

DIVISION 2

SECTION 02750 – PORTLAND CEMENT CONCRETE PAVING

PART 1 - GENERAL

1.01 Scope

- A. Furnish all labor, materials, supplies, equipment, transportation, and perform all operations in connection with and reasonably incidental to complete installation of concrete paving as shown on the drawings and as specified herein. Items of work specifically included are:
- B. Subgrade preparation for plazas, walks, ramps, playground curbs and headers.
- C. Form work.
- D. Reinforcement.
- E. Surface finish.
- F. Construction, expansion and control joints.
- G. Curing.
- H. Concrete plazas, sidewalks, ramps, playground curbs and headers.
- I. Interior slabs-on-grade in restroom, etc.

1.02 Work Not Included

- A. Items of work specifically excluded or covered under other sections:
- B. Excavation and backfill.
- C. Earthwork and grading.
- D. Cast-in-place structural concrete or precast concrete, such as foundations, drainage appurtenances, and pad and building.
- E. Joint sealers.

1.03 Related Work

- A. Division 2 – Site Work:
 - 1. Section 02050 – Demolition.
 - 2. Section 02200 – Earthwork/Grading.
 - 3. Section 02220 – Trenching, Backfilling, and Compaction.
- B. Division 3 – Concrete
 - 1. Section 03100 – Concrete Formwork
 - 2. Section 03200 – Concrete Reinforcing
 - 3. Section 03300 – Cast-in-Place Concrete
- C. Division 7 – Thermal and Moisture Protection:
 - 1. Section 07900 – Joint Sealers.

1.04 References

- A. ACI 301 – Specifications for Structural Concrete for Buildings.

- B. ASTM C33 – Concrete Aggregate.
- C. ASTM C150 – Portland Cement.
- D. ASTM C260 – Air Entraining Admixtures for Concrete.
- E. ASTM C309 – Liquid Membrane – Forming Compounds for Curing Concrete.
- F. ACI 304 – Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete.
- G. ACI 305R – Hot Weather Concreting.
- H. ACI 306R – Cold Weather Concreting.
- I. ACI 308 – Standard Practice for Curing Concrete.
- J. ACI 309 – Recommended Practice for Consolidation of Concrete.
- K. ACI 318-89 – Building Code Requirements for Reinforced Concrete.

1.05 Regulatory Requirements

- A. Conform to applicable code of governing authority for paving work within public right-of-way.

1.06 Tests

- A. Submit proposed mix design to testing laboratory for review prior to commencement of work. For standard premix concrete mixes, the supplier's quality control records may be substituted for job mix testing.
- B. Refer to Division 1, Section 01450 Quality Control and Testing.
- C. Coordinate and schedule sampling testing during concrete placement with City Representative.

1.07 Submittals

- A. Submit product data under provisions of Section 01600 – Materials and Equipment.
- B. Submit data on admixtures and curing compounds.
- C. Submit a ten pound sample of aggregate for exposed aggregate finish.
- D. Submit manufacturer's data on leave-in-place construction joint form.
- E. Submit sample chips of specified colors indicating pigment number and required dosage rate. Submittals are for general verification of color and may vary somewhat from concrete finished in field according to Specifications.
- F. Submit samples of colored sealers.

1.08 Test Panels

- A. Provide a 3' x 3' test panel for finish and tooling of joints for Owner approval. Provide one panel for each pavement type specified. In casting the panels, use personnel and methods to be employed on the work.
- B. If sample disapproved, cast additional samples until approval is obtained. Maintain test panel on site until finished work is accepted. Test panel will represent minimum workmanship standard.
- C. Work completed prior to test panel approval shall be subject to removal and replacement at Owner's request.

PART 2 MATERIALS

2.01 Concrete Materials

- A. General: Provide materials of same brand and source throughout the project unless otherwise noted.
- B. Portland Cement: ASTM C150, Type I or Type I/II, gray color.
- C. Aggregates: ASTM C33, normal weight. In addition, the combined aggregate shall comply with the following gradation, shown in percent passing.

