Bridge Deck Thermography Verification and Policy

Objectives

- Develop specifications related to the equipment type, sensor platform and environmental parameters for IRT data collection
- Establish statewide policies on the bridge deck life-cycle condition to begin and stop using IRT
- Implement guidelines on the IRT's accuracy compared to the actual condition found during overlay construction

Benefit

- Establish inspection protocols to assist WisDOT's bridge asset management program

Background

As a part of the Wisconsin Department of Transportation's (WisDOT) overall bridge asset management program, different non-destructive evaluation techniques have been utilized on bridge decks to determine bridge condition. Since the early 1980s, WisDOT has used Infrared Thermography (IRT) to assess defect quantities and locations on bridge decks. These results were used to aid bridge monitoring, routine bridge inspections and help determine rehabilitation strategies.

WisDOT recently coordinated a statewide infrared program organized by WisDOT's Bureau of Structures (BOS) for all WisDOT responsible bridges. However, interpreting the procedures between different inspection methods, such as vehicle and fixed-wing aerial IRT inspection, is difficult. The accuracy of infrared thermography inspection can vary based on different infrared equipment, environmental parameters, and data collection procedures. This research project aims to develop infrared-based inspection and analysis protocols to assist with WisDOT's bridge asset management program.

Methodology

Twelve bridge decks were selected to aid in determining the recommended IRT policies. The selected bridges were comprised of different wearing surfaces such as bare deck, Portland Cement Concrete overlay (PCC), Polymer Modified Asphalt overlay (PMA), Hot Mixed Asphalt overlay (HMA), and Thin Polymer Overlay (TPO). The four selected IRT bridge deck collection methods were handheld, drone or unmanned aerial vehicles (UAV), fixed-wing aerial, and ground vehicle mounted (vehicle). Each method was used to collect IRT images across the deck, and specific delamination locations were chosen to compare each method's ground sampling resolution. Then, each method was assessed to determine the pros and cons of the collection.

Bridge ID	Feature On	Feature Under	Wearing Surface Type	Year Wearing Surface Placed
B400519	W GRANGE AVE	ROOT RIVER	Bare	1979
B660030	CTH Q COUNTY LINE RD	IH 41-USH 45	Bare	1996
B660053	MILEVIEW RD	USH 45	Bare	1984
B660037	USH 45 SB	IH 41	HMA Overlay	1997
B300048	STH 50 EB-STH 83 SB	SOO LINE	PMA Overlay	2006
B300058	STH 50 WB-STH 83 NB	SOO LINE RR	PMA Overlay	2006
B660031	MAPLE RD	IH 41-USH 45	Concrete Overlay	1996
B670122	CENTER DRIVE	IH 43	Concrete Overlay	2001
B670152	STH 59 EB	FOX RIVER	Concrete Overlay	2004
B300073	STH 165 WB	C & N.W. RR	TPO	2017
B300074	STH 165 EB	C & N.W. RR	TPO	2017
B400330	H DAVIDSON ACCESS RD	STH 190	TPO	2004

Selected bridges for the study including their surface type and age

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"This research helps establish more rigorous specifications for our deck survey contracts, which rely heavily on accurate thermography results for both planning and scoping."

– Philip Meinel, Project Manager

Results

Each method has pros and cons for data collection and analysis, but all can identify defects on a bridge deck. Choosing the correct method is situational and must be determined based on specific project needs. Handheld cameras are recommended for spot-checking topside IRT data during routine bridge inspections or areas where a vehicle or drone cannot be utilized.

Drone IRT inspections are recommended when there are a limited number of bridges to inspect or if access is restricted by a vehicle or a handheld IRT camera. Fixed-wing aerial IRT systems are recommended when there is a large number of decks requiring IRT. Vehicle-mounted IRT systems are recommended for higher resolution requirements and on bridge decks with higher surface variation.

The validity of IRT inspection for use in rehabilitation planning depends on several factors including the accuracy of the inspection, how close the inspection is to the rehabilitation date, the quantity of defects found by an IRT inspection, and the wearing surface type. The most significant variances in results were found in decks that had overlays and/or a high quantity of defects identified in the IRT inspection.

Additionally, there may be outliers in the dataset due to past IRT inspection procedures which did not follow current WisDOT standards. It may be possible to anticipate the difference in IRT inspections and rehabilitation quantities when looking at different wearing surfaces or the quantity of defects on an IRT inspection. However, further data collection may be necessary to understand the relationships better.

Table 8 - Recommended IRT Collection Time Hours After Sunrise

Overlay Type	Start	End
General	6 HR	10 HR
Bare	3 HR	10 HR
PCC	6 HR	12 HR
AC	5 HR	11 HR
TPO	4 HR	11 HR

Table 11 - Recommended First IRT Inspection Year

Wearing Surface	Start Year
Bare	18
PCC	5
PMA	5
HMA	2
TPO	2

Recommendations for Implementation

Each method has pros and cons for data collection and analysis, but all can identify defects on a bridge deck. Choosing the correct method is situational and must be determined based on specific project needs. Based on the study, researchers made the following recommendations:

- Program level IRT surveys can be collected with handheld, drone, fixed-wing aerial or vehicle-mounted IRT cameras
- IRT data should be collected when temperatures are above 32 degrees Fahrenheit and the deck is dry for at least 24 hours prior. The time needed after sunrise for the sun to emit enough thermal load to identify bridge deck defects depends on the wearing surface. The optimal time is at least six hours after sunrise
- Once a new deck is placed, the first IRT inspection should occur at year 18 for bare decks, then in seven-year intervals after that. When a new overlay wearing surface is placed, the initial inspection should reset and follow the recommended initial inspection year for each overlay type, then in five-year intervals going forward

Interested in finding out more?
Final report is available at:
WisDOT Research website

This brief summarizes Project 0092-23-04
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Wisconsin Highway Research Program