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Pilot Construction Project for Granular Shoulder Stabilization

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Abstract
Granular shoulders need to be maintained on a regular basis because edge ruts and potholes develop, posing a safety hazard to motorists. The successful mitigation of edge-rut issues for granular shoulders would increase safety and reduce the number of procedures currently required to maintain granular shoulders in Iowa. In addition, better performance of granular shoulders reduces the urgency to pave granular shoulders. Delaying or permanently avoiding paving shoulders where possible allows more flexibility in making investments in the road network. To stabilize shoulders and reduce the number of maintenance cycles necessary per season, one possible stabilizing agent—acidulated soybean oil soapstock—was investigated in this research. A pilot testing project was conducted for selected problematic shoulders in northern and northeastern Iowa. Soapstock was applied on granular shoulders and monitored during application and pre- and post-application. Application techniques were documented and the percentage of application success was calculated for each treated shoulder section. As a result of this research, it was concluded that soybean oil soapstock can be an effective stabilizer for granular shoulders under certain conditions. The researchers also developed draft specifications that could possibly be used to engage a contractor to perform the work using a maintenance-type construction contract. The documented application techniques from this project could be used as guidance for those who want to apply soapstock for stabilizing granular shoulders but might not be familiar with this technique.

Keywords
Granular materials, Highway maintenance, Road shoulders, Ruts (Pavements), Soil stabilization, Soybeans, aggregate stabilization, edge-rut mitigation, gravel shoulders, shoulder maintenance, soybean soapstock, stabilization equipment, stabilizing agents, TR-634

Disciplines
Civil Engineering

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tech transfer summary

Soybean oil soapstock has the potential to be used cost-effectively to mitigate edge-rutting problems and stabilize granular shoulders.

Problem Statement

Edge rutting on granular shoulders is a serious traffic safety issue because it can cause vehicles to run off the road, which can lead to loss of control and even loss of life (Jahren et al. 2011). Edge rutting is caused by three factors: wind and air currents, vehicle off-tracking, and drainage.

Over time, wind and air currents from large vehicles blow fine material away from the shoulder, exposing large particles on the shoulder surface, which are removed more easily by vehicle off-tracking. Off-tracking refers to the situation where rear tires run a different path from front tires during vehicle turning movements. Pavement drainage accumulates along the pavement edge and makes shoulder materials unstable.

Background

A shoulder edge-rut mitigation research project identified applications of acidulated soapstock, which is a soybean oil by-product, as a possible strategy to mitigate the development of edge ruts on roadways with granular shoulders (Jahren et al. 2011).

Evidence indicates that this strategy has the potential to reduce the number of required maintenance cycles on high-speed high-traffic roads (such as US Highway 20 near Jessup, Iowa with 9,000 vehicles per day/vpd annual average daily traffic/AADT and a speed limit of 65 mph) and last up to five years on moderate-speed medium-traffic roads (such as US 18 near Garner, Iowa with 6,000 AADT and a speed limit of 45 mph).

Edge rutting on granular shoulder (Jahren et al. 2011)

Objective

The objective of the proposed research project was to assist the Iowa DOT in mitigating edge ruts on granular shoulders cost-effectively by pilot testing the use of soybean oil soapstock in a full-scale maintenance setting.

Pilot testing the material on roads with various AADT levels and shoulder conditions would provide an opportunity to better define situations where soybean oil soapstock and similar materials would be useful. The following questions would be answered:

- What level of AADT can the treatment tolerate?
- What amount of vehicle off-tracking can the treatment tolerate?
- How must the shoulder material be prepared prior to application given that developing a sufficiently solid surface for the base of the application was found to be a challenging task in areas that were rutted just prior to construction?
- Can the treatment be maintained to extend its life?
- How can the treatment be repaired efficiently when points of incipient failure develop?
- How can the Iowa Department of Transportation (DOT) purchase the material?
- What specifications are required so that the material be applied as part of a construction or maintenance contract?
- What other alternative strategies should be explored?

Research Description

Granular shoulders need to be maintained on a regular basis because edge ruts and potholes develop, posing a safety hazard to motorists. To stabilize shoulders and reduce the number of maintenance cycles necessary per season, one possible stabilizing agent—acidulated soybean oil soapstock—was investigated in this research.

A pilot testing project was conducted for selected problematic shoulders in northern and northeastern Iowa. Soapstock was applied on granular shoulders and monitored during application and pre- and post-application. Application techniques were documented and the percentage of application success was calculated for each treated shoulder section.

Researchers also developed draft specifications that could possibly be used to engage a contractor to perform the work using a maintenance-type construction contract.

Key Findings

Conclusions

By the end of the study, researchers were able to determine whether and under what conditions this soapstock could be effective in mitigating edge rutting and potholes for granular shoulders. Most shoulders had good performance. Of the 20 test sections, 14 had 100 percent good performance, meaning no edge ruts or potholes were identified and the soapstock stayed firmly in place on the treated shoulders.

