# DIVISION 500

# RIGID PAVEMENT

## SECTION 501

## PORTLAND CEMENT CONCRETE PAVEMENT

**501.01 Description**. This work shall consist of constructing a pavement composed of portland cement concrete, constructed on a prepared subbase or base course in a monolithic course in accordance with these specifications and in conformity with the lines, grades, thickness and typical cross-sections shown on the plans or established by the Engineer. Concrete pavement shall normally be constructed using a slip-form paver and stationary side forms shall be used where necessary.

MATERIALS

**501.02 Portland Cement, Fly Ash, and Water-Granulated Blast-Furnace Slag**. Portland cement, fly ash and water-granulated blast-furnace slag shall meet the requirements of Subsections **701.02**, **701.03**, and **701.04** respectively.

When fly ash or water-granulated blast-furnace slag is used, it shall be used in accordance with the requirements contained in Subsection **701.25**.

**501.03 Air-Entraining Admixtures**. Unless otherwise specified, all concrete shall be air-entrained. Air-entraining admixtures shall comply with the requirements of Subsection **701.06**.

**501.04 Fine Aggregate**. Fine aggregate shall meet the requirements as specified in Subsection **701.10**.

**501.05 Coarse Aggregate**. Coarse aggregate shall be Ag-

gregate No. 56 or Aggregate No. 57, meeting gradation and quality requirements as specified in Subsection **701.11**.

After designated sources are approved by Research and Materials Laboratory tests, no change in the sources or character of the material shall be made without due notice to the Engineer and further approval by the Research and Materials Laboratory.

**501.06 Water**. Water shall meet the requirements of Subsection **701.12**.

**501.07 Joint Fillers**. Filler for preformed or sawed joints shall be the type specified and shall be placed in accordance with joint details as shown in the plans. All materials shall be used in accordance with the manufacturer's recommendations regarding preparation of joint walls, application temperatures and necessary equipment to assure proper material placement.

**A. Preformed Joint Filler**. Preformed joint filler shall conform to the requirement of AASHTO M 213. All preformed joint fillers shall have a thickness equal to the width of the joint required and shall be furnished in lengths equal to the width of the slabs in which they are to be installed. The preformed joint filler shall be so shaped that, after installation, the upper and lower surfaces will conform to the shape of the slab and subbase surfaces. The lower surface of the preformed joint filler shall be on or below the surface of the subbase and the upper surface, unless otherwise specified, shall be 1/2 inch below the surface of the slab.

A preformed material composed of 100% scrap tire rubber, shredded and fused into cohesion with a non-toxic, odorless, and tasteless formulated polyurethane binder will be allowed. The shreds shall be treated to resist most types of microbes, oils, fungi, and biological growth. It shall comply with physical properties of AASHTO M 153, (ASTM D 1752, Type I.)

**B. Silicone Sealant**. Silicone sealant shall be low modulus and furnished in a one-part silicone formulation. The sealant shall be compatible with the surface to which it is applied. The silicone sealant shall not require heat or primers in order to attain a bond to the joint walls. Acid cure silicone sealants are not acceptable for use on portland cement concrete. Silicone sealant shall be from a approved source on the Department's approval list entitled *Silicone Sealants for Portland Cement Concrete Pavements*. Sawed joints (transverse and longitudinal), unless otherwise specified, shall be filler will a silicone sealant

After source approval, the manufacturer shall furnish with each shipment of materials a certification showing brand name, South Carolina File Number for the project, the shipping date, to whom it is shipped, and the quantity represented in the shipment. The certificate shall contain a statement that the material meets the Department's specifications and is essentially the same as that approved by the Department. The shipped containers shall be plainly marked with the manufacturer's name, lot number, trademark, type of silicone, and end of shelf life date. A materials safety data sheet and installation instruction shall be furnished with each shipment.

**C. Bond Breaker**. Silicone sealant must be installed over a bond breaker to prevent the sealant form bonding to the bottom of the joint. Bond breaker shall be chemically inert and resistant to oils, gasoline, and solvents. The bond breaker must not stain or adhere to the sealant. Bond breaker shall be a backer rod or tape identified and used in accordance with the plans.

The backer rod shall be of circular cross-section and consist of closed cell polyethylene foam. Generally, it will be 25% greater diameter than the saw cut width.

Bond breaker tape shall be 0.005 inch minimum thick-

ness made from extruded polyethylene and shall have a

pressure sensitive adhesive on one side.

A certification shall be furnished by the manufacturer of the backer rod stating that it complies with the Department specification for closed cell polyethylene foam and that the tape is the polyethylene type.

**D. Hot Poured Joint Sealant**. Hot poured joint sealant shall conform to the requirements of AASHTO M 301 (ASTM D 3405).

**501.08 Reinforcing Steel**. Reinforcing steel bars for use in concrete pavement shall be of the type, length, size, spacing and quantity shown on the plans and shall meet the requirements specified in Section **703** and hereinafter specified.

**501.09 Tie Bars, Dowel Bars, and Reinforcements**. Tie bars and reinforcing steel shall be deformed steel bars conforming to AASHTO M 31, (ASTM A 615), Grade 60. Dowel bars shall be plain, round bars conforming to the requirements of AASHTO M 31 or M 42 (ASTM A 615 or A 616), Grade 60. They shall be free from burring or other deformation restricting slippage in concrete. Dowel bars shall be coated with an approved material to break the bond between the steel and concrete. Sleeves for dowel bars at expansion joints shall be metal of an approved design to cover 2 inches (±1/4 inch) of the dowel, have a closed end, and have a suitable stop to hold the end of the sleeve at least one inch from the end of the dowel bar.

Wire and wire mesh shall conform to the requirements specified in Section **703**.

**501.10 Curing Materials**. Curing materials shall conform to the following requirements:

**A. Burlap Cloth Made from Jute or Kenaf**. This material shall conform to AASHTO M 182, Class 3 (10 ounces/yard) or Class 4 (12 ounces/yard).

**B. Sheet Materials for Curing Concrete**. Waterproof paper, polyethylene film, and white burlap-polyethylene sheet shall conform to the requirements of AASHTO M 171.

**C. Liquid Membrane-Forming Compounds**. Liquid curing compounds shall meet the requirements of Subsection **702.04**.

**501.11 Paving Concrete**. Paving concrete shall conform to the following requirements:

**A. Proportions**. Concrete shall be composed of portland cement, fine aggregate, coarse aggregate, fly ash, water-granulated blast-furnace slag, water and chemical admixtures and shall meet the requirements of Subsection **701.20** to produce concrete of the specified strength and workability.

**B. Concrete Strength**. The mix will be designed to produce concrete with a minimum job average flexural strength of 550 psi at the age of 14 days. The concrete shall contain the amount of cement as directed by the Engineer but in no case shall the concrete contain less than 5.5 bags of cement or allowable equivalent when using fly ash or slag per cubic yard of concrete. The water cement ratio, including moisture on the aggregates, shall not be more than 0.53 (6 gal. / bag). This shall be maintained by use of chemical admixtures and/or additional cement if necessary.

**C. Trial Batches**. At least forty-five (45) days before the beginning of concrete placement, a proposed mix design with data shall be furnished by the Contractor to the Research and Materials Laboratory for mix design approval. Trial batch tests shall be performed using proposed materials furnished by the Contractor. These tests shall be conducted at the Research and Materials Laboratory in Columbia or at the Contractor's facilities under the supervision of the Research and Materials Laboratory person-

nel. Selection of the location shall be at the sole discretion of the Research and Materials Engineer.

The concrete mix will first be batched with the proportioning as proposed by the Contractor. Should the proposed design not give adequate strength and workability and meet all the physical requirements, it will be redesigned to the satisfaction of the Contractor and the Engineer.

Concrete from the trial batches will be molded, cured and tested in accordance with AASHTO T 97 to determine the flexural strength of the concrete at the age of fourteen (14) days. From the trial batch tests, an approved mix design will be established and furnished to the Contractor. A furnished mix design will not relieve the Contractor from producing quality concrete and will not limit further negotiating of changes in the mix design if necessary.

