

Development of a Thrie Beam Retrofit for Upgrading Obsolete Bridge Railings

2019-23-BR

PS Developers

Carlos Torres, Michigan DOT; Derwood Sheppard, FLDOT, Alex Bardow, MASSDOT, Alex Lim

Project Synopsis

- Design and Test a new Thrie-Beam retrofit bridge rail closely spaced posts anchored to a 9-inch high concrete curb to meet MASH TL-3

Project Goal

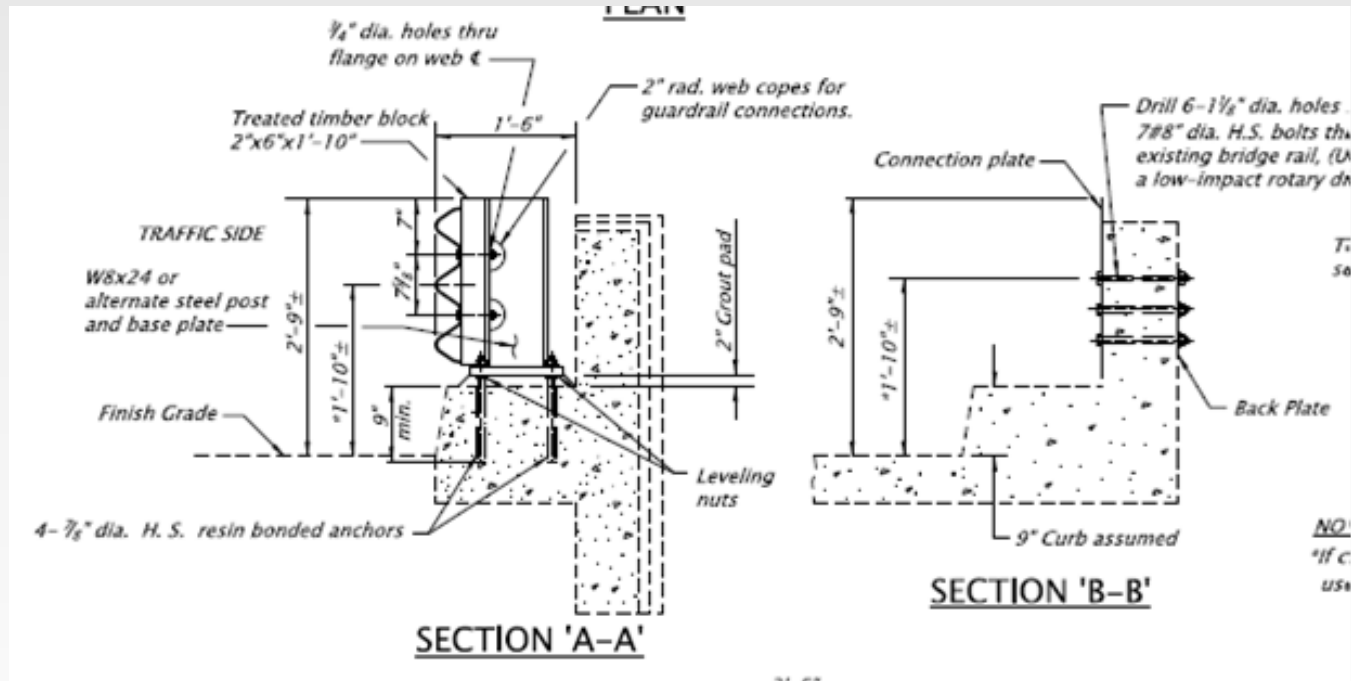
A Thrie Beam retrofit bridge rail that is MASH TL-3 compliant

Project Background

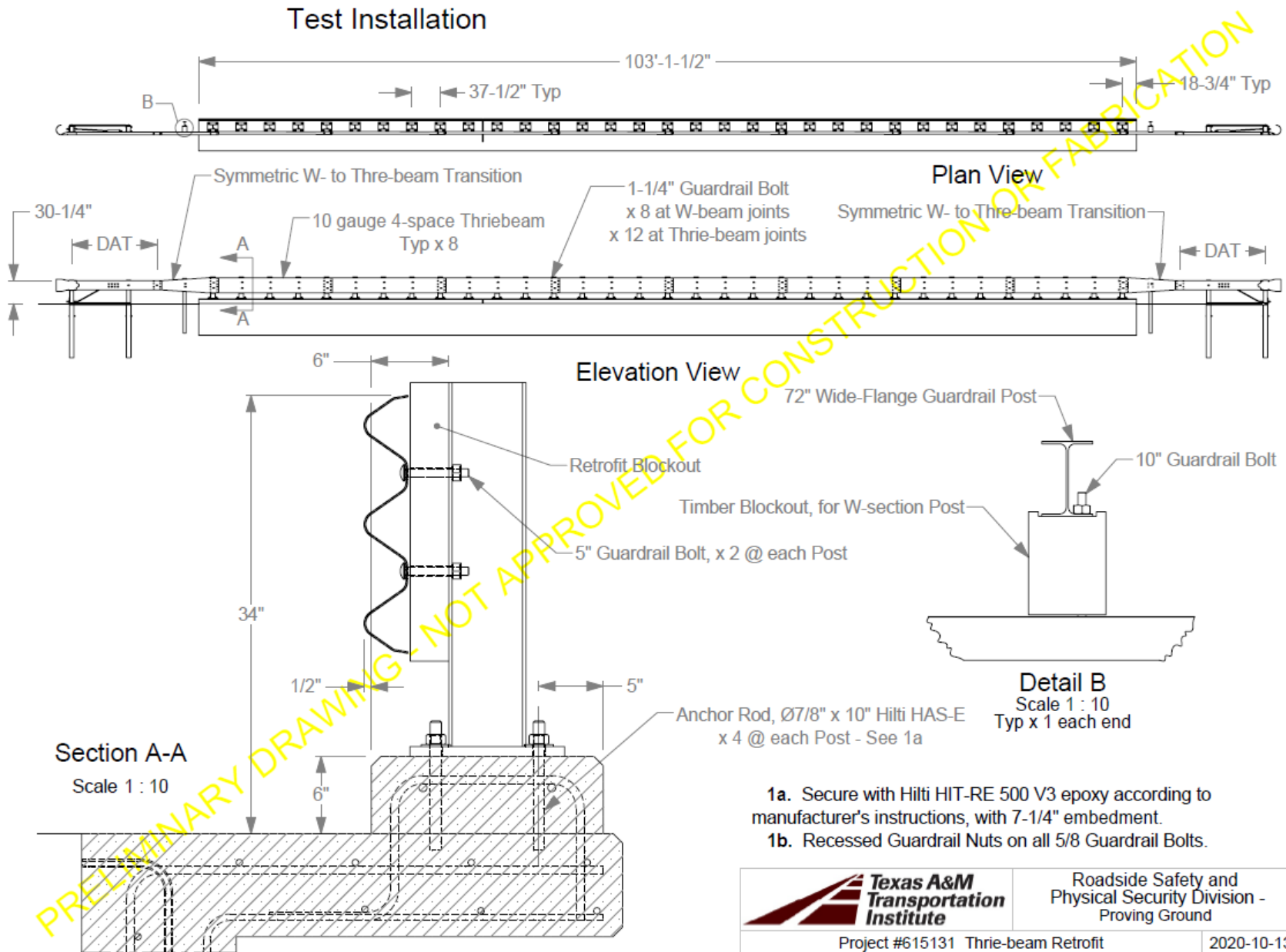
- Interest nationally in this problem statement for MASH TL-3
- Oregon DOT & Several other State standard details to consider and use as follows.
- We had a kick-off meeting on October 6, 2020 to discuss the design(s) to consider moving forward

Development of a Thrie Beam Retrofit for Upgrading Obsolete Bridge Railings

- Proposed Oregon Design to consider:

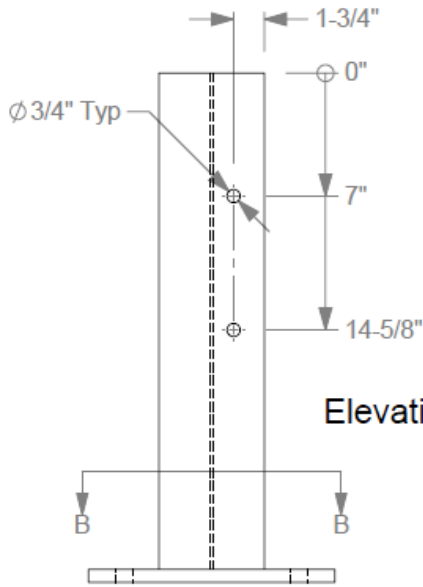


Details from our October 06, 2020 Meeting

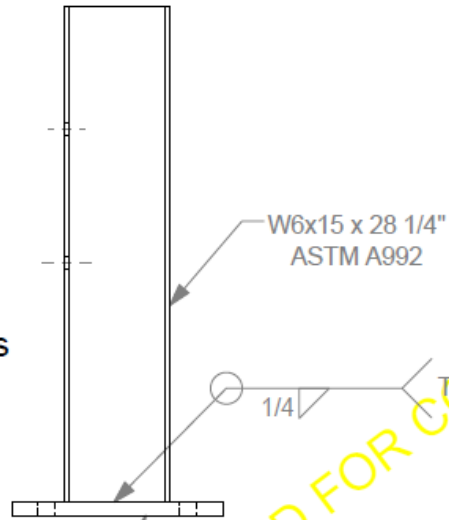


Roadside Safety and Physical Security Division - Proving Ground

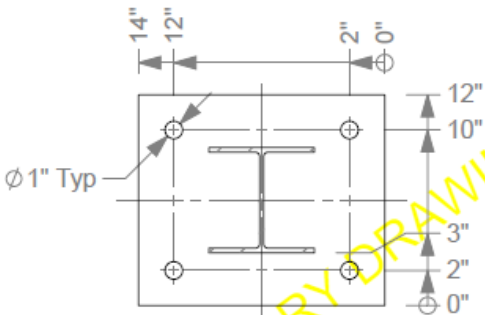
Post Details



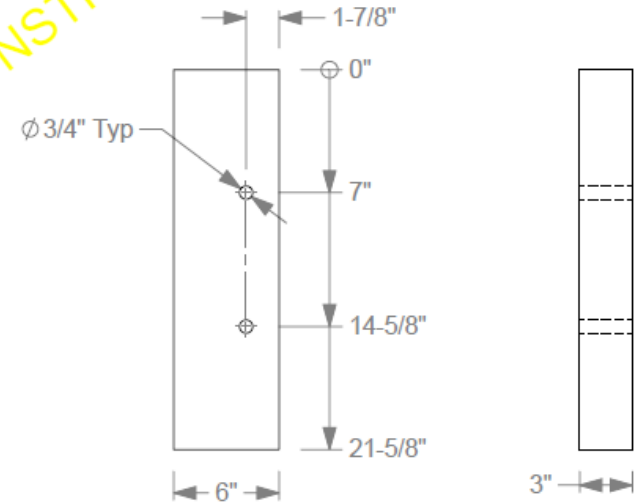
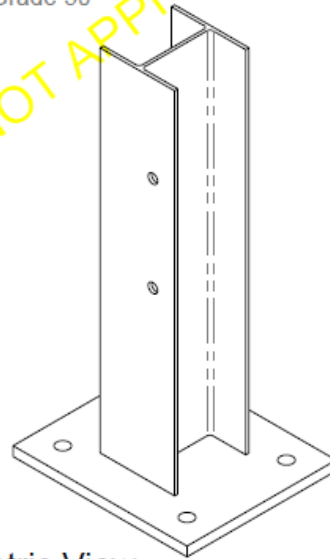
Elevation Views



Plate, 14" x 3/4" x 12"
ASTM A572 Grade 50



Section B-B



Retrofit Blockout

Timber blockout treated with a preservative in accordance with AASHTO M 133 after all cutting and drilling.



