1145

EVALUATION OF VARIOUS TYPES
OF RAILROAD CROSSINGS

Fourth Progress Report

MICHIGAN DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION

TESTING AND RESEARCH DIVISION
RESEARCH LABORATORY SECTION

EVALUATION OF VARIOUS TYPES OF RAILROAD CROSSINGS

Fourth Progress Report

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INTRODUCTION

In April 1975, the Michigan Department of Transportation, with the approval of the Federal Highway Administration, initiated a Category 2 experimental study to evaluate the performance of various types of railroad grade crossing materials. The work plan covering the experimental project is of the open-ended type so that new materials can be added by a letter of request to the FHWA rather than submitting a separate work plan for each new type of material being developed. The objectives of the study are to obtain information on construction procedures, evaluate the performance of new crossing materials with respect to durability and smoothness, and determine the relative cost of each type of crossing.

Although the experimental study concerns only the crossing material, the work involved generally includes rebuilding the entire crossing, installing new and better warning devices, and changes in roadway alignment and surface to increase the safety of the crossing. The work is 90 percent financed by Federal funds, appropriated under the Highway Safety Act of 1973, and 10 percent by Road Authority funds, either State or local depending upon the jurisdiction of the roadway.

Earlier reports on the installation and performance of various types of railroad grade crossing materials were issued in November 1976, March 1978, and April 1979. Pertinent parts or summaries of these reports are included in this fourth progress report on the evaluation of crossing materials.

Materials

Prior to initiation of this study, approved crossing materials consisted of wood, bituminous material, concrete, and a proprietary (Goodyear) rubber panel installation. The materials included in the experimental program are: T-Core, Fab-Ra-Cast, Steel Plank, Track-Span, Gen-Trac, Saf and Dri, and Parkco. All of these materials are proprietary products.

Crossing Locations

Table 1 lists the locations of the experimental crossings and gives summary information for each one. To date, 49 single-track crossings have been rebuilt: 9 in 1976, 3 in 1977, 11 in 1978, and 26 in 1979. Of the nine crossings rebuilt in 1976, three T-Core crossings were resurfaced in 1978 and the two Fab-Ra-Cast crossings are scheduled for replacement. Currently, there are 3 T-Core, 11 Steel Plank, 3 Track-Span, 4 Saf and Dri, 14 Parkco, and 19 Gen-Trac single crossings being evaluated.

TABLE 1
SUMMARY OF DATA ON EXPERIMENTAL CROSSINGS IN SERVICE
(All crossings single tracks except as noted.)

Year	Type of Crossing	Railroad	Type of Line	Crossing Length, ft	Route Location	Roadway Surface	No. of Lanes	Average Daily Traffic
1976	T-Core	A.A.R.R.	Main	36	Kress Rd	Bituminous	2	1,800
	T-Core	D & M R.R.	Main	60	[1] US 23, Omer	Bituminous	4	7,800
	T-Core	D & M R.R.	Main	111	[1] M 65, Twining	Concrete	2	3,500
	T-Core	D & M R.R.	Industrial	69	[1] US 23, Alabaster	Bituminous	2	5,300
	Fab-Ra-Cast	C&O R.R.	Industrial	56	[2] Wixom Rd	Concrete	4	11,500
	Fab-Ra-Cast	C&O R.R.	Main	56	[2] Seven Mile Rd	Concrete	4	8,300
	Steel Plank	D & T S.L.	Main	32	Hurd Rd	Bituminous	2	1,200
	Steel Plank	D & T S.L.	Main	39	Nadeau Rd	Bituminous	2	2,000
	Track-Span	C&O R.R.	Industrial	52	M 46, St. Louis	Concrete	4	8,800
1977	T-Core[3]	G.T.W. R.R	Main	48	34th St	Bituminous	2	400
	Saf and Dri	Con Rail	Industrial	67	Oakland Ave	Concrete	5	25,000
	Steel Plank	D & T S.L.	Industrial	110	M 50, Monroe	Bituminous	4	10,100
1978	Saf and Dri	G.T.W. R.R.	Main	63	US 131, Schoolcraft	Concrete	4	11,100
	Steel Plank	D & M R.R.	Main	111	M 65, Twining	Concrete	2	3,500
	Steel Plank	D & M R.R.	Main	45	US 23, Rogers City	Concrete	2	1,750
	Steel Plank	D & M R.R.	Main	52	M 33, Aloha	Bituminous	2	1,400
	Steel Plank	M.I.R.C.	Main	55	M 115, Cadillac	Bituminous	2	3,800
	Parkco	D & M R.R.	Main	48	US 23, Omer	Bituminous	4	7,800
	Parkco	D & M R.R.	Industrial	78	US 23, Alabaster	Bituminous	2	5,300
	Gen-Trac	D & M R.R.	Main	52	US 23, Alpena	Bituminous	2	9,700
	Gen-Trac	D & M R.R.	Industrial	60	US 23, Cheboygan	Concrete	4	7,900
	Gen-Trac	D & M R.R.	Main	52	F 41, Oscoda	Bituminous	4	11,500
	Gen-Trac	G.T.W. R.R.	Main	30	Niagara St, Saginaw	Concrete	2	11,000
1979	Saf and Dri	C&O R.R.	Industrial	80	US 10, Ludington	Bituminous	5	14,000
	Saf and Dri	G.T.W. R.R.	Main	66	M 21, Owosso	Bituminous	4	17,900
	Steel Plank[3]	C&O R.R.		45	M 100, Grand Ledge	Bituminous	4	5,100
	Steel Plank	D & T S.L.	Main	52	[4] Northline Rd, Wyandotte	Bituminous	4	9,000
	Steel Plank	D & T S.L.	Main	42	Goddard Rd, Wyandotte	Bituminous	2	
	Parkco	C&O R.R.	Main	45	M 100, Grand Ledge	Bituminous	4	5,100
	Parkco	G.T.W. R.R.	Industrial	60	US 131 BR, Grand Rapids	Bituminous	4	28,000
	Parkco	D.T.&I. R.R.	Industrial	60	King Rd, Trenton	Concrete	4	
	Parkco[5]	D.T.&I. R.R., Con Rail, D & T S.L.		54	Oak St, Wyandotte	Bituminous	3	
	Parkco	C&O R.R.	Industrial	60	I 196 BR, Wyoming	Bituminous	2	11,400
	Parkco[6]	D,T.&I. R.R., Con Rail		48	Goddard Rd, Wyandotte	Bituminous	2	
	Gen-Trac	G.T.W. R.R.	Main	51	M 66, Ionia	Bituminous	4	12,000
	Gen-Trac	C&O R.R.	Industrial	48	M 66, Ionia	Bituminous	4	12,000
	Gen-Trac	C&O R.R.	Main	63	US 131, Reed City	Bituminous	4	9,300
	Gen-Trac	C&O R.R.	Main	45	M 37, White Cloud	Bituminous	2	3,800
	Gen-Trac	G.T.W. R.R.		63	M 13, Bay City	Bituminous	2	14,400
	Gen-Trac	G.T.W. R.R.		30	Kelton St, Bay City	Bituminous	2	
	Gen-Trac	G.T.W. R.R.		73	State St, Bay City	Bituminous	2	
	Gen-Trac	G.T.W. R.R.		45	Backus St, Bay City	Concrete	2	
	Gen-Trac	G.T.W. R.R.		94	Wenona Ave, Bay City	Bituminous	2	
	Gen-Trac	G.T.W. R.R.		121	Marquette St, Bay City	Bituminous	2	
	Gen-Trac	G.T.W. R.R.		78	Henery St, Bay City	Bituminous	2	
	Gen-Trac	G.T.W. R.R.		36	North Union St, Bay City	Bituminous	2	
	Gen-Trac[6]	Con Rail		54	Northline Rd, Wyandotte	Bituminous	4	9,000
	Track-Span	C&O R.R.	Main	80	US 31, Manistee	Bituminous	4	16,000
	Track-Span	C&O R.R.	Industrial	115	US 31, Manistee	Bituminous	4	12,100

[1] The experimental surface material on these crossings was replaced in 1978.
[2] These crossings scheduled for resurfacing.
[3] Two tracks
[4] New design (see material description page 6).
[5] Five tracks
[6] Three tracks

CONSTRUCTION PROCEDURES

Construction of the crossings was the responsibility of the railroad agency and was done either by their own forces or by contract. The Department's Research Laboratory is charged with the responsibility of evaluating the various types of crossing material and, as part of the evaluation procedure, construction of the experimental crossings was observed by research personnel. Installation of the crossing material was to be done in accordance with the manufacturer's recommended procedure and, generally, their representative was present during placement operations.

At all crossing sites the existing rails, ties, and ballast were removed and replaced for about 10 to 30 ft beyond each crossing end. The procedures used to replace these materials depended on the requirements for maintaining both rail and highway traffic at the crossing. Basically, the following three methods were employed.

