

Historic Bridge Railing Study for Route 66 Bridges

(final)

Prepared for

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Introduction

The Oklahoma Route 66 Scenic Byway is a National Scenic Byway as designated by the Federal Highway Administration (FHWA) and National Park Service (NPS). To achieve this level of designation, the Oklahoma Department of Transportation (ODOT), in conjunction with the Scenic Byways Program, then at the University of Oklahoma, and the Oklahoma Route 66 Association, developed a Corridor Management Plan (CMP) in 2008 that outlines the measures that stakeholders and government entities may employ to assure the preservation of the intrinsic qualities and resources that comprise the byway. Designated National Scenic Byways exhibit one or more of six core intrinsic qualities, including scenic, natural, historic, recreational, archaeological, or cultural, that contribute to a unique travel experience. To be considered a National Scenic Byway, a road must possess characteristics of a regional significance within at least one of these intrinsic quality categories.

Future transportation projects may include rehabilitation or replacement of existing bridges or new bridge construction along Oklahoma's Route 66 Scenic Byway. As a result, ODOT commissioned this study to document and inventory 32 bridges and their railings located along Route 66 and recommend replacement rail options.¹ See Table 1 on the next page for a list of the bridges included in the study. The options will be aesthetically compatible with the historic railings and will maintain a consistent feel and appearance throughout the entire corridor, while meeting current safety requirements, such as crash testing ratings. The 32 bridges documented in this study do not represent all structures along the Route 66 corridor in Oklahoma, but are a sample of structures from the 1920s through the 1950s that retain their original railings. Therefore, while the railing recommendations in this study are derived from specific bridges, the recommendations provide a menu of railing options for all bridge rehabilitation, replacement, and construction projects along the Route 66 National Scenic Byway corridor in Oklahoma. The use of bridge railings recommended in this study is one strategy for maintaining the intrinsic qualities of the Scenic Byway and meeting the goals of the CMP.

This report is organized into two sections. Section 1 includes an inventory of existing railings, including general dimensions and photographs. Nine distinct railing types were identified based on differences in materials and configuration. Section 2 provides recommendations for appropriate replacement railings and a summary of background research conducted to identify replacement options that are acceptable in terms of safety requirements and visual compatibility. A photograph of existing railings is provided along with photographs of proposed replacement options and a description. Appendix A presents maps of bridge locations by railing types, and Appendix B provides an overview of the potential replacement options reviewed during the literature search but discarded as not meeting the replacement criteria (e.g., aesthetics, railing material, and configuration). Plan sheets for the replacement railing recommendations presented in Section 2 are found in Appendix C. As described in more detail below, Appendix D presents options for TL 2-rated replacement railings.

¹ The study originally included 33 bridges; however, during field review of the bridges it was discovered that Bridge 03431, which carried State Highway 66 over Pryor Creek in Rogers County, is no longer extant.

Table 1. Route 66 Bridge Rail Study Bridges

Resource #	Const. Date	Roadway #	Stream	Location	NBI#
8	1929	US-60	Horse Creek	Afton	05017
10	1926 (truss)	US-60	Little Cabin Creek	Vinita	04077
13*	1932 (truss)	SH-66 (West)	Pryor Creek	Chelsea	03431
20	1939	Cherokee Str.	Unnamed	Catoosa	07136
23	1940	Southwest Blvd.	Nickel Creek	Oakhurst	09003
42	1930	17 th Street	Lilly Creek	Stroud	02824
48	1951	SH-66	Bell Cow Creek	Chandler	12625
55	1940	Western Ave.	Deep Fork River	OKC	09474
56	1924 (truss)	Overholser Dr.	Lake Overholser	OKC	01416
58	1927 (or 1935)	Overholser Dr.	Lake Overholser	OKC	05487
61	1946	I-40B	Railroad	El Reno	10566
67	1932	E1020	Powderface Creek	Canadian Co.	02126
68	1932	E1020	Unnamed	Canadian Co.	04197
71	1933 (truss)	US-281	Canadian River	Bridgeport	04085
72	1934	US-281	Unnamed (old RR)	Bridgeport	04076
73	1934	E1020	Unnamed	Bridgeport	04051
74	1930	E1020	Unnamed	Caddo Co.	03203
75	1930	E1020	White Canyon	Caddo Co.	03202
76	1930 (truss)	E1020	Dead Woman Creek	Caddo Co.	03107
77	1930	E1020	Unnamed	Caddo Co.	02916
78	1940 (truss)	E1020	Cedar Canyon	Hydro	03081
79	1930	E1020	Unnamed	Hydro	09303
86	1930 (truss)	I-40 Frontage rd.	Bear Creek	Custer Co.	03192
NA	1953	I-40B Gary Blvd.	Washita River	Clinton	13123
92	1927	E1060	Unnamed	Custer Co.	23667
93	1927	I-40 Frontage Rd.	Dry Creek	Custer Co.	01895
95	1927	I-40 Frontage rd.	Unnamed	Custer Co.	01866
97	1929	I-40 Frontage Rd.	Unnamed	Foss	02249
99	1929	I-40 Frontage Rd.	Sand Creek	Foss	01918
102	1930	I-40 Frontage Rd.	Turkey Creek	Canute	01896
107	1929	I-40 B	Elk Creek	Elk City	02336
109	1928 (truss)	I-40 Frontage Rd.	Timber Creek	Sayre	01743
NA	1955	I-40 B (east)	Little Turkey Creek	Erick	13481

* Bridge is no longer extant.

Source: *Oklahoma Route 66 Roadbed Documentation Project (1926-1970), A Survey of Roadbed and Integral Structures*, Prepared by The Oklahoma Route 66 Association for the Oklahoma State Historic Preservation Office, 2001-2002. Available at <http://www.okhistory.org/shpo/thematic/rt66roadbed.pdf>. Note: The Resource # in the table above corresponds with the *Oklahoma Route 66 Roadbed Documentation Project* report.

1. Current Railing Types Inventory

An inventory of the bridges' current railings provides the foundation upon which the recommendations for replacement railing options were developed. To prepare the inventory, documentation consisted of photographing the railings and taking measurements of rail members and opening sizes between rail members.²

In developing the inventory, the 32 bridges were categorized by their railing types, based on material and similar configuration. Nine distinct railing types are represented by the group of bridges, which are identified by NBI number in parentheses, in this study, as described below:

- Railing Type A: Concrete post and single rail; inset panels; railing height is 2'5" to 2'6"
Study Bridges NBI No.: 01896, and 13481
- Railing Type B: Concrete post and single rail; incised lines; railing height is 2'5.5"
Study Bridges NBI No.: 09003
- Railing Type C: Concrete post and double rail; inset panels; railing height ranges from 3'6" to 4'1.5"
Study Bridges NBI No.: 01866, 01895, 01918, 02126, 02249, 02916, 03202, 03203, 04051, 04076, 04197, 05487, 07136, 09303, and 23667; Study Bridges 04077 and 04085 also include Railing Type G, described below
- Railing Type D: Concrete post and double rail; lower rail sits on curb; inset panels; railing height is 3'3"
Study Bridges NBI No.: 05017
- Railing Type E: Solid concrete panel with integrated end posts and intermediate posts; baluster cutouts topped with concrete cap; integrated curb; railing height 3'8"
Study Bridges NBI No.: 02824
- Railing Type F (sometimes referred to as "picket rail"): Concrete posts with incised lines; metal tubular railing with two secondary rails and varied-length verticals; variation with elongated end posts; railing height ranges from 2'11.5" to 4'1.75"
Study Bridges NBI No.: 02336, 09474, 10566, 12625, and 13123
- Railing Type G: Two horizontal steel I-beam rails; for study bridges, occurs only in combination with Railing Type C; railing height ranges from 3'2" to 3'9"
Study Bridges NBI No.: 04077 and 04085 (also includes Railing Type C, described above)

² Measurements revealed that small variations exist for similar railing types across the state due to deterioration, settlement, and patch and repair work that has occurred since initial construction. Although noted during field documentation, these small differences were inconsequential to the identification of appropriate replacement railing options.

Section 1

Current Railing Types Inventory

- Railing Type H: Metal X-lattice railing; railing height ranges from 2'2.5" to 3'2.75"
Study Bridges NBI No.: 01743, 03081, 03107, and 03192
- Railing Type I: Metal woven lattice railing; railing height is 3'5.125"
Study Bridges NBI No.: 01416

Organized by railing material(s) then type, the inventory table on the following pages provides details about each bridge's existing railing, the required test level (TL) rating, and photographs. Maps for bridge locations by railing types are presented in Appendix A.

**Inventory Table of Current Railing Types on the 32 Study Bridges
along Historic Route 66 in Oklahoma**

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Concrete

Railing Type - A: Concrete post and single rail, inset panels

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
01896	Washita	I-40 FRONTAGE RD.	TURKEY CREEK	1927	Steel stringer/multi-beam or girder	6'4"	2'6"	TL4



Vertical Railing Measurements

From top of curb to bottom of first rail: 10"

End posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges.

13481	Beckham	I-40 BUS.	LITTLE TURKEY CREEK	1955	Concrete culvert (reinforced)	6'4"	2'5"	TL4
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Vertical Railing Measurements

From top of curb to bottom of first rail: 11"

End posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges.

Concrete

Railing Type - B: Concrete post and single rail, incised lines

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
09003	Tulsa	E0650(S.W. BLVD)	CREEK	1940	Steel stringer/multi-beam or girder	5'9" - 6'5"	2'5.5"	TL3



Vertical Railing Measurements

From top of curb to bottom of first rail: 10"

End posts and intermediate posts have beveled edges and vertical incised lines (end posts have three lines, intermediate posts have two lines); decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges.

Concrete

Railing Type - C: Concrete post and double rail, inset panels

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
01866	Custer	I-40 FRONTAGE RD.	HACKBERRY CREEK	1927	Steel stringer/multi-beam or girder	7'0"	3'9"	TL4



Vertical Railing Measurements

From top of curb to bottom of first rail: 10.5"
Between rails: 10"

End posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges.

01895	Custer	I-40 FRONTAGE RD.	DRY CREEK	1927	Steel stringer/multi-beam or girder	6'10.5"	3'11.25"	TL4
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Vertical Railing Measurements

From top of curb to bottom of first rail: 10.25"
Between rails: 10"

End posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges.

Concrete

Railing Type - C: Concrete post and double rail, inset panels

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
01918	Washita	I-40 FRONTAGE RD.	CREEK	1927	Steel stringer/multi-beam or girder	6'10"	4'1.5"	TL4

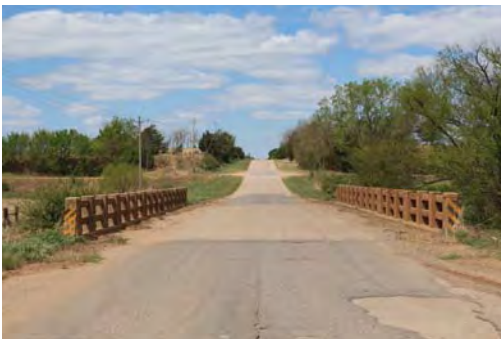


Vertical Railing Measurements

From top of curb to bottom of first rail: 11"
Between rails: 11.5"

End posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges.

02126	Canadian	E1020	CREEK	1928	Concrete slab (reinforced)	5'4.5"	3'6"	TL3
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Vertical Railing Measurements

From top of curb to bottom of first rail: 10"
Between rails: 10"

End posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges; single metal plaque on end post displays "F.A.P. 164" and "Built 1932."

Concrete

Railing Type - C: Concrete post and double rail, inset panels

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
02249	Custer	I-40 FRONTAGE RD.	CREEK	1929	Steel stringer/multi-beam or girder	7'7.5"	3'8.5"	TL4



Vertical Railing Measurements

From top of curb to bottom of first rail: 10"
Between rails: 10"

End posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges.

02916	Caddo	0804C	CREEK	1930	Steel stringer/multi-beam or girder	6'11.75"	3'8.25"	TL3
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Vertical Railing Measurements

From top of curb to bottom of first rail: 10.25"
Between rails: 10.25"

End posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges.

Concrete

Railing Type - C: Concrete post and double rail, inset panels

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
03202	Caddo	0804C	CREEK	1930	Steel stringer/multi-beam or girder	6'6"	3'8"	TL3



Vertical Railing Measurements

From top of curb to bottom of first rail: 9.75"
Between rails: 10.5"

End posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges; "OKLA S.H.C. 1930" stamped into concrete abutment wall.

03203	Caddo	0804C	CREEK	1930	Steel stringer/multi-beam or girder	6'6"	3'8.75"	TL3
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Vertical Railing Measurements

From top of curb to bottom of first rail: 10"
Between rails: 10.25"

End posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges.

Concrete

Railing Type - C: Concrete post and double rail, inset panels

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
04051	Caddo	0804C	CREEK	1933	Steel stringer/multi-beam or girder	7'2"	3'9"	TL3

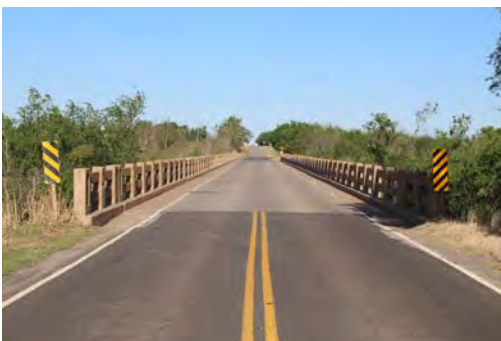


Vertical Railing Measurements

From top of curb to bottom of first rail: 8.5"
Between rails: 8"

End posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges.

04076	Caddo	U.S. 281	CREEK	1933	Steel stringer/multi-beam or girder	7'3.25"	3'9.75"	TL4
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Vertical Railing Measurements

From top of curb to bottom of first rail: 8"
Between rails: 8"

End posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges.

Concrete

Railing Type - C: Concrete post and double rail, inset panels

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
04197	Canadian	E1020	CREEK	1934	Steel stringer/multi-beam or girder	8'7"	3'10"	TL3



Vertical Railing Measurements

From top of curb to bottom of first rail: 10"
Between rails: 10"

End posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges; single metal plaque on end post displays "Oklahoma F.A.P. 164" and "Built 1932."

05487	Canadian	OVERHOLSER DR	LAKE OVERHOLSER OVERFLOW	1927	Steel stringer/multi-beam or girder	7'0"	3'10.5"	TL3
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Vertical Railing Measurements

From top of curb to bottom of first rail: 10"
Between rails: 10"

End posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges.

Concrete

Railing Type - C: Concrete post and double rail, inset panels

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
07136	Rogers	FAU 8545 (CHEROKEE)	CREEK	1939	Concrete slab (reinforced)	8'8"	3'6.5"	TL3



Vertical Railing Measurements

From top of curb to bottom of first rail: 10.25"
Between rails: 10.25"

End posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges.

09303	Caddo	0804C	CREEK	1940	Steel stringer/multi-beam or girder	6'11.75"	3'7.375"	TL3
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Vertical Railing Measurements

From top of curb to bottom of first rail: 10"
Between rails: 10.125"

End posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges.

Concrete

Railing Type - C: Concrete post and double rail, inset panels

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
23667	Custer	E1060	CREEK	1927	Steel stringer/multi-beam or girder	6'11"	3'7.5"	TL3



Vertical Railing Measurements

From top of curb to bottom of first rail: 10.5"
Between rails: 10"

End posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges.

Concrete

Railing Type - D: Concrete post and double rail, lower rail sits on curb, inset panels

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
05017	Ottawa	U.S. 60	HORSE CREEK	1936	Steel stringer/multi-beam or girder	6'8" - 7'4"	3'10"	TL4



Vertical Railing Measurements

From top of curb to bottom of first rail: 0'0"
Between rails: 8"

Inner rail: end posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; bottom rail sits on curb; curb with beveled edges.

05017	Ottawa	U.S. 60	HORSE CREEK	1936	Steel stringer/multi-beam or girder	7'0"	3'3"	TL4
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Vertical Railing Measurements

From top of curb to bottom of first rail: 0'0"
Between rails: 7"

Outer rail: end posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; bottom rail sits on curb; curb with beveled edges.

Concrete

Railing Type - E: Solid concrete panel with integrated end posts, intermediate posts, and baluster cutouts topped with concrete cap and integrated curb

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
02824	Lincoln	E0860	LILLY CREEK	1930	Concrete tee beam (reinforced)	8'7" - 9'1"	3'8"	TL3



Vertical Railing Measurements

From top of curb to bottom of first rail: 1"

Elongated end posts with beveled concrete cap are integral with rail panel; entire rail panel has concrete cap and two integral intermediate posts that protrude by approximately 1.5"; openings in rail panel simulate balusters and each opening measures 1'10" x 6".

Concrete and Metal

Railing Type - F: Concrete posts with incised lines, metal tubular railing with two secondary rails and varied-length verticals; variation with elongated end posts

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
02336	Beckham	I-40 BUS.	ELK CREEK	1929	Steel stringer/multi-beam or girder	7'2"	3'9"	TL4
						Vertical Railing Measurements From top of curb to bottom of first rail: 11.25" Between rails: 1'3.125" Second measurement between rails: 5.5" End posts have beveled edges and three incised vertical lines; intermediate posts have beveled edges and one vertical incised line; three horizontal rails, only top and bottom rails connect to posts; pickets with three different lengths (2" between pickets); decorative corner detail at bottom of posts; curb with beveled edges.		
09474	Oklahoma	WESTERN AVE.	DEEP FORK CREEK	1940	Steel stringer/multi-beam or girder	7'6"	3'0"	TL3
						Vertical Railing Measurements From top of curb to bottom of first rail: 6.5" Between rails: 1'1.25" Second measurement between rails: 5.25" Elongated and flared end posts have stepped detail and three horizontal incised lines; intermediate posts have beveled edges and one vertical incised line; three horizontal rails, only top and bottom rails connect to posts; pickets with three different lengths (2.25" between pickets); curb with beveled edges.		

Concrete and Metal

Railing Type - F: Concrete posts with incised lines, metal tubular railing with two secondary rails and varied-length verticals; variation with elongated end posts

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
10566	Canadian	I-40 BUS.	UP R.R. UNDER	1942	Steel stringer/multi-beam or girder	7'11"	3'8.25"	TL4



Vertical Railing Measurements

From top of curb to bottom of first rail: 8"
Between rails: 1'4.5"
Second measurement between rails: 4.5"

End posts and intermediate posts have beveled edges and three vertical incised lines; only top and bottom rails connect to posts; pickets with three different lengths (2.25" between pickets), curb with beveled edges; two pedestrian platforms on each side with railings that consist of tubular posts (3'5.5" high, 6.5" diameter) and two horizontal rails (same height as main rail) with pickets of equal length; non-historic concrete barrier (2'8" high x 10" deep) separates roadway from sidewalk.

12625	Lincoln	S.H. 66	BELLCOW CREEK	1951	Concrete continuous slab (reinforced)	7'10.5"	4'1.75"	TL4
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Vertical Railing Measurements

From top of curb to bottom of first rail: 9"
Between rails: 1'3"
Second measurement between rails: 5.25"

End posts and intermediate posts have beveled edges and three vertical incised lines; three horizontal rails, only top and bottom rails connect to posts; pickets with three different lengths (2.25" between pickets), curb with beveled edges; concrete barrier (2'4.5" high x 8.25" deep) separates the roadway from sidewalk.

Concrete and Metal

Railing Type - F: Concrete posts with incised lines, metal tubular railing with two secondary rails and varied-length verticals; variation with elongated end posts

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
13123	Custer	I-40 BUS.	WASHITA RIVER	1953	Steel stringer/multi-beam or girder	8'9"	2'11.5"	TL5



Vertical Railing Measurements

From top of curb to bottom of first rail: 7"
Between rails: 1'.25"
Second measurement between rails: 5.25"

Elongated parapet walls with stepped panels and curve detail; end posts have beveled edges and three incised vertical lines; intermediate posts have beveled edges and one vertical incised line; three horizontal rails, only top and bottom rails connect to posts; pickets with three different lengths (2" between pickets); curb with beveled edges.

Metal; Concrete

Railing Type - Multiple: G (two horizontal steel I-beam rails) and C (concrete post and double rail, inset panels)

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
04077	Craig	U.S. 60	LITTLE CABIN CREEK	1933	Steel truss	19'0"	3'5"	TL4



Vertical Railing Measurements

From top of curb to bottom of first rail: 8.5"
Between rails: 1'0"

Truss railing (main span): Two horizontal I-beam rails with curved detail at ends; riveted connections; horizontal members connect to vertical I-beam posts.

04077	Craig	U.S. 60	LITTLE CABIN CREEK	1933	Steel truss	7'8"	3'9"	TL4
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Vertical Railing Measurements

From top of curb to bottom of first rail: 8.5"
Between rails: 8"

Concrete rail and post (approach spans): end posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges.

Metal; Concrete

Railing Type - Multiple: G (two horizontal steel I-beam rails) and C (concrete post and double rail, inset panels)

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
04085	Canadian	U.S. 281	S. CANADIAN RIVER	1933	Steel truss	20'0"	3'2"	TL4



Vertical Railing Measurements

From top of curb to bottom of first rail: 8.5"
Between rails: 1'0"

Truss railing (main span): Two horizontal I-beam rails with curved detail at ends; riveted connections; horizontal members connect to vertical I-beam posts.

04085	Canadian	U.S. 281	S. CANADIAN RIVER	1933	Steel truss	6'11.5"	3'7.25"	TL4
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Vertical Railing Measurements

From top of curb to bottom of first rail: 10.5"
Between rails: 10"

Concrete rail and post (approach spans): end posts and intermediate posts have beveled edges and inset rectangular panels; decorative corner detail at bottom of posts; rails connect into posts; curb with beveled edges; two different metal bridge plaques on end posts that indicate "Oklahoma Federal Aid Project No. 164-H" and completion in 1933.

Metal

Railing Type - H: Metal X-lattice railing

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
01743	Beckham	I-40 FRONTAGE RD.	TIMBER CREEK	1926	Steel truss	16'1"	3'2.75"	TL4



Vertical Railing Measurements

From top of curb to bottom of first rail: 1'2.25"
Between rails: 2'.5"

Angle iron top and bottom rails; X-lattice work; riveted connections; rail is attached to verticals with T-bar; end posts are built up with combination of metal bars.

03081	Caddo	0804C	CREEK	1930	Steel truss	17'7"	2'2.5"	TL3
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Vertical Railing Measurements

From top of curb to bottom of first rail: 1'1.5"
Between rails: 2'1"

T-bar top rail, angle iron bottom rail; X-lattice work; riveted connections; rail is attached to verticals with T-bar; end posts are built up with combination of bars and angle irons; "OKLA S.H.C. 1930" stamped into concrete abutment wall.

Metal

Railing Type - H: Metal X-lattice railing

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
03107	Caddo	0804C	CREEK	1930	Steel truss	16'0"	3'6"	TL3



Vertical Railing Measurements

From top of curb to bottom of first rail: 1'1"
Between rails: 2'5"

Top and bottom rails have angle irons; X-lattice work; riveted connections; rail is attached to verticals with T-bar; end posts are built up with combination of bars and angle irons.

03192	Custer	I-40 FRONTAGE RD.	BEAR CREEK	1930	Steel truss	XXXXXX	3'1"	TL4
-------	--------	-------------------	------------	------	-------------	--------	------	-----



Vertical Railing Measurements

From top of curb to bottom of first rail: 1'1"
Between rails: 2'0"

T-bar top and bottom rail; X-lattice work; riveted connections; rail is attached to verticals with T-bar; end posts are built up with combination of bars and angle irons.

Metal

Railing Type - I: Metal woven lattice railing

NBI Number	County	Facility Carried	Feature Crossed	Year Built	Bridge Type	Length Between Posts	Total Railing Height	Required TL Rating
01416	Oklahoma	N. OVERHOLSER DR	N. CANADIAN RIVER	1924	Steel truss	16'0"	3'5.125"	TL3



Vertical Railing Measurements

From top of curb to bottom of first rail: 7.875"

Between rails: 2'4"

T-bar top rail, angle iron bottom rail; woven lattice work consists of angle irons; riveted connections; rail is attached to verticals with T-bar; end posts are built up with combination of T-bars and angle irons.

2. Recommendations for Replacement Railing Types

This section provides recommendations on options for replacement railing types. Nine distinct railing types were identified in the inventory of the 32 bridges reviewed for the study. The recommended replacement options meet TL ratings for safety standards and are aesthetically compatible with historic railings, maintaining a consistent feel and appearance along the entire corridor.

The FHWA requires bridge railings used on the National Highway System (NHS) to meet full-scale crash criteria. The test criteria are documented in the AASHTO *Manual for Assessing Safety Hardware* (MASH), which is a 2009 update of NCHRP Report 350: *Recommended Procedures for the Safety Performance Evaluation of Highway Features*. The test criteria include six levels of testing and crashworthiness ratings. The first three levels are based on impact speed, from 31 mph for TL 1 to 44 mph for TL 2, and 62 mph for TL 3. All new or replacement railing on NHS bridges must meet Test Level 3 crash-test criteria at a minimum. Test Levels 1 – 3 are based on impacts from light vehicles such as passenger cars and light trucks. Test Levels 4 – 6 contain additional tests for bridge railings designed to contain and redirect heavy vehicles such as buses and larger trucks.

Recommendations are based on information gathered from documentation of existing railings (see inventory in Section A), guidance provided by the FHWA and American Association of State Highway & Transportation Officials (AASHTO), and crash-tested railing options used by state DOTs around the country. The recommendations are also based on ODOT's standard practice of applying the TL ratings, as follows:

- TL 5: on-system bridge with divided roadway
- TL 4: on-system bridge with undivided roadway
- TL 3: off-system bridge with divided or undivided roadway

Since these bridges are located along the historic Route 66 Scenic Byway and railings are often considered character-defining features of historic bridges, the Secretary of the Interior's *Standards for Treatment of Historic Properties* (Secretary's Standards) were also taken into consideration in the identification of replacement railing options. In particular, the following two standards for rehabilitation provided guidance:

- Deteriorated historic features will be repaired rather than replaced. Where the severity of the deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture, and where possible, materials. Replacement of missing features will be substantiated by documentary and physical evidence.
- New additions, exterior alterations, or related construction will not destroy historic materials, features, and spatial relationships that characterize the property. The new work shall be differentiated from the old and will be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment.

The following factors were considered when identifying replacement railing recommendations:

- Retention of existing railing with addition of new railing that meets required TL rating
- Compatibility with materials
- Compatibility with configuration
- Overall compatibility with the Secretary Standards
- Pedestrian use (where applicable)

For each of the nine distinct railing types identified in the inventory, replacement railing recommendations that meet the required crash tested standards for TL 3, TL4, and TL5 are provided. However, in some cases, the replacement railing recommendation may not be compatible to the existing railing in configuration and/or material due to the design requirements of new railing to meet the required crash tested standards. For example, the only available TL 5-rated replacement railings consist of concrete traffic barriers or concrete parapets.

It is assumed that most railing replacements would occur in conjunction with a bridge rehabilitation project that includes deck replacement. However, if the railing replacement would not occur in conjunction with a deck replacement, there are several factors to consider. The strength of the existing bridge deck, sidewalks, and/or curbs would need to be assessed for structural capacity if new railings were installed. If deck replacement is not part of the project, outer portions of the bridge deck and/or the sidewalks and curbs may need to be replaced with sufficient new concrete and reinforcing steel to accommodate the anchorages of the railings for the various TL requirements.

A. Background research

Background research used to inform decisions related to appropriate replacement railing options was obtained from a number of sources, including bridge manuals and guidance produced and used by AASHTO, FHWA, and various state DOTs. Below is a list of sources consulted to prepare recommendations.

- FHWA Safety Bridge Railings website,
http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/barriers/bridgerailings/index.cfm
 - Memorandum from Chief, Federal-Aid and Design Division, to Regional Administrators, Federal Lands Highway Program Administrator, regarding Crash Testing of Bridge Railings, May 30, 1997, as cover to “Bridge Railing Design and Testing: A Discussion with the AASHTO Highway Subcommittee on Bridges and Structures Technical Committee (T-7) for Guardrail and Bridge Rail, May 14, 1996.”
 - Memorandum from Frederick G. Wright, Jr. to Resource Center Directors and Division Administrators regarding Bridge Rail Analysis, May 16, 2000.
- FHWA/California Department of Transportation (Caltrans), *Bridge Rail Guide*, 2005, available at Caltrans.

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Recommendations for
Replacement Railing Types

- FHWA Roadside Hardware Policy and Guidance website,
http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/
- AASHTO, *A Guide to Standardized Highway Barrier Hardware*,
https://www.aashtotf13.org/guide_display.php
- National Cooperative Highway Research Program Report 350 "Recommended Procedures for the Safety Performance Evaluation of Highway Features," 1993. *Wisconsin Department of Transportation Bridge Manual*, Chapter 30- Railings,
http://on.dot.wi.gov/dtid_bos/extranet/structures/LRFD/BridgeManual/Ch-30.pdf
- Texas Department of Transportation
 - *Bridge Railing Manual*, December 2014,
<http://onlinemanuals.txdot.gov/txdotmanuals/rlg/rlg.pdf>
 - Holt, P.E., John M. "What's Up With These New Bridge Rails?" Presentation at Transportation Short Course, October 2012.
- Oregon Department of Transportation, *Historic Bridge Preservation Plan*, December 2007,
http://environment.transportation.org/pdf/historic_cultural/ODOTHistBrPresPlan.pdf.
- Ohio Department of Transportation, Office of Environmental Services, *Ohio Historic Bridge Maintenance & Preservation Guidance*, June 2010,
https://www.dot.state.oh.us/Divisions/Planning/Environment/Cultural_Resources/HISTORIC_BRIDGES/Documents/OhioHistoricBridgePreservationManual910.pdf
- AASHTO Standing Committee on the Environment, *Guidelines for Historic Bridge Rehabilitation and Replacement*, March 2007,
http://environment.transportation.org/cop/groups/historic_bridges/media/p/30.aspx
- Kansas Department of Transportation, *Design Manual*, Volume III US (LRFD), Version 8/13, Chapter 3.13 Railings, <http://kart.ksdot.org/>
- Texas Transportation Institute, *Evaluation of the FDOT Variant of the Kansas Corral Bridge Railing*, March 2004, <http://d2dtl5nnlpfr0r.cloudfront.net/tti.tamu.edu/documents/9-8132-2.pdf>
- Wisconsin Department of Transportation, *LRFD Bridge Manual, Chapter 30-Railings*, July 2014,
http://on.dot.wi.gov/dtid_bos/extranet/structures/LRFD/LRFDManualIndex.htm

Appendix B provides an overview of the potential railing options identified during background research but discarded as not being viable options for various reasons.

B. Recommendations

This section provides recommendations on options for replacement railing types. Nine distinct railing types were identified in the inventory of the 32 bridges reviewed for the project, and recommendations were made based on the materials and configuration of the distinct railing types. Recommendations are generally organized first by material and type and then by different TL ratings within the type.

Before selecting a replacement railing option, retention of the existing railing and the addition of a new railing that meets the TL rating requirements between the existing railing and the roadway (or between the roadway and the sidewalk, if the bridge has a sidewalk) should be considered. Retaining the existing railing would be the most compatible option to meet the Secretary's Standards. The addition of a new railing may infringe on clear roadway width across the bridge, however, and it would need to be determined on a case-by-case basis if this is acceptable. If the bridge has a sidewalk, it may be necessary to obtain a design exception for pedestrian requirements when adding a new railing and retaining the existing railing. Since the inboard railing (newly added railing) would meet the appropriate TL rating requirement, the outboard railing (existing railing) would not need to meet the TL rating requirements. If a design exception cannot be achieved, consider fabricating members to add to the existing railing to decrease the size of railing openings or increase height. Another option for meeting pedestrian requirements is to reconstruct the existing railing as a close match with appropriate height and opening dimensions.

If retaining the existing railing and adding a new railing that meets the required TL rating is not possible, the following section provides replacement railing options by existing railing type for each of the three TL ratings (TL 3, TL 4, and TL 5) ODOT typically considers. There may be limited cases where options for TL 2 replacement railings may be considered, and TL 2 options are presented in Appendix D. Not all options for replacement railings meet the Secretary's Standards, and there may need to be flexibility in the TL rating requirement for the replacement railing. In limited cases, a replacement railing that has a TL rating lower than the existing TL rating may be considered. Specific design speed limitations (45 miles per hour or less for bridges on non-NHS roads), aesthetics, and/or historic preservation issues must be considered when determining if a lower TL-rated replacement railing is appropriate. Application for a design exception may also be required if a replacement railing with a lower TL rating is considered. There may also be cases where a replacement railing with at higher TL rating than the requirement is considered. For example, a TL 4-rated replacement railing may be a compatible option for a bridge where a TL 3-rated replacement railing is required. In this type of case of using a replacement railing with a higher TL rating, application for a design exception would not be required.

Table 2 on the next page summarizes the replacement railing recommendations, and is followed by a brief description of the existing railing type and analysis of recommended replacement options; please refer to the inventory table in Section A for detailed information about the existing railing types. For basic dimensions of each recommended replacement railings, please refer to the plan sheets in Appendix C.

Section 2

Recommendations for Replacement Railing Types

When more than one option is presented, Option 1 is the preferred and recommended option based on TL rating and aesthetic considerations. Although several existing railing types have inset panels or inscribed lines on the posts, the recommended options do not include this design element. Potential replacement railings that include these design elements were not identified in the research. Adding these design elements during construction has the potential for changing the railing characteristics to such a degree they would no longer meet the crash-tested standards (TL rating).

Two bridges have different railings for the main span (Existing Railing Type G) and approach spans (Existing Railing Type C) in terms of design, configuration, and materials. Recommendations for bridges with multiple railings are organized in the discussion below by the type of existing railing on the main span, which is Existing Railing Type G.

Section 2
Recommendations for
Replacement Railing Types

Table 2. Summary of replacement railing recommendations

Material	Railing Design	Rail Type	TL 3 Option(s)	TL 4 Option(s)	TL 5 Option(s)
Concrete	Single rail with posts	A	1. Texas Type T66	1. New Jersey Barrier Type 80 & 80SW 2. ODOT Concrete Traffic Rail	1. ODOT 42" F-shaped Concrete Parapet 2. Texas Type T80SS
		B	1. Texas Type T66	1. New Jersey Barrier Type 80 & 80SW 2. ODOT Concrete Traffic Rail	1. ODOT 42" F-shaped Concrete Parapet 2. Texas Type T80SS
	Double rails with posts	C	1. Texas Type T66 2. Texas Type T1W	1. Texas Type C412 2. Wyoming 2 Tube Steel Railing	1. ODOT 42" F-shaped Concrete Parapet 2. Texas Type T80SS
		D	1. Texas Type T66 2. Texas Type T1W	1. Wyoming 2 Tube Steel Railing 2. Texas Type C412	1. ODOT 42" F-shaped Concrete Parapet 2. Texas Type T80SS
	Concrete balustrade	E	1. Texas Type C412	1. Texas Type C412	1. ODOT 42" F-shaped Concrete Parapet 2. Texas Type T80SS
Metal and concrete	Metal picket rail with concrete posts	F	1. Texas Metal Picket Railing	1. Wyoming 2 Tube Steel Railing	1. ODOT 42" F-shaped Concrete Parapet 2. Texas Type T80SS
Multiple	Steel truss rail (G) – main span; concrete double rails with posts (C) – approach spans	G and C	1. Texas Type T1W and Texas Type T66 2. Side mount W Beam	1. Michigan Bridge Railing 2-Tube and Texas C412 2. Wyoming 2 Tube Steel Railing	1. ODOT 42" F-shaped Concrete Parapet 2. Texas Type T80SS
Metal	Steel truss rail	H	1. Texas Type T1W 2. Side mount W Beam	1. Wyoming 2 Tube Steel Railing	1. ODOT 42" F-shaped Concrete Parapet 2. Texas Type T80SS
		I	1. Texas Type T1W 2. Side mount W Beam	1. Wyoming 2 Tube Steel Railing	1. ODOT 42" F-shaped Concrete Parapet 2. Texas Type T80SS

Concrete – Single Rail with Posts

Existing Railing Type A Recommendations

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(1) Existing Railing Type A – Concrete post and single rail, inset panels

Existing Railing

Description: Concrete railing that consists of concrete end and intermediate posts with inset panels and a single line rail between the posts. The railing sits on a concrete curb.

Study bridge(s) with railing type: NBI No. 13481 and 01896 (required TL rating: TL4)

Example image of existing railing type:



Recommendations for Replacement Railing

Railings that meet TL 3 Rating

Option 1: Texas T66 (TL 3)



(Source: TxDOT, *Bridge Railing Manual*; Holt, “What’s Up With These New Bridge Rails?”)

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Recommendations for Replacement Railing Types

This option has a TL 3 rating and has the same material and overall appearance as the existing railing. The height of the railing is comparable to the existing railing. The dimensions of the railings would be slightly larger than existing railings. The posts have stylized details, including beveled edges similar to existing posts, and horizontal members connect into the posts rather than on top of the posts. A portion of the post also extends above the railing, making the post a more distinct feature than in the TL 4 rated options below. This option is compatible with the Secretary's Standards because it matches the materials, configuration, and scale of the existing railing.

Railings that meet TL 4 Rating

Option 1: New Jersey Barrier Type 80 & 80 SW (TL 4)



(Source: FHWA/Caltrans, *Bridge Rail Guide*³)

This option matches the concrete material and has a similar overall appearance to the existing railing. The posts have beveled edges similar to the existing posts, and horizontal members connect into the posts rather than on top of the posts. In addition, the spacing between posts closely matches that of the existing railing. This option is compatible with the Secretary's Standards because it matches the materials, configuration, and scale of the existing railing.

Note: two-toned color would not have to be used.

³ Full citation information for all sources is presented in Section 2.A of this report.

Option 2: ODOT Concrete Traffic Rail TR4 (TL 4)

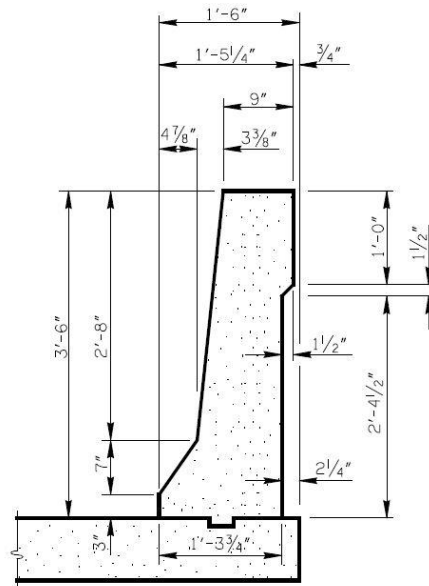


(Source: Mead & Hunt)

This option matches the concrete material of the existing railing. The height of the railing is comparable to the existing railing; however, the dimensions of the railing would be slightly larger than the existing railing. While the options provides the incorporated transition for approach guardrail attachment, it is not as aesthetically compatible with the existing railing as Option 1. The horizontal rail extends across the top of posts rather than connecting into the posts. In addition, the posts are elongated and are not visually distinctive due to the horizontal member across the top. This option is less compatible with the Secretary's Standards because it does not match the approximate configuration of the existing railing.

Railings that meet TL 5 Rating

Option 1: ODOT 42" F-shaped Concrete Parapet (TL 5)

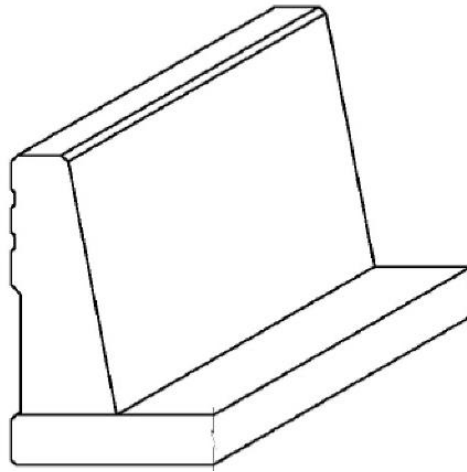


TYPICAL SECTION

(Source: ODOT, Standard Specifications, 2009; Photo not available)

No other replacement recommendations were identified that provide the TL 5 rating and that possess the same general aesthetic of the existing concrete railing. If the existing railing can't be left in place and the TL 5-rated railing added between the existing railing and the roadway, the existing railing could be replaced with the ODOT 42" F-shaped Concrete Parapet. Replacing the existing railing with this option is less compatible with the Secretary's Standards because it does not match the approximate configuration of the existing railing.

Option 2: Texas Type T80SS (TL 5)



(Source: TxDOT, *Bridge Railing Manual*; Photo not available)

This option for a TL5-rated replacement railing includes minimal aesthetic treatments (beveled edges at the top and horizontal incised lines on the outside surface). If a particular location warrants inclusion of aesthetic treatments on the replacement railing, this option may be considered. This option of replacing the existing railing is less compatible with the Secretary's Standards because it does not match the approximate configuration of the existing railing.

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Concrete – Single Rail with Posts

Existing Railing Type B Recommendations

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(2) Existing Railing Type B – Concrete post and single rail, incised lines

Existing railing

Description: Concrete railing that consists of concrete end and intermediate posts with inscribed lines and a single line rail between the posts. The railing sits on a concrete curb.

Study bridge(s) with railing type: NBI No. 09003 (Required TL Rating: TL 3)

Example image of existing railing type:



Recommendations for Replacement Railing

Railings that meet TL rating TL 3

Option 1: Texas T66 (TL 3)

See the section entitled “Railings that meet TL 3 rating” for Existing Railing Type A on page 32 for the photo and description of the Texas T66 railing. This option is compatible with the Secretary’s Standards because it matches the materials, configuration, and scale of the existing railing.

Railings that meet TL rating TL 4

Option 1: New Jersey Barrier Type 80 & 80 SW (TL 4)

See the section entitled “Railings that meet TL 4 rating” for Existing Railing Type A on page 33 for the photo and description of the New Jersey Barrier Type 80 & 80 SW. This option is compatible with the Secretary’s Standards because it matches the materials, configuration, and scale of the existing railing.

Option 2: ODOT Concrete Traffic Rail TR 4 (TL 4)

See the section entitled “Railings that meet TL 4 rating” for Existing Railing Type A on page 33 for the photo and description of the ODOT Concrete Traffic Rail TR 4. This option is less compatible with the Secretary’s Standards because it does not match the approximate configuration of the existing railing.

Railings that meet TL 5 Rating

Option 1: ODOT 42” F-shaped Concrete Parapet (TL 5)

See the section entitled “Railings that meet TL 5 rating” for Existing Railing Type A on page 35 for the photo and description of the ODOT 42” F-shaped Concrete Parapet. This option is less compatible with the Secretary’s Standards because it does not match the existing railing in configuration. There were no replacement options identified with similar configuration that meet the required TL rating.

Option 2: Texas Type T80SS (TL 5)

See the section entitled “Railings that meet TL 5 rating” for Existing Railing Type A on page 36 for the photo and description of the Texas Type T80SS. This option is less compatible with the Secretary’s Standards because it does not match the existing railing in configuration. There were no replacement options identified with similar configuration that meet the required TL rating.

Concrete – Double Rail with Posts

Existing Railing Type C Recommendations

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(3) Existing Railing Type C – Concrete post and double rail, inset panels

Existing railing

Description: Concrete railing that consists of concrete end and intermediate posts with inset panels and double line rail between the posts. The railing sits on a concrete curb.

Study bridge(s) with railing type: NBI No. 02126, 02916, 03202, 03203, 04051, 04197, 05487, 07136, 09303, and 23667 (Required TL Rating: TL 3);
01866, 01895, 01918, 02249, and 04076 (Required TL Rating: TL 4).

Example image of existing railing type:



Recommendations for Replacement Railing

Note: There were no replacement options identified in concrete with double line rails that meet required TL ratings.

Railings that meet TL 3 Rating

Option 1 (preferred): Texas T66 (TL 3)

See the section entitled “Railings that meet TL 3 rating” for Existing Railing Type A on page 32 for the photo and description of the Texas T66 railing. This option is compatible with the Secretary’s Standards because it matches the materials and scale of the existing railing.

Option 2: Texas Type T1W (TL 3)



(Source: TxDOT, *Bridge Railing Manual*; Holt, “What’s Up With These New Bridge Rails?”)

Option 2 is an all metal railing and does not match the existing concrete railing in terms of materials. Despite this difference, this option was considered because it includes two horizontal members and approximates the configuration of the existing railing with the spacing of vertical and horizontal members. This option is less compatible with the Secretary’s Standards because it does not match the material of the existing railing; however, it does approximate the two-rail configuration of the existing railing.

Railings that meet TL 4 Rating

Option 1 (preferred): Texas Type C412 (TL 4)



(Courtesy of TxDOT)

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Option 1 matches the material of the existing railing. Although the railing does not exactly match the design of the existing railing in terms of horizontal rails and posts, it does evoke a sense of historic railing with its evenly spaced concrete balusters and concrete cap. This option is compatible with the Secretary's Standards because it matches the materials and scale of the existing railing and evokes a sense of historic railing with its evenly spaced concrete balusters and concrete cap without creating a false sense of history. However, the overall configuration is different than the existing railing.

Option 2: Wyoming 2 Tube (TL 4)



(Source: FHWA/Caltrans, *Bridge Rail Guide*)

Option 2 meets the TL 4 rating requirement and provides a configuration similar to the existing railing. The railing includes two horizontal members and approximates the spacing of vertical and horizontal members on the existing railing. This option is less compatible with the Secretary's Standards because it does not match the material of the existing railing; however, it does approximate the configuration of the existing railing.

Railings that meet TL 5 Rating

Option 1: ODOT 42" F-shaped Concrete Parapet (TL 5)

See the section entitled "Railings that meet TL 5 rating" for Existing Railing Type A on page 35 for the photo and description of the ODOT 42" F-shaped Concrete Parapet. This option is less compatible with the Secretary's Standards because it does not match the existing railing in configuration. There were no replacement options identified with similar configuration that meet the required TL rating.

Option 2: Texas Type T80SS (TL 5)

See the section entitled "Railings that meet TL 5 rating" for Existing Railing Type A on page 36 for the photo and description of the Texas Type T80SS. This option is less compatible with the Secretary's Standards because it does not match the existing railing in configuration. There were no replacement options identified with similar configuration that meet the required TL rating.

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Concrete – Double Rail with Posts

Existing Railing Type D Recommendations

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(4) Existing Railing Type D – Concrete post and double rail, lower rail sits on curb, inset panels

Existing railing

Description: Concrete railing that consists of concrete end and intermediate posts with inset panels and double line rail between the posts. The lower rail sits on the concrete curb. Two railings on each side of the bridge.

Study bridge(s) with railing type: NBI No. 05017 (Required TL Rating: TL 4)

Example image of existing railing type:



Recommendations for Replacement Railing

Note: There were no replacement options identified in concrete with double line rails that meet required TL ratings.

Railings that meet TL3 Rating

Option 1 (preferred): Texas T66 (TL 3)

See the section entitled “Railings that meet TL 3 rating” for Existing Railing Type A on page 32 for the photo and description of the Texas T66 railing. This option is compatible with the Secretary’s Standards because it matches the materials and scale of the existing railing.

Option 2: Texas Type T1W (TL 3)

See the section entitled “Railings that meet TL 3 rating” for Existing Railing Type C on page 45 for the photo and description of the Texas Type T1W railing. This option is less compatible with the Secretary’s Standards because it does not match the material of the existing railing; however, it does approximate the two-rail configuration of the existing railing.

Railings that meet TL4 Rating

Option 1 (preferred): Wyoming 2 Tube Railing (TL 4)

See the section entitled “Railings that meet TL 4 rating” for Existing Railing Type C on page 46 for the photo and description of the Wyoming 2 Tube Railing. See also discussion on page 27 regarding factors to consider if the bridge has a sidewalk. If the outboard railing could be retained, the Wyoming 2 Tube Railing could replace the existing inboard railing. Although the material of the inboard railing would not be compatible with the existing railing, this option would achieve a similar visual effect of the existing paired, two-concrete railing on the bridge and would enable the traveling public to see the outboard concrete railing through its members. The combination of the new inboard railing and existing outboard railing would be compatible with the Secretary’s Standards because the configuration and scale of the existing railing is generally maintained.

Option 2: Texas Type C412 (TL 4)

See the section entitled “Railings that meet TL 4 rating” for Existing Railing Type C on page 45 for the photo and description of the Texas Type C412 railing. This option is compatible with the Secretary’s Standards because it matches the materials and scale of the existing railing and evokes a sense of historic railing with its evenly spaced concrete balusters and concrete cap without creating a false sense of history.

Railings that meet TL 5 Rating

Option 1: ODOT 42” F-shaped Concrete Parapet (TL 5)

See the section entitled “Railings that meet TL 5 rating” for Existing Railing Type A on page 35 for the photo and description of the ODOT 42” F-shaped Concrete Parapet. This option is less compatible with the Secretary’s Standards because it does not match the existing railing in configuration. There were no replacement options identified with similar configuration that meet the required TL rating.

Option 2: Texas Type T80SS (TL 5)

See the section entitled “Railings that meet TL 5 rating” for Existing Railing Type A on page 36 for the photo and description of the Texas Type T80SS. This option is less compatible with the Secretary’s Standards because it does not match the existing railing in configuration. There were no replacement options identified with similar configuration that meet the required TL rating.

Concrete – Balustrade

Existing Railing Type E Recommendations

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(5) Existing Railing Type E – Solid concrete panel with integrated end posts and intermediate posts, and baluster cutouts topped with concrete cap and integrated curb

Existing railing

Description: Concrete panel end posts, intermediate posts, and baluster cutouts topped with concrete cap. Railing has an integrated curb.

Study bridge(s) with railing type: NBI No. 02824 (Required TL Rating: TL 3)

Example image of existing railing type:



Recommendations for Replacement Railing

Railings that meet TL 3 and TL 4 Rating

Texas Type C412 (TL 4)

Although this option is a TL 4-rated railing, it is the most compatible option identified in the research that would meet the TL 3 rating requirement. See the section entitled “Railings that meet TL 4 rating” for Existing Railing Type C on page 45 for the photo and description of the Texas Type C412 railing. This option is compatible with the Secretary’s Standards because it matches the materials and scale of the existing railing and evokes a sense of historic railing with its evenly spaced concrete balusters and concrete cap without creating a false sense of history.

Railings that meet TL 5 Rating

Option 1: ODOT 42” F-shaped Concrete Parapet (TL 5)

See the section entitled “Railings that meet TL 5 rating” for Existing Railing Type A on page 35 for the photo and description of the ODOT 42” F-shaped Concrete Parapet. This option is less compatible with

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the Secretary's Standards because it does not match the existing railing in configuration. There were no replacement options identified with similar configuration that meet the required TL rating.

Option 2: Texas Type T80SS (TL 5)

See the section entitled "Railings that meet TL 5 rating" for Existing Railing Type A on page 36 for the photo and description of the Texas Type T80SS. This option is less compatible with the Secretary's Standards because it does not match the existing railing in configuration. There were no replacement options identified with similar configuration that meet the required TL rating.

Metal and Concrete – Metal Picket with Concrete Posts
Existing Railing Type F Recommendations

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(6) Existing Railing Type F – Concrete posts with incised lines, metal tubular railing with two secondary rails and varied-length verticals

Existing railing

Description: Concrete posts with incised lines; metal tubular top railing and two secondary rails with varied-length verticals; a variation has elongated end posts.

Study bridge(s) with railing type: NBI No. 09474 (Required TL Rating: TL 3); 02336, 10566, and 12625 (Required TL Rating: TL 4); and 13123⁴ (Required TL Rating: TL 5)

Example image of existing railing type:



⁴ It is assumed that the traffic barriers currently on Bridges 12625 and 10566 do not date to the historic period, but rather are more modern additions to the bridges. Therefore, these bridges were not categorized as having multiple railing types.

Recommendations for Replacement Railing

Railings that meet TL 3 rating

Option 1: Texas Type T1P Metal Picket Railing (TL 3)



(Source: Holt, "What's Up With These New Bridge Rails?"; TxDOT Bridge Railing Manual, 12/2014)

This option has a similar appearance to the existing railing. Although the horizontal railings are slightly larger, the new bridge railing possesses many of the same elements of the existing railing, including the tubular top rail, two secondary rails, and vertical pickets. Elongated concrete end posts could be stylized to match the existing railing. This option is compatible with the Secretary's Standards because it matches the materials, configuration, and scale of the existing railing.

Railings that meet TL 4 Rating

Wyoming 2 Tube (TL 4)

See the section entitled "Railings that meet TL 4 rating" for Existing Railing Type C on page 46 for the photo and description of the Wyoming 2 Tube Steel Railing. This railing could also be painted if desired. This option is less compatible with the Secretary's Standards because it does not match the existing railing in configuration. There were no replacement options identified with similar configuration that meet the required TL rating.

Railings that meet TL 5 Rating

Option 1: ODOT 42" F-shaped Concrete Parapet (TL 5)

See the section entitled "Railings that meet TL 5 rating" for Existing Railing Type A on page 35 for the photo and description of the ODOT 42" F-shaped Concrete Parapet. This option is less compatible with

Section 2
Recommendations for
Replacement Railing Types

the Secretary's Standards because it does not match the existing railing in materials and configuration. There were no replacement options identified with similar configuration that meet the required TL rating.

Option 2: Texas Type T80SS (TL 5)

See the section entitled "Railings that meet TL 5 rating" for Existing Railing Type A on page 36 for the photo and description of the Texas Type T80SS. This option is less compatible with the Secretary's Standards because it does not match the existing railing in materials and configuration. There were no replacement options identified with similar configuration that meet the required TL rating.

