

SECTION 1.5 RECOMMENDED PRACTICES FOR ROAD CROSSING FOUNDATIONS

1.5.1 GENERAL (2011)

The purpose of this section is to set forth recommendations, considerations and industry practices for the design and preparation of road crossing foundations and approaches. This includes new construction, re-construction, rehabilitation, replacement and/or maintenance. This section is strictly presented as a recommendation and not an all encompassing method as each railroad grade crossing site is unique.

1.5.2 DRAINAGE (2011)

1.5.2.1 Surface Profiles

The primary concern in the design of a durable road crossing foundation is to provide adequate drainage. Failure of a road crossing surface can generally be traced to presence of excess moisture in the foundation materials. As such it is necessary to determine the sources of water that may contribute to subgrade failure. Water may come from various sources. One source could be surface drainage from the roadway as shown in figures 1-5-1 through 1-5-4. Figure 1-5-4 would be least impacted by surface drainage from the roadway.

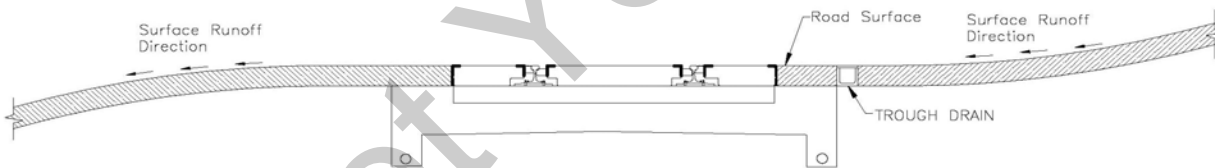


Figure 1-5-1. Roadway Surface Drainage Profile

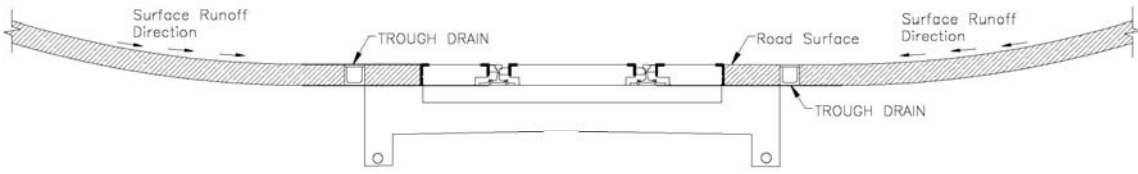


Figure 1-5-2. Roadway Surface Drainage Profile

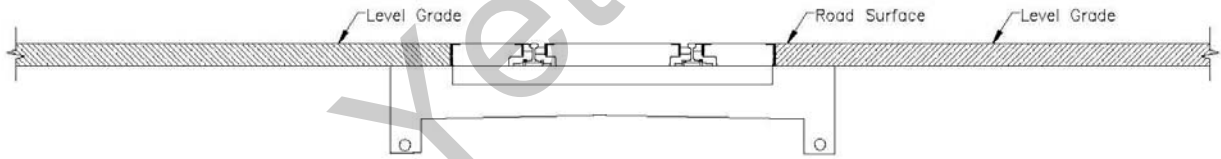
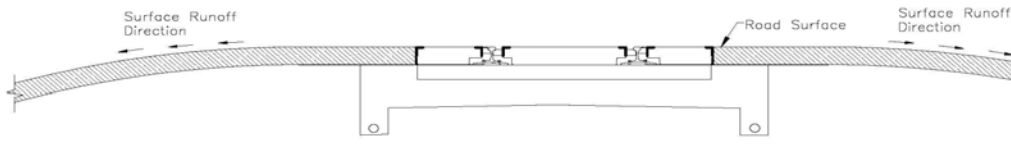


Figure 1-5-3. Roadway Surface Drainage Profile

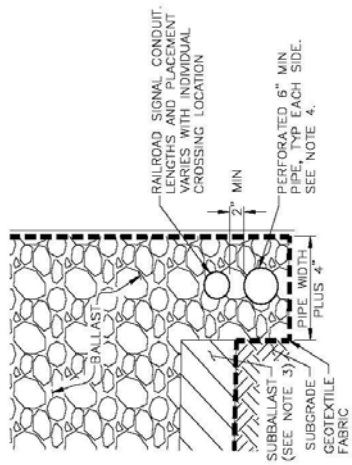
Not Yet Approved



Other contributing factors may include saturated subgrade, due to poor foundation material and/or a high groundwater table. Identifying and mitigating these issues are necessary to improve crossing stability.

