Designation: D 4788 – 88 (Reapproved 1997)

Standard Test Method for Detecting Delaminations in Bridge Decks Using Infrared Thermography[1]

This standard is issued under the fixed designation D 4788; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the determination of delaminations in portland-cement concrete bridge decks using infrared thermography. This test method is intended for use on exposed and overlaid concrete bridge decks.

NOTE 1—This test method can be used on asphalt or concrete overlays as thick as 4 in. (100 mm).

1.2 This test method uses an imaging infrared scanner and video recorder, mounted on a vehicle, to detect delaminations and debonded areas on bridge decks and to record the information.

1.3 The values stated in inch-pound units are to be regarded as the standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 4580 Practice for Measuring Delaminations in Concrete Bridge Decks by Sounding[2]

3. Summary of Test Method

3.1 The vehicle-mounted infrared scanner and video recorder is driven over the center of each lane of a bridge deck. The data from the scanner is recorded on video tape. Delaminations appear as white or "hot'' areas on a gray or "cooler'' background in the video image on a monochrome scanner system during daytime testing. During nighttime testing, the delaminations will appear as dark or "cooler'' areas on a white or "warmer'' background. Delaminations will appear as the warmer colors on color scanner systems during daytime testing. Calibration of thermal anomalies using sounding techniques are used to determine the colors associated with delaminations.

3.2 The conventional video image is used to edit the infrared image and separate those patches or surface defects that may be present and may appear as hot areas.

3.3 The video recording is used to map the delaminated areas at a suitable scale.

4. Significance and Use

4.1 This test method may be used in conjunction with other test methods in determining the general condition of a bridge deck.

4.2 Areas indicated as delaminated on overlaid bridge decks may be an indication of lack of bond between the overlay and the underlying bridge deck. This test method may be used in determining specific areas of delaminations requiring repair.

5. Apparatus

5.1 *General*—In order to collect data on the areal extent and location of the delaminations, the following apparatus is required:

5.1.1 *Infrared Scanner*— An imaging infrared scanner having a minimum thermal resolution of 0.2 Celsius degrees under ambient air conditions. The scanner shall be mounted on the front of the vehicle at a height sufficient to allow a minimum image width of 14 ft (4.3 m). The scanner shall be capable of producing a television-compatible image.

5.1.2 *Video Recorders* capable of reproducing a thermal image or a conventional video image. Each device shall have at least one audio channel available and provide a minimum resolution of 240 lines per inch. Two are required.

5.1.3 *Video Camera*— A conventional video camera capable of viewing a minimum image of 14 ft (4.3 m) and producing a color video signal that can be recorded on a standard video recorder.

5.1.4 *Distance Measuring Device* having an accuracy of ±3 in. (76 mm) over the longest span in the deck. The output of this device shall be recorded by both the infrared video recorder and the conventional video recorder.

5.1.5 *Test Vehicle* on which the imaging infrared scanner and video recorder will be mounted. The vehicle shall be capable of supporting the infrared scanner and the conventional video camera at a height sufficient to allow a minimum width of 14 ft (4.3 m) of pavement to be observed at one time. The vehicle shall be capable of supplying the necessary electrical

[1] This test method is under the jurisdiction of ASTM Committee D-4 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.32 on Bridges and Structures.

Current edition approved Sept. 30, 1988. Published November 1988.

[2] *Annual Book of ASTM Standards*, Vol 04.03.

power required for the instrumentation.

5.1.6 *Contact Thermometer* having a minimum temperature resolution of Celsius degrees.

