Chapter 10 – GROUND PENETRATING RADAR

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5.10 GROUND PENETRATING RADAR

5.10.1 Introduction

Ground Penetrating Radar (GPR) is a recognized non-destructive evaluation technique with many applications. Applications on bridges include bridge deck condition evaluation, overlay thickness, voiding under bridge approach slabs, reinforcing steel location, foundation investigation, and underwater profiling. Chapter 5 will discuss the use of GPR on bridge decks and approaches, while Chapters 24 and 25 will discuss additional uses of GPR.

A radar system typically consists of a control unit, radar antenna, and display unit. The control unit generates a radar pulse (in the microwave spectrum) and sends it through a cable to the antenna. The antenna transmits the pulse into the surface. When this energy encounters an interface between two materials of differing dielectric properties, such as reinforcing steel, air, moisture, or the base-course material, a portion of the energy is reflected back to the radar antenna. The received pulse is sent back to the control unit for processing/storage. The display unit (video or chart recorder) presents the data.

The reflected energy is received by the transducer, amplified, and recorded. The electromagnetic pulse is repeated at a rapid rate and the resultant stream of radar data produces a continuous record of the subsurface. The radar system creates a linear profile of the materials beneath the antenna pass. Refer to Figure 5.10.1-1 for an example of radar output on a typical pavement section.

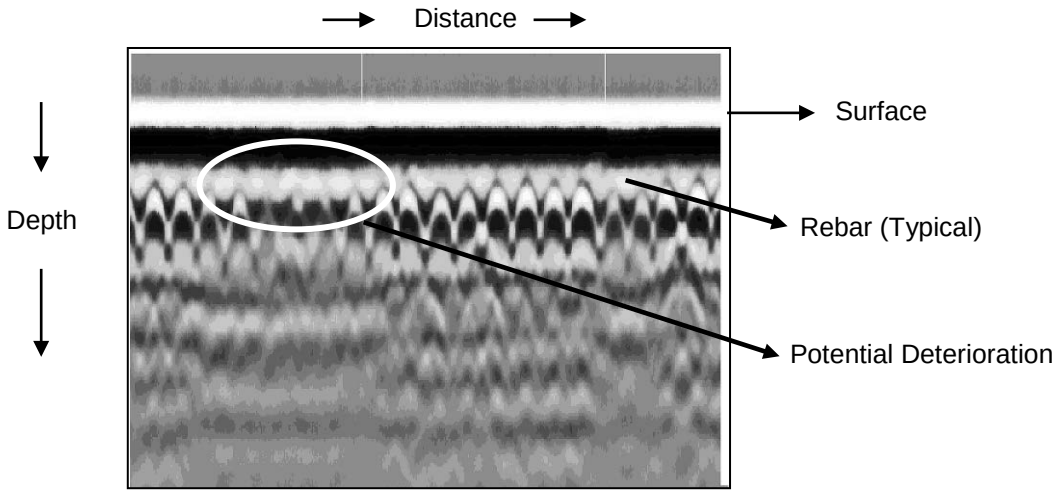

Figure 5.10.1-1: Typical Radar Output Image with Notations.

Two different types of transducers (contact or horn type) can be mounted on a data collection vehicle, or hand towed. Refer to Figure 5.10.1-2 for views of two types of vehicle-mounted transducers.

