Mn/DOT's PERVIOUS CONCRETE RESEARCH, AN LRRB PROJECT

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Synopsis

The reduction of pervious surfaces has been an issue of concern with the construction of bound pavement surfacing. Some Cities in the Metro area have been forced to improvise methods of minimizing storm water intrusion from developments that are in proximity to wetlands or some trout streams. Run-off from impervious surfaces has been known to distort the thermal balance of streams when extreme temperatures precede heavy rains. In solving this problem some communities they have made various attempts to encourage some infiltration by constructing pervious concrete on porous bases. While their understanding of the performance of pervious concrete in Northern climates is still rudimentary, Mn/DOT in collaboration with the Aggregate Ready mixed Association of Minnesota provides leadership in this technology. The partnership resulted in the construction of a pervious concrete pavement in a parking lot in MnROAD in 2005 and a pedestrian walkway in 2006. Current strategy is a more detailed study of the performance of pervious concrete in roadways. By adequately evaluating pervious concrete in this climate the study will also provide long term performance monitoring as the changes in porosity and infiltration can be monitored over time under standard measurable traffic loads environmental effects and deicing operation.

2. Research in Progress

In 2005 Mn/DOT and Aggregate ready Mix Association constructed a pervious concrete pavement in a parking lot in MnROAD. From this test cells, preliminary mechanical Properties were obtained and used in the design of the proposed Cells in the low Volume road. Some mechanical and rheological properties deduced so far are shown in the Table 1 below. Cell 64 was adequately instrumented with sensor trees to 5 ft below the surface. This will facilitate a capture of the actual freeze thaw cycles in the pavement. The same strategy will be replicated in the low volume Road

Table 1: Preliminary information from Cell 64 MnROAD Built in 2005.

PARAMETER	RANGE
Flexural Strength	
7-day	250psi
21 day	180 Psi
28-day	540 Psi
Compressive Strength	
7-day	1231- 3000 Psi
28-day	3000- 4500 Psi
Elastic Modulus	1.2 MPsi
Unit weight	128 pcf
Porosity	18-20%
COTE	TBD
Poisson's Ratio	TBD

Additionally the aggregate Ready mix industry built a sidewalk near the MnROAD Office Building in 2006.

3.1 Proposed Infiltration Mounding and Hydraulic Conductivity Studies

Sub cells of concrete on Clay and concrete on Sand subgrade and a control sub cells will be built. The inside lane is loaded with an 80 kip 5-axle semi plus environmental loading while the outside lane is subjected only to environmental loading alone. The researcher has proposed models for infiltration through pervious concrete.

- These include the block and pipe analogy that idealizes the structure into a set of vertical drain pipes surrounded by impervious concrete,
- The reverse abstraction model that idealizes aquifer response as a reverse form of abstraction
- The Hantush model

Fig 3A and B Cell 64. Mn/ROAD

Fig 4 Monitoring Well # 1 installed in the location of Pervious on Sand Sub cell

Eight Piezometric observation will detect mounding and other characteristic of the aquitard beneath the pavement. Borings show that there is an aquiclude that slopes from cell 25 to cell 24. The top of this thick clay layer is 10 ft below the surface in cell 25 and slopes down to 30ft below surface near the west end of cell 24. This implies that upstream and downstream contaminant observation will be chosen as East end and west end of cell 24 respectively.

Due to concerns about the structure clogging up with time, research task is in place to develop hydraulic conductivity monitoring. A “Perveammeter” has been improvised and calibrated for this purpose. Figure 5 shows a schematic representation of this perveammeter improvised by Ted Snyder and the author.