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Multiple – Steel Truss Railing and Concrete Double Rail with Posts
Existing Railing Types G and C – Recommendations

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(7) Bridges with Multiple Existing Railings – Types G and C – Two horizontal steel I-beam rails (G); concrete post and double line rail; inset panels (C)

Existing railing

Description: Main span railing: Two horizontal I-beam rails (G); Approach railing: Concrete railing that consists of concrete end and intermediate posts with inset panels and double line rail between the posts (C). The approach railing sits on a concrete curb, whereas the railing on the main span is attached to the truss members, on the outside of the concrete curb.

Study bridge(s) with railing type: NBI No. 04077 and 04085 (Required TL Rating: TL 4)

Example image of existing railing type: Main truss span railing – Steel I-beam double rail:



Example image of existing railing type: Approach railing – Concrete post and double line rail, inset panels:



Recommendations for Replacement Railing

Railings that meet TL 3 Rating

Option 1: Texas T1W Railing (main span) and Texas T66 Railing (approach spans) (TL 3)

Texas T1W Railing (main span)

See the section entitled “Railings that meet TL 3 rating” for Existing Railing Type C on page 45 for the photo and description of the Texas Type T1W Railing. If this option cannot be added inboard of the existing railing to retain the existing railing, this option could replace the existing railing on the main span. The Texas T1W would replace metal W beam guard rail if it is present on the bridge. One of the disadvantages of this option if it is added inboard of the existing railing is that it may infringe on clear roadway width of the roadway across the bridge. It would need to be determined on a case-by-case basis if this is acceptable. This option is compatible with the Secretary's Standards because it is generally compatible with the material and configuration of the existing railing on the main span.

Texas T66 Railing (approach spans)

See the section entitled “Railings that meet TL 3 rating” for Existing Railing Type A on page 32 for the photo and description of the Texas T66 Railing, which could replace the existing railing on the approach spans if a different railing that meets the TL rating requirement cannot be installed inboard of the existing railing to retain it. This option would not retain the existing railing, but would provide new railings that match the overall aesthetic of the existing railing. This option is compatible with the Secretary's Standards because it matches the materials, general configuration (although this option for the approach spans has only one horizontal member), and scale of the existing railing.

Option 2: Side Mount W Beam (TL 3)



(Source: FHWA/Caltrans, *Bridge Rail Guide*)

Section 2

Recommendations for Replacement Railing Types

This option replaces the existing I-beam railing on the main span and concrete railing on the approach spans with the side mount W beam, which meets TL 3 rating requirements. This option does not provide an aesthetic match to the existing railing; however, it is presented as an option because it would not infringe on the clear roadway width of the bridge. It can also be used on the approaches. With this option, the existing railing could not be left in place as there is not enough space for the posts of the side mount W beam to fit between the edge of the deck and the existing railing. Attaching the W beam directly to the existing railing and/or members of the truss would not meet the requisite TL rating. This option is less compatible with the Secretary's Standards because it does not match the existing railing in materials or configuration.

Railings that meet TL 4 Rating

Option 1 (preferred): Michigan Bridge Railing 2-Tube and Texas C412 (TL 4)

Michigan Bridge Railing 2-Tube



(Source: FHWA/Caltrans, *Bridge Rail Guide*)

Texas Type C412 Railing

See the section entitled "Railings that meet TL 4 rating" for Existing Railing Type C on page 45 for the photo and description of the Texas Type C412 Railing, which could replace the existing railing on the approach spans if a different railing that meets the TL rating requirement cannot be installed inboard of the existing railing to retain it. This option would not retain the existing railing, but would provide new railings that match the overall aesthetic of the existing railing. This option is compatible with the Secretary's Standards because it matches the materials, general configuration (although this option for the approach spans has only one horizontal member), and scale of the existing railing.

Option 2: Wyoming 2 Tube Steel Railing (TL 4)

See the section entitled “Railings that meet TL 4 rating” for Existing Railing Type C on page 46 for the photo and description of the Wyoming 2 Tube Steel Railing. This option replaces the main span and approach railings with a single Wyoming 2-Tube steel railing across the entire bridge. This would provide a consistent railing across the bridge and eliminate potential snag points at the transitions between railings. This railing could also be painted if desired. This option is less compatible with the Secretary’s Standards because it does not match the existing railing in materials or configuration.

Railings that meet TL 5 Rating

Option 1: ODOT 42” F-shaped Concrete Parapet (TL 5)

See the section entitled “Railings that meet TL 5 rating” for Existing Railing Type A on page 35 for the photo and description of the ODOT 42” F-shaped Concrete Parapet. This option is less compatible with the Secretary’s Standards because it does not match the existing railing in materials and configuration. There were no replacement options identified with similar configuration that meet the required TL rating.

Option 2: Texas Type T80SS (TL 5)

See the section entitled “Railings that meet TL 5 rating” for Existing Railing Type A on page 36 for the photo and description of the Texas Type T80SS. This option is less compatible with the Secretary’s Standards because it does not match the existing railing in materials and configuration. There were no replacement options identified with similar configuration that meet the required TL rating.

Metal – Steel Truss Railing

Existing Railing Type H Recommendations

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(8) Existing Railing Type H – Metal-lattice railing

Existing rail

Description: Metal railing with X-lattice between two horizontal members.

Study bridge(s) with railing type: NBI No. 03081 and 03107 (Required TL Rating: TL 3); 01743 and 03192 (Required TL Rating: TL 3)

Example image of existing railing type:



Recommendations for Replacement Railing

Note: No available replacement options that match the appearance and configuration of the current railing were identified.

Railings that Meet TL 3 Rating

Option 1 (preferred): Texas T1W Railing (TL 3)

See the section entitled “Railings that meet TL 3 rating” for Existing Railing Type C on page 45 for the photo and description of the Texas T1W Railing. This option could replace the existing railing if it cannot be retained and the Texas T1W railing installed inboard of the existing railing. The Texas T1W would replace metal W beam guard rail if it is present on the bridge. This option is less compatible with the Secretary’s Standards than retaining the existing railing because it does not match the configuration, or design of the existing railing.

Option 2: Side Mount W Beam (TL 3)

See the section entitled “Railings that meet TL 3 rating” for Existing Railing Types G and C on page 65 for the photo and description of the Side Mount W Beam Railing.

Railings that meet TL 4 ratings

Option 1: Wyoming 2 Tube Railing (TL 4)

See the section entitled “Railings that meet TL 4 rating” for Existing Railing Type C on page 46 for the photo and description of the Wyoming 2 Tube Railing Railing. If this option cannot be added inboard of the existing railing to retain the existing railing, this option could replace the existing railing. The Wyoming 2 Tube Railing would replace metal W beam guard rail if it is present on the bridge. This option is less compatible with the Secretary’s Standards because it does not match the configuration or design of the existing railing.

Railings that Meet TL 5 Rating

Option 1: ODOT 42” F-shaped Concrete Parapet (TL 5)

See the section entitled “Railings that meet TL 5 rating” for Existing Railing Type A on page 35 for the photo and description of the ODOT 42” F-shaped Concrete Parapet. This option is less compatible with the Secretary’s Standards because it does not match the existing railing in materials and configuration. There were no replacement options identified with similar materials and configuration that meet the required TL rating.

Option 2: Texas Type T80SS (TL 5)

See the section entitled “Railings that meet TL 5 rating” for Existing Railing Type A on page 36 for the photo and description of the Texas Type T80SS. This option is less compatible with the Secretary’s Standards because it does not match the existing railing in materials and configuration. There were no replacement options identified with similar materials and configuration that meet the required TL rating.

Metal – Steel Truss Railing

Existing Railing Type I Recommendations

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(9) Existing Railing Type I – Metal woven lattice railing

Existing rail

Description: Metal railing with woven lattice between horizontal members.

Study bridge(s) with railing type: NBI No. 01416 (Required TL Rating: TL 3)

Example image of existing railing type:



Recommendations for Replacement Railing

Note: No available replacement options that match the appearance of the current railing were identified.

Railings that Meet TL 3 Rating

Option 1 (preferred): Texas T1W Railing (TL 3)

See the section entitled “Railings that meet TL 3 rating” for Existing Railing Type C on page 45 for the photo and description of the Texas T1W Railing. This option could replace the existing railing if it cannot be retained and the Texas T1W railing installed inboard of the existing railing. The Texas T1W would replace metal W beam guard rail if it is present on the bridge. This option is less compatible with the Secretary’s Standards than retaining the existing railing because it does not match the configuration, or design of the existing railing.

Option 2: Side Mount W Beam (TL 3)

See the section entitled “Railings that meet TL 3 rating” for Existing Railing Type G and C on page 65 for the photo and description of the Side Mount W Beam Railing.

Railings that Meet TL 4 Rating

Option 1: Wyoming 2 Tube Railing (TL 4)

See the section entitled “Railings that meet TL 4 rating” for Existing Railing Type C on page 46 for the photo and description of the Texas Type T1W Railing. If this option cannot be added inboard of the existing railing to retain the existing railing, this option could replace the existing railing. The Wyoming 2 Tube Railing would replace metal W beam guard rail if it is present on the bridge. This option is less compatible with the Secretary’s Standards because it does not match the configuration or design of the existing railing.

Railings that Meet TL 5 Rating

Option 1: ODOT 42” F-shaped Concrete Parapet (TL 5)

See the section entitled “Railings that meet TL 5 rating” for Existing Railing Type A on page 35 for the photo and description of the ODOT 42” F-shaped Concrete Parapet. This option is less compatible with the Secretary’s Standards because it does not match the existing railing in materials and configuration. There were no replacement options identified with similar materials and configuration that meet the required TL rating.

Option 2: Texas Type T80SS (TL 5)

See the section entitled “Railings that meet TL 5 rating” for Existing Railing Type A on page 36 for the photo and description of the Texas Type T80SS. This option is less compatible with the Secretary’s Standards because it does not match the existing railing in materials and configuration. There were no replacement options identified with similar materials and configuration that meet the required TL rating.

Railing/Approach Roadway Guardrail Transitions Recommendations

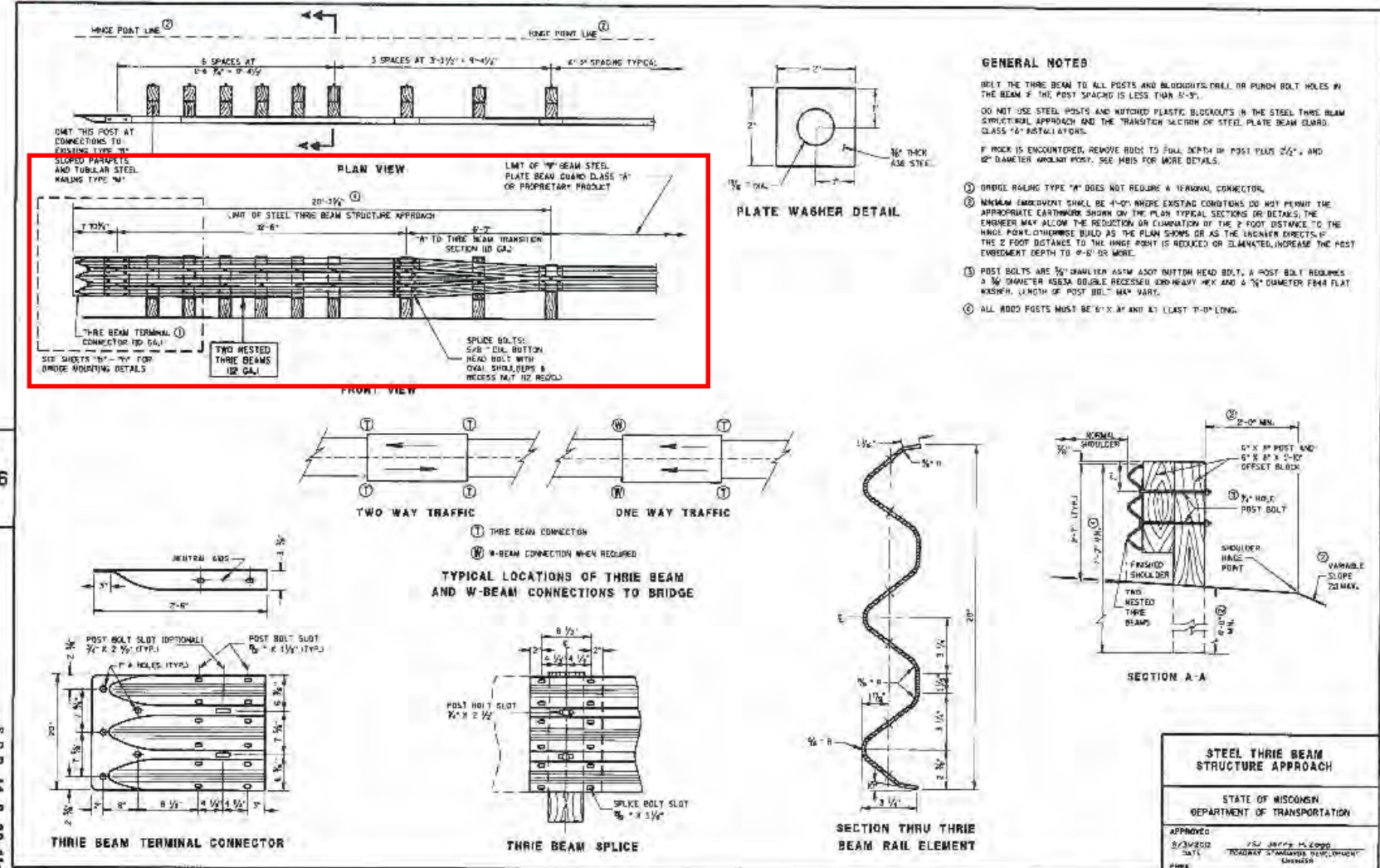
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(10) Railing/Approach Roadway Guardrail Transitions

In addition to identifying potential railing replacement options, research was conducted to identify transitions that could be used between the bridge railing and the approach roadway guardrail. The metal Thrie Beam was the only option identified for a transition between the bridge railing and the W-beam guardrail on approach roadways. Typically, the metal Thrie Beam is bolted directly into the bridge railing endpost. The following illustrates how the Thrie Beam is used as a transition:

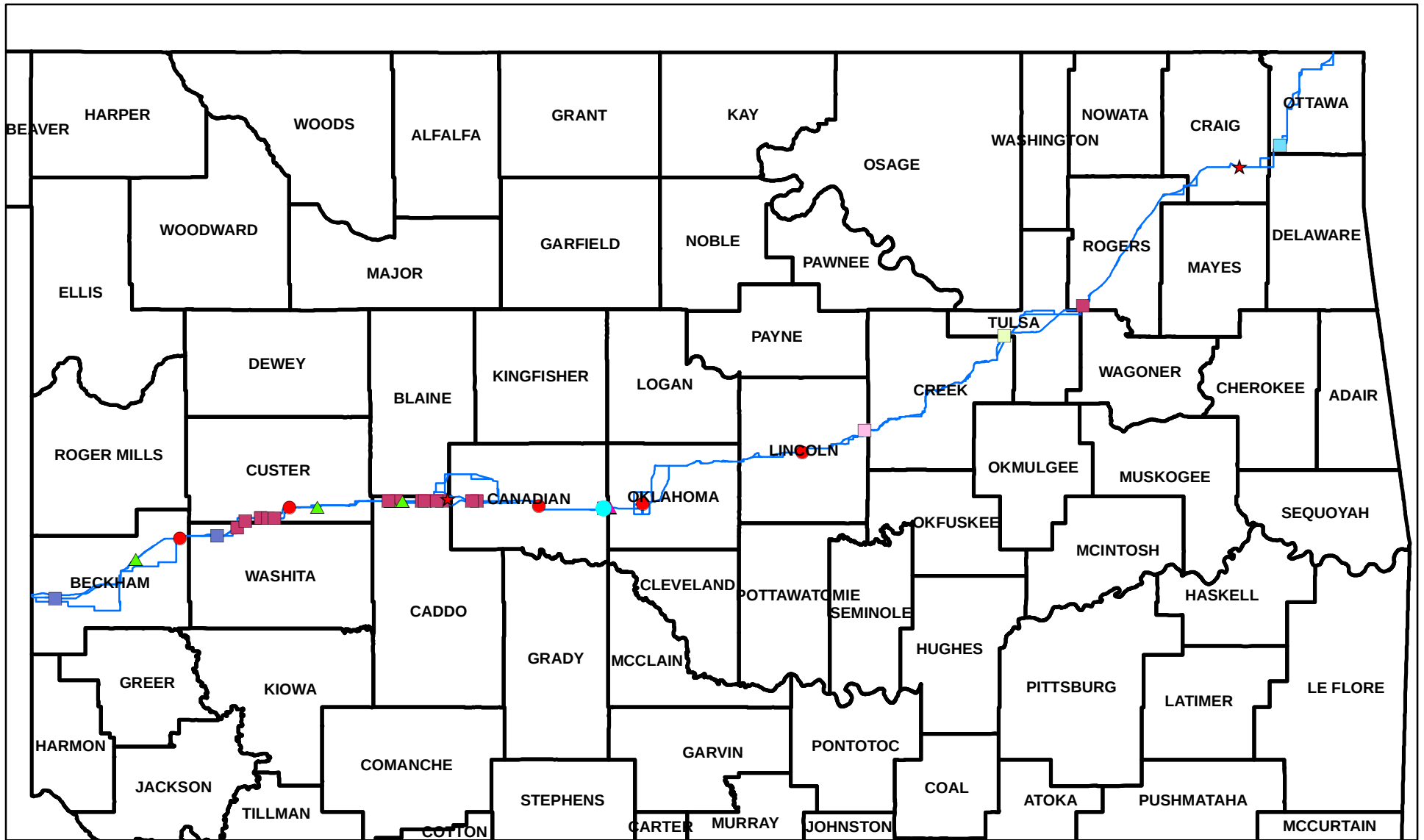
Section 2
Recommendations for
Replacement Railing Types

14B20 sheet a: Steel Thrie Beam Structure Approach

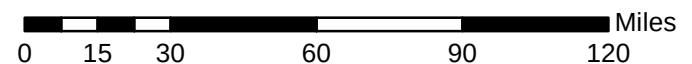
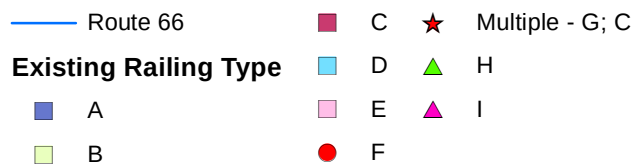


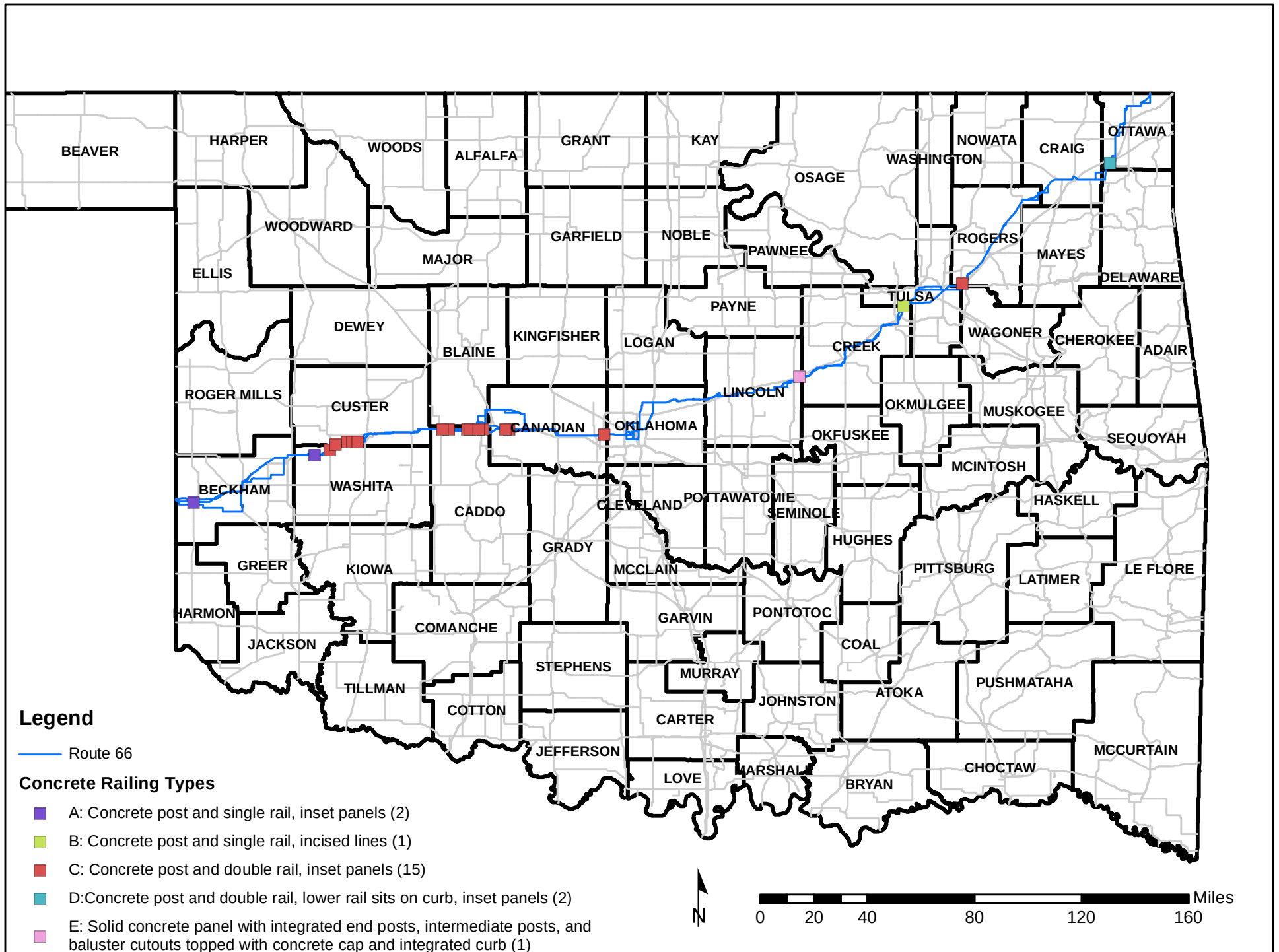
Appendix A. Maps

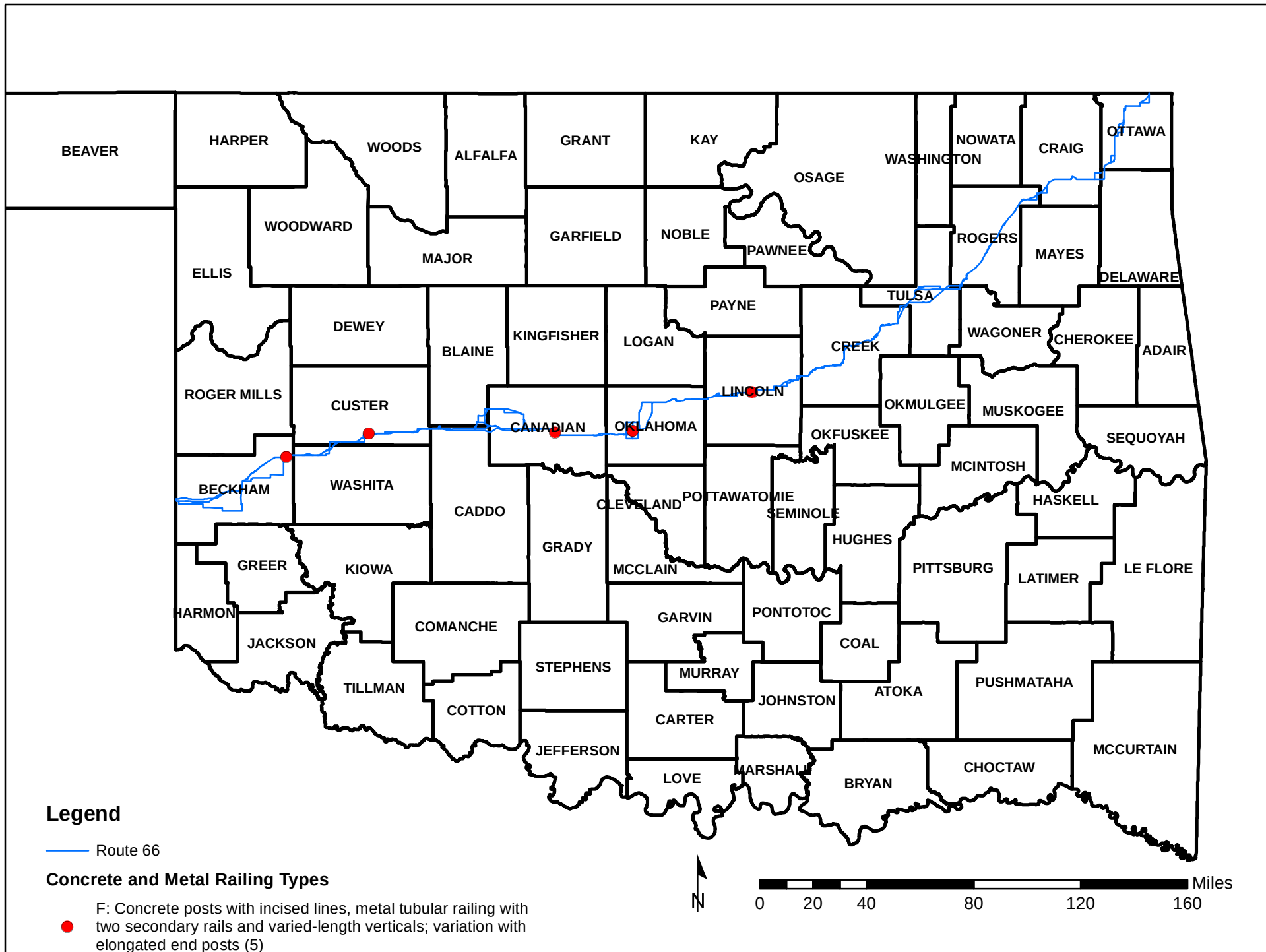
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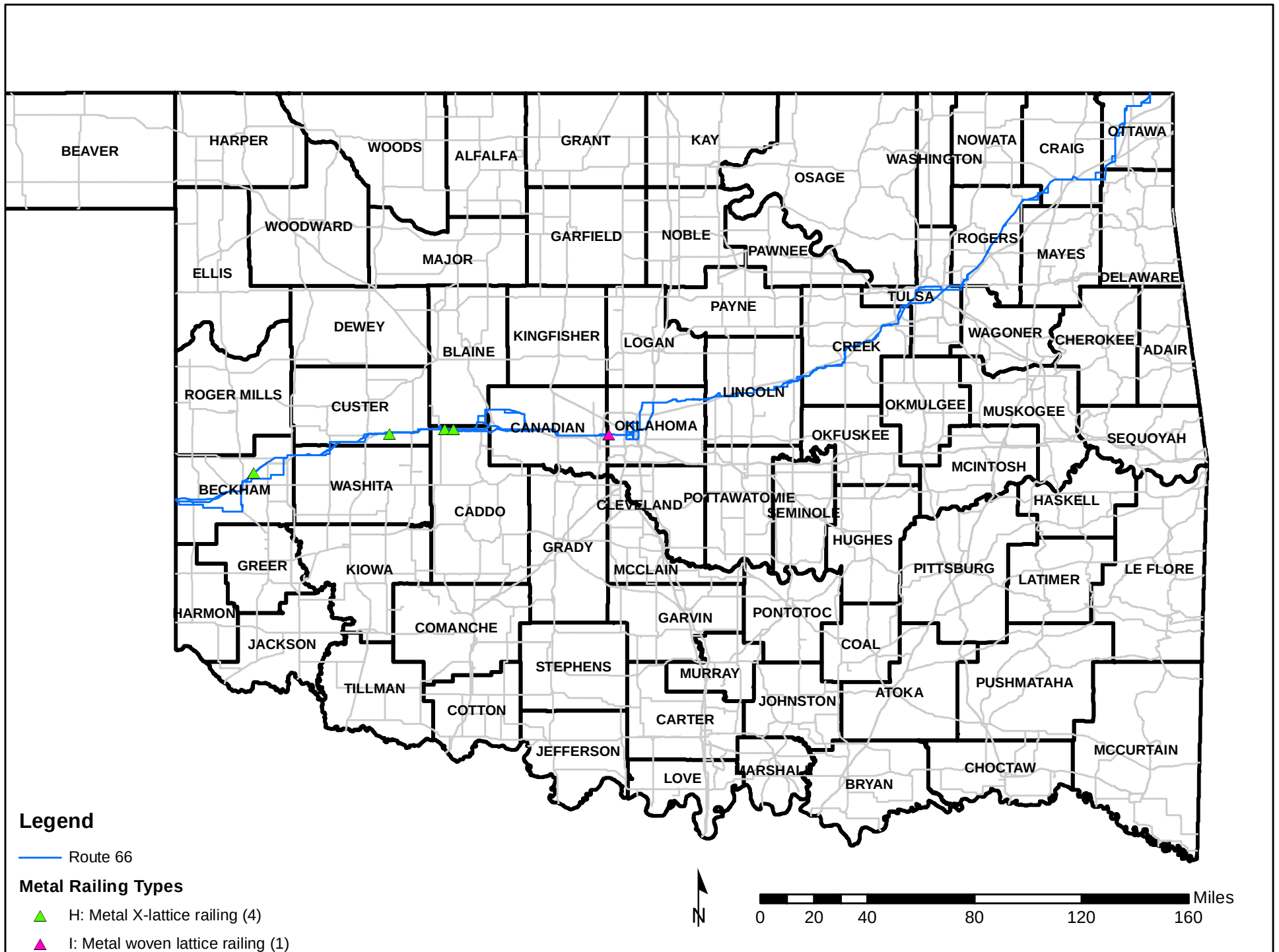


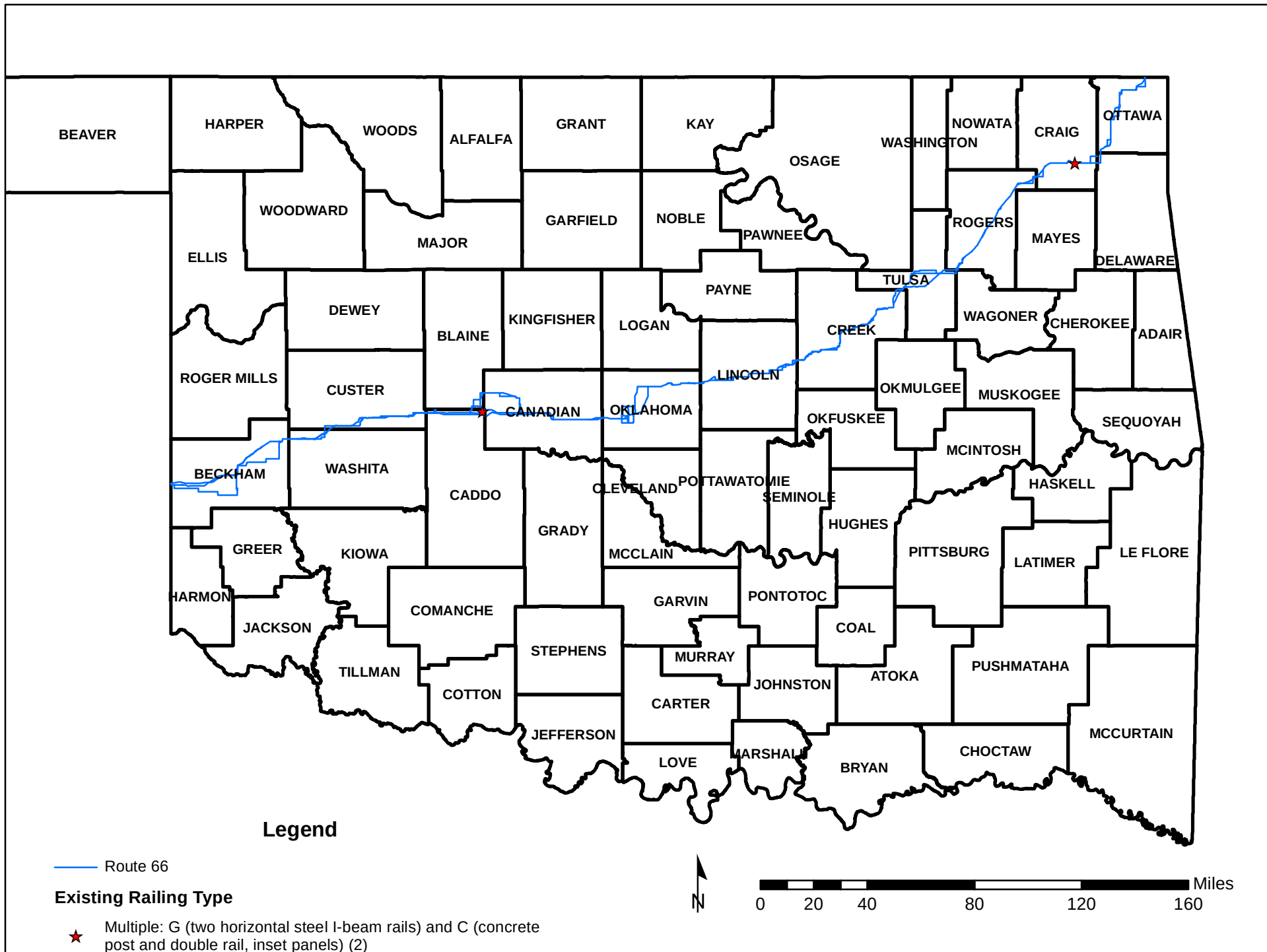
Overall Distribution of Railing Types











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Appendix B. Research Overview

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Appendix B. Research Overview

Summary of rail options considered during research

Provided below is a summary of the rail replacement options considered during the course of research. The majority of railings listed below were not included in the recommendations. For each type of railing, the railings that were chosen as options compatible with the historic railing and that meet current safety standards and TL ratings are included in the first table. The railings that were not recommended are identified in the second table for each railing type. Notable sources of information for these considerations included the FHWA/Caltrans *Bridge Rail Guide* (2005) and the Texas Department of Transportation *Bridge Railing Manual* (May 2013). A list of sources is included in Section 2.A – *Background research*.

W-Beam Bridge Rail



The Side Mount W Beam used in Michigan (pictured above) was the only option in this category that met the required TL ratings.

Recommended railing type(s)		
Additional information and images for the railings listed below can be found at http://www.fhwa.dot.gov/bridge/bridgerail/br051002.cfm .		
RAILING NAME	LOCATION OF USE	TEST LEVEL
Side Mount W Beam	Michigan	TL 3

Thrie-Beam Bridge Rail



The Delaware Thrie-Beam Retrofit Railing option (pictured above) is an example of a railing that was not recommended in this category. Railing options in this category had a similar appearance. The Michigan Thrie-Beam Rail Retrofit (RH Type) railing was recommended based on its successful use on previous bridge rehabilitation and railing replacement projects and due to its tapered design that provides a visually seamless transition between the approach and bridge railings. Listed below are Thrie-beam bridge rail options that were considered:

Recommended railing type(s)		
Additional information and images for the railings listed below can be found at http://www.fhwa.dot.gov/bridge/bridgerail/br052000.cfm .		
RAILING NAME	LOCATION OF USE	TEST LEVEL
Michigan Bridge Railing, Thrie-Beam Retrofit (R4 Type)	Michigan	TL 4

Non-recommended railing type(s)		
Additional information and images for the railings listed below can be found at http://www.fhwa.dot.gov/bridge/bridgerail/br052000.cfm .		
RAILING NAME	LOCATION OF USE	TEST LEVEL
Delaware Thrie-Beam Retrofit Railing	Delaware	TL 4
Missouri Thrie-Beam Rail and Channel, Top-Mounted	Missouri	TL 3
Nebraska Tubular Thrie-Beam Bridge Rail	Nebraska	TL 3

Metal Bridge Railing



The Steel Tube Bridge Rails Attached to Parapet railing option (pictured above) from Michigan is an example of a metal railing that was not recommended. Metal railing options were reviewed to identify those that had the same material and overall design characteristics as the existing rail and precedent for successful use on historic bridges. Most railings in this category were not compatible with the existing bridge railings in terms of scale, design, and configuration and would generally not meet the Secretary's Standards. Recommended railing types reflect a variety of configurations but generally match the material and scale of the existing railings. Listed below are metal railing options that were considered:

Recommended Railing Type(s)		
Additional information and images for the railings listed below can be found at http://onlinemanuals.txdot.gov/txdotmanuals/rlg/rlg.pdf and http://www.fhwa.dot.gov/bridge/bridgerail/br053000.cfm .		
RAILING NAME	LOCATION OF USE	TEST LEVEL
T1W Railing	Texas	TL 3
Bridge Railing, 2 Tube	Michigan	TL 4
Two-Rail Barrier	New York	TL 4
Wyoming 2-Tube Steel Railing	Wyoming	TL 4

Non-recommended Railing Type(s)

Additional information and images for the railings listed below can be found at <http://onlinemanuals.txdot.gov/txdotmanuals/rlg/rlg.pdf> and <http://www.fhwa.dot.gov/bridge/bridgerail/br053000.cfm>.

RAILING NAME	LOCATION OF USE	TEST LEVEL
T131RC Railing	Texas	TL 3
T1F Railing	Texas	TL 3
T401 Railing	Texas	TL 3
T402 Railing	Texas	TL 3
T77 Railing	Texas	TL 3
T80HT Railing	Texas	TL 5
C1W Railing	Texas	TL 3
C402 Railing	Texas	TL 3
Texas Energy-Absorbing Bridge Rail	Texas	TL 3
Illinois 2399-Type Side Mount	Illinois	TL 4
Oregon 2-Tube Side Mount	Oregon	TL 4
Alaska Rail - Curb Mounted	Alaska	TL 4
California ST-10 Rail	California	TL 4
Bridge Railing, Aesthetic Parapet Type BR 27D	Michigan	TL 4
Minnesota Combination Bridge Rail Design #3	Minnesota	TL 4
Type C202	Texas	TL 5
Illinois 2399 - Curb Mount	Illinois	TL 4
NETC 2-Rail Curb-Mounted Railing	New England	TL 4
Three-Rail Barrier Top Deck Flush Mount	New York	TL 4
Four-Rail Barrier	New York	TL 4
Five-Rail Barrier	New York	TL 4
Illinois 2399 - Curb Mount	Illinois	TL 4
Oregon 3-Tube Curb Mount	Oregon	TL 4
Wyoming 2-Tube, Curb-Mounted	Wyoming	TL 3

Concrete Railing



This Vertical Parapet with Single-Pipe Aluminum Handrail option (pictured above) is an example of a railing that was not recommended in this category. Concrete rail options were reviewed to identify those that had the same material and overall design characteristics as the existing rail and precedent for successful use on historic bridge rehabilitation or replacement projects. Railings that were not recommended in this category were determined to be incompatible with the scale and design of the existing concrete railings and would not meet the Secretary's Standards. Recommended railing types reflect a variety of configurations but generally match the material and scale of the existing railings. Listed below are concrete railing options that were considered:

Recommended Railing Type(s)		
Additional information and images for the railings listed below can be found at http://www.okladot.state.ok.us/bridge/2009-sb/brd_std_2009-lrfd-sb-index.php ; http://onlinemanuals.txdot.gov/txdotmanuals/rlg/rlg.pdf ; and http://www.fhwa.dot.gov/bridge/bridgerail/br053000.cfm .		
RAILING NAME	LOCATION OF USE	TEST LEVEL
ODOT 42" F-shaped Concrete Parapet	Oklahoma	TL 3
T223 Railing	Texas	TL 4
T66 Railing	Texas	TL 3
T80SS Railing	Texas	TL 5
C412 Railing	Texas	TL 4
Type 80 & 80 SW Concrete Barrier	California	TL 4
Kansas 32" Corral Rail	Kansas	TL 4

Non -recommended Railing Type(s)

Additional information and images for the railings listed below can be found at <http://onlinemanuals.txdot.gov/txdotmanuals/rlg/rlg.pdf> and <http://www.fhwa.dot.gov/bridge/bridgerail/br053000.cfm>.

RAILING NAME	LOCATION OF USE	TEST LEVEL
T221 Railing	Texas	TL 4
T551 Railing	Texas	TL 4
T552 Railing	Texas	TL 4
SSTR Railing	Texas	TL 4
32" New Jersey Shape Concrete Barrier	California	TL 4
New Jersey Barrier	Georgia	TL 4
Vertical Parapet with Single-Pipe Aluminum Handrail	Georgia	TL 4
Vertical Parapet with Security Fence	Georgia	TL 4
Iowa Concrete Block Railing Retrofit	Iowa	TL 4
42" Single Slope Concrete Barrier	Missouri	TL 5
Nebraska Open Concrete Bridge Rail	Nebraska	TL 4
Parapet Flush Mount	Oregon	TL 4
Type T501SW	Texas	TL 4
Type T203	Texas	TL 3
NJ Barrier	Missouri	TL 4
New Jersey Concrete Barrier	California	TL 4
LB Foster Precast NJ Shape, Bolted Down	New Jersey	TL 4
Type 732 Concrete Barrier	California	TL 4
Type 736 Concrete Barrier	California	TL 4
Type 742 Concrete Barrier	California	TL 5
California Type 20	California	TL 3
New Jersey Barrier w/22" Steel Bicycle Rail	Georgia	TL 4
Bicycle Rail Attachment to Safety Shape Concrete Rail	Minnesota	TL 4
New Jersey Safety Shape Parapet	Nevada	TL 3
Type HT	Texas	TL 5

Concrete barrier



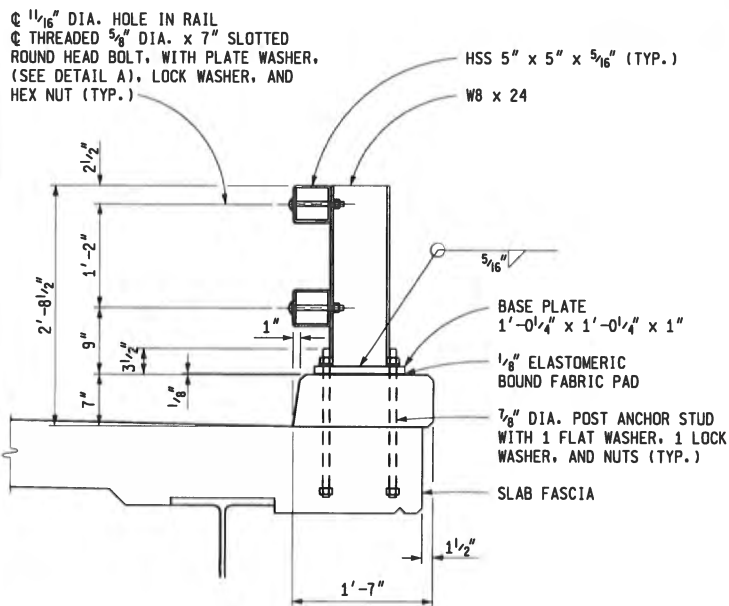
This 42" F-Shape Concrete Barrier option (pictured above) is an example of a railing that was not recommended in this category. Concrete barrier options were reviewed but the design of all options have a different scale than existing barriers and bridge rails. Concrete barriers of this size would introduce a visual element that is out of character with the existing bridge. Listed below are other options that were reviewed but not included in recommendations:

Non-recommended Railing Type(s)		
Additional information and images for the concrete barriers listed below can be found at http://www.fhwa.dot.gov/bridge/bridgerail/br055000.cfm .		
RAILING NAME	LOCATION OF USE	TEST LEVEL
32" F-Shape	Florida	TL 4
42" F-Shape	Florida	TL 5
Soundwall/F-Shape	Florida	TL 4
Vertical Face Guide, 34" Retrofit	Florida	TL 4
Vertical Face Guide, 42" Retrofit	Florida	TL 4

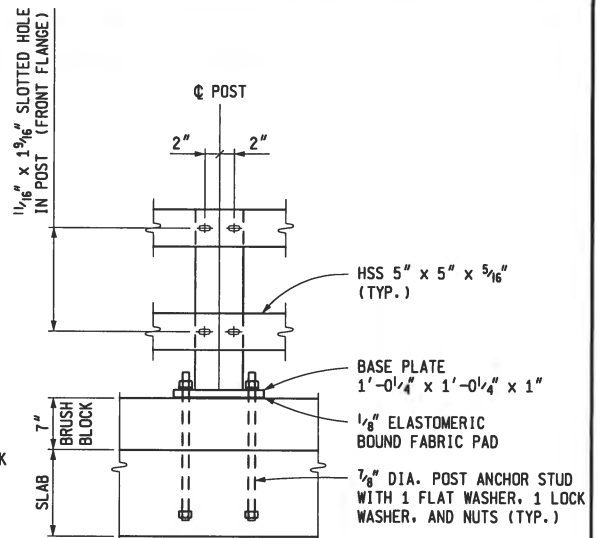
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Appendix C. Plan Sheets for Recommended Replacement Railings

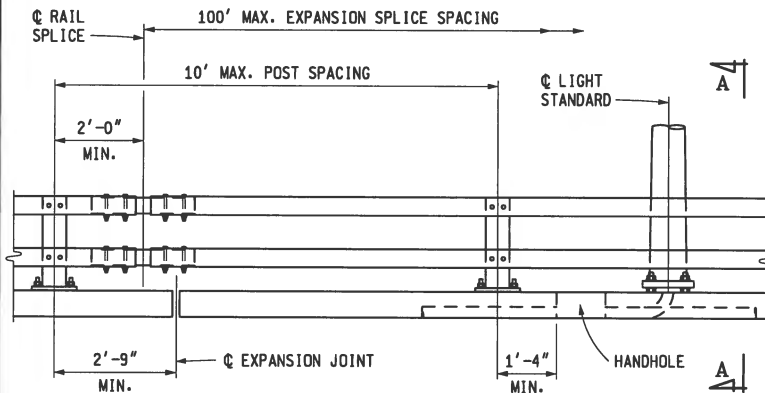
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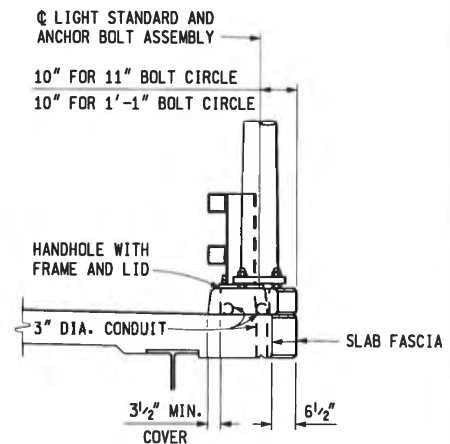
SECTION THROUGH
BRUSH BLOCK AND RAILING



POST ELEVATION



RAILING ELEVATION



SECTION A-A



PREPARED
 BY
 DESIGN DIVISION

DRAWN BY: B.L.T.

CHECKED BY: V.Z.

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 Kirk T. Stueble

APPROVED BY:

Randy V. Puffel
 DIRECTOR, BUREAU OF FIELD SERVICES

APPROVED BY:

Mark A. Van Park
 DIRECTOR, BUREAU OF HIGHWAY DEVELOPMENT

MICHIGAN DEPARTMENT OF TRANSPORTATION
 BUREAU OF HIGHWAY DEVELOPMENT STANDARD PLAN FOR

BRIDGE RAILING, 2 TUBE

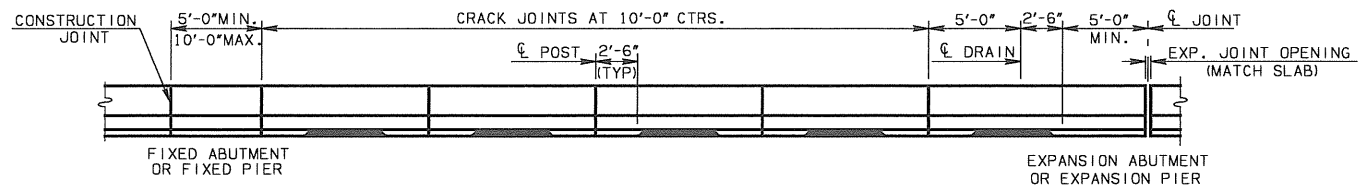
1-25-2013
 F.H.W.A. APPROVAL

6-3-2011
 PLAN DATE

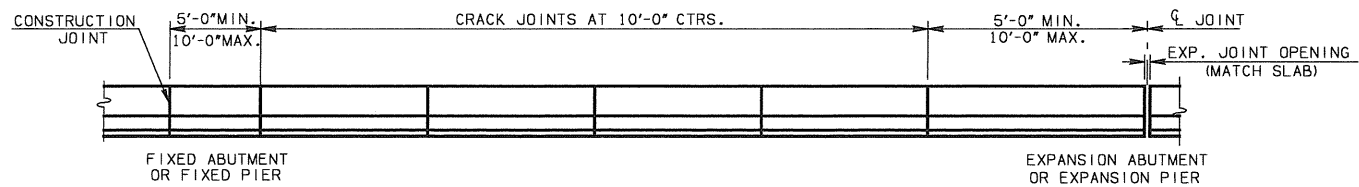
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SHEET
 1 OF 4

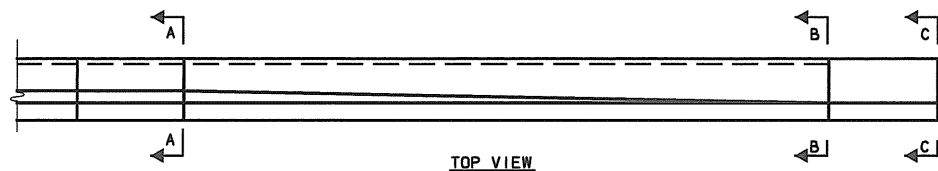
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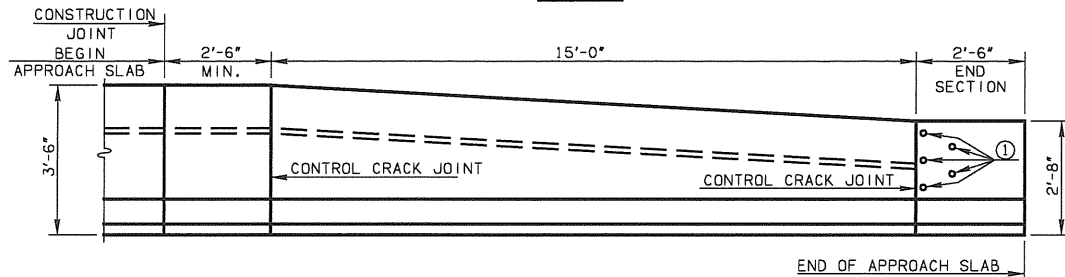
CONTROL CRACK JOINT LOCATIONS FOR SPANS WITH DRAINS



CONTROL CRACK JOINT LOCATIONS FOR SPANS WITHOUT DRAINS



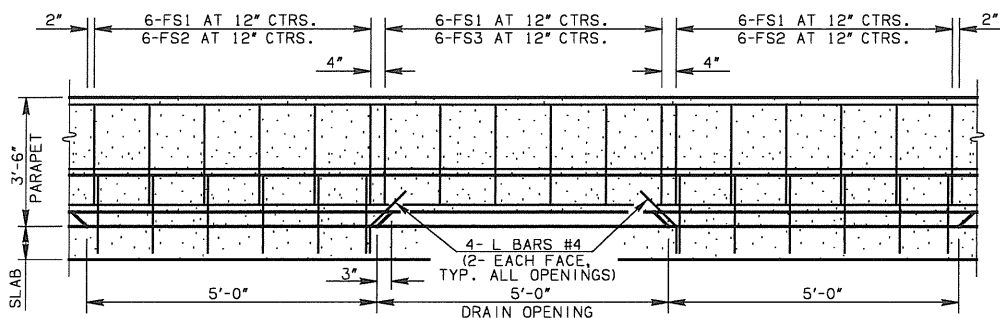
TOP VIEW



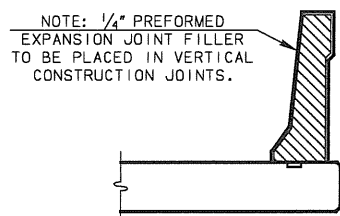
ELEVATION VIEW

DETAILS OF F-SHAPE END TRANSITION AT APPROACH SLAB

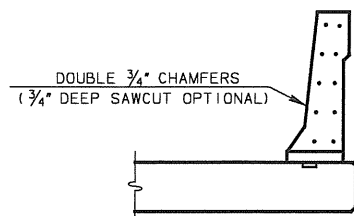
① NOTE: FOR GUARDRAIL HOLE DETAILS, SEE "ELEVATION OF GUARDRAIL CONNECTION HOLES"



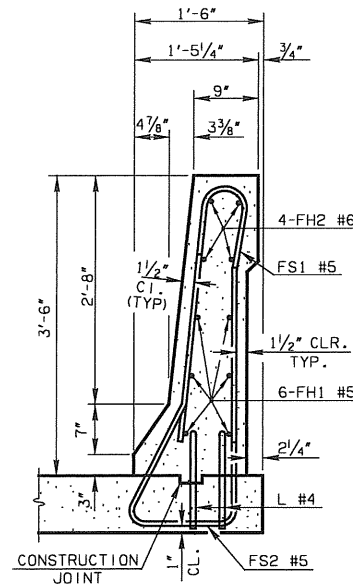
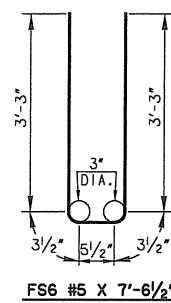
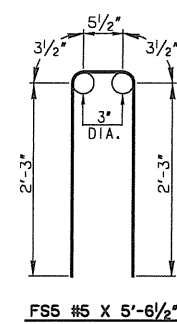
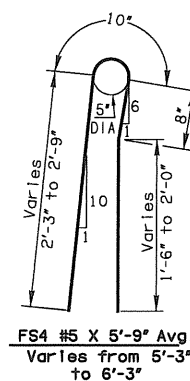
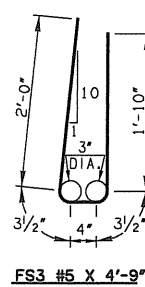
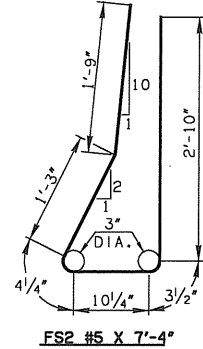
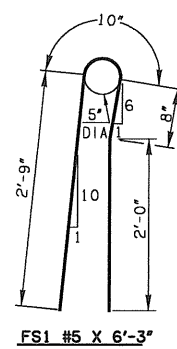
TYPICAL PARAPET REINFORCING SPACING (PARAPETS WITH DRAIN OPENINGS)



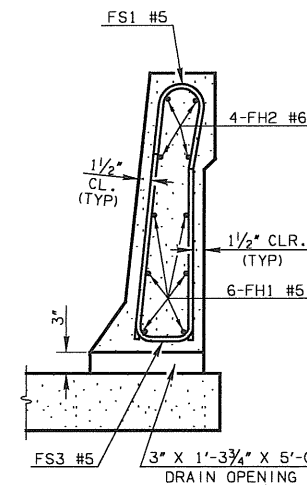
CONSTRUCTION JOINT
NOTE: TYPICAL AT FIXED PIER OR FIXED ABUTMENT



CONTROL CRACK JOINT
NOTE: ALL BARS SHALL BE CONTINUOUS THRU CONTROL CRACK JOINT

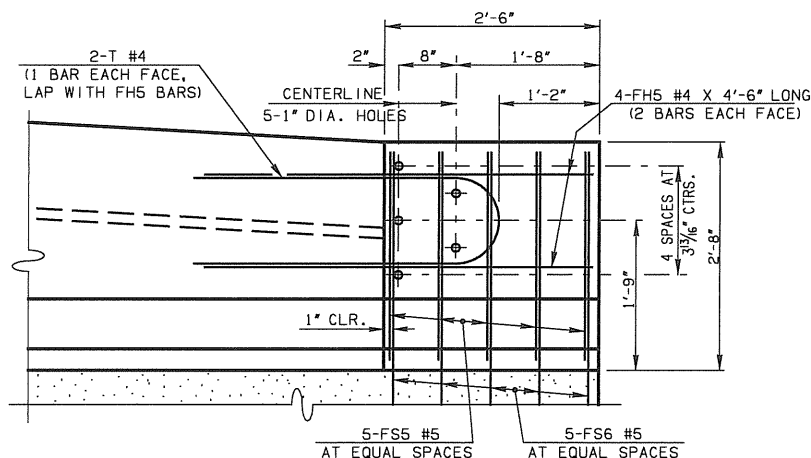


SECTION THRU POST AND SECTION A-A

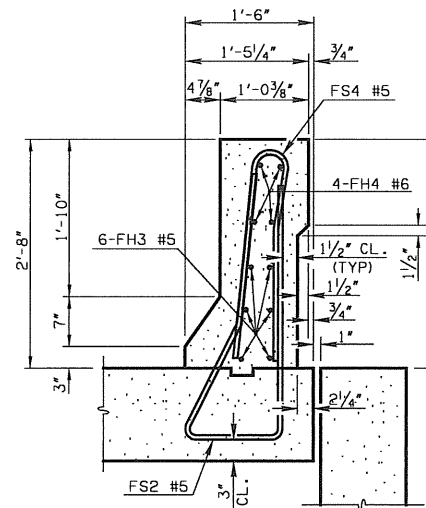
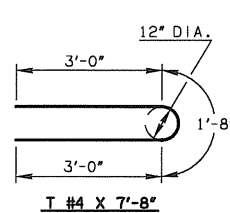
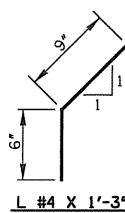


SECTION THRU DRAIN OPENING

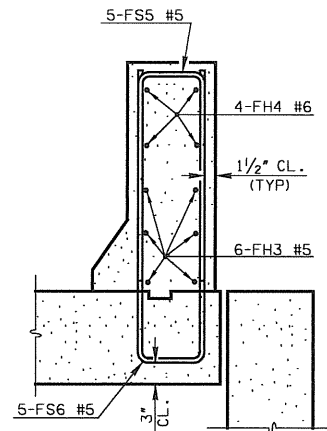
SECTION THRU BRIDGE PARAPET AT DECK SLAB



ELEVATION OF GUARDRAIL CONNECTION HOLES



SECTION B-B THRU PARAPET AT TRANSITION END



SECTION C-C THRU PARAPET AT END SECTION

SECTION THRU BRIDGE PARAPET AT APPROACH SLAB

SLOPED FACE CONCRETE PARAPET

CONSTRUCT THE SLOPED FACE CONCRETE PARAPET TO MEET THE REQUIREMENTS OF THE STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION (ENGLISH), AS WELL AS THE FOLLOWING REQUIREMENTS.
CLASS AA CONCRETE:
CLASS AA CONCRETE SHALL BE USED IN THE F-SHAPED PARAPET. ALL COSTS OF CONCRETE TO BE INCLUDED IN THE PRICE BID PER LINEAR FOOT OF "42" F-SHAPED PARAPET".

