Print Save

Search

Quality Assurance Manual

January 2014

ABOUT THE QUALITY ASSURANCE MANUAL

The Idaho Transportation Department's Quality Assurance Manual contains the Department's Quality Assurance Program which is comprised of the Acceptance Program, the Independent Assurance Program and Final Materials Certification. The Quality Assurance Program is developed in accordance with the Code of Federal Regulations, Part 637 of Title 23 and is approved by the Federal Highway Administration.

The Quality Assurance Manual is a web based manual maintained by the Quality Assurance Engineer.

In accordance with subsection 106.03 of the ITD Standard Specifications for Highway Construction, the Quality Assurance Manual is contractual on ITD contracts.

A new edition of the QA Manual will be released in conjunction with the release of each set of ITD Supplemental Specifications. The QA Manual edition and the Supplemental Specifications will be dated with the same month and year, enabling users to identify which edition of the QA Manual contractually applies to a specific project.

Prior editions of the QA Manual can be accessed on the web page.

Manual Contact Information:

Muhammad Zubery, P.E.
Quality Assurance Engineer

(208) 334-8021
muhammad.zubery@itd.idaho.gov

Summary of Edition Changes – January 2014

QA Manual

1. **Section 100.01 Conflict of Interest**
    - Rewrote section
2. **Section 230.03 Steel**
    - Updated what the certified mill test report shall include
3. **Section 230.03.02 Metal Reinforcement**
    - Added cable strand
4. **Section 230.05.01 Pre-cast Pre-stressed Concrete Girders**
    - Updated requirements for starting a new project
5. **Section 270.00 TOC**
    - Added 270.08 NCRP-350 Requirements
6. **Section 270.08 NCRP-350 Requirements**
    - Added section
7. **Section 270.30 MTR 405-8**
    - Added forms ITD-854 & ITD 769 to Surface Smoothness
8. **Section 270.40 MTR 409-4**
    - Deleted ITD-25 Standard Diary and added ITD-854 to Finished Pavement in both Acceptance Smoothness and Acceptance Final Finish
9. **Section 270.50 MTR 502-4**
    - Changed Approach Slabs to Voided Slabs and Approach Slabs,
10. **Section 270.50 MTR 503-1**
    - Changed AASHTO M31M to AASHTO M31 in Reinforcing Steel
    - Changed AASHTO M284M to AASHTO M284 in Epoxy Coated Metal Reinforcement
11. **Section 270.50 MTR 503-2**
    - Changed AASHTO M31M to AASHTO M31 in Tie Bars
12. **Section 270.50 MTR 504-1**
    - Changed AASHTO M270M to AASHTO M270 in Steel Bridge
    - Changed AASHTO M270M to AASHTO M270 in Structural Steel
    - Changed AASHTO M270M to AASHTO M270 in Steel Forgings
13. **Section 270.50 MTR 504-2**
    - Changed AASHTO M164M to AASHTO M164 in Bolts, Nuts, Hardened Washers
    - Changed AASHTO M253M to AASHTO M253 in Bolts, Nuts, Hardened Washers
    - Changed AASHTO M270M to AASHTO M270 in Structural Steel Handrail, Two Tube Curb Mount Railing, Pedestrian Bicycle Railing and Combination Pedestrian Bicycle
14. **Section 270.50 MTR 505**
    - Changed ASTM A 36M to ASTM A 36
15. **Section 270.50 MTR 512**
    - Deleted ITD-25 Standard Diary and added ITD-854 to Fill Material
16. **Section 270.60 MTR 602 - 608-1**

- Changed AASHTO M36M to AASHTO M36 in Corrugated Metal Pipe and Pipe Arches
- Changed AASHTO M196M to AASHTO M196 in Corrugated Metal Pipe and Pipe Arches
- Changed AASHTO M86M to AASHTO M86 in Concrete Pipe for Sewer, Irrigation or Drainage
- Changed AASHTO M170M to AASHTO M170 in Reinforced Concrete Culvert Storm Drain and Sewer Pipe
- Added form ITD-914 to Reinforced Concrete Culvert Storm Drain and Sewer Pipe
- Changed AASHTO M36M to AASHTO M36 in Pipe Underdrains
- Changed AASHTO M196M to AASHTO M196 in Pipe Underdrains
- Changed AASHTO M252M to AASHTO M252 in Pipe Underdrains
- Changed AASHTO M278M to AASHTO M278 in Pipe Underdrains

17. Section 270.60 MTR 602 – 608-2

- Changed AASHTO M36M to AASHTO M36 in Metal Aprons
- Changed AASHTO M196M to AASHTO M196 in Metal Aprons
- Added form ITD-914 to Metal Aprons
- Added form ITD-914 in Manhole Covers and Rings, Grates
- Added form ITD-914 in Catch Basins, Inlets and Manholes

18. Section 270.60 MTR 610-2

- Added form ITD-914 in Barbed Wire
- Added form ITD-914 in Woven Wire
- Added form ITD-914 in Chain Link
- Deleted ITD-25 Standard Diary and added ITD-914 in Metal Posts for all fence types
- Added form ITD-914 in Gates
- Added form ITD-914 in Braces
- Added form ITD-914 in Hardware for Barbed or Woven Wire Fence

19. Section 270.60 MTR 612-1

- Added form ITD-914 in Steel Rail and Fittings
- Added form ITD-914 in Metal Terminal Section

20. Section 270.60 MTR 616-1

- Added form ITD-914 in Sign Material

21. Section 270.60 MTR 616-2

- Added form ITD-914 in Steel Brackets and Brace angles
- Added form ITD-914 in Breakway Steel Sign Posts
- Added form ITD-914 in Steel Posts

22. Section 270.60 MTR 640-1

- Changed One (1) sample per lot to One (1) sample per lot (5B) in Drainage Geotextile
- Changed One (1) sample per lot to One (1) sample per lot (5B) in Riprap/Erosion
- Changed One (1) sample per lot to One (1) sample per lot (5B) in Subgrade Separation
- Changed One (1) sample per lot to One (1) sample per lot (5B) in Pavement Overlay

23. Section 270.60 MTR 640-2

- Changed One (1) sample per lot to One (1) sample per lot (5B) in Geogrid
- Updated foot notes at the bottom of MTR 640-2

24. Section 425.00 Completing the MSR

- Updated the guildlines for completing a MSR
- Added Note about Acceptance Test Strip above Table 425.1
- Updated the Postings Required in the MSR for Pre-Tested or Pre- Approved Tests on Table 425.1
- Updated the Postings Required in the MSR for Small Quantity or Non Standard Acceptance on Table 425.1
- Added Corrected Table

25. Section 590.00 ITD Sampler Tester Qualification Program

- ASTT II was added to Saybolt Viscosity on Table 1
- ASTT II was added to Bituminous Coating on Table 1
- ASTT II was added to Hveem Stability on Table 1
- ASTT II was added to Effect of Water on Compressive Strength of Compacted Bituminous Mixtures on Table 1
- ASTT II was added to Preparation of Test Specimens for Cal. Kneading Compactor on Table 1
- DTT was deleted and ASTT or ASTT II was added to Density of In Place HMA Pavement by Electronic Surface Contact Device on Table 1
- Changed AASHTO TP-68 to AASHTO T-343 in Density of In Place HMA Pavement by Electronic Surface Contact Device on Table 1
- ASTT II was added to Bulk Specific Gravity and Density of Compacted Hot Mix Asphalt (HMA) using Automatic Vacuum Sealing Method (Corelok) on Table 1
- ASTT II was added to Field Sampling Bituminous Material after Compaction on Table 1
- AASHTO T-106 was added to Concrete on Table 1

SECTION 100.00 – QUALITY ASSURANCE PROGRAM INTRODUCTION

SECTION 100.00 – QUALITY ASSURANCE PROGRAM INTRODUCTION

The Code of Federal Regulations, Part 637 of Title 23, specifies all state highway agencies, which includes the Idaho Transportation Department, shall develop a quality assurance program. The program will assure that materials and workmanship incorporated into each federal-aid highway construction project on the NHS are in conformity with the requirements of the approved plans and specifications, including approved changes. The program must be approved by the Federal Highway Administration and must contain certain elements identified in the federal regulation.

The ITD Quality Assurance Program has been approved by FHWA and will apply to all projects, whether federal-aid or state funded. The ITD QA program contains the three required elements; namely, the Acceptance Program (Section 200.00), the Independent Assurance Program (Section 300.00), and the Project Materials Certification (Section 400.00).

The ITD Quality Assurance Program defines three levels of evaluation.

1. Quality Control (Producer)

   Quality control of construction materials is the responsibility of the contractor and is performed during the production of the material and/or at the point of delivery. The test results provide information to substantiate the uniformity of the material as it is produced and the conformity of the product to specification requirements. A useful tool in quality control is the control chart or run chart. It charts each test result on a graph that shows the average, the variation about the average, and any change in the process during production.

2. Acceptance (Buyer)

   This level of evaluation encompasses all factors that comprise ITD's determination of the quality of the product as specified in the contract requirements. In addition to inspection, these factors include:

   - For specification items in the contract using QC results for acceptance, verification sampling and testing must be performed. If QC results meet specified verification result guidelines, then QC results are used for acceptance.

   - For the remainder of the specification items in the contract, ITD is responsible for acceptance sampling and testing.

   The results of acceptance evaluation are used by ITD to accept, reject, or accept at a reduced rate the material represented by the tests.

3. Independent Assurance

   Independent assurance is an unbiased and independent evaluation of all the sampling and testing procedures used in the acceptance program. It is a procedure and equipment check and is not directly a part of acceptance or rejection of a product.

100.01 Conflict of Interest.

In order to avoid an appearance of a conflict of interest, any non-ITD laboratory is allowed to perform only one of the following types of testing on the same project:

- Verification testing
- Quality control testing
- Acceptance Testing
- IA testing
- Dispute resolution testing

All levels of testing by the contractor or his designated laboratories to control the quality of a product are considered quality control testing. When properly verified by Quality Assurance testing, quality control test results may be used for acceptance of material when specified in the contract.

The laboratory performing quality control testing is allowed to prepare mix designs for the same project as long as they meet the requirements of section 225.00 of the Lab Operations Manual.

The laboratory performing verification testing is allowed to prepare mix designs for the same project as long as they do not perform quality control testing, IA testing or dispute resolution testing and meet the requirements of section 225.00 of the Lab Operations Manual.

The Federal law specifies no laboratory may perform both Quality Control and Quality Assurance testing for the same construction project.

110.10 Quality Assurance Specification Team. In 1996, an ongoing Quality Team was formed to implement Quality Assurance within the Division of Highways. The team was formed to oversee implementation of Quality Assurance measures in accordance with the CFR and to ensure the quality of materials and construction on Idaho's roadways by partnering with contractors.

In spring of 2003 the team was reestablished and renamed the Quality Assurance Specification Team. The Highways Program Oversight Engineer will serve as the team's executive sponsor to accomplish the following charge:

> To provide continued development and improvement of the Department's Quality Assurance specifications, measures and programs to assure quality materials are incorporated into ITD projects.

Team members are appointed by the Highways Program Oversight Engineer based on knowledge and experience and consist of HQ and District representatives from Materials, Training and Construction; an FHWA member, and representatives from the consultant and contracting communities. Contracting members will be recommended by the Association of General Contractors and consulting members will be recommended by the Association of

Consulting Engineers, each to serve for 4 years. Materials Engineers and Regional Engineers will be rotated every 4 years. Reappointments will be allowed based on expertise and interest.

The Quality Assurance Specification Team will have authority for establishing, maintaining and promoting Quality Assurance Specifications and programs for the Department.

SECTION 240.00 – PRE-TESTED AND PRE-QUALIFIED MATERIALS

SECTION 200.00 – ACCEPTANCE PROGRAM

In order to implement the quality assurance elements outlined in Section 100.00, the Acceptance Program must provide a frequency guide, identify the location, and identify specific quality attributes for sampling and testing. Section 270.00 contains this information for each contract bid item and the ITD Quality Assurance Special Provision (QA SP) has this information for bid items under the QA SP.

Quality control sampling and testing results may be used as part of the acceptance decision provided the following requirements are met:

- The contract must identify a particular specification item as an item for which contractor test results may be used in the acceptance decision.
- The sampling and testing must be performed by qualified laboratories and qualified sampling and testing personnel.
- The quality of the material must be validated by verification sampling and testing performed independent of the quality control samples.
- The quality control sampling and testing must be evaluated by an IA program.

If the results from the quality control sampling and testing are used in the acceptance program, then there must be a dispute resolution system established.

Dispute Resolution System:

When quality control and quality assurance test results conflict and the conflict cannot be resolved, a neutral Dispute Resolution Laboratory will test the material in question. The test results of the Dispute Resolution Laboratory will be considered the final actual test results, replacing the disputed testing for project use.

HQ Central Laboratory will perform all dispute resolutions unless a potential for conflict of interest exists or the contractor requests an independent laboratory.

200.01 Specifications Compliance and Expenditure of Public Funds. The specifications and plans provide an equitable basis for bidding by contractors. They define the minimum requirements that must be met. The contractor commits to furnishing materials and completed work that will equal or exceed such requirements.

The engineer must be satisfied, through quality assurance measures, that the public is receiving what it is entitled to under the contract. Nothing less should be accepted. To do so is not only a disservice to the state, but would be giving undue advantage to the contractor. Other contractors who bid on the same work could contend that they would have offered a lower bid had they been able to anticipate that materials or work outside of specifications would be accepted.

When payment is made to the contractor for materials furnished and work performed, the duly designated state officials must authorize disbursement of public funds for this purpose. Through the quality assurance program, the Resident Engineer and the project staff will acquire substantiating data in the form of tests, inspection records and measurements to justify acceptance of the contractor's work. Thus, the engineer can be assured the contractor has fulfilled the contract obligation and is entitled to payment. The Resident Engineer will withhold payment to the Contractor for any material where the required acceptance sampling, testing, and/or certification have not been accomplished.

In case of failure to meet the requirements, the quality assurance program data will constitute the basis for rejection of work deemed unfit for acceptance or it may be the basis for acceptance of the work upon appropriate contract price adjustment where this is permitted under the provisions of the specifications.

Complete records, including tests and inspection reports covering acceptance or rejection of any materials, are kept in the project files while required copies are distributed to other offices as needed for review and documentation. The Resident Engineer is responsible for compiling the records to provide a materials inspection summary for each project. Reference Section 400.00, Project Materials Certification, for instructions for compiling the materials inspection summary. The materials inspection summary is used to complete the Materials Certification letter for each project.

200.01.01 Semi-annual Status Report. The District Materials Section shall monitor the Districts' progress on a semi-annual basis and provide the Chief Engineer with reports of deficiencies. Deficiencies are defined as:

1. Payment for out of specification material
2. Payment for material that was not sampled, tested, or certified as required by the specifications
3. Failure to perform, or a lack of, Independent Assurance testing
4. Failure to submit the Materials Summary Report and the Materials Certification letter to the Chief Engineer within sixty (60) days from the District Engineer's final acceptance of the project

200.02 How the ITD Acceptance Program Applies to Various Types of Projects. The ITD Acceptance Program applies to all projects; however, the requirements are met according to the type of projects as shown in table 200.1. There could be circumstances where more than one project type is included in a single contract. In these cases, the acceptance will be determined by the specifications that govern each contract item.

For example, an ITD contract awarded by ITD Roadway Design could contain several contract items for constructing a local roadway or building, such as an interpretive center, which are covered by local building codes in the contract. The local jurisdiction is responsible for the inspection and acceptance of the items. At the completion of the work, the local jurisdiction must provide a letter to ITD stating the contract item met the contract specifications.

Table 200.1

Type of Project	Awarded By	Type of specifications	Materials Inspection & Acceptance	Materials Certification	Final ITD Acceptance
ITD Contract	ITD Roadway Design	ITD Standard Specifications	ITD Project Personnel per ITD QA Manual	Resident Engineer per Section 401.00	District Engineer per Section 401.00
ITD Contract	ITD Roadway Design	Public Works Specifications	Out-source to consultant inspection per contract specifications	Resident Engineer per Section 401.00	District Engineer per Section 401.00
Local Agency Enhancement	Local Agency	Public Works or Local Specifications	Local Agency per contract and specifications	Local Agency provides letter to ITD District Engineer	District Engineer provides Final Acceptance after Final Inspection.
Local Agency Off-System Highway	Local Agency	ITD Standard Specifications	Local Agency per ITD QA Manual.	Local Agency provides letter to ITD District Engineer	District Engineer provides Final Acceptance after Final Inspection.

200.02.01 Rest Areas and Buildings. Rest Area and Building projects that have contract items with acceptance requirements that are not ITD specifications will require the following:

1. The Architect of Record will issue a letter of acceptance based on field inspections and approval of required contract submittals for items governed by the Architectural Special Provisions. A copy of the inspections and approvals must be included with the letter.
2. Documented inspections by the Department of Building Safety for the applicable components.
3. Concrete governed by non-ITD specifications will require additional acceptance by:
    a. Visual observation by Department field inspection personnel of Contractor field quality control sampling and testing for proper testing methods and procedures. Actions taken pertaining to Contractor field quality control sampling and testing activities will be recorded in the Construction Diary.
    b. The Department will perform field tests for air, slump, unit weight and temperature from the same truck as every companion test cylinder set is made.
    c. The contractor shall provide companion test cylinder sets to ITD for acceptance testing at the concrete sampling frequency required by the contract

2) Metal reinforcement bar governed by non-ITD specifications will require additional acceptance by Department field inspection personnel in accordance with the Quality Assurance Manual, Section 270.00 Minimum Testing Requirements for 503 Metal Reinforcement.
3) Acceptance and documentation for items with the requirements contained in the Idaho Standards of Public Works Construction (ISPWC) will be accepted by manufacturer's certification referencing the ISPWC specifications. Project inspection and acceptance of ISPWC items will be out-sourced by the owner (ITD or Local Agency).

Items that are not ITD specifications will be exempt from the ITD Quality Assurance Manual Independent Assurance requirements.

SECTION 210.00 – INSPECTION AND TESTING RESPONSIBILITY

Inspection personnel assigned to a project are responsible for the day to day inspection of all portions of the work or materials entering into the work. It is their responsibility to see that all material going into the work has been inspected, tested and approved. Certification of some material is allowed. Reference Section 230.00 for specific directions for accepting material by certification.

All testers and inspectors must be properly qualified in accordance with ITD specifications and policies. Sampling, testing and inspection personnel are expected to know which materials must be sampled, when and where samples must be taken, the size of samples required, the proper methods of obtaining samples and methods of field testing.

The ITD Standard Specifications for Highway Construction state the required sampling and testing methods or the required standard practice methods. Methods include, AASHTO, ASTM, Idaho Standard Methods, etc.,. The QA Manual contains WAQTC FOPs, Idaho FOPs, and Standard Procedures (section 275.00) that modify certain methods. The modifications in the QA Manual govern over the methods shown in the standard specification. The Standard Procedures (section 275.00) govern over the WAQTC FOPs.

Diligent inspection of the work in progress and of each successively completed portion is important. There must be assurance that when the work is finished, all parts will be acceptable. No amount of sampling and testing can give this assurance without documented observations at the same time.

210.01 Inspection and Testing at the Project Site. The project inspector must identify and check all materials received on the project before they are incorporated into the work and must ascertain that acceptable test and inspection reports are available for all items inspected by others, as well as project personnel.

Test reports must show the tester’s printed name and qualification number and be initialed or signed by the tester.

All individuals that sign the Checked By box or certify the test results on any materials testing report must have been qualified in the appropriate Sampler / Tester area at one time or be a licensed Professional Engineer in the State of Idaho. This individual can have an expired qualification or license, but cannot have suspended Sampler / Tester qualifications or license.

Materials that have been inspected by other than project personnel must be reexamined for any damage or contamination that may have occurred subsequently, or for any defects that may not have been observed in the original inspection. Defects or contamination, unless satisfactorily remedied, may be cause for rejection in spite of prior approval.

All materials received on the project without prior inspection and approvals are to be inspected by the project inspector and, if required, sampled and tested. The contractor shall be immediately notified if the material has not been inspected and is not approved. If the required tests cannot be made at the project, appropriate samples are to be sent to the District or HQ Central Laboratory for testing. Upon notification of the test results, the material will be approved for use or rejected and the contractor promptly notified. The project inspector must know the appropriate options for disposition of any rejected or failing material and fully document the action taken.

Fabricated items accepted by certification should be visually inspected. See Section 230.00 for additional discussion on products or items accepted by certification.

Along with examining and checking all materials brought onto the job, the inspectors should maintain a continuing visual inspection of the contractor's operations where the materials are handled and incorporated into the work. Any procedures that result in damage or change in any material to the extent that it will fall outside the specification limits should not be permitted to continue and the materials so affected should be rejected or the defects satisfactorily remedied.

210.02 Inspector Safety. Sampling and testing procedures may involve hazardous materials, operations, and equipment. The inspector should be aware of safety hazards and comply with established safety procedures. ITD safety policies reinforce the necessity of protective clothing and equipment when working around construction equipment and machinery. OSHA regulations must be followed for non-ITD personnel on the project site. The contractors are responsible for providing a safe working environment and a safe means of obtaining random samples. ITD has the responsibility of stopping any unsafe operations until corrective action is taken.

When there is a safety concern for the sampler, ITD will allow the contractor, due to familiarity with their equipment or operation, to obtain the sample, however a WAQTC qualified sampler must always observe the sampling.

The sampling and testing technicians must limit the weight of aggregate samples to no more than 40 lb. (18 kg) per sack or bucket.

SECTION 215.00 – MATERIALS OR WORK FAILING SPECIFICATIONS

In case a sample does not meet specification requirements, the options for the material are:

- Rejected or removed when incorporated
- Accepted with a price adjustment when allowed to remain in place
- Corrected or remedied by the contractor and re-tested

Failing material that has not been finally incorporated into the work and can be remedied by further processing may be accepted after having been corrected.

If completed work is found to contain material that is not within specifications, a determination shall be made of the extent of the nonconformance with specifications, the limits of use of non-conforming material, and if it is feasible to be remedied.

The action taken shall be fully documented by the project inspector or tester for the project file by reports, records covering samples, tests, measurements, and corrective action taken if any. The Resident Engineer is ultimately responsible that disposition of the failing material is fully explained, including justification for acceptance, removal, or price reduction. Reference Standard Specifications Section 105.03.

215.01 Check Tests. Check tests are performed immediately following a failing acceptance test to verify the material does, or does not, meet specifications.

Where appropriate (compaction testing, for example), when a failing test result is verified with a check test, additional testing should be done to define the boundaries of the unacceptable material for corrective treatment.

In all cases, if the check test results indicate the failing test results were caused by a faulty sample or faulty test, record both test results, but add comments to the faulty test data, with appropriate reference to the check test.

Documentation will be made on the field report as to the type of failure, the corrective action taken to get the material back within specifications, and the disposition of the failing material. Include a full explanation of where the failing material was wasted. After corrective treatment, retesting is required to document acceptability.

215.02 Price Adjustments for Non-compliant Materials or Products. Non-compliant (failing or out of specification) material will be rejected / removed, or remedied by the contractor, before payment is made to the contractor. However, if it is not feasible to remove or remedy the non-compliant material incorporated into the project, a price adjustment must be made to the contractor. The contractor will not be paid full contract price for non-compliant material.

There are certain materials as listed below that are subject to price adjustments when laboratory tests indicate the materials have failed the required specifications. All other non-specification material is handled as allowed by the Standard Specifications, Minimum Testing Requirements (Section 270.00) or contract documents.

The magnitude of the price adjustment, expressed as a percentage, will be based on the extent of deviation from the specifications as indicated from test results. The price adjustments are shown in the ITD Laboratory Operations Manual.

The determined price adjustment percentage will be applied to the quantity of material that is represented by the non-compliant test results. The cost amount of the price adjustment will be calculated by the Resident Engineer's office using the actual invoice cost of the product, excluding freight, from the Contractor. The following materials or products are subject to price adjustments:

- Portland Cement
- Fly Ash
- Waterborne Traffic Line Paint
- Coating Systems (All formulas)
- Liquid Deicer
- Performance Graded Asphalt Binder
- Emulsified Asphalt
- Geotextiles

SECTION 220.00 – SAMPLING PROCEDURES

Samples will be taken in accordance with the procedures required by the specifications and will be taken concurrently with the project operations or from actual material delivered to the project. When required by the contract, a stratified random method will be used to obtain samples.

The individual taking the sample must have the appropriate ITD STQP qualification.

Standard methods of sampling are set forth in the specifications and in this Quality Assurance Manual for nearly all materials. The District and HQ Central Laboratory are resources for guidance when a standard method of sampling is not available.

220.01 Sample Size. The required size of a sample for the various tests on a given material is usually stated in the standard method of sampling. These sample sizes should be considered as minimums to avoid any deviation due to sample size alone.

When samples of materials are taken for testing by the ITD District or HQ Central Laboratory, the samples are to be of the prescribed size and shipped in the specified type of container in accordance with Table 220.1. Consulting or independent laboratories may require slightly modified sample containers; however, the samples must be adequately protected and handled to maintain the sample's condition prior to testing.

220.01.01 Improper Sampling. Any sample received that has not been properly sampled will not be tested. The laboratory will immediately notify the Resident Engineer and the sampler. Another sample must be obtained as soon as possible to replace the rejected sample. Lack of required samples is a project deficiency.

The laboratory will document the improper sampling for the project files by creating a test report with a note to indicate the sample was improperly taken. The test report will be distributed as usual with one copy forwarded to the District IA Inspector. The District IA Inspector, will complete a buff colored IA evaluation form, obtain resolution and distribute according to the usual procedures, including a copy submitted to the ITD Sampler / Tester Qualification Committee (STQC) for action.

Quality Control, Acceptance, and verification samples shall not be collected at the same location. They must be taken independent of on another.

220.02 Frequency of Sampling. The frequencies at which samples are taken will conform in general to the Minimum Testing Requirements (MTRs Section 270.00). The frequencies include fractions of quantity and are minimums. When the minimums are not met, this will constitute a deficiency on the project that could impact payment to the contractor or funding to ITD. Every effort should be made by ITD project personnel and the contractor, when sampling is the responsibility of the contractor, to meet the daily minimum frequency and fraction thereof, thus ensuring adequate samples are taken for the total quantity of material used/paid.

Reliance should not be placed wholly on the results of sampling and testing in determining the acceptability of the materials and construction work. The sampling and testing should be supplemented by sufficient visual inspection of the materials as a whole to ascertain whether the samples and tests are reasonably representative of the entire mass of material. In addition, there should be sufficient observation of the actual construction operations and processes to ascertain whether they can be expected to consistently produce uniform satisfactory results.

220.03 Numbering Samples. Field tests will be numbered consecutively starting with test number 1 for each contract item. When more than one type of field tests are performed for the same contract item, multiple series of test numbers will be necessary. For example, gradation tests and compaction tests are required for aggregate base. Numbers 1 to 100 could be assigned to gradation tests and numbers 101 to 200 could be used for the compaction tests. Test numbering must be consecutive to verify tests were not skipped or not recorded.

220.03.01 Numbering Check Tests. Circle failing test numbers on the test result form, along with the failing test result. A check test will be performed and numbered as follows:

> Aggregate Gradation: Perform the check test immediately. If the check test fails, material is considered failing and subject to rejection. Note the location where failing material is disposed. The sample numbering will continue sequentially with each test and check test. Add a remark on the check test report to indicate the test is a check test.
>
> Compaction: Perform the check test after there has been additional compaction effort and/or remedial efforts, such as drying out or reprocessing the material. The check test will be taken within 10 ft. (3 m) of the original test and at the same elevation. The sample numbering will continue sequentially with each test and check test. Add a remark on the check test report to indicate the test is a check test. Continue retesting until material passes or reject the material and note the location where failing material is disposed.

220.04 Transporting Flammable and Hazardous Material Samples. The following is general information for reference to more fully comply with the shipping regulations. Local conditions and/or regulations may vary and should be complied with when shipping flammable and/or hazardous materials.

U.S. POSTAL SERVICE - Flammable materials [flashpoint below 101°F (38°C)] cannot be shipped by air mail but can be shipped by surface mail if properly labeled, packaged, and certified. Combustible materials [flashpoint between 101°F (38°C) and 200°F (93°C)] can be shipped by air mail when properly packaged, labeled, and certified.

BUS (GREYHOUND) - All flammable and hazardous materials are prohibited – specifically mentions paints. Includes all flammable, combustible, corrosive, and/or caustic materials.

AIR FREIGHT - Flammable materials can be shipped by most air freight companies but must be properly packaged, labeled, and certified. Need to know exact chemicals involved, flashpoints, etc.

UNITED PARCEL SERVICE - Shipping of flammable materials is allowed under certain conditions depending on the exact chemical and amount. Packages must be labeled with a flammable sticker and a Hazardous Materials label filled out. The information for the Hazardous Materials label can be obtained by:

- Calling UPS and exactly identifying the chemical to be shipped

OR

- Referring to the UPS handbook, which gives hazard codes, packaging instructions, and certificates required for shipping

In addition to the foregoing, nuclear densometers and nuclear asphalt content gauges have special shipping requirements. If help is needed in arranging for transportation of these devices, contact the Central Laboratory.

Table 220.1 Materials, Sample Size and Container for Shipping

MATERIAL	MINIMUM SAMPLE SIZE	SAMPLING METHOD	TYPE OF CONTAINER[1]
AGGREGATES:			
Preliminary Base and Surfacing	400 lb. (180 kg)	All aggregates will be sampled according to AASHTO T 2 / T 248. Minimum mass of field samples will be based on the maximum nominal size of the aggregates. Samples for quality testing should be at least 60 lb. (27 kg). No single sack of aggregate shall contain more than 40 lb. (18 kg).	Canvas Sacks or 5 gal. Plastic Buckets
F.A. for Concrete	30 lb. (15 kg)		
C.A. for Concrete	55 lb. (25 kg)		
P.C.C. Pavement Design (Pit Run)	1,500 lb. (700 kg)		
P.C.C. Pavement Design (Crushed)	500 lb. (230 kg) Coarse 300 lb. (140 kg) Fine		
Base Course[2]	80 lb. (35 kg)		
Surface Course	80 lb. (35 kg)		
Cover Coat Material	60 lb. (30 kg)		
Mineral Filler	25 lb. (10 kg)		
Special Backfill	60 lb. (30 kg)		
Borrow & Granular Borrow	60 lb. (30 kg)		
Blotter	30 lb. (15 kg)		
SUPERPAVE HMA JOB MIX FORMULA (Submitted by the Contractor for Confirmation)	150 lb. (68 kg) coarse & fine aggregates according to percents of job mix formula		
	8 individual qt. (liters) of PG binder	AASHTO T 40	[1]Screw Top Can
PLANT MIX & ROAD MIX	40 lb. (18 kg)	AASHTO T 168	Cardboard Box 9" x 9" x 9"
ASPHALTS:			
PG Binder	Approximately 1 qt. (1 L)	AASHTO T 40	[1]Screw Top Can
Liquid Asphalts	Approximately 1 qt. (1 L)	AASHTO T 40	[1]Screw Top Can
Emulsified Asphalts	Approximately 1 qt. (1 L)	AASHTO T 40	[1]Plastic Jar
Anti-Strip Additive	4 oz. (120 ml)		Glass or Plastic Bottle
Building Blocks	6 Units		Bundle and Tie, Protected from Breakage
Building Bricks	10 Units		Bundle and Tie, Protected from Breakage
CONCRETE:			
Cement/Fly Ash/Silica Fume	1 gal. (4 L)	Idaho IT 143	[1]Cylinder Can
Cylinders	Set of 3	AASHTO T 23	[1]Cylinder Cans
Curing Compound	1 qt. (1 L)	Idaho IR 7	Metal Screw Top Can
Water	1 gal. (4 L)	AASHTO T 26	Plastic Bottle
Concrete for Chlorides	15 grams pulverized	Idaho IT 128	New 20-Gram Plastic Vial

[1]Standard ITD Supply Inventory item; do not re-use a sample container; all sample containers must be new. [2]If Idaho T 74 (vibrator compactor curve) is required; submit at least 100 lb. (50 kg) of material for minus 3/4" (19 mm) material and 150 lb. (70 kg) for minus 3" (75 mm) material.

Table 220.1 Materials, Sample Size and Container for Shipping (Continued)

GLASS BEADS	1- 50 lb (22.7Kg) Sack		Sack
JOINT MATERIAL	24 in. (600 mm) x full width		
LIME	1 gal. (4 L)	AASHTO T 218	Metal or Plastic
METALS:			
Reinforcing Steel (All Grades, All Sizes)	Two - 36 in. (900 mm)	Field sample from shipments delivered to project.	
Dowel Bars for Transverse Joints in Concrete Pavement	Two – Special cut by the supplier Approximately 36 in. (900 mm)		
Tie Bars for Longitudinal Joints in Concrete Pavement	Two - At least 30 in. (750 mm)	See Section 230.03.02	
Prestressing Reinforcement	60 in. (1.5 m) Length each heat number		Ship Straight (do not kink or bend)
Welded Wire Fabric	24 in. (600 mm) Square		Ship Flat
PAINT – waterborne	1 qt. (1 L)	Idaho IR 7	Plastic Screw Top Can or Lined Metal Friction Top Can
Solvent	1 qt. (1 L)	Idaho IR 7	Metal Friction Top Can
PIPE:			
Galvanized Coating (Steel Sheet)	2 in. (50 mm) Square	AASHTO M 36	Cardboard Box
SALT	10 lb. (4.5 kg)	ASTM D 632	[1]Plastic Wide Mouth or Cylinder Can
SEALANTS (SILICONE)	1 qt. (1 L)		

SOIL & SOIL AGGREGATE MIX			
PH & Resistivity (T 288, T 289)	5lbs	AASHTO R 13	Sealed Non-Metallic Container
Soil Classification (M145)	5lbs	AASHTO R 13	Sealed Non-Metallic Container
PH & Resistivity & Soil Classification (T 288, T 289, M 145*)	5lbs	AASHTO R 13	Sealed Non-Metallic Container
'R' Value, Soil Classification, PH & Resistivity (IT 8, M 145*, T 90, T 176, T 288, T 289)	26lbs	AASHTO R 13	Sack/ Canvas Bag
Complete Soils Tests (IT 8, M 145*, T 99, T 180. T 100, T 176, T 288, T 289)	50lbs	AASHTO R 13	Sack/ Canvas Bag
Complete Soils Tests Plus Permeability (IT 8, M 145*, T 99/T180,T 100, T 176, T 288, T 289, T 215)	100lbs	AASHTO R 13	2 Sacks/ Canvas Bags
Complete Soils Tests Plus Resilent Modulus(IT 8, M 145*, T 99, T 180, T 100, T 176, T 288,T 289, T 307)	100lbs	AASHTO R 13	2 Sacks/ Canvas Bags
*Note M 145 requires T 88,T 89,T 90 for Classification			
GEOTEXTILE FABRICS	At least 6.5 LF (1800 mm) across the entire width of the roll		DO NOT FOLD Geotextile Roll to Ship
FENCING:			
Barb Wire	6 LF (2 m)	AASHTO M 280	
Woven Wire	6 LF (2 m)	ASTM A 116	

Chain Link	3 LF (1 m)	AASHTO M 181
Tension Wire	3 LF (1 m)	AASHTO M 181

[1]Standard ITD Supply Inventory item; do not re-use a sample container; all sample containers must be new.

SECTION 225.00 – TESTING QUALIFICATIONS

Testing and sampling should be done strictly in accordance with the specified procedures. Standard testing procedures have been developed by organizations such as AASHTO, ASTM, AWS (American Welding Society), WAQTC (Western Alliance for Quality Transportation Construction), and ITD.

Section 590.00 is the ITD Sampler / Tester Qualification Program (STQP) and contains all the instructions for the required qualifications.

For areas not covered by STQP, qualification to the appropriate recognized standard is required. An example would be nondestructive testing related to welding inspection, which would be covered by qualification programs of the American Welding Society (AWS) and American Society for Nondestructive Testing (ASNT). The ITD District Materials Engineer, with the assistance of the Quality Assurance Engineer if necessary, will verify and document the qualification of those not covered by STQP qualification. The Independent Assurance Inspector will evaluate and document the competency of personnel qualified through STQP according to the Independent Assurance Program. See Section 590.30.

SECTION 230.00 – ACCEPTANCE OF MATERIALS BY MANUFACTURER'S OR FABRICATOR'S CERTIFICATION

Standard Specification Subsection 106.04 allows the acceptance of certain materials based on certification provided by the manufacturer or fabricator. The certification must be complete and meet the criteria as outlined in this section and such additional criteria if specified in the project contract.

230.01 General Provisions. Standard ITD certification forms will be used. The standard forms are:

- ITD-914 Steel
- ITD-849 Geotextile and Geogrid
- ITD-851 Miscellaneous Items
- ITD-966 PG Asphalt Binder
- ITD-968 Cement / Fly Ash
- ITD-875 Non-Structural Concrete

The standard forms must be completed in their entirety and be signed by the manufacturer's representative who has quality control responsibility for the manufacture or fabrication of the material.

When required by the contract, QC test results must be attached to the specified ITD standard form.

Certification does not preclude inspection, sampling, testing or verification of certified test results of the material received on the project. Project inspectors will review all certification results for specification compliance prior to accepting the material. If the certified material is found to be outside acceptable specification limits the material is subject to rejection.

Each shipment of certified material should be visually inspected for obvious defects and handling and shipping damage. Damaged or defective material will be repaired to the satisfaction of the Engineer or rejected and replaced. Also, on items where it is feasible, simple measurements of specified properties should be spot checked at least once per project and recorded to verify certification. Examples would be length, mass per unit length, or thickness of steel items.

Acceptance of material by certification will be withdrawn when sample test or inspection results show the material consistently fails to meet specifications requirements. Reestablishment of the certification acceptance may be achieved through ITD pre-testing, pre-inspection and review of historical certification records and test results of the material prior to its incorporation into a project. Additionally, the manufacturer's quality control program may require revision and reevaluation by the Department.

230.02 Certification Program Procedures for Portland Cement and Fly Ash. Cement or fly ash manufacturers approved under the ITD Cement/Fly Ash Certification Program can supply cement and/or fly ash to ITD projects by certification. HQ Central Laboratory determines which manufacturing plants have met the requirements for the certification program.

To be approved under the program the Department will evaluate the following:

- A copy of manufacturer's current quality control program
- Historical certification records and copies of all test results
- Certified Mill Analysis test reports for material delivered to ITD projects
- Verification tests on ITD project submitted samples
- Other methods deemed necessary by the Department

Once approved under the ITD Certification Program the manufacturer must continue to provide certified test results for all material produced.

If a project sample indicates out-of-specification material based on ITD verification testing additional testing may be conducted to define the extent of the problem. Price reduction or item removal will be required when specified tolerances are exceeded. In the event of continual non-conformance the manufacturer will be removed from the certification program.

230.02.01 Portland Cement. ITD will accept Portland cement by certification only from those manufacturers approved by the ITD Cement / Fly Ash Certification Program. Cement from manufacturers not approved under the certification program requires pre-testing and pre-approval prior to use.

The concrete supplier furnishing Portland cement to any ITD project from a manufacturer approved under the ITD Certification Program must provide to the project inspector at the end of each week in which concrete is placed a completed form ITD-968, Concrete Supplier's Cement / Fly Ash Certificate with the cement bill of lading attached showing the mill analysis number.

Failure to submit the completed form with the appropriate signatures will result in material rejection.

The cement manufacturer must submit certified mill test reports to the HQ Central Laboratory for all cement produced. The cement manufacturer's certified mill test reports must include:

- Name of the cement manufacture company
- Location of the cement mill
- Cement Type
- Mill Analysis Number
- Manufacturer's bin or silo number from which cement was shipped
- Mill analysis test report date and production period
- Mill analysis test results pertinent to Idaho specifications
- Certification statement indicating the cement meets all specification requirements pertinent to Idaho specifications
- Signature, Title, and date by the cement company chemist or other authorized official

The test result data will be monitored for compliance with the specifications and for the manufacturer to remain under the certification program.

Cement samples will be taken for the project in accordance with the Minimum Testing Requirements (Section 270.00) and Idaho IT-143 from the bulk tank during unload to the concrete plant silo. Samples will be immediately shipped to the Central Laboratory in Boise in moisture-proof containers. A 6" x 12" (150 mm x 300 mm) concrete cylinder container will be used for the sample, with the lid securely taped shut. The cylinder container must be completely filled and immediately sealed to eliminate excess air in the sample and to avoid moisture absorption and aeration of the sample. **Sample cans received that are not completely filled (discounting normal settling) may be rejected.**

The contractor or the supplier may take as many cement samples as they want for information only.

These samples will be tested for chemical and physical parameters to monitor production characteristics and to verify the certification.

The manufacturing companies approved by the ITD Cement / Fly Ash Certification Program to furnish Portland Cement by certification can be found on the ITD HQ Central Laboratory Intranet page or a list may be obtained from HQ Central Laboratory Section.

230.02.01.01 Cement Testing. The ITD HQ Central Laboratory will group cement samples according to the manufacturer's mill analysis numbers as the samples are received from projects. Samples with the same mill analysis number will be referenced as a mill analysis unit.

ITD's AASHTO accredited laboratory will perform a complete test on the first sample received in the mill analysis unit. The selected sample will be tested for all specification parameters. If the first tested cement sample complies with the specifications, ITD will randomly chose one cement sample from the mill analysis unit for every 4200t of cement produced in the mill analysis and perform an alkali test.

If a cement sample does not comply with the specifications, additional testing will be performed on samples from the mill analysis unit until the extent of the non-compliant material has been determined. The initial and additional test results for each specification item will be averaged and the average value for each specification item will be considered the final value. These final values will be used to determine compliance or noncompliance of the mill analysis unit.

When test results indicate the cement does not meet specifications, a price adjustment will be applied to the entire quantity of material representing that mill analysis unit. The penalty will be assessed according to Section 340.05.02 of the ITD Laboratory Operations Manual.

230.02.01.02 Cement Testing Appeal Process. The ITD HQ Central Laboratory will retain sufficient cement material from each mill analysis unit for dispute resolution.

If the contractor wishes to appeal ITD's test results and price reductions, a written appeal request must be submitted within 14 calendar days of the reported test results. The appeal must state the grounds or the circumstances of the appeal. If the test results are in question, the appeal must be accompanied by all of the quality control test results that represent the mill analysis unit in question. The appeal must also be accompanied by contractor-obtained test results for at least one complete cement test series conducted on the mill analysis in question. The state will not accept appeals when contractor test results are out of specifications.

When an appeal is accepted, the appeal testing must include all specification parameters for the material in question.

If the appeal is not accepted, ITD will submit a denial letter to the contractor, stating the grounds for the denial.

Appeal testing will be conducted by an independent, AASHTO accredited laboratory, mutually acceptable to the contractor and ITD. The AASHTO accredited laboratory will report the results to ITD. The results of such tests will be binding to both parties and any price reduction on the unit in question will be based on those test results. The contractor will agree to bear the costs of the appeal testing if the tests verify noncompliance.

230.02.02 Fly Ash. ITD will accept fly ash by certification only from those manufacturers approved by the ITD Cement / Fly Ash Certification Program. Fly ash from manufacturers not approved under the certification program requires pre-testing and pre-approval prior to use.

The concrete supplier furnishing fly ash to any ITD project from a manufacturer approved under the ITD Certification Program must provide to the project inspector at the end of each week in which concrete is placed a completed form ITD-968, Concrete Supplier's Cement / Fly Ash Certificate with the fly ash bill of lading attached showing the Sample Identification Number.

Failure to submit the completed form with the appropriate signatures will result in material rejection.

The fly ash manufacturer must submit certified test reports to the HQ Central Laboratory for all fly ash produced. The fly ash source's certified laboratory test reports must include:

- Name of the fly ash source company
- Plant Origin
- Sample Identification number
- Laboratory test report date and production period
- Laboratory test results pertinent to Idaho specifications
- Signature, title and date by the testing laboratory chemist or other authorized official

The test result data will be monitored for compliance with the specifications and for the fly ash source to remain under the certification program.

Fly ash samples will be taken for the project in accordance with the Minimum Testing Requirements (Section 270.00) and Idaho IT-143 from the bulk tank during unload to the concrete plant silo. Samples will be immediately shipped to the Central Laboratory in Boise in moisture-proof containers. A 6" x 12" (150 mm x 300 mm) concrete cylinder container will be used, with the lid securely taped shut. The cylinder container must be completely filled and immediately sealed to eliminate excess air in the sample and to avoid moisture absorption and aeration of the sample. **Sample cans received that are not completely filled (discounting minor settling) may be rejected.**

The contractor or the supplier may take as many fly ash samples as they want for information only.

These samples will be tested for chemical and physical parameters to monitor production characteristics and to verify the certification.

The fly ash sources approved to furnish fly ash under the certification procedure can be found on the ITD HQ Central Laboratory Intranet page or a list may be obtained from the HQ Central Laboratory.

230.02.02.01 Fly Ash Testing. The ITD HQ Central Laboratory will group fly ash samples according to the manufacturer's identification numbers as the samples are received from projects. Samples with the same identification number will be referenced as a mill analysis unit.

ITD's AASHTO accredited laboratory will perform a complete test on the first sample received in the mill analysis unit. The selected sample will be tested for all specification parameters

If a fly ash sample does not comply with the specifications, additional testing will be performed on samples from the mill analysis unit until the extent of the non-compliant material has been determined. The initial and additional test results for each specification item will be averaged and the average value for each specification item will be considered the final value. These final values will be used to determine compliance or noncompliance of the mill analysis unit.

When test results indicate the fly ash does not meet specifications, a price adjustment will be applied to the entire quantity of material representing that mill analysis unit. The penalty will be assessed according to Section 340.05.08 of the ITD Laboratory Operations Manual.

230.02.02.02 Fly Ash Testing Appeal Process. The ITD HQ Central Laboratory will retain sufficient fly ash material from each mill analysis unit for dispute resolution.

If the contractor wishes to appeal ITD's test results and price reductions, a written appeal request must be submitted within 14 calendar days of the reported test results. The appeal must state the grounds or the circumstances of the appeal. If the test results are in question, the appeal must be accompanied by all of the quality control test results that represent the mill analysis unit in question. The appeal must also be accompanied by contractor-obtained test results for at least one complete fly ash test series conducted on the mill analysis unit in question. The state will not accept appeals when contractor test results are out of specifications.

When an appeal is accepted, the appeal testing must include all specification parameters for the material in question.

If the appeal is not accepted, ITD will submit a denial letter to the contractor, stating the grounds for the denial.

Appeal testing will be conducted by an independent, AASHTO accredited laboratory, mutually acceptable to the contractor and ITD. The AASHTO accredited laboratory will report the results to ITD. The results of such tests will be binding to both parties and any price reduction on the unit in question will be based on those test results. The contractor will agree to bear the costs of the appeal testing if the tests verify noncompliance.

230.03 Steel. The steel fabricator must complete standard form ITD-914, Steel Certification, for each shipment of a steel product to a project. Certified mill test reports from the steel mill for all heats in the shipment must be attached to the ITD-914.

The certified mill test report shall include the following:

- Name and location of the rolling mill
- Consignee and/or destination of the shipment
- Specification
- Size
- Heat number
- Chemical analysis
- Physical tests
- Certificate number, order release number or shipment number, etc
- Signature of authorized official
- Buy America certification

230.03.01 Steel Bridge Girders. HQ Central Laboratory and/or Resource center will provide inspection during the fabrication of steel bridge girders. The district must contact HQ Central Laboratory and/or Resource center as soon as the fabricator is known so the inspection can be scheduled. The inspection may be contracted to an independent company when the fabrication is out-of-state.

HQ Central Laboratory and/or Resource center will obtain the required certifications, including form ITD-914, Steel Certification, during the fabrication of the steel girders.

HQ Central Laboratory and/or Resource center will notify the Regional Engineer by departmental memorandum when the fabrication of the girders is satisfactorily complete and accepted for delivery to the project. Copies of the inspection and certification reports will be forwarded to the Regional Engineer for the project files.

Project personnel should contact HQ Central Laboratory and/or Resource center prior to final erection of the steel girders to schedule an in-place inspection including, paint, bolting, fabrication tolerances, and field welding.

230.03.02 Metal Reinforcement. The metal reinforcement (reinforcing steel or rebar and cable strand) supplier must submit the ITD-914 and the certified mill test reports with each shipment of bars delivered to a project worksite (See Section 230.03).

Metal reinforcement (reinforcing steel or rebar) is sampled in the field by ITD personnel from shipments delivered to the project. A sample is defined as two (2) 36 inch pieces of steel cut from materials delivered to the project of the same size and heat number. Cable Strand (7 wire) one six foot sample cut from every reel. ITD Inspectors must witness or perform the sampling at the jobsite.

See Standard Specification Section 503

The two (2) additional bars which replace the field samples, if from the same heat number, will not require sampling. It is not necessary to resample any bars from a heat number that has previously been tested for the project.

In the event the same heat number is used for a long bar and a shorter bar, the shorter bar will be used for the sample to minimize the cost for the replacement bar.

Some fabricated bent bars may not have a 36 in. (900 mm) length for sampling, however, the sample bars should be submitted and the Central Laboratory will determine if a test specimen can be obtained.

Sampling of bar comprising spirals will be taken from the extra length of the spiral as required by the specifications. No cutting that would require splicing to obtain samples will be permitted.

In the event of a specialized non-standard length or size bar, the Central Laboratory should be consulted for the correct sampling technique.

Samples will be promptly shipped or delivered to the Central Laboratory within two (2) working days for testing. UPS or FedEx next day shipping is recommended when necessary. Tests will be performed to detect non-specification steel for replacement prior to incorporation into the structure. Samples must be properly tagged and accompanied by the ITD-914, ITD-1044, and the Mill Certifications

When epoxy-coated steel is specified, the coater must mark the portion of the ITD-914, Steel Certification, referring to the epoxy-coating or provide a certification statement that the coating complies with AASHTO M 284. Copies of holiday tests and coating thickness tests representing the shipment will be included. An occasional check of coating thickness will be made on the sample bars at the time of laboratory testing using a dry film paint thickness gauge.

Epoxy-coated steel is to be visually inspected for coating damage upon delivery to the project, using criteria of AASHTO M 284. It is especially important to check the outside of bends for cracking, de-bonding and rust.

230.03.03 Buy America. Buy America applies to any contract eligible for Federal Highway funding within the scope of an applicable NEPA finding, determination, or decision regardless of the funding source of such contracts if at least one contract or phase of the project is funded with Federal-aid highway funds. All permanently incorporated steel and iron materials must be certified that the steel and iron was manufactured in the United States of America including application of a coating. Certification shall be provided prior to incorporation of the materials into the project. Materials that are only used or rented during the project construction, but not incorporated into the work (temporality installed), do not require certification.

The ITD-914 form will serve as Buy America Certification and shall be signed by a person having quality control responsibility for the company that manufactures or fabricates the material. The ITD-914 will be sent with mill tests reports attached.

Small quantities of steel and iron may be accepted without Buy American Certification, so long as its total cost for the project does not exceed 0.1% of the contract amount or $2,500, whichever is greater. The total cost of steel and iron includes the cost of the material plus the cost of transportation to the project site, as evidenced by delivery receipt, but does not include labor cost involved in final assembly performed on the project site.

FHWA published a memorandum on Dec 21, 2012 to clarify FHWA's position regarding the application of Buy America requirements to manufactured products. Following is the excerpt from the memorandum:

In order for a manufactured product to be considered subject to Buy America, the product must be manufactured predominantly of steel or iron. The FHWA deems a product to be manufactured predominantly of steel or iron if the product consists of at least 90% steel or iron content, measured by weight, when it is delivered to the job site for installation. For purposes of applying Buy America and determining whether a product is a steel or iron manufactured product, the job site includes the sites where any precast concrete products are manufactured.

Examples of products that are subject to Buy America coverage include, but are not limited to, the following:

- steel or iron products used in pavements, bridges, tunnels or other structures, which include, but are not limited to, the following: fabricated structural steel, reinforcing steel, piling, high strength bolts, anchor bolts, dowel bars, permanently incorporated sheet piling, bridge bearings, cable wire/strand, prestressing / post-tensioning wire, motor/machinery brakes and other equipment for moveable structures;
- guardrail, guardrail posts, end sections, terminals, cable guardrail;
- steel fencing material, fence posts;
- steel or iron pipe, conduit, grates, manhole covers, risers;
- mast arms, poles, standards, trusses, or supporting structural members for signs, luminaires, or traffic control systems; and
- steel or iron components of precast concrete products, such as reinforcing steel, wire mesh and pre-stressing or post-tensioning strands or cables.

The miscellaneous steel or iron components, subcomponents and hardware necessary to encase, assemble and construct the above components (or manufactured products that are not predominantly steel or iron) are not subject to Buy America coverage. Examples include, but are not limited to, cabinets, covers, shelves, clamps, fittings, sleeves, washers, bolts, nuts, screws, tie wire, spacers, chairs, lifting hooks, faucets, door hinges, etc.

230.04 Concrete Pipe Products. Concrete pipe or related products (catch basins, manhole section, elbows, etc.) delivered to an ITD project will be accompanied by form ITD-851, Miscellaneous Items, completed by the manufacturer certifying that all material furnished was manufactured in accordance with the specifications set forth in the contract. All quantities and sizes included under the certification for that project shall be listed on the form ITD-851.

The ITD-851 for reinforced concrete pipe (RCP) must certify the concrete strength (psi) and the wall thickness of the pipe delivered to the project meets the requirements of the contract.

Manufacturers furnishing concrete pipe and related products shall hold current certification under the NPCA Plant Certification Program, the PCAA Plant certification program, the ACPA Q-Cast Plant Certification Program or PCI Plant Certification.

230.05 Concrete Guardrail and Other Pre-cast Concrete Products. Concrete Guardrail and other pre-cast concrete products are required by the specifications to meet Standard Specification Section 502. Standard Form ITD-851, Miscellaneous Items, will be completed by the manufacturer and all materials used will be listed.

Manufacturers furnishing pre-cast concrete products shall hold current certification under the NPCA Plant Certification Program, the PCAA Plant certification program, the ACPA Q-Cast Plant Certification Program or PCI Plant Certification.

230.05.01 Pre-cast, Pre-stressed Concrete. All manufacturers furnishing pre-cast pre-stressed concrete girders are required to hold current PCI plant certification.

Precast manufacturers are required to give the Central Laboratory or District Personnel, advanced notice before starting a new project for the State. Advanced notice will allow ITD personnel time to review items 1,2,& 3, and perform appropriate testing of items 4,5,& 6 listed below. Items 4, 5, & 6 will be obtained by ITD inspectors or during their presence.

1. Precast facility shop drawings on 22"x34", approved by State
2. Production schedule for the entire project: what is being produced on what day and a tentative timeframe for pre-pour inspections and placing of concrete
3. All Submittal information and Approved mix design
4. Aggregate samples w/ ITD-1044- to confirm Gradation
5. Cement/ Fly Ash/ Dura Slag sample w/ ITD-1044, Mill Analysis and Bill of Lading
6. Reinforcing samples – Rebar, Strand, Misc. connections/parts w/ ITD-0914, ITD-1044, and all Manufactures Mill Analysis/ Certifications

ITD will require 5 working days to review and test items mentioned above to ensure specification compliance. The time (5 working days) will start when all 6 items are received.

ITD Central Laboratory personnel will conduct Random Inspections at precast facilities to verify concrete cylinder break design release strengths before removal of forms, stressing release and the stressing of the cable strand during pre-pour operations. This will take place during each project of girder construction for the State.

Precast manufacturers are NOT to do any type of repair/ work on an ITD item until an ITD Inspector or equivalent has had the opportunity to inspect the product after it has been removed from the form. Once removed from the form, the product is to be set in the precast facilities storage area and wait for an ITD approval. The piece will be marked accordingly or communication will be made with precast facilities management.

Precast facilities are to give 48 hour notice to ITD Central Laboratory or District personnel prior to shipping items to jobsite. This will allow ITD ample time to check products in the precast yard for final inspection and sign-off. Products will have the precast facilities Quality Assurance or Quality Control initials or signature on them prior to ITD inspecting the product. Precast facility will furnish for ITD an tag or identification sticker to initial and apply to the product, signifying the State has done a final inspection and the product is ready to be loaded /or shipped.

ITD will provide on-site inspection of the manufacturing process of each girder, including acceptance field sampling and testing as required per Section 270.00 Minimum Testing Requirements. The ITD inspector will provide written acceptance of each girder to the ITD project office by interdepartmental memo. The ITD project office is required to perform on-site inspection for acceptance of the girder upon delivery to the project and throughout the installation of the girder. No member will be accepted that contains failing material.

The documentation of the samples and testing, as well as required manufacturer's certification will be collected by the ITD on-site inspector at the manufacturing plant and the originals provided to the ITD project office with the acceptance memo.

230.06 Concrete with Specified Strength 3000 psi (20.5 MPa) or Less (Including Seal Concrete). When 3000 psi (20.5 MPa) or less concrete is specified, the concrete may be accepted by certification if produced using a qualified aggregate source. Section 265.02 explains the requirements for qualification of aggregate sources. The concrete mix design must be submitted for review.

The concrete producer shall furnish a signed, completed form ITD-875 with the class and concrete mix design designation listed. ITD project personnel will provide project placement locations on the form.

The specifications require the producer or contractor to perform quality control field tests and compressive strength tests for concrete placed on the project. The test results must be attached to the ITD-875 certification

230.07 Corrugated Metal Pipe and Corrugated Plate Pipe. The supplier will furnish a completed certification form ITD-914, Steel Certification, covering the quantity of steel CMP shipped to the project. The ITD form will be accompanied by mill test reports from the pipe manufacturer for all heats of steel involved. The certification form ITD-914 will certify the galvanized coating and be accompanied with Quality Control test results from the galvanizer indicating the coating complies with the applicable specification. The appropriate AASHTO or ASTM specifications must be referenced on the form.

For aluminum corrugated metal pipe, the supplier will furnish a completed certification form ITD-851, Miscellaneous Items, from the pipe manufacturer, citing appropriate AASHTO or ASTM specifications in accordance with the contract.

Visual inspection is required at the job site to check for obvious defects, including damage in handling and shipping. Coated or bare galvanized pipe must always be checked for damage or visible gaps in the protective layers.

Bituminous coating must be verified by field inspection.

230.08 Plastic Pipe. The supplier will furnish a completed certification form ITD-851, Miscellaneous Items, from the pipe manufacturer, citing appropriate AASHTO or ASTM specifications in accordance with the contract. Final acceptance is subject to visual inspection for damage in shipping or handling or other obvious defects.

230.09 Geotextiles and Geogrids. The contractor shall furnish the manufacturer's certified test results and the completed form ITD-849, Manufacturer's Certification of Geotextile & Geogrid, covering the quantity furnished to the project.

- The documentation and sampling for ITD will be in accordance with Standard Specification Subsection 718.02 and 718.03 for geotextiles; the contract special provisions for geogrid (See also Section 270.60, MTR Section 640).
- Silt Fence; see Section 270.10, MTR Section 212-1.
- Pavement Fabrics; see Section 270.30 MTR, Section 405.8,and Standard Specifications 718.02 and 718.08
- For handling and Dispute; see Standard Specifications Section 106.06 and 106.07

Follow the procedures mentioned below to ship the samples.

Geotextile: Placing multiple samples in a capped tube is acceptable and preferred as follows.

1. Fold the sample to match the uncut selvedge edges.
2. After rolling the first sample, place the documents under the outside layer.
3. Use a paint pen (silver is preferable) to identify the sample with key #, pay item # and sample #.
4. Roll the next samples on over the previous ones.
5. Shipping is available on the contracted freight trucks between the District Supply Offices and HQ. Tubes are returned to the district of origin.

Geogrid:

1. Fold the sample to match the uncut selvedge edges.
2. Roll the sample from the fold and tie as necessary.
3. Place the required documents securely under the outside layer.
4. Ship as above.

230.10 Performance Graded Asphalt Binder. The supplier will submit, on a yearly basis, a Process Control Plan (Quality Control Plan) to the HQ Central Laboratory for Performance Graded Asphalt Binder.

Reference Section 255.00 for complete information on performance graded asphalt binder.

Anti-strip additives must be approved prior to use, see Section 240.02.

230.11 Emulsified Asphalt. The supplier will submit, on a yearly basis, a Process Control Plan (Quality Control Plan) to the Central Laboratory for emulsified asphalt.

A supplier's bill of lading will be furnished to the inspector with each load of liquid asphalt or emulsion supplied to the project. The bill of lading must contain the following information in accordance with Standard Specification Section 702.05 and 702.08:

- Date of delivery, project number, key number, county, bill of lading number, and name of customer.
- Product identification, tonnage, truck/trailer number, specific gravity, Saybolt viscosity for emulsified asphalt, and signed certification statement.
- Supplier's name and address, phone number.

ITD project inspectors will sample only undiluted emulsified asphalt (As received from the Supplier.) for verification testing in accordance with the individual bid schedule items in Section 270.00 Minimum Testing Requirements.

ITD project inspectors will perform field viscosity testing on sealcoat emulsions as required by the Minimum Testing Requirements in Section 270.00 from the truck on the project site or at a location as close to the project as practical. The contractor must provide a safe means for obtaining the emulsion samples, including but not limited to fall protection, heat resistant clothing and gloves, etc.

230.12 Seeding. For Contractor Furnished Seed, the contractor must provide official certification tags with tests results for each seed species and verify it meets the contract specifications. The contractor shall verify the company or person(s) providing the seed must hold a valid Idaho Seed Dealer's License issued for the current year and must meet all provisions of the Idaho Pure Seed Law. A seed certification tag and test results issued from a member of Association of Official Seed Certifying Agencies (AOSCA) or state seed laboratory must be provided and validate seed has been tested within the current year prior to acceptance. The official AOSCA tag or report must accompany each species and be submitted to the engineer at least sixty (60) working days prior to seeding. The official tag or report must indicate seed classification, seed germination rate and purity, lot number, number of weed seeds, number of noxious weed seeds, and number of crop seed. All restricted, prohibited and noxious weed seed found during testing shall be displayed in an official AOSCA tag or report. All seed bags (ITD or contractor supplied) must have the analysis (certification) tag attached and secured to each bag or container.

No additional seed tests are required for ITD supplied seed, if the project meets all of the following parameters:

> Project has two acres or less to be seeded, project is using seed from district stored seed inventory, seed to be used has original certification tags attached to the bag(s), seed tag indicates seed tests were conducted within one year from the date of seeding or seed was tested at ISDA for purity and germination rates within one year of the date the project will be seeded.
>
> Seed samples are taken and tested to verify seed germination rate and purity, and contains no noxious weeds. Seed germination and purity can be drastically reduced between the time it is originally tested and when it is actually seeded. For this reason we request seed to be tested 6 weeks prior to seeding. If there is inconsistency with seed germination and/or purity information on the tags and the current test results we can adjust the seeding rates in the field to obtain optimal seed germination and increase the success rate.

One random sample from unblended and individually packaged seed containers from each species and each lot will be obtained and placed in a one-gallon size heavy duty zipped plastic bag (See note 1). The samples will be submitted to the Idaho State Seed Laboratory, for analysis and verification. The sample should not be taken from the top layer of the container. Send the completed ITD-1044 form to the test lab with a copy of the seed certification tags and the seed samples. Refer to the instructions for the ITD-1044 so all required information is included. Allow thirty days for testing and receiving official test results. The test results must show the seed meets the contract specifications prior to seeding. ISDA will email the test results to the Resident / Regional Engineer and copy the HQ Roadside Program Manager. After receiving the test results, contact the Roadside Program Manager for acceptable purity and germination limits and acceptable seeding rates prior to seeding. The test lab will return all useable seed if the Resident / Regional Engineer's address is shown on the ITD-1044.

Address: Idaho State Seed Lab
2240 Kellogg Lane
Boise, ID 83712

Note 1: Fill the one-gallon bag approximately half full for medium seed species including wheatgrasses, squirreltail, and wildrye (150 g). Fill the one-gallon bag approximately full for large seed including grain, Lupines, Biscuitroot, Bitterbrush and similar size seed, as well as Brome species and Woods Rose (550 g). Fill the one-gallon bag approximately one-quarter full for small seed species including fescues, saltgrass, alfalfa, clover, and blue flax (70 g). Fill the one-gallon bag approximately one-eighth full for very small seed species including bluegrasses, penstemon species, sagebrush, rabbitbrush, globemallow, and yarrow, (40 g). All other large seed types require a full one-gallon bag. For species not covered here, refer to ISDA website for specific species sample weights:
http://www.agri.state.id.us/Categories/Laboratories/Seed/sampleWeights.php

The State Seed Lab will bill the Resident / Regional Engineer for the testing. Contact the District Business Manager or District Records Inspector for charging the costs to the project.

230.13 Miscellaneous Items Accepted by Certification. Certification of miscellaneous materials is acceptable as defined in this section.

230.13.01 General Provisions. In addition to the materials discussed individually in Section 230.00, the following miscellaneous items may also be accepted on the basis of the manufacturer's or fabricator's (not the supplier unless the supplier is also the manufacturer) certification, using form ITD-851 and signed by the manufacturer's representative who has quality control responsibility, that the material was manufactured in accordance with and meets specification requirements. Each certification must detail the quantity of material furnished to the project under that certification. Laboratory test reports will also be furnished where applicable (steel mill test reports, wood preservative treatment reports, for example).

230.13.02 List of Miscellaneous Materials Accepted on the Basis of the Manufacturer's or Fabricator's Certification. Table 230.1 lists miscellaneous items that may be accepted by certification. The manufacturer's or fabricator's certification will not preclude the sampling and testing of the material or its final acceptance or rejection on the basis of the test results. Project samples are to be taken, as indicated in the Minimum Testing Requirements (Section 270.00) for verification testing. Samples may also be taken and tested at the option of the Materials Engineer or Regional Engineer.

Visual inspection for obvious defects and handling and shipping damage should always be done. Also, on items where it is feasible, simple measurements of specified properties should be spot checked at least once per project and recorded to verify certification. Examples would be length, mass per unit length, or thickness of steel items.

Table 230.1 Miscellaneous Materials Accepted by Certification

Material	Standard Specification Subsection
Bearing Pads and Plates	507
Brick and Blocks, Masonry	Miscellaneous
Bridge Rail, Metal	504
Concrete, Rapid Set	Special Contract Provision
Delineators and Mileposts	617
Dowel Bars and Tie Bars for Concrete Pavement	409, 503, 510, 609, 611
Dust Oil	Miscellaneous
Electrical	Miscellaneous
Epoxies	Miscellaneous
Epoxy Patch	Miscellaneous
Guard Rail and Posts	612
H-Beam Piles	505
Illumination Poles and Bases	619
Joint Sealants and Sealers	409, 502, 625
Paint (only small quantities less than 25 gallons (100L))	504, 505, 627
Sewers (Storm and Sanitary)	605
Signs and Posts	616
Steel Shell Piling	505
Structural Bolts	504
Timber (Structural)	609, 612, 616
Traffic Signal Poles and Mast Arms	656

SECTION 240.00 – PRE-TESTED AND PRE-QUALIFIED MATERIALS

240.01 Pre-tested Materials. The following materials require pre-testing prior to acceptance on a project.

- Traffic Line Paint
- Glass Beads
- Curing Compound

The ITD project personnel must verify the material/product is approved prior to use on a project. Those materials/products deemed acceptable will appear on the pre-approved list found on the ITD HQ Central Laboratory Intranet page or a list may be obtained from HQ Central Laboratory.

240.01.01 Bulk Material/Products Sampled at the Manufacturing Plant. A major portion of the pre-tested products are sampled at the manufacturer's plant for bulk production. The HQ Central Laboratory is responsible for obtaining the samples at the plants and testing such material.

240.01.02 Materials/Products Sampled at the Project. ITD project personnel must obtain samples, or at least witness the sampling, at the project site when the lot/batch of traffic line paint, glass beads, or curing compound is not shown as pre-tested or pre-approved.

The samples will be obtained from the material delivered to the project and sent to the ITD HQ Central Laboratory for testing. Allow 30 days for the testing. The testing must be accomplished prior to use of the material/product on a project. The sample must be properly identified with date sampled, sampler's name, the product & manufacturer, and the lot or batch number.

240.02 Pre-qualified Materials. The Division of Highways has established a Qualified Products List (QPL) to formalize the process for the use of pre-qualified products on ITD highway projects. The list of pre-qualified products is disseminated via the Department's official web site to department staff, materials suppliers, manufactures, consultants, and contractors.

QPL products still need the appropriate tests and certifications as required by the contract in order to be accepted on the project.

The QPL is administered by the Product Review Committee (PRC). Activities of the PRC are coordinated by the QPL Program Administrator. Details of the QPL program are described in Section 900 of the Department's Materials Manual.

Documentation (such as a printout of the QPL page showing approval of the item) shall be placed in the project files and posted in the MSR for QPL items that were on ITD's QPL at the time of the project.

SECTION 250.00 – ACCEPTANCE OF MATERIAL ON THE BASIS OF THE RESIDENT ENGINEER'S LETTER OF INSPECTION (FORM ITD-854)

The purpose of form ITD-854, Resident's Letter of Inspection, is for the Resident Engineer to document the inspection of certain materials and to document the materials are acceptable according to the plans and specifications. In most cases, the inspection of the installation of these items is the most crucial element of the acceptance. The form should not be used as a catchall for items usually accepted by sampling and testing, and inclusion on the form does not excuse the inspector from sampling and testing or obtaining manufacture certifications required by the Minimum Testing Requirements.

The ITD-854 must provide accurate information of the total quantity of material accepted, the source of the material, and the date of the inspection/acceptance of the material. The project files should contain documentation to support the information on the form. The source should identify the manufacturer or fabricator, whenever possible, for future information regarding the material.

The Section 270.00, Minimum Testing Requirement (MTR) tables list materials accepted by the ITD-854. The specifications should be referred to for a complete description of the necessary inspection elements for acceptance of each item. The Resident Engineer signs the ITD-854 documenting that the items listed on the form have been inspected for acceptance and the required material documentation is in the project item file.

SECTION 255.00 – PERFORMANCE GRADED BINDER QUALITY ASSURANCE PLAN

The PG binder supplier will conform to quality control testing and certification requirements in accordance with Subsection 702.08 of the Standard Specifications. The Supplier will be accredited through the AASHTO Material Reference Laboratory (AMRL) program for Performance Graded Binder. The supplier will submit, on a yearly basis, a Process Control Plan (Quality Control Plan) to HQ Central Laboratory for Performance Graded Asphalt Binder.

255.01 Certification. Form ITD-966, PG Binder Supplier's Certification, accompanies the initial shipment of PG binder to the project. Thereafter, this form is furnished with each lot change of PG binder shipped to the project. Supplier will attach a completed ITD-966 to the bill of lading that represents the first shipment of each new lot.

255.02 Sampling. Each shift that plant mix is produced, a binder sample, comprised of three individual one-quart cans, will be taken at a random time from the mix plant's asphalt binder tank injection line. The sampling method is AASHTO T-40. All three quarts will be retained by ITD. One quart will be for ITD's verification testing, the second quart will be retained for dispute resolution and the third quart is the Contractor's. The Contractor's quart will be released to the Contractor when requested.

The contractor or the supplier may take as many samples as they want for information only. Only the three cans identified as the daily binder sample must be witnessed and signed for by the ITD Inspector.

Note: Purge one gallon from the injection line valve before taking sample.

Standard Specifications, Section 405.03 – Mixing Plants, provides that "provisions shall be made for measuring and sampling contents of the (PG binder) storage tanks." Be alert the injection line is usually under pressure. The contractor must provide a safe means to obtain the random samples.

When mix plant operations are just starting or after being suspended for more than 48 hours, the sampling sequence will not begin with a completely random sample; instead, this binder sample will be taken near the beginning or resumption of operations.

All samples will be obtained and/or witnessed by a representative of the contractor and ITD, one of which must be WAQTC Asphalt qualified. The sample identification form (ITD-859) will be signed by both parties witnessing the sampling.

Samples must be submitted to HQ for testing no later than 60 days after the sample date.

255.03 Binder Verification Unit. The quantity of binder used in one week's production of plant mix, except as modified in the remainder of this subsection, shall constitute a binder verification unit. A binder verification unit is comprised of daily binder samples.

A binder unit will include only one PG grade. Thus, if the PG grade is changed within a production day, one daily binder sample will be taken for each PG grade used and grouped with other daily binder samples representing the corresponding binder verification unit.

Complete ITD-859, Performance Graded Binder Sample Identification Form. The daily binder sample, comprised of three individual quart cans, will be labeled with the sample identification numbers, i.e., 2001-C for the first day, 2002-C for the second day, etc. List each daily binder sample identification number and the date sampled on the form. ITD and the contractor must sign the form for each daily binder sample. The ITD portions of the daily binder samples will be assembled into a binder verification unit and submitted to the Central Materials Laboratory. Indicate on the ITD-859 the date when a supplier's binder lot changes.

Perform Idaho IT-99, Presence of Anti-Strip, in accordance with the required frequency as shown in Section 270.30, Minimum Testing Requirements, and record the results on the ITD-859.

Inspection or certification of the contractor's storage tank for contamination is the sole responsibility of the contractor.

255.04 Testing. ITD's AASHTO accredited laboratory will randomly choose one daily binder sample from each unit to represent the entire unit and either completely or partially test the selected daily binder sample. If the tested PG grade complies with the specified PG grade properties, the binder unit will be accepted. If the PG grade does not comply with the specified PG grade, additional testing will be performed on the verification unit until the extent of the non-compliant material has been determined.

If multiple tests are conducted on the same binder sample, the initial and additional test results for each specification item will be averaged and the average value for each specification item will be considered the final value. These final values will be used to determine compliance or noncompliance. Non-compliant materials will be subject to the price reduction as specified in the ITD Laboratory Operations Manual.

255.05 Appeal Process. The ITD HQ Central Laboratory will retain one daily binder sample for dispute resolution.

If the contractor wishes to appeal ITD's test results and price reductions, a written appeal request must be submitted within 21 calendar days of the reported test results. The appeal must state the grounds or the circumstances of the appeal. If the test results are in question, the appeal must be accompanied by all of the quality control test results that represent each verification unit in question. The contractor must also supply complete PG binder test results on all daily binder samples in question. The state will not accept appeals when contractor test results are below the minimum specifications.

When an appeal is accepted, the appeal testing must include all specification parameters for the material in question. If the appeal is not accepted, ITD will submit a denial letter to the contractor, stating the grounds for the denial.

Appeal testing will be conducted by an independent, AASHTO accredited laboratory, mutually acceptable to the contractor and ITD. The AASHTO accredited laboratory will report the results to ITD. The results of such tests will be binding to both parties and any price reduction on the unit in question will be based on those test results. The contractor will agree to bear the costs of the appeal testing if the tests verify noncompliance.

SECTION 256.00 - ASPHALT EMULSIONS QUALITY ASSURANCE PLAN (JANUARY 2015)

The asphalt emulsion supplier will conform to quality control testing and certification requirements in accordance with Subsection 702.03 of the Standard Specifications. The Supplier will be accredited through the AASHTO Material Reference Laboratory (AMRL) program for Emulsion Testing by January 2015. The supplier will submit, on a yearly basis, a Process Control Plan (Quality Control Plan) to HQ Central Laboratory for emulsified asphalt.

SECTION 260.00 – MIX DESIGNS

Disclaimer: Section 260.01 Refers To HVEEM Design, Which Is Not Part Of The Specification Currently.

260.01 Plant Mix Pavement (Standard Specification Section 405). This section outlines the mix design review process for Section 405 Plant Mix Pavement found in Subsection 405.03 - A - Mix Design.

260.01.01 Mix Design Requirements and Review Procedure. The Contractor must submit a request for use of materials source(s) to the Resident Engineer, and if acceptable, its use will be approved in writing. The Contractor must also submit the proposed mix design and all test reports, data, and worksheets used for each trial design attempted to the Resident Engineer. The Resident Engineer will submit the data to the District Materials Engineer for review. The Resident Engineer or District Materials Engineer will send copies of these documents to the HQ Central Laboratory. Preferably, these documents will be scanned by the District and placed on Headquarters Server hqmlsv02, public folder, in the appropriate District folder.

A proposed mix design must be submitted by the Contractor to the Resident Engineer for review a minimum of five calendar days prior to beginning paving. The design must be prepared and tested by a qualified laboratory. Unless otherwise allowed, all mix designs must be prepared specifically for the project they are submitted for. Designs that do not meet ITD project requirements and specifications will not be accepted. Refer to Subsections 405.02 and 405.03 for the mix design specifications.

The District Materials Engineer will be responsible for reviewing the mix design and making a recommendation, or the mix design may be sent to the HQ Central Laboratory for review and recommendation.

The District Materials Engineer will review the mix design and will make a recommendation to the Resident Engineer whether the mix design should be used or not. The Resident Engineer will not recommend using the design without the positive recommendation of either the District Materials Engineer or the HQ Central Laboratory. The Resident Engineer will notify the Contractor of the decision and copies of the notification will go to: HQ Design Materials and Construction Engineer, Pavement Operations Engineer and the Quality Assurance Engineer. When the review is performed by HQ Central Laboratory, a written recommendation will be faxed and/or e-mailed to Resident Engineer with a copy sent to the District Materials Engineer. The original letter will be mailed with copies to the District Engineering Managers, District Materials Engineer, Design Materials and Construction Engineer, and Pavement Operations Engineer.

The Contractor’s mix design will either be recommended for use or rejected. If a mix design is rejected, the Resident Engineer will inform the Contractor of the deficiencies found and a new or adjusted mix design will be required and the five-calendar day review time will start over.

If the Contractor chooses to submit a previously used mix design for review, at a minimum, the following tests must be performed and the results submitted along with the previously used mix design:

1. Current sieve analysis on the stockpiles to be used, including crusher control charts
2. Coarse and fine aggregate specific gravities and absorptions
3. Asphalt binder content correction factor per FOP for AASHTO T-308
4. Aggregate gradation correction factors per FOP for AASHTO T-308

All previously used mix designs submitted by the Contractor must be forwarded to HQ Central Laboratory for review and recommendation. To be considered acceptable as a previously used mix design, the asphalt content, type, grade, aggregate materials, gradation, and anti-strip rate, type and grade must be the same as previously approved. The previously approved mix design data along with the new testing must be submitted for consideration. The decision to accept or reject a previously used mix design rests solely with the HQ Central Laboratory.

The District Materials Engineer is authorized to recommend for use mix designs prepared specifically for the project they are submitted for.

The Contractor or a designated representative must perform a Hveem mix design in accordance with the current version of AASHTO R-12, "Bituminous Mixture Design Using the Marshall and Hveem Procedures." The Asphalt Institute publication "Mix Design for Asphalt Concrete and Other Hot Mix Types," (MS-2), is available from the Asphalt Institute, Executive Offices and Research Building, Research Park Drive, P.O. Box 14052, Lexington, KY 40512-4052. The Contractor's mix design must have a minimum 0.4 percent range of asphalt binder content that meets all specification requirements of Subsection 405.02. The job mix formula (JMF) must specify a single aggregate gradation, a single asphalt content and a maximum theoretical density based on the specified gradation and asphalt content.

The Contractor's mix design submittal to the Resident Engineer must include the following information:

- Percent of asphalt by Weight of mix, lb./ft^3
- Percent of asphalt by Weight of Aggregates, lb./ft^3
- Air Voids, % (AASHTO T-269)
- VMA, % (Voids in Mineral Aggregate) (see definitions)
- VFA, % (Voids Filled with Asphalt) (see definitions)
- HVEEM Stability Value (AASHTO T-246 & T-247)
- Bulk Specific Gravity, (AASHTO T-166, Method A)
- Theoretical Max Specific Gravity, (Rice Gravity) (AASHTO T-209, Bowl Method) (AASHTO TP 69) (ASTM D7227)
- Asphalt Film Thickness (AFT) (see definitions)
- Surface Area (see definitions)
- NCAT Ignition Oven Correction Factor (FOP for AASHTO T-308)
- Aggregate Gradation Correction Factors (FOP for AASHTO T-308)
- Bulk Specific Gravity, dry, (AASHTO T-84 & T-85)
- Fine Aggregate Angularity (Uncompacted Voids Content of Fine Aggregate), (AASHTO T-304, Method A)
- Percent fractured faces (AASHTO T-335, Method 1)
- Percent Flat and Elongated Particles (ASTM D4791)
- Identification of stockpile source(s). (Identify the materials source or sources from where the stockpiles originated. i.e. Coarse stockpile 1 and 2 - Ad 111s, fine stockpile 3 - Ad-53s. Identify and label the stockpiles on the sieve analysis sheet.)

- Proposed Target Gradation
- Type and percent of anti-strip additive
- Immersion Compression test results at 0.5% anti-strip additive or amount required to meet specification. Dry strength, Wet strength and percent retained strength (AASHTO T-165)
- Individual stockpile gradations and blend percentages
- Laboratory Mixing Temp, (from binder supplier)
- Laboratory Compaction Temp, (from binder supplier)
- Recommended Plant Mixing Temp, (from binder supplier)
- Field Compaction Temp Range, (from binder supplier)

The Contractor must provide the following design graphs for the proposed mix design that identifies the proposed JMF and the range of asphalt contents for which the design meets all the specification requirements (see examples). These graphs must be developed using the **percent of asphalt binder by weight of mix.**

- Unit Weight, % binder by weight of mix vs. pcf of mix. (Figures 260.01.03.1A & 260.01.03.2A)
- Maximum Theoretical Unit Weight, % binder (mix) vs. pcf of mix. (Figures 260.01.03.1A & 260.01.03.2A)
- % Air Voids, % binder (mix) vs. % total air voids. (Figures 260.01.03.1B & 260.01.03.2B)
- % VMA, % binder (mix) vs. % voids in mineral aggregate. (Figures 260.01.03.1B & 260.01.03.2B)
- Hveem Stabilometer value, % binder (mix) vs. Stability Value. (Figures 260.01.03.1C & 260.01.03.2C)
- % voids Filled, % binder (mix) vs. Voids filled With asphalt. (Figures 260.01.03.1C & 260.01.03.2C)

The Contractor must provide the JMF plotted on a 0.45 power curve (Figure 260.01.03.3) which includes the maximum density line and control points for the size of aggregate used. The Contractor must ensure the JMF gradation does not go beyond the upper and lower specification limits when the allowable tolerances of Subsection 405.03 F are applied, or outside of the control point upper and lower specification limits specified in Subsection 703.05.

The Contractor must submit all test reports, data, and worksheets used for each trial attempted along with their proposed mix design. The information required must include, but is not limited to, all specific gravity worksheets, Hveem worksheets, ignition oven worksheets with AASHTO T-30 gradations, and immersion compression test worksheets. Air voids, VMA, VFA, asphalt film thickness, and surface area calculation worksheets. Fine aggregate angularity, percent fractured faces, and percent flat and elongated particles worksheets.

The Contractor's mix design will be reviewed for accuracy, completeness, reasonableness, and specifications compliance in accordance with the contract and this section. Review of the mix design does not relieve the Contractor of responsibility for providing a mix design job mix formula and a plant mix pavement that complies with all contractual requirements.

260.01.02 Definitions. The following definitions are from sources common to the hot mix asphalt industry. These items have been selected for further definition because the form of the equation published in the reference text is different than the form used by ITD or additional explanation is warranted.

***Bulk Specific Gravity of Aggregate,* G_{sb}** the ratio of the weight in air of a unit volume of a permeable material (including both permeable and impermeable voids normal to the material) at a stated temperature to the weight in air of equal density of an equal volume of gas-free distilled water at a stated temperature. (AASHTO T-85 and Asphalt Institute Manual Series No. 2 (MS-2). Use AASHTO T-84 and T-85 to determine the bulk specific gravity of fine and coarse aggregates respectively.

When the total aggregate consists of separate fractions of coarse aggregate, fine aggregate, and mineral filler, all having different specific gravities, the bulk specific gravity of the total aggregate is calculated using:

$$G_{sb} = \frac{P_1+P_2+\cdots+P_n}{\left(\frac{P_1}{G_1}\right)+\left(\frac{P_2}{G_2}\right)+\cdots+\left(\frac{P_n}{G_n}\right)}$$

where G_{sb} = average bulk specific gravity

P_1, P_2, P_n = individual percentages by mass of aggregate, coarse and fine $P_1+P_2+\cdots+P_n = 100$

G_1, G_2, G_n = individual bulk specific gravities of aggregate, coarse and fine.

(Asphalt Institute Manual Series No. 2 (MS-2)

Because the amount of fine aggregate present in the coarse aggregate fraction and the amount of coarse aggregate present in the fine aggregate fraction is very small, this equation can be simplified and written as:

$$G_{sb} = \left[\frac{100}{\left(\frac{P_{(+\#4)}}{G_{(+\#4)}}\right)+\left(\frac{P_{(-\#4)}}{G_{(-\#4)}}\right)}\right]$$ **USE THIS EQUATION**

where, G_{sb} = average bulk specific gravity

$P_{(+\#4)}$, $P_{(-\#4)}$, = individual percentages by mass of aggregate, coarse, (+#4) and fine,(-#4)

$G_{(+\#4)}$, $G_{(-\#4)}$, = individual bulk specific gravities of aggregate, coarse, (+#4) and fine,(-#4)

When more than one materials source is used to provide the coarse aggregate fraction and/or more than one materials source is used to provide the fine aggregate fraction for a mix design or mineral fillers are used, the original form of the Asphalt Institute equation will be used.

***Voids in the Mineral Aggregate,* (VMA)**: the volume of intergranular void space between the aggregate particles of a compacted paving mixture that includes the air voids and the effective asphalt content, expressed as a percent of the total volume of the sample (Asphalt Institute Manual Series No. 2 (MS-2). VMA can be calculated either as percent by weight of total mix or as a percent by weight of aggregate as follows.

VMA will be calculated using the following formula when the mix composition is **determined as percent by weight of total mixture**:

$$VMA = 100 - \left(\frac{G_{mb}P_s}{G_{sb}}\right)$$

where, VMA = voids in mineral aggregate, percent of bulk volume
G_{sb} = bulk specific gravity of total aggregate
G_{mb} = bulk specific gravity of compacted mixture (AASHTO T-166)
P_s = aggregate content, percent by total weight

VMA will be calculated using the following formula when the mix composition is **determined as percent by weight of aggregate**:

$$\text{VMA} = 100 - \left[\frac{G_{mb}}{G_{sb}} \times \frac{100}{100+P_b}\right] 100$$

where, VMA = voids in mineral aggregate, percent of bulk volume
G_{sb} = bulk specific gravity of total aggregate
G_{mb} = bulk specific gravity of compacted mixture (AASHTO T-166)
P_b or %AC = asphalt content, percent by weight of mix

***Air Voids,* V_a**: the total volume of small pockets of air between the coated aggregate particles throughout a compacted paving mixture, expressed as a percent of the bulk volume of the compacted paving mixture. (Asphalt Institute Manual Series No. 2 (MS-2).

$$V_a = 100 \times \left(\frac{G_{mm} - G_{mb}}{G_{mm}}\right)$$

where, V_a = air voids in compacted mixture, percent of total volume
G_{mm} = maximum specific gravity of paving mixture (AASHTO T-209, Bowl Method)
G_{mb} = bulk specific gravity of compacted mixture (AASHTO T-166, Method A)

***Voids Filled with Asphalt,* (VFA)**: the portion of the volume of intergranular void space between the aggregate particles (VMA) that is occupied by the effective asphalt. (Asphalt Institute Manual Series No. 2 (MS-2).

$$\text{VFA} = 100 \times \left(\frac{VMA - V_a}{VMA}\right)$$

where, VFA = voids filled with asphalt, percent of VMA
VMA = voids in mineral aggregate, percent of bulk volume
V_a = air voids in compacted mixture, percent of total volume.

***Asphalt Film Thickness,* (AFT)**: The calculated film thickness is an average film thickness which has been generally correlated with durability. If the asphalt cement film is too thin, air which enters the compacted HMA can more rapidly oxidize these thin films, causing the HMA to become brittle and to fail prematurely by cracking. Additionally, if the aggregates are susceptible to water damage, thin films are more easily and rapidly penetrated by water than thick ones producing the typical manifestations of water damage: rutting, shoving, raveling, and bleeding. The average asphalt film thickness is calculated using the following formula as published in the National Center for Asphalt Technology publication Hot Mix Asphalt Materials, Mixture Design and Construction, Second Edition 1996 (F. L. Roberts, P. S. Kandhal, E. R. Brown, D. Lee and T. W. Kennedy).

$$\text{AFT} = \left(\frac{V_{asp}}{SA \times W}\right)(304{,}800)$$

where, AFT = Asphalt film thickness,(microns)

V_{asp} = effective volume of asphalt cement, (Cubic feet)

SA = surface area of the aggregate (square feet per pound of aggregate)

W = weight of aggregate (pounds)

or, W = (bulk density of compacted mix)(100-%AC)

304,800 = constant, $\frac{1000 \text{ microns}}{\text{mm}} \times \frac{25.4 \text{ mm}}{\text{inch}} \times \frac{12 \text{ inches}}{\text{foot}} = \frac{304{,}800 \text{ microns}}{\text{foot}}$

To determine the value of the effective volume of asphalt cement, $V_{asp:}$

V_{asp} is equal to the total volume of asphalt binder minus the absorbed volume of binder,

***Surface Area,* (SA)**: The aggregate surface area is important since it affects the amount of asphalt needed to coat the aggregate. Dense-graded asphalt mixtures are usually designed to contain a desires amount of air voids; hence, the aggregate surface area is not a design factor. It is possible to increase the surface area of an aggregate and at the same time reduce the optimum asphalt content. One way to do this is by increasing the dust content, (minus# 200) of a mixture. Asphalt mixtures that have a high surface area and low optimum asphalt content are undesirable because these mixes will have thin asphalt film on the aggregate and will probably not have adequate durability.

One of the primary reasons for estimating the surface area is to determine the asphalt film thickness. This is an estimate value, but it does allow comparisons to be made for various mixtures. (National Center for Asphalt Technology publication Hot Mix Asphalt Materials, Mixture Design and Construction, Second Edition 1996 (F. L. Roberts, P. S. Kandhal, E. R. Brown, D. Lee and T. W. Kennedy).

Sieve size	Surface Area Factor
Percent Passing Maximum Sieve Size	2
Percent Passing No. 4	2
Percent Passing No. 8	4
Percent Passing No. 16	8
Percent Passing No. 30	14
Percent Passing No. 50	30
Percent Passing No. 100	60
Percent Passing No. 200	160

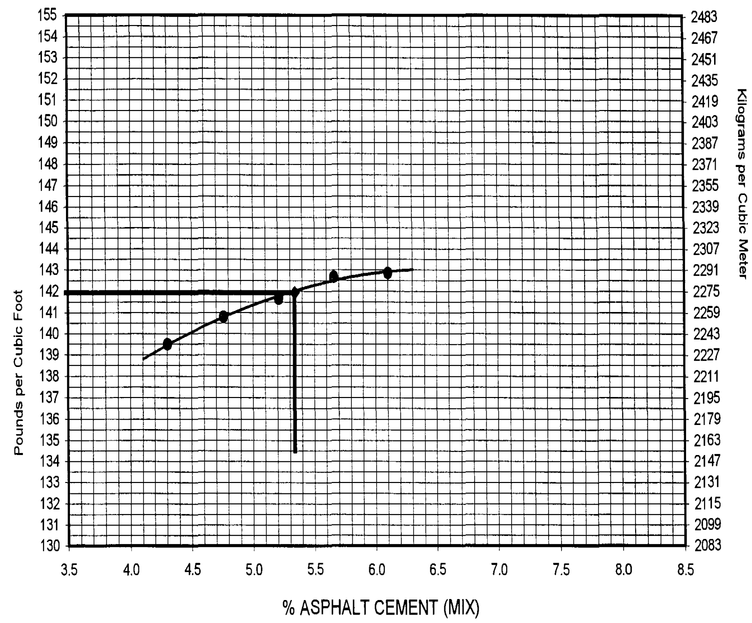
$$SA = 2\times(\%\ \text{Passing Max Sieve Size}) + 2\times(\%\ \text{Passing No. 4}) + 4\times(\%\ \text{Passing No. 8}) +$$
$$8\times(\%\ \text{Passing No.16}) + 14\times(\%\ \text{Passing No. 30}) + 30\times(\%\ \text{Passing No. 50}) +$$
$$60\times(\%\ \text{Passing No.100}) + 160\times(\%\ \text{Passing No. 200})$$

260.01.03 Examples. The following examples show typical plant mix pavement mix design curves that are generated during the mix design process. The graphs illustrate how the information should be analyzed to determine acceptability.

Figure 260.01.03.1A

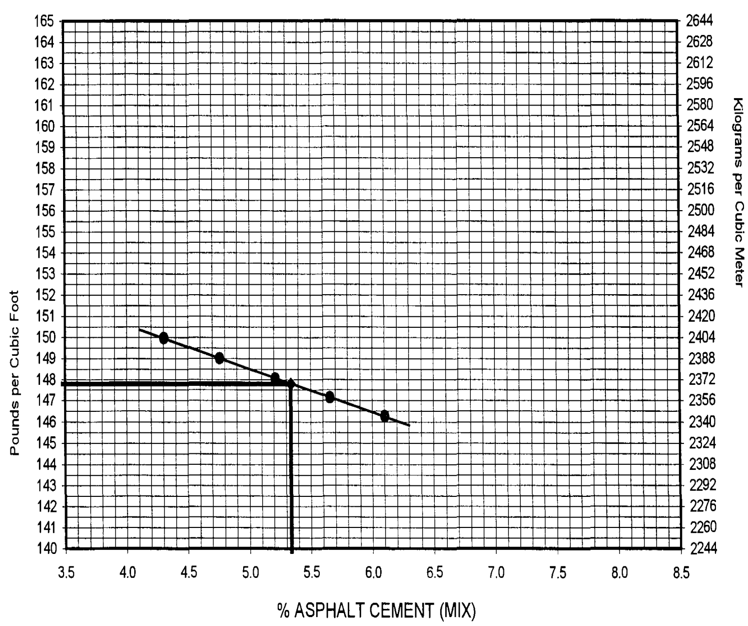
Design Curves for Proposed Job Mix Formula (JMF)

Unit Weight



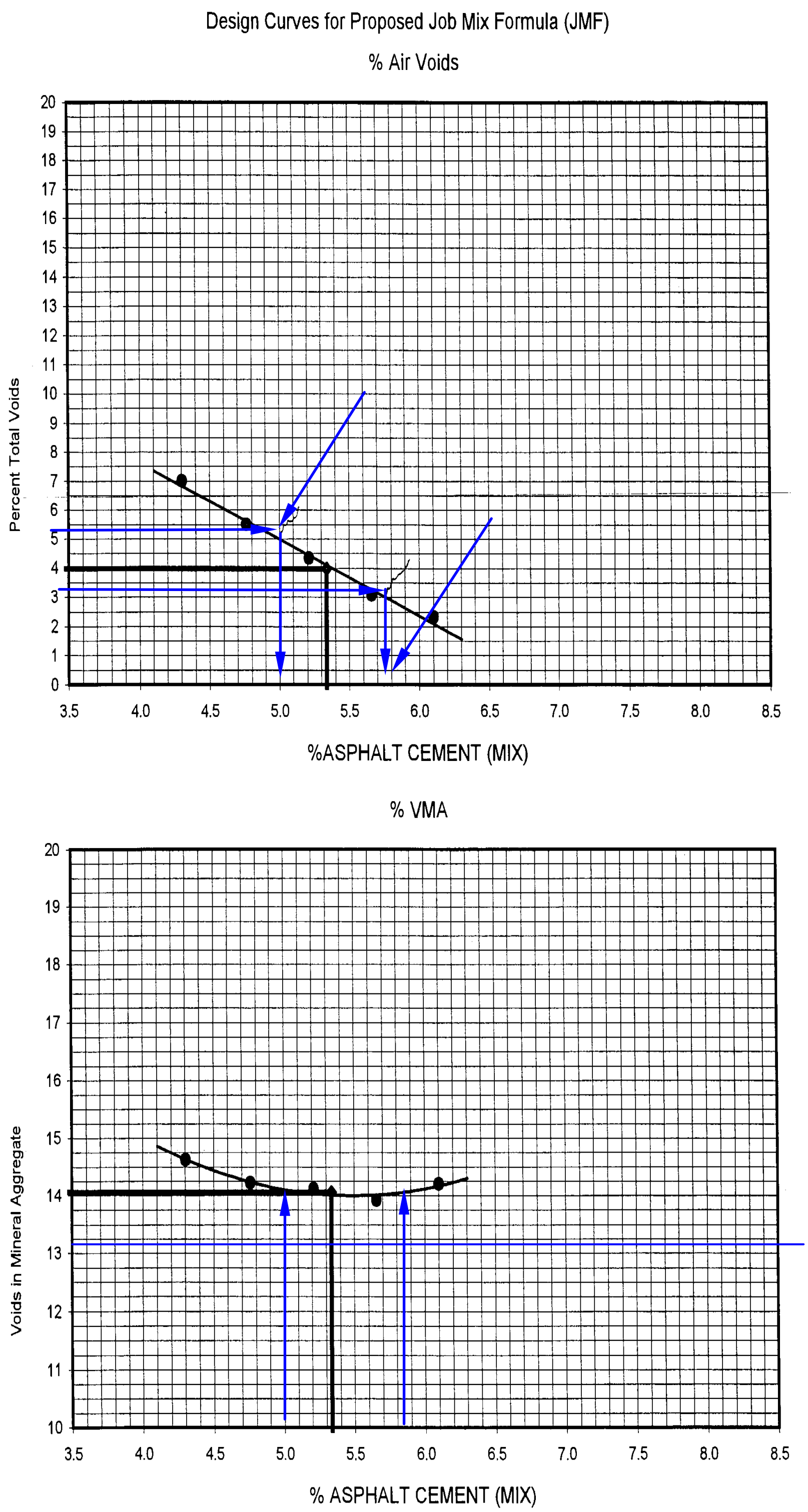
This graph shows how the unit weight of the compacted specimen changes as the percent of asphalt binder changes. This chart can be used to get an approximate bulk density of the compacted mix at a given asphalt content.

Max Theoretical Unit Weight



This graph shows how the maximum theoretical unit weight (Rice) of the compacted specimen changes as the percent of asphalt binder changes. This chart can be used to get an approximate Rice density of the compacted mix at a given asphalt content. The weight goes down as the asphalt content goes up.

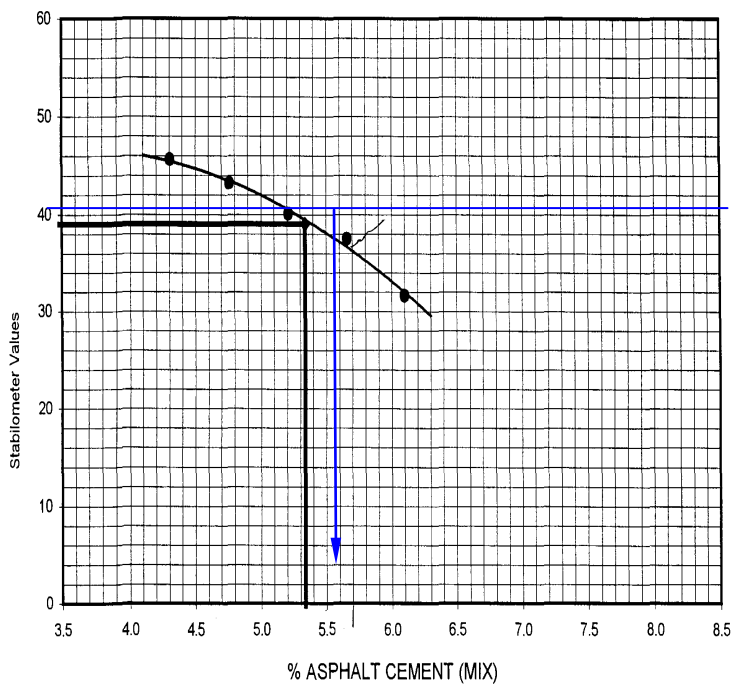
Figure 260.01.03.1B



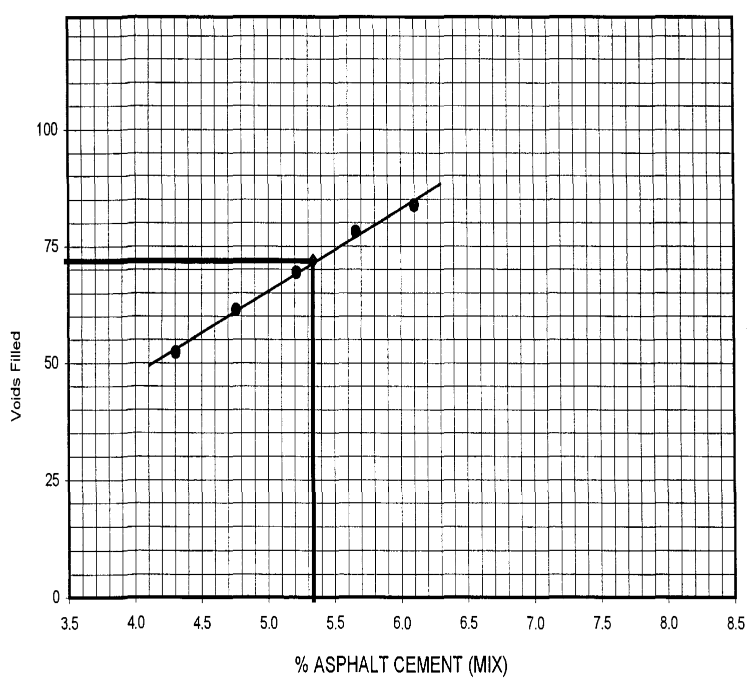
Step 1. Find the asphalt binder percent at 3% and 5% total Air Voids. Select 5% air Voids on the vertical axis and project a line to the left until it intercepts the curve. Then project the line down to the % asphalt binder on the horizontal axis. Do the same with 3% air voids. This mix has a range of asphalt contents of between 5.0 and 5.75% or a range of 0.75% which is greater than 0.4% and meets the specification, so far.

Step 2. Check the VMA at the % asphalt binder range determined in Step 1. For this mix design, the VMA is greater than the minimum of 13.0 over the entire range of asphalt contents determined in Step 1. This mix still has an acceptable AC range of 5.0 to 5.75%

Figure 260.01.03.1C



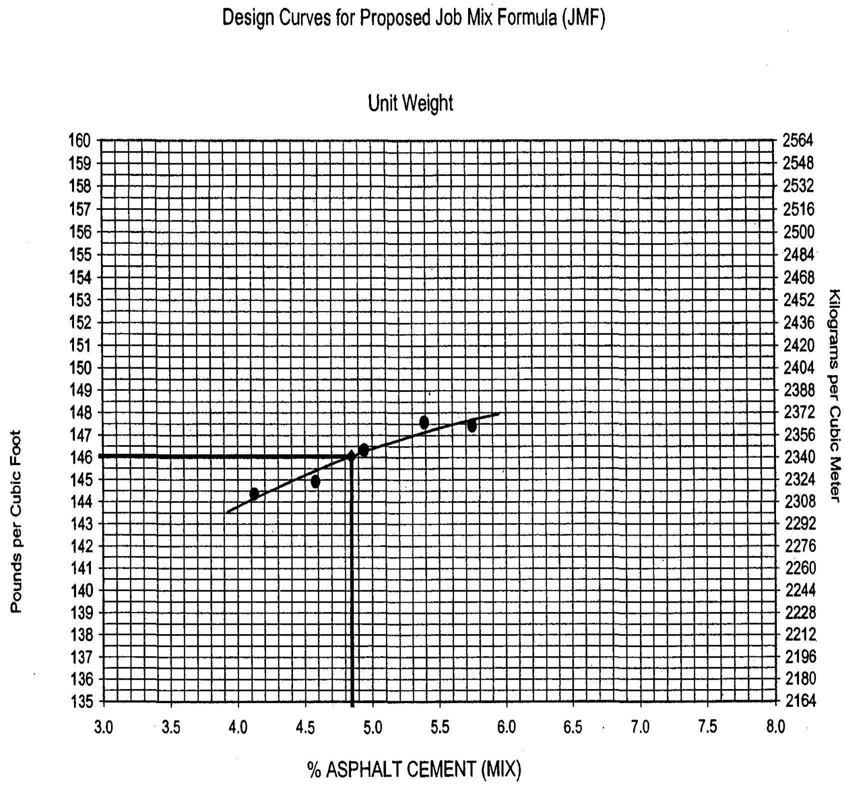
% Voids Filled



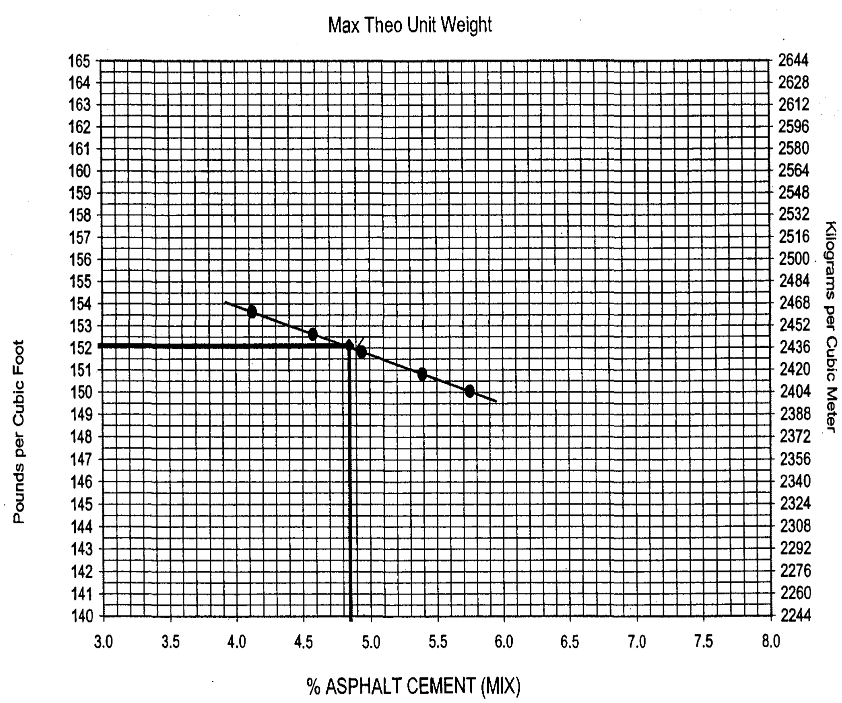
Step 3. Check the stability of the mix over the range of asphalt contents determined in the previous two steps. Draw a line horizontally at the minimum stability value, (37 for this mix), on the vertical axis that intercepts the stability curve. In this mix, the stability falls below the minimum allowed number of 37 at an asphalt content of 5.65%. Stability is within specification up to 5.65% asphalt and is out of specification at higher asphalt contents so the asphalt content range for this mix design that meets all the specification requirements of Subsections 405.02 and 405.03 is 5.0 to 5.65. This range 0.65% exceeds the 0.40% required in the specification.

VFA, Voids Filled With Asphalt is not currently a design criteria. VFA is inversely related to air voids and should be around 50 to 70%. When it exceeds approximately 80 to 85% rutting is likely to occur.

Figure 260.01.03.2A

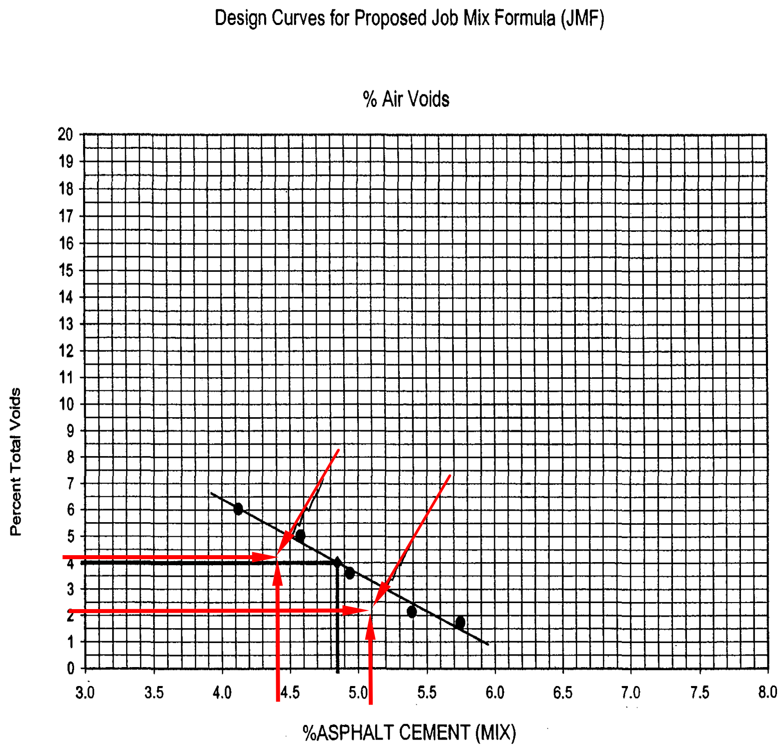


This graph shows how the unit weight of the compacted specimen changes as the percent of asphalt binder changes. This chart can be used to get an approximate bulk density of the compacted mix at a given asphalt content.

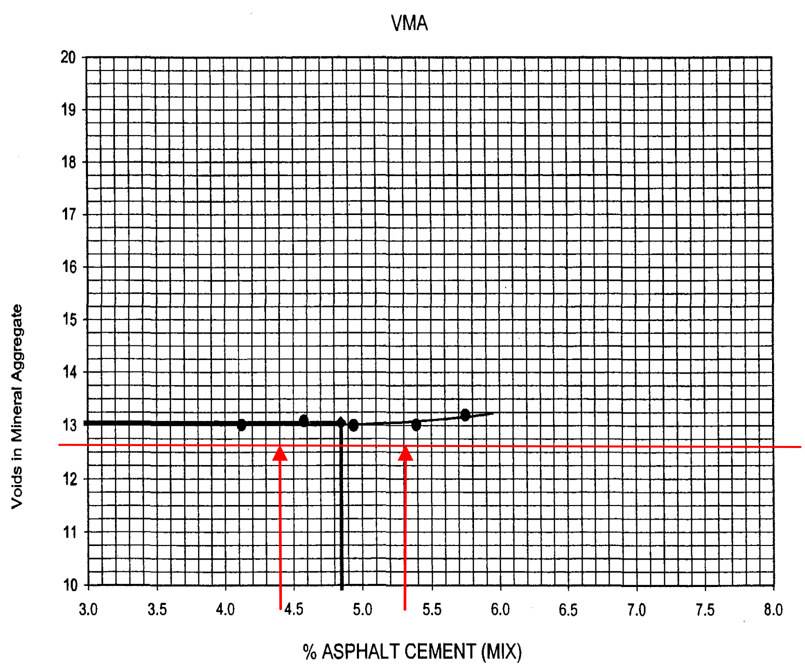


This graph shows how the maximum theoretical unit weight (Rice) of the compacted specimen changes as the percent of asphalt binder changes. This chart can be used to get an approximate Rice density of the compacted mix at a given asphalt content. The weight goes down as the asphalt content goes up.

Figure 260.01.03.2B

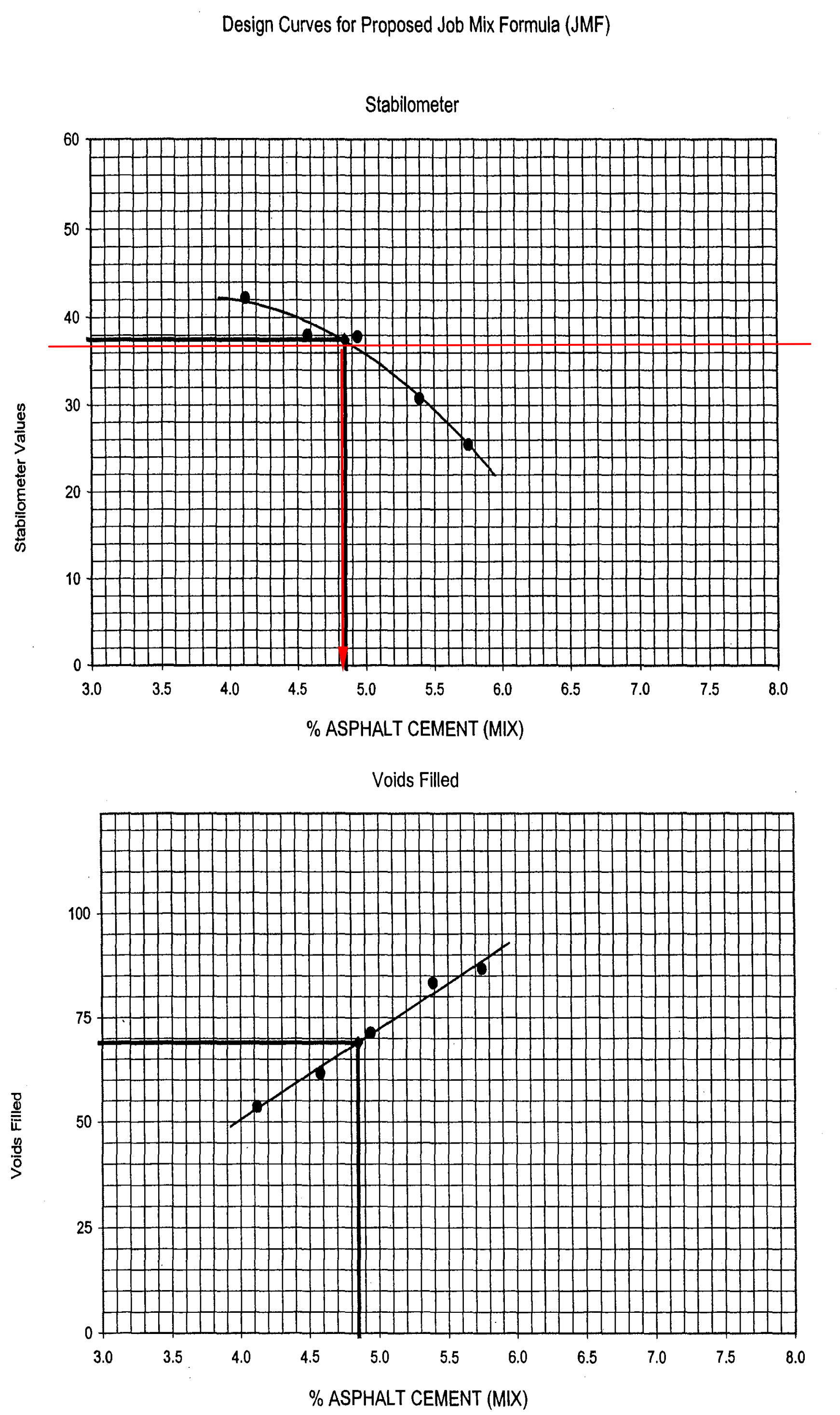


Step 1. Find the asphalt binder percent at 3% and 5% total Air Voids. Select 5% air Voids on the vertical axis and project a line to the left until it intercepts the curve. Then project the line down to the % asphalt binder on the horizontal axis. Do the same with 3% air voids. This mix has a range of asphalt contents of between 4.5 and 5.2% or a range of 0.7% which is greater than 0.4% and meets the specification so far.



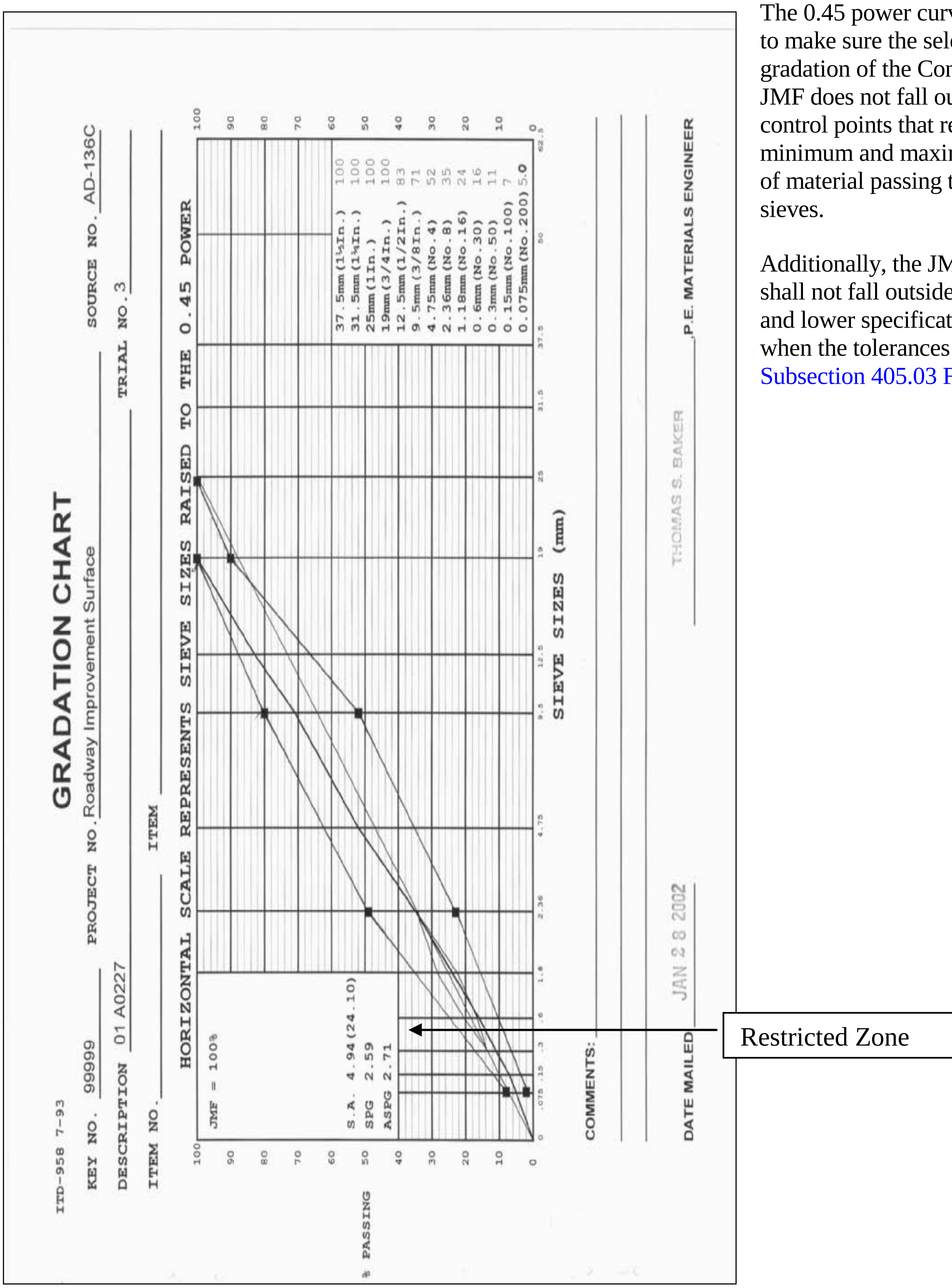
Step 2. Check the VMA at the % asphalt binder range determined in Step 1. For this mix design, the VMA curve is right on the minimum of 13.0 over the entire range of asphalt contents determined in Step 1. This mix still has an acceptable AC range of 4.5 to 5.4 %. This mix could have VMA problems based on this curve.

Figure 260.01.03.2C



Step 3. Check the stability number over the range of asphalt contents determined in the previous two steps. Draw a line horizontally from the minimum stability value, (37 for this mix), on the vertical axis that intercepts the stability curve. In this mix, the stability falls below the minimum allowed number of 37 at an asphalt content of 4.9%. Stability is within specification up to 4.9% asphalt and is out of specification at higher asphalt contents so the asphalt content range for this mix design that meets all the specification requirements of Subsections 405.02 and 405.03 is 4.5 to 4.9%. This range 0.4% meets the 0.40% required in the specification. Stability of the mix could be a problem if the asphalt content goes higher than 4.9%.

Figure 260.01.03.3. 0.45 Power Curve



The 0.45 power curve is checked to make sure the selected gradation of the Contractor's JMF does not fall outside the control points that represent the minimum and maximum amount of material passing the control sieves.

Additionally, the JMF gradation shall not fall outside the upper and lower specification limits when the tolerances of Subsection 405.03 F are applied.

260.02 Concrete Pavement (Standard Specification Section 409). Mix designs will be reviewed or confirmed according to the contract requirements.

260.02.01 Portland Cement Concrete Pavement. HQ Central Laboratory will confirm concrete mix designs for Portland Cement Concrete Pavement in accordance with the following procedures.

All sampling and testing performed shall be in accordance with the sampling and testing methods as specified in the ITD Standard Specifications.

260.02.01.01 Items Provided to HQ Central Laboratory. The HQ Central Laboratory must receive the following items before the concrete mix design confirmation process will be initiated. All samples submitted to HQCentral Laboratory must be accompanied by a completed ITD-1044. These items must be submitted 60 days in advance of proposed use:

1. A complete mix design including specific gravity (SSD) and absorption for both fine and coarse aggregates per AASHTO T-84 and T-85, respectively. The mix design must identify the aggregate source that will be used and the aggregate correction factor per AASHTO T-152.
2. For concrete aggregate sources identified during source approval as reactive per AASHTO T303 baseline testing, ASTM C1293, or ASTM C295 the mix design must include AASHTO T303 (modified) test results for mitigation of ASR expansion.
3. Gradation test results representing the material that will be used.
4. Final Set time per AASHTO T197M / T197.
5. For projects over 2500 CY, samples of the proposed aggregate, cement and admixtures. A minimum of 350 pounds of coarse aggregate, 200 pounds of fine aggregate and 100 pounds of cement must be supplied to the Central Materials Laboratory. No one sample container may weigh more than 50 pounds. All materials provided must meet the contract specifications.
6. Mill analysis test reports from the manufacturer must be included for the cement, fly ash and/or silica fume submitted.
7. Copies of all data, test reports and worksheets associated with the mix design.
8. Each mix design must be assigned a unique mix identification number identical to that which will be recorded on all batch tickets for concrete batched according to the mix design.

260.02.01.02 Central Materials Laboratory Procedures. The Central Laboratory will complete the following prior to batching the proposed mix design:

1. Verify the Contractor’s compressive strength test results are based on the average of three 28-day cylinders and indicate a minimum compressive strength of 5600 psi. If this requirement is not met the mix design will not be confirmed.
2. For aggregate sources identified as reactive for ASR, verify the Contractor’s ASR mitigation expansion testing (modified AASHTO T303) meets the following requirements. If these requirements are not met, the mix design will not be confirmed.
   a. Expansion of mortar bars shall not exceed 0.10 percent at 14 days with the addition of fly ash, lithium, or other ASR mitigation additives.
   b. The aggregate blend percentages used in the testing are reported and are within 2% of the blend percentages proposed in the mix design and to be used on the project. Coarse and fine aggregates may also be tested separately.

c. The materials used in the expansion testing are the same materials (aggregate sources, cement, fly ash, mitigation additive) and at the same proportions reported in the proposed mix design and to be used on the project.

d. When lithium is used, ensure the lithium dosage is reported as a volume and as a percent of the standard or full dose.

3. Verify the aggregate is from an approved aggregate materials source. If the source has not been approved, no further testing will be conducted until source approval has been obtained.
4. Check the mix design for conformance with the contract specifications (ie. cement content, air, slump, etc.). The design volume will be checked to ensure it totals 27 cubic feet. Should the mix design not meet contract requirements the mix design confirmation process will not proceed and the mix design will not be confirmed.
5. Test the fine aggregate for gradation and sand equivalent. Verify the specific gravity and absorption of the coarse and fine aggregate. Should the gradation or sand equivalent testing indicate the aggregate does not meet the contract specifications, the mix design confirmation process will be halted until acceptable materials are submitted.
6. Additional testing of the individual materials (cement, aggregates, fly ash, silica fume, admixtures, mineral fillers) may be conducted to verify conformance with contract specifications.

HQ Central Laboratory will batch the concrete in accordance with ASTM C192/C 192M at the proportions indicated in the Contractor's mix design submittal. Admixture dosages may be adjusted in accordance with the manufacturer's recommendations to achieve desired mix parameters. Coarse aggregate will be separated into individual-sized fractions and recombined to produce the gradation indicated in the Contractor's submittal. The weight of coarse and fine aggregate to be used in the batch will be determined per sections 6.3.2.2 and 6.3.2.3 of ASTM C192/C 192M, respectively.

The following mixing sequence will be used by the HQ Central Laboratory unless otherwise agreed to in writing:

1. Add coarse aggregate, ¾ of the mix water and the air entraining agent (if required) dispensed in solution with the mix water and mix.
2. Add fine aggregate, cement and flyash (if required) and mix.
3. Add ¼ of the mix water and the water reducing agent (if required) dispensed in solution with the mix water and mix.

If additional admixtures and/or silica fume are used in the mix they will be added in the above sequence per the manufacturer's written recommendations.

The above mixing sequence will not be altered unless the alternate sequence is pre-approved in writing by the admixture manufacturer(s) and the approved alternate mix sequence is provided with the mix design submittal. It is strongly recommended that all laboratories performing mix designs follow the mixing sequence as described above, so test results between labs will be as consistent as possible, and to enable the mix design confirmation process to be completed in as timely a manner as possible.

After mixing, the concrete will be tested for slump, air content, unit weight and yield. Cylinders will be prepared for compressive strength testing.

For mixes using aggregates that are identified as ASR reactive, the Central Laboratory may conduct AASHTO T303 (modified) testing using the proposed mitigation admixtures to confirm the Contractor's testing.

260.02.01.03 Confirmation. The Contractor's mix design will be confirmed for strength provided the HQ Central Laboratory's compressive strength test results, based on the average of three 28-day cylinders, indicate a **minimum** compressive strength of 5300 psi.

When applicable, the Contractor's mix design will be confirmed for ASR mitigation provided the HQ Central Laboratory's expansion test results indicate contract specifications are met (0.10% expansion or less at 14 days) or are within the established multi-laboratory precision of the Contractor's passing expansion test results.

The mix design confirmation results will be reported to the District Resident Engineer via memo from the HQ Central Laboratory.

260.03 Structural Concrete (Standard Specification Section 502). All sampling and testing methods performed shall be as specified in the ITD Standard Specifications. Concrete mix design requires concurrence by the HQ Central Laboratory.

260.03.01 Approval Procedures. Complete the following:

1. Verify the complete mix design submittal for conformance with the contract specifications. Designs that do not meet ITD project requirements and specifications will not be approved for use.
2. The mix design must identify an approved aggregate source(s) that will be used and the aggregate correction factor, (AASHTO T-152).
3. Final Set time per AASHTO T197M / T197
4. For aggregate sources that are reactive according to AASHTO T-303 baseline testing, ASTM C1293 or ASTM C295 review the modified AASHTO T-303, Accelerated Detection of Potentially Deleterious Expansion of Mortar Bars Due to Alkali-Silica Reaction (mitigation efforts for ASR expansion) test reports.
5. For aggregate sources identified as reactive for ASR, concrete mix design approval requires the following requirements be met for the modified AASHTO T303 mitigation testing:
    a. Expansion of mortar bars shall not exceed 0.10 percent at 14 days with the addition of fly ash, lithium, mineral admixtures or other ASR mitigation additives.
    b. The aggregate blend percentages used in the testing are reported and are within 2% of the blend percentages proposed in the mix design and to be used on the project. Aggregates may also be tested separately.
    c. The materials used in the expansion testing are the same materials (aggregate sources, cement, fly ash, mitigation additive) and at the same proportions reported in the proposed mix design and to be used on the project.
    d. When fly ash is used, ensure the calcium oxide content of the fly ash used on the project meets the 2% tolerance as established by the specifications.
    e. When lithium is used, ensure the lithium dosage is reported as a volume and as a percent of the standard or full dose.
6. Mill analysis test reports from the manufacturer must be included for the cement, fly ash, and/or silica fume, meet contract specifications and be the same material to be used on the project. Check that any admixtures are approved. HQ Central Laboratory in Boise keeps an updated qualified products list for concrete admixtures.

7. Verify that Basic Mix Strength and Design Mix Strength have been determined per Subsection 502.03 of the Specifications. Basic mix strength must equal or exceed the design mix strength calculated for the specified class of concrete. Class 15 and 22 are exempt from this requirement.
8. Each mix design shall be assigned a unique mix identification number identical to that which will be recorded on all batch tickets for concrete batched according to the mix design.
9. Check the absolute volume of the mix design. Yield should be checked with air in the mid-range. Verify that the moisture content of the aggregate is included in the water content. In addition, efforts to mitigate ASR using lithium nitrate admixture will increase the water content in the mix and must be adjusted for.
10. Calculate the volume using the maximum air content to insure that the cement factor does not fall below specifications. (Do not base the mix design using maximum air for anything but checking cement content.)
11. Check the percentage of sand based on total weight of aggregate. Generally, this percentage is 30% to 42%. (When sand exceeds 42%, the slump will become more difficult to achieve and maintain because the surface area of the aggregate has increased and requires a larger volume of paste. If during mix design, additional water is used to get the slump and workability, then the w/c ratio goes up. The yield goes up, the cement content goes down, and strength goes down.)
12. The water-cement ratio should be designed at a realistic figure for the strength/class of concrete needed. At no time should the water cement ratio be based on the maximum allowable specification. If the upper end of the water-cement ratio is to be targeted, stay at least 0.02 under the maximum specification, allowing for fluctuation in batch weights.
13. If fly ash is used, up to 25% of total cementatious material (cement and fly ash) may be fly ash as per specifications. The specific gravity of the fly ash is required. The weight of fly ash is added to the weight of cement when calculating cement content and the water cement ratio.

Attached is an example of ITD-907 Concrete Mix Design Review for Structural or Pavement Design.

Example

ITD-907 4-90

CONCRETE MIX DESIGN REVIEW FOR STRUCTURAL OR PAVEMENT DESIGN

SHEET 1 OF ____

PROJECT NO. IR-84-2(035)95

CONCRETE SUPPLIER ACME

CONTRACT ITEM NO. 409

CONCRETE MIX DESIGN NO. 3

COUNTY Elmore

SOURCE NO. EL-116

CONCRETE, CLASS 45 (5600/28 day)

DATE 7/14/97

CLASS OF CONCRETE IN 100 PSI	MINIMUM CEMENT CONTENT LB./C.Y.	MINIMUM FLY ASH CONTENT LB./C.Y.	MAX. W/C + FLY ASH RATIO LB./LB.	% AIR CONTENT	A.E.A. OZ./C.Y.	SLUMP RANGE, INCHES	COARSE AGGR. SIZE
56	467	116	0.47	4-7		½-2	3

AGGREGATE BULK SPECIFIC GRAVITY (~~DRY~~) OR (SSD) *	% ABSORP.	LABORATORY NUMBERS	% BLEND EACH SIZE
COARSE .... = 2.57	1.2	CRSE.	
FINE .... = 2.61	1.8	CRSE.	
		FINE	
BLEND SAND= ____	____	FINE	

% SAND = $\frac{Mc - M}{Mc - Mf}$ = R = . ______ or 34.5 %

W/C = 0.40

ABSOLUTE VOLUME METHOD for DESIGN of CONCRETE

YIELD = 27 CU. FT./CU. YD. .... = 27.000 C.F. = Y

WATER = 28 GAL./CU. YD. ÷ 7.48 .... = 3.743 C.F. = W

CEMENT = $\frac{LB./C.Y.}{3.15 \times 62.4}$ = $\frac{467}{196.56}$ .... = 2.376 C.F. = C

FLY ASH = $\frac{LB./C.Y.\ 116}{SP.GR.\ 2.240 \times 62.4}$ .... = 0.830 C.F. = FLY ASH

Y......... = 27.000 C.F.

AIR = Y X % AIR design at max 7% = 1.89 C.F. = A

W + C + FLY ASH + A .... = 8.839 C.F.

Y - (W + C + FLY ASH + A) ...... = 18.161 C.F. = C.A. + F.A.

(C.A. + F.A.) X R .... = 6.266 C.F. = F.A.

(C.A. + F.A.) - F.A. .... = 11.895 C.F. = C.A.

COARSE = C.A. X SP. GR. X 62.4 .... = 1908 LB. (~~DRY~~)(SSD)*

FINE = F.A. X SP. GR. X 62.4 .... = 1020 LB. (~~DRY~~)(SSD)*

BLEND SAND X SP. GR. X 62.4 .... = ____ LB. (DRY)(SSD)*

CORRECTION FOR ABSORPTION

% ABSORP. X LB. C.A. .... = 22.9 LB. WATER

% ABSORP. X LB. F.A. .... = 18.4 LB. WATER

BLEND SAND .... = ____ LB. WATER

INCREASE THE MIXING WATER BY THE SUM OF THESE THREE .... = 41.3 LB. WATER

BASIC BATCH WEIGHTS FOR A CUBIC YARD BATCH	BATCH WEIGHTS CORRECTED FOR ABSORPTION	BATCH WEIGHTS CORRECTED FOR MOISTURE	BATCH WEIGHT
CEMENT .. 467 LB.	467 LB.	____ LB.	467 LB.
FLY ASH .. 116 LB.	116 LB.	____ LB.	116 LB.
WATER .... 234 LB.	275 LB.	____ LB.	275 LB.
COARSE .. 1908 LB. (~~DRY~~) (SSD)*	1885 LB.	(x) ____ LB.	1885 LB. (DRY) (~~SSD~~)*
FINE .... 1020 LB. (~~DRY~~) (SSD)*	1002 LB.	(z) ____ LB.	1002 LB. (DRY) (~~SSD~~)*
BLEND SAND ____ LB. (DRY) (SSD)*	____ LB.	____ LB.	____ LB. (DRY) (SSD)*

DETERMINATION OF THE YIELD

TOTAL BATCH WEIGHT (DESIGN) .... = 3,745 LB.

WEIGHT PER CUBIC FOOT (DESIGN) .... = 138.7 LB.

WEIGHT PER CUBIC FOOT (FRESH CONCRETE) .... = 138.8 LB.

$\frac{\text{TOTAL BATCH WEIGHT}}{\text{WT. / CU. FT. FRESH CONC.}}$ = 26.981 CU. FT. (VOLUME OF CONCRETE PRODUCED)

$\frac{\text{VOLUME OF CONCRETE PRODUCED}}{\text{NUMBER OF YARDS} \times 27}$ = 0.999 RELATIVE YIELD.

CORRECTION FOR MOISTURE CONTENT

% MOISTURE IN C.A. X LB. COARSE AGGR. .... = ____ LB. WATER (X)

% MOISTURE IN F.A. X LB. FINE AGGR. .... = ____ LB. WATER (Z)

DECREASE THE MIXING WATER BY THE SUM OF THESE TWO .... = ____ LB. WATER

INCREASE THE WEIGHT OF THE C.A. BY (X).

INCREASE THE WEIGHT OF THE F.A. BY (Z).

★ CROSS OUT EITHER DRY OR SSD AS APPROPRIATE.
FINAL ACCEPTANCE IS CONTINGENT UPON ACCEPTANCE OF AIR CONTENT, SLUMP AND STRENGTH.

COMPUTED BY D.T. CHECKED BY Mk DATE 7/14/97

260.04 Superpave Hot Mix Asphalt (HMA) (Standard Specification Section 405). This section outlines the job-mix formula confirmation process for Superpave Hot Mix Asphalt, (HMA) found in Subsection 405.03-A mix Design.

260.04.01 Mix Design Requirements and Review Procedure. The Contractor must submit a request for use of materials source(s) to the Resident Engineer, and if acceptable, its use will be approved in writing. The Superpave HMA mix design is the Contractor's responsibility. The Contractor must submit the proposed mix design and all test reports, data, and worksheets used for each trial design attempted, to the Resident Engineer. The Resident Engineer will submit the data to the HQ Central Laboratory for mix design approval. The job mix formula (JMF) must be approved prior to beginning paving.

The Contractor's mix design shall develop the JMF for the project, using a qualified, AASHTO Accredited laboratory that is qualified through the Department's Laboratory Qualification Program. Mix designs must be prepared specifically for the project they are submitted for and each class of mix and grade of binder will have a separate mix design created, unless otherwise allowed. Refer to Standard Specification Section 405 Superpave Hot Mix Asphalt for the mix design specifications and a complete list of submittal requirements.

The Contractor's mix design submittal must include all the information required in "A. *Mix Design*" of the Construction Requirements of the 405.03.

The Contractor shall submit the following materials and samples to the Engineer:

1. A 50-pound uncompacted asphalt mix sample conforming to the JMF.
2. Six Gyratory briquettes compacted to N_{design} and conforming to the JMF. Determine V_a of each specimen and clearly label the air void content. (For SP 5-6 only)
3. Six individually packaged specimens of aggregate fabricated in accordance with AASHTO T 165 except the binder is not mixed with the aggregate. Provide enough binder without anti-strip added and anti-strip additive in separate containers to make six test specimens at the required anti-strip percentages. Include enough aggregate, binder and anti-strip additive for a "buttering batch". The Engineer will prepare test specimens from the material and perform testing in accordance with AASHTO T 165
4. A 25-pound sample of the combined coarse and fine aggregate to be used in the mix for G_{sb} testing.
5. 25-pound sample of RAP, when used, along with the RAP stockpile records and test data.
6. 1000-gram sample of other mineral admixtures, such as lime or fly ash, when used.

These samples will be used for laboratory examination and evaluation of the properties of "Materials".

ITD will perform bulk (dry) specific gravity, Gs_b, tests of the coarse and fine aggregate combination on the aggregate provided:

ITD will perform the following testing on the uncompacted HMA sample: asphalt content, gradation, theoretical maximum specific gravity, G_{mm}, Bulk Specific Gravity, G_{mb} of the compacted mixture, index of retained strength, and APA. Air voids, VMA, VFA, and dust to binder ratio will be calculated using these results.

AASHTO T 340, Determining Rutting Susceptibility of Asphalt Pavement Mixture Using the Asphalt Pavement Analyzer (APA), will be performed on the specimens for JMF confirmation. The APA specimens shall have an air void content between 3.0% and 5.0%.

The HQ Central Laboratory will have five working days from the time of receipt of all of the items required above to evaluate the JMF and make a recommendation to the Resident Engineer. HQ Central Laboratory will prepare a written recommendation that will be faxed and/or e-mailed to Resident Engineer with a copy sent to the District Materials Engineer. The original letter will be mailed with copies to the District Engineer Manager, District Materials Engineer, and District Resident Engineer.

The JMF will either be recommended for use or rejected. If a JMF is rejected, the Resident Engineer will inform the Contractor of the deficiencies found and a new or adjusted JMF will be required and the five working day review time will start over.

The Contractor or a designated representative must perform a Superpave HMA mix design in accordance with the current version of AASHTO R-35, "Superpave Volumetric Design for Hot-Mix Asphalt." The Asphalt Institute publications "Superpave Mix Design, Superpave Series No. 2, (SP-2)" and "Mix Design for Asphalt Concrete and Other Hot Mix Types," (MS-2), are available from the Asphalt Institute, Executive Offices and Research Building, Research Park Drive, P.O. Box 14052, Lexington, KY 40512-4052. The proposed JMF shall specify a single aggregate gradation; optimum asphalt content, a theoretical maximum specific gravity, and a bulk specific gravity of a specimen compacted to $N_{design.}$

The Contractor's mix design submittal must include all the information required in "A. *Mix Design*" of the Construction Requirements of 405.03.

If the Contractor chooses to submit a previously used mix design for review, at a minimum, the following tests must be performed and the results submitted along with the previously used mix design:

1. Current sieve analysis on the stockpiles to be used, including crusher control charts
2. Coarse and fine aggregate specific gravities and absorptions, (Performed by ITD)
3. Asphalt binder content correction factor per FOP for AASHTO T-308
4. Aggregate gradation correction factors per FOP for AASHTO T-308

All previously used mix designs submitted by the Contractor must be forwarded to HQ Central Laboratory for review and recommendation. To be considered acceptable as a previously used mix design, the asphalt content, type, grade, aggregate materials, gradation, and anti-strip rate, type and grade must be the same as previously approved. The previously approved mix design data along with the new testing must be submitted for consideration. The decision to accept or reject a previously used mix design rests solely with the HQ Central Laboratory.

The Engineer's approval of the mix design does not relieve the Contractor of responsibility for providing a job mix formula and a Superpave Hot-Mix Asphalt pavement that complies with all contract requirements.

260.04.02 Definitions. The following definitions are from sources common to the hot mix asphalt industry. These items have been selected for further definition because the form of the equation published in the reference text may be different than the form used by ITD or additional explanation is warranted.

Bulk Specific Gravity of Aggregate, $\mathbf{G_{sb}}$ The ratio of the weight in air of a unit volume of a permeable material (including both permeable and impermeable voids normal to the material) at a stated temperature to the weight in air of equal density of an equal volume of gas-free distilled water at a stated temperature. (AASHTO T-85 and Asphalt Institute Manual Series No. 2 (MS-2)). Use Idaho IT-144 and T-85 to determine the bulk specific gravity of fine and coarse aggregates respectively.

When the total aggregate consists of separate fractions of coarse aggregate, fine aggregate, and mineral filler, all having different specific gravities, the bulk specific gravity of the total aggregate is calculated using:

$$G_{sb} = \frac{P_1 + P_2 + \cdots + P_n}{\left(\frac{P_1}{G_1}\right) + \left(\frac{P_2}{G_2}\right) + \cdots + \left(\frac{P_n}{G_n}\right)}$$

where, G_{sb} = average bulk specific gravity
P_1, P_2, P_n = individual percentages by mass of aggregate, coarse and fine
$P_1 + P_2 + \cdots + P_n = 100$
G_1, G_2, G_n = individual bulk specific gravities of aggregate, coarse and fine.
(Asphalt Institute Manual Series No. 2 (MS-2)).

Because the amount of fine aggregate present in the coarse aggregate fraction and the amount of coarse aggregate present in the fine aggregate fraction is very small, this equation can be simplified and written as:

$$G_{sb} = \left[\frac{100}{\left(\frac{P_{(+\#4)}}{G_{(+\#4)}}\right) + \left(\frac{P_{(-\#4)}}{G_{(-\#4)}}\right)}\right]$$ **USE THIS EQUATION**

where, G_{sb} = average bulk specific gravity for the total aggregate
$P_{(+\#4)}$, $P_{(-\#4)}$, = individual percentages by mass of aggregate, coarse, (+#4) and fine,(-#4)
$G_{(+\#4)}$, $G_{(-\#4)}$, = individual bulk specific gravities of aggregate, coarse, (+#4) and fine,(-#4)

When more than one materials source is used to provide the coarse aggregate fraction and/or more than one materials source is used to provide the fine aggregate fraction for a mix design or mineral fillers are used, the original form of the Asphalt Institute equation will be used.

