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## Chapter Twenty-one

# HIGHWAY BRIDGES OVER RAILROADS

### 21.1 PROCEDURES

#### 21.1.1 Utilities Section

The MDT Utilities Section within the Right-of-Way Bureau is responsible for coordinating with the railroad companies where MDT projects impact railroads. The Utilities Section's responsibilities include:

1. obtaining cost estimates for securing agreements with railroad companies for the relocation and adjustment of their facilities as required for highway construction; and
2. conducting direct negotiations with railroad companies, when necessary, to secure temporary access or to acquire portions of their operating rights-of-way for highway purposes.

#### 21.1.2 Project Development

Because of the unique nature of highway-railroad grade separations, special coordination must occur when a railroad alignment and a road alignment intersect. A preliminary layout is developed giving consideration to the minimum horizontal and vertical clearances in this Chapter. The Bridge Area Engineer and Utilities Section will schedule an on-site meeting at the bridge site with the impacted railroad companies. The Bridge Area Engineer will submit the preliminary bridge layout to the Utilities Section for submission to the railroad company before this meeting. The on-site meeting should evaluate railroad considerations, which include:

1. construction of future tracks;
2. off-track maintenance roadways;

3. longitudinal drainage requirements, from both the railroad's perspective and the MDT's perspective;
4. heavy snow areas; and
5. bent locations.

See Chapter Two of the **MDT Structures Manual** for a discussion on how the coordination with railroad companies is incorporated into the project development process for a bridge project.

## 21.2 DESIGN CRITERIA

### 21.2.1 General

Highway bridges constructed over railroads must be designed to be consistent with the geometric requirements of railroads. This includes criteria for lateral clearances, vertical clearances and railroad structure width. These criteria are based on:

1. the Federal Highway Administration participation limits for railroad geometrics;
2. the requirements of the State of Montana;
3. the specifications of the American Railroad Engineering and Maintenance-of-Way Association (AREMA); and
4. the criteria established by individual railroad companies.

The following railroad companies operate in the State of Montana:

1. Union Pacific (UP);
2. Burlington Northern and Santa Fe (BNSF);
3. Montana Rail Link (MRL);
4. Central Montana Rail, Inc. (CMR);
5. Montana Western Rail; and
6. RARUS.

### 21.2.2 Basic Geometric Configuration

The basic geometric configuration of the railroad cross section passing under a highway bridge is primarily based on the following factors:

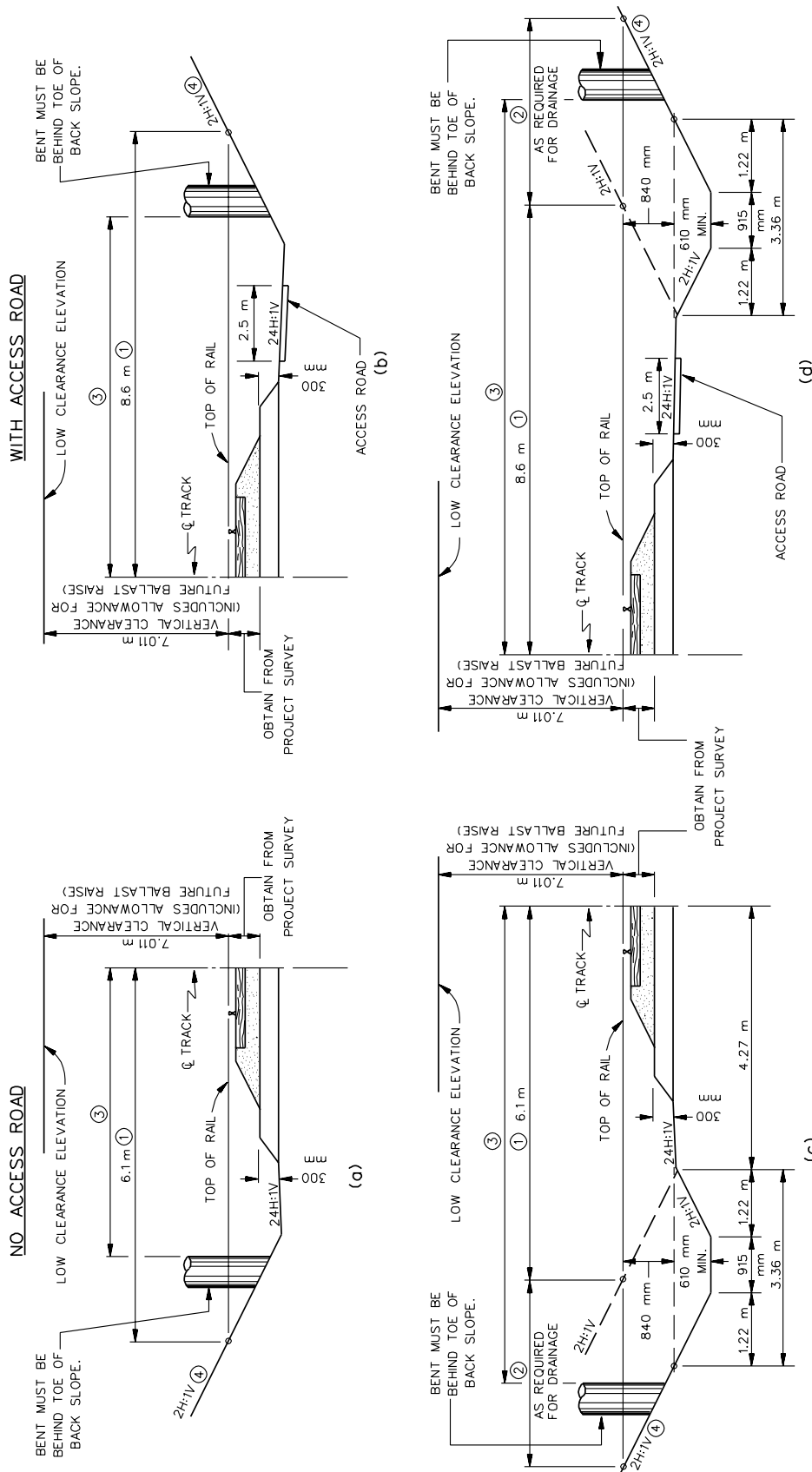
1. Type of Rail Line. This may be either a mainline or an industrial/branch line.
2. Number and Type of Tracks. Multiple sets of railroad tracks obviously require a longer bridge.

3. Drainage Treatments. The railroad typical section may or may not include a parallel drainage ditch.
4. Access Road. The railroad typical section may or may not include parallel off-track equipment/maintenance roads for access.
5. Specific Requirements of Individual Railroad Companies. The different companies have varying requirements for subgrade width and ballast thickness.
6. Backslope. This will be 2H:1V maximum unless it is specifically engineered for stability at a steeper slope and slope protection is provided.

Figures 21.2A and 21.2B present the basic railroad cross sections based on these variables. Sections 21.2.3 and 21.2.4 present additional information which must be considered. Meeting the clearance requirements in Figures 21.2A and 21.2B typically determines the length and cost of the highway structure.

