Dec. 1, 1992

Porous Asphalt Pavement

Description

Porous asphalt pavement is a paved surface and subbase comprised of asphalt, gravel, and stone, formed in a manner resulting in a permeable surface. The various layers, called "courses," have the potential for stormwater detention. Stormwater which passes through the pavement may completely or partially infiltrate the underlying soil, the excess being collected and routed to an overflow facility through perforated underdrain pipes. The pavement may also be designed to receive off-site runoff.

Other Terms Used to Describe

Pervious Pavement
Permeable Pavement

Pollutants Controlled and Impacts

When properly designed and carefully installed, porous pavement has load bearing strength, longevity, and maintenance requirements similar to conventional pavement. Some of the possible benefits over conventional pavement include: removal of fine particulates and soluble pollutants through soil infiltration; attenuation of peak flows; reduction in the volume of runoff leaving the site and entering storm sewers; reduction in soil erosion; and groundwater recharge. The degree of pollutant removal is related to the amount of runoff which exfiltrates the subsoils. This practice may also help reduce land consumption by reducing the need for traditional stormwater management structures.

There is a potential risk to groundwater due to oils, greases, and other substances that may leak onto the pavement and leach into the ground. Pre-treatment of stormwater is recommended where oil and grease or other potential groundwater contaminants are expected.

Application

Land Use
Mostly urban, urbanizing and transportation

Soil/Topography/Climate
This practice should only be used on sites with gentle slopes, permeable soils, and relatively deep water table and bedrock levels. Soils should be well or moderately well drained. Since subgrade soils will differ in their capacity to infiltrate and percolate water, the design of porous pavement will vary slightly based on soil type. See the "Specifications" section of this BMP.

Meteorological conditions will affect the design infiltration rate for the top pavement course, and the volume necessary in the reservoir course. Meteorological conditions will also affect frost penetration depth.

This practice is not recommended for barren areas subject to wind erosion.

When to Apply
Apply when the soil, topography and climatic conditions listed above can be met.

Where to Apply
Apply in low-volume parking lots and roads, and in high activity recreational areas like basketball and tennis courts or playground lots. The area is generally limited to 0.25 to 10.0 acres and generally serves only a small section of the watershed. This BMP can also accept rooftop and adjacent parking lot runoff.

Relationship With Other BMPs

Subsurface Drains may collect water infiltrating the reservoir course of porous asphalt pavement and route it to an Extended Detention Basin or Infiltration Basin. This may be necessary for soils having marginal infiltration capabilities. The use of subsurface drains may diminish the pollutant removal efficiency of this BMP by not allowing the water to fully exfiltrate the soil. Subsurface drains may also be installed but allowed to remain capped, acting as a backup system if the porous pavement becomes clogged.

Specifications

General Considerations:

As shown in Exhibit 1, a typical porous asphalt pavement consists of a top porous asphalt course, a filter course, a reservoir course (designed for runoff detention and frost penetration), and existing soil or subbase material.

> The **top porous asphalt course** is an open-graded asphalt concrete surface course approximately 2-4 inches thick. This course consists of porous asphalt concrete containing little sand or dust, with a pore space of approximately 16% (as compared to 2-3% for conventional asphalt concrete). Strength and flow properties of porous asphalt concrete are similar to conventional asphalt concrete.
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> The **filter course** is a 1-2-inch thick layer of 0.5-inch crushed stone aggregate. In addition to providing some filtration (limited by the relatively large pore space), the filter course also provides stability for the reservoir course during application of the asphalt mix.
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> The **reservoir course** is a base of 1.5-3-inch stone of a depth determined by the storage volume needed. In addition to transmitting mechanical loads, the reservoir course stores runoff water until it can infiltrate into the soil. On slopes, reservoir courses at the higher end are not credited with storage capability due to lateral drainage.
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> Where soils have low permeability, the reservoir course thickness should be increased to provide additional storage. With soils composed primarily of clay or silt, the infiltration capacity may be so slow that the soil is unacceptable as a subgrade, necessitating replacement by suitable borrow material. If the natural material beneath is relatively impermeable, drainage may have to be provided. The drainage may take the form of subsurface drains, french drains or dutch drains.

Another 2-inch **filter course** can be applied below the reservoir course to allow additional infiltration. Below the filter course, we recommend a Filter fabric.

Under the filter fabric is the undisturbed soil.

Planning Considerations:

Soil tests should be conducted to determine permeability, load bearing capacity, resistance to frost heave, swell and shrink. Soils with a permeability rating of A or B are probably more suitable than soils with a permeability rating of C. Evaluate the soils and drainage area to estimate the amount of water that may enter the porous pavement, and how fast this water will percolate through the soil. Underlying soils should have a minimum **infiltration rate** of 0.27 in/hr, or 0.52 in/hr for full exfiltration systems.

