

## Bay Area Pervious Concrete Classic™ Pervious Concrete

Written and updated by Bay Area Pervious Concrete, June 2014

### Introduction:

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## **1. General information**

### **1.1 Summary**

This work includes specifications for BAPC Classic™ Pervious concrete including pervious base aggregates and sub-grade preparation at the location and to the dimensions shown on the plans, in accordance with the project manual. Intended for use with very specific pervious concrete aggregates and mix designs, and applications.

### **1.2 Scope**

This specification provides requirements for the construction of BAPC Classic™ Pervious Concrete finish.

### **1.3 Referenced standards**

1.3.1 Annual Book of ASTM Standards, American Society for Testing and Materials (ASTM) Standards, Material References.

1.3.1.1 ASTM C 29 “Test for Unit Weight and Voids in Aggregate”

1.3.1.2 ASTM C 150 “Specifications for Portland Cement” (Types I or II only).

1.3.1.3 ASTM C 172 “Sampling fresh concrete”

1.3.1.4 ASTM C 494 “Specification for Chemical Admixtures for Concrete”

1.3.1.5 ASTM C 595 “Specifications for Blended Hydraulic Cements” (Types IP or IS only).

1.3.1.6 ASTM C 1688 “Standard Test for Density and Voids Content of Freshly Mixed Pervious Concrete”

1.3.1.7 ASTM C-1701 “Standard Test Method for Infiltration Rate of In Place Pervious Concrete”

1.3.1.8 ASTM C 1028 - 07 “Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like- Surfaces by the Horizontal Dynamometer Pull-Meter Method”

1.3.1.9 ASTM C 1692 “Clean Potable Water”

1.3.1.10 ASTM BETA Standard for Making and Curing Fresh Pervious Concrete Test Specimens in the Field

1.3.2 Maintenance and cleaning which meet the standards found in the BAPC Polished® Pervious Concrete Maintenance Manual, dated 2013 or newer.

1.3.3 ACI 306R “Cold Weather Concreting”

1.3.4 ACI 305 “Hot Weather Concreting”

### **1.4 Definition**

1.4.1. BAPC Classic™ Pervious Concrete

1.4.1.1 Pervious concrete contains little or no fines, creating an open matrix allowing water to pass through it. Properly installed and cured, pervious concrete is a strong and durable hardscape that can be used in any hardscape application in place of standard impervious concrete or asphalt.

## **1.5 Submittals**

1.5.1 Bid Submittals— The following items must be submitted with the bid proposal. Proposals without the following submittals shall be rejected.

1.5.1.1 Certificates of Qualifications for Pervious concrete installer as discussed in Quality Control Section 1.6.1.1.A.

1.5.1.2 List of 5 reference jobs as discussed in Quality Control Section 1.6.1.1.B.

1.5.2 Pre-Installation Submittals— The following items must be submitted a minimum of four (4) weeks before scheduled installation date.

1.5.2.1 Mix Design

## **1.6 Quality Control**

1.6.1 General—Test and inspect concrete materials and operations as work progresses as described in 1.3.1.6 with no less than one such test performed per day. Failure to detect defective work or material early will not prevent rejection if a defect is discovered later, nor shall it constitute final acceptance.

1.6.1.1 Contractor qualification—

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 three NRMCA certified Pervious Concrete Installers, who shall be on site working as members of each placement crew during all concrete placement.

B. Contractor must provide documentation showing 5 successful pervious concrete projects in the last 5 years totaling more than 20,000 sq ft. Documentation shall include name and address of project, contact information for project owner.

1.6.2 Testing as required by project engineer

1.6.2.1 Fresh Density Test – Obtain a minimum 1 ft<sup>3</sup> (28 L) sample for acceptance tests in accordance with ASTM C172. Measure a minimum of one density test during each day's placement in accordance with ASTM C1688. Fresh density shall be between +6 & -3 lb/ft<sup>3</sup> (80 kg/m<sup>3</sup>) of the specified fresh density.

