WYOMING DEPARTMENT OF TRANSPORTATION

QUARTERLY PROGRESS REPORT

Project title: Pooled Fund for the Development of Approach Guardrail Transitions for Box Beam and MGS

Project Number: TPF-5(393)

Progress period: 8/1/2020 – 10/31/2020

Principal Investigator and all others who have worked on the project (provide name and ORCID number): Roger Bligh (#0000-0001-5699-070X), Nauman Sheikh (#0000-0003-1718-4881), Nathan Schulz (#0000-0002-7527-9419), James Kovar (#0000-0002-1542-7010)

1. Please state whether the project is ahead of schedule, on time, or behind schedule:

The project is currently behind schedule. Task 1 *Engineering Design and Concept Development* took much longer to complete than initially scheduled. However, this was a critical task in the project because it defined the design options that will be simulated and tested in subsequent tasks and ultimately adopted into Wyoming and Montana DOT standards. Therefore, it was important that the process and WYDOT review was thorough, deliberate, and considered as many factors as possible.

Task 2 *Finite Element Modeling & Simulation* took one month longer to complete than scheduled. Researchers had to adapt to a remote work environment due to the Covid-19 pandemic. While most work was able to be successfully performed remotely, access to computer resources required for evaluating simulation runs was more limited.

The TTI Proving Ground test schedule has a 5-month backlog due to Covid-19 shutdowns, weather delays, and increased demand. Consequently, the time required to conduct the crash tests is longer than initially proposed.

A time extension of 10 months is being requested to permit completion of the programmed research tasks.

2. Percentage of overall work completed.

40%

3. Activities and Accomplishments:

a. What are the major goals and objectives of the project?

The research objective is to develop two non-proprietary approach guardrail transition systems from box beam and MGS guardrail that are MASH Test Level 3 (TL-3) compliant. The transitions are being designed to connect the guardrail systems to the Texas Department of

Transportation (TxDOT) Type C2P TL-4 bridge rail system. Direct connection between the transition section and bridge rail is desired to avoid use of a solid concrete parapet end that could hinder snow clearing operations. The work plan for the project is divided into seven tasks. These include:

Task 1: Engineering Design and Drawing Development
Task 2: Finite Element Modeling & Simulation
Task 3: Test Installation Construction
Task 4: Crash Testing of the Box Beam Transition
Task 5: Crash Testing of the MGS Transition
Task 6: Final Report
Task 7: FHWA Eligibility Letter

b. Describe what was accomplished under these goals.

Task 1: Engineering Design and Drawing Development (previously completed)

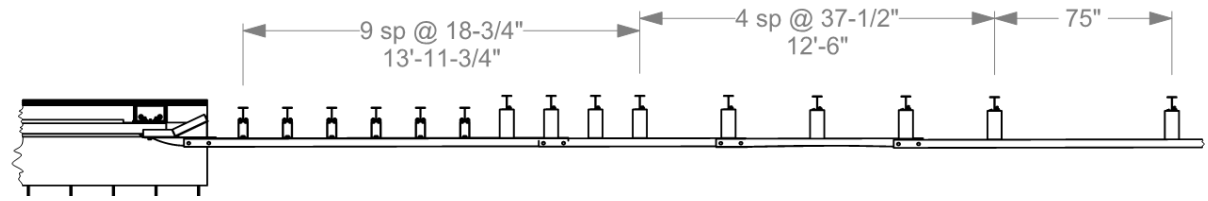
Task 2: Finite Element Modeling & Simulation (completed)

A meeting was held with technical representatives of Wyoming DOT and Montana DOT on August 21 to discuss the proposed test installation details for both the box beam and MGS transition systems. The box beam transition design was approved as recommended. For the MGS transition system, WYDOT requested investigation of the use of 8-inch steel blockouts rather than 12-inch wood blockouts.

To investigate the impact performance of the MGS transition with steel blockouts, the researchers revised the finite element model of the MGS transition to include 8-inch steel blockouts on the six transition posts adjacent to the C2P bridge rail (see Plan View, Figure 1). Details of the steel blockouts and their attachment to the posts are also shown in Figure 1. The modified finite element model is shown in Figure 2.

Impact Simulations

The researchers performed impact simulations with the MGS transition with steel blockouts using impact conditions of *MASH* Test 3-21 (pickup truck) and Test 3-20 (small car). Under both impact conditions, the vehicle impacted the transition at a speed and angle of 62 mi/h and 25 degrees. The critical impact points (CIPs) determined in the previously reported simulation analyses were used for these new simulations. The change in blockout type does not affect the lateral stiffness of the transition system, so the impact points were still considered valide. Measured from the upstream flange of the first C2P post, the CIPs were 84 inches and 76 inches for the pickup truck and the small car, respectively.



PLAN VIEW

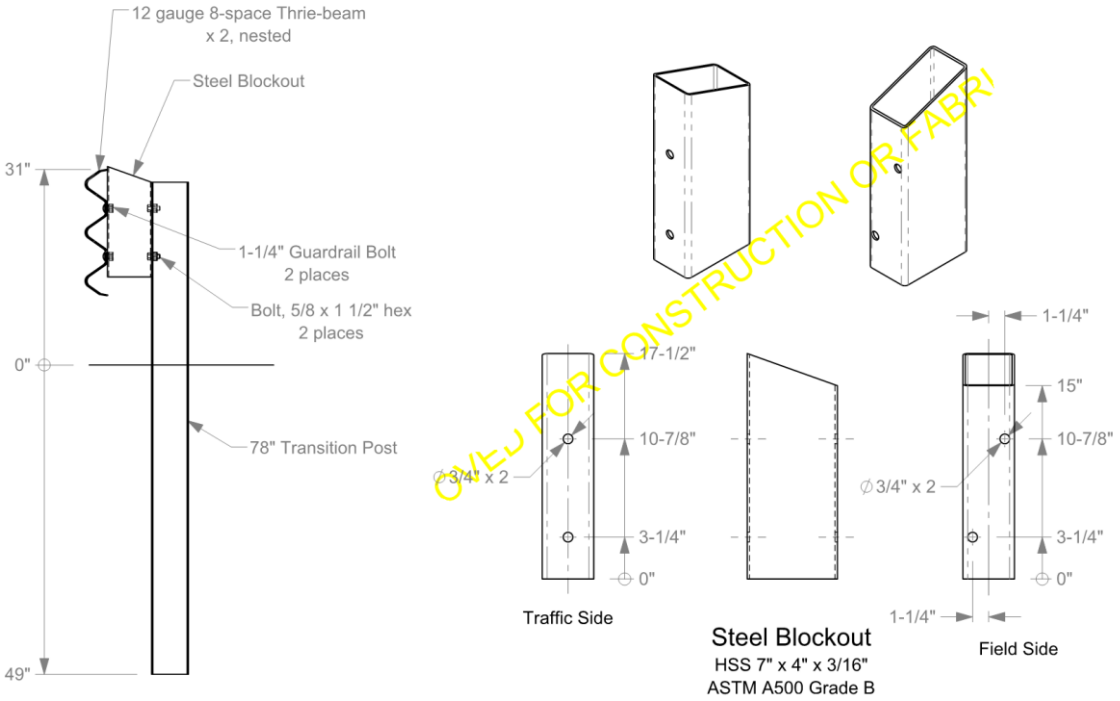
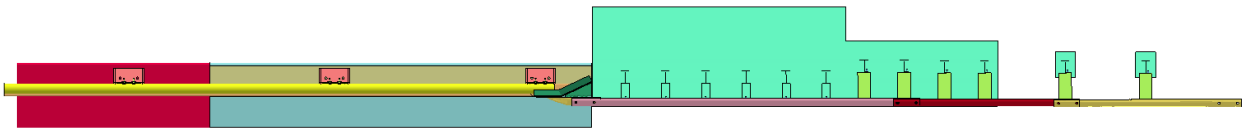
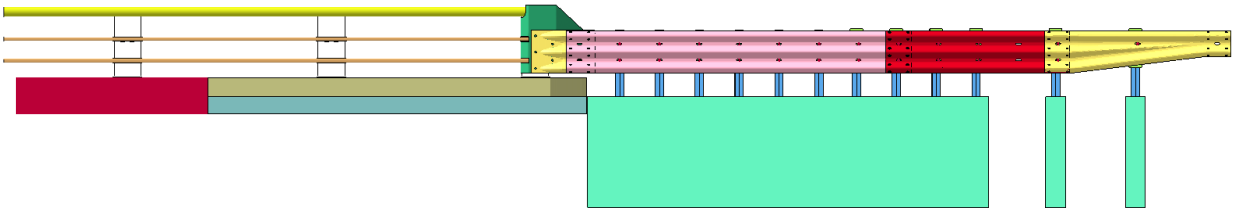


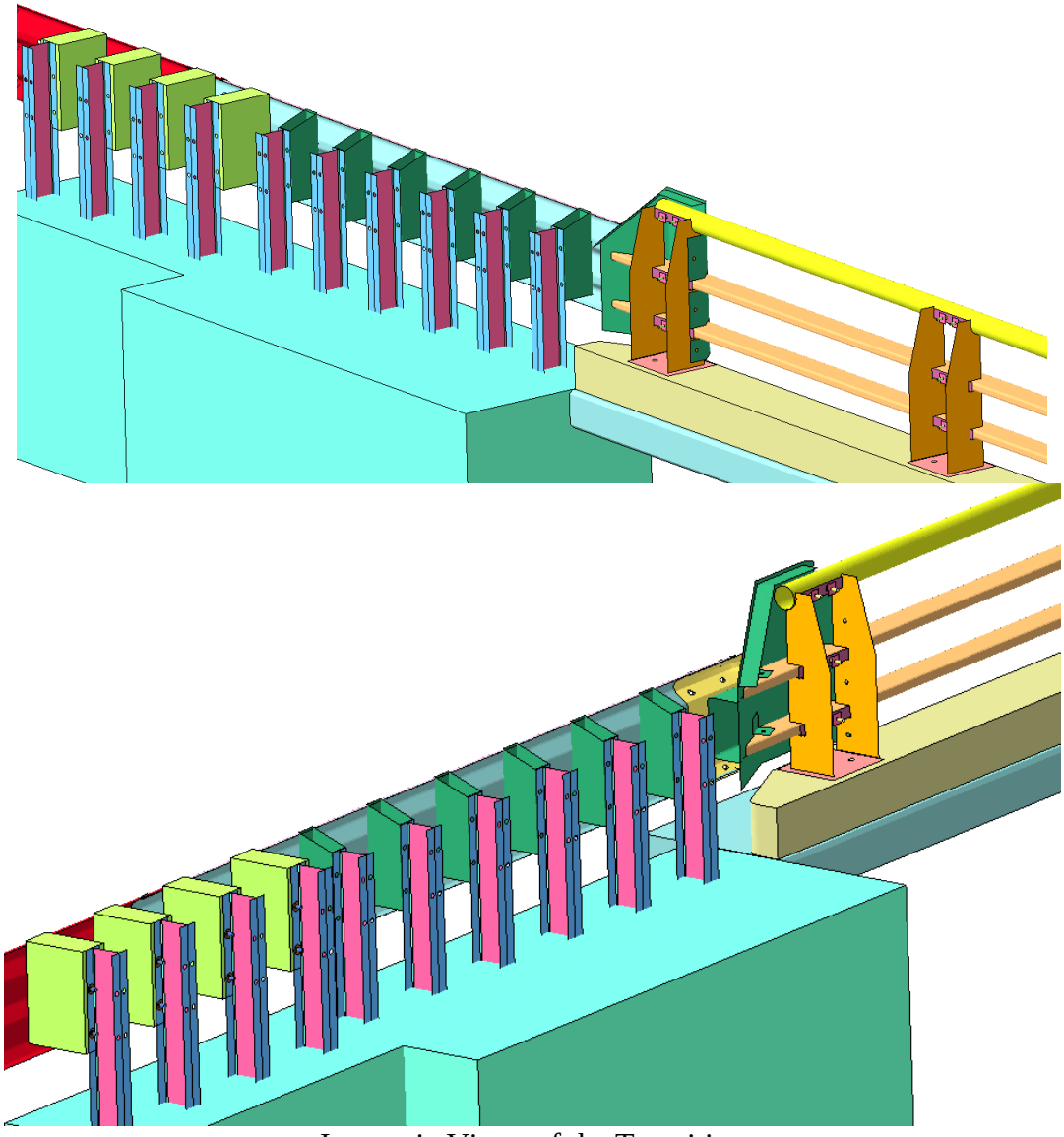
Figure 1: Steel blockout and post details of the modified transition system.



Plan View



Elevation View



Isometric Views of the Transition

Figure 2. Details of the FE model for MGS transition.

Pickup Truck (Test 3-21) Impact Simulation

In this simulation, the 5,000-lb pickup truck model impacted the transition at the CIP at an impact speed and angle of 62 mi/h and 25 degrees. Figure 3 shows the results of the simulation as the vehicle redirects after impact. The maximum dynamic and permanent deflections of the system were 9.5 inches and 8.5 inches, respectively. The vehicle was contained and redirected in a stable manner. The results of the simulation showed that the MGS transition design with steel blockouts is expected to perform acceptably for Test 3-21.

Small Car (Test 3-20) Impact Simulation

In this simulation, the 2,420-lb passenger car model impacted the transition at the CIP at an impact speed and angle of 62 mi/h and 25 degrees. Figure 4 shows the results of the simulation as the vehicle redirects after impact. The maximum dynamic and permanent deflections of the system were 5.9 inches and 5.4 inches, respectively. The vehicle was contained and redirected in a stable manner. The results of the simulation showed that the MGS transition design with steel blockouts is expected to perform acceptably for *MASH* Test 3-20.

Conclusions

Based on the results of the simulations presented herein, the design of the MGS transition with 8-inch deep steel blockouts performed very similarly to the previously presented design with 12-inch deep wood blockouts. The system performed successfully in the simulations of *MASH* Test 3-20 and Test 3-21. It is recommended that both tests be performed to verify the performance of the transition system.

Task 3: Test Installation Construction (ongoing)

Work on Task 3 was initiated during the reporting period. Detailed test installation drawings for the recommended design of the box beam and MGS transitions were prepared. The drawings reflected details developed during the Task 2 simulation analyses. The drawings were submitted to Wyoming DOT for review on August 18.

A meeting was held with technical representatives of Wyoming DOT and Montana DOT on August 21 to discuss the test installation details for both the box beam and MGS transition systems. After addressing comments, a revised set of drawings for the box beam guardrail transition to C2P bridge rail were transmitted to WYDOT on September 10 for review and approval. As requested during the project meeting, posts 16-18 were modified to have the same hole pattern on both the traffic side and field side of the post to make them interchangeable and, thereby, reduce inventory. The system drawings reflected a portion of C2P bridge rail attached to a moment slab foundation with a transition attached to each end to reduce the number of repairs required during the testing program. Approval of the test installation drawings was received from Wyoming DOT on September 17. The drawings for the box beam transition are presented in Attachment A to this report.

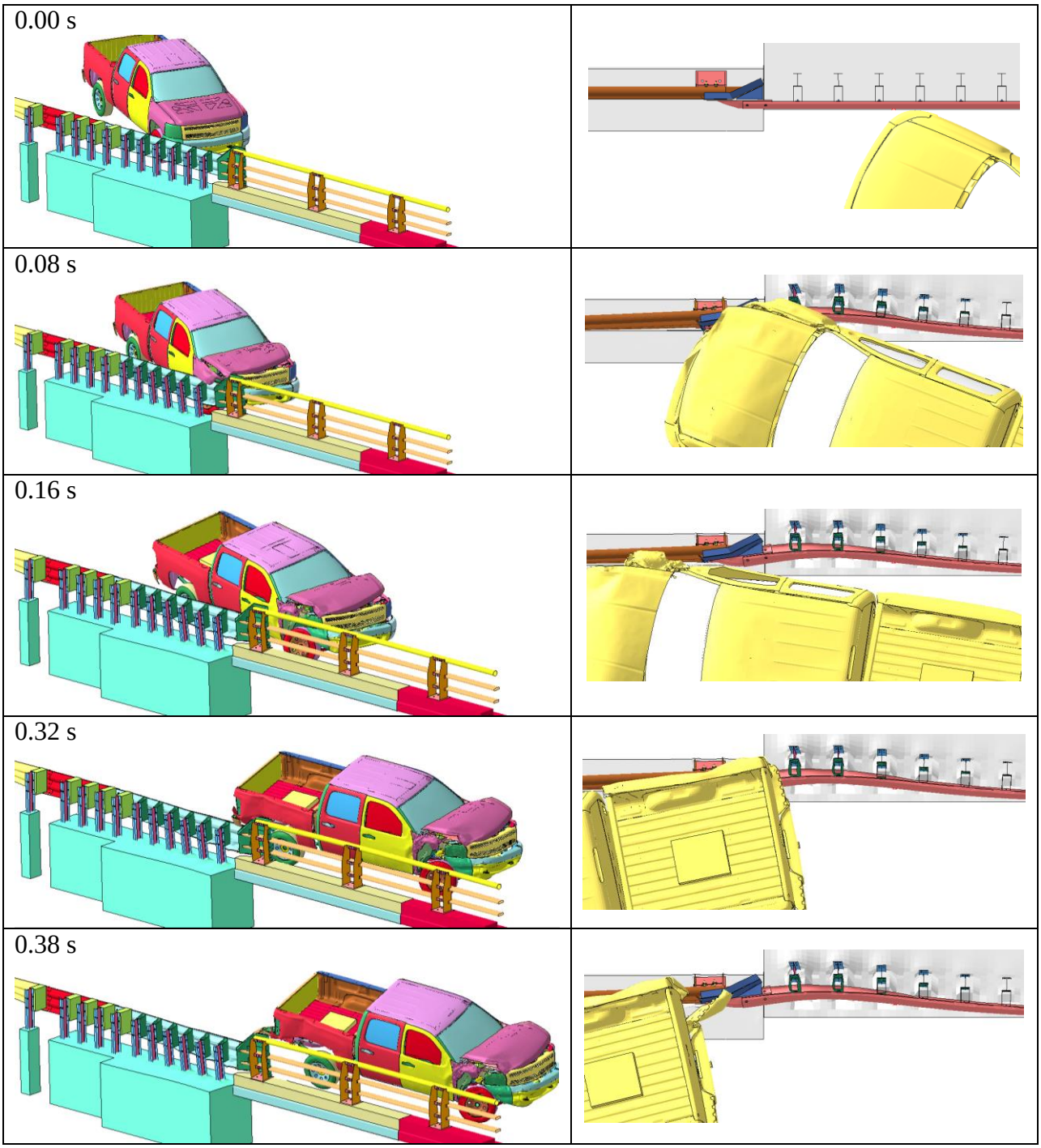


Figure 3: Results for Test 3-21 impact simulation.

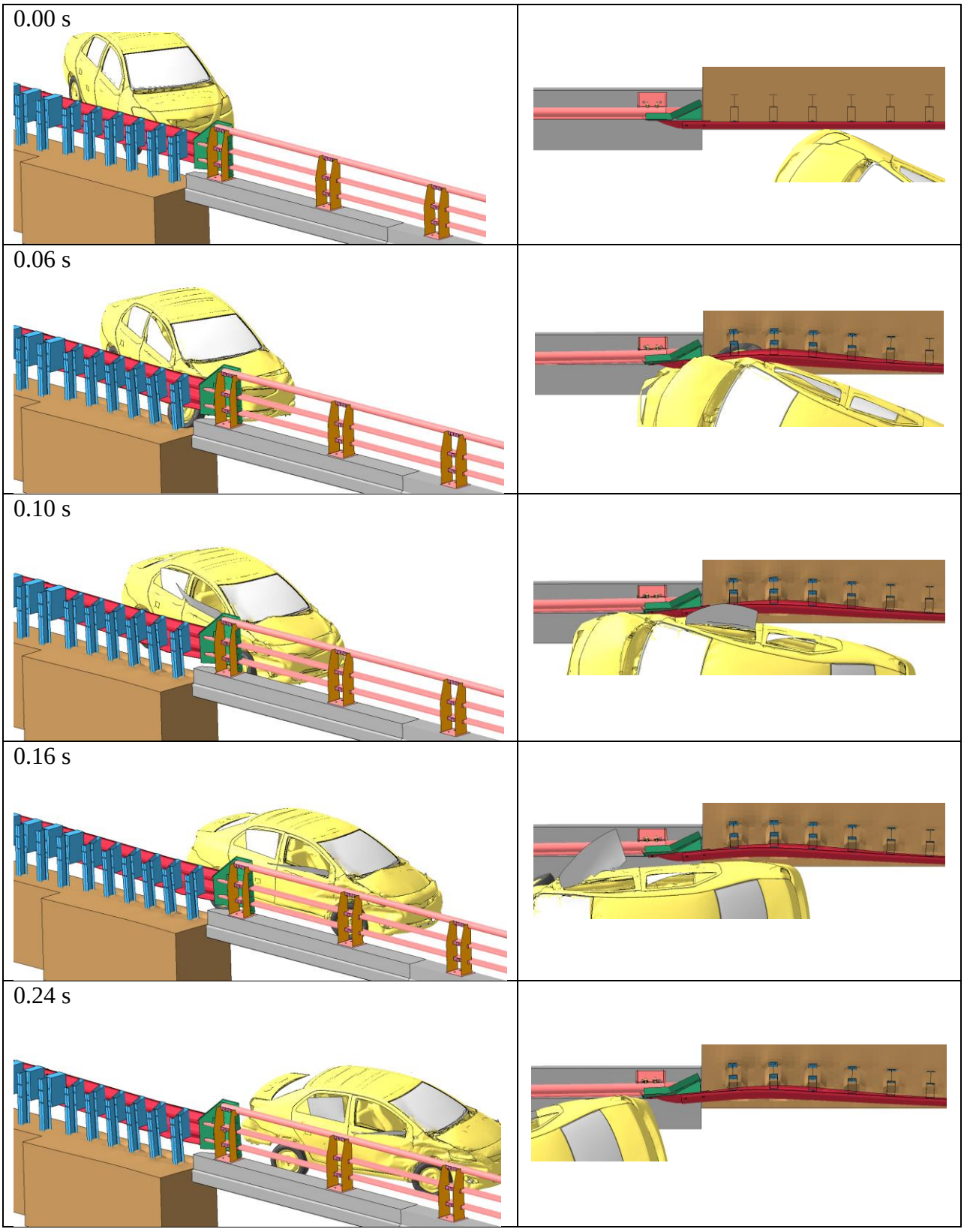


Figure 4: Results for Test 3-20 impact simulation.

Upon receipt of approval to proceed, the test installation construction process was initiated at the TTI Proving Ground. The test installation will include 20 ft of C2P bridge rail anchored to a moment slab. A transition, approach guardrail, and terminal will be attached to each end of the bridge rail section. This layout reduces repair requirements and helps expedite execution of the testing matrix. The box beam transition is being constructed first. A box beam transition is being constructed on each end of the bridge rail section. A 72 ft length of box beam approach guardrail attached to the upstream end of the transition. The end of the box beam approach guardrail will be anchored with a Type 1 end anchorage.

TTI researchers have developed a test plan for both the box beam and MGS transition systems. The *MASH* test matrix for transitions consists of two tests: Test 3-20 with a passenger car, and Test 3-21 with a pickup truck. In both tests, the vehicle impacts the more flexible of the two barrier systems being connected at a nominal speed and angle of 62 mi/h and 25 degrees.

For the box beam transition, *MASH* Test 3-20 and Test 3-21 will be performed on both the downstream and upstream ends of the transition system. The downstream end is where the transition attaches to the C2P bridge rail. The upstream end is where the box beam approach guardrail attaches to the transition. Finite element impact simulations were used to determine the critical impact point for each test.

On the downstream end of the box beam transition, the CIPs for *MASH* Test 3-20 and Test 3-21 were determined to be 36 inches and 60 inches upstream from the end of the bridge rail curb, respectively. On the upstream end of the box beam transition, the CIPs for *MASH* Test 3-20 and Test 3-21 were determined to be 8 ft and 12.25 ft upstream of the end of the lower rubrail element, respectively.

After completion of the testing for the box beam guardrail transition, the MGS transition system will be installed. As described above, modifications were made to the MGS transition system at the request of WYDOT. Based on the successful simulation results, the test installation drawings for the MGS transition system were updated and sent to WYDOT for review and approval on October 23. These draft test installation drawings are presented in Attachment B.

The test plan for the MGS transition includes *MASH* Test 3-20 and Test 3-21 on the downstream ends of the transition system where it attaches to the C2P bridge rail. Based on the Task 2 simulation analyses, the CIPs for *MASH* Test 3-20 and Test 3-21 were determined to be 76 inches and 84 inches upstream from the upstream flange of the first C2P bridge rail post.

The upstream end of the MGS transition will not be evaluated because it is similar in design to a system that was already crash tested and determined to be *MASH* compliant. If changes to the upstream end are desired, it will result in the need for additional time and resources to evaluate the changes, including the need for additional crash testing if an FHWA eligibility letter is desired by Wyoming DOT.

c. What opportunities for training and professional development has the project provided? If the research is not intended to provide training and professional development, state "Nothing to Report". Otherwise, describe opportunities for training and professional development, training activities, and professional development.

Nothing to report.

d. How have the results been disseminated to communities of interest? Describe what results have been disseminated and in what manner, including publications, conference papers, and presentation. Please list ALL derivative reports/publications which were generated from this project, and provide an electronic copy of the report/publication.

Nothing to report.

e. What do you plan to do during the next reporting period to accomplish the goals and objectives? Describe briefly what you plan to do during the next reporting period to accomplish the goals and objectives.

Work on Task 3 will continue. Materials required for construction of both the C2P bridge rail and transition systems will be acquired. Construction of the simulated bridge rail system and attached transitions will be initiated. When a date for completion of construction of the test installation can be determined, the full-scale crash tests for the box beam transition will be scheduled on the TTI Proving Ground test calendar. The tests dates will be relayed to Wyoming DOT.

f. List any products resulting from the project during the reporting period. Include in this list:

1. Publications, conference papers, and presentations.
2. Website(s) or other internet sites (List the URL).
3. Technologies or techniques.
4. Inventions, patent applications, and/or licenses.
5. Other products, such as data or databases, physical collections, audio or video products, software or NetWare, models, educational aids or curricula, instruments or equipment.

Nothing to report.

g. Impact:

1. How will this project impact WYDOT?
2. How will this project impact other agencies?

WYDOT's Mission Statement is to "provide a safe, high quality and efficient transportation system." One of the goals within the mission statement is to "improve safety on the state transportation system." Successful implementation of the transitions developed under this project into WYDOT's standard plans will provide an improved level of safety. The transitions

will provide continuity of motorist safety from MASH guardrail systems to MASH bridge rail systems. Full implementation of MASH compliant roadside safety devices, including transition systems, will provide an enhanced level of safety that will help reduce the severity of lane departure crashes that represent over 75% of highway fatalities in Wyoming. Additionally, the AASHTO/FHWA MASH Implementation Agreement requires state DOTs to provide MASH compliant roadside safety features to obtain federal funding reimbursement on projects. The results of this research will be useful to other agencies. This project is being funded as a pooled fund effort between WYDOT and Montana DOT. It will provide transition details that will be immediately implementable by both of these agencies as well as other agencies that use similar guardrail and bridge rail systems.

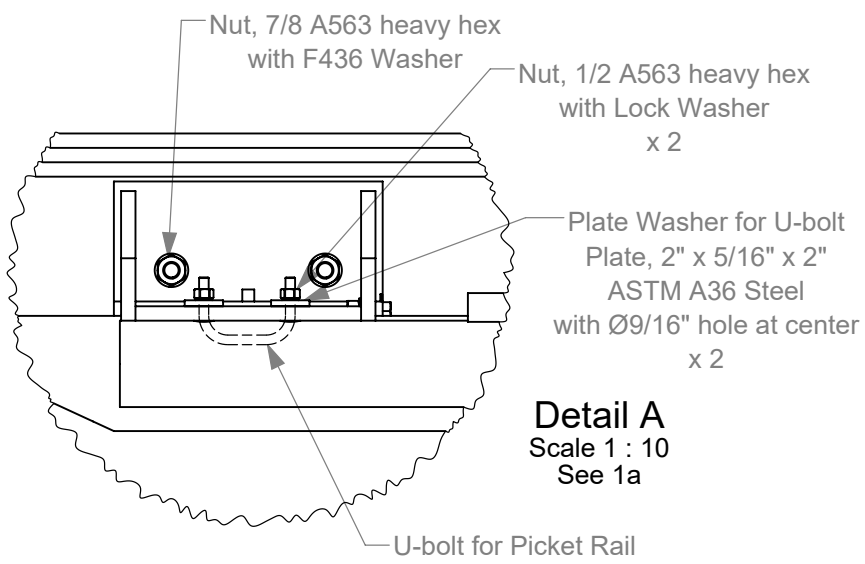
h. Changes to Scope of Work. Provide the following changes, if applicable:

1. Scope of work or objectives of the project.
2. Changes in key persons.
3. Disengagement from the project for more than three (3) months, or a twenty five (25) percent reduction in time devoted to the project.
4. The inclusion of costs that require prior approval.
5. The transfer of funds between line items in the budget.
6. The subawarding, transferring or contracting of work.
7. Changes in the approved cost-sharing or match.

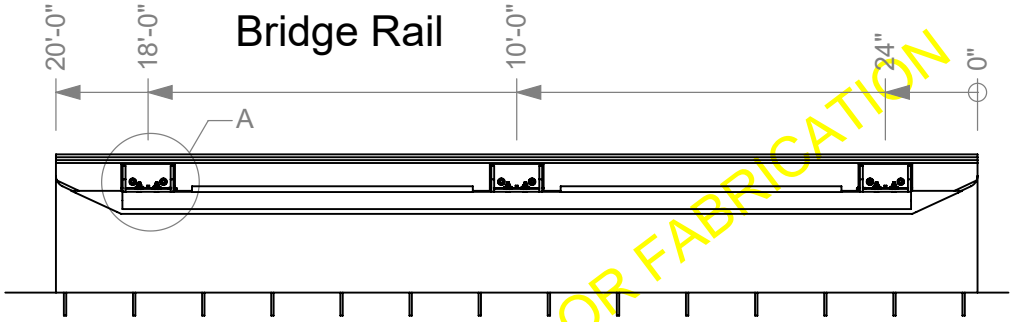
Nothing to report.