Bulk Specific Gravity of Recycled Asphalt Pavement, (RAP), RAP- $\mathbf{G_{sb}}$ The bulk Dry Aggregate Specific Gravity of RAP aggregate, (RAP-G_{sb}), is determined from Maximum Theoretical Specific Gravity, RAP G_{mm}, tests performed on the RAP material; the Effective Specific Gravity of Aggregate, G_{se}; and the asphalt absorption. These values are used to determine the Bulk Dry Specific Gravity, (G_{sb}), of the RAP.

$$\text{RAP } G_{se} = \left(\frac{(100 - Adjusted\ P_b)}{\left(\frac{100}{RAP\ G_{mm}}\right) - \left(\frac{Adjusted\ P_b}{G_b}\right)}\right)$$

where, RAP G_{se} = effective specific gravity of aggregate
P_b = asphalt content (from AASHTO T308)
G_b= specific gravity of asphalt (from mix design)
RAP G_{mm} = maximum specific gravity of mix (no air voids)

$$\text{Adjusted } P_b = \left(\frac{Mass\ of\ RAP\ AC + Mass\ of\ Virgin\ AC\ added}{New\ RAP\ Mass}\right)$$

RAP G_{sb} = dry bulk specific gravity of the RAP

RAP G_{sb}=RAP G_{se} – asphalt absorption

***Voids in the Mineral Aggregate, (VMA)**:* The volume of intergranular void space between the aggregate particles of a compacted paving mixture that includes the air voids and the effective asphalt content, expressed as a percent of the total volume of the sample (Asphalt Institute Manual Series No. 2 (MS-2). VMA can be calculated either as percent by weight of total mix or as a percent by weight of aggregate as follows.

VMA will be calculated using the following formula when the mix composition is **determined as percent by weight of total mixture**:

$$\text{VMA} = 100 - \left(\frac{G_{mb}P_s}{G_{sb}}\right)$$

where, VMA = voids in mineral aggregate, percent of bulk volume
calculate to 0.01; report to 0.1
G_{sb} = bulk specific gravity of total aggregate
G_{mb} = bulk specific gravity of compacted mixture (AASHTO T-166 Method A)
P_s = aggregate content, percent by total weight,
(this can be written as P_s = 100-%AC)

Air Voids, V_a: the total volume of small pockets of air between the coated aggregate particles throughout a compacted paving mixture, expressed as a percent of the bulk volume of the compacted paving mixture. (Asphalt Institute Manual Series No. 2 (MS-2).

$$V_a = 100 \times \left(\frac{G_{mm} - G_{mb}}{G_{mm}}\right)$$

where, V_a = air voids in compacted mixture, percent of total volume
calculate to 0.01; report to 0.1
G_{mm} = maximum specific gravity of paving mixture (AASHTO T-209, Bowl Method)
G_{mb} = bulk specific gravity of compacted mixture (AASHTO T-166, Method A)

***Voids Filled with Asphalt,* (VFA)**: the portion of the volume of intergranular void space between the aggregate particles (VMA) that is occupied by the effective asphalt. (Asphalt Institute Manual Series No. 2 (MS-2)).

$$\text{VFA} = 100 \times \left(\frac{VMA - V_a}{VMA}\right)$$

where, VFA = voids filled with asphalt, percent of VMA
calculate to 0.1; report to 1
VMA = voids in mineral aggregate, percent of bulk volume

V_a = air voids in compacted mixture, percent of total volume

Dust-to-Binder Ratio (DP = $P_{-\#200}/P_{be}$) The ratio between the percent of aggregate passing the No. 200 (0.075-mm**)** sieve and the effective binder content (P_{be}). (Asphalt Institute Superpave Series No. 2 (SP-2)).

$$\text{DP} = \left(\frac{P_{-\#200}}{P_{be}}\right)$$

where, DP = Dust Proportion, (dust-to-binder ratio)
calculate to 0.01; report to 0.1
$P_{-\#200}$ = aggregate passing the -#200 (0.075 mm) sieve, percent by mass of aggregate
P_{be} = effective asphalt content, percent by total mass of mixture
Calculate to 0.01; report to 0.1

The following equations are used to calculate P_{be}:

Effective Asphalt Content, P_{be}

$$P_{be} = P_b - \frac{P_{ba}}{100}(100 - P_b)$$

Where, P_b = asphalt content (from AASHTO T308)
P_{ba} = absorbed asphalt

Absorbed Asphalt, P_{ba}

$$P_{ba} = \left(\frac{G_{se}-G_{sb}}{G_{sb}G_{se}}\right) G_b$$

Where, G_{se} = effective specific gravity of aggregate
G_{sb} = bulk specific gravity of aggregate
G_b = specific gravity of asphalt (from mix design)

Effective Specific Gravity of Aggregate, G_{se}

$$G_{se} = \left(\frac{(100-P_b)}{\left(\frac{100}{G_{mm}}\right)-\left(\frac{P_b}{G_b}\right)}\right)$$

Where, G_{mm} = maximum specific gravity of mix (no air voids)
P_b = asphalt content (from AASHTO T308)
G_b = specific gravity of asphalt (from mix design)

260.04.03 Tolerances. The following tolerances will be applied to the Engineer's test results when confirming the job mix formula.

Gradation: ITD's gradation when tested in accordance to AASHTO T-30 must be within the tolerances shown below on any individual sieve when compared with the JMF gradation.

Sieve Size	Tolerance, % (±)	Sieve Size	Tolerance, % (±)
1 in (25 mm)	6.0	No. 8 (2.36 mm)	5.0
3/4 in (19 mm)	6.0	No. 16 (1.18 mm)	5.0
1/2 in (12.5 mm)	6.0	No. 30 (0.60 mm)	5.0
3/8 in (9.5 mm)	6.0	No. 50 (0.30 mm)	4.0
No. 4 (4.75 mm)	6.0	No. 100 (0.15 mm)	4.0
		No. 200 (0.075 mm)	2.0

Air Voids, V_a: The Contractor must design a mix with 4.0% air voids at N_{des} and optimum binder content. If ITD's results are not less than 2.5% or greater than 5.5% air voids, the two design air voids are considered comparable and the Contractor's air voids are confirmed.

Voids in the Mineral Aggregate, (VMA): If the Contractor's VMA meets the minimum specification and ITD's VMA falls below the minimum specification by no more than 1.0%, the Contractor's VMA is confirmed.

Index of Retained Strength (IRS), (Immersion Compression): The Contractor must submit a job mix formula that provides a minimum result of 85% IRS. If ITD's results are below the minimum of 85%, confirmation will be based solely on the judgment of ITD. Source file data may be used to make this judgment.

Theoretical Maximum Specific Gravity, $G_{mm.}$: The difference between any two labs cannot exceed 0.02. This difference is independent of and does not supersede the air void specification and confirmation tolerance.

Bulk specific gravity of compacted mixture, G_{mb}: The difference between any two labs cannot exceed 0.02. This difference is independent of and does not supersede the air void or VMA specification and confirmation tolerance.

Bulk specific gravity of aggregate, G_{sb}: The difference between any two labs cannot exceed 0.040 individual fraction, (+#4 AND -#4), and 0.02 combined. This difference is independent of and does not supersede the VMA specification and confirmation tolerance.

Voids Filled with Asphalt, VFA: If ITD's results for VMA and Air voids are within the tolerances provided the calculated VFA will not be used as an acceptance criteria.

Dust to Binder, DP: The Dust to Binder Ratio, or Dust Proportion, is considered acceptable if the value determined by ITD is ±0.1 from the applicable published range in Table 405.02-1 of Standard Specification.

Asphalt Binder Content, P_b: Asphalt Binder content is considered acceptable if the value determined by ITD is within ±0.4 of the job mix formula value.

SECTION 265.00 – QUALIFIED AGGREGATE MATERIAL SUPPLIERS

The District Materials Engineer will maintain current lists of qualified aggregate material suppliers. The lists will be divided by the aggregate product category. To be included on a list means the aggregate supplier has provided the state with adequate documentation to verify conformance with state specifications, including but not limited to Standard Specification Sections 106.09, 107.02, 107.17, 107.18, 703.12, and 703.13. Sampling and testing will be by an approved independent laboratory. The purpose of having the current lists is to provide ITD personnel and contractors with readily available information regarding aggregate suppliers that have met the requirements for aggregate quality and source clearance. The availability and quantity of the material in the source is not to be implied.

The lists do not imply acceptance of material should the quality change or the material not meet the contract requirements. The material must meet the contract requirements for acceptance.

The Resident Engineer has the authority to grant written approval for a contractor to use an aggregate source from the qualified material suppliers list for a specific project, providing the District Materials Engineer concurs.

The aggregate supplier's source will be identified by pit number and location. Combining stockpiles or aggregates from other sources that are not qualified will invalidate the qualification. The source may be included on the list for a period of not more than two years before the source must be re-evaluated by the District Materials Engineer. The re-evaluation will be based on the suppliers' current operation and adequate documentation provided by the supplier, including new test results when necessary, to determine specification compliance. An aggregate source may be removed from a list at any time should evidence of noncompliance exist.

ITD may test source aggregates to evaluate the submitted test results. The Contractor shall provide full access to the source, including raw and crushed materials, for ITD sampling and testing.

Refer to Subsection 106.09-II, Contractor Furnished Source, in the Contract Administration Manual for administration of source approval.

265.01 Qualified Asphalt Mix Aggregate and Base Aggregate Suppliers. The District Materials Engineer will evaluate the source based on Standard Specifications Section 703 – Aggregates, and applicable asphalt mix specification requirements. In no case will inclusion on the list imply approval of a mix design, job-mix formula, or specification material.

Mix designs or job-mix formulas will be evaluated separately for each project based on Standard Specification Section 405.03(A).

265.02 Qualified Concrete Aggregate Suppliers. The District Materials Engineer will evaluate the source based on Standard Specifications Section 703 – Aggregates, and applicable concrete specification requirements and notify the supplier if the source is qualified to be included on the list. Inclusion on the list does not imply approval of a concrete mix design or specification material.

265.03 Other Specification Aggregate Items. Other aggregate items not included in the base, asphalt mix, or concrete categories that have quality requirements may be listed as qualified, providing the supplier submits adequate documentation to the district for evaluation to verify specification conformance.

SECTION 270.00 – MINIMUM TESTING REQUIREMENTS

SECTION 270.00 – MINIMUM TESTING REQUIREMENTS

The following tables outline the minimum testing and acceptance requirements for materials incorporated into ITD construction projects and are a part of the ITD Quality Assurance Program. The tables apply to the sampling and testing of material characteristics not specified as accepted by statistical procedures. For material characteristics accepted by statistical procedures, the acceptance requirements are included in Table 106.03-1 of the Quality Assurance (QA) Special Provision. On projects containing the QA Special Provision (QC/QA projects), the minimum testing requirements outlined herein apply for all material characteristics not included in Table 106.03-1 of the QA Special Provision.

The requirements outlined herein are the established minimum acceptance requirements for materials used in standard applications and paid for under standard bid items. For special provision items, material used in non-standard, non-roadway or temporary applications or small quantities of materials alternative materials acceptance requirements will be determined as discussed herein or as specified in the contract documents.

Minimum testing frequencies are included in the tables. These frequencies may be reduced by change order with the concurrence of the District Materials Engineer and HQ Quality Assurance Engineer for materials with a history of uniform test results and exhibiting good quality material. The Engineer may elect to increase testing frequency at any time. Testing frequency should be increased when accepting material from newly developed sources or those with a wide range of results.

270.01 Content of the MTR Tables. The MTR tables are organized by Standard Specification Section. For each material listed, the testing and acceptance requirements are included. The tables also include ITD specification references and test methods. The tables indicate who is responsible for sampling and testing for each material. The required report form numbers columns include forms related to materials acceptance that are the responsibility of the project personnel. Some reports generated as a result of HQ testing are included and indicated as a Lab Report.

The *minimum required frequency* columns list the maximum quantity, and fractions of a quantity of material that can be represented by a single test. For example, a frequency of “Each 500 m^3” for gradation indicates that there must be one gradation test located within each 500 cubic meters of material accepted. Testing for each item and material must be distributed throughout the project to represent the total quantity of material accepted.

There are three types of testing listed in the *purpose of testing* columns: Acceptance, Verification and Independent Assurance. Acceptance of material is by one or a combination of the following as indicated in the MTR tables:

- acceptance testing performed by the State
- certification
- certification with quality control or other test results provided by the supplier or manufacturer
- pretesting by the State
- inspection by the State and
- laboratory testing by the State

For some materials, verification testing is indicated and is in addition to materials acceptance. Verification testing is typically performed by the HQ Central Laboratory and is used to verify manufacturer’s certifications.

Independent assurance requirements are also included in the tables. The Independent Assurance Program is described in detail in Section 300.00.

The *remarks, notes or additional directions* columns of the tables specify the location of acceptance, references to sections of the manual, small quantity exceptions, and other notes and remarks as applicable.

270.02 Source Approval. Materials source approval requirements and associated quality testing, such as Idaho Degradation, LA Abrasion and Ethylene Glycol testing, are not included in the tables. All fill and aggregate materials imported from off the project must be obtained from approved materials sources. Section 265.00 provides an overview of the materials source approval process.

270.03 Obviously Defective Material. Based on inspection and without regard for testing frequency, the Engineer may isolate and reject obviously defective material.

270.04 Acceptance of Small Quantities. The Department may accept small quantities of certain materials without sampling and testing. The determination to accept materials using this provision rests solely with the Engineer. The Engineer may elect to sample and test small quantities at any time. The following materials are not eligible for small quantity acceptance:

- Materials that are accepted by manufacturer's certification. Manufacturer's certifications must be provided for all quantities of material accepted by certification.
- Concrete with a specified strength of greater than 3000 psi
- Paving on the Interstate, with quantities above 100 ton including median crossovers

Material can be accepted as a small quantity if the estimated plan quantity is less than the minimum testing frequency. The following minimum requirements must be met and documented when using small quantity acceptance:

- Aggregates must be obtained from approved materials sources
- A mix design must be submitted, reviewed and approved by the Engineer prior to use for plant mix pavement and concrete items.
- Visual inspection of the materials during installation, placement or compaction
- For small quantities of traveled way paving, intersection paving or paving at intersection radiuses, cores are required in accordance with Standard Specification 405.03L for in-place density acceptance. Small quantity pavement applications that do not require cores for in-place density acceptance include small patches, utility repairs, and pavement placed outside the traveled way.

The basis for acceptance of the material must be documented. Documentation will be by file memo and will be included in the daily diary or will be on field or test reports. A brief statement summarizing the basis for acceptance must be included in the Materials Summary Report submitted at the end of the project. Examples of basis for small quantity acceptance are as follows:

- Satisfactory test results on the same material from a recent or concurrent project
- Visual inspection of the materials and installation
- Material Certification (ITD-851) with supporting QC or manufacturer's test results where applicable
- The use of sufficient compaction effort and equipment, as determined by the Engineer

Sampling and laboratory verification testing may be waived for the following items when the quantity of material is equal to or less than that indicated below:

Asphalt (Emulsified)	2000 gallons; 7600 liters (8 tons)
Asphalt (PG Binder)	22 Tons (20 t)
Cement, Lime, Fly ash	40 cubic yards of concrete placed
Geotextiles	600 square yards (500 square meters)

270.05 Non-standard Acceptance of Materials. Acceptance requirements will be determined on a case by case basis for the following regardless of the quantity and identified on ITD-862 form:

- material not permanently incorporated into the project (temporary detours, etc.)
- when sampling and testing per the standard requirements is not applicable due to the application or use of the material
- when sampling and testing per the standard requirements is not applicable due to the sequence of placement

Some examples of non-standard applications are:

- driveways
- field approaches
- mailbox turnouts
- asphaltic ditches and slopes
- material behind guardrail and for guardrail terminals
- asphaltic sidewalk and curb

The Engineer, in consultation with the District Materials Engineer, will develop a written acceptance plan that identifies the non-standard acceptance criteria prior to incorporating the material.

For numerous fractions of an item, such as short pipe extensions, where the required minimum frequency of testing is not practical, a written acceptance plan can be developed to replace some of the testing with visual inspection. The plan must be approved prior to incorporating the material.

The minimum requirements listed for small quantities (Section 270.04) must be met (i.e. approved sources, mix designs approval, inspection and cores for mainline and intersection paving). The documentation requirements for materials acceptance will be the same as those outlined for small quantity acceptance.

270.06 Special Provision Items. A Special Provision pay item may include multiple different materials, all of which require acceptance. When the materials acceptance requirements for a special provision item are not included in the contract the acceptance requirements for each material incorporated will be determined based on the following criteria:

- When the material is included in the MTR tables and is being used in a standard application, the MTR table acceptance requirements will be used.
- When the material is not included in the MTR tables or is not being used in a standard application, acceptance requirements will be determined by the Engineer, in consultation with the District Materials Engineer.
- When the material is required by the contract to meet a given specification, such as an ASTM or AASHTO specification, at minimum, acceptance of material will require a manufacturer's certification in accordance with Section 230.00.

A brief statement summarizing the basis for acceptance must be included in the Materials Summary Report submitted at the end of the project.

270.07 Change Order Items. A Change Order can include material to be paid for under standard pay items or can establish nonstandard pay items. For standard pay items, the MTR tables will apply. Acceptance requirements for nonstandard items will be determined based on the following criteria:

- When the material is included in the MTR tables and is being used in a standard application, the MTR table acceptance requirements will be used. This would include a change order that is paid by lump sum and includes materials covered in the MTR tables.
- When the material is not included in the MTR tables or is not being used in a standard application, acceptance requirements will be determined by the Engineer, in consultation with the District Materials Engineer.
- When the material is required by the change order or by reference to meet a given specification, such as an ASTM or AASHTO specification, at minimum, acceptance of material will require a manufacturer's certification in accordance with Section 230.00.

A brief statement summarizing the basis for acceptance must be included in the Materials Summary Report submitted at the end of the project.

270.08 MASH or NCHRP-350 Requirements. Manual for Assessing Safety Hardware (MASH) or National Cooperative Highway Research Program (NCHRP) report 350 recommended procedures for conducting vehicle crash tests and in-service evaluation of roadside safety features. The features covered by these procedures primarily can be grouped into four categories; (1) longitudinal barriers (2) crash cushions, truck-mounted attenuators (TMA); (3) support structure; (4) work zone traffic control devices. Following are the definitions of roadside safety features categories;

- **Longitudinal Barrier:** A device whose primary functions are to prevent vehicular penetration and to safely redirect an errant vehicle away from a roadside or median hazard. The longitudinal barriers include roadside barriers, median barriers, bridge rails, guardrails, transitions, and terminals.
- **Crash Cushion and TMA:** A device designed primarily to safely stop a vehicle within a relatively short distance.
- **Support Structure:** A system used to support a sign panel, chevron panel, luminaire, utility lines, mailbox, or emergency call box. The system includes the post(s), pole(s), structural elements, foundation, breakaway mechanism if used, and accompanying hardware used to support the given feature.
- **Work Zone Traffic Control Device:** A device used in a work zone to regulate, warn, and guide road users and advise them to traverse a section of highway or street in the proper manner. Work zone traffic control devices include signs, plastic drums, lights that may be used, cones, barricades, chevron panels, and their support system; and any other such device(s) commonly exposed to traffic that may pose a hazard to occupants of a vehicle and/or to work zone personnel.

  These items if used or permanently added to the project must have certs (ITD 851) from the Manufacturer meeting MASH or NCHRP-350 requirements.

BID ITEM/ MATERIAL TYPE OF CONSTRUCTION	PURPOSE OF TESTING	ITD SPEC. REF. SAMPLED BY	TEST METHOD TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **205 EXCAVATION AND EMBANKMENT**						
Excavation, Class C Compaction Excavated to top of subgrade or below Natural ground under embankments	ACCEPTANCE In-Place Density (1)	205.03 (E)	AASHTO T 99 AASHTO T 180 AASHTO T 224 AASHTO T 272 Idaho IT-74 AASHTO T 310 Method B	ITD-850	Each 5000 SY.	Obtain check tests within 10 feet (3m) and at same depth as original test.
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE In-Place Density	IA Inspector	IA Inspector	ITD-857	Observation one(1) per project	
Excavation Subgrade Embankment Fill	ACCEPTANCE In-Place Density (1)	205.03 (E)	AASHTO T 99 AASHTO T 180 AASHTO T 224 AASHTO T 272 Idaho IT-74 AASHTO T 310 Method B	ITD-850	Each 2,500 CY or 4,000 tons (2000 m^3 or 3500 t), but not less than one (1) test per lift for each bottom 3 and each top 3 lifts and 1 test every 2500 CY or 4000 tons in between.	Obtain check tests within 10 feet (3m) and at same depth as original test. Document compaction effort (equipment, number of passes etc.) for lifts not tested.
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE In-Place Density	IA Inspector	IA Inspector	ITD-857	Observation one (1) per project	

(1) Document that the material is too granular to test on the ITD-850 by completing gradation, compaction effort (including equipment and roller passes), and SE(for granular borrow and if more than 5% passing the #200 sieve) at the same frequency as the required density acceptance.

Note: Median areas and on slopes (approximate 2H:1V) that are outside the roadway prism where Class D compaction is required, fill out ITD-850 listing at least one coverage using Engineer approved track-type or rubber tired earth moving equipment.

205-1

205-2

BID ITEM/ MATERIAL TYPE OF CONSTRUCTION	PURPOSE OF TESTING	ITD SPEC. REF. SAMPLED BY	TEST METHOD TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
Borrow Subgrade Embankment Fill	ACCEPTANCE In-Place Density (1)	205.03 (E)	AASHTO T 99 AASHTO T 180 AASHTO T 224 AASHTO T 272 Idaho IT-74 AASHTO T 310 Method B	ITD-850	Each 2,500 CY or 4,000 tons (2000 m^3 or 3500 t) but not less than one (1) test per lift for each bottom 3 and each top 3 lifts and 1 test every 2500 CY or 4000 tons in between.	Obtain check tests within 10 feet (3m) and at same depth as original test. Document compaction effort (equipment, number of passes etc.) for lifts not tested.
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE In-Place Density	IA Inspector	IA Inspector	ITD-857	Observation one(1) per project	
Granular Borrow Subgrade Embankment Fill	ACCEPTANCE In-Place Density (1)	205.03 (E)	AASHTO T 99 AASHTO T 180 AASHTO T 224 AASHTO T 272 Idaho IT-74 AASHTO T 310 Method B	ITD-850	**Each 5000 CY but not less than one test per lift for each bottom 3 and each top 3 lifts and 1 test every 5000 CY in between.**	Obtain check tests within 10 feet (3m) and at same depth as original test. Document compaction effort (equipment, number of passes etc.) for lifts not tested.
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE In-Place Density	IA Inspector	IA Inspector	ITD-857	Observation one (1) per project	
	ACCEPTANCE Sand Equivalent	205.02	AASHTO T 176 Method 2	ITD-901	Each 10,000 CY (7500 m^3)	Sand equivalent requirements do not apply to Recycled Asphalt Pavement (RAP) used as granular borrow.
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE Sand Equivalent	IA Inspector	IA Inspector	ITD-857	Each 200,000 CY (150,000 m^3)	
Soft Spot Repair	ACCEPTANCE In-Place Density (1)	205.03 (D)	AASHTO T 99 AASHTO T 180 AASHTO T 224 AASHTO T 272 Idaho IT-74 AASHTO T 310 Method B	ITD-850	Each repair area or combination of areas but not less than each 300 SF	
		ITD Project Personnel	ITD Project Personnel			

(1) Document that the material is too granular to test on the ITD-850 by completing gradation, compaction effort (including equipment and roller passes), and SE(for granular borrow and if more than 5% passing the #200 sieve) at the same frequency as the required density acceptance.

Note: Median areas and on slopes (approximate 2H:1V) that are outside the roadway prism where Class D compaction is required, fill out ITD-850 listing at least one coverage using Engineer approved track-type or rubber tired earth moving equipment.

BID ITEM/ MATERIAL / TYPE OF CONSTRUCTION	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **209 – SMALL DITCHES**						
Small Ditches When constructed upon dikes	ACCEPTANCE In-Place Density (1)	205.03 209.03	AASHTO T 99 AASHTO T 180 AASHTO T 224 AASHTO T 272 Idaho IT-74 AASHTO T 310 Method B	ITD-850	One (1) per project	Testing required only when constructed upon dikes per Standard Specification Subsection 209.03.
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE In-Place Density	IA Inspector	IA Inspector	ITD-857	Observation one (1) per project	
(1) Document that the material is too granular to test on the ITD-850 by completing gradation, compaction effort (including equipment and roller passes), and SE(for granular borrow and if more than 5% passing the #200 sieve) at the same frequency as the required density acceptance.						
Note: Median areas and on slopes (approximate 2H:1V) that are outside the roadway prism where Class D compaction is required, fill out ITD-850 listing at least one coverage using Engineer approved track-type or rubber tired earth moving equipment.						

209

210

BID ITEM/ MATERIAL TYPE OF CONSTRUCTION	PURPOSE OF TESTING	ITD SPEC. REF. SAMPLED BY	TEST METHOD TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **210 – COMPACTING BACKFILL**						
Compacting Backfill (Structure Backfill)	ACCEPTANCE In-Place Density (1)	210.03 ITD Project Personnel	AASHTO T 99 AASHTO T 180 AASHTO T 224 AASHTO T 272 Idaho IT-74 AASHTO T 310 Method B ITD Project Personnel	ITD-850	Each 2,500 CY or 4,000 tons (2000 m³ or 3500 t) for each structure component. Abutments for Bridge approach slabs not less than one test per 8in compacted lift.	Document compaction effort for each lift. Obtain check tests within 10 feet (3m) and at same depth as original test. See QA Manual Section 275 for AASHTO T310.
	INDEPENDENT ASSURANCE In-Place Density	IA Inspector	IA Inspector	ITD-857	Observation one (1) per project	
Compacting Backfill (Pipe Backfill)	ACCEPTANCE In-Place Density (1)	210.03 ITD Project Personnel	AASHTO T 99 AASHTO T 180 AASHTO T 224 AASHTO T 272 Idaho IT-74 AASHTO T 310 Method B ITD Project Personnel	ITD-850	Each 200 LF of pipe installed, but no less than one (1) test per pipe installed.	See QA Manual Section 275 for AASHTO T310. A pipe is considered the total continuous length as shown on the project pipe summary sheet.
	INDEPENDENT ASSURANCE In-Place Density	IA Inspector	IA Inspector	ITD-857	Observation one (1) per project	
Compacting Backfill (Retaining Wall Backfill)	ACCEPTANCE In-Place Density(1)	210.03 ITD Project Personnel	AASHTO T 99 AASHTO T 180 AASHTO T 224 AASHTO T 272 Idaho IT-74 AASHTO T 310 Method B ITD Project Personnel	ITD-850	Each 2,500 CY or 4,000 Tons (2000 m³ or 3500 t)	Document compaction effort for each lift. Obtain check tests within 10 feet (3m) and at same depth as original test. See QA Manual Section 275 for AASHTO T310.
	INDEPENDENT ASSURANCE In-Place Density	IA Inspector	IA Inspector	ITD-857	Observation one (1) per project	
(1) Document that the material is too granular to test on the ITD-850 by completing gradation, compaction effort (including equipment and roller passes), and SE(for granular borrow and if more than 5% passing the #200 sieve) at the same frequency as the required density acceptance.						
Note: Median areas and on slopes (approximate 2H:1V) that are outside the roadway prism where Class D compaction is required, fill out ITD-850 listing at least one coverage using Engineer approved track-type or rubber tired earth moving equipment.						

BID ITEM/ MATERIAL TYPE OF CONSTRUCTION	PURPOSE OF TESTING	ITD SPEC. REF. SAMPLED BY	TEST METHOD TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **212 – EROSION AND SEDIMENT CONTROL**						
Slope Drain	ACCEPTANCE Certification	212.03 (B) 706 Manufacturer	 Manufacturer	ITD-914 (Steel) ITD-851 (All other material)	Total Quantity Paid	See QA Manual Section 230.00
Fiber Wattles	ACCEPTANCE Certification	711.20 Manufacturer	 Manufacturer	ITD-851	Total Quantity Paid	Certified noxious weed-free grain straw
Sediment Trap	ACCEPTANCE (Erosion Control Geotextile) Certification	212.03 (B) Manufacturer	 Manufacturer	ITD-849	Total Quantity Paid	See QA Manual Section 230.09
	VERIFICATION (Erosion Control Geotextile) Laboratory Test	212.03 (B) ITD Project Personnel	 ITD Central Lab	ITD-1044 (Sample Data) ITD-1047 (Lab Report)		No Samples required for quantities less than 600 SY (500 m^2)
Silt Fence	ACCEPTANCE Certification	212.03 (B) 718.09 Manufacturer	 Manufacturer	ITD-849	Total Quantity Paid	See QA Manual Section 230.09
	VERIFICATION Laboratory Test	212.03 (B) 718.09 ITD Project Personnel	 ITD Central Lab	ITD-1044 (Sample Data) ITD-1047 (Lab Report)		No samples required for quantities less than 500 linear feet (150 m)
Diversion Channels and Ditches	ACCEPTANCE Inspection	212.03 (B) No sample required	 No testing required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
	ACCEPTANCE Certification	212.03 (B) Manufacturer	 Manufacturer	ITD-849 (When Erosion Control Geotextile used)	Total Quantity Paid	See QA Manual Section 230.09
	VERIFICATION Laboratory Test	212.03 (B) ITD Project Personnel	 ITD Central Lab	ITD-1044 (Sample Data) ITD-1047 (Lab Report)		No Samples required for quantities less than 600 SY (500 m^2)
Dikes and Berms	ACCEPTANCE Inspection	212.03 (B) No sample required	 No testing required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00

212-1

212-2

BID ITEM/ MATERIAL TYPE OF CONSTRUCTION	PURPOSE OF TESTING	ITD SPEC. REF. SAMPLED BY	TEST METHOD TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
Open-top Culvert	ACCEPTANCE Inspection	212.03 (B) No sample required	 No testing required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
Water Bar	ACCEPTANCE Inspection	212.03 (B) No sample Required	 No testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
Siltation Berm	ACCEPTANCE Inspection	212.03 (B) No sample Required	 No testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
Stabilized Construction Entrance	ACCEPTANCE Inspection	212.03 (B) No sample Required	 No testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
	ACCEPTANCE (Erosion Control Geotextile) Certification	212.03 (B) Manufacturer	 Manufacturer	ITD-849	Total Quantity Paid	See QA Manual Section 230.09
	VERIFICATION (Erosion Control Geotextile) Laboratory Test	212.03 (B) ITD Project Personnel	 ITD Central Lab	ITD-1044 (Sample Data) ITD-1047 (Lab Report)	One (1) sample per lot	No Samples required for quantities less than 600 SY (500 m^2)
Soil Binder	ACCEPTANCE Certification	212.03 (B) Manufacturer	 Manufacturer	ITD-851	Total Quantity Paid	Certification of non-toxic properties
Gabion	ACCEPTANCE Inspection	212.03 (C) No sample required	 No testing required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
	ACCEPTANCE (Wire Mesh) Certification	715.01 Manufacturer	 Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Section 230.01
	ACCEPTANCE (Joints) Certification	715.05 Manufacturer	 Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Section 230.01
	ACCEPTANCE (Fill Materials) Inspection	715.06 No sample required	 No testing Required	ITD-854		
	ACCEPTANCE (Geotextile)	FOLLOW STANDARD SPECIFICATION SECTION 640				

BID ITEM/ MATERIAL TYPE OF CONSTRUCTION	PURPOSE OF TESTING	ITD SPEC. REF. SAMPLED BY	TEST METHOD TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
Gabion (Continued)	ACCEPTANCE (Backfill) In-place Density	210.03 212.03 (C)	AASHTO T 99 Method C or D AASHTO T 310 Method B	ITD-850	Each 2,500 CY or 4,000 Tons (2000 m^3 or 3500 t)	Document compaction effort for each lift. Obtain check tests within 10 feet (3m) and at same depth as original test.
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE In-Place Density	IA Inspector	IA Inspector	ITD-857	One (1) observation per project	
Revet Mattress	ACCEPTANCE (Erosion Control Geotextile) Certification	718		ITD-849	Total Quantity Paid	See QA Manual Section 230.09
		Manufacturer	Manufacturer			
	VERIFICATION (Erosion Control Geotextile) Laboratory Test	212.03 (C)		ITD-1044 (Sample Data) ITD-1047 (Lab Report)	One (1) sample per lot	No Samples required for quantities less than 600 SY (500 m^2)
		ITD Project Personnel	ITD Central Lab			
Stone Filter Berms/Dams	ACCEPTANCE Inspection	212.03 (C) Permanent Measures		ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
		No sample required	No testing required			
Sediment Basin	ACCEPTANCE Inspection	212.03 (C) Permanent Measures		ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
		No sample required	No testing required			

212-3

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **301- GRANULAR SUBBASE**						
Aggregate	ACCEPTANCE Gradation(1) Sand Equivalent	301.02 703.11	AASHTO T 2 AASHTO T 248 AASHTO T 27 AASHTO T 255 AASHTO T 265 AASHTO T 176 Method 2, Mechanical	ITD-901	Each 5,500 Tons (5000 t)	Acceptance from windrow or roadway. Wash method not required. Moisture percent required for payment only
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE Gradation Sand Equivalent	IA Inspector	IA Inspector	ITD-857	Each 110,000 Tons (100,000 t)	
(1) The test sample mass for sieve analysis will be determined using the nominal maximum size of the tested material according to AASHTO T27, except the maximum test sample mass, after reduction, will not be greater than 65 lbs.						
Compacted Roadway	ACCEPTANCE In-Place Density	301.02	Idaho IT-74 AASHTO T 180 AASHTO T 310 Method B	ITD-850	Each 5,500 Tons (5000 t)	Contractor is responsible to provide Idaho IT 74 density curve.
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE In-Place Density	IA Inspector	IA Inspector	ITD-857	One (1) observation per project	
Reclaimed Asphalt Pavement	ACCEPTANCE Gradation	301.02	Visual Inspection	ITD-854	Each 5,500 Tons (5000 t)	
		ITD Project Personnel	ITD Project Personnel			
	ACCEPTANCE In-Place Density	301.03	WAQTC TM8 modified	ITD-854	Each 7200 SY (6000 M2) each lift	
		ITD Project Personnel	ITD Project Personnel			

301

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **302 – EMULSION TREATED BASE**						
Emulsified Asphalt	ACCEPTANCE Certification	702.03 702.05 Manufacturer	Manufacturer	Loading Certificate	Each shipment to the project	See QA Manual Section 230.11
	ACCEPTANCE Saybolt Viscosity Field Test	702.03 ITD Project Personnel	Idaho IT 61 ITD Project Personnel	ITD-1045	Test each load for Saybolt viscosity. **Reject failing loads.**	Do not sample emulsions from storage tank discharge lines.
	VERIFICATION Laboratory Tests(1)	702.03 ITD Project Personnel	AASHTO T 59 ITD Central Laboratory	ITD-1045	One (1) undiluted sample per project	(1)No samples for laboratory testing required when total project quantity is less than 2000 Gal (8 tons).
Aggregate (prior to mixing)	ACCEPTANCE Gradation Sand Equivalent Fracture Count	302.02 703.04 ITD Project Personnel	AASHTO T 2 AASHTO T 248 AASHTO T 27 AASHTO T 11 AASHTO T 255 AASHTO T 265 AASHTO T 176 Method 2, Mechanical AASHTO T 335 Method 1 ITD Project Personnel	ITD-901	Each 700 CY (500 m^3) or 1000 Tons (900 t)	Acceptance at point of delivery prior to mixing. Moisture percent required for payment only
	INDEPENDENT ASSURANCE Gradation Sand Equivalent Fracture Count	IA Inspector	IA Inspector	ITD-857	Each 14,000 CY (10,000 m^3) or 20,000 tons (18,000 t)	
Compacted Roadway	ACCEPTANCE In-Place Density	302.03 ITD Project Personnel	AASHTO T 310 Method B ITD Project Personnel	ITD-850	Each 700 CY (500 m^3) or 1000 Tons (900 t)	
	INDEPENDENT ASSURANCE In-Place Density	IA Inspector	IA Inspector	ITD-857	One (1) observation per project	

302

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **303 – AGGREGATE BASE**						
Aggregate	ACCEPTANCE Gradation Sand Equivalent Fracture Count	303.02 703.04	AASHTO T 2 AASHTO T 248 AASHTO T 27 AASHTO T 11 AASHTO T 255 AASHTO T 265 AASHTO T 176 Method 2, Mechanical AASHTO T 335 Method 1	ITD-901	Each 700 CY (500 m^3) or 1000 Tons (900 t)	Acceptance from windrow or roadway. Moisture percent required for payment only
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE Gradation Sand Equivalent Fracture Count	IA Inspector	IA Inspector	ITD-857	Each 14,000 CY (10,000 m^3) or 20,000 tons (18,000 t)	
Compacted Roadway	ACCEPTANCE In-Place Density	303.02	AASHTO T 310 Method B	ITD-850	Each 700 CY (500 m^3) or 1000 tons (900 t)	Contractor is responsible for providing an Idaho T 74 density curve.
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE In-Place Density	IA Inspector	IA Inspector	ITD-857	One (1) observation per project	

303

	BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
304	STANDARD SPECIFICATION SECTION: **304 – RECONDITIONING**						
	Pulverizing Roadbed	ACCEPTANCE Gradation	304.03 / ITD Project Personnel	AASHTO T 2 AASHTO T 248 AASHTO T 27 / ITD Project Personnel	ITD-901 & ITD-854	One test after start of pulverizing, then visual inspection.	Wash method not required.
		ACCEPTANCE In-Place Density	304.03 / ITD Project Personnel	WAQTC T M8 modified per Section 275.00 (CRABS) / ITD Project Personnel	ITD-855 or ITD-854	Establish roller pattern every lane mile.	Acceptance at roadway. See QA Manual Section 275.00
	Soft Spot Repair	ACCEPTANCE In-Place Density	205.03 D 304.03 / ITD Project Personnel	AASHTO T 310 Method B / ITD Project Personnel	ITD-850	Each repair area or combination of areas but not less than each 300 SF	
307	STANDARD SPECIFICATION SECTION: **307 – OPEN-GRADED BASE**						
	Aggregate	ACCEPTANCE Gradation (1)	703.08 / ITD Project Personnel	AASHTO T 2 AASHTO T 27 / ITD Project Personnel	ITD-901	Each 1800 CY (1300 m^3) or 2500 Tons (2300t)	Acceptance at Crusher Conveyor Belt. Reducing & wash method not required for Class 1 & 2 only. Dry to constant mass is not required for Class 1 & 2 only
		INDEPENDENT ASSURANCE Gradation	IA Inspector	IA Inspector	ITD-857	Each 14,000 CY (10,000 m^3) or 20,000 Tons (18,000 t)	Field Test samples will be used for IA evaluation. No split samples required.
		ACCEPTANCE In-place Density	307.03 / ITD Project Personnel	Method Specification / ITD Project Personnel	ITD-850	Each 3000 LF but not less than once per day	

(1) The minimum test sample mass for AASHTO T27 Sieve Analysis will be 65 lbs.

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIAL PROVISION: **308 – CEMENT RECYCLED ASPHALT BASE STABILIZATION (CRABS)**						
Cement	ACCEPTANCE Certification	701.01 / Manufacturer	AASHTO M 85 / Manufacturer	Bill of Ladding with chemical analysis attached	Weekly	See QA Manual Sections 230.02 and 230.02.01
	VERIFICATION Laboratory Test	701.01 / ITD Project Personnel	ITD Central Lab	ITD-1044 (Sample Data) ITD-1825 (Lab Report)	One (1) sample per project	Price adjustment for failing cement.
Pulverizing Roadbed	ACCEPTANCE Gradation	308.03 / ITD Project Personnel	AASHTO T 2 AASHTO T 248 AASHTO T 27 / ITD Project Personnel	ITD-901	Prior to compaction each lane mile	Acceptance at roadway prior to compaction. Wash method not required.
Compacted Roadway	ACCEPTANCE In-Place Density	308.03 / ITD Project Personnel	WAQTC TM 8 modified per Section 275.00 (CRABS) / ITD Project Personnel	ITD-850	Verify the contractor met the density specification every lane mile or when mixture properties changes.	Acceptance at roadway. See QA Manual Section 275.00 See SSP 308

308

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **401 TACK COAT**						
Emulsified Asphalt	ACCEPTANCE Certification	702.03 702.05		Loading Certificate	Each individual truck, trailer, car or shipment to the project.	See QA Manual Section 230.11
		Manufacturer	Manufacturer			
	VERIFICATION Laboratory Tests	702.03	AASHTO T 59	ITD-1045	One (1) undiluted sample (as received from the asphalt supplier) per project	No samples required when total project quantity is less than 2000 Gal (7600 L) 8 Tons.
		ITD Project Personnel	ITD Central Laboratory			
STANDARD SPECIFICATION SECTION: **402 PRIME COAT**						
Emulsified Asphalt	ACCEPTANCE Certification	702.03 702.05		Loading Certificate	Each individual truck, trailer, car or shipment to the project.	See QA Manual Section 230.11
		Manufacturer	Manufacturer			
	VERIFICATION Laboratory Tests	702.03	AASHTO T 59	ITD-1045	One (1) undiluted sample (as received from the asphalt supplier) per project	No samples required when total project quantity is less than 2000 Gal (7600 L) 8 Tons.
		ITD Project Personnel	ITD Central Laboratory			
Blotter	ACCEPTANCE Gradation	703.07 402.02	AASHTO T 2 AASHTO T 248 AASHTO T 27 AASHTO T 11	ITD-901	One (1) field gradation per source.	Sample at point of loading to the project.
		ITD Project Personnel	ITD Project Personnel			
STANDARD SPECIFICATION SECTION: **403 SEAL COAT, 404 SURFACE TREATMENT**						
Asphalt & Cover Coat Material	Design of Seal Coats	403 404 703	Idaho T 60 Or McLeod Method	ITD-1044 (Sample Data)	The contractor furnishes the seal coat design.	
		ITD Project Personnel	ITD District Lab			
Distributors: Shall be certified each season. The contractor shall submit distributor certification to the Engineer prior to beginning work.						
Emulsified Asphalt	ACCEPTANCE Saybolt Viscosity Field Test	702.03	Idaho IT 61	ITD-1045	Test each load for Saybolt viscosity. If the district Saybolt viscosity result is outside specified limits, **reject the load.**	Do not sample emulsions from storage tank discharge lines.
		ITD Project Personnel	ITD Project Personnel			
	ACCEPTANCE Certification	702.03 702.05		Loading Certificate	Each individual truck, trailer, car or shipment to the project.	See QA Manual Section 230.11
		Manufacturer	Manufacturer			

403/404-2

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
Emulsified Asphalt (cont.)	VERIFICATION Laboratory Tests	702.03	AASHTO T 59	ITD-1045	Each 25,000 Gal or 100 Tons	No samples required when total project quantity is less than 2000 Gal (7600 L) 8 Tons.
		ITD Project Personnel	ITD Central Laboratory			
	INDEPENDENT ASSURANCE Viscosity Field Test	IA Inspector	IA Inspector	ITD-857	One (1) observation of Saybolt viscosity per project.	See QA Manual Sections 330.00 & 380.00
PG. Binder	ACCEPTANCE Certification	702.01 702.05		ITD-966	Initial lot & each new lot to project	See QA Manual Sections 230.10 & 255.00
		Manufacturer	Manufacturer	Loading Certificate	Each shipment to project	
	VERIFICATION Laboratory Tests	702.01	AASHTO M 320 AASHTO T 40	ITD-859 ITD-859AW	One (1) sample (3 quart cans) per shift combined into weekly binder verification unit. Sampled from the line between the storage tank (or the delivery truck) and the mix plant. Purge one gallon from the injection line valve before taking sample	No samples required when total project quantity is less than 22 tons(20t)
		ITD Project Personnel	ITD Central Laboratory			
Anti-Strip Additive	ACCEPTANCE Presence of Anti-Stripping Additive	702.04	Idaho T 99 (color method only)	ITD-859	Test the initial truck & trailer prior to unloading into the contractor's storage tank. Thereafter, test at same frequency as sampling of asphalt. Purge one gallon from the injection line valve before taking sample	If anti-strip cannot be detected, the supplier must add the anti-strip on-site.
		ITD Project Personnel	ITD Project Personnel			
Cover Coat Material	ACCEPTANCE Gradation Cleanness Value Fracture Count	703.06 403.02	AASHTO T 2 AASHTO T 248 AASHTO T 27 AASHTO T 11 Idaho IT 72 AASHTO T 335 Method 1	ITD-901	Each 280 CY (200 m^3) or 400 Tons (360 t) 26,000 yd2 or 22,000 m2	Sample at point of loading to the roadway
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE Gradation Cleanness Value Fracture Count	IA Inspector	IA Inspector	ITD-857	Each 5600 CY (4000 m3) or 8000 Tons (7200 t).	

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
Blotter	ACCEPTANCE Gradation	703.07 403.02 404.02 ITD Project Personnel	AASHTO T 2 AASHTO T 248 AASHTO T 27 AASHTO T 11 ITD Project Personnel	ITD-901	One (1) field gradation per source.	Sample at point of loading to the project.
Choke Sand	ACCEPTANCE Gradation	703.07 403.02 404.02 ITD Project Personnel	AASHTO T 2 AASHTO T 248 AASHTO T 27 AASHTO T 11 ITD Project Personnel	ITD-901	One (1) per day	Sample at point of loading to the project.

403/404-3

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **405 SUPERPAVE HOT MIX ASPHALT**						
	ACCEPTANCE Certification	702.01 702.05		ITD-966	Initial lot & each new lot to project	See QA Manual Sections 255.00
		Manufacturer	Manufacturer	Loading Certificate	Each shipment to project	
Performance Graded Binder	VERFICATION Laboratory Tests	AASHTO T 40 AASHTO M 320	AASHTO T 40	ITD-859 ITD-859AW	One (1) sample (3 quart cans) per shift combined into weekly binder verification unit. Sampled from the line between the storage tank (or the delivery truck) and the mix plant. Purge one gallon from the injection line valve before taking sample	No samples required when total quantity is less than 22 Tons (20 t) See QA Manual Section 255.00
		ITD Project Personnel	HQ Central Lab			
Anti-Strip Additive	ACCEPTANCE Presence of Anti-Stripping Additive	702.04	Idaho IT 99	ITD-859	Test the initial truck & trailer prior to unloading into the contractor's storage tank. Thereafter, test at same frequency as sampling of asphalt binder	If anti-strip cannot be detected, the supplier must add additional anti-strip. The binder will be sampled and tested until a positive result is determined. (blue color only)
		ITD Project Personnel	ITD Project Personnel			
Superpave HMA for Acceptance Test Strip	CONSTRUCTION of Test Strip by Contractor	405.03	Idaho IR 125	ITD-891 (Completed by Contractor)	Two (2) locations per Test Section	Contractor establishes roller pattern.
	ACCEPTANCE [(1)] (Aggregate Cold Feed Samples) Sand Equivalent Fracture Flat and/or Elongated Particles Fine Aggregate Angularity	405.02 405.03H 405.03F 703.05	Idaho IR 125 AASHTO T 2 ASHTO T 248 AASHTO T 176 Method 2, Mechanical AASHTO T 335 Method 1 Idaho FOP ASTM D 4791 Idaho FOP for AASHTO T 304	ITD-1046 ITD-772	**Three (3) cold feed increments per test strip.	Random Samples per Idaho IR 125 [(1)]Combine cold feed increments into a composite sample to determine test strip acceptance.
		Contractor	ITD District Project Personnel			
	INDEPENDENT ASSURANCE	IA Inspector	IA Inspector	ITD-857	Each 15,000 Tons (13,500 t)	

**When multiple test strips are required due to failures, the passing aggregate properties determined from the original cold feed sample will be used for subsequent test strips.

405-1

	BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
405-2	Superpave HMA for Acceptance Test Strip (Cont.)	ACCEPTANCE (2) (Loose Mix Samples) Air Voids Asphalt Content Gradation Voids in Mineral Aggregate (VMA) (3) Voids Filled With Asphalt (VFA) Dust to Binder Ratio (DP) Moisture Content	405.02 405.03H 405.03I Contractor	Idaho IR 125 AASHTO T 168 * AASHTO R 47 AASHTO T 166 Method A or AASHTO T 331 AASHTO T 209(4) Bowl Method AASHTO T 269 AASHTO T 308 (4) AASHTO T 30 AASHTO T329 AASHTO T 312 HQ Central Lab/District Lab	ITD-773 ITD-772	Three (3) per test section. Each sample must be at least 80 lbs.	Random sample locations per Idaho IR125 *See Note (2) Test results for each loose mix sample are averaged for each test section to determine test section acceptance. (3) For calculating VMA use the combined aggregate bulk specific gravity, G_{sb}, determined by the Engineer (4) See QA Manual Section 275.
		Note: Test Strip mix verification testing will be performed by HQ Central Lab or District lab. District Labs must be qualified by HQ Central Lab in order to perform Superpave Test Strip testing. Contact Quality Assurance Engineer for details: Phone: (208) 334-8021					
		INDEPENDENT ASSURANCE	IA Inspector	IA Inspector	ITD-857	Observation of loose mix testing performed by District Lab every 90 days.	

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **406 ROAD MIX & 407 SCRUB COAT**						
Superpave HMA for Acceptance Test Strip (Cont.)	Density GAUGE CORRELATION(5)	405.03L	Idaho IR 125 WAQTC TM 8 (Backscatter mode) AASHTO T 343	ITD-820	Five (5) per test section	Use same cores that were taken for density acceptance. (5)Each gauge to be used on the project for QC or acceptance testing must be correlated on the test strip. Gauge readings for each core must be obtained at each test site prior to coring using each gauge. Each gauge will have a unique correlation factor. Form ITD-820 is completed for each gauge.
		Contractor	Contractor and ITD District Project Personnel			
	ACCEPTANCE(7) Cores Density (Percent Compaction)	405.03L	Idaho IR 125 WAQTC TM11 AASHTO T 166 Method A AASHTO T 331 ASTM D7227	ITD-892 ITD-772	Five (5) per test section.	Random sample locations per Idaho IR 125 Test section densities are calculated as the average percent compaction of all cores from the test section using the average Gmm of the test section.
		Contractor	ITD District Lab			
	INDEPENDENT ASSURANCE	IA Inspector	IA Inspector	ITD-857	Observation of core testing performed by District Lab every 90 days	

405-3

	BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
405-4	Production Paving SP2	ACCEPTANCE Loose Mix from Roadway Asphalt Content Gradation	405.03 ITD Project Personnel	AASHTO T 168* AASHTO R 47 AASHTO T 329 AASHTO T 308 AASHTO T 30 ITD Project Personnel	ITD-833	Each 750 Tons (675 t) Each sample must be at least 40 lbs	Random sample locations * See Note
		INDEPENDENT ASSURANCE Sampling Asphalt Content Gradation	IA Inspector	IA Inspector	ITD-857	One (1) observation each project.	
		ACCEPTANCE Moisture	405.03 ITD Project Personnel	AASHTO T 329 ITD Project Personnel	ITD-833	One (1) test for moisture at least once per day.	Specification limit applies.
		ACCEPTANCE Density (Percent Compaction) (Density using correlated density gauge)	405.03 ITD Project Personnel	WAQTC TM 8 (Backscatter Mode) AASHTO T 343 ITD Project Personnel	ITD-855	Each 750 Tons (675 t)	Test at random locations The average Gmm of the Test Strip test section corresponding to the Contractor's JMF shall be used to determine densities for all production paving.
		INDEPENDENT ASSURANCE Density (Percent Compaction)	IA Inspector	IA Inspector	ITD-857	One (1) observation each project	

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. SAMPLED BY	TEST METHOD TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
Production Paving SP3, SP5, SP6	ACCEPTANCE Loose Mix from Roadway Air Voids VMA	405.03	AASHTO T 168* AASHTO R 47 AASHTO T 329 AASHTO T 308 AASHTO T 166 Method A AASHTO T 331 AASHTO T 209[5] Bowl Method AASHTO T 269 AASHTO T 312	ITD-833 ITD-777	Each 750 Tons (675 t) Each sample must be at least 40 lbs	Random Sample Locations * See Note
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE Sampling Air Voids VMA	IA Inspector	IA Inspector	ITD-857	One (1) observation each project.	Observation of the tests that are performed to calculate air voids and VMA
	ACCEPTANCE Moisture	405.03	AASHTO T 329	ITD-833	One (1) test for moisture at least once per day.	Specification limit applies.
		ITD Project Personnel	ITD Project Personnel			
	ACCEPTANCE Density (Percent Compaction) (Density using correlated density gauge)	405.03	WAQTC TM 8 (Backscatter Mode) AASHTO T 343	ITD-855	Each 750 Tons	Test at random locations The average Gmm of the Test Strip test section corresponding to the Contractor's JMF shall be used to determine densities for all production paving
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE Density (Percent Compaction)	IA Inspector	IA Inspector	ITD-857	One (1) observation each project	
Production Paving Non-structural and Temporary, except on NHS.*	ACCEPTANCE Certification	405.03	Manufacturer	ITD-851	Total Quantity Paid	ITD Project Inspector documents visual inspection.
		Manufacturer				

* Temporary paving on the NHS with divided highways will require the same mix design as the mainline paving. Acceptance will be by density; the average percent compaction of 3 random cores must be greater than 90.0%. A random loose mix sample will be obtained to determine the theoretical maximum specific gravity, (G_{mm}). Sampling will be by the contractor; testing by the State.

	BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
405-6	Production Paving When an acceptance test strip is not required, regardless of the class of SuperPave mix and the total quantity is three tests or more. **Note:** Follow QASP procedures for sampling, testing and Quality Analysis. (include each core test result in the Quality Analysis)	ACCEPTANCE Loose Mix from Roadway Asphalt Content Gradation	405.03 See Note	AASHTO T 168 * AASHTO R 47 AASHTO T 329 AASHTO T 308 AASHTO T 30 See Note	ITD-833	Each 750 Tons (675 t)	Random Sample Locations * See Note SP2 Specification Limits apply.
		INDEPENDENT ASSURANCE Sampling Asphalt Content Gradation	IA Inspector	IA Inspector	ITD-857	One (1) observation each project.	
		ACCEPTANCE Moisture	405.03 See Note	AASHTO T 329 See Note	ITD-833	One (1) test for moisture at least once per day.	Specification limit applies.
		ACCEPTANCE Density (Percent Compaction)	405.03 405.03L ITD Project Personnel	WAQTC TM11 AASHTO T 168 * AASHTO T 166 Method A AASHTO T 331 AASHTO T 209 (Bowl Method) AASHTO T 331 ASTM D7227 ITD Project Personnel	ITD-832 ITD-892	Each 750 Tons (675 t) Obtain random cores in each lot for density pay factor. (Do not average the cores).	* See Note The average max. specific gravity, (G_{mm}) from the loose mix samples will be used to determine core density (percent compaction).

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. SAMPLED BY	TEST METHOD TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
Production Paving When an acceptance test strip is not required, *regardless of the class of SuperPave mix* and the total quantity is less than three frequencies but equal to or greater than one frequency. ITD will sample and test for acceptance.	ACCEPTANCE Loose Mix from Roadway Asphalt Content Gradation	405.03 ITD Project Personnel	AASHTO T 168* AASHTO R 47 AASHTO T 329 AASHTO T 308 AASHTO T 30 ITD Project Personnel	ITD-833	Each 750 Tons (675 t)	* See Note SP2 Specification Limits apply
	INDEPENDENT ASSURANCE Sampling Asphalt Content Gradation	IA Inspector	IA Inspector	ITD-857	One (1) observation each project.	
	ACCEPTANCE Moisture	405.03 ITD Project Personnel	AASHTO T 329 ITD Project Personnel	ITD-833	One (1) test for moisture at least once per day.	Specification limit applies.
	ACCEPTANCE Density (Percent Compaction)	405.03 405.03L ITD Project Personnel	WAQTC TM11 AASHTO T 168 * AASHTO T 166 Method A AASHTO T 331 AASHTO T 209 (Bowl Method) ASTM D7227 ITD Project Personnel	ITD-832 ITD-892	Five (5) Stratified Random Cores	Density (percent compaction) acceptance will be determined from the average of the cores. The average max. specific gravity, (G_{mm}) from the loose mix samples will be used to determine core density (percent compaction).
*** See Note**						
Production Paving When an acceptance test strip is not required, *regardless of the class of SuperPave mix* and the total quantity is less than one frequency.				FOLLOW SECTION 270.04 ACCEPTANCE BY SMALL QUANTITIES Density acceptance will be determined from the average of cores.		

405-7

* The plate method is the primary method for obtaining samples from the roadway. For the lifts of 0.2' or less, the samples may be obtained from the plant using an attached sampling device or from haul units. When the point of sampling is not the roadway and the minimum frequency results in more than 3 tests, the State will obtain at least two additional samples from the roadway, behind the paver, using the plate method for information to identify possible handling or placement variability. These tests will not be used as verification tests. The roadway samples will be taken randomly in the first and second thirds of the project. The samples will be tested by the State for asphalt content per AASHTO T 308 and gradation per AASHTO T 30. The test results will be evaluated by comparing to the average of the production test results up to that point. The comparison must be within the significant difference as shown in the table under dispute resolution section. For SuperPave (SP3-SP6) items, the two roadway samples will be tested by the State for air void and VMA. The test results will be compared to the average of the production test results up to that point. The comparison must be within the significant difference as shown in the table under dispute resolution section. When the difference in the test result is significant, the contractor shall determine the cause of the difference and shall make any necessary corrections.

	BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
405-8	Surface Smoothness	ACCEPTANCE Profiler	405.03P / Contractor	AASHTO PP50 / Contractor	Contractor furnishes IRI QC test results to Engineer by next calendar day following placement. Acceptance testing to be completed on final lift within one (1) week of completion of paving.		
		VERIFICATION Profiler	405.03P / ITD Project Personnel	ITD Project Personnel	ITD-854 ITD-769	Fully witnessed with report and graph chart obtained daily	
	Pavement Reinforcement Fabric	ACCEPTANCE Certification	718.02 718.08 / Manufacturer	Manufacturer	ITD-849 with QC test results attached	Total Quantity Paid	See QA Manual Section 230.09
		VERIFICATION Laboratory Tests	718.03 718.08		ITD-1044 (Sample Data) ITD-1047 (Lab Report)	One (1) sample from each manufacturer-identified lot for each type.	

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **406 ROAD MIX & 407 SCRUB COAT**						
Aggregate	ACCEPTANCE Gradation Sand Equivalent Fracture Count	703 406.02 407.02	AASHTO T 2 AASHTO T 248 AASHTO T 27 AASHTO T 11 AASHTO T 176 Method 2, Mechanical AASHTO T 335 Method 1	ITD-901	Each 700 CY (500 m^3) or 1000 Tons (900 t)	Sample at point of loading to the roadway
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE Gradation Sand Equivalent Fracture Count	IA Inspector	IA Inspector	ITD-857	Each 14000 CY (10000 m^3) or 20000 Tons (18000 t).	
Emulsified Asphalt	ACCEPTANCE Certification	702.03 702.05		Loading Certificate	Each individual truck, trailer, car or shipment	See QA Manual Section 230.11
		Manufacturer	Manufacturer			
	VERIFICATION Laboratory Tests	702.03	AASHTO T 59	ITD-1045	Each 100 tons	No samples required when total project quantity is less than 2000 Gal (7600 L) 8 Tons
		ITD Project Personnel	HQ Central Laboratory			
PG. Binder	ACCEPTANCE Certification	702.01 702.05		ITD-966	Initial lot & each new lot to project	See QA Manual Sections 230.10 & 255.00
		Manufacturer	Manufacturer	Loading Certificate	Each shipment to project	
	VERIFICATION Laboratory Tests	702.01	AASHTO M 320 AASHTO T 40	ITD-859 ITD-859AW	One (1) sample (3 quart cans) per shift combined into weekly binder verification unit. Sampled from the line between the storage tank (or the delivery truck) and the mix plant. Purge one gallon from the injection line valve before taking sample	No samples required when total project quantity is less than 22 tons(20t) See QA Manual Section 255.00
		ITD Project Personnel	ITD Project Personnel			
		ITD Project Personnel	ITD Project Personnel			

406/407-1

	BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
406/407-2	Anti-Strip Additive	ACCEPTANCE Presence of Anti-Striping Additive	702.04 ITD Project Personnel	Idaho IT 99 ITD Project Personnel	ITD-859	Test the initial truck & trailer prior to unloading into the contractor's storage tank. Thereafter, test at same frequency as sampling of asphalt binder.	If anti-strip cannot be detected, the supplier must add additional anti-strip. The binder will be sampled and tested until a positive result is determined. (blue color only)
	STANDARD SPECIFICATION SECTION: **408 FOG COAT**						
408	Emulsified Asphalt	ACCEPTANCE Certification	702.03 702.05 Manufacturer	Manufacturer	Loading Certificate	Each individual truck, trailer, car or shipment	See QA Manual Section 230.11
408	Emulsified Asphalt	VERIFICATION Laboratory Tests	702.02 702.03 ITD Project Personnel	AASHTO T 59 HQ Central Laboratory	ITD-1045	One (1) undiluted sample (as received from the asphalt supplier) per project.	No samples required when total project quantity is less than 2000 Gal (7600 L) 8 Tons.
408	Blotter	ACCEPTANCE Gradation	703.07 408.02 ITD Project Personnel	AASHTO T 2 AASHTO T 248 AASHTO T 27 AASHTO T 11 ITD Project Personnel	ITD-901	One (1) field gradation per source.	Sample at point of loading to the project.
	Standard Supplemental Specification **415 MICROSURFACING**						
415-1	Aggregate	ACCEPTANCE Gradation Sand Equivalent	703 415 ITD Project Personnel	AASHTO T 2 AASHTO T 248 AASHTO T 27 AASHTO T 11 AASHTO T 176 Method 2, Mechanical ITD Project Personnel	ITD-901	Each 750 Tons (675 t) or fraction thereof.	Acceptance at stockpile

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS	
Polymer-modified Emulsified Asphalt	ACCEPTANCE Certification	702.03 702.05		Loading Certificate	Each individual truck, trailer, car or shipment	See QA Manual Section 230.11	415-2
		Manufacturer	Manufacturer				
	VERIFICATION Laboratory Tests	702.03	AASHTO T 59	ITD-1045	One (1) random undiluted sample (as received from the asphalt supplier) twice per day		
		ITD Project Personnel	HQ Central Laboratory				
		ITD Project Personnel	ITD Project Personnel				

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF.	SAMPLED BY	TEST METHOD	TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **409 PORTLAND CEMENT CONCRETE PAVEMENT**								
Concrete Ready-Mix Plant Inspection			ITD Project Personnel		ITD Project Personnel	ITD-893	One (1) per project	Inspection of plant is valid for one (1) year.
Mix Design	CONFIRMATION (Mix samples not required for projects less than 2500 CY)	409.01 409.03(A)	Contractor		ITD Central Lab	Central Lab will notify the Engineer of the confirmation	Submittal required 60 days prior to use	See QA Manual Section 260.02
Mix Design	ACCEPTANCE (Water from other than a municipal drinking supply)	720.01	Contractor	AASHTO T 26	Independent Lab	Submit independent test results with mix design information	One (1) per project	Water from any municipal drinking supply does not require testing.
Mix Design	ACCEPTANCE (Admixtures) Approved List	709.02 709.03 709.04 709.05	Manufacturer	ASTM C 494 AASHTO M 154	Manufacturer	Qualified Products List		
Fine Aggregate	ACCEPTANCE Gradation Sand Equivalent	409.02 703.02	ITD Project Personnel	AASHTO T 2 AASHTO T 248 AASHTO T 27 AASHTO T 11 AASHTO T 176 Method 2 Mechanical	ITD Project Personnel	ITD-901	Each 1000 CY of concrete placed	Frequency applies to multiple concrete items from same concrete plant per project.
Fine Aggregate	INDEPENDENT ASSURANCE Gradation Sand Equivalent		IA Inspector		IA Inspector	ITD-857	Each 20,000 CY of concrete placed	
Coarse Aggregate	ACCEPTANCE Gradation	409.02 703.03	ITD Project Personnel	AASHTO T 2 AASHTO T 248 AASHTO T 27	ITD Project Personnel	ITD 901	Each 1000 CY of concrete placed	Frequency applies to multiple concrete items from same concrete plant per project. Wash method not required.
Coarse Aggregate	INDEPENDENT ASSURANCE Gradation		IA Inspector		IA Inspector	ITD-857	Each 20,000 CY of concrete placed	

409-1

409-2

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
Cement	ACCEPTANCE Certification	701.01	AASHTO M 85 or AASHTO M 240 Total Alkali	ITD-968 with bills of lading attached	Each week concrete is placed representing the amount of cement used	See QA Manual Section 230.02
		Manufacturer	Manufacturer			
	VERIFICATION Laboratory Tests[1]	701.01	Idaho T 143	ITD-1044 [1A] (Sample Data) ITD-1825 (Lab Report)	Each 2500 CY (1900 m^3) of concrete placed and for each mill analysis number. [2]	The frequency applies to multiple concrete items from the same concrete plant per project. Price adjustment for failing cement.
		ITD Project Personnel	ITD Central Lab			
Fly ash	ACCEPTANCE Certification	714.01	AASHTO M 295	ITD-968 with bills of lading attached	Each week concrete is placed representing the amount of fly ash used	See QA Manual Section 230.02
		Manufacturer	Manufacturer			
	VERIFICATION Laboratory Tests[1]	714.01	Idaho T 143	ITD-1044 [1A] (Sample Data) ITD-1826 (Lab Report)	Each 15,000 CY (10,000 m^3) of concrete placed and for each sample ident number. [2]	The frequency applies to multiple concrete items from the same concrete plant per project.
		ITD Project Personnel	ITD Central Lab			

(1) No samples for laboratory tests when total quantity of concrete for project is less than 40 cubic yards

(1A) Include acceptance certification documents with ITD-1044 and sample (ITD-968 and bills of lading).

(2) When the project quantity is 40 CY or more but less than the minimum sample frequency, the cement or fly ash sample may represent multiple projects provided the material is from the same mill analysis or sample ident number, manufacturer, supplier and concrete plant. The sample test report and a file memo must be included in each project file and on each Materials Summary Report.

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
Dowel Bars	FOLLOW STANDARD SPECIFICATION 503					
Tie Bars	FOLLOW STANDARD SPECIFICATION 503					
Concrete Production (1A)	FIELD ACCEPTANCE Slump Air Content Temperature Unit Weight Cement Factor W/C Ratio	409.02	WAQTC TM 2 AASHTO T 119 AASHTO T 121 AASHTO T 309 AASHTO T 152	ITD-70	Each 300 CY (230 m^3)	See QA Manual Section 215.00 Materials or Work Failing Specifications Computerized batch ticket accompanies each load to project.
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE Field Tests	IA Inspector	IA Inspector	ITD-857	Each 6000 CY (4600 m^3)	
	ACCEPTANCE Compressive Strength	409.02	AASHTO T 22 AASHTO T 23	ITD-1044 (Sample Data) ITD-845 (Lab Report)	Three (3) sets for each day's production; one (1) set during each third of the day's placement.	Each set consists of three (3) 28-day and two (2) 7-day cylinders. Make the cylinders from loads that are tested for slump, air content, etc.
		ITD Project Personnel	ITD District or Central Lab			
	INDEPENDENT ASSURANCE Making Cylinders	IA Inspector	IA Inspector	ITD-857	Observation one (1) per project	

(1A) When concrete is delivered to the forms by means of a concrete pump, the sample will be obtained at the point of discharge in accordance with WAQTC TM 2.

409-3

	BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
409-4	Concrete Production [1A] (Multiple small placements of less then 200 CY per day, i.e. slab replacements, intersections)	FOLLOW STANDARD SPECIFICATION 502					
	Curing Compound	ACCEPTANCE Laboratory Test	709.01 / Manufacturer	AASHTO M 148 / ITD Central Lab	ITD-1044 (Sample Data) ITD-1823 (Lab Report)	Submit sample at least 30 days prior to use for each batch/lot	Pre-approved by batch or lot number.
	Finished Pavement	ACCEPTANCE (Depth Measurements)	409.03 /	Idaho T 130 / ITD Project Personnel	ITD-827	Randomly once every 0.1 mile (0.2 km)	Thickness price adjustment.
		ACCEPTANCE (Smoothness)	409.03 /	Idaho T 140 / ITD Project Personnel	ITD-854 ITD-769		Smoothness price adjustment.
		ACCEPTANCE (Final Finish)	409.03(J) /	AASHTO T 261 /	ITD-854	Initially, then each lane mile	
411	STANDARD SPECIFICATION SECTION: **411 URBAN CONCRETE PAVEMENT**						
		FOLLOW STANDARD SPECIFICATION 409 for testing frequency only.					
	For multiple small placements of less than 200 CY per day	FOLLOW STANDARD SPECIFICATIONS 502					

[1A] When concrete is delivered to the forms by means of a concrete pump, the sample will be obtained at the point of discharge in accordance with WAQTC TM 2.

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **502 CONCRETE**						
Concrete Ready-Mix Plant Inspection				ITD-893	One (1) per project	Inspection of plant is valid for one (1) year
		ITD Project Personnel	ITD Project Personnel			
Mix Design (All Concrete)	REVIEW BY HQ Central Lab	502.01 502.03(A)		See Section 260.03.		
		Contractor	Contractor			
	ACCEPTANCE (Admixtures) Approved List	709.02 709.03 709.04 709.05	ASTM C494 AASHTO M154	Qualified Products List		
		Manufacturer	Manufacturer			
	ACCEPTANCE (Water from other than a municipal drinking supply)	720.01	AASHTO T 26	Submit independent test results with mix design information	One (1) per project	Water from any municipal drinking supply does not require testing.
		Contractor	Independent Lab			
Fine Aggregate	ACCEPTANCE Gradation Sand Equivalent	703.02	AASHTO T 2 AASHTO T 248 AASHTO T 27 AASHTO T 11 AASHTO T 176 Method 2 Mechanical	ITD-901	Each 500 CY of concrete placed	Frequency applies to multiple concrete items from same concrete plant per project.
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE Gradation Sand Equivalent	IA Inspector	ITD District Lab	ITD-857	Each 10,000 CY of concrete placed	
Coarse Aggregate	ACCEPTANCE Gradation	703.03	AASHTO T 2 AASHTO T 248 AASHTO T 27	ITD-901	Each 500 CY of concrete placed	Wash method not required. Frequency applies to multiple concrete items from same concrete plant per project.
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE Gradation	IA Inspector	ITD District Lab	ITD-857	Each 10,000 CY of concrete placed	

502-1

502-2

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
Cement	ACCEPTANCE Certification	701.01 / Manufacturer	AASHTO M85 or AASHTO M240 Total Alkali / Manufacturer	ITD-968 with bill of lading attached	Each week concrete is placed representing the amount of cement used	See QA Manual Section 230.02
Cement	VERIFICATION Laboratory Test [1]	701.01 / ITD Project Personnel	Idaho IR143 / ITD Central Lab	ITD-1044[1B] (Sample Data) ITD-1825 (Lab Report)	Each 1000 CY (760 m^3) of concrete placed and for each mill analysis number [2]	The frequency applies to multiple concrete items from the same concrete plant per project. Price adjustment for failing cement.
Fly ash	ACCEPTANCE Certification	714.01 / Manufacturer	AASHTO M295 / Manufacturer	ITD-968 with bill of lading attached	Each week concrete is placed representing the amount of fly ash used	See QA Manual Section 230.02
Fly ash	VERIFICATION Laboratory Test [1]	714.01 / ITD Project Personnel	Idaho IR143 / ITD Central Lab	ITD-1044[1B] (Sample Data) ITD-1826 (Lab Report)	Each 4000 CY (3000 m^3) of concrete placed and for each sample ident number [2]	The frequency applies to multiple concrete items from the same concrete plant per project.
Metal Reinforcement	FOLLOW STANDARD SPECIFICATION SECTION 503					
Pre-Stressing Strand	FOLLOW STANDARD SPECIFICATION SECTION 506					
Curing Compound[1A]	ACCEPTANCE Laboratory Test	709.01 / Manufacturer	AASHTO M148 / ITD Central Lab	ITD-1044 (Sample Data) ITD-1823 (Lab Report)	Submit sample at least 30 days prior to use for each batch/lot	Pre-approved by batch or lot number.
Curing Compound[1A]	ACCEPTANCE Certification	Manufacturer	Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Section 230.01
Joint Fillers and Sealers	FOLLOW STANDARD SPECIFICATION SECTION 625					

(1) No samples for laboratory tests when total quantity of concrete for project is less than 40 cubic yards.

(1A) Acceptance by manufacturer's certification when total project quantity is less than 55 gallons.

(1B) Include acceptance certification documents with ITD-1044 and sample. (ITD-968 and bill of lading)

(2) When the project quantity is 40 CY or more but less than the minimum sample frequency, the cement or fly ash sample may represent multiple projects provided the material is from the same mill analysis or sample ident number, manufacturer, and concrete plant. The sample test report and a file memo must be included in each project file and on each Materials Summary Report.

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
Concrete Production [1B] Specified Strength of 24.0 MPa (3500 psi) or greater	FIELD ACCEPTANCE Slump Air Content Temperature Unit Weight Cement Factor W/C Ratio	502.02	WAQTC TM 2 AASHTO T 119 AASHTO T 152 AASHTO T 309 AASHTO T 121	ITD-70	First load, then each 50 CY (38 m^3) until quantity exceeds 100 CY (75m^3). Thereafter, every 100 CY (75 m^3) but not less than one per day.[2]	When there is a failing test, obtain check tests immediately and continue checking each load until two (2) consecutive tests are passing. Computerized batch ticket accompanies each load to project.
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE Field Tests	IA Inspector	IA Inspector	ITD-857	Each 2,000 CY (1500 m^3)	
	ACCEPTANCE Compressive Strength	502.02	AASHTO T 22 AASHTO T 23	ITD-1044 (Sample Data) ITD-845 (Lab Report)	One (1) set of three (3) 28-day cylinders and one (1) set of two (2) 7-day cylinders each 100 CY (75 m^3) but not less than one (1) per day[2].	A single sample of concrete must be of sufficient size for the cylinders and air, slump, unit weight tests.
		ITD Project Personnel	ITD District or Central Lab			
	INDEPENDENT ASSURANCE Making Cylinders	IA Inspector	IA Inspector	ITD-857	Observation one(1) per project	

[1B] When concrete is delivered to the forms by means of a concrete pump, then samples will be obtained at the point of discharge in accordance with WAQTC TM-2.

[2] For some applications involving multiple small placements not on the same day, the minimum one test per day is not required. Examples where this applies are non-structural items such as median barriers, small bases for signs or poles. Examples of items where this does **not** apply are sign or pole bases larger than 3 m^3 (4 CY) bridge footings, columns, pier caps or bridge parapet.

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
Concrete Specified Strength of 20.5 MPa (3000 psi) or less	ACCEPTANCE Certification [2B]	502.01(B)		ITD-875 with QC test results attached[3] QC tests on First load, then each 50 CY (38 m^3) until quantity exceeds 100 CY (75m^3). Thereafter, every 100 CY (75 m^3)	Total Quantity Paid	Unless lack of quality control is evident, plant inspection, aggregate testing, cement & fly ash certs & sampling, field tests and compressive strength tests by the State are not required.[2B] See QA Manual Section 230.06 Concrete supplier's certification Note locations on ITD-875
		Contractor	Contractor			

[2B] Concrete for curb and sidewalk will be accepted by certification regardless of strength requirements. Concrete for landscaping using sack mixes will NOT require certification (ITD-875) or verification tests. Acceptance will be by inspection on the RE Letter (ITD-854).

[3] When total is less than 50CY, QC tests can be from previous batches in the 30 days prior to the first placement.

502-4

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
Pre-cast Stringers, Prestressed Members	ACCEPTANCE Field Tests (Air, slump, unit weight, temperature)	502.02	AASHTO T 119 AASHTO T 152 AASHTO T 309 AASHTO T 121	ITD-70	One (1) per member	The ITD On-site Inspector will provide a memo of acceptance to the Engineer with all required test reports and certifications attached.
		ITD On-site Inspector	ITD On-site Inspector			
	ACCEPTANCE Compressive Strength	502.02	AASHTO T 22 AASHTO T 23	ITD-845	One (1) set of three (3) 28-day cylinders per member	
		ITD On-site Inspector	ITD District or Central Lab			
Concrete Parapet	FOLLOW MTR FOR STRENGTH SPECIFIED					
Voided Slabs, Approach Slabs	ACCEPTANCE Field Tests (Air, slump, unit weight, temperature)	502.02	AASHTO T 119 AASHTO T 152 AASHTO T 309 AASHTO T 121	ITD-70	One (1) per member and when multiple members are poured in one continuous line- one test per line up to 50 cy and additional tests per 50cy.	The ITD On-site Inspector will provide a memo of acceptance to the Engineer with all required test reports and certifications attached.
		ITD On-site Inspector	ITD On-site Inspector			
	ACCEPTANCE Compressive Strength	502.02	AASHTO T 22 AASHTO T 23	ITD-845	One (1) set of three (3) 28-day cylinders per member	
		ITD On-site Inspector	ITD District or Central Lab			
Permanent Metal Concrete Forms	ACCEPTANCE Certification	708.31	ASTM A653 M SS	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03
		Manufacturer	Manufacturer			

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **503 METAL REINFORCEMENT**						
Reinforcing Steel	ACCEPTANCE Certification	503.02 708.02 / Manufacturer	AASHTO M31 / Manufacturer	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03
	VERIFICATION Laboratory Tests(3)	503.02 / ITD Project Personnel	ITD Central Lab	ITD-1044(3A) (Sample Data) ITD-1810 (812) (Lab Report)	Field sample every size and heat number from deliveries to project	FedEx or overnight samples. Reject failing heat numbers. See QA Manual Section 230.03.02
Epoxy Coated Metal Reinforcement	ACCEPTANCE Certification	503.02 708.02 / Manufacturer	AASHTO M284 / Manufacturer	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03
	VERIFICATION Laboratory Tests(3)	503.02 / ITD Project Personnel	ITD Central Lab	ITD-1044(3A) (Sample Data) ITD-1810 (812)(Lab Report)	Field sample every size and heat number from deliveries to project	FedEx or overnight samples. Reject failing heat numbers. See QA Manual Section 230.03.02
Dowel Bars	ACCEPTANCE Certification	708.03 / Manufacturer	AASHTO M254 / Manufacturer	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03

(3) Samples not required when used with concrete of specified strength of 20.5 MPa (3000 psi) or less. Form ITD-914 is required.
(3A) Including acceptance certification documents with ITD-1044 and sample (ITD-914 and mill test reports).

503-1

503-2

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
Tie Bars	ACCEPTANCE Certification	708.04 / Manufacturer	AASHTO M31 / Manufacturer	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03
	VERIFICATION Laboratory Tests[(4)]	503.02 / ITD Project Personnel	/ ITD Central Lab	ITD-1044[(3A)] (Sample Data) ITD-1810 (812)(Lab Report)	One (1) sample of two (2) bars per day of concrete paving	Slab replacement or rehab project where less than 1,000 bars, then one (1) sample of two (2) bars per project.

[(3)] Samples not required when used with concrete of specified strength of 20.5 MPa (3000 psi) or less. Form ITD-914 is required.

[(3A)] Including acceptance certification documents with ITD-1044 and sample (ITD-914 and mill test reports).

[(4)] Samples not required when less than 200 bars are used on a project.

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **504 STRUCTURAL METALS**						
Steel Bridge	ACCEPTANCE Certification	504.01 504.03 708.06 / Manufacturer	AASHTO M270 / Manufacturer	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03
	ACCEPTANCE Fabrication Inspection(5)	504.01 504.02 504.03		HQ will provide memo of inspection		District notifies HQ as soon as fabricator is known. HQ arranges fabrication inspection.
Structural Steel	ACCEPTANCE Certification	504.01 504.03 708.06 / Manufacturer	AASHTO M270 / Manufacturer	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03
	ACCEPTANCE Fabrication Inspection(5)	504.01 504.02 504.03		HQ will provide memo of inspection		District notifies HQ as soon as fabricator is known. HQ arranges fabrication inspection.
Steel Forgings	ACCEPTANCE Certification	708.06 / Manufacturer	AASHTO M270 / Manufacturer	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03
	ACCEPTANCE Fabrication Inspection(5)	504.03		HQ will provide memo of inspection		District notifies HQ as soon as fabricator is known. HQ arranges fabrication inspection.
Paint	FOLLOW STANDARD SPECIFICATION SECTION 627					

(5) Fabrication Inspection not required if less than 15 t (16 T). District notification is still required. Field inspection of steel member is required. Acceptance by certification and ITD-854 Resident Engineer's Letter of Inspection (See QA Manual Section 250.00).

504-1

	BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
504-2	Bolts, Nuts, Hardened Washers, Direct Tension Indicators	ACCEPTANCE Certification	504.03(L) 708.06(2)	ASTM A307 AASHTO M164 AASHTO M253	ITD-851	Total Quantity Paid	See QA Manual Section 230.03
			Manufacturer	Manufacturer			
		VERIFICATION Laboratory Tests	504.03(L) 708.06(2)		ITD-1044 (Sample Data) ITD-1811 (Lab Report)	Three (3) random samples of each assembly from each lot and size	Sample from material delivered to the project.
			ITD Project Personnel	ITD Central Lab			
	Structural Steel Handrail	ACCEPTANCE Certification	504.02 708.06(1)	AASHTO M270	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03
			Manufacturer	Manufacturer			
	Two Tube Curb-Mount Railing	ACCEPTANCE Certification	504.02 708.06(1)	AASHTO M270	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03
			Manufacturer	Manufacturer			
	Pedestrian Bicycle Railing	ACCEPTANCE Certification	504.02 708.06(1)	AASHTO M270	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03
			Manufacturer	Manufacturer			
	Combination Pedestrian, Bicycle, and Traffic Railing	ACCEPTANCE Certification	504.02 708.06(1)	AASHTO M270	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03
			Manufacturer	Manufacturer			

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. SAMPLED BY	TEST METHOD TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **505 PILING**						
H-Beam Piles	ACCEPTANCE Certification	505.02 708.08 Manufacturer	ASTM A 36 Manufacturer	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03
Steel Shell Piles	ACCEPTANCE Certification	505.02 708.30 Manufacturer	 Manufacturer	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03
Timber Piles	ACCEPTANCE Certification	505.02 710.05 Manufacturer	ASTM D 25 Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Section 230.03
Pile Point	ACCEPTANCE Approved List	505.03(C) Manufacturer	 Manufacturer	Qualified Product List ITD-851 ITD-914 with mill test reports attached		
Concrete with specified strength of 3000 psi (20.5 MPa) or less	ACCEPTANCE Certification	502.02(B) Concrete Supplier	 Concrete Supplier	ITD-875 with QC test results attached	Total Quantity Paid	See QA Manual Section 230.06 Concrete Suppliers Certification Note locations on ITD-875
STANDARD SPECIFICATION SECTION: **506 PRE-STRESSING CONCRETE**						
Reinforcement	FOLLOW STANDARD SPECIFICATION SECTION 503					
Welded Wire	ACCEPTANCE Certification	 Manufacturer	 Manufacturer	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03
Pre-Stressing Strand	ACCEPTANCE Certification	708.05 Manufacturer	ASTM A 416 ASTM A 722 Manufacturer	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03
	VERIFICATION Laboratory Tests	506.03 ITD Project Personnel	 ITD Central Lab	ITD-1044 (Sample Data) ITD-1813 (838) (Lab Report)	One (1) per reel	See QA Manual Section 230.05.01
Grout Type A Type B Class I Type B Class II Type C (used in post tensioning)	ACCEPTANCE Compressive Strength	506.03 ITD Project Personnel	AASHTO TP 83 AASHTO T 106 ITD District or Central Lab	ITD-1044 (Sample Data) ITD-845 (Lab Report)	Grout cubes once per day for each type grout used	The average of three (3) 28-day cubes for Type A or Type B. The average of three (3) 24-hour cubes for Type C
	INDEPENDENT ASSURANCE Observation	IA Inspector	IA Inspector	ITD-857	Observation one (1) per project	

505

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
Grout Type A Type B Class I Type B Class II Type C (used in other than post tensioning)	ACCEPTANCE Compressive Strength	506.03	AASHTO TP 83 AASHTO T 106	ITD-1044 ITD-845 (Lab Report)	One (1) per project	The average of three (3) 28-day cubes for Type A or Type B. The average of three (3) 24-hour cubes for Type C
		ITD Project Personnel	ITD District or Central Lab			
Grout Type D	ACCEPTANCE Certification	506.03 701 703	AASHTO M85 AASHTO T 11 AASHTO T 27 AASHTO T 176 Method 2, Mechanical	ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
STANDARD SPECIFICATION SECTION: **507 BEARING PADS AND PLATES**						
Self-Lubricating Bronze Bearing Plates	ACCEPTANCE Certification	507.02 708.29		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
Neoprene Bearing Pads	ACCEPTANCE Certification	507.02 720.02	AASHTO M251-90	ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
TFE/PTFE Bridge Bearing Pads	ACCEPTANCE Certification	507.02 720.03		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
STANDARD SPECIFICATION SECTION: **508 CORRUGATED PLATE PIPE**						
Corrugated Plate Pipe Culvert	ACCEPTANCE Certification	508.02 708.20	AASHTO M167 or M219	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.07
		Manufacturer	Manufacturer			
Corrugated Plate Pipe Arch	ACCEPTANCE Certification	508.02 708.20	AASHTO M167 or M219	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.07
		Manufacturer	Manufacturer			
Corrugated Plate Arch	ACCEPTANCE Certification	508.02 708.20	AASHTO M167 or M219	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.07
		Manufacturer	Manufacturer			

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **509 Non-Structural Concrete**						
Mix Design	REVIEW BY HQ Central Lab	509.01 Contractor	 Contractor	See Section 260.03.		
Concrete (1)	ACCEPTANCE Certification	509.02 Contractor	 Contractor	ITD-875 with QC test results attached (1) QC tests on First load, then each 50 CY (38 m^3) until quantity exceeds 100 CY (75m^3). Thereafter, every 100 CY (75 m^3)	Total Quantity Paid	Unless lack of quality control is evident, plant inspection, aggregate testing, cement & fly ash certs & sampling, field tests and compressive strength tests by the State are not required. (2B) See QA Manual Section 230.06 Concrete supplier's certification Note locations on ITD-875

(1) When total is less than 50CY, QC tests can be from previous batches in the 30 days prior to the first placement.

Concrete for landscaping using sack mixes will NOT require certification (ITD-875) or verification tests. Acceptance will be by inspection on the RE Letter (ITD-854).

510-1

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. SAMPLED BY	TEST METHOD TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **510 CONCRETE OVERLAY**						
Mix Design	FOLLOW STANDARD SPECIFICATION SECTION 502					
Aggregate						
Portland Cement						
Curing Compound						
Latex Modified Concrete	ACCEPTANCE (Latex Modifier) Certification	510.02 Manufacturer	Idaho T 121 Manufacturer	ITD-851 with test results attached	Total Quantity Paid	See QA Manual Section 230.01
	ACCEPTANCE (Concrete) Field Tests	510.02 ITD Project Personnel	AASHTO T 119 AASHTO T 152 AASHTO T 309 AASHTO T 121 ITD Project Personnel	ITD-70	First load, then each 50 CY ($38m^3$) until quantity reaches 100 CY ($75m^3$), thereafter each 100 CY ($75m^3$).	
	INDEPENDENT ASSURANCE Field Tests	IA Inspector	IA Inspector	ITD-857	Each 2,000 CY (1500 m^3)	
	ACCEPTANCE (Concrete) Compressive Strength	510.03 ITD Project Personnel	AASHTO T 22 AASHTO T 23 ITD District or Central Lab	ITD-1044 (Sample Data) ITD-845 (Lab Report)	One (1) set of three (3) 28-day cylinders per day	
	INDEPENDENT ASSURANCE Making Cylinders	IA Inspector	IA Inspector	ITD-857	Observation one (1) per project	
Silica Fume Concrete	ACCEPTANCE (Silica Fume) Certification	510.02 Manufacturer	AASHTO M307 Manufacturer	ITD-851 with test results attached	Total Quantity Paid	See QA Manual Section 230.01
	VERIFICATION Laboratory Test	510.02 ITD Project Personnel	AASHTO M307 ITD Central Lab	ITD-1044 (Sample Data) ITD-1827 (Lab Report)	One (1) per project	One (1) Cylinder Can
	ACCEPTANCE (Concrete) Field Tests	510.02 ITD Project Personnel	AASHTO T 119 AASHTO T 152 AASHTO T 309 AASHTO T 121 ITD Project Personnel	ITD-70	First load, then each 50 CY ($38m^3$) until quantity reaches 100 CY ($75m^3$), thereafter each 100 CY ($75m^3$).	
	INDEPENDENT ASSURANCE Field Tests	IA Inspector	IA Inspector	ITD-857	Each 2,000 CY (1500 m^3)	

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
Silica Fume Concrete (Continued)	ACCEPTANCE (Concrete) Compressive Strength	510.03	AASHTO T 22 AASHTO T 23	ITD-1044 (Sample Data) ITD-845 (Lab Report)	One (1) set of three (3) 28-day cylinders per day	
		ITD Project Personnel	ITD District or Central Lab			
	INDEPENDENT ASSURANCE Making Cylinders	IA Inspector	IA Inspector	ITD-857	Observation one (1) per project	
Smoothness	ACCEPTANCE	409 510.03(F)		ITD-854		Identify any delaminations for removal.
			ITD Project Personnel			
STANDARD SPECIFICATION SECTION: **511 CONCRETE WATERPROOFING SYSTEMS**						
Liquid Asphalt Sealant Type A System	ACCEPTANCE Certification	511.02	ASTM D 3406	ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
Asphalt Roll Roofing Type A System	ACCEPTANCE Certification	511.02	ASTM D 224 TYPE II	ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
Primer Type A System	ACCEPTANCE Certification	702.03		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
Asphalt Cement Type B System	ACCEPTANCE Certification	702.01		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
Fabric Type B System	ACCEPTANCE Certification	718.02		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
Sand Membrane Protection Blanket	ACCEPTANCE Gradation Sand Equivalent	703.02	AASHTO T 27 AASHTO T 11 AASHTO T 176 Method 2, Mechanical	ITD-901	One (1) per project	If test fails immediately, perform check test. If check test fails, reject material.
		ITD Project Personnel	ITD Project Personnel			
Membrane Sheet Type D System	ACCEPTANCE Certification	511.02 511.03		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
Water Repellant Type C System	ACCEPTANCE Certification	511.02 511.03		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			

	BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
512	STANDARD SPECIFICATION SECTION: **512 GABION STRUCTURE**						
	Wire Mesh	ACCEPTANCE Certification	715.01	ASTM A 370 ASTM A 641 ASTM A 90 ASTM A 185	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.01
			Manufacturer	Manufacturer			
	Joints	ACCEPTANCE Certification	715.05	ASTM A 641 ASTM A 370 ASTM A 641 ASTM A 90 ASTM A 764	ITD-851	Total Quantity Paid	See QA Manual Section 230.01
			Manufacturer	Manufacturer			
	Fill Material	ACCEPTANCE Inspection	715.06		ITD-854		
			No sample required	No testing required			
	Compacting Backfill	ACCEPTANCE In-Place Density	512.03(5)	AASHTO T 99 Method C or A AASHTO T 310 Method B	ITD-850	Each 2500 CY or 4000 tons (2000 m^3 or 3500 t)	Document compaction effort for each lift. Obtain check tests within 10 feet (3m) and at same depth as original test.
			ITD Project Personnel	ITD Project Personnel			
		INDEPENDENT ASSURANCE In-Place Density	IA Inspector	IA Inspector	ITD-857	Observation one (1) per project	
	Geotextile	FOLLOW STANDARD SPECIFICATION SECTION 640					

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF.	SAMPLED BY	TEST METHOD	TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **602 CULVERTS, 603 PIPE SIPHONS, 604 IRRIGATION PIPE LINES, 605 SEWERS, 606 PIPE UNDERDRAINS, 607 EMBANKMENT PROTECTORS, 608 APRONS FOR PIPE**								
Corrugated Metal Pipe and Pipe Arches	ACCEPTANCE Certification	706.06	Manufacturer	AASHTO M 36 or M 196	Manufacturer	ITD-914 with mill test reports attached for steel & ITD-851 for aluminum	Total Quantity Paid	See QA Manual Sections 230.01 and 230.07
	ACCEPTANCE Certification	706.06	Manufacturer	AASHTO M 36 Galvanized Coating	Manufacturer	ITD-914 with QC results attached	Total Quantity Paid .	See QA Manual Section 230.07
Structural Plate Pipe, Pipe Arches and Arches	ACCEPTANCE Certification	708.20	Manufacturer	AASHTO M 167 or M 219	Manufacturer	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.01
Concrete Pipe for Sewer, Irrigation or Drainage,	ACCEPTANCE Certification	706.01 706.02 706.03	Manufacturer	AASHTO M 86 ASTM C 118	Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Sections 230.01 and 230.04
Reinforced Concrete Culvert, Storm Drain and Sewer Pipe	ACCEPTANCE Certification	706.01 706.04		AASHTO M 170		ITD-851 ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Sections 230.01 and 230.04
Pipe Underdrains (metallic coated corrugated steel, corrugated aluminum pipe, corrugated PE drainage tubing PVC pipe)	ACCEPTANCE Certification	706.07 706.08 706.10 706.14	Manufacturer	AASHTO M 36 AASHTO M 196 AASHTO M 252 AASHTO M 278	Manufacturer	ITD-851 or ITD-914 for steel (with mill test reports attached)	Total Quantity Paid	See QA Manual Section 230.01

602, 603, 604, 605, 606, 607, 608-1

602, 603, 604, 605, 606, 607, 608-2

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. SAMPLED BY	TEST METHOD TESTED BY	REQUIED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
ABS or PVC or PE Pipe	ACCEPTANCE Certification	706.13 706.14 706.15 706.16 706.17 Manufacturer	ASTM D 2680 AASHTO M 278 ASTM F 794 AASHTO M 294 ASTM F 894 Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Section 230.06
Metal Aprons	ACCEPTANCE Certification	708.21 Manufacturer	AASHTO M 36 or M 196 Manufacturer	ITD-851 ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.01
Concrete Aprons	ACCEPTANCE Certification	502.01(B) Concrete Supplier	 Concrete Supplier	ITD-875 with QC test results attached ITD-851	Total Quantity Paid	See QA Manual Section 230.06 Concrete Supplier's certification Note locations on ITD-875
Gaskets for Concrete Pipe	ACCEPTANCE Certification	706.11 Manufacturer	AASHTO M 198 Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Section 230.01
Rubber Gaskets for CMP	ACCEPTANCE Certification	706.12 Manufacturer	ASTM D 1056 Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Section 230.01
Manhole Covers and Rings, Grates	ACCEPTANCE Certification	708.22 Manufacturer	AASHTO M 105 Manufacturer	ITD-851 ITD-914	Total Quantity Paid	See QA Manual Section 230.01
Catch Basins, Inlets & Manholes (Pre-cast)	ACCEPTANCE Certification	Standard Drawing E6 Manufacturer	 Manufacturer	ITD-851 ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.05 Manufacturer's certification
Catch Basins, Inlets & Manholes (Cast in-Place)	ACCEPTANCE Certification	Standard Drawing E6 Manufacturer	 Manufacturer	ITD-875 with QC test results attached	Total Quantity Paid	See QA Manual Section 230.05 Concrete Supplier's certification Note locations on ITD-875
Corrugated Metal Embankment Protectors	ACCEPTANCE Certification	607.02 706.06 Manufacturer	AASHTO M 36 AASHTO M 196 Manufacturer	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.01
Compacting Backfill	FOLLOW STANDARD SPECIFICATION SECTION 210					
Drain Rock	ACCEPTANCE Certification	606.02 Contractor	AASHTO T 2 AASHTO T 248 AASHTO T 27 Contractor	ITD-851 with QC gradation tests attached	Total Quantity Paid	See QA Manual Section 230.01
Geotextile	Follow Standard Specification Section 640					

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **609 MINOR STRUCTURES**						
Concrete Specified strength of 3000 psi (20.5 MPa) or less	ACCEPTANCE Certification	509 Concrete Supplier	Concrete Supplier	ITD-851 (Precast) ITD-875 (Cast in Place) with QC test results attached	Total Quantity Paid	See QA Manual Section 230.06 Concrete Supplier's certification Note locations on ITD-875.
Concrete Specified strength of 3500 psi (24.0 MPa) or greater	FOLLOW STANDARD SPECIFICATION SECTION 502					
Metal Reinforcement [with concrete of specified strength of 3000 psi (20.5 MPa) or less]	ACCEPTANCE Certification	708.02 Manufacturer	Manufacturer	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03 No samples required.
Metal Reinforcement [with concrete of specified strength of 3500 psi (24.0 MPa) or greater]	FOLLOW STANDARD SPECIFICATION SECTION 503					
Timber	ACCEPTANCE Certification	710 Manufacturer	Manufacturer	ITD-851	Total Quantity Paid	
Compacting Backfill	FOLLOW STANDARD SPECIFICATION SECTION 210					

609

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **610 FENCE**						
610-1 Barbed Wire	ACCEPTANCE Field Tests	708.09 / ITD Project Personnel	AASHTO M 280 / ITD Project Personnel	ITD-1044 (Sample Data)	Check barb count at least once for every 50 rolls or at least once (1) per project	If field tests meet specifications, record results on ITD-1044 and submit sample to Central Laboratory for tests. If any of the field test results do not meet specification, **reject** the material.

Field Tests (Include this information on the ITD-1044):

- Total number of barbs: Count total barbs in a 25 ft. (7.6 m) length. Test lengths must contain at least 69 barbs in 25 ft. (7.6 m) length for 4 in. (102 mm) spacing or 55 barbs in 25 ft. (7.6 m) length for 5 in. (127 mm) spacing.
- Cumulative average: Divide the total length by the total number of barbs.
- Individual percent barb spacing: Measure individual barb spacing (edge of one barb at the strand to corresponding edge of adjacent barb) over the same 25 ft. (7.6 m) section. Divide the number of compliant spacings by the total number of spaces times 100. At least 93.5% of individual barb spaces must conform to the barb spacing in the table below ± 3/4 in. (19 mm).

Table Condensed (see AASHTO M 280 for full table)

Strand Gage^A	No. Points	Barb Spacing	Barb Gage^A	Barb Shape
12½	2	4 (102)	13^B	Flat
12½	2	4 (102) or 5 (127)	14	Round
12½	4	5 (127)	14	Round
12½	4	5 (127)	14^B	Half-Round
12½	2	4 (102)	12½^B	Flat
13½	2	4 (102)	14	Round
13½	4	5 (127)	14	Round

Footnotes

^A Nominal zinc-coated wire diameters:

12½ ga	0.099 in. (2.51mm)
13 ga	0.092 in. (2.32 mm)
13½ ga	0.086 in. (2.18 mm)
14 ga	0.080 in.(2.03 mm)

^B Gage of flat and half-round barbs is gage of round wire before forming.

Note: If a sample is failing on the spacing, measure samples from two randomly selected rolls in the lot. If either one of the additional samples fail, reject the entire lot in the field.

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
Barbed Wire	ACCEPTANCE Laboratory Tests	708.09		ITD-914 ITD-1044 (Sample Data) ITD-1836 (Lab Report)	One (1) sample per each 50 spools delivered to project. Minimum one sample per project per Supplier.	**Sample Size: 6 linear feet (2 meters)** Barb spacing will not be checked in the lab as a 25ft (7.6 m) sample is required. Reject failing material.
		ITD Project Personnel	ITD Central Lab			
Woven Wire	ACCEPTANCE Laboratory Tests	708.10		ITD-914 ITD-1044 (Sample Data) ITD-1837 (Lab Report)	One (1) sample per each 50 spools delivered to project. Minimum one sample per project per Supplier.	**Sample Size: 6 linear feet (2 meters)** Reject failing material.
		ITD Project Personnel	ITD Central Lab			
Chain Link	ACCEPTANCE Laboratory Tests	708.13		ITD-914 ITD-1044 (Sample Data) ITD-1838 (Lab Report)	One (1) sample per each 50 rolls delivered to each project. Minimum one sample per project per Supplier.	**Sample Size: 3 linear feet (1 meter)** Reject failing material.
		ITD Project Personnel	ITD Central Lab			
Metal Posts for all fence types	ACCEPTANCE Inspection	708.12	Field verification of ASTM A 702 or AASHTO M281 or AASHTO M181	ITD-854 ITD-914	One (1) test for weight per 1000 posts (Document on ITD-854)	RE Letter-See QA Manual Section 250.00
		ITD Project Personnel	ITD Project Personnel			
Wood Posts	ACCEPTANCE Inspection	710.08	No Testing Required	ITD-854	Total Quantity Paid	RE Letter- See QA Manual Section 250.00
Gates	ACCEPTANCE Inspection	610.03	No Testing Required	ITD-854 ITD-914	Total Quantity Paid	RE Letter- See QA Manual Section 250.00
Braces	ACCEPTANCE Inspection	610.03	No Testing Required	ITD-854 ITD-914	Total Quantity Paid	RE Letter- See QA Manual Section 250.00
Hardware for Barbed or Woven Wire Fence	ACCEPTANCE Inspection	708.11	No Testing Required	ITD-854 ITD-914	Total Quantity Paid	RE Letter- See QA Manual Section 250.00

NOTE: No samples required when total fence item is less than 50 LF. Acceptance by manufacturer's certification.

610-2

	BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
610-3	Concrete	ACCEPTANCE Certification		No Testing Required	ITD-875	Total Quantity Paid	See QA Manual Section 230.06 Concrete Supplier's certification

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. SAMPLED BY	TEST METHOD TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **611 CATTLE GUARDS**						
Concrete	ACCEPTANCE Certification	509 Concrete Supplier	 Concrete Supplier	ITD-875 with QC test results attached	Total Quantity Paid	See QA Manual Section 230.06 Concrete Supplier's certification
Metal Reinforcement	ACCEPTANCE Certification	708.02 Manufacturer	 Manufacturer	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03
Structural Metals	ACCEPTANCE Certification	504.02 Manufacturer	(1) Manufacturer	ITD-914 with mill test reports attached	Total Quantity Paid	
Culverts	FOLLOW STANDARD SPECIFICATION SECTION 602					
Fence	FOLLOW STANDARD SPECIFICATION SECTION 610					

(1) Fabrication Inspection by ITD Central Lab required when quantities over 16 Tons (15 t).

611

612-1

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **612 METAL GUARDRAIL**						
Post and Blocks	ACCEPTANCE Certification	710.03 710.09		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
Steel Rail and Fittings	ACCEPTANCE Certification	708.14		ITD-851 ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
Aluminum Rail and Fittings	ACCEPTANCE Certification	708.25		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
Metal Terminal Section	ACCEPTANCE Certification (2)	Standard Drawings		ITD-851 ITD-914 with mill test reports attached	Total Quantity Paid	Type 5 and Type 10 are certified as complete units, all other types need certifications for each component. See QA Manual Section 230.01
		Manufacturer	Manufacturer			
Impact Attenuator (Temporary or Permanent)	ACCEPTANCE Certification (2)	[Spec. Prov.]		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			

(2) Manufacturer's certification must indicate item meets Manual for Assessing Safety Hardware (MASH) or National Cooperative Highway Research Program (NCHRP) report 350 requirements on all portions of the NHS and State Highway System. See QA Manual 270.08.

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF.	TEST METHOD	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
		SAMPLED BY	TESTED BY			
STANDARD SPECIFICATION SECTION: **612 CONCRETE GUARDRAIL**						
Pre-Cast	ACCEPTANCE Certification(3)	502.01(B) Manufacturer	 Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Section 230.01 and Section 230.05
Cast-In-Place Specified strength of 3000 psi (20.5 MPa) or less	ACCEPTANCE Certification(3)	502.01(B) Concrete Supplier	 Concrete Supplier	ITD-875 with QC test results attached	Total Quantity Paid	See QA Manual Section 230.06 Concrete Supplier's certification Note locations on ITD-875.
Cast-In-Place Specified strength of 3500 psi (24.0 MPa) or greater	FOLLOW STANDARD SPECIFICATION SECTION 502					
Metal Reinforcement (Cast-In-Place only)	ACCEPTANCE Certification(3)	503.02 708.02 Manufacturer	 Manufacturer	ITD-914 with mill test results attached	Total Quantity Paid	See QA Manual Section 230.03
Concrete Terminal Section	ACCEPTANCE Certification(3)	Standard Drawings Manufacturer	 Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Section 230.01
Impact Attenuator (Temporary or Permanent)	ACCEPTANCE Certification(3)	[Spec. Prov.] Manufacturer	 Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Section 230.01

(3) Manufacturer's certification must indicate item meets Manual for Assessing Safety Hardware (MASH) or National Cooperative Highway Research Program (NCHRP) report 350 requirements on all portions of the NHS and State Highway System. See QA Manual 270.08.

612-2

	BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
613	STANDARD SPECIFICATION SECTION: **613 SIDEWALKS**						
	Concrete	ACCEPTANCE Certification	509 / Concrete Supplier	Concrete Supplier	ITD-875 with QC test results attached*	Total Quantity Paid	See QA Manual Section 230.06 Concrete Supplier's certification Note locations on ITD-875.
	Plant Mix	ACCEPTANCE Inspection	405	No Testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
	Road Mix	ACCEPTANCE Inspection	406	No Testing Required	ITD-854	Total Quantity Paid	RE Letter- See QA Manual Section 250.00
	Soil or Aggregate Under Sidewalk	ACCEPTANCE In-Place Density	613.02 / ITD Project Personnel	AASHTO T310 / ITD Project Personnel	ITD-850	One (1) per project	
614	STANDARD SPECIFICATION SECTION: **614 URBAN APPROACHES**						
	Concrete	ACCEPTANCE Certification	509 / Concrete Supplier	Concrete Supplier	ITD-875 with QC test results attached*	Total Quantity Paid	See QA Manual Section 230.06 Concrete Supplier's certification Note locations on ITD-875.
	Plant Mix	ACCEPTANCE Inspection	405	No Testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
	Road Mix	ACCEPTANCE Inspection	406	No Testing Required	ITD-854	Total Quantity Paid	RE Letter- See QA Manual Section 250.00
	Soil or Aggregate Under Sidewalk	ACCEPTANCE In-Place Density	614.02 / ITD Project Personnel	AASHTO T310 / ITD Project Personnel	ITD-850	One (1) per project	
615	STANDARD SPECIFICATION SECTION: **615 CURB AND GUTTER**						
	Type A, B, C Concrete (cast in place, precast, extruded)	ACCEPTANCE Certification	509 / Concrete Supplier	Concrete Supplier	ITD-875 with QC test results attached*	Total Quantity Paid	See QA Manual Section 230.06 Concrete Supplier's certification Note locations on ITD-875.
	Type D Plant Mix	ACCEPTANCE Inspection		No Testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00

* When total is less than 50CY, QC tests can be from previous batches in the 30 days prior to the first placement.

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **616 SIGNS AND SIGN SUPPORTS**						
Sign Material *All materials for signs and sign supports require certification for acceptance. Acceptance of all components on one ITD-851 certification form is acceptable as long as the components are listed on the ITD-851.*	ACCEPTANCE Certification	Extruded Aluminum 708.26		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
	ACCEPTANCE Certification	Sheet Aluminum 708.27		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
	ACCEPTANCE Certification	Steel and Aluminum sign supports 708.17(A)		ITD-851 ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
	ACCEPTANCE Certification	Hardware for signs 708.18		ITD-851 ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
	ACCEPTANCE Certification	Plywood for Type E signs 712.01		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
	ACCEPTANCE Certification	Reflective Sheeting 712.02		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
	ACCEPTANCE Certification	Reflective removable cutouts 712.03		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
	ACCEPTANCE Certification	Porcelain Enamel 712.05		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
	ACCEPTANCE Certification	Polyester Powder Coating 712.06		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			

616-1

	BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
616-2	Overhead Sign Structures	ACCEPTANCE Certification	708.17(B) / Manufacturer	/ Manufacturer	ITD-851 or ITD-914 for steel (with mill test reports attached)	Total Quantity Paid	ITD Central Lab Inspection required
	Breakaway Wood Posts	ACCEPTANCE Certification	710.02 710.09 / Manufacturer	/ Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Section 230.01 The manufacturer must provide a copy of the wood treatment certification to ITD Central Laboratory.
	Steel Brackets and Brace angles	ACCEPTANCE Certification	708.17(A) / Manufacturer	/ Manufacturer	ITD-851 ITD-914	Total Quantity Paid	See QA Manual Section 230.01
	Breakaway Steel Sign Posts	ACCEPTANCE Certification	708.17(A) / Manufacturer	/ Manufacturer	ITD-851 ITD-914	Total Quantity Paid	See QA Manual Section 230.01
	Breakaway Steel Sign Post Installation	ACCEPTANCE Inspection	708.17(A) /	/	ITD-854	Total Quantity Paid	See QA Manual Section 230.01
	Concrete Specified strength of 3000 psi (20.5 MPa) or less	ACCEPTANCE Certification	502.01(B) / Concrete Supplier	/ Concrete Supplier	ITD-875 with QC test results attached	Total Quantity Paid	See QA Manual Section 230.06 Concrete supplier's certification Note locations on ITD-875
	Concrete Specified strength of 3500 psi (24.0 MPa) or greater	FOLLOW STANDARD SPECIFICATION SECTION 502					
	Metal Reinforcement [with concrete of specified strength of 3000 psi (20.5 MPa) or less]	ACCEPTANCE Certification	708.02 / Manufacturer	/ Manufacturer	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03 No samples required.
	Metal Reinforcement [with concrete of specified strength of 3500 psi (24.0 MPa) or greater)]	FOLLOW STANDARD SPECIFICATION SECTION 503					

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS	
STANDARD SPECIFICATION SECTION: **617 DELINEATORS AND MILEPOSTS**							617
Steel Posts	ACCEPTANCE Certification	708.16 Manufacturer	 Manufacturer	ITD-851 ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.01	
Aluminum Posts	ACCEPTANCE Certification	708.16 Manufacturer	 Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Section 230.01	
Delineator and Milepost Plates	ACCEPTANCE Certification	708.15 Manufacturer	 Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Section 230.01	
Reflector Units	ACCEPTANCE Certification	712.04 Manufacturer	 Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Section 230.01	
Reflective Sheeting	ACCEPTANCE Certification	712.02 Manufacturer	 Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Section 230.01	
Silk Screen Paste	ACCEPTANCE Certification	712.08 Manufacturer	 Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Section 230.01	

	BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
618	STANDARD SPECIFICATION SECTION: **618 MARKER POSTS, WITNESS POSTS AND STREET MONUMENTS**						
	Right-of-Way Markers	ACCEPTANCE Inspection	618.02	No Testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
	Brass Caps	ACCEPTANCE Inspection	708.28	No Testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
	Reference Markers	ACCEPTANCE Inspection	618.02	No Testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
	Project Markers	ACCEPTANCE Inspection	618.02	No Testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
	Witness Posts	ACCEPTANCE Inspection	Steel 708.16	No Testing Required	ITD-854 ITD-914 with mill test reports attached	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
		ACCEPTANCE Inspection	Wood 710.09	No Testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
		ACCEPTANCE Inspection	Fiberglass 618.02	No Testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
	Street Monuments	ACCEPTANCE Inspection	618.02	No Testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **619 ILLUMINATION**						
Illumination Poles and Bases	ACCEPTANCE Certification	708.19 710.06		ITD-851 ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03
		Manufacturer	Manufacturer			
Illumination Components	ACCEPTANCE Inspection	710.07 713.01 713.02 713.03 713.04 713.05 713.06	No Testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
Concrete Specified strength of 3000 psi (20.5 MPa) or less	ACCEPTANCE Certification	502.01(B)		ITD-875 with QC test results attached	Total Quantity Paid	See QA Manual Section 230.06 Concrete Supplier's certification Note locations on ITD-875
		Concrete Supplier	Concrete Supplier			
Concrete Specified strength of 3500 psi (24.0 MPa) or greater	FOLLOW STANDARD SPECIFICATION SECTION 502					
Metal Reinforcement [with concrete of specified strength of 3500 psi (24.0 MPa) or greater]	FOLLOW STANDARD SPECIFICATION SECTION 503					
Metal Reinforcement [with concrete of specified strength of 3000 psi (20.5 MPa) or less]	ACCEPTANCE Certification	503.02 708.02		ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03 No samples required.
		Manufacturer	Manufacturer			

619

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS	
STANDARD SPECIFICATION SECTION: 620 PLANTING							**620**
Plants, Commercial Fertilizer, Soil Conditioner, Topsoil, Mulch	ACCEPTANCE Inspection	711.06 711.07 711.08 711.09 711.10 711.12	No Testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00	
STANDARD SPECIFICATION SECTION: 621 SEEDING							**621**
Seed, Mulch, Commercial Fertilizer, Erosion Blanket	ACCEPTANCE Certification	711.05 711.07 711.10 711.11 711.12 711.16	AOSA	ITD-851* with Laboratory Analysis Report attached	Total Quantity Paid	See QA Manual Section 230.12 Note: State furnished seed is accepted to use on projects but MUST be sampled and tested. Unless it meets all the parameters in QA Manual 230.12. Include completed ITD-1044 to test lab with seed sample. Send copy of ITD-1044 to HQ Highway Operations, Attention: Roadside Program Administrator *ITD 851 for contractor supplied seed and not needed for State furnished seed.	
		Licensed Supplier / Manufacturer	Licensed Supplier / Manufacturer				
	VERIFICATION Laboratory Test <u>Seed Only</u>	711.05	Purity, Germination & TZ	ISDA Test Results	One (1) for each individually packaged seed containers from each species		
		ITD Project Inspector	(Boise) ISDA Seed Laboratory				
STANDARD SPECIFICATION SECTION: 622 PRE-CAST CONCRETE HEADGATES							**622**
Pre-Cast Concrete Head gates	ACCEPTANCE Certification	502.01(B)		ITD-851 ITD-914	Total Quantity Paid	See QA Manual Section 230.05	
		Manufacturer	Manufacturer				
STANDARD SPECIFICATION SECTION: 623 CONCRETE SLOPE PAVING							**623**
Concrete	ACCEPTANCE Certification	502.01(B)		ITD-875 with QC test results attached	Total Quantity Paid	See QA Manual Section 230.06Concrete Supplier's certification Note locations on ITD-875	
		Concrete Supplier	Concrete Supplier				
Pre-formed-expansion Joint Fillers	ACCEPTANCE Certification	623.02	AASHTO M 213	ITD-851	Total Quantity Paid	See QA Manual Section 230.01	
		Manufacturer	Manufacturer				
Compaction	FOLLOW STANDARD SPECIFICATION SECTION 205 OR 303						

	BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
624	STANDARD SPECIFICATION SECTION: **624 RIPRAP**						
624	Loose and Hand Placed	ACCEPTANCE Inspection	711.04	Initial testing required for Apparent Specific Gravity, Absorption, and Coarse durability Index. Only visual inspection during placement.	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
624	Sack and Concrete Stabilized	ACCEPTANCE Inspection	711.04	Initial testing required for Apparent Specific Gravity, Absorption, and Coarse durability Index. Only visual inspection during placement.	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
625	STANDARD SPECIFICATION SECTION: **625 JOINTS**						
625	Pre-Formed Expansion Joint Filler	ACCEPTANCE Certification	704.01		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
			Manufacturer	Manufacturer			
625	Hot Poured Elastic Type Concrete Joint Sealer	ACCEPTANCE Certification	704.02		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
			Manufacturer	Manufacturer			
625	Hot Poured Elastomeric Type Concrete Joint Sealer	ACCEPTANCE Certification	704.03		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
			Manufacturer	Manufacturer			
625	Neoprene Compression Seal	ACCEPTANCE Certification	704.04		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
			Manufacturer	Manufacturer			
625	Silicone Sealant	ACCEPTANCE Certification	704.05		ITD-851 with test results attached	Total Quantity Paid	See QA Manual Section 230.01
			Independent Laboratory	Independent Laboratory			

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **626 CONSTRUCTION TRAFFIC CONTROL DEVICES**						
Rent Construction Signs, Barricades, Drums, Portable Tubular Markers, Incidental Traffic Control Items	ACCEPTANCE Inspection	Reflectivity 712.02	No Testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
Rent Vertical Panels, Advance Warning Arrow Panel, Traffic Control Signal, Hazard Identifi-cation Beacon	ACCEPTANCE Inspection	Reflectivity 712.02	No Testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
Temporary Pavement Striping Tape	ACCEPTANCE Inspection	Reflectivity 712.02	No Testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
Temporary Flexible Raised Pavement Marker	ACCEPTANCE Inspection	Reflectivity 712.02	No Testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
Temporary Rigid Raised Pavement Marker	ACCEPTANCE Inspection	Reflectivity 712.02	No Testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00

626

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **627 PAINTING**						
Painting Steel[(4)]	ACCEPTANCE Pre-Tests[(4)]	707.02		ITD-1832	All lots (1-quart can sample size)	Record lot numbers and lab numbers of approved pre-tested paint from ITD Central Lab letter and/ or ITD-1832.
		Coordinate with ITD Central Lab	ITD Central Lab			
	ACCEPTANCE Certification	707.03		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
Painting Wood[(4)]	ACCEPTANCE Pre-Tests[(4)]	707.02		ITD-841	All lots (1-quart can sample size)	Record lot numbers and lab numbers of approved pre-tested paint from ITD Central Lab letter and/ or ITD-841.
		Coordinate with ITD Central Lab	ITD Central Lab			
	ACCEPTANCE Certification	707.03		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			
Painting Concrete[(4)]	ACCEPTANCE Pre-Tests[(4)]	707.02		ITD-1832	All lots (1-quart can sample size)	Record lot numbers and lab numbers of approved pre-tested paint from ITD Central Lab letter and/ or ITD-1832.
		Coordinate with ITD Central Lab	ITD Central Lab			
	ACCEPTANCE Certification	707.03		ITD-851	Total Quantity Paid	See QA Manual Section 230.01
		Manufacturer	Manufacturer			

(4)Acceptance by manufacturer's certification when total project quantity is less than 25 gallons.

627

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. SAMPLED BY	TEST METHOD TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **628 SNOW POLES**						628
Rigid Posts for Delineators, Snow Poles, and Mileposts or Kilometer Posts	ACCEPTANCE Inspection	708.16	No Testing Required	ITD-854 for steel ITD-914 with mill test reports attached	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
Reflector Units for Delineators	ACCEPTANCE Inspection	712.04	No Testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
Flexible Snow Poles	ACCEPTANCE Approved List	712.11		Qualified Products List		
		Manufacturer	Manufacturer			
STANDARD SPECIFICATION SECTION: **634 MAILBOX**						634
Type I Support/ Foundation	ACCEPTANCE Certification	708.16 710.02		ITD-851 for steel ITD-914 with mill test reports	Total Quantity Paid	-See QA Manual Section 230.00
		Manufacturer	Manufacturer			
Mailbox	ACCEPTANCE Inspection	634.02	No Testing Required	ITD-854 for steel ITD-914 with mill test reports attached	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
STANDARD SPECIFICATION SECTION: **635 ANTI-SKID MATERIAL**						635
Aggregate (Production)	ACCEPTANCE Gradation	703.10	AASHTO T 2 AASHTO T 248 AASHTO T 11 AASHTO T 27	ITD-901	Each 1000 Tons (900 t)	
		ITD Project Personnel	ITD Project Personnel			
	INDEPENDENT ASSURANCE Gradation Sand Equivalent	IA Inspector	IA Inspector	ITD-857	Each 20,000 Tons (18,000 t)	

640-1

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF.	TEST METHOD	SAMPLED BY	TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **640 GEOTEXTILES**								
Drainage Geotextile	ACCEPTANCE Certification	718.05		Manufacturer	Manufacturer	ITD-849 with QC test results attached	Total Quantity Paid	See QA Manual Section 230.09
	VERIFICATION Laboratory Tests(5)	718.05		ITD Project Personnel	ITD Central Lab	ITD-1044(5A) (Sample Data) ITD-1047 (Lab Reports)	One (1) sample per lot(5B)	See QA Manual Section 230.09
Riprap/Erosion Geotextile	ACCEPTANCE Certification	718.06		Manufacturer	Manufacturer	ITD-849 with QC test results attached	Total Quantity Paid	See QA Manual Section 230.09
	VERIFICATION Laboratory Tests(5)	718.06		ITD Project Personnel	ITD Central Lab	ITD-1044(5A) (Sample Data) ITD-1047 (Lab reports)	One (1) sample per lot(5B)	See QA Manual Section 230.09
Subgrade Separation Geotextile	ACCEPTANCE Certification	718.07		Manufacturer	Manufacturer	ITD-849 with QC test results attached	Total Quantity Paid	See QA Manual Section 230.09
	VERIFICATION Laboratory Tests(5)	718.07		ITD Project Personnel	ITD Central Lab	ITD-1044(5A) (Sample Data) ITD-1047 (Lab reports)	One (1) sample per lot(5B)	See QA Manual Section 230.09
Pavement Overlay Geotextile	ACCEPTANCE Certification	718.08		Manufacturer	Manufacturer	ITD-849 with QC test results attached	Total Quantity Paid	See QA Manual Section 230.09
	VERIFICATION Laboratory Tests(5)	718.08		ITD Project Personnel	ITD Central Lab	ITD-1044(5A) (Sample Data) ITD-1047 (Lab Reports)	One (1) sample per lot(5B)	See QA Manual Section 230.09

(5) No Samples required for quantities less than 600 square yards (500 square meters).
(5A) Include acceptance certification documents with ITD-1044 and sample.

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
Geogrid	ACCEPTANCE Certification	[Spec. Prov.]		ITD-849 with QC test results attached	Total Quantity Paid	See QA Manual Section 230.09
		Manufacturer	Manufacturer			
	VERIFICATION Laboratory Tests(5)	[Spec. Prov.]		ITD-1044(5A) (Sample Data) ITD-1048 (Lab Reports)	One (1) sample per lot(5B)	See QA Manual Section 230.09
		ITD Project Personnel	ITD Central Lab			

((5) No Samples required for quantities less than 600 square yards (500 square meters).

(5A) Include acceptance certification documents with ITD-1044 and sample.

(5B) A lot is defined as geotextile or geogrid rolls within the same consignment or shipment that a manufacturer produced with the same product name or designation (section 718.03 Samples of ITD Standard Specifications)

The following geosynthetic materials cannot be tested by ITD and will be accepted by certifications with required form No. ITD-849 with QC test results attached:

- Prefabricated Vertical Drain (Wick Drain), Prefabricated Drainage Mat (Geocomposite Drainage System), Edge Drain, Geonet.
- Geocell (Cellular Confinement System)
- Geomembrane, Geosynthetic Clay Liner

640-2

	BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
656	STANDARD SPECIFICATION SECTION: **656 TRAFFIC SIGNAL INSTALLATION**						
	Signal Poles and Mast Arms	ACCEPTANCE Certification	656.02 / Manufacturer	Manufacturer	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03
	Signal Components	ACCEPTANCE Inspection		No Testing Required	ITD-854	Total Quantity Paid	RE Letter-See QA Manual Section 250.00
	Signal Cabinet Electrical Components	ACCEPTANCE PRE-TEST		HQ or District Traffic	ITD-500 memo		Post acceptance memo on MSR
	State-Furnished Material		No Testing Required	No Testing Required			
	Concrete Specified strength of 3000 psi (20.5 MPa) or less	ACCEPTANCE Certification	502.01(B) / Concrete Supplier	Concrete Supplier	ITD-875 with QC test results attached	Total Quantity Paid	See QA Manual Section 230.06 Note locations on ITD-875
	Concrete Specified strength of 3500 psi (24.0 MPa) or greater	FOLLOW STANDARD SPECIFICATION SECTION 502					
	Metal Reinforcement [with concrete of specified strength of 3500 psi (24.0 MPa) or greater]	FOLLOW STANDARD SPECIFICATION SECTION 503					
	Metal Reinforcement [with concrete of specified strength of 3000 psi (20.5 MPa) or less]	ACCEPTANCE Certification	503.02 708.02 / Manufacturer	Manufacturer	ITD-914 with mill test reports attached	Total Quantity Paid	See QA Manual Section 230.03 No samples required

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **MISCELLANEOUS BUILDING ITEMS**						
Compaction	ACCEPTANCE Density	205.03 ITD Project Personnel	AASHTO T 310 ITD Project Personnel	ITD-850	At least one (1) per project	
Structural Concrete (Footings, Foundations, Piers)	FOLLOW STANDARD SPECIFICATION SECTION 502					
Non-Structural Concrete (Sidewalks, Driveways, Slabs)	ACCEPTANCE Certification	502.02 (B) Concrete Supplier	Concrete Supplier	ITD-875 with QC test results attached	Total Quantity Paid	See QA Manual Section 230.06 Concrete Supplier's certification Note locations on ITD-875
Metal Reinforcement (for structural concrete-footings, foundations, piers)	FOLLOW STANDARD SPECIFICATION SECTION 503					
Paint	FOLLOW STANDARD SPECIFICATION SECTION 627 (No sampling or testing required when total project quantity is less than 25 gallons.)					

MISCELLANEOUS BUILDING ITEMS

MISCELLANEOUS ITEMS

BID ITEM/ MATERIAL	PURPOSE OF TESTING	ITD SPEC. REF. / SAMPLED BY	TEST METHOD / TESTED BY	REQUIRED REPORT FORM NO.	MINIMUM REQUIRED FREQUENCY	REMARKS, NOTES OR ADDITIONAL DIRECTIONS
STANDARD SPECIFICATION SECTION: **MISCELLANEOUS ITEMS**						
Magnesium Chloride for Dust Control	ACCEPTANCE Laboratory Tests	[Spec. Prov.] / ITD Project Personnel	Per Specs / ITD Central Lab	ITD-1044 (Sample Data) ITD-1822	Each 100 tons or one (1) per project	Follow Special Provision requirements for acceptance; either by test or by certification. See QA Manual Section 230.01 for certification requirements.
	ACCEPTANCE Certification	[Spec. Prov.] / Manufacturer	Manufacturer	ITD-851	Total Quantity Paid	
Epoxies	ACCEPTANCE Certification	720.04 / Manufacturer	Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Section 230.01
Traffic Line Paint[6]	ACCEPTANCE Laboratory Tests	ITD Project Personnel	ITD Central Lab	ITD-1830 (Waterborne) Or ITD-1831 (Others)	Each lot used on Project	Record lot numbers and lab numbers of approved pre-tested paint from ITD Central Lab letter and/ or ITD-1830 or ITD-1831. Do not collect Sample from striper paint guns. *Not project specific. Reject if totes do not match lot numbers.
Methyl Methacrylate (MMA) Pavement Markings (8)	ACCEPTANCE Laboratory Tests	Manufacturer	ITD Central Lab	ITD -1831	Each lot used on Project	Manufacturer provides samples to Central Laboratory. Allow 14 days for pre-test results.
	ACCEPTANCE Certification[6]	Manufacturer	Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Section 230.01
Thermoplastic Pavement Markings	ACCEPTANCE Certification	Manufacturer	Manufacturer	ITD-851	Total Quantity Paid	See QA Manual Section 230.01
Glass Beads	ACCEPTANCE Laboratory Tests	ITD Project Personnel	ITD Central Lab	ITD-1828	Each lot used on Project (Sample must be left in manufacturer's bag.)	Record lot numbers and lab numbers of approved pre-tested paint from ITD Central Lab letter and/ or ITD-1828. *Not project specific.

[6]Acceptance by manufacturer's certification when total project quantity is less than 55 gallons.
[7]Acceptance by manufacturer's certification when total project quantity is less than 350 pounds.
(8) When warranty applies, no samples or certifications required. A copy of the warranty must be in the project files; post a remark on MSR.

SECTION 275.00 – ITD QUALITY ASSURANCE STANDARD PROCEDURES

275.01 Aggregate.

AASHTO T 176	Plastic Fines in Graded Aggregates and Soils by the Use of the Sand Equivalent Test
Idaho IT 144	Fine Aggregate Specific Gravity by CoreLok
FOP for AASHTO T 304	Uncompacted Void Content of Fine Aggregate

275.02 Asphalt.

275.02.01 General Notes

AASHTO R 47	Reducing Samples of Hot Mix Asphalt (HMA) to Testing Size
AASHTO T 166	Bulk Specific Gravity of compacted Hot Mix Asphalt using Saturated Surface-Dry Specimens
AASHTO T 168	Sampling of Bituminous Paving Mixtures
AASHTO T 209	Theoretical Maximum Specific Gravity and Density of Hot-Mix Asphalt Paving Mixtures
AASHTO T 246	Resistance to Deformation and Cohesion of Bituminous Mixtures by Means of Hveem Apparatus
AASHTO T 308	Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method
AASHTO T 312	Gyratory compaction of HMA Mixtures
AASHTO T 329	Moisture Content of Hot Mix Asphalt (HMA) by Oven Method
WAQTC TM 8	In-place Density of Bituminous Mixes Using the Nuclear Moisture-Density Gauge
AASHTO T 343	Density of In-Place Hot Mix Asphalt (HMA) Pavement by Electronic Surface Contact Devices

275.03 Concrete.

AASHTO T 22	Compressive Strength of Cylindrical Concrete Specimens

275.04 Embankment and Base In-place Density.

AASHTO T 310	In-place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

275.05 Miscellaneous

ASTM E 29 - 08	Using Significant Digits in Test Data to Determine Conformance with Specifications

SECTION 275.00 – ITD QUALITY ASSURANCE STANDARD PROCEDURES

275.01 Aggregate.

AASHTO T 176

Plastic Fines in Graded Aggregates and Soils by the Use of the Sand Equivalent Test

1. Labeling of SE Solution

   1.1 SE solution containers will be labeled with the date the working solution was mixed. In accordance with AASHTO T 176, Section 2.8, working solutions older than 30 days will be discarded.

2. Sample Preparation

   2.1 Add to Step 1 the following:

   The samples must be maintained at field moist condition until testing. Do not allow the sample to dry out. If testing will not be performed immediately, the sample must be kept in a sealed container.

3. Procedure

   3.1 Only mechanical method will be used for shaking the cylinder and contents.

FOP for AASHTO T 304

Uncompacted Void Content of Fine Aggregate

Procedure Modification:

1. If the bulk specific gravity of the fine aggregate from the source is unknown, determine it according to IT -144.

275.02 Asphalt.

275.02.01 General Notes.

After the loose mix sample is obtained, the sample must not be held in a hot oven greater than 200ºF for more than 4 hours to avoid aging or oxidation. However, the sample may be held over night as long as the oven temperature does not exceed 200 ºF.

AASHTO R-47

Reducing Samples of Hot Mix Asphalt to Testing Size

Procedure Modifications:

1. Do not use the method Mechanical Splitter Type A (Quartermaster). All other methods are approved.

AASHTO T166

Bulk Specific Gravity of compacted Hot Mix Asphalt using Saturated Surface-Dry Specimens

Procedure Modification:

1. The final test result will be determined from an average of two laboratory compacted specimens.

2. Outside Temperature needs to be 80 deg F and must be documented on test forms.
   The use of a fan will aid in the process.

AASHTO T168

Sampling of Bituminous Paving Mixtures

1. Procedure Modifications:

   Method 3 Obtaining sample without cutter device:
   When the sample container is large enough to accommodate the full dimensions of the sampling plate, the sampling plate may be lifted and the HMA sample carefully placed directly into the sample container.

FOP for AASHTO T209

Theoretical Maximum Specific Gravity and Density of Hot-Mix Asphalt Paving Mixtures

Procedure Modifications

1. All laboratory developed mix samples will be conditioned per AASHTO R30 (Mixture Conditioning of Hot Mix Asphalt) for two hours plus or minus 5 minutes at the asphalt binder manufactures recommended temperature for compaction.

   The final test result will be determined from an average of two specimens.

AASHTO T246

Resistance to Deformation and Cohesion of Bituminous Mixtures by Means of Hveem Apparatus

Procedure Modification

1. The final test result will be determined from an average of two specimens.

AASHTO T 308

Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method

1. Procedure Modifications to FOP AASHTO T 308.

- The testing laboratory owner must perform the Ignition Furnace Verification Procedure as outlined in the ITD Laboratory Qualification Program. The lift test will be performed and recorded weekly when the furnace is in use. The balance verification will be performed and recorded every 30 days when the furnace is in use and following furnace transport.

- For samples where the asphalt binder content is determined by an internal balance, this value must be verified by an external balance.
  - Calculate the asphalt binder content with external masses as follows:

$$P_b = \left[\frac{M_i - M_f}{M_i}\right] \times 100 - C_f - M$$

where:

P_b = the corrected asphalt binder content as a percent by mass of the HMA sample

M_f = the final mass of aggregate remaining after ignition

M_i = the initial mass of the HMA sample prior to ignition

C_f = correction factor as a percent by mass of the HMA sample

M= percent moisture content as determined by the FOP for AASHTO T 329.

- If the calculated asphalt binder content is within 0.15% use the corrected asphalt binder content (percent) from the printed ticket. If the difference is greater than 0.15% use the calculated asphalt binder content (percent) and determine and correct the source of the variation prior to reliance on the printed ticket.

1. Agency Approved Method for Combining Aggregates for Producing Calibration Factor Samples: All samples shall be the same gradation and shall be combined sieve by sieve down to and including the material passing the No. 200 sieve.

2. If the asphalt binder correction factor exceeds 1%, the test temperature must be lowered to 482 ±5°C (900 ±8°F).

AASHTO T312

Gyratory compaction of HMA Mixtures

Procedure Modifications

1. The final test result will be determined from an average of two specimens

AASHTO T 329

Moisture Content of Hot Mix Asphalt (HMA) by Oven Method

Procedure Modifications to WAQTC FOP T 329
Delete procedure 1 and substitute the following:

> The oven will be set to the minimum JMF compacting temperature as indicated on the approved mix design.

WAQTC TM 8

In-Place Density of Bituminous Mixes Using the Nuclear Moisture-Density Gauge

1. Cement Recycled Asphalt Base Stabilization (Crabs)

   1.1 Test method WAQTC TM8 backscatter mode is used to determine in-place density with the following modification:

   A roller pattern curve must be established with single shot (no rotation required) one-minute counts with the uncorrected nuclear densometer. The required compaction is achieved and final process rolling is defined as when the final roller pass adds no more than 0.5 lb/ft3 (8 kg/m3) to the previous in-place density.

2. Plantmix Pavement

   2.1 Test method WAQTC TM8 backscatter mode is used to determine in-place density, expressed as a percentage, rounded to the nearest tenth of one percent.

   2.2 For plantmix pavement when no acceptance test strip is required See Section 270.00, Minimum Testing Requirements for 405 Plantmix.

FOP for AASHTO T 343

Density of In-Place Hot Mix Asphalt (HMA) Pavement by Electronic Surface Contact Devices

Procedure Modification:

1. Instead of entering the correction factor from the cores into the gauge, the correction factor may be mathematically compensated for using the form, (ITD 0855) to calculate corrected density and percent compaction manually.

275.03 Concrete

AASHTO T22

Compressive Strength of Cylindrical Concrete Specimens

Unbonded caps may be used for concrete with an expected compressive strength of less than 7000 psi. Maximum number of tests per set of unbonded caps: 100 . For concrete with an expected compressive strength of 7000 psi or greater, sulfur capping per AASHTO T213 or grinding to meet the tolerances specified in AASHTO T22 is required.

275.04 Embankment and Base In-place Density.

AASHTO T 310

In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1. Soil & Aggregate

1.1 Test method FOP AASHTO T 310 is used to determine the in-place density. The results are expressed as a percentage, rounded to the nearest whole percent, of the maximum dry density from the density standard.

A compaction test result over 105% is not considered valid. The material and calculations must be evaluated to resolve the cause of this type of test result.

A gradation and a SE must be performed in order to confirm the correct density standard. A wet sieve on 3”, ¾”, No. 4, and SE is performed and recorded on the ITD-850 at the same frequency as a density test.

For materials identified as too granular to test (per definitions in Standard Specification Subsection 205.03-F), materials are to be compacted according to the requirements of Subsection 205.03. Documentation is required of the compaction equipment and compaction effort.

1.2 Soils and Soil-Aggregate Mixtures

1.2.1 Standard density is the maximum dry density from the Standard Specification 205.03-F. A laboratory moisture-density curve is used (produced) that represents the soil or soil-aggregate mixture. All moisture-density curves must have at least three (3) points at or below optimum moisture and two (2) points greater than optimum moisture.

1.2.2 For AASHTO T 99 or AASHTO T 180, a one-point determination per AASHTO T 272 is performed for every compaction test to select the proper moisture-density curve, including correction for coarse aggregate (AASHTO T 224) when necessary.

1.2.3 Requirements for matching a one-point determination to an existing moisture-density curve:

1. The density of the one-point determination must match the moisture-density curve within ± 2 pounds/cubic foot (32 kg/m^3).
2. The moisture content of the one-point determination must match the moisture-density curve between 80-100% of optimum moisture of that curve.

Otherwise, an additional moisture-density curve must be developed by the ITD field personnel using form ITD-898, or a family of curves (AASHTO T 272) may be used if the curves were developed with material from the same geologic source area with concurrence from the District Materials Engineer.

1.3 Granular Materials and Processed Aggregates Above Subgrade

1.3.1 Idaho IT 74 will be used to determine standard density; the use of AASHTO T 180 is allowed only when approved by the Engineer.

1.3.2 For Idaho T 74 curve, the standard density is the maximum dry density corresponding to the percent passing the No. 4 (4.75 mm) sieve. A laboratory density curve is used (produced) that represents the granular material or processed aggregate.

- Obtain a representative sample directly beneath the gauge. The sample size will be determined by the nominal maximum aggregate size from the table in AASHTO T255.
- Determine moisture content in accordance with AASHTO T255.
- Perform a field gradation test using the representative dry sample. Shake the sample over the No. 4 sieve. Hand shaking must continue until not more than 0.5 percent by mass of the total sample passes the sieve during one minute of continuous shaking. No wash is required.
    - o When large aggregate is present, use a 1 inch buffer sieve.
    - o Do not overload the No. 4 sieve.
- Use the IT 74 laboratory curve to find the maximum dry density at the percent passing No. 4 sieve. Divide the calculated dry density by the maximum dry density to determine the compaction percent.

1.3.3 A new Idaho T 74 curve must be provided annually for existing stockpiles or for new stockpiles of processed material.

1.3.4 A field gradation test is not required for each density test if the nuclear density gauge has been calibrated for moisture correction and the gauge reading is equal to or greater than 95% (94.6 rounded) at the peak point of the Idaho T 74 curve.

1.3.5 For AASHTO T 180, follow the preceding procedures for moisture-density curves.

1.4 Compacting Backfill

1.4.1 Use density standard defined in previous procedures by the type of backfill material.

2. Determining Moisture Correction for AASHTO T 310

2.1 For each soil or material type, the average moisture content of at least seven (7) consecutive tests is calculated to indicate the density gauge is reading the moisture content within a tolerance of 1% moisture content of the actual AASHTO T 255/265 test results. If the average moisture content exceeds the 1% tolerance, a moisture correction is applied. If less than seven density tests are required for a specific material type, then the percent moisture is determined by performing AASHTO T 255/265.

275.05 Miscellaneous

For purposes of determining conformance with these specifications, an observed value or a calculated value shall be rounded "to the nearest unit" in the last right digit used in expressing the specification limit, in accordance with the rounding method of ASTM E 29-08, "Using significant digits in test data to determine conformance with specifications", except when the digit next beyond the last place to be retained is 5, and there are no digits beyond this 5, or only zeros, or non-zeros, increased by 1 digit in the last place retained (regardless if it is odd or even).

The following table will be used.

Method Number	Title	Calculate To:	Report To:
Idaho Standards – Idaho Standard Practice (IR), Idaho Standard Method of Test (IT)			
Idaho IT-61-04	Seal Coat Emulsion Acceptance Viscosity Testing	1.0	1
Idaho IT-72-08	Evaluating Cleanness of Cover Coat Material	1	1
Idaho IT-74	Vibratory Spring-Load Compaction for Coarse Granular Material	0.01	0.1
Idaho IT-96-98	Determining the Percent of Coated Particles in Bituminous Mixtures	0.1	1
Idaho IT-130-02	Testing Thickness of Plastic Concrete Pavement	0.01	0.1
Idaho IT-74	Instruction on Use of AKDOT&PF ATM-212, ITD T-74, WSDOT TM 606, or WFLHD Humphreys Curves	0.01	0.1

AASHTO FOP

AASHTO T 11	Materials Finer Than 75 µm (No. 200) sieve in Mineral Aggregates by Washing	#200 sieve: 0.1 All other sieves: 1%	#200 sieve: 0.1 All other sieves: 1%
AASHTO T 27	Sieve Analysis of Fine and Coarse Aggregates	#200 sieve: 0.1 All other sieves: 1%	#200 sieve: 0.1 All other sieves: 1%
AASHTO T 30	Mechanical Analysis of Extracted Aggregate	#200 sieve: 0.1 All other sieves: 1%	#200 sieve: 0.1 All other sieves: 1%
AASHTO T 85	Specific Gravity and Absorption of Coarse Aggregate	Gsb: 0.001 Abs: 0.001%	Gsb: 0.001 Abs: 0.1%
AASHTO T 89	Determining the Liquid Limit of Soils	0.1%	1%
AASHTO T 90	Determining the Plastic Limit and Plasticity Index of Soils	0.1%	1%
AASHTO T 99	Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and 305-mm (12-in.) Drop	0.01	0.1
AASHTO T 119	Slump of Hydraulic Cement Concrete	¼ inch	¼ inch
AASHTO T 121	Mass per Cubic Meter (Cubic Foot), Yield, and Air Content (Gravimetric) of Concrete	Air: 0.01	0.1
		Yield: 0.01	0.1
AASHTO T 152	Air Content of Freshly Mixed Concrete by the Pressure Method	0.01	0.1
AASHTO T 166	Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens	0.001	0.001
AASHTO T 176	Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test	0.1	1%
AASHTO T 180	Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and 457-mm (18-in.) Drop	0.01	0.1
AASHTO T 209	Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures	0.001	0.001
AASHTO T 224	Correction for Coarse Particles in the Soil Compaction Test	0.01	0.1
AASHTO T 255	Total Moisture Content of Aggregate by Drying	0.01	0.1
AASHTO T 265	Laboratory Determination of Moisture Content of Soils	0.01	0.1
AASHTO T 275	Bulk Specific Gravity of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens	0.001	0.001
AASHTO T 308	Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method	0.01	0.1

AASHTO T 309	Temperature of Freshly Mixed Portland Cement Concrete	1	1
AASHTO T 310	In-Place Density and Moisture Content of Soil and Soil-Aggregate by the Nuclear Method	0.01	0.1
AASHTO T 329	Moisture Content Of Hot Mix Asphalt (HMA) By Oven Method	0.01	0.01
AASHTO T 335	Determining the Percentage of Fracture in Coarse Aggregate	1%	1%
AASHTO T 331	Bulk Specific Gravity and Density of Compacted Asphalt Mixtures Using Automatic Vacuum Sealing Method	0.001	0.001
AASHTO T 343	Density of In-Place Hot Mix Asphalt (HMA) Pavement by Electronic Surface Contact Devices	0.01	0.1
AASHTO T 304	Uncompacted Void Content Of Fine Aggregate	0.01	0.1
WAQTC FOP			
WAQTC TM 8	In-Place Density of Bituminous Mixes Using the Moisture-Density Gauge	0.01	0.1
Idaho FOP			
ASTM D 4791	Flat and Elongated Particles in Coarse Aggregate	0.01	0.1
AASHTO T 304	Uncompacted Void Content Of Fine Aggregate	0.01	0.1

SECTION 300.00 – INDEPENDENT ASSURANCE PROGRAM

The Independent Assurance Program provides an unbiased and independent evaluation of all sampling and testing procedures used in the acceptance program. The basis for the program is 23 CFR, Part 637.

