PoP

Porous Pavement

Description

Porous pavement is a permeable pavement surface, often built with an underlying stone reservoir that temporarily stores surface runoff before it infiltrates into the subsoil. Porous pavement replaces traditional pavement, allowing parking lot stormwater to infiltrate directly and receive water quality treatment. There are various types of porous surfaces, including porous asphalt, pervious concrete, and even grass or permeable pavers. From the surface, porous asphalt and pervious concrete appear to be the same as traditional pavement. However, unlike traditional pavement, porous pavement contains little or no "fine" materials. Instead, it contains voids that encourage infiltration. Porous asphalt pavement consists of an open-graded coarse aggregate, bonded together by asphalt cement, with sufficient interconnected voids to make it highly permeable to water. Pervious concrete typically consists of specially formulated mixtures of Portland cement, uniform, open-graded coarse aggregate, and water. Pervious concrete has enough void space to allow rapid percolation of liquids through the pavement. Grass or permeable pavers are interlocking concrete blocks or synthetic fibrous grids with open areas that allow grass to grow within the voids. Some grid systems fill the voids with sand or gravel instead of grass to allow infiltration. While porous pavement can be a highly effective treatment practice, maintenance and proper installation are necessary to ensure its long-term effectiveness.

Like all BMPs, porous pavement should be combined with other practices to capitalize on each technology's benefits and to allow protection in case of BMP failure. However, construction using pervious materials may not require as much treatment as other BMP approaches. For instance, a small facility using porous pavement may only need several bioretention basins or a grass swale, rather than a full dry detention basin. This combined approach might prove less land intensive and more cost effective. It may increase the amount of open space for public or tenant use. It may also lead to an increase in environmental benefits.

Selection Criteria

Medium traffic areas are the ideal application for porous pavement. It may also have some application on highways, where it is currently used to reduce hydroplaning. In some areas, such as truck loading docks and areas of high commercial traffic, porous pavement may be inappropriate.

Stormwater Retrofit

A stormwater retrofit is a stormwater management practice (usually structural) installed post development to improve water quality, protect downstream channels, reduce flooding, or to meet other specific objectives. The best retrofit application for porous pavement is parking lot replacement on individual sites. If many impervious lots are replaced with pervious concrete, pavers, or porous asphalt, then overall stormwater peak flows can be reduced.

Additional Benefits

Porous pavement can help lower high water temperatures commonly associated with impervious surfaces. Stormwater pools on the surface of conventional pavement, where it is heated by the sun and the hot pavement surface. By rapidly infiltrating rainfall, porous pavement reduces stormwater's exposure to sun and heat.

Design Considerations

Siting Considerations

Soils need to have a permeability of at least 0.5 inches per hour. An acceptable alternative design for soils with low porosity would be the installation of a discharge pipe from a storage area to the traditional storm sewer system. The modified design allows the treatment of stormwater from small to medium stormwater events while allowing a bypass for large events, which will help prevent flooding.

The bottom of the stone reservoir should be flat, so that runoff can infiltrate through the entire surface.

If porous pavement is used near an industrial site or similar area, the pavement should be sited at least 2 to 5 feet above the seasonally high ground water table and at least 100 feet away from drinking water wells.

Porous pavement should be sited on low to medium traffic areas, such as residential roads and parking lots.

Design Considerations

Some basic features should be incorporated into all porous pavement practices. These design features can be divided into five basic categories: pretreatment, treatment, conveyance, maintenance reduction, and landscaping.

1. *Pretreatment*. In porous pavement designs, the porous pavement material with voids acts as the pretreatment process to the stone reservoir below. Because of this, frequent maintenance of the surface, such as sweeping, is critical to prevent clogging. A layer of fine gravel can be laid atop the coarse gravel treatment reservoir as an additional pretreatment item. Both of these pretreatment measures are marginal.

2. *Treatment*. If used, the stone reservoir below the pavement surface should be composed of layers of small stone laid directly below the pavement surface. The stone bed below the permeable surface should be sized to attenuate storm flows for the storm event to be treated. Typically, porous pavement is sized to treat a small event, such as a water quality storm – 1^{st} flush (1^{st} ¾ of an inch rainfall) volume (i.e., the storm that will be treated for pollutant removal). Water can temporary be detained in the voids of the stone reservoir.

3. *Conveyance*. Water conveyed to the stone reservoir though the pavement surface infiltrates into the ground below. A geosynthetic liner and a sand layer may be placed below the stone reservoir to prevent preferential flow paths and to maintain a flat bottom. Designs also need a means to convey larger amounts of stormwater to the storm drain system. Storm drain inlets set slightly above the pavement surface is one option. This allows for some ponding above the surface, but bypasses flows too large to be treated by the system or when the surface clogs.

4. *Maintenance Reduction*. One nonstructural component that can help ensure

proper maintenance of porous pavement is a carefully worded maintenance agreement providing specific guidance, including how to conduct routine maintenance and how the surface should be repaved. Ideally, signs should be posted on the site identifying porous pavement areas.

One design option incorporates an "overflow edge," which is a trench surrounding the edge of the pavement. The trench connects to the stone reservoir below the pavement surface. Although this feature does not in itself reduce maintenance requirements, it acts as a backup in case the surface clogs. If the surface clogs, stormwater will flow over the surface and into the trench where some infiltration and treatment will occur.

5. *Landscaping*. For porous pavement, the most important landscaping feature is a fully stabilized upland drainage. Reducing sediment loads entering the pavement can help to prevent clogging.

