

Section 500

PORTLAND CEMENT CONCRETE

SECTION 501 - PORTLAND CEMENT CONCRETE - GENERAL

501-1 DESCRIPTION. These general requirements apply to concrete furnished for pavement, structures and incidental construction. Additional requirements may be specified in the contract item. All testing will be done in accordance with Department procedures.

501-2 MATERIALS

501-2.01 Composition of Mixtures. The Contractor shall inform the Regional Director, in writing, of the materials sources prior to mixing concrete. Proportion and mix portland cement, fine aggregate, coarse aggregate, water, admixtures, pozzolan and /or microsilica to create a homogeneous portland cement concrete mixture.

Produce the class of concrete indicated in the contract documents. However, substitutions may be made according to Table 501-1, Concrete Class Options.

Concrete Class	Allowable Class Options
A	C, E, F1, H or HP
C	HES2
D	DP
DP	None
E	H or HP
H	HP
F, G, GG, or HP	None
I	J
J	None

NOTES:

1. Regional Director approval required for pavement applications, including approach slabs. DCES approval required for structural or deck applications. May not be used in mass placements, or as a substitute for class A in Sign Structure, Signal Pole, and Luminary Foundations.
2. The requirements of §502-2.01 and §502-2.02 apply

501-2.02 Material Requirements

Portland Cement	701-01	Fly Ash	711-10
Blended Portland Cement	701-03	Microsilica	711-11
Admixtures	711-08	GGBFS *	711-12
		Water	712-01

* Ground Granulated Blast Furnace Slag

A. Cementitious Materials. Use only cementitious materials meeting §701-01 whose brand name and type appears on the Department’s Approved List. Cementitious materials stored over the winter at concrete producing facilities will be retested for specification compliance. All contaminated, or hardened cementitious material will be rejected and not used in Department work.

The Department will consider requests to evaluate alternate cements, pozzolan or microsilica. The use of alternatives is subject to approval by the Director, Materials Bureau.

1. Portland Cement. Use Type I, Type II or Type I/II cement, except as indicated below or in the contract documents.

Type I cement is restricted to fresh water and low sulfate soil areas. Use Type II or Type I/II cement in high sulfate, and salt water areas. Salt water areas are defined as; The Hudson River south of the Newburg-Beacon Bridge, and all other tidal / sea water spray areas of New York State. Type I/II cement is defined as a cement that meets the requirements of both Type I and Type II cements. High alkali cement is defined as any portland cement having an alkali content in excess of 0.70% as denoted on the Approved List. High alkali cement use is restricted, unless otherwise approved by the Regional Director, to mixtures that do not contain reactive aggregates (as denoted in the Department's List of Approved Sources of Aggregates).

2. Blended Portland Cement. Blended cements meeting the requirements of 701-03, may be used as follows:

a. Type IP or SM. Blended Portland Cement (Type IP or Type SM), may be used in all classes of concrete listed in Table 501-03, Concrete Mixtures, except Class F. Type IP or SM blended cement replaces the portland cement/pozzolan portion of the designed mix in Class DP, G, GG, or HP concrete. When using Type IP or SM blended cement in Class DP and HP concrete, an addition of Microsilica §711-11 is required.

b. Type SF. Blended Portland Cement (Type SF), may be used in Class DP or HP concrete. Type SF blended cement replaces the portland cement/microsilica portion of the designed mix in Class DP or HP concrete. When using Type SF blended cement in Class DP or HP concrete, an addition of Fly Ash, §711-10, or Ground Granulated Blast Furnace Slag (GGBFS), §711-12, is required.

c. Ternary Blend. Blended Portland Cement (Ternary Blend), may be used in Class DP or HP concrete. Ternary blend cement in Class DP or HP concrete replaces the entire portland cement/pozzolan/microsilica portion of the designed mix. No subsequent addition of cementitious material is required or allowed.

3. Pozzolan. Pozzolan is defined as Fly Ash, §711-10, or Ground Granulated Blast-Furnace Slag (GGBFS), §711-12. All classes of concrete, except Class F, allow or require a pozzolan as a partial replacement for portland cement. Classes DP, G, GG, and HP concrete require the use of a pozzolan.

4. Microsilica. Class DP and HP concrete require Microsilica, §711-11, as a partial replacement for portland cement. Microsilica, a pozzolanic material, is not included in the definition of a pozzolan in these specifications.

B. Aggregates. Use aggregate from a source on the Approved List of Sources of Fine and Coarse Aggregates that also meets the following requirements for gradation and friction.

1. Gradation. Samples will be taken from stockpiles, barges, conveyor belts, or bins and tested for gradation at the plant site in accordance with NYSDOT Materials Method 9.1. Rejected aggregates may be reprocessed or reworked to meet the gradation requirements.

a. Concrete Sand. Use only sand meeting the requirements of §703-07, Concrete Sand.

b. Coarse Aggregate. Use only crushed stone, crushed gravel, or crushed slag meeting the requirements of §703-02, Coarse Aggregates in either one or a combination of size designations specified in Table 703-4, Sizes of Stone, Gravel, and Slag and graded according to Table 501-2, Coarse Aggregate Gradations.

Aggregates that are uniform in size, but do not meet the requirements in Table 703-4, may be approved by the Regional Director. When these sizes are combined to meet the mixture gradation requirements of Table 501-2, the gradation requirements of §703-02 shall not apply. Blending of aggregates during the batching process may be approved by the Regional Director. When blending aggregates prior to batching, the blending method requires approval by the Regional Director.

TABLE 501-2 COARSE AGGREGATE GRADATIONS		
Sieve Sizes	Type CA 1 General Limits % Passing	Type CA2 General Limits % Passing
37.5 mm	-	100
25.0 mm	100	93-100
12.5 mm	90-100	27-58
6.3 mm	0-15	0-8

NOTES:

ASTM C33 Size Number 7 is an acceptable equivalent to the Type CA 1 gradation.

ASTM C33 Size Number 57 is an acceptable equivalent to the Type CA 2 gradation.

Material passing the 75 µm sieve (wet) is limited to a maximum 1.0 % by mass for ASTM sizes 7 and 57.

2. Friction. Sample and test aggregate for friction characteristics according to the procedures of Materials Method 28 “Friction Aggregate Control and Test Procedures.” The Engineer will identify pavement areas, if any, represented by failing samples according to the procedures of Materials Method 28 “Friction Aggregate Control and Test Procedures.”

a. Concrete Sand. For use in concrete pavements, bridge decks, precast pavers, or any other item used in concrete highway wearing surfaces, sand (natural or manufactured) must contain at least 25.0% acid-insoluble residue in the plus 600 µm size fraction and in the minus 600 µm size fraction. Sands may be blended to meet this requirement.

b. Type 1 Coarse Aggregate. Use coarse aggregate meeting one of the of the following requirements:

Limestone, dolomite, or a blend of the two, having an acid-insoluble residue content not less than 20.0%.

- Sandstone, granite, chert, traprock, ore tailings, slag, or other similar noncarbonate materials.
- For concrete mixtures containing CA1 coarse aggregate: gravel or a blend of rock types containing no less than 95.0% noncarbonate particles (by weight with adjustments to equivalent volumes for materials of different specific gravities) in the minus 25.0 mm, plus 6.3 mm primary size fraction.
- For concrete mixtures containing CA2 coarse aggregate: gravel or a blend of rock types containing no less than 95.0% noncarbonate particles (by weight with adjustments to equivalent volumes for materials of different specific gravities) in the minus 37.5 mm, plus 12.5 mm and the minus 12.5, plus 6.3 mm primary size fractions.

c. Type 2 Coarse Aggregate. Use coarse aggregate meeting one of the following requirements:

Limestone, dolomite, or a blend of the two, having an acid-insoluble residue content not less than 20.0%.

- Sandstone, granite, chert, traprock, ore tailings, slag, or other similar noncarbonate materials.
- For concrete mixtures containing CA1 coarse aggregate: gravel or a blend of rock types containing no less than 20.0% noncarbonate particles (by weight with adjustments to equivalent volumes for materials of different specific gravities) in the minus 25.0 mm, plus 6.3 mm primary size fraction.

- For concrete mixtures containing CA2 coarse aggregate: gravel or a blend of rock types containing no less than 20.0% noncarbonate particles (by weight with adjustments to equivalent volumes for materials of different specific gravities) in the minus 37.5 mm, plus 12.5 mm and the minus 12.5, plus 6.3 mm primary size fractions.

d. Type 3 Coarse Aggregate. Use coarse aggregate meeting one of the following requirements:

Limestone or a blend of limestone and dolomite having an acid-insoluble residue content not less than 20.0%.

- Dolomite.
- Sandstone, granite, chert, traprock, ore tailings, slag or other similar noncarbonate materials.
- For concrete mixtures containing CA1 coarse aggregate: gravel or a blend of rock types containing no less than 20.0% noncarbonate particles (by weight with adjustments to equivalent volumes for materials of different specific gravities) in the minus 25.0 mm, plus 6.3 mm primary size fraction.
- For concrete mixtures containing CA2 coarse aggregate: gravel or a blend of rock types containing no less than 20.0% noncarbonate particles (by weight with adjustments to equivalent volumes for materials of different specific gravities) in the minus 37.5 mm, plus 12.5 mm and the minus 12.5, plus 6.3 mm primary size fractions.

e. Type 9 Coarse Aggregate. Use coarse aggregate meeting the requirements of §501-2.02 B.1.b. Coarse Aggregate.

C. Admixtures. Use only admixtures meeting §711-08 that appear on the Department's Approved List. Admixtures not conforming to §711-08 are subject to approval by the Director, Materials Bureau.

501-2.03 Concrete Batching Facility Requirements. Batching facilities must be of sufficient design and capacity to produce the quantity of concrete specified. Batching facilities that differ from conventional designs will be considered for use by the Director, Materials Bureau.

A. Acceptance. Each facility requires initial and annual approval by the Director, Materials Bureau. The Regional Director may disapprove use of a previously approved facility at any time for non-conformance with the specifications. Once disapproved, production for Department work will not be allowed until corrective measures are implemented under the approval of the Regional Director.

B. Bins. Each facility requires:

- Sufficient size and number of storage bins to produce the quantity of concrete specified.
- Positive separations between fine aggregate and various sizes of coarse aggregates.
- Separate cement, pozzolan, and microsilica bins, except Type I and Type II cement may be combined in common storage unless the cement is intended for use in high sulfate or salt water areas as described in §501-2.02 A. Cementitious Materials.
- Cement, pozzolan, and microsilica bins with protection from rain and moisture.
- A means of safely obtaining uncontaminated samples from all microsilica bins.
- A means of safely obtaining uncontaminated samples from any cement or pozzolan bin that has been determined by the Regional Materials Engineer as either unsafe to sample, or difficult to verify the acceptability of its contents.

Sampling will be conducted, or witnessed by the Regional Materials Engineer's representative.

C. Weigh Hoppers and Discharge Chutes. Each facility requires:

- Separate weigh hoppers for aggregate and cementitious materials.
- Enclosed cement weigh hopper to protect against moisture and reduce escaping dust.

- Chutes arranged so that materials will not lodge or be lost on discharge.
- No chutes suspended from any part of the weighing system.
- Vibrators arranged so that no significant vibrations are transmitted to the scales or other plant control equipment during the weighing process.

D. Scales. Each facility requires:

- Load cell type scales which indicate the load at all stages of the weighing operation, from zero to full capacity, when installed for weighing materials after January 2, 2003.
- Scales that meet the requirements of the National Institute of Standards and Technology, Handbook 44, with no less than 500 nor more than 2000 scale divisions.
- Digital displays that match the primary scale within 1 division.
- Minimum resolution of digital displays equivalent to the minimum resolution on the primary scale.
- Digital displays located in direct sight of the operator's normal work station.
- Face of digital displays protected from manipulation.

Test all plant scales for accuracy, at no additional cost, by a qualified technician as follows:

- Annually, prior to use for Department work.
- At intervals of not more than 90 calendar days.
- Whenever a plant changes location.
- At any time ordered by the Regional Director.

Provide a cradle or test platform, approved by the Regional Director, for each scale, and at least 20 standard 25 kg (or metric equivalent) test weights. The use of a set of test weights for two or more facilities will be permitted when they can be available within 1 hour. If directed by the Regional Director, make provisions for locking scales against tampering.

E. Proportioning Control Equipment. Proportion the materials by automatic proportioning devices approved by the Director, Materials Bureau. All systems must be approved to operate in metric units on or before January 2, 2003, unless otherwise indicated in the contract documents.

The Regional Director may require the locking or sealing of proportioning equipment that is subject to manipulation. Install automatic proportioning equipment in a dust and weather protected area of at least 4.0 square meters, with no internal dimension less than 2.0 meters.

Include equipment to:

- Produce all batches in fully automatic mode using preprogrammed metric mix designs. The only manual operation allowed is a switch or button to start the batching sequence and/or discharge the completed batch.
- Accurately proportion the various components of the mixture by mass, or by volume for admixtures and water, in the proper order so that aggregates and cementitious materials are displayed cumulatively (when appropriate).
- Deliver each constituent within the tolerances indicated in Table 501-4, Batching Tolerances.
- Control the cycle sequence.
- Interrupt and stop the automatic batching operations via auxiliary interlock cutoff circuits, whenever an error exceeding the acceptable tolerance occurs in proportioning, for all materials except water.
- Time the mixing operations for central mix plants, and provide a clear indication on the recordation whenever the mix time has been interrupted.

Interlock the system so that during the batching of cementitious materials, aggregates and admixtures:

- No inlet gate can open while the weigh hopper discharge gate is open.
- No inlet gate can open while another material is being weighed in a shared weigh hopper.
- No weigh hopper discharge gate can open while the hopper is being filled nor until the full batch mass is within delivery tolerance.

- No new batch can be weighed until the hopper is entirely empty of the previous batch and the scale has returned to within the allowable zero tolerance.

F. Admixture Dispensing Systems. Equip plants with calibrated systems that meet the following:

- A sufficient number of dispensing systems to supply the concrete mixture specified.
- The ability to dispense each admixture through its own measuring system.
- Accurate measurement within the tolerance limits specified in Table 501-4, Batching Tolerances.
- A bypass valve to obtain a calibrated sample of admixture from each measuring device.
- Uniform distribution of admixture throughout the mix within the specified mixing period.
- When multiple admixtures are added, no direct contact with each other prior to mixing.
- An approved automatic admixture dispensing system in plants equipped with automated proportioning systems.
- Volumetric measuring devices interlocked with the automated proportioning equipment that insure the preset quantity has been actually measured and completely discharged.
- A readable indication at the operator's normal work station of the actual quantity batched.

Interlock the admixture system with the automated proportioning system so that aggregate and/or cement weigh hopper discharge gates cannot be opened until the preset quantity of admixture has been batched or discharged.

Recordation of the presence of admixture is dependent on completion of admixture discharge.