Roadside Safety and Physical Security Division - Proving Ground

Project #615131 Thrie-beam Retrofit

2020-10-13

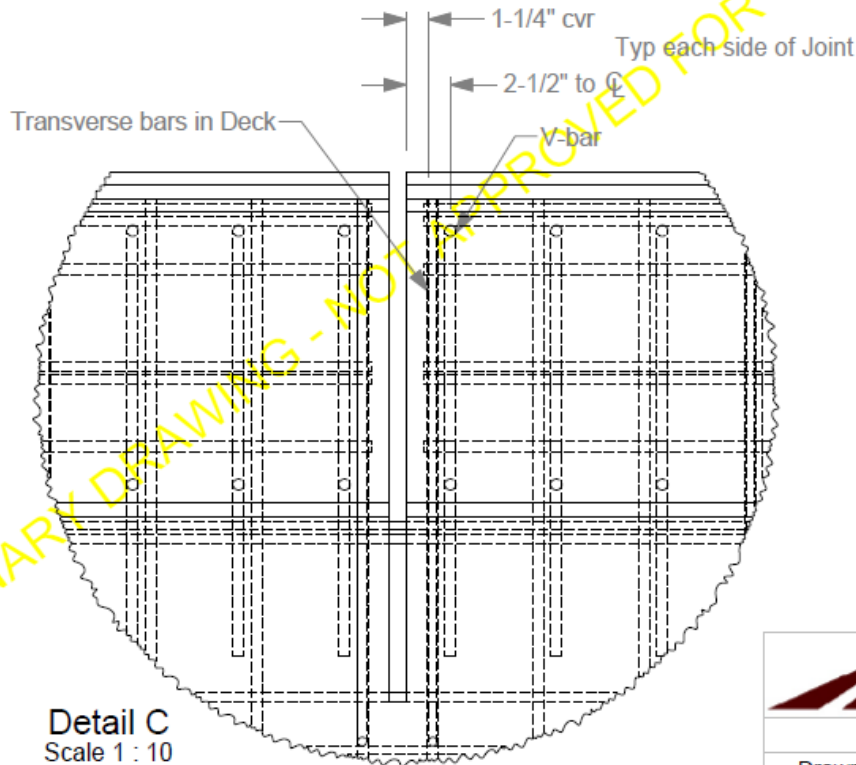
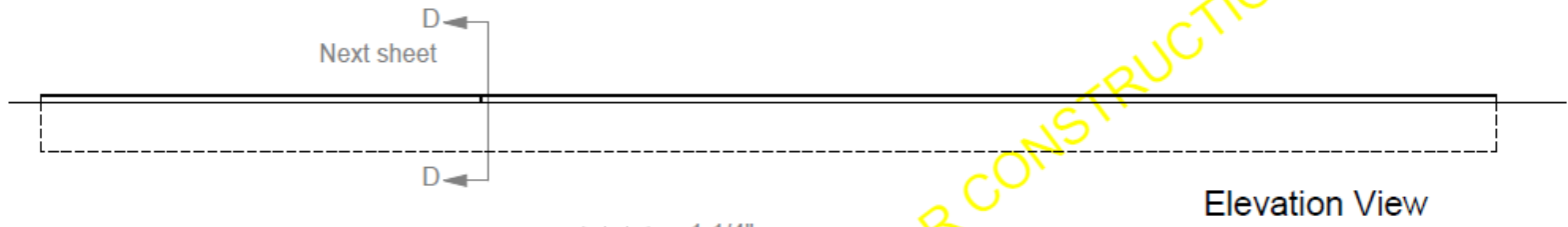
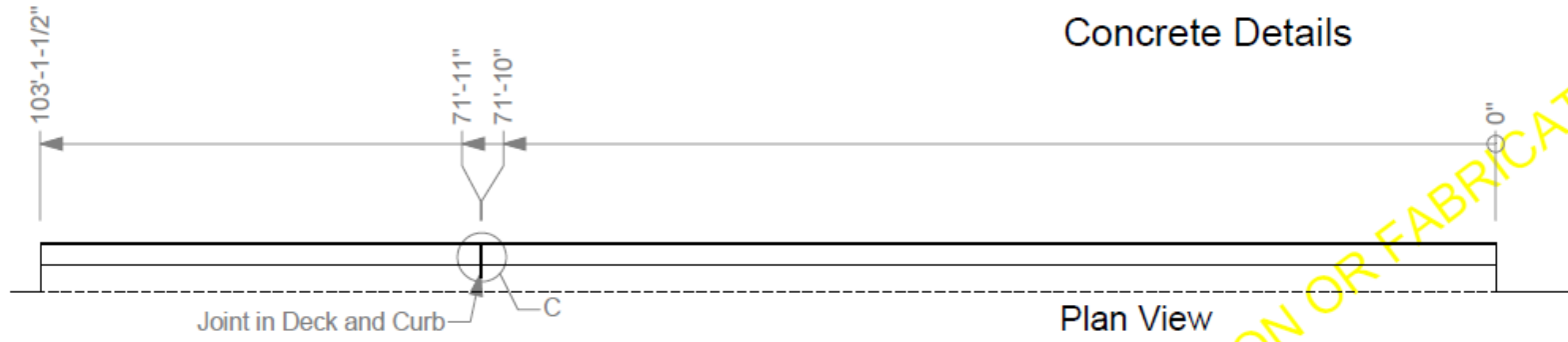
Drawn by GES

Scale 1:10

Sheet 2 of 5 Post Details

PRELIMINARY DRAWING - NOT APPROVED FOR CONSTRUCTION OR FABRICATION

Concrete Details



PRELIMINARY DRAWING - NOT APPROVED FOR CONSTRUCTION OR FABRICATION



Roadside Safety and
Physical Security Division -
Proving Ground

Project #615131 Thrie-beam Retrofit

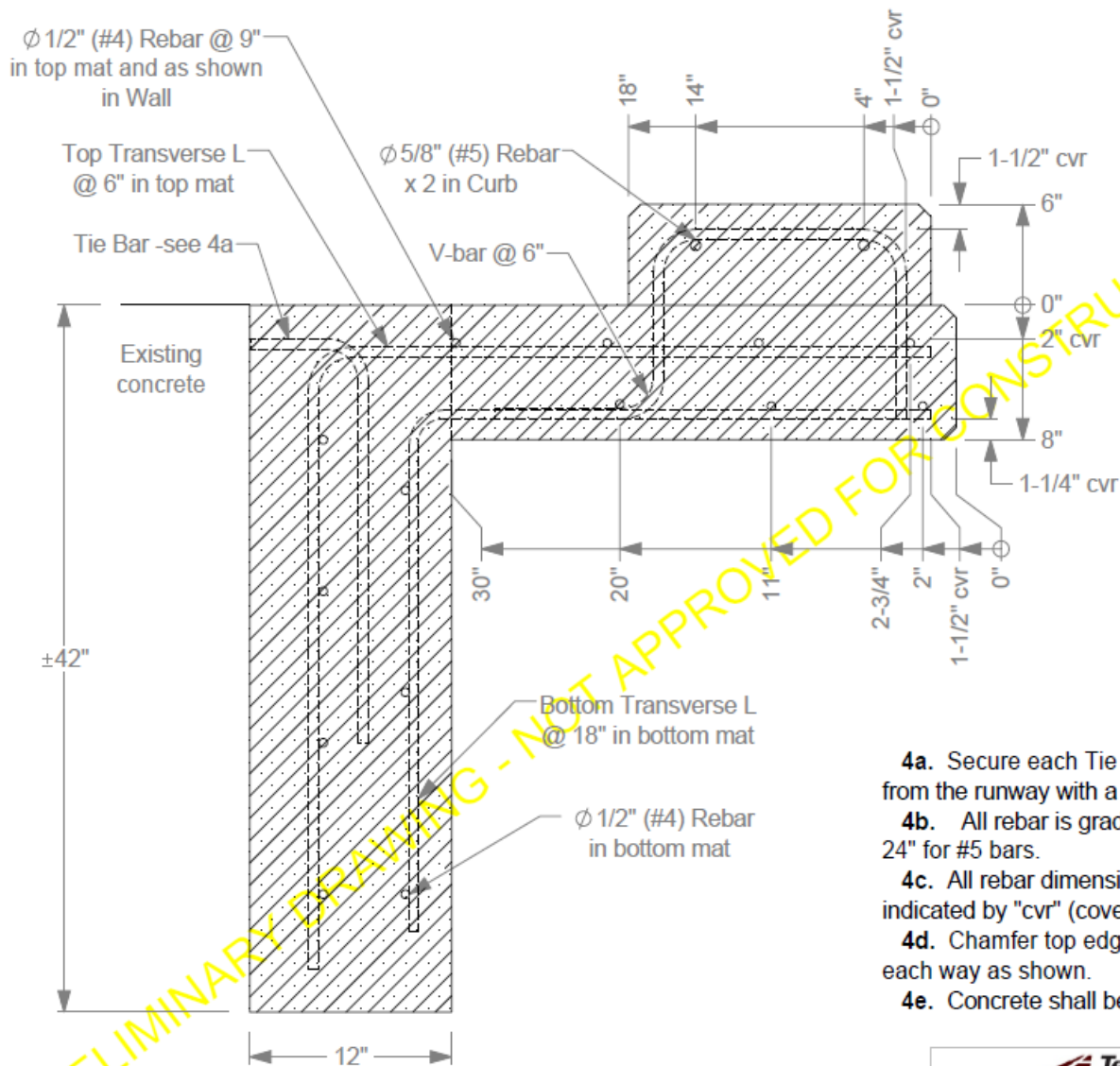
2020-10-13

Drawn by GES

Scale 1:150

Sheet 3 of 5 Concrete Details

Section D-D



- 4a.** Secure each Tie Bar to existing rebar (not shown here) protruding from the runway with a minimum 3" weld. Maximum spacing is 18".
4b. All rebar is grade 60. Minimum rebar lap is 19" for #4 bars and 24" for #5 bars.
4c. All rebar dimensions are to center of bar unless otherwise indicated by "cvt" (cover).
4d. Chamfer top edges of Curb and field side edges of Deck 3/4" each way as shown.
4e. Concrete shall be TxDOT Class S (4000psi).



Roadside Safety and
Physical Security Division -
Proving Ground

Project #615131 Thrie-beam Retrofit

2020-10-13

Drawn by GES

Scale 1:10

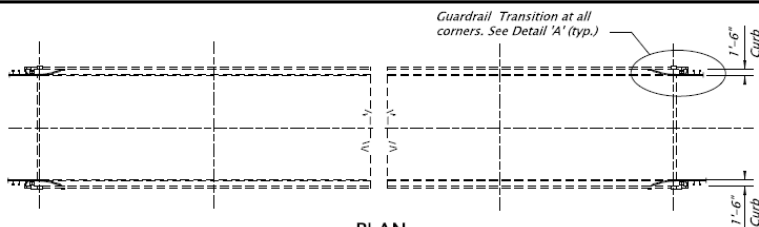
Sheet 4 of 5 Concrete Section



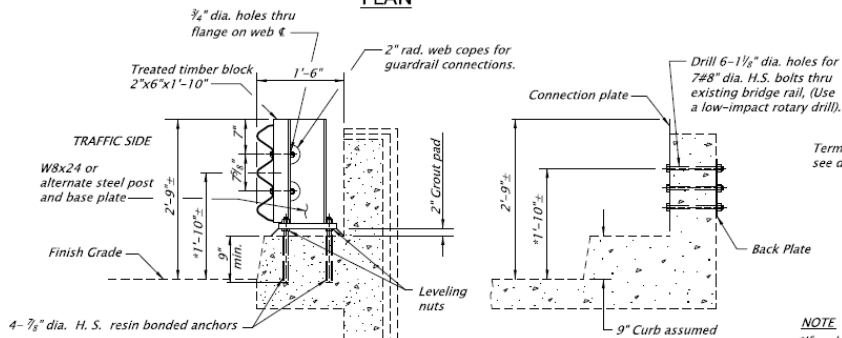
Lives, Time and Resources
Lives, Time and Resources
Lives, Time and Resources



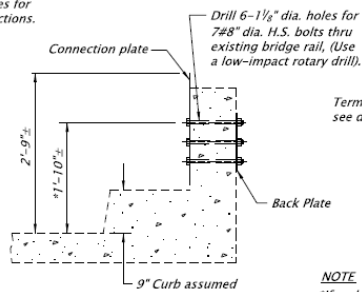
Oregon DOT – BR270



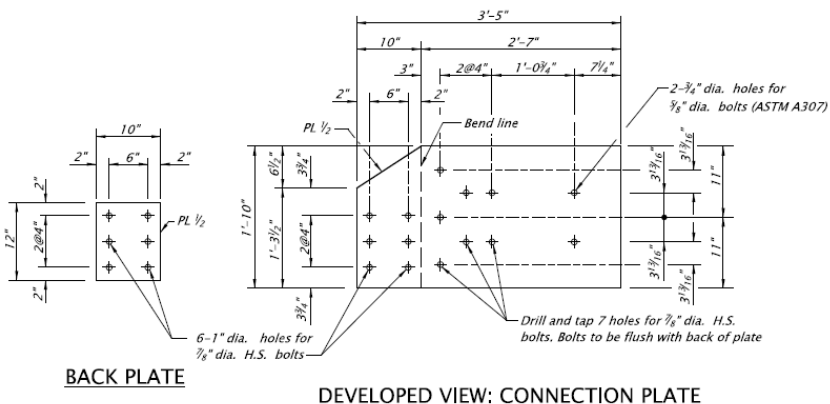
PLAN



SECTION 'A-A'

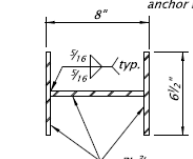


SECTION 'B-B'

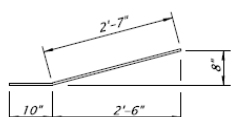


BACK PLATE

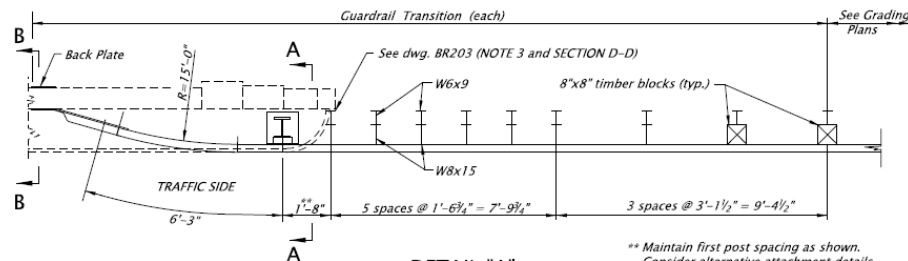
DEVELOPED VIEW: CONNECTION PLATE



ALTERNATE POST



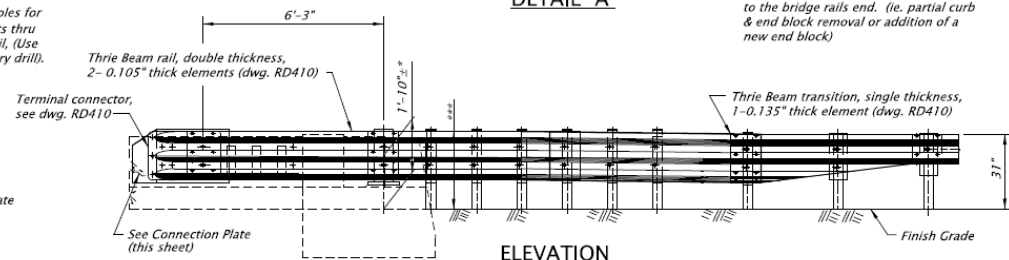
CONNECTION PLATE BEND DETAILS



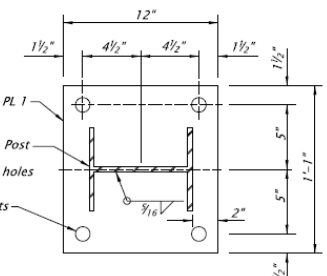
DETAIL "A"

** Maintain first post spacing as shown. Consider alternative attachment details to the bridge rails end. (ie. partial curb & end block removal or addition of a new end block)

NOTE
If curb height is less than 8", use 1'-9 1/2" for this dimension.



