

PERVIOUS CONCRETE PAVEMENT

PART I - GENERAL

1.01 CONTRACT CONDITIONS

Work of this Section is bound by the Contract Conditions and Division 1, bound herewith, in addition to this Specification and accompanying Drawings.

1.02 SUMMARY

A. Description

The work of this Section includes Subgrade preparation and installation of Portland Cement Pervious Pavement.

B. Related Sections

1. Section 01300 – Submittals
2. Section 02225 – Excavation, Backfilling and Compacting
3. Section 02233 – Aggregate Base Course
4. Section 03300 – Cast-in-Place Concrete

C. Measurement

No measurement will be made for Work described in this Section, including:

1. Portland cement concrete pervious pavement of the depth specified placed to the lines and grades shown on the Contract Drawings.
2. Extra thickness of pervious pavement, as shown.
5. Concrete joints, joint materials or joint sealant, (saw cutting or by installing pre-manufactured materials) used in the construction of Portland cement pervious concrete pavements.

D. Payment

Portland cement pervious concrete pavement of the depth and type specified, will be paid for as part of the Contract Lump Sum price, which price will be payment in full for furnishing all labor, materials, tools, equipment and incidentals, and doing all Work necessary to complete the Portland cement pervious concrete pavement, as specified, including:

Furnishing or installing curing materials, reinforcing bars or carbon fiber fabric, concrete joints, keyways, thickened edges of concrete at joints, joint material, joint sealant, or sawcutting joints, used in construction of Portland cement pervious pavement.

1.03 REFERENCES

- A. Annual Book of ASTM Standards, 1997; American Society for Testing and Materials, Philadelphia, PA.
- B. Standards of the American Association of State Highway and Transportation Officials (AASHTO).
- C. American Society of Testing and Materials ASTM C 29 “Test for Unit Weight and Voids in Aggregate.”
- D. ASTM C 33 “Specification for Concrete Aggregates.” ASTM C 42 “Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- E. ASTM C 117 “Test Method for Material Finer than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing.”
- F. ASTM C 138 “Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.”
- G. ASTM C 140 “Methods of Sampling and Testing Concrete Masonry Units.”
- H. ASTM C 150 “Specifications for Portland Cement” (Types I or II only).
- I. ASTM C 172 “Practice for Sampling Fresh Concrete.”
- J. ASTM C 260 “Specification for Air-Entraining Admixtures for Concrete.”
- K. ASTM C 494 “Specification for Chemical Admixtures for Concrete.”
- L. ASTM C 595 “Specifications for Blended Hydraulic Cements” (Types IP or IS only).
- M. ASTM C 618 “Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete.”
- N. ASTM C 989 “Specification for Ground Granulated Blast-Furnace Slag for use in Concrete and Mortars.”
- O. ASTM C 1077 “Practice for Laboratories Testing Concrete and concrete Aggregates for use in Construction and Criteria Laboratory Evaluation.”
- P. ASTM C 1688 “Standard Test Method for Density and Void Content of Freshly Mixed Pervious Concrete.”
- Q. ASTM D 448 “Specification for Standard Sizes of coarse Aggregate for Highway Construction.
- R. ASTM D 1557 “Tests for Moisture-Density Relations of Soils and Soil Aggregate Mixtures using 10 Pound Rammer and 18-inch Drop”
- S. ASTM E 329 “Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel and Bituminous Materials as used in Construction.”

1.03 SUBMITTALS

- A. See Section 01300- Administrative Requirements, for submittal procedures.
- B. Concrete Mix Design:

1.04 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 522.
- B. Follow recommendations of ACI 306R when concreting during cold weather.
- C. Use adequate numbers of skilled workmen 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.