301.00 Administration of Independent Assurance Program. The Design/Materials/Construction Engineer is responsible for:

1. Developing the policies and procedures to be used in the administration of the Independent Assurance (IA) Program, and
2. Monitoring the IA program

The District Engineer is responsible to ensure the following conditions are met:

1. Each District will provide at least one properly qualified and experienced employee for the permanent duties of District IA Inspector. The District may assign assistant or part-time IA Inspectors that are properly qualified and experienced.

2. The District IA Inspector(s), assistants, or part-time IA Inspectors may not be associated with any project construction office or crew per Federal Code 23 CFR 637. The District IA Inspector's activities must be unbiased and independent of all sampling and testing procedures used in the acceptance program.

3. No permanent or part time District IA Inspector may perform any project testing for the acceptance decision (for example: acceptance test strip, concrete strength tests and field acceptance tests).

4. Each District IA Inspector, assistants, or part-time IA Inspectors must be qualified in all WAQTC modules along with the Concrete Laboratory Testing Technician (CLTT).

District IA Inspector(s) shall be assigned to the District Materials Engineer or District Engineer.

SECTION 310.00 – INDEPENDENT ASSURANCE EVALUATIONS

Independent Assurance (IA) evaluates sampling and testing procedures and equipment for acceptance and verification testing. IA testing supplements the acceptance sampling and testing but is not used directly for acceptance of materials.

Independent Assurance is not required on the contractor's quality control tests unless the quality control test results are used for acceptance. IA may be performed, when requested, for the contractor's quality control as time and resources permit.

Acceptance and verification samples and tests are the basis of materials acceptance. IA evaluations are used to assure that sampling and testing procedures, including test equipment, are within allowable tolerances. A comparison of the project test results with IA test results, when in close conformity, gives assurance that project sampling and testing is valid. If the results are not within the allowable tolerances then corrective action must be taken by project personnel, such as checking equipment for damage, reviewing sampling and testing procedures, or other corrective action as necessary. Independent Assurance testing shall be done in the district and documented in the project files.

The Resident Engineer, as well as the project inspectors, will notify the IA Inspector as soon as possible prior to production startup and throughout the project so the required IA evaluations can be scheduled.

SECTION 320.00 – DISTRICT INDEPENDENT ASSURANCE INSPECTOR

The Independent Assurance Inspector is part of the ITD District Materials staff. This inspector should have considerable experience in all phases of testing and inspection.

The duties of the District IA Inspector typically include:

1. Independent Assurance evaluations according to the IA Program.
2. Spot check during normal IA evaluations that project testing laboratories have a current certificate of qualification issued per the ITD Laboratory Qualification Program.
3. Spot check during normal IA evaluations that samplers and testers are WAQTC qualified and the samplers and testers are including their qualification number on test forms.
4. Spot check during normal IA evaluations and during intermediate and final record reviews that acceptance sampling and testing is being conducted randomly in accordance with contract specifications.
5. Evaluate ITD samplers and testers for miscellaneous field test methods and required qualifications not covered under WAQTC. See Section 380.00 for procedures and examples.
6. Conduct intermediate and final records reviews.
7. Perform District audit of Materials Summary Report (MSR). See Section 460.00.
8. Draft the project Final Materials Certification Letter for the District Materials Engineer's review and the District Engineer's signature. See Section 470.00.
9. Assist in training samplers and testers and WAQTC tester training as time permits.
10. Serve as District Radiation Safety Officer (DRSO) according to the ITD Radiation Program.

SECTION 330.00 – SELECTION AND FREQUENCY OF INDEPENDENT ASSURANCE EVALUATIONS

Independent Assurance evaluations should commence in accordance with the frequencies in the MTR tables (Section 270.00) and IA Tables 300.2 and 300.3. Independent Assurance evaluations are accomplished by either duplicate sample testing or by observation. ITD uses a modified project approach to measure whether IA requirements have been met which means each project must have evidence the required IA evaluations have been performed.

The IA evaluation should include all test methods performed, including sampling and splitting, during performance of the actual project tests whenever possible. Occasionally, it may be necessary for the project testing technician to obtain an additional sample or perform an additional test exclusively for the benefit of providing the IA evaluation duplicate sample or observation.

The IA evaluation must accurately follow the specified test methods and procedures as closely as possible. The WAQTC performance checklists may be used as guides for evaluation of each test method. Even small deviations should be pointed out to the testing technician to ensure accurate and consistent test results, as well as accurate field equipment evaluations.

The IA Inspector may be called upon to evaluate test methods and field test equipment when a dispute arises from the test results or during a QC/QA project when there is a verification evaluation t test failure. Additional duplicate samples and observations may be necessary for resolution.

330.01 Independent Assurance Evaluation by Duplicate Samples. The minimum frequency for IA evaluation for each project using duplicate samples is summarized in Table 300.2 and included in the MTR tables (Section 270.00) under each standard specification item. Test methods evaluated by duplicate samples are those where the IA Inspector has dedicated equipment to perform an independent test. The minimum frequencies are based on one (1) IA test for every twenty (20) acceptance tests.

Duplicate samples are collected and split under the District IA Inspector's observation for those samples taken to the District Materials Laboratory for testing. Alternatively, for tests evaluated on the project site such as concrete field tests, the IA Inspector collects and tests samples independently.

One IA duplicate, or split, sample may apply to multiple items and projects provided the items are being tested by the same tester and using the same test methods and equipment. It is intended, as long as the test method, tester and equipment are the same, IA test results within the frequency interval may apply to any number of projects and any number of items. An IA test report must be completed for each project and list each item to which the IA test or evaluation applies.

For example, Project A, Project B and Project C each have several concrete items. The IA Inspector performs a duplicate air, slump and unit weight test for the testing technician on Project A. The following week the same testing technician is performing the same air, slump and unit weight tests with the same equipment on Project B and at the end of the month is performing the same tests with the same equipment on Project C. The total quantity of all of the concrete items is 960 CY. The frequency limit from Table 300.2 is 2000 CY, therefore the IA test performed on Project A will apply to Project B and Project C. The IA Inspector completes a test report for Project B listing the concrete bid items and another report for Project C, also listing the concrete bid items. These reports reference the actual IA test performed on Project A.

The following procedures are to be followed on IA duplicate samples of aggregate:

1. The testing technician will take a single sample large enough to provide not less than two minimum-size samples after splitting. Sampling is to be observed by the District IA Inspector in accordance with AASHTO T 2.
2. The sample will be mixed and quartered or split into two approximately equal size "duplicate" samples. The District IA Inspector is to observe this procedure in accordance with AASHTO T 248.
3. One of the "duplicate" samples is to be tested by the testing technician for complete gradation, sand equivalent, cleanness value, or other specification field tests as applicable. The District IA Inspector is to carefully observe techniques employed by the testing technician during the testing of the field sample as often as scheduling permits. The District IA Inspector may need to review sampling and testing procedures with the testing technician and offer helpful suggestions at this time. The second portion of the sample is to be taken to the District Laboratory by the District IA Inspector and tested for the same series of tests.
4. The testing technician's results are submitted to the District Laboratory as soon as the tests are completed, giving complete identification of the sample, date sampled, testing technician's name, District IA Inspector's name, and identifying the test results as one of the "duplicate" samples taken in the presence of the District IA Inspector.
5. The District Laboratory will issue form ITD-857, Independent Assurance Test Report, showing both test results for comparison. In addition to the standard laboratory report distribution, an additional copy will be provided for the testing technician and the testing laboratory. The ITD Laboratory Qualification Program requires testing laboratories to keep a copy of each IA evaluation, therefore, every effort should be made by the project personnel to deliver a copy of the IA report to the testing laboratory.
6. See Section 360.00 Review of Independent Assurance Results for procedures for the test result comparisons.

330.02 Independent Assurance Evaluation by Observation. It is necessary to evaluate some test methods by observation since the IA Inspector does not have dedicated equipment to perform an independent test. IA observation evaluation frequencies for each project are summarized in Table 300.3 and included in the MTR tables (Section 270.00) under each standard specification item.

An IA observation may be valid for up to 90 days. A single IA observation may apply to multiple items and projects provided the items are being tested by the same tester and using the same test methods regardless of quantity of material for up to 90 days. An IA test report must be completed for each project and list each item to which the IA observation evaluation applies.

The IA Inspector must use judgment in applying the 90-day rule and thoroughly evaluate the testing technician performing each test method involved. The IA Inspector is encouraged to use the WAQTC performance checklists as a guide for the evaluation. The 90-day rule would apply to only those test methods evaluated.

After the initial thorough IA observation evaluation is complete, the level of oversight and observation required for use of the 90-day rule is at the discretion of the IA Inspector. There should be a remark on the IA evaluation form, ITD-857, to indicate the IA Inspector’s decision when applying the 90-day rule. The remark may be based on the experience level of the testing technician, consistency of the material being tested or other information to support the IA Inspector’s decision to apply the 90-day rule.

330.03 Independent Assurance Evaluation of Verification Tests. ITD testing technicians perform verification testing in accordance with the Quality Assurance specifications when the contractor performs acceptance testing. These verification tests require IA evaluations. The frequency for IA evaluations will be one (1) IA evaluation for every twenty (20) verification tests. One IA evaluation may apply to multiple items and projects within the frequency provided the items are being tested by the same tester and using the same test methods and equipment.

SECTION 340.00 – TESTING OF DUPLICATE INDEPENDENT ASSURANCE SAMPLES

The testing of IA samples is to be done at the District Materials Laboratory, except for tests such as concrete slump and air tests that are performed in the field immediately after the sample is taken. IA samples must be tested with equipment other than that used for project acceptance testing.

SECTION 350.00 – NUMBERING INDEPENDENT ASSURANCE EVALUATIONS

IA tests will be numbered according to the first 3 or 4 characters of the bid schedule item, such as 205F, 303 or 405, followed by the letters IA and ending with the sequential number, starting at 1 and corresponding to the number of IA tests for the contract item. The sequential numbering will begin over with each contract. Contract special provision items will use the SP number for the bid schedule item number and change order items will use the CO number for the bid schedule item number.

SECTION 360.00 – REVIEW OF INDEPENDENT ASSURANCE RESULTS

The IA results are evaluated to assure the dependability and accuracy of the project sampling and testing, and to evaluate the test equipment.

360.01 Duplicate Sample Test Results. The IA duplicate test results and the field test results from the other half of the split sample are reported on form ITD-857 and compared. The comparison is made to determine whether the results are within allowable variations per Section 390.00.

When the test result comparison indicates the results are within allowable tolerances, the ITD-857 is printed on white paper and normal distribution as shown on the form is made.

If the evaluation indicates the results are not within allowable variation, another duplicate sample is obtained as soon as possible for a retest. The retest must be performed by the same testing technician and the same testing equipment must be used. The retest results will be reported on the same ITD-857 as the original duplicate test and a comparison made. If the comparison indicates the retest results are within allowable tolerances then the ITD-857 will be printed on white paper with normal distribution made.

If the comparison indicates the retest results continue to not be within allowable tolerances then the ITD-857 will be printed on buff colored paper and immediately forwarded to the ITD project representative or Resident/Regional Engineer for close-out with the IA Inspector.

When it is not possible to obtain another duplicate sample for retest, such as, the project is completed, then the ITD-857 showing the first duplicate test will be printed on buff paper and immediately forwarded to the ITD project representative or Resident / Regional Engineer for close-out with the IA Inspector.

360.02 Review of Observation Results. IA observations are documented on form ITD-857, District Independent Assurance Inspector's Report Field Evaluation. The evaluation report is completed as an observation with a duplicate sample taken or as an observation alone. Any deviations in the sampling and testing procedures observed will be documented by the IA Inspector. The report will then immediately be forwarded to the project office for close-out with the IA Inspector.

Completed and signed copies of all IA reports will immediately be sent to the project engineer, personnel responsible for sampling and testing, and the laboratory performing the testing.

360.03 Close-out Comments and Resolution Statement. When a deviation or out-of-tolerance result is identified, a close-out will be held with personnel performing the sampling and testing and an ITD project person responsible for the testing technicians.

A resolution statement signed by project personnel as indicated below is required when an IA evaluation indicates any of the following deviations:

- duplicate test results are not within acceptable variation,
- deviations in sampling and testing procedures observed,
- nonqualified samplers and testers are identified performing tests on a project,
- nonqualified laboratories are identified in use on a project,
- acceptance sampling and testing is not being conducted randomly in accordance with contract specifications.

The IA Inspector identifies deviations and works with project personnel to identify the cause of the variation. The project personnel are responsible to institute corrective action to resolve the deviations. A resolution statement will be written, or concurred with by signature, by an ITD project person responsible for the sampling and testing procedures and personnel. Usually this will be a project on-site inspector, but may also be the Resident Engineer. The resolution statement will indicate the corrective action that will take place or the corrective action that has already been enacted to prevent the deviation on subsequent sampling and testing. The action may include replacing faulty equipment, additional supervision of testing technicians and/or suspension of testing until necessary qualifications are met.

The Independent Assurance Inspector should review any resolution statement that does not indicate satisfactory resolution of the deviation with the District Materials Engineer. The District Materials Engineer should work with the Regional/Resident Engineer or other District Management as necessary to obtain a satisfactory resolution.

When the resolution statement is provided separately and not written directly on the IA report form, there will be a reference to the statement on the IA report in case the attachment becomes separated from the report form.

SECTION 370.00 – INDEPENDENT ASSURANCE TEST LOG (ITD-860)

All IA evaluations are recorded on the ITD-860, Independent Assurance Test Log, for each project by the Resident Engineer's office. Those IA evaluations identified as out-of-tolerance must have the resolution recorded as well. Use a blank line immediately below the recorded IA evaluation to briefly state the resolution. The IA Test Log is submitted at the completion of the project as part of the Materials Summary Report.

SECTION 380.00

Go to Next Page

300.2 Minimum Frequency for IA Evaluations by Duplicate Samples (split samples)

Bid Schedule Item No.	**Item Description**	**Tests (including sampling & splitting)**	**Frequency Of IA Duplicate Tests Recommended To Test Within The First Five (5) Days**	
			English	**Metric**
205	Granular Borrow	Sand Equivalent (AASHTO T 2, T 248, T 176)	200 000 CY	150 000 m^3
301	Granular Subbase	Gradation, SE (AASHTO T 2, T 248, T 27, T 176)	110 000 tons	100 000 t
302	Emulsion Treated Base	Gradation, SE (AASHTO T 2, T 248, T 11, T 27, T 176)	14 000 CY /20 000 tons	10 000 m^3/18 000 t
303	Aggregate Base	Gradation, SE (AASHTO T 2, T 248, T 11, T 27, T 176)	14 000 CY/20 000 tons	10 000 m^3/18 000 t
307	Open-Graded Rock Base	Gradation (AASHTO T 2, T248, T 27)	14 000 CY/20 000 tons	10 000 m^3/18 000 t
403/404	Cover Coat Material	Gradation, CV, Fracture (AASHTO T 2, T 248, T 11, T 27, T 335, Idaho IT 72)	5 600 CY/8 000 tons	4000 m^3/7200 t
405	Plantmix Aggregate @ Cold Feed (Acceptance Test Strip)	SE, , Fine Aggregate Angularity, Flat and Elongated (AASHTO T 2, T 248, T 176, ASTM D 4791, T 304)	15 000 tons	13 500 t
406/407	Road Mix /Scrub Coat Aggregate	Gradation, SE, Fracture (AASHTO T 2, T 248, T 11, T 27, T 176, T 335)	14 000 CY/20 000 tons	10 000 m^3/18 000 t
409	PCC Pavement Aggregate	Gradation, (course and fine plus SE on fine) (AASHTO T 2, T 248, T 11, T 27, T 176)	13 400 CY	10 000 m^3

300.2 Minimum Frequency for IA Evaluations by Duplicate Samples (split samples) (Continued)

Bid Schedule Item No.	**Item Description**	**Tests (including sampling & splitting)**	**Frequency Of IA Duplicate Tests Recommended To Test Within The First Five (5) Days**	
			English	**Metric**
409	PCC Production	Field tests** (WAQTC TM 2, AASHTO T 119, T 152, T 309, T 121)	6 000 CY	4600 m^3
502, 506, 510	Concrete (Production) Aggregate	Gradation, (course and fine plus SE on fine) (AASHTO T 2, T 248, T 11, T 27, T 176)	6 000 CY	4600 m^3
502, 506, 510	Concrete (Production)	Field Tests** (WAQTC TM 2, AASHTO T 119, T 152, T 309, T 121)	2 000 CY	1500 m^3
635	Anti-skid	AASHTO T 2, T 248, T 11, T 27	20 000 Tons	18 000 t

**Field tests: Air, slump, temperature, and unit weight.

380.3 Minimum Frequency for IA Evaluations by Observation

Bid Schedule Item No.	**Item Description**	**Tests Evaluated**	**Frequency Of IA Observation Evaluations - * Recommended To Observe Within The First Five (5) Days**
205	Excavation, Borrow, Granular Borrow	Development of Density Standard & In-place Density (AASHTO T 99, T 180, T 224, T 272, T 310)	Every 90 days /One (1) per project
210	Compacting Backfill for structure, retaining wall, or pipe backfill	Development of Density Standard & In-place Density (AASHTO T 99, T 180, T 224, T 272, T 310)	Every 90 days /One (1) per project
301	Granular Subbase	Development of Density Standard & In-place Density (AASHTO T 180, T 224, T 272, T 310, Idaho IT 74)	Every 90 days /One (1) per project
302	Emulsified Treated Base	Development of Density Standard & In-place Density (AASHTO T 180, T 224, T 272, T 310, Idaho IT 74)	Every 90 days /One (1) per project
303	Aggregate for Base	Development of Density Standard & In-place Density (AASHTO T 180, T 224, T 272, T 310, Idaho IT 74)	Every 90 days /One (1) per project
403 / 404	Emulsified Asphalt	Saybolt Viscosity (Idaho IT 61)	Every 90 days/One (1) per project
405	SuperPave HMA Aggregate @ Cold Feed (Acceptance Test Strip)	Fracture (AASHTO T335), Aggregate Specific Gravity (AASHTO T85, Idaho IT 144)	Every 90 days/One (1) per project
405	SuperPave HMA Acceptance Test Strip	Loose Mix Sample Testing & Core Bulk Density (AASHTO T 168, T 312, T 166 Method A, T 275,T 209, T 269,T 308, T 30, T 328 C, T 329, WAQTC TM 5, AASHTO T 166 Method C/A, T 275)	Every 90 days / One (1) per project
405	SuperPave HMA Pavement	Sampling Loose Mix , Asphalt Content by Ignition Method, Gradation, Fracture (AASHTO T 30, T 168, T 308, T328 C, T 329,WAQTC TM 5,T 335)	Every 90 days /One (1) per project
405	SuperPave HMA Pavement	Density (percent compaction) (WAQTC TM 8)	Every 90 days /One (1) per project
405	Asphalt Binder	Presence of Anti-Strip Additive (Idaho IT-99)	Every 90 days /One (1) per project
409 & 502	Concrete Production	Making cylinders (AASHTO T 23)	Every 90 days /One (1) per project
506 & 510	Concrete Production	Making cylinders (AASHTO T 23)	Every 90 days /One (1) per project

* Refer to Section 330.02 for use of 90-day rule for IA evaluations by observation.

SECTION 390.00 – ACCEPTABLE VARIATIONS IN DUPLICATE TEST RESULTS

Allowable variations described in 390.01 & 390.02 apply to the following:

- Properly sampled and split material to make duplicate portions for testing and tests conducted at the same time on the same material, such as concrete field tests.

These variations do not provide for material variations that occur when separate samples are taken some time apart. Variations occurring which exceed the listed duplicate test variations are to be brought to the attention of the Regional Engineer/Resident Engineer immediately.

THESE VARIATIONS ARE NOT TO BE CONSIDERED ALLOWABLE TOLERANCES TO ACCEPT MATERIALS OUTSIDE SPECIFICATION LIMITS.

390.01 Aggregate. The difference between the "duplicate" samples should not exceed the variations listed in Table 300.4.

390.02 Concrete. When duplicate tests on a single sample of concrete are taken, the results should not vary more than the following:

- Air Content---0.5%
- Slump---3/4" (19 mm)
- Density for Yield---1.0 lb./ft.^{3}(16 kg/m^3)
- Temperature---2^{o}F (1^{o}C)

300.4 Aggregate Sample Variations

Material	1" (25 mm) or larger 3/4" (19 mm)	1/2" (12.5 mm) 3/8" (9.5 mm)	No. 4 (4.75 mm)	No. 8 (2.36 mm) No. 16 (1.18 mm)	No. 30 (600 µm)	No. 50 (300 µm) No. 100 (150 µm)	No.200 (75 µm)
Coarse Concrete Aggregate	8%	6%	5%	3%			
Fine Concrete Aggregate				3%		3%	2%
Treated, Untreated Base and Road Mix Surfacing	8%	6%	5%	3%	3%	3%	2%
Plant Mix Aggregate	8%	6%	5%	3%	3%	3%	2%
Granular Subbase & Rock Cap	8%		5%				2%
Cover Coat Material		6%	5%				
Anti-Skid Material		6%	5%	3%	3%	3%	

Sand Equivalent -- 8

Cleanness Value -- 6

Fracture Count --- 5%

Flat & Elongated---2%

Fine Aggregate Angularity---1%

SECTION 400.00 – PROJECT MATERIALS CERTIFICATION

SECTION 410.00 – REPORTS AND DOCUMENTATION

SECTION 420.00 – MATERIALS SUMMARY REPORT

SECTION 425.00 – COMPLETING THE MSR

SECTION 430.00 – RESIDENT ENGINEER'S LETTER OF INSPECTION (ITD-854)

SECTION 440.00 – INDEPENDENT ASSURANCE TEST LOG (ITD-860)

SECTION 450.00 – MATERIALS CERTIFICATION CHECKLIST (ITD-852)

SECTION 460.00 – DISTRICT Review OF MATERIALS SUMMARY REPORT

SECTION 470.00 – MATERIALS CERTIFICATION LETTER

SECTION 400.00 – PROJECT MATERIALS CERTIFICATION

ITD has implemented procedures in accordance with State and Federal regulations for ensuring the materials incorporated into highway projects meet the required contract specifications.

401.00 Materials Certification Submittal Requirements by Project Type. The following documents are used for project materials certification to demonstrate that the materials incorporated into the project meet the required contract specifications:

- Materials Certification Letter (See Section 470.00)
- Materials Summary Report (See Section 420.00)
- ITD-852 Materials Certification Checklist (See Section 450.00)
- ITD-854 Resident Engineer's Letter of Inspection (See Section 430.00)
- ITD-860 Independent Assurance Test Log (See Section 440.00)

Instructions for the above documents are detailed in the indicated Sections.

Table 400.1 lists the documents that are required for project materials certification based on funding and project type as shown on the table, the District Engineer's Final Letter of Acceptance is used to document project materials certification for projects not requiring a Materials Summary Report and Materials Certification Letter.

For all projects, adequate records to document proper testing and inspection are required and must be maintained in the project files.

Table 400.1. Project Materials Certification Requirements for Projects Awarded through Roadway Design Using ITD Specifications

Type of Project	Are there materials incorporated in the project?	SUBMITTAL TO HQ MATERIALS: Materials Certification Checklist (ITD-852)	SUBMITTAL TO HQ MATERIALS: Materials Certification Letter and Materials Summary Report (including IA Log & RE Letter)	District Engineer Final Letter of Acceptance
Federal-Aid On State Highway System	Yes	Yes	Yes	Yes
	No	Yes	No	Yes
Federal-Local On-System No State Funds	Yes	Yes	Yes	Yes
	No	Yes	No	Yes
Federal-Local Off-System No State Funds Federal-Aid Limit $500k or more	Yes	Yes	Yes	Yes
	No	Yes	No	Yes
Federal-Local Off-System No State Funds Federal-Aid Limit less than $500k	Yes	Yes	No	Yes
	No	Yes	No	Yes
State-funded on NHS	Yes	Yes	Yes	Yes
	No	Yes	No	Yes
State-funded off NHS	Yes	Yes	Yes	Yes
	No	Yes	No	Yes
Supply Services Contract	N/A	No	No	No

SECTION 410.00 – REPORTS AND DOCUMENTATION

All field test reports, laboratory test reports, certifications, and other miscellaneous reports involving inspection, testing, and acceptance of materials are a part of the documentation of project records. These reports are considered a permanent record and are to be preserved with other permanent records such as survey notes, quantity measurements, etc. These records form the basis for certifying compliance with specification requirements of the contract to State auditors and the Federal Highway Administration for the materials used in construction.

The project files must sufficiently document that the acceptance of material was performed in accordance with the minimum testing requirements and the contract specifications. Specific instructions for each test report form are to be followed with the understanding that complete documentation is required for each contract. Any reports or records that apply from another contract should be either duplicated or must be completely referenced. There must be no doubt of the validity of the record applying to the pertinent project. Required materials documentation need to be in the item files. If the same material is used for another item, an additional copy needs to be added in the project item file. Add posting in the MSR for each item.

410.01 Materials Acceptance Plan (MAP) or ITD-862 Sampling Schedule. Project personnel must plan ahead using the minimum testing requirements (MTRs) and the contract specifications to determine the requirements for acceptance of all bid items and change orders. Each district shall develop a project Materials Acceptance Plan (MAP) or ITD-862 Sampling Schedule for reference by the project personnel before construction and update during construction.

The development of the MAP or Sampling Schedule should be a joint effort by District Materials and project personnel. The final MAP should summarize the acceptance requirements for all items including any small quantities (see Section 270.04), items using nonstandard acceptance (see Section 270.05) or special provision items (see Section 270.06). The final MAP should be reviewed and signed by the Resident Engineer and the District Materials Engineer. When requested by the District, HQ Design/Materials/Construction will review and provide comment on the MAP for non-standard special provision items.

410.02 Checking Test Reports and Documents. Laboratory tests, field tests, and certification reports are forwarded to the Resident Engineer whose staff regularly checks the reports so that deviations from specifications and poor documentation are mitigated. It is required that the person checking test reports have ITD STQP qualification or an Idaho PE license (see Section 210.01). Any discrepancies, lack of information, or incompleteness of the reports must be corrected without delay. After the checks are made, the reports are recorded for the Materials Summary Report (see Section 425.00 for directions) and placed in the project files.

Any items receiving less than the minimum requirements of sampling and testing and/or varying from specifications must have the corrective action or remedy efforts explained by the /Resident Engineer. The explanation must include the justification for acceptance, rejection, or price adjustment of noncompliant material. The explanation is recorded and noted for the Materials Summary Report.

SECTION 420.00 – MATERIALS SUMMARY REPORT

The Materials Summary Report (MSR) shows the basis for acceptance of all bid items and change orders of the contract as required by the minimum test requirements (MTRs) and contract specifications including:

- Acceptance test results.
- Manufacturer's certifications.
- Laboratory acceptance and verification test results.
- Notes to explain the resolution for any failing test results or lack of minimum testing.
- Notes to explain the basis for accepting any material not tested or not certified according to the minimum testing requirements or contract specifications.

The MSR is compiled for each construction contract as indicated in Table 400.1 by posting all of the field and laboratory test reports and manufacturer's certifications into the electronic Materials Summary Program. The data should be posted daily or at least weekly to ensure current reporting. All test reports should be posted as soon as possible after they are received and checked. It is a good practice to maintain the MSR so that it is contemporaneous with the most current pay estimate.

See Section 425.00 for the required postings for the MSR.

The MSR should be printed after each pay estimate and kept in a binder or file folder for easy access.

Adequate documentation of failures and/or deviations from specification requirements must be included in the Materials Summary Report to justify acceptance, rejection, or price adjustment of contract items. Section 215.00 contains details about documentation for non-compliant material.

SECTION 425.00 – COMPLETING THE MSR

The following guidelines are provided for use in typical project situations to accurately complete a project Materials Summary Report (MSR).

The acceptance documents are posted in the MSR under the contract item where the material was paid. When material is incidental to a contract item the posting will be shown under the associated contract item.

- The posting must be done using the electronic Materials Acceptance Program.
- Every contract item, including change orders, where there was material used on the project must be included in the MSR.
- Some contract items will have multiple posting in the MSR because there is more than one acceptance requirement as shown in the MTR tables.
- The postings of test result data for items that require statistical analysis (QASP items) must be checked for accuracy by someone other than the person who posted the data.
- Accepted material on ITD-0854 Resident Engineer's Letter of Inspection of Contract Items needs the required material documentation in the project item file.
- Required materials documentation need to be in the item files. If the same material is used for another item, an additional copy needs to be added in the project item file. Add posting in the MSR for each item.
- Documentation (such as a printout of the QPL page showing approval of the item) shall be placed in the project files and posted in the MSR for QPL items that were on ITD's QPL at the time of the project.
- Documentation of individual sign components (aluminum sheet, reflective coating, etc) will be listed separately on the ITD-0851 Manufacturer's Material Certification form.
- Documentation of all steel and iron products should be in compliance with section 230.03.03.
- ITD-0858 Materials Summary for District IA Audits showing deficiency findings should not be deleted from its record. All resolutions and final determinations should be on the ITD-0858 form for all deficiencies initially found by the District IA.
- All MSR information must be present or documented in the project file
- HQ handles the review and documentation of items such as pre-stressed girders, the district needs to review the packets sent from HQ and document in the MSR like other project items.
- File memos shall present a clear and complete picture of what occurred and how project specifications were met. These explanations should be clear to an individual not associated with the project.
- F&T failures shall be addressed in documentation in project item files.
- HMA Lot quantities shall be based on work shift totals as defined in the QASP.

- Independent assurance testing shall be done in the district and documented in the project files.
- Non-standard items shall be identified on ITD-0862 form.
- Quality Control, Acceptance and verification samples shall not be collected at the same location. They must be taken independent of one another.
- Document compaction effort (such as bridge abutments, back fill, embankment, etc.) for each lift on ITD-0850 form. All pertinent information shall be filled out completely on the ITD-0850 form.
- Records of AASHTO T-27 shall be documented when using "Too Granular to Test" per lift on the ITD-0850 form. Granular Borrow needs to have the Sand Equivalent test done for the ITD-850

Use Table 425.1 to determine the minimum information required in the MSR. Find the contract bid item in the Section 270.00 MTR tables of the Quality Assurance Manual, and from the MTR tables identify the type of acceptance requirements. Then, find the type of acceptance in the left column of the table below and provide the required information in the MSR as is described in the corresponding right hand column.

Note: The Acceptance Test Strip is required to be shown on the MSR; post both passing and failing test strips and the disposition of the failing test strip(s). The smoothness results are not required on the MSR

Table 425.1

Acceptance Type from MTR tables	**Postings Required in the MSR**
Statistical Analysis (QA Special Provisions)	Results of Bonus Summary Report showing the pay factor for each lot
	Remarks explaining actions taken when any lot falls below .85 or below .75
	Copy of F&T report for each day of production testing
	Remarks to indicate evaluation procedures taken when there is a t test failure
Field Tests (other than statistical analysis) [1]	Date sampled
	Test number
	Indication of pass or fail test results
	A remark indicating the location of the in-place density test for pipe or structure backfill
	Remarks to indicate tests that are considered check tests for failing tests
	Remarks to indicate the corrective action taken for a failing test
	Remarks to indicate acceptance when testing is not performed, such as, too granular to test
Manufacturer's or Fabricator's Certification	Date certification statement signed
	Quantity of material certified
	Manufacturer or fabricator company signing certification
Laboratory Verification Tests	Date sampled
	Sample number
	Laboratory number
	Indication of pass or fail test results
	Remarks to indicate corrective action or price adjustment for a failing test

Laboratory Acceptance Tests	Date sampled
	Sample number
	Laboratory number
	Indication of pass or fail test results
	Remarks to indicate corrective action or price adjustment for a failing test
Pre-Tested or Pre-Approved Tests (Approved Lists)	Remarks to indicate the material/product used on the project is included on the approved list maintained by HQ Materials Section
Acceptance by Inspection	Item will be shown on the ITD-854, Resident Engineer's Letter of Inspection
Small Quantity or Non-Standard Acceptance (see Section 270.04 & 270.05)	Remarks to summarize the basis of acceptance including the following where applicable: Remarks to indicate aggregates obtained from approved materials source Remarks to indicate mix design approval for plant mix or concrete Post core test results for plant mix paving on mainlines or intersections Remarks to indicate visual inspection during installation, placement or compaction
[1] (field tests are: in-place density, gradation, sand equivalent, fracture count, cleanness value, field saybolt viscosity, presence of anti-strip additive, asphalt content of plant mix, plant mix test strip, air/slump/temperature/unit weight of concrete)	

Acceptance Type from MTR tables	**Postings Required in the MSR**
Special Provisions (see Section 270.06)	Post acceptance information as indicated in the special provision OR as indicated below if not specified in the special provision.
	When material is included in MTR table and used in a standard application, find MTR acceptance type above and post the same information
	When special provision indicates the material must meet a given specification, such as AASHTO or ASTM: Post same information shown above for manufacturer's certification.
	When material is not included in MTR tables or not used in standard application: Remarks to summarize basis of acceptance as determined by the Engineer and District Materials Engineer.
Change Orders (see Section 270.07)	Post acceptance information as indicated in the change order OR as indicated below if not specified in the change order.
	For standard pay items or when material is included in MTR tables and used in a standard application, find MTR acceptance type above and post the same information
	When change order indicates the material must meet a given specification, such as AASHTO or ASTM: Post same information shown above for manufacturer certification.
	When material is not included in MTR tables or not used in standard application: Remarks to summarize basis of acceptance as determined by the Engineer and District Materials Engineer

SECTION 430.00 – RESIDENT ENGINEER'S LETTER OF INSPECTION (ITD-854)

The purpose of the Resident Engineer's Letter of Inspection (ITD-854) is for the Resident Engineer to document the inspection of certain materials and to document the materials are acceptable according to the plans and specifications. The form should not be used as a catch-all for items usually accepted by sampling and testing, and inclusion on the form does not excuse the inspector from sampling and testing or obtaining manufacturer certifications, as required by the Minimum Testing Requirements. A copy of the completed RE Letter will be submitted with the MSR at the completion of the project. The required material documentation needs to be added to the project item file. See Section 250.00 for complete information on the Resident Engineer's Letter of Inspection.

SECTION 440.00 – INDEPENDENT ASSURANCE TEST LOG (ITD-860)

Independent Assurance tests are not posted in the Materials Summary Report, but are recorded on the IA Test Log (form ITD-860) by the ITD project personnel. A copy of the complete IA test log must be submitted with the MSR at the completion of the project. See Section 370.00 for information on completion of the IA Test Log.

SECTION 450.00 – MATERIALS CERTIFICATION CHECKLIST (ITD-852)

Resident Engineer's office prepares the ITD-852 Materials Certification Checklist by completing each checkbox shown on the form. Explanations must be included in the "Remarks" field for any items checked "No". Known exceptions to the materials acceptance requirements for the project will be identified on the form. Once complete the checklist is provided to the Resident Engineer and Engineering Manager for review and signature. For projects not requiring a Materials Summary Report per Table 400.1 check the appropriate box to indicate no Materials Summary Report is required and complete the remainder of the form as applicable for the project.

SECTION 460.00 – DISTRICT AUDIT OF MATERIALS SUMMARY REPORT

The District will perform an independent assurance audit of the Materials Summary Report (MSR) for all projects, Independent assurance audits shall be performed by individuals who are:

1) Currently qualified in all WAQTC modules along with the Concrete Laboratory Testing Technician (CLTT).

2) Independent of both the project and the residency

3) Deemed by the District Engineer as knowledgeable in the preparation and review of Materials Summary Reports.

The audit should be done periodically as the project progresses. The most current pay estimate should be used as a guide to determine that material paid for was accepted in accordance with the contract requirements. Any deviations or exceptions found during the audit must be resolved to the satisfaction of the District Materials Engineer before issuance of the Materials Certification Letter.

- District audit of MSR report shall be completed using Form ITD-858. The District Materials Engineer will review this MSR audit, and make final resolution and document such by signature on form ITD-858. A close-out should be held with ITD project personnel to discuss any deviations found and to obtain a resolution statement. See Section 360.03 of this manual. A copy of the completed ITD-858 shall be included in the project files. The ITD-0858 Materials Summary for District IA Audits showing deficiency findings should not be deleted from its record. All resolutions and final determinations should be on the ITD-0858 form for all deficiencies initially found by the District IA.

460.10 District Audit of GARVEE and Consultant CE&I projects. The GARVEE and Consultant CE&I projects have an assigned ITD Resident Engineer. The individual assigned to audit the records will contact the assigned Resident Engineer to make arrangements for the on-site review of the project materials records.

SECTION 470.00 – MATERIALS CERTIFICATION LETTER

When the MSR and associated documentation is considered acceptable, the District will prepare the Materials Certification Letter using the inter-department memo (ITD-500) addressed to the Design/Materials/Construction Engineer (see Example 470.02 at the end of this section) for the District's Engineer signature. The Materials Certification Letter is prepared and submitted to the District Engineer along with a copy of ITD-860, IA Test Report Log; ITD-852, Materials Certification Checklist; the Materials Summary Report; and ITD-854, Resident Engineer's Letter of Inspection of Contract Items, for review, signature and distribution.

The Materials Certification Letter must contain the following statement (per *23 CFR 637*):

This is to certify that:

The results of the tests used in the acceptance program indicate that the materials incorporated in the construction work, and the construction operations controlled by sampling and testing, were in conformity with the approved plans and specifications. All independent assurance samples and tests are within tolerance limits of the samples and tests that are used in the acceptance program.

Explanations for exceptions to the plans and specifications are as follows:

The Materials Certification Letter will list, by contract item, any exceptions and how they were resolved, which includes an explanation for justification of acceptance of the contract item. See Example 470.02 at the end of this section.

For Federal-aid full oversight projects, the FHWA will review the below listed items in order to concur in the Materials Certification.

1. District Engineer Materials Certification Letter
2. ITD-0858 Materials Summary Report District IA Audit
3. Final Estimate
4. ITD-0852 Materials Certification Checklist
5. ITD- 0854 Resident Engineer's letter of Inspection of Contract Items
6. ITD-0860 Independent Assurance Log

7. Materials Acceptance Program (MAP) report for any contract pay items that has exceptions to the contract specifications or plans including the following notes:

    a. Notes to explain the resolution for any failing test results or lack of minimum testing.

    b. Notes to explain the basis for accepting any material not tested or not certified according to the minimum testing requirements or contract specifications.

Submit these documents (via cc) to the FHWA for review and approval. Upon review and approval; submit final non-participation determinations to the Department's Financial Services. See example 470.03 at the end of this section.

470.01 Exceptions. An exception is considered any instance where non-specification material is identified, the non-specification material is allowed to remain, and corrective action was required. A failing test with an immediate passing check test is not considered non-specification material. Corrective action is remedial methods, such as price adjustments or contractor repair work.

When there are indications of acceptance of non-specification material in the materials summary report, then the corrective action taken must be included in the summary remarks and in the certification letter. For QA Special Provision contract items, non-specification material is a lot where the pay factor for any quality characteristic is below 0.75 and the material was allowed to remain.

An exception is also when contract specifications and/or minimum testing requirements were not met. This may be lack of acceptance testing, lack of IA testing, or lack of manufacturer's certifications. It is usually not possible to remedy or justify these exceptions, especially if not discovered until the project is complete. A full explanation of the circumstances is necessary to ascertain the consequences of the deviation from the specifications, including the quantities accepted without the required testing or certifications. In some cases, material quantities may not be eligible for Federal-aid participation. The District will determine non-participation using the current memorandum of understanding between the Department and the Federal Highway Administration Idaho Division Office.

Exceptions should be listed by contract item number on the Materials Certification Letter as follows:

- Number of tests representing non-specification material out of the total number of tests performed with remarks for justification that allowed material to remain in place.
- Total number of tests performed and number of tests required by the minimum testing requirements when the number of tests performed is less than the required minimum, including lack of or failure to perform Independent Assurance testing.
- Lack of required manufacturer's certifications covering the quantity of material paid for.
- QA Special Provision item where the pay factor was less than 0.75 and a description of action taken.
- QA Special Provision item where t test failed and there is no indication an evaluation was made.
- Price adjustment, if applied, or justification for acceptance or rejection of material with failing laboratory test.

The items ineligible for Federal-aid participation including the dollar amount must be shown on the Materials Certification Letter.

470.02 Materials Certification Letter Example (Non-Full Oversight Project Example)

IDAHO TRANSPORTATION DEPARTMENT

Department Memorandum

DATE: PROJECT NO.(S):

TO: NAME

DESIGN/MATERIALS/CONSTRUCTION ENGINEER

FROM: NAME:
DISTRICT ___ ENGINEER

RE: MATERIALS CERTIFICATION LETTER (NON-FULL OVERSIGHT PROJECT)

This is to certify that:

The results of the tests used in the acceptance program indicate that the materials incorporated in the construction work, and the construction operations controlled by sampling and testing, were in conformity with the approved plans and specifications. All independent assurance samples and tests are within tolerance limits of the samples and tests that are used in the acceptance program.

Explanations for exceptions to the plans and specifications are as follows:
303-005A 19mm Aggregate Base: Lot #3 had a pay factor of .74 and was removed and replaced by the contractor.
405-025A PL MX PAV CL I: Acceptance Test Strip #1 failed and was paid at 50%.
602-035A 450mm Pipe Culvert: There are no required manufacturer’s certifications for 150 meters of pipe.
640 Subgrade Geotextile: No required laboratory verification tests were performed. The item was accepted by manufacturer’s certification.
S501-010 MSE Retaining Wall: The ITD laboratory test was failing for cement and a price adjustment of 25% was applied.

The original of the Materials Summary Report, correspondence, manufacturer's certifications, and test reports are on file in the project records.
cc:

DE ___
District ____ Engineering Manager
DMTL w/attach
RE (original attach)
DRI (w/attach)
DMC Engineer (w/attach)
Financial Services

470.03 Materials Certification Letter Example (Full Oversight Project)

IDAHO TRANSPORTATION DEPARTMENT

Department Memorandum

DATE: PROJECT NO.(S):

TO: NAME

DESIGN/MATERIALS/CONSTRUCTION ENGINEER

FROM: NAME:

DISTRICT ___ ENGINEER

RE: MATERIALS CERTIFICATION LETTER (FULL OVERSIGHT PROJECT)

This is to certify that:

The results of the tests used in the acceptance program indicate that the materials incorporated in the construction work, and the construction operations controlled by sampling and testing, were in conformity with the approved plans and specifications. All independent assurance samples and tests are within tolerance limits of the samples and tests that are used in the acceptance program.

Explanations for exceptions to the plans and specifications are as follows:

303-005A 19mm Aggregate Base: Lot #3 had a pay factor of .74 and was removed and replaced by the contractor.

405-025A PL MX PAV CL I: Acceptance Test Strip #1 failed and was paid at 50%.

602-035A 450mm Pipe Culvert: There are no required manufacturer's certifications for 150 meters of pipe.

640 Subgrade Geotextile: No required laboratory verification tests were performed. The item was accepted by manufacturer's certification.

S501-010 MSE Retaining Wall: The ITD laboratory test was failing for cement and a price adjustment of 25% was applied.

The original of the Materials Summary Report, correspondence, manufacturer's certifications, and test reports are on file in the project records.

cc:

DE ___
District ____ Engineering Manager
DMTL w/attach
RE (original attach)
DRI (w/attach)
DMC Engineer (w/attach)
FHWA (w/ attachment)

SECTION 500.00 –STANDARD METHODS & PRACTICES

IDAHO STANDARD PRACTICE (IR), IDAHO STANDARD METHOD OF TEST (IT)

SECTION 510.00 - AGGREGATES

SECTION 520.00 - BITUMINOUS MATERIALS

SECTION 530.00 - CONCRETE

SECTION 540.00 - PAINT

SECTION 550.00 – SOILS

SECTION 560.00 - MISCELLANEOUS

* Appears in both Quality Assurance and Laboratory Operations Manuals.

Idaho Standard Method of Test for

Measuring Mortar-Making Properties of Fine Aggregate

Idaho IT-13-03

1. Scope

1.1 This method provides a means of determining whether a natural, unproven fine aggregate meets the minimum strength requirements for mortar making properties in concrete by comparing the compressive strength to the compressive strength of Ottawa Sand, the standard.

2. References

2.1. AASHTO: T-22, T-71, T-84 & M-152

2.2. ASTM: C-87, C-109, & C-778

3. Apparatus and Tools

3.1. Flow Table (drop table), flow mold, caliper, and 1" x 5/8" hard rubber tamper as described in AASHTO M-152

3.2. Cylinder molds, 2"x4", either plastic single use, or brass, (waxed to a glass plate).

3.3. Mixing bowl and spoon. Small trowel and scoop.

3.4. Tamping rod, (3/8" diameter x 8") with spherically rounded ends.

3.5. Balance, capable of reading to the nearest gram.

3.6. Capping compound and fixture for 2" diameter specimens.

3.7. Compression testing machine with proper sized spherical test head.

3.8. Moist Closet and lime saturated water bath

4. Temperature and Humidity

4.1. The temperature of the mixing water, the Moist Closet, and the storage tank water shall be maintained at 73.4 ±3 Degrees F (23.0 ±1.7 Degrees C).

4.2. The relative humidity of the Moist Closet shall not fall below 95%

4.3. During mixing and molding of test specimens, the laboratory shall be maintained at 50% or greater relative humidity

5. Sample Preparation

5.1. Natural Sand Mortar - (AASHTO T-84) this mortar shall be made using a representative sample of natural sand from the unproven source (3,000 to 5,000 grams).

5.1.1. The sand is moistened to a point past SSD, then covered and kept moist for a minimum of 15 hours to allow the sand to reach total saturation.

5.1.2. Dry the sand to an SSD condition per AASHTO T-84, being careful not to segregate material while constantly mixing.

5.1.3. Weigh 2500.0 grams, being careful to get a representative sample. Cover this sample to keep it in an SSD condition until needed.

5.1.4. Cement: Weigh 700.0 grams of Portland cement, either Type I & II or Type III.

5.1.5. Water: Measure 420.0 ml of conditioned water. Note: Conditioned water is distilled water at 73.4 ±3 Degrees F (23.0 ±1.7 Degrees C).

5.2. Ottawa sand mortar – This mortar is the standard of comparison.

5.2.1. Blend natural Ottawa sands, combined weight 2,500.0 grams. Combine 1,225.0 grams of graded sand, and 1,275.0 grams of 20-30 sand, both conforming to ASTM C-778, and thoroughly blend.

5.2.2. Cement: Weigh 700.0 grams of Portland cement, either Type I & II or Type III.

5.2.3. Water: Measure 420.0 ml of conditioned water.

Note: All tests shall be run using the same cement Type, Manufacturer, and Lot. The amounts of water and cement used in this method are never varied. All of the water and cement must be used to maintain a consistent W/C ratio (0.60) between all samples. The amount of sand added to the mixture is varied to get the proper flow.

5.3. If brass molds are to be used, apply a light coating of release agent or light oil to molds. This will allow for removal of specimens without damage.

5.4. Start with a *damp bowl* and add 420.0 ml of conditioned water

5.5. Add 700.0 grams of cement and let it absorb for 1 minute

5.6. Stir by hand into a smooth paste.

5.7. Add the sand while stirring continuously until the desired consistency of the mix has been reached. Note: Normally, the mix will achieve the required consistency before all of the sand (2,500 grams) is used.

5.8. Stir the mixture vigorously for 30 seconds, then perform a flow test

6. Flow Test

6.1. Fill the cone in two layers, 20 blows per layer with the hard rubber tamping tool. The mixture should overfill the cone at this point

6.2. Cut the excess mortar off using the edge of a trowel creating a plane surface.

6.3. Carefully lift the cone off the mixture leaving the molded specimen on the table. The entire process to this point should be performed in one minute.

6.4. At exactly one minute, start flow table and drop 10 times. The mortar shall be proportioned to produce a consistency of 95-105 in 10 drops of the flow table.

Note: Allowance for flow trial – One free trial may be performed, but only if mix is too wet and the only ingredient that may be added is sand, to stiffen the mix. Then remix (.5.7), and perform flow again starting with (6.1).

6.5. After flow measurement, immediately place the mortar back in the bowl and remix vigorously for 15 seconds.

6.6. Fill cylinder molds (brass or plastic) in three layers, each layer receiving 25 blows using the tamping rod with spherical end. Make two sets of 3 cylinders, (6 total). One set for 3 days & one set for 7 days if Type III cement is used, or one set for 7 days and one set for 28 days if Type I & II cement is used.

6.7. Cut off the mortar to a plane surface, flush with the top of the mold, by drawing the straight edge of a trowel with a sawing motion across the top of the mold.

6.8. Place the cylinders in the Moist Closet for curing.

7. Curing Specimens

7.1. After 20 to 24 hours of curing in the Moist Closet, the specimens shall be removed from the molds, marked for identification, and immediately placed in a temperature controlled, lime saturated water bath for final curing.

7.2. 7.2. Cylinders shall remain in the water bath to cure for a period of 3 days & 7 days, or 7 days & 28 days, depending on the cement type used. They will be removed from the water bath in sufficient time to perform the capping procedure and allow for curing of capping compound prior to testing. Testing shall be performed within ±1 hour for 3 day tests, ±2 hours for 7 day tests, & ±20 hours for 28 day tests, from the time of molding.

8. Capping Specimens

8.1. Cylinders shall be capped before testing in such a manner that the ends will be plane and at right angles to the axis of the cylinder. While cylinders are in the capping process, they shall be maintained in a moistened condition by covering with wet towels. Any conventional capping material may be used.

9. Testing Specimens

9.1. Cylinders shall be tested for compressive strength at 3 days and 7 days, or 7 days and 28 days after molding. Testing age of cylinders depends on cement Type used to make test specimens.

9.2. If more than one specimen is removed from the storage water for testing, these specimens shall be covered with a wet towel to keep specimens in a moistened condition until time of testing.

9.3. Before placing the test cylinders in the compression test machine, they shall be wiped to a surface dry condition and have any loose sand and/or debris removed from the bearing test surfaces.

9.4. Place the cylinder carefully in the test machine centering it on the upper bearing block. Check the spherical head (upper) for freedom of movement prior to the beginning of each test. A constant load shall be applied without interruption until failure, at a rate of 20 psi to 50 psi per second, (standard loading rate for cylindrical specimens, AASHTO T-22). No adjustment shall be made in the controls of the testing machine while a specimen is yielding rapidly just prior to failure.

10. Acceptance

10.1. Acceptance is based on a comparative strength between the two mortars. The natural sand mortar must be at least 90% of the strength that is achieved by the standard sand mortar.

Idaho Standard Method of Test for

Idaho Degradation

Idaho IT-15-95

1 Scope

1.1 This test method is intended as a quantitative measure of the resistance of a graded aggregate to production of fines by abrasion in the presence of water. The test provides a means by which it is possible to evaluate how the aggregate may perform in the road.

2 Apparatus

2.1 Idaho Degradation Machine. The Idaho Degradation Machine is equipped with an electric motor with gear reduction. The machine shall maintain a substantially uniform speed of 30 to 33 rpm. Metal cans equipped with spring tension handles to securely hold 3.8 liter jars in place are so positioned that the jars rotate end over end. Diameter of the metal cans shall be such that the jars are a snug fit, but can be inserted and removed without binding. The cans shall be deep enough so that the straight portion of the jar sidewall is completely within the can.

2.2 Wide mouth 3.8 liter jars with lids. The lids are fitted with solid 3 mm thick rubber gaskets.

2.3 Sieves. A set of U.S. Standard, 203 mm diameter sieves 19 mm through 75 µm. These sieves shall meet AASHTO M 92 specifications.

2.4 Sand Equivalent apparatus as described in AASHTO T 176.

2.5 Scoop, brush and rustproof drying container approximately 460 mm x 300 mm x 50 mm deep.

2.6 Drying Oven - 60°C maximum.

2.7 Balance with a 2000 g capacity sensitive to 0.1 g.

3 Preparation of Sample

3.1 Sample make-up (oven dry at 60°C max.).

3.1.1 The sample for testing with 12.5 mm or larger size aggregate shall have the following gradation:

16.7% Passing the 19 mm and Retained on the 12.5 mm	183 g.
16.6% Passing the 12.5 mm and Retained on the 9.5 mm	183 g.
16.7% Passing the 9.5 mm and Retained on the 4.75 mm	184 g.
50% Passing the 4.75 mm	550 g.
Total	1100 g.

3.1.2 The sample for testing with 9.5 mm size aggregate shall have the following gradation:

25% Passing the 12.5 mm and Retained on the 9.5 mm	275 g.
25% Passing the 9.5 mm and Retained on the 4.75 mm	275 g.
50% Passing the 4.75 mm	550 g.
Total	1100 g.

3.1.3 The sample for testing with 4.75 mm size aggregate shall have the following gradation:

50% Passing the 9.5 mm and Retained on the 4.75 mm	550 g.
50% Passing the 4.75 mm	550 g.
Total	1100 g.

3.2 Combine oven dried original and crushed portions representative of the gradation of the material as intended for use. For material coarser than the 4.75 mm sieve, thoroughly mix original and crushed portions and weigh out exactly the specified amount. Obtain the specified amount of 4.75 mm material by the method of quartering or by the use of a sample splitter as described in AASHTO T 248.

Note 1: The coarse portion of the sample shall be hand shaken to refusal on each specified sieve size before make-up. Hand shaking shall continue until not more than 1% by weight of the residue passes any sieve during one (1) minute.

4 Procedure

4.1 Place the prepared oven dried material (maximum drying temperature 60°C) in a wide mouth 3.8 liter jar and enough water to cover the aggregate to a depth of approximately 13 mm.

4.2 Allow the sample to soak at least 16 hours.

4.3 If necessary, after the soaking period adjust the water in the jar so the aggregate is barely covered.

4.4 Place lid with rubber gasket on jar and seal tightly. Fit the jar into the Idaho Deg. Machine making certain that the spring tension handle is securely holding the jar.

4.5 Start the Idaho Deg. Machine and allow the jar to make 1,850 revolutions. The tumbling action of the aggregate as the jar rotates end over end produces the degradation.

4.6 At the end of the test period empty the contents of the jar over a 4.75 mm sieve placed over a container to catch all the 4.75 mm material and water.

4.7 Wash out the jar using as little water as possible. Wash the plus 4.75 mm material until all the fines sticking to the aggregate are washed into the minus 4.75 mm portion of the sample. Place the container with the minus 4.75 mm portion in the oven for drying.

4.8 Oven dry the plus 4.75 mm material and then shake to refusal over the appropriate coarse sieves. If any material passes the 4.75 mm sieve, it is to be added to the minus 4.75 mm portion.

4.9 Stir the minus 4.75 mm portion occasionally and remove from oven when a cast point is reached. A cast point is defined as that point when a portion tightly squeezed in the palm of the hand will form a cast which will bear very careful handling without breaking.

4.10 When the cast point is reached, run sand equivalent on the minus 4.75 mm material according to AASHTO T 176.

4.11 Retain the material from the sand equivalent test and return it to the minus 4.75 mm portion.

4.12 Wash entire minus 4.75 mm portion over 75 µm sieve, dry and sieve as described in AASHTO T 11.

4.13 Compute the total gradation based on initial oven dry weight of 1100 g. This becomes the gradation after degradation.

Note 2: Weights should be recorded to the nearest gram.

5 Report

5.1 The before-test gradation and sand equivalent together with the after-test gradation and sand equivalent are reported. The amount of degradation is indicated by the difference in test values.

Note 3: If the before-test gradation of material passing the 4.75 mm sieve is measured by sieve analysis of a representative sample for which the % Passing 4.75 mm is 50%, then the before-test percentages for 4.75 mm and finer sieves from the analysis are equal to the sieve analysis percentage. Otherwise, all before-test percentages for 4.75 mm and finer sieves must be multiplied by the adjustment factor. The adjustment factor is 50 divided by the percentage of material passing 4.75 mm in the representative before-test gradation sample. For example, if the 4.75 mm and finer before-test percentages are determined on sample consisting of 100% minus 4.75 mm material, the adjustment factor is 50/100=0.50. Similarly, if the sample for determining before-test gradation has 40% minus 4.75 mm, the adjustment factor for 4.75 mm and finer sieves is 50/40=1.25.

5.2 The test results shall be reported on an ITD-802.

6 Precautions

6.1 Avoid baking sample during drying period prior to sand equivalent test.

6.2 Be sure to return all of the material from the sand equivalent test back into the minus 4.75 mm portion.

Idaho Standard Method of Test for

Evaluating Cleanness of Cover Coat Material

Idaho IT-72-08

1 Scope

1.1 The cleanness test indicates the relative amount, fineness and character of clay-like materials present in aggregate as coatings or otherwise.

2 References

2.1 AASHTO Standards

- M 92– Wire Cloth Sieves for Testing Purposes.
- M 231– Weighing Devices Used in the Testing of Materials.
- T 176– Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
- T 248– Reducing Field Samples of Aggregates to Testing Size.

2.2 California Test 227 – Method of Test for Evaluating Cleanness of Coarse Aggregate.

3 Apparatus

3.1 Balance – Capacity sufficient for the sample mass, accurate to 0.1 percent of the sample mass or readable to 0.1g. Meets the requirements of AASHTO M 231.

3.2 Sample Splitter – Meets the requirements of AASHTO T 248.

3.3 Graduate assembly – Consists of:

3.3.1 funnel large enough to hold 8 inch brass wire sieves at the large end and necked down to approximately 2 in. diameter at the other end,

3.3.2 No. 8 (2.36mm) & No. 200 (0.75mm) 8 inch brass wire sieves, Meeting the requirements of AASHTO M 92.

3.3.3 500 ml graduate cylinder.

3.4 Washing vessel (as described in Figure 1) or wide-mouth 3.8 L jar with lid and rubber gasket.

3.5 Mechanical shaker – Uses oscillation or orbital action capable of securely holding the washing vessel.

3.6 Sand equivalent (SE) cylinder – Conforming to AASHTO T 176 with rubber stopper.

3.7 Graduate cylinders – 10 ml and 500 ml.

3.8 Sand equivalent (SE) solution (Stock) Conforming to AASHTO T 176

3.9 Syringe or spray attachment.

3.10 Potable water, i.e., tap water or bottled water at approximately the same temperature as the stock solution, but not at a higher temperature than the maximum temperature allowed by AASHTO T176.

4 Sample Preparation

4.1 Obtain a sample of cover coat material (CCM) in accordance with the FOP for AASHTO T 2 and reduce to 1000 ±50 grams in accordance with the FOP for AASHTO T 248.

Note 2: Sample shall be placed in a sealed container, such as concrete cylinder mold, to prevent loss of moisture. Sample shall be run in condition of placement on roadway i.e. moist. Sample shall not be allowed to dry.

4.2 Using a 10 ml graduate cylinder obtain 7 ml of SE solution.

4.3 Pour the 7 ml of SE solution into the SE cylinder.

4.4 Assemble the graduate assembly (#8 (2.36mm) sieve, #200 (0.75mm) sieve, funnel, 500 ml graduate cylinder).

5 Procedure

5.1 Place the 1000 ±50 gram CCM sample in the washing vessel or wide-mouth jar. Spread the material evenly across the bottom of the vessel or jar. Add only enough water to cover the aggregate.

5.2 Allow the sample to soak for one (1) minute from the introduction of wash water into the vessel or jar.

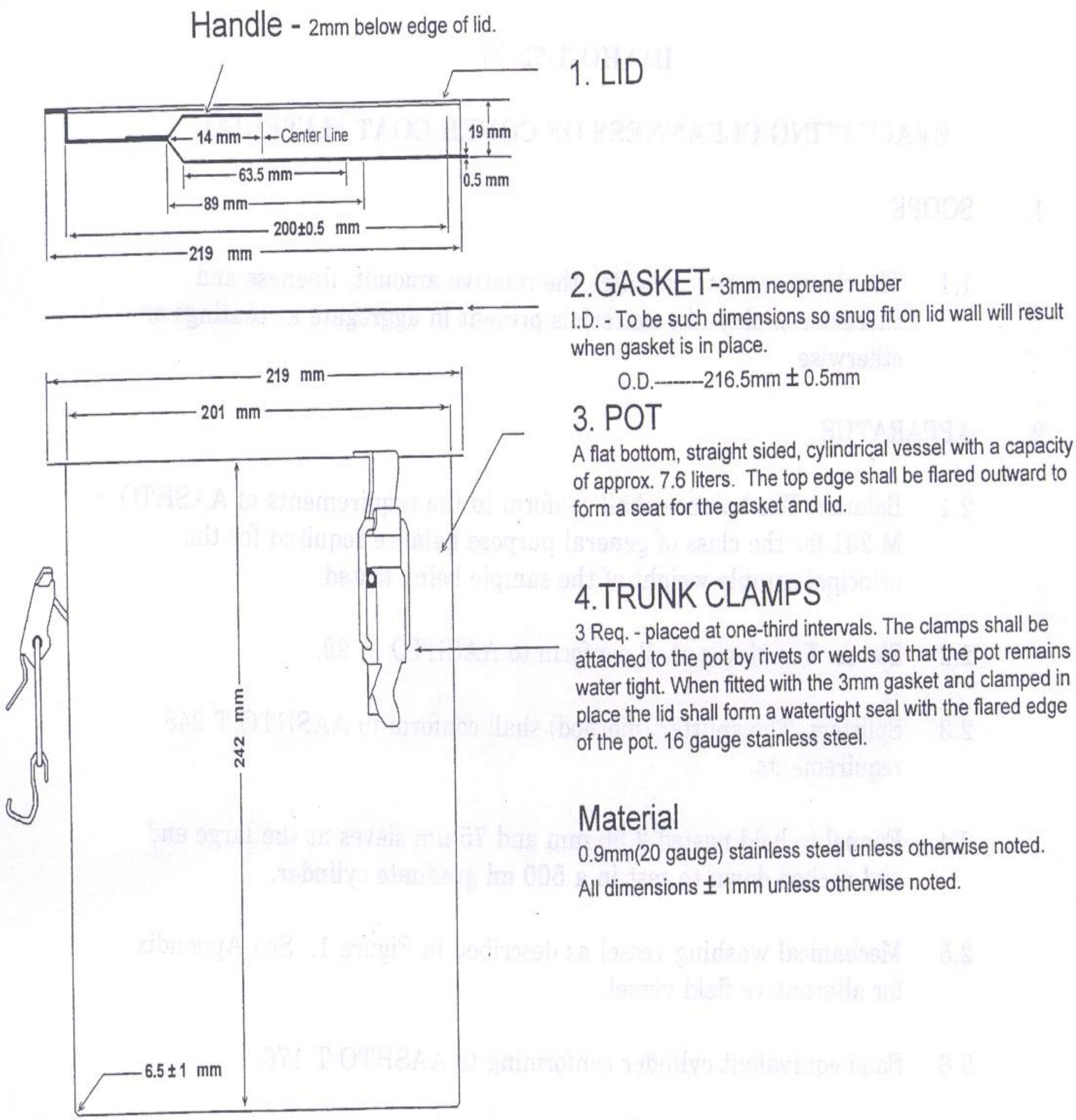
5.3 Agitate the sample by either mechanical or hand method

5.4 Mechanical Method

5.4.1 Seal and secure the wash vessel in the mechanical shaker.

5.4.2 Agitate the vessel for two (2) minutes, without using the hammer if the shaker has one.

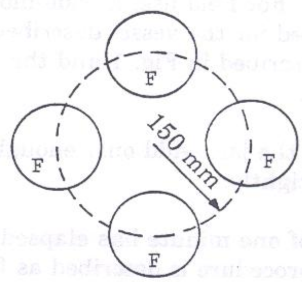
Figure 1—Washing
Vessel



5.5 Hand Method

5.5.1 Seal the jar with lid and rubber gasket.

5.5.2 Hold the jar vertical with both hands either by the sides or by the top and bottom. Agitate the sample in the vessel, creating an arm motion that causes the jar to describe a circle with at least a 6 in. (150 mm) radius. See the sketch showing the path of the jar during the agitation period. Use of a countertop with a 6 in (150 mm) radius drawn on the surface will help in this operation.



Note: The jar itself does not turn on its vertical axis. The jar's vertical axis describes a circle with a 6 in. (150 mm). radius as near as possible. Note # 3: side F always faces the operator.

5.5.3 Continue this agitation at the rate of three (3) complete rotations per second for one (1) minute.

6 Measure for Cleanness

6.1 Remove the lid from the vessel or jar. Continue agitating the vessel by hand to keep the fine contents in suspension. Pour all contents over the graduate assembly.

6.2 Wash out the vessel or jar over the graduate assembly using the syringe or spray attachment until the graduate cylinder is filled to 500 ml. mark.

6.3 Remove the sieves and funnel portion for the graduate assembly from the 500 ml graduate cylinder. Bring the solids into suspension by capping the cylinder with the palm of the hand and turning the cylinder upside down then right side up, ten (10) times, through an 180^{o} arc as rapidly as possible.

6.4 Immediately pour the thoroughly mixed liquid into the SE cylinder until the 15 inch mark is reached. Cap the SE cylinder with a rubber stopper.

6.5 Mix the contents of the SE cylinder by alternately turning the cylinder upside down and right side up, allowing the air bubble to completely traverse the length of the cylinder. Repeat this cycle 10 times. A cycle is from right side up to upside down to right side up.

6.6 On a worktable that is not subject to vibrations allow the SE cylinder and contents to stand undisturbed for 20 minutes ± 15 seconds.

6.7 After 20 minutes, read and record to the nearest 0.1 inch the height of the column of sediment.

7 Calculations

7.1 Compute the cleanness value to the nearest whole number.

$$CV = \frac{3.214 - (0.214 \times H)}{3.214 + (0.786 \times H)} \times 100$$

Where:

CV = Cleanness Value

H = Height of Sediment in inches

QUALIFICATION CHECKLIST

CLEANNESS VALUE – IDAHO T 72

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element		Trial 1	Trial 2
General			
1. The sample was maintained moist in sealed container.	1	________	________
2. The sample is equal to 1000 ± 50 grams.	2	________	________
3. There is 7 ml of SE solution in SE tube.3	3	________	________
4. The graduate assembly including sieves, funnel and 500 ml graduate cylinder is properly put together.	4	________	________
5. CCM sample was placed in washing vessel or jar and water was added just covering the aggregate.	5	________	________
Mechanical Method			
6. The vessel was secure in the shaker.	6	________	________
7. Agitation was started after one (1) minute.	7	________	________
8. The vessel was agitated for two minutes.	8	________	________
Hand Method			
9. Agitation was started after one (1) minute.	9	________	________
10. The vessel was properly rotated with 150mm radius.	10	________	________
11. Vessel was agitated 3 complete rotations per second.	11	________	________
12. Vessel was agitated for one (1) full minute.	12	________	________
Measure for Cleanness			
13. All contents of vessel or jar were washed over sieves into the 500 ml graduate cylinder.	13	________	________
14. Cylinder was rapidly turned upside down at 180º, ten (10) times.	14	________	________
15. Mixture was poured into SE cylinder to 15 inch mark.	15	________	________
16. SE Cylinder was rotated at least ten (10) complete cycles. Bubble traveled full length of tube.	16	________	________
17. Cylinder was allowed to stand 20 minutes on work table free from vibrations.	17	________	________
18. The sediment reading was to the nearest 0.1 inch.	18	________	________
19. Calculations were accurate to the nearest whole number.	19	________	________

Comments: First Attempt: Pass ☐ Fail ☐ Second Attempt: Pass ☐ Fail ☐

Testing Technician's Name: ______________________________WAQTC # : _________Date: _________

Examiner's Name: ______________________________ Signature ______________________________

Idaho Standard Method of Test for

Vibratory Spring-Load Compaction for Coarse Granular Material

Idaho IT-74-98

Idaho IT-74 is identical to WSDOT Test Method No. 606, "Method of Test for Compaction Control of Granular Materials," with the following exceptions.

A. Delete 1.1b and replace as follows: When Idaho IT-74 is specified as an alternative to AASHTO T 99 or AASHTO T 180, Idaho IT-74 should be used if the material has more than about 10% retained on the 3/4 in. (19 mm) screen.

B. Use of the WSDOT forms included in Test Method No. 606 is optional. ITD forms may be substituted.

WSDOT Test Method T 606
Method of Test for Compaction Control of Granular Materials

1. Scope

a. This test method is used to establish the theoretical maximum density of granular materials and non-granular materials with more than 30% by weight of the original specimen is retained on the No. 4 Sieve or more than 30% by weight of the original specimen is retained on the ¾” sieve.

b. There are three separate tests in this method which present a method for establishing the proper theoretical maximum density values to be used for controlling the compaction of granular materials. These tests account for variations of the maximum obtainable density of a given material for a given compactive effort, due to fluctuations in gradation.

c. By splitting the material on the U.S. No. 4 (4.75 mm) sieve and determining the specific gravity, the compacted density, and the loose density of each of the two fractions, a curve of theoretical maximum density versus percent passing the U.S. No. 4 (4.75 mm) sieve can be plotted. These curve values will correlate closely with the densities obtained in the field; using modern compaction equipment.

d. Table 1 identifies the Test, Method or Procedure to use in performing T 606. The table is divided into the Fraction of the split (Fine or Coarse) and the material type of that Fraction.

Test Method Selection Table	
Fine Material	
Soil Type	**Test Method**
Sandy, Non Plastic, Permeable	T606 Test 1
Silt, Some Plasticity, Low Permeability	T 99 Method A
Sandy Silt, Some Plasticity, Permeable	T 606 Test 1 / T 99 Method A (use higher results)
Coarse Material	
No more than 15% by weight of original aggregate specimen exceeds ¾” (19 mm)	T 606 Test 2 Procedure 1
15% or more by weight of original aggregate specimen is greater than ¾” (19 mm), but does not exceed 3 in. (76 mm)	T 606 Test 2 Procedure 2

Table 1

e. The test methods are applicable either to specifications requiring compacting to a given percentage of theoretical maximum density, or to specifications requiring compaction to a given compaction ratio.

f. Use of these test methods eliminates the danger of applying the wrong “Standard” to compaction control of gravelly soils.

g. Native soils within the contract limits to be used for embankment construction and/or backfill material do not require the sampling by a qualified tester. For material that requires gradation testing such as but not limited to manufactured aggregates and Gravel Borrow, a qualified tester shall be required for sampling.

Test No. 1
(Fine Fraction-l00 Percent Passing U.S. No. 4 (4.75 mm) Sieve)

1.1 Scope

a. This test was developed for the sandy, non-plastic, highly permeable soils which normally occur as the fine fraction of granular base course and surfacing materials.

b. When the fine fraction is primarily a soil having some plasticity and low permeability, AASHTO T 99 (Standard Proctor Test) may be used. With borderline soils, both tests should be applied and the one yielding the highest density value should be used.

1.2 Apparatus

a. Vibratory, Spring Load Compactor — Specifications for vibratory spring load compactor can be obtained from the State Materials Lab.

b. Mold — Molds can be fabricated from standard cold drawn-seamless piles or tubes. The dimensions for the small mold are; height 8 in (± 0.002 in), ID 6 in (± 0.002 in). The wall thickness of the mold shall be no less than ¼ in. The mold has a bottom plate which attaches to the mold and is slightly larger than the outer diameter of the mold. The small button at the center of the small mold follower is a measuring point. The height of this button should be adjusted so the machine follower does not bear on it during compaction.

c. Mold Piston — A piston which has a bottom face diameter of 5 ⅞ in (150 mm) OD and an overall height of 2 in. The top of the piston shall have a 2 ¼ in ID.

d. Height-Measuring Device — A scale with an accuracy of 0.01 in (0.25 mm).

e. Tamping Hammer — As specified in AASHTO T 99, Section 2.21.

f. Sieve — U.S. No. 4 (4.75 mm) sieve.

g. Oven — Capable of maintaining a temperature of 230° ± 5°F (110 ± 5° C) for drying moisture specimens.

h. Balance — A balance having a capacity of 100 lbs (45 kg) and a minimum accuracy of 0.1 lbs (50 g).

i. Tamping Rod — ⅝ in (16 mm) spherical end.

1.3 Procedure

a. Oven-dry the total original sample at a temperature not to exceed 140°F (60°C).

b. Obtain tare weight of mold and bottom plate, record weight (mass) to the nearest 0.01 lb (5 g) or less if using a balance that is more accurate than 0.1 lbs.

c. Sieve the entire specimen over a No. 4 (4.75 mm) sieve to separate the fine and coarse material. Retain the coarse material for the second half of the procedure (T 606 Test 2).

d. Split the No. 4 minus material in accordance with WSDOT FOP for AASHTO T 248 to obtain a representative specimen of approximately 13 lbs (6 kg). (This mass can be adjusted after the first compaction run to yield a final compacted specimen approximately 6 in (150 mm) high.)

e. Estimate the optimum moisture for the material. Calculate the mass of water required for optimum moisture and add water to specimen.

Weight of Water

Equation: *Wt. of water = (decimal percent water)(mass dry sample)*

f. Mix the specimen until the water and dry material are thoroughly and completely mixed.

g. Place the specimen in the mold in three layers. Rod each layer 25 times and tamp with 25 blows of the tamping hammer. The blows of the hammer should produce a 12 in (305 mm) free fall provided severe displacement of the specimen does not occur. In such cases, adjust the blow strength to produce maximum compaction. The surface of the top layer should be finished as level as possible.

h. Place the piston on top of the specimen in the mold, and mount the mold on the jack in the compactor. Elevate mold with the jack until the load-spring retainer seats on top of the piston. Apply initial seating load of about 100 lbs (45 kg) on the specimen.

i. Start the compactor hammers and, at the same time, gradually increase the spring load on the specimen to 2,000 lbs (908 kg) by elevating the jack in accordance with Table 2.

j. Check the mold for specimen saturation. The specimen is considered saturated when, free water (a drop or two of water) shows at the base of the mold. If water is not present at the base of the mold within the first 1½ minutes stop the test, remove the specimen from the mold and repeat 1.3 e-j. The specimen can be reused for subsequent water contents providing it is not a fragile material.

k. Caution: Most materials will yield the highest density at the moisture content described above. Some materials may continue to gain density on increasing the moisture above that specified; however, severe washing-out of the fines will occur, which will alter the character of the sample and void the test results.

l. If moisture is observed at the base of the mold continue applying loads at the following rates:

Load in lbs (kg)	Time in Minutes
100 to 500 lbs (45 to 227)	1
500 lbs to 1,000 lbs (227 to 454)	1/2
1,000 lbs to 2,000 lbs (454 to 908)	1/2

Rate of Load Application
Table 2

m. After reaching 2,000 lbs (908 kg), stop the hammers, release the jack, and return to zero pressure.

n. Repeat step h. four additional times; remove the mold from the compactor.

o. Measure and record the height of the compacted specimen to the nearest 0.01 in (.25 mm) and calculate the volume (see Section 1.4)

p. Remove the specimen from the mold, weigh it, and record its mass (weight) to the nearest 0.01 lbs (5 g), and calculate the wet density.

q. Vertically slice through the center of the specimen, take a representative specimen (at least 1.1 lbs (500 g)) of the materials from one of the cut faces (using the entire specimen is acceptable), weigh immediately, and dry in accordance with AASHTO T 255 to determine the moisture content, and record the results. Calculate and record the dry density.

r. Repeat steps d. through m. at higher or lower moisture contents, on fresh specimen if needed, to obtain the theoretical maximum density value for the material, three tests are usually sufficient.

1.4 Calculations

a. The formula for calculating the volume and dry and wet densities are as follows:

$$V = \frac{(H1 - H2)(B)}{1728}$$

Where:

V= Volume, ft^3

H_1= Inside height of the mold, in
H_2= Height from top of the specimen to the top of the mold, in
B = Inside bottom area of the mold, in^2

$$\text{Wet Density (pcf)} = \frac{Wet\ Mass\ (Weight, lbs.)}{Volume\ (cu.ft.)}$$

$$\text{Dry Density (pcf)} = \frac{Wet\ Density\ (pcf)}{1 + Moisture\ Content\ (in\ decimal)*}$$

*Note: See AASHTO T 255-00"Total Moisture Content of Aggregate by Drying," for moisture content calculations.

Test No. 2
(Coarse Fraction-100 Percent Retained on the U.S. No. 4 (4.75 mm) Sieve)

2.1 Scope

a. This test is used when there is 100 percent retained on the U.S. No. 4 (4.75 mm) sieve. There are two separate procedures based on the maximum size of the aggregate being tested. Procedure 1 is used when no more than 15% by weight of the original specimen of the coarse aggregate exceeds ¾ in (19 mm). Procedure 2 is used when 15% or more by weight of the original specimen of the aggregate is greater than ¾ in (19 mm), but does not exceed 3 in (76 mm). If there is any aggregate greater than 3 in (76 mm), it has to be removed before proceeding with the test.

Procedure 1
(Aggregate Size: No. 4 to ¾ in (19 mm)

2.2 Equipment

a. The apparatus for this test is the same as that used in Test No. 1

2.3 Procedure

a. From the coarse split obtained in Test No. 1, Section 1.3(C), separate a representative specimen of 10 to 11 lbs (4.5 to 5 kg) and weigh to 0.01 lbs (5 g), or less if using a balance that is more accurate than 0.1 lbs.

b. Dampen the specimen to 2½% moisture and place it in a 0.1 ft^3 (0.0028 m^3) mold, in three lifts. Tamp each lift lightly to consolidate the material to achieve a level surface. Omit rodding. Avoid loss of the material during placement.

c. Place the piston on top of the specimen in the mold, and mount the mold on the jack in the compactor. Elevate mold with the jack until the load-spring retainer seats on top of the piston. Apply initial seating load of about 100 lbs (45 kg) on the sample.

d. Start the compactor hammers and, at the same time, gradually increase the spring load on the sample to 2,000 lbs (908 kg) by elevating the jack in accordance with the Table 2.

e. Follow procedure described in Test No. 1 Section 1.3 m through 1.3 r.

f. Using the original dry weight value, calculate the dry density in lb/ft^3 (kg/m^3). Use the formula for dry density described in Test No.1, Section 1.4.

Procedure 2
(Aggregate Size: No. 4 to 3 in (76 mm))

2.4 Equipment

a. ½ ft^3 (0.014 m^3) standard aggregate measure.

b. A metal piston having a diameter ⅛ in (3 mm) less than the inside diameter of the ½ ft^3 (0.014 m^3) measure.

2.5 Procedure

a. From the coarse fraction in Test No. 1, Section 1.3c., separate a representative specimen of 45 lbs (20 kg) and weigh to 0.1 1b. (50 g), or less if using a balance that is more accurate than 0.1 lbs.

b. Split the specimen into five representative and approximately equal parts.

c. Place the specimen in the mold in five separate lifts after each lift is placed in the mold, position the piston on the specimen, mount the mold in the compactor, and compact as described in Table 2, Section 1.3h. Spacers between the load spring and piston must be used to adjust the elevation of the mold to the height of the lift being compacted.

d. After the final lift is compacted, remove the mold from the compactor, determine the height of the compacted specimen, and calculate the volume (see Test No. 1, Section 1.4(a)).

e. Calculate the dry density in lbs/ft^3 (kg/m^3) (see Test No. 1, Section 1.4(a)).

Test No. 3
Specific Gravity Determination for Theoretical Maximum Density Test

3.1 Equipment

a. Pycnometer calibrated at the test temperature having a capacity of at least 1 quart (100 ml).

b. One vacuum pump or aspirator (pressure not to exceed 100 mm mercury).

c. One balance accurate to 0.1 g.

3.2 Material

a. Fine fraction U.S. No. 4 (4.75 mm) minus 1.1 lbs (500 g) minimum.

b. Coarse fraction U.S. No. 4 (4.75 mm) plus 2.2 lbs (1,000 g) minimum.

3.3 Procedure

a. Place dry material, either fine or coarse fraction, in pycnometer, add water. Put pycnometer jar top in place and connect to vacuum apparatus. Apply vacuum for at a minimum of 20 minutes until air is removed from specimen. Slight agitation of the jar every 2 to 5 minutes will aid the de-airing process. If the material boils too vigorously, reduce the vacuum. Remove vacuum apparatus, fill pycnometer with water, dry outside of jar carefully and weigh. Water temperature during test should be maintained as close to 68° ± 1° F (20° ± 0.5° C) as possible.

Calculate Specific Gravity as follows:

$$\text{Sp. Gr.} = \frac{a}{a+b-c}$$

Where:

a = Weight of dry material, grams
b = Weight of pycnometer + water, grams
c = Weight of pycnometer + material + water, grams

3.4 Reports

a. All test results are recorded on the theoretical maximum density work sheet.

b. Use the appropriate computer program to determine the theoretical maximum density.

Idaho Standard Method of Test for

Disintegration of Quarry Aggregates (Ethylene Glycol)

Idaho IT-116-99

1. Scope

1.1. This method outlines the preparation and test procedure for measuring the presence of deleterious clay in quarry aggregates.

2. Reference

2.1. Standard Specifications, Subsection 703.01.

3. Apparatus

3.1. Oven 60 ± 2°C.

3.2. Sieves conforming to AASHTO M 92 Specifications.

4. Procedure

4.1. Wash and dry enough material passing the 12.5 mm and retained on the 9.5 mm sieve to provide 500 grams of material when shaken to refusal.

4.2. Immerse in technical grade ethylene glycol for a period of 15 days.

4.3. Decant and dry the aggregate. Shake to refusal over a 9.5 mm sieve and calculate the percent retained.

Idaho Standard Practice for

Investigation of Aggregate and Borrow Deposits

Idaho IR-142-06

1. Scope

1.1. This method sets forth the accepted procedures to be used in investigating sources of sand, gravel and rock for aggregates, borrow, and granular borrow for use in highway construction. It also includes accepted procedures for sampling, testing, and source plan development.

2. References

2.1. ITD Quality Assurance Manual.

2.2. ITD Materials Manual, Section 270.00, Materials Sources.

2.3. AASHTO T 2, Sampling of Aggregates, Appendix X2.

2.4. ASTM D 420-98, Standard Guide to Site Characterization for Engineering, Design, and Construction Purposes.

2.5. ITD Standard Specifications for Highway Construction.

2.6. Idaho Code, Sections 54-2081 and 54-2802.

3. Terminology

3.1. For the purpose of this test method, the term "Contractor" shall be defined as any individual(s) or company interested in investigating a materials source with the intent of meeting Idaho Transportation Department specifications.

4. General

4.1. The Contractor shall comply with the provisions of ITD Standard Specifications, including requirements necessary prior to beginning any work or investigation with equipment within any source. Reference ITD Materials Manual, Section 270.13, Aggregate Materials Sources.

5. Investigation and Sampling

5.1. Materials source investigation and sampling shall include the following:

5.2. Sand and gravel deposits shall be investigated by excavating test pits located 150 ft. to 200 ft. (45 m to 60 m) on centers. The test pits shall be selected to form an effective grid over the entire area to be investigated. The test pits shall represent the materials present to the full depth intended to be mined. In lieu of test pits, large diameter drilling may be acceptable if the drilling method collects a representative sample and is submitted for pre-approval by the District Materials Engineer..

5.2.1. If the sand/gravel deposit has an exposed face, the Contractor may elect to replace the first row of test pits by sampling from the face. Sample locations shall be selected forming a grid pattern over the exposed face, and extending into the face to undisturbed material, to represent the area investigated. A minimum of three (3) sample locations shall be selected along any exposed face. Any source sampled at the face will require, in addition, a minimum of one (1) row of test pits at a maximum of 150 ft. (45 m) from the face. The test pits and samples shall represent the materials present to the full depth intended to be mined.

5.3. Rock deposits shall be investigated using core drilling equipment. Drill holes shall be spaced no more than 200 ft. (60 m) on center to form an effective grid covering the entire area investigated. Drill holes shall be deep enough to represent the full depth of the excavation.

5.3.1. Bulk samples may be taken from blasted areas in lieu of core drilling. The samples may be collected from the blasted rock pile if the blasted materials accurately represent the entire area investigated and the full depth of the excavation. Additional sampling and testing of the quarry face or core drilling shall be required if additional material is required beyond the materials represent ed by the blasting. Samples from blasted rock piles shall not be used to characterize the materials more than 200 feet (60 m) beyond the blasted rock face.

5.3.1.1. If the rock quarry has an exposed face, the Contractor may elect to replace the first row of rock cores by sampling from the face. Sample locations shall be selected forming a grid pattern over the exposed face and extending into the face to represent the area investigated. A minimum of three (3) sample locations shall be selected along any exposed face. Any source sampled at the face will require a minimum of one (1) row of rock cores at a maximum of 200 ft. (60 m) from the face. The rock cores shall represent the intended materials present to the full depth intended to be mined..

5.4. For project-specific sources consisting of either sand/gravel deposits or rock deposits, sample location spacing shall be adjusted to form an effective grid over the area to be worked. A minimum of three (3) samples shall be taken. The grid shall represent the intended depth of excavation, as well as the area to be worked, to produce the required quantities. Samples from an exposed face shall meet the requirements of Paragraph 4.1 or 4.2.

5.5. The investigator shall keep an accurate, detailed record of each sample, test pit, and boring location and detailed descriptions of all materials present in the proposed source. The detailed descriptions shall include but not limited to; geologic descriptions, scaled boring logs, and 4 inch by 5 inch minimum size color photographs of the materials, cores, and samples in the moist condition. Detailed descriptions of the source materials shall be made by direct, hands-on observations. Material descriptions taken from or referenced from published or non-published documents will not be accepted in lieu of a materials source investigation in accordance with this procedure but may be used to supplement the investigation. Descriptions of bedrock materials shall be provided by a qualified Professional Geologist. Clear copies of the original records shall be provided to the Engineer for source approval.

5.6. All investigations shall be performed under the direction of or by a qualified Professional Engineer or Professional Geologist licensed in the state of Idaho. All sample locations shall be selected by the Professional Engineer or Professional Geologist and shall be in accordance with the current version of AASHTO T 2, Sampling of Aggregates, Appendix X2; and ASTM D 420 Standard Guide to Site Characterization for Engineering, Design, and Construction Purposes.

5.6.1. For the purpose of this test method, direct supervision shall include the Professional Engineer or Professional Geologist having intimate knowledge of the source so as to be able to determine the sample locations and sampling methods as well as sufficient knowledge of the site to meet the descriptive requirements herein.

5.7. Sampling shall be performed under the direct supervision of a qualified Professional Engineer or Professional Geologist licensed in the state of Idaho. Sampling procedures shall be performed in accordance with the current version of AASHTO T 2, Sampling of Aggregates, Appendix X2; and ASTM D 420-98, Standard Guide to Site Characterization for Engineering, Design, and Construction Purposes. Though the actual sample size may vary due to the gradation of the materials being sampled, the minimum sample size shall be 100 lbs (50kg) and shall be representative of the aggregate being mined. Multiple samples may be required to accurately represent the distribution of materials in the source. Each sample shall represent one test. The entire sample shall be crushed, blended and split into appropriate portions for the tests required.

6. Testing

6.1. Required test data for aggregate sources shall conform to Standard Specifications Section 703 – Aggregates, and ITD Contract Specifications.

6.1.1. Required test data for borrow and granular borrow sources shall conform to Standard Specifications Section 205 – Excavation and Embankment, and ITD Contract Specifications.

6.2. The laboratory used to perform the tests shall be qualified under the Idaho Transportation Department's Lab Qualification Program or be AASHTO accredited. All individuals that perform laboratory tests for source approval shall be qualified by the Registered Engineer in charge of the laboratory.

6.3. Copies of all test results shall be furnished by the independent laboratory to the Engineer. Consideration for source approval is contingent upon receiving complete source investigation test data from the independent laboratory.

7. Materials Source Plan

7.1. A Materials Source Plan shall be prepared and submitted to the Engineer. At a minimum, the plan shall contain the following:

7.2. A vicinity sketch in enough detail that the source can be located.

7.3. A legal description of the source.

7.4. A sketch of the source depicting the boundary dimensions and drawn to scale.

7.5. A north arrow.

7.6. The test pits, sample locations, borings, active or working faces shall be depicted on the sketch relative to their location in the source.

7.7. The area to be worked shall be delineated with test pits, sample locations, and borings representing the material shown.

8. Qualified Aggregate Material Suppliers

8.1. Upon completion of the requirements outlined in this test method, the Contractor's source may be included on the Idaho Transportation Department (ITD) list of Qualified Aggregate Materials Suppliers as defined in the ITD Quality Assurance Manual (Section 265.00, Qualified Aggregate Materials Suppliers).

Idaho Standard Method of Test for

Specific Gravity and Absorption of Fine Aggregate Using Automatic Vacuum Sealing (CoreLok) Method

Idaho IT-144-08

1 Scope

1.1 This standard covers the determination of specific gravity and absorption of fine aggregates.

1.2 The values are stated in SI units and are regarded as the standard units.

1.3 This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2 Referenced Documents

2.1 AASHTO Standards:

- M 132, Terms Relating to Density and Specific Gravity of Solids, Liquids and Gases
- M 231, Weighing Devices Used in the Testing of Materials
- T 2, Standard Practice for Sampling of aggregates
- T 19, Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate
- T 248, Standard Practice for Reducing Samples of Aggregate to Testing Size
- T255, Total Evaporable Moisture Content of Aggregate by Drying

2.2 Other Standards

- CoreLok Operational Instructions (InstroTek, Inc.)

3 Terminology

3.1 absorption—the increase in the mass of aggregate due to water in the pores of the material, but not including water adhering to the outside surface of the particles, expressed as a percentage of the dry mass. The aggregate is considered “dry” when it has been maintained at a temperature of 110 ± 5ºC for sufficient time to remove all uncombined water.

3.2 specific gravity—the ratio of the mass (or weight in air) of a unit volume of a material to the mass of the same volume of water at stated temperatures. Values are dimensionless.

3.3 apparent specific gravity—the ratio of the weight in air of a unit volume of the impermeable portion of aggregate at a stated temperature to the weight in air of an equal volume of gas-free distilled water at a stated temperature.

3.4 bulk specific gravity—the ratio of the weight in air of a unit volume of aggregate (including the permeable and impermeable voids in the particles, but not including the voids between particles) at a stated temperature to the weight in air of an equal volume of gas-free distilled water at a stated temperature.

3.5 bulk specific gravity (SSD)—the ratio of the mass in air of a unit volume of aggregate, including the mass of water within the voids filled to the extent achieved by vacuum saturating (but not including the voids between particles) at a stated temperature, compared to the weight in air of an equal volume of gas-free distilled water at a stated temperature.

4 Summary Of Method

4.1 Sufficient fine aggregate sample is dried to constant mass and representative dry fine aggregate samples of the same material are selected for testing. One sample is sealed in a vacuum chamber inside a plastic bag and opened under water for rapid saturation of the aggregate. The dry mass and submerged mass of the sample is used for calculation of apparent specific gravity. Other samples of the same aggregate are tested in a known volume metal pycnometer. The known mass of the pycnometer with water, mass of the dry aggregate, and mass of the dry aggregate and pycnometer filled with water is averaged and used for calculation of bulk specific gravity oven dry (OD.) The results from the samples tested are used to calculate absorption, and bulk specific gravity saturated-surface-dry (SSD).

5 Apparatus

5.1 Balance—A balance that conforms to AASHTO M231. The balance shall be sensitive, readable and accurate to 0.1% of the test sample mass. The balance shall be equipped with suitable apparatus for suspending the sample in water.

5.2 Water Bath—A large container that will allow for completely submerging the sample in water while suspended, equipped with an overflow outlet for maintaining a constant water level. Temperature controls may be used to maintain the water temperature at 25 ± 1° C (77 ± 2 °F).

Note 1—It is preferable to keep the water temperature constant by using a temperature controlled heater. Also, to reduce the chance for the bag to touch the sides of the water tank, it is preferable to elevate the water tank to a level at which the sample can be placed on the weighing mechanism while the operator is standing up (waist height), and the placement of the sample and the bag in the water tank can easily be inspected.

5.3 Sample holder for water displacement of the sample, having no sharp edges.

5.4 Vacuum Chamber—with a pump capable of evacuating a sealed and enclosed chamber to a pressure of 6 mm Hg, when at sea level. The device shall automatically seal the plastic bag and exhaust air back into the chamber in a controlled manner to ensure proper conformance of the plastic to the specimen. The air exhaust and vacuum operation time shall be set at the factory so that the chamber is brought to atmospheric pressure in 80 to 125 seconds, after the completion of the vacuum operations.

5.5 A Vacuum Measurement Gauge, independent of the vacuum sealing device, that could be placed directly inside the chamber to verify vacuum performance and the chamber door sealing condition of the unit. The gauge shall be capable of reading down to 3 mm Hg and readable to ± 1 mm Hg. The gauge shall be NIST traceable.

5.6 Plastic Bags, used with the vacuum device, shall have a minimum opening of 235 mm (9.25 in.) and maximum opening of 260 mm (10.25 in.). The bags shall be of plastic material, shall be puncture resistant, and shall be impermeable to water. The bags shall have a minimum thickness of 0.127mm (0.005 in.). The manufacturer shall provide the apparent specific gravity for the bags.

5.7 Metal pycnometer and lid, with 137 ± 0.13 mm (5.375 ± 0.005 in.) inside diameter (ID) and 89 ± 0.41 mm (3.5 ± 0.016 in.) height, for testing fine aggregates. The pycnometer shall be machined to be smooth on all surfaces. The inside of the lid shall be machined at a 5° angle to create an inverted conical surface.

5.8 Pycnometer clamping device to hold and secure the lid on the metal pycnometer from lifting during fine aggregate tests. The device shall be provided with a level indicator.

5.9 Syringe with a needle no larger in diameter than 3 mm (0.125 in.)

5.10 Thermometer or other temperature device with range to 40ºC (100ºF) accurate to ±1º.

5.11 Isopropyl alcohol – Technical Grade

5.12 Accessories— A bag cutting knife or scissors, spray bottle for the isopropyl alcohol, a bucket large enough to allow the pycnometer to be fully submerged in water, water containers to dispense water into pycnometer during testing, small paint brush and 25 mm (1 in.) wide aluminum spatula.

6 Verification

6.1 System Verification: The vacuum settings of the vacuum chamber shall be verified once every 12 months and after major repairs and after each shipment or relocation.

6.1.1 Place the gauge inside the vacuum chamber and record the setting, while the vacuum unit is operating. The gauge should indicate a pressure of 6 mm Hg or less. The unit shall not be used if the gauge reading is above 6 mm Hg.

> **Note 2**— In line vacuum gauges, while capable of indicating vacuum performance of the pump, are not suitable for use in enclosed vacuum chambers and cannot accurately measure vacuum levels.

6.2 Calibration of Pycnometer:

6.2.1 Prior to testing, condition the pycnometer to 25 ± 1°C (77 ± 2°F) by placing it inside a bucket of water that is maintained at 25 ± 1°C (77 ± 2°F). Place the pycnometer clamping device on a level surface. Use a level indicator or the provided level to level the device.

> **Note 3 –** The clamping device must be protected from hot or cold ambient laboratory temperatures that are more or less than 25 ± 1°C (77 ± 2°F).

6.2.2 Remove the pycnometer from the water bucket and dry it with a towel. Place the pycnometer in the device and push it back until it makes contact with the stops.

6.2.3 Fill the pycnometer with 25 ± 1°C (77 ± 2°F) water to approximately 10 mm (0.375 in.) from the top. Using the alcohol spray bottle, spray the surface of the water to remove bubbles.

6.2.4 Gently place the lid on the pycnometer and close the clamps on the device.

6.2.5 Using a syringe filled with 25 ± 1°C (77 ± 2°F) water, slowly fill the pycnometer through the large fill hole on the lid post. Make sure the syringe tip is far enough in the pycnometer to be below the water level. Gentle application in this step prevents formation of air bubbles inside the pycnometer.

6.2.6 Fill the pycnometer until water comes out of the 3 mm (1/8-in.) hole on the surface of the lid.

6.2.7 Wipe any remaining water from the top of the lid with a towel.

6.2.8 Place the entire device with the pycnometer on the scale and record the mass. Record the mass to 0.1 in the top portion of the Aggregate Worksheet. (See Appendix 1)

6.2.9 Clean the pycnometer and repeat steps 6.2.1 to 6.2.8 two more times and average the calibration masses obtained in 6.2.8.

6.2.10 If the range for the 3 calibration masses is larger than 0.5 grams, then the test is not being run correctly. Check to see if the device is level. Make certain the water injection with the syringe is done below the pycnometer water surface and is applied gently. Check the water temperature. Check the pycnometer temperature. Repeat the above procedure until you have three masses that are within a 0.5 gram range.

6.2.11 The pycnometer must be re-calibrated daily prior to testing.

7 Sampling

7.1 Sampling shall be performed in accordance with AASHTO T 2.

7.2 Samples shall be dried to constant mass in accordance with AASHTO T255.

7.3 Samples shall be reduced in accordance with AASHTO T 248.

8 Procedures

8.1 Equipment Preparation:

Note 4 – Make certain water temperature used for this test remains at 25 ± 1°C (77 ± 2°F).

8.1.1 Prior to testing, condition the pycnometer to 25 ± 1°C (77 ± 2°F) by placing it inside a bucket of water that is maintained at 25 ± 1°C (77 ± 2°F).

8.1.2 Remove the pycnometer from the water bucket and dry thoroughly with a towel.

8.1.3 Place the pycnometer clamping device on a level surface. Use a level indicator or the provided level to level the device.

8.1.4 Place the empty pycnometer in the pycnometer clamping device and push it back until it makes contact with the stops.

8.2 Determine Bulk Specific Gravity:

8.2.1 Oven dry to constant mass according to AASHTO T255, enough fine aggregate to obtain three 500 gram samples and one 1000 gram sample, reduced according to AASHTO T248..

8.2.2 Allow the sample to cool to 25 ± 1°C (77 ± 2°F).

8.2.3 Determine the mass of a 500 ± 1 gram dry sample, Trial 1, that is at 25 ± 1°C (77 ± 2°F) and record to 0.1 on the Aggregate Worksheet.

8.2.4 Steps 8.2.5 to 8.2.13 shall be completed in less than 2 minutes.

8.2.5 Place approximately 500 ml of 25 ± 1°C (77 ± 2°F) water in the pycnometer (halfway full).

8.2.6 Slowly and evenly pour the sample into the pycnometer. Make certain aggregate is not lost in the process of filling the pycnometer. Use a brush if necessary to sweep any remaining fines into the pycnometer. If any aggregate is lost during the process of filling the pycnometer, start the test over.

8.2.7 Use a metal spatula and push it to the bottom of the pycnometer against the inside circumference. Slowly and gently drag the spatula to the center of the pycnometer, removing the spatula after reaching the center. Repeat this procedure in eight equal increments until the entire circumference is covered. If necessary, use a squeeze water bottle to rinse any sample residue off the spatula into the pycnometer.

8.2.8 Fill the pycnometer with 25 ± 1°C (77 ± 2 °F) water to approximately 10 mm (0.375 in.) of the pycnometer rim. It is important the water level be kept at or below the 10 mm line to avoid spills during lid placement.

8.2.9 Use the spray bottle filled with isopropyl alcohol to spray the top of the water to remove air bubbles.

8.2.10 Gently place the lid on the pycnometer and lock the clamping device. Using the syringe, slowly fill the pycnometer through the center hole on top of the lid post. Make sure the syringe tip is far enough in the pycnometer to be below the water level. Gentle application in this step will prevent formation of air bubbles inside the pycnometer.

8.2.11 Fill the pycnometer until water comes out of the 3 mm (1/8-in.) hole on the surface of the lid.

8.2.12 Wipe any remaining water from around the 3 mm (1/8-in.) hole with a towel.

> **Note 5 –** Do not wipe water from the rim of the pycnometer if it seeps between the lid and the pycnometer. Allow this water to remain.

8.2.13 Determine the mass of the sample, the pycnometer and the device. Record the mass to 0.1 in B of the Aggregate Worksheet.

8.2.14 Discard the sample and prepare the equipment according to step 8.1.1 to 8.1.4.

8.2.15 Repeat steps 8.2.3 to 8.2.13 for another 500 ± 1 gram sample, Trial 2.

8.2.15.1 The difference in the mass of Trial 1 and Trial 2 recorded in B must be 1.0 gram or less. If the difference is greater than 1.0, then repeat steps 8.2.14 and 8.2.15 using another 500 ±1 gram dry sample.

8.2.16 Calculate the average mass for the two trials that are within 1 gram; record to 0.1 on Aggregate Worksheet.

8.2.17 Record the average weight of the pycnometer from section 6.2.9 on Aggregate Worksheet.

8.3 Determine Apparent Specific Gravity:

8.3.1 Set the vacuum device according to manufacturer's recommendation.

8.3.2 Tare the immersed weighing basket in the water bath.

8.3.3 Use a small plastic bag and inspect the bag to make sure there are no holes, stress points or side seal discontinuities in the bag. If any of the above conditions are noticed, use another bag.

8.3.4 Determine the mass of the bag and record to 0.1 on Aggregate Worksheet.

> **Note 6**—Always handle the bag with care to avoid creating weak points and punctures.

8.3.5 Determine the mass of a 1000 ± 1 gram sample of oven dry aggregate and record 0.1 at E on Aggregate Worksheet.

8.3.6 Place the sample in the bag. Support the bottom of the bag on a smooth tabletop when pouring the aggregate to protect against punctures and impact points.

8.3.7 Place the bag containing the sample inside the vacuum chamber.

8.3.8 Grab the two sides of the bag and spread the sample flat by gently shaking the bag side to side. Do not press down or spread the sample from outside the bag. Pressing down on the sample from outside the bag will cause the bag to puncture and will negatively impact the results. Lightly spray mist aggregates with high minus 75-μm (No. 200) sieve material to hold down dust prior to sealing.

8.3.9 Place the open end of the bag over the seal bar and close the chamber door. The unit will draw a vacuum and seal the bag, before the chamber door opens.

8.3.10 Gently remove the sample from the chamber and immediately (within 5 seconds) submerge the sample in the water bath equipped with a balance for water displacement analysis.

> **Note 7 -** It is extremely important the bag be removed from the vacuum chamber and immediately placed in the water bath. Leaving the bag in the vacuum chamber or on a bench top after sealing can cause air to slowly enter the bag and can result in low apparent specific gravity results.

8.3.11 Completely submerge the bag at least 2-inches below the surface of the water during cutting.

8.3.12 Make a small cut across the top edge of the immersed bag approximately 25 to 50 mm (1 to 2 in.).

8.3.13 Hold the immersed bag open at the cut for approximately 45 seconds allowing the water to freely flow into the bag. Allow any small residual air bubbles to escape. Do not shake or squeeze the sample, as these actions will cause the fines to escape from the bag.

8.3.14 After water has filled in, make another cut on the opposite side of the immersed bag approximately 25 to 50 mm (1 to 2 in.). Squeeze any residual air bubbles on top portion of the bag through the openings by running your fingers across the top of the bag. Do not completely remove any portion from the bag nor allow any portion of the bag to reach the surface of the water. Keep the sample and bag at least 2-inches below the surface of the water at all times.

8.3.15 Place the bag containing the sample in the immersed weighing basket to obtain the under water mass. Allow water to freely flow into the bag. Make certain the bag or the sample are not touching the bottom, the sides, or floating out of the water bath.

8.3.16 Allow the sample to stay in the water bath for a minimum of fifteen (15) minutes but not more than 20 minutes.

8.3.17 Record the submerged mass on the Aggregate Worksheet and wait one minute. If after this time the mass increases by more than one-gram, wait an additional five minutes. Record the mass and continue this process until the mass stops increasing.

9 Calculations

9.1 Test result calculations for percent absorption, apparent specific gravity and bulk specific gravity will be obtained from the software supplied by the manufacturer. Use the data from the Aggregate Worksheet. The software will provide a report of the test results.

9.2 The final test result will be determined from an average of two laboratory specimens.

Appendix 1

Aggregate Worksheet

Weight of pycnometer and clamping device filled with water.					1.	2.	3.	Avg.
Sample Number or Label	Trial Number		**A** Dry Sample Mass (500 g)	**B** Mass of pycnometer with sample and water (g)	**C** Plastic bag mass (g)	**D** Mass of two rubber sheets (g)	**E** Dry Sample Mass (1000 g)	**F** Mass of Sealed sample opened under water
	1							
	2							
	3*							
	Avg							
	1							
	2							
	3*							
	Avg							
	1							
	2							
	3*							
	Avg							

* Trial 3 is only necessary if the mass in B for the first 2 trials is larger than 1.0 grams.

PERFORMANCE EXAM CHECKLIST

SPECIFIC GRAVITY AND ABSORPTION OF FINE AGGREGATE USING AUTOMATIC VACUUM SEALING (CORELOK) METHOD
IDAHO IT-144-08

Participant Name______________________________________ Exam Date______________

Record 'P' For Passing "F" for failing each step of the checklist.

Verification Element	Trial 1	Trial 2
1. Pycnometer and lid placed inside a bucket of water at 25° ± 1C (77° ± 2F)?	______	______
2. Pycnometer and lid removed from water dried well and placed on clamping device until it makes contact with stops?	______	______
3. Pycnometer filled with 25° ± 1C (77° ± 2F) water to 10mm (3/8") of top, sprayed with Isopropyl alcohol to remove air?	______	______
4. Lid gently placed on Pycnometer and clamped?	______	______
5. A syringe filled with 25° ± 1C (77° ± 2F) inserted in top of lid and gently added until water is expelled through the 3mm (1/8") hole?	______	______
6. Water wiped from lid, device water and pycnometer weighed and recorded to 0.1 g?	______	______
7. Procedure repeated two additional times (no greater than 0.5 g difference) recorded to work sheet and averaged?	______	______

Procedure Element	Trial 1	Trial 2
8. Representative samples obtained per FOP for AASHTO T 2?	______	______
9. Reduced per FOP for AASHTO T 248?	______	______
10. Dried per FOP for AASHTO T 255?	______	______
11. Samples cooled to 25° ±1C (77° ± 2F)?	______	______
12. Three samples obtained @ 500g ±1g and one @ 1000g ± 1g?	______	______
13. Pycnometer and lid removed from water, dried and pycnometer placed on clamping device until it makes contact with stops?	______	______
14. Water added to pycnometer (at 25° ± 1C, 77° ± 2F) to approximately half full?	______	______

Procedure Element	Trial 1	Trial 2
15. Sample at 500 g ± 1g slowly added to pycnometer?	_______	_______
16. Metal spatula inserted against side of pycnometer and slowly pushed to center removed, repeated in eight equal increments?	_______	_______
17. Water added at 25°± 1C (77°± 2F) to within 10mm (3/8”) of rim?	_______	_______
18. Sprayed with isopropyl alcohol to remove air?	_______	_______
19. Lid gently placed on pycnometer with 3mm (1/8”) hole to the front and clamped?	_______	_______
20. Syringe filled with 25°± 1C (77°± 2F) water inserted in top of lid and water slowly added until it is expelled through 3mm (1/8”) hole?	_______	_______
21. Excess water wiped from lid?	_______	_______
22. Clamping device, pycnometer and sample mass recorded to 0.1 g?	_______	_______
23. Clamping device, pycnometer and sample mass determined no more than 2 minutes from time sample was submerged?	_______	_______
24. Second 500g ±1 g sample tested and mass recorded?	_______	_______
25. If recorded mass of first and second sample greater than 1 g, was a third 500 g ± 1 g sample tested?	_______	_______
26. Vacuum device set at manufacture’s recommended setting?	_______	_______
27. Small plastic bag inspected and mass determined to 0.1 g and recorded?	_______	_______
28. 1000 g ±1 g sample mass determined and recorded?	_______	_______
29. 1000 g ±1 g sample placed in the bag, supported by a smooth surface to prevent punctures?	_______	_______
30. Sample placed in vacuum device and spread flat by grasping both sides of bag and gently shaking?	_______	_______
31. Open end of bag placed over seal bar and closed?	_______	_______
32. Sample removed from vacuum chamber when door opens and submerged in 25°± 1C (77°± 2F) water bath within 5 seconds?	_______	_______
33. Bag maintained at a minimum depth of two inches?	_______	_______
34. A small cut made at corner of bag approximately 25 to 50mm (1” to 2”)?	_______	_______
35. Submerged bag held open until water flows freely into bag (approximately 45 seconds)	_______	_______

Procedure Element	Trial 1	Trial 2
36. A second cut approximately 25 to 50mm (1” to 2”) made to opposite side of bag?	______	______
37. Residual air removed from bag by running fingers across top of submerged bag?	______	______
38. Bag placed in weighing basket and water allowed to flow freely into bag?	______	______
39. Sample mass determined and recorded after 15 minutes but not more than 20 minutes and recorded to 0.1g?	______	______
40. Test data entered into manufacture’s software to obtain test results?	______	______

COMMENTS: First Attempt : Pass ☐ Fail ☐ Second Attempt: Pass ☐ Fail ☐

Examiner Signature:________________________________ Sampler / Tester Qualification # __________

Examiner Signature:________________________________ Sampler / Tester Qualification # __________

Idaho Standard Practice for

Design of Seal Coats and Single Surface Treatments

Idaho IR-60-98

1. Scope

1.1. This method describes the procedures involved in obtaining the data necessary to design a seal coat or single surface treatment using a method developed by Jerome Kearby of the Kansas Asphalt Association.*

2. Apparatus

2.1. U.S. Series sieves as required to obtain a sieve analysis of cover coat aggregate.

5/8 in. (16.0 mm)
1/2 in. (12.5 mm)
3/8 in. (9.5 mm)
No. 4 (4.75 mm)
No. 8 (2.36 mm)

2.2. A 1/2 ft^3 (0.014 m^3) measure conforming to the requirement of AASHTO T 19.

2.3. A 1 yd^2 (1 m^2) test board made of plywood or masonite with sides framed by 1/2 in. (12 mm) molding strips.

2.4. Balance that is accurate to 1 g (triple beam balance).

3. Procedure

3.1. Determine the gradation of the aggregate by means of AASHTO T 27, Sieve Analysis of Fine and Coarse Aggregates.

3.2. Determine the average particle size of the aggregate.

*"Tests and Theories on Seal Coats or Asphalt Surface Treatments," by Jerome P. Kearby, Engineer Director, Kansas Asphalt Association, Topeka, Kansas.

"Tests and Theories on Penetration Surfaces," by Jerome P. Kearby, Proceedings of the 32nd Annual Meeting, H.R.B., 1953.

3.2.1. The material passing any given sieve size and retained on the next smaller size will have an average particle size approximately equal to the average of the two (2) sieve sizes. For example:

Sieve Size	Average Size
3/4 in. (19.0 mm)	
	10/16 in. (15.75 mm)
1/2 in. (12.5 mm)	
	7/16 in. (11.00 mm)
3/8 in. (9.5 mm)	
	4.5/16 in. (7.13 mm)
No. 4 (4.75 mm)	
	2/16 in. (3.56 mm)
No. 8 (2.36 mm)	
	1/16 in. (1.77 mm)
No. 16 (1.18 mm)	

3.2.2. The amount of each size material in the sieve analysis is that which passes one (1) sieve and is retained on the next smaller sieve. This value is obtained by subtracting the percent passing the smaller sieve from the percent passing the larger sieve. For example:

Sieve Size	% Passing	% Each Size
1/2 in. (12.5 mm)	100	
		15
3/8 in. (9.5 mm)	85	
		65
No. 4 (4.75 mm)	20	
		17
No. 8 (2.36 mm)	3	
		1
No. 16 (1.18 mm)	2	

3.2.3. In order to determine the average particle size of any given aggregate, the percent of each size (as obtained in paragraph 3.2.2) is multiplied by the average particle size between sieves (as obtained in paragraph 3.2.1) and the sum of the products is figured. For example:

Sieve Size	Average Size		% Each Size Expressed as Decimal		
1/2 in. (12.5 mm)	7/16 in. (11.00 mm)	X	.15	=	05/16 (1.6)
3/8 in. (9.5 mm)	4.5/16 in. (7.13 mm)	X	.65	=	2.9/16 (4.6)
No. 4 (4.75 mm)	2/16 in. (3.56 mm)	X	.17	=	0.34/16 (0.6)
No. 8 (2.36 mm)	1/16 in. (1.77 mm)	X	.03*	=	0.03/16 (0.0)
			Sum of Products		4.3/16 (6.8)

The average particle size = 4.3/16 in. (6.8 mm).

*The computation is generally carried only through the No. 8 sieve.

3.2.4. A simplified method of obtaining the average size is by the use of Figure 1 (page 4). On this chart, the percent passing may be plotted and the average size read at the point where the gradation line crosses the "50% passing" line. For example, plot the gradation of the aggregate on the chart. From the point where the gradation line crosses the "50% passing" line, drop vertically to the effective size. The average particle size thus obtained is 0.27 in. (6.8 mm). The average particle size is equal to and interchangeable with the Effective Mat Thickness as calculated in the following examples.

3.3. Determine the "spread ratio" by dividing 36 in. (1000 mm) by the average particle size:

English

36/4.3 ÷ 16 = 134, or 1 yd^3 aggregate per 134 yd^2 surface. 1:134 is the spread ratio.

Metric

1000 ÷ 6.8 = 147, or 1 m^3 aggregate per 147 m^2 surface. 1:147 is the spread ratio.

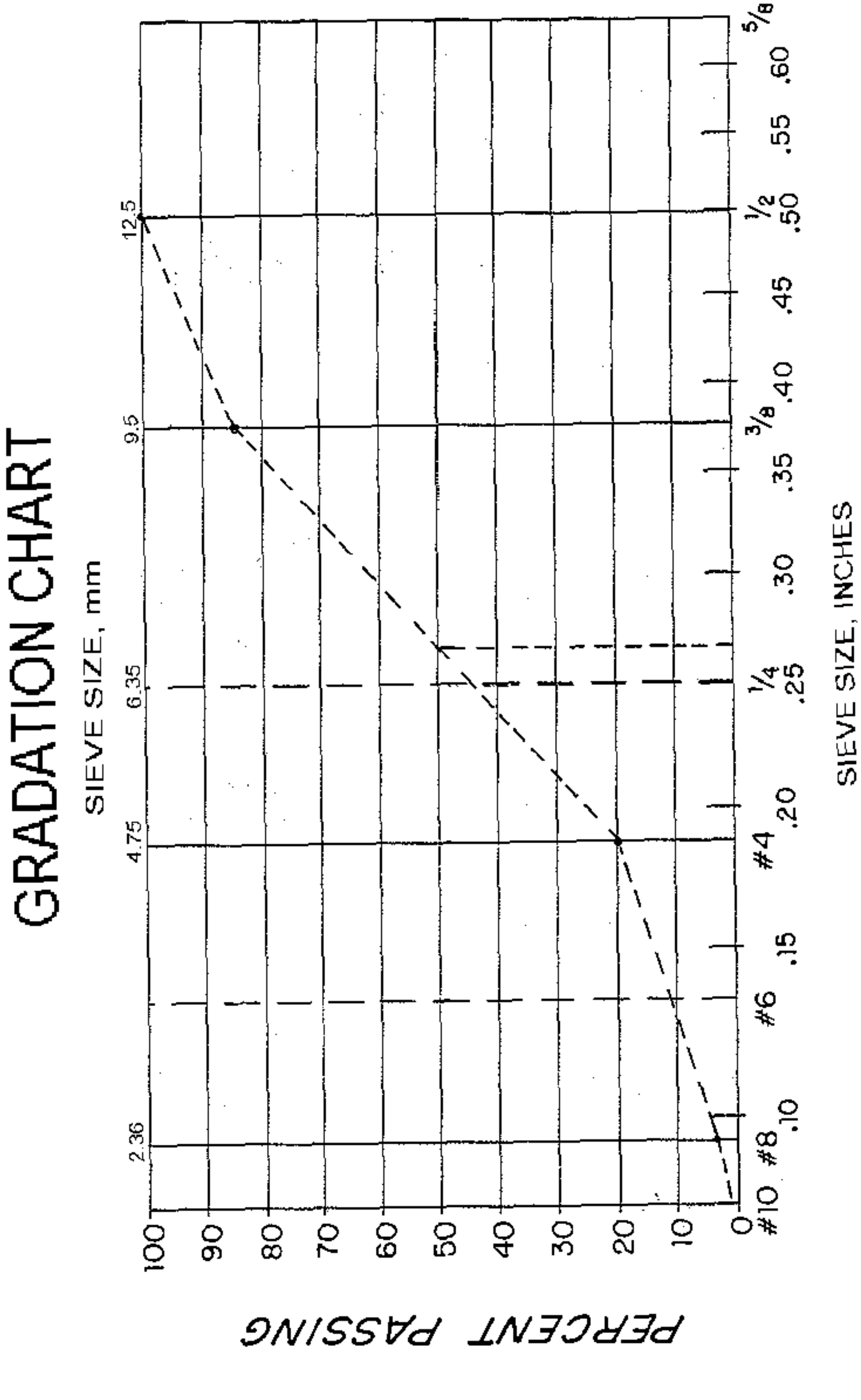

GRADATION CHART
SIEVE SIZE, mm
12.5
9.5
6.35
4.75
2.36
SIEVE SIZE, INCHES
5/8
.60
.55
1/2 .50
.45
.40
3/8
.35
.30
1/4 .25
.20
#4
.15
#6
.10
#8
#10
100
90
80
70
60
50
40
30
20
10
0
PERCENT PASSING

Figure 1

3.4. Determine the effective mat thickness by dividing 36 in. (1000 mm) by the number of yd^2 (m^2) covered by 1 yd^3 (1 m^3) of aggregate.

<u>English</u>

36 ÷ 134 = 0.27 in. effective mat thickness.

<u>Metric</u>

1000 ÷ 147 = 6.8 mm effective mat thickness.

3.5. An alternate method of arriving at the effective mat thickness is called the "test board method" and it eliminates the steps in Paragraphs 3.2 and 3.3.

- Using a 1 yd^2 (1 m^2) test board, place on the board a quantity of aggregate sufficient to obtain full coverage one (1) stone thick. Weigh this quantity of aggregate.
- Determine the loose weight of the aggregate [lb/yd^3 (kg/m^3)] by the method of AASHTO T 19.
- To obtain the spread ratio, divide the lb/yd^3 (kg/m^3) as determined in Paragraph 3.5.2 by the lb/yd^2 (kg/m^2) from Paragraph 3.5.1.
- Determine the effective mat thickness as specified in paragraph 3.4.

3.6. Determine the percent voids in the aggregate by dividing the loose unit weight in lb/ft^3 (kg/m^3) by the absolute unit weight, expressing the ratio as a percentage, and subtracting this value from 100. For example:

<u>English</u>

Given Loose Weight	=	93 lb/ft^3
Specific Gravity	=	2.70
% Voids	=	100 – [(93 x 100) ÷ (62.4 x 2.70)] = 45

<u>Metric</u>

Given Loose Weight	=	1490 kg/m^3
Specific Gravity	=	2.70
% Voids	=	100 – [(1490 x 100) ÷ (1000 x 2.70)] = 45

3.6.1. The rate of asphalt application can be calculated using the following formula:

$$Ra = C \times Em \times Te \times V$$

Where C is a constant 1.000 (5.61) found as follows:

1,296 in^2/yd^2 ÷ 231 in^3/gal. or 5.61 gal. ÷ in. · yd^2

(10,000 cm^2/m^2 ÷ 1000 cm^3/L or 10 L ÷ cm · m^2
or 10 L ÷ 10 mm · m^2 or 1.000 L ÷ mm · m^2)

Em = % Embedment ÷ 100

Te = Effective Mat Thickness, in. (mm)

V = % Voids ÷ 100

3.6.2. Ra from this formula is for asphalt cement. For cutback, multiply Ra by 1.11 to allow for volatiles. For emulsion, multiply Ra by 1.43 to allow for water.

Recommended embedment is as follows:

Average Mat Thickness	% Embedment
1/8 in. to 3/8 in. (3 mm to 9.5 mm)	30
1/2 in. (12.5 mm)	35
5/8 in. (16 mm)	40

3.7. Having determined the theoretical asphalt application in gal/yd^2 (L/m^2) in paragraph 3.6, calculate the aggregate application in lb/yd^2 (kg/m^2) from the spread ratio as shown below:

English

Spread Ratio = 1:134 or 1 yd^3 for 134 yd^2

$$\frac{lb.}{yd^2} = \frac{93\ lb.}{ft^3} \quad \frac{27\ ft^3}{yd^3} \quad \frac{1\ yd^3}{134\ yd^2} = 19$$

Metric

Spread Ratio = 1:147 or 1 m^3 for 147 m^2

$$\frac{kg}{m^2} = \frac{1490\ kg}{m^3} \quad \frac{1\ m^3}{147\ m^2} = 10$$

4. Tables

4.1 Table 1 is a guide to the classes of cover coat material which, as indicated by experience, perform most satisfactorily with each of the several types and grades of asphalt. This table is a convenient, rule-of-thumb reference.

Table 1

Grade of Asphalt \ Type	Cover Coat Aggregate				
	1	2	3	4	Sand
MC-70					x
MC-250				x	x
MC-800		x	x	x	
MC-3000	x	x	x		
RC-70					x
RC-250					x
RC-800 & RC-800 DN		x	x		
RC-3000 & RC-3000 DN	x	x	x		
200-300	x	x	x		
120-150	x	x			
RS-2		x	x		
RS-3K		x	x		
SS-1h					x

4.2 Table 2 gives estimated values for the amount of several classes of cover coat aggregate that should be used to obtain a cover of one (1) stone thickness on the road. It should be understood that these figures are estimates based upon average physical characteristics of materials currently being used.

It must be understood that Table 2 is to be used as a guide in estimating seal coat quantities only when it is not possible to obtain the data necessary to compute these quantities using the above method.

Table 2

Quantity of Aggregate for
Retention of One (1) Stone Thickness

Cover Coat Aggregate	lb/ft^3 (kg/m^3)	lb/yd^2 (kg/m^2)	ft^3/yd^2 (m^3/m^2)
Type 1	96 (1540)	26 (14)	0.25 (0.0085)
Type 2	90 (1440)	20 (26)	0.20 (0.0068)
Type 3	94 (1500)	17 (9)	0.16 (0.0054)
Type 4	125 (2000)	30* (16*)	0.23 (0.0078)
Sand	100 (1600)	10 (5)	0.10 (0.0034)

*Inverted penetration treatment. Estimate very approximate.

Idaho Standard Method of Test for

Sampling and Viscosity Testing Emulsified Asphalt Binders in the Field

Idaho IT-61-08

1. Scope

1.1. This method covers field sampling and field testing of emulsified asphalt binders used for seal coats. Testing is performed using the Saybolt Furol Viscometer.

2. References

2.1. AASHTO T 40, Sampling Bituminous Materials

2.2. AASHTO T 72, Saybolt Viscosity.

2.3. AASHTO T 59, Testing Emulsified Asphalts ("Consistency" – "Viscosity", Sections 34-38)

3. Apparatus

3.1. Saybolt Furol Viscometer with Bath, conforming to the requirements of AASHTO T 72 with an oil or water bath capable of maintaining the required testing temperature.

3.2. Receiving Flask- see figure# 1

3.3. Sieve – No. 20 (850 µm) sieve or a 20-mesh strainer of wire cloth framed or unframed.

3.4. Thermometers – ASTM No. 19°F or 19°C for tests at 122°F (50°C) conforming to the requirements of ASTM No. E1.

3.5. Thief Sampling Device – Capable of obtaining a sample from mid-depth of tanker/ tank.

3.6. Timer – Capable of measuring to the nearest 0.1 second.

3.7. Sample Can - 1-quart (1 liter) small-mouth

3.8. Plastic Jar- 1-quart (1 liter) wide mouth.

3.9. Sample bottle -8 fl. oz. (265 mL) plastic dairy bottle

3.10. Sample bottle Stopper- with an opening to insert a dial thermometer through it and sized to fit the opening in the dairy bottle

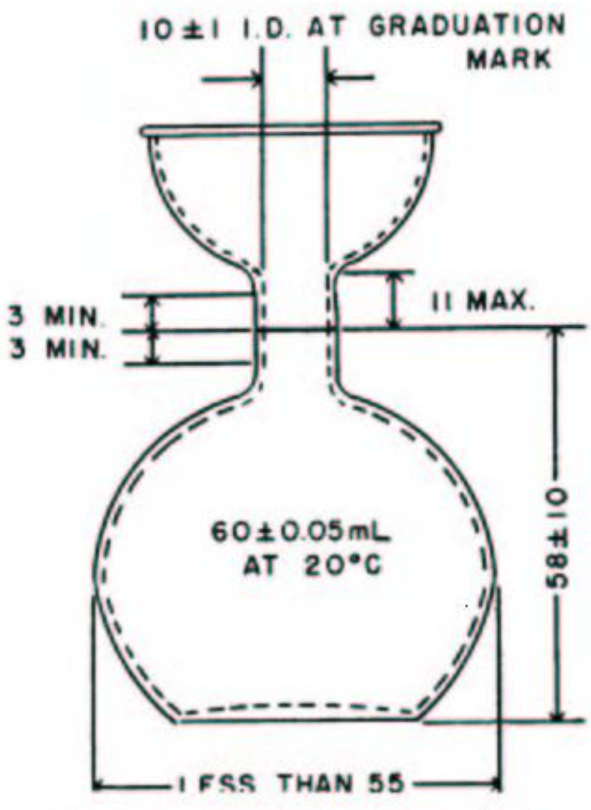


Figure #1: Receiving Flask

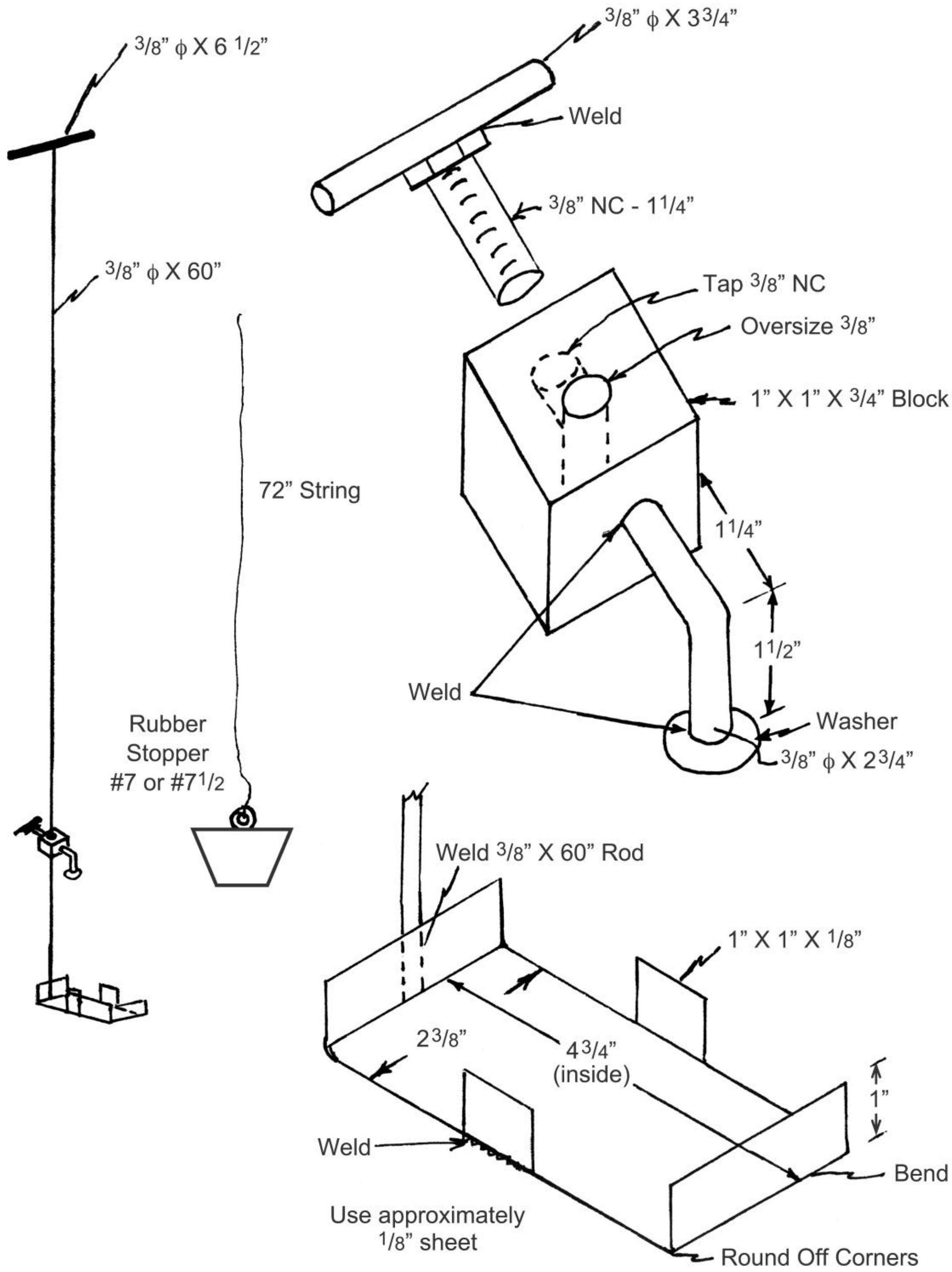


Figure #2: Thief Sampling Device (Dip method Device)

4. Sampling:

4.1. The emulsified asphalt binder sample may be obtained by either of two methods. These methods are covered in AASHTO T 40 but will also be covered here. They are; the "Valve method" and "Thief Method." Samples shall be obtained before any material is unloaded.

Note#1: A safe means of sampling shall be provided by the contractor / supplier. With the "Thief method" proper fall protection must be provided.

4.1.1. Valve Method: A recommended design for the valve is shown in AASHTO T 40.

4.1.1.1. In order to clear the line, draw and discard 4 L (1 gal) of emulsified Asphalt using a valve located in the center of the tank.

4.1.1.2. After clearing the line, immediately draw the emulsified Asphalt sample into a large mouthed 1 L (1 quart) plastic jar.

4.1.2. Thief Method (Dip Method): This method shall only be used when a truck tanker or distributor does not have a valve available to obtain the sample.

4.1.2.1. Attach the 1 L (1 quart) can at the bottom of the Thief device (see figure# 2). Stopper the can with a # 7 or #71/2 rubber stopper. The stopper shall have a way to remove it from the can once the can has been submerged on the thief device.

Note # 2: Before sampling, a careful observation of the material shall be made to detect the presence of foam or free water on top of the load. Care should be taken to immerse sampling device deep enough to pass through any foam or free water that may exist on top of material.

4.1.2.2. Lower the attached stoppered 1 L (1 quart) can to mid-depth of the tanker/ tank.

4.1.2.3. Pull the stopper from the can. Allow the can to fill.

4.1.2.4. Withdraw the Thief device along with the sample and sample can from the tanker/ tank.

4.2. Immediately transfer approximately 204 mL (6 to 7 oz.) of emulsified asphalt into a 265 mL. (8 fl. oz) plastic dairy bottle. Seal the container securely to eliminate the chance of evaporation of water in the sample with a rubber stopper having a small dial thermometer through its center.

Note# 3: It is recommended that while the sample is cooling for testing clean the thief device and can stopper.

5. Testing

5.1. Preheat the Sabolt Furol Viscometer bath to testing temperature 50 ± 0.05°C (122 ± 0.09°F).

5.2. Insure that the brass viscometer tube is clean and dry and that the cork inserted into the bottom of the tube.

5.3. Cool the emulsified asphalt sample to 51.7 ±0.3°C (125 ±0.5°F).

Note# 3: The bottom of the sealed plastic bottle containing the emulsified asphalt sample may be immersed into a cold-water bath to cool it more quickly. Insure that thermometer is not touching the bottom of the bottle.

5.4. Once cooled, immediately pour the emulsified asphalt through a No. 20 (850 mm) sieve and into the brass viscometer tube until the sample is above the overflow rim.

5.5. Stir the emulsified asphalt sample in the brass viscometer tube at 60 RPM with a thermometer until it is at a temperature of 50°C ± 0.3°C (122°F ± 0.5°F). Avoid bubble formation while stirring. Once the test temperature is attained, withdraw the thermometer.

5.6. Place the tip of a suction pipette into the viscometer tube gallery. The gallery is the area where the overflow is contained. Quickly remove the excess emulsified asphalt from the gallery until the level in the gallery is below the overflow rim. Remove the pipette without touching the overflow rim.

5.7. Immediately cover the top of the viscometer tube.

5.8. Place the receiving flask in the proper position under the viscometer tube. Proper placement will insure that the sample will roll down the inside lip of the receiving flask.

5.9. Remove the cork from the viscometer tube and immediately start the timer.

5.10. Stop the timer when the emulsified asphalt meniscus bottom reaches the graduation mark.

5.11. Clean the viscometer tube, screen, cork, thermometer, and receiving flask.

5.12. If the initial tanker / tank sample fails to meet specified limits, a second sample will be obtained using the "Thief Method." When the test results on the second sample also fail to meet specifications the tanker / tank will be rejected.

6. Report

6.1. Record the results to the nearest 1 second.

6.2. Results shall be reported on an ITD-1045, Sample Data Sheet Emulsified Asphalt and Cutbacks.

QUALIFICATION CHECKLIST
FIELD VISCOSITY – IDAHO IT 61

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element		Trial 1	Trial 2
Sampling			
1. Sample taken using a valve:			
a. Minimum of 4 L (1gal) allowed to flow before sample taken?	1a		
b. Sample taken in clean 1 L (1 quart) wide mouth jar?	1b		
2. Sample taken with Thief device.			
a. Sample can immersed approximately to middle of tanker?	2a		
b. Rubber stopper removed from can and sample taken from the middle of the tanker / tank?	2b		
3. A portion of the sample transferred to a one (1) half pint plastic bottle and sealed with a stopper having a thermometer in the center?	3		
Equipment			
4. Temperature of the viscometer bath at 50ºC (122°F)?	4		
5. Viscosity tube clean and dry and cork installed?	5		
Testing			
6. Sample cooled to 51.7 ±0.3°C (125 ±0.5°F)?	6		
7. Sample poured through a #20 sieve prior to entering the brass viscosity tube?	7		
8. Enough sample poured into the tube to allow overflow into gallery?	8		
9. Thermometer placed into tube and sample stirred slowly until testing temperature reached?	9		
10. Thermometer withdrawn and excess in the overflow gallery siphoned out using a pipette without touching overflow rim?	10		
11. Emulsified asphalt sample in viscometer immediately covered?	11		
12. Cork pulled allowing the sample roll down the inside lip of the receiving flask?	12		
13. Timer immediately started when cork is pulled?	13		
14. Timer stopped when bottom of sample meniscus reaches graduation mark?	14		
15. Test results reported to nearest 1 second on ITD-1045 form?			

First Attempt: Pass ☐ Fail ☐ Second Attempt: Pass ☐ Fail ☐

Comments:____

Participant Name ____________________ Exam Date __________ WAQTC#__________

Examiner's Name: ____________________ Signature ____________________

WAQTC #:__________

Idaho Standard Method of Test for

Determining the Percent of Coated Particles in Bituminous Mixtures

Idaho IT-96-98

1. Scope

1.1. The intent of this test is to establish a length of mixing time for the operation of a bituminous mixing plant. The method is based on the premise that the coarse aggregate is the most difficult and last to coat with asphalt. The aim is the least mixing time cycle that will produce a mix in which a minimum of 95% of the coarse aggregate particles are completely coated and all other specifications are satisfied.

2. Apparatus

2.1. Sieves – One (1) or more box-type screens of the size required for the mix.

2.1.1. For 1/2 in. (12.5 mm) maximum size aggregate, a No. 4 (4.75 mm) screen may be used.

2.1.2. For 1/2 to 1 in. (12.5 to 25.0 mm) maximum size aggregate, a 3/8 in. (9.5 mm) screen may be used.

2.1.3. For plus 1 in. (25.0 mm) maximum size aggregate, a 1/2 in. (12.5 mm) screen may be used.

2.2. Sample pan or trays.

2.3. Sample scoop or shovel.

2.4. Several sheets of manila paper, approximately 24 in. x 36 in. (600 mm x 900 mm).

2.5. Flood lamps, if required.

2.6. Stiff wire brush.

2.7. Small spatula.

2.8. Solvent and cleaning rags.

3. Procedure

3.1. Permit the plant to operate at an established mixing time per batch (timed by stop watch).

3.2. Take a sufficiently large sample to obtain a coarse fraction count of from 200 to 500 coarse particles. This will generally require from 5 to 8 lb. (2.5 to 4 kg) of plant mix.

3.3. Three (3) separate samples shall be obtained from material produced under identical conditions, immediately after discharge from the pug mill.

3.4. Sieve the samples immediately, while they are still hot, through the proper size sieve. Do not overload the sieves. If necessary, sieve each sample in two (2) or three (3) operations. Shaking should be reduced to a minimum to prevent coating of uncoated particles.

4. Calculations

4.1. Spread the coarse particles on a sheet of manila paper and very carefully examine each particle. Any particle that has a spot (even pinpoint size) which is not coated, is counted as uncoated.

4.2. Group the counted particles, placing the uncoated ones on one side and the coated ones on the other side.

4.3. Counting in normal daylight is the best, but a flood light may be used if necessary.

4.4. The percentage of coated and uncoated particles is obtained by dividing each group by the total number of particles.

5. Report

5.1. In all samples, the number of coated particles must be 95% or above. If the count is below 95%, the mixing time shall be increased in increments and additional counts made until the count rises to 95% or more.

Idaho Standard Method of Test for

Detection of Anti-Stripping Additive in Asphalt

Idaho IT-99-08

1 Scope

1.1 This method covers field procedures for verifying the presence of anti-stripping additive in asphalt. This test is qualitative only and does not indicate percentage of anti-strip.

2 Summary and Significance of Method

2.1 A small amount of asphalt is heated in a solution of Isopropyl Alcohol. The decanted alcohol is tested with an indicator of Bromophenol Blue. A visual color change indicates the presence of anti-stripping additive of organic compounds classified as amines. Use only clean containers and fresh chemical solutions, since water and other contaminants may cause a misleading color change.

3 Apparatus

3.1 Stove or hotplate.

3.2 Glass beakers of approximately 1.7-oz. (50 ml) capacity or disposable aluminum cups of approximately 4-oz. (120 ml) capacity.

3.3 Glass stirring rods or new disposable wooden stirring sticks approximately 6 in. (150 mm) long.

4 Reagents

4.1 Reagent Grade Isopropyl Alcohol (99.7% water free, minimum), a flammable solvent.

Do not store alcohol in any other bottles or cans – keep in the original container. Do not pour unused alcohol back into the original container.

4.2 Bromophenol Blue Indicator having a concentration of 0.2% in Isopropyl Alcohol (99.99% water free). The indicator, a flammable solution, should be a clear, orange color and not more than two (2) years old. The indicator and alcohol can be obtained from the Central Materials Laboratory.

5 Sample

5.1 The test sample should be taken in accordance with the sampling methods described in AASHTO T 40. However, a small, quick sample may be obtained by inserting a clean wooden lath into the load of asphalt, withdrawing the lath, and dripping the excess asphalt into a disposable aluminum cup.

6 Procedure

Note: Keep any water source or steam away from the testing area because water will alter the test results.

6.1 Control Blank. **Add** 1.35 oz. (40 ml) of Reagent Isopropyl Alcohol to a 1.7-oz. (50 ml) glass beaker or a 4 oz. aluminum cup.

6.2 Test Sample. Place approximately 1 g of asphalt to be tested into another 1.7-oz. (50 ml) beaker or an aluminum cup and add 1.35 oz. (40 ml) of Reagent Isopropyl Alcohol (1 g is about the size of a quarter and can be placed in the container with a glass rod or a wooden stick).

6.3 Warm the control blank on a hotplate until small bubbles appear. Remove beaker from hot plate and add a drop of the Bromophenol Blue Indicator and stir. Continue adding drops (normally 3-5 drops) and stirring until the control blank has turned a definite yellow color. (Be extremely cautious around open flame, as the Isopropyl Alcohol is flammable). If the liquid in the control blank is any other color than yellow, contamination has occurred. If contamination is suspected, clean the testing equipment with the Reagent Isopropyl Alcohol prior to re-testing. If contamination continues to be suspected, obtain new alcohol and replace equipment if necessary prior to re-testing.

6.4 Warm the test sample until the liquid portion becomes approximately the same shade of yellow as the control blank. Pour the liquid portion of the mixture into a clean 1.7 oz. (50 ml) beaker or disposable aluminum cup. Immediately add the same number of drops of Bromophenol Blue Indicator as was added to the control blank and stir.

Stop heating before the mixture becomes too dark, since this will interfere with the color interpretation. After heating, remove the 1.7-oz. (50 ml) beakers a safe distance from the hotplate or flame.

6.5 The presence of an anti-stripping additive is verified when the test liquid turns blue. Any other color change, including light green color, is not a positive reading.

7 Report

7.1 Report blue color as positive; report any other color change as negative.

QUALIFICATION CHECKLIST

DETECTION OF ANTI-STRIP ADDITIVE IN ASPHALT – IDAHO IT 99

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element		Trial 1	Trial 2
General			
1. All containers and or stir sticks were clean and chemical solutions were fresh.	1	______	______
Detection test by Color Method only			
2. A control blank was performed.	2	______	______
3. 40ml of Reagent Isopropyl Alcohol or equivalent was used.	3	______	______
4. The asphalt mixture was heated on a hot plate.	4	______	______
5. Heating of sample was stopped before mixture became too dark.	5	______	______
6. The same amount of Bromophenol Blue Indicator was added to both mixtures.	6	______	______
7. Test results were accurately interpreted and recorded on the proper ITD form. (Blue color as positive; report any other color change as negative).	7	______	______

Comments: First Attempt: Pass ☐ Fail ☐ Second Attempt: Pass ☐ Fail ☐

Testing Technician's Name: ______________________________WAQTC # : __________Date: _________

Examiner's Name: _______________________________ Signature _________________________________

Idaho Standard Practice for

Acceptance Test Strip for Hot Mix Asphalt (HMA) Pavement

Idaho IR-125-11

---

1 Scope

1.1 This Standard Practice is used to:

- obtain density gauge readings to establish density gauge correlation factors (State and Contractor)
- obtain cores for determining the density gauge correlation factors
- obtain loose mix samples for test strip acceptance testing (Contractor)
- obtain cold feed aggregate samples for test strip acceptance testing (Contractor)
- confirm the HMA can be compacted to the minimum of 92.0% but not in excess of 96.0% density
- develop a roller pattern to achieve the specified density

---

2 Reference Documents

2.1 AASHTO

FOP for T 168 - Sampling Bituminous Paving Mixtures

T 2 - Sampling of Aggregates

FOP for AASHTO T 343 – Method C, Density of In-Place Hot Mix Asphalt (HMA) Pavement by Electronic Surface Contact Devices

2.2 WAQTC

TM 8 - In Place Density of Bituminous Mixes Using the Nuclear Moisture-Density Gauge (Backscatter Mode)

TM11 - Field Sampling Bituminous Material after Compaction (Obtaining Cores)

---

3 Apparatus

3.1 Sampling device as specified in FOP for AASHTO T 168

3.2 Density gauge with accessory equipment as specified in WAQTC TM 8 or FOP for AASHTO T 343.

3.3 Coring equipment for collecting six-inch diameter pavement cores

3.4 Approved measuring device capable of measuring test strip length. All apparatus shall be furnished by the Contractor.