ELEVATION



BASE PLATE DETAILS

GENERAL NOTES
 Provide non-epoxy grout for the 2" nominal grout pads as noted in Section 02080.
 Provide structural steel conforming to AASHTO Specification M183 (ASTM A36).
 Provide all H.S. bolts conforming to AASHTO M164 (ASTM A325). Provide and install High Strength resin bonded anchors (Grade 105) according to ODOT Specification 00535.
 Hot-dip galvanize all anchor rods, washers, and nuts after fabrication. Hot-dip galvanize all connection plate bolts, plates, and washers after fabrication of plates.
 Field verify before fabrication.

***Transition top of rail height to match 31" approach rail.

Accompanied by dwgs. BR203, RD405, RD410

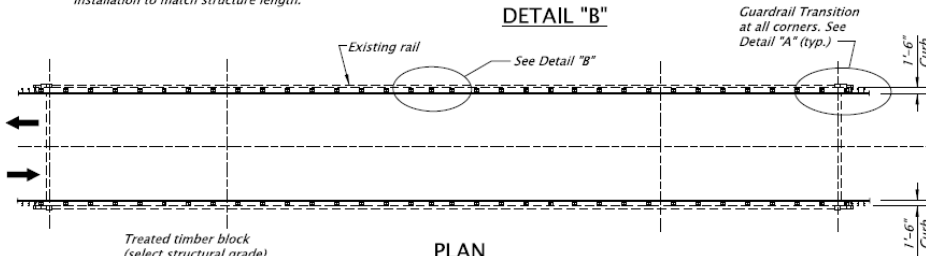
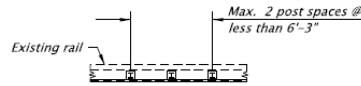
CALC. BOOK NO. _____	BASILINE REPORT DATE <u>20-April-2018</u>
NOTE: All material and workmanship shall be in accordance with the current Oregon Standard Specifications	
OREGON STANDARD DRAWINGS	
RAIL TRANSITION FROM FLEX BEAM RAIL TO CURB AND PARAPET RAIL	
2018	
DATE	REVISION DESCRIPTION

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.



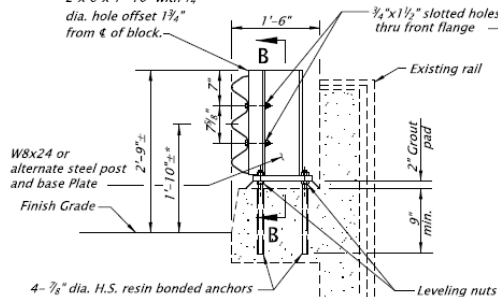
Oregon DOT – BR273

NOTE
 Maintain post spacing at 6'-3"
 full length of structure.
 A maximum of 2 non-standard post
 spaces may be used to adjust the rail
 installation to match structure length.



Treated timber block
 (select structural grade)
 2'x 6"x 1'-10" with 3/4"
 dia. hole offset 1 1/4"
 from 4. of block.

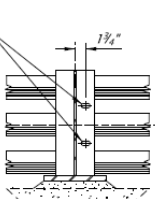
PLAN



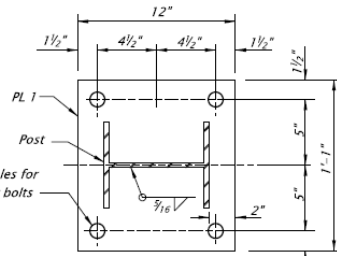
SECTION A-A

NOTE
 If curb height is less than 8",
 use 1'-9 1/2" for this dimension.

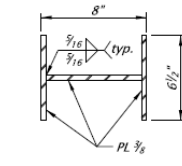
Note to Designer:
 1. Check Structural Capacity
 of the existing curb/deck
 for anchorage.
 2. Check Structural Capacity
 of the existing bridge deck
 overhang.



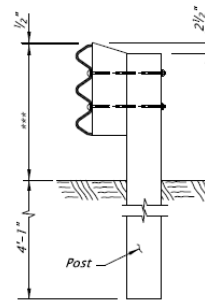
SECTION B-B



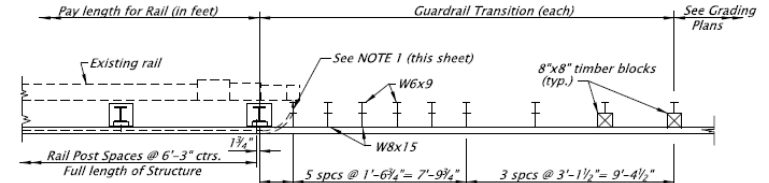
BASE PLATE DETAILS



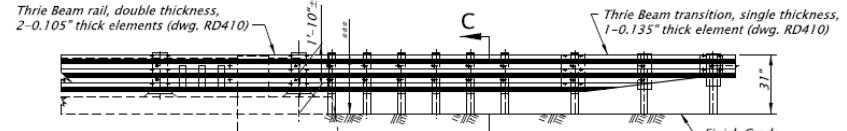
ALTERNATE POST



SECTION C-C



DETAIL "A"



ELEVATION

NOTE 1
 Transition posts may be steel W6x9
 or timber 8"x 8". All posts to be
 of same material.

** Maintain first post-spacing as shown.
 Consider alternative attachment details
 to the bridge rail's end. (i.e. partial curb
 and end block removal or addition of a
 new end block)

***Transition top of rail height
 to match 31" approach rail.

GENERAL NOTES

Provide non-epoxy grout for the 2" nominal grout pads in Section 02080.
 Provide and install High Strength resin bonded anchors (Grade 105) according to
 ODOT Specification 00535.
 Provide all structural steel conforming to AASHTO Specification M183 (ASTM A36).
 Hot-dip galvanize all posts, anchor rods, washers, and nuts be after fabrication.
 Field verify dimensions before fabrication.

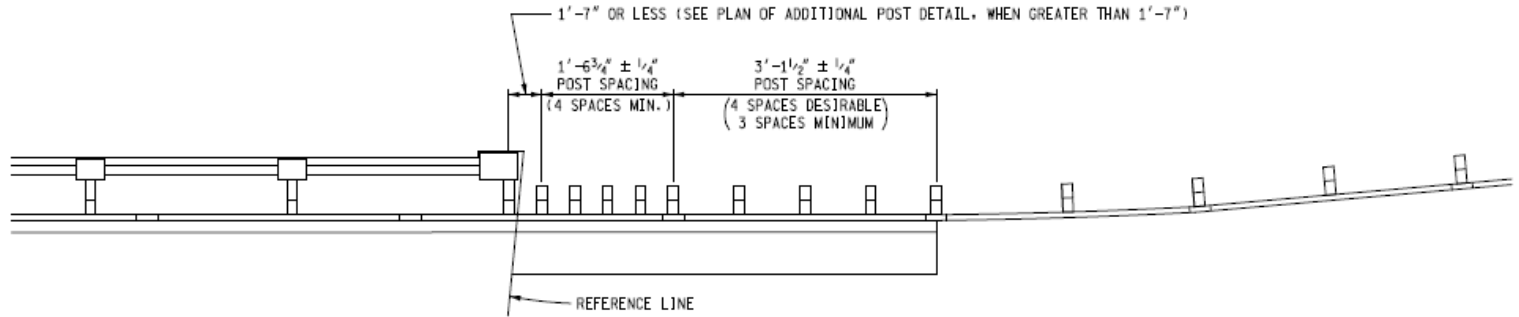
Accompanied by dwgs. RD405, RD410

CALC. BOOK NO. _____	BASLINE REPORT DATE: 20-April-2018
NOTE: All material and workmanship shall be in accordance with the current Oregon Standard Specifications	
OREGON STANDARD DRAWINGS	
THREE-BEAM RAIL RETROFIT FOR CURB AND PARAPET RAIL CONNECTION DETAILS	
2018	
DATE: 5/25/18	REVISION DESCRIPTION: Added Note for designer

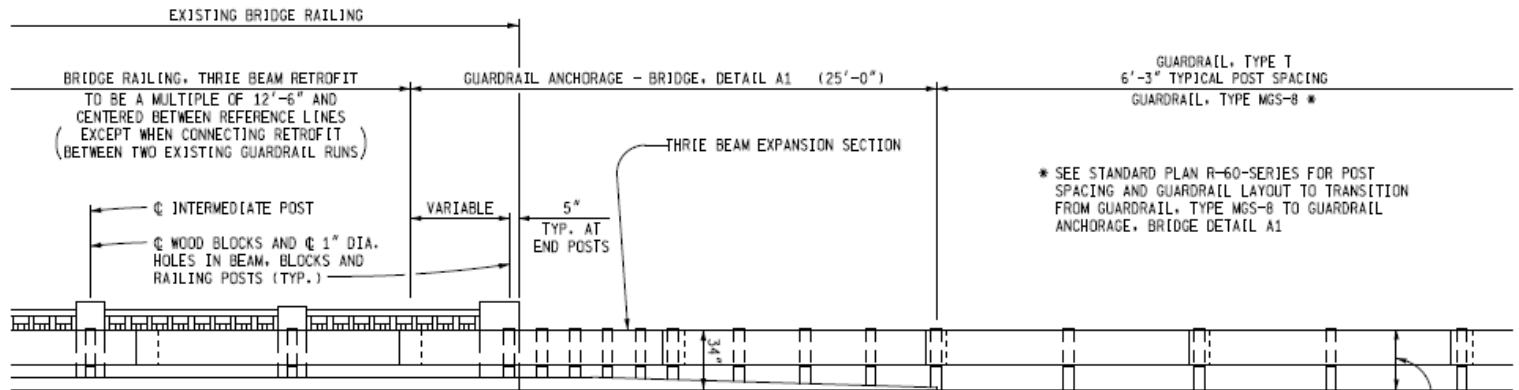
The selection and use of this Standard Drawing, while designed in accordance with generally accepted engineering principles and practices, is the sole responsibility of the user and should not be used without consulting a Registered Professional Engineer.

