5.8.1 Railings

Since National Cooperative Highway Research Program (NCHRP) Report 350 was published in 1993, traffic railings have been rated according to the crash test standards contained in the report. The AASHTO LRFD provisions for railings follow the report. The Bureau has designed the deck overhang on standard sheets according to the AASHTO LRFD Specifications.

Because traffic railings are attached to the bridge deck, the designer also should consult the decks article in this manual [BDM 5.2]. The intent of the traffic railing and supporting deck design is to make the deck stronger than the railing so that a crash-related railing failure will not propagate into the superstructure [BDM 5.2.2.4]. Designers should also generally be aware of the zone of intrusion requirements as given in BDM 3.14.

Bureau policies for pedestrian railings, bicycle railings, separation railings, and aesthetic railings currently are under discussion. As needed, contact the Methods Engineer for policies to be applied to specific projects.

5.8.1.1 General

5.8.1.1.1 Policy overview [AASHTO-LRFD 13.7.2]

Most new Iowa highway bridges are designed only for vehicular traffic and make use of the F-shape barrier rails detailed on standard sheets developed by the Bureau. The 34-inch tall and 44-inch tall Iowa standard F-shape barrier rails meet National Cooperative Highway Research Program (NCHRP) Report 350 Test Level 4 (TL-4) and Test Level 5 (TL-5) criteria, respectively. Note that the Iowa standard F-shape barrier rails are 2 inches taller than the minimum heights required for TL-4 and TL-5 barrier rails in order to account for the possibility of a 2 inch thick future overlay. Although in the past TL-4 has been considered adequate for most Iowa highways, the Highway Division Management Team recently adopted a more conservative policy that requires TL-5 rails for all mainline interstate bridges and for primary highway bridges with certain conditions. The designer will need to check all primary highway bridges with respect to the new policy.
All barrier rail to bridge deck/wing reinforcement for interstate and primary bridges shall be stainless steel. All other barrier rail and median barrier reinforcing steel, longitudinal and transverse, shall be epoxy coated.

General requirements for rural and urban areas regarding the size and number of conduits placed in rails are listed under the figures of each rail type in the articles below. For a fuller discussion of conduit and lighting requirements see BDM C5.8.1.1.1.

Bureau standard sheets detail two types of F-shape end sections and F-shape standard sections for all typical conditions. The first vertical end post section type is for high-speed highways that require connections for thrie beam guardrail beyond the bridge. The second, rounded end section type is for low-speed highways in urban areas where no guardrail connection is necessary. In cases where the railing has a maximum expansion joint opening 4 inches or greater the designer will need to provide steel cover plates [BDM 5.8.1.2.6].

The standard F-shape barrier rails are tall enough that they restrict sight distance for motorists in some vehicles, and in some highway situations an open railing may be advisable. When selecting railings the Bureau also considers splash protection during snow plowing for railways and roadways underneath a bridge.

In urban areas a bridge often will include a sidewalk or shared-use trail along one or both edges of the roadway. Standard sheets developed by the Bureau provide for a sidewalk and separation barrier along the edge of a roadway. For a trail the separation barrier is a combination railing constructed with a concrete lower section to which a steel railing is attached on the trail side. At the outer edge of the bridge a chain link fence is provided for protection of pedestrians. For these situations consult the Methods Engineer for the latest policies because the policies in subsequent articles may change before the next manual update.

For bridges given special aesthetic treatment, railings usually will be redesigned to meet the aesthetic theme. Because traffic railings typically will need to meet Test Level 4 (TL-4) or 5 (TL-5), but crash testing is not economically feasible, the designer will need to consider existing crash tested railings. The designer should consult the Federal Highway Administration (FHWA) NCHRP Report 350 Hardware website that contains a listing of crash-tested railings so as to select a design that meets the test level criterion [BDM 5.8.1.1.5]. The design guidelines in NCHRP Report 554 provide the designer with additional aesthetic alternatives for safety shape concrete barriers [BDM 5.8.1.1.5]. The designer may also choose to contact the Methods Unit in the Design Bureau, as well as other states for details on crash-tested railings.