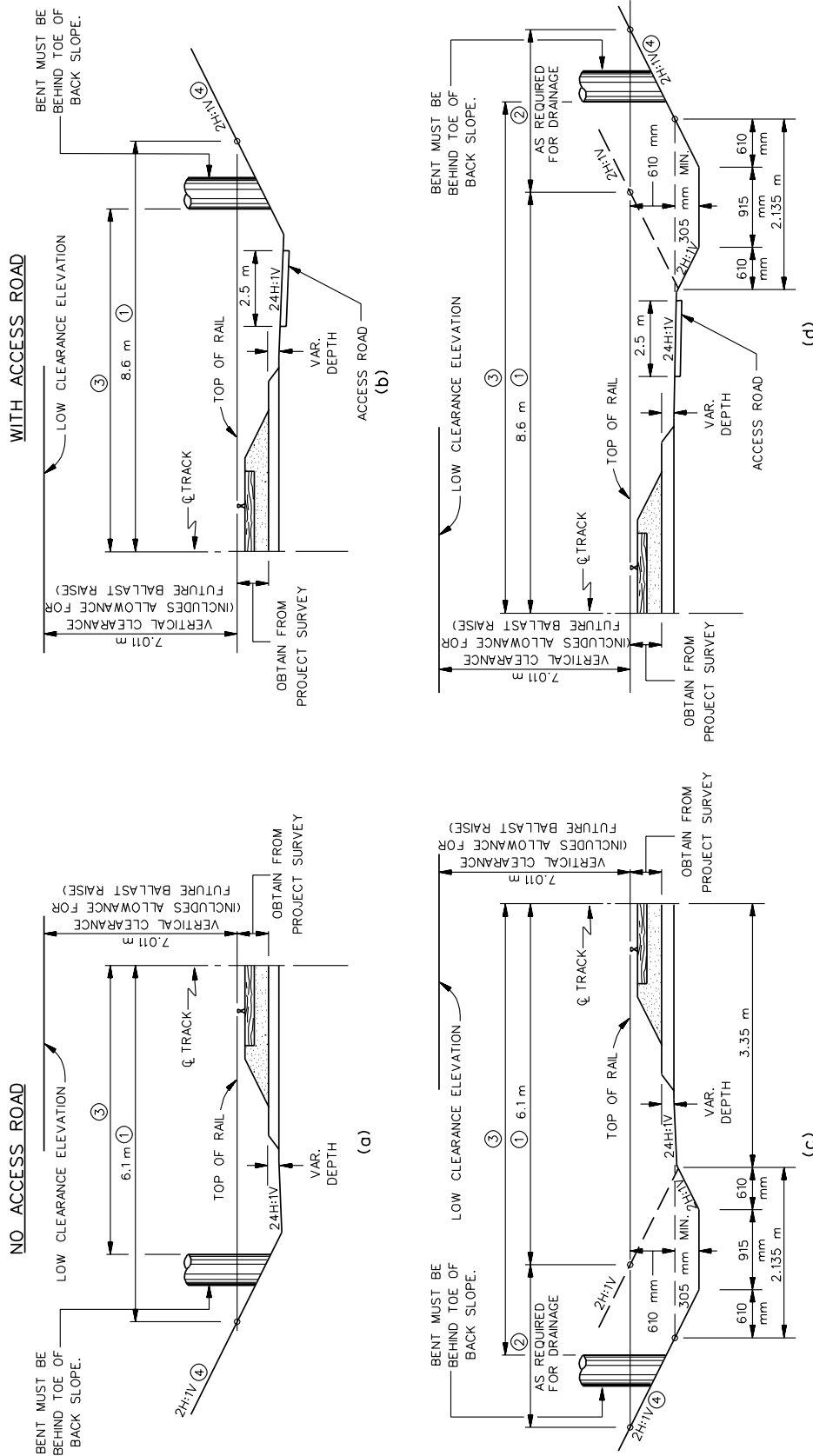
### 21.2.3 Montana/AREMA Recommendations

The Montana Public Service Commission (PSC) promulgates regulations for railroad companies operating in the State of Montana. In addition, the American Railroad Engineering and Maintenance-of-Way Association (AREMA) publishes the **AREMA Manual**, which provides design standards for railroads. This Section presents those PSC and AREMA regulations, specifications and recommendations that apply to the railroad cross section under a highway bridge.



- ① To exceed 6.1 m (without access road) or 8.6 m (with access road), the need for heavy snow areas and/or longitudinal drainage along the track must be documented.
- ② An on-site meeting with railroad owners/operators will be scheduled soon after receipt of survey to discuss drainage needs.
- ③ Face of bents will be a minimum of 7.7 m from the centerline of a mainline track. Bents less than 7.7 m from the centerline of a railroad track shall be of heavy construction or shall be protected by a reinforced concrete crashwall. See Section 21.2.3.4. At multiple track installations, at railroad yards or where an overpass is being rehabilitated or widened, the horizontal clearances will be determined at the initial meeting with the railroad involved.
- ④ Slope to fit soil type but not steeper than a 2H:1V backslope, unless a reinforced embankment is designed. See Section 21.2.3.5.