Michigan DOT Guardrail Retrofit on Bridges

 Michigan Department of Transportation	PREPARED BY: _____ DESIGN DIVISION: _____ DRAWN BY: _____ CHECKED BY: _____	DEPARTMENT DIRECTOR Paul C. Alegria
APPROVED BY: _____ DIRECTOR, BUREAU OF DEVELOPMENT	APPROVED BY: _____ DIRECTOR, BUREAU OF FIELD SERVICES	
F.H.A. APPROVAL PLAN DATE: 2-13-2019	MICHIGAN DEPARTMENT OF TRANSPORTATION BUREAU OF DEVELOPMENT STANDARD PLAN FOR BRIDGE RAILING, THRIE BEAM RETROFIT (R4 TYPE BRIDGE RAILING)	B-22-E SHEET 1 OF 4



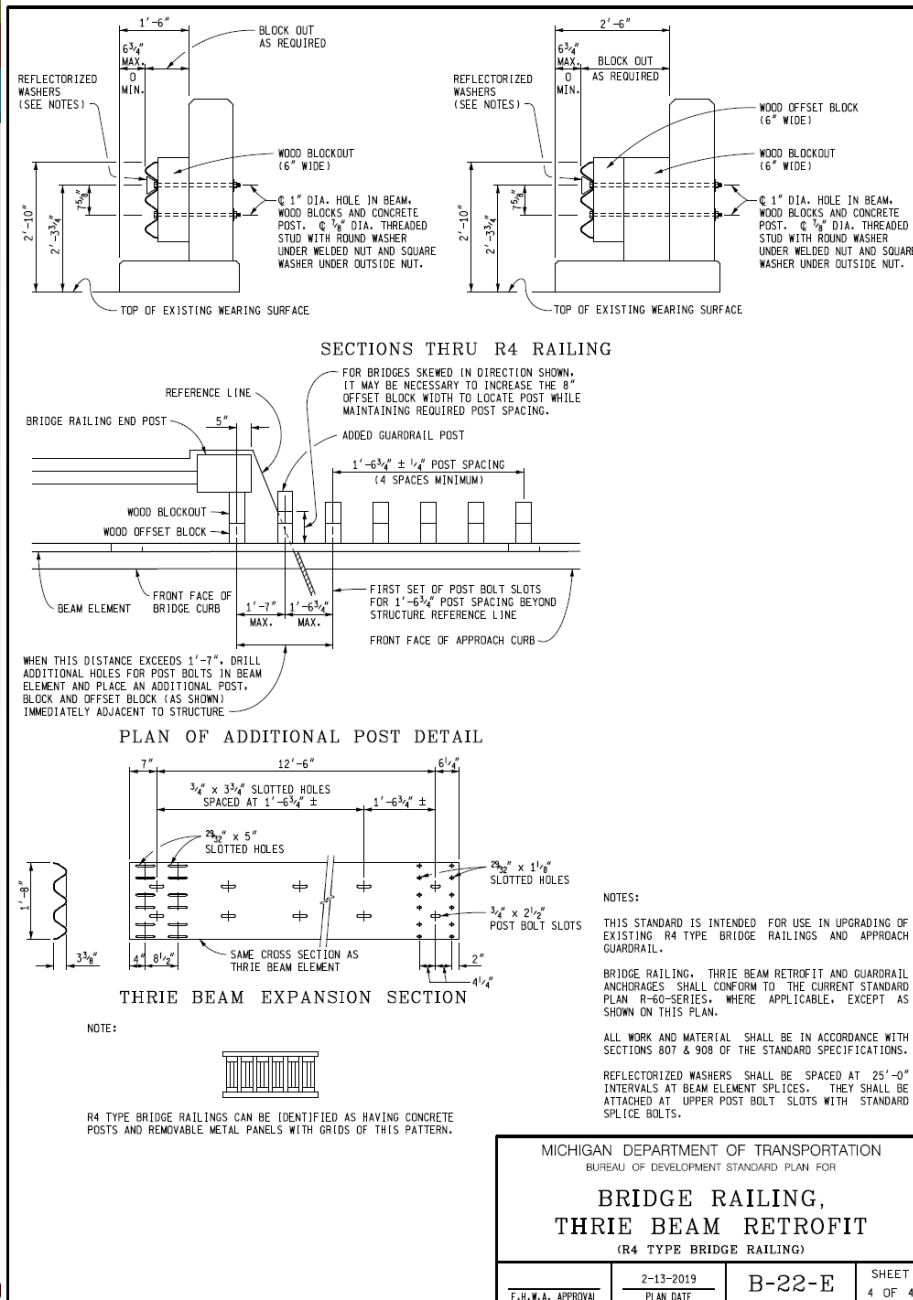
PLAN



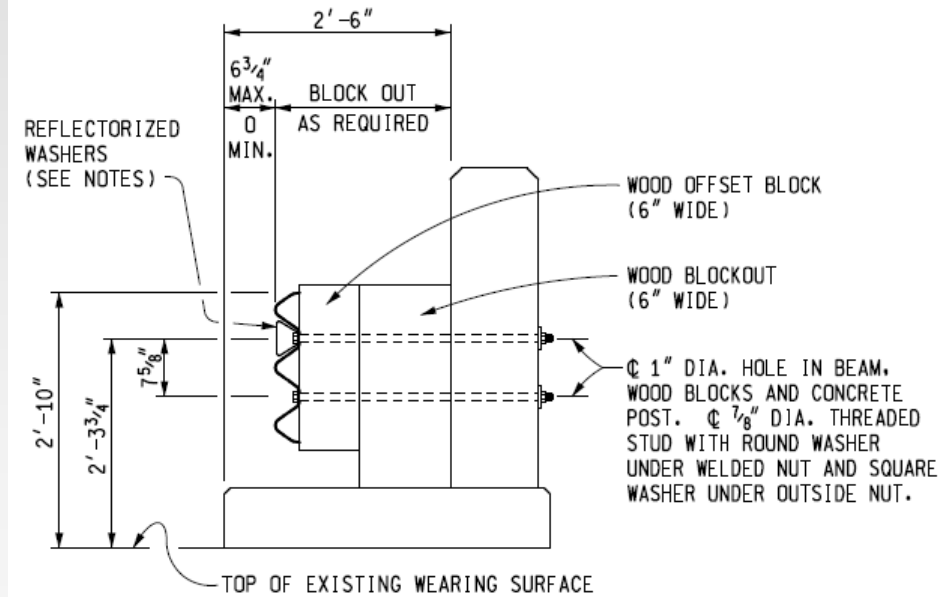
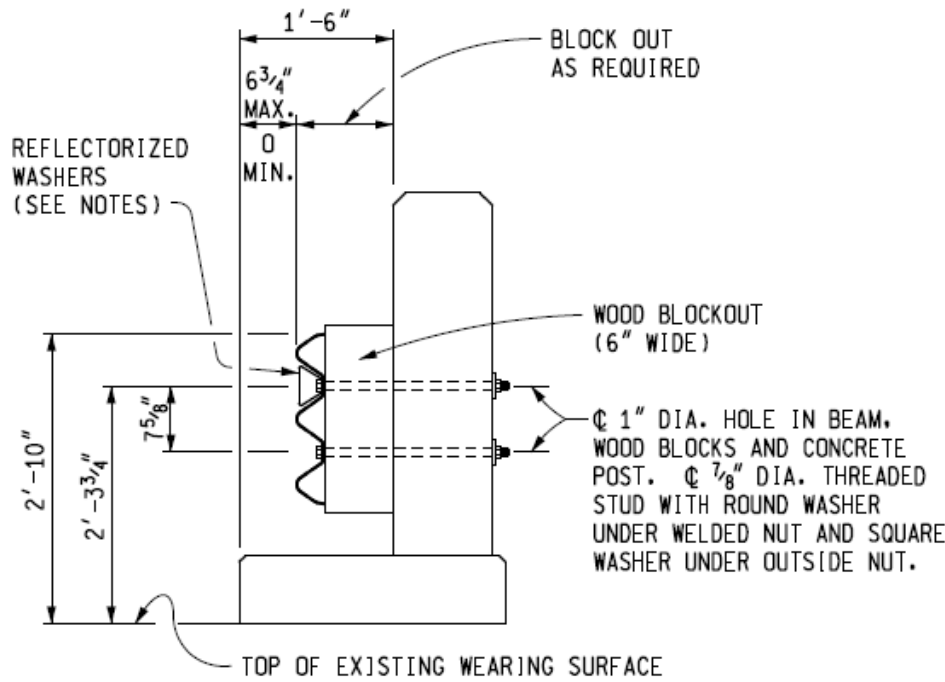
ELEVATION

BRIDGE RAILING, THRIE BEAM RETROFIT AND APPROACH GUARDRAIL
 (FOR USE WITH BEAM GUARDRAIL, TYPE T, TYPE MGS-0, & MGS-8)

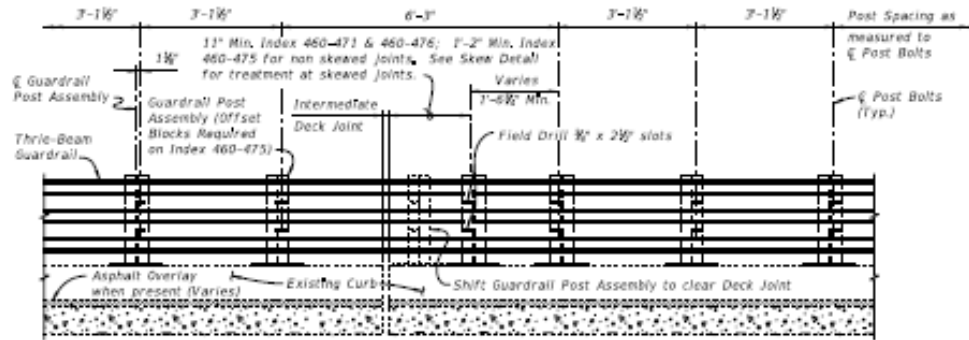
Michigan DOT Guardrail Retrofit on Bridges



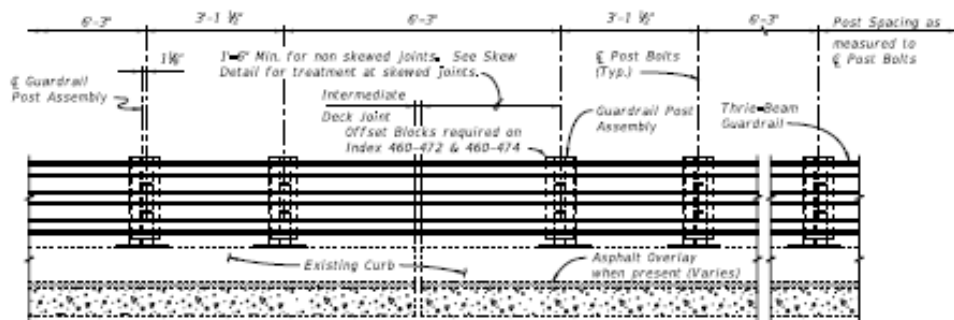
Michigan DOT Guardrail Retrofit on Bridges



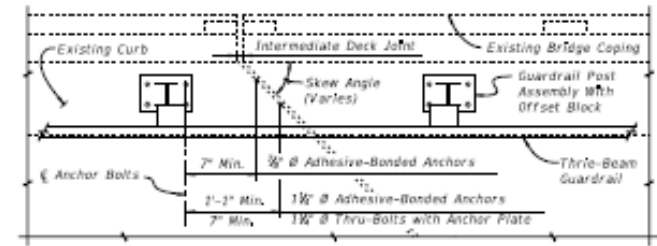
FLDOT 460-470: Thrie Beam Retrofit Typical Details



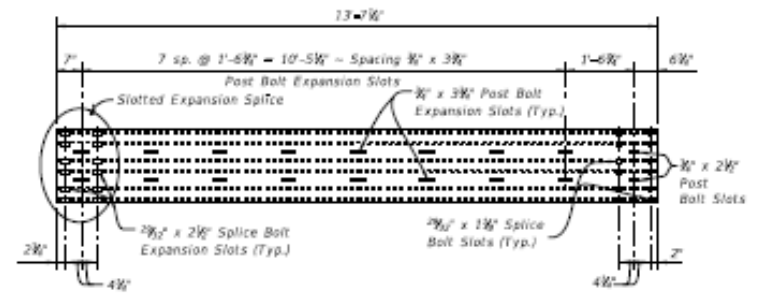
PARTIAL ELEVATION OF INSIDE FACE OF RAILING
MODIFIED POST SPACING AT INTERMEDIATE DECK JOINTS DETAIL
FOR INDEX 460-471, 460-475 & 460-476



PARTIAL ELEVATION OF INSIDE FACE OF RAILING
MODIFIED POST SPACING AT INTERMEDIATE DECK JOINTS DETAIL
FOR INDEX 460-472, 460-473 & 460-474



PARTIAL PLAN
INTERMEDIATE JOINT SKEW DETAIL



THRIE-BEAM EXPANSION SECTION

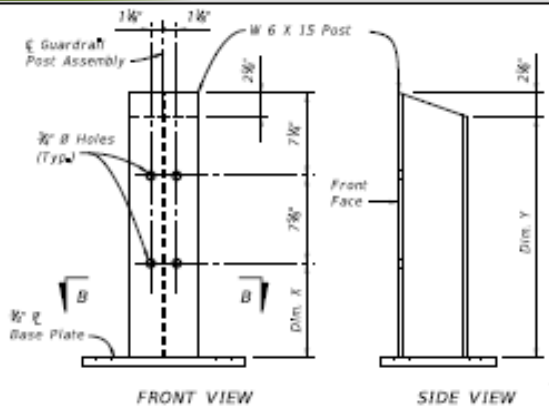
LAST REVISION	DESCRIPTION
01/01/08	

FDOT
FY 2019-20
STANDARD PLANS

TRAFFIC RAILING - (THRIE-BEAM RETROFIT)
TYPICAL DETAILS & NOTES

INDEX	SHEET
460-470	2 of 3

FLDOT 460-470: Thrie Beam Retrofit Typical Details



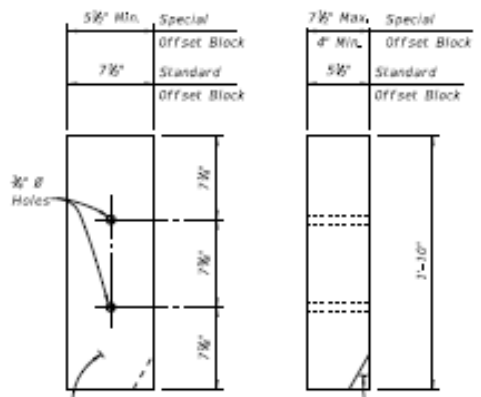
FRONT VIEW

SIDE VIEW

POST DIMENSION TABLE			
POST	CURB HEIGHT (DIM. A)	DIM. X	DIM. Y
Post "A"	5' to 7'	11 1/2"	2'-0"
Post "B"	> 7' to 10'	9 1/2"	1'-10"
Post "C"	> 10' to 14'0"	7 1/2"	1'-8"

Note: Dim. A is equal to the exposed curb height. For location of Dim. A see Index 460-471 thru 460-476, Sheet 1.

