JOINT TRANSPORTATION RESEARCH PROGRAM

Principal Investigator: Jusang Lee, Indiana Department of Transportation, jlee@indot.in.gov, 765.463.1521
Program Office: jtrp@purdue.edu, 765.494.6508, www.purdue.edu/jtrp
Sponsor: Indiana Department of Transportation, 765.463.1521

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Performance Evaluation of Seal Coat Materials and Designs

Introduction

A seal coat is a durable and functional pavement surface treatment technique that requires minimal traffic disruption. Additional benefits include sealing the existing pavement's surface cracks, providing a skid resistant surface, and preventing pavement surface damages from further aging or oxidation.

Data and literature have suggested that seal coats constructed with high quality materials provide better initial and long-term performance and extend the overall service life of the pavement being treated. However, no research or data exist on quantifying the overall performance of different seal coat materials currently available in the Indiana seal coat industry. Evaluating the performances of seal coat materials and updating/expanding standard specifications based on their performance is needed in order to provide proper guidelines to the pavement maintenance engineers in each district. Furthermore, introducing new and better performance materials from other states to Indiana, considering life cycle cost, can expand current seal coat material selection.

Although typical aggregate and asphalt application rates are available in specifications such as ASTM D1369-84 and INDOT standard specifications (Chapter 404), design method, and guidelines are still needed to compute an optimum seal coat application rate for specific aggregate, emulsion, and pavement condition on a project-specific basis.
The primary objectives of this research are: 1) To evaluate seal coat performance of various combinations of aggregates and emulsions in terms of aggregate loss; 2) To evaluate how each of the properties of theses aggregates and emulsions affect seal coat performance; 3) To evaluate current seal coat design methods based on INDOT seal coat practice; and 4) To develop a seal coat design program incorporating Indiana practice.

Findings

To evaluate the effects of aggregate and emulsion types on aggregate loss performance of seal coat, three emulsions and eight aggregates including CRS-2P, RS-2P, and AE-90S for emulsions and Trap Rock, Sandstone, Blast Furnace Slag, Steel Slag, Limestone, Dolomite, Crushed Gravel (one face), and Crushed Gravel (two faces) were tested utilizing the sweep test and Vialit test. In addition, to explore influence factors (i.e., electrical surface charge interaction, water evaporation change in emulsion, water affinity of aggregate, etc.), the Zeta potential, water content, and X-ray deflection test were conducted.

According to the Zeta potential test results, the electrical surface charge of an aggregate in emulsions varies with the type of emulsion (i.e., with the pH of emulsifier). From the water content test, CRS-2P is the earliest emulsion to have enough bond strength among the emulsions to retain aggregates in open traffic. In addition, aggregate can slow the water evaporation process of emulsions. Based on the XRD results, Sandstone and Limestone have the highest and lowest water affinity (hydrophilic and hydrophobic), respectively.

The sweep test with Limestone, which varied curing time, revealed that faster water evaporation presents better aggregate loss performance. This finding indicates that the bond strength of emulsion, or its ability to retain aggregate, is mainly a function of water evaporation in emulsion. Based on the sweep test after 24 hours of curing, CRS-2P performs the best, regardless of the type of aggregate used. On the other hand, AE-90S showed the poorest performance with large variations in aggregate loss despite the type of aggregate used. The Vialit test at a low temperature with 24 hours of curing resulted in the most aggregate loss at lower testing temperatures. Another finding was that the Crushed Gravel with two faces outperforms that with one face. In addition, AE-90S outperforms other emulsions in the Vialit test.

To develop a seal coat design, seal coat performance was evaluated for various emulsion and aggregate application rates by using three different evaluation methods: the IRI, friction, and visual inspection. Employing a factor to compensate for AAR discrepancies between target and actual is critical for seal coat survival during construction. This study confirms the lack of relevance between seal coat application and IRI values due to the thin coat and the limitation of the IRI measurement (e.g., 250 mm moving average). The friction test results showed adequate skid resistance performance on all seal coat test sections. In addition, friction improvements due to seal coat applications were confirmed within a range of seal coat rates applied in this study. Overall, IRI, friction, and visual inspection did not reveal distinct differences in seal coat performance in terms of application rates. A methodology for selecting an equipment factor for correcting any difference between a target rate and a measured rate was developed considering reliability and a designed rate using the McLeod equation.

Design software, "INDOT SEAL COAT DESIGN (iSeal)," was developed as part of the study to aid seal coat design process and to address a few problems existing with the INDOT seal coat specification. The software was largely based on the McLeod design method which includes factors that the INDOT seal coat specification lacks. Furthermore, an additional factor, an equipment factor, was implemented into the design process to resolve issues due to discrepancies between the designed rate and the applied rate.

Implementation Recommendations

The findings and iSeal software will be introduced to the INDOT Pavement Preservation Subcommittee Chapter in order to assist with district level preservation treatment practices. The details in the report and software are intended for reference only, not as specifications or design guidance. In the event that any information presented herein conflicts with the Indiana Design Manual, INDOT's Standard Specifications, or any other INDOT policy, said policy will take precedence and the software will be managed by the Asset Preservation Engineer so that conflicts do not arise.

References

Lee, J., Shields, T., Ahn, H. J. (August 2011) "Performance Evaluation of Seal Coat Materials and Designs," Joint Transportation Research Program Technical Report Series. Report SPR-3087, DOI: 10.5703/1288284314619.