Permeable Pervious Porous Pavements and Paver – Oh My!

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It goes by many different names but they all mean the same thing—a surface that will allow water to increase throughout the Twin Cities metro area because of its ability to help clean up stormwater runoff. It was only a few short years ago that examples of this technology were hard to come by in Minnesota but now there are many sites to see and learn from.

What exactly is Porous Pavement?

Porous pavements are hard infrastructure surfaces that allow water to go through the surface into the soils below instead of running off as would happen on a traditional pavement surface.

Pervious concrete allows rainwater to soak through. Photo courtesy of National Ready Mix Concrete Assn.

But Why Use Porous Pavements?
Pavements reduce the volume of stormwater that would otherwise run off roads, parking lots and sidewalks and on into the storm sewer system. The pollutants in that water also drain into the soil, where natural processes change pollutants into useful soil components.

But wait a minute ! The ground can't hold all that water without flooding, so how does this work?
Excavation and rock fill below the surface is necessary, to create a rock reservoir under the porous surface. Rock layers that do not crumble under pressure leave open air spaces between rocks. A great deal of water can be stored in this layer at the same time that the rock layer supports the weight of vehicles. This rock layer is sometimes called a "rock reservoir."

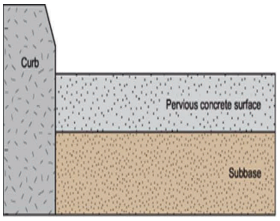


Photo courtesy of National Ready Mix Concrete Assn.

What are the disadvantages to porous pavement
Lack of experience is currently a major drawback with this technology; building codes may not allow it, and improper installations can clog or otherwise fail. Protection of groundwater quality must be considered; fuel leaks from vehicles and toxic chemicals
may leach from asphalt and/or binder surfacing.

Concerns yet to be resolved include:

1. whether porous pavement can maintain its porosity over a long period of time, particularly with resurfacing and snow removal;
2. whether porous pavement remains capable of removing pollutants after subfreezing weather and snow removal;
3. the cost of maintenance and rehabilitation options for restoration of porosity.

Best Places for Porous Surfaces

Best places for porous surfaces depends on the objective, the budget, climate and maintenance issues. Porous driveways, parking lots, cul-de-sacs, trails, sidewalks and even porous roads can be a sensible investment whenever there is value and advantage to allowing water to soak into the ground where it lands. The cost of this technology can be justified under the following circumstances:

1. When land is scarce or expensive: Because the extra excavation and rock fill can be expensive front end costs, it may be necessary to try this technology in sites where space for ponds, rain gardens, etc. is scarce or expensive. Land availability was a limiting factor for Ramsey-Washington Metro Watershed District (RWMWD) when building its new office in Little Canada, MN, in 2005. Schmelz Volkswagen in Maplewood MN also had limited land for expansion.
2. When road reconstruction is needed in an area that is a high priority for water quality improvement: Costs of porous pavements get closer to "even" when comparing to the cost of traditional pavements when the pavement itself can function as a separate stormwater treatment system. The City of Shoreview constructed a section of road to test this type of use.
3. When parking lots that get flooded or turn icy: A surface with better traction and less chance for ice buildup can decrease slips and falls. Because the water can soak through the surface quickly it doesn't have a chance to sit on the surface and freeze. Some commercial developers like to use porous pavements in walkway areas in order to provide a safer environment for their customers.
4. When roads have difficulty draining, thereby increasing hydroplaning accident potential: Holland has long used porous road surfaces for various reasons including reduction of traffic noise and safety reasons to reduce splash, spray and hydroplaning accidents. [1] Changing Minnesota climate may result in more icy road conditions.

Design Criteria (EPA)

Failures generally occur due to poor design or construction, low subsoil permeability and lack of adequate preventive maintenance. Failures and risks can be reduced with careful assessment of site conditions, construction materials and installation methods.

Performance (EPA)

Porous pavement can remove pollutants. To accomplish this, the soil must be conducive to the following functions: absorption, straining (filtering) and microbiological decomposition of pollutants. Pollutant removal is more likely if the aggregate used in installation is clean-washed, if drainage time takes at least 24 hours, and if soils below are highly permeable and the subsoils contain organic matter. Routine vacuum sweeping maintenance is also helpful.

Longevity (MECA)

Longevity is enhanced with low use and restricted vehicle weight. Maintenance factors enhancing longevity are regular vacuum sweeping, high pressure washing and limited use of de-icing chemicals and sand. Of course stringent sediment control from surrounding land is imperative.

TYPES OF POROUS SURFACING

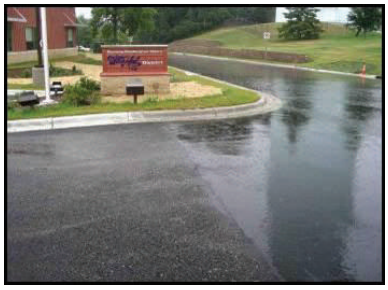
Porous Asphalt

In the fall of 2005, RWMWD installed the first example of porous asphalt in the state of Minnesota. The District had limited land to build on and was interested in demonstrating the use of porous pavements to better understand how well they work and to promote its use on other projects and sites.

