

SUMMARIES OF MICHIGAN PAVEMENT ROUGHNESS
1963-64 Test Program

Prepared for Road Construction Division

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SUMMARIES OF MICHIGAN PAVEMENT ROUGHNESS 1963-64 Test Program*

This report includes data for both the 1963 and 1964 test years. Annual reporting for 1963 was postponed, as a result of an accident in which the roughness measuring wheel was damaged. The wheel was rammed by a car, while the roughometer truck was waiting for a traffic light to change. At the time of the accident (August 28, 1963), extensive special roughness tests of older pavements had been completed, but the amount of 1963 testing of new pavements was insufficient to warrant reporting. Roughometer wheel repairs were completed by November 1, 1963, but it was decided that since the program could not be completed before snow and ice accumulations interfered with testing accuracy, reporting and further testing would be deferred to the 1964 test year.

For several years before the accident and in all subsequent testing, two measuring systems have been used in obtaining pavement roughness values--the Integrator, reporting relative movement of the roughometer wheel with respect to the roughometer frame in accumulated inches per mile, and the Acceleration Level Indicator, reporting accumulated accelerations detected by a 0-to-2 g accelerometer mounted on the rear of the roughometer frame as accumulated g's per mile. The slight modifications in the roughometer suspension system following the accident resulted in a more flexible suspension system. The resulting accumulated accelerations, determined by the roughometer frame's vertical displacements and recorded by the Level Indicator, were smaller. If the accumulated vertical frame displacements have become smaller, then the frame is holding closer to a constant horizontal position. This allows the Integrator to record the actual accumulated vertical displacements of the road surface more effectively. In summary, by effecting slight alterations to the roughometer suspension, improvements have been made in the exactness of the Integrator.

Because of standard calibration procedures before and after the accident, Integrator counts before and after the repairs may be compared directly. However, Acceleration Level Indicator counts after the

* Throughout this report, the terms "construction year" and "test year" are specifically used to distinguish between the period of construction operations, and the time when measurements were conducted by the Research Laboratory. Further, the term "project mileage" refers to length given by the Contract Division, "roadway mileage" refers to length of two-lane pavement, and "lane mile" to length given in terms of individual vehicle lanes.

repairs are lower than before and cannot be compared directly. Although a different correlation now exists between Integrator and Acceleration Level Indicator, this correlation is again very significant. The correlation coefficient for all data since the accident is 0.911 and the standard error is ± 66.1 g's per mile.

The result is a general lowering of all Acceleration Level Indicator values. While this lowering of values changes the slope of the regression line in a statistical analysis of the two measuring systems, there exists a continued significant correlation coefficient of 0.911 between the two systems. This compares favorably with the previous correlation coefficient of 0.926 obtained prior to the equipment changes which resulted from the accident. The simultaneous operation of the two recording systems continues to provide a valuable cross-check of results and method of validating operations. However, it has been deemed impractical to equate the present numerical range of Acceleration Level Indicator values with the numerical range reported prior to the equipment change.

The 1963-64 measurements included 607 line miles of standard rigid pavement (two-lane pours), 120 lane miles of flexible pavement, and 58 lane miles of rigid pavement widening (one-lane pours).

Rigid Pavement Construction (Two-Lane Pours)

Individual rigid pavement projects constructed as standard two-lane pours, and their roughness values as determined in the 1963-64 test program, are listed in Table 1, grouped by year of construction, and ranked within these years according to accumulated inches per mile roughness by Integrator measurements; where two or more projects have the same Integrator count, they are ranked by Level Indicator count. During the 14 years of roughness surveys, these Integrator values have ranges from a low (smooth) of 93 to a high (rough) of 282. For 1963-64, the range was from 103 to 186.

