TECHNICAL REPORT STANDARD PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/LA-91/231.		

4. Title and Subtitle	5. Report Date
REPEATABILITY ANALYSIS OF THE K. J. LAW MODEL 8300 ROUGHNESS SURVEROR	April 1991
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Deborah A. Boleware	231
9. Performing Organization Name and Address	10. Work Unit No.
Louisiana Transportation Research Center P. O. Box 94245 Baton Rouge, LA 70804-9245	11. Contract or Grant No. LA HPR STUDY #87-1EQM
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Louisiana Department of Transportation & Development P. O. Box 94245 Baton Rouge, LA 70804-9245	FINAL REPORT
	14. Sponsoring Agency Code

15. Supplementary Notes

Conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.

16. Abstract

The K.J. Law Model 8300 Roughness Surveyor, is a ride-quality measurement device used to determine and analyze the longitudinal roadway profile. This paper describes an analysis of IRI data as collected with Louisiana's Roughness Surveyor to determine the statistical reliability and repeatability of the device.

The results of the repeatability analysis indicate the K. J. Law Model 8300 Roughness Surveyor characterizes roadway roughness in a repeatable manner during same day or day-to-day testing for dense-graded asphaltic concrete and jointed portland cement concrete pavement surfaces. On an open-graded asphaltic concrete surface the Roughness Surveyor was found to be repeatable in some instances and not repeatable in other instances.

It was determined that the mean value of the International Roughness (IRI) from only two repeat runs are necessary to adequately characterize pavement roughness on the dense-graded asphalt and portland cement concrete surfaces. Due to the variability in repeatability on the open-graded asphaltic concrete surface, the minimum number of runs could not be determined.

17. Key Words	18. Distribution Statement
roughness surveyor, profilograph IRI	No restrictions. This document is available to the public through Nation Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	28	

Form DOT F 1700.7 (8-69)

REPEATABILITY ANALYSIS OF THE K. J. LAW MODEL 8300 ROUGHNESS SURVEYOR

FINAL REPORT
(1988-1990)

By
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Research Report No. 231
Research Project No. 87-1EQM

Conducted By
LOUISIANA DEPARTMENT OF TRANSPORTATION
AND DEVELOPMENT
Louisiana Transportation Research Center
In Cooperation with
U. S. Department of Transportation
FEDERAL HIGHWAY ADMINISTRATION

August 1990

ABSTRACT

The K.J. Law Model 8300 Roughness Surveyor, is a ride-quality measurement device used to determine and analyze the longitudinal roadway profile. A roughness summary statistic output of the Roughness Surveyor is the Mays Index which is equivalent to the International Roughness Index (IRI). This paper describes an analysis of IRI data as collected with Louisiana's Roughness Surveyor to determine the statistical reliability and repeatability of the device. Data for this analysis was collected on eighteen 0.2-mile test sections consisting of dense-graded asphaltic concrete pavement surfaces and nineteen 0.5-mile test sections consisting of jointed portland cement concrete pavement surfaces over a maximum time period of fifteen months.

Data was also collected on three one-mile test sections consisting of one section each of the previously mentioned dense-graded asphalt and portland cement concrete surfaces with an additional test section consisting of an open-graded asphaltic concrete pavement surface. This data was collected primarily to determine the minimum number of repeat runs that are necessary to accurately characterize roughness with the Roughness Surveyor, but was also utilized to supplement the repeatability analysis.

The results of the repeatability analysis indicate the K. J. Law Model 8300 Roughness Surveyor characterizes roadway roughness in a repeatable manner during same day or day-to-day testing for dense-graded asphaltic concrete and jointed portland cement concrete pavement surfaces. On an open-graded asphaltic concrete surface the Roughness Surveyor was found to be repeatable in some instances and not repeatable in other instances.

It was determined that the mean value of the International Roughness (IRI) from only two repeat runs are necessary to adequately characterize pavement roughness on the dense-graded asphalt and

portland cement concrete surfaces. Due to the variability in repeatability on the open-graded asphaltic concrete surface, the minimum number of runs could not be determined.

IMPLEMENTATION STATEMENT

For many months after initially receiving and installing the K. J. Law Model 8300 roughness surveyor, the system functioned in an acceptable manner. Since the time of data collection documented within this report, the K. J. Law Model 8300 roughness surveyor has experienced numerous and somewhat continuous downtime of various reasons. At the time of this report preparation, many of the problems encountered are believed to be associated with humidity and moisture. The Louisiana Transportation Research Center and the manufacturer are currently troubleshooting and investigating the problems.