REINFORCING STEEL:
ALL REINFORCING STEEL USED IN THE F-SHAPED PARAPET SHALL BE EPOXY COATED. PLACE AND TIE ALL FS2 AND FS6 BARS BEFORE CONCRETE IS PLACED IN THE DECK SLAB OR APPROACH SLAB, AS APPLICABLE. THE WEIGHT OF THE FS2, FS6 AND L BARS WILL BE MEASURED AND PAID FOR AS "EPOXY COATED REINFORCING STEEL". ALL OTHER REINFORCING STEEL IN THE PARAPET SHALL BE INCLUDED IN THE UNIT PRICE BID PER LINEAR FOOT OF "42" F-SHAPED PARAPET".

CONSTRUCTION JOINTS:
PLACE A CONSTRUCTION JOINT AT EACH FIXED ABUTMENT AND FIXED PIER, AND AT OTHER LOCATIONS AS SHOWN IN THE PLANS. PLACE 1/4" THICK PREFORMED EXPANSION MATERIAL IN THE CONSTRUCTION JOINT IN ACCORDANCE WITH THE DETAILS SHOWN. DO NOT PLACE FH-BARS THROUGH A CONSTRUCTION JOINT UNLESS DIRECTED TO DO SO IN THE PLANS.

EXPANSION JOINTS:
AT EXPANSION JOINTS IN THE DECK SLAB OR APPROACH SLAB, MATCH THE WIDTH OF THE OPENING BETWEEN THE ENDS OF THE PARAPET WITH THE OPENING OF THE EXPANSION JOINT.

CONTROL CRACK JOINTS:
PROVIDE DOUBLE 3/4" CHAMFERS OR 3/4" DEEP SAWCUT IN ACCORDANCE WITH THE DETAILS SHOWN. FOR PARAPETS WITH DRAIN OPENINGS, PLACE THE CONTROL CRACK JOINTS IN THE CENTER OF THE 5'-0" SOLID PARAPET BETWEEN THE DRAIN OPENINGS. FOR PARAPETS WITHOUT DRAIN OPENINGS, PLACE THE CONTROL CRACK JOINTS AT 10'-0" SPACINGS. PLACE CONTROL CRACK JOINTS AT OTHER LOCATIONS AS SHOWN IN THE PLANS OR AS DIRECTED BY THE ENGINEER.

DRAIN OPENINGS:
PLACE A SERIES OF 5'-0" DRAIN OPENINGS IN THE PARAPET AT LOCATIONS SHOWN IN THE PLANS OR AS DIRECTED BY THE ENGINEER. CONSTRUCT THE DRAIN OPENINGS SUCH THAT THEY ARE 5'-0" IN LENGTH AND ALTERNATING WITH 5'-0" SOLID PARAPET LENGTHS.

GUARDRAIL CONNECTIONS
FORM OR DRILL HOLES, AS SHOWN, FOR THE CONNECTION OF THE THRIE-BEAM GUARDRAIL TERMINAL CONNECTION (END SHOE) AT LOCATION SHOWN IN THE PLANS OR AS DIRECTED BY THE ENGINEER. IT IS THE RESPONSIBILITY OF THE BRIDGE CONTRACTOR TO PROVIDE THE HOLES. THE CONTRACTOR THAT INSTALLS THE GUARDRAIL WILL BE RESPONSIBLE FOR INSTALLING THE THRIE-BEAM GUARDRAIL TERMINAL CONNECTION.

BASIS OF PAYMENT		
ITEM NO.	DESCRIPTION	UNIT
504(F)	42" F-SHAPED PARAPET	L.F.

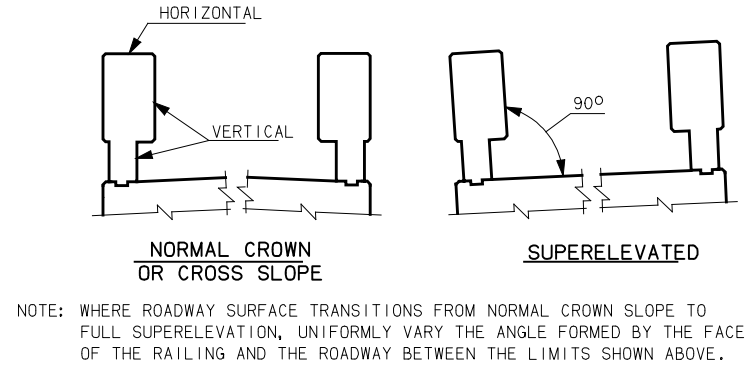
APPROVED BY BRIDGE ENGINEER

Robert L. Lively

DATE 4/2/10

OKLAHOMA DEPT. OF TRANSPORTATION
BRIDGE STANDARD (ENGLISH)

42" F-SHAPED CONCRETE PARAPET



AT EXPANSION PIERS

Diagram illustrating the layout of a bridge deck showing the span length and the placement of precast concrete panels and expansion joints.

The diagram shows a cross-section of the bridge deck with the following components and dimensions:

- SPAN LENGTH:** The total length between the centers of the piers.
- PREFORMED EXPANSION MATERIAL:** Located at both ends of the span.
- 5'-0" MINIMUM (END POST):** The minimum length of the end post sections.
- 5'-0" OPENING:** The length of the openings between the posts.
- 5'-0" (INTERIOR POST):** The length of the interior post sections.
- TYPICAL WATER BARRIER:** Located below the deck.
- DECK SLAB:** The main structural component of the bridge deck.
- 10'-0" CENTER TO CENTER OF POST:** The distance between the centers of the interior posts.

AT FIXED PIERS

SECTION THRU POST OPENING

SECTION THRU POST

END OF TRAFFIC RAIL

1'-8"

8"

TOP OF TRAFFIC RAIL

11"

3 3/16"

3 3/16"

7 5/8"

7 5/8"

2 - T #4
(1 BAR EACH FACE)

5 - 1" DIAMETER HOLES FOR
THREE-BEAM TERMINAL CONNECTION
(END SHOE)

1'-5"

A

DETAIL "A"

SECTION "A-A"

2" CL.
TYP.

T BARS

CONSTRUCTION
JOINT (KEYED)

Construct the Concrete Traffic Rail to meet the requirements of the Standard Specification For Highway Construction (English) as well as the following requirements.

Use Class AA Concrete in the Concrete Traffic Rail. All costs of concrete to be included in the price bid per linear foot of "Concrete Rail (TR4)".

All reinforcing steel, except for the S-Bar, used in the Concrete Traffic Rail is to be epoxy coated. When two or more S Bars are used in a continuous rail section, butt their ends together within the center 3'-0" of a rail post. Place and tie all SR1 Bars before the concrete is placed in the deckslab and approach slabs. SR1 Bars will be measured and paid for as "EPOXY COATED REINFORCING STEEL". All other reinforcing steel will not be measured for payment.

Form or drill holes, as shown, for the connection of the Thrie-Beam Terminal Connection (End Shoe) at the locations shown in the plans or as directed by the Engineer. It is the responsibility of the bridge Contractor to provide the holes. The contractor that installs the Guardrail will be responsible for installing the Thrie-Beam Terminal Connection.

Place a construction joint at each fixed abutment and fixed pier, and at other locations shown in the plans. Place 1/4" thick preformed expansion material in the construction joint such that it covers the entire area of the rail and post in accordance with the details shown.

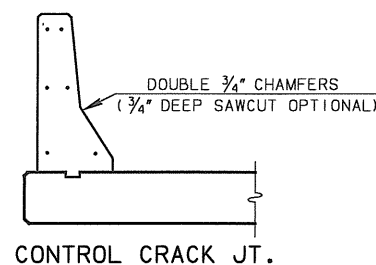
At expansion joints in the deckslab or approach slab, match the width of the opening between the ends of the railing with the opening of the expansion joints. Construct the opening between the end post and the joint as shown on the plans within the maximum and minimum dimensions as shown on this sheet.

When plans call for a control crack joint provide double $\frac{3}{4}$ " chamfers or $\frac{3}{4}$ " deep sawcut in accordance with the details shown. All bars shall be continuous through the control crack joints.

Locate posts as shown on this sheet unless shown otherwise in the plans. Construct openings such that the face of the posts are perpendicular to the roadway profile grade.

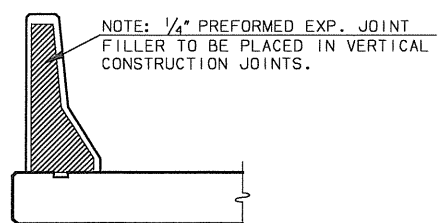
Provide water barrier at rail openings that would drain onto the undercrossing roadways and sidewalks as shown in plans or as directed by the Engineer. Place the concrete for the water barrier concurrently with the placement of the concrete in the posts. Include all costs of water barriers in the price bid per linear foot of "Concrete Rail (TR4)".

APPROVED BY BRIDGE ENGINEER :		DATE 4/2/10	
OKLAHOMA DEPT. OF TRANSPORTATION BRIDGE STANDARD (ENGLISH) CONCRETE TRAFFIC RAIL (TR4)			
2009 SPECIFICATIONS		TR4-2	00E
			B-03E

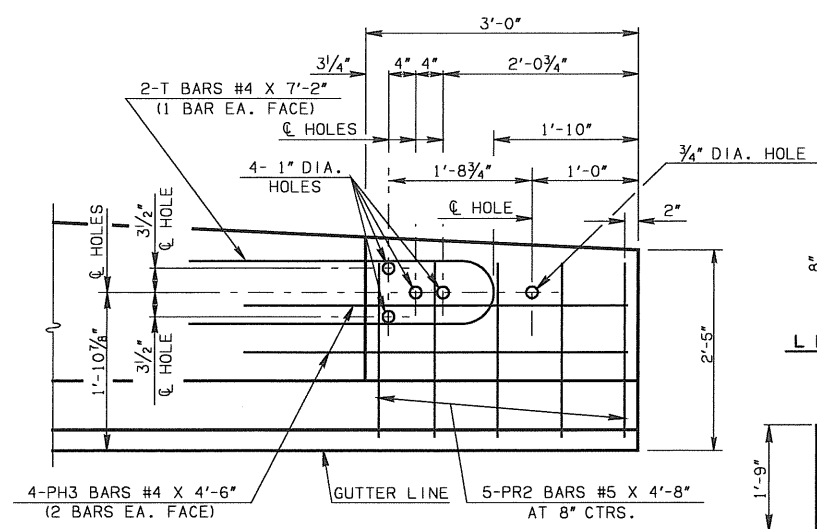


CONTROL CRACK JT.

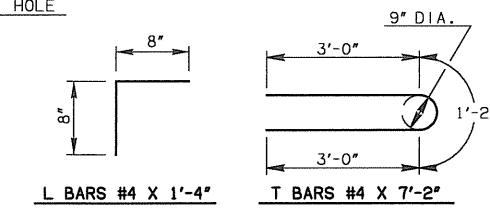
NOTE: PH BARS SHALL BE CONTINUOUS THRU CONTROL CRACK JOINT



TYPICAL PARAPET CONSTRUCTION JOINT AT FIXED PIER OR FIXED ABUTMENT



ELEVATION OF GUARDRAIL CONNECTION HOLES AND BLOCKOUT



DETAILS OF BAR BENDS

SLOPED FACE CONCRETE PARAPET

CONSTRUCT THE SLOPED FACE CONCRETE PARAPET TO MEET THE REQUIREMENTS OF THE STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION (ENGLISH), AS WELL AS THE FOLLOWING REQUIREMENTS.

REINFORCING STEEL:

EP-BARS (SLAB TO PARAPET BARS): PLACE AND TIE ALL EP-BARS BEFORE CONCRETE IS PLACED IN THE DECKSLAB OR APPROACH SLAB, AS APPLICABLE. IF THE PLANS CALL FOR EPOXY COATED REINFORCING IN THE DECKSLAB OR APPROACH SLAB, THEN FURNISH EPOXY COATED EP-BARS. THE WEIGHT OF EP-BARS WILL BE MEASURED AND PAID FOR AS "REINFORCING STEEL" OR "EPOXY COATED REINFORCING STEEL".

CONSTRUCTION JOINTS:

PLACE A CONSTRUCTION JOINT AT EACH FIXED ABUTMENT AND FIXED PIER, AND AT OTHER LOCATIONS AS SHOWN IN THE PLANS. PLACE 1/4" THICK PREFORMED EXPANSION MATERIAL IN THE CONSTRUCTION JOINT IN ACCORDANCE WITH THE DETAILS SHOWN. DO NOT PLACE PH-BARS THROUGH A CONSTRUCTION JOINT UNLESS DIRECTED TO DO SO IN THE PLANS.

EXPANSION JOINTS:

AT EXPANSION JOINTS IN THE DECKSLAB OR APPROACH SLAB, MATCH THE WIDTH OF THE OPENING BETWEEN THE ENDS OF THE PARAPET WITH THE OPENING OF THE EXPANSION JOINT.

CONTROL CRACK JOINTS:

PROVIDE DOUBLE 3/4" CHAMFERS OR 3/4" DEEP SAWCUT IN ACCORDANCE WITH DETAILS SHOWN. FOR PARAPETS WITH DRAIN OPENINGS, PLACE THE CONTROL CRACK JOINTS IN THE CENTER OF THE 5'-0" SOLID PARAPET BETWEEN THE DRAIN OPENINGS. FOR PARAPETS WITHOUT DRAIN OPENINGS, PLACE THE CONTROL CRACK JOINTS AT 10'-0" SPACINGS. PLACE CONTROL CRACK JOINTS AT OTHER LOCATIONS AS SHOWN IN THE PLANS OR AS DIRECTED BY THE ENGINEER.

DRAIN OPENINGS:

PLACE A SERIES OF 5'-0" DRAIN OPENINGS IN THE PARAPET AT LOCATIONS SHOWN IN THE PLANS OR AS DIRECTED BY THE ENGINEER. CONSTRUCT THE DRAIN OPENINGS SUCH THAT THEY ARE 5'-0" IN LENGTH AND ALTERNATING WITH 5'-0" SOLID PARAPET LENGTHS.

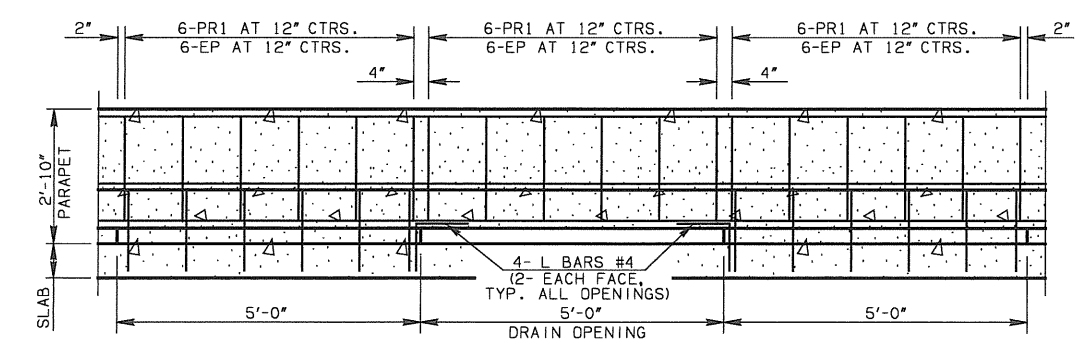
GUARDRAIL CONNECTIONS

FORM OR DRILL HOLES, AS SHOWN, FOR THE CONNECTION OF THE W-BEAM GUARDRAIL TERMINAL CONNECTION (END SHOE) AT LOCATIONS SHOWN IN THE PLANS OR AS DIRECTED BY THE ENGINEER. IT IS THE RESPONSIBILITY OF THE BRIDGE CONTRACTOR TO PROVIDE THE HOLES. THE CONTRACTOR THAT INSTALLS THE GUARDRAIL WILL BE RESPONSIBLE FOR INSTALLING THE W-BEAM GUARDRAIL TERMINAL CONNECTION. INCLUDE THE COST OF "T" BARS IN THE PRICE BID FOR "CONCRETE PARAPET".

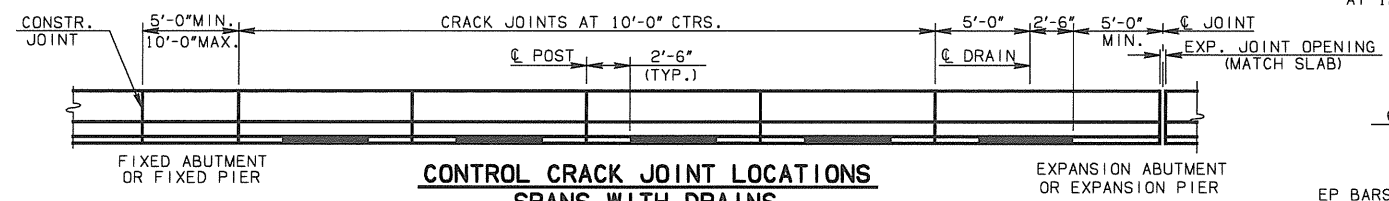
BASIS OF PAYMENT		
ITEM NO.	DESCRIPTION	UNIT
504(F)	CONCRETE PARAPET	L.F.

APPROVED BY BRIDGE ENGINEER *Scott L. Lueck* DATE 4/2/10

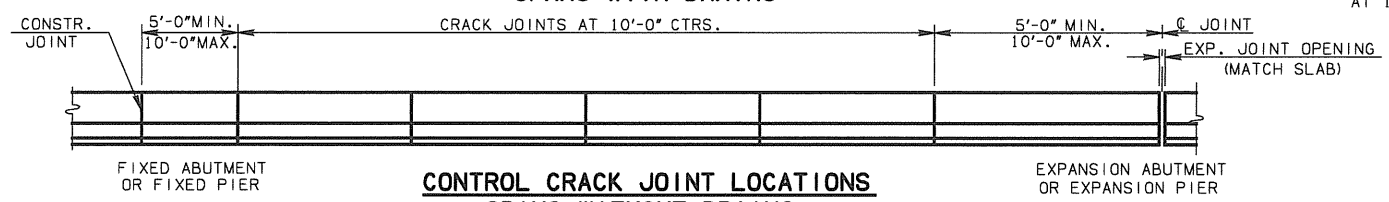
OKLAHOMA DEPT. OF TRANSPORTATION
BRIDGE STANDARD (ENGLISH)
SLOPED FACE PARAPET (SFP)



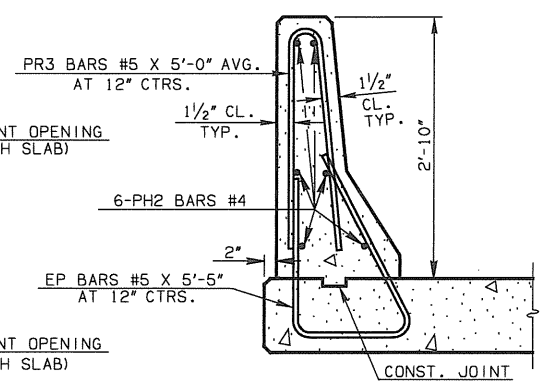
TYPICAL PARAPET REINFORCING SPACING (PARAPETS WITH DRAIN OPENINGS)



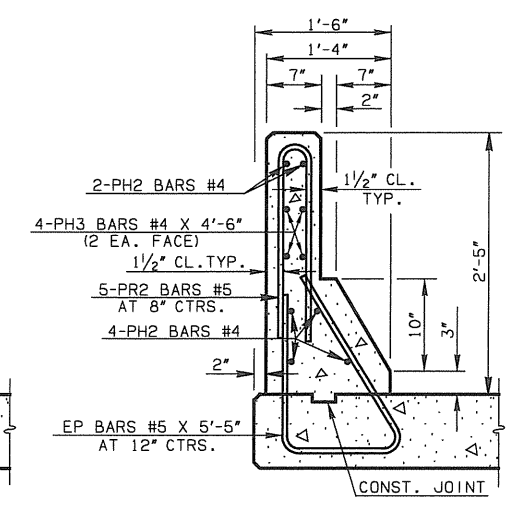
CONTROL CRACK JOINT LOCATIONS SPANS WITH DRAINS



CONTROL CRACK JOINT LOCATIONS SPANS WITHOUT DRAINS



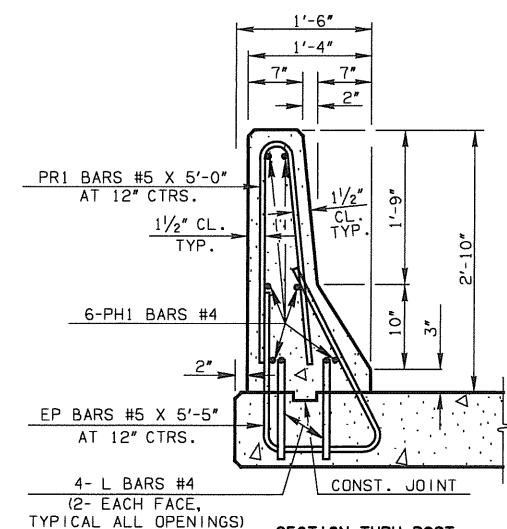
SECTION THRU PARAPET AT ABUTMENT END



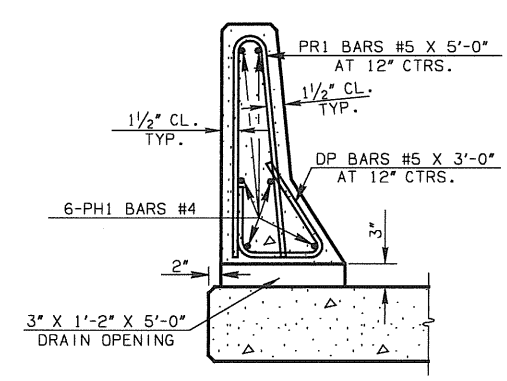
SECTION THRU BLOCKOUT AT END OF APPROACH SLAB

SECTION THRU BRIDGE PARAPET AT APPROACH SLAB

NOTE: PARAPET HEIGHT TRANSITIONS FROM 2'-10" AT ABUTMENT END TO 2'-5" AT END OF APPROACH SLAB

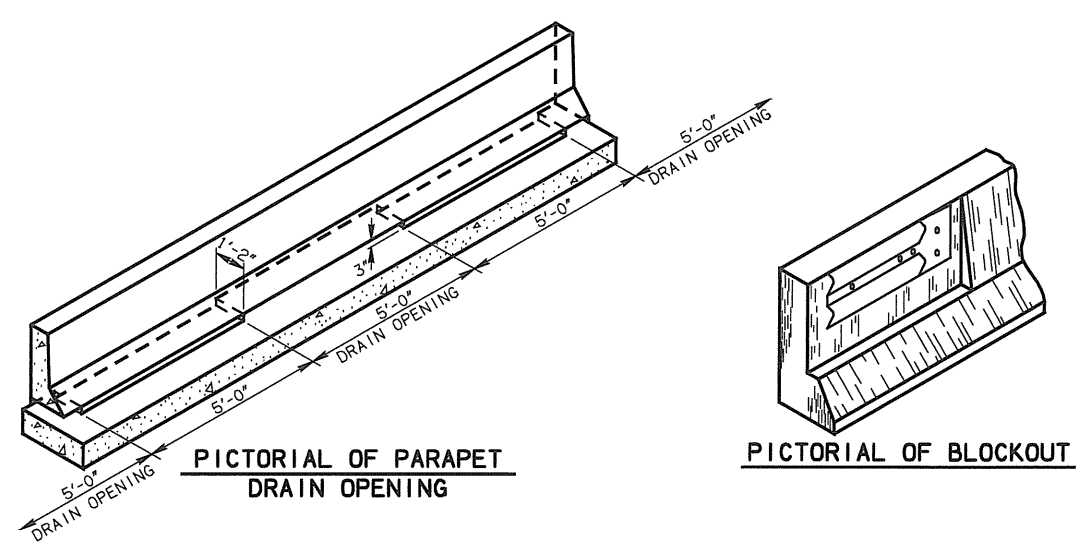


SECTION THRU POST



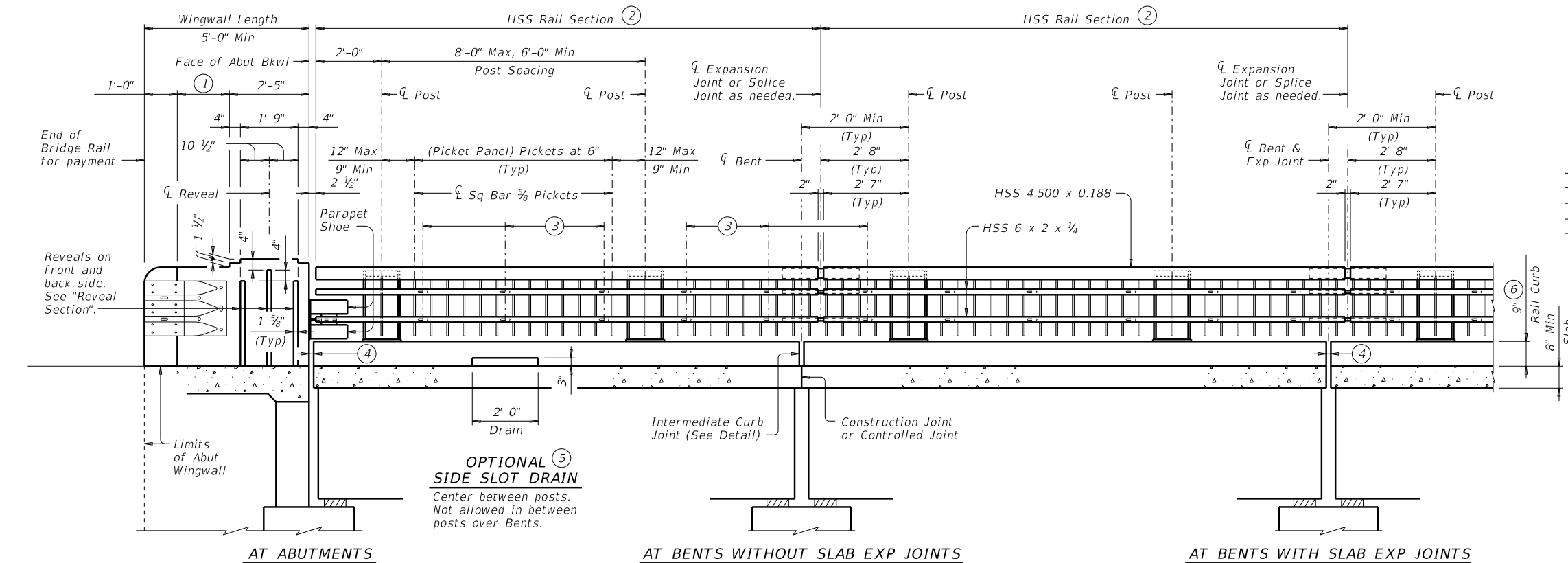
SECTION THRU DRAIN OPENING

SECTION THRU BRIDGE PARAPET AT DECK SLAB

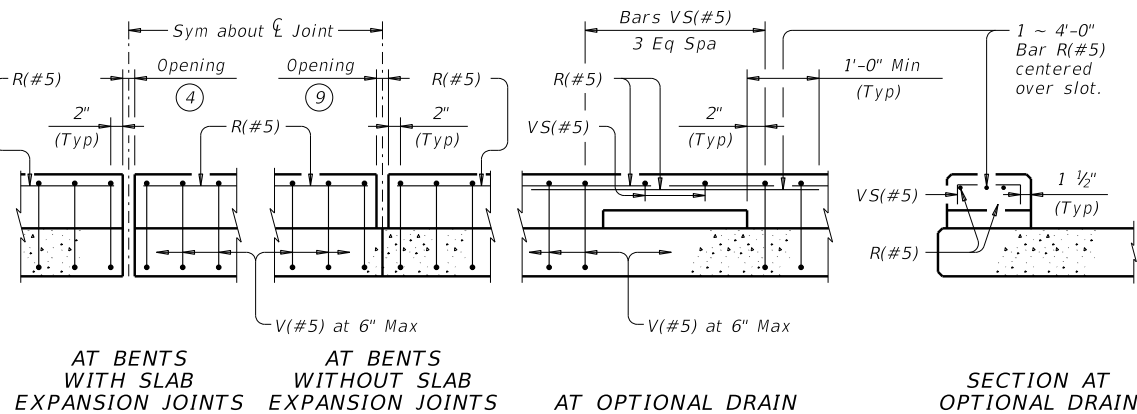
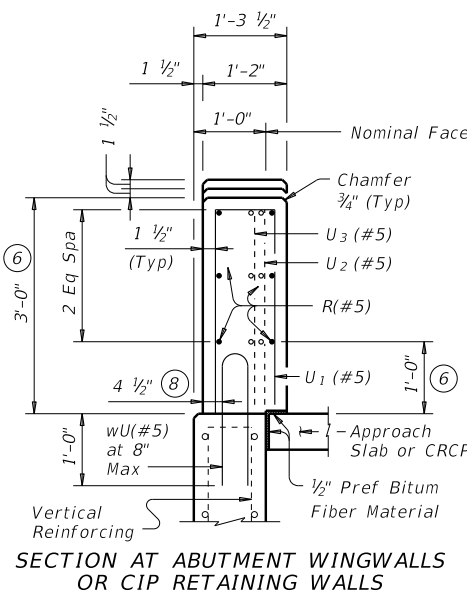
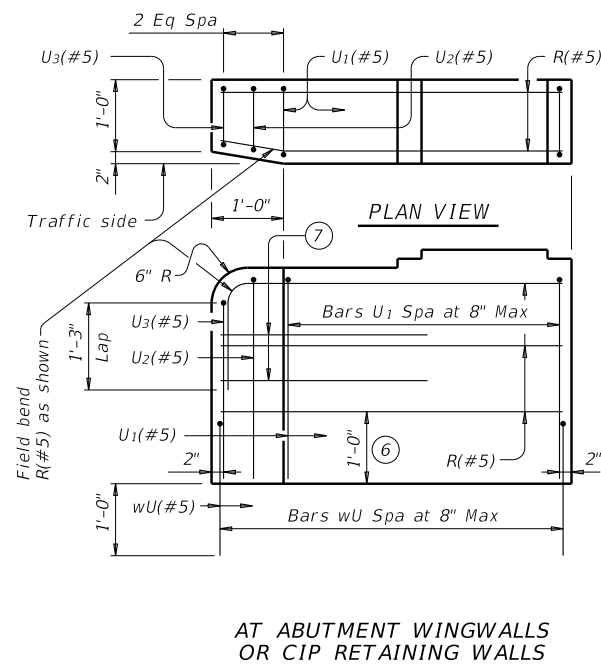


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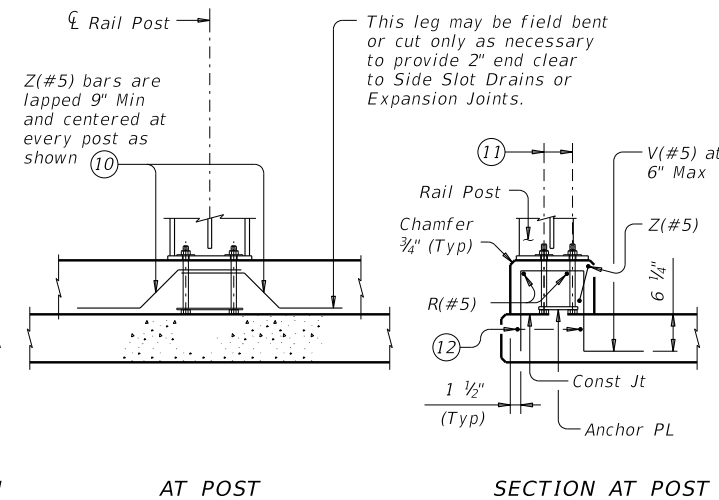
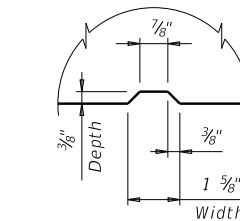
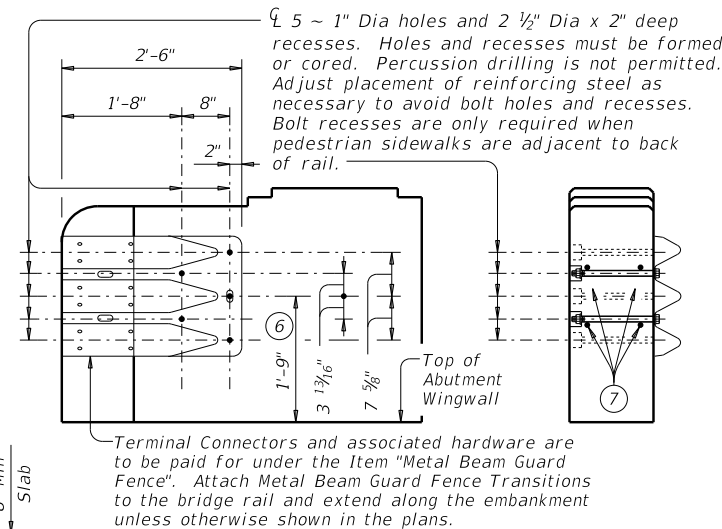
DATE: FILE:



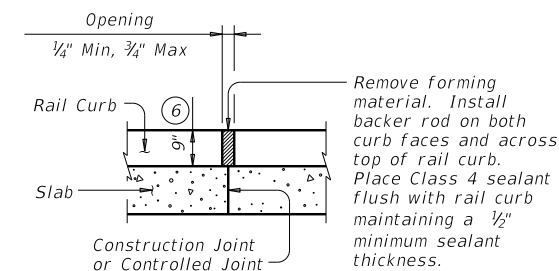
ROADWAY ELEVATION OF RAIL



ELEVATION SHOWING TYPICAL REINFORCING PLACEMENT



SHEET 1 OF 4



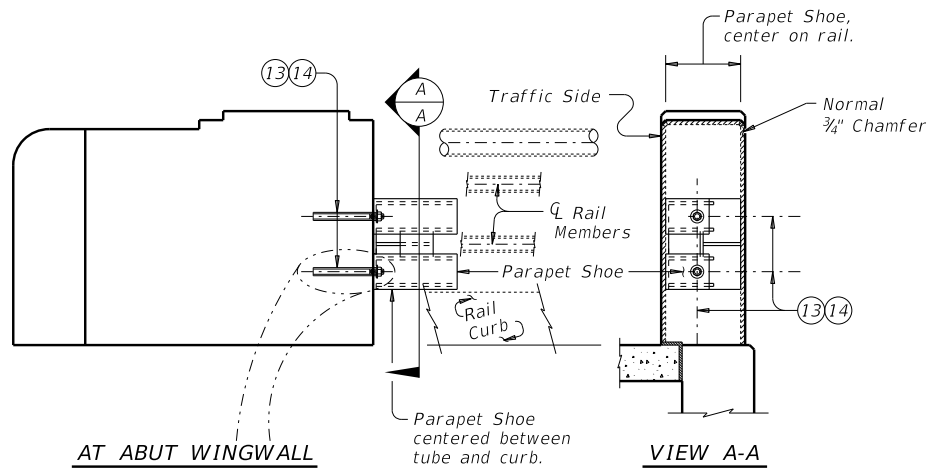
Provide at all interior bents without slab expansion joints. Location independent of HSS rail splices.

- Wingwall length minus 3'-5" (Variable) 1'-7" Min.
- HSS rail sections must have at least two posts but not more than four.
- Bolt locations for attaching picket panel to back of HSS 6 x 2 x 1/4. See "Section J-J".
- Same as slab joint opening. (5" Max Expansion Joint)
- Drains may be used where shown elsewhere on the plans or as directed by the Engineer. Do not place drains over railroad tracks, lower roadways, or sidewalks. When this rail is used as a separator between a roadway and a sidewalk, side slot drains are not permitted.
- Increase 2" for structures with overlay.
- Place 4 additional Bars R(#5) 3'-8" in length inside Bars U(#5) and centered 2'-0" from end of rail when Terminal Connections are required. Field bend as needed.
- 5 1/4" when vertical reinforcing has closer clear cover over horizontal reinforcing in abutment wingwalls or retaining walls on traffic side of wall.
- 1/4" Min, 3/4" Max.
- Adjust Bars Z(#5) as necessary to avoid Bars V(#5).
- 1/2" Dia Anchor Bolts. See "Anchor Bolt Assembly Details".
- Top longitudinal slab bar may be adjusted laterally 3" plus or minus to tie reinforcing.

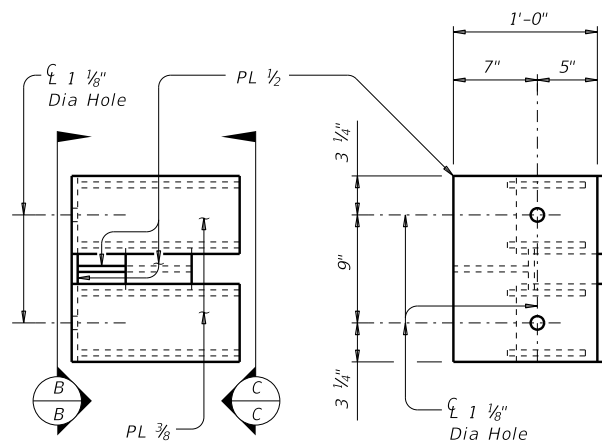
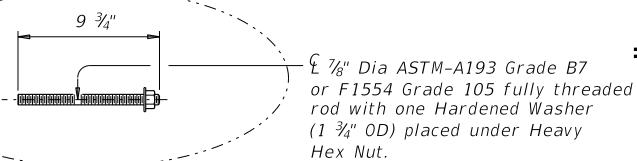
 Texas Department of Transportation				Bridge Division Standard	
TRAFFIC RAIL RIO VIEJO DE TEJAS TYPE T1P					
FILE: <i>r1st0035.dgn</i>		DN: <i>JMH</i>	CK: <i>AES</i>	DW: <i>JTR</i>	CK: <i>AES</i>
 TxDOT	July 2014	CONT	SECT	JOB	HIGHWAY
REVISIONS					
		DIST	COUNTY		SHEET NO.

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DATE: FILE:



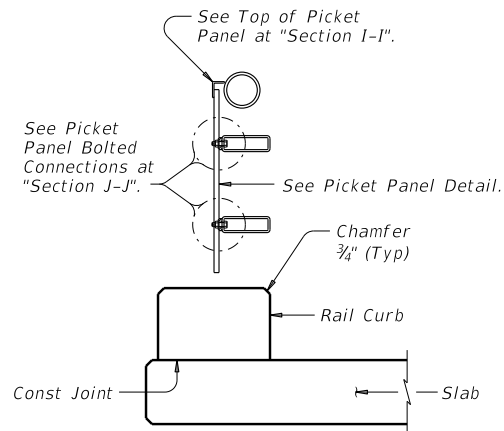
PARAPET SHOE INSTALLATION



PARAPET SHOE

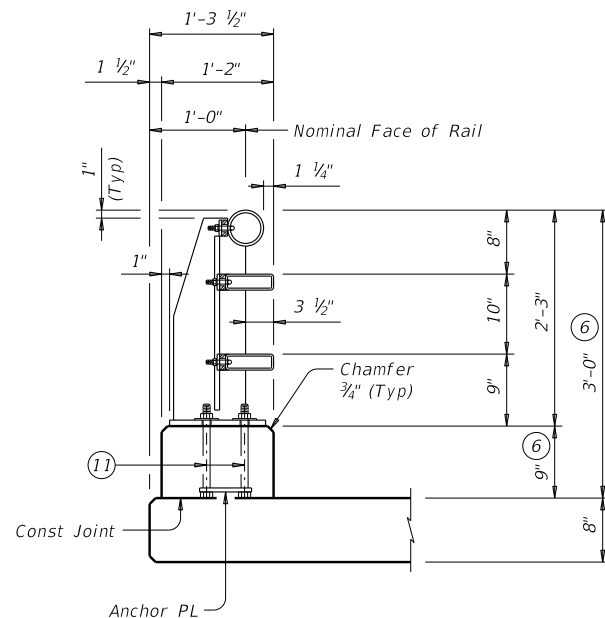
(Parapet Shoe weight = 78 lb each, for contractor's information only).

VIEW B-B



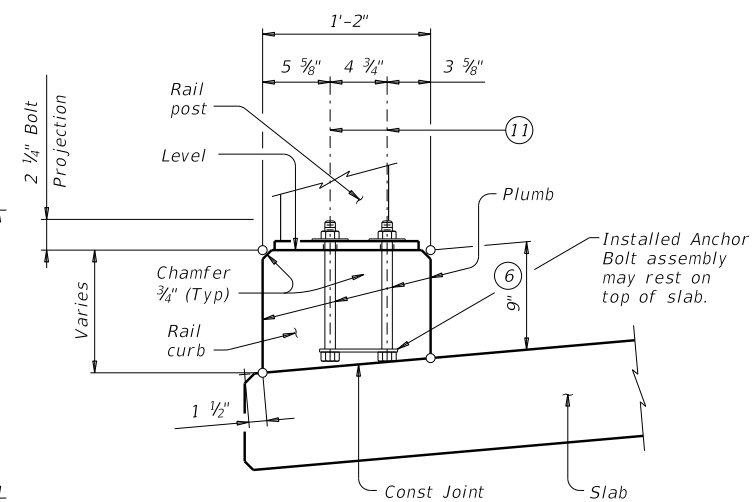
SECTION THRU BRIDGE RAIL IN BETWEEN POSTS

Reinforcing steel not shown for clarity.



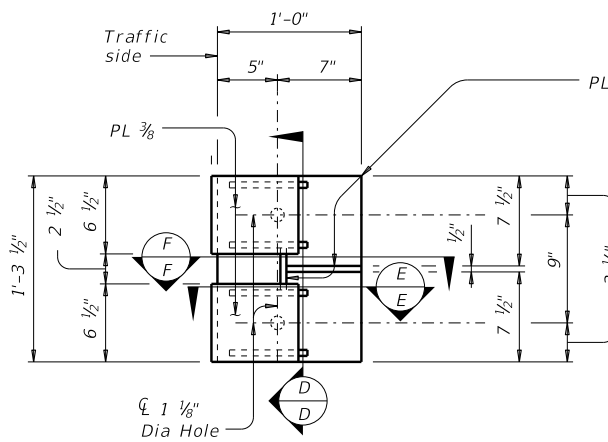
SECTION THRU BRIDGE RAIL AT POST

Reinforcing steel not shown for clarity.

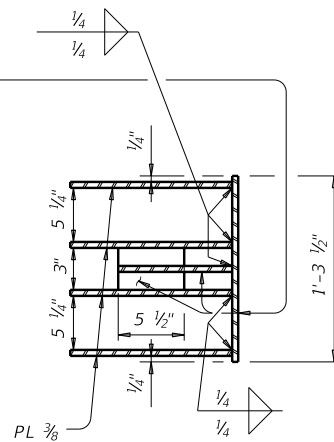


RAIL CURB FORMING DETAIL

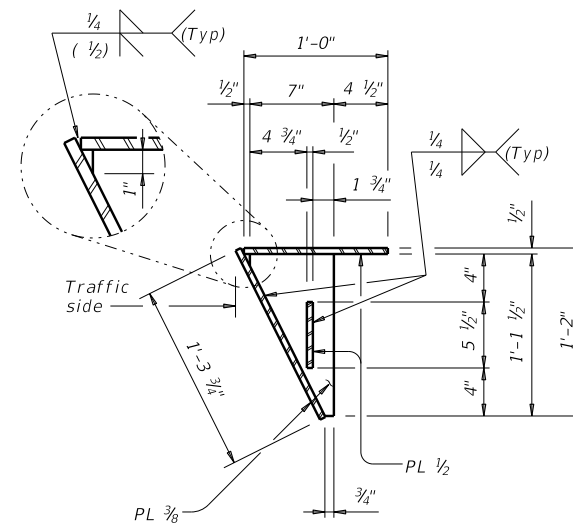
Reinforcing steel not shown for clarity.



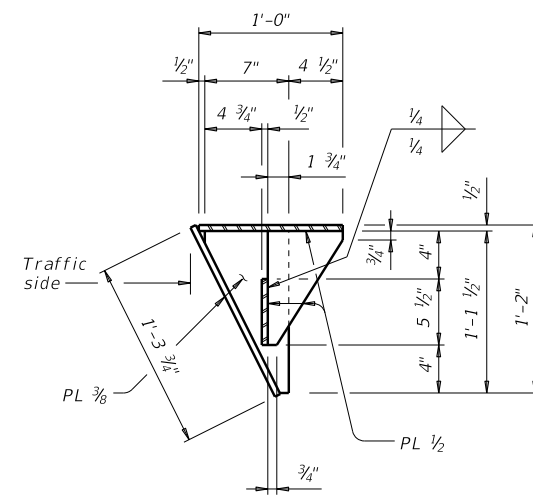
VIEW C-C



SECTION D-D

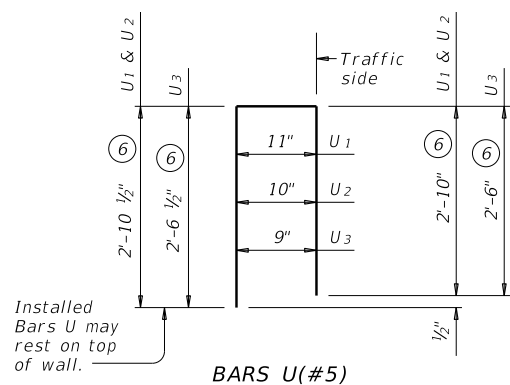


SECTION E-E

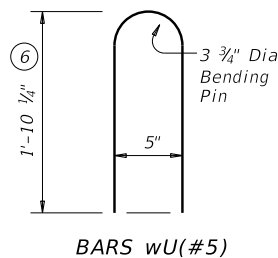


SECTION F-F

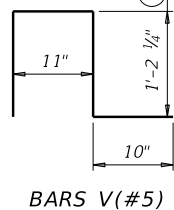
- (6) Increase 2" for structures with overlay.
- (11) 1/8" Dia Anchor Bolts. See "Anchor Bolt Assembly Details".
- (13) Anchor bolts must be 7/8" Dia ASTM A193 Grade B7 or F1554 Grade 105 fully threaded rods with heavy hex nuts and one hardened washer (1 3/4" OD) each. Embed threaded rods 8" into parapet wall with a Type III Class C epoxy anchorage system.
- (14) Install Parapet Shoe after rail has been placed. To ease installation, temporarily brace parapet shoe until the anchorage system achieves manufacturer's recommended curing time. Anchorage system must be assembled with one (1 3/4" OD) hardened washer and one heavy hex nut each. Remove temporary bracing after anchorage systems has been firmly tightened.
- (15) Length shown for 6 1/4" Min bar embedment with no overlay. Adjust as required.
- (16) Increase 2 3/4" for structures with overlay.



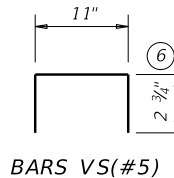
BARS U(#5)



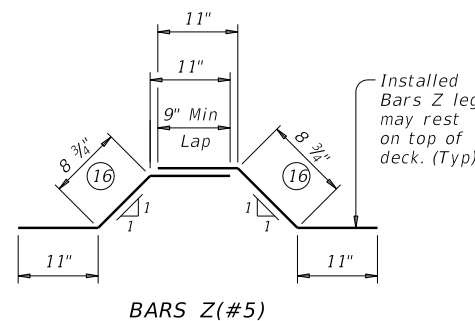
BARS wU(#5)



BARS V(#5)



BARS VS(#5)



BARS Z(#5)

SHEET 2 OF 4



TRAFFIC RAIL RIO VIEJO DE TEJAS

TYPE T1P

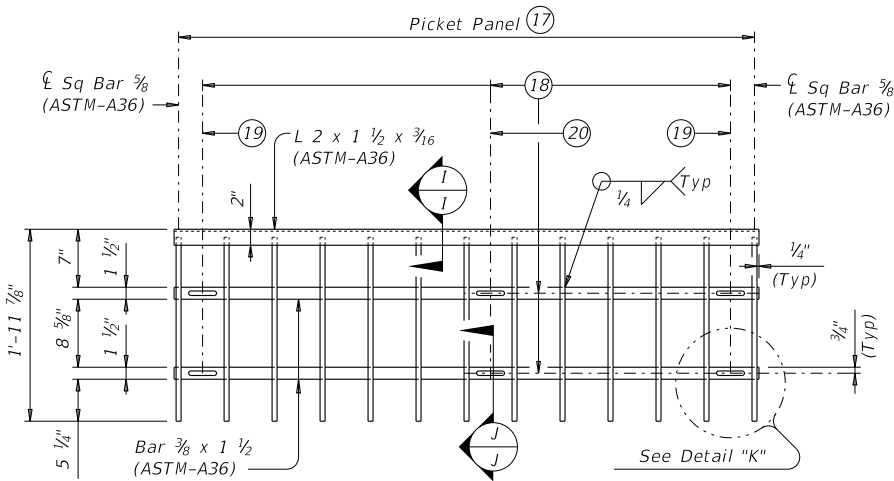
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©TxDOT July 2014	CONT	SECT	JOB	HIGHWAY
REVISIONS				
	DIST		COUNTY	SHEET NO.

