PORTLAND CEMENT CONCRETE

Article 1.1 Scope of Work

The Work covered by this Section consists of providing all plant, labor, equipment, supplies, material, transportation, handling, storage and protection for performing all operations in connection with the placement of Portland Cement Concrete in accordance with the Specifications and the Drawings. The work covered under this Section consists of the construction of driveways, sidewalks, miscellaneous and misc. concrete slabs.

Article 1.2 Applicable Standards

The latest revision of the following standards of the American Society for Testing and Materials (ASTM) and American Society of State Highway and Transportation Officials (AASHTO) are hereby made a part of these Specifications:

American Concrete Institute "Manual of Concrete Practice"
Concrete Reinforcing Steel Institute "Manual of Standard Practice"
ASTM A-185 AASHTO M-55 Specification for Welded Steel Wire Fabric for Concrete
ASTM A-615 AASHTO M-31 Specification for Billet-Steel Bars for Concrete Reinforcement
ASTM C-31 AASHTO T-23 Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Field
ASTM C-33 Specification for Concrete Aggregates
ASTM C-330 Specification for Lightweight Aggregates for Structural Concrete
ASTM C-39 AASHTO T-22 Test for Compressive Strength of Molded Concrete Cylinders.
ASTM C-40 AASHTO T-21 Test for Organic Impurities in Sands for Concrete
ASTM C-42 AASHTO T-24 Method of Securing, Preparing and Testing Specimens from Hardened Concrete for Compression and Flexure Strengths
ASTM C-90 Hollow Load-Bearing Concrete Masonry Standard Construction Specifications
ASTM C-94 AASHTO M-157 Specification for Ready-Mix Concrete
ASTM C-150 AASHTO T-119 Specification for Portland Cement
ASTM C-156 AASHTO T-155 Test for Water Retention Efficiency of Liquid Membrane-Forming Compounds and Impermeable Sheet Materials for Curing Concrete.
ASTM C-171 AASHTO M-171 Specification for Waterproof Paper for Curing Concrete
ASTM C-172 AASHTO T-141 Sampling Fresh Concrete
ASTM C-192 AASHTO T-126 Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Laboratory
ASTM C-226 AASHTO M-134 Specification for Air-Entraining Additions for Use in the Manufacture of Air-Entraining Portland Cement
ASTM C-231 AASHTO T-152 Test for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C-260 AASHTO M-154 Specification for Air-Entraining Admixture for Concrete
ASTM C-270 Mortar for Unit Masonry (Including Tentative Revision)

ASTM C-309 AASHTO M-148 Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C-494 AASHTO M-194 Specifications for Chemical Admixtures for Concrete
ASTM D-1751 AASHTO M-213 Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
AASHTO M-6 Specification for Fine Aggregate for Portland Cement Concrete
AASHTO M-32 Specification for Cold Drawn Steel Wire for Concrete Reinforcement Cement
AASHTO M-80 Specification for Coarse Aggregate for Portland Concrete

Article 1.3 Materials

A. Reinforcing Steel

Concrete reinforcing shall be deformed steel bars conforming to the requirements of ASTM A-615 (AASHTO M-31). It shall be free from loose scales, excessive rust, Standard Construction Specifications Division 30 – Portland Cement Concrete Revised 11/08 and coatings of any character which will reduce the bond between steel and concrete.

If reinforcing bars are to be welded, these Specifications shall be supplemented by requirements assuring satisfactory weldability in conformity with AWS D12.1, "Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction."

B. Welded Steel Wire Fabric

The welded steel wire fabric shall be cold-drawn steel wires or galvanized, fabricated into mesh formed by the process of electric welding. The grade of wire shall conform to AASHTO M-32. Welded Steel Wire Fabric shall conform to ASTM A-185 (AASHTO M-55).