On the basis of riding quality, the Laboratory classifies projects in three Integrator-count categories:

- "good" (0 to 130 accumulated in. per mi)
- "average" (131 to 174)
- "poor" (175 or more)

Table 2 shows that since 1951, with a total of 396 rigid pavement projects tested, 42, 47, and 11 percent of this total have been good, average, and poor, respectively. In the 1963-64 test years 40, 51, and 9 percent

of the 35 projects measured were good, average, and poor, respectively. The weighted arithmetic mean for roughness of all projects tested during the 1963-64 test years was 131 accumulated inches per mile. This is an improvement over both the 1961 and 1962 test years, and in a very general way, reflects greater overall smoothness of newly constructed pavements.

Rigid Pavement Construction (One-Lane Pours)

In addition to the usual surveys of roughness on newly constructed standard rigid pavements (two-lane pours), the 1963-64 measurements included 14 rigid pavement widening projects (one-lane pours), with the results shown in Table 3.

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

Flexible Pavement Construction

As in the case of rigid pavement widening, this type of roughness measurement represents a supplement and extension of the Department's rigid pavement roughness program, and is being included in the annual reports as construction warrants. Normally, only flexible pavements of expressway quality are included in the surveys, although other bituminous projects may be measured when construction procedures or special roughness conditions make this desirable.

Seven flexible pavement projects built to Interstate expressway standards were surveyed in the 1963-64 test years. The accumulated inches per mile figures presented in Table 5 are the result of measuring runs in separate wheel tracks in both the traffic and passing lanes.

TABLE 1
ROUGHNESS DATA SUMMARY FOR RIGID PAVEMENT
(TWO-LANE POURS)