The system, when functioning properly, is a very useful tool of determining and quantifying pavement roughness and rideability. If problems can be resolved, the Louisiana Transportation Research Center will continue to utilize the roughness surveyor for research purposes and in the calibration of Mays Ride Meters. Additional uses are envisioned in the Department's Highway Performance Monitoring System and Pavement Management programs.

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INTRODUCTION

In recent years there has been an increasing interest by international, federal and state highway agencies in the accuracy, standardization and uniformity of ride-quality measurements. Roughness measurements are utilized to characterize roughness in newly constructed and in-service pavements for the purposes of network condition monitoring, allocating construction or maintenance funding, design enhancements and specification improvements. A wide variety of devices, designed to measure some type of ride indicator or profile characteristic are currently in use. In an effort to achieve this accuracy and standardization, the Highway Performance Monitoring System (HPMS) of the FHWA now requires that the states report roughness in the International Roughness Index (IRI) with a Class I device or other class device that has been calibrated to the Class I device.

This evaluation is to document the repeatability of one such device, the K.J. Law Model 8300 Roughness Surveyor. The Roughness Surveyor is a Class II device as defined by the FHWA with Class I devices being the most precise and Class IV being the least precise.

The calibration of Louisiana's Roughness Surveyor to a Class I device has been documented in an earlier report (1).

OBJECTIVE

The primary objective of this evaluation is to determine the repeatability of the K. J. Law Model 8300 Roughness Surveyor on a variety of pavement surfaces. A secondary objective was to determine the minimum number of repeat runs that are necessary to achieve a mean IRI value that adequately characterizes the pavement roughness.

SCOPE

The scope of this study is limited to the repeatability evaluation of an individual roughness measuring device over a limited period of time. The limited period of time restriction was imposed such that changes in the equipment and not the changes in roadway roughness could be observed. Test sections were chosen considering the logistics of same day repeat testing and with the intent to provide a range of roughness and pertinent surface types.

METHODOLOGY

The K.J. Law Model 8300 Roughness Surveyor was evaluated to determine its general (same day) repeatability on each of three different pavement surfaces and the day-to-day repeatability on two of the pavement surfaces. Also evaluated were the number of test runs required for various section lengths to obtain a reliable measure of roughness on each of the three pavement surfaces.

EQUIPMENT

The K.J. Law Model 8300 is a roughness measuring or characterizing device that operates from a vehicle traveling at posted speeds. A transduced canister, containing an acoustic probe and accelerometer, is the primary data sensing device and is attached to the test vehicle frame over the selected wheelpath. An onboard microcomputer collects and processes the transmitted data from the transducer canister. The acoustic probe measures the distance from the canister to the roadway surface while the accelerometer measures the vertical motion of the canister (vehicle). A mathematical manipulation of the distance from the canister to the road surface and the relative vertical motion of the canister produces a road surface profile as if measured at closely spaced intervals from a planer surface. The profile is processed further and the data output of the device is the Root Mean Square Acceleration (RMSA) and the International Roughness Index (IRI). Accurate traveled distance information is provided by a wheel mounted distance encoder.

Only the more widely used IRI output values were tested for repeatability in this study. Since the IRI values are calculated from RMSA with a conversion relationship, testing both the IRI and RMSA values would have been redundant.

Speed dependency was not considered in this report because previous work indicates that normal speed variations do not affect the results (1).

SITE SELECTION

The data evaluated in this report is from sites chosen as test sections because they had previously been located and marked for Mays Ride Meter calibration or other roughness surveys. Eighteen of the test sections were 0.2-miles in length, nineteen were 0.5-miles in length, while three test sections were one-mile in length. The 0.2-mile dense-graded asphaltic concrete pavement surfaces were in fairly close proximity to each other; therefore, more single day data could be collected than for the 0.5-mile jointed portland cement concrete test sections.

REPEATABILITY ANALYSIS

The general (same day) and day-to-day repeatability analyses were accomplished by evaluating data collected with the Model 8300 Roughness Surveyor on eighteen 0.2-mile dense-graded asphaltic concrete test sections and nineteen 0.5-mile jointed portland cement concrete test sections. The general repeatability was also examined by testing one-mile sections of asphaltic concrete pavement with an open-graded asphaltic concrete surface, a dense- graded asphaltic concrete pavement and a jointed portland cement concrete pavement.

Five replicate tests were conducted on each of the eighteen dense-graded asphaltic concrete test sections on each of four test days between February 9, 1988 and March 3, 1988. In the general repeatability analysis, the degree of variation among the five replicate runs was evaluated for each test section, for each test date. A statistical analysis on the mean run values for each test date was also conducted.

