STRESS ABSORBING MEMBRANE INNERLAYER

Experimental Feature
Final Report

Project OR 77-03

by

Thomas A. Hardy
Research Specialist

Leon G. Brock
Research Coordinator

and

Gordon Beecroft
Research Engineer

OREGON STATE HIGHWAY DIVISION
Research Section
Salem, Oregon 97310

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Stress Absorbing Membrane Innerlayer
South Baker Interchange-Encina Interchange Section

The westbound lanes of the South Baker Interchange-Encina Interchange Section of I-84 were overlayed in 1977. A stress absorbing membrane innerlayer (SAMI), was included in this overlay as an experimental feature. This report is the final evaluation of the SAMI.

The westbound lanes of I-84 just east of Baker, Oregon were opened in 1969. By 1974, after only five years of the twenty year design life, the asphalt concrete pavement showed obvious signs of serious distress, with significantly greater distress occurring in the outside lane. Failure indicators included extensive alligator cracking, bond failure at construction joints and extensive raveling. The premature deterioration was attributed to two primary causes, poor quality aggregate and underdesign because of an underestimation of the average daily volume of heavy trucks.

Retesting of the original aggregate source showed that the fine material tended to degrade resulting in an unacceptably high percentage of material passing the 200 sieve. Excessive asphalt absorption by the fines caused a dry and brittle mix and coating of the larger aggregate with degraded fines prevented adequate asphalt bonding.

The forecasted one way 5-axle ADT for the design period was 310. Six years into the twenty year design period the actual 5-axle truck ADT was 425. On the basis of the original estimate of truck traffic, the pavement was designed for a crushed base equivalent (CBE) requirement of 29.5 inches. Subsequent analysis, incorporating the revised 5-axle ADT, indicated a CBE pavement thickness of 35.5 inches.

To halt the rapid deterioration and to extend the useful life to 20 years an overlay incorporating a SAMI was placed on the section in 1977. The SAMI was designed with a 25% rubber and 75% asphalt content to seal the old pavement and prevent reflection cracking in the new surface.

CONSTRUCTION

The specifications pertaining to the SAMI are contained in the appendix.

The overlay included the following four components: a 3/8 inch thick SAMI chip seal utilizing 0.6 gallons per square yard of asphalt rubber binder covered with 3/8-1/4 inch chips applied to both westbound lanes; a 2 inch leveling course of class "C" asphalt concrete placed over the SAMI; another 3/8 inch thick SAMI chip seal placed over the "C" mix on the outside lane; and a 2 inch thick open graded concrete class "E" mix placed as the wearing course over both lanes.

The pavement surface was prepared by power brooming and filling most of the larger cracks with a liquid rubber-asphalt mixture. All transverse cracks with a width of over 3/8 inch were filled. Some longitudinal cracks had a width greater than 1 inch. These cracks, located at the centerline of the roadway between the two lanes and at the left shoulder meet line, were not filled because the SAMI would fill them.

Placement of the SAMI required special distributors equipped with internal mixing devices designed to keep the ground rubber particles in suspension. Kerosene was added to the mixture to lower the viscosity and ease the application. The membrane was placed in five stages:

1) An asphalt tack coat was sprayed on the old pavement.
2) A special distributor applied the rubber-asphalt mixture.
3) 3/8-1/4 inch preheated and precoated chips were spread behind the distributor. The preheating and precoating was to neutralize any dust coating on the aggregate which might cause stripping between the rubber-asphalt and the aggregate.
4) A rubber tired roller made two passes over the freshly placed aggregate.
5) A rotary power broom removed any excess aggregate from the roadway.

