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Project Summary Report 0-4182-S
Project 0-4182: Full Depth Recycling: Field Performance and Design Guidelines

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PROJECT SUMMARY REPORT

Performance of Full Depth Recycling Projects in Texas: Summary Report

In the early 1990s several Texas Department of Transportation (TxDOT) districts started using full depth recycling (FDR) techniques to rehabilitate their roadways. A variety of stabilizers were used including cement, lime, fly ash, and asphalt emulsions.

Although the majority of the pavements surveyed in this project were performing well, several problems were documented. These problems include longitudinal cracking in sections built in east Texas on clay subgrades, bonding problems with primarily fly ash treated bases, and excessive cracking with some cement treated bases. To address each of these problems the TxDOT districts have developed new construction specifications and improved design criteria.

What We Did...

Project 0-4182 was initiated to survey the performance of TxDOT's initial full depth recycling projects, to document what successes and problems have been identified, and to develop recommendations for those districts wishing to embark on FDR programs. In this research a questionnaire was sent to all TxDOT districts, and, based on the questionnaire results, visits were made to six districts with active FDR programs.

FDR on US 290 in the Bryan District.

In these districts the FDR projects were nondestructively tested with both falling weight deflectometer (FWD) and ground penetrating radar (GPR), visual condition surveys were completed, and discussions were held with district and area office personnel.

What We Found...

As of August 2002, 16 Texas districts had constructed at least one FDR project. Two districts (Lubbock and Bryan) have constructed more than 30 FDR projects. Field studies indicated that the districts were generally happy with the performance of their FDR projects and most districts are planning to continue to use these techniques primarily to upgrade low-volume roadways.

The key factors in establishing a successful FDR program were found to be:

- the use of nondestructive testing in the project design phase to assist in the pavement design process and
- the heavy involvement of the district laboratory in selecting and controlling the stabilization process on a project-specific basis. The Childress District does project-specific designs for each project, and its laboratory staff actively monitor the construction process. The performance of the FDR projects in Childress was found to be outstanding even on high-volume roadways such as US 287.

In the course of district evaluations several performance problems were documented. As described in Report 4182-1, these problems included:

- longitudinal cracking on sections constructed on highly plastic soils due to edge drying (the Bryan District has effectively minimized this problem with the use of horizontal geo-grids on top of the treated layer);
- bonding problems with fly ash treated bases, a universal concern in the panhandle area (the Lubbock District requires an additional 2 days drying after the 3-day moist cure before sealing these bases, whereas other districts are reworking the upper surface with a dilute emulsion); and
- excessive shrinkage cracking on cement stabilized bases, reported on several sections (this has been minimized with the adoption of both the reduced target strengths for cement treated bases and the early application of traffic to the section; the Bryan District permits traffic on the section at the end of the construction day, and no significant shrinkage cracks were found in Bryan District pavements).

The Researchers Recommend...

Based on the results found in this project, researchers recommend that TxDOT give consideration to modifying current FDR design criteria and construction specifications. The accompanying table summarizes the new design recommendations.

Evaluation of the FDR project in the Waco District showed that in some cases excellent performance can be obtained without the use of chemical stabilization. This option

Summary of Design Recommendations for Future FDR Projects.

Objective	Level 1 Base Thickening	Level 2 Upgrade to Class 1	Level 3 Super Flexible Base	Level 4 Stabilized Base
Used When	• Existing base is uniform • No widespread structural damage • Existing subgrade is good (>15 ksi) • Low traffic	• Low-volume roadway • Good subgrade • Moisture not a concern	• High-volume roadway • Moisture a concern • Reasonable subgrade >10 ksi • Early opening to traffic	• Bridging over poor subgrade • Strengthening required • Low-quality variable base • High rainfall • Early opening to traffic
Selection of Stabilizer (Design Criteria)	• No stabilizer • Add new Class 1 flex base only	Full Texas Triaxial Design (117-E) 1) 45 psi at 0 psi confining 2) 175 psi at 15 psi confining	Full Texas Triaxial Evaluation 117-E 1) 60 psi at 0 psi confining 2) 225 psi at 15 psi confining 3) < 0.5% gain in moisture over molding moisture after 10 days capillary	7 day moist cure; then: 1) UCS > 300 psi 2) Dielectric < 10 after 10 days capillary rise 3) 85% retained strength
FPS 19 Design Recommendations*	Lowest of 70 ksi or 4 times subgrade modulus	100 ksi	150 ksi	200 ksi
Comments	1) New base should be of higher or equal quality than exisiting, or 2) Use equipment to blend existing and new base material			1) Avoid cutting into subgrade; add new base where needed. 2) Consider grids and flex base overlay where high PI soils exist (PI > 35). 3) If lab strength > 350 psi, then use microcracking.

* Conservative value: District may wish to change this value based on long-term performance studies.

is shown in the table as the Level 1 design. The major requirement when using this design option is that the new base must be less moisture susceptible than the old base or the two materials must be blended together.

For the Level 4 design the key to successful performance appears to be adding sufficient stabilizer to provide reasonable initial strength and good moisture susceptibility. New tests for obtaining this balance are described in Report 4182-1.

For More Details . . .

This research is documented in Report 4182-1, *Field Performance and Design Recommendation for Full Depth Recycling in Texas*.

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TxDOT Implementation Status—December 2003

The recommendations of this research are being implemented in the Bryan District. A formal implementation project is being planned in the future to help other districts implement full depth recycling (FDR) through technical support or training classes. This project will also add these recommendations to the pavement design manual.

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