ATTACHMENT 1

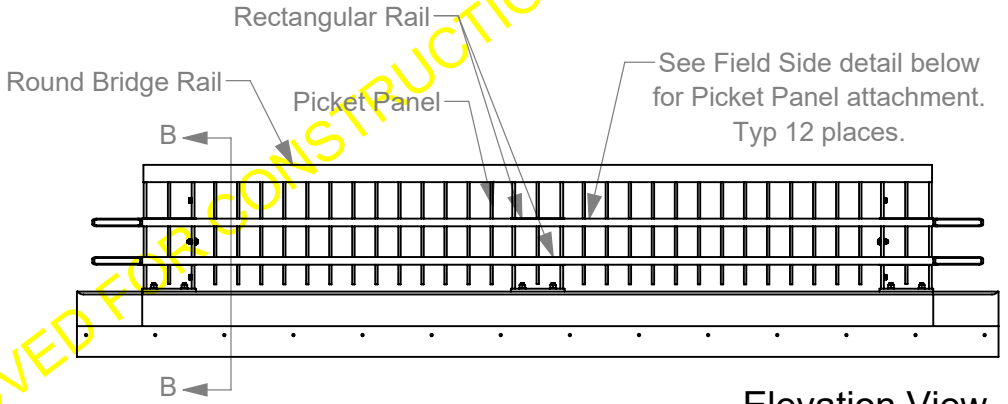
Box Beam Guardrail Transition Test Installation Details



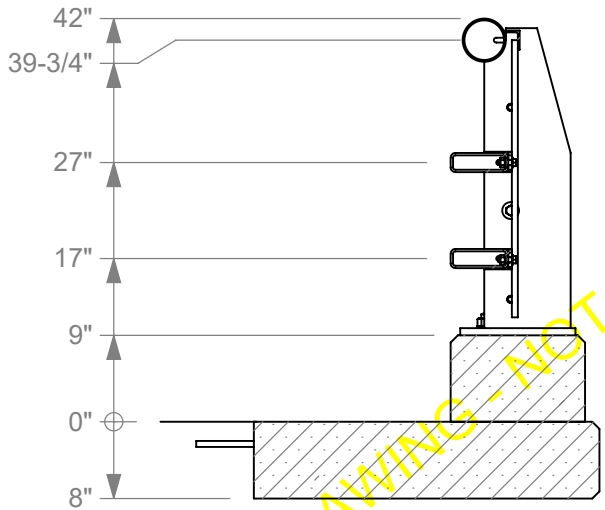
Detail A
Scale 1 : 10
See 1a



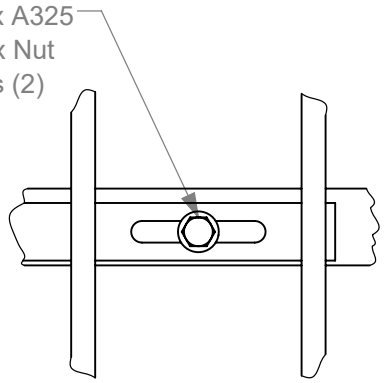
Plan View



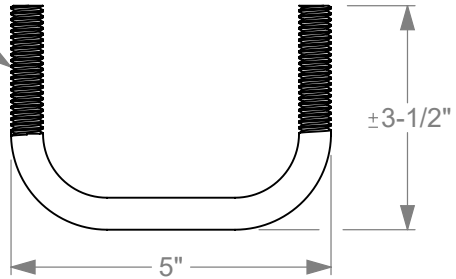
Elevation View



Section B-B
Scale 1 : 20



1a. U-bolt and hardware typical 3 places at each Post.
Anchor hardware typical 4 places at each Post.

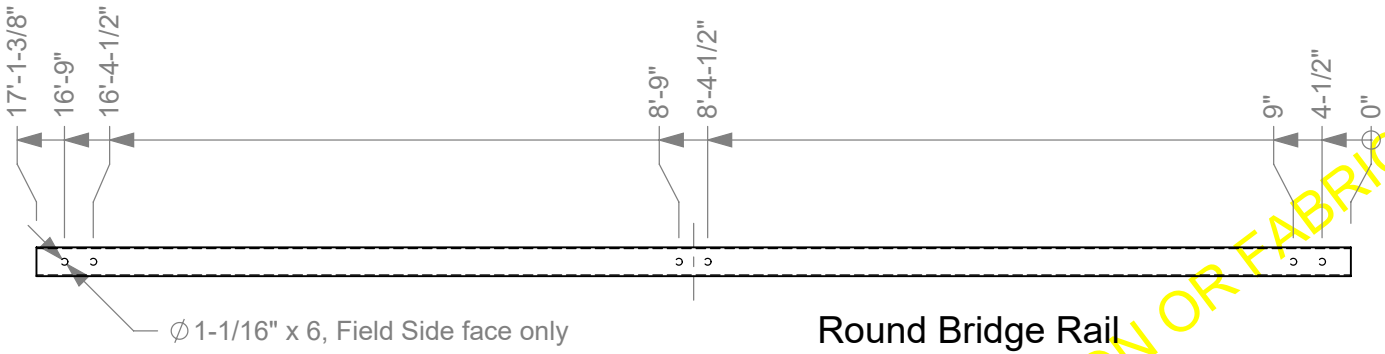


U-bolt for Picket Rail
∅1/2" ASTM A36 Steel
10" long before bending
Plan View - Scale 1:3

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 Wyoming Transition Deck		2020-09-03
Drawn by GES	Scale 1:50	Sheet 1 of 11 Bridge Rail

Bridge Rails

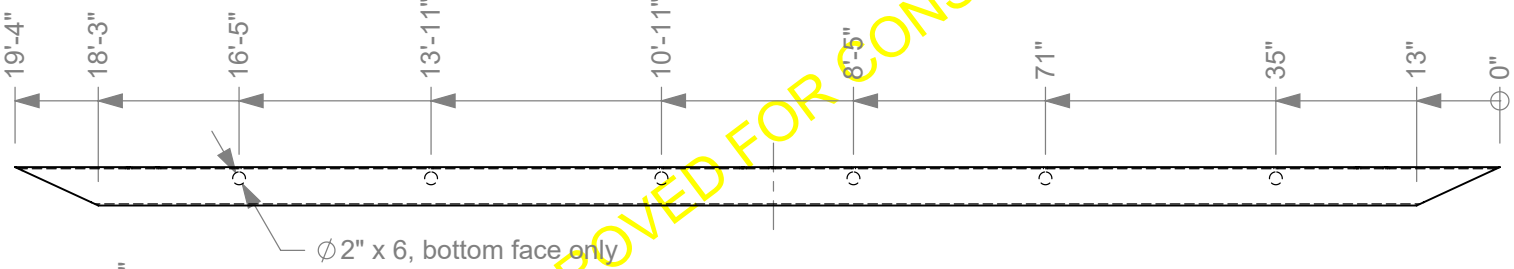
for Box Beam Rail

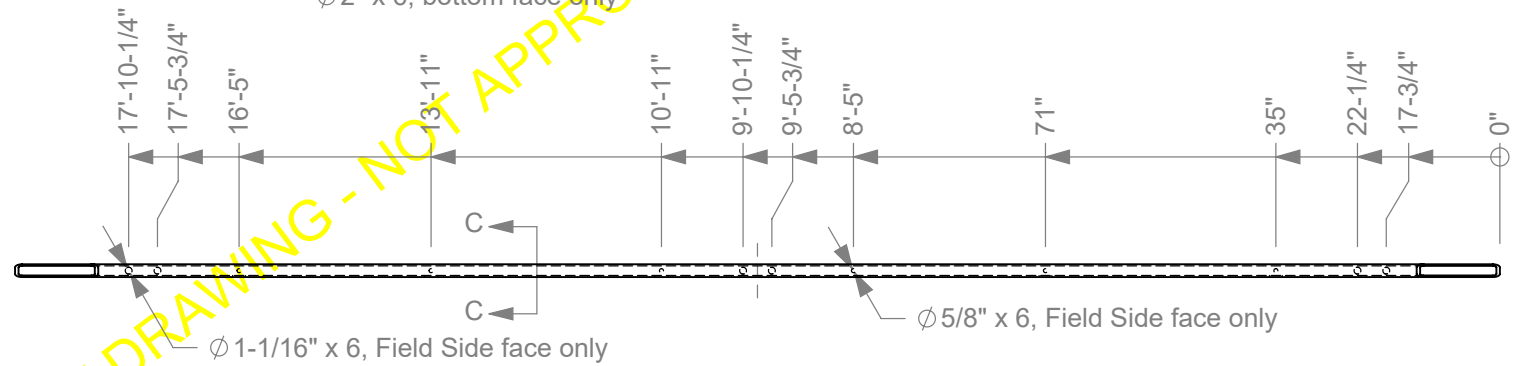


Round Bridge Rail

HSS Round 4 1/2" x 3/16" ASTM A500 Grade B

Elevation View

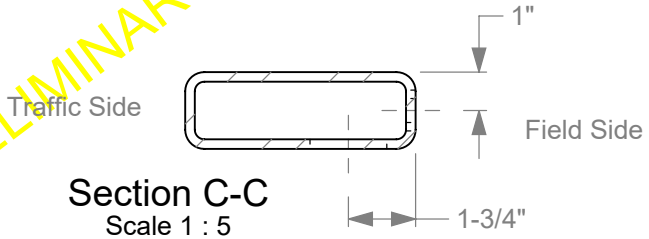




Rectangular Rail

HSS 6 x 2 x 1/4 ASTM A500 Grade B

Plan and Elevation Views



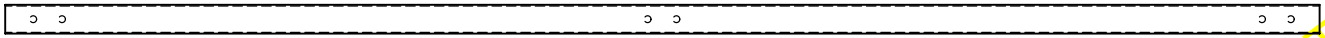
Section C-C

Scale 1 : 5

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 Wyoming Transition Deck		2020-09-03
Drawn by GES	Scale 1:30	Sheet 2 of 11 Bridge Rails

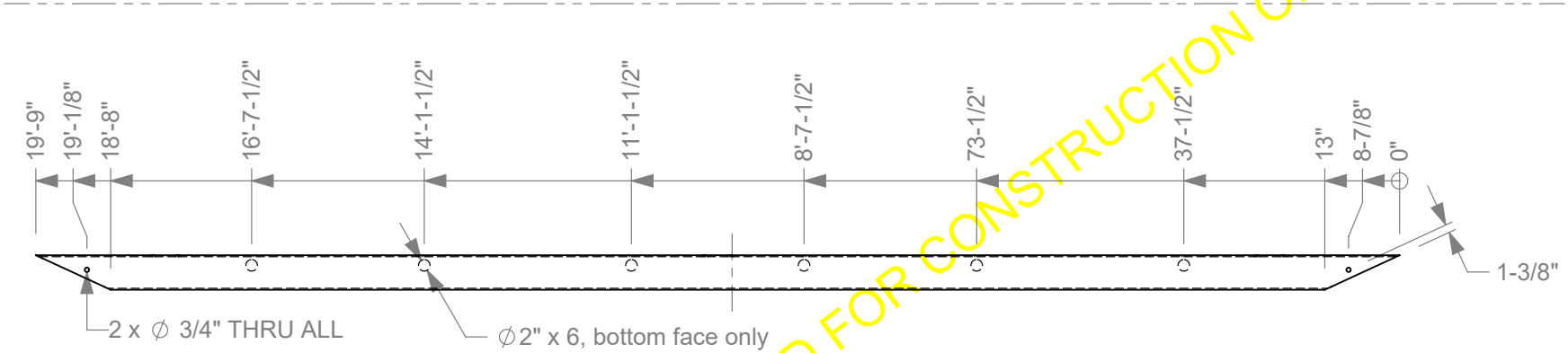
Bridge Rails

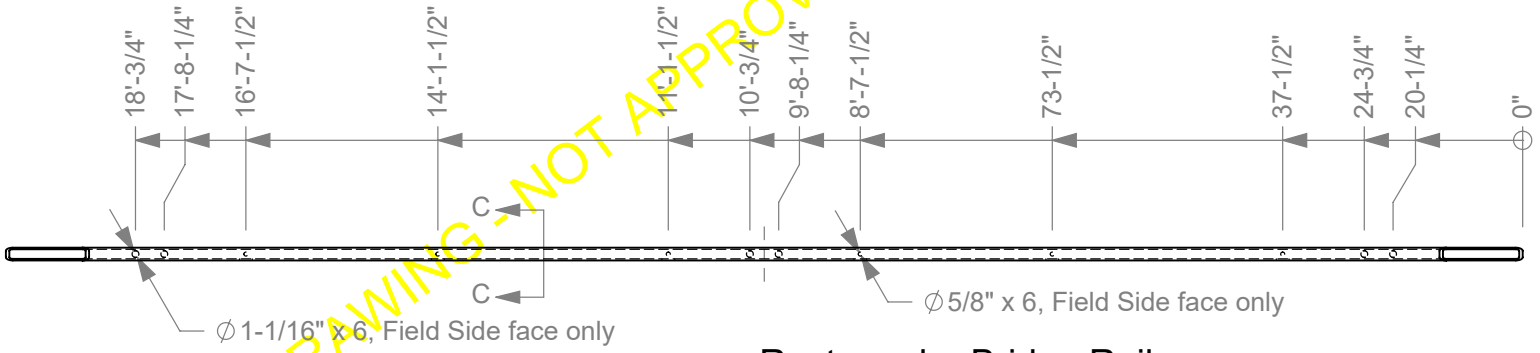
for C2P Rail



Round Bridge Rail

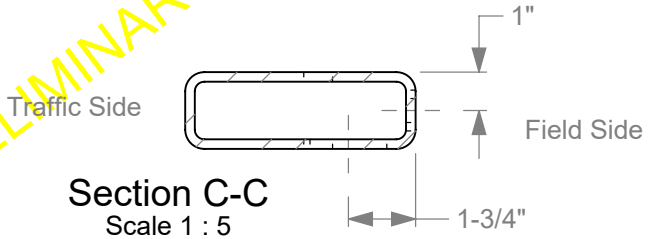
Same details as on previous sheet
Elevation View





Rectangular Bridge Rail

HSS 6 x 2 x 1/4 ASTM A500 Grade B
Plan and Elevation Views



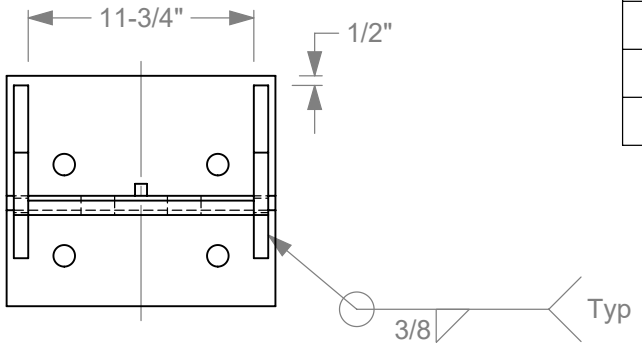
Section C-C

Scale 1 : 5

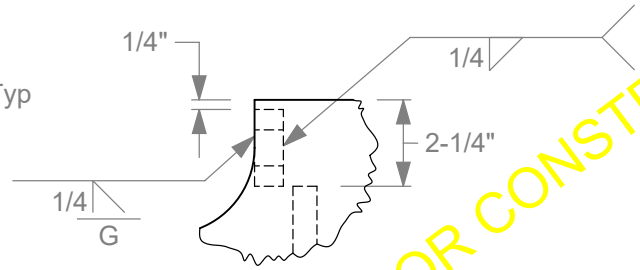
Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 Wyoming Transition Deck		2020-09-03
Drawn by GES	Scale 1:30	Sheet 3 of 11 Bridge Rails

Bridge Post

#	Body Name	Description	Length	Material	Qty
1	Base Plate	Plate, 12" x 3/4"	14"	ASTM A572 Grade 50	1
2	Side Plate	Plate, 9" x 3/4"	31 1/4"	ASTM A572 Grade 50	2
3	Rail Plate, Top	Plate, 2" x 3/4"	11 3/4"	ASTM A36 Steel	1
4	Rail Plate, Lower	Plate, 2" x 3/4"	14"	ASTM A36 Steel	2
5	Picket	Plate, 5/8" x 5/8"	27 3/4"	ASTM A36 Steel	1

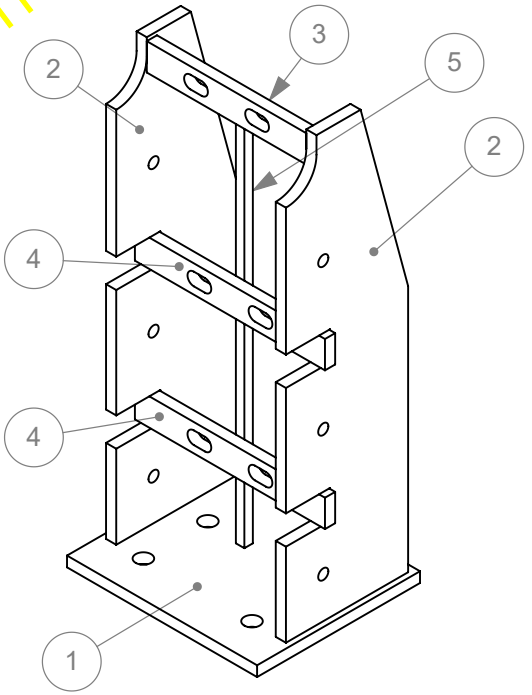


Plan View

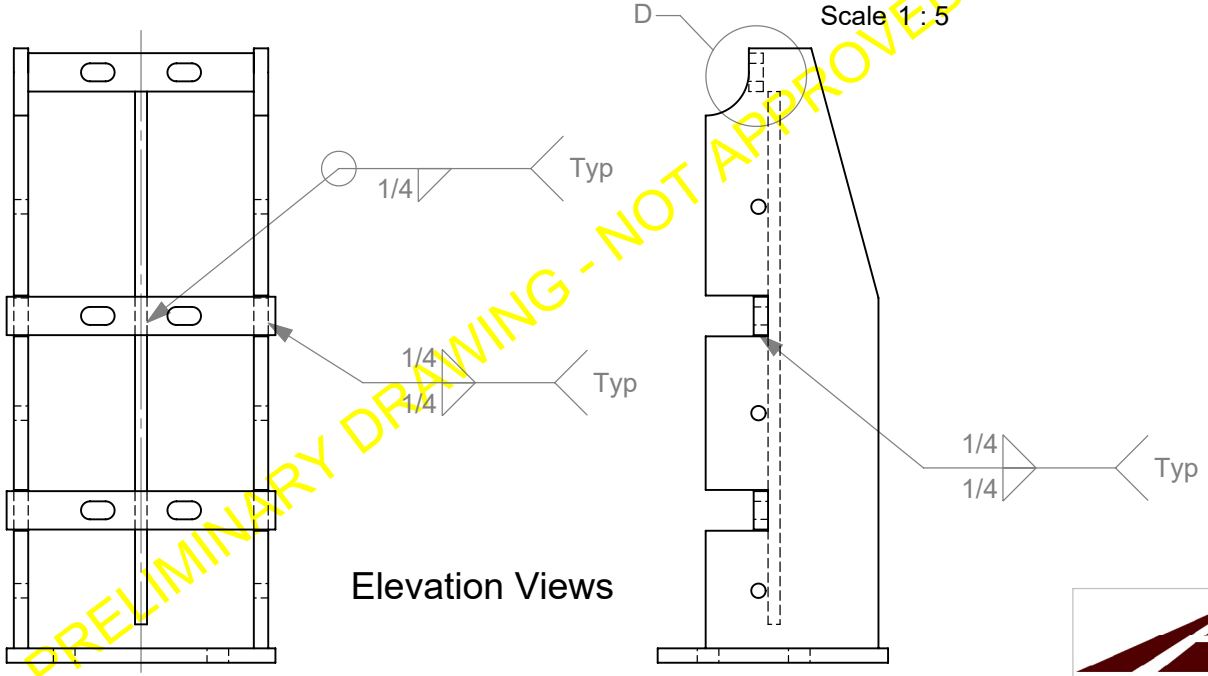


Detail D

Scale 1 : 5



Isometric View



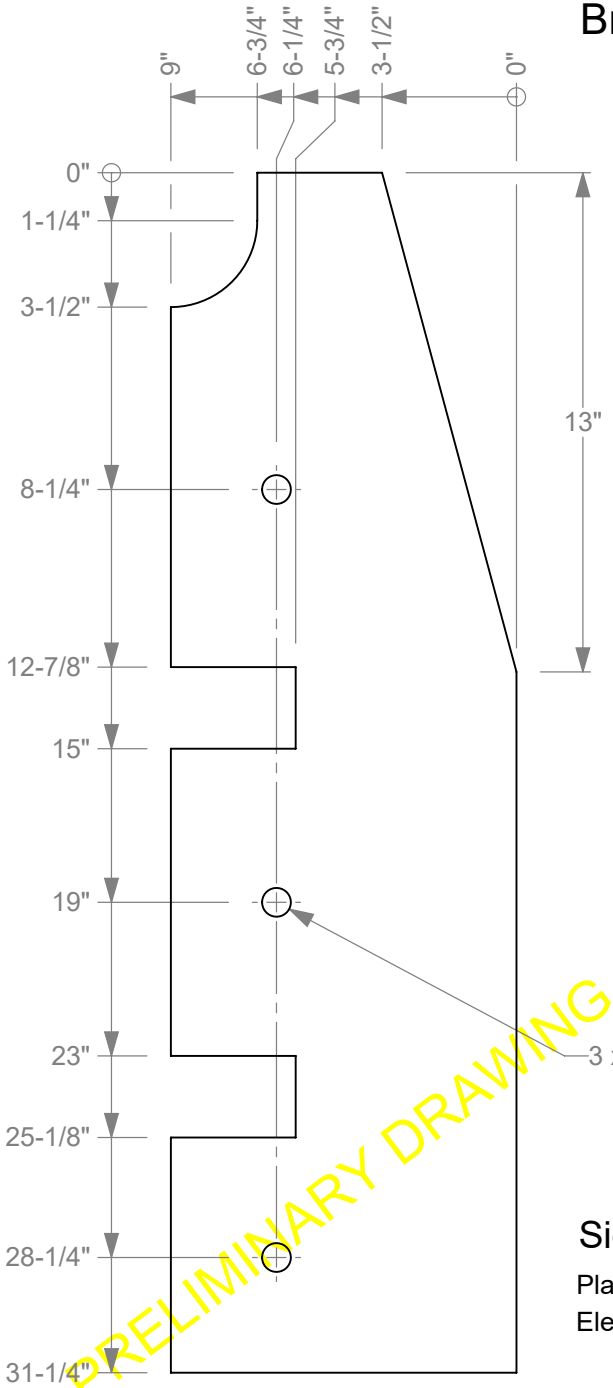
Elevation Views

4a. All welding must be performed by certified welders using industry standard practices.

4b. Galvanize after fabrication is complete.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 Wyoming Transition Deck		2020-09-03
Drawn by GES	Scale 1:10	Sheet 4 of 11 Bridge Post

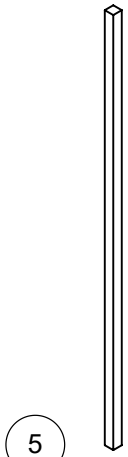
Bridge Post Parts



2

Side Plate

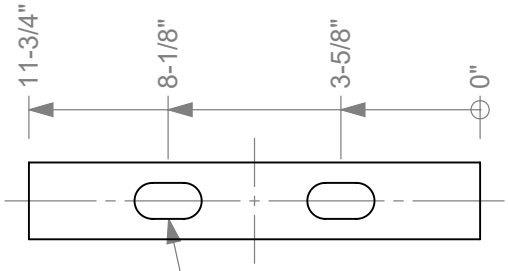
Plate, 9" x 3/4"
Elevation View



5

Picket

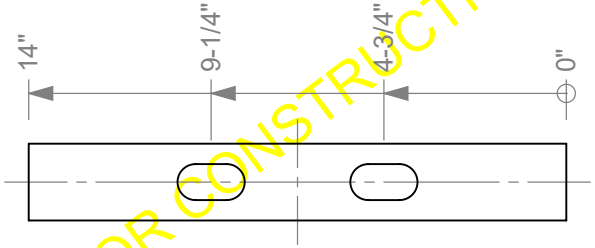
Plate, 5/8" x 5/8"



3

Rail Plate, Top

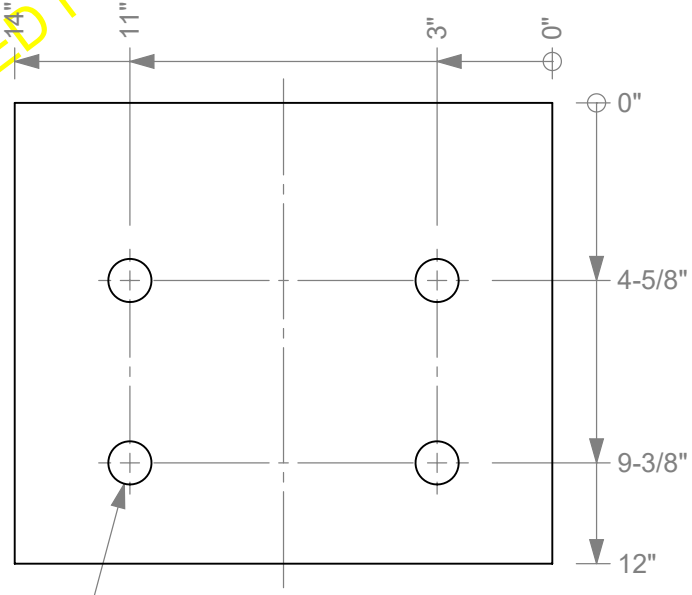
Plate, 2" x 3/4"
Elevation View



4

Rail Plate, Lower

Plate, 2" x 3/4"
Elevation View



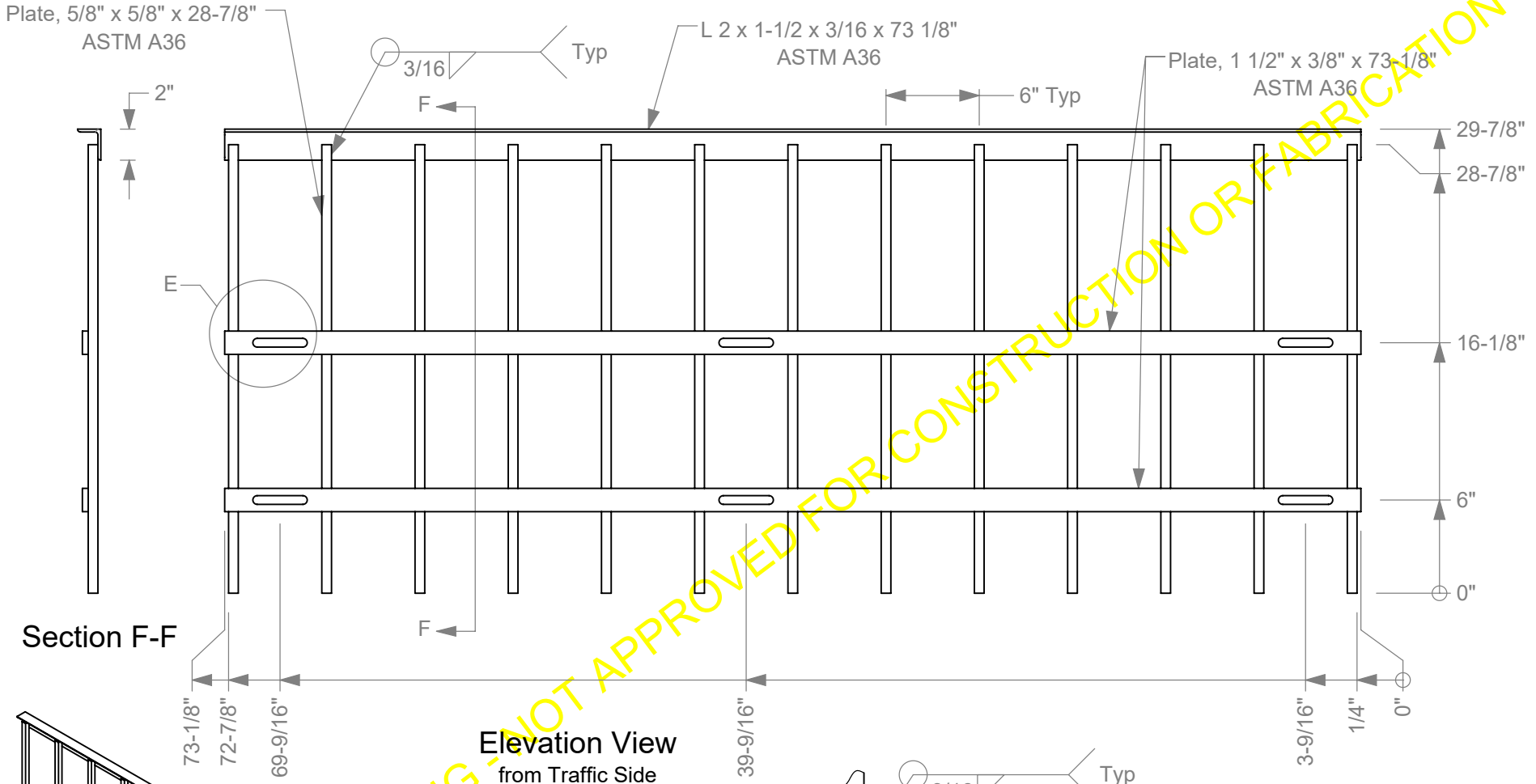
1

Base Plate

Plate, 12" x 3/4"
Plan View

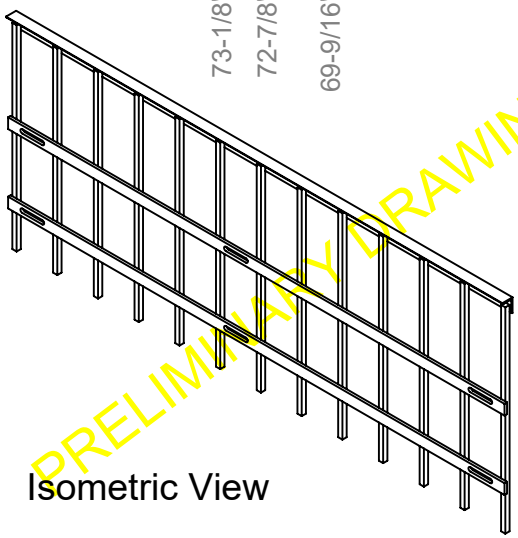
Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 Wyoming Transition Deck		2020-09-03
Drawn by GES	Scale 1:5	Sheet 5 of 11 Bridge Post Parts

Picket Panel

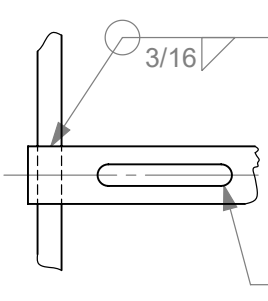


Section F-F

Elevation View
from Traffic Side



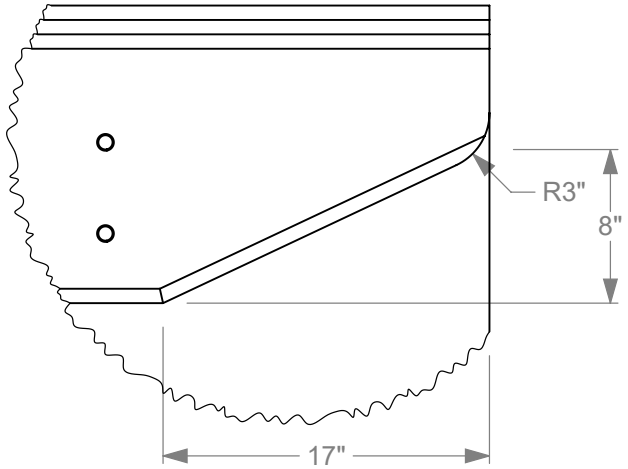
Isometric View



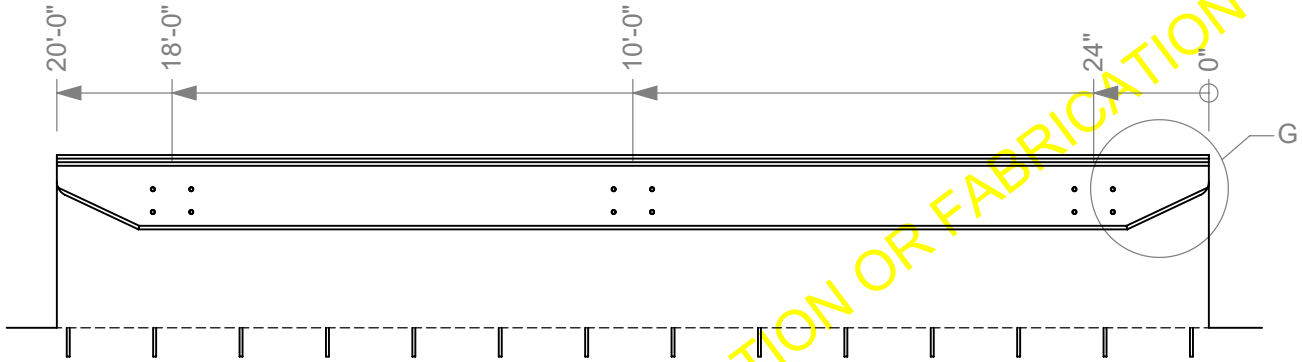
Detail E
Scale 1 : 5

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 Wyoming Transition Deck		2020-09-03
Drawn by GES	Scale 1:10	Sheet 6 of 11 Picket Panel

