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PART 1 - GENERAL

1.01 DESCRIPTION: The work of this Section includes sub-grade preparation and installation of Porous Concrete Pavement structures (i.e., porous concrete sidewalks).

1.02 RELATED SECTIONS:

Section 31 00 00 - Earthwork
Section 32 11 23 - Mineral Aggregates

1.03 REFERENCES:

A. General:

1. The City of Seattle Standard Specifications and Plans (most recent edition), and AASHTO Standards, unless otherwise specified.
2. Annual Book of ASTM Standards, (most recent edition); American Society for Testing and Materials, Philadelphia, PA.

B. Materials References:

1. ASTM C 29 “Test for Unit Weight and Voids in Aggregate.”
2. ASTM C 33 “Specification for Concrete Aggregates.”
3. ASTM C 42 “Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
4. ASTM C 117 “Test Method for Material Finer than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing.”
5. ASTM C 150 “Specifications for Portland Cement” (Types I or II only).
6. ASTM C 172 “Practice for Sampling Fresh Concrete.”
7. ASTM C 494 “Specification for Chemical Admixtures for Concrete.”
8. ASTM C 1077 “Practice for Laboratories Testing Concrete and concrete Aggregates for use in Construction and Criteria Laboratory Evaluation.”
9. ASTM D 448 “Specification for Standard Sizes of Coarse Aggregate for Highway Construction.
10. ASTM E 329 “Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel and Bituminous Materials as used in Construction.”

1.04 SUBMITTALS:

A. Submit a written list identifying the supplier(s) from which the materials are to be obtained.

B. Submit certificates, signed by the materials producer and the paving subcontractor, stating that materials meet or exceed the specified requirements.

C. Submit samples of coarse aggregates and filter fabric for review and approval by the Engineer.

D. The mixing plant shall submit a current mix design with aggregate, cement, water, and admixture proportions for approval. In addition the mixing plant shall submit any available past compressive strength test data.

1.05 QUALITY ASSURANCE:

A. Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work in this section.

B. Codes and Standards: All materials, methods of construction and workmanship shall conform to applicable requirements of the City of Seattle Standard Specifications (most recent edition), ASTM, and AASHTO Standards, unless otherwise specified.

1.06 PROJECT CONDITIONS:

A. Protection of Existing Improvements:

1. Protect adjacent work from splashing of paving materials. Remove all stains from exposed surfaces of paving, structures, and grounds. Remove all waste and spillage.
2. Do not damage or disturb existing improvements or vegetation. Provide suitable protection where required before starting work and maintain protection throughout the course of the work.
3. Restore damaged improvements, including existing paving on or adjacent to the site that has been damaged as a result of construction work, to their original condition or repair as directed to the satisfaction of the Engineer, and authority having jurisdiction at no additional cost.

B. Safety and Traffic Control:

1. Notify and cooperate with local authorities and other organizations having jurisdiction when construction work will interfere with existing roads and traffic.
2. Provide temporary barriers, signs, warning lights, flagmen, and other protections as required to assure the safety of persons and vehicles around the construction area and to organize the smooth flow of traffic.

C. Weather Limitations:

1. Do not place Portland cement porous pavement mixtures when the ambient temperature is 40 degrees Fahrenheit or lower or 80 degrees Fahrenheit or higher, unless otherwise permitted in writing by the Engineer.

1.07 CONTRACTOR QUALIFICATIONS:

A. The use of an ACI Concrete Flatwork Certified Finisher is required. Prior to award of the contract, the placing contractor shall furnish the Engineer a statement attesting to qualifications and experience and the following:

1. A minimum of 2 completed Porous Concrete Paving projects with the following information:
2. Addresses of the projects.
3. Unit weight acceptance data.
4. In-Situ pavement test results including void content and unit weight.

