NDEVC News

NONDESTRUCTIVE EVALUATION VALIDATION CENTER

U.S. DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION

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Visual Inspection Results Finalized, Published

A comprehensive study of the reliability of Visual Inspection of highway bridges was recently conducted by the NDEVC. The goal of this 2-year study was to determine the accuracy and reliability of bridge inspection as implemented by State DOTs.

The study involved having bridge inspectors from 25 States complete 10 inspection tasks on 7 of the NDEVC test bridges. Seven of these inspections were Routine Inspections, while three were In-Depth Inspections. In addition, one of the Routine Inspections was performed as a State-Dependent Inspection where inspectors performed the inspection using their home State data collection and recording procedures.

Inspector checking behind the end floor beam.

Forty-nine State bridge inspectors participated in the field testing portion of the study. This group included inspectors of diverse backgrounds, qualifications, and personal characteristics.

Routine Inspection Results

Routine Inspections are the standard bridge inspections that are performed on the majority of the bridges in the United States. One of the goals of these inspections is to rate the condition of the primary elements of the bridge on a 0 to 9 scale.

Overall, there is significant variability in the assignment of condition ratings. The results indicate that approximately 68 percent of condition ratings will vary within ± 1 condition rating point from the average, and 95 percent will vary within ± 2 points. An average of between four and five different condition ratings were assigned to each primary element of the bridges inspected.

In-Depth Inspection Results

In-Depth Inspections are close-up, hands-on inspections completed on a portion of a bridge. These inspections are usually implemented with the intent of locating specific deficiencies that may exist in the bridge. In this study, two In-Depth Inspection tasks were performed on steel superstructures.

It appears that an In-Depth Inspection completed by a State bridge inspector may not detect many of the types of deficiencies for which it is frequently prescribed. For example, the correct call rate for identifying crack indications during one of the inspection tasks was only 4 percent. The correct call rate for identifying defective bolts was 24 percent. In another In-Depth Inspection task, only 7 percent of the inspectors correctly identified the crack indication.

A few factors seemed to relate to the In-

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Inside this issue:

Wingwall Kept in Check by NDEVC

The NDEVC has recently provided technical assistance to the FHWA D.C. Division Office in relation to a structure in the District of Columbia. A wingwall adjacent to a bridge abutment on the Whitehurst Freeway had been experiencing large amounts of water flow from weep holes in the structure. Since the abutment is adjacent to the C&O Canal, there were concerns that the water flow was due to a leak in the canal wall. Initial visual observations of the wingwall showed movement relative to the abutment.

To determine future structural movement and to access the effectiveness of any repairs to the canal, a continuous monitoring system was

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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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Project Updates

Steel Bridge Virtual Shop Assembly

Most States currently require some level of shop assembly of fabricated steel bridge members. The NDEVC is continuing to work on developing a laser-based system that could provide virtual assembly of these bridge members, eliminating the need for physical shop assembly. Further proof-of-concept tests have been completed and the project is likely to move into an advanced testing phase in the near future. For further information, contact Paul Fuchs at (202) 493-3095.

Automated UT of Butt Welds

Automated ultrasonic testing (UT) is an inspection technique ideally suited to the inspection of butt welds created during the bridge fabrication process. The NDEVC is working on aiding in the transfer of automated UT technology to this industry. Proof-of-concept tests were recently conducted at High Steel Structures, Inc. in Lancaster, PA. These tests showed that automated UT can provide results similar to those gained from manual UT and from radiographic testing (RT). The advantage of automated UT is that it provides both permanent storage of inspection data and multiple views of the data, thus aiding in its interpretation. A parallel testing study, including automated UT, manual UT, and RT, is expected to commence soon. For further information, contact Glenn Washer at (202) 493-3082.

Overhead Sign Structure Inspection

Concern about overhead sign structure and light pole failures has led many State DOTs to reevaluate their inspection procedures for these highway structures. The NDEVC is in the process of surveying States to determine how these inspections are completed and what sort of problems are generally found. A market survey of techniques currently available to inspect these structures is also being performed, along with research into promising techniques. In addition, a task group is being formed to bring together States interested in disseminating pertinent information and sharing their experiences with these structures. For further information, contact Dennis Rolander at (202) 493-3120.

Procedure for UT of Hanger Pins

The NDEVC is continuing its work on the ultrasonic inspection of bridge hanger pins. The goal of the current work is to develop a procedure for the inspection of pins that can be used by State transportation agencies that are either inspecting pins themselves or contracting for inspection services. The resulting report will include a description of general hanger pin inspection procedures, including cleaning requirements, scanning patterns, use of angle beam transducers, available sizing techniques, and interpretation of signals. In addition, a general description of the types of documentation usually required and of inspector qualifications and certifications will be developed. For further information, contact Brent Phares at (202) 493-3121.

