IOWA'S CHLOE PROFILOMETER CORRELATION PROCEDURE

To Be Presented At The Pavement Profile Measurement Seminar And FHWA Demonstration Project No. 72 Open House

Fort Collins, Colorado
October 5-8, 1987

Highway Division
Iowa Department of Transportation

Iowa's CHLOE Profilometer Correlation Procedure

by

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ABSTRACT

The Iowa DOT has been correlating its roadmeters to the CHLOE Profilometer since 1968. The same test method for the Present Serviceability Index (PSI) deduction from the pavement condition (crack and patch) survey has also been used since 1968. Resulting PSI measurements on the Interstate and Primary Highway Systems have had good continuity through the years due to these test procedures. A computer program called PSITREND has been developed to plot PSI versus year tested for every rural pavement section in the State of Iowa. PSITREND provides pavement performance trends which are very useful for prediction of rehabilitation needs and for evaluation of new designs or rehabilitation techniques. The PSITREND data base should be maintained through future years to expand on nineteen years of historical PSI test information already collected.

Iowa's CHLOE Profilometer Correlation Procedure

INTRODUCTION AND BACKGROUND INFORMATION

The Iowa Department of Transportation has been performing a Present Serviceability Index (PSI) inventory of its Interstate and Primary Highway Systems since 1968. The Portland Cement Association (PCA) Roadmeter was used to measure rideability from 1968 to 1973, and the Iowa-Johannsen-Kirk (IJK) Ride Indicator was used to determine smoothness from 1974 to present. Both the PCA Roadmeter and the IJK Ride Indicator are commonly referred to as roadmeters in Iowa. Since 1968, both the PCA Roadmeters and IJK Ride Indicators have been annually correlated to the CHLOE Profilometer in early June on thirty to fifty one-half-mile test sections. The CHLOE Profilometer ties Iowa's PSI measurements to equations developed at the AASHO Road Test at Ottawa, Illinois, in the late 1950's. The CHLOE Profilometer also yields reproducible values from year to year and provides a good calibration standard for the less time stable IJK Ride Indicators.(1)

One third of the state was tested annually with either the PCA Roadmeter or the IJK Ride Indicator from 1968 to 1984. This produced a three-year test cycle which was changed to a two-year test cycle in 1985. Testing one half of the state annually generates up-to-date test information and provides more data points for PSI performance trends.

The crack and patch survey for the PSI deduction is performed by District Materials technicians during the winter months on the entire Interstate and Primary Highway Systems. This has been done every third winter from 1968 through 1983, and every other winter from 1985 to present. The crack and patch survey is conducted in a similar manner as was developed at the AASHO Road Test (see Iowa Test Method No. 1004-D in Appendix B). Supplemental measurements to the PSI deduction, such as D-crack Occurrence Factor (DOF), were added to the crack and patch survey in 1981 for pavement management purposes. The same test method for the PSI deduction has been used, however, from 1968 to present.

Since the CHLOE Profilometer has been used to calibrate roadmeters in Iowa since 1968, and since the crack and patch survey for the PSI deduction has been performed by the same test method since 1968, it is possible to use a computer program called PSITREND to plot PSI performance trends for every rural pavement section in the State of Iowa. Present Serviceability Index versus year tested is plotted by PSITREND, but 18 Kip Equivalent Single Axle Load information is available and can be plotted against PSI by the computer in the future.

CHLOE PROFILOMETER CORRELATION PROCEDURE

At the AASHO Road Test, a testing device called the AASHO Profilometer was developed to measure the variation in the longitudinal profile.(2) This unit was too expensive for general use by state highway agencies so a simpler, less expensive device called the CHLOE Profilometer was developed.(3) The CHLOE Profilometer is named after the engineers who designed it: Carey, Huckins, Leathers and other engineers. The Iowa State Highway Commission purchased its CHLOE Profilometer in 1964.

The CHLOE principle of operation is based on slope variance of the surface profile as measured by two 8-inch wheels spaced 9 inches apart and under 150 lbs. of pressure. A roller contact on the upright arm fastened at the pivot point between the wheels measures arm movement at six-inch intervals and hence slope variance through 29 electrical contacts. CHLOE test data is reliable but since the maximum operating speed is 5 mph, it is a better calibration device than an inventory tool. The CHLOE Profilometer is also prone to both mechanical and electrical breakdowns, especially now since it is 23 years old. The test procedure for operating the CHLOE Profilometer is described in Iowa Test Method No. 1003-A in Appendix B.

About fifty carefully selected one-half-mile test sections of portland cement concrete pavement were originally selected for the CHLOE correlation with the PCA Roadmeter. The one-half-mile test section length is short enough for the slow CHLOE Profilometer at 3 mph but also long enough for the PCA Roadmeter and IJK Ride Indicator at 50 mph. Both wheeltracks are tested with the CHLOE Profilometer and values averaged for correlation purposes. Since both wheeltracks influence roadmeter readings, this technique improves the correlation coefficient. Portland cement concrete pavements with as little deterioration as possible are selected as test sections since only the profile portion of the Present Serviceability Index is used. Portland cement concrete pavements are less variable from year to year than asphaltic concrete pavements which may also have open surface textures. Table 1 in Appendix A illustrates how a historical record of CHLOE slope variance values on test sections can be used to monitor proper operation of the CHLOE Profilometer itself. Test sections have a Present Serviceability Index range of 2.6 to 4.8. Lower PSI values can be found, but these roadways usually have badly broken-up faulted portland cement concrete pavement which is highly variable from year to year.

A computer program which uses a method of least squares parabolic fit correlates test data. This method allows a curve if it obtains a better correlation coefficient than a straight-line equation. Original test sections used in 1985 resulted in a straight-line fit, clusters of points, and few very rough test sections. Fifty test sections in four different counties were used requiring two weeks of work for the CHLOE correlation procedure (see Figure 1 in Appendix A). Thirty-two test sections in two counties close to Ames, Iowa, were selected in 1986 which had a better distribution of roughness. Only one week of work was required in 1986 to complete the CHLOE correlation analysis (see Figure 2 in Appendix A). Unfortunately, many of the rough CHLOE test sections are repaired by county engineers annually. This occurred in 1987 reducing the number of test sections to twenty (see Figure 3 in Appendix A). In addition, the CHLOE Profilometer malfunctioned in 1987 further reducing the number of test sections to eighteen. More test sections will be located and added in 1988. The CHLOE Profilometer has been repaired.

Please note that the same IJK Ride Indicator (vehicle and IJK mechanism) had maximum counts (sum/length) of 2000, 3000 and 6000 in 1985, 1986 and 1987, respectively. This illustrates the benefit of correlating IJK Ride Indicators to the CHLOE Profilometer on an annual basis. Large changes in IJK mechanism behavior due to winter overhaul, maintenance, wear, etc., can be handled by the CHLOE correlation procedure to yield the correct PSI. Two IJK Ride Indicators can also be used simultaneously to test one-half of the state annually as was done in 1986 and 1987. Both units give comparable PSI measurements due to the CHLOE correlation procedure (see Figure 4 in Appendix A).

Computer-generated charts are produced by the CHLOE correlation procedure for use by IJK Ride Indicator operators (see Iowa Test Method 1002-B in Appendix B). The charts are adjusted by adding sets of zeroes (0, 0) to the CHLOE correlation procedure so that the portland cement concrete sum/length value aligns as closely as possible with a Longitudinal Profile Value (LPV) of 5.00. The number of sets of zeroes is noted on each CHLOE correlation plot (see Figures 1-4 in Appendix A).

IJK RIDE INDICATOR TEST PROCEDURE

The IJK Ride Indicator Test Procedure is well-described in Iowa Test Method No. 1002-B in Appendix B. Weekly checks on up to eight CHLOE test sections of various roughness close to Ames, Iowa, are used to ensure that the IJK Ride Indicator is providing results consistent to those obtained during calibration. Weekly checks should be within 10% of CHLOE correlation values (see Table 2 in Appendix A). For most minor repairs, the IJK Ride Indicator can be adjusted to weekly check test sections and the same charts used without recorrelating to the CHLOE Profilometer. In addition, the PSI values for each county are compared to previous PSI results to check for reasonableness. At least 70% of the PSI values should be the same or less than the previous PSI determination. If not, the IJK Ride Indicator should be recalibrated and the county retested if necessary. PSI performance trends were also used for the first time in 1987 to check PSI values for reasonableness (see Figures 5-8 in Appendix A). Since IJK Ride Indicators are mechanical and rely on friction between the brush contact and contact board for dampening, they are subject to wear. IJK Ride Indicators are not very time stable. Therefore, weekly checks and comparisons with previous PSI values (and trends) are necessary to verify quality test information.

PSI PERFORMANCE TRENDS

PSITREND is a computer program that plots PSI versus year tested. In 1985, all PSI values (including new construction PSI values where available) were coded into the PSITREND data base. Checking and correcting of all PSITREND data points was completed in September 1987 for the entire Interstate and Primary Highway Systems. Examples of PSITREND plots are shown in Figures 5-8 of Appendix A. Construction histories are as follows:

Figure 5 - I-35 PC NB MP 155.21 to MP 161.05 Franklin Co.
From Wright Co. line north
1975 8" CRC, 4" CTB, Alden Class III Agg.

Figure 6 - IA 223 AC MP 7.30 to MP 12.24 Jasper Co.
From Baxter to IA 14
1956 2" BAC, 6" RSB, 6" SAS
1971 1" BAC, 2" TBB

Figure 7 - I-29 PC SB MP 112.23 to MP 119.59 Monona Co.
From Onawa north
1961 10" PC, 4" GSB, Gilmore City Class III Agg.

