JERSEY DOT'S

"Turning Problems into Solutions"

Tech Brief

Bridge Deck Evaluation Using Portable Seismic Pavement Analyzer (PSPA)

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SO, HERE'S THE PROBLEM…

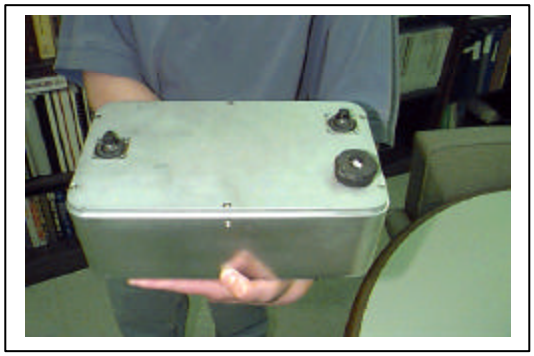
- the interstate bridges that were all built around the same time have now reached a point in their lives where they require extensive repair
- State bridges which are even older than the interstate bridges are in need of repair or replacement
- The amount of traffic on New Jersey's roadways precludes repeated lane closures for bridge repair

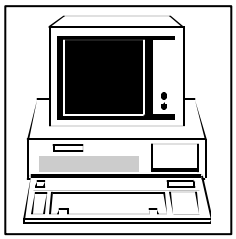
AND, HERE'S OUR SOLUTION

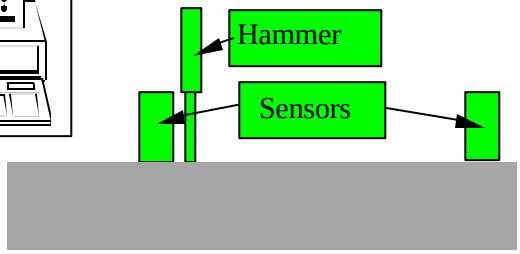
- determine a more reliable means of identifying defects in bridge deck structures
- locate the extent of all defective areas to minimize the need for repeated lane closures

We set out to evaluate the Portable Seismic Pavement Analyzer's (PSPA) ability to detect defects and delaminations in the concrete bridge decks, and its ability to estimate elastic modulus of the concrete material and deck thickness.

HERE'S WHAT IT LOOKS LIKE… AIN'T IT A BEAUTY!!!







The PSPA, alias “THE LUNCH BOX”, is a device for nondestructive evaluation of concrete bridge decks and pavements developed at the University of Texas at El Paso and is the baby of Geomedia Research and Development, Inc., El Paso, Texas. The LUNCH BOX was designed and constructed as an offspring of the Seismic Pavement Analyzer (SPA) for the sole purpose of checking out the top few inches of the concrete pavement or bridge deck.

THIS IS WHAT IT CAN DO

provide data for quality assurance/quality control
detect voids beneath the concrete pavement slab
detect the extent and degree of bridge deck delamination.
estimate elastic modulus of concrete material
determine pavement and deck thickness

BUT HOW CAN IT DO ALL THIS???

To conduct these tasks, the PSPA relies on two ultrasonic methods (Ultrasonic Compression waves and Ultrasonic Surface waves) for material characterization and it also uses the impact echo (IE) method to detect defects. The PSPA provides the bridge engineer with a sophisticated tool to effectively manage the repair and rehabilitation of the State’s bridges.

AND, HERE’S WHAT WE DID…

The device was field tested on three bridge decks on Routes Ł80, Ł495 and Ł287. The bridge decks were divided into 0.75x0.75 m or 0.9x0.9 m grids with a single point representing the data for that grid. Testing required about 1 minute per point. This included points that had to be repeated due to poor contact of the impact hammer. Data reduction procedures were fairly simple and did not require extensive operator training. Data reduction took about 1 minute per point to make a condition assessment with respect to the degree of delamination.

In addition to the main objectives of the study, we also looked into the development of improved data interpretation schemes using numerical simulations, and improved data visualization procedures. Presentation methods (line, surface or 3-dimensional plots) were developed to display collected data in a variety of ways.

As a means of comparison, the PSPA was tested side by side against the traditional chain drag method.

HERE'S WHAT WE CAME UP WITH…

Results from the Route I-287 bridge deck evaluation were compared to the results of the chain drag method. We found that the PSPA can "hear" defects in the concrete that are beyond the audible frequency of the human ear.

