

**SECTION 02530**  
**POROUS CONCRETE**

**PART I        GENERAL**

**1.01    SUMMARY**

- A. Section Includes: All labor, materials, equipment, tools, accessories, transportation, and services as required for porous concrete.
- B. Pervious concrete shall consist of Portland cement, coarse concrete aggregate, water, and when approved by the Engineer or specified in the Special Provisions, chemical admixtures, fly ash, or reclaimed concrete material.
- C. Related Requirements
  - 1. Section 01300 - Submittals
  - 2. Section 02200 - Earthwork
  - 3. Section 02230 - Base Courses

**1.02    REFERENCES**

- A. American Society for Testing and Materials
  - 1. ASTM C29 "Test for Unit Weight and Voids in Aggregate"
  - 2. ASTM C33 "Specification for Concrete Aggregates"
  - 3. ASTM C42 "Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete."
  - 4. ASTM C117 "Test Method for Material Finer than 75 microns (No. 200) Sieve in Mineral Aggregates by Washing."
  - 5. ASTM C138 "Test Method for Unit Weight, Yield and Air Content (Gravimetric) of Concrete."
  - 6. ASTM C140 "Methods of Sampling and Testing Concrete Masonry Units."
  - 7. ASTM C150 "specifications for Portland cement" (type I and II only)
  - 8. ASTM C172 "Practice for Sampling Fresh Concrete"
  - 9. ASTM C260 "Specification for Air-Entraining Admixtures for Concrete"
  - 10. ASTM C494 "Specification for Chemical Admixtures for Concrete"
  - 11. ASTM C595 "Specification for Blended Hydraulic Cements" (Types IP or IS only)
  - 12. ASTM 989 "Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars."
  - 13. ASTM C1077 "Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and criteria for Laboratory Evaluation."
  - 14. ASTM D448 "Specification for Standard Sizes of Coarse Aggregate for Highway Construction."
  - 15. ASTM D1557 "Tests for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10 Pound Rammer and 18-Inch Drop."
  - 16. ASTM E329 "Standard Recommended Practice for Inspection and testing Agencies for Concrete, Steel and Bituminous Materials as Used in Construction."
- B. American Association of State Highway and Transportation Officials (AASHTO)
  - 1. AASHTO T-180 "Moisture-Density Relations of Soils Using a 101 lb (45.4 kg) Rammer and an 18" (457 mm) Drop."

**1.03    SUBMITTALS**

- A. Product Data
  - 1. Statement of Mix Design, prepared by the batch plant servicing the Project, for each type or load delivered to Project. Include revised mix proportions when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments. Each Statement of Mix Design shall contain following information:

- a. Name, address, and telephone number of batch plant preparing Statement of Mix
  - b. Design.
  - c. Admixtures
  - d. Curing compounds
  - e. Bonding agent
  - f. Embedded items
  - g. Date of Mix Design
  - h. Contractor requesting load delivery
  - i. Mix Design Number
  - j. Gradations for aggregate
  - k. Material weights, specific gravity, and absolute volumes
  - l. Basis of testing, i.e. UBC 2605 D4 and Title 24 2604 D4.
- B. Shop Drawings
- 1. Immediately after award of Contract, prepare shop drawings showing all fabrication dimensions and locations for placing of the reinforcing steel and accessories. Follow detailing recommendations of ACI 315. Shop drawings are to be prepared by a rebar detailer.
  - 2. Do not order or deliver reinforcement to job site prior to approval of the shop drawings.
- C. Samples
- 1. The Contractor shall provide a separate Field Constructed Mock-up for each type of paving finish proposed herein this Section and as indicated on the Contract Drawings, for review and approval by the Owner's Representative.
  - 2. Contractor is to place, joint and cure one test panel, to be a minimum of 225 square feet at the required project thickness to demonstrate to the Engineer's and Owner's satisfaction that satisfactory pavement compaction and finish can be installed at the site location.
- D. Delivery Tickets:
- 1. With transit truck, provide delivery tickets, signed by an authorized representative of the batch plant, containing all information required by ASTM C94, as well as time batched, type and brand of cement, cement content, maximum size of aggregate, and total water content.
- E. The test report shall include:
- 1. The time and date of testing.
  - 2. The name and affiliation of the person performing the test.
  - 3. The location of the Work site.
  - 4. The location of each test site tested within the Work site.
  - 5. The volume of water used at each test site.
  - 6. The length of the two measurements taken at each test site.
  - 7. The discharge time for the water at each test site.
  - 8. The Infiltration Capacity at each test site.
  - 9. The average Infiltration Capacity for the Work site.