**D. Workability of Concrete**. Concrete shall be uniformly plastic and workable. The consistency of the concrete shall be determined by the slump test in accordance with SC-T-42. The slump shall be in the range of 1 to 21/2 inches for slip-form paving and 4 inches maximum for hand or other means of paving. Additional slump shall be obtained by the addition of chemical admixtures while maintaining the job approved water cement ratio. The Contractor shall strive to provide a uniform slump of approximately 2 inches for slip-form paving equipment. The percentage of entrained air voids in the mix shall be from 3% to 6%. When the concrete fails to meet the requirements for workability, the mix design will be adjusted to correct the condition.

Batches produced which have slumps and air void contents outside the above stated ranges shall not be used in the work.

**E. Field Sampling and Curing**. After the mix proportions and water cement ratio required to produce concrete of

the specified strength have been determined, placing of the concrete may be started. The strength of the concrete in the completed pavement will be determined by flexural strength test specimens made in 6 inches x 6 inches x 20 inches steel molds. Test beams will be made in accordance with SC-T-46.

A minimum of four beam specimens shall be made to represent each day's run or each 1500 cubic yards of concrete, whichever is smaller.

**F. Testing**. The beams made and cured as specified above will be tested as follows to determine the flexural strength at 14 days. One beam of the set may be tested at 3 to 7 days or as directed by the Engineer in order to anticipate the 14-day strength. If based on previous experience, the 3 to 7 day projections indicate that the 14-day strength will be below that specified, appropriate mix adjustments will be made. One beam of each set will be tested at 14 days in the field laboratory or in the Research and Materials Laboratory. Two beams of each set will be tested at 14 days in the Research and Materials Laboratory. The 14-day average strength shall be computed by averaging the results of the above 3 beams.

Individual beam strength values that are more than 10% above or below the strength for the set of 3 beams may be rejected as non-representative.

When the concrete fails to meet the requirements for workability or strength, the Contractor will correct the condition by changing the mix design. When testing indicates that a concrete batch has a 14-day flexural strength of 500 psi or less, the Engineer will investigate the causes of the low test results. The Engineer, at his discretion, may require the material to be replaced or accepted at a reduced pay factor if it is determined that the low test results are due to nonconforming concrete rather than normal test variation.

**G. Re-tempering and Admixtures**. Re-tempering concrete by adding water or by other means will not be permitted. Concrete that is not within the specified slump limits at the time of placement shall not be used. Admixtures for changing the workability for accelerating the set will be permitted only when there has been an acceptable mix design authorized by the Engineer.

**501.12 Field Materials Tests**. The Contractor shall furnish the concrete necessary for making concrete job control test specimens. He shall also furnish necessary labor to obtain samples, make specimens, and testing of materials as required in the quality control process.

## EQUIPMENT

**501.13 Equipment**. All equipment and tools necessary for handling materials and performing all parts of the work shall be on the job site sufficiently ahead of the start of construction operations to be examined thoroughly and approved by the Engineer. The equipment shall be maintained in a satisfactory working condition at all times until completion of the work.

**A. Subbase Planer**. The subbase planer shall have a cutting edge or edges, set to conform accurately to the specified subbase elevations. The planer shall be fully energized, self-propelled, and designed for the specific purpose of planing the subbase to the true grade and cross-section. Scratch planers with spikes or teeth will not be permitted.

**B. Batching Plant and Equipment**.

**1. General**. The batching plant shall include bins, meters, weighing hoppers and scales for weighing and measuring the fine aggregate, the coarse aggregate, cement, fly ash, slag, water and admixtures. The cement weighing hoppers shall be properly sealed and vented to preclude dusting during operations. The

batch plant shall be equipped with a suitable batch counter which will correctly indicate the number of batches proportioned. The batching plant may be manually controlled or automatically controlled.

All batching equipment in automatic plants shall be interlocked so that a new weighing cycle cannot be started until the weigh hopper is empty; the scales are in balance; and the discharge gates and the supply valves included in the system are closed. The automatic batching equipment shall be capable of conversion to manual operation if necessary.

The designated batch weights for bulk cement and each separate aggregate component shall be verified as directed by the Engineer before the batch cycle starts. The Contractor shall make satisfactory provisions for batching other components of the mix at the batching plant or at the roadside paver as may be necessary.

**2. Bins and Hoppers**. Bins with adequate separate compartments for fine aggregate and coarse aggregate shall be provided at the batching plant. Each compartment shall discharge efficiently and freely into the weighing hopper or hoppers and shall be equipped to control the discharge at variable speeds and to shut off cleanly for proper proportioning. Means shall be provided to enable the removal of overloads of the aggregates before their being charged into the mixer. Weighing hoppers shall be constructed to eliminate accumulations of tare materials and to discharge fully without jarring the scales. Partitions between compartments, both in bins and in hoppers shall be ample to prevent spilling under any working conditions.

**3. Scales, Meters, and Dispensers**. The scales for weighing aggregates, water, and cement shall be of beam type, springless dial type, or load cell type. They shall be accurate within 0.5%, when used for cement

and within 1.0% when used for aggregate and water under operation conditions throughout the range of use. When beam-type scales are used, provisions, 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 the weighing beams shall indicate the critical position clearly. Poises shall be designed to be locked in any position to prevent accidental change of position. The weigh beam and “tell-tale” device shall be in full view of the operator while charging the hopper and the operator shall have convenient access to all controls. Clearance between scale parts, hoppers and bin structure shall be such as to avoid displacement of, or friction between, parts due to accumulations, vibration, or other causes. Pivot mountings shall be designed so that none of the parts will jar loose and to assure unchanged spacing of knife-edges. Scales shall be so designed that all exposed fulcrums, clevises, and similar working parts may readily be kept clean. Weigh beams shall have leveling lugs, and weighing parts of other type scales shall be provided with means for precision adjustment. Scales shall be inspected and sealed at the expense of the Contractor as often as may be deemed necessary by the Engineer to assure their continued accuracy.

Cement shall be measured by weight on a separate scale and hopper. A boot or other approved means to transfer the cement from the weighing hopper shall be provided. Satisfactory methods of handling shall be employed.

Weighing of each material shall be such that the batch weights required will be within a tolerance of one percent for cement and water and two percent for aggregates. Meters for measuring water shall operate within a tolerance of one percent.

Separate devices, accurate within 3%, easily ad-

justable and satisfactory to the Engineer, shall be provided in the system for measuring the amounts of chemical admixtures to be added to each batch.

**C. Mixers.**

**1. General.** Concrete shall be mixed in central mix plants, except that truck mixers and roadside pavers may be used when authorized by the Engineer. Each mixer shall have attached to it, in a prominent place, a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the recommended speed of rotation of the mixing drum or blades.

Mixers shall be examined daily for accumulation of hard concrete or mortar and wear of blades. The Contractor shall have available at the job site, a copy of the manufacturer's design showing dimensions and arrangement of blades in reference to original height and depth. The blades shall be repaired or replaced when they are worn down one inch or more.

**2. Central Mixing Plant.** Central mixing plants shall meet the requirements set forth in Subsection **701.15**.

**3. Truck Mixers.** Truck mixers shall meet the requirements set forth in Subsection **701.16**.

**4. Roadside Paver Mixers.** Roadside mixers, where allowed by the Engineer, shall be original in design and in good working condition. Each mixer shall be inspected and approved by the Engineer before starting work.

**D. Transporting Vehicles.**

**1. Non-Agitator Trucks.** Bodies of non-agitating hauling equipment for centrally mixed concrete shall be metal with rounded internal corners. They shall be

equipped with vibrators and shall be capable of discharging the concrete at a satisfactorily controlled rate without segregation.

**2. Truck Mixers and Truck Agitators**. Truck mixers used for mixing and hauling concrete shall meet the requirements set forth in Subsection **701.16**.

**3. Dry Batch Trucks**. Vehicles for transporting batched unmixed materials from the batching plant to the roadside paver mixer shall be equipped with batch boxes, containers or bodies of adequate capacity and construction to properly carry the dry volumes required. Partitions separating batches shall be constructed to prevent spilling of the weighed batches from one compartment to another while in transit or when being dumped.

All transporting equipment and accessories used in the proportioning and transportation of concrete materials to the roadside paver mixer shall be so designed and operated as to insure the charging of the mixer with the previously weighed amounts of each material required for each batch without over-spilling or intermixing of batches or wastage.

