TABLE OF CONTENTS ~ RAILINGS

5.8.1 Railings
  5.8.1.1 General
    5.8.1.1.1 Policy overview
    5.8.1.1.2 Design information
    5.8.1.1.3 Definitions
    5.8.1.1.4 Abbreviations and notation
    5.8.1.1.5 References
  5.8.1.2 Permanent railings
    5.8.1.2.1 Traffic railings
      5.8.1.2.1.1 F-shape Single slope
      5.8.1.2.1.2 Open
      5.8.1.2.1.3 Retrofit
    5.8.1.2.2 Pedestrian railings
    5.8.1.2.3 Bicycle railings
    5.8.1.2.4 Separation railings
    5.8.1.2.5 Aesthetic and special railings
    5.8.1.2.6 Concrete railings
  5.8.1.3 Temporary barrier railings
    5.8.1.3.1 Concrete
    5.8.1.3.2 Steel

5.8.1 Railings

Previously traffic railings have been rated according to the crash test standards contained in 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. Current traffic railings shall normally meet the design and testing requirements in the Manual for Assessing Safety Hardware (MASH), 2nd edition, 2016. The Department has preapproved traffic railings and other roadside safety hardware for use in accordance with documentation in OD DM 8A-5. The traffic railings discussed in this article have been preapproved for use on the state system subject to the limitations outlined in this article for each railing. Making modifications to these traffic railings is discouraged. Any modifications to these traffic railings must be approved by the Department. Using traffic railings other than those discussed in this article is discouraged. Any traffic railing for a state project or state-owned structure must be approved for use by the Department. The AASHTO LRFD provisions for railings include information based on NCHRP 350 and MASH follow the report. The Bureau has designed the deck overhang on standard sheets according to the MASH requirements in the AASHTO LRFD Specifications and BDM 5.2.

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 and OD DM 8A-6.

Bureau policies for pedestrian railings, bicycle railings, separation railings, and aesthetic and special 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 single slopeF-shape barrier rails detailed on standard sheets developed by the Bureau. The 3834-inch tall and 44-inch tall Iowa standard single slopeF-shape barrier rails meet MASH 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 single slopeF-shape barrier rails are 2 inches taller than the minimum heights required for TL-4 and TL-5 barrier rails 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 as noted in BDM 5.8.1.2.1. 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 single slopeF-shape end sections and single slopeF-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 or sloped end section type is for low-speed highways in urban areas where no guardrail connection is necessary. The maximum posted speed for use of a sloped end transition (SET) without consultation with the BSB is 30 MPH. Refer to Design Manual Section 8A-4 for guidance. 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 single slopeF-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. The Iowa DOT considers that bridge sidewalks will occasionally accommodate bicyclists, especially children, and as such the railings on both sides should meet minimum bicycle height requirements [BDM 5.8.1.2.2, BDM 5.8.1.2.3]. For a trail the separation barrier is typically a combination railing constructed with a concrete lower section to which a steel railing is attached to meet minimum bicycle height requirements [BDM 5.8.1.2.4] on the trail side. At the outer edge of the bridge a chain link fence or other railing 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, traffic railings often become topics of conversation relative to enhancement plans. However, modifications to crash-tested barriers that impact the height, traffic face geometry, or strength of the barrier system are not typically possible. Outside face treatments such as texturing of concrete using form liners is acceptable in most cases if there is no impact on barrier strength. The associated constructability, cost, and construction schedule concerns must also be adequately addressed in the planning stages of the project. For more detailed information on aesthetic barriers and potential treatments, see BDM 5.8.1.2.5. Usually the traffic railing 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 web site 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 to existing traffic railings or barrier rails during repair projects, and requirements for rail retrofits are given in the bridge repair article of this manual [BDM 12.1.9.2.2].