1) The most efficient procedure for replacing an existing crossing was when both the highway and railroad could be closed to traffic or where at least a few hour gap in train traffic existed. The existing crossing, including the ballast, was removed by mechanical equipment. A preassembled track section was positioned on the grade or the crossing assembled in place. The joints between new and old rails were bolted and new ballast added and compacted under the ties. Final adjustment of rail height, compaction of the ballast, and installation of the surface material was done under normal train traffic or completed before train traffic was resumed.

2) Where traffic on the highway was maintained during reconstruction of a crossing, it was necessary to replace half of the crossing at a time. The general procedure employed consisted of first replacing the ties and ballast on half of the crossing and installing a temporary wood crossing. Road traffic was then routed over on the temporary crossing while the other half was replaced. Once the new ballast and ties were in place on the entire crossing, the old rails were removed and new rail sections were placed. Road traffic was stopped during replacement of the rails. The crossing material was installed on half of the crossing, traffic switched over on the completed side, the temporary wood crossing removed, and installation of the new surface material was completed.

A variation of this procedure where train traffic did not need to be maintained was to place a preassembled track section on the ballast in half the crossing, retamp the ballast and then install the new surface material. Road traffic was then rerouted onto the new surface and the other side of the crossing was rebuilt. Using this procedure the rails were welded in place while road traffic was maintained.

3) The procedure for replacing a crossing where the road traffic was detoured but high-speed frequent train movement prevailed, entailed a good deal of handwork. First, the old crossing surface was removed followed by removal of the ballast between the ties. The ties were then unfastened from under the rails. The ties, up to the center of the crossing, were slid and twisted out and new ties were inserted under the rails. New ballast was placed and compacted and the existing rails spiked to the ties to allow train traffic over the crossing. The ties in the other half of the crossing were replaced in the same manner. The new rail sections were placed and fastened into position and raised to proper elevation by adding and compacting the ballast. The crossing surface was installed during periods between train movements.

Once the ballast, ties, and rails had been replaced, the installation of the crossing surface generally was completed in a matter of hours. The actual time involved in installing the various types of crossing materials depends upon the equipment, hand tools, and number and experience of the personnel. The installation of all seven experimental crossing types used to date was fairly simple, but careful work is necessary.

In cases where the experimental surface has failed and replacement was made, the new surface material was placed on the existing ties and no rework of the ballast was done, except in one case where the existing tie spacing was adjusted to accommodate the new material.

PERFORMANCE EVALUATION

The performance of the experimental crossings is checked semi-annually. The inspections consist of visual observation of the following performance factors:

1) Surface Wear - the wearing away of the material's surface as a result of tire contact.

2) Surface Damage - cracking, fracturing, or tearing of the surface resulting from either train or vehicular traffic or from snow clearing equipment.

3) Alignment of Units - the ability of the individual units to maintain both vertical and horizontal position while in service.

4) Fastening of Units - the ability of units to remain securely fastened in position during the life of the crossing material.

5) Fastening of Rails - the securing of the rails to the ties. Loose rails may indicate that settlement of the crossing has occurred.

6) Pavement/Crossing Joint - the distance between the pavement and the crossing edge. The width of the joint may vary considerably from one crossing to another and in bituminous pavement the joint is eliminated entirely. In concrete pavements, the joint is generally filled with bituminous material.

7) Crossing Smoothness - a measure of the discomfort felt by vehicle occupants while passing over the crossing. Generally, most drivers will adjust their speed to hold the discomfort to a tolerable level and on this basis, the smoothness of the crossings is rated as 'Good, Fair, and Poor,' (Good - basically no slowdown in traffic; Fair - some slowdown in traffic; and, Poor - considerable slowdown in traffic).

In addition, the elevation of the rails, the surface material at the crossing edges, and the pavement at the crossing joints are measured at each curbline or pavement edge.

T-Core (74 NM-400)

The material is identified as expanded linear high-density polyethylene. It is fabricated in 2-in. thick pads with the center pads measuring 52 in. in width and 3 ft in length. The side pads are 17 in. wide and 3 ft long. The pads are supported on modules fabricated from the same material as the pads. These support modules run perpendicular to the railroad ties with four supports used under each center pad and one under each side pad. A tie spacing of 18 in. on centers is required. The pads are bolted to the ties with lag bolts, 12 in each center pad and 6 in each side pad. A rubber and a steel washer are used under each bolt head. The surface consists of a 1/16-in. raised diamond pattern.

The installation of the pads began in the center of the crossing and proceeded toward the edges. The pads were placed by hand. The center pads were positioned equidistant from the ball of each rail; whereas, the side pads were positioned by placing a wood 2 by 4 between the rail and the pad. The pads were fastened by first bolting through the center row of holes in each pad followed by bolting through the end rows of holes. Installation of the 3/4-in. diameter lag bolts was preceded by drilling 11/16-in. holes into the ties. Before placing bituminous material against the crossing edge, a wood 2 by 4 or 1 by 8 was installed against the side pads to prevent the material from infiltrating under the crossing surface.

The four-year old Kress Rd crossing has performed satisfactorily to date and its smoothness is rated 'Good.' The three-year old 34th St crossing has also performed satisfactorily to date, but one side panel has developed a crack. Its smoothness is rated 'Good.'

Fab-Ra-Cast (75 NM-433)

These crossings were recommended for replacement in 1978 because of poor performance and are no longer included in the performance surveys.

Steel Plank (75 NM-404)

The steel crossing consists of modular units fabricated from No. 3 gage hot-rolled steel. The center units are 50-1/2 in. wide and 6 ft 6 in. long and are fastened to the ties with 15 lag bolts. The side units are 20 in. wide and 6 ft 6 in. long, with six lag bolts used to fasten each unit to the ties. A tie spacing of 19-1/2 in. on centers is required. A steel washer and a rubber washer are used under the head of each lag bolt. The top surface of the units is coated with epoxy containing sand to increase surface friction, and the interiors of the units are epoxy coated to resist corrosion.

The Steel Plank units were placed mechanically with final positioning done by hand using breaking bars. Once the units were in position, holes for lag bolts were drilled in each corner of a unit and lag bolts were installed. After all the units were fastened in this manner, the remaining holes were drilled and the lag bolts installed.

The manufacturer of the Steel Plank crossing has modified the design described above. The modification basically consists of the surface supports running perpendicular to the ties rather than parallel; the lag bolts used for fastening are installed in dimpled holes in the surface rather than through holes in the supports; each side unit is fastened with 10 bolts rather than 6; and the center units are fastened with 6 bolts rather than 15.

Three Steel Plank crossings were installed during the 1979 construction season. All of these crossings were in good condition when inspected shortly after installation. One crossing (Northline Rd, Wyandotte) is of the modified design.

Of the four crossings installed in 1978, the Twining crossing has settled below the pavement which results in a bumpy crossing. Consequently, the crossing was rated 'Fair' with respect to smoothness. One side panel on the M 115, Cadillac crossing was found to have a crack in one of its supports and loose panels were also noted during the winter survey. The railroad was notified and the bolts had been tightened before the summer survey. The smoothness of the crossing was rated 'Good.' The remaining two crossings (US 23, Rogers City and M 33, Aloha) were in satisfactory condition and were rated 'Good' with respect to smoothness. The two-year old M 50 crossing has been slightly damaged by a derailed car and some panels are loose. Minor cracking in the pavement adjacent to the crossing is noticeable. The crossing smoothness was rated 'Good.' The three-year old crossings, one on Hurd Rd and one on Nadeau Rd, have both been damaged by a derailed car, have loose panels, and have settled with respect to the pavement. Both crossings were rated 'Fair' with respect to smoothness. Minor repair of the pavement adjacent to the crossing has been made at the Nadeau Rd location.

A common problem with Steel Plank crossings is that the panels work themselves loose with time. Once the bolts loosen, the panels rock under traffic and the alignment of the panels is disturbed. Pumping has been observed and broken supports have also occurred. The photographs shown in Figures 1 through 4 were taken at the Sheldon Rd crossing just south of M 14 and illustrate the above conditions. This crossing is not included in the Category 2 experimental evaluation study but has been inspected occasionally to supplement performance data on this type of crossing.

Track-Span (74 NM-416)

This crossing utilizes flexible epoxy and ground automobile tires and is cast-in-place. The rails, ties, and pavement edges or edge forms, are coated with epoxy prior to pouring the crossing. A base layer of flexible epoxy containing ground tire casings is placed first. Then a wearing surface about 2-1/2 in. thick consisting of flexible epoxy with rubber buffings is placed and the surface is finished by tamping. A flange-way is formed on the inside of each rail. Approximately four hours of curing time is needed and installation is limited to dry weather and temperatures above 35 F. No special tie spacing is required.

On the three-year old M 46, St. Louis crossing the surface layer was replaced in 1978 because it had separated from the bottom layer. The cause of the separation could have been due to the delay in placing the top layer. Cracks were noted to have developed in the surface when the crossing was inspected in 1979. The edges of the crossing have curled up somewhat, which gives the crossing a somewhat bumpy ride. Therefore, the smoothness of the crossing was rated only 'Fair.'

