Performance of Thin Unbonded Concrete Overlays in Minnesota

Background

With the growing inventory of older distressed concrete pavements in Minnesota, it is becoming increasingly important that cost effective rehabilitation solutions be continually explored.

One of the best performing solutions for restoring or improving the performance of older concrete pavements in Minnesota has been unbonded concrete overlays. One reason for their good performance may be the inherent conservatism in their design. Since a rational mechanistic-empirical design method has not been adopted yet, their design relies on methods derived for concrete pavement placed on more traditional base layers.

Since one of few variables one can change when placing an overlay is slab thickness, optimizing this thickness will ultimately lead to lower overall costs for this effective rehabilitation solution. Determining optimized overlay thickness is best accomplished by monitoring actual field test sections.

Test Sections

For this particular study, several thin unbonded concrete overlay test sections were constructed in the fall of 2008 at the MnROAD facility. At about the same time, a much larger thin unbonded concrete overlay project was constructed on TH53 near Duluth, Minnesota. To supplement the research sections at MnROAD, several panels in the TH53 project were instrumented, and a research monitoring program was begun.

While traditional unbonded concrete overlays were constructed with slab thicknesses greater than 7 inches, the test sections are much thinner at 4 and 5 inches thick. Details of the design for each the test sections can be found in Table 1. Table 2 highlights the difference in some of the parameters between the MnROAD and TH53 test sections.

Unbonded Concrete Overlays

Unbonded concrete overlays are designed to restore or improve the condition and/or load capacity of older, distressed concrete or composite pavements.

Unbonded concrete overlays utilize a stress relief layer between the new concrete overlay and the older concrete pavement. The stress relief layer, usually 1 to 2 inches thick, consists of a dense graded or permeable asphalt material (also recently, unwoven fabric). Its function is to reduce crack propagation and provide cushioning between the stiff layers.

Historically, unbonded concrete overlays have been designed and constructed with slab thicknesses greater than 7". This is due to the lack of a rational mechanistic-empirical design method. During the design, the older distressed concrete layer is treated simply as a stiff base layer. As such, the initial cost of unbonded overlays has been quite high, compared to other overlay alternatives.

Although load transfer efficiency had dropped significantly in the original transverse joints of MnROAD Cell 5, they still exhibited little surface faulting or deterioration. To examine the capabilities of a thin unbonded concrete overlay in bridging over severely distressed joints, like those in TH53, a pavement breaker was used to artificially increase the amount of distress occurring in a select number of the original MnROAD transverse joints.

Table 1. Thin unbonded concrete overlay test sections being monitored at MnROAD and on TH53.

Cell #	PCC overlay thickness (in)	Stress relief layer type	PCC overlay panel size (ft)	Original PCC thickness(in) /layer type	Original panel size (ft)	Sealed joints in overlay	Original PCC transverse joint condition
105	4	PASSRC	15(L) x 14(W)*	7.5/JPCP	20(L) x 14(W)	N	Good**
205	4	PASSRC	15(L) x 14(W)*	7.5/JPCP	20(L) x 14(W)	N	Good
305	5	PASSRC	15(L) x 14(W)*	7.5/JPCP	20(L) x 14(W)	N	Good
405	5	PASSRC	15(L) x 14(W)*	7.5/JPCP	20(L) x 14(W)	N	Good**
TH53	5	HMA	12(L) x 12(W), 6 x 6	8.0/JRCP	27(L) x 12(W)	N	Poor

** Passing Lane has 13 ft panel width.*
***A pavement breaker was used to further deteriorate the original transverse joints in these sections.*

Table 2. Differences in design parameters between the MnROAD and TH53 test sections

Design Parameter	MnROAD Test Sections	TH53 test section
Overlaid transverse joint condition	2 sections = 14 years traffic and climate 2 sections = 14 years + artificially distressed	36 years natural traffic and climate
Panel length(ft) to thickness (in) ratio	3.75, 3.0	2.4
Stress Relief Layer Type	PASSRC	Dense graded HMA
Edge drains	Transverse wick drains	None

Early Observations

TH53 project The TH53 test section itself is performing well after 1 year of traffic. A number of random transverse panels cracks did appear early in many portions of the remaining 9 miles of TH53 overlaid in 2008. It is thought this is due primarily to late formation (sawing) of many of the contraction joints.

MnROAD sections A significant number of low severity corner cracks have appeared in the 4 inch thick test sections 105 and 205. It is believed this has occurred due to traffic impacts on the excessively warped and curled thin unbonded overlay panels, caused by the high panel length to slab thickness ratio. A preliminary investigation has shown little correlation between cracking in the thin overlay and transverse joint distress in underlying slabs.

For More Information:

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