Correlation of the IJK Roadmeter to the International Roughness Index

Final Report for MLR-91-5

March 1992

Highway Division
Iowa Department of Transportation

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Final Report
for
MLR-91-5

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8. ABSTRACT

The Iowa Department of Transportation has been determining a present serviceability index (PSI) on the primary highway system since 1968. A CHLOE profilometer has been used as the standard for calibrating the Roadmeters that do the system survey. The current Roadmeter, an IJK Iowa DOT developed unit, is not considered an acceptable Roadmeter for determining the FHWA required International Roughness Index (IRI). Iowa purchased a commercial version of the South Dakota type profiler (SD Unit) to obtain IRI.

This study was undertaken to correlate the IRI to the IJK Roadmeter and retire the Roadmeter. One hundred forty-seven pavement management sections (IPMS) were tested in June and July 1991 with both units. Correlation coefficients and standard error of estimates were:

	r^2	Std. Error
PCC pavements	0.81	0.15
Composite pavements	0.71	0.18
ACC pavements	0.77	0.17

The correlation equations developed from this work will allow use of the IRI to predict the IJK Roadmeter response with sufficient accuracy. Trend analysis should also not be affected.

9. KEY WORDS Smoothness, Roughness, International Roughness Index Present Serviceability Index, South Dakota Profiler	10. NO. OF PAGES 26

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DISCLAIMER

The contents of this report reflect the views of the author and do not necessarily reflect the official views of the Iowa Department of Transportation. This report does not constitute a standard, specification or regulation.

INTRODUCTION

The Iowa Department of Transportation has been determining a PSI on the primary highway system since 1968. The PSI is a combined index of smoothness (LPV), rutting, cracking, and patching. Work done at the AASHO Road Test at Ottawa, Illinois resulted in the PSI concept.

To provide states with a "standard" for measuring smoothness, the CHLOE profilometer was developed at the AASHO Road Test. The CHLOE determines the variation in slope of the roadway at the test speed of 3 mph. The CHLOE was originally correlated to the AASHTO Profilometer. The AASHTO Profilometer was correlated to a 14 person rating panel. Roadmeters were developed to obtain smoothness data at highway speeds for system-wide inventories. Early Roadmeters were not stable over time due to wind, vehicle changes, and electro-mechanical changes and wear. The CHLOE was used to calibrate and recalibrate the Roadmeters to the AASHTO smoothness reference LPV.

The IRI was developed by the World Bank in 1982. The IRI is a mathematical model and is computed from a measured profile. It is considered a better "standard" for calibrating response-type Roadmeters than using a rating panel or CHLOE.(1) Newer type smoothness test equipment uses noncontact, electronic equipment to measure the roadway profile. This profile data is used to directly determine the IRI. The FHWA has adopted the IRI for reporting smoothness data for the U.S. and inter-

state system. The IJK Roadmeter used by Iowa was not considered an acceptable Roadmeter for determining IRI.

OBJECTIVE

The objective of the study was to correlate the IJK Roadmeter LPV smoothness value with the IRI value to allow for continuation of smoothness trends.

TESTING

Prior to testing each year, the IJK Roadmeter must be calibrated to the CHLOE profilometer.

IJK Calibrating

Seventeen one-half mile P.C.C. test sections of varying smoothness were used for calibration in June 1991. The IJK mechanism was initially adjusted to the LPV results from last year's section results. The IJK was then run six times on each test section. Three runs just prior to running the CHLOE and three runs after running the CHLOE. Figure 1 is the June 1991 correlation of the CHLOE raw data to the IJK raw data (correlation coefficient $r^2 = 0.97$).

The South Dakota type profiler (SD unit) was run during this calibration for comparison. Figure 2 is the correlation of the CHLOE raw data to the average IRI value (correlation coefficient $r^2 = 0.97$). The correlation between the IJK raw data and the average IRI value if Figure 3 (correlation coefficient $r^2 = 0.94$).

The details of the IJK calibration procedure are in Appendix A.

IJK Vs SD-Unit Correlation

One hundred forty-seven IPMS sections were tested in June and July 1991 to obtain a correlation between the two instruments. The two vehicles tested each section at the same time. The number of sections of each pavement type tested are as follows:

	No. of Sections for Correlation	No. of IPMS Sections (Total)
PCC	57	754
Comp.	46	754
ACC	29	328
CRC	6	90
SC*	9	--

*Two seal coat surfaces were on composite sections and seven seal coat surfaces were on ACC sections. The individual sections and the test results are in Appendix B.

The resultant correlations are shown in Figures 4 through 6. Table 1 is a summary of the correlation.

Table I
Summary of Correlation

Pave. Type	Equation	r^2	Std. Error
PCC	IJK = (-0.778 x IRI) + 5.29	0.81	0.15
COMP	IJK = (-0.588 x IRI) + 4.45	0.71	0.18
ACC	IJK = 1/ (0.0442 x IRI) + 0.2156	0.77	0.17

New seal coats were eliminated from the correlation due to high results on the SD unit. The seal coat results are plotted on the correlation graphs for comparison (Figure 5 and 6). CRC pavements were not included in the PCC correlation. Fig-

ure 4 shows the CRC sections plotted for comparison. Two composite sections roads (six sections) were retested because of questionable data.

DISCUSSION OF TESTING

Three items from the correlation testing are noteworthy. The items are: 1) the new seal coat test results; 2) the variability in the composite test section results; and 3) the results of the weekly check of the SD unit.

Seal Coat Test Results

It was expected that new seal coats would adversely affect the IRI. Previous tests of the SD unit by others had shown that heavy textures can cause higher IRIs than actual.(2) Nine IPMS sections with newer seal coats (1987 to present) were removed from the correlation. The nine sections averaged 0.34 higher than the actual LPV from the IJK.