C. Cement

The cement shall be of a recognized standard brand of Portland Cement conforming to the specification requirements listed below and of a type listed below:

Specification Type Portland Cement
ASTM C-150 Type I, II
AASHTO M-85 Type I, II
For architectural concrete only one brand of cement shall be used unless otherwise approved by the District. When no type cement is specified, the requirements of Type I shall govern.
Cement reclaimed from cleaning bags or leaking containers shall not be used.

D. Water

Water used for the mixing of concrete shall be clean and free of oil or acid, and shall not contain salt, alkali, or organic matter.

E. Aggregates

Aggregates for Portland Cement Concrete shall be well graded, clean, hard gravel, and coarse sand, non-frost susceptible material, and free of deleterious (organic) matter, and coatings of silt or clay. The gradations shall be determined by standard laboratory sieves with square openings. Material retained on a No. 4 screen shall be classified as coarse aggregate, which shall conform to the requirements of AASHTO M-80.

Aggregates shall consist of washed sand gravel; fine and coarse aggregates shall be regarded as separate ingredients. Aggregates for normal weight concrete shall conform to the requirements of ASTM C-33 and aggregates for light weight concrete, shall conform to the requirements of ASTM C-330.

The maximum size of coarse aggregates shall not exceed one and one-half inches (1 1/2") nor one-fifth (1/5) of the narrowest dimension between the forms nor three-quarters (3/4) of the clear spacing between reinforcing bars nor one-third (1/3) of the depth of slabs. The combined aggregates, coarse and fine, shall be of such composition of sizes that when separated on the No. 4 standard sieve, the weight passing shall not be less than thirty percent (30%) nor greater than fifty percent (50%) of the total weight.

The volume removed by sedimentation shall not exceed three percent (3%). Proportioning of the coarse and fine aggregate shall be obtained by weight. The weighing equipment shall be accurate within one percent (1%) of the net weight of the batch and shall permit adjustment for variations in the water content of the aggregate. Batching for fractional sacks of cement will not be permitted unless the cement is weighed for each batch. The water added shall be measured by an approved calibrated device capable of metering within one percent (1%) of the total amount of water to be used for each batch.

F. Air-Entrainment

Air-entrainment agents shall be used in all concrete. Entrainment shall be achieved by the addition of an approved air-entraining mixture to the concrete mix. Air-entrainment shall conform to ASTM C-231 (AASHTO T-152). Refer to Article 1.6 - Mix Requirements for Classes of Concrete for air-entrainment percentages for each class of concrete.

G. Curing Materials

Curing materials shall be one the following types as approved by the District:

1. Kraft paper conforming to the requirements of ASTM C-171 (AASHTO M-171).
2. Mats of commercial quality and of a type used for curing concrete.
3. Burlap of commercial quality weighing not less than fourteen (14) ounces per square yard.
4. Membrane curing compound conforming to the requirements of ASTM C-309 (AASHTO M-148).

H. Expansion Joints

Premolded joint filler for use in expansion joints shall conform to the requirements of ASTM D-1751 (AASHTO M-213).

Article 1.4 Mix

Portland Cement Concrete may be mixed at a central mixing plant or in transit mixers. All mixing equipment and operations shall conform to the requirements of ASTM C-94 (AASHTO M-157). All concrete shall be delivered to the work site thoroughly mixed to a uniform color and show uniform distribution of aggregates and cement throughout the mixture.

Concrete shall be delivered to the Project site, discharged from the truck completely and in the forms ready for vibration within one and one-half (1-1/2) hours after introduction of the cement to the aggregates. At the discretion of the Engineer, the above period may be extended one (1) minute for every degree of temperature at which the concrete is delivered below seventy degrees (70) Fahrenheit to a maximum total time of two (2) hours.

In hot weather, or under conditions contributing to quick setting of the concrete, a discharge time less than one and one-half (1-1/2) hours may be required by the District. Any concrete remaining undischarged at the end of the respective time period shall be rejected.

