PROGRESS REPORT ON EVALUATION OF A RUBBER PAD RAILROAD CROSSING

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This study was undertaken by the Michigan Department of State Highways in 1963 with the cooperation of the Bureau of Public Roads. Its main objective was to provide information to determine whether the advantages of the rubber crossing would offset the cost difference between rubber and timber crossings. On the basis of these data the Bureau could act on specifications and standard plans for this type of railroad crossing material.

The location, construction details and initial evaluation results were given in Research Report No. R-578, "Evaluation of a Rubber Pad Railroad Crossing" issued by the Research Laboratory in April 1966. The location and construction detail portions of this earlier report are included herein in their entirety. The evaluation section has been expanded to include 1966, 1967, and 1968 data.

LOCATION AND DESCRIPTION

Both sites are single-track crossings belonging to the Chesapeake and Ohio Railway. The timber crossing is located approximately 160 ft south of Garey St on eastbound M 46 in the City of Saginaw. It consists of 58 ft 4 in. of prefabricated treated timber ties, and crosses the roadway at a skew; the acute angle with respect to the roadway centerline being approximately 76 degrees. The horizontal roadway alignment is straight, whereas the vertical is on a minus 0.67-percent grade. The roadway consists of a 9-in. reinforced concrete slab, four 12-ft lanes in width, with 2-ft curb and gutter each side. Present speed limit is 30 mph and the projected ADT for 1975 is 20,000.

The rubber pad crossing is located in the 1400 block of Davenport St on westbound M 81 in the City of Saginaw. It consists of 42 ft of steel reinforced rubber pads, and is very nearly perpendicular to the roadway centerline, which in the crossing area is on a tangent portion of the horizontal alignment. The centerline of the track coincides with the crest of a 300-ft vertical curve, the tangents having grades of plus 1.44 and minus 1.16 percent, respectively. The reinforced concrete slab is 9 in. thick and three 12-ft lanes in width, with 2-ft curb and gutter each side. Presently, the speed limit is 35 mph and the projected ADT for 1983 is 19,250.

CONSTRUCTION

The crossings were constructed by C&O Railway personnel on a force account basis, with coordination and inspection of the work the responsibility of the Department's District Office. The timber crossing was installed in July 1963 in accordance with Standard Plan for Track Crossings, E-4-A-22D, Detail 2. A sketch showing a cross-section of the crossing components is shown in Figure 1.

Construction of the rubber pad crossing began in July 1965 with work done on an intermittent basis until completion in September 1965. To realize the full advantage of this type of crossing, the materials must meet specified dimensions and the installation must be precisely performed. In both of these areas some difficulties were experienced. Twice it was necessary to reject installed ties, the first time because of undersize cross-sectional tie dimensions and the second because tie length was less than required. With the cooperation of railroad personnel, satisfactory ties were obtained by carefully culling the railroad's tie stock. With respect to installation of the pads it was noted that in some cases the side shims split longitudinally when the lag bolts were installed, and it was extremely difficult to obtain the correct depth for the lag bolt heads below the rubber surface. Reaming the holes through the shims to the correct diameter and blowing out wood shavings collecting in the bottom of the drilled holes with compressed air, minimized the problems incurred when installing the lag bolts. The components of the rubber pad crossing are shown in a cross-sectional sketch in Figure 1.

The initial construction costs were as follows:

	Timber Crossing	Rubber Crossing
Material (includes handling)	$794.24	$3,532.62
Labor	313.74	850.10
Total Cost	$1,107.98	$4,382.72

On a lineal foot basis, the timber crossing cost $19.00 and the rubber crossing $104.35. The cost per lineal foot of the rubber crossing was 5-1/2 times that of the timber crossing.