Two new crossings were placed in 1979, both on US 31 in Manistee. One of these has developed a crack, but otherwise both are in excellent condition and rated 'Good' with respect to smoothness.

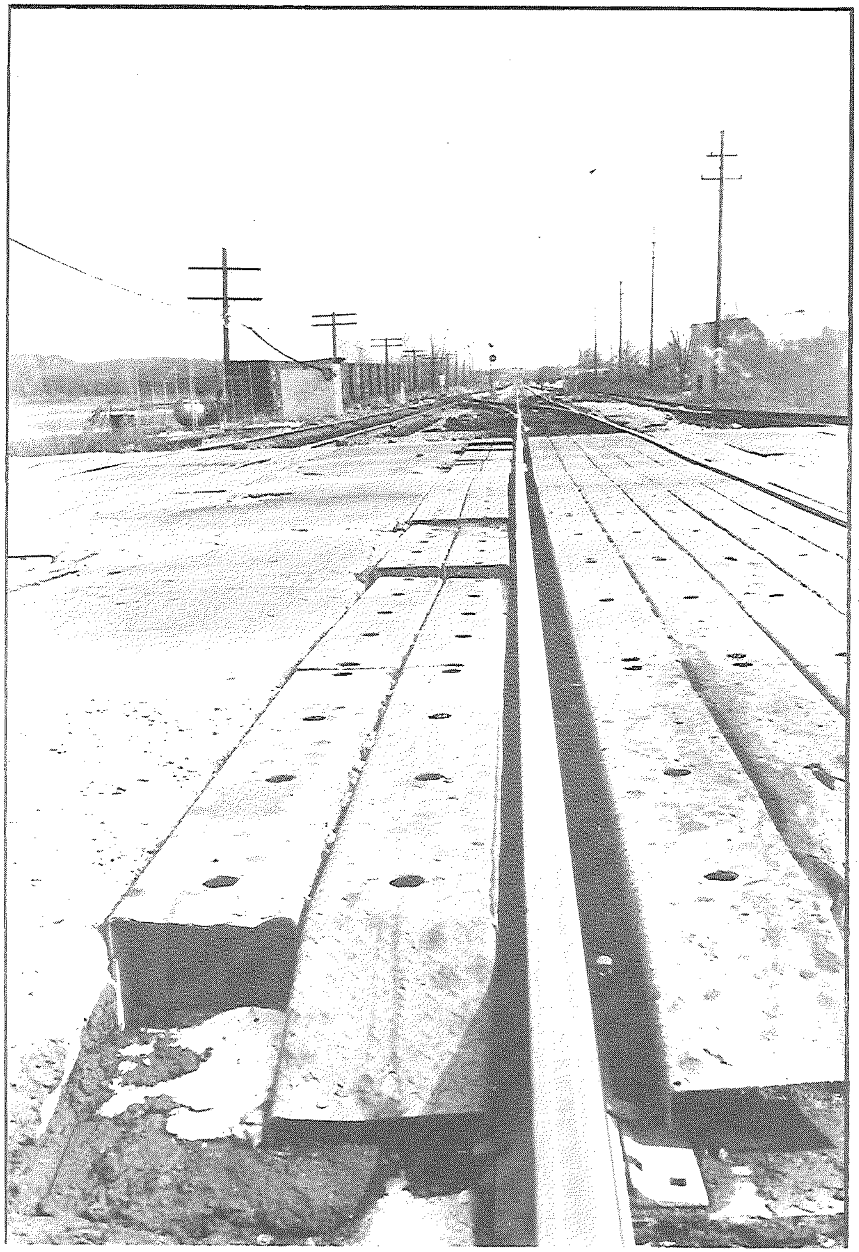


Figure 1. Loose panels and vertical alignment problem.

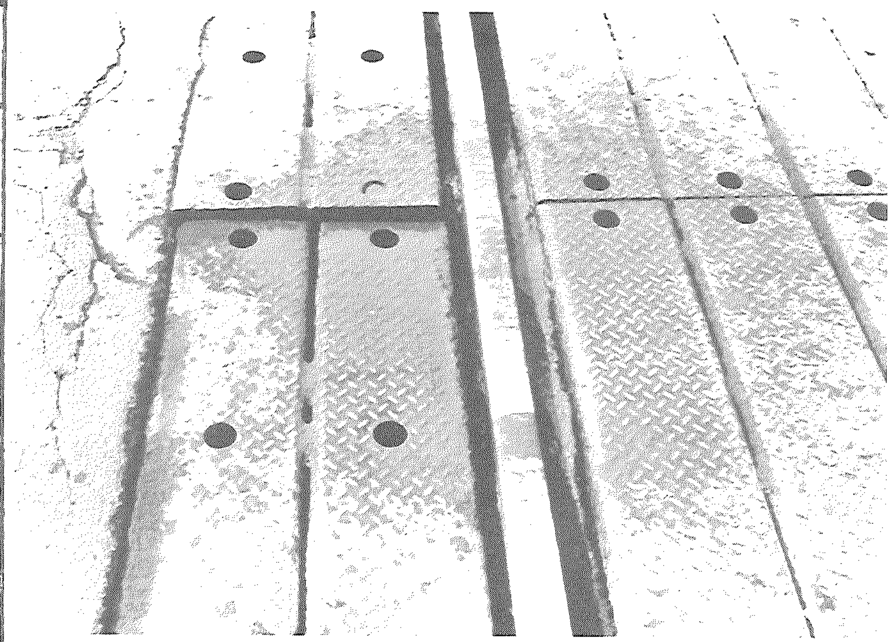


Figure 2. Pumping of side panel joint. Note center panel joint is still in good alignment.

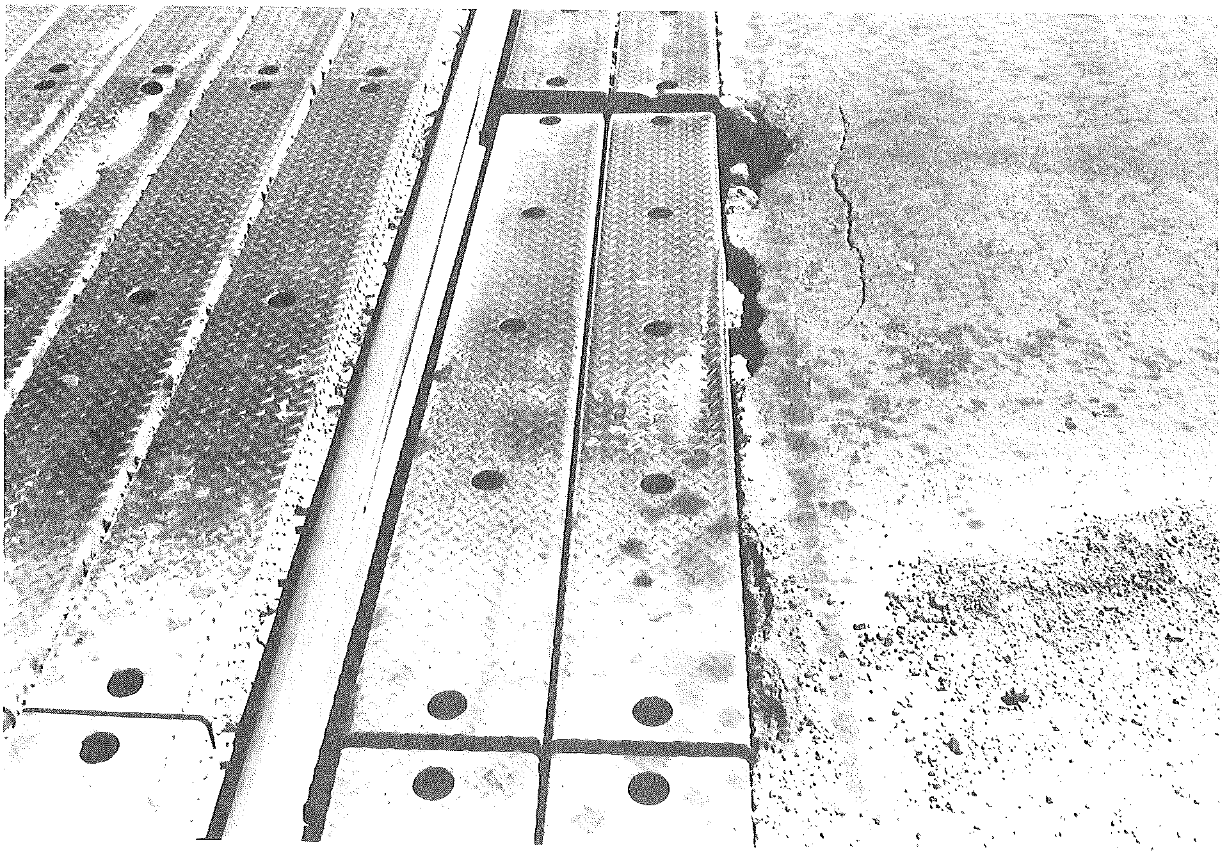


Figure 3. Loose and sunken panel before replacement.