Two locations had the worst performance with 0 percent successful application. Although no edge ruts were observed for these two sections, most of the soapstock applied on the shoulder surface was not in place when post-construction observations were made. At these locations, the soapstock was applied during rain showers and the wet conditions during application are the likely cause of poor performance.

At two other locations, new edge ruts developed in a few places, but the application was mostly successful with 98.3 and 95.7 percent successful application. Edge rutting at one location was not severe, only 1/2 in. deep, and, at the other, one 3/4 in. deep pothole was observed nearby.

Two other locations had a few places where the soapstock did not survive intact before post-construction observations were made. One location has heavier than recommended traffic volumes for soapstock use and shoulders that had unusually unstable surface aggregate.

The major causes for observed failed application were poor aggregate gradation and stability, severe vehicle off-tracking, high-volume traffic, presence of a relatively sharp curve, runoff from the road profile uphill of the failure location, and occurrence of rain during soapstock application. In addition, there was insufficient aggregate to maintain the design shoulder cross slope and fill to the interface between the pavement edge and the shoulder in a few study locations.

In fact, application results could be affected by many factors not only limited to what is listed above. Possible influence factors include cross-slope of the shoulder, stiffness of shoulder materials, gradation distribution of aggregates, preparation of shoulders (particularly compaction), weather during application, moisture content of shoulder materials, soapstock thickness and viscosity, soapstock application rate, compaction after application, and thickness of covering sand.

Recommendations

- Before soapstock application, shoulders should be prepared with proper regrading work and compaction. Aggregate materials applied during regrading should have a gradation complying with the DOT specification.

- During the soapstock application, rain should be avoided because too much moisture can prevent soapstock from staying firmly on the shoulder. Too much or too little moisture compromises the effectiveness of the application. If the shoulder is too dry, water should be applied to add more moisture. If the shoulder is too wet, soapstock application should be delayed until it is dry enough.

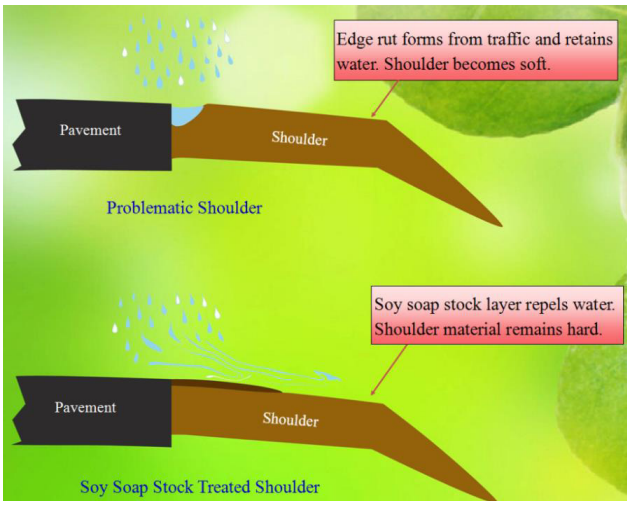
- Soapstock should be distributed evenly on the shoulder, which might require the operator to recirculate the soapstock in the tank to obtain its uniform viscosity.

- After the shoulder is treated, consider using compaction provided by a pneumatic roller to enhance the ability of the soapstock to bind with the aggregate materials.

- If potholes or edge ruts develop after soapstock application, consider filling them using a pothole patcher.

- More advanced research could be performed in the future to further determine the effects of the various possible influence factors on unpaved shoulder soapstock application.

- Developing an expedient method to stabilize and stiffen the underlying aggregate in areas of pre-existing edge ruts, pot holes, and water erosion gullies should be considered because, if successful, such a method would likely increase the success of soapstock application.



Stabilization of granular shoulders with soybean oil soapstock

Implementation Readiness and Benefits

As a result of this research, it was concluded that soybean oil soapstock can be an effective stabilizer for granular shoulders under certain conditions.

The results of this study are intended to allow maintenance personnel to improve the performance of granular shoulders with regard to edge ruts, by applying a soapstock-stabilizing agent on problematic shoulders.

The successful mitigation of edge-rut issues for granular shoulders would increase safety and reduce the number of procedures currently required to maintain granular shoulders in Iowa. In addition, better performance of granular shoulders reduces the urgency to pave granular shoulders. Delaying or permanently avoiding paving shoulders where possible allows more flexibility in making investments in the road network.

The documented application techniques from this project could be used as guidance for those who want to apply soapstock for stabilizing granular shoulders but might not be familiar with this technique.

Reference

Jahren, C. T., D. J. White, T. H. Phan, C. Westercamp, and P. Becker (2011). *Stabilization Procedures to Mitigate Edge Rutting for Granular Shoulders-Phase II*. Institute for Transportation, Iowa State University, Ames, Iowa.