Figure 8 - US 59 AC MP 160.48 to MP 170.03 Cherokee Co.
From Cherokee north to O'Brien Co. Line
1937 7.5" PC, Larrabee Class II Agg.
1974 3" AC

PSITREND has a horizontal warning line at PSI equals 2.70. This warning line was derived by subtracting the pavement management critical crack and patch PSI deduction (0.50) from the critical longitudinal profile value (3.20). Pavements may need rehabilitation above or below this line depending on level of service, type of pavement, class of aggregate, etc.

PSI values have been obtained on all new construction since 1980 for pavement management purposes. All new pavement designs, rehabilitation techniques, etc., are automatically tracked by PSITREND to determine performance. Since PSITREND plots have just recently become available, Iowa DOT engineers have a large amount of objective data to evaluate. Pavement performance over the past nineteen years gives a good indication of future performance. Top management at the Iowa DOT can use this information to support planning and design decisions.

CONCLUSIONS

PSITREND plots indicate that the CHLOE correlation procedure has worked very well from 1968 to present. Since nineteen years of PSI test data has already been collected, every effort should be made to maintain the PSITREND data base in future years.

REFERENCES

1. Marks, Vernon J., The IJK Ride Indicator, Iowa Department of Transportation, Division of Highways, Office of Materials, Special Investigations Section, 1976.

2. Less, Ronald D., Investigating Pavement Surface Variations, Final Report R-250 and HR-152, Iowa State Highway Commission, Materials Department, Central Laboratory, 1974.

3. National Academy of Sciences--National Research Council, The AASHO Road Test: Proceedings of a Conference Held May 16-18, 1962, St. Louis, Mo. HRB Special Report 73, 1962.

APPENDIX A

TABLE 1

SUMMARY OF CHLOE

PROFILOMETER VALUES ON CALIBRATION SECTIONS

Sec.	CHLOE SLOPE VARIANCE														
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1	-	-	-	5.46	6.92	4.30	4.96	6.38	5.75	6.67	5.06	4.48	6.33	7.34	6.20
2	-	-	-	5.42	6.78	4.57	5.55	4.18	4.21	6.41	5.25	4.78	6.40	5.30	5.83
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	7.36	8.87	7.72	8.63	9.84	8.40	10.44	11.55	10.35	12.60	13.40	-	-	-	-
6	-	34.48	38.42	34.19	37.23	35.08	36.78	37.34	36.01	38.64	42.10	43.63	45.58	43.93	44.16
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	-	26.80	26.56	26.00	27.75	28.49	31.16	30.87	31.01	32.46	37.18	-	-	-	-
10	9.03	9.25	9.42	9.64	9.98	7.80	10.38	10.13	8.94	11.61	11.28	-	-	-	-
11	9.04	9.35	9.02	10.44	9.11	8.38	9.39	8.57	9.42	8.82	10.44	9.51	10.07	10.29	10.74
12	8.33	9.17	8.04	9.26	8.91	8.21	7.89	8.21	7.55	7.24	7.60	9.04	9.48	9.44	10.96
13	6.93	8.30	7.95	8.17	7.94	7.25	9.18	8.29	6.91	8.90	8.34	8.82	9.73	9.85	10.63
14	8.73	8.41	8.38	8.85	8.64	7.64	9.85	8.20	7.56	8.06	8.53	9.23	9.09	8.23	9.09
15	9.84	10.23	9.86	9.78	10.12	9.03	9.95	-	-	-	-	-	-	-	-
16	10.74	10.77	-	10.40	9.99	9.03	8.84	-	-	-	-	-	-	-	-
17	-	-	8.35	8.99	8.98	7.88	9.87	-	-	-	-	-	-	-	-
18	-	-	7.16	8.54	8.19	6.03	8.87	-	-	-	-	-	-	-	-
19	-	Dirt	-	6.37	9.95	5.87	6.71	7.55	-	-	-	-	-	-	-

1979

IOWA STATE HIGHWAY COMMISSION
Materials Department
DATA SHEET

TABLE 2

Weekly Road Meter Checks

DATE	TIME	1	2	6	11	12	13	14
		343	335	4286	1267	878	970	1360
[illegible]2-79	8:30	359	368	4529	1281	809	1045	1241
7-9-79	8:00	345	358	4221	1217	793	963	1262
7-12-79	5:00	374	362	4058	1277	819	951	1232
7/19/79	5:00	321	341	4567	1269	837	970	1378
7-26	5:20	366	351	4692	1379	867	1054	1452
8-6	9:30	359	363	CONST.	1142	816	907	1227
8-13	8:30	331	365	"	1385	951	1058	1467
8-15	4:00	314	366	"	1383	862	943	1472
11/1	3:00	319	305	changed	1162	793	887	const. changed
11/8	3:30	311	320	"	1149	801	889	"
11/19	8:00 AM	529	313	"	1163	800	1051	"
[illegible]-26	1:30	322	315	"	1150	800	960	"