	Project	District	Length, mi.	Type	Route and Project Location	Roughness		Paving Contractor	
						Integrator, in./Mile	Level Indicator, g's/Mile		
1961 CONSTR.	EBI 41026, C2RN* EBI 41131, C59RN	5	5.149	24 ft (Dual) & 36 ft (Dual)	I 96 east from near Bristol Rd. to the Grand River; also US 131 north from 0.247 mi. north of Grand Rapids north city limit.	136	466	Sargent Construction Co. (1)	
	EBACI 23151A, C1RN EBACI 33083A, C1RN	8	3.604	24 ft (Dual)	I 96 east from 2980 ft southeast of M 78 to east of M 99.	106	466	Pierson Contracting Co. (2)	
	EBACI 17033B, C1RN EBACI 17033D, C1RN	2	5.897	24 ft (Dual)	I 75 north from 1 mi. south of FAS Rte. 1054, to 0.725 mi. north of existing Tone Rd.	114	389	Hodgkiss & Douma, Inc. (3)	
	EBACI 23152B, C3RN	8	4.640	24 ft (Dual)	I 96 south from south of M 43 to southeast of M 78.	115	493	Pierson Contracting Co. (4)	
	EBI 63172, C2RN	9	4.830	24 ft (Dual)	I 75 east from west of Baldwin Rd. to east of Walton Blvd.	117	362	Denton Construction Co. (5)	
	BF 39013A, C3RN	7	6.295	24 ft (Dual)	US 131 north from "U" Ave. to "O" Ave.	117	419	Denton Construction Co. (6)	
	F 47074A, C4	8	4.297	24 ft	M 52 north from M 50 to US 12.	120	574	Denton Construction Co. (7)	
	EBI 63172, C5RN* EBI 63173, C7RN	9	7.420	24 ft (Dual) & 36 ft (Dual)	I 75 northwest from west of Baldwin Rd. to 0.754 mi. west of Allen Rd.	124	486	Denton Construction Co. (5)	
	EBI 47065, C1RN	8	5.796	24 ft (Dual)	I 96 southeast 5.796 mi. from 400 ft west of Chilson Rd.	133	633	L. A. Davidson & Sargent Construction Co. (8)	
	EBACI 33083B, C3RN EBACI 33083B, C5UN EBACI 33083B, C6UN EBACI 33084A, C1RN	8	5.688	24 ft (Dual)	I 96 east from 787 ft east of Grovenburg Rd. to 2573 ft east of College Rd.	136	611	L. A. Davidson	
	BI 63173, C9RN*	9	6.134	36 ft (Dual)	I 75 northwest from 1.2 mi. west of M 16 to 0.13 mi. west of M 97.	137	383	Sargent Construction Co. (2)	
	BI 63173, C11RN*	9	6.508	36 ft (Dual)	I 75 north from 660 ft north of M 87 to Evans Rd.	139	459	Hertel-Deyo Co. (9)	
	BI 41131, C89UN*	5	1.052	36 ft (Dual)	US 131 north from 6th St. to Richmond St.	144	688	L. W. Edison Co.	
	BI 41131, C84UN* BI 41131, C86RN	5	0.732	36 ft (Dual)	US 131 north from Richmond St. to 0.247 mi. north of Grand Rapids north city limit.	150	706	L. W. Edison Co.	
	EBACI 47065A, C5RN	8	6.206	24 ft (Dual)	I 96 southeast from northwest of Millett Rd. to 400 ft west of Chilson Rd.	162	636	Sargent Construction Co. (10)	
	BF 27021D, C5U BF 27021D, C6R BF 27021E, C7U	1	4.694	24 ft & 24 ft (Dual)	US 2 east from Howell St. to the Little Black River.	162	903	Bacco Construction Co.	
	SS 77052C, C2	9	1.193	48 ft	M 29 north from Thornapple St. to St. Clair north city limit.	179	743	Anderson & Ruzzin Contractors	
	Weighted Arithmetic Mean for 1962 Construction Tested During 1963-64 test years						130	513	
	1963 CONSTRUCTION	BI 49025G, C22RN	2	6.937	24 ft (Dual)	I 75 north from 0.5 mi. north of M 134 to south of FAS Rte. 1052.	103	294	Pierson Contracting Co. (11)
BI 49025E, C18RN		2	7.803	24 ft (Dual)	I 75 north from south of existing M 123 to north of M 28.	107	321	Pierson Contracting Co. (2)	
BI 17033E, C12		2	3.125	24 ft (Dual)	I 75 north from existing US 2 to 2500 ft north of M 28.	110	285	Pierson Contracting Co.	
BI 17033A, C5RN BI 17033A, C9RN BI 49025H, C20RN		2	5.787	24 ft (Dual)	I 75 north from south of FAS Rte. 1052 to 1 mi. south of FAS Rte. 1054.	118	424	Hodgkiss & Douma, Inc. (4)	
BI 03033B, C14		7	4.3	24 ft (Dual)	I 196 north from 1600 ft north of 101st Ave. to 109th Ave.	119	350	Carl Goodwin & Sons, Inc.	

* For additional data see Table 3

- (1) Subcontract from Kenay Construction Co.
- (2) Subcontract from Canonie Construction Co.
- (3) Contract awarded to Alpine Construction Co. & Hodgkiss & Douma, Inc.
- (4) Subcontract from Gilliland Construction Co.
- (5) Subcontract from S. D. Solomon & Sons
- (6) Subcontract from Smith Brothers Excavating
- (7) Subcontract from Maclean Construction Co.
- (8) Contract awarded to L. A. Davidson
- (9) Contract awarded to Hertel-Deyo Co. & C. E. Utterback
- (10) Subcontract from Holloway Construction Co.
- (11) Subcontract from L. W. Edison Co.