G. Recordation Equipment. Equip all plants with digital recording instruments approved by the Director, Materials Bureau, that meet the following requirements:

- Is readily accessible and readable at the operator's normal work station.
- Provides separate quantity recordation of each aggregate component, cement, pozzolan, microsilica, admixture, fine aggregate moisture content, and water (at central mix plants) for each batch of concrete. Water at central mix plants may be recorded by mass or volume.
- Records the batch number, concrete class, date (day, month, year), and time of day to the nearest minute on each batch record.
- Provides cumulative recordation (when batching cumulatively) of mass and/or volume as indicated on the batching scale or meter within an accuracy of 1 scale or meter graduation.
- Has a minimum recorder resolution equivalent to or less than the minimum graduation on the scale or meter, unless otherwise approved by the Director, Materials Bureau.
- Provides a clear and legible copy of all batch records, containing permanent identification of the time and all quantities in each batch, to the Department.
- Automatically stamps the date and time of batch completion on each batch and /or delivery ticket.
- Provides clear identification on batch recordation when:
 - ◆ Initiating a batch without all conditions satisfied for full automated production.
 - ◆ An out of tolerance condition is accepted during batching.
 - ◆ A system is taken out of the full automated mode during the batching sequence.
 - ◆ A system produces a "demonstration" or "simulated" batch.
 - ◆ A system reprints a batch ticket.
 - ◆ The timing of a central mixer has been interrupted.

When the automation system can produce other than standard size batches (full, half or quarter cubic meter increments), recordation will be subject to approval of the Director, Materials Bureau.

H. Inspection Facility. Provide a weatherproof building or trailer, for use as an inspector's testing laboratory and office that meets the following criteria:

- Meets all applicable uniform fire prevention and building code requirements.
- Office area partitioned from the testing laboratory.

- Minimum gross area of 15 square meters, a minimum internal width of 2.1 meters and a ceiling height of not less than 2.3 meters.
- Protected from a noise level greater than an 8 hour, time weighted average of 85 dBa.
- Laboratory area with tables, work benches, shelving, and other equipment for testing portland cement concrete mixes.
- Increase the area proportionally to house and operate any additional testing equipment, and when there are multiple plants at one site, size the increase of the laboratory and office space to be adequate for performing inspection duties during all production circumstances.

Use the inspection facility only for its intended purpose, and when the inspection facility is used by more than one inspection authority, the Department will have priority. The facility and its location are subject to approval by the Regional Materials Engineer. Maintain the inspection facility, office, and testing equipment in good operating and clean condition. The Producer will be responsible for routine cleaning.

Equip the inspection facility with the following:

1. Office Equipment. A Standard size (approx. surface dimensions: 75 cm x 150 cm) office desk with drawers and a chair, and a fireproof file cabinet with at least two locking drawers and two keys.

2. First Aid Equipment. An adequately stocked first aid kit at the plant site including:

- An emergency eye wash station in the laboratory area.
- Safety equipment including gloves, dust mask, etc..

3. Sanitary Facilities. A flush type toilet at the plant site, enclosed in a properly vented, separate room and complying with applicable sanitary codes. A portable toilet may be substituted when a facility is set up on a temporary basis for a specific project.

4. Lighting. Electric, non glare, providing a minimum illumination level of 1000 lux at desk and work bench level.

5. Laboratory Sink / Potable Water. A Sink and faucet with an adequate supply of clean water for testing, and if necessary, a water cooler for potable drinking water.

6. Heating and Cooling. Adequate heating and air conditioning equipment to maintain an ambient temperature of $20\pm 3^{\circ}\text{C}$.

7. Ventilation. Minimum $0.1\text{ m}^3/\text{sec}$ exhaust hood, vented to the atmosphere, located over the sample drying area.

8. Communication Equipment. A telephone with a dedicated line in the laboratory office and a fax machine at the inspection facility or plant site for the inspector's use.

9. Fire Extinguisher. A 4.5 kilogram capacity multi-class ABC fire extinguisher, maintained and located in the laboratory area.

10. Coarse Aggregate Sieve Shaker. Power driven, with a minimum clear sieve area of 0.21 square meters.

- Anchored to a firm base.
- Imparts a vertical, or lateral and vertical motion.
- Equipped with an automatic timing shut-off device and dust cover.
- Fully enclosed and weatherproof when located outside the inspection facility.

11. Fine Aggregate Sieve Shaker.

- Power driven, independent of the coarse aggregate shaker.

- For 200 mm minimum diameter sieves.
- Imparts a vertical, or lateral and vertical motion.
- Equipped with an automatic timing shut-off device.

12. Sample Splitter. Able to split samples with a particle size of 13 to 50 millimeters.

13. Large Scale. Minimum capacity of 14 kg, with a maximum gradation of 0.005 kg meeting AASHTO M-231 Class G20. Scales provided as new or replacement after September 1, 2004, must be digital.”

14. Small Scale. Minimum capacity of 1500 g, with a maximum gradation of 0.1 g meeting AASHTO M-231 Class G2. Scales provided as new or replacement after September 1, 2004, must be digital.

15. Sample Drying Appliance. Stove or hot plates sized to rapidly dry aggregate samples with a minimum total of four burners.

16. Miscellaneous Testing Equipment. Miscellaneous equipment as per Department written directives or as requested by the Regional Director.

17. pH Test Kit. pH test kit meeting the requirements of Materials Procedure NY 90-1 for all plants supplying concrete containing microsilica (711-11).

501-2.04 Concrete Mixer and Delivery Unit Requirements. Each mixer requires a Manufacturer's plate, which contains the mixing capacity of the mixer, in a convenient visible location. Repair or replace blades inside the drum that have become heavily encrusted with mortar, or are loose, broken, bent, scalloped or worn 20% in any dimension or otherwise damaged.

A. Central Mixers. Central mixers meeting the following may be used unless otherwise specified:

- Equipped with an acceptable timing device that prohibits a batch of concrete from being discharged before the specified mixing time has elapsed (as per §501-3.03 C) without a clear indication on the recordation equipment.
- Able to discharge the entire batch in an unrestricted manner into a hopper or delivery unit.

B. Delivery Units. Delivery units are subject to inspection as per NYSDOT Materials Method 9.1 and approval by the Regional Director. If found unfit, it will be disapproved until properly repaired. Completely clean and empty the agitating and non-agitating units of concrete and wash water before loading again.

1. Truck Mixer Requirements. Use an inclined axis rotating drum type with a water tank system able to measure water (liters) going into the drum within a 2% accuracy, and equipped with a hatch in the drum periphery to permit access to inspect the inside.

Each truck mixer unit will be inspected and approved annually by the Regional Materials Engineer for use in Department work, and additional inspections will be made during use to determine its operating condition. Truck mixers will not be permitted to mix batches greater than the maximum capacity indicated on the Manufacturer's rating plate.

a. Transit Mixed Concrete. Equip each truck mixer used for transit mixed concrete with an electrical revolution-counting device, appearing on the Approved List, mounted in a clearly visible position as follows:

- Separate counters showing; The number of drum revolutions at speeds within the mixing range and the total number of drum revolutions.
- Both counters legible to one revolution and designed to accept a non-standard electric plug for resetting each counter to read zero when loading at the batch plant.
- Tamper-proof such that if tampering occurs, the counters will become inoperative or the device will otherwise indicate tampering, including the interruption of electric power.

- Installed to count the number of revolutions of the drum only in the direction of mixing.
- Adjusted so that it counts the number of revolutions specified for the mixing and agitating drum speed within the tolerances indicated on the Manufacturer's rating plate, but not to exceed the following Department's requirements for truck mixers:
 - ◆ Mixing - 6 RPM minimum to 18 RPM maximum
 - ◆ Agitating - 2 RPM minimum to 6 RPM maximum
 - ◆ The mixing and agitating revolution limits may be adjusted for individual mixing units upon approval of the Director, Materials Bureau.

b. Central Mixed or Truck Mixed Concrete. Equip each truck mixer used for central or truck mixed concrete, either as described in §501-2.04 B.1.a., for Transit Mixed Concrete, or as follows:

- Mixing speed capability- 6 RPM minimum to 18 RPM maximum.
- Agitating speed capability - 2 RPM minimum to 6 RPM maximum.
- Approved counter- located in a position readily visible to the Engineer that accurately counts the number of revolutions in the direction of mixing.

2. Non- Agitating/Open Haul Units for Central Mixed Concrete. Each truck shall be:

- Sound and watertight enough to prevent loss of material during delivery.
- Free of contamination.
- Covered to protect the concrete from adverse drying or precipitation, when ordered by the Engineer.

C. Mobile Concrete Mixing Units. A mobile concrete mixing unit, with the Engineer's approval, may be used for miscellaneous work such as curb, gutter, headwalls, catch basins, manholes, drop inlets, field inlets, sign foundations, lighting structure foundations, anchor units, pullboxes, leveling footings and similar placements.

Equip the mobile mixing unit with proportioning devices that deliver the materials within the following tolerances by mass:

Cement	0 to +4%	Admixtures	±1%
Fine Aggregate	±2%	Water	±3%
Coarse Aggregate	±2%		

Use a self contained, continuous mixing type, that meets the following:

- Carries unmixed dry bulk cementitious materials, fine and coarse aggregate, water and admixtures sufficient for at least 4.5 cubic meters per batch, unless otherwise approved by the Regional Materials Engineer.
- Measures the amount of cement being introduced into the mix by a clearly visible meter which is kept clean at all times.
- Records the quantity of cement by a ticket printer that, as a minimum, records the number of revolution counts of the cement feeder.

1. Water system

- a. Provides positive control of the water flow into the mixing chamber.
- b. Water flow indicated by a readily adjustable flow-meter to provide for minor variations in aggregate moisture.
- c. Equipped with a bypass valve or hose suitable to determine batching accuracy.

2. Admixture System

- a. Equipped with at least one admixture delivery system.
- b. Provides positive control of the admixture flow into the unit's mix water system.
- c. Flow-meters to control the amount of admixture added to the mix.

- d. Dispenses admixtures in a manner that provides uniform distribution throughout the concrete.
- e. Adds admixture in the amount necessary to achieve the required air content.
- f. Equipped with a bypass valve to obtain a calibrated sample to determine batching accuracy.

3. Mobile Mixing Unit:

- a. Capable of combining aggregates, cement, water and admixture into a thoroughly mixed and uniform mass, and discharging the mixture without segregation.
- b. Set the mixing time to achieve proper and uniform mix, as determined by the Engineer.
- c. Stockpile all mix materials at the project site, unless otherwise approved by the Engineer
- d. Provide the necessary scales, containers and personnel, approved by the Engineer, to calibrate the unit.
- e. Calibrate the unit and provide a record of the calibration to the Engineer for the mix design to be used. The Regional Materials Engineer will furnish the mix design information and the calibration procedure. The Department reserves the right to witness calibration of the unit.
- f. Prior to actual use, demonstrate to the Engineer that the concrete meets the specification requirements for slump, air content and proportioning. Proportioning may be verified in accordance with NYSDOT Materials Method 9.4.

Correct any improper mixer conditions as approved by the Engineer. Improper conditions include, but are not limited to, blades that have become heavily encrusted with mortar, or are loose, broken, bent, scalloped, or worn 20% in any dimension or otherwise damaged. The Engineer will discontinue use of a unit that performs unsatisfactorily.

D. Small Mixing Units. The Engineer may allow a small construction mixer to mix small quantities of concrete. Mix for at least 90 seconds after all materials are in the mixer, and the Engineer will test the concrete for the specified slump and air content.

501-3 CONSTRUCTION DETAILS

501-3.01 Proportioning. Proportion all ingredients, except for admixtures, according to Table 501-3, Concrete Mixtures and as determined by the Department unless otherwise indicated in the contract documents. Any concrete mix design not meeting the requirements of Table 501-3 will be subject to approval by the Director, Materials Bureau.

A. Aggregates and Cementitious Materials. Aggregate and cementitious material proportions are indicated in Table 501-3, Concrete Mixtures, for standard classes of concrete. Mixes containing aggregate other than those permitted by §501-2.02B, Aggregates, are subject to approval by the Director, Materials Bureau.

Certain aggregates appear in the Approved List of Sources of Fine & Coarse Aggregates that have use limitations if combined with a high-alkali portland cement. The Regional Materials Engineer may allow the use of these aggregates in combination with high-alkali cements provided that pozzolans are substituted for cement in the following way:

TABLE 501-3A POZZOLAN SUBSTITUTIONS		
Concrete Class Specified	Substitute Cement by Mass With	Class Substitution Allowed
A, C, E, H	15-20% Class F Fly Ash (§711-10)	HP1
I, J	15-20% Class F Fly Ash (§711-10)	-
D	15-20% Class F Fly Ash (§711-10)	DP1
G2 and GG2	20% Class F Fly Ash (§711-10)	-
F	No Substitution Allowed	-

NOTES:

1. Class HP and DP concrete may be substituted to mitigate ASR as listed above. Classes HP and DP require the replacement of portland cement with 20% pozzolan and 6% microsilica. The pozzolan may be either Class C or F Fly Ash (§711-10) or Ground Granulated Blast Furnace Slag (§711-12).
2. Classes G and GG require the replacement of portland cement with 20% pozzolan. The mitigation of ASR in Classes G and GG must be accomplished using Class F Fly Ash (§711-10).

Notify the Regional Materials Engineer prior to using pozzolan substitutions to mitigate ASR when using reactive aggregates in combination with a high alkali cement.

Approval may be withdrawn when unsatisfactory results occur.

B. Admixtures. Admixtures are used to achieve the desired set retardation, water reduction, slump, and/or the required air content, and are not considered part of the solid volume. The admixture manufacturer's recommended maximum dosage rate should not be exceeded to obtain the desired results as specified in Table 501-3.

1. Air Entrainment. Air entraining agent is required for all mixes to produce concrete with an air content in the range specified in Table 501-3, Concrete Mixtures unless otherwise indicated in the contract documents. The Engineer will test the concrete for plastic air content, and reject concrete with air contents outside the specified limits.

2. Retardation. The setting time of concrete may be retarded when necessary for proper placement. A water-reducing and retarding admixture (§711-08, ASTM Type D), is required in Class DP for Structural Slab Overlays (Section 584), Class HP for Superstructure Slabs and Structural Approach Slabs (Section 557), Class G and Class GG concrete. It may be used with, or in place of, a water-reducing admixture (§711-08, ASTM Type A) in other applications that allow Class DP or Class HP. Limit the use of the water-reducing and retarding admixture to the minimum amount required to achieve retardation during placing conditions. Unless otherwise specified, the use of water-reducing and retarding admixtures are subject to approval of the Regional Director.

3. Water Reduction. Unless otherwise specified, a water-reducing admixture (§711-08, ASTM Type A), is required in Classes DP, HP, I and J concrete. For all other classes, except G and GG, a water-reducing admixture may be used, subject to advance notification and approval of the Regional Materials Engineer.

High Range Water-Reducing Admixtures (§711-08, ASTM Type F), may not be used unless allowed by specification, plans, or the Director, Materials Bureau.

