Texas Department of Transportation

CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY REPORT

0-7041: Development of NextGen Texas Bridge Decks

Background

The Texas Department of Transportation (TxDOT) has long been committed to advancing bridge construction methods to improve efficiency and safety. However, traditional approaches have faced challenges, particularly in dealing with deck overhangs, which require additional forming and bracing, leading to increased costs and project durations. In pursuit of more streamlined solutions, TxDOT turned to innovative practices inspired by successful implementations abroad. Drawing from the efficient bridge designs in Spain, TxDOT introduced the NextGen Texas bridge deck system. This system, featuring full-width precast partial-depth panels connected with wire trusses, aimed to eliminate the need for extra forming and bracing, potentially reducing costs and accelerating project delivery.

What the Researchers Did

Under the coverage of Project 0-7041, a comprehensive research initiative was undertaken to develop and validate the NextGen Texas bridge deck system. The research endeavors encompassed a multi-phase approach, combining rigorous experimental investigation with advanced nonlinear finite element analysis. The primary objective was to evaluate the behavior and performance of the full-width partial-depth panels under various loading conditions. Three major tasks were addressed within the project framework: construction testing, service testing, and long-term behavior analysis. These tasks were meticulously designed to assess the feasibility, structural integrity, and durability of the NextGen Texas bridge deck system.

What They Found

The research conducted under Project 0-7041 yielded a wealth of valuable insights across different phases of testing and analysis. In the construction testing phase, load-testing on wire truss partial-depth precast concrete panels provided crucial data on the system's behavior under construction loads. The experiments revealed ductile load responses primarily governed by the yield moment, with longer unbraced spans leading to bottom chord buckling. Additional reinforcement proved effective in mitigating buckling and increasing moment capacities. Variations in yield strengths and truss member geometries were found to influence post-yield responses, with electro-welded trusses exhibiting distinct load-drop patterns compared to hand-welded ones. The shear response of the panels depended on web member properties, with different truss types exhibiting varying behavior. Notably, premature failures highlighted challenges related to wire truss embedment and concrete panel reinforcement, prompting the development of analytical methods for buckling behavior.

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Project Completed:
05-31-2024

In the service testing phase, full-scale bridge deck specimens were subjected to various loading conditions simulating common scenarios encountered in Texas bridges. The results revealed comparable ultimate capacities to traditional systems, with both wire truss types exhibiting similar failure modes under specific loading conditions. Crack widths met design requirements under specified loads, indicating satisfactory performance. Finite Element Method (FEM) analysis approximated panel capacities well, although limitations were encountered in capturing deflection and stiffness due to boundary condition and mesh size constraints. Nevertheless, FEM analysis showed potential for field use in strength and punching shear capacity determinations, offering a promising avenue for further research and refinement.

Experimental fatigue testing, conducted in the long-term behavior analysis phase, focused on precast panel bridge deck specimens subjected to cyclic loading. The objective was to verify the applicability of current fatigue stress limitations on the system. The findings indicated that specimens subjected to yielding stress in the top chords failed earlier, highlighting the importance of ductile steel reinforcement for improved fatigue resistance. Strength testing post-fatigue showed no significant loss, suggesting the system's resilience under cyclic loading conditions. Recommendations stemming from this phase included caution against high stress loading on overhang edges and a preference for ductile steel reinforcement for enhanced fatigue resistance.

What This Means

Project 0-7041 represents a significant milestone in advancing bridge construction practices in Texas. The successful demonstration and validation of the NextGen Texas bridge deck system underscore its potential as a cost-effective and durable alternative to traditional methods. The comprehensive research findings offer valuable insights into design optimizations, reinforcement strategies, and construction considerations, providing engineers with practical guidelines for implementation in accordance with TxDOT standards. With further research and refinement, the NextGen Texas Bridge Deck system holds the promise of revolutionizing bridge construction in Texas, paving the way for safer, more efficient, and resilient infrastructure networks.

For More Information

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www.txdot.gov
Keyword: Research

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