**RAILROAD CLEARANCES (Mainline)**  
**Figure 21.2A**



- ① To exceed 6.1 m (without access road) or 8.6 m (with access road), the need for heavy snow areas and/or longitudinal drainage along the track must be documented.
- ② An on-site meeting with railroad owners/operators will be scheduled soon after receipt of survey to discuss drainage needs.
- ③ Face of bents will be a minimum of 7.7 m from the centerline of a mainline track. Bents less than 7.7 m from the centerline of a railroad track shall be of heavy construction or shall be protected by a reinforced concrete crashwall. See Section 21.2.3.4. At multiple track installations, at railroad yards or where an overpass is being rehabilitated or widened, the horizontal clearances will be determined at the initial meeting with the railroad involved.
- ④ Slope to fit soil type but not steeper than a 2H:1V backslope, unless a reinforced embankment is designed. See Section 21.2.3.5.

**RAILROAD CLEARANCES (Industrial/Branch Line)**  
**Figure 21.2B**

### 21.2.3.1 Regulatory Template for Tangent Sections of Track

Figure 21.2C represents a compilation of information from several sources and is the template of the general outline for tangent track as defined by PSC regulations. This must be considered an inviolable railroad template for permanent construction, although at least one RR (UPRR) indicates that it is willing to negotiate a reduced vertical clearance of 6.4 m during construction.

### 21.2.3.2 Horizontal Curves

The clearances shown in Figures 21.2A and 21.2B are for tangent track. On curved track, the lateral clearances on each side of the track centerline shall be increased 38.1 mm per degree of curvature on the railroad alignment. When the fixed obstruction is on tangent track but the track is curved within 24.384 m of the obstruction, the lateral clearances on each side of track centerline shall be increased as shown in Figure 21.2D.

On superelevated track, the track centerline remains perpendicular to a plane across the top of rails. The superelevation of the outer rail shall be in accordance with the recommended practice of AREMA.

Distance from Obstruction to Curved Track (m)	Increase Per Degree of Curvature (mm)
6.096	38.100
12.192	28.575
18.288	19.050
24.384	9.525