The use of non-agitating equipment for transporting concrete will not be permitted. The mixing drums of transit-mix trucks shall be thoroughly washed after discharging each load to prevent the accumulation of adherent layers of concrete. The discharge of particles of hardened concrete with any batch will be sufficient grounds for the rejection of the entire batch. On curb, gutter and sidewalk work, transit mix trucks shall be operated parallel to the forms while discharging.

The addition of water to the mix at the job site will not be permitted except with the approval of the District. Any additional water that is added shall be documented and recorded on the delivery ticket by a representative of the supplier.

Article 1.5 Subbase

Prior to placement of forms, the District shall inspect the subbase to insure that it is smooth, compacted and free of soft or yielding spots and that compaction at optimum moisture is at least ninety-five percent (95%) of maximum density (AASHTO T-180 D). Backfilling within the forms will be permitted if the subbase is brought to the above specification and care is taken to maintain the forms to line, shape elevation.

Article 1.6 Mix Requirements for Classes of Concrete

Fine Aggregate Shall Conform to AASHTO M-6 Gradation. Minimum Design Strength (fc), 3000 psi Minimum design compressive strength specification shall be achieved in twenty-eight (28) days. Water shall not be used to increase slump beyond four inches (4”). If additional slump is desired, a plasticizing agent may be used subject to the District's written approval.

Article 1.7 Ready-Mixed Concrete

Ready-mixed concrete shall conform to the requirements of ASTM C-94 (AASHTO M-157). For each batch of concrete, it is the responsibility of the Contractor to furnish to the District, before unloading at the site, a delivery ticket from the manufacturer on which is printed, stamped or written, information concerning said concrete as follows:

1. Name of ready-mix batch plant.
2. Serial number of ticket.
3. Date and truck number.
4. Name of Contractor.
5. Specific designation of Project (name and location).
6. Specific class of concrete in conformance with that employed in Specifications.
7. Amount of concrete (cubic yards).
8. Time loaded or first mixing of cement and aggregate.
9. Type of cement.
10. Admixtures and amount of same.
11. Slump requested by the Contractor and recorded in inches.
12. Percentage of entrained air requested by the Contractor.
13. Fine aggregate weight/percent moisture of fine aggregate.
14. Intermediate aggregate weight/percent moisture of intermediate aggregate.
15. Coarse aggregate weight/percent moisture of coarse aggregate.
16. Weight of cement.
17. Weight of water.
18. Unit weight.

Article 1.8 Sampling and Testing

The District may take concrete samples for concrete cylinders in accordance with AASHTO T-141. Samples shall not be taken at the beginning or end of discharge. Making and curing the specimens shall be done in accordance with AASHTO T-23. Testing and sampling shall be done by the District.

Slump tests shall be taken in accordance with AASHTO T-119 or ASTM C-143. Slump tests shall be taken by the District.

Should the analysis of any test cylinder not meet the requirements of these Specifications, all concrete placed from the batch represented by the cylinder shall be removed and replaced at the Contractor's expense.

Article 1.9 Weather Limitations

Placement of Portland Cement Concrete is subject to the following requirements:

1. Salt, chemicals, or other material shall not be mixed with the concrete to prevent freezing.

2. Placement of concrete shall be prohibited whenever there is standing water on the grade or in the forms, the subgrade is yielding due to saturation, or rain is threatening.
3. Approved admixture shall be used in accordance with the manufacturer's recommendations.

Placement of concrete shall be prohibited at an ambient air temperature of less than forty degrees (40°) Fahrenheit or where the foundation material is frozen, except in special situations where authorized by the Engineer in writing. Exemption from the temperature clause of these Specifications shall be considered only under the following conditions:

A written proposal shall be submitted by the Contractor to the District outlining a procedure for maintaining the placed concrete temperature of at least fifty degrees (50°) Fahrenheit for seventy-two (72) hours where Type III cement has been used and one hundred and twenty (120) hours where Type I cement has been used. When the temperature is reduced, the drop in temperature must be gradual and not exceed thirty degrees (30°) Fahrenheit in the first twenty-four (24) hours.