For staged construction the Design Bureau usually is responsible for layout of temporary barrier rail (TBR) on the bridge deck. The Bridges and Structures Bureau generally provides input on the placement of the TBR with respect to the deck cross-section. 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 was the safety shape typically used by the Bureau for traffic railings under NCHRP 350 testing requirements. 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
SET, sloped end transition
TBR, temporary barrier rail
TL-2, TL-3, TL-4, TL-5, TL-6, test levels for traffic railings as defined in NCHRP Report 350 [AASHTO-LRFD 13.7.2]
ZOI, zone of intrusion

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: Test Levels (TL) and the associated heights for railings on interstate and primary road bridges is as follows:

- 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.
- TL-2 and TL-3 separation barrier railings may also be used in low speed applications as discussed in BDM 5.8.1.2.4.
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 Single slope** [AASHTO-LRFD 13.7.3.2]

For typical bridges that carry only vehicular traffic, the Bureau provides single slope F-shape TL-4 or TL-5 barrier rails along the edges of the roadway. The Bureau standard rail heights of 38 and 44 inches provide MASH 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 single slope F-shape barrier rails as summarized in Table 5.8.1.2.1.1-1. 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</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</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 still also include details for standard F-shape barrier rails. Single slope rails will be added in the future as time permits.
2. This standard sheet currently is under review.
3. See Figure 5.8.1.2.1.1 for a TL-4 and TL-5 single slope 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 single slope 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 consult the Chief Structural Engineer regarding rail selection especially 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-4 and TL-5 single slope barrier rails, respectively

The structural capacity required for MASH compliant rails is greater than that for rails designed according to NCHRP 350. The increase in rail strength also requires a corresponding increase in the strength of the deck overhang. Two approaches were adopted with respect to the c-bar design in the rails to not only accommodate the needed strength increase, but to also limit bar congestion in the rail and deck overhang. First, the c-bar spacing was designed separately for the interior and end regions of the rail such that the c-bar spacing in those regions may be different. Interior regions of the rail may be defined as regions “for impacts within a wall segment” and end regions “for impacts at end of wall or at joint” (AASHTO-LRFD A13.3.1). An end region typically originates at a discontinuity in both the deck and rail as may occur at a deck expansion joint or at a construction joint in the rail where the longitudinal d1 rail bars do not extend through the construction joint. Second, the spacing of the upper c1 bars and lower c2 curb bars may differ from each other in each of those regions. The lower c2 bar spacing is typically greater than the upper c1 bar spacing in cases where the spacing differs. The larger c2 bar spacing helps minimize the reinforcement required in the deck overhang since AASHTO A13.4.2 requires the deck overhang to exceed $M_{c_{base}}$ of the parapet at its base ($M_{c_{base}}$). As such, the deck overhang design is based on the strength of the lower c2 curb bars (BDM 5.2.2.4) which are used to determine $M_{c_{base}}$. The average strength of the single slope rail ($R_{uw}$) is based on yield line failure theory from AASHTO-LRFD A13.3.1 using the upper 5c1 bars to determine $M_{c_{average}}$ for the computation of $R_{uw}$. This method of satisfying AASHTO requirements is considered valid for two reasons. First the 5c1 bars extend the full height of the rail and are hooked at the base of the front face of the rail which accommodates the transfer of tension...
into the 5c2 bars and subsequently into the deck. Second, Mc_base of the lower 5c2 bars was designed to be greater than or equal to Mc_average of the upper 5c1 bars. Table 5.8.1.2.1.1-2 lists the size and spacing of the c1 and c2 bars for the standard single slope rails. Microsoft Excel applications are available on the Iowa DOT bridge website for determining the strength of the single slope rails and for deck design. See BDM 5.2.2.4 for additional information.

### Table 5.8.1.2.1.1-2. c1 & c2 bar size and spacing for MASH TL-4 and TL-5 single slope rails

<table>
<thead>
<tr>
<th>Bar Designation</th>
<th>TL-4-2 Interior Region</th>
<th>TL-4-2 End Region</th>
<th>TL-5-2 Interior Region</th>
<th>TL-5-2 End Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper c1 bars</td>
<td>No. 5 at 12.00 inches</td>
<td>No. 5 at 12.00 inches</td>
<td>No. 5 at 9.00 inches</td>
<td>No. 5 at 9.00 inches</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6.75 feet</td>
<td>6.00 inches</td>
</tr>
<tr>
<td>Lower c2 curb bars</td>
<td>No. 5 at 12.00 inches</td>
<td>No. 5 at 12.00 inches</td>
<td>No. 5 at 12.00 inches</td>
<td>No. 5 at 12.00 inches</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6.75 feet</td>
<td>6.00 inches</td>
</tr>
</tbody>
</table>

**Table Notes:**

(1) The total length needed for the c1 and c2 bar spacing at an end region is based on the critical length, Lc, from BDM Table 5.2.2.4-2. An end region typically originates at a discontinuity in both the deck and rail as may occur at a deck expansion joint or at a construction joint in the rail where the longitudinal d1 rail bars do not extend through the joint.

