

## Pervious Concrete at MnROAD

### Introduction

Pervious pavement provides a solution for many highly developed urban areas where an excessive amount of contaminated water is diverted into storm and sewer systems and left untreated before entering natural water sources such as rivers and streams. By allowing water to flow through the pavement surface and infiltrate the underlying soil, pervious pavements can reduce the amount of this pollution. Test cells were constructed at MnROAD to be monitored for drainability to evaluate the possibility of using pervious pavements to mitigate this problem. Other important criteria influencing the performance of pervious concrete in pavements will also be monitored, including mechanical and structural properties, surface characteristics, noise, and durability.

### Pervious Concrete Driveway

A pervious concrete driveway, Cell 64, was constructed in late September of 2005 in a partnership agreement with Mn/DOT and the Aggregate Ready Mix Association of Minnesota (ARM of MN). The intent of this partnership agreement was to construct a pervious concrete of similar thickness to typical transportation uses and monitor the response of the concrete to weather and loading. Although not part of the MnROAD Mainline or Low Volume Road (LVR), Cell 64 is a part of the overall MnROAD facility. Cell 64 is located on the south side of the MnROAD pole barn as part of a bituminous parking lot.

The pervious concrete was designed for an anticipated 33% air and zero slump. The size of

the pervious concrete portion of the driveway is 60-ft by 16-ft, surrounded by a 2-ft concrete curb on all sides. A special drainage system was installed beneath the slab to facilitate infiltration. A special roller vibrator was used during placement to impart compactive energy without causing bleeding and loss of porosity.

### Lessons Learned

The pavement surface experienced severe raveling and spalling shortly after placement. This likely occurred because the pavement was clogged. Clogged pavements trap water which, when freezes, causes expansive pressure that deteriorates the paste around the top layer of aggregate.



A large longitudinal crack also propagated down the length of the driveway, and was likely a result of FWD testing, traffic, and thermal loading.

Data from thermocouple and watermark sensors installed in the pavement suggest that pervious concrete may experience less freeze-thaw cycles than impervious pavements of similar thickness.



When flow testing was done using an in-field permeability measurement device, results show that sweeping of pervious pavements may lead to clogging and reduce hydraulic conductivity. More importantly, if regular maintenance is not started soon after construction, clogging and damage is irreversible. Vacuuming will not unclog the pores.

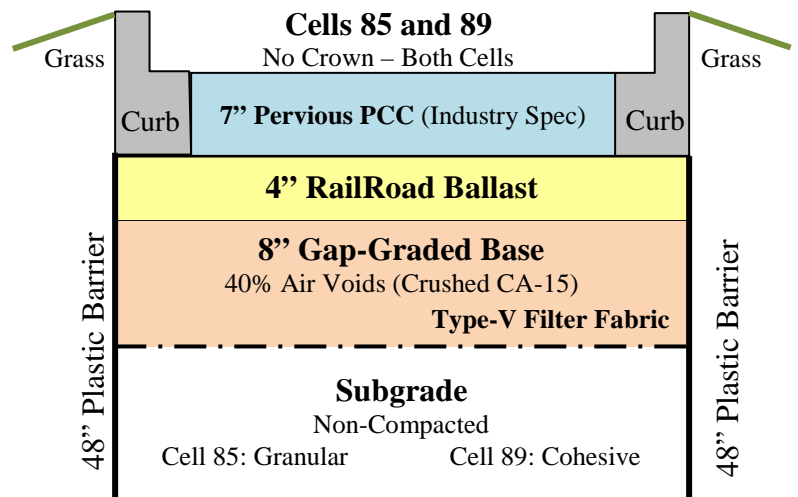
Knowledge gained from the performance of cell 64 was to be used in the design and construction of two test cells on MnROADs Mainline.

## Pervious Low Volume Road Test Cells

Cells 85 and Cell 89 were full depth reconstruction using the industry standard for pervious concrete. The mix was designed with a porosity between 15 and 18%, unit weight less than 135 pcf, and seven day flexural strength of 300 psi. The difference between the two cells is the full infiltration scenario with a granular subgrade in cell 85, and a retention system using a cohesive subgrade in cell 89. The pervious pavement in both cells is 7 inches thick, over 4 inches of railroad ballast and 8 inches of a gap-graded base to facilitate drainage. The cells are the first at MnROAD to have a curb and gutter system.

Construction began on October 17<sup>th</sup>, 2008, using fixed form pavers and roller compaction. Each cell was equipped with vibrating wire static strain gauges and thermocouples at various depths to detect freeze thaw cycles and monitor maturity. The cell was allowed to cure for 28 days using a Confilm curing compound and 2 layers of polyethylene sheeting.

