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10.1 Sign and Luminaire Supports

10.1.1 Loads

A. General – The reference used in developing the following office criteria is the AASHTO “Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals,” Fourth Edition Dated 2001 including interims, and shall be the basis for analysis and design.

B. Dead Loads

- Sign (including panel and windbeams, does not include vert. bracing) 3.25 lbs/ft²
- Luminaire (effective projected area of head = 3.3 sq ft) 60 lbs/each
- Fluorescent Lighting 3.0 lbs/in ft
- Standard Signal Head 60 lbs/each
- Mercury Vapor Lighting 6.0 lbs/in ft
- Sign Brackets Calc.
- Structural Members Calc.
- 5 foot wide maintenance walkway (including sign mounting brackets and handrail) 160 lbs/in ft
- Signal Head w/3 lenses (effective projected area with backing plate = 9.2 sq ft) 60 lbs each

C. Wind Loads – A major change in the AASHTO 2001 Specification wind pressure equation is the use of a 3 second gust wind speed in place of a fastest-mile wind speed used in the previous specification. The 3 second wind gust map in AASHTO is based on the wind map in ANSI/ASCE 7-95.

Basic wind speed of 90 mph shall be used in computing design wind pressure using Equation 3-1 of AASHTO Section 3.8.1.

Do not use the Alternate Method of Wind Pressures given in Appendix C of the AASHTO 2001 Specifications.

D. Design Life and Recurrence Interval – (Table 3-3, AASHTO 2001)

- 50 years for luminaire supports, overhead sign structures, and traffic signal structures.
- 10 years for roadside sign structures.

E. Ice Loads – 3 psf applied around all the surfaces of structural supports, horizontal members, and luminaires, but applied to only one face of sign panels (AASHTO Section 3.7).

Walk-through VMS shall not be installed in areas where appreciable snow loads may accumulate on top of the sign, unless positive steps are taken to prevent snow build-up.

F. Fatigue Design – Fatigue design shall conform to AASHTO Section 11. Fatigue Categories are listed in Table 11-1. Cantilever structures, poles, and bridge mounted sign brackets shall conform to the following fatigue categories.

- Fatigue Category I for overhead cantilever sign structures (maximum span of 30 feet and no VMS installation), high level (high mast) lighting poles 100 feet or taller in height, bridge-mounted sign brackets, and all signal bridges.
- Fatigue Category II for high level (high mast) lighting poles between 51 feet and 99 feet in height.
- Fatigue Category III for lighting poles 50 feet or less in height with rectangular, square or non-tapered round cross sections, and overhead cantilever traffic signals at intersections (maximum cantilever length 65 feet). If vehicle speeds are posted at 45 mph or greater, then overhead cantilever traffic signal structures shall be designed for Fatigue Category I.
Signs, Barriers, Approach Slabs, and Utilities

Chapter 10

Sign bridges, cantilever sign structures, signal bridges, and overhead cantilever traffic signals mounted on bridges shall be either attached to substructure elements (e.g., crossbeam extensions) or to the bridge superstructure at pier locations. Mounting these features to bridges as described above will help to avoid resonance concerns between the bridge structure and the signing or signal structure.

The “XYZ” limitation shown in Table 10.1.4-2 shall be met for Monotube Cantilevers. The “XYZ” limitation consists of the product of the sign area (XY) and the arm from the centerline of the posts to the centerline of the sign (Z). See Appendix 10.1-A2-1 for details.

G. **Live Load** – A live load consisting of a single load of 500 lb distributed over 2.0 feet transversely to the member shall be used for designing members for walkways and platforms. The load shall be applied at the most critical location where a worker or equipment could be placed, see AASHTO 2001, Section 3.6.

F. **Group Load Combinations** – Sign, luminaire, and signal support structures are designed using the maximum of the following four load groups (AASHTO Section 3.4 and Table 3-1):

<table>
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<th>Percent of *Allowable Stress</th>
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<tr>
<td>I</td>
<td>DL</td>
<td>100</td>
</tr>
<tr>
<td>II</td>
<td>DL+W**</td>
<td>133</td>
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<tr>
<td>III</td>
<td>DL+Ice+½(W**)</td>
<td>133</td>
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<tr>
<td>IV</td>
<td>Fatigue</td>
<td>See AASHTO Section 11 for Fatigue loads and stress range</td>
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* No load reduction factors shall be applied in conjunction with these increased allowable stresses.
** W – Wind Load

10.1.2 **Bridge Mounted Signs**

A. **Vertical Clearance** – All new signs mounted on bridge structures shall be positioned such that the bottom of the sign or lighting bracket does not extend below the bottom of the bridge as shown in Figure 10.1.2-1. The position of the sign does not need to allow for the future placement of lights below the sign. If lights are to be added in the future they will be mounted above the sign. To ensure that the bottom of the sign or lighting bracket is above the bottom of the bridge, the designer should maintain at least a nominal 2 inch dimension between the bottom of the sign or lighting and the bottom of the bridge. Maximum sign height shall be decided by the Region. If the structure is too high above the roadway, then the sign should not be placed on the structure.

Bridge mounted sign brackets shall be designed to account for the weight of added lights, and for the wind affects on the lights to ensure bracket adequacy if lighting is attached in the future.
B. Geometrics

1. Signs should be installed at approximate right angles to approaching motorists. For structures above a tangent section of roadway, signs shall be designed to provide a sign skew within 5° from perpendicular to the lower roadway (see Figure 10.1.2-2).

2. For structures located on or just beyond a horizontal curve of the lower roadway, signs shall be designed to provide a sign chord skew within 5° from perpendicular to the chord-point determined by the approach speed (see Figure 10.1.2-3).

3. The top of the sign shall be level.
C. Aesthetics
   1. When possible, the support structure should be hidden from view of traffic.
   2. The sign support shall be detailed in such a manner that will permit the sign and lighting bracket to be installed level.
   3. When the sign support will be exposed to view, special consideration is required in determining member sizes and connections to provide as pleasing an appearance as possible.

D. Sign Placement
   1. When possible, the designer should avoid locating signs under bridge overhangs. This causes partial shading or partial exposure to the elements and problems in lifting the material into position and making the required connections. Signs shall never be placed directly under the drip-line of the structure. These conditions may result in uneven fading, discoloring, and difficulty in reading. When necessary to place a sign under a bridge due to structural or height requirements, the installation should be reviewed by the Region Traffic Design Office.
   2. A minimum of 2 inches of clearance shall be provided between back side of the sign support and edge of the structure. See Figure 10.1.2-5.
E. Installation

1. Resin bonded anchors or cast-in-place ASTM A 307 anchor rods should be used to install the sign brackets on the structure. Size and minimum installation depth shall be given in the plans. The resin bonded anchors should be installed normal to the concrete surface. Resin bonded anchors shall not be placed through the webs or flanges of presstressed or post-tensioned girders unless approved by the WSDOT Bridge Design Engineer.

2. Bridge mounted sign structures shall not be placed on bridges with steel superstructures unless approved by the WSDOT Bridge Design Engineer.

10.1.3 Monotube Sign Structures Mounted on Bridges

A. Design Loads – Design loads for the supports of the Sign Bridges shall be calculated based on assuming a 12-foot-deep sign over the entire roadway width, under the sign bridge. This will account for any signs that may be added in the future. For Cantilever design loads, guidelines specified in Section 10.1.1 shall be followed. The design loads shall follow the same criteria as described in Section 10.1.1. Loads from the sign bridge shall be included in the design of the supporting bridge.

In cases where a sign structure is mounted on a bridge, the sign structure, from the anchor bolt group and above, shall be designed to AASHTO “Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals,” Fourth Edition, dated 2001 including interims. The concrete around the anchor bolt group and the connecting elements to the bridge structure shall be designed to the specifications in this manual and AASHTO LRFD Bridge Design Specifications. Loads from the sign structure design code shall be taken as unfactored loads for use in LFRD bridge design.

B. Vertical Clearance – Vertical clearance for Monotube Sign Structures shall be 20'-0" minimum from the bottom of the lowest sign to the highest point in the traveled lanes. See Appendix 10.1-A1-1, 10.1-A2-1, and 10.1-A3-1 for sample locations of Minimum Vertical Clearances.

C. Geometrics – Sign structures shall be placed at approximate right angles to approaching motorists. Dimensions and details of sign structures are shown in the Standard Plans G-60.10, G-60.20, G-60.30, G-70.10, G-70.20, G-70.30 and Appendix 10.1-A1-1, 2, and 3 and 10.1-A2-1, 2, and 3. When maintenance walkways are included, refer to Standard Plans G-95.10, G-95.20, G-95.30.

10.1.4 Monotube Sign Structures

A. Sign Bridge Standard Design – Table 10.1.4-1 provides the standard structural design information to be used for a Sign Bridge Layout, Appendix 10.1-A1-1; along with the Structural Detail sheets, which are Appendix 10.1-A1-2 and Appendix 10.1-A1-3; and General Notes, Appendix 10.1-A0-1.

B. Cantilever Standard Design – Table 10.1.4-2 provides the standard structural design information to be used for a Cantilever Layout, Appendix 10.1-A2-1; along with the Structural Detail sheets, which are Appendix 10.1-A2-2 and Appendix 10.1-A2-3; and General Notes, Appendix 10.1-A0-1.
## STANDARD MONOTUBE SIGN BRIDGES

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<td>60'-0&quot; TO 75'-0&quot;</td>
<td>1'-6&quot;</td>
<td>2'-0&quot;</td>
<td>⅜&quot;</td>
<td>6'-0&quot;</td>
<td>2'-0&quot;</td>
</tr>
<tr>
<td>+75'-0&quot; TO 90'-0&quot;</td>
<td>1'-6&quot;</td>
<td>2'-0&quot;</td>
<td>⅝&quot;</td>
<td>6'-0&quot;</td>
<td>2'-0&quot;</td>
</tr>
<tr>
<td>+90'-0&quot; TO 105'-0&quot;</td>
<td>1'-6&quot;</td>
<td>2'-0&quot;</td>
<td>1½&quot;</td>
<td>6'-0&quot;</td>
<td>2'-0&quot;</td>
</tr>
<tr>
<td>+105'-0&quot; TO 120'-0&quot;</td>
<td>1'-6&quot;</td>
<td>2'-0&quot;</td>
<td>⅝&quot;</td>
<td>6'-0&quot;</td>
<td>2'-0&quot;</td>
</tr>
<tr>
<td>+120'-0&quot; TO 135'-0&quot;</td>
<td>1'-6&quot;</td>
<td>2'-0&quot;</td>
<td>1½&quot;</td>
<td>6'-0&quot;</td>
<td>2'-0&quot;</td>
</tr>
<tr>
<td>+135'-0&quot; TO 150'-0&quot;</td>
<td>1'-6&quot;</td>
<td>2'-0&quot;</td>
<td>⅝&quot;</td>
<td>6'-0&quot;</td>
<td>2'-0&quot;</td>
</tr>
</tbody>
</table>

**NOTE:** DENOTES MAIN LOAD CARRYING TENSILE MEMBERS OR TENSION COMPONENTS OF FLEXURAL MEMBERS.

### Table 10.1.4-1

## STANDARD MONOTUBE CANTILEVERS

<table>
<thead>
<tr>
<th>SPAN LENGTH</th>
<th>POSTS</th>
<th>BEAM A</th>
<th>BEAM B</th>
<th>CAMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>LESS THAN 20'-0&quot;</td>
<td>1'-6&quot;</td>
<td>2'-0&quot;</td>
<td>⅛&quot;</td>
<td>6'-0&quot;</td>
</tr>
<tr>
<td>20'-0&quot; TO 30'-0&quot;</td>
<td>1'-6&quot;</td>
<td>2'-0&quot;</td>
<td>⅛&quot;</td>
<td>6'-0&quot;</td>
</tr>
</tbody>
</table>

**NOTE:** DENOTES MAIN LOAD CARRYING TENSILE MEMBERS OR TENSION COMPONENTS OF FLEXURAL MEMBERS.

### Table 10.1.4-2
Chapter 10 Signs, Barriers, Approach Slabs, and Utilities

C. **Balanced Cantilever Standard Design** – Appendix 10.1-A3-1; along with the Structural Detail sheets, Appendix 10.1-A3-2 and Appendix 10.1-A3-3, and General Notes, Appendix 10.1-A0-1, provides the standard structural design information to be used for a Balanced Cantilever Layout. Balanced Cantilevers are typically for VMS sign applications and shall have the sign dead load balanced with a maximum difference one third to two thirds distribution.

D. **Monotube Sheet Guidelines** – The following guidelines apply when using the Monotube Sign Structure Appendix 10.1-A0-1; 10.1-A1-1, 2, and 3; 10.1-A2-1, 2, and 3; 10.1-A3-1, 2, and 3; 10.1-A4-1, 2, and 3; and 10.1-A5-1.

1. Each sign structure shall be detailed and must specify:
   a. Sign structure base Elevation, Station, and Number.
   b. Type of Foundation 1, 2, or 3 shall be used for the Monotube Sign Structures, unless a special design is required. The average Lateral Bearing Pressure for each foundation shall be noted on the Foundation sheet(s).
   c. If applicable, label the Elevation View “Looking Back on Stationing.”

2. Designers shall verify the cross-referenced page numbers and details are correct.

E. **Monotube Quantities** – Quantities for structural steel are given in Table 10.1.4-3.

### Sign Structure Material Quantities

<table>
<thead>
<tr>
<th>ASTM A572 GR. 50 or ASTM 588</th>
<th>Sign Bridge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cantilever</strong></td>
<td><strong>Post (plf)</strong></td>
</tr>
<tr>
<td><strong>20' ≤</strong></td>
<td>99</td>
</tr>
<tr>
<td><strong>20' to 30'</strong></td>
<td>132</td>
</tr>
<tr>
<td><strong>Balanced</strong></td>
<td>132</td>
</tr>
<tr>
<td><strong>60' ≤</strong></td>
<td>144</td>
</tr>
<tr>
<td><strong>60' to 75'</strong></td>
<td>176</td>
</tr>
<tr>
<td><strong>75' to 90'</strong></td>
<td>204</td>
</tr>
<tr>
<td><strong>90' to 105'</strong></td>
<td>204</td>
</tr>
<tr>
<td><strong>105' to 120'</strong></td>
<td>120'</td>
</tr>
<tr>
<td><strong>120' to 135'</strong></td>
<td>120'</td>
</tr>
<tr>
<td><strong>135' to 150'</strong></td>
<td>120'</td>
</tr>
</tbody>
</table>

### Sign Structure Steel Quantities

*Table 10.1.4-3*
10.1.5 Foundations

A. Monotube Sign Bridge and Cantilever Sign Structure Foundation Types – The Geotechnical Branch shall be consulted as to which foundation type is to be used. Standard foundation designs for standard plan truss-type sign structures are provided in WSDOT Standard Plans G-60.20 and G-60.30 and G-70.20 and G-70.30; and in Section 10.1.5 of this manual. The following paragraphs describe the four types of foundations detailed in this section.

1. The Foundation Type 1, a drilled shaft, is the preferred foundation type. The standard drilled shafts are designed for a lateral bearing pressure of 2,500 psf. See Appendix 10.1-A4-1 and 10.1-A4-2 for Foundation Type 1 standard design information. The Geotech report for this foundation should include the soil friction angle and if temporary casing is required for shaft construction, in addition to the allowable lateral bearing pressures. When the Geotechnical engineer specifies temporary casing, it shall be clearly shown on shaft plans, for each required shaft.

2. The Foundation Type 2 is an alternate to Type 1 when drilled shafts are not suitable to the site. Foundation Type 2 is designed for a lateral bearing pressure of 2,500 psf. See Appendix 10.1-A4-3 for Foundation Type 2 standard design information.

3. The Foundation Type 3 replaces the foundation Type 2 for poor soil conditions where the lateral bearing pressure is between 2,500 psf and 1,500 psf. See Appendix 10.1-A4-3 for Type 3 Foundation standard design information.

4. Barrier Foundations are foundations that include a barrier in the top portion of Foundation Types 1, 2, and 3. Foundation details shall be modified to include Barrier Foundation details. Appendix 10.1-A5-1 details a single slope barrier.

B. Luminaire, Signal Standard, and Camera Pole Foundation Types – Luminaire foundation options are shown on Standard Plan J-28.30. Signal Standard and Camera Pole foundation options are provided on Standard Plans J-26.10 and J-29.10 respectively.

C. Foundation Design – Shaft type foundations constructed in soil for sign bridges, cantilever sign structures, luminaires, signal standards and strain poles are designed per the current edition of the AASHTO Standard Specifications For Highway Signs, Luminaires, and Traffic Signals; Section 13.10; Embedment of Lightly Loaded Small Poles And Posts. This design method assumes the presence of uniform soil properties with depth, including a single value for Allowable Lateral Bearing Pressure. For foundation locations with multiple soil layers within the anticipated foundation depth (and multiple values of allowable lateral bearing pressure), consideration should be given to using a single “weighted average” value of allowable lateral bearing pressure for design. For foundation locations where a soft soil (with low allowable lateral bearing pressures) is overlaid by a stronger soil (with higher allowable lateral bearing pressures), the foundation can be conservatively designed for the lower allowable lateral bearing pressure value. This design method accounts for the lateral loads applied to the foundation due to the soil pressure (increasing with depth) and the lateral loads applied from the structure above. An additional increase in lateral resistance should not be added for increasing soil lateral pressures with depth.

