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16. Abstract

The Ohio Department of Transportation requested from ORITE to conduct GPR runs to ascertain the thickness of cover above the top rebar layer of Woody County bridge WOO-75-1294 on interstate 75 over U.S. route 6. The main purpose of these surveys was to see if there was enough cover on top of the rebar to allow grinding of the concrete surface. Surveys and data collection were conducted on the bridge on April 20, 2016. A ground penetrating radar system was used to collect data on the I-75 Bridge over SR 6 to ascertain the depth of rebar at specific locations. A calibration run was conducted and the depth to rebar was manually checked at that location to calibrate the propagation velocity of the GPR antennas. Systematic data was collected at 2 foot increments, and then the data was processed to show an overall depth to cover of the top rebar, and specific graph for locations of interest were also generated.

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Introduction

Ground Penetrating Radar (GPR) is an effective, easy method to assess the condition of a bridge deck and to verify the concrete cover thickness, and to ensure that reinforcement bars are properly protect from the environment.

The Ohio Research Institute for Transportation and the Environment at Ohio University has been a leading force in the use of GPR technology in the Ohio. ORITE acquired its first system in 1997 and since has used its capabilities to provide practitioners and researchers in the State of Ohio with a quick and reliable method to characterize surface/subsurface condition for a variety of projects including bridge decks.

The Ohio Department of Transportation requested from ORITE to conduct GPR runs to ascertain the thickness of cover above the top rebar layer of Woody County bridge WOO-75-1294 on interstate 75 over U.S. route 6. The main purpose of these surveys was to see if there was enough cover on top of the rebar to allow grinding of the concrete surface.

Surveys and data collection were conducted on the bridge on April 20, 2016.

GPR Specifications and Features and Setup

As part of its research instrumentation, the Ohio Research Institute for Transportation and the Environment at Ohio University has GPR system characterized by the following specifications.

- SIR 3000 Control Unit
- 1600 MHz ground coupled antenna
- Survey Cart with encoder wheel
- 2 GB internal memory
- RADAN 7 analysis software

The system as shown in figure 1 was used on the Wood county bridge to conduct surveys to measure the bridge deck cover. The RADAN ver. 7 software licensed from GSSI was used to process the data and conduct a quality assurance (QA) study and find the concrete cover thickness over the top layer of reinforcing steel.

Figure 1 GPR system used

Table 1 lists the hardware settings of the SIR-3000 system used. These settings were the recommended settings by the manufacturer in order for the Bridge QA module to function properly and so that the data contains the specific characteristics necessary for a proper analysis.

Table 1 SIR-3000 hardware setup

Scans/ft.	80
Vertical FIR Low Pass Filter	3000 MHz
Vertical FIR High Pass Filter	250 MHz
No. of Gain Pts	1
Bits per Sample	16
Samples/Scan	512
Range	6

Further requirements to obtain proper data was that the rebar be spaced a minimum of 4”; from the data provided the steel for the Wood County bridge was at 6.5” spacing. In addition, the bridge surface was to be clear of any construction debris, pebbles or puddled water, which was accomplished with the assistance of ODOT personnel. During data collection the survey cart and antenna were in contact with the bridge surface at all times.

Figure 1 also shows the prepared surface of the bridge and the distance marks that were used to perform the GPR surveys.

Velocity Calculation

The velocity of the wave through the concrete is an important parameter that needs to be entered when calculating the depth of the concrete cover. The default velocity setting in the software is 3.74in/ns. This is a standard value for concrete, but the recommendation to get better results is to conduct a calibration run. During the calibration run, the location of the top rebar is located at a specific location and the depth is measure manually. The depth is then entered into the software, which then calculates the velocity based on the actual field measurement.

During our data collection trip, run 17 (36 feet from the north end of the bridge) at a distance of 46 feet and 4 inches from the eastern end of the bridge, the depth to the top of the rebar was measure to be 2.87 inches. This value was entered into the software and the velocity calculated was 3.88 in/ns. This value was subsequently used for all runs collected to properly identify the location of the top rebar. Figure 2 shows the calibration run and the difference between using the default velocity values versus the calibrated value.