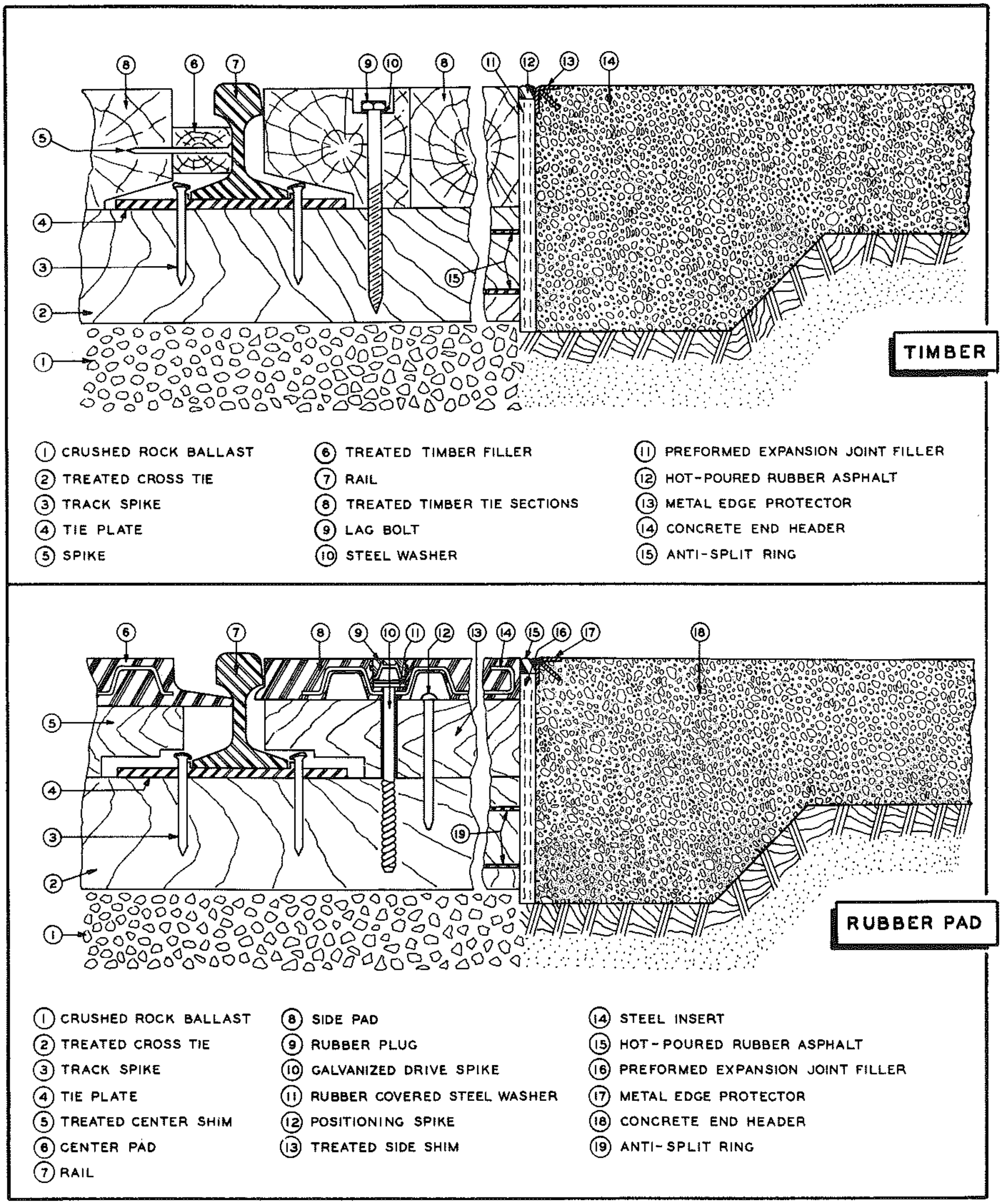

Figure 1. Cross-sectional detail drawings of railroad crossing components.

FIELD EVALUATION

The performance of the crossings was evaluated on the basis of four factors:

1. Durability--Summer and winter inspections of each crossing were performed to determine the extent of deterioration of the two materials. Maintenance operations were to be observed when performed and all maintenance expenditures recorded. No maintenance, however, was necessary. In addition the Annual Average Daily Traffic (ADT) volume for each year of the study was obtained.