<u>Sieve Size</u>	<u>¾-Inch Nominal Maximum Size</u>
¾ Inch	90 – 100
3/8 Inch	60 – 80
No. 4	40 – 60
No. 8	30 – 45
No. 16	20 – 35
No. 30	13 – 23
No. 50	5 – 15
No. 100	0 – 5

- D. Fly Ash and Water: Upon approval based on a satisfactory trial mix, the CONTRACTOR shall have the option of substituting approved fly ash for Portland cement, up to a maximum of 20 percent by weight. The total weight of cement and fly ash shall not be less than the specified mix design.
 - 1. Fly ash for concrete shall conform to the requirements of ASTM C 618, Class C or Class F. All chemical requirements of ASTM C 618 Table 1-A shall apply with the exception of footnote A. Class C fly ash will not be permitted where sulfate resistant cement is required. The CONTRACTOR shall submit certified laboratory test results for the fly ash. Test results that do not meet the physical and chemical requirements may result in the suspension of the use of fly ash until the corrections necessary have been taken to insure that the material meets the specifications.
 - 2. Water used in mixing or curing shall be clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substance injurious to the finished product. Water will be tested in accordance with, and shall meet the suggested requirements of AASHTO T 26. Water known to be of potable quality may be used without test. Where the source of water is relatively shallow, the intake shall be so enclosed as to exclude silt, mud, grass, or other foreign materials.
- E. Coarse Aggregate for Exposed Aggregate Finish: 5/8-inch maximum size; rounded shape, ratio of maximum to minimum dimensions not to exceed 2.5:1; color to be tan to brown, no more than 2% white or black combined, no pink, no red, no green.
- F. Water: Clean and not detrimental to concrete.

2.02 Pigments for Integrally Colored Concrete

- A. Manufacturer:
 - 1. Davis Colors manufactured by Davis Colors: phone (213) 269-7311.
 - 2. Substitutions: Comply with Section 01600 for substitution request procedures.
- B. Materials: Pigments shall contain pure, concentrated mineral pigments especially processed for mixing into concrete and complying with ASTM C979.

- C. Packaging: If pigments are to be added to mix at Site, furnish pigments in pre-measured Mix-Ready disintegrating bags to minimize job site waste.
- D. Colors: Concrete mix shall contain the dosage rate of pigments indicated in this specification. Dosage rate shall be based on weight of Portland cement, fly ash, silica fume, lime and other cementitious materials but not aggregate or sand. Refer to the site plans for locations of the various colors of concrete.

2.03 Form Materials

- A. Slab Edges: Two by lumber permitted for surfaces not exposed to view in the final work. Use concrete-form grade hardboard, “plyform” grade plywood, or metal for forming surfaces exposed to view. Forms shall be straight and sufficiently stiff and well braced to meet line tolerances specified in Part 3.
- B. Keyed Joint Form: Wooden key or leave-in-place metal construction joint form.
- C. Form Coatings: Commercial form-coating compounds that will not bond with, stain, or adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

2.04 Reinforcement

- A. Reinforcing Steel: ASTM A615; 60 ksi yield grade; deformed billet-steel bars, uncoated finish.
- B. Fibermesh: Bundled, fibrillated, virgin polypropylene fibers manufactured for use in premix concrete and having the following characteristics:
 1. Special Gravity: 0.91.
 2. Tensile Strength: 70 to 100 ksi.
 3. Fiber Lengths: ½ inch, ¾ inch.
 4. Accepted Materials: “Fibermesh” by Fibermesh Company of Chattanooga, TN; or “Forta CR” by Forta Corporation of Groove City, PA.
- C. Dowels: ASTM A615; 40 or 60 ksi yield grade, plain steel, uncoated finish; matched sleeve and cap one end. Provide dowel basket to hold dowels in parallel alignment.

2.05 Admixtures

- A. General: Unless specified in the mix or directed in Part 3, no admixtures shall be used without approval of the Owner’s Representative. Do not use admixtures that would result in mixing water with a concentration of more than 150 ppm of chloride ion.
- B. Air Entraining: ASTM C260.
- C. Water Reducing: ASTM C494, Type A.
- D. Accelerator: Nonchloride, ASTM C494, Type C or E.
- E. Retarder: ASTM C494, Type B or D.
- F. Color Agent: Davis Colors of Los Angeles, California.