1.6.2.2 Permeability test – Permeability shall be tested using ASTM C 1701. One test for every 5000 sq ft, minimum 3 tests, results should be averaged. Test locations should be at least 50' from each other.

- A. Must be tested on clean, level pervious pavement upon removal of the curing plastic and accepted before opening the pavement to traffic.
- B. Permeability shall be at least 300 inches per hour on average as tested after curing period has ended.

1.6.2.3 If less than four (4) inches of open graded base rock is used under the pavement the permeability rate will not be valid and the permeability rate shall not be used for criteria for acceptance or rejection of the pavement.

1.6.2.4 Compressive strength testing is not used for pervious concrete.

1.6.3 Testing agencies—Agencies that perform testing services on concrete materials shall meet the requirements of ASTM C1077. Agencies inspecting the Work shall meet the requirements of ASTM E329. Testing agencies performing the testing shall be accepted by Architect/Engineer before performing any Work.

1.6.3.1 Field tests of concrete required in 1.6.2 shall be performed by an individual certified as both an NRMCA Certified Pervious Concrete Technician or equivalent and an ACI Concrete Field Testing Technician—Grade 1 or equivalent.

## **1.7 Field conditions**

### **1.7.1 Protection of Existing Improvements**

1.7.1.1 General contractor is responsible for preparing site for work – clearing area, protecting adjacent finished surfaces, materials and previously installed objects or furniture. General contractor shall provide suitable protection where required before work commences and maintain protection throughout the course of the work.

1.7.1.2 To whatever extent possible, do not damage or disturb existing vegetation. Installer shall not be responsible for damaged vegetation within the work area. Remove all stains from exposed surfaces of paving, structures, and grounds. Remove all waste and spillage.

### **1.7.2 Safety and Traffic Control:**

1.7.2.1 General contractor shall notify and cooperate with local authorities and other organizations having jurisdiction when construction work will interfere with existing roads and traffic.

1.7.2.2 General contractor shall 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.

### **1.7.3 Weather Limitations:**

1.7.3.1 Do not place pervious concrete pavement when the ambient temperature is below 45°F, is expected to fall below 32°F within 48 hours of placement, or is above 90°F, unless otherwise permitted in writing by the

design professional of record. In the case of cold weather installation, surface efflorescence, as well as streaking, or tiger striping, which is a result of the curing membrane, may be significant.

1.7.3.2 Do not place pervious concrete pavement when the wind, heat or humidity does not allow enough time to place, properly joint, compact, edge, finish and cure before the surface dries to the point where it is no longer workable without damaging the surface.

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## **2. Products**

### **2.1 Fabric**

2.1.1 Geotech fabric (if required) shall be Mirafi 140n or approved equal.

### **2.2 Base**

2.2.1 Base shall be composed of 3/8" or larger crushed rock maintaining at least a minimum of 35% void space.

2.2.2 For installations that will utilize the tailgate method of material delivery the upper 6" of base shall be a nominal 3/4" open graded crushed rock, base rock beneath 6" shall be minimum 1 1/2".

### **2.3 Forms**

2.3.1 Form materials must be durable enough to resist deformation during edge compaction and maintain grade.

2.3.2 Forms shall be clean and free of debris of any kind, rust, and hardened concrete.

### **2.4 Classic Pervious Concrete**

Comply with ASTM C94/C94M and the following requirements:

2.4.1 Aggregates—Aggregate shall have a minimum specific gravity of 2.60, a minimum rodded void content of 35% and a maximum absorption rate of 3%. Crushed aggregate or gravel shall be permitted.

2.4.2 Admixtures—

2.4.2.1 Hydration stabilizers are authorized for use in the mix if used as directed in the mix design.

2.4.2.2 Internal curing agents may be used to have plastic free curing if the following qualifications are met:

2.4.2.2 A. Qualification:

5,000 sq ft of installed pervious concrete that has cured without plastic.

Photos, address and contact information of reference to be submitted to

the General Contractor/Project supervisor. Further instructions are in the curing section 2.9.