C. Water. Add water to obtain the slump desired by the Engineer, within the Design Mix Guidelines of Table 501-3, Concrete Mixtures. The Engineer will test the concrete for slump, and reject concrete with a slump greater than the guidelines for use in Department work.

Concrete with insufficient slump may be adjusted to within the guidelines of §501-3.03 by adding water and remixing, when permitted by the specifications or the Engineer.

D. Pozzolan. Up to 20% of the cement content for Classes A, C, D, E, H, I, and J may be substituted with a pozzolan (Fly Ash or GGBFS), except where prohibited by the Regional Director. No additional pozzolan is permitted in Classes DP, G, GG, or HP. No pozzolan is permitted in Class F.

E. Microsilica. Microsilica meeting the requirements of §711-11 may be added as part of a Blended Cement (§701-03, Type SF or Ternary Blend) or batched independently as a powder, or a slurry.

TABLE 501-3 CONCRETE MIXTURES**Design Mix Guidelines (where sand fineness modulus = 2.80)¹**

Concrete Class	T.C.M. ⁵ Content (kg/m ³)	Sand % Total Agg. (solid volume)	Water/cementitious mat'ls (by mass)	Air Content % desired (Range)	Slump Range (mm)	Type of Coarse Aggregate Gradation	Primary Use
A	360	36.2	0.46	6.5 (5.0 - 8.0)	65 - 90	CA 2	general purpose structural
C6	359	35.8	0.44	6.5 (5.0 - 8.0)	25 - 75	CA 2	Pavement: slipform paving, form paving
D	430	45.8	0.44	7.5 (6.0 - 9.0)	65 - 90	CA 1	thin structural applications
DP ²	430	45.8	0.40	7.5 (6.0 - 9.0)	75-125	CA 1	thin structural applications, overlays
E	384	35.8	0.44	6.5 (5.0 - 8.0)	75 - 100	CA 2	structural slabs and structural approach slabs
F	425	34.6	0.38	6.5 (5.0 - 8.0)	50 - 75	CA 2	high early strength for pavement or structural applications
G ³	431	45.0	0.45	6.0 (4.0 - 8.0)	150-180	CA 2	underwater
GG ³	475	45.0	0.45	6.0 (4.0 - 8.0)	150-180	CA 1	underwater (special)
H	400	40.0	0.44	6.5 (5.0 - 8.0)	75 - 100	CA 2	pumping applications
HP ²	405	40.0	0.40	6.5 (5.0 - 8.0)	75 - 125	CA 2	pumping, structural slabs, approach slabs, substructures
I ⁴	380	41.0	0.44	6.0 (4.0 - 8.0)	15 - 40	CA 2	exposed to chlorides slip forming highway median barriers
J ⁴	403	45.8	0.44	6.0 (4.0 - 8.0)	15 - 40	CA 1	slip forming structural median barriers, parapet walls and curbs

NOTES :

- Mixture proportions will be computed by the Regional Materials Engineer using the fineness modulus and bulk specific gravities (saturated surface dry) of the aggregates proposed for use.
- Class DP and HP require the replacement of portland cement with 20% pozzolan and 6% microsilica and the addition of a water reducing admixture and / or water- reducing and retarding admixture. Refer to §501-3.01 B, Admixtures.
- Class G and GG require the replacement of portland cement with 20% pozzolan, and the addition of a water- reducing and retarding admixture. Refer to §501-3.01 B, Admixtures.
- These mixes require the use of a water reducing admixture. Refer to §501-3.01 B, Admixtures.
- T.C.M. = Total Cementitious Material.
- Slump range for slipform paving is 25 – 65mm and for fixed form paving is 40 – 75 mm.

501-3.02 Handling, Measuring and Batching Materials. Arrange the batching facility and equipment to assure a continuous supply of material to the work.

When written approval is granted by the Regional Director, bagged cement, pozzolan or microsilica may be incorporated into the mix. Adjust the batch size to use whole bags of cementitious materials and batch the aggregates at the plant site according to these specifications.

A. Stockpiles. Build good draining bases for stockpiles, at the batching facility, on prepared aggregate, concrete, metal or wood surfaces, or barge floors, subject to approval by the Regional Director. Build the stockpiles by methods which do not cause particle segregation. Stockpile all aggregates separately, by source and size so that no cross contamination occurs. Label all Department approved stockpiles by source number.

Handle aggregates throughout the batching process such as to maintain uniform grading of the material. In case the aggregates contain a high or non-uniform moisture content, stockpile the aggregates for a sufficient length of time to stabilize the moisture content.

Equip each plant with a moisture sensing device that indicates, on a readily visible scale or chart, the fine aggregate moisture content as it is batched. Indicate the free moisture content on the batch recordation during batching. The free moisture content during batching is limited to a maximum of 8% of the fine aggregate’s saturated-surface dry mass.

The Regional Materials Engineer will determine the acceptability and accuracy of the moisture sensing device. If the device is considered accurate, the free moisture content of the fine aggregate may be allowed to be adjusted between batches based on the most recent moisture reading. No adjustment for free moisture will be allowed for an individual batch after batching starts.

B. Heating Materials for Cold Weather Concreting. Use equipment that uniformly heats the materials. To obtain the specified temperature of the plastic concrete when the air temperature is below 0°C, heat the aggregates by steam or dry heat and heat the mix water. When the air temperature is 0°C or more, and the aggregates are free of ice, the specified temperature may be obtained by heating only the mix water. The equipment and operations for heating the materials must be approved by the Regional Director prior to use on Department projects.

Specified Temperature Range	Minimum	Maximum
Mix Water	20°C	80°C
Aggregate	4°C	40°C
Plastic Concrete in place	10°C	20°C

To avoid the possibility of flash set when water is heated over 40°C, combine the water and aggregate in the mixer so that the water temperature is reduced before cement is added.

C. Batching.

1. Aggregates. When sizes are weighed cumulatively, allow a ±2% tolerance for each draw mass, based on the combined aggregate batch mass. If sizes are weighed separately, apply the tolerance to each scale mass.

2. Cement and Pozzolan

a. Batching without microsilica powder added independently on a common scale. Weigh the cement, blended cement, or pozzolan cumulatively with a ±1% tolerance for each draw mass, based upon the combined mass of cementitious materials. Weigh the pozzolan last in the weighing sequence.

b. Batching with microsilica powder added independently on a common scale. Weigh the cement, Type IP or SM blended cement, or pozzolan cumulatively with a ±0.5% tolerance for each draw mass, based upon the combined mass of cementitious materials. Double the minimum allowable batch mass. Weigh the microsilica last in the weighing sequence.

3. Microsilica

a. Batching with cement, Type IP or SM blended cement, or pozzolan on a common scale. Weigh the microsilica powder cumulatively with a ±0.5% tolerance for each draw mass, based upon the combined mass of cementitious materials. Double the minimum allowable batch mass. Weigh the microsilica last in the weighing sequence.

b. Batching microsilica powder on a separate scale. Allow a $\pm 1.0\%$ tolerance for the total draw mass of microsilica.

c. Batching microsilica slurry. Either add the microsilica slurry using the permanently installed automation system or using a two stop, off-line, automated batching system, approved by the Regional Materials Engineer as meeting the following requirements:

- System interlocks: To interrupt and stop the batching whenever an out of tolerance condition occurs.
- Meter accuracy: $\pm 1.0\%$ by volume of slurry
- Batching Tolerance: $\pm 2.0\%$ by volume of slurry
- Program quantity: liters, nearest tenth
- System recordation:
 - ◆ Correct date and time
 - ◆ Truck number (or other method relating slurry to batch ticket)
 - ◆ Delivered quantity (liters, nearest tenth)

Locate the control box/ printer for the off-line batching system at the plant operator's work station unless otherwise approved by the Regional Materials Engineer. Calibrate the system according to procedures approved by the Regional Materials Engineer. Re-calibrate the system if any part, or all, of the system is moved. Electrical circuits used to check delivery tolerances may be set at any span within the full allowable tolerance for any approved batch size. For plants not equipped to automatically adjust tolerances, set the tolerance span for the minimum approved batch size when producing varying batch sizes.

Agitate the slurry as necessary to prevent separation. Remove and replace slurry that reaches a temperature less than 0°C , at no additional cost to the Department.

D. Delivery Tickets. Each delivery ticket must contain the following:

- Delivery Ticket Number
- Plant Identification, with plant name and location and/ or facility number
- Contract Number
- Concrete Class or Item Number
- Quantity (Nominal Batch Size)
- Truck Number
- Batch Number
- An Automatically Applied Time- Date Stamp (immediately upon completion of batching) which may consist of one of the following :
 - ◆ Time - Date stamp by separate printing device on a regular ticket
 - ◆ Time - Date printed by a batch weight recorder on a printed ticket.
 - ◆ Time - Date printed by a batch weight recorder on a printed tape. Affix a copy of the tape to the regular delivery ticket.

E. Failure of Automatic Batching, Admixture Dispensing and Recording Equipment.

If automatic proportioning, admixture dispensing or recording instruments fail, the plant may be allowed, subject to approval of the Regional Director or his representative, to continue producing concrete for the Department for up to 48 hours from the time of breakdown. Written permission of the Regional Director will be required to operate without these instruments for periods longer than 48 hours.

During this period, batch all materials within the automatic proportioning system tolerances.

TABLE 501-4 BATCHING TOLERANCES

Cement, Pozzolan, or Blended Cement	± 1% (by mass) of total cementitious materials, if no microsilica is weighed cumulatively on common scale.
	± 0.5% (by mass) of total cementitious materials, if microsilica powder is weighed cumulatively on a common scale.
Microsilica Powder	± 0.5% (by mass) of total cementitious materials, if weighed cumulatively with cement, Type IP or SM blend, or pozzolan.
	± 1% (by mass) if weighed on a separate scale.
Microsilica Slurry	± 2% (by volume)
Aggregate	±2% (by mass)
Water (See Note 1)	± 1% (by mass or volume)
Admixtures 711-08	± 3% (by mass or volume) or ± 1 meter pulse (see Note 3), whichever is greater.
Admixture (other)	contact Director, Materials Bureau
Zero - Aggregate (See Note 2)	± 2%
Zero - Cementitious Mat'ls. (See Note 2)	± 1%
Zero - Water (See Note 1, 2)	± 1%

- NOTES:** 1: Tolerance applies to water added at central mix plants only.
 2: Zero Tolerance is based on the minimum allowable batch size.
 3: Based on the preprogrammed target quantity.

501-3.03 Concrete Mixing, Transporting and Discharging.

A. General. Mix the concrete at a central mix plant, in truck mixers in transit or at the site. When mixed at a central mix plant, transport the concrete in vehicles acceptable to the Regional Director. Place the fresh concrete directly into the forms or into conveyance equipment approved by the Regional Director before evidence of initial set. No water addition will be permitted after the mix has reached the mid-point of the slump range, as indicated in Table 501-3, Concrete Mixtures, for the class used. Concrete with a discharge temperature exceeding 32°C will be subject to rejection.

Notify the Regional Materials Engineer's office by 3:00 PM on the day before any production for the Department. Supply fresh concrete at a rate consistent with placement operations as determined by the Engineer. The Regional Director may disapprove the use of any type of concrete mixing or transporting units when unsatisfactory results occur.

Load the mixer, regardless of type, in a manner approved by the Regional Director and mix batches of concrete no larger than the rated capacity shown on the Manufacturer's plate.

A summary of time limitations for various types of concrete mixing equipment, from the beginning of batching to the completion of discharge, is given in Table 501-7, Summary of Concrete Batching, Mixing, Hauling and Discharging.

B. Concrete Uniformity. Use a mixer that combines aggregates, cementitious materials, water and admixtures into a uniform mass within the specified time. The mixer is required to discharge the mixture without segregation, and meet the uniformity requirements in Table 501-5, Concrete Uniformity. The Department will perform tests when required by the specifications or requested by the Regional Director.

It will only be necessary to verify that mixing equipment meets uniformity requirements if evidence of non-uniform concrete is found or a reduced mixing time for central mixers is requested. A reduction in the batch size below the rated mixer capacity or reduced mixing speed tolerance limits may be required to obtain uniformity.

TABLE 501-5 CONCRETE UNIFORMITY	
Test	Permissible Variation (Concrete samples taken at two locations in the batch)
Mass per cubic meter calculated to an air-free basis	32.0 kg per m ³
Air Content, % by volume of concrete	1.0%
Slump: Average slump 100 mm or less	25 mm
Average slump greater than 100 mm	40 mm
Coarse aggregate content, portion by mass of each sample retained on a 4.75 mm sieve	6.0%
Unit mass of air-free mortars based on average for all comparative samples tested	1.6 %

NOTE: The Department will take samples at the mixer discharge point and test in accordance with Materials Method 9.2.

C. Central Mixed Concrete. Central mixed concrete is concrete mixed in a stationary mixer and transported in approved agitating or non-agitating delivery units to the deposition point. If microsilica slurry is batched, consult the slurry supplier so that microsilica balling does not occur. Use a minimum 90 second mixing time after all materials are in the drum, unless tests show that the requirements of Table 501-5, Concrete Uniformity, can be consistently obtained at a lesser time as approved by the Director, Materials Bureau.

Use delivery units that transport thoroughly mixed concrete without loss of uniformity meeting the requirements of §501-2.04B.1.b. or §501-2.04B.2., pertaining to Central Mixed Concrete.

Travel on a haul road free from holes, washboarding or other features that cause segregation in plastic concrete.

Do not exceed the time limit between completion of mixing at a central mix plant and completion of discharge as noted in Table 501-6, Time Limits for Delivery of Central Mixed Concrete.

When transporting central mixed concrete in units approved for truck mixing, add a minimum of 90% of the design water to the mix with the batch plant water system.

Two additions of water will be allowed at the discharge point to obtain initial slump. After each addition, mix the concrete at least 30 mixing-speed revolutions before discharging. The initial loads may, with prior written approval by the Regional Materials Engineer, also be adjusted by using a water-reducing admixture (711-08, ASTM Type A). This adjustment will be limited to the first trucks arriving for a particular placement before any adjustments have been made at the batching facility. Observe the maximum number of mixing revolution or water addition requirements. Make all subsequent admixture additions or adjustments during production at the batching facility. No additions or adjustments are allowed when non-agitating / open haul units are used.

TABLE 501- 6 TIME LIMITS FOR DELIVERY AND DISCHARGE OF CENTRAL MIXED CONCRETE	
Delivery Unit	Maximum Time (Minutes)
Non-Agitating / Open haul	30
Agitating - rotating drum	90 *

* The Engineer will reject the concrete if there is evidence of initial set, and may reduce the time limit in hot weather or under unusual conditions if unsatisfactory results occur. For concrete that does not contain a water-reducing and retarding admixture, the time to initial strike-off or placement of subsequent lifts is included in the delivery and discharge time limit.

