## **QUANTITIES**

#### General

The quantities of the various materials involved in the construction of a project are needed for determining the estimated cost of the project and for establishing a base for the contractor's bid and payment.

Upon completion of structural design and detailing of plans, the quantities of materials in the construction of the project shall be computed. Quantities are to be computed and checked independently. Final quantities to be listed in the Special Provisions and Bid Proposal sheet are to be calculated to have an accuracy of +/-1 percent for Plan Quantity items and +/- 5 percent for all other items.

Method of measurement for the various materials shall be in accordance with the ITD Standard Specifications for Highway Construction, current edition, and Supplemental Specifications.

#### Section 210 - Structure Excavation and Compacting Backfill

Structure Excavation, Schedule No. 1, shall include excavation for bridges, box and stiffleg culverts, and Structure Excavation, Schedule No. 2, shall include excavation for all other structures.

Structure excavation will be measured by the cubic yard of material in its original position, using the average end area method. The volume of material actually removed shall be measured within a prism with limiting planes as follows:

- Conduit and Structural Plate Pipe: As shown on the plans. 1.
- 2. Other Structures:
  - The bottom of the foundation. a.
  - The vertical planes 2 ft. outside of and parallel to the outside lines of the structure, in the case of bents with b. individual column footings, the entire bent shall be considered as one structure.
  - With upper limits as follows: c.
    - In embankment sections, the existing ground surface as cross sectioned. (1)
    - (2) In roadway cut sections or channel changes, the planes of the roadway cut or channel change as excavated.

Compacting backfill will be measured by the cubic yard of backfill material placed. The volume will be determined as follows:

- 1. Conduit: As shown on the plans. 2.
  - Other Structures:
    - Below the original ground surface: A volume equal to the volume of structure excavation less the volume a. of the permanent structure including opening, contained within the limits of measurement for structure excavation.
    - b. Above the original ground surface: The volume contained between the outside walls of the structure and vertical planes 4 ft. outside thereof; the original ground surface; and a horizontal plane 1 ft. above the top of the structure or of the subgrade, whichever is the lesser.
    - Volumes of backfill placed through water around abutments, wing walls and piers, will not be included in c. the measurement of quantities for compacting backfill.

Article 16.4 Sheet 2 of 10 10/2023

#### STRUCTURE IN EMBANKMENT



#### STRUCTURE IN NATURAL GROUND



### STRUCTURE ABOVE NATURAL GROUND



#### Section 505 – Piling

#### TEST PILES

Compute the length of test pile by increasing the embedment depth by 50%.

For a predrilled pile, the test pile length would be equal to the length from the cut-off elevation to the bottom of the predrilled hole plus the length from the bottom of the predrilled hole to the estimated pile tip increased by 50%.

#### Example 1 No predrilling

Estimated pile length from cut-off elevation to estimated pile tip elevation = 50' Test pile length =  $50 \times 1.5 = 75'$ 

#### Example 2 Predrilling

Length from the cut-off elevation to the bottom of the predrilled hole = 20' Length from the bottom of the predrilled hole to the estimated pile tip = 30' Test pile length = 20 + 30x1.5 = 65'

#### PILE SPLICES

Pay items for pile splices shall be calculated for "Before Driving" and "During Driving" in accordance with Section 505.05.

The number of splices calculated is the maximum number anticipated and is used to establish the unit price for the number of splices actually used.

Example 1 No Test Piles

LOCATION	NUMBER PILES	PILE CUT-OFF	ESTIMATED PILE	ESTIMATED PILE
		ELEV	TIP ELEV	LENGTH
ABUT 1	10	2322.46	2269.5	53.0
PIER 1	27	2301.50	2238.5	63.0
PIER 2	27	2301.50	2238.5	63.0
ABUT 2	10	2322.14	2269.0	53.0

Before driving: piles > 60' = 27+27 = 541 splice per pile = 54 splices During Driving: piles 60'-100' = (27+27) = 541 splice per pile = 54 splices