TABLE 1 (Cont.)
ROUGHNESS DATA SUMMARY FOR RIGID PAVEMENT
(TWO-LANE POURS)

Project	District	Length, mi.	Type	Route and Project Location	Roughness		Paving Contractor
					Integrator, in./Mile	Level Indicator, g's/Mile	
F 79041C, C3	5	9.818	24 ft	M 46 east from Vassar Rd. to M 24.	127	646	Denton Construction Co. (12)
BI 80031A, C1	7	5.613	24 ft	1 196 north from the C&O RR to 1600 ft north of 101st Ave.	128	413	Carl Goodwin & Sons, Inc.
BI 03033D, C16	7	3.2	24 ft (Dual)	1 196 north from 109th Ave. to 116th Ave.	131	385	L. W. Edison Co. (13)
BI 77111B, C3	9	4.583	24 ft (Dual)	1 94 northeast from St. Clair Hwy. to Big Hand Rd.	134	402	Sargent Construction Co.
I 33045A, C4* U 33171A, C1 U 33171B, C2 U 33171D, C3	8	2.263	24 ft (Dual) & 36 ft (Dual)	1 496-US 127-M 78 north from Mt. Hope Ave. to Grand River Ave.	140	499	Denton Construction Co. (14)
BI 17034A, C14 BI 17034B, C15	2	5.405	24 ft (Dual)	1 75 north from 2500 ft north of M 28 to 2300 ft south of Six Mile Rd.	143	458	Hodgkiss & Douma, Inc. (15)
U 46081D, C6 SS 46071A, C1	6	11.845	24 ft & 48 ft	M 52 north from the Michigan-Ohio state line to Adrian south city limit.	144	506	Hertel-Deyo Co.
BI 77111A, C2	9	5.89	24 ft (Dual)	1 94 northeast from Springborn Rd. to St. Clair Hwy.	145	397	Sargent Construction Co.
I 33045D, C1 I 33045B, C2 I 33045F, C3	8	2.57	24 ft (Dual)	1 496-M 78 north from south of Cavanaugh Rd. to Mt. Hope Ave.	146	520	Sargent Construction Co. (16)
BF 39014A, C23	7	2.140	24 ft (Dual)	US 131 north from Parkview (M) Ave. to south of M 43.	160	564	W. H. Knapp, Inc. (16)
BF 39014A, C12 BF 39014A, C14 BI 39024B, C15	7	2.297	24 ft (Dual)	US 131 north from Milham Rd. to Parkview (M) Ave.	165	589	W. H. Knapp, Inc. (16)
U 52042E, C8	1	1.750	24 ft (Dual)	US 41-M 28 Marquette Bypass.	184	724	Bacco Construction Co.
U 78022C, C2	7	1.580	48 ft	US 12 east from Centerville St. (M 78) to 1300 ft east of Vinewood Ave.	186	904	Cross & White
Weighted Arithmetic Mean for 1963 Construction Tested During 1963-64 test years					131	440	
WEIGHTED ARITHMETIC MEAN FOR 1963-64 ROUGHNESS TEST YEARS					131	476	

* For additional data see Table 3

- (10) Subcontract from Holloway Construction Co.
- (12) Subcontract from C. E. Utterback
- (13) Contract awarded to L. W. Edison Co. & Canole Construction Co.
- (14) Subcontract from A. Lindberg & Sons, Inc.
- (15) Subcontract from Gilliland Construction Co. & Bacco Construction Co.
- (16) Contract awarded to Smith Brothers Excavating & W. H. Knapp, Inc.

TABLE 2
FOURTEEN-YEAR ROUGHNESS SUMMARY FOR RIGID PAVEMENT
(TWO-LANE POURS)

Test Year	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963-1964	1951-1964
Total Projects	17	25	40	17	22	21	33	34	45	35	37	36	35	397
Percent Good 0-130 in./mi.	47	4	17	29	36	19	61	74	51	83	38	25	40	42
Percent Average 131-174 in./mi.	29	68	68	42	64	62	36	26	42	14	49	61	51	47
Percent Poor 175 or more in./mi.	24	28	15	29	0	19	3	0	7	3	13	14	9	11
Weighted Arithmetic Mean	144	154	146	147	140	141	126	114	124	117	133	137	131	130
Project Mileage*	48.327	70.615	98.791	41.271	52.690	82.473	165.086	140.506	108.892	154.333	133.043	140.128	167.040	1463.195
Lane Mileage**	109.318	173.900	250.082	110.838	146.723	241.866	620.200	487.352	650.744	558.866	477.087	511.668	606.852	4854.496

