

SECTION 32 13 13 CONCRETE PAVING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO).
 - a. M6, Standard Specification for Fine Aggregate for Portland Cement Concrete.
 - b. M80, Standard Specification for Coarse Aggregate for Portland Cement Concrete.
 - c. M153, Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
 - d. M157, Standard Specification for Ready-Mixed Concrete.
 - e. M213, Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - f. M227/M227M, Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.
2. American Concrete Institute (ACI):
 - a. 305R, Hot Weather Concreting.
 - b. 306R, Cold Weather Concreting.
 - c. 308, Standard Practice for Curing Concrete.
 - d. 318/318R, Building Code Requirements for Structural Concrete and Commentary.
 - e. 325.9R, Guide for Construction of Concrete Pavements and Concrete Bases.
3. ASTM International (ASTM):
 - a. A615/A615M, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - b. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - c. C33, Specification for Concrete Aggregates.
 - d. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - e. C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - f. C78, Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).

- g. C88, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
- h. C94/C94M, Standard Specification for Ready-Mixed Concrete.
- i. C143/C143M, Standard Test Method for Slump of Hydraulic Cement Concrete.
- j. C150, Specification for Portland Cement.
- k. C172, Standard Practice for Sampling Freshly Mixed Concrete.
- l. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- m. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
- n. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- o. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.
- p. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
- q. C803/C803M, Test Method for Penetration Resistance of Hardened Concrete.
- r. C1330, Specification for Cylindrical Seal Backing for Use With Cold Liquid Applied Sealants.
- s. C805, Test Method for Rebound Number of Hardened Concrete.
- t. D920, Standard Specification for Elastomeric Joint Seals.
- u. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
- v. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- w. D1752, Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
- x. D2628, Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete.
- y. D2828, Specification for Non-Bituminous Inserts for Contraction Joints in Portland Cement Concrete Airfield Pavements, Sawable Type.
- z. D3406, Specification for Joint Sealant, Hot-Applied, Elastomeric-Type, for Portland Cement Concrete Pavements.
- aa. D3569, Specification for Joint Sealant, Hot-Applied, Elastomeric, Jet-Fuel-Resistant Type for Portland Cement Concrete Pavements.
- bb. D3581, Specification for Joint Sealant, Hot-Applied, Jet-Fuel-Resistant-Type, for Portland Cement and Tar-Concrete Pavements.

- cc. D5249, Specification for Backer Material for Use With Cold- and Hot-Applied Joint Sealants in Portland Cement Concrete and Asphalt Joints.
- dd. D5893, Specification for Cold-Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.
- ee. E329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
- 4. National Ready Mixed Concrete Association (NRMCA).

1.02 DEFINITIONS

- A. Specification: Contract Documents that describe the Work and include the General Conditions, the Technical Specifications, the Supplementary Conditions, and any Reference Specifications incorporated therein.

1.03 SUBMITTALS

A. Action Submittals:

- 1. Mix Designs:
 - a. Contain proportions of materials and admixtures to be used on Project, signed by mix designer.
 - b. Documentation of average strength for each proposed mix design in accordance with ACI 301.
 - c. Manufacturer's Certificate of Compliance, in accordance with Section 01 67 00, Product Requirements, for the following:
 - 1) Portland cement.
 - 2) Fly ash.
 - 3) Slag cement.
 - 4) Silica Fume.
 - 5) Aggregates, including specified class designation for coarse aggregate.
 - 6) Admixtures.
 - 7) Concrete producer has verified compatibility for constituent materials in design mix.
 - d. Test Reports:
 - 1) Water-Soluble Chloride-Ion Content in Hardened Concrete: Unless otherwise permitted, in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.
 - 2) Shrinkage Test Results: in accordance with ASTM C157/C157M as modified herein.
 - e. Aggregates:
 - 1) Coarse Aggregate Gradation: List gradings and percent passing through each sieve.

