PROGRESS REPORT No. 3
ON THE SKID RESISTANCE STUDY
EXPERIMENTAL FEDERAL AID PROJECT
No. F-147(6)

SEPT., 1956

No. 37

by

JOHN W. SHUPE

Joint Highway Research Project

PURDUE UNIVERSITY
LAFAYETTE INDIANA

PROGRESS REPORT NO. 3

ON THE

SKID RESISTANCE STUDY OF EXPERIMENTAL FEDERAL-AID

PROJECT F-147 (6)

TO: K. B. Woods, Director
Joint Highway Research Project

September 26, 1956

FROM: H. L. Michael, Assistant Director

File: 8-17
C-36-53H

Attached is a report entitled, "Progress Report No. 3 on the Skid Resistance Study of Experimental Federal-Aid, Project F-147 (6)." The report has been prepared by Mr. John W. Shupe, a member of our staff.

The skidding properties of silica sand surfaces are compared with bituminous concrete in this study. The silica sand surface conducted to exhibit better skidding resistance.

Respectfully submitted,

Harold L. Michael

Harold L. Michael, Assistant Director
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SKID RESISTANCE STUDY OF EXPERIMENTAL FEDERAL-AID

PROJECT F-147 (6)

by

John W. Shupe

Joint Highway Research Project

C-36-53H

Purdue University
Lafayette, Indiana

Sept. 17, 1956

INTRODUCTION

This report summarizes the results of the third series of skid tests performed by the Joint Highway Research Project on Federal-Aid Project F-147 (6). The project is located on Federal-Aid Route 28, U. S. Highway No. 421 in Ripley County between the West Junction of U. S. 50 and Osgood. Two different pavement surface types, silica sand and bituminous concrete were tested and their skidding properties evaluated and compared.

METHOD OF TEST

The tests were performed using the skid equipment developed in 1954 by the Joint Highway Research Project to conduct a comprehensive skid resistance study of pavement surface types. A standard 2-door 1955 Ford, fitted with this skid equipment, was used in making the tests.

PROCEDURE

Two test sites were selected for each of the surface types, one in each direction of traffic. The skid resistance of each of these locations was determined, both wet and dry, at speeds of 30 and 40 mph. Two test runs were made for each condition. To determine the skid resistance of the test sections the vehicle was first brought up to the test speed, the wheels were locked, and the distance required to skid to a stop was measured.

Since it was impossible to begin each skid at the exact test speed of 30 or 40 mph, it was necessary to adjust the measured skidding distances to give an equivalent test-speed skid. This was accomplished from an application of the physical relationship, $S = \frac{V^2}{30 f}$; where "S" is the total stopping distance in feet, "V" the original speed in mph, and "f" the average coefficient of friction between the skidding tire.

Although the coefficient of friction for most surface types will increase as the speed becomes less, within the narrow range of speeds at which these tests were begun, the change in "f" would be negligible. Therefore, the stopping distance would vary as the square of the velocity and the following expression was used for correction purposes:

$S_{corrected} = S_{measured} \times \left(\frac{V_1}{V_2}\right)^2$, where V_1 is the desired test speed of 30 or 40 mph and V_2 is the actual speed at which the wheels were locked.

On the first group of wet skid tests on test series No. 3, an effort was made to perform two skids without rewetting the surface between tests. It was found, however, that frequently the second skid was appreciably shorter than the first, indicating that the surface did not remain sufficiently wet. This was more noticeable on the open-graded sections. In order to get good consistency for each pair of skids, the surface was given a light "shot" of additional water while the test vehicle was backing up, preparatory to the second skid.

SUMMARY OF RESULTS FOR TEST SERIES NO. 3

The following figures represent the averages of four skids, namely, two tests at each location and in both directions of traffic.

	Bituminous Concrete	Silica Sand
	Total Stopping Distance in Feet	
Dry Skid Tests:		
30 MPH	62.9	60.7
40 MPH	105.9	103.4
Wet Skid Tests:		
30 MPH	97.7	71.9
40 MPH	166.0	133.3

The total test data are listed in Table I.

DISCUSSION OF RESULTS FOR TEST SERIES NO. 3

For the dry tests the silica sand surface appears to develop a slightly greater frictional resistance than the bituminous concrete. This would seem reasonable since the somewhat denser silica sand surface would have a greater amount of area in contact with the sliding tire, and for the dry tests the amount of force developed is largely dependent upon the total area in contact. The advantage of the silica sand over the bituminous concrete averaged only about 3%, however, so for a dry surface the difference is not particularly significant.

For the wet skidding tests this advantage increased appreciably. The total stopping distances on the bituminous concrete averaged about 26 and 33 feet greater at 30 and 40 mph than for the silica sand. This gives a total stopping distance on the bituminous concrete that averages over 30% greater than for the silica sand, and is certainly a significant difference.

DISCUSSION OF THE THREE SERIES OF TESTS

In comparing the results of this series of tests with those previously performed in November of 1954 and in March of 1956, reference will be made to the tabulated summary, Table 2, and the set of curves, Figure 1.

