

501.52	Steel H-beam Piles 152 kg/m (102 lb/ft), delivered	meter (Linear Foot)
501.521	Steel H-beam Piles 152 kg/m (102 lb/ft), in place	meter (Linear Foot)
501.54	Steel H-beam Piles 174 kg/m (117 lb/ft), delivered	meter (Linear Foot)
501.541	Steel H-beam Piles 174 kg/m (117 lb/ft), in place	meter (Linear Foot)
501.70	Steel Pipe Piles, delivered	meter (Linear Foot)
501.701	Steel Pipe Piles, in place	meter (Linear Foot)
501.72	Steel Casings, delivered	meter (Linear Foot)
501.721	Steel Casings, in place	meter (Linear Foot)
501.90	Pile Tips	Each
501.91	Pile Splices	Each
501.92	Pile Driving Equipment Mobilization	Lump Sum

## SECTION 502 - STRUCTURAL CONCRETE

**502.01 Description** This work shall consist of furnishing and placing Portland Cement Concrete for structures and incidental construction in accordance with these Specifications and in conformity with the lines, grades, and dimensions shown on the Plans or established, or for placing concrete fill for foundations where called for on the Plans. For METHOD A Statistical Acceptance, or METHOD B Small Quantity Product Verification, the work shall conform to the Contractor's approved Quality Control (QC) Plan and Quality Assurance (QA) provisions, in accordance with these Specifications and the requirements of Section 106 - Quality. For METHOD C, the work shall conform to the requirements of this specification and Section 106- Quality.

**502.02 Classification** The Portland Cement Concrete shall be the class indicated on the Plans.

**502.03 Materials** Materials shall meet the requirements specified in the following Sections of Division 700 Materials:

Portland Cement and Portland Pozzolan Cement	701.01
Water	701.02
Air Entraining Admixtures	701.03
Water Reducing Admixtures	701.04
Water Reducing, High Range Admixture	701.0401
Set Retarding Admixtures	701.05
Curing Materials	701.06

Water stops	701.07
Smoothed Surfaced Asphalt Roll Roofing (Formerly Heavy Roofing Felt)	701.08
Fly Ash	701.10
Calcium Nitrite Solution	701.11
Silica Fume	701.12
Ground Granulated Blast Furnace Slag	701.13
Fine Aggregate for Concrete	703.01
Coarse Aggregate for Concrete	703.02
Alkali Silica Reactive Aggregates	703.0201
Preformed Expansion Joint Filler	705.01
Bridge Drains	711.04

502.04 Shipping and Storage Cement may be shipped in bags or in bulk from pre-tested and approved silos at the cement mill. The cement shall be completely protected from rain and moisture. Any cement damaged by moisture or which fails to meet any of the specified requirements shall be rejected and removed from the site. If requested by the Resident, cement stored for a period longer than 60 days shall be retested before being used in the work.

Bags of cement in shipment or storage shall not be piled more than 8 bags high. Bags of cement which for any reason have become partially set or which contain lumps of caked cement shall be rejected. Shipments of cement in bags shall be separately stored in a manner as to provide easy access for identification and inspection of each shipment.

Fly ash and Slag shall be stored in weather tight silos approved by the Resident. All silos shall be completely empty and clean before material is deposited therein, unless the silo already contains material of the same type and properties.

Fly ash or Slag remaining in bulk storage for a period greater than one year after completion of tests will be resampled and retested by the Department before shipment or use.

Handling, shipping and stockpiling of aggregates shall be done in such a way as to minimize segregation and breakage.

Fine aggregate and each size of coarse aggregate shall be stored in completely separate stockpiles on prepared bases

constructed of the same material as that to be stockpiled, with a minimum thickness of 300 mm [1 ft]. The ground under the prepared bases shall be reasonably graded to drain away from the stockpile and shall be free of brush or other harmful vegetation. The base shall be left in place, undisturbed for the duration of the use of the stockpile. Prepared bases can be salvaged for reuse provided this material is reprocessed. Barge floors, wood, metal or other approved hard surfaces shall be considered acceptable alternates for the prepared bases described above.

502.041 Testing Equipment The Contractor shall provide test equipment and materials as specified below for use by the Resident or their representative exclusively. The equipment shall be available and acceptable to the Resident one week prior to placing any concrete. All costs associated with providing and maintaining testing equipment shall be considered incidental to the work and no additional payment will be made.

The Resident will maintain the test equipment in reasonable condition. However, the Contractor shall replace any equipment that becomes unusable due to normal wear and tear or which is stolen or damaged from other than the Resident's neglect or mistreatment. All such replacement costs shall be considered incidental to the work and no additional payment will be made.

A. Pressure Air Meter meeting requirements of AASHTO T152 (Type B) and all accessory pay items required for use with the particular design of apparatus. This shall include one 225 mm [9 in] mason trowel, one metal scoop 225 mm long x 125 mm wide [9 in long x 5 in wide], one tamping rod conforming to AASHTO T119, one rubber mallet as described in AASHTO T152, one strike off bar (flat straight bar of steel). The air meter shall be functional and shall bear a current calibration certificate issued by a recognized testing laboratory. Current shall mean within the calendar year.

B. Two pocket dial thermometers -20°C to +95°C, [0°F to 200°F] 25 mm [1 in] diameter dial, 125 mm [5 in] pointed stem, unbreakable poly carbonate crystal, stainless steel case, stem and bezel. Accuracy required is 1 percent over entire range.

C. "Contractors" rubber tired wheelbarrow.

D. Two D-handle square end shovels 240 mm wide [9 ½ in].

E. Two pair heavy duty, long cuff, rubber gloves.

F. Miscellaneous equipment: 500 mL [16 oz] plastic squeeze bottle, 19 L [5 gal] bucket, scrub brush, paper towels, folding rule, and rubber syringe.

G. Small rod - one tamping rod conforming to AASHTO T277.

H. 3 meter [10 ft] straightedge as required by Resident.

502.05 Composition and Proportioning Concrete shall be composed of a homogeneous mixture of Portland cement or Portland cement with Fly Ash, Silica Fume, or Ground Granulated Blast Furnace Slag, fine aggregate, coarse aggregate, water and admixtures proportioned according to these Specifications and shall conform to the requirements of Table 1. All material shall be approved by the Department prior to use. For Method C concrete, the mix design proportions will be designated by the Resident or, alternately, the Contractor shall submit a mix design that meets the requirements of Table 1.

Concrete CLASS	Minimum Specified Compressive Strength MPa (psi)	Method A Maximum Permeability (COULOMBS)	Method B Maximum Permeability (COULOMBS)	Method C Maximum Permeability (COULOMBS)	Entrained Air (%)		Notes
					LSL	USL	
S	20 (2900)	N/A	N/A	N/A	5.5	8.5	1, 5
A	30 (4350)	4,000	3,000	3,000	5.5	8.5	1,2,5,6
P	-----	-----	-----	-----	4	6	1,2,3,4,5
LP	35 (5075)	3,000	2,000	2,000	5.5	8.5	1,2,5,6
Fill	20 (2900)	N/A	N/A	N/A	N/A	N/A	6

TABLE 1

LSL - lower specification limit

USL - upper specification limit

NOTE # 1 Target shall be the midpoint of the range of the LSL and USL

- NOTE # 2 Permeability testing for all concrete mixes, excluding those containing fly ash (at 20 percent or greater pozzolan cement replacement), will be done at 56 days. Permeability testing for concrete mixes containing fly ash, at 20 percent or greater pozzolan cement replacement, will be done at 120 days. Concrete expected to be exposed to deicing salts prior to the test date shall be sealed with an alcohol based saline sealer listed on the Maine Department of Transportation Prequalified List of Protective Sealers for Structural Concrete in accordance with the manufacturer's recommendation, at no additional cost to the Department.
- NOTE # 3 Calcium Nitrite shall be added at the rate of 14.85 L/m<sup>3</sup> [3 gallons per cubic yard].
- NOTE # 4 Strength and permeability requirements will be shown on the Plans.
- NOTE # 5 Compressive strength testing for all concrete mixes, excluding  
NOTE # 6 those containing fly ash (at 20 percent or greater pozzolan cement replacement), will be done at 28 days. Compressive strength testing for concrete mixes containing fly ash, at 20 percent or greater pozzolan cement replacement, will be done at 56 days. Coarse aggregate for concrete shall meet the requirements of Section 703.02 for Class "A" or "AA".

At least 30 days prior to the first placement, a concrete mix design shall be submitted by the Contractor to the Department for approval. No concrete shall be placed on a project until the concrete mix design is approved by the Department.

Once the design has been approved, the Contractor shall conduct a trial batch at the concrete plant utilizing transit mixers at the plant. The Contractor shall submit four clearly identified 100 mm diameter x 200 mm high [4 in diameter x 8 in high] cylinders to the Department at least 30 days prior to the first placement for permeability testing. Full documentation shall be submitted with the cylinders and must include actual batch weights and all concrete test properties. The Contractor may submit the trial batch cylinders with the mix design. The cylinders shall be submitted between the

ages of 2 and 7 days. Subsequent use of an approved design will not require this trial batch. For Method C concrete, trial batching is not required.

The mix design submitted by the Contractor shall include the following information:

- A. Description of individual coarse aggregate stockpiles, original source, bulk specific gravity, absorption, gradation, and alkali silica reactivity test results. A combined coarse aggregate blended gradation shall be provided.
- B. Description of fine aggregate, original source, bulk specific gravity, absorption, colorimetric, gradation and Fineness Modulus (F.M.).
- C. Description and amount of cement and pozzolanic material.
- D. Target water cement ratio.
- E. Target water content by volume.
- F. Target strength.
- G. Target air content, slump and concrete temperature.
- H. Target concrete unit weight.
- I. Type and dosages of air entraining and chemical admixtures.
- J. Target Coulomb Value

Approval by the Department will be contingent upon the ability of the mix design proportions to produce concrete strength requirement and other factors that affect durability. Pozzolans are included as cementitious material.

Concrete mix designs shall contain not more than 30 percent fly ash or 50 percent slag pozzolan cement replacement, by weight.

Cast-in-place concrete shall contain not more than 377 kg/m<sup>3</sup> [635 lb/yd<sup>3</sup>] of cement and not more than 392 kg/m<sup>3</sup> [660 lb/yd<sup>3</sup>] of cementitious material.

All concrete mixes must be designed in accordance with the criteria of this Section. The design proportions with the fine aggregates designated as a percent of the total aggregate must be stated in terms of aggregates in a saturated, surface dry condition and the batch weights will be adjusted by the Contractor for the actual moisture of the aggregate at the time of use.

No change in the source or character of the mix ingredients may be made without notice to the Resident and no new mix ingredients shall be used until the Resident has approved such ingredients and new mix proportions, if they change.

502.0501 Quality Control METHOD A, METHOD B and Method C The Contractor shall control the quality of the concrete through testing, inspection, and practices which shall be described in the Quality Control Plan, hereinafter referred to as the "QC Plan", sufficient to assure a product meeting the Contract requirements. The QC Plan shall meet the requirements of Section 106 - Quality and this specification. No QC Plan is required for Method C concrete.

No work under this item shall proceed until the QC Plan is submitted to and approved by the Resident.

Concrete sampling for QC shall be taken at the discharge point with pumped concrete sampling taken at the discharge end of the pump line.

