# OFFICE MEMORANDUM

MICHIGAN
STATE HIGHWAY DEPARTMENT
JOHN C. MACKIE, COMMISSIONER

December 14, 1964

To: L. T. Oehler, Supervisor
Physical Research Section

From: J. E. Simonsen

Subject: Repair of Rubber Pad Railroad Crossing (NYC RR Crossing US 23 South of Dundee). Research Project R-64 G-134. Research Report No. R-486.

On October 19, 1964, the Research Laboratory Division was informed verbally by R. L. Greenman, that the US 23 rubber railroad crossing was scheduled for replacement, with work scheduled to begin later in the month. Because the Laboratory had previously been assigned to evaluate the performance of a similar railroad crossing to be constructed next year in the City of Saginaw, it was decided that the replacement operations should be observed, to ascertain if possible the cause of the premature failure of this rubber pad crossing.

A general condition inspection of the crossing was made by the writer on October 27, prior to the beginning of construction operations later in the day. On October 29 a more detailed inspection was made of the exposed construction materials in the traffic lane of the southbound roadway.

The crossing was constructed in July 1958, and periodic repairs were made during the intervening six-year period. According to the railroad construction crew foreman, these repairs were confined to side pad areas of the crossing, and generally consisted of interchanging damaged pads from the roadway area with pads originally installed along the shoulder width.

The condition of the crossing before replacement is shown in Fig. 1. As illustrated, the crossing surface on both roadways was higher than the adjacent pavement edge. It is thought that this elevation differential (approximately 1 in.) contributed considerably to the relatively early failure of the crossing by causing the pads and foundation to be subjected to high impact forces resulting from crossing vehicles. On both roadways, both the approach and leaving slabs were noted to dip toward the crossing, thus indicating that settlement of the subgrade had caused the variation in elevation. A tension crack in the leaving slab surface about 30 ft from the crossing was considered substantiating evidence that loss of subgrade support had occurred. Because the slabs were dipping toward the crossings, and an open space varying in width from 1 to 2-1/2 in. existed between the concrete headers and the pads, water could freely enter the subgrade thus making it very susceptible to settlement. The side pads on both sides of the track were loose, whereas the center pads were in good condition. An attempt to fasten the side pads by use of spikes during an earlier repair is illustrated in Fig. 2. The previously described open space between pads and concrete header is also noticeable in Fig. 2. Although the crossing has been subjected to an average daily traffic volume of about 4,500 vehicles, of which 22 percent was estimated as commercial, there was no apparent wear of the pad surface.

Examination of pads removed from the traffic area indicated slight elongations in bolt hole edges toward the traffic. Bolts removed from the same area showed wear on the same directional side as the bolt holes. In some cases, the timber shims were worn in the contact locations of the pads as much as 1/16 in. It is evident that this wear was caused by a combination of loose bolts and the impact forces resulting from crossing vehicles. It could not be determined whether the bolts were insufficiently tightened at the time of construction, or this condition had been caused by traffic.

After the pads and shims were removed, the rails and ties were inspected. The south rail was still spiked to the ties, but the north rail was loose. It appeared that settlement of the rail ballast had occurred along the approach edge because the ties were not in contact with the rail. As a result, the north rail was actually suspended across the roadway surface and was subjected to vibrations each time a vehicle crossed. It is thought that as the ballast settled, these vibrations eventually caused the spikes to loosen or the spike heads to wear through the rail flange as illustrated in Fig. 3.

The ties were laid on 18-in. centers, but were not spaced with equal extensions beyond the rails. For this reason, and also because some ties were shorter than the required 8 ft 6 in., in many cases the outer row of lag bolts was too close to the tie ends or missed the ties completely. Tie length and edge distance of the outer row of bolt holes in the ties are summarized in Table 1. Variation in tie length and location of bolt holes are shown in Fig. 4. A vertical section of the crossing in Fig. 5 illustrates the condition of the shims extending beyond the ties. Because some of the side pads were fastened to the ties with only the inner row of lag bolts, these pads were rocking when vehicles crossed and their shape eventually distorted.

Based on these observations it is concluded that construction deficiencies caused the conditions requiring replacement of the rubber pads. In order to prevent these conditions from occurring at the rubber pad crossing to be constructed in Saginaw, the following suggestions are offered:

1. Close cooperation between the Railroad Company and the Department is desirable to ensure that rails and roadway surfaces are constructed to correct elevations.

2. Because ballast re-work is somewhat difficult after the pads are in place, the manufacturer recommends that the track be laid and subjected to rail traffic for a few days before installing the pads. Re-compaction of the ballast before placing the pads will minimize settlement.