The Bureau upgrades existing traffic railings or barrier rails during repair projects. Requirements for rail retrofits are given in the bridge repair article of this manual [BDM 12.1.9.2.2].

For staged construction the Bureau usually is responsible for layout of temporary barrier rail (TBR) on the bridge deck. Information on the use of TBR is given in this railings article and also in the bridge repair article [BDM 5.8.1.3, 9.1.8.3].

5.8.1.1.2 Design information

If a bridge project requires traffic railings crash tested above Test Level 4 or 5 (TL-4 or TL-5) or if attachment of guardrail is unusual, the Methods Unit in the Design Bureau will provide the designer with appropriate information. The designer should consult with the Design Bureau as needed.

5.8.1.1.3 Definitions

F-shape is the safety shape typically used by the Bureau for traffic railings. Although it is similar to a New Jersey shape, the F-shape reduces vehicular climbing.
Primary Highway System: "Primary roads" or "primary road system" means those roads and streets both inside and outside the boundaries of municipalities which are under department (defined as state department of transportation) jurisdiction [Iowa Code 306.3.6].

5.8.1.1.4 Abbreviations and notation [AASHTO-LRFD 13.7.2]
CCS, continuous concrete slab
CWPG, continuous welded plate girder
FHWA, Federal Highway Administration
NCHRP, National Cooperative Highway Research Program
NHS, National Highway System
PPCB, pretensioned prestressed concrete beam
RSB, rolled steel beam
TBR, temporary barrier rail
TL-3, TL-4, TL-5, TL-6, test levels for traffic railings, as defined in NCHRP Report 350 [AASHTO-LRFD 13.7.2]

5.8.1.1.5 References


5.8.1.2 Permanent railings

5.8.1.2.1 Traffic railings [AASHTO-LRFD 13.7.2]

The Highway Division Management Team recently approved a new policy for determining Test Levels (TL) and the associated heights for railings on interstate and primary road bridges. The policy is intended to be a supplement to the current AASHTO LRFD Specifications [AASHTO-LRFD 13.7.2].

The new policy states the following:
- The need for a TL-6, minimum height 92 inches railing is not anticipated for the vast majority of bridges in Iowa.
- All new interstate mainline bridges shall require a TL-5 railing, minimum height 44 inches, 42 inches plus 2 inches for future overlay.
- Bridge railing test level and the associated height for other primary highways shall be evaluated by the Pre-Design Unit in the Design Bureau for replacement structures and the Preliminary Bridge Design Unit in the Bridges and Structures Bureau for other bridges. Basically the evaluation will follow the flow chart in Figure 5.8.1.2.1 and additional information in the policy statement.
Flow Chart for determining Bridge Barrier Rail Height for New Bridges on Interstate and Primary Highways
Revised 5 December 2016

Interstate Bridge
No

Bridge over BNSF or UP RR
No

Coordinate with Systems Planning

Heavy Truck Volume > 7,500 Annual Average Daily Truck Traffic for Design Year
No

Fracture Critical Elements within the zone of intrusion for truck roll
No

Coordinate with Design

Fly over Bridge
No

Unfavorable site conditions - see guidelines below
No

Coordinate with Design

Frequent Transitions between Mainline roadway 44" Rail and Bridge Rail
No

Coordinate with Assistant District Engineer

Based on past maintenance experience and current snow removal policies Is snow pile up a concern?
No

Coordinate with Assistant District Engineer

Have special concerns been raised about headlight glare or ramping due to snow pile up?
No

Coordinate with Assistant District Engineer

Is plowed snow spilling over roadways, Railroad track or waterways below, a concern?
No

Design for TL-4 Barrier Rail (34")

Design for TL-5 Barrier Rail (44")

Figure 5.8.1.2.1. Flow chart for determining bridge barrier rail height on interstate and primary highways
Guidelines for unfavorable site conditions (refer to Figure 5.8.1.2.1):
- Reduced radius of curvature
- Steep down-grades on curvature
- Variable cross slopes
- Adverse weather conditions

This policy is applicable to new bridges and bridge replacements as well as to widening and repair projects that affect the existing railing. Questions regarding the policy should be directed to the Chief Structural Engineer.