**E. Slip-Form Paver**. The slip-form paving machine shall be fully energized, self-propelled and designed for the specific purpose of placing concrete in one pass without the use of fixed side forms. It shall be capable of consolidating and finishing the concrete pavement true to grade and cross-section. No external tractive force shall be applied to the machine. The paver shall be equipped with trailing side forms, of dimensions, shape, and strength to support the concrete laterally for a sufficient length of time that no appreciable edge slumping will occur. The paver shall vibrate the concrete for the full width and depth of the layer being placed and shall install a continuous strip of plastic for forming longitudinal weakened plane joints when this method of forming longitudinal joints is being

used. The slip-form paver shall be equipped with necessary electronic or hydraulic devices to control the finish elevation of the pavement from a cord. The Engineer may require the use of these controls on a part or all of the paving work in the contract.

**F. Concrete Spreaders**. The spreader shall be a self-propelled machine, equipped with a power-driven device for spreading the concrete uniformly between the forms without segregation, and provided with an adjustable blade or other approved means for striking off the concrete to the required height and crown. The spreader shall be equipped with effective cleaning devices to insure proper contact at all times between the wheels and the contact surface. Wheels that are supported by an adjacent slab shall have no flanges in contact with the slab.

**G. 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 10 feet 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 no less than 8 inches. Flexible or curved forms of proper radius shall be used for curves of 150 foot 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 will 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 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 3000 square yards. Built-up forms will be allowed to extend the form depth 25%. The build-up shall be securely attached to the bottom of the form. The width of the build-up shall be equal to the bottom of the form.

The top face of the form shall not vary from a true plane by more than 1/8 inch in 10 feet and the upstanding leg shall not vary by more than 1/4 inch. The forms shall be equipped for locking the ends of abutting form-sections together tightly for secure setting.

**H. 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 vibration of concrete paving slabs may be either the surface pan type or the internal type with either immersed 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 minute and the frequency of the internal type shall be not less than 5000 for tube vibrators and 7000 for spud vibrators, unless modified by the Engineer. When spud type internal vibrators, either hand operated or attached to spreaders or finishing machines are used adjacent to forms, they shall have a frequency of not less than 3500 impulses per minute. 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 Contractor shall have and maintain necessary tachometers to verify the frequency of the vibrators.

**3. Tube Finisher**. The tube finisher shall be a self-propelled machine of the type and design that will produce a satisfactory finish to the concrete as determined by the Engineer.

**4. Hand Tools**. The Contractor will have available

appropriate straight edge tools to complete the finishing of the slab.

**I. Transverse Groover**. A mechanical device that is essentially a metal comb capable of spanning the width of the pavement shall be available to produce the transverse grooves. The metal comb shall consist of a single line of tempered spring rectangular steel tines or other approved material uniformly spaced at 1/2 inch centers and securely mounted in a suitable head. The metal comb shall be attached to a mechanical device capable of traversing the entire pavement width in a single pass at a uniform speed. The device shall be an independent separate unit complete in itself and shall not be attached to equipment performing other functions except that it may be part of the curing membrane spray unit. Small or irregular areas may be grooved by hand methods.

**J. Curing Membrane Spray Equipment**. A mechanical device capable of spanning the width of the pavement shall be provided to uniformly apply the white pigmented curing compound. It shall be self-propelled and equipped with proper pumps and nozzles to spray the slab while traveling at a uniform speed. Small or irregular areas may be sprayed by hand methods.

**K. Rain Protection**. A mechanical device with an appropriate supply of rolled polyethylene capable of spanning the pavement shall be available at all times along with the other paving equipment. This device shall be such that the polyethylene can be mechanically unrolled on the portion of the slab that has not set enough to resist rain in case of a rain shower.

**L. Concrete Saws**. The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions and at the required rate. The saws shall be equipped with water-cooled diamond edge saw blades or abrasive wheels. The Contractor shall provide at least one standby saw that

is in good working order. An ample supply of saw blades shall be maintained at the site of the work at all times during sawing operations. The Contractor shall provide adequate artificial lighting facilities for night sawing. All of this equipment shall be on the job both before and continuously during concrete placement.

**M. Miscellaneous Equipment**. The Contractor shall provide other tools and equipment, of approved design, necessary for the satisfactory completion of the work.

**N. Equipment to Heat and Apply Elastic Joint Filler**. The melter/applicator shall be a conventional double boiler type melter with a bottom-sweeping agitator. It shall be equipped with at least a 16 horse-power engine, an agitator in first class working condition, a reliable rotary pump with a 2-inch minimum port size without an internal pressure relief valve, a full 2-inch manual bypass that will allow circulation of the sealant from the pump back into the vat at the farthest possible point away from the pump intake and a 15 foot high-pressure sealing hose with a one inch inside diameter coupled to a sealing wand with a 3/4 inch to 1 inch inside diameter with appropriate insulation to maintain the sealant temperature. Temperature controls and indicators on the melter/applicator unit shall be maintained to a degree of accuracy that can be totally relied upon. A partition shall be provided in the vat to hold the fresh unheated sealant at the farthest possible point away from the pump intake until the sealant is liquefied. A recording thermometer shall be provided for recording the temperature of the liquefied sealant in relation to time, while the melter is being operated.

**O. Equipment to Place Silicone Sealant**. Equipment to place silicone sealant shall be manually or power operated. An air compressor and air powered extrusion pump shall be used for the transfer of the sealant from either drums or pails through high-pressure hoses to the joint. Seals, hoses, and hose connections shall be such as to prevent moisture permeation to prevent the sealant from

curing prematurely before being installed in the joint. The seals and packing shall be made of TEFLON or equivalent and the hoses shall be lined with TEFLON or equivalent.

The wand for installing the joint sealant shall be made to install the sealant from the bottom up in the joint and shall stay below the top surface of the joint at all times. The proper tooling device shall be available to shape the top surface of the sealant to the proper configuration at the proper time.

All equipment capacities, hose diameter, pump pressures, etc. shall be according to the sealant manufacturer's recommendations.

**P. Field Office and Laboratory**. The Contractor shall provide and maintain a fully equipped field office and laboratory for performing the quality control inspection and testing at the concrete plant. The buildings shall be used exclusively by the Engineer or his representative. They shall have satisfactory electric lighting and electrical outlets. The building shall have appropriate floor space and inside height along with workbenches, chairs, and sufficient water supply for tests and cleaning testing equipment. The field office building shall be so equipped that with the windows and doors closed the inside temperature can be maintained between 65°F and 80°F. The buildings shall be located in close proximity to and have a full view of the Contractor's plant.

The Contractor shall furnish and maintain in good condition at the field laboratory building all required equipment. Required equipment shall consist of tanks for holding the beam specimens under water controlled at 60°F to 78°F and verified by recording thermometer, equipment to test fine and coarse aggregate and necessary tools and vibrators for molding specimens. The equipment to test coarse aggregate shall consist of a Gilson shaker with appropriate sieves, a sample splitter with openings approximately 50% greater than the largest par-

ticle size, and appropriate scale apparatus for weighing materials. The equipment to test fine aggregate shall consist of a mechanical sieve shaker, appropriate sieves, and an appropriate balance for weighing. The Department will furnish molds and the test machine to perform flexural testing of the concrete beam specimens. The Contractor shall furnish a calibrated compression-testing machine for necessary field testing of cylinders if required.

The Contractor shall furnish the necessary labor to assist the Engineer in obtaining samples of concrete and aggregate, testing, making, handling, and curing the specimens.

## CONSTRUCTION REQUIREMENTS

**501.14 Preparation of Subbase**. The subbase shall be brought to reasonably close conformity to the lines, grades, and typical sections shown on the Plans or as designated by the Engineer.

All soft and yielding materials and other portions of the subbase which will not compact readily when rolled or tamped shall be removed and all loose rock or boulders found in the earth excavation shall be removed or broken off to a depth of not less than 6 inches below the surface of the subgrade. All holes or depressions made by the removal of material as described above shall be filled with approved material and the whole subbase compacted and brought to line and grade.

The subbase for concrete base courses or pavements shall include an area 3 feet in width extending beyond the edges of the base course or pavement unless shown otherwise on the plans. When curb and gutter is constructed contiguous with the pavement the subbase shall include an area 2 feet in width extending beyond the back of the curb and gutter. The subbase shall be completed for at least 2500 feet in advance of concrete placing operations when this distance is available.