- 2) Fine Aggregate Gradation: List gradings and percent passing through each sieve.
- 3) Percent of fine aggregate weight to total aggregate weight.
- 4) Deleterious substances in fine aggregate per ASTM C33/C33M, Table 4.
- 5) Test Reports:
 - a) Alkali Aggregate Reactivity: Aggregate shall be classified as nonpotentially reactive in accordance with Article Concrete Mix Design. Include documentation of test results per applicable standards.
- f. Admixtures: Manufacturer's catalog cut sheets and product data sheets for each admixture used in proposed mix designs.
2. Product Data: Specified ancillary materials.
3. Detailed plan for curing and protection of concrete placed and cured in cold weather. Details shall include, but not limited to, the following:
 - a. Procedures for protecting subgrade from frost and accumulation of ice and snow on reinforcement, other metallic embeds, and forms prior to placement.
 - b. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
 - c. Methods for temperature protection during placement.
 - d. Types of covering, insulation, housing, or heating to be provided.
 - e. Curing methods to be used during the following protection period.
 - f. Use of strength accelerating admixtures.
 - g. Methods for verification of in-place strength.
 - h. Procedures for measuring and recording concrete temperatures.
 - i. Procedures for preventing drying during dry, windy conditions.
4. Detailed plan for hot weather placements including curing and protection for concrete placed in ambient temperatures over 80 degrees F. Plan shall include, but not limited to, the following:
 - a. Procedures for measuring, and recording temperatures of reinforcement and other embedded items prior to concrete placement.
 - b. Use of retarding admixture.
 - c. Methods for controlling temperature of reinforcement and other embedded items and concrete materials before and during placement.
 - d. Types of shading and wind protection to be provided.
 - e. Curing methods, including use of evaporation retardant.
 - f. Procedures for measuring and recording concrete temperatures.
 - g. Procedures for preventing drying during dry, windy conditions.

B. Informational Submittals:

1. Preinstallation Conference minutes.
2. Manufacturer's application instructions for bonding agent and bond breaker.
3. Manufacturers' Certificate of Compliance to specified standards:
 - a. Bonding agent.
 - b. Bond breaker.
4. Statements of Qualifications:
 - a. Batch Plant: Certification as specified herein.
 - b. Mix designer.
 - c. Installer
 - d. Testing agency.
5. Field test reports.
6. Tightness test results.
7. Concrete Delivery Tickets:
 - a. For each batch of concrete before unloading at Site.
 - b. In accordance with ASTM C94/C94M, including requirements 14.2.1 through 14.2.10.
 - c. Indicate amount of mixing water withheld and maximum amount that may be permitted to be added at Site.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Batch Plant: NRMCA Program for Certification of Ready-Mixed Concrete Production Facilities or approved equivalent program.
2. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRCMA Concrete Technologist Level 2 or DOT certified mix designer in jurisdiction of the Work. Requirement may be waived if individual in Contractor's Licensed Design Engineer.
3. Flatwork Finisher: Unless otherwise permitted, at least one person on finishing crew shall be certified as an ACI Flatwork Finisher, or equivalent.
4. Testing Agency: Unless otherwise permitted, an independent agency, acceptable to authorize having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
 - a. Where field testing is required of Contractor, personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
 - b. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician – Grade I. Testing Agency laboratory

supervisor shall be an ACI-certified Concrete Laboratory Testing Technician – Grade II.

B. Preinstallation Conference:

1. Required Meeting Attendees:
 - a. Contractor, including pumping, placing and finishing, and curing subcontractors.
 - b. Ready-mix producer.
 - c. Admixture representative.
 - d. Testing and sampling personnel.
 - e. Engineer who authored Statement of Special Inspection Plan or Contracting Officer designee.
2. Schedule and conduct prior to incorporation of respective products into Project. Notify Contracting Officer of location and time.
3. Agenda shall include:
 - a. Admixture types, dosage, performance, and redosing at Site.
 - b. Mix designs, test of mixes, and Submittals.
 - c. Placement methods, techniques, equipment, consolidation, and form pressures.
 - d. Slump and placement time to maintain slump.
 - e. Finish, curing, and water retention.
 - f. Protection procedures for weather conditions.
 - g. Other specified requirements requiring coordination.
4. Conference minutes as specified in Section 01 31 00; Project Management and Coordination..

