

***MICHIGAN SPECIFIER'S GUIDE  
FOR  
PERVIOUS CONCRETE  
PAVEMENT WITH DETENTION***

August 2017



**Disclaimer**

*The MCA has prepared this document as a guide only. This is not a complete analysis of every material fact regarding pervious concrete pavement with detention. The opinions expressed herein reflect the judgment of the Michigan Concrete Association (MCA) at this date and are subject to change. The information has been obtained from sources MCA considers to be reliable, but MCA cannot guarantee that it is accurate or complete.*

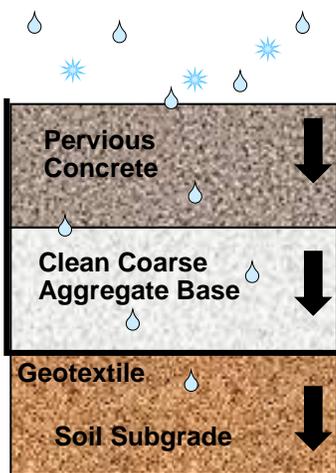
# PERVIOUS CONCRETE PAVEMENT WITH DETENTION

## FORWARD

This guide has been assembled for specifiers who consider pervious concrete for stormwater mitigation. It takes into consideration the local climate (freeze/thaw) and common presence of clay soil in Michigan, as well as local resources/materials. The EPA Phase II, NPDES stormwater mandates require post-development runoff to be equal to or less than pre-development runoff. Pervious concrete filters, cools, and detains (temporary storage) stormwater, while also serving as a parking lot, sidewalk, or pavement. Pervious concrete becomes a multipurpose product, fulfilling stormwater requirements while reducing site footprint and proving a productive pavement surface.

This guide was developed to facilitate the design, installation and performance of a system comprised of pervious concrete pavement constructed over a clean, coarse aggregate base for temporary stormwater storage, having a non-woven geotextile filter fabric interlayer, (filter fabric) or an impervious liner, on a properly prepared subgrade. For the duration of its service life, and with routine maintenance, the finished system resulting from this guide should a) collect, clean and discharge the stormwater for which it was designed, b) protect the subgrade on which it was constructed as well as the adjacent buildings and other pavements, and c) carry the traffic for which it was also designed. A system of *Pervious Concrete Pavement with Detention* may be used in conjunction with other stormwater management practices such as rooftop rain gardens, roadside swales, filter strips, basins, bio-retention cells or wetlands.

The pervious concrete pavement system consists of a surface layer of specially designed concrete consisting of 20% to 25% voids to allow rainwater to rapidly flow through the pavement. This layers sits on a base of clean coarse aggregate (40% voids) to act as temporary storage for rainwater. In areas where there are primarily sandy soils, this storage layer may be minimized. The last part of the system consists of a filter fabric placed under the aggregate storage layer on top of the soil subgrade. This filter fabric shall also wrap up the sides of the base and pervious concrete to protect the base and pervious layers from infiltration of surrounding soils or fines which can migrate into and clog the system. Refer to diagram below.



Pervious concrete pavements, as all permeable pavements, are stormwater infiltration based management systems. These pavements convey water through the pavement and hence also effectively collect and trap fine materials. Routine maintenance efforts consisting of visual inspection, infiltration rate testing and cleaning to restore pavement porosity is required to keep the system performing. Water should continue to move through the pavement and not pond into the pavement layer, otherwise surface distress and damage to the pavement will result. Ideally the pavement needs to be designed to limit sediment exposure by isolating run-on from landscape areas and limiting the draining of other non-permeable pavements elsewhere. In all cases, early removal of vegetative and other sediment loads is the most effective way to maintain infiltration and prevent damage. Maintenance of the pervious concrete pavement is the responsibility of the property owner/manager.

The Michigan Concrete Association provides training and certification for pervious concrete in the state of Michigan. It is highly recommended for the Concrete Contractor placing the pervious concrete as well as the Ready Mixed Concrete Supplier to be MCA Pervious Concrete Certified. This certification is also recommended for others involved in pervious concrete design and installation including: engineers,

architects, landscape architects, stormwater engineers, general contractors, inspectors, field testing personnel, etc.

In addition to stormwater control, *Pervious Concrete Pavement with Detention* may help gain additional LEED® (Leadership in Energy and Environmental Design) credits to a project for reduction of heat island effect, reduced site disturbance, stormwater credit, and improved energy efficiency for adjacent buildings. It may also help to achieve recognition through other sustainable construction practice programs such as SITES® or Envision®.

This guide may be used to develop the necessary communicative tools (plans, specifications and other contract documents) which will convey the intentions of the project Architect/Engineer to the Permitting Agency, the Contractor and the Inspector. Actual project conditions will require modifications and additions to this guide.

## NOTABLE UPDATES TO THE 2015 SPECIFIERS GUIDE

Pervious concrete has now been used in significant quantities in the United States since the early 2000s. Originally the design and construction guidance was developed out of experiences in climates and markets in warmer and more humid locations than Michigan. Consequently, certain practices common in those locations do not produce consistently durable pervious concrete and have been removed from this guide. The most notable changes are in the following areas:

### Pervious Concrete Mix Design

- Water reducing admixtures used in pervious concrete mixtures should be polycarboxylate-based. Polycarboxylate admixtures are more effective and durable than older water reducer types. For broad application polycarboxylate water reducing agents whose type depends on dosage, the dosage rate should be adjusted to achieve high-range reduction.
- Hydration stabilizing admixtures (not retarders) are required to maintain sufficient workability. A dosage rate chart has been included in this guide to allow adjusting dosage for air temperature, humidity, and concrete haul time.
- Large aggregates produce an overly rough texture which is not appealing from an owner's perspective. The maximum recommended aggregate size is now 3/8 inch crushed durable stone aggregate. Pea gravel is not recommended because standard washing procedures do not clean the stone sufficiently which can compromise the durability of the pervious concrete mix. If pea gravel is used, additional washing to clean the aggregate is required.
- Fibers are recommended to be used in the pervious concrete mixture to prevent excess raveling and to prevent over compaction from too wet mix, and to hold cracks together when they do happen. See Section 2.09.E for recommendations on fibers.

### Ready Mix Producer

- A majority amount (greater than 75%) of the batch water must be introduced into the mixing drum prior to all other materials.
- All water should be added during initial batching. Do not hold back water for later adjustments.

### Placement Contractor

- A test panel shall be constructed prior to construction to demonstrate that the pervious concrete mix meets the design criteria and that the contractor can sufficiently place the pervious concrete per the plans and specifications. The test area should be a minimum of 4 cubic yards of concrete or a 200

square foot area. The following tests shall be performed for the test panel: ASTM 1688 test for fresh density, ASTM C1701 infiltration rate of in place concrete (after 7 days, performed at the 3 core locations prior to coring), ASTM C1754 (Drying Method B) density and void content of hardened pervious concrete (3 core locations) and ASTM 1747 to determine potential raveling made by impact abrasion.