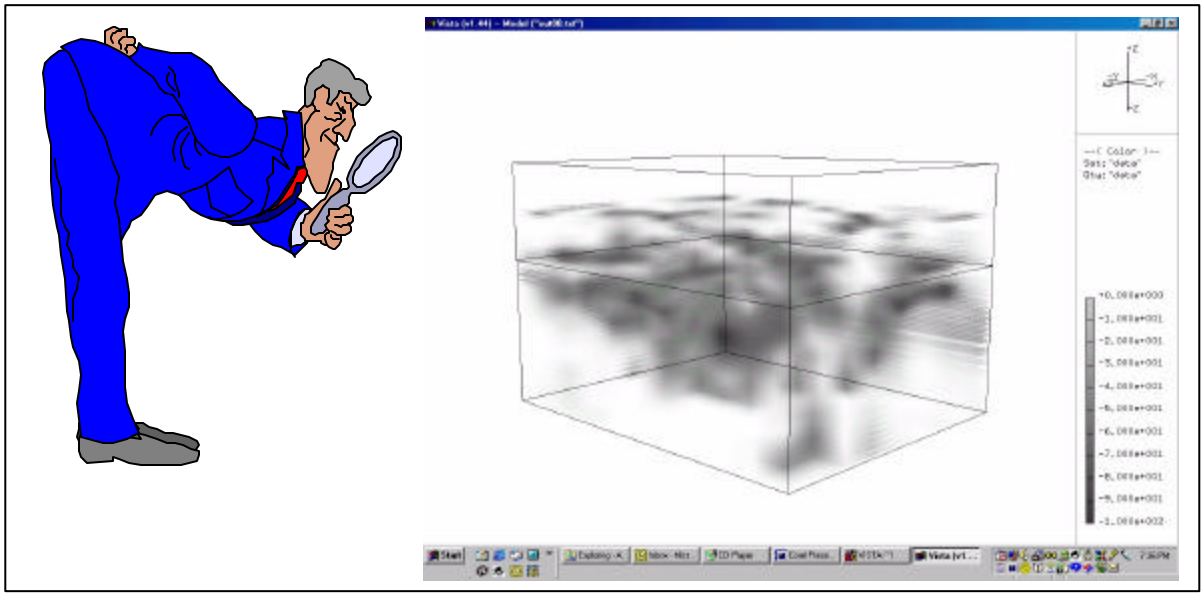
It can detect partial delamination of the deck concrete that is beyond the capabilities of the chain drag. These results were verified from small cores taken from the bridge deck.

A large number of numerical simulations were conducted for three major purposes:

- to evaluate the capabilities and limitations of the seismic methods used by the PSPA in detection of bridge deck delaminations
- to enhance data interpretation procedures, and
- to simulate the hypothetical progression of bridge deck delamination

The simulations were conducted using finite element analysis. They confirmed the ability of seismic techniques to detect the position (depth) and continuity of delamination.

Data visualization is an essential part of data interpretation and presentation. Data are typically presented in terms of surface distributions (contour or spectral plots) of elastic moduli and condition assessment based on the degree of delamination. These distributions are done for both the plan view and the deck cross section. Significant



improvement in data visualization was made through a three dimensional presentation of Impact Echo results.

Once the software is fully developed for the PSPA, the device will be able to provide real-time assessment of a bridge deck, and serve as what can be described as a "bridge deck sonar device".

THE BOTTOM LINE…

The Portable Seismic Pavement Analyzer (PSPA) evaluated in this study proved effective in detecting and quantifying concrete bridge deck delamination and estimating elastic modulus and concrete deck thickness. The study demonstrated the advantages of the PSPA over the chain drag method in evaluating bridge decks.

While this study illustrated that the PSPA can be a valuable tool in detecting bridge decks in need of repair, we noted there are many improvements that can be made to improve the accuracy and speed of testing, and simplify data interpretation. These include:

- development of testing systems consisting of several PSPA devices linked together for simultaneous testing,
- incorporation of automated data interpretation procedures based on numerical simulations and neural network models, and
- incorporation of 3-dimensional data presentation programs for real time data visualization.

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A final report is available online at
http://www.state.nj.us/transportation/research/research.html

If you would like a copy of the full report, please FAX the NJDOT, Bureau of Research, Technology Transfer Group at (609) 530-3722 or send an e-mail to Research.Bureau@dot.state.nj.us and ask for:

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