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PUTTING RESEARCH TO WORK
BRIEF

Performance of Bridge Approach Panels in Wisconsin

Several years ago, the Wisconsin Department of Transportation changed the bridge approach slab design from a system with one expansion joint to a system that now has three expansion joints. The reason for this change was to protect both the pavement and the bridge from differential expansion and contractions.

What is the Problem?

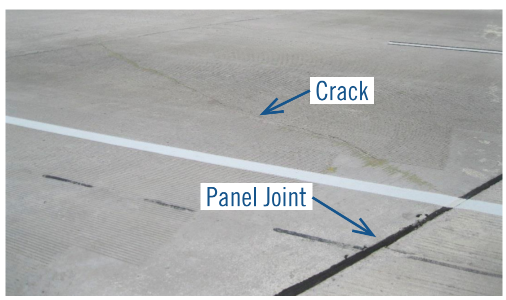
Constructability of the three-expansion joint design is proving difficult in the field. Since changing the Wisconsin bridge approach slab design from one expansion joint to three expansion joints, a new detail has emerged for use on Interstates and US Highways, with one expansion joint and approach slab footing. These two different designs beg the question are three expansion joints needed to provide stress relief, or is one expansion joint enough.

Objectives

The objectives of this research project were to provide WisDOT with guidance regarding the use of a three-expansion joint approach detail (SDD 13B2) or a single-expansion joint approach detail (Bridge Standard 12.10, 12.11) and to determine if the three-expansion joints are needed to provide relief, or if the new design with one joint will work to improve the constructability and performance of approach slabs.

Methods

The researchers performed a literature review of studies completed with respect to approach design and construction. They also reviewed approach design and construction practices at WisDOT and other states. Additionally, they completed field investigations of 12 WisDOT bridges and performed laboratory testing of WisDOT abutment backfill materials including compaction tests and collapse tests.



Approach Cracking at Bridge Exit

Results

State Practices

- The current approach design and construction practices of numerous states around the Midwest are quite similar to the practice of using Bridge Standard 12. Numerous states employ a structural slab that bears on a paving notch cast into the abutment and also on an approach slab footing, typically in the range of 20 to 30 feet from the end of the bridge. Polyethylene sheeting is often used to reduce the friction forces between the approach slab and subbase. Also, the approach slab footings are often troweled smooth and polyethylene sheeting is laid over the top as a bond breaker between it and the approach slab.
- Details appear to differ mostly in subbase/backfill drainage and required reinforcement. Several states do not have specific drainage details for below the approach, at the joints or adjoining the abutment. If water intrusion occurs, the soils become wet thereby changing the properties and/or the soil loss. This can compromise the approach slab support and lead to rider discomfort or require maintenance. The reinforcement sizes, spacing and quantities in similarly sized approach slabs varied considerably from state to state.

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SDD 13B2

- The three-expansion-joint detail (SDD 13B2) appears to be performing well at the observed locations. There was no apparent differential deflection or uneven settlement. The detailing at the paving notch and the inclusion of multiple expansion/contraction joints tends to limit the cracking that might otherwise occur if the approach were restrained from movement.
- The overall performance, however, greatly hinges on the subbase preparation and condition. This detail, more than the other (Bridge Standard 12), requires particular attention to the backfill materials and placement. Any settlement or erosion could be reflected in the approach panels, thereby potentially causing cracking and/or differential settlement at the joints which affects rideability and increases required maintenance activities.

Bridge Standard 12

- The single-expansion joint detail (Bridge Standard 12.10, 12.11) appeared to be performing well with respect to rideability. Differential deflection at the approach joints was not detected, nor was it evident through traffic observation (vehicles bouncing noticeably). The joints mostly remained in overall good condition, without loss of sealant or debris buildup. However, cracking of the approach slab or the bridge deck adjacent to the slab seemed to be prevalent at the bridges visited.
- Differential temperatures between the abutment and deck create non-uniform expansion and contraction between the two elements, and because they share a common fixity at the shared joint, the forces imposed by this discontinuity are expressed through deck cracking.
- Details indicate the approach slab is doubly reinforced. In the event of consolidation or settlement, the approach slab would require this strength to avoid premature failure. When the supporting soil structure remains in contact with the bottom side of the approach, forces developed in the slab are quite minimal.
- Ensuring the material is near saturation at the time of placement (by flooding) is critical to avoid unwanted post-construction collapse in the backfill material

Recommendations

- The expansion and contraction requirement does not seem to warrant the use of multiple expansion and contraction joints as seen in SDD 13B2. The SDD 13B2 is more highly susceptible to inadequacies within the approach supporting materials. If this detail is to perform well in the long term, it is critical that materials are prepared well and methods of preservation are built into the system.
- For Bridge Standard 12, it is recommended that the slab design is revisited to ensure it is properly sized and reinforced to act as a bridge between the approach slab footing and abutment paving notch in the event that settlement of the backfill and subbase occurs.
- The continued use of an approach slab footing at the joint between the mainline pavement and approach slab is recommended.
- The continued use of polyethylene sheeting between the approach slab and supporting materials/approach slab footing interface is recommended.
- It is recommended that all new bridges be profiled and have the gross vertical geometry measured immediately after construction. Additionally, a specification that ensures an acceptable ride quality at the time of construction should be created and adopted by WisDOT.
- Following construction, it is recommended that the approach/bridge be profiled at least every 10 years or when it is apparent that the rideability has begun to degrade. Attention should be paid to the abutment backfill and approach support materials to mitigate potential differential settlement through improved compaction, reduced erosion and use of alternative materials.
- Water drainage should be an integral part of the bridge and embankment design and maintenance. It is critical to direct water away from the bridge deck, joints and embankment in a way that does not create an erosion problem or changes in the soil properties.

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This brief summarizes Project 0092-14-04,
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