The QC Plan shall address all elements that affect the quality of the structural concrete including, but not limited to, the following:

- A. Mix Design(s)
- B. Aggregate Production
- C. Quality of Components
- D. Stockpile Management
- E. Proportioning, including Added Water
- F. Mix and Transportation, including Time from Batching to Completion of Delivery
- G. Initial and as Delivered Mix Properties, including Temperature, Air Content, Consistency and Water Cement

## Ratio

H. Process Quality Control Testing

I. Placement and Consolidation

J. Permeability

K. Compressive Strength

L. Finishing and Curing

M. Hot and Cold Weather Concreting Procedures, including curing and form removal

The QC Plan under METHOD A shall include the names and specific qualifications of the individuals meeting these requirements and qualifications:

A. Plan Administrator meeting one of the following qualifications:

1. Professional Engineer registered in the State of Maine with one year of concrete experience acceptable to the Department.

2. Engineer-in-Training certified by the State of Maine with two years of concrete experience acceptable to the Department.

3. An individual with three years concrete experience acceptable to the Department and with a Bachelor of Science Degree in Civil Engineering or a related Civil Engineering Technology discipline.

4. Construction Materials Technician certified at Level III by the National Institute for Certification in Engineering Technologies (NICET).

5. Highway Materials Technician certified at Level III by NICET.

6. Highway Construction Technician certified at Level III by NICET.

7. A NICET certified engineering technician in Civil Engineering Technology with five years of concrete experience acceptable to the Department.

8. A Maine Concrete Technician Certification Board [MCTCB] certified engineering technician with 5 years concrete experience acceptable to the Department.

9. A New England Transportation Technician Certification Program [NETTCP] certified concrete technician with 5 years concrete experience acceptable to the Department.

B. Process Control Technician(s) (PCT) shall utilize test results and other quality control practices to assure the quality of aggregates and other mix components and control proportioning to meet the mix design(s). The QC Plan shall detail the frequency of sampling and testing, corrective actions to be taken, and documentation. The PCT shall periodically inspect all equipment utilized in proportioning and mixing to assure it is operating properly and that proportioning and mixing conforms to the mix design(s) and other Contract requirements. The QC Plan shall detail how these duties and responsibilities are to be accomplished and documented and whether more than one PCT is required. The QC Plan shall include the criteria utilized by the PCT to correct or reject unsatisfactory materials. The PCT shall be a MCTCB certified concrete plant technician or a NETTCP certified concrete technician.

C. Quality Control Technician(s) (QCT) shall perform and utilize quality control tests at the job site to assure that delivered materials meet the requirements of the mix design(s), including temperature, water/cement ratio, air content, permeability and strength. The QCT shall inspect all equipment utilized in transporting, placing, consolidating, finishing, and curing to assure it is operating properly and that placement, consolidation, finishing, and curing conform to the Contract requirements. The QC Plan shall detail frequency of sampling and testing, corrective actions to be taken, and documentation. The QC Plan shall detail how these duties and responsibilities are to be accomplished and documented, and whether more than one QCT is required. The QC Plan shall include the criteria utilized by the QCT to reject unsatisfactory materials. The QCT shall a MCTCB certified concrete field technician or a NETTCP certified concrete technician.

D. The Plan shall detail the coordination of the activities of the Plan Administrator, the PCT and the QCT.

The QC Plan under METHOD B shall include the name and specific qualifications of the technician meeting the following requirements:

Quality Control Technician(s) (QCT) shall perform and utilize quality control tests at the job site to assure that delivered materials meet the requirements of the mix design(s), including temperature, water/cement ratio, air content,

permeability and strength. The QCT shall inspect all equipment utilized in transporting, placing, consolidating, finishing, and curing to assure it is operating properly and that placement, consolidation, finishing, and curing conform to the Contract requirements. The Contractor shall detail frequency of sampling and testing, corrective actions to be taken, and documentation. The Contractor shall include the criteria utilized by the QCT to reject unsatisfactory materials. The QCT shall meet one of the PCT qualifications above, or shall be a MCTCB certified concrete field technician.

Under METHOD A, METHOD B and METHOD C the Contractor shall provide a Certificate of Compliance for each truckload of concrete to the Department at the time of the load placement. The Certificate of Compliance shall be a form acceptable to the Department and shall include:

Contract Name & Number

Bridge Name

Manufacturing Plant (Batching Facility)

Name of Contractor (Prime Contractor)

Date

Time Batched/Time Discharged

Truck No.

Quantity (Quantity Batched this Load)

Type of Concrete by Class and Producer Design Mix No.

Cement Brand or Type, and Shipment Certification No.

Temperature of Concrete at Discharge

Target Weights per cubic meter [cubic yard] and Actual Batched Weights for:

1. Cement
2. Pozzolanic Additives, including Fly Ash, Slag Cement, and Microsilica
3. Coarse Concrete Aggregate
4. Fine Concrete Aggregate
5. Water (including free moisture in aggregates and water added at the project)
6. Admixtures Brand and Quantity (ml/cubic meter [fl. oz./cubic yard])

Air-Entraining Admixture

Water Reducing Admixture

Other Admixtures

Placement Location

The Contractor shall maintain records of all QC tests and calculations. The gradation test data and results shall be reported to the Department before the placement they represent. The compressive strength test results shall be reported to the Department by 10:00 A.M. of the first working day following the test. All QC test data shall be signed by the person who performed the test. The Contractor shall record all on site QC test data and calculations at the time of the placement and present this information, on a form acceptable to the Department, to the Department by 10:00 A.M. of the first working day following the concrete placement. All Method A Quality Control testing shall meet the minimum requirements found in Table 2.

Table 2  
METHOD A Minimum Quality Control Testing Requirements

TEST	TEST METHOD	SAMPLING FREQUENCY LOCATION	
Gradation	AASHTO T-27 & T-11	Stockpile	One set per mix before production. One set every 120m <sup>3</sup> [155 yd <sup>3</sup> ] Min. 1 set per month
Organic Impurities	AASHTO T-21	Stockpile	One set per each FA gradation
% Absorption	AASHTO T-84 & T-85	Stockpile	Once per aggregate per 6 months
Specific Gravity	AASHTO T-84 & T-85	Stockpile	Once per aggregate per 6 months
Total Moisture in Agg.	AASHTO T-255	Stockpile	One set per day's production
Free Water and Agg. Wt.	N/A		One per day's production per design
% Entrained Air	AASHTO T-152	On Project	On first two loads and every third load thereafter

Compressive Strength	AASHTO T-22	On Project	One set per subplot
Compressive Strength	AASHTO T-22 @ 7days	On Project	One set per subplot

502.0502 Quality Assurance METHOD A The Department will determine the acceptability of the concrete through a quality assurance program.

The Department will take Quality Assurance samples a minimum of once per subplot on a statistically random basis. Quality Assurance tests will include compressive strength, air content and permeability.

Concrete sampling for quality assurance tests will be taken at the discharge point, with pumped concrete sampling taken at the discharge end of the pump line.

Lot Size A lot size shall consist of the total quantity represented by each class of concrete in the Contract, except in the case when the same class of concrete is paid for under both lump sum items and unit price items in the Contract; in this case, the lump sum item quantities shall comprise 1 lot and the unit price item quantities shall comprise a separate lot. A lot shall consist of a minimum of 3 and a maximum of 10 sublots. If a lot is comprised of more than 10 sublots, sized in accordance with Table #3, then this quantity shall be divided equally into 2, or more, lots such that there is a minimum of 3 and a maximum of 10 sublots per lot. If there is insufficient quantity in a lot to meet the recommended minimum subplot size, then the lot shall be divided into 3 equal sublots.

Sublot Size, General The size of each subplot shall be determined in accordance with Table #3. The Resident may vary subplot sizes based on placement sizes and sequence.

Sublot Size, Unit Price Items Sublot sizes will initially be determined from estimated quantities. When the actual final quantity of concrete is determined: If there is less than one-half the estimated subplot quantity in the remaining quantity, then this quantity shall be combined with the previous subplot, and no further Acceptance testing will be performed; if there is more than one-half the estimated subplot quantity in the remaining quantity, then this quantity shall constitute the last subplot and shall be represented by Acceptance test results. If it becomes apparent part way through a lot that, due to an underrun in quantity, there will be an insufficient quantity of concrete to comprise three sublots, then the Resident may adjust the sizes of the remaining sublots and select new sample locations based on the revised estimated quantity of

concrete remaining in the lot.

Sublot Size, Lump Sum Items Each lot shall be divided into sublots of equal size, based on the estimated quantity of concrete.

Table 3

Quantity m <sup>3</sup> [cy]	Recommended Sublot Size m <sup>3</sup> [cy]
0-400 [0-500]	40 [50]
401-800 [501-1000]	60 [75]
801-1600 [1001-2000]	80 [100]
1601 [2001]or greater	200 [250]

Determination of the concrete cover over reinforcing steel for structural concrete shall be made prior to concrete being placed in the forms. Bar supports, chairs, slab bolsters, and side form spacers shall meet the requirements of Concrete Reinforcing Steel Institute (CRSI) Manual of Standard Practice, Chapter 3 Section 2.5 Class 1, Section 2.6 Class 1A, or Section 4. All supports shall meet the requirements for type and spacing as stated in the CRSI Manual of Standard Practice, Chapter 3. Concrete will not be placed until the placing of the reinforcing steel and supports have been approved by the Resident. If the Contractor fails to secure Department approval prior to placement, the Contractor's failure shall be cause for removal and replacement at the Contractor's expense. The Contractor shall notify the Resident, at least 48 hours prior to the placement, when the reinforcing steel will be ready for checking. Sufficient time must be allowed for the checking process and any needed repairs.

Evaluation of materials will be made using the specification limits in Table 1.

Compressive strength tests will be completed by the Department in accordance with AASHTO-T22 at  $\geq 28$  days, except that no slump will be taken. The average of two concrete cylinders per sublot will constitute a test result and this average will be used to determine the compressive strength for pay adjustment computations.

Testing for Entrained Air in concrete, at the rate of one test per sublot, shall be in accordance with AASHTO T152.

Rapid Chloride Permeability test specimens will be completed by the Resident in accordance with AASHTO T-277 at an age  $\geq 56$  days. Two 100 mm x 200 mm [4 in x 8 in] cylinders will be taken per subplot placed.

Surface Tolerance, Alignment and Trueness, Plumb and Batter, Finish The Resident will measure each of these properties as follows:

A. Surface Tolerance Exposed horizontal and sloping portions of the substructure, superstructure slabs, wearing surface, sidewalks, barriers and wingwalls will be measured at randomly generated locations with a 3 meter [10 ft] straightedge once per 10 m<sup>2</sup> [100 ft<sup>2</sup>]. Measurements beyond tolerances given in Table 5, Section 502.14(E) will be cause for removal or pay adjustment and potential corrective action as determined by the Resident. The Contractor shall furnish the 3-meter [10 ft] straightedge. At the Resident's discretion, measurements may be taken with a lightweight profiler. When the Resident uses the lightweight profiler to measure tolerance, and the International Ride Index (IRI) is between 3.95 m/km and 4.74 m/km [250 and 300 in/mile] for any one placement, a pay adjustment will be made. When tolerances exceed 4.74 m/km [300 in/mile], there will be cause for removal or a pay adjustment and potential corrective action.