To account for the higher IRI value in the IPMS, one of the following could be done:

1. Do not test seal coats until after two years. Use IRI prior to seal coat until new IRI is obtained.

2. Test seal coats as usual, apply a 0.34 LPV correction to those less than three years old.

FIGURE 1 1991 IJK CALIBRATION

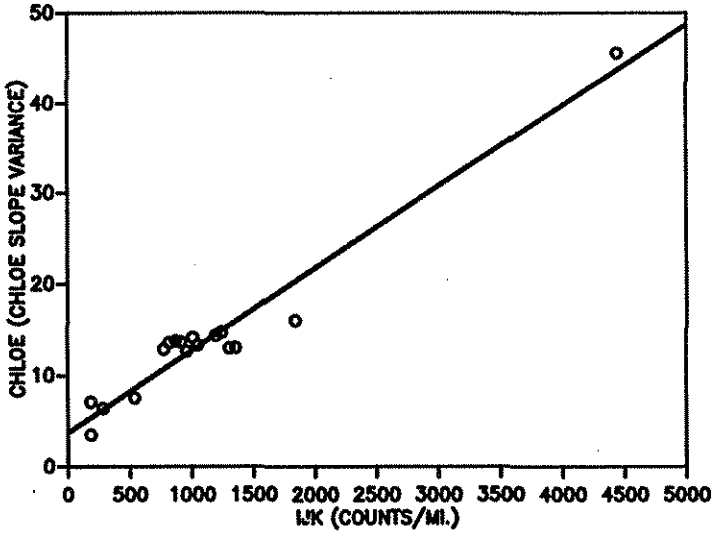


FIGURE 2 SD UNIT VS CHLOE PROFILOMETER ON CAL. SECTIONS

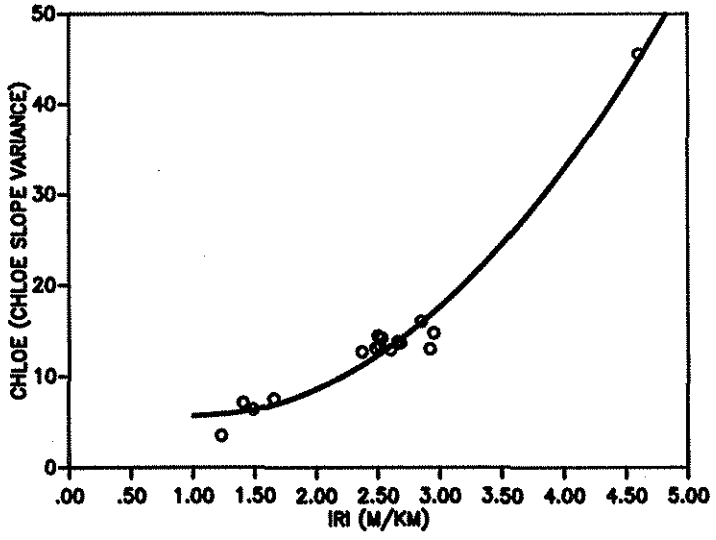


FIGURE 3 SD UNIT VS IJK ON CAL. SECTIONS

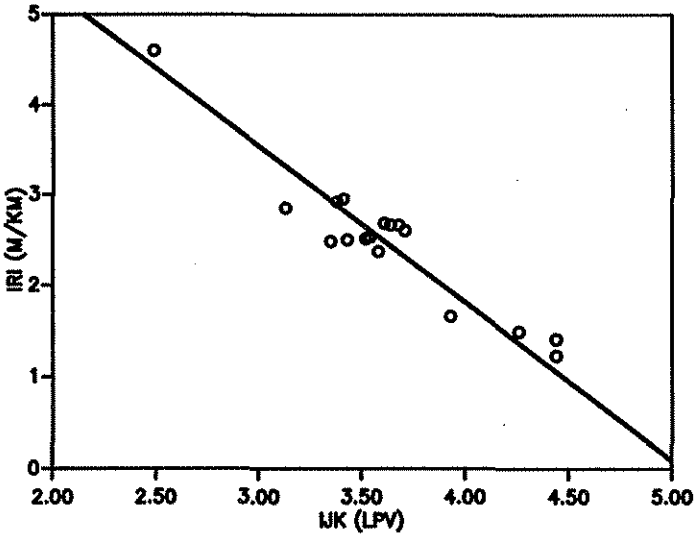


FIGURE 4 SD UNIT VS IJK
ON 57 PCC SECTIONS

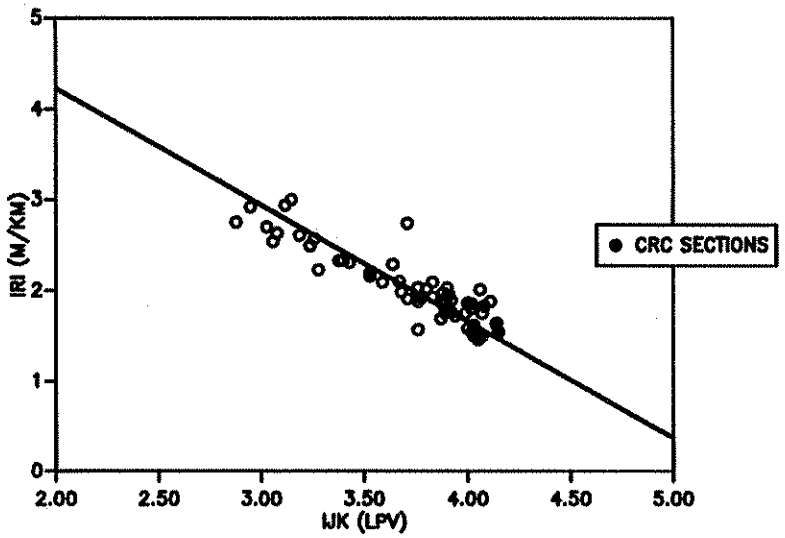


FIGURE 5 SD UNIT VS IJK
ON 46 COMPOSITE SECTIONS

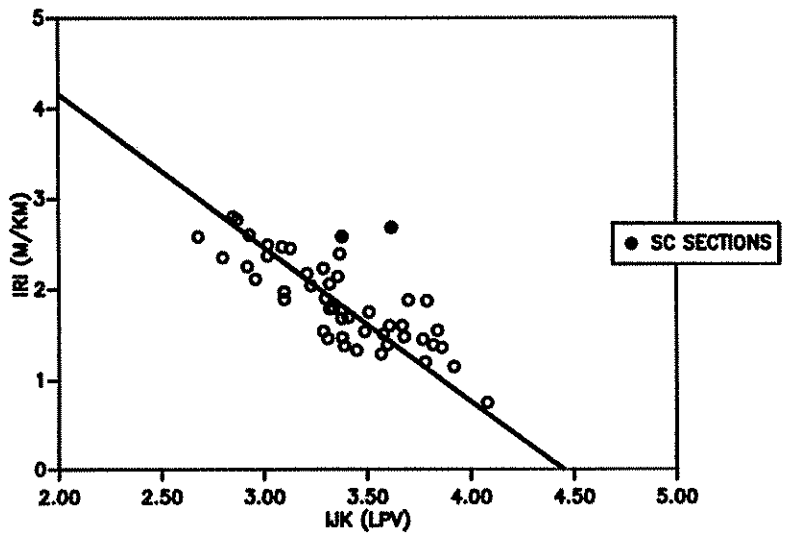
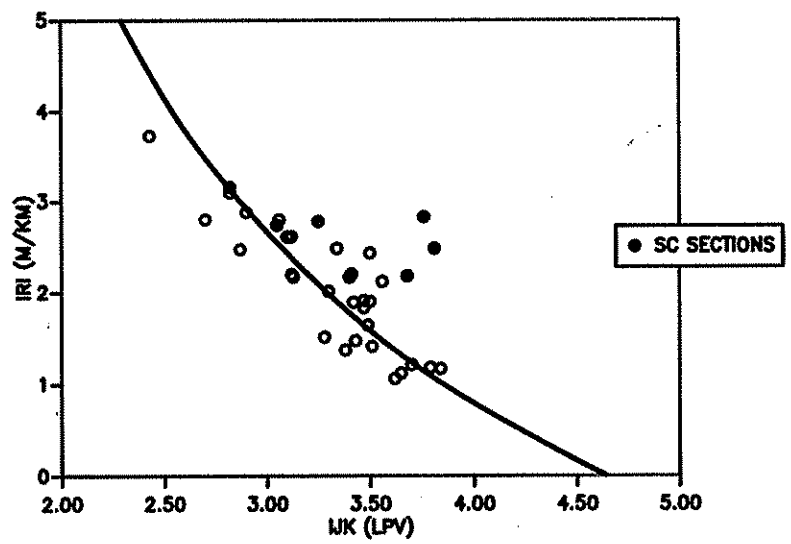