In the day-to-day repeatability analysis, the variation among the daily mean values obtained for the test section and also for the consecutive runs between each test date were examined. Also examined were the variations occurring among the mean of the daily mean values for each test date.

Three replicate tests were conducted on the nineteen jointed portland cement concrete pavement test sections on each of three test days between June 15, 1988 to September 26, 1989. As with the dense-graded asphaltic concrete pavements, this general repeatability analysis examined the degree of variation among the three replicate test runs conducted on each test section and for each consecutive run, for each test date. A statistical analysis was also conducted on the mean run values for each test date.

As with the dense-graded asphaltic concrete surface, the jointed concrete surface was tested for day-to-day repeatability by comparing the means of test sections (and run number) for each test date and additionally the means of the test section means for each test date.

The general repeatability of the Roughness Surveyor was additionally examined in a somewhat different manner than that outlined above. In this case single one-mile test sections were tested ten times, on an individual date, with the data collected in one-tenth-mile increments. These test sections consisted of a dense-graded asphaltic concrete surface, a jointed concrete pavement surface and an open-graded asphaltic concrete surface. In this analysis the variation among the ten replicate runs for each one-tenth-mile increments were examined.

ESTABLISHING MINIMUM REQUIRED TEST RUNS

When testing a section, it is desirable to have knowledge of the minimum number of replicate testing that should be conducted such that the mean values of these replicate tests will not change significantly with an increase in replications. The data obtained from the one-mile test sections of each of the three surface types were utilized in this evaluation. As indicated earlier, each of the three one-mile test sections was tested ten times and the data was collected in 0.1-mile increments. The value or mean value of each of the successive runs on the 0.1-mile section increments was compared to the mean value of the ten replications for that increment.

STATISTICAL ANALYSIS

The general and day-to-day repeatability of the Roughness Surveyor was characterized by determining the coefficients of variation in the various data sets collected as described above. The coefficient of variation is the population standard deviation divided by the population mean, multiplied by 100. The coefficient of variation is descriptive of the amount of variation occurring within the population.

SAS (Statistical Analysis System) (3) was utilized to perform the statistical analysis. The two statistical tests chosen to examine the Roughness Surveyor's repeatability were the analysis of variance and the univariate (paired difference) t-test. These tests were chosen because they are the most commonly utilized tests for this type of statistical analysis.

DISCUSSION OF RESULTS

DENSE-GRADED ASPHALTIC CONCRETE SURFACES

The general (same day) repeatability of the Roughness Surveyor was examined by characterizing and testing data obtained through repetitive testing of various test sections during a single day.

Repetitive testing on dense-graded asphaltic surfaces was conducted on eighteen 0.2-mile test sections and one one-mile test section. The 0.2-mile test sections were tested five times on each of four days, and the one-mile test section was tested ten times on one date. Tables 1 and 2 present the standard deviations and the coefficients of variation for the same day repetitive testing on the dense-graded asphaltic concrete surface test sections.

TABLE 1

DENSE-GRADED ASPHALTIC CONCRETE SURFACE
(EIGHTEEN SECTIONS/FIVE RUNS EACH)

Test Date	Standard Deviation			Coefficient of Variation		
	Min.	Max.	Avg.	Min.	Max.	Avg.
2/09/88	1.2	10.0	3.37	1.02	6.10	2.55
2/18/88	0.7	74.8	9.50	0.76	13.73	5.88
3/01/88	0.6	5.9	2.82	0.92	3.24	2.00
3/03/88	2.3	29.8	6.47	1.61	16.93	5.34

TABLE 2

DENSE-GRADED ASPHALTIC CONCRETE SURFACE
(ONE SECTION/TEN INCREMENTS/TEN RUNS EACH)

Test Date	Standard Deviation			Coefficient of Variation		
	Min.	Max.	Avg.	Min.	Max.	Avg.
5/26/89	2.7	5.9	4.40	3.21	5.71	4.27

The above data indicates that on dense-graded asphaltic surfaces there is an acceptable level of variation in data collected on repeat runs on a particular test section on a particular day. Of note is the fluctuation in the average standard deviation and coefficient of variation between test dates. Although it could not be quantified with the data collected, it is believed that this fluctuation may be accounted for by operator error, in other words, maintaining consistent test initiation points and wheel path. The analysis of variance procedure indicated there was no significant difference at the 0.05 alpha level between the means of the 0.2-mile test section values averaged over the individually numbered test runs. Paired difference t-test were also conducted on the mean value of the means of all runs conducted on a particular date. The paired difference t-test results indicated that there is not sufficient evidence to reject the hypothesis that there is no significant difference between the paired mean differences.

