Designation: D 4580 – 86 (Reapproved 1997)

Standard Practice for Measuring Delaminations in Concrete Bridge Decks by Sounding[1]

This standard is issued under the fixed designation D 4580; 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 practice covers procedures for surveying concrete bridge decks by sounding to determine delaminations in the concrete. It is not intended that the procedures described herein are to be used on bridge decks that have been overlaid with bituminous mixtures. The procedures may be used on bridge decks that have been overlaid with portland cement concrete mixtures; however, areas indicated to be delaminated may have a lack of bond between the overlay and the underlying bridge deck (Note 1).

NOTE 1—The influence of variable field conditions such as traffic noise, vibration, moisture content of the concrete, and the like, are not completely known and additional investigation may be needed. It is generally agreed that the practice should not be used on frozen concrete.

1.2 The following two procedures are covered in this practice:

1.2.1 *Procedure A, Electro-Mechanical Sounding Device*—This procedure uses an electric powered tapping device, sonic receiver, and recorder mounted on a cart. The cart is pushed across the bridge deck and delaminations are recorded on the recorder.

1.2.2 *Procedure B, Chain Drag*—This procedure consists of dragging a chain over the bridge deck surface. The detection of delaminations is accomplished by the operator noting dull or hollow sounds. Tapping the bridge deck surface with a steel rod or hammer may be substituted for the chain drag.

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

2. Significance and Use

2.1 This practice may be used in conjunction with other methods in determining the general condition of concrete bridge decks.

2.2 This practice may be used in determining specific areas of delamination requiring repair.

PROCEDURE A—ELECTRO-MECHANICAL SOUNDING DEVICE

3. Summary of Procedure

3.1 Longitudinal lines at a predetermined spacing are established on the bridge deck.

3.2 After calibration, the sounding device is pushed along the established lines. Electrically powered tapping wheels emit vibrations into the deck that are sensed by sonic receivers. Areas of delamination are indicated by deflections on a strip chart recorder.

3.3 All portions on the strip chart indicating delaminations are plotted on a scaled map of the bridge deck. An outline is made showing the areas of delamination.

4. Apparatus

NOTE 2—The apparatus described here has been found suitable and is the most common type commercially available. Other apparatuses that do not exactly conform to these requirements such as sounding device, tapping rate, or sonic receivers may also be accepted.

4.1 *Electro-Mechanical Sounding Device*—A small, three-wheeled cart upon which is mounted a 12-V battery, two tapping wheels, two sonic receivers, a two-channel-strip recorder, and associated connectors and cables.

4.1.1 *Tapping Wheels*— Two rigid-steel-tapping wheels capable of tapping the bridge deck surface at the rate of 33 times/s. The tapping wheels shall be located approximately 6 in. (152 mm) apart.

4.1.2 *Sonic Receivers*— Two sonic receivers consisting of oil-filled soft tires, inside each of which a receiving transducer is mounted in nonrotating proximity to the concrete surface. The transducers shall be piezo-electric hydrophones that are coupled to the concrete surface through the soft tires and the oil within the wheels. Each receiving wheel shall be located approximately 3 in. (76 mm) outside of and parallel to its corresponding tapping wheel.

4.1.3 *Strip Chart Recorder*—A two-channel-strip chart recorder shall be capable of receiving the signals from the sonic receivers. The electronics unit shall accept only those portions of the signal that occur during the first 3 ms after the occurrence of a tap and further limit the recorder to respond only to those frequency components of the signal that lies in the range of 300 to 1200 Hz. The processed signals shall be

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rectified and integrated to produce a visual record on the respective channels of the record chart. The chart shall be driven in proportion to the distance traveled so that the length of the record represents a predetermined length of travel. The recording pen on one channel shall be capable of acting as an event marker.

4.1.4 *Cables and Connectors*—There shall be sufficient cables and connectors for connection of the left-tapping wheel sonic-receiver system to the left channel of the strip chart recorder and the right-tapping wheel sonic-receiver system to the right channel of the strip chart recorder.

4.2 *Measuring Tape, Markers, Stringline*—A measuring tape, markers, and stringline shall be provided for establishing lines on the bridge deck that will serve to keep the sounding device positioned properly while making the survey.

4.3 *Calibrator*—A solid aluminum bar capable of checking the operational system of the sounding device.

5. Calibration

5.1 Place the device on the calibrator bar in the on position with the chart drive operating. This will establish the electrical zero line.

