EVALUATION OF A RUBBER PAD RAILROAD CROSSING

J. E. Simonsen

Research Laboratory Division
Office of Testing and Research

Research Project 64 G-134
Research Report No. R-578

State of Michigan
Department of State Highways
Lansing, April 1966

EVALUATION OF A RUBBER PAD RAILROAD CROSSING

In September 1963, J. E. Meyer submitted proposed Supplemental Specifications for Rubber Pads for Railroad Crossings (dated July 25, 1963) and Standard Plan E-4-A-146 Rubber Pad Railroad Crossing Installation (dated September 6, 1963) to the Bureau of Public Roads for approval. In reply to this request, N. E. MacDougall stated in a letter to H. E. Hill, dated December 19, 1963 that "Before we can take formal action on the proposed specification and Standard Plan, it is suggested an experimental project be set up with the objectives of evaluating the rubber crossing, as compared to the standard timber crossings presently used with regard to durability, safety, skid resistance, and riding quality.

"It would not seem that the advantages of the rubber crossing would counter balance the substantial cost difference between it and the timber crossing, but an experimental installation should provide for a judgment in that regard.

"If it is desired that such an experimental feature be incorporated in a Federal-aid project, the Standard Plan and Supplemental Specifications, as submitted, are satisfactory for use on that project."

Mr. MacDougall also stated that Item No. 563, Michigan Project U 141(8) in Saginaw had been programmed to include a rubber pad railroad crossing, but that the Bureau was holding in abeyance their approval of this type of crossing until the Department had reached a decision on this experimental feature of the project.

The Department was in accord with the Bureau's suggestion that a rubber pad railroad crossing be incorporated in a Federal-aid project as an experimental feature. After further correspondence between Messrs. MacDougall and Hill, it was agreed that crossing G06 of 73073 (U 141(8)) be constructed on an experimental basis using rubber pads, and that standard timber crossing G06 of 73063 (U 206(10)) be established as a control section. Construction of the experimental crossing was to be in accordance with Standard Plan E-4-A-146 and rubber pad material properties would conform to requirements of the supplemental specifications as previously submitted by Mr. Meyer. However, in a letter to Mr. Hill from D. E. Jones, dated March 20, 1964, the Bureau requested that certain test conditions specified in the supplemental specifications be revised. The revised edition of the supplemental specifications (dated March 26, 1964) was approved by the Bureau on March 31, 1964.

The Research Laboratory Division of the Office of Testing and Research was assigned the responsibility of conducting material tests, as well as performing field evaluation tests on the two types of crossings. A field test program was designed to evaluate each of the four factors under study and consisted of the following:

1. Durability--Performing summer and winter inspections of each crossing to determine the extent of deterioration of the two materials, observing maintenance work when performed and keeping a cumulative record of maintenance expenditures, and obtaining Annual Average Daily Traffic (ADT) volume for each year until the study has been completed.

2. Riding Quality--Measuring the surface roughness of each crossing in the summer of each year with the Laboratory's profilometer; measurements will be taken in each wheel track of all lanes.

3. Skid Resistance--Measuring the coefficient of wet sliding friction of each type of material in the summer of each year with the Laboratory's skidometer; measurements will be taken in the wheel tracks in each lane.

4. Safety--Studying observations and measurements made for the preceding three factors to determine the safety characteristics of each crossing.

No special test program was established for the physical properties of the rubber pad material, because the required test procedures were given in the ASTM Specifications referenced in the supplemental specifications. With respect to tests on the qualitative nature of the rubber an arrangement was made with the Bureau's Materials Research Division, Washington, D. C. whereby spectrophotometric tests would be conducted independently by each agency for comparative purposes.

LOCATION AND DESCRIPTION

Both crossings are single tracks and are the property of the Chesapeake and Ohio Railway Company. The timber crossing is located approximately 160 ft south of Garey Street 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°. The horizontal roadway alignment is straight, whereas the vertical is on a minus 0.67-percent grade. The roadway consists of a 9-in. thick 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 Street 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 and the completed crossing is shown in Figure 2 one year after installation.

