TOOLBASE.
# TECHSPECS

# Permeable Pavement



## TECH @ A GLANCE

### BENEFITS (+)/DRAWBACKS (–)

+ AFFORDABILITY: Economical system for stormwater management design. The usage of permeable pavement options in some areas may eliminate the cost of piping stormwater to an outfall.
+ ENVIRONMENTAL PROTECTION: Reduces stormwater runoff and impact on storm drainage systems, and provides a reservoir and percolation field for surface water to re-enter ground aquifers. Reduces erosion of local water bodies caused by excessive stormwater runoff, and pollution from contaminates carried in stormwater.
+ SAFETY: Absorbs water and provides a non-slip surface. Permeable pavements tend to be less reflective, causing less glare, and allowing motorists to see pavement better.
– AFFORDABILITY: Maintenance costs will vary and may be higher than predicted depending on installed design, usage, and climatic conditions.

### MAKING THE SWITCH:

Using permeable pavements requires preliminary planning, design, and specifications, and installation expertise. A qualified civil engineer will be able to provide a hydraulic design for stormwater management and drainage. The engineer will also be able to suggest and design a system that would work for the intended use and area. Distributors and manufacturers of permeable pavement systems may also be contacted to ensure their systems will be appropriate for the intended use. Proper installation is paramount to a functional system. In light of this, emphasis should go to planning to ensure a useful permeable paving system.

### INITIAL COST

Asphalt can cost $0.50 to $1.00 per square foot for material and installation, with pervious materials costing from $1.00 to $10.00 per square foot. However, considering the cost of stormwater management, permeable pavement can be a cost-effective alternative.

### OPERATIONAL COST

Maintenance costs are typically higher due to the specific cleaning and restoration processes for various permeable pavements. However, asphalt requires periodic maintenance as well and depending on use and climate permeable pavement can be competitive to asphalt and concrete.

### CODE ACCEPTANCE

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### CODE ACCEPTANCE

Permeable pavement is not covered under model codes, however, many jurisdictions address this type of system. Codes in many jurisdictions may also require the use of certain types of curbs, gutters, or stormwater piping or retention in addition to the permeable surfaces. All permeable materials must meet applicable material quality specifications, and requirements for compressive strength, water absorption, and freeze-thaw resistance. Mixes and installation methods should meet appropriate American Society for Testing and Materials (ASTM) standards for parking lots, driveways, and roads. Concrete used in a slab for permeable pavements must meet minimum strength requirements, and American Concrete Institute (ACI) standards.

### WARRANTY

Parking and road surfaces generally do not carry warranties because of the use and harsh conditions to which they are subjected.

### THE BASICS

Permeable pavement is a porous surface with an underlying stone reservoir to temporarily store surface stormwater runoff before it infiltrates into the subsoil. It can be used as a paving method for many roads, parking lots, driveways, and walkways to reduce stormwater runoff. Permeable pavements are also called pervious, porous, or open-graded pavements. Traditional, or impermeable, pavement systems allow for little to no water filtration, so nearly all rainwater that contacts the surface is carried into waterways through drainage systems.

There are many different types of permeable pavement materials available, depending on the region. Climate, intended use, landscaping aesthetics, and community stormwater requirements should all be considered when determining which type of permeable pavement may be best suited for the site. The underlayment and how it is constructed will also depend on these considerations.

Following are some permeable pavement options that can be considered when planning and designing the next new or renovated pavement project:

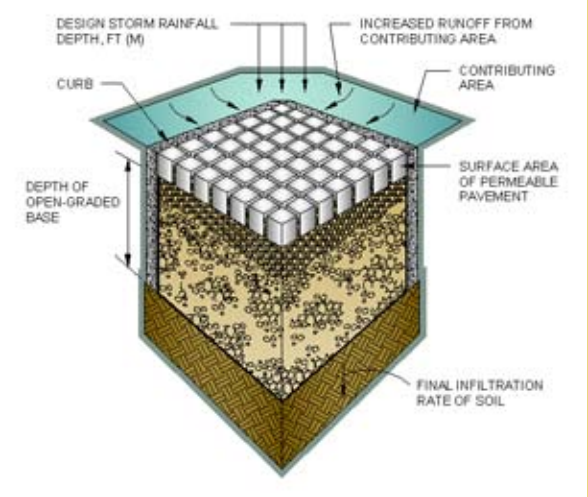
- **Porous asphalt** – A great advantage of porous asphalt is that the same mixing and application equipment is used as for impervious, or standard asphalt. From the surface, porous asphalt may appear to be the same as traditional materials. However, the design mix formula will change for porous asphalt. The mixture is produced without “fine” particles, and incorporates void spaces to allow water infiltration. Porous asphalt is appropriate for pedestrian-only areas such as walkways and patios, and for low-volume, low-speed areas such as parking areas,

*Continued on page 2*

## DOLLARS AND SENSE

**Initial Cost** – The initial cost of the permeable pavement planning and material will be higher than typical asphalt pavement. The material and installation cost of Asphalt is typically estimated at $0.50 to $1.00 per square foot. Porous concrete can range from $2.00 to $6.00 per square foot, and various pavers can range from $1.00 to $10.00 per square foot, with grass and gravel pavers making up the lower range and concrete and stone pavers on the higher end of the range. However, when considering the cost of stormwater management that must be constructed, asphalt lots become more expensive, possibly as high as $10.00 per square foot. Installation of a permeable lot can be as low as $5.00 to $7.00 per square foot total.

