

1960 SUMMARY OF PAVEMENT ROUGHNESS

Prepared for Road Construction Division

Research Laboratory Division  
Office of Testing and Research  
Research Project 47 F-15  
Report No. 366

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Michigan State Highway Department  
John C. Mackie, Commissioner  
Lansing, November 1961

## 1960 SUMMARIES OF PAVEMENT ROUGHNESS

An improvement in overall smoothness of new concrete pavements in Michigan is indicated by the Research Laboratory Division's 1960 roughness surveys. With this new data, a ten-year trend is now apparent toward more projects in the "good" classification of riding quality, and fewer in both the "average" and "poor" classifications. New methods of graphic presentation for data from the roughness program (Fig. 1) clearly show this trend, which is most apparent in the declining slope of the curve for the 10-year weighted arithmetic mean.

Approximately 554 lane miles of pavement were measured this year, about 92 lane miles less than in 1959. All surveys were conducted in the usual manner with the same equipment and instrumentation used in previous years, plus the measuring instrument called the Acceleration Level Indicator which was added in 1959.

This instrument was used for the second year on an experimental basis, as a check on the usual integrator count method. Because it registers variations in surface roughness more precisely than the integrator, the Laboratory anticipates that the level indicator will eventually replace it as the primary roughness measuring instrument. One possible value of

