

## Minnesota response State Report Questions

April 26-28, 2011 TTCC/NCC Meeting

**1. Summarize your state's current QC/QA requirements for pavements.**

See below.

**2. Identify any differences in QC/QA requirements on projects with accelerated schedules.**

None

**3. Summarize the requirements for allowable time between batching and placement for agitated and non-agitated concrete mixes.**

### G.3 Delivery Requirements

Incorporate ready-mix concrete into the work within the specified time limits as shown below. The batch time begins when the cement is added to the other batch materials.

- Type 1 Concrete – Discharge concrete into the work within 90 minutes of batching.
- Type 3 Concrete – Discharge concrete into the work within 60 minutes of batching when the air entraining agent is added at the plant. When the entire dosage of air entraining agent is added at the jobsite, discharge the concrete into the work within 90 minutes of batching. Do not add additional mixing water once the concrete is 60 minutes old.

The Engineer will allow transporting Type 3 concrete in non-agitating equipment as long as the concrete is discharged within 45 minutes of batching.

**4. Summarize acceptance and payment adjustment clauses related to QC/QA requirements.**

### D.4 Concrete Pavement Incentives and Disincentives

The Department shall apply concrete mix incentives and disincentives for Contracts using at least 3,500 cu. yd [2,900 cu. m] of concrete, calculated by multiplying the planned pavement area by the planned pavement thickness, of paving concrete.

The Department will only apply coarse aggregate quality incentives or disincentives for materials provided or produced by the Contractor's primary concrete plant.

The Department will not provide water/cement ratio incentive payments for high-early mixes. The Department will only apply water/cement incentives or disincentives for concrete hauled in dump trucks, agitator trucks, or both.

If the Contractor adds water to the pavement surface without approval by the Engineer, the Department will not pay water/cement or ride incentives on sections where the water is added and the Engineer may reject the pavement in accordance with 1503, "Conformity with Plans and Specifications" and 1512, "Unacceptable and Unauthorized Work."

#### D.4.a Coarse Aggregate Quality Incentive/Disincentive

The Engineer will accept the coarse aggregate for paving concrete by statistical methods and in accordance with all other aggregate quality requirements of 2301, 2461, and 3137.

The **Coarse Aggregate Quality Incentive/Disincentive** for CLASS B and CLASS C Aggregates will comply with the following:

The Engineer will take samples at the belt leading to the weigh hopper or other locations close to the incorporation of the work. The Engineer will take samples in accordance with Table 2301-5:

<b>Table 2301-5</b>	
Coarse Aggregate Quality Incentive/Disincentive Sampling Rates	
<b>Plan Concrete, cu. yd [cu. m]</b>	<b>Samples per Fraction (n)</b>
3,500 – 7,500 [2,900 – 6,250]	3
7,501 – 10,000 [6,251 – 8,500]	5
10,001 – 25,000 [8,501 – 21,000]	10
25,001 – 50,000 [21,001 – 42,000]	15
50,001+ [42,001+]	20

The Engineer will consider the entire Project as a single lot for each of the two fractions containing the highest percentage by weight. If the Project is planned for construction over multiple years and prior to placing any concrete pavement, the Contractor shall request the Engineer calculate the incentive/disincentive payment on a yearly basis. The Engineer, in conjunction with the Concrete Engineer, will modify the sampling and testing rates as necessary.

The Engineer will establish a new statistical family for each change in aggregate source, fraction, or both.

The Engineer will randomly choose the samples.

The Engineer will divide a lot representing the Plan cubic yards [cubic meters] of concrete by the number of samples to form sublots. The Engineer will multiply the number of cubic yards [cubic meters] in a subplot by a random number to obtain the position in the subplot for the sample. The Engineer will split the samples and leave half of the sample for the Contractor. The Engineer’s laboratory will test the samples and report the individual results. The Engineer will calculate a Quality Index (QI) for each fraction in accordance with the following:

$$QI = X + k(s)$$

Where:

$$X = \text{mean} = \sum \frac{X_i}{n}$$

$X_i$  = individual test results

$$s = \text{standard deviation} = \sqrt{\sum \frac{(x_i - x)^2}{(n-1)}}$$

k = Adjustment Factor based on the number of tests as shown in Table 2301-6:

<b>Table 2301-6</b>	
<b>Adjustment Factor “k”</b>	
<b>k</b>	<b>No. of Tests</b>
1.09	3
1.23	5
1.26	10
1.27	≥ 15

If Class A, Class B, and Class C aggregates meet the requirements as determined by the Engineer, the Department will provide payment based on a per fraction incentive in accordance with Table 2301-7.