2. Riding Quality--The surface roughness of each crossing was measured in the summer of each year with the Laboratory's profilometer. Measurements were taken in each wheel track of all lanes.

3. Skid Resistance--The coefficient of wet sliding friction of each crossing was measured in the summer of each year with the Laboratory's skid device. Measurements were taken in each lane.

4. Safety--Observations and measurements made for the preceding three factors were studied to determine the safety characteristics of each crossing.

DURABILITY

Timber Crossing

The first inspection of the timber crossing was made in August 1964. It was noted that the south side of the crossing was from 1/2 to 1 in. low with respect to the pavement and that the north side was high by about the same amount. A 6- to 12-in. wide bituminous transition strip had been laid at the north side to provide a smoother crossing. The timbers were in good condition and neither they nor the rails were loose. The 1965, 66, and 67 inspections revealed no noticeable changes. During the March 1968 inspection it was noted that the crossing had settled. The south side was found to be about 2 in. lower than the pavement and the north side was nearly at the same elevation as the concrete slab. The 1968 summer inspection disclosed no further settlement. During the final inspection all crossing elements appeared to be securely fastened and no significant surface wear of the timbers was evident. Figure 2 shows the condition of the crossing after one and five years.

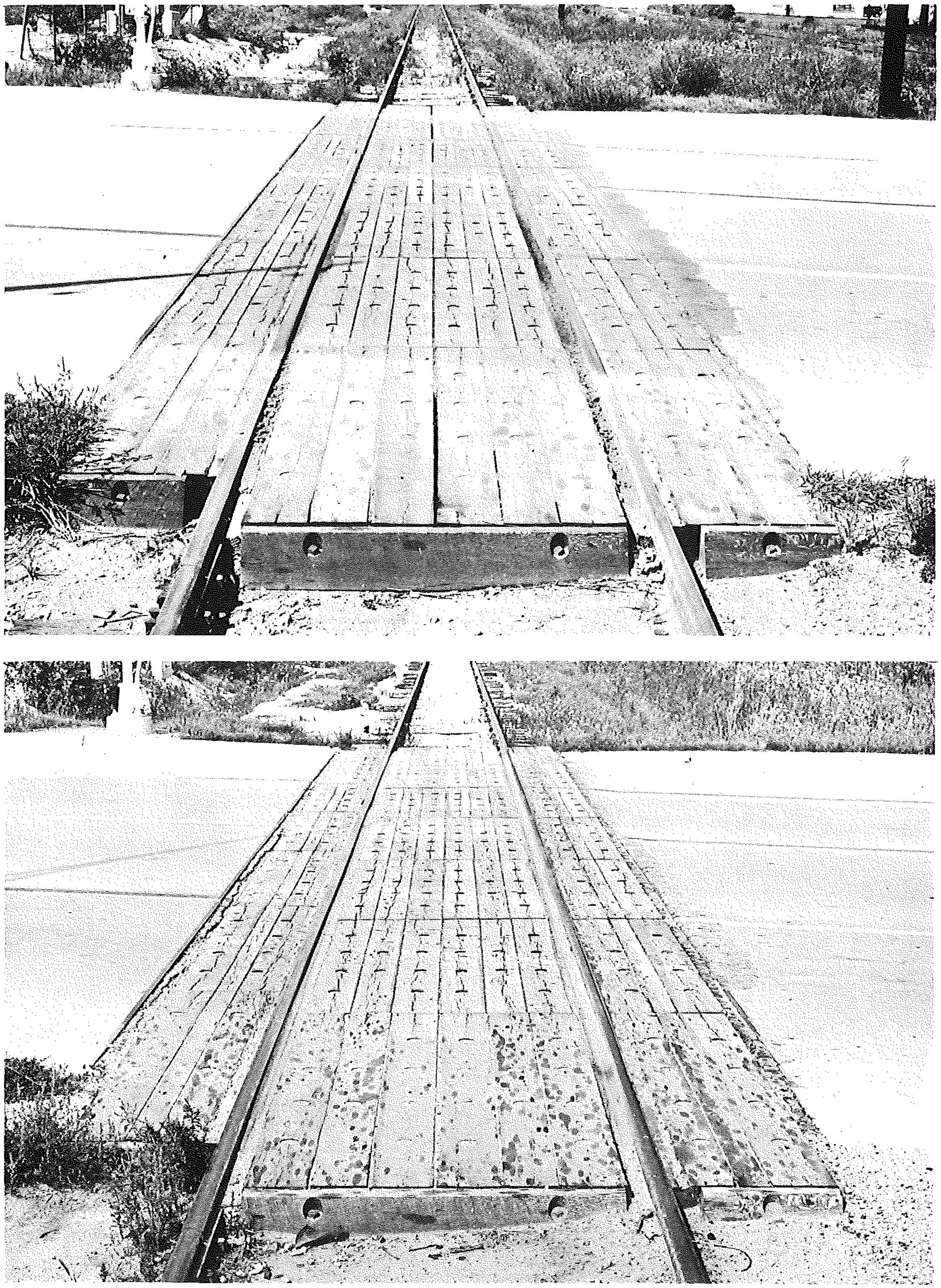

Figure 2. Views of timber crossing one year after installation (top), and five years after installation (bottom).

Rubber Crossing

