SECTION 500 -- CONCRETE PAVEMENT
SECTION 501 -- PORTLAND CEMENT CONCRETE PAVEMENT
SECTION 502 -- QUALITY CONTROL/QUALITY ASSURANCE, QC/QA

SECTION 500 -- RIGID PAVEMENT

SECTION 501 -- PORTLAND CEMENT CONCRETE PAVEMENT

501.01 Description. This work shall consist of a pavement composed of portland cement concrete, with or without reinforcement as specified, constructed on a prepared subgrade or base course in accordance with these specifications and in reasonably close conformance with the lines, grades, thicknesses, and typical cross sections shown on the plans or as directed.

MATERIALS

501.02 Materials. Materials shall be in accordance with the following:

Coarse Aggregate, Class AP, Size No. 8	904.02
Curing Materials	912.01
Dowel Bars	910.01
Entraining Admixtures	912.03
Fine Aggregate, Size No. 23	904.01
Fly Ash	901.02
Ground Granulated Blast Furnace Slag	901.03
Joint Materials	906
Portland Cement	901.01(b)
Reinforcing Steel	910.01
Water	913.01

CONSTRUCTION REQUIREMENTS

501.03 Proportioning.

(a) Composition of Concrete. The proportions of aggregate necessary to produce a workable mix within the specifications will be approved, and no change shall be made unless otherwise approved. Proportions will be based upon saturated surface dry aggregates. The fine aggregate shall be no less than 35% nor more than 45% of the total weight of the aggregate in each cubic yard.

Portland pozzolan cement, type IP; air-entraining portland pozzolan cement, type IP-A; fly ash; or ground granulated blast furnace slag may only be incorporated into concrete pavement placed between April 1 and October 15 of the same calendar year. If fly ash or ground granulated blast furnace slag is used as an additive and/or partial cement substitute, then it shall be proportioned in accordance with 702.05 and shall meet all requirements set out in 702.05.

The relative yield of the concrete placed shall be determined in accordance with 501.03(a)4. The concrete when produced shall provide a relative yield of 1.00 ± 0.02. If the relative yield is outside the tolerance, adjustments to the batch weights shall be made.

The amount of cement shall remain as specified for the desired class or as further modified herein.

Unless otherwise provided, the cement content of concrete for pavement shall be at least 335 kg/m³ (564.16 lb/cu yd), subject to the tolerances noted herein. When a cement content of more than 335 kg/m³ (564 lb/cu yd) is ordered in writing, compensation will be made for the additional cement ordered at the net unit price as shown by certified vouchers. If the Contractor elects to increase the cement content for its advantage, no additional compensation will be made. The cement content shall not be increased more than 57 kg/m^3 (94 lb/cu yd). The relative yield of the concrete shall be maintained as stated above. Class C concrete in accordance with 702 may be used as a substitution for pavement concrete described herein, provided that class AP coarse aggregate is used in the concrete. If portland pozzolan cement, type IP, or air-entraining portland pozzolan cement, type IP-A, are to be used in pavement concrete, the cement content shall be increased by a multiplier of 1.06 times the specified minimum cement content or the desired increased cement content (i.e., 1.06 x 335 = 355 kg/m^3 (1.06 x 564 = 598 lb/cu yd) for normal pavement concrete.

Water may be measured either by volume or weight. The mixture shall contain no more water than is necessary to produce a concrete that is workable and plastic and meeting the required slump. The water used, including any free water in the aggregates, shall not exceed a water to cement ratio of 0.487. If the characteristics of the combined materials are such that the required slump cannot be obtained when using the allowable maximum amount of water, the cement content shall be increased over the specified 335 kg/m^3 (564 lb/cu yd) of concrete sufficiently to produce the required slump. Such increased cement, as well as the 335 kg/m^3 (564 lb/cu yd), shall be furnished and included in the contract unit price for the concrete.

The slump of machine-placed concrete shall be no less than 30 mm (1 1/4 in.) nor more than 75 mm (3 in.) except on super-elevated curves. Where it is necessary to prevent slumping during finishing and setting, the upper limit may be reduced to 50 mm (2 in.). If concrete is hand placed, the slump shall be no less than 50 mm (2 in.) nor more than 100 mm (4 in.).

The water-cement ratio shall be determined in accordance with procedures used by the Department. The slump of the concrete shall be determined in accordance with AASHTO T 119. Test specimens shall be made, cured, and tested in accordance with AASHTO T 23 and T 97. Relative yield shall be determined in accordance with AASHTO T 121. Samples shall be obtained in accordance with applicable provisions of AASHTO T 141 except, where job conditions dictate and where test data is needed prior to placing concrete, the entire sample may be obtained from one portion of the load. All samples shall be obtained in accordance with the instructions issued. In order to comply with procedures used by the Department, the following exceptions to AASHTO standard methods of test shall apply.

1. Blank.

2. **Exceptions to AASHTO T 23 Making and Curing Concrete Specimens in the Field.** The exceptions to AASHTO T 23 for making and curing specimens in the field shall be as follows:

a. The chosen method of concrete consolidation shall be the same for all concrete test specimens.

b. Beam forms furnished by the Department will be permitted even though they are not water tight and have no provision for attaching the base to the sides.

c. Form oil used on the project will be permitted in lieu of mineral oil.

d. Curing of beams shall represent, as closely as possible, that received by the concrete represented by the beams in order to accurately reflect the strength of the concrete in place. During the first 24 h, the beam shall be cured in the same manner as the concrete in place. If burlap is used, the material shall be large enough to provide complete coverage and a means of securing against movement by the wind. The burlap shall be kept wet for the entire period. If waterproof blankets are used, they shall be large enough to completely cover the beams and permit banking around the entire perimeter to ensure against loss of moisture. The blankets shall be wetted thoroughly before covering the beams. If curing compound is used, the beams shall be shaded by covering with a piece of canvas or similar material to keep the forms from getting hot. In all cases, the curing shall begin immediately after the beams are made.

After 24 h, the beams shall be removed from the forms, positioned with the finished side up, and banked or buried flush with the top of the beams in wet sand or soil. Throughout the remainder of the curing period, the sand or soil shall be maintained sufficiently wet to provide free moisture to all surfaces of the beam except the top which shall be protected in the same manner as the concrete in place. When curing of the concrete from which the beam was taken is discontinued, it shall be discontinued on the beams. However, they shall remain in the curing position until the time of testing. They shall be tested immediately after they are removed from the curing area so as to prevent partial drying and a decrease in flexural strength.

Procedures for final curing shall be as follows:

(1) A protected area within the limits of the right of way may be selected near where the beams are molded. The beams may be buried flush in the soil, or placed on the ground and banked. There shall be a minimum of 150 mm (6 in.) between the

beams. Frequent wettings may be required to maintain free moisture.

(2) A water tight box may be constructed and filled with sand. The box shall be large enough to provide 150 mm (6 in.) of sand between, under, and around the beams. The beams shall be positioned with their surfaces flush with the sand, and the sand saturated with water. Free water shall be maintained around the beam by re-wetting. The box may be placed on the pavement or in any protected area.

(3) A pile of sand may be maintained near the field office for curing the beams. The beams shall be transported, after initial cure, from the place of molding to the curing area. They shall then be banked with sand as set out above.

3. Exceptions to AASHTO T 97 for Flexural Test. The exceptions to AASHTO T 97 for conducting a flexural test on concrete beams shall be as follows:

a. The beam size shall be measured to the nearest 1.0 mm (1/16 in.).

b. The test result shall be discarded when the break occurs outside the middle 1/3 of the beam.

c. The use of hand operated testing machines, that do not provide a continuous loading to completion of the test in one stroke, shall be permitted.

4. Exceptions to AASHTO T 121 for Determining the Relative Yield. The exceptions to AASHTO T 121 for determining the relative yield of concrete shall be as follows:

a. An aluminum measure is an acceptable alternate.

b. A strike-off bar may be used in lieu of a cover plate.

c. Weights shall be determined to the nearest 0.005 kg (0.01 lb).

(b) Methods of Entraining Air. The air content of the concrete mix shall be 6.5% ± 1.5% by volume. Air entrainment may be accomplished by the addition of an air entraining admixture to the concrete when portland cement is used, or by the use of air entraining portland cement with the addition of an air entraining admixture if necessary.

Unless otherwise provided, tests for air content shall be made in accordance with AASHTO T 152 or ASTM C 173. If slag is used, the method of test shall be in accordance with ASTM C 173.

Exceptions to AASHTO T 152, Air Tests, are as follows:

1. Samples shall be obtained as directed.

2. For aggregates indicating a high correction factor, the aggregate may be washed from the concrete sample and used to determine the correction factor.

(c) High Early Strength Pavement. If the use of high early strength concrete is specified or selected and approved, it shall be made with portland cement type I or type III. Otherwise, all requirements of this section shall apply.

The concrete shall be air-entrained. A water-reducing or water reducing retarding chemical admixture in accordance with 912.03 shall be used. Fly ash used as an additive will be permitted for use in high early strength concrete. However, no reduction in cement content will be permitted due to the addition of fly ash. The maximum amount of fly ash in the mix shall be 10% of the cement content by weight. The cement content shall be a minimum of 332 kg/m^3 (560 lb/cu yd) of concrete. The amount of mixing water shall be as small as will permit workability, but shall not exceed a water to cement ratio of 0.450 when type III cement is used in the concrete, or 0.420 when type I cement is used in the concrete. The time of mixing shall be no less than 2 min per batch.

The Contractor shall submit a concrete mix design and supporting test results for approval prior to placing concrete. All concrete testing shall be conducted by an American Concrete Institute certified portland cement concrete technician. The test report shall be signed by such technician. The supporting test results shall include air content, slump, and yield test results, the water/cement ratio determination, and the flexural strengths at one day, two days, and seven days. The approved concrete mix design shall be in accordance with all parameter requirements. The concrete shall achieve a minimum flexural strength of 3800 kPa (550 lb/sq in.) within the time period specified, but not longer than 48 h.

Field test beams shall be made from the mixture used in accordance with 501.03(a). The beams shall receive the same curing as the concrete they represent. Traffic shall not be permitted on this pavement concrete until the test beams indicate a modulus of rupture of at least 3800 kPa (550 lb/sq in.). The beams shall be tested as simple beams with third-point loading.

501.04 Equipment. Equipment and tools necessary for handling materials and performing all parts of the work shall be approved as to design, capacity, and mechanical condition. The equipment shall be at the job site sufficiently ahead of the start of construction operations to be examined thoroughly.

(a) Batching Plant and Equipment.

1. General. The batching plant shall include bins, weighing hoppers, and scales for the fine aggregate and for each size of coarse aggregate. If cement is used in bulk, a bin, hopper, and separate scale for cement shall be included. The weighing

hoppers shall be sealed and vented to preclude dusting during operation. The batch plant shall be equipped with a suitable non-resettable, batch counter which will indicate correctly the number of batches proportioned. Unless otherwise permitted, the minimum batch of concrete shall be 1.5 m^3 (2 cu yd).

If fly ash or ground granulated blast furnace slag is used as an additive in portland cement concrete, the cement and fly ash or ground granulated blast furnace slag shall be weighed and discharged separately when a manual operation is utilized. When an automatic batching plant is utilized, the fly ash or ground granulated blast furnace slag may be weighed into the cement weigh hopper in one cumulative operation with the portland cement always being weighed in first.

2. **Bins and Hoppers.** Bins with adequate separate compartments for fine aggregate and for each size of coarse aggregate shall be provided in the batching plant. If fly ash is used, the cement and fly ash bins shall be separated to the satisfaction of the Engineer.

3. **Scales.** The scales for weighing aggregates and cement shall be either the beam type or the springless dial type. For applied loads of 450 kg (1,000 lb) and greater on the cement scale, and 1800 kg (4,000 lb) and greater on the aggregate scale, the scales shall be accurate to within 0.5%. For applied loads less than 450 kg (1,000 lb) and 1800 kg (4000 lb) on the cement and aggregate scales, respectively, the scale shall be accurate to 2.0% or one graduation, whichever is larger. When beam type scales are used, provision, such as a tell-tale dial, shall be made for indicating to the operator that the required load in the weighing hopper is being approached. A device on weighing beams shall indicate critical position clearly. Control devices shall be designed to be locked in any position to prevent unauthorized change. The weigh beam and tell-tale device shall be in full view of the operator while charging the hopper, and he shall have convenient access to all controls. Scales will be inspected as often as necessary to assure their continued accuracy. No less than ten 25 kg (50 lb) weights shall be provided at all times for testing of scales.

4. **Automatic Weighing Device.** When required in the contract, batching plants shall be equipped to proportion aggregates and bulk cement by means of automatic weighing devices of an approved type.

(b) Mixers. Concrete may be mixed at a central point in accordance with 702.09, or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

1. **Truck Mixers and Truck Agitators.** Truck mixers used for mixing and hauling concrete and truck agitators used for hauling central mixed concrete shall be in accordance with 702.09(b).

2. **Non-Agitator Trucks.** Bodies of non-agitating hauling equipment for concrete shall be smooth, mortar tight, metal containers. They shall be capable of

discharging the concrete at a satisfactorily controlled rate without segregation. The concrete shall be discharged from the bottom of the container. If discharge of concrete is accomplished by tilting the body, the surface of the load shall be retarded by a suitable baffle. Covers shall be provided when needed for protection.

(c) Finishing Equipment.

1. Finishing Machine. The finishing machine shall be equipped with at least two oscillating type transverse screeds.

2. Vibrators. Vibrators for full width and depth vibration of concrete paving slabs may be either the surface pan type or the internal type with either immerse tube or multiple spuds. They may be attached to the spreader or the finishing machine or mounted on a separate carriage. They shall not come in contact with the joint, load transfer devices, subgrade, or side forms. The frequency of the surface vibrators shall be no less than 3500 impulses per min. The frequency of the internal type shall be no less than 5000 impulses per min for tube vibrators and spud vibrators shall have a frequency of from 10,000 to 12,000 impulses per min in air. The paving contractor shall provide to the Engineer a device, such as a hand reed tachometer, to determine if the specified frequencies are being obtained. This device shall remain the property of the Contractor and no additional payment will be made for its use. Vibrators attached to a separate carriage, spreader, or finishing machine shall be equipped with a control to shut off the operation automatically when forward motion stops. The maximum spacing of spud vibrators shall be 600 mm (24 in.). A constant burning green light, or other approved warning device, shall be connected to each vibrator circuit to indicate a failure of any individual vibrator. The light or device shall be mounted in such a location as to be visible from the ground.