No provisions for foundation torsional capacity are provided in Section 10.13 of the AASHTO Standard Specifications For Highway Signs, Luminaires, and Traffic Signals. The following approach can be used to calculate torsional capacity of sign structure, luminaire, and signal standard foundations:

\[ T_u = F \tan \varphi D \]  

Where:
- \( F \) = Total force normal to shaft surface (kip)
- \( D \) = Diameter of shaft (feet)
- \( \varphi \) = Soil friction angle (degree), use smallest for variable soils
1. Monotube Sign Bridge and Cantilever Sign Structures Foundation Type 1 Design – The standard embedment depth “Z”, shown in the table on Appendix 10.1-A4-1, shall be used as a minimum embedment depth and shall be increased if the shaft is placed on a sloped surface, or if the allowable lateral bearing pressures are reduced from the standard 2500 psf. The standard depth assumed that the top 4 feet of the C.I.P. cap is not included in the lateral resistance (i.e., shaft depth “D” in the code mentioned above), but is included in the overturning length of the sign structure. Bridge Special Provisions 210201A1.GB8, 210501.GB8, and 210309F2.FB8 shall be included with all Foundation Type 1 shafts.

2. Monotube Sign Bridge and Cantilever Structures Foundation Type 2 and 3 – These foundation designs are standards and shall not be adjusted or redesigned. They are used in conditions where a Foundation Type 1 (shaft) would be impractical due to difficult drilling or construction and when the Geotechnical Engineer specifies their use. The concept is that the foundation excavation would maintain a vertical face in the shape of the Foundation Type 2 or 3. Contractors often request to over-excavate and backfill the hole, after formwork has been used to construct this foundation type. This is only allowed with the Geotechnical engineer's approval, if the forming material is completely removed, and if the backfill material is either CDF or concrete class 3000 or better.

3. Monotube Sign Bridge and Cantilever Structures Special Design Foundations – The Geotechnical Engineer will identify conditions where the foundation types (1, 2, or 3) will not work. In this case, the design forces are calculated, using the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and traffic Signals, and applied at the bottom of the structure base plate. These forces are then considered service loads and the special design foundation is designed with the appropriate Service, Strength, and Extreme Load Combination Limit States and current design practices of the AASHTO LRFD Bridge Design Specifications and this manual. Some examples of these foundations are spread footings, columns and shafts that extend above ground adjacent to retaining walls, or connections to traffic barriers on bridges. The anchor rod array shall be used from Tables 10.1.4-1 and 10.1.4-2 of this manual and shall be long enough to develop the rods into the confined concrete core of the foundation. The rod length and the reinforcement for concrete confinement, shown in the top four feet of the Foundation Type 1, shall be used as a minimum.

4. Signal Foundation Design – Bridge Special Provisions 20021.GB8, 20051.GB8, and 20034041.FB8 shall be included with these foundation designs when specified by the Geotechnical engineer.

D. Foundation Quantities

1. Barrier quantities are approximate and can be used for all Foundation Types:

   Class 4000 Concrete 7.15 CY (over shaft foundation)
   Grade 60 rebar 372 lbs

2. Miscellaneous steel quantities (anchor rods, anchor plate, and template) for all Monotube Sign Structure foundation types are listed below (per foundation). Quantities vary with span lengths as shown.

   - 60 feet and under = 1,002 pounds
   - 61 feet to 90 feet = 1,401 pounds
   - 91 feet to 120 feet = 1,503 pounds
   - 121 feet to 150 feet Barrier mounted sign bridge not recommended for these spans.
3. Monotube Sign Bridge and Cantilever Sign Structure Type 1-3 Foundation quantities for concrete, rebar and excavation are given in Table 10.1.5-1. For Sign Bridges, the quantities shown below are for one foundation and there are two foundations per Sign Bridge. If the depth “Z” shown in the table on Appendix 10.1-A4-1 is increased, these values should be recalculated.

<table>
<thead>
<tr>
<th>Sign Structure Foundation Material Quantities</th>
<th>Cantilever Signs</th>
<th>Sign Bridges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Cl. 4000 (cu. yard)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type 1</td>
<td>6.3</td>
<td>7.5</td>
</tr>
<tr>
<td>Type 2</td>
<td>8.0</td>
<td>10.5</td>
</tr>
<tr>
<td>Type 3</td>
<td>11.1</td>
<td>14.1</td>
</tr>
<tr>
<td>Rebar Gr. 60 Pounds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type 1</td>
<td>685</td>
<td>1,027</td>
</tr>
<tr>
<td>Type 2</td>
<td>772</td>
<td>1,233</td>
</tr>
<tr>
<td>Type 3</td>
<td>917</td>
<td>1,509</td>
</tr>
<tr>
<td>Excavation (cu. yard)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type 1</td>
<td>9.8</td>
<td>10.9</td>
</tr>
<tr>
<td>Type 2</td>
<td>20.7</td>
<td>25.7</td>
</tr>
<tr>
<td>Type 3</td>
<td>29.0</td>
<td>34.6</td>
</tr>
</tbody>
</table>

Table 10.1.5-1

10.1.6 Truss Sign Bridges: Foundation Sheet Design Guidelines

If a Truss sign structure is used, refer to WSDOT Standard Plans for foundation details. There are four items that should be addressed when using the WSDOT Standard Plans, which are outlined below. For details for F-shape barrier details not shown in Standard Plans contact Bridge Office to access archived Bridge Office details.

1. Determine conduit needs. If none exist, delete all references to conduit. If conduit is required, verify with the Region as to size and quantity.
2. Show sign bridge base elevation, number, dimension and station.
3. Transition section shall be per Standard Plans.
4. The quantities shall be based on the Standard Plans details as needed.
10.2 Bridge Traffic Barriers

10.2.1 General Guidelines

The design criteria for traffic barriers on structures shall be in accordance with Section 13 of the AASHTO LRFD Bridge Design Specifications. The following guidelines supplement the requirements in AASHTO LRFD.

The WSDOT Bridge and Structures standard for new traffic barriers on structures is a 34" high Single Slope concrete barrier. It shall be used on all interstates, major highway routes, and over National Highway System (NHS) routes unless special conditions apply.

Use of an F Shape concrete bridge traffic barrier shall be limited to locations where there is F Shape concrete barrier on the approach grade to a bridge or for continuity within a corridor.

It shall be the Bridge and Structures Office policy to design traffic barriers for new structures using the Test Level 4 (TL-4) design criteria regardless of the height of the barrier safety shape (e.g., 2'-8", 2'-10", or 3'-6").

Loads shall be applied at the top of the barrier safety shape. If conditions require a higher test level, the test level shall be indicated in the general notes. A Test Level 5 (TL-5) traffic barrier shall be used on new structures under the following conditions:

- “T” intersections on a structure.
- Barriers on structures with a radius of curvature less than 500 ft, greater than 10% Average Daily Truck Traffic (ADTT), and where approach speeds are 50 mph or greater (e.g., freeway off-ramps). TL-4 is adequate for the barrier on the inside of the curve.

See AASHTO LRFD Section 13 for additional Test Level selection criteria.

A list of crash tested barriers can be found through the FHWA website at: http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/barriers/bridgerailings/index.cfm

10.2.2 Bridge Railing Test Levels

It must be recognized that bridge traffic barrier performance needs differ greatly from site to site. Barrier designs and costs should match facility needs. This concept is embodied in the AASHTO LRFD. Six different bridge railing test levels, TL-1 thru TL-6, and associated crash test/performance requirements are given in AASHTO LRFD Section 13 along with guidance for determining the appropriate test level for a given bridge.

10.2.3 Available WSDOT Designs

A. Service Level 1 (SL-1) Weak Post Guardrail (TL-2) – This bridge traffic barrier is a crash tested weak post rail system. It was developed by Southwest Research Institute and reported in NCHRP Report 239 for low-volume rural roadways with little accident history. This design has been utilized on a number of short concrete spans and timber bridges. A failure mechanism is built into this rail system such that upon a 10 kip applied impact load, the post will break away from the mounting bracket. The thrie beam guardrail will contain the vehicle by virtue of its ribbon strength. To ensure minimal or no damage to the bridge deck and stringers, the breakaway connection may be modified for a lower impact load (2 kip minimum) with approval of the Bridge Design Engineer. The 2 kip minimum equivalent impact load is based on evaluation of the wood rail post strength tested in NCHRP Report 239. The appropriate guardrail approach transition shall be a Case 14 placement as shown on WSDOT Standard Plan C-2h. For complete details see Appendix 10.4-A1.
B. **Texas T-411 Aesthetic Concrete Baluster (TL-2)** – Texas developed this standard for a section of highway that was considered to be a historic landmark. The existing deficient concrete baluster rail was replaced with a much stronger concrete baluster that satisfactorily passed the crash test performance criteria set forth by the NCHRP Report 230. For details, visit TXDOT’s Bridge and Structures website at www.txdot.gov/inside-txdot/division/bridge.html.

![Diagram of SL-1 Weak Post and Texas T-411](image)


C. **Traffic Barrier – 32” Shape F (TL-4)** – This configuration was crash tested in the late 1960s, along with the New Jersey Shape, under NCHRP 230 and again at this test level under NCHRP 350. The steeper vertical shape tested better than the New Jersey face and had less of an inclination to roll vehicles over upon impact. The 3” toe of the traffic barrier is the maximum depth that an ACP or HMA overlay can be placed. For complete details see Appendix 10.2-A1 and A2.
D. **Traffic Barrier – 34” Single Slope (TL-4)** – This concrete traffic barrier system was designed by the state of California in the 1990s to speed up construction by using the “slip forming” method of construction. It was tested under NCHRP 350. WSDOT has increased the height from 32” to 34” to match the approach traffic barrier height and to allow the placement of one HMA overlay. Due to inherent problems with the “slip forming” method of traffic barrier construction WSDOT has increased the concrete cover on the traffic side from 1½” to 2½”. For complete details, see Appendix 10.2-A3.

![32” F-Shape](image1)

![34” Single Slope](image2)

*Figure 10.2.3-2*

E. **Pedestrian Barrier (TL-4)** – This crash tested rail system offers a simple to build concrete alternative to the New Jersey and F-Shape configurations. This system was crash tested under both NCHRP 230 and 350. Since the traffic face geometry is better for pedestrians and bicyclists, WSDOT uses this system primarily in conjunction with a sidewalk. For complete details, see Appendix 10.2-A4.
F. **Oregon 3-Tube Curb Mounted Traffic Barrier (TL-4)** – This is another crash tested traffic barrier that offers a lightweight, see-through option. This system was crash tested under both NCHRP 230 and 350. A rigid thrie beam guardrail transition is required at the bridge ends. For details, see the Oregon Bridge and Structure website at [www.oregon.gov/ODOT/HWY/ENGSERVICES/Pages/bridge_drawings.aspx](http://www.oregon.gov/ODOT/HWY/ENGSERVICES/Pages/bridge_drawings.aspx).

![Figure 10.2.3-3](image)

G. **Traffic Barrier – 42” Shape F (TL-4 and TL-5)** – This barrier is very similar to the 32” F-shape concrete barrier in that the slope of the front surface is the same except for height. For complete details, see Appendix 10.2-A5.
H. Traffic Barrier – 42” Single Slope (TL-4 and TL-5) – This option offers a simple to build alternative to the Shape F configuration. For complete details see Appendix 10.2-A6.

AASHTO LRFD Appendix A13 shall be used to design bridge traffic barriers and their supporting elements (i.e. the deck).

Concrete traffic barriers shall be designed using yield line analysis as described in AASHTO LRFD A13.3.1. WSDOT Standard F Shape and Single Slope barriers meet these requirements.

Deck overhangs supporting traffic barriers shall be designed per AASHTO LRFD A13.4. For concrete traffic barriers in Design Case 1, AASHTO requires $M_S$, the deck overhang flexural resistance, to be greater than $M_c$ of the concrete traffic barrier base. This requirement is consistent with yield line analysis (see AASHTO LRFD CA13.3.1), but results in overconservative deck overhang designs.

In order to prevent this unnecessary overdesign of the deck overhang, the nominal traffic barrier resistance to transverse load $R_W$ (AASHTO LRFD A13.3.1) transferred from the traffic barrier to deck overhang shall not exceed 120 percent of the design force $F_t$ (AASHTO LFRD Table A13.2-1) required for a traffic barrier.
The deck overhang shall be designed in accordance with the requirements of AASHTO LRFD A13.4.2 to provide a flexural resistance $M_s$, acting coincident with the tensile force $T$. At the inside face of the barrier $M_s$ may be taken as:

- for an interior barrier segment - $M_s = \frac{R_w \cdot H}{L_C + 2 \cdot H}$

and for an end barrier segment - $M_s = \frac{R_w \cdot H}{L_C + H}$

However, $M_s$ need not be taken greater than $M_c$ at the base. $T$ shall be taken as:

- for an interior barrier segment - $T = \frac{R_w}{L_C + 2 \cdot H}$

and for an end barrier segment - $T = \frac{R_w}{L_C + H}$

The end segment requirement may be waived if continuity between adjacent barriers is provided.

When an HMA overlay is required for initial construction, increase the weight for Shape F traffic barrier. See Section 10.2.4.C for details.

B. Geometry – The traffic face geometry is part of the crash test and shall not be modified. Contact the WSDOT Bridge and Structure Office Traffic Barrier Specialist for further guidance.

Thickening of the traffic barrier is permissible for architectural reasons. Concrete clear cover must meet minimum concrete cover requirements but can be increased to accommodate rustication grooves or patterns.

C. Standard Detail Sheet Modifications – When designing and detailing a bridge traffic barrier on a superelevated bridge deck the following guidelines shall be used:

- For bridge decks with a superelevation of 8% or less, the traffic barriers (and the median barrier, if any) shall be oriented perpendicular to the bridge deck.
- For bridge decks with a superelevation of more than 8%, the traffic barrier on the low side of the bridge (and median barrier, if any) shall be oriented perpendicular to an 8% superelevated bridge deck. For this situation, the traffic barrier on the high side of the bridge shall be oriented perpendicular to the bridge deck.

The standard detail sheets are generic and may need to be modified for each project. The permissible modifications are:

- Removal of the electrical conduit, junction box, and deflection fitting details.
- Removal of design notes.
- If the traffic barrier does not continue on to a wall, remove W1 and W2 rebar references.
- Removal of the non-applicable guardrail end connection details and verbiage.
- If guardrail is attached to the traffic barrier, use either the thrie beam end section “Design F” detail or the w-beam end section “Design F” detail.