2.06 Related Materials

- A. Expansion Joint Filler: ASTM D1752, closed cell polyethylene, ½ inch thickness.
- B. Joint Sealant: See Section 07900.
- C. Surface Retardant: Surface retarding agent intended for exposed aggregate. Retardx-SR0” by Prokrete of Denver, Colorado, or approved equal.

- D. Curing Compound for Standard Non-Colored Walks, Curbs, Gutters, Etc: White pigmented, wax-resin based compound, ASTM C309, Type I, Class A. Recommended by manufacturer for use on exterior sidewalks and driveways.
- E. Curing Compound for Concrete with Coloring Agent: Davis Seal Color to match colored concrete.
- F. Curing Compound and Sealer for Exposed Aggregate Concrete: Acryseal by Prokete Industries of Denver, Colorado.
- G. Curing Compound for Interior Slabs: Protex Promulsion 100 or equal.
- H. Interior Floor Sealer: Protex Triple Seal or equal.

2.07 Concrete Mix

- A. Mix concrete in accordance with ASTM C94.
 - 1. Provide non-colored concrete for exterior slabs on grade, sidewalks, curb and gutter, walls, aprons and ramps (except panel inserts) with the following characteristics:

<u>Unit</u>	<u>Measurement</u>
a. 28-Day Field Compressive Strength	4,000 psi
b. Cement/Fly Ash	615 lbs./cu. yd. Min.
c. Max. Water/Cement Ratio	0.44
d. Air Content % Range	5-8
e. Maximum Slump	4"
f. Fine Aggregate (max. % of total Aggregate)	50%

- 2. Provide colored concrete for plazas, ramps and other flatwork with the following characteristics:

<u>Unit</u>	<u>Measurement</u>
a. 28-Day Field Compressive Strength	4,000 psi
b. Cement/Fly Ash	615 lbs./cu. yd. Min.
c. Max. Water/Cement Ratio	0.44
d. Air Content % Range	5-8
e. Maximum Slump	4"
f. Fine Aggregate (max. % of total Aggregate)	50%
g. Coloring Agent	Per manufacturer's recommendations (refer to Definition of Bid Items and/or Drawings for designated colors)

- B. Use accelerating admixtures in cold weather as directed in Part 3.
- C. Use set-retarding admixture during hot weather as directed in Part 3.
- D. Water reducing agent is permitted.

2.08 Selection of Proportions

- A. Mix Design: Cost of concrete mix design is responsibility of Contractor.
- B. Selection of Proportions: Use method of ACI 301 3.9. Proportioning base on method of ACI 301 3.10 not allowed.

1. Field test records used for documentation of the average strength produced by a proposed mix in accordance with ACI 301 3.9.3.2 shall, in addition to the requirements listed, comply with the following:
 - a. The test record shall represent production concrete from a single design mix produced during the past year.
 - b. The test record shall represent concrete proportioned to produce the maximum slump allowed by these specifications, and for air-entrained concrete, within a $\pm 0.5\%$ of the maximum air content allowed.
2. Mixes proportioned on the basis of trial mixtures shall meet the provisions of ACI 301 3.9.3.3.

PART 3 EXECUTION

3.01 Subgrade Preparation

- A. Shape and compact subgrade to match appropriate detail. Compact to 95% density as measured by ASTM D698. Coordinate with Section 02200 – Earthwork, Article 3.05, Compaction.
- B. Where subgrade cannot be compacted, remove subgrade. Replace with bed course. Compact to 95% density as measured by ASTM D698.
- C. Moisten subgrade to minimize absorption of water from fresh concrete. Subgrade shall not be muddy, soft, frozen, or covered with standing water when concrete is placed.