GUARDRAIL POST ASSEMBLY DETAIL



8" x 8" x 1'-10" (Nominal) Timber Offset Block (7 1/2" x 5 1/2" x 1'-10" Dressed Dimensions)

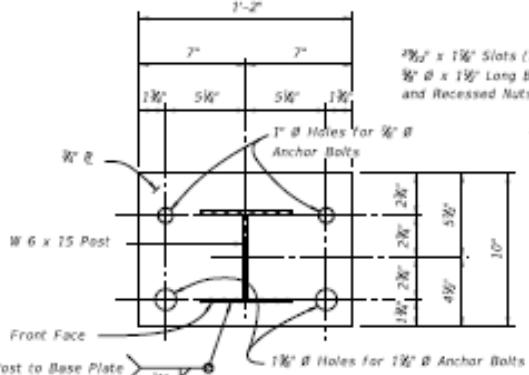
Pare corner of offset block as required to clear anchor bolt

FRONT VIEW

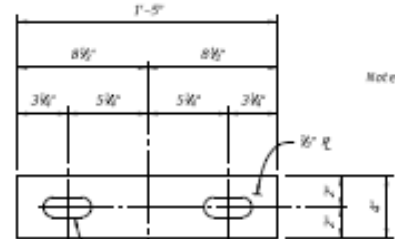
SIDE VIEW

OFFSET BLOCK DETAIL

- OFFSET BLOCK NOTES:
1. Offset blocks shall be timber or Approved Alternate. Uniformity of block size and alignment of guardrail shall be maintained along length of retrofit.
 2. Post bolt holes in offset blocks to be centered ($\pm 1/8"$).
 3. Timber offset blocks shall be dressed on all four sides (S4S).
 4. Block assemblies for Special Offset Blocks can be made up of 2 or 3 Special or Standard Offset Blocks, field dressed as required.



SECTION B-B



ANCHOR PLATE DETAIL

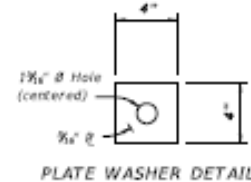
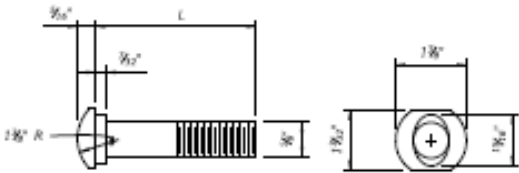


PLATE WASHER DETAIL



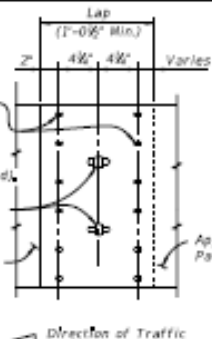
3/8" OVAL SHOULDER BUTTON HEAD BOLT

L	THREAD LENGTH	APPLICATION
1 1/2"	Full Length	Rail Splice Bolt, Post Bolt for Index 460-471, 460-473 & 460-476
Varies (8" Min.)	4" Min.	Post Bolt for Index 460-472, 460-473, 460-474, 460-475 & 460-476

7/8" x 1 1/2" Slots (12 Per Splice) with 3/8" x 1 1/2" Long Button Head Bolts and Recessed Nuts (12 Required) (Typ.)

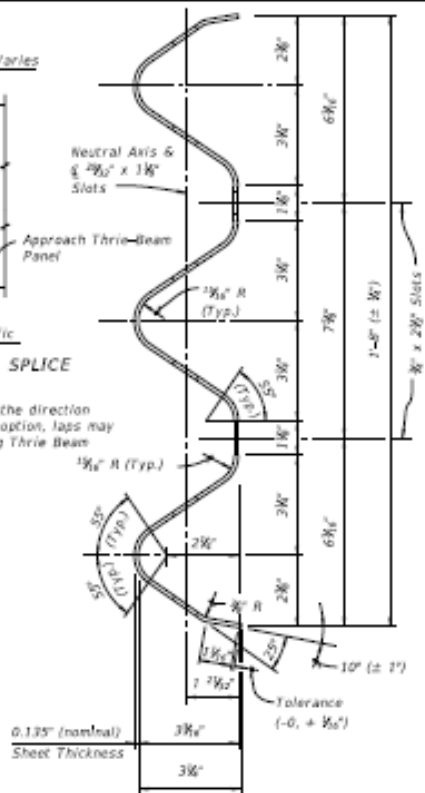
3/8" x 2 1/2" Slots (2 Per Post) with Post Bolts and Recessed Nuts (2 Required). Not required when splice is located between posts.

THRIE-BEAM GUARDRAIL SPLICE

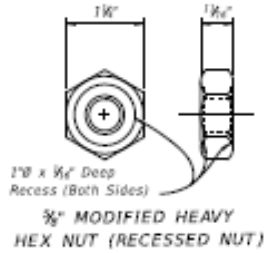


Note: All Thrie Beam Panels shall be lapped in the direction of adjacent traffic. At the Contractor's option, laps may be extended. Field drill holes in Trailing Thrie Beam Guardrail Panel as required.

Note: The Anchor Plate and Plate Washer are applicable only to 1 1/2" x 3 1/2" Anchor Bolts that are to be thru-bolted for Index 460-471 & 460-476.



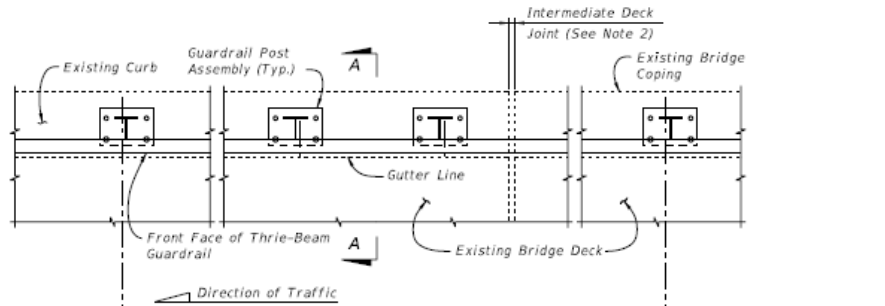
TYPICAL SECTION THRU THRIE-BEAM GUARDRAIL (EXPANSION SECTION SIMILAR)



1 1/2" x 3/8" Deep Recess (Both Sides) 3/8" MODIFIED HEAVY HEX NUT (RECESSED NUT)

LAST REVISION	DESCRIPTION
01/01/08	

FLDOT 460-471: Thrie Beam Retrofit Narrow Curb

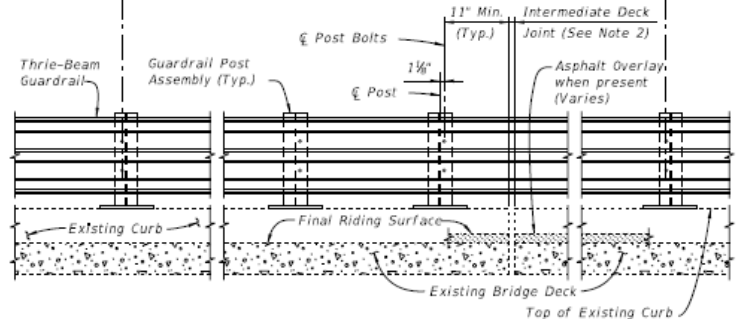


PARTIAL PLAN OF RAILING

⊕ Post Bolts and Match Line (Trailing End) (See Sheets 3 and 4)

⊕ Post Bolts and Match Line (Approach End) (See Sheets 3 and 4)

3'-1 1/2" spacing (Typ. except as noted along bridge, see Note 2)




PARTIAL ELEVATION OF INSIDE FACE OF RAILING

===== TYPICAL TREATMENT OF RAILING ALONG BRIDGE =====

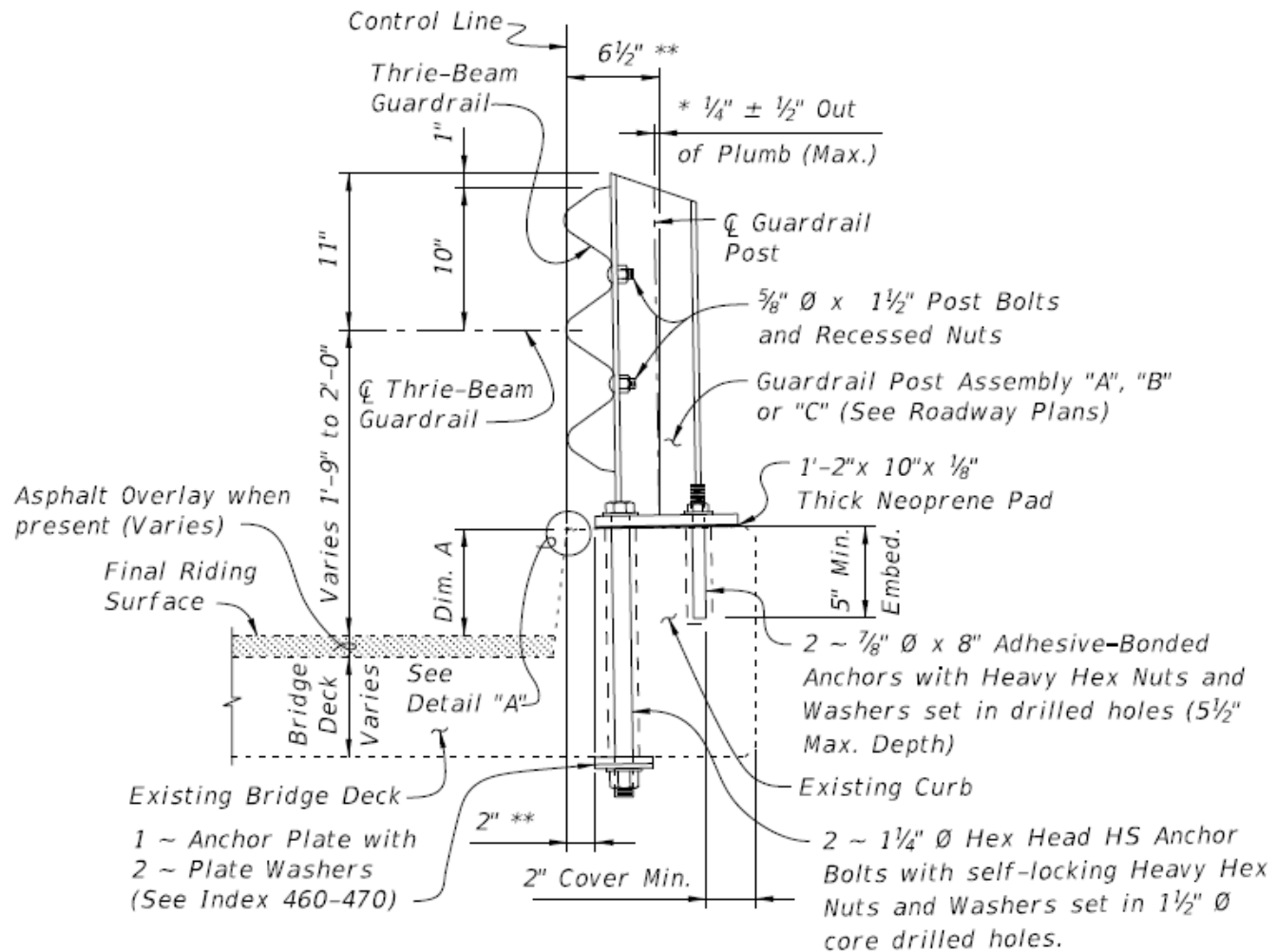
NOTES:

1. On approach end provide Index 536-002 (as shown) or other site specific treatment, see Roadway Plans. For treatment of trailing end see Roadway Plans.
2. Actual joint dimension and orientation vary. For Intermediate Deck Joints use the Modified Post Spacing at Intermediate Deck Joints Detail, Index 460-470, Sheet 2, as required.
3. Areas where existing structure has been removed shall match adjoining areas and shall be finished flat by grouting or grinding as required. Exposed existing reinforcing steel shall be burned off 1" below existing concrete and grouted over.

CROSS REFERENCES:
 For Section A-A see Sheet 2.
 For Traffic Railing Notes and Details see Index 460-470.