If the traffic barrier continues off the bridge, approach slab, or wall, remove the following:

- Guardrail details from all sheets.
- Conduit end flare detail.
- Modified end section detail and R1A or R2A rebar details from all sheets.
- End section bevel.
- Increase the 3” toe dimension of the Shape F traffic barriers up to 6” to accommodate HMA overlays.
### Barrier Impact Design Forces on Traffic Barrier & Deck Overhang

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Type F 32 in. (TL-4)</th>
<th>Single Slope 34 in. (TL-4)</th>
<th>Type F 42 in. (TL-4)</th>
<th>Single Slope 42 in. (TL-5)</th>
<th>Type F 42 in. (TL-5)</th>
<th>Single Slope 42 in. (TL-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average $M_c$ (ft-kips/ft)</td>
<td>20.55</td>
<td>20.55</td>
<td>19.33</td>
<td>19.33</td>
<td>25.93</td>
<td>25.93</td>
</tr>
<tr>
<td>$M_c$ at Base (ft-kips/ft)</td>
<td>27.15</td>
<td>27.15</td>
<td>26.03</td>
<td>26.03</td>
<td>32.87</td>
<td>32.87</td>
</tr>
<tr>
<td>$M_w$ (ft-kips)</td>
<td>42.47</td>
<td>46.04</td>
<td>46.01</td>
<td>43.16</td>
<td>72.54</td>
<td>71.72</td>
</tr>
<tr>
<td>$L_c$ (ft)</td>
<td>8.62</td>
<td>4.76</td>
<td>9.30</td>
<td>4.81</td>
<td>10.77</td>
<td>5.32</td>
</tr>
<tr>
<td>$R_w$ (kips)</td>
<td>132.82</td>
<td>73.32</td>
<td>126.92</td>
<td>65.69</td>
<td>159.62</td>
<td>78.83</td>
</tr>
<tr>
<td>$F_t$ (kips)</td>
<td>54.00</td>
<td>54.00</td>
<td>54.00</td>
<td>54.00</td>
<td>54.00</td>
<td>54.00</td>
</tr>
</tbody>
</table>

**Traffic barrier cross sectional dimensions and reinforcement used for calculation of end segment parameters are the same as interior segments. Parameters for modified end segments shall be calculated per AASHTO-LRFD article A13.3, A13.4, and the WSDOT BDM.**

**a = 1 for an end segment and 2 for an interior segment**

*Loads are based on vehicle impact only. For deck overhang design, the designer must also check other limit states per LRFD A13.4.1.*

$f_v = 60$ ksi

$f_c = 4$ ksi

---

Table 10.2.4-1
D. Miscellaneous Design Information

- Show the back of pavement seat in the “Plan – Traffic Barrier” detail.
- At roadway expansion joints, show traffic barrier joints normal to centerline except as shown on sheets Appendix 9.1-A1-1 and A2-1.
- When an overlay is required, the 2’-8” minimum dimension shown in the “Typical Section – Traffic Barrier” shall be referenced to the top of the overlay.
- When bridge lighting is part of the contract, include the lighting bracket anchorage detail sheet.
- Approximate quantities for the traffic barrier sheets are:

<table>
<thead>
<tr>
<th>Barrier Type</th>
<th>Concrete Weight (lb/ft)</th>
<th>Steel Weight (lb/ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>32” F-shape (3” toe)</td>
<td>455</td>
<td>18.6</td>
</tr>
<tr>
<td>32” F-shape (6” toe)</td>
<td>510</td>
<td>19.1</td>
</tr>
<tr>
<td>34” Single Slope</td>
<td>490</td>
<td>16.1</td>
</tr>
<tr>
<td>42” F-shape (3” toe)</td>
<td>710</td>
<td>25.8</td>
</tr>
<tr>
<td>42” F-shape (6” toe)</td>
<td>765</td>
<td>28.4</td>
</tr>
<tr>
<td>42” Single Slope</td>
<td>670</td>
<td>22.9</td>
</tr>
<tr>
<td>32” Pedestrian</td>
<td>640*</td>
<td>14.7</td>
</tr>
</tbody>
</table>

Using concrete class 4000 with a unit weight of 155 lb/ft³
*with 6” sidewalk, will vary with sidewalk thickness

- Steel Reinforcement Bars:
  S₁ & S₂ or S₃ & S₄ and W₁ & W₂ bars (if used) shall be included in the Bar List. S₁, S₃, and W₁ bars shall be epoxy coated.
10.3 At Grade Traffic Barriers

10.3.1 Median Barriers

The top of the median traffic barrier shall have a minimum width of 6". If a luminaire or sign is to be mounted on top of the median traffic barrier, then the width shall be increased to accommodate the mounting plate and 6" of clear distance on each side of the luminaire or sign pole. The transition flare rate shall follow the WSDOT Design Manual M 22-01.

A. Differential Grade Median Barriers – Barriers at grade are sometimes required in median areas with different roadway elevations on each side. The standard Single Slope barrier can be used for a grade difference up to 10" for a 2'-10" safety shape and up to 6" for a 3'-6" safety shape. See Standard Plans C-70.10 and C-80.10 for details.

If the difference in grade elevations is 4'-0" or less, then the barrier shall be designed as a rigid system in accordance with AASHTO LRFD Bridge Design Specifications with the following requirements:

1. All applicable loads shall be applied in accordance to AASHTO LRFD Section 3. The structural capacity of the differential grade barrier and supporting elements shall be designed for the required Test Level vehicle impact design forces in accordance with AASHTO LRFD Sections 5 and 13. Any section along the differential grade barrier and supporting elements shall not fail in shear, bending, or torsion when the barrier is subjected to the TL impact forces.
2. For soil loads without vehicle impact loads, the barrier shall be designed as a retaining wall (barrier weight resists overturning and sliding). Passive soil resistance may be considered with concurrence by the geotechnical engineer.
3. Vehicle impact loads shall be applied to the top of barrier on the side of the barrier retaining soil.
4. For soil loads with vehicle impact loads, the AASHTO LRFD Extreme Event loading for vehicular collision shall also be analyzed. Equivalent Static Load (ESL) per NCHRP Report 663 may be applied as the transverse vehicle impact load for evaluating sliding, bearing, and overturning only. For TL-3 and TL-4 barrier systems, the ESL shall be 10 kips and for TL-5, the ESL shall be 23 kips.
5. The length of the barrier required for stability shall be no more than 10 times the overall height limited to the length between barrier expansion joints (or one precast section). The barrier shall act as a rigid body behavior and shall be continuous throughout this length of barrier. Any coupling between adjacent barrier sections or friction that may exist between free edges of barrier and the surrounding soil shall be neglected.
6. A special impact analysis shall be performed at the barrier ends if the barrier terminates without being connected to a rigid object or dowelled to another barrier. Differential barrier deflection from barrier impact may cause a vehicle to “snag” on the undeflected barrier. The barrier depth may need to be increased at the end to prevent this deflection.
7. The differential grade traffic barrier shall have dummy joints at 8 to 12 foot centers based on project requirements.
8. Full depth expansion joints with shear dowels at the top will be required at intervals based on analysis but not to exceed a 120'-0" maximum spacing.
9. Barrier bottom shall be embedded a minimum 6” below roadway. Roadway subgrade and ballast shall be extended below whole width of differential grade barrier.

Median traffic barriers with a grade difference greater than 4'-0" shall be designed as standard plan retaining walls with a traffic barrier at the top and a barrier shape at the cut face.
## 10.3.2 Shoulder Barriers

At grade CIP shoulder barriers are sometimes used adjacent to bridge sidewalk barriers in lieu of standard precast Type 2 barriers. This barrier cross section has an equivalent mass and resisting moment for stability as the embedded double-face New Jersey Traffic Barrier which has been satisfactorily crash tested. A wire rope and pin connection shall be made at the bridge barrier end section per Standard Plan C-8. If a connection is made to an existing traffic barrier or parapet on the bridge, 15-inch long holes shall be drilled for the wire rope connection and shall be filled with an epoxy bonding agent.

## 10.3.3 Traffic Barrier Moment Slab

A. **General** – The guidelines provided herein are based on NCHRP Report 663 with the exception that a resistance factor of 0.5 shall be used to determine rotational resistance. This guideline is applicable for TL-3, TL-4, and TL-5 barrier systems as defined in Section 13 of *AASHTO LRFD Bridge Design Specifications*.

![Global Stability of Barrier–Moment Slab System](image)

B. **Guidelines for Moment Slab Design**

1. **Structural Capacity** – The structural capacity of the barrier and concrete moment slab shall be designed using impulse loads at appropriate Test Level (TL-3, TL-4, TL-5) applied to the top of the barrier in accordance with Sections 5 and 13 of *AASHTO LRFD Bridge Design Specifications*. Any section along the moment slab shall not fail in shear, bending, or torsion when the barrier is subjected to the design impact loads. The torsion capacity of the moment slab must be equal to or greater than the traffic barrier moment generated by the specified TL impulse load.

   The moment slab shall be designed as a deck supporting barrier in accordance to AASHTO LRFD A13.4.2 as modified by BDM 10.2.4.A. The moment slab reinforcement shall be designed to resist combined forces from the moment $M_s$ (kip-ft/ft) and the tensile force $T$ (kip/ft). $M_s$ and $T$ are determined from the lesser of the ultimate transverse resistance of barrier $R_W$ (kip) and 120% of transverse vehicle impact force $F_T$ (kip). $M_s$ is not to be exceeded by the ultimate strength of barrier at its base $M_C$ (kip-ft/ft).

2. **Global Stability** – Bearing stress, sliding, and overturning stability of the moment slab shall be based on an Equivalent Static Load (ESL) applied to the top of the traffic barrier. For TL-3 and TL-4 barrier systems, the ESL shall be 10 kips. For TL-5 barrier systems, the ESL shall be 23 kips.
The Equivalent Static Load (ESL) is assumed to distribute over the length of continuous moment slab through rigid body behavior. Barrier shall also be continuous or have shear connections between barrier sections if precast throughout this length of moment slab. Any coupling between adjacent moment slabs or friction that may exist between free edges of the moment slab and the surrounding soil should be neglected.

3. **Minimum and Maximum Dimensions** – Moment slabs shall have a minimum width of 4.0 feet measured from the point of rotation to the heel of the slab and a minimum average depth of 0.83 feet. Moment slabs meeting these minimum requirements are assumed to provide rigid body behavior up to a length of 60 feet limited to the length between moment slab joints.

Rigid body behavior may be increased from 60 feet to a maximum of 120 feet if the torsional rigidity constant of the moment slab is proportionately increased and the reinforcing steel is designed to resist combined shear, moment, and torsion from TL impulse loads.

For example: Rigid Body Length = \(\frac{J'}{J_{60}}\times(60 \text{ ft.}) < 120 \text{ feet}\)

The torsional rigidity constant for moment slabs shall be based on a solid rectangle using the following formula:

\[
J = a \cdot b^3 \left[ \frac{16}{3} - 3.36 \left( \frac{b}{a} \right) \left( 1 - \frac{b^4}{12a^4} \right) \right]
\]

Where:
- \(2a\) = total width of moment slab
- \(2b\) = average depth of moment slab

For example:
Minimum Moment Slab Width = 48 inches: \(a\) = 24 inches
Minimum Moment Slab Average Depth = 10 inches: \(b\) = 5 inches
\(J = J_{60} = 13,900 \text{ in}^4\)

4. **Sliding of the Barrier** – The factored static resistance to sliding (\(\phi P\)) of the barrier-moment slab system along its base shall satisfy the following condition (Figure 2).

\[
\phi P \geq \gamma Ls
\]

Where:
- \(L_s\) = Equivalent Static Load (10 kips for TL-3 and TL-4) (23 kips for TL-5)
- \(\phi\) = resistance factor (0.8) Supersedes AASHTO 10.5.5.3.3—Other Extreme Limit States
- \(\gamma\) = load factor (1.0) for TL-3 and TL-4 [crash tested extreme event]
  load factor (1.2) for TL-5 [untested extreme event]
- \(P\) = static resistance (kips)
  \(P\) shall be calculated as:

\[
P = W \tan \phi_r
\]

Where:
- \(W\) = weight of the monolithic section of barrier and moment slab between joints or assumed length of rigid body behavior whichever is less, plus any material laying on top of the moment slab
- \(\phi_r\) = friction angle of the soil on the moment slab interface (°)

If the soil-moment slab interface is rough (e.g., cast in place), \(\phi_r\) is equal to the friction angle of the soil \(\phi_s\). If the soil-moment slab interface is smooth (e.g., precast), \(\tan \phi_r\) shall be reduced accordingly \((0.8 \tan \phi_s)\).
5. **Overturning of the Barrier** – The factored static moment resistance \((\varphi M)\) of the barrier-moment slab system to over-turning shall satisfy the following condition (Figure 1).

The factored static moment resistance \((\varphi M)\) of the barrier-moment slab system to overturning shall satisfy the following condition (Figure 1).

\[
\varphi M \geq \gamma L_s h_a
\]

Where:
- \(A\) = point of rotation, where the toe of the moment slab makes contact with compacted backfill adjacent to the fascia wall
- \(L_w\) = width of moment slab
- \(L_s\) = Equivalent Static Load (10 kips for TL-3 and TL-4) (23 kips for TL-5)
- \(\varphi\) = resistance factor (0.5) Supersedes AASHTO 10.5.3.3—Other Extreme Limit States and NCHRP Report 663
- \(\gamma\) = load factor (1.0) for TL-3 and TL-4 [crash tested extreme event]
  load factor (1.2) for TL-5 [untested extreme event]
- \(h_a\) = moment arm taken as the vertical distance from the point of impact due to the dynamic force (top of the barrier) to the point of rotation \(A\)
- \(M\) = static moment resistance (kips-ft)
  \(M\) shall be calculated as:
  \[
  M = W \left( L_a \right)
  \]
- \(W\) = weight of the monolithic section of barrier and moment slab between joints or assumed length of rigid body behavior whichever is less, plus any material laying on top of the moment slab
- \(L_a\) = horizontal distance from the center of gravity of the weight \(W\) to point of rotation \(A\)

The moment contribution due to any coupling between adjacent moment slabs, shear strength of the overburden soil, or friction which may exist between the backside of the moment slab and the surrounding soil shall be neglected.

C. **Guidelines for the Soil Reinforcement** – Design of the soil reinforcement shall be in accordance with the WSDOT Geotechnical Design Manual M 46-03, Chapter 15.

D. **Design of the Wall Panel** – The wall panels shall be designed to resist the dynamic pressure distributions as defined in the WSDOT Geotechnical Design Manual, Chapter 15.

The wall panel shall have sufficient structural capacity to resist the maximum design rupture load for the wall reinforcement designed in accordance with the WSDOT Geotechnical Design Manual, Chapter 15.

The static load is not included because it is not located at the panel connection.
10.3.4 Precast Traffic Barrier

A. Concrete Barrier Type 2 – “Concrete Barrier Type 2” (see Standard Plan C-8) may be used on bridges for median applications or for temporary traffic control based on the following guidelines:

1. For temporary applications, no anchorage is required if there is 2 feet or greater slide distance between the back of the traffic barrier and an object and 3 feet or greater to the edge of the bridge deck or a severe drop off (see WSDOT Design Manual M 22-01).

2. For permanent applications in the median, no anchorage will be required if there is 2 feet or greater slide distance between the traffic barrier and the traffic lane.

3. For temporary applications, the traffic barrier shall not be placed closer than 9 inches or 6 inches to the edge of a bridge deck or substantial drop-off and shall be anchored (see Standard Plans K-80.35 and K-80.37).

4. The traffic barrier shall not be used to retain soil that is sloped or greater than the barrier height or soil that supports a traffic surcharge.

B. Concrete Barrier Type 4 and Alternative Temporary Concrete Barrier – “Concrete Barrier Type 4 (see the Standard Plan C-8a), is not a free standing traffic barrier. This barrier shall be placed against a rigid vertical surface that is at least as tall as the traffic barrier. In addition, Alternative Temporary Concrete Barrier Type 4 – Narrow Base (Standard Plan K-80.30) shall be anchored to the bridge deck as shown in Standard Plan K-80.37. The “Concrete Barrier Type 4 and Alternative Temporary Concrete Barrier” are not designed for soil retention.
10.4 Bridge Traffic Barrier Rehabilitation

10.4.1 Policy
The bridge traffic barrier retrofit policy is: “to systematically improve or replace existing deficient rails within the limits of roadway resurfacing projects.” This is accomplished by:

- Utilizing an approved crash tested rail system that is appropriate for the site or
- Designing a traffic barrier system to the strength requirements set forth by Section 2 of AASHTO Standard Specifications for Highway Bridges, 17th edition.”

10.4.2 Guidelines
A strength and geometric review is required for all bridge rail rehabilitation projects. If the strength of the existing bridge rail is unable to resist an impact of 10 kips or has not been crash tested, then modifications or replacement will be required to improve its redirectional characteristics and strength. Bridges that have deficient bridge traffic barriers were designed to older codes. The AASHTO LFD load of 10 kips shall be used in the retrofit of existing traffic barrier systems constructed prior to the year 2000. The use of the AASHTO LRFD criteria to design traffic barrier rehabs will result in a bridge deck that has insufficient reinforcement to resist moment from a traffic barrier impact load and will increase the retrofit cost due to expensive deck modifications.

10.4.3 Design Criteria
Standard thrie beam guardrail post spacing is 6’-3” except for the SL-1 Weak Post, which is at 8’-4”. Post spacing can be increased up to 10’-0” if the thrie beam guardrail is nested (doubled up).

Gaps in the guardrail are not allowed because they produce snagging hazards. The exceptions to this are:

- Movable bridges at the expansion joints of the movable sections.
- At traffic gates and drop down net barriers.
- At stairways.

Design F guardrail end sections will be used at the approach and trailing end of these gaps.

For Bridge Traffic Barrier Rehabilitation the following information will be needed from the Region Design office:

- Bridge Site Data Rehabilitation Sheet – DOT Form 235-002A.
- Photos, preferably digital Jpegs.
- Layout with existing dimensions.
- Standard Plan thrie beam guardrail transitions (selected by Region Design office) to be used at each corner of the bridge (contact bridges and structures office for thrie beam height).
- Location of any existing utilities.
- Measurements of existing ACP to top of curb at the four corners, midpoints and the locations of minimum and maximum difference (five locations each side as a minimum).
- Diagram of the location of Type 3 anchors, if present, including a plan view with vertical and horizontal dimensions of the location of the Type 3 anchor connection relative to the intersecting point of the back of pavement seat with the curb line.
- The proposed overlay type, quantities of removal and placement.
- For timber bridges, the field measurement of the distance from the edge of bridge deck to the first and second stringer is required for mounting plate design.

Placement of the retrofit system will be determined from the WSDOT Design Manual M 22-01. Exceptions to this are bridges with sidewalk strength problems, pedestrian access issues, or vehicle snagging problems.
10.4.4 WSDOT Bridge Inventory of Bridge Rails

The WSDOT Bridge Preservation office maintains an inventory of all bridges in the state on the State of Washington Inventory of Bridges.