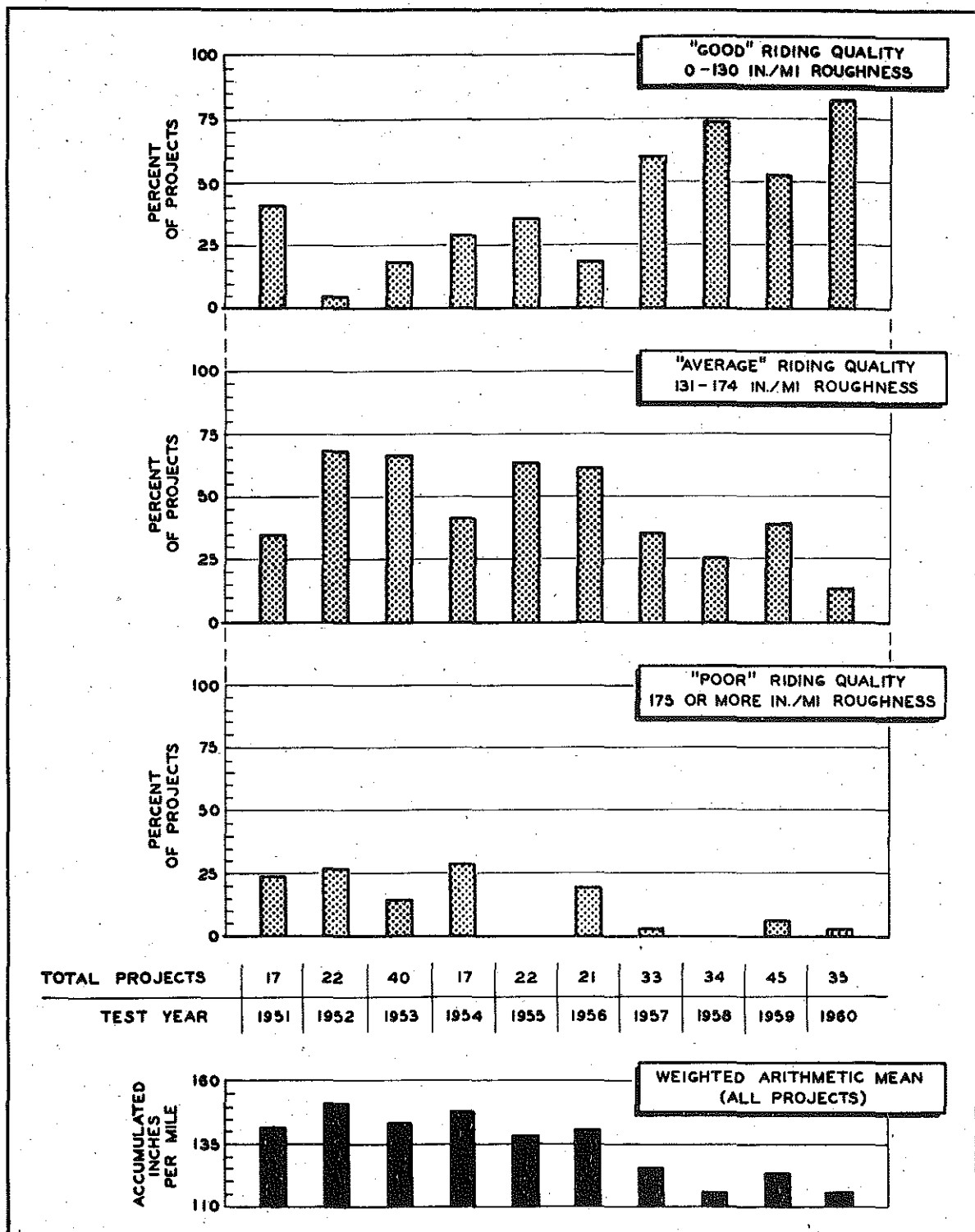
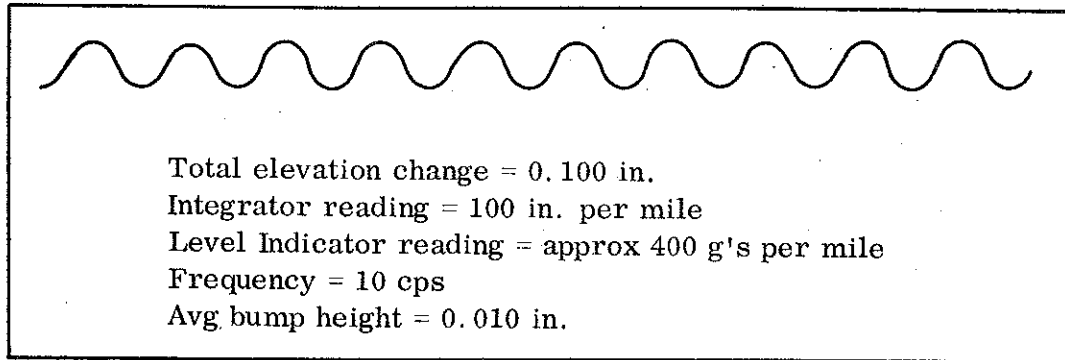