#### 1.04 QUALITY ASSURANCE

- A. Special Equipment
- 1. Some special equipment (compacting roller; mister, etc.) specific to porous concrete placement will need to be purchased by the placing contractor.
- B. Test Panels
- 1. Contractor is to place, joint and cure one test panel, to be a minimum of 225 square feet at the required project thickness to demonstrate to the Engineer's and Owner's satisfaction that satisfactory pavement compaction and finish can be installed at the site location.
    - a. Test Panels may be placed at the site location. Test panels shall be evaluated for thickness, compaction, and porosity.
    - b. If the test panels are found to be insufficiently porous or insufficiently compacted, the test panel shall be removed at the contractor's expense and disposed of in an approved landfill.

- c. If the test panels are found to be satisfactory, they can be left in place and included in the completed work.
- d. Determination of thickness, porosity and compaction shall be determined by the Engineer or Owner.
- e. Should the contractor wish to dispute finding of the Engineer or Owner, acceptability shall be determined at the contractor's expense by achieving: compacted thickness according to ASTM C42 of no less than 1/4" of specified thickness, void structure of 10% minimum when tested in accordance with ASTM C140, and unit weight within +/- 5 pcf of the design unit weight when tested in accordance with ASTM C140 paragraph 6.3.

Ed to Determine? \*  
Porosity?

C. Qualifications:

1. Installer Qualifications: Engage an experienced Installer who has completed in the last two (2) years at least four (4) Porous Concrete Pavement installations similar in material, design, and extent to that indicated for this Project, and whose work has resulted in construction with a documented record of successful in-service performance.
  - a. Provide a list of projects (4) with the address of the installation, the date of installation, the point of contact for the project and their phone number.
  - b. Provide 2 photos of each project listed above representing the project/installation.
  - c. Concrete company to have been in business 10 years or more. Provide three (3) references with phone numbers.
  - d. Verification of current National Ready Mixed Concrete Association (NRMCA) certification requirements described below:
  - e. Installer shall meet, at the time of bidding: **one** of the following criteria for the minimum certification for each placement crew and submit verification of NRMCA Pervious Concrete Certification with the bid. ([http://www.nrmca.org/Education/Certifications/Pervious\\_Contractor.htm](http://www.nrmca.org/Education/Certifications/Pervious_Contractor.htm))
    - i. The pervious concrete subcontractor shall employ no less than one (1) NRMCA Certified Pervious Concrete Craftsman who must be onsite, actively guiding and working with each placement crew during all pervious concrete placement.
    - ii. The pervious concrete subcontractor shall employ no less than three (3) NRMCA Certified Pervious Concrete Installers who must be onsite, actively guiding and working with pervious concrete for projects.
    - iii. The pervious concrete subcontractor shall employ no less than three (3) NRMCA Pervious Concrete technicians and one (1) Pervious Installer who shall be onsite, actively guiding and working with each placement crew during all pervious concrete placement
2. Source Limitations: Obtain each type of cement of the same brand from the same Manufacturer's plant, each aggregate from one source, and each admixture from the same Manufacturer.

D. Infiltration Capacity Test

Testing materials shall consist of a:

1. One gallon (4L), minimum size, water container with a spout. The spout shall be able to produce a stream with a circular cross section, the diameter of that which is large enough to discharge the entire contents of the container in 20 seconds or less;
2. Stopwatch capable of indicating elapsed time to the nearest second;
3. Tape measure of at least 36 inches that is graduated in 1/4 inch (6 mm) increments or smaller.

Testing procedure shall be as follows:

1. Place a pre-measured amount of water into the container.
2. Pour the water onto the surface in one spot. Control the discharge rate by manually adjusting the angle of the spout so that the diameter of the pool of water is between 10 to 30 inches (250mm to 760mm). Empty the container holding the spout over the spot until the pool of water vanishes.
3. Start the stopwatch when the water initially touches the concrete surface and stop it when the pool disappears from the surface.
4. Measure the longest dimension (d1) of the dampened area. Measure the width (d2) of the pool perpendicular to d1.
5. Repeat this procedure at a minimum of 4 separate locations.