B. Test Panels:

1. Regardless of qualification, the Contractor shall place, joint and cure two test panels, each to be a minimum of 225 sq. ft. at the required project thickness to demonstrate to the Engineer's satisfaction that in-place unit weights can be achieved and a satisfactory pavement can be installed at the site location.
2. Test panels may be placed at any of the specified porous concrete paving locations. Test panels shall be tested for thickness in accordance with ASTM C 42; void structure in accordance with ASTM C 138; and for core unit weight in accordance with ASTM C 140, paragraph 6.3.
3. Satisfactory performance of the test panels will be determined by:
   a. Compacted thickness no less than ¼" of specified thickness.
   b. Void Structure: 12% minimum; 21% maximum.
   c. Unit weight plus or minus 5 pcf of the design unit weight.
4. If measured void structure falls below 15% or if measured thickness is greater than ¼" less than the specified thickness or measured weight falls less than 5 pcf below unit weight, the test panel shall be removed at the contractor's expense and disposed of in an approved landfill.
5. If the test panel meets the above mentioned requirements, it can be left in-place and included in the completed work.

PART 2 - PRODUCTS

2.01 CONCRETE MIX DESIGN:

The Contractor shall furnish a proposed mix design with proportions of materials to the Engineer prior to commencement of work. The data shall include rodded unit weights determined in accordance with ASTM C29 paragraph 11, rodded unit weight.

2.02 MATERIALS:

A. Locally available material having a record of satisfactory performance shall be used. Samples of the following materials shall be submitted for the Engineer's approval:

B. Choker Base Course and Stone Recharge Beds:

1. Coarse aggregates shall meet the size and grading requirements as defined in Standard Sizes of Coarse Aggregates, Table 4, AASHTO Specifications, Part I, 13th Ed., 1982, or later, unless otherwise noted.
2. Coarse aggregate for Stone Recharge Bed shall be 1-1/2" to 2-1/2" uniformly graded crushed coarse aggregate, with a wash loss of no more than 0.05%, AASHTO size number 2 per Table 4, AASHTO Specifications, Part I, 13th Ed., 1982, or later.
3. The Choker Base Course shall be 3/8 inch to 3/4 inch, uniformly graded, crushed coarse aggregate that meets AASHTO size number 57 grading per Table 4, AASHTO Specifications, Part I, 13th Ed., 1982 (p. 47).
4. Filter fabric shall be Mirafi 180N, or approved equal.
5. Imporous liner – shall be Permalon, PLY-X 150, or approved equal.

C. Portland Cement Porous Concrete:

1. Cement: Portland Cement Type I or II conforming to ASTM C 150 or Portland Cement Type IP or IS conforming to ASTM C 595.
2. Aggregate: Use crushed gravel, stone or hydraulic cement concrete or combination there of meeting No 8 coarse aggregate (3/8 to No. 16) per ASTM C 33 or No. 89 coarse aggregate (3/8 to No. 50) per ASTM D 448. If other gradation of aggregate is to be used, submit data on proposed material to owner for approval.
3. Admixtures: The following admixtures shall be used:
   a. Type D Water Reducing/Retarding – ASTM C 494.
   b. A hydration stabilizer that also meets the requirements of ASTM C 494 Type B Retarding or Type D Water Reducing/Retarding admixtures. This stabilizer suspends cement hydration by forming a protective barrier around the cementitious particles, which delays the particles from achieving initial set.
   c. 1-1/2-inch fibrillated fiber at 1.5 lbs. per cubic yard.
4. Water: Potable shall be used.
   a. Proportions:
   b. Aggregate and Cement Content: the volume of aggregate, cement, water, and admixure per cu. yd. shall be equal to 27 cu.ft. when calculated as a function of the unit weight determined in accordance with ASTM C 29 rodding procedure. Fine aggregate, if used, should not exceed 3 cu. ft. and shall be included in the total aggregate volume.
   c. Admixtures: Shall be used in accordance with the manufacturer's instructions and recommendations.
   d. Mix Water: Mix water shall be such that the cement paste displays a wet metallic sheen without causing the paste to flow from the aggregate. (Mix water yielding a cement paste with a dull-dry appearance has insufficient water for hydration).

