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**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

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.

[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./ft³
- Percent of asphalt by Weight of Aggregates, lb./ft³
- 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 TP-61](#), Method A)
- 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:

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

where G_{sb} = average bulk specific gravity

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

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:

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

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**:

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

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)).

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

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).

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

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, $W = (\text{bulk density of compacted mix})(100-\%AC)$

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

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 desired 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.

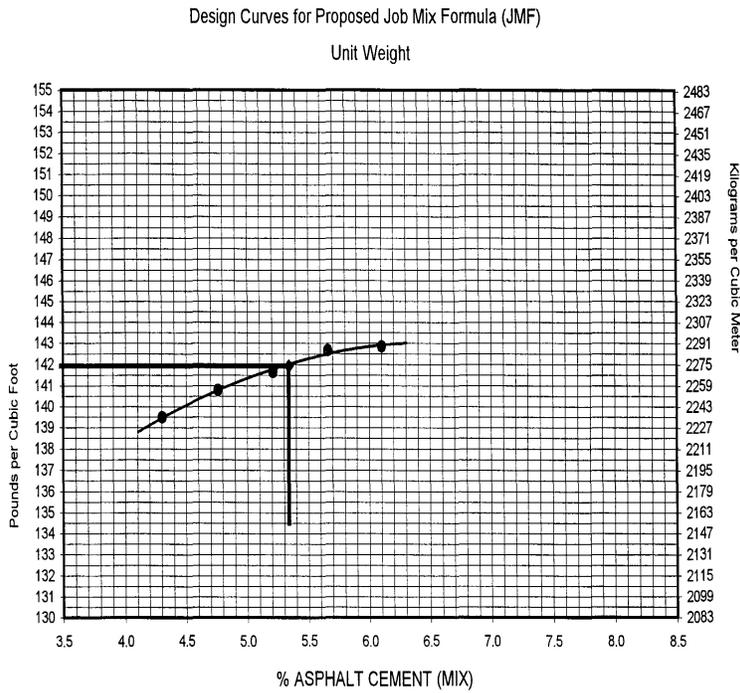
One of the primary reasons for estimating the surface area is to determine the asphalt film thickness. This is an estimate value, but it does allow comparisons to be made for various mixtures. (National Center for Asphalt Technology publication Hot Mix Asphalt Materials, Mixture Design and Construction, 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 |

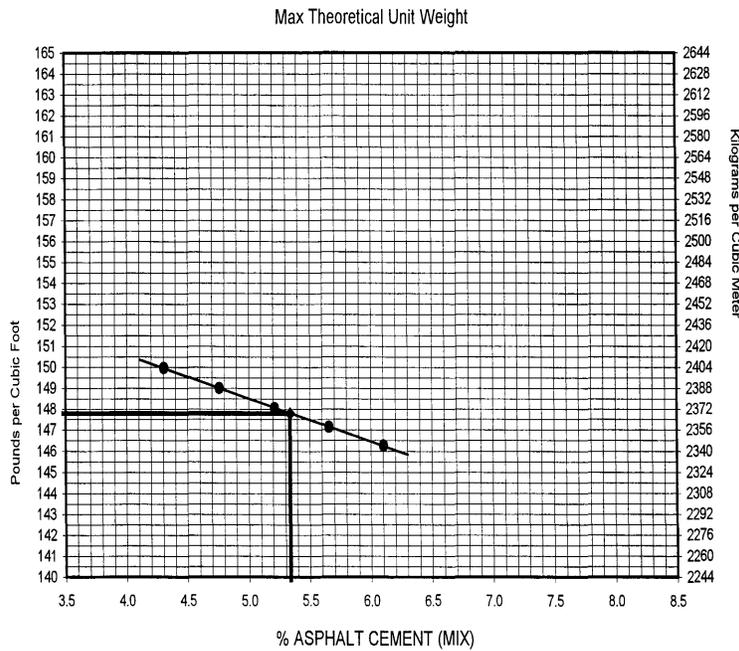
$$SA = 2 \times (\% \text{ Passing Max Sieve Size}) + 2 \times (\% \text{ Passing No. 4}) + 4 \times (\% \text{ Passing No. 8}) + 8 \times (\% \text{ Passing No. 16}) + 14 \times (\% \text{ Passing No. 30}) + 30 \times (\% \text{ Passing No. 50}) + 60 \times (\% \text{ Passing No. 100}) + 160 \times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