FIGURE 6 SD UNIT VS IJK
ON 29 ACC SECTIONS



Variability of Composite Sections

Six composite test sections from two roads were retested because of suspect data. Highway 150 in Buchanan County had a rougher reading on the IRI than on the LPV. Highway 3 in Delaware County had a smoother reading on the IRI than on the LPV. The retest on Highway 150 changed little from previous results. The retest on Highway 3 produced smoother results on both the IRI and LPV. The retests raised the r^2 slightly but did not affect the correlation equation to any extent.

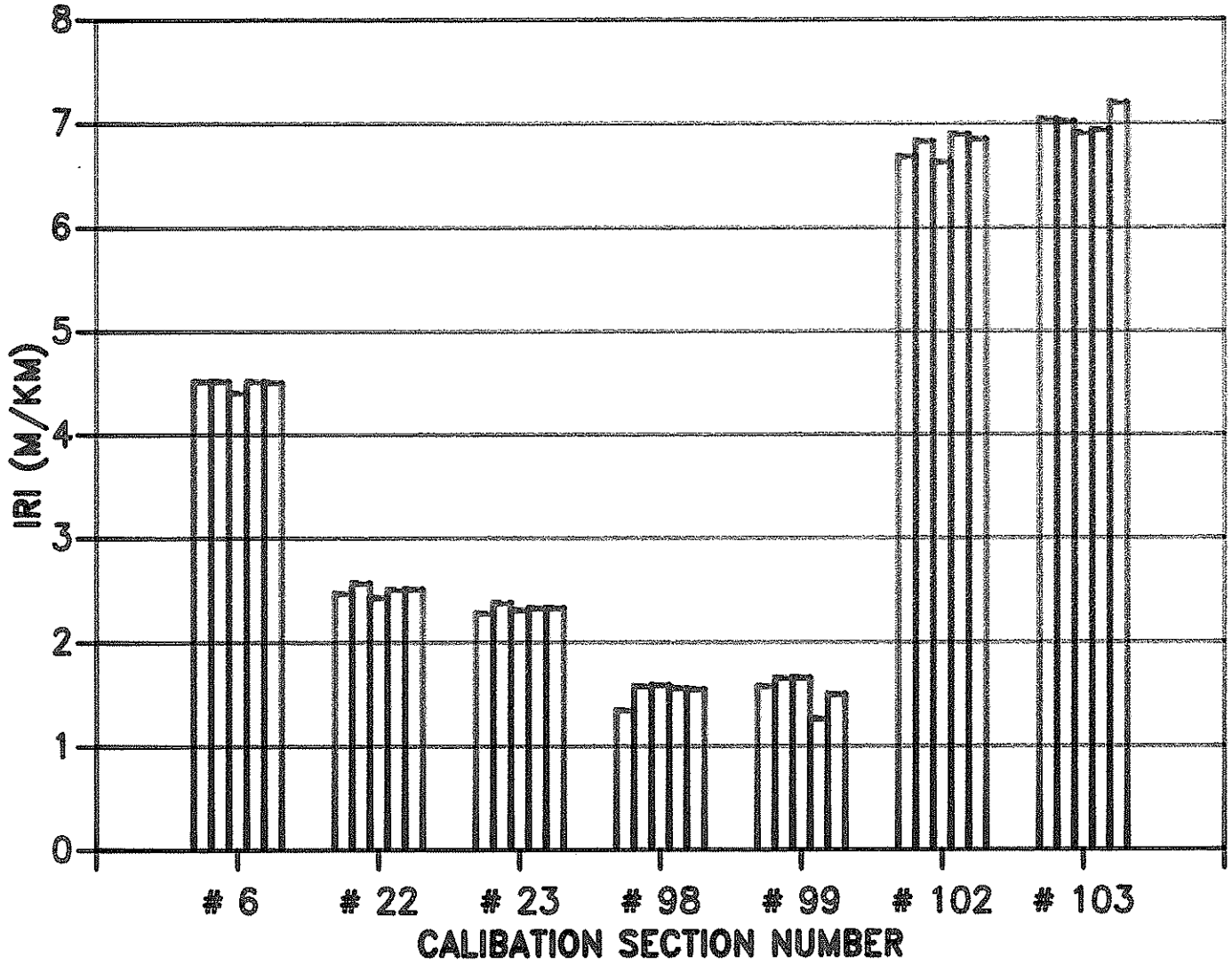
Both roadways have about the same LPV (3.30). Highway 150 has an IRI of about 2.3 and Highway 3 has an IRI of about 1.5. There is a precipitable difference in the type of bumps present on the roadways. The SD unit measures primarily bumps in the 5 foot to 75 foot range. The frequency response of the IJK to different bumps is unknown.

Profile analysis software for the SD unit is not currently available to the Iowa DOT. It is hoped that when the software is developed, the bump spacing and intensity of each roadway can be analyzed.

Weekly Check of the SD Unit

The SD unit was run on seven calibration test sections each week during the testing season. Each section was run three times to obtain an average result. Figure 7 shows the weekly average test results. The variations shown from week to week are greater than would be expected from testing variation only.

FIGURE 7 WEEKLY CHECK OF SD UNIT 1991 ON CALIBARATION SECTIONS



Smoothness of a road section can be dependent on the environmental factors at the time of testing. One test section had a standard deviation of 0.16 for the weekly check. Three sections had standard deviations of 0.10 or greater. The remaining three sections had standard deviations of 0.05.

