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INTERNATIONAL

Designation: D 6087 – 05

Standard Test Method for Evaluating Asphalt-Covered Concrete Bridge Decks Using Ground Penetrating Radar[1]

This standard is issued under the fixed designation D 6087; 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 several radar evaluation procedures that can be used to evaluate the condition of concrete bridge decks overlaid with asphaltic concrete wearing surfaces. Specifically, this test method predicts the presence or absence of concrete or rebar deterioration at or above the level of the top layer of reinforcing bar.

1.2 Deterioration in concrete bridge decks is manifested by the corrosion of embedded reinforcement or the decomposition of concrete, or both. The most serious form of deterioration is that which is caused by corrosion of embedded reinforcement. Corrosion is initiated by deicing salts, used for snow and ice control in the winter months, penetrating the concrete. In arid climates, the corrosion can be initiated by chloride ions contained in the mix ingredients.

1.2.1 As the reinforcing steel corrodes, it expands and creates a crack or subsurface fracture plane in the concrete at or just above the level of the reinforcement. The fracture plane, or delamination, may be localized or may extend over a substantial area, especially if the concrete cover to the reinforcement is small. It is not uncommon for more than one delamination to occur on different planes between the concrete surface and the reinforcing steel. Delaminations are not visible on the concrete surface. However, if repairs are not made, the delaminations progress to open spalls and, with continued corrosion, eventually affect the structural integrity of the deck.

1.2.2 The portion of concrete contaminated with excessive chlorides is generally structurally deficient compared with non-contaminated concrete. Additionally, the chloride-contaminated concrete provides a pathway for the chloride ions to initiate corrosion of the reinforcing steel. It is therefore of particular interest in bridge deck condition investigations to locate not only the areas of active reinforcement corrosion, but also areas of chloride-contaminated and otherwise deteriorated concrete.

1.3 This test method may not be suitable for evaluating bridges with delaminations that are localized over the diameter of the reinforcement, or for those bridges that have cathodic protection (coke breeze as cathode) installed on the bridge or for which a conductive aggregate has been used in the asphalt (that is, blast furnace slag). This is because metals are perfect reflectors of electromagnetic waves, since the wave impedances for metals are zero.

1.4 The values stated in SI units are to be regarded as the standard. The inch-pound units given in parentheses are for information only.

1.5 *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.* Specific precautionary statements are given in Section 5.

1.6 A precision and bias statement has not been developed at this time. Therefore, this standard should not be used for acceptance or rejection of a material for purchasing purposes.

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2. Summary of Test Method

2.1 The data collection equipment consists of a short-pulse ground penetrating radar device, data acquisition device, recording device, and data processing and interpretation equipment. The user makes repeated passes with the data collection equipment in a direction parallel or perpendicular to the centerline across an asphalt-covered bridge deck at specified locations. Bridge deck condition is quantified based on the data obtained.

3. Significance and Use

3.1 This test method provides information on the condition of concrete bridge decks overlaid with asphaltic concrete without necessitating removal of the overlay, or other destructive procedures.

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

Current edition approved July 1, 2005. Published August 2005. Originally approved in 1997. Last previous edition approved in 2003 as D 6087 - 03.

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3.2 A systematic approach to bridge deck rehabilitation requires considerable data on the condition of the decks. In the past, data has been collected using the traditional methods of visual inspection supplemented by physical testing and coring. Such methods have proven to be tedious, expensive, and of limited accuracy. Consequently, radar provides a mechanism to rapidly survey bridges in an efficient, non-destructive manner.

3.3 Information on the condition of asphalt-covered concrete bridge decks is needed to estimate bridge deck condition for maintenance and rehabilitation, to provide cost-effective information necessary for rehabilitation contracts.

3.4 Ground penetrating radar is currently the only non-destructive method that can evaluate bridge deck condition on bridge decks containing an asphalt overlay.

4. Apparatus

4.1 *Radar System*—There are two categories of radar systems, depending on the type of antenna utilized for data collection.

4.1.1 Radar control units capable of driving air-launched horn antennas with central frequencies 1 GHz and greater. The control units must operate at a transmit rate sufficient to collect 20 scans/m (25 scans/ft). The equipment may consist of either an air-coupled, short-pulse monostatic or bistatic radar(s) with a monocycle pulse 150 mm (6 in.) free space resolution and a 50 scan/s minimum data rate.