Example 2 Test Piles

LOCATION	NUMBER PILES	PILE CUT-OFF	ESTIMATED PILE	ESTIMATED PILE
		ELEV	TIP ELEV	LENGTH
ABUT 1	7	4579.21	4537.21	42.0
ABUT 1 TEST PILE	1	4579.55	4517.55	62.0 X 1.5 = 93.0
ABUT 2	7	4578.90	4508.90	70
ABUT 2 TEST PILE	1	4580.22	4476.22	104.0 X 1.5 = 156

Before driving: piles > 60' = 1+7+1 = 9 1 splice per pile = 9 splices

During Driving: piles 60'-100' = (1+7) = 81 splices per pile = 8 splices Piles > 100' = (1) = 1 2 splices per pile = 2 splices Total = 10

#### Section 510 - Concrete Overlays

#### DECKS WITH 21/2" COVER ON THE TOP LAYER OF EPOXY REINFORCEMENT

Mean removal depth is 2" with a nominal 1.5" of silica fume concrete.

#### DECKS WITH LESS THAN 21/2" COVER ON THE TOP LAYER OF PLAIN REINFORCEMENT

The new concrete overlay shall provide  $2\frac{1}{2}$ " of cover for the top layer of reinforcement and shall have a minimum thickness of 1.5".

The new deck thickness is determined by subtracting the existing top rebar cover from 2.5" and adding the result to the thickness of the existing deck.

#### **REMOVAL DEPTH**

 $\begin{array}{c} C_e = existing \ cover\\ T_e = existing \ deck \ thickness\\ D_m = mean \ removal \ depth\\ S = \frac{1}{2} \ the \ maximum \ aggregate \ size\\ \hline \\ & \underline{ITD \ Construction \ Specifications}\\ Up \ to \ 1967 \qquad & \underline{2"}\\ Between \ 1967 \ \& \ 1976 \\ 1976 \ \& \ after & 1" \end{array}$ 

 $T_n = new deck thickness = T_e + (2.5 - C_e)$ 

Te -  $(D_m-S) = Tn - 1.5 \equiv D_m = S + C_e - 1.0$ 

On the contract plan details, show D<sub>m</sub>, S, C<sub>e</sub>, T<sub>e</sub>, & T<sub>n</sub> values.

#### **CONCRETE OVERLAY QUANTITY**

Use  $D_{max}$  to calculate the concrete overlay quantity. This will provide a pay item cost that should reduce cost over-runs during construction.

$$\begin{split} D_{min} &= D_m - S \\ D_{max} &= D_m + S \end{split}$$

#### EXAMPLE

 $\begin{array}{l} T_e=6"\\ C_e=1.25"\\ T_n=6+(2.5\text{-}1.25)=7.25"\\ 1957 \mbox{ ITD Construction Specifications}=2"\mbox{ max aggregate}\\ S=2"/2=1"\\ D_m=T_e-T_n+1.5+S=6-7.25+1.5+1=1.25"\\ \end{array}$ 

 $\begin{array}{l} D_{min} = D_m - S = 1.25 - 1 = 0.25"\\ D_{max} = D_m + S = 1.25 + 1 = 2.25" \end{array}$ 

 $\begin{array}{c} \text{Concrete overlay quantity} \\ \text{Deck Thickness after Removal } T_r = T_e - D_{max} = 6 - 2.25 = 3.75" \\ \text{Overlay thickness} = T_n - T_r = 7.25 - 3.75 = 3.5" \end{array}$ 

#### Section 551 – Polyester Polymer Concrete Overlay

PPC overlays are a minimum  $\frac{3}{4}$ " thick. Compute the plan quantity by adding  $\frac{1}{8}$ " to the calculated thickness. The calculated thickness shall include the increased thickness over the pier. The additional  $\frac{1}{8}$ " thickness is to allow for surface texture variation.

#### Section 553 – Epoxy Overlay

The 2020 Supplemental Specifications provide requirements for calcined bauxite aggregate and standard aggregate. Show the type of aggregate on the plans. Refer to Bridge Design Manual Article 5.14 for epoxy overlay use.

