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PROGRESS REPORT No. 5 ON SKID RESISTANCE STUDY U.S. 31 TEST ROAD

SEPT., 1956

No. 36

by

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Joint Highway Research Project

PURDUE UNIVERSITY
LAFAYETTE INDIANA

PROGRESS REPORT NO. 5

ON THE

SKID RESISTANCE STUDY OF U. S. 31 TEST ROAD

TO: K. B. Woods, Director
Joint Highway Research Project — September 26, 1956

FROM: H. L. Michael, Assistant Director — File: 8-15-1
C-36-53E

Attached is a report entitled, "Progress Report No. 5 on the Skid Resistance Study of U. S. 31 Test Road." This report summarizes the semi-annual skid tests conducted in August 1956 on the U. S. 31 Test Road. The report has been prepared by Mr. John W. Shupe.

This sixth series of tests continued to show progressively poor skidding resistance due to the effect of time and traffic. The rigid pavement also exhibited better skidding resistance than the flexible under wet conditions.

This report will also be submitted to the Test Road Committee for their use.

Respectfully submitted,

Harold L. Michael, Assistant Director
Joint Highway Research Project

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ON THE

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by

John W. Shupe

Joint Highway Research Project

C-36-53E

Purdue University

Lafayette, Indiana

Sept. 17, 1956

PROGRESS REPORT NO. 5

SKID RESISTANCE STUDY OF U. S. 31 TEST ROAD

INTRODUCTION

One of the elements of comparison of the portland cement concrete and the bituminous concrete sections of the U. S. 31 Test Road near Columbus, Indiana is that of skid resistance. Test Road Committee Memorandum No. 5 establishes the purpose of the study as: "to measure the relative skid resistance of the two types of pavement and to measure the changes in skid characteristics as the pavements age under traffic."

In conformance with discussions at the Joint Highway Research Project Advisory Board Meeting on January 27, 1954, the Joint Highway Research Project, in co-operation with the State Highway Department of Indiana, has conducted and will continue to conduct periodic skid tests on the Test Road. In this report are the results of the group of tests made in August, 1956 and a discussion of the stopping distance trends to date.

SCOPE

The 7.1417 miles of flexible or bituminous concrete test pavement (detailed on Figure 1 as sections F-1, F-2, and F-3) and the 6.9392 miles of rigid or portland cement concrete test pavement (detailed on Figure 1 as sections R-1, R-2, R-3, R-4, and R-5) are the subject of this study. All tests made on these test sections were performed so as to compare the skid resistance characteristics of the flexible and rigid test pavements. Studies of the skid characteristics have been made since shortly after the sections were opened to traffic and tests will be conducted periodically as long as the Test Road Committee requires them.