5.8.1.2.1.1 F-shape [AASHTO-LRFD 13.7.3.2]

For typical bridges that carry only vehicular traffic, the Bureau provides F-shape TL-4 or TL-5 barrier rails along the edges of the roadway. The Bureau standard rail heights of 34 and 44 inches provide TL-4 and TL-5 crash ratings, respectively [AASHTO-LRFD 13.7.3.2] and allow for a future 2-inch bridge deck overlay. Standard sheets give details for the typical F-shape barrier rails as summarized in Table 5.8.1.2.1.1. In most cases the complete rail design for a set of bridge plans requires both an end section sheet and a standard section sheet.

<table>
<thead>
<tr>
<th>Test Level</th>
<th>Abutment Type</th>
<th>Skew</th>
<th>Additional Information</th>
<th>End or Standard Rail Section</th>
<th>Standard Sheet Number (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TL-4</td>
<td>---</td>
<td>---</td>
<td>7'-0 wing</td>
<td>End</td>
<td>1017, 1017S</td>
</tr>
<tr>
<td>TL-4</td>
<td>Integral</td>
<td>---</td>
<td>---</td>
<td>Standard</td>
<td>1020A, 1020SA</td>
</tr>
<tr>
<td>TL-4</td>
<td>Integral</td>
<td>---</td>
<td>Wing extension</td>
<td>Standard</td>
<td>1020C, 1020SC</td>
</tr>
<tr>
<td>TL-4</td>
<td>Integral</td>
<td>---</td>
<td>Urban approach slab with curb</td>
<td>End, standard</td>
<td>1019A, 1019SA (2)</td>
</tr>
<tr>
<td>TL-4</td>
<td>Stub</td>
<td>No skew</td>
<td>Wing extension</td>
<td>Standard</td>
<td>1020B, 1020SB</td>
</tr>
<tr>
<td>TL-4</td>
<td>Stub</td>
<td>Skew</td>
<td>Wing extension</td>
<td>Standard</td>
<td>1018, 1018A, 1018S, 1018SA</td>
</tr>
<tr>
<td>TL-4</td>
<td>Stub</td>
<td>No skew</td>
<td>Urban approach slab with curb</td>
<td>End, standard</td>
<td>1019B, 1019SB1, 1019SB2 (2)</td>
</tr>
<tr>
<td>TL-5 (3)</td>
<td>Integral</td>
<td>---</td>
<td>---</td>
<td>Standard</td>
<td>1020D, 1020SD</td>
</tr>
<tr>
<td>TL-5 (3)</td>
<td>Integral</td>
<td>---</td>
<td>Wing extension</td>
<td>Standard</td>
<td>1020F, 1020SF</td>
</tr>
<tr>
<td>TL-5 (3)</td>
<td>Stub</td>
<td>No skew</td>
<td>Wing extension</td>
<td>Standard</td>
<td>1020E, 1020SE</td>
</tr>
<tr>
<td>TL-5 (3)</td>
<td>Stub</td>
<td>Skew</td>
<td>Wing extension</td>
<td>Standard</td>
<td>1018C, 1018D, 1018SC1, 1018SC2, 1018SD1, 1018SD2</td>
</tr>
</tbody>
</table>

Table notes:
(1) Signed standard bridge plans for CCS and RSB bridges also include details for standard F-shape barrier rails.
(2) This standard sheet currently is under review.
(3) See Figure 5.8.1.2.1.1 for a TL-5 F-shape cross section, which matches the F-shape median barrier used by the Design Bureau [DB SS RE-44A].
(4) A designation of “S” in the standard sheet number indicates the use of stainless steel for the barrier rail to bridge deck/wing reinforcement.
The TL-4 and TL-5 F-shape barrier rails on the standard sheets are adequate for most National Highway System (NHS) and non-NHS highways in Iowa but, in rare cases where a TL-6 rating is required, the designer will need to specially design the rail.