Article 1.10 Protection of Work

The Contractor shall protect all newly placed concrete from damage of any kind to prevent disfigurement during the curing period. Damaged concrete shall be repaired or replaced to the District's satisfaction at no additional cost. Contractor shall protect adjacent construction, plantings, finishing's, structures, and the public from damage and harm.

Type I/II Portland Cement Concrete must have been placed and finished a minimum of seven (7) days prior to material being distributed against, or vibrated (compaction) adjacent to the structure.

Type III Portland Cement Concrete must have been placed and finished a minimum of three (3) days prior to material being distributed against, or vibrated (compaction) adjacent to the structure.

Article 2.1 Materials

Portland Cement Concrete, joint filler, reinforcing steel and curing materials shall conform to Article 1.3 - Materials. Concrete mix for curbs shall conform to the requirements for ASTM C-150 Type I, II unless otherwise specified.

A. Reinforcing Steel and Steel Dowels Refer to Article 1.3, Sub Article A. - Reinforcing Steel and Sub Article B. - Welded Steel Wire Fabric.

B. Preformed Expansion and Dummy Joint Filler Refer Article 1.3, Sub Article H. - Expansion Joints.

C. Curing Compounds Refer to Article 1.3, Sub Article G. – Curing Materials.

D. Forms.

Forms may be of wood or metal or any other material at the option of the Contractor, provided that the forms as set will result in the specified thickness, cross section, grade and alignment shown on the drawings. Wood forms against unexposed concrete surfaces shall be No. 2 Common Lumber or better.

Forms may be removed on the day following pour if the concrete is sufficiently set that removal can be accomplished without danger of chipping or spalling. Form materials shall be free from warp, with smooth and straight upper edges, and if used for the face of a curb, shall be surfaced on the side against which the concrete is to be placed. Wooden forms for straight work shall have a net thickness of at least one and one-half inches (1.5”). Metal forms for such a work shall be of a gage that will provide equivalent rigidity and strength. Concrete forms used shall not be less than three-quarters inches (3/4”) in thickness and held rigidly in place to line and grade by the use of metal stakes and clamps. Forms shall be of sufficient rigidity and strength, and shall supported to adequately resist springing or deflection from placing and tamping of concrete.

Form material shall be clean and free from defect at the time of use.

All forms including back planks of curb shall be and all forms shall be not less than a depth equivalent to full specified thickness of the concrete to be placed.

Forms shall be held securely in place by means of metal stakes driven in pairs at intervals not to exceed three feet (3’), one at the front form and one at the back form. Clamps, spreaders, and braces shall be used to the extent as may be necessary to insure proper form rigidity. Forms for walk and similar work shall be firmly secured by means of stakes driven at intervals not to exceed four feet (4’). Form stakes shall be of sufficient size and be driven so as to adequately resist lateral displacement.

Pump trucks may be used upon approval of the District. Prior to approval, the Contractor must demonstrate to the satisfaction of the District that the pumping equipment will not segregate, or in any other way degrade, the concrete. Additional test samples for such alternate placement methods may be taken from the discharge side of the machine for compressive strength determination assurance tests.

Article 2.2 Construction

A. Erecting Forms

All forms shall be set to the lines, grade, and dimensions shown on the drawings. The forms shall be thoroughly braced and secured to resist deformation or displacement under load, and shall be installed to permit easy removal without hammering or prying against the fresh concrete. The top of the forms shall not deviate more than one-eighth inch (1/8”) in ten feet (10’), and the alignment of forms shall be within one-fourth inch (1/4”) in ten feet (10’).

Before placement of concrete, steel forms shall be lightly oiled with a good grade of form oil. Excess oil shall be removed by wiping with clean rags, dampened in diesel or fuel oil. Wooden forms may be oiled in the same manner as metal forms, or they may be watered immediately in advance of the placement of concrete. Watering of the form shall be done with clean water of the same quality as that specified

for mixing water, and only when the atmospheric temperature is not less than forty degrees (40) Fahrenheit. Concrete shall not be placed until all forms have been inspected and approved by the District. Barricades and other safety features shall be installed as necessary.