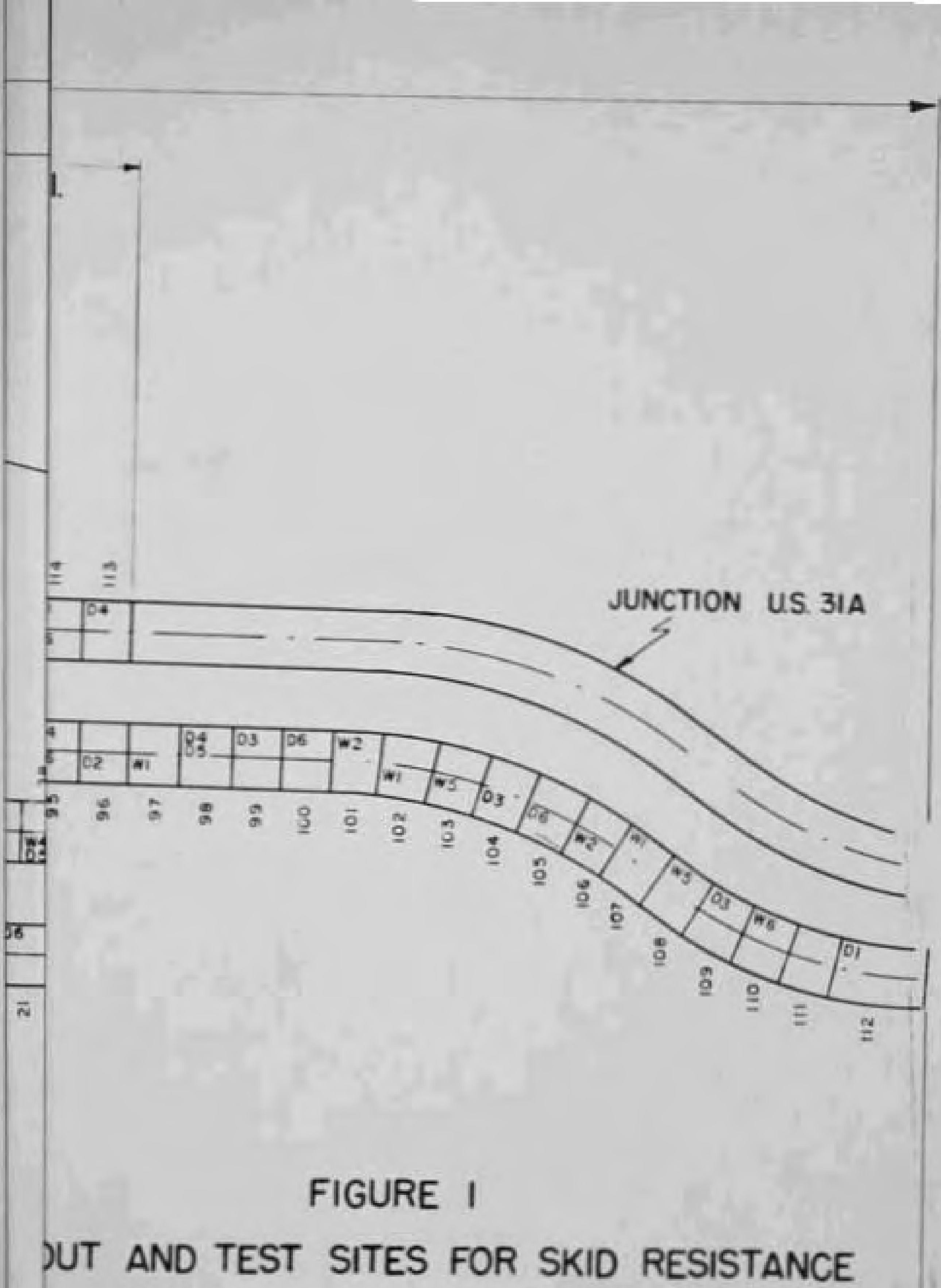

FIGURE 1

…OUT AND TEST SITES FOR SKID RESISTANCE STUDY OF U.S.31 TEST ROAD

(REDRAWN FEB. 1956)

FIGURE 1
LAYOUT AND TEST SITES FOR SKID RESISTANCE STUDY OF U.S. 31 TEST ROAD
(REDRAWN FEB. 1956)

PROCEDURE

As planned, skid tests are being performed twice a year, once during the winter and once during the summer. The winter tests are conducted in February or March and the summer tests in July or August on days that weather will permit. Tests have now been performed in February and March, 1954; August, 1954; March, 1955; August, 1955; March, 1956, and August 1956.

The skid equipment which was developed in 1954 for a comprehensive skid resistance study of pavement types has been utilized for all tests except those made in February and March, 1954. Since those tests were made with different equipment, the data were adjusted on the basis of comparative tests as reported in Progress Report No. 1, so as to be comparable with subsequent test data.

Each of the two test pavement types are divided into 70 one-tenth mile sections. The sites selected for test series No. 6 are shown in Figure 1 along with all sections tested in the five previous studies. It can be observed that the sites, selected at random, are well-distributed over the test road and may be considered as representative of the entire section.

For each semi-annual study to date the following plan has been used as a guide:

1. Skid tests were made at a speed of 30 m.p.h.
2. Skid tests were made under wet and dry conditions. Wet tests were made by artificially wetting the pavement until water would stand on the surface
3. An equal number of skid tests were made on each pavement type.
4. An equal number of skid tests were made in each traffic lane and for each direction of traffic flow.

5. Sixteen sites were selected for wet tests and sixteen different sites for dry tests. These sites were selected in a manner that gave each one-tenth mile section an equal opportunity of getting into the sample, but that maintains the policies established in items 3 and 4 above.

6. Two skids were made at each site.

7. The mean stopping distance, both wet and dry, was determined for each of the surface types, along with the range, or variation in stopping distance, for each given surface.