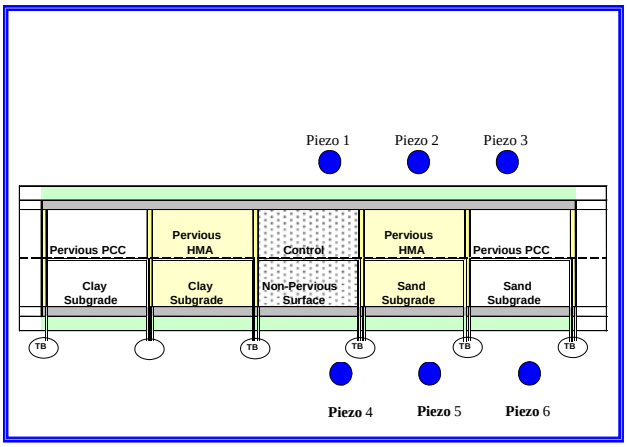

Fig 5; Layout Of Proposed Pervious concrete Cells in LVR

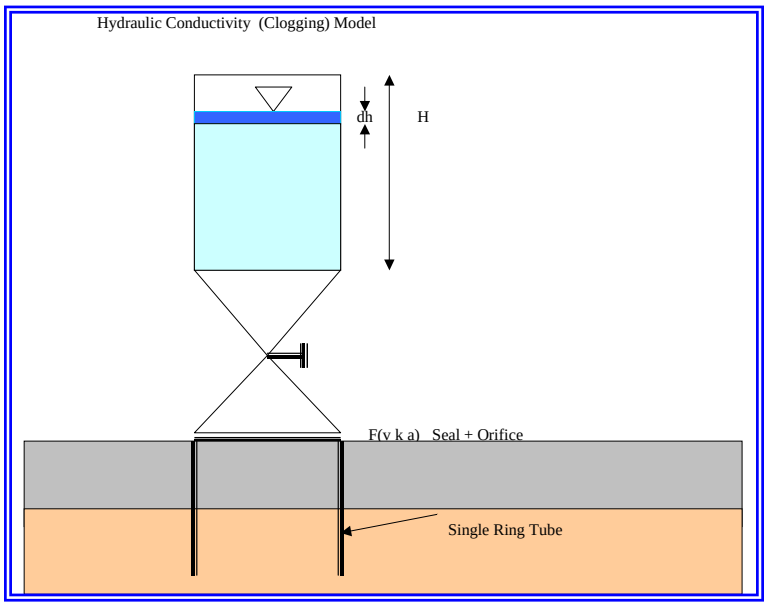

Fig 6: Improvised Perveammeter for Hydraulic Conductivity Measurement

3.2 PAVEMENT ANALYSIS

The pavement was designed to replicate the cell 64 structure so that we can utilize the 2 years of data we already have. It consists of a 7 inch pervious concrete pavement built on a 1 ft CA15 base. Using ISLAB and proposed loading a comparative analysis of pervious and normal concrete shows surprisingly that similar stress developments and deflections are anticipated. Researchers also ran the design guide for the pavement structure chosen and found that the pavement on sand is expected to last as long as 20 years but that if the layer above the clay subgrade acts as a full retention pond, the sub cell on Clay subgrade will not last very long based on the defined failure Criteria. Of a terminal IRI of 150.

Research will monitor freeze-thaw durability and susceptibility to any fatigue induced failure. Frequent falling weight deflectometer testing will be done on the sub-cells. Sensor records will be observed periodically to characterize the pavement performance...