<b>Table 2301-7</b>		
<b>Coarse Aggregate Quality Incentive/Disincentive</b>		
<b>Aggregate Class</b>	<b>QI for Fraction, %</b>	<b>Structural Concrete per cu. yd [cu. m] Payment Change per Fraction</b>
Class A (including quartzite and gneiss)	—	\$1.00 [\$1.30]
Class B (based on % absorption)	$\leq 1.00$	\$1.00 [\$1.30]
	1.01 – 1.45	\$0.50 [\$0.65]
	1.46 – 1.76	\$0.00
	1.77 – 1.85	-\$1.00 [\$1.30]
	$\geq 1.86$	As recommended by the Concrete Engineer, with coordination of the Engineer
Class C (based on % carbonate)	$\leq 15.0$	\$1.00 [\$1.30]
	15.1 – 24.0	\$0.50 [\$0.65]
	24.1 – 31.0	\$0.00
	31.1 – 35.0	-\$1.00 [\$1.30]
	$\geq 35.1$	As recommended by the Concrete Engineer, with coordination of the Engineer

The Department will not pay incentives or disincentives for Class R aggregates.

If the concrete mixture contains at least three fractions of coarse aggregate, the Engineer will consider only the two containing the highest percentage by weight as eligible for incentive. The Contractor may combine at least two sub-fractions to form the  $\frac{3}{4}$  in – [19 mm –] fraction for either the coarse or fine fraction of the coarse aggregate. Blend the sub-fractions by weight. The Engineer will base the maximum incentive for aggregate quality on the two largest fractions by weight.

The Department will pay for Coarse Aggregate Quality Incentive/Disincentive for all paving concrete, including water/cement ratio concrete, and high-early concrete provided by the Contractor's primary paving plant.

#### **D.4.b Water/Cement (w/c) Ratio**

Provide and place concrete with a water/cement ratio not to exceed 0.40. Make any adjustments immediately when the water/cement ratio exceeds 0.40.

The Department will not make incentive payments for water/cement ratio on high-early mixes.

Do not add water to the surface of the concrete to aid in finishing without the approval of the Engineer. Supply sufficient trucks to ensure a steady forward progress of the paver.

The Department will determine the water/cement ratio for concrete hauled in dump or agitator trucks in accordance with the following:

##### **D.4.b(1) Water Content Determination**

For a concrete paving batch plant, use an electronic meter approved by the Engineer to record the water, including temper water, added to the mix that is capable of printing the amount of total water on each batch ticket.

For a ready-mix plant, record the total water added to the mix, including temper water, on the computerized Certificate of Compliance.

The Engineer will determine the water content for calculating the water/cement ratio using the average water calculated from 10 batch tickets or Certificates of Compliances surrounding the randomly selected batch ticket sample (four previous tickets, ticket representing the random sample, and the five following tickets).

##### **D.4.b(2) Water Content Verification**

The Engineer will use plastic concrete taken at the plant site to verify the water content in the mix as determined in accordance with 2301.2.D.4.b.(1), “Water Content Determination.” The Contractor will sample the plastic concrete as directed by the Engineer.

The Engineer will verify the water content in the plastic concrete mixture using the test procedure specified in AASHTO T 318-02, “Standard Test Method for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying.” The Engineer will begin the test within 45 min after the water has contacted the cement. Provide the microwave oven and the ancillary equipment as required by the Engineer to perform this test.

**D.4.b(3) Cementitious Content Determination**

The Engineer will determine the cementitious content for calculating the water/cement ratio using the average total cementitious calculated from 10 batch tickets or Certificates of Compliances surrounding the randomly selected batch ticket sample (four previous tickets, ticket representing the random sample, and the five following tickets).

**D.4.b(4) W/C Ratio Incentive/Disincentive**

The Engineer will base the statistical analysis of acceptance for water/cement ratio in accordance with 2301.3.D.4.b(1) and 2301.3.D.4.b(3).

The Engineer will randomly choose acceptance samples. The Engineer will determine the sampling location by using a random number chart and multiplying the random number by the sampling rate as defined in the Schedule of Materials Control.

The Engineer will sample, test, and record the individual results.

If the quantities of concrete produced results in no Agency moisture testing for any given day, include the untested quantity of concrete into the next day’s production and include that quantity of concrete in the sampling rate. If the untested quantity is on the last day of production, add that quantity to the previous day’s production.

Do not place concrete mix not meeting the 0.40 water/cement ratio requirement in the work. The Engineer may accept material not meeting the Contract requirements and the Department will pay for the work in accordance with Table 2301-8.

<b>Table 2301-8</b>	
<b>W/C Ratio Incentive/Disincentive</b>	
<b>W/C Ratio Test Result</b>	<b>Payment incentive/disincentive per cu. yard [cu. m]</b>
$\leq 0.37$	+\$3.00 [\$3.90]
0.38	+\$1.75 [\$2.25]
0.39	\$0.50 [\$0.65]
0.40	\$0.00
0.41	-\$0.50 [\$0.65]
0.42	-\$1.75 [-\$2.25]
0.43	-\$3.00 [-\$3.90]
$\geq 0.44$	Determined by the Concrete Engineer

The Contractor may remove and replace concrete represented by water/cement ratios greater than 0.40. For concrete left in place with water/cement ratios greater than 0.40, if the level of payment is not defined in the table, the Engineer in conjunction with the Concrete Engineer, will evaluate the material based on the adequacy of the material for the use intended. Remove and replace unsatisfactory concrete as determined by the Engineer at no additional cost to the Department.

