United States Environmental Protection Agency
Office of Water Washington, D.C.
EPA 832-F-99-023
September 1999

Storm Water Technology Fact Sheet Porous Pavement

DESCRIPTION

Porous pavement is a special type of pavement that allows rain and snowmelt to pass through it, thereby reducing the runoff from a site and surrounding areas. In addition, porous pavement filters some pollutants from the runoff if maintained.

There are two types of porous pavement: porous asphalt and pervious concrete. 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 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.

The porous pavement surface is typically placed over a highly permeable layer of open-graded gravel and crushed stone. The void spaces in the aggregate layers act as a storage reservoir for runoff. A filter fabric is placed beneath the gravel and stone layers to screen out fine soil particles. Figure 1 illustrates a common porous asphalt pavement installation.

Two common modifications made in designing porous pavement systems are (1) varying the amount of storage in the stone reservoir beneath the pavement and (2) adding perforated pipes near the top of the reservoir to discharge excess storm water after the reservoir has been filled.

Some municipalities have also added storm water reservoirs (in addition to stone reservoirs) beneath the pavement. These reservoirs should be designed to accommodate runoff from a design storm and should provide for infiltration through the underlying subsoil.

APPLICABILITY

Porous pavement may substitute for conventional pavement on parking areas, areas with light traffic, and the shoulders of airport taxiways a runways, provided that the grades, subsoils, drainage characteristics, and groundwater conditions are suitable. Slopes should be flat or very gentle. Soils should have field-verified permeability rates of greater than 1.3 centimeters (0.5 inches) per hour, and there should be a 1.2 meter (4-foot) minimum clearance from the bottom of the system to bedrock or the water table.

ADVANTAGES AND DISADVANTAGES

The advantages of using porous pavement include:

- Water treatment by pollutant removal.
- Less need for curbing and storm sewers.
- Improved road safety because of better skid resistance.
- Recharge to local aquifers.

The use of porous pavement may be restricted in cold regions, arid regions or regions with high wind erosion rates, and areas of sole-source aquifers. The use of porous pavement is highly constrained, requiring deep permeable soils, restricted traffic, and adjacent land

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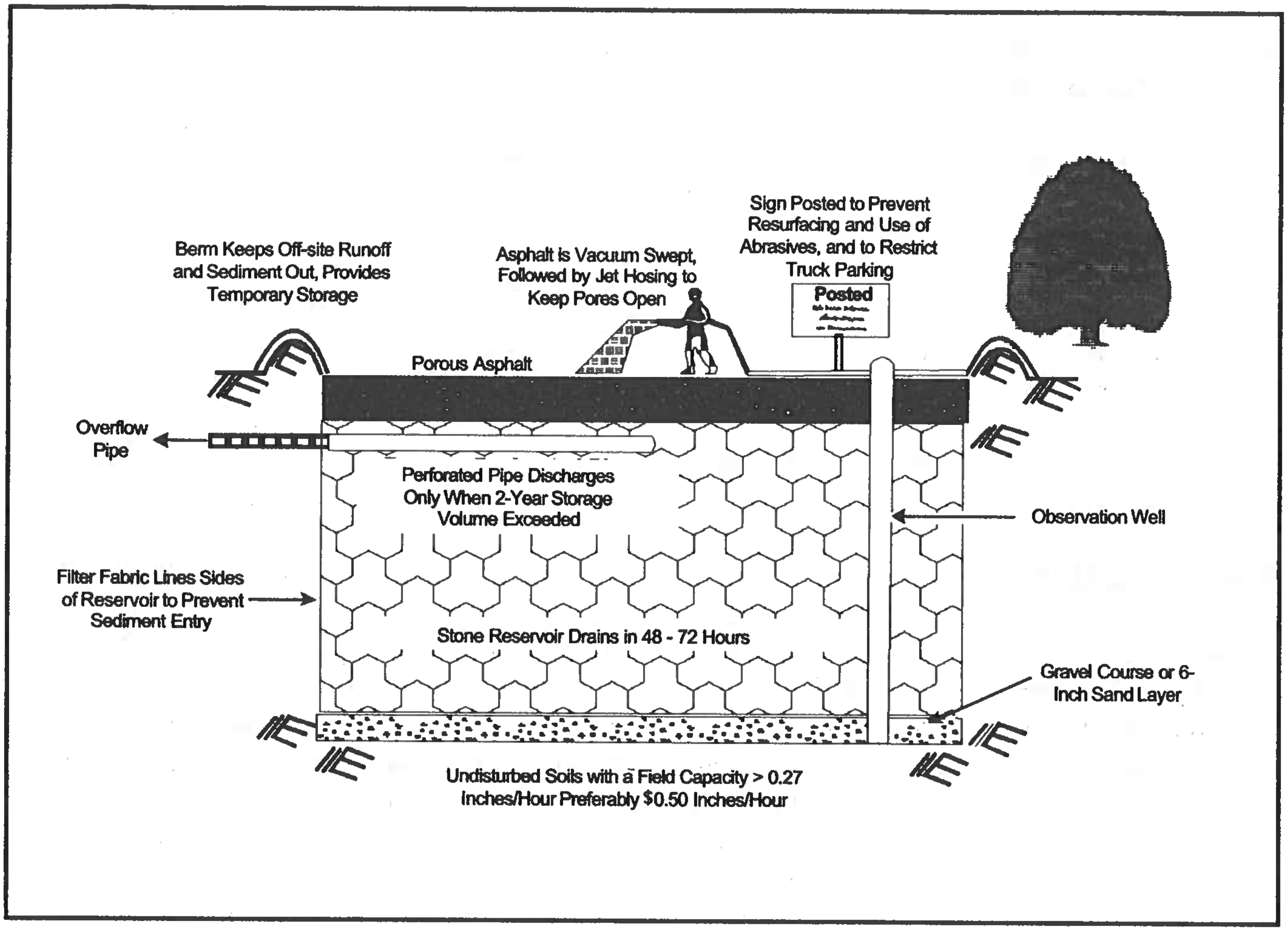

