SECTION 32 13 00
CONCRETE PAVEMENT

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section specifies providing portland cement concrete pavements complete in place as shown.

B. Related Work Specified Elsewhere:
   1. Base for pavements: Section 32 10 00.
   2. Concrete reinforcement: Section 03 20 00.
   3. Cast-in-place structural concrete: Section 03 30 00.

1.02 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements with the additional requirements as specified for each:

A. Shop Drawings:
   1. Joint devices.

B. Certification: As specified in Section 03 30 00, including design mixes.

1.03 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. AASHTO: M33, M74, M81, M148, M153, M171, M182, M194, M220, M227, T51 T148.
   3. FS: SS-S-164, SS-S-195, TT-P-86, TT-S-00227.
   4. ASTM: A185, A370, A615, C33, C294, C920.

B. Concrete: Conform to quality assurance requirements as specified in Section 03 30 00 and this section.

C. Testing: Subject concrete for pavements to test procedures specified in Section 03 30 00.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Aggregates and Cement: As specified in Section 03 30 00.

1.05 JOB CONDITIONS:

A. Environmental Requirements:
   1. Do not place concrete on frozen soil base.
   2. Apply joint sealer when the air temperature is 50F or higher.

B. Refrain from placing concrete while the temperature is lower than 40F or when by the National Weather Service forecast it may be expected to reach 40F or lower during the 24-hour period following placement of concrete.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Subgrade Paper: AASHTO M74.

B. Polyethylene sheet and tape: AASHTO M171, white opaque for curing.

C. Welded Wire Fabric: Welded steel-wire fabric, ASTM A185.

D. Bituminous Paint: AASHTO M81, Grade RC-250.

E. Joint Devices: Use joint devices which are so designed that, when under the load of fresh concrete, the parts will deviate no more than 1/4 inch from the position shown and not more than 1/8 inch from the specified tolerances, and that the finish joints can be constructed to these same tolerances. Provide joint devices complete with accessories, approved supporting devices, and installing devices and equipment.

1. Tie bars: ASTM A615, Grade 60.
2. Tie rod assemblies: Tensile requirements of AASHTO M227, Grade 80 based on measured cross-sectional area of unthreaded portion of bar when tested in assembled condition in accordance with ASTM A370.
3. Dowels:
   a. Plain round bars, AASHTO M227, Grade 80 coated with paint, FS TT-P-86, Type I.
   b. Dowel sleeves in accordance with the following:
      1) Snug fit with dowel bar.
      2) Closed end.
      3) Limit stop for dowel approximately one inch from closed end.
      4) Sufficient rigidity to prevent entry of fresh concrete and collapse during construction.
4. Grease for Dowels: Approved water-resistant graphite grease.
5. Preformed joint fillers: AASHTO M153, Type II.
6. Preformed Plank: Rigid plank of asphalt hardboard or similar material approved by the Engineer.

F. Joint Sealer Materials:

G. Joint sealing compound: Materials so proportioned that joints will be satisfactorily sealed from moisture and other foreign matter. Add appropriate tinting during manufacture, if necessary, to produce a black color.

1. Hot-poured joint sealing compound for joints in concrete pavement: FS SS-S-164 except the use of ground rubber scrap is prohibited. Ductility of not less than 40 centimeter in accordance with AASHTO T51; flow at 140F not greater than 1.0 centimeter.
2. Cold-applied joint sealing compound for joints in concrete pavement: FS SS-S-195.
3. Joint sealing compound for joints between concrete pavement and other structures: FS TT-S-00227.

