# HIGHWAY CROSSING CONSTRUCTION

**Report of Committee**

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Unusually keen competition in the transportation field has prompted the railroads to exert every effort to attract business and to promote a more friendly attitude on the part of the public. One very definite way to defeat such an attitude is to provide rough, unsafe, and poorly constructed grade crossings. In this field the maintenance of way department can either cooperate, by providing grade crossings of such character as to attract favorable comment, or bring down upon their railroads the wrath of the driving public, which includes many shippers. Nearly all of us are familiar with certain rough grade crossings that we would somewhat shamefully admit were a part of our railroad, or on which we would hesitate to place the name of our railroad conspicuously. The comments of a back-seat passenger who cracks his head against the top of the car in going over a railroad track are not fit for publication. If this same passenger happens to be a shipper, he will enjoy meeting the traffic representative of that railroad on his next visit, with resulting embarrassment to all concerned.

The construction of highway grade crossings has become one of the ever increasing problems to be faced by maintenance of way forces. This problem has grown from a relatively unimportant factor in maintenance to one that not only represents a considerable expenditure but requires careful supervision and planning, and in which the public has become much interested and exceedingly critical. Before the day of paved highways and motor vehicles, the requirements of a grade crossing meant very little. The speed of highway vehicles was scarcely considered, and repairs to these crossings were inexpensive and easily made. It is quite obvious that the improvement in highway crossing design and construction has not kept pace with the traffic and speed of the vehicles that are now using them.

The rapid growth of the motor vehicle is shown by registration statistics. In 1900 there were approximately 8,000 motor vehicles, the number increasing to a peak of 26,545,000 in 1930. Along with the rapid increase in numbers, there has also been a corresponding increase in speed and wheel loads, and a continually increasing mileage of improved roads. As evidence of the increase of commercial vehicles, trucks and buses, more than 17 per cent of the motor vehicle production in 1932 was of this type. The railroads in this country are now maintaining approximately 238,000 grade crossings, the construction of which has required a heavy investment and heavy annual expense for maintenance.

The May, 1933, issue of Railway Engineering and Maintenance contained a resume of the experiences of railway engineers with existing types of grade crossings, clearly indicating the confusion and lack of agreement as to the best type of construction for the heavy traffic that these crossings are required to carry. Many railroads which have standards for highway crossings are not following them, while others are constantly experimenting with various types, all with the express purpose of finding a design that will meet the requirements of present-day highway traffic and that will offer the least restriction to track maintenance. The continually increasing demand for greater speed in railroad traffic will require still further refinements in line and surface, all of which will have their effect upon a design of crossings that will permit the correction of defects in track through them with the least restriction.

There are many variables which must be considered in selecting the proper type of crossing for any particular location. The more important of these variables are:

1. Railroad traffic density and speed.

2. Highway traffic density and speed.

3. Permanency of the highway construction.

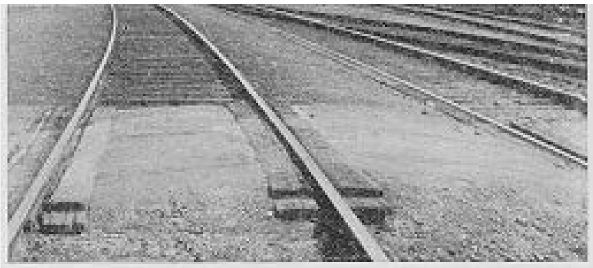
4. Location of the crossing.

5. Condition of the subsoil and drainage.

6. Possible change in design of the track structure.

7. Availability of crossing material.

8. Cost of the crossing on an annual basis.



This Type Is Economical for Crossings of Very Light Traffic

If the traffic on the railroad is very light and moves at slow speed, and the traffic on the highway is very heavy and fast, a type of crossing which is permanent in character may well be selected, without giving a great deal of consideration to the restrictions which that type of crossing may offer to track maintenance. If, however, the reverse of this situation exists, a type of crossing which will offer the least possible restriction to the maintenance of good line and surface for heavy, high speed, railroad traffic should be selected. All of the other variables will require consideration in the selection of the best type of crossing for a given location.

The final and most important determination to be made is the cost of the crossing on an annual basis. To arrive at this conclusion, all of the elements of cost must be included, although some of them will have to be estimated. The initial cost per square foot can be quite accurately estimated, and from this the carrying charges can be computed. The life of the crossing, as well as the maintenance, must be estimated and from these the cost per year may be approximately determined.

**The Types of Crossings**

The types of crossings now in most common use are:

- Untreated plank.
- Treated plank.
- Bituminous concrete.
- Preformed asphalt plank.
- Precast concrete.
- Monolithic concrete.
- Metal (rolled or cast).
- Armored (rail-type).

Some of the more apparent advantages and disadvantages of the various types of crossings are listed:

| **Type** | **Advantages** | **Disadvantages** |
|---|---|---|
| Untreated Plank | Low first cost<br>Easily removed<br>Easy to install<br>Can be made to fit any design of crossing | Short life due to decay<br>Liability of plank to become loose and be caught by dragging equipment.<br>Frequent maintenance |
| Treated Plank | Moderate cost<br>Ease of installation and removal<br>Can be adapted to any design of crossing<br>Comparatively long life | Subject to moderate wear<br>Moderate maintenance |
| Bituminous | Moderate cost<br>Can be adapted to any design of crossing<br>Easily repaired<br>Will not be greatly damaged by dragging equipment<br>Long life | Requires maintenance in patching worn areas<br>Difficult and expensive to remove for repair of track or correction of line and surface<br>When necessary to remove, very little can be salvaged |
| Asphalt Pre-formed Plank | Moderately long life<br>Easy to install and remove<br>Comparatively low maintenance | High first cost<br>Rather difficult to remove without damaging |

| Type | Advantages | Disadvantages |
|---|---|---|
| Pre-cast Concrete | Long life | High initial cost |
| | Low maintenance cost<br>Can be removed and replaced without damage | Heavy to handle |
| Monolithic Concrete | Long life<br>Low maintenance cost | High first cost<br>Expensive to remove to repair track<br>No salvage when removed to repair track |
| Metal - Rolled or Cast | Long life<br>Low maintenance cost<br>Can be removed and replaced without damage | High initial cost<br>Requires some attention to keep tight and noiseless<br>Requires special fittings to make repairs when damaged |
| Armored (Rail type) | Long life<br>Material usually available<br>Can be removed and replaced without much damage to materials<br>Low maintenance | Relatively high first cost<br>Expensive to remove and make repairs to track<br>Cannot be handled with small force |

Information furnished by various railroads having crossings in service of the types listed, indicates a life as follows:

| | **Estimated Life Years** | | |
|---|---|---|---|
| **Type of Crossing** | **Minimum** | **Maximum** | ***Average** |
| Untreated plank | 5 | 6 | 5.2 |
| Treated plank | 6 | 18 | 10.6 |
| Bituminous | 3 | 22 | 6.9 |
| Asphalt plank | 15 | 20 | 15.4 |
| Concrete-precast | 12 | 40 | 18.6 |
| Metal-rolled-cast | 10 | 25 | 17.5 |
| Armored (rail type) | 3 | 10 | 6.2 |

*Average is based upon all replies estimating life of crossings.