1.5.2.2 Cross-Drains

- a. Subsurface drainage has generally been accomplished by placing perforated drain pipes parallel to the rails across the width of the road crossing within an excavated trench. When applying this method, care must be taken to insure perforations are adequate to allow the entrance of water without becoming plugged, and insure that bedding and backfill is properly compacted and placed. Refer to Chapter 1, Section 4.18, Perforated Pipe Drains, except as modified herein with respect to minimum pipe diameter and geotextile fabric placement. Recommended minimum pipe diameter is 6" (12" diameter pipe size or larger as presented in Section 4.18 is most desirable if room permits). Coiled plastic drain pipe is not acceptable for installation. Only those pipe materials as listed in Section 4.18 should be considered while giving consideration to loading imposed on the pipes as determined by the Engineer. Perforated drainage pipe structurally designed to accommodate loading conditions should be used. Potential examples of perforated crossing pipe installations might be but are not limited to 6"-16 gauge corrugated steel pipe, 6"-Schedule 80 PVC, 12"-Class V, B Wall Reinforced Concrete Pipe, etc. Perforated drainage pipes should be installed where outfall is permitted to provide positive drainage from track structure and subgrade. See Figures 1-5-5 and 1-5-6 for Recommended Pipe Underdrain Configurations.



DRAINAGE TRENCH DETAIL
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- NOTES:**
1. ALL ROADWAY PROFILE GRADES APPROACHING AND LEAVING THE CROSSING SHALL BE IN CONFORMANCE WITH THE MOST CURRENT ASHTO STANDARDS FOR THE GIVEN JURISDICTIONAL DESIGN SPEED. ROADWAY SURFACES SHALL NOT ALLOW STORM WATER TO DRAIN INTO THE TRACK.
 2. GEOTEXTILE FABRIC SHALL CONFORM TO AREMA CHAPTER 1, SECTION 10.2 GEOTEXTILE SPECIFICATIONS FOR RAILROAD DRAINAGE APPLICATIONS, FOR CLASS-A FABRIC.
 3. GEOTEXTILE FABRIC SHALL BE PLACED UNDER SUBBALLAST. IF SUBBALLAST IS USED IN CROSSING
 4. SEE SECTION 1.5.2.2 FOR PIPE SPECIFICS AND USE.

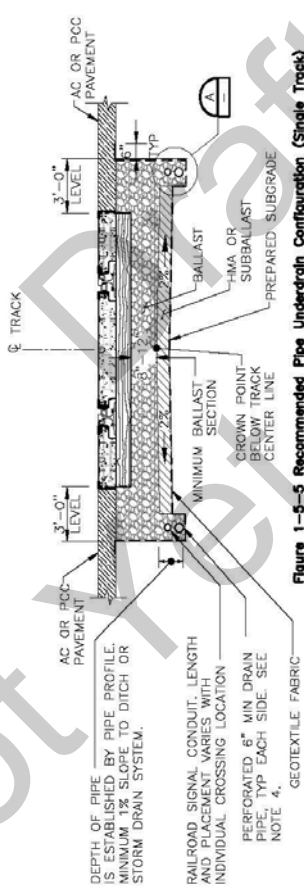


Figure 1-5-5 Recommended Pipe Underdrain Configuration (Single Track)