B. Alignment and Trueness Alignment and trueness may be measured by the Resident longitudinally along any vertical surface of any portion of the structure and shall not exceed a deviation of 5 mm per meter [ $\frac{1}{4}$  inch in 3 ft] for structures up to 10 meters [30 ft] in length. Structures in excess of 10 meters [30 ft] in length will be subject to a maximum tolerance of 50 mm [2 in]. Measurements exceeding these tolerances will be cause for removal or pay adjustment and potential corrective action as determined by the Resident.

C. Plumb and Batter The Resident will measure all columns and other vertical surfaces that will remain exposed to determine actual batter and plumbness. Measurements will be taken subsequent to every placement. Vertical faces of columns will be measured at a minimum of two faces at right angles to each other. Other vertical surfaces will be measured once every 5 meters [15 ft] along the face of longitudinal wall. All measurements will be made on a per placement basis and will be subject to a tolerance of 6 mm per 3 meters [ $\frac{1}{4}$  inch in 10 ft]. Measurements between 6 mm and 12 mm per 3 meters [ $\frac{1}{4}$  inch and  $\frac{1}{2}$  inch in 10 ft] will result in pay adjustments. Measurements beyond 12 mm per 3 meters [ $\frac{1}{2}$  inch in 10 ft] will be cause for removal or pay adjustment and potential corrective action as determined by the Resident.

D. Finish The Resident will measure and determine the areas to be repaired in accordance with Sections

502.10(d), 502.13, and 502.14(e) for each placement. Areas to be repaired will be measured as a percentage of the total surface area of the placement. Those areas to be repaired that are between 0 percent and 5 percent of the total surface area of the placement will result in no pay adjustment. Areas to be repaired that are between 5 percent and 10 percent will result in pay adjustments. Areas greater than 10 percent of the total surface area of the placement will be cause for removal or pay adjustment and corrective action as determined by the Resident.

Appropriate pay adjustments, as described in Section 502.194, will be made for any or all of the properties described above that do not meet specification requirements.

Rejection by Resident For an individual subplot with a calculated pay factor of less than 0.80, the Department will, at its sole discretion:

A. Require the Contractor to remove and replace the entire affected placement with concrete meeting the Contract requirements at no additional expense to the Department, or

B. Accept the material, at a reduced payment as determined by the Department. (See also Section 502.191)

For a lot in progress, the Contractor shall discontinue operations whenever one or more of the following occurs:

A. The pay factor for any property drops below 1.00 and the Contractor is taking no corrective action

B. The pay factor for any property is less than 0.90

C. The Contractor fails to follow the QC Plan

502.0503 Quality Assurance METHOD B The Department will determine the acceptability of the concrete through a quality assurance program.

The Department will take verification tests at times deemed appropriate by the Resident. Verification tests will include compressive strength, air content and permeability. Surface Tolerance, Alignment and Trueness, Plumb and Batter, and Finish will be measured as described in Section 502.0502.

Concrete sampling for verification tests will be taken at the discharge point, with pumped concrete sampling taken at the discharge end of the pump line.

Compressive strength test will be completed by the Department in accordance with AASHTO T22 at 28 days except that no slump will be taken. The average of two cylinders will be used to determine compressive strength.

Testing for entrained air in concrete, at the rate of one test per subplot, shall be in accordance with AASHTO T152.

Rapid chloride permeability test specimens will be completed by the Resident in accordance with AASHTO T277 at an age  $\geq$  56 days. Two 100 mm x 200 mm [4 in x 8 in] cylinders will be taken per subplot placed.

Determination of the concrete cover over reinforcing steel for structural concrete shall be made prior to concrete being placed in the forms. Bar supports, chairs, slab bolsters, and side form spacers shall meet the requirements of CRSI Chapter 3, Section 2.5 Class 1, Section 2.6 Class 1A or Section 4. All supports shall meet the requirements for type and spacing as stated in the Concrete Reinforcing Steel Institute (CRSI) Manual of Standard Practice, Chapter 3. Concrete will not be placed until the placing of the reinforcing steel and supports have been approved by the Resident. If the Contractor fails to secure Department approval prior to placement, the Contractor's failure shall be cause for removal and replacement at the Contractor's expense. The Contractor shall notify the Resident, at least 48 hours prior to the placement, when the reinforcing steel will be ready for checking. Sufficient time must be allowed for the checking process and any needed repairs.

Rejection by Resident For material represented by a verification test with a calculated pay factor of less than 0.80, the Department will, at its sole discretion:

A. Require the Contractor to remove and replace the entire affected placement with concrete meeting the Contract requirements at no additional expense to the Department, or

B. Accept the material, at a reduced payment as determined by the Department.

502.0504 Quality Assurance Method C Concrete The Department will determine the acceptability of the concrete through written verification from the Contractor that the concrete is in conformance with the Specifications. The Department reserves the right to perform verification tests at times deemed appropriate by the Resident, if the composition

and proportioning of the concrete is in question. Verification tests will include compressive strength, air content and permeability. The results of verification tests may be cause for removal if it is determined that the concrete does not Substantially Conform to the Contract requirements, as determined by the Department.

502.0505 Resolution of Disputed Acceptance Test Results The Contractor shall work cooperatively with the Resident in maintaining Control Charts, as outlined in Subsection 106.4.3, in order to identify potential issues with any test results and take appropriate actions to address these issues before they become disputed issues. Circumstances may arise, however, where the Department's test results indicate that the material has a calculated pay factor of less than 0.80. In these cases, the Department may determine that removal of the affected placement is warranted, or that the material is marginally acceptable and may remain in place and paid for at a reduced rate, in accordance with Sections 502.0502 and 502.0503 - Quality Assurance METHOD A and METHOD B. This Subsection provides recourse for the Contractor to contest the Department's QA test results as follows, at no additional cost to the Department:

A. Compressive Strength In accordance with Section 502.191 - Pay Adjustments for Compressive Strength, the Contractor must take appropriate corrective measures when compressive strength test results are out of conformance. There may be situations where there is the possibility that an underlying structural element could be built-upon before test results for the underlying element have been reported, based upon the normal frequency of testing. In these instances, it is in the Contractor's best interest to perform additional testing that will provide indications that the concrete will meet the requirements of the applicable Specifications, prior to continuing to build upon this underlying element. In the extreme case where an underlying structural element has been built-upon before test results for the underlying element have been reported, the above mentioned safeguards of tracking and additional testing have failed and the final test results for the concrete of the underlying element indicate that removal is warranted and the Contractor's QC results do not confirm the Department's test results, the following procedure concerning compressive strength may be undertaken by the Contractor and witnessed by the Department, within 36 days of the placement date.:

1. Drilled core specimens shall be retrieved from the concrete in question in accordance with the requirements of ASTM C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete. The core strength acceptance and evaluation criteria included in ACI 318 shall not apply.

2. Three drilled core specimens shall be taken from each subplot in question, from randomly selected locations to be representative to the entire volume of the subplot. The Resident and the Contractor's representative shall agree on the sample locations prior to drilling. The specimens shall have a minimum diameter of 100mm [4 in] and a minimum

length of 200mm [8 in].

3. The concrete cores shall be taken directly from the Project to the nearest MDOT laboratory where they will be tested. The cores shall be protected from drying during transport. The Contractor shall make arrangements with the appropriate MDOT laboratory for testing prior to beginning the coring process.

4. Core test results will be evaluated by the Department with the understanding that the strength of drilled cores is, in general, 85% of that of corresponding standard-cured molded cylinders. Therefore, the test results of the three cored cylinders shall be averaged, and then divided by a factor of 0.85. The resulting compressive strength shall be used by the Department in the final determination of the acceptability of the material in question and shall replace the contested test result in computing pay adjustments for the subplot in question. If coring is not done with the 36-day time limit the Department will not allow dispute testing of the subplot.

5. If the Department concludes that the strength of the structural element in question is adequate as a result of the above procedure, then the concrete shall remain in place and will be paid for at a reduced rate, as determined by the Department. If the Department concludes that the strength of the structural element in question is unsatisfactory as a result of the above procedure, then the Department will direct the Contractor to take appropriate actions, as determined by the Department, and at no additional cost to the Department.

In the case where the Department's test results for compressive strength for a particular subplot indicate that the material has a pay factor of less than 1.00 and the Department determines that the indicated strength is adequate for the structural element in question, but the Contractor's QC results indicate a significantly higher strength than the Department's results, the Contractor may contest the Department's results, provided the laboratory performing the QC testing is certified by NETTCP. When the Contractor's QC results for a particular subplot are higher than the Department's results by more than 3.45 MPa [500 psi], the Contractor may elect to undertake the preceding five-step procedure.

B. Rapid Chloride Permeability The Department's verification testing may result in values that exceed the maximum permeability requirements outlined in Section 502.192 - Pay Adjustment for Chloride Permeability, for a particular subplot. In this situation, where the material is subject to rejection and replacement, the following procedure concerning permeability maybe undertaken by the Contractor, if initiated within four calendar days of the receipt of the results and witnessed by the Department:

1. Drilled core specimens shall be retrieved from the concrete in question in accordance with the requirements of ASTM C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete. Specimens shall have a diameter of 200mm [8 in] and a minimum length of 400mm [16 in].
2. One drilled core specimen shall be taken from a location that would be from the same load as the original Department specimen for each subplot in question.
3. The concrete cores shall be taken directly from the Project to the nearest MDOT laboratory where they will be tested. The cores shall be protected from drying during transport. The Contractor shall make arrangements with the appropriate MDOT laboratory for testing prior to beginning the coring process.
4. The cored cylinder will be tested by the Department in accordance with AASHTO T-277. The resulting permeability value shall be used by the Department in the final determination of the acceptability of the material in question and shall replace the contested test result in computing pay adjustments for the subplot in question.
5. If the Department concludes that the permeability of the placement in question is adequate as a result of the above procedure, then the concrete shall remain in place and will be paid for at a reduced rate, as determined by the Department. If the Department concludes that the permeability of the affected placement in question is unsatisfactory as a result of the above procedure, then the Department will direct the Contractor to take appropriate actions, as determined by the Department, and at no additional cost to the Department.

Because the Contractor does not perform permeability testing, the Contractor may not contest the Department's results in a situation where the Department's results are within acceptable limits

C. Entrained Air In order to dispute the Department's test results, the Contractor must test material from the same sample as the Department. If the difference between the Department's and the Contractor's air tests is equal to or greater than 0.8 percent, then the material shall be retested by both parties. If the difference between the retests is equal to or greater than 0.8 percent, the concrete placement will be suspended immediately, and 1) both air meters shall be calibrated immediately, or 2) the Contractor shall immediately replace both air meters. Once it is demonstrated the QC and Acceptance air meters are in agreement with 0.8 percent, the concrete placement may resume.

502.06 Batching Measuring and batching of materials for Method A and Method B shall be performed at an approved batching plant, either commercial or otherwise in accordance with the QC Plan. Measuring and batching of materials for Method C concrete shall be performed at an approved batching plant. The plant shall meet the requirements of AASHTO M-157.

#### 502.0701 Delivery

A. Delivery and discharge of the concrete from the mixer shall be completed within a maximum of 1½ hours from the time the cement is added to the aggregate, except that in hot weather when the concrete mix temperature exceeds 21°C [70°F] or under other conditions contributing to quick stiffening of the concrete, delivery and discharge from the mixer shall be completed within 1 hour. When approved by the Resident, the use of a retarding admixture (Type D) may be used for increasing the 1 hour discharge time to 1½ hours, provided concrete temperatures are kept below 27°C [80°F] and conditions contributing to quick stiffening of the concrete are not present.

