



Project Summary Report O-4517-5  
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Project O-4517: Develop Statewide Recommendations for Application of PCC Joint Reflective Cracking Rehabilitation Strategies Considering Lufkin District Experience

Author: Tom Scullion, P.E.

## Developing Statewide Recommendations for Rehabilitating Jointed Concrete Pavements

PROJECT SUMMARY REPORT

### What We Did...

Selecting the optimal rehabilitation strategy for distressed jointed concrete pavement (JCP), such as the one shown in Figure 1, continues to be a daunting challenge for Texas Department of Transportation (TxDOT) engineers.

The variability of pavement condition, joint load transfer efficiency, and slab support along projects is a major issue contributing to both strategy selection and treatment performance. The traditional asphalt overlays typically fail rapidly on problem jointed concrete pavements. Project O-4517 was initiated first to develop recommendations on how to structurally evaluate existing JCP pavement sections, and second to monitor the performance of experimental test sections around Texas where innovative treatments were applied. Detailed field and laboratory studies were carried out and reported in the three project reports.



Figure 1. Distressed Jointed Concrete Pavement.

### What We Found...

The first step in selecting the optimal strategy is to adopt a systematic procedure for evaluating existing conditions along the proposed projects. Project O-4517 proposed a JCP evaluation procedure that includes Ground Penetrating Radar (GPR) and deflection investigations and in some instances Dynamic Cone Penetrometer (DCP) testing. The recommended steps in the evaluation process include:

1. *Assemble all existing project information.* This will include typical sections,

slab details, type of base and shoulders, and recent maintenance history.

2. *Conduct a GPR survey and visual inspection.* The GPR data is used to identify areas of trapped moisture. A problem pavement is shown in Figure 2.

The strong reflection pattern shown in Figure 2 is typical of sections with substantial free water trapped beneath the slab. Not addressing this trapped moisture in the rehabilitation design process is guaranteed to cause rapid failure.

During the GPR survey, pavement video data is also



collected and used to make a log of pavement condition. Areas of shattered slabs, wide longitudinal joints, and faulted joints must be identified. If the project is being considered for slab fracturing, the evaluation notes the drainage condition and evaluates the feasibility of retrofitting edge drains if the GPR indicates trapped subsurface moisture.

3. *Conduct a deflection survey.* The Rolling Dynamic Deflectometer (RDD) (shown in Figure 3) is the preferred tool for testing jointed concrete pavements.

A typical data set for the RDD is shown in Figure 4. This graph shows continuous deflection profiles from two sensors collected at 2-foot spacing. The blue line is from a rolling geophone placed directly between loading wheels. The red line is from a sensor 38 inches from the load wheels. The large spikes in deflection occur when the RDD sensors pass over joints with poor load transfer.

The key parameters in evaluating the quality of a jointed concrete pavement include the load transfer efficiency and subslab support. Both can be measured on 100 percent of the sections using the RDD. From performance monitoring conducted in this project, it appears that if the difference in deflection at 10 kip load as the RDD rolls over a joint is more than 6 mils, then that joint is not a good candidate for an overlay since reflection cracking will be a strong possibility.

If the RDD is not available, then deflection can also be conducted with an FWD using traditional TxDOT methods. This requires testing 30 locations along a project. At each location the FWD tests initially at the center of the slab and then moves forward to the

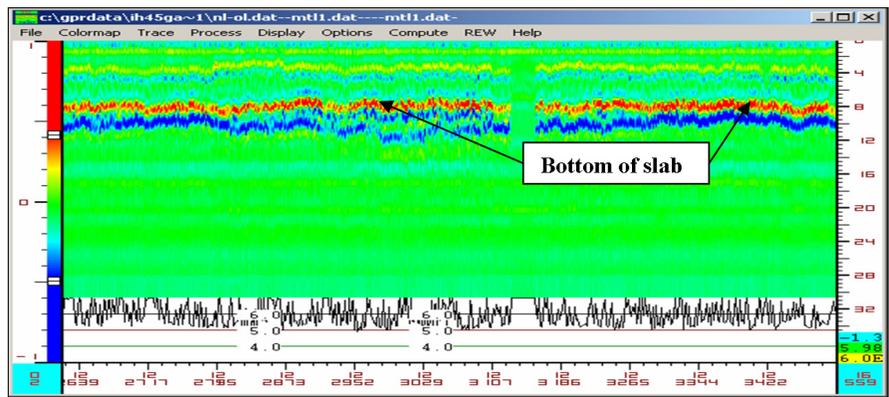


Figure 2. GPR Data from JCP with Trapped Moisture.



Figure 3. The Rolling Dynamic Deflectometer.

next joint location. Mid-depth slab temperatures should be measured at the start and end of the test.

4. *Perform verification testing.* The presence of suspected voids should be verified with drilling. If slab fracturing techniques are to be used, then the thickness and the strength of the existing pavement base and subgrade should be verified, which is best achieved by using the DCP.

### The Researchers Recommend...

Based on the performance data collected in this project, the researchers recommend the following rehabilitation options for future projects.

### Overlays

For those JCPs measured to be in good structural condition with few joint failures and reasonable load transfer efficiency, a hot-mix asphalt (HMA) overlay should be applied. Project 0-4517 determined that field performance is well matched to the performance of the mixes found in the laboratory with Texas Transportation Institute's (TTI's) overlay tester, shown in Figure 5.

