Abridgment

Monitoring and Evaluation of High-Type Railroad Crossing Surfaces

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ABSTRACT

High-type railroad crossing surface improvements have resulted in the replacement of traditional asphalt and timber crossing surfaces with specially designed durable materials and replacement or improvement of the track structure and the supporting subgrade. In this paper the various types of proprietary surfacing products installed in Pennsylvania through 1983 are summarized and the construction and design problems associated with each product are discussed. To remedy construction-related problems, which are considered to be significant, detailed guidelines for site preparation and installation of high-type railroad crossing surfaces are proposed.

A common problem that has occurred for many years on highway systems universally has been the existence of rough and dangerous railroad crossings (Figure 1). Even though the predominant causes for the problem--excessive loading of the subgrade and inadequate drainage--have been recognized for a long time, only a limited effort has been made to correct the situation until the past decade. Starting in 1973, Section 203 of the Federal Highway Safety Act provided special funding for the construction of high-type surfaces at selected railroad-highway grade crossings. This was the start of a comprehensive program to improve grade crossings across the United States. Other improvements funded by the program include provisions for upgrading protective or warning devices and the elimination of crossings where abandonment of rail service has occurred.

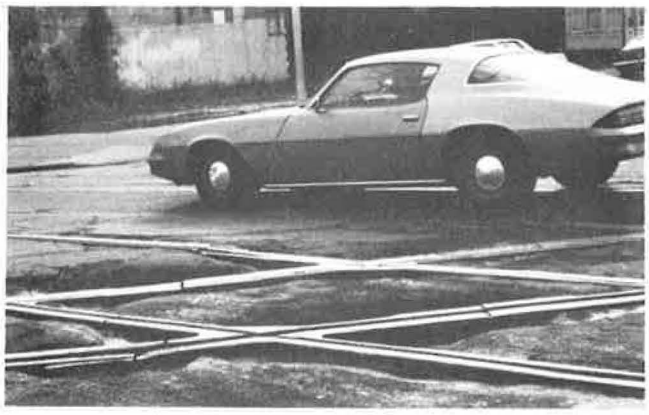

FIGURE 1 A high-type crossing surface is desirable for a rough and dangerous crossing such as this.

High-type surface improvements have resulted in the replacement of traditional asphalt and timber crossing surfaces with specially designed durable materials and replacement or improvement of the track structure and the supporting subgrade. An essential aspect of subgrade improvement has been the provision for adequate drainage. Because most of the developed surfacing products have been of a proprietary nature, their use on federally funded projects requires, by law, evaluation of performance. The Pennsylvania Department of Transportation (PennDOT), participating in the program established by the Federal Highway Safety Act, developed Research Project 77-21 in 1977. This project, entitled "High-Type Railroad Crossing Surface Monitoring and Evaluation," is PennDOT's commitment to evaluating and reporting the performance of proprietary materials used for constructing improved grade crossings.

The interim report presented herein is primarily an update of PennDOT's experience between 1978 and 1983 (using Section 203 funds). The focus of this report is on summarizing the various types of proprietary surfacing products installed through 1983 and construction and design-related problems identified with such installations. Guidelines for site preparation and installation of high-type railroad crossing surfaces are recommended for inclusion in contracts for new crossings to improve the performance of installation. An outline of Pennsylvania's new guidelines is provided for consideration.

I. Types of high-type surfaces installed
   A. Partial depth panels with timber shims
      1. "Super cushion" rubber pads (Goodyear Tire and Rubber Company): steel plate reinforced-rubber (elastomeric) pads secured to ties by lug bolts (drive spike)
      2. "Parkco" rubber pads (Park Rubber Company): steel plate reinforced-rubber pads secured in place by steel tensioned cables
   B. Full-depth sections (shimless)
      1. "Gen-Trac" elastomeric grade crossing (General Tire and Rubber Company): steel arch reinforced-rubber units secured to ties by lug bolts (drive spikes)
      2. "Cobra-X" grade crossing modules (Railroad Friction Products Corporation): high-density polyethylene ejection-molded modules secured to ties by lug bolts (drive spikes)
      3. "True Temper" grade-crossing modules (True Temper Corporation): high-density polyethylene structural foam, pressure-molded modules secured to ties by lug bolts (drive spikes)