* As given in Contract Division monthly "Report of Awards"

** Total mileage of 11- or 12-ft wide lanes

TABLE 3
ROUGHNESS DATA SUMMARY FOR RIGID PAVEMENT WIDENING
(ONE-LANE POURS)*

	Project	District	Length, mi.	Type	Route and Project Location	Roughness		Paving Contractor
						Integrator, in./Mile	Level Indicator, g's/Mile	
1961 CONSTR.	EBI 41131, C59RN	5	0.511	12 ft	US 131 (median side NB roadway, shoulder side SB roadway) north 0.511 mi. from 0.247 mi. north of Grand Rapids north city limit.	107	547	Sargent Construction Co. (1)
	BI 63173, C8RN*	9	6.134	12 ft	I 75 (median side, both roadways) northwest from 1.2 mi. west of M 15 to 0.13 mi. north of M 87.	142	491	Sargent Construction Co. (2)
1962 CONSTRUCTION	BI 41131, C84UN* BI 41131, C86RN	5	0.732	12 ft	US 131 (median side, both roadways) north from Richmond St. to 0.247 mi. north of Grand Rapids north city limit.	146	636	L. W. Edison Co.
	BI 63173, C11RN*	9	6.508	12 ft	I 75 (median side, both roadways) north from 660 ft north of M 87 to Evans Rd.	149	606	Hertel-Deyo Co. (3)
	BI 41131, C89UN*	5	1.062	12 ft	US 131 (median side, both roadways) north from 6th St. north to Richmond St.	151	708	L. W. Edison Co.
	EBI 63172, C6RN* EBI 63173, C7RN	9	1.234	12 ft	I 75 (median side, both roadways) northwest from west of Baldwin Rd. to 0.734 mi. west of Allen Rd.	100	678	Denton Construction Co. (4)
	U 73063B, C5	6	1.153	36 ft	M 46-Remington St. (WB roadway) west from 17th St. to Sheridan St.	170	656	W. F. McNally Co.
	Weighted Arithmetic Mean for 1962 Construction Tested During 1963-64 test year						149	549
1963 CONSTRUCTION	U 21031E, C3	2	1.780	11 ft	M 35 (shoulder side, both roadways) north from Lake Shore Dr. to south of US 2-US 41.	151	647	Fox Valley Construction Co.
	F 13022C, C7	7	0.700	12 ft	M 60 (median side, both roadways) east from 100 ft west of Goldup St. to 300 ft east of the Kalamazoo River.	173	675	Titus Construction Co. (5)
	U 56023A, C10	6	1.167	36 ft	M 20-Buttles St. east from Eastman Rd. to 2nd St.	179	679	Titus Construction Co. (6)
	U 55031A, C9	1	0.852	11 ft	M 35 (shoulder side, both roadways) northeast from US 41 to Menominee north city limit.	185	698	Caspian Construction Co.
	I 33045A, C4* U 33171A, C1 U 33171B, C2 U 33171D, C3	8	0.85	12 ft	I 496-M 78, Homer-Howard one-way street system (inside lanes, both roadways) north from Kalamazoo St. to Grand River Ave.	188	668	Denton Construction Co. (7)
	USS 33011B, C3 USS 33011D, C4	8	2.986	12 ft	M 99 (shoulder side, both roadways) north from I 96 to NYC RR	195	899	Eisenhour Construction Co. (8)
	U 73063B, C6	6	1.39	36 ft	M 46-Holland Ave. (EB roadway) east from Warren St. to Genesee St.	203	661	W. F. McNally Co.
	Weighted Arithmetic Mean for 1963 Construction Tested During 1963-64 test year						184	730
WEIGHTED ARITHMETIC MEAN FOR 1963-64 ROUGHNESS TEST YEARS						163	619	

* All construction is "third-lane" widening to projects reported in Table 1.