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 Texas Department of Transportation	<i>Bridge Division Standard</i>
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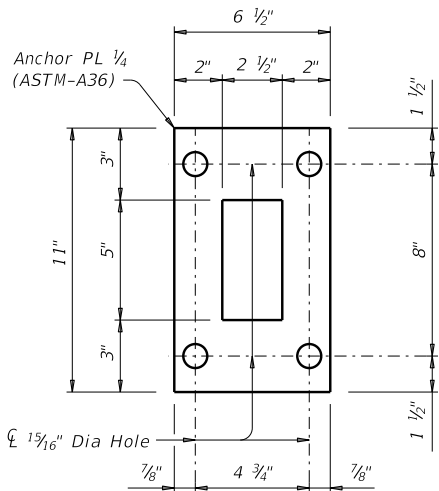
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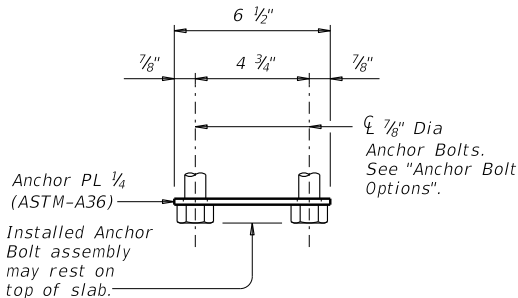
PICKET PANEL DETAIL

(6'-0" Max Picket Panel weight = 69 lb each, for contractor's information only).

- ⑥ Increase 2' for structures with overlay.
- ⑦ 5/8" Sq Bar (ASTM-A36) Spaced at 6".
- ⑧ Bolt locations for attaching picket panel to back of HSS 6 x 2 x 1/4. Six 1/2" Dia Heavy Hex Head Bolts (ASTM-A325) and Hardened Washers under Heavy Hex Head Nuts required per picket panel. 5/16" x 3 1/2" Horizontal Slot in 5/8 x 1 1/2 Bar for 1/2" Dia Heavy Hex Head Bolts (ASTM-A325). See "Section J-J".
- ⑨ Bolt locations at ends of picket panel as shown. See "Roadway Elevation Of Rail".
- ⑩ Bolt locations for attaching picket panel must always be in next adjacent picket panel bay from end of sleeve members to allow for joint movement, when sleeve members are present.
- ⑪ Galvanizing Anchor Plate is not required.

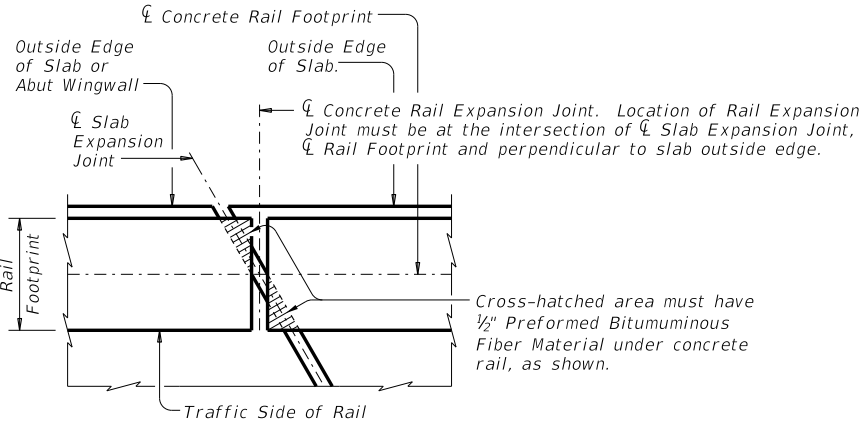


PLAN OF ANCHOR PLATE ⑪



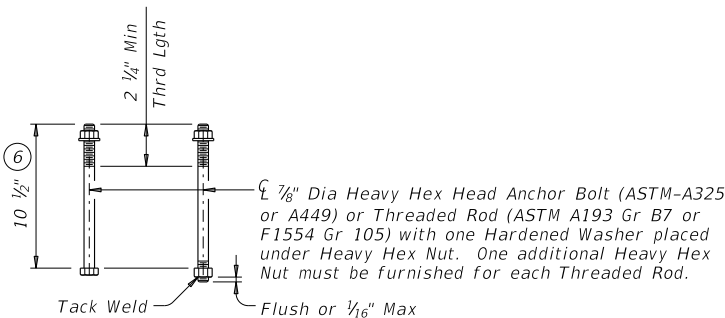
ELEVATION

ANCHOR BOLT ASSEMBLY DETAILS



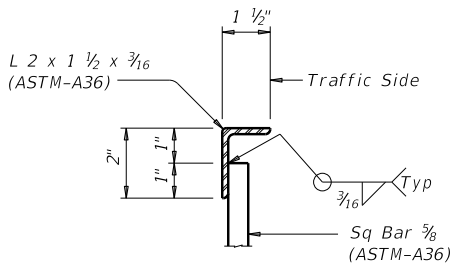
PLAN OF RAIL AT EXPANSION JOINTS

Example showing Slab Expansion Joints without breakbacks.

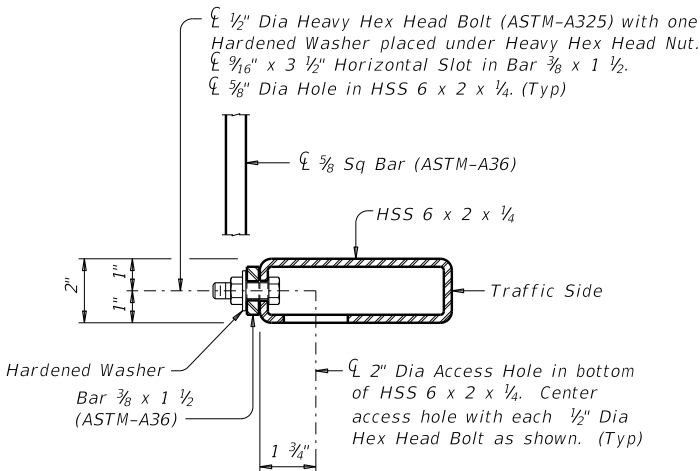


ANCHOR BOLT OPTIONS

(Showing Anchor Bolts for Base Plate)

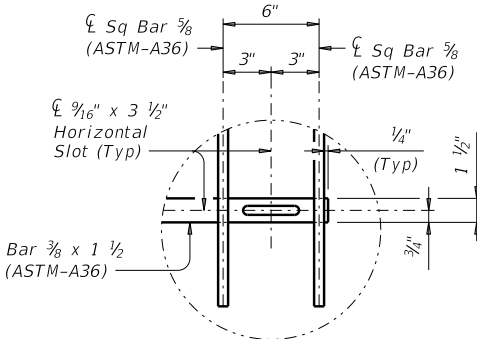


SECTION I-I



SECTION J-J

(Showing Picket Panel connecting to HSS 6 x 2 x 1/4). (Typ)



DETAIL "K"

CONSTRUCTION NOTES:

The face of tubular sections and rail curb must be plumb unless otherwise approved by the Engineer. Steel posts must be square to the top of curb. Use epoxy mortar under post base plates if gaps larger than 1/16" exist.

Bend tubes to required radius for curved rails. Shop drawings for approval are required for curved rails.

One shop splice per rail member section is permitted with minimum 85 percent penetration. The weld may be square groove or single vee groove. Grind smooth.

Exposed edges of rail members and rail posts must be rounded or chamfered to approximately 1/16" by grinding.

MATERIAL NOTES:

Galvanize all steel components except reinforcing steel and anchor plate unless noted otherwise.

When plans require painted steel, follow the requirements for painting galvanized steel in Item 446, "Cleaning and Painting Steel". Do not paint sleeve members until after they are installed.

Provide 7/8" Dia ASTM-A325 or A449 bolts (or ASTM-A193 Grade B7 or F1554 Grade 105 threaded rods with one tack welded heavy hex nut each) with one hardened washer placed under each heavy hex head nut that conforms to ASTM A563 requirements.

Provide 1/2" Dia ASTM-A325 bolts with one hardened washer placed under each heavy hex head nut that conforms to ASTM A563 requirements.

Provide Class "S" concrete. When Class "S" concrete for slab is HPC, include a minimum of 3 gallons of calcium nitrite inorganic corrosion inhibitor per cubic yard of Class "S" concrete. Chamfer all exposed corners.

Provide ASTM A1085 or A500 Grade B for all HSS.

Provide Grade 60 reinforcing steel.

Provide bar laps, where required, as follows:

Uncoated ~ #5 = 1'-9"

Epoxy coated ~ #5 = 2'-7"

Epoxy coat all rail reinforcement if slab bars are epoxy coated.

GENERAL NOTES:

This rail has been successfully evaluated by full-scale crash test to meet MASH TL-3 criteria. This rail can be used for speeds of 50 mph and greater when a TL-3 rated guard fence transition is used. When a TL-2 rated guard fence transition is used, this rail can only be used for speeds of 45 mph and less.

This railing cannot be used on bridges with expansion joints providing more than 5" movement or on cast-in-place retaining walls, unless otherwise noted.

Rail anchorage details shown on this standard may require modification for select structure types. See appropriate details elsewhere in plans for these modifications.

Submit erection drawings showing panel lengths, rail post spacing, and anchor bolt setting, to the Engineer for approval.

Average weight of railing with no overlay:

192 plf total

131 plf (Conc)

61 plf (Steel).

Cover dimensions are clear dimensions, unless noted otherwise.
Reinforcing bar dimensions shown are out-to-out of bar.

SHEET 4 OF 4

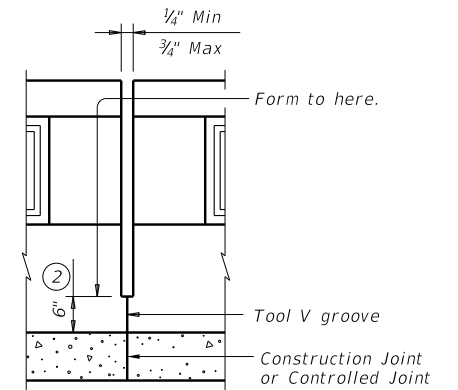


TRAFFIC RAIL RIO VIEJO DE TEJAS

TYPE T1P

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	DIST		COUNTY	SHEET NO.

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(Showing without raised sidewalk)
Provide at all interior bents without slab expansion joints.

- ① Terminal Connectors and associated hardware are to be paid for under the Item "Metal Beam Guard Fence". Attach Metal Beam Guard Fence Transitions to the bridge rail and extend along the embankment unless otherwise shown in the plans.
- ② Increase 2" for structures with overlay.
- ③ Wingwall length minus 4'-2" (Variable) 10" Min.



(Reveals not shown for clarity. See "Typical Reveal Location Detail".)



ridge
division
standard

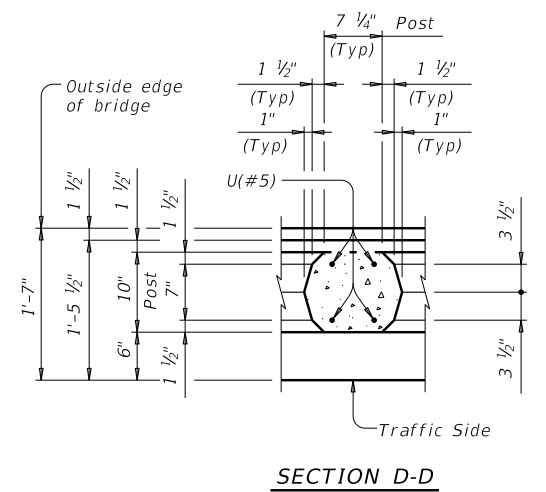
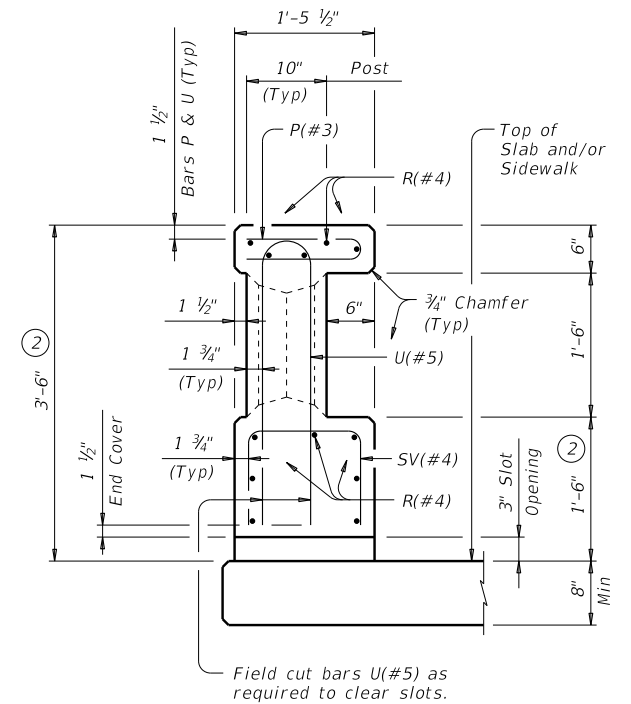
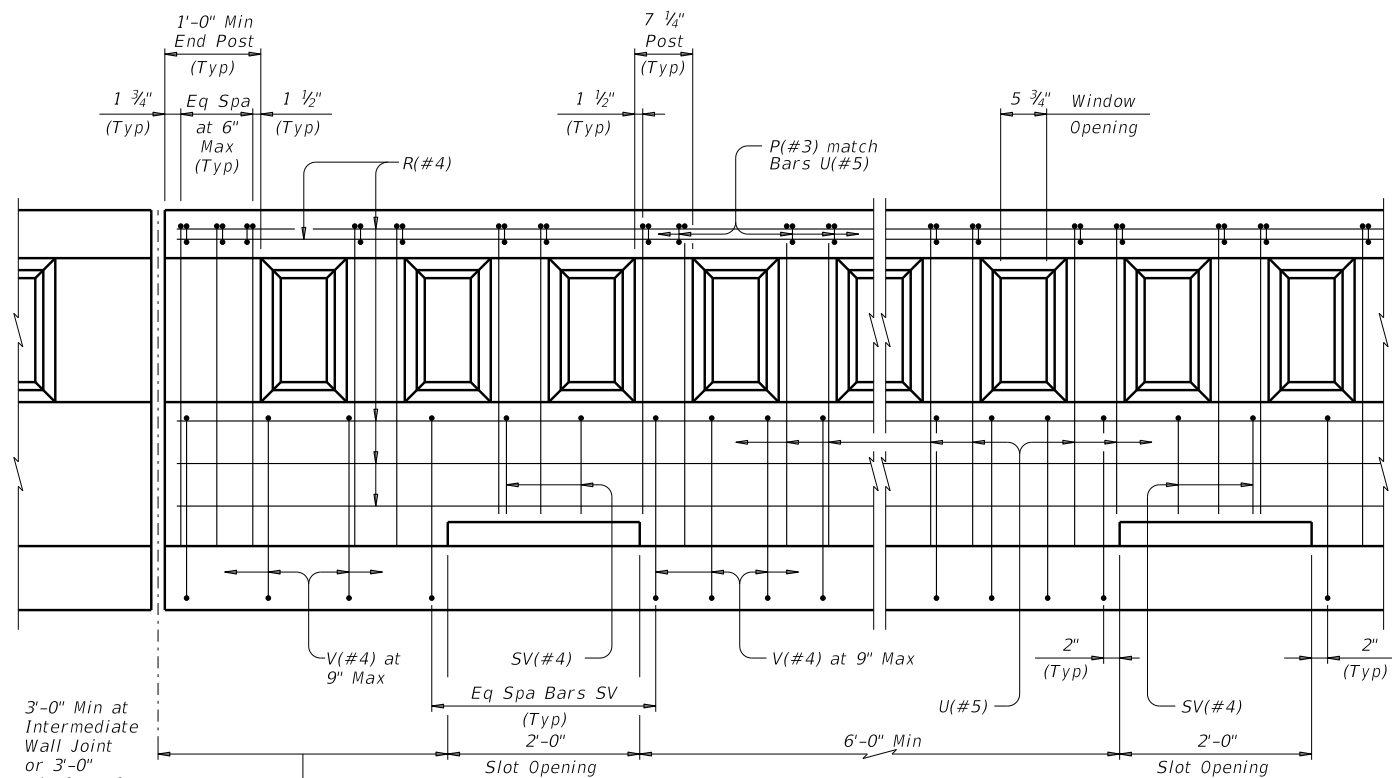
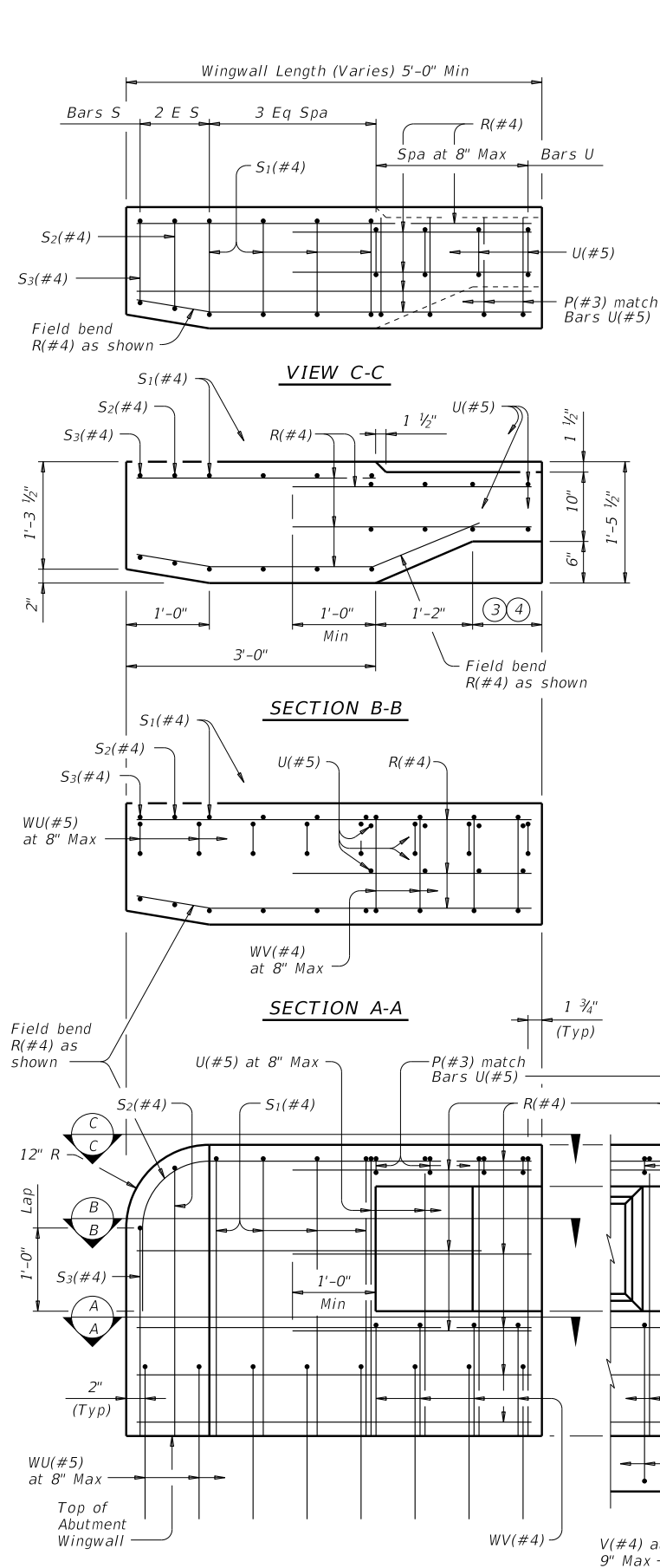
COMBINATION RAIL

TYPE C412

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SHEET 2 OF 4



Texas Department of Transportation

Bridge Division Standard

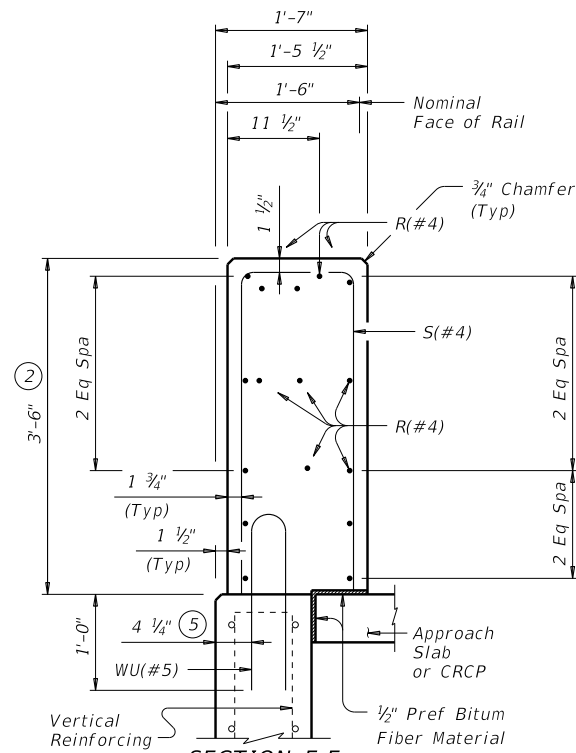
COMBINATION RAIL

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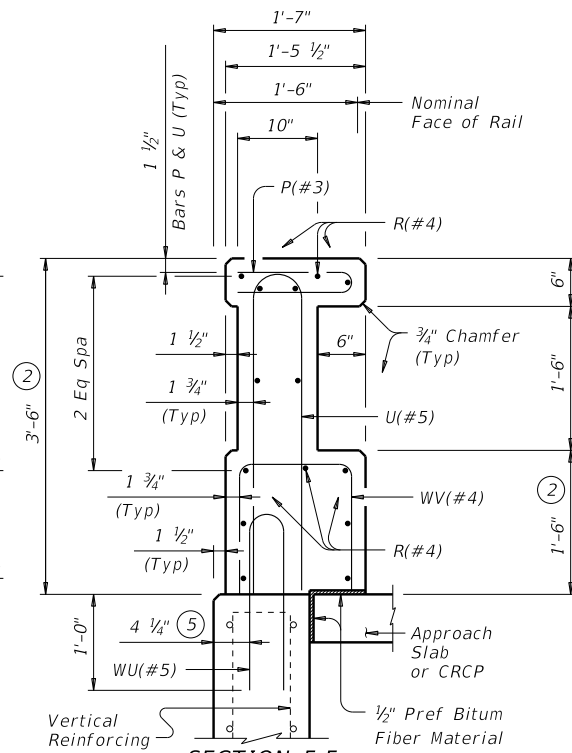
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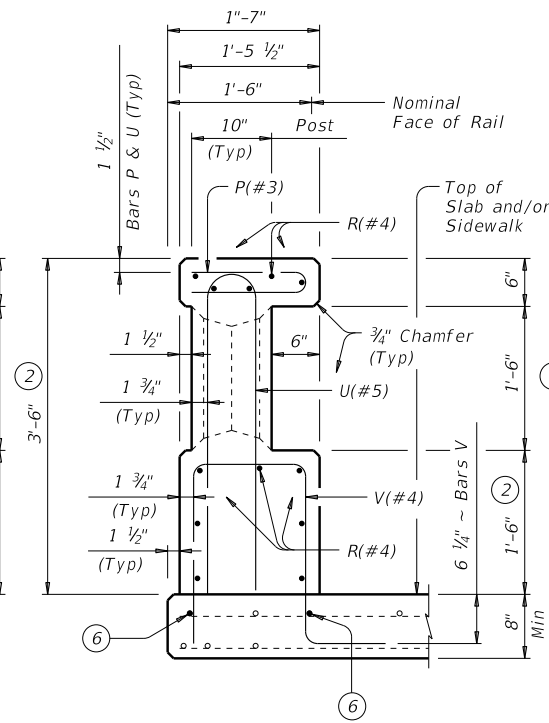
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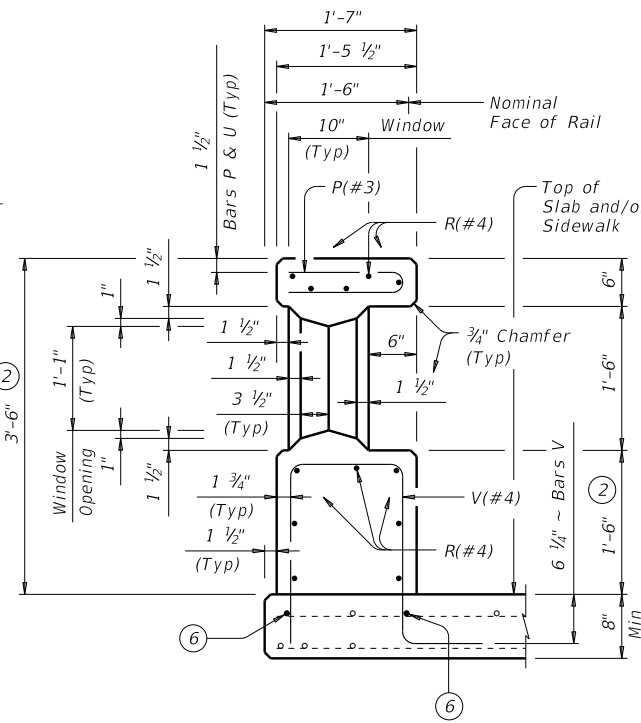
**SECTION E-E
ON ABUTMENT WINGWALLS
OR CIP RETAINING WALLS**



**SECTION F-F
ON ABUTMENT WINGWALLS
OR CIP RETAINING WALLS**



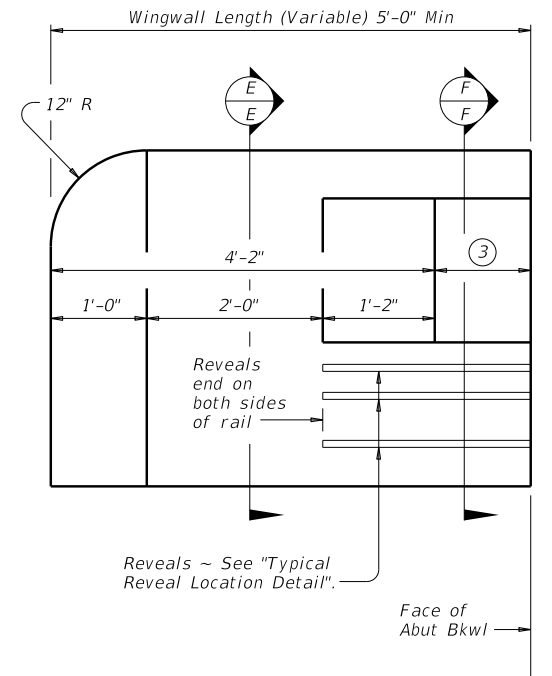
ON BRIDGE SLAB AT POST



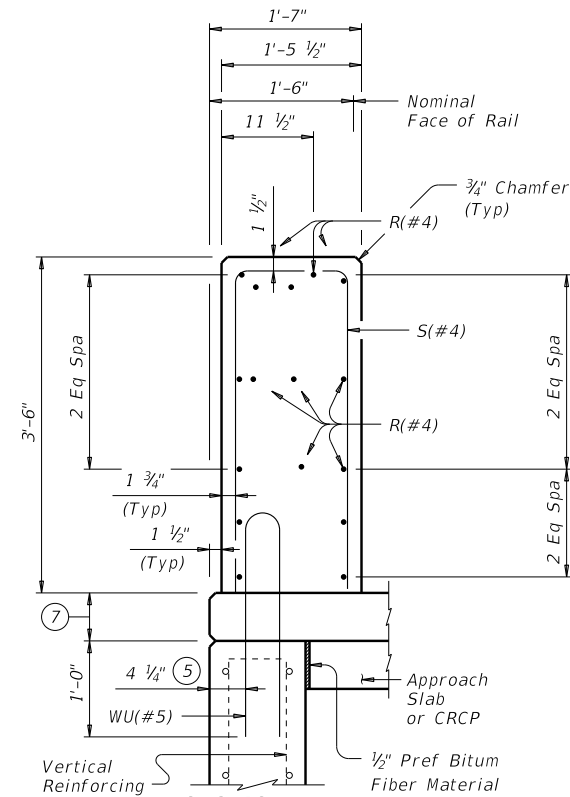
ON BRIDGE SLAB AT WINDOW

SECTIONS THRU RAIL WITHOUT RAISED SIDEWALK

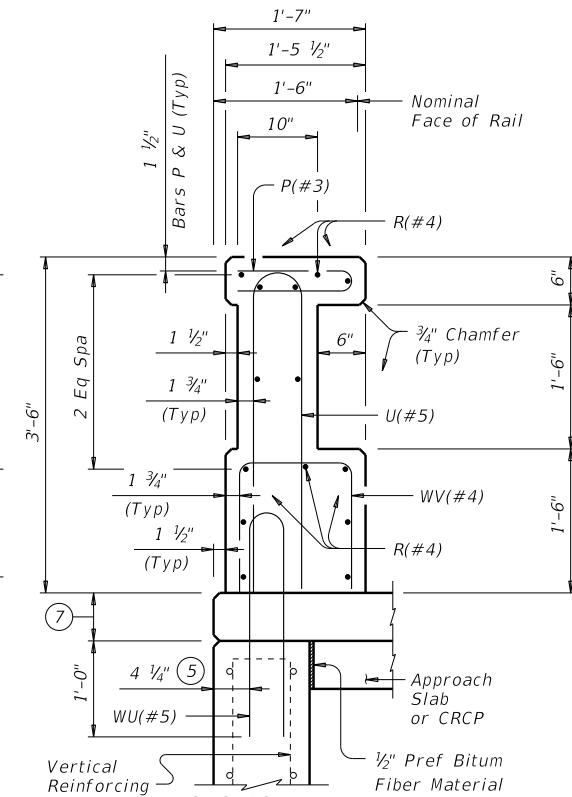
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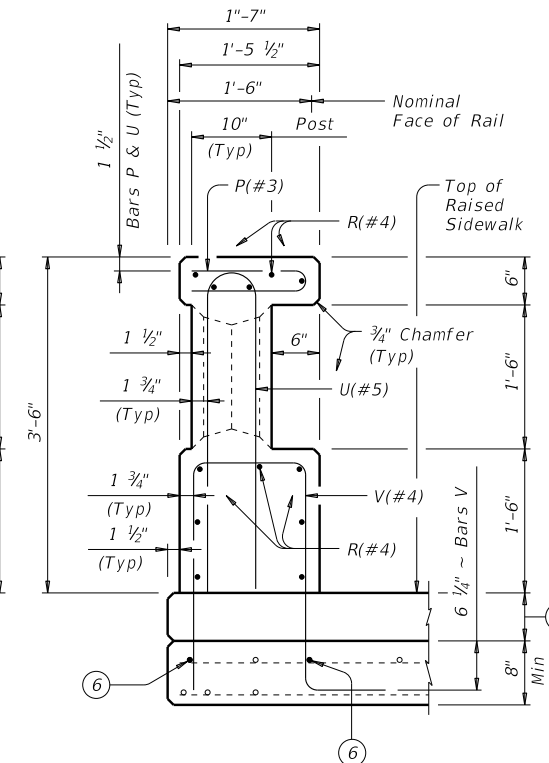
**ELEVATION AT
ABUTMENT WINGWALL**



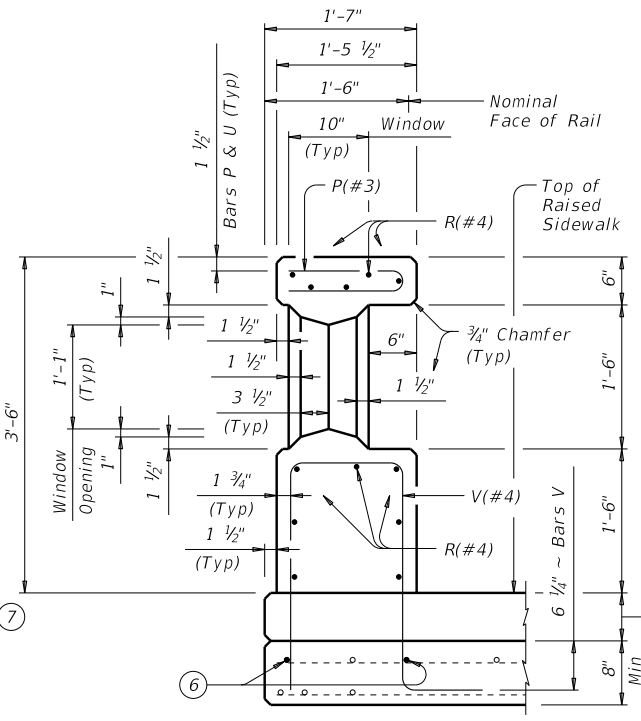
**SECTION E-E
ON ABUTMENT WINGWALLS
OR CIP RETAINING WALLS**



**SECTION F-F
ON ABUTMENT WINGWALLS
OR CIP RETAINING WALLS**



ON BRIDGE SLAB AT POST



ON BRIDGE SLAB AT WINDOW

SECTIONS THRU RAIL WITH RAISED SIDEWALK

(Reveals not shown for clarity. See "Typical Reveal Location Detail".)

- ② Increase 2" for structures with overlay.
- ③ Wingwall length minus 4'-2" (Variable) 10" Min.
- ⑤ 5 1/4" when vertical reinforcing has closer clear cover over horizontal reinforcing in abutment wingwalls or retaining walls on traffic side of wall.
- ⑥ Top longitudinal slab bar may be adjusted laterally 3" plus or minus to tie reinforcing.
- ⑦ Raised Sidewalk.

SHEET 3 OF 4



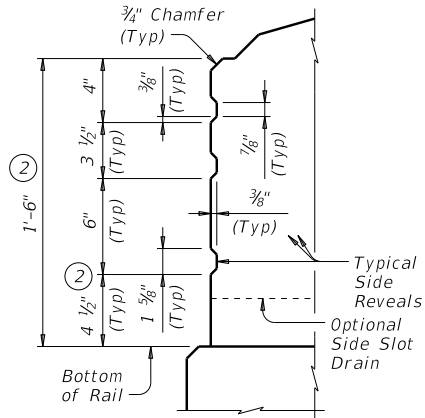
COMBINATION RAIL

TYPE C412

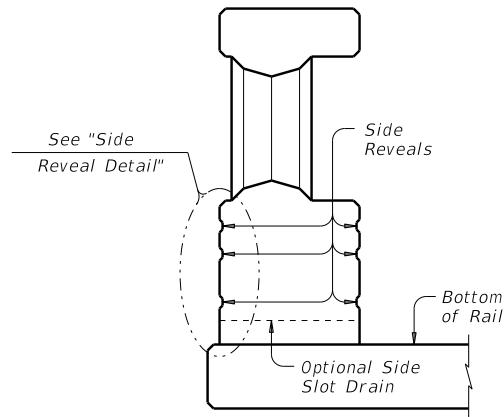
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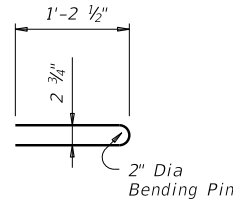


SIDE REVEAL DETAIL

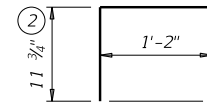


TYPICAL REVEAL LOCATION DETAIL

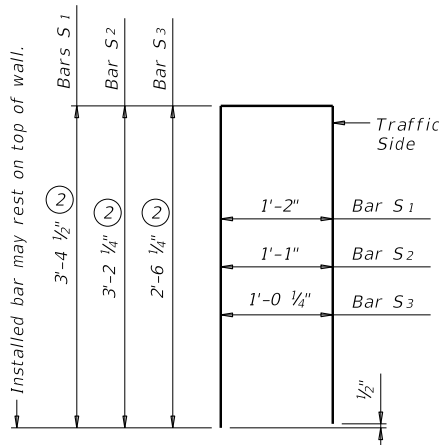
- (2) Increase 2" for structures with overlay.
(8) For raised sidewalks, add sidewalk height to total bar height. Use sidewalk height at rail's location.



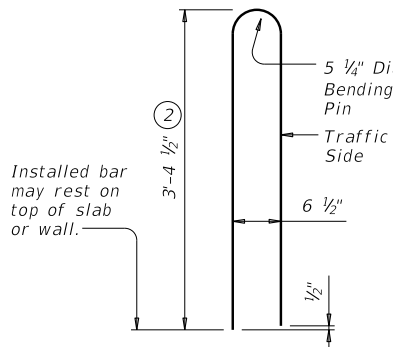
BARS P (#3)



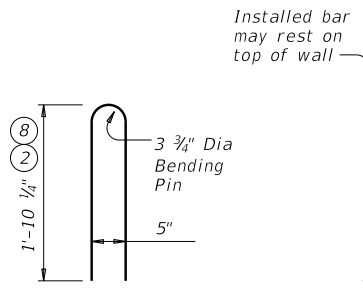
BARS SV (#4)



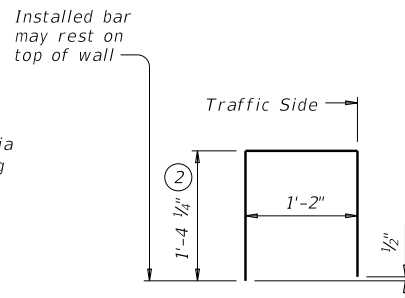
BARS S (#4)



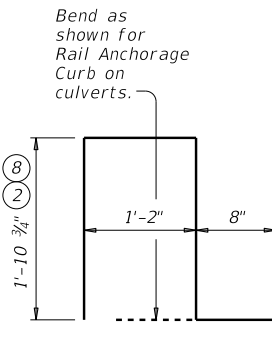
BARS U (#5)



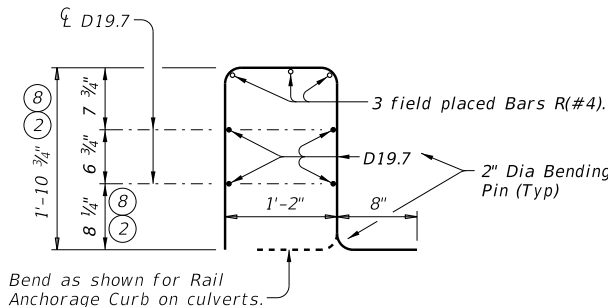
BARS WU (#5)



BARS WV (#4)



BARS V (#4)



OPTIONAL WELDED WIRE REINFORCING (WWR) FOR BARS V

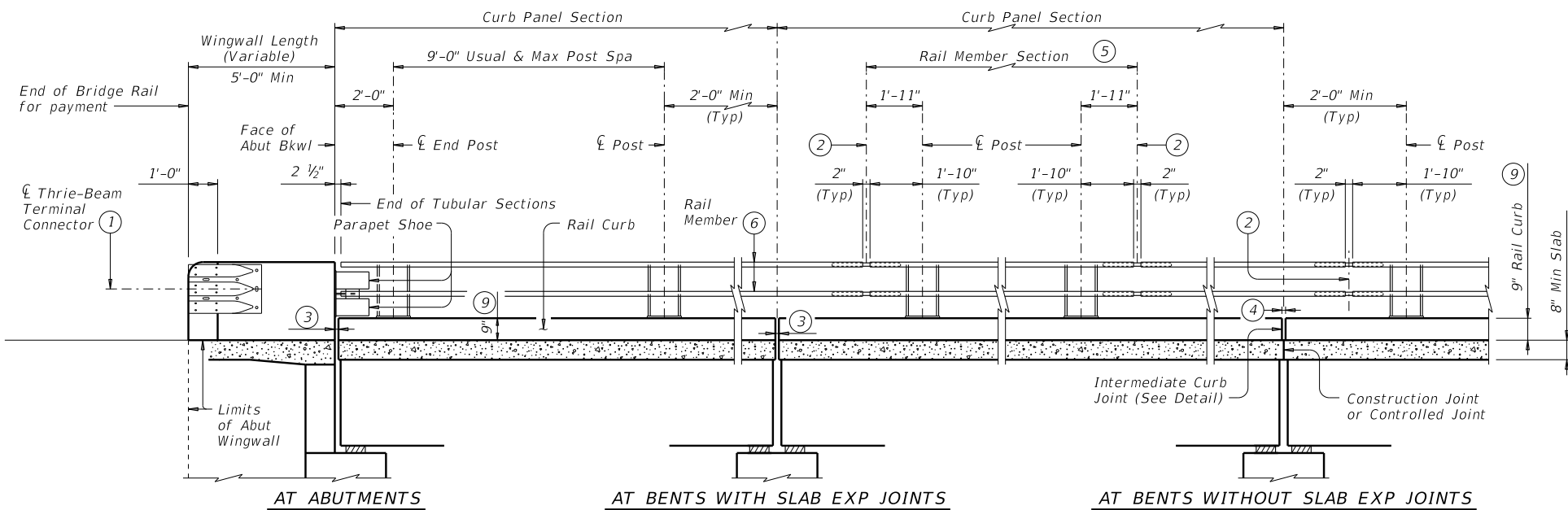
- CONSTRUCTION NOTES:**
The back of railing must be vertical unless otherwise shown on the plans or approved.
- MATERIAL NOTES:**
Galvanize all steel components except reinforcing unless otherwise shown on plans.
Provide Class "C" concrete. Provide Class "C" (HPC) if required elsewhere.
Provide Grade 60 reinforcing steel.
Epoxy coat all reinforcement if slab bars are epoxy coated.
Deformed Welded Wire Reinforcement (WWR) (ASTM A1064) of equal size and spacing may be substituted for Bars WU unless noted otherwise. Deformed WWR (A1064) may be substituted for Bars V, and 4 Bars R with 3 field placed Bars R(#4), as shown. Provide the same laps as required for reinforcing bars.
Provide bar laps, where required, as follows:
Uncoated ~ #4 = 1'-5"
Epoxy coated ~ #4 = 2'-1"

- GENERAL NOTES:**
This rail has been successfully evaluated by full-scale crash test to meet NCHRP Report 350 TL-4 criteria. This rail can be used for speeds of 50 mph and greater when a TL-3 rated guard fence transition is used. When a TL-2 rated guard fence transition is used, this rail can only be used for speeds of 45 mph and less.
Do not use this railing on bridges with expansion joints providing more than 5" movement.
Rail anchorage details shown on this standard may require modification for select structure types. See appropriate details elsewhere in plans for these modifications.
Shop drawings are not required for this rail.
Average weight of railing with no overlay is 560 plf.
- Cover dimensions are clear dimensions, unless noted otherwise.
Reinforcing bar dimensions shown are out-to-out of bar.

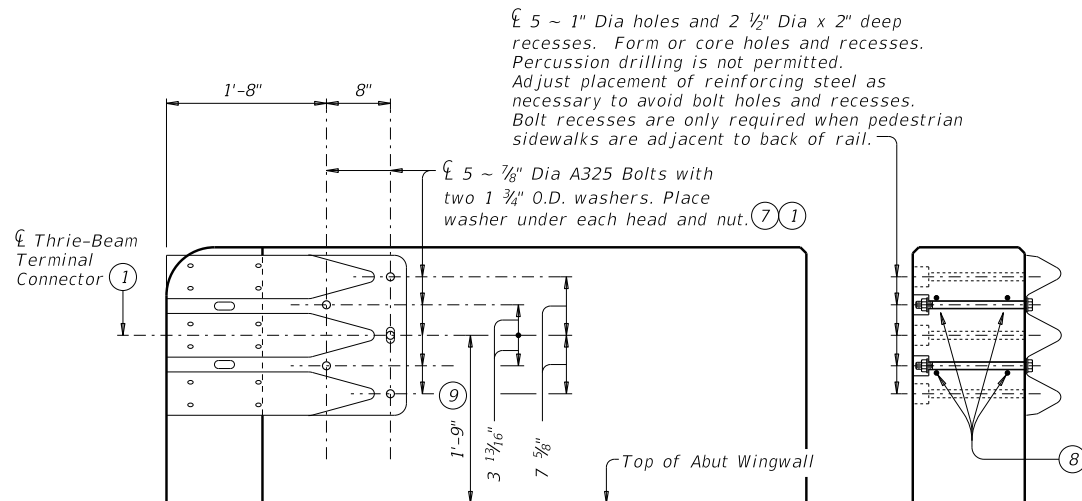
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COMBINATION RAIL					
TYPE C412					
FILE: r1std0033.dgn	DN: TxDOT		CK: TxDOT	DW: JTR	CK: JMH
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REVISIONS					
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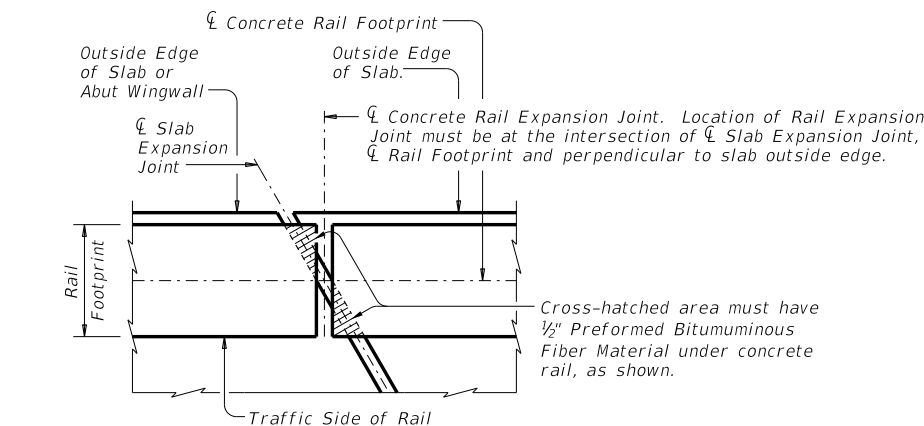
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ROADWAY ELEVATION OF RAIL

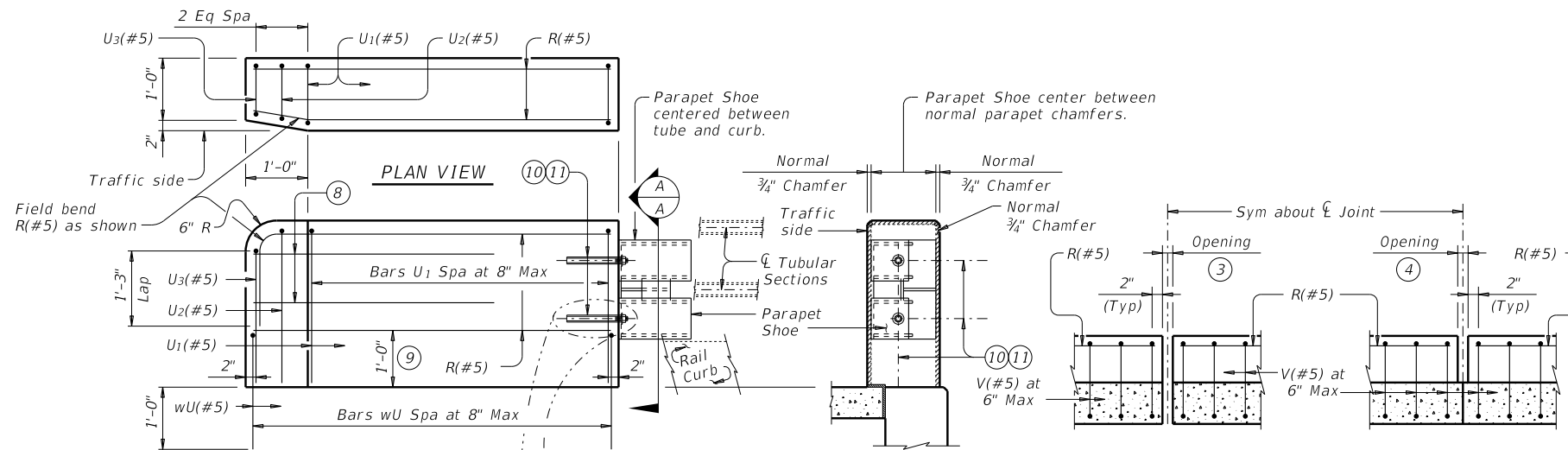


TERMINAL CONNECTION DETAILS

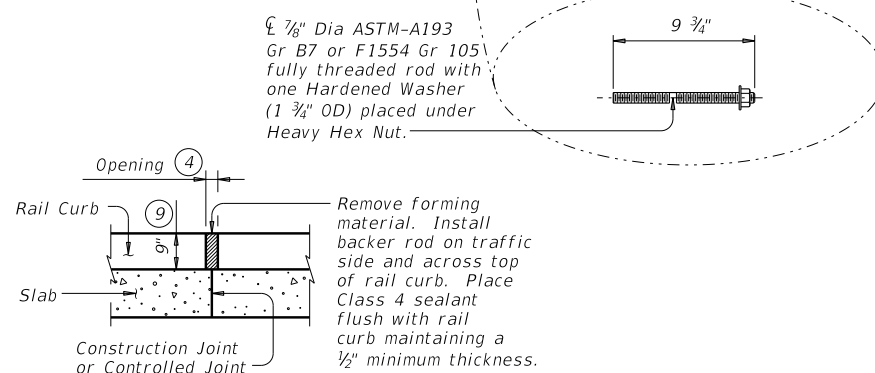


PLAN OF RAIL AT EXPANSION JOINTS

Example showing Slab Expansion Joints without breakbacks.



ELEVATION SHOWING TYPICAL REINFORCING PLACEMENT



INTERMEDIATE CURB JOINT DETAIL

Provide at all interior bents without slab expansion joints. Location independent of rail member splices.

- 1 Terminal Connectors and associated hardware are to be paid for under the Item "Metal Beam Guard Fence". Attach Metal Beam Guard Fence Transitions to the bridge rail and extend along the embankment unless otherwise shown in the plans.
- 2 Expansion Joint or Splice Joint as required.
- 3 Same as slab joint opening. (5" Max Expansion Joint).
- 4 1/4" Min, 3/4" Max.
- 5 Rail member sections must have at least two posts but not more than four.
- 6 HSS 6 x 2 x 1/4 (ASTM-A1085 or A500 Grade B).
- 7 Provide bolts of sufficient length to extend 1/2" to 3/4" beyond nut.
- 8 Place 4 additional Bars R(#5) 3'-8" in length inside Bars U(#5) and centered 2'-0" from end of rail when Terminal Connections are required. Field bend as needed.
- 9 Increase 2" for structures with overlay.
- 10 Anchor bolts must be 7/8" Dia ASTM A193 Grade B7 or F1554 Gr 105 fully threaded rods with heavy hex nuts and one hardened washer (1 3/4" OD) each. Embed threaded rods 8" into parapet wall with a Type III Class C epoxy anchorage system.
- 11 Install Parapet Shoe after rail has been placed. To ease installation, temporarily brace parapet shoe until the anchorage system achieves manufacturer's recommended curing time. Anchorage system must be assembled with one (1 3/4" OD) hardened washer and one heavy hex nut each. Remove temporary bracing after anchorage systems has been firmly tightened.

SHEET 1 OF 4



TRAFFIC RAIL

TYPE T1W

FILE: rlst0002.dgn	DN: TxDOT	CK: TxDOT	DW: JTR	CK: JMH
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Technical drawing of a concrete slab joint showing the rail post, anchor bolts, and various dimensions. The drawing includes the following labels and dimensions:

- 1'-2"**: Total width dimension at the top.
- 5 5/8"**, **4 3/4"**, **3 5/8"**: Horizontal spacing dimensions between vertical dashed lines.
- 2 1/4" Bolt Projection**: Dimension for the bolt projection above the slab.
- Level**: Indicated by a horizontal line and a level symbol.
- Plumb**: Indicated by a vertical line and a plumb symbol.
- Installed Anchor Bolt assembly may rest on top of slab.**: Note pointing to the anchor bolt assembly.
- 9**: Dimension for the height of the rail post above the slab.
- 1 1/2"**: Dimension for the height of the rail curb above the slab.
- Const Joint**: Label for the construction joint.
- Slab**: Label for the concrete slab.
- Varies**: Dimension for the height of the rail curb, noted as varying.
- 7/8" Dia Anchor Bolts.**: Label for the anchor bolts.
- Rail post**: Label for the vertical post.
- Rail curb**: Label for the horizontal curb.

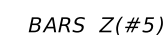
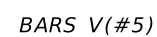
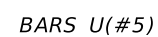
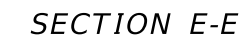
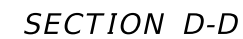
RAIL CURB FORMING DETAIL

Reinforcing steel and rail curb chamfers not shown for clarity.