Source: Modified from MWCOG, 1987.

FIGURE 1 TYPICAL POROUS PAVEMENT INSTALLATION

uses. Some specific disadvantages of porous pavement include the following:

- Many pavement engineers and contractors lack expertise with this technology.
- Porous pavement has a tendency to become clogged if improperly installed or maintained.
- Porous pavement has a high rate of failure.
- There is some risk of contaminating groundwater, depending on soil conditions and aquifer susceptibility.
- Fuel may leak from vehicles and toxic chemicals may leach from asphalt and/or binder surface. Porous pavement systems are not designed to treat these pollutants.
- Some building codes may not allow for its installation.
- Anaerobic conditions may develop in underlying soils if the soils are unable to dry out between storm events. This may impede microbiological decomposition.

As noted above, the use of porous pavement does create risk of groundwater contamination. Pollutants that are not easily trapped, adsorbed, or reduced, such as nitrates and chlorides, may continue to move through the soil profile and into the groundwater, possibly contaminating drinking water supplies. Therefore, until more scientific data is available, it is not advisable to construct porous pavement near groundwater drinking supplies.

In addition to these documented pros and cons of porous pavements, several questions remain regarding their use. These include:

- Whether porous pavement can maintain its porosity over a long period of time, particularly with resurfacing needs and snow removal.
- Whether porous pavement remains capable of removing pollutants after subfreezing weather and snow removal.
- The cost of maintenance and rehabilitation options for restoration of porosity.

DESIGN CRITERIA

Porous pavement - along with other infiltration technologies like infiltration basins and trenches - have demonstrated a short life span. Failures generally have been attributed to poor design, poor construction techniques, subsoils with low permeability, and lack of adequate preventive maintenance. Key design factors that can increase the performance and reduce the risk of failure of porous pavements (and other infiltration technologies) include:

- Site conditions;
- Construction materials; and
- Installation methods.

These factors are discussed further in Table 1.

PERFORMANCE

Porous pavement pollutant removal mechanisms include absorption, straining, and microbiological decomposition in the soil. An estimate of porous pavement pollutant removal efficiency is provided by two long-term monitoring studies conducted in Rockville, MD, and Prince William, VA. These studies indicate removal efficiencies of between 82 and 95 percent for sediment, 65 percent for total phosphorus, and between 80 and 85 percent of total nitrogen. The Rockville, MD, site also indicated high removal rates for zinc, lead, and chemical oxygen demand. Some key factors to increase pollutant removal include:

- Routine vacuum sweeping and high pressure washing (with proper disposal of removed material).
- Drainage time of at least 24 hours.
- Highly permeable soils.
- Pretreatment of runoff from site.
- Organic matter in subsoils.
- Clean-washed aggregate.

