UNH T² Center Technical Note

Pervious Pavements

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Pervious (a.k.a. porous) pavement is a surface material that allows the passage of water through the surface (see Figure 1). Pervious pavement includes porous asphalt and pervious concrete. A pervious pavement surface is more coarse than conventional pavement due to the pores, but it looks nearly identical to conventional pavement. Pervious pavement can be used for roads, sidewalks, or parking lots.

Figure 1: A typical cross-section of a pervious pavement.

Properties

The design of pervious pavement allows water to pass through the top of the pavement by traveling through air voids. Typical porous designs have an air void content of 15 to 35 percent. This allows reduction in stormwater runoff and the filtering out of pollutants that would otherwise have been released into the surrounding environment.

Water is stored in the pavement and subbase. A square foot of pervious pavement can drain water at a rate of three to five gallons per minute. This is equivalent of 275 to 450 inches of rainfall per hour. In addition, a six inch pavement layer with 20% voids can hold approximately one inch of water.

A material's ability to accept runoff is often measured using a Coefficient of Runoff, or C-factor. Conventional concrete and pavement have a C-factor of 1.0. This C-factor indicates they have total runoff and do not accept any water. Pervious pavements have a C-factor between 0.35 (the same as grassy areas) and 0.65 (the same as uncompacted gravel).

Pervious concrete usually weights between 100 to 120 pounds (lbs) per cubic foot (ft3). This is lighter than conventional concrete which usually weighs around 140 lbs/ft3.

Pervious concrete also has a lower compressive strength than conventional concrete. Pervious concrete typically has a compressive strength around 2000 pounds per square inch (psi) while conventional concrete has a compressive strength around 4000 psi.

Porous asphalt has proven to have strength characteristics comparable to standard asphalt pavement when properly designed and installed. Improving the strength of pervious pavement can be done by increasing the thickness of the pavement layer or introducing some fines into the mix. However, adding fines will reduce the permeability of the pavement.

Design and Specification

Porous asphalt consists of coarse aggregate that is "open-graded", or has little to no fines, and bonded with asphalt cement (see Figure 2). Using an open-graded aggregate leaves interconnected voids through which water can flow.

Pervious concrete consists of open-graded aggregates bonded with portland cement and water. Typical aggregates used for porous asphalt and pervious concrete conform to ASTM C33 #67 and #89.

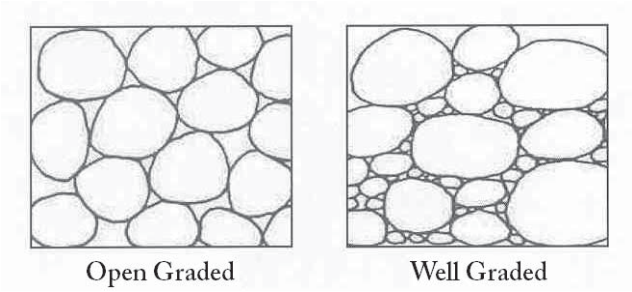

Figure 2: Open Graded. v. Well Graded aggregate

A thickness of four inches is typical for low-traffic parking lots. However, you should design the pavement thickness to meet the structural requirements of the site.

Pervious pavements require a special subbase. A stone reservoir is necessary to collect and store runoff while it drains into the soil (see Figure 3). Design the thickness of this reservoir according to the required drainage necessary for the site.

Figure 3: A stone reservoir.

Specify the stone reservoir materials to conform to AASHTO #3, AASHTO #5, or equivalent. Install a filter course of one half inch gravel both above and below the reservoir. This prevents material such as sand, salt, or pine needles from clogging the reservoir (see figure 4).

Specify filter course materials to conform to AASHTO #57 or equivalent. Also install a non-woven geotextile between the bottom filter course and the existing soil to further prevent fines from entering the subbase. The existing soil beneath the subbase should have a drainage rate of no less than 0.27 inch per hour or enough to drain the design storm event within 24 hours (whichever is greater).