B. Concrete, which has been condemned for any reason, shall be removed immediately from the job site and disposed of properly.

C. Concrete temperature before placement shall not exceed 30°C [85°F].

502.08 Cold Weather Concrete Concrete shall not be placed against frozen surfaces.

All frost, ice, and snow shall be removed from all material that will be in contact with fresh concrete.

Unless authorized by the Resident, the mixing and placing of concrete shall be discontinued when the atmospheric temperature is below 5°C [40°F] in the shade and dropping and shall not be resumed until the atmospheric temperature is as high as 2°C [35°F] in the shade and rising. If authorization is granted for the mixing and placing of concrete under atmospheric conditions different from those specified above, the water shall be heated to a temperature not exceeding 82°C [180°F]. When either the aggregate or water is heated to above 50°C [120°F], they are to be combined first in the mixer before the cement is added. If the atmospheric temperature is below -4°C [25°F], the aggregate shall also be heated when directed by the Resident. Materials containing frost or lumps of frozen material shall not be used. Stockpiled aggregates may be heated by the use of dry heat or steam. Aggregates shall not be heated directly by gas or oil flame or on sheet metal over a fire. When aggregates are heated in bins, steam coil or water coil heating or other methods that will not be

detrimental to the aggregates may be used. The heating apparatus shall be capable of heating the mass uniformly and preventing the occurrence of spots of overheated material. The temperature of the mixed concrete shall be between the minimum values shown in Table 4 and 20°C [70°F] when it is placed in the forms. Salt or other chemicals shall not be added to the concrete for any reason whatsoever, except by written permission of the Resident.

Table 4  
COLD WEATHER TEMPERATURE TABLE  
MINIMUM FORM DIMENSION SIZE

Less than 300mm(12in)	300 - 900 mm (12 -36 in)	900 - 1800 mm (36 - 72 in)	Greater than 1800mm (72in)
13°C (55°F)	10°C (50°F)	7°C (45°F)	5°C (40°F)
MINIMUM CONCRETE TEMPERATURE AS PLACED			

When permitted by the Resident, footings may be protected by completely submerging them by admitting water inside the cofferdam. Until submersion takes place, the temperature of the concrete and its surface shall be controlled as specified above. Submersion shall proceed slowly and the temperature of the air or water shall be maintained sufficient to prevent ice from forming within the cofferdam for a period of 7 days after the placing of the concrete.

When depositing concrete under water, there shall be no ice inside the cofferdam.

Permission given to place concrete under the conditions mentioned above and as described in the Contractor's QC Plan shall not relieve the Contractor of responsibility for obtaining satisfactory results. The Contractor shall be wholly responsible for the protection of concrete during cold weather operations and any concrete injured by frost action or overheating shall be removed and replaced at the Contractor's expense.

### 502.10 Forms and False work

A. Construction of Forms All forms shall be well built, substantial and unyielding, securely braced, strutted and tied to prevent motion and distortion while concrete is being placed in them. The forms shall be strong enough to safely support the weight of the concrete and all superimposed loads (such as runways, concrete buggy loads, workers, scaffolding, etc.) placed upon them.

Forms shall be built to conform to the dimensions, location, contours and details shown on the Plans. The faces of forms against which the concrete is to be placed shall be dressed smooth and uniform and shall be free from winds, twists, buckles and other irregularities.

Stay-in-place forms of any type will not be permitted for any part of the slab structures, unless otherwise indicated on the Plans.

The placing of concrete in excavated pits and trenches without forms will be permitted only in exceptional cases and then at the discretion of the Resident.

All corners within the forms shall be fitted with chamfer strips mitered at their intersections, except that chamfer strips will not be required as follows: (1) on corners of slab blocking of interior steel beams and the inside of exterior steel beams; (2) on corners constructed transversely at the underside of the slab of superstructures which consist of a concrete slab on steel beams; (3) on footings not exposed to view; and (4) on all structures when more than 600 mm [2 ft] below the final finished ground line.

Chamfer strips shall have a width across the diagonal face between 15 and 20 mm [ $\frac{1}{2}$  and  $\frac{3}{4}$  in]. The size to be adopted for a given portion of the work shall depend upon the general dimensions. Except where special size chamfer strips are shown on the Plans, the size of chamfer strips shall be uniform on individual projects. Provision shall be made for the chamfering of the top edges of abutment bridge seats and wing walls, tops of piers and retaining walls, tops of through girders, roadway curbs, etc., by nailing chamfer strips inside the forms. Unless otherwise provided, all chamfer strips shall produce plain flat surfaces on the concrete.

The forms for beams, girders and spandrel arches shall be so constructed as to permit the sides to be removed without disturbing the supports.

All foreign matter within the forms shall be removed before depositing concrete in them.

In all cases where metal anchorages or ties within or through the face forms are required to hold the forms in their correct position, such anchorages or ties shall be of ample strength and shall be so constructed that the metal work can be removed to a depth of not less than 25 mm [1 in] from the face and back surfaces of the concrete without damaging such

surfaces.

Elevations will be taken on the top flanges of structural steel beams and girders for the purpose of determining the depth of blocking necessary for the construction of the forms for the concrete slab, after the following conditions have been satisfied:

1. The satisfactory erection of the superstructure structural steel beams or girders, including any required flooring beams and stringers, unless an alternative plan is submitted by the Contractor and approved by the Department.
2. All bolt tightening operations must be complete.
3. No foreign loads supported by the beams or girders are present.

The Contractor shall submit working drawings for approval of the proposed forms and false work supporting the overhanging portion of the superstructure slab in accordance with Section 105.7. The working drawings shall show the size and location of the supporting members, the proposed loads and the weight of concrete forms to be carried by the members.

In the construction of forms and false work for the portion of superstructure slabs overhanging the exterior members of beam and girder spans, forms and supporting devices resulting in point loadings on the exterior members shall not be used. Loads resulting from supporting devices shall be distributed directly to the flanges by means of brackets or braces.

All forms shall be inspected and approved by the Department before the placing of any concrete within them.

B. Surface Treatment of Forms The inside surfaces of forms shall be uniformly coated with form oil or other approved surface treatment.

Form surfaces shall be treated before placing the reinforcing steel.

C. Construction of False work All false work used for supporting reinforced concrete superstructures shall be composed of members having ample structural sections to resist all loads imposed upon them, with deformations less than

span length / 360.

When the vertical members of false work consist of piles or when framed or other false work is supported upon piles, the piles shall be driven to secure a safe load resistance.

When false work is supported upon mud sills, the foundation pressures resulting from the imposed loads upon the mud sills (false work, forms, fresh concrete, scaffolding, etc.) shall not exceed the capacity of the on-site soils.

All false work systems shall be designed to support all vertical loading and any differential settlement forces, all horizontal and longitudinal forces, and shall account for any temporary unbalanced loading due to the placement sequence of the concrete. Sufficient redundancy shall be designed into centering or false work systems so that the failure of any member shall not cause a collapse. Design computations, layout drawings, and details of materials for the centering or false work systems shall be submitted to the Department for its records. The erection of centering or false work systems shall be accomplished in strict conformance with the design and details. No concrete shall be placed without prior approval of the Resident.

False work systems adjacent to and/or over traveled ways shall additionally be designed to resist any vibration forces due to traffic and shall incorporate sufficient protection against impact by errant vehicles.

All false work system computations, plans, and working drawings shall be designed and sealed by the Contractor's Professional Engineer, who must be registered in the State of Maine. This Professional Engineer may be directly employed, or otherwise retained, by the Contractor. Prior to concrete placement, the Professional Engineer responsible for the design of the false work system shall, after false work inspection, provide a sealed certification to the Resident that the system was erected in conformance with the Professional Engineer's plans and design details.

False work shall be so constructed that the forms will have a camber, the amount depending upon the deflection anticipated in the design.

Forms supported upon false work shall be provided with a satisfactory means for their adjustment in the event of settlement or deformation of the false work due to overloading or other causes.

Provisions shall be made for the gradual lowering of false work and rendering the supported structure self-

supporting.

#### D. Removal of Forms and False work

1. Location, weather conditions, cementitious materials used and the character of the structure involved shall be considered in determining the time for the removal of forms. Forms shall not be removed until concrete cylinders cured with the structure establish that the concrete has developed 80 percent of design strength. The Contractor shall cast and break two cylinders per subplot and furnish the Resident with these test reports before removal of the forms.

When approved by the Resident, the vertical forms of footings, walls, columns and sides of beams and slabs may be removed 48 hours after completion of placement of concrete, exclusive of the time the ambient air temperature is below 7°C [45°F] and provided the following conditions are met:

Immediately after the forms are removed, defects in the concrete surface shall be repaired in accordance with Section 502.13 and the repaired area thoroughly dampened with water. The surfaces of exposed concrete shall be cured for the remainder of the 7-day curing period by the application of a product listed on the Maine Department of Transportation Prequalified list of curing compounds. The curing compound shall be applied continuously by an approved pressure spraying or distributing equipment at a rate necessary to obtain an even, continuous membrane, meeting the manufacturer's recommendation but at a rate of not less than 0.2 L/m<sup>2</sup> [1 gal/200 ft<sup>2</sup>] of surface. Other methods of curing concrete may be used with the prior approval of the Resident.

2. Forms and false work, including blocks and bracing, shall not be removed without the consent of the Resident. The Resident's consent shall not relieve the Contractor of responsibility for the safety of the work. In no case shall any portion of the wood forms be left in the concrete. As the forms are removed, all projecting metal devices that have been used for holding the forms in place shall be removed in accordance with Section 502.10. The holes shall be filled as required in Section 502.13.

#### 502.11 Placing Concrete

A. General Concrete shall not be placed until forms and reinforcing steel have been checked and approved by the Resident. The forms shall be clean of all debris. The method and sequence of placing the concrete shall be approved before any concrete is placed.

All concrete shall be placed before it has taken its initial set and, in any case, as specified in Section 502.0701. Concrete shall be placed in horizontal layers in such a manner as to avoid separation and segregation. A sufficient number of workers for the proper handling, tamping and operation of vibrators shall be provided to compact each layer before the succeeding layer is placed and to prevent the formation of cold joints between layers. Care shall be taken to prevent mortar from spattering on structural steel, reinforcing steel and forms. Any concrete or mortar that becomes dried on the structural steel, reinforcing steel or forms shall be thoroughly cleaned off before the final covering with concrete. Following the placing of the concrete, all exposed surfaces shall be thoroughly cleaned as required, with care not to injure any surfaces.

Concrete shall not come in direct contact with seawater during placing and for a period of 72 hours thereafter, except as follows:

1. Concrete seals that are located entirely below low tide.
2. Concrete footings constructed in the dry and located entirely below low tide or final ground elevation.
3. Concrete Fill placed under water.

Concrete in any section of a structure shall be placed in approximately horizontal layers of such thickness that the entire surface shall be covered by a succeeding layer before the underlying layer has taken its initial set. Layers shall not exceed 450 mm [18 in] in thickness and be compacted to become an integral part of the layer below. Should the placement be unavoidably delayed long enough to allow the underlying layer to take initial set or produce a so-called "cold joint", the following steps shall be taken:

An incomplete horizontal layer shall be bulk-headed off to produce a vertical joint.

Horizontal joints shall be treated as required in this Section 502.11(f).

