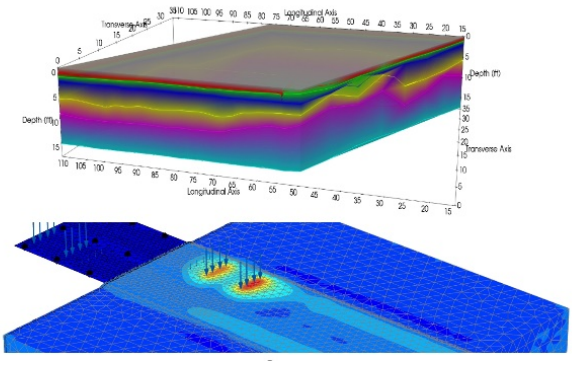
TN TDOT Department of Transportation

Research Summary

Bump at the End of the Bridge: Enhanced Remediation Decision Making via 3D Measurement and Advanced 3D Dynamic Analysis



Project Number:
RES2019-21

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WHAT WAS THE RESEARCH NEED?

The Tennessee Department of Transportation (TDOT) and transportation departments across the country have long recognized that approach slabs and pavements at bridges are prone to both settlement and cracking, which have been widely recognized as the "bump at the end of the bridge" (BEB). This study seeks to provide guidance and aid TDOT officials in their decision-making process regarding bridge approach remediation via an improved understanding of the BEB issues using 3D subsurface measurements and advanced 3D dynamic analyses.

WHAT WERE THE RESEARCH OBJECTIVES?

The research activity had two specific objectives:

1. Conduct 3D subsurface measurements using a combination of ground-penetrating radar (GPR) and multi-channel analysis of surface waves (MASW) to delineate soil layers, and
2. Develop advanced 3D dynamic analyses of the approach slab and pavement using the subsurface maps.

WHAT WAS THE RESEARCH APPROACH?

The research team took a 4-step approach. First, non-destructive surveys were conducted for bridges with varying BEB problems using an innovative strategy that combines data from multi-frequency GPR and MASW.

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Next, accurate 3D subsurface models were developed using the MASW and GPR data. Then, using the 3D soil layer models, advanced 3D finite element nonlinear models were developed for the bridge approach system subjected to dynamic vehicle loadings. Lastly, the effectiveness of nonlinear finite element models as a framework for evaluating mitigation strategies was demonstrated by evaluating the effects of using geogrid reinforcement in the backfill at bridge ends.

WHAT WERE THE FINDINGS?

Four major findings came out of the research:

1. Non-destructive 3D subsurface surveys provide information on the current state of bridge approach foundations for assessing BEB issues.
2. Accurate 3D soil maps were be developed by combining MASW and GPR data.
3. Using a geotechnical analysis software system called PLAXIS, dynamic 3D models of the bridge approach system were developed from the 3D surveyed 3D soil maps.
4. The resulting dynamic PLAXIS 3D models can provide a platform for evaluating BEB mitigation strategies and alternative retrofit designs.

IMPLEMENTATION AT TDOT

Based on the results from this study, the research team made the following recommendations to TDOT:

1. Combine MASW with GPR to provide an effective non-destructive method for developing accurate 3D subsurface surveys.
2. Use MASW and GPR surveys to provide an additional level of quality control on new construction and periodical inspections on existing bridges.
3. Consider the results from 3D soil-structure models when evaluating alternative BEB mitigation strategies.

MORE INFORMATION

Find the final report here: https://www.tn.gov/content/dam/tn/tdot/long-range-planning/research/final-reports/res2019-final-reports/RES2019-21_Final_Report_Approved.pdf.

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