D. Transit Mixed Concrete. Transit mixed concrete is concrete batched at the production facility and mixed completely in a truck mixer at the following locations or combinations thereof: the plant, while in transit, or the discharge point. Transit mix may be used for all concrete items unless otherwise specified. Use a truck mixer meeting the requirements of §501-2.04B.1.a., pertaining to Transit Mixed Concrete.

Load the mixer as follows:

1. Totally drain the drum of wash water before loading.
2. Revolve the drum while loading the mix ingredients , except when adding microsilica slurry, and add approximately 90% of the design water.
3. Begin mixing within 5 minutes of cement to aggregate contact .

TABLE 501-7 SUMMARY OF CONCRETE BATCHING, MIXING, HAULING AND DISCHARGING					
Central Mixed Concrete		Transit Mixed Concrete		Truck Mixed Concrete	
Begin Batching		Begin Batching		Begin Batching	Begin Batching
				REGULAR MIX	LAYERED MIX
Load mixer		Hatch load, or ribbon load materials through barrel hopper.		Load aggregates. Drum may be rocked or revolved	Load fine agg. , then SSD coarse agg. through hatch Drum may be rocked.
End of Batching and Begin Mixing		Add approx. 90% of design water			
90 Second minimum after all materials are in the mixer.		▲	Cement In Contact With Aggregates 5 Minutes max.	Load Cement (See Note 3)	Load Cement (See Note 3)
End of Mixing				Cement In Contact With Aggregates	Cement In Contact With Aggregates
Open Haul Units	Rotating Drum Agitate 2-6 rpm	Begin Mixing at plant or in transit		30 Minutes max.	90 Minutes max.
30 Minutes maximum	90 Minutes maximum (See Note 2)	Class HP or Class DP 100 rev. minimum 200 rev. maximum		Begin Mixing At project, after adding water	
		Mix: 6-18 rpm		Mix: 6-18 rpm	
Completion of Discharge					
(When concrete is transported in units approved for mixing, see Note 1)	90 Minutes max. (Note 2)	All Other Classes 100 rev. minimum 160 rev. maximum		100 rev. minimum 160 rev. maximum	
		Mix: 6-18 rpm		15 Minutes maximum	
		End of Mixing Agitate 2-6 rpm		End of Mixing Agitate 2-6 rpm	
		Begin Discharge		Begin Discharge	
		50 Minutes maximum		30 Minutes maximum	
		▼	Completion of Discharge	Completion of Discharge	

NOTES:

1. The remainder of the design water may be added at the work site to attain initial slump. When approved by the Regional Materials Engineer, only the first trucks may be adjusted to obtain initial slump using a water-reducing admixture (711-08, ASTM Type A). Exceeding the maximum mixing revolutions or water addition requirements will not be permitted.
2. For mixtures that do not contain a water-reducing and retarding admixture (711-08, ASTM Type D), the 90 minute maximum time includes the time to initial strike- off, or placement of subsequent lifts.
3. Add cement through hatch. Do not move drum while cement is being added.

If microsilica slurry is batched, consult the slurry supplier so that microsilica balling does not occur.

Mix for a minimum of 100 mixing- speed revolutions and then check for consistency. If the truck is en route to the project, change the speed from mixing to agitating after 100 mixing revolutions. Unless restricted by local traffic laws, do not stop the rotation of the drum during transit.

Two additions of water will be allowed to obtain initial slump at the discharge location . After each addition, mix at least 30 mixing speed revolutions. For Class DP or HP concrete, mix a total of 100 to 200 mixing speed revolutions. For all other classes of concrete, mix a total of 100 to 160 mixing speed revolutions.

The initial loads may, with prior written approval by the Regional Materials Engineer, also be adjusted by using a water- reducing admixture (§711-08, ASTM Type A). This adjustment will be

limited to the first trucks arriving for a particular placement before any adjustments have been made at the batching facility. Observe the maximum number of mixing revolution or water addition requirements. Make all subsequent admixture additions or adjustments during production at the batching facility.

After mixing, either discharge the load immediately or revolve the drum at agitating speed. Once begun, discharge the entire load within 50 minutes.

For mixes containing a water- reducing and retarding admixture, the total time interval from the moment the cement makes contact with the aggregates to the completion of discharge shall not exceed 90 minutes.

For mixes that do not contain a water- reducing and retarding admixture, the total time interval from the moment the cement makes contact with the aggregates to the completion of initial strike off or placement of subsequent lifts shall not exceed 90 minutes.

The Regional Director may reduce the total time limit in hot weather or under unusual conditions, if unsatisfactory results are obtained.

E. Truck Mixed Concrete. Truck mixed concrete is concrete completely mixed in a truck mixer meeting the requirements of §501-2.04B.1.b. Truck Mixers, after adding water at the discharge location. Apply §501-3.03D. Transit Mixed Concrete, except as follows:

1. Loading of Mixer:

a. Regular Truck Mix (cement in contact with moist aggregates). The drum may be rocked or revolved while loading coarse and/or fine aggregates with admixtures. Load the cement last, while keeping the drum stationary. Begin mixing within 30 minutes of cement to aggregate contact.

b. Layered Truck Mix (cement in contact with Saturated Surface Dry(SSD) or drier coarse aggregate). Batch the fine aggregate with admixtures, coarse aggregate and cement all separately. Load these materials through a hatch in the side of the drum in the following sequence: fine aggregate with admixtures, coarse aggregate, and cement last. The drum may be rocked after adding each aggregate size, but kept stationary while loading the cement. Begin mixing within 90 minutes of cement to coarse aggregate contact.

2. Mixing: Begin mixing at the discharge location. Add water to the drum either from the head section or by dual injection from both the head and discharge end. Mix for a minimum 100 revolutions or until uniform concrete of the specified consistency is produced, whichever is longer. Do not exceed a 15 minute mixing period.

3. Discharge: Discharge the entire load within 30 minutes after mixing.

501-4 METHOD OF MEASUREMENT. The Engineer will compute the volume of concrete as the number of cubic meters within the payment lines indicated on the plans or as specified by the Engineer. No deductions will be made for the volume of embedded reinforcement, structural shapes or joint materials. Also, no deductions will be made in concrete pavement for catch basins, manholes, etc. unless otherwise indicated in the contract documents.

501-5 BASIS OF PAYMENT. Include the cost of furnishing all materials, equipment and labor necessary to complete the work in the unit price bid for the appropriate items.

SECTION 502 - PORTLAND CEMENT CONCRETE PAVEMENT

502-1 DESCRIPTION. Construct a portland cement concrete (PCC) pavement and shoulders, if required, as detailed in the contract documents.

502-2 MATERIALS AND EQUIPMENT

Portland Cement Concrete	501
Anchoring Materials - Chemically Curing	701-07
Highway Joint Sealants (ASTM D 6690, Type IV)	705-02
Silicone Joint Sealants	705-05
Premoulded Resilient Joint Filler	705-07
Preformed Elastic Longitudinal Joint Seal	705-10
Preformed Elastic Transverse Contraction and Expansion Joint Seal	705-12
Lubricant for Preformed Elastic Joint Sealer	705-13
Longitudinal Joint Ties	705-14
Transverse Joint Supports	705-15
Wire Fabric for Concrete Reinforcement	709-02
Epoxy Coated Bar Reinforcement, Grade 420	709-04
Quilted Covers (for curing)	711-02
Plastic Coated Fiber Blankets (for curing)	711-03
Polyethylene Curing Covers (white opaque)	711-04
Membrane Curing Compound	711-05
Form Insulating Materials for Winter Concreting	711-07
Water	712-01
Backer Rods	ASTM D 5249

In addition to meeting the requirements of ASTM D 5249 (Type 1 or 3), backer rods must be closed cell polyethylene foam with a diameter at least 25% wider than the second-stage saw cut.

In addition to meeting the requirements of §701-07, Anchoring Materials - Chemically Curing, the material used to anchor longitudinal joint ties, dowels, or other miscellaneous items into hardened concrete must be a pourable, two-component, 100% solids structural epoxy dispensed:

- From side-by-side cartridges by manual or pneumatically powered injection guns.
- Through a static mixing nozzle that homogeneously mixes the material without any hand mixing.
- The Department may perform supplementary sampling and testing of the silicone and highway joint sealants. Deliver sealant in the manufacturer's original sealed container legibly marked with the:
 - Manufacturer's name.
 - Trade name of the sealant.
 - Manufacturer's lot or batch number.
 - Pouring temperature (Highway Joint Sealant only).
 - Safe heating temperature (Highway Joint Sealant only).

502-2.01 Concrete. Use Class C concrete furnished in accordance with Section 501, Portland Cement Concrete – General, when specified. High-Early-Strength (HES) concrete, meeting the requirements of §502-2.02, may be substituted for closure or short placements, subject to the Engineer's approval.

502-2.02 High-Early-Strength (HES) Concrete. Use HES concrete where required in the contract documents or where the Contractor's request to use HES concrete is approved by the Department. Whether required or requested, design the HES mix to satisfy the opening to traffic time requirements of the project and Table 502-1, High-Early-Strength Concrete Mix Requirements. Submit the HES concrete mix design to the Engineer. Include admixture brands and dosages as well as mixing, transporting, placing, paving, curing, and anticipated strength gain details.

Produce and place a 3.0 m³ (minimum) trial batch at an off-contract location selected by the Contractor and agreed upon by the Engineer. Produce the trial batch using the same materials and processes as those to be used to produce concrete for the contract. Provide the Engineer a 7-day minimum advance notification of trial batch production. Produce and place the trial batch in the presence of the Engineer, the Regional Materials Engineer, and Materials Bureau personnel.

Provide an American Concrete Institute (ACI) Certified Concrete Field Testing Technician, Grade I, or higher, to:

- Measure slump, air content, and unit weight of the trial batch.

- Cast cylinders from the trial batch for compressive strength and freeze-thaw resistance testing.

Determine the compressive strength of the trial batch concrete at the desired time as discussed in §502-3.18C, Project Strength Determination.

The Materials Bureau will render a decision on mix acceptability, curing, and opening to traffic requirements within 45 calendar days of trial batch production. Changes other than minor fluctuations in admixture dosage rates require a new mix design and trial batch. The Engineer will reject the concrete if the specified slump or plastic air content are not achieved. The Engineer may halt paving and order additional trial batches whenever the specified compressive strength requirements are not achieved.

Property	Minimum	Desired	Maximum
28 Day Compressive Strength	28.0 MPa	-	-
Opening Compressive Strength	17.0 MPa1	-	-
Freeze-Thaw Loss (Test 502-3P, 3% NaCl)	-	0.0 %	3.0 %
Plastic Air Content	5.0 %	6.5 %	8.0 %
Hardened Air Content	5.0%	6.5 %	8.0 %
Water – Cement Ratio (w/c)	-	-	0.44
Slump ²	25 mm	-	150 mm

NOTES:

1. See §502-3.18, Opening to Traffic.
2. Minimum slump provided the mix consolidates and finishes properly. Maximum slump provided the mix is nonsegregating.

502-2.03 Portland Cement Treated Permeable Base (PCTPB). Use (1) coarse aggregate meeting §501-2.02B2, Coarse Aggregate, with Type CA2 gradation, (2) portland cement, Type I, II, or I/II meeting §701-01, Portland Cement, and (3) water in the following proportions:

Cement	143 kg/m ³
Aggregate	1600 kg/m ³
W/C	0.37 max

Aggregate weight is based on a bulk density of 1600 kg/m³ and a saturated, surface-dry condition determined in accordance with AASHTO T 19M, Bulk Density (“Unit Weight”) and Voids in Aggregate. Adjust the aggregate weight accordingly if the contract aggregate has a different bulk density.

Use saturated, surface-dry coarse aggregate if PCTPB is brought to the site in open haul units. Coarse aggregate for PCTPB do not have to meet friction requirements.

502-2.04 Equipment. Provide the Engineer with an equipment list and specifications a minimum of 14 days prior to the planned start of PCC paving. Bring all equipment needed to place, consolidate, finish, texture, cure, saw cut, seal, and test the PCC pavement and permeable base to the job site a minimum of 1 full work day before its use to allow examination by the Engineer. Repair or replace any equipment found to be defective before or during its use. Discontinue any operation if unsatisfactory results are being obtained. Use of equipment other than described below is subject to the approval of the Director, Materials Bureau.

- A. Slipform Paving.** Use a self-propelled slipform paver equipped with:
- Rigid side forms that laterally support the concrete and minimize edge slumping.
 - A full-width finishing pan.
 - Attached internal vibrators capable of consolidating the entire concrete placement.

Slipform paving consists of a single paver, or a placer/spreader followed by a separate paver, capable of placing, spreading, consolidating, screeding, and finishing the concrete such that hand

finishing is kept to a minimum. Use equipment guided by a reference system that ensures the pavement is placed to the specified line, grade, and cross section.

B. Fixed Form Paving

1. Forms. Use straight forms without horizontal joints meeting Table 502-2, Form Requirements, and equipped with:

- At least 3 stake pockets spaced 1.0 m apart (maximum), each having a positive, nondetachable wedge.
- Positive, interlocking devices capable of holding abutting sections together to form neat, tight joints.

Flexible, curved, or wooden forms may be used in irregular areas or curved sections having horizontal radii of 30 m or less.

2. Paving Equipment. Use a self-propelled paver equipped with a full-width finishing pan and attached internal vibrators capable of consolidating the entire concrete placement. Three (3) full-width transverse finishing screeds may be used in lieu of the full-width finishing pan. When 2 pavers are used to employ 3 transverse screeds, vibrate with the first paver only.

Finishing machines with double cylinders and augers capable of rotating in opposite directions, attached internal vibrators, and at least 1 pan float may also be used. However, if the pavement is specified as nonprofilographed, §502-3.16, Profilograph, and §502-3.17, Diamond Grinding, will apply. §502-3.15, Hardened Surface Test, will not apply.

Fixed form paving consists of 1 or 2 pavers, or a placer/spreader followed by the paver(s), capable of placing, spreading, consolidating, screeding, and finishing the concrete to the specified line, grade, and cross section such that hand finishing is kept to a minimum.

TABLE 502-2 FORM REQUIREMENTS	
Characteristic	Requirement
Material	Steel, 6 mm thick, minimum.
Length	3.0 m, minimum.
Depth	Equal to the sum of the edge thicknesses of all pavement layers placed within the form.
Base Width	Equal to the depth, minimum.
Horizontal Top Face	50 mm wide, minimum, and lying in a plane with a maximum variation of 3 mm in 3.0 m.
Vertical Face	Maximum variation of 6 mm in 3.0 m and rounded on the upper corner with a 20 mm radius, maximum.
Flange Bracing	Extends outward on the base b of the form depth, minimum.

3. Paving Irregular Areas. Pave with the following equipment, in order of preference, if slipform or fixed form paving equipment cannot be used in an irregular area:

- a. Triple tube roller pavers.
- b. Concrete finishing machines equipped with internal vibrators and double cylinders and augers capable of rotating in opposite directions and at least 1 pan float.
- c. Roller pavers.
- d. Manual, vibrator equipped power screeds appearing on the Department’s Approved List.
- e. By hand.