2.4.3.3 Other admixtures must comply with ASTM C 494 and approved by the design professional of record.

#### 2.4.3 Supplementary Cementitious Materials

2.4.3.1 SEMs such as fly ash, slag and silica fume are approved for use in pervious concrete. SEM mix proportions shall be included in the mix design.

#### 2.4.4 Reinforcing Materials

2.4.4.1 The use of fibers in pervious concrete mixtures is permitted when required.

2.4.4.2 No reinforcing bars or tie bars will be used in the installation of pervious concrete.

2.4.5 Pigments— Use pigments or color complying with ASTM C979 if specified in Contract Documents.

2.4.6 Water— Clean potable water shall be used per ASTM C 1692.

### 2.5 Cure Materials

2.5.1 Moisture-Retaining Cover: A minimum of four mil Polyethylene film ASTM C 171 shall be used to cover the fresh BAPC pervious concrete OR

2.5.2 Internal Curing Admixture may be used in the mix to replace plastic sheet in the curing process, assuming the qualifications are met in 2.4.2.2.

2.5.3 Evaporation Control-Surface stabilizers and ASTM C309 compliant curing agents are allowed as long as they are applied in mist form and do not dilute the surface paste.

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## 3. Execution

### 3.1 Sample pad installation

3.1.1 Test panel requirement may be waived based on contractor experience, if approved by project engineer or owner.

3.1.2 At a location, as approved by the contracting agency, the proposed contractor shall construct a sample test panel on-site, using the same design requirements required for the substantial portion of the project. The sample test panel should be a minimum of 10 feet x 10 feet, and should be installed using the same required tools and qualified personnel required for project installation as found in Section 1.6.1.1. The fresh concrete used in the test panel shall be tested unit weight as per ASTM-C 1688.

3.1.3 The design professional of record shall approve a site cast sample of the specified pavement before paving begins. The following criteria for the sample shall be used:

3.1.3.1 The surface appearance of the sample must be approved for texture, finish and should have minimal surface tearing or raveling. The finished product must be a reasonable facsimile of the approved sample.

3.1.3.2 Permeability shall be tested using ASTM C 1701 or approved equal.

A) Permeability shall be at least 300 inches per hour as tested after the initial curing period.

B) If less than 4 inches of specified base rock is installed the ASTM C 1701 permeability test shall not be criteria for acceptance.

3.1.4 Accepted sample panels, in like new condition, may be used in the contract work.

3.1.5 Rejected panels shall be removed at contractor's expense.

### **3.2 Pre-installation meeting**

3.2.1 If required, a pre-paving meeting shall be scheduled at prior to the installation. The following individuals are required to attend:

3.2.1.1 General contractor representative

3.2.1.2 Pervious concrete installation contractor

3.2.1.3 Mix design author

3.2.1.4 Site work contractor

### **3.3 Subgrade prep**

3.3.1 General contractor shall ensure the subgrade is prepared in accordance with Contract Documents.

3.3.2 General contractor shall ensure that the required pavement thickness is obtained in all locations by verifying subgrade elevation.

3.3.3 General contractor shall ensure that subgrade is not over-compacted before installing the base rock material.

3.3.4 General contractor shall ensure keep all traffic off of the subgrade during construction to the maximum extent practical. Re-grade and re-compact subgrade disturbed by concrete delivery vehicles or other construction traffic, as needed. Compact the material added to obtain final subgrade elevation.

### **3.4 Base Installation**

3.4.1 Placement of all other elements of the design (i.e. conduits, drainage pipe(s), utilities, irrigation sleeves, etc.) are to be reviewed by the General contractor and base contractor prior to placing base.

3.4.2 Geotech fabric (if required) shall be Mirafi 140n or approved equal and must extend at least six inches outside of bed, or per the design documents, whichever is greater unless otherwise specified by the design professional.

3.4.3 General contractor shall inspect the in-place open graded base aggregate:

3.4.3.1 Ensure compliance to the plans and specifications.

3.4.3.2 Verify the base rock is free-draining. If not, do not proceed.

3.4.3.3 General contractor shall ensure that the required pavement thickness is obtained in all locations by verifying base elevation.

