ITEM P-501 PORTLAND CEMENT CONCRETE PAVEMENT

DESCRIPTION

501-1.1 This work shall consist of pavement composed of portland cement concrete, without reinforcement, constructed on a prepared underlying surface according to these specifications and shall conform to the lines, grades, thickness, and typical cross sections shown on the Plans.

MATERIALS

501-2.1 AGGREGATES.

a. Fine Aggregate. Fine aggregate shall conform to the requirements of AASHTO M 6, Class A, except part a in Table 2 is deleted. Gradation shall meet the requirements of Table 1 when tested according to WAQTC FOP for AASHTO T 27/T 11, except as may otherwise be qualified under Section 5.

b. Coarse Aggregate. Coarse aggregate shall conform to the requirements of AASHTO M 80, Class B. Gradations shall meet the requirements of AASHTO M 43, Number 57 or 67, when tested according to WAQTC FOP for AASHTO T 27/T 11.

Aggregates delivered to the mixer shall consist of crushed stone, crushed or uncrushed gravel, crushed recycled concrete pavement, or a combination thereof. The aggregate shall be composed of clean, hard, uncoated particles and shall meet the requirements for deleterious substances contained in AASHTO M 80, Class A. Dust and other coating shall be removed from the aggregates by washing, if necessary. The aggregate in any size group shall not contain more than 8% by weight of flat and elongated pieces when tested according to ATM 306. The percentage of wear shall be no more than 40 when tested according to AASHTO T 96.

501-2.2 CEMENT. Cement shall conform to the requirements of AASHTO M 85 including the low-alkali requirement.

If for any reason, cement becomes partially set or contains lumps of caked cement, it shall be rejected. Cement salvaged from discarded or used bags shall not be used.

501-2.3 CEMENTITIOUS MATERIALS. Fly ash shall meet the requirements of AASHTO M 295, Class C or Class F, except that the moisture content shall be 1% maximum and the amount retained on the No. 325 sieve when wet-sieved is 30% maximum. The supplementary optional chemical and physical properties shall apply.

501-2.4 PREMOLDED JOINT FILLER. Premolded joint filler for expansion joints shall conform to the requirements of AASHTO M 213 and shall be punched to admit the dowels where called for on the Plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint, unless otherwise specified by the Engineer. When the use of more than one piece is required for a joint, the abutting ends shall be fastened securely and held accurately to shape by stapling or other positive fastening means satisfactory to the Engineer.

501-2.5 JOINT SEALER. The joint sealer for the joints in the concrete pavement shall meet the requirements of Item P-605 and shall be of the type(s) specified in the Plans.

501-2.6 STEEL REINFORCEMENT. Reinforcing shall consist of Welded Steel Wire Fabric conforming to the requirements of AASHTO M 55.. Welded wire fabric shall be furnished in flat sheets only.

501-2.7 DOWEL AND TIE BARS. Tie bars shall be deformed steel bars and conform to the requirements of AASHTO M 31 or AASHTO M 322.

Dowel bars shall be plain steel bars conforming to AASHTO M 31 or AASHTO M322, and shall be free from burring or other deformation restricting slippage in the concrete. High strength dowel bars shall conform to AASHTO M 31, Bare Finish. Before delivery to the construction site each dowel bar shall be painted on all surfaces with one coat of paint meeting Federal Specification TT-P-664. If plastic or epoxy-coated steel dowels are used no paint coating is required, except when specified for a particular situation on the contract Plans. Coated dowels shall conform to the requirements of AASHTO M 254.

The sleeves for dowel bars used in expansion joints shall be metal or other type of an approved design to cover 2 to 3 inches of the dowel, with a closed end and with a suitable stop to hold the end of the bar at least 1 inch from the closed end of the sleeve. Sleeves shall be of such design that they will not collapse during construction.

501-2.8 WATER. Water used in mixing or curing shall be clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product. Water will be tested according to the requirements of AASHTO T 26. Water known to be of potable quality may be used without testing.

501-2.9 COVER MATERIAL FOR CURING. Curing materials shall conform to one of the following specifications:

- **a.** Liquid membrane-forming compound conforming to AASHTO M 148, Type 2, Class B.
- **b.** White polyethylene film conforming to AASHTO M 171.
- **c.** White burlap-polyethylene sheeting conforming to AASHTO M 171.
- **d.** Waterproof paper conforming to AASHTO M 171

501-2.10 ADMIXTURES. The use of any material added to the concrete mix shall be approved by the Engineer. The Contractor shall submit certificates indicating that the material to be furnished meets all of the requirements indicated below. In addition, the Engineer may require the Contractor to submit complete test data from an approved laboratory showing that the material to be furnished meets all of the requirements of the cited specifications. Subsequent tests may be made of samples taken by the Engineer from the supply of material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that approved.

- **a. Air-Entraining Admixtures.** Air-entraining admixtures shall meet the requirements of AASHTO M 154 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entrainment agent and any chemical admixtures shall be compatible.

- **b. Chemical Admixtures.** Water-reducing, set retarding, and set-accelerating admixtures shall meet the requirements of AASHTO M 194, including the flexural strength test.

501-2.11 EPOXY-RESIN. Epoxy-resin used to anchor dowels and tie bars in pavements shall conform to the requirements of AASHTO M 235, Type I, Grade 3, Class C. Class A or B shall be used when the surface temperature of the hardened concrete is below 60 ºF.

501-2.12 MATERIAL ACCEPTANCE. Prior to use of materials, the Contractor shall submit certified test reports to the Engineer for those materials proposed for use during construction. The certification shall show the appropriate ASTM test(s) for each material, the test results, and a statement that the material passed or failed.

The Engineer may request samples for testing, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

MIX DESIGN

501-3.1 PROPORTIONS. Concrete shall be normal weight concrete designed to achieve a 28-day flexural strength of 735 psi. The mix shall be designed according to the American Concrete Institute (ACI) Pub. 301

Section 4, and ACI Pub. 214 using the absolute volume method per ACI Pub. 211.1. Acceptance of the concrete will be based on a flexural strength of 645 psi.

The Contractor shall note that to ensure that the concrete actually produced will meet or exceed the acceptance criteria for the specified strength, the mix design average strength must be higher than the specified strength. The amount of overdesign necessary to meet specification requirements depends on the producer's standard deviation of flexural test results and the accuracy which that value can be estimated from historic data for the same or similar materials.

The minimum cementitious material (cement plus fly ash) shall be 564 lbs/yd^3. The ratio of water to cementitious material, including free surface moisture on the aggregates but not including moisture absorbed by the aggregates shall not be more than 0.50 by weight.

Prior to the start of paving operations and after approval of all material to be used in the concrete, the Contractor shall submit a mix design showing the proportions and flexural strength obtained from the concrete at 7 and 28 days. The mix design shall include copies of test reports, including test dates, and a complete list of materials including type, brand, source, and amount of cement, fly ash, coarse aggregate, fine aggregate, water, and admixtures. The fineness modulus of the fine aggregate and the air content shall also be shown. The mix design shall be submitted to the Engineer at least 40 days prior to the start of operations. Production shall not begin until the mix design is approved in writing by the Engineer.