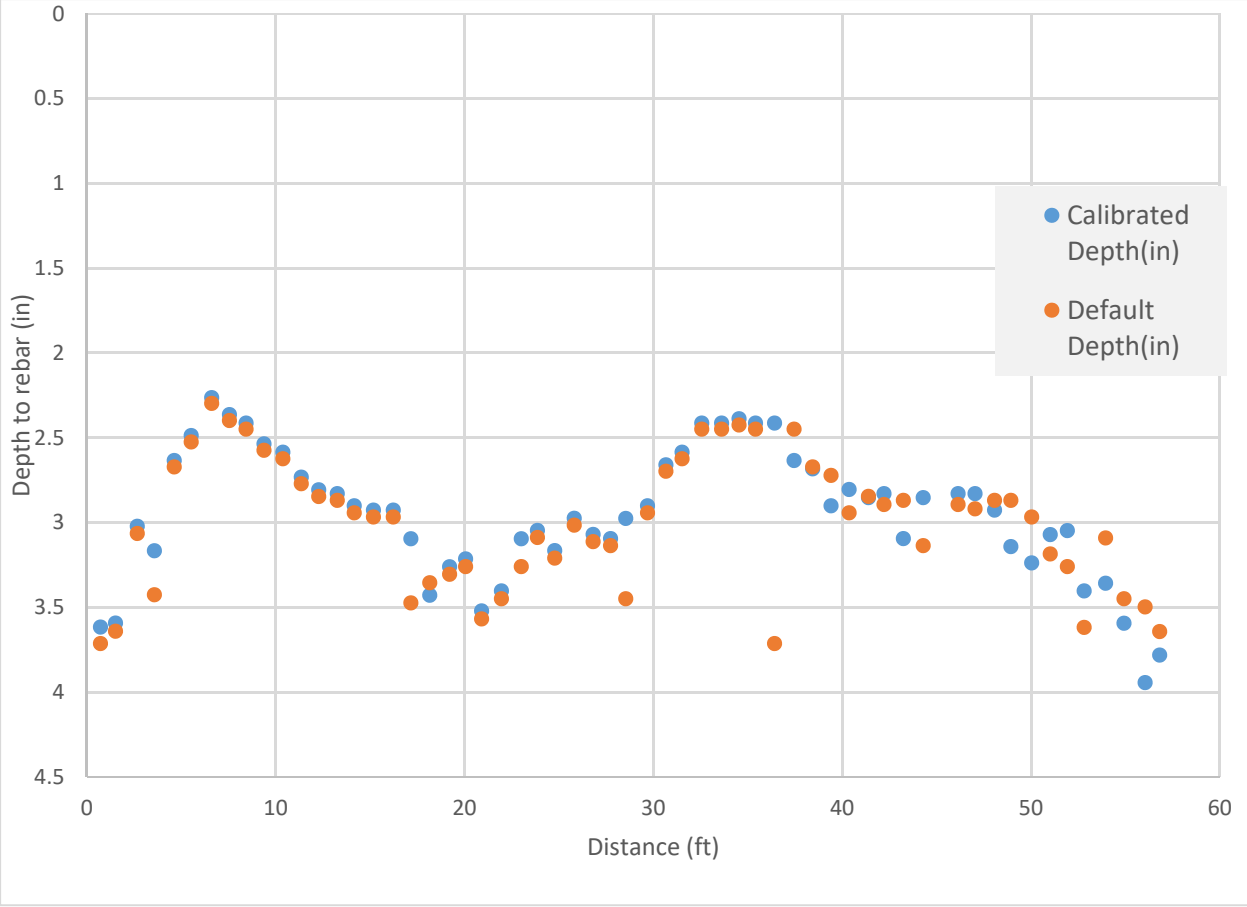

Figure 2 Rebar depth calibration run, location 17.

