Research Project: SP109B4N
Date: December 2012

RESEARCH SUMMARY

THEORETICAL AND FIELD EXPERIMENTAL EVALUATION OF SKEWED MODULAR SLAB BRIDGES

Problem

Adjacent precast, prestressed concrete multi-beam bridges have become more prevalent due to their rapid construction time and cost effectiveness. Over the years, various adjustments and refinements have been made to the design of these bridges to reduce typical deteriorations, including shear key failure, reflective cracking of the overlay, chloride penetration, and freeze/thaw damage. Transverse post-tensioning is a common method that improves a bridge's ability to perform monolithically and reduces the amount of cracking in the overlay. This method has been used with some success. However, longitudinal cracking (possibly caused by insufficient and/or inadequate transverse connection between the beams) has been discovered in the concrete overlays of some skewed bridges that have been built within the past five years.

Objective

In order to thoroughly investigate the effects of transverse post-tensioning on skewed adjacent precast-concrete multi-beam bridges, the following research objectives were identified:

- To locate, assemble, and document other states' bridge design standards for adjacent precast-concrete multi-beam bridges;
- To identify other states' concerns for this type of bridge and to examine any methods used to mitigate those concerns;
- To identify past or current research that has or is being conducted on this issue;
- To examine bridges that have undergone cracking to determine shared characteristics;
- To conduct live-load testing on a bridge that has longitudinal cracking, and to create a computer model of that bridge for further analysis;
- To determine methods to mitigate the longitudinal cracking by conducting a parametric study using finite element analysis (FEA) methods; and
- To organize, evaluate, and document the information acquired in order to produce a final report that contains recommendations for revising the current Maryland bridge design standards.

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RESEARCH SUMMARY

Description

To conduct this research, at first, a literature review and a state practices survey were conducted. Then, a bridge with a cracked concrete overlay in the State of Maryland was selected and field tested. Subsequently, the FEM model of the tested bridge was used as a base for further parametric study to gain more complete knowledge of how the skew angle affects transversely post-tensioned adjacent precast prestressed concrete slab bridges. Final summary and conclusions with recommended revisions to the current Maryland bridge design standards were made for the SHA's consideration.

Results

The following points summarize key findings:

- States share no consensus about best practices for transversely post-tensioning adjacent precast-concrete multi-beam bridges. Some states do not even consider the effects the skew angle has on the stress distribution caused by loads on this type of bridge.
- As a bridge's skew angle increases and the length-to-width ratio of a bridge decreases, the likelihood of reflective cracking occurring greatly increases due to the introduction of alternate load paths.
- The reflective cracking is probably initiated due to thermal strains, but vehicle loads play a large part in crack propagation.
- Transverse post-tensioning placed close to the abutments and oriented parallel to the skew angle is very effective at reducing the transverse stress in this type of bridge.

Report Information

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