Contour Plots Enhance Analysis of Pavement Data Collected with Nondestructive Survey Equipment

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(*Photo above:*) A Florida DOT survey vehicle tows a falling weight deflectometer.

Pavement engineers need accurate, complete, and reliable data to manage highway pavements optimally and to diagnose problems efficiently. Drilled core holes and cut trenches historically have yielded pavement samples for analysis. New nondestructive test (NDT) methods, however, can provide greater amounts of data more efficiently and cost-effectively, without damaging pavement or disrupting traffic.

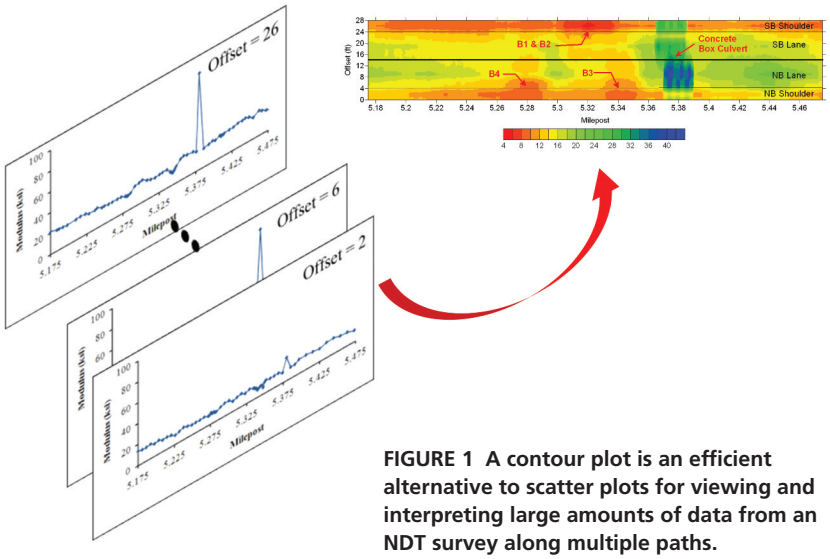

FIGURE 1 A contour plot is an efficient alternative to scatter plots for viewing and interpreting large amounts of data from an NDT survey along multiple paths.

Problem

NDT methods—such as the falling weight deflectometer (FWD) or ground-penetrating radar (GPR)—can collect pavement data at increased speeds and with great frequency. The vast amount of data obtained with NDT can enhance an engineer's understanding of the pavement's condition. An efficient and comprehensive method, however, is needed to interpret and summarize the increased quantity of data.

Two-dimensional scatter plots have served as the conventional way of presenting pavement characteristics for visual analysis. Scatter plots provide a simple and useful depiction of data points along a single survey path, but the data become more difficult to interpret when multiple survey paths are presented. Without a clear understanding of how the data interact, engineers may not be able to determine the most critical sites for follow-up destructive testing and may perform expensive, time-consuming, and damaging tests unnecessarily.

Solution

Pavement engineers at the Florida Department of Transportation (DOT) have developed a more accurate and comprehensive method to represent and interpret the voluminous data from NDT. In 2008, Florida DOT engineers applied a commercially avail-

able contour plotting tool to visualize NDT data from multiple survey paths, improving the identification of pavement areas that required follow-up destructive tests.

Figure 1 (page 48) schematically shows how the methodology enables engineers to interpret three-dimensional survey data captured with NDT equipment but presented as two-dimensional contour plots and to produce an easy-to-read map of NDT data. Contour plots allow for the efficient and reliable presentation and visualization of a large amount of NDT data and therefore eliminate the need for correlating multiple, cumbersome scatter plots. In summary, the contour plots provide pavement engineers with an improved methodology for interpreting data and accurately identifying locations for follow-up destructive testing.

Applications

Contour Plots of FWD Data

In 2010, Florida DOT pavement engineers investigated a taxiway pavement that exhibited severe cracking, heaving, and depressions near an airport hangar. With an FWD, the engineers obtained data along 14 survey paths to evaluate the structural integrity of the pavement. The contour plot generated from the FWD data (Figure 2, right) enabled the identification of critical locations for follow-up destructive tests.