3. Only ties and shims of correct dimensions should be used, and they should be of the best quality available.

4. As soon as possible after construction the joint on each side of the crossing should be sealed to prevent water from entering the ballast and roadway subgrade. Periodic resealing might be necessary to maintain an effective seal.

5. Since loose pads will result in wear on bolt holes, bolts, and shims, re-tightening of the bolts appears advisable after the crossing has been subjected to vehicle traffic for some time.

OFFICE OF TESTING AND RESEARCH

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TABLE 1
SUMMARY OF DATA ON SOUTHBOUND TRAFFIC LANE CROSSING

| Tie No. * | Tie Length | Edge Distance of Lag Bolt From... | | Remarks |
|---|---|---|---|---|
| | | North End of Tie | South End of Tie | |
| 1 | 8'-6" | 2-1/4" | 1-1/2" | ---- |
| 2 | 8'-6" | 2-1/4" | 3/4" | Bolt hole sheared out on south tie end. |
| 3 | 8'-6" | 2-1/2" and 2-1/4" | 3/4" and 1" | ---- |
| 4 | 8'-6" | 1-3/4" | 1-1/4" | ---- |
| 5 | 8'-6" | 1-3/4" and 1-1/2" | 1/2" and 1/2" | Both bolt holes sheared out on south tie end. |
| 6 | 8'-7" | 2-3/8" | 1-1/4" | ---- |
| 7 | 8'-4" | 1/4" and 1/2" | 3/4" and 3/4" | Both bolt holes sheared out on south and north tie ends. |
| 8 | 8'-5" | 1-3/4" | ---- | Bolt missed south tie end completely. |
| 9 | 8'-6" | 2-3/4" and 2-3/4" | 1" and 1" | Both holes sheared out on south tie end. |
| 10 | 8'-0" | 3/4" | ---- | Bolt missed south tie end completely. |
| 11 | 8'-5" | 3/4" and 1" | 1/2" and 3/4" | Both holes sheared out on south tie end. |
| 12 | 8'-5" | 2" | ---- | Bolt missed south tie end completely. |

* Ties numbered in order from west to east.

