

TECHNICAL SUMMARY

Construction and Comparison of Louisiana's
Conventional and Alternative Base Courses
Under Accelerated Loading

Summary of Report 347

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INTRODUCTION

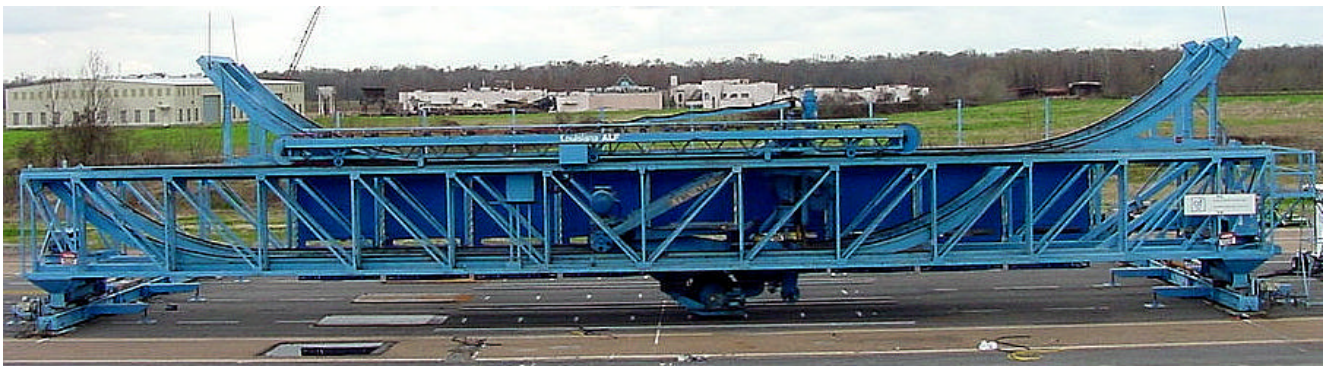
A gradual increase in the average gross weight of trucks over time has resulted in heavier axle loads and increased tire pressures. Since trucks tend to operate close to the maximum legal loads, pavement damage has accelerated and pavement life shortened. Even though current laboratory tests to compare materials are improving, there still remains a need to evaluate base designs and materials with full-scale paving technologies subjected to repeated heavy loads. The Accelerated Loading Facility (ALF) device at Louisiana's Pavement Research Facility provides this opportunity.

The Louisiana Pavement Research Facility is an experimental site housing a full-scale pavement testing area. ALF is an automated moving wheel loading device to test full-scale pavements to failure. The unit is capable of applying ten to twenty years of truck traffic in a matter of three to four months depending on the level of loading selected.

Cement stabilized soils have been extensively used as a primary load carrying material for the majority of non-interstate flexible pavements on weak soils prevalent in mid and south Louisiana. These materials are

economical, easily constructed, and they provide a stiff base layer for flexible pavements. However, this type of material cracks due to shrinkage caused by hardening of the Portland cement and soil mixture. This produces cracking in the hot mix asphalt (HMA) layers as the cracks reflect from the base to the surface. These cracks allow moisture to enter the pavement, softening pavement materials, causing roughness and other performance problems. Other types of materials and new blending methods are being considered as replacements for the standard mixed in-place soil cement base materials used in Louisiana.

This research was conducted in order to evaluate the performance of conventional soil cement bases along with alternative base materials, stabilization processes, base configurations, and material additives. The experiment was conducted in three phases on nine test lanes. The three phases of the project were designed to establish "benchmarks" for the performance characterization of this and future tests series.



OBJECTIVES

The objectives of the research was three-fold: 1) to evaluate alternative base courses with similar structural capacity but with variable shrinkage cracking potential, 2) to analyze the performance data obtained from full-scale field test lanes at the Pavement Research Facility, and 3) to compare the actual field performance with predictions from analytical models such as VESYS 3 A-M and FLEXPASS.

SCOPE

In order to achieve the objectives, the nine test lanes were tested to failure under the ALF loading. Comparisons of pavement performances were obtained. The test lanes were constructed with 3.5-inch asphalt pavement placed over the following alternate base courses.