**Figure notes:**
- In rural interchange bridges one 2-inch conduit is placed in one of the two bridge rails; a second conduit is added if needed. No conduit is placed in other rural bridges.
- In urban bridges conduit is placed in both bridge rails.
- No more than two conduits may be placed in one rail, and the maximum conduit sizes are two 2-inch or one 2-inch and one 3-inch.

**Figure 5.8.1.2.1.1. Tall F-shape barrier rail rated TL-5**

In most cases TL-4 barrier rails will provide adequate snow plowing splash protection for roadways below the bridge. If BNSF or Union Pacific Railroad tracks are below the bridge, however, Bureau policy is to provide the TL-5 barrier rail as splashboard protection.

In cases where the bridge is near an intersection, sight distance may not be adequate, especially if the barrier rail is taller than the TL-4 rail. The designer should consult with the Design Bureau if barrier rails may restrict sight distance near intersections.

In some situations it may seem desirable to mount a sign support, light pole, or other structure on top of a barrier rail. However, because a vehicle may intrude above and beyond the front face of an F-shape barrier, it is preferable to place structures behind the rail. *Guidelines for Attachments to Bridge Rails and Median Barriers, Final Report* [BDM 5.8.1.1.5] gives recommendations for intrusion zones based on speed and traffic volume. If it is unreasonable to place structures outside the intrusion zone because of space or cost limitations the designer shall consult with the Design Bureau.

In cases where the railing has a maximum expansion joint opening 4 inches or greater the designer will need to provide steel cover plates [BDM 5.8.1.2.6].
5.8.1.2.1.2 Open
If safety considerations require use of a TL-4 open railing the Bureau recommends use of the railing detailed in Figure 5.8.1.2.1.2.

Figure note:
- No more than two conduits may be placed in one rail, and the maximum conduit sizes are two 2-inch or one 2-inch and one 3-inch.

Figure 5.8.1.2.1.2. Open railing rated TL-4

An open railing should be used only with permission of the supervising Unit Leader.

5.8.1.2.1.3 Retrofit
The Bureau has had the policy of upgrading existing traffic railings or barrier rails to TL-4 as a part of repair, overlay, or paving projects. However, under new policy [BDM 5.8.1.2.1] for deck replacement and widening projects, TL-5 rails may be required for some conditions. The requirements for retrofit barrier rails are covered in the bridge repair article of this manual [BDM 12.1.9.2.2].

5.8.1.2.2 Pedestrian railings [AASHTO-LRFD 13.8]
The Bureau policy below for pedestrian railings currently is under discussion. As needed, contact the Methods Engineer for the policy to be applied to a specific project.

Where a sidewalk is provided on a bridge, the outer edge of the sidewalk shall be protected with a pedestrian railing. The minimum height of the railing shall be 42 inches above the sidewalk surface [AASHTO-LRFD 13.8.1]. Horizontal or vertical parts of the railing shall be spaced closely enough so that a 6-inch sphere will not pass through the lower 27-inch portion and an 8-inch sphere will not pass through the horizontal band 27 to 42 inches above the sidewalk.
The pass-through requirements above do not apply to chain link or metal fabric fence supports. Chain link or metal fabric fence shall have openings no larger than 2 inches. It sometimes is appropriate to consider the use of smaller chain link mesh openings to discourage climbing of the fence or pushing of objects through the mesh. Smaller mesh openings may be especially appropriate near schools or playgrounds.

For a railroad overpass the Union Pacific Railroad typically requires an 8-foot tall curved or a 10-foot tall straight safety fence at the outer edge of a sidewalk.

Design loads for pedestrian railings and fences shall be as given in the AASHTO LRFD Specifications [AASHTO-LRFD 13.8.2].

5.8.1.2.3 Bicycle railings [AASHTO-LRFD 13.9]
The Bureau policy below for bicycle railings currently is under discussion. As needed, contact the Methods Engineer for the policy to be applied to a specific project.

