RESEARCH PROJECT CAPSULE

May 2024

24-2P

TECHNOLOGY TRANSFER PROGRAM

Develop a Methodology for Pavement Drainage System Rating

JUST THE FACTS:

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18 months

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Sponsored jointly by the Louisiana Department of Transportation and Development and Louisiana State University

POINTS OF INTEREST:

Problem Addressed / Objective of Research / Methodology Used / Implementation Potential

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PROBLEM

In the realm of pavement engineering, the management of water and its impact on infrastructure longevity is of paramount importance. Water can lead to various degrees of damage to roadways, ranging from the formation of potholes to less visible issues such as the weakening of subsurface materials. One of the primary reasons for pavement failures is the weakening of the base, subbase, or subgrade when they become saturated with water. Water can seep through unsealed joints or cracks and collect beneath the pavement slabs. This accumulation of water, combined with the pressure exerted by vehicle loads, can erode the materials underneath, creating voids and compromising the pavement's structural integrity. Additionally, inadequate surface drainage can lead to another significant issue—vehicle hydroplaning. This dangerous condition occurs when water accumulates on the road surface, causing vehicles to lose traction and resulting in hazardous driving conditions and weather-related accidents.

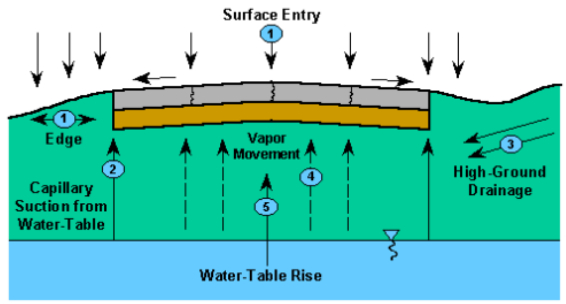

Figure 1. Sources of water to pavement (Source: https://vaasphalt.org/pavement-guide/pavement-design-by-use/street-design/)

Water in pavement comes primarily from surface water such as rainfall and runoff, which may enter the pavement through joints, cracks, shoulder, and backup in ditches, and groundwater, which may enter the pavement through the rise of groundwater table or capillary forces (see Figure 1). These water sources pose significant challenges to the durability and stability of roadways. Engineers employ various strategies to mitigate these issues, primarily through drainage systems (see Figure 2), which consist of surface drainage, subsurface drainage, and roadside drainage.

Water flows across the road surface in two ways: laterally (side to side) and longitudinally (along the length of the road). Lateral drainage is achieved by crowning or by in- or out-sloping of road surfaces (see Figure 6). Longitudinal grade is of greater significance in urban roadways than rural roadways. This is because surface water is collected by curbs and gutters, then conveyed longitudinally to a drainage system in urban roadways.

There are two types of subsurface drainage systems: interceptor drain, which is designed to remove water as it seeps down the pavement structure, and relief drain, which is employed to lower the groundwater table level. An interceptor subsurface drainage system consists of three basic elements: a permeable base layer, a filter layer to prevent the migration of fine subgrade materials into the permeable base, and a method to remove the water from the drainage layer (e.g., daylighting or longitudinal/transverse pipe collectors).

Roadside drainage is designed to collect and transport water from the surface and structure of the road so that there will be no ponds on the road or backup in the ditches. Roadside drainage consists of the following elements: foreslope, side ditches, cross drains, side drains, lateral channels, curb and gutter, drainage inlet, catch basin, storm sewer line, etc. Typically, it is more

Figure 2. Pavement drainage system

cost-effective and less risky to prevent moisture from entering and accumulating within pavements using surface drainage than it is to rely on subsurface drainage for moisture removal.

The role of efficient drainage in preserving road pavements' structural integrity and functionality cannot be overstated. Proper drainage system design and maintenance are crucial in managing surface water, preventing it from infiltrating the pavement and undermining its structural integrity. This includes techniques like the use of well-designed and -maintained cross slopes, ditches, culverts, and stormwater management systems. Suboptimal drainage can lead to an array of issues, including but not limited to water infiltration, pavement erosion, subbase weakening, pothole formation, and hydroplaning accidents. However, the literature review indicates that the drainage condition rating of the existing pavement at the network level is almost nonexistent.

The DOTD Highway Needs Database contains a drainage condition field that has not been updated for approximately 20 years. DOTD's highway maintenance section once proposed a drainage condition Level of Service (LOS) but never implemented it. Therefore, there is a critical need to develop a reliable index to rate drainage conditions.

OBJECTIVE

This research aims to explore the use of existing pavement and LiDAR data to develop a pavement drainage system rating index as part of pavement condition assessment in Louisiana.

METHODOLOGY

To achieve the objective of this research, the team will complete five tasks:

First, they will conduct an extensive literature review of traditional and electronic information related to pavement drainage systems and their condition evaluation and rating.

Second, they will conduct a statewide survey via email to gain insight into drainage performance.

Third, the team will explore the potential of utilizing the pavement data collected by the Pavement Management System (PMS) and the available LiDAR data in Louisiana, in combination with field inspection, for pavement drainage condition evaluation.

Fourth, following this evaluation, the research team will develop a methodology for pavement drainage rating based on the available pavement/LiDAR data, potentially through the creation of a drainage rating index or the application of condition codes.

Finally, a final report will be compiled to document survey results, a summary of available pavement/LiDAR data useful for drainage condition evaluation, and all significant research findings and recommendations.

IMPLEMENTATION POTENTIAL

It is expected that by the end of the proposed research, a methodology for rating pavement drainage systems will be developed with available pavement and LiDAR data.