The day-to-day repeatability of the Roughness Surveyor for dense-graded asphaltic concrete surfaces was evaluated utilizing the data from the eighteen 0.2-mile test sections. The analysis of variance procedure indicated that there was no significant difference at the 0.05 alpha level between test dates for the test section (and run) mean values or between the test date mean value of the test section (and run) means (mean of the means). Paired difference t-tests were conducted on the mean test section (and run) values and the mean of the test date mean values between test dates. The paired difference t-test results indicated there is not sufficient evidence to reject the hypothesis that there is no significant difference between the mean paired difference averaged for test section or run. The results of the statistical analysis indicate for dense-graded asphaltic concrete surfaces, the Roughness Surveyor is repeatable on a day-to-day basis.

The analysis of variance procedure was conducted to determine the minimum number of runs necessary to achieve repeatable results. The data for this analysis is from the one-mile dense-graded asphaltic concrete surface that was run ten times. The data was collected in 0.1-mile increments for the 1.0 mile distance. The analysis of variance procedure compared the mean value of the ten runs of each 0.1-mile increment and compared it to the value or mean values of successive test runs. The analysis of variance procedure indicate that the minimum number of runs required on the dense-graded asphaltic concrete surface was two. The alpha level for these tests was 0.05 significance level.

JOINTED PORTLAND CEMENT CONCRETE PAVEMENT SURFACES

Repetitive testing on portland cement concrete surfaces was conducted on nineteen 0.5-mile test sections and one one-mile test section. The 0.5-mile test sections were tested three times on each of three days with the exception of five of the nineteen sections that were tested three times on two dates. As with the dense-graded asphaltic concrete surfaces, a one-mile test section of jointed portland cement concrete pavement was also tested ten times on one date. Tables 3 and 4 present the standard deviations and the coefficients of variation for the same day repetitive testing on the portland cement concrete surface test sections.

TABLE 3

PORTLAND CEMENT CONCRETE PAVEMENT SURFACE
(FOURTEEN SECTIONS/THREE RUNS EACH)
(FIVE SECTIONS/TWO RUNS EACH)

Test Date	Standard Deviation			Coefficient of Variation		
	Min.	Max.	Avg.	Min.	Max.	Avg.
6/15/88	0.5	3.4	1.76	0.15	3.11	1.43
7/17/89	0.5	3.6	1.59	0.38	1.74	0.94
9/26/89	0.5	7.5	1.67	0.30	2.30	1.04

TABLE 4

PORTLAND CEMENT CONCRETE PAVEMENT SURFACE
(ONE SECTION/TEN INCREMENTS/TEN RUNS EACH)

Test Date	Standard Deviation			Coefficient of Variation		
	Min.	Max.	Avg.	Min.	Max.	Avg.
5/30/89	1.8	5.9	3.73	1.76	6.12	3.53

The above data indicates that on portland cement concrete surfaces there is an acceptable level of variation in data collected on repeat runs on a particular test section on a particular day. Of note are the smaller and more consistent average standard deviation and coefficient of variation obtained on the portland cement concrete surfaces than on the dense-graded asphaltic concrete surfaces. The reason for the increased degree of repeatability in this instance is not known, but could be due to the portland cement concrete pavement test sections not having the extreme range of roughness as contained on the dense-graded asphaltic concrete test sections. Operator error on rougher pavements would tend to increase due to the increased difficulty in maintaining a consistent wheelpath track. The analysis of variance and the paired difference t-test on the mean run values indicate that the Roughness Surveyor is generally repeatable on portland cement concrete pavement surfaces.

The day-to-day repeatability of the Roughness Surveyor for the portland cement concrete surfaces was evaluated utilizing the data from the nineteen 0.5-mile test sections in the same manner as described for the dense-graded asphaltic concrete pavement surfaces. The analysis of variance procedure and the paired difference t-test indicate that the Roughness Surveyor is repeatable on jointed portland cement concrete pavement surfaces
on a day-to-day basis.

As with the dense-graded asphaltic concrete surfaces, the analysis of variance procedure was conducted to determine the minimum number or runs necessary to achieve repeatable results. This statistical analysis indicated that two runs are the minimum necessary.

OPEN-GRADED ASPHALTIC CONCRETE PAVEMENT SURFACES

For the open-graded asphaltic concrete surface no day-to-day repeatability data was collected. Repetitive testing was conducted on a one-mile test section for a total of ten times on one date. Table 5 presents the standard deviations and the coefficients of variation for the same day repetitive testing on the open-graded asphaltic concrete surface test sections.