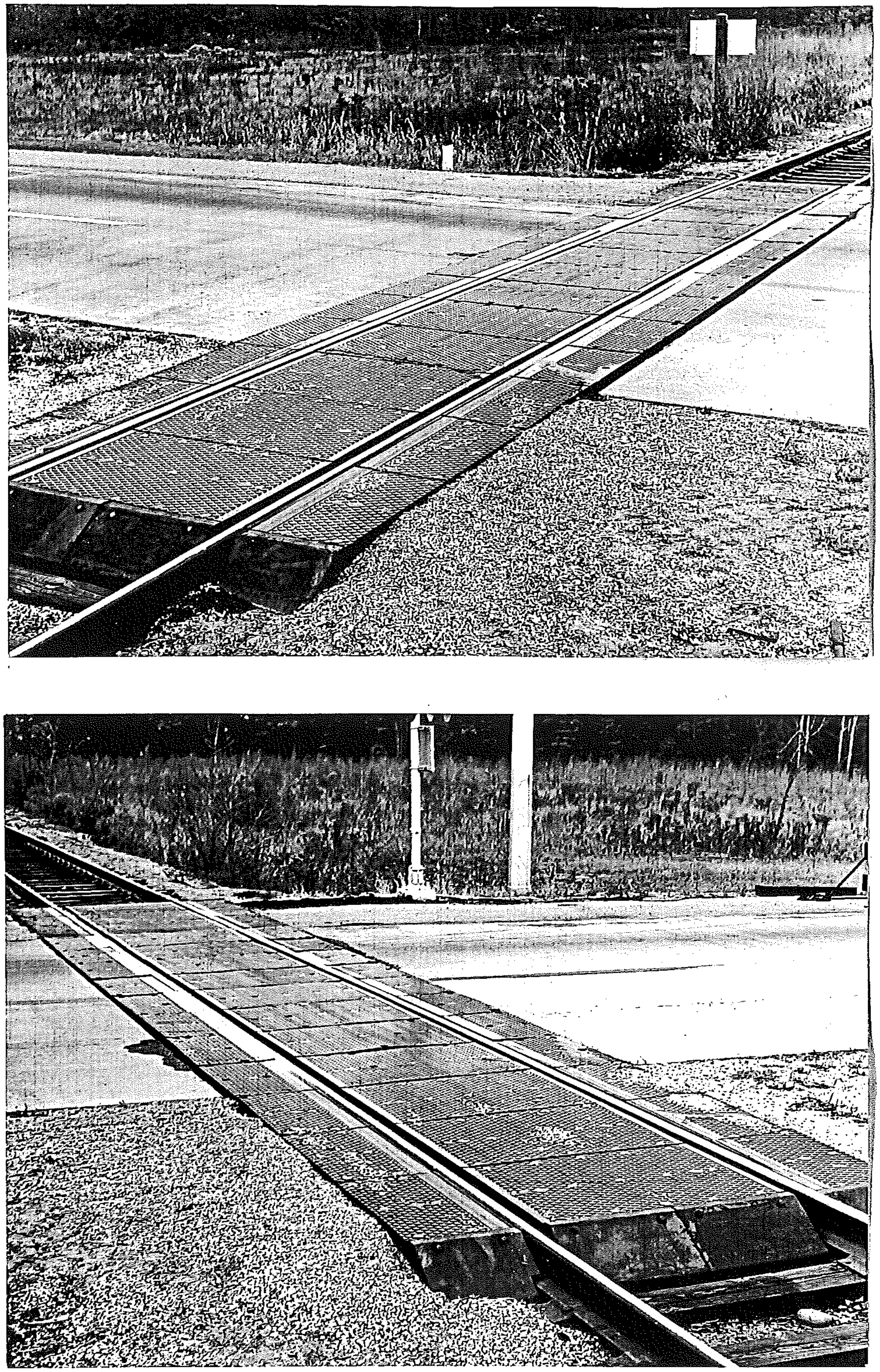

Figure 1. Condition of crossing before replacement, showing elevation differential: northbound (top) and southbound (bottom).

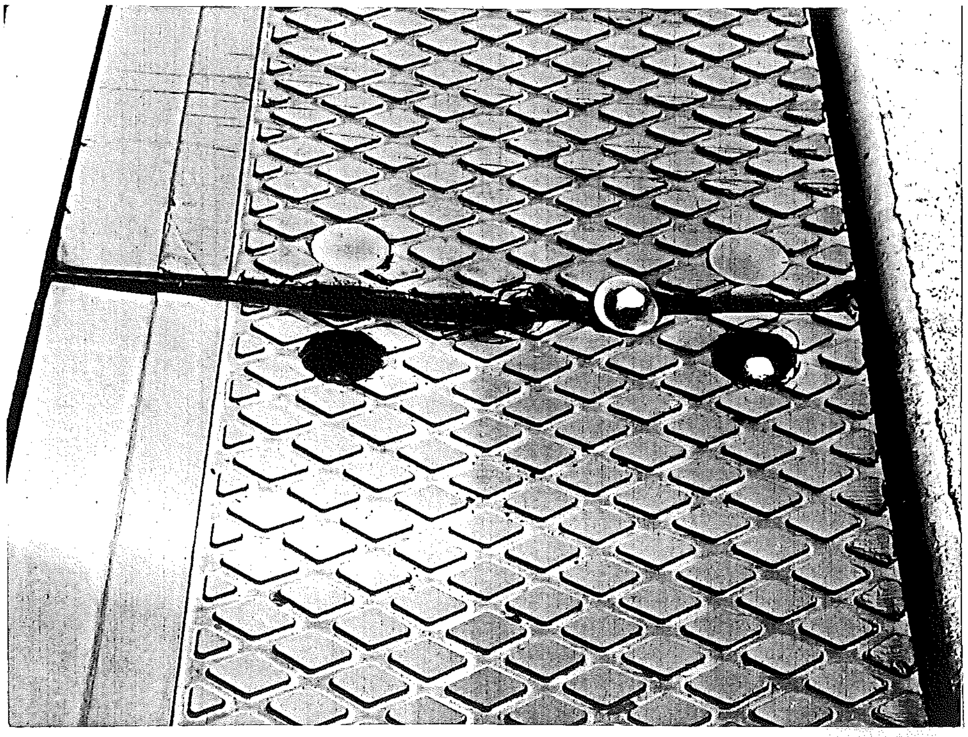

Figure 2. Close-up of side pad condition in old repair area, also showing open joint.