The standard 9’-5” long bridge rail end sections are typically attached to the top of the abutment wings and provide a transition from the steel guardrails to the single slope rails on the bridge. The standard bridge rail end section is designed for an TL-4-2 end region condition. Prior to adopting MASH, the 7’-0” long standard bridge rail end sections used in conjunction with the F-shape rails had a vertical construction joint between the end section and the F-shape without any of the longitudinal reinforcement passing through the construction joint. With the adoption of MASH, a decision was made to pass the single slope longitudinal rail bars through the construction joint and lap with the end section longitudinal rail bars in the end section. The primary benefit of this change is to maintain continuity in the railing. This is particularly beneficial in cases where there is already a discontinuity in the railing due to an expansion joint at the bridge ends as is the case for stub abutments. A secondary benefit for integral abutments is that the design for the interior region may be extended to the rail end sections since the discontinuity at the construction joint is no longer present.

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. The rail height should typically remain constant along the full length of the bridge where a TL-5 barrier rail is needed for splashboard protection. The past practice of transitioning rail heights from TL-4 to TL-5 for only the region needing splashboard protection is typically uneconomical for slip-formed barrier rails unless the affected region is 15% or less of the overall bridge length.

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 a single slope F-shape barrier, it is preferable to place structures behind the rail. *Guidelines for Attachments to Bridge*
Rails and Median Barriers. Final Report and Zone of Intrusion Envelopes Under MASH Impact Conditions for Rigid Barrier Attachments [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. The current open railing details are based on NCHRP 350 requirements. New open railing details based on MASH requirements are in development and will be incorporated at a later date.

**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 based on NCHRP 350**

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 that are not NCHRP 350 or MASH compliant 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 following guidance applies to fall protection railings at the outside edge of pedestrian sidewalk only, not to the traffic separation barrier. Please refer to BDM 5.8.1.2.4 Separation railings for information related to traffic separators.

Where a sidewalk is provided on a bridge, retaining wall, or adjacent to a culvert headwall, the outer edge of the sidewalk shall be protected with a pedestrian or bicycle railing. The minimum height of the pedestrian railing shall be 42 inches above the sidewalk surface [AASHTO-LRFD 13.8.1]. Taller railings may be appropriate under certain circumstances, such as near schools or playgrounds, or on bridges over high-volume roadways. Iowa DOT standard practice is to use pedestrian railings that are also bicycle height compliant, i.e. 48 inch min. height (BDM 5.8.1.2.3), since some bicycle traffic can be expected to occur on sidewalks that are not trail width-compliant. 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 portion above the 27-inch height. Any gap at the bottom of the railing shall not allow passage of a 4-inch sphere when any portion of the sphere is within 4 inches of the walking surface (ADA Standards for Accessible Design 405.9.2).

See BDM 5.8.1.2.3 Bicycle railings for an illustrated railing example.

Many local municipalities use the International Building Code (IBC) for setting pass-through requirements for public infrastructure railings. IBC calls for containment of a 4-inch sphere in all parts of a railing. When working on projects within city limits, it is advisable to contact city officials to confirm their expectations of the pass-through requirements being used on the project.

When chain link or metal fabric fence is required, e.g. on some railroad and highway overpasses, pass-through restrictions are more stringent. Chain link or metal fabric fence shall have openings no larger than 2 inches in at least one direction. 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. Chain link mesh is readily available with 1.25 inch x 1.25 inch openings, in aluminum, zinc coated, and vinyl coated products.

For projects involving replacement of existing bridges with pedestrian or bicycle accommodations, it is advisable to take into account the precedent conditions when determining the appropriate pedestrian railing height. Local perception of the level of safety of the replacement railing can be influenced by the type of railing previously used. It is advisable to coordinate the new railing’s design with community expectation by making contact with city officials as appropriate.