H. Preformed joint seals: AASHTO M220.

I. Burlap: AASHTO M182, Class 3.

J. Waterproof paper: AASHTO M171.

K. White burlap-polyethylene sheet shall conform to AASHTO Designation M171.

L. Liquid Membrane Forming Curing Compounds: AASHTO M148, Type 1, resin base, wax-free.

M. Concrete: Section 03 30 00, Class 4000, air-entrained, amended as follows:
   1. Portland cement: Type I.
   2. Minimum cement content: Six bags per cubic yard of concrete.
   3. Maximum water content: 0.45 maximum water cement ratio.
   4. Air content: 6-1/2 percent plus-or-minus 1-1/2 percent by volume.
   5. Slump: 2-1/2 inches plus-or-minus 1/2 inch.
   6. Water reducing admixture: AASHTO M194, Type A or D as directed.
   7. Coarse aggregate:
      a. Size: ASTM C33 Size No. 67 or a combination of Size No. 4 and Size No. 67.
      b. Deleterious materials: Maximum amount of soft fragments, 2.0 percent by weight; maximum amount of coal and lignite 0.25 percent by weight; and material passing Size 200 sieve 0.5 percent by weight.
      c. Maximum abrasion loss: 40 percent by weight.
   8. Fine aggregate:
      a. Deleterious material: Maximum amount of friable particles, 0.5 percent by weight; maximum amount of coal and lignite 0.25 percent by weight; material passing Size 200 sieve three percent maximum by weight.
   9. For bridge decks and bridge sidewalks: Use only crushed trap rock aggregate, trap rock to be diabase rock, ASTM C294.

N. High-Early-Strength Concrete: As specified for concrete and modified to produce high-early-strength concrete by one or a combination of the following methods.
   1. Substitution of Type III or Type I cement in approved mix.
   2. Addition of Type I cement to the approved mix, but so that the total cement does not exceed eight bags per cubic yard of concrete.
   3. Addition of an approved accelerating admixture to approved mix as specified in Section 03 30 00.

PART 3 - EXECUTION

3.01 EQUIPMENT:

A. General: See General Provision’s Article on equipment.
   1. Provide suitable equipment in sufficient quantity and sizes to perform work as specified and shown.
   2. Maintain machinery and equipment on site in first class working condition. Provide necessary tools and supplies for maintenance.

3. The term EQUIPMENT includes such specialized devices and tools that are customarily used in the construction of concrete pavements. The requirements for equipment given are not intended to be complete; rather, the intent is that characteristic equipment be used to produce certain of the required results. The suitability of the equipment is a determination made by the Engineer that the equipment will produce the required results.

B. Concrete Spreading Machines: Power driven spreaders capable of spreading concrete to the full width and depth specified as it is delivered and as follows:
   1. Standard-width machines with adjustments up to five feet.
   2. Controls conveniently grouped in easy reach of the operator.
   3. Multiple speeds in both reverse and forward gear.
   4. Capable of spreading concrete to both the depth specified for reinforcement and the full thickness of the slab, without segregation and without interfering with the joints or reinforcement.
   5. Not disturbing the forms due to lateral pressure of the spreading operation; the weight of the machines of such amount and so distributed as not to cause settlement of the forms.
   6. Equipped with dismountable rims to be used when operating on concrete.
   7. Provided with suitable means to keep material off the wheel and the top of the forms or slab.
   8. Spreading accomplished by either a screw, blade, or other suitable device of the reversing type, followed by a strike-off screed; the strike-off screed adjustable to the specified crown and section.

C. Internal Vibrators Operated Independently of Spreading or Finishing Machines: Use approved type of internal vibrators such as the spud-type, for compacting pavement concrete at joints and edges, operating at a frequency capable of producing at least 5,000 pulsations per minute, and with sufficient cable to permit being moved to any location directed by the Engineer. Do not use vibrators of such weight as to be unwieldy in application.

D. Concrete Finishing Machines:
   1. Power-driven and of the transverse-screed type.
   2. Equipped with traction wheel or wheels with dismountable rims to be used when operating on concrete.
   3. Equipped with two screeds, maintained in the best possible condition and adjustment throughout their use: Front screed used for striking off excess concrete to exact grade and crown; the rear screed used for finishing and smoothing operation.
   4. Screeds constructed of steel, be capable of being adjusted to the specified cross section, and be of such rigidity as to produce the specified crown and cross section.
   5. Each screed of the floating or suspended type, at least 1-1/2 feet longer than the width between the forms, and easily and quickly adjustable to the width required.
   6. Both machine and screeds are to have variable speeds and independently controlled.
   7. The weight of the machines of such amount and so distributed as not to cause settlement of the forms upon which operated.
   8. Provided with suitable means to keep material off the wheel and the top of the forms or slab.