- E. Infiltration Capacity shall be calculated as follows:
1. The formula for U.S. Standard Measures shall be:
    - a.  $IC = (V)(3,326,400)/(p)(d1)(d2)(t)$  inches per hour.
  2. The formula for SI Units shall be:  $IC = (V)(14.4 \times 10^6)/(p)(d1)(d2)(t)$  cm per hour.
    - a. Where:
      - i. IC is Infiltration Capacity
      - ii. V is the volume of water in gallons or liters
      - iii. d1 and d2 are the dimensions that were determined in part 211-3.3
      - iv. p is approximately 3.14159

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. General: Locally available material having a record of satisfactory performance shall be used.
- B. Cement: Portland Cement Type II or V conforming to ASTM C150 or Portland cement Type IP or IS, conforming to ASTM C595.
- C. Aggregate: Use 3/8" coarse aggregate which meets 3/8" to No. 16 per ASTM C33, or meeting 3/8" to No. 50 per ASTM D448. If other gradation of aggregate is to be used, submit data on proposed material to owner for approval. Larger aggregate sizes increase pore size but decrease workability. Aggregates which are well graded reduce porosity, and may require reduction of cementitious content to meet void specifications. Note that reductions below the minimums listed in Section 1.4, C of this document require written approval from the Engineer and Owner's Representative.
- D. Admixtures:  
 Type A Water Reducing Admixtures ----- ASTM C494  
 Type B Retarding ----- ASTM C494  
 Type D Water Reducing/Retarding ----- ASTM C494
- A hydration stabilizer will be utilized and is recommended in the design and production of porous concrete. This stabilizer suspends cement hydration by forming a protective barrier around the cementitious particles, which delays the particles from achieving initial set. The admixture's primary function should be as a hydration stabilizer, however it must also meet the requirements of ASTM C494 Type B Retarding or type D Water Reducing/Retarding admixtures. Air entraining agents shall comply with ASTM C260.
- E. Water: Potable or shall comply with conventional local good concrete practice.
- F. Reinforcement: Fiberglass reinforced plastic (FRP) reinforcing bar shall be used to tie adjacent concrete slabs together. FRP rebar shall be of at least one-half inch diameter, uni-directionally reinforced, placed twelve inches into each slab on thirty inch or closer spacing. Steel or epoxy-coated steel shall not be used due to the exposure to moisture experienced in porous concrete.
- G. Base Courses: See 02230 Base Course of this Specifications.

### 2.02 PROPORTIONS

- A. Cement Content: For pavement subject to vehicular traffic loading, Portland Cement content shall not be less than 630 pounds per cubic yard.
- B. Aggregate Content: The volume of aggregate per cubic yard shall be equal to 27 cubic feet when calculated as a function of the unit weight determined in accordance with ASTM C29 jigging procedure. Fine aggregate, if used, should not exceed 3 cubic feet and shall be included in the total aggregate volume.
- C. Admixtures: Shall be used in accordance with the manufacturer's instructions and recommendation.
- 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.

1. Mix water yielding a cement paste with a dull dry appearance has insufficient water for hydration
2. Insufficient water results in inconsistency in the mix and poor bond strength.
3. High water content results in the paste sealing the void system primarily at the bottom and provides a poor surface bond.

## 2.03 MIX DESIGN

- A. Contractor shall furnish a proposed mix design with proportions of materials to Owner or Agent prior to commencement of work. The data shall include unit weights determined in accordance with ASTM C29 paragraph 11, jiggling procedure. Compacted void content shall be a minimum of 10%. Cement content must be sufficient to hydrate cements but not enough to generate fluidity of mix.
- B. A mix design shall be submitted to the Engineer for approval in accordance with Section 013000, Administrative Requirements. The mix design shall show the mix identification number and the applicable proportions, weights, and quantities of Portland cement, aggregate, water, and where specified fly ash, admixtures, and concrete material. The mix design submittal shall also include the size and source of aggregate, the type and source of Portland cement and fly ash, the brand and designation of admixtures, and the type of construction for which the concrete is to be used.