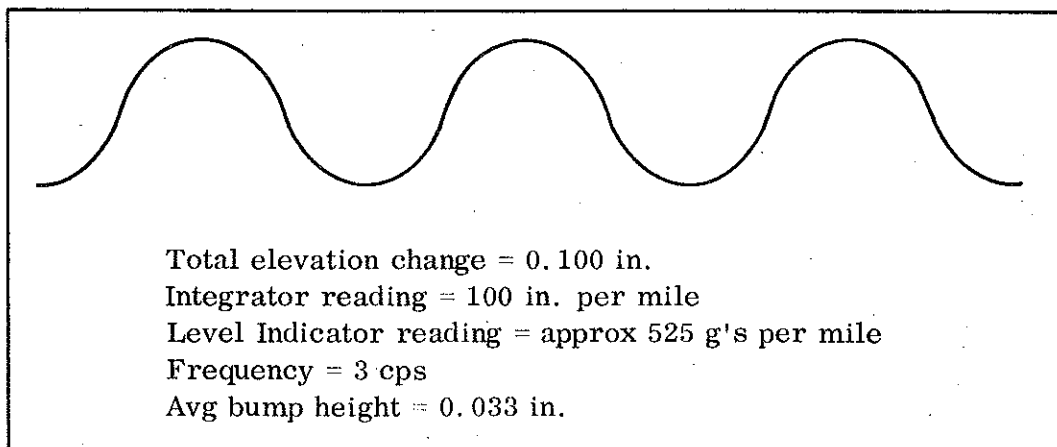