Traditionally, porous pavement sites have had a high failure rate - approximately 75 percent. Failure has been attributed to poor design, inadequate construction techniques, soils with low permeability, heavy vehicular traffic, and resurfacing with nonporous pavement materials. Factors enhancing longevity include:

- Vacuum sweeping and high-pressure washing.
- Use in low-intensity parking areas.
- Restrictions on use by heavy vehicles.
- Limited use of de-icing chemicals and sand.
- Resurfacing.
- Inspection and enforcement of specifications during construction.
- Pretreatment of runoff from offsite.
- Implementation of a stringent sediment control plan.

OPERATION AND MAINTENANCE

Porous pavements need to be maintained. Maintenance should include vacuum sweeping at least four times a year (with proper disposal of removed material), followed by high-pressure hosing to free pores in the top layer from clogging. Potholes and cracks can be filled with patching mixes unless more than 10 percent of the surface area needs repair. Spot-clogging may be fixed by drilling 1.3 centimeter (half-inch) holes through the porous pavement layer every few feet.

The pavement should be inspected several times during the first few months following installation and annually thereafter. Annual inspections should take place after large storms, when puddles will make any clogging obvious. The condition of adjacent pretreatment devices should also be inspected.

COSTS

The costs associated with developing a porous pavement system are illustrated in Table 2.

Estimated costs for an average annual maintenance program of a porous pavement parking lot are approximately $4,942 per hectare per year ($200 per acre per year). This cost assumes four inspections each year with appropriate jet hosing and vacuum sweeping treatments.

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2. Metropolitan Washington Council of Governments, 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs.*

3. Metropolitan Washington Council of Governments, 1992. *A Current Assessment of Best Management Practices: Techniques for Reducing Nonpoint Source Pollution in a Coastal Zone.*

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5. U.S. EPA, 1981. *Best Management Practices Implementation Manual.*

TABLE 2 ESTIMATED COSTS FOR A POROUS PAVEMENT SYSTEM

Component	Unit Cost	Total
Excavation Costs	740 cy X $5.00/cy	$3,700
Filter Aggregate/Stone Fill	740 cy X $20.00/cy	$14,800
Filter Fabric	760 sy X $3.00/cy	$2,280
Porous Pavement	556 sy X $13.00/sy	$7,228
Overflow Pipes	200 ft X $12.00/ft	$2,400
Observation Well	1 at $200 each	$200
Grass Buffer	822 sy X $1.50/sy	$1,250
Erosion Control	$1000	$1,000
Subtotal		$32,858
Contingencies (Engineering, Administration, etc.)	25%	$8,215
Total		$41,073

TABLE 1 DESIGN CRITERIA FOR POROUS PAVEMENTS

Design Criterion	Guidelines
Site Evaluation	• Take soil boring to a depth of at least 1.2 meters (4 feet) below bottom of stone reservoir to check for soil permeability, porosity, depth of seasonally high water table, and depth to bedrock.
	• Not recommended on slopes greater than 5 percent and best with slopes as flat as possible.
	• Minimum infiltration rate 0.9 meters (3 feet) below bottom of stone reservoir: 1.3 centimeters (0.5 inches) per hour.
	• Minimum depth to bedrock and seasonally high water table: 1.2 meters (4 feet).
	• Minimum setback from water supply wells: 30 meters (100 feet).
	• Minimum setback from building foundations: 3 meters (10 feet) downgradient, 30 meters (100 feet) upgradient.
	• Not recommended in areas where wind erosion supplies significant amounts of windblown sediment.
	• Drainage area should be less than 6.1 hectares (15 acres).
Traffic conditions	• Use for low-volume automobile parking areas and lightly used access roads.
	• Avoid moderate to high traffic areas and significant truck traffic.
	• Avoid snow removal operations; post with signs to restrict the use of sand, salt, and other deicing chemicals typically associated with snow cleaning activities.
Design Storm Storage Volume	• Highly variable; depends upon regulatory requirements. Typically design for storm water runoff volume produced in the tributary watershed by the 6-month, 24-hour duration storm event.
Drainage Time for Design Storm	• Minimum: 12 hours.
	• Maximum: 72 hours.
	• Recommended: 24 hours.
Construction	• Excavate and grade with light equipment with tracks or oversized tires to prevent soil compaction.
	• As needed, divert storm water runoff away from planned pavement area before and during construction.
	• A typical porous pavement cross-section consists of the following layers: 1) porous asphalt course, 5-10 centimeters (2-4 inches) thick; 2) filter aggregate course; 3) reservoir course of 4-8 centimeters (1.5-3-inch) diameter stone; and 4) filter fabric.
Porous Pavement Placement	• Paving temperature: 240° - 260° F.
	• Minimum air temperature: 50° F.
	• Compact with one or two passes of a 10,000-kilogram (10-ton) roller.
	• Prevent any vehicular traffic on pavement for at least two days.
Pretreatment	• Pretreatment recommended to treat runoff from off-site areas. For example, place a 7.6-meter (25-foot) wide vegetative filter strip around the perimeter of the porous pavement where drainage flows onto the pavement surface.