5.2 With the calibration switch in the calibrate position, turn on the power, transmitter, and chart drive switches. Each of the recorder pens should trace a rather erratic line approximately half way between the maximum pen movement and the electrical zero line. This line may vary one or two major divisions due to normal variations in the response of the system to the aluminum bar. If the response line does not fall as described, then each channel shall be adjusted with the appropriate calibration adjustment control.

6. Bridge Deck Layout

6.1 Any accumulation of debris on the deck must be removed.

6.2 Beginning at a curb face, mark each end of the bridge at the interval chosen for making the survey.

NOTE 3—Various spacing intervals such as 15 in. (38.1 cm), 18 in. (45.7 cm), and 3 ft (91.4 cm) have been used. The closer spacings are recommended for an in-depth analysis of the bridge deck. The wider spacing intervals are suitable for general-condition surveys of bridge decks.

7. Test Procedure

7.1 Stretch the stringline between corresponding marks on each end of the bridge.

7.2 With the switch in the operate position and the power and transmitter switches on, push the sounding device at a normal walking speed over the bridge deck. The device must be centered over the stringline. Continue in this manner until the entire deck has been surveyed.

7.3 Mark the ends of the bridge, expansion devices, etc., by activating the event marker.

8. Data Interpretation and Plotting

8.1 Construct a scaled map of the deck surface.

8.2 Plot the limits of all portions of each trace indicating a delamination. A delamination is considered a trace deflection of four or more minor chart divisions above the normal background response.

8.3 Connect the limits of these plots and outline the individual delaminated areas.

8.4 Determine the total area contained in the individual delaminated areas.

8.5 Divide the total delaminated area by the total bridge deck area and multiply times 100 to yield the percent of deck area delaminated.

PROCEDURE B—CHAIN DRAG

9. Summary of Procedure

9.1 A grid system is laid out on the bridge deck.

9.2 Chains are dragged over the deck surface. Delaminated areas are those where a dull or hollow sound from the chain dragging operation is apparent.

9.3 Delaminated areas are outlined on the deck surface. A map is prepared indicating the location of delaminations with respect to the grid lines.

10. Apparatus

10.1 *Chains, Steel Rods, or Hammers*—Acceptable sizes and configurations of chains, steel rods, or hammers are those that produce a clear ringing sound when dragged or tapped over nondelaminated concrete and a dull or hollow sound over delaminated concrete. A common chain drag configuration consists of four or five segments of 1-in. (25-mm) link chain of ¼-in. (6-mm) diameter steel approximately 18 in. (45.7 cm) long, attached to a 2-ft (61-cm) piece of aluminum or copper tube to which a 2- to 3-ft (61- to 91.4-cm) piece of tubing, for the handle, is attached to the midpoint, forming a T. Steel rods ⅝ in. by 4 ft (16 mm by 121.9 cm), or larger, have been found to produce satisfactory results.

NOTE 4—Heavier chains have generally been shown to produce a more definitive sound under heavy traffic conditions.

10.2 *Measuring Tape, Markers, and Stringline*—A measuring tape, markers, and stringline shall be provided for establishing a grid system on the bridge deck. Markers such as spray paint or lumber crayon shall be used to outline delaminated areas on the deck surface.

11. Bridge Deck Layout

11.1 Any accumulation of debris on the deck must be removed.

11.2 Construct a grid system on the deck surface with a lumber crayon so that delaminated areas marked on the deck can be plotted easily on a map by referencing the areas to the grid.

12. Test Procedure

12.1 Survey the entire bridge deck by dragging the chains or tapping with the steel rod or hammer over the entire surface. On nondelaminated concrete, a clear ringing sound will be heard. A dull or hollow sound is emitted when delaminated concrete is encountered.

12.2 Mark the areas of delamination on the deck surface with the spray paint or lumber crayon.

13. Plotting

13.1 Construct a scaled map of the deck surface.

13.2 By referencing to the established grid system on the deck, plot the areas of delamination on the map.

13.3 Determine the total area contained in the individual delaminated areas.

13.4 Divide the total delaminated area by the total bridge deck area and multiply by 100 to yield the percent of deck area delaminated.

14. Report

14.1 The report shall include the following information:

14.1.1 Bridge location and description,

14.1.2 Survey method used,

14.1.3 Date of test,

14.1.4 Spacing interval if Procedure A is used,

14.1.5 Percent of deck area delaminated, and

14.1.6 Remarks.

15. Precision and Bias

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

NOTE 5—Available data suggests that the chain drag procedure is more precise in locating delaminations than is the electromechanical sounding device.