



TECHNICAL SUMMARY

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\$80,500



The first step in studying porous asphalt pavement was to build two sections of it around a section of regular asphalt pavement.



RESEARCH SERVICES

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Porous Asphalt Pavement Performance in Cold Regions

What Was the Need?

Porous asphalt pavements, designed with higher air voids, allow water to drain directly through the open-graded pavement structure into the underlying layers, reducing runoff. These mixes have been commonly used in parking lots and thin surface courses but have been less studied as full-depth roadway pavements, particularly in cold climates. Full-depth porous pavements may lack the strength necessary for urban high-volume roads but are desirable for low-volume road applications because of their potential benefits.

Potential porous pavement benefits include drainage directly into the soil and groundwater, reducing the need for costly drainage structures and rights of way; reduction in stormwater runoff volume and damaging surges like those responsible for the dramatic road damage in Duluth, Minnesota, in 2012; reduction in sediment loading in the runoff that harms water quality; faster snowmelt and drainage of meltwater prior to refreezing; reduction in tire spray and hydroplaning; absorption of noise from tires and engines; reduction in summertime high-temperature runoff, which is harmful to nearby surface water environments; and improved transfer of water and oxygen to nearby plant roots.

Porous pavements also present challenges. Porous asphalt typically contains high binder content, requires thicker lifts and involves construction challenges, all potentially adding to costs. Porous pavements eventually clog with dirt and organic debris, reducing permeability advantages. Vacuuming and other cleaning methods employed to reduce the clogging add to costs. Toxic spills would have a more direct path to groundwater through porous pavements; in such incidents, pavements may have to be removed to address the problem. Deicers also drain directly through porous pavements. Finally, porous pavements often provide less strength and shorter life spans than standard dense-graded mixes.

What Was Our Goal?

Researchers sought to evaluate the performance of full-depth porous asphalt pavements on low-volume roads in a climate as cold as Minnesota's. The investigation studied durability, maintenance requirements, hydrologic benefits and environmental considerations for full-depth porous pavements.

What Did We Do?

Research began at [the MnROAD facility](#) with the construction of three test sections: a 6-inch, full-depth porous asphalt pavement over granular subgrade; a 6-inch, full-depth porous asphalt over cohesive subgrade; and a dense-graded asphalt over mixed materials as a control. Loading and data collection ran from December 2008 through December 2011. The sections received about 40,000 equivalent single-axle loads (ESALs) over that period, considered to be substantial loading for porous pavements.

What Did We Learn?

MnROAD results demonstrated that the porous pavements performed reasonably well and may suit certain applications.

Porous asphalt pavements have potential to improve stormwater management. Research found that even in a cold climate, porous pavements can perform reasonably well on low-volume roads.

“Porous pavement is a good tool in the toolbox for stormwater management. However, it needs to be used in the right application.”

—Larry Matsumoto,
Department of
Public Works, City of
Minneapolis

“We designed a very robust porous asphalt mix and structure. There were construction and durability challenges, but it performed well considering the amount of applied loading.”

—Matthew Lebens,
Research Project
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Permeability tests in which water is flushed through the pavement structure were central to the investigation of porous asphalt pavements. The tests confirmed that porous asphalt drains and filters water effectively through the pavement structure.

Performance and Durability

- After 40,000 ESALs, the porous pavements developed significant rutting in the loading lane, and seasonal vertical movement was observed across the entire loading lane.
- The top inch of pavement experienced significant surface raveling, which may be partially attributed to temperature segregation at the time of construction.
- Investigators identified no cracking or other significant distress in any of the three sections after three years.
- Porous HMA showed lower resiliency and more strain than the dense-graded control, but the lack of cracking discourages conclusions about the impact of these findings.

Maintenance

- MnROAD is a cleaner facility than most road environments, and surface clogging was not significant. Therefore, vacuum maintenance efforts were not conclusive.

Hydrologic Performance

- Surface permeability fell, but in the end averaged 0.5 inches per second—a much more than adequate rate for expected rainfall. No overflows were observed in the open-graded base in either the sand or clay subgrades.

Environmental Performance

- The porous pavements proved quiet and about 50 percent better for skid resistance, offering an excellent surface for friction testing with bald tires.
- Snow and ice melted faster on the porous pavements, and copper and zinc concentrations were reduced in water filtered through the porous structures.
- Temperature measurements indicated porous pavements would cool stormwater before discharge into sensitive areas.

What's Next?

The porous sections at MnROAD will remain in place for monitoring through 2014, and investigators may look into rehabilitation and continuing research after that point. Research findings will inform the design and maintenance of porous asphalt pavements in Minnesota and other cold climates. Overall, the porous pavement sections performed well in terms of ride quality, permeability, stiffness, strain response, safety and quietness. Porous asphalt remains, however, more sensitive to traffic loading and clogging issues than standard asphalt pavement. This research has shown that full-depth porous pavements can be effectively utilized in Minnesota in certain situations, particularly in applications with limited heavy loading.

This Technical Summary pertains to the LRRB-produced Report 2012-12, “Porous Asphalt Pavement Performance in Cold Regions,” published April 2012. The full report can be accessed at <http://www.dot.state.mn.us/research/documents/201212.pdf>.