NDEVC News

NONDESTRUCTIVE EVALUATION VALIDATION CENTER

U.S. DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION

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Visual Inspection Study Nearing Completion

The Visual Inspection (VI) method is, by far, the predominant nondestructive evaluation (NDE) technique used for bridge inspection. Furthermore, the VI method serves as the baseline by which all other NDE technologies and methods are generally compared. Since inception of the National Bridge Inspection Standards (NBIS) in 1971, which mandated regular and periodic bridge inspections, a complete study of the reliability of the VI method as it relates to bridge inspections has not been undertaken.

A comprehensive study of VI was initiated by the NDE Validation Center (NDEVC) in August 1998 and is currently ongoing. This significant study has three principal parts. First, a literature review of research related to visual inspection and human factors was completed so that this study could build on past findings. Second, a survey of practicing bridge inspection organizations was completed to establish the current state of the practice for bridge inspection. The final and most significant aspect of the investigation is an NDE performance evaluation of the VI method utilizing the NDEVC test bridge population.

The literature review and survey of States were completed early this year. Much was learned from these endeavors. For example, the reliability of VI has been investigated as it is practiced in other industries, but a comprehensive reliability study has never been undertaken for bridge inspection. In addition, although all States comply with the NBIS provisions, there are inconsistencies in inspection methodologies between States.

The VI reliability study began the field evaluation phase in early June of this year. The field evaluation consisted of having a representative sample of practicing bridge inspectors complete NBIS inspections of the NDEVC test bridges. Quantifiable information regarding the inspection environment is collected in order to establish its influence on VI reliability. Extensive information is collected about the inspector's physical and psychological characteristics, allowing the influence of human factors to be assessed.

An inspector looks for defects in the superstructure of a bridge in Virginia.

The pool of inspectors participating in this study comes from the State department of transportation bridge inspection groups. The help of all 50 States was solicited for participation in

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HERMES Radar System in Testing at TFHRC

There are 367,950 bridges in the United States that incorporate a concrete bridge deck design. The limitations of current visual inspection practices for evaluating the integrity of these concrete bridge decks have been recognized by the Federal Highway Administration, and a ground-penetrating radar (GPR) program has been developed in response. GPR has the potential to evaluate a variety of bridge deck configurations within the flow of traffic, thus making it an attractive alternative to current inspection practices.

Two radar systems have been designed and built by Lawrence

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NDEVC NEWS is the newsletter of the Federal Highway Administration's Nondestructive Evaluation Validation Center.

The NDE Validation Center was established by the Federal Highway Administration in 1998. The objective of the NDEVC is to improve the state of the practice for highway bridge inspection. The Center is designed to act as a resource for State transportation agencies, industry, and academia concerned with the development and testing of innovative NDE technologies. The NDEVC provides State highway agencies with independent evaluation and validation of NDE technologies, develops new NDE technologies, and provides technical assistance to States exploring the use of these advanced technologies.

The NDE Validation Center utilizes a series of unique resources to evaluate and assess the factors affecting the reliability and performance of NDE systems. The Validation Center is located at the Turner-Fairbank Highway Research Center in McLean, Virginia. To supplement the capabilities of these laboratory facilities, a series of bridges located in Northern Virginia and southern Pennsylvania are utilized to conduct field investigations. In addition, a collection of component test specimens are used in various test programs.

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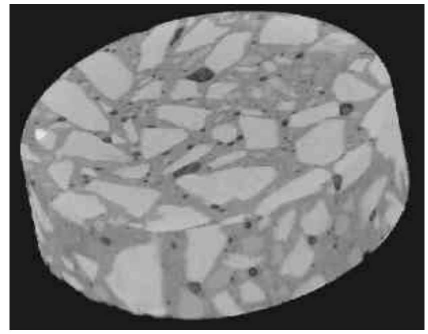
Computed Tomography Imaging



Three-dimensional tomographic image of a concrete core.

An x-ray computed tomography and digital radiography imaging system has been added to the NDEVC research facility. The advanced computed tomography imaging system ACTIS 600/420 was built by Bio-Imaging Research, Inc. according to specifications provided by researchers at the NDEVC. The system consists of dual-focus 420-kV and microfocus 160-kV continuous x-ray sources. It includes two digital detectors, with a 512-channel linear array detector for tomographic imaging and a tri-field image intensifier with a digital camera for both real-time radiography and microtomography. The system can benefit many industrial and scientific applications, including materials research, non-destructive testing, core sample characterization, weld inspection, failure analysis, and reverse engineering. It is suitable for x-ray inspection of metallic and non-metallic items over a wide range of densities. The system produces cross-sectional computed tomography (CT) images, in-motion real-time radiography (RTR) images, and digitized radiographed (DR) images. In addition to density mapping, CT provides complete 3D morphology of parts with highly accurate dimensioning capability. The CT data sets can be converted to line drawings and exported as splines for solid modeling and comparison to Computed-Aided Design (CAD) drawings. Computed tomography also provides superior flaw detection capability of extremely small cracks, porosities, and voids that are normally not visible with film radiography inspection. The system can provide spatial resolution of up to 20 lines per millimeter or 25-microns. In addition, sample sizes up to a weight of 200-kg and a length of 100-cm can be accommodated. The system has been used by researchers at the NDEVC to conduct projects such as determination of air void parameters, crack propagation, and internal structure characterization of portland cement concrete and asphalt concrete structures.