The rubber crossing was inspected for the first time in the winter of 1966 and was found to be in excellent condition. The 1966 summer inspection revealed that seven bolt-hole rubber caps had been lost, presumably due to snow removal operations. These caps have never been replaced. No change in condition was noted at the 1967 winter inspection, but a slight deflection of the approach side of the crossing in the right hand lane was noted during the summer inspection when vehicles passed over the crossing. This deflection was also noted at the winter inspection of 1968. In addition the sealer at the approach edge showed the beginning of adhesion failure. At the 1968 summer inspection the approach side of the crossing in all three lanes deflected slightly under load, and the seal at this edge had failed completely in the right hand and center lanes. The pads and rails appeared to be securely fastened to the ties. The slight deflection of the approach side is probably the result of a loss of support under the ties at this edge. However, this deflection does not adversely affect the excellent rideability of the crossing. To date there is no visible wear of the pads. Figure 3 shows the condition of the crossing as constructed and three years later.

The ADT volumes at the two crossing locations were:

	1964	1965	1966	1967	1968
Timber	5,000	5,700	6,000	7,400	8,400
Rubber	--	--	11,500	12,000	12,500

As of November 15, 1968 there had been no maintenance charges to either crossing.

ROUGHNESS

The area evaluated at each crossing consists of a 25 ft approach slab, the edge-to-edge width of the crossing, and a 25 ft leaving slab. Profilometer readings were taken in the inner and outer wheel paths in each lane at each crossing. The wheel path values were averaged to obtain a roughness index for the approach slab, crossing, and leaving slab. These values