For bridges over high-volume roadways, it has been the Iowa DOT’s past practice to use fence or railing of at least 6 feet in total height, including the parapet if present. A typical minimum height of 6'-6 was used over some interstate facilities that involved new non-standard fence or railing details. Consult the Methods Engineer for appropriate fence or railing height for bridges over interstate highways, or roadways with high (>10,000 VPD) daily traffic counts or high (>45 MPH) posted speeds.

For a railroad overpass the Union Pacific Railroad typically requires an 8-foot tall curved or a 10-foot tall vertical safety fence at the outer edge of a sidewalk. While some railroads have specific written and illustrated requirements for fence configurations, oftentimes fences or railings with characteristics different from those illustrated have been granted railroad approval. It is advisable to coordinate with the railroad or with the Iowa DOT Rail Team in the Modal Transportation Bureau early in the design process to establish the precise fence or railing configuration that will be required on the project.

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 following guidance applies to fall protection railings at the outside edge of bike trail only, not to the traffic separation barrier. Please refer to BDM 5.8.1.2.4 Separation railings for information related to traffic separators.

Where a shared use trail is provided on a bridge, retaining wall, or adjacent to a culvert headwall, the outer edge of the path shall be protected with a bicycle railing. In accordance with the Iowa Bicycle and Pedestrian Long Range Plan and Iowa DOT which contains Chapter 6: Complete Streets Policy, the minimum height of the bicycle railing shall be 48 inches above the path surface [AASHTO-LRFD 13.9.2]. The 48-inch height is preferred for all cases except where local conditions favor a taller railing (AASHTO LRFD C13.9.2). Taller railings may be appropriate under certain circumstances, such as near schools or playgrounds, or on bridges over high-volume roadways. Significantly curved bridges or steeply graded bridges may require taller bicycle railings. 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 portion above the 27-inch height. Any gap at the bottom of the railing shall not allow passage of a 4-inch sphere when any portion of the sphere is within 4 inches of the walking surface (ADA Standards for Accessible Design 405.9.2).

Many local municipalities use the International Building Code (IBC) for setting pass-through requirements for public infrastructure railings. IBC calls for containment of a 4-inch sphere in all parts of a railing. When working on projects within city limits, it is advisable to contact city officials to confirm their expectations of the pass-through requirements being used on the project.

When chain link or metal fabric fence is required, e.g. on some railroad and highway overpasses, pass-through restrictions are more stringent. Chain link or metal fabric fence shall have openings no larger than 2 inches in at least one direction. 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. Chain link mesh is readily available with 1.25 inch x 1.25 inch openings, in aluminum, zinc coated, and vinyl coated products.

For projects involving replacement of existing bridges with pedestrian or bicycle accommodations, it is advisable to take into account the precedent conditions when determining the appropriate bicycle railing height. Local perception of the level of safety of the replacement railing can be influenced by the type of railing previously used. It is advisable to coordinate the new railing’s design with community expectation by making contact with city officials as appropriate.
For bridges over high-volume roadways, it has been the Iowa DOT’s past practice to use fence or railing of at least 6 feet in total height, including the parapet if present. A typical minimum height of 6'-6" was used over some interstate facilities that involved new non-standard fence or railing details. Consult the Methods Engineer for appropriate fence or railing height for bridges over interstate highways, or roadways with high (>10,000 VPD) daily traffic counts or high (>45 MPH) posted speeds.

For a railroad overpass the Union Pacific Railroad typically requires an 8-foot tall curved or a 10-foot tall vertical safety fence at the outer edge of a shared use path. While some railroads have specific written and illustrated requirements for fence configurations, oftentimes fences or railings with characteristics different from those illustrated have been granted railroad approval. It is advisable to coordinate with the railroad or with the Iowa DOT Rail Team in the Modal Transportation Bureau early in the design process to establish the precise fence or railing configuration that will be required on the project.