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

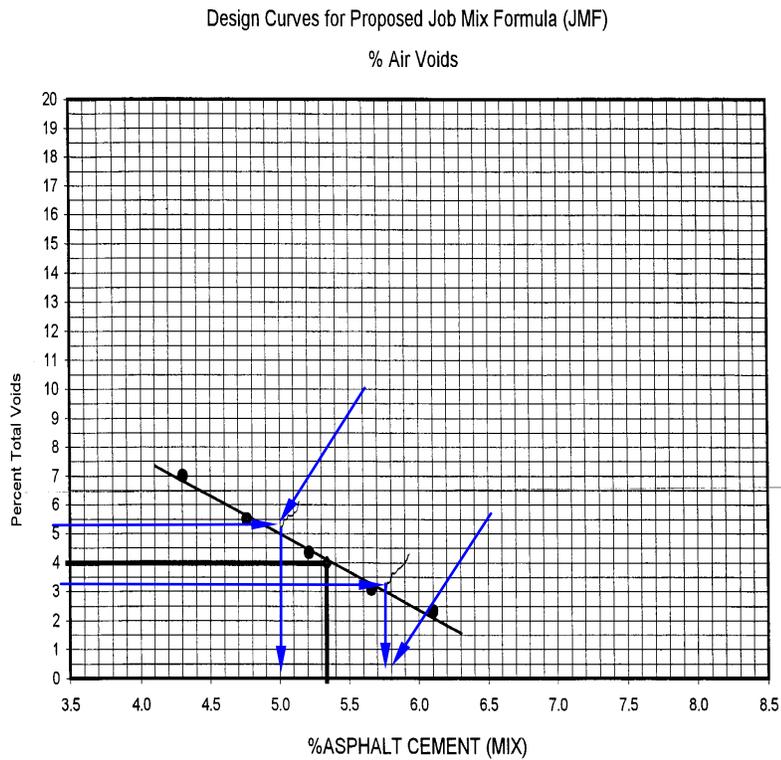


This graph shows how the unit weight of the compacted specimen changes as the percent of asphalt binder changes. This chart can be used to get an approximate bulk density of the compacted mix at a given asphalt content.

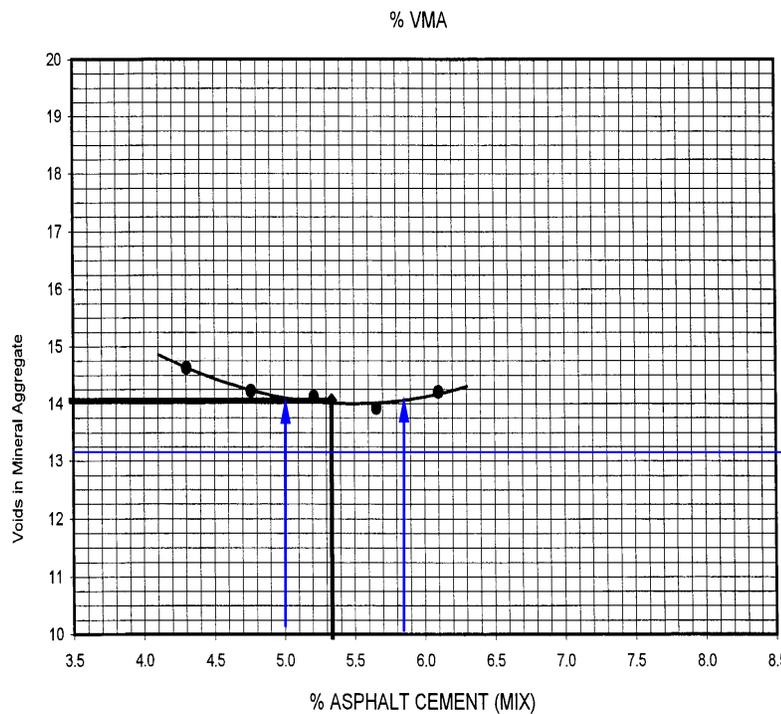


This graph shows how the maximum theoretical unit weight (Rice) of the compacted specimen changes as the percent of asphalt binder changes. This chart can be used to get an approximate Rice density of the compacted mix at a given asphalt content. The weight goes down as the asphalt content goes up.