FIGURE 1

1985 FORD ROADMETER CORRELATION

09/05/1985 NO ZEROES ADDED

CHLOE = 3.593905 + 0.0121709*RM

C.C. = 0.9745

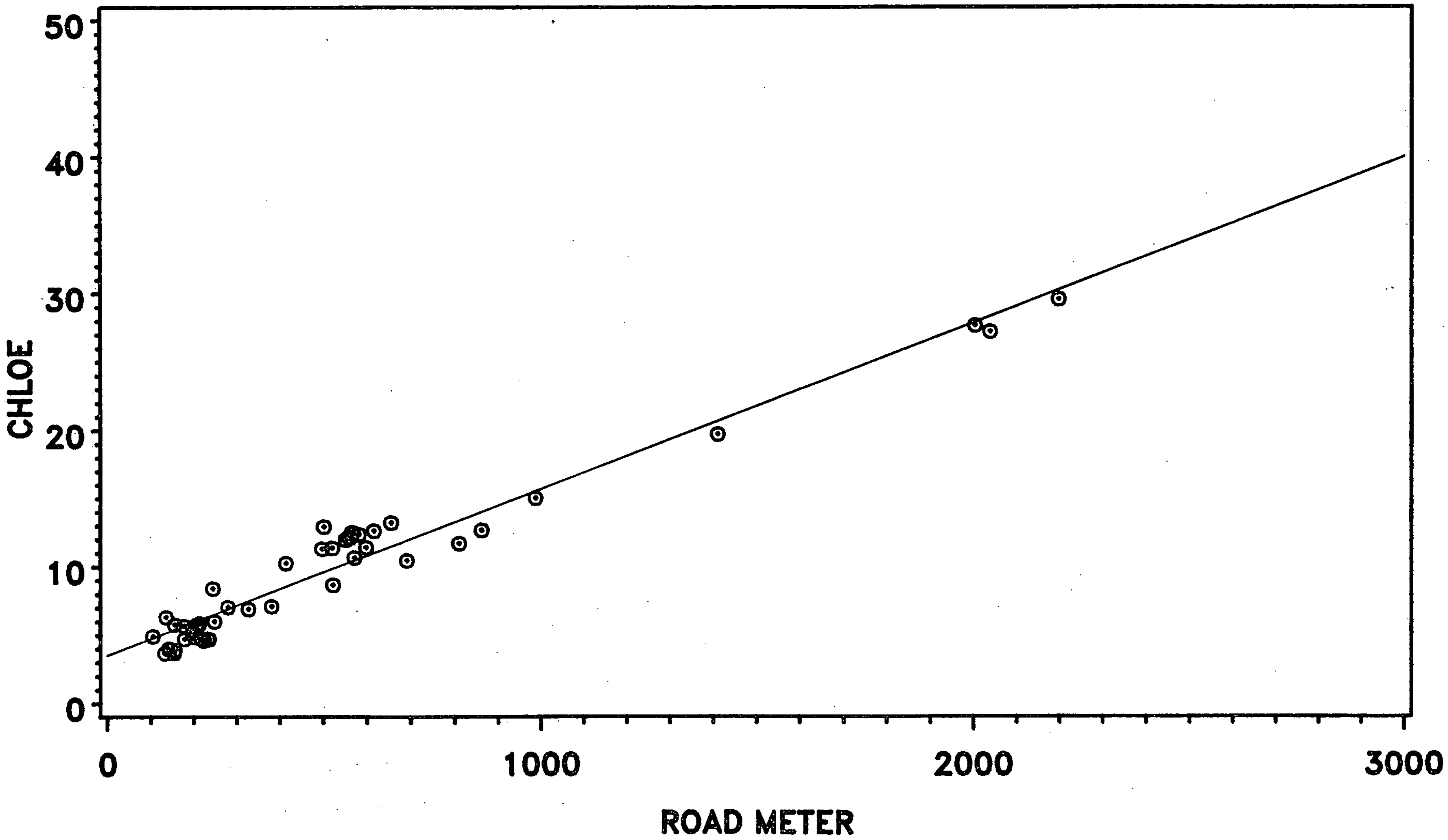


FIGURE 2

1986 FORD ROADMETER CORRELATION

06/09/1986 SIX ZEROES ADDED

CHLOE = 3.994229 + 0.0098383*RM

C.C. = 0.9409

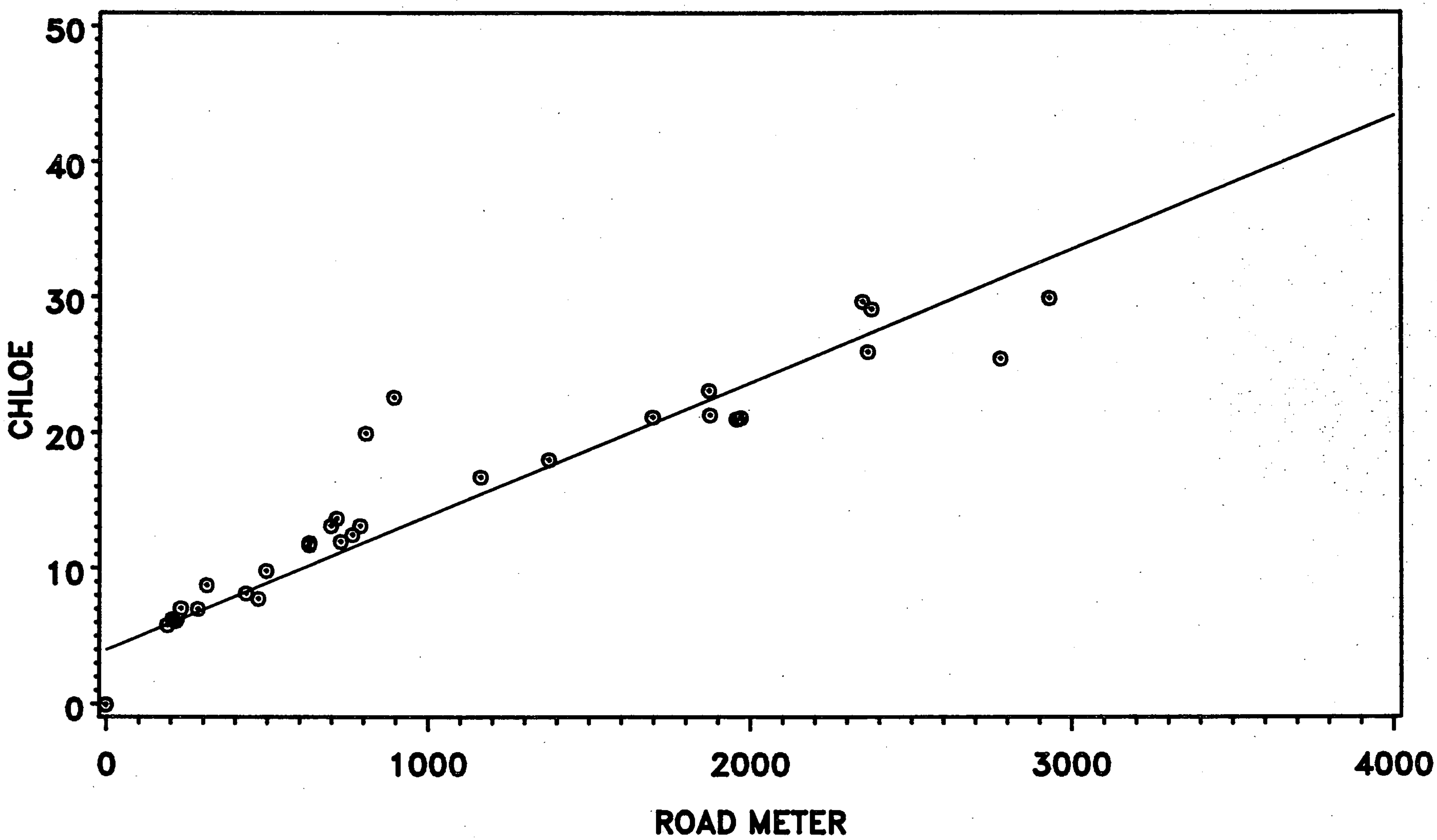


FIGURE 3

1987 FORD ROADMETER CORRELATION

07/08/1987 ONE ZERO ADDED

CHLOE = 4.563224 + 0.0046613*RM

C.C. = 0.9427

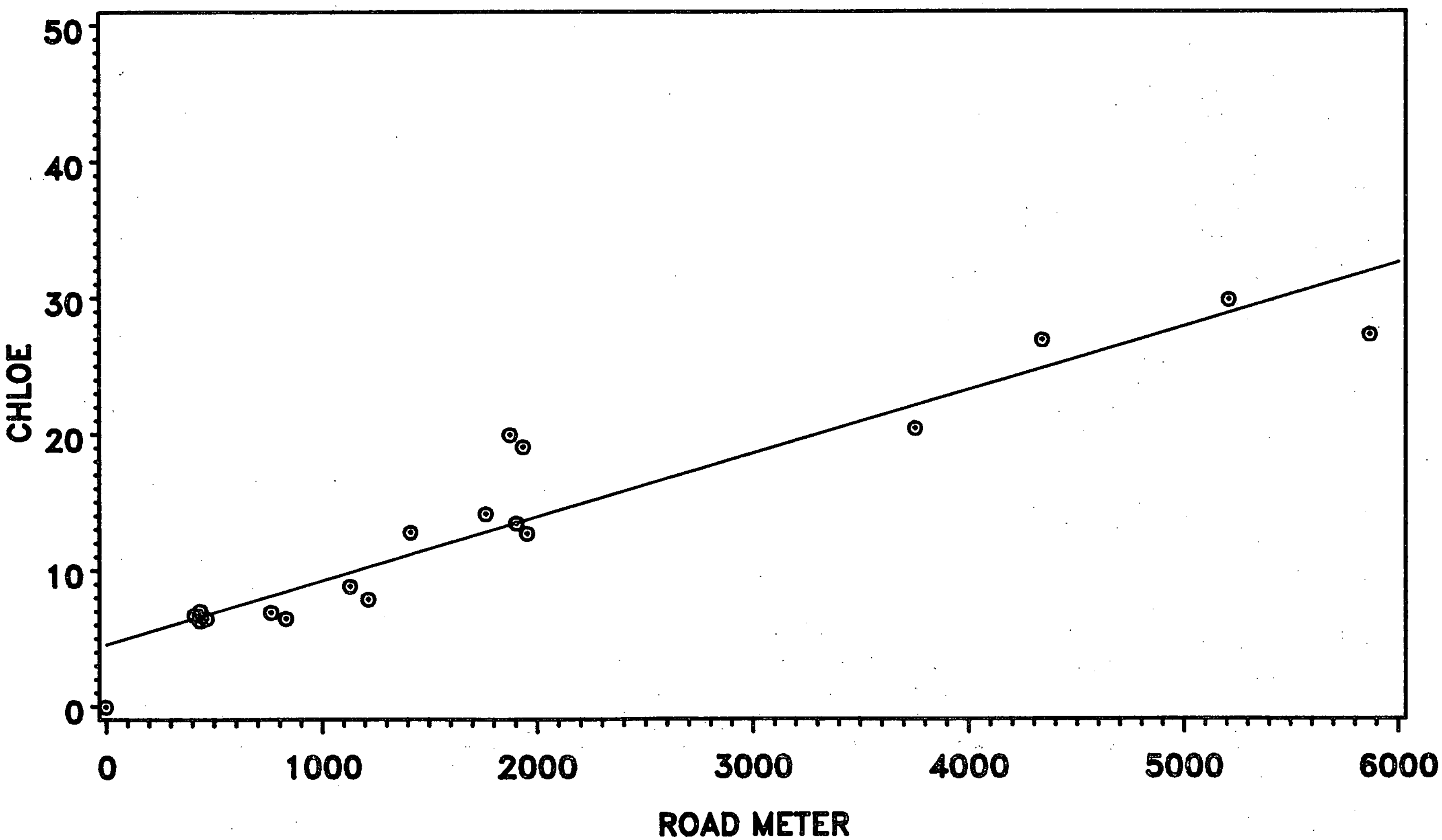


FIGURE 4

1987 GMC ROADMETER CORRELATION

07/07/87 NO ZEROES ADDED

CHLOE = 3.759048 + 0.0100052*RM

C.C. = 0.9540

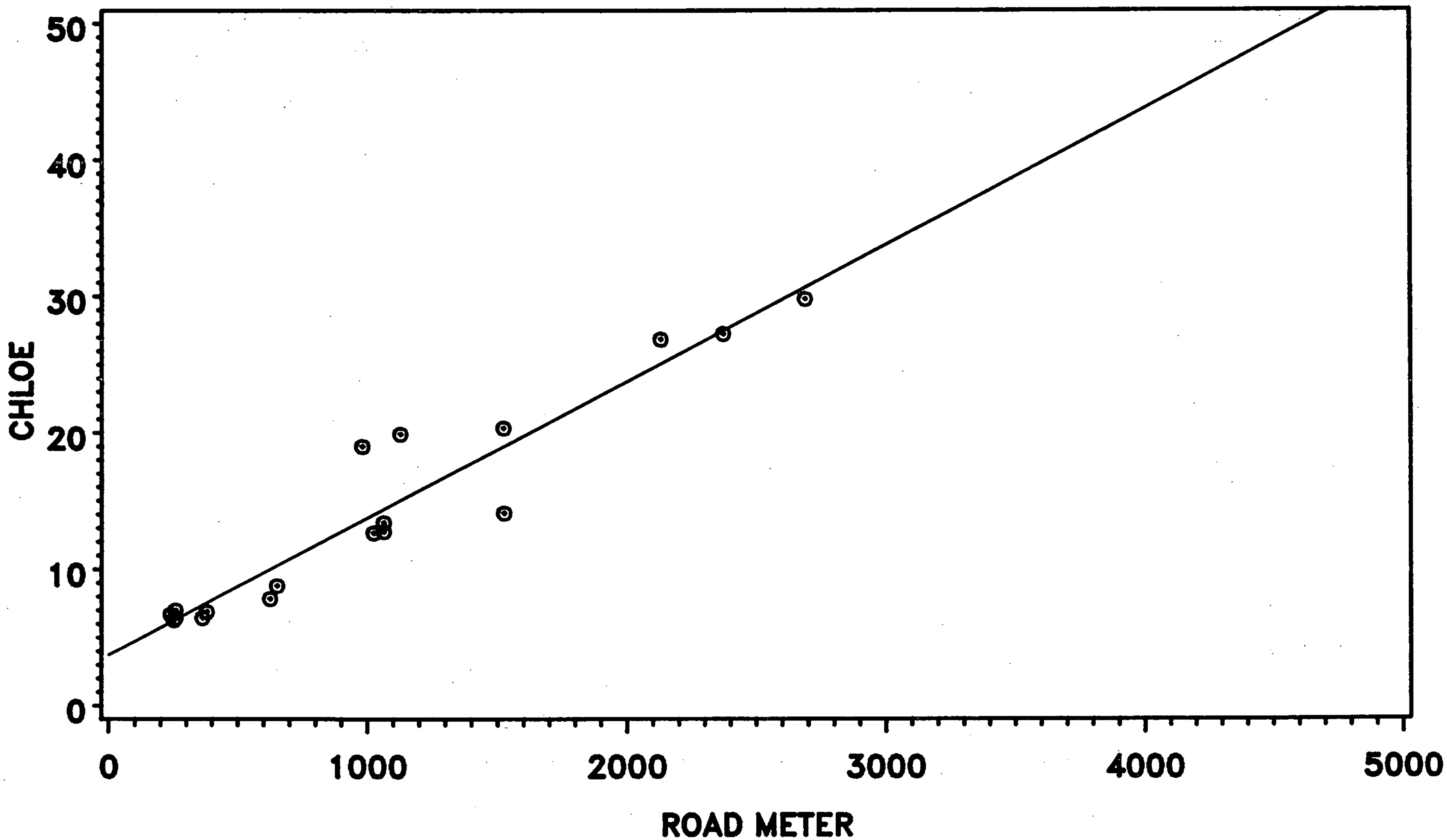


FIGURE 5

PRESENT SERVICEABILITY INDEX VS YEAR TESTED

ON I- 035 PC NB
FROM MILE POST 155.21 TO MILE POST 161.05

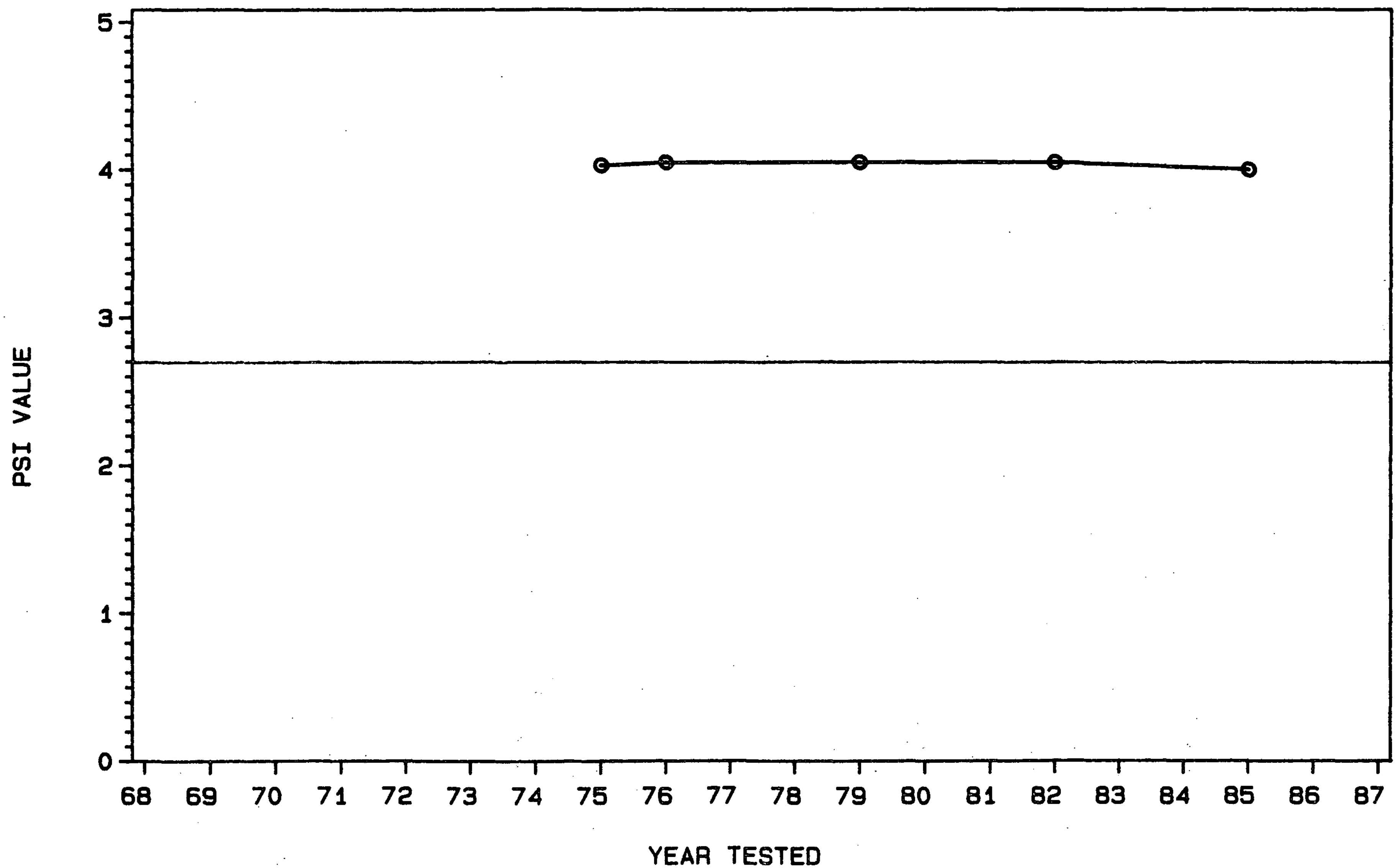


FIGURE 6

PRESENT SERVICEABILITY INDEX VS YEAR TESTED

ON IA 223 AC

FROM MILE POST 7.30 TO MILE POST 12.24

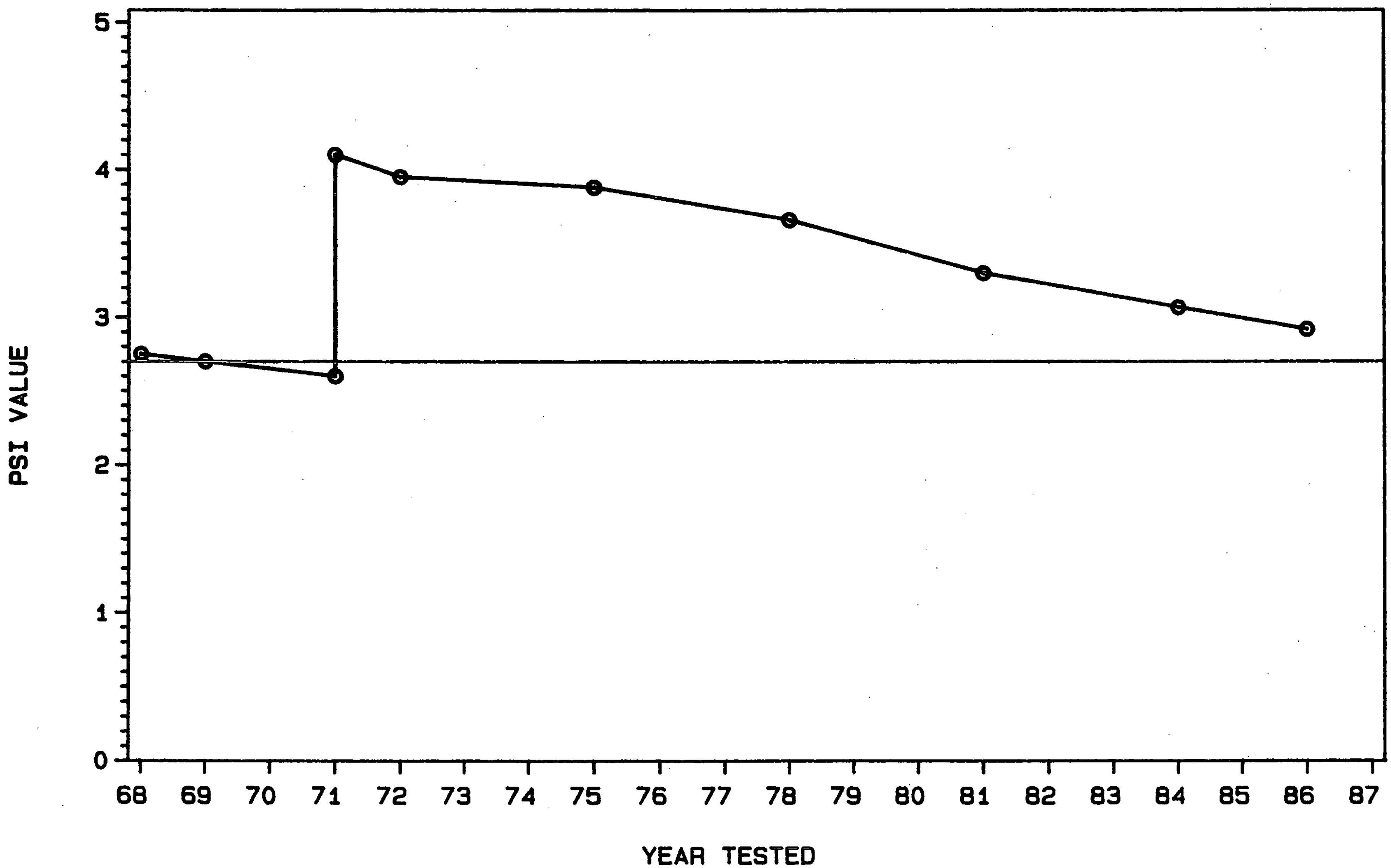


FIGURE 7

PRESENT SERVICEABILITY INDEX VS YEAR TESTED

ON I- 029 PC SB
FROM MILE POST 112.23 TO MILE POST 119.59