## Careful Preparation Necessary

The first consideration in the installation of any type of crossing will obviously be the thorough preparation of the track structure. The first requisite in providing good track is adequate drainage, and this is even more important at grade crossings. Surface ditches should be constructed to carry the water away from the crossing, and where subsoil conditions warrant, subdrainage should be provided to insure against water pockets or soft spots developing in or adjacent to the crossing.

If the track is not well ballasted or the condition of ballast is not the best, it should be dug out well below the bottom of the ties and, where possible, two feet beyond the ends of the ties for the full length of the crossing and far enough on each side to insure uniform bearing and adequate drainage throughout the crossing area. The track should then be reballasted with good clean ballast, preferably crushed rock, slag, or their equal.

All ties should be sound treated ties, carefully spaced to provide even bearing. Sawed ties should be used where the type of crossing requires them. Because of the additional loading on this portion of the track from highway traffic, it is recommended that the ties be spaced closer through the crossing than is standard in the track adjoining the crossing, in order to increase the bearing on the ballast and the roadbed and reduce the settlement within the crossing.

The rail throughout the crossing should be either new rail or usable rail of full section. If the rail at the location of the crossing is not of the section adopted as standard in that territory, it should be changed to the standard section through the crossing and for at least a rail length on each side. The rail should be continuous through the crossing, this condition being met either by welding the joints or by the use of special length rail where required.

Tie plates, preferably new or at least of full section, should be placed on each tie. The track should be full spiked to perfect gage and brought to good line and surface. The tamping should preferably be done by mechanical tampers, but should at least be done carefully and solidly to insure the most uniform and solid bearing. If it has been necessary to dig out ballast well below the bottoms of the ties, it is a good plan, where possible, to allow trains to compact the ballast before bringing the track to final level and surface.

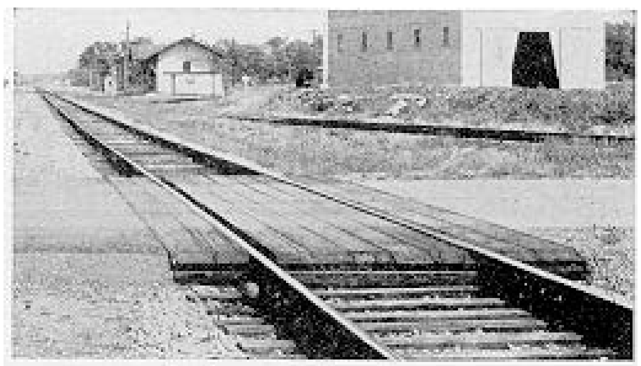
On many occasions the railroads have spent considerable money to provide a good crossing, only to have the smooth-riding qualities defeated because the pavement was not brought to a level coinciding with that of the track. Where an improved highway has been installed prior to the construction of an improved type of crossing, a crown is sometimes left in the street or highway where it meets the track. Such a condition can usually be overcome by seeking the co-operation of those in charge of highway construction or maintenance. In nearly all cases such co-operation is readily given and only requires a mutual understanding of the benefit to the driving public.

The earliest and simplest type of grade crossing consisted of gravel, cinders or dirt filled between the rails. This type of crossing was greatly improved by the addition of a plank outside and inside of each rail, the outside plank being set against the rail, and the inside plank far enough away from the gage side of the rail to provide a flangeway. Many crossings of this type are in use today on highways carrying very light traffic, and in such locations are economical and sufficient.

## Plank Crossing-Treated and Untreated

While there has been a decided tendency on the part of many railroads to replace plank crossings with some more permanent type of construction, the number of plank crossings still greatly exceeds the combined number of all other types in use today. In considering the merits of the plank crossing it must be remembered that the crossings embraced within this classification range all the way from the primitive type in which a single unsized, untreated plank is provided on each side of each rail, as described above, to the type in which carefully selected, sized and treated planks are installed in accordance with a carefully developed plan that calls for a high class of workmanship. Only a limited proportion of all plank crossings fall within the limits of what may be designated as high-grade construction.

It may safely be said that the average plank crossing receives the least amount of care in installation, and the least thought in design and planning, of all of the types employed, and yet is the most common in use. If this type of crossing receives the proper care in the selection of materials and close supervision in installation, the cost of such a crossing, on an annual basis, will compare favorably with other types and in many cases will prove more economical. Many railroad engineers are of the opinion that the plank crossing, if properly constructed with good materials, provides the best construction, all phases of the crossing problem being considered.



A Creosoted Plank Crossing

Untreated plank was for many years the accepted material for important grade crossings, and principally because of its low first cost, it is being used to a large extent today, but is rapidly being replaced by treated plank or one of the more permanent types of crossings. The labor required for installing untreated plank is little, if any, less than that for treated plank, so that on an annual basis, particularly where treated ties are used, the saving in first cost disappears because of the greatly increased life due to treatment.

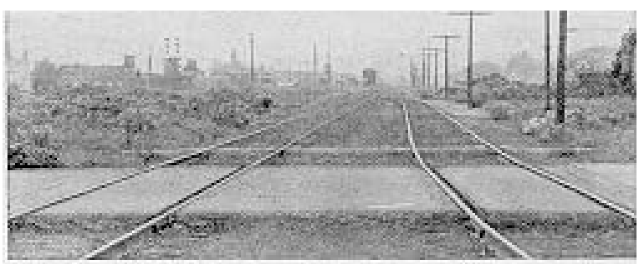
The preparation of the track structure should be made as previously outlined, care being taken in all of the details. The planks should be surfaced one side and one edge to provide uniform thickness and width so that no trimming will be required in the field to insure that the planks fit snugly between the flange rails or special flange guards. After seasoning and proper framing, the planks should receive an approved preservative treatment to insure maximum life. Creosoted red oak, or black gum planks, 4 in. by 10 in. by 16 ft., provide about the best material for such use, and if properly installed, will amply pay for the added cost of this class of material in improved wearing service.