Figure 1. Annual roughness comparison for concrete pavement.

such an instrument system would be its ability to distinguish between two pavements of equal integrator count, where one has surface variations which are of low magnitude and high frequency :



and the other has variations of high magnitude and low frequency :



In such an instance, the riding characteristics of these two pavements would differ considerably although the integrator would show equal roughness. When two projects have equal inch per mile readings of 104, as in Table 1, but the g's per mile readings are 428 and 527 for the same pavements, the project with the lower level indicator reading has better riding quality.

**TABLE 1**  
**SUMMARY OF ROUGHNESS DATA FOR CONCRETE PAVEMENT**

	Project	District	Length, mi	Type	Route and Project Location	Roughness		Paving Contractor
						Integrator, In./Mile	Level Indicator, g's/Mile	
<b>1959 CONSTRUCTION</b>	BI 13683, C4RN	7	7.738	Dual	I 94 from 2520 ft west of 23 Mile Rd east to Calhoun-Jackson Co line	117	643	Sargent Construction Co. (1)
	BF 50931, C2R, C3R, C4U *	9	7.090	34 ft	M 97 from 14 Mile Rd north to M 59 north of Mt. Clemens	125	647	Cooke Contracting Co.
	BI 16092, C1RN	4	2.465	Dual	I 75 from 0.5 mi north of Potter Rd, north to 623 ft south of Mackinaw City limit	175	923	Bacco Construction Co. (2)
	BI 16111, C1RN							
BI 24071, C3RN								
Weighted Arithmetic Mean for 1959 Construction						129	685	
<b>1960 CONSTRUCTION</b>	BI 38103, C7RN	8	4.826	Dual	I 94 from intersection with I 94 BL (old US 12 BR) and old US 12 east of Jackson, east to Willis Rd	95	464	Pierson Contracting Co.
	BI 81104, C3RN	8	5.156	Dual	I 94 from 2900 ft west of Baker Rd, east to 3129 ft east of Wagner Rd, west of Ann Arbor	98	441	Pierson Contracting Co.
	BI 81062, C3RN							
	BI 11016, C1RN	7	3.891	Dual	I 94 from Main St northeast to south of Carmody Rd, east of Benton Harbor	190	478	Pierson Contracting Co.
	BI 11017, C3RN							
	BM 09091, C1R	6	4.332	Dual & 24 ft	M 47 from US 10 BR near Freeland north to M 20 Reloc	104	428	Denton Construction Co.
	BM 73075, C1R							
	BF 47013, C1RN	8	5.084	24 ft	US 23 Reloc from 3960 ft north of Washtenaw-Livingston Co line, north to C & O RR (northbound only)	104	527	L. W. Edison Co.
	EBBF 47013, C4RN	8	4.675	24 ft	US 23 Reloc from 250 ft north of M 36 (9 Mile Rd), north to C & O RR (southbound only)	105	531	L. W. Edison Co.
	BI 16092, C6RN	4	6.059	Dual	I 75 from north of Hebron Mall Rd, north to 0.5 mi north of Potter Rd, south of Mackinaw City	106	561	Denton Construction Co. (3)
	BI 81104, C1RN	9	4.978	Dual	I 94 from 1529 ft west of Fletcher Rd, east to 2009 ft west of Baker Rd, east of Chelsea	107	573	Sargent Construction Co. (1)
	BU 56044, C3U, C4R	6	4.192	Dual	US 10 Reloc from Swede Rd southeast to M 20, east of Midland	108	549	Hertel-Deyo Co.
	BM 09101, C4R							
	BF 29614, C3RN	5	4.130	Dual	US 27 Reloc from M 46 northwest to Isabella-Gratiot Co line	109	508	Denton Construction Co. (4)
	BF 03111, C1RN, C2UN	7	6.061	Dual	US 131 from M 89 near Plainwell north to M 118 near Martin	110	557	Carl Goodwin & Sons, Inc.
	BI 09034, C2RN, C6RN	6	3.022	Dual	I 75 from M 84 (old M 47) north to Midland Rd, southwest of Bay City	110	576	L. A. Davidson
	BI 38103, C4RN	8	5.066	Dual	I 94 from Willis Rd east to Jackson-Washtenaw Co line (eastbound only)	113	546	Lonelle Construction Co. (5)
	BI 16091, C2RN	4	5.881	Dual	I 75 from Topinabee Rd north to north end of Riggsville Rd interchange	113	547	Denton Construction Co. (5)
	BI 16092, C9RN							
	BM 56044, C9R	6	5.341	Dual	US 10 Reloc from 877 ft west of Stark Rd, east to Swede Rd, north of Midland	114	564	Hertel-Deyo Co. (6)
	BU 56044, C11U							
	BI 11016, C3RN	7	3.352	Dual	I 94 from south of Pipestone Rd northeast to Main St, east of Benton Harbor	115	550	L. W. Edison Co.
	BI 11015, C1RN	7	4.402	Dual	I 94 from Ridge Rd northeast to St. Joseph River	115	622	L. A. Davidson
	BF 37013, C1RN	5	4.352	Dual	US 27 Reloc from Gratiot-Isabella Co line, north to 1792 ft north of Blanchard Rd, Shepard	116	556	Sargent Construction Co. (1)
BI 16092, C5RN	4	6.640	Dual	I 75 from Riggsville Rd interchange north to north of Hebron Mall Rd	116	608	Denton Construction Co. (3)	
BF 09035, C1RN	6	3.505	Dual	I 75 from US 10 (old M 20) north to US 23 in Kawkawin	116	632	L. A. Davidson	
BI 09035, C2RN								
BF 76023, C1RN	6	5.070	Dual	M 78 Reloc from 853 ft west of Reed Rd northwest of Durand, northeast to M 13 (Genesee-Shiawassee Co line)	120	550	Denton Construction Co.	