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 careful culling of 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 also 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

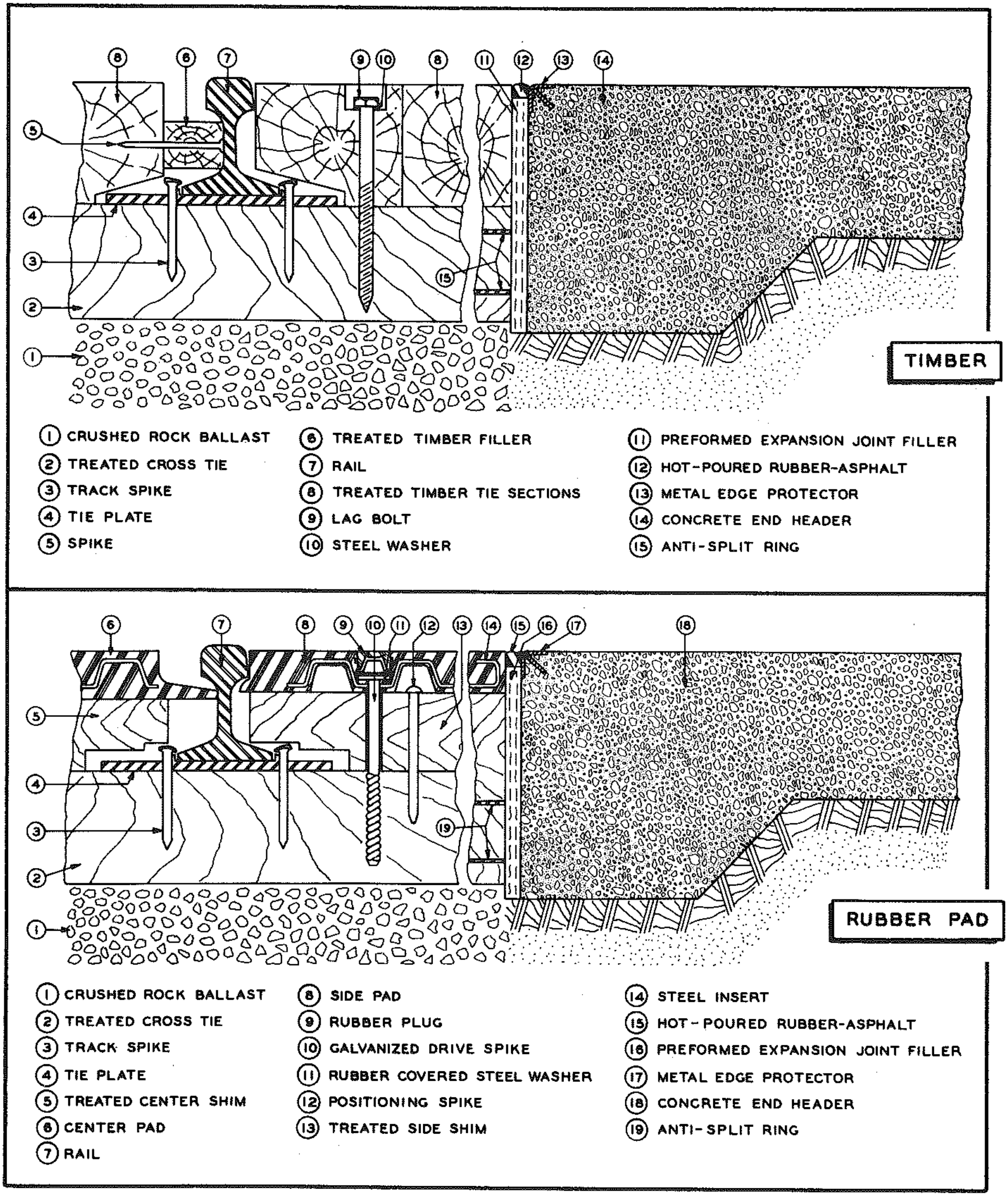

Figure 1. Cross-sectional detail drawings of railroad crossing components.