SECTIONS THRU RAIL



VIEW B-B



- SHEET 2 OF 4

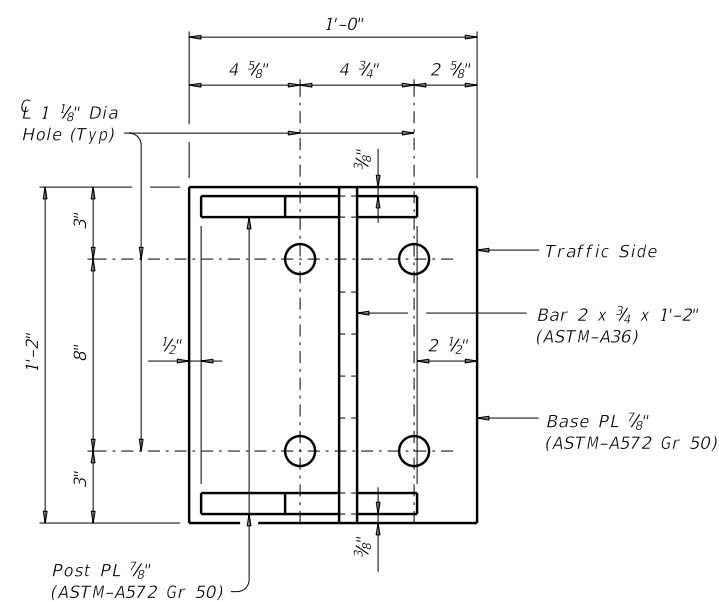
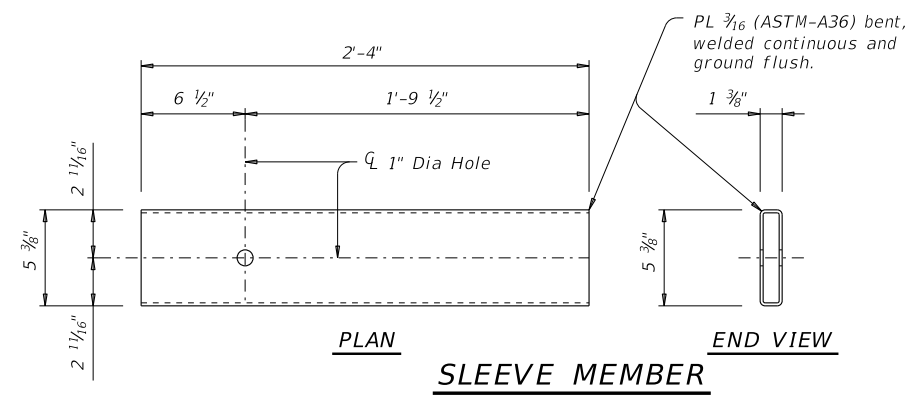


TRAFFIC RAIL

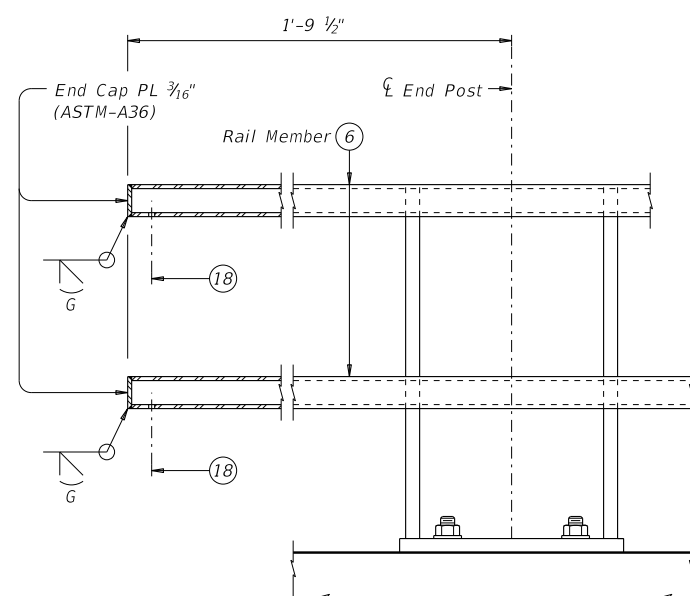
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☒ TxDOT July 2014		CONT	SECT	JOB			HIGHWAY		
REVISIONS									
		DIST	COUNTY				SHEET NO.		

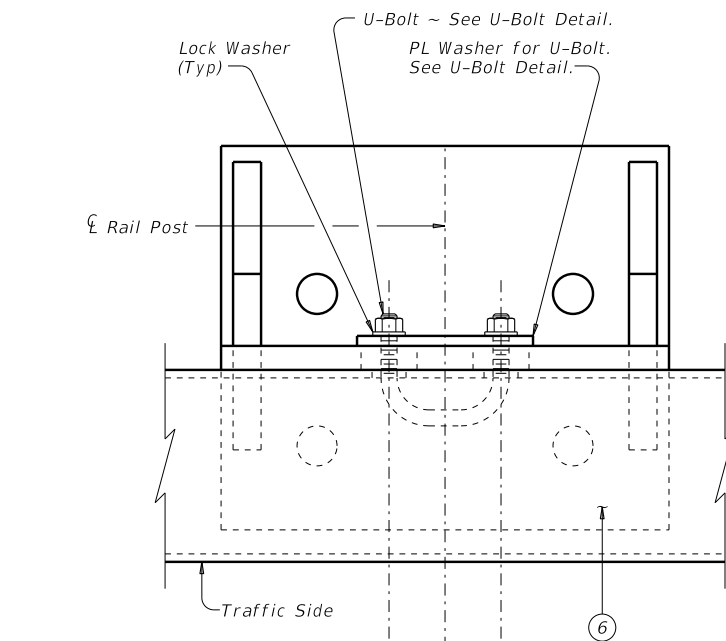
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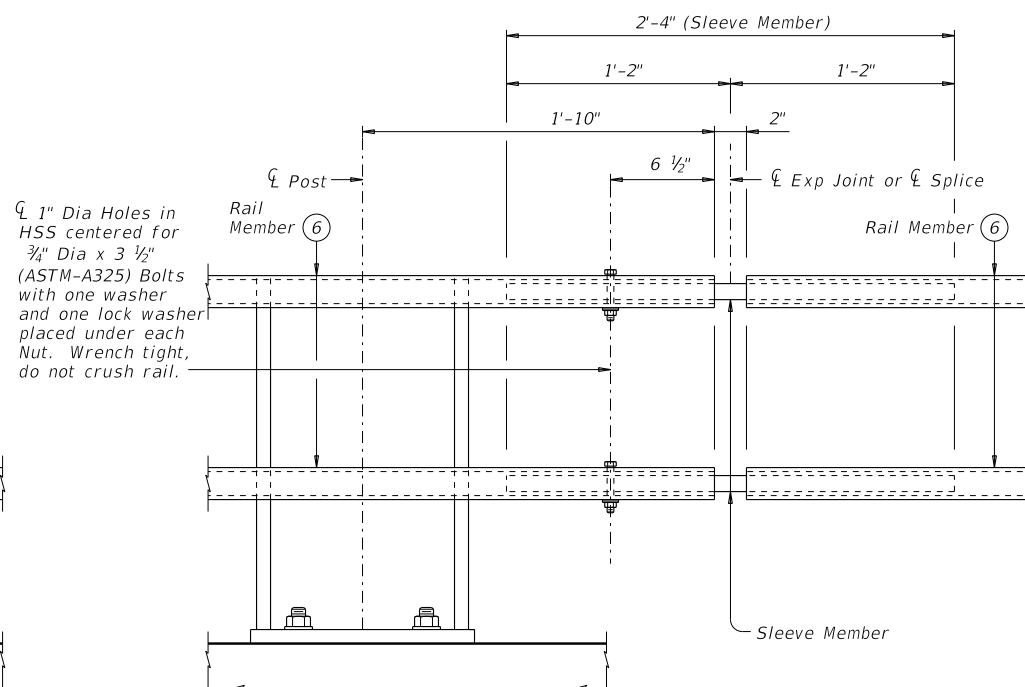
VIEW H-H
(Showing Hole location in Base PL)



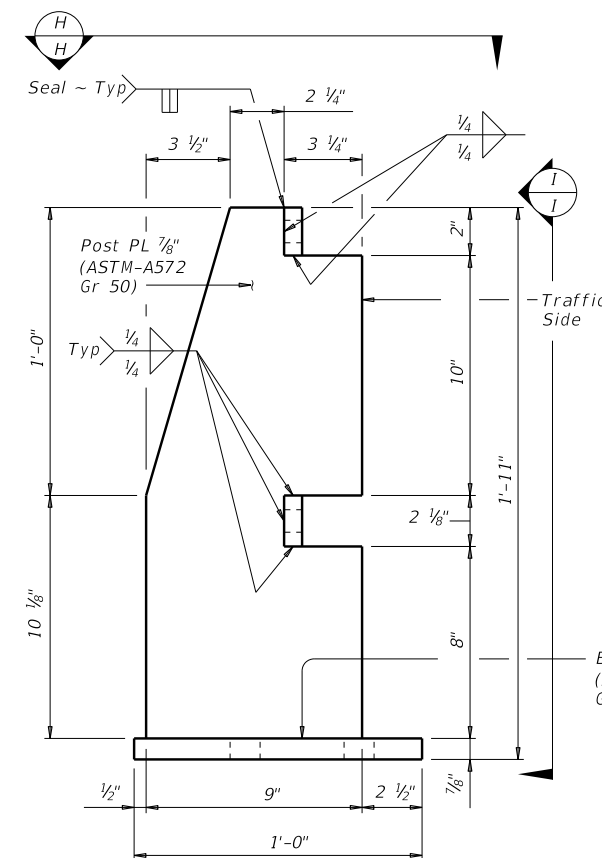
END CAPS ON HSS AT END POST



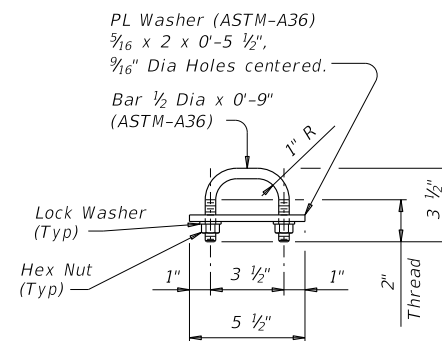
TOP VIEW OF RAIL POST
(Showing connection for rail post and HSS.)



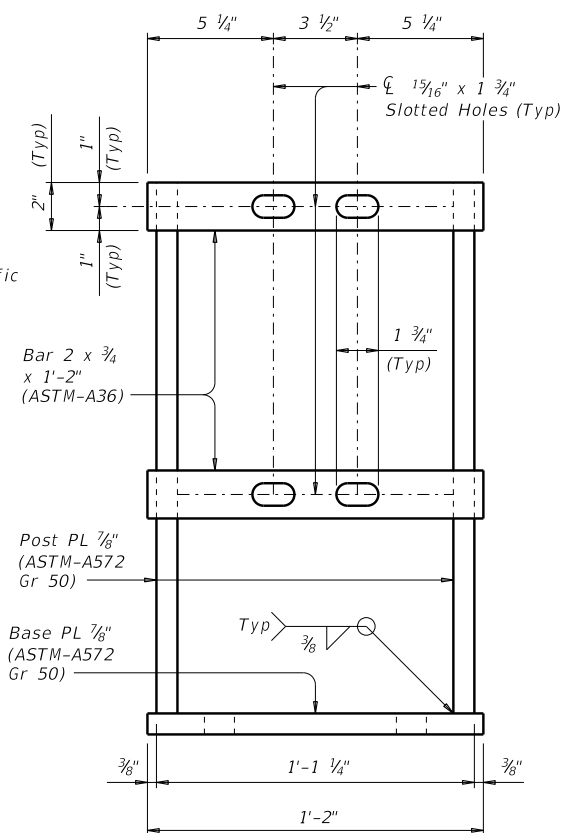
EXPANSION JOINT OR SPLICE



POST DETAIL



U-BOLT DETAIL
(Showing U-Bolt for rail post and HSS.)



VIEW I-I

- ⑥ HSS 6 x 2 x 1/4 (ASTM-A1085 or A500 Grade B).
- ⑱ 1/8" Dia Drain Hole in bottom of HSS.

SHEET 3 OF 4



**Bridge
Division
Standard**

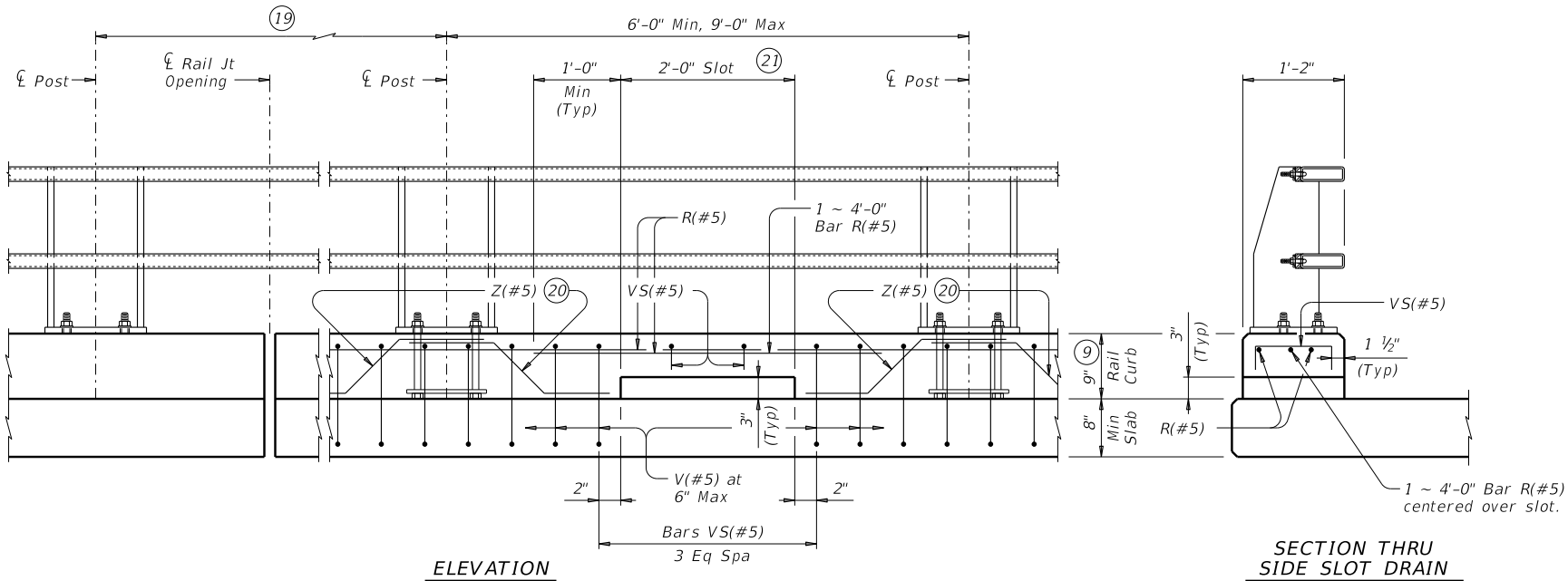
TRAFFIC RAIL

TYPE T1W

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REVISIONS									
		DIST	COUNTY				SHEET NO		

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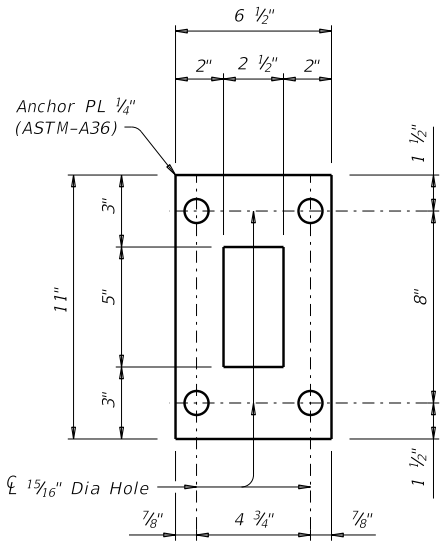
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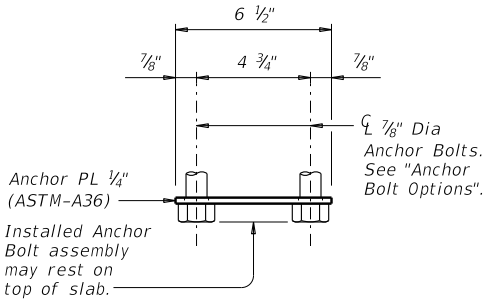
ELEVATION

SECTION THRU
SIDE SLOT DRAIN

OPTIONAL SIDE SLOT DRAIN DETAILS⁽²²⁾



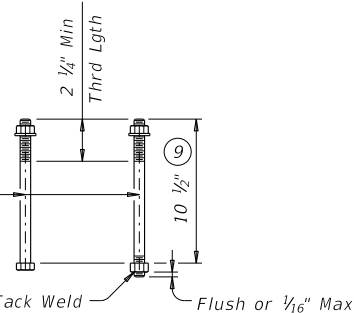
PLAN OF ANCHOR PLATE⁽²³⁾



ELEVATION

ANCHOR BOLT ASSEMBLY DETAILS

1/8" Dia Heavy Hex Head Anchor Bolt (ASTM-A325 or A449) or Threaded Rod (ASTM A193 Gr B7 or F1554 Gr 105) with one Hardened Washer placed under Heavy Hex Nut. One additional Heavy Hex Nut must be furnished for each Threaded Rod.



ANCHOR BOLT OPTIONS

(Showing Anchor Bolts for Base Plate)

CONSTRUCTION NOTES:

The face of tubular sections and rail curb must be plumb unless otherwise approved. Steel posts must be square to the top of curb. Use Type VIII epoxy mortar under post base plates if gaps larger than 1/16" exist.

Bend tubes to required radius for curved rails. Shop drawings for approval are required for curved rails.

One shop splice per rail member section is permitted with minimum 85 percent penetration. The weld may be square groove or single vee groove. Grind smooth.

Round or chamfer exposed edges of rail members and rail posts to approximately 1/16" by grinding.

MATERIAL NOTES:

Galvanize all steel components except reinforcing steel and anchor plate unless noted otherwise.

When plans require painted steel, follow the requirements for painting galvanized steel in Item 446, "Cleaning and Painting Steel". Do not paint sleeve members until after they are installed.

Anchor bolts for base plate must be 7/8" Dia ASTM A325 or A449 bolts (or ASTM-A193 Gr B7 or F1554 Gr 105 threaded rods with one tack welded heavy hex nut each) with one hardened washer placed under each heavy hex nut. Nuts must conform to A563 requirements.

Provide Class "S" concrete. When Class "S" concrete for slab is HPC, include a minimum of 3 gallons of calcium nitrite inorganic corrosion inhibitor per cubic yard of Class "S" concrete. Chamfer all exposed corners.

Provide Grade 60 reinforcing steel.

Provide bar laps, where required, as follows:

Uncoated ~ #5 = 1'-9"

Epoxy coated ~ #5 = 2'-7"

Epoxy coat all rail reinforcement if slab bars are epoxy coated.

GENERAL NOTES:

This rail has been evaluated and accepted to be of equal strength to railings with like geometry, which have been crash tested to meet NCHRP Report 350 TL-3 criteria. This rail can be used for speeds of 50 mph and greater when a TL-3 rated guard fence transition is used. When a TL-2 rated guard fence transition is used, this rail can only be used for speeds of 45 mph and less.

Do not use this railing on bridges with expansion joints providing more than 5" movement or on cast-in-place retaining walls, unless otherwise noted.

Rail anchorage details shown on this standard may require modification for select structure types. See appropriate details elsewhere in plans for these modifications.

Submit erection drawings showing panel lengths, rail post spacing, and anchor bolt setting, to the Engineer for approval.

Average weight of railing with no overlay:

173 plf total

131 plf (Conc)

42 plf (Steel).

Cover dimensions are clear dimensions, unless noted otherwise.
Reinforcing bar dimensions shown are out-to-out of bar.

SHEET 4 OF 4



Texas Department of Transportation

Bridge
Division
Standard

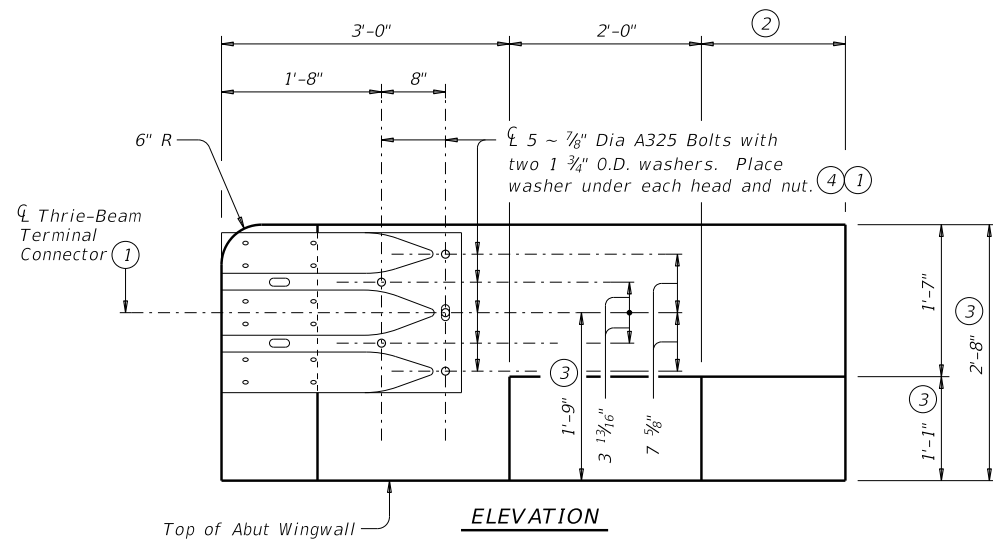
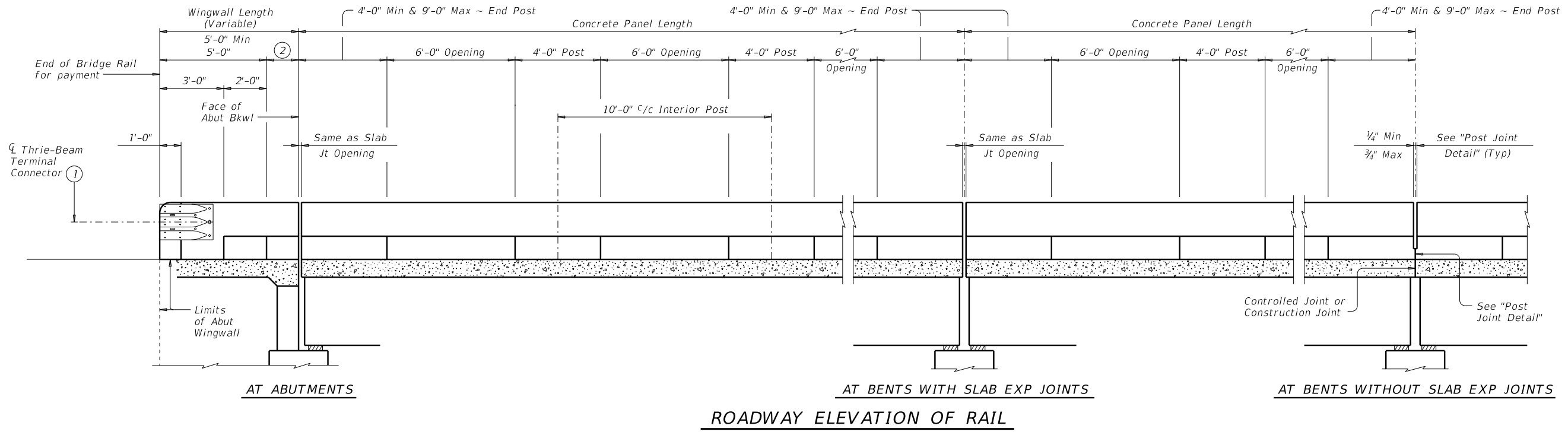
TRAFFIC RAIL

TYPE T1W

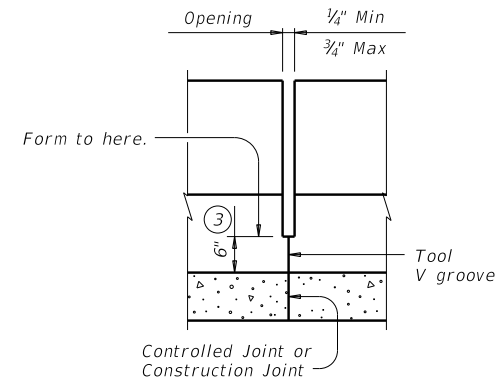
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©TxDOT July 2014	CONT	SECT	JOB	HIGHWAY
REVISIONS				
	DIST	COUNTY		SHEET NO.

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DATE:
FILE:



TERMINAL CONNECTION DETAILS



POST JOINT DETAIL

Provide at all interior bents without slab expansion joints.

- Terminal Connectors and associated hardware are to be paid for under the Item "Metal Beam Guard Fence". Attach Metal Beam Guard Fence Transitions to the bridge rail and extend along the embankment unless otherwise shown in the plans.
- Wingwall Length minus 5'-0" (Varies)
- Increase 2" for structures with overlay.
- Provide bolts of sufficient length to extend 1/2" to 3/4" beyond nut.
- Bolt recesses are only required when pedestrian sidewalks are adjacent to back of rail.

SHEET 1 OF 3



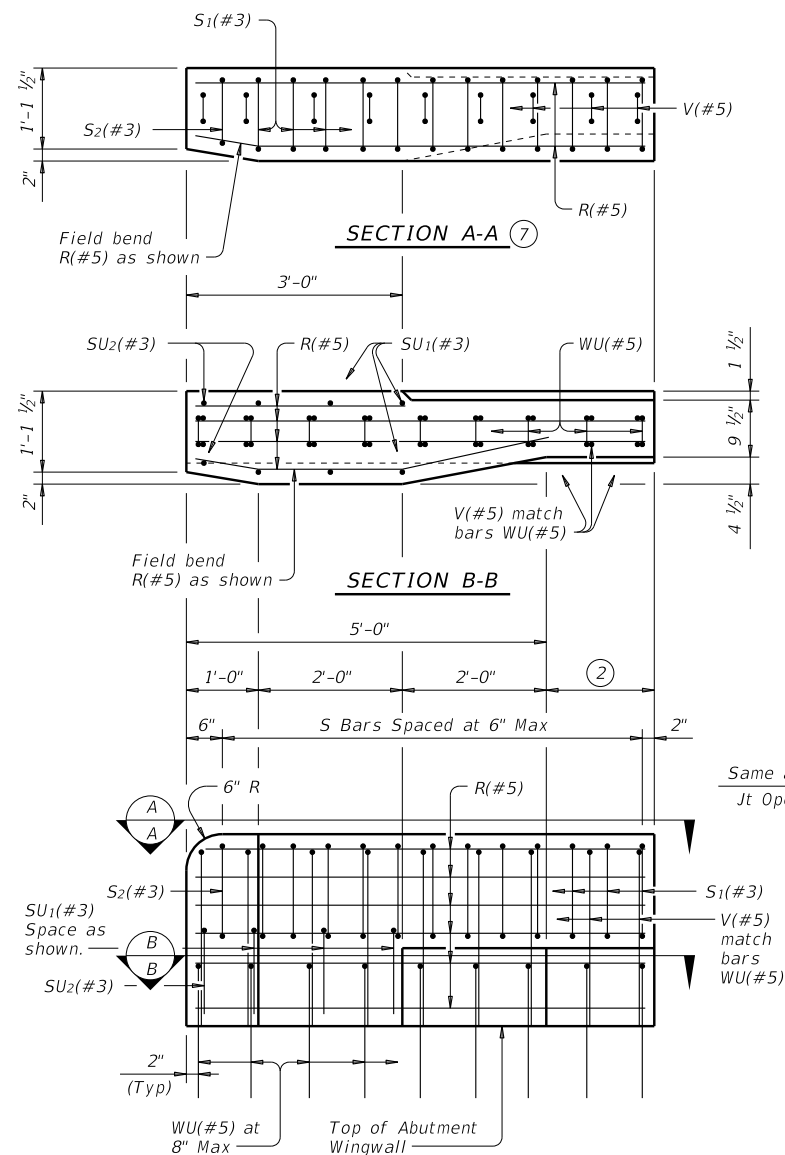
TRAFFIC RAIL

TYPE T223

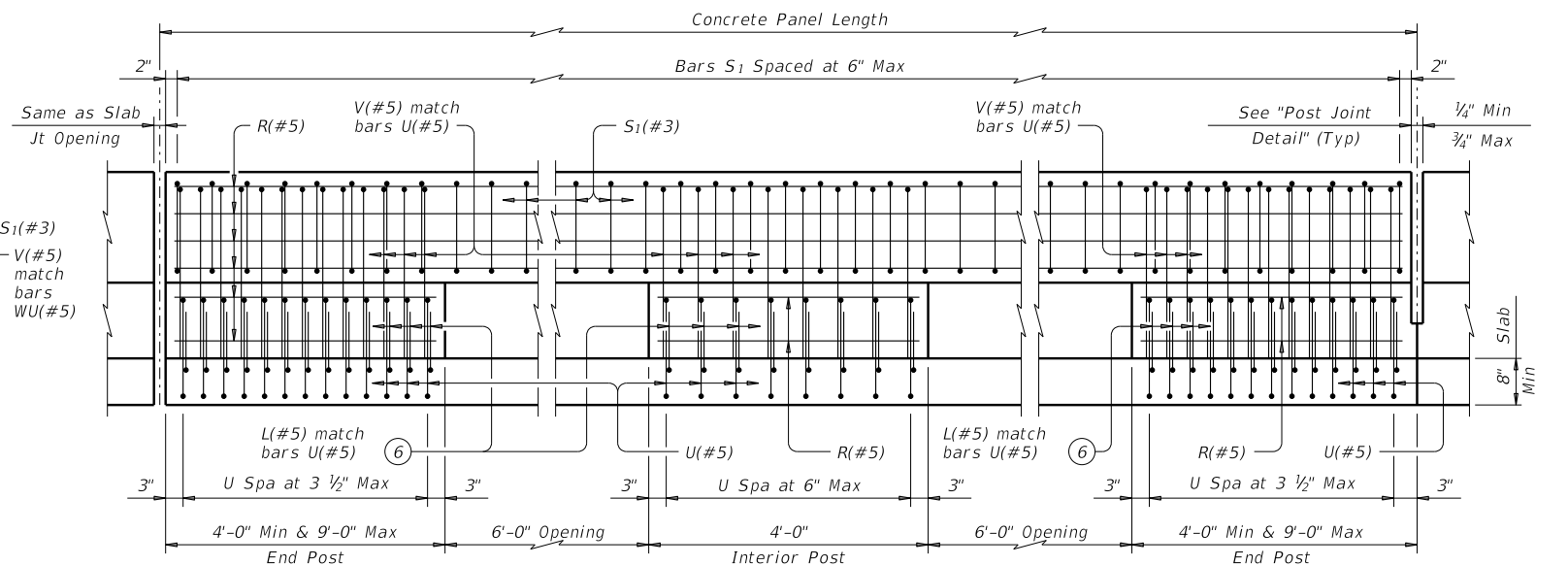
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REVISIONS	DIST	COUNTY	SHEET NO.	

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DATE:
FILE:



AT ABUT WINGWALL



ELEVATION SHOWING TYPICAL REINFORCING PLACEMENT

- (2) Wingwall Length minus 5'-0" (Varies)
- (6) Bars L(#5) are part of rail reinforcing and are included in unit price bid for railing. Space with Bars U. Bars L match slab bar cover. Bars L may be bundled with top slab reinforcing if spacing is equivalent.
- (7) Bars SU1(#3), SU2(#3) and WU(#5) not shown for clarity.

SHEET 2 OF 3



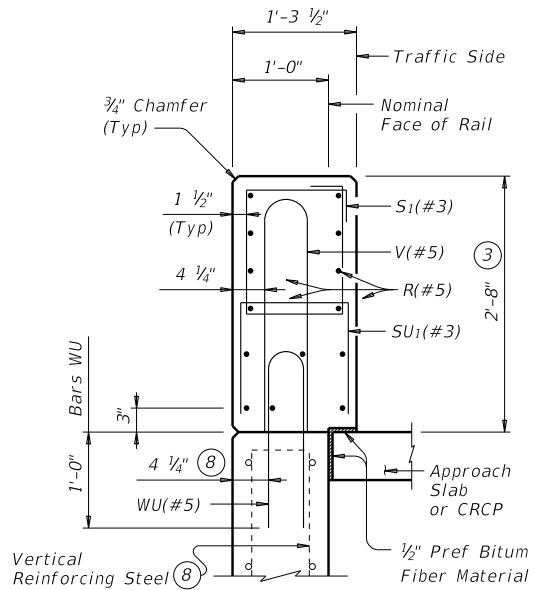
TRAFFIC RAIL

TYPE T223

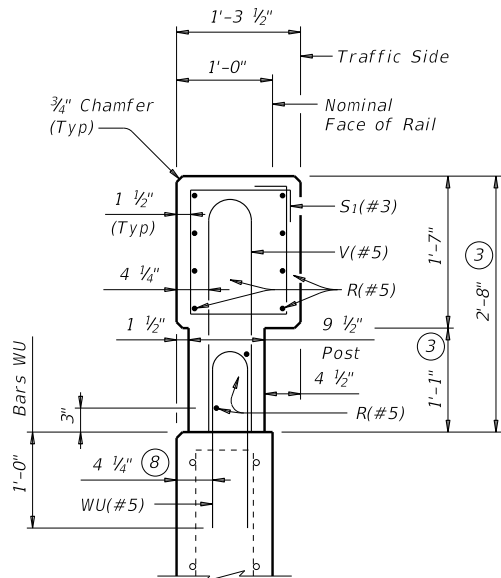
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REVISIONS	DIST	COUNTY	SHEET NO.	

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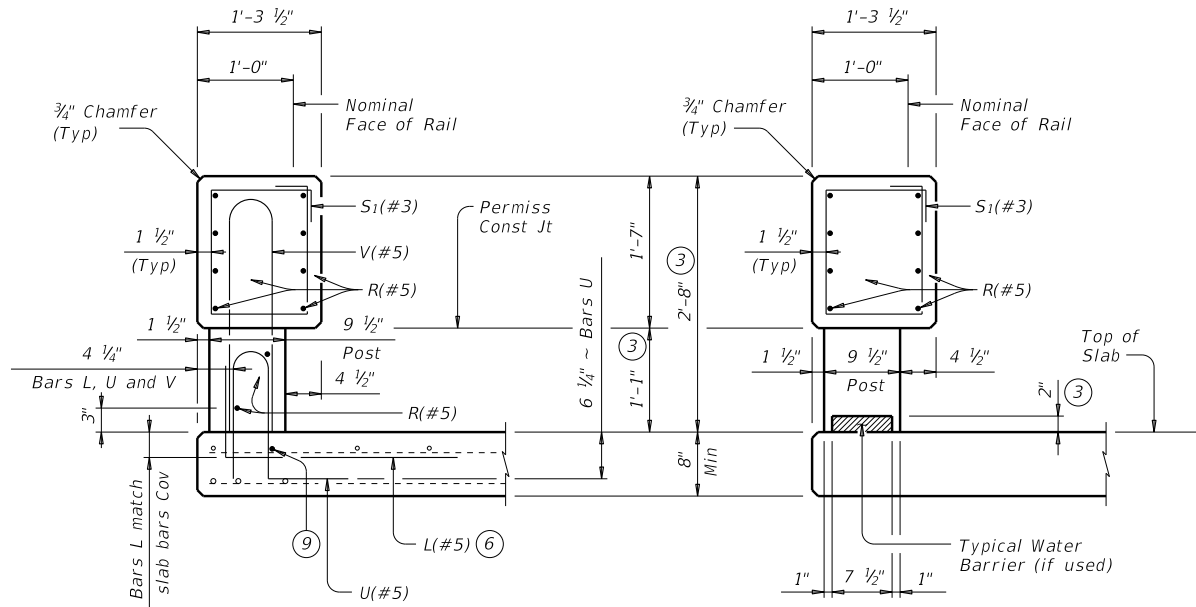
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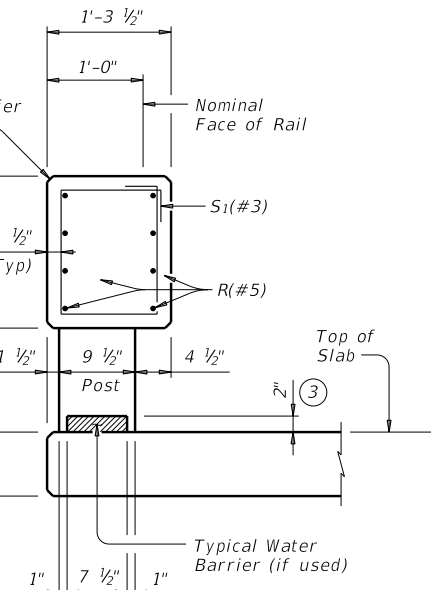
SECTION C-C
ON ABUTMENT WINGWALLS
OR CIP RETAINING WALLS



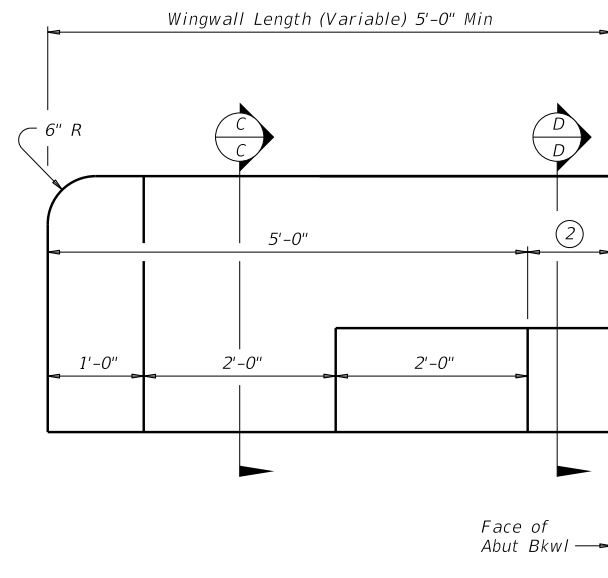
SECTION D-D
ON ABUTMENT WINGWALLS
OR CIP RETAINING WALLS



AT POST
ON BRIDGE SLAB



AT OPENING
ON BRIDGE SLAB



ELEVATION AT
ABUTMENT WINGWALL

CONSTRUCTION NOTES:

Face of rail and parapet must be vertical transversely unless otherwise shown in the plans or approved by the Engineer.

Provide water barriers at openings draining onto undercrossing roadways and sidewalks. They may be cast-in-place or precast in convenient lengths and bonded to the bridge deck with an approved epoxy cement.

MATERIAL NOTES:

All steel components except reinforcing must be galvanized unless otherwise shown on plans.

Provide Class "C" concrete. Provide Class "C" (HPC) if required elsewhere. Chamfer all exposed corners. Provide Grade 60 reinforcing steel.

Epoxy coat all rail reinforcement if slab bars are epoxy coated.

Deformed Welded Wire Reinforcing (WWR) (ASTM A1064) of equal size and spacing may be substituted for Bars U, V, and WU unless noted otherwise. Provide the same laps as required for reinforcing bars.

Provide bar laps, where required, as follows:
Uncoated ~ #5 = 1'-9"
Epoxy coated ~ #5 = 2'-7"

GENERAL NOTES:

This rail has been evaluated and accepted to be of equal strength to railings with like geometry, which have been crash tested to meet NCHRP Report 350 TL-4 criteria. This rail can be used for speeds of 50 mph and greater when a TL-3 rated guard fence transition is used. When a TL-2 rated guard fence transition is used, this rail can only be used for speeds of 45 mph and less.

Do not use this railing on bridges with expansion joints providing more than 5" movement.

Rail anchorage details shown on this standard may require modification for select structure types. See appropriate details elsewhere in plans for these modifications.

Shop drawings will not be required for this rail. Average weight of railing with no overlay is 358 plf.

② Wingwall Length minus 5'-0" (Varies)

③ Increase 2" for structures with overlay.

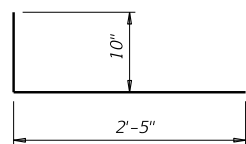
⑥ Bars L(#5) are part of rail reinforcing and are included in unit price bid for railing. Space with Bars U. Bars L match slab bar cover. Bars L may be bundled with top slab reinforcing if spacing is equivalent.

⑧ When vertical reinforcing has closer clear cover over horizontal reinforcing in abutment wingwalls on traffic side of wall, move the horizontal wingwall/retaining wall reinforcing to the inside of Bars WU where bars conflict.

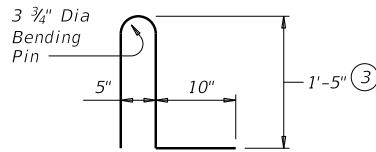
⑨ Top longitudinal slab bar may be adjusted laterally 3" plus or minus to tie reinforcing.

⑩ At the Contractor's option, Bars V may be replaced by extending Bars U to 2'-5" above the roadway surface without overlay.

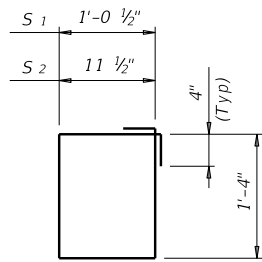
Cover dimensions are clear dimensions, unless noted otherwise.
Reinforcing bar dimensions shown are out-to-out of bar.



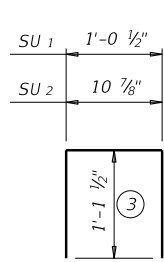
BARS L (#5)



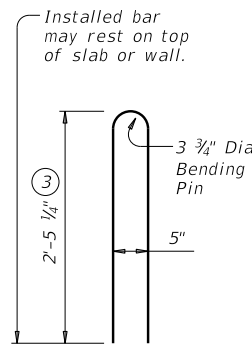
BARS U (#5) ⑩



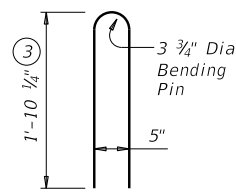
BARS S (#3)



BARS SU (#3)



BARS V (#5) ⑩



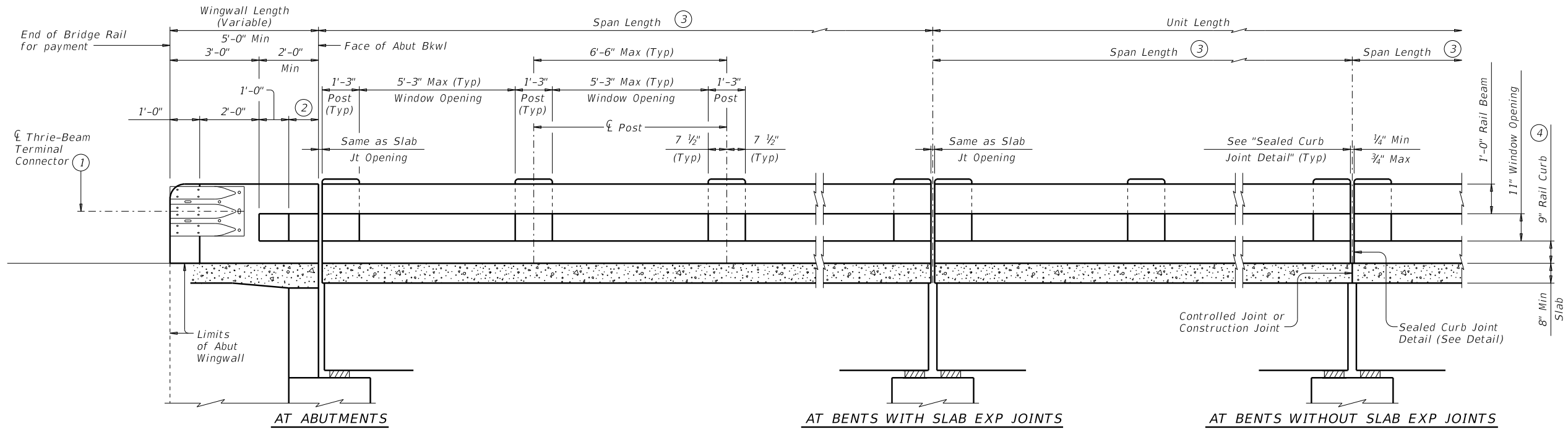
BARS WU (#5)

SHEET 3 OF 3

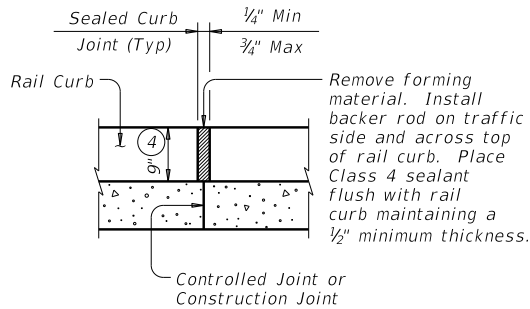
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TYPE T223									
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REVISIONS									
		DIST		COUNTY				SHEET	

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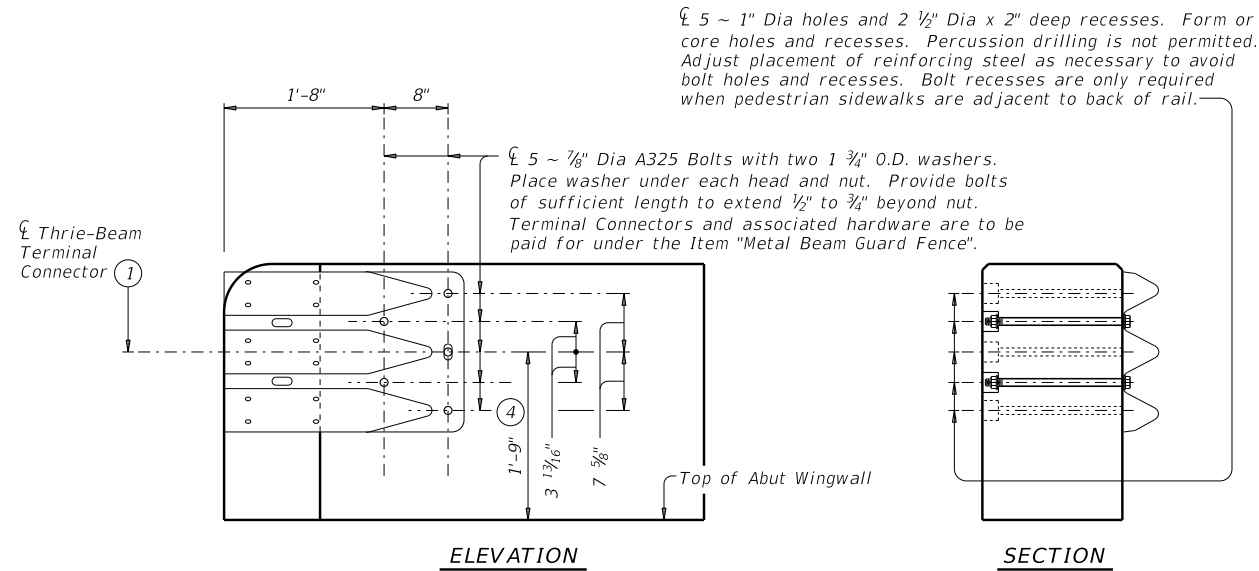


ROADWAY ELEVATION OF RAIL



SEALED CURB JOINT DETAIL

Provide at all interior bents without slab expansion joints.



TERMINAL CONNECTION DETAILS

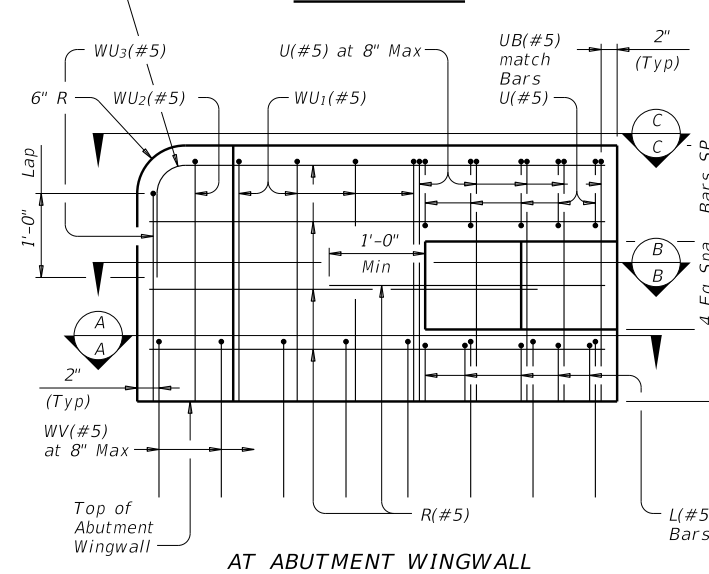
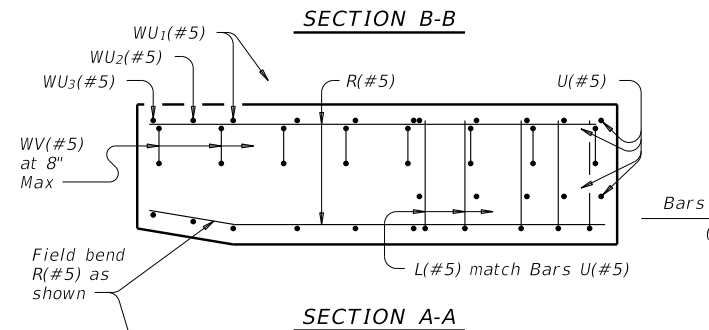
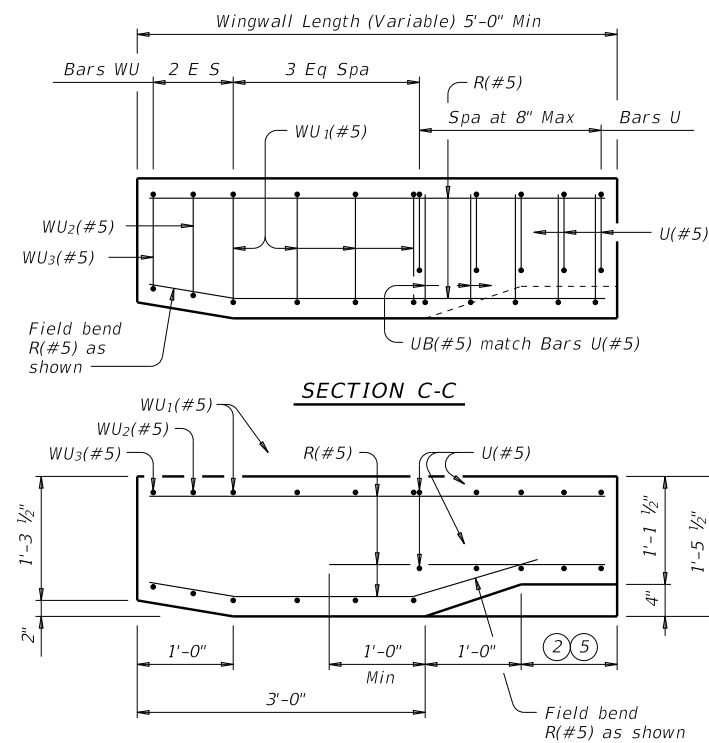
(Special forming details on parapet not shown for clarity. See "Elevation Showing Typical Reinforcing Placement".)

- ① Terminal Connectors and associated hardware are to be paid for under the Item "Metal Beam Guard Fence". Attach Metal Beam Guard Fence Transitions to the bridge rail and extend along the embankment unless otherwise shown in the plans.
- ② Wingwall length minus 4'-0" (Variable) 1'-0" Min.
- ③ Span length of rail must always have a minimum of three posts. Spans always have a post located at each end of span. Space posts equally within a span unless directed otherwise by the Engineer.
- ④ Increase 2" for structures with 2" Max overlay.