(d) Concrete Saw. When joints are to be sawed, adequate sawing equipment shall be provided to complete the sawing to the required dimensions and at the required rate. At least one spare saw in good working order shall be provided as a replacement. An ample supply of saw blades shall be maintained at the site of the work during sawing operations. Adequate artificial lighting facilities shall be provided for night sawing. All of this equipment shall be on the job both before and during concrete placement.

(e) Forms. Straight side forms shall be of sufficient thickness to maintain the true cross section of the forms and shall be furnished in sections no less than 3 m (10 ft) in length. Forms shall have a depth equal to at least the prescribed edge thickness of the concrete pavement without horizontal joint, and a base width equal to no less than the depth of the forms. Flexible or curved forms of proper radius shall be used for curves of 50 m (150 ft) radius or less. Flexible or curved forms shall be of an acceptable design. Forms shall be provided with adequate devices for secure setting so that when in place they can withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Flange braces shall extend outward on the base no less than 2/3 of the height of the form. Forms with battered top surfaces and bent, twisted, or broken forms shall be removed from the work. Repaired forms shall not be used until inspected and approved. Built-up forms shall not be used except where the total area of pavement of any specified thickness on the project is less than 1600 m^2

(2,000 sq yd). The top face of the form shall not vary from a true plane by more than 3.0 mm (1/8 in.) in 3 m (10 ft) and the upstanding leg shall not vary by more than 6 mm (1/4 in.). The forms shall contain provisions for locking the ends of abutting form sections together tightly for secure setting.

501.05 Preparation of Grade. If subbase is required, the subgrade under it shall be finished in accordance with 207.05 and the subbase surface finished in accordance with applicable provisions of 304.06. Compacted subbase shall be extended at least 600 mm (2 ft) beyond each edge of the proposed concrete pavement prior to setting forms.

501.06 Setting Forms.

(a) Base Support. The foundation under the forms shall be hard and true to grade so that the form, when set, can firmly be in contact for its whole length and be at the specified grade. Any grade which is found to be below established grade at the form line shall be filled to grade with granular material in lifts of 13 mm (1/2 in.) or less for a distance of 460 mm (18 in.) on each side of the base of the form and thoroughly compacted. Imperfections or variations above grade shall be corrected by tamping or by cutting as necessary.

(b) Form Setting. After the forms have been set to the correct grade, the grade shall be tamped thoroughly, either mechanically or by hand, at both the inside and outside edges of the base of the forms. Forms shall be staked into place with no less than three pins for each 3 m (10 ft) section. A pin shall be placed at each side of every joint. Form sections shall be locked tightly and be free from play or movement in any direction. No excessive settlement or springing of forms under the finishing machine will be allowed. Forms shall be cleaned and oiled prior to the placing of concrete.

(c) Grade and Alignment. The alignment and grade elevations of the forms shall be checked and corrected immediately before placing the concrete. Any vertical deviation, either at the joints or between, amounting to 3.0 mm (1/8 in.) or more, or 6 mm (1/4 in.) or more horizontally on the inside face, except for curved forms, shall be corrected before concrete is placed.

Stakes will be set on the outside of each form line except when construction engineering or production staking is furnished by the Contractor. Just prior to placing the concrete, the agreement of the tops and the alignment of the forms with these stakes shall be checked. The forms shall be checked for stability.

If distance permits, forms shall be kept at least 150 m (500 ft) ahead of concrete placement. If material under the forms becomes unstable before concrete is placed, the forms shall be removed, the surface corrected, and the forms reset.

501.07 Conditioning of Subgrade or Base Course. Before or after side forms have been securely set to grade, the subgrade or base course shall be brought to proper cross section. The subgrade shall be prepared in accordance with 207.05. The finished grade shall be maintained in a smooth and compacted condition until the pavement is

placed. The subgrade or base course shall be uniformly moist when the concrete is placed. If it subsequently becomes too dry, the subgrade or base course shall be sprinkled, but the method of sprinkling shall not be such as to form mud or pools of water.

501.08 Handling, Measuring, and Batching Materials. The batch plant site, layout, equipment, and provisions for transporting material shall be such as to assure a continuous supply of reasonably uniform material to the work. Aggregate stockpiles shall be located in areas sufficiently well drained to prevent the dirt underneath from becoming softened and pumping into the aggregate to a level from which the aggregate is to be removed and used in the work. Stockpiles shall be built in layers not to exceed 2 m (6 ft) in depth. Upper layers shall be prevented from spilling over the sides of the layers below.

The removal of aggregates from stockpiles shall be done in such a manner that segregation shall not occur. Aggregate which has become mixed with dirt shall not be used in the work.

Washed aggregates shall drain for at least 12 h prior to use. Twelve hours drainage may be required at any time when the moisture becomes non-uniform in aggregates from any source. Aggregates from different sources shall not be stockpiled together without written approval.

The use of bins having a group of separate compartments will not be permitted unless positive means are employed during filling and emptying operations to ensure against any mixing of the different sizes prior to batching.

The fine aggregate and coarse aggregate shall be weighed separately into hoppers in the respective amounts set out in the job mix. Cement shall be measured by weight. Separate scales and hoppers shall be used for weighing the cement.

When required by the contract, or when permitted, batching plants shall be equipped to proportion aggregates and bulk cement by weight by means of automatic and interlocked proportioning devices of approved type.

When mixing is at the site of the work, aggregates shall be transported from the batching plant to the mixer in batch boxes, vehicle bodies, or other containers of adequate capacity and construction to properly carry the volume required. Partitions separating batches shall be adequate and effective to prevent spilling from one compartment into another while in transit or being dumped. When bulk cement is used, a suitable method of handling the cement from weighing hopper to transporting container or into the batch itself shall be used for transportation to the mixer with chute, boot, or other approved device. The method used shall prevent loss of cement and provide positive assurance of the actual presence in each batch of the entire cement content specified.

Bulk cement shall be transported to the mixer in tight compartments carrying the full amount of cement required for the batch. Cement in original shipping packages may

be transported on top of the aggregates, each batch containing the number of sacks required by the job mix.

Batches shall be delivered to the mixer separate and intact. Each batch shall be dumped into the mixer without loss of cement and, when more than one batch is carried on the truck, without spilling of material from one batch compartment into another. Batching shall be so conducted as to obtain the weights of each material required within a tolerance of 1%for cement and 2% for aggregates.

The mixer shall be equipped with an easily read calibrated water measuring device, accurate to within 1.0% of the required amount. This measuring device shall be such that variations of pressure in the supply line will not affect its accuracy, nor shall it be affected by the mixer being tilted in any direction.

The amount of water delivered to each batch shall be plainly and accurately shown, and positive means provided to automatically stop the flow of water when the required amount has been delivered to the batch. No additional water shall be delivered to any batch beyond that required for that batch.

The batch shall be so charged into the drum that a portion of the mixing water enters in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first 15 s of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.

The water measuring device will be checked under actual working conditions or at any other time deemed necessary. All labor and equipment required for calibrating and checking shall be furnished, and any necessary repairs shall be made with no additional payment.

Methods and equipment for adding air-entraining agents or other admixtures to the batch, when required, shall be approved. All admixtures shall be measured into the mixer with an accuracy of ± 3%.

501.09 Mixing Concrete. The concrete may be mixed in a central-mix plant in accordance with 702.09, or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials, except water, are in the drum. Ready-mixed concrete shall be mixed and delivered in accordance with 702.09.

The mixer shall be operated at a drum speed as shown on the manufacturer's name plate on the approved mixer. Any concrete mixed less than the specified time shall be discarded and disposed of with no additional payment. The volume of concrete mixed per batch shall not exceed the nominal capacity of the mixer in cubic meters (cubic yards) as shown on the manufacturer's standard rating plate on the mixer. However, an overload of no more than 10% above the nominal capacity of the mixer may be permitted provided strength, segregation, and uniform consistency are satisfactory and no spillage of concrete takes place.

Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators, or nonagitating trucks. The time elapsing from the time water is added to the mix until the concrete is deposited in place at the site of the work shall not exceed 30 min when the concrete is hauled in nonagitating trucks, and 90 min when hauled in truck mixers or truck agitators.

Retempering of concrete by adding water, or by other means, will not be permitted after initial set. When concrete is delivered in transit mixers, additional water may be added occasionally to increase the slump, if permitted and additional mixing shall be performed as directed and all operations completed within 45 min after the initial mixing operation. The amount of water added shall be accurately determined and noted on the batch ticket. Such addition of water will not be permitted as a continuing operation. Concrete that is not within the specified slump limits at time of placement shall not be used. Chemical admixtures type B, type C, and type E will be permitted only with prior written permission. Batching and mixing shall be suspended whenever satisfactory placing, finishing, and curing operations can not be carried on in proper sequence. Different brands of cement shall not be used alternately nor mixed. One brand shall be used continuously before changing to some other brand.

501.10 Limitations of Mixing. No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

Unless authorized in writing, mixing and concreting operations shall be discontinued when a descending air temperature away from artificial heat reaches 4°C (40°F) and not resumed until an ascending air temperature away from artificial heat reaches 2°C (35°F).

When concreting is authorized during cold weather, the aggregates may be heated by either steam or dry heat prior to being placed in the mixer. The apparatus used shall heat the mass uniformly and shall be so arranged as to preclude the possible occurrence of overheated areas which might injure the materials. Unless otherwise authorized, the temperature of the mixed concrete shall be no less than 10°C (50°F) and no more than 27°C (80°F) at the time of placing it in forms.

If the air temperature is 2°C (35°F) or less at the time of placing concrete, either or both the water and the aggregates may be required to be heated to no less than 21°C (70°F) nor more than 66°C (150°F). When either aggregates or water are heated to above 38°C (100°F), they shall be combined in the mixer before the cement is added.

501.11 Placing Concrete. When the placing of concrete is started, the amount of equipment and supply of materials shall be sufficient to ensure that placing can be continuous for any given working period.

The pavement shall be constructed to its full width in a single operation unless it is otherwise required that it be by other transverse sections. Where construction is by

abutting transverse sections, the longitudinal joint line between these sections shall not deviate from the true line shown on the plans by more than 6 mm (1/4 in.).

The batches shall be deposited so as to require as little rehandling as possible. Any necessary rehandling shall be with power distributing devices or with shovels, not with rakes. Equipment made of or coated with aluminum or aluminum alloys shall not be used to transport concrete. Chutes or troughs, however, may be made of or coated with aluminum or aluminum alloys. Pumping of concrete shall be in accordance with 702.10. Workmen shall not walk on the fresh concrete with footwear coated with earth or other foreign matter.

Necessary precautions shall be taken to prevent segregation of the concrete ingredients while being placed. The discharge end of depositing equipment shall be provided with baffles or other satisfactory devices if considered necessary. All conveying equipment shall be kept clean.

Concrete shall be placed over and against the joints in such manner as can ensure that the joints, dowel bars, and assemblies are retained in correct positions. Placing shall be continuous between transverse joints without the use of intermediate bulkheads, except as hereinafter provided for construction joints.

Concrete shall be thoroughly consolidated against the faces of all forms and joints, including concrete in a previously constructed lane of pavement, by means of vibrators inserted in the concrete. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or a side form. The vibrator shall not operate more than 15 s in any one location and shall not be operated so as to bring excess mortar to the surface or cause segregation in the mix.

No concrete shall be placed around a manhole or similar structure until it has been adjusted to proper grade and alignment and the casting completely surrounded by preformed joint material in accordance with 720.04.

Where concrete is placed adjoining a previously constructed lane of pavement, the Contractor shall be responsible for the protection of the existing joints from the intrusion of fresh concrete mortar from the new concrete pavement, and for any damage caused by operation of mechanical equipment on existing lanes as provided herein. If any concrete materials fall on or are worked into the surface of a completed slab, they shall be removed immediately by approved methods.

No equipment of any kind shall be operated on or transported over any pavement surface when such equipment causes spalling at joints or edges or damages in any way any type of surface, either finished or unfinished. All injuries or damages to any portion of the work occasioned by any of the above causes shall be rebuilt or repaired with no additional payment, before its completion and acceptance, except as provided herein.

501.12 Test Specimens. The concrete necessary for testing test beams shall be furnished. Materials and necessary labor to assist the Engineer in curing the beams in accordance with 501.03(a), shall also be furnished.

501.13 Strike-off of Concrete and Placement of Reinforcement. When reinforced concrete is placed in one layer, the reinforcement may be positioned in advance of concrete placement or it may be placed in plastic concrete, after spreading, by an approved mechanical or vibratory means.

When mesh is used, it shall be delivered to the work in flat sheets and so maintained until used. When placed in the concrete it shall be free from dirt, harmful rust, scale, paint, grease, oil, or any other material which would prevent bond. Loss of section by rust will not be cause for rejection unless the minimum dimensions of the unrusted base metal are less than those permitted by ASTM A 185 and A 82.

Mesh shall be held in its required final position by metal chairs or other approved devices, or by striking off the concrete to the required elevation of the mesh by an approved mechanical strike off, or as otherwise approved.

If the Contractor elects to strike off the concrete to the required elevation of the mesh and place it thereon, dirt or any other foreign substance shall be prevented from coming in contact with the concrete surface prior to and while placing the mesh. After the initial strike off, the mesh shall be placed immediately and the remaining required concrete spread as quickly as possible within a maximum time of 30 min so that a truly monolithic slab is obtained. In all operations, care shall be taken to avoid displacing the mesh.

Reinforcement, when required for pavement at locations such as approaches to structures, over backfills, and at any other designated locations, shall consist of deformed steel bars of the size and at the spacing shown on the plans. The bars shall be rigidly wired or securely fastened at sufficient intervals to hold the steel in place and shall be supported in the required position by chairs or other suitable devices, all as approved. The amount of reinforcement may be increased over that shown on the plans if so directed.

501.14 Joints. Joints shall be constructed in accordance with the type and dimensions and at the locations required by the plans or as directed.

(a) General Requirements. All joints shall be in accordance with the details and positions shown on the plans unless different locations are designated. All joints shall be perpendicular to the subgrade. Unless otherwise indicated on the plans, longitudinal joints shall be at the center line, or parallel thereto. Transverse joints shall be at right angles to the center line and for the full width of the pavement.