Portland cement concrete with a high range, water reducing admixture shall not be placed when the concrete mix temperature is below 5°C [40°F] or above 29°C [85°F].

The concrete in superstructures shall be placed monolithically except when construction joints are shown on the Plans or are authorized in accordance with approved details submitted by the Contractor. If the concrete in the stems of T-beams is to be placed independent of the slab section, the construction joint shall be located at the under side of the slab and the bond between stem and slab shall be a mechanical one. The bond shall be produced by embedding 38 by 89 mm [2 by 4 in] wooden blocks having a length approximately 100 mm [4 in] less than the width of the stem and placed horizontally at right angles to the centerline of the beam in the top surface of the concrete immediately following the completion of the concrete placement. To provide for the uniform spacing of the blocks and their ready removal when the concrete has taken a set sufficient to hold its form, the blocks shall be firmly nailed upon a board at a distance of 300 mm [1 ft] center to center. The blocks shall be thoroughly oiled to facilitate their ready removal from the concrete.

In arch spans, the order of construction or sequence of the work, as shown on the Plans, shall be followed in the placing of concrete.

In no case shall the work on any section or layer be stopped or temporarily discontinued within 450 mm [18 in] below the top of any face, unless the Plans provide for a coping having a thickness less than 450 mm [18 in], in which case at the option of the Resident, the construction joint may be made at the under side of the coping. Concrete in columns shall be placed in one continuous operation, unless otherwise directed.

Fresh concrete, threatened with rain damage shall be protected by approved means. Sufficient material for covering the work expected to be done in one day shall be on hand at all times for emergency use. The covering shall be supported above the surface of the concrete.

Concrete Fill shall be placed at least to the pay limits shown on the Plans. Forms may be omitted at the Contractor's option. Vibration of concrete will not be required. The Contractor has the option of placing Concrete Fill under water or in the dry.

B. Chutes, Troughs, Pipes and Buckets Sectional drop chutes or short chutes, troughs, pipes and buckets when used as aids in placing concrete, shall be arranged and used in such a manner that the ingredients of the concrete do not become separated or segregated. Wood and aluminum chutes, troughs, pipes or buckets shall not be used.

Dropping the concrete a distance of more than 2 m [6 ft], unless confined by closed chutes or pipe will not be permitted. The concrete shall be deposited at or as near as possible to its final position.

C. Vibrating Mechanical, high frequency internal vibrators shall be used, operating within the concrete, for compacting the concrete in all structures and precast and cast-in-place piles, with the exception of concrete placed under water. The vibrators shall be an approved type, with a frequency of 5,000 to 10,000 cycles per minute and shall be visibly capable of properly consolidating the designed mixture. A spare vibrator shall be available on the project at all times during the placing of concrete.

Sufficient vibrators shall be used to consolidate the incoming concrete within 5 minutes after placing. Vibrators shall neither be held against forms or reinforcing steel, nor shall they be used for flowing the concrete or spreading it into place. Over-vibrating shall not be allowed.

D. Dewatering Forms All forms shall be dewatered before concrete is placed in them. Pumping will not be permitted from the inside of forms while concrete is being placed. Moving water shall not be permitted to be exposed to fresh concrete.

E. Depositing Concrete under Water No concrete shall be deposited under water except for cofferdam seals. Pumping will not be allowed within the cofferdam while concrete is being placed.

The concrete shall be placed carefully in a compact mass in its final position by means of a tremie or by other approved means and shall not be disturbed after being deposited. Bottom dump buckets will not be permitted. Special care must be exercised to maintain still water at the point of deposit. Concrete shall not be placed in running water. The method of depositing concrete shall be so regulated as to produce approximate horizontal surfaces. Each seal shall be placed in one continuous operation.

When a tremie is used, it shall consist of a tube not less than 250 mm [10 in] in diameter. The means of supporting the tremie shall be such as to permit free movement of the discharge end over the entire seal and to permit its being lowered rapidly, when necessary to choke off or retard flow. The tremie shall be filled by a method that will prevent washing of the concrete. The discharge end shall be completely submerged in concrete at all times and the tremie tube shall be kept full to the bottom of the hopper. The flow shall be regulated by raising or lowering the tremie.

When the horizontal area of the tremie seal is large, several tremie hoppers shall be provided and positioned strategically to allow easy deposit of concrete near the point where it is needed to avoid moving concrete horizontally

through the water. The number of tremie hoppers and the work plan shall be approved by the Resident.

All laitance or other unsatisfactory material shall be removed from the surface of the seal before placing additional concrete. The surface shall be cleaned by scraping, chipping or other means that will not injure the concrete.

The placing and dewatering of seal concrete within cofferdams shall be in accordance with Section 511 - Cofferdams.

F. Construction Joints Construction joints shall be located where shown on the Plans or permitted by the Resident. When the concrete is in seawater, except concrete cores for stone masonry, no horizontal construction joint will be permitted between extreme low tide and extreme high tide elevations.

At horizontal construction joints, temporary gage strips having a minimum thickness of 38 mm [1 ½ in] shall be placed horizontally inside the forms along all exposed faces to give the joints straight lines. The joint shall be so constructed that the surface of the concrete will not be less than 6 mm [¼ in] above the bottom of the gage strip. Before placing fresh concrete, the temporary gage strip shall be removed, the surfaces of construction joints shall be thoroughly cleaned, drenched with water until saturated and kept saturated until the new concrete is placed. Immediately prior to placing new concrete, the forms shall be drawn tight against the concrete already in place. Concrete in substructures shall be placed in such a manner that all horizontal joints will be horizontal and if possible, in locations such that they will not be exposed to view in the finished structure.

Where vertical construction joints are necessary, reinforcing bars shall extend across the joint in such a manner as to make the structure monolithic. Construction joints through paneled wing walls or other large surfaces which are to be treated architecturally will not be allowed except as shown on the Plans. All vertical construction joints in abutments and retaining walls shall contain water stops as shown on the Plans. The water stops shall be one continuous piece at each location.

All horizontal construction joints in abutments and retaining walls shall be constructed using a joint cover, as shown on the Plans.

Construction joints in the wearing surface shall be located where called for on the Plans. No other construction joints will be allowed.

All joints shall be formed in the manner detailed on the Plans. The forms shall not be treated with oil or any other bond breaking material that will adhere to the concrete.

Sealing slots shall be provided at all joints in the wearing surface that are located directly over a slab construction joint.

Construction joints in the wearing surface not receiving a sealing slot shall be brushed with a neat cement paste immediately prior to making the adjacent concrete placement.

After the concrete has been cured, sealing slots, when required, shall be sandblasted with approved equipment to remove all laitance and foreign material on the surfaces of the slots. The bottom of the sealing slots shall receive an approved bond breaker. The joint shall then be filled within 3 mm [ $\bullet$  in] of the surface with a poured sealant conforming to the following requirements and in accordance with the manufacturer's recommendations. The joint sealant supplied shall be an approved two component, elastomeric sealant capable of 50 percent joint movement. Both components shall be in liquid form and the combining ratio of components by volume shall be as recommended by the manufacturer.

G. Concrete Wearing Surface and Structural Concrete Slabs on Precast Superstructures When called for on the Plans, a separate concrete wearing surface or structural concrete slabs on precast superstructures shall be bonded to the supporting slab. No surface preparation of a new structural concrete slab shall begin before completion of the specified curing period.

When the supporting slab is composed of cast-in-place concrete the Contractor shall scabble the entire surface of the structural concrete slab and then sandblast the entire structural concrete slab surface. When the supporting slab is comprised of precast units, the Contractor shall sandblast the entire deck surface.

The entire area of the deck surface and the faces of curb and barrier walls or other median devices, up to a height of 25 mm [1 in] above the top elevation of the wearing surface or slab, shall be cleaned to a bright, clean appearance which is free from curing compound, laitance, dust, dirt, oil, grease, bituminous material, paint and all other foreign matter. Air lines shall be equipped with effective oil traps. The cleaning of an area of the deck shall be performed within the 24-hour period preceding placement of the wearing surface. The cleaning shall be performed by dry sand blasting or other methods approved by the Resident. All debris from the cleaning operation shall be thoroughly removed by compressed dry air from

the cleaned surfaces and adjacent areas. The cleaned areas shall be protected against contamination before placement of the wearing surface. Contaminated areas shall be recleaned by dry sand blasting. Prepared areas that have not received the wearing surface within 36 hours shall be recleaned.

All horizontal surfaces in contact with the wearing surface shall receive a coating of bonding grout or bonding agent listed on Maine Department of Transportation Prequalified List of Bonding Agents. The vertical faces in contact with the wearing surface shall be broomed up to the elevation of the top of the wearing surface with bonding grout or an approved bonding agent.

Stiff bristled street brooms shall be used to brush the grout onto the surface. The coating shall not exceed 3 mm [ $\bullet$  in] in thickness. The rate of progress in applying grout shall be limited so that the grout does not become dry before it is covered with new concrete. During delays in the surfacing operations, should the surface of the grout indicate an extensive amount of drying, the grout shall be removed by methods approved by the Resident and the area should be regouted.

The bonding grout shall have Portland cement and fine aggregate proportioned 2 to 1 by volume. The fine aggregate from which the material larger than 3 mm [ $\bullet$  in] has been removed shall be the same source as used in the concrete. The cement and fine aggregate shall be measured separately in appropriately sized containers. The fine aggregate shall be deposited in an approved mechanical mortar mixer before adding cement. Water shall be added in sufficient quantity to allow flow of the grout without segregation of the grout ingredients.

No water shall be added after initial mixing. The grout shall not be allowed to separate before placement. The cement to water contact time of the grout shall not exceed 30 minutes before it is placed. Any grout that has dried or become unworkable before application, as determined by the Resident, shall not be incorporated into the work. The use of retarding admixtures for increasing the discharge time limits will be allowed.

The Resident may approve the batching of bonding grout at an approved commercial concrete batch plant. In this case, mixing and delivery shall be in transit truck mixers. The bonding agent shall be one of the products listed on the Maine Department of Transportation's list of Prequalified Bonding Agents and shall be applied in accordance with the manufacturer's recommendations.

No structural concrete slab structure, including but not limited to concrete deck slabs, wearing surfaces, simple slab spans, and slabs on precast superstructures, shall be commenced if the combination of ambient air temperature, relative

humidity, wind speed, and plastic concrete temperature result in a



surface

moisture evaporation rate theoretically equal to or greater than 0.5 kg/m<sup>2</sup>/hr [0.1 lb/ft<sup>2</sup>/hr] of exposed surface (Refer to the Rate of Evaporation from Concrete Surface Chart). If the surface moisture evaporation rate rises to 0.75 kg/m<sup>2</sup>/hr [0.15 lb/ft<sup>2</sup>/hr] of exposed surface, the Contractor shall implement the remedial action described in the approved QC Plan. The temperature of the concrete shall not exceed 24°C [75°F] at the time of placement. The maximum temperature of the surface on which concrete will be placed shall be 32°C [90°F]. The Contractor shall provide all equipment and perform all measurements and calculations in the presence of the Resident to determine the rate of evaporation.

Rate of Evaporation from Concrete Surface Chart  
METRIC UNITS & US CUSTOMARY UNITS

502.12 Expansion and Contraction Joints Expansion and contraction joints shall be located and constructed as shown on the Plans. Water stops shall be one continuous piece at each location. Joint cover, as shown on the Plans, shall be applied to all joints where water stops cannot physically be installed, as determined by the Resident.