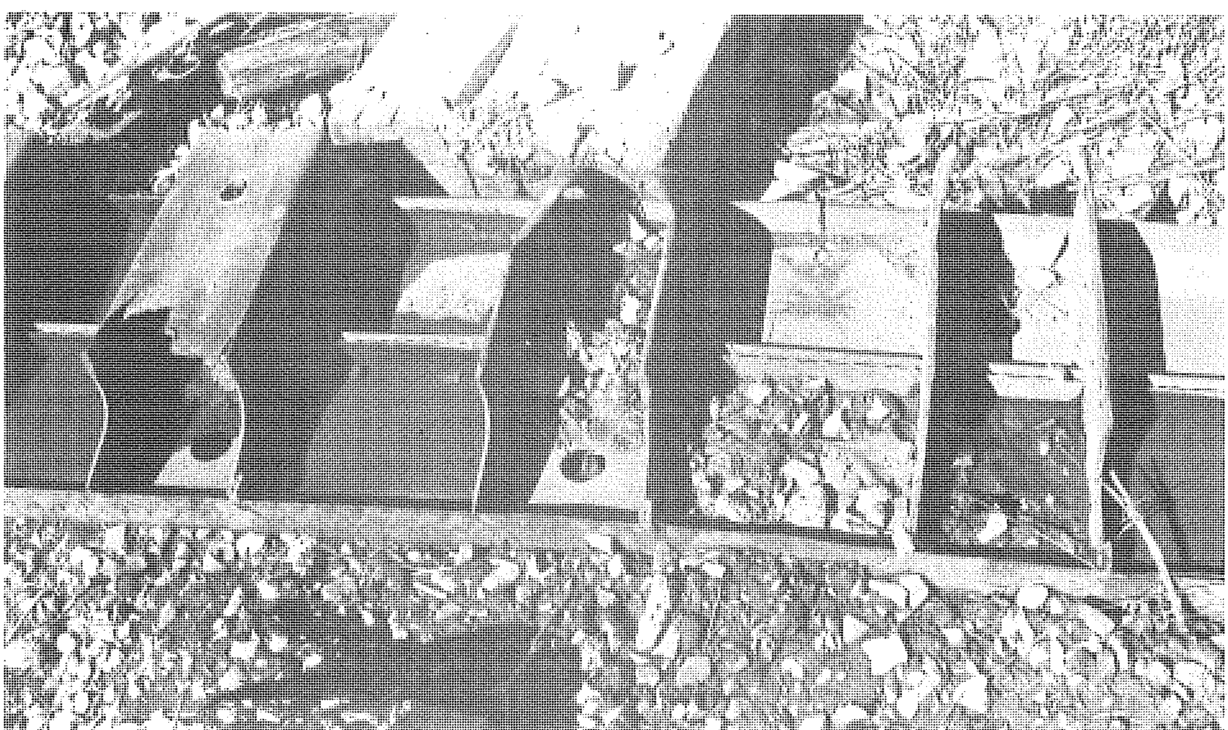


Figure 4. Underside of panel shown in Figure 3 after removal. Note fractured supports.

Saf and Dri (75 NM-428)

This type of crossing consists of modular units made of structural steel tubes enclosed in an elastomer. The tubes are filled with grout to increase their rigidity. The center units are 26 in. wide and 6 ft 8 in. long and two units are used to span the distance between rails. The side units are of the same length and are 20-7/8 in. wide. The surface pattern consists of 1/4-in. wide by 5/16-in. deep grooves spaced 1 in. apart and running perpendicular to the rails. A tie spacing of 20 in. on centers is required. Twelve 3/4-in. drive spikes with shock absorbing rubber washers are used to fasten each center unit, and four are used to fasten each side unit. The spike holes can be closed with a rubber plug, if desired.

Before placing the modular units, wood shims were placed on each tie and nailed in place using two 3/8 by 10-in. spikes in each shim. The units were placed mechanically with final positioning done by hand. The transverse joints were tightened by jacking from both crossing ends. The bolt holes are recessed 4-1/4 in. and a 1-3/4-in. diameter by 2-1/4-in. long shock absorbing rubber washer was placed under each spike head. The drive spikes used to fasten the pads to the ties were 3/4-in. diameter by 12 in. long. Driving of the spikes was preceded by drilling 5/8-in. diameter pilot holes through the shims and ties. The spike holes were not plugged.

The Oakland St crossing in Lansing was replaced in 1979 by the manufacturer because a tube had fractured in a panel of the original crossing installed in 1976. The 1976 crossing did not have grout-filled tubes to prevent fracture failures. The new crossing is in excellent condition and is rated 'Good' with regard to smoothness. The pavement next to the crossing is cracking and some minor breakup has occurred.

The US 131, Schoolcraft crossing is in good condition. One of the original 2-in. header boards has been replaced with a 1-in. board and some breakage of the bituminous material between the crossing and the concrete pavement has occurred. The ride smoothness is rated 'Good.'

The US 10, Ludington, and the M 21, Owosso crossings installed in 1979 are both in excellent condition and rated 'Good' with respect to smoothness.

Parkco (77 NM-537)

This crossing material is described by the manufacturer as molded rubber modules reinforced with steel flex plates. The slab units are placed on wood shims spiked to the ties. The slab joints are of the tongue and groove type and longitudinal channels are cast within the units. The slabs are fastened by tensioning cables passing through the longitudinal channels and through holes in steel plates bolted to the end ties of the crossing. A steel plate protects the fastening rods and plates at each crossing end. The center units are 6 ft long, 29-1/2 in. wide, and 3-1/2 in. thick and two units, placed side by side, are used between the rails. The side units are 6 ft long, 18 in. wide, and 3-1/2 in. thick. A wood header is used to prevent material from entering under the crossing surface. A tie spacing of 18 in. is required. The surface consists of a 1/2-in. raised circle pattern to divert moisture away from the contact area of the tires of crossing vehicles.

After the wood shims were fastened to the ties the surface units were placed by hand. The center units of the crossing were placed first and held in position by nailing stabilizer clips to the shims. Installation then proceeded toward the crossing ends. Each pad placed was jacked against the preceding one to ensure a tight joint. Once the unit was in place the stabilizer clips were installed. Before installing the last units at each crossing end, the steel plate was bolted to the last crossing tie. Then when the last units were in place, eight cables (four in the center units and two in each side unit) were inserted through holes in the steel end plates and through the channels cast into the surface units. The units were then fastened by tightening the cables and fastening them to the end steel plates.

The 1978 Parkco crossings replacing the T-Core crossings on US 23 in Omer and Alabaster are both in good condition and rated 'Good' with respect to smoothness. The fourth side panel from the north end on the west crossing side of the Omer crossing was noted to be bent downward slightly as if the support had settled.

The six crossings installed in 1979 are all in excellent condition and their ride smoothness rated 'Good.'

Gen-Trac (76 NM-489)

The modular units for this crossing consist of a 1/4-in. structural steel arch enclosed in an elastomer. The arch is prevented from spreading at its springing line by 1/2-in. bolts installed perpendicular to the arch. The center units are 52 in. wide and 1 ft 6 in. long. The side units are 23 in. wide and 1 ft 6 in. long. The surface pattern consists of grooves 1/8-in. deep by 1/2-in. wide, spaced 1/2 in. apart, and running perpendicular to the rails. The units are supported directly on the ties. Each center and each side unit is fastened by four 3/4-in. washer-head drive spikes with a rubber washer placed under the spike heads. Spike holes are sealed with a rubber plug. The required center-to-center tie dimension is 18 in.

The units were placed directly on the ties by hand. Normally the crossing center units were placed and secured first. Then installation proceeded toward the crossing ends. Jacks were used to ensure a tight joint between units. Pilot holes were drilled into the ties before fastening with the drive spikes. All bolt holes were plugged.

The four Gen-Trac crossings installed in 1978 have a 'Good' smoothness rating. On three of them, the train wheels have worn the rubber surface along the edge of the rail; otherwise, their condition is good. The 15 crossings rebuilt in 1979 are all in good condition and are rated 'Good' with regard to smoothness.

The performance of the various crossing types is illustrated photographically in the Appendix.

Elevation measurements made at the crossings indicate that the seven crossings with three years' service have settled an average of 3/4 in. with respect to a fixed reference point since they were rebuilt. The largest settlement was 1 in. and the smallest was 1/8 in. The average settlement after one-year service for 15 crossings was 1/4 in. and ranged from a high of 5/8 in. to a low of 0 in.