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Transporting of ready-mix concrete shall be in accordance with ASTM C94/C94M.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

A. Cement:

1. Physical Characteristics: Provide as required in Section 03 30 00, Cast-in-Place Concrete.
2. Functional Characteristics:
 - a. Furnish cement for Project from one source.
 - b. Portland cement shall be Type I.
3. Performance Characteristics:
 - a. In accordance with ASTM C150.
 - b. Pozzolan: ASTM C618, Class C or Class F flyash.

B. Aggregates:

1. General:

a. Physical Characteristics:

- 1) As specified in Section 03 30 00, Cast-in-Place Concrete.
- 2) Aggregate for portland cement concrete mixture shall be 3/4 inch maximum size stone meeting requirements of AASHTO M6 and AASHTO M80.
- 3) Material: Natural aggregates, free from deleterious coatings.

b. Functional Characteristics: Aggregates shall not be potentially reactive as defined in ASTM C33.

c. Performance Characteristics: Aggregates not in compliance with soundness and durability requirements of ASTM C33 may be used with prior approval of Contracting Officer; provided it can be shown by special testing or record of past performance that these aggregates produce concrete of adequate strength and durability. Aggregate soundness testing for fine and coarse aggregates shall be in accordance with ASTM C33 and ASTM C88.

2. Fine Aggregates:

a. Physical Characteristics:

- 1) Must be graded coarse to fine within the following limits:

General Requirements	
Sieve Size Passing	Percentages by Weight
3/8"	100
No. 4	90 - 100
No. 8	55 - 85
No. 16	45 - 75
No. 30	25 - 55
No. 50	5 - 30
No. 100	0 - 8

- 2) Sand: Equivalent of not less than 68.

- 3) Materials finer than 200 sieve shall not exceed 4 percent.

b. Functional Characteristics: Sources near or exposed to saltwater shall be washed, unless it can be shown that chloride content does not exceed 0.15 percent by weight of cement.

c. Performance Characteristics: Use of beach sand shall not be permitted.

3. Coarse Aggregate:

a. Physical Characteristics:

- 1) Materials finer than 200 sieve shall not exceed 0.5 percent.
- 2) Size: 3/4 inch to No. 4.

Grading Requirements		
Sieve Size Passing	Separated Sizes 1-1/2 Inch to 3/4 Inch	Percentages (by Weight) 3/4 Inch to No. 4
2"	100	
1-1/2"	90 - 100	
1"	30 - 65	100
3/4"	0 - 15	90 - 100
3/8"		20 - 50
No. 4		0 - 10

b. Functional Characteristics: None.

c. Performance Characteristics: None.

C. Physical Properties:

1. Physical Characteristics: None.
2. Functional Characteristics: Meet requirements of AASHTO M80 for Class B.
3. Performance Characteristics: None.

D. Water:

1. Physical Characteristics: None.
2. Functional Characteristics: ASTM C94/C94M.
3. Performance Characteristics: None.

E. Admixtures:

1. Physical Characteristics: Add admixtures to mix at batch plant.
2. Functional Characteristics: None.
3. Performance Characteristics:
 - a. Air Entraining: ASTM C260.
 - b. Water Reducing:
 - 1) ASTM C494/C494M, Type A, normal, containing no chlorides and compatible with air-entraining admixtures.
 - 2) Do not use calcium chloride, salt, or antifreeze agents.

2.02 ANCILLARY MATERIALS

A. Tie Bars:

1. Physical Characteristics: Grade 40 deformed steel bars
2. Functional Characteristics: None.
3. Performance Characteristics: Conforming to ASTM A615/A615M

B. Dowels:

1. Physical Characteristics: Grade 70.
2. Functional Characteristics: None.
3. Performance Characteristics: Conform to requirements of AASHTO M227/M227M.

C. Joint Filler:

1. Physical Characteristics: Preformed expansion joint filler as specified in Section 03 15 00, Concrete Joints and Accessories.
2. Functional Characteristics: None.
3. Performance Characteristics: Fillers furnished under AASHTO M213 shall be tested in accordance with ASTM D1751.

