SECTION 03320

PORTLAND CEMENT CONCRETE STREET PAVEMENT

PART 1 - GENERAL

1.1 Description

A. Description of Work

The work to be performed in accordance with this section includes furnishing and installing Portland cement concrete street pavement on a prepared subgrade.

The work shall include the furnishing of all labor, tools, equipment, materials and performing all required operations to provide a complete item in accordance with the project plans and these specifications.

B. Related Work Specified Elsewhere

Subgrade preparation.....Section 02600
Concrete structures.....Section 03300

1.2 Quality Assurance

A. Reference test standards and specifications

ASTM C42, Obtaining And Testing Drilled Cores And Sawed Beams of Concrete.

ASTM D3406, Specification For Joint Sealant, Hot-Poured, Elastomeric - Type, For Portland Cement Concrete Pavement.

ASTM D1751, Specification For Performed Expansion Joint Fillers For Concrete Paving And Structural Construction.

B. Frequency of Testing

1. Consistency

Air content and compressive strength to be tested per the test methods and at the frequencies as specified in Section 3300,

Concrete Structures.

2. Thickness

ASTM C42. Determine the thickness of the hardened concrete pavement by drilled cores. Obtain one core per 1000 linear feet of pavement or one days production, whichever is less. Additional cores may be required to define deficient area.

C. Tolerances

1. Consistency

The measured slump shall not exceed the design slump by more or less than one inch. In no case shall the slump exceed 4-inches.

2. Air Content

The measured air content shall not be less that 4 nor more than 6 percent when tested in accordance with ASTM C231.

3. Compressive Strength

Concrete represented by a strength test of at least 95% of the required 28-day compressive strength will be acceptable. All concrete failing to meet this requirement as evidenced by test of either standard cylinder or drilled core specimens shall be rejected, removed and replaced at the **CONTRACTOR'S** expense. Concrete Strength tests between 95 percent and 100 percent of the 28-day requirement will be paid at a reduced cost.

4. Tolerances for Formed Surfaces

ACI 301, Table 4.3.1.

5. Tolerance for Slab on Grade

a. Surface Smoothness

Slabs shall be true planes within 1/4 inch in 10 feet as determined by a 10 foot straight-edge placed anywhere

on the slab in any direction.

i. Grind down areas higher than 1/4 inch but not more than 1/2 inch above the correct surface.

ii. Correct areas lower than 1/4 inch but not lower than 1/2 inch below the correct surface by grinding down the adjacent areas.

iii. Break out and replace pavement when the deviation exceeds 1/2 inch from the correct surface. The area replace shall be of a length, width and depth as required to allow formation or a new slab of the required quality.

b. Thickness

If the slab thickness is not deficient by more than 1/4 inch the pavement shall be accepted and paid for in full. If the slab thickness is deficient by more than 1/4 inch and less than or equal to 1/2 inch it shall be accepted and paid for at a reduced rate. Slabs deficient by more than 1/2 inch shall be rejected and removed and replaced at no additional cost to the **OWNER**.

1.3 Submittals

A. Certificates of Compliance

1. Admixtures

2. Cement

3. Fly Ash

4. Pozzolan

5. Water Stop

6. Reinforcing Steel

7. Fiber Reinforcement

B. Materials Test Reports

1. Coarse Aggregates

2. Fine Aggregates

C. Mix Designs

1. ACI 211 normal weight concrete, including for variations for admixtures. Include compressive strength test data and modulus of rupture test data obtained at the same concrete age which establishes a correlation between the flexural and compressive strength properties of concrete. Establish correlation with statistical procedures outlined by ACI.

PART 2 - MATERIALS

2.1 Portland Cement Concrete

A. Strength

Provide concrete that will develop a modulus of rupture of not less than 250 psi within 14 days and 650 psi at 28 days age as determines by ASTM C78.

B. Slump

Provide concrete with the minimum required slump to adequately place, densify and finish. Do not exceed the mix design water cement ratio (W/C) or design slump.

2.2 Cement

ASTM C150, Type V.