**D.4.c Well-Graded Aggregate Optional Incentive**

The Engineer will use the Contractor’s combined aggregate gradation test results, as verified by Department testing, to determine eligibility for the incentive.

The Contractor has two well-graded aggregate optional incentives available as follows:

- (1) Percent Retained Gradation Band in accordance with Table 2301-9.

<b>TABLE 2301-9</b>		
<b>8-18 or 7-18 Percent Retained Gradation Band</b>		
<b>Sieve Sizes</b>	<b>8-18 % Retained</b>	<b>7-18 % Retained</b>
2 inch [50 mm]	0%	0%
1 ½ inch [37.5 mm]	≤9%	≤9%
1 inch [25 mm]	8% to 18%	7% to 18%
¾ inch [19 mm]	8% to 18%	7% to 18%
½ inch [12.5 mm]	8% to 18%	7% to 18%
3/8 inch [9.5 mm]	8% to 18%	7% to 18%
#4 [4.75 mm]	8% to 18%	7% to 18%
#8 [2.36 mm]	8% to 18%	7% to 18%
#16 [1.18 mm]	8% to 18%	7% to 18%
#30 [600 µm]	8% to 18%	7% to 18%
#50 [300 µm]	≤ 13%	≤ 13%
#100 [150 µm]	≤8%	≤7%
#200 [75 µm]	≤8%	≤7%

- (2) Gradation Zone II-A of the Coarseness Factor Chart in accordance with Table 2301-10.

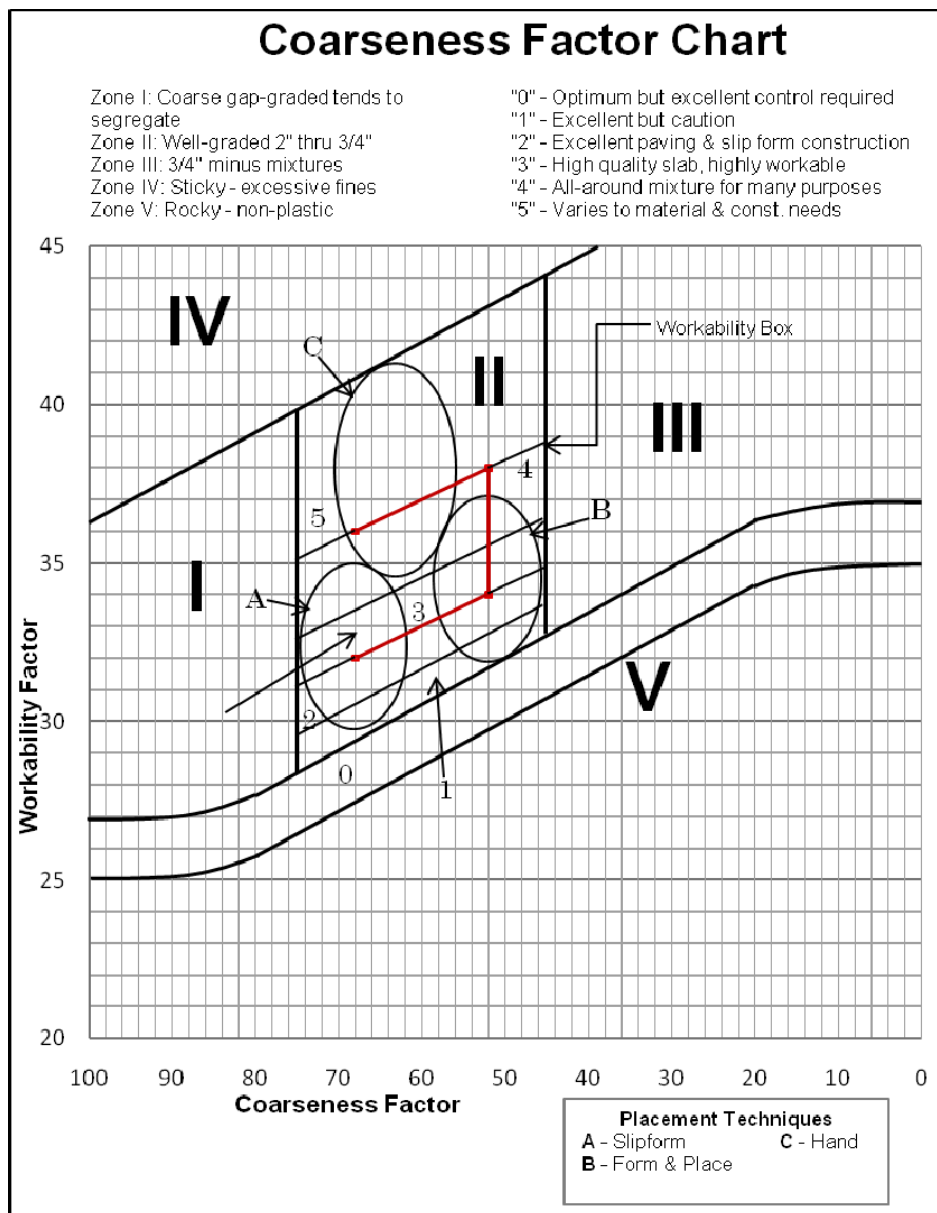
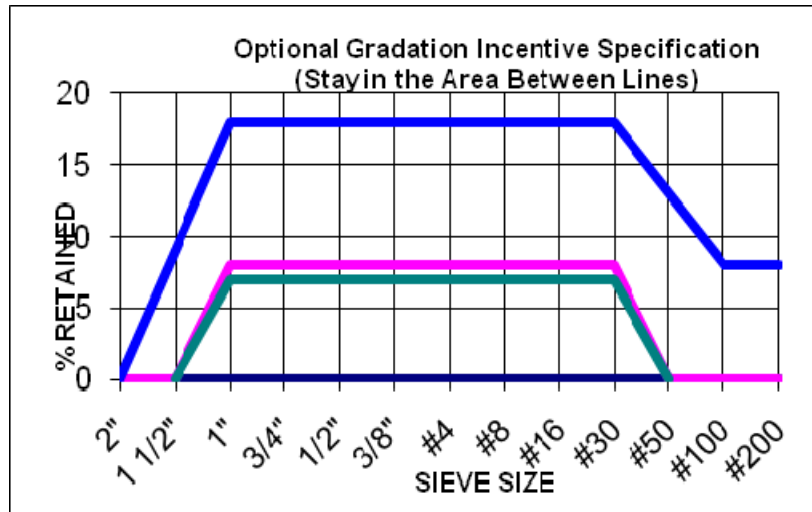
<b>TABLE 2301-10</b>	
<b>Coarseness Factor Boundaries – Zone II-A</b>	
<b>Coarseness Factor (CF)</b>	<b>Workability Factor (WF)</b>
52	34 - 38
68	32 - 36
The Coarseness Factor (CF) is defined as follows: $CF = \frac{\text{Combined \% retained above } 3/8 \text{ in [9.5 mm] sieve}}{\text{Combined \% retained above No.8 [2.36 mm] sieve}} \times 100$	The Workability Factor (WF) is defined as follows: WF = Combined % passing No.8 [2.36 mm] sieve