- Joints are installed in conventional concrete to control random cracking. Tooled joints have been recommended in the past for pervious concrete pavements, however, they have proven to be problematic due to issues with raveling. Generally, sawed joints have performed better than tooled joints but still pose issues of handling the plastic sheeting and cleaning of saw slurry or dust. Since pervious concrete already possesses a much different texture than conventional concrete, random rakes are much less visible. In an attempt to reduce problems related to joints in pervious concrete, **jointing of pervious concrete is not recommended**. A sufficient dose of synthetic fibers is recommended to control random cracking (see Section 2.09.E for recommendations on fibers).

### **Curing**

- Soy bean oil cure shall be sprayed on the pervious concrete to prevent surface evaporation. It can also be used on the forms and tools as a bond breaker. Soy bean oil cure should be a construction grade product, not food grade. Soy bean oil cure shall be sprayed after the surface is finished prior to placing the plastic sheeting.
- Plastic sheeting, cut at least 2 feet wider than the placement width, shall be used for curing the pervious concrete pavement for 7 days after placement. Plastic should be pre-rolled and available to immediately roll out over the freshly placed pavement.

### **Sealing**

- A lithium silicate densifier shall be applied to the pervious concrete surface after the 7-day curing period. Immediately after application, the surface should look wet and remain glossy for 5 to 10 minutes. Adjust the application rate as necessary to achieve this result. A recommended initial starting application rate is 200 sq ft/gal. The densifier hardens the surface, increasing its resistance to raveling.

### **Acceptance Testing**

- Compressive strength is commonly used for acceptance of conventional concrete. However, the application and characteristics of pervious concrete are significantly different than conventional concrete. Additionally, there are no standardized procedures to make and test strength specimens of pervious concrete. It is therefore inappropriate to specify compressive strength requirements for pervious concrete or to use such tests as a basis for acceptance. Instead, a density (unit weight) test of fresh pervious concrete is used for quality assurance, with the acceptable values dependent on the specific mixture proportions.

### **Owner Maintenance**

- The owner shall take responsibility to properly maintain and operate the pervious concrete with detention system. It is critical to monitor the pavement and to address any potential for clogging that might affect the infiltration rate of the system as well as any activities that might affect the surface durability such as snow removal and deicing practices. MCA recommends following the National Ready Mix Concrete Association (NRMCA) *Pervious Concrete Pavement & Operations Guide* which can be found on the NRMCA website at [NRMCA.org](http://NRMCA.org).

## **SYSTEM COMPONENTS**

**Subgrade** - Critical to the design and performance of a system of *Pervious Concrete Pavement with Detention*, is the subgrade on which it is to be constructed. Infiltration rate of the subgrade soil controls the design of the stormwater storage layer described by this guide.

Test methods to determine the subgrade soil infiltration rate must be conducted by a qualified testing laboratory. If the subgrade soil has a minimum infiltration rate of 0.5 in./hr., a filter fabric may be installed and the stormwater storage layer used for groundwater recharge. When the soil infiltration rate is below 0.5 in/hr or expansive soils are present, existing material must be excavated and replaced with a drainable base layer of coarse aggregate. The thickness of this base layer can be calculated using hydrologic software available from the Portland Cement Association. The stormwater storage layer is referred to as a “detention layer”, anticipating that the water will pass from storage via a pipe, daylighted aggregate drain or other form of positive conduit. If the soil porosity exceeds a minimum infiltration rate of 0.5 in/hr, the storage layer will be referred to as a “recharge bed”, anticipating that a substantial amount of the stored water will pass through the filter fabric into the subgrade. Note: Some local authorities may require a calculated storage volume that would contain a specific rainfall event or the first-flush (defined as the first .5 to 1 in of rain fall) for up to 72 hours.

**Stormwater storage** - Stormwater storage in the system envisioned by this guide is accomplished entirely within an aggregate base layer beneath the pervious concrete pavement. For additional storage volume the aggregate layer(s) may extend beneath adjacent impervious pavements on the site, and may include chambers, cisterns, vaults, tanks or other receptacles, as necessary to economically accommodate the design stormwater storage volume.

Plan thickness requirements for stormwater storage in the aggregate layer of the system, whether designed for detention or recharge, may be verified using the *Pervious Concrete Hydrological Analysis Program*<sup>1</sup> or other approved programs. Underdrain piping may be required to provide positive drainage and drawdown of the stormwater storage. Overdrain piping may be utilized to minimize pavement saturation and protection especially for sites with low soil infiltration rates during very large storm events.

The designer must consider the slope of the subgrade to a) compute stormwater storage volume, and b) to consider need for cross-slope “check dams” for erosion prevention at the soil surface below the storage layer. Greater stormwater storage volume will provide additional freeze-thaw protection for storms that exceed the design event.

**Pervious concrete pavement** – Pervious concrete pavement does not look like nor behave like conventional concrete pavements. The finished surface is not tight and uniform, but is open and varied, to admit large quantities of stormwater. Surface irregularities and minor amounts of surface raveling are normal. Traditional concrete testing procedures for strength and slump are not applicable to this construction. Instead, pervious concrete pavement is tested in the lab for density, void content, permeability, abrasion and strength, and in the field for slump flow, density, voids, infiltration rate and thickness; using standard test methods identified in this guide, to assure a durable, drainable pavement.

Maintenance is critical to the long-term performance of pervious concrete pavement, especially those activities that prevent clogging of the surface pavement and subsequent clogging of the subsurface layers by accumulated sediments and organic matter. Changes in infiltration rates can be monitored throughout the life of the pavement using ASTM C1701 – Standard Test Method for Infiltration Rate of In-Place

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<sup>1</sup> Program by Malcolm, Leming and Nunez, of the Civil Engineering Department, North Carolina State University, Raleigh, North Carolina. The software is available from the Michigan Concrete Association, the National Ready Mixed Concrete Association or the Portland Cement Association.

Pervious Concrete. Establishment of a base infiltration rate at the completion of pavement construction will allow for routine inspection and subsequent infiltration rate testing of potential clogged areas within the pavement to be addressed by a maintenance program. A routine inspection schedule is required to check for infiltration rate changes that would prompt the restoring procedures required to remedy porosity levels.

Developers, architects and engineers are strongly encouraged to visit locations where pervious concrete pavements with detention (or groundwater recharge) have been installed before making the decision to use this concept. The MCA can provide a list of locations in Michigan where pervious concrete has been placed. Technical assistance and installation training is available from the Michigan Concrete Association. MCA can also provide planning, design, materials and construction guidance.

## **PERVIOUS CONCRETE PAVEMENT WITH DETENTION**

### **PART 1 GENERAL**

#### **1.01 Scope of Work:**

- A. The Work described by this guide addresses the labor, materials and equipment necessary for construction of pervious concrete pavement, including subgrade testing and preparation for a stormwater storage layer for temporary detention or groundwater recharge in conformance with the plans, specifications and other contract documents, for streets, parking lots, driveways, paths, sidewalks and other pedestrian areas.