2.3 Water

Use clear water free from objectionable quantities of organic matter, alkali, acids, oil, silt and other deleterious substances. Water for prestressed concrete shall not contain chlorides calculated as sodium chloride in excess of 1,000 parts per million nor any sulphates calculated as sulphate in excess of 1,000 parts per million. Water shall not contain an amount of impurities that will cause a change in the time of setting of Portland cement of more

than 25 percent nor a reduction in the compressive strength of Portland cement mortar or more than 5 percent when compared to results obtained with distilled water.

2.4 Aggregate

A. Coarse Aggregate

ASTM C33, Class Designation M, grading size number 57, non-alkali reactive.

B. Fine Aggregate

ASTM C33, non-alkali reactive.

1. Sand equivalent

ASTM D2419, not less than 75.

2.5 Admixtures

A. Air Entraining Agent

ASTM C260.

B. Accelerating Agents

ASTM D98.

C. Water Reducing Agents

ASTM C494, Type A, D, or E.

D. Fly Ash and Pozzolan

ASTM C6618, Class N or F. Pozzolan may be used to replace up to 15 percent of the weight of the required Portland cement. The replacement ratio shall be 1.2 pounds of Pozzolan per pound of Portland cement.

2.6 Concrete Curing

Liquid membrane curing, ACI 308, ASTM C309. Liquid membrane curing compound for concrete exposed to vehicular traffic, Type 2.

2.7 Steel Reinforcement

ASTM A615, Grade 60, unless otherwise specified, and deformations to ASTM A615, A616 or A617 as applicable. All bars shall be round and deformed. Welded wire fabric or mesh shall conform to the requirements of ASTM A185.

2.8 Chairs and Spacers

Provide chairs and spacers manufactured specifically for use with concrete pavements.

2.9 Stationary Side Forms

Provide side form sections straight, free from warps, bends, indentations or other defects. Side forms shall be of metal, have a base width of at least four inches and a minimum depth equal to the thickness of the pavement. No section shall show a variation from a true plane greater than 1/8 inch in ten feet on the top of the form or more than 1/4 inch in ten feet on the inside face. Flexible or curved forms of proper radius shall be used for curves of 100 feet radius or less. Suitable materials other than metal may be used to form end closures or at other locations where use of metal forms is not practical when approved by the **OWNER**. Forms shall be thoroughly cleaned and oiled each time they are used.

2.10 Joint Sealant

ASTM D3406.

2.11 Backer Rod

Specifically made for use in joints to control the depth or sealant, achieve the desired shape factor, support sealant against indentation and sag and to prevent bond of the sealant to the bottom concrete surface.

2.12 Joint Filler

ASTM D1751.

PART 3 - EXECUTION

3.1 Inspection of the Work

Verify that all preliminary work has been performed in accordance with these specifications.

3.2 General

Construct Portland cement concrete pavement with mechanical equipment utilizing stationary side forms or by the use of slipform paving equipment without stationary side forms. Manual methods of placing and finishing concrete with stationary side forms may be permitted by the **OWNER**.

3.3 Equipment

Equipment used to place concrete may consist of one or more machines, shall be capable of uniformly distributing and consolidating the concrete as it is placed without segregation and shall be capable of producing concrete pavement which will conform to the required cross-section with a minimum of hand work. Furnish adequate number and capacity of machines to perform the work required at a rate equal to the concrete delivery rate.

Use vibrators to consolidate concrete. The rate of vibration shall not be less than 3,500 cycles per minute for surface vibrators and not less than 8,000 cycles per minute for internal vibrators. Connect power to vibrators mounted on mechanical equipment so that vibration ceases when forward or backward motion of the machine is stopped. Furnish a tachometer or other suitable device for measuring and indicating the frequency of vibration.

Equip slipform pavers with high frequency internal vibrators mounted with axes either parallel or normal to pavement alignment for the full paving width. Space vibrators mounted with axes parallel with pavement alignment at intervals not to exceed 24 inches, measured center-to-center. Vibrators mounted with axes normal to pavement alignment shall be spaces so that lateral clearance between individual vibrating units does not exceed 6 inches.

Equip slipform paving equipment which will be wholly or partially supported on subgrade with traveling side forms of sufficient dimensions, shape and strength to support the concrete at free edges laterally for a sufficient length of time during placement to produce pavement of the required cross-section. Equip and operate equipment with automatic sensing and control devices such that the machine automatically senses deviations from the established

guideline and performs the necessary corrective maneuvers to overcome variations from correct grade and alignment.

