TECHSUMMARY January 2023

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Maintenance of Roadway Edge Drop-Off Utilizing Readily Available Materials

INTRODUCTION

Road shoulders should be contiguous with the traveled lane and provide an area along the highway for vehicles to stop, particularly during an emergency. Road shoulders add a safety factor to roadways; however, edge drop-offs can cause problems that district maintenance staff must frequently repair and maintain. There are minimum standards for road shoulders, but these vary with the type of roadway (freeway, ramps, arterial, collector, or local) and by location of the roadway (urban or rural). Some rural Louisiana roads have minimal shoulders (many about 2 ft. wide) due to the historical nature of the road. Furthermore, rural roads in the northern regions of the state often have the combination of rolling hills, winding roads, narrow shoulders, and steep slopes beyond the shoulder.

Shoulders can be composed of a variety of materials that are routinely disturbed, primarily at the edge of the paved roadway, and lost down the cross-slope through dynamic (moving and spinning) tires or erosion. Wheel ruts can form and lead to slope stability issues. The Louisiana Department of Transportation and Development (DOTD) District 05, which is in the northeastern corner of the state, spent 55,000 hours and over $1 million in 2016 attempting to maintain roadway edges along non-paved shoulders. The shoulder materials adjacent to overlays or existing road edges should be stable, durable, and graded to meet the road edge. One proposed material is reclaimed asphalt pavement (RAP), and it is readily available and used in many areas of Louisiana for shoulder repair. Some parish maintenance units use 100% RAP, while others use a blended mixture of RAP and native soils.

OBJECTIVE

This research evaluated the effectiveness of different strategies like RAP and soil with additives like fly ash and cement as possible shoulder material solutions to reduce and hopefully eliminate the edge drop-off safety issues within the state. This research evaluated the application, performance, and cost-effective solutions of different alternatives and developed a logical method(s) to address problematic shoulder locations.

SCOPE

The project investigated several materials that are readily available and commonly utilized for shoulder repair by DOTD district forces. This research conducted basic property and strength tests on a range of materials (100% lean clay, 100% RAP, and RAP/clay mixtures). The research included studying several combinations of RAP/soil mixtures with additives like fly ash and cement to achieve shoulder strength targets from 100 to 150 psi.

METHODOLOGY

The Louisiana Transportation Research Center (LTRC) geotechnical research team investigated previous and ongoing work nationwide regarding edge drop-off issues. Researchers prepared and distributed a statewide survey to DOTD districts to determine current practices and remediation methods. The research team then developed a test matrix to evaluate options, including laboratory testing and possible field test sections. The researchers evaluated the various options for performance and cost-effectiveness.

RESULTS

The LTRC geotechnical research team conducted and determined the soil properties of five different sample types. The mixes consist of recycled asphalt pavement (RAP) and lean clay separately and together in mix ratios of 25-75%, 50-50%, and 75-25%, respectively. Proctor densities showed an increase as RAP (with aggregate particles) was added to the lean clay; however, the RAP alone has a low density due to void spaces between the aggregate. In the mixtures, the smaller clay particles likely filled void spaces of the RAP, creating denser mixes.

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Read online summary or final report:
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Researchers investigated applying different additives such as cement, fly ash, and asphalt emulsion to the project materials to bond particles together. A series of unconfined compressive strength (UCS), California Bearing Ratio (CBR), and durability tests were conducted on 40 different soil/RAP combinations with varied percentages of cement (2%, 4%, 6%, and 8%) or fly ash (5%, 10%, 15%, and 20%) additives by sample volume.

The 100% RAP and Mix 1 (75% RAP and 25% lean clay) additive combinations performed the best for sample breaks. The UCS strengths increased with more additive and cure time. Even though fly ash is less expensive than cement, fly ash percentages were high and did not prove to have the necessary compressive strength. In addition, the cement additive when cured to 28 days showed a significant increase in strength (over 7 days strengths), but this was not the case for the fly ash results.

For durability tests, Mix 1 (75% RAP and 25% lean clay) with an additive of 6% cement performed the best during durability testing as well as in "post-durability" compressive strength testing that was not required but deemed informational. One sample of 100% RAP and 20% fly ash additive failed durability trials even though it reached an UCS target strength of 100 – 150 psi.

Emulsions, commonly used as tack coat, were evaluated as additives. The LTRC asphalt research group molded a series of samples with various percentages of emulsion by weight. The results showed that a cationic (positively charged) emulsion performed better than a SS1-HH anionic (negatively charged) emulsion when the cure time was 6 days. Only the 6% cationic emulison reached the target range of 100 – 150 psi for UCS tests, but only when the emulsion was heated and thoroughly blended with 100% RAP material.

CONCLUSIONS & RECOMMENDATIONS

- Researchers conducted a survey that indicated reclaimed asphalt pavement (RAP) was indeed the material most-often utilized for edge drop of repairs with availability being its best attribute.
- RAP is commonly found at DOTD district offices; however, due to aging, the material has limited asphalt content and behaves as non-plastic material (gravel).
- This research created multiple sample variations in which clay was added to RAP to fill voids, add cohesion, and improve strength and durability.
- RAP was modified with additives, such as cement, fly ash, and asphalt emulsion to improve density, strength, and durability.
- Mix 1 (75% RAP & 25% lean clay) with an additive of 4% to 6% cement performed well in both feasibility (minimal additives utilized) and performance (strength and durability of test samples).
- The 6% cationic asphalt emulsion mixed with 100% RAP samples performed well; however, there would likely need to be several 2-in. lifts (sprayed on) for field applications to perform adequately.
- DOTD District 58 successfully deployed equipment to blend, compact, and finish the shoulder material. They were acknowledged at a Louisiana Transportation Conference for their innovative implementation. Similar equipment is recommended for other districts to produce a smooth surface to help control drainage and erosion.
- The Safety Edge has been implemented by the department and has reduced the severity of edge drop offs and the ability of vehicles to more easily return to the travel lanes.
- The addition of rumble strips can help reduce lane divergence through sounds and vibrations.
- Pavement Management's iVision can be utilized to locate problematic edge drop-off locations for proactive repairs.