Joint Transportation Research Program

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Long-Term Project and Network-Level NDT Implementation Plan for Indiana

Introduction

The Indiana Department of Transportation (INDOT) has traditionally paired visual inspection with bridge deck age to assess the condition of bridge decks and make programming decisions about possible future work actions. While chain dragging and hammer sounding are used by bridge inspectors to complement the information obtained from visual inspection, the internal condition of bridge decks cannot be accurately evaluated unless nondestructive inspection methods are employed. Considering the multiple NDT (nondestructive testing) methods that are available, INDOT needs guidance to select NDT methods that effectively assess the condition of large numbers of bridge decks on a network-wide basis and are also effective on a case-by-case, project-level basis for individual bridges. Consequently, the purpose of this study is to examine various NDT methods and develop recommendations for an NDT strategy for network-level and project-level bridge inspections in Indiana that will complement bridge information from traditional bridge inspections and provide asset engineers with improved information for long-term programming decisions.

Findings

Several different factors were considered for the development of the nondestructive testing plan for the research study. These included different bridge deck characteristics, such as the type of bridge deck, type of supporting structure, reinforcement protection (plain or epoxy-coated), bridge NBI deck and wearing surface conditions, presence and type of overlay (latex modified concrete or epoxy overlay), depth of top reinforcement layer, and geographic location within the state. Several different NDT methods that were suitable for ease of implementation were also considered, such as ground penetrating radar (GPR), automated sounding, impact echo (IE), and infrared thermography (IRT). For each of these NDT methods, a different way of collecting the nondestructive data was used. Lastly, a limited number of concrete cores was collected and used to assess the results from the nondestructive scanning.

The next step in the research plan was to select a variety of consultants who provide NDT services to collect NDT data from a set of bridge decks that represented various combinations of the bridge deck characteristics noted previously. The INDOT Division of Research also collected NDT data. Many of the consultants nondestructively scanned the same set of bridge decks so that a broad spectrum of NDT information could be compared. A total of nine different NDT consultants plus INDOT collected NDT information. The testing was conducted in two rounds—the first in the fall of 2020 and the second in the summer to fall of 2021. Some of the consultants conducted more than one NDT method when scanning the bridge decks, while others conducted only a single test method. The NDT results from different consultants were compared to gauge the degree of agreement in the deck conditions for a given test method. The results of different test methods were also compared to understand the relative sensitivity of the NDT methods. It was recognized that comparing different NDT methods may be problematic because different methods detect different types of deck distress conditions.

Based upon the comparisons and the results observed in this study, the following findings were discovered.

- IE results compare reasonably well, and the method was found to be repeatable. Selective concrete cores extracted from some of the bridge decks universally confirmed the IE results.
- IRT results for delamination detection were found to be somewhat comparable between entities. However, it was also determined that the IRT method can be notably affected by shaded deck areas, moisture, and small temperature differences. Percentage delamination values detected by IRT were routinely less than those found by IE, but they were greater than the values from automated sounding for most bridges.

- GPR was used to both detect the concrete cover thickness above the top reinforcement and assess the condition of the bridge deck.
  - Both air-launched GPR and ground-coupled GPR were found to be very effective in detecting the location of the top layer of reinforcement and determining the amount of concrete cover for the top reinforcement layer. Either method is suitable for verifying the concrete cover of a bridge deck.
  - Bridge deck deterioration results detected by both air-launched and ground-coupled GPR were found to have significant variations in both values and locations. Therefore, the method is not believed to be consistently repeatable, and it is not recommended as a sole method to evaluate bridge deck condition. Nevertheless, it is believed that it can provide valuable information about the possible likelihood of corrosion activity in a bridge deck and is useful when combined with other primary NDT information, such as IRT or IE.
  - Automated sounding results were found to provide low delamination detection values compared to other methods.
  - There is a need for ground-truth testing to clearly identify the actual bridge deck condition so that suitable comparisons with nondestructive testing can be verified. A follow-up study is recommended to fill in this missing information and develop additional confidence in the results found herein.

Implementation

There is a significant need by INDOT to complement current bridge inspection information based upon visual inspection data and bridge age with reliable nondestructive testing data. The combination of visual information and internal deck condition information will help bridge inspectors evaluate the deck and wearing surface conditions more accurately. Improved condition assessments will provide asset engineers with further information that can be used strategically in future programing of major bridge deck work actions.

The following recommendations were made for network-level NDT inspection and project-level NDT inspection of bridge decks in Indiana.

- Aerial IRT is recommended as the initial network-level inspection method to scan a large number of bridges and effectively conduct a triage of bridge deck condition. If significant delamination activity is detected, then follow-up network-level scanning on only the problematic bridge decks should be performed using vehicle-mounted IRT. It may be advantageous to also add vehicle-mounted air-launched GPR to complement the IRT information to assess the probability of corrosion activity.
- IE is recommended as a project-level test for future NDT assessment to detect delamination discontinuities in bridge decks.
- Pole-mounted IRT-UTD is recommended as a secondary project-level test for bridges with very high-volume traffic because of its ease of installation and removal in the field.

The recommended network-level inspection methods should be employed to evaluate the entire network of interstate bridge decks and NHS bridge decks. Additional state road bridges can also be included in the rotation of bridge assessments depending upon available funds and personnel. These condition assessments can be refreshed every 2 to 4 years so that the condition assessments can be compared and changes in bridge deck condition tracked, much like routine medical assessments are conducted for people.

If the condition of the bridge decks evaluated in the network-level assessments deteriorate to a significant extent, then project-level inspections may be initiated to gather information for making decisions regarding the application of an overlay or even a deck replacement on specific bridges. Use of reliable nondestructive test information of the actual bridge deck condition is much more reliable than simply using visual inspection and bridge deck age alone to make major programming decisions that can cost several millions of dollars.

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