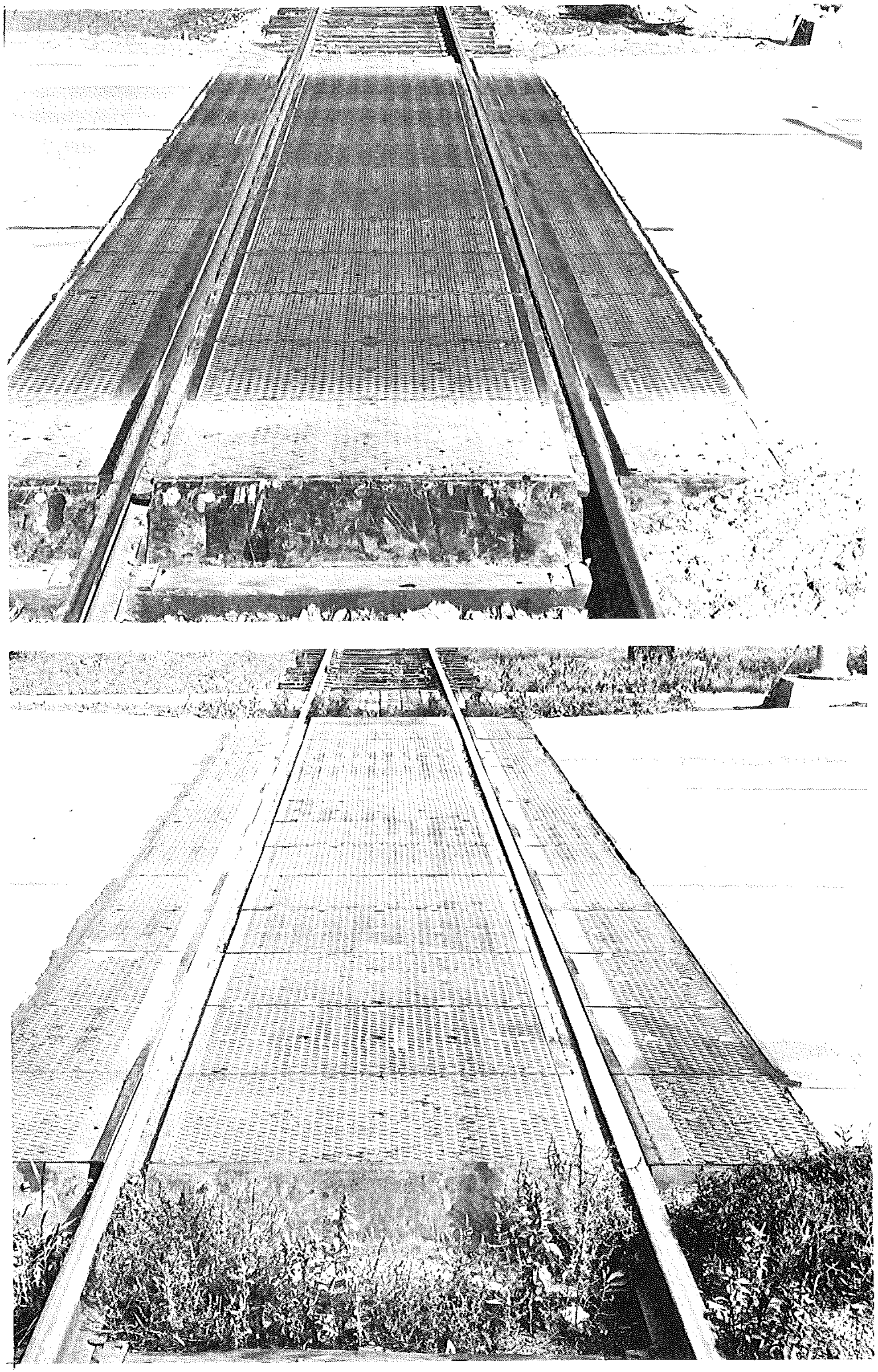

Figure 3. Views of rubber pad crossing. As constructed (top), and three years after construction (bottom).

in turn were weighed according to length, and averaged for roughness of the total area evaluated. The results are as follows:

Material	Survey Date	Roughness, inches per mile			
		Approach Slab	Crossing Material	Leaving Slab	Weighted Average for Area Evaluated
Timber	8-19-64	179	1248	283	389
	8-30-65	193	1218	282	390
	8-19-66	253	1334	370	470
	9-12-67	317	1421	198	446
	12-13-68	290	1206	307	445
Rubber	12- 1-65	95	552	93	163
	8-19-66	124	630	120	197
	9-12-67	140	587	140	206
	12-13-68	163	562	133	210

Generally speaking there has been no significant change in the roughness values measured at the two crossings. On the basis of the average roughness for the area evaluated, the roughness at the timber crossing has increased 55 inches per mile since 1965. During the same period the roughness at the rubber pad crossing has increased 47 inches per mile. The 1968 measurements show that the average roughness at the timber crossing is 2.1 times greater than the value measured at the rubber pad location.