3.4 Subgrade Preparation and Base Course

Specification Section 2600 and 2610. Uniformly moisten surface to receive concrete.

3.5 Placing, Spreading and Compacting

Deposit concrete on the subgrade and spread full width using mechanical methods that result in a minimum of handling and segregation. Necessary hand spreading shall be done with shovels, not rakes. Placement shall be continuous between transverse joints between transverse joints without the use of intermediate bulkheads.

Make adequate advance arrangements for preventing delay in delivery and placing of concrete. An interval of more than 15 minutes between placing of any two consecutive batches shall constitute cause for stopping operations, and the **CONTRACTOR** shall install a construction joint in the concrete already placed at the location and of the type directed by the **OWNER**.

Deposit concrete as near to expansion and construction joints as possible without disturbing them. Thoroughly consolidate concrete against and along the faces of all forms, adjacent pavement or curb and gutter, and on both side of all joint assemblies. Vibrators shall not be permitted to come in contact with joint assemblies, the grade, or side forms, and shall not be operated longer than 15 seconds in any one location.

Manual methods of placing, spreading, and impacting may be used in the construction of pavement lanes of irregular width or widths less than 10 feet, and sections of intersections or other locations with complex variable surface configurations when permitted by the **OWNER**. Workmen shall not be allowed to walk in the freshly placed concrete with boots or shoes coated with earth or other foreign substances.

3.6 Shaping and Initial Finishing

Strike off, consolidate, and float-finished concrete with a slipform paver, mechanical finishing machine, vibrating screed, or by hand finishing methods when approved by the **OWNER** so that the completed pavement will conform to the thickness and cross-section requirements of the plans and specifications. When the pavement being constructed is contiguous to

existing parallel concrete pavement or curb and gutter, the elevation of the new pavement surface shall conform as closely as possible to the elevation of the existing pavement or gutter surface and in a manner which will prevent ponding.

Do not apply water to the pavement surface during screeding and finishing operations in excess of the amount lost by evaporation. Adding water to the surface of the concrete to assist in furnishing operations shall not be permitted. When applications of water to the surface are required to prevent rapid evaporation of water from the surface during finishing operations, it shall be applied as a fog spray and with approved spray equipment.

A. Slipform Supported on Subgrade Method

The equipment shall spread, consolidate, screed and float-finish the concrete in one complete pass of the machine. The machine shall be operated with as nearly a continuous forward movement as possible and all paving operations shall be so coordinated as to provide uniform progress with stopping and starting of the paver held to a minimum. Sliding side forms shall be rigidly held together to prevent spreading. Any edge slump of the pavement, exclusive of edge rounding in excess of 1/4 inch shall be corrected.

No abrupt changes in longitudinal alignment of the pavement will be permitted. The horizontal deviation shall not exceed 1 inch from the alignment established by the **OWNER**.

While concrete is being spaced, compacted and shaped, vibrating units shall be operated within fresh concrete so that the longitudinal axis, at the center of each unit, is not more than 6 inches above the top of the subgrade. Amplitude of vibration shall be sufficient to be perceptible on the surface of concrete along the entire length of vibrating units and for a distance of at least on foot therefrom.

B. Mechanical Equipment Supported on Fixed Form Method

When concrete is spread without the use of internal vibration, the finishing machine shall be equipped with vibrating equipment that will internally vibrate the concrete for the full paving width and with not less than two oscillating or reciprocating screeds. Concrete shall be struck off and consolidated so that the surface will conform to the finished grade and cross-section shown on the project plans and with sufficient material on the surface for floating operations.

After the concrete has been struck off and consolidated, it shall be floated with a longitudinal float of a type approved by the **OWNER**.

A slipform paver or a single machine which will effectively spread, consolidate, screed, and float in one operation may be used in lieu of separate finishing and floating equipment.

C. Manual Methods with Fixed Forms

Concrete shall be deposited, spread and struck off to such an elevation that, when properly consolidated, the surface will conform to the required lines and grades. Concrete shall be consolidated by internal vibration as it is struck off with a screed. A slight excess of concrete shall be kept in front of the screed at all times during the strike-off operation.

Pavement shall be finished smooth and true to grade with suitable manually operated floats or powered finishing equipment.