Concrete balusters are deficient for current lateral load capacity requirements. They have approximately 3 kips of capacity whereas 10 kips is required.

The combination high-base concrete parapet and metal rail may or may not be considered adequate depending upon the rail type. The metal rail Type R, S, and SB attached to the top of the high-base parapet are considered capable of resisting the required 5 kips of lateral load. Types 3, 1B, and 3A are considered inadequate. See the WSDOT Design Manual M 22-01 for replacement criteria.

10.4.5 Available Retrofit Designs

A. Washington Thrie Beam Retrofit of Concrete Balusters – This system consists of thrie beam guardrail stiffening of existing concrete baluster rails with timber blockouts. The Southwest Research Institute conducted full-scale crash tests of this retrofit in 1987. Results of the tests were satisfactory and complied with criteria for a Test Level 2 (TL-2) category in the Guide Specifications. For complete details see Appendix 10.4-A1-1.

B. New York Thrie Beam Guardrail – This crash tested rail system can be utilized at the top of a raised concrete sidewalk to separate pedestrian traffic from the vehicular traffic or can be mounted directly to the top of the concrete deck. For complete details see Thrie Beam Retrofit Concrete Curb in Appendix 10.4-A1-3.

C. Concrete Parapet Retrofit – This is similar to the New York system. For complete details see Appendix 10.4-A1-2.

D. SL-1 Weak Post – This design has been utilized on some short concrete spans and timber bridges. A failure mechanism is built into this rail system so that upon impact with a 10 kip load the post will break away from the mounting bracket. The thrie beam guardrail will contain the vehicle by virtue of its ribbon strength. To ensure minimal damage to the bridge deck and stringers, the breakaway connection may be modified for a lower impact load (2 kip minimum) with approval of the Bridge Design Engineer. For complete details, see Appendix 10.4-A1-4.

10.4.6 Available Replacement Designs

A. Traffic Barrier – Shape F Retrofit – This is WSDOT’s preferred replacement of deficient traffic barriers and parapets on high volume highways with a large truck percentage. All interstate highway bridges shall use this type of barrier unless special conditions apply. For complete details see Appendix 10.4-A2.
Chapter 10  Signs, Barriers, Approach Slabs, and Utilities

10.5 Bridge Railing

10.5.1 Design

WSDOT pedestrian and bike/pedestrian railings are designed in accordance with Chapter 13 in the AASHTO LRFD Bridge Design Specifications. The AASHTO LRFD Bridge Design Specifications calls for a minimum of 42” for bicycle railings whereas WSDOT requires a minimum height of 54” on structures. The railings in Section 10.5.2 are not designed for vehicular impact loads assuming location is low speed, location is outside of Design Clear Zone as defined in Chapter 1600 in WSDOT Design Manual M 21-01, or location has minimal safety consequence from collapse of railing. Railings for other locations shall be designed for vehicular impact loads in accordance with Chapter 13 and/or 15 in the AASHTO LRFD Bridge Design Specifications. Emergency and maintenance access shall be considered.

10.5.2 Railing Types

A. Bridge Railing Type Pedestrian – This pedestrian railing is designed to sit on top of the 32” and 34” traffic barriers and to meet pedestrian height requirements of 42”. For complete details see Appendix 10.5-A1.

B. Bridge Railing Type BP and S-BP – These railings are designed to meet WSDOT’s minimum bicycle height requirements of 54”, and sit on top of the 32” and 34” traffic barriers.

There are two versions—the BP and S-BP. The BP is the standard railing and is made out of aluminum. The S-BP is the steel version designed for use in rural areas because of aluminum theft. For complete details see Appendix 10.5-A2 and A3.

C. Pedestrian Railing – This railing is designed to sit on top of a six-inch curb on the exterior of a bridge sidewalk. It meets the bicycle height requirements of 54”. For complete details see Appendix 10.5-A4.

D. Bridge Railing Type Chain Link Snow Fence and Bridge Railing Type Snow Fence – This railing is designed to prevent large chunks of plowed snow from falling off the bridge on to traffic below. For complete details see Appendix 10.5-A5-1 through 10.5-A5-3.

E. Bridge Railing Type Chain Link Fence – This railing is designed to minimize the amount of objects falling off the bridge on to traffic below. For complete details see Appendix 10.5-A5-4.
10.6 Bridge Approach Slabs

Bridge approaches typically experience two types of settlement, global and local. Global settlement is consolidation of the deeper natural foundation soils. Local settlement is mainly compression of fill materials directly beneath the approach pavement due to construction. The combination of global and local settlements adjacent to the bridge end piers form the characteristic “bump” in the pavement at the bridge. The approach slab significantly reduces local settlement and will provide a transition to the long term roadway differential settlements. Generally, abutments with a deep foundation will have greater differential roadway settlements than spread footing foundations.

When Are Approach Slabs Required – Bridge approach slabs are required for all new and widened bridges, except when concurrence is reached between the Geotechnical Branch, the Region Design Project Engineer Office, and the Bridge and Structures Office, that approach slabs are not appropriate for a particular site. In accordance with WSDOT Design Manual M 21-01, the State Geotechnical Engineer will include a recommendation in the geotechnical report for a bridge on whether or not bridge approach slabs should be used at the bridge site. Factors considered while evaluating the need for bridge approach slabs include the amount of expected settlement and the type of bridge structure.

Standard Plan A-40.50 – The Standard Plan A-40.50 is available for the Local Agencies (or others) to use or reference in a contract. Bridge and Structures Office designs will provide detailed information in a customized approach slab Plan View and show the approach slab length on the Bridge Layout Sheet.

Bridge Runoff – Bridge runoff at the abutments shall be carried off and collected at least 10 feet beyond the bridge approach slab. Drainage structures such as grate inlets and catch basins shall be located in accordance with Standard Plan B-95.40 and the recommendations of the Hydraulics Branch.

Approach Pay Item – All costs in connection with constructing bridge approach slabs are included in the unit contract price per square yard for “Bridge Approach Slab.” The pay item includes steel reinforcing bars, approach slab anchors, concrete, and compression seals.

10.6.1 Notes to Region for Preliminary Plan

All bridge preliminary plans shall show approach slabs at the ends of the bridges. In the Notes to Region in the first submittal of the Preliminary Plan to the Region, the designer shall ask the following questions:

1. Bridge approach slabs are shown for this bridge, and will be included in the Bridge PS&E. Do you concur?

2. The approach ends of the bridge approach slabs are shown normal to the survey line (a) with or (b) without steps (the designer shall propose one alternative). Do you concur?

3. Please indicate the pavement type for the approach roadway.

Depending on the type and number of other roadway features present at the bridge site (such as approach curbs and barriers, drainage structures, sidewalks, utilities and conduit pipes) or special construction requirements such as staged construction, other questions in the Notes to Region pertaining to the bridge approach slabs may be appropriate.

Special staging conditions exist when the abutment skew is greater than 30° and for wide roadway widths. This includes bridge widenings with (or without) existing bridge approach slabs. The preliminary plan should include details showing how these conditions are being addressed for the bridge approach slabs, and the designer shall include appropriate questions in the Notes to Region asking for concurrence with the proposed design.
10.6.2 Approach Slab Design Criteria

The standard bridge approach slab design is based on the following criteria:

1. The bridge approach slab is designed as a slab in accordance with AASHTO LRFD. (Strength Limit State, IM = 1.33, no skew).

2. The support at the roadway end is assumed to be a uniform soil reaction with a bearing length that is approximately \( \frac{1}{3} \) the length of the approach slab, or \( 25/3 = 8' \).

3. The Effective Span Length \( (S_{\text{eff}}) \), regardless of approach length, is assumed to be:

\[
25' \text{ approach} - 8' = 17'
\]

4. Longitudinal reinforcing bars do not require modification for skewed approaches up to 30° or for slab lengths greater than 25'.

5. The approach slab is designed with a 2” concrete cover to the bottom reinforcing.

10.6.3 Bridge Approach Slab Detailing

The bridge approach slab and length along center line of project shall be shown in the Plan View of the Bridge Layout sheet. The Bridge Plans will also include approach slab information as shown on Plan Sheets 10-A1-1, 10-A1-2, and 10-A1-3. The Approach Slab Plan sheets should be modified as appropriate to match the bridge site conditions. Approach slab Plan Views shall be customized for the specific project and all irrelevant details shall be removed.

Plan View dimensions need to define the plan area of the approach slab. The minimum dimension from the bridge is 25'. If there are skewed ends, then dimensions need to be provided for each side of the slab, or a skew angle and one side, in addition to the width. For slabs on a curve, the length along the project line and the width need to be shown.

Similar to Bridge Traffic Barrier detailing, approach slab steel detailing need only show size, spacing, and edge clearance. The number and total spaces can be determined by the contractor. If applicable, the traffic barrier AS1 and AS2 along with the extra top transverse bar in the slab need to be shown in the Plan View. AS1 bars shall be epoxy coated. Also remember that the spacing of the AS1 bars decreases near joints. When the skew is greater than 20°, then AP8 bars need to be rotated at the acute corners of the bridge approach slab.

Bending diagrams shall be shown for all custom reinforcement. All Approach Slab sheets will have the AP2 and AP7 bars. If there is a traffic barrier, then AP8, AS1, and AS2 bars shall be shown.

Additional layout and details may be required to address special roadway features and construction requirements such as: roadway curbs and barriers, sidewalks, utilities and conduits and staging. This means, if sidewalks and interior barriers (such as traffic-pedestrian barriers) are present, special details will be required in the Bridge Plans to show how the sidewalks and interior barriers are connected to and constructed upon the bridge approach slab. If the bridge construction is staged, then the approach slabs will also require staged construction.

10.6.4 Skewed Approach Slabs

For all skewed abutments, the roadway end of the bridge approach slab shall be normal to the roadway centerline. The Bridge Design Engineer should be consulted when approach slab skew is greater than 30°. Higher skewed bridges require modifications to the bottom mat reinforcement, and may require expansion joint modifications.
The roadway end of the approach may be stepped to reduce the size or to accommodate staging construction widths. A general rule of thumb is that if the approach slab area can be reduced by 50 SY or more, then the slab should be stepped. At no point should the roadway end of the approach slab be closer than 25’ to the bridge. These criteria apply to both new and existing bridge approach slabs. If stepped, the design should provide the absolute minimum number of steps and the longitudinal construction joint shall be located on a lane line. See Figure 10.6.4-1 for clarification.

**Skewed Approach ~ Typical**

In addition, for bridges with traffic barriers and skews greater than 20°, the AP8 bars shall be rotated in the acute corners of the bridge approach slabs. Typical placement is shown in the flared corner steel detail, Figure 10.6.4-2.

**Skewed Approach ~ Stepped**

**Skewed Approach**  
*Figure 10.6.4-1*

**Flared Corner Steel**  
*Figure 10.6.4-2*
10.6.5 Approach Anchors and Expansion Joints

For semi-integral abutments or stub abutments, the Bridge Designer must check the joint design to make sure the movement of the standard joint is not exceeded. In general, the approach slab is assumed to be stationary and the joint gap is designed to vary with the bridge movement. Approach Slab Sheets 10-A1-3 and Standard Plan A-40.50 detail a typical 2 1/2” compression seal. For approach slabs with barrier, the compression seal should extend into the barrier.

Approach slab anchors installed at bridge abutments should be as shown in the Bridge Plans. For bridges with semi-integral type abutments, this can be accomplished by showing the approach slab anchors in the End Diaphragm or Pavement Seat details.

**L Type Abutments** – L type abutments do not require expansion joints or approach anchors because the abutment and approach slab are both considered stationary. A pinned connection is preferred. The L type abutment anchor detail, as shown in Figure 10.6.5-1, must be added to the abutment plan sheets. The pinned anchor for bridges with L type abutments shall be a #5 bar at one foot spacing, bent as shown, with 1’-0” embedment into both the pier and the bridge approach slab. This bar shall be included in the bar list for the bridge substructure.

![L Type Abutment Anchor Detail](image)

L Type Abutment Anchor Detail
*Figure 10.6.5-1*

10.6.6 Approach Slab Addition or Retrofit to Existing Bridges

When approach slabs are to be added or replaced on existing bridges, modification may be required to the pavement seats. Either the new approach slab will be pinned to the existing pavement seat, or attached with approach anchors with a widened pavement seat. Pinning is a beneficial option when applicable as it reduces the construction cost and time.

The pinning option is only allowed on semi-integral abutments as an approach slab addition or retrofit to an existing bridge. Figure 10.6.6-1 shows the pinning detail. As this detail eliminates the expansion joint between the approach slab and the bridge, the maximum bridge superstructure length is limited to 150’. The Bridge Design Engineer may modify this requirement on a case by case basis. Additionally, if the roadway end of the approach slab is adjacent to PCCP roadway, then the detail shown in Figure 10.6.6-2 applies. PCCP does not allow for as much movement as HMA and a joint is required to reduce the possibility of buckling.
When pinning is not applicable, then the approach slab must be attached to the bridge with approach anchors. If the existing pavement seat is less than 10 inches, the seat shall be replaced with an acceptable, wider pavement seat. The Bridge Design Engineer may modify this requirement on a site-specific basis. Generic pavement seat repair details are shown in Appendix 10.6-A2-1 for a concrete repair and Appendix 10.6-A2-2 for a steel T-section repair. These sheets can be customized for the project and added to the Bridge Plans.

When an approach slab is added to an existing bridge, the final grade of the approach slab concrete shall match the existing grade of the concrete bridge deck or concrete slab, including bridges with asphalt pavement. The existing depth of asphalt on the bridge must be shown in the Plans and an equal depth of asphalt placed on a new approach slab. If the existing depth of asphalt is increased or decreased, the final grade must also be shown on the Plans.

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**Pinned Approach Slab Detail**

*Figure 10.6.6-1*

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**PCCP Roadway Dowel Bar Detail**

*Figure 10.6.6-2*
10.6.7 Approach Slab Staging

Staging plans will most likely be required when adding or retrofitting approach slabs on existing bridges. The staging plans will be a part of the bridge plans and should be on their own sheet. Coordination with the Region is required to ensure agreement between the bridge staging sheet and the Region traffic control sheet. The longitudinal construction joints required for staging shall be located on lane lines. As there may not be enough room to allow for a lap splice in the bottom transverse bars, a mechanical splice option should be added. If a lap splice is not feasible, then only the mechanical splice option should be given. See Figure 10.6.6-3.

Alternate Longitudinal Joint Detail

*Figure 10.6.6-3*
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10.7  Traffic Barrier on Approach Slabs

Placing the traffic barrier on the approach slab is beneficial for the following reasons.
- The approach slab resists traffic impact loads and may reduce wing wall thickness
- Simplified construction and conduit placement
- Bridge runoff is diverted away from the abutment

Most bridges will have some long-term differential settlement between the approach roadway and the abutment. Therefore, a gap between the approach slab and wing (or wall) should be shown in the details. The minimum gap is twice the long-term settlement, or 2 inches as shown in Figure 10.7-1. A 3 inch gap is also acceptable.

When the traffic barrier is placed on the approach slab, the following barrier guidelines apply.
- Barrier should extend to the end of the approach slab
- Conduit deflection or expansion fittings must be called out at the joints
- Junction box locations should start and end in the approach
- The transverse top reinforcing in the slab must be sufficient to resist a traffic barrier impact load.
  A 6'-0" (hooked) #6 epoxy coated bar shall be added to the approach slab as shown in Figure 10.7-1.

![Figure 10.7-1](image_url)

10.7.1  Approach Slab over Wing Walls, Cantilever Walls or Geosynthetic Walls

All walls that are cast-in-place below the approach slab should continue the barrier soffit line to grade. This includes geosynthetic walls that have a cast-in-place fascia. Figure 10.7.1-1 shows a generic layout at an abutment. Note the sectional Gap Detail, Figure 10.7-1 applies.
10.7.2 Approach Slab over SE Walls

The tops of structure earth (SE) walls are uneven and must be covered with a fascia to provide a smooth soffit line. Usually SE walls extend well beyond the end of the approach slab and require a moment slab. Since SEW barrier is typically 5'-0" deep from the top of the barrier, the soffit of the SEW barrier and bridge barrier do not match. The transition point for the soffit line should be at the bridge expansion joint as shown in Figure 10.7.2-2. This requires an extended back side of the barrier at the approach slab to cover the uneven top of the SE wall.

Battered wall systems, such as block walls, use a thickened section of the curtain wall to hide some of the batter. The State Bridge and Structures Architect will provide dimensions for this transition when required.
10.8 Utilities Installed with New Construction

10.8.1 General Concepts

The utilities to be considered under this section are electrical (power and communications) volatile fluids (gas), water, and sewer/storm water pipes. The Bridge designer shall determine if the utility may be attached to the structure and the location. Bridge plans shall include all hardware specifications and details for the utility attachment as provided in any written correspondence with the utility.