All joints shall be opened to their entire depth and sealed with joint sealer in accordance with 501.19. All sawed joints shall be created by means of approved concrete saws.

When deformed steel tie-bars are required, bars of specified length, size, spacing, and material shall be placed in accordance with the plans.

(b) Sawed Longitudinal Joints. Sawed longitudinal joints shall be constructed in all cement concrete pavements more than 4.9 mm (16 ft) in width. Joints shall be sawed when two or more adjacent lanes or adjacent lane and shoulder are placed monolithic.

Tie-bars shall be placed by approved mechanical equipment, or rigidly secured by chairs or other approved supports to prevent displacement.

Longitudinal sawed joints shall be cut to the depth, width, and line shown on the plans. Suitable guide lines or devices shall be used to assure cutting the longitudinal joints on the true lines as shown on the plans. The longitudinal joints shall be sawed concurrently with the contraction joints in accordance with 501.14(d) and before any equipment or vehicles are allowed on the pavement. Joint sealing shall be in accordance with 501.19.

When adjacent lanes are constructed separately, longitudinal sawed construction joints shall be constructed. Tie-bars for slip-form methods shall be deformed bars bent and placed as shown on the plans as the first lane is constructed. Tie-bars spacing shall be adjusted to not interfere with the transverse joints, but tie-bars shall not be omitted. Bent deformed bars shall be straightened before the adjacent lane is placed. If more than one of the deformed bars break per panel during straightening, or if any bent deformed bars break in adjacent panels during straightening, all broken bars shall be replaced with retrofitted tie-bars as shown on the plans. An excessive number of bent deformed bar breaks will be investigated by the Engineer.

Random cracking outside of the sawed longitudinal joint shall be satisfactorily corrected and load transfer shall be reestablished, or the pavement shall be removed and replaced, as applicable. If differential movement has occurred across the random crack, pavement replacement will be the only permitted means of correction.

(c) Expansion Joints. Expansion joints of the types specified shall be constructed at the locations shown on the plans.

The expansion joint filler shall extend from form to form, and be shaped to the subgrade. The upper edges of all preformed expansion material used in joints shall be parallel to the surface. Damaged or repaired joint filler shall not be used.

The expansion joint filler shall be held in a position which is normal to the surface. An approved device, or support system shall be used if required to secure expansion joint filler at the proper grade and alignment during placing and finishing of the concrete. Finished joints shall deviate no more than 6 mm (1/4 in.) in the horizontal alignment from a straight line. If expansion joint fillers are assembled in sections, there shall be no offsets between adjacent sections. No plugs of concrete will be permitted within the expansion space.

(d) Sawed Contraction Joints. Unless otherwise approved, contraction joints shall be created by sawing grooves in the surface of the pavement. The joints shall be of the dimensions shown on the plans. The sawed contraction joint spacing shall be as shown on the plans or as directed, but shall not exceed 5.5 m (18 ft) for new concrete pavement sections greater than 300 m (990 ft), nor shall the joint spacing exceed 4.5 m (15 ft) for new concrete pavement sections 300 m (990 ft) or less.

Sawed contraction joints shall be cut in two operations. An initial saw cut shall be made as shown on the plans and as described herein except the depth of the initial transverse saw cut shall be D/3 for new concrete pavement sections 300 m (990 ft) or less. The initial saw cut shall commence as soon as the concrete has hardened sufficiently to permit sawing without raveling, usually 2 to 12 h after placement. All joints shall be saw cut before uncontrolled shrinkage cracking takes place. If necessary, the sawing operations shall be carried on during day and night, regardless of weather conditions. The sawing of a joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. In general, all joints shall be sawed in sequence. All contraction joints in lanes adjacent to previously constructed lanes shall be sawed before uncontrolled cracking occurs. If conditions exist which make it impractical to prevent erratic cracking by early sawing, formed groove type contraction joints shall be used.

Formed joint grooves shall be made by inserting satisfactory devices for the full depth and width of the groove, as shown on the plans, in the plastic concrete after the last pass with the finishing machine. These devices shall be well oiled so that they can be easily removed as soon as the concrete is firm enough.

Before the joint is sealed, construction traffic required to place adjacent concrete travel lanes or shoulders will be permitted on the pavement after the first saw cut, but before the second saw cut, subject to the requirements of 501.21.

After the concrete has sufficiently cured, but before opening the pavement to public traffic, a second saw cut shall be made, continuous across the entire concrete paved width. Such cut shall contain the first saw cut within the width of the second saw cut. Immediately after the second saw cut is made to the dimensions shown on the plans, the sawed groove shall be sufficiently cleaned to remove all slurry and foreign matter from the entire depth of cut in accordance with the sealant manufacturer's recommendations. Installation of joint sealing material shall be in accordance with 501.19.

Random cracking outside the limits of load transfer bars shall be satisfactorily corrected by reestablishing the load transfer with approved mechanical devices across the crack or by pavement replacement. Random cracks within 0.9 m (3 ft) of a transverse joint shall only be corrected by pavement replacement. Any damaged pavement including, but not limited to, differential pavement elevations at a random crack shall only be corrected by pavement replacement.

Pavement replacement shall be made in full lane width from the random crack or damaged area to the nearest transverse joint, but not less than 1.8 m (6 ft) in length. The replacement pavement shall be connected to the end opposite the transverse joint using retrofitted tie-bars in accordance with the plans. All damaged pavement shall be removed and replaced.

(e) Transverse Sawed Construction Joints. Transverse construction joints shall be constructed when there is an interruption of more than 30 min in the concreting operations. No transverse construction joint shall be constructed within 3 m (10 ft) of an expansion joint, contraction joint, or plane of weakness. If sufficient concrete has not been mixed at the time of the interruption to form a slab at least 3 m (10 ft) long, the excess concrete shall be removed back to the last preceding joint and disposed of as directed.

Tie-bars for transverse construction joints may be placed in the plastic or hardened concrete. When placing tie-bars in plastic concrete, a header board, made of one or two pieces, with openings for the tie-bars, shall be used. The header board shall be rigid and accurately set to grade. When placed in hardened concrete, the tie-bars shall be retrofitted in accordance with 501.14(g).

(f) Dowel Bars and Assemblies. Dowel bars for contraction joints shall be of the specific length, size, spacing, and material shown on the plans. Immediately prior to placing the concrete, the dowel bars shall be coated with an approved material to break the bond.

The dowel bar assemblies shall be in accordance with the requirements as follows:

1. The dowel bars shall be supported by an approved welded assembly which shall hold them sufficiently rigid so that each individual bar is not moved from its planned alignment during placement of the concrete pavement. If movement does occur, the maximum angle of deviation from the planned position shall not be more than 1 in 48 units.

2. The assembly shall have two continuous parallel spacer bars and two continuous parallel bearing members of no less than 7 mm (size W 7.5) wire which is approximately No. 0 gage. One spacer bar shall be located at or near each end of the dowel. Alternate ends of dowels shall be welded to a spacer bar so that the dowels remain parallel to each other and permit sliding movement in the joint. The free ends of each dowel shall be retained securely in place by means of wire loops.

3. Suitable struts or ties shall be provided to hold the assembly in correct position during installation.

4. The assembly shall have an upright support welded to the spacer bar and a continuous bearing member at the end of each dowel.

5. If the upright support consists of a single vertical wire, the support shall be no less than 7 mm (size W 7.5) wire. Otherwise, the support shall be no less than 6 mm (1/4 in.) in diameter.

6. Sand plates, if required, shall be made from no less than 0.9 mm (No. 20 gage) sheet steel. Each plate shall have no less than 10,300 mm^2 (16 sq in.) of bearing area. The plates shall be furnished in sufficient number to provide uniform support for the complete assembly. They may be furnished separate from the assembly units, or attached thereto by welding, using suitable clips, or other approved means.

7. The welds of the assembly shall be made with good workmanship and shall be sound. A broken weld will be cause for rejection of the length of section of the assembly where it occurs.

8. When the dowel bar assembly is in place, it shall act as a rigid unit with each component part securely held in position relative to the other member of the assembly. The entire assembly shall be held securely in place during placing, consolidating, and finishing the concrete by means of metal pins. Pins used on granular subbase shall penetrate at least 300 mm (12 in.) below the dowel bar assembly. Pins shall not be less than 7 mm (size W 7.5) wire and shall be provided with a hook or arm welded to the pin so that it shall secure the assembly in place. At least eight pins shall be used for each 3.0, 3.4, or 3.7 m (10, 11, or 12 ft) section of assembly. At least 10 pins shall be used for assembly sections greater than 3.6 m (12 ft) and less than or equal to 4.9 mm (16 ft). Sand plates, if required, shall be punched to receive the pins.

9. After the dowel bar assembly is securely in place, all tie wires which parallel the dowel bars, and are welded to the two continuous parallel spacer bars, shall be cut near the center of the tie.

10. The wire for the welded assembly shall be in accordance with all applicable requirements of ASTM A 82.

11. The dowel bars shall be epoxy coated and shall be in accordance with 910.01. Dowel bars shall be placed 150 mm (6 in.) from the edges of the pavement. Dowel bars shall be spaced at 0.3 m (1 ft) on center across the joint. The dowels shall be 460 mm (18 in.) in length. The diameter shall be as follows:

PAVEMENT THICKNESS	DOWEL BAR DIAMETER
Less than 230 mm (9 in.)	25 mm (1 in.)

230 through 305 mm (9 through 12 in.)	32 mm (1 1/4 in.)
Greater than 305 mm (12 in.)	38 mm (1 1/2 in.)

(g) Retrofitted Tie-Bars for Pavement Joints. Retrofitted tie-bars shall be of the size and length as shown on the plans. Such tie-bars shall be secured in place with an approved chemical anchoring system. Holes for the retrofitted tie-bars shall be of at least the depth indicated; of a diameter to accommodate the chemical anchoring system; and at right angles to the pavement. The chemical anchoring system shall be one from the Department's list of approved materials.

(h) Terminal Joints. Terminal joints shall be constructed as shown on the plans. They shall consist of the sleeper slab, the polyethylene bond breaker, and the HMA mixtures. The polyethylene bond breaker shall be approved polyethylene sheeting having a thickness of no less than 0.15 mm (6 mils). The HMA materials shall be in accordance with 402 for HMA Surface 9.5 mm on HMA Intermediate 19.0 mm mixture. Mixture adjustments in accordance with 904.02(a) will not apply. Aggregate requirements of 904.02(d) will not apply. The portion of the sleeper slab on which the polyethylene bond breaker is to be placed shall be finished with a metal finishing tool. When the pavement ends at locations where a terminal joint is not required, additional reinforcement shall be placed as shown on the plans for a transverse construction joint.

501.15 Final Strike-Off, Consolidation, and Finishing.

(a) Consolidation and Strike-Off. The mainline pavement and interchange ramp pavement shall be constructed using one or more finishing machines in accordance with 501.04(c)1. The machine equipment shall be of approved type, designed and operated to strike-off, consolidate, and finish. The concrete, as soon as placed, shall be struck-off accurately and screeded with approved equipment so that, when consolidated and finished, the surface of the pavement has the required elevation and cross section. A sufficient and uniform amount of concrete to ensure filling all voids and depressions shall be carried in front of the screed at all times.

If the rate of placement exceeds the capacity of a single machine, additional machines shall be used.

The operations shall be so controlled that an excess of mortar and water is not worked to the top. Segregated particles of coarse aggregate which may have collected in front of the screed shall be thoroughly mixed by hand with the unfinished concrete already on the subgrade. Under no circumstances shall aggregate particles be carried forward by the finishing machine and pushed onto the subgrade in front of the mass.

The finishing machine shall be operated so as to prevent injury to transverse joint material. The front screed shall be stopped when it is approximately 150 mm (6 in.) from the joint. Excess concrete and coarse aggregate particles ahead of the screed and over the

joint shall be removed. The front screed shall then be lifted, brought directly over the joint, set down, and the screeding operations continued. Just before the second screed is near enough to the joint so that mortar carried ahead of it would flow onto the joint, the screed shall be lifted over the joint.

Hand methods of placing, compacting, and finishing shall not be used except as follows:

1. when a breakdown of the finishing machine or other emergency occurs and then only for the concrete already mixed or in the process of mixing;

2. on widened portions at bridges, intersections, and portions widened beyond traffic lanes;

3. on widened portions of curves as provided elsewhere in this specification;

4. where the continuous concrete pavement sections are less than 180 m (600 ft); or

5. at other places permitted by the Engineer or these specifications.

Where hand methods are used, the concrete shall be tamped to ensure maximum compaction and minimum voids. It shall be leveled slightly above the required finished surface. It shall be struck-off to the true surface with a strike board to which is rigidly attached a mechanical vibrator capable of imparting impulses at a rate of no less than 3500 per min. The strike board shall be moved forward with a combined longitudinal and transverse motion and with both ends resting on the forms. The entire area shall be gone over a sufficient number of times, but no less than two, at such intervals that produces the desired results. A slight excess of concrete shall be carried ahead of the cutting edge.

(b) Floating. After the concrete has been struck-off and consolidated, it shall be further smoothed and trued by means of a longitudinal float or an approved transverse smoothing float.

Hand methods may be used only if specifically permitted. The hand float shall be no less than 4.2 m (14 ft) long and 150 mm (6 in.) wide, properly stiffened to prevent warping and flexibility, and reasonably light to prevent its working into the surface. The use of a distorted float will not be permitted.

Floating shall be in an approximately longitudinal direction from one edge to the other. The float shall be worked along the surface with a sawing motion to each edge and with the forward operator slightly ahead. After each complete transverse operation there shall be a 1/2 lap longitudinally. The operators handling the float shall be supported by bridges which entirely clear the surface.

The transverse smoothing float shall be a machine with a smoothing float suspended from and guided by a rigid frame. The frame shall be carried by the forms and have a minimum effective wheel base of 4.2 m (14 ft). The length of the float shall be approximately 50 mm (2 in.) less than the normal width of the pavement and be adjusted to the required crown. The height of the float shall be adjusted and coordinated with the finishing screed ahead so that a small amount of mortar is carried ahead of the float at all times. The forward speed of the float shall be adjusted so as to keep starting and stopping at a minimum.