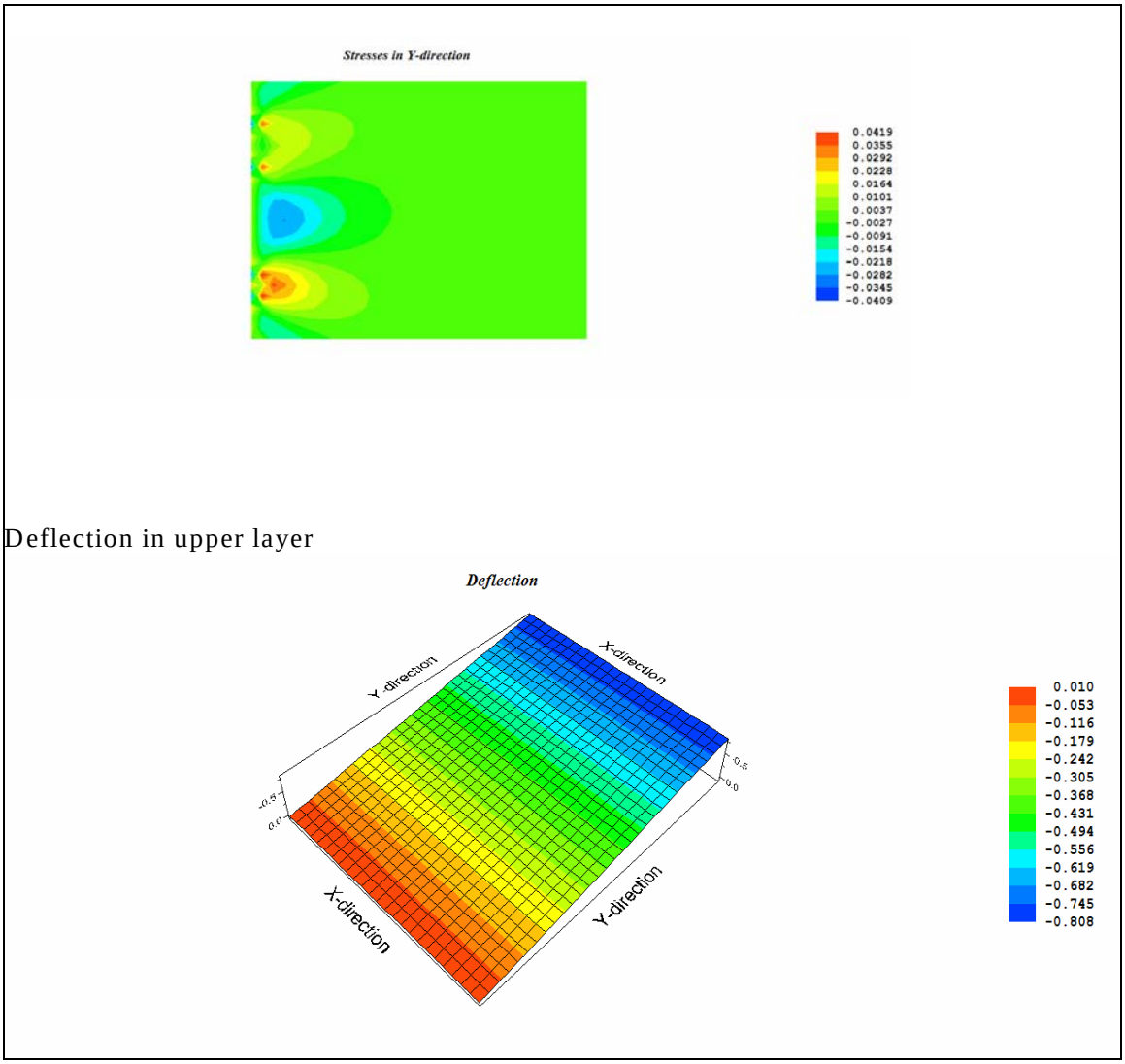

Fig 7: I-SLAB Pervious Concrete Stresses and deflections Due to 80Kip Semi-axle Edge Loading

These stresses and deflections will be validated with sensors in the pavements

3.4 Pavement Porosity And Noise Attenuation and Surface Characteristics Studies

Research will monitor seasonal On-Board Sound Intensity, friction and ride quality. It has been shown by previous researchers (1), (2), (3) that porosity enhances noise attenuation. Consequently, this research will perform and monitor Laboratory and field measurements of Sound absorption and tire-pavement interaction noise of pervious concrete.

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References

1. Izevbekhai, B.I Eller AJ Evaluation of Current texturing Practices in Minnesota Transportation Research Board January 2008
2. Wu C, Nagi, M.A. “Optimizing Surface Texture of Concrete Pavement” Portland Cement Association Research and Development Bulletin RD111T 1995.
3. Sandberg, U, Ejsmont J Tyre/Road Noise Reference Book, Informex, 2002.