On some projects that include steep slopes or stone revetment alongside the bridge approach trail, or when a bicycle trail is accommodated adjacent to a rock-covered foreslope underneath a bridge, it may be appropriate to extend the application of the bridge’s bicycle railing to protect bicyclists from these conditions. It may be necessary to consult the applicable trail authority to determine the necessity of these additional railings. The railing’s implications during high water events (where applicable) and on maintenance activities should also be considered. In most cases, bicycle railings placed alongside at-grade conditions such as revetment do not require pass-through protection, so an open railing design could be used.

In the past, there has been some debate over the use of continuous horizontal “rub rails” as a feature of bicycle railings or fences along trails. The efficacy of rub rails in preventing handlebar snagging on railings has not been determined through targeted study, nor has the appropriate height and width of such features, when used. The Iowa DOT does not include rub rails on bicycle railings due to these shortcomings of understanding and the lack of specification guidance. It is expected that the bicyclist’s tendency to ride at some distance shy of continuous longitudinal obstructions is enough to reduce or prevent handlebar snagging, and that the functional clear width provided for trail surfaces provides the necessary shy distance for safe operation of bicycles.

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

**Section 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.

Separator type will usually be determined during the development of the TSL plan. If the separator type has not been determined by the start of Final Design on the project, contact the Methods Engineer for guidance.

Separation barriers shown in this section have either been successfully crash tested to MASH requirements or otherwise meet the Iowa DOT’s MASH implementation policy and have been approved for use on Iowa bridge projects.

Standard drawings are not yet available for the three approved separator types described in this section, so it will be necessary to contact the Methods Engineer to obtain the most recent example plans. Note that each of the three separators has a different overall footprint width (10” min. to 15.5” max.).
Coordination with the BSB is essential early in the design process to properly configure the bridge cross section to accommodate the appropriate separator width. Also note that incorporation of aesthetic surface treatments may increase the width of any of the designs.

Iowa DOT standard practice is to use combination traffic and pedestrian railings that are also bicycle height compliant, i.e. 42 inch min. height on the pedestrian side (AASHTO Guide Specifications for Bridge Railings) and with a bicycle tube railing, since some bicycle traffic can be expected to occur on sidewalks that are not trail width-compliant. Exceptions must be reviewed and approved by the Methods Engineer.

Separation barriers shall continue at their full height for the length of the bridge deck at a minimum. It is undesirable to terminate a separation barrier within the limits of the bridge deck, 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 to reduce or eliminate safety hazards both for vehicle occupants and for users of pedestrian facilities.

Note that it is typical for the bicycle railing attachments on separators to extend onto the approach barrier beyond the bridge at each end. The full length of these steel railings is typically detailed in the bridge plans. These railings can terminate where the sidewalk or trail alignment tapers away from the back of barrier toward its offset position along the approach. This alignment shift typically occurs at the end of the bridge wing. Also note that pass-through restrictions for fall protection do not apply at separation barriers.

Lighting elements, signs, and other rigid attachments that have not been successfully crash tested must not be mounted to the tops of separation barriers. All necessary rigid attachments must be mounted outside of the ZOI established for the barrier type. For appropriate guidance on minimum setback to lighting, signage, or other obstructions near traffic separation barriers, contact the Methods Engineer.

Drainage of a raised sidewalk or trail is usually accomplished using penetrations through the concrete portion of the separator, sloped toward the gutterline elevation. Drainage of an at-grade sidewalk or trail may involve either draining off the edge of deck or draining through the deck using trench drains that have ADA compliant cover grates. Contact the Methods Engineer for guidance. Draining the roadway through openings in the separator onto an at-grade sidewalk or trail and off the edge of deck is generally undesirable and should be avoided.

**IBBR (Iowa Barrier with Bicycle Railing) TL-2 Separation Barrier**

Use of the IBBR separator is restricted to roadways with posted speeds of 30 MPH or less and is the preferred separator type for those conditions due to its greater transparency and potential for reducing or eliminating sight distance conflicts, especially in urban areas. The IBBR may not be used on roadways with posted speeds greater than 30 MPH because there is no guardrail or crash cushion option for termination as is required under Iowa DOT Design Manual Section 8A-4. Do not use the IBBR without its bicycle railing without review and approval by the Methods Engineer.
Figure 5.8.1.2.4-1. Iowa DOT “IBBR” TL-2 separation railing (see Project No. BRF-003-6(69)-38-09, Design No. 323 Bremer for a railing application)