Survey Method

In general, the bridge cover analysis does not require the creation of a 3D map, but since a complete map of cover thickness was required, a series of surveys were collected to enable the creation of a 3D file as required by the RADAN7. To properly identify the top rebar, and measure the thickness the GPR data was collected perpendicular to the trend of the top layer rebar. In this case since the top layer rebar is longitudinal, the data collection was conducted across the bridge. In order to achieve maximum resolution, data collection was conducted in 2-foot increment across the bridge deck. The data collection started 2 feet from the north western part of the bridge with the surveys running from west to east and reversed from east to west in 2 foot increments. This continued until the entire length of the bridge, approximately 204 feet was covered. Each of the runs was saved as a separate file. A total of 102 runs were conducted to cover the entire surface of the bridge Figure 3 shows a schematic of the bridge survey runs.

Figure 3 Schematic of Bridge Runs

Survey Results

After the completion of data collection, the data was processed using the RADAN7 software provided by GSSI. The data collected was used to create an overall map of the bridge showing the depth to rebar as a color output. This is shown in Figure 4. The color scale on the right of the figure shows the depth of cover in inches.

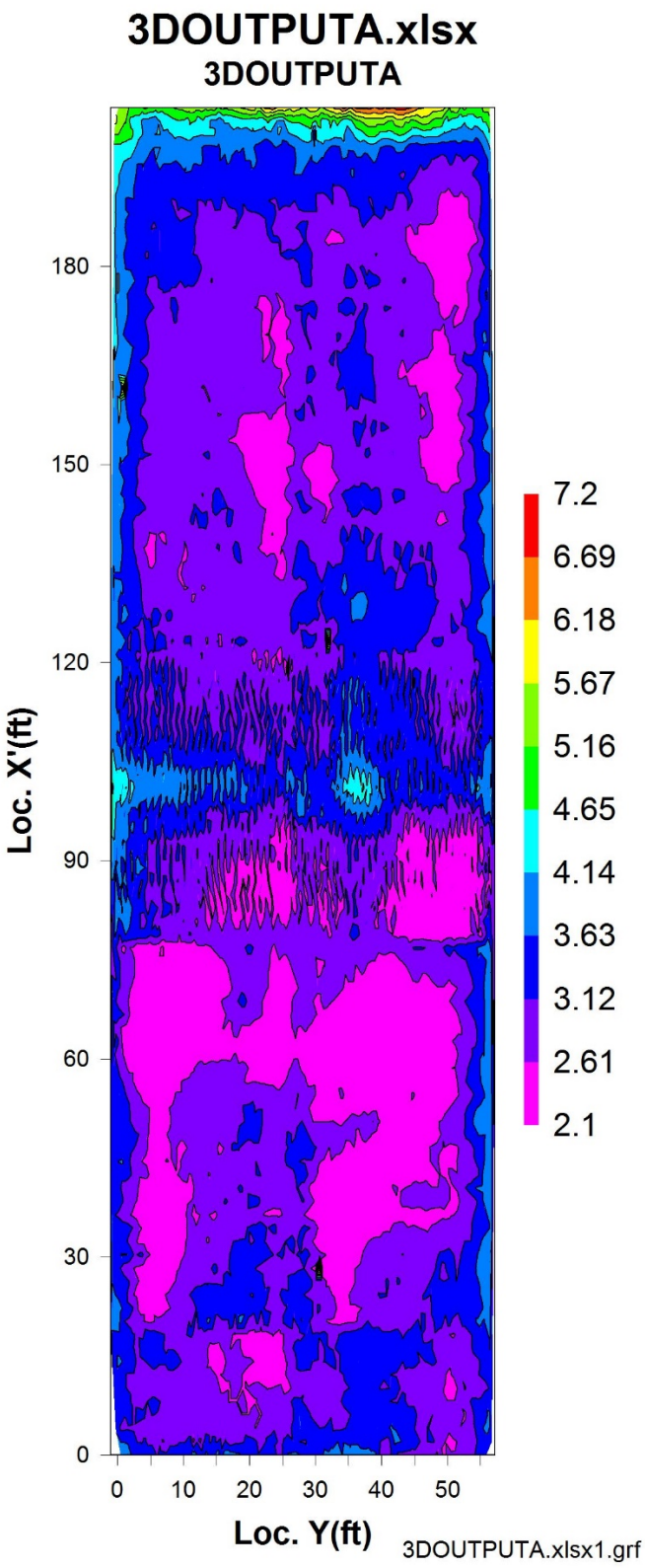

Figure 4 Overall view of cover information

In order to get more specific data on the locations that were of interest to ODOT, plots were created to depth of the rebar at locations specified by ODOT personnel, specifically runs 12, 24, 38, 50, 62, 76 and 88. Graphs of the data of interested is shown in Figure 5 through Figure 11.