There appear to be no significant trends developing for the dry skid tests. With reference to Figure 1, both surface types show values that are nearly constant and nearly identical at both 30 and 40 mph. The skidding resistance of the bituminous concrete has dropped slightly while that of the silica sand has increased about the same amount, so the relative resistance of the two surfaces, which originally favored the bituminous concrete, has reversed. This switch has amounted to only a 2 or 3% change in stopping distance, however, so it is not particularly significant.

With regard to the wet tests, the most significant result was the one presented in the previous section, namely, the bituminous concrete surface is much slicker when wet than the silica sand. This was evident in all three series of tests, and shows up most markedly on the first and third.

Considering only the first and last test series, the results would establish a trend which would seem reasonable; i.e., the test sections are becoming somewhat more slippery as they wear, with the bituminous concrete exhibiting a greater "polishing" effect, or loss in skidding resistance, than the silica sand.

As is evident from Figure 1, however, the [illegible] tests does not fit into this pattern particularly for the bituminous concrete surface. This test series gave results which indicated that after a year and a half of traffic wear, the skidding resistance of the bituminous concrete was better than it was initially.

This might be partially explained in light of some test data obtained in California and presented in Highway Research Board Bulletin No. 37. This data indicated that there is a tremendous seasonal effect, and depending upon the type of surface, the wet skidding resistance may vary as much as 30 or 40% from one season to the next. During the rainy season, when the pavement is washed "clean," the skidding resistance is high. During the dry season, however, oil drippings, dust, and worn rubber accumulate so that when the surface is sprinkled with water, preparatory to skidding, this debus is picked up and serves as an additional lubricant, giving much lower resistance values.

Returning to Indiana, the second series of tests were performed soon after a prolonged rainy spell, which had left the test sections in a "scrubbed" condition. The third series of tests were run during a relatively dry spell, and the surface did have an accumulation of foreign matter. This, coupled with the fact that the same set of tires was used in both cases and for the third series was beginning to show evidence of wear, may explain in part why the bituminous concrete surface exhibited an apparently large decrease in skidding resistance in a period of less than six months.

TABLE 1

TEST DATA FOR SERIES NO. 3

Test Section Location: US 421 from west junction with US 50
North to Osgood

Driver: W. B. In[illegible]rsoll   Recorder: J. W. Shupe

Test Date: August 21, 1956   Air Temperature: 84 to 86°

Test Section Identification:
- 1a - Silica sand: Sta. 213 to 215 + 00 - Northbound
- 1b - Silica sand: Sta. 192 to 195 + 00 - Southbound
- 2a - Bituminous concrete: Sta. 85 to 100 + 00 - Northbound
- 2b - Bituminous concrete: Sta. 85 to 95 pt 00 - Southbound

Total Stopping Distance in Feet

			Dry Tests			Wet Tests		
Section	Basic Speed	Run	Speed	Stopping Distance	Corrected Distance	Speed	Stopping Distance	Corrected Distance
1a	30	1	30.00	59.5	59.5	30.25	71.0	69.8
		2	30.25	62.5	61.4	28.75	68.5	74.5
1b	30	1	30.00	61.0	61.0	30.00	73.0	73.0
		2	30.00	60.7	60.7	31.25	76.5	70.3
	Average				60.7			71.9
2a	30	1	30.00	63.8	63.8	29.75	96.0	97.7
		2	29.75	61.5	62.6	29.50	87.5	90.6
2b	30	1	30.25	63.0	61.9	30.00	103.5	103.5
		2	30.25	64.2	63.1	30.00	99.0	99.0
	Average				62.9			97.7
1a	40	1	39.75	103.0	104.5	39.25	129.5	134.8
		2	40.25	104.5	103.0	40.50	133.5	130.2
1b	40	1	39.50	99.0	102.0	39.75	129.0	131.0
		2	39.75	102.9	104.2	40.25	139.0	137.2
	Average				103.4			133.3
2a	40	1	39.75	106.5	108.0	39.25	160.5	167.0
		2	40.00	104.5	104.5	40.00	160.0	160.0
2b	40	1	40.25	107.0	105.7	39.75	168.0	170.2
		2	39.75	103.9	105.4	38.00	150.5	166.8
	Average				105.9			166.0

TABLE 2

SUMMARY OF AVERAGE STOPPING DISTANCES

FOR THE THREE SERIES OF SKIDDING TESTS

Test Date	Surface Condition	Test Speed	Total Stopping Distance in Feet: Bituminous Concrete	Total Stopping Distance in Feet: Silica Sand
Nov. '54	Dry	30	58.9	62.1
Mar. '56	Dry	30	62.0	59.4
Aug. '56	Dry	30	62.9	60.7
Nov. '54	Dry	40	103.8	105.0
Mar. '56	Dry	40	107.5	105.[illegible]
Aug. '56	Dry	40	105.9	103.4
Nov. '54	Wet	30	89.4	[illegible]
Mar. '56	Wet	30	78.9	67.[illegible]
Aug. '56	Wet	30	97.7	71.9
Nov. '54	Wet	40	163.1	129.1
Mar. '54	Wet	40	158.5	129.9
Aug. '56	Wet	40	166.0	133.1

FIGURE 1 – STOPPING DISTANCE VARIATION FOR THREE DIFFERENT SERIES OF TESTS