Figure 260.01.03.1B

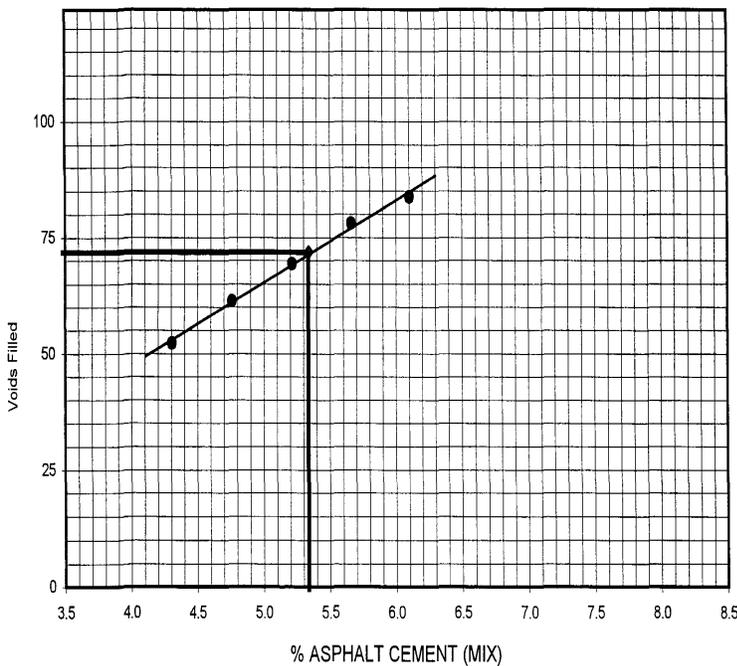
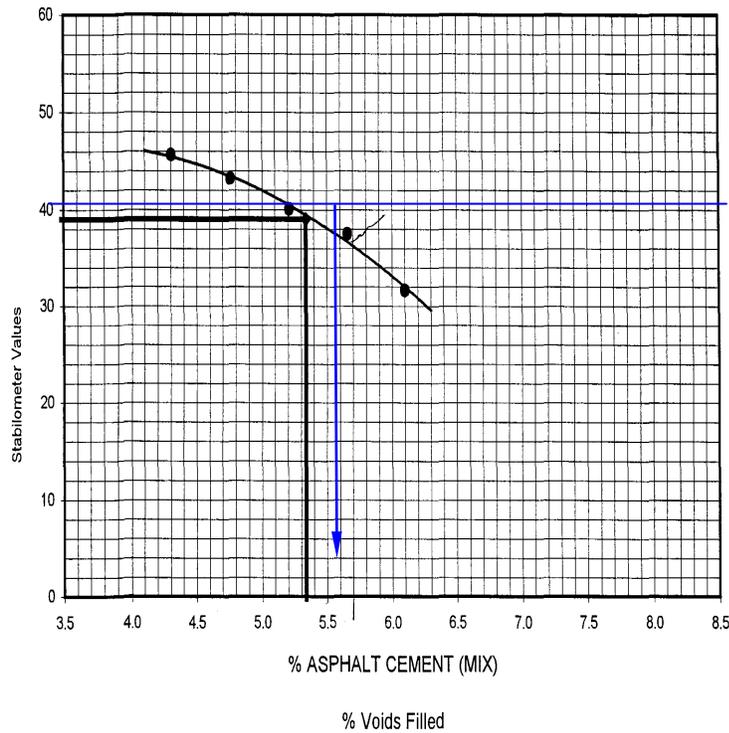