Should a change in sources be made, or admixtures added or deleted from the mix, a new mix design must be submitted to the Engineer for approval.

Flexural strength test specimens shall be prepared according to WAQTC FOP for AASHTO T 23 and tested according to AASHTO T 97.

501-3.2 CEMENTITIOUS MATERIALS. Fly ash may be used in the mix design. When fly ash is used as a partial replacement for cement, the minimum cement content may be met by considering portland cement plus fly ash as the total cementitious material. The fly ash replacement rate shall be 1.0-1.25 for Class C and 1.25 for Class F.Fly ash substitution shall not exceed 20% by weight of the portland cement.

501-3.3 ADMIXTURES.

a. Air-Entraining. Air-entraining admixture shall be added in such a manner that will insure uniform distribution of the agent throughout the batch. The air content of freshly mixed air-entrained concrete shall be based upon trial mixes with the materials to be used in the work adjusted to produce concrete of the required plasticity and workability. The percentage of air in the mix shall be 5-8. Air content shall be determined by testing according to WAQTC FOP for AASHTO T 152..

b. Chemical. Water-reducing, set-controlling, and other approved admixtures shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements. Tests shall be conducted on trial mixes, with the materials to be used in the work, according to AASHTO M 194.

501-3.4 TESTING LABORATORY. The laboratory used to develop the mix design shall meet the requirements of ASTM C 1077. A certification that it meets these requirements shall be submitted to the Engineer prior to the start of mix design and shall contain as a minimum:

a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.

b. A statement that the equipment used in developing the mix design is in calibration.

c. A statement that each test specified in developing the mix design is offered in the scope of the laboratory's services.

d. A copy of the laboratory's quality control system.

CONSTRUCTION METHODS

501-4.1 EQUIPMENT. The Contractor shall furnish all equipment and tools necessary for handling materials and performing all parts of the work.

a. Batch Plant and Equipment. The batch plant and equipment shall conform to the requirements of AASHTO M 157.

b. Mixers and Transportation Equipment.

(1) General. Concrete may be mixed at a central plant, or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer's nameplate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

(2) Central Plant Mixer. Central plant mixers shall conform to the requirements of AASHTO M 157.The mixer shall be examined daily for changes in condition due to accumulation of hard concrete or mortar or wear of blades. The pickup and throwover blades shall be replaced when they have worn down 3/4 inch or more. The Contractor shall have a copy of the manufacturer's design on hand showing dimensions and arrangement of blades in reference to original height and depth.

(3) Truck Mixers and Truck Agitators. Truck mixers used for mixing and hauling concrete and truck agitators used for hauling central-mixed concrete shall conform to the requirements of AASHTO M 157.

(4) Nonagitator Trucks. Nonagitating hauling equipment shall conform to the requirements of AASHTO M 157.

c. Finishing Equipment. The finishing equipment shall be of sufficient weight and power for proper finishing of the concrete. The finishing machine shall be designed and operated to strike off, screed and consolidate the concrete such that laitance on the surface is less than 1/8 inch thick.

d. Vibrators. Vibrator shall be either internal type with immersed tube or multiple spuds, or surface type vibrating pan or screed. For pavements 8 inches or more thick, internal vibrators shall be used. They may be attached to the spreader or the finishing machine, or they may be mounted on a separate carriage. Operating frequency for internal vibrators shall be between 8,000 and 12,000 vibrations per minute. Average amplitude for internal vibrators shall be 0.025-0.05 inches. For pavements less than 8 inches thick, vibrating surface pans or screeds shall be allowed. Operating frequencies for surface vibrators shall be between 3,000 and 6,000 vibrations per minute.

The number, spacing, and frequency shall be as necessary to provide a dense and homogeneous pavement. Adequate power to operate all vibrators shall be available on the paver. The vibrators shall be automatically controlled so that they shall be stopped as forward motion ceases.

Hand held vibrators may be used in irregular areas.

e. Concrete Saws. The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions. The Contractor shall provide at least one standby saw in good working order and a supply of saw blades at the site of the work at all times during sawing operations.

f. Side Forms. Straight side forms shall be made of steel and shall be furnished in sections not less than 10 feet in length. Forms shall have a depth equal to the pavement thickness at the edge.

Flexible or curved forms of proper radius shall be used for curves of 100 foot radius or less. Forms shall be provided with adequate devices for secure settings so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms with battered top surfaces and bent, twisted or broken forms shall not be used. Built-up forms shall not be used, except as approved by the Engineer. The top face of the form shall not vary from a true plane more than 1/8 inch in 10 feet, and the upstanding leg shall not vary more than 1/4 inch. The forms shall contain provisions for locking the ends of abutting sections together tightly for secure setting. Wood forms may be used under special conditions, when approved by the Engineer.

g. Pavers. The paver shall be fully energized, self-propelled, and designed for the specific purpose of placing, consolidating, and finishing the concrete pavement, true to grade, tolerances, and cross section. It shall be of sufficient weight and power to construct the maximum specified concrete paving lane width as shown in the Plans, at adequate forward speed, without transverse, longitudinal or vertical instability or without displacement. The paver shall be equipped with electronic or hydraulic horizontal and vertical control devices.

501-4.2 FORM SETTING. Forms shall be set sufficiently in advance of the concrete placement to insure continuous paving operation. After the forms have been set to correct grade, the underlying surface shall be thoroughly tamped, either mechanically or by hand, at both the inside and outside edges of the base of the forms. Forms shall be staked into place sufficiently to maintain the form in position for the method of placement.

Form sections shall be tightly locked and shall be free from play or movement in any direction. The forms shall not deviate from true line by more than 1/8 inch at any joint. Forms shall be so set that they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms shall be cleaned and oiled prior to the placing of concrete.

The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor immediately before placing the concrete.

501-4.3 CONDITIONING OF UNDERLYING SURFACE, SLIP-FORM CONSTRUCTION. The compacted underlying surface on which the pavement will be placed shall be widened approximately 3 feet to extend beyond the paving machine track to support the paver without any noticeable displacement. After the underlying surface has been placed and compacted to the required density, the areas which will support the paving machine and the area to be paved shall be trimmed or graded to the plan grade elevation and profile by means of a properly designed machine. The grade of the underlying surface shall be controlled by a positive grade control system using lasers, stringlines, or guide wires. If the density of the underlying surface is disturbed by the trimming operations, it shall be corrected by additional compaction and retested at the option of the Engineer before the concrete is placed except when stabilized subbases are being constructed. If damage occurs on a stabilized subbase, it shall be corrected full depth by the Contractor. If traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately before the placement of concrete. The prepared grade shall be moistened with water, without saturating, immediately ahead of concrete placement to prevent rapid loss of moisture from concrete. The underlying surface shall be protected so that it will be entirely free of frost when concrete is placed.