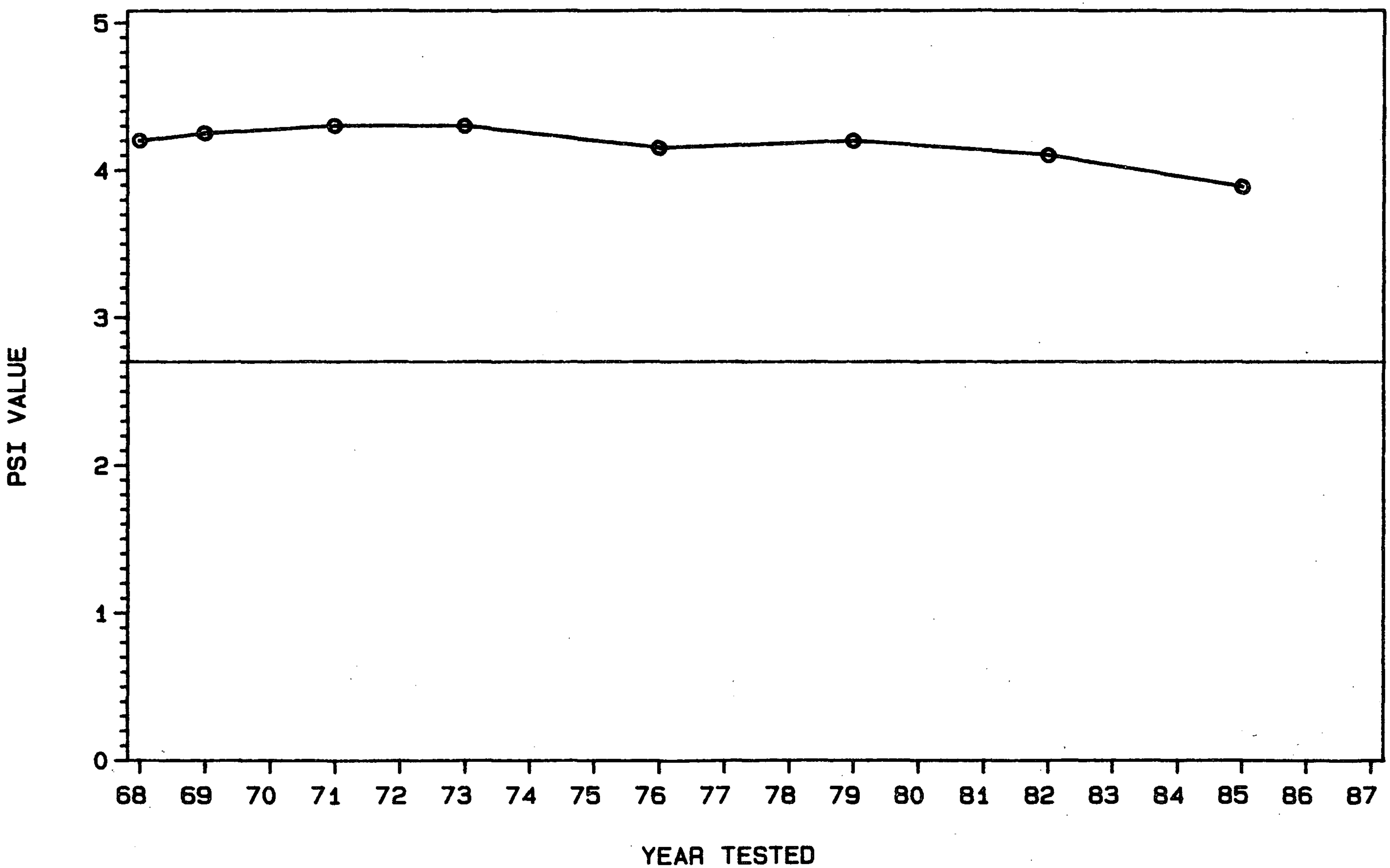
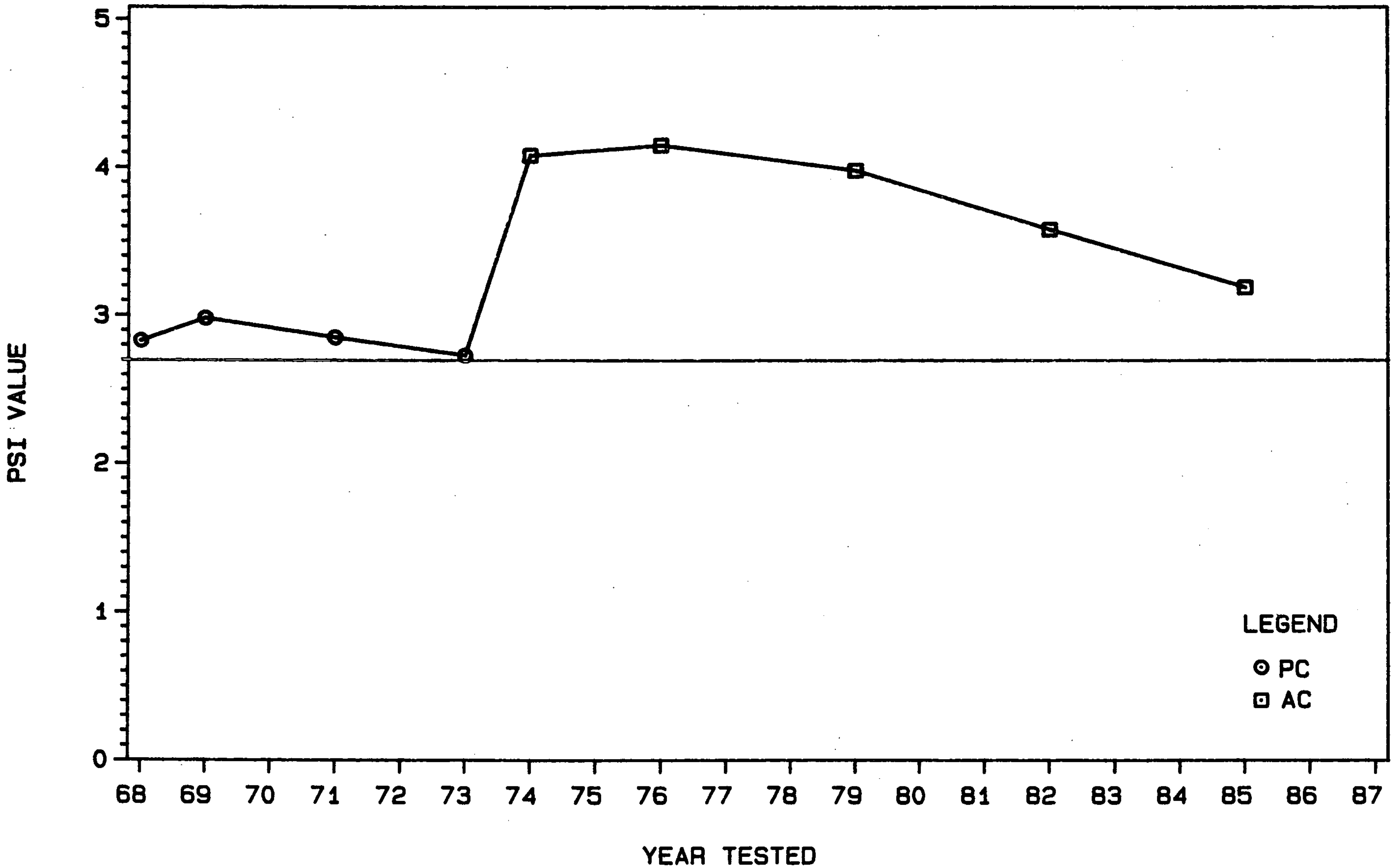


FIGURE 8

PRESENT SERVICEABILITY INDEX VS YEAR TESTED

ON US 059 AC
FROM MILE POST 160.48 TO MILE POST 170.03



APPENDIX B

Iowa Test Method No. 1002-B, March 1976

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 electro-mechanical 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.

8. Turn the main switch off while crossing railroad tracks and bridges (including approaches). This length and roughness counts are electrically omitted.

9. There is a rotary switch to change from one bank of recording counters to the other so testing can be continuous.

10. Record the counter values and calculate the Sum/L.

11. If there is some reason to indicate possible erroneous data a repeat run should be made. Valid runs are expected to check within 10% of each other.

12. Using the Sum/L, obtain the proper Longitudinal Profile Value from the table to the closest 0.05 (3.95, 4.15 etc.).

F. Precautions

1. Maintain the tire pressure at 25 psi cold, 28 psi, warm. If any tire alignment or balancing problems are noted, have them corrected.

2. Be sure to engage the IJK arm lock when not testing.

3. Keep the vehicle in a neat orderly condition.

4. Have the automobile serviced at the proper interval.

G. Calculations for Longitudinal Profile Value

1. Enter the necessary descriptive data in the heading portion of the LPV worksheet. The method of calculation is as follows: the summation of counts from counter no. 1 x 1, counter no. 2 x 2, counter no. 3 x 3, etc. These products are totaled and divided by the tested length (in miles) to obtain the Sum/L. This sum/length is then used to find the Longitudinal Profile Value from the correlation table.

H. Reporting Results

1. The final report for all testing uses the same data that was necessary for the worksheet. Form 915 is used for county inventory testing and Form 922 is used for testing individual projects. A deduction for cracking, patching and rut depth is used (from the most recent survey) to yield a Present Serviceability Index.