- 8.5 inch stone w/ fabric separator
- 5.5 inch stone w/ geogrid reinforcement
- 4 inch stone over 6" stone stabilized soil
- 8.5 inch soil cement – 10% plant mix
- 8.5 inch soil cement – 4% plant mix
- 8.5 inch soil cement – 4% plant mix w/ fiber reinforcement
- 8.5 inch soil cement – 10% in-place mix
- 4 inch stone over 6" soil cement – 10% in-place mix, 12" soil cement – 4% plant mix

METHODOLOGY

The material selection, construction specifications and procedures, and acceptance testing were accomplished through laboratory testing, standard DOTD construction practices, prior experience, and engineering judgment. The ALF machine is a 94.8 ft. long structural steel frame with a moving wheel assembly that travels at a speed of 11mph on a 38 ft. long test section. Loads are applied to the pavement in one direction, representing real traffic load, and can be distributed laterally to simulate traffic wander, producing the wheel path observed on highways. The loads applied to the pavement can be varied from 9,750 lb. to 25,000 lb. by adding or subtracting ballast weights. The test lanes were loaded with the standard wheel load of 10 kips until 100,000 passes and increased to 25 kips until failure. A rut of greater than .75 inches at the surface and/or cracking of more than 50 percent of the loaded area having a crack density of 5m/m² were selected as initial failure criteria.

Performance evaluation incorporated loading and environmental records, pavement instrumentation, destructive and nondestructive testing, and visual observations. The pavement observations were supported by laboratory testing of the materials. Pavement performance was monitored by measuring surface deformations (rutting and profile), deflection (FWD and Dynaflect), and temperature (pavement and ambient).

CONCLUSIONS

- The performance of the 4-inch crushed stone base over 6 inches of cement-stabilized soil was significantly different than that of the other lanes in both failure mode and fatigue life. Cracking was the predominant failure mode for this lane. The pavement life for this section is about five times longer than its counterparts, while the rut depth was less than 1 inch.
- The four percent, 12-inch soil cement base performed much better in both rutting and cracking than any other 8.5-inch soil cement base either with four or ten percent cement.
- Lane 2 with 8.5 inches of crushed stone, lane 9 with four inches of crushed stone base over six inches of 10 percent soil cement, and lane 10 with 12 inches of 4 percent soil cement performed better than any other combination for all performance criteria considered.
- The soil cement base with four percent performed as well as the soil cement base with ten percent.
- The mixed in-place soil cement performed as well as the plant-mixed soil cement.
- Both VESYS#A_M and FLEXPASS can be used to model and predict the performance of the pavements consisting of HMA wearing course over crushed stone base. While the difference between the observed and predicted performance varied with test lanes, both programs were able to adequately predict the rutting and PSI of the test lanes.

RECOMMENDATIONS

The Department should consider constructing more bases with crushed stone over soil cement. This base configuration appears to be an excellent material combination to carry the traffic loads while resisting rutting and retarding reflective cracking.

Thicker in-place mixed soil cement treated base courses using less cement (150 psi design) should be encouraged over the standard cement stabilized bases (300 psi design).

In-place mixing of cement for chemical stabilization of bases showed no signs of detrimental performance and should continue as a standard practice.

IMPLEMENTATION ACTIVITIES

Seminars presenting the results of the ALF experiments were held at each LADOTD District office. These seminars, conducted by LTRC researchers, provided the needed information for selecting and implementing the research results on DOTD projects

Low cement treated base course test sections were constructed on several DOTD projects including: LA 89, Vermilion Parish, District 03; LA 792, Beinville Parish, District 04; LA 531, Webster Parish, District 04; LA 496, Rapides Parish, District 08; and LA 991, Iberville Parish, District 61. LTRC has conducted field evaluations of these projects for further verification and validation of the ALF results. These results indicate that the thicker low cement content bases produced similar resilient modulus as obtained by the standard cement stabilized design and the thicker low cement content bases produced a higher layer coefficient than our standard design. These conclusions verified the performance of the thicker low cement content base course lane under the accelerated loading.

To date, the stone interlayer pavement design has been constructed on two DOTD projects. The first project, built prior to the ALF test lanes in 1991 on LA 97 in Acadia Parish, placed a 4 inch crushed stone interlayer over 8.5 inches of stabilized soil cement. After seven years of service, the interlayer section has 80 percent less cracking than the control section (standard design,

8.5 inches of soil cement). The ALF lane, built with a similar design, indicated that a service life of nearly five times the standard design is expected. It is estimated that although the cost of the initial construction maybe 20% higher, the increased life expectancy provides a very good return on the initial investment. Because of the benefits shown with the ALF experiment, the stone interlayer design is being implemented on other DOTD projects. LA 10/LA 77 in Pointe Coupee Parish is the most recent project completed in January 2001. Future projects designed with the stone interlayer concept include LA 3265 in Rapides Parish and LA 660 near Houma, LA.

Because Louisiana must import its stone aggregate, the third ALF experiment currently underway is exploring the performance of the stone interlayer concept using Reclaimed Asphaltic Pavement (RAP) as the aggregate interlayer. RAP is readily available to the Department and the proper utilization of this material could be a cost effective alternative to imported stone. Results from this experiment are expected in early 2003.

It is highly anticipated that with the knowledge gained through the research efforts at the Pavement Research Facility, DOTD will be able to construct roadways that are more durable, longer lasting and provide reduced maintenance cost.

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