Montana Department of Transportation November 2011
RESEARCH PROGRAMS
Implementation Report

Ground Penetrating Radar Analysis: Phase II Field Evaluation

http://www.mdt.mt.gov/research/projects/pave/gpr.shtml

Introduction and Purpose

The objective of this project was to evaluate the feasibility and value of expanding MDT's Ground Penetrating Radar (GPR) program to a broader range of pavement engineering applications, namely pavement design and rehabilitation, and network level evaluation. Phase I of this project concluded that in order to investigate the feasibility and value of these program expansions, a Phase II field evaluation project be designed and implemented to evaluate the accuracy of GPR pavement thickness data on Montana pavements, and correlate these findings with the accuracy requirements of the individual applications. In order to achieve this objective, it was necessary to understand:

- The types of layer structure information that GPR is capable of obtaining;
- The level of accuracy associated with this information under different pavement conditions and expected levels of confidence;
- The use of this information in the selection and design of reconstruction and rehabilitation treatments;
- The influence of the expected accuracy on the design and selection of reconstruction and rehabilitation treatments.

The recommendations made by the researcher in the final report are listed below, along with the technical panel's responses to these recommendations. Finally, unmet research needs and other implementation recommendations made by the technical panel, if any, are included.

Implementation Summary

- The data checking/ quality control method recommended will be evaluated for implementation after the GPR evaluation software has been upgraded.
- MDT will consider implementing stricter calibration procedures if, in the future, they prove to be cost effective.
- MDT has incorporated GPR data into the structural number calculation for pavement design.

Implementation Recommendations

Recommendation 1:
Implement the data checking/ quality control procedure described in the final report and below

The purpose of the data checking/quality control method is to determine if the GPR data should be reviewed and possibly re-analyzed or re-interpreted. This method is based on three indicators – the backcalculated asphalt modulus using the wide range method; the backcalculation error using the wide range method, and the difference between the GPR and the as-built asphalt thickness data. The as-built deviation was added to complete the checking procedure. While it is expected actual thicknesses will deviate from as-built data, it is reasonable to observe this deviation and to consider it as a factor in deciding whether or not to review the GPR data analysis. A threshold value was required for each of the three indicators described above. After some trial and error with different thresholds, the following thresholds were established:

- Asphalt Modulus: 2500 ksi
- Backcalculation Error: 3.0%
- Deviation from as-built asphalt thickness: 1.0 inches

The goal of the proposed procedure is to reduce the number of situations where identification of incorrect layer boundaries yields large thickness errors. Implementing this procedure will require additional analysis time, but will ultimately yield better quality data

Technical Panel Response:
The technical panel sees the value in this recommendation; however, it is not ready

TITLE: Ground Penetrating Radar Analysis: Phase II Field Evaluation

PROJECT NO: 8201

COMPLETION DATE: October 2011

MORE INFO:
Principal Investigator
Ken Maser
kmaser@verizon.net
781.648.0440

MDT Technical Contact
Jon Amestoy
jamestoy@mt.gov
406.444.7651

MDT Research Project Manager
Craig Abernathy
cabernathy@mt.gov
406.444.6229

for implementation. Software upgrades are necessary before this recommendation can be implemented. Also, MDT plans to purchase a small corer to groundtruth results.

Recommendation 2: Periodically check thickness calculations at calibration sites

As part of this project, layer thickness conditions at 26 sites have been carefully documented. It is recommended two or more of these sites be designated as "calibration sites", and twice each testing season, these sites be re-surveyed to compare layer thickness calculations to the previously documented values. The calibration sites should be chosen to represent a range of thicknesses and environments, and should be ones where the GPR was most accurate. The layer thickness checks should be based on the average thickness determined for the full length of the site.

Technical Panel Response:
The technical panel feels this recommendation is too labor intensive to implement. Also, the panel has not been convinced this calibration method is any better than the method currently employed.

Recommendation 3: Conduct plate calibration testing once a month during the testing season

The results presented in this report show the small accuracy improvement gained by conducting a plate calibration at each site did not merit the extra effort and field exposure involved. However, since antenna characteristics can change over time, it is recommended plate calibrations be conducted at approximately one month intervals during the testing season, and the data from the most recent plate calibration test be used for data analysis.

Technical Panel Response:
Currently, the plate calibration is made at the beginning of the season. In addition, the antennae are checked at each testing site to verify the position is accurate to within ± 1/8 inch. The technical panel is not convinced the additional recommended effort will yield better results than the current plate calibration method.

Recommendation 4: Utilize GPR data for overlay design

The existing structural capacity of pavements receiving mill and fill or overlay rehabilitation is characterized by a structural number, which is calculated by multiplying each layer thickness by an appropriate structural coefficient. The sensitivity analysis showed that using GPR layer information as an input into the calculation for structural number produces more accurate overlay designs and predictions of remaining life, when compared to using as-built plan data.

Technical Panel Response: This recommendation has already been implemented. The results reported in the final report have increased MDT's confidence in using GPR layer information as an input to the calculation for structural number. In fact, many times, MDT does not core to verify layer thicknesses other than base thickness, as the technology is not to the point where this evaluation can be used to accurately determine base thickness. Finally, this modification in practice decreases the time to evaluate pavement sections and easily can be incorporated into the GPR testing schedule.

This document is published as an electronic document at no cost for printing and postage.