Design Variations

In one design variation, the stone reservoir below the filter can also treat runoff from other sources, such as rooftop runoff. In this design, pipes are connected to the stone reservoir to direct flow throughout the bottom of the storage reservoir (Cahill Associates, 1993; Schueler, 1987). However, treating stormwater from other areas with porous pavement can cause failures, as it is more likely to carry clogging sediments. If used to treat off-site runoff, porous pavement should incorporate pretreatment, as with all structural management practices. Off site runoff should never come from areas that carry high sediment loadings.

Maintenance

Owners should be aware of a site's porous pavement because failure to perform maintenance is a primary reason for failure of this practice. Furthermore, using knowledgeable contractors skilled in techniques required for installation of pervious concrete, permeable pavers, or porous asphalt will increase performance and longevity of the system. Typical requirements are shown in Table 1.

Table 1. Typical maintenance activities for porous pavement (Source: WMI, 1997)

Activity	Schedule
Do not seal or repave with non-porous materials.	N/A
Ensure that paving area is clean of debris. Ensure that paving dewaters between storms. Ensure that the area is clean of sediments.	Monthly
Mow upland and adjacent areas, and seed bare areas. Vacuum sweep frequently to keep the surface free of sediment.	As needed (typically three to four times per year).
Inspect the surface for deterioration.	Annual

Limitations

In addition to the siting requirements of porous pavement, a major limitation to the practice is the poor success rate it has experienced in the field. Several studies indicate that with proper maintenance porous pavement can retain its permeability (e.g., Goforth et al., 1983; Gburek and Urban, 1980; Hossain and Scofield, 1991). Newer studies, particularly with permeable pavers and pervious concrete, indicate that success rates can be substantially high when the paving medium is properly installed and maintained (Brattebo and Booth, 2003).

Effectiveness

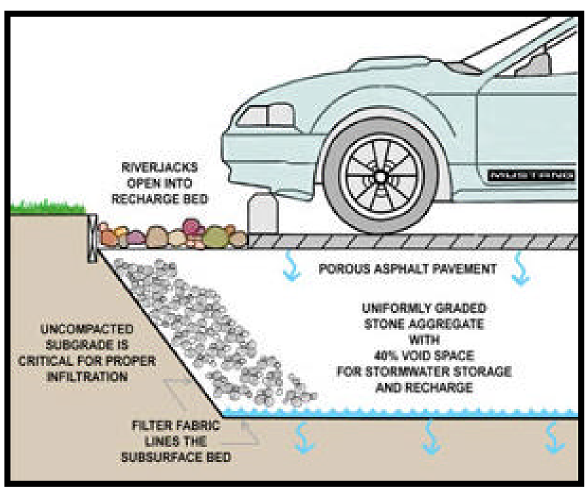
Porous pavement can be used to provide ground water recharge and to reduce pollutants in stormwater runoff. Some data suggest that as much as 70 to 80 percent of annual rainfall will go toward ground water recharge (Gburek and Urban, 1980). These data will vary depending on design characteristics and underlying soils. Two studies have been conducted on the long-term pollutant removal of porous pavement, both in the Washington, DC area. They suggest high pollutant removal, although it is difficult to extrapolate these results to all applications of the practice. The results of the studies are presented in Table 2.

Table 2. Effectiveness of porous pavement pollutant removal (Schueler, 1987)

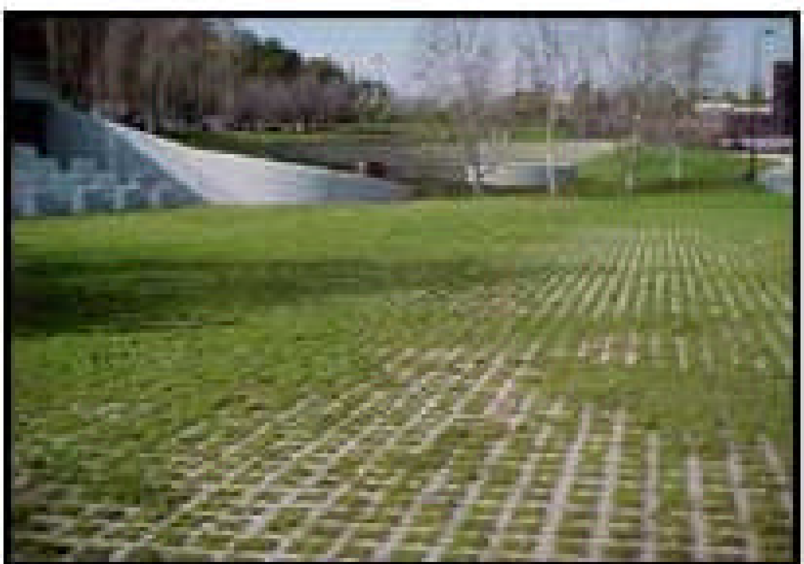
	Pollutant Removal (%)				
Study	**TSS**	**TP**	**TN**	**COD**	**Metals**
Prince William, VA	82	65	80	-	-
Rockville, MD	95	65	85	82	98-99

A third study by Brattebo and Booth (2003) indicates that many trademarked permeable paver systems effectively reduced concentrations of motor oil, copper, and zinc. Furthermore, the study found that almost all precipitation that fell on the permeable pavers infiltrated even after 6 years of daily use as a parking area.

Figure 1
Illustration of Porous Asphalt Pavement



Photos 1 – 3
Pavers



Photos 4 - 5
Porous Pavement

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