If necessary, following one of the preceding methods of floating, long handled floats having blades no less than 1.5 m (5 ft) in length and 150 mm (6 in.) in width may be used to smooth and fill in open textured areas in the pavement. Long handled floats shall not be used to float the entire surface of the mainline pavement in lieu of or supplementing one of the preceding methods of floating. On any pavement other than mainline pavement, floating may be done with a long handled 3 m (10 ft) long by 100 to 150 mm (4 to 6 in.) wide float.

(c) Checking and Surface Correction. As soon as the longitudinal or final floating is complete, all laitance, surplus water, and inert material shall be worked off the surface and the surface made smooth by a scraping or dragging motion with a long handled 3 m (10 ft) straightedge. This straightedge shall be placed at the center of the pavement with the blade parallel to the centerline and pulled slowly and uniformly to the edge. The blade shall then be moved forward 1/2 its length and the operations repeated until the surface is free from irregularities and makes contact with the blades at all points.

During this checking operation any remaining depressions shall be filled with fresh concrete and struck-off. Projections shall be removed and the checking and correcting continued until the surface has the required smoothness and contour. Care shall be taken to preserve the required crown.

(d) Final Finishing. After the surface has been prepared as described above, the final finish shall be by tining, in accordance with Method 2, unless otherwise specified or directed.

1. Method 1-Brooming. The broom shall be drawn from the center to the edge of the pavement with adjacent strokes overlapping slightly. The brooming operation shall be executed so that the corrugations produced in the surface shall be uniform in appearance and be no less than 1 mm (1/16 in.) nor more than 3 mm (1/8 in.) in depth. Brooming shall be completed before the concrete is in such condition that the surface is torn or unduly roughened by the operation. The surface thus finished shall be free from rough and porous areas, irregularities, and depressions resulting from improper handling of the broom. Brooms shall be of the quality, size, construction, and be operated so as to produce a surface finish meeting approval. Substitution of mechanical brooming in lieu of the manual brooming as herein described, will be permitted subject to satisfactory results being obtained and approved.

Brooms shall be kept clean. Those which have become worn or are otherwise unsatisfactory for acceptable work shall be discarded.

2. Method 2-Tining. The final finish for the cement concrete pavement and concrete shoulder shall be a transverse grooved finish which is accomplished by mechanized equipment using a comb made with steel tines, or other approved device. The grooves shall be formed in the plastic concrete at an appropriate time during the stiffening of the concrete, so that in the hardened concrete, the grooves are between 2.3 and 3.3 mm (0.09 and 0.13 in.) in width, between 3 and 4.8 mm (0.12 and 0.19 in.) in depth, and be spaced as follows: 22 mm, 13 mm, 25 mm, 16 mm, 19 mm, 28 mm, 13 mm, 16 mm, (7/8 in., 1/2 in., 1 in., 5/8 in., 3/4 in., 1 1/8 in., 1/2 in., 5/8 in.), and then repeat, or other measurements as otherwise approved. The grooves shall be formed without tearing the surface, and without bringing pieces of the coarse aggregate to the top of the surface.

An initial surface texture shall be provided by means of a turf drag for expressway type facilities. For other types of facilities, an initial surface texture shall be provided by means of a double thickness burlap drag or other approved drag, positioned behind the final straight-edging operation and ahead of the steel tining operation.

Texturing and curing operations may be performed by a single machine subject to satisfactory performance. If it is determined that satisfactory performance is not achieved, texturing and curing operations shall be performed by separate machines.

Manual tools such as fluted floats or rakes with spring steel tines or finned floats with a single row of fins may be used for forming the transverse grooves in areas where the mechanized grooving equipment cannot be utilized. Careful attention shall be given to the manual workmanship in order to achieve grooves which conform to the same requirements as those specified for the grooves formed by the mechanized equipment.

Areas of the hardened grooved pavement which are not in accordance with these requirements, either because of a deficiency in the grooving or because of a rough or open texture of the surface, shall be corrected by the use of an approved mechanical grinder or the cutting of acceptable grooves in the hardened pavement with an approved cutting machine in accordance with 501.16.

(e) Edging at Forms and Joints. Before the concrete has taken its initial set, the edges of the pavement along each side of each slab, on each side of transverse expansion and contraction joints, and on each side of formed joints shall be worked with an approved tool and rounded to the radius required by the plans. A well defined and continuous radius shall be produced, and a smooth dense mortar finish obtained. The surface of the slab shall not be unduly disturbed by tilting the tool during use.

Tool marks appearing on the slab adjacent to joints shall be eliminated by brooming the surface. In doing this, the rounding of the corner of the slab shall not be disturbed. Concrete on top of the joint filler shall be removed completely.

All joints shall be checked with a straightedge before the concrete has set and correction made if one side of the joint is higher than the other or if they are higher or lower than the adjacent slabs.

501.16 Pavement Smoothness. As soon as the concrete has cured sufficiently to permit testing, but not later than noon the day following its placement, the profile of the surface shall be checked. This requirement shall continue each day until it is determined by the test results that the operation is consistently providing pavement meeting these specifications without corrective action. The profile testing may at the request of the Contractor then be delayed until the completion of the paving operation except this testing shall be done before suspending operations for winter. Profile testing should be completed prior to opening the pavement to traffic. The Department reserves the right to direct that the pavement profile be tested the morning following its placement.

The profile shall be checked 1 m (3 ft) from and parallel to the outside of each lane not exceeding 3.7 m (12 ft) wide. Lanes wider than 3.7 m (12 ft) shall be checked 1 m (3 ft) from and parallel to both edges and the profile index shall be the average of the two profiles. Any curing agent removed during the straightedge operation shall be replaced immediately. The pavement smoothness shall be tested by means of a Department approved profilograph, a 4.88 m (16 ft) long straightedge, or a 3.05 m (10 ft) long straightedge. The contour shall be checked both transversely and longitudinally. Profile variations which need to be corrected to comply with these smoothness specifications shall be corrected by grinding with a groove type cutter. This grinding shall not be done until the pavement is 14 days old or until the test beams indicate a modulus of rupture of at least 3800 kPa (550 psi). The grinding of the pavement to correct the profile shall be accomplished in either the longitudinal or the transverse direction. The machine used to remove the bumps shall be capable of producing a uniform texture on the pavement surface. If the grinding operations removes the existing transverse tining, or reduces the tining grooves to a depth of 1.5 mm (1/16 in.) or less, then the surface shall be retextured if the longitudinal length of the removal area exceeds 4.6 m (15 ft) or where two or more bumps within 9.0 m (30 ft) of each other have been removed.

Retexturing shall consist of cutting grooves in the pavement surface either longitudinally or transversely by means of saw blades or other approved devices. The grooves shall be 3.0 mm (1/8 in.) in width and depth. The grooves shall be spaced at 19 mm (3/4 in.) center to center. This pattern may be varied subject to approval. The pavement surface after cutting shall not be smooth or polished. The skid resistance shall not be lessened. Tearing or dislodging of aggregates will not be permitted.

If a pay item, profilograph, is included in the contract, a Department approved profilograph shall be furnished, calibrated, and operated to record the surface profile of the finished pavement. The calibration and the operation of such machine shall be as directed and shall be in accordance with ITM 901. Annual certification of such machines shall be required and will be conducted by the Materials and Tests Division between March 1, and May 1. The profilogram produced shall become the property of the

Department. The profilograph shall remain the property of the Contractor. When this item is not set out as a bid item, the testing machine will be furnished, calibrated, and operated by the Department.

The profilograph shall be used on all mainline full width pavement lanes of 76 m (250 ft) or longer, including climbing lanes and as otherwise specified. The profilograph shall not be used on mainline full width pavement lanes of 76 m (250 ft) or longer in areas having a design speed of 70 km/h (45 mph) or less, unless otherwise specified. The profilograph shall not be used within 15 m (50 ft) of bridge ends or existing pavement which is being joined. The 4.88 m (16 ft) long straightedge shall be used on mainline full width pavement lanes of 76 m (250 ft) or longer in areas having a design speed of 70 km/h (45 mph) or less, unless otherwise specified. The 4.88 m (16 ft) long straightedge shall also be used for profiling within 15 m (50 ft) of bridge ends or an existing pavement which is being joined, pavement lanes up to 76 m (250 ft) long, turn lanes, ramps, tapers, frontage roads, access roads and as otherwise specified. The 3.05 m (10 ft) long straightedge shall be used for profiling transverse slopes, approaches, crossovers, and as otherwise specified.

SURFACE TOLERANCES TABLE

Testing Method	Specified Tolerance
Profilograph Design speeds greater 70 km/h (45 mph) Design speeds 70 km/h or less (45 mph)	 30 mm/0.16 km profile index or less (1.2"/0.1 mi.) 40 mm/0.16 km profile index or less (1.6"/0.1 mi.)
4.88 m Straightedge (16 ft) All pavements	 6 mm (1/4") or less
3.05 m Straightedge (10 ft) All pavements	 3 mm (1/8") or less

Finishing equipment that produces a profile within the specified tolerances shall be used. If testing indicates that these tolerances are not being met, the paving operation shall be discontinued when directed until other methods and equipment are approved.

When the profilograph is being used, in addition to the requirements for the profile index, any area having a high point deviation in excess of 7.6 mm (0.3 in.) shall be removed. Verifying profilograph measurements will be taken only in the 0.16 km (0.1 mi.) lengths where grinding has been performed to reduce the profile index.

501.17 Curing. Immediately after the finishing operations have been completed, and as soon as marring of the concrete is not likely to occur, the entire surface of the newly placed concrete shall be covered and cured using one of the below mentioned methods. When curing requires the use of water, the curing shall have prior right to all water supply or supplies. Failure to provide sufficient cover material of whatever kind the

Contractor may elect to use or lack of water to take care adequately of both curing and other requirements shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 1/2 h between stages of curing or during the curing period.

As soon as the forms are removed, the edges of the pavement shall be banked with earth at least 300 mm (12 in.) wide, or the edge shall be covered with a curing material equal to the material used on the surface. After rains, sprinkling shall be started in time to wet the entire area being cured before the curing agents requiring water become too dry. When any of the curing methods are started, such curing shall be continuous for 96 h, unless a longer period is ordered.

If straw, double burlap, or ponding is used for curing, all finished pavement shall be protected from rapid drying with wet burlap laid directly on the surface. This shall be done as soon as the concrete has hardened sufficiently not to be injured regardless of the time of day laid. This burlap shall be kept wet until further curing methods are started. If necessary, a fine spray of water shall be used.

Whenever there is danger of freezing, sufficient straw or other suitable material shall be added to the cure covering agents to prevent the concrete from freezing. Any concrete injured by frost action shall be removed and replaced with no additional payment.

(a) Double Burlap. Where this method is used, the initial burlap shall receive an additional covering of wet burlap not later than 9:00 a.m. the day following its placement. The burlap used in this second layer shall meet the quality and dimension requirements of that used in the initial layer and shall completely cover it. The two layers shall be kept wet for the required curing period, after which all burlap may be removed.

(b) Straw. Where this method is used, the initial burlap shall be removed by 9:00 a.m. the day following its placement and the surface immediately covered with straw, no less than 75 mm (3 in.) thick. The straw shall be thoroughly saturated immediately after being placed, and kept wet for the required curing period.

After removal, the straw shall be properly disposed of but under no condition shall it be burned on the pavement or in close proximity to its edges. If the contract requires mulching, removed curing straw may be used for that purpose.

(c) Waterproof Blankets. Where this method is used, as soon as the finished concrete has hardened sufficiently not to be injured, the surface shall, until blankets are applied, be kept wet by a fogged spray of water or by wet burlap as set out above. By 9:00 a.m. of the day following its placement the concrete surface shall be covered. If coated burlap is used, the burlap side of the blanket shall be wet or the surface of the concrete thoroughly wetted just prior to placing these blankets.

The blankets shall be unrolled from poles or timbers in such manner that the surface of the concrete is not marred. After being unrolled, the blankets shall be weighted

down by placing a row of earth on each edge. Adjoining blankets shall overlap at least 300 mm (12 in.) and the laps held securely in place by means of continuous ridges of earth or other approved means.

The blanket shall be wide enough to cover completely the full width of the pavement being cured. Any torn places or holes in any blanket shall immediately be repaired by patches over the openings, using bituminous cement having a melting point of not less than 82°C (180°F). Blankets may be reused provided they are airtight and kept serviceable by proper repairs. Any units which do not comply with these requirements shall be discarded.

When blankets are no longer serviceable as a single unit, some may serve for further application, provided two blankets are used as a single unit. The double unit may be rejected if it no longer provides an air-tight cover.

The blankets shall remain in place for the required curing period after which they may be removed.

(d) Ponding. Where this method is used, the initial burlap shall be removed by 9:00 a.m. the day following its placement. The surface to be cured shall be covered immediately with a minimum depth of 50 mm (2 in.) of water and so maintained for the required curing period. This method shall not be used if there is a danger of freezing.

(e) White Membrane. Where this method is used, after the concrete has been finished, and immediately after the surface water has disappeared, the entire surface of the concrete pavement shall be cured by mechanically applying thereon a uniform coating of the curing compound. If conditions arise which prevent immediate application, the surface shall be kept wet with a fine spray of water during checking of the surface, sawing of joints if required, and until the application of the compound is started. Joints shall be protected by an approved method so that the compound will not enter the joint.

The compound shall be type 2, in accordance with AASHTO M 148 for white pigmented compound. It shall be applied in 1 or 2 applications as directed. When applied in two applications, the second shall follow the first within 30 min.

The compound shall be applied in a continuous uniform film by means of a power operated pressure spraying or distributing device at the approved rate, but no less than 1 L per 3.7 m^2 (1 gal. per 150 sq ft) of surface. The equipment for applying the compound shall provide for adequate agitation of the compound during application and shall be approved before work is started. If the compound is too thick for satisfactory application during cold weather, the material may be warmed in a water bath at a temperature not over 38°C (100°F). Thinning with solvents will not be permitted. Should the method of applying the compound produce a non-uniform film, its use shall be discontinued and the curing done by another method that is approved.