D. Joint Sealant:

1. Physical Characteristics: None.
2. Functional Characteristics: None.
3. Performance Characteristics:
 - a. Preformed elastomeric joint seal conforming to ASTM D2628.
 - b. Hot-poured elastomeric joint seal conforming to ASTM D3406.
 - c. Hot-applied, jet-fuel-resistant joint sealant conforming to ASTM D3569.
 - d. Cold-applied single component joint sealant conforming to ASTM D5893.
 - e. Elastomeric joint sealant conforming to ASTM C920.

E. Backer Rod:

1. Physical Characteristics: None.
2. Functional Characteristics: None.
3. Performance Characteristics:
 - a. Backer material conforming to ASTM D5249.
 - b. Cylindrical sealant backing conforming to ASTM C1330.

F. Curing Compound:

1. Physical Characteristics: None.
2. Functional Characteristics: None.
3. Performance Characteristics: Conforming to ASTM C309, Type 1, Class A, suitable for spray application.

G. Curing Membranes:

1. Physical Characteristics:
 - a. White polyethylene sheeting.
 - b. Cotton or jute mats.
2. Functional Characteristics: Waterproof paper.
3. Performance Characteristics: None.

H. Evaporation Retardant:

1. Physical Characteristics: None.
2. Functional Characteristics: None.
3. Performance Characteristics:
 - a. Confilm as manufactured by Master Builders Company.
 - b. Or equal.

2.03 EQUIPMENT

A. Ready-Mix Concrete Batch Plants:

1. Physical Characteristics: None.
2. Functional Characteristics: Certified by NRMCA.
3. Performance Characteristics: None.

B. Ready-Mix Concrete Trucks:

1. Physical Characteristics:
 - a. Agitator mixer type.
 - b. Equipped with operable electrically actuated drum revolution counters.
2. Functional Characteristics:
 - a. Use of nonagitator equipment will not be permitted.
 - b. Each mixer shall carry a clearly visible manufacturer's plate showing capacity of mixer and other pertinent operating rates and limits.
 - c. Provision shall be made at mixer for controlled addition of air-entraining admixtures or other special components of mix.
3. Performance Characteristics:
 - a. Mixing Speed: 70 revolutions to 100 revolutions at a mixing speed recommended by truck mixer manufacturer.

C. Hauling Equipment:

1. Physical Characteristics: None.
2. Functional Characteristics: Hauling equipment shall conform to AASHTO M157, Paragraph 11.6 and Paragraph 12.
3. Performance Characteristics: Upon delivery of each batch of concrete to Site, a trip ticket shall be submitted to Contracting Officer.

D. Paving Equipment:

1. Physical Characteristics: None.
2. Functional Characteristics:
 - a. Slipform Paver:
 - 1) Place portland cement concrete with two separate machines, one a spreader and one a slipform paver. Machines, when operating in tandem shall spread, consolidate, screed, and float finish freshly placed portland cement concrete in one pass with a minimum of hand finishing. Each machine shall be fully self-propelled and equipped with electronic controls to control line and grade from both sides.
 - 2) Spreader shall be able to deliver mix without segregation or displacing reinforcing steel.
 - 3) Able to vibrate portland cement concrete for full width and depth and be equipped with vibrating tubes or arms to work in portland cement concrete. Sliding forms shall be held together rigidly to prevent them from spreading. Form shall be long enough so slumping of portland cement concrete will not exceed 1/4 inch.
 - 4) Supports of paver and other equipment which ride on previously placed pavement shall be equipped to prevent marring, edge breaking, or chipping of previously placed pavement.
 - b. Bridge Deck Finisher/Paver: A bridge or similar finishing/paving machine utilizing previously constructed and cured curb and gutter as side forms and support for machine rails may be used with prior approval of Contracting Officer.
3. Performance Characteristics: None.

E. Concrete Saws:

1. Physical Characteristics: None.
2. Functional Characteristics: Provide power driven concrete saws for sawing joints or finishing concrete, adequate in number of units and power to complete sawing at required rate.

3. Performance Characteristics:
 - a. Saws and related equipment shall be of proven adequacy and design to perform efficiently and shall be subject to immediate replacement, if specified results are not obtained.
 - b. Standby saw shall be available at Site.