The Engineer will use statistical analysis of the Contractor’s combined aggregate gradation samples for well-graded aggregate on a lot basis representing one day’s paving. The lot will represent the cumulative average of the subplot values on each sieve for the gradation band or the cumulative average of the subplot values of the coarseness factor and workability factor for the coarseness factor chart.

An optional incentive is available to the Contractor provided a concrete mixture is designed and produced with a well-graded aggregate gradation that meets one of the following in accordance with Table 2301-11. The Contractor may achieve only one of the optional incentives for any single lot.

<b>TABLE 2301-11</b>	
<b>Well-Graded Aggregate Optional Incentive</b>	
<b>Gradation Options</b>	<b>Payment incentive/disincentive per cu. yard [cu. m]</b>
8-18 Retained	\$2.00 per cubic yard (\$2.60 per m <sup>3</sup> )
7-18 Retained	\$0.50 per cubic yard (\$0.65/m <sup>3</sup> )
Gradation Zone II-A	\$2.00 per cubic yard (\$2.60 per m <sup>3</sup> )

The Engineer will use the Contractor’s combined aggregate gradation test results, as verified by Department testing, to determine compliance.



## **N Thickness Requirements**

Provide pavement with a finished pavement thickness as shown on the Plans or as modified, in writing, by the Engineer.

### **N.1 QC/QA Procedure**

Construct pavement to the thickness shown on the plans. On each Project and on each roadbed of a divided highway, evaluate pavement thickness in accordance with the following:

- (1) Contractor Quality Control Probing (QCP),
- (2) Probe Verification Core (PVC), and
- (3) Quality Assurance Core (QAC).

The Department defines plan thickness lot (PTL) as concrete pavement of the same thickness added together lineally. Establish a separate PTL for each concrete plan thickness on the Project.

The Department defines a subplot as the rate at which an individual measurement is taken over a given length. The Department considers a subplot as one lane wide, measured in accordance with the following:

- (1) From the pavement edge to the adjacent longitudinal joint,
- (2) From one longitudinal joint to the next, or
- (3) In the absence of a longitudinal joint, between pavement edges.
- (4) Each ramp and loop 18ft (5.5 m) wide or less is considered a single lane.

The Engineer will divide the PTL into sublots of 4,000 lineal lane ft [3,300 lineal lane m] to determine the QCP, PVC, and QAC locations. The Engineer will add partial sublots less than 2,000 ft [1,650m] to the previous lot. The Engineer will consider partial sublots equal to or greater than 2,000 lineal lane ft [1,650 lineal lane m] as individual sublots. If the PTL for the entire Project is less than 4,000 lineal lane ft [3,300 lineal lane m] the Engineer will consider the PTL as an individual subplot.

The Engineer will identify the QCP, PVC, and QAC thickness measurement locations in accordance with the following:

- (1) Determine the longitudinal locations using random numbers multiplied by length of the subplot.
- (2) Determine the transverse offset locations using a random number multiplied by the width of the traffic lane, ramp, or loop at the determined longitudinal location.
- (3) Adjust the location to ensure the Contractor takes no measurements within 1 ft [0.3 m] of the pavement edge and takes no measurements within 2 ft [0.60 m] of any transverse or longitudinal joint or other obstructions.