**501.15 Conditioning of Subbase or Base Course.**

**A. Compaction.** The entire subbase or base shall be thoroughly compacted. Any portion of the subbase that is not accessible to a roller shall be compacted with hand tampers to obtain the density requirements for the material.

**B. Protection.** Before placing any surfacing material on any section, ditches and drains along that section shall be completed to drain the subgrade effectively. In handling materials, tools, equipment, etc., the Contractor shall protect the subbase or base from damage. If ruts are formed, the subbase or base shall be reshaped and re-rolled. At all times, the subbase or base surface shall be kept in such condition that it will drain readily. Until the subbase or base has been checked and approved, no material shall be deposited thereon.

**C. Finish for Subbase.** Before paving begins, the subbase shall be brought to proper cross-section. High areas shall be trimmed to proper elevation. Low areas may be filled and compacted to a condition similar to that of surrounding grade, or filled with concrete integral with the pavement. No additional compensation will be made for concrete used to correct low subbase. The finished grade shall be maintained in a smooth and compacted condition until the pavement is placed. An approved type of subbase or base grader that follows a chord line for grade or rides on the forms shall be used in forming the crown and shaping the subbase to insure that the specified thickness of the finished pavement is secured. The grader shall have the capacity of cutting the surface without reducing compaction. After grading, rubber tired rollers may be required to recondition the surface a sufficient distance ahead of the placement of concrete to allow necessary inspection and testing of the subgrade.

## 501.16 Slip-Form Concrete Paving.

**A. Slip-Form Method**. Where practicable, the slip-form paving machine shall be used. The Contractor shall adopt procedures that shall result in a satisfactory product. No wheeled equipment that disturbs the track lane for other equipment or does not perform satisfactorily will be allowed in the paving train.

No vehicular traffic or mixing equipment will be allowed on the completed grade without the permission of the Engineer.

**B. Placing Concrete**. The concrete shall be placed with an approved slip-form paving train designed to spread, consolidate, screed, float-finish, texture and place cure material in one complete operation. Slumping of the concrete will not exceed 3/8 inch from a typical cross-section. However, slump at longitudinal construction joints shall not exceed 1/4 inch from a typical cross-section.

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

The Contractor shall employ such devices and procedures that will insure proper consolidation of the concrete and proper positioning of reinforcement, tie bars, and dowels for joints to produce a monolithic slab.

Areas inaccessible to slip-form paving equipment shall be paved in accordance with the provisions for stationary side forms.

**501.17 Fixed Form Concrete Paving**.

**A. Base Support**. The subbase under the forms shall be hard and true to grade so that the form, when set, will be firmly in contact for its whole length and at the specified grade. Any subbase that at the form line is found below established grade shall be filled to grade with granular material in lifts of 1/2 inch or less for a distance of 18 inches 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; except in the case of cement stabilized bases, the removal of random knots or high areas will not be permitted. Imperfections in cement stabilized bases shall be treated as required in Sections **307** and **308**.

**B. Form Setting**. After the forms have been set to correct grade, the subbase shall be thoroughly tamped, mechanically or by hand, at both the inside and outside edges of the base of the forms. No settlement or springing of forms under the finishing machine will be permitted.

Forms shall be staked into place with not less than 3 pins for each 10-foot section. A pin shall be placed at each side of every joint. Form sections shall be tightly locked, free from play or movement in any direction. The forms shall not deviate from true line by more than 1/4 inch at any point. Forms shall be cleaned and oiled before the placing of concrete.

The Contractor shall set and maintain sufficient forms and shall conduct his operations so that the final minor corrections, compaction of subbase and checking and approval of forms shall be complete at least 800 feet in advance of the point of depositing concrete when this distance is available.

**C. 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 hours. Forms at the end of contraction joints to be sawed may be removed as soon as joints can be sawed without raveling. Form pullers that depend on the new pavement for support shall not be used at any time. As soon as the side forms have been removed, any minor honeycombed areas shall be filled with mortar, composed of one part of portland cement to two parts of fine aggregate by weight. Major honeycombed areas will be considered as defective work and shall be removed and replaced. After the forms have been removed, the sides of the slab shall be sprayed with curing compound.

**501.18 Handling, Measuring, and Batching Materials for Concrete**. In stockpiling aggregates, the location and preparation of the sites, the minimum size of pile, and the method adopted to prevent coning or other segregation of component sizes shall be subject to the approval of the Engineer. Stockpiles shall be built up in layers of not more than 3 feet in thickness. Each layer shall be completely in place before beginning the next. Each subsequent layer shall not be allowed to cone down over the previous layer. Under no circumstances will coning of stockpiles be permitted. Aggregates from different sources shall not be stockpiled together unless approved by the Engineer. The area on which materials are to be stockpiled shall be cleared of vegetation and other extraneous materials and shall be smooth, firm, and well drained.

Aggregates shall be handled from stockpiles or other sources to the batching plant in a manner to secure a uniform grading of the material. 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 all 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 ade-

quate binning only if the car bodies permit free drainage. In case the aggregate contains a high or non-uniform moisture content, storage or stockpile periods in excess of 12 hours may be required by the Engineer.

The fine aggregate and coarse aggregate shall be separately weighed into the hopper in the respective amounts set by the Engineer in the job mix approval. Cement, fly ash, and slag shall be measured by weight in scales and hoppers separate from the aggregate scales and hoppers. This equipment shall be equipped with devices to positively indicate the complete discharge of each batch of material into the mixer.

When mixing is to be done at the job site, materials shall be transported from the batching plant to the mixer in vehicles conforming to the requirements specified in Subsection **501.13D.3**. The Contractor shall use a suitable method of handling the cement from the weighing hopper to the transporting container or into the batch itself for transportation to the mixer (with chute, boot, or other approved device) to prevent the loss of cement and arrange to provide positive assurance of the actual presence in each batch of the entire cement content specified.

In the dry batch process, bulk cement shall be transported to the roadside paver in watertight compartments carrying the full amount of cement required for the batch, or, if permitted, between the fine and coarse aggregate. Batches where cement is placed in contact with the aggregates may be rejected unless mixed within 1 1/2 hours of such contact.

Dry batches shall be delivered to the mixer separately and intact. Each batch shall be dumped into the mixer without the loss of cement and when more than one batch is carried on the truck, without spilling of material from one batch compartment into another.

Water may be measured either by volume or by weight. The accuracy of the water-measuring equipment shall be

within a range of error of one percent or less and shall be arranged so that the measurement will not be affected by variations of pressure in the water supply line and will be accurate under all construction conditions encountered. Unless the water is to be weighed, the water-measuring equipment shall include an auxiliary tank from which the measuring tank shall be filled. The measuring tank shall be equipped with an outside tap and valve to provide for checking the setting, unless other means are provided for readily and accurately determining the amount of water in the tank. The volume of the auxiliary tank shall be at least equal to that of the measuring tank.

Methods and equipment for adding the air-entraining agent or other admixtures into the batch shall meet the requirements of Subsection **701.19D**. Equipment that will not accurately and continuously dispense the correct amount of admixture will not be permitted.

**501.19 Weather and Lighting Conditions**. Weather restrictions described in Subsection **702.19** shall govern the concrete operations except that concrete operations shall not be undertaken or continued when the air temperature in the shade and away from artificial heat is 40°F or lower. When the temperature is expected to fall below 32°F, paving will not be permitted in order to prevent damage to the pavement by frost action during the early curing stages. The Contractor will 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 without additional compensation.

The concrete shall be mixed only in such quantities as are required for immediate use. Any concrete that has stood, after mixing and before placing, until its consistency is below the limits specified, or is not plastic and workable, shall not be used in the work.

Concrete shall not be mixed when either the coarse or the fine aggregate contains frozen particles.

No more concrete shall be mixed than can be placed, finished, and covered during daylight, unless an adequate artificial lighting system is approved and operating.

**501.20 Mixing Concrete**. The concrete may be mixed at the work site, in a central-mix plant, in truck mixers when allowed, or in a roadside paver.

**A. Central Plant Mixing**. The plant operations shall meet the requirements specified in Subsection **701.22D** and the additional requirements or changes as set forth below.