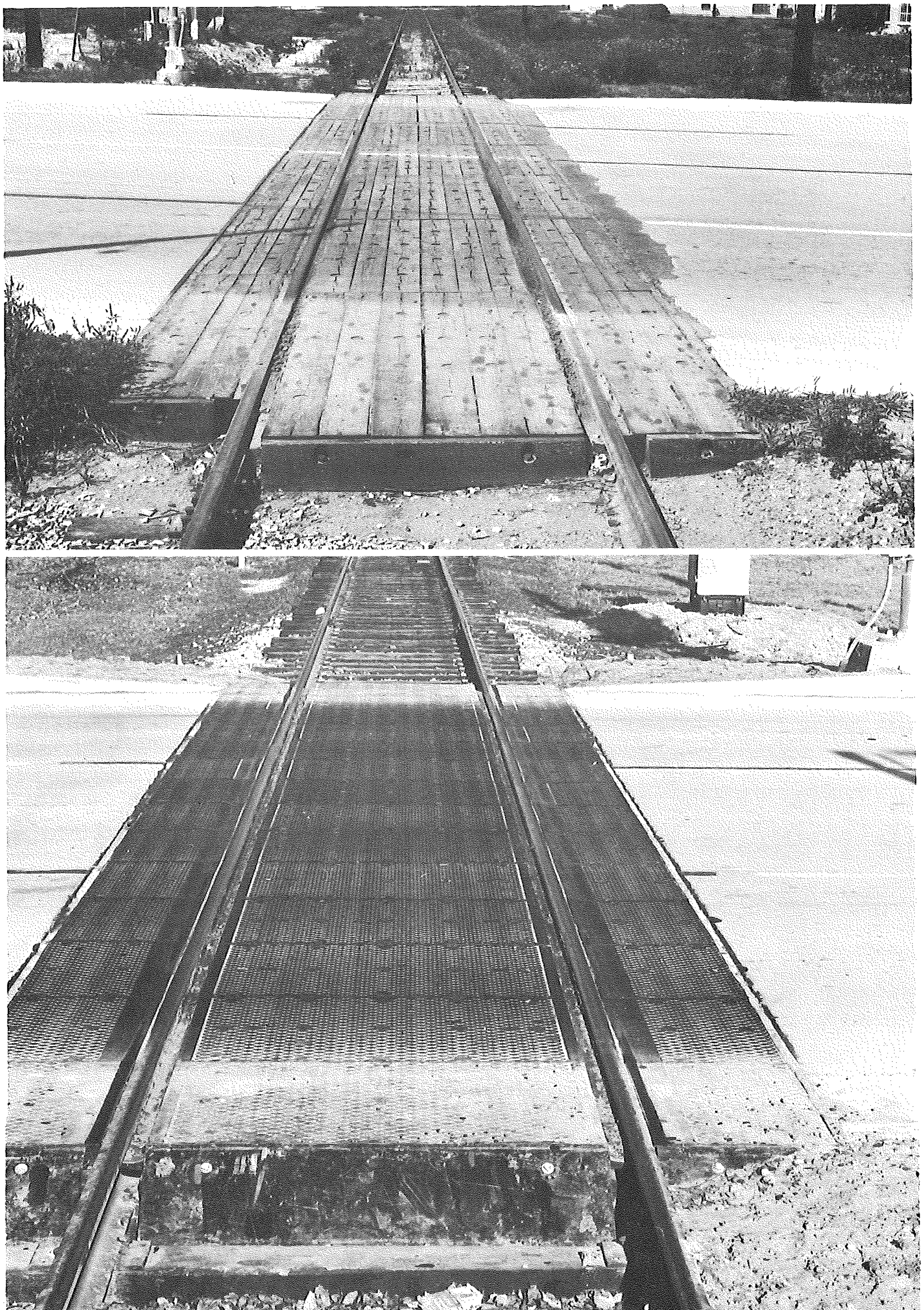

Figure 2. Views of timber crossing one year after installation (top), and rubber pad crossing two months after installation.

when installing the lag bolts. The components of the rubber pad crossing are shown in a cross-sectional sketch in Figure 1 and the finished crossing two months after completion is shown in Figure 2.

The total estimated cost of each crossing based on cost of materials, labor, and labor additives, was $1,340 and $10,374 for the timber and rubber pad crossings, respectively. The actual construction cost of each crossing is not available at this time, but will be included in a future report.

MATERIAL TESTS

Four rubber pads were selected from the delivered material (14 center pads and 28 side pads) at the railroad yard and taken to the laboratory for testing. The properties tested were hardness, tensile strength, and ultimate elongation, before and after oven aging for 96 hr at 158 F. A compression set test was performed on specimens oven aged for 22 hr at 158 F and an infrared spectrophotometric analysis was conducted on samples of the rubber material as received. Five specimens were prepared for determination of hardness, tensile strength, and ultimate elongation, each pad material being represented at least once. For compression set tests, three specimens were used, each from a different pad. Samples for the spectrophotometric analysis included material from all four pads and duplicate samples were sent to the Bureau's Materials Research Division, for analysis as previously agreed.