#### **1.02 References:**

- A. American Concrete Institute
  1. ACI 211.3R “Guide for Selecting Proportions for No-Slump Concrete”
  2. ACI 301 “Specification for Structural Concrete”
  3. ACI 305 “Hot Weather Concreting”
  4. ACI 306 “Cold Weather Concreting”
  5. ACI 522R-10 “Report on Pervious Concrete”
  6. ACI 522.1-13 “Specification for Pervious Concrete Pavement”
  7. ACI Flatwork Finisher Certification Program
  8. ACI Field Technician Certification Program
- B. American Society for Testing and Materials
  1. ASTM C 29 “Test for Bulk Density (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 94 “Specification for Ready-Mixed Concrete”
  5. ASTM C 117 “Test Method for Material Finer than 75- $\mu$ m (No. 200) Sieve in Mineral Aggregates by Washing”
  6. ASTM C 138 “Test Method for Density (Unit Weight), Yield and Air Content (Gravimetric) of Concrete”
  7. ASTM C 140 “Test Methods for Sampling and Testing Concrete Masonry Units and Related Units”
  8. ASTM C 150 “Specification for Portland Cement”
  9. ASTM C 171 “Standard Sheet Materials Used for Curing Concrete”
  10. ASTM C 172 “Practice for Sampling Freshly Mixed Concrete”
  11. ASTM C 260 “Specification for Air-Entraining Admixtures for Concrete”
  12. ASTM C 494 “Specification for Chemical Admixtures for Concrete”
  13. ASTM C 595 “Specification for Blended Hydraulic Cements”

14. ASTM C 618 “Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete”
  15. ASTM C 979 “Specification for Pigments for Integrally Colored Concrete”
  16. ASTM C 989 “Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars”
  17. ASTM C 1017 “Specification for Chemical Admixtures for Use in Producing Flowing Concrete”
  18. ASTM C 1077 “Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation”
  19. ASTM C 1116 “Standard Specification for Fiber-Reinforced Concrete”
  20. ASTM C 1240 “Specification for Silica Fume in Cementitious Mixtures”
  21. ASTM C 1542 “Standard Test Method for Measuring Length of Concrete Cores”
  22. ASTM C 1602 “Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete”
  23. ASTM C 1761 “Specification for Lightweight Aggregates for Internal Curing of Concrete”
  24. ASTM D 448 “Classification for Sizes of Aggregate for Road and Bridge Construction”
  25. ASTM D 698 “Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft<sup>3</sup>)”
  26. ASTM D 1557 “Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft<sup>3</sup>)”
  27. ASTM D 1751 “Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)”
  28. ASTM D 1752 “Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction”
  29. ASTM D 2434 “Test Method for Permeability of Granular Soils (Constant Head)”
  30. ASTM D 3385 “Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer”
  31. ASTM D 3665 “Standard Practice for Random Sampling of Construction Materials”
  32. ASTM D 5084 “Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter (Falling Head, Method C)”
  33. ASTM D 5093 “Test Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed-Inner Ring”
  34. ASTM D 6391 “Test Method for Field Measurement of Hydraulic Conductivity Limits of Porous Materials Using Two Stages of Infiltration from a Borehole”
  35. ASTM D 6690 “Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements”
  36. ASTM D 6767 “Standard Test Method for Pore Size Characteristics of Geotextiles by Capillary Flow Test”
  37. ASTM D 7357 “Specification for Cellulose Fibers for Fiber-Reinforced Concrete”
  38. ASTM E 329 “Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction”
- C. Pervious Concrete Specific Standards
1. ACI 522.1-13 “Specification for Pervious Concrete Pavement”
  2. ASTM C 1688 “Test Method for Density and Void Content of Freshly Mixed Pervious Concrete”
  3. ASTM C 1701 “Standard Test Method for Infiltration Rate of In-Place Pervious Concrete
  4. ASTM C 1747 “Standard Test Method for Determining Potential Resistance to Degradation of Pervious Concrete by Impact Abrasion”

5. ASTM C 1754 “Standard Test Method for Density & Void Content of Hardened Pervious Concrete”
- D. Michigan Concrete Association
  1. MCA Pervious Concrete Contractor Certification
- E. Michigan Department of Transportation Standard Specifications for Construction
  1. Section 902. Aggregates
- F. Ohio Ready Mixed Concrete Association Specifiers Guide, December 1, 2014
- G. The Concrete Promotion Group of Greater Kansas City Area Specifiers Guide, v1.4.17
- H. Iowa State University Pervious Concrete Research ([www.iastate.edu](http://www.iastate.edu)), ([www.cptechcenter.org](http://www.cptechcenter.org))
- I. University of Missouri, Kansas City, MO, Dr. John Kevern, Pervious Concrete Researcher ([www.UMKC.edu](http://www.UMKC.edu))
- J. NRMCA Pervious in Practice brochures, <http://www.perviouspavement.org/downloads/PiP1.pdf> and <http://www.perviouspavement.org/downloads/PiP2.pdf>
- K. NRMCA Pervious Concrete Pavement Maintenance and Operations Guide, [http://www.perviouspavement.org/downloads/pervious\\_maintenance\\_operations\\_guide.pdf](http://www.perviouspavement.org/downloads/pervious_maintenance_operations_guide.pdf)

### 1.03 Quality Assurance:

- A. Prior to construction, the Bidder/Contractor shall submit evidence of at least one successful pervious concrete pavement project greater than 1000 sq. ft. including, but not limited to, the following:
  1. Project name and address, owner name and contact information.
  2. Fresh density and void content test results per ASTM C 1688 and, if determined, in place hardened density and void content of pervious concrete mixture per ASTM C 1754.

This requirement may be waived by the Architect/Engineer provided the Bidder/Contractor demonstrates successful experience in the concrete industry and constructs test panel(s) for inspection and testing, per Section 1.08 of this guide.
- B. The Bidder/Contractor shall submit evidence at time of bid submission, that 20% of the crew or at least one member (crew leader), whichever is greater, shall be certified through the MCA Pervious Concrete Certification Program or equal. The minimum number of certified individuals listed above, must be present on each pervious concrete placement, and a certified individual must be in charge of the placement crew and procedures. This also includes the pervious concrete test panel placements (see Section 1.08).
- C. The inspectors for the project shall possess a current MCA Pervious Concrete Certificate or equal.
- D. At least 80% of the contractor crew placing pervious concrete shall be present and participate in the test panel placement. (See Section 1.08)
- E. Build the Test Panel on site in accordance with Section 1.08.
- F. Testing performed as directed, refer to Section 3.02.
- G. Curing is critical to the success of Pervious Concrete. There are several curing requirements. See Section 3.01.C.6.
- H. Sealing – Lithium silicate densifier applied after the 7-day curing period.
- I. Following curing, hardened tests will include ASTM C 1754, 3 cores for every 8,000 sf for hardened density, and ASTM C1701, 3 tests for every 8,000 sf, for in-place infiltration results, Section 3.02.D.

### 1.04 Qualifications of Laboratories:

The inspection and testing services of the testing laboratory shall be under the direction of a full-time employee registered as a Professional Engineer in the State of Michigan as appropriate for the

job and meeting the requirements of ASTM C1077. They shall have a minimum of five years of experience in inspection and testing of concrete construction. The field technician shall have, at a minimum, the ACI Field Testing Technician Grade I Certification as well as the MCA Pervious Concrete Certification.

