LOUISIANA TRANSPORTATION RESEARCH CENTER
LTRC

TECHSUMMARY April 2022

State Project No. DOTLT1000244 | LTRC Project No. 18-5B

Evaluation of Asphalt Rubber and Reclaimed Tire Rubber in Chip Seal Applications

INTRODUCTION

Chip sealing is a commonly used pavement maintenance technique that aims to delay pavement deterioration by reducing water infiltration and restoring skid resistance. Bleeding and early loss of aggregate are the most commonly observed distresses associated with chip seal. High surface roughness and increased traffic noise are also functional limitations of this treatment method. Highway agencies in a number of states including California, Florida, and Arizona have adopted the hot application of asphalt rubber in chip sealing. Incorporation of crumb rubber in asphalt cement was observed to be effective in improving its performance. However, the application temperature requirement of hot applied asphalt rubber binder is high (160-170°C), which is an issue for workers' safety in several states including Louisiana. Hence, the use of a newly introduced tire rubber modified asphalt emulsion may be considered as a promising alternative given its installment at a temperature that is similar to that of a standard emulsion, ranging between 60 and 70°C. The use of crumb rubber as part of the aggregate layer can also improve the treatment durability and reduce traffic noise. However, these benefits have not been validated in the literature especially for the operating conditions pertinent to hot and wet climate.

Construction and distress survey of the test sections during field experiment

OBJECTIVES

The objective of this study was threefold. First, the rheological and molecular properties of tire rubber modified asphalt emulsion and other conventional emulsions were evaluated in the laboratory. Second, the laboratory performance of chip seal specimens prepared with tire rubber modified asphalt emulsion was investigated in terms of aggregate loss and the results were compared to that of the chip seal specimens prepared with conventional and polymer-modified asphalt emulsions. Finally, the short-term field performance of chip seal sections constructed with tire rubber modified asphalt emulsion were evaluated.

SCOPE

Chip seal specimens were prepared in the laboratory with different types of emulsion, different application rates, and aggregate blends. Laboratory testing evaluated the loss of aggregate, adhesion bond between the emulsion and the aggregate, and the rutting performance of field extracted specimens using the Sweep Test, Pennsylvania Aggregate Retention Test (PART), the Bitumen Bond Strength (BBS) test, and the Hamburg Loaded-Wheel Tester (LWT), respectively.

The chemical compositions and rheological properties of the asphalt binder residues were evaluated using High-Pressure Gel Permeation Chromatography (HP-GPC) and Saturate, Aromatic, Resin and Asphaltene (SARA) analysis tests. Furthermore, the quantification and comparison of the rheological properties of the asphalt binder residues were evaluated using the Superpave Performance Grading (PG) and the Surface Performance Grade (SPG).

Field test sections were constructed in LA 128 near Tensas Parish. A manual distress survey was conducted on the chip seal field sections after three, six, twelve, and eighteen months of construction. Field distresses associated with chip seals such as

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PRINCIPAL INVESTIGATOR:
Mostafa A. Elseifi

LTRC CONTACT:
Corey Mayeux, P.E.
(225) 767-9138

FUNDING:
SPR: TT-Fed/TT-Reg - 6

Louisiana Transportation Research Center

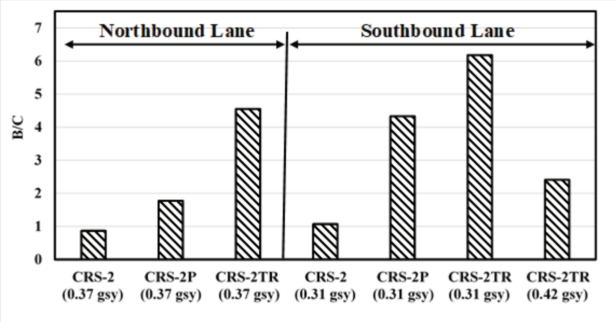
4101 Gourrier Ave
Baton Rouge, LA 70808-4443

www.ltrc.lsu.edu

bleeding, rutting, longitudinal cracking, and transverse cracking were monitored, and the Pavement Condition Index (PCI) for each test section were calculated.

METHODOLOGY

An experimental laboratory test factorial was developed and conducted to evaluate the rheological, chemical, and molecular properties of asphalt emulsions and to measure the laboratory performance of chip seals prepared with different asphalt emulsions, aggregate blends, and application rates. Based on the test results of the laboratory experiment, a field-testing program was executed to investigate the short-term performance of chip seals constructed with conventional and tire rubber modified asphalt emulsions and at different application rates. Chip seal sections were constructed on project LA 128, a 2.9-mile control section located in Tensas parish with an average daily traffic (ADT) of 470 vehicle/lane/day, and performance data were collected regularly during the field monitoring period.



Benefit-cost ratios for different field test sections constructed in the field experiment

RESULTS

Based on the results of the experimental program, it was found that aggregate retention properties of polymer-modified and tire rubber emulsions were superior to the unmodified emulsion. While a high float polymer modified emulsion (CHFRS-2P) and an asphalt rubber binder (AC20-5TR) were the best performer in terms of aggregate loss, a polymer-modified emulsion (CRS-2P) and a tire rubber modified asphalt emulsion (CRS-2TR) performed similarly followed by the unmodified emulsion. Results of the Bitumen Bond Strength (BBS) test showed a similar rank for the bond strength of the emulsions. It was also observed that the loss of aggregate in chip seal decreased with the increase in application rate. However, incorporation of rubber as aggregate in chip sealing increased the loss of aggregate in the specimens indicating poor adhesion between the emulsions and the rubber aggregate. Chemical and molecular characterization test results indicated that the tire rubber modified emulsion had lower carbonyl indices and colloidal instability indices as compared to the other conventional emulsions, indicating higher resistance to aging. On the other hand, rheological test results showed that the performance of CRS-2TR was comparable to CRS-2P and was expected to perform better than an unmodified asphalt emulsion (CRS-2). In the field study, seven chip seal sections were successfully constructed and were regularly monitored over an 18-month period as part of the short-term field performance evaluation. In the northbound lane, the chip seal section constructed with CRS-2TR (0.37 gsy) was the best performer statistically. In the southbound lane, the chip seal sections constructed with CRS-2TR and CRS-2P (0.31 gsy) performed similarly. Furthermore, the maximum Service Life Extension (SLE) was predicted for the CRS-2TR (0.31 gsy) chip seal sections; whereas, the chip seal sections constructed with CRS-2 was expected to exhibit the minimum SLE. In addition, the most cost-effective chip seal section was achieved by the application of CRS-2TR emulsion at the DOTD recommended emulsion application rate.

CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of this project, incorporation of the tire rubber modified asphalt emulsion in the Louisiana specifications is recommended. The tire rubber modified asphalt emulsion provided promising results in the laboratory and in the field experiments and is expected to provide equivalent or superior performance in chip seal applications. Furthermore, the tire rubber modified asphalt emulsion is installed at the same temperature of a standard emulsion, which is typically between 60 and 71°C. Additionally, the current asphalt emulsion and aggregate application rates in the Louisiana specifications for chip sealing are adequate and should be maintained. However, incorporation of rubber as aggregate in chip sealing increased the loss of aggregate in laboratory testing indicating poor adhesion between the emulsion and the rubber aggregate.