6. Procedure

6.1 Prior to the survey remove any debris that has accumulated on the deck.

6.2 Dry the bridge deck for a minimum of 24 h prior to the test.

6.3 Collect data from one end of the bridge deck to the other in a continuous fashion.

6.4 For the delaminations to be identified by an imaging infrared scanner, there must be a temperature difference, Δ_t, between the delaminated or debonded area and the adjacent solid concrete of at least 0.5 Celsius degrees. Weather conditions must include sunshine. A minimum of 3 h direct sunshine are generally sufficient to create a temperature difference of 0.5 Celsius degrees. Establish the magnitude of Δ_t using a contact thermometer having a minimum resolution of 0.1 Celsius degrees. Confirm thermal anomalies and the existence of delamination in the field using coring or sonic techniques as described in Practice D 4580. Confirm coincidental surface defects in the field also.

6.5 Do not test when the wind velocity exceeds 30 mph (50 kph).

6.6 Take care when testing or interpreting data, or both, from areas that are or have been shaded by adjacent structures, trees, overhead signs, and the like. Areas adjacent to barriers may become too hot to provide accurate data due to either reflected heat or trapped hot air. It may be necessary to forego infrared thermography testing in such areas.

6.7 While data can be collected any time of the year, the magnitude of Δ_t will be smaller during the winter months, and may preclude the testing of bridge decks. Testing shall not be carried out when ambient air temperatures are less than 32°F (0°C) as ice in delaminations will cause false readings. As a guide, an ambient temperature rise of 20 Fahrenheit degrees with 4 h of sun and winds less than 15 mph (24 kmph), will allow accurate data collection on portland-cement concrete surfaces during winter months. On asphalt covered decks, an ambient air temperature rise of 20 Fahrenheit degrees with at least 6 h of sun and winds less than 15 mph (24 kmph) are necessary for winter use of this procedure.

6.8 Survey the entire bridge deck by making one pass per lane. When shoulder areas are wider than 3 ft (1 m) make a separate pass along the shoulder.

6.9 Collect data at speeds no greater than 10 mph (16 kph).

6.10 Should field confirmation of the existence of a delaminated or debonded area be required, select a core location(s) during the inspection. Mark the location(s) for coring either during the survey or subsequent to the infrared survey.

7. Interpretation and Plotting of Results

7.1 Plot the delaminations on a scaled plan of the bridge deck using either a manual or a computerized process.

7.2 Total the delaminated areas and present as a percentage of the total deck area in square feet (square metres).

8. Report

8.1 The report shall include the following information:

8.1.1 Bridge location and description,

8.1.2 Survey methods used and description thereof, including equipment used and the operators names,

8.1.3 Data of test and environmental conditions,

8.1.4 Scaled plan of the bridge deck showing the areas of delamination and debonding,

8.1.5 Area of the bridge deck, ft^2(m^2) and the percentage of the area delaminated or debonded, and

8.1.6 Location and condition of any cores taken.

9. Precision and Bias

9.1 The nature of this test method does not allow for a round-robin testing program. Consequently, the precision and bias of this test method are unknown at this time.

NOTE 2—Available data shows that infrared thermography can detect between 80 and 90 % of the delaminations found in an exposed portland-cement concrete deck and 80 to 90 % of the delaminations in an asphalt overlaid bridge deck.[3,4,5]

Interoperator testing, using the same infrared scanner, has shown that operators on the same bridge, on the same day, will detect the same areas of thermal anomaly. Interoperator evaluation of the collected data has shown a variation of ±5 % of the known square footage of delamination. Interoperator testing was carried out using 4 operators on two bridge decks, one exposed concrete and one bituminous overlaid structure.

10. Keywords

10.1 bridge decks; infrared thermography

---

[3] D. G. Manning, F. B. Holt, "Detecting Delaminations in Concrete Bridge Decks,'' *Concrete International*, Nov. 1980, pp. 34.41.

[4] D. G. Manning, F. B. Hold, "Detecting Deterioration in Asphalt Covered Bridge Decks,'' *Transportation Research Record 899*, TRB, pp. 10–20.

[5] B. W. Love, "The Detection of Delaminations in Reinforced Bridge Decks Using Infrared Thermography,'' Indiana Department of Highways, June, 1986.