**Operational Cost** – Because of differences in surface texture and the importance for flow path through the surface, maintenance of permeable pavements is critical to their effectiveness. Cleaning by vacuum sweeping and pressure washing is generally recommended several times a year, depending on usage and traffic. With more traffic, the maintenance must increase. Additionally, because of different characteristics, it is not advisable to use salt or sand in winter conditions, and plows that can be too abrasive to the surface should not be used. Depending on conditions, it may be necessary to restore permeability. This may add some cost to the successful operation of the surface. However, asphalt surfaces generally need to be repaired regularly and the cost to properly maintain a permeable pavement may not differ significantly.




*Permeable pavement cross-section*

## MAKING THE SWITCH

*What is required to transition from your current building practices to using this technology?*

It is always recommended to begin researching local codes for new practices. Some jurisdictions may also have certain regulations or requirements for stormwater management with the use of permeable pavements. They may also require the use of redundant curbs, gutters, or stormwater piping or retention that would lessen the cost-saving advantages of permeable pavement.

Once aware of these codes, consulting with a qualified and practiced engineer and designer is the next step. Pervious pavements require specific design, specifications, and quality assurance, different from conventional pavements. The substrate, fill, and any piping for a drainable layer must also be designed and carefully placed. Additionally, the intent of use for the area and the climate may change the type of material and layout originally envisioned. Planning is crucial to having a cost effective and useful system.

Once a system is chosen, seek out a qualified installer. Because of more specific details for grading and layering and their importance for proper function, have a way to ensure the installation is closely watched for quality.

Once constructed, be aware of any maintenance that will be required for proper function of the permeable surface. This information should be given to and utilized by whomever manages the property.

THE BASICS *continued*

residential driveways, alleys, and parking stalls. With proper design, porous asphalt can be used in cold or hot climates. Porous asphalt should not be used in areas with high pollutant loads, unless stormwater can be pretreated prior to infiltration into the ground.

- **Pervious concrete** – Like porous asphalt, pervious concrete looks about the same as traditional concrete pavement from the surface. While similar equipment may be used for installation of pervious concrete as for standard concrete, sub-grade preparation and finishing are more critical. Use of pea gravel and a lower water-to-cement ratio, and omission of sand, are used to achieve a pebbled, open surface that is roller-compacted.
- **Plastic grid systems** – Plastic grids (often made from recycled materials) can be used for low-traffic areas, such as parking areas and driveways. Some are designed to be filled with gravel on top of an engineered aggregate material, while others are filled with a sand/soil mixture on top of an aggregate-topsoil mix that allows grass to be planted on the surface. Grids provide a support structure for heavy vehicles, and allow water to gradually absorb into the soil below. Plastic grids must be hand laid then can be filled with soil or sand by hand or machine.
- **Block pavers** – Pavers can be used to create a porous surface with the aesthetic appeal of brick, stone, or other interlocking paving materials. They are most often used for driveways, entryways, walkways, parking areas, or terraces to achieve a traditional, formal appearance. Once the bedding is prepared, pavers become more labor intensive because they must be laid out by hand and then the voids must be filled with a gravel material to allow water to seep through.

While some permeable pavements may look like standard materials, the reduced environmental impact of permeable pavement is significant. Permeable pavement systems take advantage of the natural filtration process as water moves through soil on its way to groundwater aquifers. Filtering water through the ground reduces the amount of runoff that must be managed though storm drainage systems, thereby reducing the flow of pollutants into streams and rivers. According to the U.S. Environmental Protection Agency (EPA), stormwater runoff can send as much as 90 percent of pollutants, such as oil and other hydrocarbon liquids found on the surface of traditional parking lots, directly into local water bodies. The EPA now requires state and local governments to implement measures to reduce and improve overall quality of stormwater runoff in order to address this important pollution problem. Permeable pavements are recognized by EPA as a Best Management Practice (BMP) to address this vital concern. (Refer to Storm Water Technology Fact Sheet - Porous Pavement, EPA 832-F-99-023, www.epa.gov/npdes/pubs/porouspa.pdf).

## TECH CHECK

*Below is a checklist of steps to follow in order to implement this technology in each of your projects.*

- ☐ **Research.** Obtain a list of landscape designers and engineers familiar with Low Impact Development (LID) and permeable pavement. Request that they furnish information on permeable pavement systems available and recommended for the specific region. Consult with the selected distributor or manufacturer of the permeable pavement systems.
- ☐ **Code Requirements.** Become familiar with local regulations and code requirements, and any local review and inspection requirements.
- ☐ **Project Design.** Select a professional familiar with permeable pavement and qualified to design the project. Select a permeable pavement system.
- ☐ **Contractors.** Issue an RFP and select a qualified contractor familiar with placing the particular permeable pavement system.
- ☐ **Construction.** Engage the designer to monitor construction. Upon completion, have the contractor test the system.
- ☐ **Maintenance.** Obtain maintenance requirements from the designer, manufacturer, or distributor of the pavement system.