4. "Omni" shimless grade crossing (precured RDF Tirefill, Inc., now Omni Rubber Products): rubber panels manufactured from 100 percent rubber material from tire retreading process secured to ties by self-tapping timber bolts

C. Relative use in the United States since 1978 (approximate), by manufacturer and number of crossing sites installed

1. Goodyear, 23
2. Parkco, 19
3. Gen-Trac, 8
4. Cobra-X, 3
5. True Temper, 1
6. Omni, 1

II. General problems associated with all types of crossing installations observed (* = widespread occurrence or a major problem)

A. *Failed replacement approach pavement and joint with crossing surface (cracks and settlement) due to

1. Inadequate compaction of subgrade, ballast, and pavement material in the area from the end of tie to the existing pavement
2. Failure to install header board
3. Misaligned and damaged header boards
4. Failure to seal or maintain pavement-crossing joint with rubberized asphalt sealant (see Figure 2)

FIGURE 2 Failure to seal joint resulted in pavement cracking. Note that one-half is sealed but has no header board and is performing better.

5. Inadequate existing pavement removed for crossing installation, creating a space too narrow to properly compact replacement materials (see Figures 3 and 4)
6. Improper crosstie length, creating voids and misalignment between header boards

B. *Crossing settlement causing poor transition and premature loss of riding comfort due to

1. Inadequate ballast depth or compaction or both under rails (see Figure 5)
2. Unstable subgrade (inadequate preliminary investigation by soils engineer)
3. Inadequate or improperly installed drainage system (see Figure 6)
4. Improper establishment of highway crossing elevation

C. Poor drainage of crossing area due to

1. Improper size of coarse aggregate for pipe backfill
2. Damaged pipe used and improperly installed

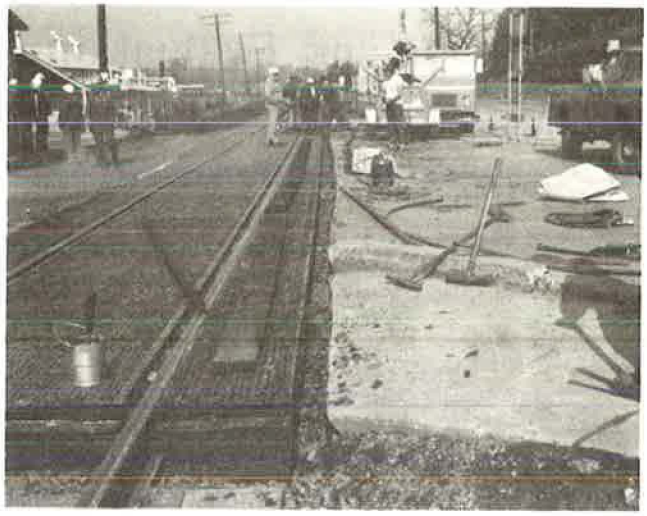

FIGURE 3 When insufficient pavement is removed for construction, it is improbable that the replacement material will be thoroughly compacted.

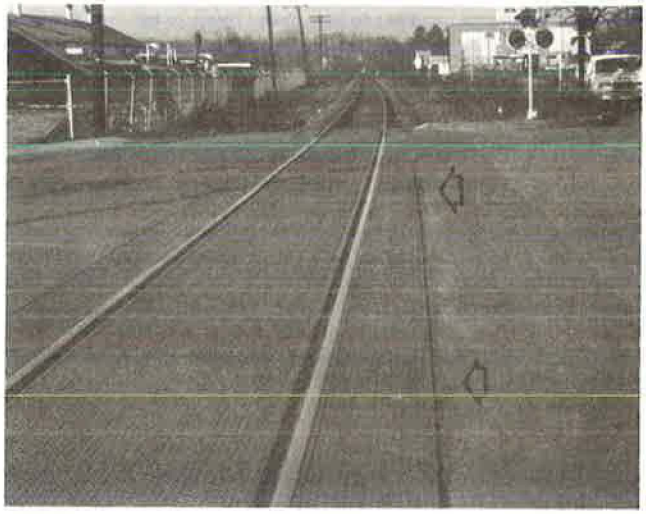

FIGURE 4 Condition of joint shown in Figure 3 after 3 years.