6. U.S. EPA, 1992. *Stormwater Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices*. EPA 833-R-92-006.

7. Washington State Department of Ecology, 1992. *Stormwater Management Manual for the Puget Sound Basin*.

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TechBrief

The Asphalt Pavement Technology Program is an integrated national effort to improve the long-term performance and cost effectiveness of asphalt pavements. Managed by the Federal Highway Administration through partnerships with state highway agencies, industry and academia, the program's primary goals are to reduce congestion, improve safety, and foster technology innovation. The program was established to develop and implement guidelines, methods, procedures and other tools for use in asphalt pavement materials selection, mixture design, testing, construction and quality control.

U.S. Department of Transportation
Federal Highway Administration

Office of Asset Management, Pavements, and Construction

FHWA-HIF-15-009

April 2015

Porous Asphalt Pavements with Stone Reservoirs

This Technical Brief provides an overview of the benefits, limitations and applications of porous asphalt pavements with stone reservoirs. Considerations for design and construction, as well as maintenance, are discussed.

Introduction

Porous asphalt pavements with stone reservoirs are a multifunctional low impact development (LID) technology, which integrates ecological and environmental goals for a site with land development goals, reducing the net environmental impact for a project. Not only do they provide a strong pavement surface for parking, walkways, trails, and roads; they are designed to manage and treat stormwater runoff. With proper design and installation, porous asphalt pavements can provide a cost-effective solution for stormwater management in an environmentally friendly way. As a result, they are recognized as a best practice by the U.S. Environmental Protection Agency (EPA) and many state agencies (EPA n.d.; PDEP 2006; NJDEP 2004).

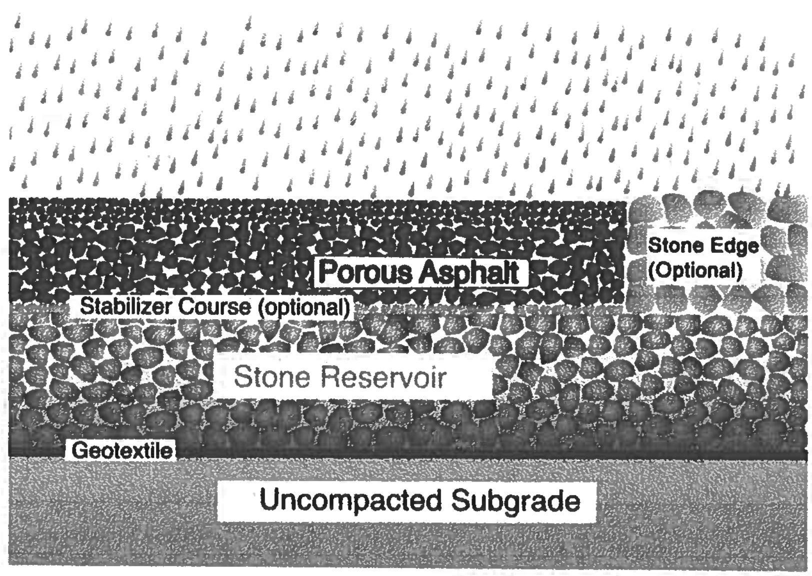

Figure 1: Typical porous asphalt pavement with stone reservoir cross section

Unlike conventional pavements, porous asphalt pavements are typically built over an uncompacted subgrade to maximize infiltration through the soil. Above the uncompacted subgrade is a geotextile fabric, which prevents the migration of fines from the subgrade into the stone recharge bed while still allowing for water to pass through. The next layer is a stone reservoir consisting of uniformly graded, clean crushed stone with 40% voids serving as a structural layer and to temporarily store water as it infiltrates into the soil below. Then, to stabilize the surface for paving, a thin (about 1-inch thick) layer of clean, smaller, single-size crushed stones is often placed on top; this is called the stabilizing course or choker course. The last layer consists of one or more layers of open-graded asphalt mixes with interconnected voids, allowing water to flow through the pavement into the stone reservoir. These open-graded asphalt layers consist of asphalt binder, stone aggregates, and other additives. By excluding fines, the open-graded mixture allows for more air voids (typically between 16% and 22% voids).

OGFC vs. Porous Pavement

There are two common uses for open-graded asphalt mixes for pavements.

