



Implementation Project Summary Report 5-1712-01-S
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Project 5-1712-01: Flexible Pavement Rehabilitation Training Courses

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Selecting Rehabilitation Options for Flexible Pavements: Training Classes and CDs

PROJECT SUMMARY REPORT

One of the major challenges facing pavement engineers is how to select the optimal repair strategy for a flexible pavement that is aging and exhibiting distress. This selection process can be relatively straightforward if the cause of the pavement distress is known. Unfortunately, finding the cause of the distress is often complex.

For example, with the alligator cracking, shown in [Figure 1](#), the cause could be related to defects in any of the pavement layers. If the cause is confined to the upper layers, then the repair can be relatively inexpensive;

however, if the problems are related to structural deficiencies in the base or subgrade, then much more extensive and expensive repairs will be required.

What We Did...

In Project 0-1712 a distress interpretation guide was developed which described each of the common distresses found in Texas flexible pavements. For each distress, the possible causes, a methodology for conducting a failure investigation, and potential rehabilitation options were identified. For longitudinal cracking such

as that shown in [Figure 2](#), 11 possible causes were described.

To determine the most probable cause, Project 0-1712 recommended the extensive use of two nondestructive testing (NDT) technologies, ground penetrating radar (GPR) and deflection testing with a falling weight deflectometer (FWD). GPR is used to compute layer thicknesses, locate subsurface defects, and identify changes in pavement structure. GPR is excellent for locating subsurface density or moisture-related problems. Experience in this project has shown that by combining visual distress information with both GPR and FWD information, it is usually



Figure 1. Distressed Flexible Pavement.



Figure 2. Longitudinal Cracking Problems.



possible to identify the cause of the pavement distress. These systems provide complementary information that must be integrated to determine the cause of the problem. Having only one set of information, for example FWD data, is often not sufficient to identify the cause of the problem.

Based on the experience gained in this research project, the recommended approach to conducting a full field investigation of flexible pavements is as follows:

- Step 1: Assemble all background information (typical sections, traffic information, construction date, maintenance activities, performance history, etc.).
- Step 2: Conduct a GPR and visual distress survey of the project. The Texas Department of Transportation's (TxDOT's) current GPR system, shown in Figure 3, collects integrated video of surface condition. It is then possible to compare subsurface anomalies identified by the GPR with surface distress.
- Step 3: Conduct an FWD survey; data are typically collected at 10th-mile intervals.
- Step 4: Integrate the GPR, FWD, and distress data and propose a cause of the pavement distress together with a field validation plan.
- Step 5: Perform validation studies. These typically involve field coring at targeted locations or dynamic cone penetrometer (DCP) testing. The field samples are recovered to verify a certain subsurface condition or to be used to run laboratory tests.

The pavement condition shown in Figure 1 has all the indications of a structural base failure. However,

using the approach described above, the FWD and GPR found that the base was not the cause of the problem. The base was found to be dry and structurally adequate. The GPR located anomalies in the middle of the thin asphalt surface layer. Subsequent field testing confirmed that this problem was caused by layer debonding.

This investigative approach has been successfully implemented on a number of forensic and pavement rehabilitation studies around the state of Texas. To implement the recommendations of Project 0-1712 within TxDOT, a training school entitled "Selecting Rehabilitation Strategies for Flexible Pavements" was developed to introduce TxDOT engineers to NDT tools available within TxDOT for diagnosing the cause of pavement problems. This three- to four-day school introduces the students to both ground penetrating radar and falling weight deflectometer technologies; the students learn when and how to request NDT services and how to collect and process data.

The class focuses on hands-on applications in which the students process NDT data from current projects within their districts. They use both the COLORMAP and MODULUS 6.0 packages to process radar and deflection data. Pavement designs are also developed using TxDOT's flexible pavement design program FPS 19. The latest design recommendations for important rehabilitation options such as full depth recycling are covered as well. At

the end of this school the students should:

- know how to collect and interpret FWD data,
- know how to collect and interpret GPR data,
- understand how to run the FPS 19 design system,
- be able to interpret pavement distress types to identify potential causes,
- know when and how to use the dynamic cone penetrometer,
- understand the approach to conducting pavement failure investigations,
- be able to generate rehabilitation alternatives for their highways, and
- be introduced to reclamation concepts and how to select stabilizer types.

What We Found...