Fig. 1

The IJK Ride Indicator Vehicle

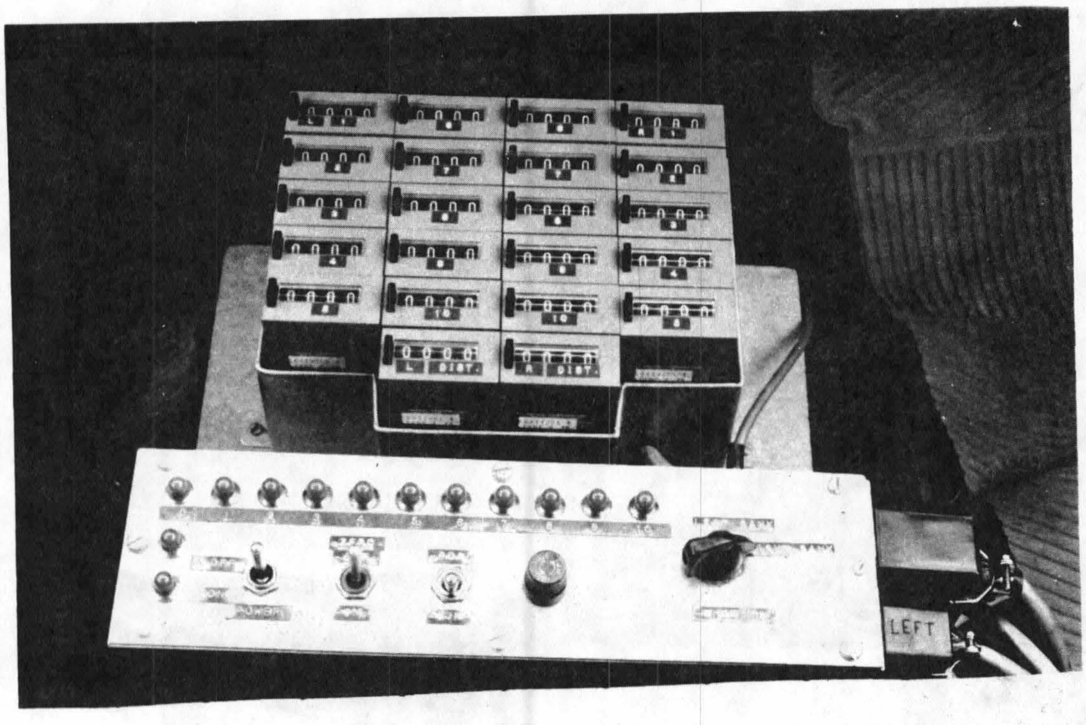


Fig. 2

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

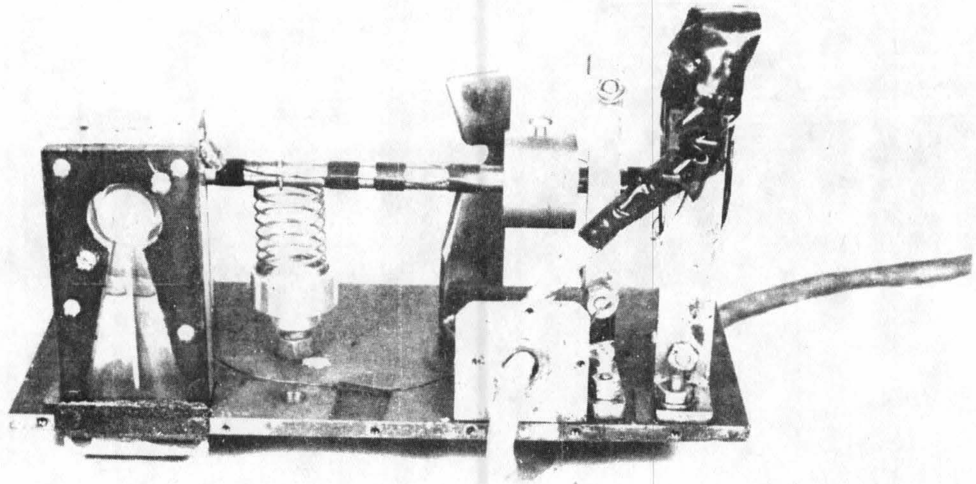


Fig. 3

The IJK Ride Indicator Sensing Unit

Fig. 4

The IJK Ride Indicator Sensing Unit with Cover as Mounted on the Rear Differential Housing of the Vehicle

CORRELATION TABLE
IJK RIDE INDICATOR UNIT E
JULY 1975

	SUM/LENGTH			SUM/LENGTH			SUM/LENGTH	
LPV	AC	PC	LPV	AC	PC	LPV	AC	PC
0.000	18770	29735	2.000	4449	7023	4.000	502	985
0.025	18462	29233	2.025	4369	6835	4.025	481	952
0.050	18159	28790	2.050	4272	6750	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	346	742
0.225	16160	25545	2.225	3693	5863	4.225	328	715
0.250	15892	25111	2.250	3615	5744	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	10916	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	3863	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	5113	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	7459	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

Unit E Worksheet

Road No. I-35 County Story Lab. No. LV
Year Built Date Tested 7-29-69 Date Reported
Contractor Hallett Construction Company Project No. I-IG-35-4(12)1
Location From Polk Co. Line to Jct. New US 30

Weather Clear Wind NE 5-8 mph Temp. 71° F.
Speed 50 mph Test Personnel Dalbey & Robinson Surface P.C.

S.T. P.C.	D. O-NB				S.T.	D. O-SB			
EMP	13.87				EMP	24.17			
BMP	3.95				BMP	14.20			
Length	9.92				Length	9.97			
1	4031	4031			1	4075	4075		
2	1794	3588			2	1740	3480		
3	412	1236			3	403	1209		
4	91	364			4	132	528		
5	25	125			5	60	300		
6	6	36			6	27	162		
7	1	7			7	12	84		
8	—	—			8	4	32		
9	—	—			9	1	9		
10	—	—			10	—	—		
Sum		9387			Sum		9879		
Sum/L		946			Sum/L		990		
LPV		4.65			LPV		4.60		

C.S.	S.T.	D.	C.S.	S.T.	D.
End			End		
Start			Start		
Length			Length		
Deduct			Deduct		
Length			Length		
1			1		
2			2		
3			3		
4			4		
5			5		
6			6		
7			7		
8			8		
9			9		
10			10		
Sum			Sum		
Sum/L			Sum/L		
RMRV			RMRV		

Notes

S.T = Surface Type D. = Direction

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. LV 6-44 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 Serviceability 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.

IOWA DEPARTMENT OF TRANSPORTATION

HIGHWAY DIVISION

OFFICE OF MATERIALS

LPV REPORT

Road No. I-35 County Story Lab Rep. No. LV-9-522

Year Built 1965 Date Tested 7-29-69 Date Reported 8-15-69

Contractor Hallett Construction Company Project No. I-IG-35-4/12/103

Project Length (Miles) 10.03 Surface Type PC

Location From Polk County line north to Junction New US 30

Weather Clear Wind NE 5-8 mph Temperature 71°

Test Personnel Dalbey and Robinson

	N Outside Bound Lane	S Outside Bound Lane
Length Tested	9.97	10.02
Longitudinal Profile Value	4.05	4.00
Average Longitudinal Profile Value		4.05
Deducation for Cracking, Patching and Rut Depth		0.05
Present Serviceability Index		4.00

Iowa Test Method No. 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 $i = 1,2,3 \cdots N$, 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 ± 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 wooden blocks, then place the scale under the slope wheels and lower them. If the scale does not read between 150 and 160 lbs., adjustment can be made by turning the 3/16" knurled screw located at the bottom of the connector box fastened to the lift motor. Turning this screw clockwise will decrease the force and turning it counterclockwise will increase the force.

f. For more detailed instructions on the operation of the CHLOE Profilometer see CHLOE Profilometer Operating and Servicing Instructions.

2. Testing Procedure

a. Set the electric eye to "road test" and lower the slope wheels.

b. Set the electronic computer indicator to a zero reading.

c. Turn the counter switch on when the slope wheels reach the beginning of a test section and turn it off at the end of the section.

d. When running a test section, the speed of the towing vehicle should be about 5 mph.

e. Record the values of N, ΣY, and ΣY^2.

f. Compute the LPV as described in "Calculations".

D. Calculations (See "Typical Calculation Example.)

1. Enter the values of N, ΣY, and ΣY^2 on lines 6, 7 and 8 respectively.

2. Divide ΣY by N to an accuracy of one ten-thousandth (0.0001) and enter on line 9.

3. Square this number and record the result to the nearest thousandth (0.001) on line 11.

4. Divide ΣY^2 by N, round the answer to the nearest thousandth, and record it on line 10.

5. Subtract line 11 from line 10 and enter the result on line 12.

6. Multiply line 12 by 8.46 to obtain the CHLOE Slope Variance (line 13).

7. Subtract 2.00 from the CHLOE Slope Variance and place the result on line 14.

8. Find the log of line 14, record it on line 15.

9. Multiply line 15 by 1.80 if the surface type is PC or 1.91 if AC, and record this result on line 17.

10. On line 16 enter 5.41 if the surface type is PC or 5.03 if the surface type is AC.

11. Subtract line 17 from line 16 to obtain the Longitudinal Profile Value (LPV) of the test section.

Precautions

A. The voltage supply to the CHLOE Profilometer from the batteries must not be less than 11.5 V.

B. The operator must watch the electronic computer indicator closely to insure that it is working properly.

Reporting of Results

Enter state, county, route no., location, project, weather, date and test personnel in the appropriate places on the work sheet.

The LPV determined by the CHLOE Profilometer may be used along with other factors to calculate a Present Serviceability Index as described in "Method of Determination of Present Serviceability Index". (Test Method No. Iowa 1004.)