**1. Mixing Time**. Mixing time for mixers having a rated capacity greater than 2 cubic yards shall not be less than 90 seconds. Any charging time in excess of 20 seconds shall be added to the required 90 second mixing time. Mixing time may be increased by the Engineer if necessary to produce a homogeneous mass.

**2. Overload**. An overload up to 10% above the mixers nominal capacity may be permitted provided concrete test data for strength, segregation, and uniform consistency is satisfactory and no spillage of concrete occurs.

**3. Elapsed Time**. Mixed concrete from the central-mixing plant shall be transported in truck mixers, truck agitators or non-agitating trucks. The time elapsing from the time water is added to the mix until the concrete is deposited in place shall not exceed 30 minutes when the concrete is hauled in non-agitating trucks, or 60 minutes when hauled in truck mixers or truck agitators. Under unusual conditions and depending upon ambient temperature, the Engineer may allow a slight increase in the elapsed times specified above provided the slump of the concrete, without retempering, is no less than the average slump for the concrete previously placed, and the concrete is, from visual inspection, otherwise satisfactory.

**B. Truck Mixing**. The truck mixers shall meet the requirements specified in Subsection **701.22E**.

**C. Roadside Paver Mixer**. For concrete mixed at the work site in roadside pavers, mixing time shall be measured from the time all materials, except water, are in the drum and shall not be less than 60 seconds. Four seconds shall be added to the specified mixing time if timing starts the instant the skip reaches its maximum raised position. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers is considered part of the mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein. Unless otherwise permitted, the mixer shall be operated outside the lane of pavement being placed.

The site mixer shall be operated at a drum speed as shown on the manufacturer's nameplate on the approved mixer. Any concrete mixed less than the specified time shall be discarded and disposed of. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic feet, as shown on the manufacturer's AGC standard rating plate on the mixer; except that an overload up to 10% above the mixer's nominal capacity may be permitted provided concrete test data for strength, segregation and uniform consistency are satisfactory and provided no spillage of concrete takes place.

The batch shall be so charged into the drum that a portion of the mixing water shall enter 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 seconds 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.

**501.21 Placing Reinforcing Steel**. Load transfers, as shown on the plans, shall be provided at bridge ends; for the

two approach slabs at each bridge end; and shall be provided for successive slabs adjacent to the approach slabs at each bridge end and at other locations indicated on the plans. The spacing of the joints on the successive slabs adjacent to the reinforced approach slabs may be varied to compensate for any added distances to accommodate the reinforced approach slabs. The minimum width of any slab shall be 16 feet, and the maximum length shall be 25 feet. All other steel shall be placed in accordance with the plans.

When reinforced concrete is placed in one layer, the reinforcement may be positioned in advance of concrete placement or it may be placed by approved mechanical methods.

Reinforcing steel shall be free from dirt, harmful rust, scale, paint, grease, oil, or any other harmful material that could impair bond of the steel with the concrete.

Dowel bars and tie bars shall be placed as shown on the plans.

**501.22 Placing Concrete**. When the placing of concrete is started, the amount of equipment and supply of materials shall be sufficient to insure that placing will 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, the longitudinal joint line between these sections shall not deviate from the true line shown on the plans by more than 1/4 inch.

The batches shall be deposited to require as little re-handling as possible. Any necessary re-handling shall be with rakes. Workers shall not walk on the fresh concrete with footwear coated with earth or other foreign matter.

The Contractor shall take necessary precautions 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 a manner as will insure that joints, dowel bars and load transfer assemblies are retained in correct position.

Unless unavoidable, 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 seconds in any one location. In no case, shall it be operated in a way that brings excess mortar to the surface or causes segregation in the mix. Vibrators shall meet the requirements specified in Subsection **501.13H.2**.

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 required in Subsection **501.07A**.

Where concrete is placed adjacent to a previously constructed lane of concrete pavement, the previously constructed concrete shall be at least 10 days old or shall have obtained a modulus of rupture of at least 500 psi as shown by tests of standard specimens. On areas where hand methods of placing and finishing are allowed as specified in Subsection **501.23**, the fresh concrete may be placed when the previously constructed concrete is 5 days old. The Contractor shall be responsible for any damage caused by the operation of mechanical equipment on any existing pavement lanes. If any concrete materials fall on or are worked into the surface of a completed slab, they shall be removed immediately by approved methods.

In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently set, the Contractor will be required to have available, at all times, necessary material for the protection of the edges and surface of the fresh concrete. When rain appears imminent, all paving operations shall stop and all available personnel shall begin placing materials to protect the surface and edges of the fresh concrete. Immediately after the rain ceases, the Contractor shall make all repairs necessitated by damage from the rain to the pavement, as directed by the Engineer.

**501.23 Final Strike-Off, Consolidation, and Finishing**.

**A. Consolidation and Strike-Off**. The Contractor will be required to construct main line pavement and interchange ramp pavement using one or more finishing machines meeting the requirements of Subsection **501.13H.1**. The machine equipment shall be of an approved type designed to strike-off, consolidate, and finish the concrete pavement. As soon as it is placed and vibrated, the concrete shall be struck-off accurately and screeded with approved equipment, so when it is consolidated and finished, the surface of the pavement will have the required elevation and cross-section.

A sufficient and uniform amount of concrete to insure filling all voids and depressions shall be carried in front of screed at all times. The rate of placement shall not exceed the finishing capacity of the single or multiple finishing machines being used.

The operations shall be controlled so an excess of mortar and water will not be worked to the top. Segregated particles of coarse aggregate that 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 ma-

chine shall be operated to prevent damage to joint installations or an existing adjacent slab.

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. Where the dimensions of the work make the use of power-operated machinery impracticable.

4. At other places permitted by the Engineer or these specifications.

Where hand methods are used, the concrete shall be tamped to insure maximum compaction and a minimum of voids. It shall be leveled slightly above the required finished surface. Then it shall be struck-off to the true surface with a strikeboard with a mechanical vibrator capable of imparting impulses at a rate of no less than 3500 per minute rigidly attached. The strikeboard 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 not less than two, and at intervals that will produce 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 an approved longitudinal float or an approved transverse smoothing float.

**1. Hand Methods**. Hand methods may be used only if specifically permitted. The hand-float shall be no

less than 14 feet long and 6 inches 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 that entirely clear the surface of the pavement.

**2. Transverse Smoothing Float**. 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 wheelbase of 14 feet. The length of the float shall be approximately 2 inches less than the normal width of the pavement and be adjusted to the required crown. The weight of the float shall be adjusted and coordinated with the finishing screed ahead so a small amount of mortar is carried ahead of the float at all times.

The forward speed of the float shall be adjusted to keep starting and stopping to a minimum.

If necessary, following one of the preceding methods of floating, long-handled floats having blades no less than 5 feet long and 6 inches wide 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 instead 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 10 foot long by 4 inch to 6 inch wide float.

**C. Checking and Surface Corrections**. As soon as the longitudinal or final floating is complete, all laitance, surplus water, and inert material shall be worked off the surface. The surface shall be made smooth by a scraping or dragging motion with the long-handled 10-foot straightedge. This straightedge shall be placed at the center of the pavement with the blade parallel to the centerline and then pulled slowly and uniformly to the edge. The blade shall then be moved forward one-half 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.

In general, the addition of superficial water to the surface of the concrete to assist in finishing operations will not be permitted. If the application of water to the surface is permitted, it shall be applied as a fog spray by means of approved equipment.

**D. Final Finishing**. After the surface has been prepared as described above and the water sheen has practically disappeared, the pavement shall, unless otherwise specified or directed, be textured with a drag strip. The drag strip shall consist of a seamless strip of damp burlap, cotton fabric, or artificial turf that shall produce a uniform surface of gritty texture after dragging it longitudinally with a slight back and forth transverse motion along the full width of the pavement.

For pavement 16 feet or more in width, the drag shall be an integral part of the paving train or in the case of stationary side forms shall be mounted on a bridge that travels on the forms. The dimension of the bottom edge of the drag strip shall be at least 3 feet. The bottom edge of

the drag strip shall be in full contact with the pavement surface for the full width of the pavement. The drag shall consist of not less than two layers where burlap fabric is used, with the bottom layer approximately 6 inches wider than the upper layer. The drag shall be maintained in a condition that produces a concrete surface of uniform appearance and reasonably free from grooves over 1/16 inch in depth. Drags shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drags substituted.