Visual Inspection Study

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this study. The field testing portion of the study was completed in early October. Overall, 25 States participated in the field testing by sending inspection teams to the NDEVC.

Results from this study will be forthcoming in early 2000.

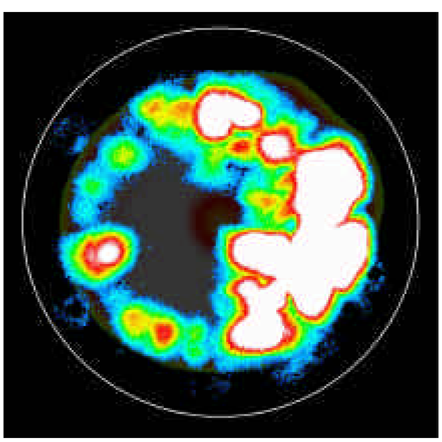
A bridge inspector measures the opening of an expansion joint.

Various NDE Techniques Used on Hanger Pins

Tests using a number of different NDE technologies were recently completed on a set of hanger pins that were removed from an in-service bridge in the Midwestern United States. The techniques included ultrasonics, radiography, and computed tomography.

Initially, misalignments were noticed in a few hanger assemblies within this particular bridge. The State DOT then investigated further, contracting for field ultrasonic inspections to be completed on each hanger pin in the bridge. This field ultrasonic inspection identified seven hanger pins that contained possible defects. The defects identified ranged from significant wear grooves to cracked cross-sections at the level of the shear plane. The defective pins were removed from the bridge and sent to FHWA's NDEVC.

At the NDEVC, the pins were first studied using ultrasonics in an immersion tank. This is a non-contact automated technique that provides highly repeatable results. A C-scan image recorded during the immersion tank testing is shown below. For this pin in particular, the immersion tank testing showed that the pin cross-section at the level of one of the shear planes had decreased to approximately 25% of its original area. Overall, the immersion tank testing confirmed the results obtained from the field ultrasonic testing prior to pin removal.



C-scan from the ultrasonic immersion tank testing of a hanger pin.

Radiographic testing was also performed on several of the pins at the NDEVC. These tests, although not practical for field use on a bridge component of this type, were useful for comparison purposes between different techniques.

Finally, several of the pins were sent to Lawrence Livermore National Laboratory in Livermore, California, to be tested using computed tomography. Tomographs of a pin section at the shear plane were consistent with the ultrasonic results. In addition, the images indicated longitudinal cracking near the shear plane defect.

HERMES Radar System in Testing

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Livermore National Laboratory under the sponsorship of FHWA. The HERMES (High-speed Electromagnetic Roadway Measurement and Evaluation System) bridge inspector is a GPR system built into a towable trailer. The design facilitates survey of the deck condition without the need to disrupt traffic flow. This system is based on a 64-channel antenna array covering 1.9-m in width with a sampling density of 3-cm.

To investigate specific areas of a bridge deck that require detailed inspection, a robotic cart-mounted radar system has been produced. This system, PERES (Precision Electromagnetic Roadway Evaluation System), has a density of data coverage of 1 cm, with an average of 100 samples taken at each location to improve the signal-to-noise ratio.

Images of the deck interior are reconstructed from the original synthetic aperture data using diffraction tomography. This technique refocuses the diffuse, original data with the aim of producing an image that is a closer representation of the internal structure. The goal of these systems is to accurately locate steel reinforcement, corrosion-related delaminations, voids, and disbonds.

The testing phase of these systems has commenced. To date, HERMES measurements have been recorded on in-service bridge decks in California, New Jersey, Tennessee, and Virginia. PERES has been tested using deck slabs that are part of the bridge component specimen collection held at the NDEVC, as well as in select field locations.

Currently, the GPR systems are completing a series of field tests, which have include stops in St. Louis (July 14-16); Denver (July 28-30); Minneapolis (August 10-12); Harrisburg, PA (October 26-28); and Washington, D.C. (November 9). Further testing and demonstration of the system will continue into winter.

HERMES Bridge Inspector performing radar imaging of a bridge deck outside Nashville, TN.

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NDE Staff Says Goodbye to Dr. Steve Chase

*I*n early summer of this year, Dr. Steve Chase moved on from the NDE Group at the Turner-Fairbank Highway Research Center. However, he has not left the FHWA family. Dr. Chase is now working in the field of Hydraulics and is located at the FHWA's Baltimore Resource Center.

Shown at right, the NDE Group came together just before his farewell luncheon. Starting from the back left are:

- Mark Moore – Project Manager
- Dr. Mike Scott – Research Engineer
- Dr. Habeeb Saleh – Research Scientist
- Dr. Fassil Beshah – Research Engineer
- Dr. Steve Chase – FHWA Baltimore Resource Center
- Dennis Rolander – Research Engineer
- Glenn Washer – FHWA NDE Project Manager
- Ben Graybeal – Research Engineer.

In the front row are:

- Fariba Parvizi – Administrative Assistant
- Dr. Brent Phares – Research Engineer
- Dr. Nigel Davidson – Former Research Scientist
- Dr. Paul Fuchs – Research Engineer.

Staff members not pictured include Research Engineer Dr. Ali Rezaizadeh and Research Engineer Richard Walther.

FHWA NDE staff pauses for a picture just prior to Dr. Chase's farewell.