# Thin Unbonded Concrete Overlays in Minnesota

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The Minnesota Department of Transportation (Mn/DOT) is currently investigating the performance of thin unbonded concrete overlays on higher volume roads. This five year study includes cell 5 of the MnROAD Phase II 2008 reconstruction project (SP 8680-157) and a section of TH 53 near Duluth, Mn (SP 6916-99). These two pavement test locations provide a unique opportunity for researchers to include additional environmental and traffic factors and validate results. It is anticipated that the results from these studies will improve the understanding of the behavior of this complicated composite system, which will lead to the development of better distress and life prediction models and ultimately contribute to a more efficient utilization of scarce resources.

## Background

Unbonded concrete overlays, or resurfacing, of older concrete pavements has performed very well in Minnesota's extreme climate and heavy traffic loadings. Historically, however, their structural design has been somewhat controversial, and therefore conservative (thick), due to the lack of rational design methods devoted strictly to their characteristics. Given their good performance, and the ever rising cost of construction and materials, interest has developed in exploring whether thinner unbonded concrete overlays could perform to acceptable (and predictable) levels.

For this study, two test sections were constructed, one at the MnROAD facility, and one on TH 53 north of Duluth. Plan and cross-sectional views of the MnROAD test section can be seen in Figure 1. The TH 53 project consisted of a 5 inch thick concrete overlay.

## Notable Differences Between TH 53 and the new MnROAD cell 5

TH 53 and the MnROAD test cells are in different climatic zones and are subjected to different traffic loadings. TH 53 has smaller panel sizes, 12 ft. long by 12 ft wide (with a short test section consisting of 6 ft. long by 6 ft. wide panels), while the MnROAD test cells have panels 15 ft. long by 13 or 14 ft. wide. TH 53 joints were distressed due to age, traffic and environmental loading; however the joints of the younger MnROAD cells were in relatively good condition. In order to more closely mimic a distressed pavement, a portion of the existing joints on the original MnROAD test cell 5 were artificially distressed by a guillotine breaking hammer. TH 53 used a non-drainable dense graded HMA non-wear course paving mixture SPNWB330B – SPEC. 2360 as the interlayer, whereas the MnROAD cells used a permeable asphalt stabilized stress relief course (PASSRC) interlayer.

## Experimental Monitoring and Testing

An important part of this study is to develop better distress and life prediction models of thin unbonded concrete overlays. To accomplish this, a number of electronic sensors were installed in MnROAD test cell 5and TH 53 to measure environmental and load responses. Due to the remote location of the TH 53 site, it had significantly less electronic sensors than MnROAD cell 5. Table 1 gives a short description of the sensors

used on the project. Figure 1 shows the sensor layout for the TH 53 test panels. In the figure, the panel on the left contains load response sensors the right panel contains environmental response sensors. Temperature and maturity sensors were also included.

Both test cells were subjected to the rigorous inspection and a testing regime afforded to all MnROAD test cells including, but not limited to, the following:

To characterize the structural condition of the existing PCC panels on TH 53, Falling Weight Deflectometer (FWD) testing was done prior to placement of the HMA bond breaking layer. Additional FWD testing will be conducted as the study progresses to monitor the change in behavior.

Dynamic load testing will also be performed each season by activating the sensors and recording the response of a truck of known axle weight at various times throughout a day.

To characterize early age warp and curl, a large concern given the dimensions of the panels in MnROAD test cell 5, laser profile testing was conducted. Profile testing of the TH53 section will take place during the spring of 2009.

**Table 1. Sensors Types installed in Unbonded Overlay Test Sections**

| Sensor Code | Sensor Name | Measurement Type |
|---|---|---|
| CE | Concrete Embedment Strain Gauge | Strain - Vehicle Response |
| VW | Vibrating Wire Strain Gauge | Strain – Environmental Response |
| HC | Horizontal Clip Gauge | Displacement – Joint Opening |
| SP | Stud Pins | Displacement – Joint Opening |
| IK | Intelli Rock Maturity Meter | Concrete Maturity |
| TC | Thermocouple | Temperature Gradients |

**MnROAD Phase 2 Test Cell 5**

| 3TBit Shoulder | | | |
|---|---|---|---|
| **Test Cell 405** 5Φthick overlay, 15TPanels (14T Wide Drv. Ln, 13TPass. Ln), | **Test Cell 305** 5Φthick overlay, 15TPanels (14T Wide Drv. Ln, 13TPass. Ln) | **Test Cell 205** 4Φthick overlay, 15TPanels (14T Wide Drv. Ln, 13TPass. Ln) | **Test Cell 105** 4Φthick overlay, 15TPanels (14T Wide Drv. Ln, 13TPass. Ln), |
| Induced cracking at joints | TRAFFIC → | | Induced cracking at joints |
| ← 157.5 ft → | 120 ft | 165 ft | 150 ft |
| 8TBit Shoulder | | | |

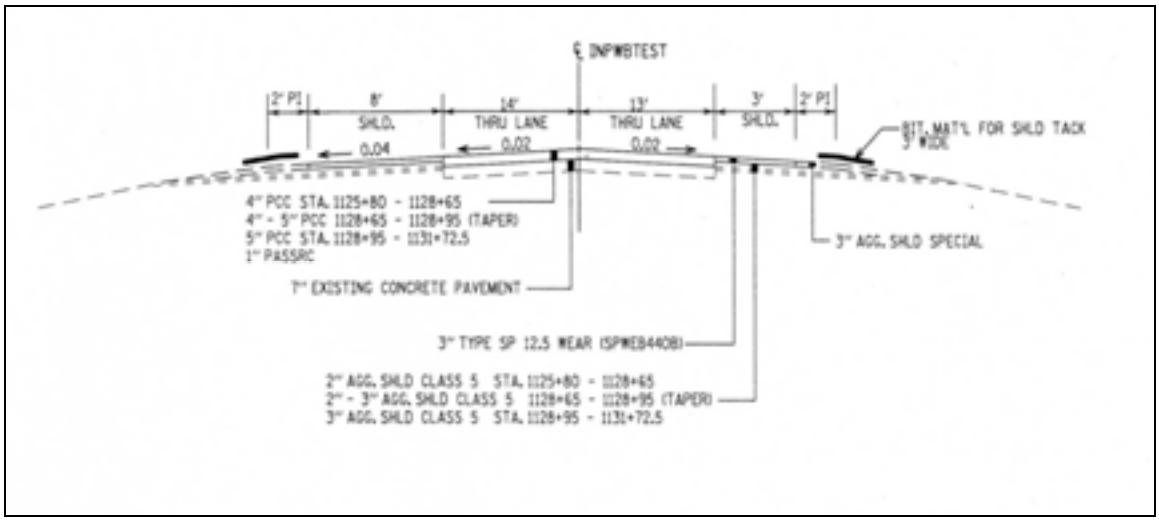


**Figure 1. Plan and Cross-sectional views of MnROAD test cells 105, 205, 305, 405.**