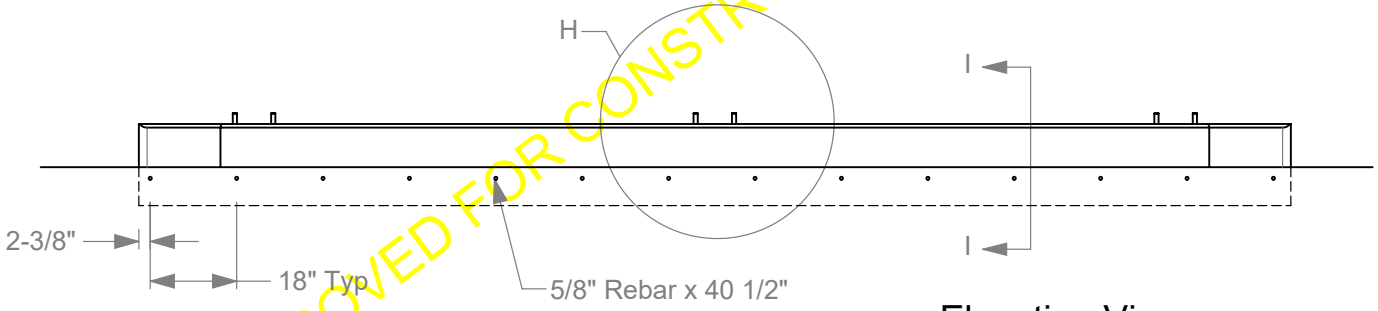
Moment Slab and Curb



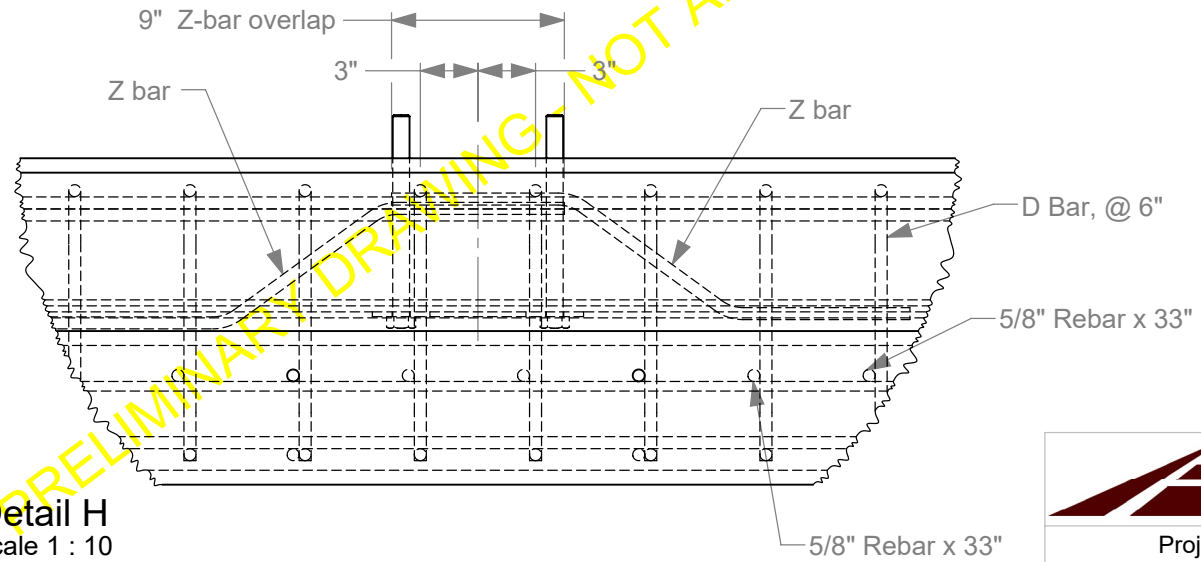
Detail G
Scale 1 : 10
Typ each end



Plan View



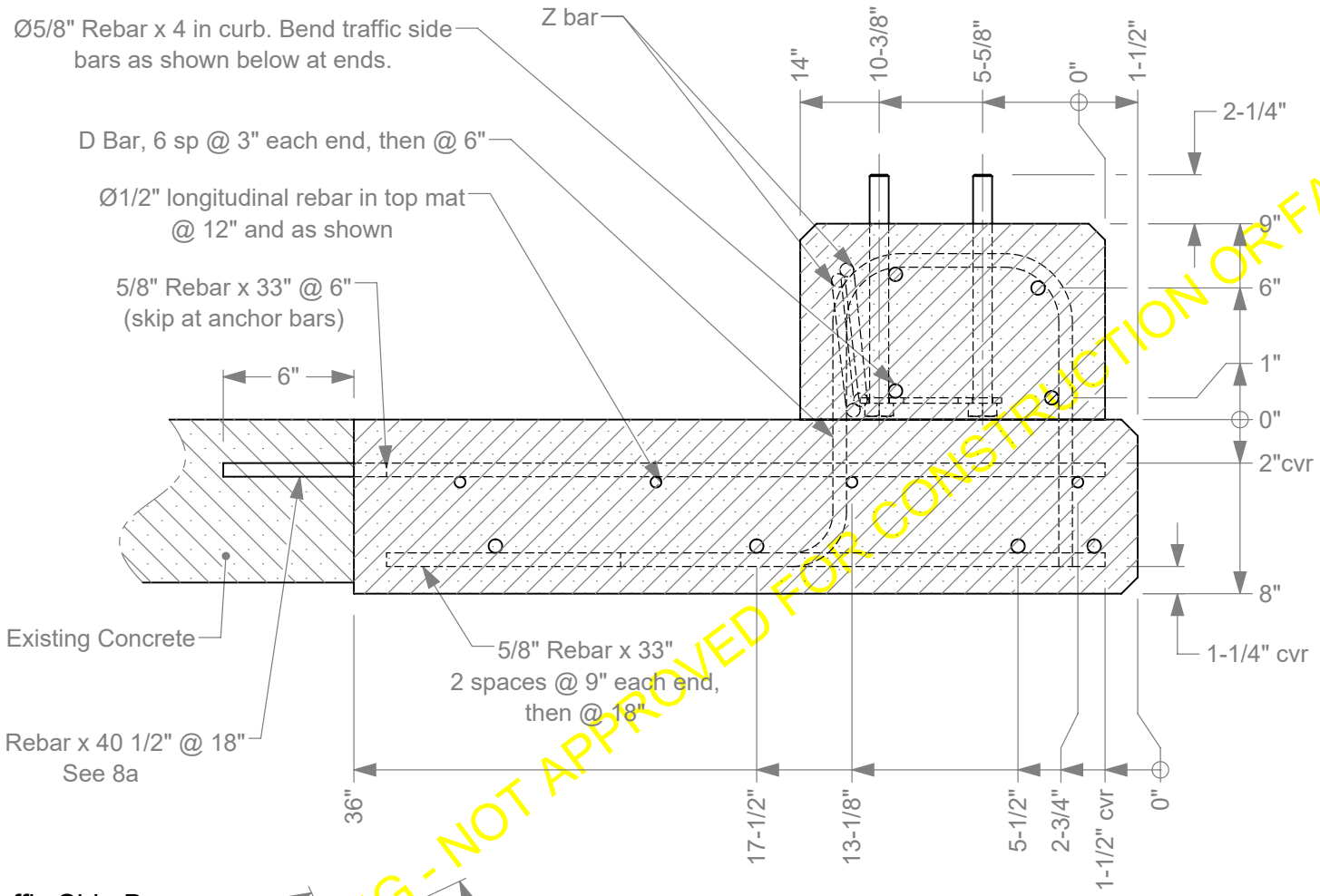
Elevation View
Section View on next sheet

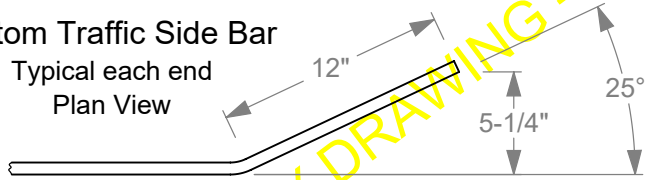


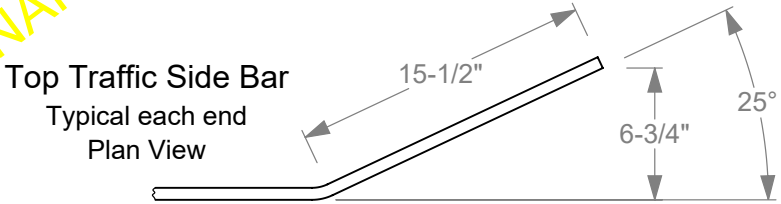
Detail H
Scale 1 : 10

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 Wyoming Transition Deck		2020-09-03
Drawn by GES	Scale 1:40	Sheet 7 of 11 Moment Slab and Curb

Section I-I







8a. Secure in existing concrete with Hilti HIT-RE 500 V3 epoxy according to manufacturer's instructions.

8b. All rebar is grade 60.

8c. All rebar dimensions are to center of bar unless otherwise indicated by "cvr" (cover).

8d. Concrete is 4000 psi.

8e. 1" chamfer (3/4" each way) edges of Deck and Curb as shown.

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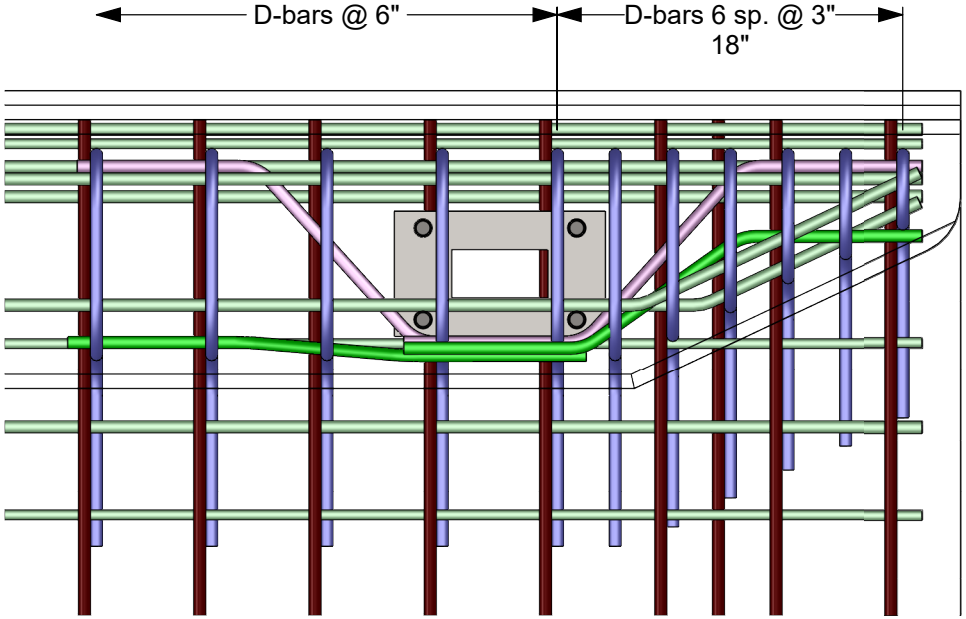
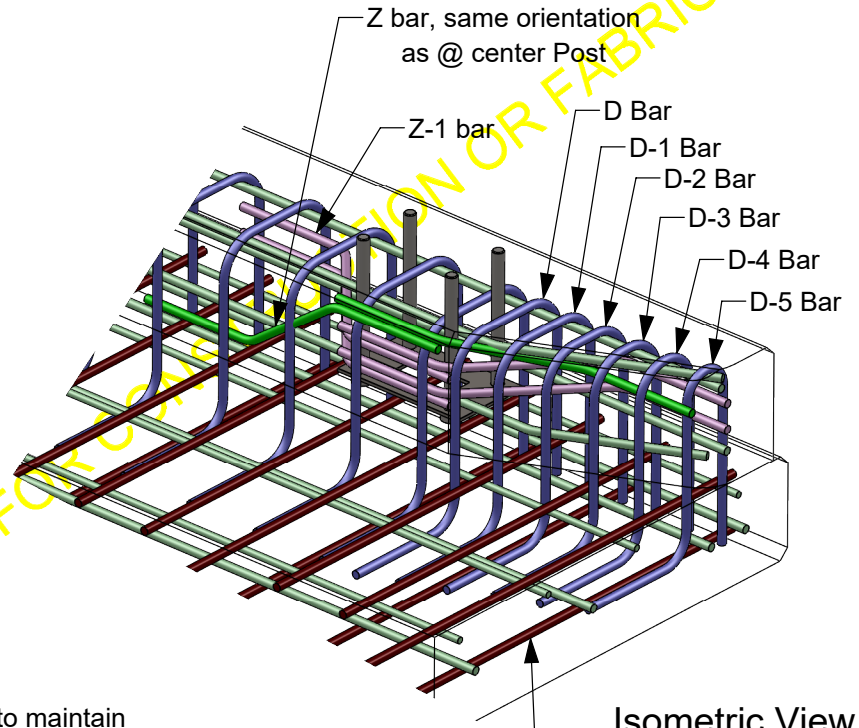
Project #611801 Wyoming Transition Deck		2020-09-03
Drawn by GES	Scale 1:8	Sheet 8 of 11 Concrete Section

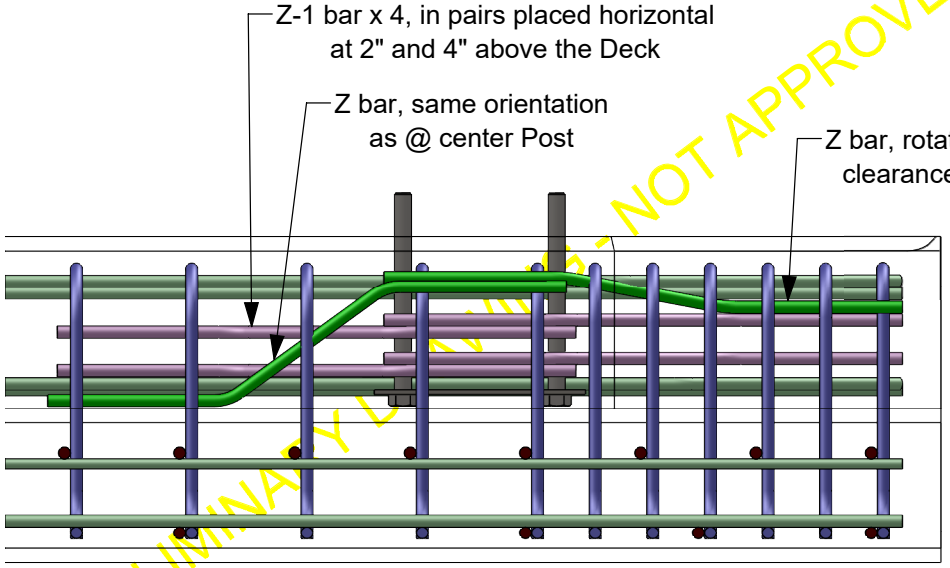
Rebar at Ends



Plan View



Isometric View



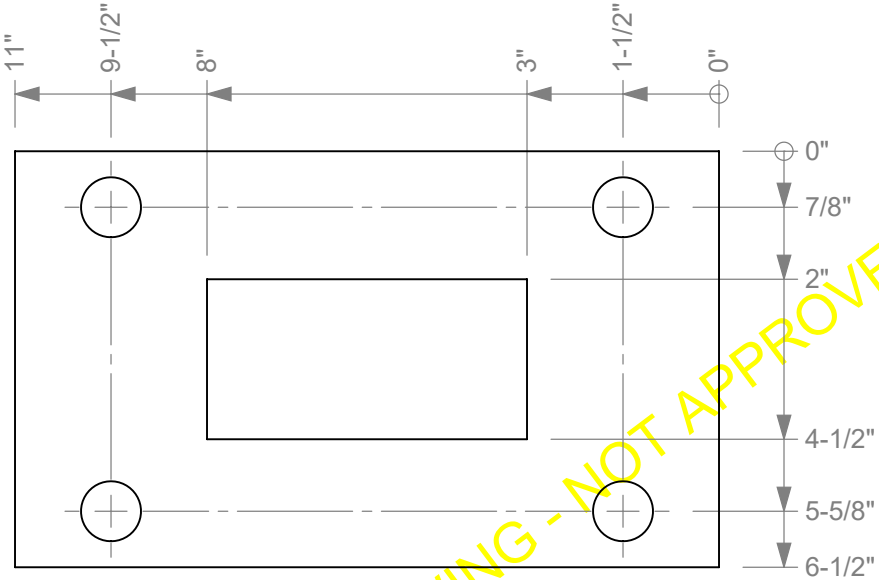
Elevation View
Anchor Bars not shown for clarity

5/8" Rebar x 33"
Two spaces @ 9", then @ 18" to end

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 Wyoming Transition Deck		2020-09-03
Drawn by GES	Scale 1:10	Sheet 9 of 11 Rebar at Ends

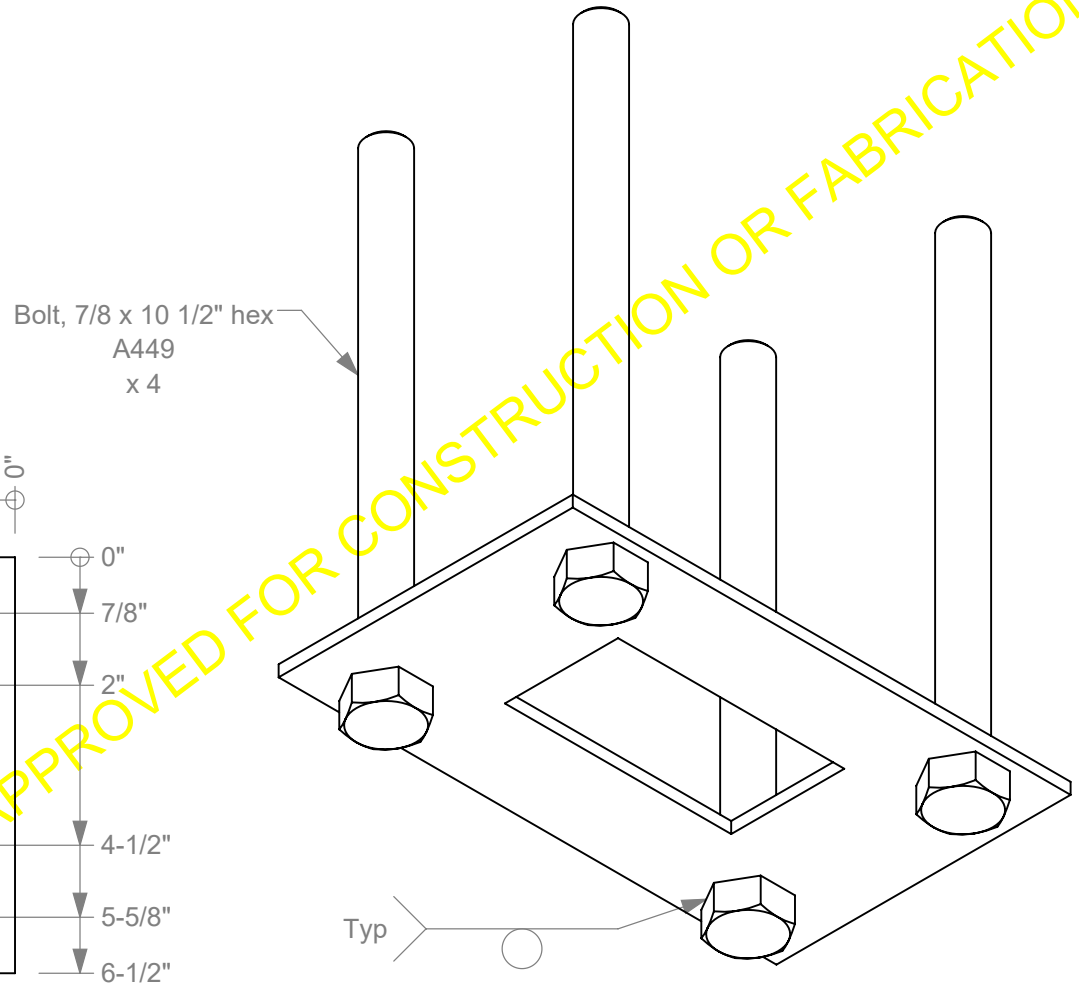
Anchor Bolt Assembly

Threads not shown for clarity



Anchor Plate

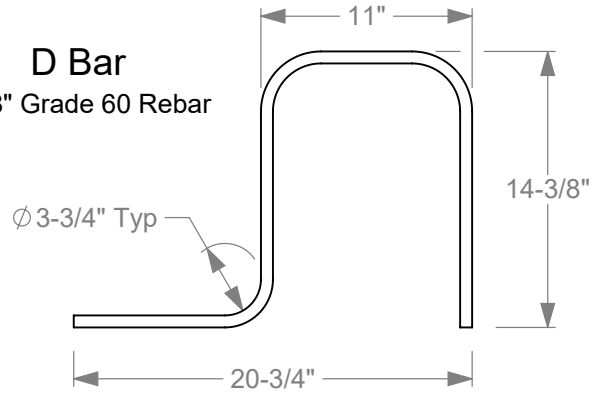
Plate, 6 1/2" x 1/4"
ASTM A36 Steel
Plan View



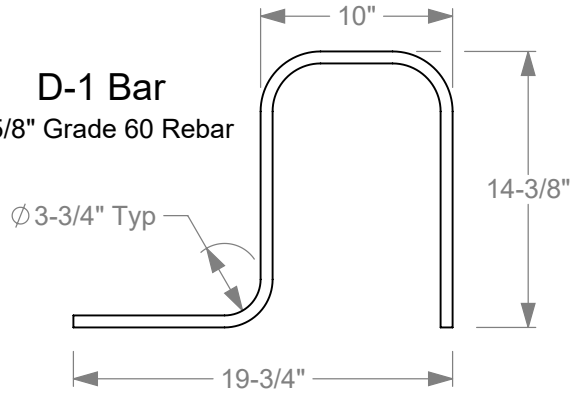
Isometric View

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 Wyoming Transition Deck		2020-09-03
Drawn by GES	Scale 1:3	Sheet 10 of 11 Anchor Bolt Assembly

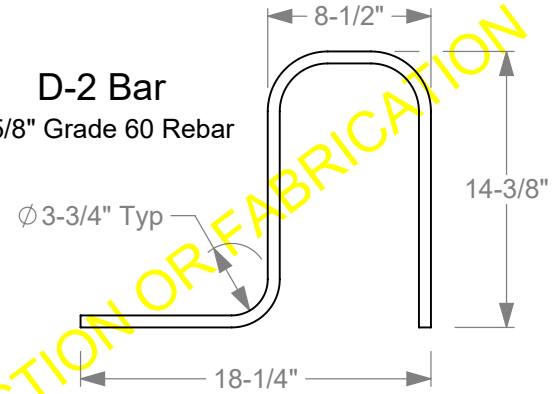
D Bar
Ø5/8" Grade 60 Rebar



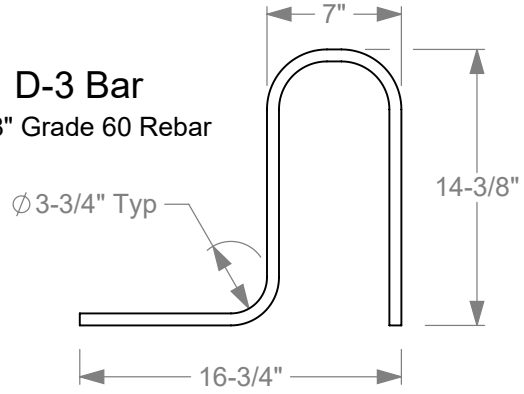
D-1 Bar
Ø5/8" Grade 60 Rebar



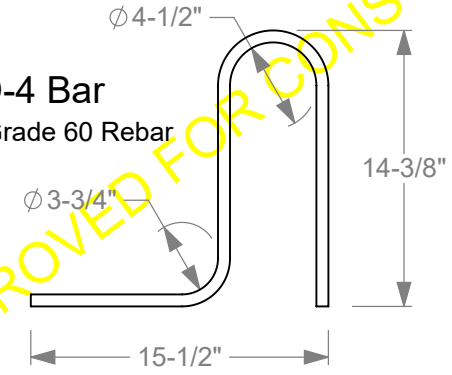
D-2 Bar
Ø5/8" Grade 60 Rebar



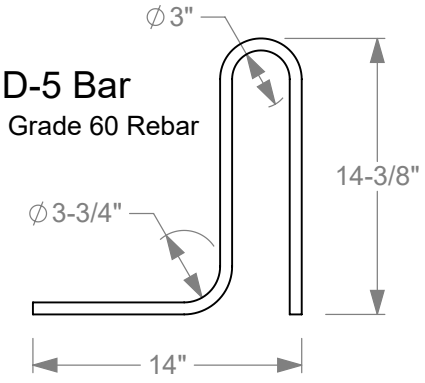
D-3 Bar
Ø5/8" Grade 60 Rebar



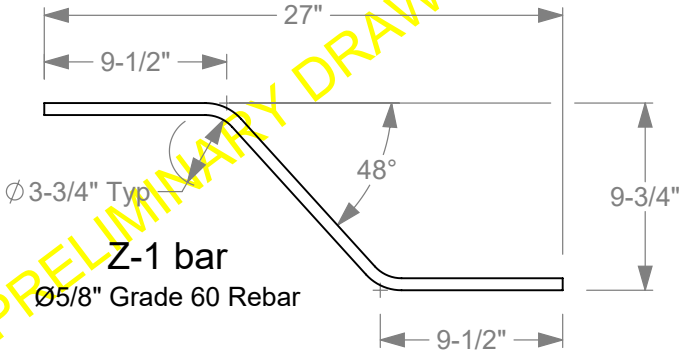
D-4 Bar
Ø5/8" Grade 60 Rebar



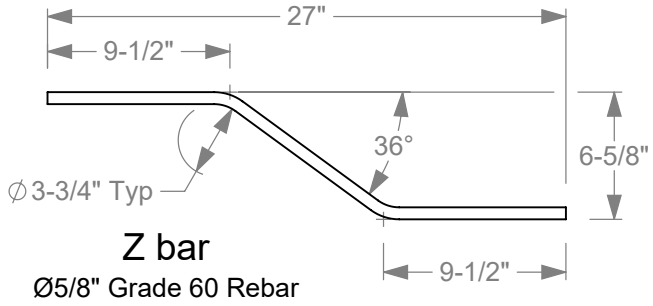
D-5 Bar
Ø5/8" Grade 60 Rebar



Z-1 bar
Ø5/8" Grade 60 Rebar

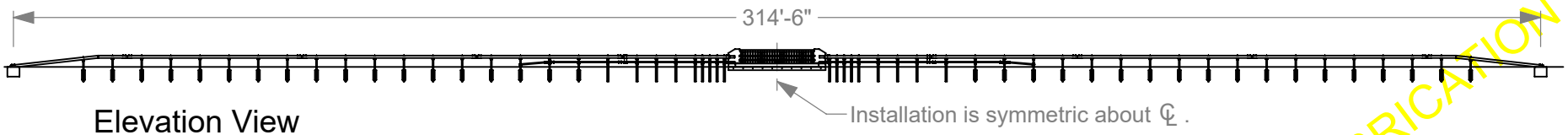


Z bar
Ø5/8" Grade 60 Rebar

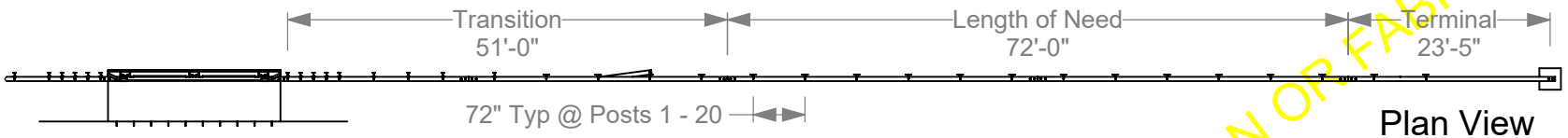


Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 Wyoming Transition Deck		2020-09-03
Drawn by GES	Scale 1:10	Sheet 11 of 11 Rebar

