Permeable Pavements Reduce Slippery Conditions During Winter Thaw

What Was the Need?
Road salt can be effective at melting snow and ice and at improving friction for drivers in winter weather. It is also relatively inexpensive. But road salt from roadways eventually works its way into streams, lakes and groundwater, damaging wildlife habitats and fouling water for drinking and other uses, as well as damaging roads and travel infrastructure.

To protect waterways and habitats, road managers are investigating ways to reduce the use of road salt. A number of local road agencies have been experimenting with the use of permeable pavement. These pavements are usually constructed with asphalt or pavers and feature a porous structure that drains water into systems below the roadway rather than allowing it to pool on road surfaces where it freezes and requires an application of road salt.

But permeable pavements present challenges. They are typically more expensive than conventional asphalt pavement, require care by contractors during construction, and require maintenance to keep pores from clogging with decaying leaves and other organic material. These pavements also don’t offer the strength of impermeable pavements and are better-suited for residential streets, parking lots and other applications not used by commercial trucks and equipment. Permeable pavements can be cost-effective, however, if they can replace storm sewer infrastructure.

Effective permeable pavements offer safe, high-friction driving surfaces in many weather conditions while protecting waterways and aquifers. Minnesota communities have had success using permeable asphalt, pavers and other forms of the technology. But engineers do not know how well permeable pavements remove meltwater, reduce accumulation of snow and ice on driving surfaces, and limit the need for road salt.

What Was Our Goal?
The goal of this Local Road Research Board project was to investigate the performance of permeable pavements in winter weather. Investigators sought to determine if unsalted, permeable pavements leave more or less snow and ice on roadways during winter conditions than salted, impermeable pavements.

What Did We Do?
Researchers conducted a literature review focusing on temperature levels at the surface and in the subgrade of permeable and conventional impermeable pavements. They also reviewed methods for analyzing snow and ice melting behavior on permeable pavements.

The team then installed equipment at MnROAD to evaluate permeable and impermeable pavements over the winter of 2017, recording surface conditions photographically and collecting readings of air temperature, pavement surface temperature and in-pavement temperature with gauges.

The following winter, researchers used a portable friction testing unit to examine wintertime surface conditions at sites in Robbinsdale, Maplewood and St. Paul. Researchers surveyed cities in the Twin Cities area to identify other sites for investigation in the
Researchers evaluated permeable and impermeable pavements at sites in the Twin Cities like this one in Maplewood, examining snow and ice cover, friction and temperature.

winter of 2020. Then they evaluated surface friction and surface and air temperatures at 22 sites featuring permeable and impermeable pavements in the Twin Cities area, and tested the dissipation of cold water on frozen pavement surfaces in Edina.

What Did We Learn?
Photographic analysis was useful in identifying the presence and dissipation of snow, but ineffective for distinguishing ice and water on pavement surfaces. Analysis of temperature differences at subgrades and surfaces correlated better with judgments of slipperiness.

Surface friction testing proved the most reliable method for comparing driving conditions. The thermal insulation properties of porous, permeable pavements regularly emerged in testing. Of the 22 sites in the final round of analysis, 13 produced higher friction levels on conventional pavements than on permeable pavements, and seven showed similar friction levels.

The voids below permeable pavement act as a thermal insulator such that the ground temperatures were less of an influence on surface temperatures. Snow and ice were slower to melt on 13 of the permeable pavements compared to their impermeable controls, and the remaining nine sites showed similar cover on the two types of paving.

However, water pooled more on impermeable pavements than on permeable at eight of the sites; 14 sites had similar or no pooled water on both pavements, and not one had less pooling on standard pavement than on permeable.

In warmer weather, permeable pavements offer benefits in moving water off roads and improving water quality. Permeable pavements insulate subgrades more, and generally retain snow and ice cover longer at or near freezing temperatures. However, permeable pavements also infiltrate meltwater and prevent refreezing while standard, impermeable pavements experience more pooling, refreezing and slippery conditions.

What’s Next?
Throughout the research, investigators conducted 14 presentations and three workshops, mostly in Minnesota and other parts of the Midwest. Researchers also published papers in 2018 and 2020. Study results will be distributed to local agencies. Future research may focus on maintenance efforts to improve permeable pavements that became clogged with organic material or experienced collapsing pores.