---

4 Terminology

4.1 Acceptance Test Strip - One or more Test Sections, the total length not less than 1,000 feet or more than 2500 feet. The Acceptance Test Strip shall be constructed to the same placement width and thickness as the course it represents. (Figure 1)

4.2 Test Section - a minimum of 500 feet (continuous) in length within the Acceptance Test Strip, constructed with a single asphalt binder content. A separate Test Section is required for each asphalt binder content used in the Acceptance Test Strip. (Figure 1)

4.3 Roller Pass Density - an uncorrected density reading determined using a density gauge in backscatter mode following a roller pass. The Roller Pass Density shall consist of one one-minute count with the density gauge placed parallel to the direction of travel. Filler material is not required and a core correlation will not be applied to these density readings.

4.4 Maximum Roller Pass Density - the uncorrected density reading following the roller pass which adds no more than 1/2 pound per cubic foot (8 kg/m^3) to the previous density value. This shall be accomplished during the intermediate rolling. Sufficient roller passes shall be made to determine that a "false" break or leveling-off point is not used for the Maximum Roller Pass Density.

4.5 Test Site Density - the uncorrected density reading taken on the compacted pavement after finish rolling is complete at a Test Site for correlation to cores. It is obtained by using the test procedure specified in WAQTC TM 8, without applying a gauge correlation factor. Filler material shall be applied before taking Test Site Density readings.

4.6 Roller Pass - the passing of the roller over an area (roller width) one time.

4.7 Roller Coverage - the rolling of the entire width of the pavement one time, including roller overlap.

4.7.1 Breakdown Rolling constitutes the first roller coverage.

4.7.2 Intermediate Rolling constitutes all rolling after the breakdown rolling and prior to the mix reaching the minimum temperature specified by the contract for such rolling.

4.7.3 Finish Rolling constitutes the roller coverage, after intermediate rolling, required to bring the mix into a smooth, tight, hard surface without the presence of fatigue or cold-brittle cracking.

4.8 Roller Pattern - the number of roller passes necessary to achieve the specified density.

4.9 Stratified Random Sampling of HMA - method used to ensure the specimens for the sample are obtained from throughout the Test Section, and are not concentrated in one portion of the Test Section. All sample locations will be determined by the Engineer using a random sampling system.

5 Procedure

5.1 An Acceptance Test Strip shall be constructed after a uniform asphalt mix is being produced. The Acceptance Test Strip may be constructed using one or more Test Sections. The asphalt binder content of each Test Section must meet all specification requirements.

5.2 The Contractor shall obtain cold feed aggregate samples in accordance with the Specifications. Sampling will be determined by the Engineer using a random sampling system.

5.3 The Contractor shall obtain 3 loose mix samples from each Test Section in accordance with the specifications. Each Test Section will be divided into 3 segments of equal length and a loose mix sample will be obtained randomly from each segment by the contractor for acceptance testing. Exclude the first and last 30 feet of each section when selecting sample locations.

5.4 Each test section will be divided into 5 segments of equal length and test sites for cores and density reading will be obtained randomly from each segment. A minimum of five cores will be required to correlate the density gauges for a test strip. (See WAQTC TM 8 or FOP for AASHTO T 343).

5.5 Standardize the density gauge. Refer to WAQTC TM 8 or FOP for AASHTO T 343.

5.6 The Contractor shall compact each Test Section and record Roller Pass Densities in at least one location within each Test Section but no less than two per Test Strip. When density gauge readings indicate the Maximum Roller Pass Density has been achieved in a Test Section, compaction shall proceed in turn to each of the remaining Test Sections, if applicable, in the Acceptance Test Strip.

5.7 The Contractor shall record the temperature of the pavement following each roller pass to monitor the drop in mix temperature as rolling progresses in at least one location within each Test Section. Temperature readings shall be taken at the mid-point of the depth of pavement being tested.

5.8 Upon completion of all Test Sections in the Acceptance Test Strip, Test Site Densities (Paragraph 4.6) shall be taken for each gauge to be used on the project for Quality Control or Acceptance Testing to determine a correlation factor according to WAQTC TM 8 or FOP for AASHTO T 343. Form ITD-820 will be used by the Contractor and ITD project personnel to record the Test Site Densities for each gauge at each Test Site in each Test Section.

5.8.1 A correlation factor is valid only for the particular gauge, gauge thickness settings, gauge mode setting and at the probe depth used in the correlation procedure. Multiple gauges may be correlated from the same series of cores if done at the same time. (See Note 7, WAQTC TM 8 or FOP for AASHTO T 343)

5.8.2 Additional core correlation factors may be required to adjust for changes in the HMA pavement.

5.8.3 Re-correlation of the gauges is necessary on each lift of pavement.

5.9 After the pavement has cooled sufficiently to avoid deformation during coring, the Contractor shall obtain one core at each Test Site in accordance with WAQTC TM 11. Pavement cores shall meet the criteria under the Correlation section of WAQTC TM 8 or FOP for AASHTO T 343.

5.10 Off-Site Mix Verification. The Contractor, at no cost to the State, may elect to perform off-site mix design testing for contract requirements at a location and time agreed upon by the Engineer. Off-site mix verification must occur within 14 calendar days prior to the anticipated start of production paving.

5.10.1 The off-site mix design verification process will verify aggregate and mix parameters only. All other properties will be determined during a density test strip placed on the prepared surface of the project.

5.10.2 The density test strip shall follow the procedure outlined in Subsection 5.8 to 5.9 and Figure 1a. Break-Over patterns, density gauge correlation factors, density acceptance of the placement, and Contactor's workmanship will be verified during the density test strip. The density test strip shall not exceed 1000 feet in length. Production paving shall not begin until an acceptable density test strip is produced.

5.10.3 Materials from Department controlled sources cannot be used for off-site mix design verification. The off-site test strip shall be accessible to ITD personnel at all times. If other than ITD property, written permission from the property owner shall be given for ITD employees to observe the work.

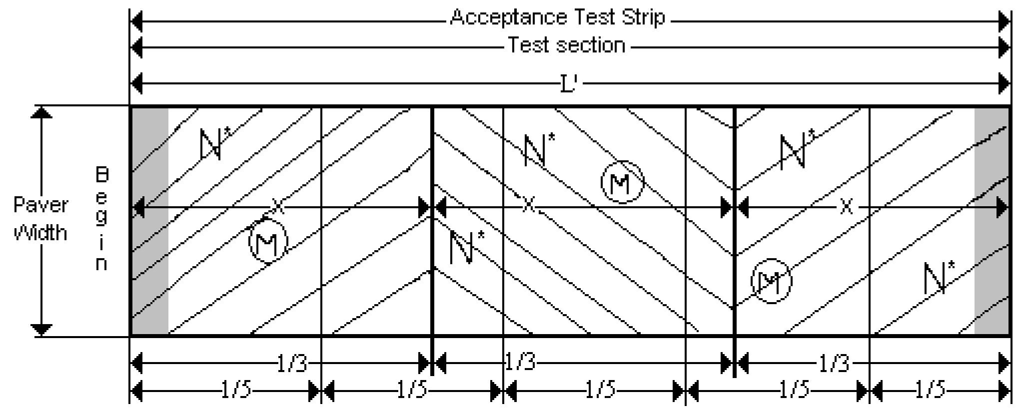
6 Report

6.1 The Contractor shall record the location, the number of roller passes, the corresponding Roller Pass Density reading, and pavement temperature following each roller pass in at least one location in each Test Section. This information shall be recorded on Form ITD-891 (Figure 2).

6.2 The Contractor shall plot Roller Pass Density readings and temperatures vs. roller passes on Form ITD-891 concurrently with the rolling. A copy of each completed ITD-891 shall be furnished to the Engineer upon completion of finish rolling.

6.3 From the cores, the Engineer will determine the density gauge correlation factors for each State gauge and core densities, percent compaction for each Test Section. Laboratory core test results will be provided to the Contractor prior to the start up of production paving for correlation of Contractor gauges. Density gauge correlation data shall be recorded on Form ITD-820 for each gauge.

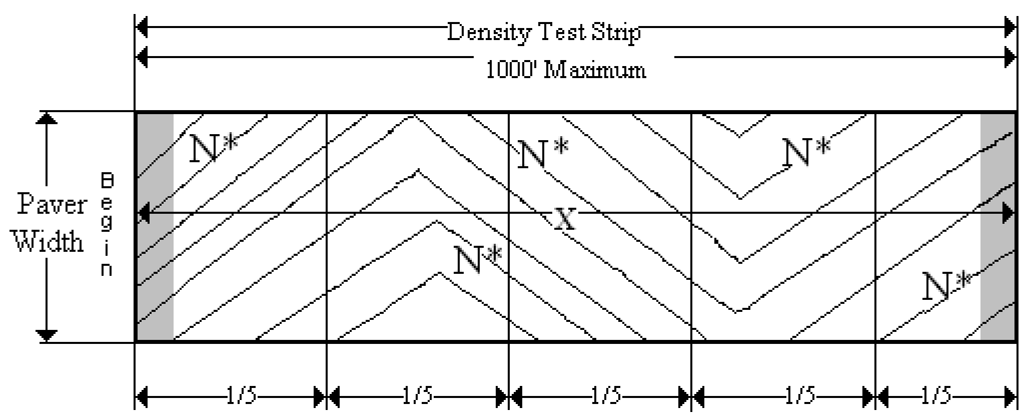
L'	X	N*	*	Ⓜ	
Test Section Length **(see 4.1 & 4.2)**	Number of Roller Passes **(see 4.7)**	Location of Density Gauge reading (test site) **(see 5 Procedure)**	Location of Core **(see 5 Procedure)**	Mix sample location **(see 5 Procedure)**	Avoid taking samples in these areas.



Take mix samples at three stratified random locations. Take one core sample from random test sites selected in each of five stratified segments of the Acceptance Test Strip. The Contractor shall obtain three mix samples and five core samples. Exclude the first and last 30' sections from the generation of the stratified sections.

Figure 1.

X	N*	
Number of roller passes **(See 4.7)**	Location of Core and Density Reading (Test Site) **(See 5.10)**	Avoid taking samples in these locations



The Contractor shall obtain one core sample from random test sites selected in each of five stratified segments of the Density Test Strip. Exclude the first and last 30' sections from the generation of the stratified sections.

Figure 1a.

Figure 2

ITD 0891 (Rev. 3-03)

Plant Mix Pavement Test Strip Density Worksheet

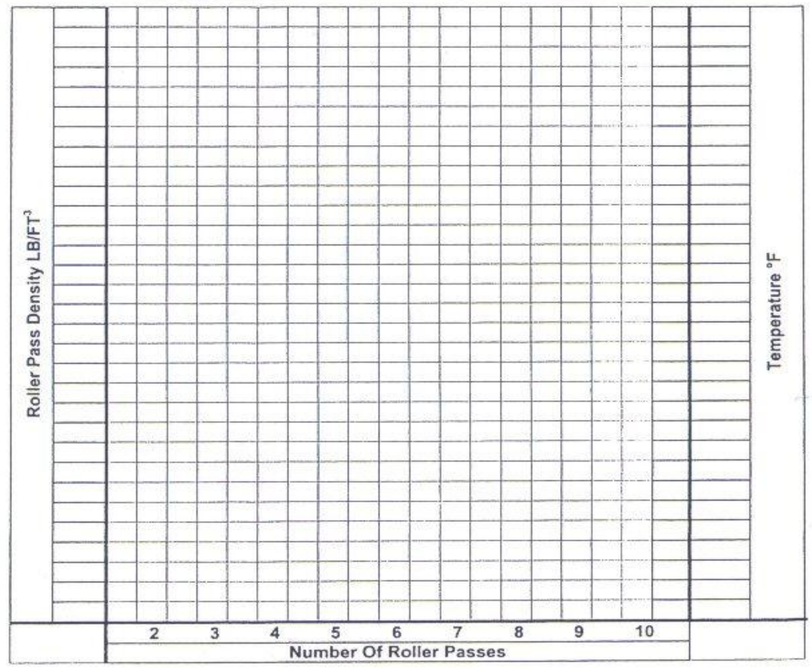
Key Number	Project Number and Name	Acceptance Test Strip Number	Date	District Number

Contract Item Number	Contract Item	Aggregate Source Number	Depth	Width	Course

Gage Make	Model	Serial Number	Maximum Theoretical Density __________ from mix design at test section intended asphalt content __________ %

Location		Offset	
Roller Pass	Roller Type Used	Uncorrected Wet Density lb/ft^3	Mix Temp °F
2			
3			
4			
5			
6			
7			
8			
9			
10			

Remarks



Tester's Name	WAQTC No.	ITD Inspector's Name

Distribution: (Original) – Tester (1 copy) – Engineer Page______ of ______

Idaho Standard Method of Test for

Effectiveness of Anti-Strip Agents After Hot Storage In Asphalt Binder Using Bottle and Sand

Idaho IT-137-04

1 Scope

1.1 This procedure describes the test for effectiveness of anti-strip agents after hot storage in asphalt binder.

1.2 This method is only applicable to asphalt binders that are not liquid at temperatures less than 100°F (38°C).

2 Reference

2.1 Colorado Procedure L-2209.

2.2 Idaho IT-99

3 Reagents and Materials

3.1 Ottawa sand meeting ASTM C 190 grading.

3.2 Distilled water maintained at 77°F (25°C)

3.3 Toluene

3.4 Asphalt binder. (Testing for approval shall be conducted with non-polymerized asphalt)

3.5 Within one (1) laboratory, test all additives using the same grade and source of asphalt binder. When intra-laboratory testing is done for precision determinations, use the same grade and source in all laboratories.

4 Apparatus

4.1 Oven capable of maintaining a temperature of 325°F ± 5°F (163°C ± 3°C).

4.2 Container of sufficient capacity to hold 800 g ± 20 g of asphalt binder plus additive. The diameter of the container shall not be greater than the depth of the asphalt binder plus additive. There shall be a tightly fitting cover or lid with an air hole 1/4 in. (6 mm) in diameter. (metal one (1) quart can dimensions: L= 4.625" W= 2.375" H= 7.25" with opening of 1.75")

4.3 Paper towels.

4.4 Spatula or other utensil for mixing purposes.

4.5 Glass or plastic bottles, approximately 2 oz. (60 ml) capacity, with top. (Fisherbrand polystyrene containers: 15 dr., I.D. 32 mm X H 64 mm)

4.6 Container having sufficient capacity to allow adequate mixing of 25 g of asphalt binder and additive while adding approximately 4.5 g of toluene. A tinfoil cup of approximately 4 fl. oz. (115 ml) capacity is suitable.

4.7 Balance conforming to AASHTO M 231 Class D.

5 Procedure

5.1 Heat the sample of asphalt binder with care to prevent local overheating until it has become sufficiently fluid to pour. Occasionally stir the sample to aid heat transfer and assure uniformity. The maximum temperature shall not exceed 325^{o}F (163^{o}C) by more than 25^{o}F (14^{o}C). Heat the additive as described above, not exceeding 100^{o}F (38^{o}C) and mix thoroughly.

5.2 Transfer 800 g ± 10 g of asphalt binder into the container (Paragraph 2.2). Add 4 g of anti-stripping agent and mix thoroughly. Place the lid (with air hole) tightly on the container and place in the oven.

5.3 Approval will be based on a concentration of 0.5 % anti-strip by weight.

5.4 After 96 hours, remove the sample, stir, and pour 25 g into a container, as described in Paragraph 2.6. At this time, also perform IT-99 (Color Method) on the aged material. Allow the poured sample to cool to 140^{o}F (60^{o}C). Add 4.5 g of toluene and mix thoroughly.

5.5 **Warning:** Be sure that the asphalt binder has cooled to less than 140^{o}F (60^{o}C) before the toluene is added. The solvent will still vaporize rapidly at this temperature, so this step should be performed where there is good ventilation. No open flames or smoking can be permitted near the mixing operation. The result of adding this solvent is a cutback similar to RC 800.

5.6 Place 20 g ± 1 g of Ottawa sand in the 2 oz. (15 dr.) bottle.

5.7 Add distilled water sufficient to cover the sand to a depth of approximately 1/2 in. (12 mm) above the surface of the sand in the bottle. (16 ml if using the 15 dr. container)

5.8 Add 1 g ± 0.2 g of the prepared cutback material to be tested by dripping it from a spatula onto the surface of the water in the bottle.

5.9 Attach the top on the bottle and shake <u>vigorously</u> for 15 seconds.

5.10 Remove the top and pour off excess water.

5.11 Gently tap wet sand onto a paper towel, spread in a thin layer (not in a cone-shaped mound), and visually inspect the coating of the sand.

6 Report

6.1 If the anti-stripping agent in the concentration tested is effective after heat storage, the wet sand and asphalt mixture described in Paragraph 4.9 will immediately combine into a homogeneous well-coated mixture having a uniform color. In this case, report the test results as "positive." If the bituminous material is deficient in effective anti-stripping agent, the wet sand and asphalt will not mix. Report the test result as "negative."

6.2 Where the sand holds a few globules of asphalt, but the mass is distinctly non-uniform in appearance, report the test as negative.

6.3 Report hours stored at 325^{o}F (163^{o}C) and the results as negative or positive.

6.4 Anti-stripping agents will be approved if, at 0.5 % initial concentration by weight, they give positive results after 96 hours (4 days) at 325^{o}F (163^{o}C) and report positive for IT-99 (Color Method).

Idaho Standard Practice for

Sampling Concrete for Chloride Analysis

Idaho IR-128-95

1 Scope

1.1 This procedure explains methods to be used in sampling concrete for chloride analysis.

1.2 Follow the general guidelines in the Bridge Deck Evaluation and Test Procedure Guideline Manual and AASHTO T 260. Specific and special guidelines are described below.

2 General Sampling Information

2.1 Lay out the test area to be sampled for a minimum of one (1) sample location per 1,000 square feet (100 square meters) and a minimum of three (3) sample locations per deck. Samples should be taken at points of probable high concentration, i.e., curb lines and lower side of super-elevated decks. Samples should not be taken at points where delamination or spalling has occurred since corrosion is obvious at these locations. Spalling or delamination can be located by performing a chain drag evaluation of a bridge deck, which can be valuable if the deck is bare or has a single seal coat. A seal coat of plant mix may give inaccurate information from a chain drag evaluation since the asphalt attenuates the sounds.

2.2 The best way to identify chloride sample depths and locations is to refer to the bridge plans for descriptions of the rebar location and depth, span size, and number of spans. A pachometer can also be used to locate the rebar depths and locations.

3 Sampling Procedures and Guidelines

3.1 For sampling, a rotary hammer is recommended with a 1 inch by 12 inches (25 mm by 300 mm) carbide-tipped bit and various thin wall electrical conduit depth sleeves. Also needed for sampling are a sampling spoon or spatula, 20-dram plastic vials or other sample containers, nylon bristle brushes, paper towels, and 2-Propanol (Isopropyl alcohol). In addition, some means of a "blowout" bulb, a portable air compressor, or other device is needed to clean out the holes after each test depth has been drilled and sampled.

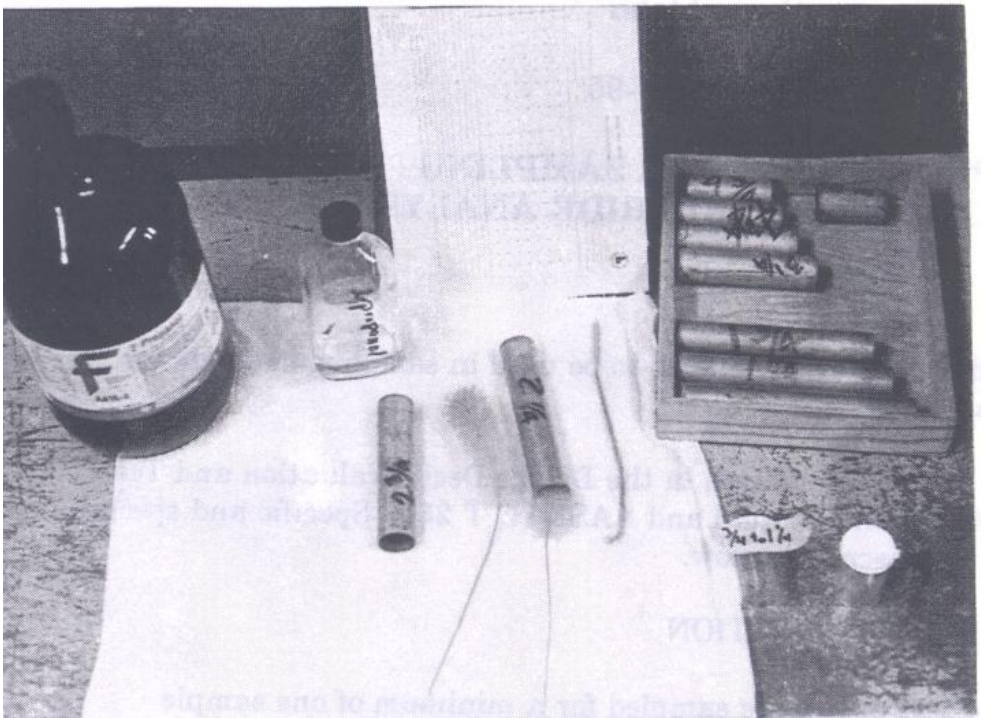


Illustration A

Electrical conduit pipe cut for use as depth sleeves; 2-Propanol and a nylon brush are used to clean between samples.

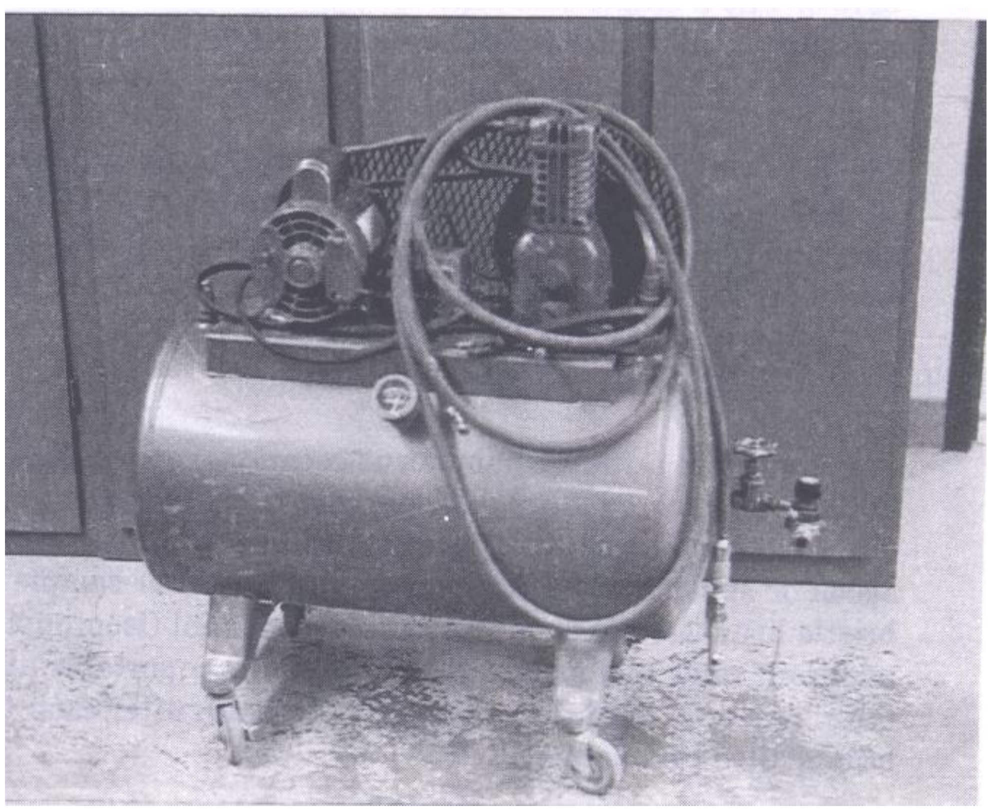


Illustration B

Portable air compressor for cleaning between samples.

3.2 Samples are usually taken at three (3) separate depths predetermined according to the depth of the rebar in the bridge deck. In addition, a sample taken at or just below the rebar can be informative for severe chloride penetration. The samples are taken at approximately even increments of 1/2 inch (15 mm). See Table 1 below.

Table 1
Nominal Drilling Depths in 1/2 inch Increments
(15 mm)

ENGLISH MEASUREMENT		METRIC MEASUREMENT	
From	To	From	To
1/4 inch	3/4 inch	5 mm	20 mm
3/4 inch	1 1/4 inch	20 mm	35 mm
1 1/4 inch	1 3/4 inch	35 mm	50 mm
1 3/4 inch	2 1/4 inch	50 mm	65 mm
2 1/4 inch	2 3/4 inch	65 mm	80 mm
2 3/4 inch	3 1/4 inch	80 mm	95 mm
3 1/4 inch	3 3/4 inch	95 mm	110 mm

Note: Millimeters (mm) are the metric sample depths and are based upon approximations of the English measurements.

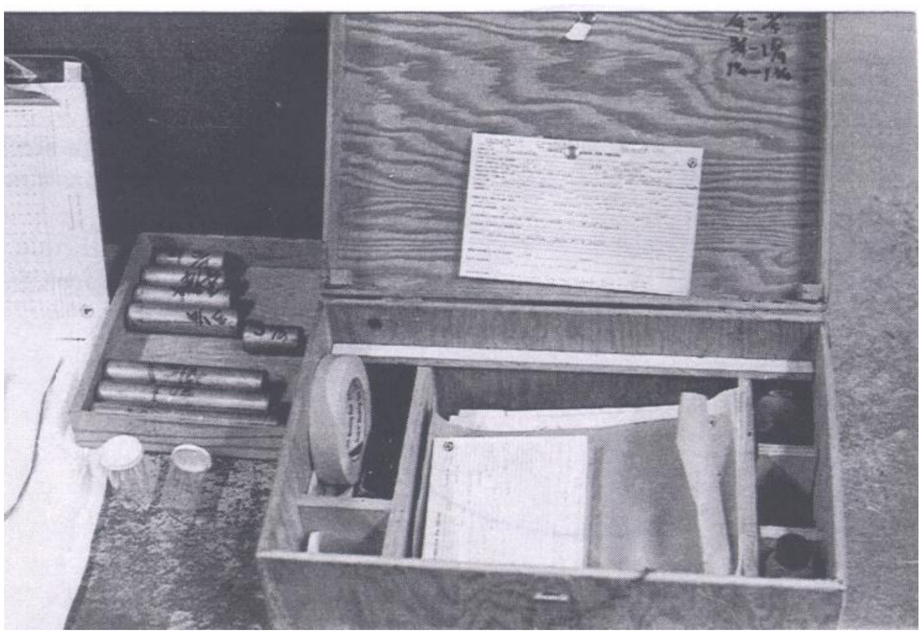


Illustration C

Chloride sampling kit.

3.3 Using the rotary hammer, scar the surface approximately 1/4 inch (6 mm) deep. This assures that the samples will be taken below the surface dirt and other possible sources of erroneously high salt content. Drill three (3) holes within a 6-inch (150 mm) diameter to obtain enough sample from each sampling depth. See Illustration E below.

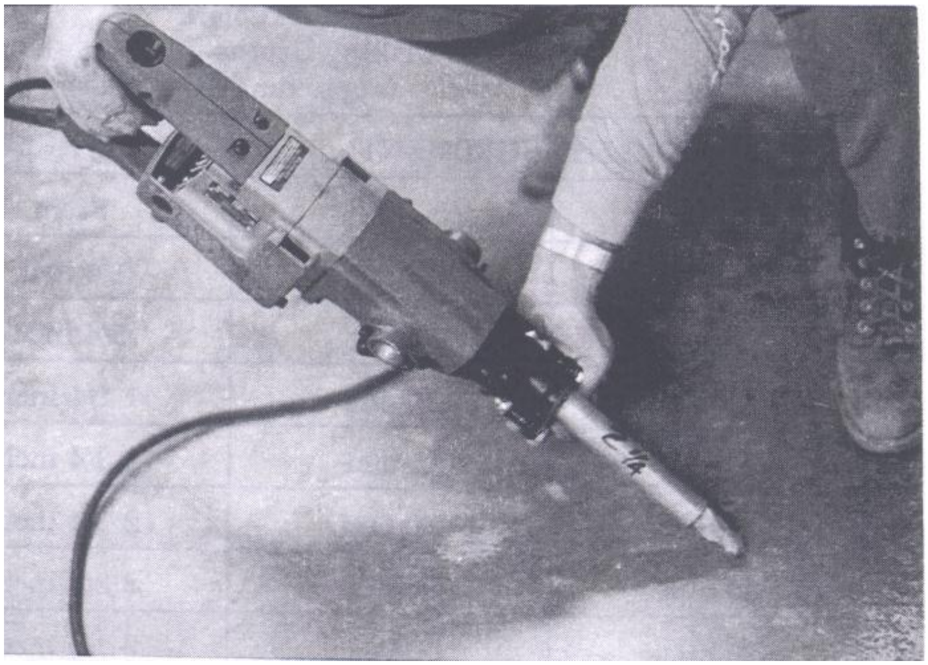


Illustration D

Rotary hammer for sampling concrete for chloride testing.

Hammer with depth sleeve set 2 1/4 inches (65 mm) sample depth.

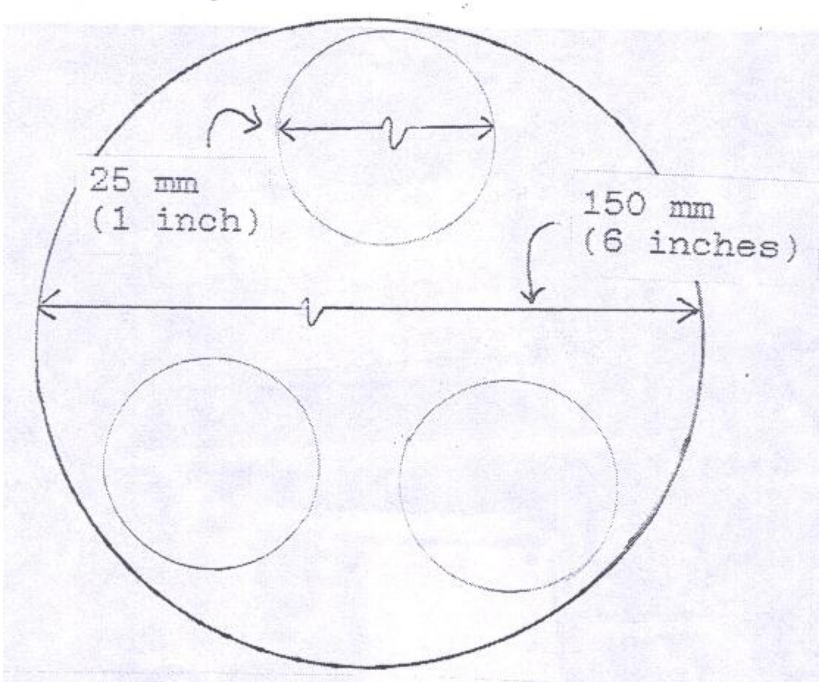


Illustration E

Illustration is not drawn to scale.

Suggested sampling area for one (1) chloride sample location.

Large circle diameter 6 inches (150 mm).

Drill hole diameter 1 inch (25 mm).

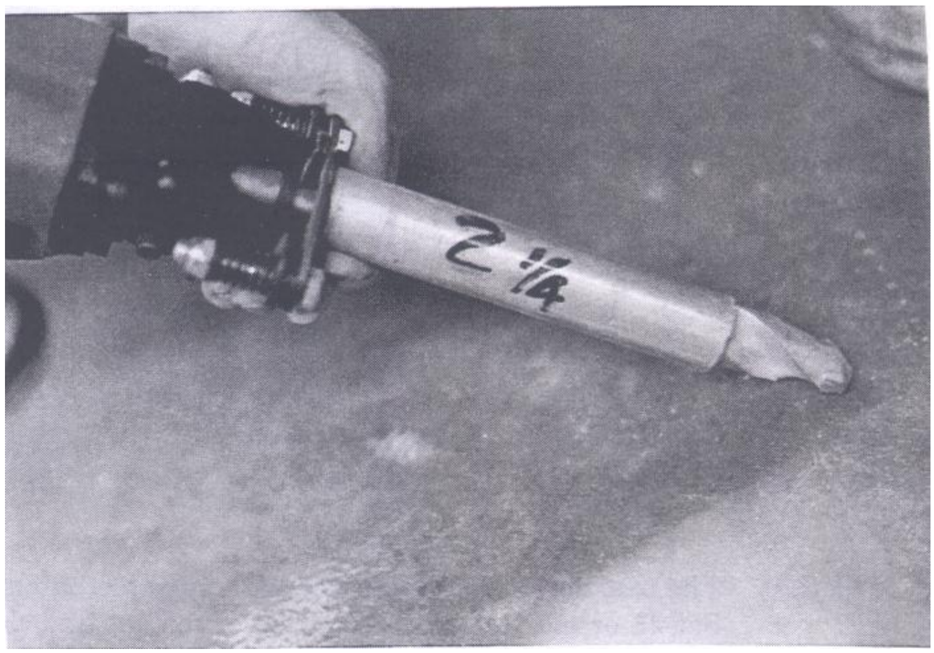
3.4 Blow out the hole and the surrounding area using an air compressor, blowout bulb, or some other means that is suitable. Do not use alcohol to clean out the sample holes. Clean sampling tools: rotary hammer drill bit, depth sleeve, spoon, etc., using a nylon brush, paper towels, and 2-Propanol (Isopropyl alcohol) between samples to assure no contamination between samples. The rotary hammer drill bit and depth sleeves must be completely dry before proceeding with the next sample.

3.5 Place the first depth sleeve on the drill bit and drill in the three (3) established holes with the rotary hammer. See Illustration F below.

Illustration F

Rotary hammer with depth sleeve in place. Ready to drill sample.

Clean drill bit, depth sleeve, and sampling spoon between sample depths with 2-Propanol.



3.6 Drill until the depth sleeve seats itself on the concrete surface. Pull out the drill bit and, using a sampling spoon, carefully gather the pulverized sample out of the three (3) drilled holes. Collect the pulverized sample material carefully and completely. Approximately 15 grams (or a 20-gram vial 3/4 full) is needed for each sample depth. Label the sample container for location and depth. The resulting pulverized concrete represents the first sample depth. See Illustration G below.

3.7 Clean the sampling tools: Drill bit, depth sleeves, spoons, etc., using a nylon brush, paper towels, and 2-Propanol (Isopropyl alcohol) to assure no contamination between samples. Rotary hammer and depth indicators must be completely dry before proceeding with the next sample. Blow out the hole and the surrounding area using an air compressor, blowout bulb, or some other suitable means using air.

3.8 Place the next sleeve guide on the rotary hammer for the next sampling depth. Drill and pulverize the concrete until the depth sleeve again seats itself on the concrete. Continue with steps 3.2.3 through 3.2.5 until all desired sample depths have been drilled and sampled.

3.9 Identify the sampling locations on the ITD-848 Bridge Deck Survey Map or using a created map drawn to scale. Please include with the samples the completed ITD-1044 forms for the samples, identifying specific holes and depths, and a copy of the Bridge Deck Survey Map or created map with information about the areas of delamination.

Illustration G

An example of a pulverized chloride sample.

3.10 The test hole may be patched with suitable patching material such as Set-45 or mortar (a combination of cement and clean sand) if appropriate.

Form ITD-848

ITD-848 8-93 M

BRIDGE DECK SURVEY MAP
Resistance/Voltage

PAGE ____ OF ____

BRIDGE NO. ________ KEY NO. ________ PROJECT NO. ________ DISTRICT ________

LOCATION ________ DATE CONSTRUCTED ________ DATE REPORTED ________

NO. OF SPANS ________ SPAN LENGTH ________ DATE OVERLAYED ________ TEST DATA BY ________

DATA UNITS IN: OHMS/VOLTS ________ LANE ________ FEATURE INTERSECTED ________

REMARKS: ________

Idaho Standard Method of Test for

Testing Thickness of Plastic Concrete Pavement

Idaho IT-130-02

1 Scope

1.1 This method is used with plastic concrete pavements to determine concrete pavement thickness while the paving machine is in position and necessary adjustments can be made. This method is used to calculate thickness incentives and disincentives when applicable.

2 Apparatus

2.1 Measuring probe.

2.2 Cleaning cloth.

2.3 Masking tape.

2.4 Tape measure.

2.5 Recording form.

2.6 Bucket.

3 Test Procedure

3.1 All thickness measurements will be taken as efficiently as possible, without disruption of the paving process, from the catwalk located on the backside of the paver.

3.2 The measuring probe shall be placed with its disk flush with the pavement surface. The inner probe shall then be inserted through the full depth of plastic concrete pavement and the thickness shall be measured to the nearest 0.05 in. (millimeter) and recorded on the *ITD-827, Plastic P.C.C. Pavement Thickness Recording Form*.

3.3 Following each measurement, the probe shall be wiped clean.

4 Longitudinal Locations Of Measurements

4.1 The depth measurements shall be taken randomly in the fresh concrete at a rate of one (1) set of probes for each test section.

4.2 Each test section shall be no greater than 0.1 mi. (0.2 km) long.

4.3 The width of a test section shall be a single placement width as defined in Section 5, below.

4.4 The concrete thickness determined by the set of probes will represent the thickness for the entire area of the test section. The average of the probe measurements shall equal one (1) test (see Section 6).

5 Transverse Locations of Measurement

5.1 For each separate placement, thickness measurements are normally made within 1 ft. (300 mm) of the center of each driving lane and near each edge of each driving lane. When adjacent lanes are placed simultaneously, a single measurement made within 1 ft. (300 mm) of the common lane boundary will represent that edge of both lanes. When a placement includes shoulders, edge measurements may be made either on the lane side or shoulder side of the lane boundary, but should be within 1 ft. (300 mm) of the lane boundary unless special circumstances dictate otherwise (see Section 5.5). When a placement does not include shoulders or when adjacent lanes are not placed simultaneously, make depth measurements at least 1 ft. (300 mm) away from placement edges, but normally not more than 2 ft. (600 mm) away from such edges. Use care to avoid striking and displacing tie bars or dowel bars when making depth measurements.

5.2 Examples of some placement variations and their measurement locations are as follows.

Placement Type	No. of Meas.	Locations of Meas.
1 lane, no shoulders	3	Within 1 ft. (300 mm) of lane center and between 1 ft. (300 mm) and 2 ft. (600 mm) from placement edges.
1 lane, 1 shoulder	3	Within 1 ft. (300 mm) of lane center, within 1 ft. (300 mm) of lane-shoulder boundary, and between 1 ft. (300 mm) and 2 ft. (600 mm) from the lane edge, which is placed against a form (including slipform) or against existing concrete.
2 lanes, no shoulders	5	Within 1 ft. (300 mm) of lane centers, within 1 ft. (300 mm) of common lane boundary, and between 1 ft. (300 mm) and 2 ft. (600 mm) from placement edges.
2 lanes, 2 shoulders (The example on page 5, Form ITD-827, corresponds to this type of placement on an interstate highway.)	5	Within 1 ft. (300 mm) of lane centers, within 1 ft. (300 mm) of common lane boundary, and within 1 ft. (300 mm) of lane-shoulder boundaries.

- In cases where a tapered or an unusual pavement width is being placed, engineering judgment shall be used to determine where thickness measurements are made. Avoid taking all thickness measurements at locations where grading stakes were positioned.
- After determining where depth measurements shall be taken for any section, the inspector may mark these locations on the paver catwalk with masking tape for convenience.

- When the subgrade base for placement of the concrete pavement is quite irregular in transverse or longitudinal grade, or if other special circumstances exist, this test method may be modified as to measurement locations to assure representative sampling. Record such changes on the ITD-827 and document reasons in the Daily Diary.

6 Analysis of Data

6.1 All thickness measurements taken at each test section location during one (1) pass of the paver shall be averaged. Record the average to the nearest 0.1 in. (2.5 mm).

6.2 AASHTO T 148 (for measuring core lengths) was used as a guideline in establishing the depth increment to be used in recording individual measurements. Also, the roundoff procedure for the average at each thickness measuring station is the same as the procedure used in AASHTO T 148.

6.3 With careful correlation between the thickness measurements and paving machine adjustments, there should be no need for concrete pavement thickness deficiency penalties. Smoothness must be carefully maintained during each adjustment of the paver.

6.4 Care must be exercised on horizontal and vertical curves to avoid excess depths at the low side of horizontal curves and the lowest area in sag-vertical curves. The converse situations of thin pavements at the high side of horizontal and vertical curves must be carefully controlled to achieve the specification thickness.

ITD-827 8-98 W

PLASTIC P.C.C. PAVEMENT THICKNESS RECORDING FORM

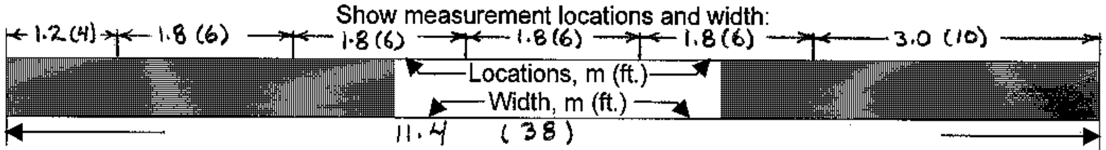
For use with Idaho T-130

Sheet 1 of X

Key No. XXXX Project No. I-84-X(XX)XX

Inspector's Name I.D. Hoe Date 5-20-98

Show measurement locations and width:



Station(s)	Distance from Transverse Edge or Longitudinal Start, m (ft.), and Depth Measurements, mm (in.)						Ave. per Sta., mm (in.)
EB =							=
0+15m =	301	297	295	298	300		= 297.5
0+50 =	306	302	310	315	309		= 307.5
0+90 =	307	310	312	314	308		= 310.0
1+50 =	311	309	304	301	307		= 307.5
3+00 =	309	311	313	310	314		= 312.5
4+50 =	306	310	308	305	307		= 307.5
6+00 =	308	309	312	305	310		= 310.0
7+50 =	312	315	310	313	309		= 312.5
=							=
=							=
——— =	———	———	———	———	———	———	= ———
=							=
=							=
EB =							=
0+50 ft =	11.85	11.70	11.50	11.75	11.80		= 11.7
1+50 =	12.05	11.90	12.20	12.40	12.15		= 12.1
3+00 =	12.10	12.20	12.30	12.35	12.15		= 12.2
5+00 =	12.25	12.15	11.95	11.85	12.10		= 12.1
10+00 =	12.15	12.25	12.30	12.20	12.35		= 12.2
15+00 =	12.05	12.20	12.15	12.00	12.10		= 12.1
20+00 =	12.15	12.15	12.30	12.00	12.20		= 12.2
25+00 =	12.30	12.40	12.20	12.30	12.15		= 12.3
=							=
=							=
=							=
=							=
=							=

Idaho Standard Method of Test for

Total Chloride Content of Hardened Concrete by Gran Plot Method

Idaho IT-131-90

1 Scope

1.1 This method describes the laboratory analysis of chloride ion in hardened concrete.

2 Summary of Method

2.1 Test according to AASHTO T 260 "Sampling and Testing for Total Chloride Ion in Concrete and Concrete Raw Materials" using Method II: Gran Plot method for analysis.

2.2 A standard solution containing 1 milliliter of known concentration of chloride ion (1000 ppm) and a blank of distilled water are also tested for percent recovery and to obtain a high degree of precision.

2.3 Equipment and Reagents for Chemical Testing.

2.3.1 Chloride ion or silver/sulfide ion selective electrode and manufacturer-recommended filling solutions. Suggested electrodes are the Orion 96-17 or Orion 94-6 used with Orion 90-02 or equivalent.

2.3.2 A millivoltmeter compatible with the ion electrode.

Suggested millivoltmeter is the Orion Model 901A Specific Ion meter or equivalent.

2.3.3 Magnetic stirrer and teflon stirring bars.

2.3.4 A 25 ml buret with 0.1 ml graduations.

2.3.5 Balance sensitive to 0.0001 gram with minimum capacity of 100 grams.

2.3.6 Balance sensitive to 0.1 grams with minimum capacity of 1 Kg.

2.3.7 Hot plate, 250°C to 400°C heating surface temperature.

2.3.8 Glassware 150 and 250 ml beakers, filter funnels, stirring rods, watch glasses, dropper, Guth wash bottles.

2.3.9 Sieve, U.S. Standard No. 50 (0.300 mm).

2.3.10 Whatman No. 40 and No. 41 filter papers (or equivalent).

If equivalent filter papers are used, they should be checked to confirm they do not contain chloride that will contaminate the sample.

2.3.11 Concentrated HNO_3 (specific gravity 1.42).

2.3.12 Sodium chloride, NaCl, reagent grade (primary standard).

2.3.13 Standard 0.01N_NaCl solution. Dry reagent grade NaCl in an oven at 105°C. Cool, in a dessicator, weigh out approximately 0.5844 to the nearest 0.0001 gram, dissolve in distilled H_20, and transfer to a 1 liter volumetric flask. Make up to the mark with distilled H_20 and mix. Calculate the exact normality as follows:

$$N\_NaCl = (0.0100)\frac{(Wt\ actual)}{0.5844}$$

Wt actual = actual weight of NaCl

N_NaCl = normality of NaCl solution

2.3.14 Standard 0.01N_$AgNO_3$. Weigh 1.7 grams of reagent $AgNO_3$, transfer to 1000 ml volumetric flask, dissolve in distilled water. QS to volume and mix thoroughly. Standardize by the titration method given in Section 2.5.2.

2.3.15 Distilled/Demineralized Water.

Deionized water may be used in place of distilled water for samples where extreme precision and accuracy are not demanded.

2.3.16 Methyl orange indicator.

2.3.17 Ethanol, denatured or methanol, technical.

2.4 AASHTO T 260 Procedure and Modifications.

2.4.1 Weigh to the nearest milligram a 3 gram powdered sample representative of the material under test.

Some users dry the sample to constant weight in a 105°C oven and determine the dry sample weight prior to analysis. This optional procedure provides a constant base for comparison of all results by eliminating moisture content as a variable. It is generally believed that drying is only necessary when very high accuracy is desired.

2.4.2 Transfer the sample quantitatively to a 150 ml beaker, add 10 ml of distilled H_2O swirling to bring the powder into suspension. Add 3 ml of conc. HNO_3 with continued swirling until the material is completely decomposed. Break up any lumps with a stirring rod and dilute with hot H_20 to 50 ml. Stir thoroughly to ensure complete sample digestion. Add five (5) drops of methyl orange indicator and stir. If yellow to yellow-orange color appears, solution is not sufficiently acidic. Add additional concentrated HNO_3 drop-wise with continuous stirring until a faint pink or red color persists in the solution. Cover with a watch glass. Heat the acid solution or slurry to boiling on a hot plate at medium heat (250°C to 400°C) and boil for about 1 minute. Remove from the hot plate, filter through double filter paper (Whatman No. 41 over No. 40 filter paper or equivalent), into a 250 ml beaker which has been preweighed with the tare weight recorded.

2.4.2.1 A blank and a known chloride concentration standard are run every 10 samples for internal Quality Assurance. The blank and known are made using only reagents and distilled H_20. The known contains 10 ml of 100 ppm chloride (Cl^-) standard.

Due to the presence of relatively insoluble materials in the sample, the solution generally will have a strong gray color, making the detection of indicator color difficult at times. Running of several trial samples is suggested to give the analyst practice in detecting the indicator color.

A sample prepared to 100 percent passing No. 50 sieve (0.300 mm) should generally allow determination of any expected chloride level with adequate precision and accuracy. Samples containing highly siliceous aggregates may require finer grinding to minimize solution bumping during boiling. This may also be the case when the concrete contains modifiers such as latex or polymer.

2.4.3 Transfer solution and wash the filter papers thoroughly with hot distilled H_20 3 to 5 times. After washing is complete, lift the filter paper carefully from the funnel and wash to outside surface of the paper with hot distilled H_20; then wash the tip of the funnel. <u>The final volume of the filtered solution should be less than 100 ml.</u> Cover with a watch glass and allow to cool to room temperature in the HC1 fume-free atmosphere. Remove the watch glass and place the beaker on the balance. Add sufficient distilled water to bring the weight of solution to 100 grams $\pm$ l grams. This eliminates the need for the volume corrections.

Weigh the filtrate solution and beaker without the watch glass and record the weight.

2.5 Method II Gran Plot Method with Cl^- selective ion electrode.

2.5.1 Setup and Calibration.

Polish the chloride electrode according to manufacturer's recommendations and attach to the Orion 901 Ionanalyzer. Fill the double junction reference electrode with inner and outer solutions according to manufacturer's instructions and attach to Ionanalyzer. Perform slope calibration as follows.

Prepare 150 ml beaker with 87 ml distilled water, 3 ml conc. HNO_3, and 10 ml 100 PPM-Cl^- standard solution for calibration standard. Set instrument to MV and put electrodes in calibration solution, wait for a steady reading. Press "set conc." button on instrument and leave on. Add 10 ml 1000 PPM-Cl^- standard solution, wait for a steady reading. Final reading on digital readout is the daily slope along with standard value of 10.00. Slope reading is read as negative number. Record slope setting in instrument notebook and on chloride sample worksheet.

2.5.2 Calibration of $AgNO_3$.

Rinse electrodes with distilled water and dry. Fill a 25 ml buret with $AgNO_3$ solution. Prepare a 250 ml beaker with 10 ml 0.01N_NaCl solution, 3 ml conc. HNO_3 and 87 ml distilled water, and stir bar. Place sample on magnetic stirplate with electrode in solution and while stirring record initial MV reading. Add $AgNO_3$ until MV reading is between 300 and 310 MV, record reading. Continue to titrate in 0.50 ml increments recording volume added and MV reading for each increment for at least five (5) increments. Calculate the exact normality as follows:

$$N\_AgNO_3 = \frac{(V\_NaCl)(N\_NaCl)}{V\_AgNO_3}$$

N_AgNO_3 = normality of $AgNO_3$ Solution

V_NaCl = volume (ml) of NaCl Solution

N_NaCl = normality of NaCl Solution

V_AgNO_3 = volume (ml) of $AgNO_3$ Solution (Use blank and volume corrected end point) Follow steps 2.6.1 through 2.6.3 for correct calculation of V $AgNO_3$.

2.6 Chloride Sample Instrumental Analysis.

After calibration of Ionanalyzer and $AgNO_3$ solution prepare sample filtrate for MV readings. Weigh filtrate, record weight and add distilled water to bring volume to 100 ± 1 grams. Place rinsed and dry electrodes in sample solution. Read and record millivolt reading for sample before $AgNO_3$ is added. Using the 25 ml buret, titrate the sample between 300-310 MV with standard 0.01 N_$AgNO_3$ solution to the nearest 0.50 ml increment. Record the volume added and the millivoltmeter reading on the chloride work sheet.

Continue to titrate in 0.50 ml increments, recording volume added and the millivoltmeter reading for each increment. Add and record the data for at least five (5) increments on the chloride work sheet.

2.6.1 Gran Plot Method Calculations.

Calculate corrected values for each of the volumes recorded in Section 2.6 by the equation:

If filtrate weight is > 101 grams then:

$$\text{V\_Correct} = \frac{\text{V\_record}}{Wt \div 100}$$

Where:

Wt = original solution weight in grams.

V_record = volumes recorded in ml.

If filtrate weight is 100 ± 1 grams, then V_correct = V_record.

Proceed to 2.6.2.

2.6.2 Titration Volume Plotting & Calculation.

If any of the V_correct values are greater than 10, see Section 2.6.3. If less than 10, plot these corrected values versus the corresponding millivolt readings on Orion Gran Plot Paper (10 percent volume corrected type with each major vertical scale division equal to 5 millivolts) or equivalent. Draw the best straight line through the points and read the endpoint at the intersection of the line with the horizontal axis of the graph. Calculate the actual endpoint by the equation:

$$E_{\text{a}} = \left(E_g\right)\left(\frac{\text{Wt}}{100}\right)$$

Where:

E_a = actual endpoint

E_g = endpoint determined from graph in ml. The reagent blank endpoint ml will be subtracted from all sample and standard endpoints before PPM-Cl^- or final lb. Cl^- /c.y. concrete calculations.

Wt = weight of solution in grams.

2.6.3 Volume Correction.

When the V_correct volumes determined during titration are greater than 10, discard the values and follow the following procedure.

Choose a constant which, when subtracted from all V_record volumes, yields values less than 10 ml.

Note 1: This constant, designated as X in the formulas below, is normally assigned an even value such as 5, 10, 15, 20, etc.

Calculate a revised solution weight Wt_r as:

$Wt_r = Wt + X$

Where:

Wt = original solution weight in grams

X = the constant

Then calculate corrected volumes for each recorded volume as:

$$\text{V\_Correct} = \frac{\text{V\_record - X}}{Wt_r \div 100}$$

Plot these values and determine the graph endpoint E_g, as described in Section 2.6.2, above.

The actual endpoint E_a is then:

$$E_a = (E_g)\left(\frac{\text{Wt}_r}{100}\right) + X$$

Where:

E_a = actual endpoint in ml.

E_g = endpoint from graph in ml with blank subtracted.

Wt_r = revised solution weight in grams.

X = the constant chosen above.

Calculate the chloride content using the formula given below.

Calculation or ppm recovery of Cl^- standard:

$$(\text{N\_AgNO}_3)\left(\frac{(mw\,\text{Cl}^-)}{35.453}\right)(1000)(\text{E}_a) = ppm\,\text{Cl}^-$$

Percent Cl^- is calculated as follows:

$$\text{Percent } Cl^- = \left(\frac{3.5453}{Wt_c}\right)(E_a)(N)$$

Where:

E_a = actual endpoint, in ml.

N = normality of $AgNO_3$ solution.

Wt_c = concrete sample weight in grams.

The percent chloride may be converted to pounds of Cl^- per cubic yard of concrete as follows:

$$\frac{lb.Cl^-}{yd^3} = (\text{percent } Cl^-)\left(\frac{Wt_U}{100}\right)$$

Where:

Wt_U = unit weight of concrete per cubic yard.

Note 2: A unit weight of 3,915 lb./yd^3 is often assumed for normal structural weight concrete when the actual unit weight is unknown.

Results are reported as lb. Cl^-/yd^3 concrete as follows for 3.0000 gram sample:

$$\frac{lb.Cl^-}{yd^3} = \left(\frac{3.5453}{3.0000}\right)(N)(E_a)\left(\frac{3{,}915}{100}\right)$$

Which reduces to:

$$\text{lb. } Cl^-/yd^3 = \underset{\text{(factor)}}{(46.27)}\,(N)\,(E_a)$$

Where:

N = normality of $AgNO_3$

E_a = actual endpoint in ml $(E_g)\left(\frac{Wt}{100}\right) - blank$

Idaho specifications for Cl^- value = 2 lb. Cl^-/yd^3 max.

Precision and Accuracy Data – As documented in AASHTO T 260.

Idaho Standard Method of Test for

Determination of the Rate of Evaporation of Surface Moisture From Concrete

Idaho IT-133-07

1 Scope

1.1 This method shall be used to determine the rate of evaporation of surface moisture from concrete surfaces.

2 Reference

2.1 ACI Manual of Concrete Practice, Section 305R.

3 Apparatus

3.1 Thermometer, 0°F to 180°F (-20°C to 80°C), Dial Type.

3.2 Wind meter.

3.3 Hygrometer, stationary mason's form.

4 Test Procedure

4.1 Determine the ambient air temperature by reading the dry-bulb on the hygrometer. For example, 80°F (27°C).

4.2 Determine the relative humidity by reading both the dry-bulb and the wet-bulb on the hygrometer. Then, using the Relative Humidity Table (Figure 1E or 1M), locate in the margin the reading corresponding to the dry-bulb indication. Locate in the other margin the reading corresponding to the wet-bulb indication. The relative humidity is read at the intersection of these two (2) columns. For example, given dry-bulb temperature 80°F (27°C) and wet-bulb temperature 67°F (19.5°C), the relative humidity is 50 percent.

4.3 Determine the concrete temperature by placing the dial thermometer into a sample of the concrete. For example, 88°F (31°C).

4.4 Determine the wind velocity by using the wind meter. Face the wind. Hold the meter in front of you in a vertical position with the scale side facing you. Do not block the bottom holes. The height of the ball indicates the wind velocity.

For winds in excess of 10 mph (16 km/hr), use the high scale. For high scale, cover the hole at the extreme top of the wind meter with a finger. For example, 12 mph (19 km/hr).

4.5 Determine the evaporation rate by using the chart (Figure 2). Enter the chart at air temperature, degrees F (C). For example, 80°F (27°C). Move up to relative humidity. For example, 50 percent. Move right to the concrete temperature. For example, 88°F (31°C). Move down to wind velocity. For example, 12 mph (19 km/hr). Move left and read approximate rate of evaporation. For example, 0.25 lb/sq ft/hr (1.25 kg/m^2/hr).

5 Precautions

5.1 Read the instructions furnished with both the hygrometer and wind meter for accurate operation of both instruments.

5.2 In determining the evaporation rate of surface moisture, keep in mind that later in the day the air temperature, relative humidity, and wind velocity may change drastically, causing a considerable increase in the evaporation rate.

6 Rate of Evaporation

6.1 The rate of evaporation is influenced by the relative humidity, concrete and air temperature, and wind velocity. Even relatively small changes in these atmospheric conditions may have a pronounced effect on the rate of evaporation, especially if they occur simultaneously.

For example, when the relative humidity changes from 90 to 50 percent, the rate of evaporation is increased five (5) times. If further reduced to ten percent (10%), evaporation is increased nine (9) times.

6.2 When both concrete and air temperature increase from 50^{o}F to 70^{o}F (10^{o}C to 21^{o}C), evaporation is doubled. If further increased to 90^{o}F (32^{o}C), evaporation is increased four (4) times.

6.3 With an air temperature of 40^{o}F (4^{o}C), the rate of evaporation is tripled when the concrete temperature is raised from 60^{o}F to 80^{o}F (16^{o}C to 27^{o}C).

6.4 The rate of evaporation is four (4) times greater when the wind velocity increases from 0 to 10 mph (0 to 16 km/hr) and is nine (9) times greater when the wind velocity further increases to 25 mph (40 km/hr).

6.5 It is apparent, then, that the rate of evaporation is highest when the relative humidity is low, when concrete and air temperatures are high, when the concrete temperature is higher than the air temperature and when the wind is blowing over the concrete surface. The combination of hot, dry weather and high winds often prevailing during summer months removes moisture from the surface faster than it can be replaced by normal bleeding; but even in cold weather rapid drying is possible if the temperature of concrete, when placed, is high compared to the air temperature.

Figure 1E—Relative Humidity Table (English)

WET BULB TEMPERATURE °F (rows) / DRY BULB TEMPERATURE °F (columns)

Wet bulb °F	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
36	3																												
38	12	7	1																										
40	22	16	10	5																									
42	32	25	18	13	8	4																							
44	42	34	27	21	16	11	7	3																					
46	53	44	37	30	24	18	14	10	6	3																			
48	64	55	46	39	32	26	21	16	12	9	5	3																	
50	76	65	56	48	41	34	29	23	19	15	11	8	5	3															
52	88	76	66	58	50	43	36	31	25	21	17	13	10	7	4	3	1												
54	100	88	77	68	59	51	44	38	33	28	23	19	16	12	10	7	5	3	1										
56		100	88	78	69	60	53	46	40	34	29	25	21	18	14	12	9	7	5	3	1								
58			100	89	79	70	61	54	48	42	36	31	27	23	20	16	14	11	9	7	5	3	2						
60				100	89	79	71	62	55	49	43	38	33	29	25	21	18	15	13	11	9	7	5	3	2				
62					100	90	80	71	64	57	50	44	39	35	30	26	23	20	17	15	12	10	8	7	5	3	2	1	
64						100	90	80	72	65	58	51	46	41	36	32	28	25	22	19	16	14	12	10	8	7	5	4	2
66							100	90	81	73	65	59	53	47	42	37	33	30	26	23	20	18	15	13	11	10	8	7	5
68								100	90	82	74	66	60	54	48	43	39	35	31	28	24	22	19	17	15	13	11	10	8
70									100	91	82	74	67	61	55	49	44	40	36	32	29	26	23	21	18	16	14	12	11
72										100	91	82	75	68	61	56	50	46	41	37	33	30	27	24	22	20	17	16	14
74											100	91	83	75	69	62	57	51	47	42	38	35	32	28	26	23	21	19	17
76												100	91	83	76	69	63	57	52	48	43	39	36	33	30	27	24	22	20
78													100	91	84	76	70	64	58	53	49	44	40	37	34	31	28	25	23
80														100	92	84	77	70	65	59	54	50	45	41	38	35	32	29	26
82															100	92	84	77	71	65	60	55	50	46	42	39	36	33	30
84																100	92	85	78	72	66	61	55	51	47	43	40	37	34
86																	100	92	85	78	72	66	61	56	52	48	44	41	38
88																		100	92	85	79	73	67	62	57	53	49	45	42
90																			100	92	85	79	73	68	62	58	53	49	46
92																				100	93	86	79	73	68	63	58	54	50
94																					100	93	86	80	74	69	64	59	55
96																						100	93	86	80	74	69	64	60
98																							100	93	86	80	75	70	65
100																								100	93	87	81	75	70
102																									100	93	87	81	75
104																										100	93	87	81
106																											100	93	87
108																												100	93
110																													100

Interpolate tables for other temperatures

Figure 1M—Relative Humidity Table (Metric)

DRY BULB TEMPERATURE °C

WET BULB TEMPERATURE °C	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	WET BULB TEMPERATURE °C
-2.5	3																									-2.5
–2.0	9	5	1																							–2.0
–1.5	14	10	7	3																						–1.5
–1.0	21	16	12	8	5	2																				–1.0
–0.5	27	22	18	14	10	7	4	1																		–0.5
0.0	33	28	24	20	16	12	9	5	2																	0.0
0.5	39	34	30	25	21	17	14	10	7	4	1															0.5
1.0	46	40	36	31	27	23	19	15	12	9	6	3	1													1.0
1.5	52	47	42	37	32	28	24	20	17	14	11	8	5	2												1.5
2.0	59	53	48	43	38	34	29	26	22	18	15	12	9	7	4	2										2.0
2.5	65	59	54	49	44	39	35	31	27	23	20	17	14	11	8	6	3	1								2.5
3.0	72	66	60	55	50	45	40	36	32	28	25	21	18	15	12	10	7	5	3	1						3.0
3.5	79	73	67	61	56	51	46	41	37	33	30	26	23	20	17	14	11	9	6	4	2					3.5
4.0	86	79	73	67	62	57	52	47	43	38	34	31	27	24	21	18	15	13	10	8	6	4	2			4.0
4.5	93	86	80	74	68	62	57	52	48	44	39	36	32	29	25	22	19	17	14	12	9	7	5	3	2	4.5
5.0	100	93	86	80	74	68	63	58	53	49	45	41	37	33	30	27	23	21	18	15	13	11	9	7	5	5.0
5.5		100	93	87	80	75	69	64	59	54	50	46	42	38	34	31	28	25	22	19	17	14	12	10	8	5.5
6.0			100	93	87	81	75	70	64	60	55	51	46	43	39	35	32	29	26	23	20	18	16	13	11	6.0
6.5				100	93	87	81	75	70	65	60	56	51	47	43	40	36	33	30	27	24	22	19	17	15	6.5
7.0					100	93	87	81	76	71	66	61	56	52	48	44	41	37	34	31	28	25	23	20	18	7.0
7.5						100	94	88	82	76	71	66	62	57	53	49	45	42	38	35	32	29	27	24	22	7.5
8.0							100	94	88	82	77	72	67	62	58	54	50	46	43	39	36	33	30	28	25	8.0
8.5								100	94	88	82	77	72	67	63	59	55	51	47	44	40	37	34	31	29	8.5
9.0									100	94	88	83	78	73	68	63	59	55	51	48	44	41	38	35	32	9.0
9.5										100	94	88	83	78	73	68	64	60	56	52	49	45	42	39	36	9.5
10.0											100	94	89	83	78	73	69	65	60	57	53	49	46	43	40	10.0
10.5												100	94	89	84	79	74	69	65	61	57	54	50	47	44	10.5
11.0													100	94	89	84	79	74	70	66	62	58	54	51	48	11.0
11.5														100	94	89	84	79	75	70	66	62	58	55	51	11.5
12.0															100	95	89	84	80	75	71	67	63	59	56	12.0
12.5																100	95	89	85	80	75	71	67	63	60	12.5
13.0																	100	95	90	85	80	76	72	68	64	13.0
13.5																		100	95	90	85	80	76	72	68	13.5
14.0																			100	95	90	85	81	76	72	14.0
14.5																				100	95	90	85	81	77	14.5
15.0																					100	95	90	86	81	15.0
15.5																						100	95	90	86	15.5
16.0																							100	95	90	16.0
16.5																								100	95	16.5
17.0																									100	17.0
17.5																										17.5
18.0																										18.0
18.5																										18.5
19.0																										19.0
19.5																										19.5
20.0																										20.0
20.5																										20.5
21.0																										21.0
21.5																										21.5
22.0																										22.0
22.5																										22.5
23.0																										23.0
23.5																										23.5
24.0																										24.0
24.5																										24.5
25.0																										25.0
25.5																										25.5
26.0																										26.0
26.5																										26.5
27.0																										27.0
27.5																										27.5
28.0																										28.0
28.5																										28.5
29.0																										29.0
29.5																										29.5
30.0																										30.0
	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	

DRY BULB TEMPERATURE °C

Sheet 1 of 4

Figure 1M (Contd)

DRY BULB TEMPERATURE °C

WET BULB TEMPERATURE °C	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	28.0	28.5	29.0	29.5	30.0
-2.5																										
-2.0																										
-1.5																										
-1.0																										
-0.5																										
0.0																										
0.5																										
1.0																										
1.5																										
2.0																										
2.5																										
3.0																										
3.5																										
4.0																										
4.5																										
5.0	3	1																								
5.5	6	4	3	1																						
6.0	9	7	6	4	2	1																				
6.5	13	11	9	7	5	4	2	1																		
7.0	16	14	12	10	8	7	5	4	2	1																
7.5	19	17	15	13	11	10	8	6	5	3	2	1														
8.0	23	20	18	16	14	12	11	9	8	6	5	3	2	1												
8.5	26	24	21	19	17	15	14	12	10	9	7	6	5	3	2											
9.0	30	27	25	23	20	18	17	15	13	11	10	8	7	6	4	3	2	1								
9.5	33	31	28	26	24	21	19	18	16	14	12	11	9	8	7	6	4	3	2	1						
10.0	37	34	32	29	27	25	23	21	19	17	15	14	12	11	9	8	7	5	4	3	2	1	1			
10.5	41	38	35	33	30	28	26	23	22	20	18	16	15	13	12	10	9	8	7	5	4	3	2	2	1	
11.0	44	41	39	36	33	31	29	27	24	22	21	19	17	16	14	13	11	10	9	8	6	5	4	3	3	2
11.5	48	45	42	39	37	34	32	30	27	25	23	22	20	18	17	15	14	12	11	10	8	7	6	5	4	4
12.0	52	49	46	43	40	38	35	33	30	28	26	24	22	21	19	17	16	15	13	12	11	9	8	7	6	5
12.5	56	53	50	47	44	41	38	36	34	31	29	27	25	23	22	20	18	17	15	14	13	12	10	9	8	7
13.0	60	57	53	50	47	44	42	39	37	34	32	30	28	26	24	23	21	19	18	16	15	14	12	11	10	9
13.5	64	61	57	54	51	48	45	42	40	37	35	33	31	29	27	25	23	22	20	19	17	16	15	13	12	11
14.0	68	65	61	58	55	52	49	46	43	41	38	36	34	32	30	28	26	24	23	21	19	18	17	15	14	13
14.5	73	69	65	62	58	55	52	49	47	44	41	39	37	34	32	30	29	27	25	23	22	20	19	18	16	15
15.0	77	73	69	66	62	59	56	53	50	47	45	42	40	37	35	33	31	29	28	26	24	23	21	20	18	17
15.5	81	77	73	70	66	63	59	56	53	50	48	45	43	40	38	36	34	32	30	28	27	25	23	22	20	19
16.0	86	82	78	74	70	67	63	60	57	54	51	48	46	43	41	39	37	35	33	31	29	27	26	24	23	21
16.5	91	86	82	78	74	70	67	64	60	57	54	52	49	46	44	42	39	37	35	33	31	30	28	26	25	23
17.0	95	91	86	82	78	74	71	67	64	61	58	55	52	50	47	45	42	40	38	36	34	32	30	29	27	26
17.5	100	95	91	87	82	79	75	71	68	64	61	58	55	53	50	48	45	43	41	39	37	35	33	31	29	28
18.0		100	95	91	87	83	79	75	72	68	65	62	59	56	53	51	48	46	44	41	39	37	35	34	32	30
18.5			100	95	91	87	83	79	75	72	69	65	62	59	56	54	51	49	46	44	42	40	38	36	34	32
19.0				100	95	91	87	83	79	76	72	69	66	63	60	57	54	52	49	47	45	42	40	38	37	35
19.5					100	96	91	87	83	80	76	73	69	66	63	60	57	55	52	50	47	45	43	41	39	37
20.0						100	96	91	87	83	80	76	73	70	66	63	61	58	55	53	50	48	46	44	42	40
20.5							100	96	91	87	84	80	76	73	70	67	64	61	58	56	53	51	48	46	44	42
21.0								100	96	92	88	84	80	77	73	70	67	64	61	59	56	54	51	49	47	45
21.5									100	96	92	88	84	80	77	74	71	67	65	62	59	57	54	52	49	47
22.0										100	96	92	88	84	81	77	74	71	68	65	62	59	57	55	52	50
22.5											100	96	92	88	84	81	77	74	71	68	65	63	60	57	55	53
23.0												100	96	92	88	85	81	78	74	71	68	66	63	60	58	55
23.5													100	96	92	88	85	81	78	75	72	69	66	63	61	58
24.0														100	96	92	88	85	81	78	75	72	69	66	64	61
24.5															100	96	92	89	85	82	78	75	72	69	67	64
25.0																100	96	92	89	85	82	79	75	72	70	67
25.5																	100	96	92	89	85	82	79	76	73	70
26.0																		100	96	92	89	85	82	79	76	73
26.5																			100	96	93	89	86	82	79	76
27.0																				100	96	93	89	86	82	79
27.5																					100	96	93	89	86	83
28.0																						100	96	93	89	86
28.5																							100	96	93	89
29.0																								100	96	93
29.5																									100	96
30.0																										100

DRY BULB TEMPERATURE °C

Sheet 2 of 4

DRY BULB TEMPERATURE °C

WET BULB TEMPERATURE °C

Wet bulb °C	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5	39.0	39.5	40.0	40.5	41.0	41.5
11.0	1																						
11.5	3	2	1																				
12.0	4	4	3	2	1	1																	
12.5	6	5	4	4	3	2	1	1															
13.0	8	7	6	5	5	4	3	2	2	1													
13.5	10	9	8	7	6	5	5	4	3	3	2	1	1										
14.0	12	11	10	9	8	7	6	5	5	4	3	3	2	2	1								
14.5	14	13	12	11	10	9	8	7	6	6	5	4	3	3	2	2	1	1					
15.0	16	15	14	12	11	10	10	9	8	7	6	6	5	4	4	3	2	2	1	1			
15.5	18	17	15	14	13	12	11	10	9	9	8	7	6	6	5	4	4	3	3	2	2	1	1
16.0	20	19	17	16	15	14	13	12	11	10	9	9	8	7	6	6	5	4	4	3	3	2	2
16.5	22	21	19	18	17	16	15	14	13	12	11	10	9	9	8	7	6	6	5	5	4	3	3
17.0	24	23	21	20	19	18	17	15	14	13	13	12	11	10	9	8	8	7	6	6	5	5	4
17.5	26	25	23	22	21	20	18	17	16	15	14	13	12	11	11	10	9	8	8	7	6	6	5
18.0	28	27	25	24	23	21	20	19	18	17	16	15	14	13	12	11	11	10	9	8	8	7	7
18.5	31	29	28	26	25	23	22	21	20	19	18	17	16	15	14	13	12	11	10	10	9	8	8
19.0	33	31	30	28	27	25	24	23	22	20	19	18	17	16	15	14	13	13	12	11	10	10	9
19.5	35	34	32	30	29	27	26	25	23	22	21	20	19	18	17	16	15	14	13	12	12	11	10
20.0	38	36	34	33	31	30	28	27	25	24	23	22	21	19	18	17	17	16	15	14	13	12	12
20.5	40	38	37	35	33	32	30	29	27	26	25	23	22	21	20	19	18	17	16	15	14	14	13
21.0	43	41	39	37	35	34	32	31	29	28	27	25	24	23	22	21	20	19	18	17	16	15	14
21.5	45	43	41	39	38	36	34	33	31	30	28	27	26	25	23	22	21	20	19	18	17	16	16
22.0	48	46	44	42	40	38	36	35	33	32	30	29	28	26	25	24	23	22	21	20	19	18	17
22.5	50	48	46	44	42	40	39	37	35	34	32	31	30	28	27	26	25	23	22	21	20	19	18
23.0	53	51	49	47	45	43	41	39	38	36	34	33	31	30	29	28	26	25	24	23	22	21	20
23.5	56	53	51	49	47	45	43	41	40	38	36	35	33	32	31	29	28	27	26	25	23	22	21
24.0	59	56	54	52	50	48	46	44	42	40	39	37	35	34	32	31	30	29	27	26	25	24	23
24.5	61	59	57	54	52	50	48	46	44	42	41	39	37	36	34	33	32	30	29	28	27	26	24
25.0	64	62	59	57	55	52	50	48	46	45	43	41	39	38	36	35	33	32	31	30	28	27	26
25.5	67	65	62	60	57	55	53	51	49	47	45	43	42	40	38	37	35	34	33	31	30	29	28
26.0	70	67	65	62	60	58	55	53	51	49	47	45	44	42	40	39	37	36	34	33	32	31	29
26.5	73	70	68	65	63	60	58	56	54	52	50	48	46	44	42	41	39	38	36	35	34	32	31
27.0	76	73	71	68	65	63	61	58	56	54	52	50	48	46	45	43	41	40	38	37	35	34	33
27.5	80	77	74	71	68	66	63	61	59	56	54	52	50	49	47	45	43	42	40	39	37	36	34
28.0	83	80	77	74	71	69	66	64	61	59	57	55	53	51	49	47	45	44	42	41	39	38	36
28.5	86	83	80	77	74	71	69	66	64	62	59	57	55	53	51	49	47	46	44	42	41	39	38
29.0	89	86	83	80	77	74	72	69	67	64	62	60	57	55	53	51	50	48	46	44	43	41	40
29.5	93	90	86	83	80	77	75	72	69	67	64	62	60	58	56	54	52	50	48	46	45	43	42
30.0	96	93	90	86	83	80	78	75	72	70	67	65	62	60	58	56	54	52	50	49	47	45	44
30.5	100	96	93	90	87	84	81	78	75	72	70	67	65	63	61	58	56	54	53	51	49	47	46
31.0		100	96	93	90	87	84	81	78	75	73	70	68	65	63	61	59	57	55	53	51	49	48
31.5			100	97	93	90	87	84	81	78	75	73	70	68	66	63	61	59	57	55	53	51	50
32.0				100	97	93	90	87	84	81	78	76	73	70	68	66	64	61	59	57	55	53	52
32.5					100	97	93	90	87	84	81	78	76	73	71	68	66	64	62	60	58	56	54
33.0						100	97	93	90	87	84	81	79	76	73	71	69	66	64	62	60	58	56
33.5							100	97	93	90	87	84	81	79	76	74	71	69	66	64	62	60	58
34.0								100	97	93	90	87	84	82	79	76	74	71	69	67	65	62	60
34.5									100	97	93	90	87	85	82	79	76	74	72	69	67	65	63
35.0										100	97	94	90	87	85	82	79	77	74	72	69	67	65
35.5											100	97	94	91	88	85	82	79	77	74	72	70	67
36.0												100	97	94	91	88	85	82	79	77	74	72	70
36.5													100	97	94	91	88	85	82	80	77	75	72
37.0														100	97	94	91	88	85	82	80	77	75
37.5															100	97	94	91	88	85	82	80	77
38.0																100	97	94	91	88	85	83	80
38.5																	100	97	94	91	88	85	83
39.0																		100	97	94	91	88	85
39.5																			100	97	94	91	88
40.0																				100	97	94	91
40.5																					100	97	94
41.0																						100	97
41.5																							100
42.0																							
42.5																							
43.0																							
43.5																							
44.0																							
44.5																							
45.0																							
45.5																							
46.0																							
46.5																							
47.0																							
47.5																							
48.0																							
48.5																							
49.0																							
49.5																							
50.0																							
50.5																							
51.0																							
51.5																							
52.0																							
52.5																							
53.0																							

WET BULB TEMPERATURE °C

30.5 31.0 31.5 32.0 32.5 33.0 33.5 34.0 34.5 35.0 35.5 36.0 36.5 37.0 37.5 38.0 38.5 39.0 39.5 40.0 40.5 41.0 41.5

DRY BULB TEMPERATURE °C

Sheet 3 of 4

DRY BULB TEMPERATURE °C

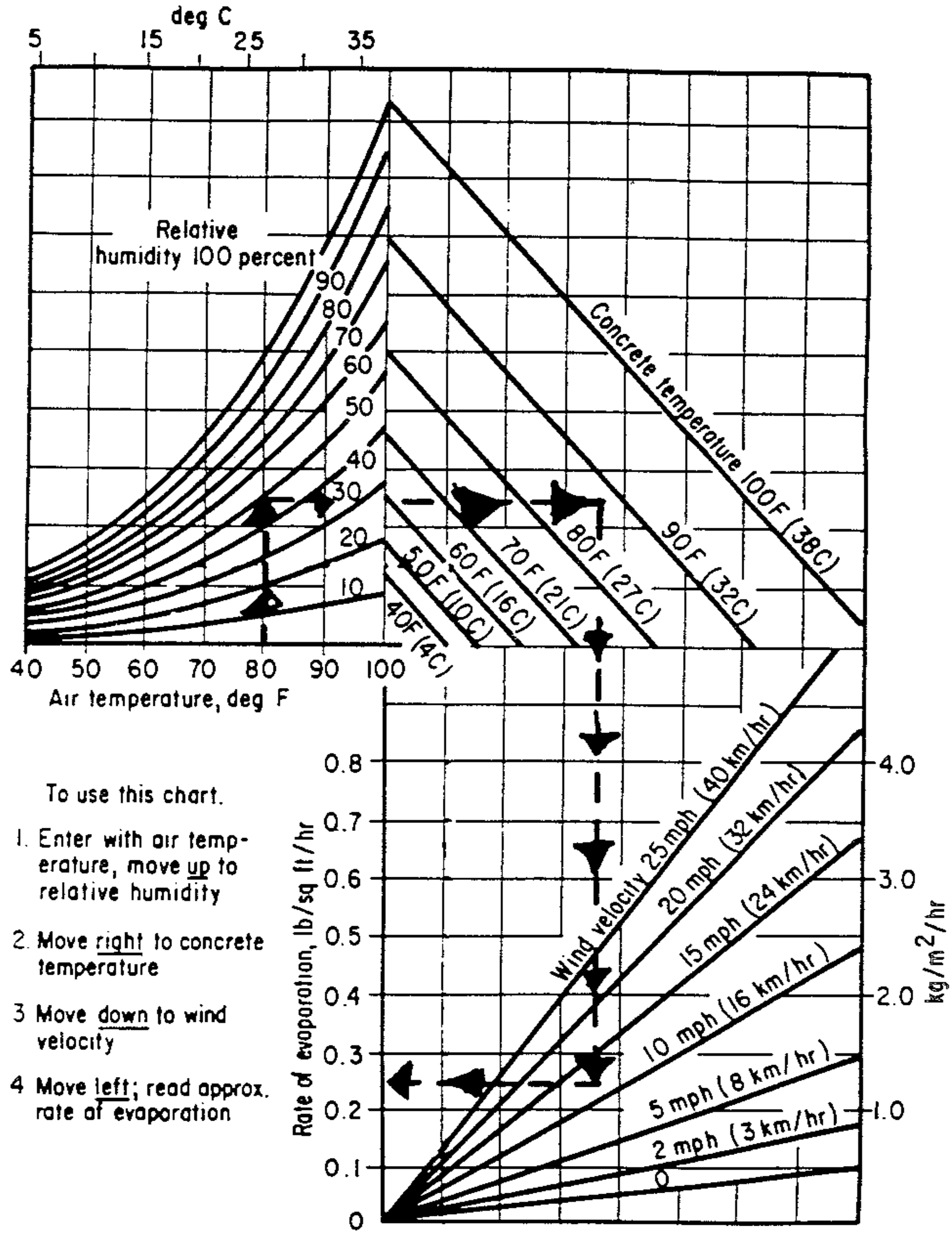
WET BULB TEMPERATURE °C

WB °C	42.0	42.5	43.0	43.5	44.0	44.5	45.0	45.5	46.0	46.5	47.0	47.5	48.0	48.5	49.0	49.5	50.0	50.5	51.0	51.5	52.0	52.5	53.0	WB °C
11.0																								11.0
11.5																								11.5
12.0																								12.0
12.5																								12.5
13.0																								13.0
13.5																								13.5
14.0																								14.0
14.5																								14.5
15.0																								15.0
15.5																								15.5
16.0	1	1	1																					16.0
16.5	3	2	2	1	1																			16.5
17.0	4	3	3	2	2	1	1	1																17.0
17.5	5	4	4	3	3	2	2	2	1	1	1													17.5
18.0	6	5	5	4	4	3	3	3	2	2	2	1	1	1										18.0
18.5	7	7	6	6	5	5	4	4	3	3	2	2	2	1	1	1	1							18.5
19.0	8	8	7	7	6	6	5	5	4	4	3	3	3	2	2	2	1	1	1					19.0
19.5	10	9	8	8	7	7	6	6	5	5	4	4	4	3	3	2	2	2	2	1	1	1		19.5
20.0	11	10	10	9	8	8	7	7	6	6	5	5	4	4	4	3	3	3	2	2	2	1	1	20.0
20.5	12	11	11	10	10	9	8	8	7	7	6	6	5	5	5	4	4	3	3	3	3	2	2	20.5
21.0	14	13	12	11	11	10	9	9	8	8	7	7	6	6	6	5	5	4	4	4	3	3	3	21.0
21.5	15	14	13	13	12	11	11	10	9	9	8	8	7	7	6	6	6	5	5	4	4	4	3	21.5
22.0	16	15	15	14	13	12	12	11	11	10	9	9	8	8	7	7	7	6	6	5	5	5	4	22.0
22.5	18	17	16	15	14	14	13	12	12	11	11	10	9	9	8	8	7	7	7	6	6	5	5	22.5
23.0	19	18	17	16	16	15	14	14	13	12	12	11	10	10	9	9	8	8	7	7	7	6	6	23.0
23.5	20	20	19	18	17	16	15	15	14	13	13	12	11	11	10	10	9	9	8	8	7	7	7	23.5
24.0	22	21	20	19	18	17	17	16	15	15	14	13	13	12	11	11	10	10	9	9	8	8	8	24.0
24.5	23	22	21	21	20	19	18	17	16	16	15	14	14	13	12	12	11	11	10	10	9	9	8	24.5
25.0	25	24	23	22	21	20	19	18	18	17	16	15	15	14	14	13	12	12	11	11	10	10	9	25.0
25.5	27	25	24	23	22	22	21	20	19	18	17	17	16	15	15	14	13	13	12	12	11	11	10	25.5
26.0	28	27	26	25	24	23	22	21	20	19	19	18	17	16	16	15	14	14	13	13	12	12	11	26.0
26.5	30	29	27	26	25	24	23	22	22	21	20	19	18	18	17	16	16	15	14	14	13	13	12	26.5
27.0	31	30	29	28	27	26	25	24	23	22	21	20	20	19	18	17	17	16	15	15	14	14	13	27.0
27.5	33	32	31	29	28	27	26	25	24	23	22	22	21	20	19	18	18	17	16	16	15	14	14	27.5
28.0	35	34	32	31	30	29	28	27	26	25	24	23	22	21	20	20	19	18	17	17	16	16	15	28.0
28.5	37	35	34	33	32	30	29	28	27	26	25	24	23	22	22	21	20	19	19	18	17	17	16	28.5
29.0	38	37	36	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	20	19	18	18	17	29.0
29.5	40	39	37	36	35	34	32	31	30	29	28	27	26	25	24	23	22	22	21	20	19	19	18	29.5
30.0	42	41	39	38	36	35	34	33	32	30	29	28	27	26	25	25	24	23	22	21	20	20	19	30.0
30.5	44	42	41	40	38	37	36	34	33	32	31	30	29	28	27	26	25	24	23	22	22	21	20	30.5
31.0	46	44	43	41	40	39	37	36	35	34	32	31	30	29	28	27	26	25	24	24	23	22	21	31.0
31.5	48	46	45	43	42	40	39	38	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	31.5
32.0	50	48	47	45	44	42	41	39	38	37	35	34	33	32	31	30	29	28	27	26	25	24	24	32.0
32.5	52	50	49	47	45	44	42	41	40	38	37	36	35	33	32	31	30	29	28	27	26	26	25	32.5
33.0	54	52	51	49	47	46	44	43	41	40	39	37	36	35	34	33	32	31	30	29	28	27	26	33.0
33.5	56	54	53	51	49	48	46	45	43	42	40	39	38	37	35	34	33	32	31	30	29	28	27	33.5
34.0	58	57	55	53	51	50	48	46	45	43	42	41	39	38	37	36	35	33	32	31	30	29	28	34.0
34.5	61	59	57	55	53	51	50	48	47	45	44	42	41	40	38	37	36	35	34	33	32	31	30	34.5
35.0	63	61	59	57	55	53	52	50	49	47	45	44	43	41	40	39	38	36	35	34	33	32	31	35.0
35.5	65	63	61	59	57	56	54	52	50	49	47	46	44	43	42	40	39	38	37	36	34	33	32	35.5
36.0	68	65	63	61	59	58	56	54	52	51	49	48	46	45	43	42	41	39	38	37	36	35	34	36.0
36.5	70	68	66	64	62	60	58	56	54	53	51	49	48	46	45	44	42	41	40	38	37	36	35	36.5
37.0	72	70	68	66	64	62	60	58	56	55	53	51	50	48	47	45	44	43	41	40	39	38	36	37.0
37.5	75	73	70	68	66	64	62	60	58	57	55	53	52	50	48	47	46	44	43	42	40	39	38	37.5
38.0	78	75	73	71	68	66	64	62	60	59	57	55	53	52	50	49	47	46	44	43	42	41	39	38.0
38.5	80	78	75	73	71	69	67	65	63	61	59	57	55	54	52	50	49	48	46	45	43	42	41	38.5
39.0	83	80	78	75	73	71	69	67	65	63	61	59	57	56	54	52	51	49	48	46	45	44	42	39.0
39.5	86	83	80	78	76	73	71	69	67	65	63	61	59	58	56	54	53	51	50	48	47	45	44	39.5
40.0	88	86	83	81	78	76	74	71	69	67	65	63	61	60	58	56	54	53	51	50	48	47	46	40.0
40.5	91	88	86	83	81	78	76	74	71	69	67	65	63	62	60	58	56	55	53	52	50	49	47	40.5
41.0	94	91	88	86	83	81	78	76	74	72	70	67	66	64	62	60	58	57	55	53	52	50	49	41.0
41.5	97	94	91	89	86	83	81	79	76	74	72	70	68	66	64	62	60	58	57	55	54	52	51	41.5
42.0	100	97	94	91	89	86	83	81	79	76	74	72	70	68	66	64	62	60	59	57	55	54	52	42.0
42.5		100	97	94	91	89	86	84	81	79	76	74	72	70	68	66	64	62	61	59	57	56	54	42.5
43.0			100	97	94	91	89	86	84	81	79	77	74	72	70	68	66	64	63	61	59	57	56	43.0
43.5				100	97	94	91	89	86	84	81	79	77	75	72	70	68	66	65	63	61	59	58	43.5
44.0					100	97	94	92	89	86	84	81	79	77	75	73	71	69	67	65	63	61	59	44.0
44.5						100	97	94	92	89	86	84	82	79	77	75	73	71	69	67	65	63	61	44.5
45.0							100	97	94	92	89	87	84	82	79	77	75	73	71	69	67	65	63	45.0
45.5								100	97	94	92	89	87	84	82	79	77	75	73	71	69	67	65	45.5
46.0									100	97	94	92	89	87	84	82	80	77	75	73	71	69	67	46.0
46.5										100	97	94	92	89	87	84	82	80	78	75	73	71	69	46.5
47.0											100	97	94	92	89	87	84	82	80	78	76	73	71	47.0
47.5												100	97	95	92	89	87	84	82	80	78	76	74	47.5
48.0													100	97	95	92	89	87	85	82	80	78	76	48.0
48.5														100	97	95	92	89	87	85	82	80	78	48.5
49.0															100	97	95	92	90	87	85	82	80	49.0
49.5																100	97	95	92	90	87	85	83	49.5
50.0																	100	97	95	92	90	87	85	50.0
50.5																		100	97	95	92	90	87	50.5
51.0																			100	97	95	92	90	51.0
51.5																				100	97	95	92	51.5
52.0																					100	97	95	52.0
52.5																						100	97	52.5
53.0																							100	53.0
	42.0	42.5	43.0	43.5	44.0	44.5	45.0	45.5	46.0	46.5	47.0	47.5	48.0	48.5	49.0	49.5	50.0	50.5	51.0	51.5	52.0	52.5	53.0	

DRY BULB TEMPERATURE °C

Sheet 4 of 4

Figure 2—Evaporation Rate Chart



Effect of concrete and air temperatures, relative humidity, and wind velocity on the rate of evaporation of surface moisture from concrete.

Idaho Standard Practice for

Field Sampling of Hydraulic Cement and Fly Ash

Idaho IR-143-07

1 Scope

This method covers obtaining the required field samples of hydraulic cement and fly ash from bulk shipments by means of the ITD in-line sampler.

2 Apparatus

2.1 In-line sampler with couplers fitting a 4” line

2.2 5” coupler adaptor

2.3 In-line sample container

2.4 Two 4” to 5” hose adaptors (1 female, 1 male)

2.5 Rubber mallet

2.6 4” pipe brush

2.7 ½” pipe brush

2.8 Manual for assembly and cleaning of in-line sampler

Refer to the Manual for details on assembly.

2.9 Pelican 1650 transport & storage case

3 Procedure

3.1 Before the line is pressurized, connect the sampler to the discharge tube on the trailer of the bulk cement truck and secure with the Kam-Loc levers.

3.2 Connect the rubber hose / line which feeds cement into the silo or bins to the sampler and secure with Kam-Loc levers.

3.3 Strike Kam-Loc levers with rubber hammer until connectors are secure.

3.3.1. Note: The ring on the lever must be toward the outside in order to open the lever. The ball valve must be in closed position before the line is pressurized.

3.4 After 5 minutes of unloading, carefully open the ball valve to ensure that cement comes out of the valve, to verify the sample container is full.

3.5 Close the valve.

3.6 Allow the truck to depressurize.

3.7 Remove sampler after the line has been depressurized.

3.8 Remove container portion of the sampler and pour sample into a suitable sample container.

3.9 Properly label sample container with a permanent marker and complete the ITD-1044 Sample Data form with a copy of the mill analysis certification attached.

3.10 The sampler must be thoroughly cleaned after each sample is taken by following the directions in the sampler manual.

Idaho Standard Method of test for

Lithium Dosage Determination Using Accelerated Mortar Bar Testing

Idaho IT-145-12

---

1. Scope

1.1 Lithium compounds have been shown to control expansion due to Alkali Silica Reactivity (ASR). This test method outlines the procedure necessary to determine the ideal dosage of lithium nitrate ($LiNO_s$) for use as an admixture in fresh concrete.

2. References

2.1 AASHTO: T-303

2.2 ASTM: C-1260, C-1567

3. Apparatus and Tools

3.1 Refer to AASHTO T-303 for test apparatus and tools.

4. Test Specimen Preparation

4.1 Refer to AASHTO T-303 for sampling and preparation of test specimens

5. Procedure

5.1 For each coarse, fine and intermediate aggregate perform the following procedures

5.1.1 Control Test – Refer to AASHTO T-303 for test procedure, except continue taking measurements for 28 days.

5.1.2 Lithium Nitrate Dosage Test – Refer to AASHTO T-303 for test procedure except:

5.1.2.1 Add 0.74 ratio of [Li/(Na+K)] to the mixing water using the following equations (refer to section 6 for an example):

$A = C \times (P/100)$

Where:

A = Alkali content

C = cement content

P = % Na_2O equivalent in cement

$d = A \times 4.63$

Where:

d =dosage of $LiNO_3$ 30% solution added to the mixing water (ml).

D = d x 1.2

Where:

D = dosage of $LiNO_3$ 30% solution added to the mixing water (g).

W = w – (D x 0.7)

Where:

w = Water content (g)

W = adjusted water content to account for water in $LiNO_3$ 30% solution (g).

5.1.2.2 Add 0.148 ratio of [LI/Na] to the soak solution. To produce 1 L of soak solution, add 500 ml of 2M Standard NaOH to a 1L volumetric flask, followed by 28.4 ml of $LiNO_3$, and then add de-ionized water to the 1000 ml mark.

5.1.2.3 Continue taking measurements until 28 days.

6. Calculations

6.1 Calculate the expansion of each test according to AASHTO T-303

Where:

E_1 = 28 day expansion of the control test

E_2 = the 28 day of the Lithium Nitrate Dosage Test.

6.2 Calculate the ratio [Li/(Na +K)] to be used as an admixture.

Ratio = 1.0 +0.7[(E_2-E_1)/ E_1]

6.3 Calculate the amount of Lithium in gallons needed per pound of alkalis:

G=(ratio/0.74) x(0.55 gal/lb Na_2O_{eq})

Where G= gallons of 30 % $LiNo_3$ of alkalis.

Note : for low alkali cement use 0.6 % Na_2O_{eq}.

7. Example

7.1 The following example performs the required calculations of section 5.1.2 for the testing of three mortar bars.

7.1.1 Given:

C = 440g

P = 0.52%

w=220g

7.1.2 Therefore:

A = C x (P/100) = 440 x(0.52/100)=2.29g

d = A x 4.63 =2.29 x 4.63 =10.6ml

D = d x 1.2 = 10.6 x 1.2 = 12.7g

W = w – (D x 0.7) = 220 – (12.7x0.7) = 211.1g

7.2 The following example performs the required calculation required in section 6 for determining the lithium nitrate dosage.

7.2.1 Given:

E_1 = 0.82% as determined by AASHTO T-303 extended to 28 days

E_2 = 0.34% as determined above at 28 days

Ratio = 1.0 +0.7[(E_2-E_1)/ E_1] = 1+ 0.7[(0.34 – 0.82)/0.82] = 0.59

7.2.2 Therefore:

G = (ratio/0.74) x(0.55 gal/lb Na_2O_{eq}) = (0.59/0.74) x (0.55) = 0.44 gal/lb alkalis

8. Report

8.1 Report all information required per AASHTO T-303 plus all additional calculations.

Idaho Standard Practice for

Inspecting / Sampling Paint and Curing Compound

Idaho IR-7-04

1 Scope

1.1 This method is intended to cover the inspection and sampling of product components and production batches of paints and curing compounds.

2 References

2.1 ASTM D 3925 Standard Practice for Sampling Liquid Paints and Related Pigmented Coatings

2.2 Federal Standard Test Methods 141

Method 1022 Sampling for Inspection and Testing

3 Terminology

3.1 Batch – A batch is defined as a unit or quantity of material produced at one (1) operation, the weight and volume of which may vary, depending on the manufacturing facilities. As an example, a number of small mill grinds may be combined together in a larger mixer. This material will be considered as one (1) batch and should be labeled as such. Similarly, when a number of varnish cooks are reduced in the same tank the combined reduced material shall be considered as one (1) batch.

3.2 Boxing – Boxing is a method by which a product that is exhibiting settlement is uniformly remixed without the use of power agitation equipment. (Boxing is accomplished by pouring approximately 60% of the liquid portion of the material into a new clean container that is the same size or larger than the package product. Stir the remaining liquid and the settled portions of the material into a uniform thin paste.) The previously removed liquid portion is then poured slowly and with constant stirring back into the original container. The contents are finally poured back and forth from container to container until the product is uniformly mixed and a representative sample can be taken.

3.3 Inspection – Refers to the collection of documentation and visual observation of materials. Inspection does not necessitate the destruction of the packaging or physical alteration of the product. Inspection should include the examination and reporting of the condition of the material in containers, number of units involved, type, class, grade, color, review of manufacturer’s documentation, or other visual considerations of the units as may be called out in the product specifications. Inspection may also include the witnessing of a sample being taken by an authorized manufacturer’s representative.

3.4 Cake – Dry settlement found in the bottom of a container.

4 Apparatus

4.1 One quart metal cans for solvent based curing compounds and paints.

4.2 One quart lined metal cans for water based curing compounds and paints.

4.3 Mixing equipment consisting of stir paddles, jiffy mixers, shakers, air stirrers, mechanical roller mixers, recirculation pumps, and buckets for boxing.

4.4 Dry pigment sampling equipment consists of Keystone Sampler and Splitter.

5 Sampling at Locations

5.1 Manufacturing Plant

5.1.1. Materials are generally packaged and ready for shipment at the time of arrival of the inspector. However, in some instances when large amounts of material are involved, the manufacturer may not have filled the containers, but will hold the material in a large tank until the inspector arrives. Samples will be collected from either the containerized products or from the holding tanks.

5.2 Project Site or Fabrication Plant

5.2.1. The packaged materials are at the project site or fabrication plant and will be sampled by the inspector.

6 Inspection and Sampling Procedures

6.1 Products are inspected for uniformity and samples are taken for the purpose of having a representative quantity, from each batch of material, for physical examination and laboratory testing. The samples will be analyzed to ascertain if the materials meet the specification requirements, the covering product specification, and to determine uniformity within a batch.

6.2 No set of directions for sampling, however explicit, can take the place of judgment, skill and previous experience on the part of a person actually engaged in the sampling and in the supervision of the sampling. These directions are intended to supplement this experience and to serve as a guide in the selection of the sampling method.

6.3 All containers shall be marked with the production batch number, date of manufacture, and product name. At least one (1) sample shall be taken from each batch.

6.4 For all grades of materials, precautions shall be taken to assure the sampling apparatus and the samples themselves are not contaminated and are clean and dry. Slight contamination of the product may lead to false test results. Use the appropriate container for the type of material that is being sampled (Refer to Section 3.1 and 3.2, above).

6.5 The batches shall be sampled according to the applicable plan as describe within this method. Samples shall be selected at random so that they are representative of the batch.

6.6 The samples shall be of such size as to permit the performance of all inspections and laboratory tests. In most cases, one (1) quart of liquid or one (1) pound of dry material is sufficient.

6.7 To the extent possible, it is advisable that original, unopened containers within each batch be selected as samples. When individual containers are less than the one (1) quart or one (1) pound size a sufficient number of containers shall be selected to achieve the required size. Obviously it is not always convenient or economical to have samples of very large size be submitted for testing. In these cases, care must be exercised so that samples are uniform and representative of the batch of material.

6.8 For dry pigments and resins, the package shall be opened by the inspector and a representative sample taken at random from the contents. This sample shall be placed in a clean, dry, metal container closed with an air tight cover, sealed, marked and sent to the Central Laboratory.

6.9 For liquid material the original unopened containers shall be sent to the Central Laboratory. When this is not applicable the inspector shall determine, by thorough testing with a paddle or spatula, if the material meets the absence of caking requirements in the container. The inspector shall thoroughly mix the contents of the container and draw a sample as specified, normally not less than one (1) quart. This sample shall be placed in a suitable clean and dry container. The sample should be filled as full as possible to minimize air contact within the container. The container is then closed with a tight cover, sealed, marked and sent to the Central Laboratory for testing.

6.9.1. With material that has a significant amount of pigment added such as single component zinc paint the zinc settles out rather quickly. The zinc needs to be mixed extensively by the use of a jiffy mixer so that the zinc is suspended back into the binder. Continue agitation with the mixer while taking a sample to insure proper sampling of the material.

6.10 The sample container should be dry and not cooler than room temperature. Because pigmented products are dispersions and not solutions, finely divided pigment particles may settle upon standing. Consequently, thorough and careful agitation of the product before sampling is necessary to restore the product to its original, uniform condition. The method of agitation or stirring is therefore of prime importance.

6.11 6.11 Do not place samples in plastic bottles because volatile solvents may diffuse through the walls. Loss of the solvents may introduce errors in such tests as viscosity, weight per gallon and nonvolatile content as well as other properties. (Refer to Section 3.1 and 3.2 for the appropriate containers.) Place either safety clips or a safety ring on the lid of the sample container prior to shipping

6.12 When representative samples have been obtained and packaged in clean closed containers send them promptly to the Central Laboratory for testing along with all the batch and product information.

6.13 During the period between sampling and delivery, it is important that samples be kept at temperatures from 40 to 90°F. Extreme temperatures may change the properties of some products.

---

7 Uniformity of Samples

7.1 Clear Liquid Products. Clear liquid products require stirring prior to sampling to achieve uniformity and a representative sample. Care must be taken so that any separation, sediment, gel or other matter indicative of non-uniformity is reincorporated back into the product prior to sampling.

7.2 Pigment Liquid Products. Pigmented liquid products require stirring prior to sampling to achieve uniformity and a representative sample. Where there is settling, or separation of constituents, these should be reincorporated by “boxing” or other means of agitation that will sufficiently homogenize the sample to uniformity prior to sampling.

7.3 Dry Pigments and Powders. Ordinarily dry pigments, powders, hard resins, etc. are more likely to be uniform than pigmented liquids. Care must be exercised to ensure that samples of these materials are representative of the batch being sampled. For sampling very large containers of these materials a Keystone Sampler and Sample Splitter should be used.

8 Sampling According to Container Size

8.1 Containers Smaller Than 5 Gallons.

8.1.1. When the batch to be sampled is contained in multiple small containers and batch numbers are marked on the containers, put all containers from the same batch together. From each batch select at random one percent (1%) of the containers, but not more than five (5) containers, for sampling. For example, it there are 275 containers in a batch, randomly select three (3) for sampling. A minimum of one (1) sample is required per batch.

8.1.2. After selection of the containers to be sampled, thoroughly agitate or stir the contents. Acceptable methods of mixing are mechanical shaking or stirring, or hand stirring with a paddle, followed by boxing. Mechanical shakers are desirable for most materials since there is thorough agitation in a closed container. Before mechanical shaking, open the container and check to be sure that the pigment has not caked on the bottom of the container. If caking exists, stir manually or with a jiffy mixer to break up the hard settling and then put the containers on the mechanical shaker again. Agitate products having a weight per gallon of 11 lbs/gal or less on the shaker for 5 minutes and those with a weight per gallon of more than 11 lbs/gal for 10 minutes. After agitation, check the products for uniformity again before sampling. If the product is not uniform repeat the process until the product is brought into uniform consistency. After thorough agitation decant a one (1) quart can full and send to the Central Laboratory for testing.

8.2 Containers Larger than 5 Gallons.

8.2.1. From each batch select at random five percent (5%) of the containers, but not more than three (3) containers, for sampling. A minimum of one (1) sample is required per batch. Drums may be stirred satisfactorily by several means. With open-head types, mechanical or manual stirring may be used. Some drums contain their own agitators; drum shakers or rollers may also be used. After agitation, check the products for uniformity again before sampling. If the product is not uniform repeat the process until the product is brought into uniform consistency. After thorough agitation decant a one (1) quart can full and send to the Central Laboratory for testing.

8.3 Containers from 250 to 500 Gallons (Totes)

8.3.1. From each batch randomly select one (1) tote per 5000 gallons of material for testing. For example if the batch represents 12,000 gallons take three (3) samples from three (3) separate totes within the batch. The material shall be thoroughly agitated by using mechanical mixers or recirculating the material. Recirculating the material shall be done until the entire contents have been turned over within the tote a minimum of three (3) times. The pump rate shall be adequate to achieve this recirculation rate of the material within 1 hour. Alternatively the material may be pump into an empty tote and then pumped back and forth, a minimum of three (3) times, similarly to boxing the material until the material is thoroughly agitated and mixed. Once complete mixing has been accomplished open the valve of the tote and allow a minimum of 2 gallons of product to flow into a 5 gallon bucket. Examine the product for uniformity and then take a one (1) quart sample from the 5 gallon bucket and send it to the Central Laboratory for testing.

8.3.1.1. Care should be used in pump selection as the gear driven pumps can cause shearing in waterborne products causing the emulsion components to separate.

8.4 Alternative Sampling Procedure.

8.4.1. When it is impractical, inconvenient, or dangerous to take samples as described above, and where permitted, samples may be taken in the manufacturer’s plant during filling operations or in the production line as applicable. In such cases samples should be taken near the beginning, in the middle, and near the end of the operation. These individual samples should be a minimum of one (1) quart each. Sampling in this manner must be supervised by a representative of the purchaser. Once the three (3) samples have been collected mix them together uniformly, decant the product into a one (1) quart can and send the sample to the Central Laboratory.

8.5 Composite Samples.

8.5.1. While not recommended, occasionally composites samples may be permitted for economy in testing. The use of composite samples requires prior approval of the Central Laboratory. When permitted a composite sample shall be used to represent the batch of material in its final state.

9 Disposition of Samples

9.1 Unless otherwise specified each sample taken as directed herein shall be sealed in a clean, dry one (1) quart size container and marked so as to clearly identify the batch number of material involved. Unless otherwise specified, each sample shall be inspected and sampled in accordance with these specifications. Failures of any sample to meet the product specification requirements shall be cause for rejection of the material.

10 Termination of Sampling

10.1 When in the course of sampling, the material is found to have serious and obvious defects sampling shall be terminated and resumed only after defects have been corrected or the defective material is replaced.

11 Time of Sampling

11.1 Samples shall be taken as soon as possible after manufacturing or delivery to a site location.

12 Laboratory Testing Time

12.1 Allow a minimum of two (2) weeks for test results on all products after they have been received into the Central Laboratory.

Idaho Standard Practice for

Determining Total Solids-Latex Percent

Idaho IR-121-98

1 Scope

1.1 This involves the determination of the percent of solids on all latex samples. It involves weighing a sample of wet latex, drying it in an oven, and expressing the weight ratio of dry/wet in percent.

2 Procedure

2.1 All samples to be tested must be at room temperature. If the sample is warm, it can be cooled in a pan of cold tap water.

2.2 Weigh three (3) aluminum cups and record the weight of each (tare weight).

Note: Every sample tested must be done in triplicate.

2.3 Mix by hand each sample when cool by inverting the container five (5) to ten (10) times.

2.4 Weigh approximately one (1) gram of latex to the nearest milligram into each preweighed aluminum cup.

2.5 Place all three (3) samples in the oven to dry for 120 minutes at a temperature of $285^{o}F \pm 2^{o}F$ ($140^{o}C \pm 1^{o}C$).

2.6 Remove the samples from the oven and place immediately in a desicator for a few minutes or until cool. This prevents moisture pick-up from the air while cooling.

2.7 Reweigh each sample out of the desicator to the nearest milligram and record.

3 Calculations and Report

$$\text{Total solids in percent} = \frac{C - A}{B - A} \times 100$$

Where:

A = The weight of the empty cup
B = The weight of the aluminum cup and the wet sample
C = The weight of the aluminum cup and the dried sample

3.1 Example:

If A = 1.374 g
B = 2.356 g
C = 1.779 g

Then C - A = 1.779 - 1.374 = 0.405 g

B - A = 2.356 - 1.374 = 0.982 g

Therefore $\frac{C - A}{B - A} \times 100 = \frac{0.405}{0.982} \times 100 = 41.2\%$ solids

3.2 If all three (3) samples are within 2%, average the three (3) samples to obtain the percent solids.

3.3 If all three (3) samples are not within 2%, but two (2) samples are within 1%, report the average between the two (2) samples within 1% as the percent solids and discard the third determination.

3.4 If all three (3) samples are not within 2% and no two (2) are within 1%, discard all the values and repeat the solids procedure.

Idaho Standard method of Test for

Resistance R-Value and Expansion Pressure of Compacted Soils and Aggregates

Idaho IT-8-11

ITD Standard Specification Designation: Idaho T-8

This method covers the procedures for determination of Resistance R- value and Expansion Pressure for compacted soils or aggregates. This test method is divided into the following parts:

I. Method of Preparation of Materials

II. Method of Compaction for Test Specimen

III. Method of Determination of Exudation Pressure

IV. Method of Determination of Expansion Pressure

V. Method of Determination of Resistance R-value by Means of the Hveem Stabilometer

VI. Method of Calculating the Densities of Test Specimens

PART I. METHOD OF PREPARATION OF MATERIALS

1. Scope

This part of the procedure describes the methods of batching , mixing and curing of the materials.

2. Apparatus

2.1 Mechanical mixer.
2.2 Scales, 5000 g. capacity, accurate to 1.0 g.
2.3 Scales, 175 lb. capacity, with 0.1 lb. graduations.
2.4 Set of screens, 3", 2", 1", 3/4", 1/2", and No. 4.
2.5 Fiberglass pans and cover.
2.6 Vinyl plastic sheets large enough to cover fiberglass pans.
2.7 Burette or graduated cylinder for measuring water.
2.8 Riffle splitter with chutes 3/4" wide.

3. Test Record Form

Keep all pertinent data regarding the soil sample on the ITD-899 Preliminary Soils Worksheet.

4. Preparation of Sample

4.1 Refer to Test Method AASHTO R 58 for preparation of samples.
4.2 The preparation of test samples must include removal of coatings from coarse aggregates, and clay lumps must be broken down to pass the No. 4 sieve. This is important because

relatively small test samples are used. It is also important that the test sample be accurately prepared.

5. Determining of Grading and Batch Weights Used in Preparing Test Samples

5.1 Definitions of "Original" and "As used" grading:

"Original": Original grading is grading on a sample prior to any adjustment such as scalping, wasting, or crushing.

"As used": As used grading is the grading after the material has been adjusted as necessary to meet the specifications or to eliminate material too large to test. This adjusted grading is referred to as the "As used' grading. In cases where 100% of the material as received passes the 3/4" sieve and no adjustments are necessary, the "Original" and the "As used" grading will be the same.

5.2 Criteria for scalping (removing the oversize material) samples containing oversize material.

5.2.1 If 75% or more of the sample as received passes the 3/4" sieve, scalp the sample on the 3/4" sieve.

5.2.2 If less than 75% of the sample as received passes the 3/4" sieve, scalp the sample on the 1" sieve.

5.3 A total of 13 lb. is used to ensure sufficient material for five specimens and a moisture sample.

5.4 Calculations required for determining the "As used" grading are as in the following example:

Given an aggregate with the following grading:

More than 75% of the sample as received passes the 3/4" sieve, so scalp materials above the 3/4" sieve.

Sieve	Original % Passing	Corrected % Passing	Corrected % Retained	Accumulated Weight, Lb.
1"	90			
3/4"	85	100	0	0
1/2"	75	88	12	1.6
No. 4	65	77	23	3.0
Weight of Sample				13.0 lb.

Using the above example, weigh out 1.6 lb. (13 x 12/100) of retained 1/2" materials; add to this 1.4 lbs (13 x (23-12)/100) of retained No. 4 material and 10.0 lb. of minus No. 4 material to make a total of 13.0 lb.

If the corrected percent retained on the No. 4 sieve is less than 6%, no plus No. 4 material need be added and the sample is treated as though 100% passed the No. 4 sieve.

5.5 Add to the sample enough water to approach optimum. This operation is performed by placing the 13.0 lb. sample in the mechanical mixer and adding water. The amount of water added is left to the discretion of the operator and need not be recorded. Continue mixing for at least 30 seconds after the water has been added. The period of mixing given is a minimum requirement. Place the sample in a large fiberglass pan and cover with a plastic sheet in order to prevent moisture loss. Allow to stand overnight.

5.6 Before preparing the individual test specimens, an initial moisture sample of approximately 500 g having the same grading as the test sample is taken. The moisture content is determined by weighing before and after drying to constant weight at temperature of 220-230°F.

5.7 The R-value test requires the preparation of three or four test specimens at different moisture contents. The first specimen is used as a pilot specimen. After completing the pilot specimen, it can be used as a guide in the preparation of the other three specimens, which shall conform to the following limitations:

Height = 2.5 ± 0.05 inches
Exudation: One should be above and two below the 2,500 lb. exudation load (200 psi pressure) or two above and one below 2,500 lb. load. The exudation load should be between 1000 and 5000 lbs.

Should the pilot specimen satisfy both height and exudation load requirements, it may be used as one of the sample specimens and only three (two additional) specimens need be fabricated. It often requires about 1000 g to 1100 g of material to produce a specimen of proper height. Experience will help in amount selection. Any correction of amount necessary may be made by use of the chart in Figure 1.

5.8 The amount of water needed to bring the exudation pressure into one of the above ranges is added to the soil and mixed in the mechanical mixer. Very granular and sandy materials can be mixed as thoroughly and as easily with a pan and trowel. It is necessary here to record the amount of water added.

With the use of the mixing machine, about 30 seconds at a moderate speed is ample time to mix the material. Any amount of time over this may cause excessive loss of water due to evaporation.

5.9 To obtain a representative test specimen when the sample contains plus No. 4 material, proceed as follows:

5.9.1 Roll the 13.0 lb. sample on a plastic splitting cloth.
5.9.2 From the thoroughly rolled and mixed material, scoop out a representative portion for the test specimen.

5.9.3 Thoroughly roll the sample again and scoop out the material for the next specimen.

5.9.4 Obtain all additional specimens in this manner.

5.10 To prevent evaporation loss of moisture, keep samples covered at all times except during immediate processing.

PART II. METHOD OF COMPACTION FOR TEST SPECIMEN

1. Scope

This part of the method describes the compaction procedure for test specimens using a kneading compactor. The kneading compactor densifies the material without depending on straight compression or damaging impact, but rather by a series of individual impressions made with a ram having a face shaped as a sector of a 4" diameter circle. The kneading action is developed by the application of pressures alternately to small localized areas of the specimen while the remainder of the surface is free to move.

2. Apparatus

2.1 Kneading compactor (Figure 2).
2.2 Tared steel molds 4" height.
2.3 Mold holders.
2.4 Basket fabrication equipment.
2.5 Paper strips for making baskets.
2.6 Supply of phosphor-bronze perforated disks.
2.7 Supply of 4" diameter manila disks.
2.8 Weighted brass rod.
2.9 Trowel shaped to fit trough on compactor.
2.10 Separate trough and trowel for use with soils requiring baskets.
2.11 1/2" x 4" steel disk.

3. Preparation of Sample

Sample is prepared as in Part I.

4. Procedure

4.1 Place mold in mold holder with 1/4" thick shims between bottom of mold and base of mold holder. Place 4" diameter manila disk over 3 15/16" diameter and 1/8" thick rubber disk in bottom of mold. Place the assembled mold and holder on the compactor turntable and tighten with thumb screws.

4.2 Place well mixed sample in compactor feeder trough with the loose material distributed evenly along the full length.

4.3 Using trowel formed to fit feeder trough, push the lower three inches of material in the trough into the mold. Start compactor and maintain 75 psi foot pressure, if possible. The compactor is adjusted to give 30 blows per minute. Push the remainder of the material into the mold in 20 equal parts, using two blows of the compactor for each part of material, for a total of 40 blows. Constant adjustment of the mold stage must be made to obtain the correct length of stroke. The correct length of stroke does not allow the piston to strike the base of the cylinder, thus ensuring continuous pressure on the specimen during the loading part of the cycle. A mark is scribed on the foot guide giving a 3/4" clearance between the piston and the cylinder base. When all the material is in the mold, raise and clean the compactor foot. Remove the shims beneath the mold. Put a 4" diameter, 1/8" thick rubber disk on top of the soil and tamp 100 more times while maintaining the pressure at100 psi for these 100 blows, if possible.

4.4 Clays and clean sands may require lower compaction pressures. In these cases, use the greatest compaction pressure possible, but do not allow the foot to penetrate over 1/4" into the surface after all the material is in the mold. If the pressure is reduced, record the pressure used.

4.5 If free water appears around the bottom of the mold during compaction, stop the compactor immediately and note the number of blows. In all probability, the sample is too wet.

4.6 If the surface is left uneven by the action of the compactor foot, smooth and level the surface by gently tamping with the weighted rod. A square tipped spatula is helpful in removing the accumulation of material around the edge of the mold. Return the mold to the compactor with a 1/2" thick and 4" diameter steel disk on top of the specimen. Lower the stage 1/2" and apply about 10 additional blows without changing foot pressure. This additional leveling aids in more consistent exudation readings.

4.7 Granular materials are very difficult to handle without damage and require a paper basket to keep the specimen intact. Baskets prevent the specimen from falling out of the mold and from crumbling when transferred from the mold to the stabilometer. When a basket is used, place the specimen in four approximately equal layers in a mold before compacting by use of the portable trough. Tamp each layer lightly with about ten strokes of the weighted brass rod to arrange the coarser particles in the mold. Apply 140 blows to the specimen with compactor maintaining 100 psi foot pressure. Then remove mold from compactor keeping it upright so specimen will not fall out.
(To fabricate paper basket, see Appendix A, Method of Fabricating Paper Baskets)

4.8 Record test data into form ITD 882 “R-value Worksheet”

5. Precautions

5.1 It is important that the operator feed the material into the mold uniformly. Differences in the compactive effort can cause variation in the exudation pressures.

5.2 Even distribution of the coarse aggregates throughout the length of the feeder trough is important in order to avoid segregation in the compacted specimen. The material should be evened out and leveled manually with the fingers or spatula along the trough before starting the feeding operations.

5.3 The decision whether to use baskets on a given material must be based on experience. They should not be used if they are not needed. If baskets are not used and the specimen breaks up while being transferred into the stabilometer, the fact may not be apparent at the time, but it will result in both excessive stabilometer pressure readings and excessive displacement readings. Both of these errors tend to lower the R-value, and a group of four tests will be erratic with respect to one another. When this happens, the test must be repeated using baskets.

5.4 Care must be taken to select the proper amount of material to produce a 2.5" pat. No material shall be removed from the trough or mold in order to produce the correct height.

5.5 Precautions should be taken to avoid any drying of material during mixing, in the feed trough or in the mold.

6. Hazards

Caution must be used to make certain nothing comes in contact with the compactor foot while it is in operation. A finger caught between the edge of the mold and the compactor foot will receive serious injury.

PART III. METHOD OF DETERMINATION OF EXUDATION PRESSURE

1. Scope

This part of the method describes the procedure used to determine the pressure required to exude water from the compacted specimen. This pressure is the "Exudation Pressure" for the specimen at that particular moisture content.

2. Apparatus

2.1 Compression testing machine, 10,000 lb. minimum capacity with solid head (Figure 3). If head is spherically seated, use proper shims to lock it in such a manner that the contact face is fixed firmly in a horizontal plane.
2.2 Perforated phosphor-bronze disks, 4" diameter and 28 gage.
2.3 Moisture exudation device (Figure 4).
2.4 Press. A level equipped with a 4" diameter foot.
2.5 Filter paper. Smooth type, 4" diameter BKH qualitative, Catalog No. 28310, or equivalent.
2.6 Height gage.
2.7 Follower ram, 4" outside diameter and 6" height.
2.8 Supply of 4" diameter manila disks.

3. Sample

The specimens as prepared in Part II.

4. Procedure

4.1 Place perforated phosphor-bronze disk directly on tamped surface of specimen in mold and place a single piece of filter paper on the disk.

4.2 Invert mold with specimen so that filter paper is on the bottom, and place mold on the moisture exudation device. Place 4" manila disk on top surface. Then push specimen through to other end with press. It is very important that the mold be centered on the exudation device; this is accomplished by viewing in the mirror and adjusting as necessary. In the case of a basket specimen, do not invert the sample prior to placing on the exudation device; simply center a filter paper on the contact plate and wipe moisture from bronze disk. Then place mold containing basket and material on filter paper.

4.3 Insert the follower ram in top of the mold on the specimen. Attach battery clamp to mold and place exudation device with mold in the testing machine and center to ensure even loading.

4.4 Use the testing machine to apply an increasing load at the rate of 2,000 lb. per minute until there are lights on in five of the six sections of the moisture exudation indicator device (Figure 5). Note and record the load at this point. However, if free moisture becomes visible around the bottom of the mold, covering an area approximately 2" in length (which should touch four contact points) and there are lights on in at least three of the six sections, record the load at that moment in lieu of waiting for five sections**.**

4.5 Discard the specimen if the exudation load does not fall within the required range. A low of 1,000 lb and a high of 5,000 lb may be accepted if necessary.

4.6 Leave the mold with follower in place on the exudation device and then place the height gage over mold and follower. Allow dial to come to rest, then read and record. A constant of 2" is understood; that is, if the dial was to read 0.460, the actual height would be 2+0.460 = 2.460".

4.7 Record all test data in form ITD 899

4.7 Next, remove height gage, follower, manila paper, bronze disk, and filter paper and weigh the mold with specimen and record. In the cases where a basket is used, the weight of the basket must be taken into consideration and accounted for by adding its weight to the weight on the mold. The basket's average weight is about 33 g.

5. Precautions

5.1 When the exudation contact plate becomes worn or grooved and the contact points become raised or depressed, the plate should be machined to a plane surface or replaced.

5.2 The operator must wipe the contact plate dry between tests, since any moisture remaining will prematurely dampen the new filter paper and cause erroneous exudation pressure results.

5.3 The height gage must be checked and reset daily to ensure correct readings.

5.4 Wipe plate of basket prior to contact with filter paper.

6. Notes

6.1 Occasionally material from exceptionally heavy clay test specimens will extrude from under the mold and around the follower ram during the loading operation. Yet, when the 5,000 lb load point is reached, less than five sections are lit. When this occurs, the soil is of very poor quality and should be reported as having R-value less than 5.

6.2 There are many cases where high quality materials of a gravelly, sandy or silty nature will have exudation pressures that are extremely sensitive to slight changes in moisture content. Very often these pressures will appear erratic and out-of-step with the sequence of moistures. However, these materials generally exhibit uniform R-values having small variation throughout the entire range of exudation pressures and moisture contents. The R-value versus exudation curve is drawn as an average value in these cases.

PART IV. METHOD OF DETERMINATION OF EXPANSION PRESSURE

1. Scope

The expansion test is used to determine the amount of ballast required to prevent a reduction in density of a soil due to expansion when the soil becomes saturated.

2. Apparatus

2.1 Swell frames (Figure 6)
2.2 Micrometer dial calibrated to 0.0001" mounted on a tripod designed to fit the swell frame.
2.3 Proving ring for adjusting swell frames
2.4 Perforated disks with screw stems.
2.5 5/16" open-end wrench.

3. Sample

The samples are the soil specimens as removed from the exudation device. Each specimen should be allowed to rebound for at least 30 minutes after the exudation test before assembling in the swell frame.

4. Procedure

4.1 Place micrometer dial in position on swell frame. Using the 5/16" open-end wrench, adjust the swell frame for an initial reading of minus (-) 0.0016" (the dial will read 0.0084"). You may notice a variance in the dial as there is a slight amount of play as the dial sits on the swell frame, so for the sake of uniformity, the dial is placed as far to the right as possible. The swell frames should be checked periodically with the proving ring and adjusted.

4.2 Place one of the perforated plates with screw stems on top of specimen. Place the mold in the swell frame, making sure the base of the frame is dry and free of dirt and sand. After the 30-minute rebound period, adjust the screw stem on the disk until the micrometer dial reads 0.0000" with the dial placed as far to the right as possible. This is equivalent to a surcharge pressure of 0.5 psi. It is necessary that the pointed end on the screw stem makes contact with the elastic steel bar exactly in the center. This can be accomplished by visually sighting it in from two different angles. Add water to a depth of approximately 3/4" above the perforated disk and allow the mold to remain in the swell frame overnight or a period of at least 16 hours. Do not readjust the screw stem after adding the water to the mold.

4.3 After the 16-hour waiting period, read the deflection of the steel bar by means of the micrometer dial and record on the work sheet. It is again important that the dial be pushed as far to the right as possible. The amount of drainage should also be indicated by the presence or absence of free water at the base of the mold. No drainage at all is indicated by a zero. Slight drainage will be denoted by "SL" and is recognized by a small amount of free water at the base of the mold. Moderate drainage will be "MOD" and is recognized by free water at the base of the mold and a definite drop of the water level inside the mold. Free drainage, denoted as "FD", will be completely void of standing water inside the mold. If the specimen is free draining, a little water must be added and allowed to percolate through in case the sample has dried out considerably.

4.4 The next step is to remove the mold from the swell frame, drain off the remaining water, and replace the perforated disk with a 4" Manila paper disk. Save the specimen for the R-value test.

4.5 Determine the expansion pressure in psi by multiplying the dial reading by 0.0308. Record the Expansion pressures into form ITD 899

PART V. METHOD OF DETERMINATION OF RESISTENCE R-VALUE BY HVEEM STABILOMETER

1. Scope

This method covers the procedure for determining the Resistance R-value of compacted soils or aggregates.

2. Apparatus

2.1 Hveem stabilometer (Figure 7) complete with standard metal specimen and follower .
2.2 Compression testing machine with spherically seated head.
2.3 Press. A lever equipped with a 4" diameter foot to push soil specimens from mold into stabilometer.
2.4 Dial on testing machine to measure head speed.
2.5 Stop watch.
2.6 Drying oven thermostatically controlled to maintain a temperature of 220-230°F.

3. Sample

The specimens as removed from the swell test frames.

4. Procedure

The correct volumetric adjustment of the air cell in the hydraulic chamber of the stabilometer is necessary in order to establish standardized horizontal pressure and displacement readings. The following is an outline of this calibration procedure.

4.1 Adjust the bronze nut on the stabilometer base so that the top of the stage is 3" below the bottom of the upper tapered ring. Perform all tests at this setting. The object is to have the entire briquette surface in contact with the diaphragm and any surplus diaphragm above the sample restrained by the follower.

4.2 Put standard metal specimen (4" diameter steel tube) in place in the stabilometer. Seat it firmly on the stage and by holding it in place with either the hand or a confining load of 100 lb. in the testing machine, turn the pump to cause a pressure of exactly 5.0 psi on the stabilometer gage. Adjust the turn indicator dial to zero. Turn pump handle at an approximate rate of two turns per second until the stabilometer dial reads 100 psi. The turns indicator dial should read 2.00 ± 0.05 turns. If it does not, the air in the cell must be adjusted. Remove or add air by means of the valve and repeat the displacement measurement after each air change until the proper number of turns is obtained. This initial displacement should be checked after each 3 or 4 specimens have been run through the stabilometer.

4.3 Place the mold containing the soil specimen on the stabilometer and push the specimen into the stabilometer using the press. The displacement pump should be backed off a sufficient number of turns to ensure no friction between the specimen and the diaphragm wall. Be certain free diaphragm is exposed above the top edge of specimen. All free diaphragm surface must be in contact with follower. Place the follower on top of the specimen and put the stabilometer in the testing machine with spherically seated head. Lower the testing machine head until it just engages the follower, but does not apply any load to the specimen.

4.4 Apply an initial reading of 5.0 psi on the stabilometer gage with the displacement pump. Then start the testing machine and adjust for a head speed of 0.05" per minute. The head speed must be checked and may need readjusting while the test is being made.

4.5 Record the stabilometer gage readings at loads of 500, 1,000, 1,500, and 2,000 lb, respectively, on the testing machine gage. In the case of a very expansive soil, a reading somewhat over 140 psi on the stabilometer gage at 2,000 lb. load may be encountered. In any case where 140 psi is reached before the 2,000 lb. is applied, do not continue to the 2,000 lb. point. Simply record the pressure at the 2,000 lb. load level as 140+ psi.

4.6 Vertical loading by the testing machine must cease at 2,000 lb. and the load must immediately be reduced to 1,000 lb. Turn the displacement pump so that the stabilometer gage reading is reduced to 5.0 psi. This will result in a further reduction in the applied testing machine load, which is normal and should be ignored. Set the displacement dial indicator to zero and turn the displacement pump handle to the right at a speed of 2 turns per second until the stabilometer gage reads 100 psi. During this operation, the applied testing machine load will increase and in some cases exceed the initial 1,000 lb. load. As before, these changes in testing machine loadings are normal and should be ignored.

4.7 Record the number of turns indicated on the dial as the displacement of the specimen. The turn indicator dial reads in 0.001" and each 0.1" is equal to one turn. Thus a net reading of 0.250" indicates that 2.50 turns were made and should be recorded as such on form ITD 882 “R Value Worksheet”.

4.8 Remove the stabilometer from the testing machine and release the lateral pressure. Then remove the follower and the specimen from the stabilometer.

4.9 The Resistance R-value is computed from the following equation:

$$R = 100 - \frac{100}{[\left(\frac{2.5}{D}\right)\left(\frac{Pv}{Ph} - 1\right)] + 1}$$

Where: R = Resistance R-value
D = Turn Displacement
Pv = 160 psi (Vertical pressure)
Ph = Horizontal pressure, psi (at vertical pressure of 160 psi)

This value may also be taken from the chart shown in Figure 8. Another chart is shown in Figure 9 that can be used to correct the R-value of any specimen that must be used but exceed the height limits of 2.45" - 2.55". These R-values are then plotted against the corresponding exudation pressures and connected with a smooth curve in form ITD 882.

Determine the point where the curve crosses the 2,500 lb. exudation load line (200 psi exudation pressure) and record it as the Resistance R-value for the tested material (see Example in Figure 10).

PART VI. METHOD OF CALCULATING THE DENSITIES OF TEST SPECIMENS

1. Scope

This part of the test method covers the procedure for calculating the densities of R-value test specimens.

2. Sample

The measurements of height and weight of the test specimen necessary for the density determination are made immediately after the determination of exudation pressure of R-value test specimens according to Part III of this test method and they are recorded into form ITD 899 "Preliminary Soils Worksheet" .

3. Procedure

3.1 A moisture sample of approximately 500 g is taken from the original 13 lb. sample, as explained in Part I, and the data entered into form ITD 882 "R Value Worksheet". The Moisture Content or Percent Water is computed by the following equation:

$$\% \text{ Water} = \frac{Wt.of\ Water\ (g)}{Wt.of\ Dry\ Soil\ (g)}\ x\ 100$$

3.2 The Weight of Water is determined as follow:

$$\text{Dry Weight (g)} = \frac{Original\ Weight\ (wet,g)}{1+\frac{\%\,Water}{100}}$$

Weight of Water (g) = Original Weight (g) – Dry Weight (g)

The Weight of Water is carried over to the line labeled "Wt. of Water" and entered for each specimen in form ITD 882. This is then added to the figures on the next line labeled "Water Added" giving the Total Water for each specimen. The Total Percent of Water is calculated as follow:

$$\% \text{ Water} = \frac{Total\ Water\ (g)}{Dry\ Weight\ (g)}\ x\ 100$$

3.3 The densities of the specimen are then computed from the following equations:

$$\text{Wet Density (pcf)} = \frac{Net\ Weight\ of\ Soil,Wet\ (g)}{Height\ (Inch)}\ x\ 100$$

$$\text{Dry Density (pcf)} = \frac{Wet\ Density\ (pcf)}{1+\frac{\%\,Water}{100}}$$

APPENDIX A

METHOD OF FABRICATING PAPER BASKETS FOR
R-VALUE SPECIMENS

1. Scope

This method covers the procedure for fabricating paper baskets that are used in Test Methods No. California 301 and 304.

2. Procedure

2.1 Apparatus

Basket making device consisting of a 3 7/8" diameter cylindrical wooden block and a 1/2" masking tape dispenser (see Figure 11).

2.2 Materials

2.2.1 Strips of notched paper: 60 lb. brown Kraft paper 2 1/2" x 13 3/8" with slots 1 7/8" in length and 3/4" apart down the center of the strip (see Figure 12).

2.2.2 4" diameter phosphor-bronze perforated exudation pressure disks.

2.2.3 1/2" width masking tape.

2.3 Fabrication Procedure

2.3.1 Take a piece of slotted paper and fold around the cylindrical wooden block, hooking the slotted ends together. See photos B and C of Figure 11.

2.3.2 Using four strips of 1/2" masking tape, tape phosphor-bronze disk to the paper so that the holes in the disk are not obscured in the process. See photos D and E of Figure 11.