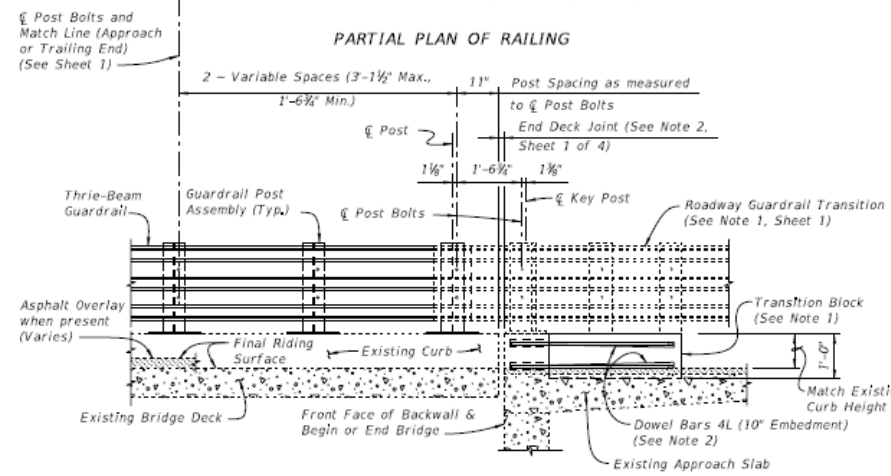
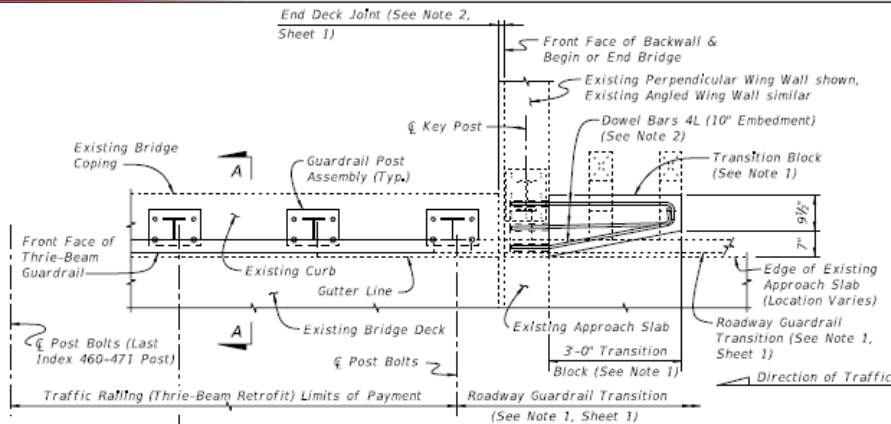
LAST REVISION 01/01/08	DESCRIPTION:	 FY 2019-20 STANDARD PLANS	TRAFFIC RAILING - (THRIE-BEAM RETROFIT) NARROW CURB	INDEX 460-471	SHEET 1 of 4
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FLDOT 460-471: Thrie Beam Retrofit Narrow Curb



SECTION A-A
TYPICAL SECTION THRU RAILING ON BRIDGE DECK

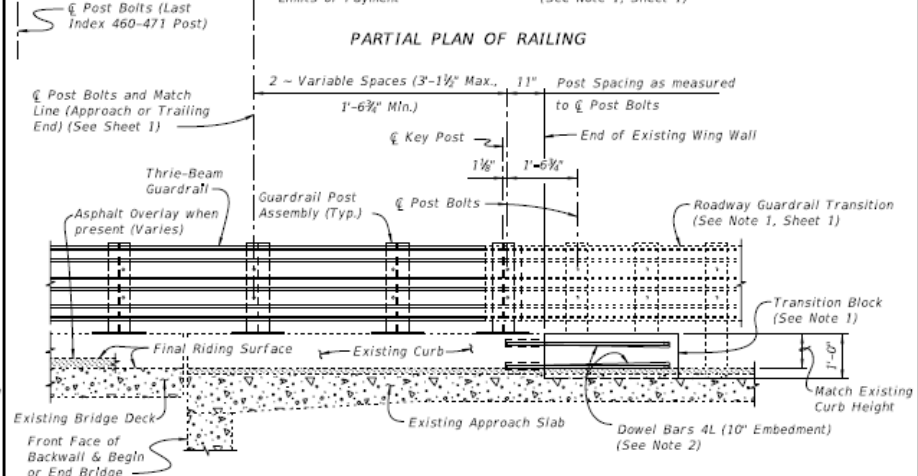
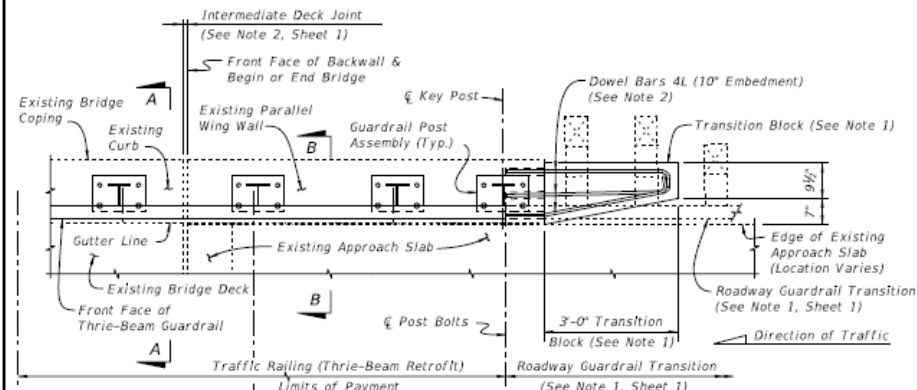
FLDOT 460-471: Thrie Beam Retrofit Narrow Curb



SCHEME 1
RAILING END TREATMENT FOR PERPENDICULAR OR ANGLED WING WALLS

SCHEME 1 NOTES:

1. Provide Transition Block (as shown) or Curb if existing Approach Slab does not have a curb, see Roadway Plans. Shape and height of Transition Block or Curb shall match existing bridge curb. Transition Block may be omitted on trailing ends with no opposing traffic.
2. Field bend Dowel Bars 4L within Transition Block as required to maintain 2" top and side clearance and 3" bottom clearance.



SCHEME 2
RAILING END TREATMENT FOR PARALLEL WING WALLS

SCHEME 2 NOTES:

1. Provide Transition Block (as shown) or Curb if existing Approach Slab does not have a curb, see Roadway Plans. Shape and height of Transition Block or Curb shall match existing bridge curb. Transition Block may be omitted on trailing ends with no opposing traffic.
2. Field bend Dowel Bars 4L within Transition Block as required to maintain 2" top and side clearance and 3" bottom clearance.

LAST REVISION 01/01/08



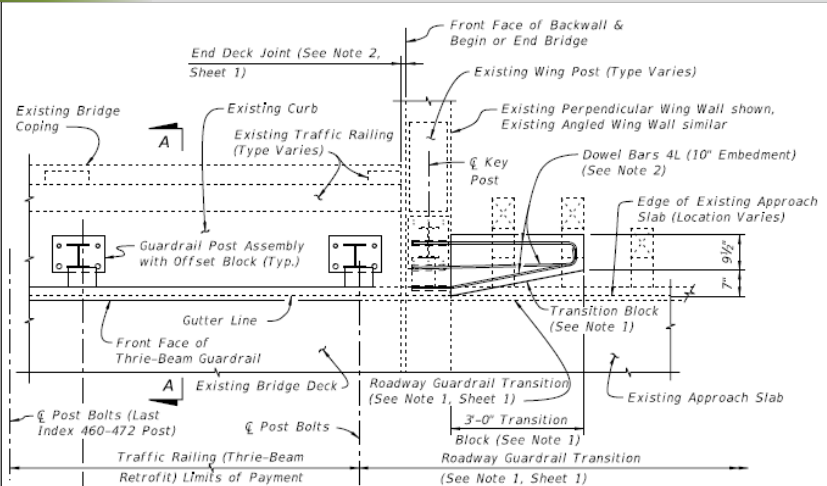
FY 2019-20
STANDARD PLANS

TRAFFIC RAILING - (THRIE-BEAM RETROFIT)
NARROW CURB

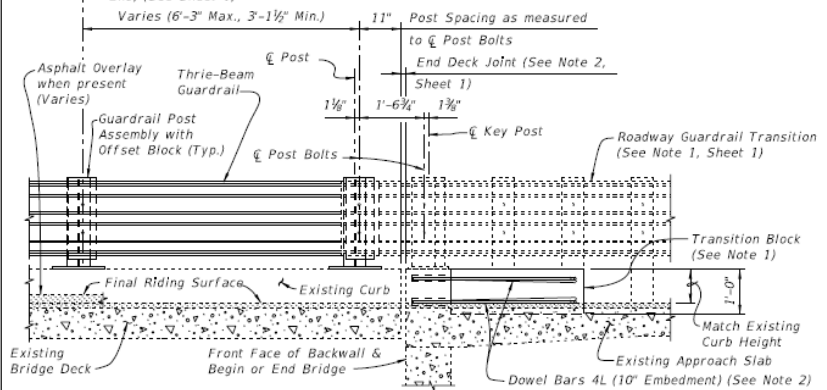
INDEX
460-471

SHEET
3 of 4

FLDOT 460-472: Thrie Beam Retrofit Wide Curb Type 1



PARTIAL PLAN OF RAILING

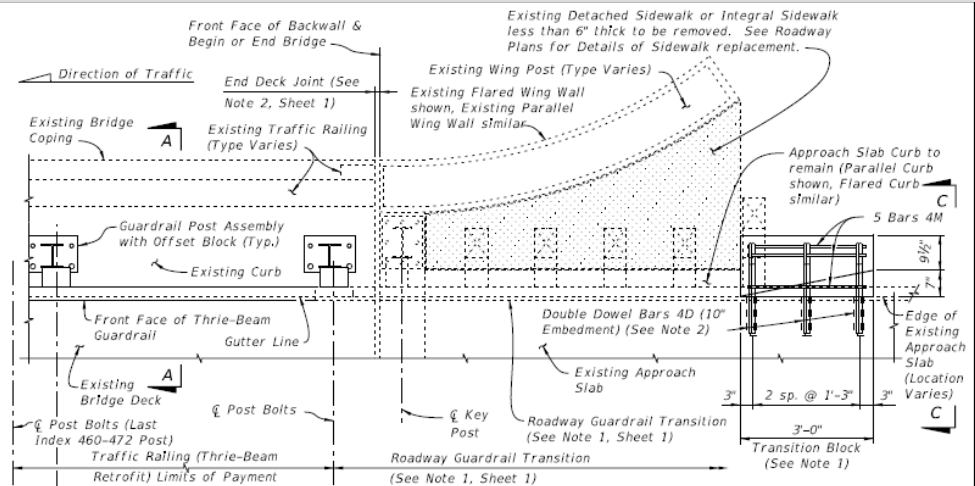


PARTIAL ELEVATION OF INSIDE FACE OF RAILING
(Existing Wing Post and Traffic Railing not shown for clarity)

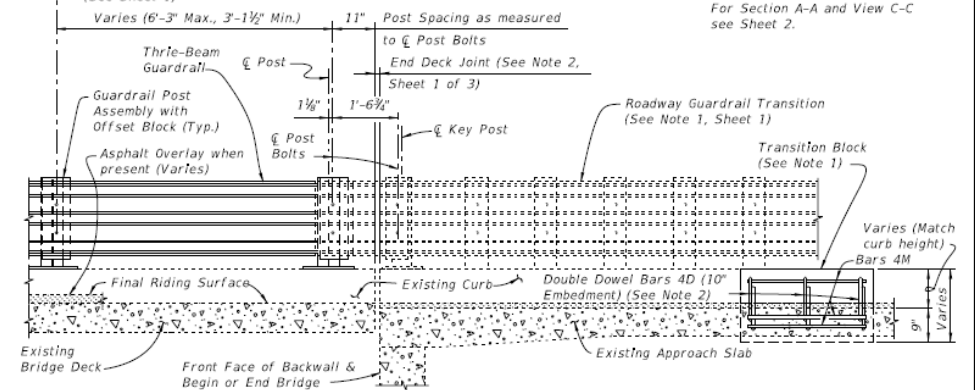
SCHEME 1
RAILING END TREATMENT FOR PERPENDICULAR OR ANGLED WING WALLS

SCHEME 1 NOTES:

1. Provide Transition Block (as shown) or Curb if existing Approach Slab does not have a curb, see Roadway Plans. Shape and height of Transition Block or Curb shall match existing bridge curb. Transition Block may be omitted on trailing ends with no opposing traffic.
2. Field bend Dowel Bars 4L within Transition Block as required to maintain 2" top and side clearance and 3" bottom clearance.