It has been, and in many cases is today, the practice on some railroads to use almost any material available for shims to bring the plank level with the top of rail. Old fence boards, old grain doors, or any other material of about the right thickness has been used for this purpose and therein lies much of the cause for condemning the plank crossing. One of the most important requisites for the permanence of a good surface on plank crossings, as well as on the most elaborate types of permanent crossings, is a uniform bearing. Shims should be made in suitable lengths and surfaced on one side to the exact thickness required to bring the plank level with the top of the rail, depending upon the section of the rail, the thickness of the tie plates and the plank in use. These shims should be treated and in all respects provide a service life equal to that expected of the treated plank. Each tie should be fitted with a shim, securely nailed in such a way that if splitting should occur, the shims will not work out from under the plank.

A flange rail or special type flange guard should be applied and securely supported in place before the planks are laid. The planks should be laid so that the ends join on a tie, if the crossing is more than one plank in length. Planks should be fastened by boat spikes or lag screws; in either ease the planks and shims should be bored to prevent splitting. If boat spikes are used, they should have a penetration in the tie of at least four inches and should be fitted with flat washers under the head to provide increased bearing on top of the plank. Planks should be spiked at each end and on at least every second tie. In very heavy-traffic crossings, the planks should be spiked on every tie, the spikes to be driven with the chisel point across the grain of the tie. At both ends of the crossing, the planks should be beveled to prevent dragging equipment from catching.

**Bituminous Crossings**

Bituminous crossings have proved their merit and have become recognized as one of the types that lend themselves to economical maintenance. In the selection of this type of crossing, as previously pointed out, consideration must be given to the stability of the roadbed, as it affects the necessity of disturbing the track to maintain the required refinement of line and surface. This is apparent when it is realized that any work of this character on the crossing immediately defeats the economy which would otherwise result from the use of a crossing of this type. Where the characteristics of a crossing lend themselves to this type, it will be found to have many advantages if properly constructed. It is not expensive in first cost, can be installed without skilled labor to produce a smooth-riding crossing, and with a small amount of material and labor can be kept in first-class condition until it becomes necessary to rebuild or repair the track structure. The selection of this type of crossing, therefore, resolves itself into a determination of the probable length of time, under known traffic conditions and the presumed stability of the roadbed, that the track structure may be left without disturbing it.


A Bituminous Crossing

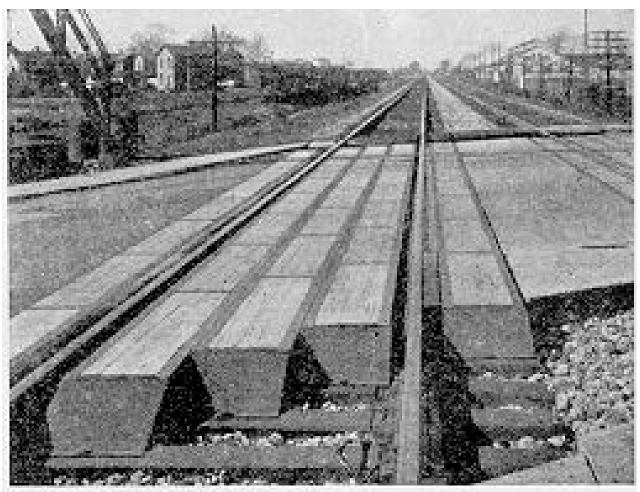
After the track structure has been placed in proper condition, the ballast should be dug out to the bottom of the ties to receive the bituminous concrete material. The aggregate should be of clean crushed rock or gravel, graded from 1 in. to 2-1/2 in. in size for the foundation or lower course. The amount of bituminous binder to be used should be increased as the material approaches the crossing level; at the bottom it need be only sufficient to allow the aggregate to be tamped solidly in place and prevent the material from moving. This size of aggregate should be used until the bituminous concrete is at a level approximately two inches below the top of rail. The remaining two inches should have a sufficient amount of bituminous binder to coat thoroughly each particle of aggregate, which for this wearing surface should be of 1/4-in. rock chips or gravel.

The use of natural rock asphalt, or a synthetic rock asphalt material such as has been placed on the market in recent years, provides an unusually fine material for the two-inch wearing surface, where the foundation has been constructed as outlined above. This material can be shipped in open-top cars, ready to apply, and can be stocked successfully for a considerable length of time, for repairs when needed. The material is easily applied and can be tapered out to a feather edge in smoothing depressions in the crossing as they occur. The completed crossing presents a compact surface which is smooth, resilient, non-reflecting and nearly skid proof.

**Preventing Damage by Vibration**

The occasion for the early repair of bituminous crossings usually results from vibration or movement of the running rails. This movement of the rails causes a crumbling of the material next to the rail, particularly during cold weather when the resilience of the material is low and it has become more or less brittle. To overcome this condition, some railroads have adopted the plan of placing a rail on each side of the running rails, the rails being of the same section and laid "workways." This obviously affords greater protection for the material from the effects of the wave motion and vibration of the rail, and eliminates this troublesome condition to a great extent. A flange rail or special flange guard is preferred by some railroads for use on the gage side, using a supplemental rail only on the outside. One railroad that uses the three-rail construction reports the-use of special tie plates made for this purpose.

In crossings of this kind, it is always good practice to use a richer mixture, with the finer aggregate next to the rails in order to provide more resilience. The success of bituminous crossings depends largely upon the care taken in providing a well-compacted foundation, using sufficient asphaltic material to bind the aggregate. The practice of building these bituminous crossings above the level of the rails to allow for settlement frequently results in a rough riding crossing. It is far better to build the crossing to the correct level and, after the material has compacted under traffic, bring the crossing to perfect level by the addition of material used for the wearing surface. One of the important advantages of this type of crossing is that it practically prevents water from getting into the track structure.



A Concrete Slab Crossing

It is the practice of some railroads using treated plank crossings to build them with the top 1/4 in. to 3/8 in. below the top of rail, and place a wearing surface of rock asphalt or other bituminous material on top, thereby not only preventing wear on the plank, but increasing the waterproofing of the plank crossing. In order for this method to be successful, the planks must have a very uniform bearing and be securely fastened to prevent movement. Another important use of bituminous material is in the intertrack spaces of multiple-track crossings. Regardless of the type of crossing that may be used in the track proper in such locations, this class of material is ideal for this purpose.

