Pervious Concrete Specifications: Technology, Testing, and Trends

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Overview

1. Technology
2. Testing
3. Trends
Technology

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Mix Proportioning by ACI 522R-10

- Maximize w/c to...
- Maximize Workability to...
- Maximize Field Density to...
- Maximize Strength and...
- Surface Durability

- Specs Should Not Include:
  - Minimum Cementitious
  - Maximum w/c
  - Aggregate Weights
  - Aggregate Volumes
  - Fly Ash Replacement Factors
Admixture Technology

- The End of Meatball Mixes
- Faster Discharge Time
- Fewer Rejected Loads
- Improved Crew Efficiency
- More Consistent Quality
- Broader Water Tolerance
Construction Technology

- New and Innovative Equipment
- Higher Efficiency
- More Consistent Surface, Smoothness, Quality
Coming Soon: Heavy Duty Roads

- MNRoad Research
- Other State DOT's (CA, FL, MD, GA...)
- Cities/Counties
- Market Demand
Current Test Methods

- ASTM C 1688 -08 Standard Test Method for Density and Void Content of Freshly Mixed Pervious Concrete
- C1701 -09 Standard Test Method for Infiltration Rate of In Place Pervious Concrete
- Fresh Density by ASTM C 29 (with 2 Lifts)
- Hardened Density by ASTM C 140 (Paragraph 9.3)
- Thickness by ASTM C 42
Fresh Density Test

- Density and Voids by ASTM C 1688
  - 2 Lifts, 20 Blows Proctor Hammer
  - Modification with 5 blows/lift of Marshall Hammer – Maybe b) method?
Surface Infiltration Rate

- C 1701
- "This test method covers the determination of the field water infiltration rate of in place pervious concrete."
- "Tests performed at the same location across a span of years may be used to detect a reduction of infiltration rate of the pervious concrete, thereby identifying the need for remediation."
- NOT intended for construction acceptance
Pulling Cores

- Issues with C 42 on Measuring Thickness

ASTM C 174: With cores from pavements placed over open-graded aggregate bases the foregoing provisions frequently cannot be met because of the great number of projections or voids on the bottom surface.
Pavement Thickness
The Missing Test Methods

- Consistency (Slump)
- Air Entrainment
- Field Strength (Cores)

- Academic Research Topics
The Coming Test Methods

- **ASTM C09.49 Tests in Development:**
  - Surface Durability (Raveling Resistance)
  - Hardened Density and Porosity
  - Compressive Strength
  - Flexural Strength
Fresh/Hardened Tests

- **Surface Durability by ASTM Draft Method**
  - Weighed Specimen
  - Count Marshall Hammer Drops to 4” Specimen Height
  - 7-Day Cure
  - 500 Revolutions in LAR/3 Specimens
Flexural Strength

- Needed for Heavy Pavement Design
- Probably Used for Lab Mix Qualification Only
- Needs to Be Easy, Cheap, Low COV
Trends
New Permitting Rules

- Stormwater Management
  - Quality/quantity credit
  - Aquatic Resource (Channel) Protection
  - Flood Protection
- Credit for pervious area (ISR)
- ‘Big Box’ ordinances
- Wetland rules
- Tree ordinances
Coastal Stormwater Supplement to the GSMM

Credits

- Stormwater Management “Credits”

  The Center for Watershed Protection (Hirschman et al., 2008) recently documented the ability of permeable pavement systems to reduce annual stormwater runoff volumes and pollutant loads on development sites.
CSS Permeable Pavement “Credits”

- **Stormwater Runoff Reduction:** Subtract 100% of the storage volume provided by a non-underdrained permeable pavement system from the runoff reduction volume ($RR_v$) conveyed through the system. Subtract 50% of the storage volume provided by an underdrained permeable pavement system from the runoff reduction volume ($RR_v$) conveyed through the system.

- **Water Quality Protection:** Subtract 100% of the storage volume provided by a non-underdrained permeable pavement system from the runoff reduction volume ($RR_v$) conveyed through the system. Subtract 50% of the storage volume provided by an underdrained permeable pavement system from the runoff reduction volume ($RR_v$) conveyed through the system.