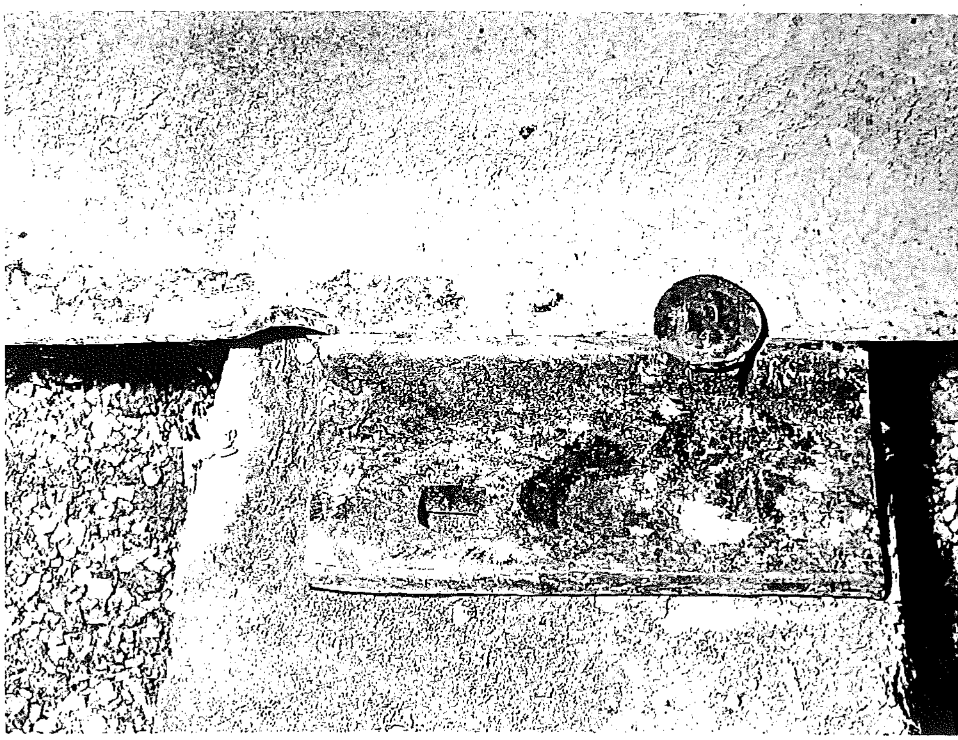

Figure 3. Wear of rail flange caused by vibrations in rail. Photo taken after rail was moved a few inches to the left and re-spiked.

Figure 4. Condition of exposed ties. Note sheared-out bolt holes in top and center tie. Bolts missed the bottom tie completely.

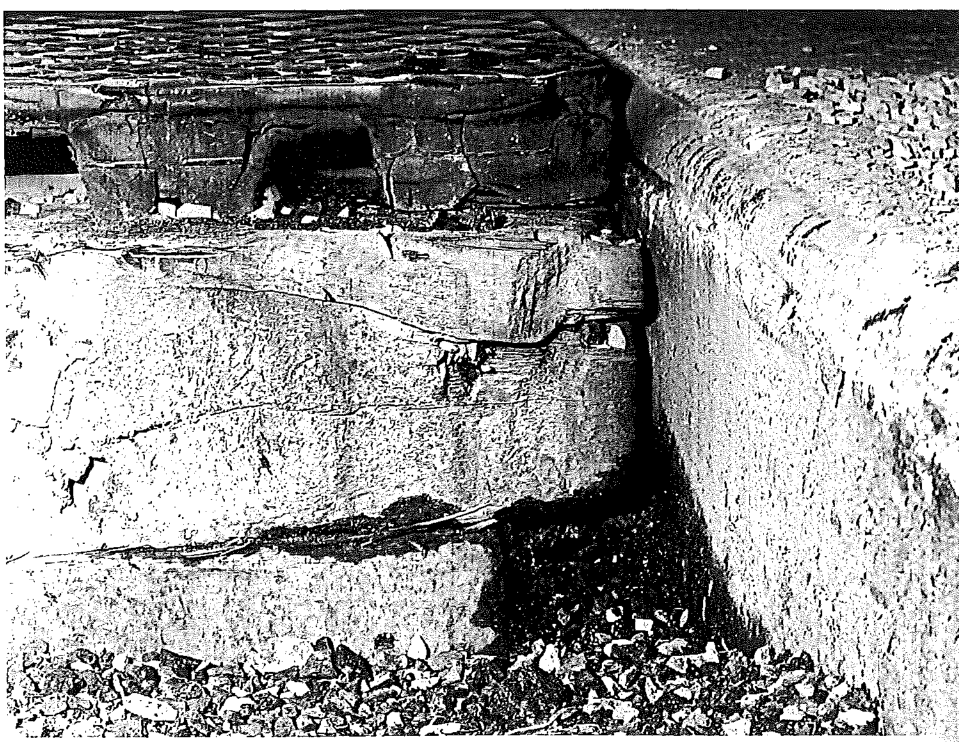

Figure 5. Vertical section of the crossing illustrating shim extension beyond tie end.