F. Smoothness Testing Equipment:

1. Physical Characteristics: Two 12-foot straightedges.
2. Functional Characteristics: Determining smoothness.
3. Performance Characteristics: None.

2.04 CONCRETE MIX DESIGN

A. Physical Characteristics:

1. Maximum water-cement ratio or water-cement plus pozzolan ratio, if applicable, shall not exceed 0.48.
2. Replacement of cement with pozzolan shall not exceed 20 percent.
3. Maximum Aggregate Size: 3/4 inch minus.
4. Allowable Slump: 3 inches, plus or minus 1 inch.
5. Allowable Air Entrainment: 5 percent, plus or minus 1 percent by volume.
6. Concrete shall contain water reducer. Amount of admixture added to concrete shall be in accordance with manufacturer's written instructions.
7. Do not use frozen materials or materials containing ice or snow.
8. Concrete temperature as delivered to site ready for placement shall be above 50 degrees F and below 90 degrees F.

B. Functional Characteristics:

1. Minimum 28-Day Compressive Strength: 4,500 psi.
2. As specified in Section 03 30 00, Cast-in-Place Concrete, with a minimum flexural strength of 650 psi.
3. Concrete target strengths shall be in accordance with ACI 318/318R.

C. Performance Characteristics:

1. Use of set-retarding admixtures shall be subject to prior approval by Contracting Officer.
2. If Contractor proposes to use a current mix design that meets these Specifications, has been used on previous Phantom Ranch project, and less than 1 year has elapsed since it was last used; Contractor shall submit documentation of production of concrete produced from that mix design to Contracting Officer for review. If review verifies concrete produced meets these Specifications and strength requirements, and

establishes a correlation between compressive strength and flexural strength, no trial batches for proposed mix design will be required.

PART 3 EXECUTION

3.01 WEATHER LIMITATIONS

- A. Concrete shall not be placed:
 - 1. Until the air temperature in the shade is 35 degrees F and rising and is forecast to remain above 35 degrees F.
 - 2. On frozen ground.
 - 3. During periods of rain or snow.
- B. Concrete placement shall not continue when air temperature drops below 40 degrees F.
- C. Protect concrete pavement from inclement weather for 7 days after it has been placed, when rain is imminent, and when air temperature drops or is forecast to drop below 35 degrees F.

3.02 PREPARATION

- A. Prepare base as specified in Section 32 11 23, Aggregate Base and Subbase Course(s).
- B. Dampen base thoroughly prior to concrete placement; standing water will not be permitted.
- C. Formwork shall be complete prior to placement of concrete. Area in which concrete is to be placed, shall be smooth and free of ruts, projections, debris, spilled concrete, mud, sloughed soil, standing water, organic and other objectionable materials.
- D. Construction Joints: Inspect prior to placement of concrete.
- E. Prior to placing paving equipment in position, full width and length of the area on which the tracks of the paving equipment is to operate shall be brought to density and surface tolerances required.
- F. Protect existing exposed surfaces such as grates, catch basins, air valves, manholes, and cleanout lids from splattered and spilled concrete during concrete placement by use of durable waterproof paper.
- G. Furnish operable backup vibrator on Site prior to concrete placement.

