Introduction to Durability and In-Place Infiltration of Pervious Concrete

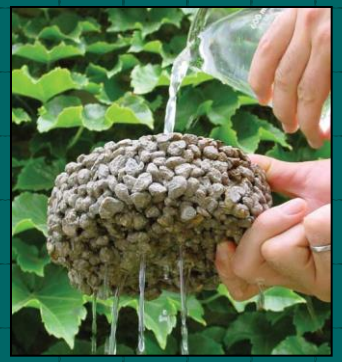
Charles Mitchell, P.E.

SPECIALIZED ENGINEERING
Engineers • Geologists • Inspectors

cmitchell@specializedengineering.com

What is Pervious Concrete?

- NRMCA defines it…..
- www.perviouspavement.org



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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/ft^3 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?

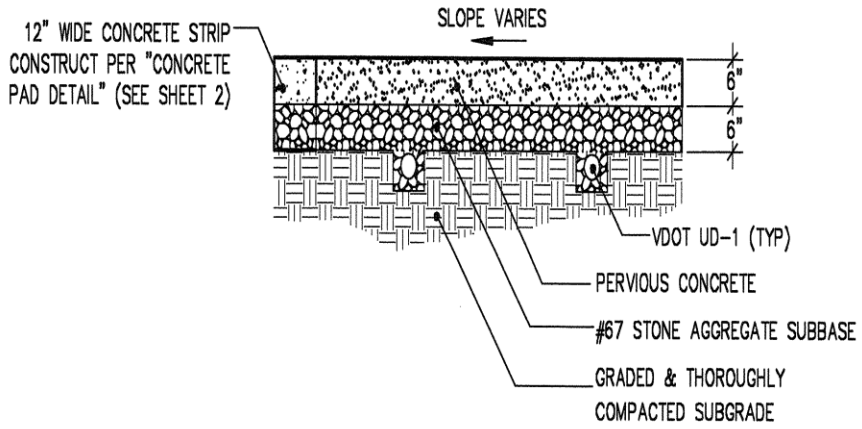
- Pervious concrete is not a proprietary product; it is a "recipe" for concrete that can be made to order by any concrete batch plant. Pervious concrete is installed without rebar; the thickness is minimum 6 inches for most parking lot applications.

Applications

...Recreation and Parks Pathways

Green house or Nursery...

Brambleton Public Safety Center Pervious Concrete Design Section



MAINTENANCE REQUIREMENTS:

MAINTENANCE OF THE DUAL-USE SYSTEM IS THE OWNER'S RESPONSIBILITY. THE PERIVOUS CONCRETE PAVEMENT SHOULD BE CHECKED PERIODICALLY FOR BUILDUP OF TRASH AND DEBRIS. TRASH AND DEBRIS SHOULD BE REMOVED FROM THE PAVEMENT BY HARD-VACUUM SYSTEMS AS REQUIRED. AT LEAST ONCE EVERY YEAR, THE PAVEMENT SHOULD BE PRESSURE-WASHED WITH THE RESIDUE BEING REMOVED BY WET-VACUUMING (SIMILIAR TO STEAM-CLEANING A CARPET).

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 (AASTHO-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
Abrasion Resistance

- Strong, dense surface
- Good curing
- Durable mix

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.

ASTM C1747/C1747M-13

Standard Test Method for Determining Potential Resistance to Degradation of Pervious Concrete by Impact and Abrasion

ASTM C1747/C1747M-13

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

ASTM C1747/C1747M-13

Apparatus

- Balance
- Marshall hammer
- 4x8 cylinder mold
- LA Abrasion machine
- 1” Sieve
- Ruler

ASTM C1747/C1747M-13

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”

ASTM C1747/C1747M-13

Procedure – Molding Cylinders (cont.)

- Use Marshall Hammer to consolidate sample to 4” height
- Cap to prevent moisture loss
- Prepare 3 specimens

ASTM C1747/C1747M-13

Procedure – Curing Cylinders

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

ASTM C1747/C1747M-13

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.