**BMBR (Back-Mounted Bicycle Railing) TL-2 Separation Barrier**
Use of the BMBR separator is restricted to roadways with posted speeds of 45 MPH or less. At posted speeds of 35 MPH and higher, a guardrail end connection or crash cushion is required under Iowa DOT Design Manual Section 8A-4 unless space restrictions prevent it. If these conditions arise, contact the Methods Engineer for guidance. The BMBR may be used in place of the IBBR for lower posted speeds if desired for aesthetic reasons or to meet local municipality expectations or preferences. Check the application for sight distance conflicts before substituting the BMBR for the IBBR, and contact the Methods Engineer for guidance. The BMBR may be used without its bicycle railing attachment for the traffic-only side(s) of bridges or as a sidewalk separation barrier with review and approval by the Methods Engineer.
Modified B-25 Series TL-3/TL-4 Separation Barrier

Use of the Modified B-25 Series separator is typically reserved for high-speed roadway bridges that include a trail or sidepath. Bridges carrying roadways with posted speeds greater than 45 MPH must use this design unless there are mitigating circumstances. Contact the Methods Engineer for guidance on possible alternate solutions.

Note that the Modified B-25 Series separator cannot be used with a raised trail on a bridge, since raising the bicycle railing attachment to the required 42-inch minimum height above the trail surface could place it within the barrier’s vehicle intrusion zone. Consider using an at-grade trail on the bridge and warp the trail connection at the ends of the bridge to a curbed approach condition, if necessary.

The Modified B-25 Series barrier may be used in a vehicular traffic-only condition when used on both sides of a bridge that has a sidewalk or trail only along one side. Omit the back-mounted bicycle railing attachment for vehicular traffic-only applications.

The Modified B-25 Series barrier requires guardrail or crash cushion termination in accordance with Iowa DOT Design Manual Section 8A-4.

Combination steel and concrete traffic barrier systems used on Iowa projects must include requirements for embrittlement testing of any cold-rolled and galvanized steel pipes or tubes exposed to traffic loads. Include the appropriate plan notes to cover this testing whenever using the Modified B-25 Series barrier.
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.
Figure 5.8.1.2.4. Separation railing (under discussion)

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. Historic bridge replacement projects may require special traffic or pedestrian railings to meet or supplement mitigation requirements. Also, in situations where sight distance considerations apply, such as in or near urban areas, railings may need to be specially designed or selected for better motorist visibility.

Design of pedestrian and bicycle railings and fences generally can be accomplished easily within the rules for geometry and loads in the AASHTO LRFD Specifications [AASHTO-LRFD 13.8, 13.9]. Concrete parapets with aesthetic features may sometimes be used as part of a complete pedestrian/bicyclist fall protection system. Various atypical materials for railing components such as welded wire mesh, perforated metal panels, weathering steel and aluminum may be explored during the design process.
Side-mounting of railings to the bridge deck has been used for aesthetic and functional reasons (prevention of weathering steel staining on sidewalk) but is not advised for general use. Duplex coating systems for steel such as polyester powder coating over galvanizing is commonly used and may be considered. However, constructability, material availability, and cost, however, are important additional issues that the designer must also carefully consider. Occasionally, it has been prudent to query each of the DOT’s approved railing fabricators for a constructability evaluation of a unique design prior to advertisement for letting, but this must be done with caution to avoid providing advantage to any single potential bidder. Coordination with other Bureaus is required. Consult the Methods Engineer before considering any contact with fabricators.