Plan to design any necessary Diversions in conjunction with the porous pavement. Diversions should be placed around the perimeter of the porous pavement to keep runoff and sediment completely away from the site both before and during construction.

Do *not* store heavy equipment on the area in which porous asphalt pavement will be laid. Heavy equipment will compact soils and reduce the soil's infiltration.

Design Considerations:

Porous asphalt pavement systems should be designed by registered professional engineers.

Slope:

The slope of porous asphalt pavement should not exceed 5% and is best when as flat as possible. If low spots do develop in the parking lot, it may be advisable to install drop inlets to divert runoff into the stone reservoir more quickly.

Depth:

The depth of the stone reservoir should be such that it drains completely within 72 hours. This allows the underlying soils to dry out between storms (improving pollutant removal) and also preserves capacity for the next storm. If the site has marginal soils for infiltration (e.g. loams, silt loams), or covers a wide area, it may be prudent to design the reservoir to drain within 48 hours.

Residence Time:

Care should be taken in spacing the underdrain network in partial exfiltration systems. If perforated underdrains are too close together, runoff may be collected too efficiently to provide the exfiltration needed for high pollutant removal. As a general design rule, a minimum residence time of 12 hours should be a target for the design storm.

Effects of Frost:

If frost penetrates deeper than the thickness of the pavement and reservoir courses, and the subgrade soil has potential for frost heaving, it is recommended that additional material be added to the reservoir course to below the frost zone. If the subsurface freezes, the effectiveness of this BMP is diminished.

Construction Considerations:

1. Before the entire development site is graded, the planned area for the porous pavement should be roped off by Construction Barriers to prevent heavy equipment from compacting the underlying soils.

2. Install Diversions as needed to keep runoff off the site until the porous pavement is in place.

3. Excavate the subgrade soil using equipment with tracks or over-sized tires. Narrow rubber tires should be avoided since they compact the soil and reduce its infiltration capabilities.

4. After excavation is complete, the bottom and sides of the stone reservoir should be lined with filter fabric to prevent upward piping of underlining or underlying soil. The fabric should be placed flush with a generous overlap between rolls. Follow manufacturer's specifications.

5. Clean, washed 1.5-3-inch aggregate should be placed in the excavated reservoir in lifts, and lightly compacted with plate compactors to form the reservoir or base course. Unwashed stone has enough sediment to pose a clear risk of clogging at the soil/filter cloth interface. The minimum depth of this layer is usually 9 inches.

6. A 1-2-inch thick layer of 0.5-inch stone should be placed over the reservoir or base course, and manually graded to plan specifications.

7. Add the porous asphalt layer (2-4 inches thick), but only when the air temperature is above 50^{o}F and the laying temperature is between $230\text{-}260^{o}$F. Failure to follow these guidelines can lead to premature hardening of the asphalt and subsequent loss of infiltration capacity.

8. Asphalt used in porous asphalt concrete ranges from a 50% to 100% penetration grade, depending upon the ambient temperatures and viscosity characteristics desired. Generally, the grades used in a given locality for conventional asphalt concretes will suffice for porous asphalt as well. However, the porous product is more subject to scuffing, which occurs when the front wheels of stationary vehicles are turned. It is therefore suggested that for porous asphalt, an 85 to 100% penetration grade be used.

9. The percent of asphalt should be specified between 5.5 and 6, based on the total weight of the pavement. The lower limit is to assure adequately thick layers of asphalt around the stones, and the upper limit is to prevent the mix from draining asphalt during transport.

10. To avoid damage due to photo-oxidative degradation of the asphalt, the asphalt coatings on the aggregate surfaces should be thicker than usual. In this case, the asphalt can form skins or otherwise be mildly degraded without significant loss of cementing properties.

11. Roll the asphalt when it is cool enough to withstand a ten-ton roller. Normally, only one or two passes of the roller are necessary. More frequent rolling can reduce the infiltration capabilities on the open-graded asphalt mix.

12. After rolling is complete, all traffic should be kept out of the porous pavement area for a minimum of one day to allow proper hardening.

After Construction:

1. Stabilize the surrounding area and any established outlet following specifications in the Seeding and Mulching or Sodding BMPs. This will prevent sediment from entering the porous pavement.

2. Where applicable, remove temporary Diversions after vegetation is established.

3. Post signs to prevent vehicles from entering the area with muddy tires. If muddy vehicle access cannot be prevented, a temporary Access Road should be installed.

4. Although snow and ice tends to melt more quickly on porous pavement, it may still be necessary to apply de-icing compounds to melt snow and ice. Do not use sand or ash because they may cause clogging of the pavement.