If rain should fall on the newly coated pavement before the film has dried sufficiently to resist damage, or if the film is damaged in any other way, a new coat of material shall be applied to the affected areas equal in curing rate to that specified for the original coat. The treated surface shall be protected from injury until the expiration of the curing period. All vehicles and pedestrian traffic will be considered injurious to the film of the applied compound and will be prohibited. However, a minimum of walking may be permitted on the dried film as necessary to carry on the work properly, provided any damage to the film is immediately repaired by the application of a second coat of the compound. If there should be a breakdown of the spraying equipment, protection of the uncoated pavement shall be provided.

(f) Curing in Cities and Towns. Curing may be done in cities and towns by any one of the above methods. However, straw curing shall not be used unless written permission is obtained.

501.18 Removing Forms. Except for auxiliary forms used temporarily in widened areas, forms shall not be removed from freshly placed concrete until it has set at least 8 h. Forms at the ends of contraction joints to be sawed may be removed as soon as joints can be sawed without raveling. Form pullers which depend on the new pavement for support shall not be used at any time. After the forms have been removed, the sides of the slab shall be cured in accordance with one of the methods indicated in 501.17.

501.19 Sealing Cracks and Joints. Prior to discontinuing work for the winter, or before a section is opened to traffic, construction vehicles, or equipment, or is finally accepted, all cracks and joints shall be sealed, except as permitted or specified in 501.14(d).

The cracks and joints shall be thoroughly cleaned in accordance with the sealant manufacturer's recommendations by means of water blasting, sand blasting, or mechanical wire brushing. Multiple passes may be required to remove all fine aggregates from joint faces. Equipment used in the water blasting operation shall be operated at 10300 kPa (1,500 lb/sq in.) or more. Water shall not be applied under pressure which may damage the concrete. The sand blasting operation will not have a specified pressure, however, several passes may be required to properly clean the adjacent concrete surfaces.

Prior to application of the sealant, the joint shall be blown with a jet of compressed air. The air pressure used in driving off the water and cutting residue shall be at least 550 kPa (80 lb/sq in.). The joint faces shall be clean and dry, and in accordance with the sealant manufacturer's recommendations, when placing the sealant.

If a liquid sealant is being used, filling shall be repeated as many times as necessary to obtain the required fullness. If preformed elastomeric joint seals are used, they shall be installed in one continuous piece by means of an approved machine. The seal shall not be stretched more than 5% while being placed. The installed seal shall show no twisting, rollover, folding, cutting, nor excess lubricant-adhesive on the top of the seal. For phased construction, elastomeric joint seal may be installed in two separate pieces

with the splice point occurring at the highest point of the joint. The splicing method used shall be in accordance with the seal manufacturer's recommendations.

501.20 Inspection for Pavement Cracking. The Contractor and Engineer will conduct an inspection of the new concrete pavement for random cracking. The inspection will be conducted after the pavement is placed and just prior to opening it to traffic or construction vehicles and equipment, except joint cutting saws. All random, full-depth cracking of the new pavement shall be satisfactorily corrected in accordance with 501.14. The cracking correction plan shall be submitted in writing and shall be subject to approval.

501.21 Protection of Pavement. The pavement and its appurtenances shall be protected against damage caused by public traffic, work equipment, employees, and agents. This protection shall include watchers to direct traffic and the erection and maintenance of warning signs, lights, pavement bridges, or crossovers, etc. The plans or specifications will indicate, in general, the location and type of device or facility required to protect the work and provide adequately for traffic. Further protection may be ordered. Construction vehicles or equipment, except joint cutting saws, having a gross weight exceeding 2.7 Mg (3 tons) will not be permitted on new pavement for 10 days after it is placed or until the test beams indicate a modulus of rupture of at least 3800 kPa (550 psi). All damage to the pavement occurring prior to final acceptance shall be repaired or the pavement shall be replaced.

501.22 Opening to Traffic. Pavement shall be closed to traffic for 14 days after it is placed or until the test beams indicate a modulus of rupture of at least 3800 kPa (550 psi). The beams shall be tested as simple beams with third point loading in accordance with AASHTO T 97 as modified in 501.03(a). When air entraining portland pozzolan cement, type IP-A, or fly ash used as an additive is incorporated into concrete pavement, the concrete strength shall be used to determine when the pavement can be opened to traffic, and the aforementioned opening to traffic 14 days after placement shall not apply to such concrete pavement.

Prior to opening to traffic, joints shall be sealed in accordance with 501.19 and the pavement shall be cleaned.

501.23 Concrete Pavement, Slip-Form Method.

(a) General Requirements. Except as modified or changed herein, all pertinent and applicable provisions of 501 shall apply to placing cement concrete pavement with a slip-form paver in lieu of stationary forms and other placing and finishing devices required in 501.13. Where a slipform paver is used, all references to forms in the preceding parts of this specification shall be considered nonapplicable and procedures shall be adopted as shall result in a satisfactory end product. No wheeled equipment that disturbs the track lane for other equipment or does not perform satisfactorily otherwise will be allowed in the paving train.

(b) Grade. After the subbase has been placed and compacted to the required density to a width beyond the pavement limits sufficient to support all paving equipment, the area which can support the paving machine shall be brought to the proper grade by an approved grader. The area on which the pavement is to be placed shall then be graded by an approved subgrader. If the density of the subbase is disturbed by the subgrading operations, it shall be restored to the required density by additional compaction before concrete is placed. The completed grade shall be in accordance with all applicable provisions of 207.05. No vehicular traffic or mixing equipment will be permitted on the completed grade.

(c) Placing Concrete. Concrete shall be in accordance with 501.03 for proportion and consistency. The concrete shall be placed with an approved slip-form paver designed to spread, consolidate, screed, and floatfinish the freshly placed concrete in one complete pass of the machine in such manner that a minimum of hand finishing is necessary to provide a dense and homogeneous pavement in accordance with the plans and specifications. The machine shall vibrate the concrete for the full width and depth of the strip of pavement being placed. Such vibration shall be accomplished with a vibrating screed or vibrating equipment in accordance with 501.04(c)2. The sliding forms shall be rigidly held together laterally to prevent spreading the forms. The forms shall trail behind the paver for such a distance that slumping of the concrete does not exceed 9 mm (3/8 in.) from a typical cross section. However, slump at longitudinal construction joints shall not exceed 6 mm (1/4 in.) from a typical cross section.

The slip-form paver shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering, and spreading concrete shall be coordinated so as to provide uniform progress with stopping and starting of the paver held to a minimum. If for any reason it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately. Except in emergency, no tractive force shall be applied to the machine except that which is controlled from the machine.

Such devices and procedures that ensure proper position of the mesh and produce a monolithic slab shall be employed. Other required steel, including tie-bars and dowels for joints, shall be placed under the same requirements.

Places inaccessible to slip-form paving equipment shall be paved in accordance with the applicable provisions of 501 including the provisions for stationary forms.

(d) Finishing. Surface smoothness, texture, and straightedge tolerances in accordance with 501.15 and 501.16 shall apply to that portion of the pavement bounded by lines 150 mm (6 in.) from the edge of the pavement.

(e) Curing. Unless otherwise specified, curing shall be done in accordance with one of the methods in 501.17. The curing media shall be applied at the appropriate time. It shall be applied uniformly and completely to all surfaces and edges of the pavement.

(f) Joints. Contraction and longitudinal joints shall be sawed to dimensions shown on the plans and in accordance with applicable provisions of 501.14. All cracks and joints shall be sealed in accordance with 501.19.

(g) Protection Against Rain. In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, the Contractor shall have available at all times, materials for the protection of the edges and surface of the unhardened concrete. For protection of the pavement edges, such material shall consist of standard metal forms, or wood plank which has a nominal thickness of no less than 50 mm (2 in.) and a nominal width of no less than the thickness of the pavement at its edge. Covering material such as burlap, cotton mats, curing paper, or plastic sheeting material shall be provided for the protection of the pavement surface. When rain appears imminent, paving operations shall stop. All available personnel shall be used to place forms against the sides of the pavement and to cover the surface of the plastic concrete with the protective covering.

501.24 Tolerance In Pavement Thickness.

(a) General Requirements. Pavement thickness locations shall be determined after corrective grinding by obtaining cores. The Contractor shall obtain these cores at the locations determined by the Engineer. Cores shall be taken for the full depth of the pavement thickness and shall be 125 mm (5 in.) in diameter. The coring operation will be witnessed by the Engineer who will identify, mark, and take immediate custody of the cores. Field measurements will be taken by the Engineer after cores are obtained. Cores which show abnormal defects or that have been damaged appreciably in the drilling operations, will not be accepted. Non-acceptable cores shall be replaced by drilling 450 mm (18 in.) in a transverse direction from the damaged core. At least one core shall be drilled from each traffic lane in the section. Coring will not be required for concrete pavement patching work. Excluded locations shall include bridge structures and within 0.6 m (2 ft) of the edge of pavement, over dowels, or within 1.5 m (5 ft) of the headers.

(b) Taking Cores. The pay items for concrete pavement or base will be defined as sections. A section will be divided into subsections of 1000 m^2 (1200 sq yd). Bridge approach slabs shall be cored in 1000 m^2 (1200 sq yd) subsections, regardless of the method of construction. The area remaining of the section after subtraction of all subsections shall not be cored unlesss otherwise directed. Widening of 1.0 m (3 ft) or less shall not be cored unless otherwise directed. If the total pavement area in a section is less than 1250 m^2 (1500 sq yd), cores will be required only if directed. At least one core shall be drilled at random locations from each subsection with not less than four cores per section, when cores are required.

If the core measurement reveals that the pavement is more than 13 mm (0.5 in.) deficient in thickness, additional cores shall be drilled at 6.0 m (20 ft) intervals on each side of the original core. These additional cores shall be on a line which passes through the original core and parallel to the centerline of the pavement. The drilling shall continue in both directions at 6.0 m (20 ft) intervals, distance permitting, until two successive cores indicate a thickness deficiency of 13 mm (0.5 in.) or less.

If a single core indicates a thickness deficiency of more than 25 mm (1.0 in.), or if two or more adjacent cores indicate a thickness deficiency of more than 13 mm (0.5 in.), then additional cores shall be taken. The additional cores shall be taken from the adjoining traffic lanes or shoulders at the same station at which the first core or cores indicated the deficiency, whether the lane was paved at the same time or not.

If a core indicates a thickness deficiency of more than 25 mm (1.0 in.) and two cores drilled adjacent at 6.0 m (20 ft) intervals indicate a thickness deficiency of not more than 25 mm (1.0 in.), then additional cores shall be drilled at 1.5 m (5 ft) intervals on each side of the initial core. The additional coring will be required to determine the limits of the deficiency. If the two adjacent cores indicate a thickness deficiency of more than 25 mm (1.0 in.), the pavement shall be removed in accordance with 501.24(e). If only one core indicates a thickness deficiency of more than 25 mm (1.0 in.), removal and replacement of pavement will not be required. The area for non-payment for deficient pavement thickness will be determined as shown in 501.26(c).

(c) Measuring the Cores. Each core, unless defective, will be measured for thickness by means of an approved apparatus furnished by the Department. Readings will be recorded to the nearest 2 mm (0.08 in.) and averaged to the nearest 2 mm (0.08 in.) for a final core thickness value.

(d) Determination of Average Thickness. The average thickness of the pavement of each subsection shall be the average of the lengths of all cores drilled from the subsection. However, no cores shall be included which have been drilled from portions to be replaced, nor from portions for which no payment will be made. In computing the average thickness of a subsection, each core, the length of which is in excess of the designated thickness by more than 13 mm (0.5 in.), shall be considered as the designated thickness plus 13 mm (0.5 in.). The average thickness of each section shall be determined by averaging the thickness of each subsection. Calculations shall be to the nearest 1 mm (0.04 in.).

(e) Pavement Removal and Replacement for Core Thickness Deficiency of Greater than 25 mm (1.0 in.). Where two or more adjacent cores indicate the pavement to be deficient in thickness by more than 25 mm (1.0 in.), such pavement shall be removed and replaced. Pavement that has been replaced shall be subsequently cored.

The longitudinal length of the pavement to be removed and replaced shall be from the location of the deficient cores that show a thickness deficiency of greater than 25 mm (1.0 in.) to a transverse line where the exposed cross section of the pavement is not more than 13 mm (0.5 in.) deficient at one point. If the limits of removal and replacement occur within 3.0 m (10 ft) of an existing transverse joint, the pavement shall be removed to that joint. The width of removal and replacement shall be the width of pavement lane in which the deficiency occurs.

(f) Reinforcing Steel Requirements for Reinforced Concrete Pavement. Pavement shall be constructed with the reinforcing steel as shown on the plans. The steel placement depth will be measured after corrective grinding.

(g) Measuring the Reinforcing Steel Placement in Concrete Pavement. The depth of reinforcing steel will be measured from the top of the core to the top of the longitudinal reinforcing steel. If reinforcing steel is not positioned within the specified limits, additional cores shall be drilled at 6.0 m (20 ft) intervals on each side of the original core. The 6.0 m (20 ft) intervals shall continue in both directions, distance permitting, until two successive cores indicate that the reinforcing steel is within the specified limits. The additional cores shall be parallel to the centerline of the pavement.

Additional cores shall also be taken in adjoining lanes or shoulders and at the same station of each deficiency.

(h) Removal Limits for Deficiency in Steel Placement. Pavement removal and replacement will be required if the reinforcing steel is located within 25 mm (1.0 in.) of the pavement surface. Removal limits shall be from the first of two adjacent cores that are measured within the specified limits on each end of the series. The removal width shall be the width of pavement as placed. Removal that falls within 3.0 m (10 ft) of a joint shall be removed to that joint. Pavement that has been replaced shall be re-cored to ensure proper placement of the reinforcing steel.

501.25 Method of Measurement. Portland cement concrete pavement will be measured by the square meter (square yard) of the type and thickness specified. The width for measurement will be the width of the pavement shown on the plans, additional widening where specified, or as otherwise directed in writing. The length will be measured parallel to the surface of the pavement along the centerline of each roadway or ramp.

Pavement of extra thickness constructed as approach slabs to structures or railroad crossings, or at other locations if so designated, will be measured and converted to the equivalent square meters (square yards) of the adjacent pay item thickness.

At a structure which has the top of the floor slab at the same grade as the adjacent finished pavement, the floor slab will not be measured as pavement.

The weight of reinforcing steel, except mesh, tie-bars, and dowel bars, will be the theoretical mass (weight) of the steel in kilograms (pounds), in place and accepted.