An open-graded friction course (OGFC) is a thin, open-graded asphalt mix placed atop a dense-graded pavement. Rainwater drains into the OGFC and then out the side of the pavement.

Porous asphalt pavements use open-graded mixes placed atop a stone reservoir. Rainwater flows down through the open-graded mix layers into the stone reservoir where it can then infiltrate into the subgrade.

Benefits and Limitations

Table 1 summarizes many benefits and limitations of porous asphalt pavements. One of the greatest benefits of porous asphalt pavements is its effectiveness for stormwater management, improving water runoff quality, reducing stormwater runoff, and restoring groundwater supplies. Stormwater drains through the open-graded asphalt surface, is temporarily held in the voids of the stone reservoir reducing stormwater runoff, and then slowly drains into the underlying, uncompacted subgrade to eventually restore groundwater supplies. As it drains, contaminants are filtered and microbial activity decomposes pollutants, improving water quality.

Several studies have quantified high removal rates of total suspended solids (TSS), metals, oil and grease, as well as moderate removal rates for phosphorous, from using porous asphalt pavements (Cahill et al. 2005; Roseen et al. 2012). During the winter, porous asphalt pavements have excellent performance since water drains quickly through the surface. They are a potential strategy for minimizing use of deicing chemicals. The University of New Hampshire Stormwater

Center reports a 75% or greater reduction of deicing salts. While the system does not remove chloride, the drastic reduction of deicing chemicals required is an effective method for reducing chloride pollution (Roseen et al. 2014).

Table 1. Benefits and limitations of porous asphalt pavements with stone reservoirs

Benefits/Advantages	Limitations/Disadvantages
• Snow and ice melts faster, reduction in deicing salts (Lebens 2012) • Cools stormwater temperature during summertime before discharge and mitigates heat island effects (Lebens 2012). • Reduction in contamination in water runoff and sediment loading (Lebens 2012; Houle et al. 2013) • Recharging of groundwater supplies (UNHSC 2012) • Low impact development and cost effective technology for stormwater management, by reducing need for drainage structures and rights of way (Houle et al. 2013; UNHSC 2011; EPA 2014) • Improved wet-weather visibility, tire spray, and hydroplaning (Lebens 2012) • Absorption of noise from tires and engines (Lebens 2012) • Reduction in Stormwater runoff volume (Lebens 2012) • Improves water and oxygen transfer to nearby plant roots (CTC & Associates 2012) • Credits in green construction rating systems (i.e., LEED; Greenroads; IgCC)	• Pavement structure initial costs are often higher; however, this may be offset by cost reductions realized from stormwater infrastructure (Houle et al. 2013) • Sloped pavements require extra design considerations such as terraced parking, underground berms, and drainage pipes at low points • Potential clogging with dirt and organic debris requiring specialized maintenance such as vacuuming or other cleaning mechanisms (UNHSC 2012) • Limited use for heavy loading areas where sharp turns are probable • Porous pavements should not be constructed where there is a high risk of toxic spills; however, porous pavements have been noted to contain spills from uncontrolled runoff (Lebens 2012) • Some variation from standard construction practices

For roads, other major benefits include reduced noise, increased wet-weather friction and visibility, and reduced stormwater temperatures before discharge (Lebens 2012). Recent research has identified permeable pavements as a "cool pavement technology." Due to their high air-void structure, porous asphalt can mitigate urban heat island (UHI) effect by reducing stored pavement energy and allowing for rapid cooling via evaporation (Li et al. 2013; Stempihar et al. 2012; EPA 2008).

Along with its many benefits, porous asphalt pavements also have limitations. The vast majority of projects constructed to date were designed to carry light automobile traffic only. Application of porous pavements for highways is challenging due to variability in soil conditions, utilities, fills, and slope. However, with diligent engineering the use of porous asphalt pavements for highways is possible for some situations. There have been some porous asphalt pavements used for some road and highway pavements such as the Arizona Avenue/SR 87 in Chandler, Ariz., and Maine Mall Road in South Portland, Maine (Palmer 2012; Peabody 2010).

Applications

Porous asphalt pavements are typically recommended for parking areas and low-volume roadways (Roseen et al. 2012). Additional applications of porous asphalt are for pedestrian walkways, sidewalks, driveways, bike lanes, and shoulders (Hein et al. 2013). Also, porous asphalt pavements have been used successfully for residential and urban streets, as well as highways. Porous asphalt pavements can be installed as whole or in part with traditional impervious asphalt pavements. When installed in combination with impervious pavements or adjacent to building roofs, porous asphalt can sufficiently contain and treat the additional runoff generated.