**Note:** To convert degree of curvature ( $D$ ) to radius of curve ( $R$ , in meters),  $R = 1746.8/D$ .

### LATERAL CLEARANCE INCREASE FOR FIXED OBSTRUCTION

Figure 21.2D

### 21.2.3.3 Track Centers

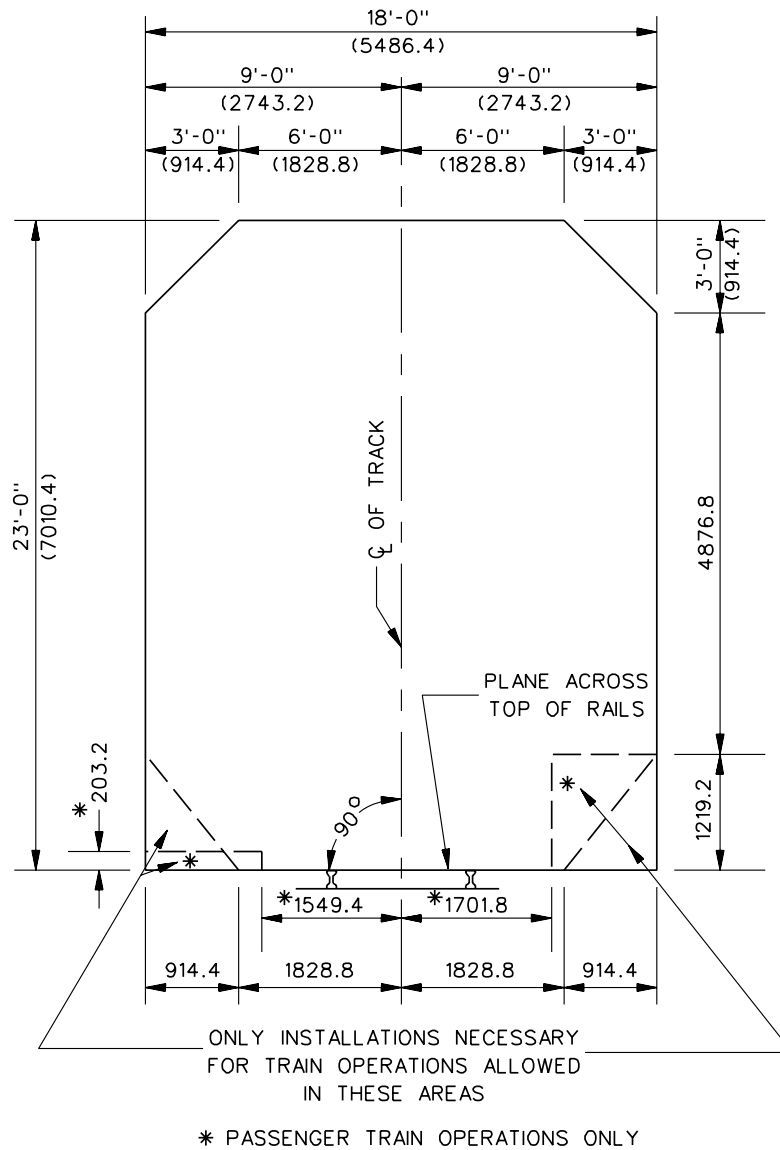
The following applies to the width of track centers:

1. Mainline Track. According to the PSC, the minimum distance between track centers is 4.27 m with minor exceptions. Individual railroad companies may have different requirements. These requirements, and any plans the railroad companies may have for future additional tracks, must be discussed at the on-site meeting with the railroad.
2. Parallel Team, House or Industry Track. The minimum distance between track and centers shall be 3.96 m.
3. Ladder Tracks. Ladder tracks shall be at least 6.1-m centers from any other parallel track.

### 21.2.3.4 Pier Protection

To limit damage by the redirection and deflection of railroad equipment, piers supporting bridges over railways and with a clear distance of less than 7.7 m from the centerline of a railroad track shall be of heavy construction (defined below) or shall be protected by a reinforced concrete crash wall. Crash walls for piers from 3.66 m to 7.7 m clear from the centerline of track shall have a minimum height of 1.85 m above the top of rail. Piers less than 3.66 m clear from the centerline of track shall have a minimum crash wall height of 3.66 m above the top of rail. The following also applies:

1. The crash wall shall be at least 770 mm thick and at least 3.66 m long. When two or more columns compose a pier, the crash wall shall connect the columns and extend at least 305 mm beyond the outermost columns parallel to the track. The crash wall shall be anchored to the footings and column, if applicable, with adequate reinforcing steel and shall extend to at least 1.22 m below the lowest surrounding grade.



NOTE: METRIC DIMENSIONS  
IN mm.

**REGULATORY TEMPLATE FOR TANGENT TRACK**

**Figure 21.2C**

2. Consideration may be given to providing protection for bridge piers over 7.7 m from the centerline track as conditions warrant. In making this determination, consider such factors as horizontal and vertical alignment of the track, embankment height and an assessment of the consequences of serious damage in case of a collision.

#### **21.2.3.5 Side Slopes**

When slopes steeper than 2H:1V are proposed, some method of preventing the slopes from eroding must be provided. Methods could include slope protection with concrete or asphalt or a very wide drainage ditch. Seeding and attempting to develop cover vegetation are not effective techniques for preventing erosion of slopes steeper than 2H:1V.

#### **21.2.3.6 Existing Tracks**

Clearances for reconstruction work or for alteration of existing tracks are dependent on existing physical conditions and, where reasonably possible, should be improved to meet the requirements for new construction.

#### **21.2.4 Railroad Company Design Criteria**

Each railroad company operating within the State of Montana requests or requires that MDT comply with its design criteria for highway bridges over railroads. These may apply to restrictions during construction, fencing, drainage, erosion control, etc. The bridge designer must ensure that the Department coordinates early with the railroad companies, through the MDT Utilities Section, to identify these site-specific design criteria.

