Development of a Machine Learning-Based Model to Determine the Optimum and Safe Restriping Timing of Thermoplastic Pavement Markings in Hot and Humid Climates

Project Number:

21BLSU11

Start Date:

08/01/2021

Principal Inverstigator(s):

Momen R. Mousa

Louisiana State University

Lead Institution:

Louisiana State University

Funding Source(s):

Tran-SET

Louisiana State University

Total Project Cost:

$ 75,179

Evaluating the optimum restriping timing of thermoplastic markings in Louisiana

Pavement markings are a key safety component of the highway system that are used to delineate the roadway path and specific traffic lanes. They provide continuous information to road users related to the roadway alignment, vehicle positioning, and other important driving-related tasks, and therefore, reducing motor vehicle traffic crashes and fatalities. Timing is critical in the decision-making process of restriping activities. The objective of this study is to develop new cost-effective restriping strategies for thermoplastic pavement markings when applied to pavements in hot and humid climates. To achieve this objective, the field performance (retroreflectivity and durability) of thermoplastic pavement markings under hot and humid climate service conditions will be evaluated. Based on the results, the research team will develop performance prediction models that could predict the thermoplastic pavement marking service life based on the roadway conditions. This will assist transportation agencies maintain minimum retroreflectivity levels in conformance with the proposed Federal Highway Administration (FHWA) requirements with minimal risk of under restriping or over restriping. Eventually life cycle cost analysis will be conducted to compare different restriping strategies. The implementation of this research will significantly improve traffic safety in rainy conditions encountered in Region 6. In addition, the results of this research are important to ensure safe and reliable navigation of autonomous vehicles through the roadway, which are recently emerging in Region 6. The results of this research will be used to implement and optimize the use and maintenance of thermoplastic pavement markings in South-Central United States, and to reduce costs.

Problem Statement

With time, pavement markings deteriorate and become less retroreflective. Eventually, most of the glass beads disappear, and their effectiveness in communicating the intended travel path and roadway alignment to road users at night diminishes. After their deterioration, if pavement markings are left unattended, the coefficient of retroreflection can decrease to a point where the markings are invisible for nighttime drivers to react appropriately. Therefore, the road need to be re-stripped to maintain retroreflectivity. Based on a nationwide survey, NCHRP project 306 indicated that about 39% of the state agencies conduct day and night visual inspections and rely on the judgment of inspectors to decide when to maintain pavement markings. On the other hand, about 20% of the agencies replace pavement markings based on a regular cycle (paint is replaced annually, while epoxy is replaced every three years), while 12% remove durable markings when adhesion problems manifest. The survey findings also indicated that 6% of the state agencies never replaced or maintained pavement markings, while only 8% replaced them when traffic patterns changed during construction. It is well recognized that is decision-making procedure is subjective and questionable in terms of both sufficiency and economy. Restriping marking materials that did not reach the end of their service lives will lead to over restriping and unnecessary replacement costs. Similarly, this strategy may be deficient for pavement markings that have already reached their service lives leading to under restriping and safety problems for the users. Therefore, it is essential to provide state agencies with a quantitative tool that could accurately predict the service life of pavement markings, and hence the optimum time of restriping, based on the project conditions. This will also ensure that state agencies establish an objective pavement marking management program that will be effective in maintaining nighttime visibility for their pavement markings.

Objectives

The The objective of this study is to develop new cost-effective restriping strategies for thermoplastic pavement markings when applied to pavements in hot and humid climates. To achieve this objective, the field performance (retroreflectivity and durability) of thermoplastic pavement markings under hot and humid climate

service conditions will be evaluated. Based on the results, the research team will develop performance prediction models that could predict the thermoplastic pavement marking service life based on the roadway conditions. This will assist transportation agencies maintain minimum retroreflectivity levels in conformance with the proposed Federal Highway Administration (FHWA) requirements with minimal risk of under restriping or over restriping. Eventually life cycle cost analysis will be conducted to compare different restriping strategies.

Figure 1: White and yellow markings after installation (left) and after 36 months (right) for one of markings installed in Florida.

Intended Implementation of Research

Workforce Development, Education, and Outreach: This research project will provide funding to one PhD student at Louisiana State University. This will help recruit and train future leaders in the Transportation Sector. The research team will also prepare educational materials on the new decision-making procedures for pavement marking maintenance to be summarized and disseminated to government entities and the industry. Results of this work will be also disseminated at national conferences such as TRB and ASCE.

Anticipated Impacts/Benefits of Implementation

The implementation of this research will significantly improve traffic safety in rainy conditions encountered in Region 6. In addition, the results of this research are important to ensure safe and reliable navigation of autonomous vehicles through the roadway, which are recently emerging in Region 6. The results of this research will be used to implement and optimize the use and maintenance of thermoplastic pavement markings in South-Central United States, and to reduce costs.

Web links

- Tran-SET's website https://transet.lsu.edu/research-in-progress/

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

Learn More

For more information about Tran-SET, please visit our website, LinkedIn, Twitter, Facebook, and YouTube pages. Also, please feel free to contact Dr. Momen Mousa (Tran-SET Program Manager) directly at transet@lsu.edu.