Cost of Material

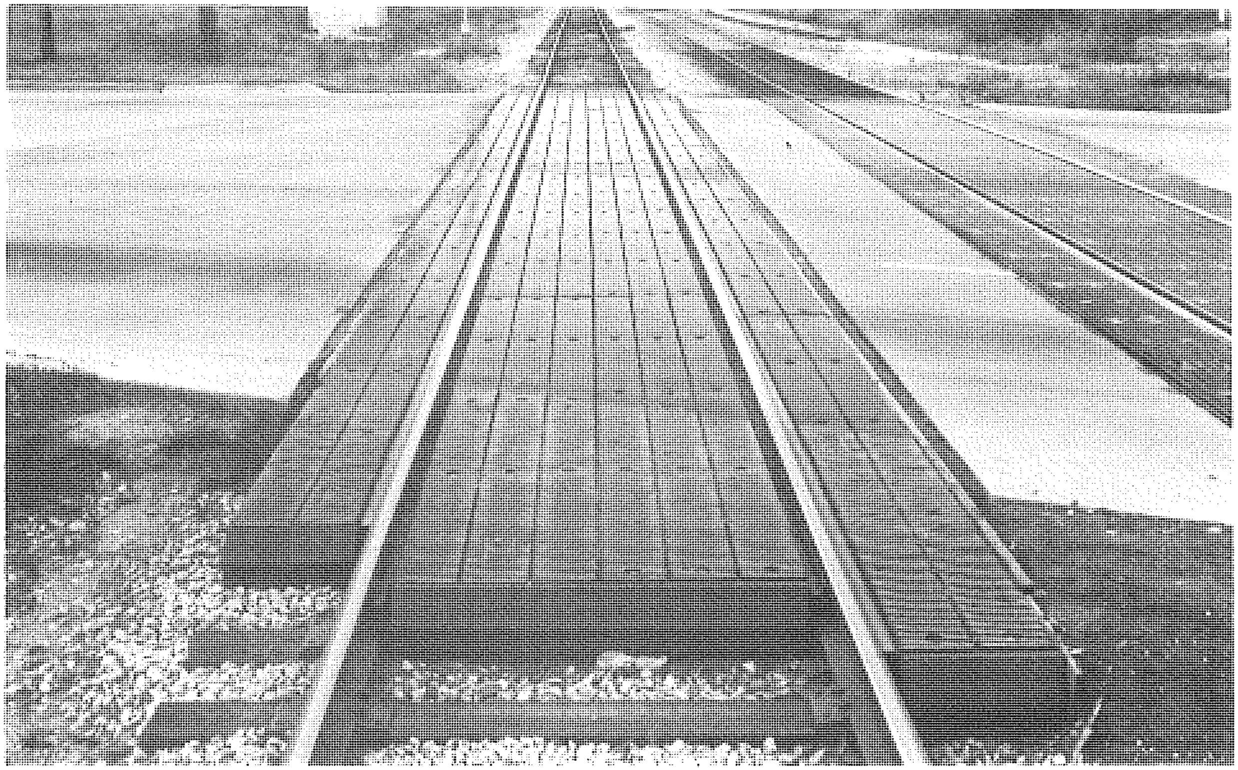
The average unit bid prices for each of the five types of crossing material, including fastening hardware, are as follows:

Crossing Type	Cost per Track-Foot			
	1976	1977	1978	1979
T-Core	$103	$ 98	--	--
Fab-Ra-Cast	$ 98	--	--	--
Steel Plank	$105	$120	$130	$135
Track-Span	$212	--	--	$180
Saf and Dri	--	$210	$230	$230
Parkco	--	--	$220	$234
Gen-Trac	--	--	$240	$249

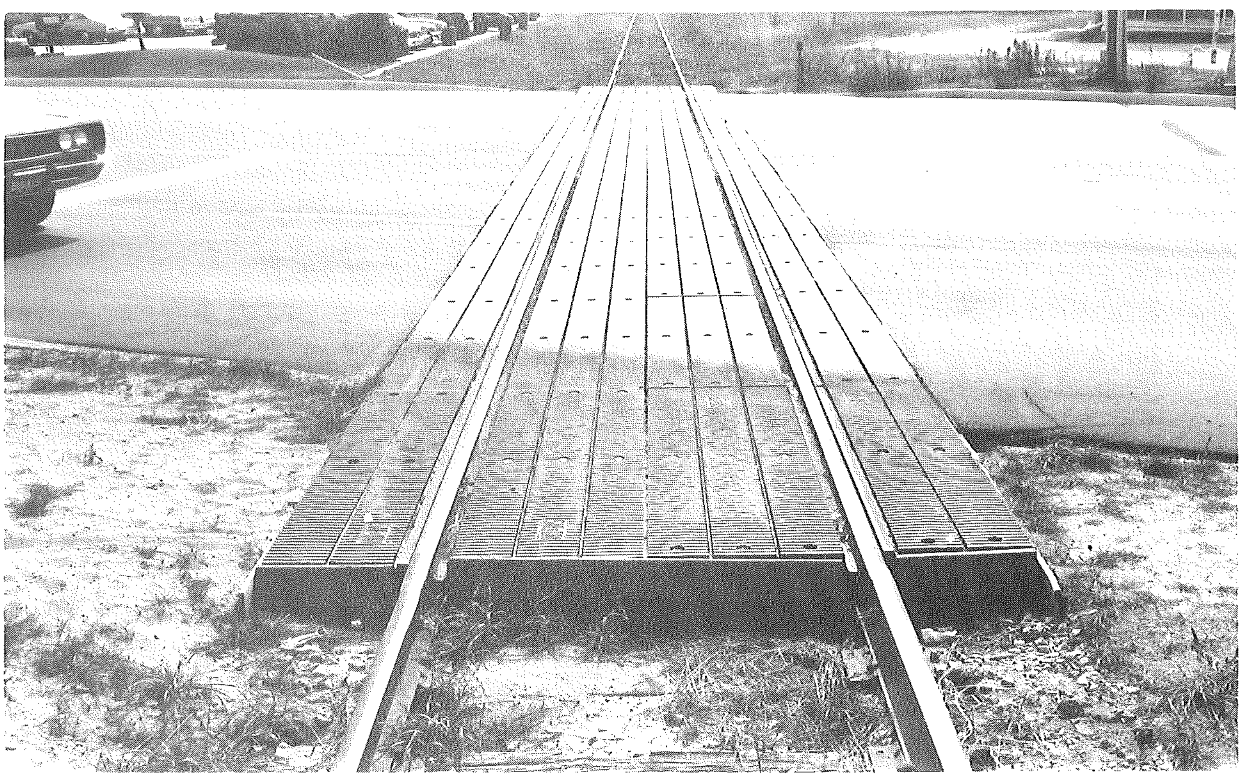
Conclusions

On the basis of observations of the performance of the experimental crossings, it is concluded that Track-Span, Saf and Dri, Parkco, and Gen-Trac continue to perform satisfactorily. The original Steel Plank design (with supports parallel to the ties) appears to develop fastening problems relatively soon after installation. This apparently leads to further problems such as misalignment and fracturing of the panel supports. The one crossing utilizing the modified design was installed only recently and has not been exposed to sufficient traffic to evaluate its performance. Until further information is available on the modified design's performance, it is suggested that Steel Plank crossings be used on locations with less than 5,000 ADT volumes where the traffic and train speeds are low.