Contraction joints and terminal joints will be measured by the meter (linear foot). Retrofitted tie-bars will be measured by the number of units installed.

The pay length for terminal joints for concrete pavements will be the same as the approach width.

Drilling concrete cores shall include all incidentals necessary to complete the operation such as: drill, cores bits, maintenance of traffic, patching material, labor, etc. All cores holes shall be filled with portland cement concrete within 24 h of drilling. Coring shall be as required by the Engineer to satisfy the requirements of 501.24.

Pavement cores taken by the Contractor for determining pavement thickness or reinforcing steel location will not be measured for payment.

501.26 Basis of Payment. The accepted quantities of cement concrete pavement will be paid for at the contract unit price per square meter (square yard) for the type and thickness specified, complete in place.

Unless otherwise specified, contraction joints will be paid for at the contract unit price per meter (linear foot) for the type of joint specified.

Reinforcing steel in accordance with 501.13, for pavement will be paid for by the kilogram (pound), complete in place.

Payment will be made for each retrofitted tie-bar, shown on the plans, complete in place.

Pavement cores taken by the Contractor for determining pavement thickness or reinforcing steel location will be paid for at the contract lump sum price for coring concrete pavement.

Payment for furnishing, calibrating, and operating the profilograph, and furnishing profile information will be made at the contract lump sum price for profilograph. When the pavement smoothness is tested with the profilograph, the payment for pavement will be based on the profile index in accordance with the following table. The adjusted cost will be based on the total area of pavement represented by the profile index.

(a) Adjusted Payment for Deficient Pavement Thickness. If an average pavement thickness is less than the designated thickness by 13 mm (0.5 in.) or less, payment for that section will be adjusted. The adjusted pavement quantity will be determined from the formula as follows:

$$\frac{[MT]^2}{[ST]^2} \times [Q]$$

MT = The average thickness of the pavement section as determined from 501.24(d);

ST = The specified thickness of the pavement section; and

Q = The placed quantity of the pavement section.

(b) Reduced Payment for Deficient Reinforcing Steel Placement in Concrete Pavement. Adjustment will be made to the contract unit price for reinforced concrete pavement according to the following schedule. The limits shall be from the core on each side of the deficient core that either shows no deficiency or a different deduction level.

13 mm (0.5 in.) or less above or below tolerance .....Deduct 20%

More than 13 mm (0.5 in.) above or below tolerance .....Deduct 30%
but not within 25 mm (1 in.) of the pavement surface

PRICE ADJUSTMENT SCHEDULE

Design Speed Greater Than 70 km/h (45 mph)		Design Speed Less Than Or Equal To 70 km/h (45 mph)	
Final Profile Index mm/0.16 km (in./0.1 mile)	% of Contract Unit Price	Final Profile Index mm/0.16 km (in./0.1 mile)	% of Contract Unit Price
0 to 30 (0 to 1.2)	100.0	0 to 41 (0.0 to 1.6)	100.0
over 30 to 33 (1.2 to 1.3)	98.0	over 41 to 46 (1.6 to 1.8)	98.0
over 33 to 36 (1.3 to 1.4)	96.0	over 46 to 51 (1.8 to 2.0)	96.0
over 36 to 38 (1.4 to 1.5)	92.0	over 51 to 56 (2.0 to 2.2)	92.0
All pavement with a profile index greater than 38 (1.5) shall be corrected		All pavement with a profile index greater than 56 (2.2) shall be corrected	

Payment will be made under:

Metric Pay Item (English Pay Item	Metric Pay Unit Symbol English Pay Unit Symbol)
Pay Item	Metric Pay Unit Symbol (English Pay Unit Symbol)
Cement Concrete Pavement, Plain, _____ mm thickness	..... m2
(Cement Concrete Pavement, Plain, _____ in. thickness	..... SYS)
Cement Concrete Pavement, Reinforced, _____ mm thickness	..... m2
(Cement Concrete Pavement, Reinforced, _____ in. thickness	..... SYS)
Contraction Joint, _____ type	..... m (LFT)
Coring Concrete Pavement	..... LS
Profilograph	..... LS
Reinforcing Steel, Pavement	.....kg (LBS)

Retrofitted Tie-Bars..... EACH
Terminal Joint ..... m (LFT)

No additional payment over the contract unit price will be made for pavement which has an average thickness which is in excess of that shown on the plans. The costs of deficient pavement which has been directed to be removed, and pavement required to replace such deficient pavement shall be included in the cost of cement concrete pavement.

(c) Non-payment or Removal of Pavement for Core Thickness Deficiencies of more than 13 mm (0.5 in.) to 25 mm (1.0 in.) If two or more adjacent cores at intervals of 6.0 m (20 ft) indicate a pavement thickness deficiency of more than 13 mm (0.5 in.), payment will not be made for such pavement unless the deficient pavement is removed and replaced with pavement of the required thickness. The longitudinal limits for the deficient area will be measured from the first of two adjacent cores on each end of the series that indicate thickness deficiency of 13 mm (0.5 in.) or less. For pavement which is deficient in depth and is within 3.0 m (10 ft) of a pavement transverse joint, then the non-payment or replacement limits shall be to the transverse joint. The width of replacement shall be the width of the pavement lane in which the deficiency occurs.

The cost of all investigative cores for deficient pavement, or cores necessary to replace damaged cores shall be included in the cost of coring concrete pavement. If the final pavement quantity differs from the original quantity by more than 2000 m^2 (2400 sq yd) the contract lump sum price of coring concrete pavement will be adjusted. The adjustment, plus or minus, will be a fixed price of $100 per 1000 m^2 (1200 sq yd) subsection, and will be based on the original plan quantity rounded to the nearest full subsection.

The costs of furnishing and placing all materials, including steel mesh, tie-bars, and fillers for joints not included as a pay items shall be included in the cost of cement concrete pavement. Joints not included as pay items shall include, but shall not be limited to, longitudinal joints, construction joints, keyway joints, and expansion joints.

The costs of all dowels, holding devices, joint fillers, sealing materials, and all necessary incidentals shall be included in the cost of joints.

The costs of the sleeper slab with reinforcing steel as shown on the plans or as specified in 501.14(h), bond breaker, and HMA mixtures shall be included in the cost of terminal joint.

The costs of repeated use of the profilograph or the extent of profile information furnished shall be included in the cost of profilograph. The cost of necessary power cutting shall be included in the costs of the cement concrete pavement pay items.

The costs of retrofitted tie-bars used to replace deformed bars broken during straightening, correcting new pavement cracking, and removal and replacement of pavement damaged due to fault or negligence shall be included in the costs of the pay items.

SECTION 502 -- QUALITY ASSURANCE FOR PORTLAND CEMENT CONCRETE PAVEMENT

502.01 Description. This work shall consist of a pavement composed of portland cement concrete, with or without reinforcement as specified, constructed on a prepared subgrade or base course in accordance with these specifications and in reasonably close conformance with the lines, grades, thicknesses, and typical cross sections shown on the plans or as directed.

Mainline pavement, shoulder pavement which is 1.2 m (4 ft) or wider, and ramps shall be constructed in accordance with these specifications. Shoulder pavement of less than 1.2 m (4 ft) width, when placed as an integral part of the mainline pavement, shall be constructed in accordance with these specifications. Pavement placed in the locations of tapers, approach slabs, variable width pavement of less than 6.65 m (12 ft), and shoulders less than 1.2 m (4 ft) wide unless placed as an integral part of the mainline pavement shall be in accordance with the applicable requirements of 501 or the requirements herein. Concrete used at gaps in the pavement created at crossovers for public road approaches, driveways, or other permitted breaks in concrete paving shall be in accordance with the applicable requirements of 501 or 502, and may be produced from a commercial plant or a captive plant.

502.02 Quality Control Plan. Quality control of the portland cement concrete during production and placement shall be the responsibility of the Contractor. A Quality Control Plan shall be submitted for review at least 30 days prior to commencing portland cement concrete paving operations. The Quality Control Plan will be reviewed. Paving operations shall not begin before the Quality Control Plan has been accepted.

The contents of the Quality Control Plan shall be current to the cement concrete paving operations. Prior to executing a change to the cement concrete paving operations, the Quality Control Plan shall be revised by addendum to incorporate the change. Acceptance of the addendum shall be required before the change is made to the paving operations. Failure to keep the Quality Control Plan current may affect subsequent decisions, such as those made during the appeal process.

As a minimum, the Quality Control Plan shall contain the following information.

(a) General Requirements. The Quality Control Plan shall have a signature page. The authorized Contractor's representative shall sign and date such page when the Quality Control Plan is submitted for acceptance.

The name, qualifications, and duties of the person responsible for quality control on the project shall be identified. Also, the names, qualifications and duties of the concrete technicians shall be identified. The titles, qualifications, responsibilities, and

authority of all other persons having a major role in quality control on the project shall be identified.

The location of the quality control laboratory shall be given along with a full description of the required facilities. Adequate room for testing equipment, flexural beams in plastic state, and curing tanks shall be confirmed. Location and equipment provided for obtaining acceptance test samples shall be described.

The commitment towards communicating with Department personnel shall be stated. Specific circumstances and arrangements for communication shall be identified as appropriate throughout the plan.

(b) Origin and Sampling of Materials. The producers or manufacturers of all portland cement concrete materials shall be identified. The procedures and methods of delivery and storage of portland cement concrete materials shall be described.

(c) Trial Batch Demonstration. The location, the equipment to be used, and all other pertinent information about the trial batch demonstration shall be identified.

(d) Concrete Batching and Hauling. An explanation shall be provided which describes the concrete batching operations. The explanation shall detail techniques and controls used to produce a mix which is in accordance with the specifications, and is suitable for the paving spread workability needs. A description of the plant, including the capacity and intended batch size, and the methods and sequence by which the plant produces a batch shall be provided.

The traffic pattern in the vicinity of the plant shall be described or drawn on a plan. The equipment and methods to deliver the concrete mix to the paving spread shall be identified. General traffic patterns to accomplish the delivery to the paving spread, which may be adjusted without addendum to the Quality Control Plan for construction conditions, shall be described or drawn on a plan sheet.

The initial and routine equipment checks, including those performed on scales, water meters, and admixture dispensers, shall be described. All material checks, including frequencies of testing, shall be identified. The methods to monitor ingredients used and the record of each batch shall be described.

(e) Concrete Placement. The paving sequence shall be explained in detail. The plan for the paving sequence shall include the termini and widths of placement. The plan shall also describe the techniques used to place concrete at difficult locations, such as joining existing pavement, crossovers, approaches, and tapers.

All equipment included in the paving spread shall be identified. The methods of controlling the alignment and profile of the paving spread shall be detailed.

(f) Concrete Finishing, Texturing, and Curing. The methods for finishing, texturing, and curing concrete shall be described, including the description and identification of equipment used during this work.

(g) Production Testing. The types, applicable standards, and frequency of production tests shall be stated. As a minimum, the number of tests performed for air content, unit weight, flexural strength, and water/cementitious ratio shall be in accordance with 502.04. The methods and procedures for controlling and checking the pavement depth, surface profile, and surface smoothness shall be described. The corrective action procedure for results found to be outside of satisfactory limits for each type of test shall be provided.

The report format used to convey production control results, including tabulations, control charts, and all other methods of communication with Department personnel, shall be explained.

MATERIALS

502.03 Materials. Materials shall be in accordance with the following:

Admixtures	912.03
Coarse Aggregate, Class AP, Size No. 8*	904.02
Curing Materials	912.01
Dowel Bars	910.01
Fine Aggregate, Size No. 23*	904.01
Fly Ash	901.02
Joint Materials	906
Reinforcing Steel	910.01
Portland Cement	901.01(b)
Water	913.01

* Or gradation as identified in the Quality Control Plan.

502.04 Concrete Mixture and Mix Design. The portland cement concrete mix designs shall produce workable concrete mixtures having the properties as follows:

Minimum Portland Cement Content	260 kg/m^3 (440 lbs/yd^3)
Maximum Water/Cementitious Ratio	0.450
Minimum Portland Cement/Fly Ash Ratio	3.2 by weight
Target Air Content	6.5%
Minimum Flexural Strength, Third Point Loading*	4.0 MPa (570 lbs/in^2) at seven days

* The test specimens shall be cured in accordance with standard AASHTO procedures.

The Contractor may elect to use fine and coarse aggregates in accordance with 904.01(g) and 904.02(e), or may propose the use of alternate gradations. The Quality

Control Plan shall contain a positive statement regarding the aggregates to be used. If aggregates in accordance with 904.01(g) or 904.02(e) are selected, the tolerances for each sieve shall be as stated therein. If alternate gradations are proposed, the Quality Control Plan shall specify the control band tolerances on each sieve selected for the gradation. In either case, 100% of the coarse aggregate shall pass the 25 mm (1 in.) sieve. The combined amount of fine and coarse aggregates passing the 75 μm (No. 200) sieve shall be from 0% to 2.0%for sand and gravel, and from 0%to 2.5% for sand and crushed stone or crushed slag.

Proportions will be based upon saturated surface dry aggregates. The fine aggregate shall be no less than 35%nor more than 50% of the total weight of the aggregate in each cubic meter (cubic yard).

Absorption tests shall be performed on the fine aggregate in accordance with AASHTO T 84 and on the coarse aggregate in accordance with AASHTO T 85 and 904.03(f). When an absorption test result for a particular size of aggregate differs by more than one percentage point from the Department's value for the source, the discrepancy shall be reported. The absorption value for the source will be investigated and an absorption percentage will be determined. The Contractor's water absorption values shall apply when calculating the water/cementitious ratio.

All cement/pozzolan products, which are portland pozzolan cement type IP or type IS, air-entraining portland pozzolan cement type IP-A or type IS-A, or fly ash used as an additive, may only be incorporated into concrete pavement placed between April 1 and October 15 of the same calendar year. If portland pozzolan cement type IP, or air-entraining portland pozzolan cement type IP-A, are to be used in the pavement concrete, the minimum portland cement content shall be increased to 300 kg/m³ (500 pounds per cubic yard). The use of fly ash as an additive will not be permitted.

The water reducing admixture type A, or water reducing and retarding admixture type D, may be used in concrete. However, the water reducing admixture type A shall not be used in conjunction with the water reducing and retarding admixture type D.

