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RESEARCH PROJECT TITLE
Integral Bridge Abutment-to-Approach Slab Connection

SPONSORS
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The Bridge Engineering Center (BEC) is part of the Center for Transportation Research and Education (CTRE) at Iowa State University. The mission of the BEC is to conduct research on bridge technologies to help bridge designers/owners design, build, and maintain long-lasting bridges.

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tech transfer summary

A commonly recommended solution to bridge settlement and cracking is to attach the approach slab to the bridge abutment.

Objective

The primary objective of this research was to evaluate the effects of tying approach slabs to integral abutment bridges and to investigate the performance and the impacts the approach slabs have on the bridge.

Problem Statement

The Iowa Department of Transportation has long recognized that approach slab pavements of integral abutment (I-A) bridges are prone to settlement and cracking, which manifests itself as the "bump at the end of the bridge." The bump is not a significant safety problem; rather, it is an expensive maintenance issue. A commonly recommended solution is to integrally attach the approach slab to the bridge abutment, which moves the expansion joint typically found at the approach slab/abutment interface to a location further from the bridge where soil settlement is less of a concern and maintenance is easier.

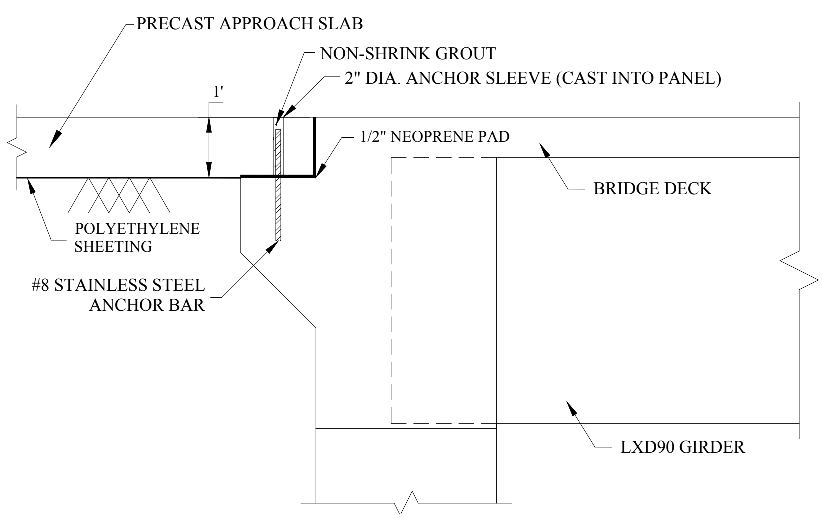

Figure 1. Connection detail for the precast approach slab to abutment, northbound

Research Description

Two new, side-by-side, three-span bridges on the new Iowa Highway 60 bypass of Sheldon, IA in O'Brien County were chosen as test bridges for testing connection details. The integral approach slab to abutment connection detail was implemented on both bridges. These are the first bridges in Iowa to tie the approach slab to an I-A bridge. The southbound bridge utilized an approximately 30-ft-long, cast-in-place approach slab system, while the northbound bridge utilized an approximately 77-ft-long, precast approach slab system. All other aspects of the bridges were identical.

The research team instrumented the south approach slab, abutments, and south bridge span of both bridges in order to determine the performance of the approach slab, the effects on the bridge, and the possible range of forces to consider when designing connected approach slabs. The following bridge components were evaluated:

- Slab and bridge temperature
- Abutment movement (displacement and rotation)
- Girder, approach slab, longitudinal post-tensioning strand, and pile strains
- Slab joint movement

Instrumentation readings from the various elements were collected every hour for one year (April 2007 to April 2008). Figures 2 and 3 are plots derived from the research.

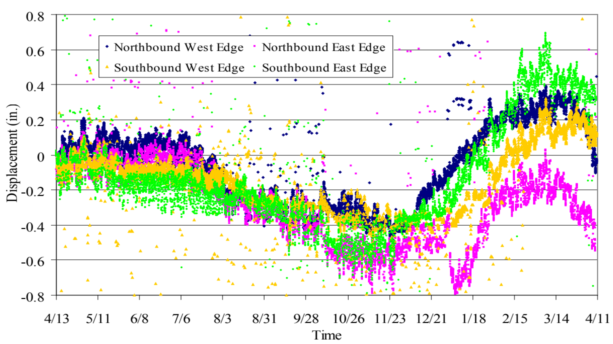

Figure 2. Longitudinal abutment displacements (south end) for both bridges

Key Findings

- The integral connection between the approach slabs and the bridges appears to function well with no observed distress at this location and no relative longitudinal movement measured between the two components.
- Tying the approach slab to the bridge appears to impact the bridge abutment displacements and girder forces. The source of the impact may be the manner in which the approach slab is attached to the main line pavement.
- The two different approach slabs—the longer precast slab and the shorter cast-in-place slab—appear to impact the bridge differently. This impact was clear in the differences in the mid-span moments and the slab strain patterns over time. It is not clear, however, whether it was the type of approach slab or the size of the approach slab that had the greatest impact.
- The measured strains in the approach slabs indicate a force exists at the expansion joint and should be taken into consideration when designing both the approach slab and the bridge.
- The observed responses generally followed an annual cyclic and/or short-term cyclic pattern over time. The annual cyclic pattern had summer responses at one extreme, a transition through the fall to the other extreme response in the winter, followed by a transition in the spring back to the summer response. A linear relationship of the transitions between the extreme responses was typically observed. Seasonal and short-term cycles were evident in most data, most likely due to friction ratcheting.

Implementation Recommendations

The authors recommend that additional bridges are constructed using the approach slabs and connections studied in this research project and that these new bridges be similarly monitored. At some point, it may be appropriate to consider retro-fitting older bridges.

Further bridge monitoring programs would contribute to better understanding of integral abutment bridges with integral approach slabs and different skew angles, span lengths, slab lengths, horizontal alignments, and girder type—concrete or steel—especially since not all the experimentally measured results were similar to results from previous studies, which reported no friction ratcheting.

In addition, future studies should also monitor whether the "bump" is still created at the bridge-to-approach slab connection location, if the bump is moved to the expansion joint location, or if the bump is eliminated altogether. The expansion joint should also be studied in more detail to determine the joint behavior and if modifications to the expansion joint design would change the slab and bridge response.

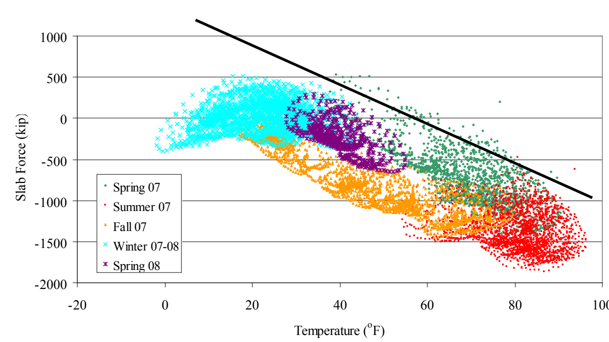

Figure 3. Northbound bridge approach slab average force with respect to slab temperature