Effect of Drainage on The Performance Concrete Pavement Joints in Minnesota

Background

After 13 years of live interstate traffic and the extreme climate of Minnesota, the condition of the original concrete pavement test sections at the MnROAD facility was still very good. The introduction of Phase 2 research studies at MnROAD prompted the need to remove or replace several of those test sections. To extract all useful information from the sections before they were reconstructed (or overlaid), a comprehensive forensic investigation was conducted. This investigation focused principally on joint performance, as little panel cracking had occurred.

Findings

Interestingly, core samples taken over transverse joints for the investigation revealed a unique distress phenomenon for sections constructed over undrained, dense graded, gravel bases. The cores showed that a significant amount of concrete material was missing from the middle section of the joint, with the area of greatest distress just below the saw cut, approximately at mid depth. Cores taken from similar locations in test sections constructed over the more freely draining permeable asphalt stabilized base (PASB) showed virtually no distress. See Photos 1A and 1B for a comparison.

Photo 1. A) Core sample "BJ" (shown inverted) from joint over nondrained gravel base. B) Sample "A" from joint over drainable PASB.

To determine whether this distress was unique to MnROAD test sections, core samples from six other Minnesota concrete pavement projects, of similar age and materials, were examined. While similar types of distress were found, the extent of the damage was not as severe. This may be due to much less

traffic loadings being applied to those sections compared to MnROAD. In all cases though, sections with base layers that adequately drained water within the joints performed significantly better.

An examination of the potential causes of the unique MnROAD joint distress revealed that a combination of freeze/thaw damage, and more importantly, erosion due to fast traveling trucks, was what ultimately caused the distress. The absence of similar mid-depth erosion in core samples taken from the low volume road test sections at MnROAD (all had undrained gravel bases), confirmed that traffic speed and frequency was likely a factor for the interstate test sections.

During the investigation, it was revealed that joint sealing can have a significant effect on joint distress. For joints over slowly draining base materials, a core sample taken near a breach in a joint revealed more degradation than a more completely sealed area.
See Photo 2.

Photo 2. Effect of breached joint seal.

Conclusions

High Volume Traffic

- Undrained PCC on a poorly draining (CL 5 Sp) base has resulted in significant joint distress (regardless of joint seal condition).
- Drained PCC on poorly draining base with edge drains and well sealed joints performed better than undrained PCC.
- The combination of a drainable base layer and edge drains performed best.

Low Volume Traffic

- Undrained PCC on a poorly draining (CL 5 Sp) base with well sealed joints performed very well.
- Undrained PCC on a poorly draining base with breached joint seals exhibited significant distress.

Based on these findings, it is recommended that a drainable base layer be used under jointed concrete pavements, with a properly maintained system to remove water.

For More Information:

A full Mn/DOT report on these findings will be available in Spring 2010.

Otherwise, contact:
Mn/DOT Office of Materials and Road Research
Tom Burnham, P.E.
Senior Road Research Engineer
651-366-5452
tom.burnham@state.mn.us

MnROAD details: www.dot.state.mn.us/mnroad