Texas A&M Transportation Institute

Texas Department of Transportation

PROJECT SUMMARY REPORT

0-7013: Performance and Improvement of Texas Poor Boy Continuous Bridge Deck Details

Background

The Texas Department of Transportation uses link slabs, known as poor boy joints (PBJs), to provide a continuous bridge deck linking discontinuous bridge spans. These link slabs reduce the number of a bridge's expansion joints, which are known to cause deterioration and maintenance issues. Unlike link slabs in other states, PBJs often incorporate precast concrete panels (PCPs) in the deck. These panels are placed flush at the center of the PBJ or may be placed offset from the PBJ with cast-in-place concrete between. Despite these panels being used on thousands of Texas highway bridges, little was known about the performance of PBJ details. This project investigated the current state of PBJ details and used experimental and analytical testing to develop potential improvements to their design and implementation.

What the Researchers Did

The project team first investigated the performance of PBJs on 468 existing bridges in northwest and east Texas with data gathered from design drawings and inspection reports. Researchers used non-destructive evaluation techniques on PBJs on eight bridges to evaluate construction practices and potential damage. Five bridges were fitted with sensors at their deck joints to gather data on their deformation under ambient live and thermal loading. Researchers then used analytical modeling to investigate a wide array of PBJ designs. These models helped inform a full-scale test program of six specimens:

- Two with flush PCP designs, including a retrofit design debonded at the depth of the PCP
- Three with offset PCP designs, including a retrofit using ultra-high performance concrete (UHPC)
- One specimen with a PCP continuous across the PBJ.

Based on this research, the team developed design recommendations for improved PBJ details.

What They Found

Investigating PBJs on existing bridges revealed:

- Longer bridge spans and continuous deck lengths correlated with reduced performance in PBJs.
- As PBJs age, those with a high number of load cycles, larger rotational demands, and lower moment capacity were more likely to incur damage.

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Project Completed:
December 2023

- While increased support skew correlated with worse PBJ damage on older bridges, newer skewed bridges were not linked to poorer performance.
- Reinforcement placement and link slab thickness may differ from what was shown in design details.
- Both live and thermal loads may control deformation and strain demands in the link slab.
- Increasing the number of spans in a continuous deck produced larger demands under live load, while decks with fewer spans had larger demands under thermal load.
- Sensor data showed that the cracking strain was surpassed in the top and bottom of the deck for each PBJ detail.
- The added stiffness of railings and barriers reduced the deformation demand of the PBJ beneath.

The analytical modeling and experimental test program revealed:

- The existing flush and offset PCP details sustained large cracks at the PBJ. Shear lag causes secondary cracks that extend away from the center of the PBJ between girder lines.
- Analytical models were able to replicate cracking patterns found in the field and experimental testing.
- Adding longitudinal reinforcement provided modest improvements to cracking behavior.
- Debonding the ends of the girders from the link slab delayed the formation of deck cracks and formed a more distributed crack pattern with smaller cracks under both gravity and thermal loads.
- Debonding also improved the performance of retrofitted decks debonded between the PCP and topping slab, for a new design with PCPs continuous across the PBJ, and for analytical models with skewed supports.
- Inflexibility at bearing pad supports has the potential to cause harmful tensile forces in the PBJ.

What This Means

The project had the following findings:

- Limiting the unit length of continuous decks and span lengths while increasing deck moment capacity and link slab lengths may reduce PBJ damage.
- Standard drawings may be clarified to prevent contractors from misinterpreting PBJ details.
- Both thermal and live load effects should be considered in PBJ designs.
- Maintenance of bearing pads to ensure their flexibility is key for preventing PBJ damage.
- Existing PBJ designs may be improved with the addition of longitudinal reinforcement and the removal of crack-forming details.
- Debonded PBJ details may be used to delay and reduce damage to the deck.
- Debonded continuous PCP designs may simplify PBJ construction while improving performance.

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www.txdot.gov
Keyword: Research

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