Pervious Asphalt Pavement

Practice Description

Pervious asphalt, also known as porous, permeable, “popcorn,” or open-graded asphalt, is standard hot-mix asphalt with reduced sand or fines that allow water to drain through it. Pervious asphalt over an aggregate storage bed will reduce stormwater runoff volume, rate, and pollutants. The reduced fines leave stable air pockets in the asphalt. The interconnected void space allows stormwater to flow through the asphalt and enter a crushed stone aggregate bedding layer and base that supports the asphalt while providing storage and runoff treatment. When properly constructed, pervious asphalt is a durable and cost-competitive alternative to conventional asphalt.

Planning Considerations

Pervious asphalt can be used for municipal stormwater-management programs and private development applications. The runoff volume and rate control, plus pollutant reductions, allow municipalities to improve the quality of stormwater discharges. Municipal initiatives, such as Portland’s Green Streets program (shown in the photo above), use pervious asphalt to reduce combined sewer overflows by infiltrating and treating stormwater on site. Private development projects use pervious asphalt to meet post-construction stormwater quantity and quality requirements. The use of pervious asphalt can potentially reduce additional expenditures and land consumption for conventional collection, conveyance, and detention stormwater infrastructure.

Pervious asphalt can replace traditional impervious pavement for most pedestrian and vehicular applications. Open-graded asphalt has been used for decades as a friction course over impervious asphalt on highways to reduce noise, spray, and skidding. Highway applications with all-pervious asphalt surfacing have been used successfully for highway pilot projects in the United States; however, generally, pervious asphalt is recommended for low-volume and low-speed applications (Hossain et al., 1992). Pervious asphalt performs well in pedestrian walkways, sidewalks, driveways, parking lots, and low-volume roadways. The environmental benefits from pervious asphalt allow it to be incorporated into municipal green infrastructure and low impact development programs. The appearance of pervious asphalt and conventional asphalt is very similar. The surface texture of pervious asphalt is slightly rougher, providing more traction to vehicles and pedestrians.

Design Criteria

Pervious asphalt should be designed and sited to intercept, contain, filter, and infiltrate stormwater on site. Several design possibilities can achieve these objectives. For example, pervious asphalt can be installed across an entire street width or an entire parking area. The pavement can also be installed in combination with impermeable pavements or roofs to infiltrate runoff. Several applications use pervious asphalt in parking lot lanes or parking stalls to treat runoff from adjacent impermeable pavements and roofs. This design economizes pervious asphalt installation costs while providing sufficient treatment area for the runoff generated from impervious surfaces. Inlets can be placed in the pervious asphalt to accommodate overflows from extreme storms. The stormwater volume to be captured, stored, infiltrated, or harvested determines the scale of permeable pavement required.

Pervious asphalt comprises the surface layer of the permeable pavement structure and consists of open-graded coarse aggregate, bonded together by bituminous asphalt. Polymers can also be added to the mix to increase strength for heavy load applications. The thickness of pervious asphalt ranges from 2 to 4 inches depending on the expected traffic loads. For adequate permeability, the pervious asphalt should have a minimum of 16% air voids. Additional subsurface components of this treatment practice (illustrated in Figure 1) include the following (National Asphalt Pavement Association, 2008):

- *Choke course* - This permeable layer is typically 1-2 inches thick and provides a level and stabilized bed surface for the pervious asphalt. It consists of small-sized, open-graded aggregate.
- *Open-graded base reservoir* - This aggregate layer is immediately beneath the choke layer. The base is typically 3-4 inches thick and consists of crushed stones typically 3/4 to 3/16 inch. Besides storing water, this high-infiltration rate layer provides a transition between the bedding and subbase layers.
- *Open-graded subbase reservoir* - The stone sizes are larger than the base, typically ¾ to 2½ inch stone. Like the base layer, water is stored in the spaces among the stones. The subbase layer thickness depends on water storage requirements and traffic loads. A subbase layer may not be required in pedestrian or residential driveway applications. In such instances, the base layer is increased to provide water storage and support.
- *Underdrain (optional)* - In instances where pervious asphalt is installed over low-infiltration rate soils, an underdrain facilitates water removal from the base and subbase. The underdrain is perforated pipe that ties into an outlet structure. Supplemental storage can be achieved by using a system of pipes in the

aggregate layers. The pipes are typically perforated and provide additional storage volume beyond the stone base.

- *Geotextile (optional)* - This can be used to separate the subbase from the subgrade and to prevent the migration of soil into the aggregate subbase or base.
- *Subgrade* - The layer of soil immediately beneath the aggregate base or subbase. The infiltration capacity of the subgrade determines how much water can exfiltrate from the aggregate into the surrounding soils. The subgrade soil is generally not compacted.