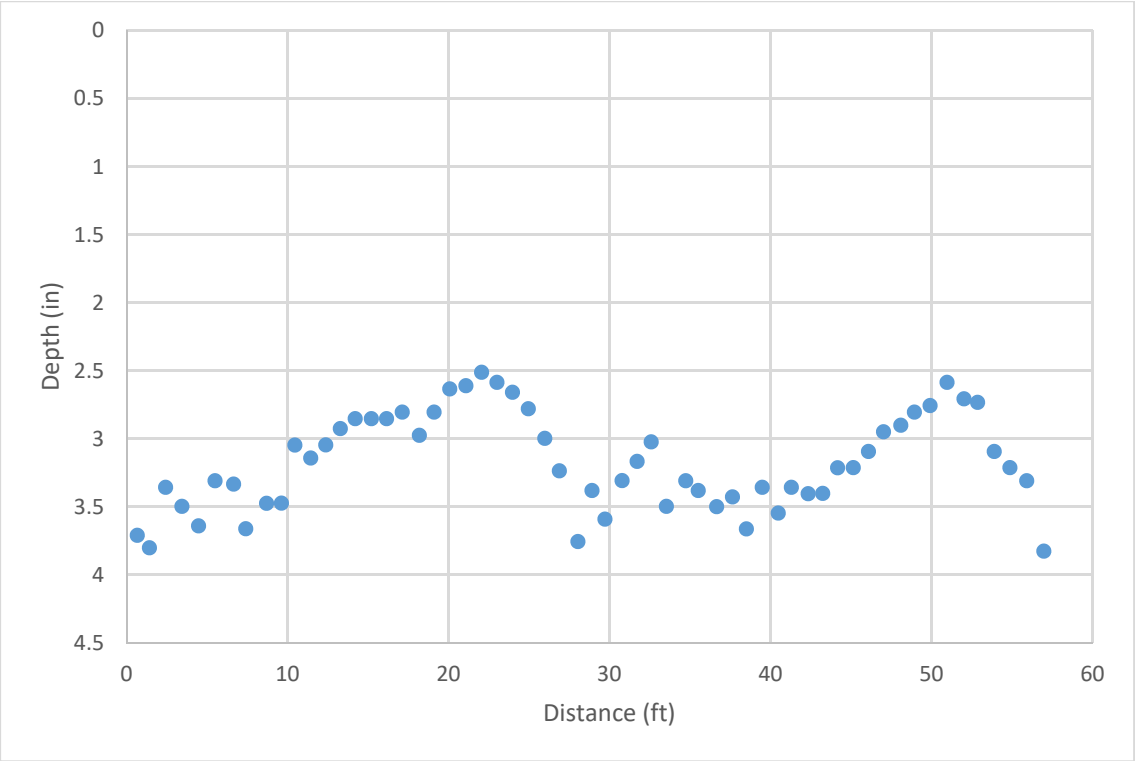

Figure 5 Depth to Rebar, location 12

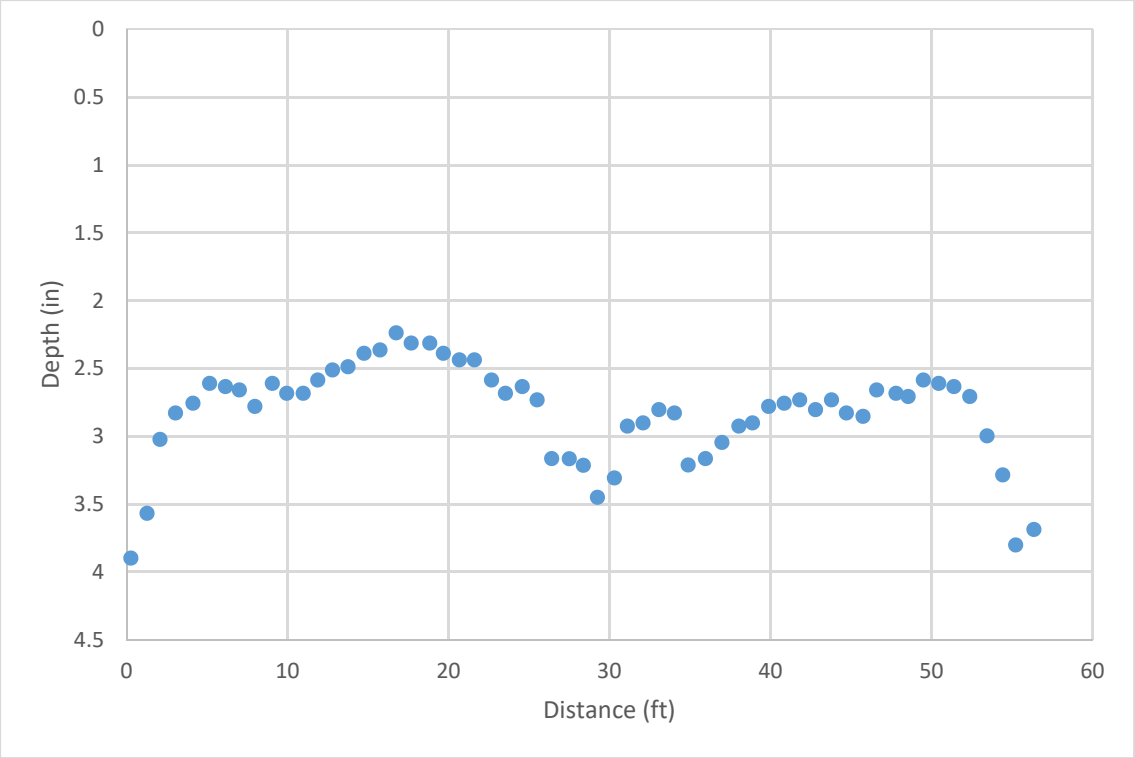