501-4.4 CONDITIONING OF UNDERLYING SURFACE, SIDE-FORM AND FILL-IN LANE CONSTRUCTION. The prepared underlying surface shall be moistened with water, without saturating, immediately ahead of concrete placement to prevent rapid loss of moisture from the concrete. Damage caused by hauling or usage of other equipment shall be corrected and retested at the option of the Engineers. If damage occurs to a stabilized subbase, it shall be corrected full depth by the Contractor. A template shall be provided and operated on the forms immediately in advance of the placing of all concrete. The template shall be propelled only by hand and not attached to a tractor or other power unit. Templates shall be adjustable so that they may be set and maintained at the correct contour of the underlying surface. The adjustment and operation of the templates shall be such as will provide an accurate retest of the grade before placing the concrete thereon. All excess material shall be removed and wasted. Low areas shall be

filled and compacted to a condition similar to that of the surrounding grade. The underlying surface shall be protected so that it will be entirely free from frost when the concrete is placed. The use of chemicals to eliminate frost in the underlying surface shall not be permitted.

The template shall be maintained in accurate adjustment, at all times by the Contractor, and shall be checked daily.

501-4.5 HANDLING, MEASURING, AND BATCHING MATERIAL. The batch plant site, layout, equipment, and provisions for transporting material shall assure a continuous supply of material to the work. Stockpiles shall be constructed in such a manner that prevents segregation and intermixing of deleterious materials.

Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Rail shipments requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage.

Batching plants shall be equipped to proportion aggregates and bulk cement, by weight, automatically using interlocked proportioning devices of an approved type. When bulk cement is used, the Contractor shall use a suitable method of handling the cement from weighing hopper to transporting container or into the batch itself for transportation to the mixer, such as a chute, boot, or other approved device, to prevent loss of cement. The device shall be arranged to provide positive assurance that the cement content specified is present in each batch.

501-4.6 MIXING CONCRETE. The concrete may be mixed at the work site, in a central mix plant 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 emptied into the drum. All concrete shall be mixed and delivered to the site according to the requirements of AASHTO M 157. Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators, or nonagitating trucks. The elapsed time from the addition of cementitious material to the mix until the concrete is deposited in place at the work site shall not exceed 30 minutes when the concrete is hauled in nonagitating trucks, nor 90 minutes when the concrete is hauled in truck mixers or truck agitators. Retempering concrete by adding water or by other means will not be permitted, except when concrete is delivered in transit mixers. With transit mixers additional water may be added to the batch materials and additional mixing performed to increase the slump to meet the specified requirements provided the addition of water is performed within 45 minutes after the initial mixing operations and provided the water/cementitious ratio specified in the mix design is not exceeded.

501-4.7 LIMITATIONS ON MIXING AND PLACING. 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 by the Engineer, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40 ºF and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35 ºF.

The aggregate shall be free of ice, snow, and frozen lumps before entering the mixer. The temperature of the mixed concrete shall not be less than 50 ºF at the time of placement. Concrete shall not be placed on frozen material nor shall frozen aggregates be used in the concrete.

When concreting is authorized during cold weather, water and/or the aggregates may be heated to not more than 150 ºF. The apparatus used shall heat the mass uniformly and shall be arranged to preclude the possible occurrence of overheated areas which might be detrimental to the materials.

501-4.8 PLACING CONCRETE. The Contractor has the option of side (fixed) form or slip-form paving. At any point in concrete conveyance, the free vertical drop of the concrete from one point to another or to the underlying surface shall not exceed 3 feet.

Hauling equipment or other mechanical equipment can be permitted on adjoining previously constructed lots of pavement when the concrete strength reaches a flexural strength of 550 psi, based on the average of three specimens, with no individual specimen below 525 psi when tested according to AASHTO T 97. Subgrade and subbase planers, concrete pavers, and concrete finishing equipment may be permitted to ride upon the edges of previously constructed pavement when the concrete has attained a minimum flexural strength of 400 psi.

a. Side-form Method. For the side-form method, the concrete shall be deposited on the moistened grade to require as little rehandling as possible. Unless truck mixers, truck agitators, or nonagitating hauling equipment are equipped with means for discharge of concrete without segregation of the materials, the concrete shall be placed and spread using an approved mechanical spreading device that prevents segregation of the materials. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Necessary hand spreading shall be done with shovels--not rakes. Workers shall not be allowed to walk in the freshly mixed concrete with boots or shoes coated with earth or foreign substances.

Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing them but shall not be dumped from the discharge bucket or hopper onto a joint assembly unless the hopper is centered above the joint assembly.

Concrete shall be thoroughly consolidated against and along the faces of all forms and previously placed concrete and along the full length and on both sides of all joint assemblies 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. In no case shall the vibrator be operated longer than 20 seconds in any one location, nor shall the vibrators be used to move the concrete.

b. Slip-form Method. For the slip-form method, the concrete shall be placed with an approved crawler-mounted, slip-form paver designed to spread, consolidate and shape the freshly placed concrete in one complete pass of the machine so that a minimum of hand finishing will be necessary to provide a dense and homogeneous pavement in conformance with requirements of the Plans and specifications. The concrete shall be placed directly on top of the joint assemblies to prevent them from moving when the paver moves over them. Side forms and finishing screeds shall be adjustable to the extent required to produce the specified pavement edge and surface tolerance. The side forms shall be of dimensions, shape, and strength to support the concrete laterally for a sufficient length of time so that no edge slumping exceeds the requirements of Subsection 501-5.2e(5). Final finishing shall be accomplished while the concrete is still in the plastic state.

In the event that slumping or sloughing occurs behind the paver or if there are any other structural or surface defects which, in the opinion of the Engineer, cannot be corrected within permissible tolerances, paving operations shall be immediately stopped until proper adjustment of the equipment or procedures have been made. In the event that satisfactory procedures and pavement are not achieved after not more than 2,000 linear feet of single lane paving, the Contractor shall complete the balance of the work with the use of standard metal forms and the formed method of placing and curing. Any concrete not corrected to permissible tolerances shall be removed and replaced at the Contractor's expense.

501-4.9 STRIKE-OFF OF CONCRETE AND PLACEMENT OF REINFORCEMENT. Following the placing of the concrete, it shall be struck off to conform to the cross section shown on the Plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement shall be at the elevation shown on the Plans. When reinforced concrete pavement is placed in two layers, the bottom layer shall be struck off to such length and depth that the sheet of reinforcing steel fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off, and screeded. If any portion of the bottom layer of concrete has been placed more than 30 minutes without being covered with the top layer or if initial set has taken place, it shall be removed and replaced with freshly mixed concrete at the Contractor's expense. 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 by mechanical or vibratory means after spreading.

Reinforcing steel, at the time concrete is placed, shall be free of mud, oil, or other organic matter that may adversely affect or reduce bond. Reinforcing steel with rust, mill scale or a combination of both will be considered satisfactory, provided the minimum dimensions, weight, and tensile properties of a hand wire-brushed test specimen are not less than the applicable AASHTO/ASTM specification requirements.