C. Vibrators. Use paver-mounted internal vibrators capable of consolidating the entire concrete placement that are:

- Capable of being shut off without shutting off the paver.
- Equipped with frequency controls readily accessible to the paver operator.
- Capable of simultaneously operating at the same frequency as the other paver-mounted vibrators.

- Capable of operating through a frequency range of 6,000 - 10,000 vibrations per minute.

Check vibrator operating frequencies daily when paving begins. Check frequencies under load with the Engineer present. If the paver is not equipped with direct-read frequency gauges for each vibrator, supply the Engineer with a calibrated, hand-held tachometer, including instructions, to monitor vibrator frequencies. The tachometer will remain the Contractor's property after paving is complete.

Use hand-held vibrators capable of operating through a frequency range of 6,000 - 10,000 vibrations per minute in irregular areas or at any location that is not consolidated by internal vibrators attached to the paving equipment.

D. Permeable Base Paving Equipment. Use pavers meeting §502-2.04A, Slipform Paving, with vibrators disengaged or §402-3.02, HMA Pavers, with an attached vibrating screed. Permeable base may be placed by hand and compacted with plate or small drum vibrators in fixed form operations with permeable base placed within the forms or in areas not accessible to pavers.

E. Saw Cutting Equipment. Use diamond blade saws capable of making straight cuts to the dimensions depicted in the Standard Sheets that are equipped with cutting guides, blade guards, water cooling systems, dust controls, and cut depth control. Where beveled saw cuts are required, use a cutting or grinding device attached to the saw blade, or a separate device following the saw.

Maintain equipment and supplies to ensure uninterrupted saw cutting. Early entry saws require approval from the Director, Materials Bureau. Submit requests to use early entry saws at least 7 calendar days before paving.

F. Curing Compound Applicators. Use atomizing mechanical sprayers capable of exerting consistent pressure without hand pumping that are equipped with tank agitators to continuously mix the curing compound. Use nozzles with spray shields to prevent drift. Flush nozzles daily before use.

Maintain equipment and supplies, including extra nozzles, to ensure uninterrupted curing compound application. In a slipform paving operation, use self-propelled applicators guided by the same reference system as the slipform paver. In a fixed form operation, applicators need not be self-propelled.

G. Profilograph. For projects with profilograph smoothness requirements, use an automated California-type profilograph capable of producing and analyzing a profile trace in accordance with Materials Method 24, Portland Cement Concrete Pavements Profilograph Operations. Use automation capable of reporting profile indices in mm/km using a 5 mm blanking band and in mm/km using a zero blanking band.

H. Diamond Grinding. Use equipment having gang-mounted diamond saw blades on a multiblade arbor specifically designed for pavement bump cutting or production grinding. When production grinding, use equipment capable of producing a 1.2 m (minimum) grinding pass width that is equipped with a vacuum system capable of removing slurry from the pavement surface. Use blade spacers having a minimum thickness of 2.67 mm. Inform the Engineer of the spacer thickness selected.

I. Drills. Use gang drills with a minimum of 2 independently powered and driven drills. Use tungsten carbide drill bits. Rest and reference the drill rig frame on and to the pavement surface such that the drilled holes are cylindrical, perpendicular to the surface being drilled, and repeatable in terms of position and alignment. Hand-held drills, or gang drills resting on the permeable base or subbase, are permitted for drilling holes in longitudinal joints if there is not enough room to use gang drills resting on the pavement surface. This typically occurs when traffic is being maintained on a previous placement.

J. Joint Sealing - Silicone Joint Sealant. Use equipment that pumps the silicone directly from plastic pails or drums by compressed air powered extrusion pumps designed for moisture curing

silicone sealants. Use teflon seals and packing and teflon lined hoses to prevent moisture permeation. Use nozzles that apply the silicone within the joint confines for the full width of the joint, and to the level below the pavement surface depicted in the Standard Sheets.

- K. Joint Sealing - Highway Joint Sealant.** Heat the sealant in a melter constructed either:
- As a double boiler with the space between inner and outer shells filled with oil or other heat-transfer medium.
 - With internal tubes or coils carrying the sealant through a heated oil bath and into a heated double-wall hopper.

Do not use direct heating. Use a melter capable of maintaining the sealant's pouring temperature and providing homogeneous sealant equipped with:

- Positive temperature control.
- Continuous full sweep mechanical agitation.
- Separate thermometers indicating the temperatures of the heat transfer medium and the sealant in the hopper. Do not place any sealant if the thermometers are defective or missing.

Provide 2 thermometers having stems 450 mm long and temperature ranges sufficient to meet the requirements of this specification. Use a discharge hose equipped with a controlled heating apparatus or sufficiently insulated to maintain the proper sealant pouring temperature. Use nozzles that apply the joint sealant within the joint confines for the full width of the joint, 5 mm - 10 mm below the pavement surface.

L. Air Blasting Equipment. Use equipment with traps or other installed devices that prevent moisture and oil from contaminating the concrete surface. Use a compressor that delivers air at a minimum of 3.4 m³ per minute and develops a minimum nozzle pressure of 0.62 MPa. Check the compressed air stream purity daily with a clean white cloth.

502-3 CONSTRUCTION DETAILS. Convene a prepaving meeting 7 to 14 days before the planned start of PCTPB paving with the Engineer and any PCC paving and saw cutting subcontractors to coordinate all aspects of paving and inspection, including equipment review, construction methods, and time and personnel requirements.

Construct a smooth, well consolidated, properly finished, textured, and cured pavement to the line and grade depicted in the contract documents, 6 mm vertically at any location.

502-3.01 Weather Limitations

A. Rain. Do not pave in the rain. Supply sufficient quilted covers, plastic coated fiber blankets, or polyethylene curing covers near the paving operation when rain may be expected. Securely cover any concrete exposed to rain that has not reached initial set or will be visibly affected by the rain.

B. Cold Weather. Place concrete when the air temperature is 4°C and rising, or warmer, and when the surface temperature of the area to be paved is 4°C, or warmer. Stop paving when the air temperature falls below 4°C. Measure temperatures in the shade to an accuracy of 1°C. Refer to §502-3.11C, Cold Weather Curing.

502-3.02 Subbase Course. Furnish in accordance with Section 304, Subbase Course, before placing any PCTPB or PCC. If the subsequent PCC placement is a profilographed traveled way and the area is available, widen the prepared subbase course at the same line, grade, and cross slope such that it is at least:

- m beyond the longitudinal edges of a slipform pavement.
- 300 mm beyond the outside longitudinal edges of the fixed forms.

Additional subbase course that is not included in the finished work will be paid for under Section 304 items included in the contract.

502-3.03 Portland Cement Treated Permeable Base. Apply §502-3.01, Weather Limitations. Place and consolidate permeable base within 2 hours of water addition to the mix. Allow to air cure for a minimum period of time such that concrete placement results in no damage to the permeable base. Place permeable base on a prepared subbase course to the dimensions depicted in the contract documents such that the final surface elevation does not vary more than 6 mm above or 25 mm below the design grade elevation at any location. In a slipform paving operation, test the surface both perpendicular to the pavement centerline and diagonally across the pavement using a stringline placed across the referencing system. Test the surface (1) at the beginning of each day's placement, (2) every 15 m thereafter, (3) at the end of each day's placement, and (4) wherever required to ensure reasonably close conformance to the contract documents. In a fixed form paving operation, use a scratch board placed transversely across the forms to continuously test the surface elevation and verify the appropriate concrete thickness will be placed. Trim excess permeable base from high areas exceeding 6 mm in 3 m before it hardens. Build up low areas deeper than 25 mm in 3 m with CA 1 or CA 2 coarse aggregate.

In a slipform paving operation, place the permeable base slightly wider than the pavement width being placed. Remove and replace permeable base placed wider than the pavement if it is damaged or contaminated.

In a fixed form paving operation, place permeable base either within the forms or beneath the forms. When placing within forms, place a bead of commercial masonry caulk along the top surface of the permeable base at the form interface before placing concrete to prevent paste infiltration down the vertical face of the form. The masonry caulk bead is not required at placement edges outside of the underdrains.

Construction traffic may be maintained on permeable base in areas of limited access. Remove and replace damaged or contaminated permeable base before placing PCC.

502-3.04 Slipform Paving. Establish a reference system to achieve the specified smoothness level. If string lines are used, set them by survey and use dual lines for the initial placement if it is a profilographed traveled way and the area is available.

Maintain uniform concrete quality and head in front of the paver. Coordinate concrete delivery to maintain continuous forward movement of the paver and avoid excessive delivery truck queues. Keep paver tracks clear of concrete and debris before and during paving.

If concrete is placed directly on subbase, i.e., there is no permeable base, wet the entire subbase surface without forming puddles or mud immediately before placing concrete.

Whenever possible, unload concrete into a mechanical spreader that deposits it near the final position before paving. If a spreader is not used, uniformly distribute the concrete in front of the paver by maneuvering the delivery truck chute.

Consolidate the entire concrete placement using internal vibrators attached to the machine. Combine paver forward speed, vibrator frequency, and vibrator depth to consolidate the concrete without segregation, vibrator trails, or contacting the joint assemblies. Discontinue vibration and tamping if the paver stops.

Determine edge slump by extending a 600 mm (minimum) long straightedge over the longitudinal pavement edges. Immediately correct edge slumps greater than 6 mm that are between concrete placements and greater than 10 mm at free edges and HMA shoulders.

502-3.05 Fixed Form Paving.

A. Setting Forms. Compact the supporting layer at the form line such that the forms are supported for their full length. Set forms to string lines placed at the pavement elevation, line, and grade and to achieve the specified smoothness. If a form sits above the string line, remove the form and trim the form line to the proper grade. If a form sits below string line, remove the form and fill and compact the low area with granular material at least 150 mm on both sides of the form. Frequently check form grade and alignment while paving. Reset forms as necessary.

Set forms to accommodate a full days paving before placing concrete. Extend forms beyond construction bulkheads to provide a working platform at the end of a placement. Secure each form with a minimum of 3 pins each of sufficient length to hold the forms in place without movement during any operation. Lock the forms together such that the form ends are aligned and the joints are

tight and smooth. Run the paving equipment atop the forms before placing any concrete and recheck form alignment. Reset forms as necessary.

Align keyway strips in a smooth, horizontal plane, parallel to the top of the form. Match keyway strips on abutting forms such that a nearly seamless keyway results.

B. Paving. Apply oil to forms before placing concrete. Immediately before placing concrete, wet the entire subbase or permeable base surface without forming puddles or mud. Whenever possible, unload concrete into a mechanical spreader that deposits it near the final position before paving. If a spreader is not used, uniformly distribute the concrete in front of the paver by maneuvering the delivery truck chute.

Maintain uniform concrete quality and head in front of the paving machine and without running over the screeds. Coordinate concrete delivery to maintain continuous forward movement of the paver and avoid excessive delivery truck queues. Keep form tops clean before and during paving. Consolidate the entire concrete placement using internal vibrators attached to the paver. Combine paver forward speed, vibrator frequency, and vibrator depth to consolidate the concrete without segregation, vibrator trails, or contacting the joint assemblies. Discontinue vibration and tamping if the paver stops.

Mark the midpoint (10 mm) of each transverse contraction joint with a shim placed into the plastic concrete immediately adjacent to each form. Use shims equal in width and depth to the contraction joint first-stage saw cuts depicted in the Standard Sheets. Set the shims perpendicular to the forms and the pavement surface. Make first-stage saw cuts from shim to shim as discussed in §502-3.06A1, Transverse Contraction Joints. Use shims of sufficient lengths to allow complete first-stage saw cutting to each shim without striking the form.

C. Paving Irregular Areas. Uniformly spread concrete. If concrete is spread by hand, use come-alongs or shovels. Do not use rakes or hand-held vibrators to spread concrete. Use hand-held vibrators ahead of the paving equipment to consolidate all concrete not vibrated by equipment-mounted internal vibrators. Keep hand-held vibrators perpendicular to the pavement surface. Vibrate between 2 and 4 seconds in each location, overlapping adjacent locations. Do not drag hand-held vibrators through the concrete. Do not walk through consolidated concrete.

D. Form Removal. Remove forms after the concrete has developed sufficient strength to allow removal without damaging the pavement. Repair pavement damaged during form removal. Remove forms before making second-stage saw cuts.

502-3.06 Joint Construction. Provide the Engineer approved Materials Details for longitudinal joint ties and transverse joint supports before placing any joint hardware. Construct joints in accordance with the Standard Sheets and approved Materials Details. Do not stand on joint hardware.

Base final joint layout on construction staging and the actual location of utilities, drainage structures, intersections, tapers, and other irregular areas. Submit a proposed joint layout to the Engineer at least 10 calendar days prior to PCC paving. Obtain the Engineer's joint layout approval before paving.

Make second-stage saw cuts and bevels, clean, and seal joints in accordance with §502-3.12, Sealing Joints.

A. Transverse Joints. Transverse joints include contraction, expansion, hinge, and construction joints. Secure joint supports to the permeable base or subbase as depicted in the Materials Details. Maintain joint supports in their proper position and alignment during paving.

Construct transverse joints perpendicular to both the pavement surface and longitudinal joints in the area being paved. Use a 4.8 m typical transverse joint spacing for pavements having standard slab widths of 3.66 m and 4.27 m. For pavements having other slab widths, determine typical maximum and minimum transverse joint spacings in accordance with the following:

$$\begin{aligned} L_{\max} &= \text{maximum transverse joint spacing (slab length), m} = W_{\min} \times 1.33 \\ L_{\min} &= \text{minimum transverse joint spacing (slab length), m} = W_{\max} \div 1.33 \\ W_{\max} &= \text{maximum slab width across the pavement (load carrying slabs only), m} \leq 4.8 \text{ m} \\ W_{\min} &= \text{minimum slab width across the pavement (load carrying slabs only), m} \end{aligned}$$

The range of slab lengths may be extended to 3.0 m - 5.0 m (from L_{\min} m - L_{\max} m above) in accordance with the contract documents to accommodate utilities, drainage structures, and irregular areas.

1. Transverse Contraction Joints. All transverse joints are contraction joints unless otherwise shown in the contract documents. Typically, contraction joints are constructed in a straight line across the full width of the PCC pavement and shoulders. Contraction joints may be slightly angled (rather than straight across a pavement) at tied longitudinal joints between lanes placed separately if the placements do not have the same centerline, e.g., where a ramp centerline diverges from parallel to the pavement centerline. Contraction joints may terminate at, or be misaligned at, untied longitudinal joints as discussed in §502-3.06B3, Untied Longitudinal Joints with Keyway.

Store transverse contraction joint support assemblies in inverted stacks at the project site. Handle joint supports such that no twisting or bending occurs during storage and positioning. Supports with bent, twisted, or deformed wires will be rejected.