1.05 CONTRACTOR QUALIFICATIONS

- A. The Contractor shall employ no less than one National Ready Mixed Concrete Association (NRMCA) Certified Pervious Concrete Craftsman who must be on site, overseeing each placement crew during all concrete placement, or the Contractor shall employ no less than one NRMCA Certified Pervious Concrete Installer, who shall be on site working as a member of each placement crew of at least four NRMCA certified Pervious Concrete Technicians, during all concrete placement unless otherwise specified. Alternative documentation of qualifications shall be permitted when approved by the Architect/Engineer. Prior to award of the contract, the placing contractor shall furnish Owner/Engineer a statement attesting to qualifications and experience and the following:
1. A minimum of 3 completed projects, total square footage to exceed 10,000 sf with addresses.
 2. Unit weight acceptance data.
 3. In-Situ pavement test results including void content and unit weight.
 4. Sample of Product (i.e. core or test panel)
- B. If the placing contractor and concrete producer have insufficient experience with Portland Cement pervious concrete pavement (less than 3 successful jobs), the placing contractor shall retain an experienced consultant or NRMCA Certified Pervious Craftsman to monitor production, handling, and placement operations at the contractor's expense.
- C. Test Panels: Regardless of qualification, Contractor is to 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 Architect's and Owner's satisfaction that in-place unit weights can be achieved and a satisfactory pavement can be installed at the site location.
- D. Test panels may be placed at any of the specified Portland Cement pervious locations on the project or at another test site.
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.
- E. Satisfactory performance of the test panels will be determined by:
1. Compacted thickness no less than ¼" of specified thickness.
 2. Void Structure: 15% minimum; 23% maximum.
 3. Unit weight plus or minus 5 pcf of the design unit weight.
 4. If measured void structure falls below 13% or if measured thickness is greater than ¼" less than the specified thickness or if 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.
- E. If the test panel meets the above-mentioned requirements, it can be left in-place and included in the completed work.

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 Owner, 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

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

1.07 PRE PAVING CONFERENCE

A pre-paving conference with the engineer shall be held two (2) days prior to beginning placing the pervious concrete. The contractor shall have the pervious concrete consultant, ready mix supplier, the foreman and the entire concrete crew that will form and place the concrete in attendance at this meeting.

PART 2 - PRODUCTS

2.01 CONCRETE MIX DESIGN

Contractor shall furnish a proposed mix design with proportions of materials prior to commencement of work. The data shall include unit weights determined in accordance with ASTM C 1688.

2.02 STORMWATER STORAGE/INFILTRATION BEDS

1. Coarse aggregates shall meet the size and grading requirements as defined in Standard Sizes of Coarse Aggregate, Table 4, AASHTO Specifications, Part I, 13th Ed., 1982, or later, unless otherwise specified.
2. Coarse aggregate for groundwater recharge bed shall be 2-1/2" to 1-1/2" uniformly graded Crushed coarse aggregate, with a wash loss of no more than 0.5%, AASHTO size number 2 per Table 4, AASHTO Specifications, Part I, 13th Ed., 1982, or later.
3. Choker base course aggregate for groundwater recharge bed shall be 1" to 3/8" uniformly graded, crushed coarse aggregate, or approved equal, AASHTO Specifications, Part I, 13th Ed., 1982, or later.
4. Filter fabric shall be Propex PERC™ Pervious Concrete Infiltration Fabric or approved equal.
5. Impervious liner – shall be Permalon, PLY-X 150, or approved equal.

2.03 PORTLAND CEMENT PERVIOUS 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. Slag or Flyash may be used as part of the total cementitious content.
2. Aggregate:

Use #9 Washed, crushed limestone coarse aggregate. If other gradation of aggregate are to be used, submit data on proposed material to owner for approval.
3. Admixtures:

The following admixtures may be used as needed:
 - a) Type A/F Water Reducing – ASTM C 494.
 - b) Air Entraining Agent – ASTM C 260.
May be used to improve resistance to freeze/thaw cycles.
 - c) A viscosity modifier.
Used to reduce paste drain down caused by using a dirty aggregate

- d) Buckeye Cellulose fibers
Dosed at the rate of 3# per cubic yard

The following admixtures shall be used:

- a) 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 initial set.
- b) HydroMax® Internal Curing Admixture
Dosed at the rate of 1.5 oz/cwt of total cementitious material.
Should reduce the amount of cementitious material needed as well as the need for a viscosity modifier.

4. Water: Potable water shall be used.

5. Proportions:

- a. Cement Content: For pavements subjected to vehicular traffic loading, the total cementitious material shall not be less than 515 lbs. per cu. yd. For other pavement areas not subject to vehicular traffic loading, the total cementitious material shall not be less than 500 lbs. per cu. yd.
- b. Aggregate Content: the volume of aggregate 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 1688.