## Preformed Asphalt Plank

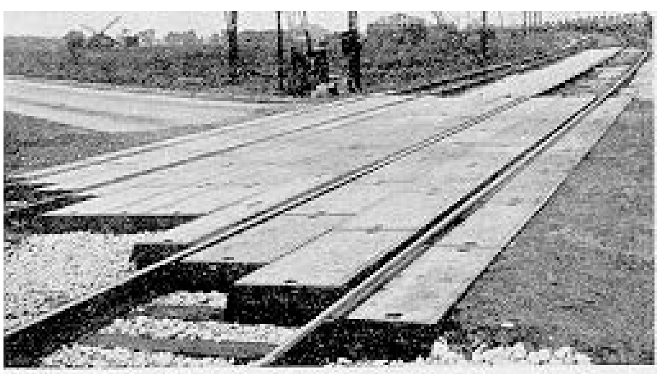
The use of asphalt plank as a wearing surface for grade crossings produces a smooth and somewhat resilient type of crossing. Because of lack of structural strength of the material, it is laid on a timber deck of the height necessary to bring the top of the asphalt plank level with the rail. The timber deck is laid parallel with the rail and fastened to the ties by lag screws. The plank is ordinarily 2 in. thick and from 8 to 10 in. wide, being nailed to the timber deck, with a small washer under the head of the nail.

## Precast Concrete Slabs

The introduction of precast concrete for grade crossings followed closely the use of concrete for the paving of highways. Many of the original designs for slabs proved to be poorly suited for this purpose. Better reinforcing of these slabs, together with an armored protection of the edges, has eliminated many of the early failures caused by breakage and crumbling. Some railroads have their own designs and construct the slabs with their own forces. Others are using patented types, which can be purchased in any desired thickness to accommodate the height of rail in use. Descriptions of the more common types of slab crossings on the market are given in the following:

**Weltrus, Type -** The Weltrus type crossing, manufactured by the Truscon Steel Company, Youngstown, Ohio, provides a welded form with a concrete filler. The forms are purchased from the manufacturer and filled with concrete by the railroad. The forms provide protection of the concrete on all corners and edges. The reinforcing provided to carry the loading is all of copper-alloy steel, electrically pressure welded. The standard sections are made 16-3/4 in. by 6 in., by 6 ft., long, although they can be furnished in any required dimensions. No fastenings are used in securing the sections in the crossing, the units being simply laid in place.

**Permacrete Slab Crossing -** The Permacrete crossing, manufactured by the Permanent Concrete Products, Inc., Columbus, Ohio, consists of reinforced concrete slabs, protected on the top edges by 1-3/4-in. channels. These slabs are furnished in standard sizes 16-3/4 in. in width, 6 ft. in length and in thicknesses of 5 in., 5-1/2 in., 6 in., 6-1/2 in., and 7 in., and may also be secured in special sizes or shapes to fit special conditions.

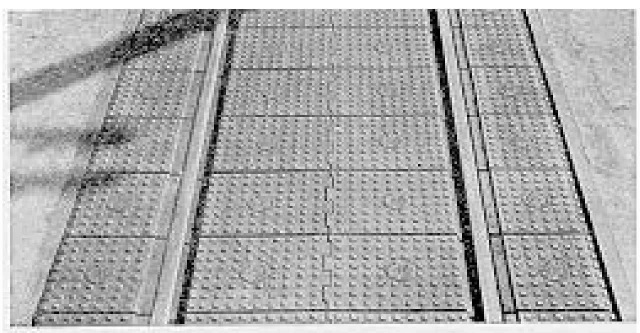


Another Type of Concrete Crossing

**Massey Armored Slabs -** Armored concrete crossing slabs constructed by the Massey Concrete Products Corporation, Chicago, differ considerably from those already described. The slabs are made in standard sizes, 16-3/4 in. by 4 in. by 4 ft. 6 in. A frame of structural steel channels completely protects the edges and corners. The slabs are further reinforced pear the top and bottom with cold drawn wire fabric. These slabs, when in place, are supported only at each end, wood shims being used only on the supporting ties. The slabs are held in place by 5/8-in. by 10-in. lag screws, one at each end of the slab, provision being made for these lag screws in the design of the slab.

Certain side-track crossings carrying a very light railroad traffic, but having a stable roadbed, may well be paved with concrete if the highway is paved and carries heavy traffic. In such cases the ties should all be renewed with treated timber and the track dug out four inches below the bottom of the ties. The track can then be blocked up at the correct level and concrete of high early strength tamped under the ties and filled in around the rails, necessary flangeways being provided. Such a crossing will require no further attention until it is necessary to rebuild it.

Many highway crossings have been constructed of rails, of either fair, second-hand or good scrap quality. If the rails are carefully selected and are of equal height, and care is taken to provide a uniform bearing, a smooth-riding crossing can be constructed which will be economical, provided the track structure is unyielding. The space between the running rails should be filled with intermediate rails laid as closely as possible and still allow room for spiking. The distance between adjacent rail heads should not exceed four inches in any case and when necessary the rail bases can be notched to permit spiking. Creosoted hardwood shims of the proper height to bring the crossing rails level with the running rails should be spiked to each tie. These shims should be surfaced to exact thickness and should be at least seven inches in width. Creosoted sawed ties, 7 in. by 9 in., of sufficient length to permit the spiking of the outside approach rails, should be used throughout the crossing. The outside ends of the rails should be beveled at not more than 45 deg. with the horizontal, to prevent possible damage from dragging equipment.

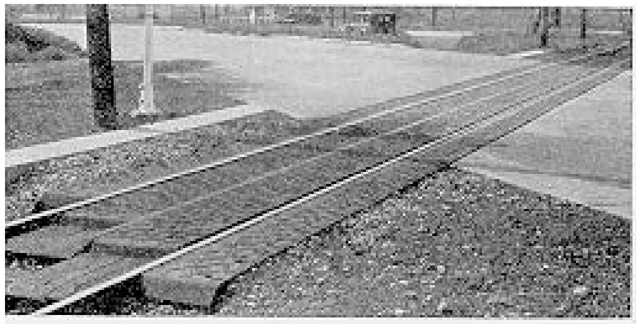


Example of a Metal Crossing

In signal territory the center rail should be replaced with a creosoted wood filler to provide insulation. After completing the installation of the crossing rails, the openings on both sides of the running rails, as well as all other spaces between crossing rails, should be filled to the top with poured bituminous filler. A crossing constructed as outlined above makes repairs to the track very expensive. When taking up such a crossing, it becomes necessary to build a detour to carry highway traffic, or to close the road during the course of work.