APPENDIX

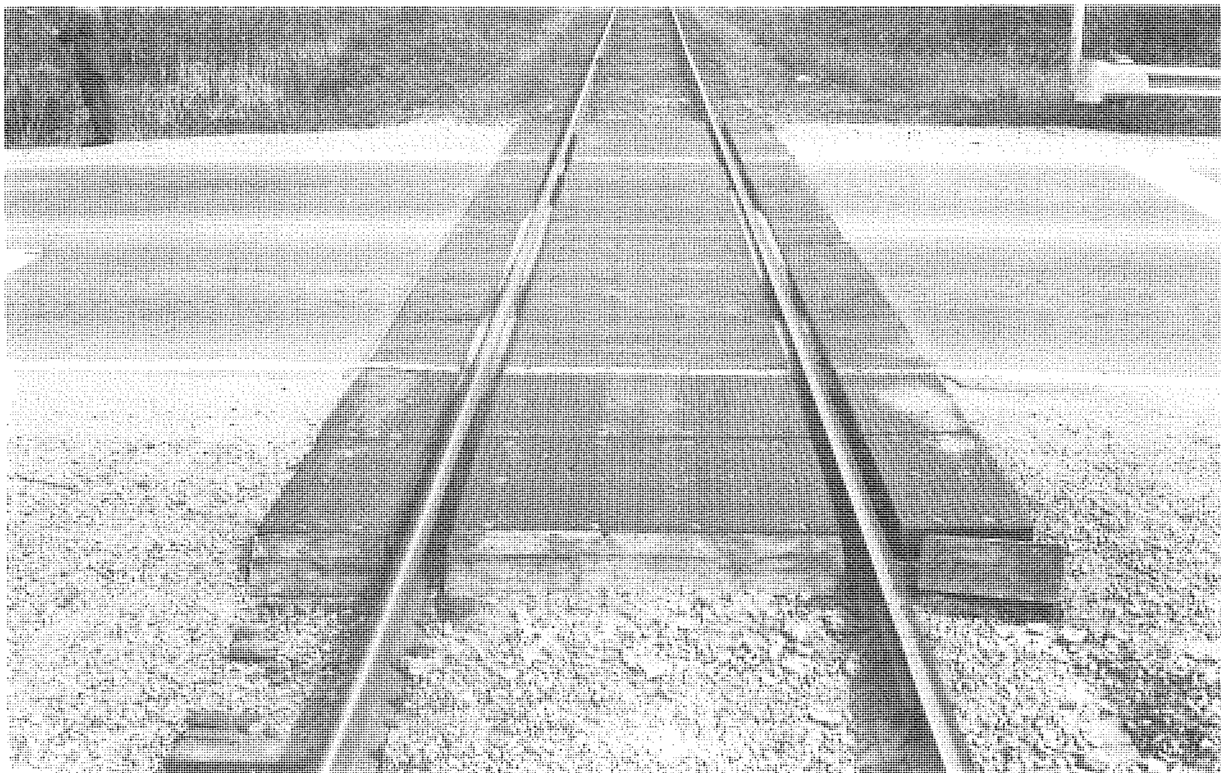


US 131--two years old--ADT - 11,100

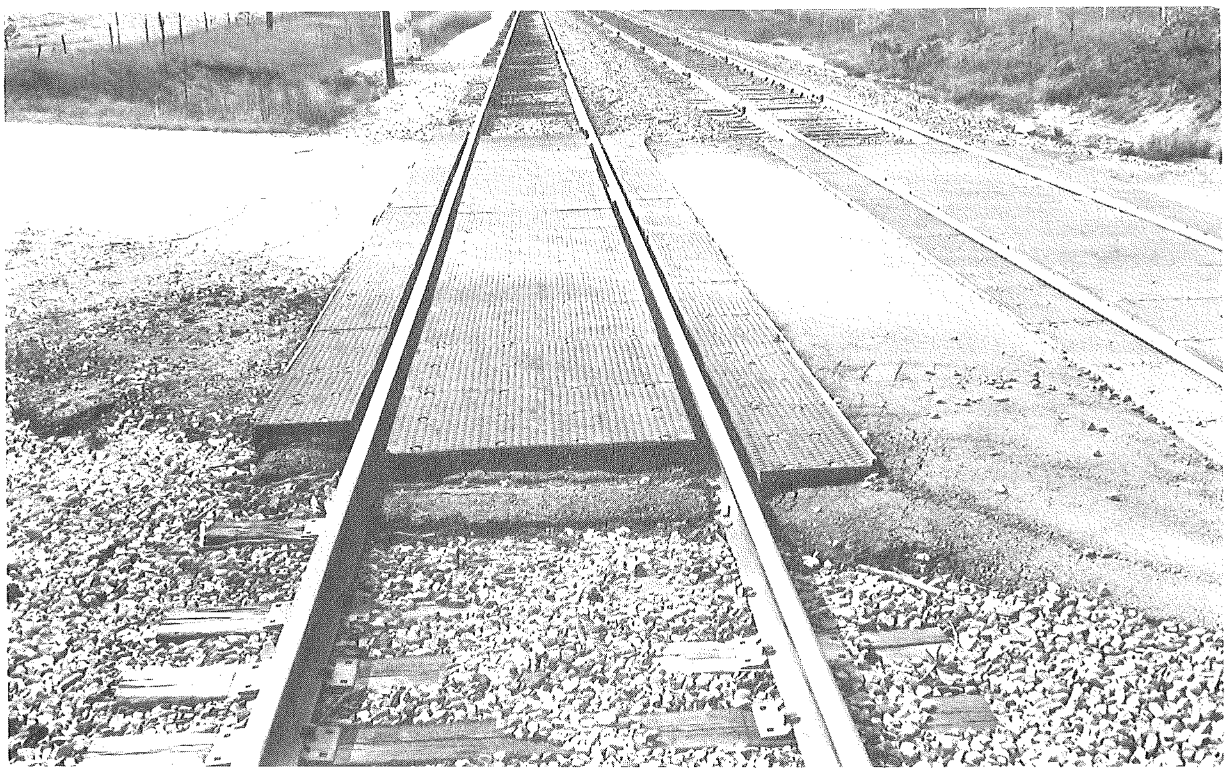


US 10 crossing--one year old--ADT - 14,000

Figure A1. Condition of Saf and Dri crossings.

