R-337

OFFICE MEMORANDUM

MICHIGAN
STATE HIGHWAY DEPARTMENT
JOHN C. MACKIE, COMMISSIONER

July 6, 1960

To: W. W. McLaughlin
Testing and Research Engineer

From: E. A. Finney

Subject: Roughness Evaluation of Railroad Crossings in Battle Creek.
Research Project 60 F-56, Report No. 337.

At the request of Mr. R. F. Van Hoef, Director, Planning Division, and with your approval the Research Laboratory Division conducted a study to determine the relative roughness of eight railroad grade crossings on the trunkline system in Battle Creek.

The locations of the railroad crossings selected for this relative roughness study are:

1. Michigan Ave. - US 12 at Porter and Lansing.
2. Michigan Ave. - US 12 between Gilbert and Union.
3. Michigan Ave. - US 12 at Elm St.
4. Capital Ave. - M 78 between State and Van Buren.
5. & 6. Capital Ave. - M 78 between Dickman and Hamblin.
7. Kalamazoo St. between Washington and Carlyle.
8. Elm St. between Van Buren and Michigan Ave.

Intersections Nos. 5 & 6 consisted of a three-track crossing with a single-track siding nearby. For the purposes of this study the four tracks were considered as one crossing.

The MSHD Roughometer is the vehicle normally used for measuring pavement roughness. It is ordinarily operated at 20 mph and thus a 50-ft length of pavement is measured in 1.71 seconds. Therefore, for such very short distances as were involved in these railroad crossings, starting and stopping times are very critical and a fraction-of-a-second delay in starting or stopping leads to a large percentage error in the roughness reading. Therefore, the Research Laboratory Profilometer is normally used for measuring roughness over very short distances. This is a straight-edge type of profilometer which was designed for a maximum displacement of 1/2-in. in a 10-ft length, but the irregularities at the crossing were greater than this, making readings with this device impossible. The method finally used was

operation of the roughometer at 10 mph with an accelerometer to measure the vertical acceleration of the roughometer wheel as it passed over these railroad crossings. A Statham 15-g accelerometer was attached to the leaf spring, with the accelerometer output connected to a strain analyzer and a Brush oscillograph. Using this method, it was possible to secure a permanent record of the accelerations obtained as the roughometer wheel passed over the track crossings. Two passes were made with the roughometer wheel for each wheel path of each lane, a total of eight passes per track crossing.

Comparison of the six track crossings was accomplished by accumulation of the peak-to-peak accelerations obtained on the Brush oscillograph paper without regard to direction. These accelerations were divided into increments of 1/2-g and the number of occurrences per 1/2-g increment were recorded for each pass over the track crossing (g = acceleration of gravity = 32.2 ft per second per second). An average value for each pass and wheel path was obtained for each crossing.

Since each crossing varied in width, an arbitrary standard of g's per 100 ft was used in order to compare the roughness of the crossings. The results are tabulated in Table 1. Based on this study and using the g's per 100 ft value as the roughness criterion the railroad crossings are ranked below according to riding quality from the best to the worst:

Smoothest	-	Crossing No. 3 - Mich. Ave. - at Elm St.
		Crossing No. 8 - Elm St. - between Van Buren & Mich. Ave.
		Crossing No. 1 - Michigan Ave. at Porter & Lansing
		Crossing No. 2 - Michigan Ave. - between Gilbert and Union
		Crossing No. 4 - Capital Ave. - between State & Van Buren
Roughest	-	Crossing No. 5 & 6 - Capital Ave. - between Dickman & Hamblin

As an indication of relative roughness for these crossings, the acceleration as measured by g's per 100 ft should be a satisfactory measure. A high reading of vertical acceleration is definitely related to increased pavement roughness as measured by conventional means, such as in. per mi of vertical displacement. Since this is the first time the Laboratory has used acceleration for measuring pavement roughness, there has been no opportunity yet to relate it statistically to conventional means, but this is possible and will be done in the near future.

OFFICE OF TESTING AND RESEARCH

E. A. Finney, Director
Research Laboratory Division

EAF:RH:js

cc: R. F. Van Hoef

TABLE 1

CROSSING ROUGHNESS AS MEASURED BY WHEEL ACCELERATION

Crossing No.	Length, ft	Number of Occurrences at Stated Acceleration Level															Acceleration	
		0.5g	1.0g	1.5g	2.0g	2.5g	3.0g	3.5g	4.0g	4.5g	5.0g	5.5g	6.0g	6.5g	7.0g	7.5g	8.0g	Accumulated g's	g's per 100 ft
1	61	48	42	22	17	11	8	4	4	2	2	1	1	0	1	0	0	252	415
2	54	30	30	25	22	9	10	6	6	4	3	1	1	1	1	0	0	282	525
3	129	138	57	26	12	6	2	1	0	0	0	0	0	0	0	0	0	214	173
4	23	9	11	8	6	5	5	4	4	3	3	2	2	1	1	1	1	178	775
5 & 6	39	17	20	15	14	10	10	8	8	6	4	3	2	2	2	1	0	304	895
7		- This crossing under repair -																	
8	60	58	40	19	16	6	5	4	4	3	3	0	1	1	0	0	0	223	372