Although delayed several days due to rain, the SAMI construction proceeded smoothly with no major difficulties. Unfortunately, the construction of the other overlay components did not proceed as smoothly. The aggregate for the Class "C" leveling course was substantially outside the gradation specification. Eight of the nine samples had excess passing 200 material. This condition, which is similar to that of the original pavement, may cause a reduction of asphalt film thickness and lead to stripping. The Class "E" wearing course was even more substandard than the Class "C" mix. The contractor was paid for only 30% of the Class "E" pavement due to the reduction in long range pavement serviceability in terms of durability, skid resistance, water runoff and resistance to surface flushing.

EVALUATION

The tests scheduled to evaluate the performance of the SAMI are as follows:

1) Deflection measurements with the Benkelman Beam.
2) Visual inspections including checks for evidence of cracking, rutting and raveling, and
3) Cores at selected crack locations to determine the cause of the cracks, i.e., reflective or not.

The deflection tests were conducted with a Benkelman Beam and an 18 kip axleload with results as indicated in the table below. The test sections were 1,000 feet in length, with deflection tests every 50 feet. The following table summarizes the deflection data.

80th PERCENTILE DEFLECTIONS
in mils

Mile Post	Outside Lane 1974 before overlay	Outside Lane 1979 after overlay	1982	Inside Lane 1974 before overlay	Inside Lane 1979 after overlay
307.70	11	22	--	9	--
308.00	--	--	20		
309.00	12	23	--	11	14
310.00	19	25	--	15	15
311.00	17	20	25	12	13
312.00	21	21	--	18	16
313.00	16	17	--	15	12

It should be noted that the overlay did not decrease the magnitude of the deflection readings. In fact, the outside lane deflections actually increased after the overlay was constructed when compared with readings taken three years before construction. The double rubber asphalt membrane in the outside lane may have added enough resilience to more than overcome the added stiffness of the rest of the overlay.

Visual inspections, conducted at the same time as the other tests, revealed transverse temperature cracks within two years after construction. After five years of service, even the double SAMI in the outside lane was not totally effective in preventing transverse cracking. Although many of the transverse cracks did not cross the outside lane, there were several areas on the project where wide transverse cracks crossed both lanes at variable 25 to 100 foot intervals.

The five year inspection revealed fine map cracking in both wheel tracks throughout the outside lane. Some segments were as small as two inches square. In a few areas of the project some of these pieces were being dislodged by traffic. This fatigue cracking correlates with the large deflections recorded in the outside lane. The resiliency of the double rubber asphalt application might have allowed more flexure than the other components in the overlay could tolerate. Neither rutting nor raveling were serious problems. The outside lane showed evidence of minor rutting in the wheel tracks with rut depth averaging between 1/8 and 1/4 inch. Raveling occurred only in a few small isolated patches.

In 1980, three years after the overlay was constructed, cores were taken at 18 transverse crack locations. At five of the locations the crack was reflective. At the other locations, cracks originating in the overlay were halted at the SAMI. While effective at sealing and preventing the penetration of surface cracks, the SAMI was not completely successful in preventing reflective cracking.

More than two thirds of the cores separated at the SAMI. This lack of bonding between the SAMI and the overlaying layer was apparently due to an inadequate tack or excess aggregate in the SAMI. The surface and leveling course segments of many cores crumbled upon sampling. This may be attributed, at least in part, to the non-specification aggregates used in the mixes.

CONCLUSIONS:

Although the pavement did not perform as well as expected, the analysis of the SAMI's performance was complicated by two factors; lack of a control section and the deficient aggregate furnished for the overlay. The material deficiencies which had contributed to failure of the original pavement were also present in the overlay.

The SAMI was effective in sealing the old pavement and preventing the intrusion of water into the base material. The five year inspection revealed a substantial number of temperature cracks that reflected through to the overlay and a large number of temperature cracks originating in the overlay. The outside lane with the double SAMI was more effective in preventing the propagation of temperature cracks than was the inside lane with the single SAMI. However, more extensive map cracking was observed in the outer lane with the double SAMI. It is believed that the greater resilience of the double SAMI, a higher level of distress in the underlying pavement and higher truck traffic each contributed to the increased level of map cracking in the outer lane.