8. Temperatures were recorded several times during the experiment.

SUMMARY OF RESULTS FOR TEST SERIES NO. 6

Each of the following values represents the average of eight tests, namely, two skids on each of two test sections in both directions of traffic.

<u>TOTAL STOPPING DISTANCE IN FEET FROM 30 TO 0 MPH</u>

	Dry Tests	Wet Tests
Flexible Pavement:		
Inner Lane	59.9	91.5
Outer Lane	60.7	110.9
Rigid Pavement:		
Inner Lane	61.7	77.7
Outer Lane	61.0	103.2

As is generally the case in a study of this nature, the results of the dry skid tests were not particularly significant. The stopping distances on the flexible pavement averaged about a foot shorter than for the rigid pavement, but considering the variation in test results this was not significant.

In considering the results of the wet skid tests, however, there was a wide variation in skid resistance, not only between the two surface types but also between lanes. In fact, the effect of the traffic lane was more dominant than the surface type. It required a 33% greater distance to stop in the outer lane of the rigid pavement than in the inner lane, and for the flexible pavement this increase in skidding distance in the outer lane amounted to about 21%.

In comparing the wet skid resistance of the surface types, the rigid pavement showed the better skidding characteristics of the two. The mean stopping distance for the flexible pavement was 18% greater than for the rigid pavement in the inner lane, but only 7% greater in the outer lane. This is surprising, because it would seem that any "polishing" or wear effect would be more severe in the outer lane, so that any difference between surface types would be more pronounced in this lane. Further discussion on lane effect will appear in a subsequent section.

Discussion of the Stopping Distance Trends for the Six Series of Tests

In discussing the skidding trends which have developed during the six series of tests covering a 2 1/2 year period, reference will be made to the summary of data in Table 1, where each value represents the mean stopping distance for four skids, and to the curves of Figure 2, where each plotted point represents the mean value for eight skids. In Figure 2 the brackets shown for each of the plotted points on test series No. 6 indicate the variation in stopping distances that existed between the four "similar" sections for which the mean value was computed.

There have been no significant trends developed for the dry skid tests. Although there has been some variation observed between surface types and traffic lanes for a given test series, these variations have not been consistent over the entire test period, and the stopping distances measured during Test Series #6 were quite similar to the original values. It would appear, therefore, that the dry skidding resistances of these two surface types are nearly identical, and are relatively unaffected by wear and traffic.

For the wet skidding tests, however, there exists a wide variation in skidding resistance not only between surface types, but also between the inner and outer traffic lanes. In addition, the stopping distances for wet skids increased appreciably with age. These trends are clearly illustrated in Figure 2.

First, considering the two surface types, the rigid pavement has consistently exhibited better skidding resistance than the flexible pavement with the mean wet stopping distances for each of the six test series measuring from 3 to 12 feet longer for the flexible than the rigid pavement surface.

In addition, the rigid pavement has less variation in skidding properties along its length. In the outer lane for test series No. 5 the mean of the wet skids for the rigid pavement was 103.2 feet and for the flexible 110.9, or a difference of only 7.7 feet. However, the maximum stopping distances for each of these surfaces was 107.2 and 124.0 feet, respectively, or a difference of nearly 17 feet, indicating that there are some sections of the flexible pavement which are appreciably slicker than the mean would indicate. It is the presence of these "slick spots" which present the maximum hazard to traffic. It would appear from this last test series that some of these danger points are developing in the flexible surface, and this possible trend should be examined in subsequent testing.

There has been a tremendous difference develop with time in the skidding resistance of the inner and outer lanes of traffic. Initially, the properties of each were nearly identical, but due to a combination of traffic, time, wear, and an accumulation of oil drippings, worn rubber, etc. the traffic lane has become much slicker than the passing lane. After 2 1/2 years of service it now requires 19 feet longer to stop on the outer lane of the wet flexible pavement as compared to the inner lane, and on rigid pavement this difference is 26 feet.

The mean wet stopping distances in the outer lanes for both surface types have increased over 50% in the 2 1/2 year period of service. The inner lanes have experienced a smaller increase, with the rigid pavement showing a loss in resistance of 14% and the flexible pavement 31%. This trend toward an increase in wet stopping distance with time has been fairly constant except for the fifth series of tests performed in March, 1955.