The porous asphalt mix is similar to a traditional asphalt mix and is installed in the same manner. The difference is that for the porous asphalt there are no fine particles used in the mix that normally would make the surface smooth; the asphalt simply coats the pavement gravel which then sticks together under pressure from a roller.

Footnote 1: Maarten Noort, Metro Consult, The Netherlands. Winter Maintenance on Porous Asphalt, in Snow removal and ice control technology: selected papers presented at Fourth Symposium. By National Research Council (U.S.). Transportation.

The porous asphalt then has void spaces that allow the water to flow through into the rock reservoir below.



Close up of water pouring onto porous asphalt. Porous asphalt on the left, traditional street on the right.
Both photos courtesy of Ramsey-Washington Metro Watershed District.

As for European use, the Netherlands have used porous asphalt roads since 1986 and have studied the advantages and disadvantages of porous asphalt roads in their country.[1] The Netherlands reports their greatest challenge to be freezing rain, the most common winter element there. In Lulea Sweden a residential street was installed in 1995. [2]

The earliest use in the US reported their biggest challenge as at the Franklin Institute parking lot in Philadelphia PA in the late 1970's. In the early 1980's Cahill Associates in West Chester PA installed several in mid-Atlantic states, notably 600 porous parking spaces in an office park adjacent to a highly valued creek in a Philadelphia suburb. Porous asphalt and concrete performance in the cold Upper Midwest climate is being studied at MnDOT's Office of Materials and Road Research.

For the last three years RWMWD staff have watched for the parking lot to fill up and overflow into the adjacent rain garden. That has never happened yet. All of the water that falls on the parking lot or makes its way there from the street soaks right into the pavement and rock layers below, and then on down into the native soils.

Since the District's porous asphalt parking lot installation, many others have been done in the District including the City of Maplewood's Public Works parking lot and the Church of St. Peter's parking lot in North St. Paul where some new parking stalls are porous rather than the entire parking lot.

Elsewhere around the Twin Cities Metro Area, porous asphalt has been used.

- In 2007 the White Bear Unitarian Universalist Church in Mahtomedi installed a 15200 square foot porous asphalt parking lot.

Porous Concrete

Similar to porous asphalt is porous concrete. It works the same as asphalt in that water can soak into the surface because there are no fine sands used. Some say that porous concrete looks like a Rice Krispies bar with empty spaces between the rocks of the concrete.

Use of porous concrete goes back to early 1900's where Mexico City used it to recharge their groundwater aquifer.[3] Further north in the United States, climates can be more challenging and testing more cautious.

Footnote 2: Christer Stenmark, 1995, An Alternative Road Construction for Stormwater Management in Cold Climates, in Water Science and Technology vol.32, no. 1, p. 79-84.

Footnote 3: omprehensive Onsite Stormwater Management Program for Small Parcel Site Development, Angie Nikolas, Zabest Environmental Concrete, LLC. September 14, 2006

Examples in the Twin Cities Metro Area:

- City of Minneapolis recently used porous concrete for street gutters.
- In 2009 porous concrete was used for the parking lot of the Mahtomedi Public Works Building.
- At Bryn Mawr and Ewing Ave. a porous concrete sidewalk 600 feet long was constructed in 2006; that same year at Bryn Mawr and Antoinette Ave. they laid a project half with porous concrete and half in porous asphalt.
- In 2006 Rawson Commons Retail Center in Franklin WI used porous concrete for parking stalls.
- City of Shoreview used porous concrete as a residential street reconstruction demonstration in 2009. Porous concrete now stretches for ¾ mile in a neighborhood on the shores of Lake Owasso. The City found that almost a mile of porous concrete streets cost about the same as traditional concrete; in addition the concrete stored and treated the required amount of stormwater that runs off the street in a normal storm, thereby protecting downstream ponds lakes. The concrete is 7" thick, laid on top of an 18-inch aggregate base. For more details go to http://www.terraroadalliance.org/publications/enews/documents/ShoreviewPerviousWebinar.pdf
- The City of Blaine encourages the use of porous surfaces as part of new development as well as areas of redevelopment. The city currently is using its own sites as demonstration areas and is collecting data to illustrate several infiltration statistics. The city also installed a section of pervious concrete at the garage addition at City Hall last year, and will add an area of pervious pavers at the new parking lot at Lakeside Commons Park in Blaine.

Pavers

Photo courtesy of Ramsey-Washington Metro Watershed District.

Pavers or bricks are often used in landscaping, where porous surfaces are important and aesthetic. Although the pavers themselves are not porous, the space between the pavers is a calculated distance; the space is filled with pea gravel—a fill that will allow the necessary amount of water to soak into the space and move on down into the ground. That amount of water would otherwise run off the traditional hard surface carrying pollutants along with it to the storm sewer or downstream lake.