FIGURE 5 This method of compaction will not prevent settlement of track structure.

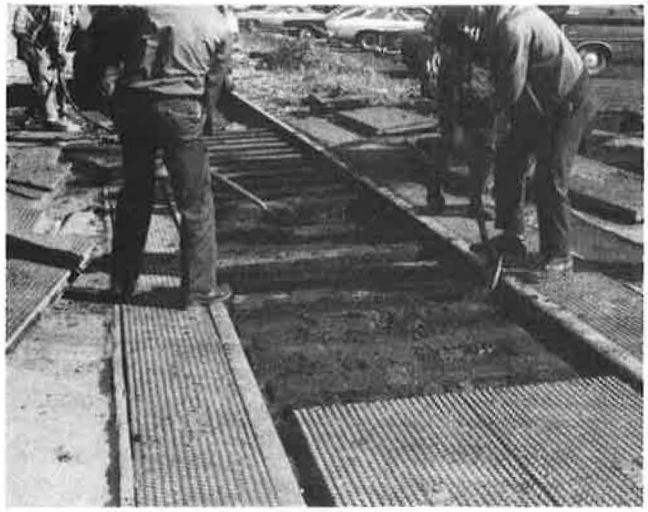

FIGURE 6 Because of a high water table and poor drainage design, crossing was completely clogged with saturated fines after only 3 years.

3. Pipe improperly sloped
4. *Heat-bonded geotextiles often chosen to wrap trenches, which trap water and do not provide planar flow
5. *Excess flow into crossing area when excessive debris and road dirt accumulate along the flange way; need for routine cleaning to maintain seal of high-type surface (see Figure 7)

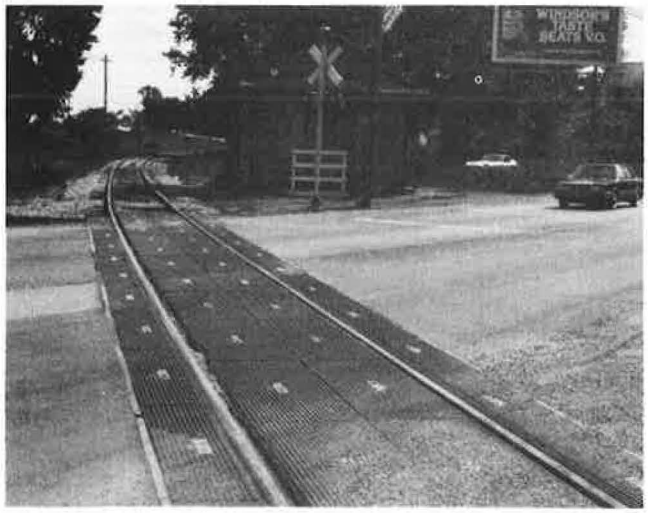

FIGURE 7 Without routine cleaning, excess highway anti-skid material has accumulated in shoulder area and in flange way.

D. *Inadequate geotextiles used for trackbed stabilization; lightweight and heat-bonded fabrics often selected due to inadequate specification in guidelines because minimal performance data available for geotextiles during initial guideline write-up

E. Damage to high-type crossing surface material due to

1. Dragging railroad equipment where end drag protection plates are missing
2. Digging by blades of highway snowplows
3. Same as C.4.--Deforms shape of crossing material

III. Specific problems associated with type of crossing (design)

A. Major failure of the high-type surface material caused by structural failure of the member or deterioration of material from abrasion (Cobra X, Omni, Gen-Trac)