The Specifications Engineer will contact the Region Utility Engineer for additional design or construction requirements that may be stipulated in the utility agreement.

Responsibilities of the Utility Company – The Region or utility company will initiate utility installations and provide design information. The utility company shall be responsible for calculating design stresses in the utility and design of the support system. Utility support design calculations with a State of Washington Professional Engineer stamp, signed and dated, shall be submitted to the Bridge and Structures Office for review. The following information shall be provided by the utility company and shown in the final Bridge Plans.

- Location of the utility outside the limits of the bridge structure
- Number of utilities, type, size, and weight (or Class) of utility lines
- Utility minimum bending radius for the conduit or pipeline specified

Utility General Notes and Design Criteria are stated in WSDOT Form 224-047 “General Notes and Design Criteria for Utility Installations to Existing Bridges”. See Figure 10.8.1-1. This form outlines most of the general information required by the utility company to design their attachments. The Bridge Office will generally provide the design for lightweight hanger systems, such as electrical conduits, attached to new structures.

Confined Spaces – A confined space is any place having a limited means of exit that is subject to the accumulation of toxic or flammable contaminants or an oxygen deficient environment. Confined spaces include but are not limited to pontoons, box girder bridges, storage tanks, ventilation or exhaust ducts, utility vaults, tunnels, pipelines, and open-topped spaces more than 4 feet in depth such as pits, tubes, vaults, and vessels.

Coating and Corrosion Protection – When the bridge is to receive pigmented sealer, consideration shall be given to painting any exposed utility lines and hangers to match the bridge. When a pigmented sealer is not required, steel utility conduits and hangers shall be painted or galvanized for corrosion protection. The special provisions shall specify cleaning and painting procedures.
General Notes and Design Criteria for Utility Installations to Existing Bridges

General Notes

All materials and workmanship shall be in accordance with the requirements of the state of Washington, Department of Transportation, Standard Specifications for Road, Bridge, and Municipal Construction, current edition. The utility conduits shall be labeled in accordance with Section 6-01.10.

All steel in utility supports, including fastenings and anchorages, shall be galvanized in accordance with AASHTO M-111 or M-232 (ASTM A-123 or A-153 respectively).

All utilities and utility support surfaces, including any galvanized utilities, shall be given a primer coat of state standard formula A-6-86 and two coats of state standard formula C-9-86. The final coat shall match the bridge color.

Galvanized metal or aluminum utilities completely hidden from public view may be exempted from the above painting requirements.

Any painted surfaces damaged during construction shall be cleaned and painted as noted above.

Any paint splatters shall be removed from the bridge.

Appearance of the utility installation shall be given serious consideration in all cases. Where possible, the utility installation shall be hidden from public view.

The notes and criteria explained here are presented as a guide only. Each proposed utility installation shall be submitted to the Department of Transportation for approval on an individual basis. Compliance with these criteria does not assure approval, nor does variance from these criteria, for reasonable cause, necessarily exclude approval.

Design Criteria

1. Pipelines carrying volatile fluids through a bridge superstructure shall be designed by the utility company in accordance with WAC 480-93, Gas Companies - Safety, and Minimum Federal Safety Standard, Title 49 Code of Federal Regulations (CFR) Section part 192. WAC 468-34-210, Pipelines - Encasement, describes when casing is required for conveying natural gas per the requirements of WAC 468-34-210. If casing is required, then WAC 468-34-210 and WAC 480-93-115 shall be followed.

2. Utilities shall not be attached above the bridge deck nor attached to railing or rail posts.

3. Utilities shall not extend below bottom of superstructure.
4. The utilities shall be provided with suitable expansion devices near bridge expansion joints and/or other locations as required to prevent temperature and other longitudinal forces from being transferred to bridge members.

5. Rigid conduit shall extend 10 feet (3 meters) minimum, beyond the end of the bridge abutment.

6. Utility supports shall be designed such that neither the conduit, the supports, nor the bridge members are overstressed by any loads imposed by the utility installation.

7. Utility locations and supports shall be designed so that a failure (rupture, etc.) will not result in damage to the bridge, the surrounding area, or be a hazard to traffic.

8. Conduit shall be rigid.

(Items 1 through 8 may be cross-referenced with Bridge Design Manual, Utilities Section.)

9. Lag screws may be used for attaching brackets to wooden structures. All bolt holes shall meet the requirements of Sections 6-04.3(4) and 6-04.3(5) of the Washington State Department of Transportation Standard Specifications for Road, Bridge, and Municipal Construction, current edition.

10. Welding across main members will not be permitted. All welding must be approved.

11. Utilities shall be located to minimize bridge maintenance and bridge inspection problems.

12. Attach conduits or brackets to the concrete superstructure with resin bond anchors. Lag screws shall not be used for attachment to concrete.

13. Drilling through reinforcing steel will not be permitted. If steel is hit when drilling, the anchorage location must be moved and the abandoned hole filled with nonshrink grout conforming to the requirements of Section 9-20.3(2) and placement shall be as required in Section 6-02.3(20) of the Washington State Department of Transportation Standard Specifications for Road, Bridge, and Municipal Construction, current edition.

14. There shall be a minimum of 3 inches (80 millimeters) edge distance to the center line of bolt holes in concrete.

15. All utilities and utility supports shall be designed not only to support their dead load but to resist other forces from the utility (surge, etc.) and wind and earthquake forces. The utility company may be asked to submit one set of calculations to verify their design forces.

16. Drilling into prestressed concrete members for utility attachments shall not be allowed.

17. Water or sewer lines to be placed lower than adjacent bridge footings shall be encased if failure can cause undermining of the footing.

General Notes and Design Criteria for Utility Installations to Existing Bridges (continued)

WSDOT Form 224-047

Figure 10.8.1-1
10.8.2 Utility Design Criteria

All utilities shall be designed to resist Strength and Extreme Event Limits States. This includes and not limited to dead load, expansion, surge, and earthquake forces. Designers should review WSDOT Form 224-047 “General Notes and Design Criteria for Utility Installations to Existing Bridges” and the items in this section when designing a utility system or providing a review for an existing bridge attachment. See Figure 10.8.1-1.

The Bridge Engineer shall review the utility design to ensure the utility support system will carry all transverse and vertical loading. Loading will include (and is not limited to): dead load, temperature expansion, dynamic action (water hammer), and seismic inertial load. Positive resistance to loads shall be provided in all directions perpendicular to and along the length of the utility as required by the utility engineer.

Where possible, dynamic fluid action loads shall be resisted off of the bridge. If these loads must be resisted on the bridge, the utility engineer shall be involved in the design of these supports. The utility engineer shall determine these design forces being applied to the bridge. Realize these forces can be generated in any pipe supporting moving fluids, which may include, but are not limited to: water, sewer, and storm water.

Where utilities are insulated, the insulation system shall be designed to allow the intended motion range of the hardware supporting the utility. This will prevent unanticipated stresses from being added to the hanger in the event the insulation binds up the hardware.

Utility Location – Utilities should be located, if possible, such that a support failure will not result in damage to the bridge, the surrounding area, or be a hazard to traffic. In most cases, the utility is installed between girders. Utilities and supports must not extend below the bottom of the superstructure. Utilities shall be installed no lower than 1 foot 0 inches above the bottom of the girders. In some cases when appurtenances are required (such as air release valves), care should be taken to provide adequate space. The utility installation shall be located so as to minimize the effect on the appearance of the structure. Utilities shall not be attached above the bridge deck nor attached to the railings or posts.

Termination at the Bridge Ends – Utility conduit and encasements shall extend 10 feet minimum beyond the ends of the structure in order to reduce effects of embankment settlement on the utility and provide protection in case of future work involving excavation near the structure. This requirement shall be shown on the plans. Utilities off the bridge must be installed prior to paving of approaches. This should be stated in the Special Provisions.

Utility Expansion – The utilities shall be designed with a suitable expansion system as required to prevent longitudinal forces from being transferred to bridge members.

Water mains generally remain a constant temperature and are anchored in the ground at the abutments. However, the bridge will move with temperature changes and seismic forces. Pipe support systems must be designed to allow for the bridge movements. For short bridges, this generally means the bridge will move and the utility will not since it is anchored at the abutments. For long bridges that require pipe expansion joints, design must carefully locate pipe expansion joints and the corresponding longitudinal load-carrying support.

Electrical conduits that use PVC should have an expansion device for every 100 foot of pipe due to the higher coefficient of expansion. If more than two joints are specified, a cable or expansion limiting device is required to keep the ends from separating.

Utility Blockouts – Blockouts shall be provided in all structural members that prohibit the passage of utilities, such as girder end diaphragms, pier crossbeams, and intermediate diaphragms. These blockouts shall be large enough to fit deflection fittings, and shall be parallel to the utility. For multiple utilities, a note shall be added to the plans that the deflection fittings shall be staggered such that no fitting is located adjacent to another, or the blockouts shall be designed to fit both fittings. Expansion fittings shall be staggered.
Gas Lines or Volatile Fluids – Pipelines carrying volatile fluids through a bridge superstructure shall be designed by the utility company in accordance with WAC 480-93, Gas Companies—Safety, and Minimum Federal Safety Standard, Title 49 Code of Federal Regulations (CFR) Section part 192. WAC 468-34-210, Pipelines—Encasement, describes when casing is required for carrying volatile fluids across structures. Generally, casing is not required for pipelines conveying natural gas per the requirements of WAC 468-34-210. If casing is required, then WAC 468-34-210 and WAC 480-93-115 shall be followed.

Water Lines – Water lines shall be galvanized steel pipe or ductile iron pipe. Transverse support or bracing shall be provided for all water lines to carry Strength and Extreme Event Lateral Loading. Fire control piping is a special case where unusual care must be taken to handle the inertial loads and associated deflections. The Utility Engineer shall be involved in the design of supports resisting dynamic action loads and deflections.

In box girders (closed cell), a rupture of a water line will generally flood a cell before emergency response can shut down the water main. This will be designed for as an Extreme Event II load case, where the weight of water is a dead load (DC). Additional weep holes or open grating should be considered to offset this Extreme Event (see Figure 10.8.3-1).

Sewer Lines – Normally, an appropriate encasement pipe is required for sewer lines on bridges. Sewer lines must meet the same design criteria as waterlines. See the utility agreement or the Hydraulic Section for types of sewer pipe material typically used.

Electrical (Power and Communications) – Telephone, television cable, and power conduit shall be galvanized Rigid Metal Conduit (RGS) or Rigid Polyvinyl Chloride Conduit (PVC). Where such conduit is buried in concrete curbs or barriers or has continuous support, such support is considered to be adequate. Where hangers or brackets support conduit at intervals, the maximum distance between supports shall be 5 feet. Generally, the conduit shall be designed to support the cable in bending without exceeding working stresses for the conduit material.

10.8.3 Box/Tub Girder Bridges

Utilities shall not be permitted inside reinforced concrete box girders less than 4 feet inside clear height and all precast prestressed concrete tub girders because reasonable access cannot be provided. Utilities shall be located between girders or under bridge deck soffit in these cases. Inspection lighting, access and ventilation shall always be provided in girder cells containing utilities. Refer to the concrete and steel chapters for additional details.

Continuous Support and Concrete Pedestals – Special utilities (such as water or gas mains) in box girder bridges should use concrete pedestals. This allows the utility to be placed, inspected, and tested before the deck is cast. Concrete pedestals consist of concrete supports formed at suitable intervals and provided with some type of clamping device. A continuous support may be achieved by providing a ledge of concrete to support the conduit. Continuous supports should be avoided due to the very high cost and additional dead load to the structure.
10.8.4 Traffic Barrier Conduit

All new bridge construction will install two (2) 2-inch galvanized Rigid Metal Conduit (RGS) or Rigid Polyvinyl Chloride Conduit (PVC) in the traffic barriers. These conduits generally carry wiring for Traffic Signals (TS) and Lighting (LT). Other wiring may be installed or the conduit may be used for future applications. PVC conduit may be used only in stationary-form barriers, and will connect to RGS using a PVC adaptor when exiting the barrier. RGS conduit may be used in stationary-form barriers, but it shall be used in slipform barriers.

Conduits shall be stubbed-out at a concrete junction box provided in the Region Plans. The Bridge Plans must show the placement of the conduits to clear the structure or any foreseeable obstructions.

The galvanized steel conduit shall be wrapped with corrosion resistant tape at least one foot inside and outside of the concrete structure, and this requirement shall be so stated on the plans. The corrosion resistant tape shall be 3M Scotch 50, Bishop 5, Nashua AVI 10, or approved equal. The usual location of the conduit throughout the remainder of the bridge should be in the traffic barrier.

Pull boxes shall be provided at a maximum spacing of 180 feet. For fiber optics only, spacing shall not exceed 360 feet. The pull box size shall conform to the specifications of the National Electric Code or be a minimum of 8 inches by 8 inches by 18 inches to facilitate pulling of wires. Galvanized steel pull boxes (or junction boxes) shall meet the specifications of the “NEMA Type 4X” standard for stationary-form barrier, shall meet the specifications of the “NEMA 3R” and be adjustable in depth for slip form barrier, and the NEMA junction box type shall be stated on the plans. Stainless steel pull boxes shall be allowed as an option to the galvanized steel.

In the case of existing bridges, an area 2 feet in width shall be reserved for conduit beginning at a point either 4 feet or 6 feet outside the face of usable shoulder. The fastening for and location of attaching the conduit to the existing bridge should be worked out on a job-by-job basis.


### 10.8.5 Conduit Types

All electrical conduits shall be galvanized Rigid Metal Conduit (RGS) or Rigid Polyvinyl Chloride Conduit (PVC).

- **Steel Pipe** – All pipe and fittings shall be galvanized except for special uses.
- **PVC Pipe** – PVC pipe may be used with suitable considerations for deflection, placement of expansion fittings, and of freezing water within the conduits. PVC pipe should not be placed in concrete traffic barriers when the slip form method is used due to damage and pipe separation that often occurs during concrete placement.

### 10.8.6 Utility Supports

The following types of supports are generally used for various utilities. Selection of a particular support type should be based on the needs of the installation and the best economy. All utility installations shall address temperature expansion in the design of the system or expansion devices.

Utility supports shall be designed so that a failure will not result in damage to the bridge, the surrounding area, or be a hazard to traffic. Utility supports shall be designed so that any loads imposed by the utility installation do not overstress the conduit, supports, bridge structure, or bridge members.

Designs shall provide longitudinal and transverse support for loads from gravity, earthquakes, temperature, inertia, etc. It is especially important to provide transverse and longitudinal support for inserts that cannot resist moment.

The Bridge Engineer should request calculations from the utility company for any attachment detail that may be questionable. Utility attachments, which exert moments or large forces at the supports, shall be accompanied by at least one set of calculations from the utility company. Bridge attachments designed to resist surge forces should always be accompanied by calculations.

- **Concrete Embedment** – This is the best structural support condition and offers maximum protection to the utility. Its cost may be high for larger conduit and the conduit cannot be replaced.
- **Pipe Hangers** – Utility lines shall be suspended by means of cast-in-place inserts, whenever possible. This is the most common type of support for utilities to be hung under the bridge deck. This allows the use of standard cast-in-place inserts and is very flexible in terms of expansion requirements. For heavy pipes over traffic (10” water main or larger), a Safety Factor of 1.5 should be used to resist vertical loads for Strength design. This is to avoid complete failure of the utility hanger system by failure of one hanger. Vertical inserts will not provide resistance to longitudinal forces. Longitudinal and transverse supports shall be provided for ITS conduits. Vertical supports shall be spaced at 5 foot maximum intervals for telephone and power conduits, and at a spacing to resist design loads for all other utilities.

When 3/4” or 7/8” diameter hanger rods are suspended from cast-in-place inserts, at least three of the following inserts shall be identified: Cooper B-Line B22-I Series, Unistrut 3200 Series, Powerstrut 349 Series, Halfen HT5506 or similar. The specific cast-in-place insert within each series shall be identified based on the required length of insert. The cast-in-place insert shall be at least 6” long and hot dipped galvanized per AASHTO M 111 or AASHTO M 232.

The Bridge Engineer shall verify that the cast-in-place insert has sufficient capacity to support the loads from the hanger rod.
Transverse supports may be provided by a second hanger extending from a girder or by a brace against the girder. The Appendix 10.8-A1-1 and 10.8-A1-2 depict typical utility support installations and placement at abutments and diaphragms. Transverse supports shall, at a minimum, be located at every other vertical support.
10.9 Utility Review Procedure for Installation on Existing Bridges

It is the responsibility of the Region Utilities Engineer to forward any proposed attachments to existing bridges to the Bridge Preservation Office. The Bridge Preservation Office is responsible for reviewing only those details pertaining to the bridge crossing such as attachment details or trenching details adjacent to bridge piers or abutments.

The Bridge Preservation Office reviews proposed utility attachments and either approves the attachment or returns for correction (RFC). A current file for most utility attachments is maintained in the Bridge Preservation Office. The turnaround time for reviewing the proposals should not exceed four weeks.