Step 1. Find the asphalt binder percent at 3% and 5% total Air Voids. Select 5% air Voids on the vertical axis and project a line to the left until it intercepts the curve. Then project the line down to the % asphalt binder on the horizontal axis. Do the same with 3% air voids. This mix has a range of 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

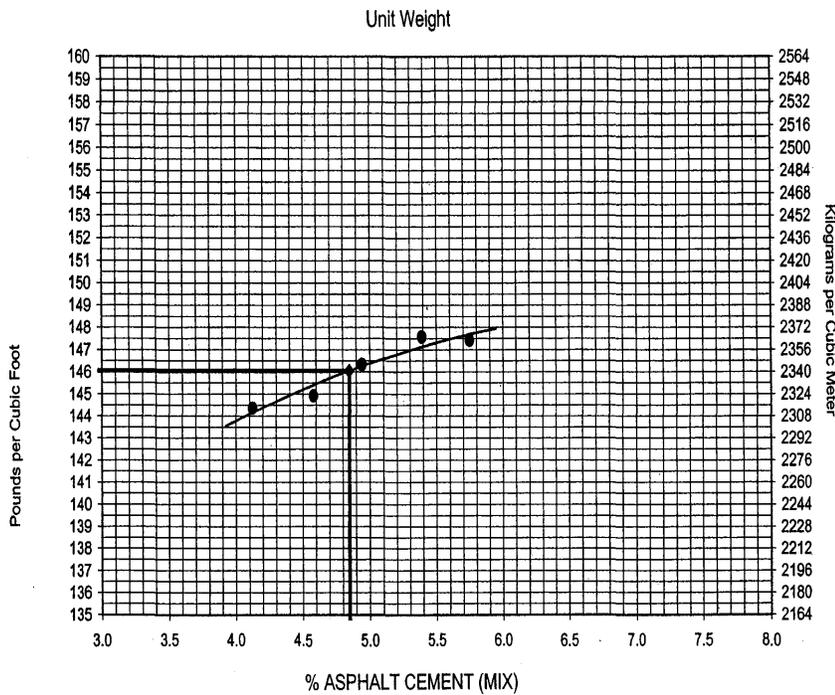


Step 3. Check the stability of the mix over the range of asphalt contents determined in the previous two steps. Draw a line horizontally at the minimum stability value, (37 for this mix), on the vertical axis that intercepts the stability curve. In this mix, the stability falls below the minimum allowed 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.

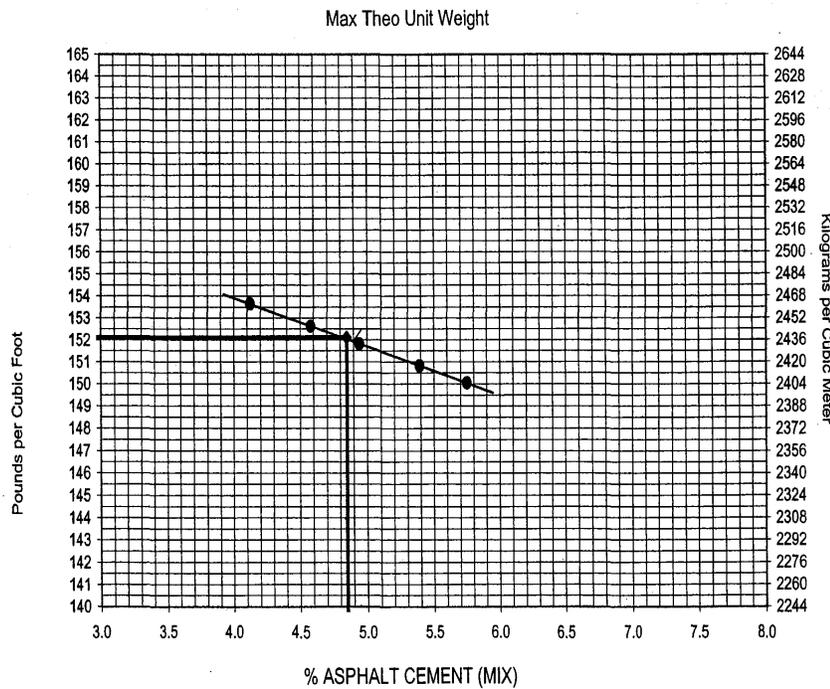
VFA, Voids Filled With Asphalt is not currently a design criteria. VFA is inversely related to air voids and should be around 50 to 70%. When it exceeds approximately 80 to 85% rutting is likely to occur.

