TERRA Transportation Engineering and Road Research Alliance
Partnering for Roadway Innovation
November 2008
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Pervious Concrete

Storm water runoff can have harmful effects on our streams, lakes, and wetlands. To reduce this problem, TERRA is leading the way with innovative research into the use of pervious pavements in northern climates. Pervious concrete, which allows some infiltration, is used primarily to control storm water runoff for parking lots, low-volume roads, and walking trails.

In the past, low strengths and limited freeze-thaw test results hindered the use of pervious concrete in the midwestern and northeastern United States. Pervious concrete mixes that possess adequate strength, permeability, and freeze-thaw resistance have now been developed for such climates.

Besides preserving native ecosystems, pervious concrete also offers advantages that include improving skid resistance by removing water during rainy days, reducing noise, minimizing the heat-island effect in large cities, and, in some cases, minimizing costs.

The following highlights were gleaned from a variety of sources, including published reports of research conducted at MnROAD and other research centers, as well as industry publications.

What is Pervious Concrete?

Pervious concrete has functionality and workability similar to that of regular concrete, but the mix lacks sand and other fine particles. This creates a significant number of interconnected voids, through which water flows relatively unobstructed.

A typical cross-section of pervious pavement consists of a pervious concrete layer, a permeable base up to 18 inches thick, and a permeable subgrade. Drainage pipes are sometimes used to drain water from a subgrade with low permeability.

Though pervious concrete typically is used to control storm water runoff, it also has been used in applications such as swimming pool decks, greenhouse floors, and boat ramps.

Design and Construction

- Typically, between 15 and 25 percent voids are achieved in hardened pervious concrete. Flow rates for water through pervious concrete are typically around 500 inches per hour, though they can be much higher.
- An important aspect in designing pervious concrete pavements for freeze-thaw areas is avoiding, or at least limiting, saturation, especially during the time of year when freezing can be expected. It is possible to design pervious concrete pavements to control the degree of saturation and the average maximum distance to a free surface.
- The hydrologic and structural success of pervious concrete depends on correct material selection, design, installation, and maintenance. Failures—clogging and structural degradation—result from neglecting one or more of these steps.
- Due to concerns about the clogging over time of pervious pavement structures, Mn/DOT researchers improvised and calibrated a "perveameter" to monitor hydraulic conductivity.
- The American Society for Testing and Materials (ASTM) is developing standard testing procedures for surface infilitration monitoring and fresh pervious concrete density.
- Nearby debris and sedimentation should not drain directly into the pervious concrete to prevent clogging. In addition, a landscape fabric can be an effective separation layer between soils and the drainable base layer.
- Despite the high void content, properly placed pervious concrete pavements can achieve strengths more than adequate for most low-volume pavement applications, including high-axle loads for garbage trucks and emergency vehicles such as fire trucks.

Pervious Concrete Research at MnROAD

Though the understanding of the performance of pervious concrete in northern climates is still limited, the Minnesota Department of Transportation (Mn/DOT) is collaborating with the Aggregate and Ready Mix Association of Minnesota (ARM) to provide leadership in this technology. This partnership resulted in construction at the MnROAD facility of a pervious concrete driveway, a pedestrian walkway, and two test cells on the low-volume road (LVR).

Design and instrumentation similar to that used in the pervious concrete driveway at MnROAD has been replicated in the LVR pervious concrete test cells. This makes it possible to capture data about the actual freeze-thaw cycles in the pavement and further use the two years of data already collected from the driveway and sidewalk.

By evaluating pervious concrete in Minnesota's climate, the LVR study also will provide long-term performance monitoring of changes in porosity and infiltration under standard measurable traffic loads, environmental effects, and deicing operation.

Benefits

- Pervious concrete systems replenish the ground water table while at the same time decreasing the amount of runoff and pollution entering streams during large storm events, significantly reducing potential for downstream flooding events.
- This pavement technology can lower overall project costs and create more efficient land use by eliminating the need for retention ponds, swales, and other storm water management devices.
- Pervious concrete pavement voids tend to absorb tire-pavement noise, and sound absorption levels have been shown to increase with higher porosity levels and smaller aggregate sizes.

Implementation

- These recent projects in Minnesota used pervious concrete:
  - MnROAD low-volume road test cells 85 and 89, Albertville, Minnesota (October 2008)
  - Boat ramp project (Mn/DOT SP 0301-47), Detroit Lakes, Minnesota (Summer 2008)
  - Public alleyway, Owasso Heights Neighborhood, Shoreview, Minnesota (Fall 2007)
  - MnROAD sidewalk test cell 74, Albertville, Minnesota (September 2006)
  - MnROAD driveway test cell 64, Albertville, Minnesota (Summer/Fall 2005)
  - Cul-de-sac, 10th Ave. at Lake St., Minneapolis, Minnesota (October 2006)
  - Edgewater Park walking trail, Marshall St. NE., near Lowry Ave. N.E., Minneapolis, Minnesota (Summer 2006)

For Further Reading

- *Mn/DOT's Pervious Concrete Research* (MnROAD, 2008)
- *MnROAD Cell 64 Pervious Concrete, First Year Performance Report* (MnROAD, 2007)
- *2006 MnROAD Pervious Concrete Project* (MnROAD, 2007)
- *2005 MnROAD - Pervious Concrete Project, Cell-64 Driveway Construction Report* (MnROAD, 2006)
- *Mix Design Development for Pervious Concrete in Cold Weather Climates* (CP Tech Center, 2006)
- *Integrated Materials and Construction Practices for Concrete Pavement: A State-of-the-Practice Manual* (CP Tech Center, 2007)
- *Pervious Concrete (*ACI, 2006)
- *Specification for Pervious Concrete Pavements* (ACI, 2008)
- *Effect of Aggregate Type of the Freeze-Thaw Durability of Pervious Concrete* (PCA, 2008)
- National Concrete Pavement Technology Center (CP Tech Center)
- NRMCA Pervious Concrete
- Villanova Pervious Concrete
- American Concrete Institute
- ConcreteNetworks.com
- Portland Cement Association

Links to these resources are on the TERRA Web site at www.TerraRoadAlliance.org

For More Information

For more information about the research in this fact sheet, please contact the following from the Mn/DOT Office of Materials and Road Research:

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TERRA Partners

- Minnesota Department of Transportation (Mn/DOT)
- Minnesota Local Road Research Board (LRRB)
- Federal Highway Administration (FHWA)
- University of Minnesota
- Iowa State University
- National Ready Mixed Concrete Association (NRMCA)
- Aggregate and Ready Mix Association of Minnesota (ARM)
- Industry representatives, including contractors and material providers

About TERRA

The Transportation Engineering and Road Research Alliance, or TERRA, brings together government, industry, and academia in a dynamic partnership to advance innovations in road engineering and construction, including issues related to cold climates. More about TERRA is online at www.TerraRoadAlliance.org.

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