LOUISIANA TRANSPORTATION RESEARCH CENTER
LTRC

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Accelerated Loading Evaluation of Stabilized BCS Layers in Pavement Performance

INTRODUCTION

The Louisiana Department of Transportation and Development (LADOTD) began to use blended calcium sulfate (BCS) as an alternative base material in the 1990s. Raw BCS base without further chemical stabilization can achieve relatively high strength and stiffness under a dry environment. However, it is associated with severe moisture susceptibility problems under a wet environment. Extra moisture in BCS can cause both short-term construction difficulties and long-term performance problems. A previously completed laboratory study conducted at the Louisiana Transportation Research Center (LTRC) indicated that chemically stabilized BCS using a grade 120 granulated ground blast furnace slag with or without some secondary stabilizers (e.g., Type I portland cement, lime, or Class C fly ash) can achieve a significantly better performance than raw BCS materials in terms of both water resistance and lab-determined compressive strength. In order to verify the efficiency of laboratory derived BCS stabilization schemes and evaluate related field performance and economic benefits, an accelerated pavement testing (APT) experiment was initiated.

OBJECTIVE

The objectives of this research study were to: (1) evaluate field performance of stabilized BCS base materials as compared to a crushed stone base course under accelerated loading and (2) assess economic benefits of using stabilized BCS materials in lieu of a stone base course.

SCOPE

This study mainly deals with the accelerated loading of three full-scale flexible pavement test sections constructed at the LTRC's Pavement Research Facility. Each test section was 107.5 ft. long and 13 ft. wide. Normal flexible pavement construction practice was followed in the construction. The scope included construction of test sections, field instrumentation for monitoring moving-load induced pavement responses, non-destructive testing using both the falling weight deflectometer (FWD) and Dynaflect, surface distress survey, evaluation of pavement structural performance of tested APT sections, and cost benefit analyses of using stabilized BCS base materials in lieu of a crushed stone base.

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METHODOLOGY

The APT experiment included three different base test sections: the first one contained a granulated ground blast furnace slag stabilized BCS base course (called BCS/Slag), the second used a fly ash stabilized BCS base course (called BCS/Flyash), and the third had a crushed limestone base. As outlined in Figure 1, the three APT sections shared a common pavement structure: a 2-in. asphalt wearing course, an 8.5-in. base course, and a 12-in. lime-treated working table layer over an A-6 soil subgrade. The APT loading device used is called the Accelerated Load Facility (ALF), which simulates one half of a single truck axle with dual tires and provides adjustable moving loads ranged from

9,750 lb. to 18,950 lb. Each section was instrumented with one multi-depth deflectometer (MDD) and two pressure cells for measuring ALF moving load induced pavement responses (i.e., deflections and vertical stresses). The instrumentation data were collected at approximately every 8,500 ALF load repetitions; whereas, non-destructive deflection tests and surface distress surveys (for surface rutting and cracking) were performed at every 25,000 ALF load passes.

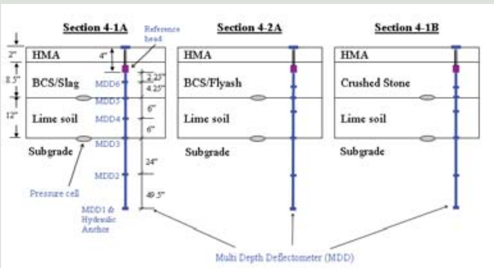

Figure 1
Pavement structures of ALF test lanes

The average surface rutting measurements for the three sections tested are presented in Figure 2, marked with the corresponding ALF load levels during different load repetitions. Dynaflect deflection results were used to determine pavement structural capacity of test sections in terms of the structural number. In-situ elastic moduli of different pavement layers were backcalculated from the FWD results. ALF wheel load induced pavement deformations and vertical stresses from MDD and pressure cells were analyzed to determine the break-down contributions of each pavement layer in a total surface measured rut depth and the load carrying capacity of each base material evaluated. The measured pavement responses were compared to those predicted from an elastic-layer pavement analysis program. The measured rutting development of different test sections was further assessed using the newly developed Mechanistic-Empirical Pavement Design Guide (MEPDG) software Version 1.0 and compared to the results obtained from MDDs and post-mortem trenches. The structural layer coefficients for stabilized BCS base materials were predicted for the use in pavement design. Finally, the cost benefits of using stabilized BCS base materials in lieu of a crushed stone base were determined based upon a construction cost analysis as well as a life cycle cost analysis (LCCA).

CONCLUSIONS

The overall APT results indicated that the 10 percent slag stabilized BCS base material outperformed a crushed stone base by a significantly large margin. The backcalculated layer moduli of the BCS/Slag base ranged from 1,190 psi to 2,730 ksi, much higher than that of an asphalt concrete layer. Post-mortem trench results revealed that the BCS/Slag base performed just like a lean concrete layer inside the pavement without showing any moisture damage indications. The 15 percent fly ash stabilized BCS base also performed significantly better than the crushed stone base. However, a shear failure was observed inside the BCS/Flyash base layer from the post-mortem trench, which raised a potential concern of its long-term moisture-resistance. Cost-benefit analysis showed that implementation of a slag stabilized BCS base in lieu of a crushed stone base will lead to a thinner asphalt pavement design, resulting in an initial construction cost reduction up to 16 percent. A 30-year LCCA indicated that using an 8.5-in. slag stabilized or 8.5-in. fly ash stabilized BCS base course in lieu of an 8.5-in. crushed stone base will potentially result in an LCCA cost savings up to 62 percent and 56 percent per lane mile, respectively. Overall, it was concluded that both the slag and fly ash stabilized BCS materials evaluated in the study can be a viable base material in lieu of a crushed stone base for a flexible pavement design in Louisiana.

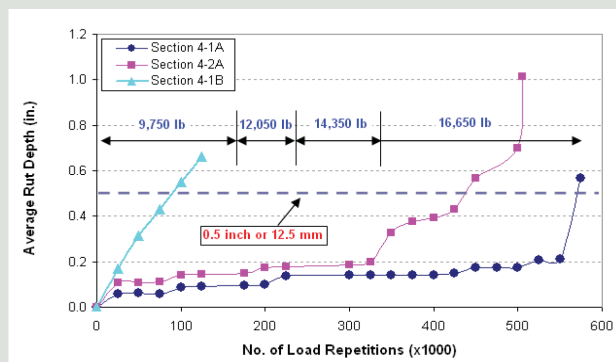

Figure 2
Rut depth development on test sections

RECOMMENDATIONS

It is recommended that LADOTD begin implementing a 10 vol.% slag stabilized BCS in lieu of a Class-II crushed stone base course in a flexible pavement design for both medium and high volume roads. A 15 vol.% fly ash stabilized BCS is also recommended to use instead of the crushed stone base. However, cautions should be made for using a fly ash stabilized BCS base when the pavement is under a constantly wet subgrade condition or in poor drainage areas. It is further recommended that LADOTD use the slag stabilized BCS materials in perpetual flexible pavement design, where a full-depth asphalt concrete layer may be partially replaced by a slag stabilized BCS layer without compromising its long-lasting pavement performance.