3.03 SLIP FORM PAVING

- A. Deliver from hauling vehicles to paving machine hopper.
- B. Contractor's equipment hauling portland cement concrete or reinforcement will not be permitted on subgrade, but will be allowed on base, with turns or other maneuvering kept to a minimum. Damage to subgrade or base shall be corrected to satisfaction of Contracting Officer.
- C. Place in final position uniformly in one layer, so a minimum of finishing will be necessary to provide a dense, homogenous pavement conforming to true grade and cross-section.
 - 1. Spreader shall receive portland cement concrete mixture in its hopper and uniformly spread and strike it off at proper thickness for full width of area being paved.
 - 2. Paver shall vibrate, consolidate, and finish slab to proper grade and cross section.
- D. Paver:
 - 1. Operated with as continuous forward movement as possible.
 - 2. Coordinate mixing, delivering, and spreading portland cement concrete to provide uniform progress.
 - 3. Stopping and starting paver shall be held to a minimum. If, for any reason, it is necessary to stop forward motion of paver, vibratory and tamping elements shall also be stopped immediately.
 - 4. No external force shall be applied to paver, except with approval of Contracting Officer.
- E. While placing portland cement concrete, provision shall be made for constructing joints, placing dowels, tie bars, and other devices as called for by the Drawings and as provided in Article Joints.
- F. Portland cement concrete shall be rejected if it:
 - 1. Is not in place within 1 hour after being mixed.
 - 2. Has begun to take an initial set prior to placement.
 - 3. Has been rettempered with water.
- G. If necessary, supplemental hand spreading and distributing shall be with shovels. Rakes will not be permitted.
- H. Portland cement concrete shall not be fouled with foreign matter.
- I. Use vibrators to consolidate portland cement concrete pavement at least 6 feet each side of construction joints and expansion joints.

3.04 STATIONARY SIDE FORM CONSTRUCTION

- A. Where width of pavement is narrow, tapering, or of irregular pattern not lending itself to being constructed by prescribed machine methods, Contractor shall be permitted to place concrete as specified in Section 03 30 00, Cast-in-Place Concrete.
- B. Defects:
 - 1. Fill areas of minor honeycomb or other minor defect in composition of portland cement concrete along exposed edges of portland cement concrete with a stiff mortar of cement and fine aggregate. Apply to moistened portland cement concrete to satisfaction of Contracting Officer.
 - 2. Area showing serious defects in composition of concrete shall be removed and replaced with pavement of specified quality for full width of strip between longitudinal joints or edges and for a length not less than between the nearest transverse joints.

3.05 JOINTS

- A. General:
 - 1. Referred to as contraction or construction, either of which may be transverse or longitudinal, as called for by the Drawings or as approved by Contracting Officer.
 - 2. Joints, backer material, joint filler and joint sealants shall extend to pavement edges or to each other, as the case may be, and shall be constructed perpendicular to surface of pavement.
 - 3. Joints shall not vary from specified or indicated line by more than 1/4 inch.
 - 4. Contractor shall submit jointing plan and details to Contracting Officer for approval. Take into consideration placement of joints in curb and gutter, at catch basins, and position of manholes and other large structures, as well as other limitations herein mentioned.
 - 5. Place manhole or similar large structure in line of joint, or if impractical, isolate structure from pavement with premolded joint filler, 1/2-inch wide, conforming to AASHTO M213 and ASTM D1751.
- B. Contraction Joints:
 - 1. Sawed Type with Poured Filler:
 - a. Sawing shall be to a depth as shown on the Drawings with a maximum width of 1/4 inch and a minimum width of 1/8 inch, in straight lines as shown or as approved by Contracting Officer.
 - b. Perform saw cuts as soon as portland cement concrete has set enough to permit sawing without tearing or raveling, before

uncontrolled cracking results, and within 24 hours of placing portland cement concrete.

- c. Saws may be single or tandem, as Contractor may elect, and shall be controlled by guides to true line.
- d. Clean joints thoroughly of foreign matter before pouring approved rubber asphalt filler.
- e. Tops of joint filler shall be true to pavement cross section within 1/8 inch and shall be protected from damage by portland cement concrete operations.
- f. Areas containing uncontrolled cracks shall be removed and replaced.
- g. Restore curing agents broken or damaged by sawing operations.
2. Space longitudinal joints as shown on the Drawings at the interface between lanes, normally at intervals between 12 feet to 16 feet.
3. Transverse joints shall be as shown on the Drawings or as approved by Contracting Officer, with intervals of 12 feet to 16 feet.