3.7 Final Finishing

After the pavement has been float finished, it shall be scraped with a 10-foot long straightedge equipped with a handle to permit operation from the edge of the pavement, and excess water and latence shall be removed from the surface. The straightedge shall be operated parallel to the centerline of the pavement and shall be moved forward one-half length after each pass. Irregularities shall be corrected by adding or removing concrete, and disturbed places shall be again straight-edged.
Long-handled wood floats shall be used only in areas not accessible to finishing equipment and in emergencies, and use of such floats shall be confined to a minimum.

The addition of water to the surface of the concrete to assist in finishing operations shall not be permitted unless approved by the **OWNER**. When addition of the water to the surface is permitted to prevent rapid evaporation of water from the surface during finish, it shall be applies as a fog spray with approved spray equipment.

Pavement edges and joints shall be edged in accordance with the details shown on the project plans or as directed by the **OWNER**.

In advance of curing operations, pavement shall be given a texturing.

Texturing shall be performed with an artificial turf drag with a board added to assure the weight needed to obtain an approved surface. Artificial turf shall be a molded composite structure with polyethylene face, nylon and polyester backing, a pile height of 0.85 inches, and total weight of 75 oz./sq. yd. The approved surface will be made by the **OWNER** on the initial construction and shall not be changed without approval. Each time the construction is stopped or causes the texturing to stop, the artificial turf must be shaken clean before continuing.

3.8 Curing

Curing shall begin immediately following surface texturing and edging. **CONTRACTOR** shall have at hand and ready to install before concrete placement begins the materials and equipment needed for adequate curing.

After finishing operations have been completed, the newly placed concrete shall be cured by moist curing methods, by application of a white liquid membrane compound, or by a combination of these methods. All surfaces not covered by reasonably waterproof forms shall be kept damp by applying water with a nozzle that so atomizes the flow of water that a fog mist and not a spray is formed until the surface is covered with liquid membrane compound, the surface has hardened sufficiently to permit sprinkling of the surface, or moist curing by covering with wet burlap or other approved materials can be initiated. Moisture from the nozzle shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow and erode the surface. Moist curing shall be continued until liquid membrane curing compound or other type of curing membrane is applied.

Membrane curing compound shall be applied to all pavement by automatic mechanical method from a construction bridge.

The edges of concrete slabs exposed by the removal of forms shall be protected immediately to provide these exposed surfaces with continuous curing treatment equal to the method selected for curing the pavement surface.

The membrane method of curing may be applied behind the final finishing operation after all free water has disappeared from the surface. Complete and uniform coverage at the rate of one gallon per 100 square feet, or as otherwise recommended by the manufacturer, shall be required. Compound shall be kept agitated to prevent pigment from settling.

3.9 Joints

A. General

Provide joints in the pavement of the type, dimensions and at the locations as indicated in the plans or as specified herein.

The faces of all joints shall be perpendicular to the pavement surface. Joints shall be constructed in accordance with the details shown in the plans and in accordance with the following provisions.

At all times prior to acceptance of the construction, joints shall be maintained clean and free of all soil, gravel, and other foreign material except approved typed of joint filler materials.

B. Longitudinal Joints

Longitudinal joints shall be weakened plane or construction joints. Longitudinal weakened plane joints shall be constructed with keyways as indicated in the plans.

C. Transverse Joints

Transverse joints shall be weakened plane, construction or expansion joints. All transverse weakened plane joints will be constructed by sawing and in accordance with the details shown in the project plans. Transverse construction joints shall be constructed with keyways and in accordance with the details shown in the project plans. Transverse expansion joints shall be constructed as butt joints with vertical expansion joint filler and with or without dowel bars in accordance with the details shown in the project plans. Dowel bars shall be supported on a basket-type system with a base plate on a subgrade and up the side form to prevent material from entering dowel openings.

D. Joint Location

Longitudinal joints shall be constructed between traffic lanes and at other locations as indicated in the project plans.

Transverse construction joints shall be constructed at the end of a day's production or when placing of concrete is discontinued for more than 45 minutes.

Transverse weakened plane joints in concrete placed in lanes adjacent to previously placed concrete shall be located to align with weakened plane joints in the adjacent lanes. No transverse weakened plane joint shall be constructed within 6 feet of another transverse joint. When the planned spacing of transverse weakened plane joints results in location of a weakened plane joint within 6 feet of another transverse joint, the transverse weakened plane joint shall be relocated so it is not within 6 feet of said transverse joint.