TABLE 5

OPEN-GRADED ASPHALTIC CONCRETE PAVEMENT SURFACE
(ONE SECTION/TEN INCREMENTS/TEN RUNS EACH)

Test Date	Standard Deviation			Coefficient of Variation		
	Min.	Max.	Avg.	Min.	Max.	Avg.
10/03/89	4.7	10.7	6.42	6.12	13.31	8.19

The above data indicates that on open-graded asphaltic concrete surfaces the Roughness Surveyor was not consistently repeatable. Due to the lack of consistent repeatability, the minimum number of runs required on open-graded asphaltic concrete pavement surfaces could not be determined.

A summary of all the data collected and evaluated in this report has been included as Appendix tables.

CONCLUSIONS

The K. J. Law Model 8300 Roughness Surveyor is a device that characterizes pavement roughness in a repeatable manner on dense-graded asphaltic and jointed portland cement concrete pavement surfaces. The repeatability of the device reduces somewhat on open-graded asphaltic concrete pavement surfaces, and therefore, cannot be considered as being repeatable.

On the dense-graded asphalt and portland cement concrete pavement surfaces tested with the Roughness Surveyor, it was found that the mean IRI value will not significantly change by conducting more than two repeat runs. The minimum number or runs necessary on open-graded asphaltic concrete pavement surfaces could not be determined.

RECOMMENDATIONS

The LaDOTD should continue to utilize the Roughness Surveyor as a research tool. When precise data is needed such as in calibration studies or in research, two or more repeat runs should be conducted. When network level data is collected, a single run should be sufficient contingent upon periodic repeat or check runs conducted to verify system performance. It is recommended that data on open textured surfaces not be collected or utilized for other than specific research purposes.

Periodic calibration through correlation to a Class I roughness device should be continued to verify the accuracy of the system.

LIST OF REFERENCES

1. Cumbaa, Steven L., Correlation of Profile Based Roughness Devices and Response Type Devices for Louisiana's HPMS Program, Louisiana Transportation Research Center, January 1990.

2. K. J. Law Engineers, Inc., Model 8300 Road Roughness Surveyor Manual, Michigan.

3. SAS User's Guide: Statistics, Version 5 Edition, Cary, N.C., SAS Institute Inc., 1985.

APPENDIX

TABLE A-1

GENERAL REPEATABILITY TEST STATISTICS

DENSE-GRADED ASPHALTIC CONCRETE PAVEMENT SURFACES (2-09-88)

Section Number	Minimum	Average	Maximum	Standard Deviation	Coefficient of Variation
1	59	63.6	68	3.9	6.10
2	67	70.4	74	2.6	3.66
3	54	57.8	61	2.3	4.01
4	57	61.6	67	3.3	5.39
5	314	320.6	327	4.9	1.52
6	286	297.8	311	8.3	2.78
7	201	205.0	207	2.1	1.02
8	96	98.0	100	1.7	1.71
9	96	101.2	104	3.0	2.96
10	537	546.8	560	10.0	1.83
11	162	167.2	172	3.3	1.98
12	158	160.0	164	2.2	1.37
13	170	174.0	177	2.4	1.41
14	118	120.0	122	1.4	1.18
15	155	160.2	164	3.7	2.28
16	76	77.8	79	1.2	1.50
17	79	81.6	85	2.8	3.43
18	84	86.2	88	1.5	1.70
				Average	2.55

TABLE A-2

GENERAL REPEATABILITY TEST STATISTICS

DENSE-GRADED ASPHALTIC CONCRETE PAVEMENT SURFACES (2-18-88)

Section Number	Minimum	Average	Maximum	Standard Deviation	Coefficient of Variation
1	55	67.2	75	6.8	10.07
2	61	70.6	83	7.2	10.16
3	51	61.8	73	8.4	13.63
4	54	64.4	78	8.7	13.49
5	280	302.0	313	11.6	3.86
6	280	289.0	298	7.2	2.50
7	196	206.0	217	8.2	3.97
8	97	98.2	99	0.7	0.76
9	94	100.6	109	5.3	5.24
10	480	545.0	689	74.8	13.73
11	160	166.4	177	6.2	3.72
12	154	159.2	164	3.5	2.23
13	166	168.0	171	1.8	1.06
14	123	126.0	131	2.7	2.13
15	143	151.2	157	5.1	3.36
16	73	79.0	91	6.8	8.59
17	75	78.2	82	2.3	2.96
18	80	86.4	91	3.8	4.37
				Average	5.88