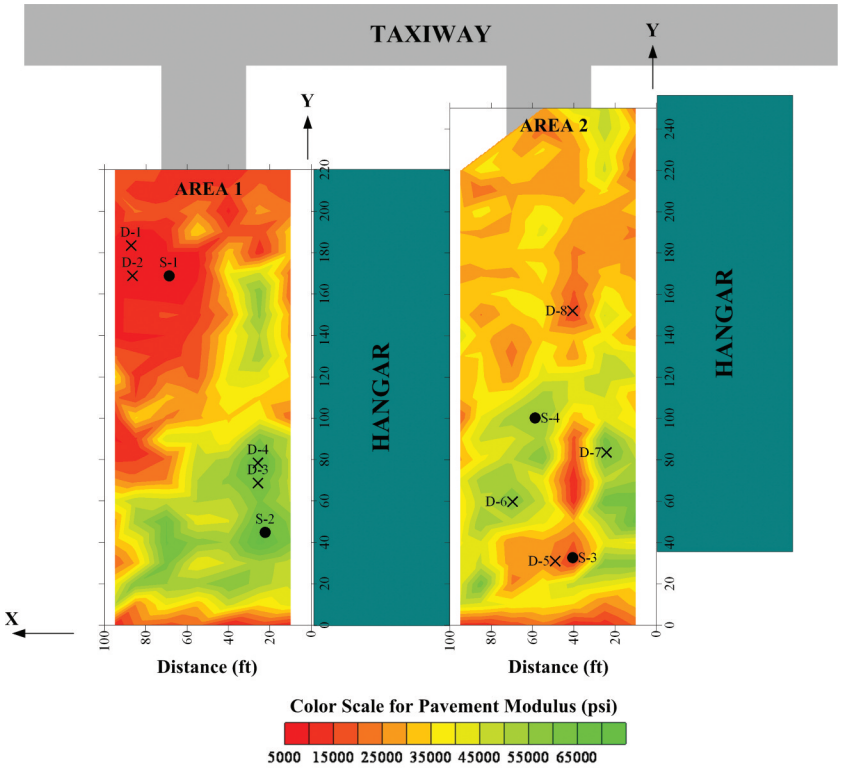

FIGURE 2 Contour plot of an airport pavement survey conducted with an FWD. Researchers combined data from 14 survey paths into a single contour plot to identify critical locations for follow-up tests.

Contour Plots of GPR Data

In a recent research project, Florida DOT pavement engineers developed a methodology to estimate asphalt pavement density with multiple survey paths from GPR. Using a contour plot like the one shown in Figure 3 (below), the engineers were able to evaluate the entire roadway density by identifying specific locations of high and low density and were able to minimize the number of destructive test cores required.

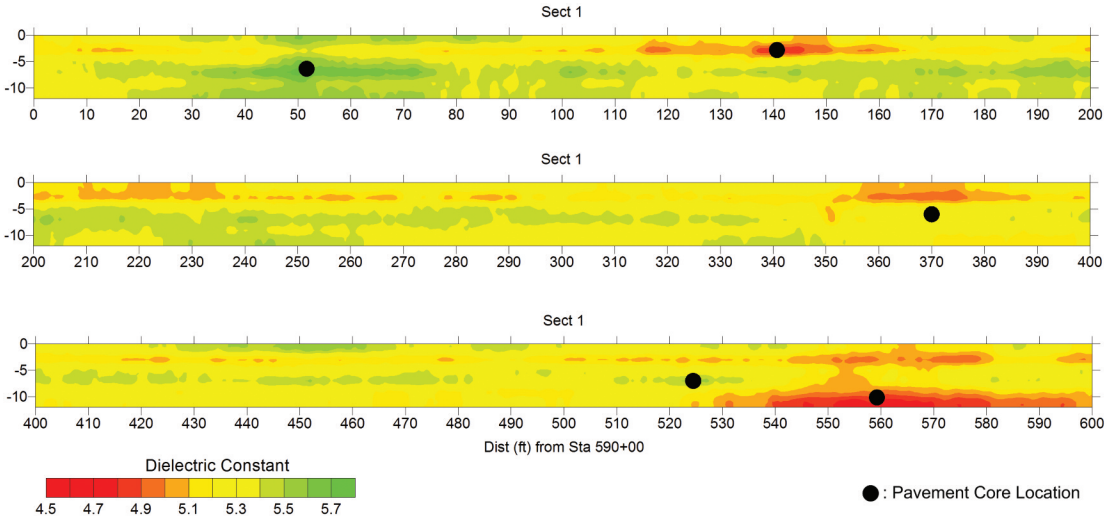

FIGURE 3 Contour plot of asphalt pavement density survey using GPR. Researchers combined data from six survey paths into a single contour map of pavement density to determine locations for destructive tests.

Survey vehicle equipped with ground-penetrating radar.

Benefits

Analyzing pavement data with contour plots offers an improved and efficient method for evaluating pavement characteristics and selecting the most critical areas for follow-up destructive testing. The contour plot analysis saves time and money by reducing the number of unnecessary destructive tests; improves safety by limiting the exposure of pavement technicians to highway traffic; and reduces disruption to the traveling public. Florida DOT estimates that integrating NDT equipment and analysis through contour plots can reduce the costs of production testing by as much as 50 percent, because of the decreased need for destructive tests and the reduced duration of lane closures.

The American Association of State Highway and Transportation Officials' Technology Implementation Group has selected this analysis technique—along with three pavement-related analysis tools developed by Florida DOT—as focus technologies to promote in the next two years. Marketed as "PaveSuite," the three analysis tools include the following:

- A method that uses FWD data to predict ground motion induced by vibratory compaction,
- An automated faulting method that uses a high-speed profiler to locate the joints in jointed concrete pavements, and
- An automated method for evaluating cross-slopes and drainage paths using a multipurpose survey vehicle to detect roadway areas prone to poor drainage and surface water entrapment.

Together or individually, these four techniques provide critical information to support informed decision making about cost-effective rehabilitation and preservation strategies for highway transportation infrastructure.

Additional information about contour plotting technology is available at www.aashtotig.org.

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Resource

PaveSuite. http://tig.transportation.org/Pages/PaveSuite.aspx.

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Suggestions for Research Pays Off topics are welcome. Contact G. P. Jayaprakash, Transportation Research Board, Keck 488, 500 Fifth Street, NW, Washington, DC 20001 (202-334-2952; gjayaprakash@nas.edu).