- **Aquatic Resource Protection:** Proportionally adjust the post-development runoff curve number (CN) to account for the runoff reduction provided by a permeable pavement system when calculating the aquatic resource protection volume ($ARP_v$) on a development site.

- **Overbank Flood Protection:** Proportionally adjust the post-development runoff curve number (CN) to account for the runoff reduction provided by a permeable pavement system when calculating the overbank peak discharge ($Q_{p25}$) on a development site.

- **Extreme Flood Protection:** Proportionally adjust the post-development runoff curve number (CN) to account for the runoff reduction provided by a permeable pavement system when calculating the extreme peak discharge ($Q_{p100}$) on a development site.
Source: Center for Watershed Protection
Specification Update

- Updated Feb. 2010
- As Errata
- C 138/C29 is Out
- C 1688 is In
Novel Spec Language

- Maryland SHA
- US ACOE
- GA DOT
- Others
Maryland SHA Draft

- **CONSTRUCTION.** Construction of the PP shall not begin until all contributing drainage areas are stabilized as shown on the plans and to the satisfaction of the Engineer. The PP area shall not be used as sediment control facilities, nor constructed in areas previously used for erosion and sediment control.

- **Excavators and backhoes,** operating on the ground adjacent to the PP area, shall be used for excavation when possible. Otherwise, excavators, backhoes and other equipment shall be wide-track or marsh-track for use within the PP area. The use of light equipment with turf tires operating within the perimeter is also acceptable. **The use of equipment with narrow tracks or narrow tires, rubber tires with large lugs, or high pressure tires is prohibited.**
Maryland SHA Draft – cont’d

- **Sand Layer.** After the rotor tilling is complete and the PP area is leveled out, place a layer of PCC sand as shown on the plans and as directed by the Engineer. Level out the sand layer and of equal depth in all areas. The method of placement shall not incur undue compaction of the rotor-tilled soil.

- **The area shall be protected from water runoff at all times until construction is complete.**
US UFGS Draft

- The paving equipment shall be operated to produce a thoroughly consolidated slab throughout, true to line and grade within specified tolerances. The paver-finishing operation shall produce a surface finish free of irregularities, tears, and any other discontinuities.

- When using a static roller for consolidation, roller must be stiffened to prevent flexing and warping, straightness tolerance shall be 1/4 inch in 10 feet.
US UFGS Draft

- Protect concrete adequately from injurious action by sun, rain, flowing water, [frost,] mechanical injury, tire marks and oil stains, and do not allow it to dry out from the time it is placed until the expiration of the minimum curing periods specified herein.

- In accordance with the Waste Management Plan, protect excess material from contamination and return to manufacturer, or reuse on-site for walkways, patching, ditch beds...
GA DOT

- The Contractor placing the pervious concrete shall employ no less than one National Ready Mixed Concrete Association (NRMCA) certified pervious concrete craftsman or certified pervious concrete installer who must be on site, overseeing each placement crew during all concrete placement.

- Do not allow foot traffic on the fresh concrete.

- Protect the unhardened concrete from rain.
Others

- **Permeability**: Subgrade shall have a minimum permeability of 1.5 inches per hour determined in accordance with ASTM D3385. Subgrade permeability testing shall be performed for each 20,000 sq. ft. of pervious concrete pavement area. Test results shall be provided to the Engineer for approval prior to placement of forms or any subgrade covering.

- **Embedded single-ring infiltrometers** shall be installed for every 20,000 sq. ft. of pervious concrete pavement area. Infiltrometers shall be placed within the pervious concrete section during the construction phase and shall extend to a depth of 8 inches into the prepared subgrade. Infiltrometers shall be used for the testing of infiltration rates of the completed pavement section.

- **Discharge shall be a continuous operations...** If consolidation occurs during discharge, placement shall be halted and wet concrete removed.

- **Provide test cores, 4 inches in diameter for testing from locations as directed.**
Summary

- **Technology:** Chemical advances are allowing development of mix and placement technologies to rapidly advance.
- **Testing:** New and developing ASTM standards will expand the research base and market for pervious concrete.
- **Trends:** Good spec language is coming from the community outside of the concrete industry.
For Further Reading…

- [www.perviousblog.com](http://www.perviousblog.com)
- ACI 522R-10
- ACI 522.1-08
- NRMCA
Thank You!

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