3.02 Form Work

- A. General: Design, construct, and brace forms in accordance with ACI 301 and ACI 347. In addition to those requirements, forms shall be placed and braced so the finished edges and joints meet the tolerances listed later in this section.
- B. Preparation of Form Surfaces:
 1. Clean reused forms of concrete matrix residue; repair and patch as required to return forms to acceptable surface condition.
 2. Coat contact surfaces of forms with specified form-coating compound before reinforcement is placed. Apply form-coating compound according to manufacturer's instructions. Do not allow excess form-coating material to accumulate in forms or to come in contact with concrete surfaces against which fresh concrete will be placed.
- C. Slipforming: Slipforming of vertical curb and gutter sidewalks is permitted.
- D. For Surfaces Exposed To View: Form faces shall be free from raised grain, tears, worn edges, patches, dents, or other defects which would impair texture of the concrete surfaces. Minimize number of seams in form material, and arrange seams in an orderly manner.

3.03 Reinforcement and Embedments

- A. General:
 1. Fabricate, position, and secure reinforcement and embedded items according to ACI 301 and ACI 315. Coordinate with other sections for locations, instructions, or equipment for embedded items.
 2. Shop drawings are not required.
 3. Welding reinforcement is not permitted.
 4. In the event of discrepancy, immediately notify the Owner's Representative. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

- B. Field-Bending of Reinforcement: Reinforcement partially embedded in concrete shall not be field-bent, except as noted on the drawings or specifically permitted by the Owner's Representative.
- C. Inspection of Reinforcement: Completed installation of concrete reinforcement must be reviewed by the Owner's Representative before depositing concrete.
- D. Unless otherwise indicated, place reinforcement where required at top of slabs on grade. Provide ½-inch minimum cover over reinforcement.
- E. Dowels: Grease sleeves, insert dowels and through form, secure dowel basket against movement.
- F. Notches for Sleeving: Notch both vertical sides of walk or slab where sleeving occurs.
- G. Welded wire fabric shall be overlapped one full mesh and tied.
- H. Fibrous Reinforcement:
 - 1. Add fibrous concrete reinforcement to concrete materials at the time concrete is batched in amounts in accordance with approved submittals for each type of concrete required.
 - 2. Mix batched concrete in accordance with manufacturer's recommendations for uniform and complete dispersion.

3.04 Joints

- A. General: Place joints in accordance with ACI 301. Conform to the tolerances listed later in Part 3.
- B. Isolation/Expansion Joints: Isolation joint and expansion joint are synonymous for concrete paving.
 - 1. Place isolation joints where work abuts existing walls, curbs and structures, and where shown on the drawings.
 - 2. Interrupt reinforcement at isolation joint. Install dowels only where indicated on drawings.
 - 3. Joint filler shall extend full depth of the slab. Hold back filler from top of slab as required for sealant. Attach joint filler to first placement.
 - 4. Seal all expansion joints and joints between concrete and asphalt per Section 07900.
- C. Keyed/Construction Joints: Keyed joint and construction joint are synonymous for concrete paving.
 - 1. Reinforcement, if required, shall continue through the joint.
 - 2. Install where indicated on drawings, or where required by concrete delivery or finishing rate.
 - 3. Key first placement. Key shall be 1½ inches wide and ¾ inches deep.
 - 4. After first placement has hardened, clean and roughen face. Install control joint form at top of slab.
 - 5. Subject to Owner's Representative approval; manufactured leave-in-place cold joint form may be used.
- D. Control/Score Joint: Control joint and score joint are synonymous for concrete paving.
 - 1. Control joints shall penetrate 1/3 of slab thickness.
 - 2. Sawn Joints: Control joints on play area curb shall be sawn. Kerf shall be 3/16-inch wide. Start cutting as soon as concrete is able to be sawn without dislodging aggregate. Complete cutting before shrinkage cracks occur. Joints perpendicular to walls may be less than required depth within 6 inches of the wall, and may stop 2 inches from the wall. Wash slurry from concrete to avoid staining of slab.