The Region determines the number of copies to be returned. Most Regions send five copies of the proposed utility attachment. If the proposal is approved, Bridge Preservation will file one copy in the utility file and return four marked copies. If it has been returned for correction or not approved, one copy is placed in the utility file and two marked copies are returned, thru the Region, to the utility. See Section 10.9.1, “Utility Review Checklist.”

Utility attachments, which exert moments or large forces at the supports, should be accompanied by at least one set of calculations from the utility company. Bridge attachments designed to resist surge forces should always be accompanied by calculations. The connection details shall be designed to successfully transfer all forces to the bridge without causing overstress in the connections or to the bridge members to which they are attached. For large utilities, the bridge itself shall have adequate capacity to carry the utility without affecting the live load capacity.

The engineer may request calculations from the utility company for any attachment detail that may be questionable. All plans, details, and calculations shall be stamped, signed, and dated by a Professional Engineer licensed in the State of Washington. Additionally, for heavier utilities, such as waterlines or sewer lines, the engineer may request a load rating of the structure, which shall be stamped, signed, and dated by a licensed professional engineer in the state of Washington to follow the guidelines of Chapter 13 of the BDM. The ratings shall be based solely on the engineer of record calculations.

Guidelines for Utility Companies

Detailing guidelines for utility companies to follow when designing utility attachments are listed in WSDOT Form 224-047, “General Notes and Design Criteria for Utility Installations to Existing Bridges.” See Figure 10.8.1-1. See Section 10.8 for other requirements, which include, but are not limited to: design of utility, material used, and spacing of supports.

Guidelines for Column Attachments

The following guidelines shall be followed for installing attachments to columns.

- Attachments on round columns may be either drilled and bolted or banded.
- Attachments on non-circular column shapes shall be drilled and bolted.
- Only percussion drilling methods shall be allowed on bridge columns, and only for small diameter resin bonded anchor installation (0.50” diameter max.). Drilling will normally result in blind holes, and these holes shall be patched with material conforming to Standard Specification 6-02.3(20).
- Drilling into prestressed or post-tensioned concrete elements is not permitted. Some WSDOT bridges utilize prestressed columns.

Any proposed conduit installation on a WSDOT bridge structure needs to be reviewed and approved by the Risk Reduction Engineer in the Bridge Preservation Office. If the conduit installation originates via a change order, then the Headquarters Construction Office may provide approval, and shall inform the Risk Reduction Engineer of the decision.
10.9.1 Utility Review Checklist

This checklist applies to all proposed utility attachments to existing bridges.

1. Complete cursory check to become familiar with the proposal.

2. Determine location of existing utilities.
   a. Check Bridge Inspection Report for any existing utilities.
   b. Check Bridge Preservation’s utility file for any existing utility permits or franchises and possible as-built plans.
   c. Any existing utilities on the same side of the structure as the proposed utility should be shown on the proposal.

3. Review the following with all comments in red:
   a. Layout that includes dimension, directions, SR number and bridge number.
   b. Adequate spacing of supports.
   c. Adequate strength of supports as attached to the bridge (calculations may be necessary).
   d. Maximum design pressure and regular operating pressure for pressure pipe systems.
   e. Adequate lateral bracing and thrust protection for pressure pipe systems.
   f. Does the utility obstruct maintenance or accessibility to key bridge components?
   g. Check location (elevation and plan view) of the utility with respect to pier footings or abutments. If trench limits encroach within the 45° envelope from the footing edge, consult the Materials Lab.
   h. Force mains or water flow systems may require encasement if they are in excavations below the bottom of a footing.

4. Write a letter of reply or e-mail to the Region so a copy will be returned to you indicating the package has been accepted and sent out.

5. Stamp and date the plans using the same date as shown on the letter of reply or e-mail.

6. Create a file folder with the following information:
   a. Bridge no., name, utility company or utility type, and franchise or permit number.
   b. One set of approved plans and possibly one or two pages of the original design plans if necessary for quick future reference. Previous transmittals and plans not approved or returned to correction should be discarded to avoid unnecessary clutter of the files.
   c. Include the letter of submittal and a copy of the letter of reply or e-mail after it has been accepted.

7. Give the complete package to the section supervisor for review and place the folder in the utility file after the review.
10.10 Resin Bonded Anchors

WSDOT allows standard set resin bonded anchors in many aspects of bridge design, including the permanent sustained tension applications listed below.

- Sign structures mounted to the sides of bridges.
- Light standards.
- Retrofitted corbels for bridge approach slabs.
- Bridge widenings, for both the decks and for pier caps.
- Supporting utilities under bridges, including water pipes, electrical conduit and other utility piping systems.

Fast set epoxy anchors shall not be used for resin bonded anchors.
10.11 Drainage Design

Even though it is rare that poor drainage is directly responsible for a structural failure, it still must be a primary consideration in the design. Poor drainage can cause problems such as ponding on the roadway, erosion of abutments, and deterioration of structural members. Collecting the runoff and transporting it away from the bridge can prevent most of the problems. Proper geometrics during the preliminary stage is essential in order to accomplish this. The Hydraulics Branch recommends placing the bridge deck drainage off of the structure. Therefore, the Bridge Design Section has adopted the policy that all expansion joints will be watertight.

**Geometrics** – Bridges should have adequate transverse and longitudinal slopes to allow the water to run quickly to the drains. A transverse slope of .02'/ft and longitudinal slope of 0.5% for minimum valves are adequate. Avoid placing sag vertical curves and superelevation crossovers on the structure that could result in hydroplaning conditions or, in cold climates, sheets of ice from melting snow. The use of unsymmetrical vertical curves may assist the designer in shifting the low point off the structure.

**Hydrology** – Hydrological calculations are made using the rational equation. A 10-year storm event with a 5-minute duration is the intensity used for all inlets except for sag vertical curves where a 50-year storm intensity is required.

**On Bridge Systems** – Where bridge length and geometry require a bridge drain system within the bridge, the first preference is to place 5-inch diameter pipe drains that have no bars and drop straight to the ground. At other times, such as for steel structures, the straight drop drain is unacceptable and a piping system with bridge drains is required. The minimum pipe diameter should be 6 inches with no sharp bends within the system. The Hydraulics Branch should be contacted to determine the type of drain required (preferably Neenah).

**Construction** – Bridge decks have a striated finish in accordance with the *Standard Specifications* listed below, however, the gutters have an untextured finish (steel trowel) for a distance of 2 feet from the curb. This untextured area provides for smooth gutter flow and a Manning $n$ value of .015 in the design.

*Standard Specification* Section 6-02.3(10) — Bridge Decks and Bridge Approach Slabs
Appendix A

Chapter 10

BRIEF DESIGN MANUAL

JUNE 2012

Monotube Sign Structures

Sign Bridge Layout

GENERAL NOTES


2. THE SIGN STRUCTURE DESIGN AND ANALYSIS HAS BEEN DONE IN ACCORDANCE WITH ASHTO STANDARD SPECIFICATIONS FOR STRUCTURAL DESIGN OF HIGHWAY SIGNS, LUMINARIES, AND TYPICALLY COMPONENTS OF TRAFFIC MEMBERS AND SHALL MEET THE CONNECTIONAL CHARTY V-NOTCH TEST AS DESCRIBED IN SECTION G-053 FOR ASHTO M-370 MATERIAL. NON-DESTRUCTIVE TEST ACCEPTANCE CRITERIA TO CONFORM TO TRAFFIC MEMBER WITH CYCLIC LOAD.

3. ALL JOINT WELDS SHALL BE FULL Penetration groove welds with back-up plates of 1/4" MIN. THICKNESS.

4. THE BACK-UP PLATES FOR FULL Penetration Welds shall be welded continuously to the joined pieces. THIS can be done by either a continuous fillet weld on the back side of the piece, or by a continuous weld in the root of the full penetration weld, unless otherwise noted.

5. ALL REDUCING PIPE, AND RELATED HARDWARE SHALL BE GALVANIZED AFTER FABRICATION PER ASHTO M-370.

6. ALL STEEL SURFACES SHALL BE GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH ASHTO M-370. ALL EXTERIOR STEEL SURFACES SHALL BE PAINTED IN ACCORDANCE WITH THE SPECIAL PREVISIONS. THE MAINTENANCE PLATFORM AND ALLIED HAND RAILS shall NOT BE PAINTED. FOR MAINTENANCE PLATFORM ATTACHMENT BRACKET DETAILS FOR MONUMENTS SEE STANDARD PLAN G-050. PAINT ENTIRE ATTACHMENT BRACKET TO MATCH EXISTING STRUCTURE EXCEPT FOR MOUNTING SA BAN. MAINTENANCE PLATFORM DETAILS shall NOT BE DETERMINED FROM THE CONTRACT PLANS OR THE STANDARD PLAN.

7. ALL STEEL SURFACES shall be Galvanized in ACCORDANCE WITH ASHTO M-370. ALL EXTERIOR STEEL SURFACES shall be PAINTED IN ACCORDANCE WITH THE SPECIAL PREVISIONS.

8. SIGN PANEL AS SHOWN IN THE CONTRACT PLANS shall be INSTALLED WITH THE SIGN STRUCTURE OR IMMEDIATELY AFTER THE SIGN STRUCTURE is ERECTED.

9. FABRICATE BEAM to PROVIDE SMOOTH PARBOIL CAMBER CURVE. SEE CAMBER DIAGRAM DO NOT SHAW AT BOLTED SPACES.

10. FABRICATE BEAM to PROVIDE STRAIGHT CAMBER, SEE CAMBER DIAGRAM DO NOT SHAW AT BOLTED SPACES

11. BOTTOM OF BASE PLATE ELEVATIONS and FOUNDATION LOCATIONS, ELEVATIONS, CLEARANCES, and ALL STRUCTURE DIMENSIONS, and SUBMIT TO ENGINEER FOR APPROVAL PRIOR TO FABRICATION.

12. POSTS, BASE PLATES, BEAMS, and SPACER PLATES are Main LOAD CARRYING Members or ADDITIONAL COMPONENTS OF MONUMENT Members and shall MEET THE CONSTANTIAL CHARTY V-NOTCH TEST AS DESCRIBED IN SECTION G-053 FOR ASHTO M-370 MATERIAL. NON-DESTRUCTIVE TEST ACCEPTANCE CRITERIA to CONFORM TO TRAFFIC MEMBER WITH CYCLIC LOAD.

13. SEE OTHER PLANS FOR CONDUIT PENETRATIONS and HAND HOLES. REFER TO ELECTRICAL PLANS FOR INTERNAL ROUTING OF CONDUITS, CONDUIT CONDUCTORS shall NOT be ATTACHED to the OUTSIDE of the SIGN STRUCTURE. Do not suspend conduit on the OUTSIDE OF THE SIGN STRUCTURE. See NOTA TERMINAL CAMELINE DETAIL ON BRIDGE SHEET 10.1.1A-1, 10.1.2-1 of 10.1.2-2.

14. THE MAXIMUM SIGN AREA on the STRUCTURE shall be 10.1.1A-1, 10.1.2-1 of 10.1.2-2.

15. FOR SIGN AND LIGHT ATTACHMENT BRACKET DETAILS for MONUMENTS SEE STANDARD PLAN G-050. PAINT ENTIRE ATTACHMENT BRACKET TO MATCH EXISTING STRUCTURE EXCEPT FOR MOUNTING BEAM. SIZE SHALL be DETERMINED FROM THE STANDARD PLAN. SPACING shall NOT be DETERMINED FROM THE CONTRACT PLANS, VARIOUS MESSAGE SIGN shall have MOUNTING RINGS 3'-0" of MAXIMUM.

16. FOR SIGN AND LIGHT ATTACHMENT BRACKET DETAILS for MONUMENTS SEE STANDARD PLAN G-050. PAINT ENTIRE ATTACHMENT BRACKET TO MATCH EXISTING STRUCTURE EXCEPT FOR MOUNTING BEAM. SIZE SHALL be DETERMINED FROM THE STANDARD PLAN. SPACING shall NOT be DETERMINED FROM THE CONTRACT PLANS.

17. THE TOTAL BEAM LENGTH "F" shall not EXCEED 50'-0".

18. ALL WELDS shall be DONE TO MAXIMIZE DISTORTION OR PERMISSIBLE MONUMENT DIMENSION VARIATIONS FOR OUTSIDE DIMENSIONS, WALL THICKNESS, LENGTH, STRAIGHTNESS, PARABOLICALLY CAMBERED SIGN BRIDGE BEAMS EXCLUDED. SQUINCHNESS OF SIDES and TWIST shall be IN ACCORDANCE with SECTION 11 OF ASHTO CODE.

Note to designer:
- Camber only
- Balance "F" & sign bridges only
- Balance "E" & camber only
- Sign bridge only

(Any these notes to its specific project structure type)

LEGEND

- IDENTIFIED SECTION, VIEW or DETAIL
- TAKEN or SHOWN on BRIDGE SHEET
- TAKEN or SHOWN on THE SAME SHEET

STANDARD MONOTUBE SIGN STRUCTURES

Washington State Department of Transportation

GENERAL NOTES
Monotube Sign Structures

Appendix A

Chapter 10

AUGUST 2010

Appendix 10.1-A1-3 Monotube Sign Bridge Structural Details 2

10.1-A1-3

SECTION K

1'-6" 1'-6"

2" 2"

10.1-A1-1

J

1"ø SPLICE BOLT (TYP.)

¢ ¾"ø HOLE AT BOT. OF TUBE (TYP.)

¢ BOLTED SPLICE

¢ 6" x 11" HAND HOLE

¢ 6" x 11" HAND HOLE

1'-6"

2"

VIEW J

10.1-A1-1

SECTION K

45°

DETAIL P

"T5" SPLICE #1 "T5" SPLICE #2 (TYP.)

"T5" SPLICE #1 "T5" SPLICE #2 (TYP.)

½" REINFORCEMENT RING

½" MAX. ALLOWABLE OFFSET

¼" SPLICE #2 SHOWN. BOLTED SPLICE #1 SIMILAR.

REINFORCEMENT RING

¼" COVER SCREWS (TYP.) EQUALLY SPACED AROUND HAND HOLE.

6 SCREWS FOR 6" x 11" HAND HOLE.

4 SCREWS FOR 6"ø HAND HOLE.

6" x 11" HAND HOLE SHOWN. 6"ø HAND HOLE SIMILAR EXCEPT AS NOTED.

BOLTED SPLICE #2 SHOWN.

BOLTED SPLICE #1 SIMILAR.

BOLTED SPLICE

BOLTED SPLICE

SEE DETAIL P

"T5" SPLICE #1 "T5" SPLICE #2 (TYP.)

45°

"T4" SPLICE #1 "T4" SPLICE #2 (TYP.)

"T4" SPLICE #1 "T4" SPLICE #2 (TYP.)

HAND HOLE GASKET (TYP.) EXCEPT AT BOT. OF BEAM

INNER SET OF BOLTS AT BOLTED SPLICE #2 EXCEPT AS OTHERWISE NOTED

REINFORCEMENT RING

6" x 11" FOR 6" x 11" HAND HOLE

6" FOR 6"ø HAND HOLE

6" ø HOLE FOR 1"ø BOLT (TYP.)

½" MAX. ALLOWABLE OFFSET

½" MAX. - SEAL WITH APPROVED SEALANT AT INSTALLATION OF HAND HOLES ON TOP OF BEAM ONLY.

½" ø HOLE AT BOT. OF TUBE (TYP.)

5" MAX. SEEP. (TYP.)

6" x 11" HAND HOLE SHOWN. 6"ø HAND HOLE SIMILAR EXCEPT AS NOTED.

5" MAX. - SEAL WITH APPROVED SEALANT AT INSTALLATION OF HAND HOLES ON TOP OF BEAM ONLY.

6" ø HOLE FOR 1"ø BOLT (TYP.)

5" MAX. SEEP. (TYP.)

6" x 11" HAND HOLE SHOWN. 6"ø HAND HOLE SIMILAR EXCEPT AS NOTED.

5" MAX. - SEAL WITH APPROVED SEALANT AT INSTALLATION OF HAND HOLES ON TOP OF BEAM ONLY.

6" ø HOLE FOR 1"ø BOLT (TYP.)

5" MAX. SEEP. (TYP.)

6" x 11" HAND HOLE SHOWN. 6"ø HAND HOLE SIMILAR EXCEPT AS NOTED.

5" MAX. - SEAL WITH APPROVED SEALANT AT INSTALLATION OF HAND HOLES ON TOP OF BEAM ONLY.
### Appendix 4

**Bridge Design Manual**

**Monotube Cantilever Structural Details 1**

#### Section E

1. **Details**
   - **Detail A**
     - For cantilever structures only. 1/4" cap screws ASTM F-593 for reinforcement ring with a total equally spaced around cover.
   - **Detail B**
     - Ground wire terminal. **See Standard Plan J-7540-00 Sheet 1 of 2. Detail B for pulling grip or two screw connector detail.**
   - **Detail C**
     - NEMA 3R terminal cabinet detail. **See detail G.**

#### Section F

- **NEMA 3R Terminal Cabinet Detail**
  - If no other hand hole is within 1'-6" of cabinet.
  - 1/4" gap with 1/4" thick nylon bushing washer for spacer (typ.).
  - 2" dia. tapped hole w/ threaded nipple.
  - 1/4" lock washer & lock nut (4 typ.).
  - 1/8" drain hole at radius (typ.).

