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by Milan Lipensky



Permeable Pavements Taking Industry by 'Storm'

These porous pavements can reduce the need for expensive stormwater drainage and wet pond retention systems and excavation.

Porous asphalt and pervious concrete are hot topics in the construction industry right now. Both are stormwater drainage systems that, if designed and installed properly, will reduce stormwater runoff while also gaining environmental and economical benefits.

When permeable pavements are used for parking areas, streets, plazas, and walkways, they minimize stormwater runoff to surrounding streams and lakes and allow for natural filtration to recharge local groundwater supplies. Permeable pavements reduce the need for expensive stormwater drainage and wet pond retention systems and excavation, thereby allowing for more economical and beneficial land use.

Permeable pavement and the aggregate industry

Permeable pavement designs use a very deep sub-base of crushed aggregate uniformly graded with about 40 percent void space for stormwater storage and recharge. The sub-base design depth depends on the soil. Silty clay soil is slow to drain so a deeper base might be needed; sandy loam will drain more quickly and require less depth. Permeability of soils should be verified. A percolation rate of 0.5 inch per hour and a soil layer of 4 feet or more are generally recommended. The average sub-base is about 2

feet deep, with some as deep as 4 feet to handle the stormwater. This is a significant increase in aggregate usage-per-square-foot versus sub-base under traditional impervious materials.

"There are hundreds of systems out there, and we are getting calls every week asking if a permeable pavement system is the answer to a particular application," points out Dan Wible, P.E., a water resource engineer at Cahill Associates, which designs porous asphalt pavements.

Phil Kresge national resource senior director, Mid-Atlantic for the National Ready Mixed Concrete Association (NRMCA), which promotes pervious concrete and tracks projects, says there are more than 250 projects listed with 60 percent of them in the Southeast, the majority of which are in North Carolina. Twenty percent are in California, with the remainder spread across the Northeast in Pennsylvania, Ohio, Vermont, and Minnesota.

As the need and popularity of these stormwater systems increases, so will the need for more aggregate to make them functional, Kresge notes.

What in the world is permeable pavement?

Porous asphalt and pervious concrete are engineered with a 15- to 30-percent void system that allows rainwater to percolate through it. Essentially,

Photos courtesy of Permso Supply



this is achieved by reducing or eliminating the “fines” or fine aggregate in the mix. The fines are replaced with more coarse aggregate to make up the cubic yard in the case of pervious concrete or the ton as porous asphalt is sold. This reduction in fines creates voids that are made from the coarse aggregate bridging each other and creating air voids. Permeable pavements can drain at a rate of 3 to 5 gallons-per-minute per square foot.

The most common aggregate gradation for both asphalt and concrete applications is an AASHTO No. 8. Crushed and cubical are preferred more than gravel for functionality and aesthetic value, although gravel has been used with success.

Pervious concrete normally requires a sub-base or reservoir of No. 57 stone, while porous asphalt calls for an AASHTO No. 1 to AASHTO No. 5, with AASHTO No. 3 most commonly specified. Both sub-base’s are frequently placed on top of a geotextile fabric. Remember, the depth of the stone will vary according to the hydrologic conditions of the soil. Poorly draining soils will require deeper stone beds and/or underground stormwater chambers, dependent on the soil’s infiltration rate and the size of the maximum storm for which the system is being designed. Normally, the minimum depth for this reservoir course is shown as 8 or 9 inches, but more commonly the average depth is 24 inches. There is a “top filter course” or “choker course” made up of AASHTO No. 57, AASHTO No. 8, or similar that is placed on top of the “reservoir” course at a depth of 1 to 3 inches.

In addition to providing some filtration, it stabilizes the surface to accept the permeable product without movement or rolling during the application. The preferred particle shape for sub-base is crushed aggregate to ensure interlock and a stable base.

Why use permeable pavement stormwater systems?

There are substantial environmental benefits, says Greg Yoko from Dubuque, Iowa-based Land Development Break Throughs, a company that specializes in workshops and conferences for the land development industry.