B. Placing Concrete

The subgrade shall be properly compacted and brought to specified grade in accordance with the Drawings before placing concrete. The subgrade shall be thoroughly dampened immediately prior to the placement of the concrete. Forms shall not be splashed with concrete in advance of placing. Concrete shall be discharged from transport vehicle to the point of final placement in a continuous manner as rapidly as practicable. The rate of placement shall not exceed the rate at which the various placing and finishing operations can be performed in accordance with these Specifications. Concrete shall not be allowed to free fall more than three feet (3').

The concrete shall be spread uniformly between the forms and thoroughly compacted with a steel shod strike board. After the concrete has been thoroughly compacted and leveled, it shall be floated with wood floats and finished at the proper time with a steel float. Joints shall be edged with a one-quarter inch (1/4") radius edger and the sidewalk edges shall be tooled with a one-half inch (1/2") radius edger. After final troweling, sidewalk on grades of less than six percent (6%) shall be given a fine hair broom finish applied transversely to the centerline. On grades exceeding six percent (6%), walk shall be finished by hand with a wood float. Walk shall be re-marked as necessary after final finish to assure neat uniform edges, joints, and score lines. Unsightly, poorly finished, and sidewalk failing to meet the requirements of the Drawings, Specifications, and this Section will be rejected.

The sidewalk shall be divided into panels by scoring one inch (1") deep every five feet (5'). Article 2.2, E - Expansion and Contraction Joints for requirements for contraction and expansion joints. The expansion joints shall be placed at all structures such as catch basins and manholes, at driveways, and at all points of tangency and points of curvature.

C. Stripping Forms and Finishing

The face form of the curb shall be stripped at such time in the early curing as will enable inspection and correction of all irregularities that appear thereon. Forms shall not be removed until the concrete has set sufficiently to retain its true shape. The face of the curb shall be troweled with a tool cut to the exact section of the curb and at the same time maintain the shape, grade, and alignment of the curb. Both front and back edges shall be troweled to a radius of one-half inch (1/2"). Final finish shall be obtained by brooming the surface, including the troweled edge to a gritty finish after all free moisture has disappeared from the surface. Sprinkling of cement or sand for blotting will not be permitted.
It is the intent of this Specification to insure the highest quality of workmanship in the construction and finishing of the concrete.

Unsightly or poorly finished surfaces will be considered grounds for rejection of the Work. The top and/or face and gutter of the finished concrete surfaces shall be true and straight, of uniform width and free of cracks, humps, sags, or other irregularities. The finished concrete surface shall not vary more

than two hundredths of a foot (0.02’) from a ten foot (10’) straight edge, except at grade changes or curves. No freestanding water is permitted on slopes at or greater than one percent (1%). No freestanding water deeper than one-sixteenth inch (1/16”) is permitted on slopes of less than one percent (1%). The Contractor shall flow test all new concrete curb and gutter. Curb and gutter failing to meet this requirement will be rejected.

All defective areas shall be removed and replaced at the Contractor's expense, unless permission to patch is granted by the Engineer. Such permission shall not be construed as an acceptance of the Work or as a waiver of the Engineer's right to require the complete removal of the Work, if in his opinion the patch does not satisfactorily restore the quality or appearance of the surface.

Should patching be permitted, the area shall be chipped clean to a depth of one inch (1”) perpendicular to the surface and saturated with clean water prior to being patched. The patch shall be made with a mortar extracted from fresh concrete by passing it through a three-eighths inch (3/8”) screen. The mortar shall be thoroughly compacted and screeded off slightly higher than the surrounding surface to allow for contracting or setting after the maximum shrinkage has taken place. After one (1) to two (2) hours, the patch shall be troweled to the same finish as the surrounding area and shall be cured as specified herein. The use of special patching material will be permitted if approved by the Engineer.