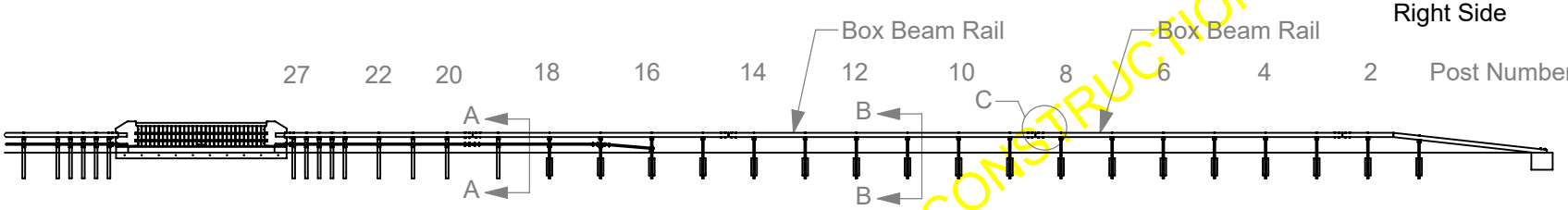
Test Installation



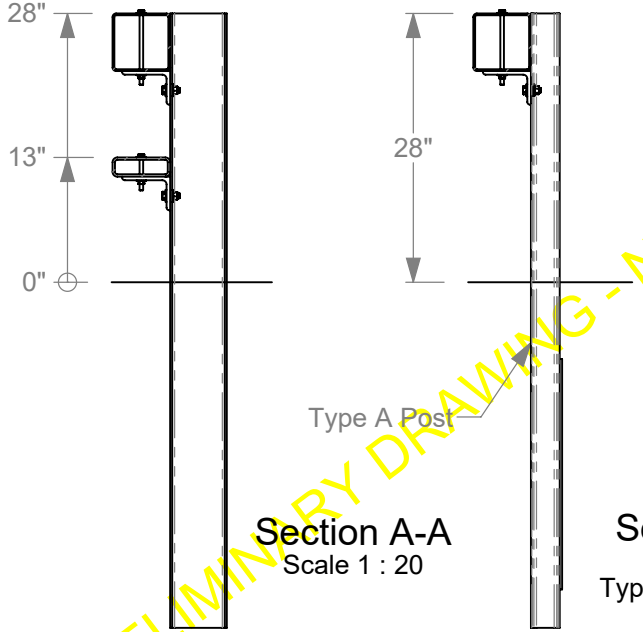
Elevation View



Plan View
Right Side

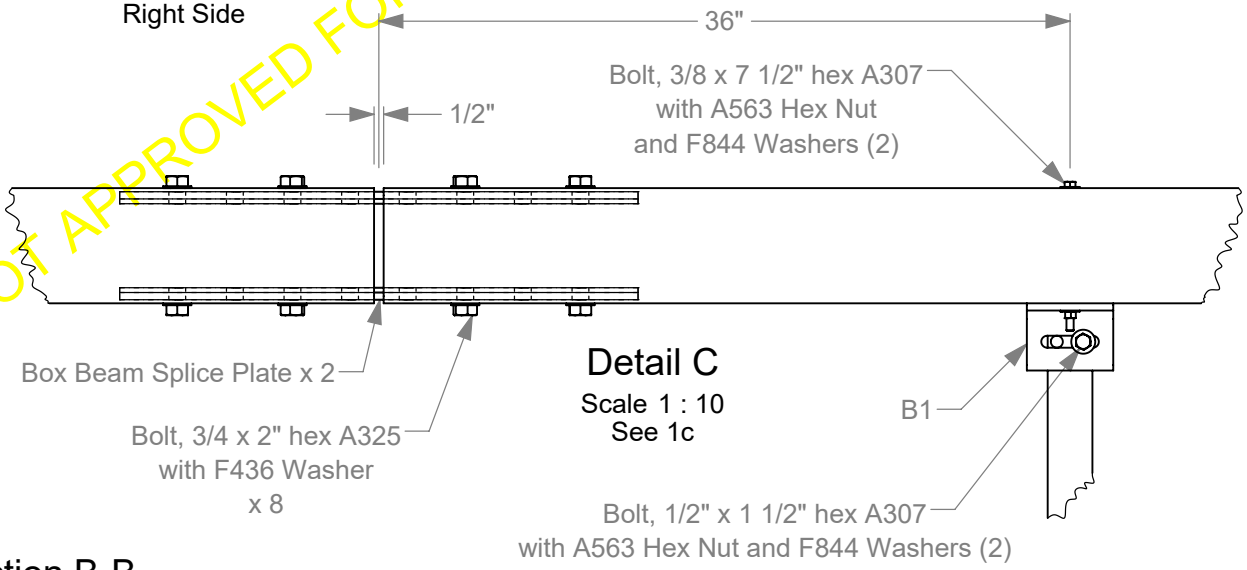


Elevation View
Right Side



Section A-A
Scale 1 : 20

Section B-B
Scale 1 : 20
Typ @ Posts 2 - 15



Detail C
Scale 1 : 10
See 1c

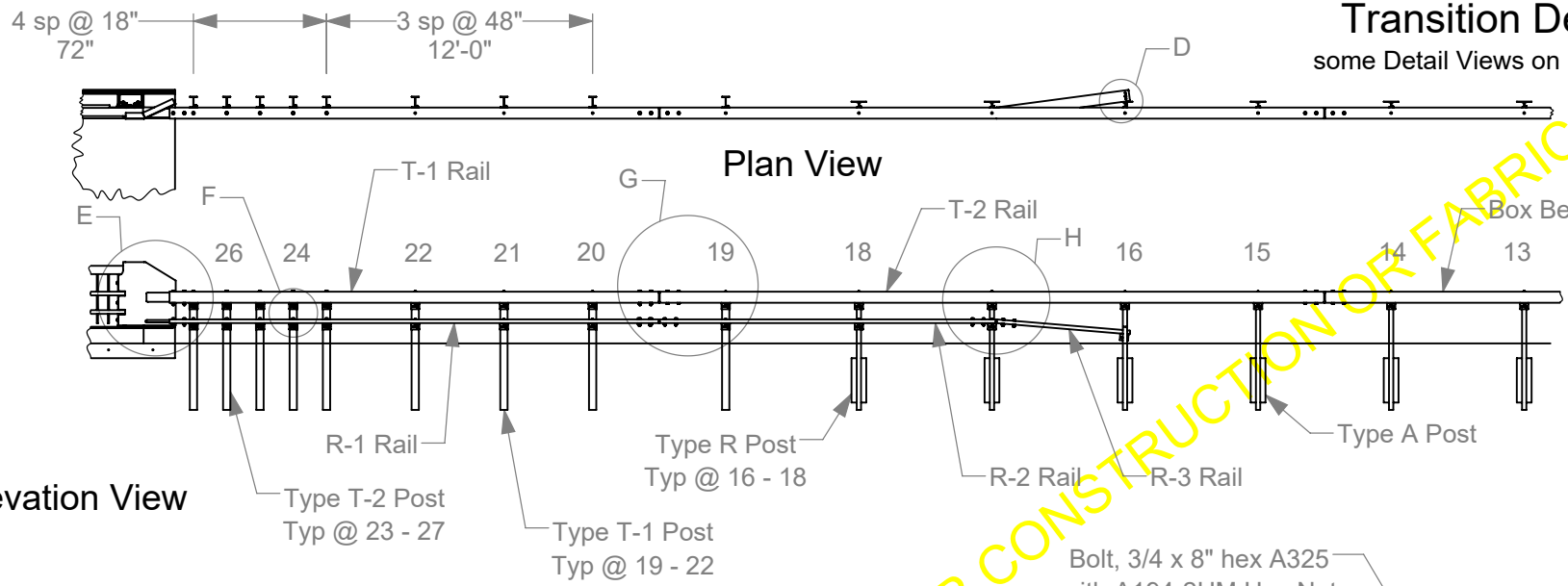
1a. All steel components, including fasteners, shall be galvanized.
1b. Threads not shown on Bolts for clarity.
1c. Rail Joint hardware typical 4 places. Post bracket and hardware typical from Post 1 to 22.

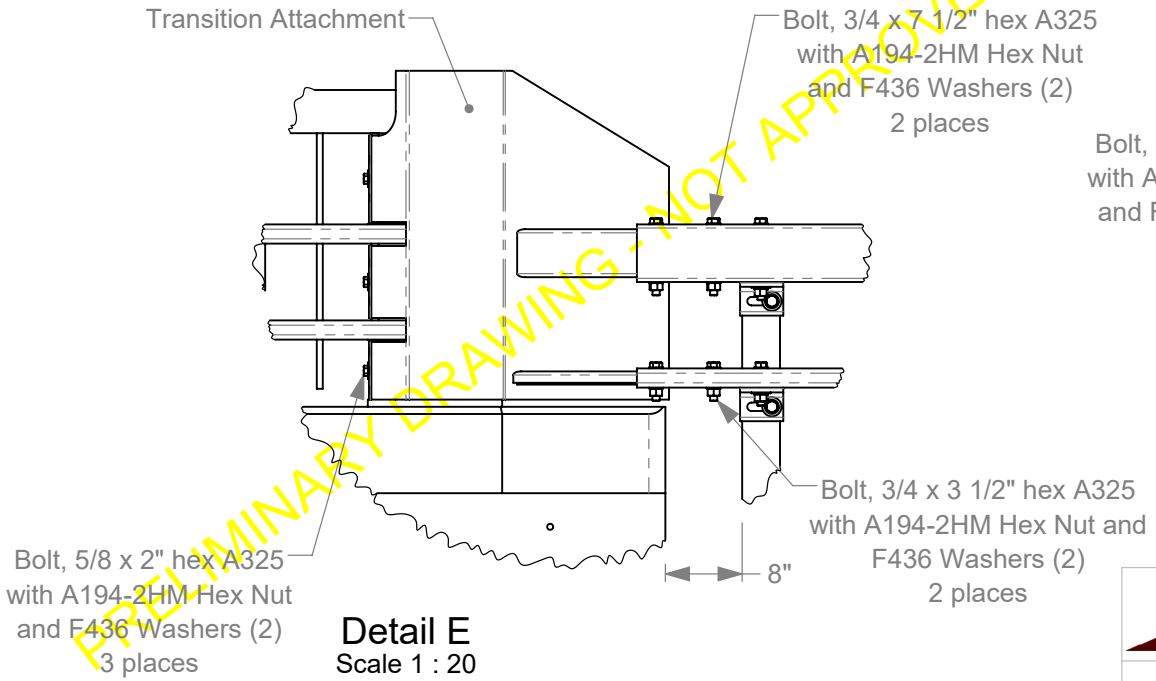
Texas A&M Transportation Institute		Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 Wyoming Box Beam Transition			2020-09-02
Drawn by GES	Scale 1:250	Sheet 1 of 16 Test Installation	

Q:\Accreditation-17025-2017\EIR-000 Project Files\611801-02 - Wyoming DOT - Bligh\Drafting, 611801\Drafting, 611801 1-4\2020-08-27\611801 1-4 Drawing

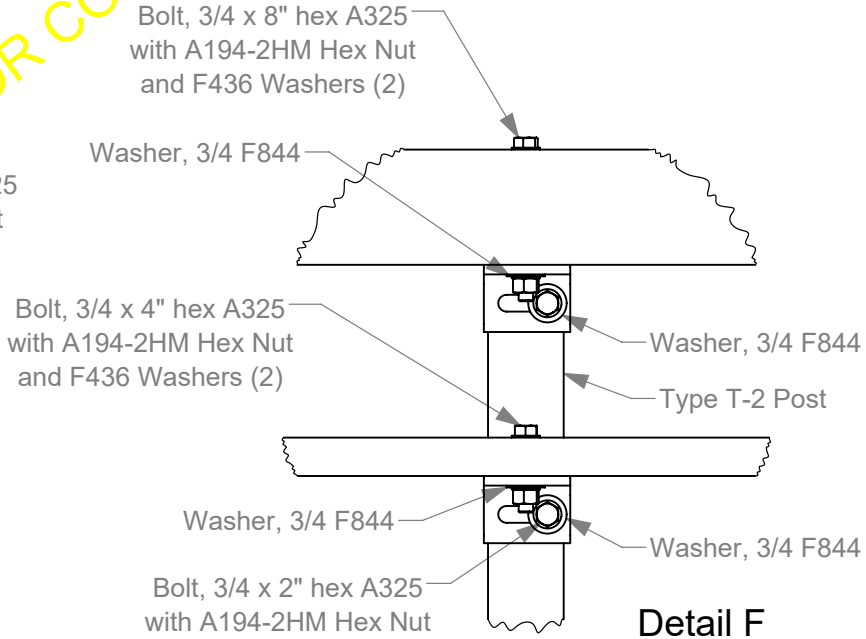
Transition Details

some Detail Views on next sheet





Detail E
Scale 1 : 20



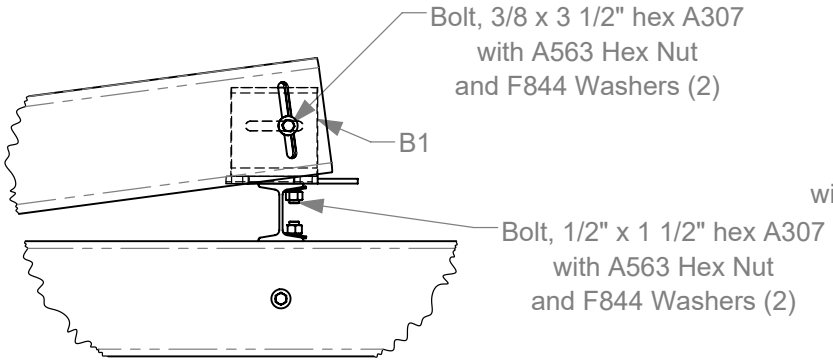
Detail F
Scale 1 : 10
Typ @ Posts 23 - 27

Texas A&M Transportation Institute

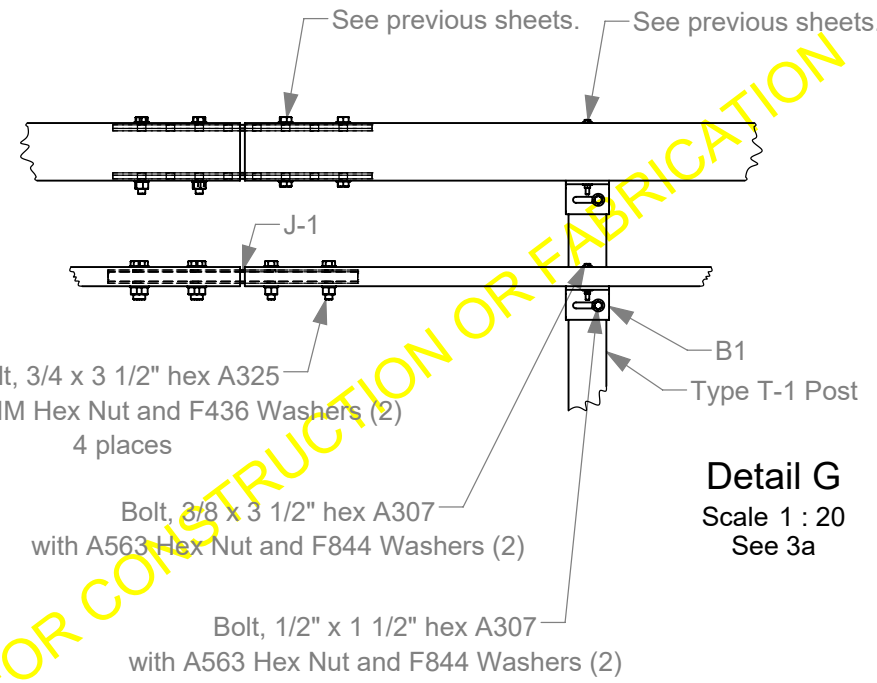
Roadside Safety and Physical Security Division - Proving Ground

Project #611801 Wyoming Box Beam Transition		2020-09-02
Drawn by GES	Scale 1:100	Sheet 2 of 16 Transition Details

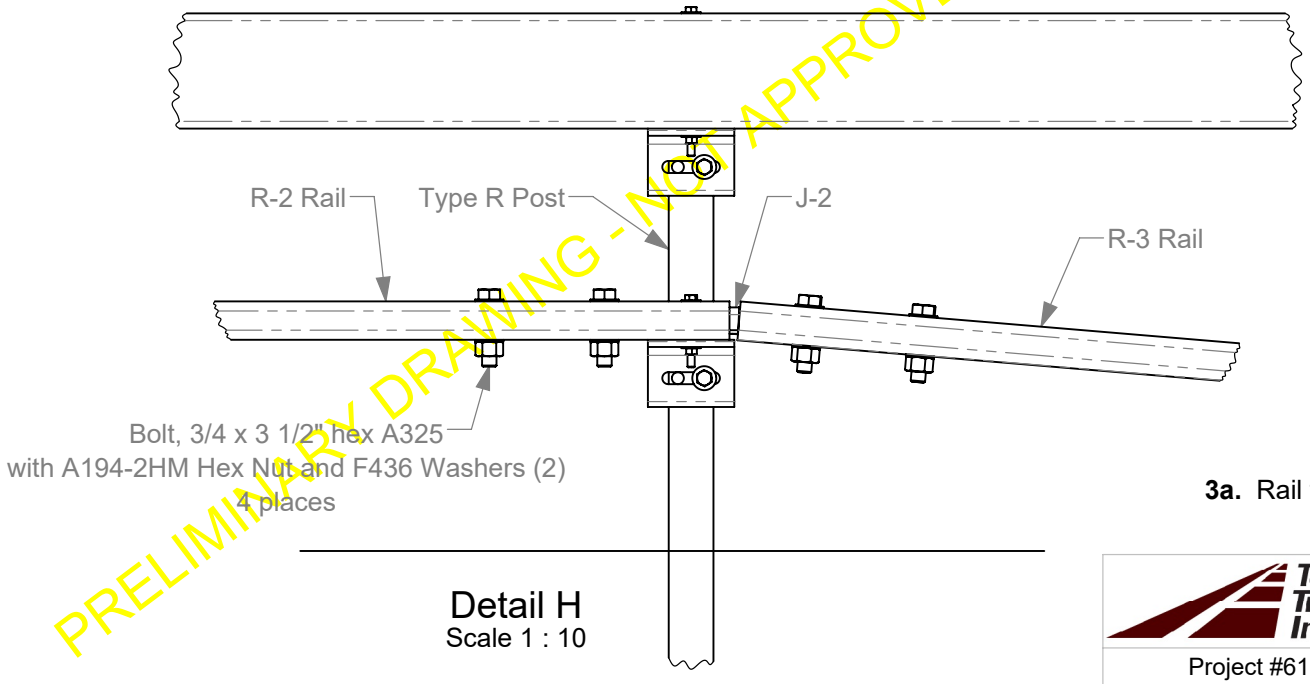
Transition Detail Views



Detail D
Scale 1 : 10



Detail G
Scale 1 : 20
See 3a

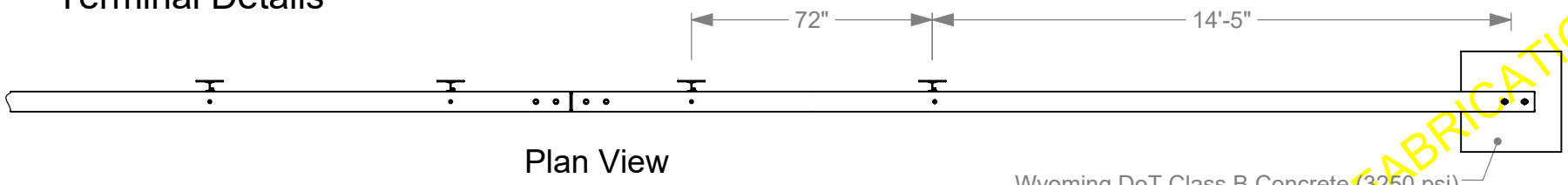


Detail H
Scale 1 : 10

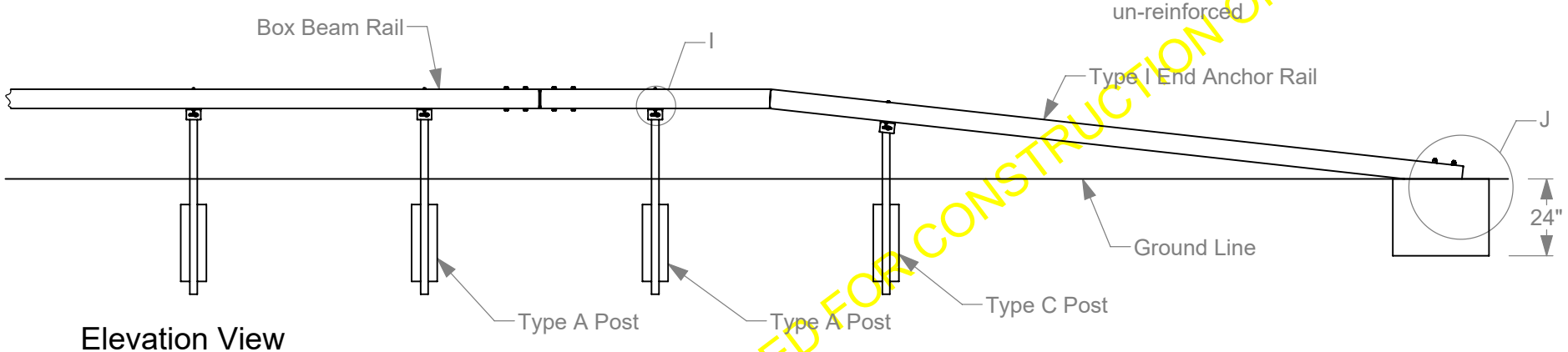
3a. Rail to Post connection details typical at Posts 17 - 22.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 Wyoming Box Beam Transition		2020-09-02
Drawn by GES	Scale 1:250	Sheet 3 of 16 Transition Detail Views

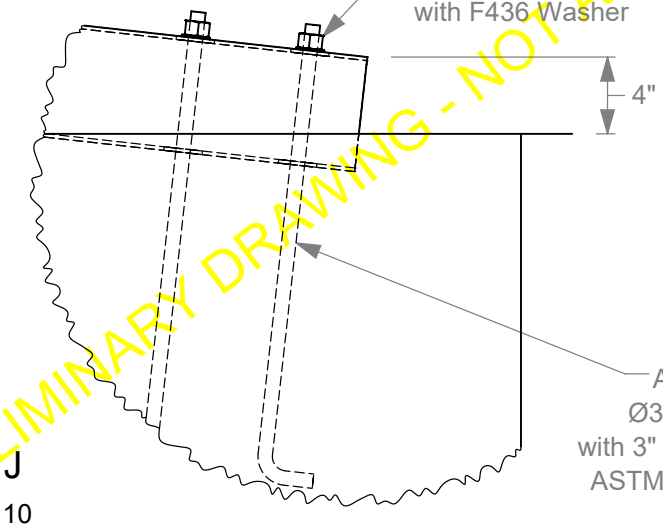
Terminal Details



Plan View

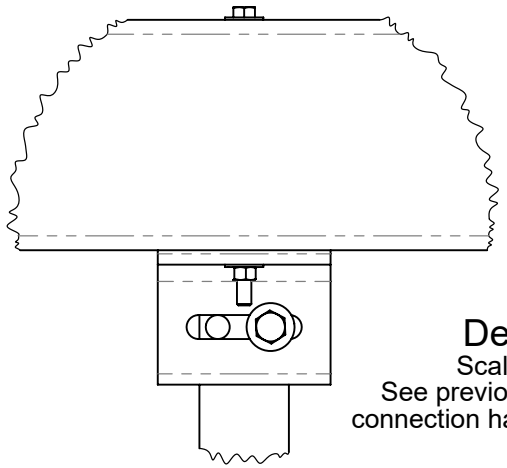


Elevation View



Detail J

Scale 1 : 10



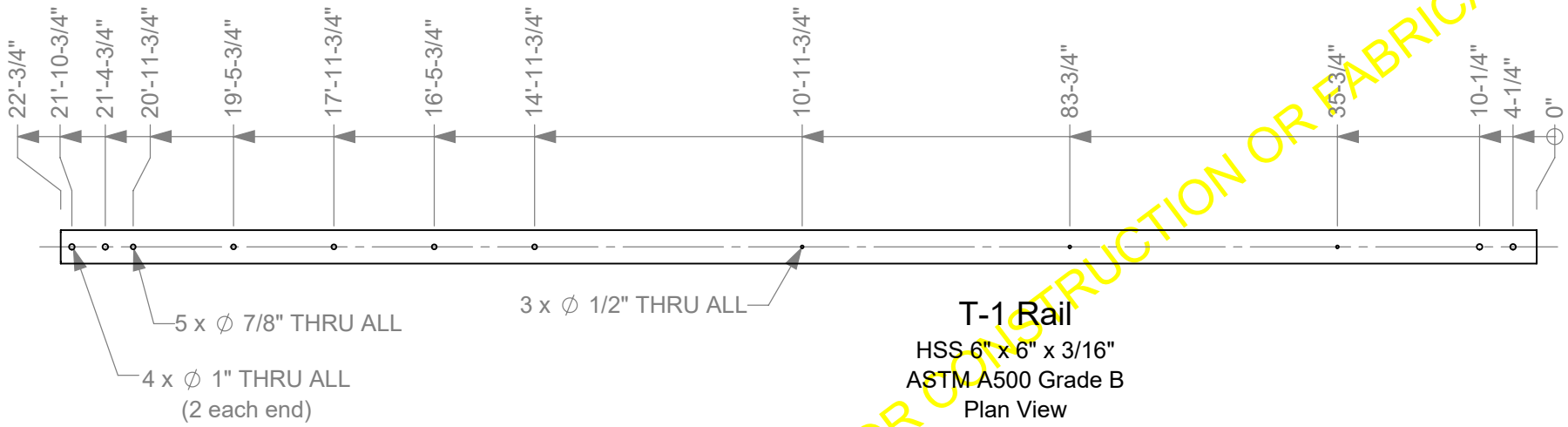
Detail I

Scale 1 : 5

See previous sheets for connection hardware details.

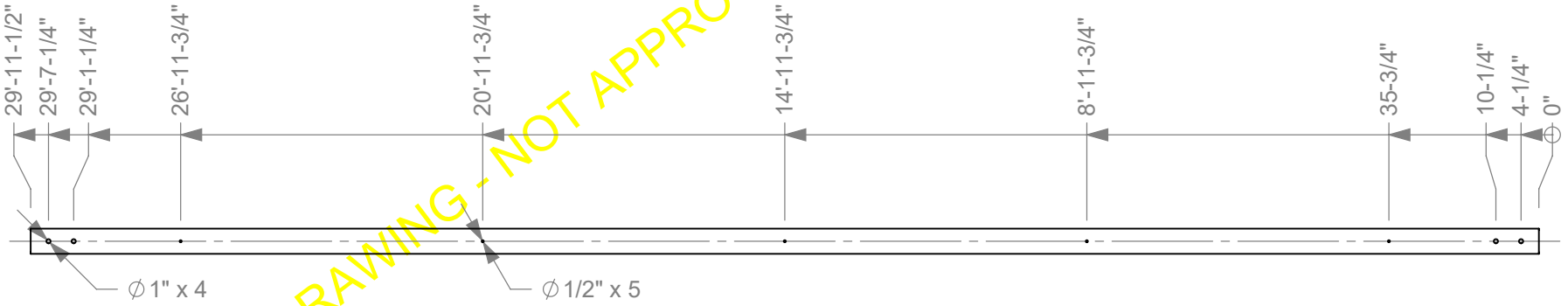
Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 Wyoming Box Beam Transition		2020-09-02
Drawn by GES	Scale 1:50	Sheet 4 of 16 Terminal Details

Transition Rails



T-1 Rail

HSS 6" x 6" x 3/16"
ASTM A500 Grade B
Plan View



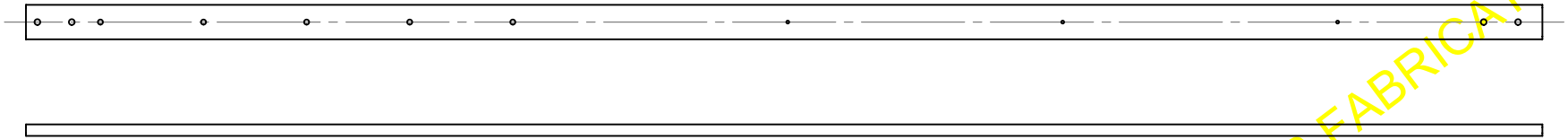
T-2 Rail

HSS 6" x 6" x 3/16"
ASTM A500 Grade B
Plan View - Scale 1:40

5a. Galvanize all components after fabrication is complete.

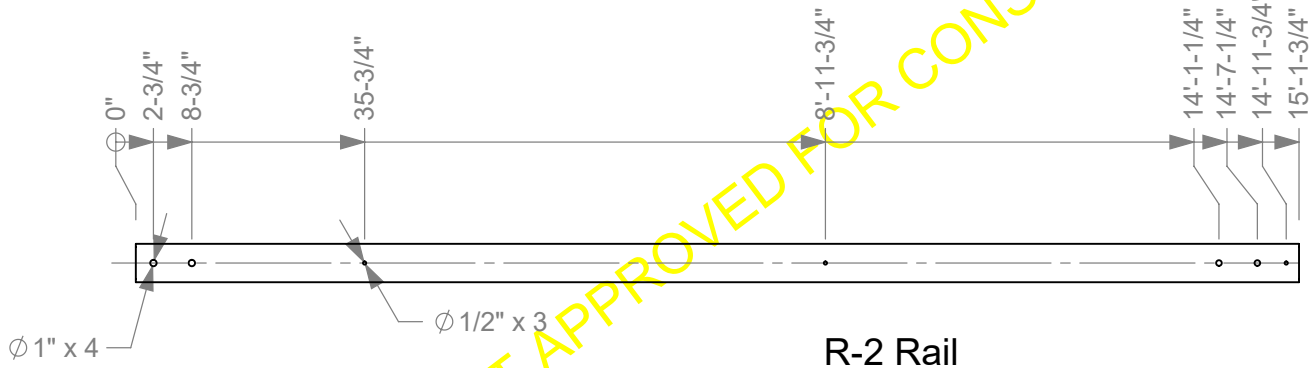
Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 Wyoming Box Beam Transition		2020-09-02
Drawn by GES	Scale 1:30	Sheet 5 of 16 Transition Rails

Rub Rails



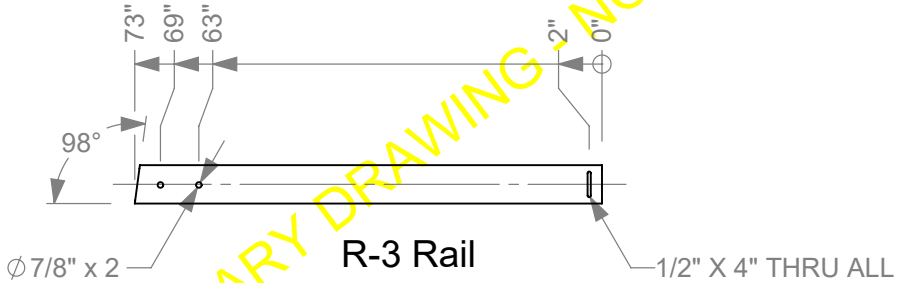
R-1 Rail

HSS 6" x 2" x 1/4"
ASTM A500 Grade B
See T-1 Rail on previous sheet for all other details.
Plan and Elevation Views



R-2 Rail

HSS 6" x 2" x 1/4"
ASTM A500 Grade B
Plan View



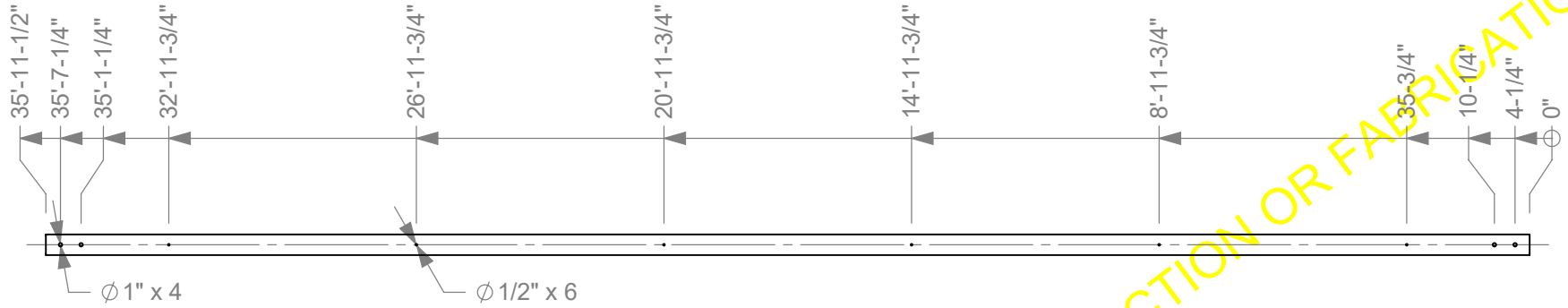
R-3 Rail

HSS 6" x 2" x 1/4"
ASTM A500 Grade B
Plan View

6a. Galvanize all components after fabrication is complete.