## PART 3 EXECUTION

### 3.01 SUBGRADE PREPARATION AND FORM WORK

- A. Subgrade support: The upper 6 to 8 inches of the subgrade at the base should be scarified, moisture conditioned and compacted. Compaction of 85 to 90 percent of the maximum dry density as evaluated by ASTM D1557-07.
- B. Subgrade moisture: The moisture content should be within 2 percent of the optimum moisture content.
- C. Forms: Forms may be of wood or steel and shall be the depth of the pavement. Forms shall be of sufficient strength and stability to support mechanical equipment without deformation of plan profiles following spreading, strike-off and compaction operations. Forms shall have a removable spacer of 1/2" to 5/8" thickness placed above the depth of pavement. The spacers are removed following placement and vibratory strike-off to allow roller compaction. Forms shall allow for tie-in to adjacent concrete via the use of fiberglass reinforced plastic (FRP) reinforcing bar.

### 3.02 MIXING, HAULING, AND PLACING

- A. 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.
- B. Transportation: The Portland cement aggregate mixture may be transported or mixed on-site and should be used within one hour of the introduction of mix water, unless otherwise approved by an engineer.
- C. Discharge: Each mixer will be inspected for appearance of concrete uniformity. Water may be added to obtain the required mix consistency. A minimum of 20 revolutions at the manufacturer's designated mixing speed shall be required following the addition of any 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.
- D. Placement and Finishing:
  1. Unless otherwise approved by the Owner or 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" in 10 feet from profile grade. Normal placement procedures involve utilizing a mechanical vibratory screed to strike off the concrete 1/2" to 5/8" above final height, utilizing the form spacers described in this specification. Where the use of a vibratory screed can not be used traditional manual methods may be used to strike off the concrete. Following strike-off, the spacers are removed, and the concrete compacted to form level utilizing a steel roller made from nominal 8" diameter steel pipe. Care should be taken during compaction that full compactive force is achieved without working the concrete surface enough to seal

- off the surface porosity. Any apparent defects in the surface can be remedied by placing some fresh mix into any depressions and compacting using a hand tamper. After roller compacting and defect inspection/fixing, no further finishing is performed on the concrete.
2. During placement, care should be taken to prevent workers from stepping into the slurry mix. Footprints can compress and force cement paste into the voids at the bottom of the slab, forming resistance to percolation through the slab.
  3. Porous Concrete does not lend itself to being pumped. However, it can be placed using a belt conveyor.
  4. During placement all tools including screed machines, compaction rollers, rakes, trowels and forms shall be kept clean, and coated with a release agent to reduce the possibility of raveling. Compaction rollers displaying aggregate adhesion will accelerate raveling and disintegration.
- E. **CURING:** Curing procedures shall begin within 20 minutes of final placement operations. The pavement surface shall be covered with a minimum of 6ml thick polyethylene sheet or other approved covering material. In cold weather black plastic may be used in aid in heat retention. The curing cover shall remain in place for a minimum of 7 days. The low water/cement ratio and high amount. 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: Cure times listed are ideal. Cover shall remain on during cure. No vehicular traffic shall be allowed for 14 days.
- F. **JOINTS:**
1. Joints shall be installed at the location shown on the plans. Install joints to match approved sample.
  2. Control (contraction) joints shall be installed at regular intervals not to exceed 20 feet, or two times the width of the placement. They shall be installed at 1/4 the depth of the thickness of the pavement, not to exceed 1-1/2"t. These joints can be installed in the plastic concrete or saw-cut. Joints installed in the plastic concrete are generally rolled in utilizing a small roller with a flange welded to the center. This type of jointing is done immediately after roller compaction and immediately prior to curing.
  3. If joints are saw-cut, the procedure should begin as soon as the pavement has hardened sufficiently to prevent raveling and uncontrolled cracking, normally after 24 hours. Curing cover must be removed and recovered after joint sawing. Transverse construction joints shall be installed whenever placing is suspended long enough to allow the concrete to begin to harden. In order to assure aggregate bond at construction joints, a bonding agent suitable for bonding fresh concrete to existing concrete shall be brushed, rolled or sprayed on existing pavement surface edge.
  4. Isolation (expansion) joints will not be used except when pavement is abutting slabs or other adjoining structures
  5. Do not dowel longitudinal joints between successive placements.

**END OF SECTION**