The results as compared with specification requirements are as follows:

Property	Average Test Value	Specification Value
Sample as Received		
Hardness (Shore A2)	61	60 ± 5
Tensile Strength, psi	1890	2000 min
Ultimate Elongation, percent	465	400 min
Oven Aged		
Compression Set, percent	6	25 max
Hardness Change (Shore A2)	+1	+7 max
Tensile Strength Change, percent	+1.6	-25 max
Ultimate Elongation Change, percent	-3.7	-25 max

As can be seen, the average tensile strength is below the specified value. However, ASTM Specification D 735 values apply to test specimens obtained from standard laboratory test slabs or blocks, and test results from finished products may vary from values given for standard test specimens. This variation may result from the method of processing or from difficulty in obtaining suitable test specimens from the finished product.

On the basis of infra-red spectra of pyrolysates and pyrolysis-gas chromatography data, the elastomer was identified as GRS rubber by both the Bureau and the Department. This result shows that the rubber conforms to the specified Type R compound.

FIELD EVALUATION

Durability

The first inspection of the timber crossing was made on August 19, 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 the north side 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. Two 1965 inspections and the 1966 winter inspection revealed little change in the noted crossing condition. The rubber pads had been in service about three months at the time of the 1966 inspection and the crossing was in excellent shape.

The ADT volume at the timber crossing was 5,000 in 1964 and 5,700 in 1965. Counts at the rubber pad crossing are scheduled to begin in 1966.

As of January 31, 1966 there had been no maintenance charges relative to either crossing.

Roughness

The length of the area evaluated at each crossing consists of a 25-ft approach slab, the edge-to-edge width of the crossing material, 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 each of the three lengths, and these values in turn were averaged for roughness of the total length evaluated. The results were as follows:

Material Type	Survey Date	Roughness, inches per mile			
		Approach Slab	Crossing Material	Leaving Slab	Average for Area Evaluated
Timber	8-19-64	179	1248	283	389
Timber	8-30-65	193	1218	282	390
Rubber	12-1-65	95	552	93	163

The indices for the approach and leaving slabs include roughness contributed by the joint between the crossing and the concrete slab. For the crossing material, the roughness due to the rails is included. As can be seen the average roughness for the crossing area at the timber crossing is 2.4 times greater than the value measured at the rubber crossing. It should be noted that the roughness value of 163 obtained for the rubber crossing is less than the roughness of some bridge spans measured during an earlier study of bridge deck roughness conducted on 203 structures by the Research Laboratory, and described in a series of seven progress reports under Research Project 61 F-65.

Skid Resistance

Skid resistance tests have produced the following results for the two railroad crossings, with each value representing the average of three tests and the lanes numbered from left to right with respect to traffic direction:

Material Type	Lane No.	Avg. Coefficient of Wet Sliding Friction (at speeds less than 2 mph)	
		August 1964	October 1965
Timber	1	0.52	0.74
	2	0.52	0.78
	3	0.55	0.78
	4	0.55	0.78
Rubber	1	Constructed	0.77
	2	July-September	0.77
	3	1965	0.76

Because the widths of the crossings are too short for measurement of the coefficient of wet sliding friction of the two materials at normal test speeds for pavements (20 or 40 mph), 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 reported 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.

Safety

It appears that a safe railroad crossing would be one that can be crossed at the legal speed limit without undue disruption of the driving comfort of the vehicle driver and passengers, and without causing damage to the vehicle. This definition excludes the hazards of rail crossings caused by drivers failing to observe warning devices, by mechanical failures of vehicles, and by unsafe driving under existing road conditions. Since these hazards exist at all railroad crossings, the safety of the two crossings under study will be evaluated in terms of the performance of the two materials involved.

As previously discussed, the materials are securely fastened to the ties, and very little surface wearing has occurred. The roughness measurements indicate the timber crossing is more than twice as rough as the rubber crossing. This roughness difference can be noted in driving over the crossings, but neither crossing causes sufficient discomfort to be classified as unsafe. With respect to skid resistance, the latest measurements show almost identical coefficients of friction for the two materials.

Summary

It is, of course, too early to make any conclusions as to which type of crossing will give the best performance in the long run within reasonable expenditures. At present the timber crossing is rough compared to the rubber. Some of this roughness is caused by the crossing being out of vertical alignment with respect to the abutting concrete slabs, and improvements probably could be made by adjusting the crossing elevation. Aside from some difficulty in obtaining satisfactory ties and installing the pads, the finished rubber crossing was smooth riding and is now performing very well. A fitting description of the present condition of the rubber pad crossing is the following statements taken from "Rubberized Railroad Crossings," a reprint from the American Road Builder included in the manufacturer's advertising literature: "What you notice first is that you don't notice anything. Your car doesn't bounce, your teeth don't rattle. Unless you can see the crossing, you will never know when you ride over it." Whether these statements will continue to apply will be determined from future data.