Project Capsule

26-4GT

May 2026

Performance Evaluation of Flexible Pavements Reinforced with Wicking Geotextiles Built Over Soft Subgrade Soils

PROBLEM

The presence of water within pavement structures is a major contributor to performance deterioration due to reductions in the strength and stiffness (modulus) of the subgrade and base layers, as well as the erosion and pumping of fine materials. In Louisiana, pavements are often constructed over weak, high-plasticity subgrades with shallow groundwater tables, making them particularly vulnerable to moisture-related damage. Cracks and joints formed during construction and/or under repeated traffic loading allow rainwater to infiltrate pavement layers from the surface. Additionally, capillary rise from groundwater can introduce moisture from below. This water can become trapped within the base, subbase, and subgrade layers, leading to the weakening of subsurface materials, pumping, soil volume change, and long-term pavement distresses such as rutting and cracking. These moisture-induced mechanisms often result in premature failure, unsafe driving conditions, and increased maintenance costs.

To mitigate these issues, various geotechnical solutions have been used, including chemical stabilization of subgrade soils (e.g., with cement or lime) and the use of geosynthetics for separation, reinforcement filtration, and drainage. However, conventional woven and non-woven geotextiles, typically made of hydrophobic materials such as polypropylene or polyester, are generally ineffective at extracting and transporting moisture away from the subgrade and base layers in unsaturated conditions. Recently, wicking geotextiles (WGs) have been developed to address these limitations. WGs incorporate hydrophilic fibers that can generate capillary suction, allowing them to actively remove and laterally transport moisture under both saturated and unsaturated conditions. This dual drainage mechanism, which is both gravity- and capillary-driven, enhances drainage efficiency, reduces moisture content, and improves the strength and stiffness of pavement layers.

Laboratory and field studies have shown that WGs can significantly reduce moisture buildup and permanent deformation while improving overall pavement performance. In Louisiana, their application is expected to improve pavement performance over moisture-sensitive subgrades. The proposed research will evaluate WG mechanisms through laboratory and field testing, develop mechanistic relationships between moisture reduction and mechanical property improvement, and use finite element modeling to simulate field performance and support integration into mechanistic-empirical design frameworks such as AASHTOWare MEPDG. The outcomes will support the development of design guidelines and promote more durable, cost-effective pavement systems in moisture-prone regions.

Figure 1. Wicking Geotextile

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36 months

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OBJECTIVE

The primary objective of the proposed study is to evaluate the potential benefits of incorporating wicking geotextiles (WGs) to enhance the performance of flexible pavements constructed over soft, moisture-susceptible subgrade soils in Louisiana. The study aims to investigate how WGs can enhance the capillary capacity and improve drainage rate efficiency to transport water from the base and subgrade soil and reduce their soil moisture, mobilize reinforcement mechanisms (i.e., stabilize pavement layers), and mitigate moisture-related distresses such as rutting and fatigue. The findings will lead to the development of design guidelines and performance-based recommendations for incorporating WGs into the design of pavement systems and implementing their benefits within pavement design frameworks (e.g., AASHTOWare MEPDG).

METHODOLOGY

The work plan for the proposed study has been divided into the following eleven (11) tasks:

- **Task 1:** Conduct a literature review and review market available wicking geotextiles (WGs).
- **Task 2:** Conduct laboratory tests: capillary rise, soil-water characteristic curves, triaxial compression, and large-size direct shear tests.
- **Task 3:** Conduct large-scale indoor in-box laboratory tests to evaluate the performance and dehydration (i.e., drainage/moisture reduction efficiency) of pavement reinforced with wicking geotextile (PRwWG) under static and cyclic plate load tests.
- **Task 4:** Construct, instrument, and monitor controlled full-scale testing at LTRC's Pavement Research Facility (PRF) to evaluate the performance of PRwWG subjected to simulated rainfall and open environmental rainfall conditions.
- **Task 5:** Identify, instrument, and monitor several under-construction pavement lane sections in Louisiana to evaluate the performance of PrwWG under environmental loading conditions and traffic-associated responses.
- **Task 6:** Conduct finite element (FE) numerical modeling and parametric study analysis.
- **Task 7:** Explore artificial intelligence (AI) and machine learning (ML) predictive-based models to estimate the capillary suction and reinforcement capacity of PRwWG from lab-scale, full-scale, and field-scale measured testing data, results of FE analysis, and literature data.
- **Task 8:** Implement WGs into AASHTO 1993 and AASHTOWare MEPDG flexible pavement design frameworks.
- **Task 9:** Provide recommendations for the design and construction guidelines of PRwWG.
- **Task 10:** Analyze and evaluate the life-cycle cost and sustainability assessment of PRwWG.
- **Task 11:** Prepare and submit a final report.

IMPLEMENTATION POTENTIAL

The use of wicking geotextiles (WGs) in the construction of flexible pavements in Louisiana is expected to significantly improve both the short- and long-term performance of pavements by facilitating lateral drainage of infiltrated water from rainfall and/or capillary rise from high groundwater tables. The use of WGs should be particularly effective in pavements built on soft subgrade soils. In addition to maintaining pavement layers in a relatively dry condition, WGs also provide reinforcement/stabilization benefits. As a result, the strength and stiffness of pavement materials are enhanced, leading to improved pavement performance and reduced pavement distresses, such as cracking and rutting, over time. The implementation of WGs is expected to provide DOTD with an efficient and cost-effective approach for designing and constructing safer pavements with reduced maintenance and rehabilitation needs.