Maintenance

All porous pavement should be inspected several times in the first few months after construction, and at least annually thereafter. Inspections should be conducted after large storms to check for surface ponding that might indicate local or widespread clogging. If severe clogging occurs, the entire structure may have to be replaced.

The porous pavement surface should be vacuum swept at least four times per year, followed by high-pressure jet hosing to keep the asphalt pores open.

Spot clogging of the porous pavement layer can be relieved by drilling half-inch holes through the porous asphalt layer every few feet. In cases where clogging occurs in a low spot in the pavement, it may be advisable to install a drop inlet to route water into the stone reservoir.

Potholes and cracks can be repaired using conventional, non-porous patching mixes as long as the cumulative area repaired does not exceed 10% of the parking lot area.

Additional Considerations

Safety:

Porous pavement overlays on conventional surfaces prevent many wet skidding or hydroplaning accidents. For safety application, a 3/4-1-inch layer over normal dense pavement is used to provide rapid lateral surface drainage.

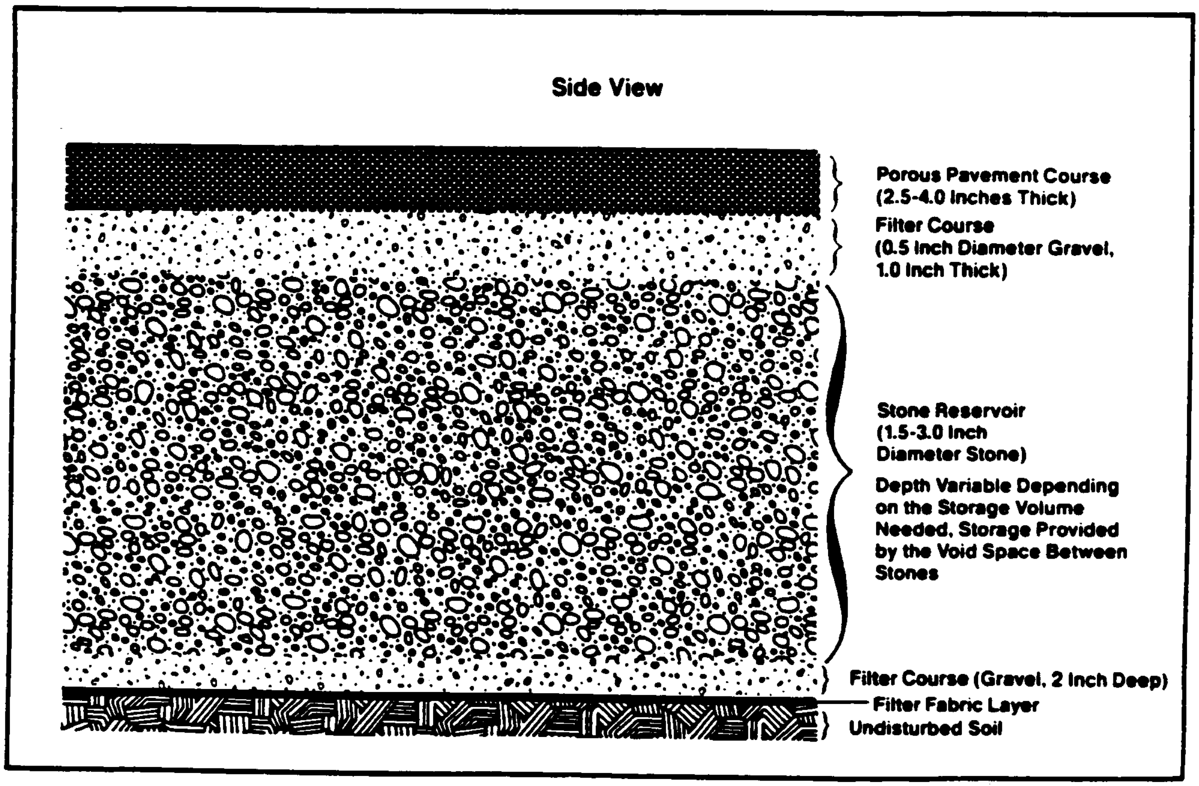
The visibility of pavement markings is improved on porous/modular pavement because of the rapid removal of water, and because the marking material penetrates the voids to present an oblique view. The enhanced visibility of pavement markings would be an important factor in preventing accidents during storms.

Exhibits

Exhibit 1: Design Schematic for Porous Pavement. Source: City of Rockville, Md., as copied from "Water Resources Protection Technology: A Handbook of Measures to Protect Water Resources in Land Development." The Urban Land Institute. 1981.

Exhibit 1

Schematic of Typical Porous Pavement Section



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