In order to obtain the desired surface qualities or texture, the Engineer may require the use of an approved belt and belting procedure or an approved brooming operation. A belting or brooming operation may be required separately, jointly, or along with the fabric or turf drag. When all finishing is complete, the texturing shall be performed by mechanical equipment for grooving plastic concrete that utilized rectangular shaped spring steel tines. The tines shall be evenly spaced at intervals of approximately 1/2 inch on center. The tines shall produce transverse grooves in the hardened surface of the concrete that are approximately 0.08 inch to 0.12 inch in width and approximately 0.10 inch to 0.15 inch in depth. The finished surface shall meet all straight edge tolerances and rideability and smoothness requirements.

**E. Edging at Forms and Joints**. Before the concrete has taken its initial set, the edge of the pavement along each side of each slab 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 of the tool during use.

At all joints, any tool marks appearing on the slab adjacent to the joints shall be eliminated by brooming the surface. In doing so, the rounding of the corner of the slab shall not be disturbed. All concrete on top of the joint filler shall be completely removed.

All joints shall be tested 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.

**501.24 Curing**. Immediately after the finishing operations have been completed and immediately after the surface water has disappeared, the entire surface of the concrete pavement shall be cured by mechanically applying a uniform coating of the white pigmented curing compound.

If the compound is not applied immediately, the surface shall be kept thoroughly wetted with a fine spray of water until the application of the compound is started. Joints shall be so protected by an approved method that the compound will not enter the joint. The white pigmented compound shall be applied in one or two applications as required by the manufacture's recommendations or as directed by the Engineer. When applied in two applications, the second shall follow the first within 30 minutes.

The compound shall be applied in a continuous uniform film by means of a power-operated pressure spraying or distributing equipment at the approved rate, but not less than 0.06 gallon per square yard 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 with a temperature not exceeding 100°F. Thinning with solvents will not be permitted. Should the method of applying the compound produce a non-uniform film, corrections shall be made immediately.

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, the Contractor shall apply a new coat of material to the affected areas equal in curing value to

that specified for the original coat. The treated surface shall be protected from damage 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 from using the pavement. 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.

**501.25 Protection of Pavement**. All vehicle traffic shall be excluded from the newly constructed pavement for a period of not less than 14 days, unless the Engineer directs that sections be opened to traffic at an earlier date. Time during the curing period, when the atmospheric temperature is below 40°F shall not be considered or counted. Time when the temperature is in the range of 40°F to 50°F shall be considered at only one-half of the actual time.

Concrete with Type III cement shall be cured for a period of 48 hours in the manner specified herein, or until test specimens indicate a modulus of rupture of 550 psi, whichever is greater. The facility may then be opened to traffic unless weather or other conditions make it advisable to extend this time.

When required by the Engineer, the Contractor shall erect and maintain suitable barricades and shall furnish satisfactory and competent personnel to exclude traffic from the newly constructed pavement for the period herein prescribed. The barriers shall be arranged to not interfere with or impede public traffic on any lane intended to be kept open. The signs, barricades, and lights necessary to clearly indicate the lanes open to traffic shall be maintained by the Contractor. Should it become necessary to move traffic across a lane of pavement from which traffic must be temporarily prohibited, the Contractor shall, without additional compensation, construct suitable and substantial crossings to bridge over the con-

crete. These crossings shall be adequate for traffic and satisfactory to the Engineer. Any part of the pavement damaged by traffic or other causes occurring before its final acceptance shall be repaired or replaced by the Contractor in a satisfactory manner. The crossing and pavement repair or replacement shall be done without cost to the Department.

All ditches and drains shall be maintained to provide effective drainage.

A berm of earth adjacent to the pavement edges shall be placed and maintained to prevent underwash of the pavement slab if directed by the Engineer.

**501.26 Joints.**

**A. General Requirements.** Longitudinal and transverse joints shall be constructed at the locations and in accordance with the dimensions and other requirements shown on the plans or in the special provisions.

Longitudinal joints shall be constructed parallel to the pavement centerline unless otherwise required. Transverse joints shall be at right angles to the pavement centerline or at the skew angle shown on the plans and shall extend the full width of the pavement. All joints shall be constructed true to line with their faces perpendicular to the pavement surface.

The surface of the pavement adjacent to all joints shall be finished to a true plane and unless otherwise specified, the edges of the pavement at all joints shall be rounded to a radius of 1/8 inch or beveled on a 45° angle at the top 1/16 inch to 1/8 inch on each side with an approved mechanically powered rock or disc as shown on the plans or hereinafter specified. The surface across the joints shall be tested with an approved straightedge as the joints are finished and irregularities shall be corrected before the concrete has hardened.

When the pavement is placed in lanes or partial width slabs, or when existing pavement is widened, transverse joints shall be placed in line with like joints in the adjacent pavement unless otherwise shown on the plans.

When keyed construction joints are required, the key shall be constructed by fastening a wooden strip or a deformed metal plate to the form to produce a continuous keyway conforming to the dimensions shown on the plans. When the adjacent slab of concrete is placed, it shall be carefully consolidated by vibrating or spading along the edge to insure the forming of the key portion of the joint without pockets or honeycomb.

When deformed steel bars are used in keyed joints or in plain butt-type construction joints, they may be bent at right angles against the form of the first lane or portion constructed and straightened into final position before the concrete of the adjacent lane or section is placed.

Dowel bars shall be placed across transverse joints at locations and in accordance with details shown on the plans. Dowels shall be held in position, parallel to the surface and centerline of the pavement, by an approved metal dowel support that will remain in the pavement. The dowels shall be treated as required in Subsection **501.09** to permit free horizontal movement.

When used in expansion joints, one end of each dowel shall be treated and capped with a close fitting, closed end, metal sleeve as required in Subsection **501.09**.

Preformed expansion material used in joints shall be prepared in accordance with Subsection **501.07A** and shall be placed perpendicular to the pavement surface.

**B. Longitudinal Joint**. Longitudinal joints shall be constructed in all concrete pavement 16 feet or more in width. If a particular type is not specified, the joint shall be sawed when two adjacent lanes are placed monolithic.

Tie bars of the specified length, size, spacing, and material shall be placed in all longitudinal contraction and longitudinal construction joints. The bars shall be placed perpendicular to the longitudinal joints. They shall be placed by approved mechanical equipment or rigidly secured by chairs or other approved supports to prevent displacement.

**1. Longitudinal Sawed Joints**. Longitudinal sawed joints shall be cut by means of approved concrete saws to the depth, width, and line shown on the plans. Suitable guides or devices shall be used to assure cutting the longitudinal joint on the true line as shown on the plans. The longitudinal joint shall be sawed before the end of the curing period or immediately thereafter and before any equipment or vehicles are allowed on the pavement. Joint sealing shall be as required in Subsection **501.27**. Beveling of longitudinal sawed joint will not be required.

When adjacent lanes are constructed separately and where required by the plans, a trapezoidal keyway of the dimensions shown on the plans shall be secured to the side forms along the longitudinal joint. Tie bars may be two-piece bolt assemblies as shown on the plans or deformed bars bent at right angles against the form at the first lane constructed and bent back without breaking into final position before the concrete is placed in the adjacent lane. Longitudinal joints so constructed shall be free of surface fins extending beyond the vertical face of the joint and shall be sawed and sealed as specified above.

**2. Longitudinal Weakened Plane Joints**. The Contractor may form longitudinal weakened plane joints by placing an approved continuous strip of plastic instead of sawing the joint. The plastic shall not react adversely with the chemical constituents of the concrete or bond with the concrete. The plastic strip shall have

a minimum thickness of not less than 0.020 inch and a depth not less than 1/4 of the thickness of the slab plus 1/2 inch. The final vertical position of the insert shall be within 10 degrees of a plane normal to the surface of the concrete. The top edge of the strip shall be flush with the finished concrete. The final alignment of the inserted strip shall be uniformly parallel with the centerline of the pavement and shall be free from local irregularities in alignment that exceed 1/2 inch in 10 feet.