Figure 260.01.03.2A

Design Curves for Proposed Job Mix Formula (JMF)



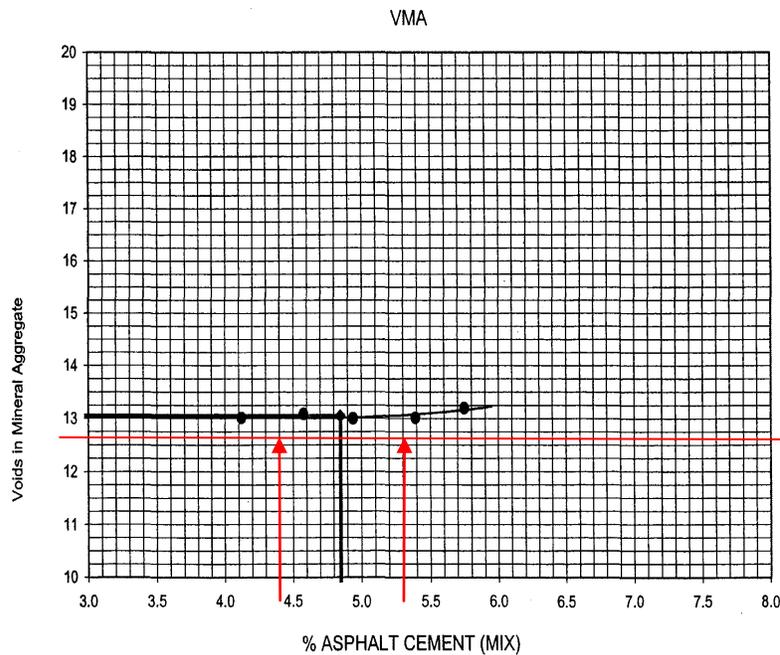
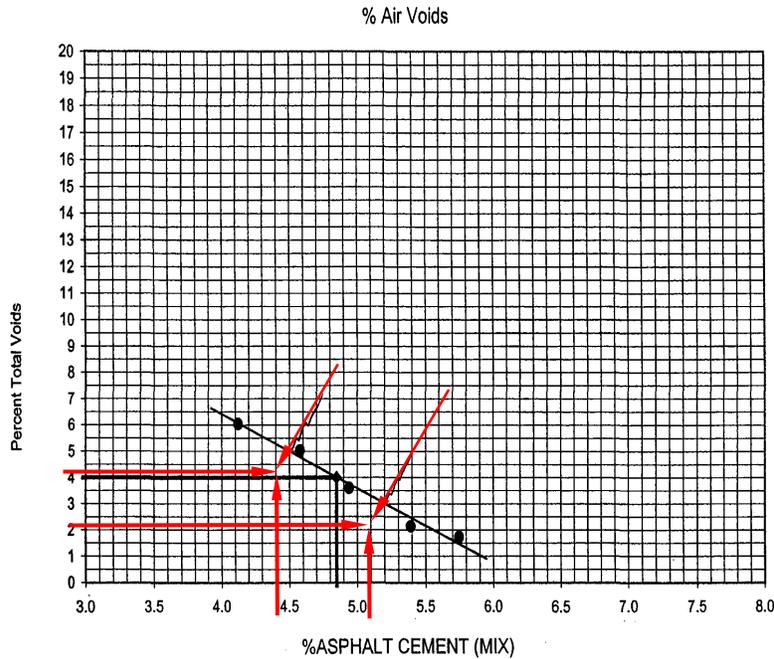
This graph shows how the unit weight of the compacted specimen changes as the percent of asphalt binder changes. This chart can be used to get an approximate bulk density of the compacted mix at a given asphalt content.