Concrete mix designs shall be submitted for verification. An explanation of intended use for each mix design shall be provided. Trial batch demonstrations shall be conducted to assure complete concrete parameter compliance with the properties contained herein. Each proposed concrete mix design shall include the requirements as follows:

(a) a list of all ingredients;
(b) the source of all materials;
(c) the gradation of the aggregates;
(d) the absorption of the aggregates;
(e) the specific gravity of the aggregates;
(f) the unit weight of the aggregates;
(g) the batch weights;

(h) the names of all admixtures; and
(i) the admixture dosage rates.

502.05 Production Control and Acceptance Testing. Sufficient production testing shall be conducted to ensure a uniform product and process control. Acceptance testing will be performed by the Department and shall not be used for production control purposes. Samples may be jointly obtained, but the Department's and Contractor's technicians shall perform all work of testing separately. Production and acceptance testing results shall be shared and compared to resolve test discrepancies in a timely manner.

At least one American Concrete Institute certified concrete field testing technician, grade 1, shall direct all sampling, and testing necessary for production control. The technician shall determine the magnitude of the various properties of concrete governed by the specifications. The technician shall ensure that the concrete pavement properties are maintained within the specifications, Quality Control Plan, and accepted mix design limits.

The frequency of acceptance tests and determinations will be as follows:

TEST/DETERMINATION	FREQUENCY
Flexural Strength	One set of 2 beams for each sublot.
Air Content	One air content for each sublot.
Unit Weight	Not less than one unit weight for each sublot.
Water/Cementitious Ratio	Not less than one per week or one for every five lots, whichever is more restrictive by frequency.

Production control testing shall include the same or a greater number of tests than those performed for acceptance testing. The types and frequency of tests shall be identified in the Quality Control Plan.

Production control test results for flexural strength and air content shall be charted. The control charts shall show both sublot and lot values, and 100% payment limits shall be plotted. A legend shall appear on each chart. Other information shall be provided which permits easy understanding of data being shown. The charts shall be mounted at a convenient and clearly visible location on a wall of the common testing facility. When the concrete paving operations have been completed, the production control charts will become the property of the Department.

A production control aggregate gradation verification shall be performed at a minimum frequency of once per day on each day of concrete paving operations. Aggregate gradation verification will be performed by the Department at a minimum frequency of one per week or one for every five lots, whichever is more restrictive by

frequency. Gradation tests shall verify the maximum size of the aggregate and the total amount passing the 75 μm (No. 200) sieve for the mathematically combined amount of the fine and coarse aggregates which have been proportioned in accordance with the concrete mix design. Gradation tests shall also verify compliance with intermediate sieves in accordance with 904.01 and 904.02 or with sieve band tolerances established by the Quality Control Plan.

Not less than two production control water absorption determinations shall be performed for each aggregate used during cement concrete paving operations. When an absorption test result for a particular size of aggregate differs from the design mix value by more than 0.5 of a percentage point, the concrete paving operations shall stop unless adjustments have been made. The absorption value for the source will be investigated and an absorption percentage will be determined.

502.06 Facilities and Equipment for Production Control and Acceptance Testing. Testing equipment shall be provided to perform production control testing and shall be maintained in suitable working order. The equipment shall be in accordance with AASHTO requirements, except as such requirements may be as modified herein. The Department will provide testing equipment for acceptance testing. However, a spud vibrator with power source in suitable working order shall be provided by the Contractor.

A common testing facility shall be used for both production control and acceptance testing. The field laboratory shall provide a controlled curing environment in accordance with AASHTO T 23 and contain storage tanks with curing solution of adequate size to cure both production control and acceptance test beams. Water shall be conveniently available for cleaning testing equipment and for serving other tasks at the facility. Office space, having suitable heat and air conditioning, shall be provided to the Department within the testing facility. The Department shall have reasonable access to a telephone. Floor space shall be provided for a beam breaker. The beam breaker will be furnished by the Department.

A current set of AASHTO's Standard Specifications for Transportation Materials and Methods of Sampling and Testing, Part II Tests, and ASTM C 173 shall be provided in the common testing facility.

An adequate method of access to the concrete transporting equipment, such as a platform, shall be provided and located as directed. It shall be convenient for obtaining plastic portland cement concrete samples and located adjacent to the testing facility. The access shall be in accordance with applicable OSHA and Indiana OSHA requirements and directives.

502.07 Test Methods and Procedures. The following test methods and procedures shall be used, except as modified in 502.07(a), 502.07(b), 502.07(c), 502.07(d), and 502.07(e).

TEST/DETERMINATION	METHOD AND PROCEDURE
Sampling Fresh Concrete	AASHTO T 14
Making and Curing Specimens	AASHTO T 23*
Flexural Strength	AASHTO T 97*
Unit Weight	AASHTO T 121*
Air Test	AASHTO T 152* or ASTM C 173**
Water/Cementitious Ratio	General Instructions to Field Employees, Section 46

* If AASHTO T 152 is used for air content determination, all the concrete test specimens shall be consolidated by the method of internal vibration. If ASTM C 173 is used for air content determination, all concrete test specimens shall be consolidated by rodding.

** If slag aggregate is used, the method and procedure for the test shall be in accordance with ASTM C 173.

(a) Exceptions to AASHTO T 141. The exceptions to AASHTO T 141 for sampling fresh concrete in the field shall be as follows:

1. Sampling will be allowed at the plant or common testing facility.

2. The entire sample may be obtained from one portion of the load.

3. Sampling from the transport equipment shall be in accordance with Section 4.2.2, except the cement concrete may not be discharged on the grade and the portion location can be from the top of the load.

(b) Exceptions to AASHTO T 23. The exceptions to AASHTO T 23 for making and curing specimens in the field shall be as follows:

1. Beam forms furnished by the Department will be permitted even though they are not watertight and have no provision for attaching the base to the sides.

2. Form oil used on the project site will be permitted in lieu of mineral oil.

3. The test beams shall be made at the field laboratory site and shall be moved immediately into the laboratory while in a plastic state for the initial 24 h cure.

(c) Exceptions to AASHTO T 97. The exceptions to AASHTO T 97 for conducting a flexural test on concrete beams shall be as follows:

1. The beam size shall be measured to the nearest 1.6 mm (1/16 in.).

2. The test result shall be discarded when the break occurs outside the middle third of the beam.

3. The use of hand operated testing machines, which do not provide a continuous loading to completion of the test in one stroke, will be permitted.

4. The modulus of rupture shall be calculated in megapascal to the nearest figure in the second decimal place (pounds per square inch to the nearest whole unit).

(d) Exceptions to AASHTO T 121. The exceptions to AASHTO T 121 for determining the unit weight of concrete shall be as follows:

1. An aluminum measure or air meter bowl, as used by the Department, will be acceptable alternates.

2. A strike-off bar may be used in lieu of a cover plate.

3. Weights shall be determined to the nearest 0.005 kg (0.01 lb).

(e) Exceptions to AASHTO T 152. The exceptions to AASHTO T 152 for determining the air content in portland cement concrete shall be as follows:

1. Samples shall be obtained as directed.

2. A fixed amount of aggregates, as specified, shall be used to determine the aggregate correction factor instead of computing the aggregate fraction for the specific mixture.

3. A 5 min soaking period after placing the sample in the meter will not be required before determining the aggregate correction factor. The aggregate may be washed from the concrete sample and used to determine the correction factor for aggregates indicating a high correction factor.

502.08 Trial Batch Demonstration. A trial batch demonstration shall be conducted such that both the Engineer's and the Contractor's certified technician shall test the proposed concrete mix design together and report the results. The trial batch shall be produced in a laboratory or a field mixer of sufficient capacity for both certified technicians to perform all tests from the same batch without the concrete material being used for more than one test. However, the concrete material used to obtain a trial batch unit weight may be used to conduct the air content test.

Following the trial batch demonstration, all required test and determination results shall be submitted. In addition to the concrete properties established for a mix design in accordance with 502.04, the plastic concrete target unit weight and target water/cementitious ratio shall be determined during the trial batch. The target unit weight and the target water/cementitious ratio may be adjusted during the first lot. However, the adjusted water/cementitious ratio shall not exceed 0.45. Verification of the trial batch

shall include seven day flexural strength tests having a minimum of two beam breaks. The average of the two flexural strength tests shall have a value greater than 3.93 MPa (570 psi).

Except for adjustments to compensate for routine aggregate moisture fluctuations, concrete mix design gradation of aggregate changes after the trial batch verification shall be documented and justified prior to implementing. A maximum adjustment of ±3% of fine aggregate to total aggregate ratio will be permitted. Changes to the dosage amounts of admixtures will be permitted. A new mix design shall be prepared and successfully demonstrated for all changes in the source of material, the amounts of cementitious materials, the adjustments of greater than ±3% of fine or total aggregate ratio, or the addition or deletion of admixtures.

502.09 Lots and Sublots, and Selection of Test Locations. The statistical principles used in this specification will rely on the random selection of test locations. Sampling and testing of the portland cement concrete properties shall be performed at random locations within a sublot.

A lot shall consist of 6000 m^2 (6,900 sq yd) of pavement. A sublot shall consist of 2000 m^2 (2,300 sq yd) of pavement within a lot. There shall normally be three sublots within one lot. If one day's production approximately equals 6000 m^2 (6,900 sq yd), that lot size may be adjusted by ± 500 m^2 (± 500 sq yd) in order to agree with the one day's production. If this event occurs, the size of the third sublot shall be adjusted by the same quantity as the adjustment for the total lot quantity.

In order to randomly select the relative location of each sublot sample, a container will be maintained with identical sized devices numbered from one through 23 (20). Each number will represent the relative 100 m^2 (100 sq yd) in a sublot. The number "1" will represent the pavement area from zero to 100 m^2 (100 sq yd) at the beginning of the sublot. The number "2" will represent the pavement area from 100 to 200 m^2 (100 to 200 sq yd), and so on to the device number "23" ("20"), which will represent the pavement area from 1900 to 2000 m^2 (2,200 to 2,300 sq yd) in the sublot. The numbered device will be selected from the mixed-up array. The number selected will represent the 100 m^2 (100 sq yd) area from which the sample will be taken. The sample will be taken anywhere within the 100 m^2 (100 sq yd) limit. The device will be returned to the container before a device is selected for the next lot.

The sample area will be selected shortly before the sublot is to be tested. The location of the sample will be determined and recorded by stationing at the time the sample is taken.

If the randomly selected location for the third sublot sample has not been reached and the Contractor requests to use the aforementioned adjustment provisions, one set of acceptance tests, conducted in accordance with 502.07, will be performed for the sublot before the day's concrete pavement placement ends.

502.10 Equipment. Equipment and tools necessary for handling materials and performing all parts of the work shall be in accordance with 501.04. The batch plant and equipment provided in accordance with 501.04(a) shall include an automated documented record of each ingredient in each batch.

502.11 Preparation of Grade. If subbase is required, the subgrade under the subbase shall be prepared in accordance with 501.05.

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502.12 Setting Forms. When concrete forms are used, they shall be set in accordance with 501.06.

502.13 Conditioning of Subgrade or Base Course. Before or after the side forms have been securely set to grade, the subgrade or base course shall be prepared in accordance with 501.07.

502.14 Handling, Measuring, and Batching Materials. The handling, measuring, and batching of materials shall be in accordance with 501.08.

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502.15 Mixing Concrete. The concrete may be mixed in accordance with 501.09 and 702.09 at central mix plant or in truck mixers. Changes to sources of material and additions or deletions of admixtures shall be in accordance with 502.08. Batching and mixing shall be suspended whenever satisfactory placing, finishing, and curing operations cannot be performed in proper sequence.

502.16 Natural Light and Weather Limitations. The limitations on mixing, placing, or finishing concrete due to natural light or weather conditions shall be in accordance with 501.10.

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502.17 Placing Concrete. The placing of concrete shall be in accordance with 501.11.

502.18 Test Specimens. The concrete necessary for conducting flexural beam tests shall be furnished. Equipment, materials, and labor necessary to assist the Engineer with the curing of beams in accordance with 502.06 and 502.07(b) shall also be furnished.

502.19 Placement of Reinforcement and Strike-off of Concrete. The placement of reinforcement and the strike-off of the concrete shall be in accordance with
450 501.13.

502.20 Joints. Joints shall be constructed as shown on the plans or as directed, and in accordance with 501.14.

502.21 Final Consolidation, Strike-Off, and Finishing. The final consolidation, strike-off, and finishing of the concrete pavements produced in accordance with the requirements included herein shall be in accordance with 501.15.

502.22 Curing. Curing the portland cement concrete pavement shall be in accordance with 501.17.

502.23 Removing Forms. The removal of forms shall be performed in accordance with 501.18.

502.24 Sealing Cracks and Joints. The sealing of cracks and joints shall be performed in accordance with 501.19.

502.25 Inspection for Pavement Cracking. The inspection of the concrete pavement for cracking shall be performed in accordance with 501.20.

502.26 Protection of Pavement. The pavement and its appurtenances shall be protected against damage caused by public traffic, work equipment, employees, and agents in accordance with 501.21.

502.27 Opening to Traffic. Pavement shall be opened to traffic in accordance with 501.22. Test beams designated to control the opening of the concrete pavement to traffic shall be prepared and cured separately from production control and acceptance test beams. Test beams cast for opening pavement to traffic shall be field cured in accordance with 501.03(a)2.

502.28 Concrete Pavement, Slip-Form Method. Constructing portland cement concrete pavement with a slip-form paver shall be performed in accordance with 501.23.

502.29 Substandard Work Produced During Concrete Paving Operations. General problems and procedures, which cause an obviously substandard product, shall be promptly corrected. Operations continued in a manner which results in a reduced payment will not be permitted. A stop paving order will be issued and shall apply until a satisfactory plan for future paving has been accepted.

The option to remove and replace pavement, or to leave it in place at reduced or with no payment shall be as directed. If the test results are close to the specified minimum, the option will be given. More divergent results will require removal and replacement. A material in this category will be considered and adjudicated as a failed material in accordance with normal Department practice.

502.30 Acceptance Testing and Approval of Concrete Pavement Properties. Plastic unit weight, water/cementitious ratio, flexural beam, and air content acceptance tests will be performed during concrete paving operations. Slump tests will not be required for acceptance. When calculations are performed, the standard AASHTO or ASTM rounding off techniques will apply.