PARTIAL PLAN OF RAILING



PARTIAL ELEVATION OF INSIDE FACE OF RAILING
(Existing Wing Post and Traffic Railing not shown for clarity)

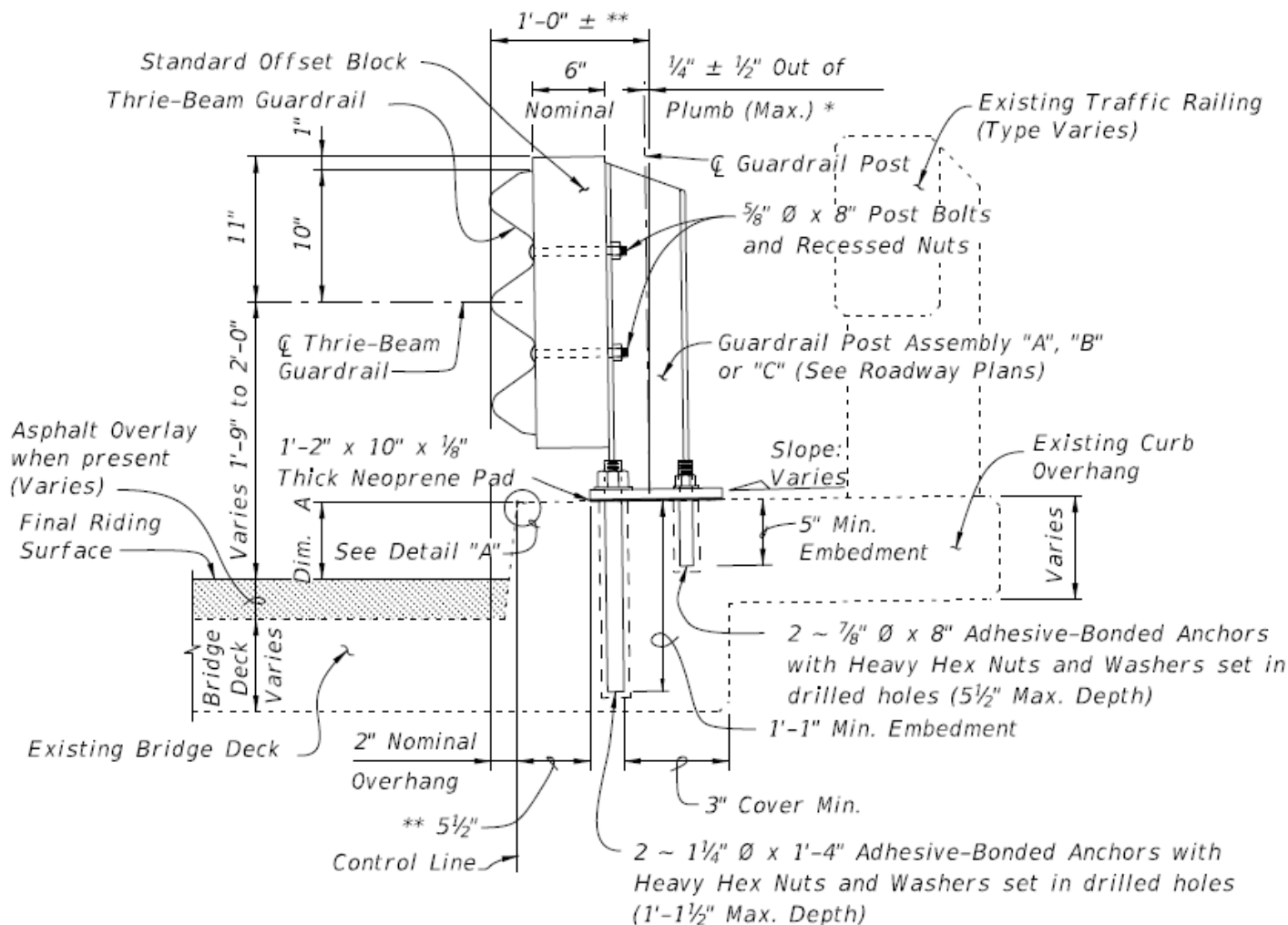
SCHEME 2
RAILING END TREATMENT FOR PARALLEL OR FLARED CURBS WITH DETACHED SIDEWALKS OR INTEGRAL SIDEWALKS LESS THAN 6" THICK

SCHEME 2 NOTES:

1. Provide Transition Block (as shown) or Curb if existing Approach Slab Curb does not extend to end of Approach Slab. Shape and height of Transition Block or Curb shall match existing bridge curb. Transition Block may be omitted on trailing ends with no opposing traffic and on bridges with flared Approach Slab Curbs.
2. Field bend or lift Dowel Bars 4D and Bars 4M within Transition Block as required to maintain 2" top and side clearance and 3" bottom clearance.

LAST REVISION 01/01/08	DESCRIPTION: FDOT	FY 2019-20 STANDARD PLANS	TRAFFIC RAILING - (THRIE-BEAM RETROFIT) WIDE STRONG CURB TYPE 1	INDEX 460-472	SHEET 3 of 4
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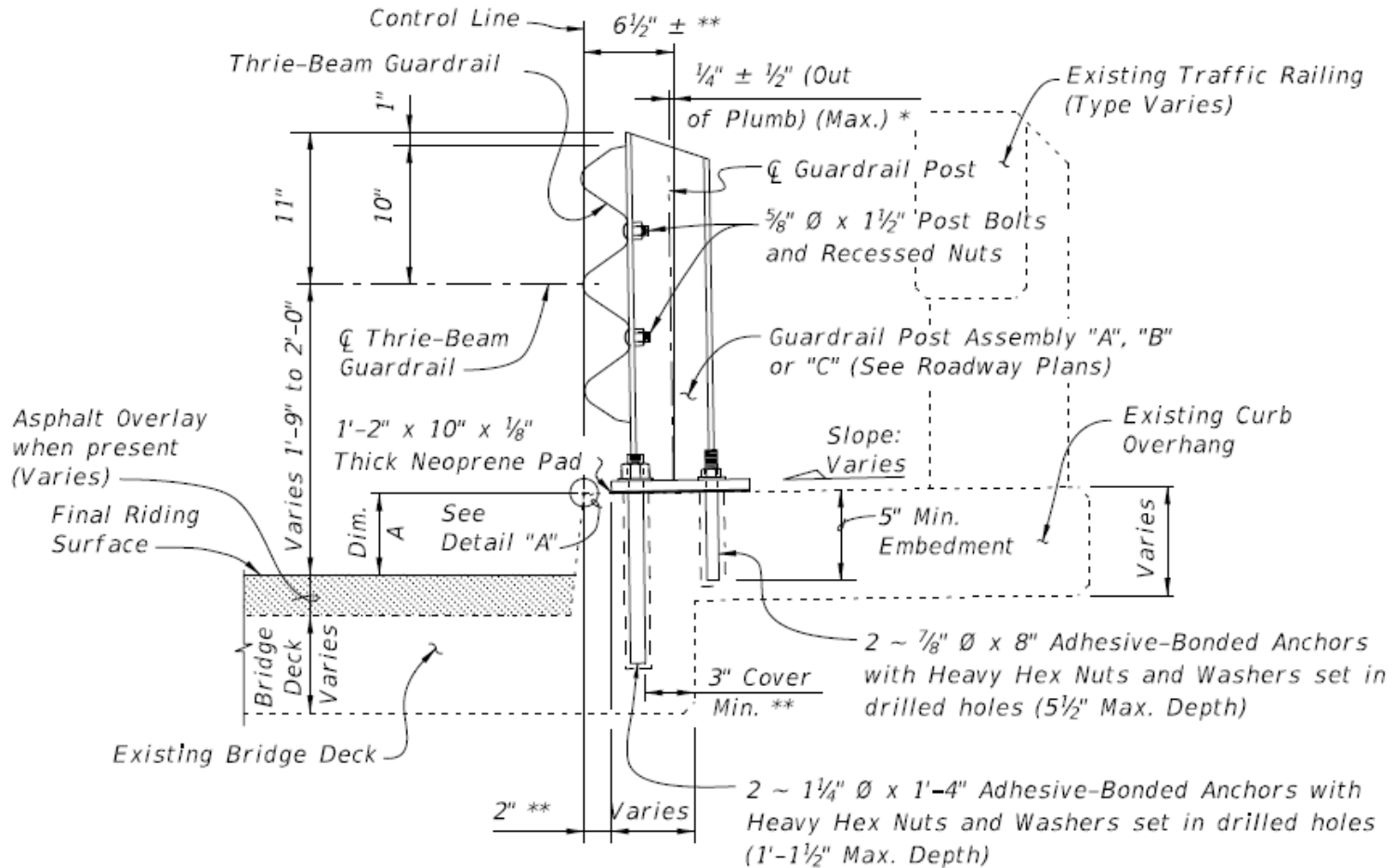
FLDOT 460-472: Thrie Beam Retrofit Wide Curb Type 1



SECTION A-A

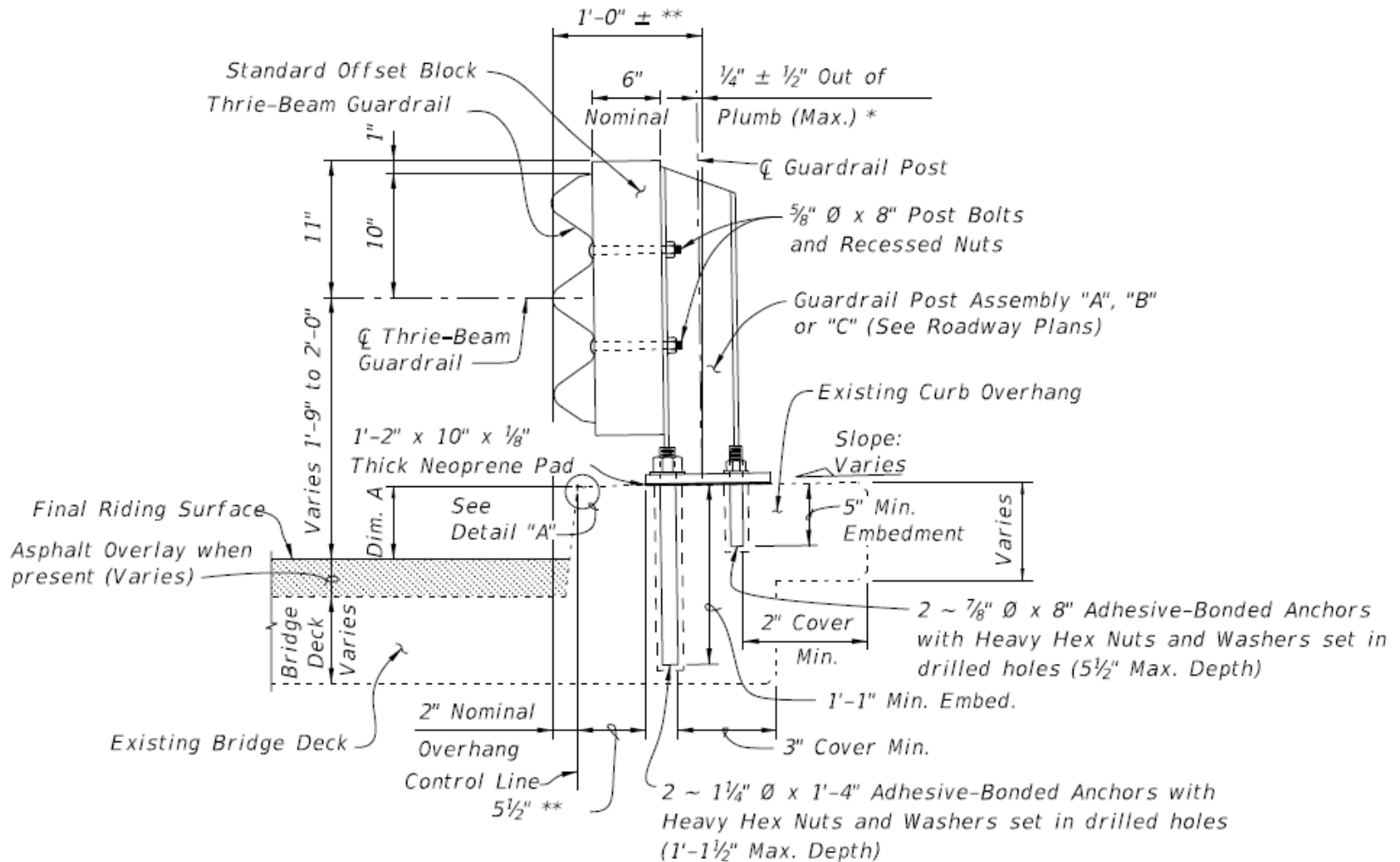
TYPICAL SECTION THRU RAILING ON BRIDGE DECK