4.1.2 Radar control units capable of driving ground-coupled antennas with central frequencies greater than 1 GHz. The control units must operate at a transmit rate sufficient to collect 80 scans/m.

4.2 *Data Acquisition System*—A data acquisition system, consisting of equipment for gathering radar data at the minimum data rate of the radar system(s), 50 kHz for one radar, 100 kHz for two radars, and 150 kHz for three radars. The system shall be capable of accurately acquiring radar data with a 60-dB dynamic range.

4.3 *Distance Measurement System*—A distance measurement system consisting of a fifth-wheel or appropriate distance measurement instrument (DMI) with accuracy of ±100 mm/km (±6.5 in./mile) and a resolution of 25 mm (1 in.).

4.4 *Test Vehicle*—A vehicle with all equipment necessary to perform the test and proper warning and safety devices installed.

NOTE 1—Fig. 1 shows a functional block diagram for multiple radars and support equipment.

5. Hazards

5.1 During operation of the radar system, observe the manufacturer's safety directions at all times. When conducting inspections, ensure that appropriate traffic protection is utilized in accordance with accepted standards.

6. Procedure

6.1 *Conditions for Testing*:

6.1.1 If soil, aggregate, or other particulate debris is present on the bridge deck surface, clean the bridge deck.

6.1.2 Test the bridge deck in a surface dry condition.

6.2 *System Performance Compliance*—Conduct a test on the radar equipment to ensure proper performance, at least once per year, or after periods of prolonged storage, or in accordance with manufacturer's recommendations. For air-launched antennas, this test shall consist of the following:

6.2.1 *Signal-to-Noise Ratio*:

6.2.1.1 *Signal-to-Noise Ratio Test*—Position the antenna at its far field distance approximately equal to maximum dimension of antenna aperture above a square metal plate with a width of 4× antenna aperture, minimum. Turn on the radar unit and allow to operate for a 20-min warm-up period or the time

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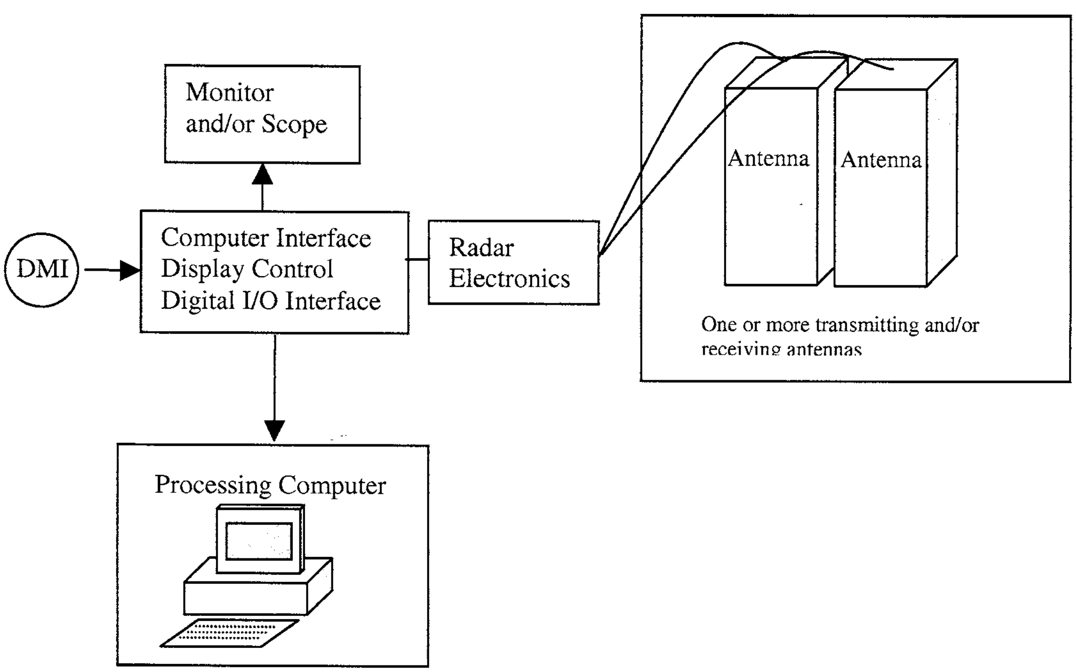

FIG. 1 Block Diagram of Radar and Support Equipment