SKID RESISTANCE

The widths of the crossing were too short for measurements of the coefficient of wet sliding friction at normal pavement test speeds (20 or 40 mph). Consequently, skid tests were conducted by positioning the trailer wheels just past the first rail, locking the wheels and then pulling the trailer across the wetted surface between the rails. The friction coefficients for the crossings, therefore, cannot be directly compared to coefficients for pavement, but reflect the friction characteristics of the two materials when tested as described. The tests have produced the following results for the two crossings, with each value representing the average of three tests and the lanes numbered from left to right with respect to traffic direction:

Material	Lane No.	Avg. Coefficient of Wet Sliding Friction (at speeds less than 2 mph)			
		8-64	10-65	9-66	9-67
Timber	1	0.52	0.74	0.58	0.75
	2	0.52	0.78	0.63	0.81
	3	0.55	0.78	0.64	0.99
	4	0.55	0.78	0.60	0.94
Rubber	1	----	0.77	0.91	0.95
	2	----	0.77	0.84	0.81
	3	----	0.76	0.93	0.88

Skid resistance tests on concrete pavement conducted in the manner described here and reported in Part II of the First International Skid Prevention Conference (August 1959) indicate that at low speeds a small change in speed can cause considerable variation in the coefficient of friction. Assuming this to be true also for timber and rubber the variations in the measured coefficients from year to year and from lane to lane are believed to be caused by testing under slightly different speeds rather than changes in the surface smoothness of the materials. Because of this difficulty any firm conclusions as to which material has the better skid resistance, would be meaningless.

The skid coefficients reported here were recorded continuously on a direct writing oscillograph for manual reduction. In 1967 the oscillograph method was exchanged for a completely digital system. One step of the programmed operation of this system involves integration which cannot be sufficiently slowed to permit operation at the speeds used on the crossings. In view of the uncertain accuracy of the measured coefficients and the considerable amount of work involved in changing the skidometer back to the old recording method, skid tests were not conducted in 1968 and no further tests will be made.

SAFETY

From the evaluation results obtained to date there are no indications that the safety of the crossings has been impaired. Both materials show no appreciable surface wear and are securely fastened to the ties. The average roughness of the total area evaluated at each location has increased somewhat, but not to such an extent to cause unsafe conditions.

CONCLUSIONS

On the basis of the data collected to date, the performance of the rubber pad crossing is equal to or better than that of the timber crossing. In particular, the smoothness of the rubber crossing is excellent.

Since neither crossing has required any maintenance there are no indications as yet that the additional first cost of the rubber crossing can be justified in terms of reduced maintenance costs. Under the conditions that these crossings are subjected to, it could be several years before sufficient information is available on which to base a judgement in that regard.

The roughness experienced by vehicle occupants when driving over the rubber crossing is judged to be similar to that experienced when passing over closely spaced pavement expansion joints. The ADT counts show that the rubber pad crossing has served the occupants of over 13,000,000 vehicles at this very reasonable roughness level. This accomplishment should not be overlooked when considering the approval of this type of crossing material.

The experience with rubber pad railroad crossings in highway application is very limited, and should approval of this material be given, it would be necessary to take the following action to ensure a satisfactory crossing:

1. The railroad ballast must be of such quality and compacted in such a manner that settlement is limited to the least possible amount in order to minimize rework of the foundation after the crossing is in service.

2. The ties and shims must meet dimensions specified and installation of all components must be done accurately.

3. The vertical alignment of the highway and railroad must be compatible. Poor alignment appears to be the greatest cause of roughness and deterioration of any railroad crossing.

4. The joints between the crossing and the roadway should be constructed to a width of 1 in. and the seal should be maintained to limit the amount of moisture entering the foundation.

5. The problem of maintaining railroad crossings is a serious one. With a rubber pad crossing the initial cost of the material and its predicted service life of twenty years, indicates the need to initiate maintenance before structural damage to the pads occurs.