NDEVC Tests Prestressed-Concrete Box Girders

The third in a series of full-scale tests of prestressed-concrete box girders was recently completed at the Turner-Fairbank Highway Research Center. These 40-year-old girders were donated by the New York State DOT after having been removed from service due to severe deterioration. The goal of the testing was to improve the knowledge base for the behavior of bonded composite laminates used in retrofitting deteriorated concrete beams.

The five donated girders were each approximately 21.5 m (70 ft) long and had depths of 0.84 m (33 in). Deterioration of the bottom flange of the girders caused these girders to be removed from service. The deterioration included spalling concrete, corroded strands, and broken strands.

In practice, a number of States have recently become interested in retrofitting the bottom flange of this type of girder with bonded composite laminates. The retrofits are designed to replace any loss of strength that may have occurred due to deterioration.

The first two tests in the series were on girders that had not been repaired. These tests provided information on the pre-repair strength and behavior of the girders.

The third girder was repaired on site at TFHRC. The repair included removal of deteriorated bottom flange concrete, patching of spalled areas, and application of the composite laminate repair material. A carbon fiber laminate was used for this test. The application of the laminate included applying multiple layers of the composite in three strips along the bottom flange.

The testing of the girders was completed by the application of loads at two load points, each 1.5 m (5 ft) from midspan. Four 445-kN (100-kip) hydraulic jacks were used. The girder was instrumented to measure horizontal and vertical deflection, as well as strain in the concrete and the laminate.

A number of NDE techniques were also used throughout this testing. Prior to testing, the Virginia Polytechnic Institute NDE team assessed the quality and presence of the adhesive bond between the laminate and the concrete. This testing was performed with infrared thermal imaging. Also prior to the test, NDT Engineering, Inc. performed sonic testing on the concrete to determine its strength. During the test of the repaired girder, Physical Acoustics Corporation assessed the condition of the concrete prestressing strands through the use of acoustic emission monitoring.

New York State DOT is in the process of analyzing the results of the three box girder tests.

The fiber-composite plates debonded at the conclusion of the test. This photograph was taken at the moment of failure.

Wingwall Kept in Check . . .

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designed and built specifically for this application. The purpose of the system is to measure the long-term movement of the wingwall relative to the abutment. An innovative part of the instrument is a low-cost electromagnetic displacement sensor, designed and built for this application by the NDEVC. The monitoring system has been providing information on the condition of the structure since installation in mid-August.

This project was coordinated with the cooperation of Kathleen Linehan, FHWA D.C. Division Office Structural Engineer. Further information on this project can be obtained by contacting Paul Fuchs at (202) 493-3095.

Visual Inspection Results

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Depth Inspection results. They include time to complete inspection, comfort with access equipment and heights, and flashlight use.

Deck Delamination Survey

The third In-Depth Inspection task focused on the delamination survey inspection of a concrete bridge deck. The inspectors worked in pairs to complete the mechanical-sounding-based survey. The bridge deck showed few outward signs of distress; however, it was approximately 19 percent delaminated.

This portion of the study showed that the accuracy of deck delamination inspection is relatively poor. Few teams provided maps that could be considered to accurately portray the condition of the deck. Also, only about one-quarter of the teams provided overall delamination percentages within 5 percentage points of the actual amount.

State-Dependent Inspection

During one of the Routine Inspections, the inspectors were asked to complete the inspection as if the bridge were located in their home State and were part of their bridge inventory. Unlike in the other tasks, the inspectors used their own inspection forms and followed their home State inspection format (i.e., element-level inspection and/or condition rating inspection).

This portion of the study showed that most States follow similar inspection procedures and provide the same general information in their inspection results. However, the presentation of the reports varied greatly, as would be expected. Also, approximately two-thirds of the States that participated in this study presented element-level data. The use of element-level inspection elements was generally consistent with the FHWA *Commonly Recognized (CoRe) Element Guide*.

Crack indication in a tack weld.

Concluding Remarks

Visual inspection of highway bridges is critical to the continued fitness of our Nation's infrastructure. This study established a benchmark for the state-of-the-practice and should help to ensure the continued advancement of visual inspection techniques for years to come.

Further information can be obtained by contacting the NDEVC or by referencing FHWA Report Nos. FHWA-RD-01-020 and FHWA-RD-01-021, which contain the complete results of the study.

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