\* For widening construction at these locations, see Table 2.

- (1) Subcontract from Holloway Construction Co. (per daily report of concrete proportioning)
- (2) Contract let to A. Lindberg & Sons, Inc., and Bacco Construction Company (per contract estimate report)
- (3) Subcontract from Johnson-Green Co. (per daily report of concrete proportioning)
- (4) Subcontract from A. Lindberg & Sons, Inc. (per daily report of concrete proportioning)
- (5) Subcontract from D. J. McQuestion & Sons (per daily report of concrete proportioning)
- (6) Contract let to Hertel-Deyo Co. and C. E. Utterback (per contract estimate report)

**TABLE 1 (con't)**  
**SUMMARY OF ROUGHNESS DATA FOR CONCRETE PAVEMENT**

	Project	District	Length, mi	Type	Route and Project Location	Roughness		Paving Contractor	
						Integrator, In./Mile	Level Indicator, g's/Mile		
CONCRETE REPORTS	BU 82112, C6U*	10	3.898	22 ft	James Couzens Hwy from 850 ft east of Wyoming Ave, northwest to Wayne-Oakland Co line (6 Mile Rd)	122	611	Denton Construction Co.	
	BI 80023, C3RN	7	3.641	Dual	I 94 from 2317 ft east of Kane Rd, east to 2453 ft west of M 40, southeast of Lawrence	124	566	L. W. Edison Co. (7)	
	BI 80023, C2RN	7	5.985	Dual	I 94 from 409 ft west of Thomas Rd, east to 2317 ft east of Kane Rd, southeast of Hartford	125	613	Carl Goodwin & Sons, Inc. (8)	
	BI 16091, C1RN	4	3.126	Dual	I 75 from 1200 ft northwest of old US 27, north to Topinabee Rd	126	651	Loselle Construction Co. (9)	
	BF 13031, C5RN	7	3.994	24 ft	M 78 Reloc from 5259 ft south of Graham Lake Rd, north to 213 ft north of Beckley Rd, south of Battle Creek	127	633	Bairley & Lindley, Inc. (7)	
	BI 13033, C1RN	7	1.411	Dual	I 194 - M 78 - I 94 BL from 2160 ft north of I 94, north to 1412 ft south of old US 12, south of Battle Creek	129	636	Bairley & Lindley, Inc. (7)	
	BI 80023, C4RN	7	4.097	Dual	I 94 from 4277 ft west of M 40, east to M 119	132	630	Denton Construction Co. (10)	
	BI 80024, C3RN								
	BI 11016, C2RN	7	1.716	Dual	I 94 from St. Joseph River, south of Benton Harbor, east to south of Pipestone Rd	139	810	Cross & White (11)	
	BI 09034, C1RN	6	6.286	Dual	I 75 from M 13 (old US 23) near Zilwaukee, north to M 84 (old M 47)	140	785	Sargent Construction Co. (10)	
	BI 73112, C1RN								
	BI 73111, C3RN	6	1.871	24 ft	US 23 from 4396 ft south of M 46, north to 12 ft north of M 81 (southbound only)	151	880	Sargent Construction Co. (10)	
	Y 73063, C2R*	6	1.310	Dual & 24 ft	M 46 from 148 ft east of 25th St, east to 40 ft west of Towerline Rd, east of Saginaw	164	861	W. H. Knapp, Inc. and W. F. McNally Co.	
									Weighted Arithmetic Mean for 1960 Construction
							115	579	
								WEIGHTED ARITHMETIC MEAN FOR 1959-60 CONSTRUCTION REPORTED ABOVE	
						117	590		

\* For widening construction at these locations, see Table 2

- (7) Subcontract from Canonic Construction Co. (per daily report of concrete proportioning)
- (8) Subcontract from S. D. Solomon & Sons (per daily report of concrete proportioning)
- (9) Subcontract from Gilliland Construction Co. (per daily report of concrete proportioning)
- (10) Subcontract from Louis Garavaglia Contractors, Inc. (per daily report of concrete proportioning)
- (11) Subcontract from C. A. Hull Co., Inc. (per daily report of concrete proportioning)

With the accumulation of more data in future surveys, it is anticipated that more precise and comprehensive roughness reporting will be possible. Fig. 2 shows good correlation between readings from the two instruments. The 1960 standard error of estimate is lower and the correlation coefficient higher than in the first year of this comparison (1959), indicating greater reliability in predicting the level indicator value from the integrator reading. Thus, a more definite relationship has been established between the two instruments and their respective systems of interpreting relative pavement roughness. Additional information on the level indicator was given in last year's "1959 Summaries of Pavement Roughness," Research Report No. 324 (March 1961).

#### Concrete Pavement Construction

Individual concrete construction projects and their roughness values are tabulated in Table 1, grouped by year of construction and ranked according to accumulated inches per mile of roughness by integrator measurement. During the ten years of the roughness program, these integrator values for individual projects have ranged from a low of 93 to a high of 282. On the basis of riding quality, the Laboratory classifies projects in three categories: "good" surfaces (0 to 130 in. per mile), "average" (131 to 174), and "poor" (175 or more).

Table 2 shows that since 1951, a total of 286 projects have been tested with 45, 44, and 11 percent in the good, average, and poor classifications,