In the event the Contractor demonstrates that he is not able to consistently form a satisfactory weakened plane joint, he shall, upon being notified by the Engineer, discontinue the forming of such joints and saw the longitudinal contraction joints as specified in Subsection **501.26B.1** above.

**C. Expansion Joints**. Expansion joints of the types specified shall be constructed at the locations shown on the plans or as directed. Dowel bars, if required, shall be furnished and placed in accordance with the requirements specified in Subsection **501.26A** above. Premolded joint filler shall be appropriately punched to admit the dowels.

The expansion joint filler shall be continuous from form to form and shaped to the subgrade and to the keyway along the form. Preformed joint filler shall be furnished in lengths equal to the pavement width or equal to the width of one lane. Damaged or repaired joint filler shall not be used unless approved.

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

Transverse expansion joints will not be required, except at bridge ends, unless otherwise specified on the plans. Transverse expansion joints shall have a thickness of one inch, unless otherwise specified.

**D. Transverse Contraction Joints.** Transverse contraction joints shall be constructed to the dimensions, lines and spacing shown on the plans. They shall be skewed and the spacing shall be randomized when so indicated on the plans. Transverse contraction joints shall be of the sawed type. The forming of joints by using preformed parting strips of any kind is prohibited. Sawed joints shall be constructed as follows:

> Sawed contraction joints shall be joints established by sawing grooves in the surface of the pavement with an approved concrete saw. After each joint is sawed, the saw cut and adjacent concrete surface shall be thoroughly cleaned.
>
> Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling, usually 4 to 6 hours. Some raveling of the green concrete must be expected in order for the sawing process to prevent uncontrolled shrinkage cracking. If sharp edged joints are being obtained, the sawing process shall be speeded up to the point where some raveling is observed. This process shall continue during the day and night regardless of the weather conditions until the day's paving has been sawed. In case of emergency and the sawing procedure gets behind, every third transverse joint shall be sawed as a control system to prevent cracking until raveling is again observed.

**E. Transverse Construction Joints.** Transverse construction joints shall be made whenever placing of con-

crete is suspended longer than 30 minutes. Sections of pavement less than 10 feet in length between joints will not be permitted unless directed by the Engineer. To form the joint, a suitable and satisfactory header board, cut to the required cross-section and drilled to receive the dowel bars, shall be accurately set and securely held in a plane perpendicular to the surface. Dowel bars as specified shall be installed in the drilled holes and the concrete thoroughly vibrated.

When the placing of concrete is resumed, the header board shall be carefully removed and any surplus concrete on the subgrade shall be removed. The fresh concrete shall be deposited against the previously placed concrete, and the surface across the joint shall be finished true to grade and cross-section to avoid detriment to the riding qualities of the pavement. The joint will not require a joint sealant.

**501.27 Sealing Joints**. After curing is completed, both longitudinal and transverse joints shall be filled with the specified sealant. The required joint configuration to receive the seal shall be formed by sawing as outlined in Subsection **501.26**. Immediately following the sawing operation, the joints shall be flushed with a high-pressure water jet to remove the slurry and any loose material from the joint faces. Joint washing shall be performed in one direction to prevent re-contamination.

Once the joint is dry and before final cleaning begins, it shall be sandblasted to remove contaminants, including membrane curing compound. Sandblasting shall be done in two passes, one for each face, with the nozzle held at an angle to the joint face and within 1 to 2 inches of the pavement. Sandblasting shall be done the same day as the sealing operation and repeated if rain showers occur between initial sandblasting and sealing.

The blast material as well as dust and dirt deposited by wind and traffic shall be blown out of the joint and away from

the area around it using a high-pressure air blast. The air compressor shall produce at least 90 psi and shall be equipped with traps capable of removing moisture and oil from the compressed air. As with the water, the air blast shall move in only one direction to prevent re-contamination of the joint.

Joints shall be inspected for proper width, depth, alignment, and preparation, and shall be approved by the Engineer before installation of sealant. All joints to be sealed must be sound, clean, dry, and frost free. Just before placing of the backer rod, the cleanliness of the joint walls shall be judged by rubbing a finger across the dry joint face to assure that residual cement and/or dust has been removed. Joints that still contain dust or have become dirty or contaminated shall be re-cleaned.

After cleaning has been completed, the backer rod shall be placed at the proper depth to form the bottom of the seal. The bond breaker shall be compatible with the sealant. Installation methods and equipment shall be in accordance with the manufacturer's recommendations. Backer rods shall then be made leak proof where required by caulking with a silicone product compatible with the sealant to be used. This may be applied from tubes with a caulking gun device.

The sealant shall then be placed in the joint in accordance with the plan configuration by means of an appropriate pump equipped with a nozzle that is narrow enough to place the material from the bottom up in the joint. The material shall be placed to establish a surface profile the desired depth below the surface of the pavement. All equipment for placing the seal and methods of placement shall be in accordance with the sealant manufacturer's recommendations.

Final cleaning, placing of the bond breaker, and placing of the sealant shall be performed in a continuous operation. Once the final cleaning and sealing operation has begun on a section of pavement, no traffic, construction vehicles, or other equipment shall be allowed on the section of pavement for a minimum of two hours or until the seal material has cured.

Joints not properly sealed shall have the sealant removed for the full sealant depth, be thoroughly cleaned and resealed in accordance with this specification at no expense to the Department where directed by the Engineer.

Any material spilled on the pavement shall be immediately removed. Solvents shall not be used to remove spills, because they generally carry the materials further into the porous concrete or spread them on the surface.

The silicone sealant shall conform to the requirements of Subsection **501.07B** and shall be handled and applied as follows:

1. The power extrusion pump shall be connected to either the drum or pail of sealant.

2. All seals on the drum, pail, hoses, and hose connections shall be properly connected to prevent moisture permeation.

3. All hoses and connections shall be cleaned to be assured that blockage from prematurely cured sealant has not occurred. All hoses and connections shall have been previously cleaned.

4. After the final cleaning of the joints, the backer rod shall be installed to the proper depth. The depth is measured from the pavement slab surface to the top of the backer rod.

5. The sealant shall be installed in a single continuous pass from the bottom to the top of the joint.

6. The sealant shall then be tooled to the desired depth and joint configuration and allowed to cure to a tack free condition before allowing traffic on it.

**501.28 Requirements for Smoothness and Rideability**. The surface of the concrete pavement shall be true to the specified crown and grade. When an unsatisfactory riding surface is detected, the Engineer shall notify the Contractor that this condition exists. Any defective areas including any unsatisfactory riding surfaces shall be corrected without additional compensation. As soon as the concrete has cured sufficiently to permit walking on it, but not later than 9:00 AM the day following its placement, the surface shall be checked with a 10 foot straightedge or other approved device to check the surface contour. Any curing agent removed during straightedging shall be replaced immediately. All variations of 1/8 inch or more, exclusive of texturing corrugations, shall be plainly marked on the surface. The Contractor shall immediately correct them by rubbing with a carborundum brick and water. In no case shall rubbing be done so that contact with the coarse aggregate is made and the enveloping mortar is broken. If any variations of 1/8 inch or more remain after compliance with the above provisions, they shall be removed by the Contractor, at his expense, with a power-driven grinding machine after the concrete has reached its approximate full strength, but not before it is 30 days old.

Unless otherwise specified in the special provisions, the Department will test the rideability of ground and textured pavement with a Mays Ride Meter. The pavement will be considered acceptable provided the relative roughness does not exceed 55 inches for each mile of each vehicle lane when tested in accordance with the requirements of *Test Method for Determining Pavement Roughness with the Mays Ride Meter*, or if it satisfies requirements in accordance with test methods specified in the special provisions. If the pavement is not acceptable, the Contractor shall correct the deficiencies to the satisfaction of the Engineer and at not cost to the Department.

Any random cracking determined by the Engineer to be detrimental to the concrete pavement shall be removed and replaced without additional compensation.

When removal is required, the minimum length of slab removed shall be 10 feet in length and shall be the full width of the lane involved. If a remaining length of slab adjacent to a joint is less than 10 feet in length, that portion of slab shall also be removed and replaced. Additional requirements for smoothness in the area of replaced slabs may be required in the special provisions.