Figure 6 Depth to rebar, location 24

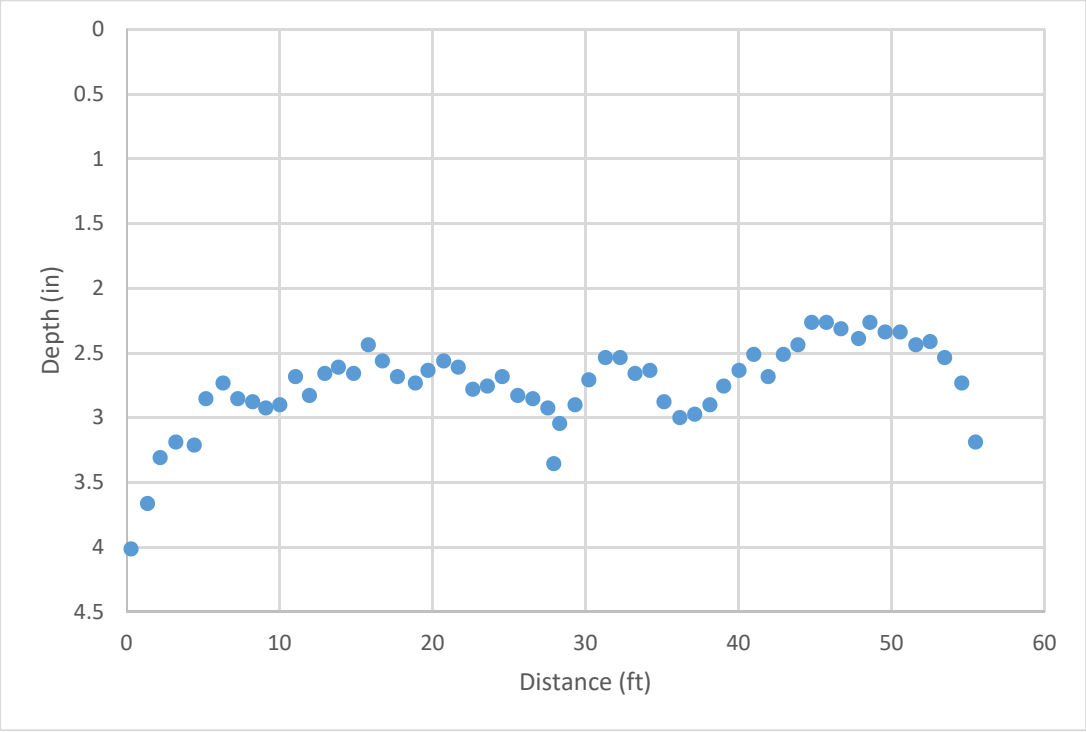