Consult the *National Asphalt Pavement Association Design, Construction, and Maintenance Guide for Porous Asphalt Pavements, Information Series 131 (2003)* for more information on specification and design.

Standard Stone Size	#67	#89
Min to Max	No. 4 to 3/4 in	No. 16 to 3/8 in
Sieve Size	Percentage by Weight Passing	
2-1/2 in	---	---
2 in	---	---
1-1/2 in	---	---
1 in	100	---
3/4 in	90-100	---
1/2 in	---	100
3/8 in	20-55	90-100
No. 4	0-10	20-55
No. 8	0-5	5-30
No. 16	---	0-10
No. 50	---	0-5

Figure 4: A chart of particle size and percentage passing through.

Applications

Use pervious pavements in low traffic areas with minimal heavy vehicle traffic. Do not use pervious pavements on truck routes or in high traffic volume locations.

Prevent freeze-thaw damage with proper design and maintenance. The pavement must be fully saturated for water to freeze and create pressures that crack the pavement. If the pervious pavement is designed properly and not clogged, then it should never become fully saturated.

Typical applications of pervious pavement include:

- Driveways, low-traffic roads, fire lanes, and emergency access roads
- Parking areas, especially over-flow parking and those associated with office buildings, shopping centers and recreational facilities
- Sidewalks
- Road shoulders and vehicle cross-overs on divided highways
- Boat launching ramps
- Pool decks and patios

Design Considerations

1. **Pretreatment.** In porous pavement designs, the pavement itself acts as pretreatment to the stone reservoir below. Sweep the surface regularly to maintain a clean surface and prevent clogging. Design the landscaping and drainage around the site to prevent the flow of materials into the pavement.
2. **Flow.** Water will filter through the pavement surface, then into the stone reservoir, and then eventually into the ground. The geotextile liner and sand layer below the stone reservoir distributes the water evenly to the subsurface and maintains a flat base.

   Designs may also require a means to handle stormwater overflow to the storm drain system. If this is the case, install perforated piping just below the pavement surface to route overflow water from the reservoir to the storm drain system.
3. **Maintenance.** Create a maintenance plan that includes specific guidance on how to conduct routine maintenance, a maintenance schedule, and how to repave the surface. Identify pervious pavement areas with signs.

   Acceptable routine maintenance practices to prevent clogging include vacuum sweeping, power scrubbing, and power washing. Complete these three to four times per year. Also, inspect pervious pavement surfaces at least annually for damage.
4. **Landscaping.** For porous pavement, the most important landscaping feature is a fully stabilized upland drainage system. Reducing sediment loads on to the pavement can help prevent clogging. Mow upland vegetation and seed bare areas to stabilize soils and catch sediments.
5. **Construction.** Quality control during construction is crucial to a long pavement life. Consider air void structure and unit weight characteristics when deciding on pavement. Prevent sealing voids so water can drain through to achieve the correct surface texture. Do not use trowels, seal the surface, or leave roller marks. Compact pavement surfaces with one to two passes of a compaction roller. Do not overcompact the pavement surface. This will compress the air voids in the pavement and prevent water infiltration.

Cost Considerations

Porous pavement is initially more expensive than traditional asphalt. While traditional asphalt and concrete costs between $0.50 to $3.00 per square foot (ft2), porous pavement can range from $2 to $8 per ft2, depending on the design. However, porous pavement may eliminate or reduce the need for land intensive BMPs, such as dry extended detention

or wet retention ponds. The cost of vacuum sweeping may be prohibitive if a community does not own a vacuum sweeper. Consider site specific costs in estimates including proximity and cost of gravel supplies and site permeability.