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

Design Curves for Proposed Job Mix Formula (JMF)

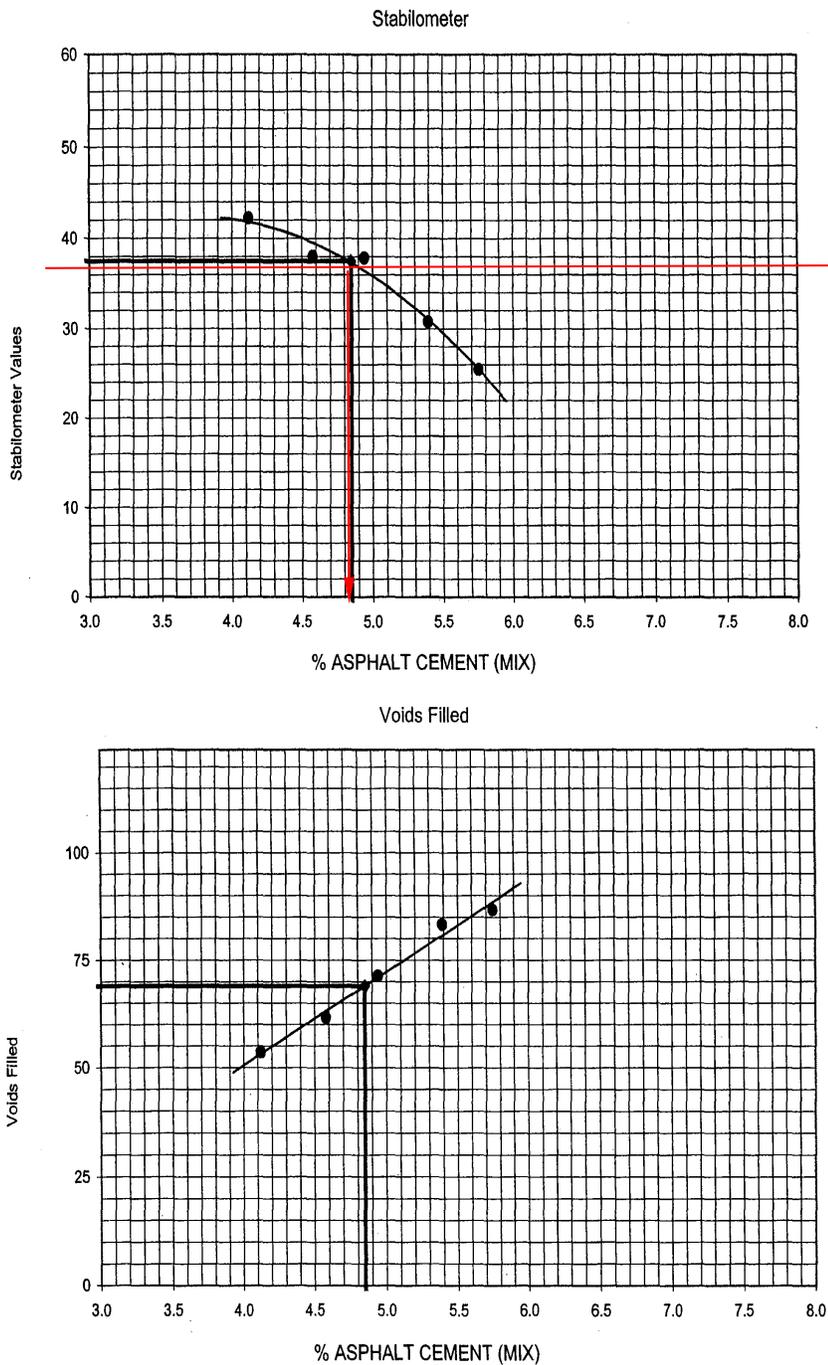


Step 1. Find the asphalt binder percent at 3% and 5% total Air Voids. Select 5% air Voids on the vertical axis and project a line to the left until it intercepts the curve. Then project the line down to the % asphalt binder on the horizontal axis. Do the same with 3% air voids. This mix has a range of 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.