Figure 7 Depth to rebar, Location 38

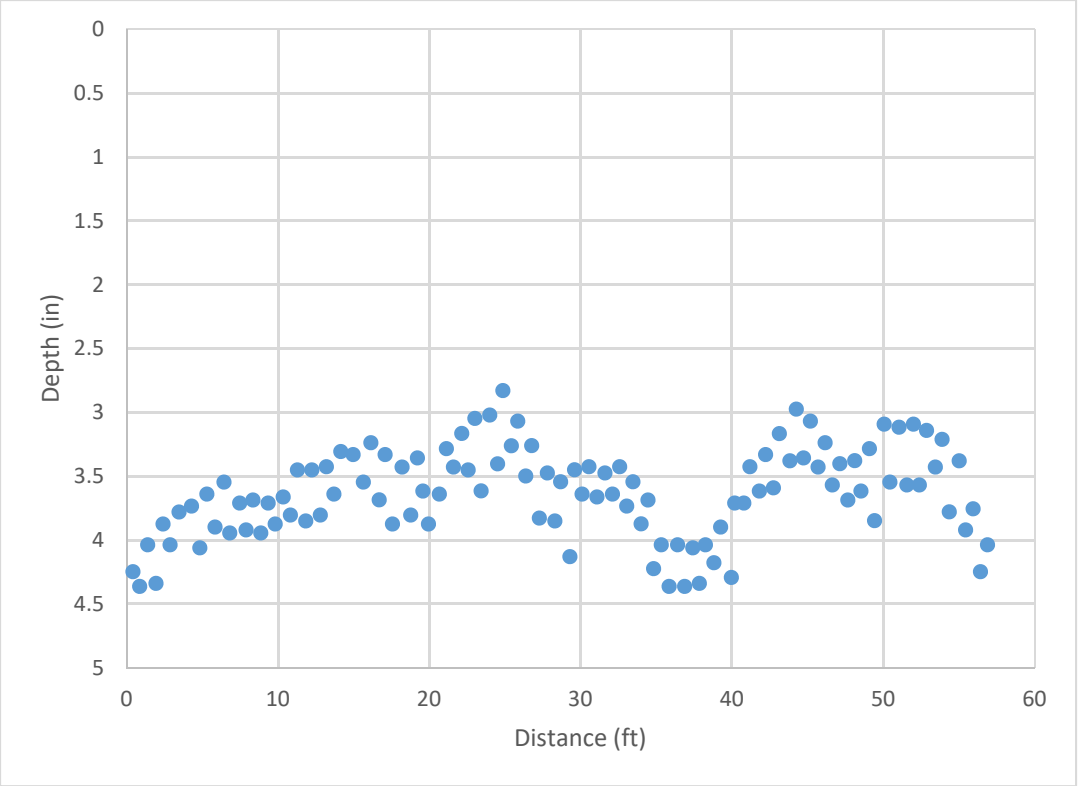

Figure 8 Depth to rebar, location 50.