**501.29 Slabs Adjacent to Bridge Ends and Bar Mat Reinforcement**. The length of the first and second slab section from bridge ends shall be the length indicated on the plans and shall contain bar mat reinforcement as shown on the plans. The length of the slab adjacent to skewed bridge ends shall be measured along the centerline of the slab. The left side or right side of this slab shall be increased or decreased as necessary to conform to the bridge skew.

The thickness of the two approach slabs at each bridge end may exceed the slab thickness of the remainder of the road. The thickness shall be in accordance with the plans. For measurement purposes, the additional thickness shall be converted to equivalent square yards of slab of the nominal plan thickness. No direct payment will be made for furnishing and placing reinforcing steel mat reinforcement in approach slabs.

**501.30 Tapers at Acceleration and Deceleration Lanes**. The method of widening for tapers shall be as shown on the plans or as approved by the Engineer.

**501.31 Adjacent Lane Construction**. Unless otherwise shown on the plans or in the special provisions, the pavement shall be constructed in double lanes; that is, two adjacent lanes paved in a single operation. Whenever possible, the concrete transport vehicles or roadside pavers shall be operated on the subbase or shoulder adjacent to the lanes being paved. If there is insufficient unpaved width adjacent to the last strip to be paved, the equipment may be operated upon a newly paved strip with approval of the Engineer. The Contractor shall make a written request and secure written ap-

proval for such operation. The request shall set forth the kind, size and type of equipment; the proposed size of batch; and the safeguards to be installed to prevent damage to the existing pavement.

**501.32 Pavement Thickness Tolerance**. The thickness of the pavement shall be determined by caliper measurement of a core or the average of caliper measurements of cores cut from the pavement by the Contractor at locations selected by the Engineer. If the measurement or average of measurements is less than the thickness specified in the plans, the area of pavement represented by the deficient cores will either be accepted, replaced or subject to a reduced payment depending on the severity of the deficiency.

**A. Averaging of Core Measurements**. In calculating the average measurement of the cores, individual measurements that are more than the specified thickness by more than 0.2 inch shall be limited to the maximum of the specified thickness plus 0.2 inch. Measurements that are less than the specified thickness by more than 0.5 inch shall not be included in the average.

**B. Representative Areas and Core Measurements**.

**1. Normal Width Through Lanes**. For pavements with uniform cross-sections, each 1000 linear feet, or fraction thereof, of each traffic lane will be considered one area unit. The Engineer will select one or more cores as he sees fit in each area unit.

If the core measurement or the average of the core measurements is deficient by 0.2 inch or less from the plan thickness, full payment will be made.

If the core measurement or the average of the core measurements is deficient by more than 0.2 inch, but less than 0.5 inch from the plan thickness, an adjusted unit price as specified in Subsection **501.32C,** will be paid for that area of pavement.

**2. Varying Width Pavement**. For intersections, entrances, crossovers, ramps, and other pavements with varying cross-sections, each 1000 square yards of pavement, or fraction thereof, will be considered as one area unit. The Engineer will select one core location in each area unit.

If the core measurement is deficient by 0.2 inch or less from the plan thickness, full payment will be made.

If the core measurement is deficient by more than 0.2 inch, but less than 0.5 inch from the plan thickness, two additional cores will be taken from the area represented, and the average of the three cores determined. If the average measurement of the three cores is deficient by 0.2 inch or less from the plan thickness, full payment will be made. If the average measurement of the three cores is deficient by more than 0.2 inch, but less than 0.5 inch from the plan thickness, an adjusted unit price as provided in Subsection **501.32C**, will be paid for that area of pavement.

**C. Concrete Pavement Requiring Price Adjustment**. When an area of pavement reveals a deficiency in slab thickness or average slab thickness, sufficient to warrant a reduction in the unit price as provided in Subsections **501.32B.1** or **501.32B.2**, the adjusted unit price shall bear the same ratio to the contract unit price as the square of the thickness or the average thickness of the slab bears to the square of the thickness specified on the plans.

**D. Core Measurements Deficient By More Than 0.5 Inch**. Where any core measurement indicates a thickness is deficient by more than 0.5 inch, the extent of the deficient thickness shall be determined by taking additional cores at 25 foot intervals in both directions parallel to the centerline until, in each direction, a core is found that is deficient by less than 0.5 inch. The area of pavement subject to this determination shall be the product of

the full width of the slab, or of a traffic lane if only one lane is affected, multiplied by the sum of the distance in each direction from the deficient core along the centerline of the road to the transverse section found not to be deficient by more than 0.5 inch. No payment will be made for the area of pavement determined as outlined above.

With respect to areas of pavements where the thickness is deficient by more than 0.5 inch and payment is withheld, the Engineer shall have the following options:

> If in the Engineer's opinion, deficiency is such as to seriously impair the traffic service expected from the pavement, the Engineer may direct that deficient areas be removed and replaced with slabs of satisfactory quality and thickness, which, when accepted, will be duly included in the pay quantity; or
>
> If in the opinion of the Engineer, there is no probability of failure, the Department may allow the Contractor the choice of leaving the defective slab or slabs in place and receiving no compensation or payment for the same, or of removing and replacing the pavement as provided above.

No additional payment over the contract unit price will be made for any pavement, the thickness, or average thickness of which, exceeds the thickness shown on the plans.

**501.33 Method of Measurement**. The quantity measured for payment under this section shall be the number of square yards of Portland Cement Concrete Pavement completed and accepted, and measured in place along the surface of normal width of through-lane pavement. Pavement constructed outside the area designated to be paved shall be disregarded in computing the number of square yards.

Measurement of Portland Cement Concrete Pavement For Ramps will include ramps acceleration and deceleration lanes, tapers, widened areas and other configurations, other than the normal width of the through lanes, necessary for the interchange of traffic.

Adjacent to bridge ends, over trenches and at other places where the Engineer authorizes the thickness to be other than that shown on the typical cross-section, the volume of concrete pavement authorized by the Engineer and actually placed and accepted shall be converted into equivalent square yards of the typical pavement as shown on the plans.

Wire mesh, bar mat reinforcement, tie bars, dowels, load transfer devices, joint sealant, other materials, and labor necessary to complete the pavement in accordance with the plans will not be measured separately. No direct payment will be made for those items.

**501.34 Basis of Payment**. The quantity, measured as provided above, will be paid for at the contract unit price for Portland Cement Concrete Pavement, or Portland Cement Concrete Pavement for Ramps, of the thickness specified, which price and payment shall be full compensation for furnishing all materials, equipment, tools, labor, and incidentals necessary to satisfactorily complete the work.

The bid price shall include joint construction and sealing and the furnishing and placing of wire mesh, bar mat reinforcement, tie bars, load transfer devices, dowels and all materials, labor and equipment necessary to complete the work.

Pavement that is deficient in thickness, but is permitted to be left in place, will be paid for at the reduced unit price or deducted as provided in Subsection **501.32**. Reductions for deficient thickness may be entered on any estimate after the information becomes available.

No compensation will be allowed for the materials or labor involved in the removal of the defective slabs.

Payment for each item includes all direct and indirect costs and expenses required to complete the work.

Payment will be made under:

| **Item No.** | **Pay Item** | **Pay Unit** |
|---|---|---|
| 5011XXX | Portland Cement Concrete Pavement - *(thickness)*" Uniform | Square Yard |
| 5012XXX | Portland Cement Concrete Pavement for Ramps - *(thickness)*" Uniform | Square Yard |

## SECTION 502

## CONCRETE PAVEMENT PATCHING

**502.01 Description**. This work shall consist of replacing full depth pavement slabs on a prepared subgrade or base course in accordance with the plans and in accordance with the applicable requirements of the special provisions and Sections **501**, **701**, and **702**. The pavement replacement slabs will be placed where the distressed concrete has been removed and shall range in size from 12 feet wide by a minimum of 6 feet long up to the full slab length for jointed concrete pavements, while patches of continuously reinforced concrete pavements shall have a minimum dimension of 6 feet in length and width. The depth shall be the depth of the existing pavement. See the plans for details.

The Engineer will locate and establish the areas to be replaced by marking on the surface of the existing pavement the boundaries of the area to be patched. The boundaries of the patch area will be of sufficient width and length to assure that all of the distressed concrete is removed. Transverse boundaries do not have to be perpendicular to the shoulder in all cases, but shall be at least 18 inches away from trans-