TABLE A-3

GENERAL REPEATABILITY TEST STATISTICS

DENSE-GRADED ASPHALTIC CONCRETE PAVEMENT SURFACES (3-01-88)

Section Number	Minimum	Average	Maximum	Standard Deviation	Coefficient of Variation
1	61	64.4	66	1.9	2.88
2	68	69.0	70	0.6	0.92
3	53	55.0	57	1.4	2.57
4	57	59.4	61	1.5	2.52
5	294	300.6	305	3.7	1.24
6	274	280.6	284	3.4	1.23
7	191	201.2	208	5.9	2.92
8	90	92.4	94	1.4	1.47
9	93	95.6	97	1.4	1.42
10	501	511.2	518	5.9	1.16
11	155	160.2	166	4.2	2.60
12	159	162.8	168	3.5	2.18
13	166	171.8	178	5.0	2.88
14	120	124.8	128	2.8	2.23
15	139	147.8	153	4.8	3.24
16	68	69.6	71	1.0	1.47
17	73	74.2	75	0.7	1.01
18	81	83.0	85	1.7	2.02
				Average	2.00

TABLE A-4

GENERAL REPEATABILITY TEST STATISTICS

DENSE-GRADED ASPHALTIC CONCRETE PAVEMENT SURFACES (3-03-88)

Section Number	Minimum	Average	Maximum	Standard Deviation	Coefficient of Variation
1	55	65.6	71	5.6	8.49
2	61	69.4	74	4.5	6.48
3	45	55.6	73	9.4	16.93
4	50	60.0	78	9.8	16.33
5	280	297.6	313	10.7	3.59
6	285	292.0	298	4.7	1.61
7	206	210.6	217	4.0	1.91
8	88	95.4	98	3.8	3.96
9	91	95.8	104	4.7	4.96
10	480	520.2	563	29.8	5.73
11	154	160.8	165	3.9	2.41
12	154	159.8	164	3.4	2.11
13	161	166.4	169	2.9	1.77
14	120	124.8	131	3.6	2.88
15	146	152.2	159	4.7	3.09
16	70	75.4	82	4.2	5.54
17	72	76.0	78	2.3	3.00
18	80	85.2	91	4.5	5.32
				Average	5.34

TABLE A-5

DAY-TO-DAY REPEATABILITY TESTS FOR

DENSE-GRADED ASPHALTIC CONCRETE PAVEMENT SURFACES

Sect Num	Mean for each Date 2-09-88	2-18-88	3-01-88	3-03-88	Mean	Standard Deviation	Coefficient of Variation
1	63.6	67.2	64.4	65.6	65.2	1.4	2.08
2	70.4	70.6	69.0	69.4	69.9	0.7	0.96
3	57.8	61.8	55.0	55.6	57.6	2.7	4.63
4	61.6	64.4	59.4	60.0	61.4	1.9	3.16
5	320.6	302.0	300.6	297.6	305.2	9.0	2.96
6	297.8	289.0	280.6	292.0	289.9	6.2	2.14
7	205.0	206.0	201.2	210.6	205.7	3.3	1.63
8	98.0	98.2	92.4	95.4	96.0	2.4	2.45
9	101.2	100.6	95.6	95.8	98.3	2.6	2.65
10	546.8	545.0	511.2	520.2	530.8	15.4	2.91
11	167.2	166.4	160.2	160.8	163.7	3.2	1.94
12	160.0	159.2	162.8	159.8	160.5	1.4	0.87
13	174.0	168.0	171.8	166.4	170.1	3.0	1.77
14	120.0	126.0	124.8	124.8	123.9	2.3	1.86
15	160.2	151.2	147.8	152.2	152.9	4.5	2.97
16	77.8	79.0	69.6	75.4	75.5	3.6	4.79
17	81.6	78.2	74.2	76.0	77.5	2.8	3.56
18	86.2	86.4	83.0	85.2	85.2	1.3	1.58
						Average	2.50

TABLE A-6

GENERAL REPEATABILITY TEST STATISTICS

DENSE-GRADED ASPHALTIC CONCRETE PAVEMENT SURFACE

Mile (tenths)	Minimum	Mean	Maximum	Standard Deviation	Coefficient of Variation
1	83	88.0	93	3.1	3.56
2	93	102.6	109	4.9	4.80
3	101	107.5	113	4.2	3.93
4	86	91.4	104	5.2	5.71
5	92	99.0	106	4.1	4.16
6	80	82.9	89	2.7	3.21
7	97	102.9	111	4.8	4.65
8	101	107.5	120	5.0	4.62
9	121	127.5	137	5.9	4.60
10	111	118.4	124	4.1	3.45
				Average	4.27