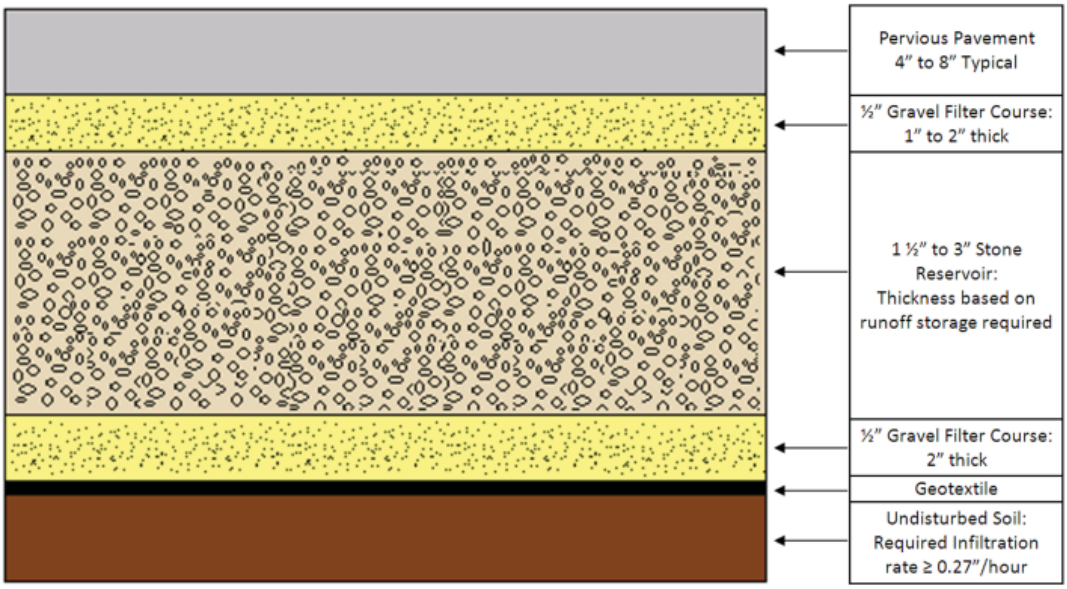

Figure 5: A cross-section illustration of typical porous pavement.

Benefits

The biggest benefit of pervious pavement is stormwater runoff collection. This meets needs for site runoff restrictions and limitations, prevents flooding, recharges groundwater, and reduces non-point source pollution.

Pervious pavement also has a role in the removal of pollutants. Removal is accomplished through absorption, filtration, and microbiological degradation. Pervious pavements have high removal efficiencies for sediments, phosphorous, nitrogen, zinc, lead and Chemical Oxygen Demand (COD).

Pervious pavements also:

- Eliminate hydroplaning
- Are considered a BMP by the EPA
- Eliminate the need for retention ponds and other stormwater management practices
- Minimize upgrades of existing systems to keep up with development
- Reduce road glare from wet surface
- Dampen tire and rain noise
- Improve traction due to a coarser surface

Disadvantages

Conduct thorough quality control inspections when pervious pavements are installed.

Disadvantages to pervious pavement include:

- Requires careful finishing and curing
- Local engineers and contractors often lack expertise for specification and installation
- High initial cost
- High rate of failure when designed or installed improperly
- Local planning commissions may still require additional stormwater management-consult your local planning commission before design
- Requires routine maintenance
- Cannot be installed on slopes
- Pervious pavements have not been found to effectively treat fuel leaks from automobiles

References

Pervious Concrete. www.perviouspavement.org. 2009. Accessed May, 2009.

Stormwater Best Management Practices in an Ultra-Urban Setting. FHWA. 2000.

Pervious Pavement. Lake Superior Streams. 2005.

Stormwater Technology Fact Sheet: Porous Pavement. EPA. 1999.

EPA Menu of BMPs: Porous Pavement. www.epa.gov. 2006. Accessed May, 2009.

Workshops are held on porous pavement by the UNH Stormwater Center: www.unh.edu/erg/cstev/porous_asphalt_workshop.html