E. Straightedges: Ten feet long, made of metal with handles suitable for ease of use, and rigidly constructed so that there will be no deflection exceeding 1/32 inch.

F. Templates: Constructed to extend from form to form and to ride on the form, equipped with adjustable tines spaced at six-inch intervals, and rigidly constructed that there will be no deflection exceeding 1/32 inch.

3.02 BASE:

A. Base Preparation: In accordance with Section 32 10 00.

B. Check previously placed base for grade and crown with templates and straightedges for compliance with tolerances specified in Section 32 10 00.

C. Correct deficiencies in grade, contour and compaction.

D. Obtain approval of base prior to placing forms and impervious material.

3.03 SETTING FORMS:

A. Unless concrete is placed against abutting structures, use steel forms to maintain concrete within required tolerance and to support paving equipment.

B. Use flexible steel forms for curve radii less than 250 feet. For small radius curves and non-standard closures, use approved wood forms. Provide properly drilled forms to accommodate tie rod assemblies.

C. Set forms accurately and firmly to line and grade throughout entire length of approved base.

D. Set forms sufficiently ahead of other work to avoid conflict during operations.

E. Concurrent with setting of forms, cover base with layer of impervious material of either subgrade paper or polyethylene sheet.
   1. Subgrade paper: Overlap adjacent strips at least four inches and ends not less than 12 inches.
   2. Polyethylene sheet: Overlap sides at least 12 inches.
   3. Maintain cover intact until concrete is placed.

F. Apply one coat of bituminous paint to contact areas of abutting structures and previously placed slabs.

3.04 FIELD QUALITY CONTROL:

A. Allowable Tolerances:
   1. Joints and joint devices: Maximum deviation of 1/4 inch from position shown and 1/8 inch from ten-foot steel straightedge.
   2. Dowels: Aligned to tolerance of not more than 1/8 inch in 12 inches.
   3. Fabric reinforcement:
      a. Clearance from vertical surfaces and joints: Minus 1/4 inch or plus 1/2 inch.
      b. Clearance from top and bottom surfaces: Plus-or-minus 1/4 inch.
      c. Clearance from top surface of additional reinforcing at penetrating structures: Plus-or-minus 1/8 inch.
   4. Top surface of concrete: Maximum deviation of 1/8 inch from ten-foot steel straightedge and within plus-or-minus 1/8 inch of the required elevation.

5. Grooves for joints: Within minus 1/16 inch or plus zero inch of dimensions shown.
6. Thickness of concrete pavement: Within minus 1/8 inch of the thickness shown, in accordance with AASHTO T148.

B. Testing of Concrete:
1. Conform to requirements specified in Section 03 30 00.

3.05 JOINT DEVICES:

A. General:
1. Place and secure joint devices to ensure that deviation does not exceed specified tolerances. Finish joints to such tolerances.
2. Provide acceptable means of splicing.
3. Provide satisfactory gages for checking position of joint devices.
4. Where joints are to be completed after placing concrete, mark location of joint devices so as to permit installation of joint to tolerances specified.
5. Where options for construction are permitted, use approved method.
6. Do not disturb joint devices. Do not permit workers to step on joint devices. Realign devices immediately if displaced.
7. Hold initial installation of devices firmly in place by tap bolts installed in holes drilled in forms. If holes in forms have been formed by method other than drilling, use steel washers in addition to tap bolts. After removal of forms replace tap bolts until adjoining subgrade is ready for concrete placement. Remove tap bolts and install remainder of tie devices prior to placing adjoining slab. Apply heavy coating of bituminous paint prior to placing concrete for adjacent slab.