The search for the more permanent construction of grade crossings has resulted in the introduction of several types of metal crossings, all with the intent of providing units which can be easily taken up and replaced to permit the ready maintenance of the track structure and to provide smooth, non-skid and noiseless crossings. Examples are described on the following pages.

**Ramapo Ajax -** The Ramapo Ajax Corporation, New York, manufactures a crossing of this type that is constructed of semi-steel castings, provided with a non-skid checkered surface and the necessary ribs and flanges to provide the requisite beam strength, suitable bearing & and wheel flangeways. All units have a length of 24 in. lengthwise of the track, there being two lines of these inside the rails and one line outside of each rail. A system of wood filler blocks, shims and wedges provides the insulation and Anchorage on the gage side of the running rails while a lip that engages the under side of the head, serves to hold the units in place on the outside of the running rail as well as along the center line of the track, where a rail of the same pattern as the running rails is spiked to the ties. Direct attachment to the ties by means of the lag screws is required only along the outside edge of the outside units. The method of holding the units in place is such that they are readily removed for the conduct of work on the track, the weight of the units being such that they may be lifted by two men. The units are interchangeable from one location to another with any standard section of rail.



Another Type of Metal Crossing

**Truscon Crossing -** The Truscon Steel Company, Youngstown, Ohio, manufactures two types of steel crossings. The all-steel crossing, Type-A, consists of heavy steel "planks" having an exclusive safety tread. The sections, of 1/4-in. material, are 3 in. in depth, 5-11/16 in. in width, and have a standard length of 9 ft., although any lengths up to 18 ft. may be provided. The sections are laid parallel with the rail and are brought flush with the top of rail by means of wood shims which are spiked to the ties. The sections are secured in place with lag screws, the heads of which sink into specially formed recesses, leaving the road surface smooth. Insulation is secured by the use of creosoted oak or asphalt fillers between the running rails and the metal plank.

Type "B" consists of a pressed-steel form, 6 in. by 16-3/4, in. by 6 ft. long, having a checkerboard top. These steel forms are filled with concrete by the railroad and when complete weigh approximately 700 lb. No fastening is used with this type, it being claimed that these sections will stay in place by their own weight. Insulation is obtained by wood filler blocks on each side of the running rails.

**Bull Frog Crossing -** The Indianapolis Switch & Frog Co. has developed a crossing constructed of malleable units 20 in. in length, supported on the track rails, using rubber cushion insulators to afford some resilience, as well as to eliminate the noise of bearing of steel on steel. The support and fastenings require the use of three stringer rails, one in the center of track and one on each side of track near the edge of pavement. By special locking units, the crossing or any part of it may be easily removed to provide access to the track.

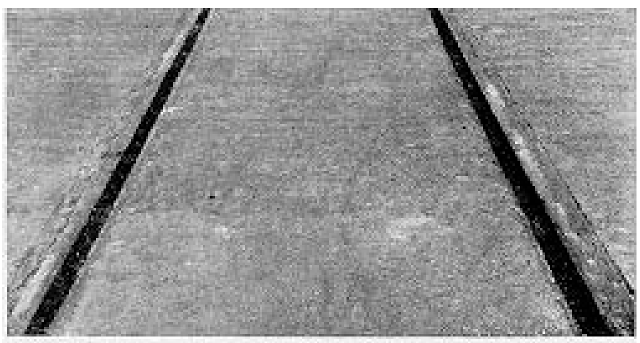
**Titan Highway Crossing -** This crossing, which is manufactured by the Weir-Kilby Corporation, Cincinnati, Ohio, consists of a system of steel channels, angles and forged supports for a checkered T-plate, that forms the running surface of the crossing. This top plate is bolted to the supports, which rest directly on top of the track ties. The center support consists of two channels, back to back, with insulation between them.

**Smithsteel Crossing -** The A. O. Smith Corporation, Milwaukee, Wis., has introduced the "Smithsteel" crossing, consisting briefly of copper bearing steel locking bases that are spiked to the ties, copper bearing steel deck channels and special flangeway and end ramp sections that rest on the locking bases and are held in place by clips. The height of the locking bases is varied to suit the rail height. The section of crossing between the track rails is divided into three panels by creosoted wood insulating boards. It is claimed that this type of construction permits the easy removal of deck channels in order to make track repairs, it being necessary to drive these deck channels only a few inches longitudinally, in order to lift them out. The crossing provides a non-skid surface.

**Diamond-Pattern Crossing -** The Alan Wood Steel Company, Conshohocken, Pa., has adapted its diamond-pattern steel floor plate to the construction of a steel surface highway crossing. This crossing consists of a solid timber deck laid parallel with the track rails, at the proper height to allow a 1/4,-in. floor plate to be level with the track rails. The plate is fastened to the deck with 3/8-in. diameter drive screws 3 in. long. Insulation is provided at the center of the track by a one-inch insulation filler between the plates. Special filler blocks provide the flangeway.

The protection of the flangeway is one of the important features of any well-constructed crossing. Such a flangeway guard should absorb as much of the running-rail vibration as possible, in order to protect the crossing from damage. It should be as free from contact with the running rail as possible and still leave the least amount of opening for water and dirt to get into the track structure. If the trough of a closed type of flangeway is of soft material, it will tend to fill up with snow and ice in winter much more readily than one of steel construction, due to the action of wheel flanges through the flangeway.

A good flangeway guard can be made of a light rail section, such as the 60-lb. A.S.C.E. section, placed on its side with the head fitting against the web of the running rail and supported so as to provide a reasonably tight fit under the head of the running rail. Care should be taken in installation to see that the flange rail is securely supported and fastened to prevent it from tipping. The C.R.S. Continuous Web Crossing Flangeway, manufactured by The Cleveland Railway Supply Company, Cleveland, Ohio, is of the closed-trough type, and Affords opportunity to spike it securely in place. The Bethlehem braced flangeway guard, manufactured by the Bethlehem Steel Company, is of the open-trough type. It is fastened independently of the running rail and, therefore, will not transmit rail movement or vibration to the crossing material.



A Flangeway Installation

Crossings can be installed and maintained by section forces at less expense than by bridge and building forces, and if properly trained, the former will do a creditable job. If crossings are constructed by the gangs on their own sections, their pride in a good job will encourage better maintenance of the crossings. In general, the service life of any of the accepted types of grade crossings will reflect very definitely the degree of care exercised in design and installation. Adequate and uniform bearing on the track structure must be provided if the crossing is to carry the heavy highway traffic of today. If the pavement level does not coincide with the top of rail, the crossing will not only ride rough but this will result also in undue abuse of the crossing material. Cooperation with the state highway departments or city street officers will correct many of the poor riding conditions of otherwise well constructed crossings. The railroads can ill afford to convey the "public be damned" attitude to the traveling public on the highways, by providing unsafe and rough grade crossings.