501-4.10 JOINTS. Joints shall be constructed as shown on the Plans and according to these requirements. All joints shall be constructed with their faces perpendicular to the surface of the pavement and finished or edged as shown on the Plans. Joints shall not vary more than 1/2 inch from their designated position and shall be true to line with not more than 1/4 inch variation in 10 feet. The surface across the joints shall be tested with a Contractor furnished 10-foot straightedge as the joints are finished and any irregularities in excess of 1/4 inch shall be corrected before the concrete has hardened. All joints shall be so prepared, finished, or cut to provide a groove of uniform width and depth as shown on the Plans.

a. Construction. Longitudinal construction joints shall be slip-formed or formed against side forms with or without keyways, as shown in the Plans.

Transverse construction joints shall be installed at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for more than 30 minutes or it appears that the concrete will obtain its initial set before fresh concrete arrives. The installation of the joint shall be located at a planned contraction or expansion joint. If placing of the concrete is stopped, the Contractor shall remove the excess concrete back to the previous planned joint.

b. Contraction. Contraction joints shall be installed at the locations and spacing as shown on the Plans. Contraction joints shall be installed to the dimensions required by forming a groove or cleft in the top of the slab while the concrete is still plastic or by sawing a groove into the concrete surface after the concrete has hardened. When the groove is formed in plastic concrete the sides of the grooves shall be finished even and smooth with an edging tool. If an insert material is used, the installation and edge finish shall be according to the manufacturer's instructions. The groove shall be finished or cut clean so that spalling will be avoided at intersections with other joints. Grooving or sawing shall produce a slot at least 1/8 inch wide and to the depth shown on the Plans.

c. Expansion. Expansion joints shall be installed as shown on the Plans. The premolded filler of the thickness as shown on the Plans, shall extend for the full depth and width of the slab at the joint, except for space for sealant at the top of the slab. The filler shall be securely staked or fastened into position perpendicular to the proposed finished surface. A cap shall be provided to protect the top edge of the filler and to permit the concrete to be placed and finished. After the concrete has been placed and struck off, the cap shall be carefully withdrawn leaving the space over the premolded filler. The edges of the joint shall be finished and tooled while the concrete is still plastic. Any concrete bridging the joint space shall be removed for the full width and depth of the joint.

d. Keyways. Keyways shall be formed in the plastic concrete by means of side forms or the use of keyway liners which are inserted during the slip-form operations. The keyway shall be formed to a tolerance of 1/4 inch in any dimension and shall be of sufficient stiffness to support the upper keyway flange without distortion or slumping of the top of the flange. The dimensions of the keyway forms shall not vary more than plus or minus 1/4 inch from the mid-depth of the pavement. Liners that remain in place permanently and become part of the keyed joint shall be made of galvanized, copper clad, or of similar rust-resistant material compatible with plastic and hardened concrete and shall not interfere with joint reservoir sawing and sealing.

e. Tie Bars. Tie bars shall consist of deformed bars installed in joints as shown on the Plans. Tie bars shall be placed at right angles to the centerline of the concrete slab and shall be spaced at intervals shown on the Plans. They shall be held in position parallel to the pavement surface and in the middle

of the slab depth. When tie bars extend into an unpaved lane, they may be bent against the form at longitudinal construction joints, unless threaded bolt or other assembled tie bars are specified. These bars shall not be painted, greased, or enclosed in sleeves. When slip-form operations call for tie bars, two-piece hook bolts can be installed in the female side of the keyed joint provided the installation is made without distorting the keyed dimensions or causing edge slump. If a bent tie bar installation is used, the tie bars shall be inserted through the keyway liner only on the female side of the joint. In no case shall a bent tie bar installation for male keyways be permitted.

f. Dowel Bars. Dowel bars or other load-transfer units of an approved type shall be placed across joints in the manner as shown on the Plans. They shall be of the dimensions and spacings as shown and held rigidly in the middle of the slab depth in the proper horizontal and vertical alignment by an approved assembly device to be left permanently in place. The dowel or load-transfer and joint devices shall be rigid enough to permit complete assembly as a unit ready to be lifted and placed into position. A metal, or other type, dowel expansion cap or sleeve shall be furnished for each dowel bar used with expansion joints. These caps shall be substantial enough to prevent collapse and shall be placed on the ends of the dowels as shown on the Plans. The caps or sleeves shall fit the dowel bar tightly and the closed end shall be watertight. The portion of each dowel painted with rust preventative paint, as required under Subsection 501-2.7 and shown on the Plans to receive a debonding lubricant, shall be thoroughly coated with asphalt MC-70, or an approved lubricant, to prevent the concrete from bonding to that portion of the dowel. If free-sliding plastic-coated or epoxy-coated steel dowels are used, a lubrication bond breaker shall be used except when approved pullout tests indicate it is not necessary. Where butt-type joints with dowels are designated, the exposed end of the dowel shall be oiled.

Dowel bars at contraction joints may be placed in the full thickness of pavement by a mechanical device approved by the Engineer. The device shall be capable of installing dowel bars within the maximum permissible alignment tolerances. Dowels bars at longitudinal construction joints shall be bonded in drilled holes.

g. Installation of Joint Devices. All joint devices shall be approved by the Engineer.

The top of an assembled joint device shall be set at the proper distance below the pavement surface and the elevation shall be checked. Such devices shall be set to the required position and line and shall be securely held in place by stakes or other means to the maximum permissible tolerances during the placing and finishing of the concrete. Where premolded joint material is used, it shall be placed and held in a vertical position; if constructed in sections, there shall be no offsets between adjacent units.

Dowel bars and assemblies shall be checked for position and alignment. The maximum permissible tolerances on dowel bar alignment shall be according to Subsection 501-5.2. During the concrete placement operation, it is advisable to place plastic concrete directly on dowel assemblies immediately prior to passage of the paver to help maintain dowel position and alignment within maximum permissible tolerances.

When concrete is placed using slip-form pavers, dowels and tie bars shall be placed in longitudinal construction joints by bonding the dowels or tie bars into holes drilled into the hardened concrete. Holes approximately 1/8 to 1/4 inch greater in diameter than the dowel or tie bar shall be drilled with rotary-type core drills that must be held securely in place to drill perpendicularly into the vertical face of the pavement slab. Rotary-type percussion drills may be used provided that spalling of concrete does not occur. Any damage of the concrete shall be repaired by the Contractor in a method approved by the Engineer. Dowels or tie bars shall be bonded in the drilled holes using an epoxy resin material. Installation procedures shall be adequate to insure that the area around dowels is completely filled with epoxy grout. Epoxy shall be injected into the back of the hole and displaced by the insertion of the dowel bar. Bars shall be completely inserted into the hole and shall not be withdrawn and reinserted creating air pockets in the epoxy around the bar. The Contractor shall furnish a template for checking the position and alignment of the dowels. Dowel bars shall not be

less than 10 inches from a transverse joint and shall not interfere with dowels in the transverse direction.

h. Sawing of Joints. Joints shall be cut as shown on the Plans. Equipment shall be as described in Subsection 501-4.1. The circular cutter shall be capable of cutting a groove in a straight line and shall produce a slot at least 1/8 inch wide and to the depth shown on the Plans. The top portion of the slot shall be widened by sawing to provide adequate space for joint sealers as shown on the Plans. Sawing shall commence as soon as the concrete has hardened sufficiently to permit cutting without chipping, spalling, or tearing and before uncontrolled shrinkage cracking of the pavement occurs. Sawing shall be carried on both during the day and night as required. The joints shall be sawed at the required spacing, consecutively in sequence of the concrete placement.