C. Water to cement ratios can range from 0.27 to 0.35.

1. Insufficient water results in inconsistency in the mix and poor bond strength.

2. High water content results in the paste sealing the void system primarily at the bottom and poor surface bond.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Construction Requirements:

The Engineer shall be notified at least 48 hours prior to all recharge bed and porous paving work, including sub-grade preparation. The Contractor shall hold a preconstruction meeting with the Engineer, the drainage design Consultant, materials testing laboratory and the pavement design Consultant a minimum of one week prior to the initiation of porous paving work, including sub-grade preparation.

B. Sub-grade preparation:

1. Existing sub-grade under bed areas shall NOT be compacted or subject to excessive construction equipment traffic prior to filter fabric and stone bed placement.
2. Where erosion of sub-grade has caused accumulation of fine materials and/or surface ponding, this material shall be removed with light equipment and the underlying soils scarified to a minimum depth of 6 inches with a York rake or equivalent and light tractor.
3. Bring sub-grade of stone recharge bed to line, grade, and elevations indicated. Fill and lightly regrade any areas damaged by erosion, ponding, or traffic compaction before the placing of stone.

C. Recharge Bed Installation:

1. Upon completion of sub-grade work, the Engineer shall be notified and shall inspect at his discretion before proceeding with recharge bed installation.
2. Filter fabric, pipe, and recharge bed aggregate shall be placed immediately after approval of sub-grade preparation. Any accumulation of debris or sediment which has taken place after approval of sub-grade shall be removed prior to installation of filter fabric at no extra cost to the Engineer.
3. Place filter fabric in accordance with manufacturer's standards and recommendations. Adjacent strips of filter fabric shall overlap a minimum of sixteen inches (16"). Secure fabric at least two feet (2') outside of bed and take steps necessary to prevent any runoff or sediment from entering the storage bed. Place imporous liner over geo-textile extending 6’ beyond toe of slope face at building face, secure as recommended by manufacturer.
4. Install coarse aggregate in 8-inch maximum lifts. Lightly compact each layer with equipment, keeping equipment movement over storage bed sub-grades to a minimum. Install aggregate to grades indicated on the drawings.

5. Install 1" thick choker base course size No. 57 (AASHTO) aggregate evenly over surface of stone bed, sufficient to allow placement of pavement, and notify Engineer for approval.
6. Following placement of bed aggregate, the filter fabric shall be folded back along all bed edges to protect from sediment washout along bed edges. A minimum of a two foot edge strip shall be used to protect beds from adjacent bare soil. This edge strip shall remain in place until all bare soils contiguous to beds are stabilized and vegetated. In addition, hay bales shall be placed at the toe of slopes that may be adjacent to beds to further prevent sediment from washing into beds during site development. As the site is fully stabilized, excess filter fabric along bed edges can be cut back to gravel edge.

D. Portland Cement Porous Pavement Concrete Mixing, Hauling and Placing:

1. Mix Time: Truck mixers shall be operated at the speed designated as mixing speed by the manufacturer for 75 to 100 revolutions of the drum.
2. Transportation: The Portland Cement aggregate mixture may be transported or mixed on site and should be used within one (1) hour of the introduction of mix water, unless otherwise approved by the Engineer. This time can be increased to 90 minutes when utilizing the hydration stabilizer specified in paragraph 2.02.C.3.b. as long as the temperature of the concrete does not exceed 90 degrees Fahrenheit. Under no circumstance will retempering of concrete be allowed after any water adjustments have been made to delivered concrete at jobsite. Trucks used to transport porous concrete shall have no more than 3 consecutive loads of material without hauling conventional concrete or rinsing.
3. Prior to placing concrete, the sub-base shall be moistened and in a wet condition.
4. Discharge: Each mixer truck will be inspected for appearance of concrete uniformity according to paragraph 2.02.C.4.d. Water may be added to obtain the required mix consistency. Any water adjustments made at the jobsite shall be made by QC representatives of the concrete supplier. A minimum of 20 revolutions at the manufacturer’s designated mixing speed shall be required following any addition of water to the mix. Discharge shall be a continuous operation and shall be completed as quickly as possible. Concrete shall be deposited as close to its final position as practicable and such that fresh concrete enters the mass of previously placed concrete. The practice of discharging onto sub-grade and pulling or shoveling to final placement is not allowed.
5. Placing and Finishing Equipment: Unless otherwise approved by the Engineer in writing, the Contractor shall provide mechanical equipment of either slipform or form riding with a following compactive unit that will provide a minimum of 10 psi vertical force. The porous concrete pavement will be placed to the required cross section and shall not deviate more than +/- 3/8 inch in 10 feet from profile grade. If placing equipment does not provide the minimum specified vertical force, a full width roller or other full width compaction device that provides sufficient compactive effort shall be used immediately following the strike-off operation. After mechanical or other approved strike-off and compaction operation, no other finishing operation will be allowed. If vibration, internal or surface applied, is used, it shall be shut off immediately when forward progress is halted for any reason. The Contractor will be restricted to pavement placement