#### Notes

- See Standard Plan J-7540-00 Sheet 1 of 2, Detail B for pulling grip or two screw connector detail.
- Ground wire terminal. **See Standard Plan J-7540-00 Sheet 1 of 2, Detail B for pulling grip or two screw connector detail.**
- NEMA 3R terminal cabinet detail. **See detail G.**

---

**Appendix 10.1-A2-2 Monotube Cantilever Structural Details 1**
Appendix A

Chapter 10

BRIDGE DESIGN MANUAL

SEPTEMBER 2010

Monotube Cantilever

Structural Details 2

Washington State Department of Transportation

STANDARD SIGN BRIDGES

MONOTUBE CANTILEVER

STRUCTURAL DETAILS 2
Appendix 10.1-A3-1 Monotube Balanced Cantilever Layout

brigade design manual

chapter 10

Monotube Sign Structures
Balanced Cantilever Layout

BEAM CAMBER DIAGRAM

* CONTRACTOR TO VERIFY NIPPLE LOCATION TO MATCH VAM CONDUIT LOCATIONS PRIOR TO SIGN STRUCTURE PARAPET. NO FIELD WELDING OR DRILLING SHALL BE PERMITTED.

** 6" HAND HOE REQUIRED OVER NIPPLE, IF NIPPLE IS NOT WITHIN 1'-0" OF EXISTING HANDHOE.


**ELEVATION**

**PLAN**

**VIEW N**

**ANCHOR ROD ARRAY**

**ANCHOR ROD DETAIL**

**TYPE 1 FOUNDATION TABLE**

**BENDING DIAGRAM**

**ANCHOR RODS NOT SHOWN.**

**NOTE: USE A TEMPLATE TO LOCATE AND SECURE ANCHOR RODS IN PLACE DURING FOUNDATION INSTALLATION. FOR DETAILS, SEE ANCHOR ROD ARRAY THIS SHEET.**
Appendix A

BRIDGE DESIGN MANUAL

Chapter 10

Monotube Sign Structures

Foundation Type 1

AUGUST 2010

View F

View E

Centralizer Detail Notes:
- Each leg shall be tied to one vertical bar & two spirals.
- See Special Provisions for spacing requirements.

* Concrete Cover = Minus 6"

Welded Lap Splice Detail
Welding shall meet the requirements of Std. Spec. G60/G42A for weld dimensions. See table below:

<table>
<thead>
<tr>
<th>Designd Bar</th>
<th>Designd Diameter</th>
<th>Designd Length</th>
<th>Weld Dimen. (In.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø2.0</td>
<td>0.15</td>
<td>0.30</td>
<td>E</td>
</tr>
</tbody>
</table>

Centralizer Detail:
- Epoxy coat centralizer or paint with inorganic zinc after fabrication (Option 2)

Spiral Termination Detail:
- 3 wraps of spiral
- Welded splice at end of spiral
## Appendix 10.1-A4-3 Monotube Sign Structures Foundation Types 2 and 3

### Type 2 Foundation Table

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>Span Length (&quot;S&quot;)</th>
<th>Depth (&quot;Z&quot;)</th>
<th>Reinforcement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cantilever Sign</td>
<td>10'-0&quot; (2'-6&quot;)</td>
<td>1'-0&quot;</td>
<td>9 12 10</td>
</tr>
<tr>
<td>Sign Bridge</td>
<td>20'-0&quot; (2'-6&quot;)</td>
<td>10&quot;</td>
<td>2-9 10 11</td>
</tr>
</tbody>
</table>

**Notes:**
- Use Concrete Class 4000P and Tremie if water is present in the excavation.
- Anchor Rods + "D1+0.25" long threaded Rod with (2) Washers and (4) Heavy Hex Nuts (TYP.) are used for securing concrete embed tabs.
- The foundation depth "Z" is based on an Allowable Lateral Bearing Pressure of 2500 PSF or more.
- Use a template to locate and assemble anchor rods as a complete unit.
- Use Conduit to be installed where directed by the Engineer.
- Concrete cover shall be 8" unless shown otherwise.

### Type 3 Foundation Table

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>Span Length (&quot;S&quot;)</th>
<th>Depth (&quot;Z&quot;)</th>
<th>Reinforcement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cantilever Sign</td>
<td>10'-0&quot; (2'-6&quot;)</td>
<td>1'-0&quot;</td>
<td>9 12 10</td>
</tr>
<tr>
<td>Sign Bridge</td>
<td>20'-0&quot; (2'-6&quot;)</td>
<td>10&quot;</td>
<td>2-9 10 11</td>
</tr>
</tbody>
</table>

**Notes:**
- Use Concrete Class 4000P and Tremie if water is present in the excavation.
- Anchor Rods + "D1+0.25" long threaded Rod with (2) Washers and (4) Heavy Hex Nuts (TYP.) are used for securing concrete embed tabs.
- The foundation depth "Z" is based on an Allowable Lateral Bearing Pressure of 2500 PSF or more.
- Use a template to locate and assemble anchor rods as a complete unit.
- Use Conduit to be installed where directed by the Engineer.
- Concrete cover shall be 8" unless shown otherwise.

### Bending Diagram

- Use Concrete Class Mix and Tremie if water is present in the excavation.
- The foundation depth "Z" is based on an Allowable Lateral Bearing Pressure of 2500 PSF or more.
**BRIDGE DESIGN MANUAL**

**Chapter 10**

**AUGUST 2010**

---

### Monotube Sign Structures

**Single Slope Barrier Foundation**

---

#### BENDING DIAGRAM

<table>
<thead>
<tr>
<th>WORK</th>
<th>LOCATION</th>
<th>SIZE</th>
<th>WT. KG.</th>
<th>LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>HORIZONTAL</td>
<td>10</td>
<td>0</td>
<td>8'-0&quot;</td>
</tr>
<tr>
<td>22</td>
<td>VERTICAL</td>
<td>10</td>
<td>0</td>
<td>7'-0&quot;</td>
</tr>
<tr>
<td>23</td>
<td>VERTICAL</td>
<td>10</td>
<td>0</td>
<td>6'-0&quot;</td>
</tr>
</tbody>
</table>

---

CONCRETE COVER SHALL BE 1½" UNLESS SHOWN OTHERWISE.

---

**PLAN**

**BARRIER TRANSITION**

ANCHOR RODS NOT SHOWN.

---

**ELEVATION**

---

**SECTION (A)**

---

**NOTE:**

CONCRETE COVER SHALL BE 1½" UNLESS SHOWN OTHERWISE.

---

**TOP OF BARRIER**

---

**BASE PLATE**

---

**GROUNDING CONDUCTOR**

NON-INSULATED 
#4 AWG STRANDED COPPER. PROVIDE 3'0" MIN. SLACK. ROUTE CONDUCTOR TO GROUND WIRE TERMINAL SHOWN IN DETAIL C 10.1-A2, 10.1-A2-2, OR 10.1-A2-3.

---

**FOR TERMINATION OF GROUND, SEE RESPECTIVE FOUNDATION DETAILS.**
Appendix A

Bridge Design Manual

January 2014

Pedestrian Barrier

Details 1 of 3

**NOT TO DESIGNERS:**

The non-removable sheet would be removed from the bridge plans.

**Additional Note:**

Sheet metal should be added to limit to 1'-0" splices with adequate increases in barrier height.

**NW Region:**

terminate each conduit pipe at separate

junction boxes on end of bridge as shown on layout.

**PLAN PEDESTRIAN BARRIER**

Barrier continuous between roadway expansion joints.

Construction joints with shear keys are permissible at dummy joint locations. Form joints between dummy joint shall not be permitted.

---

**OUTSIDE ELEVATION TRAFFIC BARRIER - GUARDRAIL CONNECTION**

Provide 3/4" rocketeader P-90, Lancaster malleable, or Dayton/Redmond F-62 flanged tee slab ferrule inserts or approved equal. (Typ.) Resin-bonded anchors may be substituted. Guardrail.

---

**OUTSIDE ELEVATION END OF PEDESTRIAN BARRIER**

Shown with bridge approach slab.
Appendix A
BRIDGE DESIGN MANUAL
JANUARY 2014

Traffic Barrier — Single Slope 42°

End of Traffic Barrier

Outside Elevation

TYPICAL SECTION

Traffic Barrier — Guardrail Connection

Note to Drawers:
1. It was assumed that the number of traffic barriers to be built was 10.
2. General details of traffic barrier designs shall include the edge of the barrier.
3. The non-applicable bars should be removed from the actual design plan.

Traffic Barrier — Single Slope 42°

Details 1 of 3

Washington State Department of Transportation

Traffic Barrier — Single Slope 42°

Details 1 of 3

Bridge and Structures Office
THREE BEAM RETROFIT CONCRETE RAILBASE

EXISTING CONCRETE BARRIER
¾" Ø HOLE FOR ½" Ø BOLT (TYP.)
STEEL BLOCKOUT
BEAM GUARDRAIL TYPE THREE BEAM
½" x 1½" BUTTON HEAD BOLT & NUT WITH LOCK WASHER (TYP.)

RESIN BONDED ANCHOR BOLT W/ LOCK AND FLAT WASHERS (TYP.)
1½" (TYP.)

TYPICAL SECTION
AT STEEL BLOCKOUT
(TYP ASSEMBLIES REQUIRED)

EXPIRING CURB LINE (TYP.)
EXIST. SLOPE
CORE DRILL HOLES FOR ½" Ø RESIN BONDED ANCHORS W/ LOCK AND FLAT WASHERS (A TOTAL PER STEEL BLOCKOUT) ENGRAVED AND HOLE DIAMETER PER MANUFACTURER'S RECOMMENDATION. 7" MIN. 3" CLEAR TO EDGE OF RAILBASE JOINT OR EXPANSION JOINT. ADJUST BLOCKOUT SPACING WITHIN SPECIFIED TOLERANCE TO MAINTAIN EDGE CLEARANCE AND AVOID VERTICAL AND TOP HORIZONTAL REINFORCEMENT.

EXISTING CURB LINE (TYP.)
STEEL GUARDRAIL POST
CONC. PARAPET
RESIN BONDED ANCHOR BOLT (TYP.)

BEAM GUARDRAIL TYPE THREE BEAM
½" Ø HOLE FOR ½" Ø BOLT (TYP.)
STEEL BLOCKOUT
EXISTING CONCRETE BARRIER
THREE BEAM QUADRANT
THREE BEAM QUADRANT
STEEL GUARDRAIL POST
RESIN BONDED ANCHOR BOLT (TYP.)

ISOMETRIC VIEW

BACKUP PLATE
BACKUP PLATE REQUIRED AT POST WHERE NO THREE BEAM GUARDRAIL SPACE OCCURS.

SECTION A

NOTES:
* SEE GENERAL NOTE NO. 5 ON BRIDGE SHEET NO. 1.

CORE DRILL HOLES FOR ½" Ø RESIN BONDED ANCHORS W/ LOCK AND FLAT WASHERS. (4 TOTAL PER STEEL BLOCKOUT) ENGRAVED AND HOLE DIAMETER PER MANUFACTURER'S RECOMMENDATION. 7" MIN. 3" CLEAR TO EDGE OF RAILBASE JOINT OR EXPANSION JOINT. ADJUST BLOCKOUT SPACING WITHIN SPECIFIED TOLERANCE TO MAINTAIN EDGE CLEARANCE AND AVOID VERTICAL AND TOP HORIZONTAL REINFORCEMENT.
THREE BEAM RETROFIT CONCRETE CURB

TOP OF EXIST. CONCRETE DECK

TOP OF HMA OVERLAY

POST REQUIRED

TYPICAL STEEL POST ANCHORAGE

$2'-8"$

1" x $6¼$" BUTTONHEAD BOLT & NUT WITH LOCK WASHER (TYP.)

BASE PLATE DETAIL

1½" RADIUS (TYP.)

1½" x 10 x 1'-0"

STEEL GUARDRAIL POST

6½" Hole for 1½" Bolt

BASE PLATE

VIEW A

BEFORE FABRICATION OF ASSEMBLIES.

NOTES:

* SEE GENERAL NOTE NO. 5 ON BRIDGE SHEET NO. 1.

** POST HEIGHT MAY VARY DEPENDING ON CURB HEIGHT.

CONTRACTOR TO VERIFY BEFORE FABRICATION OF ASSEMBLIES.

BASE PLATE DETAIL

BACKUP PLATE REQUIRED AT POST WHERE NO THREE BEAM GUARDRAIL SPlice OCCURS.

BASE PLATE

ATTACHMENT BOLT

SPLICE BOLT

THREE BEAM GUARDRAIL

STEEL GUARDRAIL POST

BASE PLATE

ISOMETRIC VIEW

THREE BEAM SECTION
JUNCTION BOX LOCATIONS

<table>
<thead>
<tr>
<th>STATION</th>
<th>OFFSET</th>
<th>&quot;TS&quot; OR &quot;LT&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Junction box locations shown are approximate. Center junction box installation between barrier dummy joints.

INSTALL ALL CONDUIT RUNS TO DRAIN TO A BRIDGE END OR PROVIDE DRAIN AT ALL LOW POINTS IN CONDUIT RUN ON BRIDGE.

BENDING DIAGRAM

ALL DIMENSIONS ARE OUT TO OUT.
= DIMENSIONS TO POINTS OF INTERSECTION.

FOR W1 £ & W2 BARS SEE WINGWALL OR RETAINING WALL PLANS.

SECTION A APPROACH SLAB

FOR DETAILS NOT SHOWN SEE OUTSIDE ELEVATION AND "TYPICAL SECTION - TRAFFIC BARRIER"

SECTION C BRIDGE

FOR DETAILS NOT SHOWN SEE OUTSIDE ELEVATION AND "TYPICAL SECTION - TRAFFIC BARRIER"

* BLOCKOUT WIDTH MAY BE INCREASED TO 6" TO ALLOW CONDUITS OF A LARGER DIAMETER THAN 2" TO EXIT BARRIER OR WALL WITHOUT REBAR STEEL CONFLICT.
Appendix 10.4-A1-3 Thrie Beam Retrofit Concrete Curb

NOTE:
1. PIPE RAILING, PIPE RAILING SPACERS, COVER PLATES AND BOTTOM EXTENDED CHANNEL SHALL BE BENT TO THE HORIZONTAL CURVE WHERE THE RADIUS OF CURVATURE IS LESS THAN 600. THESE ITEMS MAY BE HEATED TO NOT MORE THAN 200° TO EXCEED 30 MINUTES TO FACILITATE FORMING OR BENDING TO HORIZONTAL CURVATURE.

2. SHOP DRAWINGS OF RAILING SHALL BE SUBMITTED FOR APPROVAL SHOWN COMPLETE DIMENSIONS AND DETAILS OF FABRICATION AND INCLUDING AN ERECTION DIAGRAM. MATERIAL SPECIFICATIONS SHALL BE PROVIDED IN THE SHOP DRAWINGS FOR ALL COMPONENTS.

3. CUTOFFS SHALL BE DONE BY SAWING OR MILLING AND ALL CUTOFFS SHALL BE TRUE AND SMOOTH. FLAME CUTTING WILL NOT BE PERMITTED.


5. ALL ALUMINUM PARTS SHALL BE GIVEN A "CEAR OR PRIME" ANODIC COATING OR AT LEAST GOOSE THICK AND SEALLED TO MEET THE REQUIREMENTS OF ASA 7820 WITH A UNIFORM FINISH.

6. PIPE RAILING, PIPE RAILER AND PIPE RAILING SPACERS SHALL BE ADEQUATELY WRAPPED TO REDUCE SURFACE PROTECTION DURING HANDLING AND TRANSPORTATION TO THE JOB SITE.

* NOTE TO DESIGNER:
   Designer to choose color for their project in consultation with the Bridge Architect.
NOTES

1. PIPE RAILING, PIPE RAILING SPACERS, COVER PLATES AND BOTTOM EXTENDED CHANNELS SHALL BE BENT TO THE HORIZONTAL CURVE WHERE THE RADIUS OF CURVATURE IS LESS THAN 500. THESE ITEMS MAY BE HEATED TO NOT MORE THAN 600°F TO EXCEED 30 MINUTES TO FACILITATE FORMING OR BENDING TO HORIZONTAL CURVATURE.

2. SHOP DRAWINGS OF RAILING SHALL BE SUBMITTED FOR APPROVAL SHOWING COMPLETE DIMENSIONS AND DETAILS OF FABRICATION AND INCLUDING AN ERECTION DIAGRAM. MATERIAL SPECIFICATIONS SHALL BE PROVIDED IN THE SHOP DRAWINGS FOR ALL COMPONENTS.