Figure 5.8.1.2.5-1. Aesthetic Pedestrian and Bicycle Railing Examples in Iowa

When structures over high-volume roadways or railroads require the use of chain link mesh to limit pass-through, it can be aesthetically desirable to design a picket-style welded railing with traditional 4-inch or 6-inch gaps and attach chain link mesh to the outside face. From many viewpoints, the appearance of this type of system is more like that of a picket railing than of a plain fence and is aesthetically effective. The chain link mesh can be vinyl coated to remain compatible with painted or powder coated framing elements. Vinyl coating color is strictly limited to standard available colors (black, brown, green, white). Chain link mesh with smaller openings than the standard 2”x2” (e.g., 1.25”x1.25”) can sometimes be desirable for aesthetics, to discourage climbing of the fence or pushing of objects through the mesh. Smaller mesh openings may be especially appropriate near schools or playgrounds. When chain link mesh fences taller than 6 feet are necessary, use standard available chain link mesh fabric width increments to determine overall system height.
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. Appropriate end sections such as SETs [BDM 5.81.1.5] for low-speed conditions or end sections for approach guardrail or crash cushion attachment must also be available for use with the chosen barrier type. Note that Iowa DOT typically adds 2 inches to the height of any crash-tested barrier system to account for future roadway grade raise. Establishment of MASH equivalency for many barrier systems is an ongoing task and may impact the validity of non-standard barrier selections. Consult with the Methods Engineer before considering use of any non-standard traffic railing. 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].

Aesthetic enhancement of a standard single slope concrete barrier is possible in several ways. First, the back (non-traffic) face may receive rustication, form liner texture, projected surfaces, or a combination of these. Most treatments involving manipulation of concrete surfaces will require additional width to be added to the standard barrier footprint. Coloration is also possible using post-applied color coatings on the outside face or throughout the barrier concrete using integral color pigment.

Unless clear concrete cover beyond the established minimum is already present in the barrier section to accommodate surface texture, form liner texturing of the outside face of concrete traffic barriers will require inclusion of additional barrier width equal to or greater than the depth of the texture to maintain the minimum clear concrete cover over near reinforcing. For aesthetic enhancement of the standard single slope barriers, it essential to maintain the standard reinforcing. Unreinforced outside face projections must not exceed 4 inches of unreinforced concrete, which typically limits projections to 2 inches maximum.

Many types of barrier aesthetic treatment cannot be slip-formed, so the designer must consider the implications of casting barriers in place on the project’s cost, constructability, and construction duration. Barrier construction work is often one of the last operations that occurs prior to bridge completion, roadway opening, and the contractor vacating the site. On horizontally curved bridges, cast-in-place forming requirements for barrier aesthetic treatments may represent more significant constructability and cost implications when compared to slip-formed barrier solutions.
Horizontal rustications can be added to the outside face of standard concrete barrier shapes and remain slip-formable, and therefore economical. If typical 1.50-inch wide by 0.75-inch deep V-grooves are used, no increase in clear concrete cover or barrier width is necessary to accommodate the rustications. Integral coloring of concrete barriers has also been successfully employed on Iowa projects, both slip-formed and cast-in-place. Relevant Special Provisions are available from past project work.

The use of post-applied color treatments on traffic faces and tops of concrete barriers is generally discouraged, due to harsh roadway conditions. Salt brine splashing and chemical action, vehicle strikes, and snowplow scraping can have severely detrimental effects on post-applied coloring systems. Barrier top surfaces that have been over-tooled during finishing can exhibit durability problems that become exaggerated by the presence of post-applied coatings. The outside faces of traffic barriers are generally acceptable surfaces for post-applied color treatments. Special notes are necessary to ensure that no incompatible curing agents or sealers are applied to barrier surfaces intended to receive post-applied coatings. Consult the Methods Engineer before considering barrier coating treatments.

Figure 5.8.1.2.5-3. Examples of Barrier Outside Face Rustication and Texturing

If any part of the traffic face of a barrier 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 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. Shallow texturing or rustication of the traffic face of some barrier shapes is generally possible when in conformance with the guidance found in these publications. In general, surface rustications up to 0.50-inch deep with beveled edges are acceptable, as are some shallow textures created by form liners. Consult the Methods Engineer before considering barrier traffic face treatments.