Before placing concrete, position transverse joint supports such that the:

- Entire longitudinal axis of each dowel is located at the middepth of the pavement slab.(6mm).
- Longitudinal axes of the dowels are aligned parallel with the pavement centerline and pavement surface such that the maximum misalignment of one dowel end relative to the other is 4 mm.
- Midpoint of the longitudinal axis of each dowel is at the center of the joint.(25 mm).
- Longitudinal axes of the two end dowels are 100 mm - 200 mm from the longitudinal joints.
- Longitudinal axes of the dowels are spaced 100 mm - 300 mm apart.

Mark the location of each contraction joint before placing concrete. In a slipform paving operation, mark the joint support midpoint on the subbase or permeable base immediately adjacent to the pavement. In a fixed form paving operation, mark the joint support midpoint with shims as discussed in §502-3.05B, Paving. Immediately before concrete placement, cut the tie wires (parallel to the dowels) holding the 2 upper transverse support members in position.

Make first-stage saw cuts as soon as the concrete has hardened sufficiently to permit sawing without causing raveling wider than 3 mm. Replace blades if raveling persists. Center first-stage saw cuts within 25 mm of the longitudinal midpoints of the dowels.

Complete first-stage saw cuts before any uncontrolled cracking occurs. Be prepared to make first-stage saw cuts 24 hours a day to prevent uncontrolled cracking. Provide lighting required to make first-stage saw cuts at night at no additional cost to the State.

Sweep or wash first-stage saw cut debris from the pavement before profilographing, before it rains, or before opening the pavement to any traffic, such that debris does not enter the joint.

2. Transverse Expansion Joints. Construct transverse expansion joints as part of the utility and drainage structure isolation systems depicted in the Standard Sheets or where indicated in the contract documents. Handle and position expansion joint supports in accordance with §502-3.06A1, Transverse Contraction Joints.

Construct expansion joints using 10 mm – 15 mm thick premoulded resilient joint filler placed in 1 piece between longitudinal joints. Tightly place and support abutting sections of joint filler such that no concrete infiltrates the joint. Place expansion caps on the dowels as depicted in the Materials Details. Do not tap or hammer the caps onto the dowels.

No saw cuts are required in expansion joint construction. Remove the finishing cap, if supplied, after the concrete has developed sufficient strength to prevent damage.

3. Transverse Construction Joints. Construct transverse construction joints wherever there is an interruption of more than 30 minutes in concrete paving operations. Construct these joints as wide as the concrete placement, typically 1 or 2 lanes, but not necessarily the full pavement width. Align construction joints with transverse contraction or construction joints in adjacent lanes.

At unplanned stops, remove plastic concrete to the midpoint of the preceding transverse joint support. Place an Engineer-approved bulkhead over the exposed support assembly such that half of the dowel lengths are embedded within newly placed concrete. Immediately remove all plastic concrete in front of the bulkhead and from the exposed joint support.

At planned stops, use either the bulkhead system described above or transverse joint supports fabricated with hollow plastic cylinders, closed on one or both ends, instead of dowels. Use hollow cylinders with an inner diameter 0 mm – 1 mm greater than the required dowel diameter and an outer diameter 7 mm, maximum, larger than the required dowel diameter. Position cylinders as required in §502-3.06A1, Transverse Contraction Joints, with closed ends on the side of the support opposite to the paving direction.

Pave beyond the joint support containing the hollow cylinders. After the concrete has gained sufficient strength to prevent damage, saw cut the newly placed concrete full depth through the midpoint of the longitudinal axis of each cylinder (25 mm). Do not saw cut into previously placed PCC. Instead, stop saw cutting at the longitudinal joint between placements and chip out any uncut concrete such that a vertical joint face results.

Remove concrete and the joint assembly ahead of the saw cut. Repair damaged permeable base and/or subbase with coarse aggregate having a CA 1 or CA 2 gradation. Insert dowels into the exposed hollow cylinder to the required alignment in §502-3.06A1, Transverse Contraction Joints, and resume paving.

First-stage saw cuts are not required at construction joints.

4. Transverse Hinge Joints. Do not place hinge joints without the Engineer's approval. Construct transverse hinge joints when a slab length exceeds the geometric requirements of §502-3.06, Transverse Joints. (This situation typically occurs near structures that are skewed from perpendicular to the pavement centerline.)

Locate hinge joints such that they are equally spaced between other types of transverse joints. Construct hinge joints in accordance with 502-3.06A1, Transverse Contraction Joints, except the positioning requirements do not apply. Instead, position transverse hinge joint supports such that the:

- Entire longitudinal axis of each deformed bar is located at the middepth of the pavement slab (6 mm).
- Longitudinal axes of the bars are aligned parallel with the pavement centerline and pavement surface such that the maximum misalignment of one bar end relative to the other is 25 mm.
- Midpoint of the longitudinal axis of each bar is at the center of the joint (25 mm).
- Longitudinal axes of the two end bars are 100 mm - 250 mm from the longitudinal joints.
- Longitudinal axes of adjacent bars are spaced 100 mm - 450 mm apart.

B. Longitudinal Joints. Select tie type, size, spacing, and positioning in accordance with the contract documents. Provide a minimum clearance of 75 mm between the end ties in a slab and any part of the transverse joint support. Keep ties free of materials that inhibit bonding to concrete or anchoring material. Maintain ties in their proper position during paving.

Eliminating a longitudinal joint (and subsequent sawing and sealing) between a shoulder and adjacent lane is optional provided (1) the lane and shoulder are paved simultaneously and (2) the resulting slabs meet the geometric requirements detailed in §502-3.06A, Transverse Joints.

It is highly desirable to align longitudinal joints with the permanent pavement markings. Tied longitudinal joints located in the wheelpaths of the completed pavement will require additional ties.

1. Longitudinal Joints Between Lanes Paved Simultaneously. Use one-piece ties fabricated into assemblies capable of securely holding 2 or more ties. Secure the assemblies to the permeable base or subbase prior to paving in accordance with the Materials Details.

Make first-stage saw cuts parallel to the pavement centerline and perpendicular to the pavement surface within 24 hours of concrete placement and after first-stage transverse saw cuts are complete. Replace saw blades if raveling wider than 3 mm occurs. Center first-stage saw cuts within 25 mm of the longitudinal midpoint of the ties.

Sweep or wash first-stage saw cut debris from the pavement before profilographing, before it rains, or before opening the pavement to any traffic, such that debris does not enter the joint.

2. Tied Longitudinal Joints Between Lanes Paved Separately. In a slipform operation, construct a butt joint and drill and anchor one-piece ties into the hardened concrete. Do not drill holes until the concrete has developed sufficient strength to withstand drilling without damage. Damage from drilling will be treated in accordance with §502-3.14, Damaged or Defective Concrete.

Use # 19 ties, 700 mm long between travel lanes and 450 mm long between a travel lane and a PCC shoulder. Anchor ties between travel lanes 300 mm into the previously placed concrete, leaving 400 mm projecting from the joint face. Anchor ties between a travel lane and a PCC shoulder 200 mm into the previously placed concrete, leaving 250 mm projecting from the joint face.

Place end ties in a slab 300 mm - 350 mm from the transverse joint. Typically, space ties between the end ties 600 mm apart, maximum. Pavements having 4 or more tied lanes, or 3 lane pavements 300 mm (or more) thick, may require a decreased spacing in accordance with the contract documents.

Drill such that the hole diameters are in accordance with the anchoring material manufacturer's written recommendations. Give those recommendations to the Engineer before drilling any holes. Replace worn bits when necessary to ensure the proper hole diameter is drilled.

Follow the anchoring material manufacturer's written recommendations for cleaning the holes. Give those recommendations to the Engineer. As a minimum, air blast the drilled holes. Insert the air blasting equipment nozzle to the back of the hole to force out all dust and debris.

When using new cartridges of anchoring material, ensure the initial material exiting the nozzle appears uniformly mixed. If it is not uniformly mixed, waste the material until uniformly mixed material extrudes.

Place the anchoring material in the back of the hole using a nozzle or wand of sufficient length. Push the tie into the hole while twisting such that the air pocket within the hole is heard to burst and the anchoring material is evenly distributed around the bar. Use sufficient amounts of anchoring material such that it slightly extrudes out the hole as the bar is inserted.

In a fixed form operation, construct either a butt or a keyed joint. If a butt joint is constructed, drill and anchor longitudinal joint ties as described above. If a keyed joint is constructed, use multiple-piece ties. Apply a corrosion inhibiting coating to the threads of all components before assembly. Bolt the female portion of the tie to the form prior to paving as depicted in the Standard Sheets. Insert and tighten the male ends before paving the adjacent lane. Ensure all threaded connections are tight.

First-stage saw cuts are not required between lanes paved separately.

3. Untied Longitudinal Joints with Keyway. Construct untied longitudinal joints with keyways at utilities and/or drainage structures, at intersections, between adjacent lanes having non-parallel center lines (such as ramps), or where indicated in the contract documents. Form as depicted in the Standard Sheets. Transverse joint type, location, and alignment may be changed when a transverse joint intersects an untied longitudinal joint.

Patch honeycombing along the untied longitudinal joint face to achieve a smooth surface prior to applying the bond breaker and placing the adjacent concrete.

First-stage saw cuts are not required.

C. Utility and Drainage Structure Isolation Joint Systems and Telescoping Manholes.

Isolate utilities and drainage structures from the pavement using the isolation joint systems or telescoping manhole castings depicted in the Standard Sheets. Remove temporary support bolts from the telescoping manhole casting as soon as the concrete hardens. If telescoping manhole castings are not used, form the required isolation joint system.

Construct transverse portions of the isolation joint systems in accordance with §502-3.06A2, Transverse Expansion Joints, or §502-3.06A3, Transverse Construction Joints, in accordance with the contract documents. Construct other isolation joints in accordance with the contract documents.

502-3.07 Paving Adjacent To Existing Concrete. Wherever paving equipment operates on existing PCC pavement that is to remain, install bolt-on track covers or rubber tired, flangeless wheels. Remove all debris on the existing PCC pavement in the equipment track. Immediately remove any concrete that spills onto the existing concrete.

When paving from (or to) a transverse construction joint or intersecting pavement, use hand-held vibrators to thoroughly consolidate any concrete inaccessible to the paving equipment vibrators. Hand finish these areas with the minimum effort required to produce an acceptable surface. Do not dump the grout box head into the pavement concrete when approaching a construction joint.

502-3.08 Plastic Thickness Determination. In a slipform paving operation, anchor flat, thin (1 mm - 3 mm), 150 mm x 150 mm rigid steel or plastic plates to the permeable base (or subbase) surface 600 mm from both placement edges at 50 m intervals. Clearly mark the plate locations on the subbase, permeable base, or previously placed concrete immediately adjacent to the placement. Provide the Engineer with a round, rigid, nonaluminum probe, having a 3 mm - 4 mm diameter. The Engineer will determine the plastic concrete thickness by inserting the probe to the plate and measuring the insertion depth. The plate thickness will be added to the insertion depth to determine concrete thickness.

In a slipform paving operation, the minimum measured plastic thickness must be within 10 mm of the thickness required in the contract documents. Areas not meeting minimum thickness will be treated in accordance with §502-3.14, Damaged or Defective Concrete. If 2 consecutive measurements do not meet minimum thickness, stop paving and reestablish the paving operation to achieve acceptable thickness.

502-3.09 Finishing. Mechanically finish the pavement after consolidation and strike off. Use machine mounted finishers such as full-width finishing pans, transverse oscillating screeds, longitudinal floats, pan floats or separate pieces of equipment such as tube floats or Lewis floats.

After mechanical finishing, hand finish the pavement to correct and seal minor imperfections. Provide an ACI certified concrete flatwork finisher to supervise all hand finishing. Provide proof of ACI flatwork certification to the Engineer. Keep hand finishing to a minimum. Do not use excess mortar or discarded concrete to fill low areas. Use work bridges to hand finish concrete inaccessible from the pavement edge. Do not add water to the concrete surface to close imperfections. Stop paving or reformulate the concrete mix if surface imperfections that require additional water to close routinely occur.

502-3.10 Texturing. Immediately after finishing and prior to applying the curing compound, texture the concrete surface using one of the following procedures in accordance with the contract documents. Apply longitudinal tining if no texturing method is designated in the contract documents. Additional requirements, such as Mean Texture Depth measured by a sand patch test or a profiler may be included in the contract documents. If the contract has a closed drainage system, provide a 200 mm – 300 mm blank in the texture along the pavement edges to enhance drainage to catch basins.

A. Longitudinal Tining. Texture the concrete parallel to the pavement centerline with a set of evenly spaced spring steel tines. Use rectangular tines 3 mm wide, 0.7 mm thick, and approximately 125 mm long at a center-to-center spacing of 19 mm.

Operate the tine head manually or mechanically. In either case, hold the tines as near an angle of 45° to the concrete surface as possible to minimize mortar dragging. Produce tine texture 2 mm - 4 mm deep with minimal dislodging of aggregate. Do not make multiple tine passes in the same area. Keep tines 50 mm - 100 mm from the placement edges. Keep the tines free of hardened concrete.

B. Artificial Turf Drag. Use a seamless strip of artificial turf drag appearing on the Department's Approved List entitled "Turf Drag" under "Equipment, Concrete Related." Produce a consistent texture, free of ridges or gouges, parallel to the pavement centerline either by hand or by attaching a weighted strip to the paver, texture\cure machine, or work bridge. Periodically replace or clean the drag to remove hardened concrete paste that compromises texture.

C. Transverse Tining. Texture the concrete perpendicular to the pavement centerline with a set of variably spaced spring steel tines. Use rectangular tines 3 mm wide, 0.7 mm thick, and approximately 125 mm long at the following center-to-center spacing in millimeters:

16/25/22/16/32/19/25/25/25/19/22/25/22/10/25/25/25/32/38/22/25/22/25.

Operate the tine head manually or mechanically. In either case, hold the tines as near an angle of 45° to the concrete surface as possible to minimize mortar dragging. Produce tine texture 2 mm - 4 mm deep with minimal dislodging of aggregate. Do not make multiple tine passes in the same area. Keep the tines free of hardened concrete. If the tine texture is placed manually, or if the mechanical equipment does not operate from the same referencing system as the paver, provide a 75 mm - 100 mm blank at each transverse joint saw cut location.

502-3.11 Curing. Keep the curing operation close to the texturing operation such that concrete is cured immediately after it is textured. The Engineer may stop paving if curing lags. Cure Class C concrete placed between June 1 and September 15 for 4 days, minimum. Cure Class C concrete placed between September 16 and May 31 for 6 days, minimum. Cure HES concrete in accordance with Materials Bureau requirements based on the Contractor-submitted mix design and the trial batch evaluation.

