Lessons Learned from the R06D
Proof-of-Concept Evaluations

- 3D-GPR collects measurements at reasonable highway speed, eliminating the need for a lane closure and reducing the risk to agency personnel and the traveling public.

- The comprehensive data on the condition of the existing pavement generated through the 3D-GPR system enable the DOT to make better and more cost-effective project development decisions while avoiding costly construction revisions or reducing the performance life of the rehabilitation.

- The IE/SASW technologies show future promise, but also require further development. It was generally recommended that advancements such as simplifying the data analysis and increasing the speed of data collection would be helpful.

Resources

For additional information on these technologies, go to the R06D webpages at [http://shrpl2.transportation.org/Pages/R06D.aspx](http://shrpl2.transportation.org/Pages/R06D.aspx).

- Primer (provides guidelines for GPR and SASW/IE to detect delamination)
- Peer Exchange Presentations by State DOTs and Resulting Report
- Recordings of Two Topic Webinars (SASW/IE and GPR)
- Showcase Summary Report
- Promotional video
- Brochures

FHWA Staff Resources

- Steve Cooper, FHWA, [stephen.j.cooper@dot.gov](mailto:stephen.j.cooper@dot.gov)
- Monica Jurado, FHWA, [monica.jurado@dot.gov](mailto:monica.jurado@dot.gov)

Contact: Bill Owen, [bill.owen@dot.ca.gov](mailto:bill.owen@dot.ca.gov)

Advanced Methods to Identify Pavement Delamination

When pavements begin to deteriorate, everyone notices—especially drivers and the maintenance crews whose job it is to keep them in good repair. Delamination (debonding and stripping) between asphalt layers underneath the highway surface can lead to several types of pavement surface problems, such as cracking in the wheel paths and tearing in the surface. Once pavement starts deteriorating, it may not easily be detected, especially in the early stages.

As part of the second Strategic Highway Research Program (SHRP2), three new technologies to detect problems in the asphalt pavement beneath the surface were tested and evaluated by six state departments of transportation (DOTs) as part of a “proof of concept” implementation effort.

The project, Advanced Methods to Identify Pavement Delamination (or R06D), field tested of ground penetrating radar (GPR) equipped with stepped frequency antenna array (3D-GPR) and a scanning system employing Spectra Analysis of Surface Waves (SASW) and Impact Echo (IE). These nondestructive technologies may enable DOTs to obtain reliable results for project-level planning and forensics in a safer, faster, and less expensive way.

Details of how each of these technology systems work can be found in the companion brochure: Safer, Faster, and More Cost-Efficient Ways to Find Deficiencies in Pavement. In this brochure, brief descriptions of the outcomes of the six implementation efforts are discussed, along with the benefits of each technology.
Six States Evaluated 3D-GPR and Scanning IE/SASW in SHRP2 Proof-of-Concept Effort

Minnesota DOT

The Minnesota Department of Transportation (MnDOT) has been using GPR technology for pavement evaluations for more than 15 years, mostly to determine and assess pavement thickness and conditions.

MnDOT found that 3D-GPR is a great tool to assist in detecting stripping in asphalt mixtures, and in providing continuous coverage of the pavement structure profile.

During the R06D proof-of-concept evaluations, measurements were collected with MnDOT’s 3D-GPR system on multiple pavements and at MnDOT’s MnROAD pavement test track. These measurements were evaluated and correlated with data from 200 cores taken in 2016.

MnDOT found that 3D-GPR is a great tool to assist in detecting stripping in asphalt mixtures, and in providing continuous coverage of the pavement structure profile. Overall, the technology correctly identified stripping on 43 percent of the sites.

Contact: Shongtao Dai, shongtao.dai@state.mn.us

Kentucky TC

The Kentucky Transportation Cabinet (KYTC) evaluated both technology systems at locations across the state. For the 3D-GPR analysis, KYTC collected measurements at two locations, one in an urban environment in downtown Paris, Kentucky, on US 60 with a speed limit of 25 mph; the other on a town Paris, Kentucky, on US 60 with a speed limit of 25 mph; the other on a.

KYTC/KTC intends to adopt the 3D-GPR system in lieu of other single-channel radar systems on selected pavement rehabilitation projects in the future, with hopes that the multi-channel unit will provide superior depth resolution and detail to that of a single-channel unit,” said Brad W. Rister, Program Manager, Pavement, Materials, GeoTech, and IA Group, Kentucky Transportation Center, University of Kentucky.

Contact: Brad Frazier, brad.frazier@ky.gov

Florida DOT

The Florida Department of Transportation (FDOT) consistently searches for high-speed, nondestructive pavement evaluation techniques to minimize traffic delays and maintain safe roadways. FDOT’s interest in implementing 3D-GPR was based in part on the possibility that it could be used for other applications beyond pavement delamination detection.

Contact: Boud Choubane, boud.choubane@dot.state.fl.us

New Mexico DOT

New Mexico DOT (NMDOT) evaluated both technologies at locations across the state and in different climates and altitudes.

NMDOT has a Pavement Management System database for surface distress; however, one of the key parameters that is currently missing is structural condition. The state’s current GPR system picks up moderate and severe stripping but does not have the capacity to offer network-wide information on delamination due to software limitations.

For this project, measurements were collected with three GPR units on multiple pavements, including asphalt pavements on I-40, US 491, and Rte. 264, as well as on flexible pavements, bridge decks, and concrete pavements.

The scanning IE/SASW technology was tested on three pavement sections, including a full day of repeated measurements on one site to evaluate the influence of pavement temperature on measurement signal quality. Following testing, NMDOT found that general trends observed in the data appear repeatable even across a wide range of temperatures. At shallow depths, debonding was detected and matched to the cores; however, it was not picked up at larger depths.

Contact: Shawn Romero, shawn.romero@dot.state.nm.us

Texas DOT

Texas Department of Transportation (TxDOT) evaluated both technologies at locations across the state. In general, both systems—3D-GPR and scanning IE/SASW—met expectations to identify pavement delamination.

After reviewing three GPR systems—a 2D-GPR developed in Texas, SHRP2’s 3D-GPR, and its existing GPR—the state determined that the benefits found in the 3D-GPR system were not enough to overcome the equipment costs, staff training, and other resources that would be needed to go beyond their existing system.

TxDOT found it very difficult to distinguish between severities of deterioration/de-lamination using the GPR equipment.

In Texas, the scanning IE/SASW was used to evaluate one 1,000-foot pavement section on US 59, making six passes two feet apart to cover the entire lane width.

TxDOT recognized the benefits of creating a wide area of data with the antenna array and is acquiring a 3D-GPR system and plans to work with the Texas Transportation Institute to develop and implement the technology.

In Texas, the scanning IE/SASW was used to evaluate one 1,000-foot pavement section on US 59, making six passes two feet apart to cover the entire lane width. The process identified the location and depth of delamination and correlated well with the pavement cores and GPR data.

Contact: Enad Mahmoud, enad.mahmoud@txdot.gov

Caltrans

The California Department of Transportation (Caltrans) also evaluated both technology systems.

Caltrans’ results demonstrated an 80 percent success rate in identifying areas of delamination in asphalt pavement.

Caltrans acquired the 3D-GPR system for use on pavement and bridge deck investigations, as well as for subsurface utility investigations over pavement. Caltrans collected measurements.

(continued on next page)