FLDOT 460-473: Thrie Beam Retrofit Wide Strong Curb Type 2



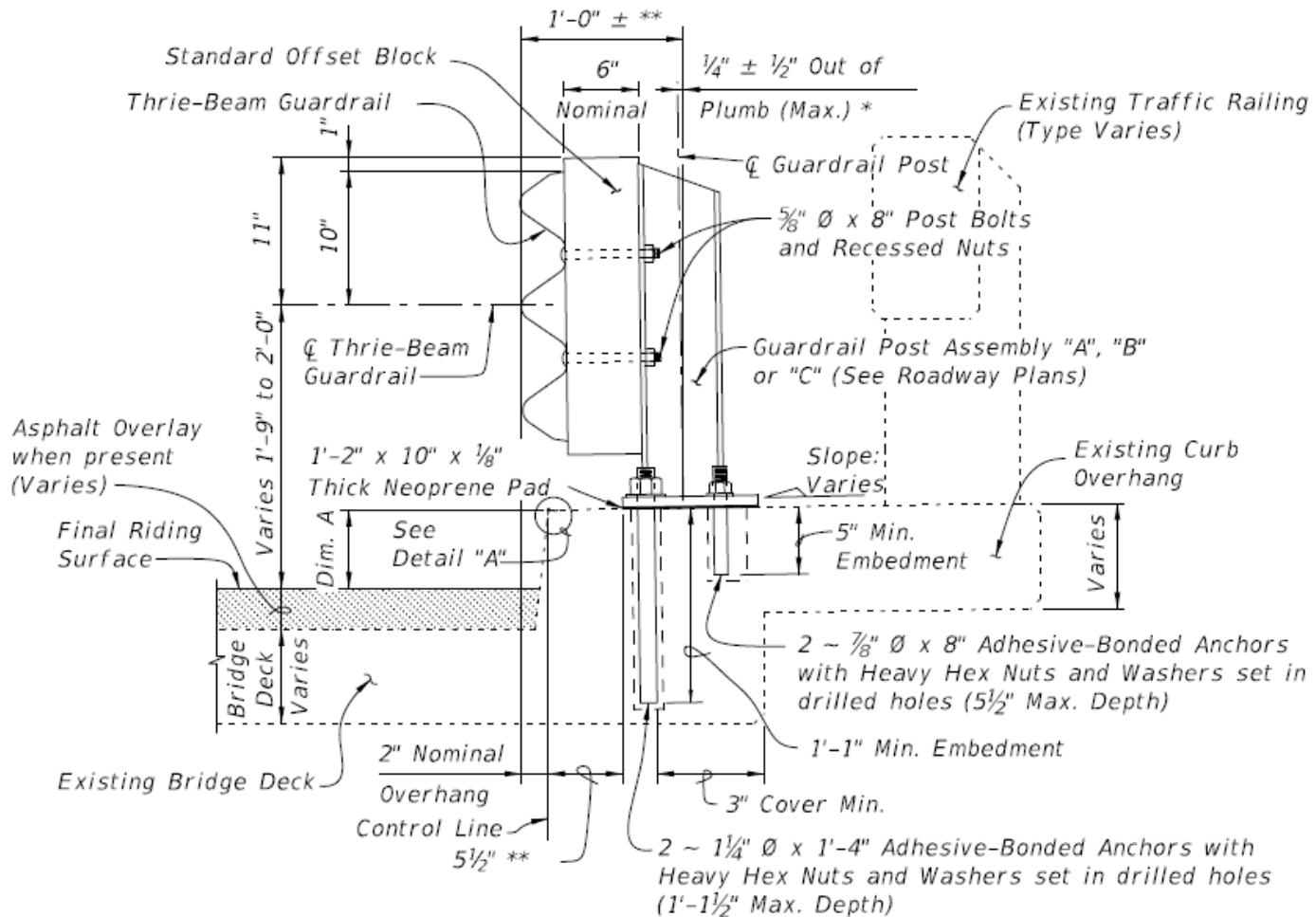
SECTION A-A
TYPICAL SECTION THRU RAILING ON BRIDGE DECK

FLDOT 460-474: Thrie Beam Retrofit Intermediate Curb



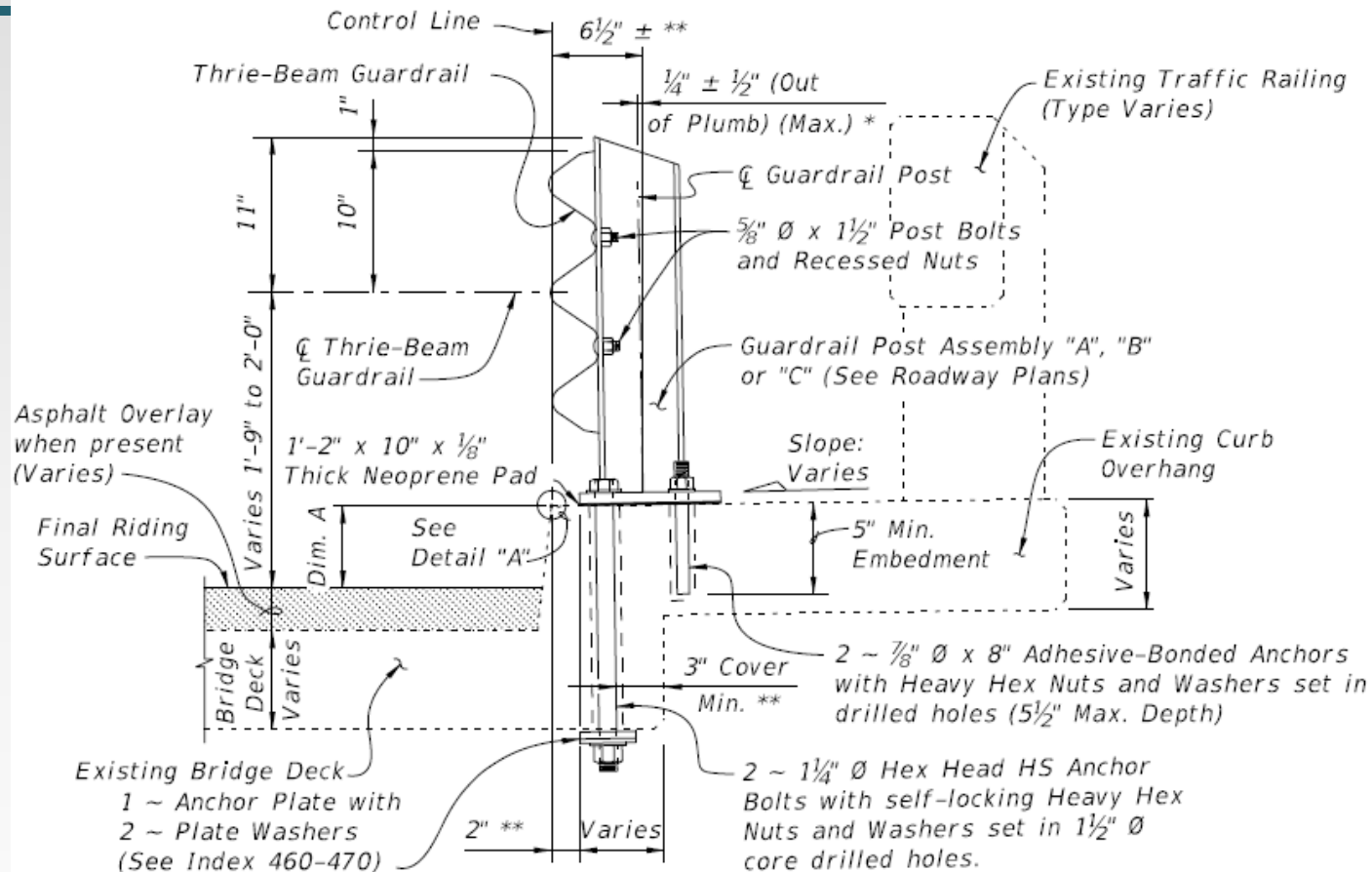
SECTION A-A
TYPICAL SECTION THRU RAILING ON BRIDGE DECK

FLDOT 460-475: Thrie Beam Retrofit Wide Curb Type 1



SECTION A-A
TYPICAL SECTION THRU RAILING ON BRIDGE DECK

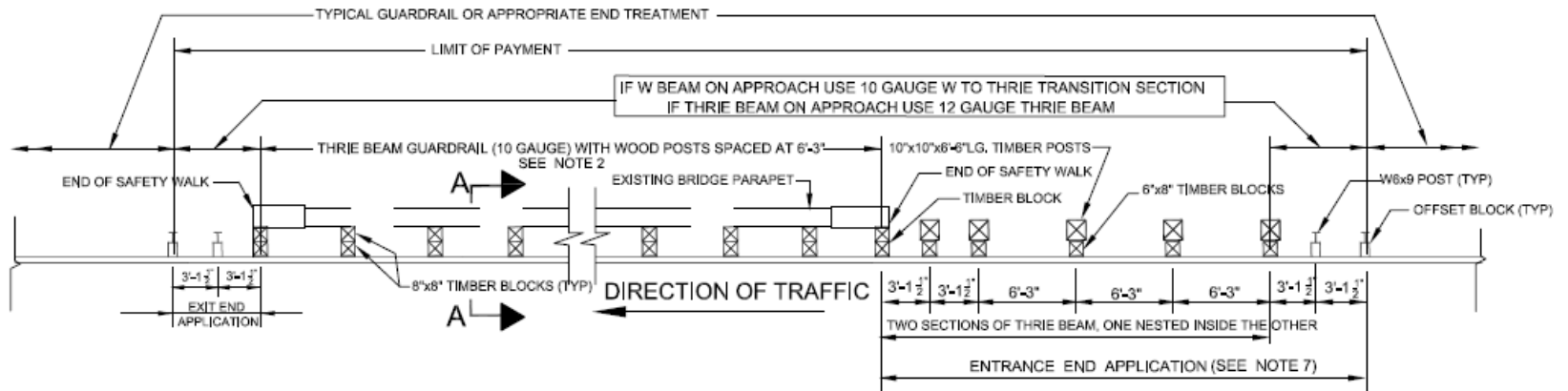
FLDOT 460-476: Thrie Beam Retrofit Wide Curb Type 2



SECTION A-A
TYPICAL SECTION THRU RAILING ON BRIDGE DECK

MASSDOT Guardrail Retrofit on Bridges

GUARDRAIL RETROFIT ON BRIDGES (PLAN VIEW)



PLAN
NOT TO SCALE

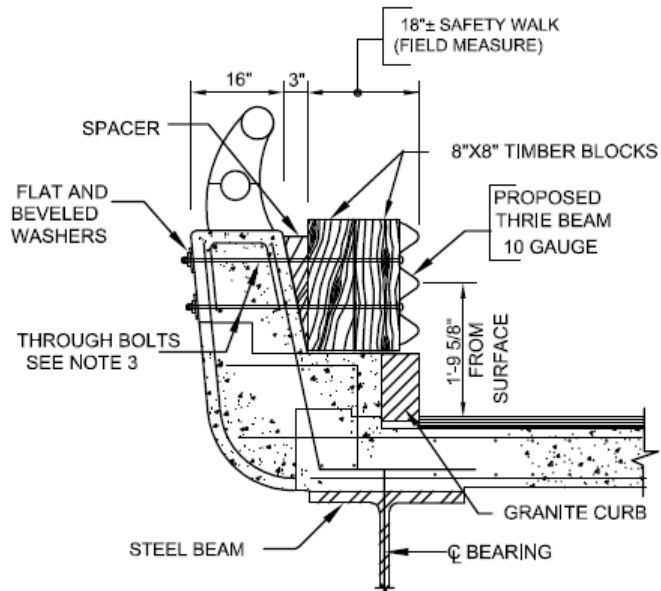
DATE OF ISSUE

JUNE 2014

DRAWING NUMBER

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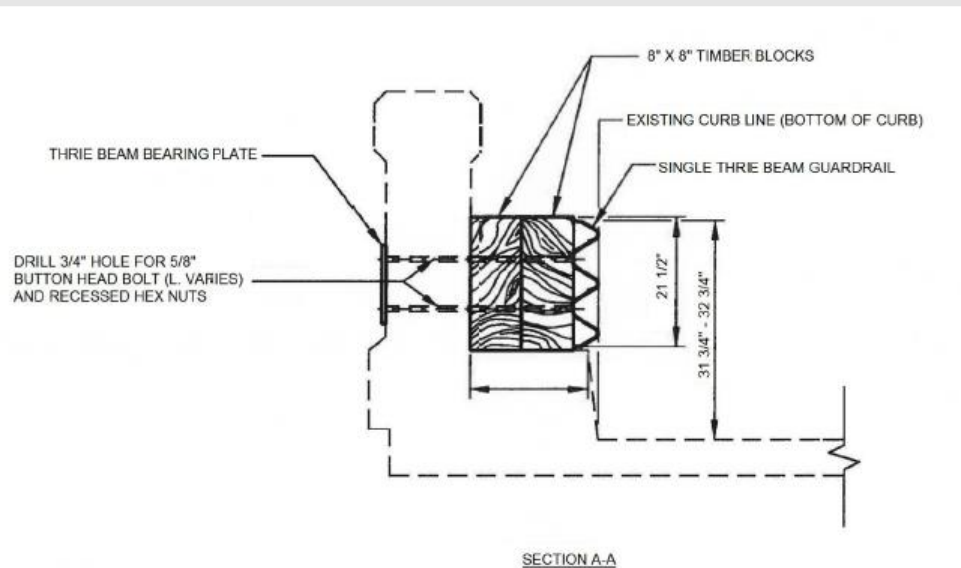
MASSDOT Guardrail Retrofit on Bridges



SECTION A-A

THROUGH CONCRETE PARAPET WALL

NOT TO SCALE



SECTION A-A

Development of a Thrie-Beam Retrofit for Upgrading Obsolete Bridge Railings

2019-XX-XXX

Proposed Work Plan

- 1.) Task 1 - Literature Review (2 mons.)
- 2.) Task 2 – Engineering Design and detailing (3 mons.)
- 3.) Task 3 – Construction of full scale test installation (5 mons.)
- 4.) Task 4 – Full-scale crash testing – MASH Tests 3-10 & 3-11. (5 mons.)

Deliverables

A report providing details of the new retrofit design, documentation of the crash test results, and the assessment of the performance of the new design according to MASH TL-3 specifications.