**President Howson:** It has not been many years since the untreated plank crossing was the standard on almost all railways. The coming of the automobile on the highway has changed that, and this report illustrates the diversity of designs that have been introduced to solve the new problem that has been thrust on the railways by highway traffic. The report is before you; the committee has done its work. Who can contribute further to the consideration of the subject?

**J. J. Desmond (I. C.):** I would like to inquire of Mr. Davis whether he ever has established the practice of mixing his own material for the wearing surface for bituminous crossings?

**Mr. Davis:** So far as our own experience is concerned, we use 1/4 in. of roofing gravel for the wearing surface, coated with any one of a number of good road oils. We mix it on the job. If it is a small crossing, that is, small enough so it wouldn't pay to send put a concrete mixer, it is mixed by hand. Whenever it is a rather extensive job, where it proves to be more economical to use a concrete mixer, that method is carried out.

In the winter-time it does become necessary to heat both the aggregate as a whole and the oils in order to get a successful job.

**Mr. Desmond:** Mr. Davis, regardless of the weather, there will be considerable moisture in the material you use, but you can heat it readily, and some of the manufacturers advise heating it all. I was wondering whether or not you felt it was necessary to do it in the summertime?

**Mr. Davis:** I think you should do whatever is advised by those who produce the material. If they recommend it should be done, I would do it. Others not only advise against it but recommend adding a slight amount of water and thinning out the material when it is coated. We have found that to be successful on the larger aggregate at the bottom. We throw a little water over the aggregate when it is mixed.

**E. P. Safford (N. Y. C.):** I wish to refer to the remarks in the committee's report with reference to bituminous crossings: "Difficult and expensive to remove for repair of track or correction of line and surface." I am now in the process of replacing such crossings with creosoted plank in order to be able to make the necessary repairs to the surface and line of the track in a more economical manner.

In discussing the plank crossing the report stresses the importance of shims on the ties-not just whatever happens to be around, but a specified material. I use 4-in. plank, and with a 6-in. rail I use a 2-in. plank on the ties; with a 7-in. rail I use a 3-in. plank on the ties for the shims, and I use new material. I lay the shims from rail base to rail base, place a 3-in. by 4-in. stick under the head of the rail, butting close against the plank, to provide a flange. I use two planks outside of the rail to the full width of the tie so that the track will raise freely, and in the inner track space I use bituminous filling. That does not have to be disturbed. And with the gradual raising of the track, if that is done, I simply add an inch or so to this bituminous filling, using bituminous filling outside the track to meet the grade of the street.

The report, I think, incorrectly advises the use of 16-ft. plank. That is all right on a crossing that is 16-ft. long. But our store department brought up the question a year or two ago, which I think is a very vital one, namely, that timber bought all in one length costs more than when purchased in various lengths. Now crossings run all the way from 14 to, say, 50 ft. in length. On a 28-ft. crossing you can use two 14-ft. plank or a 16 and a 12. Many of our street and outlying highway crossings are 20 ft. Here 10-ft. plank are very satisfactory and it gives the purchaser an opportunity to buy those lengths.

**G. T. Donahue (N. Y. C.):** I want to bring up one point. Where bituminous crossings have been put on a roadbed of cinders, we have found quite a few crossings where the stone wasn't carried out far enough beyond the cinders, with the result that the crossing would break off along the edges. The stone should have been carried farther out.

**A. H. Peterson (C. M. St. P. & P.):** I am particularly interested in this report for the reason that we have some 500 crossings on my district, including all the types mentioned and some others.

The report fails to mention the effect of rail joints in bituminous crossings. We have found that the joints are a constant source of expense and trouble. If a joint cannot be eliminated, and a mud rail is provided to protect the crossing material in the center of the track, it is good practice to burn out the head of the mud rail so as to have continuous protection through the joint.

We are now taking out two steel crossings on account of water leaks, and practically half the bolts, of which there are 200 or 300 in each crossing, have corroded so badly that they break off. In some cases we have to burn them off. The crossing provides an excellent roadway surface, but the repairs that are necessary after the crossing has been in the track for any length of time, are a source of large expense and a lot of trouble.

We are now experimenting with treated and untreated plank in our crossings. We have found that plank in crossings subject to heavy traffic, are destroyed by mechanical wear rather than decay.

We have found that a bituminous crossing can be installed for about 75 per cent of the cost of a plank crossing, including all items except the work on the track structure. We have practically agreed in our own minds that the emulsified asphalt crossing is the crossing that we want. Whenever a plank crossing gets to the point where 60 or 75 per cent of the plank have to be renewed we put it on our program for renewal with asphalt. We have a lot of them in the city of Chicago and they are giving wonderful satisfaction. They are easy to repair, they are waterproof, are smooth riding and give a fine appearance.

**Mr. Davis:** I would like to take this opportunity to defend the report, so far as the rail is concerned. That is covered under preparation of track structure. It says, "The rail should be continuous through the crossing, this condition being met either by welding the joints or by the use of special length rail where required."

**E. E. R. Tratman (consulting engineer):** I think the crossing that presents a peculiar difficulty is one in track on a curve, and that is still worse if the street is on a grade. I have in mind some crossings where you drive down a fairly steep pitch to the track, or go up a steep elevation over the first track, and then down another grade on the highway. Now the railroad has just paved those crossings with one of these bituminous materials. It is as good a crossing as can be made, but periodically the local papers take a sarcastic whack at the railroads because the people bump their heads as they go over the crossing.

**O. Surprenant (D. & H.):** I find no reference in the report to provision for drainage in permanent crossings. I think we should make some arrangement for permanent drainage in those crossings.

**Mr. Davis:** That is covered as follows: "The first requisite in providing good track is adequate drainage, and this is even more important at grade crossings. Surface ditches should be constructed to carry the water away from the crossing, and where subsoil conditions warrant, subdrainage should be provided to insure against water pockets or soft spots developing in or adjacent to the crossing."

**Mr. Surprenant:** But you are not recommending any type of drainage.

**Mr. Davis:** That can be either perforated pipe or tile drains. It should be perforated iron pipe, of course, under the track.