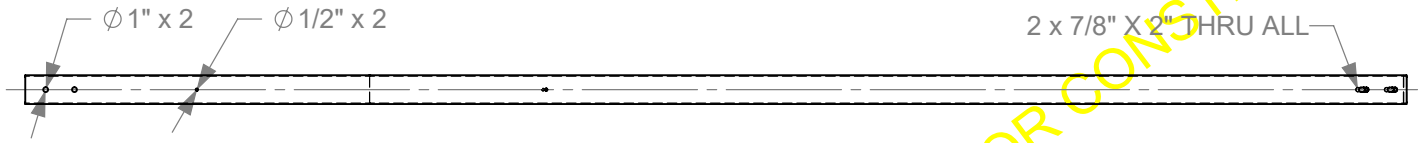
Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 Wyoming Box Beam Transition		2020-09-02
Drawn by GES	Scale 1:30	Sheet 6 of 16 Rub Rails

LON and Terminal Rails



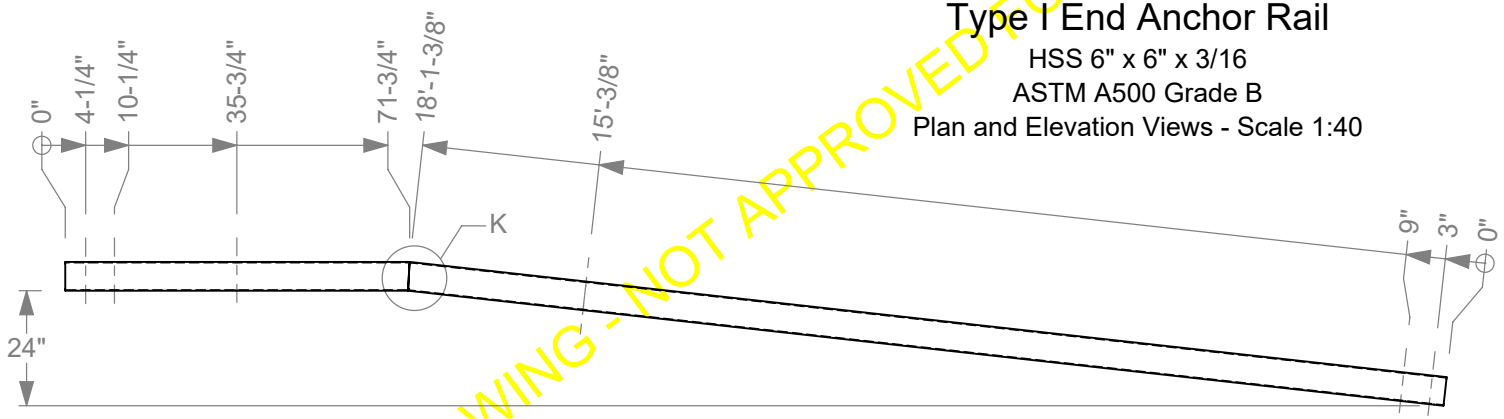
Box Beam Rail

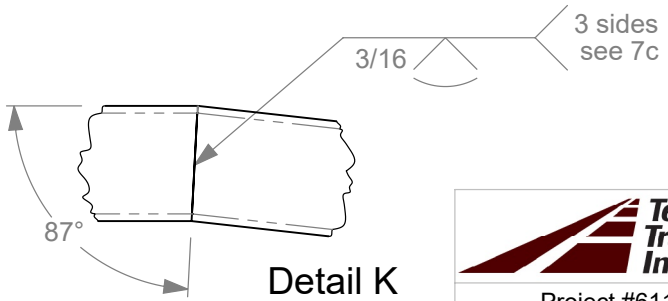
HSS 6" x 6" x 3/16"
ASTM A500 Grade B
Plan View



Type I End Anchor Rail

HSS 6" x 6" x 3/16
ASTM A500 Grade B
Plan and Elevation Views - Scale 1:40





Detail K

Scale 1 : 10

7a. All welding must be performed by certified welders using industry standard practices.

7b. Galvanize all components after fabrication is complete.

7c. Cut 3 sides (inverted V-shape, 5/8" wide at bottom), bend, and weld.

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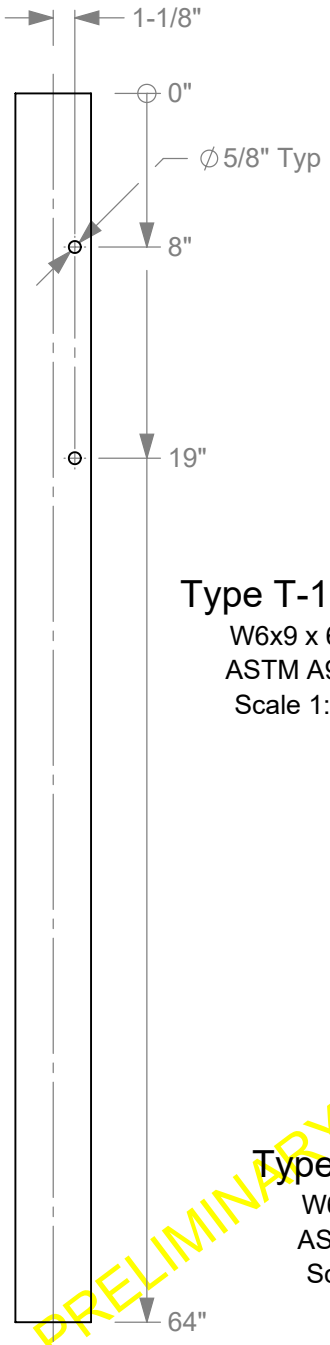
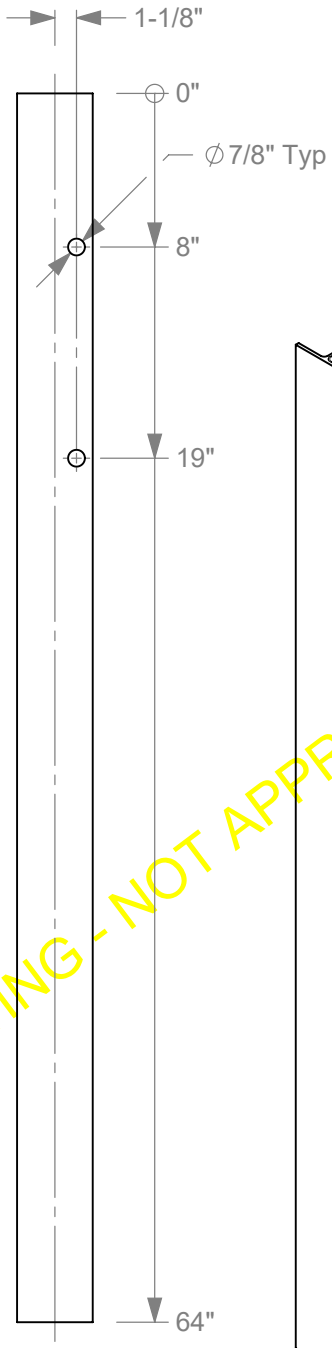
Drawn by GES	Scale 1:50	Sheet 7 of 16 LON and Terminal Rails



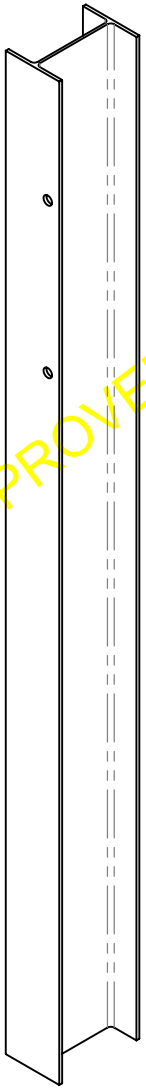
Type T-1 Post

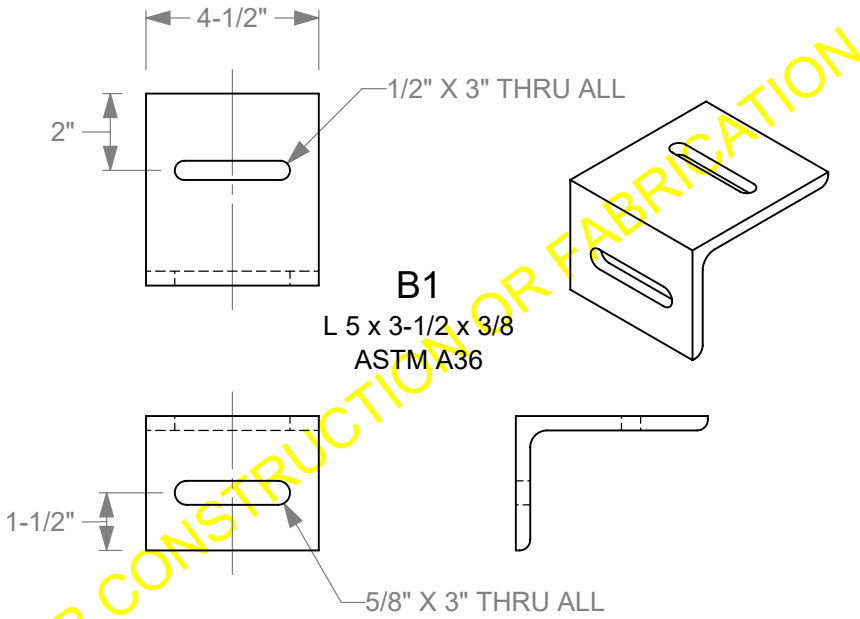
W6x9 x 64"
ASTM A992
Scale 1:10



Type T-2 Post

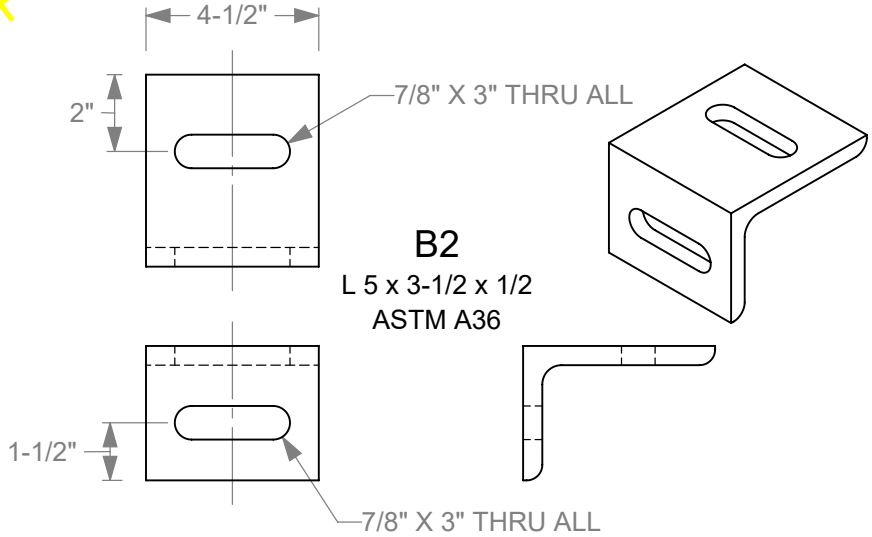
W6x9 x 64"
ASTM A992
Scale 1:10





B1

L 5 x 3-1/2 x 3/8
ASTM A36



B2

L 5 x 3-1/2 x 1/2
ASTM A36

8a. Galvanize all components after fabrication is complete.

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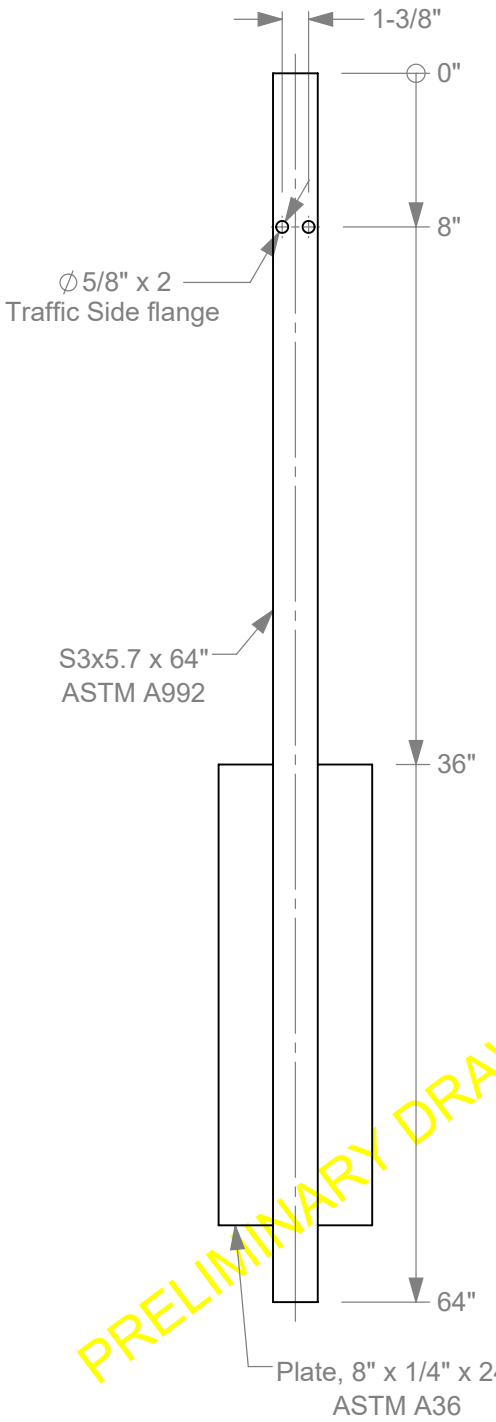
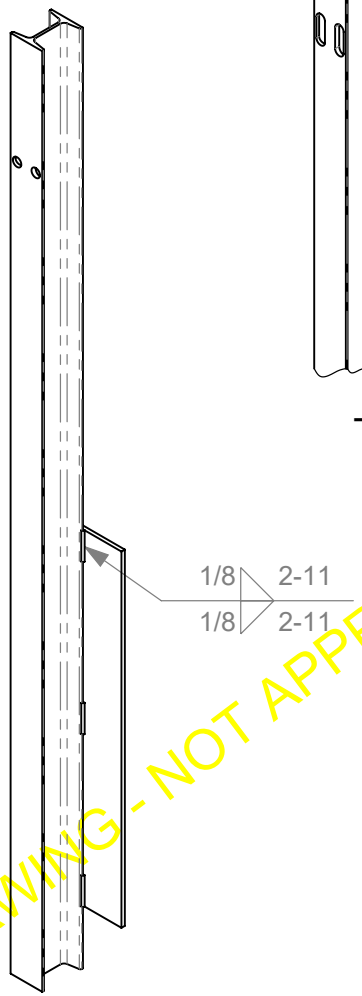
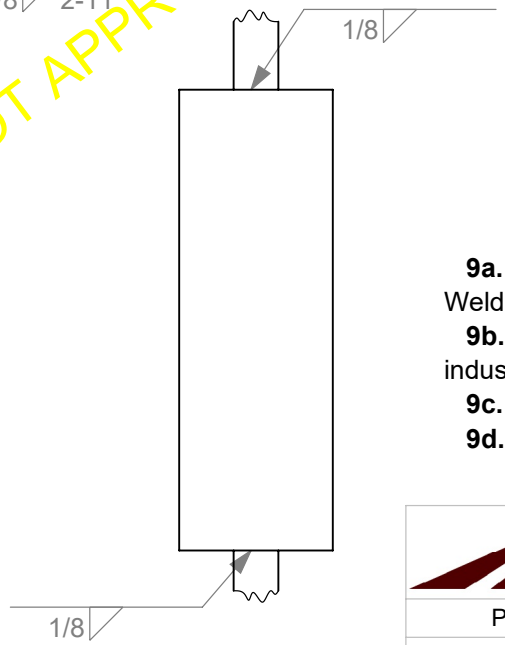
Drawn by GES	Scale 1:5	Sheet 8 of 16 Type T Posts and Brackets

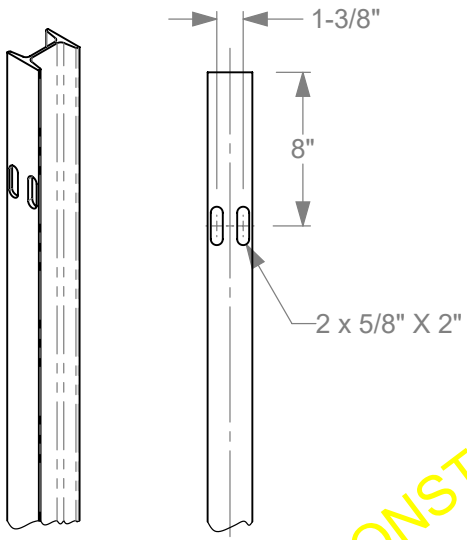
Posts



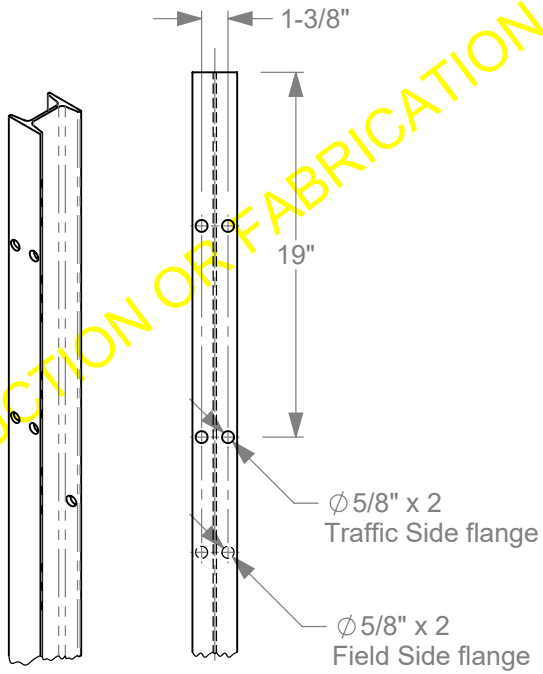
Type A Post
Elevation View







Type C Post
Elevation View
See 9d



Type R Post
Elevation View
See 9d

9a. Holes in traffic side flange only unless otherwise indicated. Weld details typical all Post types on this sheet.

9b. All welding must be performed by certified welders using industry standard practices.

9c. Galvanize all components after fabrication is complete.

9d. All other details same as Type A Post.

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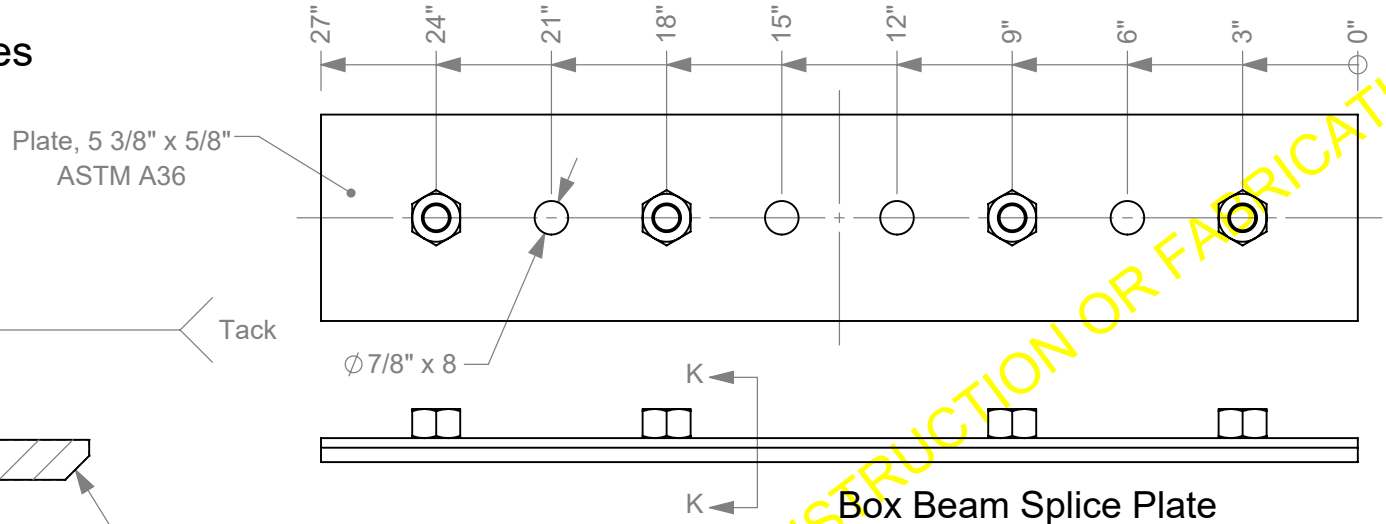
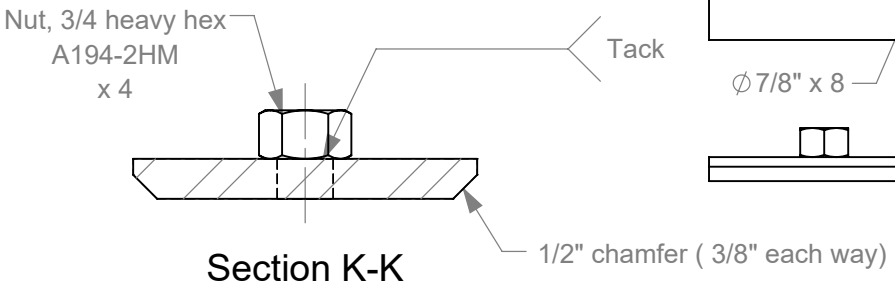
Rail Splices



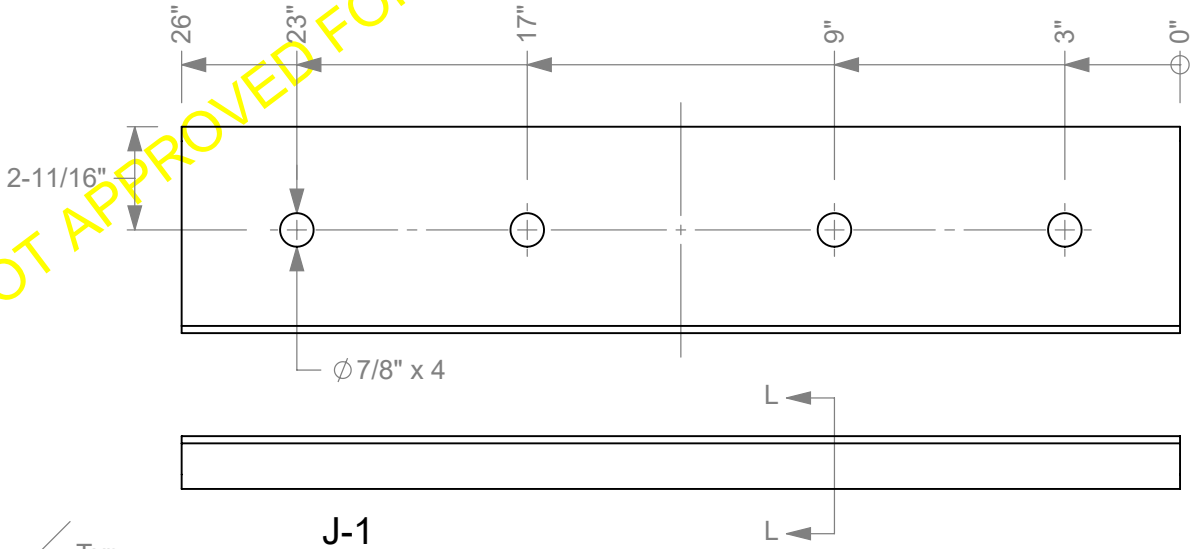
Box Beam Splice Plate

Plan and Elevation Views



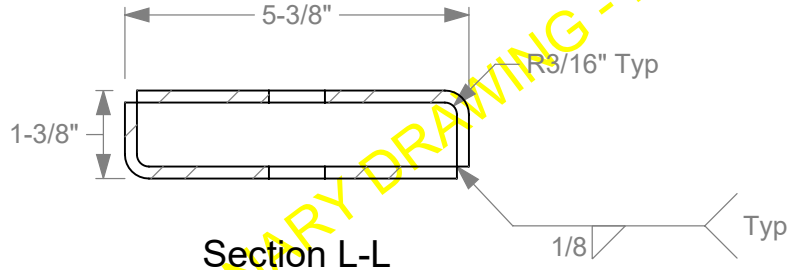
Section K-K

Scale 1 : 3



J-1

3/16" ASTM A36 Plate
Plan and Elevation Views
Scale 1:5



Section L-L

Scale 1 : 3

10a. All welding must be performed by certified welders using industry standard practices.

10b. Galvanize all components after fabrication is complete.

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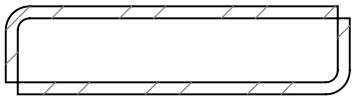
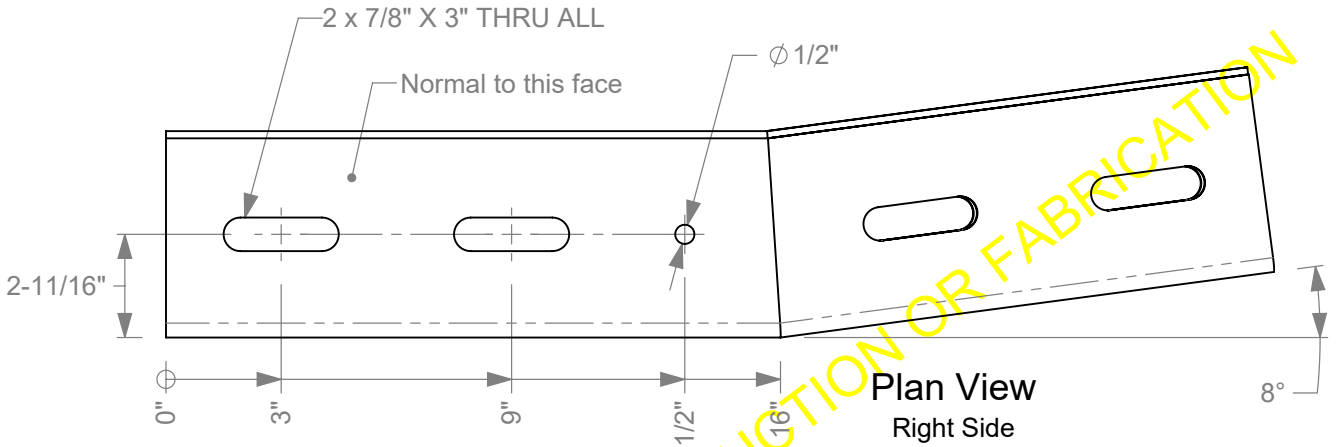
J-2

3/16" ASTM A36 Plate
See 11a



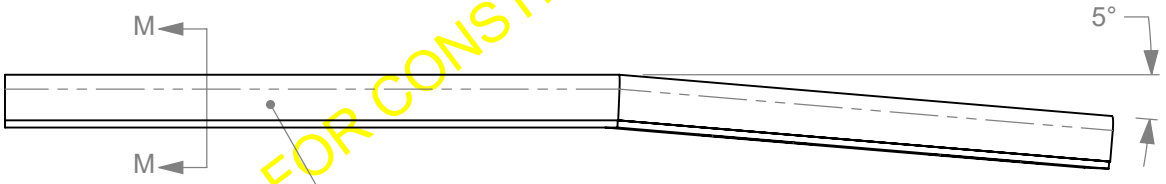
Section M-M

Scale 1 : 3
See J-1 Section View on previous sheet.



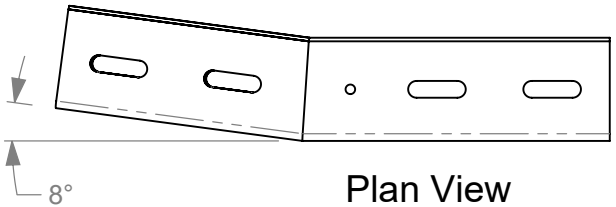
Plan View

Right Side



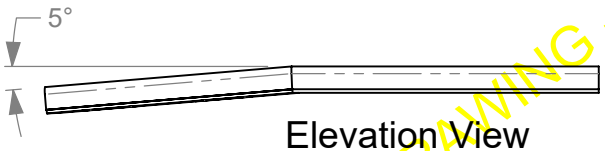
Elevation View

Right Side



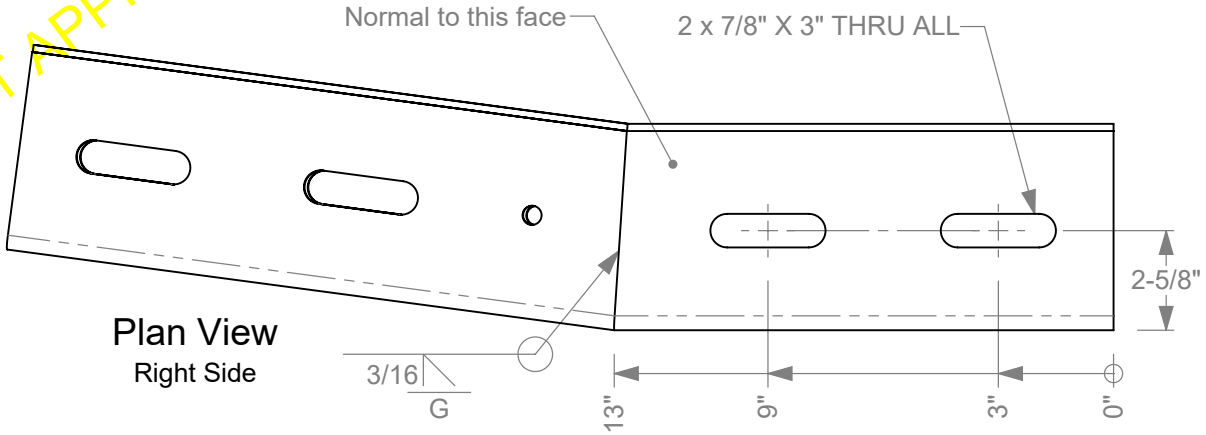
Plan View

Left Side
Scale 1:10



Elevation View

Left Side
Scale 1:10



Plan View

Right Side

11a. Need one Right Side and one Left Side part for each installation. The Parts are mirror images of each other, so plate lengths, hole sizes, and hole locations are typical for both Parts.