Provide isolation joints around manholes, catch basins, or other elements which extend into or project through the pavement and act as points of restraint to horizontal or vertical movement of the pavement.

3.10 Construction of Joints

A. Sawed Joints

Sawed joints shall be constructed by cutting a groove in the pavement using a single or multiple-blade power saw. The groove shall be cut to the dimensions shown on the project plans. Suitable guidelines or devices shall be used to assure joints are cut true to the lines as shown on the project plans.

If joints ate sawed in stages, the initial saw cut shall be of the minimum width specified and sawed to the required depth shown on the project plans. The depth of the initial saw cut in the construction of weakened plane joints shall be a minimum of 1/4 of the slab thickness.

Sawing of weakened plane joints shall be done before uncontrolled cracking takes place, and after the concrete has hardened to the extent that tearing or raveling of the edges of the saw cut is not excessive. The exact time for all sawing shall be determined by the **CONTRACTOR**.

Any procedure for sawing joints that results in premature, uncontrolled cracking shall be revised immediately. The **CONTRACTOR** shall be responsible for replacing or repairing areas containing uncontrolled cracking and for repairing spilled or chipped concrete along the edges of sawed joints as directed and to the satisfaction of the **OWNER**.

After sawcutting of the joint and just prior to sealing the joint, the internal joint surfaces shall be cleaned of all dirt, curing compound residue, latence and other foreign materials. The internal joint surface shall be defined as the sawed portion of the joint and resultant crack for the full depth of the pavement.

B. Sealing of Joints

Complete sealing prior to the opening of the pavement to traffic unless otherwise approved by the **OWNER**. When delayed sealing of sawed joints is permitted, saw cuts and formed recess to be filled with sealant shall be protected to ensure thorough curing of the concrete along the edges of the joint recesses and to prevent entry of foreign materials into the joint. At the **CONTRACTOR'S** option, inert compressible joint filler material such as plastic backer rod may be inserted into joints immediately after sawing or forming of the joint recess to provide curing protection and prevent entry of foreign material.

Apply sealant in accordance with the sealant manufacturer's recommendations. Furnish and apply a primer after the joint has been cleaned and prepared to receive sealant if so indicated in the manufacturer's recommendations.

Prior to the application of the sealant, an approved type of inert, compressible joint filler material such as plastic rod or an approved type of bond breaker, shall be inserted along the joint in accordance with the details shown on the project plans. Fill the joint with sealant to a level not less than 1/8 inch or more than 1/4 inch below the elevation of the pavement surface adjacent to the joint edge.

Apply sealant with the equipment as recommended by the sealant manufacturer. Sealant shall not be spilled on the surface of the concrete pavement. Remove any sealant inadvertently spilled on the pavement surface.

3.11 Repair of Cracks, Spills, Raveling and Tearing

CONTRACTOR shall be responsible for replacing or repairing all areas of pavement containing uncontrolled cracking, surface spills, or other types of surface defects as directed by the **OWNER**. Repairs shall be made by methods acceptable to the **OWNER** and the repair shall be completed to the satisfaction of the **OWNER**.

PART 4 - MEASUREMENT AND PAYMENT

4.1 Measurement

Measurement for Portland cement concrete pavement will be the number of square yards in-place and accepted by the **OWNER**. The quantity shall be based on plan dimensions.

4.2 Payment

Payment for Portland cement concrete pavement will be made at the contract unit price per bid per square yard. The unit price shall be full compensation for furnishing all materials, for all preparation, mixing, testing and placing of these materials, and for all labor, equipment, tools and incidentals necessary to complete this item.

A. When concrete is accepted on the basis of strength of less than 100% of the required minimum 28-day compressive strength, an adjustment in the contract unit price will be made for the quantity of concrete represented by such strength test in accordance with the following schedule:

Adjustment in Contract Unit Price for Strength Deficiency

Percent of Specified Minimum 28-day Compressive Strength tained (Nearest 1%)	Percent of Concrete Unit Price Allowed
100% or greater	100
98-99	90
96-97	85
95	80

See Section 00310 Bid Schedule for Bid Items.

END OF SECTION