PROJECT SUMMARY REPORT

# 0-7076: Develop Laboratory Mix Design for Full Depth Reclamation (FDR) Projects Using Foamed Asphalt Binder and Emulsified Asphalt

## Background

Full depth reclamation (FDR) is a pavement rehabilitation technique in which the full thickness of the asphalt pavement and a portion of the underlying materials are uniformly pulverized and blended to create a new, homogenous base layer. The technique is beneficial for enhancing the structural capacity of pavements and extending their service life. The Texas Department of Transportation (TxDOT) has increasingly used FDR due to its cost-effectiveness and environmental benefits. However, the mix design procedures for FDR using asphalt binders, particularly foamed asphalt and emulsified asphalt, needed refinement to align with the 2024 TxDOT Standard Specifications.

The purpose of this research project, conducted by the Texas A&M Transportation Institute, was to update and refine the mix design procedures for FDR to improve consistency, reliability, and performance of rehabilitated pavements. The project aimed to address the gaps and variability in current practices by suggesting certain changes to the standardized procedures for specimen preparation, curing, and testing. This research was crucial because it ensured that FDR treatments result in durable and structurally sound pavements, reducing the need for frequent repairs and extending the service life of roadways. By improving the mix design process, TxDOT can achieve better performance outcomes, cost savings, and environmental benefits, contributing to more sustainable infrastructure development in Texas.

## What the Researchers Did

The researchers reviewed existing FDR practices in Texas and other regions, focusing on mix design procedures, specimen size, and test temperature impact on indirect tensile (IDT) strength.

The research team also conducted a comprehensive laboratory study to assess the factors affecting IDT strength. This laboratory study involved varying specimen size, compaction level, emulsion temperature, curing time, curing temperature, testing temperature, and cement type. Field materials were collected and characterized to ensure the study's relevance to actual field conditions.

In addition, various TxDOT laboratories and a private laboratory participated in an interlaboratory study to establish a preliminary precision statement for the FDR mix design procedures. This collaboration helped evaluate the reproducibility of the mix design methods across different testing environments.

Finally, field evaluations were conducted on selected sections of two FDR projects. These evaluations aimed to measure the effectiveness of the FDR treatments in improving pavement performance.

## What They Found

The literature review identified optimization opportunities in compaction methods and IDT strength limits. It highlighted the variability in current practices and the need for standardized procedures.

With regard to the laboratory study, statistical and trend analyses indicated that most variables significantly impacted IDT strength. The findings were generally as anticipated, validating the initial

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hypotheses about the impact of laboratory test factors on FDR mix design procedures. All laboratory factors except for emulsion temperature and cement type showed a significant effect on IDT strength results. Notably, 4-inch-diameter specimens were found to be more consistent, albeit higher, in IDT strength test results (Figure 1). The recommended mix design procedures included ensuring a minimum curing time of 72 hours and maintaining the curing temperature at 104°F. A tighter control of testing temperatures within 72° ± 2°F was proposed to ensure consistent results.

The interlaboratory study demonstrated some variability in results, especially for some types of materials. The preliminary precision statement provided a benchmark for future studies and implementation.

**Figure 1. 4-Inch-Diameter Soil Specimen Tested for Indirect Tensile Strength.**

Field evaluations showed that FDR treatments generally improved pavement performance, with backcalculated base layer moduli meeting or exceeding design assumptions in most cases. This confirmed the effectiveness of the recommended mix design procedures in real-world applications.

## What This Means

The findings from this study provided a robust foundation for updating TxDOT's FDR mix design procedures. By adopting the recommended procedures, TxDOT could ensure more consistent and high-quality FDR projects across Texas. The use of 4-inch-diameter specimens and controlled curing and testing temperatures would lead to more reliable IDT strength measurements, ultimately enhancing the structural integrity and longevity of rehabilitated pavements.

Implementing these procedures in Tex-122 and Tex-134-E would not only improve the performance of FDR-treated pavements but also contribute to cost savings and environmental benefits. Enhanced pavement performance reduces the need for frequent repairs and maintenance, leading to lower life-cycle costs. Additionally, the use of recycled materials in FDR aligns with sustainability goals by reducing the demand for new materials and minimizing waste.

In conclusion, this research marked an advancement in FDR mix design procedures. Implementation of the recommendations provided would help standardize mix design procedures, improve pavement performance, and contribute to more sustainable infrastructure development. The research team suggested that TxDOT implement these findings in upcoming projects and continue to monitor and refine the procedures as needed to help ensure that Texas remains at the forefront of innovative and effective pavement rehabilitation techniques.

## For More Information

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