- 502.13 Repairing Defects and Filling Form Tie Holes in Concrete Surfaces After the forms are removed, all surface defects and holes left by the form ties shall be repaired.

All fins and irregular projections shall be removed from the following: Surfaces which are visible in the completed work; surfaces to be waterproofed; and the portion of vertical surfaces of substructure units which is below the final ground surface to a depth of 300 mm [12 in], not including underwater surfaces.

In patching surface defects, all coarse or fractured material shall be chipped away until a dense uniform surface,

exposing solid coarse aggregate is obtained. Feathered edges shall be saw cut away to form faces having a minimum depth of 25 mm [1 in] perpendicular to the surface. All surfaces of the cavity shall be saturated thoroughly with water, after which a thin layer of neat cement paste shall be applied. The cavity shall then be filled with thick, reasonably stiff mortar, not more than 30 minutes old, composed of material of the same type and quality and of the same proportions as that used in the concrete being repaired. The surface of this mortar shall be floated before initial set takes place and shall be neat in appearance. The patch shall be water cured for a period of five days.

If the removal of defective concrete materially impairs the soundness or strength of the structure, as determined by the Resident, the affected unit shall be removed and replaced by the Contractor at their expense.

The holes left by form ties, on the portions of substructure concrete that are to be permanently covered in the finished work, may be filled with an acceptable grade of plastic roofing cement. Holes in the bottom of slabs caused by supporting hangers need not be filled.

502.14 Finishing Concrete Surfaces Neat cement paste, dry cement powder or the use of mortar for topping or plastering of concrete surfaces will not be permitted.

A. Float Finish A float finish for horizontal surfaces shall be achieved by placing an excess of concrete in the form and removing or striking off the excess with a template or screed, forcing the coarse aggregate below the surface. Creation of concave surfaces shall be avoided. After the concrete has been struck off, the surface shall be thoroughly floated to the finished grade with a suitable floating tool. Aluminum and steel floats are not allowed.

Float finish, unless otherwise required, shall be given to all horizontal surfaces except those intended to carry vehicular traffic and those of curbs and sidewalks.

B. Structural Concrete Slab Structures Include but not limited to structural concrete deck slabs, wearing surfaces, slabs on precast superstructures, top and bottom slabs of box culverts, approach slabs, rigid frame structures and simple slab spans, as applicable. Screed rails shall be set entirely above the finished surface of the concrete and shall be supported in a manner approved by the Resident. Where shear connector studs are available, welding to the studs will be permitted. No welding will be permitted directly on the stringer flanges to attach either screed rail supports or form supports of any type.

Screed rail supports set in the concrete shall be so designed that they may be removed to at least 50 mm [2 in] below the surface of the concrete. Voids created by removal of the upper part of the screed rail supports shall be filled with mortar having the same proportions of sand and cement as that of the slab or wearing surface. The mortar shall contain an approved additive in sufficient proportions to produce non-shrink or slightly expansive characteristics.

The rate of placing concrete shall be limited to that which can be finished without undue delay and shall not be placed more than 3 m [10 ft] ahead of strike-off.

The Contractor shall furnish a minimum of two work bridges behind the finishing operation, capable of spanning the entire width of the deck and supporting at least a 225 kg [500 lb] load without deflection to the concrete surface, to be supported on the screed rails. These working bridges shall be used by the Contractor for touch-up and curing cover application and shall be available for inspection purposes. When the overall length of the structure is 18 m [60 ft] or less only one working bridge will be required.

An approved bridge deck finishing machine complying with the following requirements shall be used, except as otherwise specified, for finishing structural concrete slab structures. The finishing machine shall have the necessary adjustments, built in by the manufacturer, to produce the required cross section, line and grade. The supporting frame shall span the section being cast in a transverse direction without intermediate support. The finishing machine shall be self-propelled and capable of forward and reverse movement under positive control. Provisions shall be made for raising all screeds to clear the screeded surface for traveling in reverse. The screed device shall be provided with positive control of the vertical position.

The finishing machine shall be self-propelled with one or more oscillating screeds or one or more rotating cylinder screeds. An oscillating screed shall oscillate in a direction parallel to the centerline of the structure and travel in a transverse direction. A rotating cylinder screed shall rotate in a transverse direction while also traveling in the same direction. Either type of screed shall be operated transversely in overlapping strips in the longitudinal direction not to exceed 150 mm [6 in]. One or more powered augers shall be operated in advance of the screed(s) and a drag (pan type) float shall follow the screed(s). For concrete placements less than 150 mm [6 in] in depth, vibratory pan(s) having a minimum of 3000 vibrations/min shall be operated between the oscillating screed(s) or rotating cylinder screed(s) and the power auger(s). For concrete placed in excess of 90 mm [3 ½ in] but less than 150 mm [6 in] thickness, hand-operated spud vibrators shall be used in addition to the machine vibratory pan(s).

The transversely operated rotating cylinder(s) of the bridge deck finishing machine shall be rotated such that the

direction of the rotation of the cylinder(s) at the surface of the concrete is in accordance with the manufacturer's recommendations.

Concrete immediately in front of the power auger(s) of a bridge deck finishing machine shall be placed or cut to a depth no higher than the center of the rotating auger(s). The advance auger(s) shall strike off the concrete to approximately 6 mm [ $\frac{1}{4}$  in] above the final grade. The concrete shall then be consolidated with the vibrating pan(s) and then finished to final grade.

A small handheld pan vibrator shall be required at edges and adjacent to joint bulkheads. In lieu of the handheld pan vibrator equipment, the Resident may approve small spud vibrator(s).

Lightweight, vibrating screeds may be used on slab structures which are more than 300 mm [12 in] below the roadway finish grade or have a length of 9 m [30 ft] or less, or where concrete placements are specified to be less than 5 m [16 ft] in width and shall have the following features:

1. It shall be portable and easily moved, relocated, or adjusted by no more than four persons.
2. The power unit shall be operable without disturbing the screeded concrete.
3. It shall be self-propelled with controls that will allow a uniform rate of travel and by which the rate of travel can be increased, decreased or stopped.
4. It shall have controlled, uniform, variable frequency vibration, end to end.
5. It shall be fully adjustable for flats, crowns, or valleys.
6. The screed length shall be adjustable to accommodate the available work area.

When a lightweight vibrating screed is utilized, the concrete shall be placed or cut to no more than 13 mm [ $\frac{1}{2}$  in] above the finished grade in front of the front screed. The screed shall be operated such that at least 1 m [3 ft] of concrete is in position in front of the screed.

Supporting slabs for bituminous wearing surfaces shall be finished in accordance with the recommendations of the waterproofing membrane manufacturer.

The texturing of concrete wearing surfaces shall be applied as approved by the Resident. The surface tolerance and texture shall be acceptable to the Resident, or the placement may be suspended until remedial action has been taken. The

Resident may order the removal and replacement of material damaged by rainfall.

On all concrete wearing surfaces, a 300 mm [1 ft] wide margin shall be finished adjacent to curbs and permanent barriers with a magnesium float.

Immediately after screeding, floating and texturing, the surface of the concrete shall be tested for trueness, by the Contractor, with a 3 m [10 ft] straightedge and all irregularities corrected at once in order to provide a final surface within the tolerance required in Table 5. The surface shall be checked both transversely and longitudinally. Any area that requires finishing to correct surface irregularities shall be retextured.

The straightedges shall be furnished and maintained by the Contractor. They shall be fitted with a handle and all parts shall be made of aluminum or other lightweight metal. The straightedges shall be made available for use by the Resident when requested.

In the event of a delay during a concrete placement, all concrete that cannot receive the final curing cover shall be covered with wet burlap.

No vehicles will be allowed, either directly or indirectly, on reinforcing steel before concrete placement.

C. Curb and Sidewalk Finish on Bridges Curb and sidewalk finish is a float finish produced by using a short float, moved in small circles to produce a shell-like pattern on the surface of the concrete. Alternately, sidewalks may receive a light broom finish perpendicular to the sidewalk.

When a concrete curb is monolithic with a sidewalk, a 150 mm [6 in] wide smooth margin shall be made along the top of the curb with a magnesium float.

Unless shown on the Plans, the sidewalk area shall not be divided into sections by transverse grooves.

At all transverse construction and expansion joints, except where steel expansion dams are used, the edges of the joints, on the surface of the sidewalk, shall be finished with a sidewalk edging tool, 50 mm [2 in] in width, with a 6 mm [ $\frac{1}{4}$  in] radius lip.

D. Form Surface Finish The character of the materials used and the care with which forms are constructed and concrete placed shall be considered in determining the amount of rubbing required. If, using first class form material, well-constructed forms and the exercise of special care, concrete surfaces are obtained that are satisfactory to the Resident, the Contractor may be relieved in part from the requirement of rubbing.

1. Ordinary Finish An Ordinary Finish is defined as the finish left on a surface after the removal of the forms, the filling of all holes and the repairing of all defects. The surface shall be true and even, free from stone pockets and depressions or projections and of uniform texture. All formed concrete surfaces shall be given an ordinary finish unless otherwise specified.

Repaired areas that do not meet the above requirements or areas that cannot be satisfactorily repaired to meet the requirements for ordinary finish shall be given a rubbed finish. When a rubbed finish is required on any part of a surface, the entire surface shall be given a rubbed finish.

2. Rubbed Finish After removal of forms, the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work, the concrete shall be thoroughly saturated with water. Sufficient time shall have elapsed before wetting down to allow the mortar used in ordinary finish to become thoroughly set. Surfaces to be finished shall be rubbed with a medium coarse carborundum stone, using a small amount of mortar on its face. The mortar shall be composed of cement and fine sand mixed in proportions as used in the concrete being finished. Rubbing shall be continued until all form marks, projections and irregularities have been removed, all voids filled and a uniform surface has been obtained. A thin layer of paste produced by this rubbing shall be left on the surfaces.

After all concrete above the surface being treated has been cast, the final finish shall be obtained by a second rubbing with a fine carborundum stone using only water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color. The paste produced by this second rubbing shall be carefully spread with a moist whitewash brush to form a very thin uniform coating upon the surface of the concrete.

After the final rubbing is completed and the surface has dried, it shall be rubbed lightly with clean and dry burlap to remove excess loose powder and shall be left free from all unsound patches, paste, powder and objectionable marks. This finish shall result in a surface of smooth texture and uniform color.

No surface finishing shall be done in freezing weather or when the concrete contains frost. In cold weather the

preliminary rubbing necessary to remove the inert sand and cement materials and the surface irregularities may be done without the application of water to the concrete surfaces.

The following portions of concrete roadway grade separation structures shall be given a rubbed finish unless otherwise indicated in the Contract:

- (a) Retaining walls and the breast and wing walls of abutments-face surfaces to 300 mm [12 in] below the finished ground line.
- (b) Piers-All vertical surfaces and the underside of overhanging portions of caps, except that for overpass structures, the piers beyond the outside limits of the roadway pavement, the vertical surfaces on the back which are not visible from the roadway or sidewalk will not require a rubbed finish.

If, in the opinion of the Resident, the general appearance of a concrete structure, due to the excellence of workmanship, cannot be improved by a rubbed finish, this requirement may be waived.

E. Surface Finish After the concrete has cured the surface shall be tested with a 3m [10 ft] straightedge or a lightweight profiler.