**J. B. Kelly (M. St. P. & S. S. M.):** The report, as I see it, is very complete, but there have been cases of criticism about the riding qualities of plank crossings because the bolt head with the washer projected above the planks. I think it would be good policy to countersink the plank to take care of the washer and the head of the bolt spike.

In the bituminous crossing, we have had greater success with granite chips about one-quarter or three-eighths inch size. Gravel doesn't seem to take hold. Round pebbles give out in a rather short time. We mix the oil with the rock chips with shovels on the ground. This mixture is prepared two weeks in advance of application and is then put in with ordinary tampers.

We have realized considerable damage to monolithic crossings by failure to make due allowance for false flanges on the wheels. A great many wheels will stick out a quarter of an inch, and if the concrete is flush with the top of the rail, the concrete around the rail immediately shatters. We now leave the concrete low enough to clear the false flanges.

We have been asked to explain why we use tie plates or even use the full number of ties in the monolithic concrete crossings. It is contended by many that with a foot of concrete under the ties and concrete also to the top of the rail surface that the tie plates or one-half the ties might be dispensed with. I would like to hear from some of the members and the committee as to their views on that particular subject.

**Secretary Donahoe:** I am not one of the committee, but I would like to say that the structure under the crossing is very important, and I can see a reason for more ties but not for less ties. I think better ties should be selected for the crossing and, if anything, they should be a little closer than the standard spacing to give extra support.

**W. E. Carter (B. & L. E.):** I just completed a gum-plank crossing ten days ago, and it is apparently going to be very satisfactory. The planks are all treated.

**G. T. Anderson (K. C. S.):** We use several different types of crossings, but the type in most general use is the treated-plank crossing. On the light-duty crossings we use a plank outside the rail and a plank on the inside with a separator. We fill between the planks with whatever ballast we wish to use, mixed with heavy road oil. That seems to make a very satisfactory construction for light-duty crossings. For heavy service we use the solid plank crossing. We also have several concrete crossings.

**Tom Thompson (A. T. & S. F.):** I recently looked at a plank crossing that has been in the track about six or eight years. The planks are 3 in. thick and 16 or 18 ft. long, supported on strips laid on top of the ties. The tops of the planks are covered with second-hand iron plates that came out from under some old crossings. That crossing is in excellent condition today and it is a good one. I have driven over the crossing myself a number of times and I have been watching it.

**L. M. Denny (C. C. C. & St. L.):** I want to say a word for a metal crossing in service in my territory on a street that carries a heavy truck traffic in Indianapolis. The crossing has had very little repair since it was installed in 1925, and it is in good condition.

**Robert Yost (A. T. & S. F.):** We use 4-in. creosoted gum plank with furring. Some crossings have the flangeway-cut planks and others have independent flangeways. The former are very satisfactory, but I prefer the latter because in the winter-time we don't have the trouble due to the heaving of the plank nearest the running rail where we have the independent flangeway.

We also have the bituminous crossings, and it is our practice to use a running rail or header rail on the inside as well as the outside where we put in this type of crossing in order to prevent the asphalt from feathering away. I would like to ask Mr. Davis if it is the practice to fill the cribs at the crossings where plank is used to the top of the tie or to the top of the furring?

**Mr. Davis:** We usually leave the ballast down two to three inches below the top of the tie in our plank crossings. There is always some material that works down between the planks that tends to fill up those holes. I would say three inches is not too much.

**W. J. Daehn (C. & N. W.):** We have a number of asbestos Tarvia crossings, and we find that they have been made with too rich a mixture. Too rich a mixture is worse than not enough. We put in a three-track crossing a year ago this month, that was constructed with good stone in the bottom and a 2-in. Tarvia top dressing, and it hasn't been touched this year. A good many horses pass over it each day going to a creamery and so far their sharp shoes have had no effect on it at all.

**Mr. Thompson:** I would like to hear a discussion on rail crossings.

**B. E. Haley (A. C. L.):** We have some rail crossings and find them very satisfactory. We weld three pieces across the bottom of the rails to hold them together, so that the rails that are in the center of the track are in one piece when we put them in. When we get ready to renew the crossing, we just jack the assembly up, get some rollers under it and slide it down the track, put the ties in, bring it back to surface, roll the rail unit back in and the job is done.

We use another form of crossing where we have more than one track. We use a concrete slab between the tracks cast in place, and a plank crossing. If you can get your people to buy the timber thick enough to make shims unnecessary, you will get a better crossing. Of course, that is a matter that you have to fight out with the purchasing agent. With our 100-lb. rail we use a 6 by 12 timber framed to fit against the flange of the rail, and held down with 12-in. lag screws. We find that a very satisfactory construction and it lasts a great deal longer than boards that are laid on shims. Any crossing other than a plank crossing should have the flangeway on the inside and outside of the rail. Any material that is put against the rail will immediately start raveling from vibration.

At crossings of important streets we butt-weld the rail. We don't leave any joints in the crossing. Where this can't be done, it is well not to spike any joints in the slots, but to leave them loose. But it is much more satisfactory not to leave a joint in a crossing. We have almost come to the conclusion that a plank crossing is the best.

**J. B. Martin (N. Y. C.):** I don't think there is anything the general public "cusses" the railroads more for than poor crossings, and there are lots of them in the country. We use some bituminous crossings and we have some very good ones, but pretty generally on our heavy-traffic lines we are going to plank crossings. And we find them most satisfactory because the public likes them the best and we find them the easiest to keep in repair and, I think, the most economical. The great secret with the plank crossing lies in its installation. If it is properly installed, you have a good crossing; if it isn't properly installed, you always have a poor crossing.

**J. Morgan (C. of Ga.):** We have all manner of crossings, including some that have not been mentioned. We have the rail crossings, including one we constructed four years ago almost exactly according to the plan noted in the report, and we have had no occasion to repair it. We butt-weld our running rail, we use the same number of ties as in the track elsewhere, and we provide a good foundation and good drainage.

**J. J. Clutz (Penna.):** I would like to hear a discussion of the best method of building a crossing where trolley tracks cross the railroad at grade. I haven't found any way of making a good crossing yet. Maybe somebody else has.

**J. P. Corcoran (Alton):** Trolley crossings are the hardest crossings to keep up. We happen to have quite a few in Joliet, and we have found that a wooden crossing is the best. We tried out a 4-in. plank with 3-in. shims nailed solidly to every tie, but we have had a hard time keeping the crossing plank in.