An aggregate/cement ratio range of 4:1 to 4.5:1.

A unit weight range of 105 lbs/cu. ft. to 140 lbs/cu. ft. per ASTM C 1688.

Voids of 15% to 23%.

- 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).

Water cement ratios can range from 0.27 to 0.35.

Insufficient water results in inconsistency in the mix and poor bond strength. High water content results in the paste sealing the void system primarily at the bottom and poor surface bond.

PART 3 – EXECUTION

Owner shall be notified at least 24 hours prior to all recharge bed and pervious paving work

3.01 INSTALLATION

1. SUBGRADE PREPARATION

- a) Existing subgrade under bed areas shall NOT be compacted or subject to excessive construction equipment traffic prior to stone bed placement.
- b) Where erosion of subgrade 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.
- c) Bring subgrade of stone recharge bed to line, grade, and elevations required.
- d) Fill and lightly regrade any areas damaged by erosion, ponding, or traffic compaction before the placing of stone.

2. RECHARGE BED INSTALLATION

- a) Upon completion of subgrade work, the Architect shall be notified and shall inspect at his discretion before proceeding with recharge bed installation.
- b) Filter fabric, pipe, and recharge bed aggregate shall be placed immediately after approval of subgrade preparation. Any accumulation of debris or sediment which has taken place after approval of subgrade shall be removed prior to installation of filter fabric at no extra cost to the Owner.
- c) Place PERC™ 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 impervious liner over geo-textile extending six feet (6') beyond toe of slope face at building face, secure as recommended by manufacturer.
- d) Install coarse aggregate in 6 inch maximum lifts. Lightly compact each layer with equipment, keeping equipment movement over storage bed subgrades to a minimum. Install aggregate to grades required on the drawings.
- e) Install 1" thick choker base course size #57 (AASHTO) aggregate evenly over surface of stone bed, sufficient to allow placement of pavement, and notify Engineer for approval.
- f) Following placement of bed aggregate, the filter fabric shall be folded back along all bed edges to protect from sediment washout along bed edges. At least a two foot (2") 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 which 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 the bed edges can be cut back to gravel edge.

3.02 PORTLAND CEMENT PERVIOUS PAVEMENT CONCRETE MIXING, HAULING AND PLACING:

1. Mix Time: Central mixed concrete shall be mixed for a minimum of one minute after introduction of all materials into mixer. 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 by ready mix trucks or dump trucks or mixed on site and should be used within one (1) hour of the introduction of mix water, unless otherwise approved by an engineer. This time can be increased to 120 minutes when utilizing the hydration stabilizer specified above, unless otherwise approved by an engineer.
3. Each truck should not haul more than two (2) loads before being cycled to another type concrete, unless delivered by dump truck or if a stabilizing hydration agent is used in the pervious concrete mix design or if field experience proves that there is no significant concrete buildup in concrete mixer after delivery.
4. Prior to placing concrete, the subbase shall be soaked and in a wet condition (no ponding of water) at time of placement. Failure to provide a moist subbase will result in a reduction in strength of the pavement.
8. Discharge shall be a continuous operation and shall be completed as quickly as possible.
 - a) if consolidation occurs during concrete discharge, placement shall be halted and wet concrete removed (this may happen towards the end of some loads).
6. 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 subgrade and pulling or shoveling to final placement is not allowed.
7. Placing and Finishing Equipment: 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.
- 8 The pervious 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.
9. 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.
10. Strike off the pervious concrete 1/2" to 3/4" above the final grade prior to compaction, if needed, by using either slip-form, form riding vibrating screed, form riding aluminum roller screed or laser screed. Strike off may be done by hand for sidewalks. Care must be taken to avoid filling voids in the concrete.
11. If vibration, internal or surface applied, is used, it shall be shut off immediately when forward progress is halted for any reason.
12. 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 Owner.

3.03 CURING

1. Curing procedures shall begin immediately following all finishing operations if PerviousShield™ liquid spray on curing compound/densifier is used.
2. Curing procedures shall be complete within 20 minutes after the final placement operations if polyethylene sheeting is used.