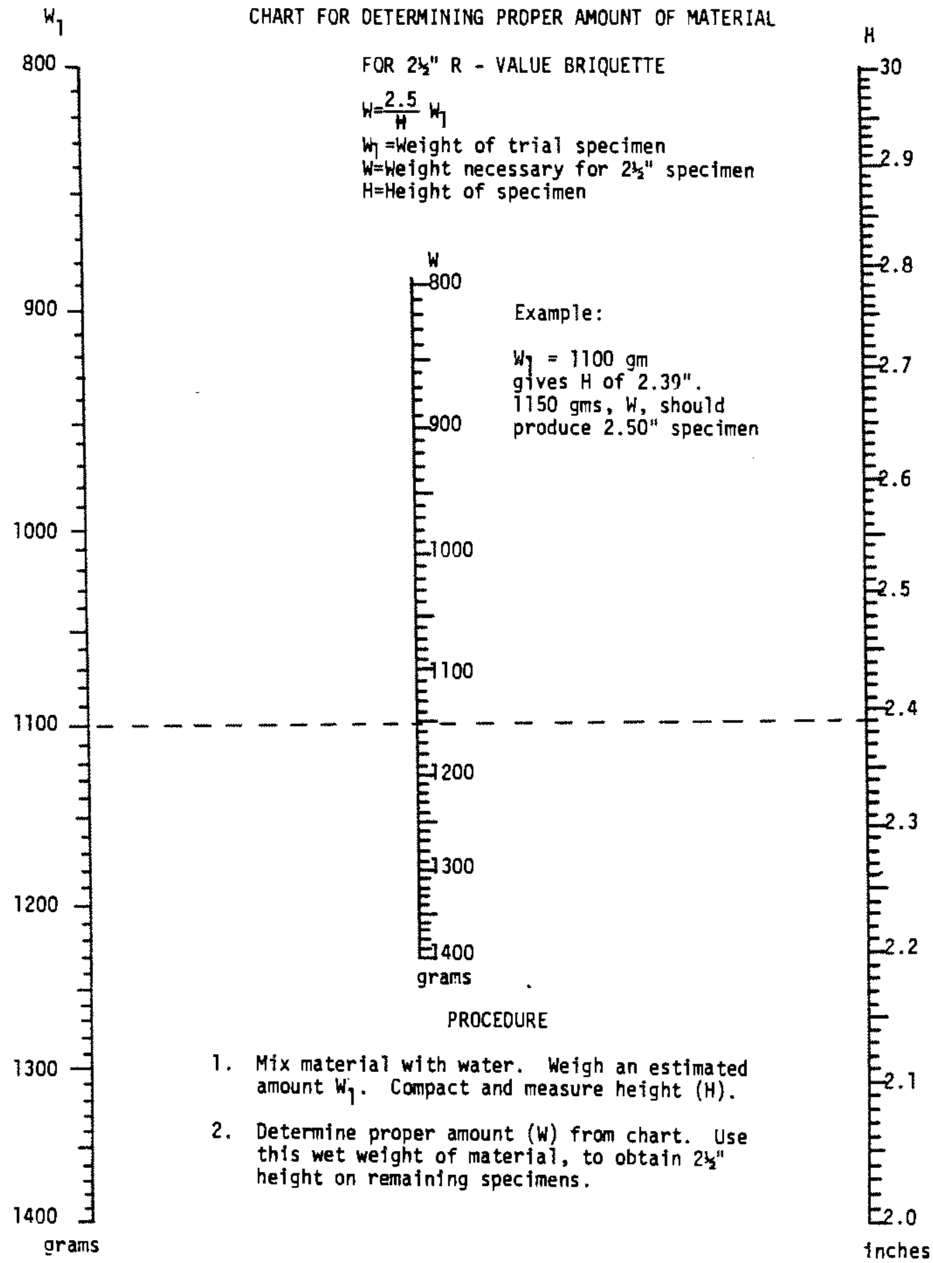


CHART FOR DETERMINING PROPER AMOUNT OF MATERIAL
FOR 2½" R - VALUE BRIQUETTE
$W = \frac{2.5}{H} W_1$
W_1 =Weight of trial specimen
W=Weight necessary for 2½" specimen
H=Height of specimen
Example:
W_1 = 1100 gm
gives H of 2.39".
1150 gms, W, should
produce 2.50" specimen
PROCEDURE
1. Mix material with water. Weigh an estimated amount W_1. Compact and measure height (H).
2. Determine proper amount (W) from chart. Use this wet weight of material, to obtain 2½" height on remaining specimens.
W_1
800
900
1000
1100
1200
1300
1400
grams
W
800
900
1000
1100
1200
1300
1400
grams
H
30
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
inches

FIGURE 1

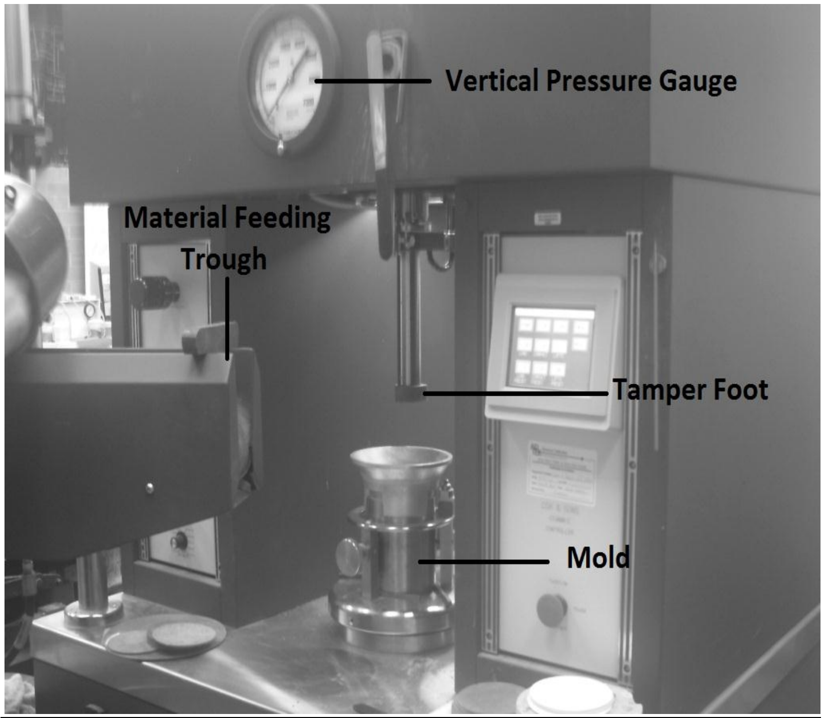


FIGURE 2: KNEADING COMPACTOR

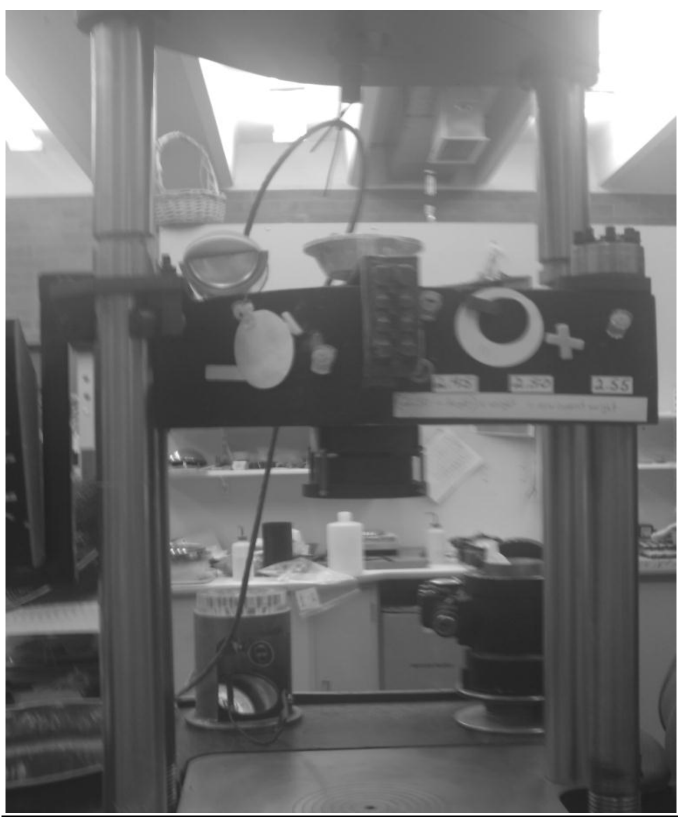


FIGURE 3: COMPRESSION TESTING MACHINE

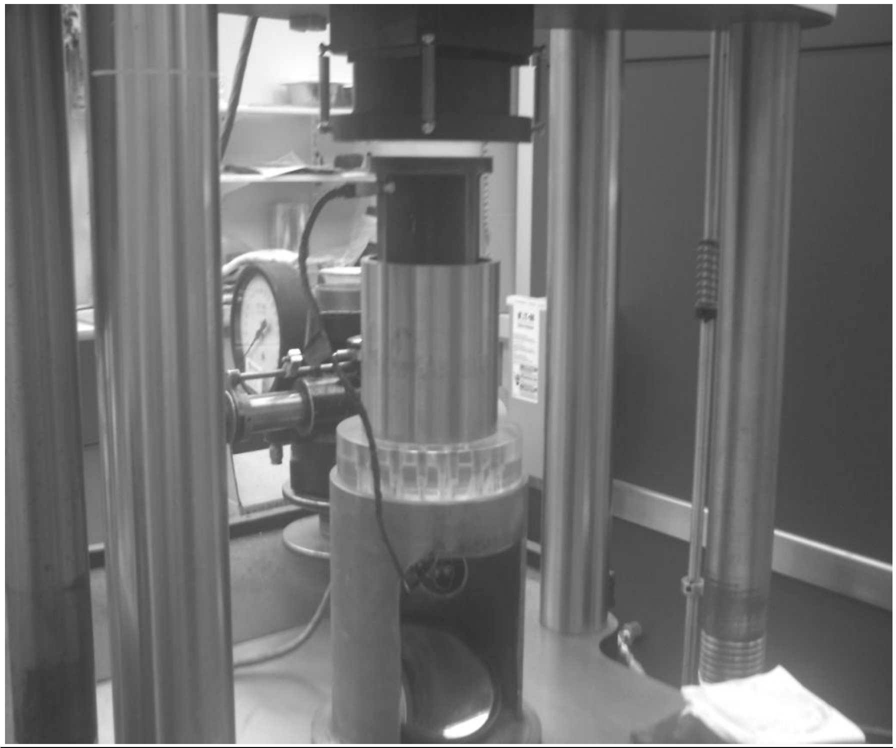


FIGURE 4: MOISTURE EXUDATION DEVICE

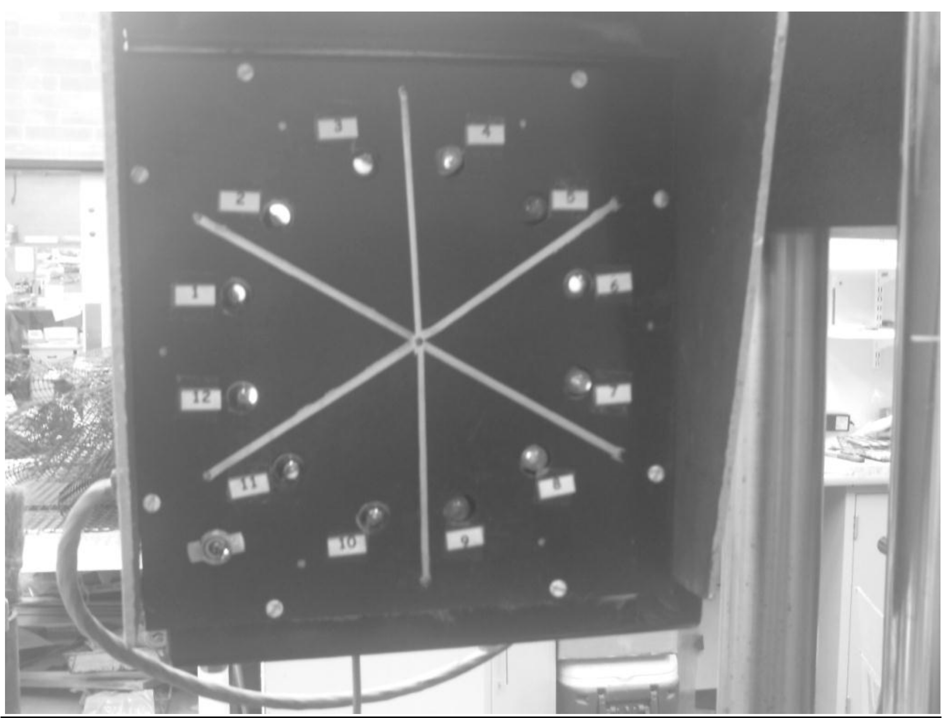


FIGURE 5: MOISTURE EXUDATION INDICATOR DEVICE WITH 6 LIGHT SECTIONS

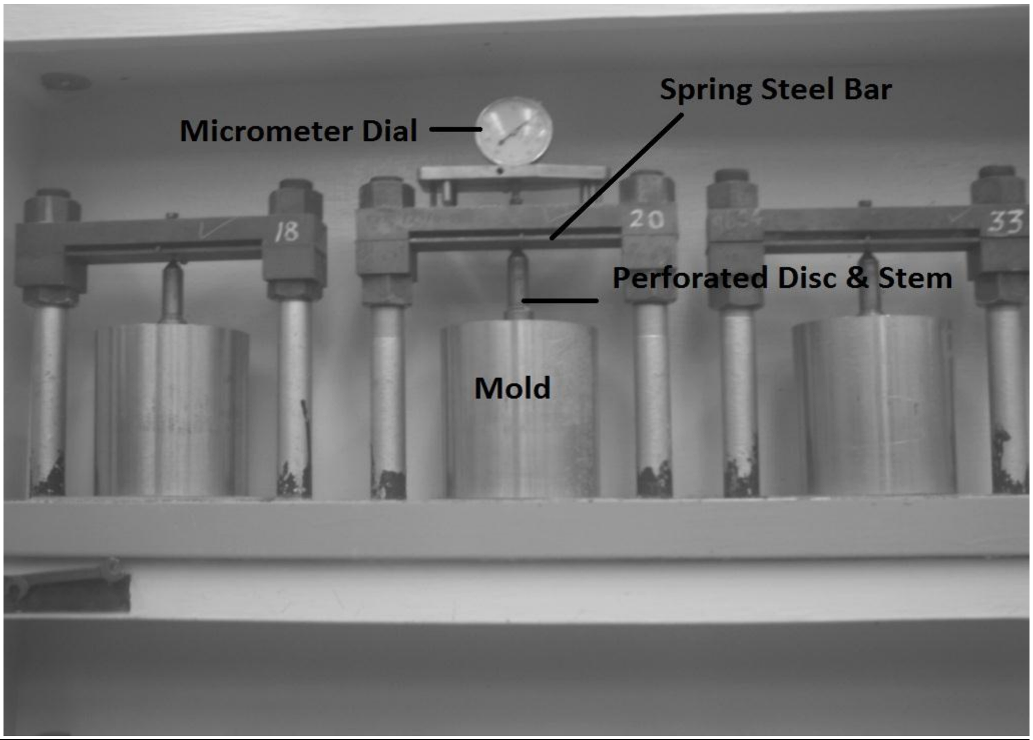


FIGURE 6: SWELL FRAMES FOR MEASURING EXPANSION PRESSURE

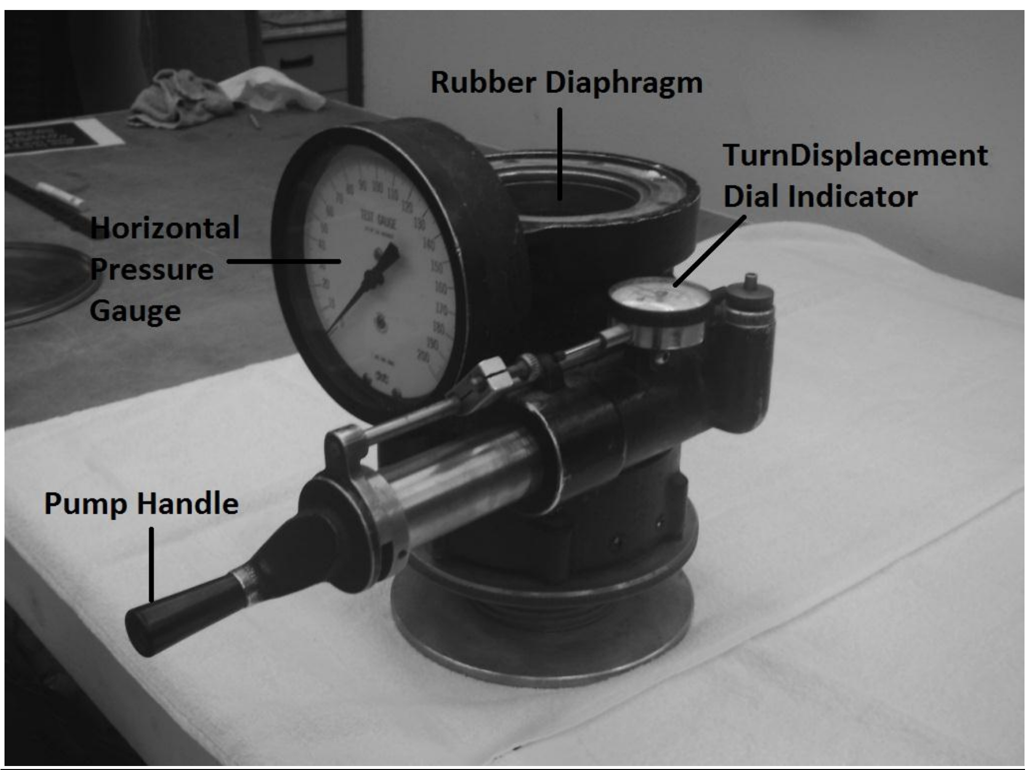


FIGURE 7: HVEEM STABILOMETER

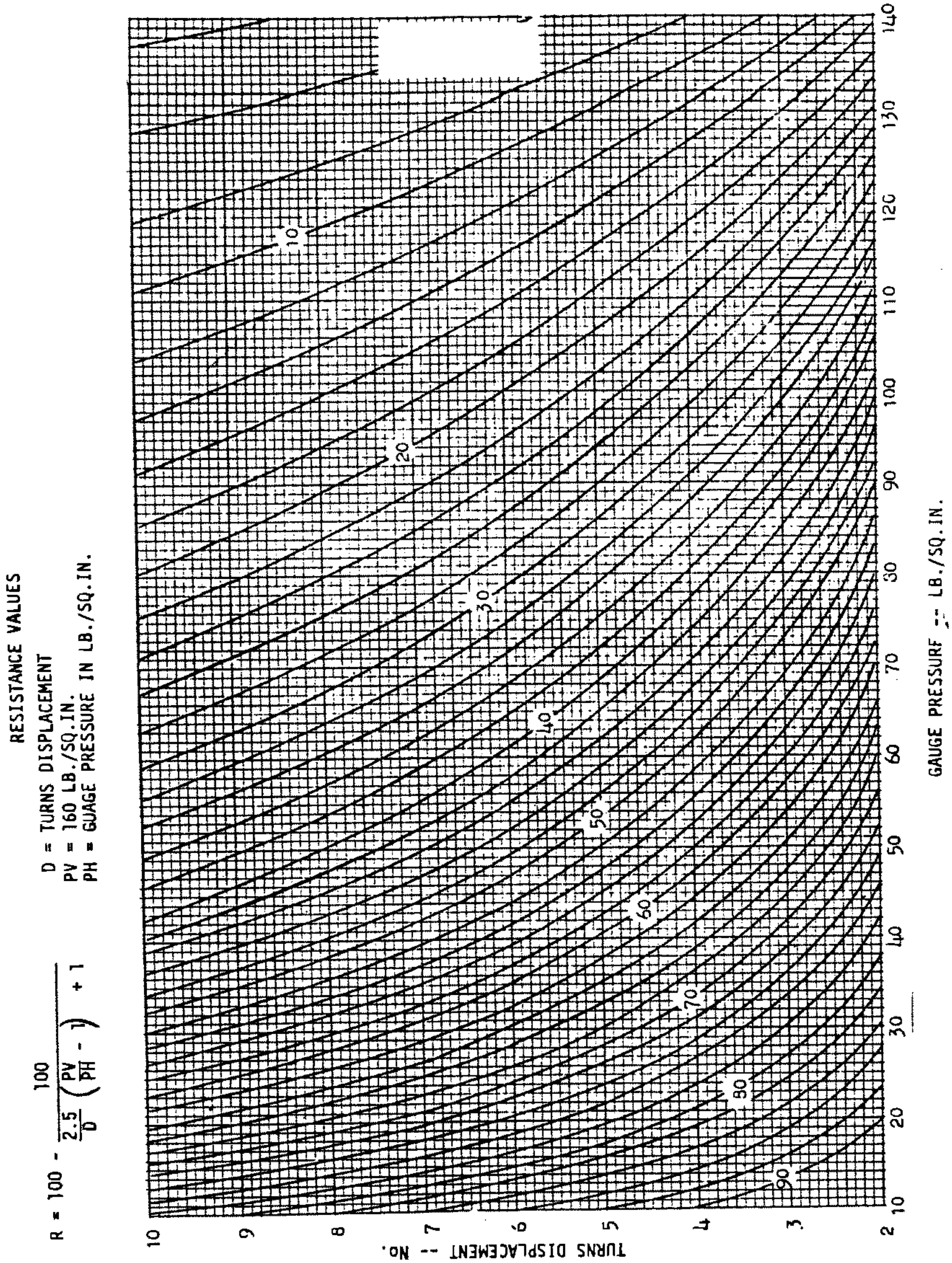


FIGURE 8: CHART FOR DETERMINING RESISTANCE R-VALUE

CHART FOR CORRECTING R-VALUES TO
SPECIMEN HEIGHT OF 2.50"
HEIGHT CORRECTION SHOULD BE
MADE USING THE CHART BELOW.

NOTE: NO CORRECTION FOR SPECIMEN
HEIGHTS BETWEEN 2.45" AND 2.55".
INTERPOLATE R-VALUE CORRECTIONS
FOR OTHER HEIGHTS.

EXAMPLE: OVERALL HEIGHT OF 2.65"
R-VALUE (UNCORRECTED) = 50
R-VALUE (CORRECTED) = 54

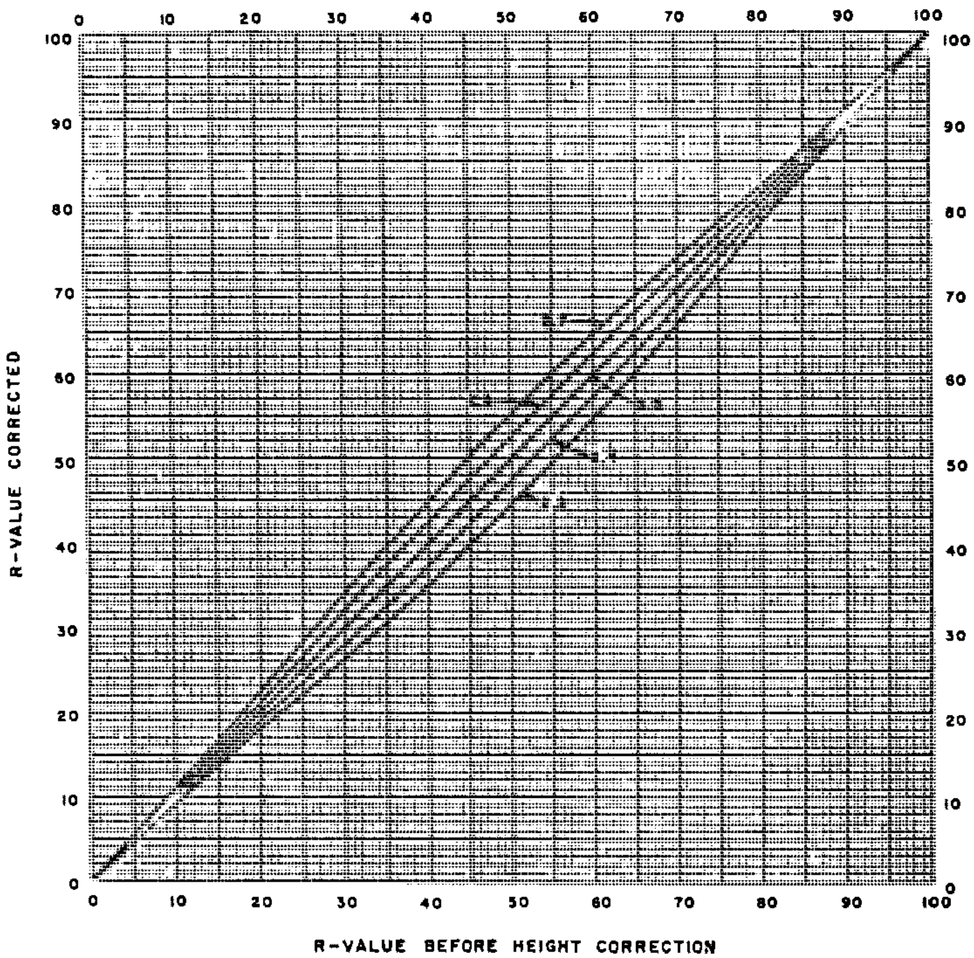


FIGURE 9: CHART FOR CORRECTING R-VALUE TO SPECIMEN HEIGHT OF 2.5”

ITD-882 2-01

R-VALUE WORKSHEET

Lab Number : ____________
Project No. ____________
Key Number : ____________

TRIAL	A	B	C	D	E
MOLD NUMBER	6	7	9	8	
ORIGINAL WEIGHT (grams)	750.6	800.7	790.6	770.9	
WEIGHT OF WATER (grams)	157	167	165	161	
WATER ADDED (grams)	75.01	64.11	58.79	49.89	
TOTAL WATER (grams)	232	231	224	211	
% WATER	39.0%	36.5%	35.8%	34.5%	
WT. OF MOLD + SOIL (grams)	2917.7	2953.7	2948.2	2920.9	
WT. OF MOLD + BASKET (grams)	2102.6	2094	2104.3	2105	
NET WT. OF SOIL, WET (grams)	815.1	859.7	843.9	815.9	
HEIGHT, INCHES	2.443	2.609	2.525	2.39	
WET DENSITY - Lbs/Cu.Ft	101.1	99.8	101.3	103.4	
DRY DENSITY - Lbs/Cu.Ft	72.7	73.2	74.6	76.9	
STABILITY Ph. 500	19	15	12	13	
Ph. 1000	33	26	23	24	
Ph. 1500	50	41	36	35	
Ph. 2000	72	62	53	49	
DISPLACEMENT	4.9	6.24	6.68	6.08	
"R" VALUE	38	39	43	48	
"R" VALUE - Corrected	37	41	44	46	
EXUDATION PRESS, LBS	1020	1917	3225	5747	
DRAINAGE	SL	SL	SL	SL	
GAGE READS	18	23	50	41	
EXPANSION PRESS. PSI	0.55	0.71	1.54	1.26	

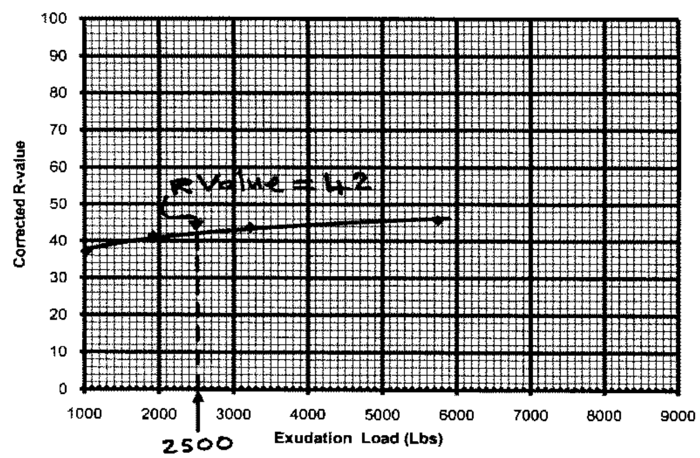
Coarse R-value Make up Calculations

Weight Of Sample					Lbs
Sieve Size	Corr. Accum. Lbs	% Passing	% Each Size	Grams Each Size	Accum. Grams
3/4 inch					
1/2 inch					
3/8 inch					
# 4					
Minus # 4					

Make Up Moisture Content Calculations

To Achive		% Moisture, Add Grams Of Water	

Comments:



CAN NUMBER	M-2
WT. OF CAN + WET SOIL, GRAMS	497.81
WT. OF CAN + DRY SOIL, GRAMS	402.86
WT. OF WATER, GRAMS	94.95
WT. OF CAN, GRAMS	42.63
WT. OF DRY SOIL, GRAMS	360.23
% WATER	26.4%

TRIAL >>>>>	A	B	C
ORIGINAL WT (gram	750.6	800.7	790.6
DRY WEIGHT (grams	594	634	626
WATER (grams)	157	167	165

TRIAL >>>>>>>>>>>	D	E
ORIGINAL WT (gram	770.9	
DRY WEIGHT (grams	610	
WATER (grams)	161	

SOIL DATA	
TRAFFIC INDEX	
"R" VALUE	42
EXPANSION PRESS, PSI	
BALLAST FROM "R"	
FROM EXP. PRESSURE	

FIGURE 10: R-VALUE TEST WORKSHEET

FIGURE 11: FABRICATING PAPER BASKET FOR TEST SPECIMEN

SPECIFICATIONS FOR THE SLOTTED PAPER USED IN FABRICATING PAPER BASKETS FOR STABILOMETER SPECIMENS

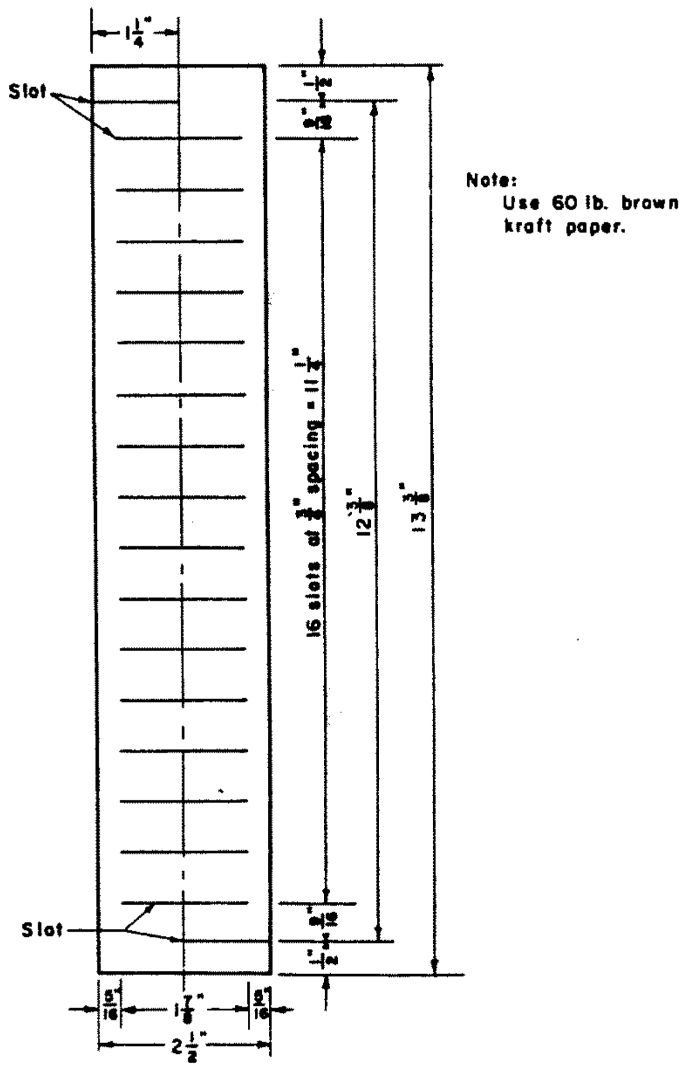


FIGURE 12: SPECIFICATIONS FOR PAPER USED TO FABRICATE BASKET

Idaho Standard Practice for

Taking Undisturbed Soil Samples for Laboratory Consolidation, Shear and Permeability Tests

Idaho IR-62-98

1 Scope

1.1 This method of sampling is designed to secure relatively undisturbed soil samples for laboratory tests. Only soils relatively free of gravel and other rock fragments are considered suitable for this type of sampling.

2 Apparatus

2.1 Mobile drill or diamond drill with standard attachments.

2.2 Clean-out device to assure a clean hole.

2.3 A 2 1/2-in. (63.5 mm) I.D. sample barrel with a supply of 1-in. (25 mm) high brass liner rings and/or a supply of 2- to 3-in. (50 to 75 mm) diameter Shelby thin-wall tubes, 18 to 36 in. (450 to 900 mm) in length with a wall thickness not greater than No. 16 (1.5 mm) gage.

3 Procedure

3.1 The boring should be cleaned out either by hand auger or air jetting to the sampling elevation. Make sure that the bottom of the boring is free of excess loose material.

3.2 With the sampling device resting on the bottom, push it into the soil by a continuous and rapid motion using the hydraulic ram on the mobile drill or diamond drill. The penetration should be approximately five (5) times the diameter of the tube. Do not push the tube farther than the length provided for the sample. The time and pressure required, when measured, should be noted.

3.2.1. If driving is required, the number of blows, driving weight, drop, and penetration should be recorded. Heavy driving weights are preferable to light driving weights because they cause less sample disturbance.

3.3 Before pulling the sample, turn it two (2) revolutions by hand to shear it on the bottom. Pull the sample tube to the surface.

3.4 After pulling the sample, measure and record the length of sample in the tube and also the length penetrated. If the ring-lined sampler is used, select a central portion of the sample and place it in the watertight containers. If the Shelby tube is used, discard the disturbed soil in the upper end. Ream the lower end to a depth of at least 1 in. (25 mm), seal both ends with wax or other approved methods, and secure with masking tape.

3.5 Containers and/or tubes should be clearly labeled as to project, boring number and location, sample number, depth taken, date taken, and personnel.

3.6 Samples should be taken to supplement in-place vane shear tests or standard penetration tests. The number taken is left to the discretion of the investigator. Generally, enough samples should be taken to provide information on each soil type encountered.

3.7 Samples should not be shipped to the Central Laboratory by common carrier, but should be delivered by state vehicle. Sedans are preferred, as the sample can be laid on the seat and cushioned. Deliver as soon as possible. No storage is permitted. Protection should be provided for heat and cold.

3.8 Dropped samples or frozen samples are of no value. Thus, precautions must be taken to eliminate mishandling.

4 Records

4.1 The following information should be taken in the field and transmitted with the samples (see also instructions for "Preparation of Field Logs,").

4.1.1. Date of boring and project identification.

4.1.2. Location of boring, including offset distance.

4.1.3. Boring number.

4.1.4. Collar elevation.

4.1.5. Log of the boring.

4.1.6. Location of the samples taken in profile.

4.1.7. Water data.

4.2 Information regarding the present topography and landform, as well as dimensions of the proposed structure or embankment, should be noted. This, plus the estimated weight per ft^3 (m^3) of a proposed embankment, should be recorded and the information supplied to the Central Materials Laboratory with the undisturbed sample.

Idaho Standard Practice for

Calibrating Torque Wrenches, Tightening and Testing Bolt Tension

Idaho IR-12-07

1 Scope

1.1 This method is intended to provide a standard procedure for the calibration of torque wrenches

2 Referenced Documents

2.2 *AASHTO Standards:*

T-67 Standard Method of Test for Standard Practices for Force Verification of Testing Machines

2.3 *ASTM Standards:*

E4-03 Standard Practices for Force Verification of Testing Machines

3 Procedure

3.1 Before proceeding with calibration, assure that the tension measuring device has been calibrated by an approved testing agency within the last year in accordance with AASHTO T-67/ASTM E-4.

Prior to each day's activities, verify the calibration of the wrench or wrenches being used. If a parameter is found to be out of calibration, adjust the wrench to assure the parameter is within the tolerable range. Report all calibration measurements including the date, out of tolerance values, and adjusted values.

4 Calibration Of Torque Wrench

4.1 Clamp the calibration unit on a solid immovable mount (e.g., beam, column, etc.)

4.2 Install front plate and matching rear bolt bushing for bolt size being used

4.3 Insert bolt from bushing side; washer and nut from plate side.

4.4 Torque Control Impact Wrenches:

Run up nut with impact wrench until wrench stalls. Read the dial for pounds tension. If reading is too high or low, adjust torque setting accordingly and repeat using new bolt and nut.

4.5 Conventional Impact Wrenches:

Set wrench air line regulator at desired power value. Run up nut until it stops rotating. Again, read the dial for pounds tension. Adjust regulator as necessary until wrench delivers desired bolt-tension dial reading.

4.6 Manual Torque Wrenches:

Run up nut with wrench until reaching desired tension. Adjust ratchet release as necessary until wrench delivers desired bolt tension dial reading. For dial gage wrenches, document the dial reading to achieve the appropriate tension on the calibration unit, or adjust the dial gage if applicable.

4.7 Wrenches shall be calibrated to induce approximately 105 – 110% of the installation bolt tension listed in the ITD Standard Specifications Subsection 708.06 for the given bolt size, and in no case exceed 125% of the listed bolt tension. Acceptable calibration will consist of three (3) bolt assemblies testing within 10% of each other.

Idaho Standard Practice for

Calibrating the Skidmore-Wilhelm Torque-Wrench Calibration Unit

Idaho IR-17-98

1 Scope

1.1 This method is intended to provide a standard procedure for the calibration of the Skidmore-Wilhelm Torque-Wrench Calibration Unit (see Figure 1).

2 References

2.1 ASTM E 4, Calibration

2.2 Manufacturer's Pamphlet

3 Equipment

3.1 Testing machine with a capacity of at least as high as the Skidmore unit and calibrated to ± 1%.

3.2 Steel pressure plates (two (2) each to fit piston No. 3 and inside plate screens No. 16).

4 Procedure

4.1 Place torque-wrench calibration unit in the testing machine with the bolt plate No. 5 centered directly under the upper compression head. In centering the unit in the testing machine, make sure the steel pressure plates are in place. One (1) pressure plate fits the piston No. 3 from the back sides, making sure it clears the snap ring No. 7. The other steel pressure plate fits over bolt plate No. 5 and inside the plate screws No. 16.

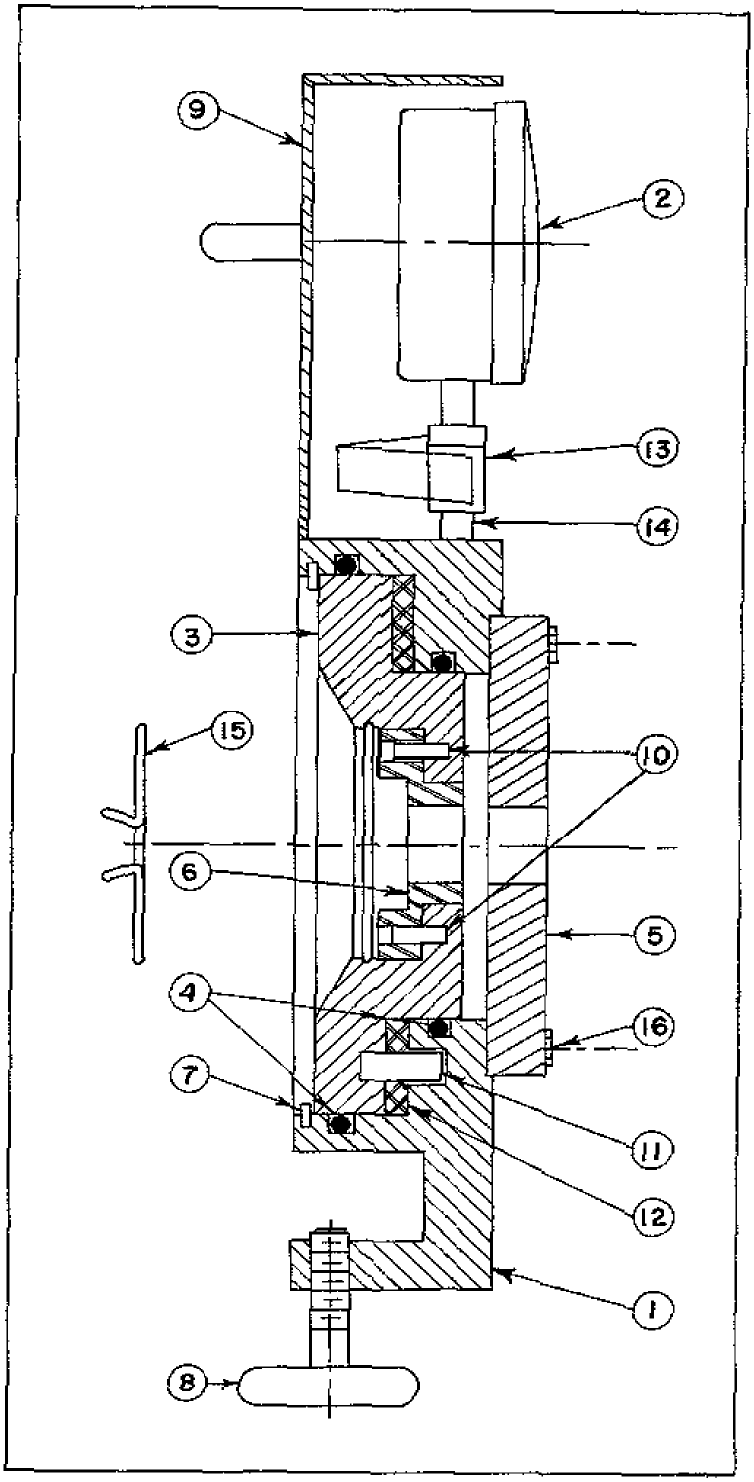
4.2 After the foregoing has been accomplished, apply pressure with the testing machine to the torque-wrench calibration unit.

Note 1: Before mating surfaces of the torque calibration unit with the testing machine heads, retain a small clearance. This clearance is then taken up with the hydraulic head of the testing machine. This step must be accomplished to prevent locking the heads of the testing machine together.

This pressure shall be at a slow, even rate so readings can be taken from both the testing machine dial and the torque-wrench calibration unit dial. This speed should not exceed 0.3125 in./minute. The Skidmore unit is read at 5,000-lb. (20 kN) increments through the total range of the Skidmore unit.

4.3 The object of this calibration procedure is to relate the pounds pressure indicated by the torque-wrench calibration unit with the pounds pressure indicated by the calibrated testing machine in exact increments of pounds to each other. If there is any deviation between the two (2) devices, the torque-wrench calibration unit must be sent to the manufacturer for repair, unless the repair is deemed minor and can be done by the laboratory accomplishing the calibrating.

Figure 1—Skidmore-Wilhelm Torque-Wrench Calibration Unit



No.	Name
1	Body
2	110,000# Gage
3	Piston
4	Set of Packing
5	Bolt Plate
6	Bolt Bushing
7	Snap Ring
8	Mounting Screw
9	Gage Guard
10	Dowel Pin (for Bushing)
11	Dowel Pin
12	S.A.E. 40 Oil (Non-Detergent)
13	Gage Saver
14	Pipe Coupling
15	Bushing Retainer
16	Plate Screw

Idaho Standard Practice for

Pavement Straightedge Procedures

Idaho IR-87-99

1 Scope

1.1 This method establishes procedures for making straightedge measurements on the riding surfaces of pavements and is intended for use with the hand-held 10 ft. (3 m) straightedge.

2 Apparatus

2.1 The apparatus shall consist of a 10 ft. (3 m) straightedge. The straightedge shall be visually straight when checked periodically against a taut fine (about 1/64 in. or 0.5 mm diameter) wire.

3 Procedure

3.1 Surface irregularities shall be measured from the straightedge to various points on the pavement surface below the straightedge. The straightedge shall be firmly supported by the pavement.

3.2 Tests for surface irregularities shall be made parallel to centerline and normal (transverse) to centerline as required to verify conformance with specified limits.

3.3 All transverse construction joints shall be measured. Make these measurements with the straightedge centered on each joint.

3.4 Individual judgement shall be exercised when taking measurements on short, steep, super-elevated sections and crowned sections of short radii such as at intersections of city streets, etc.

3.5 On bridge decks where the specifications require 90 percent of the readings to be less than 1/8 in. (3 mm), measurements shall be taken in each wheel path in continuous lines as provided in paragraph 3.2 above for the full length of the structure. In addition, at locations determined by the Engineer, straightedge measurements are to be taken perpendicular to centerline. These transverse measurements may be made either in continuous lines or as individual 10 ft. (3 m) samples at selected locations. Measure the lengths of irregularities, which are less than 1\8 in. (3 mm) below the straightedge, to the nearest 1 in. (25 mm). Add up the lengths having less than 1/8 in. (3 mm) deviation within each 10 ft. (3 m) increment, divide by the straightedge length and multiply by 100 to obtain the percentage less than 1/8 in. (3 mm). Also measure any deviations greater than 1/4 in. (5 mm) when the specification requires. Measure joints separately as provided in Paragraph 3.3 above.

Idaho Standard Method of Test for

Determining Volume of Liquids in Horizontal or Vertical Storage Tanks

Idaho IT-120-98

1 Scope

1.1 This method is used to determine the volume of liquids in horizontal and vertical storage tanks. It is usually called "sticking" the tank.

2 Purpose

2.1 The quantity of liquid materials at the beginning and end of shifts are needed to determine approximately how much material is being used each day and to compare with invoice totals at specific intervals when the tank is empty, full, etc.

3 Apparatus

3.1 A 50-foot flexible steel tape graduated in inches or tenths of feet. (A 15 m or longer flexible steel tape with markings at 0.01 m intervals.)

3.2 Graduated wooden rod made for tank measurements, if available.

3.3 Rags.

3.4 Insulated gloves (see Section 5, Safety Precautions).

3.5 Ladder, string, flashlight, etc., as found necessary.

Note 1: Many tanks have some indicator showing the height of liquid in the tank. This indicator may be a glass sight gauge; a permanently installed metal ladder gauge inside, visible from the top or through windows; a float with a pulley and indication on the outside; or other method. In case of doubt about the accuracy of these indicators, they should be calibrated using the data in this Test Method.

4 Test Procedure

4.1 Horizontal Tanks

The volume of the tank must be known or calculated as follows.

Determine the length and the diameter of the tank using calculated inside measurements. Calculate the volume:

4.1.1 English

$$V(\text{gallons}) = \frac{\pi D^2}{4} \times L \times 7.48 \text{ [D \& L are expressed in feet and tenths of feet]}$$

4.1.2 Metric

$$V(m^3) = \frac{\pi D^2}{4} \times L$$ [D & L are expressed in meters to the nearest hundredth]

4.1.3 Measure the depth of the liquid in the tank by use of the "stick" or a weighted tape. Divide this depth by the diameter of the tank and multiply by 100 to get the percent depth filled. Using this percent figure from Table 1 at the end of this Test Method, obtain the percent of capacity. Multiply the known volume of the tank by the percent capacity just obtained and divide by 100 to give the volume of hot liquid.

4.2 Vertical Tanks

4.2.1 Measure the inside diameter of the tank. Calculate the volume per foot (meter) as follows.

English

$$V(\text{gallons}) = \frac{\pi D^2}{4} \times 7.48$$

Metric

$$V(m^3) = \frac{\pi D^2}{4}$$

4.2.2 Measure the depth of liquid (h) in feet to the nearest tenth (meters to the nearest hundredth). Calculate the volume of liquid as follows:

English

$$V(\text{gallons}) \times h = \text{TotalVolume (hot)}$$

Metric

$$V(m^3) \times h = \text{TotalVolume (hot)}$$

4.2.3 Convert the volume of hot liquid obtained from Paragraph 4.1.1 or 4.2.2 to standard 60°F (15.6°C) volume using standard temperature conversion charts such as Tables IV-1, 2, and 3 of the Asphalt Institute Manual Number MS-6.

4.2.4 Convert standard temperature volume in gallons (cubic meters) to English tons (metric tons) using Table 2 at the end of this Test Method.

5 Safety Precautions

5.1 Materials being sampled are usually hazardous. They may be hot (asphalt), flammable (gas, fuel oil, or solvents), caustic (lime solutions), poison (weed killers), etc., and every care must be taken to protect the person sampling. Protective clothing should be worn. Hard hats, goggles or safety glasses, insulated gloves, long-sleeved shirts, heavy shoes, and face masks, if necessary, should be used.

Table 1— Quantities for Various Depths of Cylindrical Tanks in a Horizontal Position

% Depth Filled	% of Capacity	% Depth Filled	% of Capacity	% Depth Filled	% of Capacity
1	0.20	34	30.03	67	71.16
2	0.50	35	31.19	68	72.34
3	0.90	36	32.44	69	73.52
4	1.34	37	33.66	70	74.69
5	1.87	38	34.90	71	75.93
6	2.45	39	36.14	72	77.00
7	3.07	40	37.39	73	78.14
8	3.74	41	38.64	74	79.27
9	4.45	42	39.89	75	80.39
10	5.20	43	41.14	76	81.50
11	5.98	44	42.40	77	82.60
12	6.80	45	43.66	78	83.68
13	7.64	46	44.92	79	84.74
14	8.50	47	46.19	80	85.77
15	9.40	48	47.45	81	86.77
16	10.32	49	48.73	82	87.76
17	11.27	50	50.00	83	88.73
18	12.24	51	51.27	84	89.68
19	13.23	52	52.55	85	90.60
20	14.23	53	53.81	86	91.50
21	15.26	54	55.08	87	92.36
22	16.32	55	56.34	88	93.20
23	17.40	56	57.60	89	94.02
24	18.50	57	58.86	90	94.80
25	19.61	58	60.11	91	95.55
26	20.73	59	61.36	92	96.26
27	21.86	60	62.61	93	96.93
28	23.00	61	63.86	94	97.55
29	24.07	62	65.10	95	98.13
30	25.31	63	66.34	96	98.66
31	26.48	64	67.56	97	99.10
32	27.66	65	68.81	98	99.50
33	28.84	66	69.97	99	99.80

Asphalt Institute MS-6

Table 2 — Weight and Volume Relations [60°F (15.6°C)]

			METRIC	
SP. GR.	Pounds per Gallon	Gallons per Ton	kg per m^3	m^3 per metric ton
0.855	7.119	280.9	853	1.172
60	.161	279.3	858	1.163
65	.203	277.7	863	1.158
70	.244	276.1	868	1.152
75	.286	274.5	873	1.145
80	.328	272.9	878	1.139
85	.369	271.4	883	1.133
90	.411	269.9	888	1.126
95	.453	268.4	893	1.120
0.900	.494	266.9	898	1.114
05	.536	265.4	903	1.107
10	.578	263.9	908	1.101
15	.620	262.5	913	1.095
20	.661	261.1	918	1.089
25	.703	259.6	923	1.083
30	.745	258.2	928	1.078
35	.786	256.9	933	1.073
40	.828	255.5	938	1.066
45	.870	254.1	943	1.060
50	.911	252.8	948	1.055
55	.953	251.5	953	1.049
60	.995	250.2	958	1.044
65	8.036	248.9	963	1.038
70	.078	247.6	968	1.033
75	.120	246.3	973	1.028
80	.162	245.0	978	1.022
85	.203	243.8	983	1.017
90	.245	242.6	988	1.012
95	.287	241.4	993	1.007

Page 1 of 2

Table 2 — Weight and Volume Relations [60°F (15.6°C)] (Contd)

	ENGLISH		METRIC	
SP. GR.	Pounds per Gallon	Gallons per Ton	kg per m^3	m^3 per metric ton
1.000	8.328	240.2	998	1.002
05	.370	239.0	1003	0.997
10	.412	237.8	1008	0.992
15	.453	236.6	1013	0.987
20	.495	235.4	1018	0.982
25	.537	234.3	1023	0.977
30	.578	233.1	1028	0.972
35	.620	232.0	1033	0.968
40	.662	230.9	1038	0.963
45	.704	229.8	1043	0.959
50	.745	228.7	1048	0.954
55	.787	227.6	1053	0.949
60	.829	226.5	1058	0.945
65	.870	225.5	1063	0.941
70	.912	224.4	1068	0.936
75	.954	223.4	1073	0.932

Page 2 of 2

Idaho Standard Practice for

Operation of the Profiler and Evaluation of Profiles

Idaho IR-140-07

1 Scope

1.1 The operation of the profiler, the procedure used for determining the Profile Index from profilograms of pavements made with the profilograph, and the procedure used to locate individual specified high points, are described in Parts I, II, III and IV respectively, in this test method.

1.2 Although both metric and English units are given in the test method, the values do not correspond identically in most cases. For example, a 100 m base length is considerably different than a 0.1 mi. base length. As another example, a "must grind" bump of 0.3 in. over 25 ft. is not identical to 8 mm over 8 m, although the ratio of length to height is 1,000 in both cases. Most metric constants have been selected to be convenient whole numbers, following the same idea used originally when the method was developed under the English system of units. For this reason, the usual English / metric conversion factors are not, in most cases, directly applicable when comparing English and metric versions of this method.

2 References

2.1 California test method number 526.

2.2 Texas test method number 1000-s.

2.3 Iowa DOT Materials I.M. number 341

PART I. OPERATION OF THE CALIFORNIA PROFILOGRAPH

3 Equipment

3.1 The California Profilograph consists of a frame 25 ft. (7.62 m) in length supported upon wheels at either end. The profile is recorded from the vertical movement of a wheel located at the frame at midpoint and is in reference to the mean elevation of the points of contact with the road surface established by the support wheels (see Figure 3). The profilogram is recorded on a scale of 1/300 longitudinally and full scale vertically.

3.1.1. Motive power may be provided manually or by the use of a propulsion unit powered with a gasoline engine attached to the center assembly.

Note 1: On some models (Ames, for example), the profile recording wheel is fixed to the frame and the frame is hinged to allow vertical movement of the wheel. Such models are acceptable provided the manufacturer furnishes satisfactory evidence that results are equivalent to the original

California design illustrated in Figure 3. This also applies to profilometers that have a profilograph output option.

4 Calibration and Operation

4.1 The instructions for assembling the profilograph are contained in a booklet accompanying each unit. Particular attention should be paid to the listed precautions.

4.2 Horizontal and vertical calibration are to be checked just prior to initial use on each project, and at such other times as may be required for verification. Adjustments or repairs shall be made if calibration standards are not met.

Horizontal calibration shall be performed by operating the profilograph over a measured test section of at least 300 ft. (100 m) in length. Divide the length of test section in feet by the length of recording in inches (nearest 0.05 in.). The result shall be 25.0 ± 0.2. [Divide the length of test section in meters by the length of recording in nearest mm (mm). The result shall be 0.300 ± 0.003.]. If out of tolerance, make adjustments and recheck.

Vertical calibration shall be performed on a relatively flat and level area. Place two (2) small objects* of different heights in the approximate range of 1/4 in. to 1 in. (5 to 25 mm) about 3 ft. (1 m) apart on the pavement surface and push the profilograph over them with the recorder operating. Place the objects on the chart and compare their heights with the spike heights. These should be visually identical [± .03 in. (0.5 mm) approximately], and if not, find the cause and correct it.

Computerized profilographs usually have built-in calibration routines for horizontal and vertical calibration. When available, use such routines instead of the procedures described above. Verify vertical calibration of computerized profilographs daily.

4.3 In operation, the profilograph must be moved at a speed no greater than a walk to eliminate as much bounce as possible. Too high a speed will result in a profilogram that is difficult to evaluate.

A tie to project stationing shall be noted on the graph approximately every 500 ft. (200 m). This may be lengthened to 1,000 ft. (400 m) when alignment is primarily straight. If stationing is not available, use mileposts, signposts with notation of legend, or other easily identifiable features. On computerized profilographs, the stationing printed on the chart is adequate, provided the profilograph is accurately calibrated.

4.4 Use a transverse guide rod fastened to the profilograph frame to assure that the profilograph is operated at a constant offset from a joint, paint stripe, or pavement edge. Record the offset and the reference feature (i.e., 1 m right of centerline joint). Keep the end of the guide rod aligned with the reference feature during the run. This is very important for repeatability on subsequent runs and to assure that areas needing grinding can be relocated. Some bumps do not cover the full pavement width and may be missed on subsequent runs unless the location of the initial run is accurately duplicated.

---

*Small pieces of plywood, surveyor's stake, lath, etc.

PART II. EVALUATION OF PROFILE TRACE

5 Equipment

5.1 Use a plastic scale representing the specified pavement length at a scale of 1/300. A plastic scale for the profilograph may be obtained from the Central Materials Lab. Near the center of the scale is a blanking band 0.2 in. (5 mm) wide extending the entire length of the scale. On either side of this band are scribed lines 0.1 in. (2 mm) apart, parallel to the blanking band. These lines serve as a convenient scale to measure deviations or excursions of the graph above or below the blanking band. These are called "scallops."

6 Method of Counting

6.1 Place the plastic scale over the profile in such a way as to "blank out" as much of the profile as possible. When this is done, scallops above and below the blanking band usually will be approximately balanced (see Figure 1).

6.2 The profile trace will move from a generally horizontal position when going around super-elevated curves making it impossible to blank out the central portion of the trace without shifting the scale. When such conditions occur, the profile should be broken into short sections and the blanking band repositioned on each section while counting, as shown in the upper part of Figure 2.

6.3 Starting at the right end of the scale, measure and total the height of all the scallops appearing both above and below the blanking band, measuring each scallop to the nearest 0.05 in (mm.). Write this total on the profile sheet near the left end of the scale together with a small mark to align the scale when moving to the next section. Short portions of the profile line may be visible outside the blanking band but unless they project 0.03 in. (0.5 mm) or more and extend longitudinally for 2 ft. (0.6 m) [0.08 in. (2 mm) on the profilogram] or more, they are not included in the count (see Figure 1 for illustration of these special conditions).

6.4 When scallops occurring in the first 0.1 mi. (100 m) are totaled, slide the scale to the left, aligning the right end of the scale with the small mark previously made, and proceed with the counting in the same manner. The final section of a placement will usually not be an exact 0.1 mi. (100 m). Except at the boundaries of excluded areas (bridges, project limits, etc.), do not include such short sections in the day's run. Instead, wait until the next placement is to be profiled, then begin profiling at the ending point of the previous complete 0.1 mi. (100 m) section. In this way, the profile record will consist entirely of 0.1 mi. (100 m) sections except at the boundaries of excluded areas. At these locations, treat the short sections as follows. If the length is less than 250 ft. (50 m), combine the count with the count for the adjoining full section, then multiply by the ratio of standard section length to combined length. If the length is 250 ft. (50 m) or more, multiply the count by the ratio of standard section length to short section length. In either case, after the multiplication, round the result to the nearest 0.05 in. (mm). Perform such rounding manually if the profilograph computer is not programmed to do so. See Section 10 for additional information on rounding. An example follows:

ENGLISH		
Section Length, miles	Counts, tenth of an inch	Profile Index
0.10	5.0	0.50 in./0.1 mi.
0.10	4.0	0.40 in./0.1 mi.
0.10	3.5	0.35 in./0.1 mi.
400 ft. = 0.076	2.0	0.2/0.76 = 0.26 in./0.1 mi. (Report as 0.25)

METRICS		
Section Length, meters	Counts, mm	Profile Index
100	6	6 mm/100 m
100	9	9 mm/100 m
100	8	8 mm/100 m
62	4	4/0.62 = 6.45 (Report as 6 mm/100 m)

7 Limits of Counts – Joints

7.1 When counting profiles, a day's paving is considered to include the last portion of the previous day's work, which includes the daily joint. The last 15 to 30 ft. (5 to 10 m) of a day's paving cannot usually be obtained until the following day. In general, the paving contractor is responsible for the smoothness of joints if he places the pavement on both sides of the joint. On the other hand, the contractor is responsible only for the pavement placed by him if the work abuts a bridge or a pavement placed under another contract. Profilograph readings when approaching such joints should be taken in conformance with current specifications.

PART III. DETERMINATION OF "MUST GRIND" HIGH POINTS

8 Equipment

8.1 Use a plastic template having a line 1 in. (26.7 mm) long scribed on one (1) face with a small hole or scribed mark at either end, and a slot or line 0.3 in. (8 mm) from and parallel to the scribed line (see Figure 2). The 1 in. (26.7 mm) line corresponds to a horizontal distance of 25 ft. (8 m) on the horizontal scale of the profilogram. The plastic template may be obtained from the Central Materials Lab.

9 Locating "Must Grind" High Points

9.1 At each prominent peak or high point on the profile trace (including the breaks in the profile trace at the beginning and end of any dip), place the template so that the small holes or scribe marks at each end of the scribed line intersect the profile trace to form a chord across the base of the peak or indicated bump. The line on the template need not be horizontal, and in the case of the entrance or exit of a profile dip, the line may depart significantly from horizontal. With a sharp pencil, draw a line using the narrow slot in the template as a guide. Any portion of the trace extending above this line will indicate the approximate length and height of the deviation in excess of 0.3 in. (8 mm). Applying the bump template at the entrance and exit of a dip is important because grinding at these locations is the only practical way to reduce the pavement roughness associated with the dip.

There may be instances where the distance between easily recognizable low points is less than the template length. In such cases, a shorter chord length shall be used in making the scribed line on the template tangent to the trace at the low points. It is the intent, however, of this requirement that the baseline for measuring the height of bumps will correspond as nearly to 25 ft. (8 m) as possible, but in no case is to exceed this value. When the distance between prominent low points is greater than the template length, make the ends of the scribed line intersect the profile trace when the template is in a nearly horizontal position, except at the entrance and exit of a profile dip as discussed above. A few examples of the procedure are shown in the lower portion of Figure 2.

PART IV. MISCELLANEOUS

10 Computer Equipped Profilers

10.1 Some profilograph models use an electronic computer to produce and evaluate the profilogram. Filtering is normally used to remove spikes, followed by automatic summation of roughness. It has been found, however, that certain types of spike filters remove short wavelength roughness features that should be included in the count. Current (approximately 1993 or later) models of Cox, Ames, and McCracken Profilographs use a spike (sometimes called low pass) filter developed by Michigan DOT that eliminates the problem mentioned in the previous sentence. Such profilographs are acceptable for use on ITD projects, provided a low pass filter setting of two (2) is used. Any high pass or long wavelength filter is to be turned off (some manufacturers use a setting of zero for this purpose). All other testing parameters given in this test method apply to computer-equipped profilographs, as well as manual models, and are to be entered by the operator as program constants.

10.2 If a computer-equipped profilograph other than those listed in 9.1, above, is proposed for use, the contractor shall furnish evidence satisfactory to the engineer that the unit produces results equivalent to a manually operated California Profilograph.

10.3 In case of any unresolvable dispute about the results from a computer-equipped profilograph, the referee method shall consist of a retest using a manually operated California Profilograph.

10.4 Calibration of the unit should be verified at the beginning of the project and as needed thereafter

11 Additional Discussion on Profiler Accuracy and Variability

11.1 Computerized profilographs generally are capable of reporting scallop height to some decimal fraction of the nearest 0.01 in. (mm). However, the representation of overall pavement roughness by a single run is always significantly less accurate than this, as discussed below.

11.2 Specifications call for measurement along a single line to represent the entire wheel path, which is about 3 ft. (1 m) wide. In some cases, the width represented is a full lane width, which is up to four (4) times the wheel path width. Testing has shown that the height of a bump or depth of a dip can easily vary by more than 0.05 in. (1 mm) across the wheel path, with even greater variation possible across the full lane.

11.3 Other sources of uncertainty also affect the accuracy with which a single run can represent the pavement surface. The pavement surface moves slightly during the day as heating and cooling take place. The calibration sometimes drifts during the course of a day by a small but detectable amount. Also, response characteristics of a profilograph may change slightly as its various mechanical and/or electrical components react to changes in ambient temperature. Such influences are probably smaller than the variability described in 10.2, but their effect is to increase overall variability of measurement.

11.4 In light of the discussion above, no real improvement in accuracy would result from recording the scallop heights any closer than 0.05 in. (the nearest mm). Doing so would give an incorrect impression as to the real accuracy of overall representation.

11.5 Pay factor tables in the contract may include limits stated as decimal fractions of a 0.01 in. (mm). This is only done so that the profile index cannot fall on the boundary, but will always be on one side or the other. Stating the limits in this way does not imply that it is appropriate to record profilograph scallops in increments less than 0.05 in. (1 mm). For example, a given pay factor range might be 0.26 to 0.34 in./0.10 mi. (4.1 to 5.3 mm/100 m). Thus, a result of 0.30 in./0.10 mi. (5 mm/100 m) would be the only test result that would fall within the stated range.

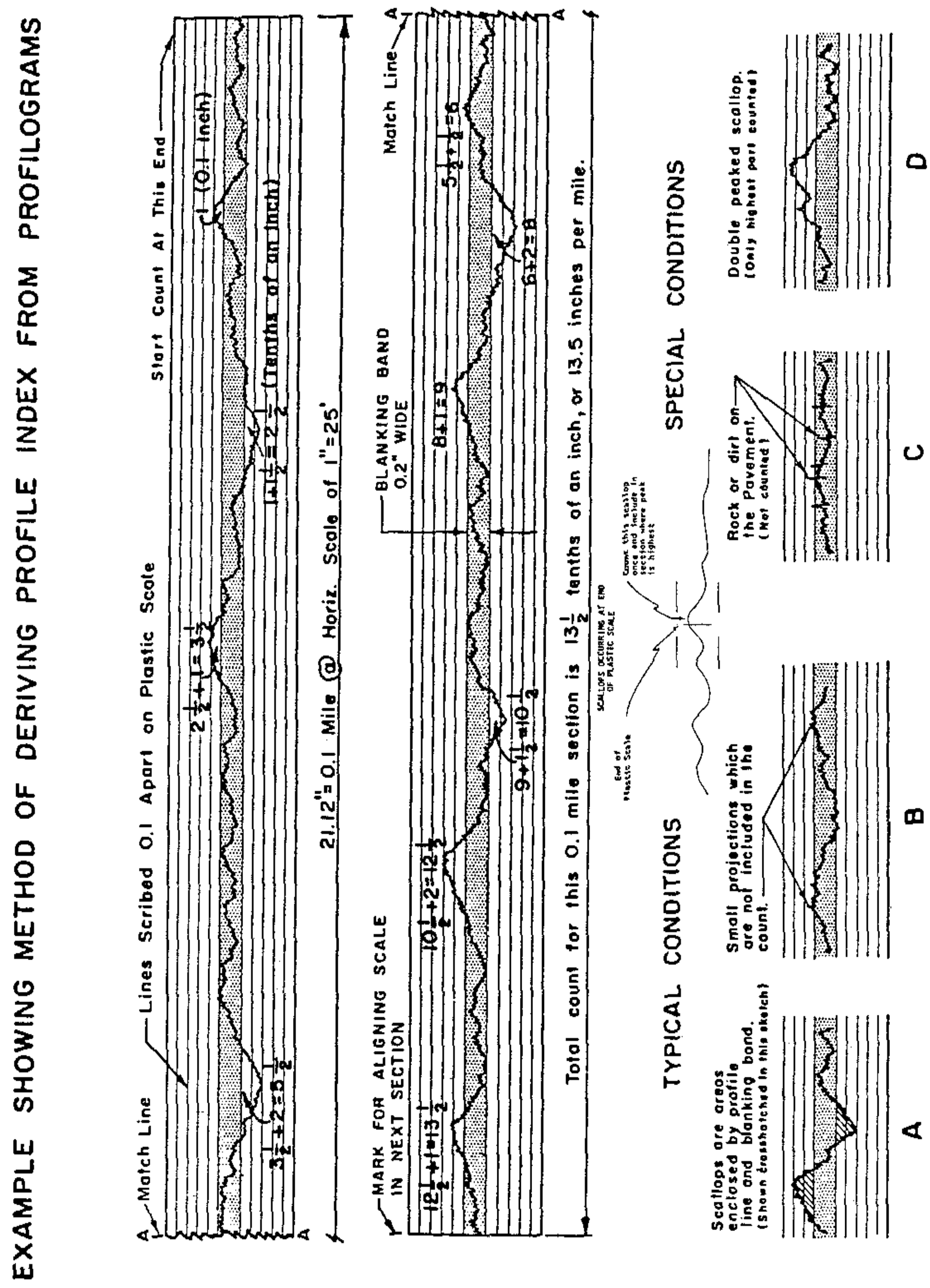

EXAMPLE SHOWING METHOD OF DERIVING PROFILE INDEX FROM PROFILOGRAMS
A
Match Line
Lines Scribed 0.1 Apart on Plastic Scale
Start Count At This End
3 1/2 + 2 = 5 1/2
2 1/2 + 1 = 3 1/2
1 + 1/2 = 2 1/2 (Tenths of an Inch)
1 (0.1 Inch)
21.12" = 0.1 Mile @ Horiz. Scale of 1" = 25'
MARK FOR ALIGNING SCALE IN NEXT SECTION
BLANKING BAND 0.2" WIDE
Match Line
12 1/2 + 1 = 13 1/2
10 1/2 + 2 = 12 1/2
9 + 1 1/2 = 10 1/2
8 + 1 = 9
6 + 2 = 8
5 1/2 + 1/2 = 6
Total count for this 0.1 mile section is 13 1/2 tenths of an inch, or 13.5 inches per mile.
TYPICAL CONDITIONS
SPECIAL CONDITIONS
Scallops are areas enclosed by profile line and blanking band. (Shown crosshatched in this sketch)
Small projections which are not included in the count.
End of Plastic Scale
SCALLOPS OCCURRING AT END OF PLASTIC SCALE
Count this scallop once and include in section where peak is highest
Rock or dirt on the Pavement. (Not counted)
Double peaked scallop. (Only highest part counted)
A
B
C
D

FIGURE I

EXAMPLE SHOWING METHOD OF DERIVING PROFILE INDEX FROM PROFILOGRAMS

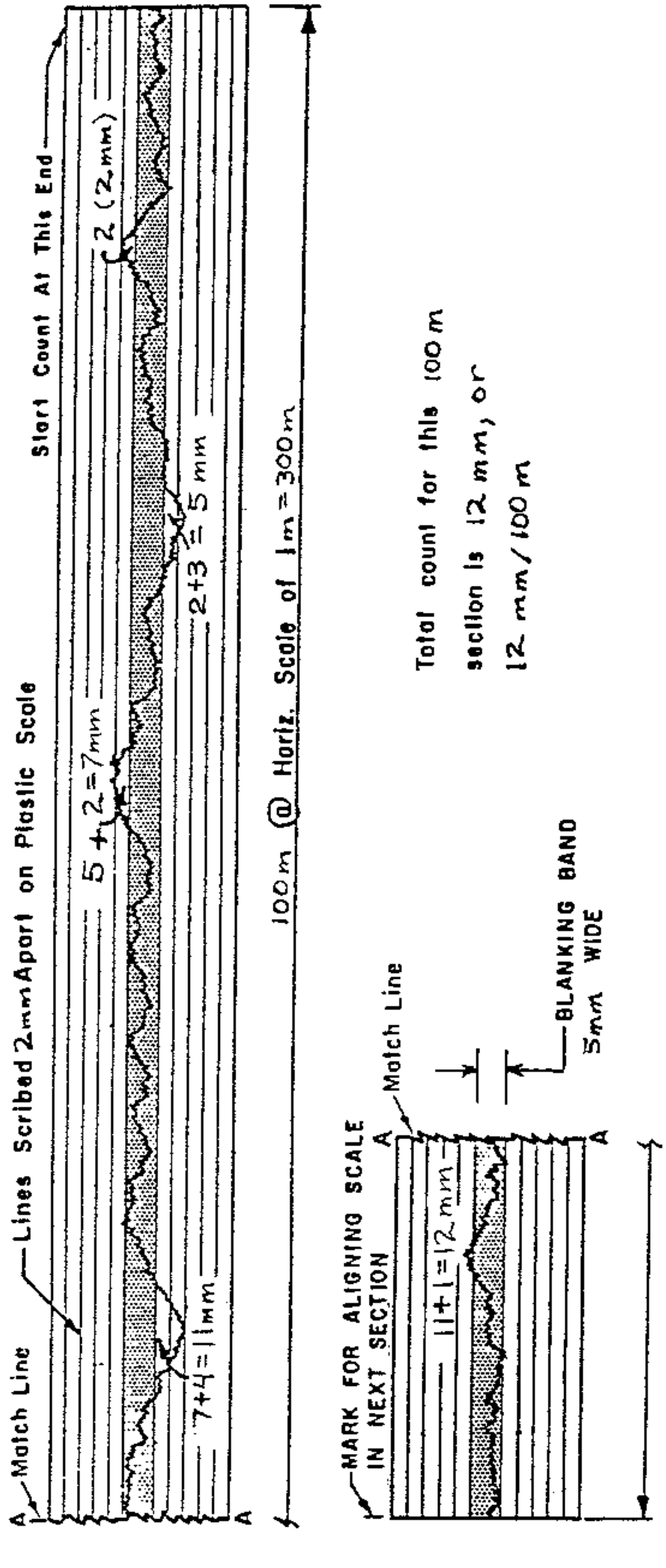


FIGURE 1 M

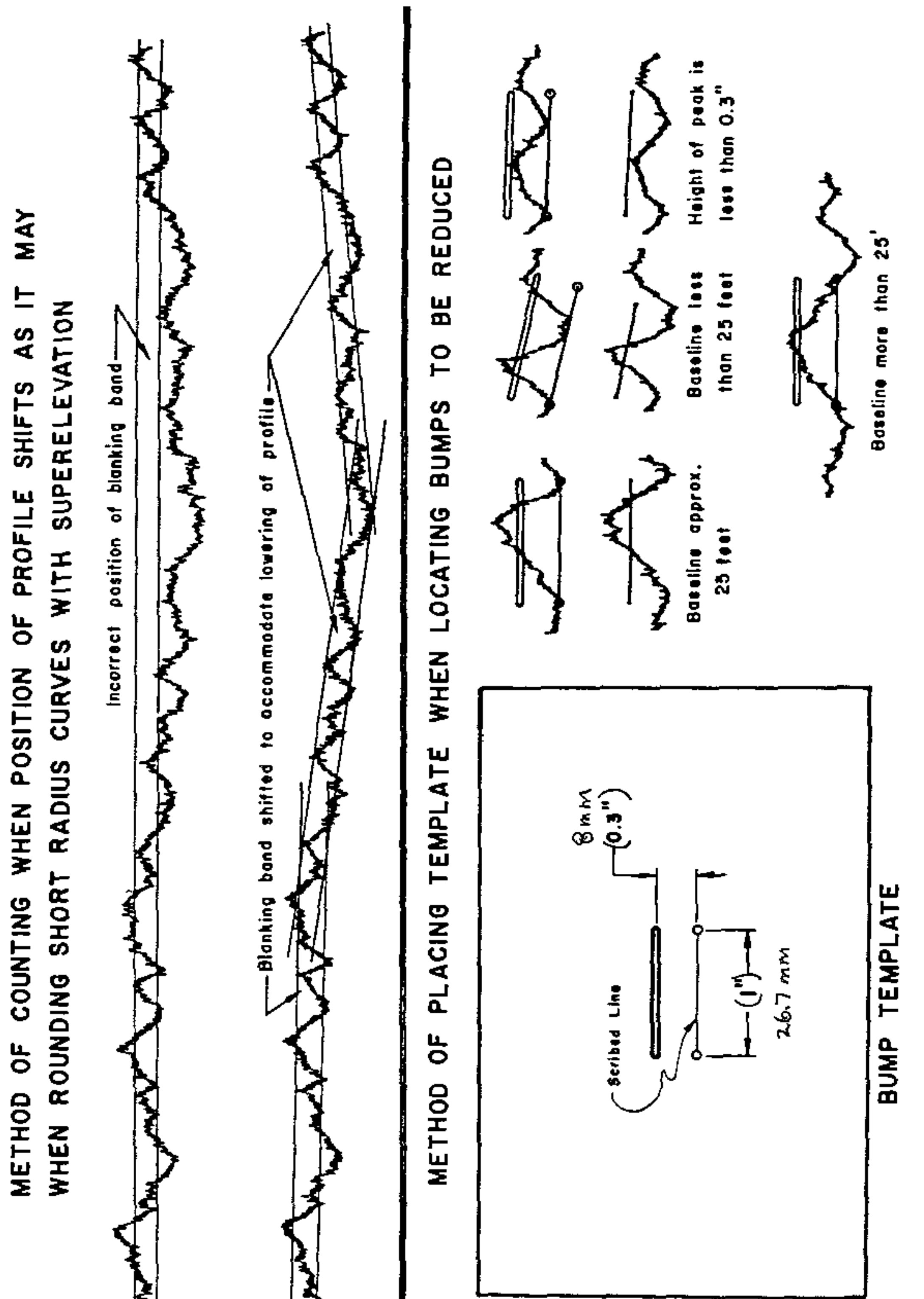

METHOD OF COUNTING WHEN POSITION OF PROFILE SHIFTS AS IT MAY
WHEN ROUNDING SHORT RADIUS CURVES WITH SUPERELEVATION
Incorrect position of blanking band
Blanking band shifted to accommodate lowering of profile
METHOD OF PLACING TEMPLATE WHEN LOCATING BUMPS TO BE REDUCED
Baseline approx. 25 feet
Baseline less than 25 feet
Height of peak is less than 0.3"
Baseline more than 25'
8mm
(0.3")
Scribed Line
(1")
26.7 mm
BUMP TEMPLATE

FIGURE 2

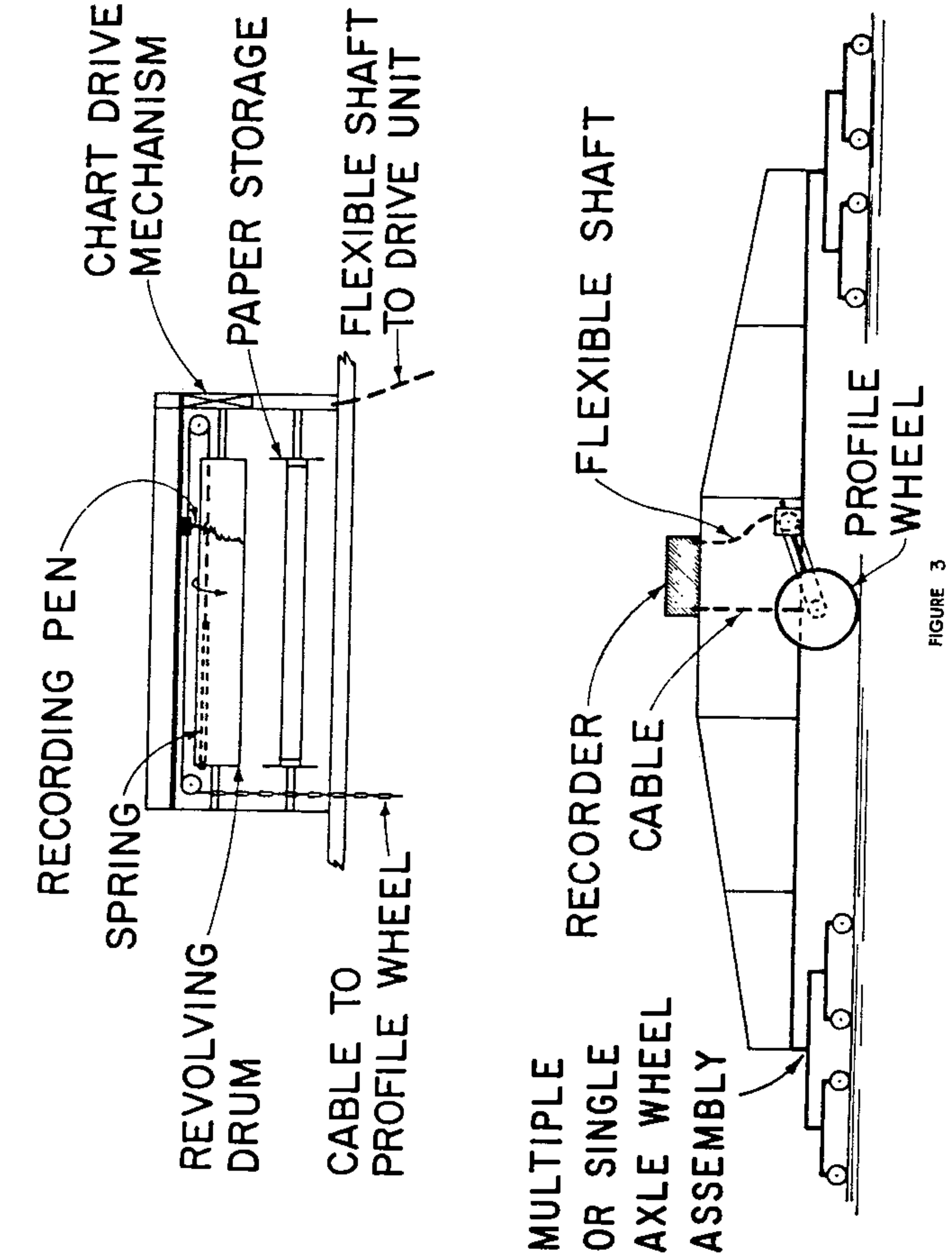


CHART DRIVE MECHANISM
PAPER STORAGE
FLEXIBLE SHAFT TO DRIVE UNIT
RECORDING PEN
SPRING
REVOLVING DRUM
CABLE TO PROFILE WHEEL
FLEXIBLE SHAFT
RECORDER
CABLE
PROFILE WHEEL
MULTIPLE OR SINGLE AXLE WHEEL ASSEMBLY

FIGURE 3

ITD-880 8-98 W

PROFILOGRAPH SUMMARY

IDAHO T-140

Sheet ______ of ______

Roll No. ____________

For Information Only ☐ Preliminary ☐ Intermediate ☐ Final ☐

Key No. ____________ Project No. ______________________________

Location ____

Contractor ______________________________ Date Paved ________

Tested By ______________________________ Date ________

Trace Reduced By ____________________________ Date ________

Comments ____

NB ☐ EB ☐ WB ☐ SB ☐

Inside Lane	☐	Inside Lane	☐
Outside Lane	☐	Outside Lane	☐
Center Line	☐	Center Line	☐
1 m (3') from Outside Edge	☐	1 m (3') from Outside Edge	☐
1 m (3') from Inside Edge	☐	1 m (3') from Inside Edge	☐

PROFILE INDEX mm/100 m (in./0.1 mi.)	MEASURED ROUGHNESS mm (inches)	LENGTH m (miles)	LOCATION (Station)	LENGTH m (miles)	MEASURED ROUGHNESS mm (inches)	PROFILE INDEX mm/100 m (in./0.1 mi.)

STATION ◄———— 8 mm (.3 inch) Bump Location ————► STATION

Idaho Standard Practice for

Design of Seal Coats and Single Surface Treatments by the McLeod Method

Idaho IR-63-13

1. Scope

In the late 1960's Norman McLeod (1969) presented the following design method which was later adapted by the Asphalt Institute (1979, 1983) and the Asphalt Emulsion Manufacturers Association (1981). In this method, the aggregate application rate depends on the aggregate gradation, shape, and specific gravity. The binder application rate depends on the aggregate gradation, absorption and shape, traffic volume, existing pavement condition, and the residual asphalt content of the binder. It should be noted that this method was developed primarily for use with emulsion binders and has not been verified in Idaho.

The McLeod method is based on two basic principles:

1. The application rate of a given aggregate should be determined such that the resulting seal coat will be one-stone thick. This amount of aggregate will remain constant, regardless of the binder type or pavement condition.
2. The voids in the aggregate layer need to be 70 percent filled with asphalt for good performance on pavements with moderate levels of traffic.

2. Design Procedure Components

2.1 Median Particle Size. The Median Particle Size (M) is determined from the aggregate gradation chart. It is the theoretical sieve size through which 50 percent of the material passes. The following sieve sizes should be used:

Sieve Sizes
1 inch
¾ inch
½ inch
Inch
¼ inch
No. 4
No. 8

No. 16
No. 50
No. 200

2.2 Flakiness Index. The flakiness index (F) is a measure of the percent, by weight, of flat particles. It is determined by testing a sample of the aggregate particles for their ability to fit through a slotted plate (Idaho IR-64-09).

2.3 Average Least Dimension. The Average Least Dimension, or ALD (H), is determined from the Median Particle Size and the Flakiness Index. It is a reduction of the Median Particle Size after accounting for flat particles. It represents the expected seal coat thickness in the wheel paths where traffic forces the aggregate particles to lie on their fattest side. The ALD is calculated as follows:

Equation 63-1 $H=M / [1.139285 + (0.011506) FI]$

Where:
H = Average Least Dimension, inches
M = Median Particle Size, inches
FI = Flakiness Index, percent

2.4 Loose Unit Weight of the Cover Aggregate. The dry loose unit weight (W) is determined according to AASHTO T-19 and is needed to calculate the voids in the aggregate in a loose condition. The loose unit weight is used to calculate the air voids expected between the stones after initial rolling. It depends on the gradation, shape, and specific gravity of the aggregate.

2.5 Voids in the Loose Aggregate. The voids in the loose aggregate (V) approximate the voids present when the stones are dropped from the spreader onto the pavement. Generally, this value will be near 50 percent for one size of aggregate, less for graded aggregate. After initial rolling, the voids are assumed to be reduced to 30 percent and will reach a low of about 20 percent after sufficient traffic has oriented the stones on their fattest side. However, if there is very little traffic, the voids will remain 30 percent, and the seal will require more binder to ensure good aggregate retention. The following equation is used to calculate the voids in the loose aggregate:

Equation 63-2 $V = 1 – W/ (62.4G)$

Where:
V = Voids in the loose aggregate, in percent expressed as a decimal
W = Loose unit weight of the cover aggregate, lbs/ft^3
G = Bulk specific gravity of the aggregate (AASHTO T 19).

2.6 Aggregate Absorption. Most aggregates absorb some of the binder applied to the roadway. The design procedure should be able to correct for this condition to ensure enough binder will remain on the pavement surface. McLeod suggests an absorption correction factor, A or 0.02 gal/SY if the aggregate absorption is around 2 percent (as determined from AASHTO T-84). In the Minnesota Seal Coat Handbook, it is recommended that a correction factor of 2 percent be used if the absorption is 1.5 percent or higher.

2.7 Traffic Volume. The traffic volume, in terms of vehicles per day, plays a role in determining the amount of asphalt binder needed to sufficiently embed the aggregate. Typically, the higher the traffic volume, the lower the binder application rate. At first glance, this may not seem correct. However, remember that traffic forces the aggregate particles to lie on their flattest side. If a roadway had no traffic, the particles would be lying in the same orientation as when they were first rolled during construction. As a result, they would stand taller and need more asphalt binder to achieve the ultimate 70 percent embedment. With enough traffic, the aggregate particles will be laying as flat as possible causing the seal coat to be as thin as possible. If this is not taken into account, the wheelpaths will likely bleed. The McLeod procedure uses Table 63-1 to estimate the required embedment, based on the number of vehicles per day on the roadway.

Table 63-1, Traffic Correction Factor, T				
Traffic Factor*				
Traffic – Vehicles per day				
Under 100	100 to 500	500 to 1000	1000 to 2000	Over 2000
0.85	0.75	0.70	0.65	0.60
*The percentage, expressed as a decimal, of the ultimate 20 percent void space in the aggregate to be filled with asphalt.				

Note: The factors above do not make allowance for absorption by the road surface or by absorptive aggregate.

2.8 Traffic Whip-Off. The McLeod method also recognizes that some of the aggregate will get thrown to the side of the roadway by passing vehicles as the seal coat is curing. This loss is related to the speed and number of vehicles on the new seal coat. To account for this, a traffic whip-off factor (E) is included in the aggregate design equation. A reasonable value is to assume 5 percent for low volume, residential type and 10 percent for higher speed roadways. The traffic whip-off factor is shown in Table 63-2.

Table 63-2. Aggregate Wastage Factor, E*	
Percentage Waste Allowed for Traffic Whip-Off and Handling	**Wastage Factor, E**
1	1.01
2	1.02
3	1.03
4	1.04

5	1.05
6	1.06
7	1.07
8	1.08
9	1.09
10	1.10
11	1.11
12	1.12
13	1.13
14	1.14
15	1.15
*(Source: Asphalt Institute MS-19, March 1979).	

2.9 Existing Pavement Condition. The condition of the existing pavement plays a major role in the amount of binder required to obtain proper embedment. A new smooth pavement with low air voids will not absorb much of the binder applied to it. Conversely, a dry porous and pocked pavement surface can absorb much of the applied binder. Failure to recognize when to increase of decrease binder application rate to account for the pavement condition can lead to excessive stone loss or bleeding. The McLeod method uses the descriptions and factors in Table 63-3 to add or reduce the amount of binder to apply in the field.

Table 63-3, Surface Correction Factor, S.	
Existing Pavement Texture	**Correction, S**
Black, flushed asphalt surface	-0.01 to 0.06
Smooth, nonporous surface	0.00
Slightly porous, oxidized surface	+ 0.03
Slightly pocked, porous, oxidized surface	+ 0.06
Badly pocked, porous, oxidized surface	+0.09

These surface conditions may vary throughout the project, and adjustments should be made accordingly.

---

3. McLeod Seal Coat Design Equations

The following equations are used to determine the aggregate and binder application rates. While the results may need adjustment in the field, especially the binder application rate, they have been shown to provide a close approximation of the correct material quantities.

3.1 Aggregate Design Equation. The aggregate application rate is determined from the following equation:

Equation 63-3 $C = 46.8\,(1 - 0.4V)\,HGE$

Where:
C = Aggregate application rate, lbs/SY
V = Voids in the loose aggregate, in percent expressed as a decimal (Eq. 63-2)
H = Average least dimension, inches
G = Bulk specific gravity of the aggregate
E = Wastage factor for traffic whip-off (Table 63-2)

3.2 Binder Design Equation. The binder application rate is determined as follows:

Equation 63-4 $B = (2.244HTV + S + A) / R$

Where:
B = Binder application rate, gal/SY
H = Average least dimension, inches
T = Traffic Correction Factor (based on vehicles per day, Table 63-1)
V = Voids in loose aggregate, percent expressed as decimal (Eq. 63-2)
S = Surface condition factor, gal/SY (based on existing surface, Table 63-3)
A = Aggregate absorption factor, gal/SY
R = Percent residual asphalt in the emulsion expressed as a decimal. Check with supplier to determine percent residual asphalt content of emulsion. For asphalt cement, R = 1.

Please do not forget to check Section 275 for TEST Methods Modifications

SECTION 570.00 – WAQTC / IDAHO FIELD OPERATING PROCEDURES

570.01 Aggregate.

570.02 Asphalt I & II.

570.03 Concrete.

570.04 Embankment and Base.

570.05 In-Place Density

AGGREGATE

FIELD OPERATING PROCEDURES - SHORT FORM

SAMPLING OF AGGREGATES
FOP FOR AASHTO T 2

Scope

This procedure covers sampling of coarse, fine, or a combination of coarse and fine aggregates (CA and FA) in accordance with AASHTO T 2-91. Sampling from conveyor belts, transport units, roadways, and stockpiles is covered.

Apparatus

- Shovels or scoops, or both
- Sampling tubes of acceptable dimensions
- Mechanical sampling systems: normally a permanently attached device that allows a sample container to pass perpendicularly through the entire stream of material or diverts the entire stream of material into the container by manual, hydraulic, or pneumatic operation
- Belt template
- Sampling containers

Procedure – General

Sampling is as important as testing, and the technician shall use every precaution to obtain samples that will show the true nature and condition of the materials the sample represents. In all situations, determine the time or location for sampling in a random manner.

1. Wherever samples are taken, obtain multiple increments of approximately equal size.
2. Mix the increments thoroughly to form a field sample that meets or exceeds the minimum mass recommended in Table 1.

TABLE 1
Sample Sizes

Nominal Maximum Size* mm (in.)	Minimum Mass g (lb)
2.36 (No. 8)	10,000 (25)
4.75 (No. 4)	10,000 (25)
9.5 (3/8)	10,000 (25)
12.5 (1/2)	15,000 (35)
19.0 (3/4)	25,000 (55)
25.0 (1)	50,000 (110)
37.5 (1 1/2)	75,000 (165)
50 (2)	100,000 (220)
63 (2 1/2)	125,000 (275)
75 (3)	150,000 (330)
90 (3 1/2)	175,000 (385)

* One sieve larger than the first sieve to retain more than 10 percent of the material using an agency specified set of sieves based on cumulative percent retained. Where large gaps in specification sieves exist, intermediate sieve(s) may be inserted to determine nominal maximum size. Maximum size is one size larger than nominal maximum size.

Note 1: Based upon the tests required, the sample size may be four times that shown in Table 2 of the FOP for AASHTO T 27/T 11, if that mass is more appropriate. As a general rule the field sample size should be such that, when split twice will provide a testing sample of proper size.

Procedure – Specific Situations

Conveyor Belts

Avoid sampling at the beginning or end of the aggregate run due to the potential for segregation. Be careful when sampling in the rain. Make sure to capture fines that may stick to the belt or that the rain tends to wash away.

Method A (From the Belt):

1. Stop the belt.
2. Set the sampling template in place on the belt, avoiding intrusion by adjacent material.
3. Scoop off the sample, including all fines.
4. Obtain a minimum of 3 approximately equal increments.
5. Combine the increments to form a single sample.

Method B (From the Belt Discharge):

1. Pass a sampling device through the full stream of the material as it runs off the end of the conveyor belt. The sampling device may be manually, semi-automatic or automatically powered.

2. The sampling device shall pass through the stream at least twice, once in each direction, without overfilling while maintaining a constant speed during the sampling process.

3. When emptying the sampling device into the sample container, include all fines.

4. Combine the increments to form a single sample.

Transport Units

1. Visually divide the unit into four quadrants.

2. Identify one sampling location in each quadrant.

3. Dig down and remove approximately 0.3 m (1 ft) of material to avoid surface segregation. Obtain each increment from below this level.

4. Combine the increments to form a single sample.

Roadways

Method A (Berm or Windrow):

1. Sample prior to spreading.

2. Take the increments from a minimum of three random locations along the fully-formed windrow or berm. Do not take the increments from the beginning or the end of the windrow or berm.

3. Obtain full cross-section samples of approximately equal size at each location. Take care to exclude the underlying material.

4. Combine the increments to form a single sample.

Note 2: Sampling from berms or windrows may yield extra-large samples and may not be the preferred sampling location.

Method B (In-Place):

1. Sample after spreading and prior to compacting.

2. Take the increments from three random locations.

3. Obtain full-depth samples of approximately equal size from each location. Take care to exclude the underlying material.

4. Combine the increments to form a single sample.

Stockpiles

Method A – Coarse, Fine, or a Combination of Coarse and Fine Aggregates:

1. Create, with a loader if one is available, horizontal surfaces with vertical faces in the top, middle, and bottom third of the stockpile. When no equipment is available a shovel may be used to create the horizontal surfaces with vertical faces.

2. Prevent continued sloughing by shoving a flat board in against the vertical face. Sloughed material will be discarded to create the horizontal surface.

3. Sample from the horizontal surface as close to the intersection as possible of the horizontal and vertical faces.

4. Obtain at least one increment of equal size from each of the top, middle, and bottom thirds of the pile.

5. Combine the increments to form a single sample.

Method B – Fine Aggregate (Alternate Tube Method):

1. Remove the outer layer that may have become segregated.

2. Using a sampling tube, obtain one increment of equal size from a minimum of five random locations on the pile.

3. Combine the increments to form a single sample.

Note 3: Sampling at stockpiles should be avoided whenever possible due to problems involved in obtaining a representative gradation of material.

Report

- On forms approved by the agency
- Date
- Time
- Location
- Quantity represented

PERFORMANCE EXAM CHECKLIST

SAMPLING OF AGGREGATES
FOP FOR AASHTO T 2

Participant Name ______________________________Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
Conveyor Belts – Method A (From the Belt)		
1. Belt stopped?	_____	_____
2. Sampling template set on belt, avoiding intrusion of adjacent material?	_____	_____
3. Sample, including all fines, scooped off?	_____	_____
4. Samples taken in at least three approximately equal increments?	_____	_____
Conveyor Belts – Method B (From the Belt Discharge)		
5. Sampling device passed through full stream of material twice (once in each direction) as it runs off end of belt?	_____	_____
Transport Units		
6. Unit divided into four quadrants?	_____	_____
7. Increment obtained from each quadrant, 0.3 m (1ft.) below surface?	_____	_____
8. Increments combined to make up the sample?	_____	_____
Roadways (berm or windrow)		
9. Sample taken prior to spreading?		
10. Full depth of material taken?	_____	_____
11. Underlying material excluded?	_____	_____
12. Samples taken in at least three approximately equal increments?	_____	_____
Roadways (in-place)		
13. Sample taken after spreading?		
14. Full depth of material taken?	_____	_____
15. Underlying material excluded?	_____	_____
16. Samples taken in at least three approximately equal increments?	_____	_____

OVER

Stockpiles

17. Created horizontal surfaces with vertical faces? _____ _____
18. At least one increment taken from each of the top, middle, and bottom thirds of the stockpile. _____ _____
19. When using a sampling tube, outer layer removed and increments taken from at least five locations with a sampling tube? _____ _____

General

20. Increments mixed thoroughly to form sample? _____ _____

Comments: First attempt: Pass____ Fail____ Second attempt: Pass____ Fail ____

Examiner Signature ______________________WAQTC #:_____________________

PERFORMANCE EXAM CHECKLIST (ORAL)

SAMPLING OF AGGREGATES
FOP FOR AASHTO T 2

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. How is a sample obtained from a conveyor belt using method A?		
a) Stop the belt.	_____	_____
b) Set the sampling template on belt, avoiding intrusion of adjacent material.	_____	_____
c) All the material is removed from belt including all fines.	_____	_____
d) Take at least approximately three equal increments.	_____	_____
2. How is a sample obtained from a conveyor belt using method B?		
a) Pass the sampling device through a full stream of material as it runs off the end of the belt.	_____	_____
b) The device must be passed through at least twice (once in each direction).	_____	_____
3. How is a sample obtained from a transport unit?		
a) Divide the unit into four quadrants.	_____	_____
b) Dig 0.3 m (1 ft.) below surface.	_____	_____
c) Obtain an increment from each quadrant.	_____	_____
4. Describe the procedure for sampling from roadways berm or windrow?		
a) Sample prior to spreading	_____	_____
b) Sample the material full depth without obtaining underlying material.	_____	_____
c) Take at least three approximately equal increments.	_____	_____
5. Describe the procedure for sampling from roadway in-place?		
a) Sample after spreading, prior to compaction.	_____	_____
b) Sample the material full depth without obtaining underlying material.	_____	_____
c) Take at least three approximately equal increments.	_____	_____
6. Describe the procedure for sampling a stockpile.		
a) Create horizontal surfaces with vertical faces and at least one increment taken from each of the top, middle, and bottom thirds of the stockpile.	_____	_____
7. Describe the procedure for sampling of a fine aggregate stockpile with a sampling tube.		
a) Remove the outer layer and increments taken from at least five locations.	_____	_____

OVER

8. After obtaining the increments what should you do prior to performing T248?

a) Increments mixed thoroughly to form sample. _____ _____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

____

____

____

Examiner Signature _______________________WAQTC #:_______________________

REDUCING SAMPLES OF AGGREGATES TO TESTING SIZE
FOP FOR AASHTO T 248

Scope

This procedure covers the reduction of samples to the appropriate size for testing in accordance with AASHTO T 248-11. Techniques are used that minimize variations in characteristics between test samples and field samples. Method A (Mechanical Splitter) and Method B (Quartering) are covered.

This FOP applies to fine aggregate (FA), coarse aggregate (CA), and mixes of the two, and may also be used on soils.

Apparatus

Method A – Mechanical Splitter

Splitter chutes:

- Even number of equal width chutes
- Discharge alternately to each side
- Minimum of 8 chutes total for CA, 12 chutes total for FA
- Width:
    - Minimum 50 percent larger than largest particle
    - Maximum chute width of 19 mm (3/4 in.) for fine aggregate passing the 9.5 mm (3/8 in.) sieve

Feed control:

- Hopper or straightedge pan with a width equal to or slightly less than the overall width of the assembly of chutes
- Capable of feeding the splitter at a controlled rate

Splitter receptacles / pans:

- Capable of holding two halves of the sample following splitting

The splitter and accessory equipment shall be so designed that the sample will flow smoothly without restriction or loss of material.

Method B – Quartering

- Straightedge scoop, shovel, or trowel
- Broom or brush
- Canvas or plastic sheet, approximately 2 by 3 m (6 by 9 ft)

Method Selection

Samples of FA which are drier than the saturated surface dry (SSD) condition shall be reduced by a mechanical splitter according to Method A. As a quick determination, if the fine aggregate will retain its shape when molded with the hand, it is wetter than SSD. Samples of FA that are at SSD or wetter than SSD shall be reduced by Method B, or the entire sample may be dried to the SSD condition – using temperatures that do not exceed those specified for any of the tests contemplated – and then reduced to test sample size using Method A.

Samples of CA or mixtures of FA and CA may be reduced by either method. Method A is not recommended for FA / CA mixtures that adhere to the apparatus.

Procedure

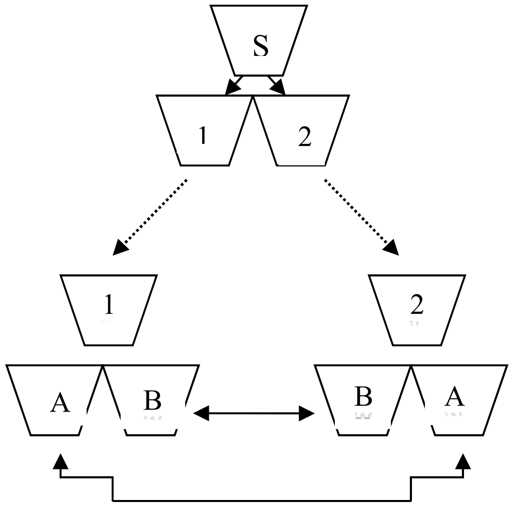
Method A – Mechanical Splitter

1. Place the sample in the hopper or pan and uniformly distribute it from edge to edge so that approximately equal amounts flow through each chute. The rate at which the sample is introduced shall be such as to allow free flowing through the chutes into the pans below.

2. Reduce the sample from one of the two pans as many times as necessary to reduce the sample to meet the minimum size specified for the intended test. The portion of the material collected in the other pan may be reserved for reduction in size for other tests.

3. As a check for effective reduction, determine the mass of each reduced portion. If the percent difference of the two masses is greater than 5 percent, corrective action must be taken. In lieu of the check for effective reduction, use the method illustrated in Figure 1.

Figure 1



Sample (S) is an amount greater than or equal to twice the mass needed for testing. Sample (S) is reduced in a mechanical splitter to yield parts (1) and (2)

Part (1) is further reduced yielding (A) and (B) while part (2) is reduced to yield (B) and (A).

Final testing sample is produced by combining alternate pans, i.e. A/A or B/B only.

Calculation

$$\frac{Smaller\ Mass}{Larger\ Mass} = Ratio \qquad (1 - ratio) \times 100 = \%\ Difference$$

Splitter check: 5127 g total sample mass

Splitter pan #1: 2583 g

Splitter pan #2: 2544 g

$$\frac{2544\text{ g}}{2583\text{ g}} = 0.985 \qquad (1 - 0.985) \times 100 = 1.5\%$$

Procedure

Method B – Quartering

Use either of the following two procedures or a combination of both.

Procedure # 1: Quartering on a clean, hard, level surface:

1. Place the sample on a hard, clean, level surface where there will be neither loss of material nor the accidental addition of foreign material.

2. Mix the material thoroughly by turning the entire sample over a minimum of four times. With the last turning, shovel the entire sample into a conical pile by depositing each shovelful on top of the preceding one.

3. Flatten the conical pile to a uniform thickness and diameter by pressing down with a shovel. The diameter should be four to eight times the thickness.

4. Divide the flattened pile into four approximately equal quarters with a shovel or trowel.

5. Remove two diagonally opposite quarters, including all fine material, and brush the cleared spaces clean.

6. Successively mix and quarter the remaining material until the sample is reduced to the desired size.

7. The final test sample consists of <u>two diagonally opposite</u> quarters.

Procedure # 2: Quartering on a canvas or plastic sheet:

1. Place the sample on the sheet.

2. Mix the material thoroughly a minimum of four times by pulling each corner of the sheet horizontally over the sample toward the opposite corner. After the last turn, form a conical pile.

3. Flatten the conical pile to a uniform thickness and diameter by pressing down with a shovel. The diameter should be four to eight times the thickness.

4. Divide the flattened pile into four approximately equal quarters with a shovel or trowel, or, insert a stick or pipe beneath the sheet and under the center of the pile, then lift both ends of the stick, dividing the sample into two roughly equal parts. Remove the stick leaving a fold of the sheet between the divided portions. Insert the stick under the center of the pile at right angles to the first division and again lift both ends of the stick, dividing the sample into four roughly equal quarters.

5. Remove two diagonally opposite quarters, being careful to clean the fines from the sheet.

6. Successively mix and quarter the remaining material until the sample size is reduced to the desired size.

7. The final test sample consists of <u>two diagonally opposite</u> quarters.

PERFORMANCE EXAM CHECKLIST

REDUCING FIELD SAMPLES OF AGGREGATES TO TESTING SIZE
FOP FOR AASHTO T 248

Participant Name ________________________________ Exam Date _______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

	Trial 1	Trial 2
Method A - Splitting		
1. Material spread uniformly on feeder?	______	______
2. Rate of feed slow enough so that sample flows freely through chutes?	______	______
3. Material in one pan re-split until desired mass is obtained?	______	______
Method B - Quartering		
1. Sample placed on clean, hard, and level surface?	______	______
2. Mixed by turning over 4 times with shovel or by pulling sheet horizontally over pile?	______	______
3. Conical pile formed?	______	______
4. Diameter equal to about 4 to 8 times thickness?	______	______
5. Pile flattened to uniform thickness and diameter?	______	______
6. Divided into 4 equal portions with shovel or trowel?	______	______
7. Two diagonally opposite quarters, including all fine material, removed?	______	______
8. Cleared space between quarters brushed clean?	______	______
9. Process continued until desired sample size is obtained when two opposite quarters combined?	______	______

*The sample may be placed upon a sheet and a stick or pipe may be placed under the sheet to divide the pile into quarters***.**

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass______Fail_____

____
____
____
____
____
____
____
____

Examiner Signature ______________________________ WAQTC #:________________

TOTAL EVAPORABLE MOISTURE CONTENT OF AGGREGATE BY DRYING FOP FOR AASHTO T 255

Scope

This procedure covers the determination of moisture content of aggregate in accordance with AASHTO T 255-00. It may also be used for other construction materials.

Overview

Moisture content is determined by comparing the wet mass of a sample and the mass of the sample after drying to constant mass. The term constant mass is used to define when a sample is dry.

Constant mass – the state at which a mass does not change more than a given percent, after additional drying for a defined time interval, at a required temperature.

Apparatus

- Balance or scale: Capacity sufficient for the principle sample mass, accurate to 0.1 percent of sample mass or readable to 0.1 g, meeting the requirements of AASHTO M 231.
- Containers, clean, dry and capable of being sealed
- Suitable drying containers
- Microwave safe containers
- Heat source, temperature controlled
  - Forced draft oven
  - Ventilated or convection oven
- Heat source, uncontrolled
  - Infrared heater, hot plate, fry pan, or any other device/method that will dry the sample without altering the material being dried
  - Microwave oven (600 watts minimum)
- Hot pads or gloves
- Utensils such as spoons

Sample Preparation

In accordance with the FOP for AASHTO T 2 obtain a representative sample in its existing condition. The representative sample size is based on Table 1 or other information that may be specified by the agency

TABLE 1
Sample Sizes for Moisture Content of Aggregate

Nominal Maximum Size* mm (in.)	Minimum Sample Mass g (lb)
4.75 (No. 4)	500 (1.1)
9.5 (3/8)	1500 (3.3)
12.5 (1/2)	2000 (4)
19.0 (3/4)	3000 (7)
25.0 (1)	4000 (9)
37.5 (1 1/2)	6000 (13)
50 (2)	8000 (18)
63 (2 1/2)	10,000 (22)
75 (3)	13,000 (29)
90 (3 1/2)	16,000 (35)
100 (4)	25,000 (55)
150 (6)	50,000 (110)

* One sieve larger than the first sieve to retain more than 10 percent of the material using an agency specified set of sieves based on cumulative percent retained. Where large gaps in specification sieves exist, intermediate sieve(s) may be inserted to determine nominal maximum size.

Immediately seal or cover samples to prevent any change in moisture content or follow the steps in “Procedure”.

Procedure

Determine all masses to the nearest 0.1 percent of the sample mass or to the nearest 0.1 g.

When determining the mass of hot samples or containers or both, place and tare a buffer between the sample container and the balance. This will eliminate damage to or interference with the operation of the balance or scale.

1. Determine and record the mass of the container.

2. Place the wet sample in the container.

    a. For oven(s), hot plates, heat lamps, etc.: Spread the sample in the container.

    b. For microwave oven: Heap sample in the container with ventilated lid.

3. Determine and record the total mass of the container and wet sample.

4. Determine and record the wet mass of the sample by subtracting the container mass determined in Step 1 from the mass of the container and sample determined in Step 3.

5. Dry the sample.

    a. Controlled heat source (oven): at 110 ±5°C (230 ±9°F).

    b. Uncontrolled heat source (Hot plate, heat lamp, etc.): Stir frequently to avoid localized overheating.

6. Dry until sample appears moisture free.

7. Determine mass of sample and container.

8. Determine and record the mass of the sample by subtracting the container mass determined in Step 1 from the mass of the container and sample determined in Step 7.

9. Return sample and container to the heat source for additional drying.

    a. Controlled heat source (oven): 30 minutes

    b. Uncontrolled heat source (Hot plate, heat lamp, etc.): 20 minutes

    c. Uncontrolled heat source (Microwave oven): 10 minutes

Caution: Some minerals in the sample may cause the aggregate to overheat, altering the aggregate gradation.

10. Determine mass of sample and container.

11. Determine and record the mass of the sample by subtracting the container mass determined in Step 1 from the mass of the container and sample determined in Step 10.

12. Determine percent change by subtracting the new mass determination (M_n) from the previous mass determination (M_p) divide by the previous mass determination (M_p) multiply by 100.

13. Continue drying, performing steps 9 through 12, until there is less than a 0.10 percent change after additional drying time.

14. Constant mass has been achieved, sample is defined as dry.

15. Allow the sample to cool. Determine and record the total mass of the container and dry sample.

16. Determine and record the dry mass of the sample by subtracting the mass of the container determined in Step 1 from the mass of the container and sample determined in Step 15.

17. Determine and record percent moisture by subtracting the final dry mass determination (M_D) from the initial wet mass determination (M_W) divide by the final dry mass determination (M_D) multiply by 100.

Table 2
Methods of Drying

Heat Source	Specific Instructions	Drying increments (minutes)
Controlled: Forced draft (preferred), ventilated, or convection oven	110 ±5°C (230 ±9°F)	30
Uncontrolled:		
Hot plate, Heat Lamp, etc.	Stir frequently	20
Microwave	Heap sample and cover with ventilated lid	10

Calculation

Constant Mass:

Calculate constant mass using the following formula:

$$\frac{M_p - M_n}{M_p} \times 100 = \%\ \text{Change}$$

Where:

M_p = previous mass measurement

M_n = new mass measurement

Example:

Mass of container: 1232.1 g

Mass of container after first drying cycle: 2637.2 g

Mass, M_p, of possibly dry sample: 2637.2 g - 1232.1 g = 1405.1 g

Mass of container and dry sample after second drying cycle: 2634.1 g

Mass, M_n, of dry sample: 2634.1 g - 1232.1 g = 1402.0 g

$$\frac{1405.1\text{ g} - 1402.0\text{ g}}{1405.1\text{ g}} \times 100 = 0.22\%$$

0.22 percent is not less than 0.10 percent, so continue drying

Mass of container and dry sample after third drying cycle: 2633.0 g

Mass, M_n, of dry sample: 2633.0 g - 1232.1 g = 1400.9 g

$$\frac{1402.0\text{ g} - 1400.9\text{ g}}{1402.0\text{ g}} \times 100 = 0.08\%$$

0.08 percent is less than 0.10 percent, so constant mass has been reached

Moisture Content:

Calculate the moisture content, w, as a percent, using the following formula:

$$\frac{M_W - M_D}{M_D} \times 100 = \%\ Moisture\ Content$$

where:

M_W = wet mass

M_D = dry mass

Example:

Mass of container: 1232.1 g

Mass of container and wet sample: 2764.7 g

Mass, M_W, of wet sample: 2764.7 g - 1232.1 g = 1532.6 g

Mass of container and dry sample (COOLED): 2633.0 g

Mass, M_D, of dry sample: 2633.0 g - 1232.1 g = 1400.9 g

$$w = \frac{1532.6\text{g} - 1400.9\text{g}}{1400.9\text{g}} \times 100 = \frac{131.7\text{g}}{1400.9\text{g}} = 9.40\% \text{ rounded to } 9.4\%$$

Report

- Results on forms approved by the agency
- M_W, wet mass
- M_D, dry mass
- w, moisture content to nearest 0.1 percent

PERFORMANCE EXAM CHECKLIST

TOTAL MOISTURE CONTENT OF AGGREGATE BY DRYING
FOP FOR AASHTO T 255

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	**Trial 1**	**Trial 2**
1. Representative sample of appropriate mass obtained?	_____	_____
2. Mass of container determined to 0.1 percent or 0.1 g?	_____	_____
3. Sample placed in container and wet mass determined to 0.1 percent or 0.1 g?	_____	_____
4. Test sample mass conforms to the required mass?	_____	_____
5. Wet mass of sample determined to 0.1 percent or 0.1 g?	_____	_____
6. Loss of moisture avoided prior to mass determination?	_____	_____
7. Sample dried by a suitable heat source?	_____	_____
8. If aggregate heated by means other than a controlled oven, is sample stirred to avoid localized overheating?	_____	_____
9. Is aggregate heated for the additional, specified time (forced draft – 30 minutes; ventilated – 30 minutes; microwave – 10 minutes; other – 20 minutes) and then mass determined and compared to previous mass – showing less than 0.10 percent loss?	_____	_____
10. Sample cooled prior to dry mass determination to 0.1 percent or 0.1 g?	_____	_____
11. Calculations performed properly and results reported to the nearest 0.1 percent?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

Examiner Signature ____________________________ WAQTC #:_______________

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES
FOP FOR AASHTO T 27

MATERIALS FINER THAN 75 µm (No. 200) SIEVE IN MINERAL AGGREGATE BY WASHING
FOP FOR AASHTO T 11

Scope

Sieve analysis determines the gradation or distribution of aggregate particle sizes within a given sample.

Accurate determination of material smaller than 75 µm (No. 200) cannot be made with AASHTO T 27 alone. If quantifying this material is required, it is recommended that AASHTO T 27 be used in conjunction with AASHTO T 11.

This FOP covers sieve analysis in accordance with AASHTO T 27-11 and materials finer than 75 µm (No. 200) in accordance with AASHTO T 11-05 performed in conjunction with AASHTO T 27. The procedure includes three method choices: A, B, and C.

Apparatus

- Balance or scale: Capacity sufficient for the masses shown in Table 1, accurate to 0.1 percent of the sample mass or readable to 0.1 g, and meeting the requirements of AASHTO M 231
- Sieves: Meeting the requirements of AASHTO M 92
- Mechanical sieve shaker: Meeting the requirements of AASHTO T 27
- Suitable drying equipment (see FOP for AASHTO T 255)
- Containers and utensils: A pan or vessel of a size sufficient to contain the sample covered with water and to permit vigorous agitation without loss of any part of the sample or water
- Optional mechanical washing device

Sample Sieving

- In all procedures, it is required to shake the sample over nested sieves. Sieves are selected to furnish information required by specification.
- The sieves are nested in order of decreasing size from the top to the bottom and the sample, or a portion of the sample, is placed on the top sieve.

- Sieves are shaken in a mechanical shaker for approximately 10 minutes, or the minimum time determined to provide complete separation for the sieve shaker being used. As established by the Time Evaluation.

Time Evaluation

The sieving time for each mechanical sieve shaker shall be checked at least annually to determine the time required for complete separation of the sample by the following method:

1. Shake the sample over nested sieves for approximately 10 minutes.

2. Provide a snug-fitting pan and cover for each sieve, and hold in a slightly inclined position in one hand.

3. Hand-shake each sieve by striking the side of the sieve sharply and with an upward motion against the heel of the other hand at the rate of about 150 times per minute, turning the sieve about one sixth of a revolution at intervals of about 25 strokes.

If more than 0.5 percent by mass of the total sample prior to sieving passes any sieve after one minute of continuous hand sieving adjust shaker time and re-check.

In determining sieving time for sieve sizes larger than 4.75 mm (No. 4), limit the material on the sieve to a single layer of particles.

Overload Determination

- For sieves with openings smaller than 4.75 mm (No. 4), the mass retained on any sieve shall not exceed 7 kg/m^2 (4 g/in^2) of sieving surface.

- For sieves with openings 4.75 mm (No. 4) and larger, the mass, in grams shall not exceed the product of 2.5 × (sieve opening in mm) × (effective sieving area). See Table 1.

Additional sieves may be necessary to keep from overloading sieves or to provide other information, such as fineness modulus. The sample may also be sieved in increments to prevent overload.

TABLE 1
Maximum Allowable Mass of Material Retained on a Sieve, g
Nominal Sieve Size, mm (in.)
Exact size is smaller (see AASHTO T 27)

Sieve Size mm (in.)		203 dia (8)	305 dia (12)	305 by 305 (12 × 12)	350 by 350 (14 × 14)	372 by 580 (16 × 24)
				Sieving Area m^2		
		0.0285	**0.0670**	**0.0929**	**0.1225**	**0.2158**
90	(3 1/2)	*	15,100	20,900	27,600	48,500
75	(3)	*	12,600	17,400	23,000	40,500
63	(2 1/2)	*	10,600	14,600	19,300	34,000
50	(2)	3600	8400	11,600	15,300	27,000
37.5	(1 1/2)	2700	6300	8700	11,500	20.200
25.0	(1)	1800	4200	5800	7700	13,500
19.0	(3/4)	1400	3200	4400	5800	10,200
16.0	(5/8)	1100	2700	3700	4900	8600
12.5	(1/2)	890	2100	2900	3800	6700
9.5	(3/8)	670	1600	2200	2900	5100
6.3	(1/4)	440	1100	1500	1900	3400
4.75	(No. 4)	330	800	1100	1500	2600
-4.75	(-No. 4)	200	470	650	860	1510

Sample Preparation

Obtain samples in accordance with the FOP for AASHTO T 2 and reduce to the size shown in Table 2 in accordance with the FOP for AASHTO T 248. These sample sizes are standard for aggregate testing but, due to equipment restraints, samples may need to be partitioned into several “subsamples.” For example, a gradation that requires 100 kg (220 lbs) of material would not fit into a large tray shaker in one batch.

Some agencies permit reduced sample sizes if it is proven that doing so is not detrimental to the test results. Some agencies require larger sample sizes. Check agency guidelines for required or permitted test sample sizes.

TABLE 2
Sample Sizes for Aggregate Gradation Test

Nominal Maximum Size* mm (in.)		Minimum Dry Mass g (lb)	
4.75	(No. 4)	500	(1)
6.3	(1/4)	1000	(2)
9.5	(3/8)	1000	(2)
12.5	(1/2)	2000	(4)
19.0	(3/4)	5000	(11)
25.0	(1)	10,000	(22)
37.5	(1 1/2)	15,000	(33)
50	(2)	20,000	(44)
63	(2 1/2)	35,000	(77)
75	(3)	60,000	(130)
90	(3 1/2)	100,000	(220)
100	(4)	150,000	(330)
125	(5)	300,000	(660)

*Nominal maximum size: One sieve larger than the first sieve to retain more than 10 percent of the material using an agency specified set of sieves based on cumulative percent retained. Where large gaps between specification sieves exist, intermediate sieve(s) may be inserted to determine nominal maximum size.

Selection of Procedure

Agencies may specify what method will be performed. If a method is not specified method A will be performed.

Overview

Method A

- Determine dry mass of original sample
- Wash through a 75µm (No. 200) sieve
- Determine dry mass of washed sample
- Sieve material

Method B

- Determine dry mass of original sample
- Wash through a 75µm (No. 200) sieve
- Determine dry mass of washed sample
- Sieve coarse material
- Determine dry mass of fine material
- Reduce fine portion
- Determine mass of reduced portion
- Sieve fine portion

Method C

- Determine dry mass of original sample
- Sieve coarse material
- Determine mass of fine material
- Reduce fine portion
- Determine mass of reduced portion
- Wash through a 75µm (No. 200) sieve
- Determine dry mass of washed sample
- Sieve reduced fine portion

Procedure Method A

1. Dry the sample to a constant mass in accordance with the FOP for AASHTO T 255, and record to the nearest 0.1 percent of the total sample mass or 0.1 g.

2. When the specification requires that the amount of material finer than 75 µm (No. 200) be determined, perform Step 3 through Step 9; otherwise, skip to Step 10.

3. Nest a sieve, such as a 2.0 mm (No. 10), above the 75 µm (No. 200) sieve.

4. Place the test sample in a container and add sufficient water to cover it.

   Note 1: A detergent, dispersing agent, or other wetting solution may be added to the water to assure a thorough separation of the material finer than the 75 µm (No. 200) sieve from the coarser particles. There should be enough wetting agent to produce a small amount of suds when the sample is agitated. Excessive suds may overflow the sieves and carry material away with them.

5. Agitate vigorously to ensure complete separation of the material finer than 75 µm (No. 200) from coarser particles and bring the fine material into suspension above the coarser material. When using a mechanical washing device, exercise caution to avoid degradation of the sample.

6. Immediately pour the wash water containing the suspended and dissolved solids over the nested sieves, being careful not to pour out the coarser particles.

7. Add a second change of water to the sample remaining in the container, agitate, and repeat Step 6. Repeat the operation until the wash water is reasonably clear. If a detergent or dispersing agent is used, continue washing until the agent is removed.

8. Remove the upper sieve, return material retained to the washed sample.

9. Rinse the material retained on the 75 µm (No.200) sieve until water passing through the sieve is reasonably clear.

10. Return all material retained on the 75 µm (No.200) sieve to the container by flushing into the washed sample.

Note 2: Excess water may be carefully removed with a bulb syringe as long as the removed water is discharged back over the No. 200 sieve to preclude loss of fines.

11. Dry the washed aggregate to constant mass in accordance with the FOP for AASHTO T 255, and then cool prior to sieving. Record the "dry mass after washing".

12. Select sieves to furnish the information required by the specifications. Nest the sieves in order of decreasing size from top to bottom and place the sample, or a portion of the sample, on the top sieve.

13. Place sieves in mechanical shaker and shake for the minimum time determined to provide complete separation for the sieve shaker being used (approximately 10 minutes).

    Note 3: Excessive shaking (more than 10 minutes) may result in degradation of the sample.

14. Determine the individual or cumulative mass retained on each sieve and the pan to the nearest 0.1 percent or 0.1 g. Ensure that all material trapped in full openings of the sieve are cleaned out and included in the mass retained.

    Note 4: For sieves No. 4 and larger, material trapped in less than a full opening shall be checked by sieving over a full opening. Use coarse wire brushes to clean the 600 µm (No. 30) and larger sieves, and soft bristle brushes for smaller sieves.

15. In the case of coarse / fine aggregate mixtures, the minus 4.75 mm (No. 4) may be distributed among two or more sets of sieves to prevent overloading of individual sieves.

Calculations

The total mass of the material after sieving, for both coarse and fine portions should check closely with the original mass of sample placed on the sieves. If performing T 11 with T 27, this would be the dry mass after wash. If performing just T 27 this would be the original dry mass. When the masses before and after sieving differ by more than 0.3 percent, do not use the results for acceptance purposes.

Check Sum

Total mass of material after sieving must agree with mass before sieving to within 0.3 percent.

$$\frac{dry\ mass\ after\ washing - total\ mass\ after\ sieving}{dry\ mass\ after\ washing} \times 100$$

Calculate the total percentages passing, individual or cumulative percentages retained, or percentages in various size fractions to the nearest 0.1 percent by dividing the masses for

Method A, or adjusted masses for methods B and C, on the individual sieve masses or cumulative sieve masses by the total mass of the initial dry sample. If the same test sample was first tested by T 11, use the total dry sample mass prior to washing in T 11 as the basis for calculating all percentages. Report percent passing as indicated in the “Report” section at the end of this FOP.

Percent Retained:

Where:

IPR= Individual Percent Retained
CPR= Cumulative Percent Retained
M= Total Dry Sample mass before washing
IMR= Individual Mass Retained OR Adjusted Individual mass from Methods B or C
CMR= Cumulative Mass Retained OR Adjusted Cumulative Mass from Methods B or C

$$IPR \frac{IMR}{M} \times 100 \qquad or \qquad CPR = \frac{CMR}{M} \times 100$$

Percent Passing (Calculated):

Where:

PP= Percent Passing
PPP= Previous Percent Passing

$$PP = PPP - IPR \qquad or \qquad PP = 100 - CPR$$

Method A Sample Calculation

Calculate percent retained on and passing each sieve on the basis of the total mass of the initial dry sample. This will include any material finer than 75 µm (No. 200) that was washed out.

Example:

Dry mass of total sample, before washing: 5168.7 g
Dry mass of sample, after washing out the 75µm (No. 200) minus: 4911.3 g
Amount of 75µm (No. 200) minus washed out: 5168.7 g – 4911.3 g = 257.4 g

Gradation on All Sieves

Sieve Size mm (in.)	Individual Mass Retained g (IMR)	Individual Percent Retained (IPR)	Cumulative Mass Retained g (CMR)	Cumulative Percent Retained (CPR)	Calc'd Percent Passing (CPP)	Reported Percent Passing* (RPP)
19.0 (3/4)	0	0	0	0.0	100.0	100
12.5 (1/2)	724.7	14.0	724.7	14.0	86.0	86
9.5 (3/8)	619.2	12.0	1343.9	26.0	74.0	74
4.75 (No. 4)	1189.8	23.0	2533.7	49.0	51.0	51
2.36 (No. 8)	877.6	17.0	3411.3	66.0	34.0	34
1.18 (No. 16)	574.8	11.1	3986.1	77.1	22.9	23
0.600 (No. 30)	329.8	6.4	4315.9	83.5	16.5	17
0.300 (No. 50)	228.5	4.4	4544.4	87.9	12.1	12
0.150 (No. 100)	205.7	4.0	4750.1	91.9	8.1	8
0.075(No. 200)	135.4	2.6	4885.5	94.5	5.5	5.5
Pan	20.4		4905.9			

*Report 75 µm (No. 200) sieve to 0.1 percent. Report all others to 1 percent.

Check sum:

$$\frac{4911.3\ g - 4905.9\ g}{4911.3\ g} \times 100 = 0.1\%$$

This is less than 0.3 percent therefore the results can be used for acceptance purposes.

Percent Retained:

9.5 mm (3/8) sieve:

$$\frac{619.2\ g}{5168.7\ g} \times 100 = 12.0\% \quad or \quad \frac{1343.9\ g}{5168.7\ g} \times 100 = 26.0\%$$

Percent Passing (Calculated):

9.5 mm (3/8) sieve:

$$86.0\% - 12.0\% = 74.0\% \quad or \quad 100\% - 26.0\% = 74.0\%$$

Procedure Method B

1. Perform steps 1 through 11 from the "Procedure – Method A", then continue as follows:

2. Select sieves to furnish information required by the specifications. Nest the sieves in order of decreasing size from top to bottom through the 4.75 mm (No. 4) with a pan at the bottom to retain the minus 4.75 mm (No. 4).

3. Place the sample, or a portion of the sample, on the top sieve. Sieves may already be in the mechanical shaker, or place the sieves in the mechanical shaker and shake for the minimum time determined to provide complete separation for the sieve shaker being used (approximately 10 minutes).

   Note 3: Excessive shaking (more than 10 minutes) may result in degradation of the sample.

4. Determine the individual or cumulative mass retained on each sieve to the nearest 0.1 percent or 0.1 g. Ensure that all particles trapped in full openings of the sieve are cleaned out and included in the mass retained.

   Note 4: For sieves No. 4 and larger, material trapped in less than a full opening shall be checked by sieving over a full opening .Use coarse wire brushes to clean the 600 μm (No. 30) and larger sieves, and soft hair bristle for smaller sieves.

5. Determine the mass of the material in the pan [minus 4.75 mm (No. 4)] (M_1).

6. Reduce the minus 4.75 mm (No. 4) using a mechanical splitter in accordance with the FOP for AASHTO T 248 to produce a sample with a mass of 500 g minimum. Determine and record the mass of the minus 4.75 mm (No. 4) split (M_2).

7. Select fine sieves to furnish information required by the specifications. Nest the sieves in order of decreasing size from top to bottom through the 75 μm (No. 200) with a pan at the bottom to retain the minus 75μm (No. 200).

8. Repeat steps 3 and 4, Method B, with the minus 4.75 mm (No. 4) including determining the mass of the material in the pan.

9a. Compute the "Adjusted Individual Mass Retained" of the size increment of the original sample as follows when determining "Individual Mass Retained".

$$IMR = \frac{M_1}{M_2} \times B$$

where:

IMR = adjusted individual mass retained of the size increment on a total sample basis
M_1 = mass of minus 4.75mm (No. 4) sieve in total sample
M_2 = mass of minus 4.75mm (No. 4) sieve actually sieved
B = individual mass of the size increment in the reduced portion sieved

9b. Compute the "Adjusted Cumulative Mass Retained" of the size increment of the original sample as follows when determining "Cumulative Mass Retained":

$$CMR = \left(\frac{M_1}{M_2} \times B\right) + D$$

where:

CMR = Total cumulative mass retained of the size increment based on a total sample
M_1 = mass of minus 4.75mm (No. 4) sieve in total sample
M_2 = mass of minus 4.75mm (No. 4) sieve actually sieved
B = cumulative mass of the size increment in the reduced portion sieved
D = cumulative mass of plus 4.75mm (No. 4) portion of sample

Method B Sample Calculation

Sample calculation for percent retained and percent passing each sieve in accordance with Method B when the previously washed 4.75mm (No. 4) minus material is split:

Example:

Dry mass of total sample, before washing: 3214.0 g
Dry mass of sample, after washing out the 75 µm (No. 200) minus: 3085.1 g
Amount of 75 µm (No. 200) minus washed out: 3214.0 g – 3085.1 g = 128.9 g

Gradation on Coarse Sieves

Sieve Size mm (in.)	**Individual Mass Retained g (IMR)**	**Individual Percent Retained (IPR)**	**Cumulative Mass Retained g (CMR)**	**Cumulative Percent Retained (CPR)**	**Calculated Percent Passing (CPP)**
16.0 (5/8)	0	0	0	0	100
12.5 (1/2)	161.1	5.0	161.1	5.0	95.0
9.50 (3/8)	481.4	15.0	642.5	20.0	80.0
4.75 (No. 4)	475.8	14.8	1118.3	34.8	65.2
Pan	1966.7 (**M_1**)		3085.0		

Coarse check sum:

$$\frac{3085.1\ g - 3085.0\ g}{3085.1\ g} \times 100 = 0.0\%$$

This is less than 0.3 percent therefore the results can be used for acceptance purposes.

Note 5: The pan mass determined in the laboratory (M_1) and the calculated mass (3085.1 – 1118.3 = 1966.7) should be the same if no material was lost.

The pan (1966.7 g) was reduced in accordance with the FOP for AASHTO T 248, so that at least 500 g are available. In this case, the mass determined was **512.8 g**. This is $\mathbf{M_2}$.

In order to account for the fact that only a portion of the minus 4.75mm (No. 4) material was sieved, the mass of material retained on the smaller sieves is adjusted by a factor equal to M_1/M_2. The factor determined from M_1/M_2 must be carried to three decimal places. Both the individual mass retained and cumulative mass retained formulas are shown.

Individual Mass Retained:

M_1 = total mass of the minus 4.75mm (No. 4) before reducing.
M_2 = mass before sieving from the reduced portion of the minus 4.75 mm (No. 4).

$$\frac{M_1}{M_2} = \frac{1{,}966.7\ g}{512.8\ g} = 3.835$$

Each "individual mass retained" on the fine sieves must be multiplied by this adjustment factor.

For example, the overall mass retained on the 2.00mm (No. 10) sieve is:

3.835 × 207.1 g = 794.2 g, as shown in the following table:

Final Gradation on All Sieves
Calculation by Individual Mass

Sieve Size mm (in.)	**Individual Mass Retained, g (IMR)**	**Adjusted Individual Mass Retained (AIMR)**	**Individual Percent Retained (IPR)**	**Calc'd Percent Passing (CPP)**	Reported Percent Passing* (RPP)
16.0 (5/8)	0	0	0.0	100.0	100
12.5 (1/2)	161.1	161.1	5.0	95.0	95
9.5 (3/8)	481.4	481.4	15.0	80.0	80
4.75 (No. 4)	475.8	475.8	14.8	65.2	65
2.0 (No. 10)	207.1 *× 3.835*	794.2	24.7	40.5	41
0.425 (No. 40)	187.9 *× 3.835*	720.6	22.4	18.1	18
0.210 (No. 80)	59.9 *× 3.835*	229.7	7.1	11.0	11
0.075 (No. 200)	49.1 *× 3.835*	188.3	5.9	5.1	5.1
Pan	7.8 *× 3.835*	29.9			
Dry mass of total sample, before washing: 3214.0 g					

*Report 75 µm (No. 200) sieve to 0.1 percent. Report all others to 1 percent.

Fine check sum:

$$\frac{512.8\ g - 511.8\ g}{512.8\ g} \times 100 = 0.2\%$$

This is less than 0.3 percent therefore the results can be used for acceptance purposes.

For Percent Passing (Calculated) see “Calculation” under Method A.

Cumulative Mass Retained:

M_1 = mass of the minus 4.75 mm (No. 4) before split
M_2 = mass before sieving of the split of the minus 4.75 mm (No. 4)

$$\frac{M_1}{M_2} = \frac{1{,}966.7\ g}{512.8\ g} = 3.835$$

Each “cumulative mass retained” on the fine sieves must be multiplied by this adjustment factor then the cumulative mass of plus 4.75 mm (No. 4) portion of sample is added to equal the adjusted cumulative mass retained .

For example, the adjusted cumulative mass retained on the 0.425 mm (No. 40) sieve is:

$$3.835 \times 395.0\ g\ =\ 1514.8\ g$$

1514.8 + 1118.3 g = 2633.1: “Total Cumulative Mass Retained” as shown in the following table:

Final Gradation on All Sieves
Calculation by Cumulative Mass

Sieve Size mm (in.)	Cumulative Mass Retained g (CMR)	Adjusted Cumulative Mass Retained, g (ACMR)	Total Cumulative Mass Retnd. g (TCMR)	Cumulative Percent Retnd. (CPR)	Calc'd Percent Passing (CPP)	Reported Percent Passing* (RPP)
16.0 (5/8)	0		0	0.0	100.0	100
12.5 (1/2)	161.1		161.1	5.0	95.0	95
9.5 (3/8)	642.5		642.5	20.0	80.0	80
4.75 (No. 4)	1118.3		1118.3	34.8	65.2	65
2.0 (No. 10)	207.1 × *3.835*	794.2 + *1118.3*	1912.5	59.5	40.5	41
0.425 (No. 40)	395.0 × *3.835*	1514.8 + *1118.3*	2633.1	81.9	18.1	18
0.210 (No. 80)	454.9 × *3.835*	1744.5 + *1118.3*	2862.8	89.1	10.9	11
0.075 (No. 200)	504.0 × *3.835*	1932.8 + *1118.3*	3051.1	94.9	5.1	5.1
Pan	511.8 × *3.835*	1962.8 + *1118.3*	3081.1			

*Report 75 µm (No. 200) sieve to 0.1 percent. Report all others to 1 percent.

Fine check sum:

$$\frac{512.8\ g - 511.8g}{512.8\ g} \times 100 = 0.2\%$$

This is less than 0.3 percent therefore the results can be used for acceptance purposes. For Percent Passing (Calculated) see "Calculation" under Method A.

Procedure Method C

1. Dry sample in accordance with the FOP for AASHTO T 255. Determine and record the total dry mass of the sample to the nearest 0.1 percent.

   Note 6: AASHTO T 27 allows for coarse aggregate to be run in a moist condition unless the nominal maximum size of the aggregate is smaller than 12.5 mm (1/2 in.), the coarse aggregate (CA) contains appreciable material finer than 4.75 mm (No. 4), or the coarse aggregate is highly absorptive.

2. Break up any aggregations or lumps of clay, silt or adhering fines to pass the 4.75 mm (No. 4) sieve. If substantial coatings remain on the coarse particles in amounts that would affect the percent passing any of the specification sieves, the sample should be tested with either Method A or Method B.

3. Select sieves to furnish information required by the specifications. Nest the sieves in order of decreasing size from top to bottom through the 4.75 mm (No.4) with a pan at the bottom to retain the minus 4.75 mm (No. 4).

4. Place the sample, or a portion of the sample, on the top sieve. Sieves may already be in the mechanical shaker or place the sieves in the mechanical shaker and shake for the minimum time determined to provide complete separation for the sieve shaker being used (approximately 10 minutes).

   Note 3: Excessive shaking (more than 10 minutes) may result in degradation of the sample.

5. Determine the cumulative mass retained on each sieve to the nearest 0.1 percent or 0.1 g. Ensure that all material trapped in full openings of the sieve are cleaned out and included in the mass retained.

   Note 4: For sieves No. 4 and larger, material trapped in less than a full opening shall be checked by sieving over a full opening. Use coarse wire brushes to clean the 600 µm (No. 30) and larger sieves, and soft bristle brush for smaller sieves.

6. Determine the mass of material in the pan [minus 4.75 mm (No. 4)] (M_1).

7. Reduce the minus 4.75mm (No. 4), using a mechanical splitter in accordance with the FOP for AASHTO T 248, to produce a sample with a mass of 500 g minimum.

8. Determine and record the mass of the minus 4.75mm (No. 4) split ($M_{-\#4}$).

9. Perform steps 3 through 11 of Method A (Wash) on the minus 4.75mm (No. 4) split.

10. Select fine sieves to furnish information required by the specifications. Nest the sieves in order of decreasing size from top to bottom through the 75µm (No. 200) with a pan at the bottom to retain the minus 75 µm (No. 200).

11. Repeat steps 4 and 5, Method C, with the minus 4.75mm (No. 4) including determining the mass of the material in the pan.

12. Compute the "Cumulative Percent Retained" and "Cumulative Percent Passing" for the 4.75 mm (No. 4) and larger as follows:

$$CPR = \frac{CMR}{M} \times 100 \qquad CPP = 100 - CPR$$

where:

CMR = Cumulative Mass Retained
CPR= Cumulative Percent Retained
M= Total Dry Sample mass before washing
CPP= Cumulative Percent Passing

13. Compute the "Cumulative Percent Retained" and/or "Cumulative Percent Passing" for the minus 4.75 mm (No. 4) as follows:

$$CPR_{-\#4} = \frac{CMR_{-\#4}}{M_{-\#4}} \times 100 \qquad CPP_{-\#4} = 100 - CPR_{-\#4} \qquad CPP = \frac{(CPP_{-\#4} \times CPP_{\#4})}{100}$$

where:

$CMR_{-\#4}$ = Cumulative mass retained for the sieve size based on a minus#4 split sample
$CPR_{-\#4}$ = Calculated cumulative percent retained based on the minus #4 split
$CPP_{-\#4}$ = Calculated percent passing based on the minus #4 split
$M_{-\#4}$ = Total mass of the minus #4 split before washing
$CPP_{\#4}$ = Calculated percent passing the #4 sieve

Also note that for minus No. 4 material using this method that:

$$CPP = \frac{CPP_{-\#4} \times (M_{-\#4} - CMR_{-\#4})}{M_{-\#4}}$$

Method C Sample Calculation

Sample calculation for percent retained and percent passing each sieve in accordance with Method C when the minus 4.75mm (No. 4) material is reduced and then washed:

Dry Mass of total sample (M): 3304.5 g

Dry Mass of minus 4.75mm (No. 4) reduced portion before wash ($M_{-\#4}$): 527.6

Dry Mass of minus 4.75mm (No. 4) reduced portion after wash: 495.3

Gradation on Coarse Sieves

Sieve Size mm (in.)	Cumulative Mass Retained g (CMR)	Cumulative Percent Retained (CPR)	Cumulative Percent Passing (CPP)	Reported Percent Passing* (RPP)
16.0 (5/8)	0	0.0	100.0	100
12.5 (1/2)	125.9	3.8	96.2	96
9.50 (3/8)	604.1	18.3	81.7	82
4.75 (No. 4)	1295.6	39.2	**60.8**	61
Pan	2008.9			
Total Dry Sample (**M**) = 3304.5				

Coarse check sum:

$$\frac{3304.5\ g - 3304.5\ g}{3304.5\ g} \times 100 = 0.0\%$$

This is less than 0.3 percent therefore the results can be used for acceptance purposes.

The pan (2008.9 g) was reduced in accordance with the FOP for AASHTO T 248, so that at least 500 g are available. In this case, the mass determined was $M_{-\#4}$ = **527.6 g**.

Gradation on -#4 Sieves

Sieve Size mm (in.)	Cumulative Mass Retained g ($CMR_{-\#4}$)	Cumulative Percent Retained$_{-\#4}$ ($CPR_{-\#4}$)	Cumulative Percent Passing$_{-\#4}$ ($CPP_{-\#4}$)	Cumulative Percent Passing (CPP)	Reported Percent Passing* (RPP)
2.0 (No. 10)	194.3	36.8	63.2	38.4	38
0.425 (No. 40)	365.6	69.3	30.7	18.7	19
0.210 (No. 80)	430.8	81.7	18.3	11.1	11
0.075 (No. 200)	484.4	91.8	8.2	5.0	5.0
Pan	495.1				
Dry mass of minus 4.75 mm (No. 4) sample, before washing (**$M_{-\#4}$**) : 527.6 g Dry mass of minus 4.75 mm (No. 4) sample, after washing: 495.3 g Calculated percent passing the #4 sieve (**$CPP_{-\#4}$**) = 60.8%					

Fine check sum:

$$\frac{495.3\ g - 495.1\ g}{495.3\ g} \times 100 = 0.04\%$$

This is less than 0.3 percent therefore the results can be used for acceptance purposes.

Final Gradation on All Sieves
Calculation by Cumulative Mass

Sieve Size mm (in.)	Cumulative Mass Retained, g (CMR)	Cumulative Percent Retained (CPR)	Cumulative Percent Passing (CPP)	Cumulative Percent Passing (CPP)	Reported Percent Passing* (RPP)
16.0 (5/8)	0	0.0		100.0	100
12.5 (1/2)	125.9	3.8		96.2	96
9.5 (3/8)	604.1	18.3		81.7	82
4.75 (No. 4)	1295.6	39.2		**60.8**	61
2.0 (No. 10)	194.3	36.8	63.2	38.4	38
0.425 (No. 40)	365.6	69.3	30.7	18.7	19
0.210 (No. 80)	430.8	81.7	18.3	11.1	11
0.075 (No. 200)	484.4	91.8	8.2	5.0	5.0
Pan	495.1				

*Report 75 µm (No. 200) sieve to 0.1 percent. Report all others to 1 percent

Fineness Modulus

Fineness Modulus (FM) is used in determining the degree of uniformity of the aggregate gradation in PCC mix designs. It is an empirical number relating to the fineness of the aggregate. The higher the FM the coarser the aggregate. Values of 2.40 to 3.00 are common for FA in PCC.

The sum of the cumulative percentages retained on specified sieves in the following table divided by 100 gives the FM.

Sample Calculation

	Example A				**Example B**		
	Percent				**Percent**		
		Retained				**Retained**	
Sieve Size mm (in)	**Passing**		**On Spec'd Sieves***		**Passing**		**On Spec'd Sieves***
75*(3)	100	0	0		100	0	0
37.5*(11/2)	100	0	0		100	0	0
19*(3/4)	15	85	85		100	0	0
9.5*(3/8)	0	100	100		100	0	0
4.75*(No.4)	0	100	100		100	0	0
2.36*(No.8)	0	100	100		87	13	13
1.18*(No.16)	0	100	100		69	31	31
0.60*(No.30	0	100	100		44	56	56
0.30*(No.50)	0	100	100		18	82	82
0.15*(100)	0	100	100		4	96	96
			$\sum = 785$				$\sum = 278$
			FM = 7.85				FM = 2.78

In decreasing size order, each * sieve is one-half the size of the preceding * sieve.

Report

- Results on forms approved by the agency
- Individual mass retained on each sieve
- Individual percent retained on each sieve
- Cumulative mass retained on each sieve
- Cumulative percent retained on each sieve
- FM to the nearest 0.01

Report percentages to the nearest 1 percent except for the percent passing the 75 µm (No. 200) sieve, which shall be reported to the nearest 0.1 percent.

PERFORMANCE EXAM CHECKLIST

METHOD A
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES
FOP FOR AASHTO T 27
MATERIALS FINER THAN 75 µm (No. 200) SIEVE IN MINERAL AGGREGATE BY WASHING
FOP FOR AASHTO T 11

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Minimum sample mass meets requirement of Table 2?	_____	_____
2. Test sample dried to a constant mass by FOP for AASHTO T 255?	_____	_____
3. Test sample cooled and mass determined to nearest 0.1 percent or 0.1 g?	_____	_____
4. Sample placed in container and covered with water? (If specification requires that the amount of material finer than the 75 µm (No. 200) sieve is to be determined.)	_____	_____
5. Contents of the container vigorously agitated?	_____	_____
6. Complete separation of coarse and fine particles achieved?	_____	_____
7. Wash water poured through nested sieves such as 2 mm (No. 10) and 75 µm (No. 200)?	_____	_____
8. Operation continued until wash water is clear?	_____	_____
9. Material retained on sieves returned to washed sample?	_____	_____
10. Washed aggregate dried to a constant mass by FOP for AASHTO T 255?	_____	_____
11. Washed aggregate cooled and mass determined to nearest 0.1 percent or 0.1 g?	_____	_____
12. Sample placed in nest of sieves specified? (Additional sieves may be used to prevent overloading as allowed in FOP.)	_____	_____
13. Material sieved in verified mechanical shaker for proper time?	_____	_____
14. Mass of residue on each sieve and pan determined to 0.1 g?	_____	_____
15. Total mass of material after sieving agrees with mass before sieving to within 0.3 percent?	_____	_____

OVER

Procedure Element	**Trial 1**	**Trial 2**
16. Percentages calculated to the nearest 0.1 percent and reported to the nearest whole number, except 75 µm (No.200) - reported to the nearest 0.1 percent?	_____	_____
17. Percentage calculations based on original dry sample mass?	_____	_____
18. Calculations performed properly?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

Examiner Signature ______________________________ WAQTC #:________________

PERFORMANCE EXAM CHECKLIST

METHOD B
SIEVE ANALYSIS OF FINE AND COARSE AGGREGATES
FOP FOR AASHTO T 27
MATERIALS FINER THAN 75 µm (No. 200) SIEVE IN MINERAL AGGREGATE BY WASHING
FOP FOR AASHTO T 11

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Minimum sample mass meets requirement of Table 2?	_____	_____
2. Test sample dried to a constant mass by FOP for AASHTO T 255?	_____	_____
3. Test sample cooled and mass determined to nearest 0.1 percent or 0.1 g?	_____	_____
4. Sample placed in container and covered with water? (If specification requires that the amount of material finer than the 75 µm (No. 200) sieve is to be determined.)	_____	_____
5. Contents of the container vigorously agitated?	_____	_____
6. Complete separation of coarse and fine particles achieved?	_____	_____
7. Wash water poured through nested sieves such as 2 mm (No. 10) and 75 µm (No. 200)?	_____	_____
8. Operation continued until wash water is clear?	_____	_____
9. Material retained on sieves returned to washed sample?	_____	_____
10. Washed aggregate dried to a constant mass by FOP for AASHTO T 255?	_____	_____
11. Washed aggregate cooled and mass determined to nearest 0.1 percent or 0.1 g?	_____	_____
12. Sample placed in nest of sieves specified? (Additional sieves may be used to prevent overloading as allowed in FOP.)	_____	_____
13. Material sieved in verified mechanical shaker for proper time?	_____	_____
14. Mass of residue on each sieve and pan determined to the nearest 0.1 percent or 0.1 g?	_____	_____
15 Total mass of material after sieving agrees with mass before sieving to within 0.3 percent?	_____	_____

OVER

Procedure Element	Trial 1	Trial 2
16. Material in pan reduced in accordance with FOP for AASHTO T 248 to a minimum sample size of 500 g and weighed to the nearest 0.1 g?	_____	_____
17. Sample placed in nest of sieves specified? (Additional sieves may be used to prevent overloading as allowed in FOP.)	_____	_____
18. Material sieved in verified mechanical shaker for proper time?	_____	_____
19. Mass of residue on each sieve and pan determined to the nearest percent or 0.1 g?	_____	_____
20. Total mass of material after sieving agrees with mass before sieving to within 0.3 percent?	_____	_____
21. Percentages calculated to the nearest 0.1 percent and reported to the nearest whole number, except 75 µm (No.200) - reported to the nearest 0.1 percent?	_____	_____
22. Percentage calculations based on original dry sample mass?	_____	_____
23. Calculations performed properly?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

Examiner Signature ______________________________ WAQTC #:________________

DETERMINING THE PERCENTAGE OF FRACTURE IN COARSE AGGREGATE FOP FOR AASHTO T 335

Scope

This procedure covers the determination of the percentage, by mass, of a coarse aggregate (CA) sample that consists of fractured particles meeting specified requirements in accordance with AASHTO T 335-09.

In this FOP, a sample of aggregate is screened on the sieve separating CA and fine aggregate (FA). This sieve will be identified in the agency's specifications, but might be the 4.75 mm (No. 4) sieve. CA particles are visually evaluated to determine conformance to the specified fracture. The percentage of conforming particles, by mass, is calculated for comparison to the specifications.

Apparatus

- Balance or scale: Capacity sufficient for the principle sample mass, accurate to 0.1 percent of the sample mass or readable to 0.1 g, and meeting the requirements of AASHTO M 231.

- Sieves: Meeting requirements of AASHTO M 92.

- Splitter: Meeting the requirements of FOP for AASHTO T 248.

Terminology

1. Fractured Face: An angular, rough, or broken surface of an aggregate particle created by crushing or by other means. A face is considered a "fractured face" whenever one-half or more of the projected area, when viewed normal to that face, is fractured with sharp and well defined edges. This excludes small nicks.

2. Fractured particle: A particle of aggregate having at least the minimum number of fractured faces specified. (This is usually one or two.)

Sampling and Sample Preparation

1. Sample and reduce the aggregate in accordance with the FOPs for AASHTO T 2 and T 248.

2. When the specifications list only a total fracture percentage, the sample shall be prepared in accordance with Method 1. When the specifications require that the fracture be counted and reported on each sieve, the sample shall be prepared in accordance with Method 2.

3. Method 1 - Combined Fracture Determination

   a. Dry the sample sufficiently to obtain a clean separation of FA and CA material in the sieving operation.

   b. Sieve the sample in accordance with the FOP for AASHTO T 27/ T 11 over the 4.75 mm (No. 4) sieve, or the appropriate sieve listed in the agency's specifications for this material.

Note 1: Where necessary, wash the sample over the sieve designated for the determination of fractured particles to remove any remaining fine material, and dry to a constant mass in accordance with the FOP for AASHTO T 255.

   c. Reduce the sample using Method A – Mechanical Splitter, in accordance with the FOP for AASHTO T 248, to the appropriate test size. This test size should be slightly larger than shown in Table 1, to account for loss of fines through washing if necessary.

TABLE 1
Sample Size
Method 1 (Combined Sieve Fracture)

Nominal Maximum Size* mm (in.)	Minimum Cumulative Sample Mass Retained on 4.75 mm (No. 4) Sieve g (lb)
37.5 (1 1/2)	2500 (6)
25.0 (1)	1500 (3.5
19.0 (3/4)	1000 (2.5)
12.5 (1/2)	700 (1.5)
9.5 (3/8)	400 (0.9)
4.75 (No. 4)	200 (0.4)

* One sieve larger than the first sieve to retain more than 10 percent of the material using an agency specified set of sieves based on cumulative percent retained. Where large gaps in specification sieves exist, intermediate sieve(s) may be inserted to determine nominal maximum size.

4. Method 2 – Individual Sieve Fracture Determination

   a. Dry the sample sufficiently to obtain a clean separation of FA and CA material in the sieving operation. A washed sample from the gradation determination (the FOP for T 27/T 11) may be used.

   b. If not, sieve the sample in accordance with the FOP for AASHTO T 27 over the sieves listed in the specifications for this material.

