Nebraska Soybean Board

Year-End Summary Research Report Form for Multi-Year Projects

Please use this form to summarize the practical benefits of your research project and what has been accomplished. Your answers need to convey why the project is important and how the results will impact soybean production.

Note that this form must be submitted with the 4th Quarter Report in all multi-year projects.

Project # and Title: Research on Soybean Oil as a Sustainable Recycling Agent **Principal Investigator:** Hamzeh Haghshenas Fatmehsari

Year of Multi Year: 2 of 3 (example: Year 1 of 3, Year 2 of 2)

1. What was the focus of the research project?

The ultimate goal of this multi-phase research project is to evaluate the effect of soybean oil (SO), as a locally available, affordable, and environmentally – friendly recycling agent, on the performance of asphalt pavements containing reclaimed asphalt pavement.
More specifically, the focus of the Phase II of this project was to examine the effect of SO as a recycling agent and its combination with other modifiers (e.g., antioxidants) on long-term performance, moisture resistance, and thermal behavior of asphalt binders. In this regard, the optimum dosage of SO and two antioxidants, zinc diethyldithiocarbamate (ZnDEC) and dilauryl thiodipropionate (DLTDP), were determined for a binder named CR, consisting of 65% Reclaimed Asphalt Binder (RAB) and 35% virgin binder with a PG 64-28. Then, the synergistic effects of the SO and the antioxidants were evaluated using physical and rheological characterization techniques. The binders were tested for high-temperature rutting resistance (HT-RR), Mid-Temperature Cracking Resistance (MT-CR) and Low-Temperature Cracking Resistance (LT-CR), and moisture damage resistance using Wilhelmy Plate, at different aging conditions. In addition, Saturates-Aromatics-Resins-Asphaltenes (SARA) and Differential Scanning Calorimetry (DSC) were conducted to evaluate the internal stability and thermal behavior of binders, respectively.

2. What are the major findings of the research?

- It was observed that the the addition of SO into the CR led to the softening of the binder and improvement in rheological properties; however, the low-temperature aging indices of CR modified with SO (CRSO) was higher than that of the CR binders. Also, the results showed that the aging rate of CRSO for HT-RR, MT-CR, and LT-CR is higher than that of CR binder. These observations might be a concern regarding the long-term performance of binders modified with SO, especially at sub-zero temperatures.

-The inclusion of both antioxidants into the binder showed a softening behavior which is not desirable due to the fact that antioxidants are expected to retard the oxidation process through scavenging free radicals, not by softening the asphalt binder. Therefore, this softening effect was minimized by using the optimum dosage of the antioxidant which was determined based on the high temperature performance grading (PG) approach.

-The addition of optimum dosage of ZnDEC antioxidant into the CRSO resulted in a significant positive effect on retarding the oxidation process and also reduced the aging rate under all testing temperatures. In contrast, DLTDP antioxidant did not show any positive effect in controlling the oxidation process of the binder.

-The inclusion of ZnDEC into the CRSO led to an increase in moisture susceptibility. However, the value was comparable to the moisture susceptibility of three commercial PG64-28 binders (Jebro, Suncor, Western) that were tested by Wilhelmy Plate.

- The SARA analyses of binders showed that ZnDEC could reduce the colloidal instability of CRSO which indicates an improvement in the internal stability of the binder and an improvement in the long-term performance.

-The results of the thermal behavior evaluation using DSC analysis indicated that the addition of SO into the CR binder reduces the glass transition temperature. Also, the glass transition temperature was further decreased using ZnDEC antioxidant.

3. Briefly summarize, in lay terms, the impact your findings have had, or will have, on improving the productivity of soybeans in Nebraska and the U.S.

We aim to implement this research by placing and testing the asphalt mixture containing improved soybean oil and recycled materials (e.g., RAP) on a one-mile section of Nebraska road and monitor the performance of this section for a few years. If successful, the outcomes of this research will ultimately provide new use of soybean and create an expanded market for this oil. In addition, Nebraskans may find themselves with an improved economy and more sustainable asphalt roads.

4. Describe how your findings have been (or soon will be) distributed to (a) farmers and (b) public researchers. List specific publications, websites, press releases, etc.

The news about this project has been released in the University of Nebraska website and Nebraska TV. You can access the news from the links below:

https://news.unl.edu/newsrooms/today/article/local-crops-could-provide-green-solution-for-blacktop-repair/
https://nebraska.tv/news/local/corn-and-soybeans-bring-potential-for-cheaper-road-repairs
https://engineering.unl.edu/making-blacktop-green-nebraska-engineers-using-soybean-oil-recycle-asphalt/

The outcome of this project was presented in Petersen Asphalt Research Conference in July 2022 with title of "Increasing the Efficacy of Recycling Agents with Simultaneous Addition of Antioxidants".

In addition, the findings of this research were submitted as a paper , "Using Crude Vegetable-Based Oils and Antioxidants to Improve the Performance of Asphalt Binders", to Transportation Research Board (TRB) conference. Based on the peer review results, the TRB committee recommended the paper for presentation at the TRB Annual Meeting which will be held in Washington DC. in January 2023 and for publication in TRR (Transportation Research Record) journal.

5. Did the NE soybean checkoff funding of your project, leverage additional State or Federal funding support? Please list sources and dollars approved.

The NE soybean checkoff funding of our project can potentially leverage additional funding in the next phase of the project.

Please submit this completed form to the Agriculture Research Division, jmcmahon10@unl.edu, based on the reporting schedule given to you. If you have any questions, please call Jen McMahon at the Agricultural Research Division (402) 472-7082.

Please check your information before submitting the form. Submit by Email

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