SUMMARY AND CONCLUSIONS

One hundred forty-seven pavement management sections were tested in June and July 1991 to obtain a correlation between the IJK smoothness and IRI smoothness value. Separate correlations were computed for the different pavement types. Correlation coefficients ranged from 0.71 to 0.81.

The following conclusions can be drawn based on the results of the study.

1. The International Roughness Index is correlatable to the IJK Roadmeter.

2. Heavy textured surfaces affect the IRI value (seal coat surfaces).

3. Smoothness of a road section can increase or decrease from week to week due to environmental factors.

RECOMMENDATIONS

The following is recommended based on this study.

1. Future pavement management smoothness testing should be collected by the SD unit and converted to an LPV.

2. Future testing of new construction should be done by the SD unit and the BPR Roughometer. IRI should be used for current year comparison. An LPV should be calculated to continue trend analysis.

3. IRI results on new seal coats (3 years old or less) should be converted using the correlation equations and adding 0.35 from the calculated LPV to obtain the proper smoothness result.

4. The SD unit should be tested against the BPR Roughometer for correlation. The IRI calculation is patterned after a single-wheeled trailer unit.

5. Daily and seasonal fluctuations in pavement smoothness values do occur. Attempting to measure smoothness more precisely than it exists in the field appears fruitless.

REFERENCES

1. Gillespie, T. D., et al, "Calibration of Response-Type Road Roughness Measuring Systems," NCHRP Report 228 (1980), pg 40

2. Huft, D. L., "Description and Evaluation of the South Dakota Road Profiler," FHWA Report DP-89-072-002 (1989), pg 60

APPENDIX A

IJK Roadmeter Correlation Procedure

Test Method No. Iowa 1002-B
March 1976

IOWA DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION

Office of Materials

METHOD OF DETERMINATION OF LONGITUDINAL PROFILE VALUE USING THE IJK RIDE INDICATOR

Scope

This testing method is used to determine the Longitudinal Profile Value (LPV) using the IJK Ride Indicator. The Longitudinal Profile Value is used to determine the Present Serviceability Index (P.S.I.), a concept developed by the American Association of State Highway Officials (AASHO) Road Test. It (P.S.I.) is used as an indicator of the ability of a pavement to serve the traveling public and as an objective method of highway evaluation.

The IJK (Iowa-Johannsen-Kirk) Ride Indicator was developed by the Iowa Department of Transportation Materials Laboratory.

Procedure

A. Apparatus

1. IJK Ride Indicator (An electromechanical device mounted on the differential of a standard automobile)(Fig. 1 to 4).
2. Tire pressure gauge.
3. Portable calculator.

B. Test Record Forms and Section Identification

1. Longitudinal Profile Value Worksheet (Form 921).
2. Final Report (Forms 915 or 922).
3. "Test Sections by Milepost" booklet.
4. Correlation Table (Longitudinal Profile Value vs. Sum/Length for testing unit).

C. Personnel

1. Two personnel are required. One is assigned to drive while the other operates the counters and makes calculations.

D. Correlation

1. The Longitudinal Profile Value is derived from equations of the AASHO Road Test using a correlation between the CHLOE Profilometer and the IJK Ride Indicator. The CHLOE is used as a correlation standard because it is not affected by possible changes in suspension but primarily is dependent only on proper electrical operation. The relationship between the CHLOE and the IJK Ride Indicator is determined through a computer program by the least square parabolic method ($Y=CX^2+MX+B$).

E. Test Procedure

1. Drive the test vehicle at least 10 miles before beginning testing.
2. Operate the vehicle in a careful, legal, conscientious manner.
3. Be sure the IJK unit is accurately zeroed before mounting on the vehicle.
4. Be sure the dampening fluid level is correct. This should be checked weekly during continuous operation.
5. During continuous testing, the unit should be tested on eight conveniently close correlation sections weekly to verify proper operation.
6. When ready to begin testing, disengage the IJK arm lock.
7. Start the test vehicle far enough from the beginning of the test section to insure adequate distance for acceleration to the standard test speed of 50 MPH. Turn the main switch to the "ON" position as the rear wheels pass the start of the test section. It is turned off in the same position at the end of the section.