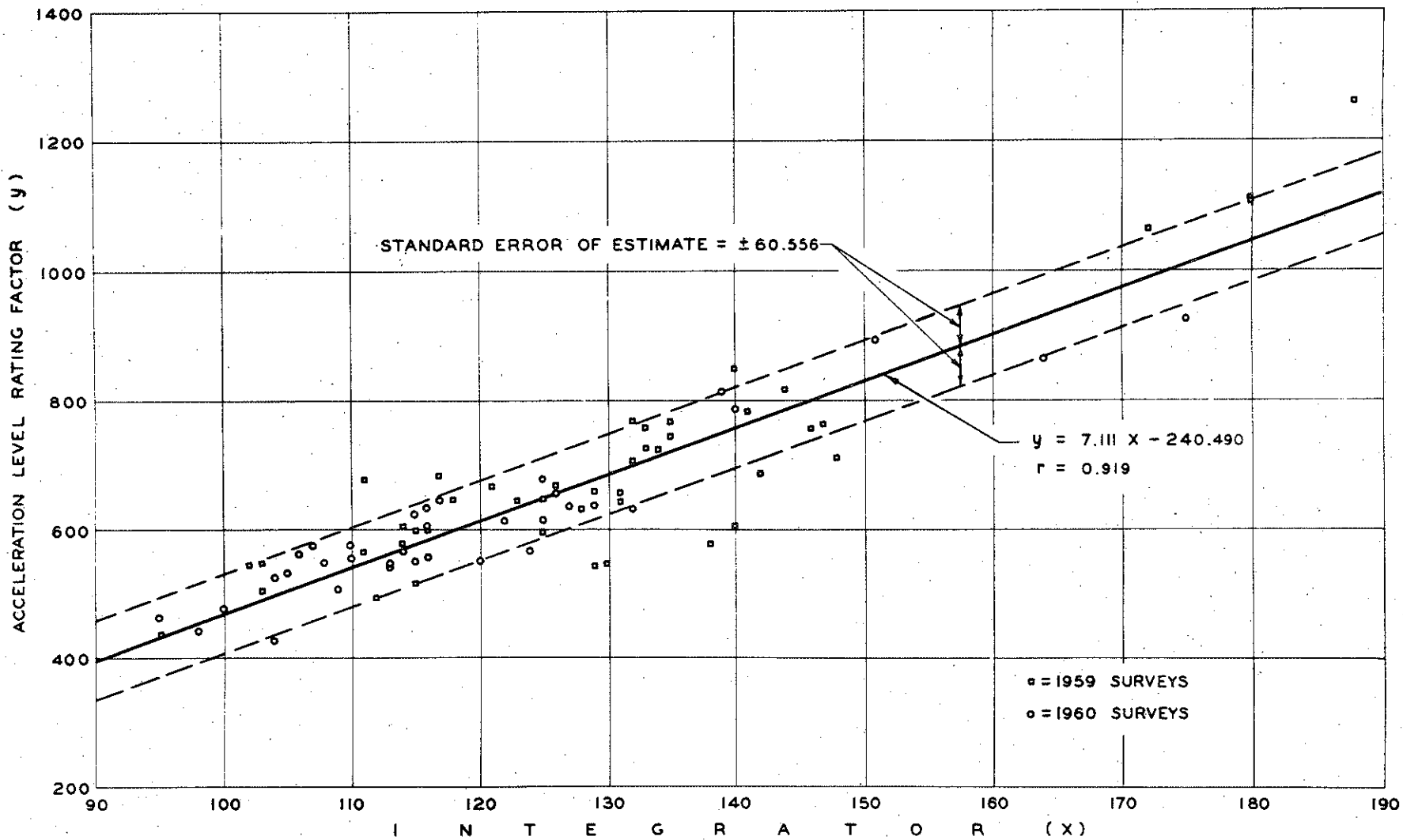


Figure 2. Comparison of pavement roughness measurements by Acceleration Level Indicator and Integrator methods.



