Implementing NDE Technology and Effective Integration to a US Highway Agency Bridge Management Program

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Abstract

The state trunkline system managed by the Michigan Department of Transportation (MDOT) comprised of 9,695 miles and carries 51 percent of total statewide traffic. There are 4,413 bridges on the trunkline and 40 percent is on freeways. Total bridge deck area maintained by the MDOT is 49 million square feet (i.e., 75 percent of the bridge deck area of all Michigan's highway bridges). Michigan has eleven corridors on National/International significance. The decision principles to guide the management, operation, and investments on these corridors include strategies to reduce delays and minimize impacts during inspection as well as construction. One of the strategies explored by MDOT is to incorporate and integrate NDE technologies to bridge management.

The authors were charged for organizing a workshop for MDOT engineers and administrators for understanding the state of the practice NDE technologies. The goal of the workshop was to provide technology transfer to MDOT staff regarding the effective implementation of readily available and proven NDE technology, and how NDE is most effectively integrated into the specific components of the bridge management program. The workshop presentations would focus on those NDE technologies that have been successfully used by other Highway Agencies, and the advantages and drawbacks of a particular technology. Presentations include specific examples of how the NDE was used as part of a successful bridge management program; the level of difficulty or specialized training needed for operation and data interpretation; and lessons learned.

The article will discuss the outcome of the workshop including MDOT administrators' and engineers' reliability expectations. The article will also describe the road map to NDE technology integration to the highway agency bridge management program.

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Poster # 12

5th European-American Workshop on Reliability of NDE

MOTIVATION

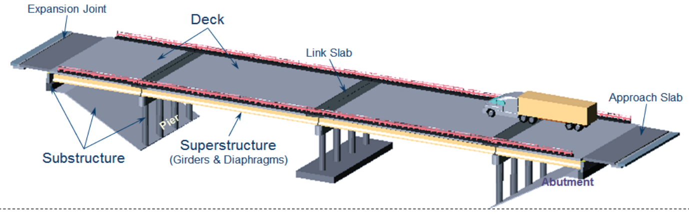
- Michigan Department of Transportation (MDOT) manages the state trunkline system comprised of 9,695 miles and consists of 4,413 bridges, supports local agencies responsible for 12,210 bridges, and 1,765 bridges are on freeways representing eleven corridors of National/International significance.
- MDOT Bridge Program Activities:
  - Establish condition of bridges for the 5 year planning program.
  - Design and implement "mix of fixes" strategies for the bridges in the 5 year plan.
  - Document detailed condition of a bridge for repair and rehabilitation design.

OBJECTIVES

- To explore the reliability based strategy of incorporating and integrating NDE technologies into the bridge management (preservation) program.
- Focus on proven NDE technologies successfully used by Highway Agencies.
- Identify a pool of NDE technologies for Michigan bridge management system/ program (BMS) components.
- Propose a road map for the reliability based integration of NDE within Michigan BMS.
- Identify and describe research needs for verifying and calibrating promising NDE, including the reliability expectations.

BRIDGE MANAGEMENT (PRESERVATION)

- Purpose
  - To provide a framework for maintaining bridges in good condition.
- BMS Components Requiring Bridge Condition State
  - Biennial safety inspections for assigning National Bridge Inventory (NBI) condition ratings to components.
  - Scoping projects for designing repairs to restore the structural integrity.
  - Specifications for condition-based maintenance activities.



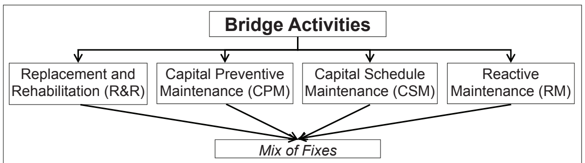


Figure 1. Activities of Bridge Preservation

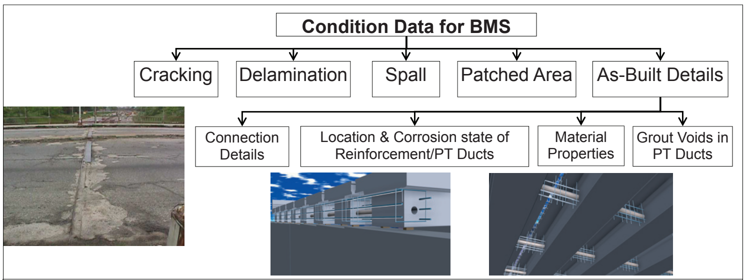


Figure 2. Common Condition Data Required for Designing the Right Fix

IMPLEMENTATION READY NDE TECHNOLOGIES

Technology	Application
Ground Penetrating Radar-**Figure 4**	• Map reinforcement details. • Map post-tensioning duct locations. • Map concrete delamination in the presence of moisture. • Map deteriorated concrete areas with corrosion vulnerability.
Laser Scanner (LiDAR)-**Figure 5**	• Document bridge component and structural geometric information.
Infrared Thermography (IR)-**Figure 6**	• Map shallow delamination in concrete and asphalt.
Phased Array Ultrasonic Testing (UT)-**Figure 7**	• Map deep delamination in concrete. • Locate tendon duct and grouting defects.
Impact Echo-**Figure 8**	• Map shallow delamination in concrete. • Measure component thickness.
Ultrasonic Echo (Imaging)-**Figure 9**	• Evaluate tendon duct grout defects.
Ultrasonic Pulse Velocity (UPV)-**Figure 10**	• Measure near surface permeability properties.
Ultrasonic Surface Waves (USW)-**Figure 11**	• Evaluate modulus of elasticity of concrete.

