Texas Department of Transportation

Texas A&M Transportation Institute

PROJECT SUMMARY REPORT

0-7143: Develop Methodologies for Reducing Costs in Full Depth Reclamation (FDR)

Background

Full-depth reclamation (FDR) is widely used to rehabilitate pavements cost-effectively. Most FDR mixtures treated with emulsified or foamed asphalt also include 1 percent cement additive for early strength, but this additive involves another material cost and requires one more step in the construction sequence. This study evaluated emulsified- and foamed-asphalt FDR mixtures with and without additive to determine when the additive could be eliminated. Laboratory and mechanistic analyses assessed early strength, temperature effects, moisture behavior, and long-term performance implications. Economic evaluations compared material, schedule, and user costs of mixtures with and without the additive.

What the Researchers Did

Researchers collected materials from five districts and produced laboratory FDR mixtures using emulsified and foamed asphalt, with and without additive. Researchers performed tests for indirect tensile strength, resilient modulus, unconfined compressive strength, and permanent deformation to evaluate strength and performance-related properties over time. Analyses using the Texas Mechanistic-Empirical Flexible Pavement Design and Analysis System (TxME) estimated pavement performance, while Construction Analysis for Pavement Rehabilitation Strategies (CA4PRS) simulations evaluated construction time and user delay costs. The team compared economic outcomes between additive and non-additive mixes.

What They Found

Laboratory and modeling results showed that both emulsified- and foamed-asphalt FDR mixtures developed sufficient strength without cement additive, providing expected similar performance in the long term so long as these materials without additive were not exposed to significant moisture. Cement additive accelerated early strength, especially within the first 24 hours, but its influence on long-term performance was smaller than anticipated. Researchers found similar early strength benefits could often be obtained by substituting lime for cement although lime's effectiveness as an additive in the mix design stage was not as reliable as cement. Non-additive mixes exhibited slower strength gain and may require 3 to 4 hours of additional cure time prior to opening to traffic yet achieved comparable expected performance over longer curing times.

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Temperature and moisture conditions were found to be the most critical factors governing early traffic-opening readiness. When these conditions are properly addressed during construction, TxME simulations confirmed that non-additive mixes should be able to provide acceptable early-traffic performance (Figure 1). Economic analyses indicated that eliminating the additive reduced material and construction costs by up to 20 percent and can allow for faster production and improved overall project efficiency. From a purely cost perspective, emulsion treatment with no additive provided the best economic benefits. However, the economic benefits of non-additive mixes may be offset by increased performance risks due to moisture susceptibility.

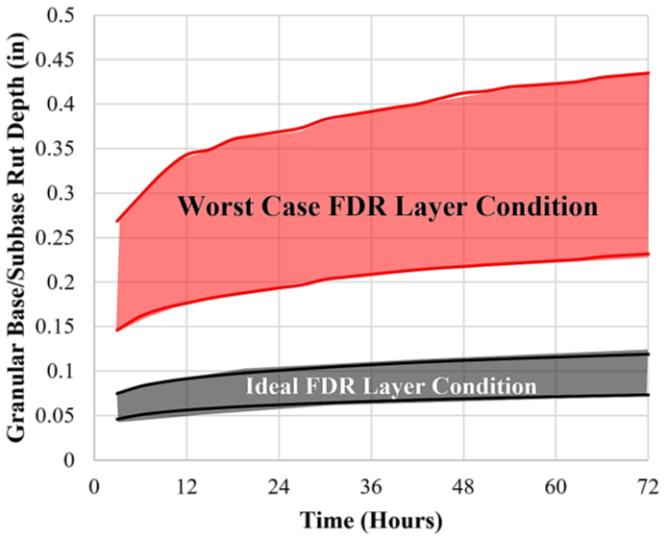

Figure 1. TxME Simulations Confirming That Non-additive Mixes Could Provide Acceptable Early-Traffic Performance.

What This Means

Additive-free FDR with emulsified or foamed asphalt can perform effectively when properly designed and cured—provided that dry and wet indirect tensile strength values meet the design thresholds of 50 psi and 30 psi, respectively. However, the proportion of materials in Texas that will meet the wet strength mix design criteria is low. If sourcing cement is problematic, lime should be investigated as a substitute for cement.

Provided that the mix meets design strength requirements, projects with moderate traffic and suitable moisture and curing conditions can safely omit additive. High-traffic or moisture-sensitive projects should continue to include the additive. In practice, emulsified or foamed asphalt-treated FDR mixes without additive could provide materials cost savings, faster production, and user delay savings, with the potential tradeoff of increased long-term performance risks due to their higher level of moisture susceptibility. Thus, non-additive mixes are best considered on a case-by-case basis for low-risk areas, projects with logistical challenges for sourcing additives, or projects where simply upgrading material properties is desired.

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