501-4.11 FINAL STRIKE-OFF, CONSOLIDATION, AND FINISHING.

a. Sequence. The sequence of operations shall be the strike-off, floating and removal of laitance, straightedging, and final surface finish. The addition of superficial water to the surface of the concrete to assist in finishing operations will not be permitted.

b. Finishing at Joints. The concrete adjacent to joints shall be compacted or firmly placed without voids or segregation against the joint material; it shall be firmly placed without voids or segregation under and around all load-transfer devices, joint assembly units, and other features designed to extend into the pavement. Concrete adjacent to joints shall be mechanically vibrated as required in Subsection 501-4.8a. After the concrete has been placed and vibrated adjacent to the joints, the finishing machine shall be operated in a manner to avoid damage or misalignment of joints. If uninterrupted operations of the finishing machine, to, over, and beyond the joints, cause segregation of concrete, damage to, or misalignment of the joints, the finishing machine shall be stopped when the screed is approximately 8 inches from the joint. Segregated concrete shall be removed from the front of and off the joint; and the forward motion of the finishing machine shall be resumed. Thereafter, the finishing machine may be run over the joint without lifting the screed, provided there is no segregated concrete immediately between the joint and the screed or on top of the joint.

c. Machine Finishing. The concrete shall be spread as soon as it is placed, and it shall be struck off and screeded by a finishing machine. The machine shall go over each area as many times and at such intervals as necessary to give to proper consolidation and to leave a surface of uniform texture. Excessive operation over a given area shall be avoided. When side forms are used, the tops of the forms shall be kept clean by an effective device attached to the machine, and the travel of the machine on the forms shall be maintained true without lift, wobbling, or other variation tending to affect the precision finish. During the first pass of the finishing machine, a uniform ridge of concrete shall be maintained ahead of the front screed for its entire length. When in operation, the screed shall be moved forward with a combined longitudinal and transverse shearing motion, always moving in the direction in which the work is progressing, and so manipulated that neither end is raised from the side forms during the striking-off process. If necessary, this shall be repeated until the surface is of uniform texture, true to grade and cross section, and free from porous areas.

d. Hand Finishing. Hand finishing methods will not be permitted, except under the following conditions: in the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade; in areas of narrow widths or of irregular dimensions where operation of the mechanical equipment is impractical. Concrete, as soon as placed, shall be struck off and screeded. An approved portable screed shall be used. A second screed shall be provided for striking off the bottom layer of concrete when reinforcement is used.

The screed for the surface shall be a least 24 inches longer than the maximum width of the slab to be struck off. It shall be of approved design, sufficiently rigid to retain its shape, and shall be constructed either of metal or of other suitable material covered with metal. Consolidation shall be attained by the use of suitable vibrators.

e. Floating. After the concrete has been struck off and consolidated, it shall be further smoothed and trued by means of a longitudinal float using one of the following methods:

(1) Hand Method. Long-handled floats shall not be less than 12 feet in length and 6 inches in width, stiffened to prevent flexibility and warping. The float shall be operated from foot bridges spanning but not touching the concrete or from the edge of the pavement. Floating shall pass gradually from one side of the pavement to the other. Forward movement along the centerline of the pavement shall be in successive advances of not more than one-half the length of the float. Any excess water or laitance in excess of 1/8 inch thick shall be removed and wasted.

(2) Mechanical Method. The Contractor may use a machine composed of a cutting and smoothing float(s), suspended from and guided by a rigid frame and constantly in contact with, the side forms or underlying surface. If necessary, long-handled floats having blades not less than 5 feet in length and 6 inches in width may be used to smooth and fill in open-textured areas in the pavement. When the crown of the pavement will not permit the use of the mechanical float, the surface shall be floated transversely by means of a long-handled float. Care shall be taken not to work the crown out of the pavement during the operation. After floating, any excess water and laitance in excess of 1/8 inch thick shall be removed and wasted. Successive drags shall be lapped one-half the length of the blade.

f. Straight-edge Testing and Surface Correction. After the pavement has been struck off and while the concrete is still plastic, it shall be tested for trueness with a Contractor furnished 16-foot straightedge swung from handles 3 feet longer than one-half the width of the slab. The straightedge shall be held in contact with the surface in successive positions parallel to the centerline and the whole area gone over from one side of the slab to the other, as necessary. Advancing shall be in successive stages of not more than one-half the length of the straightedge. Any excess water and laitance in excess of 1/8 inch thick shall be removed from the surface of the pavement and wasted. Any depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the smoothness requirements of Subsection 501-5.2. Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and until the slab conforms to the required grade and cross section. The use of long-handled wood floats shall be confined to a minimum; they may be used only in emergencies and in areas not accessible to finishing equipment.

501-4.12 SURFACE TEXTURE. The surface of the pavement shall be finished with either a broom, burlap drag, or artificial turf finish for all newly constructed concrete pavements. It is important that the texturing equipment not tear or unduly roughen the pavement surface during the operation. Any imperfections resulting from the texturing operation shall be corrected. The corrugations shall be uniform in appearance and approximately 1/16 inch in depth.

a. Brush or Broom Finish. If the pavement surface texture is to be a type of brush or broom finish, it shall be applied when the water sheen has practically disappeared. The equipment shall operate transversely across the pavement surface.

b. Burlap Drag Finish. If a burlap drag is used to texture the pavement surface, it shall be at least 15 oz/yd^2. To obtain a textured surface, the transverse threads of the burlap shall be removed approximately 1 foot from the trailing edge. A heavy buildup of grout on the burlap threads produces the desired wide sweeping longitudinal striations on the pavement surface.

c. Artificial Turf Finish. If artificial turf is used to texture the surface, it shall be applied by dragging the surface of the pavement in the direction of concrete placement with an approved full-width drag made with artificial turf. The leading transverse edge of the artificial turf drag will be securely fastened to a lightweight pole on a traveling bridge. At least 24 inches of the artificial turf shall be in contact with the concrete surface during dragging operations. A variety of different types of artificial

turf are available and approval of any one type will be done only after it has been demonstrated by the Contractor to provide a satisfactory texture. One type that has provided satisfactory texture consists of 7,200 approximately 0.85-inches-long polyethylene turf blades per square foot.