TABLE A-7

GENERAL REPEATABILITY TEST STATISTICS

JOINTED PORTLAND CEMENT CONCRETE PAVEMENT SURFACES (6-15-88)

Section Number	Minimum	Average	Maximum	Standard Deviation	Coefficient of Variation
21	266	268.3	271	2.1	0.77
22	106	109.3	114	3.4	3.11
24	95	98.0	101	2.4	2.50
31	209	209.7	211	0.9	0.45
32	185	187.0	189	1.6	0.87
33	141	142.3	144	1.2	0.88
35	116	120.3	124	3.3	2.74
37	190	192.7	195	2.1	1.07
39	118	118.3	119	0.5	0.40
71	191	192.0	193	0.8	0.43
82	107	107.7	108	0.5	0.44
83	149	153.3	157	3.3	2.15
84	91	91.7	93	0.9	1.03
85	83	86.3	88	2.4	2.73
86	82	83.7	85	1.2	1.49
87	69	71.7	73	1.9	2.63
88	78	80.7	82	1.9	2.34
89	313	313.7	314	0.5	0.15
90	236	239.7	242	2.6	1.10
				Average	1.43

TABLE A-8

GENERAL REPEATABILITY TEST STATISTICS

JOINTED PORTLAND CEMENT CONCRETE PAVEMENT SURFACES (7-17-89)

Section Number	Minimum	Average	Maximum	Standard Deviation	Coefficient of Variation
21	265	267.0	268	1.4	0.53
22	97	98.3	100	1.2	1.27
24	89	90.0	91	0.8	0.91
31	209	211.0	214	2.2	1.02
32	183	186.3	189	2.5	1.34
33	138	140.3	142	1.7	1.21
35	121	121.3	122	0.5	0.39
37	201	204.0	209	3.6	1.74
39	116	116.7	118	0.9	0.81
71	187	189.3	192	2.1	1.09
82	107	108.0	109	0.8	0.76
83	159	161.3	163	1.7	1.05
84					
85					
86					
87					
88					
89	323	324.7	326	1.2	0.38
90	244	246.3	248	1.7	0.69
				Average	0.94

TABLE A-9

GENERAL REPEATABILITY TEST STATISTICS

JOINTED PORTLAND CEMENT CONCRETE PAVEMENT SURFACES (9-26-89)

Section Number	Minimum	Average	Maximum	Standard Deviation	Coefficient of Variation
21	267	268.0	269	0.8	0.30
22	95	97.0	98	1.4	1.46
24	96	97.7	99	1.2	1.28
31	219	220.0	221	0.8	0.37
32	183	186.0	191	3.6	1.91
33	145	147.0	148	1.4	0.96
35	120	121.0	122	0.8	0.67
37	204	205.7	208	1.7	0.83
39	123	124.7	126	1.2	1.00
71	190	193.3	198	3.4	1.76
82	109	109.7	111	0.9	0.86
83	159	159.7	160	0.5	0.30
84	76	77.0	78	0.8	1.06
85	93	94.3	96	1.2	1.32
86	88	88.3	89	0.5	0.53
87	72	73.0	74	0.8	1.12
88	84	84.3	85	0.5	0.56
89	318	326.0	336	7.5	2.30
90	244	246.0	250	2.8	1.15
				Average	1.04

TABLE A-10

DAY-TO-DAY REPEATABILITY TESTS FOR

JOINTED PORTLAND CEMENT CONCRETE PAVEMENT SURFACES

Section Number	Mean for each Date 6-15-88	7-17-89	9-26-89	Mean	Standard Deviation	Coefficient of Variation
21	268.3	267.0	268.0	267.8	0.6	0.21
22	109.3	98.3	97.0	101.5	5.5	5.43
24	98.0	90.0	97.7	95.2	3.7	3.89
31	209.7	211.0	220.0	213.6	4.6	2.14
32	187.0	186.3	186.0	186.4	0.4	0.22
33	142.3	140.3	147.0	143.2	2.8	1.96
35	120.3	121.3	121.0	120.9	0.4	0.35
37	192.7	204.0	205.7	200.8	5.8	2.87
39	118.3	116.7	124.7	119.9	3.5	2.88
71	192.0	189.3	193.3	191.5	1.7	0.87
82	107.7	108.0	109.7	108.5	0.9	0.81
83	153.3	161.3	159.7	158.1	3.5	2.19
84	91.7		77.0	84.4	7.3	8.71
85	86.3		94.3	90.3	4.0	4.43
86	83.7		88.3	86.0	2.3	2.67
87	71.7		73.0	72.4	0.6	0.90
88	80.7		84.3	82.5	1.8	2.18
89	313.7	324.7	326.0	321.5	5.5	1.72
90	239.7	246.3	246.0	244.0	3.0	1.25
					Average	2.40