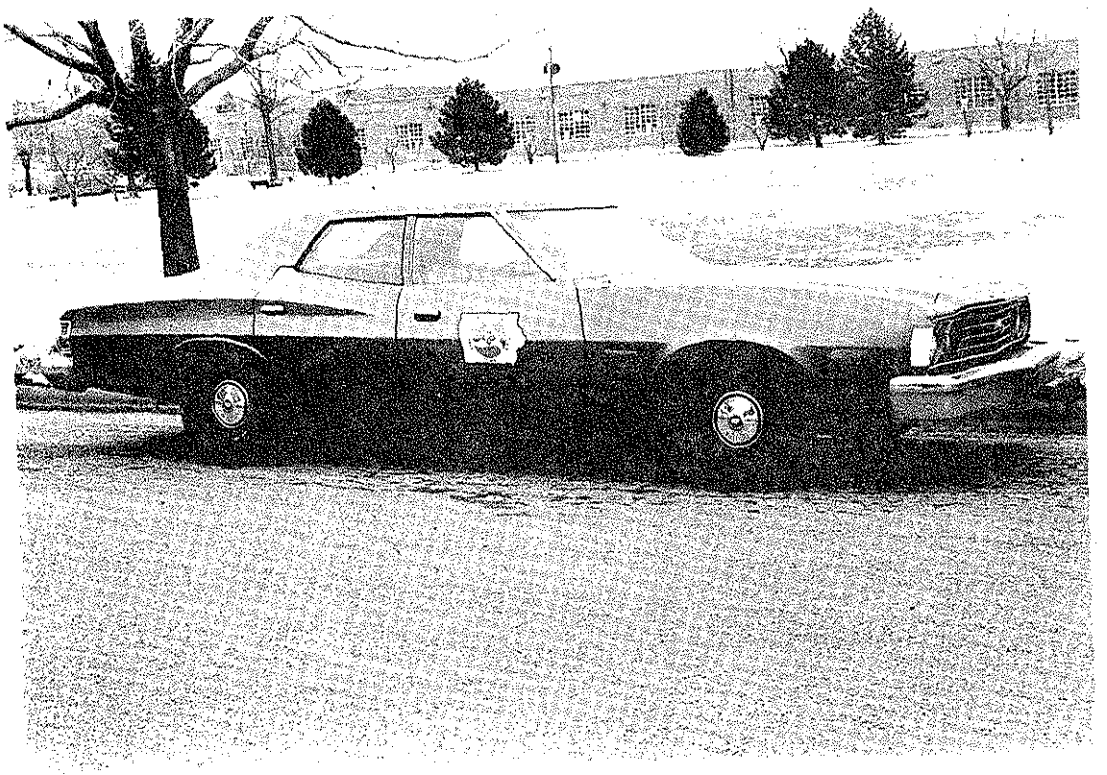


Fig. 1

The IJK Ride Indicator Vehicle

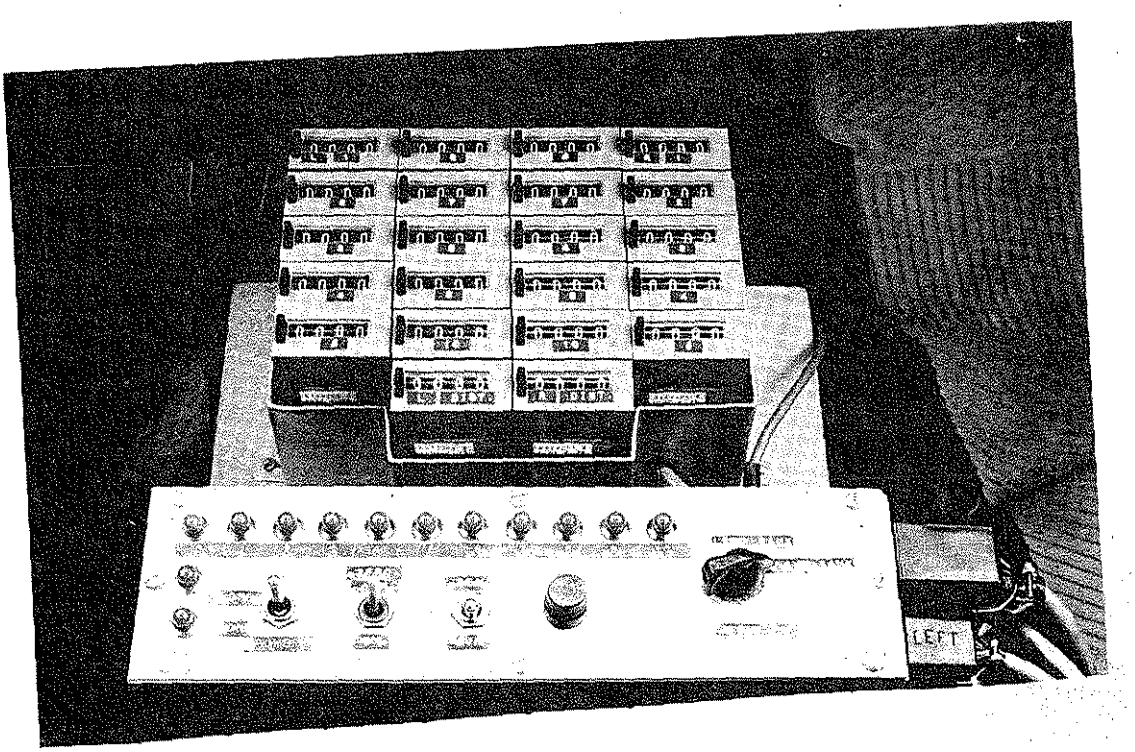


Fig. 2

The IJK Ride Indicator Control Console, showing Visual Indicators, Switches and Electrical Counters on the floor of the automobile.

CORRELATION TABLE
IJK RIDE INDICATOR UNIT E
JULY 1975

Test Method No. Iowa 1002-B
March 1976

LPV	SUM/LENGTH AC	SUM/LENGTH PC	LPV	SUM/LENGTH AC	SUM/LENGTH PC	LPV	SUM/LENGTH AC	SUM/LENGTH PC
0.000	18770	29785	2.000	4449	7023	4.000	502	985
0.025	18462	29283	2.025	4360	6886	4.025	481	952
0.050	18159	28790	2.050	4272	6753	4.050	460	920
0.075	17860	28304	2.075	4185	6617	4.075	440	889
0.100	17566	27825	2.100	4100	6486	4.100	420	858
0.125	17276	27355	2.125	4016	6357	4.125	401	828
0.150	16991	26891	2.150	3933	6231	4.150	382	799
0.175	16710	26435	2.175	3852	6106	4.175	364	770
0.200	16433	25987	2.200	3772	5984	4.200	345	742
0.225	16160	25545	2.225	3693	5863	4.225	328	715
0.250	15892	25111	2.250	3615	5746	4.250	311	688
0.275	15628	24684	2.275	3539	5628	4.275	294	661
0.300	15367	24263	2.300	3464	5513	4.300	277	635
0.325	15110	23849	2.325	3391	5400	4.325	261	610
0.350	14858	23441	2.350	3318	5290	4.350	245	585
0.375	14609	23041	2.375	3247	5181	4.375	230	561
0.400	14364	22646	2.400	3176	5073	4.400	215	538
0.425	14122	22258	2.425	3107	4968	4.425	200	515
0.450	13885	21876	2.450	3039	4864	4.450	186	492
0.475	13650	21500	2.475	2973	4762	4.475	172	470
0.500	13420	21130	2.500	2907	4662	4.500	158	448
0.525	13193	20766	2.525	2842	4563	4.525	145	427
0.550	12969	20407	2.550	2779	4467	4.550	132	407
0.575	12749	20055	2.575	2716	4371	4.575	119	387
0.600	12532	19708	2.600	2655	4278	4.600	107	367
0.625	12318	19366	2.625	2594	4186	4.625	94	348
0.650	12107	19030	2.650	2535	4095	4.650	83	329
0.675	11900	18700	2.675	2477	4006	4.675	71	311
0.700	11696	18374	2.700	2419	3919	4.700	60	293
0.725	11495	18054	2.725	2363	3833	4.725	49	275
0.750	11297	17739	2.750	2307	3748	4.750	38	258
0.775	11102	17429	2.775	2253	3665	4.775	27	242
0.800	10910	17124	2.800	2199	3583	4.800	17	225
0.825	10721	16824	2.825	2146	3503	4.825	7	210
0.850	10534	16529	2.850	2095	3424	4.850	1	194
0.875	10351	16238	2.875	2044	3347	4.875		179
0.900	10170	15952	2.900	1994	3270	4.900		164
0.925	9992	15670	2.925	1944	3196	4.925		150
0.950	9817	15393	2.950	1896	3122	4.950		136
0.975	9645	15121	2.975	1849	3050	4.975		122
1.000	9475	14853	3.000	1802	2979	5.000		109
1.025	9308	14589	3.025	1756	2909	5.025		96
1.050	9143	14329	3.050	1711	2840	5.050		84
1.075	8981	14074	3.075	1667	2773	5.075		71
1.100	8821	13822	3.100	1624	2707	5.100		59
1.125	8663	13575	3.125	1581	2642	5.125		48
1.150	8509	13332	3.150	1539	2578	5.150		36
1.175	8356	13092	3.175	1498	2515	5.175		25
1.200	8206	12856	3.200	1458	2454	5.200		14
1.225	8058	12625	3.225	1418	2393	5.225		4
1.250	7912	12396	3.250	1379	2334			
1.275	7769	12172	3.275	1341	2275			
1.300	7628	11951	3.300	1303	2218			
1.325	7489	11734	3.325	1267	2162			
1.350	7352	11520	3.350	1231	2107			
1.375	7217	11309	3.375	1195	2052			
1.400	7084	11102	3.400	1160	1999			
1.425	6953	10899	3.425	1126	1947			
1.450	6825	10698	3.450	1093	1896			
1.475	6698	10501	3.475	1060	1845			
1.500	6573	10307	3.500	1028	1796			
1.525	6451	10116	3.525	996	1748			
1.550	6330	9928	3.550	965	1700			
1.575	6211	9744	3.575	935	1653			
1.600	6094	9562	3.600	905	1608			
1.625	5978	9383	3.625	876	1563			
1.650	5865	9207	3.650	847	1519			
1.675	5753	9034	3.675	819	1475			
1.700	5643	8863	3.700	791	1433			
1.725	5534	8696	3.725	764	1391			
1.750	5428	8531	3.750	738	1351			
1.775	5323	8369	3.775	712	1311			
1.800	5220	8209	3.800	687	1272			
1.825	5118	8052	3.825	662	1233			
1.850	5018	7898	3.850	637	1196			
1.875	4919	7746	3.875	614	1159			
1.900	4822	7597	3.900	590	1123			
1.925	4727	7450	3.925	567	1087			
1.950	4633	7305	3.950	545	1052			
1.975	4540	7163	3.975	523	1018			