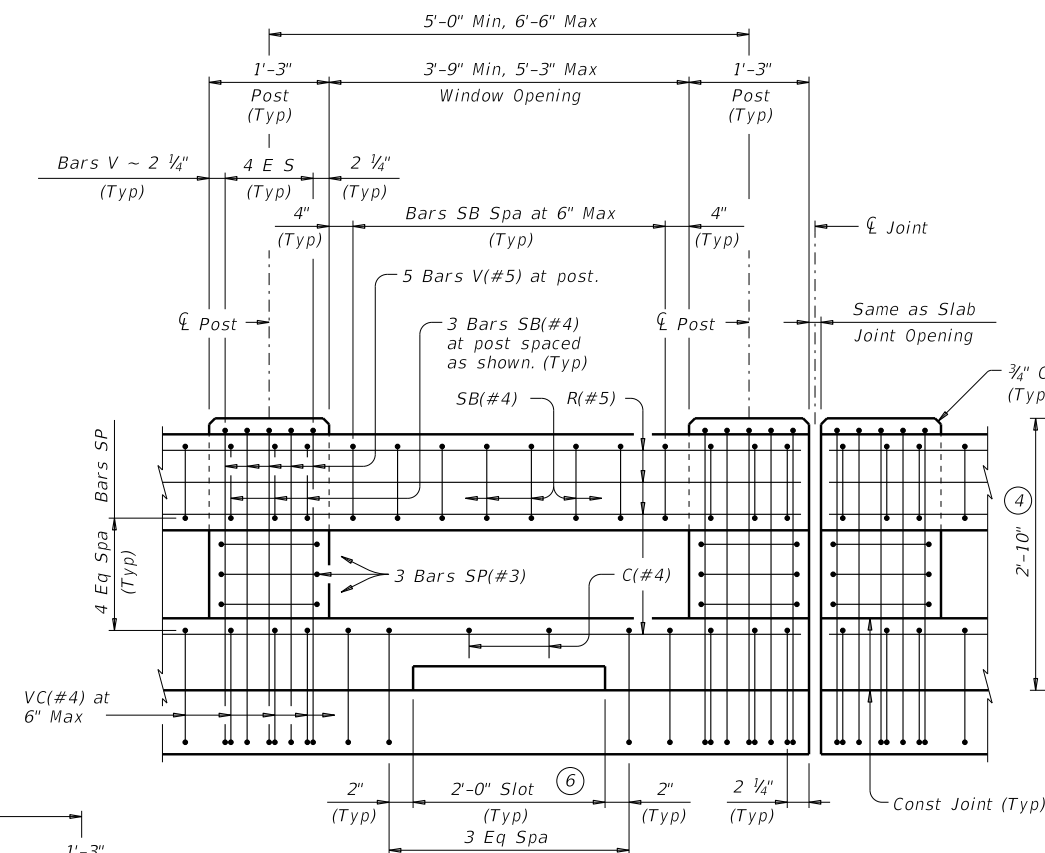
SHEET 1 OF 3

 Texas Department of Transportation				Bridge Division Standard	
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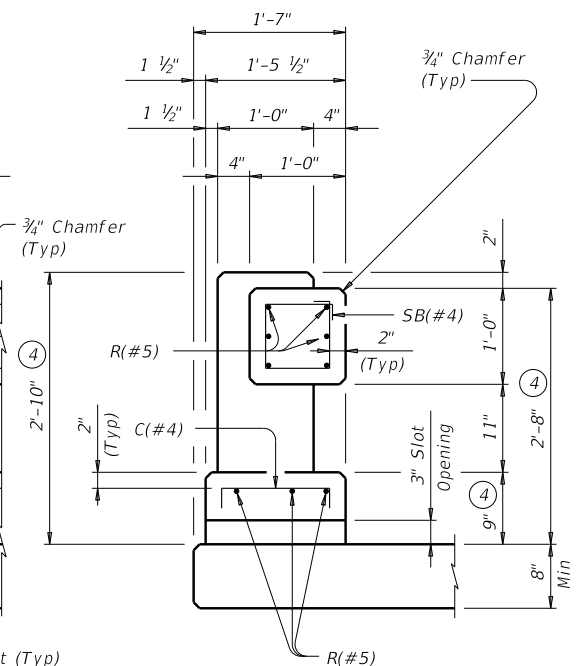
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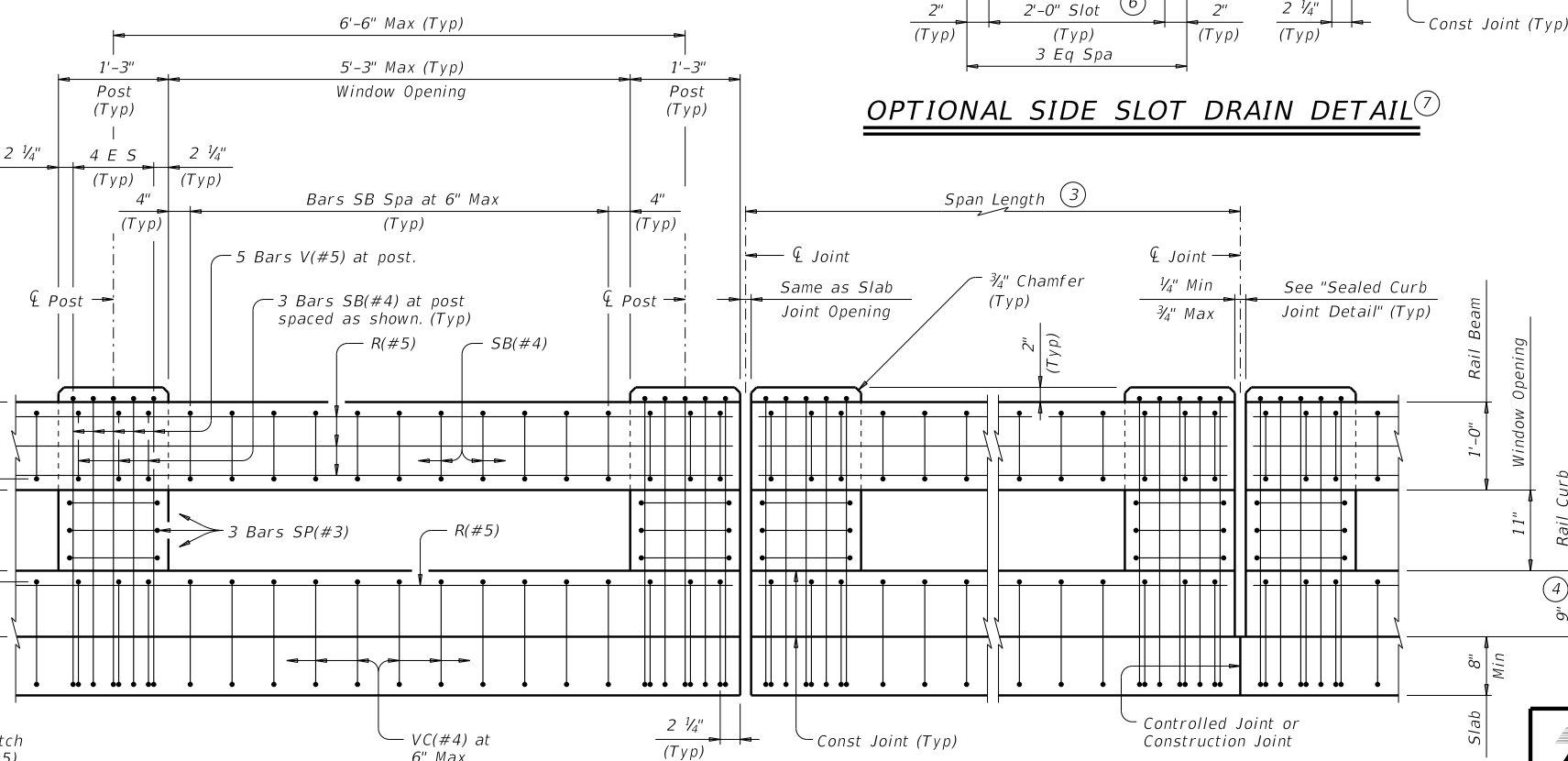
- ② Wingwall length minus 4'-0" (Variable) 1'-0" Min.
- ③ Span length of rail must always have a minimum of three posts. Spans always have a post located at each end of span. Space post equally within a span unless directed otherwise by the Engineer.
- ④ Increase 2" for structures with 2" Max overlay.
- ⑤ Bars L, U and UB are spaced at 8" Max.
- ⑥ Side Slot Drains must be centered between rail post.
- ⑦ Side Slot Drains must be centered between rail posts within the limits shown. Side Slot Drains may be used where shown elsewhere on the plans or as directed by the Engineer. Do not place drains over railroad tracks, lower roadways, or sidewalks. When this rail is used as a separator between a roadway surface and a sidewalk surface, side drain slots are not permitted.



OPTIONAL SIDE SLOT DRAIN DETAIL⁽⁷⁾



SECTION
THRU OPTIONAL
SIDE SLOT DRAIN



ELEVATION SHOWING TYPICAL REINFORCING PLACEMENT

AT BENTS WITHOUT SLAB EXP JOINTS

SHEET 2 OF 3



Texas Department of Transportation

**Bridge
Division
Standard**

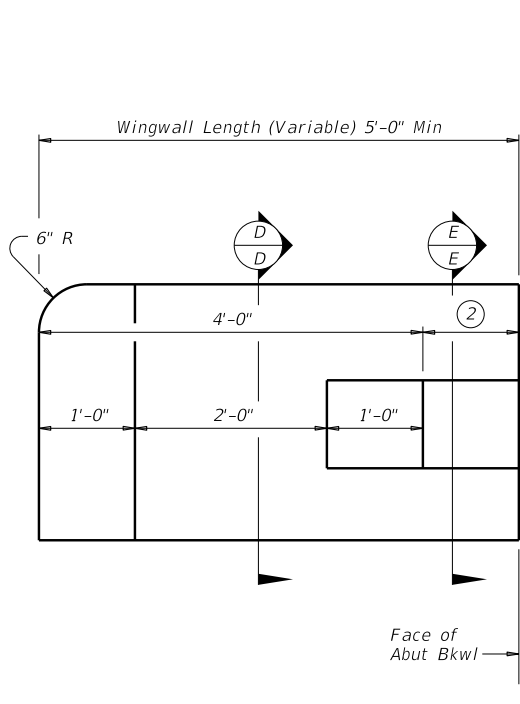
TRAFFIC RAIL

TYPE T66

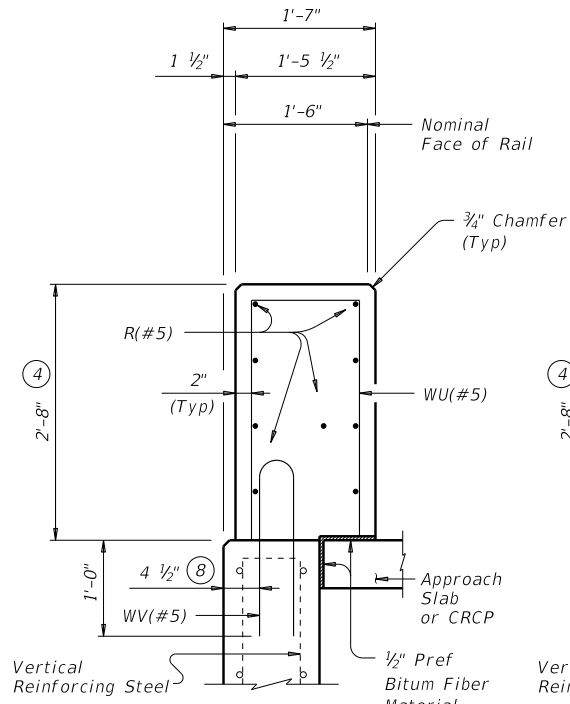
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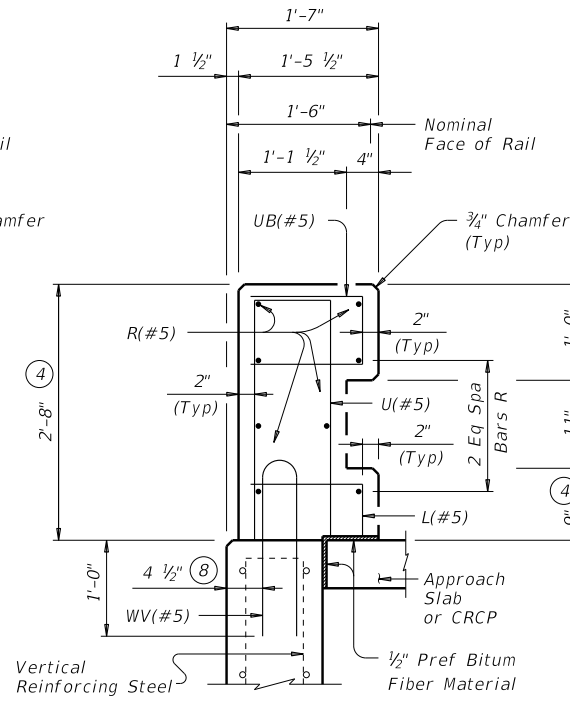
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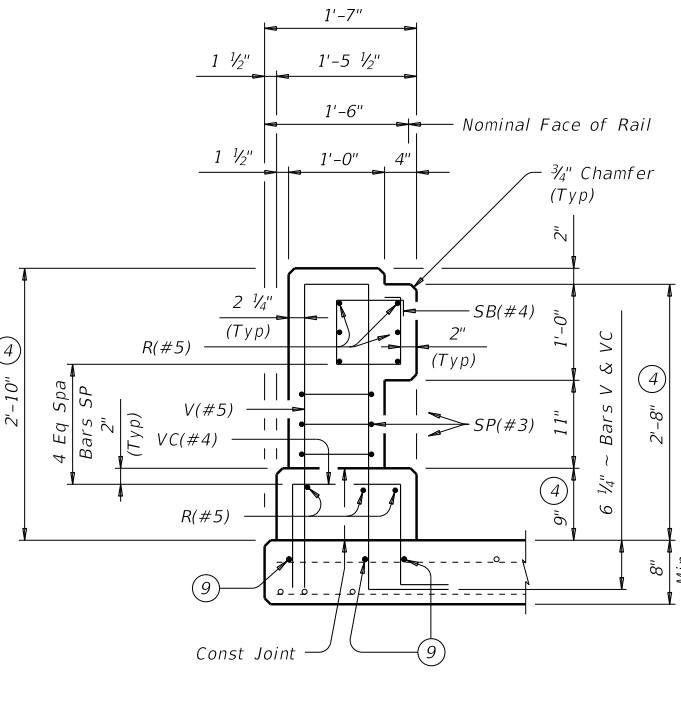
**ELEVATION AT
ABUTMENT WINGWALL**



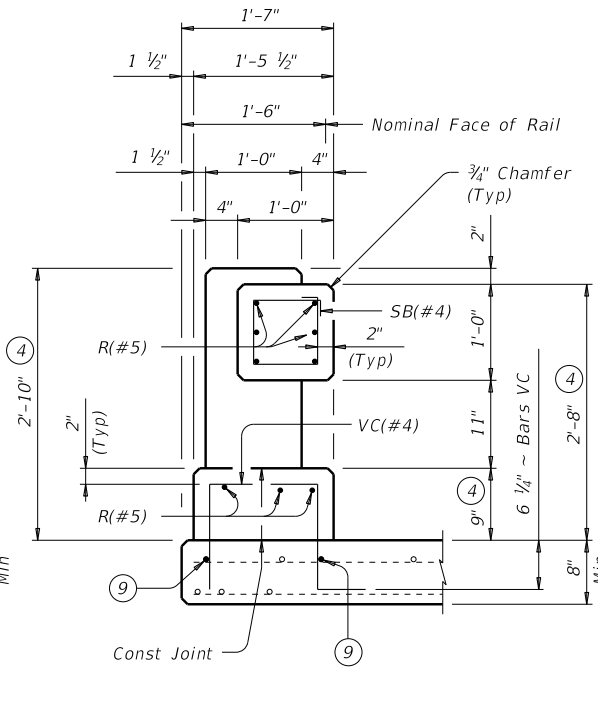
**SECTION D-D
ON ABUTMENT WINGWALLS
OR CIP RETAINING WALLS**



**SECTION E-E
ON ABUTMENT WINGWALLS
OR CIP RETAINING WALLS**



ON BRIDGE SLAB AT POST



ON BRIDGE SLAB AT WINDOW

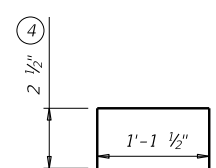
SECTIONS THRU RAIL

- ② Wingwall length minus 4'-0" (Variable) 1'-0" Min.
- ④ Increase 2" for structures with 2" Max overlay.
- ⑧ 5 1/4" when vertical reinforcing has closer clear cover over horizontal reinforcing in abutment wingwalls or retaining walls on traffic side of wall.
- ⑨ Top longitudinal slab bar may be adjusted laterally 3" plus or minus to tie reinforcing.

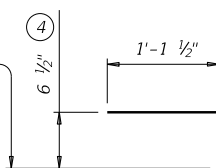
CONSTRUCTION NOTES:
The back of railing must be vertical unless otherwise shown on the plans or approved by the Engineer.
Clear cover is 2" minimum, unless shown otherwise.

MATERIAL NOTES:
Galvanize all steel components except reinforcing steel unless otherwise shown on plans.
Provide Class "C" concrete. Provide Class "C" (HPC) if required elsewhere.
Provide Grade 60 reinforcing steel.
Provide bar laps, where required, as follows:
Uncoated ~ #5 = 1'-9"
Epoxy coated ~ #5 = 2'-7"
Epoxy coat all rail reinforcing if slab bars are epoxy coated.

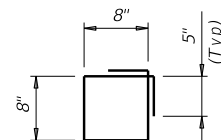
GENERAL NOTES:
This rail has been evaluated and accepted to be of equal strength to railings with like geometry, which have been crash tested to meet NCHRP Report 350 TL-3 criteria. This rail can be used for speeds of 50 mph and greater when a TL-3 rated guard fence transition is used. When a TL-2 rated guard fence transition is used, this rail can only be used for speeds of 45 mph and less.
This railing cannot be used on bridges with expansion joints providing more than 5" movement.
Rail anchorage details shown on this standard may require modification for select structure types. See appropriate details elsewhere in plans for these modifications.
Shop drawings are not required for this rail.
Average weight of railing with no overlay is 355 plf.



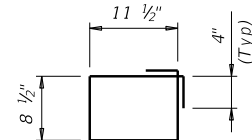
BARS C (#4)



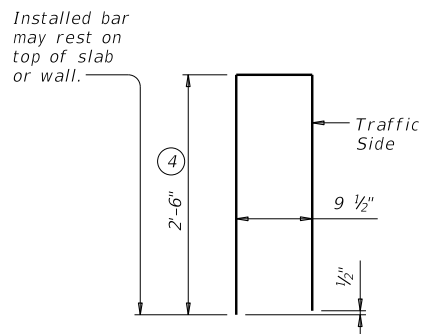
BARS L (#5)



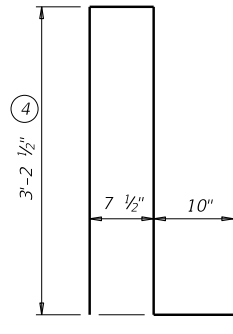
BARS SB (#4)



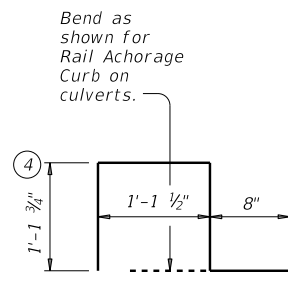
BARS SP (#3)



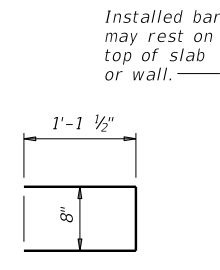
BARS U (#5)



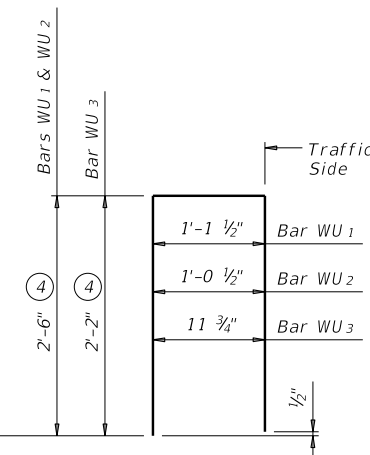
BARS V (#5)



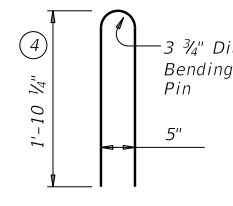
BARS VC (#4)



BARS UB (#5)



BARS WU (#5)



BARS WV (#5)

Cover dimensions are clear dimensions, unless noted otherwise.
Reinforcing bar dimensions shown are out-to-out of bar.

SHEET 3 OF 3



Texas Department of Transportation

Bridge Division Standard

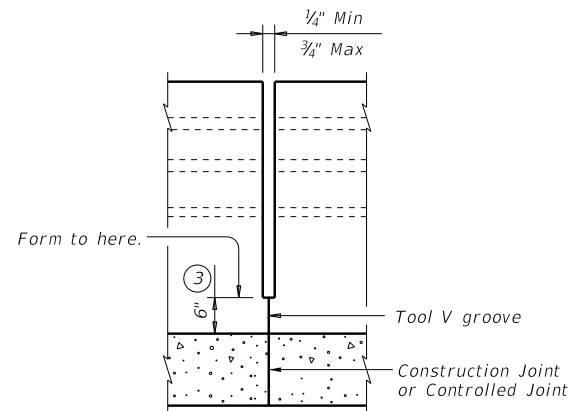
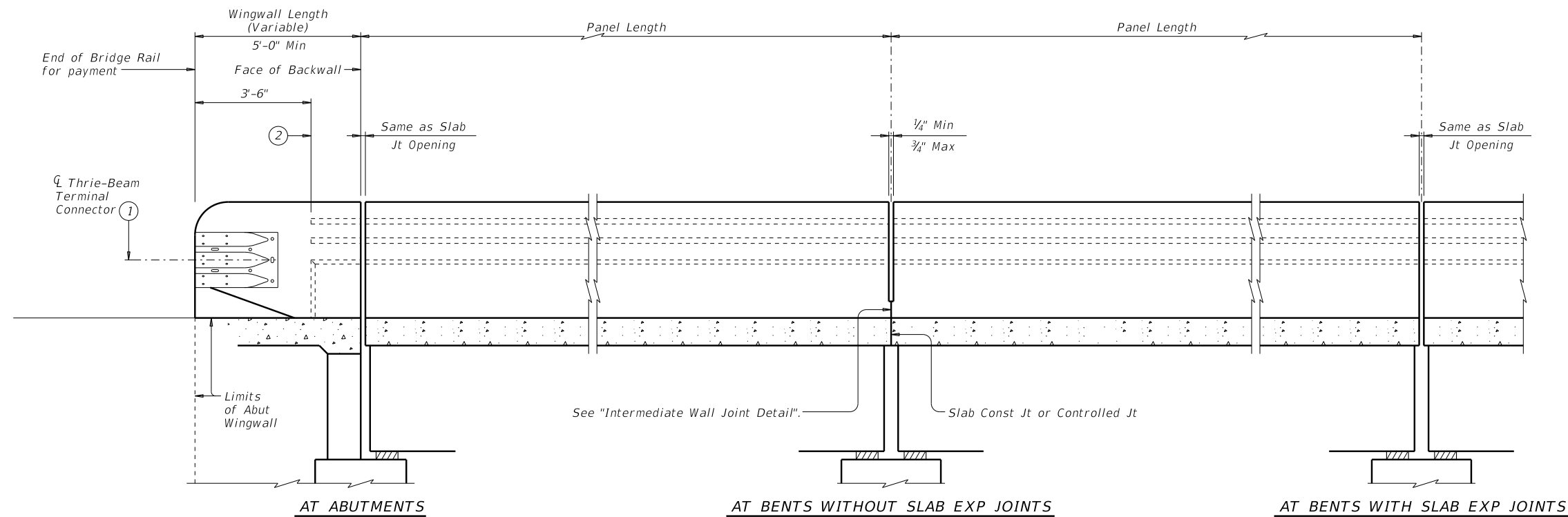
TRAFFIC RAIL

TYPE T66

FILE: rlst0012.dgn	DN: TxDOT	CK: TxDOT	DW: JTR	CK: JMH
©TxDOT July 2014	CONT	SECT	JOB	HIGHWAY
REVISIONS	DIST		COUNTY	SHEET NO.

DISCLAIMER:
The use of this standard is governed by the "Texas Engineering Practice Act". No warranty of any kind is made by TxDOT for any purpose whatsoever. TxDOT assumes no responsibility for the conversion of this standard to other formats or for incorrect results or damages resulting from its use.

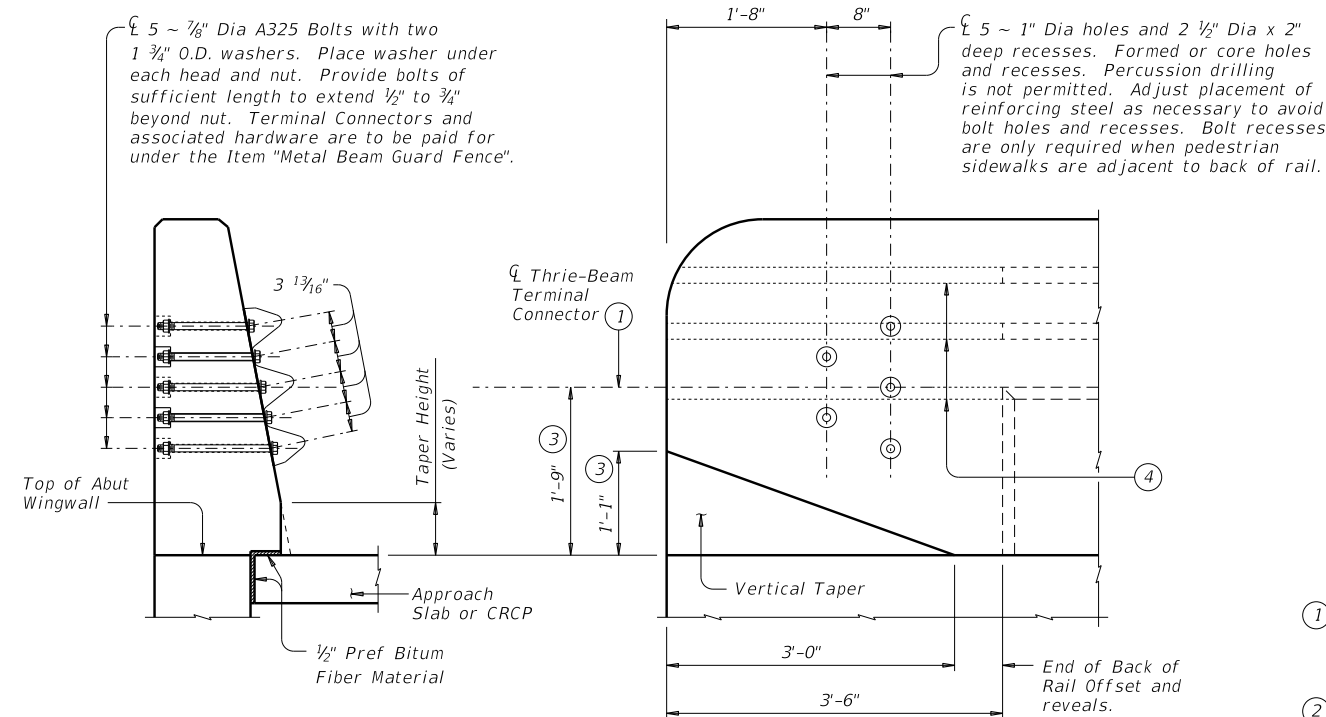
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FILE:



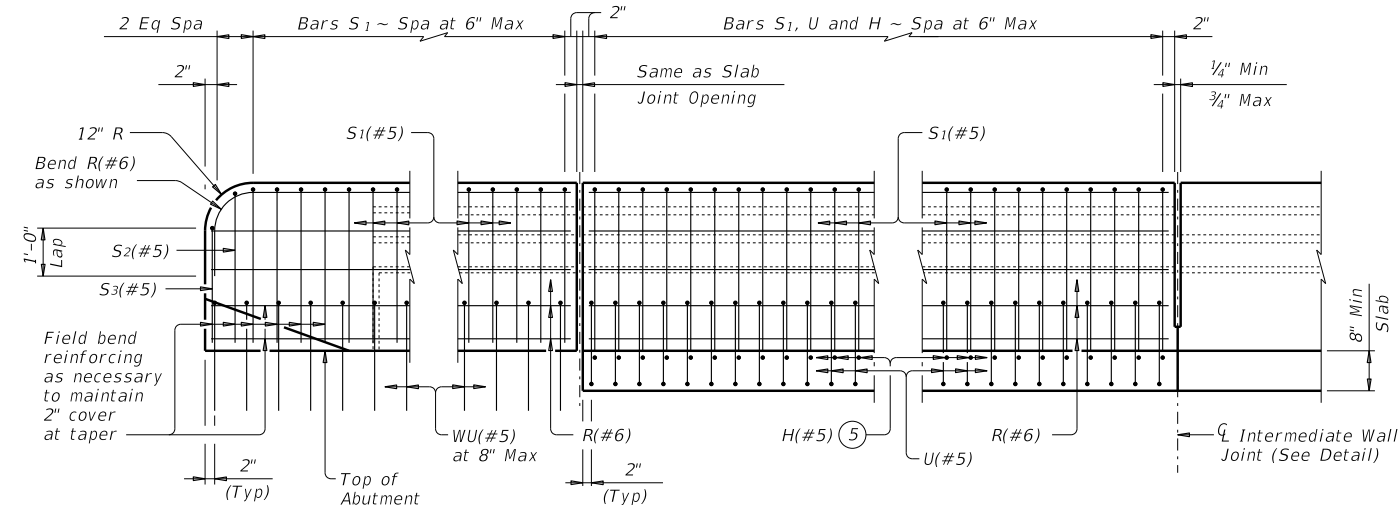
INTERMEDIATE WALL JOINT DETAIL

Provide at all Interior Bents without slab expansion joints.

ROADWAY ELEVATION OF RAIL



SECTION ELEVATION TERMINAL CONNECTION DETAILS



ELEVATION SHOWING TYPICAL REINFORCING PLACEMENT

- 1 Terminal Connectors and associated hardware are to be paid for under the Item "Metal Beam Guard fence". Attach Metal Beam Guard Fence Transitions to the bridge rail and extend along the embankment unless otherwise shown in the plans.
- 2 End back of rail offset and reveals. See "Terminal Connection Details".
- 3 Increase 2" for structures with Overlay.
- 4 Back of rail offset and reveals may, with Engineer's approval, be continued to end of the railing.
- 5 Bars H(#5) are part of rail reinforcing and are included in unit price bid for railing. Extend Bars H 2'-0" Min past L of beam/girder. Space with Bars U. Bars H match slab bar cover. Bars H may be bundled with top slab reinforcing if spacing is equivalent. Omit Bars H when top slab reinforcement is spaced less than 4".

SHEET 1 OF 3



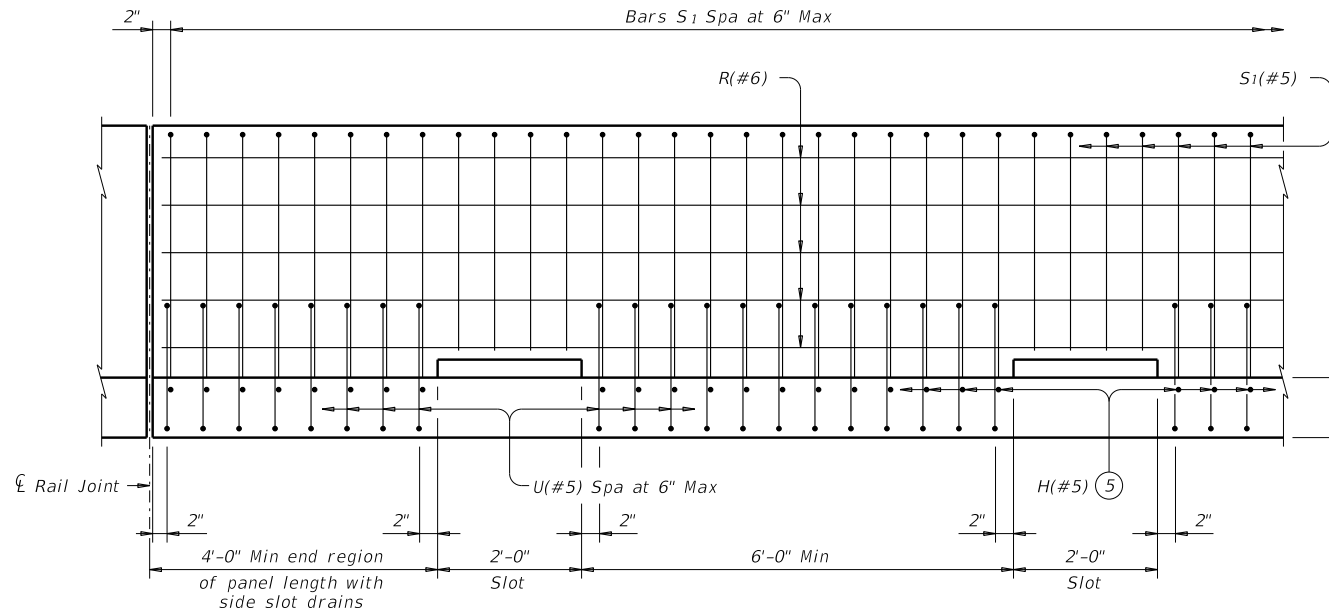
TRAFFIC RAIL

TYPE T80SS

FILE: r1st0016.dgn	DN: TxDOT	CK: TxDOT	DW: JTR	CK: JMH
©TxDOT July 2014	CONT	SECT	JOB	HIGHWAY
REVISIONS				
	DIST	COUNTY		SHEET NO.

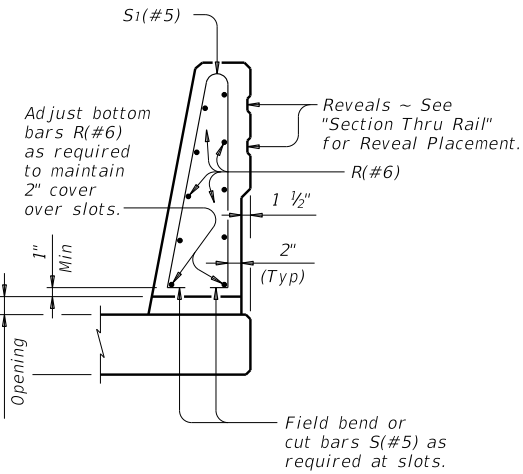
DISCLAIMER:
The use of this standard is governed by the "Texas Engineering Practice Act". No warranty of any kind is made by TxDOT for any purpose whatsoever. TxDOT assumes no responsibility for the conversion of this standard to other formats or for incorrect results or damages resulting from its use.

DATE:
FILE:

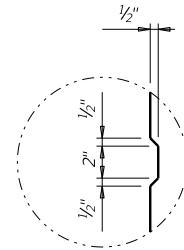


OPTIONAL SIDE SLOT DRAIN DETAIL

Note: Side Slot Drains may be used where shown elsewhere on the plans or as directed by the Engineer. Do not place drains over railroad tracks, lower roadways, or sidewalks. When this rail is used as a separator between a roadway surface and a sidewalk surface, side drain slots will not be permitted.

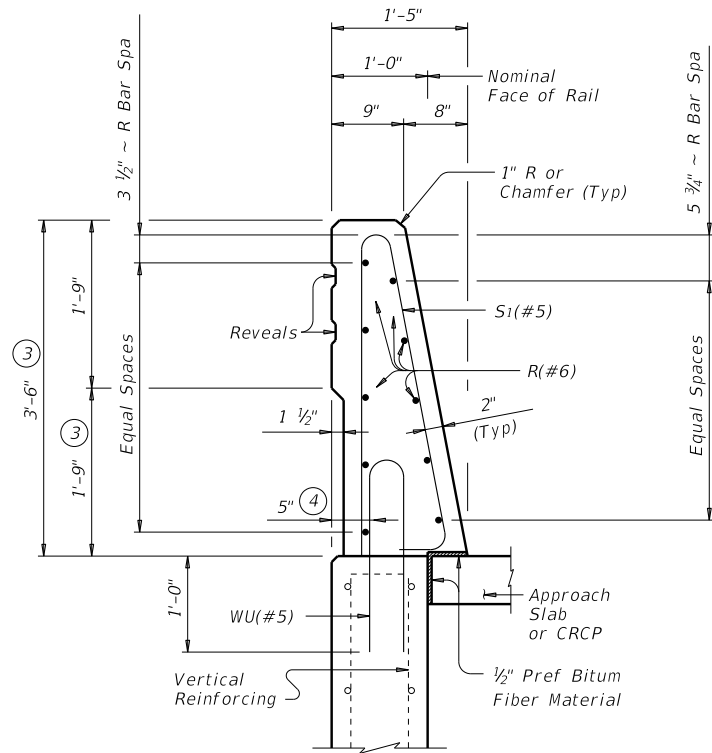


SECTION THRU OPTIONAL SIDE SLOT DRAIN

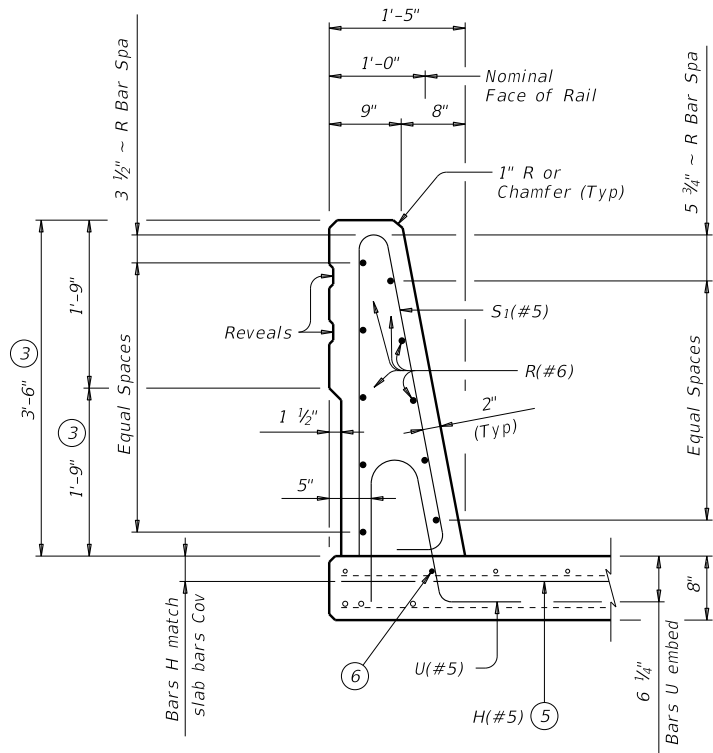


TYPICAL REVEAL DETAIL

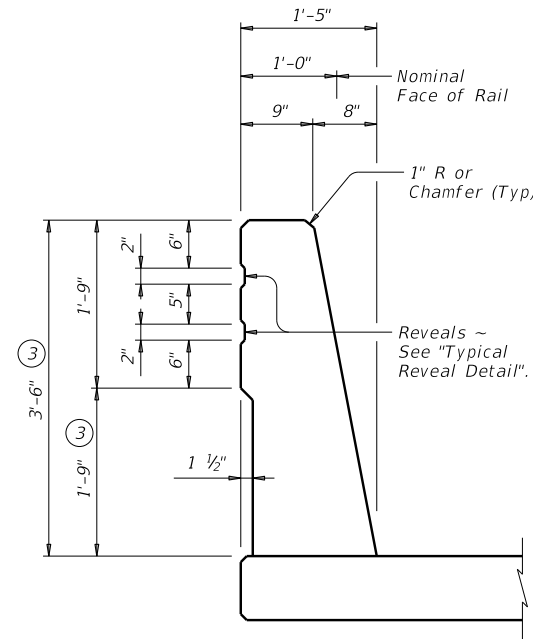
- ③ Increase 2" for structures with Overlay.
- ④ 5 1/4" when vertical reinforcing has closer clear cover over horizontal reinforcing in abutment wingwalls on traffic side of wall.
- ⑤ Bars H(#5) are part of rail reinforcing and are included in unit price bid for railing. Extend Bars H 2'-0" Min past $\frac{1}{4}$ of beam/girder. Space with Bars U. Bars H match slab bar cover. Bars H may be bundled with top slab reinforcing if spacing is equivalent. Omit Bars H when top slab reinforcement is spaced less than 4".
- ⑥ Top longitudinal slab bar may be adjusted laterally 3" plus or minus to tie reinforcing.
- ⑦ Mounting this rail to retaining walls requires additional details not covered by this standard.



ON ABUTMENT WINGWALLS ⑦



ON BRIDGE SLAB SECTIONS THRU RAIL ⑦



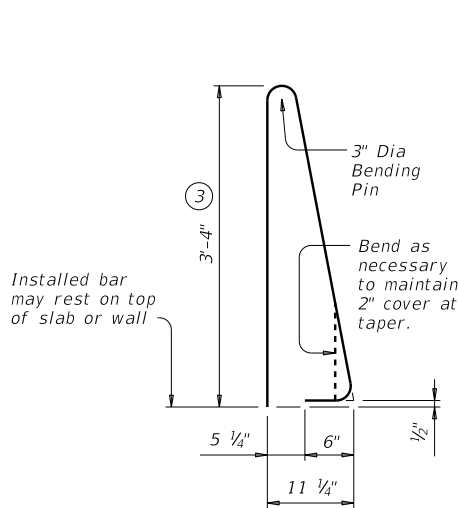
REVEAL PLACEMENT (Showing location of Reveals)

SHEET 2 OF 3

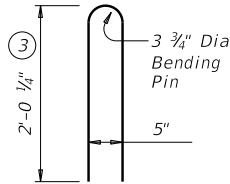
 Texas Department of Transportation				Bridge Division Standard	
TRAFFIC RAIL					
TYPE T80SS					
FILE: r1std016.dgn		DN: TxDOT	CK: TxDOT	DW: JTR	CK: JMH
©TxDOT July 2014		CONT	SECT	JOB	HIGHWAY
REVISIONS					
		DIST	COUNTY		SHEET NO.

DISCLAIMER:
The use of this standard is governed by the "Texas Engineering Practice Act". No warranty of any kind is made by TxDOT for any purpose whatsoever. TxDOT assumes no responsibility for the conversion of this standard to other formats or for incorrect results or damages resulting from its use.

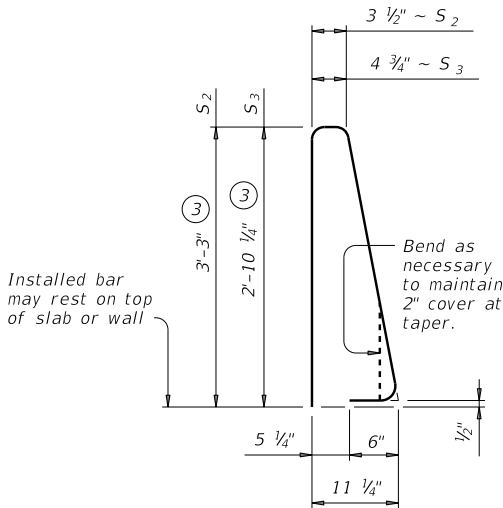
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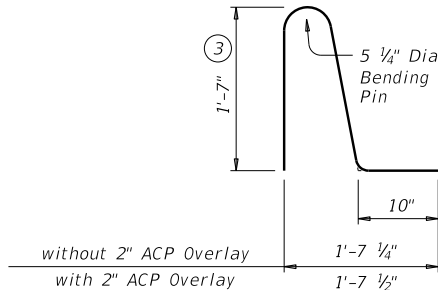
BARS S_1 (#5)



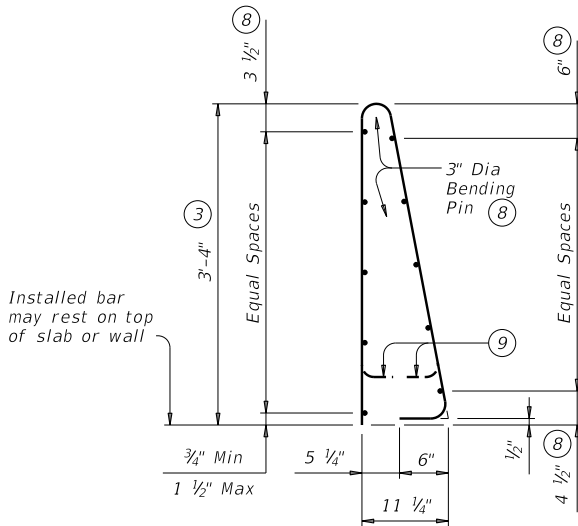
BARS WU (#5)



BARS S_{2-3} (#5)



BARS U (#5)



OPTIONAL WELDED WIRE
REINFORCEMENT (WWR)

DESCRIPTION	LONGITUDINAL WIRES	VERTICAL WIRES
Minimum (Cumulative Total) Wire Area	3.770 Sq In.	0.530 Sq In. per Ft
Minimum	No. of Wires 10	Spacing 4"
Maximum	14	8"
Maximum Wire Size Differential	The smaller wire must have an area of 40% or more of the larger wire.	

- ③ Increase 2" for structures with Overlay.
⑧ No longitudinal wires may be within bend area.
⑨ Bend or cut as required to clear drain slots.

CONSTRUCTION NOTES:

This railing may be constructed with slip-forms when approved by the Engineer, with equipment approved by the Engineer. Provide sensor control for both line and grade. Tack welding to provide bracing for slip-form operations is acceptable. Welding can be performed at a minimum spacing of 3 ft between the cage and the anchorage. It is permissible to weld to U, WU and S bars at any location on the cage. If increased bracing is needed, additional anchorage devices must be added and welding must be performed in the upper two thirds of the cage. The back of railing must be vertical unless otherwise shown on the plans or approved by the Engineer.

MATERIAL NOTES:

Galvanize all steel components except reinforcing steel unless otherwise shown on plans. Provide Class "C" concrete. Provide Class "C" (HPC) if required elsewhere. Provide Grade 60 reinforcing steel. Epoxy coat all rail reinforcement if slab bars are epoxy coated. Deformed Welded Wire Reinforcement (WWR) (ASTM A1064) of equal size and spacing may be substituted for Bars U and WU unless noted otherwise. Deformed WWR (ASTM A1064) may be substituted for Bars R and S, as shown. Combinations of reinforcing steel and WWR or configurations of WWR other than shown are permitted if conditions in the table are satisfied. Provide the same laps as required for reinforcing bars. Provide bar laps, where required, as follows:
Uncoated ~ #6 = 2'-1"
Epoxy coated ~ #6 = 3'-1"

GENERAL NOTES:

This rail has been evaluated and approved to be of equal strength to railings with like geometry, which have been crash tested to meet NCHRP Report 350 TL-5 criteria. This rail can be used for speeds of 50 mph and greater when a TL-3 rated guard fence transition is used. Do not use this railing on bridges with expansion joints providing more than 5" movement. Rail anchorage details shown on this standard may require modification for select structure types. See appropriate details elsewhere in plans for these modifications. Shop drawings will not be required for this rail. Average weight of railing is 533 plf.

Cover dimensions are clear dimensions, unless noted otherwise.
Reinforcing bar dimensions shown are out-to-out of bar.

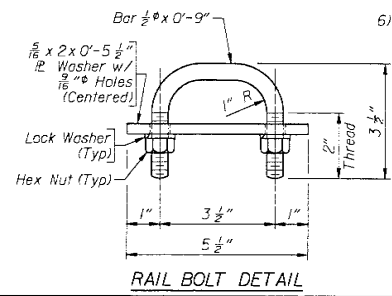
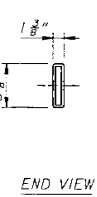
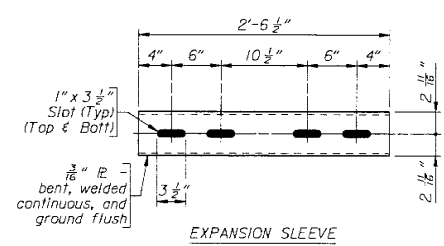
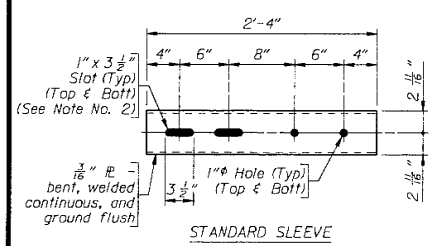
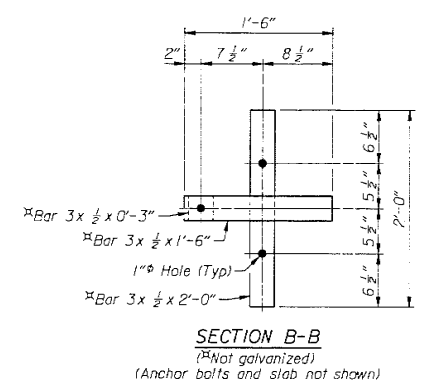
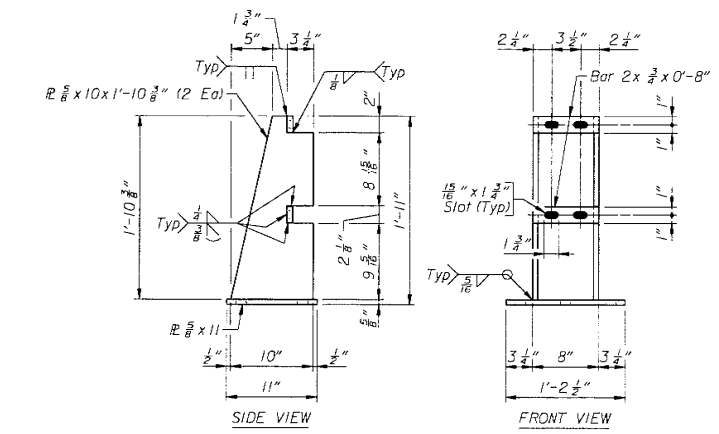
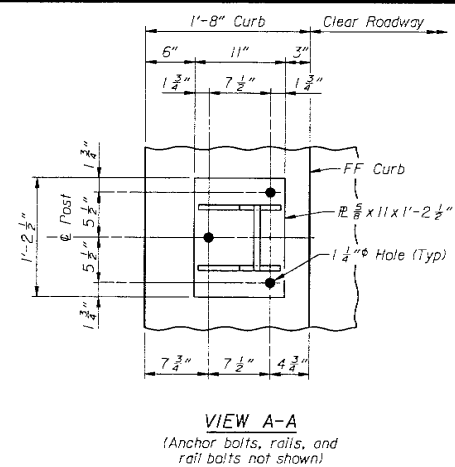
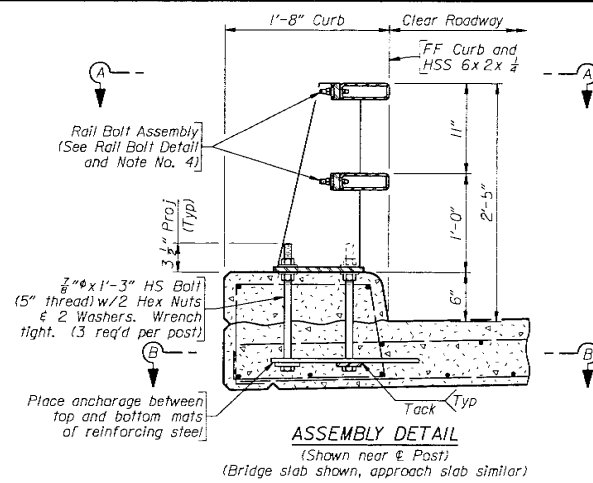
SHEET 3 OF 3



TRAFFIC RAIL

TYPE T80SS

FILE: r1st0016.dgn	DN: TxDOT	CK: TxDOT	DW: JTR	CK: JMH
©TxDOT July 2014	CONT	SECT	JOB	HIGHWAY
REVISIONS				
	DIST	COUNTY		SHEET NO.

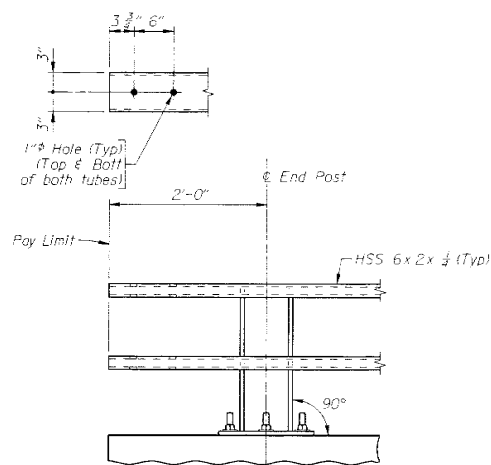


PLAN
(X posts req'd on bridge)
(X posts req'd on approach slabs)

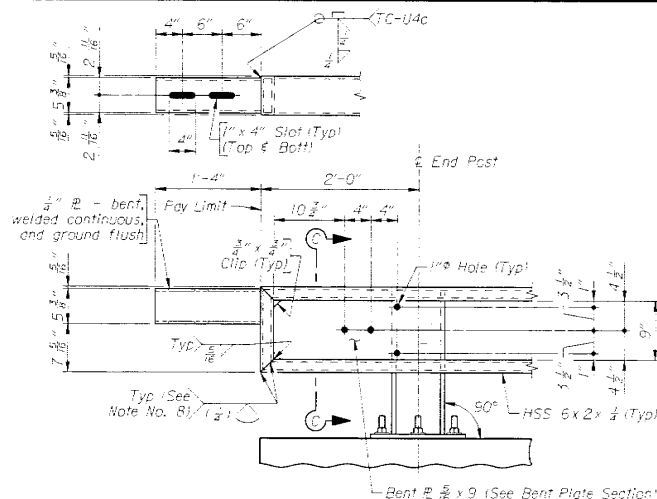
- Note:**
- 1) Ensure the expansion splice is located in the railing panel which passes over the bridge expansion joint as indicated on the plan.
 - 2) Slots may be omitted in standard sleeves where bolts are required on one side of splice only.
 - 3) Anchor bolts may be tack welded to anchorage (Shop or field).
 - 4) At post locations, drill two 1 1/8" holes in the rails to receive rail bolts (Shop or field). See Post Details for hole spacing.
 - 5) Before installing rails, paint cut, drilled, or otherwise damaged surface areas of the railing components with two coats of zinc rich paint conforming to the requirements of ASTM A 780.
 - 6) After installing the rails, paint exposed bolt threads with two coats of zinc rich paint conforming to the requirements of ASTM A 780.