TABLE A-11

GENERAL REPEATABILITY TEST STATISTICS

JOINTED PORTLAND CEMENT CONCRETE PAVEMENT

Mile (tenths)	Minimum	Mean	Maximum	Standard Deviation	Coefficient of Variation
1	132	137.2	145	3.9	2.86
2	113	117.6	121	2.5	2.09
3	100	102.5	107	1.8	1.76
4	105	111.1	120	4.2	3.79
5	117	121.6	127	3.5	2.85
6	95	100.7	104	2.5	2.47
7	74	78.3	84	2.9	3.70
8	97	105.2	117	5.4	5.17
9	85	96.5	105	5.9	6.12
10	97	104.5	111	4.7	4.49
				Average	3.53

TABLE A-12

GENERAL REPEATABILITY TEST STATISTICS

OPEN-GRADED ASPHALTIC CONCRETE PAVEMENT SURFACE

Mile (tenths)	Minimum	Mean	Maximum	Standard Deviation	Coefficient of Variation
1	71	76.7	83	4.7	6.12
2	75	88.1	102	9.4	10.64
3	68	80.4	94	7.1	8.87
4	64	72.0	82	5.7	7.98
5	68	77.2	87	5.8	7.55
6	64	71.3	81	5.1	7.18
7	69	75.6	87	5.2	6.88
8	56	64.8	73	4.6	7.17
9	68	80.5	103	10.7	13.31
10	88	95.3	107	5.9	6.19
				Average	8.19

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
P. O. BOX 3929
BATON ROUGE, LOUISIANA 70821

REGION 6

Copied for
Bill Temple
Steve Cumbaa
4-17-91
DC

April 12, 1991

IN REPLY REFER TO

Repeatability Analysis of the
K.J. Law
Model 8300 Roughness Surveyor
Research Project No. 87-1EQM
State Project No. 736-15-95
Louisiana HPR No. 0010(14)

Mr. Neil L. Wagoner, Secretary
Department of Transportation
and Development
Baton Rouge, Louisiana

Attention: Mr. Peter Stopher

Dear Mr. Wagoner:

The research report transmitted by Mr. W. H. Temple's April 1, 1991, letter is accepted as evidence of satisfactory completion of the study objectives. The project may be closed out.

We agree with the LTRC plans to not publish the report since the product is no longer on the market.

Sincerely yours,

V. W. Page

Virgil W. Page, P.E.
Planning and Research Engineer

LOUISIANA TRANSPORTATION RESEARCH CENTER

LTRC

4101 GOURRIER • BATON ROUGE, LOUISIANA 70808 • (504) 767-9131
FAX NUMBER (504) 767-9108

April 1, 1991

REPEATABILITY ANALYSIS OF THE K.J. LAW
MODEL 8300 ROUGHNESS SURVEYOR
RESEARCH PROJECT NO. 87-1EQM
STATE PROJECT NO. 736-15-95
LOUISIANA HPR NO. 0010(14)

Mr. William A. Sussman
Division Administrator
Federal Highway Administration
P. O. Box 3929
Baton Rouge, LA 70821

Dear Mr. Sussman:

Please find enclosed for your review and approval, three copies of the research report which documents the evaluation of the repeatability of the K. J. Law, Model 8300 Roughness Surveyor. The report indicates that when functioning properly the Model 8300 is repeatable on dense graded asphaltic concrete and portland cement concrete pavement surfaces. The device was found to be not repeatable on open graded asphaltic concrete surfaces.

Since completion of the data collection effort, equipment problems have surfaced that neither LTRC or the manufacturer have been able to correct. We do not anticipate at this time that the equipment problems can be resolved. K. J. Law no longer markets this particular device and therefore LTRC does not plan to publish this report.

Thank you for your cooperation and assistance in this matter.

Sincerely,

PETER R. STOPHER, PH.D.
DIRECTOR
PROFESSOR OF CIVIL ENGINEERING

William Temple

WILLIAM H. TEMPLE, P.E.
DIRECTOR OF RESEARCH

PRS:WHT:ja
Enclosure
cc: Mr. Steven Cumbaa
Ms. Deborah Boleware