## FOOD FOR THOUGHT

*This section provides some things to think about before switching to this building technology – make sure it's the right choice for you.*

- Be sure to consider what type of traffic this area will encounter. If it is a parking lot or driveway, will there be a significant amount of large or commercial traffic? Will it be mainly used for bikes or pedestrians? If there is a lot of loading and runoff, more conventional systems may be necessary, or certain characteristics will have to be incorporated into the permeable design to maintain structural and environmental integrity.
- Consider the climate in which you will be installing the pavement. If the winters are snowy or icy, will the pavement require specific snow removal or melting procedures? Depending on if you are using pavers or permeable asphalt or concrete, you may have to use a specific plow blade. Additionally, rock salt may affect the porosity of the site. Consider the tools required for proper maintenance.
- For areas with a significant amount of precipitation, ensure that you are allowing enough drainage time through the underlayment. If it may fill up, be sure to incorporate an overflow basin or perforated drainage pipe.
- Local code requirements for stormwater management design may impact on the cost of installation, and time required for the approval process.
- If you are concerned with aesthetics, consider the color and appearance options presented with colored permeable concrete or block pavers.

## DEFINITIONS

**Aquifer**
is an underground layer of water-bearing permeable rock or unconsolidated material (gravel, sand, or stone) from which groundwater can be usefully extracted using a well.

**Best Management Practices (BMP)**
are effective and practical stormwater management methods which prevent or reduce the movement of sediment, nutrients, pesticides and other pollutants from the land to surface or ground water, or which otherwise protect water quality. These practices are developed to achieve a balance between water quality protection and production of wood crops within natural and economic limitations.

**Infiltration rate**
in soil science is a measure of the rate at which a particular soil is able to absorb rainfall or irrigation. It is measured in inches per hour or millimeters per hour. The rate decreases as soil becomes saturated. If the precipitation rate exceeds the infiltration rate, runoff will usually occur, unless there is some physical barrier.

**Permeability**
is a measure of the ability of a material, typically rock or unconsolidated material, to transmit water. It is important in determining the flow characteristics of groundwater through pavement and soil.

**Standard proctor density**
is the maximum dry density and optimum moisture content of a compacted granular soil. Fills for pavement construction must be compacted to attain an appropriate strength and minimize settlement. The most common method of specifying compaction is to require a certain percentage of maximum that can be obtained in Standard Proctor or Standard Moisture-Density Tests, such as "95% of Standard Proctor."

*Above left: Difference between permeable asphalt and impermeable asphalt laid side by side for comparison. Above right: Permeable asphalt allows water to seep through.*

*Source: United States Department of Agriculture – National Resources Conservation Service (NRCS), www.ia.nrcs.usda.gov/features/urbanphotos.html. Used with permission.*

## RESOURCES

*General information about permeable pavement and its installation:*

### ToolBase Services

Information on this building technology and many others brought to you by PATH and the building scientists at the NAHB Research Center.

www.toolbase.org

### PCA – Portland Cement Association

5420 Old Orchard Road
Skokie, IL 60077-1083
847-966-6200

www.cement.org

### US EPA – United States Environmental Protection Agency

Ariel Rios Building
200 Pennsylvania Avenue, N.W.
Washington, DC 20460

www.epa.gov

### NRMCA – National Ready Mixed Concrete Association

Pervious Concrete Contractor Certification Program
900 Spring Street
Silver Spring, MD 20910
888-846-7622
301-587-1400

www.nrmca.org

### ICPI – Interlocking Concrete Pavement Institute

1444 I Street, NW
Suite 700
Washington, DC 20005
202-712-9036

www.icpi.org

### NAPA – National Asphalt Pavement Association

5100 Forbes Boulevard
Lanham, MD 20706
888-468-6499

www.hotmix.org

### NIBS – National Institute of Building Sciences

WBDG - Whole Building Design Guide:
Federal Green Specs - 32-12-43 (02795)
Porous Paving
1090 Vermont Avenue, NW
Suite 700
Washington, DC 20005-4905

www.wbdg.org

### Low Impact Development Center, Inc.

4600 Powder Mill Road
Suite 200
Beltsville, MD 20705
301-982-5559

www.lid-stormwater.net/index.html

### City of Portland Bureau of Environmental Services

Environmental Research
1120 SW 5th Avenue
Portland, OR 97204
503-823-7740

www.portlandonline.com/bes

PATH
PARTNERSHIP FOR ADVANCING TECHNOLOGY IN HOUSING

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PATH addresses barriers to innovation, provides information on advanced building technologies, and advances housing technology research; making affordable, quality American homes a reality.

For more information on the PATH program, visit www.pathnet.org.

*TechSpecs are prepared for PATH by the NAHB Research Center.*

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*Permeable paver grids*