The straightedge shall be furnished and maintained by the Contractor. It shall be fitted with a handle and all parts shall be made of aluminum or other lightweight metal. The straightedges shall be made available for use by the Resident when requested. The lightweight profiler will be furnished by the Department.

Areas found to not comply with the tolerance of Table 5 shall be brought into conformity by methods proposed by the Contractor and approved by the Resident at no additional cost to the Department.

Table 5  
SURFACE TOLERANCE LIMITS

Type of Surface	*Maximum deviation of surface in millimeters [in] below 3 m [10 ft] straightedge
Concrete Wearing Surface, Curbs, Sidewalks, and Barriers	3 mm [• in]

Concrete Slab Surfaces to be Covered by Membrane Waterproofing or Concrete Wearing Surfaces	6 mm [ $\frac{1}{4}$ in]
Concrete Slab Surfaces with Integral Concrete Wearing Surface	6 mm [ $\frac{1}{4}$ in]
Concrete Slab Surfaces to be Covered By Earth or Gravel	10 mm [ $\bullet$ in]
Concrete Surface of Box Culvert Bottom Slab	10 mm [ $\bullet$ in]
Concrete Surface of Abutments, Piers, Pier Shafts, Footings, and Walls	10 mm [ $\bullet$ in]

\*Allowance shall be made for crown, camber and vertical curve.

502.15 Curing Concrete All concrete surfaces shall be kept wet with clean fresh water for a curing period at least 7 days after placing of concrete. For concrete wearing surfaces and all concrete containing fly ash or slag, the temperature of the concrete shall be kept above 10°C [50°F] for the entire seven (7) day period. All other concrete and its surfaces shall be kept above 10°C [50°F] for the first four (4) days of the curing period and above 0°C [32°F] for the remainder of the period.

As an alternative to the above, the Contractor may shorten the seven (7) day curing period when it can be shown that the concrete has developed 80 percent of design strength. The Contractor shall make cylinders and furnish test results to the Resident before curing is stopped. In the 24 hours following the end of the curing period, the temperature of the concrete shall be decreased on a gradual basis, not to exceed a total change of 22°C [40°F] for moderate sections, such as abutments and pier bents, and 17°C [30°F] for mass sections, such as massive piers.

When the ambient temperature is expected to fall below 2°C [35°F] during the shortened curing period and 24 hours following, the Contractor shall make provisions to maintain the temperature of the concrete and its surface above 0°C [32°F].

All slabs and wearing surfaces shall be water cured only and kept continuously wet for the entire approved curing period by covering with one of the following systems:

- A. 2 layers of wet burlap,
- B. 2 layers of wet cotton mats,
- C. 1 layer of wet burlap and either a polyethylene sheet or a polyethylene coated burlap blanket,
- D. 1 layer of wet cotton mats and either a polyethylene sheet or a polyethylene coated burlap blanket.

Except as otherwise specified, curing protection for slabs and wearing surfaces shall be applied within 30 minutes after the concrete is screeded and before the surface of the concrete has lost its surface "wetness" or "sheen" appearance. The first layer of either the burlap or the cotton mats shall be wet and shall be applied as soon as it is possible to do so without damaging the concrete surface. Polyethylene sheets shall not be placed directly on the concrete, but may be placed over the fabric cover to prevent drying.

The covering of concrete wearing surfaces, decks, curbs, and sidewalks shall be kept continuously wet for the entire curing period by the use of a continuous wetting system and shall be located to insure a completely wet concrete surface for the entire curing period.

All other surfaces, if not protected by forms, shall be kept thoroughly wet either by sprinkling or by the use of wet burlap, cotton mats or other suitable fabric until the end of the curing period. Polyethylene sheets shall not be placed directly on the concrete, but may be placed over the fabric cover to prevent drying.

Surfaces of all concrete placements containing silica fume additive shall be coated with an approved evaporation retardant immediately after finishing and texturing the concrete surface. The application of wet burlap or wet cotton mats shall be made within 15 minutes after the finishing of the concrete surface.

The application rate, the desired equipment, and the mixing and application procedures for an approved evaporation retardant shall be as designated by the manufacturer. Successive applications or heavier applications of this evaporation retardant shall be applied as necessary to retain the required surface "wetness" appearance.

#### 502.16 Loading Structures and Opening to Traffic No superstructure concentrated loads such as structural steel beams,

girders and trusses shall be placed upon finished concrete substructures until the concrete has reached its design strength.

No load or work will be permitted on concrete superstructure slabs or rigid frame structures until concrete cylinders cured with the slab establish that design strength has been reached. However, after a shorter period of time the Resident may permit handwork for form construction and setting stone bridge curb. No curbing or other materials shall be stored on the bridge during the 7 day curing period, except that if handwork is permitted, curb stones may be stored in a line near to their final location until ready to be set.

Neither traffic nor fill material shall be allowed on superstructures of concrete bridges or culverts until concrete cylinders cured with the slab establish that design strength has been reached, dependent upon conditions as specified in Section 502.10 and with the approval of the Resident.

No traffic will be allowed on the cured concrete of a concrete wearing surface until 24 hours after the completion of the application of protective coating for concrete surfaces.

Concrete approach slabs at the end of structures may be opened to traffic or backfilled if buried, when the design strength has been reached.

502.17 Bridge Drains and Incidental Drainage. All drains shall be accurately placed at the locations shown on the Plans or authorized and adequate means provided for securely holding them in the required positions during the placing of concrete.

Bridge drains shall be galvanized in accordance with Section 711.04 - Bridge Drains. The Contractor shall furnish an insulator between surfaces of galvanized and weathering steels when erecting the bridge drain support assembly. Epoxy-coated washers shall be used when the support assembly attaches to weathering steel beam webs.

Drains or weep holes through abutments and retaining walls shall be pipe of the size and shape shown on the Plans and shall be of Schedule 40 PVC pipe.

For the purpose of providing drainage for any moisture that may collect between the floor slab and the bituminous concrete roadway surface, approved 25 mm [1 in] inside diameter plastic tube drains shall be installed at the low points of the slab surface, adjacent to the end dam or dams. The exact location will be determined in the field by the Resident and

the discharge from them shall be such as to clear the bridge seats and any other portion of the structure in their proximity. The tops of the drains shall be depressed 10 mm [ $\bullet$  in] below the surface of the slab and the outlets shall project 50 mm [2 in] below the underside of the slab. Care shall be exercised such that the drains are open after the installation of the membrane waterproofing, when it is installed.

### 502.18 Method of Measurement

A. Structural concrete satisfactorily placed and accepted will be measured by the cubic meter [cubic yard], in accordance with the dimensions shown on the Plans or authorized changes in the Plans, or as one lump sum unit, as indicated in the Schedule of Items.

Structural Concrete for any irregular shapes may be measured by the cubic meter [cubic yard] as determined from the theoretical yield of the design mix or in the case of transit mixed concrete, by delivery ticket as directed by the Resident.

B. The limits to be used in determining the quantities of the aforementioned structural concrete items for arriving at a lump sum price will be as follows:

1. Structural Concrete Superstructure Slabs, Structural Concrete Roadway and Sidewalk Slabs on Steel Bridges, Structural Concrete Roadway and Sidewalk Slabs on Concrete Bridges and Structural Concrete Superstructure T-beam Type The limits will be the entire concrete superstructure, outside to outside, both transversely and longitudinally, exclusive of concrete curbs, sidewalks, permanent transition barrier and concrete transition barriers.

2. Structural Concrete Wearing Surfaces The limits will be the entire concrete wearing surface bounded transversely by the roadway curbs and longitudinally by the extreme ends.

3. Structural Concrete Box Culverts The limits will be the entire structure, meaning the bottom floor slab, abutments, wings, superstructure floor slab and headwalls or curbs.

4. Structural Concrete, Approach Slabs The limit will be the entire approach slab or slabs, as shown on the Plans.

5. Structural Concrete, Abutments and Retaining Walls, Structural Concrete, Abutments and Retaining Walls (placed under water), Structural Concrete Piers, and Structural Concrete Piers (placed under water) The limits will be the entire concrete substructure unit or units, from the bottom of the footing to the top of the unit, and outside to outside, both transversely and longitudinally, except for the portion to be placed under water, as indicated on the Plans, which will be the limits of the concrete unit or units, outside to outside, transversely, longitudinally, and vertically.

6. Structural Concrete Rigid Frame Structures The limits will be the entire concrete structure, meaning the frame walls and top slab. Included within the limits for payment, unless otherwise shown on the Plans, are bottom slab, wing walls and headwalls.

7. Structural Concrete Culvert End walls The limit will be the entire concrete end wall or end walls, as shown on the Plans.

8. Structural Concrete Curb and Sidewalks The limit will be the entire concrete curb or sidewalk, as shown on the Plans.

9. Concrete Fill Will be measured for payment by the number of cubic meters [cubic yards] of concrete, in place, to the vertical pay limits shown on the Plans. If the Contractor elects to omit forms, then any excavation or concrete placed beyond the pay limits indicated on the Plans shall not be paid for, but shall be at the Contractor's expense.

C. No deduction will be made for the volume of concrete displaced by structural steel, reinforcing steel, pile heads, expansion joint material, drains, chamfers on corners, inset panels of 38 mm [1 ½ in] or less in depth, pipes, weep holes and authorized openings for utilities of 0.2 m<sup>3</sup> [¼ yd<sup>3</sup>] or less in volume, when any of these items occur in structural concrete which is to be paid for on a cubic meter [cubic yard] basis.

D. When the bottom of foundations for concrete structures is required to be at a definite elevation within rock excavation, as shown on the Plans or otherwise designated, the quantity to be measured will be the number of cubic meters [cubic yards] of concrete actually and satisfactorily placed above a plane at 300 mm [1 ft] below the above specified plan elevation and within the neat lines of the structure as shown on the Plans or on authorized changes in the Plans. If the ledge rock is excavated below the plane at 300 mm [1 ft] below the plan elevation, without authorization, then this space shall be replaced with concrete of the same composition as required for the structure foundation but will not be measured for payment.

E. For the purposes of making pay adjustments under Method A, quantities of lots and sublots shall be determined as outlined under Section 502.0502 - Quality Assurance Method A, and under Section 502.19 - Basis of Payment.

502.19 Basis of Payment The accepted work done under structural concrete, of the classes and for the types of work required, will be paid for at the Contract unit price per cubic meter [cubic yard], or at the Contract lump sum price, for the respective Contract items involved. Payment for both the unit price and the lump sum price items will be full compensation for furnishing and installing bridge drains, water stops, expansion joint filler, PVC or plastic tube drains, asphalt roll roofing (roofing felt), asphalt for painting or covering various type of joints, all required sandblasting, bonding, curing and joint sealing and all incidentals necessary to complete the work satisfactorily. No direct payment will be made for concrete admixtures.

No price adjustments will be made to the lump sum bid for the respective items that are bid lump sum, except when quantity changes are directed by the Department. It will be the responsibility of the Contractor to verify the estimated quantities prior to submitting bid documents.

Payment for structural concrete culvert connection shall include drilling and grouting the dowels into the existing headwall and excavation. Reinforcing will be paid for under Pay Item 503.12, Reinforcing Steel, Fabricated and Delivered and Pay Item 503.13, Reinforcing Steel, Placing.

Reinforcing steel, railings, stone curbing and any material that may be required for bridge lighting systems, will be measured and paid for separately as provided in the appropriate sections.

