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Porous Pavements Q&A

Answers from the man who wrote the book on the subject

Photo: Robert Ott

By Bruce Ferguson

As the use of porous pavements grows, designers and agencies all over North America are learning for the first time this new approach to stormwater management. People like me have been asked to speak to them hundreds of times in the last five years, in workshops, webinars, consulting sessions, and agency testimonies and reviews. The questions that are raised from all the diverse groups have a lot in common.

Since 2005, I have saved 230 files of porous pavement questions conveyed in e-mails, telephone calls, and conference question-and-answer sessions. This article summarizes the questions that I have received most commonly over the years. My answers to them are based on 12 years of research and experience in the field, including surveying research reports, interviews with national experts, and firsthand observations in the field. There is a huge amount of knowledge about porous pavements now, and it is continuing to grow rapidly. The questions reported here are what people most frequently say they need to know.

Q: Is there a recognized measure, or index, of permeability for paving materials?

A: Pervious concrete and permeable pavers that are properly designed, installed, and maintained have surface infiltration rates of 140+ in/hr. An example of research suggesting this is “Study on the Surface Infiltration Rate of Permeable Pavements,” accessible through the North Carolina State University Web site listed at the end of this article.

Q: What is the runoff coefficient?

A: Almost the only runoff coefficient that has ever been measured on properly built porous pavements is zero: There is no runoff, because the surface permeability is so high. But surface runoff coefficient does not take into account the limited capacity of the pavement’s base reservoir: In a long, intense storm, the base could become saturated and overflow, either across the surface or through a perforated drainage pipe if one is provided. At that point, the pavement would in effect be generating runoff. So it would be prudent to use some positive number—not zero—for the runoff coefficient. An example would be to set the runoff coefficient equal to that of the local jurisdiction’s “predevelopment” condition, which might be

forest, meadow, or grass. To assign a coefficient larger than predevelopment would be arbitrary. A predevelopment grass surface generates some runoff during large storms, so it provides a valid analogy for porous pavement hydrology.

Q: How much credit should be given for the pavement as a "pervious" surface?

A: Correctly designed, installed, and maintained pervious pavements have surface infiltration rates higher than that of almost any natural soil, and several times greater than the maximum possible rainfall intensity anywhere in the country—in other words, greater than anything that is already called "pervious." So a surface of this type must be given complete credit for "100% perviousness," as would a meadow or forest. Giving it any credit less than 100% pervious would fly in the face of scientific evidence.

Q: What is involved in maintaining the pavement "right"?

A: If you are in a municipality where sand or cinders are spread on the roads for winter traction, then vacuuming will be necessary at least once per year: in the spring, following snowmelt. The key word is vacuuming, with or without simultaneous washing, to lift material out and restore the open, permeable pores. Any washing or sweeping without simultaneous vacuuming would just drive sediment farther down into the pores. In areas where there is no sanding or other routine source of sediment, no special maintenance is needed except when something happens such as construction vehicles tracking sediment onto the surface; then the sediment can be removed by vacuuming.

Q: How long will the system last before it becomes a "non-permeable" surface?

A: Just make sure that your pavement is selected, designed, installed, and maintained correctly. If you are duly careful with all these steps, then the installation should be permeable indefinitely.

Q: Pretreatment using a filter strip or vegetated swale is required, right?

A: Absolutely not: Don't do that! Any upstream soil, even soil that is grassed or mulched, can erode and generate pavement-clogging sediment sometime. Adding a grass strip or forebay would just add more erodible upstream soil. Wherever earth drains down toward a pavement edge, a swale should be added to divert runoff and sediment away from the pavement. It is okay to drain impervious roofs or pavements directly onto a porous pavement, because those surfaces don't produce sediment the way soil does.

Q: Should porous pavement be avoided where trees are present? Should overhanging trees be removed?

A: The only thing overhanging trees do to porous pavements is deposit their annual drop of organic debris. The debris decomposes to a minute fraction of the volume it started with. Vacuuming might be called for after a number of years, to reopen the pavement's pores. Trees are immensely helpful for water resource management, counteracting the urban heat island, shading urban open spaces, and absorbing carbon, and they should not be discouraged.

Q: What is recommended when you have a large chemical spill or hazardous material spill?

A: The same as if a spill occurred anywhere else in your city: Immediate and complete cleanup is the legal responsibility of the industry that spilled it, at their expense. No pavement or drainage anywhere is designed for this contingency, outside of the grounds of the industry that produces the chemicals.

Q: What are the risks associated with hydrocarbon (oil) contamination?

A: Letting oil into a porous pavement's voids is the whole idea in water-quality improvement. In the pavement, naturally occurring microorganisms biodegrade hydrocarbons before they migrate to the bottom of the pavement. The constituents go off as carbon dioxide and water vapor, and very little else; the hydrocarbons cease to exist as water-quality pollutants. An example of the research suggesting this, accessible on several Web archives, is C. Pratt's 1999 paper, "Mineral Oil Bio-Degradation Within a Permeable Pavement: Long Term Observations."