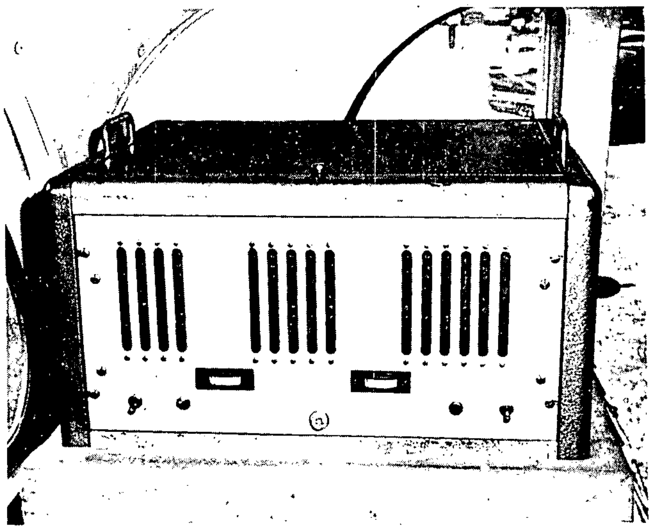


Fig. 1
Electronic Computer Indicator

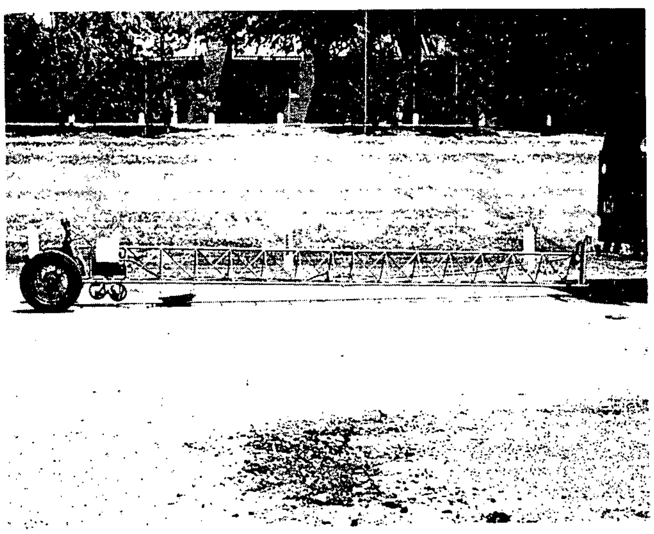


Fig. 2
CHLOE Trailer Section

TABLE I

Switch Segment	N=10 Y	Y^2
1	10	10
2	20	40
3	30	90
4	40	160
5	50	250
6	60	360
7	70	490
8	80	640
9	90	810
10	100	1,000
11	110	1,210
12	120	1,440
13	130	1,690
14	140	1,960
15	150	2,250
16	160	2,560
17	170	2,890
18	180	3,240
19	190	3,610
20	200	4,000
21	210	4,410
22	220	4,840
23	230	5,290
24	240	5,760
25	250	6,250
26	260	6,760
27	270	7,290
28	280	7,840
29	290	8,410

TYPICAL CALCULATION EXAMPLE

LPV for PC or AC Pavement

State Iowa | Location E. of Ames | Date 4-16-70

County Story | Project | Test Personnel

Route No. 13th Street | Weather

1	Section No.	10									
2	Location	1648-1673									
3	Surface Type	PC									
4	Direction	EB									
5	Wheelpath	O									
6	No. of readings (N)	4951									
7	ΣY	71733									
8	ΣY^2	1044724									
9	$(\Sigma Y/N)$	14.4886									
10	$\Sigma Y^2/N$	211.013									
11	$(\Sigma Y/N)^2$	209.920									
12	(line 10 - line 11)	1.093									
13	CSV = (line 12) x 8.46	9.247									
14	(1 + SV) = (line 13 - 2)*	7.247									
15	Log (1 + SV) = Log (line 14)	0.8596									
16	Enter 5.41 for PC, or 5.03 for AC	5.41									
17	If PC 1.80 x line 15 If AC 1.91 x line 15	1.55									
18	LPV = (line 16 - line 17)	3.86									

* SV = CSV - 3

LPV(PC) = 5.41 - 1.80 Log (1+SV)

LPV(AC) = 5.03 - 1.91 Log (1+SV)

Iowa Test Method No. 1004-C, December 1981

IOWA DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION

Office of Materials

METHOD OF DETERMINATION OF PRESENT SERVICEABILITY INDEX

General Scope

The Present Serviceability Index (PSI) was developed by the AASHO Road Test as an objective means of evaluating the ability of a pavement to serve traffic. The Present Serviceability Index is primarily a function of longitudinal profile with some influence from cracking, patching and rut depth.

The AASHO rating scale ranges from 0 to 5 with adjective designations of:

Very Poor	0 - 1
Poor	1 - 2
Fair	2 - 3
Good	3 - 4
Very Good	4 - 5

The Bureau of Public Roads has a similar scale with the following designations which are more realistic in the evaluation of new pavements:

PSI	Rating
Above 4.5	Outstanding
4.5 - 4.1	Excellent
4.1 - 3.7	Good
3.7 - 3.3	Fair
Below 3.3	Poor

The test is conducted in two parts: (1) Determination of the Longitudinal Profile Value (LPV), (2) Determination of Deduction for Cracking, Patching and Rut Depth.

Part I. Determination of the Longitudinal Profile Value

Scope:

The Iowa DOT uses three methods for determination of the longitudinal profile value:

1. CHLOE Profilometer
2. BPR Type Road Roughometer
3. IJK Type Road Meter

Test Procedure:

1. The determination of longitudinal profile value by the CHLOE Profilometer is described in Test Method No. Iowa 1003-A.
2. The determination of road roughness by the BPR Type Roughometer is described in Test Method No. Iowa 1001-A. The inches per mile as described therein is then used in conjunction with the most current correlation of road roughness (inches/mile) vs. longitudinal profile value (LPV) determined by the CHLOE Profilometer to obtain a longitudinal profile value.
3. The determination of the road meter roughness value, which is the same as the Longitudinal Profile Value, by the IJK Type Road Meter, is described in Test Method No. Iowa 1002-B.

Part II. Determination of Deduction for Cracking, Patching and Rut Depth

Scope:

The purpose of this portion of the test is to determine the value of the Present Serviceability Index lost due to physical deterioration of the roadway.

The evaluation is conducted according to general procedure established by the AASHO Road Test and described in detail in the "Highway Research Board Special Report 61E."

Test Procedure -- Flexible Pavement:

The equation for Present Serviceability Index of flexible pavement is:

$$PSI = LPV - .01\sqrt{C+P} - 1.38\,\overline{RD}^2$$

where;

PSI = Present Serviceability Index

LPV = Longitudinal Profile Value

C+P = Measures of cracking and patching of the pavement

$\overline{RD}$ = A measure of rutting in the wheel paths

Cracking, C, is defined as the square feet per 1000 square feet of pavement surface exhibiting alligator or fatigue cracking. This type of cracking is defined as load related cracking which has progressed to the state where cracks have connected together to form a grid like pattern resembling chicken wire or the skin of an alligator. This type of distress can advance to the point where the individual pieces become loosened.

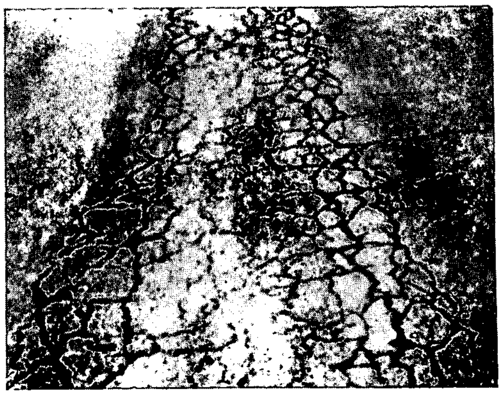


Figure 1.

Alligator cracking

Patching, P, is the repair of the pavement surface by skin (i.e. widening joint strip seal) or full depth patching. It is measured in square feet per 1000 square feet of pavement surface.

Rut depth, $\overline{RD}$, is defined as the mean depth of rutting, in inches, in the wheel paths under a 4-ft straightedge.

Cracking, L, is defined as the number of longitudinal (parallel to traffic flow) cracks which excede 100 feet in length and 1) are open to a width of 1/4" over half their length or 2) have been sealed. If these cracks are observed to occur less than 3 feet from one another, the condition described under C should be looked for and if present reported instead of reporting the distress as longitudinal cracking.

Cracking, T, is defined as the number of transverse (right angles to traffic direction) cracks that are open to a width of 1/4" over half their length or have been sealed. Random or diagonal cracks are ignored.

Faulting, F, is defined as the mean vertical displacement, in inches, measured with a 4-ft. straightedge.

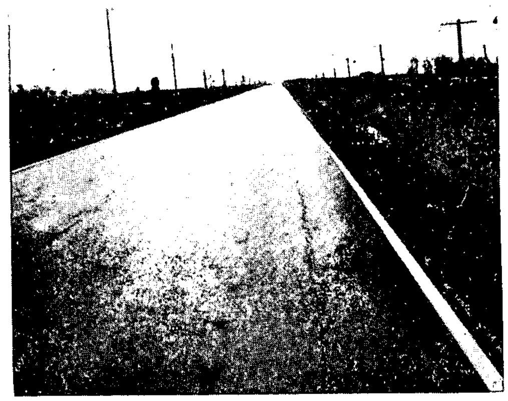


Figure 2.

Longitudinal Cracks

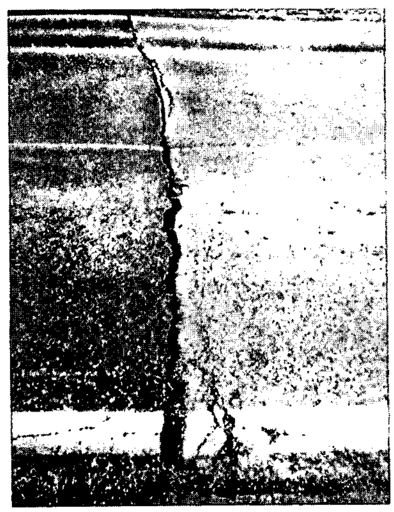


Figure 3.