Implementation of the Quality Control Plan and costs associated with acceptance test sampling shall be incidental.

All costs associated with obtaining, testing and evaluating drilled core specimens for dispute resolution will not be paid for directly, but will be considered incidental to related items.

Pay adjustments will be made only for cast-in-place concrete accepted under Method A. Pay adjustments shall be computed on the actual final quantity for unit price items. Pay adjustments shall be computed on the estimated quantity for lump sum items, except when precast deck panels are used, or when quantity changes are directed by the Department. When precast deck panels are used, the precast deck panel quantity, as computed from the Working Drawings, shall be

deducted from the estimated lump sum quantity to determine the new estimated quantity that will be used to compute pay adjustments. When Department-directed quantity changes are made, this quantity shall be added to, or subtracted from, the estimated lump sum quantity to determine the new estimated quantity that will be used to compute pay adjustments. When precast deck panels are used and Department-directed quantity changes are made under the same lump sum item, the combined quantity change shall be added to, or subtracted from, the estimated lump sum quantity to determine the new estimated lump sum quantity that will be used to compute pay adjustments. Pay adjustments will be made according to the formulas in Sections 502.191 through 502.194. P, the unit value for pay adjustment purposes, is specified in Special Provision Section 502, Structural Concrete (QC/QA Acceptance Methods). P values, as specified in Special Provision Section 502, reflect the price per cubic meter (yd<sup>3</sup>) for all pay adjustment purposes.

502.191 Pay Adjustment for Compressive Strength Compressive strength tests will be completed by the Department in accordance with AASHTO-T22 at 28 days. If three consecutive tests fail to meet the below listed strength requirements, the Contractor shall submit remedial actions acceptable to the Department, at no additional cost. These remedial actions shall be taken until the source of the problem can be identified and corrected or new trial batches can be performed. When the average of three consecutive tests falls to less than 1.0 Mpa [150 psi] above the specified strength or any single test more than 1.4 Mpa [200 psi] below the specified strength, the Resident will notify the Contractor to make corrective changes in the materials, mix proportions, or in the concrete manufacturing procedures before placing additional concrete of the same class. Such changes shall be subject to the approval of the Resident.

The lot pay adjustment for compressive strength will be as follows:

Pay factors (PF) for subplot pay adjustments for compressive strength per subplot will be determined as specified below.

Table 6

Class	Compressive Strength	Pay Factor (PF) {Metric}	Pay Factor (PF) [US Customary]
A	>30 MPa [4350 psi]	1	1
	27 - 30 MPa [3900 - 4350 psi]	$(0.10/3) \times (\text{strength})$	$(0.10/450) \times (\text{strength}) + 0.0333$
	<27MPa[3900 psi]	$(0.10/3) \times (\text{strength})$	$(0.10/450) \times (\text{strength}) + 0.0333$

LP	>35 MPa [ 5075 psi]	1	1
	32 - 35 MPa [4575 - 5075 psi]	$(0.10/3) \times (\text{strength}) - 0.1667$	$(0.10/500) \times (\text{strength}) - 0.0150$
	<32MPa [4575 psi]	$(0.10/3) \times (\text{strength}) - 0.1667$	$(0.10/500) \times (\text{strength}) - 0.0150$
S	> 20 MPa [2900 psi]	1	1
	17 - 20 MPa [2600 - 2900 psi]	$(0.10/3) \times (\text{strength}) + 0.3333$	$(0.10/300) \times (\text{strength}) + 0.0333$
	<17MPa [2600 psi]	$(0.10/3) \times (\text{strength}) + 0.3333$	$(0.10/300) \times (\text{strength}) + 0.0333$

The pay adjustment per subplot for compressive strength will be as follows:

$$\text{Sublot Pay Adjustment} = P \times (\text{PF} - 1) \times \text{Sublot Size}$$

No positive pay adjustments for compressive strength will be made.

502.192 Pay Adjustment for Chloride Permeability Pay factors (PF) for subplot pay adjustments for rapid chloride permeability per subplot for Class A concrete will be determined as specified below, except for those decks provided for in Table 8. Decks that will be covered with one of the approved products on the Department's Prequalified List of Approved Materials for High Performance Waterproofing Membrane or gravel will be computed using the pay factors shown in Table 7.

Table 7

Rapid Chloride Permeability Coulomb Value	Pay Factor (PF)
< 800	1.05
800 - 2000	$1.100 - [(0.050/1200) \times \text{Permeability}]$
2001 - 3000	1
3001 - 4000	$1.75 - [(0.25/1000) \times (\text{Permeability})]$

Values greater than 4000 coulombs shall be subject to rejection and replacement at no additional cost to the Department.

Pay factors (PF) for subplot pay adjustments for rapid chloride permeability per subplot for Class A concrete placed in decks which will receive a concrete wearing surface, will have an integral wearing surface, or will have a sheet type membrane, will be determined as specified in Table 8.

Table 8

Rapid Chloride Permeability Coulomb Value	Pay Factor (PF)
< 800	1.075
800 - 2000	$1.125 - [(0.075/1200) \times (\text{Permeability})]$
2001 - 3000	1
3001 - 4000	$1.75 - [(0.25/1000) \times (\text{Permeability})]$

Values greater than 4000 coulombs shall be subject to rejection and replacement at no additional cost to the Department.

Pay factors (PF) for subplot pay adjustments for rapid chloride permeability per subplot for Class LP concrete will be determined as specified below.

Table 9

Rapid Chloride Permeability Coulomb Value	Pay Factor (PF)
< 800	1.075
800 - 1500	$1.16 - [(0.075/700) \times (\text{Permeability})]$
1501 - 2000	1
2001 - 3000	$1.50 - [(0.25/1000) \times (\text{Permeability})]$

Values greater than 3000 coulombs shall be subject to rejection and replacement at no additional cost to the Department.

The pay adjustment per subplot for rapid chloride permeability will be as follows:

$$\text{Sublot Pay Adjustment} = P \times (\text{PF} - 1) \times \text{Sublot Size}$$

502.193 Pay Adjustment for Air Content Pay factors (PF) for pay adjustments for air content will be determined using the Quality Level Analysis as specified in Section 106. The pay adjustment for air content will be as follows: Lot Pay Adjustment =  $P \times (\text{PF}-1) \times \text{Lot Size}$

The maximum allowable bonus for air content shall be 2.5 percent.

502.194 Pay Adjustments for Surface Tolerance, Alignment and Trueness, Plumb and Batter, and for Finish No positive pay adjustments will be made under this section. Negative pay adjustments will be made on a per placement basis as follows:

A. Surface Tolerance When the Resident uses a 3 meter [10 ft] straightedge to measure surface tolerance and more than 15 percent of the measurements taken for any one placement exceed the maximum deviations shown in Table 5 of Section 502.14(b), a pay adjustment of 10 percent as required, will be computed according to the formula given below.

When the Resident uses a lightweight profiler to measure tolerance and the International Ride Index (IRI) is in excess of 6.5 m 3.95 m/km [250 in/mile] for any one placement, a pay adjustment of 10 percent as required, will be computed as follows:

$$\text{Pay Adjustment} = P \times \text{Placement Size} \times .10$$

B. Alignment and Trueness When alignment and trueness exceed the tolerances described in Section 502.0502, the Resident will make a pay adjustment of 10 percent as required, according to the formula given below: Pay adjustment =  $P \times \text{Placement Size} \times .10$

C. Plumb and Batter The Resident will take measurements in accordance with Section 502.0502. When any one measurement is beyond the allowable limits, a pay adjustment of 10 percent as required, will be computed as follows: Pay adjustment =  $P \times \text{Placement Size} \times .10$

D. Finish The Resident will take measurements to determine the areas to be repaired in accordance with Section

502.0502. When more than 5 percent and less than 10 percent of the surface of any placement requires repairs of defects or there are defects that expose reinforcing steel, a pay adjustment of 10 percent as required, will be computed as follows:

$$\text{Pay adjustment} = P \times \text{Placement Size} \times .10$$

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
502.21 Structural Concrete, Abutments and Retaining Walls	Cubic Meter [Cubic Yard]
502.219 Structural Concrete, Abutments and Retaining Walls	Lump Sum
502.22 Structural Concrete, Abutments and Retaining Walls (placed under water)	Cubic Meter [Cubic Yard]
502.229 Structural Concrete, Abutments and Retaining Walls (placed under water)	Lump Sum
502.23 Structural Concrete Piers	Cubic Meter [Cubic Yard]
502.239 Structural Concrete Piers	Lump Sum
502.24 Structural Concrete Piers (placed under water)	Cubic Meter [Cubic Yard]
502.249 Structural Concrete Piers (placed under water)	Lump Sum
502.25 Structural Concrete Superstructure Slab	Lump Sum
502.26 Structural Concrete Roadway and Sidewalk Slab	Lump Sum    Lump Sum
502.261 on Steel Bridges Structural Concrete Roadway and Sidewalk Slab on Concrete Bridges	
502.27 Structural Concrete Superstructure T-beam Type	Lump Sum
502.28 Structural Concrete Rigid Frame Structures	Cubic Meter [Cubic Yard]
502.289 Structural Concrete Rigid Frame Structures	Lump Sum
502.29 Structural Concrete Wearing Surface on Bridges	Lump Sum
502.30 Structural Concrete Box Culvert	Lump Sum
502.31 Structural Concrete Approach Slab	Lump Sum

502.32	Structural Concrete Culvert End wall	Cubic Meter [Cubic Yard]
502.33	Structural Concrete Culvert End wall	Lump Sum
502.40	Structural Concrete Box Culvert	Cubic Meter [Cubic Yard]
502.41	Structural Concrete Superstructure Slab	Cubic Meter [Cubic Yard]
502.42	Structural Concrete Roadway and Sidewalk Slab on Steel Bridges	Cubic Meter [Cubic Yard]
502.43	Structural Concrete Superstructure T-beam Type	Cubic Meter [Cubic Yard]
502.44	Structural Concrete Wearing Surface on Bridges	Cubic Meter [Cubic Yard]
502.45	Structural Concrete Approach Slab	Cubic Meter [Cubic Yard]
502.46	Structural Concrete Culvert Connection	Cubic Meter [Cubic Yard]
502.48	Low Permeability Concrete Structural Concrete	Cubic Meter [Cubic Yard]
502.49	Curbs and Sidewalks Concrete Fill	Lump Sum Cubic Meter
502.56		[Cubic Yard]

## SECTION 503 - REINFORCING STEEL

503.01 Description This work shall consist of furnishing and placing reinforcement, either plain or epoxy-coated, in accordance with these specifications and in conformance with the Plans, Supplemental Specifications and Special Provisions.

503.02 Materials Materials shall meet the requirements of the following Sections of Division 700 - Materials:

Reinforcing Steel	709.01
Welded Steel Wire Fabric	709.02

503.03 Schedule of Material When the Department does not furnish reinforcing steel schedules, the Contractor shall submit order lists, bending diagrams and bar layout drawings to the Resident for approval. The reinforcing steel shall not be ordered until these lists and drawings are approved. Approval shall not relieve the Contractor of full responsibility for the satisfactory completion of this item. When the Department allows the use of precast concrete deck panels, or any other significant changes that effect the quantity of reinforcing steel, the Contractor shall be responsible for revising the reinforcing steel schedule; the revised schedule shall be submitted to the Resident for approval.