**P. J. McAndrews (C. & N. W.):** The crossing problem is one that is always with us. Mr. Donahoe made a suggestion regarding additional ties in the crossing. I believe that is a very good point. Drainage is the essential thing. Where we have a side track in a street to be paved, we have the contractor pave the entire crossing, by putting in a "two by four" while pouring the concrete and removing it afterwards to form a flangeway. I believe that is the solution we should adopt whenever possible. It settles the matter for all time. And ordinarily the sidetrack doesn't go down like our main, high-speed tracks do. And wherever we can get that done, that is the way we handle it. We hope to be able to eliminate a great deal of plank and a great deal of labor in maintaining those crossings.

At Dixon, Ill., we have about a mile and a half of track in the street. Some of it is taken care of with rail flangeways with a composition mixture between them and this continues to break up, especially along the outside of the rail. The thought I have in particular in regard to sidetrack crossings is to get them paved.

**Mr. Michael (St. John, N. B.):** We have used the concrete slab crossings on heavy traffic roads on the highways. We find them very satisfactory. We also use asphalt and rock asphalt. But on the high-speed tracks neither of them has proved satisfactory on account of the vibration of the track. No matter how well you put the crossing down, there is a vibration that you can't get away from. I have had some concrete slab crossings in some of the high-speed lines for nine years and they have been very satisfactory. For yards and sidetracks, I think asphalt makes a strong and safe crossing.

When we have to remove these crossings, we should have something we can take out readily and put back. We use a plank between the asphalt and the slab so the plank can be taken out and the rock slipped under the rail.

**D. V. O'Connell (C. & N. W.):** I would like to ask the gentleman from Canada if he has any trouble in the winter with those concrete slabs.

**Mr. Michael:** I have one crossing on Highway No. 2 about 18 miles from Windsor that I don't think I have had up in nine years.

**Mr. O'Connell:** Did you have any trouble with it sloughing off ?

**Mr. Michael:** No; you want to keep your ballast down.

**Mr. O'Connell:** We keep the ballast down even with the top of the ties. I was just wondering if anybody is having any trouble with frost lifting up the slabs in the winter-time.

**President Howson:** Does anyone have trouble with concrete crossings being raised by frost in the winter-time?

**Mr. Michael:** I would like to ask some gentleman with the Michigan Central if the concrete slabs are satisfactory? I notice they have some. And I would like to hear some more comment on the rail type of crossing. We have tried them and they have not proved satisfactory. We excavated down about 18 inches and filled in with washed gravel and installed perforated corrugated pipe between the main line and the house track, with cross drains coming in from the main track. We did not weld the rail in the crossing. And we have had trouble.

**Mr. Morgan:** We welded the running rails, and we put anchor bars on the other rails. The crossing is about 90 feet wide. We tighten them up as though we are going to run traffic on them. If the joints get loose they will work up.

**Secretary Donahoe:** I have observed that the Pennsylvania is using a 3-rail crossing, that is, running rail, outside rail and inside rail. Previous to the last year or two they were cutting the flange of the rail and had trouble with it turning over. Now they use the full width rail and fill in. It makes a very strong crossing, and we are now using the same design. We have some crossings that have been in three or four years and they have been giving good service.

We get the joints out of the crossing wherever it is possible. If the 39-foot rail goes out to the sidewalk, we use it and then use a short piece. We use large ties and long plates on the ties. The only objection I see to that kind of crossing is that on a curve the rails are inclined to straighten, thus giving trouble with the line. Otherwise, it is an excellent job.

The bituminous crossing can be repaired easily. You can give it a treatment of oil and sand so the water doesn't get down into the track. That seems to be the trouble with so many of those crossings.

**Porter Sipe (West. Md.):** We have had quite a lot of trouble with the crossings on my division and we have now adopted the three-rail crossing as our standard. Before we install the crossing we dig the material all out and put in good ties. We also see that we have a uniform surface and that the rail is not higher or lower than the street crossing. Then we fill in with what they call ready-mixed Amacite and roll it down with a road-roller and make it perfectly smooth. This makes a very easy riding crossing.

**R. L. Sims (C. B. & Q.):** We have a lot of asphalt crossings and our experience has been that they are the most satisfactory crossings in our heavy traffic territory. Plank crossings cause much trouble, for the reason that they do not properly protect the track from rainfall.

**Mr. O'Connell:** Does the committee recommend the use of longer ties than eight feet? Where you use a plank crossing, do you have planks outside the rail ?

**Mr. Davis:** Where you use two planks outside the rail or where the end of the pavement is from 20 to 24 inches from the rail you won't have proper support unless you do use long ties.

**Mr. O'Connell:** Long ties may give trouble in lining your track.

**Mr. Davis:** Yes, the concrete may crowd the track. But we have been pretty successful in avoiding such trouble by getting the highway department to put a four-inch expansion gap back about 15 feet from the crossing. That has prevented the crowding action of the pavement. I think in a good many cases we overlook the opportunity to get the highway people to cooperate with us in taking care of those difficulties. We have been rather successful in getting the highway people to work with us very well. If the pavement was rough, in spite of the kind of crossing we put in, they would put a cold patch on to bring it level throughout the width of the crossing. Usually it is only a matter of getting in touch with them to correct a lot of difficulties that are not really the fault of the crossing construction.

**F. B. Lafleur (S. P.):** In our State of Louisiana the highway commission has adopted a standard for the road crossings, and furnishes the ties, plank, metal covering-in fact, they furnish the entire crossing. All they expect us to do is to furnish the labor for surfacing the track, flagging, and so forth. The state forces put the crossing in.

Exactly as Mr. Davis explained to you a while ago, the highway commission puts an expansion joint in the concrete 30 to 50 feet from the crossing. They furnish us with 6 by 8 by 8-1/2-foot ties. That is something out of the ordinary, but since they furnish them to us and they answer the purpose, we are glad to get them. As a rule, before we allow them to put this crossing in, we dig out the track and get the best material, preferably crushed rock, and put this down with pipe drains on both sides of the crossing to take care of the rainfall. And we leave an expansion joint of three inches between the ends of the ties and the concrete pavement. This opening allows water to get in, but as long as we have drainage under the crossing we don't have any trouble.

We weld the rails to avoid joints. And if it becomes necessary to make repairs in the track, all we have to do is to call on the state highway department for assistance, and it provides the gangs and highway policemen for flag protection. They remove the crossing and give us a chance to make the necessary repairs and put it back in at their expense. (Laughter and applause.)

**President Howson:** The discussion this report has received bears testimony to the interest it has aroused. The association is indebted to Mr. Davis and his committee for this constructive report. We thank you. (Applause.)

(The session was adjourned at 4:45 p. m.)