Florida Department of Transportation
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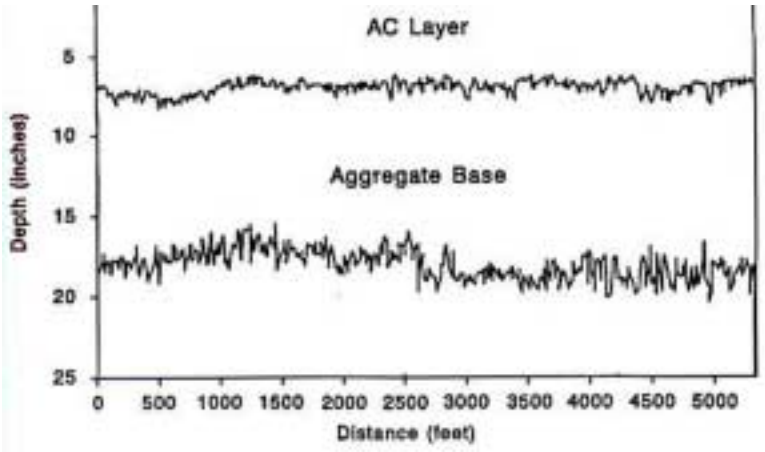
DEVELOPMENT OF A RADAR ANALYSIS PROGRAM FOR LAYER THICKNESS DETERMINATIONS

PROBLEM STATEMENT

Ground Penetrating Radar (GPR) provides a safe, nondestructive method for estimating pavement layer thicknesses at highway speeds. Layer thickness profiles (as shown below) can be generated from radar survey data. This type of information is important for pavement management applications. By quantifying the variability in pavement layer thicknesses, more reliable projections of network maintenance and rehabilitation needs can be established, thus resulting in cost-effective use of available funds. This variability in layer thicknesses is difficult to quantify by coring alone, a method that becomes prohibitively expensive to use for network level inventories of layer thicknesses. In this regard, GPR is another tool that highway agencies may use to develop a network level database of pavement layer thicknesses in the most efficient manner possible.

The Florida Department of Transportation (FDOT) has been involved in ongoing research of GPR technology, which resulted in the delivery of a GPR system to the Department.



OBJECTIVES

The objectives of this study were to automate the pre-processing of radar data and to develop an integrated, Windows compatible package to analyze radar data in a production environment. The first objective was to be accomplished by developing an algorithm that automatically identified the relevant layer interface reflections based on user-prescribed criteria. The second objective consisted of developing, revising, and integrating a series of computer routines into a single program.

FINDINGS AND CONCLUSIONS

The computer program developed through this research, *Thickness Evaluation of Roads by Radar* (TERRA), incorporates decision criteria for automated detection of layer interfaces. Based on the evaluation of the TERRA program presented in this report, the following findings were noted:

1. The sensitivity analysis showed that the peak detection algorithm behaves as expected and produces results that agree with visual examination of the radar data.

2. Tests conducted to verify the algorithm's capability to track peaks demonstrated the stability of the method.

3. Verification of the layer thicknesses predicted from GPR data using TERRA revealed that:

    a. Variability in the thickness predictions may indicate the presence of highly variable layer interface reflections.
    b. When reflections are highly variable, the mode of the predicted thicknesses may be more representative of the actual average than the mean of the predicted thicknesses.
    c. Changes in surface layer thickness were correctly detected by radar as confirmed by cores taken from sites where such changes were detected.
    d. The means of the predicted surface thicknesses were found to compare favorably with the corresponding means of the core thicknesses for the majority of the radar data analyzed. The average of the absolute differences between means is 0.30 inches.

The evaluation results suggest that TERRA may be used with confidence to estimate pavement layer thicknesses from GPR data. GPR is not expected to completely eliminate the need for coring. There will be sections of routes where the layer interface reflections are not visible from the data or where the reflections are difficult to interpret. However, GPR can be used to establish the coring requirements to help interpret GPR data, fill gaps in the thickness predictions, and verify the results.

It is also advisable to have sections of known thicknesses that may be used to verify the radar system periodically or as needed. FDOT's radar vehicle may be run on these sections to check the thickness predictions with the known values to establish the need for servicing the system

Finally, other applications of GPR should be investigated. For example, the technology may be used (1) to provide thickness data needed for pavement design, (2) to check the as-built layer thicknesses during construction, (3) to plan deflection tests along a given route to serve pavement evaluation needs, (4) to provide the layer thicknesses required for deflection data analysis, and (5) to conduct forensic studies of premature pavement failures.

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