Note 2: If overload (buffer) sieves are used the material from that sieve must be added to the next specification sieve.

c. The size of test sample for each sieve shall meet the minimum size shown in Table 2. Utilize the total retained sieve mass or select a representative portion from each sieve mass by splitting or quartering in accordance with the FOP for AASHTO T 248.

Note 3: Where necessary, wash the sample over the sieves designated for the determination of fractured particles to remove any remaining fine material, and dry to a constant mass in accordance with the FOP for AASHTO T 255.

TABLE 2
Sample Size
Method 2 (Individual Sieve Fracture)

Sieve Size mm (in.)	Minimum Sample Mass g (lb)
31.5 (1 1/4)	1500 (3.5)
25.0 (1)	1000 (2.2)
19.0 (3/4)	700 (1.5)
16.0 (5/8)	500 (1.0)
12.5 (1/2)	300 (0.7)
9.5 (3/8)	200 (0.5)
6.3 (1/4)	100 (0.2)
4.75 (No. 4)	100 (0.2)
2.36 (No. 8)	25 (0.1)
2.00 (No. 10)	25 (0.1)

Note 3: If fracture is determined on a sample obtained for gradation, use the mass retained on the individual sieves, even if it is less than the minimum listed in Table 2. If less than 5 percent of the total mass is retained on a single specification sieve, include that material on the next smaller specification sieve. If a smaller specification sieve does not exist, this material shall not be included in the fracture determination.

Procedure

1. After cooling, spread the dried sample on a clean, flat surface large enough to permit careful inspection of each particle. To verify that a particle meets the fracture criteria, hold the aggregate particle so that the face is viewed directly.

2. To aid in making the fracture determination, separate the sample into three categories:

   - fractured particles meeting the criteria
   - particles not meeting the criteria
   - questionable or borderline particles

3. Determine the dry mass of particles in each category to the nearest 0.1 g.

4. If, on any determination, more than 15 percent of the total mass of the sample is placed in the questionable category, repeat the sorting procedure until no more than 15 percent is present in that category.

Calculation

Calculate the mass percentage of questionable fractured particles to the nearest 1 percent using the following formula:

$$\%Q = \frac{Q}{F + Q + N} \times 100$$

where: %Q = Percent of questionable fractured particles
F = Mass of fractured particles
Q = Mass of questionable or borderline particles
N = Mass of unfractured particles

Example:

F = 632.6 g, Q = 97.6 g, N = 352.6 g
% Q =

$$\frac{97.6\ g}{632.6\ g + 97.6\ g + 352.6\ g} \times 100 = 9.0\% \qquad \%\text{Q} = \mathbf{9}\%$$

Calculate the mass percentage of fractured faces to the nearest 1 percent using the following formula:

$$\text{P} = \frac{\frac{Q}{2} + F}{F + Q + N} \times 100$$

where: P = Percent of fracture
F = Mass of fractured particles
Q = Mass of questionable or borderline particles
N = Mass of unfractured particles

Example:

F = 632.6 g, Q = 97.6 g, N = 352.6 g

$$\text{P} = \frac{\frac{97.6\ g}{2} + 632.6\ \text{g}}{632.6\ g + 97.6\ g + 352.6\ g} \times 100 \qquad \mathbf{P = 63}\%$$

Report

- Results on forms approved by the agency
- Fracture to the nearest 1 percent.

PERFORMANCE EXAM CHECKLIST

DETERMINING THE PERCENTAGE OF FRACTURE IN COARSE AGGREGATE FOP FOR AASHTO T 335

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Sample properly sieved through specified sieve(s)?	_____	_____
2. Sample reduced to correct size?	_____	_____
3. Sample dried and cooled, if necessary?	_____	_____
4. Particles separated into fractured, unfractured, and questionable categories?	_____	_____
5. Dry mass of each category determined to nearest 0.1 g?	_____	_____
6. Procedure repeated if more than 15 percent of total mass falls into the questionable category?	_____	_____
7. Fracture calculation performed correctly?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

____
____
____
____
____
____
____
____
____
____
____

Examiner Signature ____________________________ WAQTC #:_______________

PLASTIC FINES IN GRADED AGGREGATES AND SOILS BY THE USE OF THE SAND EQUIVALENT TEST
FOP FOR AASHTO T 176

Scope

This procedure covers the determination of plastic fines in accordance with AASHTO T 176-08. It serves as a rapid test to show the relative proportion of fine dust or clay-like materials in fine aggregates (FA) and soils.

Apparatus

See AASHTO T 176 for a detailed listing of sand equivalent apparatus. Note that the siphon tube and blow tube may be glass or stainless steel as well as copper.

- Graduated plastic cylinder.
- Rubber stopper.
- Irrigator tube.
- Weighted foot assembly: Having a mass of 1000 ±5g. There are two models of the weighted foot assembly. The older model has a guide cap that fits over the upper end of the graduated cylinder and centers the rod in the cylinder. It is read using a slot in the centering screws. The newer model has a sand-reading indicator 254 mm (10 in.) above this point and is preferred for testing clay-like materials.
- Siphon assembly: The siphon assembly will be fitted to a 4 L (1 gal) bottle of working calcium chloride solution placed on a shelf 915 ±25 mm (36 ±1 in.) above the work surface.
- Measuring can: With a capacity of 85 ±5 mL (3 oz.).
- Funnel: With a wide-mouth for transferring sample into the graduated cylinder.
- Quartering cloth: 600 mm (2 ft) square nonabsorbent cloth, such as plastic or oilcloth.
- Mechanical splitter: See the FOP for AASHTO T 248.
- Strike-off bar: A straightedge or spatula.
- Clock or watch reading in minutes and seconds.
- Manually-operated sand equivalent shaker: Capable of producing an oscillating motion at a rate of 100 complete cycles in 45 ±5 seconds, with a hand assisted half stroke length of

127 ±5 mm (5 ±0.2 in.). It may be held stable by hand during the shaking operation. It is recommended that this shaker be fastened securely to a firm and level mount, by bolts or clamps, if a large number of determinations are to be made.

- Mechanical shaker: See AASHTO T 176 for equipment and procedure.
- Oven: Capable of maintaining a temperature of 110 ±5°C (230 ±9°F).
- Thermometer: Calibrated liquid-in-glass or electronic digital type designed for total immersion and accurate to 0.1°C (0.2°F).

Materials

- Stock calcium chloride solution: Obtain commercially prepared calcium chloride stock solution meeting AASHTO requirements.
- Working calcium chloride solution: Dilute one 3 oz measuring can (85 ±5 mL) of stock calcium chloride solution to 3.8 L (1 gal) with distilled or demineralized water. (The graduated cylinder filled to 111.8 mm [4.4 in.] contains 88 mL.)

    Note 1: Mix the working solution thoroughly. Add 85 mL (3 oz.) of stock solution to a clean, empty 3.8 L (1 gal.) jug, add approximately 1 L (1 qt), and agitate vigorously for 2 or 3 minutes. Add the remainder of the water in approximately 1 L (1 qt) increments, repeating the agitation process.

    Note 2: Tap water may be used if it is proven to be non-detrimental to the test and if it is allowed by the agency.

    Note 3: The shelf life of the working solution is approximately 30 days. Working solutions more than 30 days old shall be discarded.

Control

The temperature of the working solution should be maintained at 22 ±3°C (72 ±5°F) during the performance of the test. If field conditions preclude the maintenance of the temperature range, reference samples should be submitted to the Central/Regional Laboratory, as required by the agency, where proper temperature control is possible. Samples that meet the minimum sand equivalent requirement at a working solution temperature outside of the temperature range need not be subject to reference testing.

Sample Preparation

1. Obtain the sample in accordance with the FOP for AASHTO T 2 and reduce in accordance with the FOP for AASHTO T 248.

2. Prepare sand equivalent test samples from the material passing the 4.75 mm (No. 4) sieve. If the material is in clods, break it up and re-screen it over a 4.75 mm (No. 4) sieve. All fines shall be cleaned from particles retained on the 4.75 mm (No. 4) sieve and included with the material passing that sieve.

3. Split or quarter 1000 to 1500 g of material from the portion passing the 4.75 mm (No. 4) sieve. Use extreme care to obtain a truly representative portion of the original sample.

   Note 4: Experiments show that, as the amount of material being reduced by splitting or quartering is decreased, the accuracy of providing representative portions is reduced. It is imperative that the sample be split or quartered carefully. When it appears necessary, dampen the material before splitting or quartering to avoid segregation or loss of fines.

   Note 5: All tests, including reference tests, will be performed utilizing Alternative Method No. 2 as described in AASHTO T 176, unless otherwise specified.

4. The sample must have the proper moisture content to achieve reliable results. This condition is determined by tightly squeezing a small portion of the thoroughly mixed sample in the palm of the hand. If the cast that is formed permits careful handling without breaking, the correct moisture content has been obtained.

   Note 6: Clean sands having little 75 µm (No. 200), such as sand for Portland Cement Concrete (PCC), may not form a cast.

   If the material is too dry, the cast will crumble and it will be necessary to add water and remix and retest until the material forms a cast. When the moisture content is altered to provide the required cast, the altered sample should be placed in a pan, covered with a lid or with a damp cloth that does not touch the material, and allowed to stand for a minimum of 15 minutes. Samples that have been sieved without being air-dried and still retain enough natural moisture are exempted from this requirement.

   If the material shows any free water, it is too wet to test and must be drained and air dried. Mix frequently to ensure uniformity. This drying process should continue until squeezing provides the required cast.

5. Place the sample on the quartering cloth and mix by alternately lifting each corner of the cloth and pulling it over the sample toward the diagonally opposite corner, being careful to keep the top of the cloth parallel to the bottom, thus causing the material to be rolled. When the material appears homogeneous, finish the mixing with the sample in a pile near the center of the cloth.

6. Fill the measuring can by pushing it through the base of the pile while exerting pressure with the hand against the pile on the side opposite the measuring can. As the can is moved through the pile, hold enough pressure with the hand to cause the material to fill the tin to overflowing. Press firmly with the palm of the hand, compacting the material and placing the maximum amount in the can. Strike off the can level full with the straightedge or spatula.

7. When required, repeat steps 5 and 6 to obtain additional samples.

Procedure

1. Start the siphon by forcing air into the top of the solution bottle through the tube while the pinch clamp is open.

2. Siphon 101.6 ±2.5 mm (4 ±0.1 in.) of working calcium chloride solution into the plastic cylinder. Pour the prepared test sample from the measuring can into the plastic cylinder, using the funnel to avoid spilling. Tap the bottom of the cylinder sharply on the heel of the hand several times to release air bubbles and to promote thorough wetting of the sample.

3. Allow the wetted sample to stand undisturbed for 10 ±1 minutes. At the end of the 10-minute period, stopper the cylinder and loosen the material from the bottom by simultaneously partially inverting and shaking the cylinder.

4. After loosening the material from the bottom of the cylinder, shake the cylinder and contents by any one of the following methods:

    a. Mechanical Method – Place the stoppered cylinder in the mechanical shaker, set the timer, and allow the machine to shake the cylinder and contents for 45 ±1 seconds.

    Caution: Agencies may require additional operator qualifications for the next two methods.

    b. Manually-operated Shaker Method – Secure the stoppered cylinder in the three spring clamps on the carriage of the manually-operated sand equivalent shaker and set the stroke counter to zero. Stand directly in front of the shaker and force the pointer to the stroke limit marker painted on the backboard by applying an abrupt horizontal thrust to the upper portion of the right hand spring strap.

       Remove the hand from the strap and allow the spring action of the straps to move the carriage and cylinder in the opposite direction without assistance or hindrance. Apply enough force to the right-hand spring steel strap during the thrust portion of each stroke to move the pointer to the stroke limit marker by pushing against the strap with the ends of the fingers to maintain a smooth oscillating motion. The center of the stroke limit marker is positioned to provide the proper stroke length and its width provides the maximum allowable limits of variation.

       Proper shaking action is accomplished when the tip of the pointer reverses direction within the marker limits. Proper shaking action can best be maintained by using only the forearm and wrist action to propel the shaker. Continue shaking for 100 strokes.

    c. Hand Method – Hold the cylinder in a horizontal position and shake it vigorously in a horizontal linear motion from end to end. Shake the cylinder 90 cycles in approximately 30 seconds using a throw of 229 mm ±25 mm (9 ±1 in.). A cycle is defined as a complete back and forth motion. To properly shake the cylinder at this speed, it will be necessary for the operator to shake with the forearms only, relaxing the body and shoulders.

5. Set the cylinder upright on the work table and remove the stopper.

6. Insert the irrigator tube in the cylinder and rinse material from the cylinder walls as the irrigator is lowered. Force the irrigator through the material to the bottom of the

cylinder by applying a gentle stabbing and twisting action while the working solution flows from the irrigator tip. Work the irrigator tube to the bottom of the cylinder as quickly as possible, since it becomes more difficult to do this as the washing proceeds. This flushes the fine material into suspension above the coarser sand particles.

Continue to apply a stabbing and twisting action while flushing the fines upward until the cylinder is filled to the 381 mm (15 in.) mark. Then raise the irrigator slowly without shutting off the flow so that the liquid level is maintained at about 381 mm (15 in.) while the irrigator is being withdrawn. Regulate the flow just before the irrigator is entirely withdrawn and adjust the final level to 381 mm (15 in.).

Note 7: Occasionally the holes in the tip of the irrigator tube may become clogged by a particle of sand. If the obstruction cannot be freed by any other method, use a pin or other sharp object to force it out, using extreme care not to enlarge the size of the opening. Also, keep the tip sharp as an aid to penetrating the sample.

7. Allow the cylinder and contents to stand undisturbed for 20 minutes ±15 seconds. Start timing immediately after withdrawing the irrigator tube.

   Note 8: Any vibration or movement of the cylinder during this time will interfere with the normal settling rate of the suspended clay and will cause an erroneous result.

8. Clay and sand readings:

   a. At the end of the 20-minute sedimentation period, read and record the level of the top of the clay suspension. This is referred to as the clay reading.

      Note 9: If no clear line of demarcation has formed at the end of the 20-minute sedimentation period, allow the sample to stand undisturbed until a clay reading can be obtained, then immediately read and record the level of the top of the clay suspension and the total sedimentation time. If the total sedimentation time exceeds 30 minutes, rerun the test using three individual samples of the same material. Read and record the clay column height of the sample requiring the shortest sedimentation period only. Once a sedimentation time has been established, subsequent tests will be run using that time. The time will be recorded along with the test results on all reports.

   b. After the clay reading has been taken, place the weighted foot assembly over the cylinder and gently lower the assembly until it comes to rest on the sand. Do not allow the indicator to hit the mouth of the cylinder as the assembly is being lowered. Subtract 254 mm (10 in.) from the level indicated by the extreme top edge of the indicator and record this value as the sand reading.

   c. If clay or sand readings fall between 2.5 mm (0.1 in.) graduations, record the level of the higher graduation as the reading. For example, a clay reading that appears to be 7.95 would be recorded as 8.0; a sand reading that appears to be 3.22 would be recorded as 3.3.

   d. If two Sand Equivalent (SE) samples are run on the same material and the second varies by more than ±4, based on the first cylinder result, additional tests shall be run.

e. If three or more Sand Equivalent (SE) samples are run on the same material, average the results. If an individual result varies by more than ±4, based on the average result, additional tests shall be run.

Calculations

1. Calculate the SE to the nearest 0.1 using the following formula:

$$\text{SE} = \frac{\text{Sand Reading}}{\text{Clay Reading}} \times 100$$

For example: Sand Reading = 3.3 and Clay Reading = 8.0

$$\text{SE}=\frac{3.3}{8.0} \times 100 = 41.25 \; or \; 41.3$$

Note 10: This example reflects the use of equipment made with English units. At this time, equipment made with metric units is not available.

2. Report the SE as the next higher whole number. In the example above, the 41.3 would be reported as 42. An SE of 41.0 would be reported as 41.

3. In determining the average of the two or more samples, raise each calculated SE value to the next higher whole number before averaging. For example, calculated values of 41.3 and 42.8 would be reported as 42 and 43, respectively.

   Then average the two values:

$$\frac{42 + 43}{2} = 42.5$$

   If the average value is not a whole number, raise it to the next higher whole number – in this case: 43.

Report

- Results on forms approved by the agency
- Results to the whole number.
- Sedimentation time if over 20 minutes.

PERFORMANCE EXAM CHECKLIST

PLASTIC FINES IN GRADED AGGREGATES AND SOILS BY THE USE OF THE SAND EQUIVALENT TEST
FOP FOR AASHTO T 176

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	**Trial 1**	**Trial 2**
Sample Preparation		
1. Sample passed through 4.75 mm (No. 4) sieve?	_____	_____
2. Material in clods broken up and re-screened?	_____	_____
3. Split or quarter 1,000 to 1,500g of material passing the 4.75 mm (No. 4) sieve? NOTE: If necessary, the material may be dampened before splitting to avoid segregation or loss of fines.	_____	_____
4. No fines lost?	_____	_____
5. Working solution dated?	_____	_____
6. Temperature of working solution 22 ±3°C (72 ±5°F)?	_____	_____
7. Working calcium chloride solution 915 mm ±25 mm (36 ±1in) above the work surface?	_____	_____
8. 101.6 ±2.5 mm (4 ±0.1in) working calcium chloride solution siphoned into cylinder?	_____	_____
9. Material checked for moisture condition by tightly squeezing small portion in palm of hand and forming a cast?	_____	_____
10. Sample at proper water content?		
a. If too dry (cast crumbles easily) water added, re-mixed, covered, and allowed to stand for at least 15 minutes?	_____	_____
b. If too wet (shows free water) sample drained, air dried and mixed frequently?	_____	_____
11. Sample placed on splitting cloth and mixed by alternately lifting each corner of the cloth and pulling it over the sample toward diagonally opposite corner, causing material to be rolled?	_____	_____
12. Is material thoroughly mixed?	_____	_____
13. When material appears to be homogeneous, mixing finished with sample in a pile near center of cloth?	_____	_____
14. Fill the 85 mL (3 oz) tin by pushing through base of pile with other hand on opposite side of pile?	_____	_____
15. Material fills tin to overflowing?	_____	_____

OVER

Procedure Element	Trial 1	Trial 2
16. Material compacted into tin with palm of hand?	_____	_____
17. Tin struck off level full with spatula or straightedge?	_____	_____
18. Prepared sample funneled into cylinder with no loss of fines?	_____	_____
19. Bottom of cylinder tapped sharply on heel of hand several times to release air bubbles?	_____	_____
20. Wetted sample allowed to stand undisturbed for 10 min. ±1 min.?	_____	_____
21. Cylinder stoppered and material loosened from bottom by shaking?	_____	_____
22. Stoppered cylinder placed properly in mechanical shaker and cylinder shaken 45 ±1 seconds?	_____	_____
23. Following shaking, cylinder set vertical on work surface and stopper removed?	_____	_____
24. Irrigator tube inserted in cylinder and material rinsed from cylinder walls as irrigator is lowered?	_____	_____
25. Irrigator tube forced through material to bottom of cylinder by gentle stabbing and twisting action?	_____	_____
26. Stabbing and twisting motion applied until cylinder filled to 381 mm (15 in.) mark?	_____	_____
27. Liquid raised and maintained at 381 mm (15 in.) mark while irrigator is being withdrawn?	_____	_____
28. Liquid at the 381 mm (15 in.) mark?	_____	_____
29. Contents let stand 20 minutes ±15 seconds?	_____	_____
30. Timing started immediately after withdrawal of irrigator?	_____	_____
31. No vibration or disturbance of the sample?	_____	_____
32. Readings taken at 20 minutes or up to 30 minutes, when a definite line appears?	_____	_____
33. Clay level correctly read, rounded, and recorded?	_____	_____
34. Weighted foot assembly lowered into cylinder without hitting mouth of cylinder?	_____	_____
35. Sand level correctly read, rounded, and recorded?	_____	_____
36. Calculations performed correctly?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

____

____

Examiner Signature ______________________________ WAQTC #:________________

ASPHALT I & II
FIELD OPERATING PROCEDURES - SHORT FORM

SAMPLING OF BITUMINOUS PAVING MIXTURES
FOP FOR AASHTO T 168

Scope

This procedure covers the sampling of bituminous paving mixtures from HMA plants, haul units, and roadways in accordance with AASHTO T 168-03. Sampling is as important as testing, and every precaution must be taken to obtain a truly representative sample.

Apparatus

- Shovel
- Sample containers: such as cardboard boxes, metal cans, stainless steel bowls, or other agency-approved containers
- Scoops, trowels, or other equipment to obtain mix
- Sampling plate: heavy gauge metal plate 380 mm x 380 mm (15 in x 15 in) minimum 8 gauge thick, with a wire attached to one corner long enough to reach from the center of the paver to the outside of the farthest auger extension. Holes ¼" in diameter should be provided in each corner.
- Cookie cutter sampling device: A 330 mm (13 in.) square sampling template, constructed from 75 mm x 50 mm x 3 mm (3 in. x 2 in. x 1/8 in.) formed steel angle with two 100mm x 150 mm x 9 mm (4 in. x 6 in. x 3/8 in.) handles. (See diagram) Sampling Plate and cookie cutter may be sized appropriately to accommodate sample size requirements.
- Mechanical sampling device

Sample Size

Sample size depends on the test methods specified by the agency for acceptance. Check agency requirement for the size required.

Sampling

General

1. The material shall be tested to determine variations. The supplier/contractor shall provide equipment for safe and appropriate sampling, including sampling devices on plants when required.

2. Place dense graded mixture samples in cardboard boxes, stainless steel bowls or other agency-approved containers. Place open graded mixture samples in stainless steel bowls.

Do not put open graded mixture samples in boxes until they have cooled to the point that bituminous material will not migrate from the aggregate.

Attached Sampling Devices

Some agencies require mechanical sampling devices for hot mix asphalt (HMA) and cold feed aggregate on some projects. These are normally permanently attached devices that allow a sample container to pass perpendicularly through the entire stream of material or divert the entire stream of material into the container. Operation may be hydraulic, pneumatic, or manual and allows the sample container to pass through the stream twice, once in each direction, without overfilling. Special caution is necessary with manually operated systems since a consistent speed is difficult to maintain and non-representative samples may result. Check agency requirements for the specifics of required sampling systems.

1. Lightly coat the container attached to the sampling device with an agency-approved release agent or preheat it, or both, to approximately the same discharge temperature of the mix.

2. Pass the container twice through the material perpendicularly without overfilling the container.

3. Repeat until proper sample size has been obtained.

4. Transfer the HMA to an agency-approved container without loss of material.

Sampling from Haul Units

1. Visually divide the haul unit into approximately four equal quadrants.

2. Identify one sampling location in each quadrant.

3. Dig down and remove approximately 0.3 m (1 ft) of material to avoid surface segregation. Obtain each increment from below this level.

4. Combine the increments to form a sample of the required size.

Sampling from Roadway Prior to Compaction (Plate Method)

Plate method using the "cookie cutter" sampling device.

There are two conditions that will be encountered when sampling hot mix asphalt (HMA) from the roadway prior to compaction. The two conditions are:

1. Laying HMA on grade or untreated base material requires Method 1.

2. Laying HMA on existing asphalt or laying a second lift of HMA requires Method 2.

SAFETY:

Sampling is performed behind the paving machine and in front of the breakdown roller. For safety, the roller must remain at least 3 m (10 ft) behind the sampling operation until the sample has been taken and the hole filled with loose HMA.

Method 1 requires a plate to be placed in the roadway in front of the paving operation and therefore there is always concern with moving, operating equipment. It is safest to stop the paving train while a plate is installed in front of the paver. When this is not possible the following safety rules must be followed.

1. The plate placing operation must be at least 3 m (10 ft) in front of the paver or pickup device. The technician placing the plate must have eye contact and communication with the paving machine operator. If eye contact cannot be maintained at all time, a third person must be present to provide communication between the operator and the technician.

2. No technician is to be between the asphalt supply trucks and the paving machine. The exception to this rule is if the supply truck is moving forward creating a windrow, in which case the technician must be at least 3m (10 ft) behind the truck.

If at any time the Engineer feels that the sampling technique is creating an unsafe condition, the operation is to be halted until it is made safe or the paving operation will be stopped while the plate is being placed.

Method 1 - Obtaining a Sample on Untreated Base:

1. Following the safety rules detailed above, the technician is to:

   a. Smooth out a location in front of the paver at least 0.5 m (2 ft) inside the edge of the mat.

   b. Lay the plate down diagonally with the direction of travel, keeping it flat and tight to the base with the lead corner facing the paving machine.

2. Secure the plate in place by driving a nail through the hole in the lead corner of the plate.

3. Pull the wire, attached to the outside corner of the plate, taut past the edge of the HMA mat and secure with a nail.

4. Let the paving operation proceed over the plate and wire. Immediately proceed with the sampling.

5. Using the exposed end of the wire, pull the wire up through the fresh HMA to locate the corner of the plate. Place the "cookie cutter" sample device, just inside the end of the wire; align the cutter over the plate. Press "cookie cutter" device down through the HMA to the plate.

6. Using a small square tipped shovel or scoop, or both, carefully remove all the HMA from inside of the cutter and place in a sample container. Care shall be taken to prevent contamination of bituminous mixes by dust or other foreign matter, and to avoid segregation of aggregate and bituminous materials.

7. Remove the sample cutter and the plate from the roadway. The hole made from the sampling must be filled by the contractor with loose HMA.

Method 2 - Obtaining a Sample on Asphalt Surface:

1. After the paving machine has passed the sampling point, immediately place the "cookie cutter" sampling device on the location to be sampled. Push the cutter down through the HMA until it is flat against the underlying asphalt mat.

2. Using a small square tipped shovel or scoop, or both, carefully remove all the HMA from inside of the cutter and place in a sample container. The hole made from the sampling must be filled by the contractor with loose HMA.

Identification and Shipping

1. Identify sample containers as required by the agency.

2. Ship samples in containers that will prevent loss, contamination, or damage.

Report

- On forms approved by the agency
- Date
- Time
- Location
- Quantity represented

PERFORMANCE EXAM CHECKLIST

SAMPLING BITUMINOUS PAVING MIXTURES
FOP FOR AASHTO T 168

Participant Name ________________________________ Exam Date _______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Was sample taken with an attached sampling device correctly?	_____	_____
a. Container coated or preheated or both?	_____	_____
b. Sampling device passed through stream twice perpendicular to material?	_____	_____
c. Sampling device not over filled?	_____	_____
2. Samples from truck transports taken from four quadrants at required depth of 300 mm (12 in)?	_____	_____
3. Samples from roadway taken correctly with plate(s).		
a. When on untreated base plate placed well in front of paver?	_____	_____
b. Wire pulled to locate plate corner?	_____	_____
c. Cookie cutter placed on asphalt and pushed through to plate?	_____	_____
d. All material removed from inside the cutter?	_____	_____
4. Sample placed in appropriate container.	_____	_____
5. Sample size meets agency requirements?	_____	_____
6. Sample identified as required?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

____

____

Examiner Signature ______________________________ WAQTC #:_______________

PERFORMANCE EXAM CHECKLIST (ORAL)

SAMPLING BITUMINOUS PAVING MIXTURES
FOP FOR AASHTO T 168

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. At the hot plant how must a sample be obtained using an attached sampling device?		
a. Coat or preheat sample container.	____	_____
b. Sampling device passed through stream twice perpendicular to material.	_____	_____
c. The sampling device cannot be overfilled.	_____	_____
2. What must be done to sample from transport units?		
a. Divide the unit into four quadrants.	_____	_____
b. Obtain increments from each quadrant, 300 mm (12 in) below surface.	_____	_____
3. Describe how to take samples from the roadway using a plate.		
a. Place the plate well in front of the paver.	_____	_____
b. Pull the wire to locate the corner of the plate.	_____	_____
c. Place the cutter on the HMA above the plate and push it down to the plate.	_____	_____
d. Collect all the material inside the cutter.	_____	_____
4. What types of containers can be used?		
a. Cardboard boxes, stainless steel bowls, or other agency approved containers.	_____	_____
5. What dictates size of sample?		
a. Agency requirements.	_____	_____
b. Specified by test method.	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

____

____

Examiner Signature ______________________________ WAQTC #:_______________

REDUCING SAMPLES OF HOT MIX ASPHALT (HMA) TO TESTING SIZE FOP FOR AASHTO R 47

Scope

This procedure covers sample reduction of Hot Mix Asphalt (HMA) to testing size in accordance with AASHTO R 47-08. The reduced portion is to be representative of the original sample.

Apparatus

- Thermostatically controlled oven capable of maintaining a temperature of at least 110°C (230°F) or high enough to heat the material to a pliable condition for splitting.
- Non-contact temperature measuring device.
- Metal spatulas, trowels, metal straightedges, or drywall taping knives, or a combination thereof; for removing HMA samples from the quartering device, cleaning surfaces used for splitting, etc.
- Square-tipped, flat-bottom scoop, shovel or trowel for mixing HMA prior to quartering.
- Miscellaneous equipment including hot plate, non-asbestos heat-resistant gloves or mittens, pans, buckets, and cans.
- Sheeting: Non-stick heavy paper, heat-resistant plastic, or other material as approved by the agency.
- Agency-approved release agent, free of solvent or petroleum-based material that could affect asphalt binder.
- Mechanical Splitter Type A (Quartermaster): having four equal-width chutes discharging into four appropriately sized sample receptacles. Splitter is to be equipped with a receiving hopper that will hold the sample until the release lever is activated with four sample receptacles of sufficient capacity to accommodate the reduced portion of the HMA sample from the mechanical splitter. Refer to AASHTO R 47, Figures 1 through 3, for configuration and required dimensions of the mechanical splitter.
- Mechanical Splitter Type B (Riffle): having a minimum of eight equal-width chutes discharging alternately to each side with a minimum chute width of at least 50% larger than the largest particle size. A hopper or straight-edged pan with a width equal to or slightly smaller than the assembly of chutes in the riffle splitter to permit uniform discharge of the HMA through the chutes without segregation or loss of material. Sample receptacles of sufficient width and capacity to receive the reduced portions of HMA from the riffle splitter without loss of material.

- Quartering Template: formed in the shape of a cross with equal length sides at right angles to each other. Template shall be manufactured of metal that will withstand heat and use without deforming. The sides of the quartering template should be sized so that the length exceeds the diameter of the flattened cone of HMA by an amount allowing complete separation of the quartered sample. Height of the sides must exceed the thickness of the flattened cone of HMA.

- Non-stick mixing surface that is hard, heat-resistant, clean, level, and large enough to permit HMA samples to be mixed without contamination or loss of material.

Sampling

Obtain samples according to the FOP for AASHTO T 168.

Sample Preparation

The sample must be warm enough to separate. If not, warm in an oven until it is sufficiently soft to mix and separate easily. Do not exceed either the temperature or time limits specified in the test method(s) to be performed.

Selection of Procedure (Method)

Refer to agency requirements when determining the appropriate method(s) of sample reduction. In general, the selection of a particular method to reduce a sample depends on the initial size of the sample vs. the size of the sample needed for the specific test to be performed. It is recommended that, for large amounts of material, the initial reduction be performed using a mechanical splitter. This decreases the time needed for reduction and minimizes temperature loss. Further reduction of the remaining HMA may be performed by a combination of the following methods, as approved by the agency. The methods for reduction are:

- Mechanical Splitter Method
  - Type A (Quartermaster)
  - Type B (Riffle Splitter)
- Quartering Method
  - Full Quartering
  - By Apex
- Incremental Method

Procedure

Mechanical Splitter Type A (Quartermaster)

1. Clean the splitter and apply a light coating of approved release agent to the surfaces that will contact HMA.

2. Close and secure hopper gates.

3. Place the four sample receptacles in the splitter so that there is no loss of material.

4. Remove the sample from the agency-approved container(s) and place in the mechanical splitter hopper. Avoid segregation, loss of HMA or the accidental addition of foreign material.

5. Release the handle, allowing the HMA to drop through the divider chutes and discharge into the four receptacles.

6. Any HMA that is retained on the surface of the splitter shall be removed and placed into the appropriate receptacle.

7. Close and secure the hopper gates.

8. Reduce the remaining HMA as needed by this method or a combination of the following methods as approved by the agency.

9. Combine the material contained in the receptacles from opposite corners and repeat the splitting process until an appropriate sample size is obtained.

10. Retain and properly identify the remaining unused portion of the HMA sample for further testing if required by the agency.

Mechanical Splitter Type B (Riffle)

1. When heating of the testing equipment is desired, it shall be heated to a temperature not to exceed 110 ºC (230ºF).

2. Clean the splitter and apply a light coating of approved release agent to the surfaces that will come in contact with HMA (hopper or straight-edged pan, chutes, receptacles).

3. Place two empty receptacles under the splitter.

4. Carefully empty the HMA from the agency-approved container(s) into the hopper or straight-edged pan without loss of material. Uniformly distribute from side to side of the hopper or pan.

5. Discharge the HMA at a uniform rate, allowing it to flow freely through the chutes.

6. Any HMA that is retained on the surface of the splitter shall be removed and placed into the appropriate receptacle.

7. Reduce the remaining HMA as needed by this method or a combination of the following methods as approved by the agency.

8. Using one of the two receptacles containing HMA, repeat the reduction process until the HMA contained in one of the two receptacles is the appropriate size for the required test.

9. After each split, remember to clean the splitter hopper and chute surfaces if needed.

10. Retain and properly identify the remaining unused HMA sample for further testing if required by the agency.

Quartering Method

1. When heating of the testing equipment is desired, it shall be heated to a temperature not to exceed the mix temperature.

2. If needed, apply a light coating of release agent to quartering template.

3. Dump the sample from the agency approved container(s) into a conical pile on a hard, "non-stick", clean, level surface where there will be neither a loss of material nor the accidental addition of foreign material. The surface can be made non-stick by the application of an approved asphalt release agent, or sheeting.

4. Mix the material thoroughly by turning the entire sample over a minimum of four times with a flat-bottom scoop; or by alternately lifting each corner of the sheeting and pulling it over the sample diagonally toward the opposite corner, causing the material to be rolled. Create a conical pile by either depositing each scoop or shovelful of the last turning on top of the preceding one, or lifting both opposite corners.

5. Flatten the conical pile to a uniform diameter and thickness where the diameter is four to eight times the thickness. Make a visual observation to ensure that the material is homogeneous.

6. Divide the flattened cone into four equal quarters using the quartering template. Press the template down until it is in complete contact with the surface on which the sample has been placed, assuring complete separation.

   Note 1: Straightedges may be used in lieu of the quartering device to completely separate the material in approximately equal quarters.

7. Reduce the sample by quartering the sample completely or by removing the sample from the apex.

8. Full Quartering

    8a. Remove two diagonally opposite quarters, including all of the fine material.
    8b. Remove the quartering template and combine the remaining quarters, again forming a conical pile.

    8c. Repeat steps 4, 5, 6, 8a, and 8b until a sample of the required size has been obtained. The final sample must consist of the two remaining diagonally opposite quarters.

    8d. Retain and properly identify the remaining unused portion of the HMA sample for further testing if required by the agency.

9. By Apex

    9a. Using a straightedge, slice through a quarter of the HMA from the center point to the outer edge of the quarter.

    9b. Pull or drag the material from the quarter with two straight edges or hold one edge of the straightedge in contact with quartering device.

    9c. Remove an equal portion from the opposite quarter and combine these increments to create the required sample size.

    9d. Continue using the apex method with the unused portion of the HMA until samples have been obtained for all required tests.

    9e. Retain and properly identify the remaining unused portion of the HMA sample for further testing if required by the agency.

Incremental Method

1. Cover a hard, clean, level surface with sheeting. This surface shall be large enough that there will be neither a loss of material nor the accidental addition of foreign material.

2. Place the sample from the agency approved container(s) into a conical pile on that surface.

3. Mix the material thoroughly by turning the entire sample over a minimum of four times with a flat-bottom scoop; or by alternately lifting each corner of the sheeting and pulling it over the sample diagonally toward the opposite corner, causing the material to be rolled. Create a conical pile by either depositing each scoop or shovelful of the last turning on top of the preceding one, or lifting both opposite corners.

4. Grasp the sheeting and roll the conical pile into a cylinder (loaf), then flatten the top. Make a visual observation to determine that the material is homogenous.

5. Pull the sheeting so at least ¼ of the length of the loaf is off the edge of the counter. Allow this material to drop into a container to be saved. As an alternate, using a straightedge, slice off approximately ¼ of the length of the loaf and place in a container to be saved.

6. Pull material off the edge of the counter and drop into an appropriate size sample pan or container for the test to be performed. Continue removing material from the loaf until the proper size sample has been acquired. As an alternate, using a straightedge, slice off an appropriate size sample from the length of the loaf and place in a sample pan or container.

7. Repeat step 6 until all the samples for testing have been obtained.

   Note 3: When reducing the sample to test size it is advisable to take several small increments, determining the mass each time until the proper minimum size is achieved. Unless the sample size is grossly in excess of the minimum or exceeds the maximum test size, use the sample as reduced for the test.

8. Retain and properly identify the remaining unused portion of the HMA sample for further testing if required by the agency.

Sample Identification

1. Identify the sample as required by the agency.

2. Samples shall be submitted in agency approved containers and secured to prevent contamination and spillage.

Report

- On forms approved by the agency
- Date
- Time
- Location
- Quantity represented

PERFORMANCE EXAM CHECKLIST

REDUCING SAMPLES OF HOT MIX ASPHALT (HMA) TO TESTING SIZE FOP FOR AASHTO R 47

Participant Name ________________________________ Exam Date _______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	**Trial 1**	**Trial 2**
1. Sample made soft enough to separate easily without exceeding temperature limits?	______	______
Quartering Method		
2. Testing equipment preheated to a temperature not to exceed mix temperature?	______	______
3. Sample placed in a conical pile on a hard, non-stick, heat-resistant splitting surface such as metal or sheeting?	______	______
4. Sample mixed by turning the entire sample over a minimum of 4 times?	______	______
5. Conical pile formed and then flattened uniformly to diameter equal to about 4 to 8 times thickness?	______	______
6. Sample divided into 4 equal portions either with a metal quartering template or straightedges such as drywall taping knives?	______	______
7. Reduction by Full Quartering:		
a. Two diagonally opposite quarters removed and returned to sample container?	_____	_____
b. Two other diagonally opposite quarters combined and process continued until appropriate sample size has been achieved?	_____	_____
8. Reduction by Apex:		
a. Using two straightedges or a splitting device and one straightedge, was one of the quarters split from apex to outer edge of material?	_____	_____
b. Similar amount of material taken from opposite quarter?	_____	_____
c. Increments combined to produce appropriate sample size?	_____	_____
9. Remaining unused HMA stored in suitable container, properly labeled?	_____	_____

OVER

Procedure Element	Trial 1	Trial 2
Incremental Method		
10. Sample placed on hard, non-stick, heat-resistant splitting surface covered with sheeting?	______	______
11. Sample mixed by turning the entire sample over a minimum of 4 times?	______	______
12. Conical pile formed?	_____	_____
13. HMA rolled into loaf and then flattened?	______	______
14. The first quarter of the loaf removed by slicing off or dropping off edge of counter and set aside?	______	______
15. Proper sample size sliced off or dropped off edge of counter into sample container?	______	______
16. Process continued until all samples are obtained?	_____	_____
18. All remaining unused HMA stored in suitable container, properly labeled?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass______Fail_____

Examiner Signature ______________________________ WAQTC #:________________

MOISTURE CONTENT OF HOT MIX ASPHALT (HMA) BY OVEN METHOD FOP FOR AASHTO T 329

Scope

This procedure covers the determination of moisture content of HMA in accordance with AASHTO T 329-13.

Overview

Moisture content is determined by comparing the wet mass of a sample and the mass of the sample after drying to constant mass. The term constant mass is used to define when a sample is dry.

Constant mass – the state at which a mass does not change more than a given percent, after additional drying for a defined time interval, at a required temperature.

Apparatus

- Balance or scale: 2 kg capacity, readable to 0.1 g and conforming to AASHTO M 231.
- Forced draft, ventilated, or convection oven: Capable of maintaining the temperature surrounding the sample at 163 ±14°C (325 ±25°F).
- Sample Container: Clean, dry, not affected by heat and of sufficient size to contain a test sample without danger of spilling.
- Thermometer or other suitable device with a temperature range of 10-260°C (50-500°F).

Sample

The test sample shall be obtained in accordance with the FOP for AASHTO T 168, and reduced in accordance with the FOP for AASHTO R 47. The size of the test sample shall be a minimum of 1000 g.

Procedure

1. Preheat the oven to a minimum of 105°C (221°F), but do not exceed the Job Mix Formula (JMF) mixing temperature. If the mixing temperature is not supplied, a temperature of 163 ± 14ºC (325 ± 25ºF) is to be used.

   Note 1: For repeatability between laboratories, the preferred practice is to dry the sample at no less than 9° C (15° F) below the JMF mixing temperature.

2. Determine and record the mass of the sample container, including release media, to the nearest 0.1 g.

Note 2: Ensure the release media is dry before performing Step 2.

3. Place the test sample in the sample container.

4. Determine and record the temperature of the test sample.

5. Determine and record the total mass of the sample container and test sample to the nearest 0.1 g.

6. Calculate the initial, moist mass (M_i) of the test sample by subtracting the mass of the sample container as determined in Step 2 from the total mass of the sample container and the test sample as determined in Step 5.

7. The test sample shall be initially dried for 90 ±5 minutes, and its mass determined. Then it shall be dried at 30 ±5 min intervals until further drying does not alter the mass by more than 0.05 percent.

8. Cool the sample container and test sample to ±9°C (±15°F) of the temperature determined in Step 4.

9. Determine and record the total mass of the sample container and test sample to the nearest 0.1 g.

   Note 3: Do not attempt to remove the test sample from the sample container for the purposes of determining mass.

10. Calculate the final, dry mass (M_f) of the test sample by subtracting the mass of the sample container as determined in Step 2 from the total mass of the sample container and the test sample as determined in Step 9.

   Note 4: Moisture content and the number of samples in the oven will affect the rate of drying at any given time. Placing wet samples in the oven with nearly dry samples could affect the drying process.

Calculations

Constant Mass:

Calculate constant mass using the following formula:

$$\%Change = \frac{M_p - M_n}{M_p} \times 100$$

Where: M_p = previous mass measurement
M_n = new mass measurement

Example:

Mass of container: 232.6 g

Mass of container and sample after first drying cycle: 1361.8 g

Mass, M_p, of possibly dry sample: 1361.8 g – 232.6 g = 1129.2 g

Mass of container and possibly dry sample after second drying cycle: 1360.4 g

Mass, M_n, of possibly dry sample: 1360.4 g – 232.6 g = 1127.8 g

$$\frac{1129.2\ g - 1127.8\ g}{1129.2\ g} \times 100 = 0.12\%$$

0.12 percent is not less than 0.05 percent, so continue drying the sample.

Mass of container and possibly dry sample after third drying cycle: 1359.9 g

Mass, M_n, of dry sample: 1359.9g – 232.6g = 1127.3g

$$\frac{1127.8\ g - 1127.3\ g}{1127.8\ g} \times 100 = 0.04\%$$

0.04 percent is less than 0.05 percent, so constant mass has been reached.

Moisture Content:

Calculate the moisture content, as a percent, using the following formula.

$$Moisture\ Content = \frac{M_i - M_f}{M_f} \times 100$$

Where: M_i = initial, moist mass

M_f = final, dry mass

Example:

M_i = 1134.9 g
M_f = 1127.3 g

$$Moisture\ Content = \frac{1134.9\ g - 1127.3\ g}{1127.3\ g} \times 100 = 0.674, \text{say } 0.67\%$$

Report

- Results on forms approved by the agency
- Moisture content to 0.01 percent

PERFORMANCE EXAM CHECKLIST

MOISTURE CONTENT OF HOT MIX ASPHALT BY OVEN METHOD
FOP FOR AASHTO T 329

Participant Name ____ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	**Trial 1**	**Trial 2**
1. Mass of clean dry container including release media determined to 0.1 g?	______	______
2. Representative sample obtained; 1000 g minimum?	______	______
3. Initial temperature taken and recorded?	______	______
4. Mass of sample determined to 0.1 g?	______	______
5. Sample placed in drying oven for 90 ± 5 minutes?	______	______
6. Sample dried at a temperature not to exceed the JMF mixing temp?	______	______
7. Constant mass checked at 30 ± 5 minute intervals and reached?	______	______
8. Sample and container cooled to ±9°C (15°F) of the initial temperature before final mass determined to 0.1 g?	______	______
9. Calculation of moisture content performed correctly to 0.01 percent?	______	______

$$Moisture\ Content = \frac{M_i - M_f}{M_f} \times 100$$

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass______Fail______

____
____
____
____
____
____
____
____

Examiner Signature _________________________________WAQTC #:________________

DETERMINING THE ASPHALT BINDER CONTENT OF HOT MIX ASPHALT (HMA) BY THE IGNITION METHOD
FOP FOR AASHTO T 308

Scope

This procedure covers the determination of asphalt binder content of hot mix asphalt (HMA) by ignition of the binder in accordance with AASHTO T 308-10.

Overview

The sample is heated in a furnace at 538°C (1000°F) or less; samples may be heated by convection or direct infrared irradiation (IR). The aggregate remaining after burning can be used for sieve analysis using the FOP for AASHTO T 30.

Some agencies allow the use of recycled HMA. When using recycled HMA, check with the agency for specific correction procedures.

Binder in the HMA is ignited in a furnace. Asphalt binder content is calculated as the difference between the initial mass of the HMA and the mass of the residual aggregate, correction factor, and moisture content. The asphalt binder content is expressed as percent of moisture-free mix mass.

Two methods, A and B, are presented.

Apparatus

Note 1: The apparatus must be calibrated for the specific mix design. See “Correction Factors” at the end of this FOP.

There are two methods – A and B. The apparatus for the two methods are the same except that the furnace for Method A has an internal balance.

- Ignition Furnace: A forced-air ignition furnace that heats the specimens by either the convection or direct IR irradiation method. The convection-type furnace must be capable of maintaining the temperature at 578°C (1072°F).

  For Method A, the furnace will be equipped with an internal scale thermally isolated from the furnace chamber and accurate to 0.1 g. The scale shall be capable of determining the mass of a 3500 g sample in addition to the sample baskets. A data collection system will be included so that mass can be automatically determined and displayed during the test. The furnace shall have a built-in computer program to calculate the change in mass of the sample baskets and provide for the input of a correction factor for aggregate loss. The furnace shall provide a printed ticket with the initial specimen mass, specimen mass loss, temperature compensation, correction factor, corrected binder content, test time, and test temperature. The furnace shall provide an audible alarm and indicator light when the sample mass loss does not exceed 0.01 percent of the total sample mass for three consecutive minutes.

Note 2: The furnace shall be designed to permit the operator to change the ending mass loss percentage from 0.01 percent to 0.02 percent.

For both Method A and Method B, the furnace chamber dimensions shall be adequate to accommodate a 3500 g sample. The furnace door shall be equipped so that it cannot be opened during the ignition test. A method for reducing furnace emissions shall be provided and the furnace shall be vented so that no emissions escape into the laboratory. The furnace shall have a fan to pull air through the furnace to expedite the test and to eliminate the escape of smoke into the laboratory.

- Sample Basket Assembly: consisting of sample basket(s), catch pan, and basket guards. Sample basket(s) will be of appropriate size allowing samples to be thinly spread and allowing air to flow through and around the sample particles. Sets of two or more baskets shall be nested. A catch pan: of sufficient size to hold the sample basket(s) so that aggregate particles and melting binder falling through the screen mesh are caught. Basket guards will completely enclose the basket and be made of screen mesh, perforated stainless steel plate, or other suitable material.

- Thermometer, or other temperature measuring device, with a temperature range of 10 - 260°C (50-500°F).

- Oven capable of maintaining 110 ±5°C (230 ±9°F).

- Balance or scale: Capacity sufficient for the sample mass and conforming to the requirements of M 231, Class G2.

- **Safety equipment**: Safety glasses or face shield, high temperature gloves, long sleeved jacket, a heat resistant surface capable of withstanding 650°C (1202°F), a protective cage capable of surrounding the sample baskets during the cooling period, and a particle mask for use during removal of the sample from the basket assembly.

- Miscellaneous equipment: A pan larger than the sample basket(s) for transferring sample after ignition, spatulas, bowls, and wire brushes.

Sampling

1. Obtain samples of HMA in accordance with the FOP for AASHTO T 168.

2. Reduce HMA samples in accordance with the FOP for AASHTO R 47.

3. If the mixture is not sufficiently soft to separate with a spatula or trowel, place it in a large flat pan in an oven at 110 ±5°C (230 ±9°F) until soft enough.

4. Test sample size shall conform to the mass requirement shown in Table 1.

   Note 3: When the mass of the test specimen exceeds the capacity of the equipment used or for large samples of fine mixes, the test specimen may be divided into suitable increments, tested, and the results appropriately combined through a weighted average for calculation of the binder content.

Table 1

Nominal Maximum Aggregate Size* mm (in.)	Minimum Mass Specimen g	Maximum Mass Specimen g
37.5 (1 ½)	4000	4500
25.0 (1)	3000	3500
19.0 (3/4)	2000	2500
12.5 (1/2)	1500	2000
9.5 (3/8)	1200	1700
4.75 (No. 4)	1200	1700

* One sieve larger than the first sieve to retain more than 10 percent of the material using an agency specified set of sieves based on cumulative percent retained. Where large gaps in specification sieves exist, intermediate sieve(s) may be inserted to determine nominal maximum size.

Procedure – Method A (Internal Balance)

1. For the convection-type furnace, preheat the ignition furnace to 538°C (1000°F) or to the temperature determined in the "Correction Factor" section, Step 9 of this method. Manually record the furnace temperature (set point) prior to the initiation of the test if the furnace does not record automatically. For the direct IR irradiation-type furnace, use the same burn profile as used during the correction factor determination.

2. Dry the sample to constant mass, according to the FOP for AASHTO T 329; or determine the moisture content of a companion sample in accordance with the FOP for AASHTO T 329.

3. Determine and record the mass to the nearest 0.1 g of the sample basket assembly.

4. Evenly distribute the sample in the sample basket assembly, taking care to keep the material away from the edges of the basket. Use a spatula or trowel to level the sample.

5. Determine and record the total mass of the sample and sample basket assembly to the nearest 0.1 g. Calculate and record the initial mass of the sample (total mass minus the mass of the sample basket assembly) to the nearest 0.1 g. Designate this mass as (M_i).

6. Record the correction factor or input into the furnace controller for the specific HMA.

7. Input the initial mass of the sample (M_i) into the ignition furnace controller. Verify that the correct mass has been entered.

   CAUTION: Operator should wear safety equipment – high temperature gloves, face shield, fire-retardant shop coat – when opening the door to load or unload the sample.

8. Open the chamber door and gently set the sample basket assembly in the furnace. Carefully position the sample basket assembly so it is not in contact with the furnace

wall. Close the chamber door and verify that the sample mass displayed on the furnace scale equals the total mass of the sample and sample basket assembly recorded in Step 5 within ±5 g.

Note 4: Furnace temperature will drop below the set point when the door is opened, but will recover when the door is closed and ignition begins. Sample ignition typically increases the temperature well above the set point – relative to sample size and binder content.

9. Initiate the test by pressing the start button. This will lock the sample chamber and start the combustion blower.

Safety note: Do not attempt to open the furnace door until the asphalt binder has been completely burned off.

10. Allow the test to continue until the stable light and audible stable indicator indicate that the change in mass does not exceed 0.01 percent for three consecutive minutes. Press the stop button. This will unlock the sample chamber and cause the printer to print out the test results.

Note 5: An ending mass loss percentage of 0.02 may be used, if allowed by the agency, when aggregate that exhibits an excessive amount of loss during ignition testing is used.

11. Open the chamber door, remove the sample basket assembly, and place on the cooling plate or block. Place the protective cage over the sample basket assembly and allow it to cool to room temperature (approximately 30 minutes).

12. Determine and record the total after ignition mass to the nearest 0.1 g. Calculate and record the mass of the sample, after ignition (total after ignition mass minus the mass of the sample basket assembly) to the nearest 0.1 g. Designate this mass as Mf.

13. Use the asphalt binder content percentage from the printed ticket. Subtract the moisture content from the printed ticket asphalt binder content and report the difference as the corrected asphalt binder content.

$$P_b = BC - MC - C_f \text{ (if not input in the furnace controller)}$$

where:

P_b = the corrected asphalt binder content as a percent by mass of the HMA

BC = asphalt binder content shown on printed ticket

MC = moisture content of the companion HMA sample, percent, as determined by the FOP for AASHTO T 329 (if the specimen was oven-dried prior to initiating the procedure, MC=0)

C_f = correction factor as a percent by mass of the HMA sample

14. Asphalt binder content percentage can also be calculated using the formula from “Method B” Step 16.

Procedure – Method B (External Balance)

1. Preheat the ignition furnace to 538°C (1000°F) or to the temperature determined in the "Correction Factor" section, Step 9 of this method. Manually record the furnace temperature (set point) prior to the initiation of the test if the furnace does not record automatically.

2. Dry the sample to constant mass, according to the FOP for AASHTO T 329; or determine the moisture content of a companion sample in accordance with the FOP for AASHTO T 329.

3. Determine and record the mass of the sample basket assembly to the nearest 0.1 g.

4. Place the sample basket(s) in the catch pan. Evenly distribute the sample in the sample basket(s), taking care to keep the material away from the edges of the basket. Use a spatula or trowel to level the sample.

5. Determine and record the total mass of the sample and sample basket assembly to the nearest 0.1 g. Calculate and record the initial mass of the sample (total mass minus the mass of the sample basket assembly) to the nearest 0.1 g. Designate this mass as (M_i).

6. Record the correction factor for the specific HMA.

7. Open the chamber door and gently set the sample basket assembly in the furnace. Carefully position the sample basket assembly so it is not in contact with the furnace wall. Burn the HMA sample in the furnace for 45 minutes or the length of time determined in the "Correction Factors" section.

8. Open the chamber door, remove the sample basket assembly, and place on the cooling plate or block. Place the protective cage over the sample and allow it to cool to room temperature (approximately 30 min).

9. Determine and record the total after ignition mass to the nearest 0.1 g. Calculate and record the mass of the sample, after ignition (total after ignition mass minus the mass of the sample basket assembly) to the nearest 0.1 g.

10. Place the sample basket assembly back into the furnace.

11. Burn the sample for at least 15 minutes after the furnace reaches the set temperature.

12. Open the chamber door, remove the sample basket assembly, and place on the cooling plate or block. Place the protective cage over the sample basket assembly and allow it to cool to room temperature (approximately 30 min.).

13. Determine and record the total after ignition mass to the nearest 0.1 g. Calculate and record the mass of the sample, after ignition (total after ignition mass minus the mass of the sample basket assembly) to the nearest 0.1 g.

14. Repeat Steps 10 through 13 until the change in measured mass of the sample after ignition does not exceed 0.01 percent of the previous sample mass after ignition.

Note56: An ending mass loss percentage of 0.02 may be used, if allowed by the agency, when aggregate that exhibits an excessive amount of loss during ignition testing is used.

15. Determine and record the total after ignition mass to the nearest 0.1 g. Calculate and record the mass of the sample, after ignition (total after ignition mass minus the mass of the sample basket assembly) to the nearest 0.1 g. Designate this mass as Mf.

16. Calculate the asphalt binder content of the sample as follows:

$$P_b = \frac{M_i - M_f}{M_i} \times 100 - MC - C_f$$

where:

P_b = the corrected asphalt binder content as a percent by mass of the HMA sample

M_f = the final mass of aggregate remaining after ignition

M_i = the initial mass of the HMA sample prior to ignition

MC= moisture content of the companion HMA sample, percent, as determined by the FOP for AASHTO T 329 (if the specimen was oven-dried prior to initiating the procedure, MC=0).

C_f = correction factor as a percent by mass of the HMA sample

Example

Correction Factor	= 0.42
Moisture Content	= 0.04
Initial Mass of Sample and Basket	= 5292.7
Mass of Basket Assembly	= 2931.5
M_i	= 2361.2
Total Mass after First ignition + basket	= 5154.4
Sample Mass after First ignition	= 2222.9

Sample Mass after additional 15 min ignition = 2222.7

$$\frac{2222.9 - 2222.7}{2222.9} \times 100 = 0.009$$

Not greater than 0.01 percent, so $\mathbf{M_f}$ = 2222.7

$$P_b = \frac{2361.2 - 2222.7}{2361.2} \times 100 - 0.42 - 0.04 = 5.41\%$$

$\mathbf{P_b}$= 5.41%

Gradation

1. Empty contents of the basket(s) into a flat pan, being careful to capture all material. Use a small wire brush to ensure all residual fines are removed from the baskets.

   Note 6: Particle masks are a recommended safety precaution.

2. Perform the gradation analysis in accordance with the FOP for AASHTO T 30.

Report

- Results on forms approved by the agency
- Method of test (A or B)
- Corrected asphalt binder content, P_b, per agency standard
- Correction factor, C_f , to 0.01 percent
- Temperature compensation factor (if applicable)
- Total percent loss
- Sample mass
- Moisture content to 0.01%
- Test temperature

Attach the original printed ticket with all intermediate values (continuous tape) to the report for furnaces with internal balances.

Annex – Correction Factors

(Mandatory Information)

Asphalt Binder and Aggregate

Asphalt binder content results may be affected by the type of aggregate in the mixture and by the ignition furnace. Asphalt binder and aggregate correction factors must, therefore, be established by testing a set of correction specimens for each Job Mix Formula (JMF) mix design. Each ignition furnace will have its own unique correction factor determined in the location where testing will be performed.

This procedure must be performed before any acceptance testing is completed, and repeated each time there is a change in the mix ingredients or design. Any changes greater than 5 percent in stockpiled aggregate proportions should require a new correction factor.

Historical data or scientific studies may be used to determine the correction factor(s) in lieu of using this testing procedure if the testing agency provides reference to the studies/data. All correction samples will be prepared by a central / regional laboratory unless otherwise directed.

Asphalt binder correction factor: A correction factor must be established by testing a set of correction specimens for each Job Mix Formula (JMF). Certain aggregate types may result in unusually high correction factors (> 1.00 percent). Such mixes should be corrected and tested at a lower temperature as described below.

Aggregate correction factor: Due to potential aggregate breakdown during the ignition process, a correction factor will need to be determined for the following conditions:

a. Aggregates that have a proven history of excessive breakdown

b. Aggregate from an unknown source.

This correction factor will be used to adjust the acceptance gradation test results obtained according to the FOP for AASHTO T 30.

Procedure

1. Obtain samples of aggregate in accordance with the FOP for AASHTO T 2.

2. Obtain samples of asphalt binder in accordance with the FOP for AASHTO T 40.

   Note 7: Include other additives that may be required by the JMF.

3. Prepare an initial, or "butter," mix at the design asphalt binder content. Mix and discard the butter mix prior to mixing any of the correction specimens to ensure accurate asphalt content.

4. Prepare two correction specimens at the JMF design asphalt binder content. Aggregate used for correction specimens shall be sampled from material designated for use on the project. An agency approved method will be used to combine aggregate. An additional "blank" specimen shall be batched and tested for aggregate gradation in accordance with the FOP for AASHTO T 30. The gradation from the "blank" shall fall within the agency specified mix design tolerances.

5. Place the freshly mixed specimens directly into the sample basket assembly. If mixed specimens are allowed to cool prior to placement in the sample basket assembly, the specimens must be dried to constant mass according to the FOP for AASHTO T 329. Do not preheat the sample basket assembly.

6. Test the specimens in accordance with Method A or Method B of the procedure.

7. Once both of the correction specimens have been burned, determine the asphalt binder content for each specimen by calculation or from the printed oven tickets, if available.

8. If the difference between the asphalt binder contents of the two specimens exceeds 0.15 percent, repeat with two more specimens and, from the four results, discard the high and low result. Determine the correction factor from the two original or remaining results, as appropriate. Calculate the difference between the actual and measured asphalt binder contents for each specimen to 0.01 percent. The asphalt binder correction factor, C_f, is the average of the differences expressed as a percent by mass of HMA.

9. If the asphalt binder correction factor exceeds 1.00 percent, the test temperature must be lowered to 482 ±5°C (900 ±8°F) and new samples must be burned. The temperature for determining the asphalt binder content of HMA samples by this procedure shall be the same temperature determined for the correction samples.

10. For the direct IR irradiation-type burn furnaces, the **default** burn profile should be used for most materials. The operator may select burn-profile Option 1 or Option 2 to optimize the burn cycle. The burn profile for testing HMA samples shall be the same burn profile selected for correction samples.

    Option 1 is designed for aggregate that requires a large asphalt binder correction factor (greater than 1.00 percent) – typically very soft aggregate (such as dolomite).

    Option 2 is designed for samples that may not burn completely using the **default** burn profile.

11. Perform a gradation analysis on the residual aggregate in accordance with the FOP for AASHTO T 30, if required. The results will be utilized in developing an "Aggregate Correction Factor" and should be calculated and reported to 0.1 percent.

12. From the gradation results subtract the percent passing for each sieve, for each sample, from the percent passing each sieve of the "Blank" specimen gradation results from Step 4.

13. Determine the average difference of the two values. If the difference for any single sieve exceeds the allowable difference of that sieve as listed in Table 2, then aggregate gradation correction factors (equal to the resultant average differences) for all sieves shall be applied to all acceptance gradation test results determined by the FOP for AASHTO T 30. If the 75 µm (No. 200) is the only sieve outside the limits in Table 2, apply the aggregate correction factor to only the 75 µm (No. 200) sieve.

Table 2
Permitted Sieving Difference

Sieve	Allowable Difference
Sizes larger than or equal to 2.36 mm (No.8)	± 5.0%
Sizes larger than to 75 µm (No.200) and smaller than 2.36 mm (No.8)	± 3.0%
Sizes 75 µm (No.200) and smaller	± 0.5%

Examples:

Sieve Size mm (in.)	Correction Factor Blank Sample % Passing	Correction Factor Sample #1 % Passing	Correction Factor Sample #2 % Passing	Difference 1 / 2	Avg. Diff.	Sieves to adjust
19.0 (3/4)	100	100	100	0/0	0.0	
12.5 (1/2)	86.3	87.4	86.4	-1.1/-0.1	-0.6	
9.5 (3/8)	77.4	76.5	78.8	+0.9/-1.4	-0.2	
4.75 (No. 4)	51.5	53.6	55.9	-2.1/-4.4	-3.2	
2.36 (No. 8)	34.7	36.1	37.2	-1.4/-2.5	-2.0	
01.18 (No. 16)	23.3	25.0	23.9	-1.7/-0.6	-1.2	
0.600 (No. 30)	16.4	19.2	18.1	-2.8/-1.7	-2.2	
0.300 (No. 50)	12.0	11.1	12.7	+0.9/-0.7	+0.1	
0.150 (No. 100)	8.1	9.9	6.3	-1.8/+1.8	0.0	
75 µm (No. 200)	5.5	5.9	6.2	-0.4/-0.7	-0.6	**- 0.6**

In this example, all gradation test results performed on the residual aggregate (FOP for AASHTO T 30) would have an aggregate correction factor applied to the percent passing the 75 µm (No. 200) sieve. The correction factor must be applied because the average difference on the 75 µm (No. 200) sieve is outside the tolerance from Table 2.

In the following example, aggregate correction factors would be applied to each sieve because the average difference on the 4.75mm (No. 4) is outside the tolerance from Table 2.

Sieve Size mm (in.)	**Correction Factor Blank Sample % Passing**	**Correction Factor Sample #1 % Passing**	**Correction Factor Sample #2 % Passing**	**Difference 1 / 2**	**Avg. Diff.**	**Sieves to adjust**
19.0 (3/4)	100	100	100	0/0	0.0	0.0
12.5 (1/2)	86.3	87.4	86.4	-1.1/-0.1	-0.6	**-0.6**
9.5 (3/8)	77.4	76.5	78.8	+0.9/-1.4	-0.2	**-0.2**
4.75 (No. 4)	51.5	55.6	57.9	-4.1/-6.4	-5.2	**-5.2**
2.36 (No. 8)	34.7	36.1	37.2	-1.4/-2.5	-2.0	**-2.0**
01.18 (No. 16)	23.3	25.0	23.9	-1.7/-0.6	-1.2	**-1.2**
0.600 (No. 30)	16.4	19.2	18.1	-2.8/-1.7	-2.2	**-2.2**
0.300 (No. 50)	12.0	11.1	12.7	+0.9/-0.7	+0.1	**+0.1**
0.150 (No. 100)	8.1	9.9	6.3	-1.8/+1.8	0.0	0.0
75 µm (No. 200)	5.5	5.9	6.2	-0.4/-0.7	-0.6	**-0.6**

PERFORMANCE EXAM CHECKLIST

DETERMINING THE ASPHALT BINDER CONTENT OF HOT MIX ASPHALT (HMA) BY THE IGNITION METHOD FOP FOR AASHTO T 308

Participant Name ________________________________ Exam Date _______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Oven at correct temperature 538°C (1000°F) or correction factor temperature? Or: for IR ovens, correct burn profile applied?	______	______
2. Sample reduced to correct size?	______	______
3. HMA sample or companion moisture sample taken and dried per FOP for AASHTO T 329?	______	______
4. Mass of sample basket assembly recorded to 0.1 g?	______	______
5. With pan below basket(s) sample evenly distributed in basket(s)?	_____	_____
6. Sample conforms to the required mass and mass recorded to 0.1 g?	_____	_____
7. Method A		
a. Initial mass entered into furnace controller?	_____	_____
b. Sample correctly placed into furnace?	_____	_____
c. Test continued until stable indicator signals?	_____	_____
d. Uncorrected binder content obtained on printed ticket?	_____	_____
e. Sample mass determined to nearest 0.1 g.?	_____	_____
8. Method B		
a. Sample correctly placed into furnace?	_____	_____
b. Sample burned for 45 min or time determined by correction process?	_____	_____
c. Sample cooled to room temperature?	_____	_____
d. Sample burned to constant mass?	_____	_____
e. Sample mass determined to nearest 0.1 g.?	_____	_____
f. Uncorrected binder content calculated correctly and recorded?	_____	_____

OVER

Procedure Element	**Trial 1**	**Trial 2**
9. Binder content corrected for Correction Factor if needed?	_____	_____
10. Binder content corrected for moisture per T 329 if needed?	_____	_____
11. Corrected binder content recorded?	_____	_____
12. Contents of the basket(s) carefully emptied into a pan?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

Examiner Signature _______________________________WAQTC #:_______________

MECHANICAL ANALYSIS OF EXTRACTED AGGREGATE
FOP FOR AASHTO T 30

Scope

This procedure covers mechanical analysis of aggregate recovered from bituminous mix samples in accordance with AASHTO T 30-13. This FOP utilizes the aggregate recovered from the ignition oven used in AASHTO T 308. AASHTO T 30 was developed for analysis of extracted aggregate and thus includes references to extracted bitumen and filter element, which do not apply in this FOP.

Sieve analyses determine the gradation or distribution of aggregate particles within a given sample in order to determine compliance with design and production standards.

Apparatus

- Balance or scale: Capacity sufficient for the sample mass, accurate to 0.1 percent of the sample mass or readable to 0.1 g
- Sieves
- Mechanical sieve shaker
- Suitable drying equipment (see FOP for AASHTO T 255)
- Containers and utensils: A pan or vessel of a size sufficient to contain the sample covered with water and to permit vigorous agitation without loss of any part of the sample or water

Sample Sieving

- In this procedure it is required to shake the sample over nested sieves. Sieves are selected to furnish information required by specification.
- Sieves are nested in order of decreasing size from the top to the bottom and the sample, or a portion of the sample, is placed on the top sieve.
- Sieves are shaken in a mechanical shaker for approximately 10 minutes, or the minimum time determined to provide complete separation for the sieve shaker being used. As established by the Time Evaluation.

Time Evaluation

The minimum time requirement should be evaluated for each shaker at least annually by the following method:

1. Shake the sample over nested sieves for approximately 10 minutes.

2. Provide a snug-fitting pan and cover for each sieve, and hold in a slightly inclined position in one hand.

3. Hand-shake each sieve by striking the side of the sieve sharply and with an upward motion against the heel of the other hand at the rate of about 150 times per minute, turning the sieve about one sixth of a revolution at intervals of about 25 strokes.

If more than 0.5 percent by mass of the total sample prior to sieving passes any sieve after one minute of continuous hand sieving adjust shaker time and re-check.

In determining sieving time for sieve sizes larger than 4.75 mm (No. 4), limit the material on the sieve to a single layer of particles.

Overload Determination

- For sieves with openings smaller than 4.75 mm (No. 4), the mass retained on any sieve shall not exceed 6 kg/m^2 (4 g/in^2) of sieving surface.

- For sieves with openings 4.75 mm (No. 4) and larger, the mass (in kg) shall not exceed the product of 2.5 x (sieve opening in mm) x (effective sieving area). See Table 1.

Additional sieves may be necessary to keep from overloading the specified sieves. The sample may also be sieved in increments.

TABLE 1
Maximum Allowable Mass of Material Retained on a Sieve, g
Nominal Sieve Size, mm (in.)
Exact size is smaller (see AASHTO T 27)

Sieve Size mm (in.)		**203 dia (8)**	**305 dia (12)**	**305 by 305 (12 × 12)**	**350 by 350 (14 × 14)**	**372 by 580 (16 × 24)**
				Sieving Area m²		
		0.0285	**0.0670**	**0.0929**	**0.1225**	**0.2158**
90	(3 1/2)	*	15,100	20,900	27,600	48,500
75	(3)	*	12,600	17,400	23,000	40,500
63	(2 1/2)	*	10,600	14,600	19,300	34,000
50	(2)	3600	8400	11,600	15,300	27,000
37.5	(1 1/2)	2700	6300	8700	11,500	20,200
25.0	(1)	1800	4200	5800	7700	13,500
19.0	(3/4)	1400	3200	4400	5800	10,200
16.0	(5/8)	1100	2700	3700	4900	8600
12.5	(1/2)	890	2100	2900	3800	6700
9.5	(3/8)	670	1600	2200	2900	5100
6.3	(1/4)	440	1100	1500	1900	3400
4.75	(No. 4)	330	800	1100	1500	2600
-4.75	(-No. 4)	170	400	560	740	1300

Mass Verification

1. Using the aggregate sample obtained from the FOP for AASHTO T 308, determine and record the mass of the sample, $M_{(T30)}$, to 0.1 g. This mass shall agree with the mass of the aggregate remaining after ignition, M_f from T 308, within 0.10 percent. If the variation exceeds 0.10 percent the results cannot be used for acceptance.

$$\frac{M_{f\,(T308)} - M_{(T30)}}{M_{f\,(T308)}} \times 100$$

Where:

$M_{(T30)} =$ 2422.3 g
$M_{f(T308)} =$ 2422.5 g

$$\frac{2422.5\text{ g} - 2422.3\text{ g}}{2422.5\text{ g}} \times 100 = 0.01\%$$

Procedure

1. Nest a sieve, such as a 2.0 mm (No. 10) or 1.18 mm (No. 16), above the 75µm (No. 200) sieve.

2. Place the test sample in a container and add sufficient water to cover it. Add a detergent, dispersing agent, or other wetting solution to the water to assure a thorough separation of the material finer than the 75µm (No. 200) sieve from the coarser particles. There should be enough wetting agent to produce a small amount of suds when the sample is agitated. Excessive suds may overflow the sieves and carry material away with them.

3. Agitate vigorously to ensure complete separation of the material finer than 75µm (No. 200) from coarser particles and bring the fine material into suspension above the coarser material. When using a mechanical washing device, exercise caution to avoid degradation of the sample.

   Note 1: When mechanical washing equipment is used, the introduction of water, agitating, and decanting may be a continuous operation. Use care not to overflow or overload the 75µm (No. 200) sieve.

4. Immediately pour the wash water containing the suspended and dissolved solids over the nested sieves, being careful not to pour out the coarser particles.

5. Add a second change of water to the sample remaining in the container, agitate, and repeat Step 5. Repeat the operation until the wash water is reasonably clear. Continue washing until the agent is removed.

6. Rinse the material on the nested sieves until water passing through the sieve is reasonably clear.

7. Remove the upper sieve, return material retained to the washed sample.

8. Rinse the material retained on the 75 µm (No. 200) sieve until water passing through the sieve is reasonably clear.

9. Return all material retained on the 75 µm (No. 200) sieve to the washed sample by flushing into the washed sample.

10. Dry the washed aggregate to constant mass in accordance with the FOP for AASHTO T 255, and then cool prior to sieving. Record the "dry mass after washing".

11. Select sieves to furnish information required by the specifications. Nest the sieves in order of decreasing size from top to bottom and place the sample, or a portion of the sample, on the top sieve.

12. Place sieves in mechanical shaker and shake for the minimum time determined to provide complete separation for the sieve shaker being used (approximately 10 minutes).

    Note 2: Excessive shaking (more than 10 minutes) may result in degradation of the sample.

13. Determine the mass retained on each sieve (individual/cumulative) to the nearest 0.1 g. Ensure that all material trapped in full openings of the sieves are cleaned out and included in the mass retained.

    Note 3: For sieves #4 and larger, material trapped in less than a full opening shall be checked by sieving over a full opening. Use coarse wire brushes to clean the 600 µm (No. 30) and larger sieves, and soft bristle brushes for smaller sieves.

Calculation

1. The total mass of the material after sieving should check closely with the original mass of sample placed on the sieves (dry mass after washing). When the masses before and after sieving differ by more than 0.2 percent, do not use the results for acceptance purposes.

2. Divide the masses for each sieve (individual/cumulative) by the total dry mass before washing and multiply by 100 to determine the percent retained on and passing each sieve.

3. Calculate the percent retained and passing each sieve to the nearest 0.1 percent.

4. Apply the Aggregate Correction Factor to the calculated percent passing, as required in the FOP for AASHTO T 308 “Correction Factor” Steps 10 through 12, to obtain the reported percent passing. Report percentages to the nearest 1percent except for the percent passing the 75 µm (No. 200) sieve, which shall be reported to the nearest 0.1 percent.

CHECK SUM

Total mass of material after sieving must agree with mass before sieving to within 0.2 percent.

$$\frac{dry\ mass\ after\ washing - total\ mass\ after\ sieving}{dry\ mass\ after\ washing} \times 100$$

PERCENT RETAINED:

Where:

IPR= Individual Percent Retained
CPR= Cumulative Percent Retained
M= Total Dry Sample mass before washing
IMR= Individual Mass Retained
CMR= Cumulative Mass Retained

$$\text{IPR} = \frac{IMR}{M} \times 100 \quad \textbf{OR} \quad \text{CPR} = \frac{CMR}{M} \times 100$$

PERCENT PASSING and REPORTED PERCENT PASSING:

Where:

PP= Calculated Percent Passing

PCP= Previous Calculated Percent Passing

RPP= Reported Percent Passing

$$PP = PCP - IPR \quad \boldsymbol{OR} \quad PP = 100 - CPR$$

$$RPP = PP + \text{Aggregate Correction Factor}$$

Example:

Dry mass of total sample, before washing (M): 2422.3 g

Dry mass of sample, after washing out the 75 µm (No. 200) minus: 2296.2 g

Amount of 75 µm (No. 200) minus washed out: 2422.3 g – 2296.2g = 126.1 g

Percent Retained 75 µm / No. 200:

$$\frac{63.5\text{ g}}{2422.3\text{ g}} \times 100 = 2.6\% \quad or \quad \frac{2289.6\text{ g}}{2422.3\text{ g}} \times 100 = 94.5\%$$

Percent Passing: 8.1% – 2.6% = 5.5% or 100 %– 94.5% = 5.5%

Reported Percent Passing: 5.5% + (-0.6%) = 4.9%

Gradation on All Screens

Sieve Size mm (in.)	**Mass Retained (g) (MR)**	**Percent Retained (PR)**	**Cumulative Mass Retained (g) (CMR)**	**Cumulative Percent Retained (CPR)**	**Calc'd Percent Passing (PP)**	**Agg. Corr. Factor from T 308 (ACF)**	**Reported Percent Passing (RPP)**
19.0 (3/4)	0.0		0.0	0	100.0		100
12.5 (1/2)	346.9	14.3	346.9	14.3	85.7		86
9.5 (3/8)	207.8	8.6	554.7	22.9	77.1		77
4.75 (No. 4)	625.4	25.8	1180.1	48.7	51.3		51
2.36 (No. 8)	416.2	17.2	1596.3	65.9	34.1		34
01.18 (No. 16)	274.2	11.3	1870.5	77.2	22.8		23
0.600 (No. 30)	152.1	6.3	2022.6	83.5	16.5		16
0.300 (No. 50)	107.1	4.4	2129.7	87.9	12.1		12
0.150 (No. 100)	96.4	4.0	2226.1	91.9	8.1		8
75 µm (No. 200)	63.5	2.6	2289.6	94.5	5.5	-0.6	4.9
Pan	5.7		2295.3				

Check sum:

$$\frac{2296.2\ g - 2295.3\ g}{2296.2\ g} \times 100 = 0.04\%$$

This is less than 0.2 percent therefore the results can be used for acceptance purposes.

Report

- Results on forms approved by the agency
- Depending on the agency, this may include:
  - Individual mass retained on each sieve
  - Individual percent retained on each sieve
  - Cumulative mass retained on each sieve
  - Cumulative percent retained on each sieve
  - Aggregate Correction Factor for each sieve from AASHTO T 308
  - Calculated percent passing each sieve to 0.1 percent

  Reported percent passing to the nearest 1 percent, except 75 µm (No. 200) sieve to the nearest 0.1 percent.

PERFORMANCE EXAM CHECKLIST

MECHANICAL ANALYSIS OF EXTRACTED AGGREGATE
FOP FOR AASHTO T 30

Participant Name ________________________________ Exam Date _______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Total dry mass determined to 0.1 g	_____	_____
2. Dry mass agrees with sample mass after ignition (M_f) from AASHTO T 308 within 0.1%?	_____	_____
3. Sample placed in container and covered with water?	_____	_____
4. Wetting agent added?	_____	_____
5. Contents of container agitated vigorously?	_____	_____
6. Wash water poured through proper nest of two sieves?	_____	_____
7. Washing continued until wash water is clear and no wetting agent remaining?	_____	_____
8. Retained material returned to washed sample?	_____	_____
9. Washed material coarser than 75 µm (No. 200) dried to constant mass at 110 ±5°C (230 ±9°F)?	_____	_____
10. Sample cooled to room temperature?	_____	_____
11. Dry mass after washing determined to 0.1 g?	_____	_____
12. Material sieved on specified sieves?	_____	_____
13. Mass of each fraction of aggregate, including minus 75 µm (No. 200), determined and recorded to 0.1 g?	_____	_____
14. Percent passing on each sieve determined correctly to the nearest 0.1%?	_____	_____
15. Aggregate correction factor applied?	_____	_____
16. Percent passing on each sieve reported correctly to the nearest 1% and nearest 0.1% on the 75 µm (No. 200)?	_____	_____
17. Does summation of sieve masses check total washed dry mass to within 0.2 percent?	_____	_____

Comments: First attempt: Pass_____Fail________ Second attempt: Pass______Fail______

____
____
____

Examiner Signature _________________________________WAQTC #:________________

THEORETICAL MAXIMUM SPECIFIC GRAVITY (G_{mm}) AND DENSITY OF HOT MIX ASPHALT (HMA) PAVING MIXTURES FOP FOR AASHTO T 209

Scope

This procedure covers the determination of the maximum specific gravity (G_{mm}) of uncompacted hot mix asphalt (HMA) paving mixtures in accordance with AASHTO T 209-12. Two methods using two different containers – bowl and flask – are covered.

Specimens prepared in the laboratory shall be cured according to agency standards.

Apparatus

- Balance or scale: 10,000 g capacity, readable to 0.1 g
- Container: A glass, metal, or plastic bowl or volumetric flask between 2000 and 10,000 mL as required by the minimum sample size requirements in Table 1 sample and capable of withstanding a partial vacuum
- Container cover: A glass plate or a metal or plastic cover with a vented opening
- Vacuum lid: A transparent lid with a suitable vacuum connection, with a vacuum opening to be covered with a fine wire mesh
- Vacuum pump or water aspirator: Capable of evacuating air from the container to a residual pressure of 4.0 kPa (30 mm Hg)
- Residual pressure manometer or vacuum gauge: Traceable to NIST and capable of measuring residual pressure down to 4.0 kPa (30 mm Hg) or less
- Manometer or vacuum gauge: Capable of measuring the vacuum being applied at the source of the vacuum
- Water bath: A constant-temperature water bath (optional)
- Thermometers: Standardized liquid-in-glass, or electronic digital total immersion type, accurate to 0.5°C (0.9°F)
- Bleeder valve to adjust vacuum
- Timer

Standardization of Flask

Use a volumetric flask that is standardized to accurately determine the mass of water, at 25 ±0.5°C (77 ±0.9°F), in the flask. The volumetric flask shall be standardized periodically in conformance with procedures established by the agency.

Test Sample Preparation

1. Obtain samples in accordance with the FOP for AASHTO T 168 and reduce according to the FOP for AASHTO R 47.

2. Test sample size shall conform to the requirements of Table 1. Samples larger than the capacity of the container may be tested in two or more increments. Results will be combined and averaged. If the increments have a specific gravity difference greater than 0.014 the test must be re-run.

Table 1
Test Sample Size for G_{mm}

Nominal Maximum* Aggregate Size mm (in.)	Minimum Mass g
37.5 or greater (1 ½)	4000
19 to 25 (3/4 to1)	2500
12.5 or smaller (1/2)	1500

*Nominal maximum size: One sieve larger than the first sieve to retain more than 10 percent of the material using an agency specified set of sieves based on cumulative percent retained.

Procedure – General

Two procedures – bowl and flask – are covered. The first 11 steps are the same for both.

1. Separate the particles of the sample, taking care not to fracture the mineral particles, so that the particles of the fine aggregate portion are not larger than 6.3 mm (1/4 in.). If the mixture is not sufficiently soft to be separated manually, place it in a large flat pan and warm in an oven only until it is pliable enough for separation.

2. Cool the sample to room temperature.

3. Determine and record the mass of the dry bowl or flask, including the cover, to the nearest 0.1 g.

4. Place the sample in the bowl or flask.

5. Determine and record the mass of the dry bowl or flask, cover, and sample to the nearest 0.1 g.

6. Determine and record the mass of the sample by subtracting the mass determined in Step 3 from the mass determined in Step 5. Designate this mass as “A”.

7. Add sufficient water at approximately 25° C (77° F) to cover the sample by about 25 mm (1 in.).

   Note 1: The release of entrapped air may be facilitated by the addition of a wetting agent. Check with the agency to see if this is permitted and, if it is, for a recommended agent.

8. Place the lid on the bowl or flask and attach the vacuum line. To ensure a proper seal between the flask and the lid, wet the O-ring or use a petroleum gel.

9. Remove entrapped air by subjecting the contents to a partial vacuum of 3.7 ±0.3 kPa (27.5 ±2.5 mm Hg) residual pressure for 15 ±2 minutes.

10. Agitate the container and contents, either continuously by mechanical device or manually by vigorous shaking, at 2 minute intervals. This agitation facilitates the removal of air.

11. Turn off the vacuum pump, slowly open the release valve, and remove the lid. When performing the flask method, complete steps 12B through 16B within 10±1 minutes.

Procedure – Bowl

12A. Suspend and immerse the bowl and contents in water at 25 ±1°C (77 ±2°F) for 10 ±1 minutes. The holder shall be immersed sufficiently to cover both it and the bowl.

13A. Determine and record the submerged weight of the bowl and contents to the nearest 0.1 g.

14A. Empty and re-submerge the bowl following Step 12A to determine the submerged weight of the bowl to the nearest 0.1 g.

15A. Determine and record the submerged weight of the sample the nearest 0.1 g by subtracting the submerged weight of the bowl from the submerged weight determined in Step 13A. Designate this submerged weight as “C”.

Procedure – Flask

12B. Immediately fill the flask with water without reintroducing air.

13B. Stabilize the temperature of the flask and contents so that the final temperature is within 25 ±1°C (77 ±2°F).

14B. Finish filling the flask with water that is 25 ±1°C (77 ±2°F), place the cover or a glass plate on the flask, and eliminate all air from the flask.

Note 2: When using the metal flask and cover, place the cover on the flask and push down slowly, forcing excess water out of the hole in the center of the cover. Use care when filling flask to avoid reintroducing air into the water.

15B. Towel dry the outside of the flask and cover.

16B. Determine and record the mass of the flask, cover, de-aired water, and sample to the nearest 0.1 g. within 10 ±1 minutes of completion of Step 11. Designate this mass as "E".

Procedure – Mixtures Containing Uncoated Porous Aggregate

If the pores of the aggregates are not thoroughly sealed by a bituminous film, they may become saturated with water during the vacuuming procedure, resulting in an error in maximum density. To determine if this has occurred, complete the general procedure and then:

1. Carefully drain water from sample through a towel held over the top of the container to prevent loss of material.

2. Spread sample in a flat shallow pan and place before an electric fan to remove surface moisture.

3. Determine the mass of the sample when the surface moisture appears to be gone.

4. Continue drying and determine the mass of the sample at 15-minute intervals until less than a 0.5 g loss is found between determinations.

5. Record the mass as the saturated surface dry mass to the nearest 0.1 g. Designate this mass as "ASSD".

6. Calculate, as indicated below, G_{mm}, using "A" and "ASSD", and compare the two values.

Calculation

Calculate the G_{mm} to three decimal places as follows:

Bowl Procedure

$$G_{mm} = \frac{A}{A - C} \qquad or \qquad G_{mm} = \frac{A}{A_{SSD} - C}$$

(for mixes containing uncoated aggregate materials)

where:

A = mass of dry sample in air, g

A_{SSD} = Mass of saturated surface dry sample in air, g

C = submerged weight of sample in water, g

Example:

A = 1432.7 g

A_{SSD} = 1434.2 g

C = 848.6 g

$$G_{mm} = \frac{1432.7\text{g}}{1432.7\text{g} - 848.6\text{g}} = 2.453 \qquad or \qquad G_{mm} = \frac{1432.7\text{g}}{1434.2\text{g} - 848.6\text{g}} = 2.447$$

Flask Procedure

$$G_{mm} = \frac{A}{A + D - E} \qquad or \qquad G_{mm} = \frac{A}{A_{SSD} + D - E}$$

(for mixtures containing uncoated materials)

where:

A = Mass of dry sample in air, g

A_{SSD} = Mass of saturated surface-dry sample in air, g

D = Mass of flask filled with water at 25°C (77°F), g, determined during the Standardization of Flask procedure

E = Mass of flask filled with water and the test sample at test temperature, g

Example (in which two increments of a large sample are averaged):

Increment 1	Increment 2
A = 2200.3 g	A = 1960.2 g
D = 7502.5 g	D = 7525.5 g
E = 8812.0 g	E = 8690.8 g
Temperature = 26.2°C	Temperature = 25.0°C

$$G_{mm_1} = \frac{2200.3 \text{ g}}{2200.3 \text{ g} + 7502.5 \text{ g} - 8812.0 \text{ g}} = 2.470$$

$$G_{mm_2} = \frac{1960.2 \text{ g}}{1960.2 \text{ g} + 7525.5 \text{ g} - 8690.8 \text{ g}} = 2.466$$

Allowable variation is: 0.014

2.470 - 2.466 = 0.004, which is < 0.014, so they can be averaged.

Average

2.470 + 2.466 = 4.936 4.936 ÷ 2 = **2.468**

Theoretical Maximum Density

To calculate the theoretical maximum density at 25°C (77°F) use one of the following formulas. The density of water at 25°C (77°F) is 997.1 in Metric units or 62.245 in English units.

Theoretical maximum density kg/m^3 = G_{mm}× 997.1 kg/ m^3

2.468 × 997.1 kg/ m3 = 2461 kg/ m^3

or

Theoretical maximum density lb/ft^3 = G_{mm}× 62.245 lb/ft^3

2.468 × 62.245 lb/ft^3 = 153.6 lb/ft^3

Report

- Results on forms approved by the agency
- G_{mm} to three decimal places
- Theoretical maximum density to1 kg/m^3 (0.1 lb/ft^3)

PERFORMANCE EXAM CHECKLIST

THEORETICAL MAXIMUM SPECIFIC GRAVITY AND DENSITY OF HOT MIX ASPHALT (HMA) PAVING MIXTURES
FOP FOR AASHTO T 209

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	**Trial 1**	**Trial 2**
1. Sample reduced to correct size?	_____	_____
2. Particles carefully separated insuring that aggregate is not fractured?	_____	_____
3. After separation, fine aggregate particles not larger than 6.3 mm (1/4in)?	_____	_____
4. Sample at room temperature?	_____	_____
5. Mass of bowl or flask & cover determined to 0.1 g?	_____	_____
6. Mass of sample and bowl or flask & cover determined to 0.1 g?	_____	_____
7. Mass of sample calculated and conforms to required size?	_____	_____
8. Water at approximately 25°C (77°F) added to cover sample?	_____	_____
9. Entrapped air removed using partial vacuum for 15 ±2 min?	_____	_____
10. Container and contents agitated continuously by mechanical device or manually by vigorous shaking at intervals of about 2 minutes?	_____	_____
11. Bowl determination:		
a. Bowl and contents suspended in water at 25 ±1°C (77 ±2°F) for 10 ±1 minutes?	_____	_____
b. Submerged weight of bowl and contents determined to 0.1 g?	_____	_____
c. Submerged weight of empty bowl determined to 0.1 g?	_____	_____
d. Net submerged weight of contents calculated?	_____	_____

OVER

Procedure Element	**Trial 1**	**Trial 2**
12. G_{mm} calculated correctly and to 0.001?	_____	_____
13. Density calculated correctly and to 1 kg/m^3 (0.1 lb/ft^3)?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

____
____
____
____
____
____
____
____
____
____
____

Examiner Signature _______________________________WAQTC #:_______________

BULK SPECIFIC GRAVITY (G_{mb}) OF COMPACTED HOT MIX ASPHALT (HMA) USING SATURATED SURFACE-DRY SPECIMENS FOP FOR AASHTO T 166

Scope

This procedure covers the determination of bulk specific gravity (G_{mb}) of compacted hot mix asphalt (HMA) using three methods – A, B, and C – in accordance with AASHTO T 166-13. This FOP is for use on specimens not having open or interconnecting voids or absorbing more than 2.0 percent water by volume, or both. When specimens have open or interconnecting voids or absorbing more than 2.0 percent water by volume, or both, AASHTO T 275 or AASHTO T 331 should be performed.

Overview

- Method A: Suspension
- Method B: Volumeter
- Method C: Rapid test for A or B

Test Specimens

Test specimens may be either laboratory-molded or from HMA pavement. For specimens it is recommended that the diameter be equal to four times the maximum size of the aggregate and the thickness be at least one and one half times the maximum size.

Test specimens from HMA pavement will be sampled according to WAQTC TM 11.

Terminology

Constant Mass: The mass at which further drying at 52 ±3°C (125 ±5°F) does not alter the mass by more than 0.05 percent. Samples shall initially be dried overnight and that mass determinations shall be made at 2-hour drying intervals. Recently molded laboratory samples that have not been exposed to moisture do not need drying.

Apparatus - Method A (Suspension)

Balance or scale: 5 kg capacity, readable to 0.1 g, and fitted with a suitable suspension apparatus and holder to permit weighing the specimen while suspended in water, conforming to AASHTO M 231.

- Suspension apparatus: Wire of the smallest practical size and constructed to permit the container to be fully immersed.
- Water bath: For immersing the specimen in water while suspended under the balance or scale, and equipped with an overflow outlet for maintaining a constant water level.
- Towel: Damp cloth towel used for surface drying specimens.
- Oven: Capable of maintaining a temperature of 110 ±5°C (230 ±9°F) for drying the specimens to a constant mass.
- Pan: Pan or other suitable container of known mass, large enough to hold a sample for drying in oven.
- Thermometer: Having a range of 19 to 27°C (66 to 80°F), graduated in 0.1°C (0.2°F) subdivisions.

Procedure - Method A (Suspension)

1. Dry the specimen to constant mass, if required.

   Note 1: To expedite the procedure, steps 1 and 2 may be performed last. To further expedite the process, see Method C.

2. Cool the specimen in air to 25 ±5°C (77 ±9°F), and determine and record the dry mass to the nearest 0.1 g. Designate this mass as "A".
3. Fill the water bath to overflow level with water at 25 ±1°C (77 ±1.8°F) and allow the water to stabilize.
4. Zero or tare the balance with the immersion apparatus attached, ensuring that the device is not touching the sides or the bottom of the water bath.
5. Immerse the specimen shaking to remove the air bubbles. Place the specimen on its side in the suspension apparatus. Leave it immersed for 4 ±1 minutes.
6. Determine and record the submerged weight to the nearest 0.1 g. Designate this submerged weight as "C".
7. Remove the sample from the water and quickly surface dry with a damp cloth towel within 5 seconds.
8. Zero or tare the balance.
9. Immediately determine and record the mass of the SSD specimen to nearest 0.1 g. Designate this mass as "B". Any water that seeps from the specimen during the mass determination is considered part of the saturated specimen. Do not to exceed 15 seconds performing Steps 7 through 9.

Calculations - Method A (Suspension)

$$G_{mb} = \frac{A}{B - C}$$

where:

A = Mass of dry specimen in air, g

B = Mass of SSD specimen in air, g

C = Weight of specimen in water at 25 ±1°C (77 ±1.8°F), g

$$Percent\ Water\ Absorbed\ (by\ volume) = \frac{B - A}{B - C} \times 100$$

Example:

$$G_{mb} = \frac{4833.6\ g}{4842.4\ g - 2881.3\ \text{g}} = 2.465$$

$$\%\ \boldsymbol{Water\ Absorbed\ (by\ volume)} = \frac{\mathbf{4842.4}\ \boldsymbol{g} - \mathbf{4833.6}\ \boldsymbol{g}}{\mathbf{4842.4}\ \boldsymbol{g} - \mathbf{2881.3}\ \boldsymbol{g}} \times \mathbf{100} = \mathbf{0.4}\%$$

Apparatus - Method B (Volumeter)

- Balance or scale: 5 kg capacity, readable to 0.1 g and conforming to AASHTO M 231.
- Water bath: Thermostatically controlled to 25 ±0.5°C (77 ±0.9°F).
- Thermometer: Range of 19 to 27°C (66 to 80°F), and graduated in 0.1°C (0.2°F) subdivisions.
- Volumeter: Calibrated to 1200 mL or appropriate capacity for test sample and having a tapered lid with a capillary bore.
- Oven: Capable of maintaining a temperature of 110 ±5°C (230 ±9°F) for drying the specimens to a constant mass.
- Pan: Pan or other suitable container of known mass, large enough to hold a sample for drying in oven.
- Towel: Damp cloth towel used for surface drying specimens.

Procedure - Method B (Volumeter)

1. Dry the specimen to constant mass, if required.

   Note 1: To expedite the procedure, steps 1 and 2 may be performed last. To further expedite the process, see Method C.

2. Cool the specimen in air to 25 ±5°C (77 ±9°F), and determine and record the dry mass to the nearest 0.1 g. Designate this mass as “A”.

3. Immerse the specimen in the temperature-controlled water bath for at least 10 minutes.

4. Fill the volumeter with distilled water at 25 ±1°C (77 ±1.8°F) making sure some water escapes through the capillary bore of the tapered lid. Wipe the volumeter dry. Determine the mass of the volumeter to the nearest 0.1 g. Designate this mass as “D”.

5. At the end of the ten minute period, remove the specimen from the water bath and quickly surface dry with a damp cloth towel within 5 seconds.

6. Immediately determine and record the mass of the SSD specimen to the nearest 0.1 g.

7. Designate this mass as “B”. Any water that seeps from the specimen during the mass determination is considered part of the saturated specimen.

8. Place the specimen in the volumeter and let stand 60 seconds.

9. Bring the temperature of the water to 25 ±1°C (77 ±1.8°F) and cover the volumeter, making sure some water escapes through the capillary bore of the tapered lid.

10. Wipe the volumeter dry.

11. Determine and record the mass of the volumeter and specimen to the nearest 0.1 g. Designate this mass as “E”.

    Note 2: Method B is not acceptable for use with specimens that have more than 6% air voids.

Calculations - Method B (Volumeter)

$$G_{mb} = \frac{A}{B + D - E}$$

where:

A = Mass of dry specimen in air, g

B = Mass of SSD specimen in air, g

D = Mass of volumeter filled with water at 25 ±1°C (77 ±1.8°F), g

E = Mass of volumeter filled with specimen and water, g

$$Percent\ Water\ Absorbed\ (by\ volume) = \frac{B - A}{B + D - E} \times 100$$

Example:

$$G_{mb} = \frac{4833.6\ g}{4842.4\ g + 2924.4\ g - 5806.0\ g} = 2.465$$

$$\%\ Water\ Absorbed\ (by\ volume) = \frac{4842.4\ g - 4833.6\ g}{4842.4\ g + 2924.4\ g - 5806.0\ g} \times 100 = 0.4\%$$

Apparatus - Method C (Rapid Test for Method A or B)

See Methods A or B.

Note 3: This procedure can be used for specimens that are not required to be saved and contain substantial amounts of moisture. Cores can be tested the same day as obtained by this method.

Procedure - Method C (Rapid Test for Method A or B)

1. Determine which method to perform, A or B. Proceed with Method A or B, except that the dry mass, A, is determined last. In method A and B, start on Step 3 and complete that procedure, then continue as follows to determine mass "A".

2. Place the specimen on a large, flat-bottom pan of known mass.

3. Heat at a minimum of 105°C (221°F), until the specimen can be easily separated to the point where the fine aggregate particles are not larger than 6.3 mm (¼ in.). In no case should the Job Mix Formula mixing temperature be exceeded.

4. Dry to constant mass. Constant mass is defined as the mass at which further drying at the temperature in Step 3 does not change by more than 0.05% after an additional 2 hour drying time.

5. Cool in air to 25 ±5°C (77 ±9°F).

6. Determine and record the mass of the pan and specimen to the nearest 0.1 g.

7. Determine and record the mass of the dry specimen to the nearest 0.1 g by subtracting the mass of the pan from the mass determined in Step 6. Designate this mass as "A".

Calculations - Method C (Rapid Test for Method A or B)

Complete the calculations as outlined in Methods A or B, as appropriate.

Report

- Results on forms approved by the agency
- G_{mb} to 3 decimal places
- Absorption to 2 decimal places
- Method performed.

PERFORMANCE EXAM CHECKLIST

BULK SPECIFIC GRAVITY OF COMPACTED HOT MIX ASPHALT (HMA) USING SATURATED SURFACE-DRY SPECIMENS FOP FOR AASHTO T 166

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
Method A:		
1. Mass of dry sample in air determined.		
a. Dried overnight at 52 ±3°C (125 ±5°F) and at successive 2-hour intervals to constant mass?	_____	_____
b. Cooled in air to 25 ±5°C (77 ±9°F)?	_____	_____
c. Dry mass determined to 0.1g?	_____	_____
2. Water at the overflow?	_____	_____
3. Balance zeroed?	_____	_____
4. Immersed weight determined.		
a. Water at 25 ±1°C (77 ±1.8°F)?	_____	_____
b. Immersed, shaken, on side, for 4 ±1 minutes?	_____	_____
c. Immersed weight determined to 0.1g?	_____	_____
5. Sample rapidly surface dried with damp towel and saturated surface dry (SSD) mass determined to 0.1g (entire operation performed within 15 seconds)?	_____	_____
6. G_{mb} calculated to 0.001?	_____	_____
7. Absorption calculated to 0.01 percent	_____	_____

Comments: First attempt: Pass_____Fail_______ Second attempt: Pass______Fail_____

____
____
____
____
____
____
____
____

Examiner Signature _______________________________WAQTC #:_______________

SAMPLING BITUMINOUS MATERIALS
FOP FOR AASHTO T 40

Scope

This procedure covers obtaining samples of liquid bituminous materials in accordance with AASHTO T 40-02. Sampling of solid and semi-solid bituminous materials – included in AASHTO T 40 – is not covered here.

Agencies may be more specific on exactly who samples, where to sample, and what type of sampling device to use.

Warning: Always use appropriate safety equipment and precautions for hot liquids.

Procedure

1. Coordinate sampling with contractor or supplier.
2. Allow a minimum of 4 L (1 gal) to flow before obtaining a sample(s).
3. Obtain samples of:
   - Asphalt binder from hot mix asphalt (HMA) plant from the line between the storage tank and the mixing plant while the plant is in operation, or from the delivery truck.
   - Cutback and emulsified asphalt from distributor spray bar or application device; or from the delivery truck before it is pumped into the distributor. Sample emulsified asphalt at delivery or prior to dilution.

Containers

Sample containers must be new, and the inside may not be washed or rinsed. The outside may be wiped with a clean, dry cloth.

All samples shall be put in 1 L (1 qt) containers and properly identified on the outside of the container with contract number, date sampled, data sheet number, brand and grade of material, and sample number. Include lot and sublot numbers when appropriate.

- Emulsified asphalt: Use wide-mouth plastic jars with screw caps. Protect the samples from freezing since water is a part of the emulsion. The sample container should be completely filled to minimize a skin formation on the sample.
- Asphalt binder and cutbacks: Use metal cans.

  Note: The sample container shall not be submerged in solvent, nor shall it be wiped with a solvent saturated cloth. If cleaning is necessary, use a clean dry cloth.

Report

- On forms approved by the agency
- Date
- Time
- Location
- Quantity represented

HOT MIX ASPHALT (HMA) SPECIMENS BY MEANS OF THE SUPERPAVE GYRATORY COMPACTOR
FOP FOR AASHTO T 312

Scope

This procedure covers preparing specimens, using samples of plant produced HMA, for determining the mechanical and volumetric properties of HMA in accordance with AASHTO T 312-12.

Apparatus

- Superpave Gyratory Compactor (SGC) meeting the requirements of AASHTO T 312
- Molds meeting the requirements of AASHTO T 312
- Chute, mold funnel or both (Optional)
- Scale meeting the requirements of AASHTO M 231 Class G 5
- Oven, thermostatically controlled, capable of maintaining set temperature within ±3ºC (±5ºF)
- Thermometers accurate to ±1ºC (±2°F) between 10 and 232°C (50 - 450°F)

Note 1: Non-Contact thermometers are not acceptable.

- Miscellaneous pans, spoons, spatulas, hot pads, gloves, paper discs, markers, etc.

Equipment Requirements

The calibration shall be performed on the SGC per the Manufacturer's instructions. See agency requirements for the calibration frequency.

The mold and base plate dimensions shall be checked every twelve months or 80 hours of operation to determine that they are within the tolerances listed in AASHTO T 312.

Equipment Preparation

Prepare the equipment in accordance with manufacturer's recommendations. At a minimum preparation includes:

- Warm-up gyratory compactor
- Verify machine settings
  - Internal Angle: 1.16 ±0.02°
  - Ram Pressure: 600 kPa ±18 kPa
  - Number of gyrations

Note 2: The number of gyrations (N_{des}) is obtained from the Job Mix Formula (JMF).

- Lubricate bearing surfaces
- Prepare recording device as required
- Pre-heat molds and plates at compaction temperature (minimum of 30 min.) or before reuse reheat (minimum of 5 min.)

Note 3: The use of multiple molds will speed up the compaction process.

- Pre-heat chute, mold funnel, spatulas, and other apparatus (not to exceed compaction temperature)

Sample Preparation

Laboratory Prepared HMA

This is a sample produced during the Mix Design process using aggregate and binder that is combined in the laboratory. When designing HMA mixes using the gyratory compactor refer to AASHTO T 312.

Plant Produced HMA

- Determine initial sample size, number of gyrations (N_{des}), and compaction temperature range from the Job Mix Formula (JMF).
- Obtain the sample in accordance with the FOP for AASHTO T 168.
- Reduce the sample in accordance with the FOP for AASHTO R 47.
- The sample size should be such that it results in a compacted specimen that is 115 ±5mm at the desired number of gyrations.

Note 4: Replicate specimens are generally prepared. Refer to agency requirements.

If the material is not in the compaction temperature range:

1. Place the appropriate sample mass into a container.
2. Spread to a depth of 1 to 2 in. for even heating of mixture.
3. Place in the oven until compaction temperature is reached.

Note 5: The material properties may be altered when the times of delivery of the test sample and the placement of the material on the roadway are different.

Compaction Procedure

Follow the manufacturer's recommended loading procedure. This may require the steps below to be performed in a different order. Steps 1 through 8 must be performed before the sample and mold cools below compaction temperature.

1. Remove pre-heated mold and plate(s) from the oven (verify mold and plate(s) has been cleaned if previously used).
2. Place the base plate and paper disc in bottom of mold.
3. Place the mix into the mold in a single lift (care should be taken to avoid segregation or loss of material).
4. Level the mix in the mold.
5. Place a paper disc and the heated upper plate (if required) on top of the leveled sample.
6. Load the mold into the compactor; check settings.
7. Start the compaction process.
    a. Check the pressure (600 ±18 kPa).
    b. Check the angle (1.16 ±0.02°).
8. Upon completion of the compaction process and record the number of gyrations and specimen height.

Note 6: If the specimen is not 115 ±5mm follow agency requirements.

9. Extrude the specimen from the mold; a brief cooling period may be necessary before fully extruding some specimens to ensure the specimens are not damaged.

Note 7: Clean molds after each use.

10. Carefully remove the paper discs.
11. Cool the compacted specimen to room temperature.
12. Identify the specimen with chalk or other marker.

Report

- On forms approved by the agency
- Number of gyrations
- Specimen height

PERFORMANCE EXAM CHECKLIST

GYRATORY COMPACTION OF HMA MIXTURES
FOP FOR AASHTO T 312

Participant Name ____________________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Angle, pressure and number of gyrations set?	_____	_____
2. Bearing surfaces, rotating base surface, and rollers lubricated?	_____	_____
3. Representative sample obtained according to the FOP for AASHTO T 168?	_____	_____
4. Sample reduced according to FOP AASHTO R 47?	_____	_____
5. HMA heated to compaction temperature?	_____	_____
6. Mold, base plate, and upper plate heated to compaction temperature?	_____	_____
7. Mold, base plate, and upper plate (if required) removed from oven and paper disk placed on bottom of mold?	_____	_____
8. Mix placed into mold in one lift without segregation?	_____	_____
9. Paper disk placed on top of the HMA?	_____	_____
10. Mold placed into compactor and upper plate clamped into place?	_____	_____
11. Pressure applied at 600 kPa ±18 kPa?	_____	_____
12. Specified number of gyrations applied?	_____	_____
13. Proper angle confirmed from display?	_____	_____
14. Compacted specimen removed from mold, paper disc(s) removed, and allowed to cool to room temperature?	_____	_____
15. HMA sample measured to a height of 115 ±5mm at required gyrations?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

____

____

____

____

____

____

____

____

Examiner Signature _________________________________WAQTC #:________________

Volumetric Properties of Hot Mix Asphalt (HMA)
WAQTC TM 13

Scope

This procedure covers the determination of volumetric properties of plant produced Hot Mix Asphalt, i.e., air voids (V_a), voids in mineral aggregate (VMA), voids filled with asphalt binder (VFA), effective asphalt binder content (P_{be}) and Dust to Binder Ratio ($P_{\#200}/P_{be}$). The in-production volumetric properties are then compared to agency specifications.

Definition of Terms

- G_{mm} = theoretical maximum specific gravity (Gravity $_{mix\ max}$)
- G_{mb} = measured bulk specific gravity (Gravity $_{mix\ bulk}$)
- G_{sb} = oven-dry bulk specific gravity of aggregate (Gravity $_{stone\ bulk}$)
- G_{sa} = apparent specific gravity of aggregate (Gravity $_{stone\ apparent}$)
- G_{se} = effective specific gravity of aggregate (Gravity $_{stone\ effective}$)
- G_b = specific gravity of the binder (Gravity $_{binder}$)
- V_a = air Voids (Voids $_{air}$)
- VMA = Voids in Mineral Aggregate
- VFA = Voids Filled with Asphalt (binder)
- V_{ba} = absorbed binder volume (Voids $_{binder\ absorbed}$)
- V_{be} = effective binder volume (Voids $_{binder\ effective}$)
- P_b = percent binder content (Percent $_{binder}$)
- P_{ba} = percent absorbed binder (Percent $_{binder\ absorbed}$)
- P_{be} = percent effective binder content (Percent $_{binder\ effective}$)
- P_s = percent of aggregate (Percent $_{stone}$)
- DP = Dust proportion to effective binder ratio ($P_{0.075}/P_{be}$)

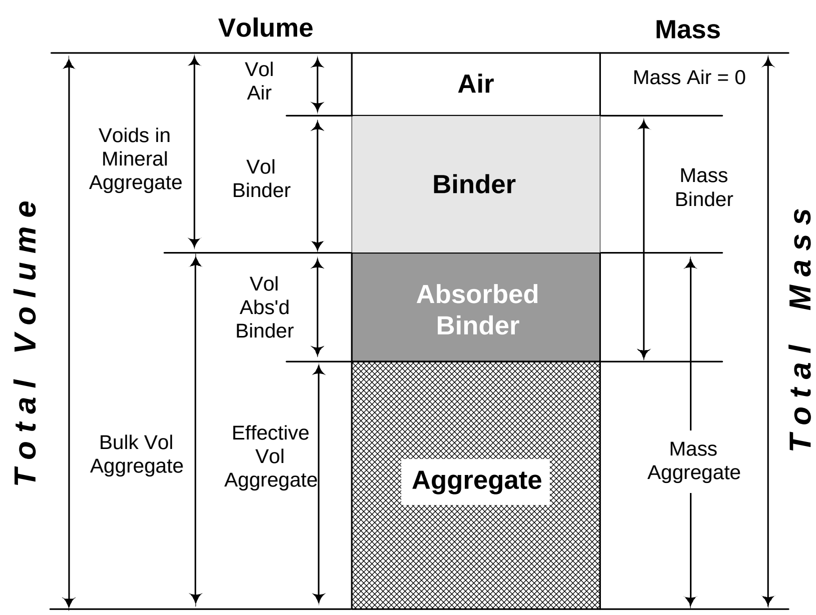
Background

Whether a mix design is developed through a Marshall, Hveem, or Superpave mix design process there are basic volumetric requirements of all. Volumetric properties are the properties of a defined material contained in a known volume. HMA Volumetric properties HMA Volumetric properties can include bulk specific gravity, theoretical maximum specific gravity, air voids, and voids in mineral aggregate.

Many agencies specify values of the volumetric properties to ensure optimum performance of the pavement. The HMA must be designed to meet these criteria. In production the HMA is evaluated to determine if the mix still meets the specifications and is consistent with the original mix design (JMF). The production HMA may vary from the mix design and may need to be modified to meet the specified volumetric criteria.

To compare the in-production volumetric properties to agency specifications and the JMF a sample of loose HMA mix is obtained in accordance with FOP for AASHTO T 168. The sample is then compacted in a gyratory compactor to simulate the in-place HMA pavement after it has been placed, compacted, and the volumetric properties of the compacted sample are determined.

HMA Phase Diagram

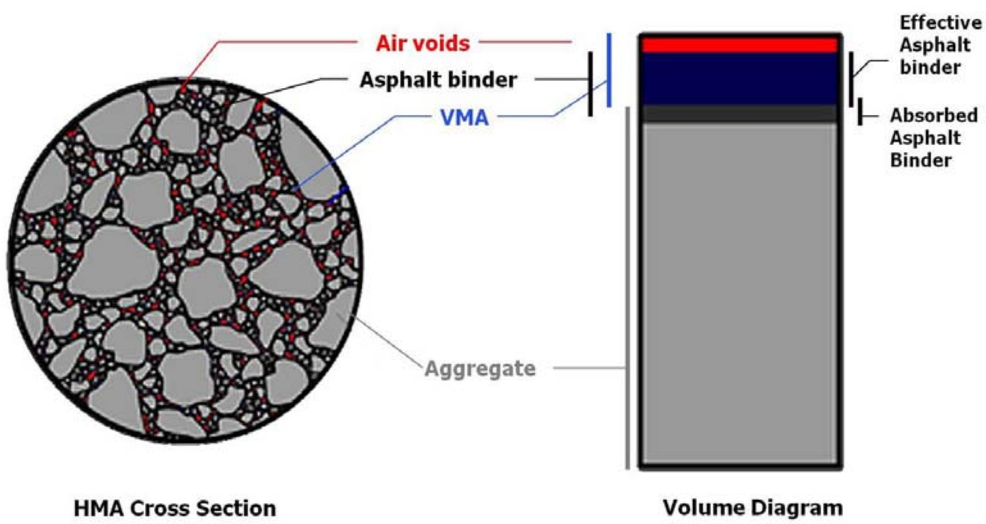


Each of the properties in the HMA phase diagram can be measured or calculated. For example: The mass of the aggregate is measured; the voids in mineral aggregate (VMA) is calculated; total asphalt binder can be measured but the amount available to act as a binder in the mix must be calculated because it is the quantity left after the aggregate has absorbed some of the asphalt binder.

The volumetric proportions of the asphalt binder and aggregate components of an asphalt mixture and their relationship to the other components are considered. The mass of the components and their specific gravities are used to determine the volumes of each of the components in the mix. The volumetric properties of a compacted HMA paving mixture: air voids (V_a), voids in mineral aggregate (VMA), voids filled with asphalt binder (VFA), and effective asphalt binder content (P_{be}) provide some indication of the mixtures probable performance.

Volumetric Properties

Volumetric Relationship of HMA Constituents



Required Values

The specific gravities listed in Table 1 and the percent by mass of each of the components in the HMA are needed to determine the volumetric properties. Other values required are also listed. Some of these values are obtained from the JMF and some are measured from a plant produced HMA sample.

Table 1

Data	Test Method	Obtained
G_{sb} - combined aggregate bulk specific gravity	AASHTO T 84 / T 85 or agency approved test method	JMF or performed at the beginning of placement
G_b – measured specific gravity of the asphalt binder	AASHTO T 228	JMF or from the supplier
G_{mm} – measured maximum specific gravity of the loose mix	FOP for AASHTO T 209	Performed on the field test sample
G_{mb} – measured bulk specific gravity of the compacted paving mix	FOP for AASHTO T 166	Performed on the field compacted specimen
P_b – percent asphalt binder	FOP for AASHTO T 308	Performed on the field test sample
$P_{-\#200}$ – aggregate passing the #200 (0.075 mm) sieve	FOP for AASHTO T 30	Performed on the field test sample

Air Voids (V_a)

Air voids are the total volume of the small pockets of air between the coated aggregate particles throughout a compacted paving mixture. Appropriate air voids contribute to the stability of the HMA and help the pavement withstand the combined action of environment and traffic loads. The designated percent air voids allows for thermal expansion of the asphalt binder and contributes a cushion for future compaction. Air voids are expressed as a percent of the bulk volume of the compacted mixture (G_{mb}) when compared to the maximum specific gravity (G_{mm}).

$$V_a = 100\left[\frac{(G_{mm} - G_{mb})}{G_{mm}}\right]$$

Where:

V_a = air voids in compacted mixture, percent of total volume (report to 0.1)
G_{mm} = maximum specific gravity of paving mixture (AASHTO T 209)
G_{mb} = bulk specific gravity of compacted mixture (AASHTO T 166)

Percent Aggregate (Stone) (P_s)

P_s is the percent aggregate (stone) content, expressed as a percentage of the total mass of the sample.

$$P_s = 100 - P_b$$

Where:

P_s = percent aggregate (stone) (report to 0.1) percent by total weight
P_b = asphalt binder content (AASHTO T 308)

Voids in the Mineral Aggregate (VMA)

VMA is the volume of intergranular void space between the aggregate particles of the compacted paving mixture that includes the air voids and the effective binder content, expressed as a percent of the total volume of the sample.

$$VMA = 100 - \left[\frac{(G_{mb} \times P_s)}{G_{sb}}\right]$$

Where:

VMA = voids in mineral aggregate, percent of bulk volume (report to 0.1**)**

G_{sb} = bulk specific gravity of combined aggregate (AASHTO T 85 / T 84 or agency approved method from Job Mix Formula)

G_{mb} = bulk specific gravity of compacted mixture (AASHTO T 166)

P_s = aggregate content, percent by total weight = 100 – P_b

P_b = asphalt binder content (AASHTO T 308) percent by total weight

Voids Filled with Asphalt (binder) (VFA)

VFA is the volume of space between the aggregate particles of the compacted paving mixture filled with asphalt binder, expressed as a percent of the total volume of the sample. The VFA increases as the asphalt binder content increases as it is the percent of voids that are filled with asphalt which doesn't include the absorbed asphalt.

$$VFA = 100\left[\frac{(VMA - V_a)}{VMA}\right]$$

Where:

VFA = voids filled with asphalt, percent of VMA (report to 1)
VMA = voids in mineral aggregate, percent of bulk volume
V_a = air voids in compacted mixture, percent of total volume.

Effective Specific Gravity of the Aggregate (Stone) (G_{se})

The G_{se} is used to quantify the asphalt binder absorbed into the aggregate particle. This is a calculated value based on the specific gravity of the mixture, G_{mm}, and the specific gravity of the asphalt binder, G_b This measurement includes the volume of the aggregate particle plus the void volume that becomes filled with water during the test soak period minus the volume of the voids that absorb asphalt binder. Effective specific gravity lies between apparent and bulk specific gravity.

G_{se} is formally defined as the ratio of the mass in air of a unit volume of a permeable material (excluding voids permeable to asphalt binder) at a stated temperature to the mass in air (of equal density) of an equal volume of gas-free distilled water at a stated temperature.

$$G_{se} = \frac{P_s}{\left[\left(\frac{100}{G_{mm}}\right) - \left(\frac{P_b}{G_b}\right)\right]}$$

Where:

G_{se} = effective specific gravity of combined aggregate (report to 0.001)
P_s = aggregate content, percent by total weight = 100 – P_b
G_{mm} = maximum specific gravity of mix (AASHTO T 209)
P_b = asphalt binder content (AASHTO T 308) percent by total weight
G_b = specific gravity of asphalt binder (JMF or asphalt binder supplier)

Percent of Absorbed (asphalt) Binder (P_{ba})

P_{ba} is the total percent of the asphalt binder that is absorbed into the aggregate, expressed as a percentage of the mass of aggregate rather than as a percentage of the total mass of the mixture. This portion of the asphalt binder content does not contribute to the performance of the mix.

$$P_{ba} = 100\left[\frac{(G_{se} - G_{sb})}{(G_{sb} \times G_{se})}\right] G_b$$

Where:

P_{ba} = absorbed asphalt binder (report to 0.01) percent of aggregate

G_{se} = effective specific gravity of combined aggregate
G_{sb} = bulk specific gravity of combined aggregate (AASHTO T 85 / T 84 or agency approved method from Job Mix Formula)
G_b = specific gravity of asphalt binder (JMF or asphalt binder supplier)

Percent of Effective (asphalt) Binder (P_{be})

P_{be} is the total asphalt binder content of a paving mixture minus the portion of asphalt binder that is lost by absorption into the aggregate particles, expressed as a percentage of the mass of aggregate. It is the portion of the asphalt binder content that remains as a coating on the outside of the aggregate particles. This is the asphalt content that controls the performance of the mix.

$$P_{be} = P_b - \left[\frac{P_{ba}}{100} \times P_s\right]$$

Where:

P_{be} = effective asphalt binder content (report to 0.01), percent by total weight

P_s = aggregate content, percent by total weight = 100 – P_b

P_b = asphalt binder content (AASHTO T 308) percent by total weight

P_{ba} = absorbed asphalt binder

Dust Proportion – DP (Dust to Effective (asphalt) Binder Ratio)

The DP is the percent passing the No. 200 sieve of the gradation divided by the percent of effective asphalt binder. Excessive dust reduces asphalt binder film thickness on the aggregate which reduces the durability. Insufficient dust may allow excessive asphalt binder film thickness, which may result in a tender, unstable mix.

$$DP = \frac{P_{-\#200}}{P_{be}}$$

Where:

DP = Dust Proportion, (dust-to-binder ratio) (report to 0.01)

$P_{-\#200}$ = aggregate passing the -#200 (0.075 mm) sieve, percent by mass of aggregate (AASHTO T 30)

P_{be} = effective asphalt binder content, percent by total weight

Mix Design and Production Values

Job Mix Formula

Table 2 includes example data required from the JMF. Some of these values are used in the example calculations.

Note: Some of the targets may change after the HMA is in production based on field test data.

Table 2

JMF Data	
Asphalt binder grade	PG 64-28
N_{values}	N_{ini} = 7 **N_{des} = 75** N_{max} = 115
G_{sb} (combined specific gravity of the aggregate)	2.678
Target P_b	4.75%
Initial sample mass for gyratory specimens	4840 grams
Mixing temperature range	306 – 312 °F
Laboratory compaction temperature range	286 – 294 °F
G_b (specific gravity of the asphalt binder)	1.020
Target gradation	
Sieve Size mm (in.)	**Percent Passing**
19.0 (3/4)	100
12.5 (1/2)	85
9.5 (3/8)	80
4.75 (No. 4)	50
2.36 (No. 8)	30
01.18 (No. 16)	25
0.600 (No. 30)	15
0.300 (No. 50)	10
0.150 (No. 100)	7
75 µm (No. 200)	5.0

Sample Test Result

Tables 3 and 4 include data from test results performed on a field sample of HMA used in the example calculations.

Table 3

Field Data		
	Test method	**Example values**
P_b	FOP for AASHTO T 308	4.60%
G_{mb}	FOP for AASHTO T 166	2.415
G_{mm}	FOP for AASHTO T 209	2.516

Table 4

Sieve Analysis FOP for AASHTO T 30	
Sieve Size mm (in.)	**Percent Passing**
19.0 (3/4)	100
12.5 (1/2)	86
9.5 (3/8)	77
4.75 (No. 4)	51
2.36 (No. 8)	34
01.18 (No. 16)	23
0.600 (No. 30)	16
0.300 (No. 50)	12
0.150 (No. 100)	8
75 µm (No. 200)	4.9

Sample Calculations

Air Voids (V_a)

$$V_a = 100\left[\frac{(G_{mm} - G_{mb})}{G_{mm}}\right]$$

$$V_a = 100\left[\frac{(2.516 - 2.415)}{2.516}\right] = 4.0\%$$

Given:

G_{mm} = 2.516
G_{mb} = 2.415

Percent Aggregate (Stone) (P_s)

$$P_s = 100 - P_b$$

$$P_s = 100 - 4.60\% = 95.40\%$$

Given:

P_b = 4.60%

Voids in the Mineral Aggregate (VMA)

$$VMA = 100 - \left[\frac{(G_{mb} \times P_s)}{G_{sb}}\right]$$

$$VMA = 100 - \left[\frac{2.415 \times 95.40\%)}{2.678}\right] = 13.96\%$$

Given:

G_{sb} =2.678

Voids Filled with Asphalt (binder) (VFA)

$$VFA = 100\left[\frac{(VMA - V_a)}{VMA}\right]$$

$$VFA = 100\left[\frac{(13.96\% - 4.0\%)}{13.96\%}\right] = 71\%$$

Effective Specific Gravity of the Aggregate (Stone) (G_{se})

$$G_{se} = \frac{P_s}{\left[\left(\frac{100}{G_{mm}}\right) - \left(\frac{P_b}{G_b}\right)\right]}$$

$$G_{se} = \frac{(100 - 4.60\%)}{\left[\left(\frac{100}{2.516}\right) - \left(\frac{4.60\%}{1.020}\right)\right]} =$$

$$G_{se} = \frac{95.40\%}{39.7456 - 4.5098} = 2.707$$

Given:

G_b = 1.020

Percent of Absorbed (asphalt) Binder (P_{ba})

$$P_{ba} = 100\left[\frac{(G_{se} - G_{sb})}{(G_{sb} \times G_{se})}\right] G_b$$

$$P_{ba} = 100\left[\frac{(2.707 - 2.678)}{(2.678 \times 2.707)}\right] 1.020 =$$

$$P_{ba} = 100\left[\frac{0.0290}{7.2493}\right] 1.020 = 0.41\%$$

Percent of Effective (asphalt) Binder (P_{be})

$$P_{be} = P_b - \left[\frac{P_{ba}}{100} \times P_s\right]$$

$$P_{be} = 4.6 - \left[\frac{0.41\%}{100} \times (100 - 4.60\%)\right] = 4.21\%$$

Dust Proportion – DP (Dust to Effective (asphalt) Binder Ratio)

$$DP = \frac{P_{-\#200}}{P_{be}}$$

$$DP = \frac{4.9\%}{4.21\%} = 1.16$$

Given:

$P_{-\#200}$ = 4.9%

Report

- Results on forms approved by the agency
- Air Voids, V_a to 0.1 percent
- Voids in the Mineral Aggregate, VMA to 0.1 percent
- Voids Filled with Asphalt, VFA to nearest whole value
- Effective Specific Gravity of Aggregate (stone), G_{se} to 0.001
- Percent of Absorbed (asphalt) Binder, P_{ba} to 0.01
- Percent Effective (asphalt) Binder, P_{be} to 0.01
- Dust Proportion, DP to 0.01

Appendix - Formulas

Air Voids (V_a)

$$V_a = 100\left[\frac{(G_{mm} - G_{mb})}{G_{mm}}\right]$$

Where:

V_a = air voids in compacted mixture, percent of total volume (report to 0.1)
G_{mm} = maximum specific gravity of paving mixture (AASHTO T 209)
G_{mb} = bulk specific gravity of compacted mixture (AASHTO T 166)

Percent Aggregate (Stone) (P_s)

$$P_s = 100 - P_b$$

Where:

P_s = percent aggregate (stone) (report to 0.1) percent by total weight
P_b = asphalt binder content (AASHTO T 308)

Voids in the Mineral Aggregate (VMA)

$$VMA = 100 - \left[\frac{(G_{mb} \times P_s)}{G_{sb}}\right]$$

Where:

VMA = voids in mineral aggregate, percent of bulk volume (report to 0.1)

G_{sb} = bulk specific gravity of combined aggregate (AASHTO T 85 / T 84 or agency approved method from Job Mix Formula)

G_{mb} = bulk specific gravity of compacted mixture (AASHTO T 166)

P_s = aggregate content, percent by total weight = 100 – P_b

P_b = asphalt binder content (AASHTO T 308) percent by total weight

Voids Filled with Asphalt (binder) (VFA)

$$VFA = 100\left[\frac{(VMA - V_a)}{VMA}\right]$$

Where:

VFA = voids filled with asphalt, percent of VMA (report to 1)
VMA = voids in mineral aggregate, percent of bulk volume
V_a = air voids in compacted mixture, percent of total volume.

Effective Specific Gravity of the Aggregate (Stone) (G_{se})

$$G_{se} = \frac{P_s}{\left[\left(\frac{100}{G_{mm}}\right) - \left(\frac{P_b}{G_b}\right)\right]}$$

Where:

G_{se} = effective specific gravity of combined aggregate (report to 0.001)
P_s = aggregate content, percent by total weight = 100 – P_b
G_{mm} = maximum specific gravity of mix (AASHTO T 209)
P_b = asphalt binder content (AASHTO T 308) percent by total weight
G_b = specific gravity of asphalt binder (JMF or asphalt binder supplier)

Percent of Absorbed (asphalt) Binder (P_{ba})

$$P_{ba} = 100\left[\frac{(G_{se} - G_{sb})}{(G_{sb} \times G_{se})}\right] G_b$$

Where:

P_{ba} = absorbed asphalt binder (report to 0.01) percent of aggregate
G_{se} = effective specific gravity of combined aggregate
G_{sb} = bulk specific gravity of combined aggregate (AASHTO T 85 from Job Mix Formula)
G_b = specific gravity of asphalt binder (JMF or asphalt binder supplier)

Percent of Effective (asphalt) Binder (P_{be})

$$P_{be} = P_b - \left[\frac{P_{ba}}{100} \times P_s\right]$$

Where:

P_{be} = effective asphalt binder content (report to 0.01), percent by total weight

P_s = aggregate content, percent by total weight = 100 – P_b

P_b = asphalt binder content (AASHTO T 308) percent by total weight

P_{ba} = absorbed asphalt binder

Dust Proportion – DP (Dust to Effective (asphalt) Binder Ratio)

$$DP = \frac{P_{-\#200}}{P_{be}}$$

Where:

DP = Dust Proportion, (dust-to-binder ratio) (report to 0.01)

$P_{-\#200}$ = aggregate passing the -#200 (0.075 mm) sieve, percent by mass of aggregate (AASHTO T 30)

P_{be} = effective asphalt binder content, percent by total weight

SAMPLING HOT MIX ASPHALT (HMA) AFTER COMPACTION (OBTAINING CORES)

WAQTC TM 11

Scope

- This method describes the process for removal of a core sample of compacted hot mix asphalt (HMA) from a pavement for laboratory testing. Cores may range in diameter from 2 in. to 12 in.

- The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

- Safety— This method does not purport to address all of the safety problems associated with its use. This test method involves potentially hazardous conditions.

Significance

- Samples obtained in accordance with the procedure may be used for measuring pavement thickness and density. Additional testing may be performed as required by the agency.

- When cores are used to determine gauge correlation, see:
  - WAQTC TM 8 for nuclear gauges
  - AASHTO T 343 for electronic gauges

- When cores are used to determine pavement density, the Bulk Specific Gravity (**G_{mb}**) is determined according to WAQTC FOP for AASHTO T 166 .

Apparatus

- Coring Machine – A motor driven core machine shall be used to obtain the sample. The device shall be capable of obtaining a core to the full depth of the HMA and mounted on a platform such that the core barrel is perpendicular to the pavement during the cutting process. A Core Drill Machine of sufficient horsepower and depth to minimize distortion of the compacted cores of HMA.

- Core Bit – The cutting edge of the core drill bit shall be of hardened steel or other suitable material with diamond chips embedded in the metal cutting edge. The core barrel inside diameter shall be as specified.

- Separation Equipment –A saw or other method(s) that provides a clean smooth plane representing the layer to be tested without damaging the specimen.

- Retrieval Device – A device for removing core samples that will preserve the integrity of the core. The device may be a steel rod of suitable length and with a diameter that will fit into the space between the core and the pavement material. There may be a 90 degree bend at the top to form a handle and a 90 degree bend at the bottom, approximately 2 in. (50 mm) long, forming a hook to assist in the retrieval of the core or other suitable device.

Material

- Cooling agent such as: water, ice, dry ice, or liquid nitrogen.

Test Site Location

- The number of cores obtained shall be determined by the test procedure or agency requirements.

- Core location(s) shall be determined by the agency.

Procedure

1. For freshly compacted HMA, the core shall be taken when the material has had sufficient amount of time to cool to prevent damage to the core.

2. To accelerate the coring process, a cooling agent may be used.

3. Provide a means such as water or air to aid in the removal of cuttings and to minimize the generation of heat caused by friction.

4. Position the coring machine above the selected location. Engage power and water or air source to coring machine. Slowly advance bit until contact with the HMA surface.

5. Keep the core bit perpendicular to the HMA surface applying constant pressure during the process.

Note #1: If any portion of the coring machine shifts during the operation, the core may break or distort. Failure to apply constant pressure, or too much pressure, may cause the bit to bind or distort the core.

6. Continue the coring operation until the desired depth.

7. Use a retrieval device to obtain the core.

Note #2: If the core is damaged to a point that it cannot be used for its intended purpose, a new core shall be obtained within 6 in. of the original location.

8. Clearly label the core.

Filling Core Holes

- Fill the hole made from the coring operation with HMA, non-shrink grout, or other suitable material. Consolidate or compact the material in the hole, multiple lifts may be required. Ensure that the final surface is level with the surrounding surface.

Transporting

- Transport cores in a manner that prevents damage from jarring, rolling or impact with any object.

- Prevent cores from freezing or from excessive heat, 54° C (130°F), during transport.

Note #3: In extreme ambient temperature conditions, an insulated container should be used during transport.

- If the core is damaged in transport to a point it cannot be utilized for its intended purpose the core will not be used.

Layer Separation

- Separate two or more pavement courses, lifts, or layers; on the designated lift line using appropriate separation equipment.

Note #4: Lift lines are often more visible by rolling the core on a flat surface.

Thickness Determination

- Measure the thickness of the designated lift to 0.10 in. (3 mm). Three or more measurements shall be taken around the lift and averaged.

Report

On forms approved by the agency:

- Date the cores were obtained
- Paving date
- Coring location
- The lift / layer being evaluated
- Material type
- Average thickness

CONCRETE
FIELD OPERATING PROCEDURES - SHORT FORM

SAMPLING FRESHLY MIXED CONCRETE
FOP FOR WAQTC TM 2

Scope

This method covers procedures for obtaining representative samples of fresh concrete delivered to the project site. The method includes sampling from stationary, paving and truck mixers, and from agitating and non-agitating equipment used to transport central mixed concrete.

This method also covers the removal of large aggregate particles by wet sieving.

Sampling concrete may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices.

Warning—Fresh Hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.

Apparatus

- Wheelbarrow
- Cover for wheelbarrow (plastic, canvas, or burlap)
- Buckets
- Shovel
- Cleaning equipment, including scrub brush, rubber gloves, water
- Apparatus for wet sieving, including: a sieve(s), conforming to AASHTO M 92, minimum of 2 ft^2 (0.19 m^2) of sieving area, conveniently arranged and supported so that the sieve can be shaken rapidly by hand.

Procedure

1. Use every precaution in order to obtain samples representative of the true nature and condition of the concrete being placed being careful not to obtain samples from the very first or very last portions of the batch. The size of the sample will be 1.5 times the volume of concrete required for the specified testing, but not less than 0.03 m^3 (1 ft^3).
2. Dampen the surface of the receptacle just before sampling, empty any excess water.

Note 1: Sampling should normally be performed as the concrete is delivered from the mixer to the conveying vehicle used to transport the concrete to the forms; however, specifications may require other points of sampling, such as at the discharge of a concrete pump.

- **Sampling from stationary mixers, except paving mixers**

  Sample the concrete after a minimum of 1/2 m^3 (1/2 yd^3) of concrete has been discharged. Perform sampling by passing a receptacle completely through the discharge stream, or by completely diverting the discharge into a sample container. Take care not to restrict the flow of concrete from the mixer, container, or transportation unit so as to cause segregation. These requirements apply to both tilting and nontilting mixers.

- **Sampling from paving mixers**

  Sample after the contents of the paving mixer have been discharged. Obtain material from at least five different locations in the pile and combine into one test sample. Avoid contamination with subgrade material or prolonged contact with absorptive subgrade. To preclude contamination or absorption by the subgrade, the concrete may be sampled by placing a shallow container on the subgrade and discharging the concrete across the container.

- **Sampling from revolving drum truck mixers or agitators**

  Sample the concrete after a minimum of 1/2 m^3 (1/2 yd^3) of concrete has been discharged. Obtain samples after all of the water has been added to the mixer. Do not obtain samples from the very first or last portions of the batch discharge. Sample by repeatedly passing a receptacle through the entire discharge stream or by completely diverting the discharge into a sample container. Regulate the rate of discharge of the batch by the rate of revolution of the drum and not by the size of the gate opening.

- **Sampling from open-top truck mixers, agitators, non-agitating equipment or other types of open-top containers**

  Sample by whichever of the procedures described above is most applicable under the given conditions.

- **Sampling from pump or conveyor placement systems**

  Sample after a minimum of 1/2 m^3 (1/2 yd^3) of concrete has been discharged. Obtain samples after all of the pump slurry has been eliminated. Sample by repeatedly passing a receptacle through the entire discharge system or by completely diverting the discharge into a sample container. Do not lower the pump arm from the placement position to ground level for ease of sampling, as it may modify the air content of the concrete being sampled. Do not obtain samples from the very first or last portions of the batch discharge.

3. Transport samples to the place where fresh concrete tests are to be performed and specimens are to be molded. They shall then be combined and remixed with a shovel the minimum amount necessary to ensure uniformity. Protect the sample from direct sunlight, wind, rain, and sources of contamination.

4. Complete test for temperature and start tests for slump and air content within 5 minutes of obtaining the sample. Start molding specimens for strength tests within 15 minutes of obtaining the sample. Complete the test methods as expeditiously as possible.

Wet Sieving

When required due to oversize aggregate, the concrete sample shall be wet sieved, after transporting but prior to remixing, for slump testing, air content testing or molding test specimens, by the following:

1. Place the sieve designated by the test procedure over the dampened sample container.
2. Pass the concrete over the designated sieve. Do not overload the sieve (one particle thick).
3. Shake or vibrate the sieve until no more material passes the sieve. A horizontal back and forth motion is preferred.
4. Discard oversize material including all adherent mortar.
5. Repeat until sample of sufficient size is obtained. Mortar adhering to the wet-sieving equipment shall be included with the sample.
6. Using a shovel, remix the sample the minimum amount necessary to ensure uniformity.

Note 2: Wet sieving is not allowed for samples being used for density determinations according to the FOP for AASHTO T 121.

Report

- On forms approved by the agency
- Date
- Time
- Location
- Quantity represented

PERFORMANCE EXAM CHECKLIST

SAMPLING FRESHLY MIXED CONCRETE
FOP FOR WAQTC TM 2

Participant Name ______________________________Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Receptacle dampened and excess water removed?	_____	_____
2. Obtain a representative sample from drum mixer:		
a) Concrete sampled after 1/2 m^3 (1/2 yd^3) discharged?	_____	_____
b) Receptacle passed through entire discharge stream or discharge stream completely diverted into sampling container?	_____	_____
3. Obtain a representative sample from a paving mixer:		
a) Concrete sampled after all the concrete has been discharged?	_____	_____
b) Material obtained from at least 5 different locations in the pile?	_____	_____
c) Avoid contaminating the sample with sub-grade materials.	_____	_____
4. Obtain a representative sample from a pump:		
a) Concrete sampled after 1/2 m^3 (1/2 yd^3) has been discharged?	_____	_____
b) All the pump slurry is out of the lines?	_____	_____
c) Receptacle passed through entire discharge stream or discharge stream completely diverted into sampling container?	_____	_____
d) Do not lower the pump arm from the placement position.	_____	_____
5. Samples transported to place of testing?	_____	_____
6. Sample(s) combined, or remixed, or both?	_____	_____
7. Sample protected?	_____	_____
8. Minimum size of sample used for strength tests 0.03 m^3 (1ft^3)?	_____	_____
9. Completed temperature test within 5 minutes of obtaining sample?	_____	_____
10. Start tests for slump and air within 5 minutes of obtaining sample?	_____	_____
11. Start molding cylinders within 15 minutes of obtaining sample?	_____	_____
12. Protect sample against rapid evaporation and contamination?	_____	_____
13. Wet Sieving:		
a) Required sieve size determined for test method to be performed?	_____	_____
b) Concrete placed on sieve and doesn't overload the sieve.	_____	_____
c) Sieve shaken until no more material passes the sieve.	_____	_____
d) Sieving continued until required testing size obtained.	_____	_____

OVER

Procedure Element	**Trial 1**	**Trial 2**
e) Oversized aggregate discarded.	_____	_____
f) Sample remixed.	_____	_____

Comments: First attempt: Pass_____Fail_______ Second attempt: Pass______Fail_____

____

____

____

Examiner Signature _______________________________WAQTC #:_______________

This checklist is derived, in part, from copyrighted material printed in ACI CP-1, published by the American Concrete Institute.

PERFORMANCE EXAM CHECKLIST (ORAL)

SAMPLING FRESHLY MIXED CONCRETE
FOP FOR WAQTC TM 2

Participant Name ______________________________Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. What is the minimum sample size?		
a) 0.03 m^3 or 1 ft^3	_____	_____
2. Describe how to obtain a representative sample from a drum mixer.		
a) Dampen receptacle and empty excess water.	_____	_____
b) Sample the concrete after 1/2 m^3 (1/2 yd^3) has been discharged.	_____	_____
c) Pass receptacle through entire discharge stream or completely divert discharge stream into sampling container.	_____	_____
3. Describe how to obtain a representative sample from a paving mixer.		
a) Dampen receptacle and empty excess water.	_____	_____
b) Sample the concrete after all the concrete has been discharged.	_____	_____
c) Obtain the material from at least 5 different locations in the pile.	_____	_____
d) Avoid contaminating the sample with sub-grade materials.	_____	_____
4. Describe how to obtain a representative sample from a pump:		
a) Dampen receptacle and empty excess water.	_____	_____
b) Sample the concrete after 1/2 m^3 (1/2 yd^3) has been discharged.	_____	_____
c) Make sure all the pump slurry is out of the lines.	_____	_____
d) Pass receptacle through entire discharge stream or completely divert discharge stream into sampling container.	_____	_____
e) Do not lower the pump arm from the placement position.	_____	_____
5. After obtaining the sample or samples what must you do?		
a) Transport samples to place of testing.	_____	_____
6. What must be done with the sample or samples once you have transported them to the place of testing?		
a) Combine & remix the sample.	_____	_____
b) Protect sample against rapid evaporation and contamination.	_____	_____
7. What are the two time parameters associated with this test?		
a) Complete temperature test and start tests for slump and air within 5 minutes of sample being obtained?	_____	_____
b) Start molding cylinders within 15 minutes of sample being obtained?	_____	_____
8. What test methods may require wet sieving?		
a) Slump, air content, & strength specimens?	_____	_____

OVER

Procedure Element	**Trial 1**	**Trial 2**
9. The sieve size used for wet sieving is based on?		
a) The test method to be performed.	_____	_____
10. How long must you continue wet sieving?		
a) Until a sample of sufficient size for the test being performed is obtained.	_____	_____
11. What is done with the oversized aggregate?		
a) Discard it.	_____	_____
12. What must be done to the sieved sample before testing?		
a) Remix.	_____	_____

Comments: First attempt: Pass_____Fail_______ Second attempt: Pass_____Fail_____

____

____

____

Examiner Signature ________________________________WAQTC #:_______________

TEMPERATURE OF FRESHLY MIXED PORTLAND CEMENT CONCRETE FOP FOR AASHTO T 309

Scope

This procedure covers the determination of the temperature of freshly mixed Portland Cement Concrete in accordance with AASHTO T 309-11.

Warning—Fresh Hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.

Apparatus

- Container — The container shall be made of non-absorptive material and large enough to provide at least 75 mm (3 in.) of concrete in all directions around the sensor; concrete cover must also be a least three times the nominal maximum size of the coarse aggregate.
- Temperature measuring device — The temperature measuring device shall be calibrated and capable of measuring the temperature of the freshly mixed concrete to ±0.5°C (±1°F) throughout the temperature range likely to be encountered. Partial immersion liquid-in-glass thermometers (and possibly other types) shall have a permanent mark to which the device must be immersed without applying a correction factor.
- Reference temperature measuring device — The reference temperature measuring device shall be a thermometric device readable to 0.2°C (0.5°F) that has been verified and calibrated. The calibration certificate or report indicating conformance to the requirements of ASTM E 77 shall be available for inspection.

Calibration of Temperature Measuring Device

Each temperature measuring device shall be verified for accuracy annually and whenever there is a question of accuracy. Calibration shall be performed by comparing readings on the temperature measuring device with another calibrated instrument at two temperatures at least 15°C or 27°F apart.