### **N.2 Contractor Quality Control Probing (QCP)**

Measure the pavement thickness of freshly finished concrete pavement at a rate of at least four QCP measurements per subplot. Notify the Engineer before performing probing thickness measurements in the plastic concrete so they may inspect or observe the Contractor's QCP tests during the paving operations.

Provide daily summary reports listing the results of the day's QCP thickness measurements and additional probing results to the Engineer.

### **N.3 Contractor QCP Probing Equipment and Probing Method**

Provide the following equipment as approved by the Engineer to perform QCP probing:

- (1) Probing rod meeting the following characteristics and requirements:
  - (1.1) Non-flexing,
  - (1.2) Length capable of completely penetrating the pavement for measuring,
  - (1.3) Utilizes a circular or square top plate,

- (1.4) Contains a centrally located hole in the top plate with a diameter allowing for easy maneuvering along the length of the probing rod, and
- (1.5) Fitted with a locking device fixing the angle between the top plate and the probing rod at 90 degrees when locked.
- (2) Base plate meeting the following characteristics and requirements:
  - (2.1) 10.5 in [267 mm] square 26 gage galvanized steel plates or 11.8 in [295 mm] diameter 28 gage high strength steel circular plates or,
  - (2.2) Rigid when in place, allowing the probing rod to be pushed against it without flexing, and
- (3) Work bridge meeting the following characteristics and requirements:
  - (3.1) Spans the full width of the freshly laid concrete,
  - (3.2) Supports a person, and
  - (3.3) Height above the concrete allows for the use of the probing device.
- (4) Tape measure accurate to nearest  $\frac{1}{8}$  in [even mm] and with a length capable of measuring the depth of penetration of the probing device into the plastic concrete pavement.

Perform probing in accordance with the following:

- (1) Place the base plates at the randomly selected locations and anchor the plates to prevent movement during concrete placement. Mark the locations of the base plates to ensure ease of locating the plates after the paver has passed,
- (2) Position the bridge at the selected locations to reach and locate each point,
- (3) Assemble the probing device. Keeping the probing rod perpendicular to the pavement surface, insert the rod into the plastic concrete until the rod strikes the base plate,
- (4) Slide the top plate down the probing rod until it contacts the pavement surface, then lock to the probing rod,
- (5) Withdraw the probing device, and
- (6) Measure the length of the probing rod inserted into the plastic concrete from the underside of the top plate to the end of the probing rod. Record this measurement to the nearest  $\frac{1}{8}$  in [even mm].

#### **N.4 Quality Assurance Testing – Coring**

The Engineer will measure the pavement thickness of concrete for each subplot in accordance with the following:

- (1) Probe Verification Core (PVC), and
- (2) Quality Assurance Core (QAC).

The Engineer will mark one of every four QCP measurement locations per subplot for a PVC. The Engineer will mark one QAC per subplot. The Contractor will core at the designated PVC and QAC locations.

#### **N.5 PVC and QAC Coring Method**

- (1) Begin coring on concrete older than 7 days, when the control beams attain a flexural strength in accordance with Table 2301-1, or when the control cylinders attain a compressive strength of 3,000 psi [20.6 MPa]. Use 3U18 concrete or another concrete mix approved by the Engineer to fill the core holes within 72 h of coring at no additional cost to the Department. Provide traffic control for coring;
- (2) Cut 4 in [100 mm] nominal diameter cores at marked locations. Lay the cores next to the holes in a curing condition. Protect the cores. Do not submit cores out of round, not perpendicular, or containing ridges;
- (3) The Engineer will field measure the core thickness to the nearest  $\frac{1}{8}$  in [even mm], verify (Field ID Number) the cores, and record the field measurement on Mn/DOT Form 24327, “Field



Core Report” or a computerized spreadsheet available on the Mn/DOT Concrete Engineering website;

- (4) Pick up the cores, accompanied by the Engineer. Store the cores in a water tank heated from 60° F [15° C] to 80° F [25° C] at the Department field office. The Engineer will not require the storage of cores in a curing condition for concrete older than 28 days;
- (5) The Engineer will transport the cores in a curing condition, unless older than 28 days, to the Mn/DOT Office of Materials and Road Research; and
- (6) The Mn/DOT Office of Materials and Road Research will determine the pavement thickness by measuring the length of the PVC and QAC cores in accordance with the procedure on file at the Mn/DOT Office of Materials and Road Research. Following this procedure, the Mn/DOT Office of Materials and Road Research will use nine probes interconnected in a hydraulic linkage to obtain the average length of the core in one operation. The Mn/DOT Office of Materials and Road Research will record the core length to the nearest 0.05 in [1 mm].

#### **N.6 Non-conforming thickness**

The Department will base acceptance of the pavement thickness and price adjustment for deficient thickness on the combination of both lab measured PVC and QAC coring.