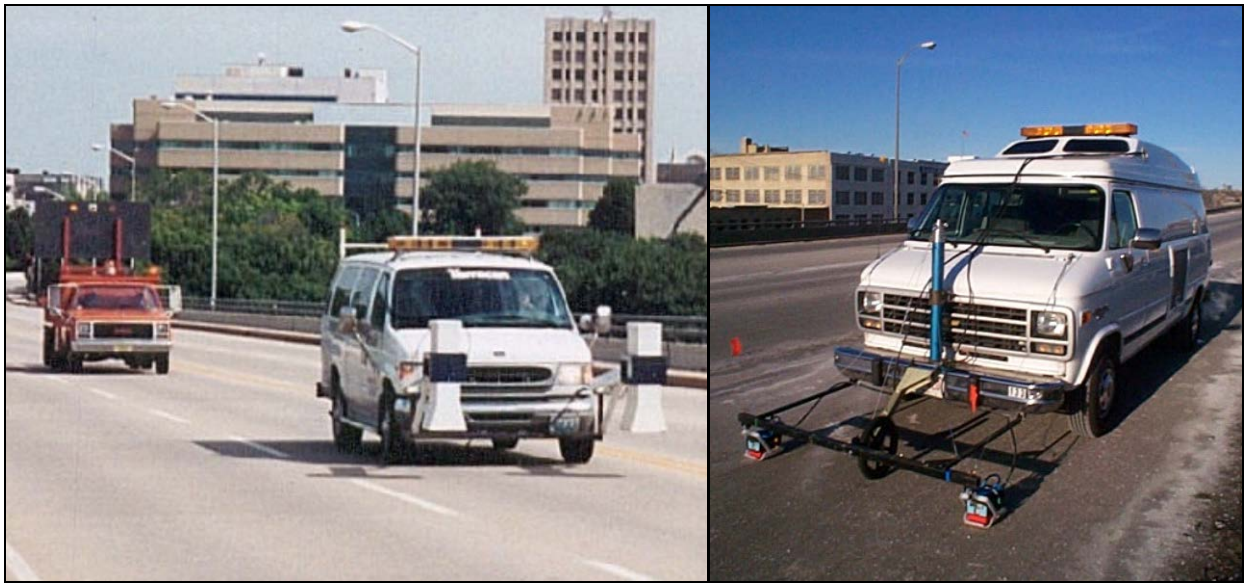

Figure 5.10.1-2: Horn Style (left) and Contact Style (right) Vehicle-Mounted Transducers.

The location of the transducers can be varied across the width of the pavement and, if additional information is required, a number of passes with the antenna in different locations can be made.

For the majority of surveys, the antennae are mounted over the wheel tracks. The data is normally collected with vehicle speed slower than normal traffic speeds. Faster speeds are attainable, but the longitudinal and vertical resolution of the system is reduced. Horizontal data positioning is accomplished by using a distance transducer connected to the drive train of the data collection vehicle.

An event mark is automatically placed on the data at user-defined intervals, allowing defects to be located accurately. Once the survey is completed, a computer processes the data and the results of the survey can then be presented in a variety of formats.

Another advantage of GPR is the fact that only one side of the element needs to be tested. Indications on the opposite side can be picked up.

GPR is covered in American Society for Testing and Materials (ASTM) D6087-97 (2001), "Standard Test Method for Evaluating Asphalt-Covered Concrete Bridge Decks Using Ground Penetrating Radar."

5.10.2 Applications

Ground Penetrating Radar (GPR) is most commonly used on concrete bridge decks with an overlay surface. This allows for an inspection of the concrete deck surface, which is hidden by the overlay surface. If the concrete deck is not covered, GPR is not often used since it is not as accurate or rapid as infrared thermography.

The GPR system provides a means of determining the following items:

1. Pavement and/or overlay thickness.

2. Locating and/or determining the depth of reinforcing steel, mesh, or pre and post tensioning strands.

3. If sufficient rigid pavement cover exists above reinforcing steel to allow pavement-grinding rehabilitation.

4. Identifying pavement or joint types.

5. Locating and determining the size of voids beneath pavements.

5.10.3 Limitations

Ground penetrating radar (GPR) identifies areas of a concrete deck with different dielectric properties or conductivities. Some concretes, such as dry low permeability concrete, affect the accuracy of GPR to detect areas of delamination. GPR is also sensitive to the presence of water and chlorides on the deck and between overlays and the base concrete, as well as the presence of debris on the deck surface. These conditions can significantly influence the accuracy of the data. Heavy or congested reinforcing layouts will also affect the detection of detects below the reinforcing mat.

GPR must also be scanned perpendicular to the top layer of reinforcing steel. Therefore, inspection of some structures will require the survey to be conducted perpendicular to the flow of traffic. This will require traffic to be restricted or stopped altogether while the survey is being conducted. Frequently, several passes must be made on the deck area and the cost may be prohibitive.