B. Construction.
1. Longitudinal: The longitudinal joint at a previously placed slab and the joint between a slab and abutting curb and gutter are longitudinal construction joints.
   a. For these joints, with the exception of the ones at the curb and gutter sections, use a tongue-and-groove joint of an isosceles trapezoidal section one inch in height with the bases two inches and 2-1/2 inches, respectively; with the groove located as shown
   b. Tie the separately constructed slab sections together by the installation of longitudinal tie devices.
   c. The groove for concrete pavement for surface course may be made by forming or sawing as specified below, or by preformed plank left in place.
   d. Coat edges of the slab first constructed with heavy coat of bituminous paint prior to placing concrete for the adjacent slab.
2. Transverse joints: Make transverse construction joints only at a planned transverse expansion or contraction joint. Accordingly, have transverse construction joint devices conform to the requirements for the particular type of joint.

C. Contraction Joints:

D. Provide longitudinal contraction joints between previously placed slabs and new slabs and between slabs and abutting curbs and gutters.
1. Tie longitudinal contraction joints together by installation of 1/2-inch tie rods or tie-rod assemblies 30 inches long placed across longitudinal contraction joint and spaced as shown. Do not install tie rods or tie-rod assemblies closer than 18 inches to transverse joints.

2. Make groove for contraction joints by formwork, sawing or leaving filler in place.

E. Expansion Joints and Joint Filler: Make grooves for expansion joints by forming. Where grooves are made by device, use approved device of such design that work can be properly performed.

1. Prepare preformed expansion joint filler in greatest length possible and no less than ten feet.
2. Cut filler for joints transverse to the slab in a single piece of the required shape.
3. Cut pieces for curb and gutter as directed to exact size, from larger pieces.
4. When splicing joint filler, butt tightly to prevent penetration of concrete between adjacent strips of joint filler.
5. For longitudinal joints, except at curb and gutter sections, use preformed tongue and groove filler as shown.
6. Where dowels or other approved load-transfer devices have to penetrate joint filler, properly locate and drill holes of correct size or diameter through filler at required intervals to receive bars and to achieve tight fit.
7. Make groove for cement pavement for surface course by forming, sawing or leaving preformed joint in place.
8. Protect preformed joint filler during placing of concrete.

3.06 PLACING REINFORCEMENT:

A. Install welded steel wire fabric in flat sheets where shown in accordance with Section 03200.

B. Unless otherwise noted, use wire fabric as follows:

	Slab Thickness (Inches)	Roadway Width	
		Equal to or less than 24'-0"	Greater than 24'-0"
		Pounds/100 Square Feet	Pounds/100 Square Feet
	6	44	46
	8	51	54
	10	61	69

C. Place wire fabric to clear vertical surfaces and joints by two inches and within tolerances specified. Lap sheets distance equal to spacing of wires and tie securely.

D. Place two layers of wire fabric in concrete pavements over trench cuts, each layer to be of weight and type as specified for thickness of concrete. Position each layer two inches clear of top and bottom surfaces of slab and within tolerance specified. Extend each layer nine inches beyond sides of trench.

E. Where other structures, such as manholes, penetrate concrete pavements, place wire fabric on one inch centers in each direction so that there is a minimum of two feet of fabric extending horizontally around perimeter of structure. Install layer of fabric one inch clear of top surface of slab and within tolerance specified.

F. In surface courses, place wire fabric two inches clear of top surface of slab and within tolerance specified.

G. Install layer of wire fabric to serve as top layer over trenches. Install additional fabric around penetrations.

H. Except for pavements over trench cuts and around penetrations, do not place wire fabric in base course.

3.07 PLACING CONCRETE:

Supply and place portland cement concrete as specified in Section 03 30 00, with the following additional requirements:

A. Place concrete only during daylight unless otherwise approved. If placement is authorized during darkness provide adequate lighting system.