501-4.13 CURING. Immediately after finishing operations are completed and marring of the concrete will not occur, the entire surface of the newly placed concrete shall be cured for a 7-day cure period according to one of the methods below. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use, or lack of water to adequately take care 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 hour during the curing period. The concrete shall be maintained at a temperature of at least 50 ºF for a period of 72 hours after placing and at a temperature above freezing for the remainder of the curing time. The Contractor shall be responsible for the quality and strength of the concrete placed during cold weather, and any concrete injured by frost action shall be removed and replaced at the Contractor's expense.

a. Impervious Membrane Method. The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place. The curing compound shall not be applied during rainfall. Curing compound shall be applied by mechanical sprayers under pressure at the rate of 1 gallon to not more than 150 square feet. The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During application the compound shall be stirred continuously by mechanical means. Hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms will be permitted. The curing compound shall be of such character that the film will harden within 30 minutes after application. Should the film become damaged from any cause, including sawing operations, within the required curing period, the damaged portions shall be repaired immediately with additional compound or other approved means. Upon removal of side forms, the sides of the exposed slabs shall be protected immediately to provide a curing treatment equal to that provided for the surface.

b. Polyethylene Films. The top surface and sides of the pavement shall be entirely covered with polyethylene sheeting. The units shall be lapped at least 18 inches. The sheeting shall be placed and weighted to cause it to remain in contact with the surface and sides. The sheeting shall have dimensions that will extend at least twice the thickness of the pavement beyond the edges of the pavement. Unless otherwise specified, the sheeting shall be maintained in place for 7 days after the concrete has been placed.

c. Waterproof Paper. The top surface and sides of the pavement shall be entirely covered with waterproofed paper. The units shall be lapped at least 18 inches. The paper shall be placed and weighted to cause it to remain in contact with the surface covered. The paper shall have dimensions that will extend at least twice the thickness of the pavement beyond the edges of the slab. The surface of the pavement shall be thoroughly saturated prior to placing of the paper. Unless otherwise specified, the paper shall be maintained in place for 7 days after the concrete has been placed.

d. White Burlap-Polyethylene Sheets. The surface of the pavement shall be entirely covered with the sheeting. The sheeting used shall be such length (or width) that it will extend at least twice the thickness of the pavement beyond the edges of the slab. The sheeting shall be placed so that the entire surface and both edges of the slab are completely covered. The sheeting shall be placed and weighted to remain in contact with the surface covered, and the covering shall be maintained fully saturated and in position for 7 days after the concrete has been placed.

501-4.14 REMOVING FORMS. Unless otherwise specified, forms shall not be removed from freshly placed concrete until it has hardened sufficiently to permit removal without chipping, spalling, or tearing but in no case, less than 24 hours. After the forms have been removed, the sides of the slab shall be cured as outlined in one of the methods indicated in Subsection 501-4.14. Major honeycombed areas shall be considered as defective work and shall be removed and replaced according to Subsection 501-5.2.

501-4.15 SEALING JOINTS. The joints in the pavement shall be sealed according to Section P-605.

501-4.16 PROTECTION OF PAVEMENT. The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by the Contractor's employees and agents. This shall include workers to direct traffic and the erection and maintenance of warning signs, lights, pavement bridges, crossovers, and protection of unsealed joints from intrusion of foreign material, etc. Any damage to the pavement occurring prior to final acceptance shall be repaired or the pavement replaced at the Contractor's expense. The Contractor shall have available at all times, materials for the protection of the edges and surface of the unhardened concrete. Such protective materials shall consist of rolled polyethylene sheeting at least 4 mils thick of sufficient length and width to cover the plastic concrete slab and any edges. The sheeting may be mounted on either the paver or a separate movable bridge from which it can be unrolled without dragging over the plastic concrete surface. When rain appears imminent, all paving operations shall stop and all available personnel shall begin covering the surface of the unhardened concrete with the protective covering.

501-4.17 OPENING TO TRAFFIC. The pavement shall not be opened to traffic until test specimens molded and cured according to WAQTC FOP for AASHTO T 23 have attained a flexural strength of 550 psi when tested according to AASHTO T 97. If such tests are not conducted, the pavement shall not be opened to traffic until 14 days after the concrete was placed. Prior to opening to traffic, the pavement shall be cleaned.

MATERIAL ACCEPTANCE

501-5.1 ACCEPTANCE SAMPLING AND TESTING. All acceptance sampling and testing, with the exception of coring for thickness determination, necessary to determine conformance with the requirements specified in this subsection will be performed by the Engineer. Concrete will be accepted for strength and thickness on a lot basis. After initial curing, the Contractor shall deliver the beams to the Central Region Materials Laboratory (5750 Tudor Road, Anchorage, Alaska) or the Northern Region Materials Laboratory (2301 Peger Road, Fairbanks, Alaska); or the Southeast Region Materials Laboratory (6860 Glacier Highway, Juneau, Alaska); as directed by the Engineer, for final curing and/or acceptance testing. Deliver cores for measuring thickness to the Project Engineer.

Lot Size. A lot will consist of 1000 cubic yards.

a. Flexural Strength.

(1) Sampling. Each lot will be divided into five equal sublots. One sample shall be taken for each sublot from the plastic concrete delivered to the job site. Sampling locations will be determined by the Engineer according to random sampling procedures contained in ASTM D 3665. The concrete shall be sampled according to WAQTC TM 2. The Contractor shall make and initially cure the number of flexural beam specimens specified according to WAQTC FOP for AASHTO T 23. Each beam shall be between 20 and 30 inches in length..

(2) Testing. Two specimens shall be made from each sample. The flexural strength of each specimen shall be determined according to AASHTO T 97 at a loading rate that constantly increases the extreme fiber stress at the mid-point of the allowable range. Test results will be checked for outliers as described in Subsection 501-5.1.d. and outliers will be discarded. The flexural strength for each sublot will be computed by averaging the results of the remaining test specimens representing that sublot.

(3) Curing. The Contractor shall provide adequate facilities for the initial curing of beams according to WAQTC FOP for AASHTO T 23.

(4) Acceptance. Acceptance of pavement for flexural strength will be determined by the Engineer according to Subsection 501-5.2.

b. Pavement Thickness. Pavement placed using fixed forms shall not be cored. Sampling and testing will be accomplished by inspection and measurement of the forms prior to and after placing of concrete. Sampling and testing for pavement placed with slipform paving methods will be as follows:

(1) Sampling. Each lot will be divided into four equal sublots and one core shall be taken by the Contractor for each sublot. Sampling locations will be determined by the Engineer according to random sampling procedures contained in ASTM D 3665. Areas, such as thickened edges, with planned variable thickness, will be excluded from sample locations.

Cores shall be neatly cut with a core drill. The Contractor shall furnish all tools, labor, and materials for cutting samples and filling the cored hole. Core holes shall be filled by the Contractor with a non-shrink grout approved by the Engineer within one day after sampling.

(2) Testing. The thickness of the cores will be determined by the Engineer by the average caliper measurement according to AASHTO T 148.

(3) Acceptance. Acceptance of pavement for thickness will be determined by the Engineer according to Subsection 501-5.2.

c. Partial Lots. When sampling for flexural strength, if 150 cubic yards or less remain to complete the project quantity, it will be considered as part of the previous sublot. If more than 150 cubic yards remain, it will be considered as a complete sublot and sampled and tested as such.