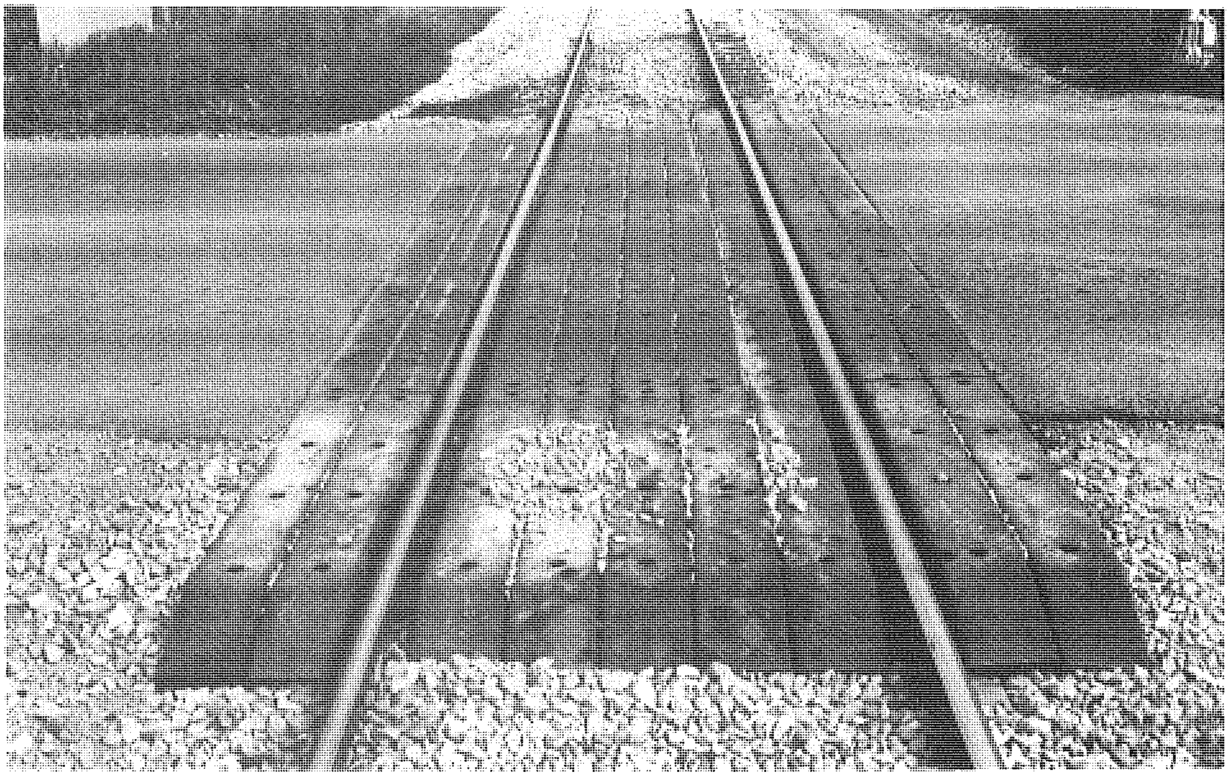


Kress Rd crossing--four years old--ADT - 1,800

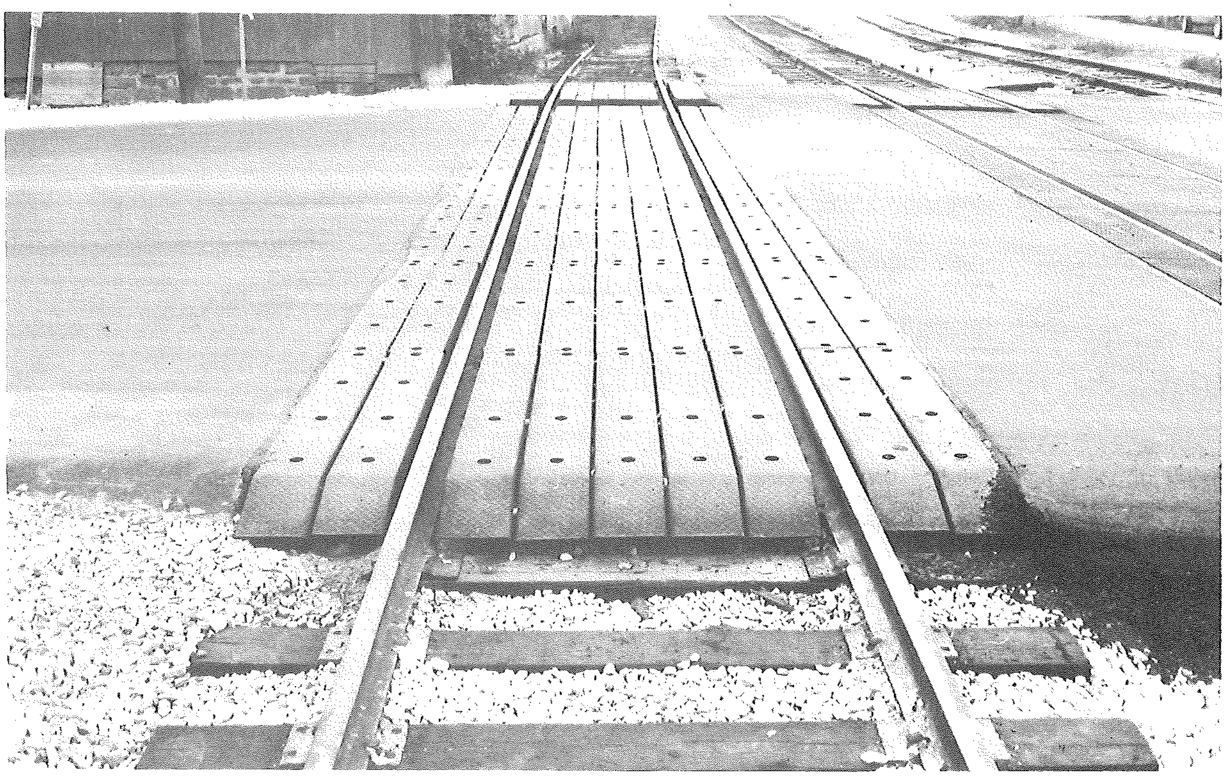


34th St crossing--three years old--ADT - 400

Figure A2. Condition of T-Core crossings.

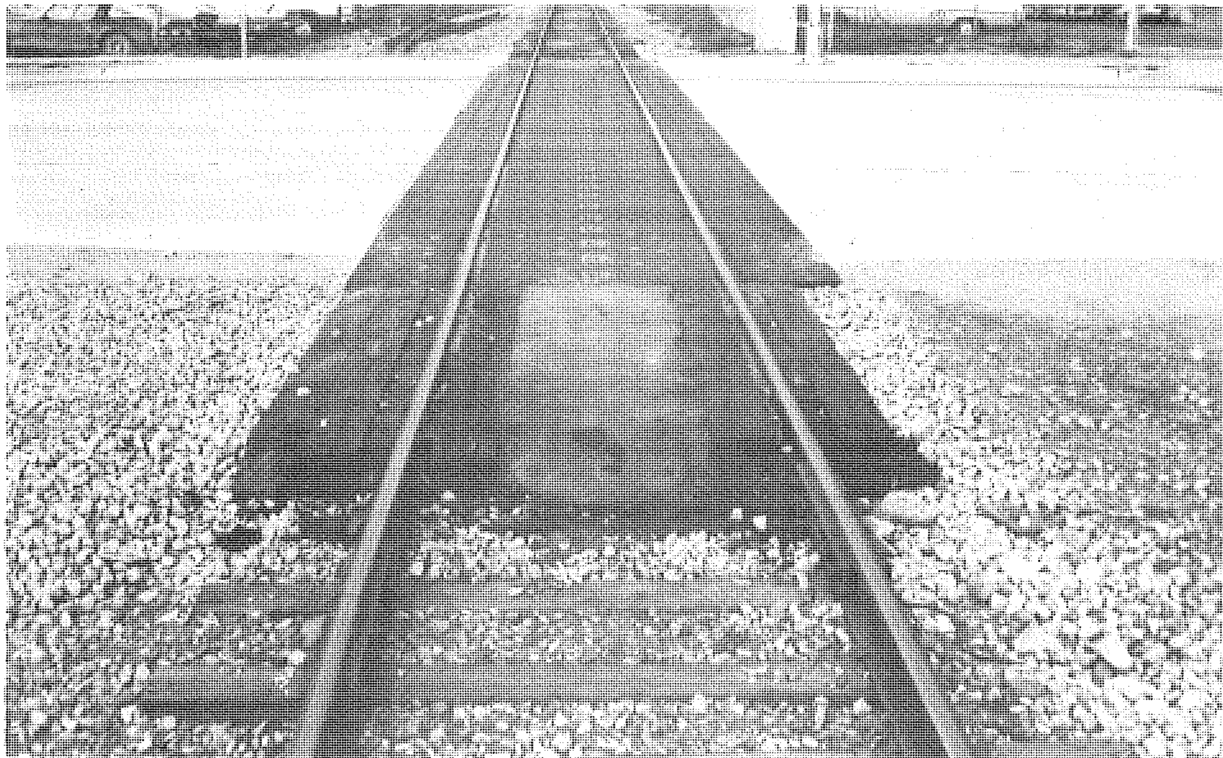


Hurd Rd crossing--four years old--ADT - 1,200

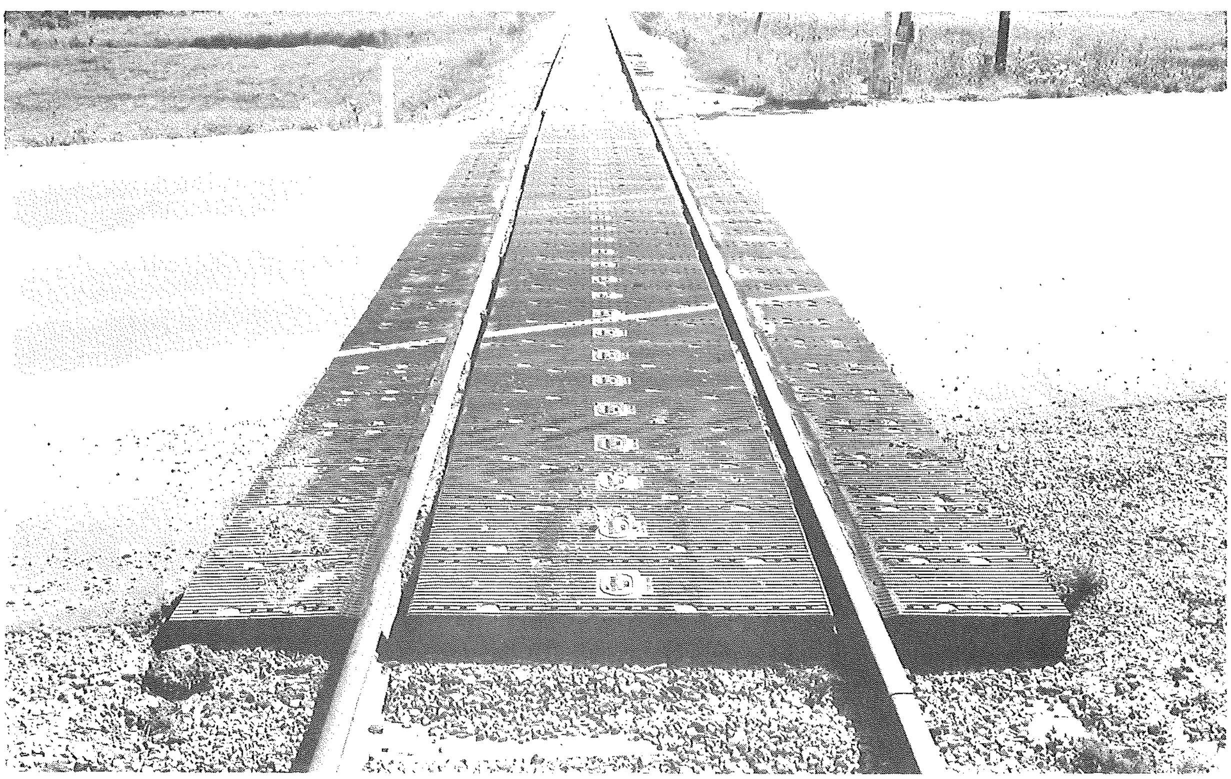


M 100 crossing--one year old--ADT - 5,100

Figure A3. Condition of Steel Plank crossings.