Sample Locations and Times

The temperature of freshly mixed concrete may be measured in the transporting equipment, in forms, or in sample containers, provided the sensor of the temperature measuring device has at least 75 mm (3 in.) of concrete cover in all direction around it.

Complete the temperature measurement of the freshly mixed concrete within 5 minutes of obtaining the sample.

Concrete containing aggregate of a nominal maximum size greater than 75 mm (3 in.) may require up to 20 minutes for the transfer of heat from the aggregate to the mortar after batching.

Procedure

1. Dampen the sample container.
2. Obtain the sample in accordance with the FOP for WAQTC TM 2.
3. Place sensor of the temperature measuring device in the freshly mixed concrete so that it has at least 75 mm (3 in.) of concrete cover in all directions around it.
4. Gently press the concrete in around the sensor of the temperature measuring device at the surface of the concrete so that air cannot reach the sensor.
5. Leave the sensor of the temperature measuring device in the freshly mixed concrete for a minimum of two minutes, or until the temperature reading stabilizes.
6. Complete the temperature measurement of the freshly mixed concrete within 5 minutes of obtaining the sample.
7. Read and record the temperature to the nearest 0.5°C (1°F).

Report

- Results on forms approved by the agency
- Measured temperature of the freshly mixed concrete to the nearest 0.5°C (1°F)

.

PERFORMANCE EXAM CHECKLIST

TEMPERATURE OF FRESHLY MIXED CONCRETE
FOP FOR AASHTO T 309

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Obtain sample of concrete large enough to provide a minimum of 75 mm (3") of concrete cover around sensor in all directions?	_____	_____
2. Place temperature measuring device in sample with a minimum of 75 mm (3") cover around sensor?	_____	_____
3. Gently press concrete around thermometer?	_____	_____
4. Read temperature after a minimum of 2 minutes or when temperature reading stabilizes?	_____	_____
5. Complete temperature measurement within 5 minutes of obtaining sample?	_____	_____
6. Record temperature to nearest 0.5°C (1°F)?	_____	_____

Comments: First attempt: Pass_____Fail_______ Second attempt: Pass______Fail______

____
____
____
____
____
____
____
____
____
____

Examiner Signature _______________________________WAQTC #:_______________

SLUMP OF HYDRAULIC CEMENT CONCRETE
FOP FOR AASHTO T 119

Scope

This procedure provides instructions for determining the slump of hydraulic cement concrete in accordance with AASHTO T 119-13. It is not applicable to non-plastic and non-cohesive concrete. With concrete using 37.5mm (1½ in.) or larger aggregate, the +37.5mm (1½ in.) aggregate must be removed in accordance with the FOP for WAQTC TM 2.

Warning—Fresh Hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.

Apparatus

- Mold: The metal mold shall be provided with foot pieces and handles. The mold must be constructed without a seam. The interior of the mold shall be relatively smooth and free from projections such as protruding rivets. The mold shall be free from dents. A mold that clamps to a rigid nonabsorbent base plate is acceptable provided the clamping arrangement is such that it can be fully released without movement of the mold.
- Mold: If other than metal, it must conform to AASHTO T 119, Sections 5.1.2.1 & 5.1.2.2.
- Tamping rod: 16 mm (5/8 in.) diameter and approximately 600 mm (24 in.) long, having a hemispherical tip the same diameter as the rod. (Hemispherical means "half a sphere"; the tip is rounded like half of a ball.)
- Scoop: a receptacle of appropriate size so that each representative increment of the concrete sample can be placed in the container without spillage.
- Tape measure or ruler with at least 5 mm or 1/8 in. graduations
- Base: Flat, rigid, non-absorbent moistened surface on which to set the slump cone

Procedure

1. Obtain the sample in accordance with the FOP for WAQTC TM 2. If any aggregate 37.5mm (1½ in.) or larger aggregate is present, aggregate must be removed in accordance with the Wet Sieving portion of the FOP for WAQTC TM 2.

   Note 1: Testing shall begin within five minutes of obtaining the sample.

2. Dampen the inside of the cone and place it on a dampened, rigid, nonabsorbent surface that is level and firm.
3. Stand on both foot pieces in order to hold the mold firmly in place.
4. Use the scoop to fill the cone 1/3 full by volume, to a depth of approximately 67 mm (2 5/8 in.) by depth.

5. Consolidate the layer with 25 strokes of the tamping rod, using the rounded end. Distribute the strokes evenly over the entire cross section of the concrete.

   For this bottom layer, incline the rod slightly and make approximately half the strokes near the perimeter, and then progress with vertical strokes, spiraling toward the center.

6. Use the scoop to fill the cone 2/3 full by volume, to a depth of approximately 155 mm (6 1/8 in.) by depth.
7. Consolidate this layer with 25 strokes of the tamping rod, penetrate approximately 25 mm (1 in.) into the bottom layer. Distribute the strokes evenly.
8. Use the scoop to fill the cone to overflowing.
9. Consolidate this layer with 25 strokes of the tamping rod, penetrate approximately 25 mm (1 in.) into the second layer. Distribute the strokes evenly. If the concrete falls below the top of the cone, stop, add more concrete, and continue rodding for a total of 25 strokes. Keep an excess of concrete above the top of the mold at all times. Distribute strokes evenly as before.
10. Strike off the top surface of concrete with a screeding and rolling motion of the tamping rod.
11. Clean overflow concrete away from the base of the mold.
12. Remove the mold from the concrete by raising it carefully in a vertical direction. Raise the mold 300 mm (12 in.) in 5 ±2 seconds by a steady upward lift with no lateral or torsional (twisting) motion being imparted to the concrete.

    The entire operation from the start of the filling through removal of the mold shall be carried out without interruption and shall be completed within an elapsed time of 2 1/2 minutes. Immediately measure the slump by:

13. Invert the slump cone and set it next to the specimen.
14. Lay the tamping rod across the mold so that it is over the test specimen.
15. Measure the distance between the bottom of the rod and the displaced original center of the top of the specimen to the nearest 5 mm (1/4 in.).

    Note 2: If a decided falling away or shearing off of concrete from one side or portion of the mass occurs, disregard the test and make a new test on another portion of the sample. If two consecutive tests on a sample of concrete show a falling away or shearing off of a portion of the concrete from the mass of the specimen, the concrete probably lacks the plasticity and cohesiveness necessary for the slump test to be applicable.

16. Discard the tested sample.

Report

- Results on forms approved by the agency
- Slump to the nearest 5 mm (1/4 in.).

PERFORMANCE EXAM CHECKLIST

SLUMP OF HYDRAULIC CEMENT CONCRETE
FOP FOR AASHTO T 119

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
First layer		
1. Cone and floor or base plate dampened?	_____	_____
2. Cone held firmly against the base by standing on the two foot pieces? Cone not allowed to move in any way during filling?	_____	_____
3. Representative sample scooped into the cone, moving a scoop around the perimeter of the mold to evenly distribute the concrete as discharged?	_____	_____
4. Cone approximately one third (by volume), 67 mm (2 5/8 in) deep?	_____	_____
5. Layer rodded throughout its depth 25 times with hemispherical end of rod, uniformly distributing strokes?	_____	_____
Second layer		
6. Representative samples scooped into the cone, moving a scoop around the perimeter of the mold to evenly distribute the concrete as discharged?	_____	_____
7. Cone filled approximately two thirds (by volume), 155 mm (6 1/8 in), deep?	_____	_____
8. Layer rodded throughout its depth 25 times with hemispherical end of rod, uniformly distributing strokes, penetrate approximately 25 mm (1 in.) into the bottom layer?	_____	_____
Third layer		
9. Representative sample scooped into the cone, moving a scoop around the perimeter of the mold to evenly distribute the concrete as discharged??	_____	_____
10. Cone filled to just over the top of the cone?	_____	_____
11. Layer rodded throughout its depth 25 times with hemispherical end of rod, uniformly distributing strokes, penetrate approximately 25 mm (1 in.) into the second layer?	_____	_____
12. Excess concrete kept above the mold at all times while rodding?	_____	_____
13. Concrete struck off level with top of cone using tamping rod?	_____	_____

OVER

Procedure Element	**Trial 1**	**Trial 2**
14. Concrete removed from around the outside bottom of the cone?	_____	_____
15. Cone lifted upward 300 mm (12in) in one smooth motion, without a lateral or twisting motion of the cone, in 5 ±2 seconds?	_____	_____
16. Test performed from start of filling through removal of the mold within 2 1/2 minutes?	_____	_____
17. Slump immediately measured to the nearest 5 mm (1/4 in) from the top of the cone to the displaced original center of the top surface of the specimen?	_____	_____

Comments: First attempt: Pass_____Fail_______ Second attempt: Pass_____Fail_____

____

____

____

____

____

____

Examiner Signature _______________________________WAQTC #:_______________

DENSITY (UNIT WEIGHT), YIELD, AND AIR CONTENT (GRAVIMETRIC) OF CONCRETE
FOP FOR AASHTO T 121

Scope

This procedure covers the determination of density, or unit weight, of freshly mixed concrete in accordance with AASHTO T 121-12. It also provides formulas for calculating the volume of concrete produced from a mixture of known quantities of component materials, and provides a method for calculating cement content and cementitious material content – the mass of cement or cementitious material per unit volume of concrete. A procedure for calculating water/cement ratio is also covered.

Warning—Fresh Hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.

Apparatus

- Measure: May be the bowl portion of the air meter used for determining air content under the FOP for AASHTO T 152. Otherwise, it shall be a metal cylindrical container meeting the requirements of AASHTO T 121. The capacity and dimensions of the measure shall conform to those specified in Table 1.

- Balance or scale: Accurate to within 45 g (0.1 lb) or 0.3 percent of the test load, whichever is greater, at any point within the range of use.

- Tamping rod: 16 mm (5/8 in.) diameter and approximately 600 mm (24 in.) long, having a hemispherical tip the same diameter as the rod. (Hemispherical means “half a sphere”; the tip is rounded like half of a ball.)

- Vibrator: 7000 vibrations per minute, 19 to 38 mm (3/4 to 1 1/2 in.) in diameter, and the length of the shaft shall be at least 610 mm (24 in.).

- Scoop: a receptacle of appropriate size so that each representative increment of the concrete sample can be placed in the container without spillage.

- Strike-off plate: A flat rectangular metal plate at least 6 mm (1/4 in.) thick or a glass or acrylic plate at least 12 mm (1/2 in.) thick, with a length and width at least 50 mm (2 in.) greater than the diameter of the measure with which it is to be used. The edges of the plate shall be straight and smooth within tolerance of 1.5 mm (1/16 in.).

- Mallet: With a rubber or rawhide head having a mass of 0.57 ±0.23 kg (1.25 ±0.5 lb) for use with measures of 0.014 m^3 (1/2 ft^3) or less, or having a mass of 1.02 ±0.23 kg (2.25 ±0.5 lb) for use with measures of 0.028 m^3 (1 ft^3).

Table 1
Dimensions of Measures

Capacity m^3 (ft^3)	Inside Diameter mm (in.)	Inside Height mm (in.)	Minimum Thicknesses mm (in.) Bottom	Minimum Thicknesses mm (in.) Wall	Nominal Maximum Size of Coarse Aggregate** mm (in.)
0.0071	203 ±2.54	213 ±2.54	5.1	3.0	25
(1/4)*	(8.0 ±0.1)	(8.4 ±0.1)	(0.20)	(0.12)	(1)
0.0142	254 ±2.54	279 ±2.54	5.1	3.0	50
(1/2)	(10.0 ±0.1)	(11.0 ±0.1)	(0.20)	(0.12)	(2)
0.0283	356 ±2.54	284 ±2.54	5.1	3.0	76
(1)	(14.0 ±0.1)	(11.2 ±0.1)	(0.20)	(0.12)	(3)

Note: Measure may be the base of the air meter used in the FOP for AASHTO T 152.
** Nominal maximum size: One sieve larger than the first sieve to retain more than 10 percent of the material using an agency specified set of sieves based on cumulative percent retained. Where large gaps in specification sieves exist, intermediate sieve(s) may be inserted to determine nominal maximum size.

Standardization of Measure

Standardization is a critical step to ensure accurate test results when using this apparatus. Failure to perform the standardization procedures as described herein will produce inaccurate or unreliable test results.

1. Determine the mass of the dry measure and strike-off plate.

2. Fill the measure with water at a temperature between 16°C and 29°C (60°F and 85°F) and cover with the strike-off plate in such a way as to eliminate bubbles and excess water.

3. Wipe the outside of the measure and cover plate dry, being careful not to lose any water from the measure.

4. Determine the mass of the measure, strike-off plate, and water in the measure.

5. Determine the mass of the water in the measure by subtracting the mass in Step 1 from the mass in Step 4.

6. Measure the temperature of the water and determine its density from Table 2, interpolating as necessary.

7. Calculate the volume of the measure, V_m, by dividing the mass of the water in the measure by the density of the water at the measured temperature, from Table 2.

$$V_m = \frac{Mass\ of\ Water}{Density\ of\ Water}$$

Example: at 23°C (73.4°F)

$$V_m = \frac{7.062\ kg}{997.54\ kg/m^3} = 0.007079 m^3 \qquad V_m = \frac{15.53 lb}{62.274\ lb/ft^3} = 0.2494 ft^3$$

Table 2
Unit Mass of Water
15°C to 30°C

°C	(°F)	kg/m^3	(lb/ft^3)	°C	(°F)	kg/m^3	(lb/ft^3)
15	(59.0)	999.10	(62.372)	23	(73.4)	997.54	(62.274)
15.6	(60.0)	999.01	(62.366)	23.9	(75.0)	997.32	(62.261)
16	(60.8)	998.94	(62.361)	24	(75.2)	997.29	(62.259)
17	(62.6)	998.77	(62.350)	25	(77.0)	997.03	(62.243)
18	(64.4)	998.60	(62.340)	26	(78.8)	996.77	(62.227)
18.3	(65.0)	998.54	(62.336)	26.7	(80.0)	996.59	(62.216)
19	(66.2)	998.40	(62.328)	27	(80.6)	996.50	(62.209)
20	(68.0)	998.20	(62.315)	28	(82.4)	996.23	(62.192)
21	(69.8)	997.99	(62.302)	29	(84.2)	995.95	(62.175)
21.1	(70.0)	997.97	(62.301)	29.4	(85.0)	995.83	(62.166)
22	(71.6)	997.77	(62.288)	30	(86.0)	995.65	(62.156)

Procedure Selection

There are two methods of consolidating the concrete – rodding and vibration. If the slump is greater than 75 mm (3 in.), consolidation is by rodding. When the slump is 25 to 75 mm (1 to 3 in.), internal vibration or rodding can be used to consolidate the sample, but the method used must be that required by the agency in order to obtain consistent, comparable results. For slumps less than 25 mm (1 in.), consolidate the sample by internal vibration. When using measures greater than 0.0142 m^3 (1/2 ft^3) see AASHTO T 121.

Procedure – Rodding

1. Obtain the sample in accordance with the FOP for WAQTC TM 2. Testing may be performed in conjunction with the FOP for AASHTO T 152. When doing so, this FOP should be performed prior to the FOP for AASHTO T 152.

   Note 1: If the two tests are being performed using the same sample, this test shall begin within five minutes of obtaining the sample.

2. Determine the mass of the dry empty measure.

3. Dampen the inside of the measure.

4. Use the scoop to fill the measure approximately 1/3 full with concrete. Evenly distribute the concrete in a circular motion around the inner perimeter of the measure.

5. Consolidate the layer with 25 strokes of the tamping rod, using the rounded end. Distribute the strokes evenly over the entire cross section of the concrete. Rod throughout its depth without hitting the bottom too hard.

6. Tap the sides of the measure smartly 10 to 15 times with the mallet to close voids and release trapped air.

7. Add the second layer, filling the measure about 2/3 full. Evenly distribute the concrete in a circular motion around the inner perimeter of the measure.

8. Consolidate this layer with 25 strokes of the tamping rod, penetrating about 25 mm (1 in.) into the bottom layer.

9. Tap the sides of the measure smartly 10 to 15 times with the mallet.

10. Add the final layer, slightly overfilling the measure. Evenly distribute the concrete in a circular motion around the inner perimeter of the measure.

11. Consolidate this layer with 25 strokes of the tamping rod, penetrating about 25 mm (1 in.) into the second layer.

12. Tap the sides of the measure smartly 10 to 15 times with the mallet.

    Note 2: The measure should be slightly over full, about 3 mm (1/8 in.) above the rim. If there is a great excess of concrete, remove a portion with the scoop. If the measure is under full, add a small quantity. This adjustment may be done only after consolidating the final layer and before striking off the surface of the concrete.

13. Strike off by pressing the strike-off plate flat against the top surface, covering approximately 2/3 of the measure. Withdraw the strike-off plate with a sawing motion to finish the 2/3 originally covered. Cover the original 2/3 again with the plate; finishing the remaining 1/3 with a sawing motion (do not lift the plate; continue the sawing motion until the plate has cleared the surface of the measure). Final finishing may be accomplished with several strokes with the inclined edge of the strike-off plate. The surface should be smooth and free of voids.

14. Clean off all excess concrete from the exterior of the measure including the rim.

15. Determine and record the mass of the measure and the concrete.

16. If the air content of the concrete is to be determined, proceed to Rodding Procedure Step 13 of the FOP for AASHTO T 152.

Procedure - Internal Vibration

1. Perform Steps 1 through 3 of the rodding procedure.

2. Use the scoop to fill the measure approximately 1/2 full with concrete. Evenly distribute the concrete in a circular motion around the inner perimeter of the measure.

3. Insert the vibrator at three different points in each layer. Do not let the vibrator touch the bottom or sides of the measure.

   Note 3: Remove the vibrator slowly, so that no air pockets are left in the material.

   Note 4: Continue vibration only long enough to achieve proper consolidation of the concrete. Over vibration may cause segregation and loss of appreciable quantities of intentionally entrained air.

4. Fill the measure a bit over full. Evenly distribute the concrete in a circular motion around the inner perimeter of the measure.

5. Insert the vibrator as in Step 3. Do not let the vibrator touch the sides of the measure, but do penetrate the first layer approximately 25 mm (1 in.).

6. Return to Step 13 of the rodding procedure and continue.

Calculations

- **Density –** Calculate the net mass, M_m, of the concrete in the measure by subtracting the mass of the measure from the gross mass of the measure plus the concrete. Calculate the density, W, by dividing the net mass, M_m, by the volume, V_m, of the measure as shown below.

$$W = \frac{M_m}{V_m}$$

Example: $W = \frac{16.290\ kg}{0.007079\ m^3} = 2390\ \ kg/m^3$ $W = \frac{36.06\ lb}{0.2494\ ft^3} = 144.6\ \ lb/ft^3$

- **Yield –** Calculate the yield, Y (m^3 or yd^3), or volume of concrete produced per batch, by dividing the total mass of the batch, W_1, by the density, W, of the concrete as shown below.

$$Y_{m^3} = \frac{W_1}{W}$$ Example: $Y_{m^3} = \frac{2436\ kg}{2390 kg/m^3} = 1.02 m^3$

$$Y_{ft^3} = \frac{W_1}{W} \qquad Y_{yd^3} = \frac{Y_{ft^3}}{27 ft^3/yd^3}$$

Example: $Y_{ft^3} = \frac{3978 lb}{144.6 lb/ft^3} = 27.51 ft^3$ $Y_{yd^3} = \frac{27.51 ft^3}{27 ft^3/yd^3} = 1.02\ yd^3$

Note 5: The total mass, W_1, includes the masses of the cement, water, and aggregates in the concrete.

- **Cement Content –** Calculate the actual cement content, N, by dividing the mass of the cement, N_t, by the yield, Y, as shown below.

  Note 6: Specifications may require Portland cement content and cementitious materials content

$$N = \frac{N_t}{Y} \quad \text{Example: } N = \frac{261\,kg}{1.02\,m^3} = 256\,kg/m^3 \quad N = \frac{602\,lb}{1.02\,yd^3} = 590\ lb/yd^3$$

- **Water Content** – Calculate the mass of water in a batch of concrete by summing the:

  - water added at batch plant
  - water added in transit
  - water added at jobsite
  - free water on coarse aggregate
  - free water on fine aggregate
  - liquid admixtures (if the agency requires this)

This information is obtained from concrete batch tickets collected from the driver. Use the following conversion factors.

To Convert From	To	Multiply By
Liters, L	Kilograms, kg	1.0
Gallons, gal	Kilograms, kg	3.785
Gallons, gal	Pounds, lb	8.34
Milliliters, mL	Kilograms, kg	0.001
Ounces, oz	Milliliters, mL	28.4
Ounces, oz	Kilograms, kg	0.0284
Ounces, oz	Pounds, lb	0.0625
Pounds, lb	Kilograms, kg	0.4536

Calculate the mass of free water on aggregate as follows:

$$Free\ Water\ Mass = Total\ Aggregate\ Mass - \frac{Total\ Aggregate\ Mass}{1 + (Free\ Water\ Percentage/100)}$$

Example:

Total Aggregate Mass = 3540 kg (7804 lb)

Free Water Percentage = 1.7*

∗ To determine Free Water percentage:

Total moisture content of the aggregates – absorbed moisture = Free Water

$$Free\ Water\ Mass = 3540\ kg - \frac{3540\ kg}{1 + (1.7\%/100)} \quad 7804\ lb - \frac{7804\ lb}{1 + (1.7\%/100)}$$

Example for actual water content:

Water added at batch plant =	300 L	79 gal
Water added in transit =	0 L	
Water added at jobsite =	40 L	11 gal
	340 L=340 kg	90 gal = 751 lb

Coarse aggregate: 3540 kg (7804 lbs) @ 1.7% free water

Fine aggregate: 2490 kg (5489 lb) @ 5.9% free water

$$CA\ Free\ Water = 3540kg - \frac{3540kg}{1 + (1.7\%/100)} = 59kg \quad 7804\ lb - \frac{7804\ lb}{1 + (1.7\%/100)} = 130\ lb$$

$$FA\ Free\ Water = 2490kg - \frac{2490kg}{1 + (5.9\%/100)} = 139kg \quad 5489\ lb - \frac{5489\ lb}{1 + (5.9\%/100)} = 306\ lb$$

Mass of water in batch = 59 kg + 139 kg = 538 kg 130 lb + 306 lb = 1187 lb

Water/Cement Ratio – Calculate the water/cement ratio by dividing the mass of water in a batch of concrete by the mass of cementitious material in the batch. The masses of the cementitious materials are obtained from concrete batch tickets collected from the driver.

Example:

Cement:	950 kg	2094 lb
Fly Ash:	180 kg	397 lb
Water:	538 kg (from previous example)	1187 lb

$$W/C = \frac{538\ kg}{980\ kg + 180\ kg} = 0.476 \quad W/C = \frac{1187\ lb}{2094\ lb + 397\ lb} = 0.48$$

Report 0.48

Report

- Results on forms approved by the agency
- Density (unit weight) to 1 kg/m^3 (0.1 lb/ft^3)
- Yield to 0.01 m^3 (0.01 yd^3)
- Cement content to 1 kg/m^3 (1 lb/yd^3)
- Cementitious material content to 1 kg/m^3 (1 lb/yd^3)
- Water/Cement ratio to 0.01

PERFORMANCE EXAM CHECKLIST

DENSITY (UNIT WEIGHT), YIELD, AND AIR CONTENT (GRAVIMETRIC) OF CONCRETE
FOP FOR AASHTO T 121

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Mass and volume of empty measure determined?	_____	_____
First Layer		
2. Dampened measure filled approximately one third full, moving a scoop around the perimeter of the mold to evenly distribute the concrete as discharged?	_____	_____
3. Layer rodded throughout its depth 25 times, without forcibly striking the bottom of the measure, with hemispherical end of rod, uniformly distributing strokes?	_____	_____
4. Sides of the measure tapped 10 to 15 times with the mallet after rodding?	_____	_____
Second layer		
5. Measure filled approximately two thirds full, moving a scoop around the perimeter of the mold to evenly distribute the concrete as discharged?	_____	_____
6. Layer rodded throughout its depth, just penetraiting the previous layer (approximately 25 mm (1 in.)) 25 times with hemispherical end of rod, uniformly distributing strokes?	_____	_____
7. Sides of the measure tapped 10 to 15 times with the mallet after rodding?	_____	_____
Third layer		
8. Measure filled, moving a scoop around the perimeter of the mold to evenly distribute the concrete as discharged?	_____	_____
9. Layer rodded throughout its depth, just penetraiting the previous layer (approximately 25 mm (1 in.)) 25 times with hemispherical end of rod, uniformly distributing strokes?	_____	_____
10. Sides of the measure tapped 10 to 15 times with the mallet after rodding each layer?	_____	_____
11. Any excess concrete removed using a trowel or a scoop, or small quantity of concrete added to correct a deficiency, after consolidation of final layer?	_____	_____

OVER

Procedure Element	**Trial 1**	**Trial 2**
12. Strike-off plate placed flat on the measure covering approximately 2/3 of the surface, then sawing action used to withdraw the strike-off plate across the previously covered surface?	_____	_____
13. Strike-off plate placed flat on the measure covering approximately 2/3 of the surface, then sawing action used to advance the plate across the entire measure surface?	_____	_____
14. Strike off completed using the inclined edge of the plate creating a smooth surface?	_____	_____
15. All excess concrete cleaned off and mass of full measure determined?	_____	_____
16. Net mass calculated?	_____	_____
17. Density calculated correctly?	_____	_____

Comments: First attempt: Pass_____Fail_______ Second attempt: Pass_____Fail____

____

____

____

____

Examiner Signature _______________________________WAQTC #:_______________

AIR CONTENT OF FRESHLY MIXED CONCRETE BY THE PRESSURE METHOD FOP for AASHTO T 152

Scope

This procedure covers determination of the air content in freshly mixed Portland Cement Concrete containing dense aggregates in accordance with AASHTO T 152-13, Type B meter. It is not for use with lightweight or highly porous aggregates. This procedure includes standardization of the Type B air meter gauge, and two methods for standardizing the gauge are presented.

Concrete containing aggregate that is 37.5 mm (1 ½”) or larger must be wet sieved. Sieve a sufficient amount of the sample over the 37.5 mm (1 ½”) sieve in accordance with the wet sieving portion of the FOP for WAQTC TM 2.

Warning—Fresh Hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.

Apparatus

- Air meter: Type B, as described in AASHTO T 152
- Balance or scale: Accurate to 0.3 percent of the test load at any point within the range of use (for Method 1 standardization only)
- Tamping rod: 16 mm (5/8 in.) diameter and approximately 600 mm (24 in.) long, having a hemispherical tip the same diameter as the rod. (Hemispherical means “half a sphere”; the tip is rounded like half of a ball.)
- Vibrator: 7000 vibrations per minute, 19 to 38 mm (0.75 to 1.50 in.) in diameter, at least 75 mm (3 in.) longer than the section being vibrated for use with low slump concrete
- Scoop: a receptacle of appropriate size so that each representative increment of the concrete sample can be placed in the container without spillage.
- Container for water: rubber syringe (may also be a squeeze bottle)
- Strike-off bar: Approximately 300 mm x 22 mm x 3 mm (12 in. x 3/4 in. x 1/8 in.)
- Strike-off plate: A flat rectangular metal plate at least 6 mm (1/4 in.) thick or a glass or acrylic plate at least 12 mm (1/2 in.) thick, with a length and width at least 50 mm (2 in.) greater than the diameter of the measure with which it is to be used. The edges of the plate shall be straight and smooth within tolerance of 1.5 mm (1/16 in.).

  Note 1: Use either the strike-off bar or strike-off plate; both are not required.

- Mallet: With a rubber or rawhide head having a mass of 0.57 ±0.23 kg (1.25 ±0.5 lb)

Standardization of Air Meter Gauge

Standardization is a critical step to ensure accurate test results when using this apparatus. Failure to perform the standardization procedures as described below will produce inaccurate or unreliable test results.

There are two methods for standardizing the air meter, mass or volume, both are covered below.

1. Screw the short piece of straight tubing into the threaded petcock hole on the underside of the cover. Determine the mass of the dry, empty air meter bowl and cover assembly (mass method only).
2. Fill the bowl nearly full with water.
3. Clamp the cover on the bowl with the tube extending down into the water. Mark the petcock with the tube attached for future reference.
4. Add water through the petcock having the pipe extension below until all air is forced out the other petcock. Rock the meter slightly until all air is expelled through the petcock.
5. Wipe off the air meter bowl and cover assembly, and determine the mass of the filled unit (mass method only).
6. Pump up the air pressure to a little beyond the predetermined initial pressure indicated on the gauge. Wait a few seconds for the compressed air to cool, and then stabilize the gauge hand at the proper initial pressure by pumping up or relieving pressure, as needed.
7. Close both petcocks and immediately open the main air valve exhausting air into the bowl. Wait a few seconds until the meter needle stabilizes. The gauge should now read 0 percent. If two or more tests show a consistent variation from 0 percent in the result, change the initial pressure line to compensate for the variation, and use the newly established initial pressure line for subsequent tests.
8. Determine which petcock has the straight tube attached to it. Attach the curved tube to external portion of the same petcock.
9. Pump air into the air chamber. Open the petcock with the curved tube attached to it. Open the main air valve for short periods of time until 5 percent of water by mass or volume has been removed from the air meter. Remember to open both petcocks to release the pressure in the bowl and drain the water in the curved tube back into the bowl. To determine the mass of the water to be removed, subtract the mass found in Step 1 from the mass found in Step 5. Multiply this value by 0.05. This is the mass of the water that must be removed. To remove 5 percent by volume, remove water until the external standardization vessel is level full.

Note 3: Many air meters are supplied with a standardization vessel(s) of known volume that are used for this purpose. Standardization vessel(s) should be brass, not plastic, and must be protected from crushing or denting. If an external standardization vessel is used, confirm what percentage volume it represents for the air meter being used. Vessels commonly represent 5 percent volume, but they are for specific size meters. This should be confirmed by mass.

10. Remove the curved tube. Pump up the air pressure to a little beyond the predetermined initial pressure indicated on the gauge. Wait a few seconds for the compressed air to cool,

and then stabilize the gauge hand at the proper initial pressure by pumping up or relieving pressure, as needed.

11. Close both petcocks and immediately open the main air valve exhausting air into the bowl. Wait a few seconds until the meter needle is stabilized. The gauge should now read 5.0 ±0.1 percent. If the gauge is outside that range, the meter needs adjustment. The adjustment could involve adjusting the starting point so that the gauge reads 5.0 ±0.1 percent when this standardization is run, or could involve moving the gauge needle to read 5.0 percent. Any adjustment should comply with the manufacturer's recommendations.

Note 4: Standardization shall be performed at a minimum every three months. Record the date of the standardization, the standardization results, and the name of the technician performing the standardization in the log book kept with each air meter.

12. When the gauge hand reads correctly at 5.0 percent, additional water may be withdrawn in the same manner to check the results at other values such as 10 percent or 15 percent.
13. If an internal standardization vessel is used, follow steps 1 through 8 to set initial reading.
14. Release pressure from the bowl and remove cover. Place the internal standardization vessel into the bowl. This will displace 5 percent of the water in the bowl. (See AASHTO T 152 for more information on internal standardization vessels.)
15. Place the cover back on the bowl and add water through the petcock until all the air has been expelled.
16. Pump up the air pressure chamber to the initial pressure. Wait a few seconds for the compressed air to cool, and then stabilize the gauge hand at the proper initial pressure by pumping up or relieving pressure, as needed.
17. Close both petcocks and immediately open the main air valve exhausting air into the bowl. Wait a few seconds until the meter needle stabilizes. The gauge should now read 5 percent.

Note 5: Remove the extension tubing from threaded petcock hole in the underside of the cover before starting the test procedure.

Procedure Selection

There are two methods of consolidating the concrete – rodding and vibration. If the slump is greater than 75 mm (3 in.), consolidation is by rodding. When the slump is 25 to 75 mm (1 to 3 in.), internal vibration or rodding can be used to consolidate the sample, but the method used must be that required by the agency in order to obtain consistent, comparable results. For slumps less than 25 mm (1 in.), consolidate the sample by internal vibration.

Procedure – Rodding

1. Obtain the sample in accordance with the FOP for WAQTC TM 2. If any aggregate 37.5mm (1½ in.) or larger is present, aggregate must be removed in accordance with the Wet Sieving portion of the FOP for WAQTC TM 2.

Note 6: Testing shall begin within five minutes of obtaining the sample.

2. Dampen the inside of the air meter bowl and place on a firm level surface.
3. Use the scoop to fill the bowl approximately 1/3 full with concrete. Evenly distribute the concrete in a circular motion around the inner perimeter of the measure.
4. Consolidate the layer with 25 strokes of the tamping rod, using the rounded end. Distribute the strokes evenly over the entire cross section of the concrete. Rod throughout its depth without hitting the bottom too hard.
5. Tap the sides of the bowl smartly 10 to 15 times with the mallet to close voids and release trapped air.
6. Add the second layer, filling the bowl about 2/3 full. Evenly distribute the concrete in a circular motion around the inner perimeter of the measure.
7. Consolidate this layer with 25 strokes of the tamping rod, penetrating about 25 mm (1 in.) into the bottom layer.
8. Tap the sides of the bowl 10 to 15 times with the mallet.
9. Add the final layer, slightly overfilling the bowl. Evenly distribute the concrete in a circular motion around the inner perimeter of the measure.
10. Consolidate this layer with 25 strokes of the tamping rod, penetrating about 25 mm (1 in.) into the second layer.
11. Tap the sides of the bowl smartly 10 to 15 times with the mallet.

Note 7: The bowl should be slightly over full, about 3 mm (1/8 in.) above the rim. If there is a great excess of concrete, remove a portion with the trowel or scoop. If the bowl is under full, add a small quantity. This adjustment may be done only after consolidating the final layer and before striking off the surface of the concrete.

12. Strike off the surface of the concrete and finish it smoothly with a sawing action of the strike-off bar or plate, using great care to leave the bowl just full. The surface should be smooth and free of voids.
13. Clean the top flange of the bowl to ensure a proper seal.
14. Moisten the inside of the cover and check to see that both petcocks are open and the main air valve is closed.
15. Clamp the cover on the bowl.
16. Inject water through a petcock on the cover until water emerges from the petcock on the other side.
17. Incline slightly and gently rock the air meter until no air bubbles appear to be coming out of the second petcock. The petcock expelling water should be higher than the petcock where water is being injected. Return the air meter to a level position and verify that water is present in both petcocks.
18. Close the air bleeder valve and pump air into the air chamber until the needle goes past the initial pressure determined for the gauge. Allow a few seconds for the compressed air to cool.

19. Tap the gauge gently with one hand while slowly opening the air bleeder valve until the needle rests on the initial pressure. Close the air bleeder valve.
20. Close both petcocks.
21. Open the main air valve.
22. Tap the sides of the bowl smartly with the mallet.
23. With the main air valve open, lightly tap the gauge to settle the needle, and then read the air content to the nearest 0.1 percent.
24. Release or close the main air valve.
25. Open both petcocks to release pressure, remove the concrete, and thoroughly clean the cover and bowl with clean water.
26. Open the main air valve to relieve the pressure in the air chamber.

Procedure - Internal Vibration

1. Obtain the sample in accordance with the FOP for WAQTC TM 2. If any aggregate 37.5mm (1½ in.) or larger is present, aggregate must be removed in accordance with the Wet Sieving portion of the FOP for WAQTC TM 2.
2. Dampen the inside of the air meter bowl and place on a firm level surface.
3. Use the scoop to fill the measure approximately 1/2 full with concrete. Evenly distribute the concrete in a circular motion around the inner perimeter of the measure.
4. Insert the vibrator at three different points. Do not let the vibrator touch the bottom or sides of the bowl.

Note 8: Remove the vibrator slowly, so that no air pockets are left in the material.

Note 9: Continue vibration only long enough to achieve proper consolidation of the concrete. Over vibration may cause segregation and loss of appreciable quantities of intentionally entrained air.

5. Use the scoop to fill the bowl a bit over full. Evenly distribute the concrete in a circular motion around the inner perimeter of the measure.
6. Insert the vibrator as in Step 4. Do not let the vibrator touch the sides of the bowl, and penetrate the first layer approximately 25 mm (1 in.).
7. Return to Step 12 of the rodding procedure and continue.

Report

- Results on forms approved by the agency
- Percent of air to the nearest 0.1 percent.
- Some agencies require an aggregate correction factor in order to determine total % entrained air.

  Total % entrained air = Gauge reading – aggregate correction factor from mix design

  (See AASHTO T 152 for more information.)

PERFORMANCE EXAM CHECKLIST

AIR CONTENT OF FRESHLY MIXED CONCRETE BY THE PRESSURE METHOD FOP FOR AASHTO T 152

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Representative sample selected?	_____	_____
First Layer		
1. Dampened measure filled approximately one third full, moving a scoop around the perimeter of the mold to evenly distribute the concrete as discharged?	_____	_____
2. Layer rodded throughout its depth 25 times, without forcibly striking the bottom of the measure, with hemispherical end of rod, uniformly distributing strokes?	_____	_____
3. Sides of the measure tapped 10 to 15 times with the mallet after rodding?	_____	_____
Second layer		
4. Measure filled approximately two thirds full, moving a scoop around the perimeter of the mold to evenly distribute the concrete as discharged?	_____	_____
5. Layer rodded throughout its depth, just penetraiting the previous layer (approximately 25 mm (1 in.)) 25 times with hemispherical end of rod, uniformly distributing strokes?	_____	_____
6. Sides of the measure tapped 10 to 15 times with the mallet after rodding?	_____	_____
Third layer		
7. Measure filled, moving a scoop around the perimeter of the mold to evenly distribute the concrete as discharged?	_____	_____
8. Layer rodded throughout its depth, just penetraiting the previous layer (approximately 25 mm (1 in.)) 25 times with hemispherical end of rod, uniformly distributing strokes?	_____	_____
9. Sides of the measure tapped 10 to 15 times with the mallet after rodding each layer?	_____	_____
10. Concrete struck off level with top of container using the bar or strike-off plate and rim cleaned off?	_____	_____
11. Top flange of base cleaned?	_____	_____

OVER

Procedure Element	Trial 1	Trial 2
Using a Type B Meter:		
12. Both petcocks open?	_____	_____
13. Air valve closed between air chamber and the bowl?	_____	_____
14. Inside of cover cleaned and moistened before clamping to base?	_____	_____
15. Water injected through petcock until it flows out the other petcock?	_____	_____
16. Water injection into the petcock continued while jarring and or rocking the meter to insure all air is expelled?	_____	_____
17. Air pumped up to just past initial pressure line?	_____	_____
18. A few seconds allowed for the compressed air to stabilize?	_____	_____
19. Gauge adjusted to the initial pressure?	_____	_____
20. Both petcocks closed?	_____	_____
21. Air valve opened between chamber and bowl?	_____	_____
22. The outside of bowl tapped smartly with the mallet?	_____	_____
23. With the main air valve open, gauge lightly tapped and air percentage read to the nearest 0.1 percent?	_____	_____
24. Air valve released or closed and then petcocks opened to release pressure before removing the cover?	_____	_____
25. Aggregate correction factor applied if required?	_____	_____
26. Air content recorded to 0.1 percent?	_____	_____

Comments: First attempt: Pass_____Fail_______ Second attempt: Pass_____Fail_____

____
____
____
____
____
____
____
____

Examiner Signature _______________________________WAQTC #:_______________

This checklist is derived, in part, from copyrighted material printed in ACI CP-1, published by the American Concrete Institute.

METHOD OF MAKING AND CURING CONCRETE TEST SPECIMENS IN THE FIELD
FOP FOR AASHTO T 23

Scope

This procedure covers the method for making, initially curing, and transporting concrete test specimens in the field in accordance with AASHTO T 23-13.

Warning—Fresh Hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.

Apparatus and Test Specimens

- Concrete cylinder molds: Conforming to AASHTO M 205 with a length equal to twice the diameter. Standard specimens shall be 150 mm (6 in.) by 300 mm (12 in.) cylinders. Mold diameter must be at least three times the maximum aggregate size unless wet sieving is conducted according to the FOP for WAQTC TM 2. Agency specifications may allow cylinder molds of 100 mm (4 in.) by 200 mm (8 in.) when the nominal maximum aggregate size does not exceed 25 mm (1 in.).
- Beam molds: Rectangular in shape with ends and sides at right angles to each other. Must be sufficiently rigid to resist warpage. Surfaces must be smooth. Molds shall produce length no more than 1.6 mm (1/16") shorter than that required (greater length is allowed). Maximum variation from nominal cross section shall not exceed 3.2 mm (1/8 in.). Ratio of width to depth may not exceed 1:5; the smaller dimension must be at least 3 times the maximum aggregate size. Unless otherwise noted in specifications, beam molds for casting specimens in the field shall result in specimens having width and depth of not less than 150 mm (6 inches). Specimens shall be cast and hardened with the long axes horizontal.
- Standard tamping rod: 16 mm (5/8 in.) in diameter and approximately 600 mm (24 in.) long, having a hemispherical tip of the same diameter as the rod for preparing 150mm (6 in.) x 300 mm (12 in.) cylinders.
- Small tamping rod: 10 mm (3/8 in.) diameter and approximately 305 mm (12 in.) long, having a hemispherical tip of the same diameter as the rod for preparing 100 mm (4 in.) x 200 mm (8 in.) cylinders.
- Vibrator: At least 7000 vibrations per minute, with a diameter no more than ¼ the diameter or width of the mold and at least 75 mm (3 in.) longer than the section being vibrated for use with low slump concrete.
- Scoop: a receptacle of appropriate size so that each representative increment of the concrete sample can be placed in the container without spillage.
- Trowel or float
- Mallet: With a rubber or rawhide head having a mass of 0.57 ±0.23 kg (1.25 ±0.5 lb.).

- Rigid base plates and cover plates: may be metal, glass, or plywood.
- Initial curing facilities: Temperature-controlled curing box or enclosure capable of maintaining the required range of 16 to 27°C (60 to 80°F) during the entire initial curing period (for concrete with compressive strength of 40 Mpa (6000 psi) or more, the temperature shall be 20 to 26°C (68 to 78°F). As an alternative, sand or earth for initial cylinder protection may be used provided that the required temperature range is maintained and the specimens are not damaged.
- Thermometer: Capable of registering both maximum and minimum temperatures during the initial cure.

Procedure – Making Specimens – General

1. Obtain the sample according to the FOP for WAQTC TM 2.
2. Wet Sieving per the FOP for WAQTC TM 2 is required for 150 mm (6 in.) diameter specimens containing aggregate with a nominal maximum size greater than 50 mm (2 in.); screen the sample over the 50 mm (2 in.) sieve.
3. Remix the sample after transporting to testing location.
4. Begin making specimens within 15 minutes of obtaining the sample.
5. Set molds upright on a level, rigid base in a location free from vibration and relatively close to where they will be stored.
6. Fill molds in the required number of layers, attempting to slightly overfill the mold on the final layer. Add or remove concrete prior to completion of consolidation to avoid a deficiency or excess of concrete.
7. There are two methods of consolidating the concrete – rodding and internal vibration. If the slump is greater than 25 mm (1 in.), consolidation may be by rodding or vibration. When the slump is 25 mm (1 in.) or less, consolidate the sample by internal vibration. Agency specifications may dictate when rodding or vibration will be used.

Procedure – Making Cylinders – Rodding

1. For the standard 150 mm (6 in.) by 300 mm (12 in.) specimen, fill each mold in three approximately equal layers, moving the scoop or trowel around the perimeter of the mold to evenly distribute the concrete. For the 100 mm (4 in.) by 200 mm (8 in.) specimen, fill the mold in two layers. When filling the final layer, slightly overfill the mold.
2. Consolidate each layer with 25 strokes of the appropriate tamping rod, using the rounded end. Distribute strokes evenly over the cross section of the concrete. Rod the first layer throughout its depth without forcibly hitting the bottom. For subsequent layers, rod the layer throughout its depth penetrating approximately 25 mm (1 in.) into the underlying layer.
3. After rodding each layer, tap the sides of each mold 10 to 15 times with the mallet (reusable steel molds) or lightly with the open hand (single-use light-gauge molds).

4. Strike off the surface of the molds with tamping rod or straightedge and begin initial curing.

   Note 1: Floating or troweling is permitted instead of striking off with rod or straightedge.

Procedure – Making Cylinders – Internal Vibration

1. Fill the mold in two layers.
2. Insert the vibrator at the required number of different points for each layer (two points for 150 mm (6 in.) diameter cylinders; one point for 100 mm (4 in.) diameter cylinders). When vibrating the bottom layer, do not let the vibrator touch the bottom or sides of the mold. When vibrating the top layer, the vibrator shall penetrate into the underlying layer approximately 25 mm (1 in.)
3. Remove the vibrator slowly, so that no large air pockets are left in the material.

   Note 2: Continue vibration only long enough to achieve proper consolidation of the concrete. Over vibration may cause segregation and loss of appreciable quantities of intentionally entrained air.
4. After vibrating each layer, tap the sides of each mold 10 to 15 times with the mallet (reusable steel molds) or lightly with the open hand (single-use light-gauge molds).
5. Strike off the surface of the molds with tamping rod or straightedge and begin initial curing.

Procedure – Making Flexural Beams – Rodding

1. Fill the mold in two approximately equal layers with the second layer slightly overfilling the mold.
2. Consolidate each layer with the tamping rod once for every 1300 mm^2 (2 in^2) using the rounded end. Rod each layer throughout its depth, taking care to not forcibly strike the bottom of the mold when compacting the first layer. Rod the second layer throughout its depth, penetrating approximately 25 mm (1”) into the lower layer.
3. After rodding each layer, strike the mold 10 to 15 times with the mallet and spade along the sides and end using a trowel.
4. Strike off to a flat surface using a float or trowel and begin initial curing.

Procedure – Making Flexural Beams – Vibration

1. Fill the mold to overflowing in one layer.
2. Consolidate the concrete by inserting the vibrator vertically along the centerline at intervals not exceeding 150 mm (6 in.). Take care to not over-vibrate, and withdraw the vibrator slowly to avoid large voids. Do not contact the bottom or sides of the mold with the vibrator.
3. After vibrating, strike the mold 10 to 15 times with the mallet.
4. Strike off to a flat surface using a float or trowel and begin initial curing.

Procedure – Initial Curing

- When moving cylinder specimens made with single use molds support the bottom of the mold with trowel, hand, or other device.
- For initial curing of cylinders, there are two methods, use of which depends on the agency. In both methods, the curing place must be firm, within ¼ in. of a level surface, and free from vibrations or other disturbances.
- Maintain initial curing temperature of 16 to 27° C (60 to 80°F) or 20 to 26°C (68 to 78°F) for concrete with strength of 40 Mpa (6000 psi) or more.
- Prevent loss of moisture.

Method 1 – Initial cure in a temperature controlled chest-type curing box

1. Finish the cylinder using the tamping rod, straightedge, float, or trowel. The finished surface shall be flat with no projections or depressions greater than 3.2 mm (1/8 in.).
2. Place the mold in the curing box. When lifting light-gauge molds be careful to avoid distortion (support the bottom, avoid squeezing the sides).
3. Place the lid on the mold to prevent moisture loss.
4. Mark the necessary identification data on the cylinder mold and lid.

Method 2 – Initial cure by burying in earth or by using a curing box over the cylinder

Note 3: This procedure may not be the preferred method of initial curing due to problems in maintaining the required range of temperature.

1. Move the cylinder with excess concrete to the initial curing location.
2. Mark the necessary identification data on the cylinder mold and lid.
3. Place the cylinder on level sand or earth, or on a board, and pile sand or earth around the cylinder to within 50 mm (2 in.) of the top.
4. Finish the cylinder using the tamping rod, straightedge, float, or trowel. Use a sawing motion across the top of the mold. The finished surface shall be flat with no projections or depressions greater than 3.2 mm (1/8 in.).
5. If required by the agency, place a cover plate on top of the cylinder and leave it in place for the duration of the curing period, or place the lid on the mold to prevent moisture loss.

Procedure – Transporting Specimens

- After 24 to 48 hours of initial curing, the specimens will be transported to the laboratory for a final cure. Specimen identity will be noted along with the date and time the specimen was made and the maximum and minimum temperatures registered during the initial cure.
- While in transport, specimens shall be protected from jarring, extreme changes in temperature, freezing, or moisture loss.
- Cylinders shall be secured so that the axis is vertical.
- Transportation time shall not exceed 4 hours.

Final Curing

- Upon receiving cylinders at the laboratory, remove the cylinder from the mold and apply the appropriate identification.
- For all specimens (cylinders or beams), final curing must be started within 30 minutes of mold removal. Temperature shall be maintained at 23° ±2°C (73 ±3°F). Free moisture must be present on the surfaces of the specimens during the entire curing period. Curing may be accomplished in a moist room or water tank conforming to AASHTO M 201.
- For cylinders, during the final 3 hours prior to testing the temperature requirement may be waived, but free moisture must be maintained on specimen surfaces at all times until tested.
- Final curing of beams must include immersion in lime-saturated water for at least 20 hours prior to testing.

Report

- On forms approved by the agency
- Pertinent placement information for identification of project, element(s) represented, etc.
- Date and time molded.
- Test ages.
- Slump, air content, & density.
- Temperature (concrete, initial cure max. & min., and ambient).
- Method of initial curing.
- Other information as required by agency, such as: concrete supplier, truck number, invoice number, water added, etc.

PERFORMANCE EXAM CHECKLIST

MAKING AND CURING CONCRETE TEST SPECIMENS IN THE FIELD FOP FOR AASHTO T 23 (6 X 12)

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Molds placed on a level, rigid, horizontal surface free of vibration?	_____	_____
2. Representative sample selected?	_____	_____
3. Making of specimens begun within 15 minutes of sampling?	_____	_____
First layer		
4. Concrete placed in the mold, moving a scoop or trowel around the perimeter of the mold to evenly distribute the concrete as discharged?	_____	_____
5. Mold filled approximately one third full?	_____	_____
6. Layer rodded throughout its depth 25 times with hemispherical end of rod, uniformly distributing strokes?	_____	_____
7. Sides of the mold tapped 10-15 times after rodding each layer?		
a. With mallet for reusable steel molds	_____	_____
b. With the open hand for flexible light-gauge molds	_____	_____
Second layer		
8. Concrete placed in the mold, moving a scoop or trowel around the perimeter of the mold to evenly distribute the concrete as discharged?	_____	_____
9. Mold filled approximately two thirds full?	_____	_____
10. Layer rodded 25 times with hemispherical end of rod, uniformly distributing strokes and penetrating 25 mm (1 in.) into the underlying layer?	_____	_____
11. Sides of the mold tapped 10-15 times after rodding?		
a. With mallet for reusable steel molds	_____	_____
b. With the open hand for flexible light-gauge molds	_____	_____
Third layer		
12. Concrete placed in the mold, moving a scoop or trowel around the perimeter of the mold to evenly distribute the concrete as discharged?	_____	_____

OVER

Procedure Element	**Trial 1**	**Trial 2**
13. Mold filled, attempting to exactly fill the mold on the last layer?	_____	_____
14. Layer rodded 25 times with hemispherical end of rod, uniformly distributing strokes and penetrating 25 mm (1 in.) into the underlying layer?	_____	_____
15. Sides of the mold tapped 10-15 times after rodding?		
a. With mallet for reusable steel molds	_____	_____
b. With the open hand for flexible light-gauge molds	_____	_____
16. Concrete struck off with tamping rod or, if necessary, finished with a trowel or float?	_____	_____
17. Specimens covered with non-absorptive, non-reactive cap or plate?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

Examiner Signature _______________________________WAQTC #:_______________

This checklist is derived, in part, from copyrighted material printed in ACI CP-1, published by the American Concrete Institute.

EMBANKMENT & BASE
FIELD OPERATING PROCEDURES - SHORT FORM

TOTAL EVAPORABLE MOISTURE CONTENT OF AGGREGATE BY DRYING FOP FOR AASHTO T 255

Scope

This procedure covers the determination of moisture content of aggregate in accordance with AASHTO T 255-00. It may also be used for other construction materials.

Overview

Moisture content is determined by comparing the wet mass of a sample and the mass of the sample after drying to constant mass. The term constant mass is used to define when a sample is dry.

Constant mass – the state at which a mass does not change more than a given percent, after additional drying for a defined time interval, at a required temperature.

Apparatus

- Balance or scale: Capacity sufficient for the principle sample mass, accurate to 0.1 percent of sample mass or readable to 0.1 g, meeting the requirements of AASHTO M 231.
- Containers, clean, dry and capable of being sealed
- Suitable drying containers
- Microwave safe containers
- Heat source, temperature controlled
  - Forced draft oven
  - Ventilated or convection oven
- Heat source, uncontrolled
  - Infrared heater, hot plate, fry pan, or any other device/method that will dry the sample without altering the material being dried
  - Microwave oven (600 watts minimum)
- Hot pads or gloves
- Utensils such as spoons

Sample Preparation

In accordance with the FOP for AASHTO T 2 obtain a representative sample in its existing condition. The representative sample size is based on Table 1 or other information that may be specified by the agency

TABLE 1
Sample Sizes for Moisture Content of Aggregate

Nominal Maximum Size* mm (in.)	Minimum Sample Mass g (lb)
4.75 (No. 4)	500 (1.1)
9.5 (3/8)	1500 (3.3)
12.5 (1/2)	2000 (4)
19.0 (3/4)	3000 (7)
25.0 (1)	4000 (9)
37.5 (1 1/2)	6000 (13)
50 (2)	8000 (18)
63 (2 1/2)	10,000 (22)
75 (3)	13,000 (29)
90 (3 1/2)	16,000 (35)
100 (4)	25,000 (55)
150 (6)	50,000 (110)

* One sieve larger than the first sieve to retain more than 10 percent of the material using an agency specified set of sieves based on cumulative percent retained. Where large gaps in specification sieves exist, intermediate sieve(s) may be inserted to determine nominal maximum size.

Immediately seal or cover samples to prevent any change in moisture content or follow the steps in “Procedure”.

Procedure

Determine all masses to the nearest 0.1 percent of the sample mass or to the nearest 0.1 g.

When determining the mass of hot samples or containers or both, place and tare a buffer between the sample container and the balance. This will eliminate damage to or interference with the operation of the balance or scale.

1. Determine and record the mass of the container.

2. Place the wet sample in the container.

    a. For oven(s), hot plates, heat lamps, etc.: Spread the sample in the container.

    b. For microwave oven: Heap sample in the container with ventilated lid.

3. Determine and record the total mass of the container and wet sample.

4. Determine and record the wet mass of the sample by subtracting the container mass determined in Step 1 from the mass of the container and sample determined in Step 3.

5. Dry the sample.

    a. Controlled heat source (oven): at 110 ±5°C (230 ±9°F).

    b. Uncontrolled heat source (Hot plate, heat lamp, etc.): Stir frequently to avoid localized overheating.

6. Dry until sample appears moisture free.

7. Determine mass of sample and container.

8. Determine and record the mass of the sample by subtracting the container mass determined in Step 1 from the mass of the container and sample determined in Step 7.

9. Return sample and container to the heat source for additional drying.

    a. Controlled heat source (oven): 30 minutes

    b. Uncontrolled heat source (Hot plate, heat lamp, etc.): 20 minutes

    c. Uncontrolled heat source (Microwave oven): 10 minutes

Caution: Some minerals in the sample may cause the aggregate to overheat, altering the aggregate gradation.

10. Determine mass of sample and container.

11. Determine and record the mass of the sample by subtracting the container mass determined in Step 1 from the mass of the container and sample determined in Step 10.

12. Determine percent change by subtracting the new mass determination (M_n) from the previous mass determination (M_p) divide by the previous mass determination (M_p) multiply by 100.

13. Continue drying, performing steps 9 through 12, until there is less than a 0.10 percent change after additional drying time.

14. Constant mass has been achieved, sample is defined as dry.

15. Allow the sample to cool. Determine and record the total mass of the container and dry sample.

16. Determine and record the dry mass of the sample by subtracting the mass of the container determined in Step 1 from the mass of the container and sample determined in Step 15.

17. Determine and record percent moisture by subtracting the final dry mass determination (M_D) from the initial wet mass determination (M_W) divide by the final dry mass determination (M_D) multiply by 100.

Table 2
Methods of Drying

Heat Source	**Specific Instructions**	**Drying increments (minutes)**
Controlled: Forced draft (preferred), ventilated, or convection oven	110 ±5°C (230 ±9°F)	30
Uncontrolled:		
Hot plate, Heat Lamp, etc.	Stir frequently	20
Microwave	Heap sample and cover with ventilated lid	10

Calculation

Constant Mass:

Calculate constant mass using the following formula:

$$\frac{M_p - M_n}{M_p} \times 100 = \%\ \text{Change}$$

Where:

M_p = previous mass measurement

M_n = new mass measurement

Example:

Mass of container: 1232.1 g

Mass of container after first drying cycle: 2637.2 g

Mass, M_p, of possibly dry sample: 2637.2 g - 1232.1 g = 1405.1 g

Mass of container and dry sample after second drying cycle: 2634.1 g

Mass, M_n, of dry sample: 2634.1 g - 1232.1 g = 1402.0 g

$$\frac{1405.1 \text{ g} - 1402.0 \text{ g}}{1405.1 \text{ g}} \times 100 = 0.22\%$$

0.22 percent is not less than 0.10 percent, so continue drying

Mass of container and dry sample after third drying cycle: 2633.0 g

Mass, M_n, of dry sample: 2633.0 g - 1232.1 g = 1400.9 g

$$\frac{1402.0 \text{ g} - 1400.9 \text{ g}}{1402.0 \text{ g}} \times 100 = 0.08\%$$

0.08 percent is less than 0.10 percent, so constant mass has been reached

Moisture Content:

Calculate the moisture content, w, as a percent, using the following formula:

$$\frac{M_W - M_D}{M_D} \times 100 = \%\ Moisture\ Content$$

where:

M_W = wet mass

M_D = dry mass

Example:

Mass of container: 1232.1 g

Mass of container and wet sample: 2764.7 g

Mass, M_W, of wet sample: 2764.7 g - 1232.1 g = 1532.6 g

Mass of container and dry sample (COOLED): 2633.0 g

Mass, M_D, of dry sample: 2633.0 g - 1232.1 g = 1400.9 g

$$w = \frac{1532.6\text{g} - 1400.9\text{g}}{1400.9\text{g}} \times 100 = \frac{131.7\text{g}}{1400.9\text{g}} = 9.40\% \text{ rounded to } 9.4\%$$

Report

- Results on forms approved by the agency
- M_W, wet mass
- M_D, dry mass
- w, moisture content to nearest 0.1 percent

PERFORMANCE EXAM CHECKLIST

TOTAL MOISTURE CONTENT OF AGGREGATE BY DRYING
FOP FOR AASHTO T 255

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Representative sample of appropriate mass obtained?	_____	_____
2. Mass of container determined to 0.1 percent or 0.1 g?	_____	_____
3. Sample placed in container and wet mass determined to 0.1 percent or 0.1 g?	_____	_____
4. Test sample mass conforms to the required mass?	_____	_____
5. Wet mass of sample determined to 0.1 percent or 0.1 g?	_____	_____
6. Loss of moisture avoided prior to mass determination?	_____	_____
7. Sample dried by a suitable heat source?	_____	_____
8. If aggregate heated by means other than a controlled oven, is sample stirred to avoid localized overheating?	_____	_____
9. Is aggregate heated for the additional, specified time (forced draft – 30 minutes; ventilated – 30 minutes; microwave – 10 minutes; other – 20 minutes) and then mass determined and compared to previous mass – showing less than 0.10 percent loss?	_____	_____
10. Sample cooled prior to dry mass determination to 0.1 percent or 0.1 g?	_____	_____
11. Calculations performed properly and results reported to the nearest 0.1 percent?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

____
____
____
____
____
____
____
____
____
____
____
____

Examiner Signature ____________________________ WAQTC #:_______________

MOISTURE-DENSITY RELATIONS OF SOILS: USING A 2.5 kg (5.5 lb) RAMMER AND A 305 mm (12 in.) DROP FOP FOR AASHTO T 99 USING A 4.54 kg (10 lb) RAMMER AND A 457 mm (18 in.) DROP FOP FOR AASHTO T 180

Scope

This procedure covers the determination of the moisture-density relations of soils and soil-aggregate mixtures in accordance with two similar test methods:

- AASHTO T 99-10: Methods A, B, C, and D
- AASHTO T 180-10: Methods A, B, C, and D

This test method applies to soil mixtures having 40% or less retained on the 4.75 mm (No 4) sieve for methods A or B, or, 30% or less retained on the 19 mm (¾") with methods C or D. The retained material is defined as oversize (coarse) material. If no minimum percentage is specified, 5% will be used. Samples that contain oversize (coarse) material that meet percent retained criteria should be corrected by using the FOP for AASHTO T 224. Samples of soil or soil-aggregate mixture are prepared at several moisture contents and compacted into molds of specified size, using manual or mechanical rammers that deliver a specified quantity of compactive energy. The moist masses of the compacted samples are multiplied by the appropriate factor to determine moist density values. Moisture contents of the compacted samples are determined and used to obtain the dry density values of the same samples. Maximum dry density and optimum moisture content for the soil or soil-aggregate mixture is determined by plotting the relationship between dry density and moisture content.

Apparatus

- Mold – Cylindrical, made of metal and with the dimensions shown in Table 1 or Table 2. It shall include a detachable collar and a base plate to which the mold can be fastened. If permitted by the agency, the mold may be of the "split" type, consisting of two half-round sections, which can be securely locked in place to form a cylinder.

- Rammer –Manually or mechanically-operated rammers as detailed in Table 1 or Table 2. A manually-operated rammer shall be equipped with a guide sleeve to control the path and height of drop. The guide sleeve shall have at least four vent holes no smaller than 9.5 mm (3/8 in.) in diameter, spaced approximately 90 degrees apart and approximately 19 mm (3/4 in.) from each end. A mechanically-operated rammer will uniformly distribute blows over the sample and will be calibrated with several soil types, and be adjusted, if necessary, to give the same moisture-density results as with the manually operated rammer. For additional information concerning calibration, see the FOP for AASHTO T 99 and T 180.

- Sample extruder – A jack, lever frame, or other device for extruding compacted specimens from the mold quickly and with little disturbance.

- Balance(s) or scale(s) of the capacity and sensitivity required for the procedure used by the agency.

  A balance or scale with a capacity of 20 kg (45 lb) and a sensitivity of 5 g (0.01 lb) for obtaining the sample, meeting the requirements of AASHTO M 231.

  A balance or scale with a capacity of 2 kg and a sensitivity of 0.1 g is used for moisture content determinations done under both procedures, meeting the requirements of AASHTO M 231.

- Drying apparatus – A thermostatically controlled drying oven, capable of maintaining a temperature of 110 ±5°C (230 ±9°F) for drying moisture content samples in accordance with the FOP for AASHTO T 255/T 265.

- Straightedge – A steel straightedge at least 250 mm (10 in.) long, with one beveled edge and at least one surface plane within 0.1 percent of its length, used for final trimming.

- Sieve(s) – 4.75 mm (No. 4) and/or 19.0 mm (3/4 in.), conforming to AASHTO M 92.

- Mixing tools – Miscellaneous tools such as a mixing pan, spoon, trowel, spatula, etc., or a suitable mechanical device, for mixing the sample with water.

- Containers with close-fitting lids to prevent gain or loss of moisture in the sample.

Table 1
Comparison of Apparatus, Sample, and Procedure – Metric

	T 99	**T 180**
Mold Volume, m^3	Methods A, C: 0.000943 ± 0.000008	Methods A, C: 0.000943 ±0.000008
	Methods B, D: 0.002124 ± 0.000021	Methods B, D: 0.002124 ± 0.000021
Mold Diameter, mm	Methods A, C: 101.6± 0.41	Methods A, C: 101.6± 0.41
	Methods B, D: 152.4± 2.54	Methods B, D: 152.4± 2.54
Mold Height, mm	116.43± 0.13	116.43± 0.13
Detachable Collar Height, mm	50.80± 0.64	50.80± 0.64
Rammer Diameter, mm	50.80	50.80
Rammer Mass, kg	2.495	4.536
Rammer Drop, mm	305	457
Layers	3	5
Blows per Layer	Methods A, C: 25	Methods A, C: 25
	Methods B, D: 56	Methods B, D: 56
Material Size, mm	Methods A, B: 4.75 minus	Methods A, B: 4.75 minus
	Methods C, D: 19.0 minus	Methods C, D: 19.0 minus
Test Sample Size, kg	Method A: 3 Method C: 5 (1)	Method B: 7 Method D: 11(1)
Energy, kN-m/m^3	592	2,693

(1) This may not be a large enough sample depending on your nominal maximum size for moisture content samples.

Table 2
Comparison of Apparatus, Sample, and Procedure – English

	T 99	T 180
Mold Volume, ft^3	Methods A, C: 1/30 (0.0333) ± 0.0003	Methods A, C: 1/30 (0.0333) ± 0.0003
	Methods B, D: 1/13.33 (0.0750) ± 0.00075	Methods B, D: 1/13.33 (0.0750) ± 0.00075
Mold Diameter, in.	Methods A, C: 4.000±0.016	Methods A, C: 4.000±0.016
	Methods B, D: 6.000± 0.100	Methods B, D: 6.000± 0.100
Mold Height, in.	4.584± 0.005	4.584± 0.005
Detachable Collar Height, in.	2± 0.025	2± 0.025
Rammer Diameter, in.	2.000± 0.025	2.000± 0.025
Rammer Mass, lb	5.5± 0.02	10± 0.02
Rammer Drop, in.	12	18
Layers	3	5
Blows per Layer	Methods A, C: 25	Methods A, C: 25
	Methods B, D: 56	Methods B, D: 56
Material Size, in.	Methods A, B: No. 4 minus	Methods A, B: No.4 minus
	Methods C, D: 3/4 minus	Methods C, D: 3/4 minus
Test Sample Size, lb	Method A: 7 Method B: 16 Method C: 12(1) Method D: 25(1)	
Energy, lb-ft/ft^3	12,375	56,250

(1) This may not be a large enough sample depending on your nominal maximum size for moisture content samples.

Molds Out of Tolerance Due to Use—A mold that fails to meet manufacturing tolerances after continued service may remain in use provided those tolerances are not exceeded by more than 50 percent; and the volume of the mold, calibrated in accordance with T 19M/T 19, is used in the calculations.

Sample

If the sample is damp, dry it until it becomes friable under a trowel. Drying may be in air or by use of a drying apparatus maintained at a temperature not exceeding 60°C (140°F). Thoroughly break up aggregations in a manner that avoids reducing the natural size of individual particles.

Obtain a representative test sample of the mass required by the agency by passing the material through the sieve required by the agency. See Table 1 or Table 2 for test sample mass and material size requirements.

Note 1: Both T 99 and T 180 have four methods (A, B, C, D) that require different masses and employ different sieves.

Note 2: If the sample is plastic (clay types), it should stand for a minimum of 12 hours after the addition of water to allow the moisture to be absorbed. In this case, several samples at different moisture contents should be prepared, put in sealed containers and tested the next day. In instances where the material is prone to degradation, i.e., granular material, a compaction sample with differing moisture contents should be prepared for each point.

Procedure

1. Determine the mass of the clean, dry mold. Include the base plate, but exclude the extension collar. Record the mass to the nearest 0.005 kg (0.01 lb).

2. Thoroughly mix the selected representative sample with sufficient water to dampen it to approximately 4 to 8 percentage points below optimum moisture content. See Note 2. For many materials this condition can be identified by forming a cast by hand.

3. Form a specimen by compacting the prepared soil in the mold (with collar attached) in approximately equal layers. For each layer, spread the loose material uniformly in the mold. Lightly tamp the fluffy material with the manual rammer or other similar device. This establishes a firm surface on which to hold the rammer sleeve. Compact each layer with uniformly distributed blows from the rammer. See Table 1 for mold size, number of layers, number of blows, and rammer specification for the various test methods. Use the method specified by the agency. If material that has not been compacted remains adjacent to the walls of the mold and extends above the compacted surface, trim it down.

   Note 3: During compaction, the mold shall rest firmly on a dense, uniform, rigid, and stable foundation or base. This base shall remain stationary during the compaction process.

4. Remove the extension collar. Avoid shearing off the sample below the top of the mold. A rule of thumb is that the material compacted in the mold should not be over 6 mm (¼ in.) above the top of the mold once the collar has been removed.

5. Trim the compacted soil even with the top of the mold with the beveled side of the straightedge.

6. Determine the mass of the mold and wet soil in kg to the nearest 0.005 kg (0.01 lb) or better.

7. Determine the wet mass of the sample by subtracting the mass in Step 1 from the mass in Step 6.

8. Calculate the wet density as indicated below under "Calculations."

9. Extrude the material from the mold. For soils and soil-aggregate mixtures, slice vertically through the center and take a representative moisture content sample from one of the cut faces, ensuring that all layers are represented. For granular materials, a vertical face will not exist. Take a representative sample. This sample must meet the sample size requirements of the test method used to determine moisture content.

   Note 4: When developing a curve for free-draining soils such as uniform sands and gravels, where seepage occurs at the bottom of the mold and base plate, taking a representative moisture content from the mixing bowl may be preferred in order to determine the amount of moisture available for compaction.

10. Determine the moisture content of the sample in accordance with the FOP for AASHTO T 255 / T 265.

11. Thoroughly break up the remaining portion of the molded specimen until it will again pass through the sieve, as judged by eye, and add to the remaining portion of the sample being tested. See Note 2.

12. Add sufficient water to increase the moisture content of the remaining soil by approximately 1 to 2 percentage points and repeat steps 3 through 11.

13. Continue determinations until there is either a decrease or no change in the wet density. There will be a minimum of three points on the dry side of the curve and two points on the wet side.

Note 5: In cases of free-draining granular material, the development of points on the wet side of optimum may not be practical.

Calculations

When the mold meets the criteria of Table 1 or Table 2 calculating unit mass can be accomplished by multiplication using a Mold Factor, by division using a Mold volume; or by division using a measured volume (determined by performing AASHTO T 19).

For molds not meeting the criteria of Table 1 or Table 2 but within 50%, a measured volume must be used.

Mold Factor

1a. Calculate the wet density, in kg/m^3 (lb/ft^3), by multiplying the wet mass from Step 7 by the appropriate factor chosen from the two below.

Methods A and C molds: 1060 (30)

Methods B and D molds: 471 (13.33)

Note 6: The moist mass is in kg (lb). The factors are the inverses of the mold volumes in m^3 (ft^3) shown in Table 1 or Table 2. If the moist mass is in grams, use 1.060 or 0.471 for factors when computing kg/m^3.

Example – Methods A or C mold:

Wet mass = 1.916 kg (4.22 lb)

(1.916)(1060) = 2031 kg/m^3 Wet Density* (4.22)(30) = 126.6 lb/ft^3 Wet Density*

Volume

1b. Calculate the wet density, in kg/m^3 (lb/ft^3), by dividing the wet mass from Step 7 by the appropriate volume from Table 1 or Table 2.

Example – Methods A or C mold:

Wet mass = 1.916 kg (4.22 lb)

$$\frac{1.1916\ kg}{0.000943\ m^3} = 2023 kg/m^3\ Wet\ Density^* \qquad \frac{4.22\ lb}{0.0333 ft^3} = 126.7 lb/ft^3\ Wet\ Density^*$$

* Differences in wet density are due to rounding in the respective calculations.

Measured Volume

1c. Calculate the wet density, in kg/m^3 (lb/ft^3), by dividing the wet mass by the measured volume of the mold (T 19).

Example – Methods A or C mold:

39

Wet mass = 1.916 kg (4.22 lb)

Measured volume of the mold = 0.000946m^3 (0.0334 ft^3)

$$\frac{1.1916\ kg}{0.000946\ m^3} = 2025 kg/m^3\ Wet\ Density^* \qquad \frac{4.22\ lb}{0.0334 ft^3} = 126.3 lb/ft^3\ Wet\ Density^*$$

2. Calculate the dry density as follows.

$$\rho_d = \left(\frac{\rho_w}{w + 100}\right) \times 100 \quad or \quad \rho_d = \frac{\rho_w}{\left(\frac{w}{100}\right) + 1}$$

Where:

ρ_d = Dry density, kg/m^3 (lb/ft^3)
ρ_w = Wet density, kg/m^3 (lb/ft^3)
w = Moisture content, as a percentage

Example:

ρ_w = 2030 kg/m^3 (126.6 lb/ft^3) and w = 14.7%

$$\rho_d = \left(\frac{2030\ kg/m^3}{14.7 + 100}\right) \times 100 = 1770\ kg/m^3 \quad \rho_d = \left(\frac{126.6\ lb/ft^3}{14.7 + 100}\right) \times 100 = 110.4\ lb/ft^3$$

or

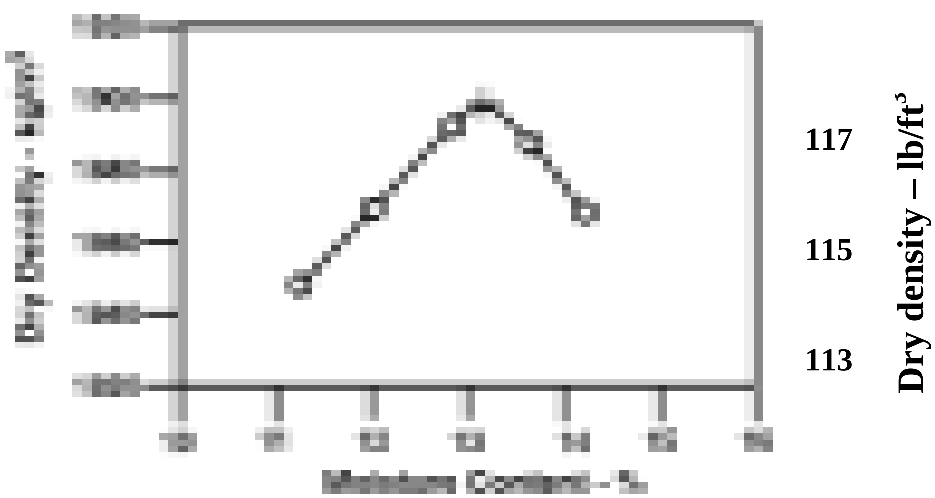
$$\rho_d = \left(\frac{2030\, kg/m^3}{\frac{14.7}{100}+1}\right) = 1770\ kg/m^3 \quad \rho_d = \left(\frac{126.6\, lb/ft^3}{\frac{14.7}{100}+1}\right) = 110.4\, lb/ft^3$$

Moisture-Density Curve Development

When dry density is plotted on the vertical axis versus moisture content on the horizontal axis and the points are connected with a smooth line, a moisture-density curve is developed. The coordinates of the peak of the curve are the maximum dry density, or just “maximum density,” and the “optimum moisture content” of the soil.

Example:
Given the following dry density and corresponding moisture content values develop a moisture-density relations curve and determine maximum dry density and optimum moisture content.

Dry Density		Moisture Content, %
kg/m^3	**lb/ft^3**	
1846	114.3	11.3
1868	115.7	12.1
1887	116.9	12.8
1884	116.7	13.6
1871	115.9	14.2



In this case, the curve has its peak at:

Maximum dry density = 1890 kg/m^3 (117.0 lb/ft^3)
Optimum water content = 13.2%

Note that both values are approximate, since they are based on sketching the curve to fit the points.

Report

- Results on forms approved by the agency
- Maximum dry density to the closest 1 kg/m^3 (0.1 lb/ft^3)
- Optimum moisture content to the closest 0.1 percent

PERFORMANCE EXAM CHECKLIST

MOISTURE-DENSITY RELATION OF SOILS FOP FOR AASHTO T 99

Participant Name _______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	**Trial 1**	**Trial 2**
1. If damp, sample dried in air or drying apparatus, not exceeding 60°C (140°F)?	_____	_____
2. Sample broken up and an adequate amount sieved over the appropriate sieve (4.75 mm / No. 4 or 19.0 mm / 3/4 in.) to determine oversize (coarse particle) percentage?	_____	_____
3. Sample passing the sieve has appropriate mass?	_____	_____
4. If soil is plastic (clay types):		
a. Multiple samples mixed with water varying moisture content by 1 to 2 percent, bracketing the optimum moisture content?	_____	_____
b. Samples placed in covered containers and allowed to stand for at least 12 hours?	_____	_____
5. Sample determined to be 4 to 8 percent below expected optimum moisture content?	_____	_____
6. Mold placed on rigid and stable foundation?	_____	_____
7. Layer of soil (approximately one third compacted depth) placed in mold with collar attached?	_____	_____
8. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
9. Material adhering to the inside of the mold trimmed?	_____	_____
10. Layer of soil (approximately two thirds compacted depth) placed in mold with collar attached?	_____	_____
11. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
12. Material adhering to the inside of the mold trimmed?	_____	_____
13. Mold filled with soil such that compacted soil will be above the mold?	_____	_____
14. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
15. Collar removed without shearing off sample?	_____	_____

OVER

Procedure Element	Trial 1	Trial 2
16. Approximately 6 mm (1/4 in.) of compacted material above the top of the mold (without the collar)?	_____	_____
17. Soil trimmed to top of mold with the beveled side of the straightedge?	_____	_____
18. Mass of mold and contents determined to appropriate precision?	_____	_____
19. Wet density calculated from the wet mass?	_____	_____
20. Soil removed from mold using a sample extruder if needed?	_____	_____
21. Soil sliced vertically through center (non-granular material)?	_____	_____
22. Moisture sample removed ensuring all layers are represented?	_____	_____
23. Moist mass determined immediately to 0.1 g?	_____	_____
24. Moisture sample mass of correct size?	_____	_____
25. Sample dried and water content determined according to T 255/T 265?	_____	_____
26. Remainder of material from mold broken up until it will pass through the sieve, as judged by eye, and added to remainder of original test sample?	_____	_____
27. Water added to increase moisture content of the remaining sample in 1 to 2 percent increments?	_____	_____
28. Steps 2 through 26 repeated for each increment of water added?	_____	_____
29. If material is degradable: Multiple samples mixed with water varying moisture content by 1 to 2 percent, bracketing the optimum moisture content?	_____	_____
30. Process continued until wet density either decreases or stabilizes?	_____	_____
31. Moisture content and dry density calculated for each sample?	_____	_____
32. Dry density plotted on vertical axis, moisture content plotted on horizontal axis, and points connected with a smooth curve?	_____	_____
33. Moisture content at peak of curve recorded as optimum water content and recorded to nearest 0.1 percent?	_____	_____
34. Dry density at optimum moisture content reported as maximum density to nearest 1 kg/m^3 (0.1 lb/ft^3)?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

____

____

____

____

Examiner Signature _________________________________WAQTC #:________________

PERFORMANCE EXAM CHECKLIST

MOISTURE-DENSITY RELATION OF SOILS
FOP FOR AASHTO T 180

Participant Name ______________________________Exam Date______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. If damp, sample dried in air or drying apparatus, not exceeding 60°C (140°F)?	_____	_____
2. Sample broken up and an adequate amount sieved over the appropriate sieve (4.75 mm / No. 4 or 19.0 mm / 3/4 in.) to determine oversize (coarse particle) percentage?	_____	_____
3. Sample passing the sieve has appropriate mass?	_____	_____
4. If soil is plastic (clay types):		
a. Multiple samples mixed with water varying moisture content by 1 to 2 percent, bracketing the optimum moisture content?	_____	_____
b. Samples placed in covered containers and allowed to stand for at least 12 hours?	_____	_____
5. Sample determined to be 4 to 8 percent below expected optimum moisture content?	_____	_____
6. Mold placed on rigid and stable foundation?	_____	_____
7. Layer of soil (approximately one fifth compacted depth) placed in mold with collar attached?	_____	_____
8. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
9. Material adhering to the inside of the mold trimmed?	_____	_____
10. Layer of soil (approximately two fifths compacted depth) placed in mold with collar attached?	_____	_____
10. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
11. Material adhering to the inside of the mold trimmed?	_____	_____
12. Layer of soil (approximately three fifths compacted depth) placed in mold with collar attached?	_____	_____
13. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
14. Material adhering to the inside of the mold trimmed?	_____	_____

OVER

Procedure Element	Trial 1	Trial 2
15. Layer of soil (approximately four fifths compacted depth) placed in mold with collar attached?	_____	_____
16. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
17. Material adhering to the inside of the mold trimmed?	_____	_____
18. Mold filled with soil such that compacted soil will be above the mold?	_____	_____
19. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
20. Collar removed without shearing off sample?	_____	_____
21. Approximately 6 mm (1/4 in.) of compacted material above the top of the mold (without the collar)?	_____	_____
22. Soil trimmed to top of mold with the beveled side of the straightedge?	_____	_____
23. Mass of mold and contents determined to appropriate precision?	_____	_____
24. Wet density calculated from the wet mass?	_____	_____
25. Soil removed from mold using a sample extruder if needed?	_____	_____
26. Soil sliced vertically through center (non-granular material)?	_____	_____
27. Moisture sample removed ensuring all layers are represented?	_____	_____
28. Moist mass determined immediately to 0.1 g?	_____	_____
29. Moisture sample mass of correct size?	_____	_____
30. Sample dried and water content determined according to T 255/T 265?	_____	_____
31. Remainder of material from mold broken up until it will pass through the sieve, as judged by eye, and added to remainder of original test sample?	_____	_____
32. Water added to increase moisture content of the remaining sample in 1 to 2 percent increments?	_____	_____
33. Steps 2 through 20 repeated for each increment of water added?	_____	_____
34. If soil is plastic (clay types):		
a. Samples mixed with water varying moisture content by 1 to 2 percent, bracketing the optimum moisture content?	_____	_____
b. Samples placed in covered containers and allowed to stand for at least 12 hours?	_____	_____
35. If material is degradable:		
Multiple samples mixed with water varying moisture content by 1 to 2 percent, bracketing the optimum moisture content?	_____	_____

OVER

Procedure Element	**Trial 1**	**Trial 2**
36. Process continued until wet density either decreases or stabilizes?	_____	_____
37. Moisture content and dry density calculated for each sample?	_____	_____
38. Dry density plotted on vertical axis, moisture content plotted on horizontal axis, and points connected with a smooth curve?	_____	_____
39. Moisture content at peak of curve recorded as optimum water content and recorded to nearest 0.1 percent?	_____	_____
40. Dry density at optimum moisture content reported as maximum density to nearest 1 kg/m^3 (0.1 lb/ft^3)?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

____
____
____
____
____
____
____
____

Examiner Signature _______________________________WAQTC #:_______________

FAMILY OF CURVES – ONE-POINT METHOD
FOP FOR AASHTO T 272

Scope

This procedure provides for a rapid determination of the maximum density and optimum moisture content of a soil sample, utilizing a family of curves and a one-point determination in accordance with AASHTO T 272-10. This procedure is related to the FOP for AASHTO T 99/T 180.

One-point determinations are made by compacting the soil in a mold of a given size with a specified rammer dropped from a specified height. Four alternate methods – A, B, C, and D – are used and correspond to the methods described in the FOP for AASHTO T 99/T 180. The method used in AASHTO T 272 must match the method used in the FOP for AASHTO T 99/T 180.

Apparatus

See the FOP for AASHTO T 99/T 180.

Sample

Sample size determined according to the FOP for AASHTO T 310. In cases where the existing family cannot be used a completely new curve will need to be developed and the sample size will be determined by the FOP for AASHTO T 99/T 180.

Procedure

See the FOP for AASHTO T 99/T 180.

Calculations

See the FOP for AASHTO T 99/T 180.

Maximum Dry Density and Optimum Moisture Content Determination

1. If the moisture-density one-point falls on one of the curves in the existing family of curves, the maximum dry density and optimum moisture content defined by that curve shall be used.

2. If the moisture-density one-point falls within the family of curves but not on an existing curve, a new curve shall be drawn through the plotted single point, parallel and in character with the nearest existing curve in the family of curves. The maximum dry density and optimum moisture content as defined by the new curve shall be used.

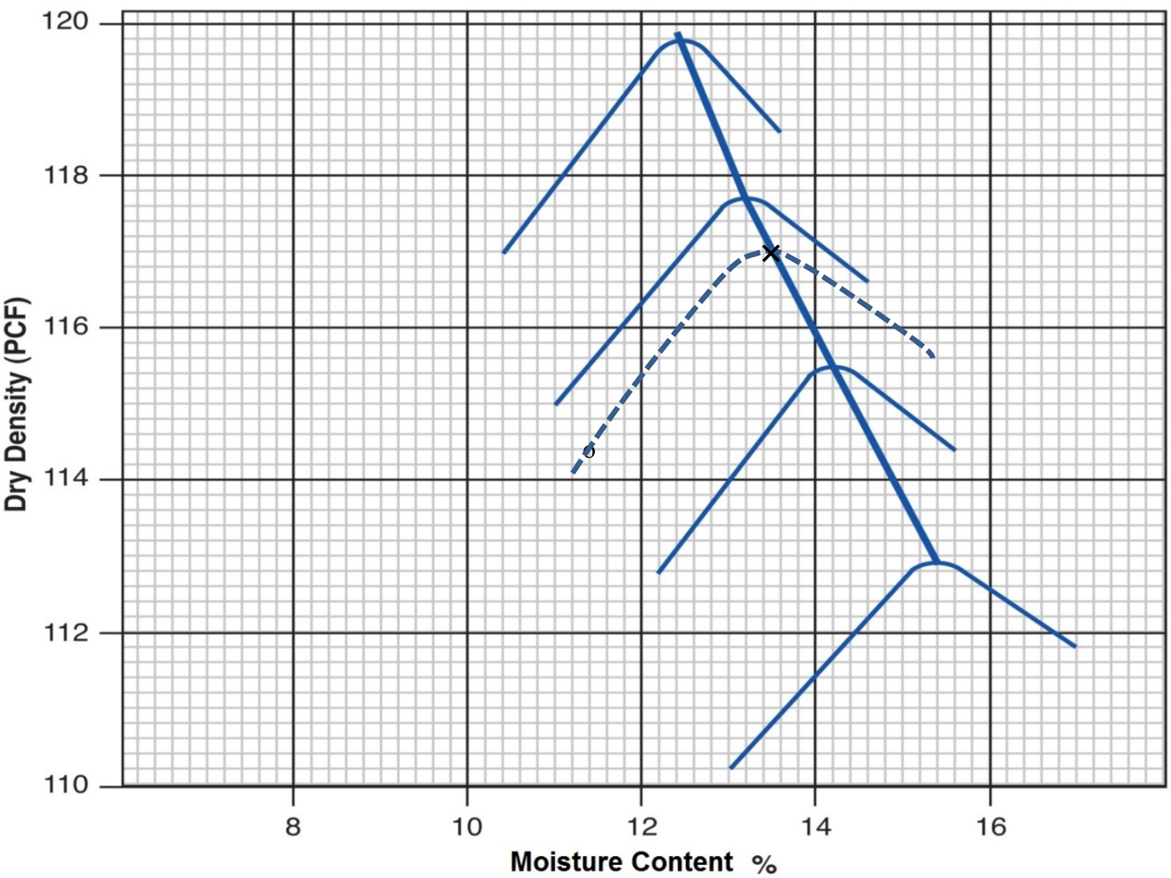
3. The one-point must fall either between or on the highest or lowest curves in the family. If it does not, then a full curve must be developed.

4. If the one-point plotted within or on the family of curves does not fall in the 80 to 100 percent of optimum moisture content, compact another specimen, using the same material, at an adjusted moisture content that will place the one point within this range.

5. If the family of curves is such that the new curve through a one-point is not well defined or is in any way questionable, a full moisture-density relationship shall be made for the soil to correctly define the new curve and verify the applicability of the family of curves.

Note 1: New curves drawn through plotted single point determinations shall not become a permanent part of the family of curves until verified by a full moisture-density procedure following the FOP for AASHTO T 99/T 180.

EXAMPLE



Example

A moisture-density procedure (FOP for AASHTO T 99/T 180) was performed. A dry density of 114.4 lb/ft^3 and a corresponding moisture content of 11.4 percent were determined. This point was plotted on the appropriate family between two previously developed curves.

The "dashed" curve beginning at the moisture-density one-point was sketched between the two existing curves. A maximum dry density of 117.0 lb/ft^3 and a corresponding optimum moisture content of 13.5 percent were estimated.

Report

- Results on forms approved by the agency
- Maximum dry density to the closest 1 kg/m^3 (0.1 lb/ft^3)
- Optimum moisture content to the closest 0.1 percent

PERFORMANCE EXAM CHECKLIST

FAMILY OF CURVES - ONE-POINT METHOD
FOP FOR AASHTO T 272 (T 99)

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. One-point determination of dry density and corresponding moisture content made in accordance with the FOP for AASHTO T 99?	_____	_____
a. Correct size (4.75 mm / No. 4 or 19.0 mm / 3/4 in.) material used?	_____	_____
2. If damp, sample dried in air or drying apparatus, not exceeding 60°C (140°F)?	_____	_____
3. Sample broken up and an adequate amount sieved over the appropriate sieve (4.75 mm / No. 4 or 19.0 mm / 3/4 in.) to determine oversize (coarse particle) percentage?	_____	_____
5. Sample passing the sieve has appropriate mass?	_____	_____
6. Layer of soil (approximately one third compacted depth) placed in mold with collar attached?	_____	_____
7. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
8. Material adhering to the inside of the mold trimmed?	_____	_____
9. Layer of soil (approximately two thirds compacted depth) placed in mold with collar attached?	_____	_____
10. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
11. Material adhering to the inside of the mold trimmed?	_____	_____
12. Mold filled with soil such that compacted soil will be above the mold?	_____	_____
13. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
14. Collar removed without shearing off sample?	_____	_____
15. Approximately 6 mm (1/4 in.) of compacted material above the top of the mold (without the collar)?	_____	_____
16. Soil trimmed to top of mold with the beveled side of the straightedge?	_____	_____
17. Mass of mold and contents determined to appropriate precision?	_____	_____
18. Wet density calculated from the wet mass?	_____	_____
19. Soil removed from mold using a sample extruder if needed?	_____	_____
20. Soil sliced vertically through center (non-granular material)?	_____	_____
21. Moisture sample removed ensuring all layers are represented?	_____	_____

OVER

Procedure Element	**Trial 1**	**Trial 2**
22. Moist mass determined immediately to 0.1 g?	_____	_____
23. Moisture sample mass of correct size?	_____	_____
24. Sample dried and water content determined according to T 255/T 265?	_____	_____
25. One-point plotted on family of curves supplied?	_____	_____
26. One-point falls within 80 to 100 percent of optimum moisture content in order to be valid?	_____	_____
27. If one-point does not fall within 80 to 100 percent of optimum moisture content, another one-point determination with an adjusted water content is made?	_____	_____
28. Maximum dry density and corresponding optimum moisture content correctly estimated?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

____
____
____
____
____
____
____
____
____
____
____

Examiner Signature _________________________________WAQTC #:________________

PERFORMANCE EXAM CHECKLIST

FAMILY OF CURVES - ONE-POINT METHOD
FOP FOR AASHTO T 272 (T 180)

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. One-point determination of dry density and corresponding moisture content made in accordance with the FOP for AASHTO T 180?	_____	_____
a. Correct size (4.75 mm / No. 4 or 19.0 mm / 3/4 in.) material used?	_____	_____
2. If damp, sample dried in air or drying apparatus, not exceeding 60°C (140°F)?	_____	_____
3. Sample broken up and an adequate amount sieved over the appropriate sieve (4.75 mm / No. 4 or 19.0 mm / 3/4 in.) to determine oversize (coarse particle) percentage?	_____	_____
4. Sample passing the sieve has appropriate mass?	_____	_____
5. Mold placed on rigid and stable foundation?	_____	_____
6. Layer of soil (approximately one fifth compacted depth) placed in mold with collar attached?	_____	_____
7. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
8. Material adhering to the inside of the mold trimmed?	_____	_____
9. Layer of soil (approximately two fifths compacted depth) placed in mold with collar attached?	_____	_____
10. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
12. Material adhering to the inside of the mold trimmed?	_____	_____
13. Layer of soil (approximately three fifths compacted depth) placed in mold with collar attached?	_____	_____
14. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
15. Material adhering to the inside of the mold trimmed?	_____	_____
16. Layer of soil (approximately four fifths compacted depth) placed in mold with collar attached?	_____	_____
17. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
18. Material adhering to the inside of the mold trimmed?	_____	_____

OVER

Procedure Element	Trial 1	Trial 2
19. Mold filled with soil such that compacted soil will be above the mold?	_____	_____
20. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
21. Collar removed without shearing off sample?	_____	_____
22. Approximately 6 mm (1/4 in.) of compacted material above the top of the mold (without the collar)?	_____	_____
23. Soil trimmed to top of mold with the beveled side of the straightedge?	_____	_____
26. Mass of mold and contents determined to appropriate precision?	_____	_____
27. Wet density calculated from the wet mass?	_____	_____
28. Soil removed from mold using a sample extruder if needed?	_____	_____
29. Soil sliced vertically through center (non-granular material)?	_____	_____
30. Moisture sample removed ensuring all layers are represented?	_____	_____
31. Moist mass determined immediately to 0.1 g?	_____	_____
32. Moisture sample mass of correct size?	_____	_____
33. Sample dried and water content determined according to T 255/T 265?	_____	_____
34. One-point plotted on family of curves supplied?	_____	_____
35. One-point falls within 80 to 100 percent of optimum moisture content in order to be valid?	_____	_____
36. If one-point does not fall within 80 to 100 percent of optimum moisture content, another one-point determination with an adjusted water content is made?	_____	_____
37. Maximum dry density and corresponding optimum moisture content correctly estimated?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

Examiner Signature _________________________________WAQTC #:______________

SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATE FOP FOR AASHTO T 85

Scope

This procedure covers the determination of specific gravity and absorption of coarse aggregate in accordance with AASHTO T 85-13. Specific gravity may be expressed as bulk specific gravity (G_{sb}), bulk specific gravity, saturated surface dry (G_{sb} SSD), or apparent specific gravity (G_{sa}). G_{sb} and absorption are based on aggregate after soaking in water. This procedure is not intended to be used with lightweight aggregates.

Terminology

Absorption – the increase in the mass of aggregate due to water being absorbed into the pores of the material, but not including water adhering to the outside surface of the particles, expressed as a percentage of the dry mass. The aggregate is considered "dry" when it has been maintained at a temperature of 110 ±5°C (230 ±9°F) for sufficient time to remove all uncombined water.

Saturated Surface Dry (SSD) – condition of an aggregate particle when the permeable voids are filled with water, but no water is present on exposed surfaces.

Specific Gravity – the ratio of the mass, in air, of a volume of a material to the mass of the same volume of gas-free distilled water at a stated temperature.

Apparent Specific Gravity (G_{sa})– the ratio of the mass, in air, of a volume of the impermeable portion of aggregate to the mass of an equal volume of gas-free distilled water at a stated temperature.

Bulk Specific Gravity (G_{sb})– the ratio of the mass, in air, of a volume of aggregate (including the permeable and impermeable voids in the particles, but not including the voids between particles) to the mass of an equal volume of gas-free distilled water at a stated temperature.

Bulk Specific Gravity (SSD) (G_{sb} SSD) – the ratio of the mass, in air, of a volume of aggregate, including the mass of water within the voids filled to the extent achieved by submerging in water for 15 to 19 hours (but not including the voids between particles), to the mass of an equal volume of gas-free distilled water at a stated temperature.

Apparatus

- Balance or scale: with a capacity of 5 kg, sensitive to 1 g. Meeting the requirements of AASHTO M 231.

- Sample container: a wire basket of 3.35 mm (No. 6) or smaller mesh, with a capacity of 4 to 7 L (1 to 2 gal) to contain aggregate with a nominal maximum size of 37.5 mm (1 1/2 in.) or smaller; or a larger basket for larger aggregates, or both.
- Water tank: watertight and large enough to completely immerse aggregate and basket, equipped with an overflow valve to keep water level constant.
- Suspension apparatus: wire used to suspend apparatus shall be of the smallest practical diameter.
- Sieves 4.75 mm (No. 4) or other sizes as needed, conforming to AASHTO M 92.
- Large absorbent towel

Sample Preparation

1. Obtain the sample in accordance with the FOP for AASHTO T 2 (see Note 1).
2. Mix the sample thoroughly and reduce it to the approximate sample size required by Table 1 in accordance with the FOP for AASHTO T 248.
3. Reject all material passing the appropriate sieve by dry sieving.
4. Thoroughly wash sample to remove dust or other coatings from the surface and re-screen the washed dry sample over the appropriate sieve. Reject all material passing that sieve.
5. The sample shall meet or exceed the minimum mass given in Table 1.

Note 1: If this procedure is used only to determine the Bulk G_{sb} of oversized material for the FOP for AASHTO T 99 / T 180 and in the calculations for the FOP for AASHTO T 224, the material can be rejected over the appropriate sieve. For T 99 / T 180 Methods A and B, use the 4.75 mm (No. 4) sieve; T 99 / T 180 Methods C and D use the 19 mm (3/4 in).

Table 1

Nominal Maximum Size* mm (in.)	Minimum Mass of Test Sample, g (lb)
12.5 (1/2) or less	2000 (4.4)
19.0 (3/4)	3000 (6.6)
25.0 (1)	4000 (8.8)
37.5 (1 1/2)	5000 (11)
50 (2)	8000 (18)
63 (2 1/2)	12,000 (26)
75 (3)	18,000 (40)

* One sieve larger than the first sieve to retain more than 10 percent of the material using an agency specified set of sieves based on cumulative percent retained. Where large gaps in specification sieves exist, intermediate sieve(s) may be inserted to determine nominal maximum size.

Procedure

1. Dry the test sample to constant mass at a temperature of 110 ±5°C (230 ±9°F) and cool in air at room temperature for 1 to 3 hours.

   Note 2: Where the absorption and specific gravity values are to be used in proportioning concrete mixtures in which the aggregates will be in their naturally moist condition, the requirement for initial drying to constant mass may be eliminated, and, if the surfaces of the particles in the sample have been kept continuously wet until test, the 15-to-19 hour soaking may also be eliminated.

2. Immerse the aggregate in water at room temperature for a period of 15 to 19 hours.

   Note 3: When testing coarse aggregate of large nominal maximum size requiring large test samples, it may be more convenient to perform the test on two or more subsamples, and then combine the values obtained.

3. Place the empty basket into the water bath and attach to the balance. Inspect the immersion tank to ensure the water level is at the overflow outlet height. Tare the balance with the empty basket attached in the water bath.

4. Remove the test sample from the water and roll it in a large absorbent cloth until all visible films of water are removed. Wipe the larger particles individually. If the test sample dries past the SSD condition, immerse in water for 30 min, and then resume the process of surface-drying.

   Note 4: A moving stream of air may be used to assist in the drying operation, but take care to avoid evaporation of water from aggregate pores.

5. Determine the SSD mass of the sample, and record this and all subsequent masses to the nearest 0.1 g or 0.1 percent of the sample mass, whichever is greater. Designate this mass as “B”.

6. Re-inspect the immersion tank to insure the water level is at the overflow outlet height. Immediately place the SSD test sample in the sample container and weigh it in water maintained at 23.0 ±1.7°C (73.4 ±3°F). Shake the container to release entrapped air before recording the weight. Designate this submerged weight as “C”.

   Note 5: The container should be immersed to a depth sufficient to cover it and the test sample during mass determination. Wire suspending the container should be of the smallest practical size to minimize any possible effects of a variable immersed length.

7. Remove the sample from the basket. Ensure all material has been removed. Place in a container of known mass.

8. Dry the test sample to constant mass in accordance with the FOP for AASHTO T 255 / T 265 (Aggregate section) and cool in air at room temperature for 1 to 3 hours. Designate this mass as “A”.

Calculations

Perform calculations and determine values using the appropriate formula below. In these formulas, A = oven dry mass, B = SSD mass, and C = weight in water.

Bulk specific gravity (G_{sb})

$$G_{sb} = \frac{A}{B - C}$$

Bulk specific gravity, SSD (G_{sb} SSD)

$$G_{sb}SSD = \frac{B}{B - C}$$

Apparent specific gravity (G_{sa})

$$G_{sa} = \frac{A}{A - C}$$

Absorption

$$\text{Absorption} = \frac{B - A}{A} \times 100$$

Sample Calculations

Sample	A	B	C	B - C	A - C	B - A
1	2030.9	2044.9	1304.3	740.6	726.6	14.0
2	1820.0	1832.5	1168.1	664.4	651.9	12.5
3	2035.2	2049.4	1303.9	745.5	731.3	14.2

Sample	G_{sb}	G_{sb} SSD	G_{sa}	Absorption
1	2.742	2.761	2.795	0.7
2	2.739	2.758	2.792	0.7
3	2.730	2.749	2.783	0.7

These calculations demonstrate the relationship between G_{sb}, G_{sb} SSD, and G_{sa}. G_{sb} is always lowest, since the volume includes voids permeable to water. G_{sb} SSD is always intermediate. G_{sa} is always highest, since the volume does not include voids permeable to water. When running this test, check to make sure the values calculated make sense in relation to one another.

Report

- Results on forms approved by the agency
- Specific gravity values to 3 decimal places
- Absorption to 0.1 percent

.

PERFORMANCE EXAM CHECKLIST

SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATE FOP FOR AASHTO T 85

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Sample obtained by FOP for AASHTO T 2 and reduced by FOP for AASHTO T 248 or from FOP for AASHTO T 99 / T 180?	_____	_____
2. Screened on the appropriate size sieve?	_____	_____
3. Sample mass appropriate?	_____	_____
4. Particle surfaces clean?	_____	_____
5. Dried to constant mass 110 ±5°C (230 ±9°F) and cooled to room temperature?	_____	_____
6. Covered with water for 15 to 19 hours?	_____	_____
7. Basket placed into immersion tank and attached to balance?	_____	_____
8. Immersion tank inspected for proper water height?	_____	_____
9. Balance tared with basket in tank and temperature checked 23.0 ±1.7°C (73.4 ±3°F)?	_____	_____
10. Sample removed from water and rolled in cloth to remove visible films of water?	_____	_____
11. Larger particles wiped individually?	_____	_____
12. Evaporation avoided?	_____	_____
13. Sample mass determined to 0.1 g?	_____	_____
14. Sample immediately placed in basket, in immersion tank?	_____	_____
15. Entrapped air removed before weighing by shaking basket while immersed?	_____	_____
16. Immersed sample weight determined to 0.1 g?	_____	_____
17. All the sample removed from basket?	_____	_____
18. Sample dried to constant mass and cooled to room temperature?	_____	_____

OVER

Procedure Element	**Trial 1**	**Trial 2**
19. Sample mass determined to 0.1 g?	______	______
20. Proper formulas used in calculations?	______	______

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

____

____

____

____

____

____

Examiner Signature _______________________________WAQTC #:_______________

CORRECTION FOR COARSE PARTICLES IN THE SOIL COMPACTION TEST FOP FOR AASHTO T 224

Scope

This procedure covers the adjustment of the maximum dry density determined by FOP for AASHTO T 99 / T 180 to compensate for coarse particles retained on the 4.75 mm (No. 4) or 19.0 mm (3/4 in.) sieve. For Methods A and B of the FOP for AASHTO T 99 / T 180 the adjustment is based on the percent, by mass, of material retained on the 4.75 mm (No. 4) sieve and the bulk specific gravity (G_{sb}) of the material retained on the 4.75 mm (No. 4) sieve. A maximum of 40 percent of the material can be retained on the 4.75 mm (No. 4) sieve for this method to be used. For Methods C and D of the FOP for AASHTO T 99 / T 180, the adjustment is based on the percent, by mass, of material retained on the 19.0 mm (3/4 in.) sieve and the bulk specific gravity (G_{sb}) of the material retained on the 19.0 mm (3/4 in.) sieve. A maximum of 30 percent of the material can be retained on the 19.0 mm (3/4 in.) sieve for this method to be used. Whether the split is on the 4.75 mm (No. 4) or the 19.0 mm (3/4 in.) sieve, all material retained on that sieve is defined as oversized material.

This method applies to soils with percentages up to the maximums listed above for oversize particles. A correction may not be practical for soils with only a small percentage of oversize material. The agency shall specify a minimum percentage below which the method is not needed. If not specified, this method applies when more than 5 percent by weight of oversize particles is present.

This procedure covers the lab-to-field corrections in accordance with AASHTO T 224-10 (see AASHTO T 224 for field-to-lab corrections).

Adjustment Equation Moisture

Along with density, the moisture content can be corrected. The moisture content can be determined by the FOP for AASHTO T 255 / T 265, other agency approved methods, or the nuclear density gauge moisture content reading from the FOP for AASHTO T 310. If the nuclear gauge moisture reading is used, or when the moisture content is determined on the entire sample (both fine and oversized particles), the use of the adjustment equation is not needed. Combined moisture contents with material having an appreciable amount of silt or clay should be performed using FOP for AASHTO T 255 / T 265 (Soil). Moisture contents used from FOP for AASHTO T 310 must meet the criteria for that method.

When samples are split for moisture content (oversized and fine materials) the following adjustment equations must be followed:

1. Split the sample into oversized material and fine material.

2. Dry the oversized material following the FOP for AASHTO T 255 / T 265 (Aggregate). If the fine material is sandy in nature, dry using the FOP for AASHTO T 255 / T 265 (Aggregate), or other agency approved methods. If the fine material has any appreciable

amount of clay, dry using the FOP for AASHTO T 255 / T 265 (Soil) or other agency approved methods.

3. Calculate the dry mass of the oversize and fine material as follows:

$$M_D = \frac{M_m}{1 + \mathrm{MC}}$$

Where:

M_D = mass of dry material (fine or oversize particles).
M_m = mass of moist material (fine or oversize particles).
MC = moisture content of respective fine or oversized, expressed as a decimal.

4. Calculate the percentage of the fine and oversized particles by dry weight of the total sample as follows: See Note 2.

$$P_f = \frac{100 M_{DF}}{M_{DF} + M_{DC}} \qquad \frac{100 \times 15.4\ lbs}{15.4\ lbs + 5.7\ lbs} = 73\% \qquad \frac{100 \times 7.034\ kg}{7.03\ kg + 2.602\ kg} = 73\%$$

And

$$P_c = \frac{100 M_{DC}}{M_{DF} + M_{DC}} \qquad \frac{100 \times 5.7\ lbs}{15.4\ lbs + 5.7\ lbs} = 27\% \qquad \frac{100 \times 2.602\ kg}{7.03\ kg + 2.602\ kg} = 27\%$$

Or for $\mathbf{P_c}$:

$$P_c = 100 - P_f$$

Where:

P_f = percent of fine particles, of sieve used, by weight.
P_c = percent of oversize particles, of sieve used, by weight.
M_{DF} = mass of fine particles.
M_{DC} = mass of oversize particles.

5. Calculate the corrected moisture content as follows:

$$MC_T = \frac{(MC_F \times P_f) + (MC_c \times P_c)}{100} \qquad \frac{(10.6\% \times 73.0\%) + (2.1\% \times 27.0\%)}{100} = 8.3\%$$

MC_T = corrected moisture content of combined fines and oversized particles, expressed as a % moisture.
MC_F = moisture content of fine particles, as a % moisture.
MC_C = moisture content of oversized particles, as a % moisture.

Note 1: Moisture content of oversize material can be assumed to be two (2) percent for most construction applications.

Note 2: In some field applications agencies will allow the percentages of oversize and fine materials to be determined with the materials in the wet state.

Adjustment Equation Density

6. Calculate the corrected dry density of the total sample (combined fine and oversized particles) as follows:

$$D_d = \frac{100 \times D_f \times k}{(D_f \times P_c) + (k \times P_f)} \qquad or \qquad D_d = \frac{100}{\frac{P_f}{D_f} + \frac{P_c}{k}}$$

Where:

D_d = corrected total dry density (combined fine and oversized particles) kg/m^3 (lb/ft^3)

D_f = dry density of the fine particles kg/m^3 (lb/ft^3), determined in the lab

P_c = percent of oversize particles, of sieve used, by weight.

P_f = percent of fine particles, of sieve used, by weight.

k = Metric: 1,000 * Bulk Specific Gravity (G_{sb}) (oven dry basis) of coarse particles (kg/m^3).

k = English: 62.4 * Bulk Specific Gravity (G_{sb}) (oven dry basis) of coarse particles (lb/ft^3)

Note 3: If the specific gravity is known, then this value will be used in the calculation. For most construction activities the specific gravity for aggregate may be assumed to be 2.600.

Calculation

Sample Calculations:

- Metric:

Maximum laboratory dry density (D_f): 2329 kg/m^3

Percent coarse particles (P_c): 27%

Percent fine particles (P_f): 73%

Mass per volume coarse particles (k): (2.697) (1000) = 2697 kg/m^3

$$D_d = \frac{100 \times D_f \times k}{\left(D_f \times P_c\right) + \left(k \times P_f\right)} \qquad or \qquad D_d = \frac{100}{\frac{P_f}{D_f} + \frac{P_c}{k}}$$

$$D_d = \frac{100 \times 2329\,kg/m^3 \times 2697\,kg/m^3}{(2329\,kg/m^3 \times 27\%) + (2697\,kg/m^3 \times 73\%)}$$

$$or\;\; D_d = \frac{100}{\frac{73\%}{2329\,kg/m^3} + \frac{27\%}{2697\,kg/m^3}}$$

$$D_d = \frac{628{,}131{,}300\,kg/m^3}{(628{,}883\,kg/m^3 +\; 2697\,kg/m^3)} \quad or\;\; D_d = \frac{100}{0.03134\,kg/m^3 + 0.01001\,kg/m^3}$$

$$D_d = 2418.1\,kg/m^3\; report\;\; 2418\,kg/m^3$$

$$or\;\; D_d = 2418.1\,kg/m^3\;\; report\;\; 2418\,kg/m^3$$

English:

Maximum laboratory dry density (D_f): 140.4 lb/ft^3

Percent coarse particles (P_c): 27%

Percent fine particles (P_f): 73%

Mass per volume of coarse particles (k): (2.697) (62.4) = 168.3 lb/ft^3

$$D_d = \frac{100 \times D_f \times k}{(D_f \times P_c) + (k \times P_f)} \qquad or \qquad D_d = \frac{100}{\frac{P_f}{D_f} + \frac{P_c}{k}}$$

$$D_d = \frac{100 \times 140.4\, lb/ft^3 \times 168.3\, lb/ft^3}{(140.4\, lb/ft^3 \times 27\%) + (168.3\, lb/ft^3 \times 73\%)}$$

$$or\ D_d = \frac{100}{\frac{73\%}{140.4\, lb/ft^3} + \frac{27\%}{168.3\, lb/ft^3}}$$

$$D_d = \frac{2{,}362{,}932\, lb/ft^3}{(3790.8\, lb/ft^3 + 12285.9\, lb/ft^3)} \quad or\ D_d = \frac{100}{0.51994\, lb/ft^3 + 0.16043\, lb/ft^3}$$

$$D_d = \frac{2{,}362{,}932\, lb/ft^3}{16{,}076.7\, lb/ft^3} \quad or\ D_d = \frac{100}{0.68037\, lb/ft^3}$$

$$D_d = 146.98\, lb/ft^3 \quad report\ 147.0\, lb/ft^3$$

Report

- Results on forms approved by the agency
- Adjusted maximum dry density to the closest 1 kg/m^3 (0.1 lb/ft^3)
- Adjusted optimum moisture to the 0.1 percent

USE OF AKDOT & PF ATM 212, ITD T 74, WSDOT TM 606, OR WFLHD HUMPHRYS CURVES

Background

Coarse-grained granular soils are free-draining and have little or no cohesion. These soils are, therefore, not particularly well suited for the moisture-density relations procedures of AASHTO T 99 or AASHTO T 180. Transportation agencies have developed specialized test methods that are hybrids of those moisture-density procedures and methods that employ compaction under load with vibration. Those methods include:

- AKDOT & PF's ATM 212
- ITD's T 74
- WSDOT's TM 606
- WFLHD's Humphrys

Description of Procedure

In these tests, material is compacted in a mold and in a manner similar to those used in a Proctor test, after which the material is further compacted through a combination of applied loads and vibration. A laboratory maximum dry density is determined, as is the percent of material passing a certain sieve such as the 4.75 mm (No. 4). A number of determinations are made for different percentages passing the specified sieve. A graph is developed in which dry density is plotted versus the percentage of material passing that sieve. These tests are conducted in the agency's central lab, and the curve developed is a central lab function. Figure 1 is an example of such a curve.

Construction specifications will call out a percent of maximum dry density required for the granular materials used on the job. These specified values will be based on ATM 212, T 74, TM 606, or Humphrys, depending on the agency.

In the field, the dry density of the granular material will be determined in accordance with the FOP for AASHTO 310. The percent of material passing the specified sieve will be determined for a sample obtained at the site of the density test. The dry density and percent passing values will then be compared with the curve developed in the lab for that particular granular material to determine conformance with the project specifications.

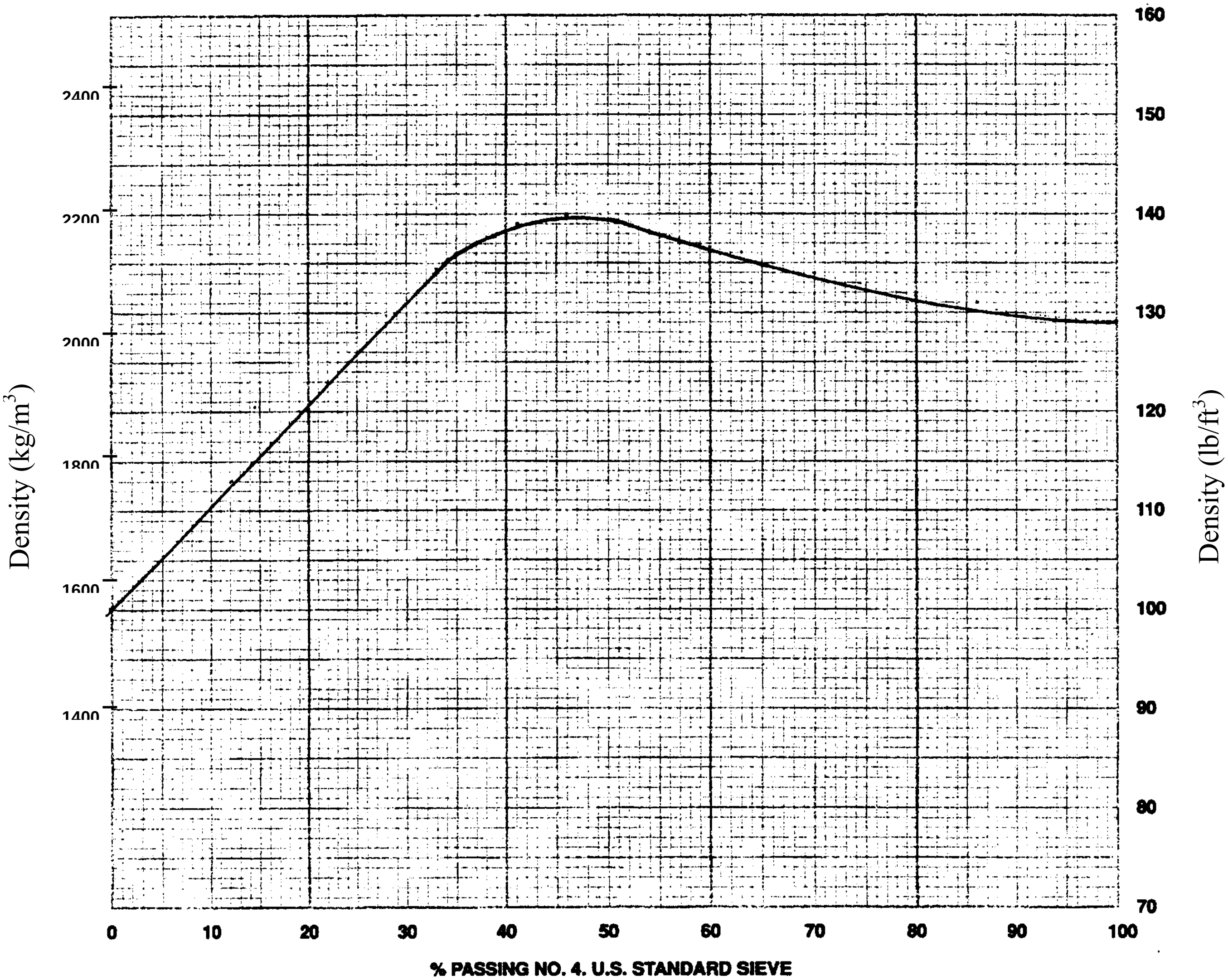


Figure 1. Maximum Density Curve Graph

Example:

A compaction test was taken and a sample was removed from the test site per the FOP for AASHTO T 310. The sample was graded over a 4.75 mm (No. 4) sieve. The following results were reported.

Dry density from T 310 = 2141 kg/m^3 (metric) 137.0 lb/ft^3 (English)

Percent passing 4.75 mm (No.4) sieve = 49%

Maximum density = 2173 kg/m^3 (metric) 139.0 lb/ft^3 (English)

Percent compaction = 99%

IN-PLACE DENSITY
FIELD OPERATING PROCEDURES - SHORT FORM

IN-PLACE DENSITY OF BITUMINOUS MIXES USING THE NUCLEAR MOISTURE-DENSITY GAUGE
FOP FOR WAQTC TM 8

Scope

This test method describes a test procedure for determining the density of bituminous mixes by means of a nuclear gauge employing either direct transmission or backscatter methods. Correlation with densities determined under the FOP for AASHTO T 166 is required by some agencies.

Apparatus

- Nuclear density gauge with the factory-matched standard reference block.
- Drive pin, guide/scraper plate, and hammer for testing in direct transmission mode.
- Transport case for properly shipping and housing the gauge and tools.
- Instruction manual for the specific make and model of gauge.
- Radioactive materials information and calibration packet containing:
  - Daily standard count log
  - Factory and laboratory calibration data sheet
  - Leak test certificate
  - Shippers' declaration for dangerous goods
  - Procedure memo for storing, transporting and handling nuclear testing equipment
  - Other radioactive materials documentation as required by local regulatory requirements

Material

- Filler material: Fine-graded sand from the source used to produce the asphalt pavement or other agency approved materials.

Radiation Safety

This method does not purport to address all of the safety problems associated with its use. This test method involves potentially hazardous materials. The gauge utilizes radioactive materials that may be hazardous to the health of the user unless proper precautions are taken.

Users of this gauge must become familiar with the applicable safety procedures and governmental regulations. All operators will be trained in radiation safety prior to operating nuclear density gauges. Some agencies require the use of personal monitoring devices such as a thermoluminescent dosimeter or film badge. Effective instructions, together with routine safety procedures such as source leak tests, recording and evaluation of personal monitoring device data, etc., are a recommended part of the operation and storage of this gauge.

Calibration

Calibrate the nuclear gauge as required by the agency. This calibration may be performed by the agency using the manufacturer's recommended procedures or by other facilities approved by the agency. Verify or re-establish calibration curves, tables, or equivalent coefficients every 12 months.

Standardization

1. Turn the gauge on and allow it to stabilize (approximately 10 to 20 minutes) prior to standardization. Leave the power on during the day's testing.

2. Standardize the nuclear gauge at the construction site at the start of each day's work and as often as deemed necessary by the operator or agency. Daily variations in standard count shall not exceed the daily variations established by the manufacturer of the gauge. If the daily variations are exceeded after repeating the standardization procedure, the gauge should be repaired, recalibrated, or both.

3. Record the standard count for both density and moisture in the daily standard count log. The exact procedure for standard count is listed in the manufacturer's Operator's Manual.

Note 1: New standard counts may be necessary more than once a day. See agency requirements.

Test Site Location

1. Select a test location(s) randomly and in accordance with agency requirements. Test sites should be relatively smooth and flat and meet the following conditions:

    a. At least 10 m (30 ft) away from other sources of radioactivity.

    b. At least 3 m (10 ft) away from large objects.

    c. If the gauge will be closer than 600 mm (24 in.) to any vertical mass, or less than 300 mm (12 in.) from a vertical pavement edge, use the gauge manufacturer's correction procedure.

Overview

There are two methods for determining the in-place density of HMA. See agency requirements for method selection.

- Direct Transmission
- Backscatter

Procedure

Direct Transmission

1. Maximum contact between the base of the gauge and the surface of the material under test is critical.

2. Use the guide and scraper plate as a template and drill a hole to a depth of at least 7 mm (1/4 in.) deeper than the measurement depth required for the gauge.

3. Place the gauge on the prepared surface so the source rod can enter the hole. Insert the probe in the hole and lower the source rod to the desired test depth using the handle and trigger mechanism. Position the gauge with the long axis of the gauge parallel to the direction of paving. Pull the gauge so that the probe is firmly against the side of the hole.

4. Take one four-minute test and record the wet density (WD) reading.

Backscatter

1. Maintain maximum contact between the base of the gauge and the surface of the material under test. Use filler material to fill surface voids. Spread a small amount of filler material over the test site surface and distribute it evenly. Strike off the surface with a straightedge (such as a lathe or flat-bar steel) to remove excess material.

2. Place the gauge on the test site. Using a crayon (not spray paint), mark the outline or footprint of the gauge. Extend the probe to the backscatter position.

3. Take a one-minute test and record the wet density reading.

4. Rotate the gauge 90 degrees centered over the original footprint. Mark the outline or footprint of the gauge.

5. Take another one-minute test and record the wet density reading.

6. If the difference between the two one-minute tests is greater than 40 kg/m^3 (2.5 lb/ft^3), retest in both directions. If the difference of the retests is still greater than 40 kg/m^3 (2.5 lb/ft^3) test at 180 and 270 degrees.

7. The density reported for each test site shall be the average of the two individual one-minute wet density readings.

Calculation of Results

Percent compaction is determined by comparing the in-place wet density as determined by this method to the appropriate agency density standard. See appropriate agency policy for use of density standards.

Backscatter Example:

Reading #1: 141.5 lb/ft^3

Reading #2: 140.1 lb/ft^3 Are the two readings within the tolerance? (YES)

Reading average: 140.8 lb/ft^3

Core correction : +2.1 lb/ft^3

Corrected reading: 142.9 lb/ft^3

G_{mm} and maximum density from the FOP for AASHTO T 209: G_{mm} = 2.466 = 153.5 lb/ft^3

$$\frac{Corrected\ Reading}{Maximum\ Density} \times 100 = \%\ compaction \qquad \frac{142.9\ lb/ft^3}{153.5\ lb/ft^3} \times 100 = 93.1\%$$

Direct Transmission Example:

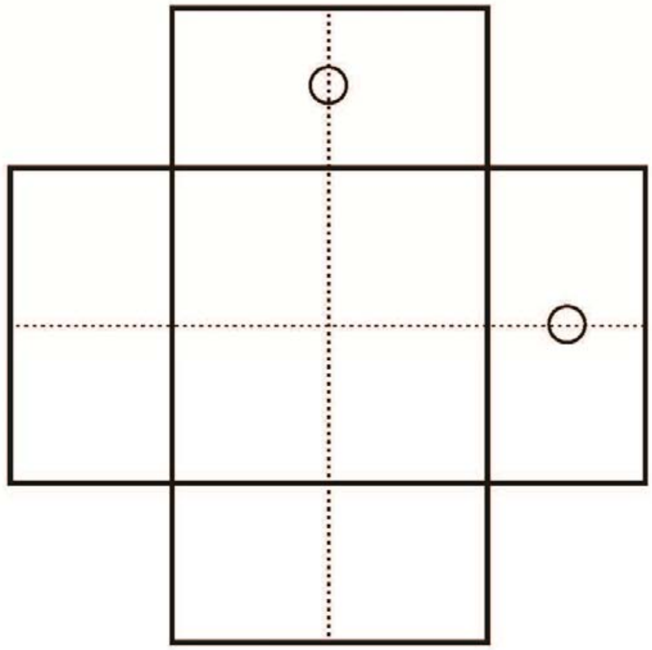
Reading: 140.8 lb/ft^3

Core correction: +2.1 lb/ft^3

Corrected reading: 142.9 lb/ft^3

G_{mm} and maximum density from the FOP for AASHTO T 209: G_{mm} = 2.466 = 153.5 lb/ft^3

$$\frac{Corrected\ Reading}{Maximum\ Density} \times 100 = \%\ compaction \qquad \frac{142.9\ lb/ft^3}{153.5\ lb/ft^3} \times 100 = 93.1\%$$



Footprint of the gauge test site

Report

- Results on forms approved by the agency
- Location of test and thickness of layer tested
- Mixture type
- Make, model and serial number of the nuclear moisture-density gauge
- Mode of measurement, depth, calculated wet density of each measurement and any adjustment data
- Standard density
- Percent compaction, percent air voids, or both
- Name and signature of operator

APPENDIX – CORRELATION WITH CORES

(Nonmandatory Information)

The Bulk Specific Gravity (G_{mb}) of the core is a physical measurement of the in-place HMA and can be compared with the nuclear density gauge readings. Comparing the core value to the corresponding gauge values, a correlation can be established.

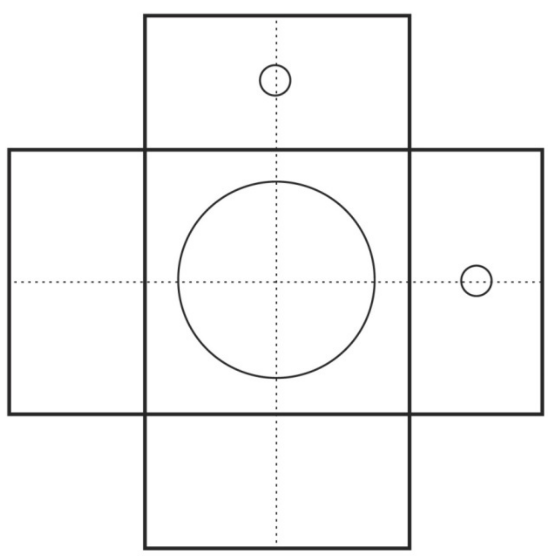
The correlation can then be used to adjust the gauge readings to the in-place density of the cores. The core correlation is gauge specific and must be determined without traffic allowed on the pavement between nuclear density gauge readings and obtaining the core. When using multiple nuclear density gauges each gauge should be correlated to the core locations prior to removal of the core.

When density correlation with the FOP for AASHTO T 166 is required, correlation of the nuclear gauge with pavement cores shall be made on the first day's paving (within 24 hours) or from a test strip constructed prior to the start of paving. Cores must be taken before traffic is allowed on the pavement.

Correlation with Cores

1. Determine the number of cores required for correlation from the agency's specifications. Cores shall be located on the first day's paving or on the test strip. Locate the test sites in accordance with the agency's specifications. Follow the "Procedure" section above to establish test sites and obtain densities using the nuclear gauge.

2. Obtain a pavement core from each of the test sites in accordance with WAQTC TM 11. The core should be taken from the center of the nuclear gauge footprint. If direct transmission was used, locate the core at least 25 mm (1 in.) away from the edge of the drive pin hole.



Footprint of the gauge test site. Core location in the center of the footprint.

3. Determine the density of the cores by the FOP for AASHTO T 166, Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface Dry Specimens.

4. Calculate a correlation factor for the nuclear gauge reading as follows:

   a. Calculate the difference between the core density and the average nuclear gauge density at each test site to the nearest 1 kg/m^3 (0.1 lb/ft^3). Calculate the average difference and standard deviation of the differences for the entire data set to the nearest 1 kg/m^3 (0.1 lb/ft^3).

   b. If the standard deviation of the differences is equal to or less than 40 kg/m^3 (2.5 lb/ft^3), the correlation factor applied to the average nuclear gauge density shall be the average difference calculated above in 4.a.

   c. If the standard deviation of the differences is greater than 40 kg/m^3 (2.5 lb/ft^3), the test site with the greatest variation from the average difference shall be eliminated from the data set and the data set properties and correlation factor recalculated following 4.a and 4.b.

   d. If the standard deviation of the modified data set still exceeds the maximum specified in 4.b, additional test sites will be eliminated from the data set and the data set properties and correlation factor recalculated following 4.a and 4.b. If the data set consists of less than five test sites, additional test sites shall be established.

Note A1: The exact method used in calculating the nuclear gauge correlation factor shall be defined by agency policy.

Note A2: The above correlation procedure must be repeated if there is a new job mix formula. Adjustments to the job mix formula beyond tolerances established in the contract documents will constitute a new job mix formula. A correlation factor established using this procedure is only valid for the particular gauge and in the mode and at the probe depth used in the correlation procedure. If another gauge is brought onto the project, it shall be correlated using the same procedure. Multiple gauges may be correlated from the same series of cores if done at the same time.

Note A3: For the purpose of this procedure, a job mix formula is defined as the percent and grade of paving asphalt used with a specified gradation of aggregate from a designated aggregate source. A new job mix formula may be required whenever compaction of the wearing surface exceeds the agency's specified maximum density or minimum air voids.

Core Correlation Example:

English

	Core results from T 166:	Average Gauge reading:	Difference:	X	X^2
1	144.9 lb/ft^3	142.1 lb/ft^3	2.8 lb/ft^3	-0.7	0.49
2	142.8 lb/ft^3	140.9 lb/ft^3	1.9 lb/ft^3	0.2	0.04
3	143.1 lb/ft^3	140.7 lb/ft^3	2.4 lb/ft^3	-0.3	0.09
4	140.7 lb/ft^3	138.9 lb/ft^3	1.8 lb/ft^3	0.3	0.09
5	145.1 lb/ft^3	143.6 lb/ft^3	1.5 lb/ft^3	0.6	0.36
6	144.2 lb/ft^3	142.4 lb/ft^3	1.8 lb/ft^3	0.3	0.09
7	143.8 lb/ft^3	141.3 lb/ft^3	2.5 lb/ft^3	-0.4	0.16
8	142.8 lb/ft^3	139.8lb/ft^3	3.0 lb/ft^3	0.9	0.81
9	144.8 lb/ft^3	143.3 lb/ft^3	1.5 lb/ft^3	-0.6	0.36
10	143.0 lb/ft^3	141.0 lb/ft^3	2.0 lb/ft^3	-0.1	0.01
		Average Difference:	+2.1 lb/ft^3		

$$\sqrt{\frac{\sum x^2}{n-1}}$$

Where:

$\sum$ = Sum
x = Difference from the average Difference
n-1 = number of data sets minus 1

Example: 10 – 1 = 9

$$\sqrt{\frac{2.5}{9}} = 0.53$$

The Sum of X^2 = 2.5 and the number of data sets = 9 for a computed standard deviation of 0.53. This is within the allowable 2.5 therefore no cores are eliminated, use the average difference from all ten cores.

PERFORMANCE EXAM CHECKLIST

IN-PLACE DENSITY OF BITUMINOUS MIXES USING THE NUCLEAR MOISTURE-DENSITY GAUGE
FOP FOR WAQTC TM 8

Participant Name ________________________________ Exam Date _______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Gauge turned on approximately 10 to 20 minutes before use?	_____	_____
2. Gauge calibrated and standard count recorded?	_____	_____
3. Test location selected appropriately [600 mm (24 in.) from vertical projections or 10 m (30 ft) from any other radioactive sources]?	_____	_____
4. Backscatter:		
a. Filler spread evenly over test site?	_____	_____
b. Excess filler material removed by striking off the surface?	_____	_____
c. Gauge placed on pavement surface and footprint of gauge marked?	_____	_____
d. Probe extended to backscatter position?	_____	_____
e. One-minute count taken; gauge rotated 90°, reseated, and another one-minute count taken?	_____	_____
f. Densities averaged?	_____	_____
g. If difference of the wet densities is greater than 40 kg/m^3 (2.5 lb/ft^3), retest conducted in both directions?	_____	_____
5. Core correlation applied if required?	_____	_____
6. Percent compaction calculated correctly?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

____

____

Examiner Signature ________________________________WAQTC #:________________

IN-PLACE DENSITY AND MOISTURE CONTENT OF SOIL AND SOIL-AGGREGATE BY NUCLEAR METHODS (SHALLOW DEPTH) FOP FOR AASHTO T 310

Scope

This procedure covers the determination of density, moisture content, and relative compaction of soil, aggregate, and soil-aggregate mixes in accordance with AASHTO T 310-13. This field operating procedure is derived from AASHTO T 310. The nuclear moisture-density gauge is used in the direct transmission mode.

Apparatus

- Nuclear density gauge with the factory matched standard reference block.
- Drive pin, guide/scraper plate, and hammer for testing in direct transmission mode.
- Transport case for properly shipping and housing the gauge and tools.
- Instruction manual for the specific make and model of gauge.
- Radioactive materials information and calibration packet containing:
  - Daily Standard Count Log.
  - Factory and Laboratory Calibration Data Sheet.
  - Leak Test Certificate.
  - Shippers Declaration for Dangerous Goods.
  - Procedure Memo for Storing, Transporting and Handling Nuclear Testing Equipment.
  - Other radioactive materials documentation as required by local regulatory requirements.
- Sealable containers and utensils for moisture content determinations.

Radiation Safety

This method does not purport to address all of the safety problems associated with its use. This test method involves potentially hazardous materials. The gauge utilizes radioactive materials that may be hazardous to the health of the user unless proper precautions are taken. Users of this gauge must become familiar with the applicable safety procedures and governmental regulations. All operators will be trained in radiation safety prior to operating nuclear density gauges. Some agencies require the use of personal monitoring devices such as a thermoluminescent dosimeter or film badge. Effective instructions together with routine safety procedures such as source leak tests, recording and evaluation of personal monitoring device data, etc., are a recommended part of the operation and storage of this gauge.

Calibration

Calibrate the nuclear gauge as required by the agency. This calibration may be performed by the agency using manufacturer's recommended procedures or by other facilities approved by the agency. Verify or re-establish calibration curves, tables, or equivalent coefficients every 12 months.

Standardization

1. Turn the gauge on and allow it to stabilize (approximately 10 to 20 minutes) prior to standardization. Leave the power on during the day's testing.

2. Standardize the nuclear gauge at the construction site at the start of each day's work and as often as deemed necessary by the operator or agency. Daily variations in standard count shall not exceed the daily variations established by the manufacturer of the gauge. If the daily variations are exceeded after repeating the standardization procedure, the gauge should be repaired and/or recalibrated.

3. Record the standard count for both density and moisture in the Daily Standard Count Log. The exact procedure for standard count is listed in the manufacturer's Operator's Manual.

Note 1: New standard counts may be necessary more than once a day. See agency requirements.

Overview

There are two methods for determining in-place density of soil / soil aggregate mixtures. See agency requirements for method selection.

- Method A Single Direction
- Method B Two Direction

Procedure

1. Select a test location(s) randomly and in accordance with agency requirements. Test sites should be relatively smooth and flat and meet the following conditions:

    a. At least 10 m (30 ft) away from other sources of radioactivity

    b. At least 3 m (10 ft) away from large objects

c. The test site should be at least 150 mm (6 in.) away from any vertical projection, unless the gauge is corrected for trench wall effect.

2. Remove all loose and disturbed material, and remove additional material as necessary to expose the top of the material to be tested.

3. Prepare a flat area sufficient in size to accommodate the gauge. Plane the area to a smooth condition so as to obtain maximum contact between the gauge and the material being tested. For Method B, the flat area must be sufficient to permit rotating the gauge 90 or 180 degrees about the source rod.

4. Fill in surface voids beneath the gauge with fines of the material being tested passing the 4.75 mm (No. 4) sieve or finer. Smooth the surface with the guide plate or other suitable tool. The depth of the filler should not exceed approximately 3 mm (1/8 in.).

5. Make a hole perpendicular to the prepared surface using the guide plate and drive pin. The hole shall be at least 50 mm (2 in.) deeper than the desired probe depth, and shall be aligned such that insertion of the probe will not cause the gauge to tilt from the plane of the prepared area. Remove the drive pin by pulling straight up and twisting the extraction tool.

6. Place the gauge on the prepared surface so the source rod can enter the hole without disturbing loose material.

7. Insert the probe in the hole and lower the source rod to the desired test depth using the handle and trigger mechanism.

8. Seat the gauge firmly by partially rotating it back and forth about the source rod. Ensure the gauge is seated flush against the surface by pressing down on the gauge corners, and making sure that the gauge does not rock.

9. Pull gently on the gauge to bring the side of the source rod nearest to the scaler / detector firmly against the side of the hole.

10. Perform one of the following methods, per agency requirements:

    a. Method A Single Direction: Take a test consisting of the average of two, one minute readings, and record both density and moisture data. The two wet density readings should be within 32 kg/m^3 (2.0 lb/ft^3) of each other. The average of the two wet densities and moisture contents will be used to compute dry density.

    b. Method B Two Direction: Take a one-minute reading and record both density and moisture data. Rotate the gauge 90 or 180 degrees, pivoting it around the source rod. Reseat the gauge by pulling gently on the gauge to bring the side of the source rod nearest to the scaler/detector firmly against the side of the hole and take a one-minute reading. (In trench locations, rotate the gauge 180 degrees for the second test.) Some agencies require multiple one-minute readings in both directions. Analyze the density and moisture data. A valid test consists of wet density readings in both gauge positions that are within 50 kg/m^3 (3.0 lb/ft^3). If the tests do not agree within this limit, move to a new location. The average of the wet density and moisture contents will be used to compute dry density.

11. If required by the agency, obtain a representative sample of the material, 4 kg (9 lb) minimum, from directly beneath the gauge full depth of material tested. This sample will be used to verify moisture content and / or identify the correct density standard. Immediately seal the material to prevent loss of moisture.

    The material tested by direct transmission can be approximated by a cylinder of soil approximately 300 mm (12 in.) in diameter directly beneath the centerline of the radioactive source and detector. The height of the cylinder will be approximately the depth of measurement. When organic material or large aggregate is removed during this operation, disregard the test information and move to a new test site.

12. To verify the moisture content from the nuclear gauge, determine the moisture content with a representative portion of the material using the FOP for AASHTO T 255/T 265 or other agency approved methods. If the moisture content from the nuclear gauge is within ±1 percent, the nuclear gauge readings can be accepted. Retain the remainder of the sample at its original moisture content for a one-point compaction test under the FOP for AASHTO T 272, or for gradation, if required.

Note 2: Example: A gauge reading of 16.8 percent moisture and an oven dry of 17.7 percent are within the ±1 percent requirements. Moisture correlation curves will be developed according to agency guidelines. These curves should be reviewed and possibly redeveloped every 90 days.

13. Determine the dry density by one of the following.

    a. From nuclear gauge readings, compute by subtracting the mass (weight) of the water (kg/m^3 or lb/ft^3) from the wet density (kg/m^3 or lb/ft^3) or compute using the percent moisture by dividing wet density from the nuclear gauge by 1 + moisture content expressed as a decimal.

    b. When verification is required and the nuclear gauge readings cannot be accepted, the moisture content is determined by the FOP for AASHTO T 255/T 265 or other agency approved methods. Compute dry density by dividing wet density from the nuclear gauge by 1 + moisture content expressed as a decimal.

Percent Compaction

- Percent compaction is determined by comparing the in-place dry density as determined by this procedure to the appropriate agency density standard. For soil or soil-aggregate mixes, these are moisture-density curves developed using the FOP for AASHTO

T 99/T 180. When using curves developed by the FOP for AASHTO T 99 / T 180, it may be necessary to use the FOP for AASHTO T 224 and FOP for AASHTO T 272 to determine maximum density and moisture determinations.

For coarse granular materials, the density standard may be density-gradation curves developed using a vibratory method such as AKDOT&PF's ATM 212, ITD's T 74, WSDOT's TM 606, or WFLHD's Humphrys.

See appropriate agency policies for use of density standards.

Calculation

Wet density readings from gauge: 1963 kg/m^3 (121.6 lb/ft^3)
1993 kg/m^3 (123.4 lb/ft^3)

Avg: 1978 kg/m^3 (122.5 lb/ft^3)

Moisture readings from gauge: 14.2% and 15.4% = Avg 14.8%

Moisture content from the FOP's for AASHTO T 255/ T 265: 15.9%

Moisture content is greater than 1 percent different so the gauge moisture cannot be used.

Calculate the dry density as follows:

$$\rho_d = \left(\frac{\rho_w}{w+100}\right) \times 100 \quad or \quad \rho_d = \left(\frac{\rho_w}{\frac{w}{100}+1}\right)$$

Where:

ρ_d = Dry density, kg/m^3 (lb/ft^3)
ρ_w = Wet density, kg/m^3 (lb/ft^3)
w = Moisture content from the FOP's for AASHTO T 255 / T 265, as a percentage

$$\rho_d = \left(\frac{1978\,kg/m^3 \ or \ 122.5 \ lb/ft^3}{15.9+100}\right) \times 100 \quad \rho_d = \left(\frac{1978\,kg/m^3 \ or \ 122.5 \ lb/ft^3}{\frac{15.9}{100}+1}\right)$$

Corrected for moisture Dry Density: 1707 kg/m^3 (105.7 lb/ft^3)

Calculate percent compaction as follows:

$$\% \text{ Compaction} = \frac{\rho_d}{Agency\ density\ standard} \times 100$$

Report

- Results on forms approved by the agency
- Location of test, elevation of surface, and thickness of layer tested.
- Visual description of material tested.
- Make, model and serial number of the nuclear moisture-density gauge.
- Wet density to 0.1 lb/ft^3.
- Moisture content as a percent, by mass, of dry soil mass to 0.1 percent.
- Dry density to 0.1 lb/ft^3.
- Standard density to 0.1 lb/ft^3.
- Percent compaction.
- Name and signature of operator.

PERFORMANCE EXAM CHECKLIST

IN-PLACE DENSITY AND MOISTURE CONTENT OF SOIL AND SOIL-AGGREGATE BY NUCLEAR METHODS (SHALLOW DEPTH) FOP FOR AASHTO T 310

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Gauge turned on 10 to 20 minutes before use?	_____	_____
2. Calibration verified?	_____	_____
3. Standard count taken and recorded in accordance with manufacturer's instructions?	_____	_____
4. Test location selected appropriately 10 m (30 ft) from other radioactive sources, 3 m (10ft) from large objects, 150 mm (6 in) away from vertical projections?	_____	_____
5. Loose, disturbed material removed?	_____	_____
6. Flat, smooth area prepared?	_____	_____
7. Surface voids filled with native fines (-#4) to 3 mm (1/8 in) maximum thickness?	_____	_____
8. Hole driven 50 mm (2 in) deeper than probe depth?	_____	_____
9. Gauge placed, probe placed, and source rod lowered without disturbing loose material?	_____	_____
10. **Method B**:		
a. Gauge firmly seated, and gently pulled back so that the source rod is against the side of the hole toward the scaler / detectors?	_____	_____
b. A minimum of a one-minute reading taken; density and moisture data recorded?	_____	_____
c. Gauge turned 90° or 180° (180° in trench)?	_____	_____
d. Gauge firmly seated, and gently pulled back so that the source rod is against the side of the hole toward the scaler / detectors?	_____	_____
e. A minimum of a one-minute reading taken; density and moisture data recorded?	_____	_____
f. Wet densities within 50 kg/m^3 (3.0 lb/ft^3)?	_____	_____
g. Density and moisture data averaged?	_____	_____

OVER

Procedure Element	**Trial 1**	**Trial 2**
11. Representative sample (4 kg or 9 lbs) obtained from test location?	_____	_____
12. Sample sealed immediately to prevent moisture loss?	_____	_____
13. Moisture content correctly determined using other means than the nuclear density gauge reading ?	_____	_____
14. Dry Density calculated using proper moisture content?	_____	_____
15. Percent compaction calculated correctly?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

Examiner Signature _______________________________WAQTC #:_______________

TOTAL EVAPORABLE MOISTURE CONTENT OF AGGREGATE BY DRYING FOP FOR AASHTO T 255 LABORATORY DETERMINATION OF MOISTURE CONTENT OF SOILS FOP FOR AASHTO T 265

Scope

This procedure covers the determination of moisture content of aggregate and soil in accordance with AASHTO T 255-00 and AASHTO T 265-12. It may also be used for other construction materials.