### **3.5 Setting formwork**

3.5.1 Set, align, and brace forms so that the hardened pavement meets the tolerances specified in 3.6. Install forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement. Assemble formwork to permit easy stripping and dismantling without damage to concrete.

3.5.2 The vertical face of previously placed concrete may be used as a form ensuring that the pavement is protected from damage.

3.5.3 Forms need to be wood or metal.

### **3.6 Tolerances**

3.6.1 Top of Forms: Not more than 3/8" inch variance in 10 feet.

3.6.2 Vertical Face on Longitudinal Axis: Not more than 3/8" inch in 10 feet.

### **3.7 Batching & Mixing**

3.7.1 Mix Proportions

3.7.1.1 Total cementitious material should be sufficient to result in a design void content of 18-22%.

3.7.1.2 The volume of aggregate, cement, water, and admixture per cubic yard calculated as a function of the unit weight as determined by ASTM C1688 Standard Test for Density and Voids Content of Freshly Mixed Pervious Concrete and must result in a yield of 27 cubic feet per cubic yard.

3.7.1.3 The unit weight per CY of the concrete shall be +/- 6 lbs. of the design unit weight (ASTM 1688).

3.7.2 Batch and mix in compliance with ASTM C94/C94M

3.7.3 Discharge shall be completed as long as the mix is workable.

3.7.4 Hydration stabilizer can significantly increase working time. Installer should be well versed in the use of hydration stabilizer.

3.7.5 Water addition is permitted at the point of discharge. Water addition at site does not meaningfully extend workability time.

### **3.8 Delivery**

3.8.1 Delivery of materials must be carefully scheduled to avoid trucks waiting on job. Pervious concrete that has been in the truck for excessive periods of time and is no longer workable should be rejected.

#### **3.8.2 Standard Ready Mix Concrete trucks**

3.8.2.1 Standard Ready Mix Concrete trucks can be used for pervious concrete mixes.

#### **3.8.3 Volumetric trucks also known as 'Truck Mounted Mobile Mixers'**

3.8.3.1 Volumetric trucks can be used for delivery and mixing of pervious concrete as well.

### **3.9 Pervious Concrete Placement**

#### **3.9.1 Inspection**

3.9.1.1 Before placing concrete, inspect and complete formwork installation.

#### **3.9.2 Prior to placement**

3.9.2.1 Prior to placement of pervious concrete, moisten sub-base aggregate to provide a uniform dampened condition at the time concrete is placed. If initial application of water is quickly absorbed apply a second application of water just before installing pervious concrete.

#### **3.9.3 Placement**

3.9.3.1 Deposit concrete either directly from the transporting equipment or by conveyor onto the pre-wetted subgrade or sub-base, unless otherwise specified.

3.9.3.2 Do not place concrete on frozen subgrade or sub-base.

3.9.3.3 Spread the concrete using a come-along, short-handle, square-ended shovel, or rake.

3.9.3.4 Strike off concrete using tools and equipment described in 3.9.4-3.9.6.

3.9.3.5 Finish the pavement to the elevations and thickness specified in Contract Documents and meet the requirements of 3.6.

#### **3.9.4 Edging**

3.9.4.1 Edge top surface to a radius of not less than 2x the nominal size of the aggregate.

#### **3.9.5 Finishing**

3.9.5.1 Compact fresh concrete to stay within the requirement tolerances.

3.9.5.2 Compact pervious concrete to a dense, pervious surface.

### 3.9.5.3 Tools

- A. Spinning “Roller” screed -- Spinning “Roller” screed is the preferable method of strike off and initial compaction.
- B. Hand Operated Straight Edge -- A hand operated straight edge may be used to place the pervious concrete where the spinning roller screed is not feasible.
- C. Finishing Tools – Hand floats and other tools typical to concrete finishing may be used but only if they do not seal the surface, reduce permeability below acceptable infiltration rates.
- D. Asphalt rollers or plate compactors – shall not be used.