A. White Pigmented Membrane Curing Compound. Typically, cure concrete with white pigmented membrane curing compound. Mix the curing compound before each use and continuously agitate during use. Thoroughly and uniformly coat all exposed surfaces (including slipformed edges and formed edges immediately after form removal) at a minimum rate of 3.5 m²/L. Check the application rate after every paving day, including exposed vertical slab faces in the calculations. Apply the curing compound in 2 opposite direction passes with no longer than 15 minutes between passes.

Immediately reapply curing compound to any damaged coating areas during the curing period. During curing equipment breakdown, cure the pavement in accordance with §502-3.11B, Curing Covers. Do not apply curing compound in the rain. If rain damages the curing compound before it sets, reapply curing compound after the pavement surface dries.

B. Curing Covers. Use of curing covers is subject to the approval of the Engineer. Use quilted covers, plastic coated fiber blankets, or polyethylene curing covers. Do not use covers with tears or holes. Cover all exposed surfaces and extend the covers a minimum of 300 mm beyond the pavement edges or beyond the forms, when used. Overlap successive covers 300 mm, minimum. Secure the covers to keep them in contact with the entire surface and maintain the overlap. Wet the entire surface of quilted covers and maintain them in a wetted condition throughout the curing period.

C. Cold Weather Curing. Supply form insulating materials for winter concreting when the air temperature is expected to fall below 4°C at any time during the curing period. Use material capable of maintaining a surface temperature of 13°C and being easily removed and replaced to accommodate first-stage saw cuts. Apply the insulating material to prevent newly placed concrete from being exposed to air temperatures below 2°C for the curing period. Secure the insulation tight to the concrete surface to prevent air intrusion beneath the insulation. Extend the insulation 300 mm beyond the newly placed concrete. Insulate the pavement vertical edge and/or forms as well.

Place recording surface thermometers between the pavement surface and insulating material 300 mm from one of the placement edges wherever insulation is used. Use 4 equally spaced thermometers for each day's paving. Do not subject the concrete to a temperature drop in excess of 10°C during the first 24 hours after removing the insulation.

502-3.12 Sealing Joints. Seal joints as depicted in the Standard Sheets. Refer to Table 502-3, Joint Sealing Alternatives.

First-stage sawcuts may be temporarily left unfilled if a placement is only subjected to occasional construction traffic, such as pickup trucks or cars. In this case, sweep the pavement to ensure debris does not enter the joints.

Temporarily fill unsealed first-stage cuts with jute or backer rod if a placement is:

- Subjected to consistent construction traffic.
- Used as a haul road for subsequent concrete placements.

- Temporarily opened to general traffic while final sealing has been delayed for convenience, such as to maximize sealing production.

Before cleaning, remove any temporary fillers and repair damaged joints in accordance with §502-3.14, Defective or Damaged Concrete, including chipped joints resulting from debris accumulation in an unfilled or unsealed joint. Do not reuse backer rod used as temporary fillers in the final joint sealing.

A. Sealing Transverse Contraction Joints - Highway Joint Sealant. Widen joints to 6 mm – 9 mm for a depth of 25 mm if the first-stage saw cuts are less than 6 mm wide to allow full-depth sealing. Immediately wash the widening cut slurry from the pavement such that it does not reenter the joint. Do not seal transverse construction joints or longitudinal joints when highway joint sealants are specified for transverse contraction joints.

Joint cleaning and sealing may be delayed for convenience. Clean the joints by abrasive blasting immediately before sealing. Keep the nozzle within 50 mm of the joint surfaces.

The Engineer may allow pressure washing in lieu of abrasive blast cleaning if it is not allowed in the contract. When pressure washing, use (1) a 6.0 MPa minimum pressure and (2) a maximum pressure such that no damage occurs to the concrete. Manually dislodge debris remaining in the joint after cleaning, and reclean the joint. Immediately after pressure washing, air blast the joint to remove any debris from the cut and dry the exposed faces.

Do not allow any traffic on the pavement between cleaning and sealing. Reclean the joint if it rains between cleaning and sealing or if any traffic is on the placement between cleaning and sealing. Provide the Engineer a copy of the sealant Manufacturer's written recommendations for heating and application at least 1 work day before sealing. Follow those recommendations. Unless stated otherwise, the recommended pouring temperature is 5°C below the manufacturer's designated safe heating temperature, with an allowable variation of 5°C.

Prior to sealing, discharge sealant from the applicator wand into a vessel and measure the sealant temperature. The temperature must be equal to or above the Manufacturer's recommended minimum pouring temperature and equal to or below the Manufacturer's recommended safe heating temperature.

Do not use sealant heated above the safe heating temperature. Sealant may be reheated or heated in excess of 6 hours if allowed by the Manufacturer's heating and application recommendations. In these cases, recharge the melter with fresh sealant amounting to at least 20% of the sealant volume remaining in the melter.

Seal joints immediately after cleaning. Seal the joint from the bottom of the cut to within 5 mm - 10 mm of the pavement surface. Seal when the:

- Air and surface temperatures are 5°C or warmer.
- Air temperature is above the dew point.
- Pavement surface and all joint surfaces are dry.

Open to traffic after the sealant has cured to prevent tracking. Do not blot with fine aggregate.

B. Sealing Joints - Silicone Sealant. Make second-stage saw cuts and/or bevels in accordance with the Standard Sheets and (1) no sooner than 72 hours after concrete placement and (2) after the curing period has ended if curing covers are used. Wash the resulting slurry from the pavement and joint immediately after making second-stage saw cuts and/or bevels.

Second-stage saw cuts may be delayed for convenience, but do not leave second-stage saw cuts unsealed or unfilled while open to any traffic. Temporarily fill second-stage saw cuts with jute or backer rod if (1) they are exposed to any traffic before cleaning and sealing or (2) weather conditions are not favorable for timely (within 2 calendar days) cleaning and sealing, whether or not they are exposed to any traffic. Do not reuse backer rod used as temporary filler in the final joint sealing.

Install the sealant in accordance with the Manufacturer's written instructions. Give those instructions to the Engineer before any second-stage saw cutting begins. Consult the Manufacturer for primer requirements associated with the coarse aggregate used in the concrete.

Abrasive blast both vertical joint faces immediately before sealing. Tilt the nozzle to abrasive blast one vertical face at a time at each joint until uniformly abraded surfaces result. Air blast after

abrasive blasting to remove all abrasives. Reclean the joint if it rains between cleaning and sealing. Do not allow any traffic on the pavement between cleaning and sealing. Immediately after blasting, install backer rod to the required depth without ripping, tearing, or puncturing the rod. Roll the insertion wheel over the backer rod twice, once in each direction.

Seal when the:

- Air and surface temperatures are 5°C or warmer.
- Air temperature is above the dew point.
- Pavement and all joint surfaces are dry.

Where possible, first widen and seal the longitudinal joints (if required), then widen and seal the transverse joints such that the entire transverse joint contains a continuous sealant bead. If this is not possible, install the silicone in full placement widths.

Traffic may traverse silicone sealed joints after the sealant has skinned over, provided traffic opening and sealer manufacturer requirements have been met.

C. Sealing Joints - Preformed Joint Sealers. Make second-stage saw cuts and/or bevels in accordance with the Standard Sheets and (1) no sooner than 72 hours after concrete placement and (2) after the curing period has ended if curing covers are used. Extend the second-stage saw cut vertically down the free concrete edges. Wash the resulting slurry from the pavement and joint immediately after making second-stage saw cuts and/or bevels.

Second-stage saw cuts may be delayed for convenience, but do not leave second-stage saw cuts unsealed or unfilled while open to any traffic. Temporarily fill second-stage saw cuts with jute or backer rod if (1) they are exposed to any traffic before cleaning and sealing or (2) weather conditions are not favorable for timely (within 2 calendar days) cleaning and sealing, whether or not they are exposed to any traffic.

Clean the joints by pressure washing before sealing. Use (1) a 6.0 MPa minimum pressure and (2) a maximum pressure such that no damage occurs to the concrete. Manually dislodge debris remaining in the joint after cleaning, and reclean the joint. Within 24 hours of pressure washing, air blast the joint to remove any debris from the cut and dry the exposed faces. Reclean the joint if it rains between cleaning and sealing. Do not allow any traffic on the pavement between cleaning and sealing.

Install the sealant in accordance with the Manufacturer's written instructions. Give those instructions to the Engineer before any second-stage saw cutting begins. Lubricate the concrete, the sealer, or both before installation such that the lubricant fully covers the sealer/concrete interface, but not the top of the sealer.

Install one piece of transverse joint sealer in a compressed condition across the full pavement width, including concrete shoulders, and down the vertical saw cut at the free edge. Cut the longitudinal sealer where it crosses a transverse joint. Do not splice the longitudinal sealer between transverse joints. Seal the intersection between longitudinal and transverse sealers with lubricant.

Install the sealer such that it is not stretched more than 5% , nor compressed more than 2%, of the minimum theoretical length. Check the installation for stretch and compression by installing sealers in 5 transverse joints and removing the sealer immediately after installation and checking the length. An alternate method for checking stretch and compression, where applicable, may be performed by premarking or precutting the sealer to length prior to installation. If the measurement of any of these 5 sealers exhibits stretching in excess of 5% or compression in excess of 2%, modify the installation method to meet the requirements or discontinue installation.

Once sealing operations begin, remove 1 joint per 100 in the presence of the Engineer to check stretch and compression. If the sealer is found to be stretched in excess of 5% or compressed in excess of 2%, remove the sealer material from successive joints in both directions until sealers are found that meet the stretch and compression requirements. Replace all joints sealers found with excess stretch or compression. Replace joint sealers removed and found to meet the stretch and compression requirements.

TABLE 502-3 JOINT SEALING ALTERNATIVES

Joint Type	Sealing Alternative	First-Stage Saw Cut Required	Second-Stage Saw Cut and Bevel Required
Transverse Contraction	Silicone or Preformed	Yes	Both
	Highway Joint Sealant	Yes	Neither
Transverse Expansion and Isolation	Silicone or Preformed	No	Bevel Only
Transverse Construction	Silicone or Preformed	No	Both
	Do Nothing ¹	No	Neither
Longitudinal - Between Lanes Placed Simultaneously	Silicone or Preformed	Yes	Second-Stage Only
	Do Nothing ¹	Yes	Neither
Longitudinal - Between Lanes Placed Separately and Untied Joints With Keyway	Silicone or Preformed	No	Second-Stage Only
	Do Nothing ¹	No	Neither

NOTE:

1. Do nothing if highway joint sealants are specified for transverse contraction joints.

502-3.13 Pavement Protection. Protect the pavement and appurtenances from traffic and construction operations. Protect the work and provide for traffic as indicated in the contract documents.

502-3.14 Damaged or Defective Concrete. Repair or replace all damaged or defective concrete which occurs prior to final acceptance. Perform these repairs as described in the contract documents at no cost to the State. Damage and defects include, but are not limited to, cracking, spalling, honeycombing, or imperfections caused by inadequate pavement protection, traffic, and/or construction practices. Slipformed concrete with inadequate plastic thickness as described in §502-3.08, Plastic Thickness Determination, will be rejected in 50 m segment lengths.

502-3.15 Hardened Surface Test (Nonprofilographed Concrete). After the concrete has hardened sufficiently, test the entire longitudinal center of each travel lane, including ramps, with a 3 m, minimum, long straight edge laid longitudinally. The Engineer will mark high and low deviations in the pavement surface exceeding 3 mm in 3 m. Diamond grind these deviations such that they do not exceed 3 mm in 3 m when retested with the straight edge.

502-3.16 Profilograph. This section applies to profilographed concrete (and nonprofilographed concrete when a full-width finishing pan or triple transverse screed paving operation is not employed). The Engineer will divide each travel lane into reporting segments that are 160 m long. The Engineer will group segments shorter than 160 m with previous or subsequent segments. Provide survey stationing and develop a reference system that allows the Engineer to readily associate profilograph data to the corresponding reporting segment.

Develop a profile trace for each wheelpath in each reporting segment in accordance with Materials Method 24, PCC Pavement Profilograph Operations. Determine an initial profile index (PI) for each reporting segment by averaging the PIs of the wheelpaths. Provide the traces and initial PIs to the Engineer. The Engineer will identify bumps exceeding 10 mm in 7.6 m on each profile trace. Locate and diamond grind these bumps, if any, to 10 mm or less in 7.6 m. If no grinding is required for a given reporting segment, the initial PI may be used to determine the payable Quality Units of Smoothness Quality Adjustment per reporting segment.

Production diamond grinding equipment can be used to increase the amount of Quality Units payable as discussed in §502-3.17, Diamond Grinding. Whether diamond grinding was required through profile trace analysis, or performed as a Contractor option, reprofilograph each reporting segment that was

diamond ground and determine a final PI. Give the Engineer the final profile traces and final PI determined by using both the 5 mm and zero blanking bands.

502-3.17 Diamond Grinding. Diamond grind the pavement longitudinally, beginning and ending at lines normal to the pavement centerline, and in full travel lane width increments. Provide surface drainage by maintaining the proper cross slope on the finished surface and by blending adjacent passes. Continuously vacuum the slurry from the pavement when production grinding. If roadside slurry discharge is not allowed by the contract documents, transfer the slurry into equipment capable of transporting it from the contract site without spills. Dispose of slurry in conformance with all Federal, State, and local regulations.

In any case, do not allow slurry to enter:

- Occupied travel lanes.
- Drainage structures.
- Wetlands, streams, estuaries, or sensitive environmental resources.
- Areas where it will become a public nuisance.

Use of bump grinding equipment is restricted to grinding bumps that exceed 10 mm in 7.6 m in profilographed concrete and bump grinding non-profilographed concrete. Production grinding equipment can be used to grind bumps or increase the amount of Quality Units payable subject to the following:

- For pavements textured with longitudinal tining or artificial turf drag, any amount of a reporting segment surface area may be diamond ground to increase the amount of Quality Units payable.
- For transverse tined pavements, Quality Units are payable if less than 20% or more than 95% of the reporting segment surface area is ground. If more than 20% of the reporting segment area is ground for any reason, diamond grind 95%, minimum, of the entire reporting segment.

502-3.18 Opening to Traffic

A. Construction Traffic. Class C concrete may be opened to construction traffic and paving equipment 7 days after placement. With the Engineer's approval, this time frame may be shortened to 3 days if cylinders achieve a compressive strength of 17 MPa in accordance with §502-3.18C, Project Strength Determination. Any pavement damaged from opening to construction traffic in a reduced time frame will be treated in accordance with §502-3.14, Damaged or Defective Concrete.

B. General Traffic. Class C concrete placed between June 1 and September 15 may be opened to general traffic 10 days after placement. Class C concrete placed outside this interval may be opened to general traffic 15 days after placement. With the Engineer's approval, these time frames may be shortened to 4 days if cylinders achieve a compressive strength of 21 MPa in accordance with §502-3.18C, Project Strength Determination, and the joints are addressed in accordance with §502-3.12, Sealing Joints.