WYOMING DEPARTMENT OF TRANSPORTATION			
BRIDGE PROGRAM			
BRIDGE RAILING DETAILS			
TL3_br1.dgn			
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APPROVED	DESIGN	DETAIL	DATE
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	X	X	X
Drwg. No. X	Sheet X of X		

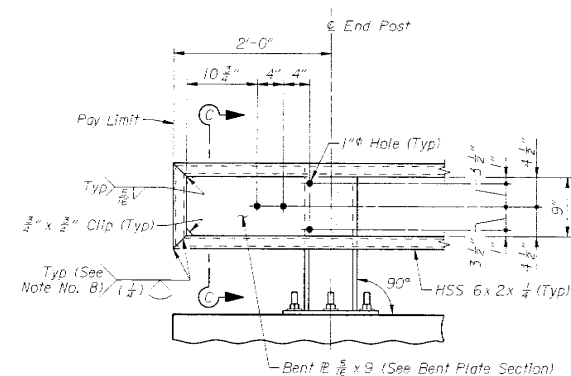
TL-3



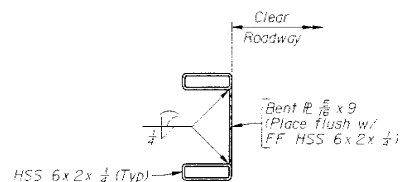
ELEVATION AT TERMINAL TYPE ①
(Box beam guardrail connection)



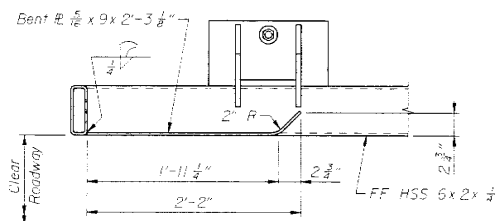
ELEVATION AT TERMINAL TYPE ②
(Box beam guardrail connection, interstate exit end only)
(With provision for temporary corrugated beam guardrail connection)



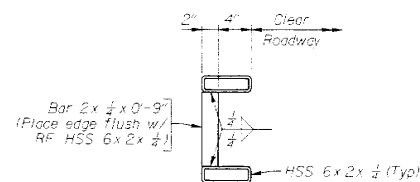
ELEVATION AT TERMINAL TYPE ③
(Corrugated beam guardrail connection
or no guardrail connection)



SECTION C-C

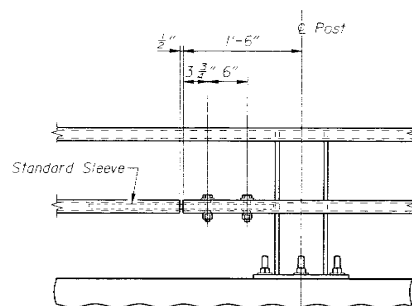


BENT PLATE SECTION
(Top rail not shown)
(Req'd. of Type (2) and (3) Terminating)

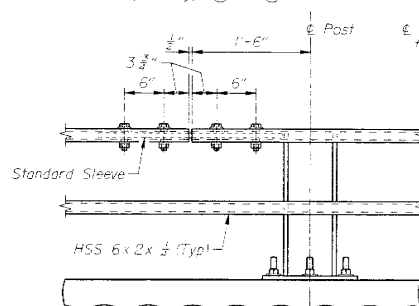


BRACE BAR DETAIL
(See Note No. 7)

- Note: 1) Either top or bottom rail in terminal section may be the longer rail.
- 2) Ensure each rail length is continuous over a minimum of two posts. Railing that is part of a type ② or ③ terminal is continuous if either the top or bottom rail in the terminal is continuous over a minimum of two posts.
- 3) In rehabilitation work, ensure railing that cannot feasibly be made continuous over a minimum of two posts has a double-bolted splice.
- 4) Splices may be located on either side of post.
- 5) Not more than one splice is permitted per side of post, except at expansion splices.
- 6) Do not shop splice rails.
- 7) Ensure a brace bar is placed 2'-0" from the splice end of the shorter tube at type ② and ③ terminals.
- 8) Ensure the fabricator prepares a sample of the indicated joint and it is macroetched to demonstrate that the required effective throat is achieved.

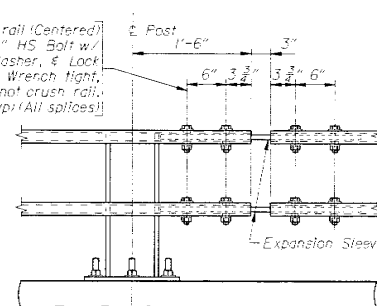


STANDARD SPLICE
(Top or bottom rail)



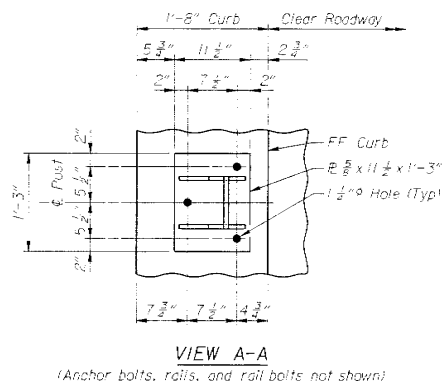
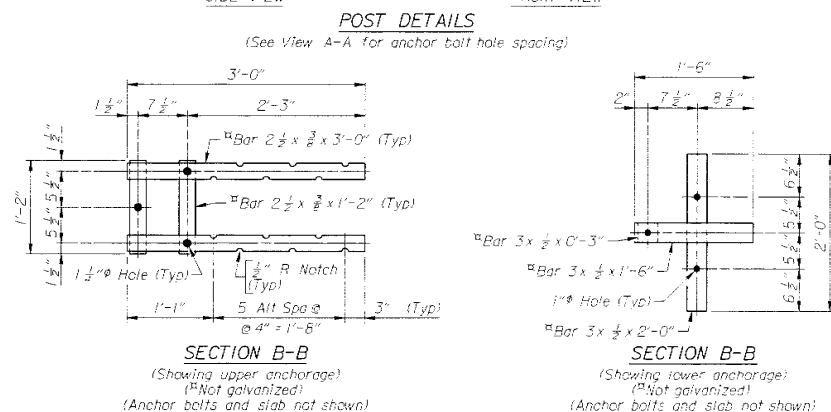
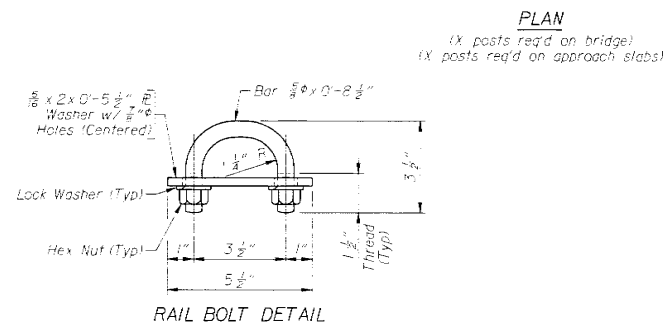
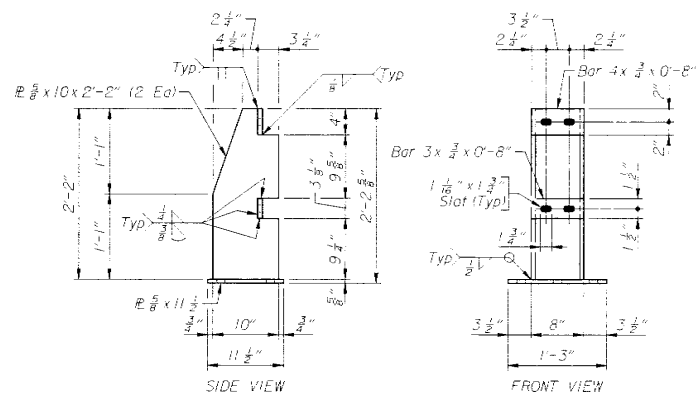
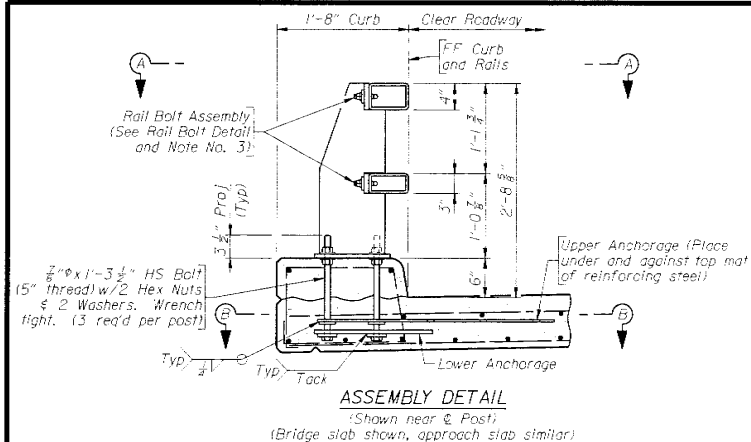
DOUBLE-BOLTED SPLICE
(Top or bottom rail)
SPLICE DETAILS

④ 1" Holes in rail (Centered)
 for $\frac{3}{4}$ " ϕ x $3\frac{1}{2}$ " HS Bolt w/
 Hex Nut, Washer, & Lock
 Washer. Wrench tight,
 do not crush rail.
 (Typ) (All splines)



EXPANSION SPLICE
(Top and bottom rail)

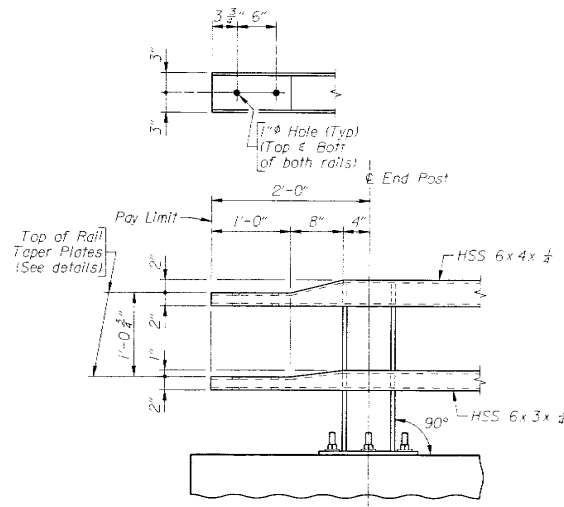
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		BRIDGE #4016AM	
REVISIONS	BRIDGE RAILING DETAILS		
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	DETAIL	X	X
DATE	0%	X	X
		Drwg. No. X	Sheet X of X



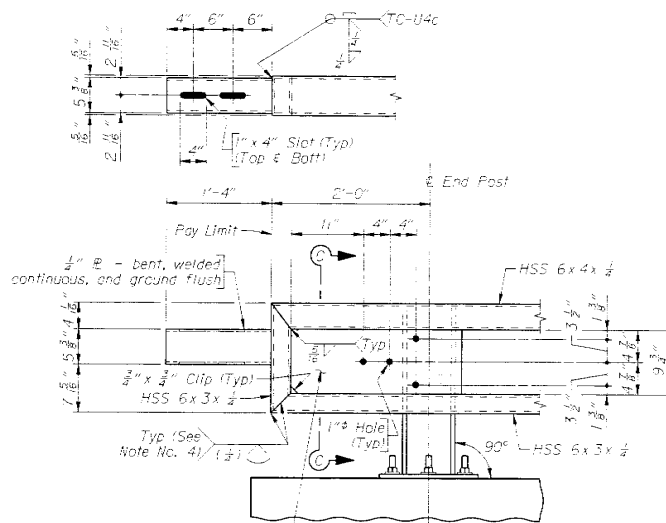
Notes:

- 1) Ensure the expansion splice is located in the railing panel which passes over the bridge expansion joint as indicated on the plan.
- 2) Anchor bolts may be tack welded to the lower anchorage (shop or field).
- 3) At post locations, drill two 1/2" holes in the rails to receive rail bolts (shop or field). See Post Details for hole spacing.
- 4) Before installing rails, paint all out, drilled, or otherwise damaged surface areas of the railing components with two coats of zinc rich paint conforming to the requirements of ASTM A 780.
- 5) After installing the rails, paint all exposed bolt threads with two coats of zinc rich paint conforming to the requirements of ASTM A 780.

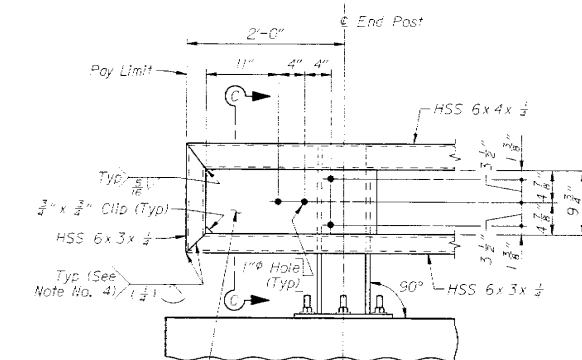
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BRIDGE PROGRAM			
REVISION	BRIDGE RAILING DETAILS		
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DRAWN	DETAIL	X X	Dwg. No. X
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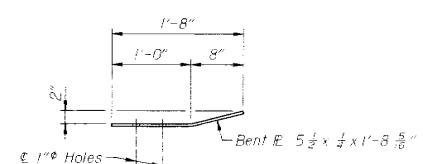
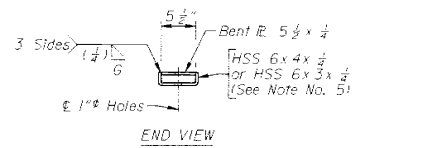
ELEVATION AT TERMINAL TYPE ①
(Box beam guardrail connection)



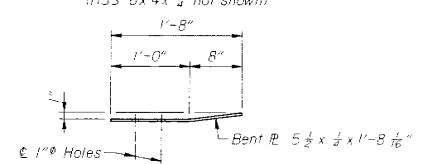
ELEVATION AT TERMINAL TYPE ②
(Box beam guardrail connection, Interstate exit end only)
(With provision for temporary corrugated beam guardrail connection)



ELEVATION AT TERMINAL TYPE ③
(Corrugated beam guardrail connection or no guardrail connection)

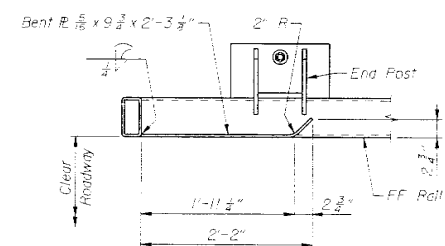


ELEVATION OF BENT PLATE FOR TOP RAIL
(HSS 6x4x1/4 not shown)

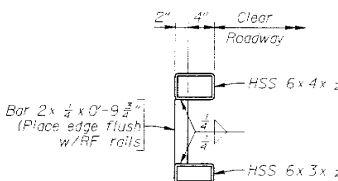


ELEVATION OF BENT PLATE FOR BOTTOM RAIL
(HSS 6x3x1/4 not shown)

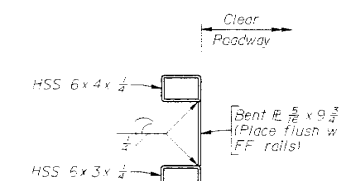
RAIL TAPER PLATE DETAILS



BENT PLATE SECTION
(Top rail not shown)
(Req'd at Type ② and ③ Terminals)



BRACE BAR DETAIL
(See Note No. 3)



SECTION C-C

- Note: 1) Either top or bottom rail in terminal section may be the longer rail.
2) Ensure each rail length is continuous over a minimum of two posts. Railing that is part of a type ② or ③ terminal is continuous if either the top or bottom rail in the terminal is continuous over a minimum of two posts.
3) Ensure a brace bar is placed 2'-0" from the splice end of the shorter tube at type ② and ③ terminals.
4) Ensure the fabricator prepares a sample of the indicated joint and it is macroetched to demonstrate that the required effective throat is achieved.
5) Cut top and bottom rails for Terminal Type ① as required for fabrication of tapered end sections.

WYOMING DEPARTMENT OF TRANSPORTATION BRIDGE PROGRAM			
BRIDGE RAILING DETAILS			
TL4_br2.dgn			
DESIGNED	DESIGN	Design Section X	
CHECKED	CHECK		
DATE	DATE	Drawn No. X	Sheet X of X

Appendix D. TL 2 Replacement Railing Options

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Appendix D

TL 2 Replacement Railings Options

Replacement bridge railings that meet a TL 2 rating may be considered to replace a railing with a higher TL rating in certain situations where the design speed is 45 miles per hour or less and the bridge is located on a non-National Highway System roadway. Several states utilize TL 2 railings for low speed roadways and for railings that serve the dual purpose of containing vehicles and pedestrians or bicycles. These railings are generally located on the outside edge of a raised sidewalk on the bridge and detailed for the geometric requirements for bicyclists and pedestrians; raised sidewalks offer some protection to pedestrians from errant vehicles entering the walkway. Other historic preservation and/or aesthetic considerations must be weighed in determining whether a TL 2 railing is an appropriate railing replacement option. In addition, application for a design exception may be needed.

Summarized below are TL 2 replacement railing options. The table is followed by a brief analysis of each option with regards to the existing railings.

Material	Railing Design	Rail Type	Required TL Rating(s)	TL 2 Option(s) to consider
Concrete	Single rail with post	A	4	Nebraska Concrete Beam and Post
		B	3	Natchez Trace Concrete Bridge Rail
	Double rails with posts	C	3 and 4 (dependent on specific bridge)	1. Natchez Trace Concrete Bridge Rail 2. Oregon 2-Tube Curb Mount
		D	4	1. Oregon 2-Tube Curb Mount 2. Natchez Trace Concrete Bridge Rail
	Concrete balustrade	E	3	1. Type C411 2. Texas Type T411 Aesthetic Rail
Metal and concrete	Metal picket rail with concrete posts	F	4	Washington D.C. Historic Bridge Rail Retrofit (Curb Mount)
		J	3 and 5 (dependent on specific bridge)	Washington D.C. Historic Bridge Rail Retrofit (Curb Mount)
Metal	Steel truss rail	H	3 and 4 (dependent on specific bridge)	1. Replace existing railing with Oregon Thrie Beam Side Mount Railing.
		I	3	1. Replace existing railing with Oregon Thrie Beam Side Mount Railing.
Multiple	Steel truss rail (G) and concrete double rails with posts (C)	G and C	4	1. Replace main span railing with Oregon Thrie Beam Side Mount Railing and approach railing with Natchez Trace Concrete Bridge Rail. 2. Replace main span and approach railings with Oregon Thrie Beam Side Mount Railing

(1) Existing Railing Type A – Concrete post and single rail, inset panel



TL 2 Option: Nebraska Concrete Beam and Post



(Source: FHWA/Caltrans, *Bridge Rail Guide*)

The Nebraska Concrete Beam and Post has the same material as the existing railing. The basic posts and horizontal members that extend over the top of the posts do not reflect the distinctive end and intermediate posts of the existing railing. This option is less compatible with the Secretary's Standards as it does not match the approximate configuration of the existing railing. However, it does match the materials of the existing railing and of the available TL 2 options this is the best choice in terms of overall appearance. Other TL 2 options have features that are not present on the existing railing, including elongated posts and raised concrete curbs, and this railing generally matches the opening size on the existing railing.

(2) Existing Railing Type B – Concrete post and single rail, incised lines



TL 2 Option: Natchez Trace Concrete Bridge Railing



(Source: FHWA/Caltrans, *Bridge Rail Guide*)

The Natchez Trace Concrete Bridge Railing matches the material as the existing railing. The basic posts and horizontal members that extend over the top of the posts do not reflect the distinctive end and intermediate posts of the existing railing. This option is less compatible with the Secretary's Standards because it does not match the approximate configuration of the existing railing. However, it does match the materials of the existing railing and of the available TL 2 options this is the best choice in terms of overall appearance. This option has rectangular posts, a raised concrete curb, and opening widths that are similar to the existing railing.

(3) Existing Railing Type C – Concrete post and double rail, inset panels



TL 2 Option 1: Natchez Trace Concrete Bridge Railing



(Source: FHWA/Caltrans, *Bridge Rail Guide*)

Option 1 matches the material as the existing railing. The basic posts and horizontal members that extend over the top of the posts do not reflect the distinctive end and intermediate posts of the existing railing. This option is less compatible with the Secretary's Standards because it does not match the approximate configuration of the existing railing. However, it does match the materials of the existing railing and of the available concrete TL 2 options this is the best choice in terms of overall appearance. This option has rectangular posts, a raised concrete curb, and opening widths between horizontal members that are similar to the existing railing.

TL 2 Option 2: Oregon 2-Tube Curb Mount



(Source: FHWA/Caltrans, *Bridge Rail Guide*)

Option 2 is an all metal railing and does not match the existing concrete railing in terms of materials. Despite this difference, this option was considered because it includes two horizontal members, raised concrete curb, and approximates the configuration of the existing railing with the spacing of vertical and horizontal members. This option is less compatible with the Secretary's Standards because it does not match the material of the existing railing; however, it does approximate the two-rail configuration of the existing railing.

(4) Existing Railing Type D – Concrete post and double rail, lower rail sits on curb, inset panels



TL 2 Option 1: Oregon 2-Tube Curb Mount



(Source: FHWA/Caltrans, *Bridge Rail Guide*)

This option would install Oregon 2-Tube Curb Mount railing between the roadway and sidewalk, leave the existing railing in place, and obtain a design exception to meet the pedestrian requirements. This option is compatible with the Secretary's Standards because the existing railing would be left in place.

If a design exception cannot be achieved, replace the inboard railing with the Oregon 2-Tube Curb Mount railing and reconstruct outside railing to closely match current railing and to meet pedestrian requirements. Since the new inboard would meet the appropriate TL rating requirement, the outboard railing would not also need to meet the TL rating requirements. The new inboard railing would be metal, however, which does not match the materials of the existing concrete railing. The Oregon 2-Tube Curb Mount railing includes two horizontal members, raised concrete curb, and approximates the spacing of

vertical and horizontal members on the existing inboard concrete railing. This option would achieve a similar visual effect of the existing paired, two-concrete railing on the bridge and would enable the traveling public to see the outboard concrete railing through its members. This option is compatible with the Secretary's Standards because the combination of the existing or replicated outboard railing and replacement inboard railing generally maintains the materials, configuration, and scale of the existing railing.

TL 2 Option 2: Natchez Trace Concrete Bridge Railing



(Source: FHWA/Caltrans, *Bridge Rail Guide*)

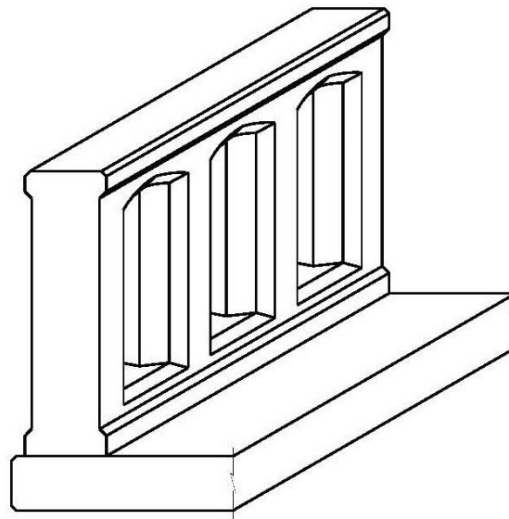
This option would install Natchez Trace Concrete Bridge Railing inboard of the existing railing, leave existing railing in place, and obtain a design exception to meet pedestrian requirements. This option is compatible with the Secretary's Standards because it would leave the existing railing in place.

If a design exception cannot be achieved, replace the existing inboard railing with the Natchez Trace Concrete Bridge Railing and reconstruct outboard railing to match as closely as possible the current railing and to meet pedestrian requirements. Since the new Natchez Trace Concrete Bridge Railing would meet the appropriate TL rating requirement, the existing or reconstructed railing would not also need to meet the TL rating requirements. The new inboard railing would match the existing inner railing in terms of material but would not reflect the design and configuration of the existing railing. This option is less compatible with the Secretary's Standards because it does not match the approximate configuration of the existing railing.

- (5) **Railing Type E – Solid concrete panel with integrated end posts and intermediate posts, and baluster cutouts topped with concrete cap and integrated curb**



TL 2 Option 1: Type C411



(Source: TxDOT, *Bridge Railing Manual*)

This option matches the concrete material and displays similar features to the existing railing, including the evenly spaced concrete balusters and concrete cap. The dimensions of the new railing would be similar to the existing railing. The ends of the new railing could be designed without the openings to approximate the elongated end posts on the existing railing. This option is compatible with the Secretary's Standards because it matches the materials, configuration, and scale of the existing railing and evokes a sense of historic railing with its evenly spaced concrete balusters and concrete cap without creating a false sense of history.

TL 2 Option 2: Texas Type T411 Aesthetic Railing



(Source: FHWA/Caltrans, *Bridge Rail Guide*)

This option matches the concrete material of the existing railing and displays similar features to the existing railing, including the evenly spaced concrete balusters and concrete cap. The dimensions of the new railing would be similar to the existing railing. The ends of the new railing could be designed without the openings to approximate the elongated end posts on the existing railing. This option is compatible with the Secretary's Standards because it matches the materials, configuration, and scale of the existing railing and evokes a sense of historic railing with its evenly spaced concrete balusters and concrete cap without creating a false sense of history.

(6) Railing Type F – Concrete posts with incised lines, metal tubular railing with two secondary rails and varied-length verticals



TL 2 Option: Washington, D.C. Historic Bridge Rail Retrofit (Curb Mount)



(Source: FHWA/Caltrans, Bridge Rail Guide)

This option would install Washington, D.C. Washington, D.C. Historic Bridge Rail Retrofit (Curb Mount) railing between road and sidewalk, retain existing outboard railing, and obtain a design exception for pedestrian requirements. This option is compatible with the Secretary's Standards because the existing railing would remain in place.

If a design exception cannot be achieved, install the Washington, D.C. Historic Bridge Rail Retrofit (Curb Mount) railing inboard of the existing railing and reconstruct outside railing to closely match current railing and to meet pedestrian requirements. Since the inboard railing would meet the appropriate TL rating requirement, the outboard railing would not need to meet the TL rating requirements.

This option retains the existing historic railing or reconstructs it with appropriate height requirements for pedestrian railing and installs railing between the road and sidewalk that meets the TL 2 rating requirement. The Steel Tube Bridge Railings would not detract from the overall design of the existing railing, if retained, or the new railing if it is reconstructed. The low profile of the Historic Bridge Railing Retrofit (Curb Mount) railing would enhance the visibility of the outboard railing and would pose a much less visual impact than the existing concrete barrier. This option is compatible with the Secretary's Standards because it results in a railing that matches or is very similar to the existing railing in terms of materials, configuration, and scale.

(7) Railing Type H – Metal-lattice railing



Note: No available replacement options that match the appearance of the current rail were identified.

TL 2 Option: Oregon Thrie Beam Side Mount Railing



(Source: FHWA/Caltrans, *Bridge Rail Guide*)

Replacing the existing railing with this type of railing was the only identified option that would not encroach on the clear roadway width of the bridge. Due to the spacing between the edge of the deck and the existing railing, the side mounted railing could not be installed in front of the existing railing in order to retain the existing railing. Attaching the Thrie beam (or other type of metal guardrail) directly to the truss members and existing railing would not achieve a sufficient TL rating. The Oregon Thrie Beam Side Mount Railing would provide a similar material that meets the TL 2 rating requirement but is less compatible with the Secretary's Standards because it does not match the configuration or design of the existing railing.

(8) Type I – Metal woven lattice railing



Note: No available replacement options that match the appearance of the current rail were identified.

TL 2 Option: Oregon Thrie Beam Side Mount Railing



(Source: FHWA/Caltrans, *Bridge Rail Guide*)

Replacing the existing railing with this type of railing was the only identified option that would not encroach on the clear roadway width of the bridge. Due to the spacing between the edge of the deck and the existing railing, the side mounted railing could not be installed in front of the existing railing in order to retain the existing railing. Attaching the Thrie beam (or other type of metal guardrail) directly to the truss members and existing railing would not achieve a sufficient TL rating. The Oregon Thrie Beam Side Mount Railing would provide a similar material that meets the TL 2 rating requirement but is less compatible with the Secretary's Standards because it does not match the configuration or design of the existing railing.

(9) Railing Type J – Concrete post with incised line; metal tubular railing with two secondary rails and varied-length verticals, and elongated end posts



TL 2 Option: Washington, D.C. Historic Bridge Rail Retrofit (Curb Mount)



(Source: FHWA/Caltrans, *Bridge Rail Guide*)

This option would install Washington, D.C. Washington, D.C. Historic Bridge Rail Retrofit (Curb Mount) railing between road and sidewalk, retain existing outboard railing, and obtain a design exception for pedestrian requirements. This option is compatible with the Secretary's Standards because the existing railing would remain in place.

If a design exception cannot be achieved, install the Washington, D.C. Historic Bridge Rail Retrofit (Curb Mount) railing inboard of the existing railing and reconstruct outside rail to closely match current railing and to meet pedestrian requirements. Since the inboard railing would meet the appropriate TL rating requirement, the outboard railing would not need to meet the TL rating requirements.

This option retains the existing historic railing or reconstructs it with appropriate height requirements for pedestrian railing and installs railing between the road and sidewalk that meets the TL 2 rating requirement. The Steel Tube Bridge Railing would not detract from the overall design of the existing railing, if retained, or the new railing if it is reconstructed. The low profile of the Historic Bridge Rail Retrofit (Curb Mount) railing would enhance the visibility of the outboard railing and would pose a much less visual impact than the existing concrete barrier. This option is compatible with the Secretary's Standards because it results in a railing that matches or is very similar to the existing railing in terms of materials, configuration, and scale.

(10) Bridges with Multiple Railing – Types G and C – Two horizontal steel I-beam rails (G); concrete post and double line rail; inset panels (C)



Example image of existing railing type: Approach railing – Concrete post and double line rail, inset panels:



TL 2 Option (main span): Oregon Thrie Beam Side Mount Railing



(Source: FHWA/Caltrans, *Bridge Rail Guide*)

TL 2 Option (approach span): Natchez Trace Concrete Bridge Railing



(Source: FHWA/Caltrans, *Bridge Rail Guide*)

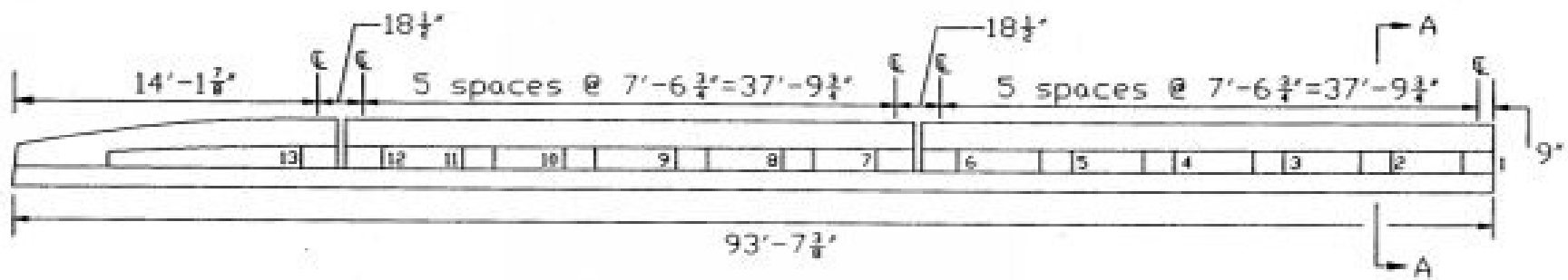
This option replaces the main span railing with Oregon Thrie Beam Side Mount Railing and replaces the approach span railings with Natchez Trace Concrete Bridge Railing. This option meets the TL 2 rating requirement. The replacement main span railing would be similar to the material of the existing railing but would not match the design or configuration. The replacement Natchez Trace Concrete Bridge railing on the approach spans would match the concrete material of the existing approach railing but not the design. Since options were not identified that meet the required TL rating, avoid encroachment on the clear roadway width, and provide an exact match to the existing railing, this option is the most compatible with the Secretary's Standards because it does generally match the material of the existing railings and the general configuration and openings of the approach railing. Due to the spacing between the edge of the deck and the existing railing, the side mounted railing cannot be installed on the truss span in front of the existing railing in order to retain the existing railing. Attaching the Thrie beam (or other type of metal guardrail) directly to the truss members and existing railing would not achieve a sufficient TL rating.

TL 2 Option 2: Oregon Thrie Beam Side Mount Railing

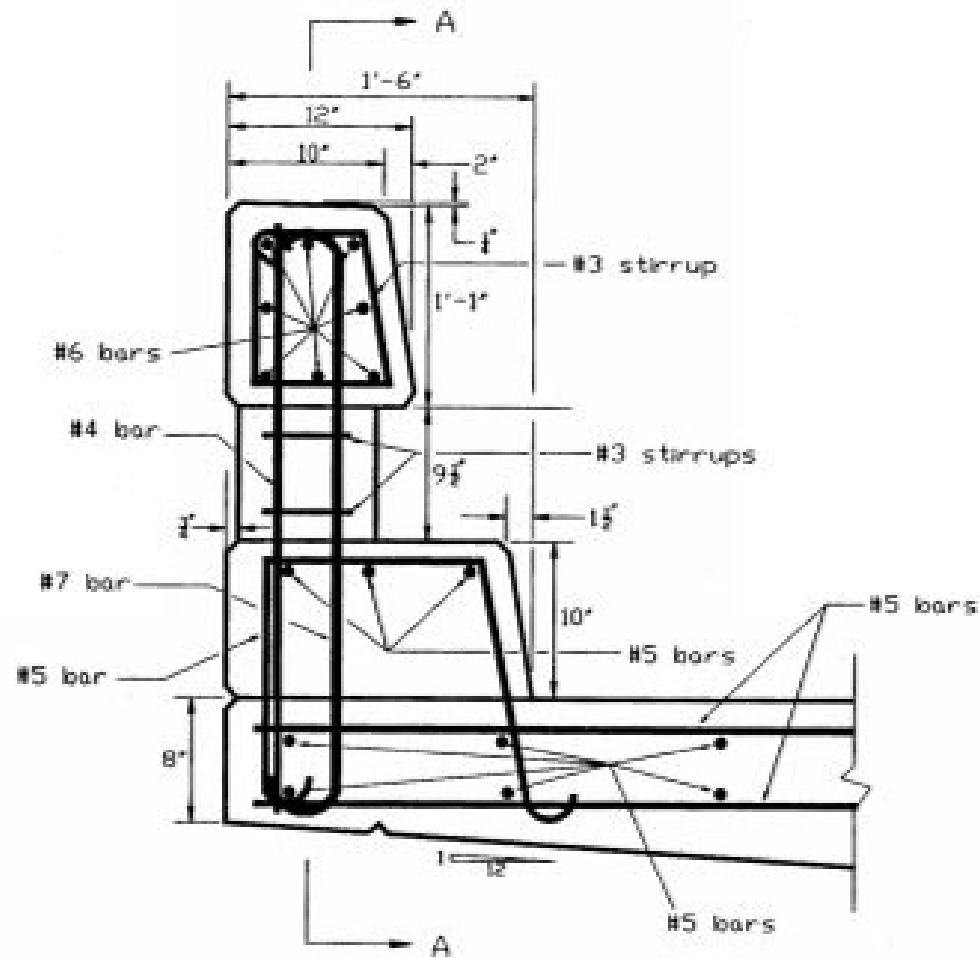


(Source: FHWA/Caltrans, *Bridge Rail Guide*)

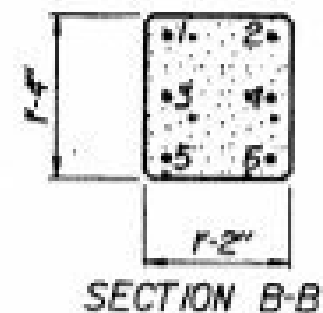
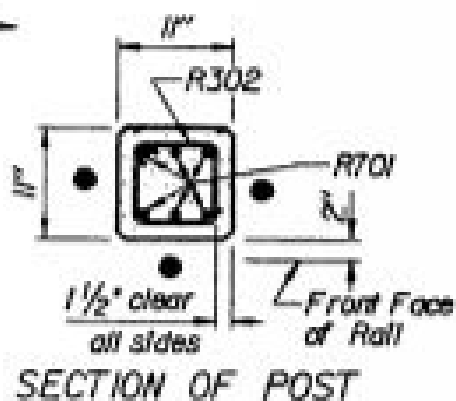
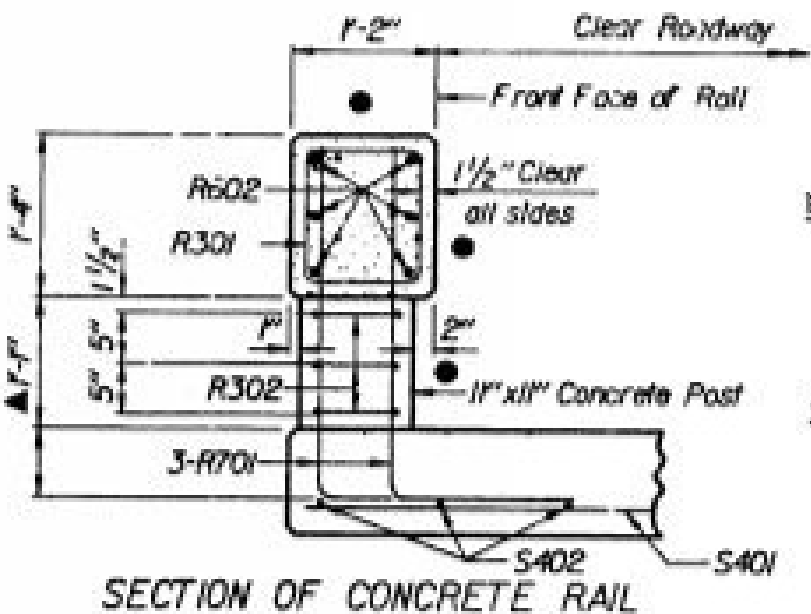
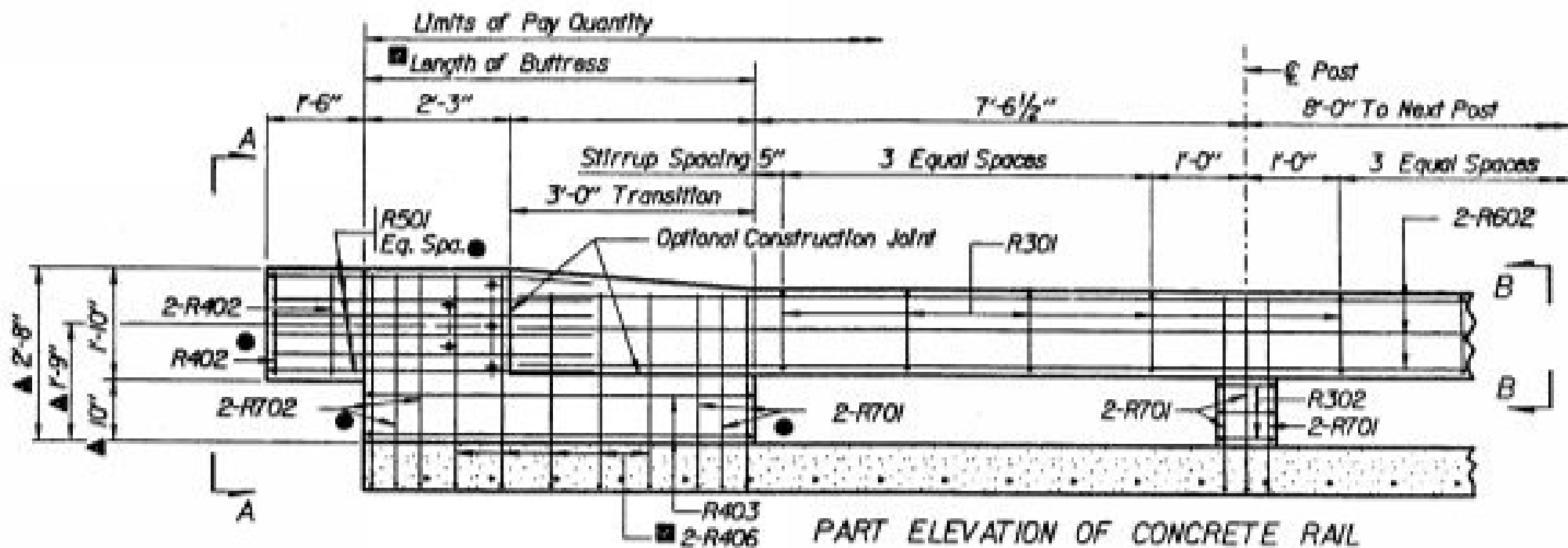
This option replaces the main span and approach span railings with a single Oregon Thrie Beam Side Mount Railing across the entire bridge. This would provide a consistent railing across the bridge and eliminate potential snag points at the transitions between railings. Additionally, it would not encroach on the clear roadway width of the bridge. This railing could also be painted if desired. This option is less compatible with the Secretary's Standards because it does not match the existing main span or approach railings in design or configuration.

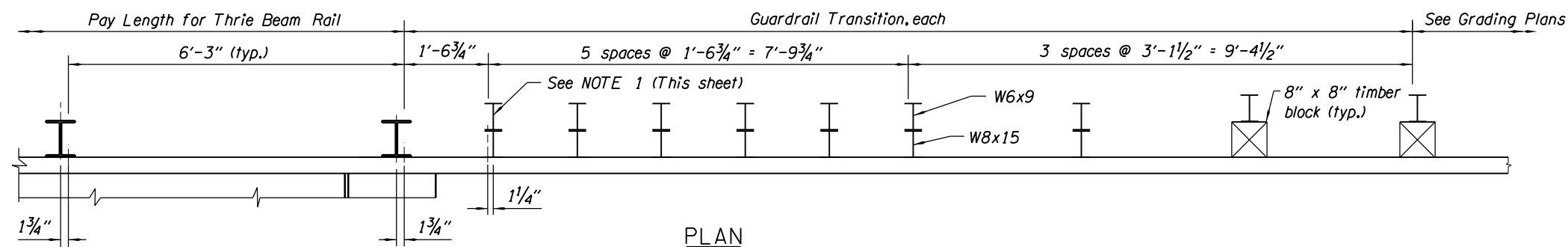


PROFILE VIEW



CROSS-SECTION A-A

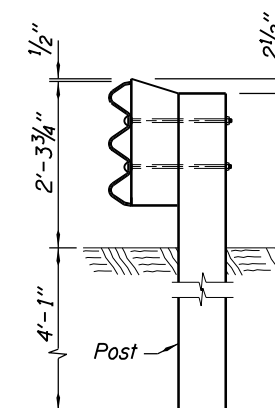
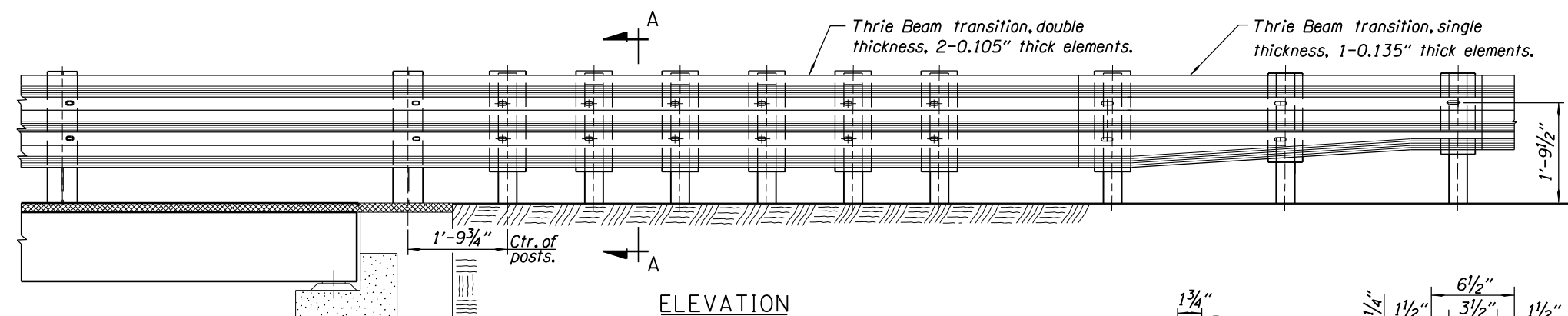




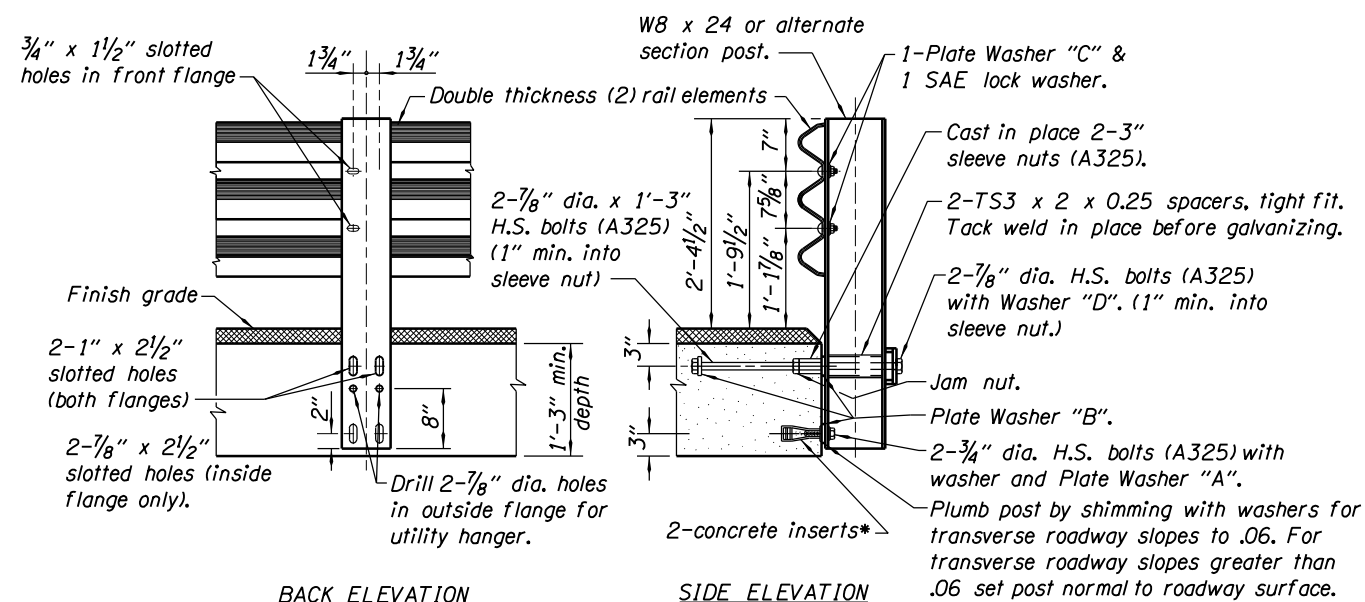
NOTE 1: Transition posts may be steel W6x9 or timber 8"x 8". All posts to be of same material. See dwg. BR203 for Thrie Beam blockouts.

*CONCRETE INSERTS

Hot-dip galvanized expanded coil concrete inserts
with closed-back ferrule threaded to receive
3/4" dia., Gr36 (ASTM A307)
Minimum insert length= 4 1/2"
Minimum safe working load in tension= 4000 lbs.



SECTION A-A



BACK ELEVATION

SIDE ELEVATION

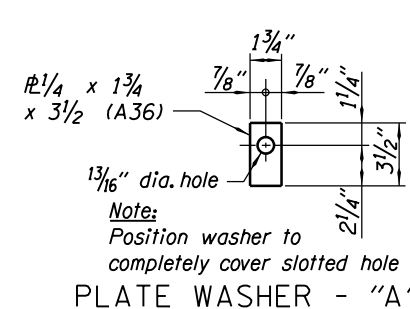


PLATE WASHER - "A"

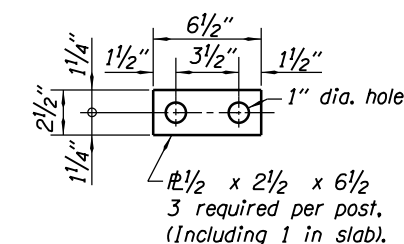


PLATE WASHER - "B"

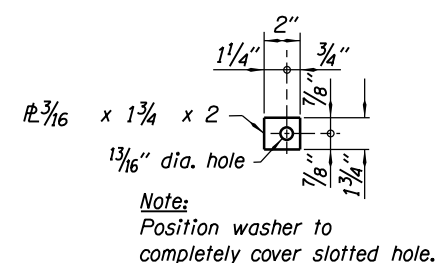
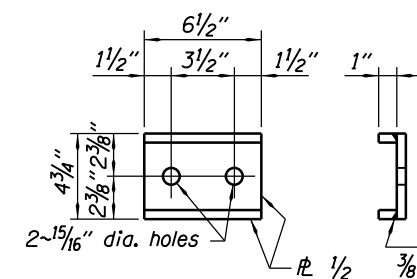


PLATE WASHER - "C"



WASHER - "D

GENERAL NOTES:

Provide steel posts and plates conforming to AASHTO Specification M183 (ASTM A36), unless noted otherwise.

Provide anchor bolts conforming to ASTM A325. (AASHTO M164).

Provide guardrail hardware as shown on Std. Dwgs. RD405 and RD410.

Hot dip galvanize all structural steel and hardware after fabrication.

Fabricate railing to the horizontal and vertical alignment of the structure. Install posts normal to grade. When wearing surface thickness varies due to beam camber and/or superelevation, vary rail post lengths to provide uniform rail height.

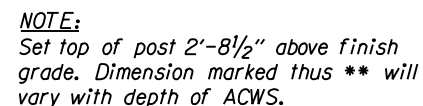
Tap nuts and inserts 0.0021" ~~0.002~~ ^{0.0025} oversize after galvanizing in accordance with ASTM A563.

Tighten upper high strength post bolts 1/6 turn past snug tight condition. Tighten lower high strength post bolts 1/3 turn past snug tight condition.

Do not use this rail for 12" thick slab.

Accompanied by dwqs. BR203, RD400, RD405, RD410

CALC. BOOK NO. _____		BASELINE REPORT DATE 01-JUL-2009	
<i>The selection and use of this Standard Drawing, while designed in accordance with generally accepted engineering principles and practices, is the sole responsibility of the user and should not be used without consulting a Registered Professional Engineer.</i>		NOTE: All material and workmanship shall be in accordance with the current Oregon Standard Specifications	
		OREGON STANDARD DRAWINGS	
		THRIE-BEAM RAIL AND TRANSITION	
		2015	
		DATE	REVISION DESCRIPTION



PLAN

Pay Length for Rail (See Project Plans for rail length & post spacing)

10'-0" max. post spacing for ASTM A500 Grade B and A618 or A501

3'-9"

2'-5 3/4"

1'-11 1/4"

End of rail tubing cap

W6x9

4 1/2" taper

W8x15

1'-6" curb taper

End of deck or End Panel.

2-1" dia. holes thru each rail tube. Extend thru both top and bottom faces of tube.

End Rail Post

For guardrail connection details. See dwg. BR207

NOTE:
Guardrail Connection may be omitted on exit end of one way structures when omitted on detail plans.

4- 7/8" dia. H.S. anchor bolts threaded 5" min. with 2 nuts and flat washer.

ELEVATION

Rail Splice

L

L/4 ± 6"

(Provide continuous rail over 2 or more posts.)

Galvanize-Control Silicon-typ.

Thrie beam rail, double thickness 2- 0.105" thick elements.

2'-1"

1'-6 3/4"

See Dwg. BR207 (NOTE 1 and SECTION B-B)

Technical drawing of a rectangular plate washer. The overall dimensions are 2 1/8 inches by 1 3/4 inches. The hole has a diameter of 7/8 inch. The distance from the hole center to the nearest edge is 1/4 inch. The distance from the hole center to the opposite edge is 7/8 inch. The drawing includes dimension lines and labels for the hole diameter and the distance from the hole center to the edge.

Technical drawing of a square plate with the following specifications:

- Overall dimensions: 12" x 13"
- Central hole: 6" dia. hole
- Four corner holes: 4 holes, each 1/8" dia.
- Dimensions for corner holes: 1 1/2" from each side.
- Dimensions for central hole: 4 1/2" from each side.
- Material: A36 steel
- Finish: Zn (galvanizing not required)

Technical drawing of a steel plate with dimensions and labels:

- Overall width: 12"
- Overall height: 13"
- Horizontal dimensions (from left edge):
 - 1 1/2"
 - 4 1/2"
 - 4 1/2"
 - 1 1/2"
- Vertical dimensions (from top edge):
 - 1 1/2"
 - 5"
 - 5"
 - 1 1/2"
- Labels:
 - ϕ 1
 - Post
 - 4-1 1/8" dia. holes for 7/8" dia. anchor bolts
 - 5/16"
 - 6"

1"*

5 1/2"

4"

3/16"

Grind all edges prior to galvanizing to assure proper fit.

4 1/4"

0-0"

3/16" typ.

4 1/4"

0-0"

Make splice tube from 1/4"

RAIL SPLICE DETAILS

***NOTE:**
1" gap unless noted otherwise on
detail plans. Rail Splice will be needed
in panel that has a deck expansion joint.