- (1) Subcontract from Kenny Construction Co.
- (2) Subcontract from Canonic Construction Co.
- (3) Contract awarded to Hertel-Deyo Co. & C. E. Utterback.
- (4) Subcontract from S. D. Solomon & Sons.
- (5) Subcontract from Reith-Riley Construction Co.
- (6) Contract awarded to Eisenhour Construction Co. & Titus Construction Co.
- (7) Subcontract from A. Lindberg & Sons, Inc.
- (8) Contract awarded to Eisenhour Construction Co. & Spartan Asphalt Paving Co.

TABLE 4
SEVEN-YEAR ROUGHNESS SUMMARY
FOR RIGID PAVEMENT WIDENING
(ONE-LANE POURS)

Test Year	1958	1959	1960	1961	1962	1963-1964	1958-1964
Total Projects	3	2	5	10	4	14	38
Percent <u>Good</u> 0-130 in./mi	33.3	0	20	0	0	0	5
Percent <u>Average</u> 131-174 in./mi	33.3	50	60	70	75	64	63
Percent <u>Poor</u> 175 or more in./mi	33.3	50	20	30	25	36	32
Weighted Arithmetic Mean	122	194	138	182	169	163	158
Project Mileage*	5.403	3.092	13.925	17.704	10.006	27.093	77.223
Lane Mileage**	11.176	6.184	24.152	31.995	20.012	57.940	151.459

* As given in Contract Division monthly "Report of Awards"
 ** Total mileage of 11- or 12-ft wide lanes

TABLE 5
ROUGHNESS DATA SUMMARY FOR FLEXIBLE PAVEMENT

	Project	District	Length mi.	Type	Route and Project Location	Roughness		Paving Contractor
						Integrator in/Mile	Level Indicator, g's/Mile	
1962 CONSTRUCTION	EBACI 11111B, C8RN	7	3.506	24 ft (Dual)	I 196 north from Riverside Dr. to the Berrien-Van Baren county line	106	261	Globe Construction Co. (1)
	EBACI 11111A, C1RN	7	4.469	24 ft (Dual)	I 196 north from I 94 to Riverside Dr.	109	297	John Yerington (2)
	EHI 16093, C1RN EHI 69014, C6RN	4	10.551	24 ft (Dual)	I 75 north from Vanderbilt to Wolverine	111	434	Reith-Riley Construction Co. (3)
	Weighted Arithmetic Mean for 1962 Construction Tested During 1963-64 test years						110	368
1963 CONSTRUCTION	BI 11014A, C4	7	2.2	24 ft (Dual)	I 94 northeast from LaPorte Rd. to 1500 ft southwest of M 60	94	140	Spartan Asphalt Paving Co. (4)
	BI 80012A, C1	7	5.896	24 ft (Dual)	I 196 north from Berrien-Van Baren county line to north of 30th Ave.	95	154	Globe Construction Co. (5)
	SS 11019A, C1	7	0.854	24 ft	M 239 northwest from Michigan-Indiana state line northwest to I 94	99	178	Spartan Asphalt Paving Co. (6)
	BI 80012B, C3	7	3.340	24 ft (Dual)	I 196 north from north of 30th Ave. to C & O RR	100	158	Sagmaw Asphalt Paving Co. (3)
	Weighted Arithmetic Mean for 1963 Construction Tested During 1963-64 test years						99	153
WEIGHTED ARITHMETIC MEAN FOR 1963-64 ROUGHNESS TEST YEARS						106	286	

- (1) Subcontract from Canonic Construction Co. & John Yerington
 (2) Contract awarded to Canonic Construction Co. & John Yerington
 (3) Subcontract from Holloway Construction Co.
 (4) Subcontract from Maclean Construction Co.
 (5) Contract awarded to L. W. Edison Co. & Globe Construction Co.
 (6) Subcontract from Maclean Construction Co. & H. F. Stukay