widths of a maximum of fifteen (15') feet unless the Contractor can demonstrate competence to provide pavement placement widths greater than the maximum specified to the satisfaction of the Engineer.

6. Curing: Curing procedures shall begin within 20 minutes after the final placement operations. The pavement surface shall be covered with a minimum six (6) mil thick polyethylene sheet or other approved covering material. Prior to covering, a fog or light mist shall be sprayed with a pump sprayer above the surface when required due to ambient conditions (high temperature, high wind, and low humidity). The cover shall overlap all exposed edges and shall be secured (without using dirt or stone) to prevent dislocation due to winds or adjacent traffic conditions.
   Cure Time: Portland Cement Type I, II, – 7 days minimum.No truck traffic shall be allowed for 10 days (no passenger car/light trucks for 7 days).
7. Jointing: Control (contraction) joints shall be installed at intervals of a maximum of 15 feet, or as indicated by landscape architect plans. They shall be installed at a depth of the 1/ 4 the thickness of the pavement. These joints can be installed in the plastic concrete or saw cut. If saw cut, the procedure should begin as soon as the pavement has hardened sufficiently to prevent raveling and uncontrolled cracking (normally after curing). Transverse constructions joints shall be installed whenever placing is suspended a sufficient length of time that concrete may begin to harden. In order to assure aggregate bond at construction joints, a bonding agent suitable for bonding fresh concrete shall be brushed, rolled, or sprayed on the existing pavement surface edge. Isolation (expansion) joints will not be used except when pavement is abutting slabs or other adjoining structures.

E. Portland Cement Porous Pavement Concrete Testing, Inspection, and Acceptance:

1. Laboratory Testing: Testing will be conducted by the Materials Laboratory. Materials Laboratory shall complete testing within 2-weeks from receiving of cores.
2. Testing and Acceptance:
   a. A minimum of one test for each day's placement of porous concrete in accordance with ASTM C 172 and ASTM C 29 to verify unit weight shall be conducted. Delivered unit weights are to be determined in accordance with ASTM C 29 using a 0.25 cubic foot cylindrical metal measure. The measure is to be filled and compacted in accordance with ASTM C 29 paragraph 11, rodding procedure. The unit weight of the delivered concrete shall be +/- 5 pcf of the design unit weight. Infiltration rate shall be +/- 15% of accepted core sample.
   b. The paving contractor shall provide three cores taken from each panel in accordance with ASTM 42 at a minimum of seven (7) days after placement of the porous concrete. The Engineer shall specify the location of the cores, which shall include any areas of the finished surface not appearing porous. If specified by the Engineer, core samples will be tested for infiltration rate. The cores shall be measured for thickness, void structure, and unit weight. Untrimmed, hardened core samples shall be used to determine placement thickness. The average of all production cores shall not be less than the specified thickness with no individual core

being more than ½ inch less than the specified thickness. After thickness determination, the cores shall be trimmed and measured for unit weight per ASTM C 642-97. Ranges of satisfactory unit weight values are +/- 5 pcf of the design unit weight.

c. After a minimum of 7 days following each placement, three cores shall be taken in accordance with ASTM C 42. The cores shall be measured for thickness and unit weight determined as described above for test panels. Core holes shall be filled with concrete meeting the porous mix design per ASTM C 642-97

END OF SECTION