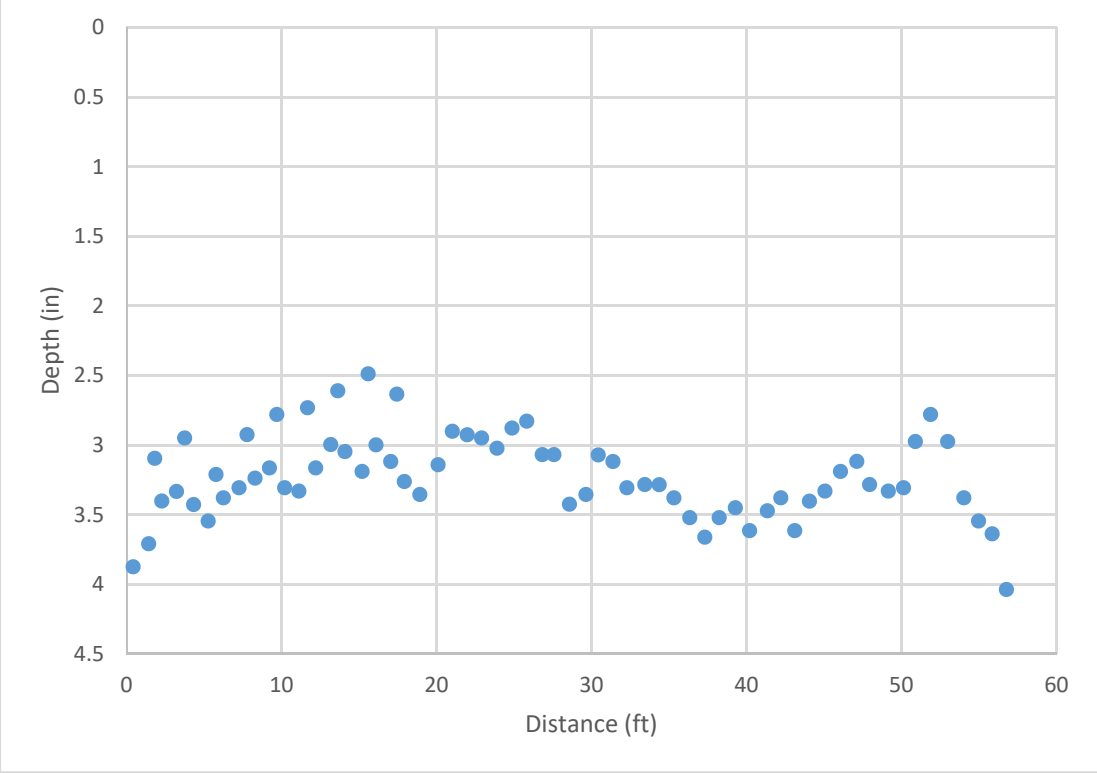

Figure 9 Depth to rebar, Location 62

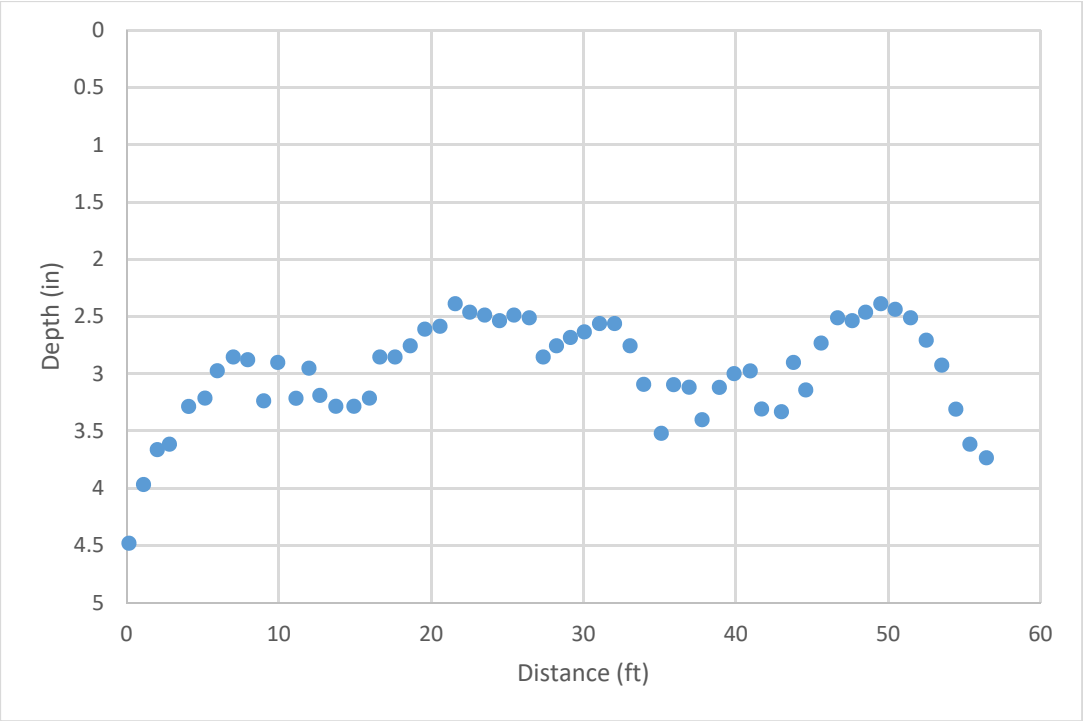

Figure 10 Depth to rebar, location 76

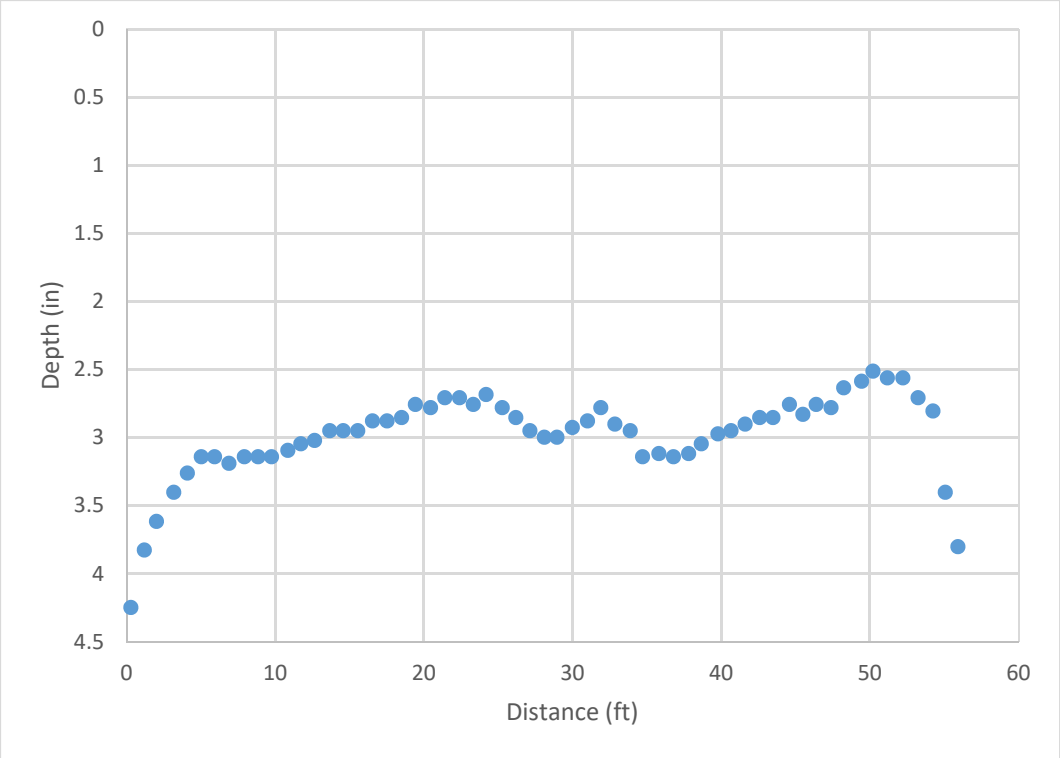

Figure 11 Depth to rebar, location 88

Summary

A ground penetrating radar system was used to collect data on the I-75 Bridge over Rt6 to ascertain the depth of rebar at specific locations. A calibration run was conducted and the depth to rebar was manually checked at that location to calibrate the propagation velocity of the GPR antennas. Systematic data was collected at 2 foot increments, and then the data was processed to show an overall depth to cover of the top rebar, and specific graph for locations of interest were also generated.