### **1.05 Equipment**

- A. Placement shall be performed with a 6-inch diameter roller screed. (For alternate placement techniques refer to section 3.01.C.4.d.)
- B. Cross rollers or pan floats shall be used behind the roller screed to aid in rolling out the ridges left by the roller screed and for final compaction.
- C. Tampers shall be used on the edges against the forms to aid in better compaction where more wear and tear occurs and where consolidation is more difficult. These are typically 8" X 8" steel plates attached to a 52" handle.
- D. Minimum of two working spray cans, or one mechanical system, to apply the bean oil after the paving process over the entire pavement surface. Follow dosage rate instructed by the manufacturer. Adequate amount of bean oil shall be present to keep up with daily production rate of pervious placement.
- E. Appropriate hand tools such as squared shovels and come-along for placing the pervious as it is deposited from the concrete truck's chute or belt placement.
- F. Plastic sheeting for pavement curing. Plastic should be pre-rolled and set so as to quickly and efficiently be available to immediately roll over the freshly placed pavement. Plastic sheeting should be cut a minimum 2 feet wider than the forms width.
- G. When using internal curing methods, plastic sheeting shall also be needed to prevent moisture loss.
- H. Anchors to hold down the plastic sheeting to prevent it from blowing off or allowing air to billow underneath. (Wood 2x4's [or equivalent] stretched along each side to continuously hold down the plastic, anchored with sand bags or equivalent weights every 5 to 6 feet.) If wood forms are used, the plastic can be stapled along the outside edge of the forms to keep the plastic down for additional security.
- I. Pervious concrete is NOT pumpable. Belt placers are recommended.

### **1.06 Submittals: Administrative Requirements for Submittal Procedures**

Prior to commencement of the work the contractor shall submit the following to the specifier:

- A. Concrete materials:
  - i. Proposed concrete mixture proportions including all material weights, volumes, density, water-cement (cementitious ratio), and void content. ASTM C1688 fresh density, and designed or desired ASTM C1701 values. If mix proportions are proprietary, a written submittal from the concrete supplier will be required documenting a minimum of two prior successful projects using the same mix design. The density, water to cement ratio, and void content is still required to be reported.
  - ii. Aggregate type, source and grading per ASTM C33 for Pervious Concrete.
  - iii. Cement, supplementary cementitious materials and chemical admixture manufacturer certifications all meeting the appropriate ASTM requirements.
  - iv. Certification that fibers conform to ASTM C1116.
- B. Proposed aggregate for use in stormwater storage or detention layer: washed aggregate type, source, grading and void content (percent porosity).
- C. Qualifications: Evidence of qualifications listed under Quality Assurance in Section 1.03 of this guide, which should have accompanied initial bid.
- D. Plan for Placement: Include in Plan specifics for jointing (if required), project details, schedule, construction procedures and any additional quality control information.

- E. For hot weather placement (over 90 degrees for 7 days following placement) or cold weather (40 degrees or lower during the next 7 days following placement) submit a curing and procedural plan to monitor/protect the concrete.
- F. Subcontractors: List all materials suppliers, subcontractors and testing laboratories to be used on the project.

### **1.07 Pre-paving Conference**

- A. A pre-paving conference with the specifier, concrete contractor supervisor (pervious concrete certified), general contractor, ready mixed supplier (pervious concrete certified) and inspection party shall be held prior to placement of the Test Panel and at least one week prior to pervious concrete placement.
- B. As a guide for the meeting, the document *Checklist for the Concrete Pre-Construction Conference* (provided as an attachment) shall be used to review all requirements of the contract during the meeting.
- C. In addition, a pre-construction conference shall be held and/or notice shall be provided to all subcontractors, identifying the special precautions that are required when working around pervious concrete pavement.

### **1.08 Test Panels**

Prior to construction, test panels shall be constructed in accordance with the plans and specifications. A test panel takes a minimum of 7 days for cure before it is reviewed for approval by owner/specifier. A panel that fails requires another test panel placement until approved.

- A. The test panel will be constructed in accordance with the plans and specifications. The test area will be a minimum of 4 cubic yards or a 200 sq. ft. area, as determined by the specifier at the design depth. The panel shall be installed, consolidated, jointed (if required) and cured using the materials equipment and personnel proposed for the project. The test panels are to demonstrate to the specifier that in-place densities can be achieved, acceptable permeability can be achieved and satisfactory pavement can be installed at the site location.
- B. The test panel can be constructed on-site in an area for demolition after test approval or in a predetermined area that may be saved and used (for example a pad under a picnic table) or with prior approval in a small part of the actual project. If the test proves to be unsatisfactory by the specifier it will be removed and replaced until accepted. If the actual site is too small or limited, the specifier and contractor shall come to an agreement for an alternate test site.
- C. The cost for removal of the test panel, if necessary, shall be included as a line item in the contract proposal and contract. Test panels may be placed at any of the specified pervious concrete pavement locations on the project site or other test site.
- D. Quality: Test panels shall have acceptable surface finish, joint details (if necessary), thickness, porosity and curing procedures and shall comply with the testing and acceptable standards listed in the quality control section of this document.
  - 1. ASTM C1688 will establish the target fresh density to use in the field for acceptance at the actual placement. The acceptance level is +/- 3 pcf from this established ASTM C1688 density. The measured density of fresh pervious concrete provides a means of determining the void content of the mixture when consolidated in a standard manner. It will not, however, represent the void content of the installed pavement which receives a different compactive effort.
  - 2. ASTM C1701 will establish infiltration rate of in-place pervious concrete after 7 day curing period. (Test a minimum of 3 locations within the pavement)
  - 3. ASTM C1754 will establish density and void content of hardened pervious concrete (coring in a minimum of 3 locations). The average density of cores taken from the test panel (no sooner than 7 days after placement) set the basis for subsequent quality assurance and acceptance testing.

4. ASTM C1747 will determine the potential raveling made by impact or abrasion.
- E. Satisfactory performance of the test panels shall be determined by:
  1. Organized construction team with all the proper equipment at hand and used on the test pour, consolidating the surface to a satisfactory thickness and smoothness.
  2. Use ASTM C1754 to establish the in-place density and void content. Hardened density to be within +/- 5% of the design.
  3. An average infiltration value of 400 in./hr. is desirable for sites not accepting additional contributing run-on with no individual value below 250 in./hr. nor above 1,000 in./hr.
- F. Review of the testing information from the Test Panel construction should indicate desirable results.

### **1.09 Weather Restrictions**

- A. The Contractor shall not place pervious concrete when the ambient temperature is 40 °F or lower, unless otherwise permitted in writing by the Architect/Engineer.
- B. The contractor shall not place pervious concrete for pavement when the ambient temperature is 90 °F or higher, unless otherwise permitted in writing by the Architect/Engineer.
- C. Heated water, typically used by ready mix producers to mitigate cold weather concreting, may NOT be used for batching pervious concrete.