TABLE 2  
10-YEAR SUMMARY OF CONCRETE PAVEMENT ROUGHNESS

Test Year	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1951-1960
Total Projects	17	22	40	17	22	21	33	34	45	35	286
Percent Good 0-130 in./mi	41	5	18	29	36	19	61	74	53	83	45
Percent Average 131-174 in./mi	35	68	67	42	64	62	36	26	40	14	44
Percent Poor 175 or more in./mi	24	27	15	29	0	19	3	0	7	3	11
Weighted Arithmetic Mean	142	152	144	148	138	141	126	116	124	117	130
Project Mileage	48.33	61.58	98.79	41.27	52.69	82.47	165.09	134.05	168.89	154.33	1007.49
Lane Mileage	100.51	163.34	233.73	91.62	140.57	230.40	558.78	461.52	645.96	554.35	3180.78

respectively. In the 1960 test series, values ranged from 95 to 175. Of these projects, 83 percent were good--the best figure in this category since the start of the roughness program, 14 percent were average, and 3 percent poor. This improvement in overall smoothness is denoted in Fig. 1 by a decrease of 7 in. per mile roughness in the weighted arithmetic mean from 1959 to 1960. The record 83 percent of good projects represents 88 percent of the actual project lane miles surveyed last year.

### Concrete Pavement Widening

In addition to the standard surveys of roughness on newly constructed concrete pavements, the 1960 measurements included five pavement widening projects, with the results shown in Table 3 and -Fig. 3.

**TABLE 3  
SUMMARY OF ROUGHNESS DATA  
FOR CONCRETE PAVEMENT WIDENING**

	Project	District	Length, mi	Type	Route and Project Location	Roughness		Paving Contractor
						Integrator, Inches/Mile	Level Indicator g's/Mile	
<b>1959 CONSTR.</b>	BF 60031, C2R, C3R, C4U	9	7.090	12 ft R & L	M 97 from 14 Mile Rd north to M 59 north of Mt. Clemens	126	582	Cooke Contracting Co.
	Weighted Arithmetic Mean for 1959 Construction						126	582
<b>1960 CONSTRUCTION</b>	F 73063, C2R F 73111, C7RN	6	1.310	12 ft R & L	M 46 from 148 ft east of 25th St., east to 40 ft west of Towerline Rd., omitting from 95 ft east of Outer Dr to 1481 ft west of northbound US 23, east of Saginaw	140	759	W. H. Knapp, Inc. and W. F. McNally Co.
	BU 82112, C6U	10	3.698	11 ft	James Couzens Hwy from 850 ft east of Wyoming Ave. northwest to Wayne-Oakland Co line (8 Mile Rd)	150	846	Denton Construction Co.
	BUSB 08012, C7U	7	1.043	12 ft R & L	M 43 (Broadway St) from State Rd north to 250 ft north of Hastings north city limit	153	765	Eisenhour Construction Co. <sup>(1)</sup>
	F 38072, C1U, C2R	8	0.784	12 ft R & L	M 50 from W. North St north to Andrew Ave, Jackson	201	1142	Kutovina Co. & subsidiaries
	Weighted Arithmetic Mean for 1960 Construction						154	861
WEIGHTED ARITHMETIC MEAN FOR 1959-60 CONSTRUCTION REPORTED ABOVE						140	714	

<sup>(1)</sup> Subcontract from Reith-Riley Construction Co. (per daily report of concrete proportioning)