#### Section 581 – Concrete Crack Repair

For quantity calculations, use the following table as a guide:

CRACK WIDTH	CRACK DEPTH
0.016"	2"
0.03"	3"
1/16"	4"
1/8"	6"
1/4"	12"

1 gallon of epoxy is equal to total cubic inches of crack divided by 231.

<u>Precision of Units</u> The precision of the units to be shown on the Cost Estimate is shown in the following table.

DESCRIPTION	UNIT	UNIT PRECISION
SECTION 205		
Granular Borrow	CY	1
SECTION 210		
Structure Excavation Sch. No. 1	CY	1
Compacting Backfill	CY	1
SECTION 215		
Geosynthetic Reinforced Abutment Backfill	CY	1
SECTION 502		
Concrete – All classes	CY	0.1
Prestressed Girders	FT	0.1
Concrete Parapet	FT	0.1
Approach Slab	SY	0.1
Prestressed Slabs, T-beams, Box Beams	FT	0.1
SECTION 503		
Metal Reinforcement	LB	1
SECTION 504		
Structural Steel	LB	1
Railing	FT	0.1
SECTION 505		
Provide & Drive Piling, Test Piling	FT	1
SECTION 510		
Concrete Overlay	CY	0.1
SECTION 511		
Concrete Waterproofing System	SY	1
SECTION 520		
Pre-drilling for Piles	FT	1
SECTION 551		
PPC Overlay – Prepare & Place	SY	0.1
PPC Overlay – Furnish Material	CY	0.1
SECTION 553		
Epoxy Overlay	SF	0.1

SECTION 565		
Asphaltic Plug Joint	CF	0.1
SECTION 566 & 567		
Expansion Joints	FT	0.1
DESCRIPTION	UNIT	UNIT PRECISION
SECTION 568		
Elastomeric Concrete Header	CY	0.1
SECTION 569		
Remove Expansion Joint	FT	0.1
SECTION 574		
Anti-Graffiti Coating	SF	1
SECTION 575		
Textured Concrete Surface	SY	1
SECTION 576		
GFRP	FT	0.1
SECTION 577		
Pile sleeves	FT	1
SECTION 580		
Remove Asphalt Overlay	SY	0.1
SECTION 581		
Crack Preparation	FT	1
Crack Injection	GAL	0.1
SECTION 582		
Patch & Repair Concrete Surface	SF	1
SECTION 623		
Concrete Slope Paving	SY	0.1
SECTION 624		
Riprap	CY	1
SECTION 632		
Concrete Bridge Deck Removal	SY	0.1
SECTION 640		
Geotextiles	SY	1
SPECIAL PROVISIONS		
MSE Wall	SF	1
Coping for MSE Wall	FT	1
UHPC	СҮ	0.01
Paint Concrete	SF	1

Reference: Contract Administration Manual and Standard Specifications for Highway Construction

# **Revisions:**

Nov 2019	Moved Article A5.7 Concrete Overlay quantity calculations to this article under Section 510. Added instructions for Concrete Overlay on decks with epoxy reinforcement. Added quantity calculation instructions for PPC overlays, Section 551. Revised Precision of Units Table for 2018 Specification pay items.
May 2021	Changed unit precision of crack injection from 1.0 to 0.1 gallons.
Sept 2021	Clarified the PPC Overlay plan quantity calculations. Added accuracy of plan quantity items of +/- 1% and all other items of +/- 5%. Added Section 505 for computing test pile length.
June 2022	Reformatted Precision of Units Table and added Sections 215 & Section 574. Added type of aggregate for epoxy overlays should be shown on the plans.
Oct 2023	Corrected the length of pile from cut-off elevation to pile tip elevation rather than from bottom of pile cap. Corrected the test pile length from the cut-off elevation to the bottom of the predrilled hole plus 1.5 times the length from the bottom of the predrilled hole to pile tip elevation. Revised the number of pile splices before driving & during driving to agree with the 2024 Supplemental Specifications. Added Section 581 formula to compute gallons of epoxy injection.