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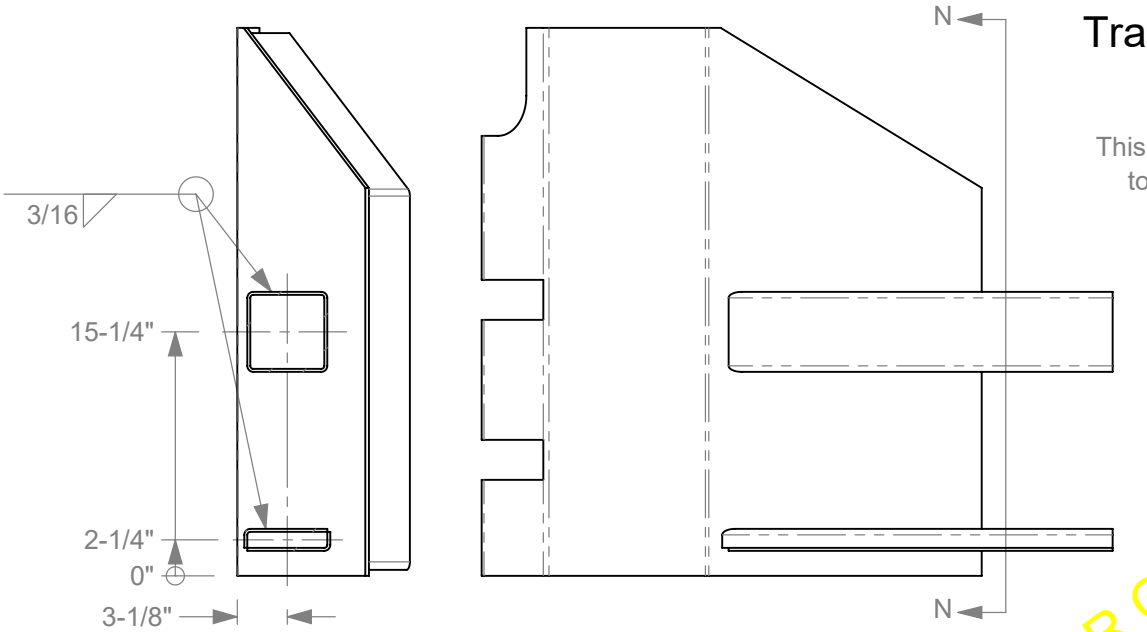
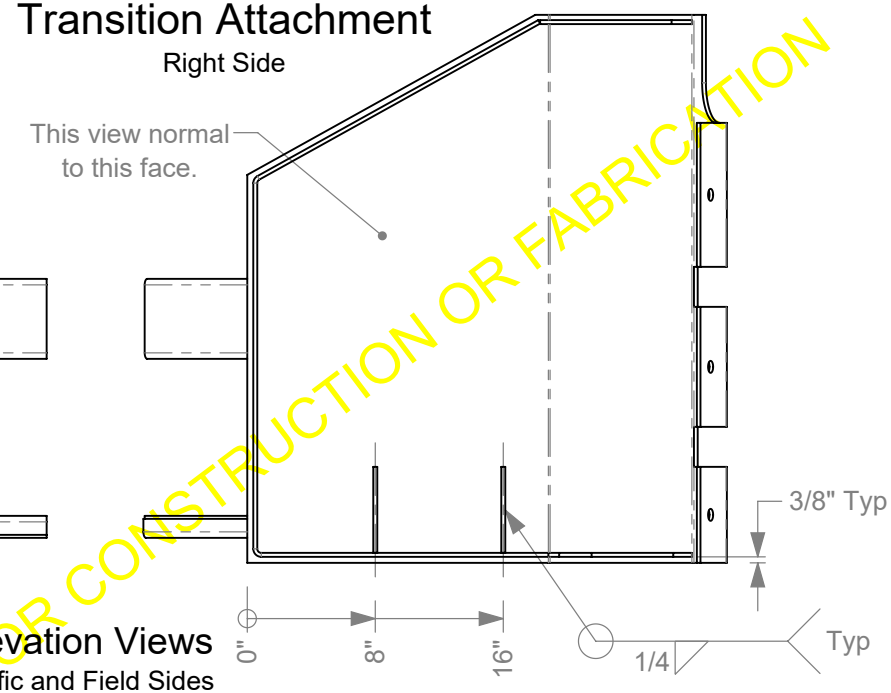
Transition Attachment

Right Side

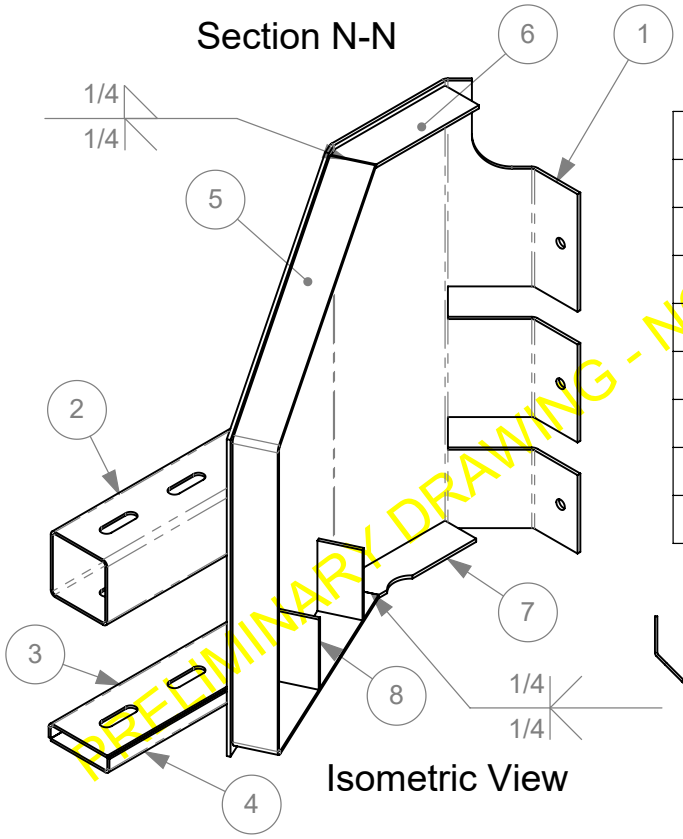


Section N-N

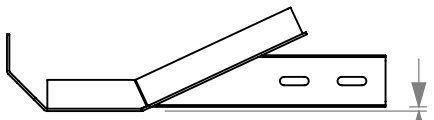


Elevation Views

Traffic and Field Sides



Isometric View



Plan View

Scale 1:20

#	Body Name	Description	Length	MATERIAL	Qty
1	Main Plate	Plate, 34 1/4" x 1/4"	38 3/8"	ASTM A572 Grade 50	1
2	Main Rail Attachment	HSS 5" x 5" x 3/16"	24"	ASTM A500 Grade B	1
3	Rub Rail Attachment	Plate, 24 1/2" x 3/16"	6 1/16"	ASTM A572 Grade 50	1
4	Rub Rail Attachment	Plate, 24" x 3/16"	6 1/16"	ASTM A572 Grade 50	1
5	Side Stiffener	Plate, 3" x 1/4"	61 7/8"	ASTM A572 Grade 50	1
6	Top Stiffener	Plate, 3" x 1/4"	10 5/16"	ASTM A572 Grade 50	1
7	Bottom Stiffener	Plate, 2 3/4" x 1/4"	9 7/8"	ASTM A572 Grade 50	1
8	Gusset	Plate, 3" x 1/4"	5 3/8"	ASTM A572 Grade 50	2

12a. All welding must be performed by certified welders using industry standard practices.

12b. Galvanize after fabrication is complete.

Texas A&M Transportation Institute

Roadside Safety and Physical Security Division - Proving Ground

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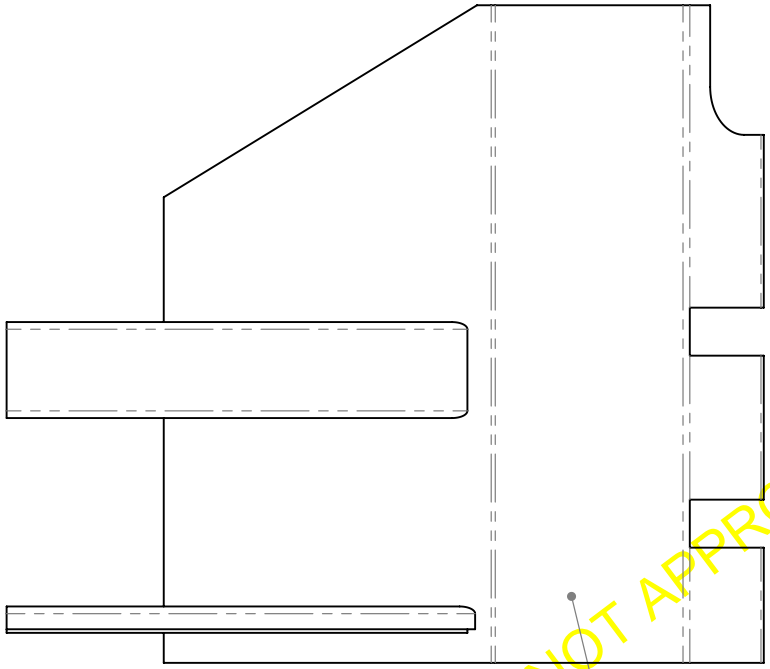
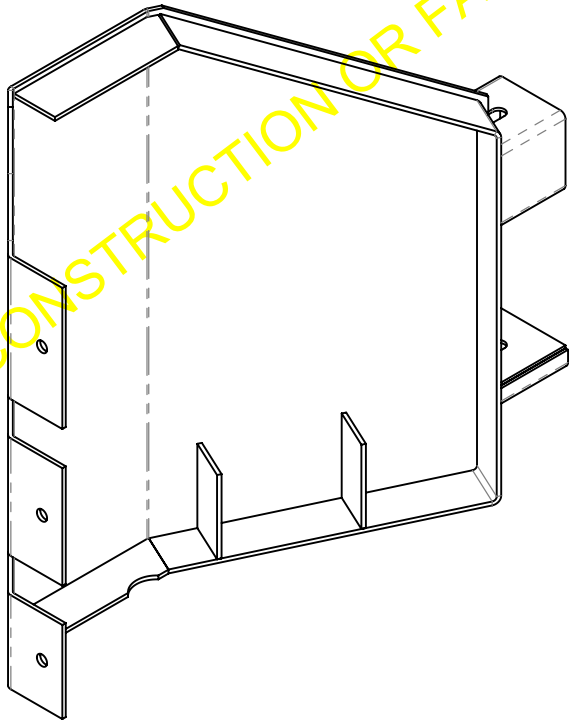
Drawn by GES	Scale 1:12	Sheet 12 of 16 Transition Attachment

Transition Attachment

Left Side





Main Plate is mirror image of the one on the Right Side part. All other comonents and details are identical.

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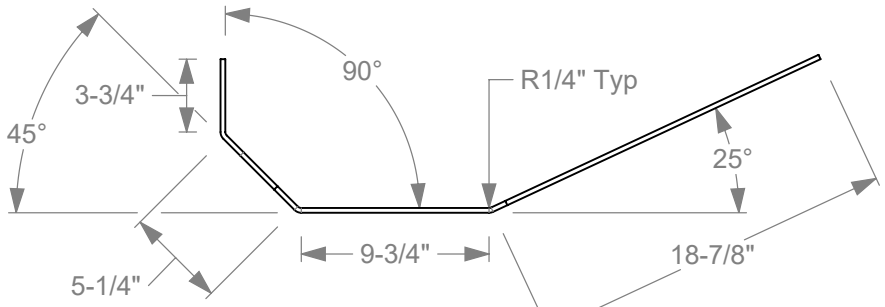
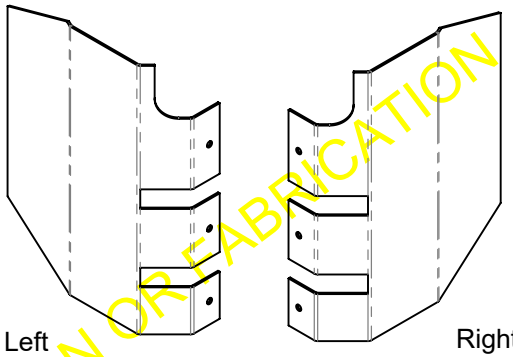
1

Main Plate

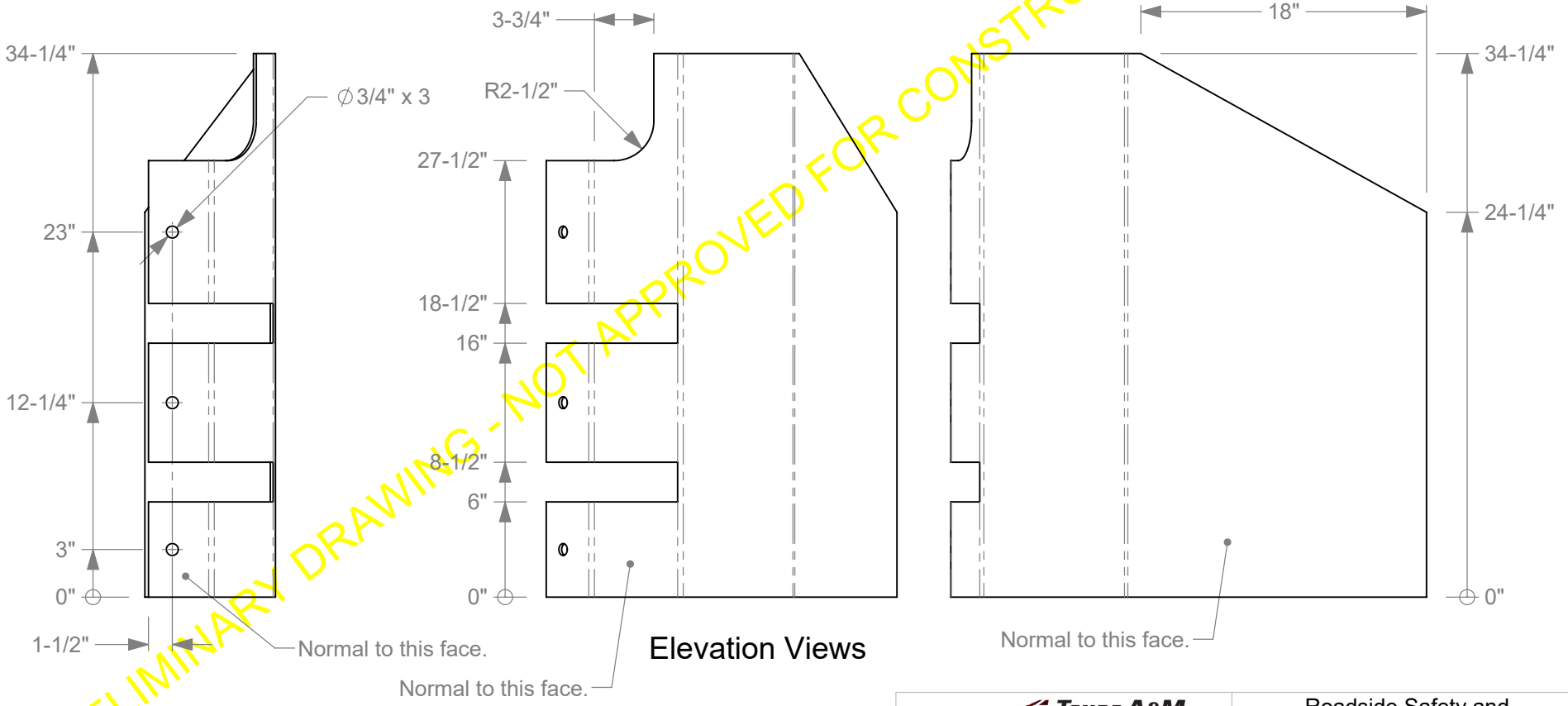
Plate, 34 1/4" x 1/4" x 38 3/8"
ASTM A572 Grade 50
See 14a



Plan View



Isometric Views



Elevation Views

14a. Main Plate details shown are for right side Transition Attachment part. Main Plate for left side is a mirror image of this one (pre-bend details are identical, but bent in opposite directions).

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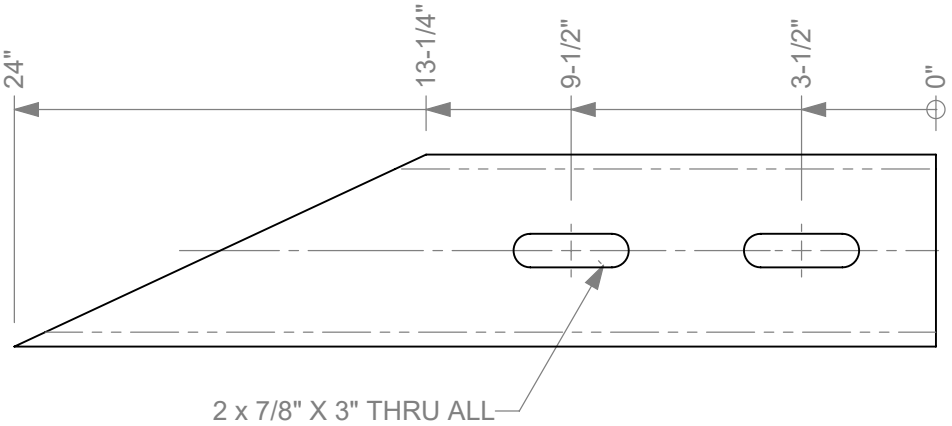
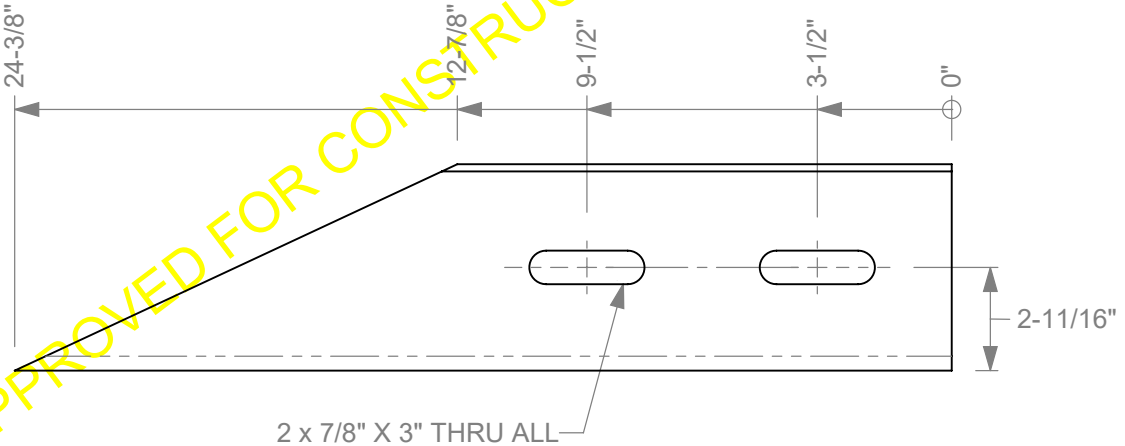
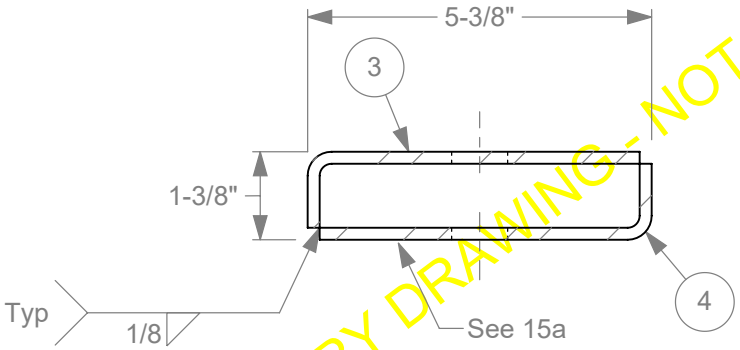
Rail Attachments



2 Main Rail Attachment

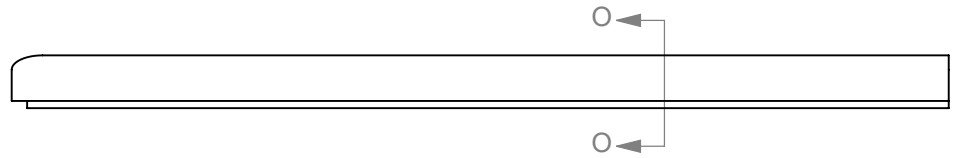
HSS 5" x 5" x 3/16" x 24"
ASTM A500 Grade B
Plan View





Section O-O

Scale 1 : 3



Rub Rail Attachment

Plate, 24 1/2" x 3/16" x 6 1/16"
ASTM A572 Grade 50
Plan and Elevation Views

15a. Check Rub Rail Attachment for fit in HSS 6 x 2 x 1/4 after welding.
15b. All welding must be performed by certified welders using industry standard practices.

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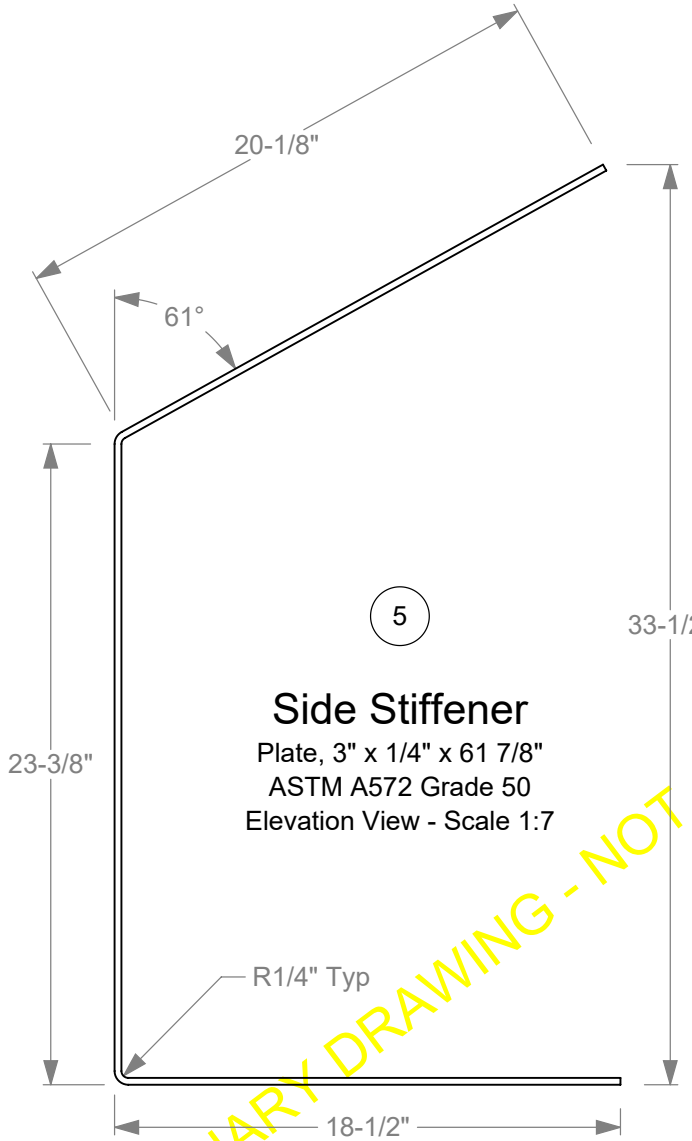
Drawn by GES	Scale 1:5	Sheet 15 of 16 Rail Attachments

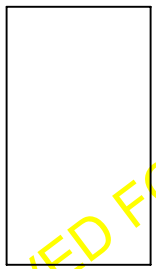
Stiffeners and Gussets



5

Side Stiffener

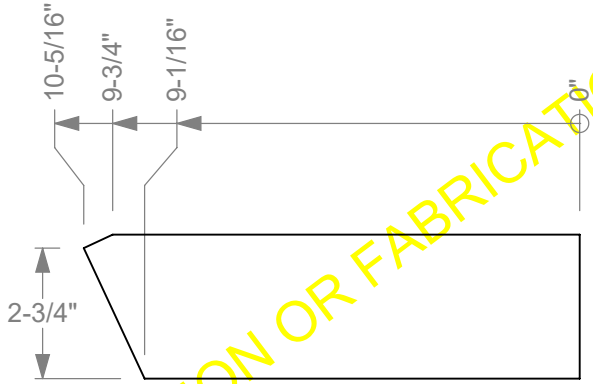
Plate, 3" x 1/4" x 61 7/8"
ASTM A572 Grade 50
Elevation View - Scale 1:7



8

Gusset

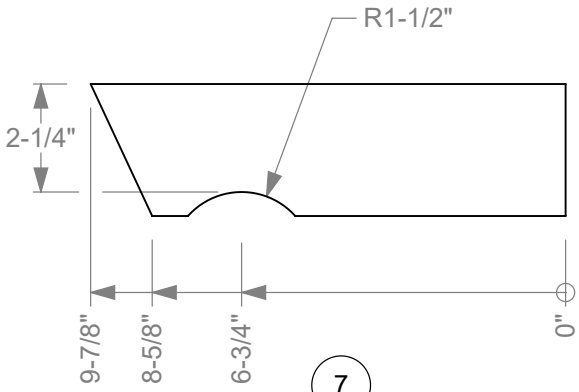
Plate, 3" x 1/4" x 5 3/8"
ASTM A572 Grade 50
Elevation View
2 needed



6

Top Stiffener

Plate, 3" x 1/4" x 10 5/16"
ASTM A572 Grade 50
Plan View



7

Bottom Stiffener

Plate, 2 3/4" x 1/4" x 9 7/8"
ASTM A572 Grade 50
Plan View

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Drawn by GES	Scale 1:4	Sheet 16 of 16 Stiffeners and Gussets

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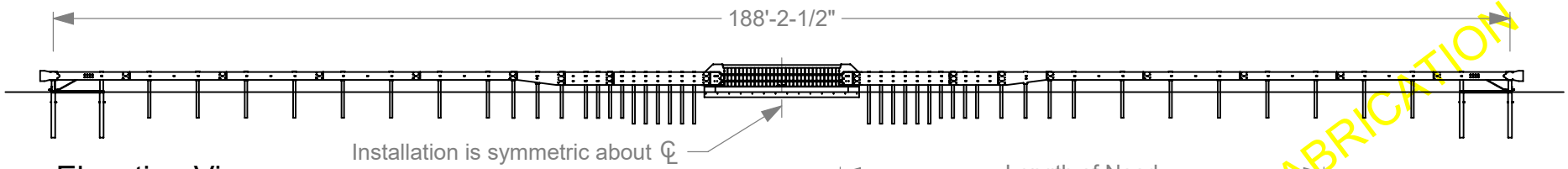
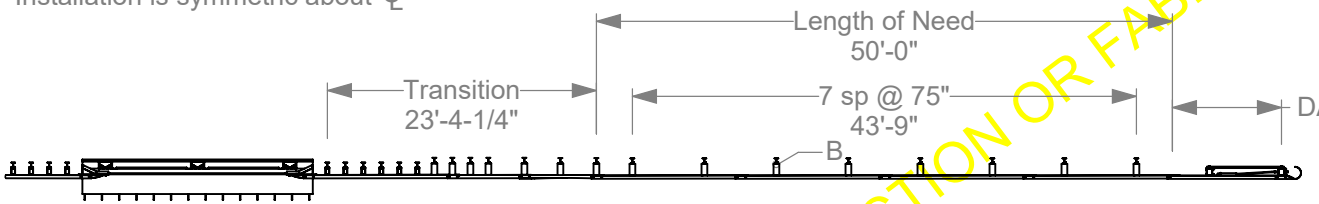
ATTACHMENT 2

MGS Transition Test Installation Details

Test Installation

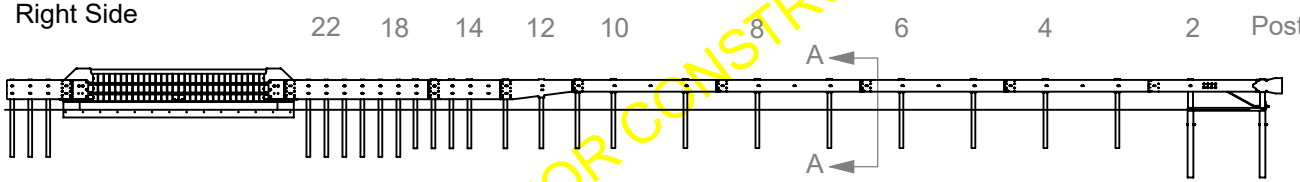


Elevation View



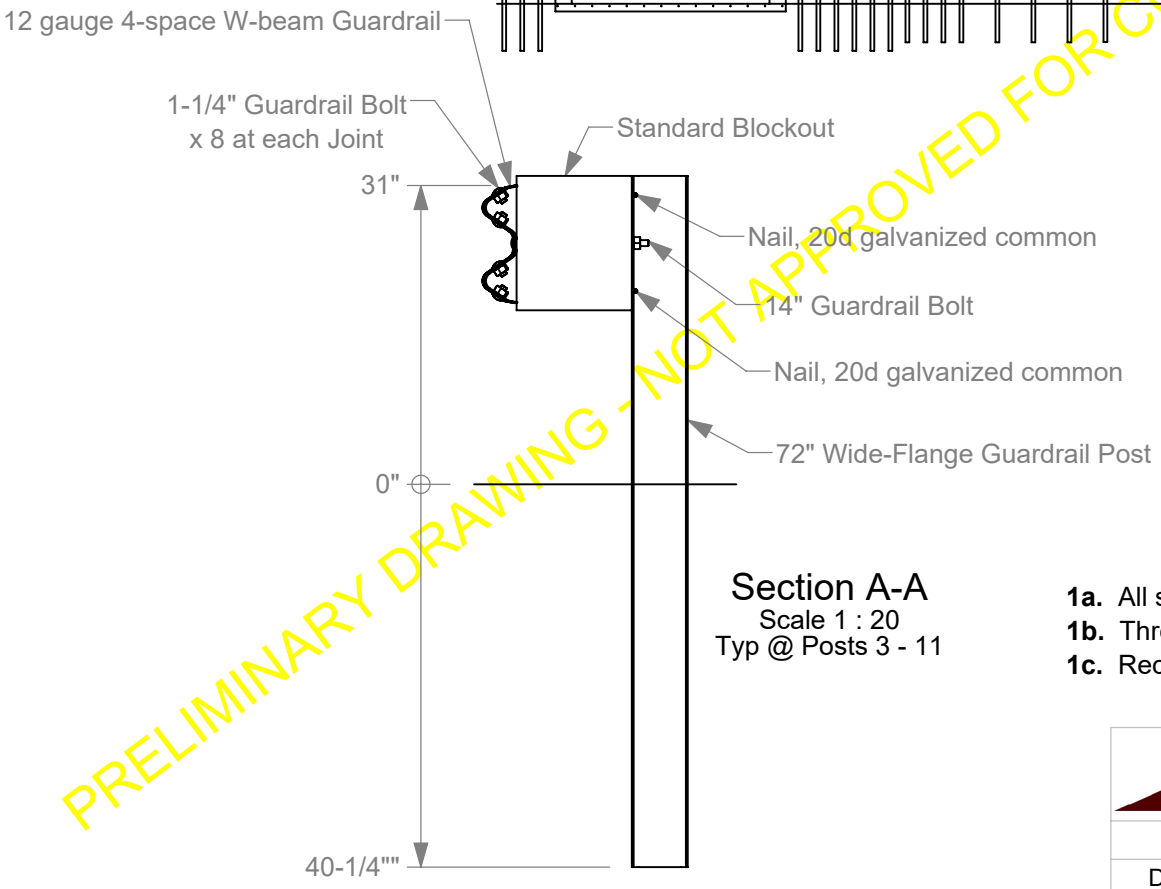
Plan View

Right Side



Elevation View

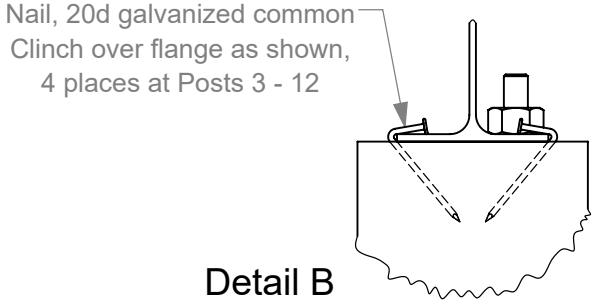
Right Side



Section A-A

Scale 1 : 20

Typ @ Posts 3 - 11



Detail B

Scale 1 : 5

1a. All steel components, including fasteners, shall be galvanized.

1b. Threads not shown on Bolts for clarity.

1c. Recessed Guardrail Nut on all Guardrail Bolts.