## **PART 2 – MATERIALS**

### **2.01 Subgrade**

Testing to determine the subgrade soil infiltration rate shall be conducted by a qualified testing laboratory, by either the field or laboratory methods listed below:

- Field methods – ASTM D3385 or ASTM D5093
- Laboratory methods – ASTM D5084 or ASTM D2434

If the subgrade soil has less than a minimum infiltration rate of 0.5 in./hr, a “positive outlet” shall be provided to drain water from the storage layer. If a positive outlet is not used, the storage layer will be referred to as a recharge bed, anticipating a substantial amount of the stored water will pass through the filter fabric to the subgrade. Note: Sizing and locations of any pipes, etc. is to be designed by others, and is not a part of this guide.

### **2.02 Filter Fabric**

A filter fabric consisting of a minimum 4 oz. non-woven geotextile fabric shall be installed on top of the subgrade soil.

### **2.03 Coarse Aggregate for Storage Layer**

2.03.1 This layer shall be a minimum of 6 inches thick (sidewalks may vary) depending on the design parameters. The material shall conform to ASTM C33 standards and be capable of having minimum voids of 38% by weight measured in accordance with ASTM Standard C29.

2.03.2 Plan thickness requirements for stormwater storage in the system may be verified using the Pervious Concrete Hydrological Analysis Program, or other approved program. This software assumes a flat subgrade; calculations may require adjustments for subgrade slope.

### **2.04 Curing**

- A. Plastic Sheetting – The primary method of curing pervious concrete shall be the placement of a waterproof covering, consisting of minimum 6 mil thick clear polyethylene sheeting. This sheeting shall be classified as heavy duty in accordance with ASTM C172.
- B. Soy bean oil (cure), enough quantity to cure the pavement according to the manufacturer recommendation. The soy bean oil can also used on the forms as a bond breaker and to spray the roller screed and other placement equipment/tools. This is construction grade soy bean oil, not a food grade product.
- C. Other curing compounds must conform to ASTM C309, to be used as an alternate surface cure to the soy bean oil when using one of the internal curing options below, noted in section D.
- D. Internal Curing
  - 1. Pre-wetted lightweight fine aggregates in accordance with ASTM C1761.
  - 2. Super absorbent polymer (SAP) material for pervious concrete use, following the manufacturer’s recommendations.

**2.05 Surface Sealer**

Lithium silicate densifier applied to the pervious concrete surface, at a starting application rate of 200 sq ft/gal.

**2.06 Joint Sealant**

Joint sealants, if specified, in accordance with ASTM D6690, D1751 or D1752.

**2.07 Cement:** Portland Type I conforming to ASTM C150

**2.08 Supplementary Cementitious Materials:**

- A. Fly ash conforming to ASTM C618
- B. Ground granulated blast-furnace slag (slag cement) conforming to ASTM C989.
- C. Silica fume in accordance with ASTM C1240  
(Note: When fly ash or slag cement are used, initial set may be delayed, while long term strength gain is typically increased. When silica fume is used, initial set may be accelerated.)

**2.09 Admixtures**

- A. Air-entrained admixtures shall conform to ASTM C260. (Note: There is no current way to test pervious for air in the plastic state. Normal air testing procedures will not work with pervious concrete.) Air entraining admixtures shall be used in pervious concrete. Air entraining admixtures should be used at a dosage rate which produces an acceptable (6%) air content in stiff, conventional concrete such as a curb mix. If the pervious concrete mixture contains silica fume, the air-entraining admixture dosage rate should be increased by 50%.
- B. Water Reducing Admixtures shall conform to ASTM C494.
  - 1. Polycarboxylate water reducing admixtures shall be type A, B, D or F, mid-range or high-range versions. For broad application products, dose for high-range water reduction. Typical ranges are usually in the 4 to 6 oz/cwt range.
  - 2. Extended control admixtures (hydration stabilizers) meeting the requirements of ASTM C494 Type B Retarding or Type D Water Reducing/Retarding shall be used. This admixture is critical to the success of the mix design. The warmer the weather, the more of this admixture to be used. Changes in cement supplier and/or type will also require changes in admixture dosage, given the same cement content. Pervious concrete mixes use more of this chemical than dosage rates for conventional concrete. All pervious concrete projects shall have these products, or equal. Additional admixture shall be at the jobsite for re-dosing as needed.

Recommended Hydration Stabilizer Dosage Rates (oz/cwt) for Pervious Concrete

Temperature	Humidity			
	< 10%	10% - 30%	31% - 60%	> 60%
< 50°F	14	12	9	6
50°F - 72°F	17	15	12	9
73°F - 90°F	20	19	15	13
> 90°F	26	24	20	18

**Notes:**

- a. Dosage rates are shown in ounces of hydration stabilizer per 100 lbs of cementitious material (oz/cwt).
  - b. Dosage rates are approximate values for typical hydration stabilizers available as of this printing. Tests should be conducted to determine specific admixture effectiveness and compatibility for the actual pervious concrete mixture proportions being used, prior to the start of the project.
  - c. Dosage rates are appropriate for mixing plus hauling times of 0 to 60 minutes.
  - d. If concrete requires 60 to 90 minutes before discharge, increase dosage by 12 oz/cwt.
  - e. If concrete require 90 to 120 minutes before discharge, increase dosage by 24 oz/cwt.
  - f. Dosage rates listed are not appropriate for pervious concrete mixtures containing blast furnace slag. Hydration stabilizer significantly increases setting time for pervious concrete mixtures containing slag cement, making curing especially important. If slag is used, several trial mixtures should be performed to evaluate appropriate dosage rates to achieve acceptable set times (typically within 24 hours).
- C. Viscosity modifying admixtures shall meet the requirements of ASTM C494.
- D. Miscellaneous admixtures. Proprietary admixtures are available which may or may not meet referenced ASTM Standards. Their performance shall be demonstrated prior to the placement.
- E. Synthetic fibers shall be used in pervious concrete pavements.
1. Mono-filament micro fibers shall be polypropylene, cellulose, nylon or polyvinyl alcohol type and dosed between 1.0 and 2.0 pcy.
  2. Fibrillated fibers shall be polypropylene and dosed between 1.5 and 3.0 pcy.
  3. Macro fibers shall be polypropylene or nylon and dosed between 3.0 and 5.0 pcy.
  4. Micro and fibrillated fibers are generally used to improve surface durability, raveling resistance, and to prevent over compaction. Macro fibers are generally used to control random cracking. A combination of the two is allowable and appropriate to achieve both aims.
  5. Micro and fibrillated fibers should be removed from bags and distributed in 2-3 gallons of water before addition to the mix to prevent balling of the material and to promote even distribution.