(a) Plastic Unit Weight Acceptance Test. During the production of pavement concrete, the plastic unit weight acceptance test will be conducted in accordance with 502.07 and at a minimum frequency in accordance with 502.05. The plastic unit weight shall not vary by more than ± 3.0% from the average unit weight determined from the first lot. If the plastic unit weight exceeds ± 3.0% from the average unit weight determined from the first lot, a stop paving order will be issued unless adjustments are made. Paving shall not resume until a satisfactory plastic unit weight is obtained or an approved alternate mix design is employed.

Calculations for the plastic unit weight in kg/m^3 (lb/cu ft) will be made and reported to the nearest whole unit (lb/cu ft to the nearest figure in the first decimal place).

(b) Water/Cementitious Ratio Acceptance Determination. During the production of concrete pavement, the water/cementitious ratio acceptance determination will be conducted in accordance with 502.07 and at the minimum frequency in accordance with 502.05. If the resulting test value is greater than 0.450, or if the test value varies from the result determined during the first lot by more than ± 0.030, a stop paving order will be issued unless adjustments are made. Paving shall not resume until a satisfactory water/cementitious ratio is obtained or an approved alternate mix design is employed.

Calculations for water/cementitious ratio will be made and reported to the nearest figure in the third decimal place.

(c) Flexural Strength Acceptance Test. During the production of concrete pavement, the flexural strength test beams will be made in accordance with 502.07. The tests will be performed at the required frequency in accordance with 502.05. The test value for each lot, which is the average of respective test values for sublots in the particular lot, that is less than 4.0 MPa (570 lb/sq in.) shall have a price adjustment in accordance with 502.35(b)1. A lot value, having a flexural strength less than 3.55 MPa (515 lb/sq in.), or a sublot value, having a flexural strength of 3.45 MPa (500 lb/sq in.) or less, will be considered and adjudicated as a failed material in accordance with normal Department practice.

Calculations for flexural strength in MPa (lb/sq in.) will be made and reported to the nearest figure in the second decimal place (lb/sq in. to the nearest whole unit).

(d) Air Content Acceptance Test. During the production of concrete pavement, the air content test of the plastic concrete will be conducted in accordance with 502.07. The tests will be performed at the required frequency in accordance with 502.05. Lot test values below 5.7% or above 7.3% shall have a price adjustment in accordance with 502.35(b)2. A lot test value less than 4.5% or more than 9.0% shall subject the concrete pavement to removal and replacement or to remain in place at reduced payment or with no payment, as directed. An individual sublot having an air content of less than 4.0% or more than 10.0% will be considered and adjudicated as a failed material in accordance with normal Department practice.

Calculations for air content percentage will be made and reported to the nearest figure in the first decimal place.

502.31 Pavement Smoothness and Surface Tolerances. Pavement smoothness shall be in accordance with 501.16, except surface tolerances shall be as contained herein. The profilograph tolerance will not apply to the concrete shoulders.

The pavement surface tolerances shall be as follows:

SURFACE TOLERANCES TABLE

TESTING METHOD	SPECIFIED TOLERANCE
Profilograph (profile index)	25 mm/0.16 km (1.0"/0.1 mi) or less*
4.88 m (16') Straightedge	6.3 mm (1/4") or less
3.05 m (10') Straightedge	3.15 mm (1/8") or less

* A pavement surface having a profile index value greater than 25 mm/0.16 km (1.0"/0.1 mi) shall be corrected to 25 mm/0.16 km (1.0"/0.1 mi) or less.

502.32 Tolerance in Pavement Thickness. The tolerances in pavement thickness and for the location of reinforcing steel shall be in accordance with 501.24. Coring will be performed by the Department.

502.33 Appeal Procedure for Air Content and Flexural Strength Acceptance Test Results. The Department will be the final authority regarding acceptances and adjusted payment for air content and flexural strength test results. Appeals will not be honored or considered unless evidence is furnished that demonstrates substantial difference by showing production control test results which differ significantly from acceptance test results. Routine appeals submitted for the sake of making an appeal will not be honored or considered.

Appeals shall satisfy the following criteria:

(a) Appeals shall be submitted in writing to the Engineer within 10 calendar days after the lot data has been reported.

(b) The submission shall contain test data which equals or exceeds the number of tests conducted by the Department.

(c) The difference in the test result for the control test nearest the acceptance test result shall be at least 0.5% for air content.

(d) The difference in the set of test results for the control tests nearest the set of acceptance test results shall be at least 0.35 Mpa (50 lb/sq in.) for flexural strength.

(a) Pavement Cores. Except in the case of an obvious testing error, appeals will be adjudicated by evaluation of pavement cores. Such cores shall be taken by the Contractor. The cores shall be taken for the full depth of pavement and shall be 100 mm (4 in.) in diameter. All core holes shall be filled with portland cement concrete within 24 h of drilling.

The Engineer will determine the location of the cores. The cores will be taken at a location that most closely approximates the appropriate plastic sublot test locations. The nearest sublots in chronological age to the sublot in dispute will be selected. Therefore, the location for core samples will depend on the original paving sequence. Cores will not be taken within 0.6 m (2 ft) of the edge of the pavement, over dowels, or within 1.5 m (5 ft) of the headers.

The Engineer will:

1. mark the location on the pavement to be cored within the middle third of the chosen lane;

2. witness the coring operations;

3. identify and mark each core as to location; and

4. submit the cores to the Materials and Tests Division.

(b) Air Content Appeal. An appeal on air content may be based on a test result. Unless the appeal is adjudicated by a Department determination that obvious erroneous acceptance test results were obtained, the appeal will be decided by pavement cores. The core locations will be determined in accordance with 502.33(a). One full-depth core will be taken for each appealed sublot.

The hardened concrete air contents will be determined in accordance with ASTM C 457, Modified Point Count Method, except that a disk will be cut from each core at approximate mid-depth. The disk will be approximately 25 mm (1 in.) thick, and both the upper and lower surfaces will be polished for evaluation. The report for each core will include the number of stops on air voids, in paste, and on aggregates, as well as the operator identification.

When cores are taken and the Department has completed its analysis of the sublot in question, the final air content percentage will be based on the result of the Point Count Method, modified as follows:

Point Count Result, PCR	Additive, A	Final Value
0.0 to 5.6%	0.5%	PCR + A = Final
5.6 and higher	1.0%	PCR + A = Final

The final value will then be considered as the actual air content for that sublot. That value will be used to determine all subsequent actions involving the sublot or lot.

(c) Flexural Strength Appeal. An appeal on flexural strength may be based on a set of test results. Unless the appeal is adjudicated by a Department determination that obviously erroneous acceptance test results were obtained, the appeal will be decided by pavement cores.

The core locations will be determined in accordance with 502.33(a). Two full depth, 100 mm (4 in.) diameter cores shall be obtained at each sublot in dispute. In addition, two full depth, 100 mm (4 in.) diameter cores shall be obtained from the two sublots which are closest to the sublot in dispute by following the chronological sequence of work performed. This procedure shall apply where all sublots cored were produced using the same mix design. If the sublots were not produced using the same mix design, the matter will be considered and adjudicated as a failed material in accordance with normal Department practice.

Each core will be tested for compressive strength in accordance with ASTM C 42. A minimum 40 h submerged cure in lime saturated water prior to testing will be used. The report for each core will include the unit weight, compressive strength, and technician's identification.

The average core compressive strength will be determined for each sublot in dispute and being appealed. Likewise, the average core compressive strength will be determined for each adjacent sublot closest in chronological sequence of work performed to the sublot in dispute. The compressive strength/flexural strength ratio of the two acceptable adjacent sublots will be averaged. Such value will be applied to the compressive strength of the disputed sublot. The result will be the final flexural strength for the disputed sublot. This value will be considered as the actual flexural strength for the disputed sublot. It will be used to determine all subsequent actions involving the sublot or lot.

502.34 Method of Measurement. Portland cement concrete pavement will be measured by the square meter (square yard) of the type and thickness specified. The width for measurement will be the width of the pavement shown on the typical cross section of the plans, additional widening where called for, or as otherwise directed in writing. The length will be measured parallel to the surface of the pavement along the centerline of each roadway or ramp.

Measurement of other pavement components, such as reinforcing steel, retrofitted tie-bars, and contraction and terminal joints, will be made in accordance with 501.25.

Work performed for smoothness of the pavement will not be measured for payment.

502.35 Basis of Payment. The accepted quantities of cement concrete pavement will be paid for at the contract unit price per square meter (square yard) for the type and thickness specified complete in place.

690

Furnishing, calibrating, and operating the profilograph, and furnishing profile information will be paid for at the contract lump sum price for profilograph.

Payment will be made under:

Pay Item	Pay Unit Symbol
QA Cement Concrete Pavement, Reinforced, _____ mm (thickness)	m2
(QA Cement Concrete Pavement, Reinforced, _____ in. (thickness)	SYS)
QA Cement Concrete Pavement, Plain, _____ mm (thickness)	m2
(QA Cement Concrete Pavement, Plain, _____ mm (thickness)	SYS)

700

The costs of quality assurance work, including preparing a Quality Control Plan, conducting trial batch demonstrations, performing production testing, and similar requirements included herein; profile correction as required and pavement cores required for acceptance test results appeals; furnishing and placing all materials, including steel mesh, tie-bars, and fillers for joints not included as pay items shall be included in the cost of cement concrete pavement.

710

No additional payment over the contract unit price will be made for pavement which has an average thickness in excess of that shown on the plans.

Payment for the profilograph will be in accordance with 501.26.

(a) Payment for Other Pavement Components. Payment for other cement concrete pavement components, such as reinforcing steel, anchor bolts, and various types of joints will be in accordance with 501.26.

720

(b) Price Adjustment for Flexural Strength and Air Content. Price adjustments for flexural strength and air content shall be cumulative, relative to the contract unit price for QA cement concrete pavement. If the total adjusted price for each lot of QA cement concrete pavement that is determined to be 60% of the unit price or less, the Engineer may order the deficient pavement to be removed and replaced. If the deficient QA cement concrete pavement is permitted to remain in place, no payment will be made for that pavement determined to be deficient.

730

If an adjusted price is required, the contract unit price for the cement concrete pavement will not be changed. Instead, the percent of price adjustment will be applied to the area of the lot in question. The quantity of the lot, normally 6000 m^2 (6,900 sq yd), will be increased or decreased by the percent of adjustment to the contract unit price.

1. Flexural Strength Price Adjustment. The adjusted payment will be based on the total area of cement concrete pavement represented by a lot. The test values for each lot will be the average of the respective test values of the sublots within a lot. The area of cement concrete pavement represented by a sublot, which has a flexural strength of
740 3.45 MPa (500 lb/sq in.) or less, shall be subject to removal and replacement or left in place at reduced payment or with no payment. It will be considered and adjudicated as a failed material in accordance with normal Department practice.

PRICE ADJUSTMENT FOR FLEXURAL STRENGTH OF CEMENT CONCRETE PAVEMENT

Average Lot Flexural Strength, MPa (pounds per square inch)	Percent of Contract Unit Price
750 4.0 (570) and Above	100
3.95 (565) - 3.99 (569)	98
3.90 (560) - 3.94 (564)	96
3.85 (555) - 3.89 (559)	94
3.80 (550) - 3.84 (554)	92
3.75 (545) - 3.79 (549)	89
3.70 (540) - 3.74 (544)	86
3.65 (535) - 3.69 (539)	83
3.60 (525) - 3.64 (534)	78
3.55 (515) - 3.59 (524)	72
760 3.54 (514) or less	*

* The QA cement concrete pavement for a lot shall be subject to removal and replacement or left in place at reduced payment or with no payment. It will be considered and adjudicated as a failed material in accordance with normal Department practice.

2. Air Content Price Adjustment. The adjusted payment will be based on the total area of QA cement concrete pavement represented by a lot. The test values for each lot will be the average of the respective test values of the sublots within a lot.

770 PRICE ADJUSTMENT FOR AIR CONTENT OF CONCRETE PAVEMENT

Average Lot Air Content Net Percentage	Percent of Contract Unit Price
5.7 - 7.3	100
7.4 - 7.5	99
7.6 - 8.0	98
8.1 - 8.2	96

8.3 - 8.5	91
8.6 - 8.8	85
8.9 - 9.0	80
9.1 or greater	*
5.0 - 5.6	99
4.7 - 4.9	98
4.6	88
4.5	80
4.4 or less	*

* The QA cement concrete pavement for a lot shall be subject to removal and replacement or left in place at reduced payment or with no payment. It will be considered and adjudicated as a failed material in accordance with normal Department practice.

(c) Smoothness Price Adjustment. The payment for smoothness of QA cement concrete pavement will be based on the profile index for each lane in accordance with the following table. The payment will be for the initial measured profile index. However, the price adjustment schedule for 100% payment will also apply to pavement segments upon completion of corrective work. The adjusted payment will be based on the total area of pavement represented by the profile index.

PRICE ADJUSTMENT SCHEDULE

Final Profile Index, mm/0.16 km (in./0.1 mile)	Percent of Contract Unit Price
0.0 to less than 13 (0.5)	103*
13 (0.5) to less than 18 (0.7)	102*
18 (0.7) to less than 23 (0.9)	101*
23 (0.9) and above	100**

* Incentive payment for QA cement concrete pavement.
** All pavements shall be corrected to 25 mm/0.16 km (1.0"/0.1 mi).

An incentive payment may be attained for the mainline pavement which shows superior profilograph results. Grinding will be required, if necessary, to be in accordance with the minimum smoothness requirements of 25 mm/0.16 km (1.0 in./mi) as well as for high point deviations in excess of 7.5 mm (0.3 in.). This evaluation will be conducted in 0.16 km (0.1 mi) sections. No 0.16 km (0.1 mi.) section will be eligible for incentive payments if that section or an adjacent 0.16 km (0.1 mi) section requires grinding. The adjustments will be made without consideration of other concrete pavement lot and sublot boundaries.

(d) Pavement Thickness and Reinforcing Steel Price Adjustment. The adjusted payment for cement concrete pavement for deficient pavement thickness and for reinforcing steel not placed within specified limits will be in accordance with 501.24(f).

SECTION 500 -- RIGID PAVEMENT

SECTION 501 -- PORTLAND CEMENT CONCRETE PAVEMENT

501.01 Description