Ride characteristics, noise characteristics, surface properties, and physical properties of the two cells were tested immediately after construction, and periodically over the next three years to gain



a comprehensive understanding of pervious pavement performance.

### Lessons Learned

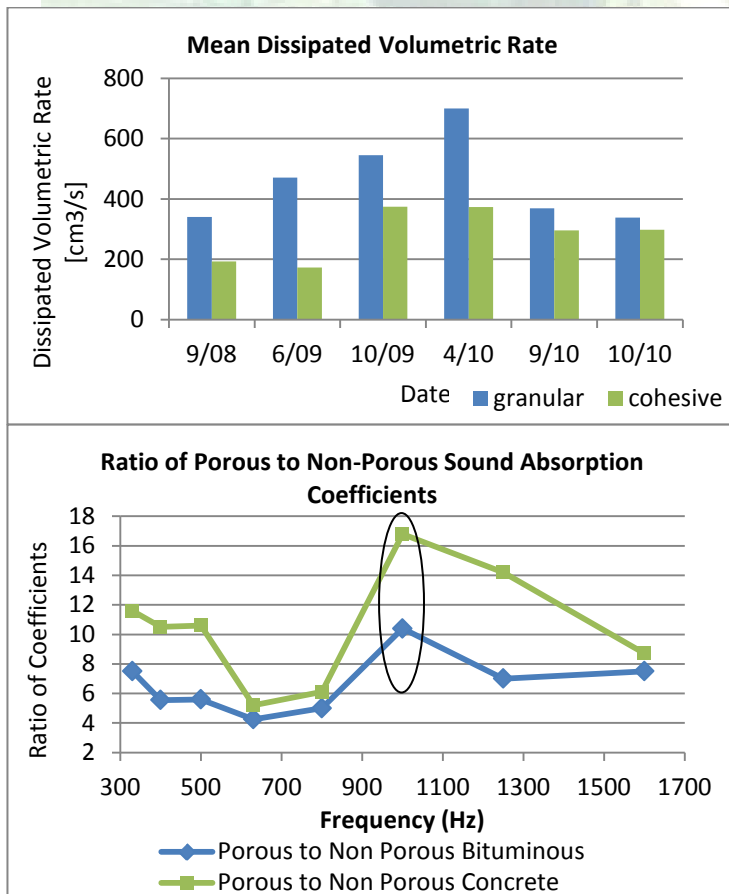
- Pervious concrete pavements can be designed with traditional methods such as the AASHTO 1993 method or the MEPDG. The design processes produced pervious concrete pavement which met performance expectations.
- ISLAB and similar programs can be used to accurately analyze and predict stresses in pervious concrete.
- Temperature and moisture sensors show a reduced temperature gradient throughout the pavement, base, and subgrade, and possibly a reduced amount of freeze thaw cycles for full depth pervious concrete.
- The frequent raveling the pervious cells experienced is expected to be from freeze thaw distress. Keeping the pavement unclogged can likely lessen the chances for this freeze thaw damage to happen, and therefore reduce raveling.
- Vacuuming more than two times a year has shown promising results and improved performance compared to the original lighter maintenance schedule. Pervious pavements can be maintained over time with this amount of effort. However, sweeping may cause clogging.
- Predicting OBSI from sound absorption does not seem feasible at this point. This is likely



because sound relief in pervious pavements come from air compression instead of the conventional methods found in normal concrete. However, it is evident the sound absorption is related to the porosity of pervious pavements.

- OBSI testing shows pervious concrete is the second most quiet surface at MnROAD, second only to the innovative diamond ground concrete.
- The pervious test cells show improved sound absorption compared to typical PCC pavement, with the degree of improvement dependant on the sound frequency being tested. Sound absorption at 1000 hz (closest to tire pavement noise frequency) shows the most improvement.
- The Infiltration methods utilized in the design can be maintained over time if proper maintenance activities are performed.

- Dissipated volumetric rate varied significantly throughout cells, suggesting uneven material consistency. This flow rate was generally higher in the granular base cell 85 than in the clay base in cell 89.
- Evaluation of the pervious test cells over the years has shown FWD deflection results higher than other typical concrete pavements. It is unsure how this can translate into durability. However, a relationship between the two is very likely and this matter should be a subject of further study.
- Results show IRI measurements significantly higher than FWHA standards for acceptable pavements. However, all three cells maintained excellent surface ratings.



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