THE EFFECT OF VARYING THE MODULUS AND THICKNESS OF ASPHALTIC CONCRETE SURFACING MATERIALS

SUMMARY REPORT 123-24(S)

SUMMARY OF
RESEARCH REPORT 123-24

PROJECT 1-8-69-123

Cooperative Highway Research Program
with U. S. Department of Transportation
Federal Highway Administration

TEXAS HIGHWAY DEPARTMENT

CENTER FOR HIGHWAY RESEARCH
THE UNIVERSITY OF TEXAS AT AUSTIN

TEXAS TRANSPORTATION INSTITUTE
TEXAS A&M UNIVERSITY

October, 1974

The Effect of Varying the Modulus and Thickness of Asphaltic Concrete Surfacing Materials

by

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The purpose of this study is to investigate the effect of varying the modulus and thickness of asphaltic concrete surfacing materials. Principal stresses and strains, as well as vertical deflections of flexible pavement structures, under a standardized dual-wheel load, are analyzed based on linear elastic theory. Three typical flexible pavement design problems are selected to illustrate the effects. Each problem is divided into two series: the elastic modulus of the surface layer is assigned a value of 500,000 psi in series 1 and 100,000 psi in series 2.

The three design problems are briefed below.

Problem 1 investigates the variations of major principal stresses and strains as well as vertical deflections of a three-layer design at a surface point between the dual-wheel loads and a point at the bottom of the top layer under one of the loads, versus the thickness of the top layer. Problem 2 investigates the variations of major principal stresses and strains as well as vertical deflections of a three-layer design at the top and bottom of the top layer in a vertical plane through the truck axle. The top layer is assumed to be very thin (0.5 inches). Problem 3 investigates the variations of major principal stresses and strains as well as vertical deflections at layer interfacial points of a four-layer design, versus the elastic modulus of the second layer. The second layer is assumed to be very thin (0.5 inches), and simulates that portion of a base material likely to become saturated under certain climatic conditions sometimes occurring in west Texas. The surface layer is three inches thick, typical of many west Texas pavements.

In summary, study of critical HMAC thickness (Problem 1) and critical stress along HMAC surface layer (Problem 2) concludes that:

1. A high value of the E_1/E_2 ratio is discouraged;

2. If a high value of E_1/E_2 cannot be avoided, then the HMAC thickness of 1 inch to 6 inches should be avoided; and;

3. High values of E_1/E_2 result in tension at the bottom of the surface layer when the HMAC is very thin, while low values result in compression.

For application to FPS-11, which is currently in use in Texas, when E_1/E_2 is high, there are two design alternatives:

1. Set $D_1 \geqq 6$ inches for initial construction, or

2. Set D_1 = 1 inch for initial construction and more than 5 inches for the first overlay construction in addition to level up.

Study of the softening of base material (Problem 3) shows that the tensile stress at the bottom of the top layer under the load increases rapidly when the elastic modulus of the upper 0.5 inches of the base course decreases below 25,000 psi. As the upper 0.5 inches of the base course becomes wetter as a result of infiltration or vapor condensation, then the elastic modulus of the base course will decrease and result in higher tensile stresses at the bottom of the top layer. This will accelerate fatigue deterioration of the pavement. If this condition is expected to occur during the life of the pavement, then it is suggested that the FPS-stiffness coefficient for the base course be reduced to take into account the expected reduction in pavement service life. More field and laboratory information is needed to determine to what extent the stiffness coefficient should be reduced when this condition occurs.

It is anticipated that results of this study can be used to introduce certain restraints in the Texas Flexible Pavement Design System to avoid thickness-stiffness combinations in hot mixed asphaltic concrete that lead to surface cracking.

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