Systems for integral thin veneer brick for structural concrete have been used on traffic barriers in Iowa, for both the traffic face and outside surfaces. If used on the traffic side, brick surfaces must generally be kept flush or within 0.50 inch of the untreated traffic face concrete surfaces. Edges of recessed brick zones must be beveled at 45 degrees. On past projects, integral thin brick has been considered part of the clear concrete cover over reinforcing, so no additional barrier width was required for accommodation.
The Modified B-25 Series barrier system [BDM 5.8.1.2.4] is a combination steel-on-concrete barrier design that is approved for use up to TL-4 on Iowa projects. Consult the Methods Engineer before considering use. This barrier type can help to preserve views to scenic areas visible from the bridge. Combination steel-on-concrete barrier systems should generally not include painting of the steel components due to the harsh conditions mentioned above. Plain galvanized steel traffic railing surfaces are preferred. When painted steel is used, the Iowa DOT prefers a duplex coating system, i.e. galvanizing with a high-performance paint system such as 3-coat fluoropolymer or polyester powder coating. Consult the Methods Engineer before considering steel traffic railing paint coatings. Note that all combination steel and concrete traffic barrier systems used on Iowa projects must include requirements for ASTM E 436 embrittlement testing of any cold-rolled and galvanized steel pipes or tubes intended for exposure to traffic loads. In addition, epoxy-anchored steel traffic railings typically must refer to the Developmental Specifications for Installing Adhesive-Bonded Anchors and Dowels for Traffic Railings.

Some Iowa DOT and Local Systems projects located within communities have employed the Texas Classic barrier type, a concrete barrier with many small vertical openings. These are especially popular for historic bridge replacements because the character of these barriers emulates historic concrete barrier styles. Maintenance concerns have been raised about how snow removal equipment may interact with these barriers, and the potential for snow and ice to be pushed through the openings and off the bridge.
District maintenance staff should be engaged for feedback on their use. Consult the Methods Engineer before considering use of the Texas Classic barrier type.

The Texas Classic comes in multiple types: 32-inch tall T411 and 42-inch tall C411, both crashworthy to MASH TL-2 conditions or lower. Both versions have multiple vertical openings that are formed by standardized liner components that are readily available to contractors. Some Iowa contractors have experience in constructing the Texas Classic barrier types. When used as a separation barrier, the overall height must be raised, and the lower segment (below the windows) increased to maintain ADA compliance at the base of the barrier along a raised sidewalk. Consult the Methods Engineer for example details. A steel bicycle railing attachment is generally not possible for this barrier type, so usage as a trail separator is discouraged since it would require a Design Exception process.

The bicycle railing attachment on the IBBR separation barrier system [BDM 5.8.1.2.4] can be enhanced only by using a duplex coating system such as powder coating or 3-coat fluoropolymer paint over galvanizing, but this is discouraged in most cases due to the harsh roadway conditions previously mentioned in this section. The IBBR steel railing details must remain identical to the crash-tested version. The bicycle railing attachment on the BMBR separation barrier system [BDM 5.8.1.2.4] can be enhanced by a coating or by manipulation of the railing component shapes, provided the railing remains at least 12 inches from the traffic face of the barrier and projects no more than 4 inches into the sidewalk/trail.

Attachment of non-crash-tested metal railings, fences or other features for the purpose of ornamentation or decoration is not allowed within a traffic barrier’s Zone of Intrusion [BDM 5.8.1.1.5] for the posted speed. For the current ZOI limits for all barrier Test Levels see NCHRP Report 1018, Zone of Intrusion Envelopes Under MASH Impact Conditions for Rigid Barrier Attachments [BDM 5.8.1.1.5]. If the posted speed differs substantially from the barrier’s test conditions, it may be possible to reduce the effective ZOI through engineering judgment or analysis. Consultation with the Methods Engineer is required to establish the effective ZOI in these cases. Mounting of the decorative feature(s) to the back side of the traffic barrier may locate the feature entirely outside of the barrier’s ZOI in some cases. The mounting of such attachments must not negatively affect the barrier’s structural performance and increase the maintenance burden on the structure. Agreements between the Iowa DOT and the local municipality or other authority are often required to establish funding and maintenance responsibilities for such attachments on State-owned structures.

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 designates 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 1/8 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 Design Bureau usually is responsible for layout of temporary barrier rail (TBR) on the bridge deck. The Bridges and Structures Bureau generally provides input on the placement of the TBR with respect to the deck cross-section. The TBR may be either concrete or steel; the Bureau has discontinued but the Bureau does not permit the 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 [DB RDD 8210, 8212BSB 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 DM 9B-9, DB SRP BA-400, and DB RDD 560-07]. 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 [DB RDD 8210, 8212BSB SS 1056, 1058]. Details of the placement policy are given elsewhere in this manual [BDM 12.1.8.3].