Transverse Cracks and Faulting

Test Procedure -- Rigid Pavement:

The equation for Present Serviceability Index of rigid pavement is:

$$PSI = LPV - .09 \sqrt{C+P}$$

where;

PSI = Present Serviceability Index

LPV = Longitudinal Profile Value

C+P = Measures of cracking and patching of the pavement

Cracking, C, is defined as the lineal feet of cracking per 1000 square feet of pavement surface. Only those cracks which are open to a width of 1/4" or more over half their length or which have been sealed are to be included.

Patching, P, is the repair of the pavement surface by skin or full depth patching. It is measured in square feet per 1000 square feet of pavement surface.

Rut depth, $\overline{RD}$, is defined as the mean depth of rutting, in inches, in the wheel paths under a 4-ft. straightedge.

Faulting, F, is defined as the mean vertical displacement, in inches, measured with a 4-ft. straightedge.

D-cracking, D, refers to a characteristic pattern than can develop in portland cement concrete. Initially, the occurrence of D-cracking may be preceded and accompanied by staining of the pavement surface near joints and cracks. However, not all stained joints and cracks develop D-cracking. D-cracked concrete will first exhibit fine parallel cracks adjacent to the transverse and longitudinal joints at the interior corners. The D-cracks will bend around the corner in a concave or hourglass pattern. As the D-cracking progresses, the entire length of the transverse, longitudinal and random cracks will be affected. The cracked pieces may become loose and dislodged under the action of traffic. The occurrence of D-cracking in the check sections will be rated on a point scale as described in the Test Procedure section.

Figure 4.

D-cracking - Initial stages

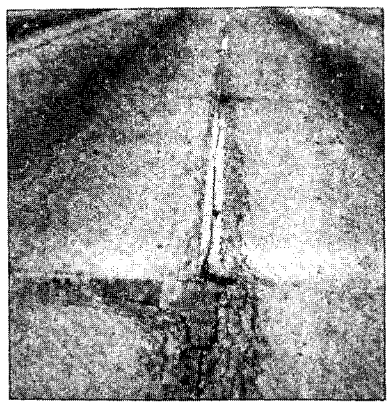


Figure 5.

D-cracking - All joints affected

Procedure

A. Apparatus

1. A passenger vehicle with an accurate odometer.
2. A four foot long rut/fault gauge.
3. Mechanical counters.
4. A 50-foot tape.
5. Safety equipment -- hard hats, safety vests, survey signs.

B. Test Record Forms

1. Crack and Patch Survey worksheet (A.C. or P.C.C.).

2. Crack and Patch Calculation and Summary Sheet.

3. Present Serviceability Index Summary (Form 915).

C. Test Procedure

The control sections are as described in the "Control Sections by Mileposts" booklet. For control sections of 0-5.00 miles in length, one representative 1/2 mile test section will be evaluated. For 5.01-10.00 miles, two 1/2 mile test sections are used. Three 1/2 mile sections are used for any control section greater than 10.0 miles.

After determining a location for the representative 1/2 mile test section or sections, the county, highway number, beginning and ending control section milepost, pavement width, beginning and ending milepost of the 1/2 mile test section being surveyed, date of survey and names of those doing the survey shall be recorded on the worksheet.

Flexible

The procedure for evaluation of flexible pavement is to drive on the shoulder, if possible, and estimate the area of each instance of alligator cracking and patching recording them individually on the worksheet.

The rut depth is measured in the outside and inside wheeltrack in both lanes at 0.05 mile intervals and recorded (10 sets of readings per test section).

While driving the first and last 0.05 mile portion of the test section the number of longitudinal and transverse cracks meeting the previously described criteria will be counted and recorded. Transverse cracks extending across only one lane will be counted as "half cracks" and recorded as such.

While driving the first and last 0.05 mile portions, the occurrence of faulted cracks will be looked for and the worst instance in each portion will be measured. These measurements will be taken one foot in from the pavement edges at the two cracks selected and the data recorded.

Rigid

The procedure for rigid pavement is to drive on the shoulder, if possible, and count all cracks meeting the previously described criteria. Cracks extending across only one lane are recorded as "half cracks" and summed to full cracks during the data summary phase. Longitudinal, diagonal and random cracks are accounted for by estimating how many times they would extend across the roadway and recording that number.

The area of each patch is estimated and recorded individually on the worksheet.

The rut depth is measured in the outside and inside wheeltracks of both lanes. One set of measurements will be taken at the beginning of the 1/2 mile test section and one set at the end.

Faulting is measured one foot in from each pavement edge at 0.05 mile intervals and recorded (10 sets of readings per check section).

The D-crack Occurrence Factor (DOF) in the test section will be evaluated and assigned a numerical rating based on the following description.

DOF Value

0 = No D-cracking noticeable

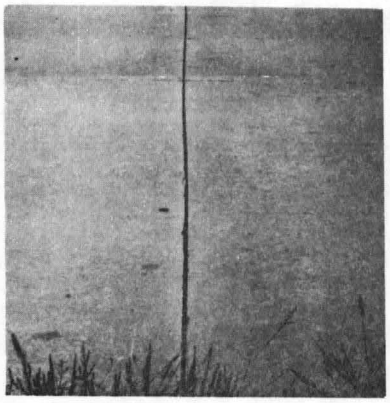
1 = D-cracking is evident at some joints especially the interior corners. Pavement is sound condition and no maintenance is required due to D-cracks.

2 = D-cracking is evident at most joints and has progressed across width of slab. Pavement is in sound condition and no maintenance is required due to D-cracking.

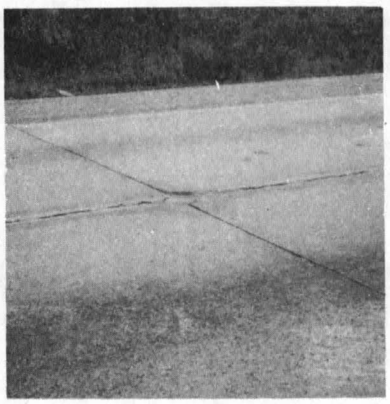
3 = D-cracking is evident at virtually all joints and random cracks. Minor raveling and spalling are occurring and traffic is causing some loosening of cracked pavement. Some minor maintenance of spalled areas is required.

4 = D-cracking very evident as in 3 above. Spalling and removal by traffic has progressed to point that regular maintenance patching is required. Effect on riding quality of pavement is now noticeable.

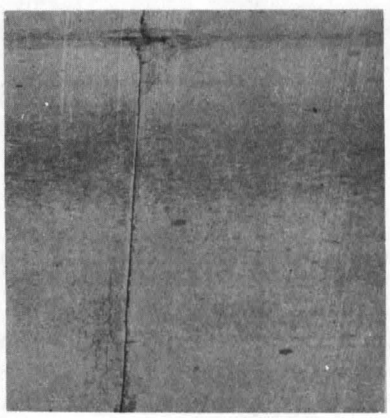
5 = D-cracking has continued to progress at sites identified in 3 above and requires regular maintenance patching. Full depth patches may be necessary. Ride quality has deteriorated to point where reduced driving speed is necessary for comfort and safety.



DOF = 0



DOF = 1



DOF = 2

DOF = 3

DOF = 4

DOF = 5

Figure 6. Examples of D-crack Occurrence Factors

D. Calculations

1. Flexible Pavement

a. The area of cracking is totaled and divided by the area of the test section in thousands of square feet to obtain C.

b. The area of patching is totaled and divided by the area of the test section in thousands of square feet to obtain P.

c. The rut depth measurements are totaled and averaged to obtain $\overline{RD}$.

D. The number of longitudinal cracks in the two areas surveyed are totaled, averaged, and reported as L.

e. The number of transverse cracks and 1/2 cracks (divided by 2) in the two areas surveyed are totaled, averaged, and reported as T.

f. The faulting measurements are totaled and averaged to obtain F.

g. Cracking (C), patching (P), and rut depth ($\overline{RD}$) as calculated above and LPV, as determined in Part I, are used in the following formula to determine the Present Serviceability Index (PSI):

$$PSI = LPV - 0.01\sqrt{C+P} - 1.38\ \overline{RD}^2$$

2. Rigid Pavement

a. The number of cracks and 1/2 cracks (divided by 2) are totaled and multiplied by the width of the roadway and divided by the area of the test section in thousands of square feet to obtain C.

b. The area of patching is totaled and divided by the area of the test section in thousands of square feet to obtain P.

c. The rut depth measurements are totaled and averaged to obtain $\overline{RD}$.

d. The faulting measurements are totaled and averaged to obtain F.

e. Cracking (C) and patching (P) as calculated above and LPV as determined in Part I are used in the following formula to determine the Present Serviceability Index (PSI):

$$PSI = LPV - .09\sqrt{C+P}$$

E. Reporting Results

1. Lab. Number.
2. Beginning Milepost.
3. Ending Milepost.
4. Road Number.
5. Length.
6. Surface Type.
7. Direction and Lane.
8. RMRV or LPV.
9. Deduction for cracking and patching.
10. Present Serviceability Index.

<u>Rut Depth Gauge Calibration</u>

A. Procedure

Place the rut depth gauge on a section of channel iron or any perfectly flat surface over 4 feet long. Make sure that the gauge is placed vertically perpendicular to the surface to insure accurate readings. Press the measuring scale down until it makes contact with the flat surface, while still keeping the ends of the gauge on the surface. Check to see that the scribed line on the plastic marker lines up with the '0' mark on the measuring scale.

If the marker does not line up with the '0' mark, remove the plastic marker and file the holding screw holes to allow the marker to slide up and down. This is accomplished by either filing the bottom of the screw holes to allow the marker to slide up or by filing the top of the screw holes to allow the marker to slide down.

Mount the plastic marker template but do not tighten the holding screws. Place the gauge on the flat surface making sure the gauge is perpendicular and the measuring scale is in contact with the surface. Line up the scribed line with the '0' mark and then tighten the holding screws.

The rut depth gauge should be calibrated at least once per year and before any rutting survey such as the statewide Crack and Patch Survey.