Desired In Place Properties
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

ASTM C1701/C1701M – 09

- 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

ASTM C1701/C1701M – 09

Apparatus

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

ASTM C1701/C1701M – 09

Apparatus

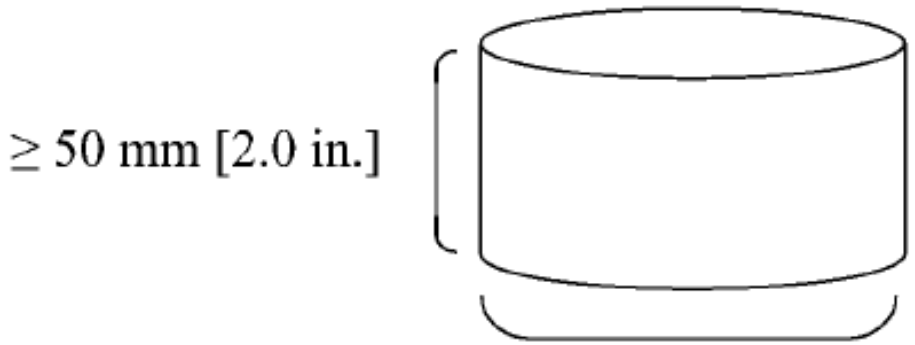


FIG. 1 Dimensions of Infiltration Ring

ASTM C1701/C1701M – 09

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

ASTM C1701/C1701M – 09

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

ASTM C1701/C1701M – 09

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

ASTM C1701/C1701M – 09

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

ASTM C1701/C1701M – 09

Calculate

- $I = \frac{KM}{D^2 * t}$ in/h

- K = 126,870 (in.^{3}s)/(lbh)

ASTM C1701/C1701M – 09

Report

- Test locations
- Date
- Age of Pervious Concrete
- Prewetting time
- Amount of last rain
- Weight of water used for test

ASTM C1701/C1701M – 09

Report

- Inside diameter of ring
- Time elapsed during test
- Infiltration rate
- Note retests if any

ACI 522R-10

Single-ring infiltrometer

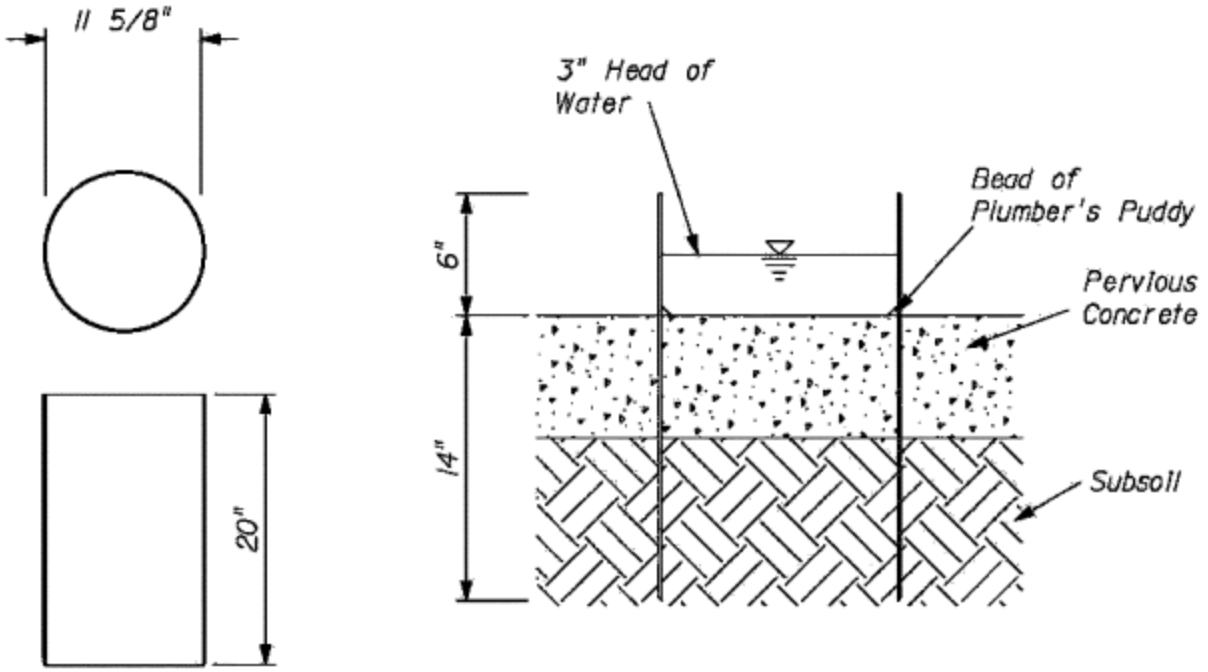


Fig. 9.1—Single-ring infiltrometer (1 in. = 25.4 mm).

Other Tests

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

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Other Tests

- ASTM D3665, random core location
- ASTM C42, Coring, 3 cores/5,000 sf
- ASTM C174, Core Thickness, -½”, +1½”

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.

Frequently Asked Questions

- 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.