Test Method No. Iowa 1002-B
March 1976

IOWA DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION
OFFICE OF MATERIALS

Road Meter
County
J. McCaskey
V.R. Snyder (2)

1976 Present Serviceability Index Summary for Jones County (53)

Date Reported 3-16-76 Lab. No. LV6-44 to 57

Lab. No. LV-	Beginning Milepost	Ending Milepost	Road No.	Length (Miles)	Surface Type	Dir. & Lane	Longitudinal Profile Value of March 1976	Winter 75-76 Ded. for Cracking Patching	Present Service-ability Index
44	20.77	22.24	US 151	1.47	AC	EB	3.70	.05	3.65
						WB	3.70	.05	3.65
45	22.24	27.34	US 151	5.10	AC	EB	3.65	.10	3.55
						WB	3.65	.10	3.55
46	27.34	37.61	US 151	(5.58)	AC	EB	3.55	.05	3.50
						WB	3.60	.05	3.55
				(4.26)	PC	EB	3.30	.15	3.15
						WB	3.50	.15	3.35
47	38.69	48.07	US 151	(6.68)	AC	EB	3.55	.05	3.50
						WB	3.55	.05	3.50
				(2.52)	PC	EB	3.35	.10	3.25
						WB	3.25	.10	3.15
48	0.00	21.22	IA 64	(14.47)	AC	EB	3.15	.00	3.15
						WB	3.20	.00	3.20
				(5.16)	PC	EB	3.25	.70	2.55
						WB	3.25	.70	2.55
49	115.78	119.25	IA 1	3.47	AC	NB	3.05	.35	2.70
						SB	3.10	.35	2.75
50	39.10	42.44	IA 38	3.34	AC	NB	4.00	.00	4.00
						SB	3.95	.00	3.95
51	43.45	47.81	IA 38	4.36	AC	NB	3.55	.10	3.45
						SB	3.50	.10	3.40
52	50.01	53.39	IA 38	3.38	AC	NB	3.55	.00	3.55
						SB	3.55	.00	3.55
53	53.39	63.50	IA 38	10.11	AC	NB	4.00	.00	4.00
						SB	4.00	.00	4.00
54	65.11	68.41	IA 38	3.30	PC	NB	4.05	.00	4.05
						SB	4.05	.00	4.05
55	43.16	53.42	IA 136	10.26	AC	NB	3.85	.00	3.85
						SB	3.85	.00	3.85
56	54.79	58.39	IA 136	3.60	AC	NB	3.75	.05	3.70
						SB	3.80	.05	3.75
57	58.39	72.04	IA 136	13.65	AC	NB	3.90	.00	3.90
						SB	3.95	.00	3.95

Deductions for cracking and patching were calculated on a 2 lane roadway basis.
(Length) indicates tested length on an AC/PC section.

Test Method No. Iowa 1003-A
February 1971

IOWA STATE HIGHWAY COMMISSION

Materials Department

METHOD OF DETERMINATION OF LONGITUDINAL PROFILE VALUE BY MEANS OF THE CHLOE PROFILOMETER

Scope

This method is used to determine the Longitudinal Profile Value (LPV) of pavement by the CHLOE Profilometer. The test is conducted at 5 mph, while obtaining the summation of a value $Y_{(i)}$ which can be related to the slope of the pavement and that of the square of $Y_{(i)}$, where i = 1,2,3 ···N, and N is the total number of points at 6-inch intervals. The values of N, Yi, and Yi^2, are used to determine the CHLOE Slope Variance (CSV), Road Test System Slope Variance (SV), and the Longitudinal Profile Value (LPV).

Procedure

A. Apparatus

1. CHLOE Profilometer

   a. Electronic Computer Indicator (Fig. 1).

   b. CHLOE trailer section (Fig. 2).

2. Towing and transporting vehicle.

3. Safety support vehicles as needed to insure safe operation.

B. Test Record Form

Use work sheet "LPV for PC or AC Pavement" for recording field measurements.