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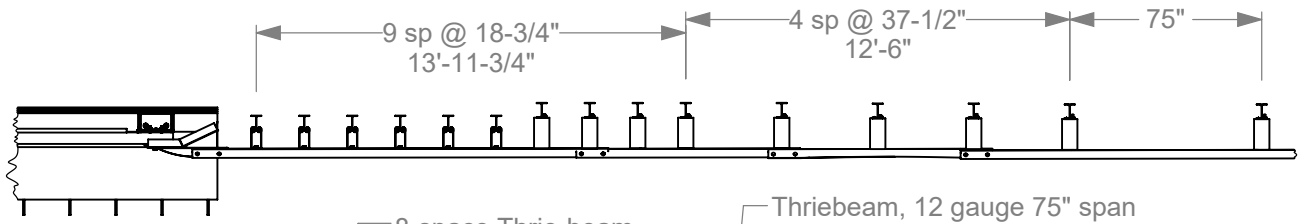
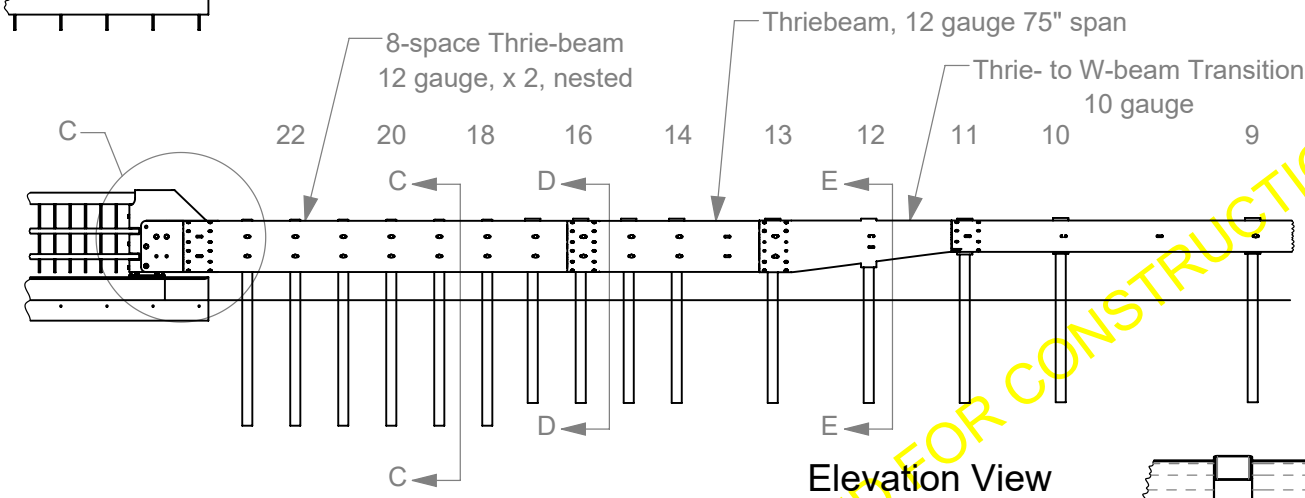
Drawn by GES	Scale 1:200	Sheet 1 of 9 Test Installation

Transition Details

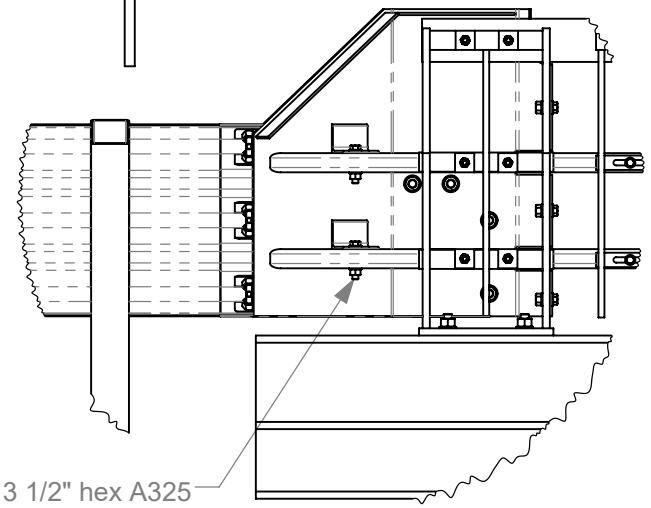
Sectiion views on next sheet



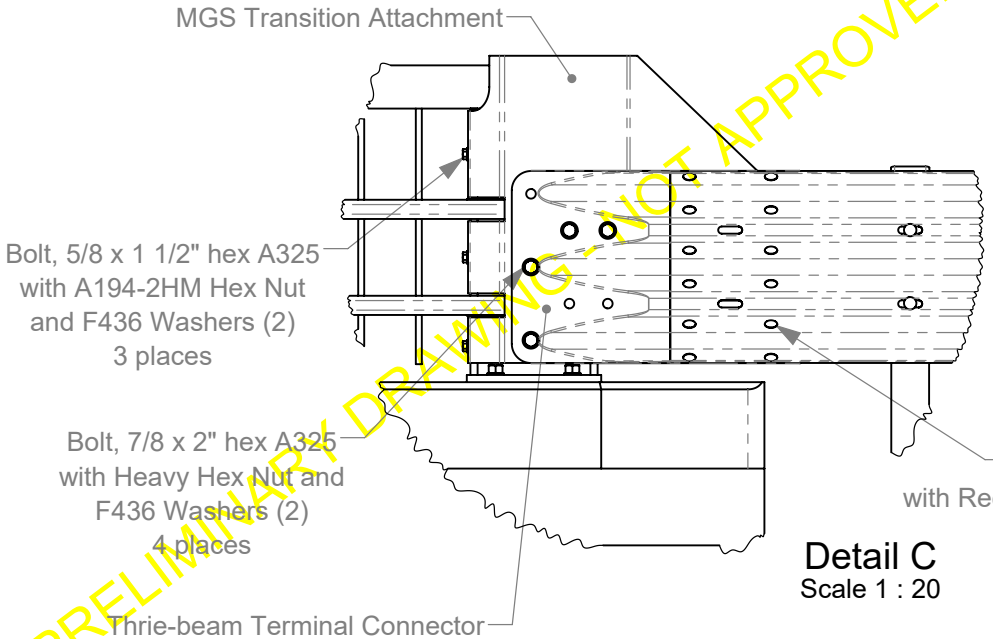
Plan View



Elevation View



Detail C
Field Side



Detail C
Scale 1 : 20

Bolt, 5/8 x 3 1/2" hex A325
with A194-2HM Hex Nut
and F436 Washers (2)
2 places

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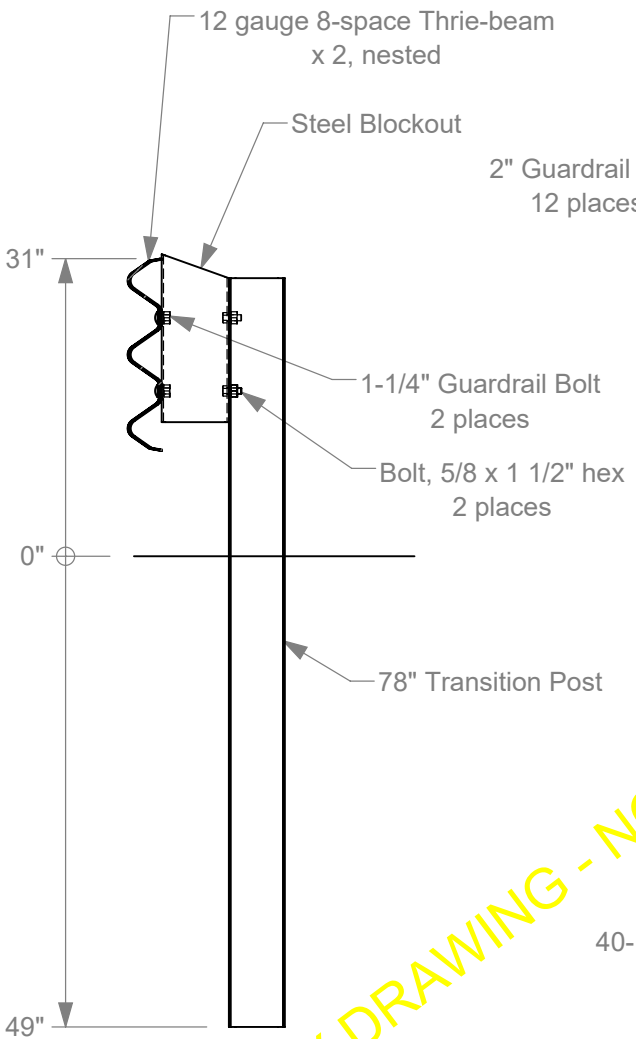
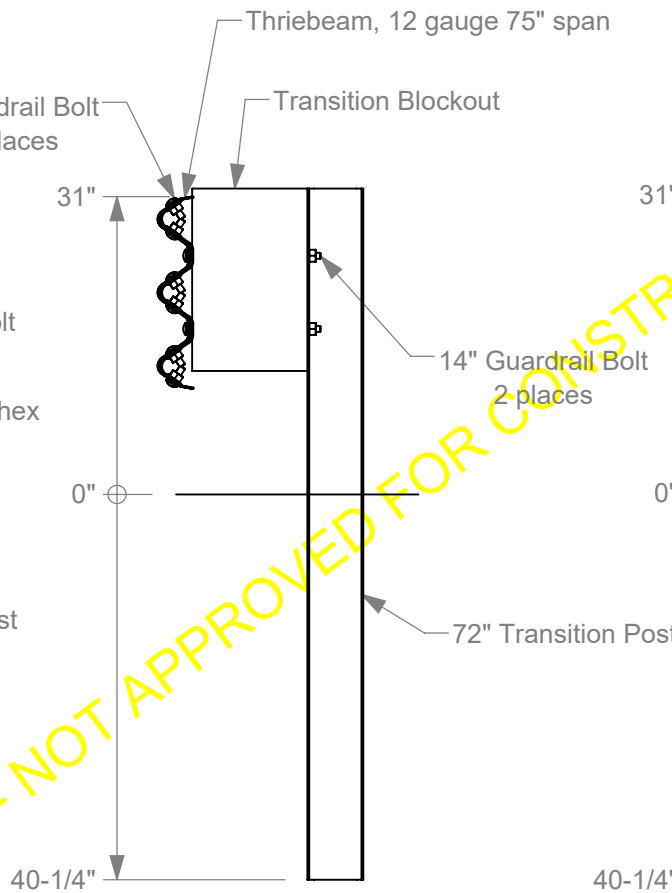
Drawn by GES	Scale 1:75	Sheet 2 of 9 Transition Details

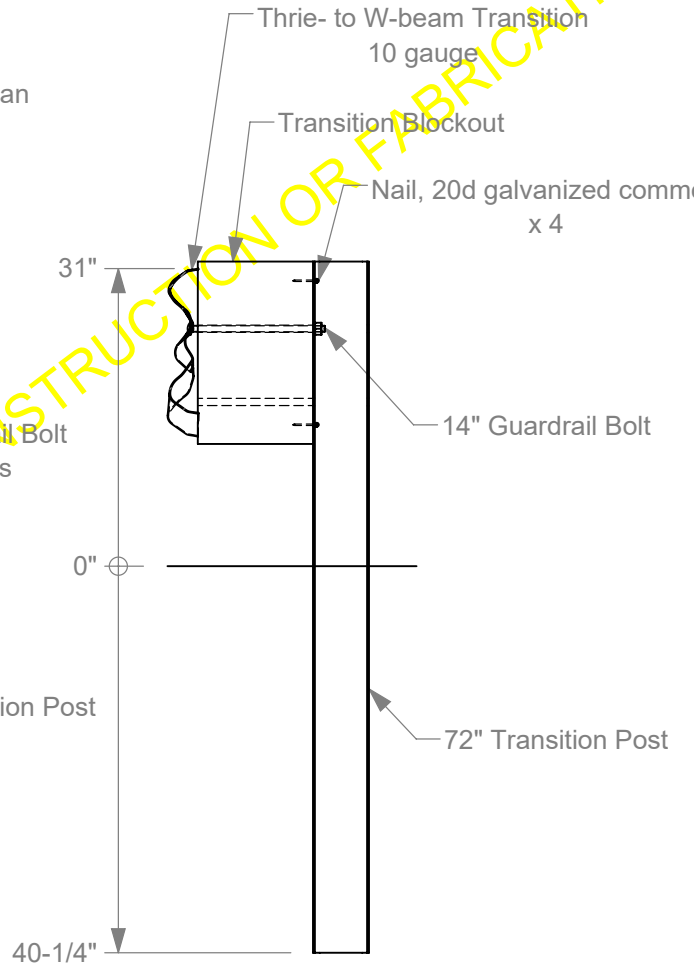
Section Views



Section C-C
Typ @ Posts 18 - 23



Section D-D
Typ @ Posts 13 - 17

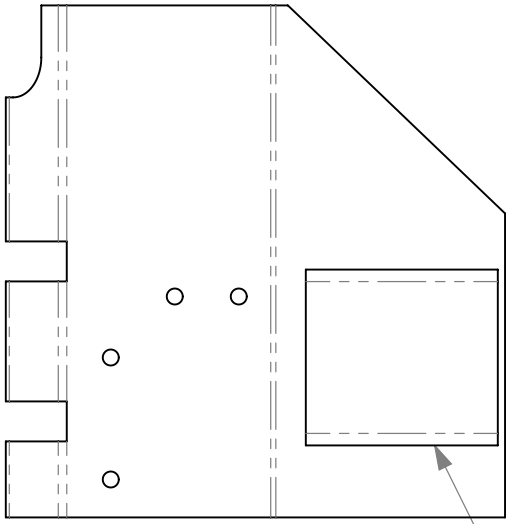


Section E-E
@ Post 12

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 5-6 Wyoming MGS Transition		2020-10-21
Drawn by GES	Scale 1:20	Sheet 3 of 9 Section Views

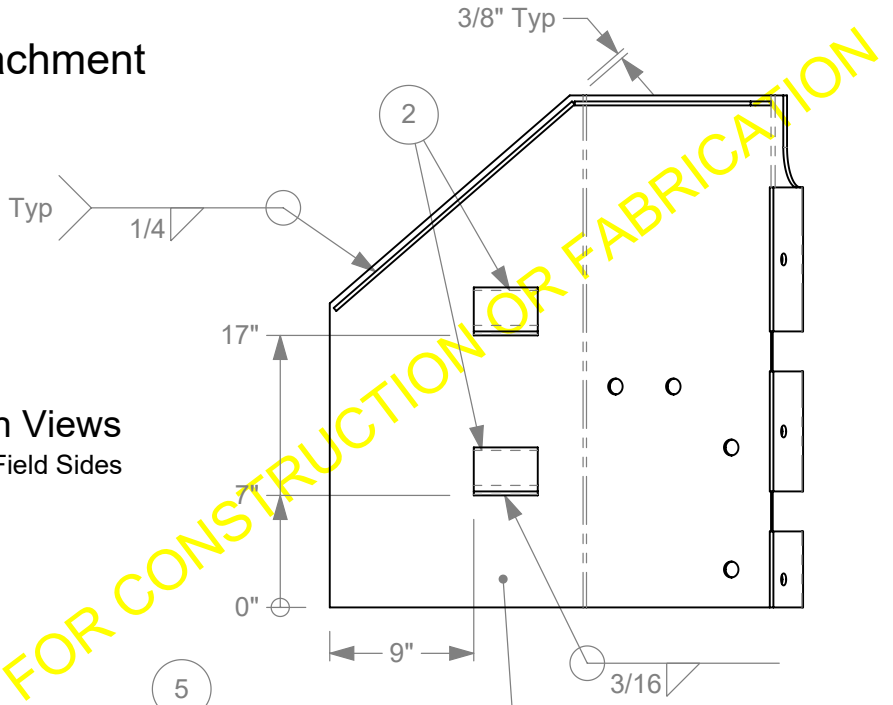
MGS Transition Attachment

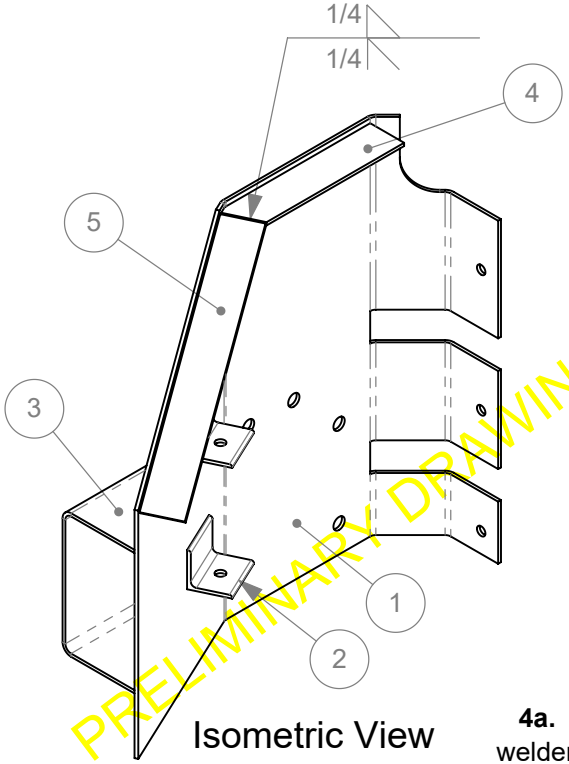
Right Side



Elevation Views

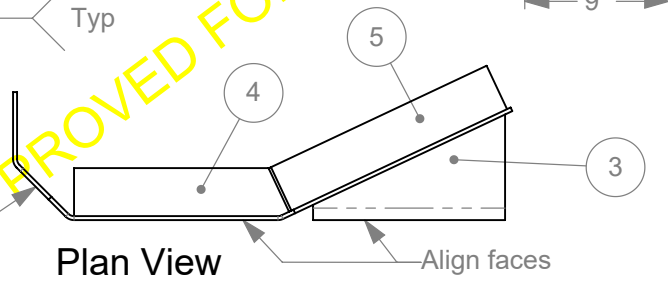
Traffic and Field Sides





Isometric View

Field Side



Plan View

#	Body Name	Description	Length	MATERIAL	Qty
1	Bent Plate	Plate, 32" x 1/4"	38 3/8"	ASTM A36	1
2	Tab	L 3 x 3 x 1/4	4"	ASTM A36	2
3	Thrie-beam Support	Plate, 12" x 1/4"	23 1/8"	ASTM A36	1
4	Top Stiffener	Plate, 3" x 1/4"	13 7/16"	ASTM A36	1
5	Side Stiffener	Plate, 3" x 1/4"	19 11/16"	ASTM A36	1

4a. All welding must be performed by certified welders using industry standard practices.

4b. Galvanize after fabrication is complete.

Texas A&M Transportation Institute

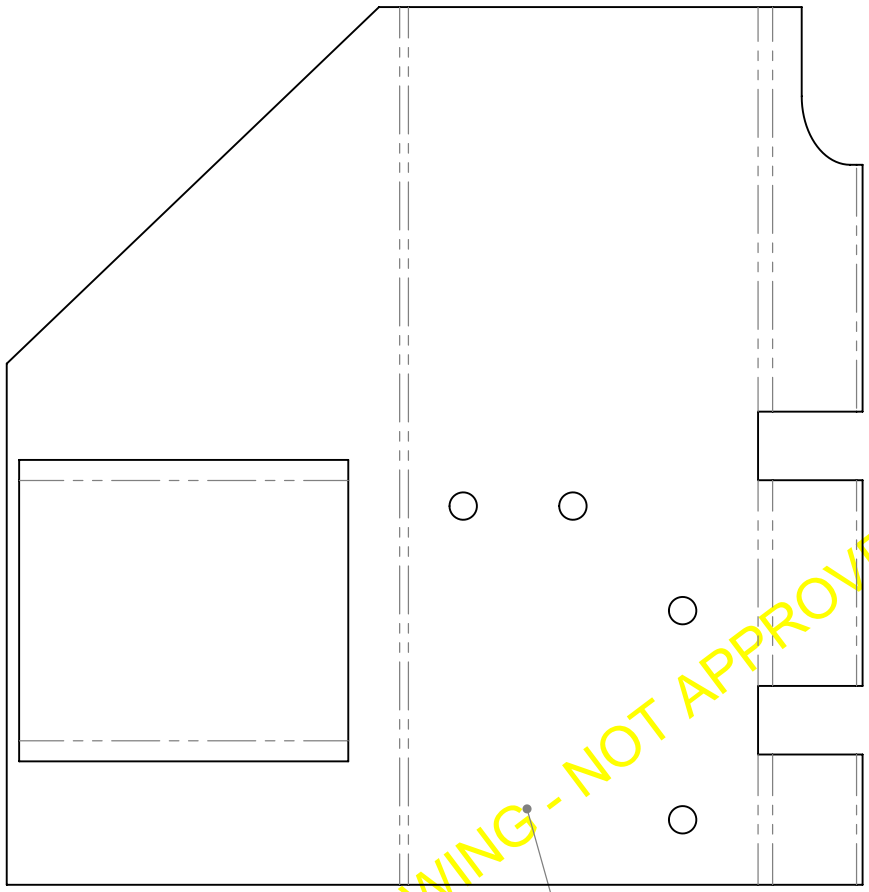
Roadside Safety and Physical Security Division - Proving Ground

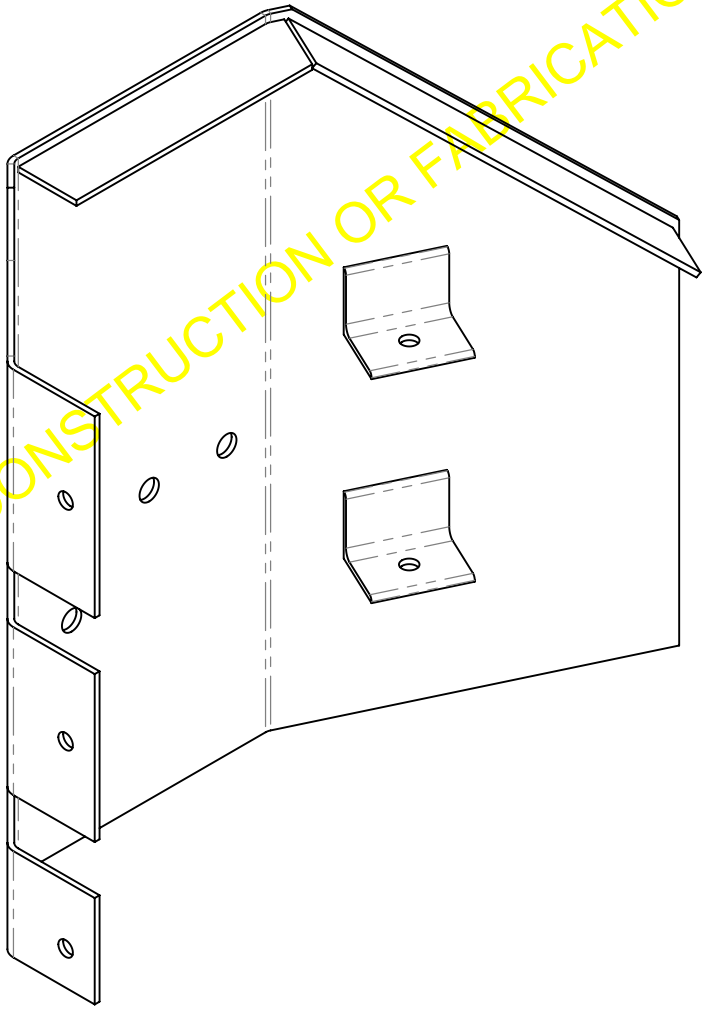
Project #611801 5-6 Wyoming MGS Transition | 2020-10-21

Drawn by GES | Scale 1:12 | Sheet 4 of 9 Transition Attachment

Transition Attachment

Left Side



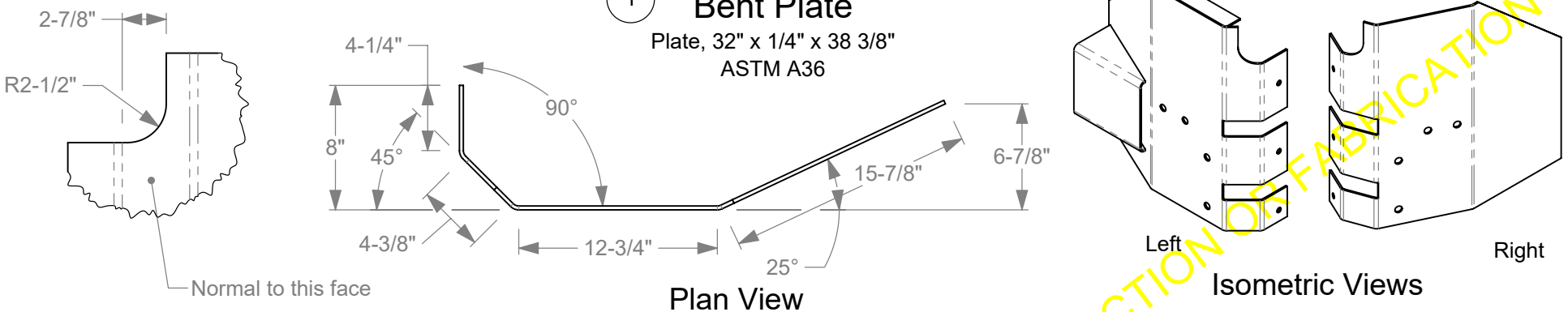


Main Plate is mirror image of the one on the Right Side.
All other components and details are identical.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 5-6 Wyoming MGS Transition		2020-10-21
Drawn by GES	Scale 1:7	Sheet 5 of 9 Transition Attachment

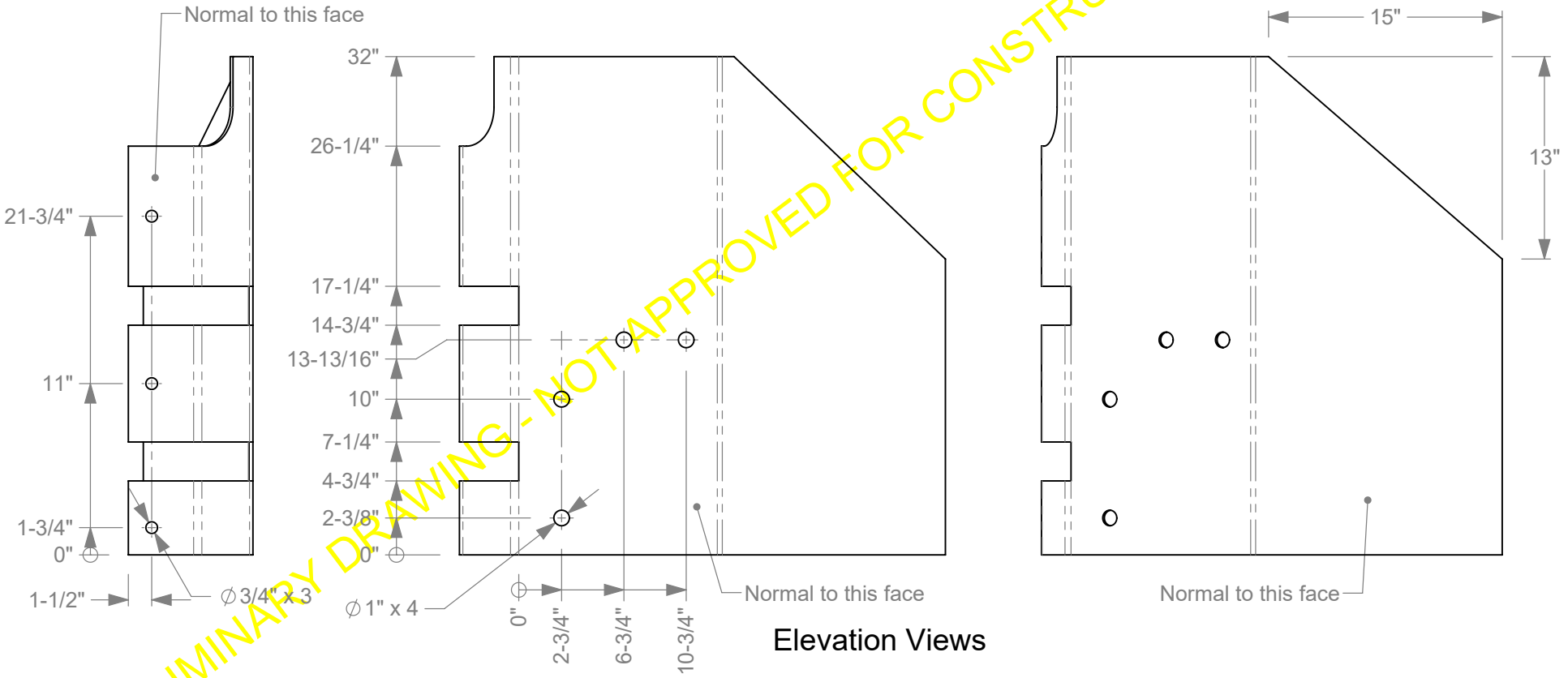
1 Bent Plate

Plate, 32" x 1/4" x 38 3/8"
ASTM A36



Plan View

Isometric Views

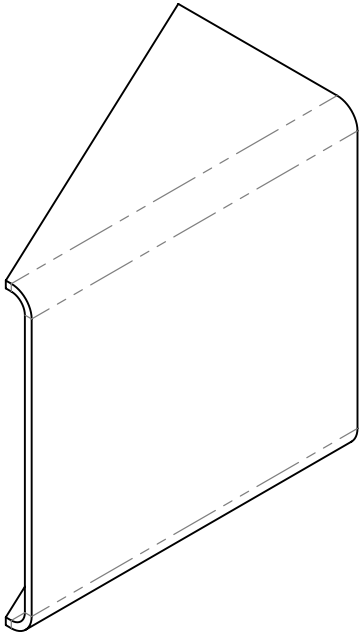


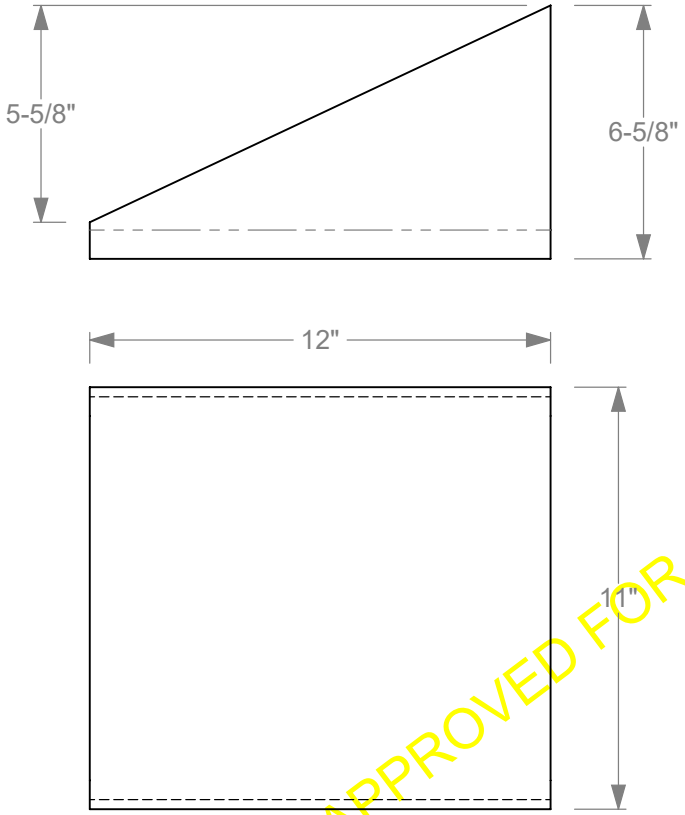
Elevation Views

6a. Plate details shown are for right side Transition Attachment part. The Bent Plate for the left side is a mirror image of this one (pre-bend details are identical, but bent in opposite directions).