Good field performance was found on overlays containing modified binders in both the Houston and Beaumont Districts. However, poorer performance in terms of early reflection cracking was reported for mixes in the



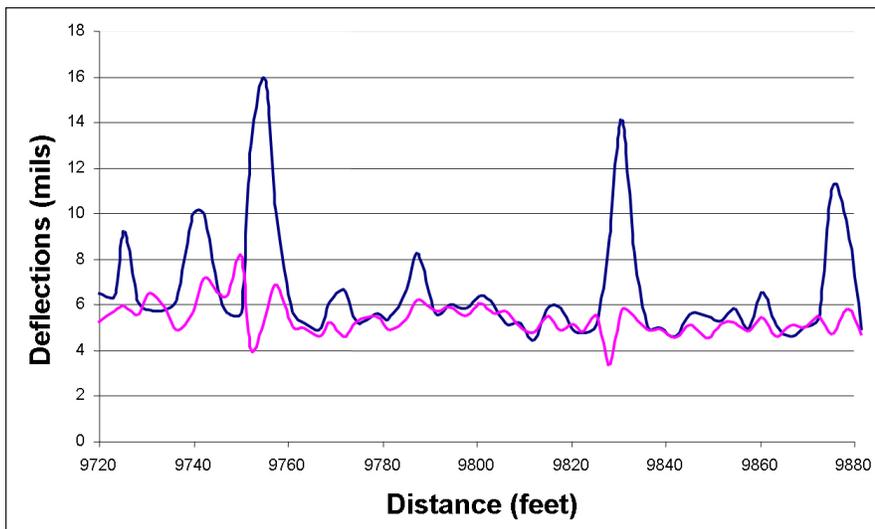


Figure 4. A Typical Two-Channel Continuous Deflection Plot from the Rolling Dynamic Deflectometer for Jointed Concrete Pavement.



Figure 5. TTI Overlay Tester (a New Version Is in Operation in TxDOT's Flexible Pavement Branch of the Construction Division).

Childress District. Until current ongoing studies are complete, TxDOT should consider the following overlay test mix design criteria when selecting overlays for JCP in good condition:

- For dense graded and performance mixes:  
300 cycles to failure
- For crack resistant mixes:  
750 cycles to failure

### Slab Fracturing Techniques

For distressed JCPs with joint failures, very poor load transfer, or severe reflection cracking problems, rubblization is the preferred slab fracturing technique. Rubblization will be possible only if the existing slab has reasonable base support

(as measured by the DCP) and if any trapped moisture can be effectively removed with retrofitted drains. Old JCPs resting on select materials with clay subgrades are normally not good candidates for rubblization. Design criteria are currently being developed in Project 0-4687. Based on the FWD testing performed on a section of US 83, a conservative design modulus of 150 ksi could be used for the rubblized concrete.

### Flexible Base Overlays

For JCPs in poor condition with poor subslab support, an attractive alternative is a flexible base overlay and thin HMA surfacing. This treatment performed very well on

both US 59 in Lufkin and on US 83 in Childress. This treatment can be used only on rural sections because it requires a thick base overlay of at least 8 inches. The critical issue in this design is that the top of the base must be sealed. The use of an underseal is mandatory. The surface mix should also be a dense-graded mix. If the base overlay is to be used in an area with more than 20 inches of rain per year, then a Class 1 base should be used. For additional insurance the base should have a dielectric value of less than 12 in the tube suction test, as measured by TX Method 144 E. Until further sections have been built and monitored, this treatment is not recommended for very heavily trafficked highways such as interstate highways.

In Project 0-4517 the use of grids within asphalt layers was found not to be a cost-effective alternative. Delamination problems were reported early in the life of sections, and long-term benefits of grids could not be identified. If grids are to be used in the future, steps must be implemented to ensure that debonding will not occur.

The use of crack and seat of jointed concrete pavements was found to provide much more variable results than rubblization. The crack and seat section on the Lufkin project failed within one year. This failure was attributed to the weak base layer. In Childress (and other areas of west Texas) crack and seat appears to work well only when a flexible base material is placed over the fractured concrete. However, as discussed above, flexible base overlays were found to work well without fracturing the slab, so the benefits of crack and seat are not clear. Furthermore, if slab fracturing is required, the researchers recommend the rubblization process.



## For More Details...

This information is documented in the following reports:

Report 0-4517-1: *Performance Report on Jointed Concrete Pavement Repair Strategies in Texas*

Report 0-4517-2: *Using Rolling Deflectometer and Ground Penetrating Radar Technologies for Full Coverage Testing of Jointed Concrete Pavements*

Report 0-4517-3: *Methods of Reducing Joint Reflection Cracking: Field Performance Studies*

**Researcher Supervisor:** Tom Scullion, P.E., TTI, (979) 845-9913, t-scullion@tamu.edu

**Researcher:** Chris Von Holdt, TTI, (979) 845-9914, c-vonholdt@tamu.edu

**TxDOT Project Director:** Dar-Hao Chen, P.E., Construction Division, (512) 467-3963, dchen@dot.state.tx.us

**TxDOT Research Engineer:** German Claros, P.E., Research and Technology Implementation Office, (512) 465-7403, gclaros@dot.state.tx.us

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