#### **21.2.5 FHWA Participation**

The Appendix to Subpart B of 23 CFR 646 presents the limits of FHWA participation for the costs of highway bridges over railroads. For

convenience, this Section reproduces those portions of the Appendix which are applicable in Montana.

The following implements provisions of 23 CFR 646.212(a)(3).

#### **21.2.5.1 Lateral Geometrics**

A cross section with a horizontal distance of 6.1 meters, measured at right angles from the centerline of track at the top of rails, to the face of the embankment slope, may be approved. The 6.1-m distance may be increased at individual structure locations as appropriate to provide for drainage if justified by a hydraulic analysis or to allow adequate room to accommodate special conditions, such as where heavy and drifting snow is a problem. The railroad must demonstrate that this is its normal practice to address these special conditions in the manner proposed. Additionally, this distance may also be increased up to 2.5 meters as may be necessary for off-track maintenance equipment, provided adequate horizontal clearance is not available in adjacent spans and where justified by the presence of an existing maintenance road or by evidence of future need for such equipment. All piers should be placed at least 2.8 meters horizontally from the centerline of the track and preferably beyond the drainage ditch. For multiple track facilities, all dimensions apply to the centerline of the outside track.

Any increase above the 6.1-m horizontal clearance distance must be required by specific site conditions and be justified by the railroad to the satisfaction of the MDT (SHA) and the FHWA.

#### **21.2.5.2 Vertical Clearance**

A vertical clearance of 7.1 m above the top of rails, which includes an allowance for future ballasting of the railroad tracks, may be approved. Vertical clearance greater than 7.1 m may be approved when the State regulatory



agency having jurisdiction over such matters requires a vertical clearance in excess of 7.1 m or on a site-by-site basis where justified by the railroad to the satisfaction of the MDT and the FHWA. A railroad's justification for increased vertical clearance should be based on an analysis of engineering, operational and/or economic conditions at a specific structure location.

make certain that they outflow to the drainage ditches.