## 3.10 Jointing

3.10.1 Joint placement in pervious concrete is more restrictive than traditional concrete. Joint placement is at the discretion of the installer unless noted in the design documents in which case the designer or engineer shall consult with installer on joint location.

3.10.2 When joint placement is not indicated on the Project Drawings, installer shall submit drawings describing proposed jointing. Do not proceed with Work until the joint placement is accepted by the Architect/ Engineer.

3.10.3 Spacing between contraction joints shall not exceed 20 feet. The larger horizontal dimension of the slab panel, shall not exceed 135% of the smaller dimension.

3.10.4 Tool contraction joints to the specified depth and width in fresh concrete immediately after the concrete is compacted.

3.10.4.1 Contraction joint depth shall be a minimum of one quarter the pavement thickness.

3.10.5 Saw cut concrete joints may be placed after concrete has hardened sufficiently to prevent aggregate from being dislodged and soon enough to prevent pavement cracking. If saw cuts are performed before the curing period has ended, the slabs will be kept sufficiently wet when it is uncovered and immediately recovered.

## 3.11 Concrete curing

3.11.1. Begin the curing as soon as possible after discharge of material and before excessive loss of surface moisture occurs. There are 2 approved methods of curing:

3.11.1.1 Polyethylene Moisture-Retaining Cover:

- A. Completely cover the pavement surface with a minimum 4 mil thick polyethylene sheet. Cut sheeting to a minimum of a full placement width plus 12” on both sides.

- B. Cover all exposed edges of pavement with polyethylene sheet. Overlap sheet edges by at least 18”.
- C. Secure curing cover material in such a manner as to ensure curing sheet will remain securely in place throughout the duration of the curing period.
- D. Evaporation Control: Surface stabilizers and ASTM C309 compliant curing agents are allowed as long as they are applied in mist form and do not dilute the surface paste

3.11.1.2 Chemical Moisture-Retaining Cover: Internal cure compound used in conjunction with an approved ASTM C-309 surface-curing compound may be used in lieu of polyethylene sheeting assuming the qualifications are met in 2.4.2.2.

3.11.2 Cure pavement for a minimum of 7 uninterrupted days, unless otherwise specified. Mixes with 20% or more SEMs shall be cured a minimum of 10 days.

3.11.3 All curing times are based on temperatures at or above 55°F during the curing time. Each day temperatures are lower than 55°F does not count as a curing day. The added time required is to be determined by the design professional of record.

### **3.12 Concrete protection**

#### **3.12.1 Pavement Protection during Construction**

3.12.1.1 General contractor must inform all trades who use the pavement for staging, storage or other reasons; especially landscapers, not to dump materials such as dirt, debris, or bark on the pervious concrete.

3.12.1.2 General contractor shall protect the pavement surface from abrasion, discoloration, or sediments until completion of any construction or landscaping activity that may expose the pavement to hazards.

3.12.1.3 General contractor shall be responsible to clean, repair and touch-up, or replace when directed, pavement which has been soiled, discolored, or damaged by other trades outside the installer’s control prior to substantial completion.

### **3.13 Cleaning**

3.13.1 Pressure washing or vacuuming or a combination of both may be used as required. Pressure washing no higher the 3500 psi and the nozzle no closer then 12 inches from the slab. Pressure washers are approved for use after 14 days.

### **3.14 Maintenance/Cleaning**

3.14.1 After installation General Contractor is responsible for protecting and cleaning.

3.14.2 Owner is responsible for all maintenance after project work acceptance.

3.14.3 The contractor must supply the owner with a copy of an owner's manual which contains all of the information as found in "Bay Area Pervious Concrete's Pervious Concrete Maintenance Manual" dated June 2014 or newer.

### **3.15 Opening to traffic**

3.15.1 The pavement must cured for at least 7 uninterrupted days before light vehicle traffic is permitted, 14 days cure for heavy vehicles. The Architect/Engineer must accept the pavement before being opened up to traffic.