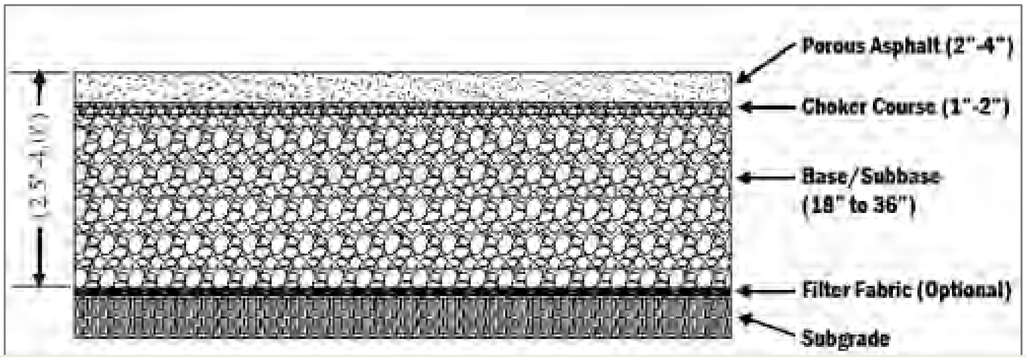

Figure 1 Typical Porous Asphalt Pavement Section (diagram adapted from USEPA, 1986)

The same equipment can be used for mixing and laying permeable asphalt as for conventional asphalt. The method for laying the asphalt will also be similar. During compaction of the asphalt, minimal pressure should be used to avoid closing pore space. Vehicular traffic should be avoided for 24 to 48 hours after pavement is installed.

The load-bearing and infiltration capacities of the subgrade soil, the infiltration capacity of the pervious asphalt, and the storage capacity of the stone base/subbase are the key stormwater-design parameters. To compensate for the lower structural support capacity of clay soils, additional subbase depth is often required. The increased depth also provides additional storage volume to compensate for the lower infiltration rate of the clay subgrade. Underdrains are often used when permeable pavements are installed over clay. In addition, an impermeable liner may be installed between the subbase and the subgrade to limit water infiltration when clay soils have a high shrink-swell potential, or if there is a high depth to bedrock or water table (Hunt and Collins, 2008).

Common Problems

Measures should be taken to protect permeable pavement from high sediment loads, particularly fine sediment. Appropriate pretreatment BMPs for run-on to permeable pavement include filter strips and swales. Preventing sediment from entering the base of permeable pavement during construction is critical. Runoff from disturbed areas should be diverted away from the permeable pavement until these areas are stabilized.

Several factors may limit permeable pavement use. Pervious asphalt has reduced strength compared to conventional asphalt and will not be appropriate for applications with high volumes and extreme loads. It is not appropriate for stormwater hotspots where hazardous materials are loaded, unloaded, stored, or where there is a potential for spills and fuel leakage. For slopes greater than 2 percent, terracing of the soil subgrade base may likely be needed to slow runoff from flowing through the pavement structure.

Maintenance

The most prevalent maintenance concern is the potential clogging of the pervious asphalt pores. Fine particles that can clog the pores are deposited on the surface from vehicles, the atmosphere, and runoff from adjacent land surfaces. Clogging will increase with age and use. While more particles become entrained in the pavement surface, it does not become impermeable. Studies of the long-term surface permeability of pervious asphalt and other permeable pavements have found high infiltration rates initially, followed by a decrease, and then leveling off with time (Bean et al., 2007). With initial infiltration rates of hundreds of inches per hour, the long-term infiltration capacity remains high even with clogging. When clogged, surface infiltration rates usually well exceed 1 inch per hour, which is sufficient in most circumstances for the surface to effectively manage intense stormwater events (Interlocking Concrete Pavement Institute, 2000). Permeability can be increased with vacuum sweeping. In areas where extreme clogging has occurred, half-inch holes can be drilled through the pavement surface every few feet or so to allow stormwater to drain to the aggregate base. A stone apron around the pavement connected hydraulically to the aggregate base and subbase can be used as a backup to surface clogging or pavement sealing.

Due to the well-draining stone bed and deep structural support of pervious asphalt pavements, they tend to develop fewer cracks and potholes than conventional asphalt pavement. When cracking and potholes do occur, a conventional patching mix can be used. Freeze/thaw cycling is a major cause of pavement breakdown; pervious asphalt parking lots can have a lifespan of more than 30 years because of the reduced freeze/thaw stress (Gunderson, 2008).

Cold weather and frost penetration do not negatively impact surface infiltration rates. Pervious asphalt freezes as a pervious medium rather than a solid block because permeable pavement systems are designed to be well drained; infiltration capacity is preserved because of the open void spaces (Gunderson, 2008). However, plowed snow piles should not be left to melt over the pervious asphalt, as they can receive high sediment concentrations that can clog the pavement system more quickly.

Permeable pavements do not treat chlorides from road salts but also require less applied deicer. Deicing treatments are a significant expense, and chlorides in stormwater runoff have substantial environmental impacts. Reducing chloride concentrations in runoff is achieved only through reduced application of road salts, because removal of chloride with stormwater BMPs is not effective.