C. Construction Joints:

1. Construct when there is an interruption of longer 45 minutes in portland cement concrete placing operations or where specified.
2. Place parallel with intended contraction joint.
3. Tool both free edges of joints with 1/8 inch radius rounder to remove laitance and mortar resulting from finishing operations and to provide clean rounded edge. Tooling shall not form ridges on surface of concrete.
4. New portland cement concrete placed contiguous to joint shall conform to proportions and consistency of previously placed concrete.
5. Transverse Construction Joint:
 - a. As shown on the Drawings.
 - b. If sufficient portland cement concrete has not been mixed at the time of interruption to place a construction joint at least 3 feet from a planned contraction joint, remove excess portland cement concrete back to a position to satisfactorily meet these criteria and to satisfaction of Contracting Officer.
 - c. Fill joint which has opened to a width of 1/8 inch or greater during construction or maintenance periods with poured filler.
 - d. Do not construct within 3 feet of a transverse contraction joint.
6. Longitudinal Construction Joint:
 - a. Tied type using No. 5 by 36-inch deformed tie bars at 12-inch centers.
 - b. Tie Bars:
 - 1) Not required at construction joint between portland cement concrete pavement and gutter, except where shown on the Drawings and mentioned above.

- 2) Placement:
 - a) Plastic Portland Cement Concrete: Insert before vibrating and finishing portland cement concrete; or
 - b) Hardened Concrete:
 - (1) Drill hole, insert, and grout tie bars into place.
 - (2) Drill holes large and deep enough to allow tie bars to be inserted with grout.
 - (3) Perform any time after portland cement concrete has attained enough strength to resist any damage caused by drilling.
 - (4) Tie bars shall be grouted a maximum of 3 hours prior to placement of adjacent portland cement concrete.
- 3) Replace loose tie bars by drilling and grouting as described.

D. Scored Joints:

1. Configuration: 1/4-inch wide by 1/4-inch deep at locations indicated on the Drawings formed by tooling of concrete while it is still fresh.
2. Do not fill or seal.
3. Layout of joints shall be straight and true and shall not vary from indicated line by more than 1/4 inch.

3.06 SURFACE FINISHING

- A. Use temporary screeds. Wet screeding and jitterbugging shall not be permitted.
- B. Pavement shall have surface tolerance of 1/4 inch in 10 feet in accordance with ACI 325.9R.
- C. Salting, spreading of cement or cement and sand mixture to speed up hardening shall not be permitted.
- D. Exposed pavement edges shall be edged to a 1/2-inch radius and construction joints shall be edged to 1/8-inch radius after finishing. Edging shall not form ridges on pavement surface.
- E. Pavement shall be treated and protected by use of evaporation retardant applied in accordance with manufacturer's written instructions. Flat surfaces shall be treated immediately after screeding and floating or if time period greater than 15 minutes occurs between finishing operations.

- F. Pavement shall be screeded, floated, and given a longitudinal burlap drag.
 - 1. Burlap Drag Finish: Trail moistened coarse burlap from a device that allows control of the time and rate of texturing to provide a uniform finish.

3.07 CURING OF PORTLAND CEMENT CONCRETE

- A. Immediately after the final floating, surface finishing, and edging has been completed, and while portland cement concrete surface is still moist, cover and cure entire exposed surface for at least 72 hours in accordance with one of the following provisions:
 - 1. Liquid Membrane-Forming Compounds: Apply compound uniformly to portland cement concrete by pressure spray methods at a rate which will form an impervious membrane, but at least at a rate of 1 gallon per 150 square feet.
 - 2. Other Membranes:
 - a. Apply to damp portland cement concrete as soon as it can be placed without marring surface.
 - b. Place in contact with surface, extend beyond sides or edges of slabs or forms, and fasten down to hold it in position as a waterproof and moistureproof covering.
 - c. Laps shall be sufficient to maintain tightness equivalent to sheeting.
 - d. Transverse laps for waterproof paper shall be at least 18 inches, and longitudinal seams shall be cemented.
 - e. Cotton or jute mats shall be saturated with water prior to placing and kept fully wetted during curing period.
- B. Concrete shall be cured by use of curing compound, for minimum of 7 days after concrete placement, in accordance with ACI 308. Curing compounds shall be applied in accordance with manufacturer's written instructions.
- C. Exposed surfaces shall be sprayed with curing compound immediately after free surface water has disappeared from finished surface.
- D. Concrete temperature shall be maintained in accordance with ACI 306R.
- E. Curing compounds shall not come in contact with hardened concrete that is to be concreted against.