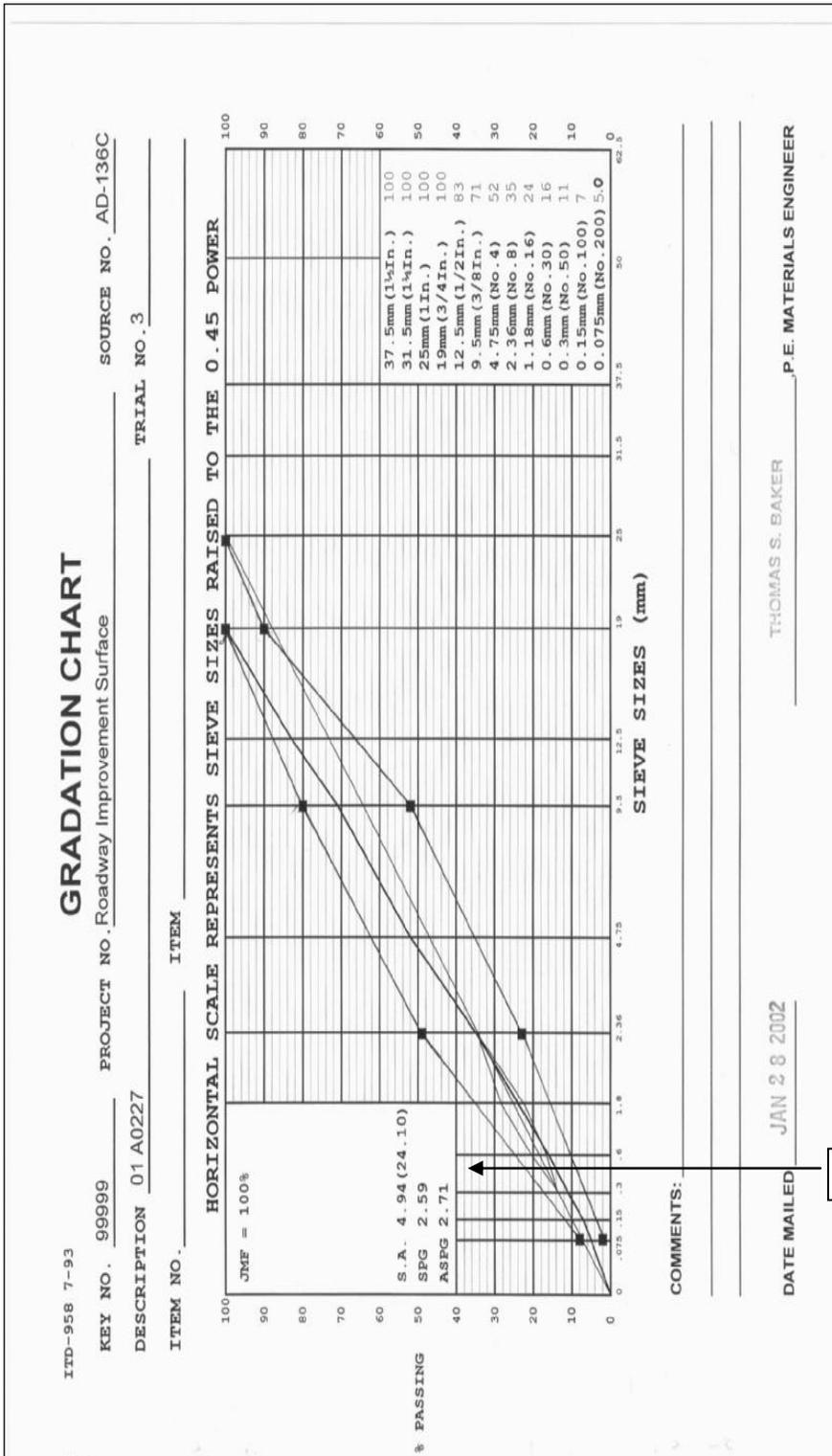
Figure 260.01.03.2C

Design Curves for Proposed Job Mix Formula (JMF)



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.