Q: What's the use of porous pavement on a clay soil, or where there is a shallow water table, and water cannot be absorbed into or treated in the soil? Is a subdrain necessary to ensure good performance? Can a porous pavement work here?

Photo: Bruce K. Ferguson
Permeable pavers in Minnesota correctly installed with highly permeable single-sized aggregate in the joints

A: On clay soils, permeable pavements do not make the 100-year storm disappear; a perforated drainage pipe is ordinarily required to discharge excess water. But most of the water-quality benefit of any permeable pavement occurs within the pavement structure, without regard to the underlying soil; the soil is only a redundant "backup" system. Porous pavements on clay soils do:

Reduce runoff coefficient and impervious cover
Detain peak flows
Treat water quality
Recharge aquifers by gradual infiltration of rainwater from small, frequent, year-round storms

Q: What is the cost difference between standard and porous pavements in the same situation?

A: Pervious concrete costs approximately 20% more than conventional impervious concrete, because of its high cement content and specialized quality control. Permeable pavers cost about the same as pervious concrete. When you use these materials intelligently in a site plan to absorb and treat stormwater, and the municipality gives you credit for their stormwater functions, then the use of porous paving ordinarily reduces total development cost by reducing or eliminating the need for additional stormwater facilities.

Q: How does the use of pervious concrete affect the pavement life in cold climates?

A: Properly installed pervious concrete is free from freeze-thaw issues as long as the surface concrete layer drains freely down into an open-graded aggregate base, thence rapidly into the soil or a perforated drainage pipe. The material's durability is ensured by adequate strength, which comes from proper installation; further help comes from air entrainment and reinforcement with polymer fibers.

Q: Salt used for deicing... does it clog the paving?

A: Deicing salt does not clog porous pavements. The whole idea of deicing agents is that they dissolve readily in snow and water, lowering the water's thawing temperature. The dissolved salt flushes through with meltwater and does not accumulate. Ongoing research at the University of New Hampshire suggests that many porous pavements require less salting than impervious pavements, because the thawed meltwater drains so readily away through the pores.

Q: Do you use traditional trench backfill material under porous pavement, or do you use open-graded material instead?

A: The base material must be open-graded (single-sized) aggregate **such as ASTM No. 57, so it can store and convey water.**

Q: Are there standard specs (DOT type) for pervious concrete?

A: The American Concrete Institute has adopted Specification 522.1, Pervious Concrete. In addition, the National Ready Mixed Concrete Association has a specialty certification program to help identify qualified pervious concrete installers. It is vital that industry standards such as these be followed—failures have occurred where established standards have been ignored.

Q: We need options for cost, appearance, etc.

A: A material that deserves to be used more is permeable pavers, also known as open-jointed block or PICP (permeable interlocking concrete pavement). These are manufactured units with openings in the joints where single-sized aggregate gives the pavement its permeability. Pavers manufactured to ASTM standards (as almost all of them are) are extremely

Photo: Bruce K. Ferguson
A vital step in correctly installing pervious concrete is covering it quickly with plastic sheets and keeping it covered for seven days.

strong and durable units. It is rather easy to install them correctly—just stick to the long-established guidelines of the Interlocking Concrete Pavement Institute. This is not the same construction as bricks on sand! Firmly specify that only single-sized aggregate must be used for the base, setting bed, and joint fill.

Q: For what parts of the country are porous pavement available, in terms of freeze-thaw, etc.? What site conditions, such as soil type, limit its use?

A: Properly selected, designed, constructed, and maintained porous pavements work wherever they are located. Improperly selected, designed, constructed, and maintained ones do not.

Q: How widespread is this usage? How much (and how rapidly) is it changing? What is the future for widespread adoption?

A: Porous pavements are still a small proportion of all the paving being done in the world, but they are growing at an exponential rate. Developers and suppliers are ready to install these new materials; their motivation is to meet today's environmental requirements in economical ways. The potential future application of porous paving is vast.

Q: What can my municipality do to encourage the use of porous pavements?

A: Make sure your municipality is not an unnecessary impediment. When a developer proposes porous paving, give it credit for what it can do to satisfy your stormwater requirements: It reduces impervious cover; lowers the runoff coefficient; and absorbs, detains, and treats stormwater.

Q: Where might I find research reports? I need data.

A: Watch Web sites such as the following for broad new information, links to detailed sources, and continuing updates:

Concrete Pavement Technology Center: www.cptechcenter.org (search for "pervious")
Interlocking Concrete Pavement Institute: www.icpi.org
PCA Southeast: www.secement.org/pervious_concrete.htm
Pervious Concrete: www.perviouspavement.org
North Carolina State University: www.bae.ncsu.edu/info/permeable-pavement
University of New Hampshire: www.unh.edu/erg/cstev
Many additional Web sites run by proprietary suppliers
Topics: Low-impact development,Pollutants,BMP Post Construction