**2.10 Aggregates for Pervious Concrete**

Aggregate used will have a direct influence on the permeability, surface texture, and the appearance of the pervious concrete slab. It is extremely important that the ready mix supplier monitor and measure the SSD aggregate moisture content when batching pervious concrete. **The water to cement ratio is low in pervious concrete. Changes in aggregate moisture affect the success or failure of the pervious concrete.**

- A. Coarse Aggregate shall be crushed stone or crushed gravel and shall meet the grading and quality requirement of MDOT 25A, 26A or 29A unless an alternate size or specification (e.g. ASTM C33, AASHTO) is demonstrated that it can be successfully used, based on meeting the project requirements. Gradation choice shall be limited to sizes ¼” to 3/8” unless otherwise approved by the architect/engineer. The specific gravity shall be >2.5 and the absorption shall be < 2.5% to aid in durability and performance.
- B. Fine aggregate for pervious concrete shall meet the size and grading requirements as defined as MDOT 2NS sand and/or shall comply with ASTM C33. Sand will be included in the total combined aggregate gradation. General limits of 7% sand shall be allowed in the mix.

**2.11 Water:** Water shall be potable and comply with ASTM C94.

**2.12 Mix Design - Proportions**

- A. The contractor shall furnish to the specifier a proposed mix design with proportions of materials prior to commencement of work in compliance with ASTM C1688 and ASTM C1754. The composition of the proposed concrete mixture shall be submitted to the specifier for review and /or approval and shall comply with the following provisions unless an alternate composition is demonstrated to comply with the project requirements.
- B. Generally pervious concrete shall be designed and placed with a water/cement ratio between 0.30 and 0.35. Typical cement contents range from 500 to 600 lb/cyd.
- C. Heated water (typically used by ready mix suppliers in cold weather) shall **not** be used in the making of pervious concrete by the supplier (see section 1.09)

**PART 3 EXECUTION**

**The Specifier shall be notified at least 24 hours prior to detention layer installation and 24 hours prior to pervious concrete installation.**

**3.01 Installation**

- A. Stormwater Detention Layer
  - 1. Subgrade Preparation
    - a. Existing subgrade under detention layer areas shall be shaped to drain per plan lines, grades and specifications. Compaction of the existing subgrade should be kept to a minimum to avoid reduction in the permeability of the soil.
    - b. Conduct an ASTM D3385 test to determine the soil condition. Remediate/scarify to improve infiltration as needed.
    - c. Cuts necessary to establish proper subgrade level shall not be compacted or subject to excessive construction equipment traffic prior to coarse aggregate bed placement and may be scarified to improve infiltration rates.
    - d. When fill is needed to establish proper subgrade level some compaction may be necessary. Compaction to 92% standard proctor is sufficient.
    - e. Fill and lightly re-grade any areas damaged by erosion, ponding or traffic compaction before placing of filter fabric and coarse aggregate.
  - 2. Installation of Filter Fabric and Detention Layer

- a. Upon completion of subgrade work, the Architect/Engineer shall be notified and shall inspect at their discretion before the contractor may proceed with the stormwater detention layer installation.
- b. Filter fabric, stormwater detention layer coarse aggregate, pipe for conveying stormwater out of the detention layer (if needed), or other storage devices 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 the contractor's expense.
- c. Place geotextile filter fabric in accordance with the manufacturer's standards and recommendations. Adjacent strips of filter fabric shall overlap a minimum of 16 in. The filter fabric shall be placed on the floor of the excavation and up the vertical face of the excavation, stone detention and pervious layer. The contractor shall secure fabric at least 2ft. outside of the pervious pavement and detention layer and take steps necessary to prevent any runoff or sediment from entering the storage bed. For protection of existing adjacent building foundations, place impervious liner extending 6 ft. beyond slope face at building face and secure as recommended by manufacturer.
- d. Install coarse aggregate in 6 in. minimum lifts. Lightly compact each layer with equipment, keeping the equipment movement over storage bed subgrade to a minimum. Install aggregate to grades required on the drawings.
- e. Hay bales or equivalent 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.

## B. Pervious Concrete Pavement

### 1. Pavement Thickness:

Pavement shall be placed to depth specified on the plans. Typical parking lot pavement thicknesses range from 6 inches to 8 inches. Pavements for frequent use by vehicles heavier than single axle service/delivery trucks shall be 8 inches thick. Heavy truck traffic may require special design. Sidewalks are typically be 4-5 inches.

### 2. Formwork:

- a. Form materials are permitted to be of wood or steel and shall be the full 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

### 3. Mixing and Hauling:

- a. Production: Pervious concrete shall be manufactured and delivered in accordance with ASTM C 94.
- b. Batching: A majority amount of water (greater than 90% of the total) must be introduced into the mixing drum prior to all other materials, adjusted for daily aggregate moisture content measurements.
- c. All water should be added during initial batching. **Do not** hold back any water for later adjustments, whether at the plant or at the job site.
- d. Mixing: Pervious concrete shall be batched in central mixers or in transit (truck) mixers. (For central mixed concrete, the concrete shall be mixed for a minimum of 1.0 minute or until a homogenous mix is achieved.) Concrete mixed in transit mixers shall be mixed at the mixing speed designated by the manufacturer for 70 – 100 revolutions.
- e. Transportation: Pervious concrete should be discharged within one (1) hour of the introduction of mix water to the cement. Discharge times may be extended beyond 60 minutes when an increased dosage of hydration stabilizer is used to maintain a wet

metallic sheen, or by the discretion of the specifier. **Typical admixtures used in pervious concrete function effectively for up to 30 minutes. They start to lose effectiveness between 30 to 60 minutes mixing time. Poor workability can be remediated with re-dosing admixtures at the jobsite at the time of placement.**

- f. Discharge and Adjustments: Each truckload shall be visually inspected for consistency of the concrete mix. Water addition to adjust the consistency is strongly discouraged but may be permitted at the point of discharge. It is strongly suggested that the hydration stabilizer and/or water reducer be available for re-dose at the jobsite, as they can be a better alternative to adding more water. A minimum of 30 revolutions at the manufacturer's designated mixing speed shall be counted following the addition of any water to the mix, prior to further discharge. Concrete shall be deposited as close to its final position as practical and such that discharged concrete is incorporated into previously placed plastic concrete.
4. Placing and Finishing:
    - a. The base shall be in a damp condition at time of placement. The contractor shall spray the aggregate base with water just prior to placing pervious.
    - b. Concrete may be deposited into the forms by mixer truck chute, conveyor or buggy. Pervious concrete is NOT pumpable.
    - c. Use a roller screed as described under Section 1.05 Equipment. Failure to properly weigh down the roller screed may result in poor surface quality.
    - d. If approved by the Architect/Engineer in writing, the contractor may place the pervious concrete with an alternate screed. The contractor must show proper information to substitute his/her ability to successfully place pervious concrete with an alternate method.
    - e. Cross rollers or pan floats shall be used behind the roller screed to aid in rolling out the ridges left by the roller screed and for final compaction. When plastic sheeting is used for curing, cross rolling can be conducted over the plastic sheeting.
  5. Jointing
    - a. Conventional concrete jointing is not recommended.
    - b. Joints can be placed with sawcuts, however, extra steps must be taken to protect the pervious concrete from raveling at the sawed joint. A conventional concrete saw may be used at the earliest possible time as soon as it will not ravel. Slurry/dust shall be vacuumed or washed. Sawcut depth is  $\frac{1}{4}$  to  $\frac{1}{3}$  the thickness of the pavement. When sawing pervious concrete, the sheeting may only be removed as needed to make the cuts, and then re-secured for a minimum of 7 days.
    - c. Sawed joints in pervious concrete, when implemented, are spaced similarly to conventional concrete. As a general rule of thumb, space joints two times the thickness in feet or 15 feet, whichever is smaller. (Example: A typical 6 inch thick pervious pavement should have a maximum spacing of 12 ft. Maximum joint spacing for pavements thicker than 7 inches is 15 ft.)
    - d. Isolation joints shall be used when abutting fixed vertical structures such as manholes, light poles, signage poles, etc.
    - e. Seal joints after sawing and curing per manufacturer's directions, to minimize future raveling of the sawed joint.
  6. Curing
    - a. Curing procedures should begin as soon as possible and not later than 5 to 10 minutes behind the roller screed.

