Stone Interlayer Pavement System

Extending the Service Life of Low-Volume Roads

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Accelerated pavement testing at the Louisiana Transportation Research Center has confirmed that a stone interlayer design reduces reflection cracking in flexible pavements on low-volume roads.

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Louisiana does not have a natural source of high-quality stone aggregates and must rely on imported material. The costs of stone base courses have increased with the steady rise in transportation costs. For high-volume roads, the Louisiana Department of Transportation and Development (DOTD) typically uses 10 to 12 inches of crushed stone aggregate for base courses. Low-volume roads receive in-place, cement-stabilized soil base courses.

Louisiana has thousands of miles of roads constructed with soil-cement base courses. Shrinkage in the soil-cement layer, however, is a major cause of reflection cracking in the asphalt. The reflection cracking in turn accelerates pavement deterioration and decreases pavement life. Because of the cracking problem with soil-cement bases and the high cost of imported stone, Louisiana DOTD has experimented with stone interlayer pavements.

Problem

Cracking has limited the use of soil-cement mixtures on high-volume roads and has caused performance problems on low-volume roads. Shrinkage cracking usually extends to the pavement surface in the form of reflection block cracks. These cracks do not seem to affect pavement performance adversely at first, but the negative impact on the service life accelerates as the pavement ages and as the traffic loadings accumulate. A method was needed to minimize reflection cracking in asphaltic pavements.

Accelerated loading facility device at Louisiana Transportation Research Center's Pavement Research Facility, Port Allen.

Solution

Through long-term field research and accelerated pavement testing, the Louisiana Transportation Research Center (LTRC) determined an effective and feasible method to minimize reflection cracking. The stone interlayer pavement system consists of a layer of crushed stone on top of a cement-stabilized base. The tensile stresses developed within the base are absorbed by the stone particles, minimizing reflection cracking.

Field Experience

The first field experiment was conducted in 1991 near Jennings, Louisiana, on LA-97—a rural collector highway with low-volume traffic that includes heavy agricultural haul vehicles. A 4-inch layer of stone was placed over a 6-inch soil-cement base. An 8.5-inch soil-cement base course served as the control section. The surface layer consisted of 3.5 inches of asphalt.

Performance parameters such as pavement roughness, cracking, and deformation were monitored for 10 years. After 4 years, no cracks were visible in the stone interlayer section or the control section. After 10 years, the cracks in the stone interlayer section measured a total of 388 feet, compared with 764 feet of cracking in the soil-cement, control section.

Accelerated Testing

Using an accelerated loading facility (ALF) device, LTRC further evaluated the load-carrying capacity of the stone interlayer pavements. The ALF is a 100-foot long, 55-ton machine that simulates truck loading on pavements (see photograph).

A computer-controlled load trolley repetitively simulates the weight and movement of traffic in one direction, applying the loads in 10-second cycles. The loads are adjustable from 10,000 to 21,000 pounds. Increasing the loads and running the device 24 hours a day can produce within a few months the equivalent of a pavement loading of many years.

The results of ALF loadings on three pavement sections were compared:

- A base course of 8.5 inches of limestone;
- An 8.5-inch-thick, in-place stabilized soil-cement base course; and
- A stone interlayer base with 4 inches of limestone placed over 6 inches of soil-cement.

All lanes were paved with 3.5 inches of asphalt in two layers.

The results, shown in Figure 1, indicate that at the time of failure, the stone interlayer pavement had sustained nearly 4 times the equivalent single-axle loads of the soil-cement section and 2.5 times more than the stone section. Failure was defined as an average rut depth of 0.75 inches. The accelerated pavement test results verified the superior performance of the stone interlayer design.

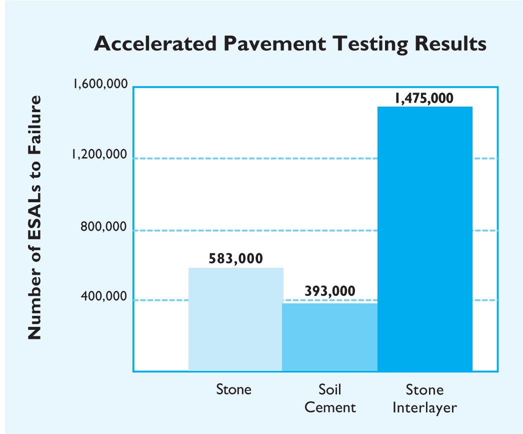

FIGURE 1 Performance of stone interlayer compared with soil-cement and crushed rock.

Application

In 1999, Louisiana DOTD employed the stone interlayer concept on a second project, a 3.6-mile flexible-pavement reconstruction of a low-volume road. In 2004, the department adopted the stone interlayer base course design as a standard option for pavements in Louisiana. Two major projects are under construction, with three more projects, 5 to 10 miles long, scheduled for letting this year. The performance of these sections will be monitored with data collected through the department's pavement management procedures.

Benefits

For low-volume roads, the initial cost of the stone interlayer pavement is more than that of an in-place soil-cement base course. A flexible pavement with 3.5 inches of asphalt concrete (AC) and a stone interlayer base course of 4 inches of limestone over 8.5 inches of soil-cement costs $118,000 per lane-mile. A lane-mile of the same pavement with 8.5 inches of stabilized soil-cement costs $86,000.

A 30-year life-cycle cost analysis was performed using data from the ALF testing. The soil-cement section would require reconstruction at the end of Years 10 and 20, while the stone interlayer section would require a one-time milling and overlay in Year 15. At a 4 percent inflation rate and no salvage value—that is, value after the useful service life—the annual life-cycle cost for the stone interlayer would be $11,000 per lane-mile, compared with $15,000 per lane-mile for the soil-cement base course. The stone interlayer construction would reduce the annual cost per lane-mile by 28 percent.

For a high-volume road, a 9-inch-thick AC pavement over a 12-inch stone base course is expected to be comparable in performance to a pavement of the same AC thickness over an interlayer base course of 4 inches of limestone over 8.5 inches of soil-cement. A 30-year life-cycle cost analysis of the two pavement structures indicates an annual cost savings of approximately 40 percent per lane-mile with the stone interlayer design.

The accelerated pavement testing confirms the field evaluation of the superior performance of the stone interlayer design. Although the initial cost of constructing the low-volume pavement structure is higher, the life-cycle cost is lower because the design lasts longer than pavements constructed with conventional methods. The initial and annual maintenance costs of high-volume asphalt pavements built with a stone interlayer base course also are expected to be lower than those of pavements built with conventional base courses.

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Suggestions for "Research Pays Off" topics are welcome. Contact G. P. Jayaprakash, Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001 (telephone 202-334-2952, e-mail gjayaprakash@nas.edu).