3. CUTTING SHALL BE DONE BY SAWING OR MILLING AND ALL CUTS SHALL BE TRUE AND SMOOTH. FLAME CUTTING WILL NOT BE PERMITTED.

4. WELDING OF ALUMINUM SHALL CONFORM TO ASTM B 800 WITH A UNIFORM FINISH.

5. ALL ALUMINUM PARTS SHALL BE GIVEN A CLEAR ANODIC COATING OF AT LEAST 0.002" THICK AND SEALLED TO MEET THE REQUIREMENTS OF ASTM B 586 WITH A UNIFORM FINISH.

6. PIPE RAILING, PIPE BALUSTERS AND PIPE RAILING SPACERS SHALL BE ADEQUATELY WRAPPED TO INSURE SURFACE PROTECTION DURING HANDLING AND TRANSPORTATION TO THE JOB SITE.

* NOTE TO DESIGNER:
Designer to choose color for their project in consultation with the Bridge Architect.
Appendix 10.5-A1-1 Bridge Railing Type Pedestrian Details 1 of 2

ELEVATION

Balusters normal to grade.
Top & bottom rails parallel to grade.

NOTES

1. Pipe railing, and pipe railing splices, shall be bent to the horizontal curve where the radius of curvature is less than 200 feet.

2. Shop drawings of railing shall be submitted for approval showing complete dimensions and details of fabrication and including an indication of material being used shall be specified in the shop drawings.

3. Pipe railing, and pipe railing splices, may be heated to a temperature not more than 400° F and held for a period not to exceed 30 minutes to facilitate forming or bending horizontal curvature.

4. Cutting shall be done by shearing or milling, and all cuts shall be true and smooth. Flame cutting will not be permitted.

5. Weights of aluminum shall conform to Std. Spec. Section 25.18.2.1b.

6. After fabrication, posts shall be heat treated in accordance with Section 6b of the AAMA Standard specifications for structural supports for highway signs, landmarks, and traffic signals dated 2001 and revisions through 2003.

7. All aluminum parts shall be given a (clear or bronze) powder coating of at least 0.004 inch thickness, and sealed to meet the requirements of ASTM B 860 with a uniform finish.

8. Pipe railing, pipe balusters, pipe railing splices, shall be adequately wrapped to ensure surface protection during handling and transportation to the job site.

* NOTE TO DESIGNER:
Designer to choose color for their project in consultation with the Bridge Architect.

PART | MATERIAL SPECIFICATION
---|---
Pipes | ASTM B 32-6000-T6 Schedule 40 (STD. PIPE) ASTM B 22-1 or B 420-60016
Bar | ASTM B 22-6000-T6
Drive Pin | ASTM A 27 TYPE 304 STAINLESS STEEL
Appendix A

Bridge Design Manual

January 2014

Pedestrian Railing Details 2 of 2

Section B

Option #1

- Locate on opposite side of traffic. Drive pin shall be driven flush with the outside face of the railing.

Section B

Option #2

- Locate on opposite side of traffic. Drive pin shall be driven flush with the outside face of the railing.

Section A
NOTE TO DESIGNER:
1. Post spacing and adjustment in fence panels shall be such that an 8" sphere will not pass through panel above 3' from finished grade, an 8" sphere shall not pass through otherwise.

2. Adjust dummy joint spacings on traffic barrier sheets to be centered between posts.

3. Fence panel dimensions are intended to be horizontal (typ.).

4. The top of the post is adjusted to provide a post height pleasing to the eye.

5. Adjust fence panel height and dimension between tabs on this sheet and on section D to ensure the top of the snow fence is 4'-6" above the deck elevation. Ensure the top of the post is adjusted to provide a post height pleasing to the eye.

6. See "NOTE TO DESIGNER" on this sheet for height requirement.

ARCHITECTURAL FINISH OMITTED FOR CLARITY.

TRAFFIC BARRIER OUTSIDE ELEVATION

NOTE TO DESIGNER:
1. For angle lengths less than 7', use 3 x 2 x ¼ in the frame. For angle lengths between 7' and 8'-8", use 3 x 2 x ⅝ in the frame. For angle lengths longer than 8'-8", the designer shall re-evaluate all structural steel components and post anchorages. Loads shall be for AASHTO 13.8.2.

2. See "NOTE TO DESIGNER" on this sheet for height requirement.
NOTE:
- BUTTON HEAD BOLTS SHALL INCLUDE A SLOT IN THE DOMED BOLT HEAD. THE THREADS SHALL BE FULLY COATED WITH THREAD LOCKING AGENT JUST PRIOR TO CONNECTING THE RAILING PANELS TO THE POSTS. THE BUTTON HEAD BOLTS SHALL BE TIGHTENED IN ACCORDANCE WITH SECTION 6-06.3(2) AS SUPPLEMENTED IN THE SPECIAL PROVISIONS.

SECTION A

SECTION B

SECTION C

SECTION D

SECTION E

SECTION F

BARRIER REINFORCING MAY BE ADJUSTED TO ACCOMMODATE ANCHOR BOLTS.

# THE ANCHORAGE SHALL BE EITHER:
1) ¾" HEX BOLTS, 1 HEX NUT, 1 REGULAR JAM NUT, 2 REGULAR WASHERS & 1 SQUARE FLAT WASHER (2½" x 2½" x ¼") REQUIRED PER BOLT.
2) ¾" RESIN BONDED ANCHORS. USE MANUFACTURER’S RECOMMENDED EMBEDMENT DEPTH FOR RESIN BONDED ANCHORS. RESIN BONDED ANCHORS REQUIRE JAM NUT AND AN ADDITIONAL WASHER.

STRIKE HOLE FOR ¼" BUTTON HEAD BOLT w/ LOW CROWN BLIND NUT (TYP.)
PROTECTIVE SCREENING NOTES

- All elements of fence shall be hot dipped galvanized after fabrication.
- Steel pipe for posts and longitudinal members shall conform to ASTM specification A53, Grade B, galv.
- Per AASHTO M 311.
- All hardware shall conform to AASHTO specification M 186, galv. Per AASHTO M 311 and B unless noted otherwise.
- Fabric shall be heavy duty galvanized with 8-gage wire woven in a 60 chain link, diamond mesh.
- Fabric ties shall be installed to all frames in accordance with good trade practices at 36 in centers minimum spacing.

Please coordinate approval with the Bridge Architect before providing designs with this fence type.
**Appendix 10.5-A3-2 Bridge Railing Type S-BP Details 2 of 2**

### APPROACH ANCHOR - METHOD A

**NOTE:**
- All metal parts of the approach expansion anchor shall receive one coat of paint conforming to the standard specification section B-602.120 or be galvanized in accordance with AASHTO M-26.

---

### COMPRESSION SEAL TABLE

<table>
<thead>
<tr>
<th>D.O.デザイン</th>
<th>機関所戦表</th>
<th>材質</th>
<th>試験</th>
<th>使用する前の適合サイズ</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 mm</td>
<td>100 mm</td>
<td>1.2 mm</td>
<td>2.0 mm</td>
<td>2.5 mm compression seal size</td>
</tr>
<tr>
<td>3.5 mm</td>
<td>150 mm</td>
<td>2.0 mm</td>
<td>3.0 mm</td>
<td>3.5 mm compression seal size</td>
</tr>
</tbody>
</table>

**TESTING SHALL BE PER AASHTO M-220 PRIOR TO USE.**

### APPROACH ANCHOR - METHOD B

- COMPRESSION SEAL DETAIL

- COMPRESSION SEAL DETAIL (SAMPLE JOINT AT END OF GIRDER)

### COMPRESS SEAL DETAIL

- EXPANSION JOINT AT END OF GIROD

---

**NOTE:**
- Ensure all expansion joints at barrier details are used with an expansion gap of 2.5 mm.
Appendix A

Bridge Design Manual

Chapter 10

JUNE 202

Pavement Seat Repair Details

Appendix 10.5-A4-1 Pedestrian Railing Details 1 of 2

---

**Diagram:**

**Pavement Seat End View**

- **Existing Structures:**
  - Bridge
  - Existing Curb Line (Typ.)
  - Existing Slab Anchor (Typ.)
  - Detailed View

- **New Structures:**
  - Pavement Seat, Cover with one layer 6 lb. asphalt building felt
  - Approach Slab Anchor Method B @ 2'-0" Slab, in accordance with bridge approach slab details & attachment
  - See compression seal details, in accordance with bridge approach slab details & attachment
  - Expanded Polystyrene Full Length of Joint Beneath Compression Seal

**Bar List**

<table>
<thead>
<tr>
<th>Bar Grade</th>
<th>Size</th>
<th>Length</th>
<th>Remarks</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td></td>
<td>(A)</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>1'-3&quot;</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

- The dimensions shown in the plans are based on original construction records together with survey data. These dimensions shall be measured in the field by the contractor prior to fabrication of any components.

**Retrofit Condition**

- Drilled 9/16" hole @ 1'-0" O.C. for #6 rebar (set in epoxy resin)
- Drilled 9/16" x 7" hole @ 1'-0" O.C. for #6 rebar (set in epoxy resin)
- Surface shall be roughened at 1" max., and be clean and free of loose or unhardened concrete

**Diagram Details:**

- **Existing Bridge Approach Slab (to be removed)**
- **Adjacent Roadway**
- **Existing Anchor Rods @ 2'-0" O.C.
  - Cut bars as needed to vertical face of back of pavement seat and coat (exposed end with epoxy resin)

---

**Disclosure:**

- The Washington State Department of Transportation is responsible for the design and construction of the pavements in accordance with the specifications outlined in the Bridge and Structures Office manual. The details provided in this document are for informational purposes only and should not be used as the sole basis for construction. Refer to the referenced documents for complete and accurate specifications.
**Appendix A**

**Bridge Design Manual**

**Chapter 10**

**January 2014**

**T-Section Pavement Seat Repair Details**

---

**NOTE TO DESIGNER**

- If core drilling is not allowed, the bolt holes in the WT section may need to be field drilled.
- Designer to modify sheet as required.

---

**Pavement Seat Replacement**

- Repair existing pavement seat concrete prior to installing WT sections.

---

**Pavement Seat Repair**

- WT 12 x 47 (TYP.)
  - ASTM A992 and galvanized per ASHTO M111 (TYP.)

---

**Approach Slab Anchor (TYP.)**

- 1½" holes (TYP.)
- WT 12 x 47 (TYP.)
- and galvanized per ASHTO M111 (TYP.)

---

**Edge Detail**

- Grind off corner of existing pavement seat.

---

**Compression Seal**

- Expanded rubber joint filler cemented to joint seal at end.

---

**Detail 1**

- Typical WT 12 Section Detail

---

**TYPICAL WT 12 SECTION DETAIL**

- WT 12 x 47 (TYP.)
  - and galvanized per ASHTO M111 (TYP.)

---

**SECTION A**

- Dimensions shown in the plans are based on original construction records together with survey data. These dimensions shall be measured in the field by the contractor prior to fabrication of any components.

---

**NOTE:**

- Repair existing pavement seat concrete prior to installing WT sections.
Appendix 10.5-A5-1 Bridge Railing Type Chain Link Snow Fence

12/24/2013

UTILITY HANGER DETAILS

1. ALL MATERIALS SHALL BE GALVANIZED AFTER FABRICATION PER AASHTO M 111 OR AASHTO M 232 EXCEPT PIPE ROLLERS. PAINT ROLLERS WITH THREE COATS OF GALVANIZING REPAIR PAINT. SEE STD. SPEC. SECTION 9-08.1(2)B.

2. BAR 4 x ½ WITH 2 - ×”ø HOLES FOR ¾”ø HANGER RODS (TYP.) USE NEXT LARGER TRADE SIZE CONDUIT THAT ALLOWS FOR FREE MOVEMENT OF INNER CONDUIT (TYP.)

3. ¾”ø HANGER ROD WITH 6 HEXNUTS AND LOCK WASHERS @ 6’-6” CONDUIT

4. ¢ BOLT OR THREADED ROD WITH LOCK WASHER

NOTES:
- Verify that the insert does not interfere with reinforcement.
- Verify that the load on the insert and rod is acceptable.
- See BDM chapter 10, section 10.8.6 for insert design.
- "DETAIL A" is provided for prestressed girders only. For steel girders use angle iron bolted connections.

HANGER UTILITY SUPPORT

NOTES TO DESIGNERS:
- Verify that the load on the insert and rod is acceptable.
- See BDM chapter 10, section 10.8.6 for insert design.
- "DETAIL A" is provided for prestressed girders only. For steel girders use angle iron bolted connections.
Appendix U

BRIDGE DESIGN MANUAL

Chapter 10

JANUARY 2014

Utility Hanger Details

Section 4

Utilities Other Than Rod or PVC Conduits

Section 5

Utilities Other Than RGS or PVC Conduits

NOTE TO DESIGNER: COORDINATE WITH UTILITY ENGINEER FOR CONDUIT PLACEMENT DETAILS AT ABUTMENTS FOR UTILITIES OTHER THAN RGS OR PVC.

NOTES:
1. SET POSITION OF EXPANSION FITTING BASED ON MANUFACTURER RECOMMENDATIONS AND TEMPERATURE AT TIME OF INSTALLATION.
2. EXPANSION FITTINGS SHALL BE INSTALLED EVERY 100'-0" MAX, AND SHALL ACCOMMODATE 5.1 INCHES OF MOVEMENT. THE DESIGN TEMPERATURE RANGE IS 125 DEGREES (-15° TO 110°).
3. SEE BARRIER SHEETS FOR CONDUIT DEFLECTION FITTING A DETAIL.

WASHINGTON STATE
DEPARTMENT OF TRANSPORTATION

BRIDGE AND STRUCTURES OFFICE

UTILITY INSTALLATION GUIDELINE DETAILS FOR EXISTING BRIDGES

UTILITY HANGER DETAILS
Appendix 10.6-A1-1 Bridge Approach Slab Details 1 of 3

**ALTERNATE MODIFICATION**

FOR BRIDGE DRAIN TYPES "1", "1B" & "1C"

**OVERLAY MODIFICATION**

FOR BRIDGE DRAIN TYPE "0"

---

**OVERLAY MODIFICATION**

**FOR BRIDGE DRAIN**

**TYPES "1", "1B" & "1C"**

**PLAN**

**DETAIL**

- **CONCRETE AS APPROVED BY ENGINEER MIN. 3 DAYS PRIOR TO OVERLAY**
- **EPOXY TYPE 1**
- **GR. 3 CLASS B OR C**
- **NEW 4" Ø STD. GALV. STEEL PIPE**
- **NEW 4" Ø STD. GALV. STEEL PIPE**

**SECTION A**

- **MODIFIED CONCRETE OVERLAY**
- **** ACTUAL PIPE LENGTH (L) SHALL BE DETERMINED BY THE CONTRACTOR IN THE FIELD AND SHALL BE INSTALLED AS SHOWN ON THIS SHEET.

**SECTION B**

- **MEMBRANE OVERLAY**
- **DRAINAGE OF WATER**
- **OVERLAY SHALL BE DEPRESSED ¾"**
- **EPOXY TYPE 3 OR 4 Ø 5" OR 6" PVC PIPE O.D. = 5.56"**

**SECTION C**

- **MEMBRANE OVERLAY**
- **DEPRESS ¾"**
- **FILL CAVITY WITH CONCRETE AS APPROVED BY ENGINEER MIN. 3 DAYS PRIOR TO OVERLAY**
- **FACE OF ACP OVERLAY TO BE REMOVED CONCRETE AS APPROVED BY ENGINEER MIN. 3 DAYS PRIOR**

**BRIDGE DRAIN MODIFICATION BY CORE DRILLING**

**OVERLAY MODIFICATION**

**FOR BRIDGE DRAIN**

**OVERLAY SHALL BE DEPRESSED**

**ELEVATION VIEW**

**STRAIGHT DROP**

**SECTION**

**OVERLAY**

**PLAN**

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**BRIDGE DRAIN PLUG DETAIL**

**OVERLAY MODIFICATION**

**FOR BRIDGE DRAIN**

**OVERLAY SHALL BE DEPRESSED**

**ELEVATION VIEW**

**INCLINED DROP**

**SECTION**

**OVERLAY**

**PLAN**

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**GENERAL NOTES**

- **CONTENTS OF SHEET E-13, DATED 12/29/67 AND BEFORE.**
- **FOR STANDARD BRIDGE DRAINS DATED SEPTEMBER 1, 1965, AND AFTER. IT WILL BE NECESSARY TO GRIND OFF THE NIPPLE EXTENSION ON ONE SHORT SIDE OF THE TYPICAL GRATE COVER.**
Appendix 4

Bridge Design Manual

August 2010

Bridge Drains Types 2 thru 5
Modification for Overlay

Plan - Existing Drain

Plan After Retrofit

Section A

Section B

Appendix 10.6-A1-2 Bridge Approach Slab Details 2 of 3