Table of Contents

5.11 INFRARED THERMOGRAPHY

5.11.1 Introduction

One type of deterioration encountered in bridge decks is delamination within the concrete deck. A delamination is defined as a horizontal fracture plane at or above the top layer of the reinforcing. Overlay surfaces can hide delaminations until they are well advanced and it can be difficult to distinguish between deterioration in the concrete deck slab and debonding of the overlay. Refer to Figure 5.11.1-1 for an overall view of a concrete bridge deck with an asphalt overlay.

Figure 5.11.1-1: Bridge Deck with Asphalt Overlay and Extensive Patching.

As discussed in Chapter 3 of Part 5, traditional nondestructive evaluation (NDE) methods involve chain dragging and hammer sounding. These audible methods require inspector judgment, a great deal of effort, traffic control, and traffic disruption from the lane closures. The presence of an asphalt or concrete overlay reduces the effectiveness of these traditional audible methods.

Infrared Thermography (IR) is an alternative tool for locating and mapping delaminations in bridge decks and pavements. A technique using an infrared scanner and control video camera, infrared thermography senses temperature differences between delaminated and non-delaminated areas.

A delamination in a concrete deck creates a thermal discontinuity that acts as an insulator. IR operates on the principal that when the sun warms the deck, the delaminated area heats up at a faster rate and reaches a higher temperature than the solid areas. This detection also works when the sun is setting and the ambient temperature begins to cool. The delaminated area will cool faster than the surrounding solid concrete. This method is best used on sunny or partially sunny days.

. The deck must be dry and winds must be less than 25 mph. Temperature difference is primarily related to the amount of sun, not the ambient air temperature, so inspections can be undertaken under various temperatures. From a practical standpoint, the majority of inspections are made between March and November with the use of a moving vehicle. Refer to Figure 5.11.1-2 for a schematic of a typical infrared thermography inspection.

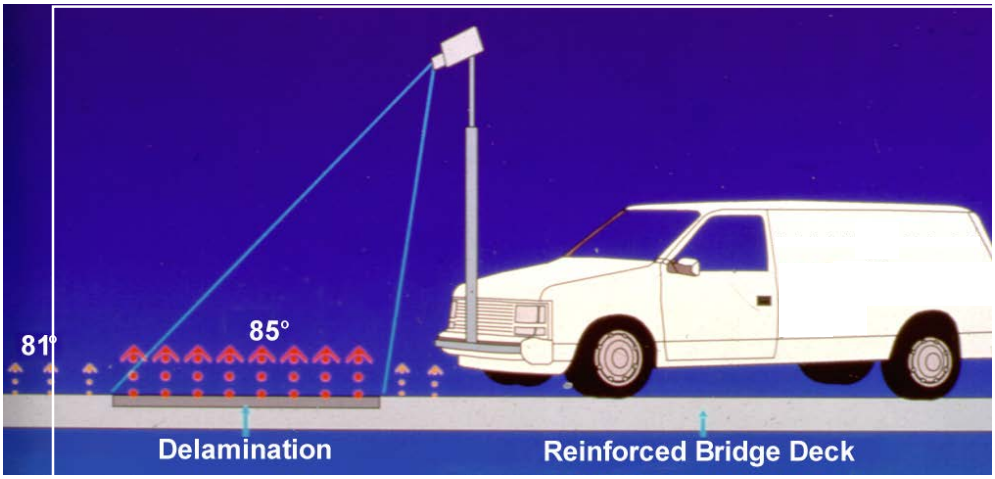

Figure 5.11.1-2: Illustration of IR of a Bridge Deck.

The procedure involves scanning the bridge deck with an infrared camera and recording the video signal on videotape for detailed analysis in the office. A single pass, with a vehicle speed of approximately five mph, is typically made for each lane and shoulder of the bridge deck. At the same time, a real-life control image of the bridge deck surface is recorded. Distance footage is superimposed onto both videotape signals to locate defects. Refer to Figure 5.11.1-3 for a view of the display images from an inspection.

Field confirmation of the infrared data consists of sounding several suspect deteriorated areas and measuring surface temperatures of both suspect and solid areas. Furthermore, select deck cores may be taken for confirmation. These proposed core locations are typically marked at the time of the inspection.

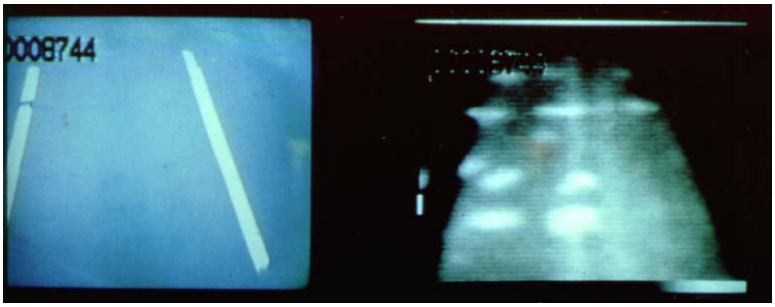

Figure 5.11.1-3: Real Life Image (left), Infrared Image (right).

Analysis of the infrared data is completed with the aid of a computer digitization program. During the analysis, the recorded temperature variations are interpreted to identify specific, delaminated areas. Each delamination is identified and plotted onto plan view drawings of the bridge deck. Square footage and percentage of delaminated deck are calculated. The

real-life control data is examined to make sure that temperature variations were not caused by concrete spalls, discoloration, patches, tar, or debris. In addition, the real life control data is used to plot patches, spalls, etc.

The use of IR for bridge decks is covered in American Society for Testing and Materials (ASTM) D4788-88; "Standard Test Method for Detecting Delaminations in Bridge Decks Using Infrared Thermography."

5.11.2 Applications

IR is most commonly used on concrete bridge decks with or without overlays; however, it can also be used on other concrete components. This is commonly accomplished through hand-held infrared camcorders that allow the inspector to move around the structure at a necessary pace. This method is proven to be accurate and easily repeatable.

IR also provides for quicker data collection, since the equipment can be vehicle mounted and driven over the bridge deck. By mounting the equipment to a vehicle, the process typically results in minimal traffic disruption. Compared to an audible inspection, infrared thermography can be used in areas with high traffic volumes or noise levels. The use of a hand-held infrared can also be used as an aid to quickly map out suspect areas for evaluation.

Data collection for infrared thermography is completed with the aid of computer logging software and the image can be digitally processed for an overall assessment of the bridge deck.

5.11.3 Limitations

Currently, IR requires a temperature differential of approximately 0.9 degrees Fahrenheit (0.5° C) between the delaminated or debonded areas and solid regions of the concrete deck. This typically requires that inspections be done on days with approximately 50 percent sunshine. Moreover, there are particular times of the day this method is applicable. As the temperature of the object cyclically warms and cools, there are periods when the delaminated area and sound concrete are at a similar temperature and therefore will not display on the infrared image. Wet areas, shadows, and debris on the deck do not allow a temperature difference to be established, and therefore, these areas cannot be inspected.

IR locates the delaminated areas in the horizontal plane but does not provide any information on the depth layer where the defect occurs. If confirmation on depth is desired, cores can be taken from the deck.

If an inspector plans to use this technology at only a few structures, or is considering setting up and operating a data collection vehicle, cost may be a prohibitive factor since the scanning equipment and data processing software are expensive. Also, the vehicle must typically be operated by at least two inspectors. However, when compared to manually sounding a large deck or several smaller decks, IR may be more cost-effective and may require less traffic control.