TECHSUMMARY *June 2020*

State Project No. DOTLT1000145 / LTRC Project No. 17-1P

Improving the Use of Crack Sealing to Asphalt Pavement in Louisiana

INTRODUCTION

Surface cracking is one of the most critical distresses in asphalt concrete (AC) pavement, allowing water infiltration through the cracks, causing stripping in asphalt pavement layers and weakening and deteriorating in the base and/ or subgrade. Many states use crack sealing and filling on a routine basis for preventive maintenance. Crack sealing and filling prevent the egress of water in the pavement structure, thus avoiding the weakening of the pavement and delaying its deterioration. The use of crack sealing in Louisiana has been limited as studies conducted in the 1960s showed that the performance of this maintenance practice can be affected by the shallow groundwater table conditions in the state. According to these studies, crack sealing can prevent water from escaping through the cracks and; therefore, cause an acceleration of AC stripping in the overlay. Yet, the use of any impermeable treatment including overlays on top of a pavement with shallow groundwater table may cause the same problem.

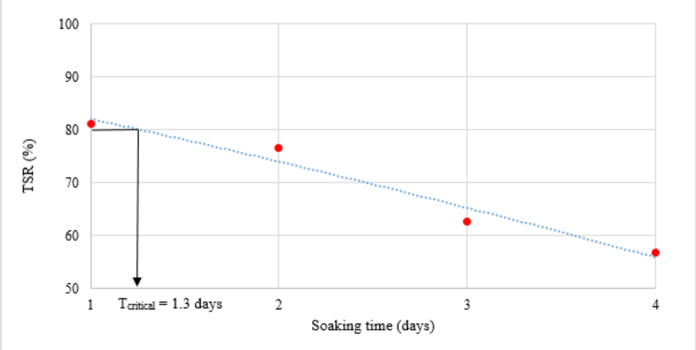

Figure 1
Results of the Lottman Test to estimate the critical soaking time

OBJECTIVE

This project quantified the benefits of using crack sealing, chip seal, and microsurfacing with respect to their ability to provide immediate and long-term benefits. Furthermore, this project assessed the optimal application timing of crack sealing, chip seal, and microsurfacing by evaluating the cost effectiveness of these treatments using various economic measures. In addition, this project evaluated potential moisture damage in AC treated with crack sealing, chip seal, and microsurfacing. Based on this evaluation, a user-friendly tool was developed in the form of a spreadsheet that could be used by the Department during the planning and design of maintenance activities to select the most cost-effective treatment based on the project conditions.

SCOPE

Measurements from a field experiment conducted by the research team in District 58 were analyzed to evaluate the effect of groundwater and other parameters on the performance of crack sealing. Furthermore, the research team analyzed pavement management system (PMS) data collected in all the districts from 2003 to 2015 to quantify the short- and long-term effectiveness of crack sealing, chip seal, and microsurfacing. To facilitate the implementation of the results, a user-friendly tool was developed in the form of a spreadsheet that could be used by the Department during the planning and design of maintenance activities.

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FUNDING:
TT-Fed/TT-Reg-6

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METHODOLOGY

To achieve the study objectives, the research activities were divided into 11 main tasks. As part of these tasks, the research team conducted a district survey and laboratory evaluation of the most common sealant materials in Louisiana to ensure their suitability for hot and humid climate such as the one encountered in the state. In addition, pavement segments that were constructed with crack sealing, chip seal, and microsurfacing were identified from the DOTD databases. PMS data were then analyzed to evaluate the field performance of crack sealing, chip seal, and microsurfacing in flexible and composite pavements in Louisiana. Furthermore, the research team analyzed the field sections to quantify the immediate benefits, in terms of performance jump and the long-term performance in terms of the increase in pavement service life (PSL). A comprehensive cost benefits analysis was conducted for the use of crack sealing, chip seal, and microsurfacing when applied to AC overlays to evaluate the cost-effectiveness of these maintenance treatments and to determine the optimal timing of application. To assess the effects of crack sealing on moisture damage, the research team developed an innovative methodology to assess the effects of water submersion on the mix durability and to estimate the critical soaking time. A calibrated finite-element (FE) model was then used to model the field experiment consisting of cracked and crack-sealed asphalt pavement sections. A sensitivity analysis was then conducted to compare water accumulation between crack-sealed and unsealed sections under different groundwater table (GWT) levels, air relative-humidity, air-temperatures, rain-intensities, and asphalt hydraulic conductivities.

CONCLUSIONS AND RECOMMENDATIONS

Results indicated that crack sealing could be applied under common rain intensities in Louisiana and any GWT depth without potential for stripping due to moisture entrapment if the hydraulic conductivity of the original pavement does not exceed 2x10-6 m/s. Yet, crack sealing should be applied after a dry period to ensure that the existing moisture in the original pavement is minimal. On the other hand, microsurfacing should be avoided in areas with shallow groundwater table as it could contribute to moisture damage in asphalt pavements due to moisture entrapment. With respect to field effectiveness, the crack-sealed sections experienced an average increase in PSL of two years more than the unsealed segment. Crack sealing and chip seal should be avoided on AC overlays with a pre-existing random cracking index (RCI-) greater than 90 since no net benefits would be obtained. In addition, crack sealing should be applied when RCI- is between 81 and 89 and preferably between 81 and 85.

Based on the findings of this project, it is recommended to use crack sealing in routine preventive maintenance activities according to the guidelines developed in this study. On the other hand, microsurfacing should be avoided in Southern Louisiana in areas with shallow groundwater table as it could contribute to moisture damage in asphalt pavements due to moisture entrapment. The use of the developed spreadsheet tool is recommended to assist in selecting and planning maintenance activities. For a given project, this tool will predict the most cost-effective maintenance treatment (crack sealing, chip seal, microsurfacing, or do nothing) that addresses existing surface distresses without causing moisture damage. The tool will also provide the optimal timing of the recommended maintenance treatment. The developed tool is implementation-ready and should be utilized by the Department to maximize savings to the state.

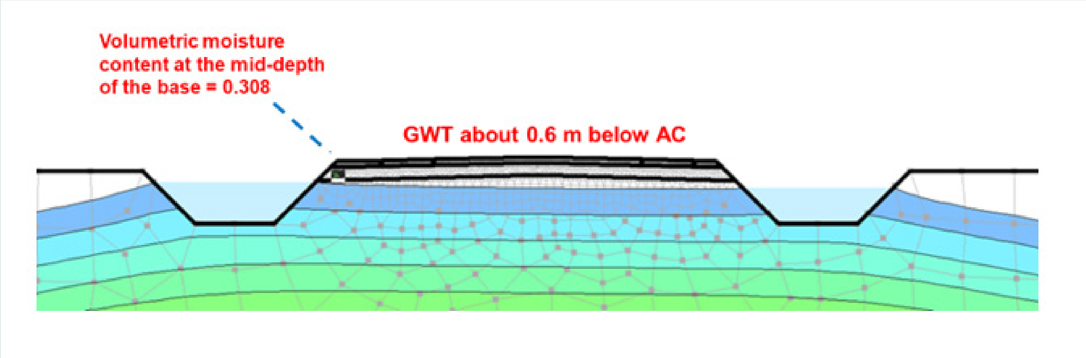

Figure 2
Results of the FE analysis for zero and negative pore-water pressure contours in the steady-state