The pavement surface shall be covered with a minimum .31 mil thick polyethylene sheet (painters plastic) or other approved covering material prior to final cross rolling of the surface and then covered with a layer of four to six (4 – 6) mil thick polyethylene sheeting. Prior to covering, an evaporative reducer

shall be sprayed 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.

3. Cure Time: Portland Cement Type I, II, or IS – 7 days minimum.
4. **No truck traffic shall be allowed for 10 days (no passenger car/light trucks for 7 days and no pedestrian traffic for 24 hours).**

3.04 JOINTING

1. Control (contraction) joints shall be installed as indicated by plans. They shall be installed at a depth of the 1/3 to 1/4 the thickness of the pavement.
2. These joints can be installed in the plastic concrete or saw cut.
 - a) If saw cut, the procedure should begin as soon as the pavement has hardened sufficiently to prevent raveling and uncontrolled cracking (normally after curing), minimum of 24 hours after placement.
 - b) Possible complications from saw cutting include:
 - a. Removal of plastic to perform saw cutting will cause pervious concrete to hydrate too quickly (Not a concern if PerviousShield™ is used). If plastic is removed to accommodate saw cutting, re-hydrating of pervious concrete is required.
 - b. Walking on pervious concrete too early can damage concrete surface
 - c. Saw cutting pervious concrete will introduce slurry into the pervious concrete possibly rendering those areas impervious.
3. Transverse construction joints shall be installed whenever placing is suspended a sufficient length of time that concrete may begin to harden.
4. Isolation (expansion) joints will not be used except when pavement is abutting slabs or other adjoining structures.
5. To reduce raveling, if transverse or isolation joints are used, or where pervious concrete meets impervious pavement, extra compaction may be necessary.
6. Additional installation specifications for the pervious concrete provided by the material source and engineer shall be followed strictly.

3.05 PORTLAND CEMENT PERVIOUS PAVEMENT CONCRETE TESTING, INSPECTION, AND ACCEPTANCE

1. The owner will retain an independent testing laboratory.
2. The testing laboratory shall conform to the applicable requirements of ASTM E 329 “Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction” and ASTM C 1077 “Standard Practice for Testing Concrete and Concrete Aggregates for use in Construction, and Criteria for Laboratory Evaluation” and shall be inspected and accredited by the Construction Materials Engineering Council, Inc. or by an equivalent recognized national authority.
3. The Agent of the testing laboratory performing field sampling and testing of concrete shall be certified by the American Concrete Institute as a Concrete Field Testing Technician Grade I, or by a recognized state or national authority for an equivalent level of competence.
4. Testing and Acceptance:
 - a) A minimum of 1 gradation test of the subgrade is required every 5000 square feet to determine percent passing the No. 200 sieve per ASTM C 117.
 - b) A minimum of one test for each load of pervious 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 1688. The unit weight of the delivered concrete shall be +/- 5 pcf of the design unit weight.

- c) Test panels shall have two cores taken from each panel in accordance to ASTM C 42 at a minimum of seven (7) days after placement of the pervious concrete. 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 1/2" less than the specified thickness. After thickness determination, the cores shall be trimmed and measured for unit weight in the saturated condition as described in paragraph 6.3.1 of 'Saturation' of ASTM C 140 "Standard Methods of Sampling and Testing Concrete Masonry Units." The trimmed cores shall be immersed in water for 24 hours, allowed to drain for one (1) minute, surface water removed with a damp cloth, the weighed immediately. Range of satisfactory unit weight values are +/- 5 pcf of the design unit weight.
 - d) After a minimum of seven (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 pervious design or other concrete material as permitted by the owner.
5. Maintenance: There shall be a maintenance plan submitted by the owner to prevent the clogging of the pervious concrete pavement which shall include periodic testing for flowability by the pervious concrete installer prior to the pervious concrete being opened to service, with flow rates reported in writing to the owner and again at six (6), twelve (12) eighteen (18) and twenty-four (24) months and again report the results in writing to the owner. It is the contractor's responsibility to help the owner to develop a maintenance plan. The owner must have a plan and methods to restore flowability if the flow rate drops below 75% of the original rate. Acceptable methods to restore levels of flowability are either to vacuum or powerwash the pervious concrete sections.

END OF SECTION