C. General Procedure

1. Calibration Procedure

   a. Attach the CHLOE trailer section to the towing vehicle.

   b. The roller contact, switch plate, and electronic computer indicator should be checked before beginning the road test. Anytime the data appears to be in error a check should be made and if an error is verified the malfunction should be corrected. The procedure for checking is as follows: First turn the electric eye switch at the rear of the trailer section from the road test to the manual position, then with the slope wheels up, the upright arm of the slope wheels is moved forward until the roller contact goes off the switch plate. While turning the calibrating crank, slowly move the upright arm to the rear until the roller contact impinges on the first switch segment. Hold this position and set the electronic computer indicator to zero, then turn the calibrating crank slowly until N = 10. Check to see if the quantities indicated ($\Sigma Y, \Sigma Y^2$) are correct. (Table I gives the values that should be obtained for each segment). If correct, reset the electronic computer indicator to zero, move the upright arm rearward until the number two switch segment is contacted and follow the same procedure used for the first switch segment. Continue this procedure until all 29 switch segments have been checked.

   c. Check to see if the pressure in the CHLOE trailer tires is 45 $\pm$ 0.5 psi.

   d. The position of the trailer hitch should be such that a slope mean ($\Sigma Y \div N$) between 14 and 15 is obtained. To check this, lower the slope wheels, set the electric eye switch to the road test position, and zero the electronic computer indicator. Pull the CHLOE Profilometer ahead until N = 100. The ΣY value should be between 1400 and 1500. If it is not, the trailer tongue should be raised or lowered by turning the crank at the front of the trailer section. Turning the crank counterclockwise lowers the ΣY value and turning it clockwise raises the ΣY value. Repeat the procedure if necessary.

   e. The downward force of the CHLOE slope wheels should be between 150 and 160 lbs. To check this a bathroom scale and two wooden blocks of the same thickness as the scale are needed. Pull the CHLOE carriage wheels onto the

APPENDIX B

Test Results of IJK Roadmeter and South Dakota Unit

TEST RESULTS OF IJK ROADMETER AND SD UNIT

COUNTY	ROUTE	BMP	EMP	PAVE TYPE	IJK (LPV)	LT IRI (M/KM)	RT IRI (M/KM)	AVG IRI (M/KM)
3	9	270.13	276.72	1	3.24	2.46	2.54	2.50
3	9	276.72	277.96	1	4	1.78	1.93	1.86
28	13	27.92	39.54	1	3.28	1.98	2.47	2.23
38	14	138.22	144.15	1	3.38	2.23	2.43	2.33
40	17	54.42	56.02	1	3.83	1.84	2.34	2.09
40	17	39.75	46.92	1	3.68	1.79	2.16	1.98
40	17	32.76	36.54	1	3.64	2.07	2.50	2.29
40	17	36.54	39.75	1	3.15	2.87	3.13	3.00
40	17	46.92	49.56	1	3.40	2.15	2.50	2.33
22	18	300.75	303.68	1	3.76	1.69	1.44	1.57
94	20	121	124.1	1	4.03	1.48	1.51	1.50
28	20	282.71	293	1	4.02	1.44	1.65	1.55
40	20	141.50	149.50	1	3.83	1.81	2.05	1.93
40	20	141.50	149.50	1	3.76	1.81	1.94	1.88
94	20	121	124.1	1	4.07	1.60	1.90	1.75
94	20	124.87	125.54	1	3.53	2.31	2.08	2.20
94	20	124.1	124.87	1	3.88	1.89	2.04	1.97
94	20	129.21	134.32	1	4.02	1.69	2.01	1.85
94	20	129.21	134.32	1	4.05	1.41	1.57	1.49
10	20	254.19	260.64	1	3.89	1.81	2.03	1.92
94	20	125.54	129.21	1	4.00	1.54	1.61	1.58
10	20	248.67	254.19	1	3.91	1.67	1.97	1.82
40	20	136.10	140.09	1	4.11	1.60	2.16	1.88
10	20	260.64	266.7	1	3.67	2.00	2.20	2.10
40	20	140.09	141.50	1	3.76	1.86	2.19	2.03
10	20	245.23	248.67	1	3.99	1.59	1.90	1.75
40	20	134.32	136.10	1	3.94	1.59	1.84	1.72
94	20	115.86	121	1	3.92	1.66	2.12	1.89
94	20	115.86	121	1	4.07	1.43	1.57	1.50
94	20	124.1	124.87	1	3.89	1.74	1.85	1.80
94	20	125.54	129.21	1	4.02	1.61	1.99	1.80
94	20	124.87	125.54	1	3.92	1.73	1.78	1.76
10	20	254.19	260.64	1	3.78	1.86	1.99	1.93
10	20	248.67	254.19	1	3.88	1.64	2.05	1.85
40	20	136.10	140.09	1	4.14	1.37	1.90	1.64
10	20	260.64	266.7	1	3.80	1.92	2.12	2.02
40	20	134.32	136.10	1	3.90	1.82	2.23	2.03
10	20	245.23	248.67	1	3.89	1.52	1.98	1.75
40	20	140.09	141.50	1	3.76	1.83	2.02	1.93
40	35	131.00	133.85	1	3.87	1.75	1.63	1.69
40	35	126.01	131.00	1	4.05	1.35	1.57	1.46

PAVEMENT TYPE 1= PCC
2= CRC
3= COMP
4= ACC
5= SC OVER ACC
6= SC OVER COMP

TEST RESULTS OF IJK ROADMETER AND SD UNIT

COUNTY	ROUTE	BMP	EMP	PAVE TYPE	IJK (LPV)	LT IRI (M/KM)	RT IRI (M/KM)	AVG IRI (M/KM)
40	35	131.00	133.85	1	4.06	1.85	2.17	2.01
28	38	85.94	96.95	1	3.03	2.54	2.85	2.70
28	38	74.17	81.84	1	2.95	2.73	3.10	2.92
28	38	68.41	73.58	1	3.08	2.48	2.78	2.63
28	38	82.95	85.41	1	3.06	2.37	2.71	2.54
94	50	0.00	6.16	1	3.59	1.87	2.31	2.09
3	51	0.3	3.17	1	3.12	2.92	2.96	2.94
3	51	3.17	10.87	1	2.88	2.73	2.77	2.75
94	169	152.96	156.7	1	3.88	1.73	1.98	1.86
94	169	159.24	166.49	1	3.43	2.24	2.38	2.31
40	175	156.45	158.20	1	3.71	2.66	2.81	2.74
38	175	192.15	197.10	1	3.19	2.66	2.56	2.61
42	175	187.93	192.15	1	3.24	2.47	2.51	2.49
38	214	0.00	5.04	1	3.26	2.56	2.58	2.57
10	380	48.62	55.36	1	3.76	1.90	2.16	2.03
10	380	48.62	55.36	1	3.71	1.76	2.06	1.91
40	35	143.94	150.10	2	4.03	1.57	1.66	1.62
40	35	133.85	139.88	2	4.15	1.49	1.59	1.54
40	35	133.85	139.88	2	4.14	1.60	1.66	1.63
40	35	126.01	128.86	2	4.08	1.66	2.00	1.83
40	35	139.88	143.94	2	3.53	2.11	2.21	2.16
40	35	128.86	131.00	2	3.91	1.75	2.15	1.95
28	3	292.1	297.63	3	3.31	1.37	1.55	1.46
28	3	277.88	280.75	3	3.39	1.32	1.44	1.38
28	3	281.63	284.48	3	3.38	1.35	1.59	1.47
28	3	284.48	292.1	3	3.29	1.46	1.62	1.54
3	9	282.25	284.51	3	2.85	2.53	3.07	2.80
3	9	287.91	290.13	3	3.21	2.1	2.24	2.17
3	9	293.25	294.46	3	3.09	2.36	2.57	2.47
28	13	48.21	53.63	3	3.02	2.20	2.77	2.49
28	13	43.44	48.21	3	3.02	2.04	2.70	2.37
38	14	113.56	123.53	3	4.08	0.70	0.79	0.75
38	14	131.22	138.22	3	3.67	1.44	1.75	1.60
38	14	123.53	129.72	3	2.68	2.50	2.65	2.58
40	17	56.33	62.28	3	3.45	1.13	1.53	1.33
22	18	300	300.75	3	3.49	1.46	1.61	1.54
22	18	295.87	300	3	3.82	1.31	1.46	1.39
42	20	161.26	171.68	3	3.84	1.45	1.64	1.55
42	20	174.56	185.95	3	2.92	2.11	2.39	2.25
38	20	187.97	191.42	3	2.80	2.11	2.58	2.35
42	20	187.25	187.97	3	2.96	1.94	2.27	2.11