Where a shared use trail is provided on a bridge, the outer edge of the path shall be protected with a bicycle railing. The minimum height of the railing shall be 54 inches above the path surface [AASHTO-LRFD 13.9.2]. Horizontal or vertical parts of the railing shall be spaced closely enough so that a 6-inch sphere will not pass through the lower 27-inch portion, and an 8-inch sphere will not pass through the horizontal band 27 to 54 inches above the path surface.

The pass-through requirements do not apply to chain link or metal fabric fence supports. Chain link or metal fabric fence shall have openings no larger than 2 inches [AASHTO-LRFD 13.9.2]. It sometimes is appropriate to consider the use of smaller chain link mesh openings to discourage climbing of the fence or pushing of objects through the mesh. Smaller mesh openings may be especially appropriate near schools or playgrounds.

For a railroad overpass the Union Pacific Railroad typically requires an 8-foot tall curved or a 10-foot tall straight safety fence at the outer edge of a shared use path.

Design loads for bicycle railings shall be as given in the AASHTO LRFD Specifications [AASHTO-LRFD 13.9.3].

5.8.1.2.4 Separation railings [AASHTO-LRFD C13.7.1.1, 13.10]
The Bureau policy below for separation railings currently is under discussion. As needed, contact the Methods Engineer for the policy to be applied to a specific project.

Where a bridge provides for pedestrian and/or bicycle traffic in addition to vehicular traffic the designer shall provide appropriate separation between the different streams of traffic. Although a barrier curb may be used for traffic speeds of 45 mph or less [AASHTO-LRFD C13.7.1.1], the Bureau has the policy of providing a separation railing for all but unusual circumstances.

The following are guidelines for designing and detailing combination concrete and steel railings to be used for separation in urban areas where the vehicle speed limit is less than 45 mph. Figure 5.8.1.2.4 shows a railing that would meet the guidelines.

- The railing shall have a vertical face on both sides.
- The concrete railing shall be a minimum of 24 inches high on the pedestrian side.
- The concrete railing shall be minimum of 27 inches and a maximum of 34 inches high on the traffic side.
- The concrete railing shall be a minimum of 10 inches thick.
- Reinforcing shall be a minimum of No. 5 at 12-inch spacing
- The steel railing’s total suggested minimum height (by AASHTO) is 42 inches.
Alternate railings that separate pedestrian from vehicular traffic or that separate bicycle from vehicular traffic shall be designed to meet the AASHTO LRFD Specifications [AASHTO-LRFD 13.10]. The designer should note that a minimum railing height is measured from the surface that the railing protects, which is important where the roadway and sidewalk or trail surfaces are not at the same elevation.

In many cases it is undesirable to terminate a separation barrier within the limits of the bridge, as this would result in inadequate crash protection of fence, railing, or abutment features at the bridge corner outside of the sidewalk or shared use path. Sidewalk or shared use path approaches also may be adversely affected by the placement of guardrails attached to separation barriers terminating on or close to the bridge end. The designer shall consult with the Methods Unit in the Design Bureau regarding the appropriate terminus location and configuration for separation barriers.

5.8.1.2.5 Aesthetic and special railings [AASHTO-LRFD 13.7-13.9]

Bureau policy for aesthetic and special railings currently is under discussion. As needed, contact the Methods Engineer for the policy to be applied to a specific project.

Bridges that are given special aesthetic treatment usually will include redesign of standard traffic, pedestrian, bicycle, and/or combination railings. *Aesthetic Concrete Barrier Design* [BDM 5.8.1.1.5] provides guidelines for applying aesthetic treatments to various types of barriers. Also, in situations where sight distance considerations apply, railings may need to be specially designed or selected for better motorist visibility.

Design of pedestrian and bicycle railings generally can be accomplished easily within the rules for geometry and loads in the AASHTO LRFD Specifications [AASHTO-LRFD 13.8, 13.9]. Constructability and cost, however, are additional issues that the designer must consider carefully.