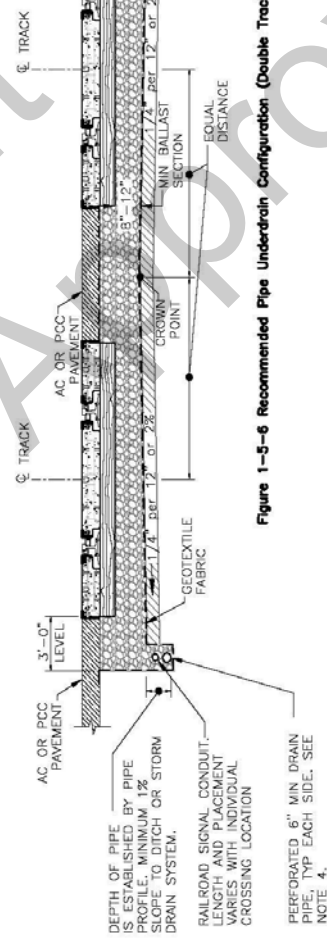


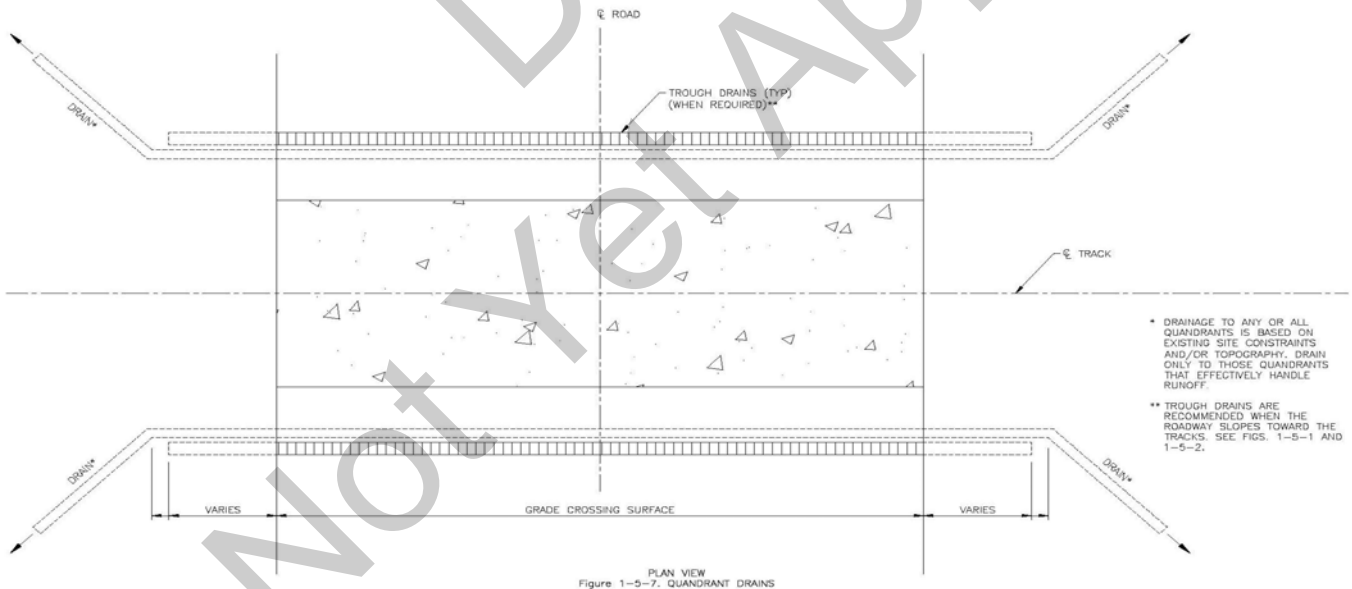
Figure 1-5-6 Recommended Pipe Underdrain Configuration (Double Track)

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- b. Backfill around the drainage pipes should consist of free-draining materials. It is recommended that the trench be lined with a non-woven geotextile fabric. Pipes should not be wrapped in fabric. Outlets for these drainage pipes should daylight in a location which will allow them to avoid damage, and remain clear and functional with low maintenance effort. Clean-outs for drainage pipes may be installed to facilitate maintenance.
- c. An alternative means of drainage is to construct a French Drain. French Drains, as described herein, use a coarse aggregate to facilitate drainage without the means of a pipe as presented above. The trench is excavated and lined with a geotextile fabric and backfilled with an open graded coarse aggregate or ballast. For specifics on geotextile fabrics and their recommended installation practices refer to Chapter 1, Part 10 of this manual. Upstream ends of pipes that do not provide outlets for drainage should be capped.

1.5.2.3 Quadrant Drains

Quadrant drains should be considered when the physical characteristics of the crossing permit. See Figure 1-5-7.