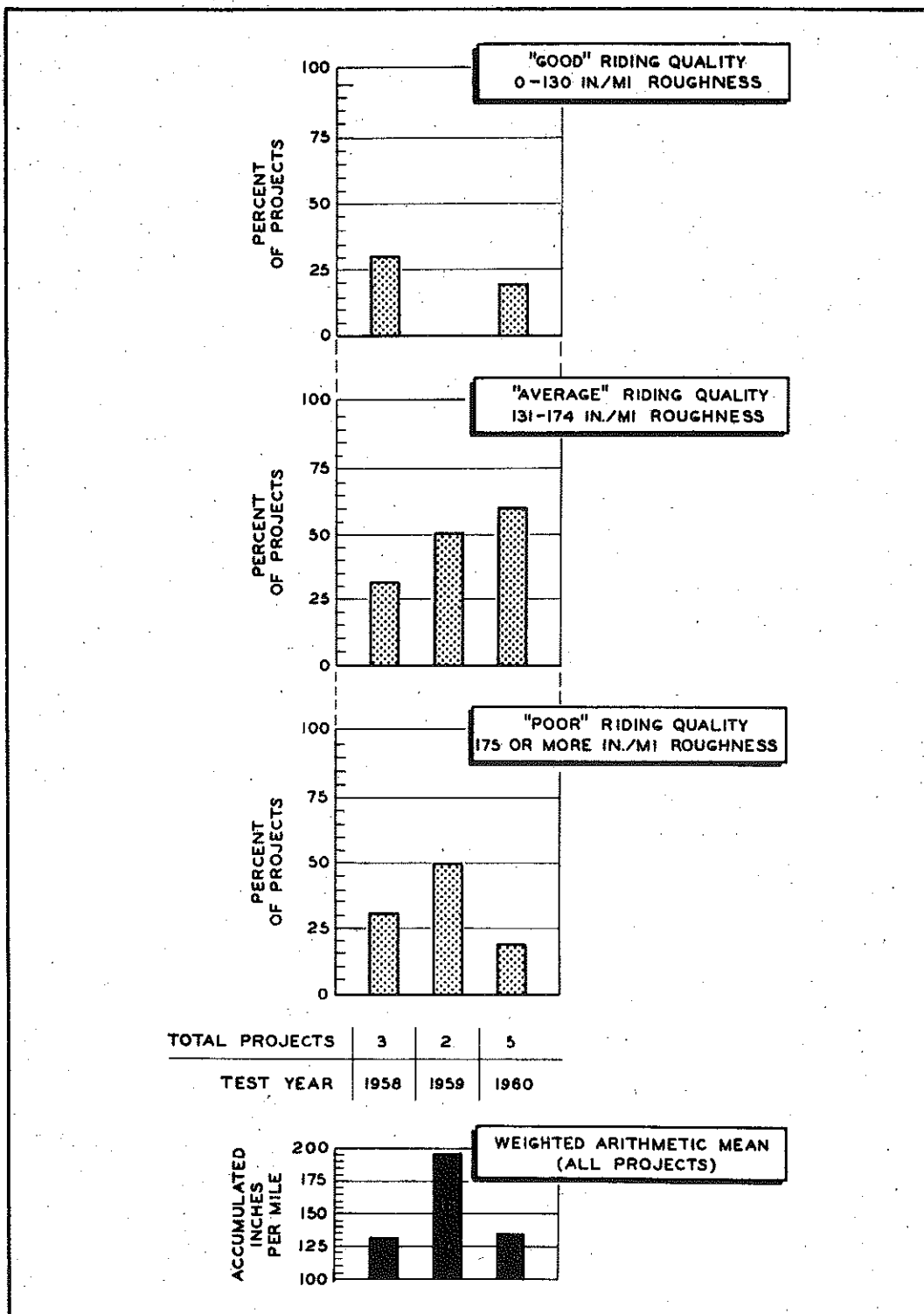


Figure 3. Annual roughness comparison for concrete pavement widening.

The testing and reporting procedures used on these projects are the same as those for standard concrete pavements. However, due to the somewhat different construction procedures required for widening, the range of roughness values varies from that for standard concrete pavements. For this reason, concrete widening projects are reported and tabulated separately from the standard construction. Table 4 summarizes test data obtained during the three years in which this type of construction has been under study.

TABLE 4  
3-YEAR SUMMARY OF  
CONCRETE PAVEMENT WIDENING ROUGHNESS

Test Year	1958	1959	1960	1958-1960
Total Projects	3	2	5	10
Percent Good 0-130 in./mi	33.3	0	20	20
Percent Average 131-174 in./mi	33.3	50	60	50
Percent Poor 175 or more in./mi	33.3	50	20	30
Weighted Arithmetic Mean	130	194	140	144
Project Mileage	6.40	3.09	13.92	23.41
Lane Mileage	10.62	6.18	24.15	40.95