Figure 5.8.1.2.4. Separation railing (under discussion)
Aesthetic design of traffic railings is more complicated because of the need to meet a designated NCHRP Report 350 crash test level [AASHTO-LRFD 13.7], as well as constructability and cost criteria. Furthermore, if the designer uses steel shapes such as tubes in the railing, the designer shall consult with the Chief Structural Engineer regarding special testing to ensure that the rail does not fail in a brittle mode during cold weather. For an aesthetic railing, either the designer must modify only the face of the barrier away from traffic as shown in Figure 5.8.1.2.5-1, select an already tested rail with appropriate characteristics such as the rail in Figure 5.8.1.2.5-2, or relate any new design to a crash test by crash testing the new rail directly or comparing the new rail to a similar, successfully tested rail.

Figure notes:
- In rural interchange bridges one 2-inch conduit is placed in one of the two bridge rails; a second conduit is added if needed. No conduit is placed in other rural bridges.
- In urban bridges conduit is placed in both bridge rails.
- No more than two conduits may be placed in one rail, and the maximum conduit sizes are two 2-inch or one 2-inch and one 3-inch.

Figure 5.8.1.2.5-1. Aesthetic F-shape barrier rail rated TL-4
Figure notes:
- In rural interchange bridges one 2-inch conduit is placed in one of the two bridge rails; a second conduit is added if needed.
- In urban bridges conduit is placed in both bridge rails.
- No more than two conduits may be placed in one rail, and the maximum conduit sizes are two 2-inch or one 2-inch and one 3-inch.

**Figure 5.8.1.2.5-2. Aesthetic partially open rail rated TL-4**

The primary purpose of a traffic railing is to contain and redirect vehicles on the bridge superstructure. In order to serve that purpose a railing must be both geometrically and structurally crashworthy.

When selecting or redesigning a traffic railing, the designer should consider several principles. Safety shapes, such as the F-shape, cause the vehicle contacting the rail to climb and thereby temporarily release energy, but the climb may be sufficient to cause rollover. Vertical rails generally do not cause vehicles to tip away from the rail, which provides safety against rollover.

Because of the difference in performance with respect to climbing, the heights of the two shapes are considered differently. Heights of safety shapes generally are not restricted, but heights of vertical rails above 32 inches are discouraged, unless the portion above 32 inches is set back at least 5.5 inches. The climbing associated with a safety shape provides safety by tipping the vehicle, thereby preventing a car occupant’s head from contacting the barrier.

If any part of a rail contacted by a vehicle is not smooth, it may cause a vehicle to snag, which is undesirable. Therefore, it is necessary to limit rustication depth in barrier faces to 1 inch or less and chamfer the edges of rustication. See "Acceptance Letter B110: Texture Guidelines for SS and Vertical Concrete Barriers" and *NCHRP Report 554* [BDM 5.8.1.1.5] for further details on acceptable traffic face rustication. Also, posts supporting a horizontal rail must be set back sufficiently so that a vehicle does not snag on a post.

Attachments to the tops of concrete barrier rails need to be considered carefully so that a vehicle that climbs the rail does not snag on the attachments or become speared by part of the attachment, or that snowplowing does not damage the attachments. Generally it is better to mount attachments that extend
above barrier rails, such as rails for bicyclists, on the backside of the rail. Additionally it may enhance safety to provide a cable tie through a pedestrian or bike rail.

Consideration also should be given toward making all or portions of barrier attachments breakaway for vehicular contact. Conditions at the backside of the barrier, such as sidewalk or edge of structure above roadway, may dictate to what extent breakaway features are employed. Consult Guidelines for Attachments to Bridge Rails and Median Barriers, Final Report [BDM 5.8.1.1.5] for further information.

Except for low-speed highways, the bridge railing is only part of the total safety railing. If guardrail must be attached to the bridge rail, the designer will need to plan for the attachment, usually for a thrie beam.

For most bridges, traffic railings will need to meet NCHRP Report 350 TL-4 or TL-5. The designer may determine the test level for a proposed railing by one of three methods:

1. Select a railing that has been tested or rated,
2. Design and crash-test a new railing, or
3. Compare a new railing with an existing, rated railing.