The Department defines the tolerance limit for pavement thickness as the plan thickness lot (PTL) minus ½ in [13 mm]. If the QCP measurement shows a thickness deficiency greater than PTL minus ½ in [13 mm], take a core at the location of the deficient QCP. If any core thickness measurement (PVC or QAC) shows a thickness deficiency greater than PTL minus ½ in [13 mm], consider the pavement defective and take exploratory cores as directed by the Engineer.

The Department defines the defective pavement area as the entire area surrounding the deficient core within a traffic lane and between acceptable cores. The Department considers the pavement acceptable in the remaining areas as the increment where the cores show a thickness deficiency no greater than PTL minus ½ in [13 mm].

Take the first exploratory cores at any location within 10 ft [5 m] on each side of the deficient thickness location and at the same distance from the pavement centerline. Take an additional exploratory core in the adjacent traffic lane if the concrete was placed in the same operation. If the length of each of the first exploratory cores is at least equal to the PTL minus ½ in [13 mm], the Engineer will not require additional cores from this location. If any cores do not fall within the PTL minus ½ in [13 mm], take additional exploratory cores at 25 ft [10 m] intervals and at the same distance from the pavement centerline in the same lane as the original thickness measurement, as directed by the Engineer. Perform coring in the direction of the deficiency until obtaining a core with a length at least equal to the PTL minus ½ in [13 mm]. The Engineer will use exploratory cores to determine the extent of deficient pavement thickness for adjusting the unit bid price or requiring pavement removal and replacement.

For cores showing a pavement thickness greater than the PTL minus ½ in [13 mm] to 1 in [25 mm], the Contractor may choose one of the following:

- (1) Remove and replace the defective pavement area, or
- (2) Leave the pavement in place with a monetary deduction of \$20 per sq. yd [\$25 per sq. m] for the defective pavement area, as approved by the Engineer.

For cores showing a pavement thickness greater than PTL minus 1 in [25 mm], the Engineer, in conjunction with the Concrete Engineer, will determine whether the Contractor will remove and replace concrete

pavement or leave the pavement in place at no cost to the Department and apply a monetary deduction of \$20 per sq. yd [\$25 per sq. m] for the defective pavement area in accordance with 1503.

The Engineer will use the PVC and QAC cores to determine the final average plan thickness lot (PTL), except for the following:

- (1) If exploratory cores are taken to identify the defective pavement area, substitute the two outside exploratory cores that are within PTL minus ½ in [13 mm] for the deficient PVC or QAC.
- (2) If the length of a PVC or QAC exceeds the by PTL plus 0.30 in [8 mm], the Engineer will limit the core length to the PTL plus 0.30 in [8 mm].

The Engineer will consider the pavement thickness as conforming provided the deficiency of the final average PTL does not exceed PTL minus 0.10 in [3 mm]. If the final average PTL is deficient by more than the PTL minus 0.10 in [3 mm], the Department will pay for the pavement in the PTL at the Contract unit price less the following monetary deductions in accordance with 1503 and Table 2301-14, excluding areas of defective pavement.

<b>Table 2301-14</b>	
<b>Deductions for Thickness Deficiencies</b>	
<b>Thickness Deficiency Exceeding Permissible Deviations, in [mm]</b>	<b>Adjusted unit bid price per sq. yd [sq. m] of Payment</b>
0.00 – ≤ 0.10 [≤ 3]	None (tolerance)
0.10 – ≤ 0.20 [3 – ≤ 5]	\$0.20 [\$0.25]
0.20 – ≤ 0.30 [5 – ≤ 8]	\$0.40 [\$0.50]
0.30 – ≤ 0.40 [8 – ≤ 10]	\$0.70 [\$0.90]
0.40 – ≤ 0.50 [10 – ≤ 13]	\$1.00 [\$1.25]
0.50 – ≤ 1.00 [13 – ≤ 25]*	\$20.00 [\$25.00]
* Perform exploratory coring as required by the Engineer.	

After Department thickness verification, the Department will test all of the cores for compressive strength at 60 days of age. The Department will test three of the cores from the entire Project for rapid chloride permeability (RCP) in lieu of compressive strength testing for information only.

**IV. Concrete Construction Items (cont.) (www.dot.state.mn.us/materials/concrete.html)**

**Concrete Pavement - Concrete Plant Production**

**Remarks:**

- (1) Mix Design is Contractor's responsibility with review by Mn/DOT unless otherwise specified in the Contract.
- (2) When incentives apply according to 2301:
  - a) Contractor QC Technician and Agency Plant Monitor are required to be present during the entire pour.
  - b) A certified ready-mix plant shall be **dedicated (provides concrete only to the concrete paving project)**.
- (3) All gradation samples shall be taken in the presence of the Agency, unless otherwise authorized by the Engineer. All gradation and quality tests require companion samples
- (4) Perform Quality testing as directed by the Concrete Engineer.

**Minimum Sample Sizes:**

**Gradation Test:**

+19 mm (3/4" Plus)	10 (25 lb.)
-19 mm (3/4" Minus)	5 kg (10 lb.)
CA-70, CA-80	2.5 kg (5 lb.)
Sand	500 g (1.1 lb.)