3. Tooled Joints: Control joints may be cut into the plastic concrete during finishing operations. Tooled joints shall have ¼ radius, and shall not incorporate a troweled edge unless specifically noted on the drawings.
4. Formed control joints are permitted only in conjunction with keyed joints.
5. Unless otherwise indicated, provide control joints at the following intervals:

<u>Use</u>	<u>Type</u>	<u>Maximum Spacing</u>
Uncolored Exterior & Interior Slabs, Sidewalks	Tooled broom over joint	Symmetrically placed: 10' maximum or 1 ½ times width of walk, whichever is smaller
Curb and Gutter	Tooled joints	10' maximum
Pans	Tooled joints	15' maximum
Play Area Curb & Header	Tooled joints	10' maximum
Concrete	Tooled joints	10' maximum

3.05 Concrete

- A. Preplacement Inspection: Form work installation, reinforcing steel placement, and installation of all items to be embedded or cast in, to be verified by the Owner's Representative prior to placement.
- B. General: Comply with ACI 301, ACI 304, and as herein specified.
- C. Added Water: Concrete mix has been designed to a specific water cement ratio in order to enhance durability of the final product. Do not add water at the job site or concrete will not be accepted.
- D. Cold Weather Placement: When depositing concrete after the first frost or when the mean daily temperatures area below 40 degrees, follow recommendations of ACI 306 as modified herein. Use specified accelerator. Maintain concrete temperature at a minimum of 55 degrees for not less than 72 hours after depositing. Do not place concrete without approval of the Owner's Representative on days when temperature at 9:00 a.m. is below 30 degrees. Job-cured cylinders for verification of strength and/or the adequacy of the Contractor's protective methods will be required.
- E. Hot Weather Placement: When depositing concrete in hot weather, follow recommendations of ACI 305 as modified herein. When the air temperature is expected to exceed 90 degrees, the Contractor shall obtain acceptance from the Civil Engineer or Owner's Representative of the procedures to be used in protecting, depositing, finishing, and curing the concrete. The temperature of concrete at the time of placement shall not exceed 90 degrees. Protect to prevent rapid drying. Start finishing and curing as soon as possible. Specified water reducing retarding admixture may be used. The use of continuous wetting or fog sprays may be required by the Owner's Representative for 24 hours after depositing.
- F. Placing: Deposit and consolidate concrete slabs in a continuous operation, within the limits of construction joints, until the placing of a panel or section is completed. Deposit concrete as nearly as practicable in its final location to avoid segregation.
- G. Consolidation: Consolidate concrete with internal vibrators with a minimum frequency of 7,000 rpm. Maintain one standby vibrator for every three vibrators used. Consolidate according to ACI 309. Do not transport concrete with vibrators. Work concrete into corners and around embedments and reinforcement.
- H. Surface Leveling: Strike off and level surface with screed of sufficient length to span the slab. On slabs greater than 15 feet wide, use intermediate screed strips.

- I. Integral colored concrete: Add color by weight directly into the mixer along with the aggregate, cement and water while the mixer is operating at mixing speed. Continue mixing for 5-10 minutes or from 50 – 100 revolutions.

3.06 Finishes

- A. Float Finish: After surface stiffens enough to support the operation, float with hand floats or powered disc floater. Use magnesium float; do not use wood float on air entrained concrete. Check surface planeness with a 10-foot straight edge, applied at not less than two different angles. Cut down high spots and fill low spots to produce a surface with Class B tolerance. Refloat the slab to a uniform sandy texture.
- B. Broom Finish: Concrete flatwork shall receive a heavy broom finish applied at a right angle to the direction of travel. The plaza area shall have smooth troweled joints, 1½ inches from the centerline of the joint, to result in a total trowel width of 3 inches. All other flatwork shall have broom finish over joints.
- C. Exposed Aggregate Finish: Immediately after floating, apply surface retardant. Apply retardant uniformly. Cover with polyethylene sheet to retain moisture. When mortar is hard enough to retain aggregate but soft enough to be removed by brushing, wash the surface with water and remove mortar from surface aggregate by brushing. Do not dislodge aggregate.
- D. Coordinate rate of concrete placement with pace of washing crew.
- E. Formed Finishes:
 1. Surfaces Not Exposed to View: Patch tie holes and defects. Chip off fins greater than ¼ inch in height.
 2. Surfaces Exposed to View: Patch tie holes and defects. Completely remove fins.
- F. Schedule of Finishes:
 1. Curbs, gutters, ramps within ROW – per City Specifications.
 2. Sidewalk – heavy broom finish.
 3. Plaza paving – as shown on plans.
 4. Playground curbs and header – exposed aggregate finish.
 5. Interior slabs at restroom – medium broom finish.
- G. Notch both vertical sides of concrete flatwork to indicate location of irrigation sleeves.