The designer shall consult the Design Bureau for the proper approval procedure prior to beginning development of any new barrier configurations.

In most situations the first method will be the most economical and efficient. The Federal Highway Administration maintains a web site for NCHRP Report 350 hardware. Crash-tested or otherwise rated traffic railings are listed and described in detail. If one of the rated railings is appropriate, the designer may use the railing. The designer also may obtain additional railing information from the Methods Unit in the Design Bureau or from other states.

The second method, designing and crash testing a new railing, is both expensive and time consuming. In most cases this option will not be feasible due to the time delay and cost of the test.

The third method is relatively new and permitted by an FHWA memorandum dated 16 May 2000 [BDM 5.8.1.1.5]. In this method the designer needs to have detailed information on a tested railing that is very similar to the new railing. Detailed analysis of the geometry and crashworthiness and structural computations then can show that the new railing is at least equivalent to the tested railing.

In cases where the railing has a maximum expansion joint opening 4 inches or greater the designer will need to provide steel cover plates [BDM 5.8.1.2.6].

5.8.1.2.6 Concrete railings

Concrete railings shall be placed either by the slipform method with Class BR concrete [IDOT SS 2513.03, A, 2] or by the cast in place method with Class C concrete. Due to quality issues, Class D concrete no longer is permitted for placing rails by either method. The designer shall include general note E188/M188 [BDM 13.3.2] on the plans. Bid item reference information EST139/MST139 has been updated for the changes in permissible concrete class.

Relatively wide expansion joints in concrete barrier railings (but not open railings) require steel cover plates. The designer shall provide cover plates whenever the maximum expansion joint opening is 4 inches or greater. Details shall be as follows:

- The entire barrier rail joint opening (front and back) shall be covered by a galvanized steel plate with a minimum thickness of 3/8 inch and shall extend a minimum of 9 inches past the expansion opening. Larger plate thicknesses should be considered for openings greater than 6 inches.
- The plate shall be fabricated to conform to the front face of the barrier including the top. In addition, a separate back plate shall be used that meets the front plate at the top of the barrier rail.
- The joint where the two plates meet shall be sealed with light gray non-sag latex caulking sealer marketed for outdoor use.
• The exterior face of the plates shall be recessed ¼ inch below the surface of the rail to reduce potential for snagging. Plates shall be detailed so that traffic passes the attached ends first and in passing cannot snag the sliding ends.
• The cover plate will allow for the full thermal movements required at that joint location plus any setting factors that are required for the joint.

For cover plates on pedestrian, bicycle, separation, and aesthetic railings the designer shall consult with the supervising Unit Leader and Aesthetic Specialist.

5.8.1.3 Temporary barrier railings
For staged construction the Bureau usually is responsible for layout of temporary barrier rail (TBR) on the bridge deck. The TBR may be either concrete or steel; the Bureau has discontinued use of a combination of both types of rail in the same installation. Additional information on the use of TBR is given in a bridge repair article of this manual [BDM 12.1.8.3].

5.8.1.3.1 Concrete
Concrete temporary barrier rail is detailed on several Design Bureau standard road plan sheets [DB SRP BA-401]. The standard rail has a double F-shape, a 32-inch height, and 12.5-foot lengths.

Typical layout of the rail for one-way and two-way traffic is shown on standard sheets [BSB SS 1049, 1050]. Details of the placement policy are given elsewhere in this manual [BDM 12.1.8.3].

Rules for use of tie-downs are given in the Design Bureau's design manual [DB DM 9B-9] and on a standard sheet [DB SRP BA-401].

5.8.1.3.2 Steel
Steel HP 14x73 temporary barrier rail is composed of two pile sections welded flange tip to flange tip, with a concrete fill [DB SRP BA-400]. The height of the cross section is 29.25 inches, and the length of a rail section is 20 feet.

Typical layout of the rail for one-way and two-way traffic is shown on standard sheets [BSB SS 1056, 1058]. Details of the placement policy are given elsewhere in this manual [BDM 12.1.8.3].