“Recent interest in green building and recognition of pervious pavements by the U.S. Environmental Protection Agency (EPA) as a best practice for stormwater management has heightened interest in its use throughout North America,” Yoko says.

The U.S. Green Building Council’s Leadership in Energy and Environmental Design (LEED) Rating





A Pennsy Supply employee rolls over permeable concrete to create a smooth surface.

System is the standard for determining a building's degree of sustainability. At least two credits toward a LEED certification can be attained by using a permeable pavement stormwater system — one credit for managing rate and quantity of stormwater and another for managing water quality, Wible says. Both are achievable if they are designed and installed properly. There are many other credits available depending if concrete or asphalt surface is chosen including rainwater collected and used onsite, innovation in design, heat island reduction, and others. If a building or property receives enough credits, it is LEED-certified as a sustainable property, which is very attractive when property owners plan to sell or lease a building. Indirectly, this could lead to more properties using the pervious concrete in place of other materials.

Importance of water quality

Water quality is very important. The National Pollutant Discharge Elimination System (NPDES) requirements mandate criteria for a stormwater runoff quality. As mentioned earlier, the silty clay soil may drain slowly, but is better at filtering the water. The sandy loam soil drains quickly, but it is less effective at filtering out dissolved solids. The stormwater that percolates through the system will undergo natural filtering and purification so that the water reaching the groundwater table is close to the same quality as runoff soaking directly into the surface as long as the infiltrating runoff contains only the common, mostly biodegradable, materials. The purpose of naturally treating the water is to prevent pollutants from entering streams, lakes, rivers, or groundwater supplies. Some pollutant sources for parking lots include litter, spills, fertilizers, pesticides, and vehicle pollutants, such as greases and oils.

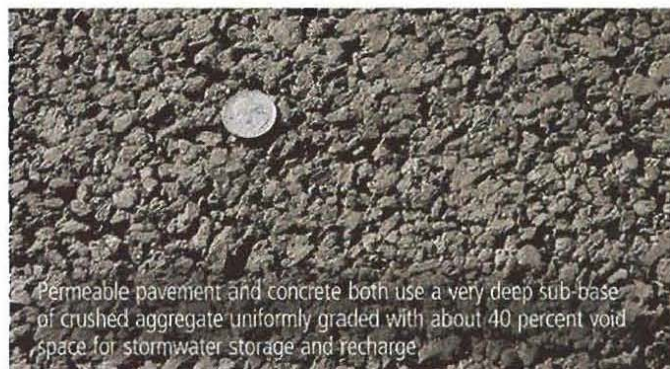
A study on water quality is currently being conducted on porous asphalt and pervious concrete pavements right now at Villanova University, located outside Philadelphia. "It's just a matter of waiting for Mother Nature to cooperate," Kresge says. The project consists of side-by-side, 1,500-square-foot pavement sections divided by a concrete barrier with a waterproof membrane. The RMC Research & Education Foundation in partnership with Villanova University, the U.S. Environmental Protection Agency, and Prince George's County, Md., is funding the study.

Patrick Jeffers, a Villanova graduate student participating in the study, says the next step is to wait for rain. The pavements must receive a minimum 1/4-inch rainfall to flush the system and calibrate the equipment. Following that, data can be gathered with each rainfall of at least 1/4 inch. The three-year study of water quantity and quality will focus on adjacent pervious concrete and porous asphalt surfaces and will measure both systems' efficacy in treating polycyclic aromatic hydrocarbons (PAH), phosphorous, nitrogen, metals, total suspended solids (TSS), total dissolved solids (TSD), PH, and conductivity. Additionally, first flush samplers will be used to evaluate any runoff from both pavements.

For more information on pervious concrete or porous asphalt pavements systems, see the following publications:

- **Porous Asphalt Pavements** — National Asphalt Pavement Association. Information Series 131.
- **Pervious Concrete** — National Ready Mixed Concrete Association NRMCA/American Concrete Association ACI pub. ACI 522R-06 Pervious Concrete. **AM**

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Permeable pavement and concrete both use a very deep sub-base of crushed aggregate uniformly graded with about 40 percent void space for stormwater storage and recharge.