B. *Loose or broken supporting wood shims (Parkco, Goodyear)

C. Failure of the mechanism securing the surface material to the track structure due to either overstressing or corrosion caused by poor drainage of track structure (Parkco tension cables)

D. Loss of numerous panel spike plugs or rubber caps (Goodyear, Gen-Trac)

E. Minor cracking in surface material (Gen-Trac)

DETAILED CONSTRUCTION GUIDELINES INDICATE IMPROVEMENT

Several projects in Pennsylvania have been constructed by using revised, detailed specifications for crossing installations designed to regulate construction procedures more closely. The specifications or guidelines place particular emphasis on compaction, drainage installation, and pavement-crossing joint construction (see Figures 8-12). Early evaluation of these crossings indicates longer satisfactory performance is expected relative to prior installations constructed with less stringent controls. An outline of these guidelines follows (an unabridged printing of the guidelines is available from the Information Center of the Pennsylvania Department of Transportation by requesting a copy of the report for Research Project 77-21):

I. General design requirements

A. Outline responsibility and involvement of all parties in contract

B. Highlight design criteria

II. Preconstruction coordination

A. Establish method of submission and acceptance of design proposal

FIGURE 8 A properly designed and installed header board serves several functions. It provides a uniform rigid wall against which to compact the approach.

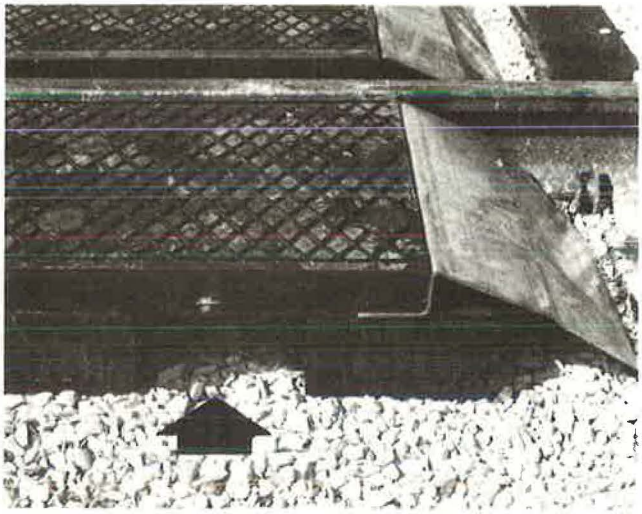

FIGURE 9 A header board placed full depth prevents loss of material in the tie cribs, which would eventually result in joint settlement.

B. Establish method of traffic control to be maintained during construction (a detour is always preferred)

C. Detail limits of inspection and criteria for acceptance of work

D. Attendance of all parties at an on-site preconstruction meeting usually promotes better cooperation between parties, provides better understanding of work to be accomplished, and eliminates surprise conditions

III. Construction requirements: provide detailed specifications for performance of each phase of work [* = providing an accompanying detailed sketch or specification is beneficial for these items (see Figure 13)]

A. Maintenance and protection of traffic

B. *Site preparation

C. *Drainage installation and subgrade stabilization

D. *Ballast replacement

E. *Track reconstruction

FIGURE 10 The top of a header board can also be designed to facilitate the construction of a flexible sealed joint between the pavement and the crossing.

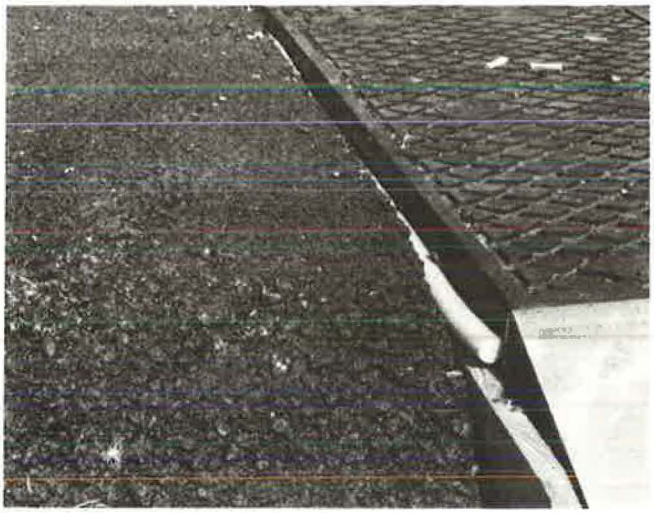

FIGURE 11 Backer rod is recommended because it forms desired shape and prevents adhesion on bottom of joint for proper movement.