3.08 FIELD QUALITY CONTROL

- A. Retain independent testing or inspection agency to perform inspection, sampling, and testing.
- B. Concrete Sampling: In accordance with ASTM C172. Take sample not less than every 5,000 square feet or fraction thereof of concrete placed each day.
- C. Perform following tests on each sampling:
 - 1. Slump: ASTM C143/C143M.
 - 2. Air Content: ASTM C231.
 - 3. Compressive Strength: ASTM C39/C39M.
 - 4. Flexural Strength: ASTM C78.
- D. Strength Tests:
 - 1. Make and cure cylinders and beams in accordance with ASTM C31/C31M.
 - 2. Cylinders: Make four, standard 6-inch diameter by 12 inches high. Cure one in field and three in laboratory.
 - 3. Beams: Make three, standard 6 inches by 6 inches by 21 inches. Cure in field.
 - 4. Compressive: Test one field-cured cylinder at 7 days and two laboratory-cured cylinders at 28 days. Test last cylinder at 56 days if 28-day cylinder is below specified strength.
 - 5. Flexural: Test one beam at 7 days and two beams at 28 days.
- E. Acceptance of concrete shall be in accordance with ACI 318/318R.
- F. Concrete with compressive strength less than specified, as evidenced by cylinder tested at 56 days, shall be additionally tested as follows:
 - 1. Less Than 500 psi Low in Compression or Less Than 75 psi Low in Flexure:
 - a. Penetration Resistance Test: ASTM C803.
 - b. Rebound Hammer Test: ASTM C805.
 - c. Perform tests within 24 hours of noncomplying strength tests.
 - 2. More Than 500 psi Low in Compression or More Than 75 psi Low in Flexure:
 - a. Concrete Coring: Take three standard cores from concrete representing original specimens.
 - b. Take and prepare cores in accordance with ASTM C42/C42M.
 - c. Test cores in accordance with ASTM C39/C39M.
 - d. Take cores within 24 hours of noncomplying strength test.

G. Pay Factor:

1. Portland cement concrete shall be accepted according to average compressive strengths of four or more cylinders taken for 28-day tests for each 500 cubic yards placed and the following acceptance schedule:

Acceptance Schedule Compressive Strength	
Pay Factor	Percent of Specified Strength
1.00	95 percent or higher
0.90	90 to 95 percent
0.70	80 to 90 percent
Remove and replace	Less than 80

2. Whenever percentage of specified compressive strength falls below the level of 80 percent, Contracting Officer may require the portland cement concrete be removed and replaced to meet required Specifications.
3. If the compressive strength, f_c , to comply with the flexural strength requirement is greater than 4,000 psi, then the specified strength shall be multiplied by:

$$\frac{F_c}{4000}$$

3.09 CLEANING

- A. Clean concrete splatter from exposed surfaces.
- B. Thoroughly broom and wash concrete surfaces before opening to traffic.

3.10 PROTECTION OF CONCRETE

- A. Do not operate construction equipment or allow traffic on newly placed portland cement concrete until the following requirements are met:
 1. Joints have been filled as per Article Joints.
 2. Concrete has attained a compressive strength of at least 4,000 pounds per square inch.
- B. Protect new concrete from construction operations, mechanical disturbances, water flow, and soiling until open for traffic.
- C. Erect and maintain suitable barriers to protect concrete from traffic or other detrimental trespass until pavement is opened to traffic.

- D. Maintain watchmen after normal working hours for at least a 24-hour period to ensure barriers are not removed or destroyed, and that trespass and vandalism upon pavement does not occur.
- E. Wherever it is necessary that traffic, including Contractor's vehicles and equipment, be carried from one side of pavement to the other, construct suitable bridges over pavement, and maintain them in good condition as long as they may be required. Leaving gaps in pavement to facilitate movement of traffic will not be allowed, unless prior written permission is obtained from Contracting Officer.
- F. Protect new concrete from dirt, asphalt, and other deleterious substances that may be tracked onto new pavement from construction activities.
- G. Pavement damaged by traffic or damaged from any other cause, prior to its official acceptance, shall be repaired or replaced to the satisfaction of Contracting Officer.

END OF SECTION