B. Do not place concrete at temperatures below 40F unless otherwise approved; nor place concrete on a frozen base.

C. Prior to placing concrete around poles, manholes or other structures projecting through pavement, coat such structures heavily with bituminous paint.

D. Place concrete to the full thickness, deposited in successive batches for full width of slab by means of discharging device which does not cause segregation of materials.

E. Compact concrete thoroughly during placement.

F. Place concrete mechanical spreaders except where hand methods for spreading are approved. When spreading by hand, employ sufficient work force for leveling, spading and spreading concrete in front of screed. Do not use rakes for handling concrete.

G. Deposit concrete as near as practicable to joints but not touching expansion and contraction joint devices. Shovel concrete to height approximately two inches more than depth of the joint. As soon as forms are removed, clean ends of expansion joints of concrete and expose full width of preformed joint filler for full depth of slab. Place concrete against previously constructed slabs only after ends of preformed joint filler have been so cleaned and ends of performed joint filler in slab being poured have been neatly and firmly butted.

H. Where wire fabric is required, place concrete in layers so that wire fabric may be properly placed. Requirements for machine placing and for vibration apply for each layer. Place layers and wire fabric, large wires running in longitudinal direction in such rapid sequence that monolithic slab will result.

I. Compact concrete both by internal and surface vibration. Vibrators may be combined with spreading and finishing machines. Compact concrete adjacent to forms, joints, existing concrete or other structures by use of spud vibrator. Insert vibrator in concrete and work along entire length. Avoid contact with joint devices or underlying base. Evidence of honeycomb or lack of compaction constitute basis for rejection of concrete pavement as deficient.

J. Construction Joints:
   1. Form construction joints where it is necessary and approved to stop concreting for 30 minutes or longer, by staking in a bulkhead and finishing the concrete to the bulkhead.
   2. If, due to an emergency, concreting must be stopped within less than ten feet of a previously formed joint of any type, remove the concrete to the joint prior to resuming the placing of the slab.

3.08 INITIAL FINISHING, FLOATING AND FINAL FINISHING:

A. Give concrete initial finish by use of finishing machines operated so as to minimize formation of laitance and to give required uniformity of surface and compaction. Remove laitance in approved manner.

B. Avoid prolonged operation over a given area. Operate the machine over each area of pavement as directed and only as many times and at such intervals as required to give the proper compaction and uniformity of surface.

C. Keep tops of forms clean to permit true and accurate movement of machine.

D. On completion of screeding, bring surface to smooth finish by use of floats, eight inches wide and a minimum of four feet long, with handles at least four feet longer than width of slab and not less than 16 feet long.

E. Operate float transversely with combined longitudinal and transverse motion for sufficient number of passes to smooth ridges and fill depressions.

F. On completion of floating operations, screed top surface of concrete with deviation not exceeding 1/8 inch from straightedge and within tolerance specified for required elevation. Correct deficiencies by handwork if approved.

G. After floating and verifying that surface is within specified tolerances, drag surface in longitudinal direction with longitudinal and crosswise motions using burlap so to prevent edges digging into surface of concrete or working crown out of pavement.

H. Brooming:
   1. Upon completion of burlap dragging, broom finish top surface of pavement. Use street brooms made for the purpose with split bamboo bristles or metal bristles.
   2. Broom width: 14 inches.
   3. Broom handle: At least one-half slab width.
   4. In general make brooming perpendicular to centerline of paving unless otherwise shown. Prior to brooming, obtain the Engineer's approval of the direction of brooming for each area.
   5. Pull broom gently over surface of pavement from edge to edge walking back and forth on bridge over pavement, holding handle almost vertical and allowing broom to drag lightly over surface without interruption, leaving slight ridges in concrete perpendicular to centerline of pavement.
   6. Overlap ridging. Ridging not more than 1/8 inch in depth with corrugations of uniform character and width.
   7. Complete brooming before rounding edges of pavement and joints.