If a project has more than 1 lot and less than 4 additional sublots have been sampled at the time a lot is terminated, the additional sublots will be included in the previous lot. If 4 or more additional sublots have been sampled, they will be considered as a separate lot and the acceptance criteria calculation will be based on the actual number of samples in the shortened lot.

d. Outliers. All individual flexural strength tests within a lot will be checked for an outlier (test criterion) according to ATM, SP-7. Outliers will be discarded, and the PWL will be determined using the remaining test values.

e. Yield, Cement Content, and Air Content. Acceptance of pavement for yield, cement content, and air content will be determined by the Engineer according to Subsection 501-5.2 at the testing rate of 1 test series per 200 cubic yards.

501-5.2 ACCEPTANCE CRITERIA.

a. General. Acceptance will be based on the following characteristics of the completed pavement:

(1) Flexural strength
(2) Thickness
(3) Smoothness
(4) Grade
(5) Edge slump
(6) Dowel bar alignment
(7) Yield, cement content, and air content

Flexural strength and thickness will be evaluated for acceptance on a lot basis using the method of estimating percentage of material within specification limits (PWL). Acceptance using PWL considers the variability (standard deviation) of the material and the testing procedures, as well as the average (mean) value of the test results to calculate the percentage of material that is above the lower specification tolerance limit (L).

Acceptance for flexural strength will be based on the criteria contained according to Subsection 501-5.2e(1). Acceptance for thickness will be based on the criteria contained in Subsection 501-5.2e(2).

Acceptance for smoothness will be based on the criteria contained in Subsection 501-5.2e(3). Acceptance for grade will be based on the criteria contained in Subsection 501-5.2e(4).

The Engineer may at any time reject and require the Contractor to dispose of any batch of concrete mixture which is rendered unfit for use due to contamination, segregation, or improper slump. Such rejection may be based on only visual inspection. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the Engineer, and if it can be demonstrated in the laboratory, in the presence of the Engineer, that such material was erroneously rejected, payment will be made for the material at the contract unit price.

b. Flexural Strength. Acceptance of each lot of in-place pavement for flexural strength will be based on PWL. The Contractor shall target production quality to achieve 90 PWL or higher.

c. Pavement Thickness. Acceptance of each lot of in-place pavement will be based on PWL. The Contractor shall target production quality to achieve 90 PWL or higher.

d. Percentage of Material Within Limits (PWL). The PWL will be determined according to procedures specified in Section 110 of the General Provisions.

The lower specification tolerance limit (L) for flexural strength and thickness will be:

Lower Specification Tolerance Limit (L)	
Flexural Strength	0.93 x strength specified in Subsection 501-3.1
Thickness	Plan Thickness - 0.5 inch

e. Acceptance Criteria.

(1) Flexural Strength. If the PWL of the lot equals or exceeds 90%, the lot will be acceptable. Acceptance and payment for the lot will be determined according to Subsection 501-8.1.

(2) Thickness. If the PWL of the lot equals or exceeds 90%, the lot will be acceptable. Acceptance and payment for the lot will be determined according to Subsection 501-8.1.

(3) Smoothness. As soon as the concrete has hardened sufficiently, the pavement surface will be tested with a 12-foot straightedge or other specified device. Surface smoothness deviations shall not exceed 1/4 inch from the straightedge placed in any direction, including placement along and spanning any pavement joint edge.

Areas in a slab showing high spots of more than 1/4 inch but not exceeding 1/2 inch in 12 feet shall be marked and immediately ground down with an approved grinding machine to an elevation that will fall within the tolerance of 1/4 inch or less. Where the departure from correct cross section exceeds 1/2 inch, the pavement shall be removed and replaced at the expense of the Contractor when so directed by the Engineer.

(4) Grade. An evaluation of the surface grade will be made by the Engineer for compliance to the tolerances contained below.

(a) Lateral Deviation. Lateral deviation from established alignment of the pavement edge shall not exceed plus or minus 0.10 foot in any lane.

(b) Vertical Deviation. Vertical deviation from established grade shall not exceed plus or minus 0.05 foot at any point.

(5) Edge Slump. When slip-form paving is used, not more than 15% of the total free edge of each 500-foot segment of pavement, or fraction thereof, shall have an edge slump exceeding 1/4 inch, and none of the free edge of the pavement shall have an edge slump exceeding 3/8 inch. (The

total free edge of 500 feet of pavement will be considered the cumulative total linear measurement of pavement edge originally constructed as nonadjacent to any existing pavement; i.e., 500 feet of paving lane originally constructed as a separate lane will have 1,000 feet of free edge, 500 feet of fill-in lane will have no free edge, etc.). The area affected by the downward movement of the concrete along the pavement edge shall be limited to not more than 18 inches from the edge. When excessive edge slump cannot be corrected before the concrete has hardened, the area with excessive edge slump shall be removed and replaced at the expense of the Contractor when so directed by the Engineer.

(6) Dowel Bar Alignment. Dowel bars and assemblies will be checked for position and alignment. The maximum permissible tolerance on dowel bar alignment in each plane, horizontal and vertical, shall not exceed 2% (or 1/4 inch per foot) of a dowel bar.

(7) Yield, Cement Content, and Air Content. Yield, cement content, and air content will be determined according to WAQTC FOP for AASHTO T 121 and T 152.

f. Removal and Replacement of Concrete. Any area or section of concrete that is removed and replaced shall be removed and replaced back to planned joints. The Contractor shall replace damaged dowels and the requirements for doweled longitudinal construction joints in Subsection 501-4.10 shall apply to all contraction joints exposed by concrete removal.

CONTRACTOR QUALITY CONTROL

501-6.1 QUALITY CONTROL PROGRAM. The Contractor shall develop a Quality Control Program according to Section 100 of the General Provisions. The program shall address all elements which affect the quality of the pavement including but not limited to:

a. Mix Design	**e.** Proportioning	**i.** Dowel Placement and Alignment
b. Aggregate Gradation	**f.** Mixing and Transportation	**j.** Flexural Strength
c. Quality of Materials	**g.** Placing and Consolidation	**k.** Finishing and Curing
d. Stockpile Management	**h.** Joints	**l.** Surface Smoothness

501-6.2 QUALITY CONTROL TESTING. The Contractor shall perform all quality control tests necessary to control the production and construction processes applicable to this specification and as set forth in the Quality Control Program. The testing program shall include, but not necessarily be limited to, tests for aggregate gradation, aggregate moisture content, slump, and air content.

A Quality Control Testing Plan shall be developed as part of the Quality Control Program.

a. Fine Aggregate.

(1) Gradation. A sieve analysis shall be made at a minimum of every 100 cubic yards according to WAQTC FOP for AASHTO T 27/T 11 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

(2) Moisture Content. If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made according to WAQTC FOP for AASHTO T 255/T 265.

b. Coarse Aggregate.