- b. Bean Oil shall be sprayed onto the pavement from both sides of the paving operation. (See reference 2.3 Curing Materials) The pavement surface shall be covered with plastic sheeting or other approved covering materials
- c. The plastic sheeting shall be rolled on tubes prior to paving. The plastic sheeting rolls over the forms, covering the fresh pavement. There shall be a minimum of 12" overhang on each side of the form to have enough extra sheeting to properly anchor the sides.
- d. Any holes, tears, or cuts in the plastic sheeting shall be taped or repaired to prevent moisture loss and to prevent air infiltration under the sheeting.
- e. Anchors, such as 2x4's, sand bags, or water bags shall be properly secured to the edges of the plastic. Mud clumps and construction trash is not proper anchorage. No wind driven billowing of the plastic is allowable during the 7 day cure. If using wood forms, the plastic sheeting can be stapled to the outside edge of the form, then 2x4's placed on the upper outer edge for added continual anchoring and sand bags placed every 5 to 6 feet to hold them in place.
- f. The curing shall remain in place for a minimum of 7 days, uninterrupted.

#### 7. Sealing

- a. Lithium silicate densifying sealer shall be applied to the pervious concrete surface after the 7-day curing period. Immediately after application, the surface should look wet and remain glossy for 5 to 10 minutes. Adjust the application rate as necessary to achieve this result. A recommended initial starting application rate is 200 sq ft/gal.

#### 8. Open to Traffic

- a. No vehicular traffic shall be permitted on the pavement until curing is complete (7 days) and no truck traffic shall be permitted for at least 14 days. No off road construction traffic shall access the concrete at any time. Once the plastic is removed, densifier applied and dry, and traffic is using the pervious concrete, ensure that no debris or dirt are deposited on the surface.

### 3.02 Testing

ASTM C09.49 and ACI 522 committees are working together to develop standardized testing for pervious concrete. There are five recommended tests for pervious concrete, four of which are standardized ASTM tests at the time of printing of this document:

- A. ASTM C1688, Fresh density is the primary quality control criteria during placement. The designed density will be provided by the specifier. During the Test Panel (described in section 1.08) the in-situ density is established by the construction team. The ambient temperature and the moisture condition of the aggregates have a heavy hand in consistency of the pervious and the density. The Ready Mix Producer may need to adjust the mix at this time to achieve a workable mix for the contractor to place and achieve the desired consistency. Test every truck for density per ASTM C1688 using parameters of +/- 3 lbs/ft<sup>3</sup> of the density from the accepted test slab.
- B. ASTM C1754, Hardened density and void content +/- 5% of the density from the hardened density established at the test panel or mock up. Three cores, taken no sooner than 7 days after placement, for every 8,000 sf.
- C. Inverse Slump Flow Test reproduces the discharge of pervious concrete from the ready mix truck. This is an indicator of the workability at the job site and/or a change in the consistency of the pervious concrete between trucks. The following procedure is directly applicable to roller screed type placement where highly workable mixtures are desirable. As a general rule of thumb for

pervious concrete workability, manual placement should be very workable, while mechanized placement can be stiffer. Workability requirements for placement of other than that using roller screed equipment should be determined during test placements.

1. Fill an inverted slump cone with the plastic pervious concrete without any compacting or rodding. Fill it roughly to the top of the inverted slump cone.
2. With a smooth even motion, lift the slump cone about knee height. If necessary give it a jostle or mild shake to loosen the material and let it begin to flow.
3. If the material flows from the cone it will discharge from the truck and place correctly for the contractor. If the materials stay lodged in the cone then the concrete is too stiff and will be difficult to discharge from the truck. The concrete is likely to have high porosity and low strength, potentially leading to surface raveling and loss of surface durability.
4. Concrete that will not flow through the cone indicates loss of admixture effectiveness. **Site Remediation** for pervious concrete that is too stiff/dry/lost workability: Add 0.5 gallon of water per yard of pervious concrete mix. Retest. If more remediation is needed add 50% of the original dosage of either the water reducer or the hydration stabilizer, in addition to adding 0.5 gallon of water per cubic yard of pervious concrete and mix. If this doesn't work, reject the load. Call the ready mix plant to have them adjust production at the plant prior to batching additional loads.

D. ASTM C1701, Infiltration Rate of In-Place Pervious Concrete.

1. An infiltration ring is temporarily sealed to the surface of a pervious pavement. After pre-wetting the test location, a given mass of water is introduced into the ring and the time for the water to infiltrate the pavement is recorded. The infiltration rate is calculated.
2. ASTM C1701 may be conducted after a test panel has hardened to establish if the infiltration meets expectations.
3. ASTM C1701 can be conducted on a pervious pavement at any time to establish the infiltration rate. Typically a reduction of 25% triggers maintenance activities.
4. ASTM C1701 can be done after curing to establish a baseline for future tests.
5. ASTM C1701 is not a pass/fail test. It is a subjective test, but it is recommended that infiltration rates be between 250 to 750 in./hr., with no value above 1,000 in./hr.

E. For Test Panel only. Determining Potential Resistance to Degradation of Pervious Concrete by Impact Abrasion, ASTM 1747. In general, pervious concrete with less than 40% mass loss has good performance in the field.

### 3.03 Site Acceptance Procedures and Remediation Strategies

The workability and consistency of pervious concrete may be determined for each ready mix truck to ensure quality construction. Typically, workability is adjusted on-site for the first load and then readjusted during batching for all subsequent loads.

- A. Check Batch Ticket: Upon arrival at the jobsite. Check for the correct mixture and appropriate delivery and mixing time.
- B. Determine Consistency: Determine ASTM C1688 density and compare against required values +/- 3 pcf. In most situations, poor flow through the inverse slump cone will indicate potential for low density values. Adjusting for workability will improve density.
- C. Check Workability: Perform an inverse slump check. If workability remediation is required, add up to 50% of the original dosage of water reducer or the hydration stabilizer, mix and retest.
- D. Adjust subsequent loads: Contact the batch plant operator and relay water and /or admixture adjustments.