I. Round joints and edges to radius shown.

J. To form flow line for gutters, trowel smooth 12-inch width of pavement adjacent to curbs unless otherwise shown.

K. Joint Work and Edging: Where there is an option of method for doing joint work, secure approval for the method elected and use only that method.
   1. Perform joint work and edging when condition of concrete permits.

2. Ensure that joints are within tolerances specified and that there is no perceptible lip or depression other than rounding.
3. Prepare clean grooves rounded to 1/4-inch radius with smooth even walls.
4. Make grooves for expansion joints by forming. See requirements above for expansion joints.
5. For joints to be sealed with poured sealer, prepare grooves with dimensions as shown and within tolerance specified. For joints to be sealed with preformed elastomeric seals, leave grooves of dimensions and within tolerances shown. Provide suitable gauges for checking dimensions.
6. Where joints in surface course are sealed with cold-poured joint sealer, break bottom bond by placing polyethylene tape full width of groove, laid flat along top of preformed joint filler prior to joint sealing.
7. When using hot-poured or cold-applied joint sealer, use only equipment designed for purpose. Hand-pouring pots are prohibited. Maintain material within temperature range recommended by manufacturer. Apply sealer when air temperature is as specified. Construct so that resulting stripe is straight, neat, of uniform width and joint is filled to 1/4 inch from top surface of pavement.
8. When placing elastomeric joint seals, use equipment and methods recommended by manufacturer.

3.09 CURING:

A. Allow finished concrete to cure by one of the following methods for seven days or until concrete has developed flexural strength of 500 psi:
   1. Wet burlap: Cover pavement with double thickness of thoroughly wet burlap, overlapping adjacent sheets by at least six inches. Maintain burlap in saturated state by sprinkling until it is removed. Use only clean material free from holes.
   2. Waterproof paper, polyethylene sheet or white burlap-polyethylene sheet: Place material so that adjacent sheets overlap by at least 12 inches. Secure material along side and ends so as to maintain reasonably airtight seal.
   3. Use approved liquid-membrane curing compounds as recommended by manufacturer, using equipment designed for purpose.

B. Obtain approval of the Engineer for the curing method elected and use only that method.

3.10 REMOVAL OF FORMS:

A. Remove forms as soon as condition of concrete permits, but in no case sooner than 12 hours after placement.

B. When the temperature is below 40F, leave forms in place for at least 48 hours or as directed.

3.11 COLD WEATHER CONSTRUCTION:

A. Whenever, by the National Weather Service forecast for the locality, the temperature may be expected to reach 50F or lower during the 24-hour period following placement concrete mix, include a Type C accelerating admixture in the concrete mix as specified in Section 03 30 00. The accelerating admixture shall comply with AASHTO M 194, Type C, except that it shall contain not more than 500 parts per million chloride ion.

B. Place concrete when temperature conditions are as specified, unless otherwise directed. If placing of concrete is so directed, in addition to adding an accelerator heat aggregates, water or both, so that mix when laid is not less than 55F nor more than 90F. Do not exceed 140F for mixing water and 150F for aggregates.

C. As soon as concrete has hardened sufficiently to prevent marring, cover pavement surface and edges with dry burlap, building paper or other approved material and subsequent layer of at least six inches of dry hay, straw or other approved material. Maintain such protection for at least three days or until field tests indicate that concrete has attained required strength.

D. During low temperatures, install truck-mixed concrete immediately upon delivery.

E. When temperature by National Weather Service forecast will be 40F or lower during the 72-hour period following placement of concrete, do not use membrane curing compound.

3.12 HOT WEATHER CONSTRUCTION:

A. When by National Weather Service forecast, temperature will be 90F or higher during the 24-hour period following placement of concrete, cover pavement by wet-burlap method for first 24 hours, after which curing may be completed by one of the specified methods.

3.13 PROTECTION OF CONCRETE PAVEMENT:

A. Obtain approval prior to permitting use of completed pavement by public and construction traffic.

3.14 DEFICIENT PAVEMENT:

A. Where directed, remove and replace with new materials or correct concrete pavement that does not meet requirements.

END OF SECTION