F. *Crossing surface installation

G. *Approach pavement-crossing joint construction

H. *Highway approach pavement reconstruction

IV. Maintenance requirements and warranties: provide details of post-construction requirements (if any) for each party (highway department, railroad, surface manufacturer, and so forth)

INTERIM CONCLUSIONS

1. Lack of quality control during installation and inappropriate or inadequate construction procedures are often the primary causes of premature failure of high-type grade crossings.

2. Detailed installation guidelines or specifications can effectively reduce premature failure of many grade crossings by providing a uniform measure of quality control during construction. Particular emphasis on compaction, drainage installation, and pavement-crossing joint construction is essential for long-term performance.

FIGURE 12 Hot-poured rubberized sealant has performed best.

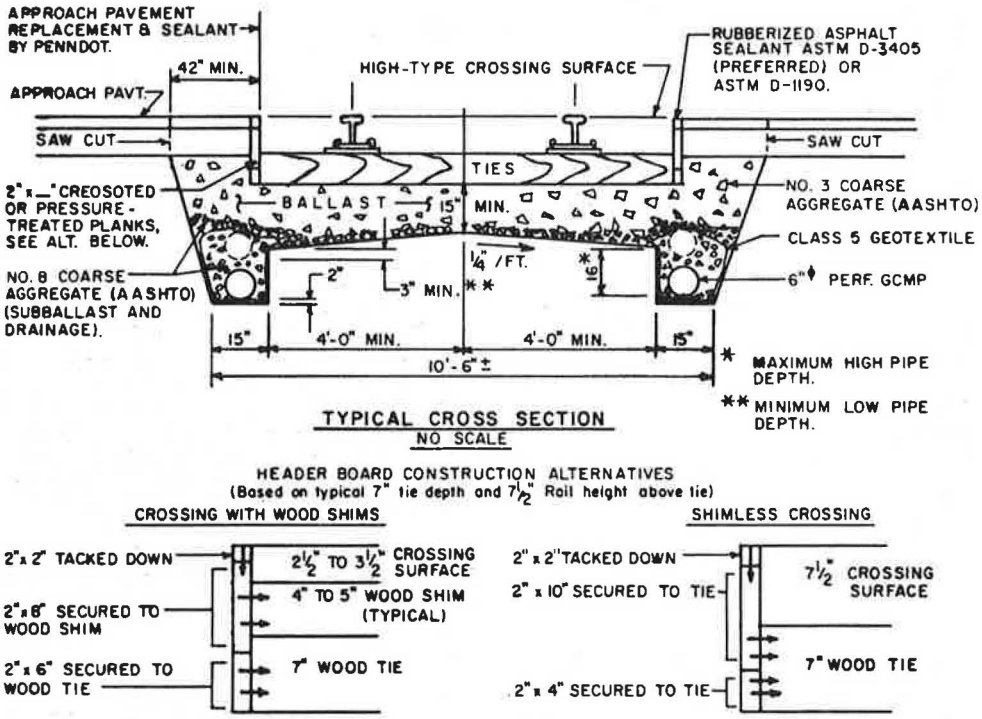

FIGURE 13 Typical detailed sketch.

3. Although most high-type crossing failures that have been evaluated indicate failure related to construction details, some failures indicate that the cause was compounded or even independently due to design factors related to structural support, type of connections, and material type. Continued evaluation is necessary to achieve complete documentation and to determine the relevance and frequency of the observed deficiencies.

4. Routine inspection to determine maintenance needs, such as sealing of pavement-crossing joints and cleaning debris from rail flange ways, is essential for the long-term performance of in-service crossings.

ACKNOWLEDGMENT

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