D. Curing

Curing compounds shall be applied to all exposed surfaces immediately after finishing. Transparent curing compounds shall contain a color dye of sufficient strength to render the film distinctly visible on the concrete for a minimum period of four (4) hours after application.

If, at any time during the curing period any of the forms are removed, a coat of curing compound shall be applied immediately to the exposed surface. The curing compound shall be applied in sufficient quantity to obscure the natural color of the concrete. Additional coats shall be applied if the Engineer determines that the coverage is not adequate. The concrete shall be cured for the minimum period of time set forth below. Curb and gutter constructed of Type I/II Portland Cement Concrete must have been placed and finished a minimum of seven (7) days prior to material being distributed against, or vibrated (compaction) adjacent to the structure.

Curb and gutter constructed of Type III Portland Cement Concrete must have been placed and finished a minimum of three (3) days prior to any material being distributed against, or vibrated (compaction) adjacent to the structure.

When forms are removed before the expiration of the curing period, the edges of the concrete shall be protected with moist earth, or sprayed with curing compound.

Other standard methods of curing the curb and gutter may be used upon approval of the Engineer. Concrete shall not be placed unless curing compounds and necessary equipment for applying such is on the Project site.

E. Expansion and Contraction Joints

1. Expansion Joints

Expansion joints shall be placed along all structures, as shown in the Drawings and/or Standard Details, and around all features that project into, through, or against the concrete. An expansion joint shall be constructed at the intersection of sidewalks; between sidewalk crossings and sidewalks; between curbs and sidewalks (except parallel curb); and at the beginning and end of curb returns. Additionally expansion joints shall be constructed every fifty feet (50') where the concrete span exceeds seventy-five feet (75') and expansion joints are not required for the above listed reasons. Expansion joint material shall conform to the requirements of ASTM D-1751 (AASHTO M-213). Expansion joints shall not exceed one half inch plus or minus one-eighth inch (1/2"±1/8") in width. Expansion joint material shall extend the full width of the structure and shall be cut to such dimensions that the base of the expansion joint shall extend to the subgrade and the top shall be depressed not less than one-quarter inch (1/4") nor more than one-half inch (1/2") below the finished surface of the concrete. The material shall be of one (1) piece in the vertical dimension and shall be securely fastened in a vertical position to the existing concrete face against which fresh concrete is to be placed. After the concrete has set, the expansion joints shall be filled flush to the finish concrete surface with an approved polyurethane sealant applied according to the manufacturer's recommendation.

Before sealing, the joint shall be cleaned of all dirt, gravel, concrete mortar, and other extraneous material. Sealing shall be done in a neat workmanlike manner.

2. Contraction Joints

Transverse contraction joints, cut to a depth of one inch (1") prior to the final set of the concrete, shall be tooled in the sidewalks at intervals of five feet (5'), and at ten feet (10') intervals in the curb and gutter. Where the sidewalk adjoins the curb (parallel to it), contraction joints in the sidewalk and curb shall be made to match where practicable.

D. Curing and Protection

The curing agent shall be applied immediately after finishing and be maintained for a period of seven (7) days. The curing agent(s) and/or concrete mixtures shall in no way deter or prevent final finishing of concrete.

The Contractor shall have readily available sufficient protective covering, such as waterproof paper or plastic membrane, to cover the pour of an entire day in event of rain or other unsuitable weather. The concrete shall be protected against damage or defacement of any kind until it has been accepted by the District. Concrete which is not acceptable to the District because of damage or defacement shall be removed and replaced at the expense of the Contractor.

Article 2.3 Clean-up

When all concrete Work has been completed and cured, the Contractor shall remove the forms, stakes, blocking, and concrete spoil from the site. The area adjoining the concrete that was excavated to permit the construction and placement of forms shall be filled with select material, and the slopes and parking areas, if any, shall be filled, shaped and smoothed to the level as shown on the Drawings or Standard Details.

Description of Work / Location of Work

See attached supplemental data