Design of Porous Asphalt Pavements

There are three considerations required when determining the thickness of the layers of porous pavements: 1) site considerations to ensure that the site is acceptable; 2) hydrological design to ensure the porous pavement meets the potential stormwater runoff demands; and, 3) structural design to ensure that the porous pavement withstands the anticipated traffic loading. Most often, the thickness of the stone recharge bed will be controlled by the water quantity (hydrological design) and soil infiltration rates (site considerations), rather than structural requirements, while the porous asphalt surface layer will be determined by the traffic loads (structural design).

1. Site Considerations

The location of porous pavements should be considered early during the design process. Contrary to conventional construction pavement siting, porous pavements perform best on upland soils (Cahill et al. 2005). Additional site considerations include soil types, depth of bedrock, pavement slope, and additional sources of runoff. General site guidelines include:

- Soil infiltration rates of 0.1 to 10 inches/hour (0.5 inches/hour is recommended by EPA). Do not place over known sinkholes.
- Minimum depth to bedrock or seasonal high water should be greater than 2 feet.
- Frost depth should be considered. The University of New Hampshire recommends the bottom of the stone reservoir be 60% of the frost depth. However, many projects in cold regions have been constructed at lesser depths with no problems from freezing noticed.
- The bottom of the infiltration bed should be flat. For roads it may be necessary to construct berms under the pavement surface to retain water on slopes and install drains/overflows at low points (Roseen et al. 2011).
- For parking areas, the slope of the porous pavement surface should be less than 5%. For slopes greater than 5% the parking areas should be terraced with berms in between.
- Opportunities to route runoff from nearby impervious areas to infiltration bed. Impervious to pervious areas should be less than a 5:1 ratio for most conditions or 3:1 for sinkhole-susceptible areas (karst formations).

2. Hydrology Design

Hydrological design determines what layer thicknesses are required to sufficiently infiltrate, store, and release the expected inflow of water, which includes both rainfall and excess stormwater runoff from any adjacent impervious surfaces. This requires information regarding the layer thicknesses and subgrade permeability along with precipitation intensity levels.

The hydrologic design of porous pavements should be performed by a licensed engineer. The two most common methods for modeling stormwater runoff are the SCS/NCRS Curve Number method and the Rational method. The Rational method is not recommended for evaluation of porous pavement systems. Specific details on hydrological design are beyond the scope of this TechBrief.

Porous pavements are often not designed to store and infiltrate the maximum precipitation at the site. Therefore overflow should be included in the design to prevent stored stormwater from reaching the surface layers. This typically will involve perforated pipes in the stone reservoir that are connected to discharge pipe as shown in Figure 2. It is also recommended that an alternate path for stormwater to enter the stone reservoir be provided in case the surface should become plugged. Figure 2 shows examples of designs using a stone edge or drop inlet to manage overflows.

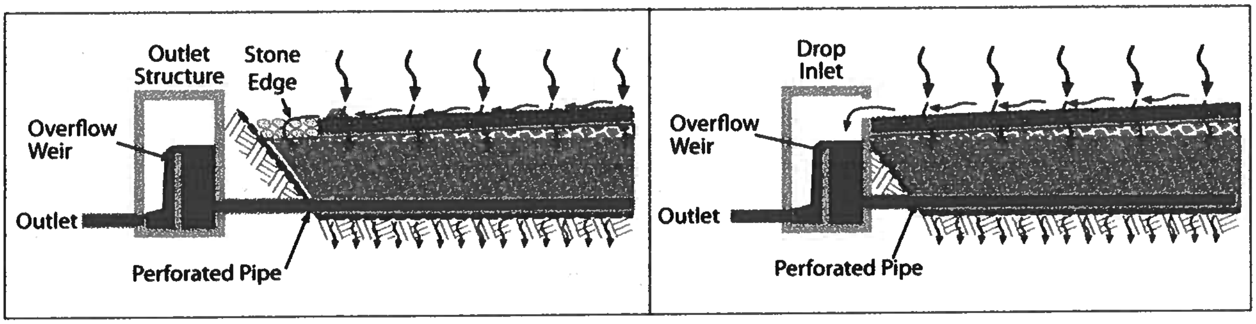

Figure 2: Stone edge design (left) and drop inlet design (right)

3. Structural Design

While limited structural information is available, porous pavements have lasted for more than 20 years. For porous pavements carrying light automobile traffic only, the structural requirements are not significant, and the material thicknesses are determined by the hydrological design and minimum thicknesses required for porous asphalts. For porous asphalt pavements expected to carry truck loads, the structural design procedures should follow standard AASHTO 93 design procedures. Recommended layer coefficients for porous asphalt pavements are found in Table 2. Recommended minimum thickness of the compacted porous asphalt layer for different truck loadings are found in Figure 3.