**Moisture Test:**

Coarse Aggregate	2000 g (4.4 lb.)
Fine Aggregate	500 g (1.1 lb.)

**Quality Sample Size for Lab Submittal:**

+19 mm (3/4" Plus)	25 kg (50 lb.)
-19 mm (3/4" Minus)	15 kg (30 lb.)
Fine Aggregate	15 kg (30 lb.)

Pay Item No.	Test Type	Spec. No.	Producer/Contractor Testing		Agency Testing	Form No.
2301	Gradation Testing (QC/QA) (5-694.145 and 5-694.148)	3126	<b><u>For a concrete paving batch plant:</u></b> <b><u>When over 200 m<sup>3</sup> (250 yd<sup>3</sup>) is produced per day:</u></b> 1 per 750 m <sup>3</sup> (1000 yd <sup>3</sup> ) or completed 1 per ½ day, whichever results in the highest sampling rate.	<b><u>For a certified ready-mix plant:</u></b> <b><u>When over 20 m<sup>3</sup> (yd<sup>3</sup>) is produced per day:</u></b> 1 per 175 m <sup>3</sup> (250 yd <sup>3</sup> ) or completed every 4 hours, whichever results in the highest sampling rate.	Test the first 4 QA samples of production each time the Contractor mobilizes the plant or changes aggregate sources. 1 per day on randomly selected samples thereafter. Identify the gradation samples with "QA Gradation" on the Sample ID Card and include the JMF Number and the QC Gradation results. <b>If Coarse Aggregate Quality Incentive/Disincentives apply:</b> The Agency may also use the QA gradation sample for the Coarse Aggregate Quality incentive/disincentive testing. In this case, notify the Producer/Contractor to double the QC/QA gradation sample size.	21764 Concrete Aggregate Worksheet JMF  Well-graded Concrete Aggregate Worksheet
		3137				

Concrete Pavement - Concrete Plant Production							
Pay Item No.	Test Type	Spec. No.	Producer/Contractor Testing		Agency Testing	Form No.	
2301	Coarse Aggregate Testing on -75 µm (#200) (QC/QA) (5-694.146)	3137	Test the first 4 samples of production each time the Contractor mobilizes the plant, changes aggregate sources, or the cleanliness of the coarse aggregate is in question. 1 test per day thereafter		On the first day of production and each time the Contractor mobilizes the plant, changes aggregate sources, or the cleanliness of the coarse aggregate is in question: Test the first sample and then at least 1 of the next 3 samples. 1 test per week thereafter <b>Test these samples at the plant.</b>	21764 Concrete Aggregate Worksheet JMF	
	Aggregate Moisture Testing (QC/Verification) (5-694.142)		<b><u>For a concrete paving batch plant:</u></b> <b>If w/c incentives do not apply:</b> 1 per 750 m <sup>3</sup> (1000 yd <sup>3</sup> ) or completed every 4 hours, whichever results in the highest sampling rate.	<b><u>For a certified ready-mix plant:</u></b> <b>If w/c incentives do not apply:</b> 1 per 175 m <sup>3</sup> (250 yd <sup>3</sup> ) or completed every 4 hours, whichever results in the highest sampling rate.	<b><u>For a concrete paving batch plant:</u></b> <b>If w/c incentives apply:</b> 1 per 750 m <sup>3</sup> (1000 yd <sup>3</sup> ) or completed every 4 hours, whichever results in the highest sampling rate. Take initial samples for aggregate moisture testing within the first 175 m <sup>3</sup> (250 yd <sup>3</sup> ).	<b><u>For a certified ready-mix plant:</u></b> <b>If w/c incentives apply:</b> 1 per 175 m <sup>3</sup> (250 yd <sup>3</sup> ) or completed every 4 hours, whichever results in the highest sampling rate. Take initial samples for aggregate moisture testing within the first 75 m <sup>3</sup> (100 yd <sup>3</sup> ).	Concrete W/C Ratio Calculation Worksheet
			Complete the initial moisture content and adjust the batch water prior to the start of concrete production each day. If weather conditions allow, performing moisture testing on representative material at the end of production the prior evening is allowed.		<b>If w/c incentives apply:</b> Use aggregate moisture results for determining the water content to calculate the w/c ratio incentive/disincentive. <b>Do not leave samples unattended.</b>		
	Water Content Verification Testing (Microwave Oven)		Sample the fresh concrete at the plant.		<b>If w/c incentives apply:</b> Microwave oven verification testing to verify the w/c ratio is completed in conjunction with Agency aggregate moisture testing. <b>Do not leave samples unattended.</b>	Concrete W/C Ratio Calculation Worksheet	