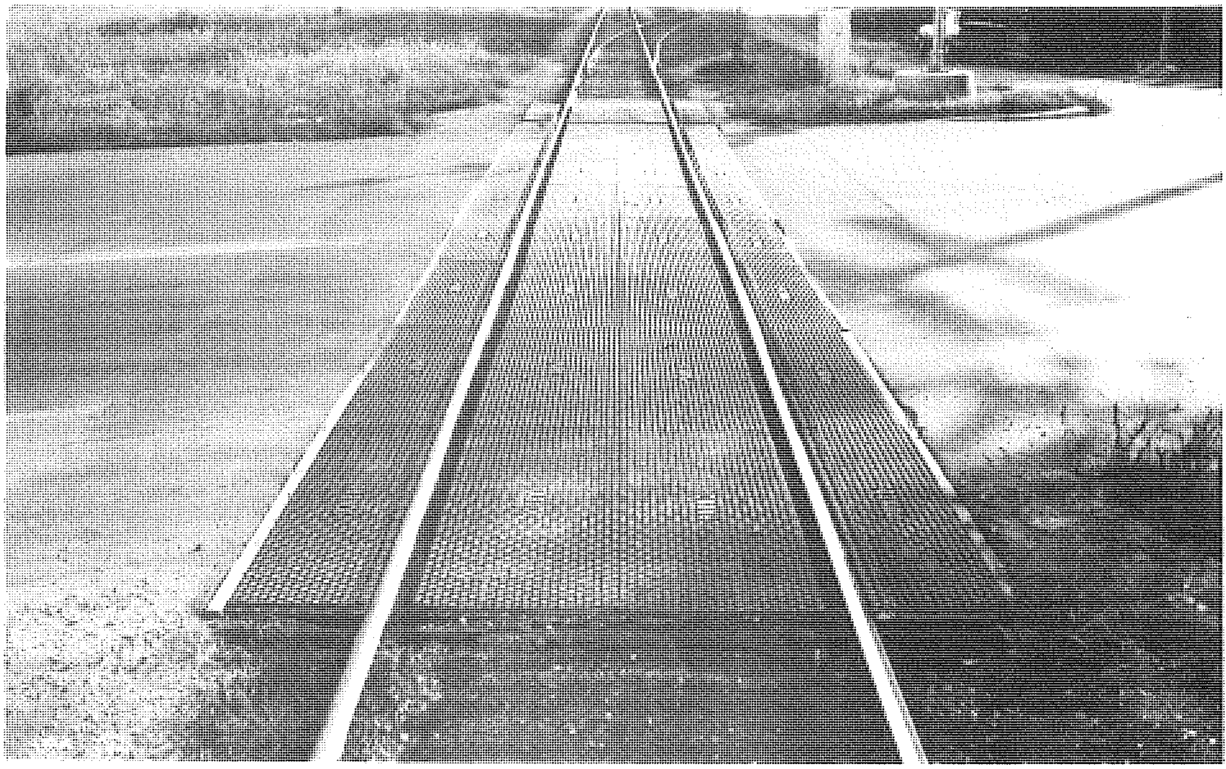


US 23, Alpena crossing--two years old--ADT - 9,700

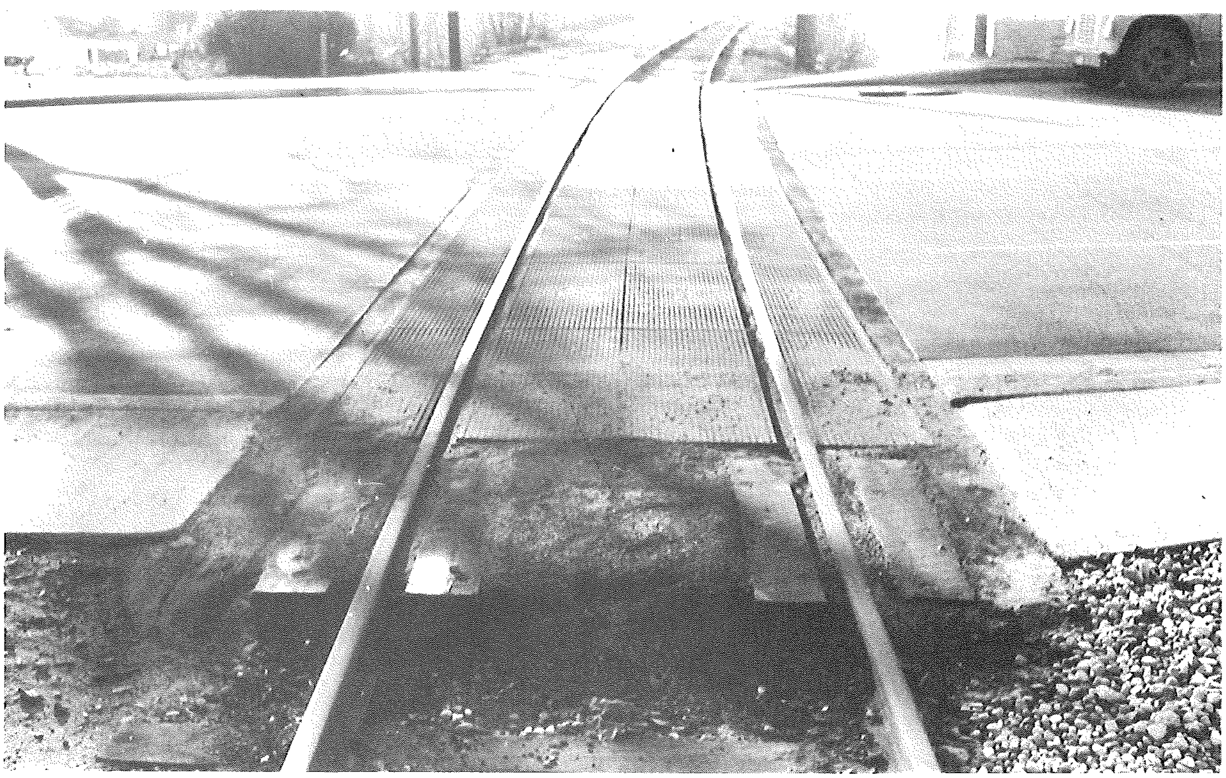


M 66 crossing--one year old--ADT - 12,000

Figure A4. Condition of Gen-Trac crossings.

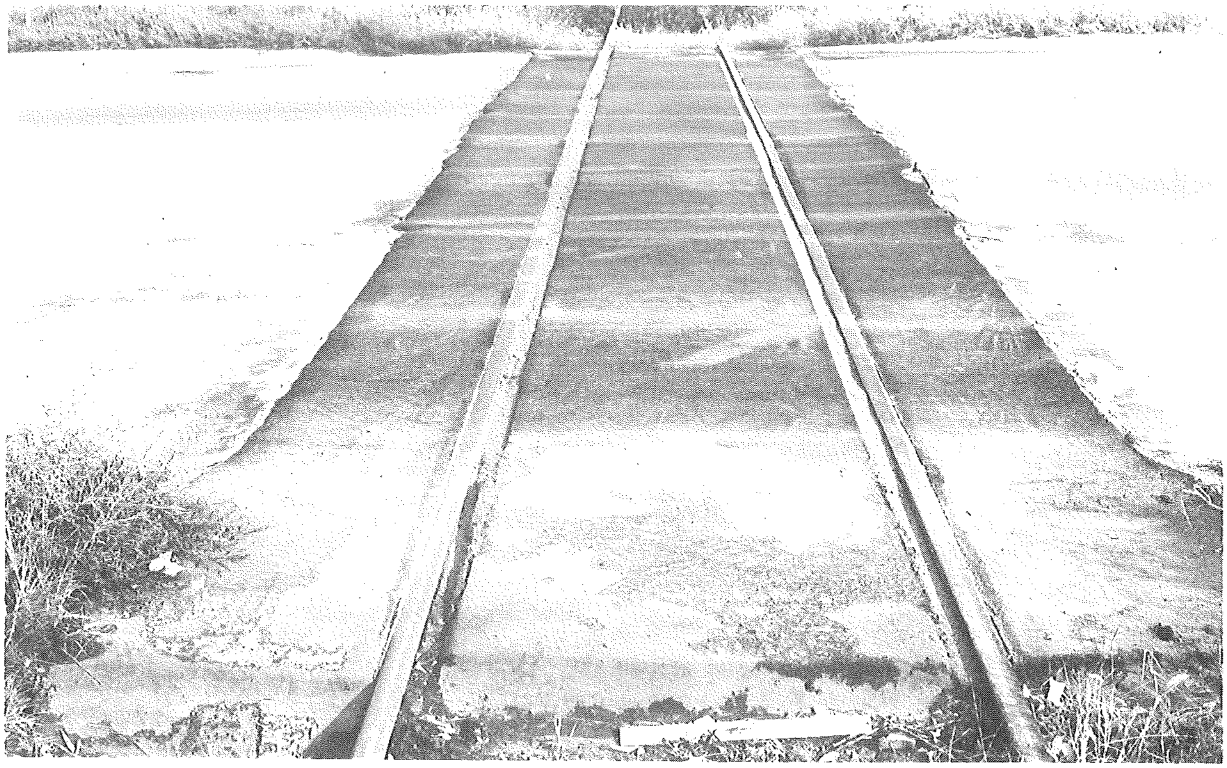


US 23, Omer crossing--two years old--ADT - 7,800



US 131 BR crossing--one year old--ADT - 28,000

Figure 5. Condition of Parkco crossings.



M 46 crossing--four years old--ADT - 8,800

US 31 crossing--one year old--ADT - 16,000

Figure A6. Condition of Track-Span crossings.