(1) Gradation. A sieve analysis shall be made at a minimum of every 100 cubic yards for each size of aggregate. Tests shall be made according to WAQTC FOP for AASHTO T 27/T 11 from

randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

(2) Moisture Content. If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made according to WAQTC FOP for AASHTO T 255/T 265.

c. Slump. Slump tests shall be performed for every 100 cubic yards of material produced. Slump tests shall be performed according to WAQTC FOP for AASHTO T 119 from material randomly sampled from material discharged from trucks at the paving site. Material samples shall be taken according to WAQTC TM 2.

d. Air Content. Air content tests, shall be performed for every 100 cubic yards of material produced. Air content tests shall be performed according to WAQTC FOP for AASHTO T 152, from material randomly sampled from trucks at the plant site. Material samples shall be taken according to WAQTC TM 2.

501-6.3 CONTROL CHARTS. The Contractor shall maintain linear control charts for fine and coarse aggregate, gradation, slump, and air content.

Control charts shall be posted in a location satisfactory to the Engineer and shall be kept up to date at all times. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the Action and Suspension Limits, or Specification limits, applicable to each test parameter, and the Contractor's test results. The Contractor shall use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the Contractor's projected data during production indicates a potential problem and the Contractor is not taking satisfactory corrective action, the Engineer may halt production or acceptance of the material.

a. Fine and Coarse Aggregate Gradation. The Contractor shall record the running average of the last five gradation tests for each control sieve on linear control charts. Specification limits contained in Tables 1 and 2 shall be superimposed on the Control Chart for job control.

b. Slump and Air Content. The Contractor shall maintain linear control charts both for individual measurements and range (i.e., difference between highest and lowest measurements) for slump and air content according to the following Action and Suspension Limits.

CONTROL CHART LIMITS
Based on Sample Size n=4

Control Parameter	Individual Measurements		Range Suspension Limit
	Action Limit	Suspension Limit	
Slump	+/- 1 in.	+/- 1.5 inch	+/- 2.4 inch
Air Content	+/- 1.2%	+/- 1.8%	+/- 2.8%

The individual measurement control charts shall use the mix design Target Values as indicators of central tendency.

501-6.4 CORRECTIVE ACTION. The Quality Control Plan shall indicate that appropriate action shall be taken when the process is believed to be out of control. The Quality Control Plan shall detail what action will be taken to bring the process into control and shall contain sets of rules to gauge when a process is out of control. As a minimum, a process shall be deemed out of control and corrective action taken if any one of the following conditions exists.

a. Fine and Coarse Aggregate Gradation. When two consecutive averages of five tests are outside of the Tables 1 or 2 specification limits, immediate steps, including a halt to production, shall be taken to correct the grading.

b. Fine and Coarse Aggregate Moisture Content. Whenever the moisture content of the fine or coarse aggregate changes by more than 0.5%, the scale settings for the aggregate batcher(s) and water batcher shall be adjusted.

c. Slump. The Contractor shall halt production and make appropriate adjustments whenever:

(1) one point falls outside the Suspension Limit line for individual measurements or range; or

(2) two points in a row fall outside the Action Limit line for individual measurements.

d. Air Content. The Contractor shall halt production and adjust the amount of air-entraining admixture whenever:

(1) one point falls outside the Suspension Limit line for individual measurements or range; or

(2) two points in a row fall outside the Action Limit line for individual measurements.

Whenever a point falls outside the Action Limits line, the air-entraining admixture dispenser shall be calibrated to ensure that it is operating correctly and with good reproducibility.

METHOD OF MEASUREMENT

501-7.1 Portland cement concrete pavement will be measured by the number of cubic yards of pavement as specified in place, completed and accepted.

BASIS OF PAYMENT

501-8.1 PAYMENT. Payment for accepted concrete pavement will be made at the contract unit price per cubic yard, adjusted according to Subsection 501-8.1a.

Payment shall be full compensation for all labor, materials, tools, equipment, and incidentals required to complete the work as specified herein and on the drawings.

a. Basis of Adjusted Payment. The pay factor for each individual lot will be calculated according to Table 1. A pay factor will be calculated for both flexural strength and thickness. The lot pay factor will be the lower of the two pay factors.

TABLE 1. PRICE ADJUSTMENT SCHEDULE

Percentage of Material Within Specification Limits (PWL)	Pay Factor
96 – 100	1.05
90 – 95	0.01 PWL + 0.10
75 - 89	0.005 PWL + 0.55
55 – 74	0.14 PWL – 0.12
Below 55	0*

*If the PWL falls below 55, the lot shall be removed and replaced. However, the Engineer may decide to allow the rejected lot to remain. In that case, if the Engineer and Contractor agree in writing that the lot shall not be removed, the pay factor for the lot shall be 0.50.

For each lot accepted, the adjusted contract unit price shall be the product of the lot pay factor for the lot and the contract unit price.

b. Payment. Payment will be made under:

Item P-501a Portland Cement Concrete Pavement - per cubic yard

TESTING REQUIREMENTS

AASHTO T 26	Quality of Water to be Used in Concrete
AASHTO T 96	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
AASHTO T 97	Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C 1077	Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM D 3665	Random Sampling of Construction Materials
ATM 306	Percentage of Flat and Elongated Particles in Coarse Aggregate
ATM SP-7	Determination of Outlier Test Results
WAQTC FOP for AASHTO T 23	Making & Curing Concrete Test Specimens in the Field
WAQTC FOP for AASHTO T 27/T 11	Sieve Analysis of Aggregates & Soils
WAQTC FOP for AASHTO T 119	Slump of Freshly Mixed Concrete
WAQTC FOP for AASHTO T 121	Unit Weight, Cement Factor & Water/Cement Ratio of Freshly Mixed Concrete
WAQTC FOP for AASHTO T 152	Air Content of Freshly Mixed Concrete by the Pressure Method
WAQTC FOP for AASHTO T 255/T 265	Moisture Content of Aggregate and Soils
WAQTC TM 2	Sampling Freshly Mixed Concrete

MATERIAL REQUIREMENTS

AASHTO M 6	Fine Aggregate for Portland Cement Concrete
AASHTO M 31	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
AASHTO M 43	Sizes of Aggregate for Road and Bridge Construction
AASHTO M 55	Steel Welded Wire Reinforcement, Plain, for Concrete
AASHTO M 80	Coarse Aggregate for Portland Cement Concrete
AASHTO M 85	Portland Cement

AASHTO M 148	Liquid Membrane-Forming Compounds for Curing Concrete
AASHTO M 154	Air-Entraining Admixtures for Concrete
AASHTO M 157	Ready-Mixed Concrete
AASHTO M 171	Sheet Materials for Curing Concrete
AASHTO M 194	Chemical Admixtures for Concrete
AASHTO M 213	Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
AASHTO M 235	Epoxy Resin Adhesives
AASHTO M 254	Corrosion-Resistant Coated Dowel Bars
AASHTO M 295	Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
AASHTO M 322	Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ACI 306R	Cold Weather Concreting

Federal Specification TT-P-664