### **21.2.6 Pedestrian Fencing**

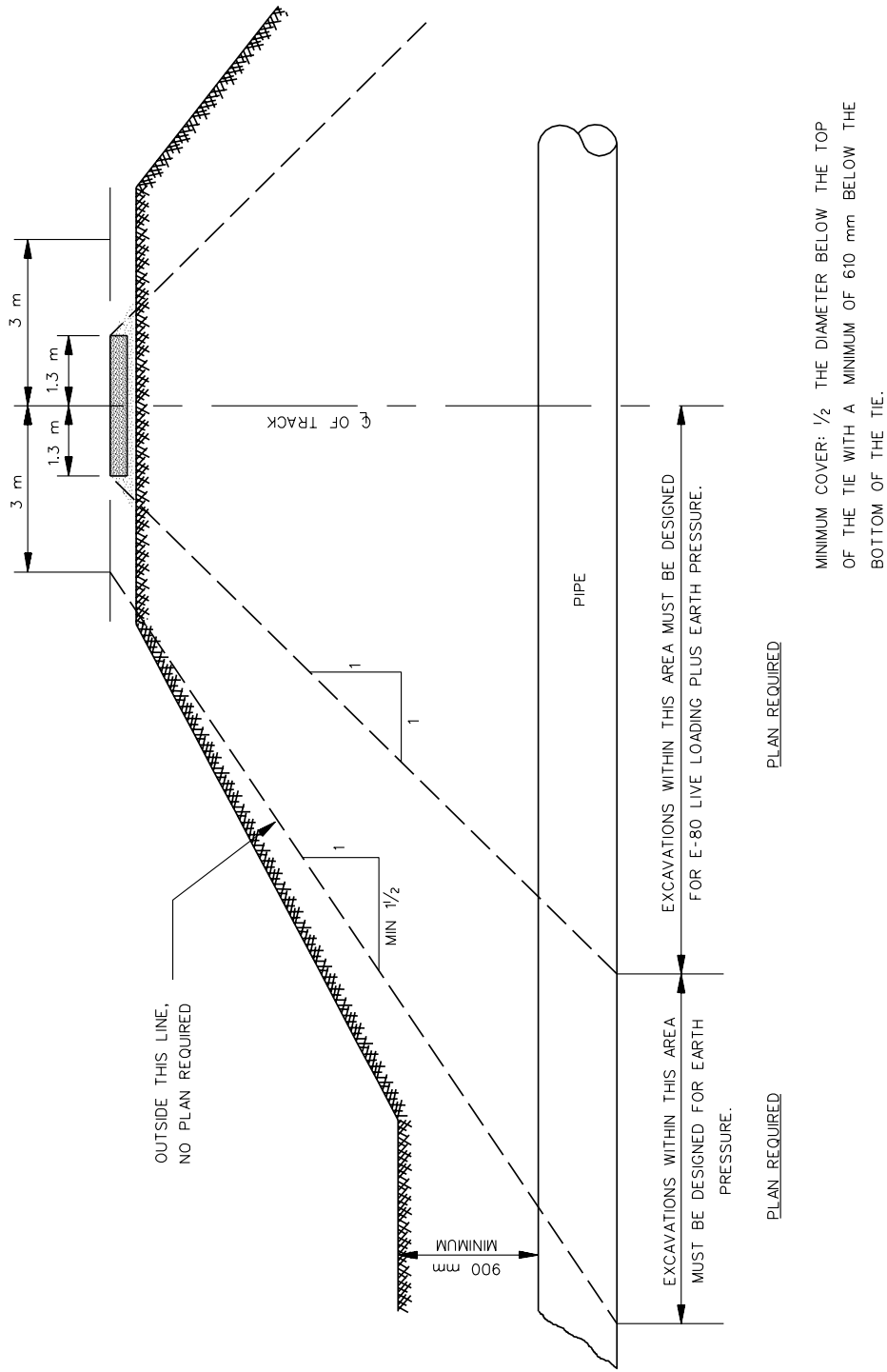
On bridges with sidewalks, designers must provide a means of protecting railroad facilities and the safety of railroad employees below from objects being thrown from above by pedestrians or passing motorists. Provide a 2.7-m high curved guard fence at least 8 m beyond the centerline of the outermost track or access road.

### **21.2.7 Shoring for Construction Excavations**

Railroad companies will not allow any excavation that will cause settlement or warpage of their tracks. Each railroad company has a template adjacent to and below their tracks that limits excavations that may be made without shoring plans. Shoring plans must be an engineering submittal to the railroad for approval. The designer should make reasonable efforts to lay out the structure so that shored excavations are not needed for foundation construction. Figures 21.2E and 21.2F provide examples of the shoring templates for MRL and UPRR.