The pavement rehabilitation schools have been taught in eight district offices around Texas (Figure 4). In each case both FWD and GPR data are collected on rehabilitation projects in the host



Figure 3. TxDOT's Current GPR System.





Figure 4. TxDOT Employees Attending the Pavement Rehabilitation Training Course.

district. The students are introduced to the NDT interpretation software and then provided with raw data from their projects. The 2004 schools were recently taught in the Bryan and Lufkin Districts.

Based on the success of the schools, a training CD was developed by the Texas Transportation Institute. The CD includes all of the materials covered in the rehabilitation schools. Versions of the MODULUS, FPS 19, and COLORMAP software are included together with user manuals and sample problems. For many of the problems on the CD the students are asked to perform a complete structural evaluation of the highway section, identify the cause of the distress, and develop a rehabilitation design to address the problem. The first step is typically to review a stored video clip of the existing pavement condition. The student is then provided with the GPR data and asked to identify sub-surface defects that could potentially be the cause of the surface distress. In several problems FWD data are supplied and enables the student to run MODULUS 6 to backcalculate in-situ layer moduli. The final step asks the student to run TxDOT

flexible pavement design system FPS 19 to compute the thickness of a structural overlay or a new pavement structure. All of the data required to run the complete analysis are provided on the CD, and at the end of the problem the student can review the supplied solutions.

The opening screen of the CD is shown in Figure 5. The CD was first released in May 2002, and an updated version was distributed statewide in February 2005. The

response to the schools and CD has been positive.

The approach taken in Project 0-1712 appears to be ideal to implement new technologies within highway agencies. Students appreciate the hand-on, real-world problems. The CD developed in this project has been provided to two universities for them to include in their graduate-level pavement engineering courses.

The Researchers Recommend...

The training schools, followed by distribution of the CD, appear to be an ideal way of implementing engineering-based analysis and design systems. Many of the students attending the class frequently do not have immediate access to NDT on their upcoming projects. The CD then can be used as a refresher course when their project level data are available.

The existing CD should be updated on a regular basis when significant improvements are made to the analysis or design software.

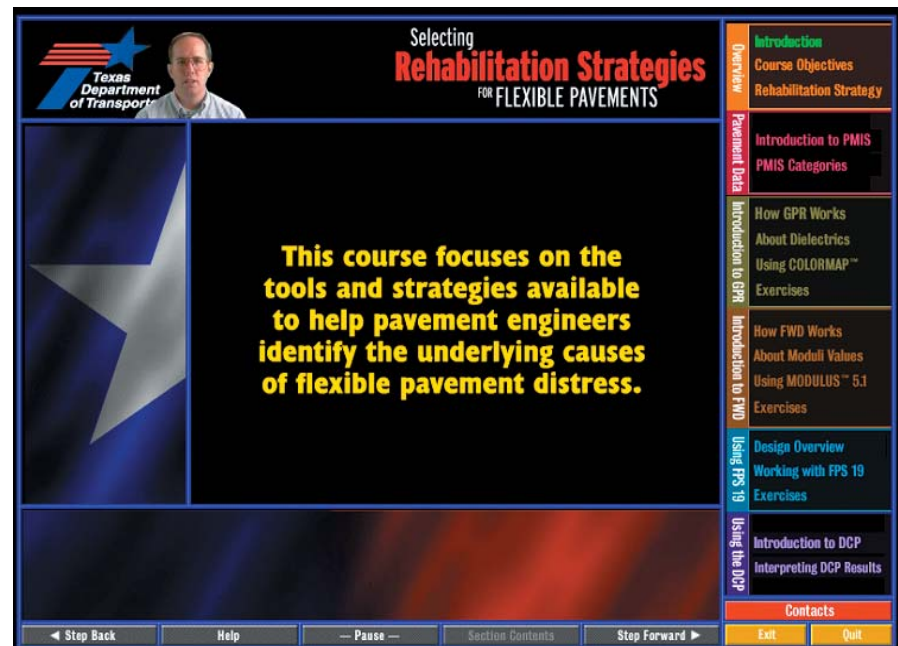


Figure 5. Introductory Screen to TxDOT's Rehabilitation Training CD.



For More Details...

Research is documented in Report 0-1712-4: *Selecting Rehabilitation Options for Flexible Pavements: Guidelines for Field Investigations*.

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