	<b>Verification) (5-694.532)</b>			<b><u>For a concrete paving batch plant:</u></b> Take initial sample for microwave oven verification testing within the first 175 m <sup>3</sup> (250 yd <sup>3</sup> ). At least one additional verification test should be taken if more than 750 m <sup>3</sup> (1000 yd <sup>3</sup> ) is produced in a day.	<b><u>For a certified ready-mix plant:</u></b> Take initial sample for microwave oven verification testing within the first 75 m <sup>3</sup> (100 yd <sup>3</sup> ). At least one additional verification test should be taken if more than 175 m <sup>3</sup> (250 yd <sup>3</sup> ) is produced in a day.	
	Unit Weight (QC) (5-694.542)		Test one load of concrete per day at the plant.	None		
	Air Content (QC) (5-694.541)	2461	Test the first load of concrete at the plant.	None		
	Quality Testing including Coarse Aggregate Testing on -75 μm (#200)	3126 3137	Test the -75μm (#200) on the Quality companion sample the day it was sampled. All other testing is at the Contractor's discretion	1 test each fraction every 17,500 m <sup>3</sup> (20,000 yd <sup>3</sup> ) of production. Split the Quality sample 4 ways: <ol style="list-style-type: none"> <li>1) Provide 2 quarters of the sample to the Producer/Contractor.</li> <li>2) Test the -75μm (#200) on the quality sample <u>at the plant</u> the day it was sampled.</li> <li>3) Submit the remaining sample to the lab for quality testing including testing on the -75μm (#200) sieve.</li> </ol> Identify quality samples with a "Q" and record the QC and QA -75μm (#200) test results on the Sample ID Card. Identify the Quality Companion samples with a "Q"..		2410 Sample ID Card

IV. Concrete Construction Items (cont.) (www.dot.state.mn.us/materials/concrete.html)

Concrete Pavement - Concrete Plant Production						
Pay Item No.	Test Type	Spec. No.	Producer/Contractor Testing	Agency Testing	Form No.	
2301	Coarse Aggregate Quality Testing for Incentive/Disincentive	3137	Test at Contractor's discretion	<p><b>If coarse aggregate quality incentives apply:</b>                      Test the Class B aggregates for % absorption and Class C aggregates for % carbonate including any other tests necessary to make those determinations.                      Sample the 2 largest fractions in accordance with the following table and 2301:</p>	2410 Sample ID Card  Coarse Aggregate Quality Incentive/Disincentive Worksheet	
				:Coarse Aggregate Quality Incentive/Disincentive Sampling Rates		
				Plan Concrete] m <sup>3</sup> [ <b>cubic yards</b> ]		Samples per fraction (n)
				2,900 – 6,250 [3,500 – 7,500]		3
				6,251 – 8,500 [7,501 – 10,000]		5
				8,501 – 21,000 [10,001 – 25,000]		10
				21,001 – 42,000 [25,001 – 50,000]		15
				42,001+ [50,001+]		20
				Identify incentive samples on the Sample ID Card with "I/D."		

Concrete Field Testing – Concrete Pavement					
Pay Item No.	Test Type	Spec. No.	Contractor Testing	Agency Testing	Form No.
2301	Air Content Before Consolidation (QC/QA) (5-694.541)	2461	1 per 300 m <sup>3</sup> (300 yd <sup>3</sup> ) or 1 per hour, whichever is less Test first load each day per mix	1 air test per day	2448 Weekly Concrete Report

Air Content After Consolidation (QC/QA) (5-694.541)	2461	Test 1 air content per ½ day of slip form paving to establish an air loss correction factor (ACF). See Special Provisions for additional information.	1 air test per day	
Slump (QC/QA) (5-694.531)	2461	<b><u>For fixed form placement:</u></b> 1 per 300 m <sup>3</sup> (300 yd <sup>3</sup> ) and as directed by the Engineer Test first load each day per mix <b><u>For slipform placement:</u></b> No slump testing is required	<b><u>For fixed form placement:</u></b> 1 slump test per day <b><u>For slipform placement:</u></b> No slump testing is required	
Concrete Temperature (QC/QA) (5-694.550)	2461	Record temperature each time air content, slump or strength test specimen is performed/fabricated by the Contractor.	Record temperature each time air content, slump or strength test specimen is performed/fabricated by the Agency.	
Flexural Strength (QC) (5-694.521)	2301	1 beam (28-day) per day - Make additional control beams as necessary. - Control beams shall be made <u>within the last hour</u> of concrete poured each day. Fabricate beams, deliver beams to curing site, and clean beam boxes.	Supply beam boxes, cure, and test beams.	2162 Concrete Test Beam Data
Concrete Pavement Texture (QC)	2301	1 per 1000 linear feet per lane of concrete pavement at locations determined by the Agency. All adjoining lanes shall be tested at the same location if paved at the same time. The Contractor supplies all materials necessary to perform the required testing.	Determine texture testing locations using random numbers.	Concrete Texture Worksheet
Thickness (QC/Verification)	2301	The Contractor drills concrete cores at locations determined by the Agency. The Contractor probes the plastic concrete at locations determined by the Agency.	Determine probing and coring locations using random numbers. Initial pavement at core locations and re-initial the sides of specimens after coring to clearly verify their authenticity.	24327 Field Core Report Probing and Coring Report
Surface Smoothness	2301	Contractor provides Mn/DOT certified inertial profiler results for bumps/dips and/or Areas of Localized Roughness for the entire project as required by the Contract.	None	Concrete Profile Summary Worksheet