3.07 Curing/Sealing

- A. Apply curing compound within 30 minutes of completing finish. Follow manufacturer's recommendations for applying compound. Reapply in areas exposed to rain within 3 hours of initial application. Maintain continuity of coating and repair damage during 7-day curing period. Follow manufacturer's instructions for sealing interior slabs.
- B. Integral colored concrete is to be cured with the matching Davis Color Seal. Follow manufacturer's recommendations for application.

3.08 Tolerances

- A. Surface Planeness: Unless otherwise specified, produce slabs with a Class B tolerance.
 1. Finishes with Class B tolerances shall be true planes within ¼ inch in 10 feet, as determined by a 10-foot straight edge placed anywhere on the slab in any direction.
 2. Slope interior slabs to drains as indicated.

B. Formed Surfaces, Joints, and Embedments: Unless otherwise specified, the finished work shall meet the following tolerances:

1. Variations of formed, or cut or tooled linear element:

- a. In 20 feet: ½ inch.
- b. For entire length: 1 inch.

3.09 Field Quality Control

A. Field inspection and testing will be performed under provisions of Paragraph 1.06, Tests, and as specified below.

B. Concrete Tests:

1. Shall be provided by the Contractor and shall be accordance with requirements of ACI 301, Chapter 16 – Testing, except as noted or modified in this section.

a. Strength test.

- i. Mold and cure four cylinders from each sample.
- ii. Test one at 7 days and one at 14 days for information and one at 28 days for acceptance. Keep the remaining one as a spare to be tested as directed by the Owner.

b. Minimum samples.

- i. Collect the following minimum samples for each 28-day strength concrete used in the work for each day's placing:

<u>Quantity</u>	<u>Number of Samples</u>
50 cubic yards or less	one
50 to 100 cubic yards	two
100 cubic yards or more	two plus one sample for each additional 100 cubic yards

c. Sample marking.

- ii. Mark or tag each sample of compression test cylinders with date and time of day cylinders were made.
- iii. Identify location in work where concrete represented by cylinders was placed.
- iv. Identify delivery truck or batch number, air content, and slump.

d. Slump test.

Conduct test for each strength test sample and whenever consistency of concrete appears to vary.

e. Air content.

Conduct test from one of first three batches mixed each day and for each strength test sample.

C. Acceptance of Concrete:

- 1. If the average of three consecutive 7-day tests falls below the specified 7-day strength, the Owner shall have the right to require conditions of temperature and moisture necessary to secure the required strength and may require core tests in accordance with ASTM C-42.
- 2. Strength level of concrete will be considered satisfactory so long as average of all sets of three consecutive strength test results equals or exceeds specified 28-day strength and no individual strength test result falls below specified strength by more than 500 psi.

D. Failure of Test Cylinder Results:

- 1. Upon failure of the 28-day test cylinder results, Owner may require Contractor, at his expense, to obtain and test at least three cored samples from area in question.

2. Concrete will be considered adequate if average of three core tests is at least 85 percent of, and if no single core is less than 75 percent of the specified 28-day strength.
 3. Upon failure of core test results, Owner may require Contractor, at his expense, to perform load tests as specified in ACI 318, Chapter 2.
 4. In the event an area is found to be structurally unsound, the Owner may order removal and replacement of concrete as required. The costs of the core tests, the load test and the structural evaluation shall be borne by the Contractor.
 5. Fill all core holes with a non-shrink grout as Master Builders Masterflo 713 or approved equal.
- E. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

END OF SECTION