If Project Strength Determination testing for construction traffic opening indicates the concrete has achieved a compressive strength in excess of 21 MPa, the concrete may be opened to general traffic after 4 days. Any pavement damaged from opening to general traffic in a reduced time frame will be treated in accordance with §502-3.14, Damaged or Defective Concrete.

C. Project Strength Determination. Provide an ACI Certified Concrete Field Testing Technician, Grade I, or higher, to cast all cylinders. Unless otherwise noted in the contract documents, use an agency accredited by the AASHTO Accreditation Program (AAP) in the field of construction materials testing of portland cement concrete to perform compressive strength testing.

Cast and test in the presence of the Engineer, or the Engineer's representative. Provide acceptable proof of ACI Certification and AASHTO Accreditation to the Engineer before placing any concrete.

The Engineer, or the Engineer's representative, will complete the Concrete Cylinder Report as cylinders are cast and tested.

Cast a minimum of 3 cylinder pairs (6 total) from each 300 m of paving length, or fraction thereof, in accordance with Materials Method 9.2, Field Inspection of Portland Cement Concrete. Cast each pair from different delivery trucks. Develop an Engineer-approved marking system that

allows a cylinder to be readily associated with the corresponding placement location and placement time. Mark the cylinders and place them adjacent to the pavement under similar curing conditions. Determine the concrete compressive strength at the desired time in accordance with ASTM C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens. The pavement may be opened to construction (or general) traffic if all the following apply:

- Average compressive strength of all cylinder pairs exceed 17 MPa (or 21 MPa).
- Average compressive strength of each cylinder pair exceeds 14 MPa (or 17 MPa).
- Appropriate time frame has elapsed for the entire area to be opened.

If these conditions are not met, test 3 additional cylinder pairs at a later time, provided the appropriate numbers of additional cylinders were cast. If the above conditions are not met after additional testing, or, if the required number of additional cylinders were not cast, open the pavement in accordance with the nonreduced time frames of §502-3.18A, Construction Traffic, and §502-3.18B, General Traffic.

D. HES Concrete. HES concrete may be opened to construction traffic when it has achieved a compressive strength of 17MPa and to general traffic when it has achieved compressive strength of 21 MPa, in accordance with §502-3.18C, Project Strength Determination, and the joints are addressed in accordance with §502-3.12, Sealing Joints.

502-4 METHOD OF MEASUREMENT. The Engineer will measure the following quantities for items incorporated into the finished pavement:

502-4.01 Portland Cement Treated Permeable Base. The work will be measured for payment as the number of cubic meters of portland cement treated permeable base satisfactorily placed based on the payment lines shown in the contract documents. No deductions will be made for catch basins, manholes, or other similar pavement obstructions.

502-4.02 PCC Pavement, Unreinforced. The work will be measured for payment as the number of cubic meters of unreinforced PCC pavement satisfactorily placed based on the payment lines shown in the contract documents. Deductions in 50 m segment lengths will be made for areas that do not meet minimum plastic thickness requirements. Deductions (and separate payment) will be made for catch basins, manholes, or other similar pavement obstructions requiring either mesh reinforced or heavily reinforced placements.

502-4.03 PCC Pavement, Mesh or Heavily Reinforced. The work will be measured for payment as the number of cubic meters of reinforced concrete satisfactorily placed. No deductions will be made for drainage and utility structures or other similar pavement obstructions being isolated from the surrounding pavement.

502-4.04 Smoothness Quality Adjustment (Profilographed Items Only). The work will be measured for payment as the number of Quality Units of Smoothness Quality Adjustment, if any, payable for each reporting segment determined by the following:

Quality Units (Per Segment) = (SAF - 1.00) x PCC Cubic Meters (Per Segment)

The Smoothness Adjustment Factor (SAF) from Table 502-4, Smoothness Adjustment Factors, is based on the final PI obtained for each reporting segment using a 5 mm blanking band. No Quality Units are computed for pavements specified as nonprofilographed.

Final Profile Index (mm/km.)	Level 1 SAF	Level 2 SAF
0.0 - 16.0	1.05	1.05
16.1 - 32.0	1.04	1.04
32.1 - 48.0	1.03	1.03
48.1 - 64.0	1.02	1.02
64.1 - 79.9	1.01	1.01
80	1.00	1.00
80.0 +	Grind	1.00
190.0 +	Not Applicable	Grind

502-4.05 Constructing Transverse Joints. The work will be measured for payment as the number of meters of transverse joints satisfactorily constructed.

502-4.06 Constructing Longitudinal Joints. The work will be measured for payment as the number of meters of longitudinal joints satisfactorily constructed.

502-4.07 Sealing Transverse Joints. The work will be measured for payment as the number of meters of transverse joints satisfactorily sealed, excluding preformed sealers turned down at the pavement edges.

502-4.08 Sealing Longitudinal Joints. The work will be measured for payment as the number of meters of longitudinal joints satisfactorily sealed.

502-5 BASIS OF PAYMENT

502-5.01 Portland Cement Treated Permeable Base. Include the cost of all labor, material, and equipment necessary to satisfactorily perform the work in the unit price bid for Portland Cement Treated Permeable Base.

502-5.02 PCC Pavement, Unreinforced, Nonprofilographed. Include the cost of all labor, material, and equipment necessary to satisfactorily perform the work in the unit price bid for PCC Pavement, Unreinforced, Nonprofilographed. No payment will be made for areas that do not meet minimum plastic thickness requirements. No additional payment will be made for Contractor-requested HES concrete mixes.

Also include the cost of all labor, material, and equipment necessary to profilograph and diamond grind the pavement to meet the Level 2 smoothness requirements of Table 502-4, Smoothness Adjustment Factors, if paving equipment other than a paver equipped with a full-width finishing pan or triple transverse screeds is used. In this case, no payment will be made for SAF Quality Units.

PCC Pavement, Unreinforced, Nonprofilographed will be eligible for progress payments in accordance with the following:

- 80% upon satisfactory completion of all work up to, and including, first-stage saw cutting.
- An additional 10% upon satisfactory completion of diamond grinding, if any.
- The remaining 10% upon satisfactory completion of the work.

502-5.03 PCC Pavement, Unreinforced, Profilographed. Include the cost of all labor, material, and equipment necessary to satisfactorily perform the work in the unit price bid for PCC Pavement, Unreinforced, Profilographed. No payment will be made for areas that do not meet minimum plastic thickness requirements. No additional payment will be made for Contractor-requested HES concrete mixes.

PCC Pavement, Unreinforced, Profilographed will be eligible for progress payments in accordance with the following:

- 80% upon satisfactory completion of all work up to, and including, first-stage saw cutting.

- An additional 10% upon satisfactory completion of diamond grinding, if any.
- The remaining 10% upon satisfactory completion of the work.

502-5.04 Smoothness Quality Adjustment. Quality Units of Smoothness Quality Adjustment are a fixed price in the bid documents and cannot be changed by the Contractor.

502-5.05 PCC Pavement, Mesh or Heavily Reinforced. Include the cost of all labor, material, and equipment necessary to satisfactorily perform the work in the unit price bid for PCC Pavement, Mesh or Heavily Reinforced. No additional payment will be made for Contractor-requested HES concrete mixes.

502-5.06 Constructing Transverse Joints. Include the cost of all labor, material, and equipment necessary to satisfactorily perform the work in the unit price bid for Constructing Transverse Joints.

502-5.07 Constructing Longitudinal Joints. Include the cost of all labor, material, and equipment necessary to satisfactorily perform the work in the unit price bid for Constructing Longitudinal Joints. Placing the inside shoulder and inside lane simultaneously, at the Contractor’s option, will not generate a Significant Change in the Character of Work. No additional payment will be provided for the additional number of longitudinal joint ties associated with:

- Constructing butt joints between lanes placed separately in a slipform paving operation.
- Constructing longitudinal joints in wheelpaths.

502-5.08 Sealing Transverse Joints. Include the cost of all labor, material, and equipment necessary to satisfactorily perform the work in the unit price bid for Sealing Transverse Joints.

502-5.09 Sealing Longitudinal Joints. Include the cost of all labor, material, and equipment necessary to satisfactorily perform the work in the unit price bid for Sealing Longitudinal Joints. Placing the inside shoulder and inside lane simultaneously, at the Contractor’s option, will not generate a Significant Change in the Character of Work.

Payment will be made under:

Item No.	Item	Pay Unit
502.0001	Portland Cement Treated Permeable Base	Cubic Meter
502.RPCF	PCC Pavement	Cubic Meter
<u><i>R – Pavement & Reinf.</i></u>	<u><i>P – Profilgaphing</i></u>	<u><i>C – Concrete Class</i></u>
<i>0 – Unreinforced</i>	<i>0 – Nonprofilographed</i>	<i>1 – Class C</i>
<i>1 – Mesh Reinforced</i>	<i>1 – Level 1</i>	<i>3 – HES</i>
<i>2 – Heavily Reinforced</i>	<i>2 – Level 2</i>	
		<u><i>F – Friction Type</i></u>
		<i>1 – Type 1</i>
		<i>2 – Type 2</i>
		<i>3 – Type 3</i>
		<i>9 – Type 9</i>
502.9010	Smoothness Quality Adjustment	Quality Unit
502.91	Constructing Transverse Joints	Meter
502.9110	Constructing Longitudinal Joints	Meter
502.92	Sealing Transverse Joints – Silicone Joint Sealant	Meter
502.9201	Sealing Transverse Joints – Preformed Elastic Joint Sealer	Meter
502.9210	Sealing Transverse Contraction Joints – Highway Joint Sealant	Meter
502.93	Sealing Longitudinal Joints – Silicone Joint Sealant	Meter
502.9301	Sealing Longitudinal Joints – Preformed Elastic Joint Sealer	Meter

SECTION 503 - PORTLAND CEMENT CONCRETE FOUNDATION FOR PAVEMENT

503-1 DESCRIPTION. Construct a portland cement concrete (PCC) foundation for pavements and shoulders, if required, as detailed in the contract documents.

503-2 MATERIALS.

Portland Cement Concrete

501

§503

Anchoring Materials - Chemically Curing	701-07
Premoulded Resilient Joint Filler	705-07
Longitudinal Joint Ties	705-14
Transverse Joint Supports	705-15
Epoxy Coated Bar Reinforcement, Grade 420	709-04
Quilted Covers (for curing)	711-02
Plastic Coated Fiber Blankets (for curing)	711-03
Polyethylene Curing Covers (white opaque)	711-04
Form Insulating Materials for Winter Concreting	711-07
Water	712-01

In addition to meeting the requirements of §701-07, Anchoring Materials - Chemically Curing, the material used to anchor longitudinal joint ties, dowels, or other miscellaneous items into hardened concrete must be a pourable, two-component, 100% solids structural epoxy dispensed:

- From side-by-side cartridges by manual or pneumatically powered injection guns.
- Through a static mixing nozzle that homogeneously mixes the material without any hand mixing.

Apply the requirements of the following in accordance with the contract documents:

§502-2.01, Concrete.

§502-2.02, High-Early-Strength (HES) Concrete.

§502-2.03, Portland Cement Treated Permeable Base.

§502-2.04, Equipment.

§502-2.04A, Slipform Paving.

§502-2.04B, Fixed Form Paving.

§502-2.04C, Vibrators.

§502-2.04D, Permeable Base Paving Equipment.

§502-2.04E, Saw Cutting Equipment.

§502-2.04I, Drills.

§502-2.04L, Air Blasting Equipment.

503-3 CONSTRUCTION REQUIREMENTS. Apply the requirements of §502-3, Portland Cement Concrete Pavement, except as modified herein.

503-3.01 Placement of Reinforcement. Place bar reinforcement around utilities, drainage structures, and other projections into the pavement as depicted in the Standard Sheets for PCC Pavements. Use telescoping manholes when required by the contract documents in accordance with §502-3.06C, Utility and Drainage Structure Isolation Joint Systems and Telescoping Manholes.

503-3.02 Joints. Transverse joint supports are not required for contraction joints. Saw cut skewed contraction joints at a “6 on 1” skew across the pavement (approximately 10° from perpendicular to the centerline) before uncontrolled cracking occurs. Saw cut in accordance with the first-stage saw cut details in the Standard Sheets.

Use a maximum joint spacing of 6 m and a minimum spacing that satisfies the geometric requirements of §502-3.06A, Transverse Joints. Center utilities and drainage structures between saw cuts. Skewed joints may be cut at the same angle across the pavement or chevron-shaped with the vertex at a longitudinal joint between separate placements. Maintain the same technique once selected. Construct transverse construction joints perpendicular to the centerline in accordance with §502-3.06A3, Transverse Construction Joints.

Construct longitudinal joints in accordance with §502-3.06B, Longitudinal Joints.

503-3.03 Finishing. Hand finish the pavement to correct surface irregularities.

503-3.04 Testing the Surface. Immediately after placement, test the entire longitudinal center of each travel lane with a 3 m, minimum, long straight edge laid longitudinally. Immediately correct any surface irregularity exceeding 10 mm in 3 m.

503-3.05 Texturing. Immediately after testing the surface, apply an aggressive transverse broom finish.

503-3.06 Curing. Cure in accordance with §502-3.11, except the impervious membrane method, i.e., curing compound, is not be permitted.

503-3.07 Surface Test. No surface test on the hardened concrete will be required.

503-3.08 Sealing Joints. Typically, no joint sealing is required in the PCC foundation course. Seal skewed contraction joints in accordance with §502-3.12A, Sealing Transverse Contraction Joints – Highway Joint Sealant, if a construction delay occurs that prevents the placement of the final pavement course until the subsequent construction season.

503-4 METHOD OF MEASUREMENT.

503-4.01 Portland Cement Concrete Foundation for Pavement. The work will be measured for payment as the number of cubic meters of Portland Cement Concrete Foundation for Pavement based on the payment lines shown in the contract documents. No deductions will be made for catch basins, manholes, or other similar pavement obstructions.

503-4.02 Constructing Longitudinal Joints. The work will be measured for payment as the number of meters of longitudinal joints satisfactorily constructed.

503-5 BASIS OF PAYMENT.

503-5.01 Portland Cement Concrete Foundation for Pavement. Include the cost of all labor, material, and equipment necessary to satisfactorily perform the work in the unit price bid for Portland Cement Concrete Foundation for Pavement. No payment will be made for areas that do not meet minimum plastic thickness requirements as described in §502-3.08, Plastic Thickness Determination. No additional payment will be made for Contractor-requested HES concrete mixes.

503-5.02 Constructing Longitudinal Joints. Include the cost of all labor, material, and equipment necessary to satisfactorily perform the work in the unit price bid for Constructing Longitudinal Joints.

Payment will be made under:

Item No.	Item	Pay Unit
503.1010	PCC Foundation for Pavement, Class C	Cubic Meter
503.1011	PCC Foundation for Pavement, Class F	Cubic Meter
503.1012	PCC Foundation for Pavement, HES Concrete	Cubic Meter
503.9110	Constructing Longitudinal Joints in Foundation Pavement	Meter

SECTIONS 504 THRU 549 (VACANT)

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