Overview

Moisture content is determined by comparing the wet mass of a sample and the mass of the sample after drying to constant mass. The term constant mass is used to define when a sample is dry.

Constant mass – the state at which a mass does not change more than a given percent, after additional drying for a defined time interval, at a required temperature.

Apparatus

- Balance or scale: capacity sufficient for the principle sample mass, accurate to 0.1 percent of sample mass or readable to 0.1 g, and meeting the requirements of AASHTO M 231
- Containers, clean, dry and capable of being sealed
- Suitable drying containers
- Microwave safe containers
- Heat source, temperature controlled:
  - Forced draft oven
  - Ventilated / convection oven
- Heat source, uncontrolled:
  - Infrared heater, hot plate, fry pan, or any other device/method that will dry the sample without altering the material being dried
  - Microwave oven (600 watts minimum)
- Utensils such as spoons

- Hot pads or gloves

Sample Preparation

In accordance with the FOP for AASHTO T 2 obtain a representative sample in its existing condition.

For aggregates the representative sample size is based on Table 1 or other information that may be specified by the agency.

TABLE 1
Sample Sizes for Moisture Content of Aggregate

Nominal Maximum Size* mm (in.)	Minimum Sample Mass g (lb)
4.75 (No. 4)	500 (1.1)
9.5 (3/8)	1500 (3.3)
12.5 (1/2)	2000 (4)
19.0 (3/4)	3000 (7)
25.0 (1)	4000 (9)
37.5 (1 1/2)	6000 (13)
50 (2)	8000 (18)
63 (2 1/2)	10,000 (22)
75 (3)	13,000 (29)
90 (3 1/2)	16,000 (35)
100 (4)	25,000 (55)
150 (6)	50,000 (110)

* One sieve larger than the first sieve to retain more than 10 percent of the material using an agency specified set of sieves based on cumulative percent retained. Where large gaps in specification sieves exist, intermediate sieve(s) may be inserted to determine nominal maximum.

For soils the representative sample size is based on Table 2 or other information that may be specified by the agency.

TABLE 2
Sample Sizes for Moisture Content of Soil

Maximum Particle Size mm (in)	Minimum Sample Mass g
0.425 (No. 40)	10
4.75 (No. 4)	100
12.5 (1/2)	300
25.0 (1)	500
50 (2)	1000

Immediately seal or cover samples to prevent any change in moisture content or follow the steps in "Procedure".

Procedure

Determine and record the sample mass as follows:

- For aggregate, determine and record all masses to the nearest 0.1 percent of the sample mass or to the nearest 0.1 g.
- For soil, determine and record all masses to the nearest 0.1 g.

When determining the mass of hot samples or containers or both, place and tare a buffer between the sample container and the balance. This will eliminate damage to or interference with the operation of the balance or scale.

1. Determine and record the mass of the container.
2. Place the wet sample in the container.
    a. For oven(s), hot plates, heat lamps, etc.: Spread the sample in the container.
    b. For microwave oven: Heap sample in the container with ventilated lid.
3. Determine and record the total mass of the container and wet sample.
4. Determine and record the wet mass of the sample by subtracting the container mass determined in Step 1 from the mass of the container and sample determined in Step 3.

5. Dry the sample.

   a. For aggregate –

      i. Controlled heat source (oven): at 110 ±5°C (230 ±9°F).

      ii. Uncontrolled heat source (Hot plate, heat lamp, etc.): Stir frequently to avoid localized overheating.

   b. For soil – controlled heat source (oven): at 110 ±5°C (230 ±9°F).

Note 1: Soils containing gypsum or significant amounts of organic material require special drying. For reliable moisture contents dry these soils at 60°C (140°F). For more information see AASHTO T 265, Note 2.

6. Dry until sample appears moisture free.

7. Determine mass of sample and container.

8. Determine and record the mass of the sample by subtracting the container mass determined in Step 1 from the mass of the container and sample determined in Step 7.

9. Return sample and container to the heat source for additional drying.

   a. For aggregate –

      i. Controlled heat source (oven): 30 minutes

      ii. Uncontrolled heat source (Hot plate, heat lamp, etc.):20 minutes

      iii. Uncontrolled heat source (Microwave oven): 10 minutes

Caution: Some minerals in the sample may cause the aggregate to overheat, altering the aggregate gradation.

   b. For soil – controlled heat source (oven): 1 hour

10. Determine mass of sample and container.

11. Determine and record the mass of the sample by subtracting the container mass determined in Step 1 from the mass of the container and sample determined in Step 10.

12. Determine percent change by subtracting the new mass determination (M_n) from the previous mass determination (M_p) divide by the previous mass determination (M_p) multiply by 100.

13. Continue drying, performing steps 9 through 12, until there is:

    a. For Aggregate – less than a 0.10 percent change after additional drying time.

    b. For Soil – no change after additional drying time. A sample dried overnight (15 to 16 hours) is sufficient in most cases.

14. Constant mass has been achieved, sample is defined as dry.

15. Allow the sample to cool. Immediately determine and record the total mass of the container and dry sample.

16. Determine and record the dry mass of the sample by subtracting the mass of the container determined in Step 1 from the mass of the container and sample determined in Step 15.

17. Determine and record percent moisture by subtracting the final dry mass determination (M_D) from the initial wet mass determination (M_W) divide by the final dry mass determination (M_D) multiply by 100.

Table 3
Methods of Drying

Aggregate		
Heat Source	**Specific Instructions**	**Drying increments (minutes)**
Controlled: Forced draft (preferred), ventilated, or convection oven	110 ±5°C (230 ±9°F)	30
Uncontrolled:		
Hot plate, Heat Lamp, etc.	Stir frequently	20
Microwave	Heap sample and cover with ventilated lid	10
Soil		
Heat Source	**Specific Instructions**	**Drying increments (minutes)**
Controlled: Forced draft (preferred), ventilated, or convection oven	110 ±5°C (230 ±9°F)	1 hour

Calculation

Constant Mass:

Calculate constant mass using the following formula:

$$\frac{M_p - M_n}{M_p} \times 100 = \%\ \text{Change}$$

Where: M_p = previous mass measurement
M_n = new mass measurement

Example:

Mass of container: 1232.1 g

Mass of container and sample after first drying cycle: 2637.2 g

Mass, M_p, of possibly dry sample: 2637.2 g - 1232.1 g = 1405.1 g

Mass of container and dry sample after second drying cycle: 2634.1 g

Mass, M_n, of dry sample: 2634.1 g - 1232.1 g = 1402.0 g

$$\frac{1405.1\ g - 1402.0\ g}{1405.1\ g} \times 100 = 0.22\%$$

0.22 percent is not less than 0.10 percent, so continue drying

Mass of container and dry sample after third drying cycle: 2633.0 g
Mass, M_n, of dry sample: 2633.0 g - 1232.1 g = 1400.9 g

$$\frac{1402.0g - 1400.9g}{1402.0g} \times 100 = 0.08\%$$

0.08 percent is less than 0.10 percent, so constant mass has been reached for an aggregate, but continue drying for soil.

Moisture Content:

Calculate the moisture content, as a percent, using the following formula:

$$w = \frac{M_W - M_D}{M_D} \times 100$$

Where:

w = moisture content, percent

M_W = wet mass

M_D = dry mass

Example:

Mass of container: 1232.1 g

Mass of container and wet sample: 2764.7 g

Mass, M_W, of wet sample: 2764.7 g - 1232.1 g = 1532.6 g

Mass of container and dry sample (COOLED): 2633.0 g

Mass, M_D, of dry sample: 2633.0 g - 1232.1 g = 1400.9 g

$$w = \frac{1532.6\text{g} - 1400.9\text{g}}{1400.9g} \times 100 = \frac{131.7g}{1400.9g} \times 100 = 9.40\% \quad report\ 9.4\%$$

Report

- Results on forms approved by the agency
- M_W, wet mass
- M_D, dry mass
- w, moisture content to nearest 0.1 percent

PERFORMANCE EXAM CHECKLIST

TOTAL EVAPORABLE MOISTURE CONTENT OF AGGREGATE BY DRYING FOP FOR AASHTO T 255

LABORATORY DETERMINATION OF MOISTURE CONTENT OF SOILS FOP FOR AASHTO T 265

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Representative sample of appropriate mass obtained?	_____	_____
2. Mass of container determined to 0.1 g?	_____	_____
3. Sample placed in container and mass determined to 0.1 g?	_____	_____
4. Test sample mass conforms to the required mass?	_____	_____
5. Wet sample mass determined to 0.1 g?	_____	_____
6. Loss of moisture avoided prior to mass determination?	_____	_____
7. Sample dried by a suitable heat source?	_____	_____
8. If aggregate heated by means other than a controlled oven, is sample stirred to avoid localized overheating?	_____	_____
9. For aggregate: if other than a forced draft, microwave or conventional oven, is aggregate heated for a minimum of 20 minutes additional drying time and then mass determined and compared to previous mass – showing less than 0.10 percent loss?	_____	_____
10. For soil: Is soil heated for at least 1 hour additional drying time and then mass determined and compared to previous mass - showing no loss?	_____	_____
11. Sample cooled, dry mass determined & recorded to the nearest 0.1 percent?	_____	_____
12. Moisture content calculated correctly and recorded to the nearest 0.1 percent?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

____

____

____

____

Examiner Signature ______________________________WAQTC #:_______________

FAMILY OF CURVES – ONE-POINT METHOD
FOP FOR AASHTO T 272

Scope

This procedure provides for a rapid determination of the maximum density and optimum moisture content of a soil sample, utilizing a family of curves and a one-point determination in accordance with AASHTO T 272-10. This procedure is related to the FOP for AASHTO T 99/T 180.

One-point determinations are made by compacting the soil in a mold of a given size with a specified rammer dropped from a specified height. Four alternate methods – A, B, C, and D – are used and correspond to the methods described in the FOP for AASHTO T 99/T 180. The method used in AASHTO T 272 must match the method used in the FOP for AASHTO T 99/T 180.

Apparatus

See the FOP for AASHTO T 99/T 180.

Sample

Sample size determined according to the FOP for AASHTO T 310. In cases where the existing family cannot be used a completely new curve will need to be developed and the sample size will be determined by the FOP for AASHTO T 99/T 180.

Procedure

See the FOP for AASHTO T 99/T 180.

Calculations

See the FOP for AASHTO T 99/T 180.

Maximum Dry Density and Optimum Moisture Content Determination

1. If the moisture-density one-point falls on one of the curves in the existing family of curves, the maximum dry density and optimum moisture content defined by that curve shall be used.

2. If the moisture-density one-point falls within the family of curves but not on an existing curve, a new curve shall be drawn through the plotted single point, parallel and in character with the nearest existing curve in the family of curves. The maximum dry density and optimum moisture content as defined by the new curve shall be used.

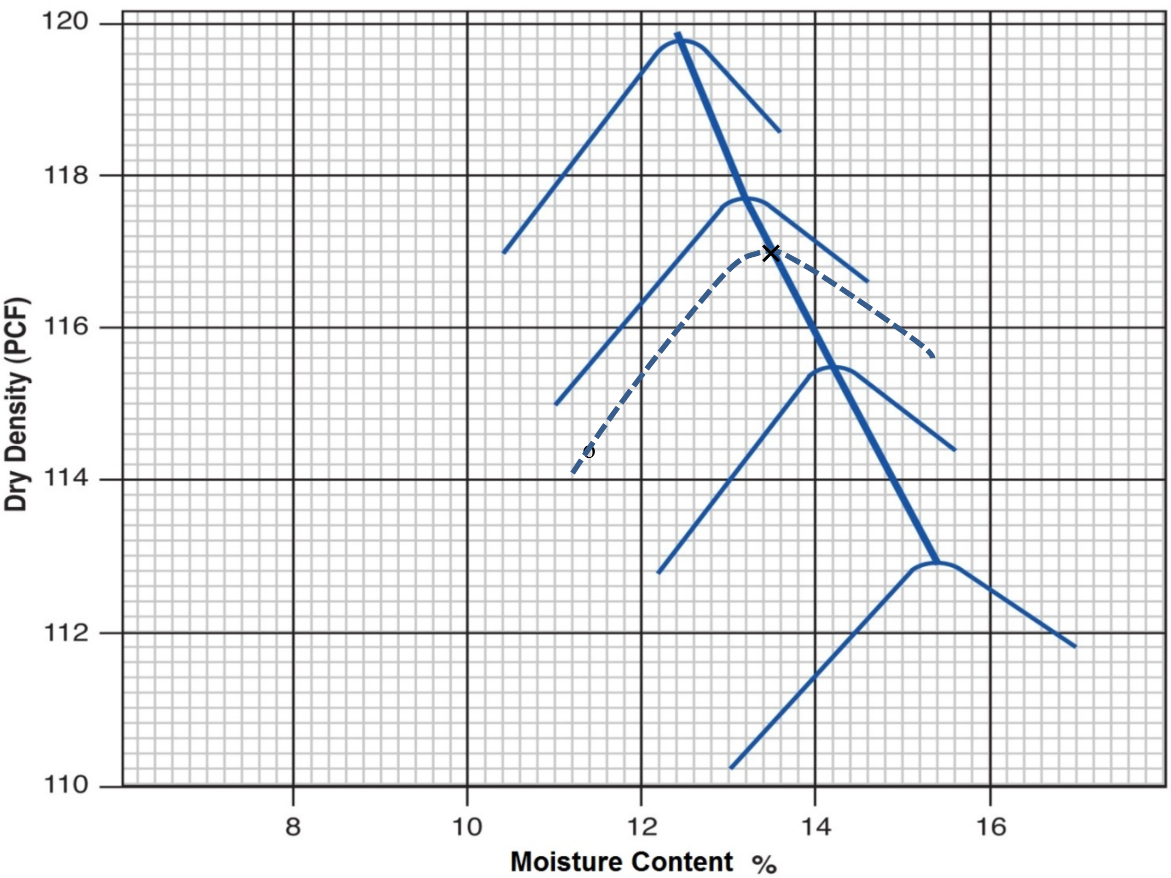
3. The one-point must fall either between or on the highest or lowest curves in the family. If it does not, then a full curve must be developed.

4. If the one-point plotted within or on the family of curves does not fall in the 80 to 100 percent of optimum moisture content, compact another specimen, using the same material, at an adjusted moisture content that will place the one point within this range.

5. If the family of curves is such that the new curve through a one-point is not well defined or is in any way questionable, a full moisture-density relationship shall be made for the soil to correctly define the new curve and verify the applicability of the family of curves.

Note 1: New curves drawn through plotted single point determinations shall not become a permanent part of the family of curves until verified by a full moisture-density procedure following the FOP for AASHTO T 99/T 180.

EXAMPLE



Example

A moisture-density procedure (FOP for AASHTO T 99/T 180) was performed. A dry density of 114.4 lb/ft^3 and a corresponding moisture content of 11.4 percent were determined. This point was plotted on the appropriate family between two previously developed curves.

The "dashed" curve beginning at the moisture-density one-point was sketched between the two existing curves. A maximum dry density of 117.0 lb/ft^3 and a corresponding optimum moisture content of 13.5 percent were estimated.

Report

- Results on forms approved by the agency
- Maximum dry density to the closest 1 kg/m^3 (0.1 lb/ft^3)
- Optimum moisture content to the closest 0.1 percent

PERFORMANCE EXAM CHECKLIST

FAMILY OF CURVES - ONE-POINT METHOD
FOP FOR AASHTO T 272 (T 99)

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. One-point determination of dry density and corresponding moisture content made in accordance with the FOP for AASHTO T 99?	_____	_____
a. Correct size (4.75 mm / No. 4 or 19.0 mm / 3/4 in.) material used?	_____	_____
2. If damp, sample dried in air or drying apparatus, not exceeding 60°C (140°F)?	_____	_____
3. Sample broken up and an adequate amount sieved over the appropriate sieve (4.75 mm / No. 4 or 19.0 mm / 3/4 in.) to determine oversize (coarse particle) percentage?	_____	_____
5. Sample passing the sieve has appropriate mass?	_____	_____
6. Layer of soil (approximately one third compacted depth) placed in mold with collar attached?	_____	_____
7. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
8. Material adhering to the inside of the mold trimmed?	_____	_____
9. Layer of soil (approximately two thirds compacted depth) placed in mold with collar attached?	_____	_____
10. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
11. Material adhering to the inside of the mold trimmed?	_____	_____
12. Mold filled with soil such that compacted soil will be above the mold?	_____	_____
13. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
14. Collar removed without shearing off sample?	_____	_____
15. Approximately 6 mm (1/4 in.) of compacted material above the top of the mold (without the collar)?	_____	_____
16. Soil trimmed to top of mold with the beveled side of the straightedge?	_____	_____
17. Mass of mold and contents determined to appropriate precision?	_____	_____
18. Wet density calculated from the wet mass?	_____	_____
19. Soil removed from mold using a sample extruder if needed?	_____	_____
20. Soil sliced vertically through center (non-granular material)?	_____	_____
21. Moisture sample removed ensuring all layers are represented?	_____	_____

OVER

Procedure Element	**Trial 1**	**Trial 2**
22. Moist mass determined immediately to 0.1 g?	_____	_____
23. Moisture sample mass of correct size?	_____	_____
24. Sample dried and water content determined according to T 255/T 265?	_____	_____
25. One-point plotted on family of curves supplied?	_____	_____
26. One-point falls within 80 to 100 percent of optimum moisture content in order to be valid?	_____	_____
27. If one-point does not fall within 80 to 100 percent of optimum moisture content, another one-point determination with an adjusted water content is made?	_____	_____
28. Maximum dry density and corresponding optimum moisture content correctly estimated?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

Examiner Signature _________________________________WAQTC #:________________

PERFORMANCE EXAM CHECKLIST

FAMILY OF CURVES - ONE-POINT METHOD
FOP FOR AASHTO T 272 (T 180)

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. One-point determination of dry density and corresponding moisture content made in accordance with the FOP for AASHTO T 180?	_____	_____
a. Correct size (4.75 mm / No. 4 or 19.0 mm / 3/4 in.) material used?	_____	_____
2. If damp, sample dried in air or drying apparatus, not exceeding 60°C (140°F)?	_____	_____
3. Sample broken up and an adequate amount sieved over the appropriate sieve (4.75 mm / No. 4 or 19.0 mm / 3/4 in.) to determine oversize (coarse particle) percentage?	_____	_____
4. Sample passing the sieve has appropriate mass?	_____	_____
5. Mold placed on rigid and stable foundation?	_____	_____
6. Layer of soil (approximately one fifth compacted depth) placed in mold with collar attached?	_____	_____
7. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
8. Material adhering to the inside of the mold trimmed?	_____	_____
9. Layer of soil (approximately two fifths compacted depth) placed in mold with collar attached?	_____	_____
10. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
12. Material adhering to the inside of the mold trimmed?	_____	_____
13. Layer of soil (approximately three fifths compacted depth) placed in mold with collar attached?	_____	_____
14. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
15. Material adhering to the inside of the mold trimmed?	_____	_____
16. Layer of soil (approximately four fifths compacted depth) placed in mold with collar attached?	_____	_____
17. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
18. Material adhering to the inside of the mold trimmed?	_____	_____

OVER

Procedure Element	**Trial 1**	**Trial 2**
19. Mold filled with soil such that compacted soil will be above the mold?	_____	_____
20. Soil compacted with appropriate number of blows (25 or 56)?	_____	_____
21. Collar removed without shearing off sample?	_____	_____
22. Approximately 6 mm (1/4 in.) of compacted material above the top of the mold (without the collar)?	_____	_____
23. Soil trimmed to top of mold with the beveled side of the straightedge?	_____	_____
26. Mass of mold and contents determined to appropriate precision?	_____	_____
27. Wet density calculated from the wet mass?	_____	_____
28. Soil removed from mold using a sample extruder if needed?	_____	_____
29. Soil sliced vertically through center (non-granular material)?	_____	_____
30. Moisture sample removed ensuring all layers are represented?	_____	_____
31. Moist mass determined immediately to 0.1 g?	_____	_____
32. Moisture sample mass of correct size?	_____	_____
33. Sample dried and water content determined according to T 255/T 265?	_____	_____
34. One-point plotted on family of curves supplied?	_____	_____
35. One-point falls within 80 to 100 percent of optimum moisture content in order to be valid?	_____	_____
36. If one-point does not fall within 80 to 100 percent of optimum moisture content, another one-point determination with an adjusted water content is made?	_____	_____
37. Maximum dry density and corresponding optimum moisture content correctly estimated?	_____	_____

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass_____Fail_____

Examiner Signature _________________________________WAQTC #:______________

CORRECTION FOR COARSE PARTICLES IN THE SOIL COMPACTION TEST FOP FOR AASHTO T 224

Scope

This procedure covers the adjustment of the maximum dry density determined by FOP for AASHTO T 99 / T 180 to compensate for coarse particles retained on the 4.75 mm (No. 4) or 19.0 mm (3/4 in.) sieve. For Methods A and B of the FOP for AASHTO T 99 / T 180 the adjustment is based on the percent, by mass, of material retained on the 4.75 mm (No. 4) sieve and the bulk specific gravity (G_{sb}) of the material retained on the 4.75 mm (No. 4) sieve. A maximum of 40 percent of the material can be retained on the 4.75 mm (No. 4) sieve for this method to be used. For Methods C and D of the FOP for AASHTO T 99 / T 180, the adjustment is based on the percent, by mass, of material retained on the 19.0 mm (3/4 in.) sieve and the bulk specific gravity (G_{sb}) of the material retained on the 19.0 mm (3/4 in.) sieve. A maximum of 30 percent of the material can be retained on the 19.0 mm (3/4 in.) sieve for this method to be used. Whether the split is on the 4.75 mm (No. 4) or the 19.0 mm (3/4 in.) sieve, all material retained on that sieve is defined as oversized material.

This method applies to soils with percentages up to the maximums listed above for oversize particles. A correction may not be practical for soils with only a small percentage of oversize material. The agency shall specify a minimum percentage below which the method is not needed. If not specified, this method applies when more than 5 percent by weight of oversize particles is present.

This procedure covers the lab-to-field corrections in accordance with AASHTO T 224-10 (see AASHTO T 224 for field-to-lab corrections).

Adjustment Equation Moisture

Along with density, the moisture content can be corrected. The moisture content can be determined by the FOP for AASHTO T 255 / T 265, other agency approved methods, or the nuclear density gauge moisture content reading from the FOP for AASHTO T 310. If the nuclear gauge moisture reading is used, or when the moisture content is determined on the entire sample (both fine and oversized particles), the use of the adjustment equation is not needed. Combined moisture contents with material having an appreciable amount of silt or clay should be performed using FOP for AASHTO T 255 / T 265 (Soil). Moisture contents used from FOP for AASHTO T 310 must meet the criteria for that method.

When samples are split for moisture content (oversized and fine materials) the following adjustment equations must be followed:

1. Split the sample into oversized material and fine material.

2. Dry the oversized material following the FOP for AASHTO T 255 / T 265 (Aggregate). If the fine material is sandy in nature, dry using the FOP for AASHTO T 255 / T 265 (Aggregate), or other agency approved methods. If the fine material has any appreciable

amount of clay, dry using the FOP for AASHTO T 255 / T 265 (Soil) or other agency approved methods.

3. Calculate the dry mass of the oversize and fine material as follows:

$$M_D = \frac{M_m}{1 + \text{MC}}$$

Where:

M_D = mass of dry material (fine or oversize particles).
M_m = mass of moist material (fine or oversize particles).
MC = moisture content of respective fine or oversized, expressed as a decimal.

4. Calculate the percentage of the fine and oversized particles by dry weight of the total sample as follows: See Note 2.

$$P_f = \frac{100M_{DF}}{M_{DF} + M_{DC}} \qquad \frac{100 \times 15.4\ lbs}{15.4\ lbs + 5.7\ lbs} = 73\% \qquad \frac{100 \times 7.034\ kg}{7.03\ kg + 2.602\ kg} = 73\%$$

And

$$P_c = \frac{100M_{DC}}{M_{DF} + M_{DC}} \qquad \frac{100 \times 5.7\ lbs}{15.4\ lbs + 5.7\ lbs} = 27\% \qquad \frac{100 \times 2.602\ kg}{7.03\ kg + 2.602\ kg} = 27\%$$

Or for $\mathbf{P_c}$:

$$P_c = 100 - P_f$$

Where:

P_f = percent of fine particles, of sieve used, by weight.
P_c = percent of oversize particles, of sieve used, by weight.
M_{DF} = mass of fine particles.
M_{DC} = mass of oversize particles.

5. Calculate the corrected moisture content as follows:

$$MC_T = \frac{(MC_F \times P_f) + (MC_c \times P_c)}{100} \qquad \frac{(10.6\% \times 73.0\%) + (2.1\% \times 27.0\%)}{100} = 8.3\%$$

MC_T = corrected moisture content of combined fines and oversized particles, expressed as a % moisture.
MC_F = moisture content of fine particles, as a % moisture.
MC_C = moisture content of oversized particles, as a % moisture.

Note 1: Moisture content of oversize material can be assumed to be two (2) percent for most construction applications.

Note 2: In some field applications agencies will allow the percentages of oversize and fine materials to be determined with the materials in the wet state.

Adjustment Equation Density

6. Calculate the corrected dry density of the total sample (combined fine and oversized particles) as follows:

$$D_d = \frac{100 \times D_f \times k}{(D_f \times P_c) + (k \times P_f)} \qquad or \qquad D_d = \frac{100}{\frac{P_f}{D_f} + \frac{P_c}{k}}$$

Where:

D_d = corrected total dry density (combined fine and oversized particles) kg/m^3 (lb/ft^3)

D_f = dry density of the fine particles kg/m^3 (lb/ft^3), determined in the lab

P_c = percent of oversize particles, of sieve used, by weight.

P_f = percent of fine particles, of sieve used, by weight.

k = Metric: 1,000 * Bulk Specific Gravity (G_{sb}) (oven dry basis) of coarse particles (kg/m^3).

k = English: 62.4 * Bulk Specific Gravity (G_{sb}) (oven dry basis) of coarse particles (lb/ft^3)

Note 3: If the specific gravity is known, then this value will be used in the calculation. For most construction activities the specific gravity for aggregate may be assumed to be 2.600.

Calculation

Sample Calculations:

- Metric:

  Maximum laboratory dry density (D_f): 2329 kg/m^3

  Percent coarse particles (P_c): 27%

  Percent fine particles (P_f): 73%

  Mass per volume coarse particles (k): (2.697) (1000) = 2697 kg/m^3

$$D_d = \frac{100 \times D_f \times k}{(D_f \times P_c) + (k \times P_f)} \qquad or \qquad D_d = \frac{100}{\frac{P_f}{D_f} + \frac{P_c}{k}}$$

$$D_d = \frac{100 \times 2329\,kg/m^3 \times 2697\,kg/m^3}{(2329\,kg/m^3 \times 27\%) + (2697\,kg/m^3 \times 73\%)}$$

$$or\ \ D_d = \frac{100}{\frac{73\%}{2329\,kg/m^3} + \frac{27\%}{2697\,kg/m^3}}$$

$$D_d = \frac{628{,}131{,}300\,kg/m^3}{(628{,}883\,kg/m^3 + \ 2697\,kg/m^3)} \quad or\ \ D_d = \frac{100}{0.03134\,kg/m^3 + 0.01001\,kg/m^3}$$

$$D_d = 2418.1\,kg/m^3\ report\ \ 2418\,kg/m^3$$

$$or\ \ D_d = 2418.1\,kg/m^3\ \ report\ \ 2418\,kg/m^3$$

English:

Maximum laboratory dry density (D_f): 140.4 lb/ft^3

Percent coarse particles (P_c): 27%

Percent fine particles (P_f): 73%

Mass per volume of coarse particles (k): (2.697) (62.4) = 168.3 lb/ft^3

$$D_d = \frac{100 \times D_f \times k}{(D_f \times P_c) + (k \times P_f)} \qquad or \qquad D_d = \frac{100}{\frac{P_f}{D_f} + \frac{P_c}{k}}$$

$$D_d = \frac{100 \times 140.4\, lb/ft^3 \times 168.3\, lb/ft^3}{(140.4\, lb/ft^3 \times 27\%) + (168.3\, lb/ft^3 \times 73\%)}$$

$$or\ D_d = \frac{100}{\frac{73\%}{140.4\, lb/ft^3} + \frac{27\%}{168.3\, lb/ft^3}}$$

$$D_d = \frac{2{,}362{,}932\, lb/ft^3}{(3790.8\, lb/ft^3 + 12285.9\, lb/ft^3)} \quad or\ D_d = \frac{100}{0.51994\, lb/ft^3 + 0.16043\, lb/ft^3}$$

$$D_d = \frac{2{,}362{,}932\, lb/ft^3}{16{,}076.7\, lb/ft^3} \quad or\ D_d = \frac{100}{0.68037\, lb/ft^3}$$

$$D_d = 146.98\, lb/ft^3 \quad report\ 147.0\, lb/ft^3$$

Report

- Results on forms approved by the agency
- Adjusted maximum dry density to the closest 1 kg/m^3 (0.1 lb/ft^3)
- Adjusted optimum moisture to the 0.1 percent

USE OF AKDOT & PF ATM 212, ITD T 74, WSDOT TM 606, OR WFLHD HUMPHRYS CURVES

Background

Coarse-grained granular soils are free-draining and have little or no cohesion. These soils are, therefore, not particularly well suited for the moisture-density relations procedures of AASHTO T 99 or AASHTO T 180. Transportation agencies have developed specialized test methods that are hybrids of those moisture-density procedures and methods that employ compaction under load with vibration. Those methods include:

- AKDOT & PF's ATM 212
- ITD's T 74
- WSDOT's TM 606
- WFLHD's Humphrys

Description of Procedure

In these tests, material is compacted in a mold and in a manner similar to those used in a Proctor test, after which the material is further compacted through a combination of applied loads and vibration. A laboratory maximum dry density is determined, as is the percent of material passing a certain sieve such as the 4.75 mm (No. 4). A number of determinations are made for different percentages passing the specified sieve. A graph is developed in which dry density is plotted versus the percentage of material passing that sieve. These tests are conducted in the agency's central lab, and the curve developed is a central lab function. Figure 1 is an example of such a curve.

Construction specifications will call out a percent of maximum dry density required for the granular materials used on the job. These specified values will be based on ATM 212, T 74, TM 606, or Humphrys, depending on the agency.

In the field, the dry density of the granular material will be determined in accordance with the FOP for AASHTO 310. The percent of material passing the specified sieve will be determined for a sample obtained at the site of the density test. The dry density and percent passing values will then be compared with the curve developed in the lab for that particular granular material to determine conformance with the project specifications.

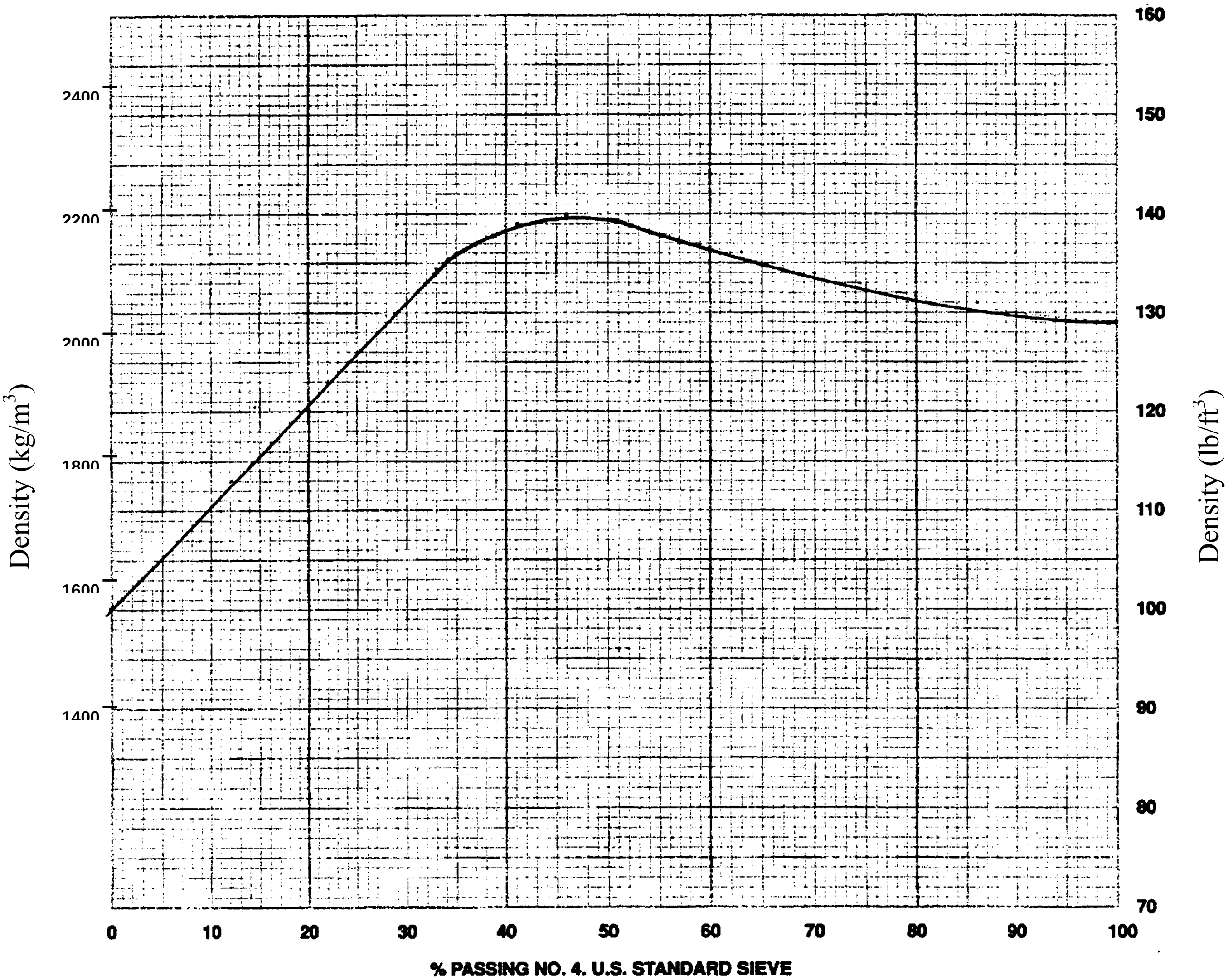


Figure 1. Maximum Density Curve Graph

Example:

A compaction test was taken and a sample was removed from the test site per the FOP for AASHTO T 310. The sample was graded over a 4.75 mm (No. 4) sieve. The following results were reported.

Dry density from T 310 = 2141 kg/m^3 (metric) 137.0 lb/ft^3 (English)

Percent passing 4.75 mm (No.4) sieve = 49%

Maximum density = 2173 kg/m^3 (metric) 139.0 lb/ft^3 (English)

Percent compaction = 99%

SECTION 580.00 – IDAHO Field Operating Procedures

FLAT AND ELONGATED PARTICLES IN COARSE AGGREGATE
FOP FOR ASTM D 4791

Scope

This FOP covers the determination of the percentage, by mass, of flat and elongated particles in coarse aggregates for comparison with specification limits.

This FOP can be performed in conjunction with AASHTO T 27/T 11.

Flat and elongated particles of aggregates, for some construction applications, may interfere with consolidation and result in harsh, difficult to place materials and a potentially unstable mixture.

Apparatus

- Balance or scale: Capacity sufficient for the principal sample mass, accurate to 0.1 percent of the sample mass or readable to 0.1 g. Meets the requirements of AASHTO M 231.

- Sieves, meeting requirements of AASHTO M 92.

- Proportional Caliper Device, meeting the requirements of ASTM D 4791. The device typically consists of a base plate with two fixed posts and a swinging arm mounted between them so that the openings between the arm and the posts maintain a constant ratio. The numbers on the arm represent the ratios for which the apparatus can be set. For example, the number 5 represents the 5:1 ratio.

Terminology

Flat and elongated particles are defined as those coarse aggregate particles that have a ratio of length to thickness equal to or greater than a specified value such as 5:1.

Sample and Sample Preparation

1. Sample the aggregate in accordance with the FOP for AASHTO T 2.
2. Mix the sample and reduce to sample size in accordance with the FOP for AASHTO T 248. See Table 1 for minimum required sample mass.

Table 1 Sample Size

Nominal Maximum Size	Sample Mass, min.	
	kg	lb
3/8”	1	2
1/2”	2	4
3/4”	5	11
1”	10	22
1½”	15	33

3. Dry the sample to constant mass.
4. Sieve the aggregate according to the FOP for AASHTO T 27/11.
5. If an individual sieve size fraction is not represented by at least 10% of the +No. 4 aggregate material, combine that sieve size fraction with the next smaller fraction for all sieves except the 3/8" sieve. If the 3/8" sieve is not represented by at least 10% of the +No. 4, combine the 3/8" sieve material with the next larger sieve size material.
6. Reduce each individual sieve size fraction through and including the 3/8" sieve to approximately 100 particles per T-248 (Reduction to an exact amount is not permitted).

Procedure

From Step 6, perform the following for each sieve size fraction:

1. Determine the total dry mass of each fraction to the nearest 0.1 g. This mass is designated as **T** in the calculation.

2. Set the proportional caliper device to the ratio required in the contract specifications: (2:1, 3:1, or 5:1).

3. Expedite testing through preliminary visual separation of all material which obviously is not flat and elongated.

4. Test each questionable particle by setting the larger opening of the proportional caliper device equal to the maximum dimension of the particle's length. Determine the dimension which represents the particle thickness (the smallest dimension). Pull the particle horizontally through the smaller opening without rotating, maintaining contact of the particle with the fixed post at all times. If the entire particle thickness can be pulled through the smaller opening, the particle is flat and elongated. Develop two categories of aggregate for each size fraction, flat and elongated and not flat and elongated.

5. Determine the dry mass of the flat and elongated particles in each size fraction to the nearest 0.1 g. This mass is designated as **F** in the calculation.

Calculations

1. Calculate the percentage of flat and elongated particles in each size fraction to the nearest 0.1% according to the equation shown below.

$$P_i = \frac{F}{T} x100$$

where:

P_i = percent flat & elongated of individual size fraction
F = mass of flat and elongated particles in fraction
T = total mass of particles in fraction

Example –

- **Individual Percent Flat & Elongated for 3/4" Sieve Size Fraction:**

$$P = \frac{196.4}{1178.0} x100 = 16.7, \text{ report } 17\%$$

Sample Report

Sieve Size	Total Mass in Size Fraction (Mass)	Mass of Flat & Elongated Particles (Mass)	Flat & Elongated (Percent) *
1"	1640.9	589.2	36
3/4"	1178.0	196.4	17
1/2"	825.7	70.1	8
3/8"	277.0	23.3	8

* Report to the nearest 1 percent.

PERFORMANCE EXAM CHECKLIST

Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate Fop for ASTM D 4791

Participant Name:___________________________ Exam Date:______________________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
Sample Preparation		
1. Sample obtained, mixed and reduced in accordance with AASHTO T 2 and AASHTO T 248 to approximately the amount required for testing?	______	______
2. Minimum dry sample mass meets requirements?	______	______
Procedure		
1. If determination by mass, sample oven-dried to constant mass at 230 ±9° F? **Note:** If determination is by particle count drying is not necessary.	______	______
2. Sample sieved according to AASHTO T 27?	______	______
3. Each size fraction larger than No. 4 sieve present in amount of 10% or more of original sample reduced according to T 248 until approximately 100 particles obtained?	______	______
Flat and Elongated Particle Test:		
4. Each particle in each size fraction tested and placed into one of two groups: (1) flat and elongated or (2) not flat and elongated?	______	______
5. Proportional caliper device positioned at proper ratio?	______	______
6. Larger opening set equal to particle <u>length</u>?	______	______
7. Particle is <u>flat and elongated</u> if the <u>thickness</u> can be placed in the smaller opening?	______	______
8. Proportion of sample in each group determined by count or by mass, as required?	______	______
Calculation		
1. Percentage of flat and elongated particles calculated to nearest 1% for each sieve size greater than No. 4?	______	______
2. When weighted average for sample is required, sieve sizes not tested (those representing less than 10% of sample) assumed to have same percentage of flat particles, elongated particles, or flat and elongated particles as the next smaller or the next larger size? Or if both are present, is average for next smaller and larger sizes used?	______	______

Comments and Score: First Attempt: Pass ☐ Fail ☐ Second Attempt: Pass ☐ Fail ☐

____

____

____

Signature of Examiner: ____

UNCOMPACTED VOID CONTENT OF FINE AGGREGATE
FOP FOR AASHTO T 304

Scope

This Idaho Field Operating Procedure (FOP) covers a method for determining the loose uncompacted void content of a sample of fine aggregate

Three procedures are included for the measurement of void content:

- Standard Graded Sample (Method A)
- Individual Size Fractions (Method B)
- As-Received Grading (Method C)

For Method A or C, the percent void content is determined directly and the average value of two test runs is reported.

For Method B, the mean percent void content is calculated using the results from each of the three individual size fractions.

Significance

Methods A and B provide percent void content determined under standardized conditions which depend on the particle shape and texture of a fine aggregate. An increase in void content by these procedures indicates greater angularity, less sphericity, rougher surface texture, or some combination of these three factors.

Method C measures the uncompacted void content of the minus No. 4 portion of the as-received material. This void content depends on grading as well as particle shape and texture.

The standard graded sample (Method A) is most useful as a quick test that indicates the particle shape properties of a graded fine aggregate. Typically, the material used to make up the standard graded sample can be obtained from the remaining size fractions after performing a single sieve analysis of the fine aggregate.

Obtaining and testing individual size fractions (Method B) is more time-consuming and requires a larger initial sample than using the graded sample. However, Method B provides additional information concerning the shape and texture characteristics of individual size fractions.

Testing samples in the as-received grading (Method C) may be useful in selecting proportions of the components used in a variety of mixtures. In general, high void content suggests that the material could be improved by providing additional fine aggregate or more binder may be needed to fill the voids between particles.

The bulk dry specific gravity of the fine aggregate (G_{sb}) is used to calculate the void content. The effectiveness of these methods of determining void content and its relationship to particle shape and texture depend on the bulk specific gravity of the various size fractions being equal (or nearly so).

Void content information from Methods A, B, and C may be a useful indicator of properties such as:

- Mixing water demand of hydraulic cement concrete.
- Flowability, pumpability, or workability of grouts and mortars.
- The effect of fine aggregate on stability, strength and VMA in bituminous concrete.
- Stability and strength of base course material.

Apparatus

- **Cylindrical Measure:** A right cylinder of approximately 100 mL capacity having an inside diameter of approximately 1.5 inches and an inside height of approximately 3.4 inches made of drawn copper water tube. The bottom of the measure shall be at least 0.25 inches thick, shall be firmly sealed to the tubing, and shall be provided with the means for aligning the axis of the cylinder with that of the funnel. Determine the volume of the measure to the nearest 0.1 mL.
- **Funnel:** A funnel such that the lateral surface of the right frustum of the cone is sloped 60 □4 from the horizontal with an opening 0.5 □0.02 inches diame piece of metal, smooth on the inside, and at least 1.5 inches high. It shall have a volume of at least 200 mL, or shall be provided with a supplemental container to provide the required volume.
- **Funnel stand:** A three or four-legged support capable of holding the funnel firmly in position with the axis of the funnel collinear (within 4° angle and a displacement of 0.07 inches) with the axis of the cylinder measure. The funnel opening shall be 4.5 inches above the top of the cylinder.
- **Glass Plate:** A square glass plate approximately 2.3 by 2.3 inches with a minimum 0.15-inch thickness.
- **Pan:** A metal or plastic pan of sufficient size to contain the funnel stand and prevent loss of material.
- **Spatula:** A metal spatula with a blade approximately 4 inches long and at least 0.75 inches wide, with straight edges. The end shall be cut at a right angle to the edges.
- **Balance:** A balance with a capacity of 1000 g and sensitive to 0.1 g.

Sample

The samples used for this test shall be obtained using AASHTO T 2 and AASHTO T 248, or from sieve analysis samples used for AASHTO T 27, or from an extracted bituminous concrete sample.

For Methods A and B, the sample is washed over a No. 100 or No. 200 sieve in accordance with AASHTO T 11 and then dried and sieved into separate size fractions according to AASHTO T 27. Maintain the necessary size fractions obtained from one or more sieve analyses in a dry condition in separate containers for each size.

For Method C, dry a split of the as-received sample in accordance with the drying provisions of AASHTO T 27.

Sample Preparation

Method A – Standard Graded Sample

Weigh out and combine the following quantities of fine aggregate that has been dried and sieved in accordance with AASHTO T 27.

Individual Size Fraction	Mass, g
Passing No. 8 to Retained on No. 16	44 ±0.2
Passing No. 16 to Retained on No. 30	57 ±0.2
Passing No. 30 to Retained on No. 50	72 ±0.2
Passing No. 50 to Retained on No. 100	17 ±0.2
	190 ±0.2

Method B – Individual Size Fractions

Prepare a separate 190 g sample of fine aggregate, dried and sieved in accordance with AASHTO T 27 for each of the following size fractions:

Individual Size Fraction	Mass, g
Passing No. 8 to Retained on No. 16	190 ±1
Passing No. 16 to Retained on No. 30	190 ±1
Passing No. 30 to Retained on No. 50	190 ±1

Do not mix fractions together. Each size is tested separately.

Method C – As-received Grading

Pass the sample (dried in accordance with AASHTO T 27) through a No. 4 sieve. Obtain a 190 ±1 g sample of this material for the test.

Specific Gravity of Fine Aggregate

If the bulk specific gravity (G_{sb}) of the fine aggregate sample is unknown, determine it according to Idaho IT-144.

Procedure

1. Record all masses to the nearest 0.1 g.
2. Record the mass of the empty measure
3. Mix each test sample with the spatula until it appears to be homogeneous.
4. Position the jar and funnel section in the stand and center the cylindrical measure with the axis of the funnel. Use a finger to block the opening of the funnel.
5. Pour the test sample into the funnel. Level the material in the funnel with the spatula.
6. Remove the finger and allow the sample to freely flow into the cylindrical measure.

7. After the funnel empties, strike off excess from the top of the cylindrical measure by a single pass of the spatula with the width of the blade vertical, using the straight part of its edge in light contact

with the top of the measure. Until this operation is complete, avoid vibration or disturbance that could cause compaction of the fine aggregate in the measure (see note).

8. Brush adhering grains from the outside of the cylindrical measure. Determine the mass of the measure and its contents to the nearest 0.1 g.
9. Recombine the sample from the retaining pan and cylindrical measure, repeat the procedure, and average the results of the two test runs.

Calculation

Calculate the uncompacted voids for each determination according to the following formula:

$$U = \frac{V - \left(\frac{F}{G}\right)}{V} \times 100$$

where:
U = uncompacted voids, percent, in the material;
V = volume of cylindrical measure, mL;
F = net mass of fine aggregate in measure, g; and,
G = bulk specific gravity (G_{sb}) of aggregate

For Methods A and C: **Calculate the average uncompacted voids for the two determinations.**

For Method B: First determine the uncompacted void content for each of the individual size fractions; then calculate the mean uncompacted void content as follows:

$$U_m = \frac{U_1 + U_2 + U_3}{3}$$

where:
U_m = Mean uncompacted void content, %
U_1, U_2, U_3 = Uncompacted void content of individual size fractions

Calculation Examples

$$U = \frac{99.8 - \left(\frac{146.2}{2.636}\right)}{99.98} \times 100 = 44.43, \text{ say } 44.4\%$$

where:

U = Uncompacted void content, %;
V = 99.8 mL
F = 146.2 g.
G = 2.636

$$U_m = \frac{48.7 + 49.9 + 47.0}{3} = 48.53, \text{ say } 48.5\%$$

where:

U_m = Mean uncompacted void content, %
U_1 = 48.7%
U_2 = 49.9%
U_3 = 47.0%

Report
Results shall be reported on Form ITD-1046 to the nearest 0.1 percent.

PERFORMANCE EXAM CHECKLIST

Uncompacted Void Content of Fine Aggregate for AASHTO T 304

Participant Name:___________________________ Exam Date:______________________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element (all test methods are AASHTO unless otherwise shown)

Sampling	**Trial 1**	**Trial 2**
1. **Sample obtained by one of the following:**		
(a) T 2 & T 248 (sampling, splitting and quartering)?	______	______
or (b) From sieve analysis samples used for T 27?	______	______
or (c) From aggregate extracted from a bituminous concrete specimen (T 308)?	______	______
2. **Methods A**		
(a) Sample washed over No. 100 or No. 200 sieve in accordance with T 11?	______	______
(b) Sample dried and sieved into separate size fractions in accordance with T 27?	______	______
(c) Necessary size fractions obtained from sieve analysis maintained in a dry condition in separate containers for each size?	______	______

Sample Preparation

Method A- Standard Graded Sample

1. Following quantities of aggregate that has been dried and sieved in accordance with T 27 weighed out and combined? ______ ______

Individual Size Fractions	Mass, g	OK?
No. 8 to No. 16	44 ± 0.2	
No. 16 to No. 30	57 ± 0.2	
No. 30 to No. 50	72 ± 0.2	
No. 50 to No. 100	17 ± 0.2	
Total:	190 ± 0.2	

Specific Gravity of Fine Aggregate

If bulk dry specific gravity of aggregate from the source is unknown, specific gravity determined on material passing No. 4 sieve in accordance with IT 144. ______ ______

Procedure

1. Each test sample mixed with spatula until it appears to be homogeneous? ______ ______
2. Funnel stand apparatus with cylindrical measure, positioned in retaining pan? ______ ______
3. Finger used to block opening of funnel? ______ ______
4. Test sample poured into funnel? ______ ______

5. Material in funnel leveled with spatula? _______ _______
6. After funnel empties, excess heaped aggregate struck off from cylindrical measure by single pass of spatula, with blade width vertical and using straight part of its edge in light contact with top of measure? _______ _______
7. Care exercised to avoid vibration or any disturbance that could cause compaction of aggregate into cylindrical measure? _______ _______

   Note: *After strike-off, measure may be tapped lightly to compact sample to make it easier to transfer container to scale or balance without spilling any of the sample.*

8. Adhering grains brushed from outside of container? _______ _______
9. Mass of cylindrical measure and contents determined to nearest 0.1 g? _______ _______
10. All aggregate particles retained for second test run? _______ _______
11. Sample from retaining pan and cylindrical measure recombined and procedure repeated? _______ _______
12. Mass of empty measure recorded? _______ _______
13. Calculations performed properly? _______ _______

Formula for Calculation of Uncompacted Voids, percent

$$U = \frac{V - \left(\frac{F}{G}\right)}{V} \times 100$$

where:
- U = uncompacted voids, percent;
- V = volume of cylindrical measure to nearest 0.1 mL;
- F = net mass, g, of fine aggregate in measure; and,
- G = bulk dry specific gravity of fine aggregate (G_{sb})

Comments: First attempt: Pass ☐ Fail ☐ Second attempt: Pass ☐ Fail ☐

____
____
____
____
____
____

Signature of Examiner___________________________________.

Density of In-Place Hot Mix Asphalt (HMA) Pavement by Electronic Surface Contact Devices
FOP for AASHTO T 343

Scope

This procedure covers the in-place density determination of Hot Mix Asphalt (HMA) in accordance with AASHTO T343using an electronic surface contact device / gauge. This field operating procedure is derived from AASHTO T343. The gauge measures density and relative compaction of HMA pavements by measuring changes in the electromagnetic field resulting from the compaction process.

Apparatus

- electronic surface contact gauge shall meet the following requirements:
  - be housed in an enclosure of heavy-duty construction.
  - function in the temperature and moisture levels experienced during the placement of HMA pavements.
  - include the internal circuitry suitable for displaying individual measurements.
  - include a continuous measurement mode of operation.
  - provide power to the sensor which allows data acquisition, readout function, and calibration.

Calibration

Calibration of the gauge shall be performed as specified in the Idaho Transportation Departments Laboratory Operations Manual section 200.

Standardization

Standardize the gauge daily per the manufacturers instructions. Note: gauges are paired to the standardization (reference) blocks. Using only the standardization block paired with the gauge.

PQI 301. Establish initial reference reading with the standardization block after calibration. Calculate and record upper and lower limits. Record date. Record and compare daily readings to upper and lower limits. Remove gauge from service if values are not within limits

PQI 380. Record date. Record results (pass/fail). Remove failing gauge from service

Pavetracker. Record date. Remove gauge from service if it displays an error message.

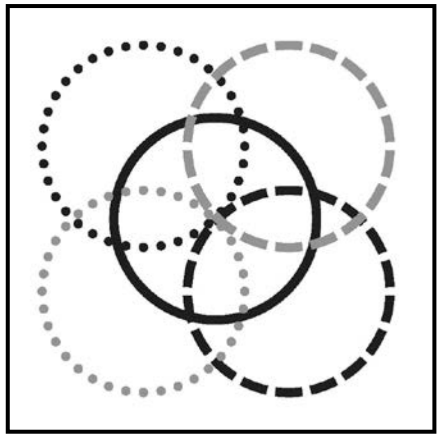
Correlation with Cores

Correlate the gauge for each Job Mix Formula (JMF) and each pavement lift. These correlation measurements / readings should be taken at the same temperature range as the acceptance tests.

1. Determine the number of cores required for correlation. Cores shall be located on the first day's paving or on the test strip. For projects with test strips locate the test sites in accordance with the IT125. Test sites shall be determined using random sampling practices.
2. Clear any existing correlations from the gauge.
3. Place the gauge on the HMA mat at the test sites and draw an outline around the base of the gauge. The mat shall have no noticeable moisture visible. The mat shall be flat, relatively smooth and clear of any loose particles.

4. Perform and record five (5) measurements as shown in diagram #1. Determine and record the average test site measurement / reading.

DIAGRAM # 1



5. Obtain a 6" core from of each test site in accordance with WAQTC TM 11. The core should be taken from approximately the center of the footprint.

5. Determine the density of the cores by the FOP for AASHTO T 166, Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface Dry Specimens.

6. Calculate a correlation factor for the gauge reading as follows:

   a. Calculate the difference between the core density and the average gauge density at each test site to the nearest 0.1 lb/ft^3. Calculate the average difference and standard deviation of the differences for the entire data set to the nearest 0.1 lb/ft^3.

   b. If the standard deviation of the differences is equal to or less than 2.5 lb/ft^3, the correlation factor applied to the gauge reading shall be the average difference calculated above in 6.a.

   c. If the standard deviation of the differences is greater than 2.5 lb/ft^3, the test site with the greatest variation from the average difference shall be eliminated from the data set and the data set properties and correlation factor recalculated following 6.a and 6.b.

   d. If the standard deviation of the modified data set still exceeds the maximum specified in 5.b, additional test sites will be eliminated from the data set and the data set properties and correlation factor recalculated following 6.a and 6.b. If the data set consists of less than five (5) test sites, additional test sites shall be established.

Core Correlation Example:

Core Density T 166:	Avg. Test site In-Place T343:	Difference:
144.9 lb/ft^3	142.1 lb/ft^3	2.8 lb/ft^3
142.8 lb/ft^3	140.9 lb/ft^3	1.9 lb/ft^3
143.1 lb/ft^3	140.7 lb/ft^3	2.4 lb/ft^3
140.7 lb/ft^3	138.9 lb/ft^3	1.8 lb/ft^3
145.1 lb/ft^3	143.6 lb/ft^3	1.5 lb/ft^3
144.2 lb/ft^3	142.4 lb/ft^3	1.8 lb/ft^3
143.8 lb/ft^3	141.3 lb/ft^3	2.5 lb/ft^3
	Average Difference:	**+ 2.1 lb/ft^3**
	Standard Deviation (n – 1):	0.47 lb/ft^3

7. Adjust the gauge, following the manufacturer's procedures, to account for the average difference. This will calibrate the instrument to the HMA mat by adding (or subtracting) the average difference.

Procedure

1. Select a test location(s) randomly and in accordance with ITD requirements. Ensure that the device is correlated in accordance with "Correlation with Cores Section". Locate the measurement area away from any known sources of electromagnetic interference such as overhead high-tension power lines or large metal objects. For best results avoid surfaces with large temperature extremes.
2. Brush the surface clear to remove any loose particles. The mat shall have no noticeable moisture visible. It shall be flat, relatively smooth and clear of any loose particles.
3. Place the gauge firmly on the test surface and trace an outline around the probe (base) of the unit.
4. Perform and record five (5) measurements as shown in diagram #1. Determine and record the average test site measurement / reading.

Calculation

Density measurements / readings from gauge: 142.9 lb/ft^3, 141.9 lb/ft^3, 142.6 lb/ft^3, 141.6 lb/ft^3, & 143.1 lb/ft^3

Avg. density: 142.4 lb/ft^3
Core Correction: +2.1 lb/ft^3

Avg. corrected Density: 144.5 lb/ft^3

Percent Compaction

Percent compaction is determined by comparing the average corrected test site density as determined by this procedure to the maximum density from AASHTO T 209.

G_{mm} and maximum density from the FOP for AASHTO T 209: G_{mm} = 2.466 = 153.5 lb/ft^3

$$\frac{\text{Corrected Reading}}{\text{Maximum Density}} X100 = \% \text{ compaction} \qquad \frac{144.5}{153.5} X100 = 94.1\%$$

Report

Results shall be reported on standard forms approved by ITD. Include the following information:

- Location of test and thickness of layer tested.
- Visual description of material tested.
- Make, model and serial number of the density gauge.
- Density readings to 0.1 lb/ft^3.
- Average Density readings to 0.1 lb/ft^3.
- Core Correction to 0.1 lb/ft^3.
- Maximum density to 0.1 lb/ft^3.
- Percent compaction to 0.1%.
- Name and signature and STQP / WAQTC qualification number of the tester.

PERFORMANCE EXAM CHECKLIST

Density of In-Place Hot Mix Asphalt (HMA) Pavement by Electronic Surface Contact Devices
FOP for AASHTO T 343

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Gauge turned on?	_____	_____
2. Gauge calibrated using data from cores?	_____	_____
3. Test location selected away from any known sources of electromagnetic interference such as overhead high-tension power lines or large metal objects?	_____	_____
4. The HMA surface is free of moisture, relitively flat, and smooth?	_____	_____
5. Surface brushed clear of loose particles?	_____	_____
6. Gauge placed firmly on HMA surface?	_____	_____
7. Outline traced around base?	_____	_____
8. Five (5) measurements taken per diagram # 1 and recorded?	_____	_____
9. Average density calculated?	_____	_____
10. Compaction calculated to 0.1%?	_____	_____

Comments: First attempt: Pass ☐ Fail ☐ Second attempt: Pass ☐ Fail ☐

____

____

Examiner Signature _______________________________WAQTC #:______________

Examiner Signature _______________________________WAQTC #:______________

Sampling and Fabrication of 50-mm Cube Specimens Using Grout (Non-Shrink) or Mortar FOP FOR AASHTO TP 83

1. Scope

1.1. This method covers field sampling and fabrication and initial curing of 50-mm (2-in) cube specimens of non-shrink grout and/or mortar materials.

1.2. The values stated in either SI or inch-pound units shall be regarded separately as standard. The inch-pound units are shown in brackets. The values stated might not be exact equivalents; therefore, each system must be used independently of the other.

Note 1—Unit weight was the previous terminology used to describe the property determined by this test method, which is mass per unit volume.

1.3. The text of this test method references notes and footnotes that provide explanatory information. These notes and footnotes (excluding those in tables) shall not be considered as requirements of this test method.

1.4. This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

Warning—Fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.

2. Referenced Documents

2.1. AASHTO / ASTM

- C 1107 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
- T 106 / C 109 Test method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens.)

---

3. Terminology

3.1. *Definitions*

3.1.1. Plastic mix – material viscous enough that an indentation will be left in the surface of the grout after tamping.

3.1.2. Fluid mix – material fluid enough that little or no indentation will be left in the surface after puddling.

4. Apparatus

4.1. Specimen Molds including cover plate (s): The 2 in. (50 mm) cube specimen molds shall be tight fitting and made of brass or other suitable material. This material shall not be susceptible to attack by the cement mortar. The molds shall have not more than three (3) cube compartments and shall be separable into not more than two (2) parts. The parts of the molds, when assembled, shall be positively held together. The cover plate(s) working surface shall be plane and shall be positively attached to the side walls of the mold. The interior faces of the molds shall conform to the tolerances of table 1.

Table 1

Permissible Variations of Specimen Molds				
	2 in. Cube Molds		50-mm Cube Molds	
Parameter	New	In Use	New	In Use
Planeness of Sides	**<0.001 in.**	**<0.002 in.**	**<0.025 mm**	**<0.05 mm**
Distance Between Opposite Sides	**2 in. + 0.005 in.**	**2 in. + 0.02 in.**	**50 mm + 0.13 mm**	**50 mm + 0.50 mm**
Height of Each Compartment	**2 in. + 0.001 in. to -0.005 in.**	**2 in. + 0.01 in. to -0.015 in.**	**50 mm + 0.25 mm to -0.013 mm**	**50 mm + 0.25 mm to -0.38 mm**
Angle Between Adjacent FacesA	**90 + 0.5°**	**90 + 0.5°**	**90 + 0.5°**	**90 + 0.5°**

[A] Measured at points slightly removed from the intersection. Measured separately for each compartment between all the interior faces and the adjacent face and between interior faces and top and bottom planes of the mold.

4.2. Tamper: A non-absorptive, nonabrasive, non-brittle material such as a hard rubber compound having a Shore A durometer hardness of 80 ± 10. The tamper shall have a cross section of about 1/2 in. x 1 in. (13 mm x 25 mm) and a length of 5 in. to 6 in. (125 mm to 150 mm). The tamping face shall be flat and at right angles to the length of the tamper.

4.3. Trowel: Steel bladed, (100 to 150 mm (4″ to 6″) in length, with straight edges.

4.4. Water tight container: a 6 in. x 12 in. (150 mm x 300 mm) concrete cylinder mold with lid

4.5. Other Equipment: Rubber gloves, scoop, clamps to secure the cover plate, light release oil for oiling the molds, small brush or lint-free cloth for applying and removing excess release oil, burlap or wrapping cloth capable of retaining moisture.

---

5. Sampling

5.1. Samples shall be obtained in accordance with WAQTC TM 2 when the batch equals or exceeds 1 m3 (1 cy). When the batch is less than 1 m3 (1 cy) sample from the batch after discharge. If remixing is required sample after remixing. Begin molding the specimens within an elapsed time of not more than 2 1/2 minutes from completion of the mixing.

Note 2—This test is to be used only for grouts with 100 percent passing the 3/8- in. (9.5-mm) sieve.

5.2. Obtain a representative sample of the mix. Samples shall be a minimum size of 2000 g (4 lb) for each set of three (3) cubes to be fabricated.

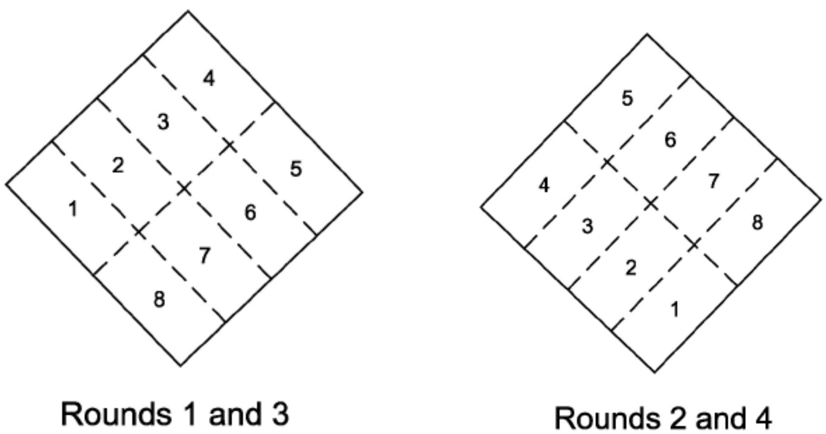
6. Procedure

6.1. Assemble both portions of the mold and the bottom cover plate. All joints shall be water tight. If not water tight, seal the surfaces where the halves of the mold join by applying a coating of light cup grease (non water soluble). The amount should be sufficient to extrude slightly when the halves are tightened together. Repeat this process for attaching the mold to the bottom cover plate. Remove any excess grease. Apply a thin coating of release agent to the interior faces of the mold and the bottom cover plate. Wipe the mold faces and base plate as necessary to remove any excess release agent and to achieve a thin, even coating on the interior surfaces. Adequate coating is that which is just sufficient to allow a distinct fingerprint to remain following light finger pressure.

6.2. Place a layer of grout about 25 mm (1″) (approximately one-half of the depth of the mold) in all of the cube compartments. Consolidated according to the consistency (plastic or fluid) of the mix.

6.2.1. For plastic mixes, tamp the lift in four rounds of 8 tamps for a total of 32 tamps with the rubber tamper in 10 seconds. See Figure 1 for tamping sequence of each round. Rounds 1 and 3; and 2 and 4 shall be the same.

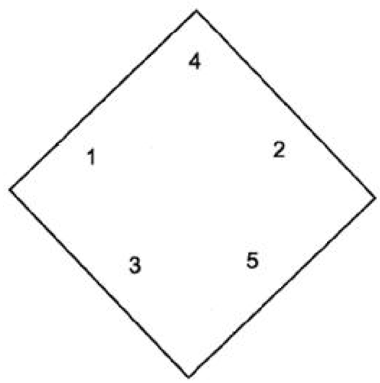
FIGURE # 1



Tamping Sequence

6.2.2. For fluid mixes, puddle the lift 5 times with a gloved finger. See Figure 2 for tamping sequence.

FIGURE # 2



Puddling sequence

6.3. Place the second lift in each of the cube compartments, slightly over-filling each compartment Consolidate the material in the same fashion as the first lift with the additional requirement that during consolidation of the second lift any grout forced out onto the top of the mold after each round will be pushed back onto the compartment by means of the tamper and/or gloved fingers before the next consolidation round. When consolidation of the grout is completed, material should extend slightly above the top of the mold. Push any grout forced out onto the top of the mold after the last round back onto the compartment with the trowel.

6.4. Smooth off the cubes by drawing the flat side of the trowel (with the leading edge slightly raised) once across the top of each cube at right angles to the length of the mold. Then, for the purpose of leveling the mortar and making the mortar that protrudes above the top of the mold of more uniform thickness, draw the flat trailing edge of the trowel (with leading edge slightly raised) once lightly along the length of the mold. Cut off the mortar to a plane surface flush with the top of the mold by drawing the straight edge of the trowel (held nearly perpendicular to the mold) with a sawing motion over the length of the mold. The material shall be flush with the top of the mold.

6.5. Immediately secure the top cover plate to the cube mold.

6.6. Place the molds in a secure location away from vibration and as close as possible to the structure for initial curing. Cover with wet burlap, towels, or rags, seal it in a plastic sack in a level location out of direct sunlight, and record the time. These samples shall remain undisturbed and protected from freezing or overheating for a period of 24 ± 4 hours.

6.7. At the end of the initial curing period as required by the agency either.

6.7.1. Place the sealed plastic sack into a water tight container. Transport the cube samples immediately to the location of final curing. During transport, the cube samples shall be protected from jarring, freezing, and moisture loss.

6.7.2. Disassemble the mold and carefully remove the cube samples. Using a permanent marker, identify the cube samples. Handling the cube samples very carefully, wrap them in wet burlap or wet towels and place them into a water tight container. Transport the cube samples immediately to the location of final curing. During transport, the cube samples shall be protected from jarring, freezing, and moisture loss.

6.8. Final curing shall consist of immersing the cube samples in a lime-saturated water storage tank. They are to remain in the storage tank until time of test. (Curing cube samples of material other than hydraulic cement shall be in conformance with the manufacturer’s recommendations.) The storage tank shall be made of non-corroding materials.

SECTION 590.00 – IDAHO TRANSPORTATION DEPARTMENT (ITD) SAMPLER / TESTER QUALIFICATION PROGRAM (STQP)

Section 590.00 – Idaho Transportation Department (ITD) Sampler / Tester Qualification Program (STQP)

Information found in this section can also be found in the Laboratory Operations Manual, Section 250.

Qualifications are granted by ITD through the STQP. The purpose of the ITD STQP is for conformance to State and Federal requirements. All individuals shall be qualified who sample or test on ITD projects. Valid sampler / tester qualification for ITD projects is only available through this program.

The ITD STQP includes Six (6) Western Alliance for Quality Transportation Construction (WAQTC) modules, two (2) ITD STQP modules, and nineteen (19) individual test method qualifications.

Details on the five WAQTC and three ITD STQP modules are located in the Registration Policies and Information Hand book (RP &IH) which can be downloaded from the Sampler Tester qualification web page. http://itd.idaho.gov/highways/ops/materials/techqual/techqual.asp. Details on individual test method qualifications are found in section 590.10.

QUALIFICATION (S) ARE VALID WHEN POSTED ON THE ITD'S WEB PAGE UNDER "INSPECTOR AND SAMPLER / TESTER QUALIFICATION (WAQTC).

590.10 Individual Test Method Qualifications. Table 1 below lists the individual test methods that require qualification. Prerequisite Sampler / Tester (WAQTC) qualifications are required before any performance examination can occur. Performance exam documentation (Registration Form, Rights and Responsibilities form, and completed Performance Exam Checklist) shall be submitted to HQ Central Laboratory. The Individual Qualification certificate is form ITD-949 for all test methods.

QUALIFICATION(S) ARE VALID WHEN POSTED ON ITD WEB PAGE UNDER "IDAHO INDIVIDUAL QUALIFICATIONS."

The individual qualification is valid for five (5) years.

The District Independent Assurance Inspector (I.A.I.) or an I.A.I. assigned ITD qualified person with 5 years experience will provide individual qualifications unless otherwise specified. Performance exam checklist must be used.

590.10.1 Non-ITD Personnel. The Laboratory Manager will notify the ITD representative who qualifies the laboratory or the District I.A.I. which testing personnel will require individual qualification. Notification shall be made a minimum of 14 calendar days in advance.

Table 1 Individual Test Methods

Test Method	Test Reference	Notes For Pre-Qualification
Aggregates		
Cleanness Value	Idaho IT 72	AgTT Qualification is required.
Specific Gravity and Absorption of Fine Aggregate	Idaho IT 144	AgTT Qualification is required. Performance exam administered by HQ Central Laboratory
Bulk Density ("Unit Weight") and Voids in Aggregate	AASHTO T 19	AgTT Qualification is required.
Specific Gravity and Absorption of Fine Aggregate	AASHTO T 84	AgTT Qualification is required.
Uncompacted Void Content Of Fine Aggregate	AASHTO T 304	AgTT Qualification is required.
Flat and Elongated Particles in Coarse Aggregate	ASTM D4791	AgTT Qualification is required.
Bituminous Materials		
Saybolt Viscosity	Idaho IT 61	AsTT or ASTT II Qualification is required.
Bituminous Coating	Idaho IT 96	AsTT or ASTT II Qualification is required.
Anti-strip Detection	Idaho IT 99	
Hveem Stability	AASHTO T 246	AsTT or ASTT II Qualification is required. Performance exam administered by HQ Materials
Effect of Water on Compressive Strength of Compacted Bituminous Mixtures	AASHTO T 165	AsTT or ASTT II Qualification is required. Performance exam administered by HQ Central Laboratory
Preparation of Test Specimens for Cal. Kneading Compactor	AASHTO T 247	AsTT or ASTT II Qualification is required. Performance exam administered by HQ Central Laboratory
Density of In-place HMA Pavement by Electronic Surface Contact Device	AASHTO T343	ASTT or ASTT II Qualification is required.
Bulk Specific Gravity and Density of Compacted Hot Mix Asphalt (HMA) using Automatic Vacuum Sealing Method (CoreLok)	AASHTO T 331	AsTT or ASTT II Qualification is required.
Field Sampling Bituminous Material after Compaction (Obtaining Cores)	WAQTC TM 11	AsTT or ASTT II Qualification is required.
Soils		
Determining the Plastic Limit and Plasticity Index of Soils	AASHTO T 90	EbTT Qualification is required.
Determining the Liquid Limit of Soils	AASHTO T 89	EbTT Qualification is required.
Specific Gravity of Soils	AASHTO T 100	EbTT Qualification is required.

Concrete		
Sampling & Fabrication of 2" Cube Specimens using Grout or Mortar	AASHTO TP83	CTT Qualification is required.
Compressive Strength of Hydraulic Cement Mortar using 2" Cube Specimens	AASHTO T 106	CTT Qualification is required

Section 590.00 – Test Method Performance Exam Check Lists

The following performance exam checklists at to be used along with the appropriate AASHTO Test and Idaho Test methods.

PERFORMANCE EXAM CHECKLIST

CLEANNESS VALUE – IDAHO IT 72

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element		Trial 1	Trial 2
General			
1. The sample was maintained moist in sealed container.	1	______	______
2. The sample is equal to 1000 ± 50 grams.	2	______	______
3. There is 7 ml of SE solution in SE tube.3	3	______	______
4. The graduate assembly including sieves, funnel and 500 ml graduate cylinder is properly put together.	4	______	______
5. CCM sample was placed in washing vessel or jar and water was added just covering the aggregate.	5	______	______
Mechanical Method			
6. The vessel was secure in the shaker.	6	______	______
7. Agitation was started after one (1) minute.	7	______	______
8. The vessel was agitated for two minutes.	8	______	______
Hand Method			
9. Agitation was started after one (1) minute.	9	______	______
10. The vessel was properly rotated with 150mm radius.	10	______	______
11. Vessel was agitated 3 complete rotations per second.	11	______	______
12. Vessel was agitated for one (1) full minute.	12	______	______
Measure for Cleanness			
13. All contents of vessel or jar were washed over sieves into the 500 ml graduate cylinder.	13	______	______
14. Cylinder was rapidly turned upside down at 180º, ten (10) times.	14	______	______
15. Mixture was poured into SE cylinder to 15 inch mark.	15	______	______
16. SE Cylinder was rotated at least ten (10) complete cycles. Bubble traveled full length of tube.	16	______	______
17. Cylinder was allowed to stand 20 minutes on work table free from vibrations.	17	______	______
18. The sediment reading was to the nearest 0.1 inch.	18	______	______
19. Calculations were accurate to the nearest whole number.	19	______	______

Comments: First Attempt: Pass ☐ Fail ☐ Second Attempt: Pass ☐ Fail ☐

Testing Technician's Name: __________________________WAQTC # : ______Date: _________

Examiner's Name: ________________________ Signature ________________________________

Idaho Standard Method of Test for

Specific Gravity and Absorption of Fine Aggregate Using Automatic Vacuum Sealing (CoreLok) Method

Idaho IT-144-08

1 Scope

1.1 This standard covers the determination of specific gravity and absorption of fine aggregates.

1.2 The values are stated in SI units and are regarded as the standard units.

1.3 This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2 Referenced Documents

2.1 AASHTO Standards:

- M 132, Terms Relating to Density and Specific Gravity of Solids, Liquids and Gases
- M 231, Weighing Devices Used in the Testing of Materials
- T 2, Standard Practice for Sampling of aggregates
- T 19, Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate
- T 248, Standard Practice for Reducing Samples of Aggregate to Testing Size
- T255, Total Evaporable Moisture Content of Aggregate by Drying

2.2 Other Standards

- CoreLok Operational Instructions (InstroTek, Inc.)

3 Terminology

3.1 absorption—the increase in the mass of aggregate due to water in the pores of the material, but not including water adhering to the outside surface of the particles, expressed as a percentage of the dry mass. The aggregate is considered “dry” when it has been maintained at a temperature of 110 ± 5ºC for sufficient time to remove all uncombined water.

3.2 specific gravity—the ratio of the mass (or weight in air) of a unit volume of a material to the mass of the same volume of water at stated temperatures. Values are dimensionless.

3.3 apparent specific gravity—the ratio of the weight in air of a unit volume of the impermeable portion of aggregate at a stated temperature to the weight in air of an equal volume of gas-free distilled water at a stated temperature.

3.4 bulk specific gravity—the ratio of the weight in air of a unit volume of aggregate (including the permeable and impermeable voids in the particles, but not including the voids between particles) at a stated temperature to the weight in air of an equal volume of gas-free distilled water at a stated temperature.

3.5 bulk specific gravity (SSD)—the ratio of the mass in air of a unit volume of aggregate, including the mass of water within the voids filled to the extent achieved by vacuum saturating (but not including the voids between particles) at a stated temperature, compared to the weight in air of an equal volume of gas-free distilled water at a stated temperature.

4 Summary Of Method

4.1 Sufficient fine aggregate sample is dried to constant mass and representative dry fine aggregate samples of the same material are selected for testing. One sample is sealed in a vacuum chamber inside a plastic bag and opened under water for rapid saturation of the aggregate. The dry mass and submerged mass of the sample is used for calculation of apparent specific gravity. Other samples of the same aggregate are tested in a known volume metal pycnometer. The known mass of the pycnometer with water, mass of the dry aggregate, and mass of the dry aggregate and pycnometer filled with water is averaged and used for calculation of bulk specific gravity oven dry (OD.) The results from the samples tested are used to calculate absorption, and bulk specific gravity saturated-surface-dry (SSD).

5 Apparatus

5.1 Balance—A balance that conforms to AASHTO M231. The balance shall be sensitive, readable and accurate to 0.1% of the test sample mass. The balance shall be equipped with suitable apparatus for suspending the sample in water.

5.2 Water Bath—A large container that will allow for completely submerging the sample in water while suspended, equipped with an overflow outlet for maintaining a constant water level. Temperature controls may be used to maintain the water temperature at 25 ± 1° C (77 ± 2 °F).

Note 1—It is preferable to keep the water temperature constant by using a temperature controlled heater. Also, to reduce the chance for the bag to touch the sides of the water tank, it is preferable to elevate the water tank to a level at which the sample can be placed on the weighing mechanism while the operator is standing up (waist height), and the placement of the sample and the bag in the water tank can easily be inspected.

5.3 Sample holder for water displacement of the sample, having no sharp edges.

5.4 Vacuum Chamber—with a pump capable of evacuating a sealed and enclosed chamber to a pressure of 6 mm Hg, when at sea level. The device shall automatically seal the plastic bag and exhaust air back into the chamber in a controlled manner to ensure proper conformance of the plastic to the specimen. The air exhaust and vacuum operation time shall be set at the factory so that the chamber is brought to atmospheric pressure in 80 to 125 seconds, after the completion of the vacuum operations.

5.5 A Vacuum Measurement Gauge, independent of the vacuum sealing device, that could be placed directly inside the chamber to verify vacuum performance and the chamber door sealing condition of the unit. The gauge shall be capable of reading down to 3 mm Hg and readable to ± 1 mm Hg. The gauge shall be NIST traceable.

5.6 Plastic Bags, used with the vacuum device, shall have a minimum opening of 235 mm (9.25 in.) and maximum opening of 260 mm (10.25 in.). The bags shall be of plastic material, shall be puncture resistant, and shall be impermeable to water. The bags shall have a minimum thickness of 0.127mm (0.005 in.). The manufacturer shall provide the apparent specific gravity for the bags.

5.7 Metal pycnometer and lid, with 137 ± 0.13 mm (5.375 ± 0.005 in.) inside diameter (ID) and 89 ± 0.41 mm (3.5 ± 0.016 in.) height, for testing fine aggregates. The pycnometer shall be machined to be smooth on all surfaces. The inside of the lid shall be machined at a 5° angle to create an inverted conical surface.

5.8 Pycnometer clamping device to hold and secure the lid on the metal pycnometer from lifting during fine aggregate tests. The device shall be provided with a level indicator.

5.9 Syringe with a needle no larger in diameter than 3 mm (0.125 in.)

5.10 Thermometer or other temperature device with range to 40ºC (100ºF) accurate to ±1º.

5.11 Isopropyl alcohol – Technical Grade

5.12 Accessories— A bag cutting knife or scissors, spray bottle for the isopropyl alcohol, a bucket large enough to allow the pycnometer to be fully submerged in water, water containers to dispense water into pycnometer during testing, small paint brush and 25 mm (1 in.) wide aluminum spatula.

6 Verification

6.1 System Verification: The vacuum settings of the vacuum chamber shall be verified once every 12 months and after major repairs and after each shipment or relocation.

6.1.1 Place the gauge inside the vacuum chamber and record the setting, while the vacuum unit is operating. The gauge should indicate a pressure of 6 mm Hg or less. The unit shall not be used if the gauge reading is above 6 mm Hg.

> **Note 2**— In line vacuum gauges, while capable of indicating vacuum performance of the pump, are not suitable for use in enclosed vacuum chambers and cannot accurately measure vacuum levels.

6.2 Calibration of Pycnometer:

6.2.1 Prior to testing, condition the pycnometer to 25 ± 1°C (77 ± 2°F) by placing it inside a bucket of water that is maintained at 25 ± 1°C (77 ± 2°F). Place the pycnometer clamping device on a level surface. Use a level indicator or the provided level to level the device.

> **Note 3 –** The clamping device must be protected from hot or cold ambient laboratory temperatures that are more or less than 25 ± 1°C (77 ± 2°F).

6.2.2 Remove the pycnometer from the water bucket and dry it with a towel. Place the pycnometer in the device and push it back until it makes contact with the stops.

6.2.3 Fill the pycnometer with 25 ± 1°C (77 ± 2°F) water to approximately 10 mm (0.375 in.) from the top. Using the alcohol spray bottle, spray the surface of the water to remove bubbles.

6.2.4 Gently place the lid on the pycnometer and close the clamps on the device.

6.2.5 Using a syringe filled with 25 ± 1°C (77 ± 2°F) water, slowly fill the pycnometer through the large fill hole on the lid post. Make sure the syringe tip is far enough in the pycnometer to be below the water level. Gentle application in this step prevents formation of air bubbles inside the pycnometer.

6.2.6 Fill the pycnometer until water comes out of the 3 mm (1/8-in.) hole on the surface of the lid.

6.2.7 Wipe any remaining water from the top of the lid with a towel.

6.2.8 Place the entire device with the pycnometer on the scale and record the mass. Record the mass to 0.1 in the top portion of the Aggregate Worksheet. (See Appendix 1)

6.2.9 Clean the pycnometer and repeat steps 6.2.1 to 6.2.8 two more times and average the calibration masses obtained in 6.2.8.

6.2.10 If the range for the 3 calibration masses is larger than 0.5 grams, then the test is not being run correctly. Check to see if the device is level. Make certain the water injection with the syringe is done below the pycnometer water surface and is applied gently. Check the water temperature. Check the pycnometer temperature. Repeat the above procedure until you have three masses that are within a 0.5 gram range.

6.2.11 The pycnometer must be re-calibrated daily prior to testing.

7 Sampling

7.1 Sampling shall be performed in accordance with AASHTO T 2.

7.2 Samples shall be dried to constant mass in accordance with AASHTO T255.

7.3 Samples shall be reduced in accordance with AASHTO T 248.

8 Procedures

8.1 Equipment Preparation:

Note 4 – Make certain water temperature used for this test remains at 25 ± 1°C (77 ± 2°F).

8.1.1 Prior to testing, condition the pycnometer to 25 ± 1°C (77 ± 2°F) by placing it inside a bucket of water that is maintained at 25 ± 1°C (77 ± 2°F).

8.1.2 Remove the pycnometer from the water bucket and dry thoroughly with a towel.

8.1.3 Place the pycnometer clamping device on a level surface. Use a level indicator or the provided level to level the device.

8.1.4 Place the empty pycnometer in the pycnometer clamping device and push it back until it makes contact with the stops.

8.2 Determine Bulk Specific Gravity:

8.2.1 Oven dry to constant mass according to AASHTO T255, enough fine aggregate to obtain three 500 gram samples and one 1000 gram sample, reduced according to AASHTO T248..

8.2.2 Allow the sample to cool to 25 ± 1°C (77 ± 2°F).

8.2.3 Determine the mass of a 500 ± 1 gram dry sample, Trial 1, that is at 25 ± 1°C (77 ± 2°F) and record to 0.1 on the Aggregate Worksheet.

8.2.4 Steps 8.2.5 to 8.2.13 shall be completed in less than 2 minutes.

8.2.5 Place approximately 500 ml of 25 ± 1°C (77 ± 2°F) water in the pycnometer (halfway full).

8.2.6 Slowly and evenly pour the sample into the pycnometer. Make certain aggregate is not lost in the process of filling the pycnometer. Use a brush if necessary to sweep any remaining fines into the pycnometer. If any aggregate is lost during the process of filling the pycnometer, start the test over.

8.2.7 Use a metal spatula and push it to the bottom of the pycnometer against the inside circumference. Slowly and gently drag the spatula to the center of the pycnometer, removing the spatula after reaching the center. Repeat this procedure in eight equal increments until the entire circumference is covered. If necessary, use a squeeze water bottle to rinse any sample residue off the spatula into the pycnometer.

8.2.8 Fill the pycnometer with 25 ± 1°C (77 ± 2 °F) water to approximately 10 mm (0.375 in.) of the pycnometer rim. It is important the water level be kept at or below the 10 mm line to avoid spills during lid placement.

8.2.9 Use the spray bottle filled with isopropyl alcohol to spray the top of the water to remove air bubbles.

8.2.10 Gently place the lid on the pycnometer and lock the clamping device. Using the syringe, slowly fill the pycnometer through the center hole on top of the lid post. Make sure the syringe tip is far enough in the pycnometer to be below the water level. Gentle application in this step will prevent formation of air bubbles inside the pycnometer.

8.2.11 Fill the pycnometer until water comes out of the 3 mm (1/8-in.) hole on the surface of the lid.

8.2.12 Wipe any remaining water from around the 3 mm (1/8-in.) hole with a towel.

> **Note 5 –** Do not wipe water from the rim of the pycnometer if it seeps between the lid and the pycnometer. Allow this water to remain.

8.2.13 Determine the mass of the sample, the pycnometer and the device. Record the mass to 0.1 in B of the Aggregate Worksheet.

8.2.14 Discard the sample and prepare the equipment according to step 8.1.1 to 8.1.4.

8.2.15 Repeat steps 8.2.3 to 8.2.13 for another 500 ± 1 gram sample, Trial 2.

8.2.15.1 The difference in the mass of Trial 1 and Trial 2 recorded in B must be 1.0 gram or less. If the difference is greater than 1.0, then repeat steps 8.2.14 and 8.2.15 using another 500 ±1 gram dry sample.

8.2.16 Calculate the average mass for the two trials that are within 1 gram; record to 0.1 on Aggregate Worksheet.

8.2.17 Record the average weight of the pycnometer from section 6.2.9 on Aggregate Worksheet.

8.3 Determine Apparent Specific Gravity:

8.3.1 Set the vacuum device according to manufacturer's recommendation.

8.3.2 Tare the immersed weighing basket in the water bath.

8.3.3 Use a small plastic bag and inspect the bag to make sure there are no holes, stress points or side seal discontinuities in the bag. If any of the above conditions are noticed, use another bag.

8.3.4 Determine the mass of the bag and record to 0.1 on Aggregate Worksheet.

> **Note 6**—Always handle the bag with care to avoid creating weak points and punctures.

8.3.5 Determine the mass of a 1000 ± 1 gram sample of oven dry aggregate and record 0.1 at E on Aggregate Worksheet.

8.3.6 Place the sample in the bag. Support the bottom of the bag on a smooth tabletop when pouring the aggregate to protect against punctures and impact points.

8.3.7 Place the bag containing the sample inside the vacuum chamber.

8.3.8 Grab the two sides of the bag and spread the sample flat by gently shaking the bag side to side. Do not press down or spread the sample from outside the bag. Pressing down on the sample from outside the bag will cause the bag to puncture and will negatively impact the results. Lightly spray mist aggregates with high minus 75-μm (No. 200) sieve material to hold down dust prior to sealing.

8.3.9 Place the open end of the bag over the seal bar and close the chamber door. The unit will draw a vacuum and seal the bag, before the chamber door opens.

8.3.10 Gently remove the sample from the chamber and immediately (within 5 seconds) submerge the sample in the water bath equipped with a balance for water displacement analysis.

> **Note 7 -** It is extremely important the bag be removed from the vacuum chamber and immediately placed in the water bath. Leaving the bag in the vacuum chamber or on a bench top after sealing can cause air to slowly enter the bag and can result in low apparent specific gravity results.

8.3.11 Completely submerge the bag at least 2-inches below the surface of the water during cutting.

8.3.12 Make a small cut across the top edge of the immersed bag approximately 25 to 50 mm (1 to 2 in.).

8.3.13 Hold the immersed bag open at the cut for approximately 45 seconds allowing the water to freely flow into the bag. Allow any small residual air bubbles to escape. Do not shake or squeeze the sample, as these actions will cause the fines to escape from the bag.

8.3.14 After water has filled in, make another cut on the opposite side of the immersed bag approximately 25 to 50 mm (1 to 2 in.). Squeeze any residual air bubbles on top portion of the bag through the openings by running your fingers across the top of the bag. Do not completely remove any portion from the bag nor allow any portion of the bag to reach the surface of the water. Keep the sample and bag at least 2-inches below the surface of the water at all times.

8.3.15 Place the bag containing the sample in the immersed weighing basket to obtain the under water mass. Allow water to freely flow into the bag. Make certain the bag or the sample are not touching the bottom, the sides, or floating out of the water bath.

8.3.16 Allow the sample to stay in the water bath for a minimum of fifteen (15) minutes but not more than 20 minutes.

8.3.17 Record the submerged mass on the Aggregate Worksheet and wait one minute. If after this time the mass increases by more than one-gram, wait an additional five minutes. Record the mass and continue this process until the mass stops increasing.

9 Calculations

9.1 Test result calculations for percent absorption, apparent specific gravity and bulk specific gravity will be obtained from the software supplied by the manufacturer. Use the data from the Aggregate Worksheet. The software will provide a report of the test results.

9.2 The final test result will be determined from an average of two laboratory specimens.

Appendix 1

Aggregate Worksheet

Weight of pycnometer and clamping device filled with water.					1.	2.	3.	Avg.
Sample Number or Label	Trial Number		**A** Dry Sample Mass (500 g)	**B** Mass of pycnometer with sample and water (g)	**C** Plastic bag mass (g)	**D** Mass of two rubber sheets (g)	**E** Dry Sample Mass (1000 g)	**F** Mass of Sealed sample opened under water
	1							
	2							
	3*							
	Avg							
	1							
	2							
	3*							
	Avg							
	1							
	2							
	3*							
	Avg							

* Trial 3 is only necessary if the mass in B for the first 2 trials is larger than 1.0 grams.

PERFORMANCE EXAM CHECKLIST

SPECIFIC GRAVITY AND ABSORPTION OF FINE AGGREGATE USING AUTOMATIC VACUUM SEALING (CORELOK) METHOD
IDAHO IT-144-08

Participant Name______________________________________ Exam Date______________

Record 'P' For Passing "F" for failing each step of the checklist.

Verification Element	**Trial 1**	**Trial 2**
1. Pycnometer and lid placed inside a bucket of water at 25°± 1C (77°± 2F)?	______	______
2. Pycnometer and lid removed from water dried well and placed on clamping device until it makes contact with stops?	______	______
3. Pycnometer filled with 25°± 1C (77°± 2F) water to 10mm (3/8") of top, sprayed with Isopropyl alcohol to remove air?	______	______
4. Lid gently placed on Pycnometer and clamped?	______	______
5. A syringe filled with 25°± 1C (77°± 2F) inserted in top of lid and gently added until water is expelled through the 3mm (1/8") hole?	______	______
6. Water wiped from lid, device water and pycnometer weighed and recorded to 0.1 g?	______	______
7. Procedure repeated two additional times (no greater than 0.5 g difference) recorded to work sheet and averaged?	______	______

Procedure Element	**Trial 1**	**Trial 2**
8. Representative samples obtained per FOP for AASHTO T 2?	______	______
9. Reduced per FOP for AASHTO T 248?	______	______
10. Dried per FOP for AASHTO T 255?	______	______
11. Samples cooled to 25°±1C (77°± 2F)?	______	______
12. Three samples obtained @ 500g ±1g and one @ 1000g ± 1g?	______	______
13. Pycnometer and lid removed from water, dried and pycnometer placed on clamping device until it makes contact with stops?	______	______
14. Water added to pycnometer (at 25°± 1C, 77°± 2F) to approximately half full?	______	______

Procedure Element	Trial 1	Trial 2
15. Sample at 500 g ± 1g slowly added to pycnometer?	_______	_______
16. Metal spatula inserted against side of pycnometer and slowly pushed to center removed, repeated in eight equal increments?	_______	_______
17. Water added at 25°± 1C (77°± 2F) to within 10mm (3/8”) of rim?	_______	_______
18. Sprayed with isopropyl alcohol to remove air?	_______	_______
19. Lid gently placed on pycnometer with 3mm (1/8”) hole to the front and clamped?	_______	_______
20. Syringe filled with 25°± 1C (77°± 2F) water inserted in top of lid and water slowly added until it is expelled through 3mm (1/8”) hole?	_______	_______
21. Excess water wiped from lid?	_______	_______
22. Clamping device, pycnometer and sample mass recorded to 0.1 g?	_______	_______
23. Clamping device, pycnometer and sample mass determined no more than 2 minutes from time sample was submerged?	_______	_______
24. Second 500g ±1 g sample tested and mass recorded?	_______	_______
25. If recorded mass of first and second sample greater than 1 g, was a third 500 g ± 1 g sample tested?	_______	_______
26. Vacuum device set at manufacture’s recommended setting?	_______	_______
27. Small plastic bag inspected and mass determined to 0.1 g and recorded?	_______	_______
28. 1000 g ±1 g sample mass determined and recorded?	_______	_______
29. 1000 g ±1 g sample placed in the bag, supported by a smooth surface to prevent punctures?	_______	_______
30. Sample placed in vacuum device and spread flat by grasping both sides of bag and gently shaking?	_______	_______
31. Open end of bag placed over seal bar and closed?	_______	_______
32. Sample removed from vacuum chamber when door opens and submerged in 25°± 1C (77°± 2F) water bath within 5 seconds?	_______	_______
33. Bag maintained at a minimum depth of two inches?	_______	_______
34. A small cut made at corner of bag approximately 25 to 50mm (1” to 2”)?	_______	_______
35. Submerged bag held open until water flows freely into bag (approximately 45 seconds)	_______	_______

Procedure Element	Trial 1	Trial 2
36. A second cut approximately 25 to 50mm (1" to 2") made to opposite side of bag?	______	______
37. Residual air removed from bag by running fingers across top of submerged bag?	______	______
38. Bag placed in weighing basket and water allowed to flow freely into bag?	______	______
39. Sample mass determined and recorded after 15 minutes but not more than 20 minutes and recorded to 0.1g?	______	______
40. Test data entered into manufacture's software to obtain test results?	______	______

COMMENTS: First Attempt : Pass ☐ Fail ☐ Second Attempt: Pass ☐ Fail ☐

Examiner Signature:_________________________________ Sampler / Tester Qualification # __________

Examiner Signature:__________________________________ Sampler / Tester Qualification # __________

PERFORMANCE EXAM CHECK LIST

BULK DENSITY (UNIT WEIGHT) AND VOIDS IN AGGREGATE
AASHTO T 19

Participant Name: ______________________________ Exam Date: ____________________

Record the symbols "P" for passing or "F" for failing on each step of the checklist:

Procedure Elements:		Trial#1	Trial#2
1.	**Obtain Sample.** Use the FOP for AASHTO T 2.	_____	_____
2.	**Aggregate dried to constant mass per the FOP for AASHTO T 255**.	_____	_____
3.	**Reduce Sample to required size.** Use the FOP for AASHTO T 248. Sample shall be 125% to 200% of the quantity needed to fill the measure.	_____	_____
4.	**Inspect measure and other apparatus.** Measure must be calibrated within the last 12 months, balance conforms to M 231, scoop/ shovel, & tamping rod in good working order.	_____	_____
5.	<u>**Rodding** aggregate NMS 1 1/2" (37.5 mm) or less</u>		
a.	**Measure filled 1/3 full, leveled by hand, and rodded 25 times evenly distributed.** The rod shall not strike the bottom of the measure forcibly.	_____	_____
b.	**Measure filled 2/3 full, leveled by hand, and rodded 25 times evenly distributed.** The rod shall not penetrate into the first layer.	_____	_____
c.	**Measure filled to overflowing, and rodded 25 times evenly distributed.** The rod shall only penetrate the top lift. The surface shall be leveled in such a way either by hand or straightedge that the number of slight projections equals the voids.	_____	_____
6.	<u>**Jigging:** aggregates NMS greater than 1 ½" (37.5 mm) but not exceeding 5" (125mm)</u>		
a.	**Measure filled 1/3 full**.	_____	_____
b.	**Measure placed on concrete floor with opposite side lifted 2" (50mm) and allowed to drop freely, continue this process for 25 times then drip it 25 more times from the opposite side for a total of 50 drops and leveled by hand.**	_____	_____
c.	**Measure filled 2/3 full and placed on concrete floor with opposite side lifted 2" (50mm) and allowed to drop freely, continue this process for 25 times then drip it 25 more times from the opposite side for a total of 50 drops and leveled by hand**	_____	_____
d.	**Measure filled to overflowing, and placed on concrete floor with opposite side lifted 2" (50mm) and allowed to drop freely, continue this process for 25 times then drip it 25 more times from the opposite side for a total of 50 drops and leveled.** The surface shall be leveled in such a way either by hand or straightedge that the number of slight projections equals the voids.	_____	_____

OVER

Procedure Elements continued: **Trial#1 Trial#2**

7. **<u>Shoveling:</u>** only when specified

a. **Measure filled to overflowing with shovel or scoop.** Material placed into measure from a height not to exceed 2" (50mm) above the top of the measure minimizing segregation while filling. _____ _____

b. **Measure leveled by hand or straightedge.** The surface shall be leveled in such a way either by hand or straightedge that the number of slight projections equals the voids. _____ _____

8. **Determine mass of the measure and aggregate and mass of the measure alone to 0.1lb (0.05 kg).** _____ _____

9. **Determined & record the mass of Aggregate 0.1lb (0.05 kg)**. _____ _____

10. **Calculate the bulk density to 1 lb/ft^3 (10 kg/ m^3).** _____ _____

COMMENTS: First Attempt : Pass☐ Fail ☐ Second Attempt: Pass☐ Fail ☐

Examiner Signature:____ **Sampler / Tester Qualification #** ____________

Examiner Signature:____ **Sampler / Tester Qualification #** ____________

PERFORMANCE EXAM CHECKLIST

Specific Gravity and Absorption of Fine Aggregate
FOP for AASHTO T 84

Participant Name _ ____ Exam Date __ ____________
____

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Sample Preparation

	Trial 1	Trial 2
1. Sampled according to AASHTO T 2?	_____	_____
2. Sample reduced according to AASHTO T 248 to approximately 2000 g?	_____	_____
3. Dried to a constant mass at 230 ±9º F, cooled to a comfortable handling temp.?	_____	_____
4. Addition of 6% moisture to sample?	_____	_____
5. Allowed to stand 15 – 19 hours?	_____	_____
6. Uniformly dried by a current of warm air, with frequent stirring?	_____	_____
7. Mold placed on flat, non-absorbent surface and filled to over-flowing?	_____	_____
8. Sample compacted with 25 light drops of tamper from 0.2" above top of sample?	_____	_____
9. Tamper allowed to fall freely under gravitational attraction?	_____	_____
10. Loose sand removed from around bases and mold lifted vertically?	_____	_____
11. Sample fails to slump on the first test?	_____	_____
12. If it does slump, is water added, sample covered and allowed to stand 30 minutes?	_____	_____
13. Drying continued, and test repeated at frequent intervals until sample slumps slightly? Slight slump is when there is some evidence of slumping around the circumference of the cone?	_____	_____

Testing Procedure

	Trial 1	Trial 2
1. Split out two 500 gram samples that weigh within 0.2 grams of each other.	_____	_____
2. 1000 ml Pycnometer partially filled with water and first sample added?	_____	_____
3. Second sample dried back to constant mass?	_____	_____
4. Pycnometer filled to 90 % of calibrated capacity and agitated to eliminate air bubbles?	_____	_____
5. Temperature adjusted to 73.4 ±3º F.?	_____	_____
6. Water level brought to calibrated capacity and agitated to eliminate air bubbles?		

7. Second sample cooled in air at room temperature for 1.0 ±0.5 hr. and weighed? ________ ________
8. Pycnometer calibrated mass determined? ________ ________
9. All masses determined to nearest 0.1 g? ________ ________
10. Calculations performed and values rounded correctly? ________ ________

Formulas for Specific Gravities and Absorption

Bulk Specific Gravity $\dfrac{A}{B+S-C}$

Bulk Specific Gravity (SSD) $\dfrac{S}{B+S-C}$

Apparent Specific Gravity $\dfrac{A}{B+A-C}$

Absorption, percent $\dfrac{(S-A)}{A}\times 100$

where:

A = mass of oven-dry specimen (second sample) in air, g;
B = mass of pycnometer filled with water, g;
C = mass of pycnometer with specimen and water to calibration mark, g; and
S = mass of saturated surface-dry specimen (weight of first sample), g.

Comments: First attempt: Pass ☐ Fail ☐ Second attempt: Pass ☐ Fail ☐

____
____
____
____
____
____
____

Examiner Signature:____________________________ **Sampler / Tester Qualification #** __________

PERFORMANCE EXAM CHECKLIST

Uncompacted Void Content of Fine Aggregate for AASHTO T 304

Participant Name:_________________________ Exam Date:____________________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element (all test methods are AASHTO unless otherwise shown)

Sampling	**Trial 1**	**Trial 2**
1. **Sample obtained by one of the following:**		
(a) T 2 & T 248 (sampling, splitting and quartering)?	______	______
or (b) From sieve analysis samples used for T 27?	______	______
or (c) From aggregate extracted from a bituminous concrete specimen (T 308)?	______	______
2. **Methods A**		
(a) Sample washed over No. 100 or No. 200 sieve in accordance with T 11?	______	______
(b) Sample dried and sieved into separate size fractions in accordance with T 27?	______	______
(c) Necessary size fractions obtained from sieve analysis maintained in a dry condition in separate containers for each size?	______	______

Sample Preparation

Method A- Standard Graded Sample

1. Following quantities of aggregate that has been dried and sieved in accordance with T 27 weighed out and combined? ______ ______

Individual Size Fractions	Mass, g	OK?
No. 8 to No. 16	44 ± 0.2	
No. 16 to No. 30	57 ± 0.2	
No. 30 to No. 50	72 ± 0.2	
No. 50 to No. 100	17 ± 0.2	
Total:	190 ± 0.2	

Specific Gravity of Fine Aggregate

If bulk dry specific gravity of aggregate from the source is unknown, specific gravity determined on material passing No. 4 sieve in accordance with IT 144. ______ ______

Procedure

1. Each test sample mixed with spatula until it appears to be homogeneous?	______	______
2. Funnel stand apparatus with cylindrical measure, positioned in retaining pan?	______	______
3. Finger used to block opening of funnel?	______	______
4. Test sample poured into funnel?	______	______
5. Material in funnel leveled with spatula?	______	______

6. After funnel empties, excess heaped aggregate struck off from cylindrical measure by single pass of spatula, with blade width vertical and using straight part of its edge in light contact with top of measure? ______ ______
7. Care exercised to avoid vibration or any disturbance that could cause compaction of aggregate into cylindrical measure? ______ ______

   Note: *After strike-off, measure may be tapped lightly to compact sample to make it easier to transfer container to scale or balance without spilling any of the sample.*

8. Adhering grains brushed from outside of container? ______ ______
9. Mass of cylindrical measure and contents determined to nearest 0.1 g? ______ ______
10. All aggregate particles retained for second test run? ______ ______
11. Sample from retaining pan and cylindrical measure recombined and procedure repeated? ______ ______
12. Mass of empty measure recorded? ______ ______
13. Calculations performed properly? ______ ______

Formula for Calculation of Uncompacted Voids, percent

$$U = \frac{V - \left(\frac{F}{G}\right)}{V} \times 100$$

where:
U = uncompacted voids, percent;
V = volume of cylindrical measure to nearest 0.1 mL;
F = net mass, g, of fine aggregate in measure; and,
G = bulk dry specific gravity of fine aggregate (G_{sb})

Comments: First attempt: Pass ☐ Fail ☐ Second attempt: Pass ☐ Fail ☐

____
____
____
____
____
____

Signature of Examiner___________________________________.

PERFORMANCE EXAM CHECKLIST

Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate Fop for **ASTM D 4791**

Participant Name:_________________________ Exam Date:____________________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
Sample Preparation		
1. Sample obtained, mixed and reduced in accordance with AASHTO T 2 and AASHTO T 248 to approximately the amount required for testing? For combined samples fine portion (- # 4) removed?	_____	_____
2. Minimum dry sample mass meets requirements of Table 1?	_____	_____
Procedure		
1. Sample sieved according to AASHTO T 27?	_____	_____
2. Each coarse aggregate size fraction present in amount of 10% or more of original coarse sample reduced according to T 248 until approximately 100 particles obtained?	_____	_____
Flat and Elongated Particle Test:		
3. Each particle in each size fraction tested and placed into one of two groups: (1) flat and elongated or (2) not flat and elongated?	_____	_____
4. Proportional caliper device positioned at proper ratio?	_____	_____
5. Larger opening set equal to particle length?	_____	_____
6. Particle is flat and elongated if the thickness can be placed in the smaller opening?	_____	_____
8. Proportion of sample in each group determined by count or by mass, as required?	_____	_____
Calculation		
1. Percentage of flat and elongated particles calculated to nearest 1% for each sieve size greater than No. 4?	_____	_____
2. When weighted average for sample is required, sieve sizes not tested (those representing less than 10% of sample) assumed to have same percentage of flat particles, elongated particles, or flat and elongated particles as the next smaller or the next larger size? Or if both are present, is average for next smaller and larger sizes used?	_____	_____

Comments and Score: First Attempt: Pass ☐ Fail ☐ Second Attempt: Pass ☐ Fail ☐

____

____

____

Signature of Examiner: ____

QUALIFICATION CHECKLIST

FIELD VISCOSITY – IDAHO T 61

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element

Procedure Element		Trial 1	Trial 2
Sampling			
1. Sample taken using a valve:			
a. Minimum of 4 L (1gal) allowed to flow before sample taken?	1a		
b. Sample taken in clean 1 L (1 quart) wide mouth jar?	1b		
2. Sample taken with Thief device.			
a. Sample can immersed approximately to middle of tanker?	2a		
b. Rubber stopper removed from can and sample taken from the middle of the tanker / tank?	2b		
3. A portion of the sample transferred to a one (1) half pint plastic bottle and sealed with a stopper having a thermometer in the center?	3		
Equipment			
4. Temperature of the viscometer bath at 50ºC (122°F)?	4		
5. Viscosity tube clean and dry and cork installed?	5		
Testing			
6. Sample cooled to 51.7 ±0.3°C (125 ±0.5°F)?	6		
7. Sample poured through a #20 sieve prior to entering the brass viscosity tube?	7		
8. Enough sample poured into the tube to allow overflow into gallery?	8		
9. Thermometer placed into tube and sample stirred slowly until testing temperature reached?	9		
10. Thermometer withdrawn and excess in the overflow gallery siphoned out using a pipette without touching overflow rim?	10		
11. Emulsified asphalt sample in viscometer immediately covered?	11		
12. Cork pulled allowing the sample roll down the inside lip of the receiving flask?	12		
13. Timer immediately started when cork is pulled?	13		
14. Timer stopped when bottom of sample meniscus reaches graduation mark?	14		
15. Test results reported to nearest 1 second on ITD-1045 form?			

First Attempt: Pass ☐ Fail☐ Second Attempt: Pass☐ Fail ☐

Comments:____

Participant Name ___________________________Exam Date ______________WAQTC#____________

Examiner's Name: _______________________________ Signature _________________________

WAQTC #:_______________

Idaho Standard Method of Test for

Determining the Percent of Coated Particles in Bituminous Mixtures

Idaho IT-96-98

ITD Standard Specification Designation: Idaho T-96

1. Scope

1.1. The intent of this test is to establish a length of mixing time for the operation of a bituminous mixing plant. The method is based on the premise that the coarse aggregate is the most difficult and last to coat with asphalt. The aim is the least mixing time cycle that will produce a mix in which a minimum of 95% of the coarse aggregate particles are completely coated and all other specifications are satisfied.

2. Apparatus

2.1. Sieves – One (1) or more box-type screens of the size required for the mix.

2.1.1. For 1/2 in. (12.5 mm) maximum size aggregate, a No. 4 (4.75 mm) screen may be used.

2.1.2. For 1/2 to 1 in. (12.5 to 25.0 mm) maximum size aggregate, a 3/8 in. (9.5 mm) screen may be used.

2.1.3. For plus 1 in. (25.0 mm) maximum size aggregate, a 1/2 in. (12.5 mm) screen may be used.

2.2. Sample pan or trays.

2.3. Sample scoop or shovel.

2.4. Several sheets of manila paper, approximately 24 in. x 36 in. (600 mm x 900 mm).

2.5. Flood lamps, if required.

2.6. Stiff wire brush.

2.7. Small spatula.

2.8. Solvent and cleaning rags.

3. Procedure

3.1. Permit the plant to operate at an established mixing time per batch (timed by stop watch).

3.2. Take a sufficiently large sample to obtain a coarse fraction count of from 200 to 500 coarse particles. This will generally require from 5 to 8 lb. (2.5 to 4 kg) of plant mix.

3.3. Three (3) separate samples shall be obtained from material produced under identical conditions, immediately after discharge from the pug mill.

3.4. Sieve the samples immediately, while they are still hot, through the proper size sieve. Do not overload the sieves. If necessary, sieve each sample in two (2) or three (3) operations. Shaking should be reduced to a minimum to prevent coating of uncoated particles.

4. Calculations

4.1. Spread the coarse particles on a sheet of manila paper and very carefully examine each particle. Any particle that has a spot (even pinpoint size) which is not coated, is counted as uncoated.

4.2. Group the counted particles, placing the uncoated ones on one side and the coated ones on the other side.

4.3. Counting in normal daylight is the best, but a flood light may be used if necessary.

4.4. The percentage of coated and uncoated particles is obtained by dividing each group by the total number of particles.

5. Report

5.1. In all samples, the number of coated particles must be 95% or above. If the count is below 95%, the mixing time shall be increased in increments and additional counts made until the count rises to 95% or more.

QUALIFICATION CHECKLIST

DETECTION OF ANTI-STRIP ADDITIVE IN ASPHALT – IDAHO T 99

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element		Trial 1	Trial 2
General			
1. All containers and or stir sticks were clean and chemical solutions were fresh.	1	______	______
Detection test by Color Method only			
2. A control blank was performed.	2	______	______
3. 40ml of Reagent Isopropyl Alcohol or equivalent was used.	3	______	______
4. The asphalt mixture was heated on a hot plate.	4	______	______
5. Heating of sample was stopped before mixture became too dark.	5	______	______
6. The same amount of Bromophenol Blue Indicator was added to both mixtures.	6	______	______
7. Test results were accurately interpreted and recorded on the proper ITD form.	7	______	______

Comments: First Attempt: Pass ☐ Fail ☐ Second Attempt: Pass ☐ Fail ☐

Testing Technician's Name: ______________________________WAQTC # : __________Date: _________

Examiner's Name: _______________________________ Signature ________________________________

PERFORMANCE EXAM CHECKLIST

Resistance to Deformation and Cohesion Of Bituminous Mixtures By Means Of Hveem Apparatus For AASHTO T246

Participant Name:____________________________ Exam Date:____________________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

	Trial 1	Trial 2
Adjustment of Stabilometer		
1. Base adjusted so that distance from bottom of upper tapered ring to top of base is 89 mm (3.5 in.)?	______	______
2. Calibration cylinder inserted into stabilometer?	______	______
3. A horizontal pressure of 34.5kPa (5 psi) applied?	______	______
4. Turns indicator dial adjusted to zero?	______	______
5. Pump handle turned until the stabilometer dial reads 689kPa (100 psi)?	______	______
6. Pump handle turned at approx. two turns per second?	______	______
7. Turns indicator dial reads 1.95 and 2.05 turns?	______	______
8. If not, is in the air in the cell adjusted and procedure repeated?	______	______
Resistance to Deformation		
1. Test specimens mixed and compacted in accordance with T247?	______	______
2. Specimen brought to 60 ± 3°C (140 ± 5°F)?	______	______
3. Specimen transferred from mold to stabilometer by means of the push-out device?	______	______
4. Tamped end of specimen is up?	______	______
5. Follower placed on top of specimen?	______	______
6. Vertical movement of press begun?	______	______
7. Speed of 1.3 mm/min (0.05 in./min)?	______	______
8. If locking shims used on spherical head of loading device, shims removed prior to stabilometer test?	______	______
9. Stabilometer gauge readings recorded at vertical loads of 2.23, 4.45, 8.90, 13.4, 17.8, 22.3 and 26.7 kN (500, 1000, 2000, 3000, 4000, 5000, 6000 lbf)?	______	______
10. Vertical movement of press stopped at 26.7 kN (6000 lbf) load?	______	______
11. Vertical load immediately reduced to 4.45 kN (1000 lbf)?	______	______
12. Horizontal pressure adjusted to 34.5 kPa(5 psi)? *Note: This will result in a further reduction of the vertical load and is normal.*	______	______
13. Pump handle turned until the stabilometer dial reads 689 kPa (100 psi)?	______	______
14. Pump handle turned at approx. two turns per second?	______	______
15. Number of turns recorded as the displacement reading (D)?	______	______
16. Stabilometer value calculated correctly?	______	______
17. If height of specimen is not 64 ± 3 mm (2.5 ± 0.1 in.), is stabilometer value corrected as shown below?	______	______

$$S = \frac{22.2}{P_h * D / (P_v - P_h) + 0.222}$$

Where: S = stabilometer value
P_h = horizontal pressure
P_v = vertical pressure
D = displacement

COMMENTS: First attempt: Pass ☐ Fail ☐ Second attempt: Pass ☐ Fail ☐

____

____

____

____

Signature of Examiner ______________________________

PERFORMANCE EXAM CHECKLIST

Preparation of Test Specimens Of Bituminous Mixtures By Means of California Kneading Compactor For AASHTO T247

Participant Name:____________________________ Exam Date:____________________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

	Trial 1	Trial 2
1. Estimated optimum bitumen content determined?	______	______
2. Tests conducted on 3 samples of different asphalt content: one at estimated optimum, one above, and one below?	______	______
3. Aggregate separated into fractions?	______	______
4. Aggregate dried?	______	______
5. Aggregate recombined to 1200 g of specified grading?	______	______
6. Asphalt and aggregate at correct temperature when mixing begins (see table below)?	______	______

Asphalt Grade	AASHTO min.	maximum	Trial 1	Trial 2
AC-2.5, AR 1000, or 200-300 Pen	107 (225)	121 (250)	______	______
AC-5, AR 2000, or 120-150 Pen	121 (250)	135 (275)	______	______
AC-10, AR 4000, or 85-100 Pen	135 (275)	149 (300)	______	______
AC-20, AR 8000, or 60-70 Pen	149 (300)	163 (325)	______	______
AC-40, AR 16000, or 40-50 Pen	149 (300)	163 (325)	______	______

	Trial 1	Trial 2
7. Asphalt and aggregate rapidly and thoroughly mixed?	______	______
8. Mixture and molds brought to correct temperature [110°C (230°F)] for paving grade asphalt?	______	______
9. Mold placed on mold holder and paper disk placed on bottom of mold?	______	______
10. Shim placed under mold?	______	______
11. Mass of mixture for one specimen placed in preheated trough?	______	______
12. Mixture spread uniformly in trough?	______	______
13. One half of mixture pushed into mold with paddle?	______	______
14. Mixture rodded 20 times in center and 20 times around periphery with preheated rod?	______	______
15. Rest of mixture placed in mold and rodding repeated?	______	______
16. Compactor foot heated?	______	______
17. Mold holder and mold placed in compactor?	______	______
18. Approx. 20 tamping blows at 1.7 MPa (250psi) applied?	______	______
19. Shim removed and mold tightening screw released?	______	______
20. 150 tamping blows at 3.4 MPa (500 psi) applied?	______	______
21. Mold and mixture placed in oven at 60°C (140°F):		
(a) For 1 hour if compacted at 60°C (140°F) [liquid grade asphalt]?	______	______
(b) For 1.5 hours if compacted at 110°C (230°F) [paving grade asphalt]?	______	______

22. Followers inserted into mold? ______ ______
23. Leveling-off load of 6.9 MPa (1000 psi) applied to specimen using followers ad plungers? ______ ______
24. Height measured to the nearest 0.25 mm (0.01 in.) in mold? ______ ______
25. Specimen returned to 60°C (140°F) oven in mold in order to obtain desired temp. for testing? ______ ______

COMMENTS: First attempt: Pass ☐ Fail ☐ Second attempt: Pass ☐ Fail ☐

Signature of Examiner ______________________________

Density of In-Place Hot Mix Asphalt (HMA) Pavement by Electronic Surface Contact Devices
FOP for AASHTO T 343

Scope

This procedure covers the in-place density determination of Hot Mix Asphalt (HMA) in accordance with AASHTO T343using an electronic surface contact device / gauge. This field operating procedure is derived from AASHTO T343. The gauge measures density and relative compaction of HMA pavements by measuring changes in the electromagnetic field resulting from the compaction process.

Apparatus

- electronic surface contact gauge shall meet the following requirements:
  - be housed in an enclosure of heavy-duty construction.
  - function in the temperature and moisture levels experienced during the placement of HMA pavements.
  - include the internal circuitry suitable for displaying individual measurements.
  - include a continuous measurement mode of operation.
  - provide power to the sensor which allows data acquisition, readout function, and calibration.

Calibration

Calibration of the gauge shall be performed as specified in the Idaho Transportation Departments Laboratory Operations Manual section 200.

Standardization

Standardize the gauge daily per the manufacturers instructions. Note: gauges are paired to the standardization (reference) blocks. Using only the standardization block paired with the gauge.

PQI 301. Establish initial reference reading with the standardization block after calibration. Calculate and record upper and lower limits. Record date. Record and compare daily readings to upper and lower limits. Remove gauge from service if values are not within limits

PQI 380. Record date. Record results (pass/fail). Remove failing gauge from service

Pavetracker. Record date. Remove gauge from service if it displays an error message.

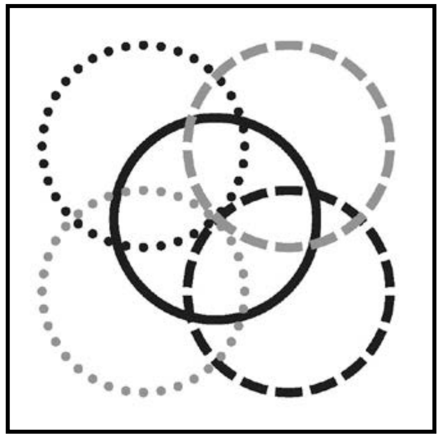
Correlation with Cores

Correlate the gauge for each Job Mix Formula (JMF) and each pavement lift. These correlation measurements / readings should be taken at the same temperature range as the acceptance tests.

1. Determine the number of cores required for correlation. Cores shall be located on the first day's paving or on the test strip. For projects with test strips locate the test sites in accordance with the IT125. Test sites shall be determined using random sampling practices.
2. Clear any existing correlations from the gauge.
3. Place the gauge on the HMA mat at the test sites and draw an outline around the base of the gauge. The mat shall have no noticeable moisture visible. The mat shall be flat, relatively smooth and clear of any loose particles.

4. Perform and record five (5) measurements as shown in diagram #1. Determine and record the average test site measurement / reading.

DIAGRAM # 1



5. Obtain a 6" core from of each test site in accordance with WAQTC TM 11. The core should be taken from approximately the center of the footprint.
5. Determine the density of the cores by the FOP for AASHTO T 166, Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface Dry Specimens.
6. Calculate a correlation factor for the gauge reading as follows:
   a. Calculate the difference between the core density and the average gauge density at each test site to the nearest 0.1 lb/ft^3. Calculate the average difference and standard deviation of the differences for the entire data set to the nearest 0.1 lb/ft^3.
   b. If the standard deviation of the differences is equal to or less than 2.5 lb/ft^3, the correlation factor applied to the gauge reading shall be the average difference calculated above in 6.a.
   c. If the standard deviation of the differences is greater than 2.5 lb/ft^3, the test site with the greatest variation from the average difference shall be eliminated from the data set and the data set properties and correlation factor recalculated following 6.a and 6.b.
   d. If the standard deviation of the modified data set still exceeds the maximum specified in 5.b, additional test sites will be eliminated from the data set and the data set properties and correlation factor recalculated following 6.a and 6.b. If the data set consists of less than five (5) test sites, additional test sites shall be established.

Core Correlation Example:

Core Density T 166:	Avg. Test site In-Place T343:	Difference:
144.9 lb/ft^3	142.1 lb/ft^3	2.8 lb/ft^3
142.8 lb/ft^3	140.9 lb/ft^3	1.9 lb/ft^3
143.1 lb/ft^3	140.7 lb/ft^3	2.4 lb/ft^3
140.7 lb/ft^3	138.9 lb/ft^3	1.8 lb/ft^3
145.1 lb/ft^3	143.6 lb/ft^3	1.5 lb/ft^3
144.2 lb/ft^3	142.4 lb/ft^3	1.8 lb/ft^3
143.8 lb/ft^3	141.3 lb/ft^3	2.5 lb/ft^3
	Average Difference:	**+ 2.1 lb/ft^3**
	Standard Deviation (n – 1):	0.47 lb/ft^3

7. Adjust the gauge, following the manufacturer's procedures, to account for the average difference. This will calibrate the instrument to the HMA mat by adding (or subtracting) the average difference.

Procedure

1. Select a test location(s) randomly and in accordance with ITD requirements. Ensure that the device is correlated in accordance with "Correlation with Cores Section". Locate the measurement area away from any known sources of electromagnetic interference such as overhead high-tension power lines or large metal objects. For best results avoid surfaces with large temperature extremes.
2. Brush the surface clear to remove any loose particles. The mat shall have no noticeable moisture visible. It shall be flat, relatively smooth and clear of any loose particles.
3. Place the gauge firmly on the test surface and trace an outline around the probe (base) of the unit.
4. Perform and record five (5) measurements as shown in diagram #1. Determine and record the average test site measurement / reading.

Calculation

Density measurements / readings from gauge: 142.9 lb/ft^3, 141.9 lb/ft^3, 142.6 lb/ft^3, 141.6 lb/ft^3, & 143.1 lb/ft^3

Avg. density: 142.4 lb/ft^3
Core Correction: +2.1 lb/ft^3

Avg. corrected Density: 144.5 lb/ft^3

Percent Compaction

Percent compaction is determined by comparing the average corrected test site density as determined by this procedure to the maximum density from AASHTO T 209.

G_{mm} and maximum density from the FOP for AASHTO T 209: G_{mm} = 2.466 = 153.5 lb/ft^3

$$\frac{\text{Corrected Reading}}{\text{Maximum Density}} X100 = \%\ \text{compaction} \qquad \frac{144.5}{153.5} X100 = 94.1\%$$

Report

Results shall be reported on standard forms approved by ITD. Include the following information:

- Location of test and thickness of layer tested.
- Visual description of material tested.
- Make, model and serial number of the density gauge.
- Density readings to 0.1 lb/ft^3.
- Average Density readings to 0.1 lb/ft^3.
- Core Correction to 0.1 lb/ft^3.
- Maximum density to 0.1 lb/ft^3.
- Percent compaction to 0.1%.
- Name and signature and STQP / WAQTC qualification number of the tester.

PERFORMANCE EXAM CHECKLIST

Density of In-Place Hot Mix Asphalt (HMA) Pavement by Electronic Surface Contact Devices
FOP for AASHTO T 343

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Gauge turned on?	_____	_____
2. Gauge calibrated using data from cores?	_____	_____
3. Test location selected away from any known sources of electromagnetic interference such as overhead high-tension power lines or large metal objects?	_____	_____
4. The HMA surface is free of moisture, relitively flat, and smooth?	_____	_____
5. Surface brushed clear of loose particles?	_____	_____
6. Gauge placed firmly on HMA surface?	_____	_____
7. Outline traced around base?	_____	_____
8. Five (5) measurements taken per diagram # 1 and recorded?	_____	_____
9. Average density calculated?	_____	_____
10. Compaction calculated to 0.1%?	_____	_____

Comments: First attempt: Pass ☐ Fail ☐ Second attempt: Pass ☐ Fail ☐

____

____

Examiner Signature ______________________________WAQTC #:______________

Examiner Signature ______________________________WAQTC #:______________

PERFORMANCE EXAM CHECKLIST

BULK SPECIFIC GRAVITY AND DENSITY OF COMPACTED HOT MIX ASPHALT (HMA) USING AUTOMATIC VACUUM SEALING METHOD FOP FOR AASHTO T 331

Participant Name ______________________________ Exam Date ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Mass of dry sample in air determined?	______	______
a. Dried overnight at 125°F and at successive 2-hour intervals to constant mass?	______	______
b. Cooled in air to 77°± 9°F?	______	______
c. Dry mass determined to 0.1g?	______	______
d. Record initial dry mass as (A)?	______	______
2. Bag weight recorded?	______	______
a. Bag inspected for holes or irregularities?	______	______
b. Bag weight recorded?	______	______
3. Bag placed in vacuum chamber?	______	______
4. Specimen placed in bag 25mm or 1in. from end of bag?	______	______
5. Check that there are no wrinkles in the bag along the seal bar.	______	______
6. Lid closed and lid retaining latch engaged?	______	______
7. Once sealed remove the specimen carefully from chamber?	______	______
8. Weight Specimen in bag in air?		
a. Record mass to 0.1g?	______	______
b. Subtract bag weight from total mass, record mass as (B).	______	______
9. Sealed puck quickly placed in water bath at 77°± 1.8°F?	______	______
a. From time vacuum lid opens to being submerged in water, not to exceed 1 min?	______	______
b. Specimen fully submerged?	______	______
c. Specimen not touching edges of water bath?	______	______
d. Once scale stabilizes, record mass as (E).	______	______
10. Bag removed from water bath?	______	______
11. Sample removed from bag?	______	______

12. Sample Mass determined and designated as (C)? _____ _____
    a. Verify mass (A) is no more than 5g from mass specimen (C)? _____ _____
    b. If more than 5g different, oven dry to constant mass and retest? _____ _____

$$Gmb = A/([C + (B - A)] - E - [(B - A)/F])$$

G_{mb} = specimen bulk specific gravity;

A = initial mass of the dried specimen in air, g;

B = calculated mass of the dry, sealed specimen, g;

C = final mass of the specimen after removal from the sealed bag, g;

E = mass of the sealed specimen underwater, g; and

F = apparent specific gravity of the plastic sealing material at 77°F, provided by the Manufacture.

Comments: First attempt: Pass_____Fail_____ Second attempt: Pass______Fail_____

____

____

Examiner Signature _________________________________WAQTC #:________________

WAQTC Standard Practice for

Field Sampling Bituminous Material after Compaction (Obtaining Cores)

WAQTC TM 11 - 07

1 Scope

1.1 This method describes the process for removal of a core sample of compacted bituminous material from a pavement for laboratory testing. Cores may range in size from 2 in. to 12 in.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 **Safety**—This method does not purport to address all of the safety problems associated with its use. This test method involves potentially hazardous conditions.

2 Referenced Documents

2.1 WAQTC / AASHTO standard

- WAQTC TM 8, In-Place Density of Bituminous Mixes using the Nuclear Density Gauge
- WAQTC FOP for AASHTO T 166 / 275, Bulk Specific Gravity of Compacted Hot Mix Asphalt Mixtures Using Saturated Surface – Dry Specimens & Bulk Specific Gravity of Compacted Bituminous Mixtures Using Paraffin – Coated Specimens
- T 331 Bulk Specific Gravity and Density of Compacted Asphalt Mixtures Using Automatic Vacuum Sealing Method

3 Significance and Use

3.1 Samples obtained in accordance with the procedure may be used for measuring pavement thickness and density. Additional testing may be performed as required by the agency.

3.2 When cores are used to determine nuclear gauge correlation, see WAQTC TM 8.

3.3 When cores are used to determine pavement density, the Bulk Specific Gravity ($\mathbf{G_{mb}}$) is determined according to WAQTC FOP for AASHTO T 166 / T 275 or AASHTO T 331.

4 Apparatus

4.1 Coring Machine –A motor driven core machine shall be used to obtain the sample. The device shall be capable of obtaining a core to the full depth of the bituminous material.

4.2 Core Bit – The cutting edge of the core drill bit shall be of hardened steel or other suitable material with diamond chips embedded in the metal cutting edge. The core barrel inside diameter shall be as specified.

4.3 Separation Equipment –A saw or other method(s) that provides a clean smooth plane representing the layer to be tested.

4.4 Retrieval Device – A device for removing core samples that will preserve the integrity of the core.

5 Material

5.1 Cooling agent such as: water, ice, dry ice, or liquid nitrogen.

6 Test Site Location

6.1 The number of cores obtained shall be determined by the test procedure or agency requirements.

6.2 Core location(s) shall be determined by the agency.

7 Procedure

7.1 For freshly compacted bituminous materials, the core shall be taken when the material has had sufficient amount of time to cool to prevent damage to the core.

7.2 To accelerate the coring process, a cooling agent may be used.

7.3 Place the coring machine such that the core bit is over the selected location.

7.4 Provide a means such as water or air to aid in the removal of cuttings and to minimize the generation of heat caused by friction.

7.5 Keep the core bit perpendicular to the bituminous surface during the coring process.

7.6 Apply constant downward pressure on the core bit. Failure to apply constant pressure, or too much pressure, may cause the bit to bind or distort the core.

7.7 Continue the coring operation until the desired depth is achieved.

7.8 Use a retrieval device to obtain the core.

7.9 Clearly label the core.

8 Filling Core Holes

8.1 The hole made from the coring operation shall be filled with a material that will not become dislodged.

9 Transporting

9.1 Transport cores on a smooth surface, top side down in a container(s) that prevents damage from jarring, rolling or impact with any object.

9.2 Prevent cores from freezing or from excessive heat, 54° C (130° F), during transport.

Note 1— In extreme ambient temperature conditions, an insulated container should be used during transport.

10 Layer Separation

10.1 Separate two or more pavement courses, lifts, or layers; by the use of separation equipment on the designated lift line.

Note 2— Lift lines are often more visible by rolling the core on a flat surface.

11 Thickness Determination

11.1 Measure the thickness of the designated lift to 3 mm (0.10 in). Three or more measurements shall be taken around the lift and averaged.

12 Report

12.1 Core information shall be reported on standard agency forms. Include the following information:

13.1.1. Date

13.1.2. Coring Location

13.1.3. Lift / Layer being evaluated

13.1.4. Material Type

13.1.5. Average Thickness.

PERFORMANCE EXAM CHECK LIST
DETERMINING THE PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS AASHTO T-90

Participant Name: ______________________________ Exam Date: ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist:

Procedure Elements:		Trial#1	Trial#2
1.	**Inspect and clean apparatus.** Apparatus include mixing dish, spatula, rolling surface, moisture containers with lids, balance readable to 0.01g and a drying oven. All apparatus should be clean dry and within specifications. Moisture containers and their lids will be weighed and recorded before each test.	_____	_____
2.	**Prepare sample .** As per AASHTO T-87 or AASHTO T-146. This test requires approximately 20g of material. Material for this test can be obtained from material used for AASHTO T-89.	_____	_____
3.	**Adjustment of moisture content.** Moisture content shall be such that the material can be shaped into a ball and is not sticky. Use distilled or demineralized water only.	_____	_____
4.	**Roll sample to 3.0 mm (approx. 1/8").** Take approximately 8g of the 20g sample and separate into1.5– 2.0 gram increments. Roll on a ground surface with just enough pressure to make a thread of uniform diameter for it's entire length. A rolling rate of 80 to 90 strokes/minute shall be used. When the diameter of the thread becomes 3.0 mm (approx. 1/8") break thread into 6 to 8 pieces then make a ball and repeat process. There is a 2 minute time to get from a ball down to 3.0 mm (approx. 1/8").	_____	_____
5.	**Re-roll until thread breaks or crumbles.** Repeat step # 4 until thread breaks into a series of segments 6.4 mm (1/4") to 9.5 mm (3/8") in length. The sample must be rolled to 3.0 mm (1/8") at least once before it breaks or crumbles, if failure occurs on the first try add moisture and repeat steps. Do not attempt to produce failure at 3.0 mm (1/8") in diameter.	_____	_____
6.	**Collect crumbled particles.** Using the spatula, gather all portions of the crumbled particles into a suitable container, **cover immediately** and determine the mass to the nearest 0.01g.	_____	_____
7.	**Remove cover and place in oven at 110±5° C (230±9° F) and dry to constant mass.** When removing sample from the drying oven **cover immediately.**	_____	_____
8.	**Determine moisture content.** After drying to a constant mass, cool and determine the mass to the nearest 0.01g and calculate moisture content to the nearest 0.1%.	_____	_____
9.	**Report Plastic Limit.** Plastic Limit is recorded as the nearest whole number .	_____	_____
10.	**Determine Plasticity Index (PI).** Calculate the Plasticity Index of the soil as the difference between its Liquid Limit and its Plastic Limit. Example: LL – PL = PI, the result is reported to the nearest whole number.	_____	_____

COMMENTS: First Attempt : Pass ☐ Fail ☐ Second Attempt: Pass ☐ Fail ☐

Examiner Signature:______________________________ **Sampler / Tester Qualification #**__________

Examiner Signature:______________________________ **Sampler / Tester Qualification #**__________

PERFORMANCE EXAM CHECK LIST
DETERMINING THE LIQUID LIMIT OF SOILS
AASHTO T-89 (METHOD "B" ONE POINT)

Participant Name: ______________________________ Exam Date: ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist:

Procedure Elements:	Trial#1	Trial#2
1. **Prepare sample.** Using AASHTO T-87 or AASHTO T-146. This test requires a minimum of 50g of minus # 40 (0.425 mm) material.	_____	_____
2. **Inspect and adjust test apparatus.** Apparatus includes liquid limit device**,** porcelain mixing dish, spatula, grooving tool, gauge for cup height drop, containers with lids, balance readable to the hundredth and a drying oven. All apparatus shall be clean, dry and within specifications. Moisture containers and lids will be weighed and recorded before each test. Check the drop height on the liquid limit device using the gauge and a piece of tape and adjust as necessary.	_____	_____
3. **Adjust sample moisture and mix.** Use distilled or demineralized water only Add 8 to 10 ml of water to material and mix thoroughly, approximately 5 to 10 minutes. Moisture may then be adjusted by adding increments of 1 to 3 ml of water and mixing thoroughly, approximately 1 minute, or by air drying while mixing and kneading. Moisture **may not** be adjusted by adding dry soil to the moistened sample. Cover the sample and allow to season for 30 minutes.	_____	_____
4. **Spread sample into cup of device.** Remix sample and spread above the spot where cup rests on the base. The top surface should be as level as possible and 10 mm in thickness at it's maximum depth. Use as few strokes as possible, do not entrap air into the sample. Return excess material to the mixing dish.	_____	_____
5. **Cut groove into the sample.** Cut groove through the center of the sample, perpendicular to the hinge pin of the cup. Use as few strokes as possible. Up to 6 strokes may be used, only the last stroke should touch the bottom of the cup.	_____	_____
6. **Turn the device on and count the taps.** Count the number of taps required to close the groove for a length of approx. ½" (13 mm). If sample slides instead of flowing, add water, remix and repeat test. If problem re-occurs discontinue test and note.	_____	_____
7. **Repeat steps 3 through 6 until the grove closes with a range of 22 and 28 taps.** Return remaining soil in the brass cup to the mixing dish with something other than the spatula. Apparatus shall be cleaned and dried between tests. Adjustment of moisture shall follow the guidelines in step 3.	_____	_____
8. **Take sample for moisture content determination.** Using the spatula, take a slice of the sample the width of the spatula at the point of closure. The slice shall extend from edge to edge of the soil and perpendicular to the groove for the full depth of the sample. Place the moisture sample in a suitable container, **cover immediately, determine the mass** to the nearest 0.01g and record immediately.	_____	_____
9. **Remove cover, place in oven at 110±5° C (230±9° F) and dry to a constant mass.** When removing the sample from the oven to determine constant mass **cover immediately.**	_____	_____

OVER

Procedure Elements continued: **Trial#1 Trial#2**

10. **Complete moisture content determination on samples.** After drying to a constant mass Cool to room temperature and determine the mass to a 0.01g and record. Calculate moisture content to the nearest 0.1% _____ _____

11. **Calculate the Liquid Limit.** Using the formula $LL = (w_N)(N/25)^{0.121}$ calculate the corrected Liquid Limit for 25 taps to the nearest 0.1%. _____ _____

12. **Report the Liquid Limit.** The Liquid Limit is the nearest whole number. _____ _____

COMMENTS: **First Attempt : Pass** ☐ **Fail** ☐ **Second Attempt: Pass** ☐ **Fail** ☐

Examiner Signature:____ **Sampler / Tester Qualification #** ___________

Examiner Signature:____ **Sampler / Tester Qualification #** ___________

PERFORMANCE EXAM CHECK LIST

DETERMINING THE SPECIFIC GRAVITY OF SOILS

AASHTO T-100

Participant Name: ______________________________ Exam Date: ______________

Record the symbols "P" for passing or "F" for failing on each step of the checklist:

Procedure Elements:	Trial#1	Trial#2
1. Sample obtained?	______	______
2. Flask filled three quarters with distilled water?	______	______
3. Entrapped air removed?	______	______
4. Vacuum 100mm or less?	______	______
5. Flask agitated gently for the allowed amount of time?	______	______
a. Oven dried sample 2 – 4 hours	______	______
b. Low plasticity 4 – 6 hours	______	______
c. High plasticity containing moisture 6 -8 hours	______	______
6. Pycnometer filled to calibration mark?	______	______
7. Pycnometer mass determined?	______	______
8. Temperature determined?	______	______

$$\text{Specific Gravity, } T_x / T_x = W_o / [W_o + (W_a - W_b)]$$

$$\text{Specific Gravity, } T_x / 20^oC = (\text{Specific Gravity, } T_x/T_x) \times K$$

Where:

T_x = temperature of the contents of the Pycnometer when mass W_b was determined, in degrees Celsius;

W_o = mass of sample of oven-dried soil in grams

W_a = mass of pycnometer filled with water at temperature T_x in grams

W_b = mass of pycnomter filled with water and soil at temperature T_x, in grams

K = Correction Factor = (Rel. Density of Water at T_x / Rel. Density of Water at 20^oC)

COMMENTS: First Attempt : Pass ☐ Fail ☐ Second Attempt: Pass ☐ Fail ☐

Examiner Signature:______________________________ **Sampler / Tester Qualification #**__________

Examiner Signature:______________________________ **Sampler / Tester Qualification #**__________

PERFORMANCE EXAM CHECK LIST
SAMPLING & FABRICATION OF 2” (50 – MM) CUBE SPECIMENS USING GROUT (NON-SHRINK) MORTAR
AASHTO TP 83

Participant Name: ______________________________ Exam Date: ______________

Record the symbols “P” for passing or “F” for failing on each step of the checklist:

Procedure Elements: **Trial#1 Trial#2**

1. **Obtain Sample.** Use AASHTO T-141 for 1 yd^3 or more or for less than 1 yd^3 sample from discharge after remixing takes place. _____ _____

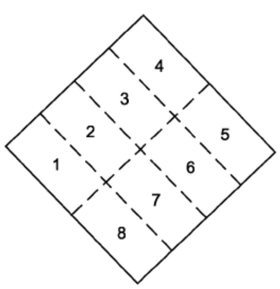
2. **Inspect and adjust test apparatus.** Apparatus includes mold assembly, tamper, trowel, watertight container. _____ _____

3. **Mold portion attached to bottom plate and joints are water tight.** Use of a light coating of non water-soluble grease is allowed. _____ _____

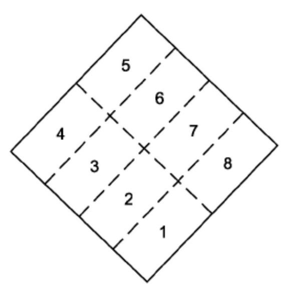
4. **Place a 1”(approximately 1/2 the depth of the mold) layer of Grout or non-shrink mortar into the mold.** Grout or mortar shall be placed in all compartments. _____ _____

5. **Consolidate the mix.** The mix shall be consolidated depending on the consistency, either plastic or fluid. _____ _____

6. **Plastic mixes:** tamp lift in 4 rounds, 8 tamps per round, for a total of 32 tamps in 10 seconds with rubber tamper. Rounds 1 and 3 and 2 and 4 shall be the same. _____ _____

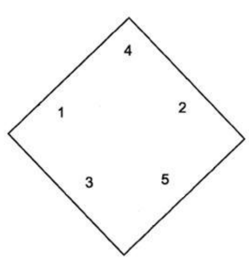


Rounds 1 and 3



Rounds 2 and 4

7. **Fluid Mixes:** puddle the lift 5 times with gloved finger. _____ _____



OVER

Procedure Elements continued: **Trial#1 Trial#2**

8. **Place the second lift into all of the mold compartments and consolidate:** Slightly overfill. Consolidate in same fashion as first lift. After consolidation material should extend slightly above the top of the mold. Push any grout forced out onto the top of the mold back onto the compartment with a trowel. _____ _____

8. **Strike off the surface.** Using the trowel draw the flat side with the leading edge slightly raised once across the top of each cube at right angles to the length of the mold. Then draw the flat trailing edge of the trowel, with leading edge slightly raised,) once lightly along the length of the mold. Cut off the mortar to a plane surface flush with the top of the mold by drawing the straight edge of the trowel (held nearly perpendicular to the mold) with a sawing motion over the length of the mold. The material shall be flush with the top of the mold. _____ _____

9. **Immediately secure the top plate to the molds.** _____ _____

10. **Molds properly stored:** Cover with wet burlap, towels, or rags, seal it in a plastic sack in a level location out of direct sunlight, and record the time. These samples shall remain undisturbed and protected from freezing or overheating for a period of 24 ± 4 hours. _____ _____

COMMENTS: First Attempt : Pass☐ Fail ☐ Second Attempt: Pass☐ Fail ☐

Examiner Signature:____ Sampler / Tester Qualification # ____________

Examiner Signature:____ Sampler / Tester Qualification # ____________