Introduction to Durability and In-Place Infiltration of Pervious Concrete

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What is Pervious Concrete?

- NRMCA defines it.....
- www.perviouspavement.org
Pervious Concrete

From ACI 522R-10
Report on Pervious Concrete:

concrete, pervious—hydraulic cement concrete proportioned with sufficient interconnected voids that result in a highly permeable material, allowing water to readily pass.
What is Pervious Concrete?

A Concrete producer defines it as:
- No-Fines Mix
- Low water/cement Ratio
- Delivery and Placement

A Design Professional defines it:
- Intended for use as an open-graded drainage material
- Capable of handling a given traffic load
- Beneficial to the environment
What is Pervious Concrete?

- Because of the absence of sand, the void space is between 10% and 25%
- 100-120 lbs/ft³ unit weight
- Air void structure and unit weight are used as acceptance criteria

“it looks a bit like a rice cake”
What is Pervious Concrete?

Pervious concrete is not a proprietary product; it is a "recipe" for concrete that can be made to order by any concrete batch plant. Pervious concrete is installed without rebar; the thickness is minimum 6 inches for most parking lot applications.
Applications

...Recreation and Parks Pathways

- Parking Lots
- Driveways
- Critical Sites
- Erosion Control
- Greenhouse or Nursery
- Any new development

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MAINTENANCE REQUIREMENTS:

NOTES:
(1) UNDERDRAINS TO BE SPACED EVERY 10' ON CENTER.
(2) DESIGN OF PERVIOUS PAVEMENT BASED ON GEOTECHNICAL REPORT SUBBASE INDICATION FOR CBR DESIGN RANGE OF 5-7.
(3) FINAL DESIGN OF PERVIOUS CONCRETE & SUBBASE DEPTH SUBJECT TO REVIEW OF GEOTECHNICAL ENGINEER.
WHEREVER HEREON THE TERM "THOROUGHLY COMPACTED" IS USED IT SHALL BE UNDERSTOOD TO MEAN COMPACTION TO 95% DENSITY AT OPTIMUM MOISTURE CONTENT (AASHTO-T-99).

PERVIOUS CONCRETE SECTION
(SCALE: NONE)
Test Methods for Pervious Concrete

- **Plastic Tests**
  - ASTM C1688 Density and Void Content

- **Hardened Sample Tests**
  - ASTM C1754 Density and Void Content
  - *ASTM C1747 Potential Resistance to Degradation*

- **In-situ Tests**
  - *ASTM C1701 Infiltration Rate*
Desired In Place Properties
Abrasions Resistance

- Strong, dense surface
- Good curing
- Durable mix

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Desired In Place Properties

Durability

From ACI 522R-10

Report on Pervious Concrete:

raveling—the wearing away of the concrete surface caused by the dislodging of aggregate particles.
Standard Test Method for Determining Potential Resistance to Degradation of Pervious Concrete by Impact and Abrasion
Purpose:
Evaluate the potential resistance to degradation by impact and abrasion of pervious concrete mixtures. Allows the comparison of the relative potential resistance to raveling of pervious concrete mixtures of varying proportions and raw materials.

Note: Test method not for cores
Apparatus

- Balance
- Marshall hammer
- 4x8 cylinder mold
- LA Abrasion machine
- 1” Sieve
- Ruler
Procedure – Molding Cylinders

- Get C1688 density
- Calculate mass needed to fill 4x8 mold halfway
- Weigh out calculated mass in mold
- Drop mold 10 times on level, rigid surface from a height of 1”
Use Marshall Hammer to consolidate sample to 4” height
Cap to prevent moisture loss
Prepare 3 specimens
Procedure – Curing Cylinders

- Initial curing similar to C31
- Cure at 70-77°F until cylinders are 7 days old
Test Procedure

- Remove molds
- Weigh 3 cylinders
- Place 3 cylinders together in LA Abrasion machine with no charges for 500 revolutions
- Hand sieve on 1” sieve
- Weigh material retained on 1” sieve
ASTM C1747/C1747M-13

Calculate

- Divide the mass loss by the original mass of the three cylinders and multiply by 100.
- Record the mass loss as a percentage of the original mass.
Percolation (Infiltration) Rate

From ACI 522R-10 Report on Pervious Concrete: percolation rate—the rate, usually expressed as inches per hour or inches per day, at which water moves through pervious concrete.
ASTM C1701/C1701M – 09

Standard Test Method for Infiltration Rate of In Place Pervious Concrete
Purpose:
Determination of the field water infiltration rate of in place pervious concrete (surface)

Restrictions:
Does not determine if bottom of pervious concrete is clogged, and does not determine infiltration of underlying drainage layer and soil
Apparatus

- Infiltration ring - 12±½” diameter
- Balance
- Container – 5 gallons
- Stop Watch
- Plumbers Putty
- Water
Apparatus

FIG. 1 Dimensions of Infiltration Ring

≥ 50 mm [2.0 in.]

300 mm +/- 10 mm [12.0 in. +/- 0.5 in.]
Test Locations

- 3 tests for up to 25,000 sf
- Additional tests each 10,000 sf
- Minimum 3’ between test locations
- Don’t test if standing water on surface
- Don’t test within 24 hours of precipitation
Infiltration Ring Installation

- Clean surface by brooming
- Apply plumbers putty on bottom of ring
- Place ring on pervious concrete surface
- Press putty into surface and around ring edge, use more putty if needed
Prewetting

- Pour 8 lbs. of water into ring
- Maintain a head of ½” inside of ring
- Determine time from start until no free water is on surface
- Determine water quantity for test
  - 40 lbs. if time is less than 30 seconds
  - 8 lbs. if time is 30 seconds or more

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Test

- Start within 2 minutes of prewetting
- Record the weight of water to be used
- Pour water into ring
- Maintain a head of ½” inside of ring
- Determine time from start until no free water is on surface
Calculate

\[ I = \frac{KM}{D^2 \times t} \text{ in/h} \]

\[ K = 126,870 \text{ (in.}^3 \text{s)/(lbh)} \]
### Test locations

<table>
<thead>
<tr>
<th>Test locations</th>
<th>Date</th>
<th>Age of Pervious Concrete</th>
<th>Prewetting time</th>
<th>Amount of last rain</th>
<th>Weight of water used for test</th>
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Report

- Inside diameter of ring
- Time elapsed during test
- Infiltration rate
- Note retests if any
ACI 522R-10

Single-ring infiltrometer

Fig. 9.1—Single-ring infiltrometer (1 in. = 25.4 mm).
Other Tests

Subgrade Infiltration Testing (note: a rate less than 0.52 in/hr acceptable for pervious) - Double Ring Infiltrometer, ASTM D 3385
Other Tests

- ASTM D3665, random core location
- ASTM C42, Coring, 3 cores/5,000 sf
- ASTM C174, Core Thickness, \(-\frac{1}{2}\)\,”, \(+1\frac{1}{2}\)”
Frequently Asked Questions

- What if oil spills on the concrete?
  - Oil is actually contained in the pervious system. Microrganisms actually feed on it and they are biodegraded with time.

- Can pervious become clogged? How do you fix it?
  - Pervious can be clogged by runoff from adjoining areas that contains fines. Routine sweeping and vacuuming can restore the porosity.
Is pervious susceptible to freeze thaw environments?

- If pervious is placed on sufficient stone, in Virginia enough to manage the 10 yr storm event, the concrete will be protected from ice formation. Furthermore, the cement paste can be air entrained.