### 3.04 Maintenance

- A. **WARNING!** Other traditional construction processes that normally follow pavement installation include using the parking lot or pavement for a staging area for landscape materials, soils, or mulch. Other arrangements will need to be planned for the staging area when utilizing pervious concrete pavements. Fines from the soils or mulch **will** clog the pervious pavement.
- B. Vacuuming and/or power washing the pervious pavement are acceptable practices for occasional maintenance. As with all pavements, pervious concrete pavements will occasionally need cleaning. Research and experience show us that debris typically stays in the top inch of the pavement. Vacuuming will more easily remove the dirt, fines and organic material. Power washing can be harmful if the psi adjustment is too intense. Power washing tends to push materials further down into the pavement. Combination cleaning machines that combine a wet spray and vacuum process have proven to work successfully. Many pervious pavements have been maintained with street cleaners, walk behind vacuums, riding vacuums, etc. How often the pavement needs maintenance differs with the environment that it is in. Some owners have established an annual vacuuming. Others have cleaned the pervious on an as-needed basis.
- C. The General Contractor shall be responsible for making sure soil erosion (rain event, loss of silt fencing, landscaping staging errors, etc.) does not clog the pavement prior to turning the pavement over to the owner. The GC shall perform proper vacuuming/cleaning in this event.
- D. Winter Maintenance
  - 1. Snow Removal. Use proper plowing procedures, taking care to not damage the surface. Snow plow blades should be kept slightly above the pavement surface.
  - 2. Salt/Sand is generally not necessary. Salt may be required in certain ice or seasonal conditions, but should be avoided if possible since continued use will damage the pervious concrete. Sand will reduce permeability. Sanded pavements will require more routine vacuuming for maintenance.
  - 3. See NRMCA Pervious in Practice and Guide to Pervious Concrete Maintenance and Operation.

### SECTION 4 – SPECIALTY PERVIOUS CONCRETE (Decorative)

- A. Integral colored pervious concrete can be attained by adding powdered color or liquid color to the mix in the batching process in the ready mix truck or central mix unit. This process needs to be tested and adjusted for each individual job. The water/cement ratio is very low in pervious concrete already. When adding powder color to the mix, it will use up more of the water in the mix. More water may be needed in the decorative pervious mix than in pervious without color.
- B. Surface Color can be applied to pervious concrete. There are coloring agents that can be applied to the surface. Color can then be sprayed on the surface in the curing stage and reapplied as needed for color intensity or maintenance.
- C. Stamping pervious concrete can be done with metal/hard stamping tools. Stamping shall be performed on top of 2-mil plastic sheeting applied immediately after strikeoff. Work quickly and apply the 6-mil plastic sheeting to the stamped surface as soon as possible.

## **SECTION 5 Pre-Construction Conference Checklist & Pre-Paving Checklist**

### **Pre-Construction Conference Checklist**

The pre-construction conference check list is to be used as a guide during the pre-construction conference. It is modified from the NRMCA's pre-construction conference checklist.

### **Pre-Paving Checklist**

The pervious checklist is used to aid in organization and implementation.

Both checklists are attached to this document.

## **END OF SECTION**

*"This specifier's guide is intended solely for use by professional personnel who are competent to evaluate the significance and limitations of the information provided and who will accept responsibility for the application of this information. The Michigan Concrete Association disclaims any and all responsibility and liability for the accuracy and the application of the information contained in this publication to the full extent permitted by law."*

## Pervious Concrete Pre-Construction ✓ Checklist

✓	Submittals	<p>Contractor Certified Technician, Installer or Craftsman Certified?          Ready Mix Certified Technician?          Are Internal Curing Options being used on this job?          Weight/Density from the Test Panel?          Shop Drawing for Joints, Depth? Marked? Isolation Joints?          Access for Concrete Trucks &amp; Conveyor Truck? Any Site Restrictions?          Testing Lab Field Technician Pervious Certified?          Which tests will be performed? How often? Test Samples?          Erosion Control Plan?</p>
	Site Work	<p>Subgrade Thickness, Cut or Fill? Scarify or Compaction? Graded?          Additional Drainage?          Subbase Thickness?          Soak Base Prior to Pervious Placement?          Onsite Water Source?          Forms? Grade?          Block Outs?          Erosion Control Implemented?</p>
	Weather	<p>Weather Forecast?          Temperature Day of Placement? &lt; 90 degrees? or &gt; 40 degrees?          Temperatures for 7 days After Placement?          Wind in Excess of 15 mph?          Humidity?          Curing Materials? Sprayers? Poly Sheeting being used? Pre-Rolled?          Curing Procedures? Timing?          Poly Sheeting Pre-rolled on tubes?          Plenty of Anchors on Hand to Secure Poly?          Authority to Cancel and Reschedule Based on Weather/Temperature?</p>
	Pre-Placement Confirmation	<p>Pervious Concrete Mix Design Approved?          Test Panel Placement &amp; Approval, What is the Field Established Density?          Joint Layout Approved (if used)? Joints Pre-Marked?          All Equipment &amp; Tools on Hand? Water Source?          Proper Size Crew for the Job?          Conveyor Belt or Other Placement Type Required, Ordered, Fit on Site?          Block Outs for Drainage or Other Structures in Pavement?          Isolation joints at manholes, sign post, light posts, etc.</p>
	Post-Placement	<p>Plastic Sheeting Monitored for 7 Days          Apply Lithium Silicate Sealer</p>
	Notes from meeting:	

# Pervious Concrete Construction Checklist

1. Use a Pervious Certified Technician, Installer or Craftsman Contractor and a Pervious Certified Technician Ready Mix Producer, Field Tester, & Inspector.
2. Approved Mix Design meeting the Specification
3. Excavation deep enough to accommodate the designed depth of the Pervious Concrete System (the pervious layer and the base layer).
4. Geotextile filter fabric placed up the sides and over the base of the excavated area.
5. Stable clean rock base (< 1.5 inches) on top of the filter fabric to designed depth.
6. Durable rock, (1/4" to 3/8") for the pervious concrete component, > 2.5 sp. gr., < 2.5 absorption.
7. Maximum 7% sand in the concrete matrix and fibers in the mix.
8. ASTM C1688 performed with every new truck  $\pm 3$  lbs from the Test Panel density.
9. Placed with a roller screed (roller filled with water or sand for weight)/or approved technique.
10. Joints are not recommended. If joints are used, pre-mark the locations.
11. Cure 5-10 minutes behind the screed. Spray on cure from both side of the pavement
12. Cover with poly sheeting & securely anchored at sides and where necessary, as to not blow off in the wind or billow.
13. Pre-roll poly on tubes to roll over freshly placed pervious for efficiency and timing.
14. Cross-roll after screed (and over poly sheeting) for further consolidation and smoothing out ruts potentially left by screed.
15. Cure for a minimum of 7 days. Plastic sheeting secured and monitored during the curing period.
16. Forms and plastic sheeting removed after 7 days.
17. Lithium silicate densifier applied after 7 days.
18. Backfill as needed next to concrete, being very careful to not contaminate pervious concrete with the soils.
19. Erosion control plan in place to protect the pavement until landscaping is ESTABLISHED.
20. Provide maintenance information to the owner.
21. ASTM C1754 and ASTM C1701 performed, 3 for every 8,000 sf