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TEST RESULTS OF IJK ROADMETER AND SD UNIT

COUNTY	ROUTE	BMP	EMP	PAVE TYPE	IJK (LPV)	LT IRI (M/KM)	RT IRI (M/KM)	AVG IRI (M/KM)
94	20	108.30	115.86	3	3.10	1.87	2.07	1.97
40	20	158.93	161.26	3	3.68	1.33	1.62	1.48
38	20	208.16	220.43	3	3.58	1.43	1.58	1.51
94	20	121.11	124.87	3	3.77	1.34	1.56	1.45
3	52	123.54	124.75	3	3.57	1.24	1.34	1.29
38	57	8.21	13.10	3	3.78	1.15	1.25	1.20
42	65	138.86	148.67	3	3.61	1.54	1.65	1.60
42	65	132.59	138.86	3	3.51	1.66	1.83	1.75
42	65	125.97	132.59	3	3.34	1.70	1.87	1.79
40	69	147.90	153.79	3	3.38	1.60	1.76	1.68
40	69	128.81	135.65	3	3.30	1.88	1.91	1.90
40	69	137.64	147.75	3	3.32	1.92	2.19	2.06
10	150	29.02	40.05	3	3.29	2.30	2.15	2.23
10	150	41.67	52.1	3	3.37	2.37	2.41	2.39
10	150	52.1	53.68	3	3.79	1.67	2.06	1.87
94	169	133.39	137.25	3	3.70	1.80	1.95	1.88
94	169	143.83	152.96	3	2.93	2.39	2.81	2.60
94	169	137.25	143.83	3	2.87	2.54	2.99	2.77
94	169	166.49	168.25	3	3.92	1.11	1.18	1.15
38	175	204.79	216.81	3	3.10	1.72	2.05	1.89
42	175	178.41	185.22	3	3.23	1.91	2.16	2.04
94	175	126.58	128.36	3	3.36	1.92	2.35	2.14
40	928	13.64	16.05	3	3.41	1.67	1.71	1.69
40	928	20.19	27.25	3	3.32	1.68	1.90	1.79
40	928	10.20	13.64	3	3.13	2.35	2.55	2.45
40	928	30.82	34.93	3	3.60	1.28	1.50	1.39
40	928	27.25	30.82	3	3.86	1.25	1.47	1.36
94	7	62.17	73.41	4	2.70	2.69	2.90	2.80
3	9	290.13	293.25	4	3.42	1.89	1.88	1.89
3	9	279.33	282.25	4	2.9	2.73	3.03	2.88
3	9	284.51	287.91	4	3.12	2.53	2.68	2.61
28	13	39.54	40.81	4	3.28	1.51	1.51	1.51
28	20	269.24	275.66	4	3.70	1.23	1.18	1.21
28	20	275.66	282.71	4	3.65	1.13	1.10	1.12
28	20	283.02	293	4	3.50	2.46	2.39	2.43
10	20	266.7	269.24	4	3.49	1.62	1.65	1.64
40	20	157.82	158.93	4	2.82	2.74	3.45	3.10
28	20	269.24	275.66	4	3.62	1.02	1.10	1.06
28	20	275.66	283.02	4	3.84	1.21	1.13	1.17
10	20	266.7	269.24	4	3.51	1.39	1.43	1.41
3	76	7.54	11.55	4	3.38	1.35	1.38	1.37

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TEST RESULTS OF IJK ROADMETER AND SD UNIT

COUNTY	ROUTE	BMP	EMP	PAVE TYPE	IJK (LPV)	LT IRI (M/KM)	RT IRI (M/KM)	AVG IRI (M/KM)
22	76	5.49	7.54	4	2.87	1.74	3.2	2.47
3	76	31.09	49.86	4	3.3	1.96	2.06	2.01
3	76	11.55	28.16	4	3.12	2.15	2.24	2.20
94	144	30.48	34.48	4	3.34	2.59	2.37	2.48
94	175	117.65	122.76	4	3.43	1.36	1.57	1.47
40	175	158.95	164.53	4	3.40	2.13	2.20	2.17
40	175	138.75	144.74	4	3.47	1.57	2.08	1.83
94	175	129.20	137.30	4	3.50	1.68	2.12	1.90
94	175	111.65	117.65	4	3.79	1.13	1.23	1.18
40	175	145.65	153.65	4	3.47	2.00	1.81	1.91
42	175	164.53	172.21	4	3.56	2.10	2.13	2.12
42	215	0.40	7.75	4	3.06	2.67	2.93	2.80
10	283	0.32	5.86	4	2.43	3.47	3.98	3.73
42	299	0.49	5.56	4	3.10	2.48	2.74	2.61
42	359	0.89	7.39	4	3.13	1.85	2.49	2.17
3	26	0.79	10.74	5	3.05	2.67	2.81	2.74
10	187	0	10.14	5	3.81	2.45	2.51	2.48
10	187	10.14	12.17	5	3.68	2.13	2.22	2.18
10	281	24	31.41	5	3.41	2.08	2.32	2.20
10	281	22.24	23.45	5	3.25	2.68	2.88	2.78
10	282	0.69	5.28	5	3.76	2.86	2.80	2.83
3	364	0	5.79	5	2.82	2.86	3.45	3.16
10	939	10.03	21.59	6	3.62	2.66	2.69	2.68
10	939	0.51	7.89	6	3.38	2.70	2.46	2.58

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