Table 2. Recommended layer coefficients (Hansen, 2008)

Material Layer	Structural Coefficients
Porous Asphalt	0.40 – 0.42
Asphalt-Treated Permeable Base (ATPB)	0.30 – 0.35
Porous Aggregate Base (Stone Recharge Bed)	0.10 – 0.14

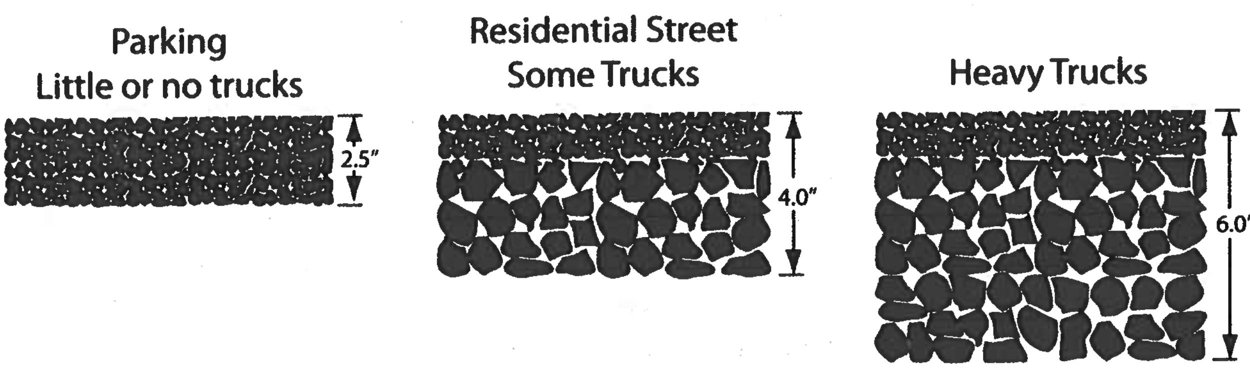

Figure 3: Recommended minimum compacted porous asphalt thicknesses

Porous Asphalt Mixture Properties and Characteristics

Porous asphalt mixtures are designed using the Superpave (50 gyrations) or Marshall (35 blows per side) methods with requirements for higher air voids and low draindown to assure permeability and performance. To reduce draindown and provide resistance to scuffing, mixes are typically designed with polymer-modified binders. Fibers are often added to the mix to reduce draindown. Many states have specification for open-graded friction courses and asphalt-treated permeable bases that may be used in specifying mixes for porous asphalt pavements. State specifications should be checked to see if they have the key properties shown in Table 3.

Table 3. Typical properties and characteristics for asphalt surface layer (Hansen, 2008)

Mix Properties	Requirement
Air Voids (AASHTO T 269-11/ASTM D3203M-11)	> 16%
Draindown (AASHTO T 305-09/ASTM 6390-11)	≤ 0.3%
Asphalt Content (by weight of total mix)	Note 1
Maximum Aggregate Size	Note 2

Note 1: For 9.5 mm nominal aggregate size porous asphalt mixes, the recommended minimum asphalt content is 5.75% by weight of mix. In rare cases this may not be possible. In these cases the Cantabro test (ASTM D7064M-08) should be run to assure durability. For larger stone mixes, the asphalt content will decrease. The asphalt content should be the highest possible without exceeding draindown requirements.

Note 2: The maximum recommend aggregate size for surfaces is 12.5 NMAS. Larger NMAS mixes are recommended for base courses.

Porous Asphalt Mixture Test Methods

There are a number of guides and specifications available for porous asphalt mixes, including Hansen 2008, UNHSC 2014, and Mallick et al. 2000, as well as guidance from state DOTs, AASHTO, ASTM, and state asphalt pavement associations. Test methods for porous asphalt are as follows:

- AASHTO T 269-11/ASTM D3203M-11 Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
- AASHTO T 331-13/ASTM D6857M-11 Standard Test Method for Maximum Specific Gravity and Density of Bituminous Paving Mixtures Using Automatic Vacuum Sealing Method
- AASHTO T 305-09/ASTM D6390-11 Standard Test Method for Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures
- ASTM D7064M-08(2013) Standard Practice for Open-Graded Friction Course (OGFC) Mix Design (Cantabro test)

Because porous asphalt surfaces do not hold water, they have a very low risk of moisture-related damage. Despite this, it is still recommended to add an anti-stripping agent to the mix if it would be required for dense-graded mixtures using the same materials. If there is no history determining whether an anti-stripping agent would be required, then a moisture susceptibility test may be run on a dense-graded mix with the same aggregate and binder (ASTM D7064M-08).