Design Capacities
 P_p (post)= 32.7 kips
 M_p (post)= 62.7 kip-ft
Wgt.= 1.913 kip/post (includes 7" curb)
Center of gravity= 0.901 ft

CALC. BOOK NO. _____	BASELINE REPORT DATE <u>01-JUL-2009</u>	
<i>The selection and use of this Standard Drawing, while designed in accordance with generally accepted engineering principles and practices, is the sole responsibility of the user and should not be used without consulting a Registered Professional Engineer.</i>	NOTE: All material and workmanship shall be in accordance with the current Oregon Standard Specifications	
	OREGON STANDARD DRAWINGS 2-TUBE CURB MOUNT RAIL 2015	
	DATE	REVISION DESCRIPTION

CALC. BOOK NO. _____ BASELINE REPORT DATE 01-JUL-2009

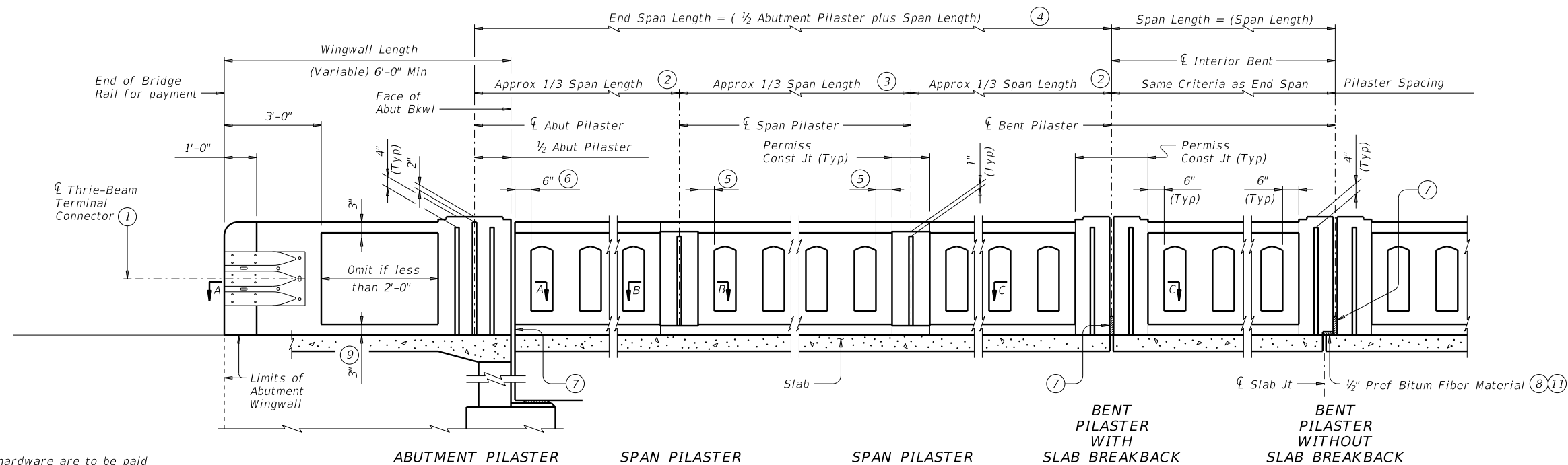
NOTE: All material and workmanship shall be in accordance with the current Oregon Standard Specifications

2-TUBE CURB MOUNT RAIL

2015

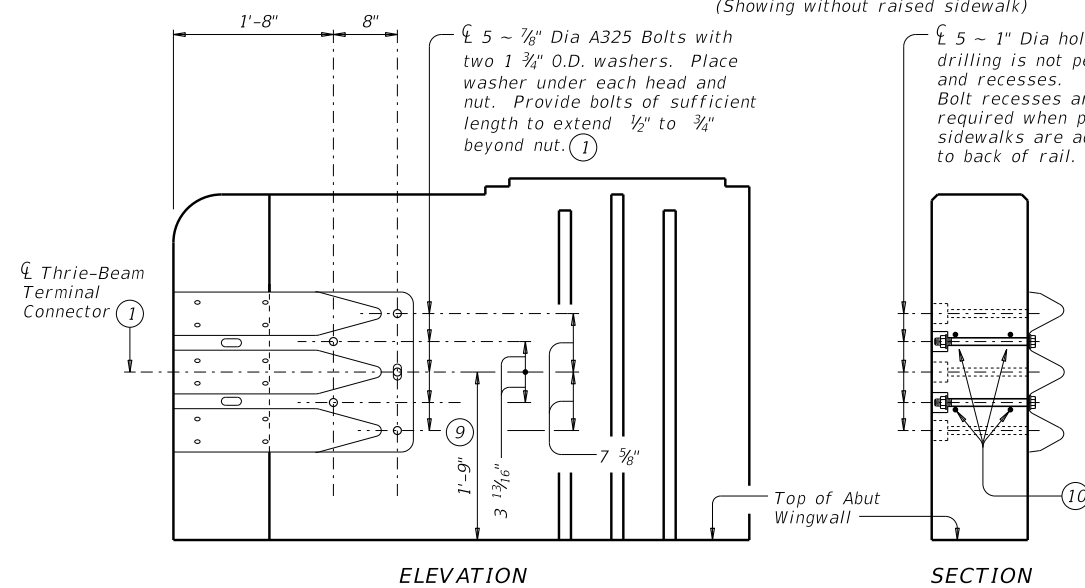
DATE	REVISION DESCRIPTION
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DATE: _____
FILE: _____



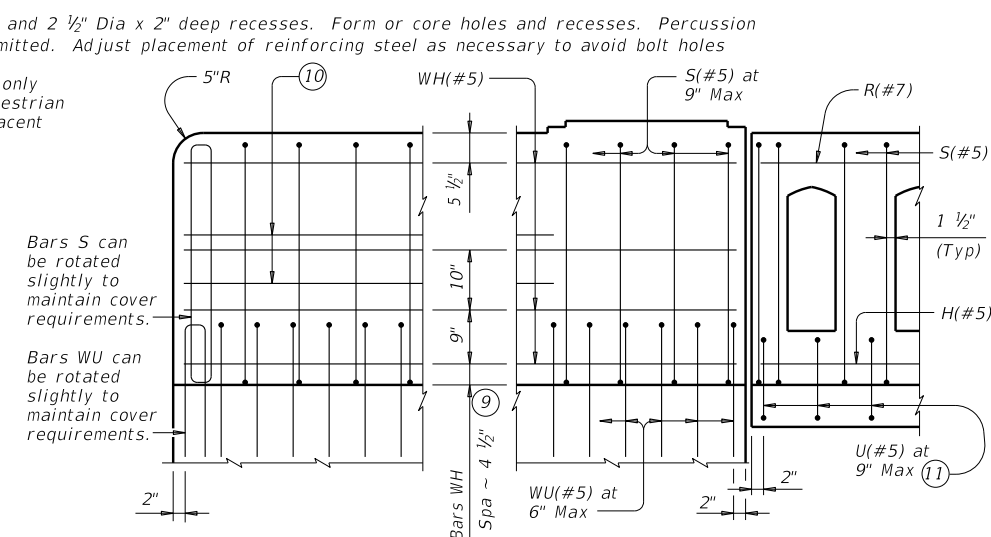
ROADWAY ELEVATION OF RAIL

(Showing without raised sidewalk)



TERMINAL CONNECTION DETAILS

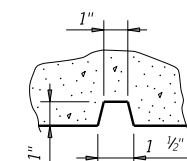
(Showing parapet with Pilaster on 6'-0" Wingwall)



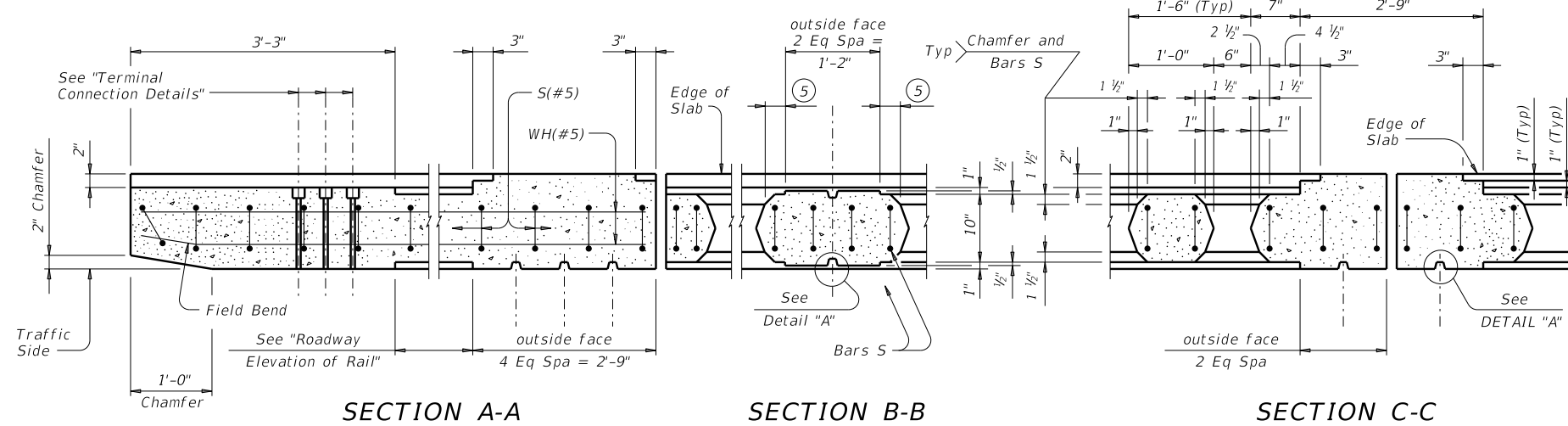
ELEVATION SHOWING
TYPICAL REINFORCING PLACEMENT

(Showing without raised sidewalk)

The use of this railing is restricted to speeds of 45 mph or less.



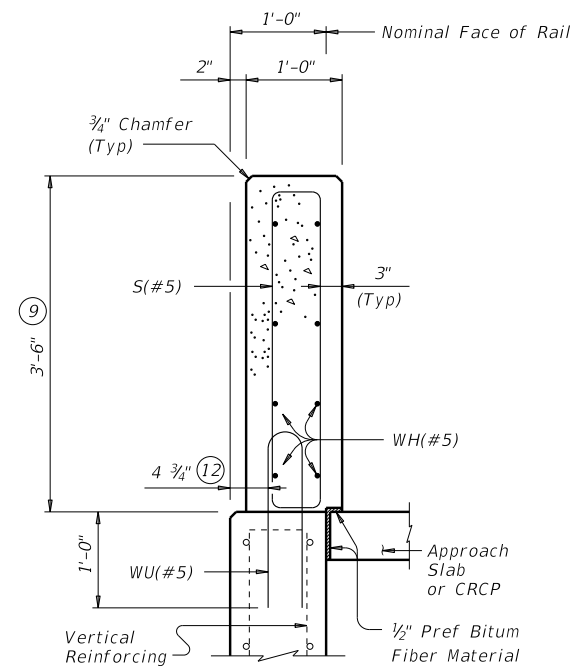
DETAIL "A"

COMBINATION RAIL
TEXAS CLASSIC

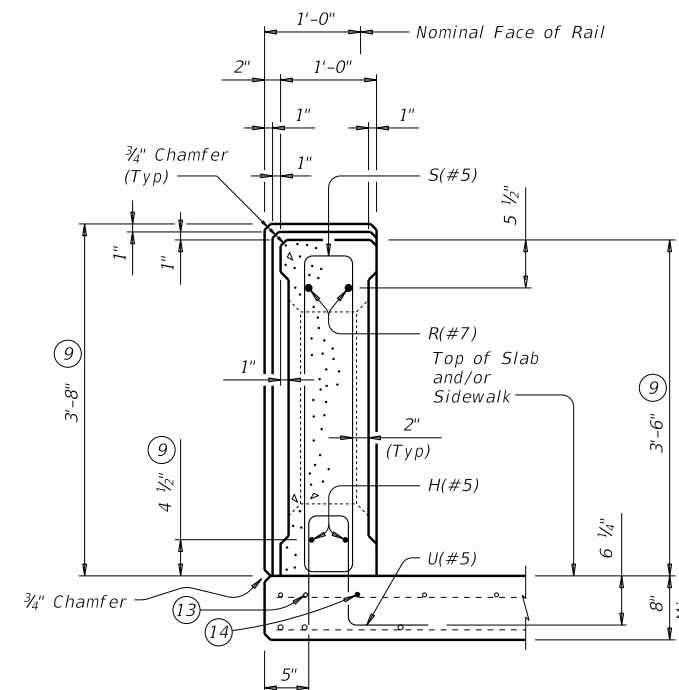
TYPE C411

FILE: rlst021.dgn		DN: TxDOT		CK: TxDOT		DW: TxDOT		CK: TxDOT	
 July 2014 REVISIONS		CONT SECT		JOB		HIGHWAY			
		DIST		COUNTY			SHEET NO.		

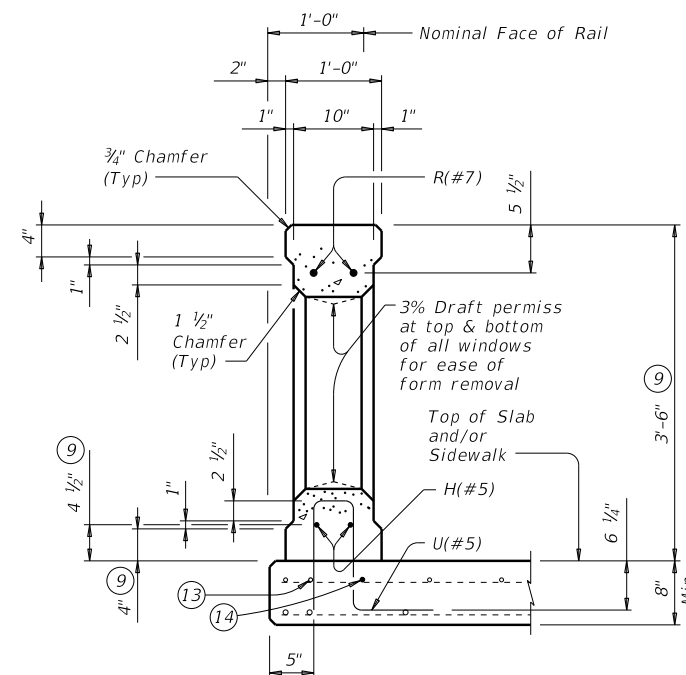
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ON ABUTMENT WINGWALLS
OR CIP RETAINING WALLS

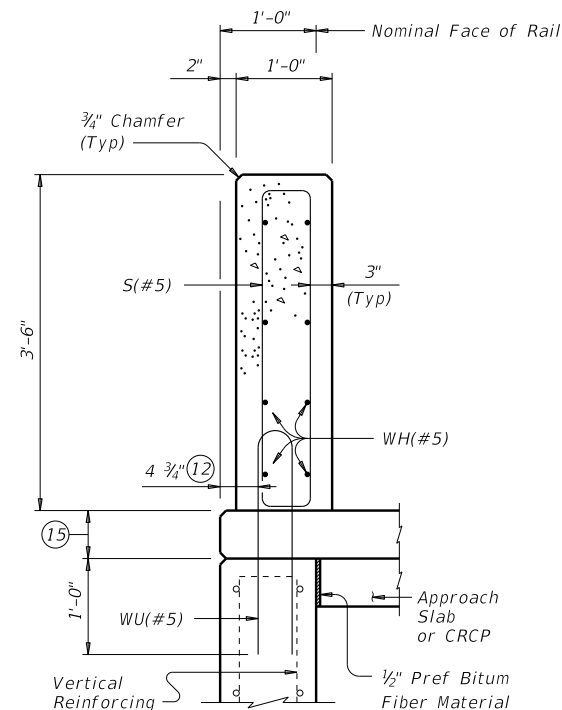


SECTION THRU
POST ON BRIDGE SLAB
(Showing Pilaster)

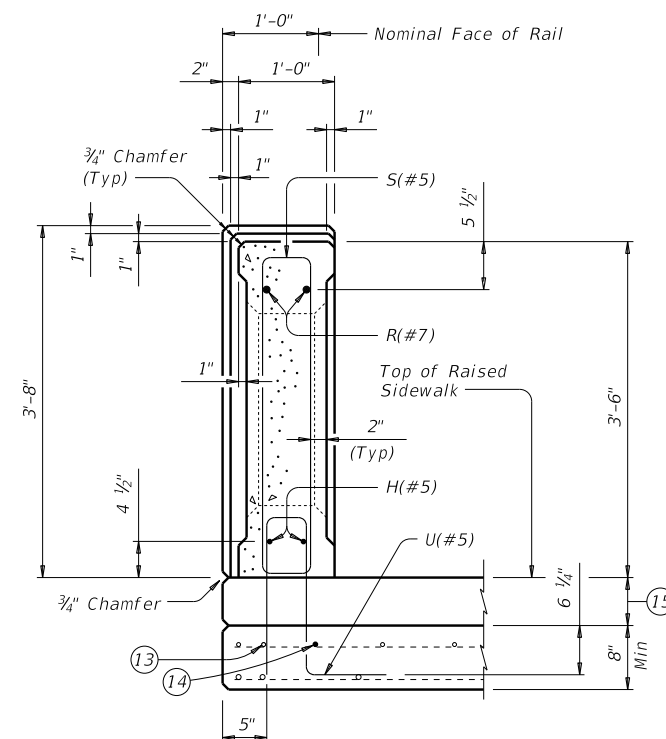


SECTION THRU
WINDOW ON BRIDGE SLAB

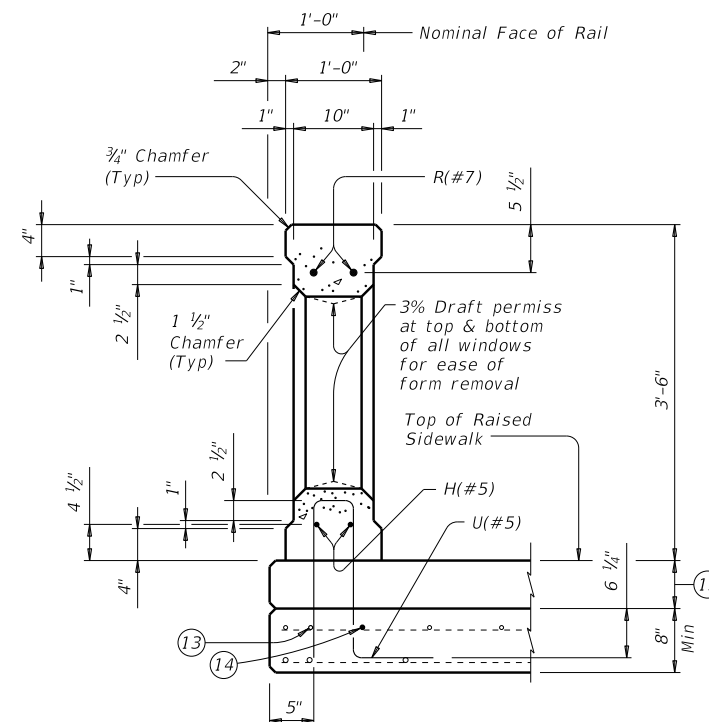
- ⑨ Increase 2" for structures with overlay.
- ⑫ 5 1/4" when vertical reinforcing has closer clear cover over horizontal reinforcing in abutment wingwalls or retaining walls on traffic side of wall.
- ⑬ As an aid in supporting reinforcement, additional longitudinal bars may be used in the slab with the approval of the Engineer. Such bars must be furnished at the Contractor's expense.
- ⑭ Top longitudinal slab bar may be adjusted laterally 3" plus or minus to tie reinforcing.
- ⑮ Raised Sidewalk



ON ABUTMENT WINGWALLS
OR CIP RETAINING WALLS



SECTION THRU
POST ON BRIDGE SLAB
(Showing Pilaster)



SECTION THRU
WINDOW ON BRIDGE SLAB

SECTIONS THRU RAIL WITH RAISED SIDEWALK

SHEET 2 OF 3



Texas Department of Transportation

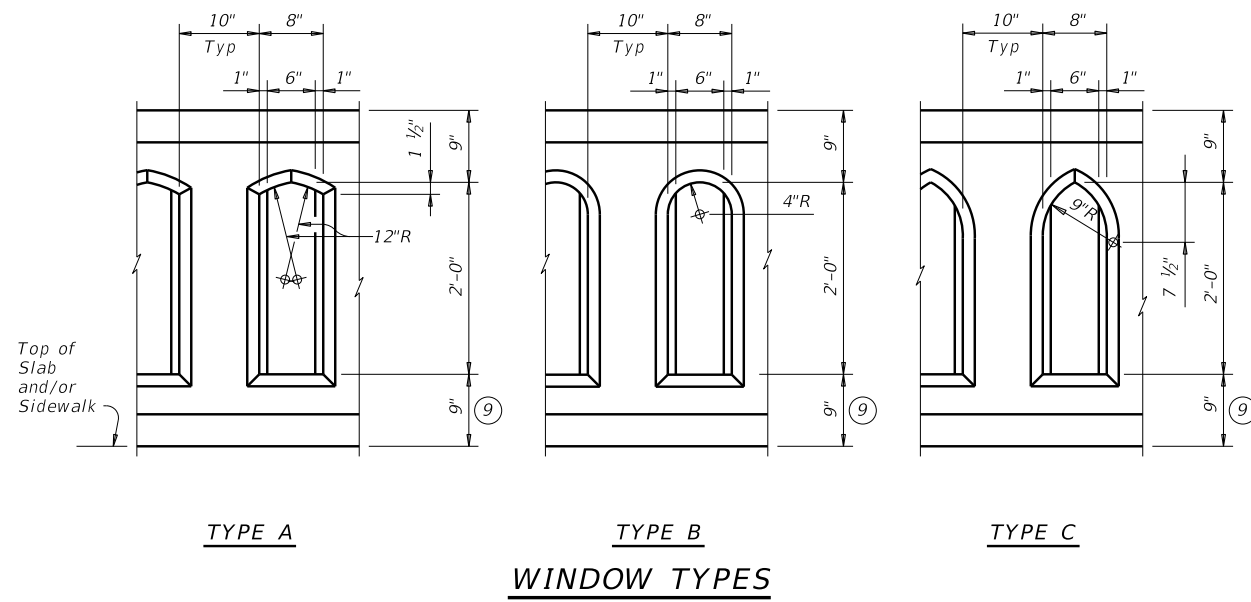
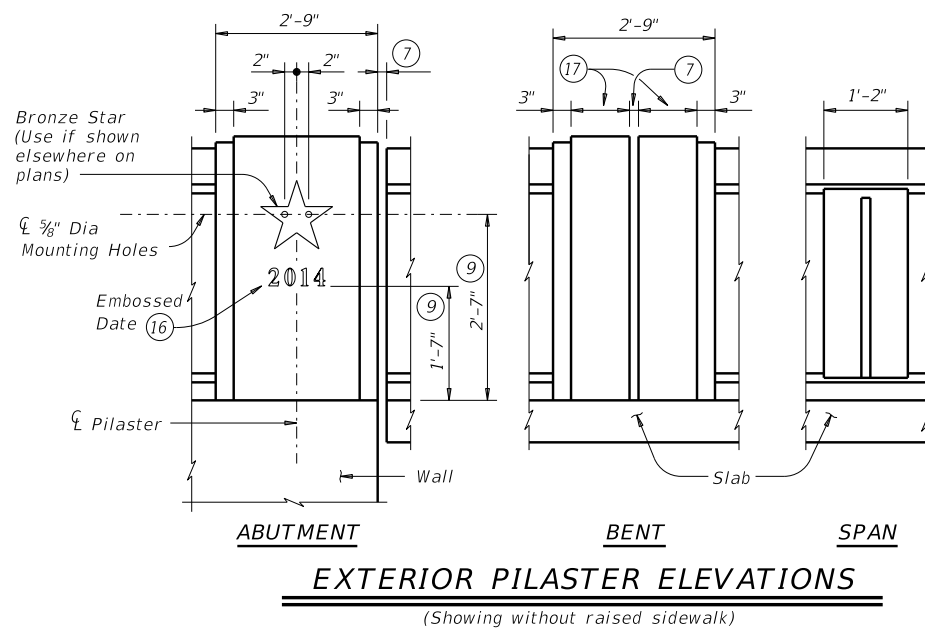
**Bridge
Division
Standard**

COMBINATION RAIL
TEXAS CLASSIC

TYPE C411

FILE: rlst021.dgn		DN: TxDOT		CK: TxDOT		DW: TxDOT		CK: TxDOT	
 July 2014 REVISIONS		CONT SECT		JOB		HIGHWAY			
		DIST		COUNTY				SHEET NO.	

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CONSTRUCTION NOTES:
 Attach Bronze Star with a Type III Class C epoxy. Clamp star until epoxy achieves set. Remove any visible epoxy "squeeze out" from under star.
 Face of rail and pilasters, parapet must be plumb unless otherwise approved.
 Apply a one rub finish to all railing surfaces unless otherwise shown elsewhere on the plans.

MATERIAL NOTES:
 Provide Class "C" concrete for railing. Provide Class "C" (HPC) concrete if shown elsewhere in the plans.
 Provide Grade 60 reinforcing steel.
 Epoxy coat all rail reinforcement if slab bars are epoxy coated.
 Bronze Star must be cast of architectural bronze having the following composition: Copper 85 %, Tin 5 %, Lead 5 %, Zinc 5 %.
 Provide bar laps, where required, as follows:

Uncoated ~ #5	= 1'-9"
Uncoated ~ #7	= 2'-9"
Epoxy coated ~ #5	= 2'-7"
Epoxy coated ~ #7	= 4'-1"

GENERAL NOTES:

This rail was evaluated based on the results of previous crash tests and approved for a NCHRP Report 350 TL-2 rating. This rail is only approved for low speed use, speeds of 45 mph and less.

Do not use this railing on bridges with expansion joints providing more than 5" movement.

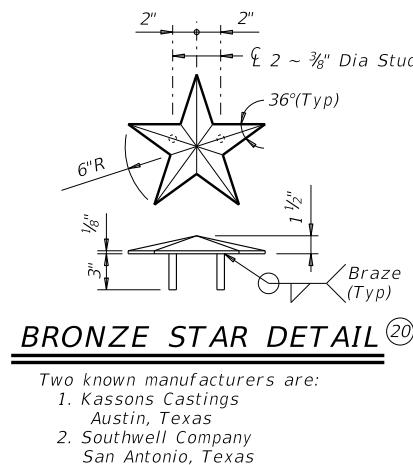
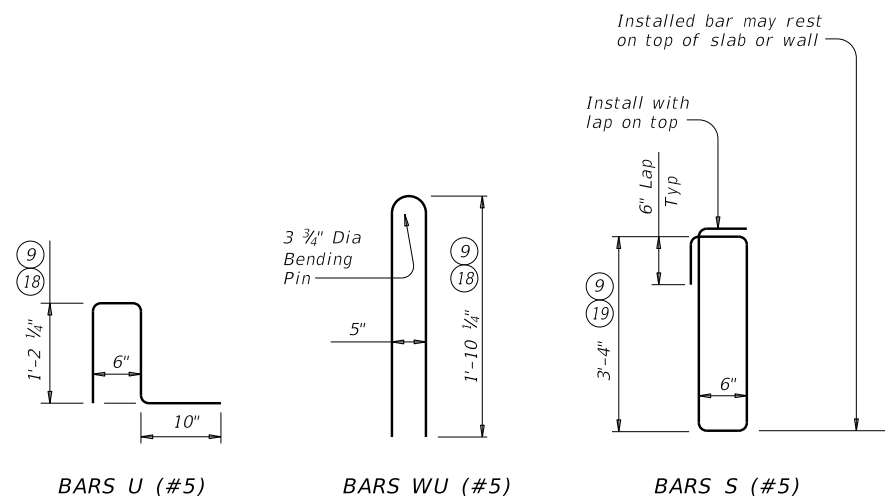
Rail anchorage details shown on this standard may require modification for select structure types. See appropriate details elsewhere in plans for these modifications.

Shop drawings will not be required for this rail.

See Bridge Layout or other plan sheets for the following: dimensions with the number of span pilasters, dimensions with the number of windows, window type, inclusion of bronze stars, inclusion of construction year with abutment identity.

Submit erection drawings showing span number, span pilaster locations, number of windows between pilasters and spacing to first window (see Note 6) to the Engineer for approval.

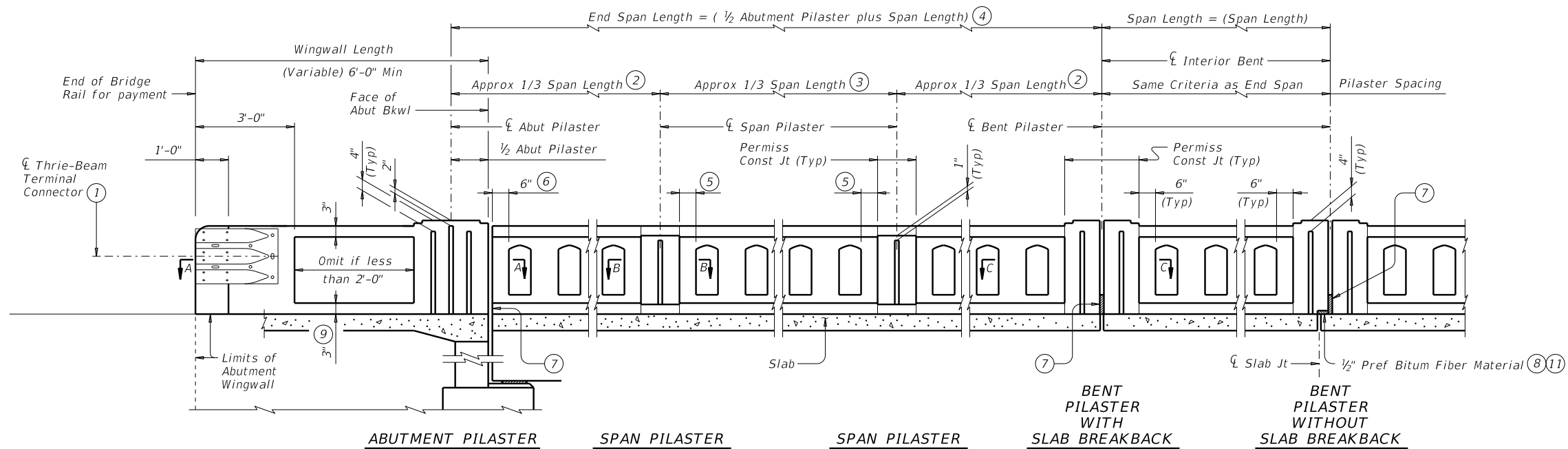
Average weight of railing with no overlay increase and no pilasters is 350 plf.



- ⑦ Provide rail joints at ends of all spans the same width as Slab joint opening, except that Rail Joints over construction joints must be $\frac{1}{4}$ " Min to $\frac{3}{4}$ " Max in width. Joints must be open if slab joint opening is not sealed. Joints over construction joints and over sealed deck joints must be plugged. Forming material used in joints may be left in place if it is light in color and compressible, such as the following materials: polystyrene, molded cork granules, sponge rubber sheet, etc. If forming material is not left in place, plug the bottom 6" with slab joint sealing compound to prevent drainage and staining.
- ⑨ Increase 2" for structures with overlay.
- ⑪ Construction year (use if shown elsewhere on plans) 3" High "Plantin Bold" Typeface with $\frac{1}{4}$ " recess. Placed at one Abutment only or as directed by the Engineer.
- ⑬ Dimensions must be the same on each side of joint.
- ⑮ For raised sidewalks, add sidewalk height to total bar height. Use sidewalk height at rail's location.
- ⑰ Reduce by 2" or field bend over Preformed Bituminous Fiber Material to gain cover.
- ⑲ Bronze Star dimensions of the final product can be slightly smaller due to shrinkage after casting.

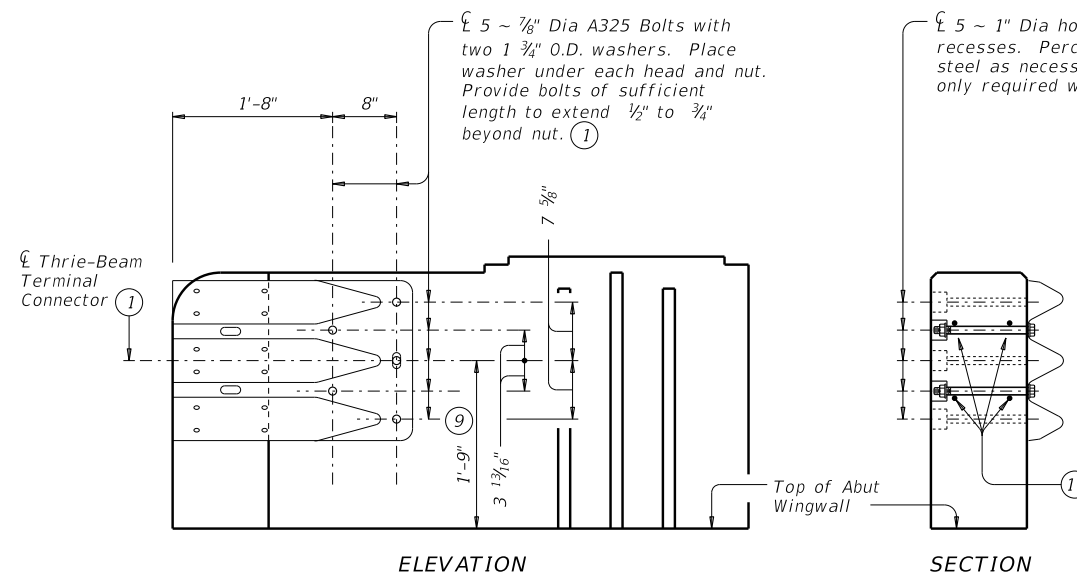
Cover dimensions are clear dimensions, unless noted otherwise.
Reinforcing bar dimensions shown are out-to-out of bar.

DATE: _____
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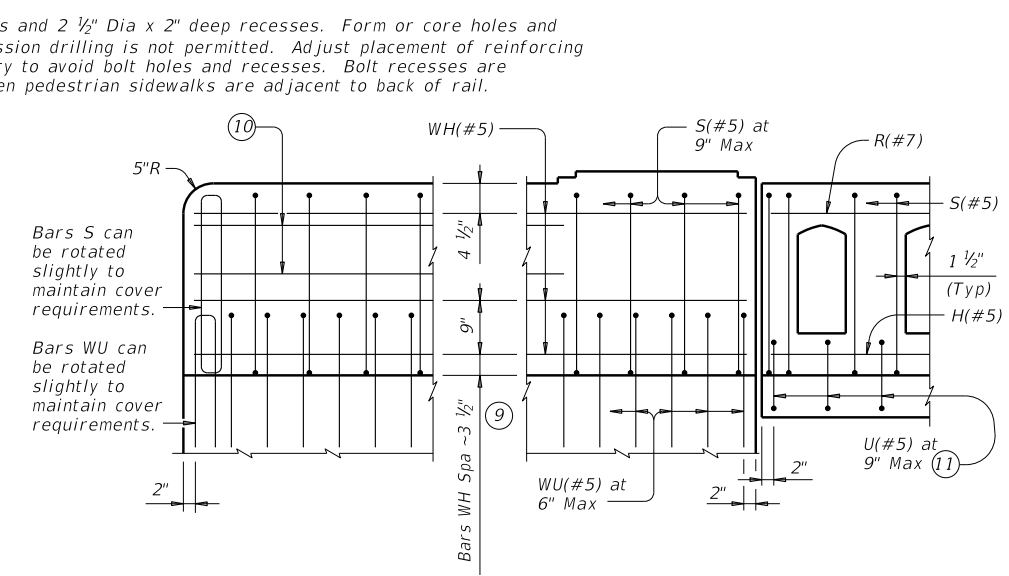
ROADWAY ELEVATION OF RAIL

- ① Terminal Connectors and associated hardware are to be paid for under the Item "Metal Beam Guard Fence". Attach Metal Beam Guard Fence Transitions to the bridge unless otherwise shown in the plans.
- ② Number of windows in exterior bays are equal.
- ③ Number of windows in interior bay(s) are not less than the amount in exterior bays (Note 2).
- ④ Space Span Pilasters at 1/3 span length (Approx) when spans are 100 ft and less, as shown. Space Span Pilasters at 1/5 span length (Approx) for spans greater than 100 ft.
- ⑤ Dimension is the same for all posts adjacent to Span Pilasters in a span. Dimension may vary from span to span, Min = 3", Max = 7 1/2".
- ⑥ Min = 6", Max = 1'-3".
- ⑦ Provide rail joints at ends of all spans the same width as Slab joint opening, except that Rail Joints over construction joints must be 1/4" Min to 3/4" Max in width. Joints must be open if slab joint opening is not sealed. Joints over construction joints and over sealed deck joints must be plugged. Forming material used in joints may be left in place if it is light in color and compressible, such as the following materials: polystyrene, molded cork granules, sponge rubber sheet, etc. If forming material is not left in place, plug the bottom 6" with slab joint sealing compound to prevent drainage and staining.
- ⑧ Place Preformed Bituminous Fiber Material between slab and rail when rail extends over expansion joint. Shift Bars U as necessary.
- ⑨ Increase 2" for structures with overlay.
- ⑩ Place 4 additional Bars WH(#5) 3'-8" in length inside Bars S(#5) and centered 2'-0" from end of rail when Terminal Connections are required. Field bend as needed.
- ⑪ Shift U Bars from region below 1/2" Preformed Bituminous Fiber Material at joints.



TERMINAL CONNECTION DETAILS

(Showing parapet with Pilaster on 6'-0" Wingwall)



ELEVATION SHOWING
TYPICAL REINFORCING PLACEMENT

The use of this railing is restricted to speeds of 45 mph or less.

SHEET 1 OF 2



Texas Department of Transportation

**Bridge
Division
Standard**

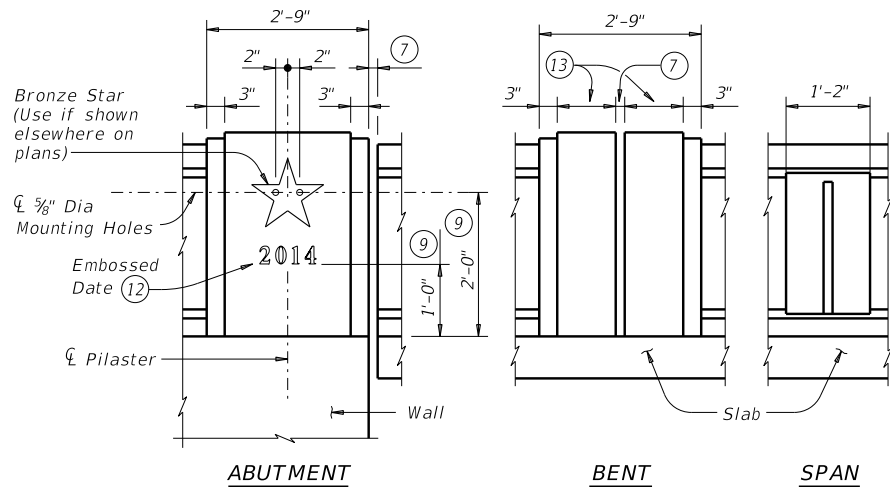
TRAFFIC RAIL
TEXAS CLASSIC

TYPE T411

FILE: r1std008.dgn		DN: TxDOT	CK: TxDOT	DW: TxDOT	CK: TxDOT
☒ TxDOT July 2014 REVISIONS	CONT	SECT	JOB		HIGHWAY
	DIST	COUNTY			SHEET NO.

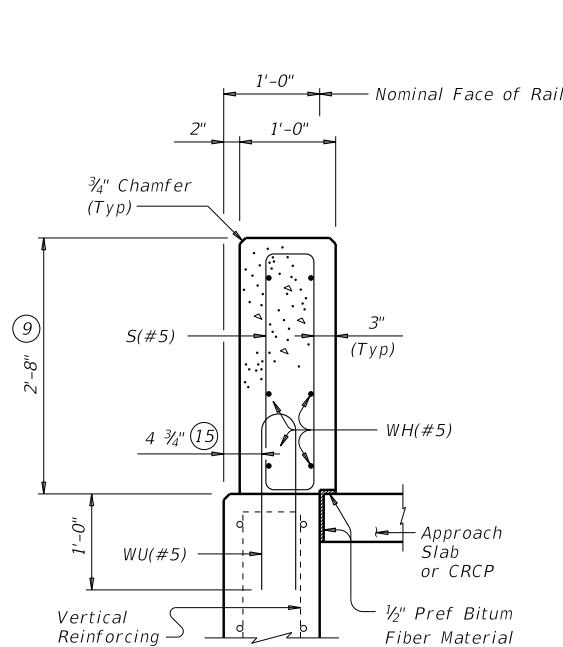
DISCLAIMER: The use of this standard is governed by the "Texas Engineering Practice Act". No warranty of any kind is made by TxDOT for any purpose whatsoever. TxDOT assumes no responsibility for the conversion of this standard to other formats or for incorrect results or damages resulting from its use.

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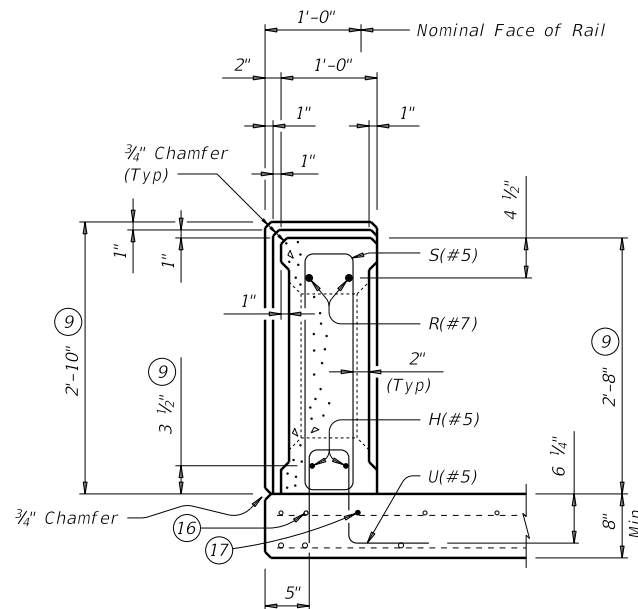


EXTERIOR PILASTER ELEVATIONS

- ⑦ Provide rail joints at ends of all spans the same width as Slab joint opening, except that Rail Joints over construction joints must be $\frac{1}{4}$ " Min to $\frac{3}{4}$ " Max in width. Joints must be open if slab joint opening is not sealed. Joints over construction joints and over sealed deck joints must be plugged. Forming material used in joints may be left in place if it is light in color and compressible, such as the following materials: polystyrene, molded cork granules, sponge rubber sheet, etc. If forming material is not left in place, plug the bottom 6" with slab joint sealing compound to prevent drainage and staining.
- ⑨ Increase 2" for structures with overlay.
- ⑫ Construction year (use if shown elsewhere on plans) 3" High "Plantin Bold" Typeface with $\frac{1}{4}$ " recess. Placed at one Abutment only or as directed by the Engineer.
- ⑬ Dimensions must be the same on each side of joint.
- ⑭ Reduce by 2" or field bend over Preformed Bituminous Fiber Material to gain cover.
- ⑮ 5 $\frac{1}{4}$ " when vertical reinforcing has closer clear cover over horizontal reinforcing in abutment wingwalls or retaining walls on traffic side of wall.
- ⑯ As an aid in supporting reinforcement, additional longitudinal bars may be used in the slab with the approval of the Engineer. Such bars must be furnished at the Contractor's expense.
- ⑰ Top longitudinal slab bar may be adjusted laterally 3" plus or minus to tie reinforcing.
- ⑱ Bronze Star dimensions of the final product can be slightly smaller due to shrinkage after casting.

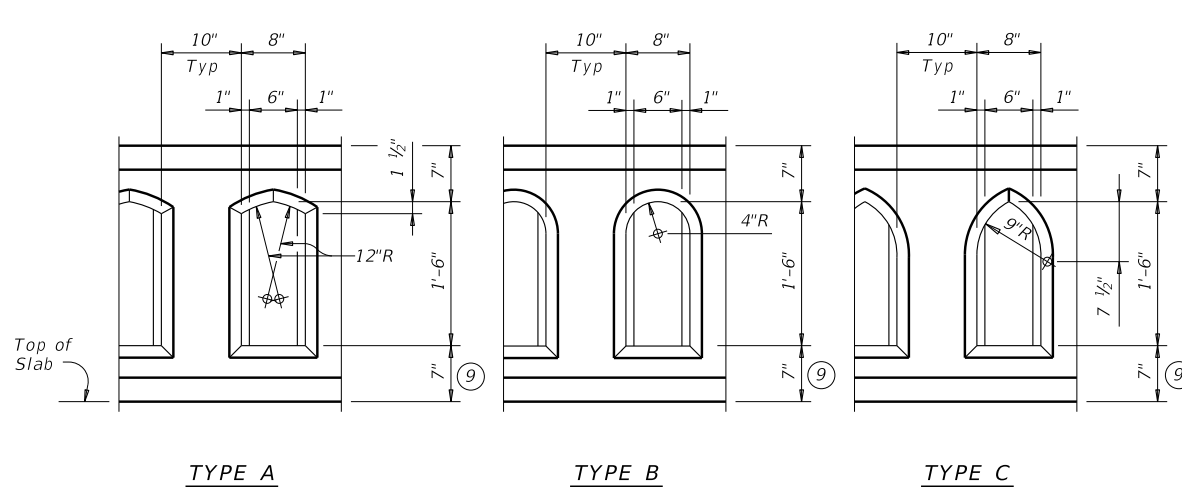


ON ABUTMENT WINGWALLS
OR CIP RETAINING WALLS

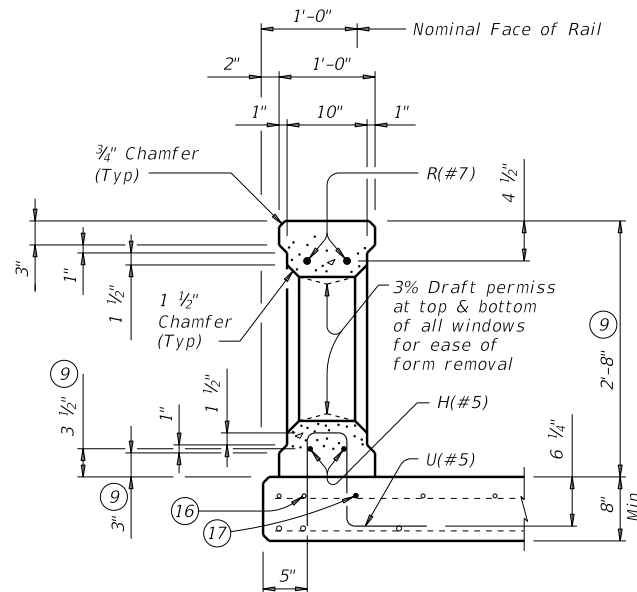
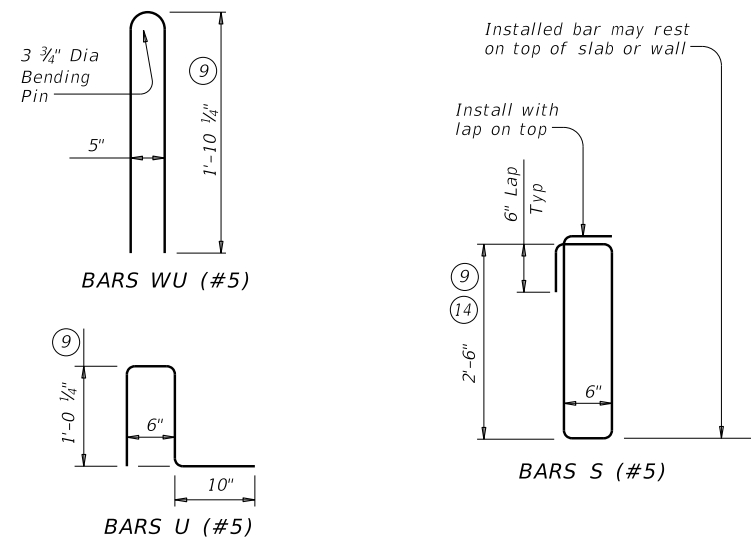


SECTION THRU
POST ON BRIDGE SLAB
(Showing Pilaster)

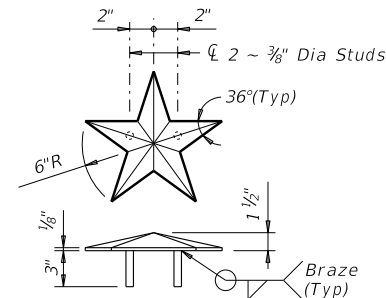
SECTIONS THRU RAIL



WINDOW TYPES



SECTION THRU
WINDOW ON BRIDGE SLAB



BRONZE STAR DETAIL¹⁸

Two known manufacturers are:

- Kassons Castings
Austin, Texas
- Southwell Company
San Antonio, Texas

CONSTRUCTION NOTES:

Attach Bronze Star with a Type III Class C epoxy. Clamp star until epoxy achieves set. Remove any visible epoxy "squeeze out" from under star.

Face of rail and pilasters, parapet must be plumb unless otherwise approved.

Apply a one rub finish to all railing surfaces unless otherwise shown elsewhere on the plans.

MATERIAL NOTES:

Provide Class "C" concrete for railing. Provide Class "C" (HPC) concrete if shown elsewhere in the plans.

Provide Grade 60 reinforcing steel.

Provide bar laps, where required, as follows:

Uncoated ~ #5 = 1'-9"

Uncoated ~ #7 = 2'-9"

Epoxy coated ~ #5 = 2'-7"

Epoxy coated ~ #7 = 4'-1"

Epoxy coat all rail reinforcement if slab bars are epoxy coated.

Bronze Star must be cast of architectural bronze having the following composition: Copper 85 %, Tin 5 %, Lead 5 %, Zinc 5 %.

GENERAL NOTES:

This rail was evaluated based on the results of previous crash tests and approved for a NCHRP Report 350 TL-2 rating. This rail is only approved for low speed use, speeds of 45 mph and less.

Do not use this railing on bridges with expansion joints providing more than 5" movement.

Rail anchorage details shown on this standard may require modification for select structure types. See appropriate details elsewhere in plans for these modifications.

Shop drawings will not be required for this rail.

See Bridge Layout or other plan sheets for the following: dimensions with the number of span pilasters, dimensions with the number of windows, window type, inclusion of bronze stars, inclusion of construction year with abutment identity.

Submit erection drawings showing span number, span pilaster locations, number of windows between pilasters and spacing to first window (see Note 6) to the Engineer for approval.

Average weight of railing with no overlay increase and no pilasters is 270 plf.

Cover dimensions are clear dimensions, unless noted otherwise.
Reinforcing bar dimensions shown are out-to-out of bar.

SHEET 2 OF 2

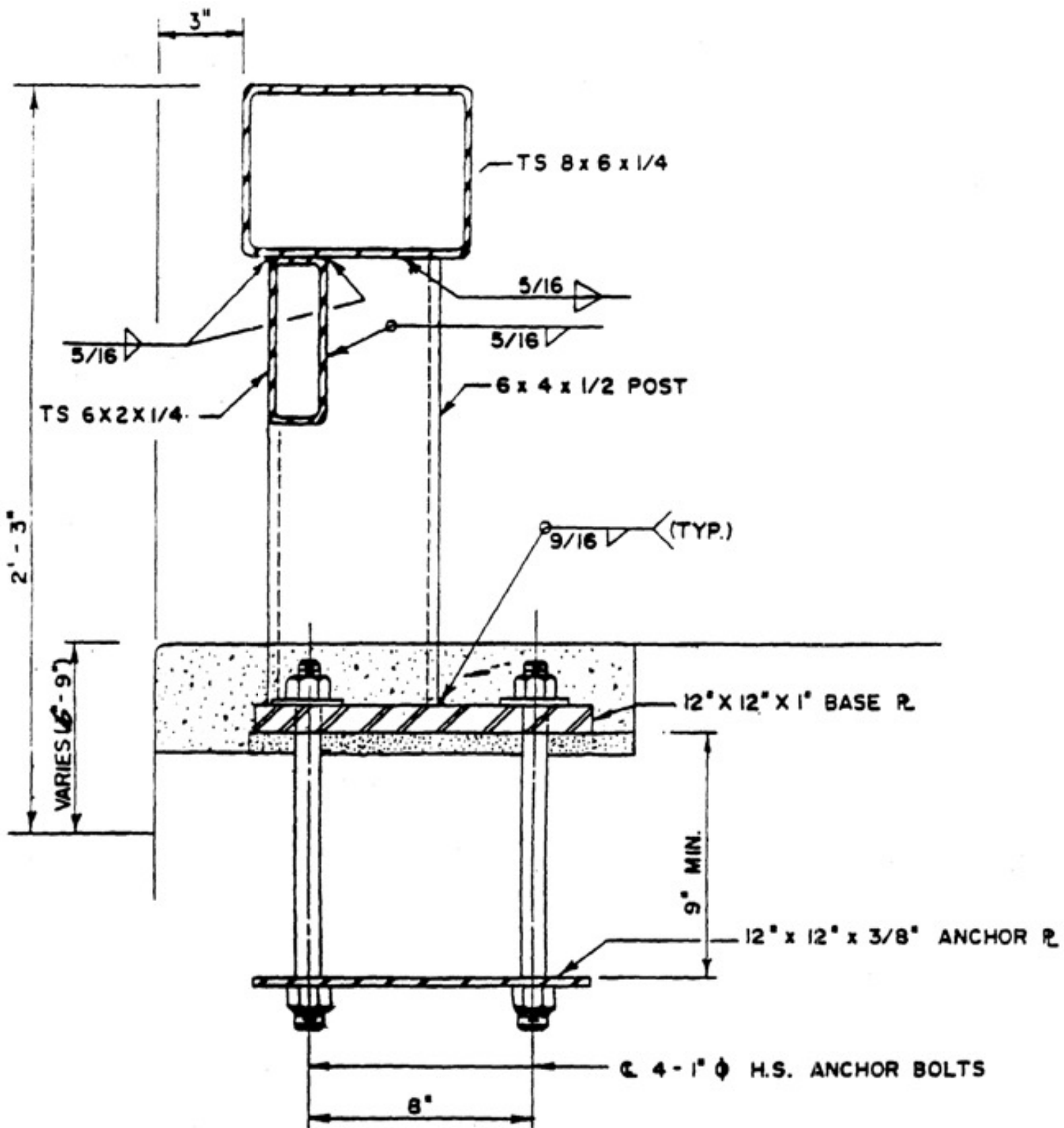


TRAFFIC RAIL TEXAS CLASSIC

TYPE T411

FILE: r1st0008.dgn	DN: TxDOT	CK: TxDOT	DW: TxDOT	CK: TxDOT
©TxDOT July 2014	CONT	SECT	JOB	HIGHWAY
REVISIONS				
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Washington D.C. Historic Bridge Rail Retrofit (curb mount)

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