ACKNOWLEDGEMENTS

This project is funded by the Michigan Department of Transportation. The authors would like to acknowledge the support and effort of Mr. Steve Kahl for initiating this research. The authors would like to thank to Professors Tess Ahlborn of Michigan Technological University, Jerome Lynch of University of Michigan, and Ali Maher and Nenad Gucunski both from Rutgers, the State University of New Jersey for attending and presenting at the workshop. Assistance of graduate research assistant **Abdul Wahed Mohammed, MSE., EIT.,** is greatly appreciated.

BMS ACTIVITIES-ASSOCIATED DATA COLLETION

Two-Tier Inspection Process

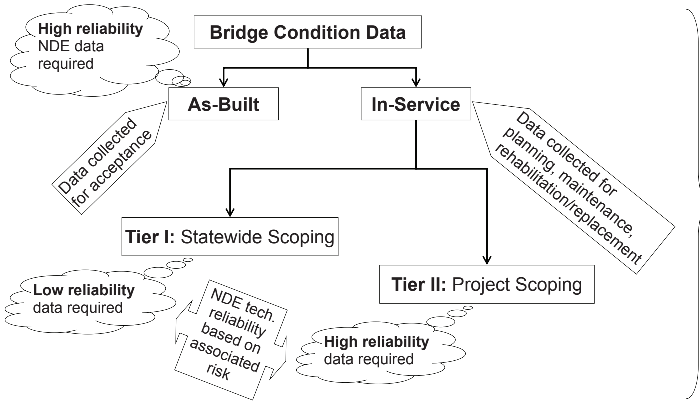


Figure 3. Two-Tier Data Collection Process

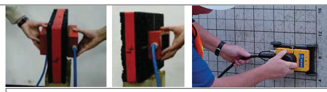
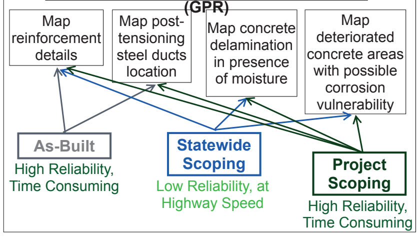


Figure 4. Ground Penetrating Radar (GPR)



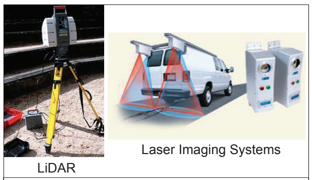
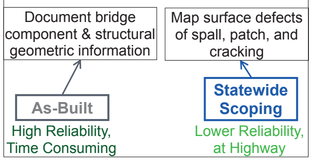


Figure 5. Laser Scanner



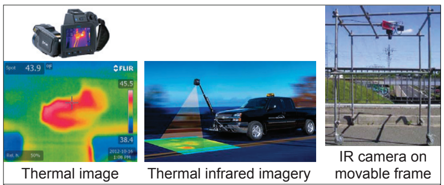
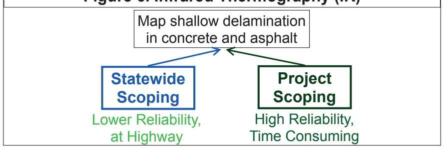


Figure 6. Infrared Thermography (IR)



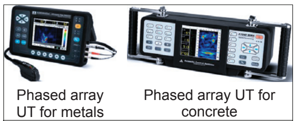
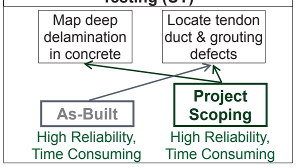


Figure 7. Phased Array Ultrasonic Testing (UT)



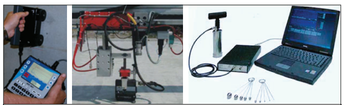
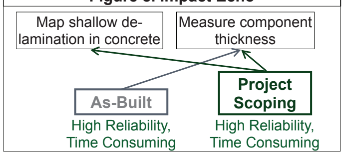


Figure 8. Impact Echo



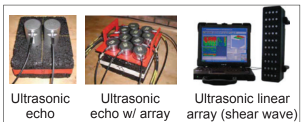
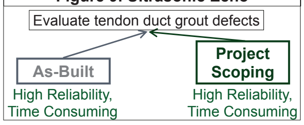


Figure 9. Ultrasonic Echo



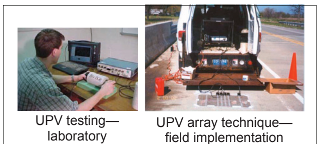


Figure 10. Ultrasonic Pulse Velocity (UPV)

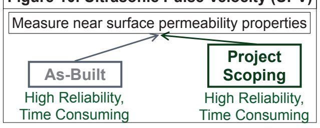
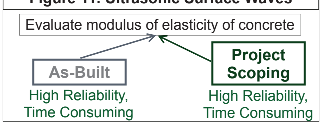


Figure 11. Ultrasonic Surface Waves



RECOMMENDED ACTION PLAN

- Develop a library of laboratory-fabricated specimens with embedded defects', field specimens from decommissioned bridges, and list of in-service bridges at various states-of-repair.
- Calibrate & validate recommended NDE procedures with the specimen library.
- Conduct education & hands-on training sessions for the recommended NDE technologies.
- Develop provisions for field implementation of recommended NDE technologies.
- Develop & support an NDE operator certification program in partnership with an industry association, such as American Council of Engineering Companies (ACEC).