Construction

One of the most important concerns during the construction of porous asphalt pavements is the clogging of the surface or filling of the voids in the stone reservoir. As a result, protecting the pavement during construction from uncontrolled runoff from adjacent areas and the surrounding soil from compaction is critical. This includes having temporary stormwater controls in place until the site is stabilized and clear, specific guidance for construction procedures.

Typical guidelines for construction procedures for porous pavement include:

- Plan to construct the porous pavement as late as possible in the construction schedule.
- Protect site area from excessive heavy equipment running on the subgrade, compacting soil, and reducing permeability.
- Excavate the subgrade soil using equipment with oversized tires or tracks to minimize compaction to soil.
- As soon as the bed has been excavated to the final grade, the fabric filter should be placed with an overlap of a minimum of 16 inches. Use the excess fabric (at least 4 feet) to fold over the stone bed to temporarily protect it from sediment.
- Install drainage pipes, if required.
- Place the aggregate stone recharge bed carefully to avoid damaging the fabric. The aggregate should be dumped at the edge of the bed and placed in layers of 8 to 12 inches using tracked equipment and compacted with a single pass of a light roller or vibratory plate compactor.
- When using a stabilizer course, it is important that the aggregate be sized properly to interlock with the aggregate in the recharge bed. The stabilizer course should be placed at a thickness of about 1 inch. Some larger stones from the stone reservoir should be visible at the surface.
- The porous asphalt should be placed in 1- to 4-inch-thick lifts following state or national guidelines for the construction of open-graded asphalt mixes. (Track pavers are recommended)
- The porous asphalt should be compacted with two to four passes of a 10-ton static roller.
- Restrict traffic for at least 24 hours after final rolling.

Maintenance

In order to maintain long-term performance of porous asphalt pavements' stormwater management capabilities, it is recommended that the surface infiltration rates be inspected annually during rain events to observe any changes in effectiveness of infiltrating stormwater. University of New Hampshire has created a regular inspection and maintenance guide for porous pavements (UNHSC 2011). In addition, to remove any solids and debris that could lead to more permanent clogging of the pavement, it is recommended that porous asphalt pavements be vacuumed two to four times a year or power-washed (UNHSC 2012; Palmer 2012).

During winter months, there are no special requirements for plowing. Deicing chemicals may be used to melt ice and snow from the surface, but the amount of deicing chemicals will be significantly less than for impervious pavements.

BEST PRACTICE	CAUTION	CAUTION
In addition to visual inspections, University of New Hampshire recommends measuring the surface infiltration rates annually.	Porous asphalt pavements should never be sealcoated or crack sealed. If patching is necessary, conventional mixes may be used if less than 10% of the pavement area is affected.	Porous asphalt pavements should never be sealcoated or crack sealed. If patching is necessary, conventional mixes may be used if less than 10% of the pavement area is affected.

Summary and Future Needs

Porous asphalt pavements have been successfully used for more than 35 years in a variety of climates around the United States. They provide a pavement surface that is also part of the stormwater management system, reducing stormwater runoff and pollutants and replenishing groundwater. A number of porous asphalt parking lots have lasted more than 20 years with no maintenance other than cleaning.

Improvements have been made over the past 20 years in the design and construction of porous asphalt mixes; however, additional research should be conducted to develop improved mix-design procedures to reduce the potential for clogging and scuffing of these pavements. There is limited research on structural values for all layers of porous asphalt, therefore additional research should be conducted to determine structural values for the porous asphalt mixes and stone reservoir course. Research should be conducted on rehabilitation of porous asphalt pavements to determine what procedures (i.e., milling, cleaning, tack coat) may be used to rehabilitate these surfaces.

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Porous Asphalt Pavements with Stone Reservoirs

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Research — This TechBrief was developed by Heather L. Dylla, Ph.D., and Kent R. Hansen, P.E. (National Asphalt Pavement Association), as part of FHWA's Advancement of Innovative Asphalt Technologies cooperative agreement. The TechBrief is based on research cited within the document.

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Key Words — porous asphalt, stormwater, low impact development (LID), permeable pavement, pervious pavement

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APRIL 2015 FHWA-HIF-15-009