Restricted Zone

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 HQ Central 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, $\frac{3}{4}$ 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 $\frac{1}{4}$ 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 cementitious 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(0.35)95 COUNTY ELMORE

CONCRETE SUPPLIER ACME SOURCE NO. EL-116

CONTRACT ITEM NO. 409 CONCRETE, CLASS 45 (5600/28 day)

CONCRETE MIX DESIGN NO. 3 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 | AGGREGATE | | LABORATORY NUMBERS | % BLEND EACH SIZE |
|------------------------------|---------------------------------|----------------------------------|----------------------------------|---------------|-----------------|---------------------|-------------------|--|------------|--------------------|-------------------|
| | | | | | | | | BULK SPECIFIC GRAVITY (PPI) OR (SSD) * | % ABSORP. | | |
| 56 | 467 | 116 | 0.47 | 4-7 | | 1/2-2 | 3 | COARSE = 2.57 FINE = 2.61 | 1.2 1.8 | | |
| BLEND SAND = | | | | | | | | CRSE. | CRSE. | FINE | FINE |

% SAND = $\frac{Mc-M}{Mc-Mi}$ = R = 34.5 % 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 = GAL./CU. YD. ÷ 7.48 = 3.743 C.F. = W

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

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

AIR = Y X % AIR $\frac{0.65 \times 1.11}{1.11}$ at max 7% = 1.87 C.F. = A

W + C + FLY ASH + A = 8.837 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. (PPI)(SSD) *

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

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

CORRECTION FOR ABSORPTION

% ABSORP. X LB. C.A. = 22.7 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

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

| BASIC BATCH WEIGHTS FOR A CUBIC YARD BATCH | BATCH WEIGHTS CORRECTED FOR MOISTURE | BATCH WEIGHT |
|--|--------------------------------------|-------------------------------|
| CEMENT .. <u>467</u> LB. | <u>467</u> LB. | <u>467</u> LB. |
| FLY ASH .. <u>116</u> LB. | <u>116</u> LB. | <u>116</u> LB. |
| WATER ... <u>334</u> LB. | <u>334</u> LB. | <u>334</u> LB. |
| COARSE .. <u>1908</u> LB. (PPI) (SSD) * | <u>1885</u> LB. (X) | <u>1885</u> LB. (DRY) (PPI) * |
| FINE <u>1020</u> LB. (PPI) (SSD) * | <u>1002</u> LB. (Z) | <u>1002</u> LB. (DRY) (PPI) * |
| BLEND SAND = <u> </u> LB. (DRY) (SSD) * | <u> </u> LB. | <u> </u> LB. (DRY) (SSD) * |

DETERMINATION OF THE YIELD

TOTAL BATCH WEIGHT (DESIGN) = 3745 LB.

WEIGHT PER CUBIC FOOT (DESIGN) = 138.7 LB.

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

TOTAL BATCH WEIGHT = 26.981 CU. FT. (VOLUME OF CONCRETE PRODUCED)

WT./CU. FT. FRESH CONC. = 0.999 RELATIVE YIELD.

VOLUME OF CONCRETE PRODUCED = 0.999 RELATIVE YIELD.

NUMBER OF YARDS X 27 =

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).

COMPUTED BY D.T. CHECKED BY M.L. 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, G_{sb} , 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, 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:

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

where, G_{sb} = average bulk specific gravity
 P_1, P_2, P_n = individual percentages by mass of aggregate, coarse and fine
 $P_1 + P_2 + \dots + P_n = 100$
 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:

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

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), $RAP-G_{sb}$ 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.

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

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

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

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

$\text{RAP } G_{sb} = \text{RAP } G_{se} - \text{asphalt absorption}$

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)).

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

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)).

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

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.

| <u>Sieve Size</u> | <u>Tolerance, % (±)</u> | <u>Sieve Size</u> | <u>Tolerance, % (±)</u> |
|-------------------|-------------------------|--------------------|-------------------------|
| 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.