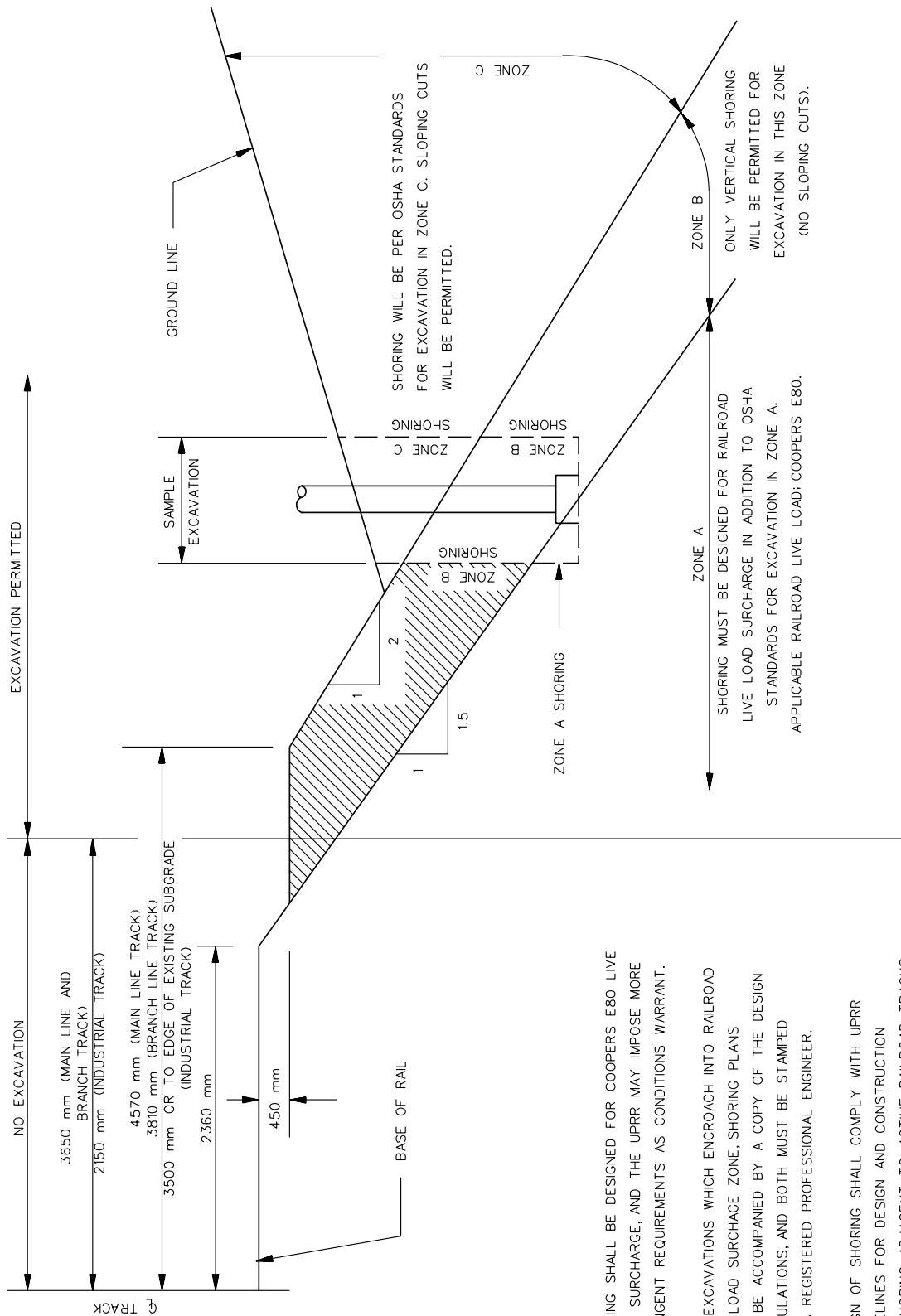
### **21.2.8 Control of Drainage from Highway Bridge Deck**

Railroad companies are quite sensitive to water that may come from the highway bridge onto their tracks or ballast. Drains are not permitted that would discharge water onto the track or access road areas at any time. Concrete splash blocks or aggregate ditch linings will be required at the discharge area of downspouts. Locate downspouts behind the face of the piers and



**SHORING TEMPLATE  
(MRL)**

**Figure 21.2E**



SHORING SHALL BE DESIGNED FOR COOPERS E80 LIVE LOAD SURCHARGE, AND THE UPRR MAY IMPOSE MORE STRINGENT REQUIREMENTS AS CONDITIONS WARRANT.

FOR EXCAVATIONS WHICH ENCRUCH INTO RAILROAD LIVE LOAD SURCHARGE ZONE, SHORING PLANS WILL BE ACCOMPANIED BY A COPY OF THE DESIGN CALCULATIONS, AND BOTH MUST BE STAMPED BY A REGISTERED PROFESSIONAL ENGINEER.

DESIGN OF SHORING SHALL COMPLY WITH UPRR GUIDELINES FOR DESIGN AND CONSTRUCTION OF SHORING ADJACENT TO ACTIVE RAILROAD TRACKS.

**SHORING TEMPLATE (UPRR)**

**Figure 21.2F**