The advantage to using pavers for removing stormwater from the surface, is that clogging of the pea gravel with sediment is rare, but if it happens the trouble spots can be fixed without affecting other areas. Pavers are used in low traffic areas or in a patio or driveway setting most often. The disadvantage is that laying the pavers is a very labor intensive process and pavers themselves are more expensive than mass-produced porous concrete or asphalt.

Examples in the Twin Cities Metro Area:

- Schmelz Volkswagen in Maplewood used pavers in a parking lot expansion project in 2002 in lieu creating a pond where parking space was needed.
- In Minneapolis porous pavers were used in an animal shelter parking lot in 2002.
- In 2005 the RWMWD demonstrated the use of porous pavers in a cul-de-sac retrofit project in Woodbury.
- University of Minnesota Landscape Arboretum installed 5 test areas with different configurations of pavers and vegetation in a parking lot area to compare their effectiveness.
- Grass paved fire lanes were installed at 2632 35th St East & 3014 39th St. East in Minneapolis.
- Gravelpave walking path was installed at Minnehaha Academy in Minneapolis.

Out state examples include Borgert Products in St. Joseph MN, where EcoStone was used. Grasspave fire lane at 10 University Drive in Duluth.

What Else is Out There?

The future of porous pavements includes refining the mixes of current porous asphalt and concrete in order to provide a better product with the same benefits. Other products are coming on the market such as porous surfaces made from recycled tires and recycled glass.

Other porous surfaces such as reinforced grass surfaces or a gravel filled grid system can be used in a similar manner. Grass surfaces installed over soil filled plastic grids can hold the weight of a fire truck and are used in areas only designated as an emergency fire lane or in overflow parking lots that are only used a few times a year. Gravel filled grid systems have similar uses.

Examples in the Twin Cities Metro Area mixed uses of porous pavements:

- In Minneapolis, at Minnehaha and James Avenues, 100 feet of grass pavers were used for a walkway and driveway in 2002.
- A combination of mixtures of technology are used on sites to manage stormwater innovatively. One local example is at 29th Street along 5th Avenue in south Minneapolis, where Glenn Rehbein Companies installed a grass lawn parking lot that is also used for soccer scrimmages—dual land use where available land is scarce.
- In Lino Lakes the Lino Lakes state Bank used Netpave for its driveway in 2006.
- In Dearborn Michigan, at the Ford Truck Plant and surrounding Rouge Center buildings, is the world's largest installation of porous pavement—over 16 acres. In addition, 10.4 acres of building roof are topped with sedum plants to absorb and use stormwater. All of this became necessary because the plant had been built long ago on 2 million acres of low-lying poorly drained area of the Rouge River watershed.

Of course maintenance of any of these porous surface technologies is of great concern. The Netherlands addressed maintenance . The University of Rhode Island Case Study of its porous asphalt parking lots includes maintenance recommendations. MnDOT research includes maintenance considerations. The Public Works Engineering, Construction and Maintenance Journal of July 2003 addressed many concerns about porous pavement maintenance (www.pwmag.com)

Photo courtesy of Ramsey-Washington Metro Watershed District.

References and Resources

Minnesota sources of information:

A Global Perspective on Porous Pavement: The Alternative Nationwide, by Bruce Ferguson, MECA, 2002. This resource summarizes design standards related to soils, hydrology, frost, runoff and infiltration, porous pavement structure, and provides references and resources including design software, useful websites and publications.

MnDOT Office of Materials and Roads Research, Maplewood, MN.

Minnesota Asphalt Pavement Association

Minnesota Concrete Pavement Association

Aggregate & Ready Mix Association of Minnesota: www.armofmn.com

National Stone Association: www.aggregates.org and The Aggregate Handbook (1991) Section 11.9

Netlon Turfguard & Advanced Turf: www.netlon.co.uk

Manufacturers, Suppliers, Installers of Uni-Eco Stone Cement pavers:

Bogert Products

Gertens

Landscape Center

Leitner Nursery

Rock Gardens

Northland Landscape Supply

Rush Lake Gardens, LLC

Cemstone Products Company

Porous Asphalt: Pine Bend Paving

Porous Concrete: Cemstone makes it and North Country Concrete installs it.

Permeable Turf Paving Systems: Glenn Rehbein Companies

National References and Resources:

US EPA Porous Pavement Fact Sheet. Publication # EPA832-F-99-023 September 1999.

Center for Watershed Protection: www.cwp.org

Nonpoint Education for Municipal Officials: http://nemo.uconn.edu

Stormwater Journal: www.stormh2o.org

US EPA Porous Pavement Fact Sheet. Publication # EPA832-F-99-023 September 1999.

American Concrete Institute: www.aci-int.org

Porous pavement design software: www.uni-groupusa.org

http://ehp.niehs.nih.gov/members/2005/113-7/focus.html

http://www.perviouspavement.org/resources.htm