Bridge Deck Integrity Measurements for Asset Management

tech transfer summary

Stress-wave–based non-destructive testing methods can potentially be used to evaluate concrete bridge deck integrity while minimizing traffic disruption.

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RESEARCH PROJECT TITLE
Bridge Deck Integrity Measurements for Asset Management

SPONSORS
Midwest Transportation Consortium (MTC Project 2007-03)

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The Midwest Transportation Consortium (MTC) is part of the Institute for Transportation (InTrans) at Iowa State University. The MTC is the University Transportation Centers Program regional center for Iowa, Kansas, Missouri, and Nebraska.

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Objectives

- Investigate implementation of stress-wave–based non-destructive evaluation (NDE) methods to detect and evaluate defects in bridge decks
- Investigate use of sensors placed on the underside of the bridge deck and energy emanating from the surface to detect bridge deck condition
- Generate theoretical dispersion curves of wave propagation for a range of concrete conditions and plate thicknesses

The ultimate goal of this research is to develop reliable and economical NDE methods that can detect defects and evaluate the condition of bridge decks and be implemented without disrupting the traffic flow.

Problem Statement

Bridge decks deteriorate over time and can develop potholes and punch-throughs that decrease the efficiency of the bridge and create a hazard for motorists. To detect these problems quickly and plan for repairs, periodic inspections are necessary. Currently, inspections require lane closures and manually intensive sounding methods using either an impact device or chain. Developing stress-wave–based NDE techniques that detect defects in the bridge deck can help keep bridges safe and well-maintained while minimizing traffic disruptions.

Full-scale bridge deck at the Remote Testing Facility at the University of Missouri, Columbia

Research Description

Theoretical and experimental methods were used to study guided stress waves (Lamb waves) in concrete plates. Theoretical dispersion curves were created to simulate Lamb wave propagation through concrete plates of different conditions and thicknesses using Disperse software.

Field experiments were conducted at the Remote Testing Facility and at Midway, both sites operated by the University of Missouri, Columbia. At both sites, stress wave propagation was studied using a variety of source and receiver configurations.

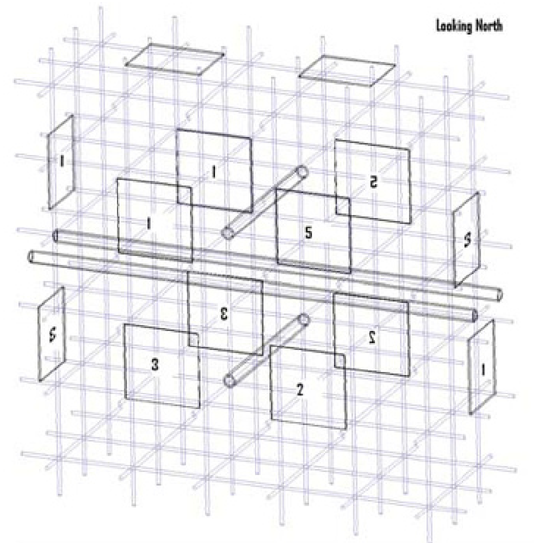
The theoretical curves were later compared to the experimental results taken from field experiments.

Key Findings

- Using the dispersion curves generated from the measurements of stress wave propagation performed on a full-scale bridge deck with a single sensor and multiple impact locations, Lamb waves can be detected and the modes can be separated.
- The measurements taken from sensors placed in the vertical, radial, and transverse directions were consistent with the theoretical modes of Lamb wave propagation.
- The dispersion curves from the experimental testing could be used to determine the velocity of Rayleigh waves and thickness of the concrete deck.
- Successful measurements were taken with the source and receiver on opposite sides of the deck.
- Measuring the changes in frequency content of a stress wave propagating past subsurface flaws showed potential for identifying the presence and depth of flaws.

Implementation Benefits

Stress-wave–based non-destructive testing methods can be used to help evaluate the condition of concrete bridge decks and have the potential to be successfully implemented in a manner that minimizes traffic disruption.

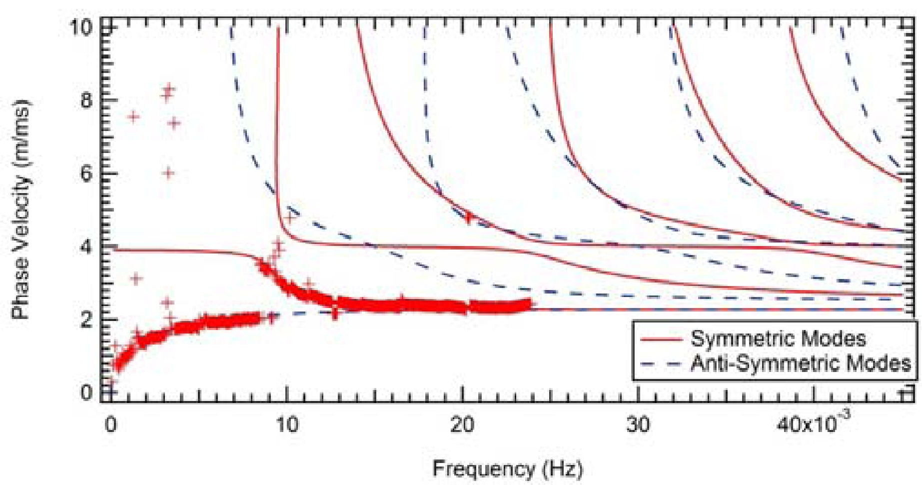


Drawing showing the interior of the Midway block and the locations of the subsurface defects in relation to the block.

Implementation Readiness

Further investigation is needed before this method can be implemented.

- Perform measurements on synthetic or real subsurface flaws on a full-scale bridge deck to better simulate the field conditions.
- To help make this method practical, study the performance of inexpensive piezoelectric-film sensor arrays that could be attached to the underside of the deck.



An example of the dispersion curves generated from both the theoretical (represented by the solid thin red and dotted blue lines) and experimental studies.