This apparent inconsistency of series No. 5 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, preparatory to skidding, this debris is flushed up and serves as an additional lubricant, giving much lower resistance values.

Although Indiana does not experience the extreme seasonal variation of California, this phenomena is still present to a limited extent. Test series No. 5 was performed soon after a prolonged rainy spell, which had left the test sections in a "scrubbed" condition. Test series No. 6 was 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 test Series No. 6 was beginning to show evidence of wear, may explain in part the apparent loss in skidding resistance of as much as 20%, which occurred in a period of less than six months between test series No. 5 and 6.

One other possible trend that appeared for the first time in test series No. 6 was that for the wet tests in the outer lane, better skidding resistance was developed in the southbound direction than in the northbound. For the flexible pavement the mean stopping distance was 10.4 feet less in the southbound direction, and for the rigid pavement, 4.7 feet less. Direction was not significant, however, for wet tests on inner lanes or for any of the dry tests.

SUMMARY AND CONCLUSIONS BASED ON THE SIX TEST SERIES

1. For the dry skid tests there is no significant difference between the rigid and flexible pavements, between the inner and outer lanes or between the directions of traffic.

2. For wet skid tests the rigid pavement has consistently exhibited better skidding resistance than the flexible. For test series No. 6 this advantage amounted to about 8 feet in the outer lane and 14 feet in the inner lane.

3. The flexible pavement shows a wider variation in wet skid resistance than the rigid. The maximum stopping distance for the flexible pavement exceed the mean by over 13 feet, while for the rigid pave- this value was less than 7 feet.

4. Under wet conditions the stopping distance in the outer traffic lane is greater than for the passing lane. For the flexible pavement the difference in length of skid for the two lanes averaged 19 feet, and for the rigid pavement 26 feet.

5. With the exception of the fifth series of tests run in March, 1956, the test surfaces have exhibited progressively poorer skidding resistance due to the effect of time and traffic. For both the rigid and flexible pavements the average stopping distance in the outer lane has increased over 50% during the 2 1/2 years of testing.

6. For test series No. 6 the wet skidding resistance in the outer lane for both the rigid and flexible pavement is significantly greater for southbound traffic than for northbound.