PLAN VIEW
Figure 1-5-7. QUADRANT DRAINS

- * DRAINAGE TO ANY OR ALL QUADRANTS IS BASED ON EXISTING SITE CONSTRAINTS AND/OR TOPOGRAPHY. DRAIN ONLY TO THOSE QUADRANTS THAT EFFECTIVELY HANDLE RUNOFF.
- ** TROUGH DRAINS ARE RECOMMENDED WHEN THE ROADWAY SLOPES TOWARD THE TRACKS. SEE FIGS. 1-5-1 AND 1-5-2.

1.5.2.4 Trough Drains

Pre-fabricated trough drains are installed in the road surface adjacent to and parallel to the road crossing. Trough drains will capture road surface drainage prior to it reaching the crossing surface. This method of drainage is suitable for surface drainage only and does not lessen the need for sub-drains. Trough drains may require approval of the local municipality, road district and/or sewer district.

1.5.2.5 Cross Road/Cross Track Culverts

The placement of this type of drainage is similar to the trough drain, i.e. adjacent to the crossing surface and placed beneath the roadway instead of at the surface. Use of a cross road culvert requires consideration of all other types of drainage. These include surface runoff from crowned roadway approaches, runoff from the crossing surface, and subsurface drainage relief at the end of the crossings.

Cross road and cross track culverts will capture both roadway drainage and track ditch drainage adjacent to the surface crossing and convey the water beneath the road or track. Cross road and cross track culverts shall be designed per Chapter 1, Part 4. Refer to Figure 1-5-7. Placement of cross road culverts should take into consideration possible installation of active grade crossing protection, thereby avoiding any interference during installation as necessary.

1.5.2.6 Identify Locations of Potential Drainage Release

An initial investigation of drainage facilities (existing, new or proposed), should include an on-site observation of drainage patterns and a survey of surrounding topographic features prior to any crossing work. Drainage improvements could and most likely will need to extend beyond the limits of the grade crossing. However, improvements must be made so as to not cause a negative effect or impact to existing drainage patterns (particularly with regard to roadways).

1.5.2.7 Surface Drainage

Daylighting of drainage installations discussed above may involve the release of stormwater in the quadrants of the crossing. The volume of water expected should be considered to determine if there is an adequate facility to accept this type of drainage. Surface drainage outside the limits of the roadway crossing must always slope away from the crossing so as not to trap water at the ends of the crossing and thereby contribute to the repeated failure of the track and roadway subgrade.

1.5.2.8 Sumps and Dry Wells

Sumps can be used for several purposes. If used to collect and detain runoff, sumps should be located a sufficient distance from the track and roadway grade crossing so as to reduce the likelihood of the sump area becoming a source of water to the subgrade soils. Moreover, the sump area must be designed to hold the anticipated volume of runoff as required by local stormwater management practices (i.e. design storm duration, intensity and frequency) and subsequently release of the detained/retained water at an appropriate rate. If used to lower the groundwater table, then the surrounding soil must have the capability to allow for infiltration without negative impact to the track foundation.

Note: holding water for an extended period of time is not the intent of a sump and a means of removal may be necessary.

1.5.2.9 Existing Storm Sewer Drainage

In some cases nearby storm drains or storm sewer structures may be accessible for discharge of collected runoff. However, capacity of the existing storm sewer system, distance from the roadway grade crossing and other possible utility issues need to be considered. Associated permits may be costly in time and money.

1.5.2.10 Coordination with Public Agencies

- a. It is advisable to coordinate with government agencies (road authorities, public works, drainage district etc.) as to extent of roadway modifications particularly concerning temporary road closures and drainage. One-call agencies and non-subscribing agencies should be contacted prior to construction for location of utilities.
- b. Dependent on governing municipality guidelines and/or regulations it may be necessary to obtain a discharge permit especially with regard to water quality.

1.5.3 DESIGN LOADS (2011)

To adequately design the roadway grade crossing foundation it is necessary to determine both roadway and railroad loads to be supported by the bearing soils. Once the most significant design load and an appropriate safety factor have been determined, the appropriate calculations can be performed to determine the necessary thickness and strength of foundation materials.

1.5.3.1 Subgrade

- a. Following the procedures recommended in Chapter 1, Section 1.1 Exploration and Testing, determine the properties of the existing soils in the area of the proposed crossing. If necessary, modification of the foundation soils can be accomplished by several means. Some of these methods are described in Chapter 1, Section 1.2 Design and Section 1.3 Construction.
- b. The subgrade surface should be crowned or sloped to cause water to gravity flow away from the track into the nearest roadway or railroad ditch or storm drainage system. Subgrade for crossing approaches may differ from that needed at the crossing itself, thus, for purposes of construction, the roadway subgrade should be defined as that which is railroad or AREMA defined and should include roadway and/or walkway approaches if within the limits of responsibility of the railroad.

1.5.3.2 Subballast

The gradation and quality of subballast should be designed in accordance with Chapter 1, Part 2 Ballast. The subballast thickness should be designed to withstand the crossing traffic loads and to match the cross section of the adjacent track roadbed. Additionally, like the subgrade, the subballast should be crowned or sloped to cause water to gravity flow away from the track into the nearest roadway or railroad ditch or storm drainage system.

1.5.3.2.1 Hot Mix Asphalt (HMA)

- a. Consideration may be given to using hot mix asphalt (HMA) as a subballast material if it meets the loading and design life needs of the crossing. Applying a layer of hot-mix asphalt, similar to that used as a base for roadway pavements, under the crossing surface and track performs the function of a base (for the track). At roadway crossings its primary function is to provide a strong impermeable base to support loadings and convey water away.¹
- b. Roadway crossings most suited for HMA base layer¹ use are those where one or more of the following conditions may exist:
 - Difficulty in maintaining a sufficiently strong and stable hardpan* when it is not feasible to remediate inadequate soil and drainage conditions.
 - Difficulty in establishing and maintaining proper surface and/or subsurface drainage.
 - Difficulty in controlling ground water.
 - Adequate amount of track closure time at the required crossing as required for installation of the HMA layer.
 - Difficulty in obtaining suitable subballast material at a reasonable cost.

1.5.3.3 New Construction

After appropriate design and recommendations from the geotechnical investigation additional considerations may include but are not limited to:

- Single or multiple track installation and where the crown of the subballast should be placed during the grading process to accommodate drainage and the type of track being constructed.
- The allowance of trains to temporarily operate over crossing, or use a ballast stabilizer (consolidator, compactor) after track is in place after tamping and before final dump of ballast to finish surface. This would be done to reduce settlement of roadbed/subgrade.

1.5.3.4 Replacement of Crossings

Excavation during replacement of crossings is an important factor during removal of the existing crossing and installation or re-installation of the crossing panels. The depth, in most cases, should be limited to adequate bearing soil or hardpan thereby minimizing disturbance. The subgrade should be leveled or dressed with suitable well-graded aggregate base to prevent ponding of water where applicable. In cases where an adequate bearing soil or hardpan does not exist, there are some practical means to alleviate

settlement and frequent re-work of the grade crossing. However, an investigation prior to the re-work would be ideal to substantiate any recommendations to alleviate the soft subgrade problem. Various methods which have proven to be successful in certain applications include:

- Removal of the soft subgrade and backfill with an engineered fill.
- The installation of a geogrid or a non-woven geotextile. Refer to Chapter 1, Section 10 for proper application.
- The scarifying of the subgrade and introducing lime, fly ash or cement as a drying and/or stabilizing agent.

Conditions may warrant application of one or more of these subgrade stabilization methods.

1.5.4 MAINTENANCE (2011)

Maintenance activities that do not include the removal of the track structure, but may include the removal and re-installation of the crossing surface, allow for improvements to drainage and/or subgrade stabilization activities such as:

- The horizontal directional boring of drains is a possibility, provided site characteristics allow for drainage from the pipe and the installation does not conflict with other on-site facilities.
- The cleanout of existing subdrains as long as access to these drains is permitted.
- Cribbing and shoulder cutting of fouled ballast

1.5.5 BALLAST (2011)

Ballast should be designed and installed in accordance with Chapter 1, Part 2 Ballast. The ballast thickness should be in a range of 8” to 12” and should be sufficient to support the track loads and at a minimum, should match the section of the adjacent track.

1.5.6 ROADWAY GEOMETRICS AND CROSSING SURFACE (2011)

For elements of the road crossing above the ballast reference should be made to *Chapter 5, Part 8 Highway – Railway Crossings*.

¹Reference article from Dr. Jerry Rose, PE as published in “Better Roads”, May 1998

* Hard dense layer highly impermeable to water.