FIGURE 2 - STOPPING DISTANCE TRENDS ON U.S. 31 TEST ROAD

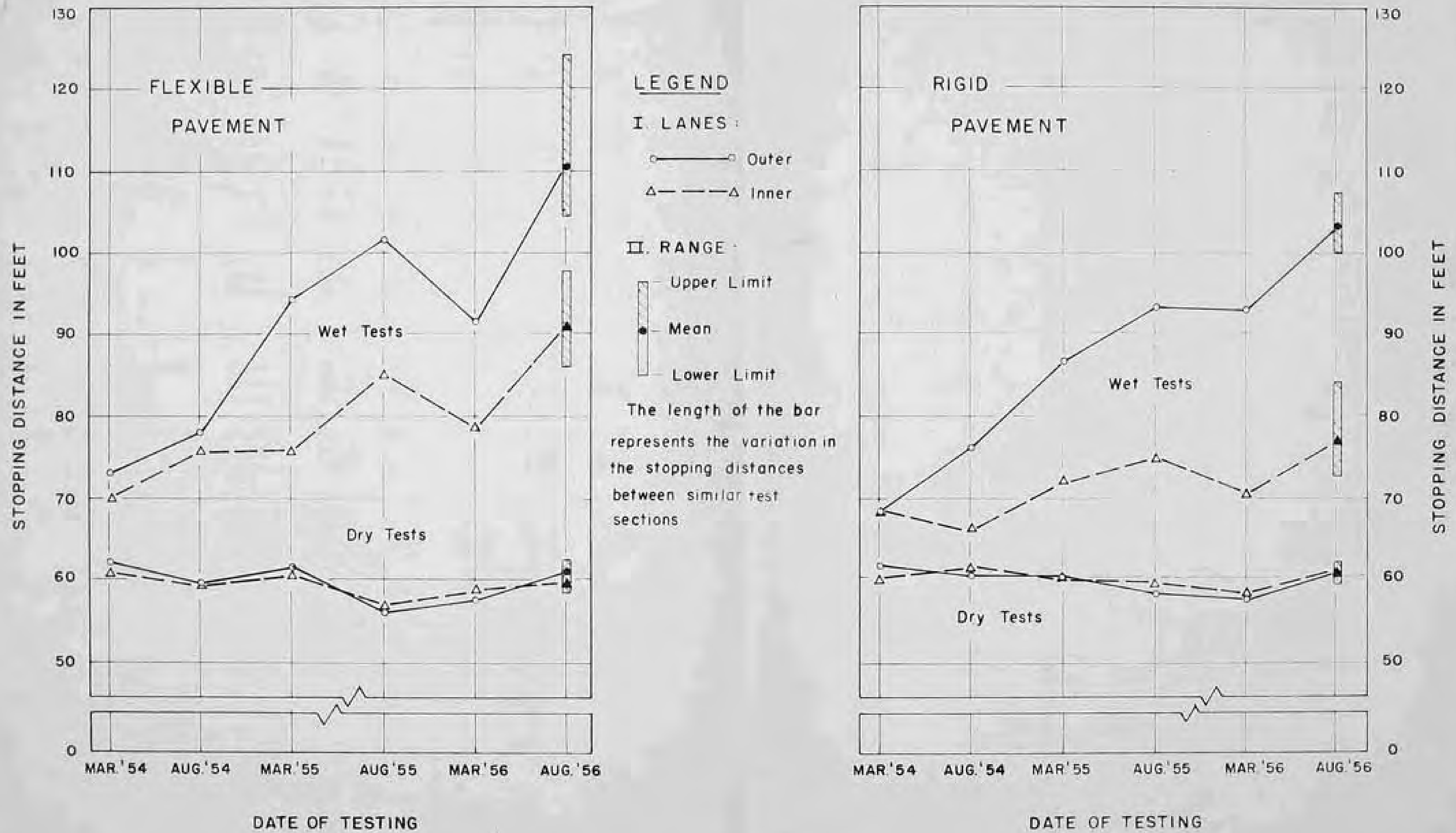

TABLE I – SUMMARY OF STOPPING DISTANCES FOR THE SIX SERIES OF TESTS

Mean Stopping Distance in Feet From 30 to 0 MPH

Surface Type	Condition	Lane	Direction	1 Mar. '54	2 Aug. '54	3 Mar. '55	4 Aug. '55	5 Mar. '56	6 Aug. '56
Flexible	Wet	Inner	South	71.8	79.7	78.4	85.5	81.6	91.7
			North	68.2	71.8	73.6	84.6	75.2	91.3
			Average	70.0	75.7	76.0	85.1	78.4	91.5
Flexible	Wet	Outer	South	72.4	80.4	94.7	102.0	90.5	105.8
			North	74.1	75.7	94.2	101.3	92.6	116.0
			Average	73.2	78.1	94.4	101.6	91.6	110.9
Rigid	Wet	Inner	South	72.3	64.6	71.6	74.6	72.8	73.8
			North	64.3	67.3	72.1	75.6	68.5	81.6
			Average	68.3	66.0	71.8	75.2	70.6	77.7
Rigid	Wet	Outer	South	68.0	77.9	90.8	94.0	97.2	100.8
			North	66.6	75.0	82.8	93.5	89.8	105.5
			Average	68.3	76.4	86.8	93.8	93.5	103.2
Flexible	Dry	Inner	South	58.3	59.2	59.9	57.6	59.3	60.6
			North	62.9	59.6	61.1	56.5	58.0	59.3
			Average	60.6	59.4	60.5	57.1	58.7	59.9
Flexible	Dry	Outer	South	60.7	59.5	59.6	54.9	57.5	61.7
			North	63.0	59.5	63.2	56.4	57.1	60.2
			Average	61.9	59.5	61.4	55.6	57.3	61.0
Rigid	Dry	Inner	South	58.6	61.9	60.7	60.3	59.1	61.7
			North	62.2	62.1	60.0	59.4	58.1	61.7
			Average	60.4	62.0	60.3	59.9	58.6	61.7
Rigid	Dry	Outer	South	61.5	60.5	60.9	57.1	58.5	61.7
			North	62.8	61.1	60.1	60.1	57.7	60.2
			Average	62.2	60.8	60.5	58.6	58.1	61.0

Each value represents the average of four tests, namely, two skids in each of two test sections.