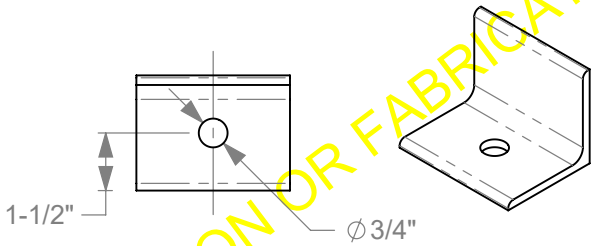
Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 5-6 Wyoming MGS Transition		2020-10-21
Drawn by GES	Scale 1:10	Sheet 6 of 9 Bent Plate

Attachment Parts

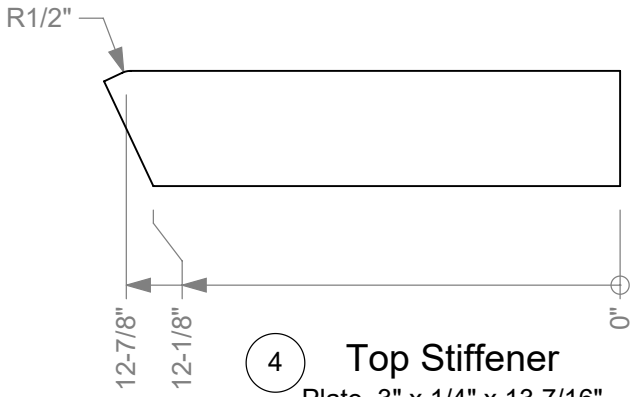




3 **Thrie-beam Support**
Plate, 12" x 1/4" x 23 1/8"
ASTM A36



2 **Tab**
L 3 x 3 x 1/4 x 4"
ASTM A36

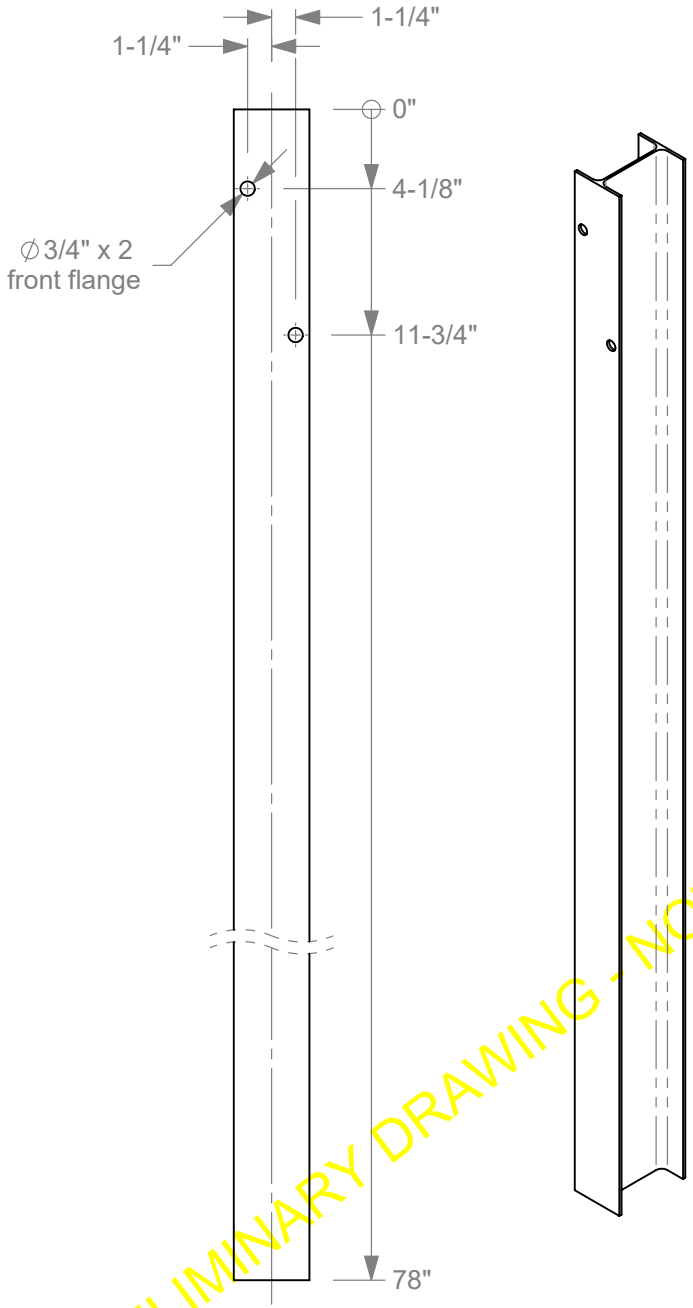


4 **Top Stiffener**
Plate, 3" x 1/4" x 13 7/16"
ASTM A36

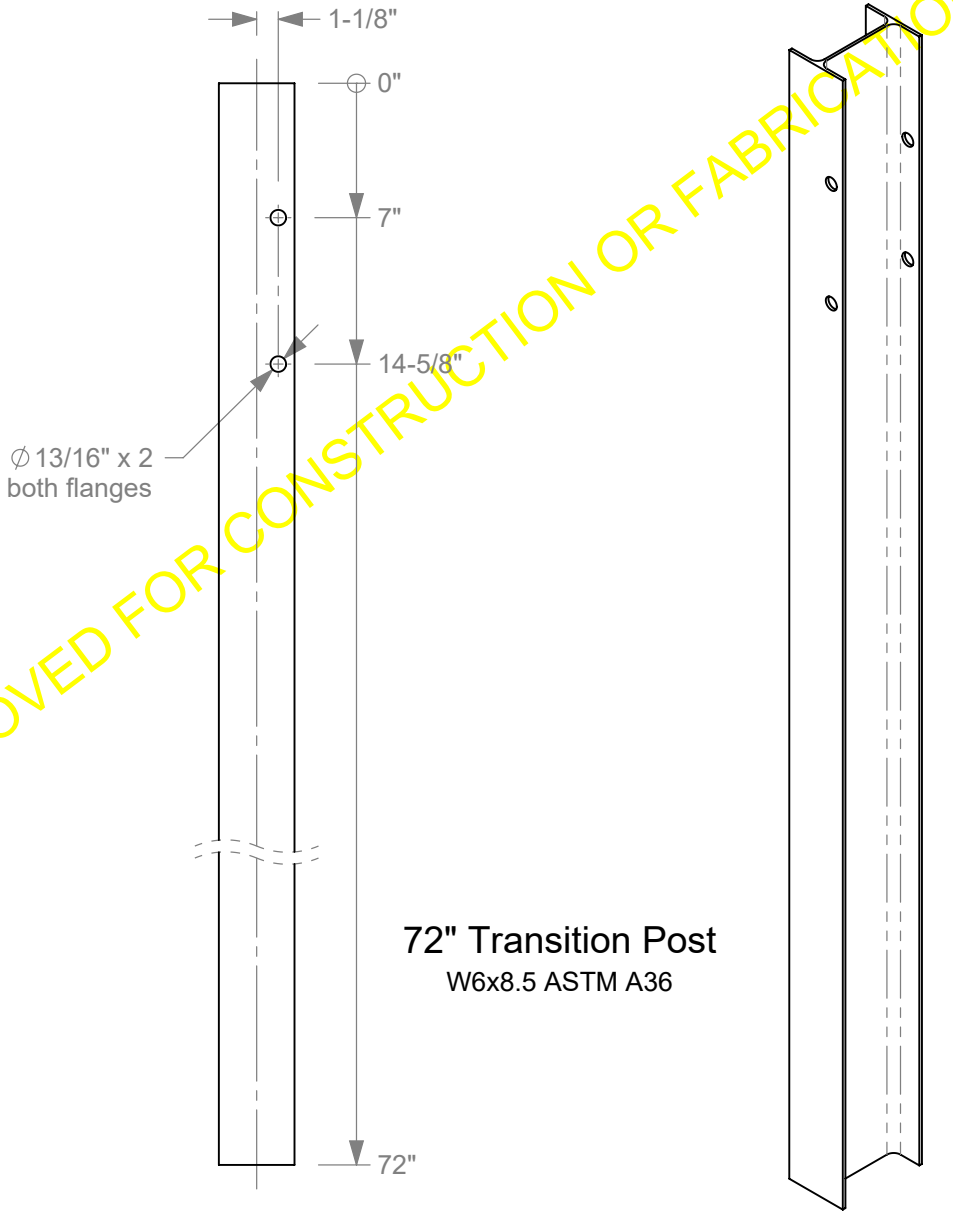
5 **Side Stiffener**
Plate, 3" x 1/4" x 19 11/16"
ASTM A36

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 5-6 Wyoming MGS Transition		2020-10-21
Drawn by GES	Scale 1:5	Sheet 7 of 9 Attachment Parts

Transition Posts



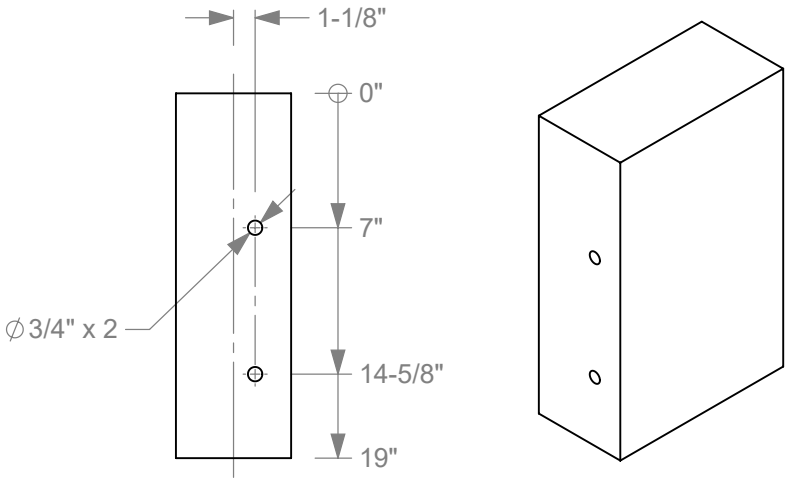
78" Transition Post
W6x8.5 ASTM A36



72" Transition Post
W6x8.5 ASTM A36

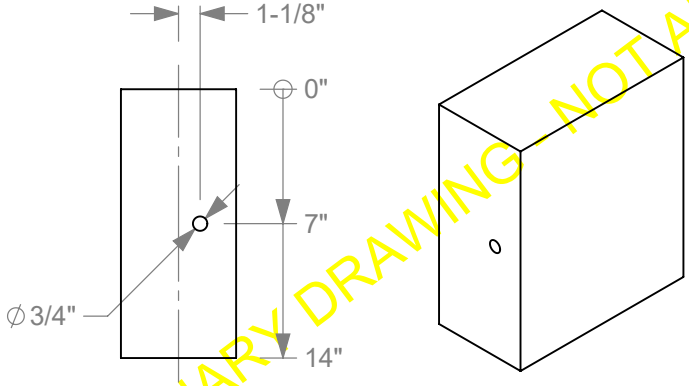
Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 5-6 Wyoming MGS Transition		2020-10-21
Drawn by GES	Scale 1:10	Sheet 8 of 9 Transition Posts

Transition Blockouts



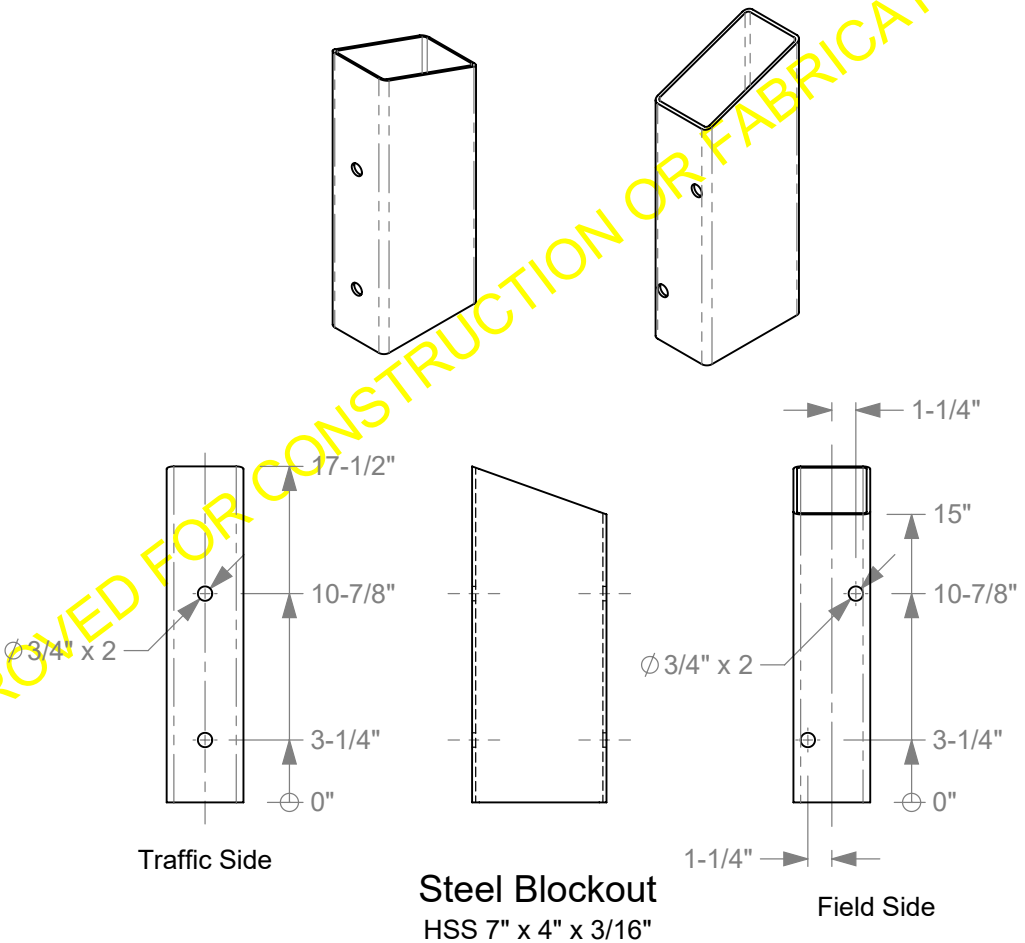
Transition Blockout

Pressure-treated Yellow Pine Timber
6" x 12" x 19"



Standard Blockout

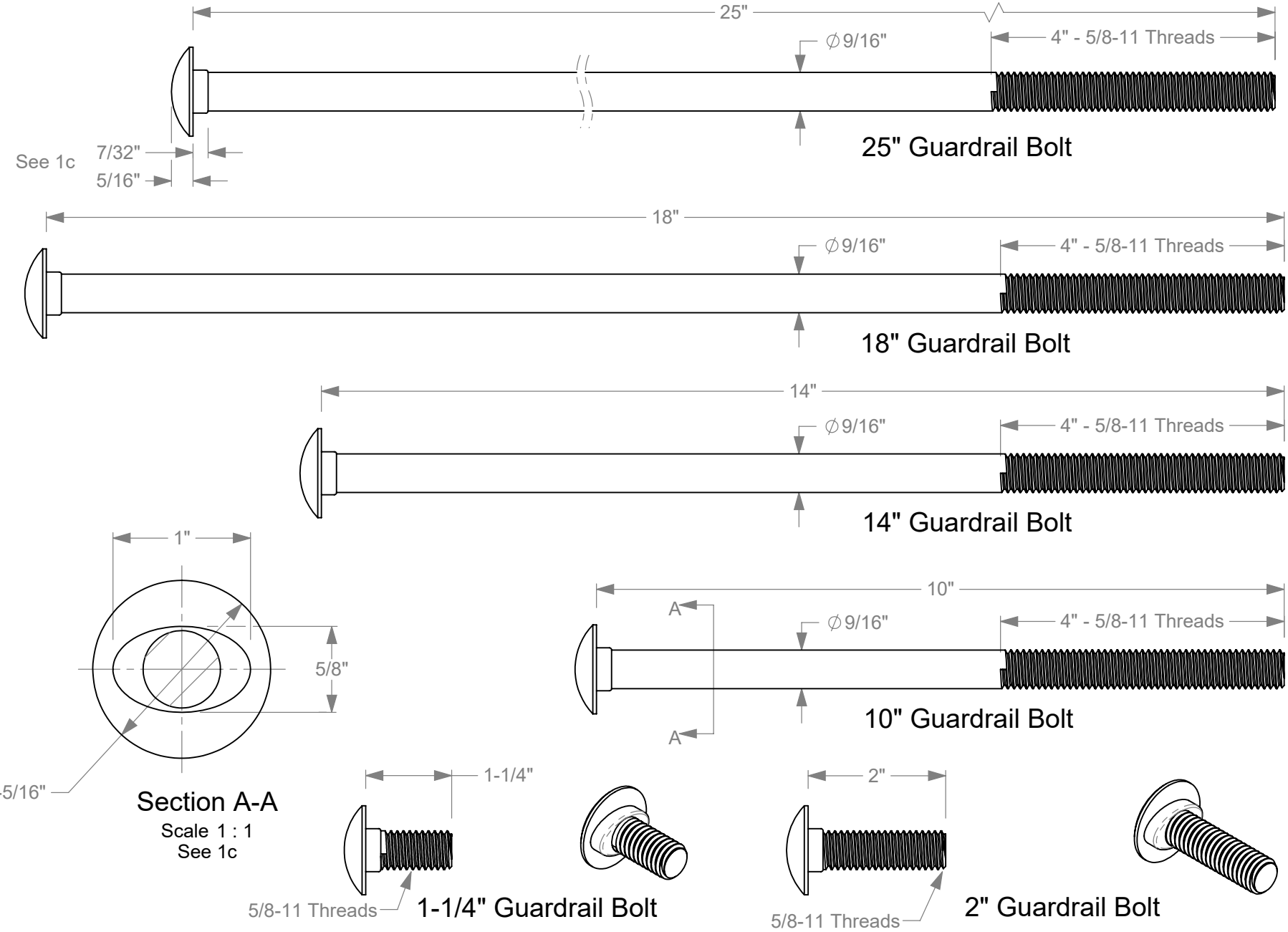
Pressure-treated Yellow Pine Timber
6" x 12" x 14"



Steel Blockout

HSS 7" x 4" x 3/16"
ASTM A500 Grade B

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #611801 5-6 Wyoming MGS Transition		2020-10-21
Drawn by GES	Scale 1:10	Sheet 9 of 9 Transition Blockouts

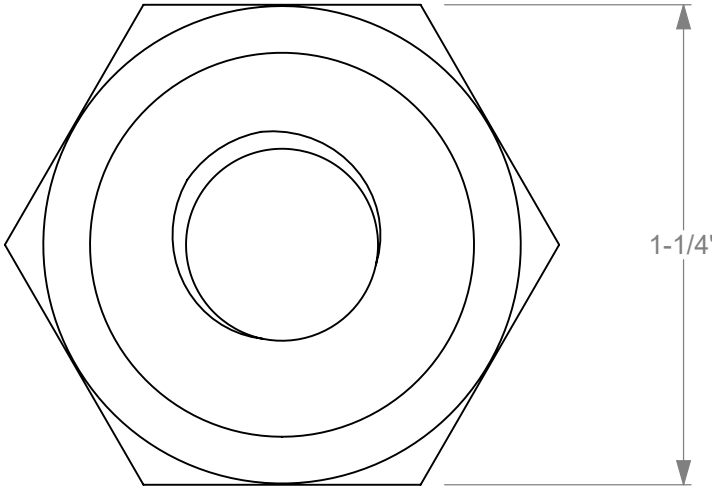


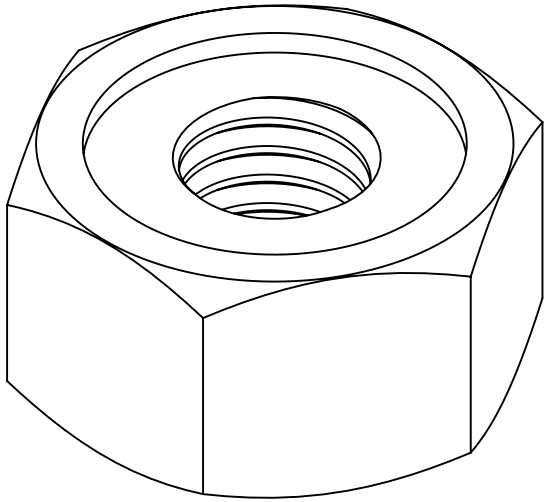
1a. Material is ASTM A307.
1b. All bolt sizes not used in all projects. See system drawing.
1c. Head and shoulder dimensions typical all sizes.

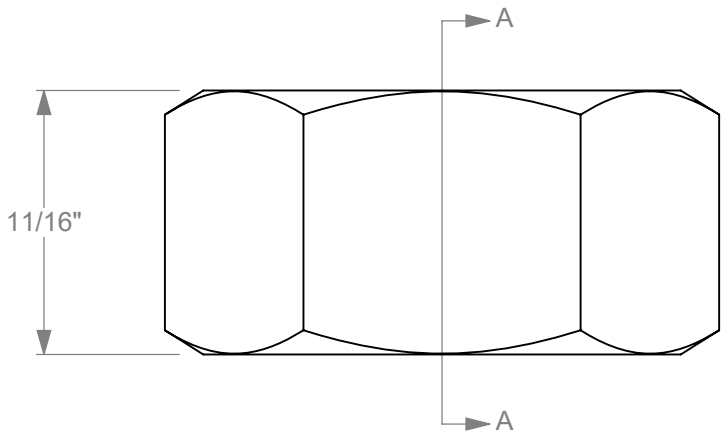
Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Guardrail Bolt		2020-04-22
Drawn by GES/WS	Scale 1:2	Sheet 1 of 1

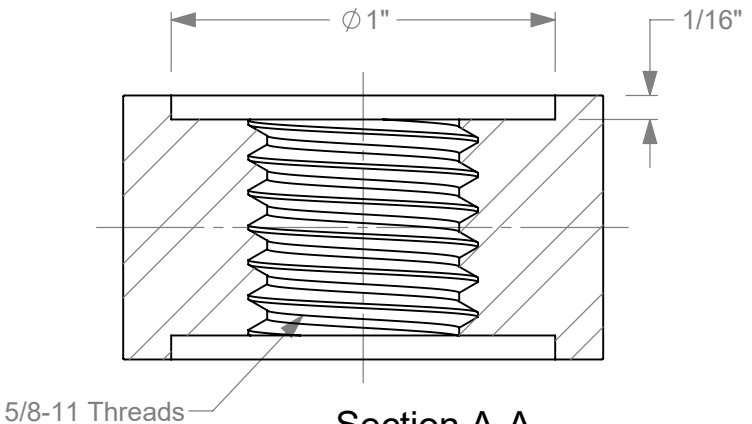
T:\Drafting Department\Solidworks\Standard Parts\Guardrail Parts and Subs\Guardrail Drawings\Guardrail Bolt

Recessed Guardrail Nut









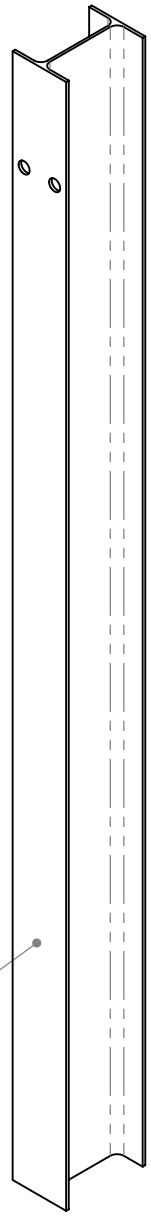
Section A-A

1a. Material is ASTM A 563 Grade A.

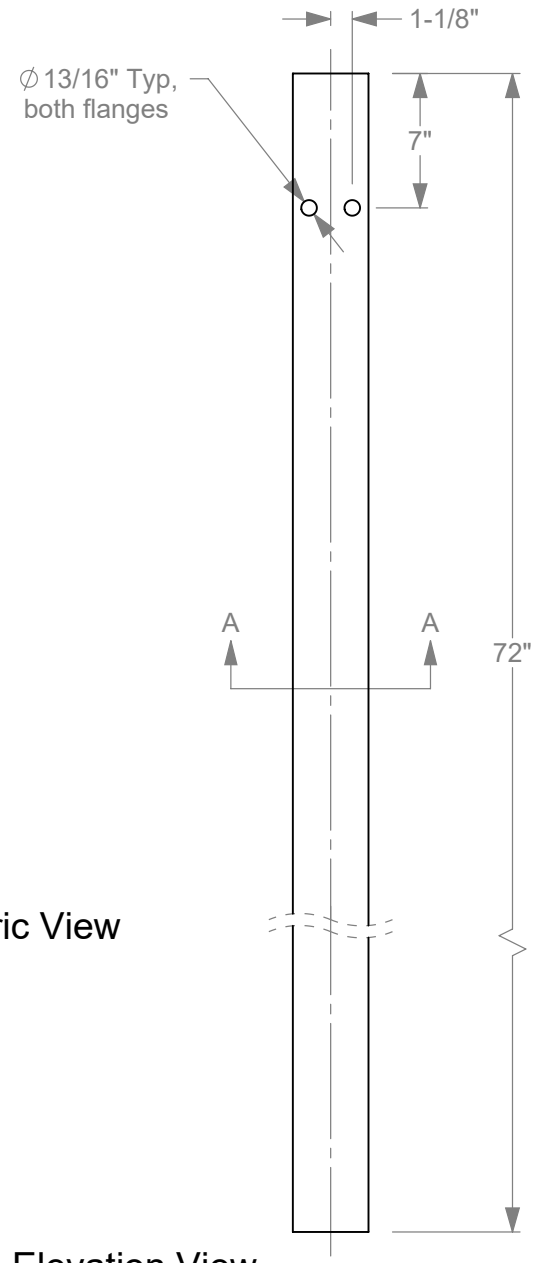
Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Recessed Guardrail Nut		2019-06-27
Drawn by GES	Scale 2:1	Sheet 1 of 1

T:\Drafting Department\Solidworks\Standard Parts\Guardrail Parts and Subs\Guardrail Drawings\Nut, Recessed Guardrail

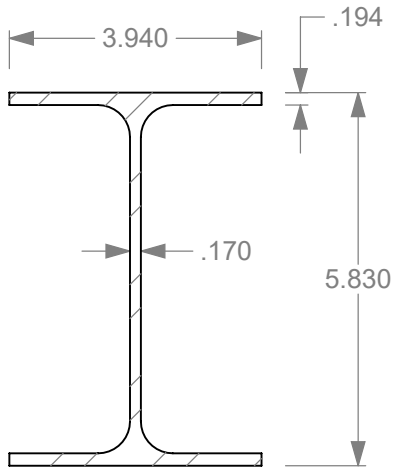
72" Wide-Flange Guardrail Post



Isometric View



Elevation View



Section A-A

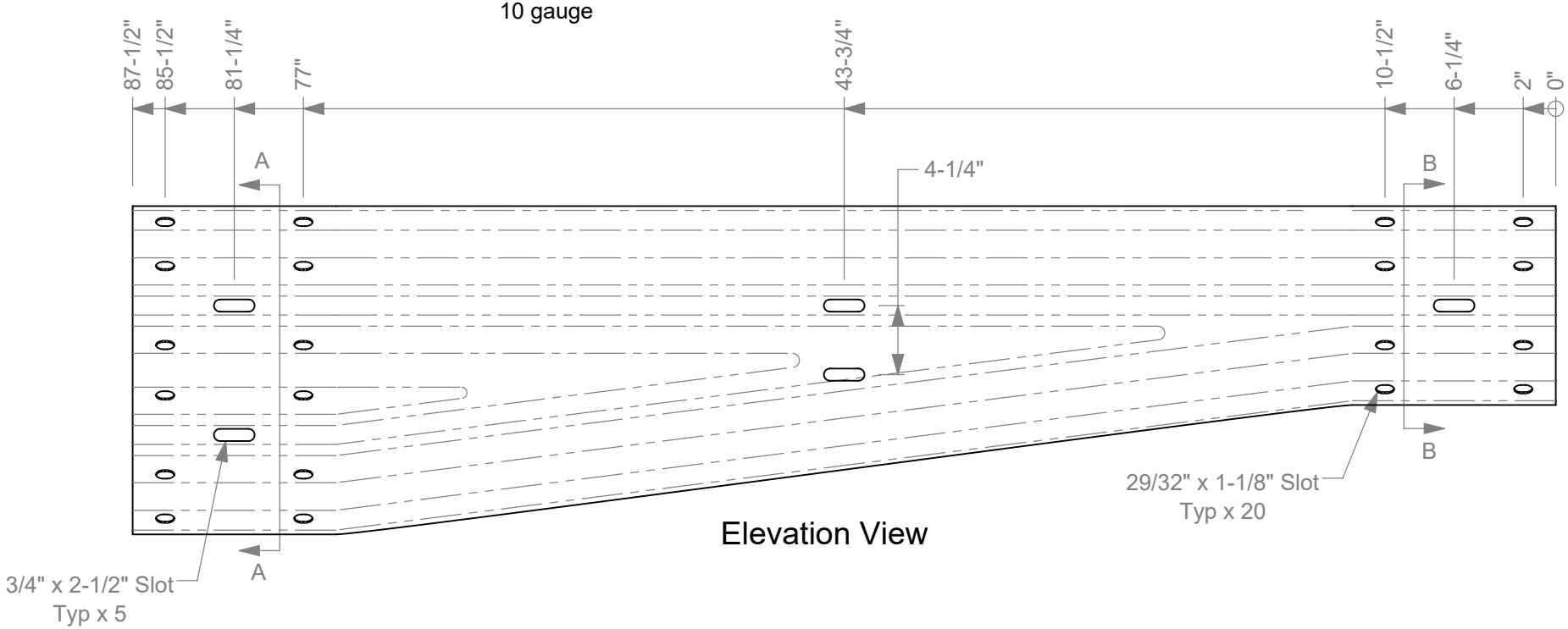
Scale 1 : 3

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
72" Wide-Flange Guardrail Post		2020-01-06
Drawn by GES	Scale 1:10	Sheet 1 of 1

T:\Drafting Department\Solidworks\Standard Parts\Guardrail Parts and Subs\Guardrail Drawings\Post, 72" Wide Flange Guardrail

Thrie to W-Beam, asymmetric

10 gauge



Elevation View

Section A-A

See Thrie-beam Drawing

Section B-B

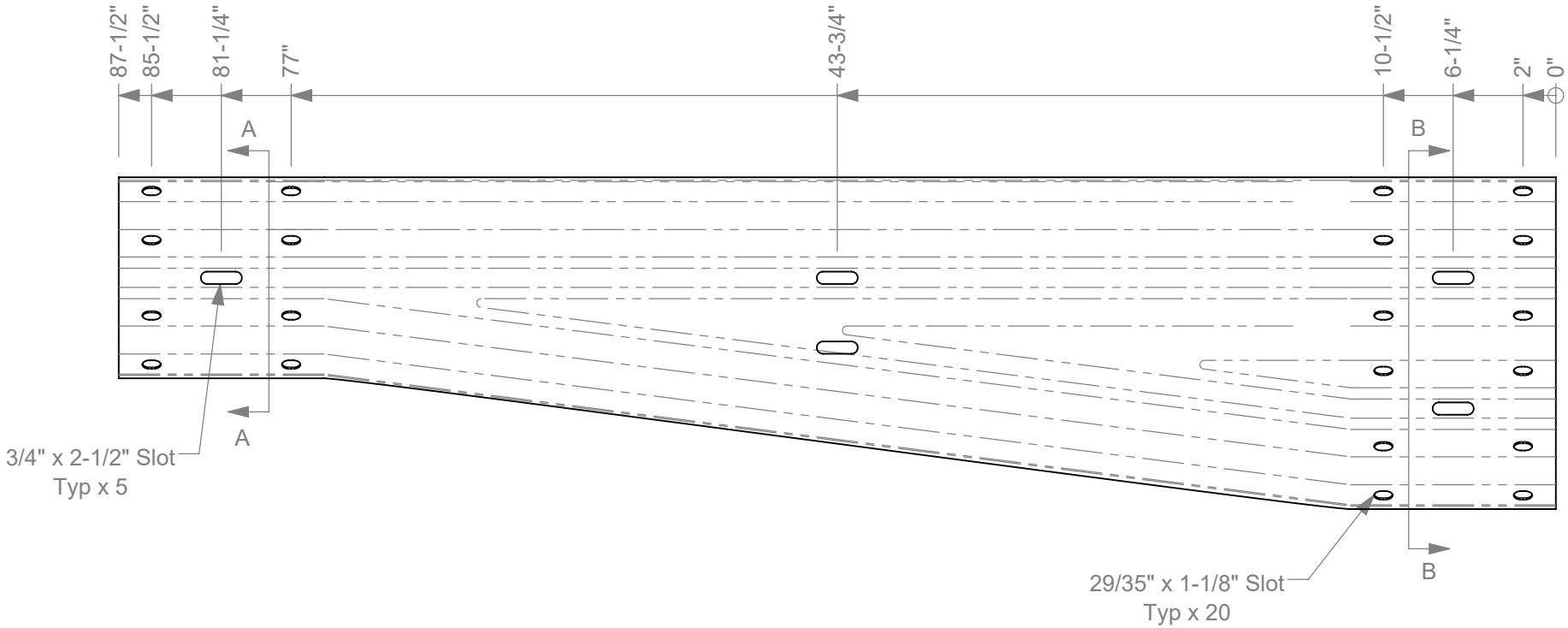
See W-beam Drawing

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Thrie- to W-beam Transition		2019-08-22
Drawn by GES	Scale 1:10	Sheet 1 of 1

T:\Drafting Department\Solidworks\Standard Parts\Guardrail Parts and Subs\Guardrail Drawings\Thrie to W-Beam, asymmetric

W- to Thrie-beam, asymmetric

10 gauge



Section A-A

See W-beam Drawing

Section B-B

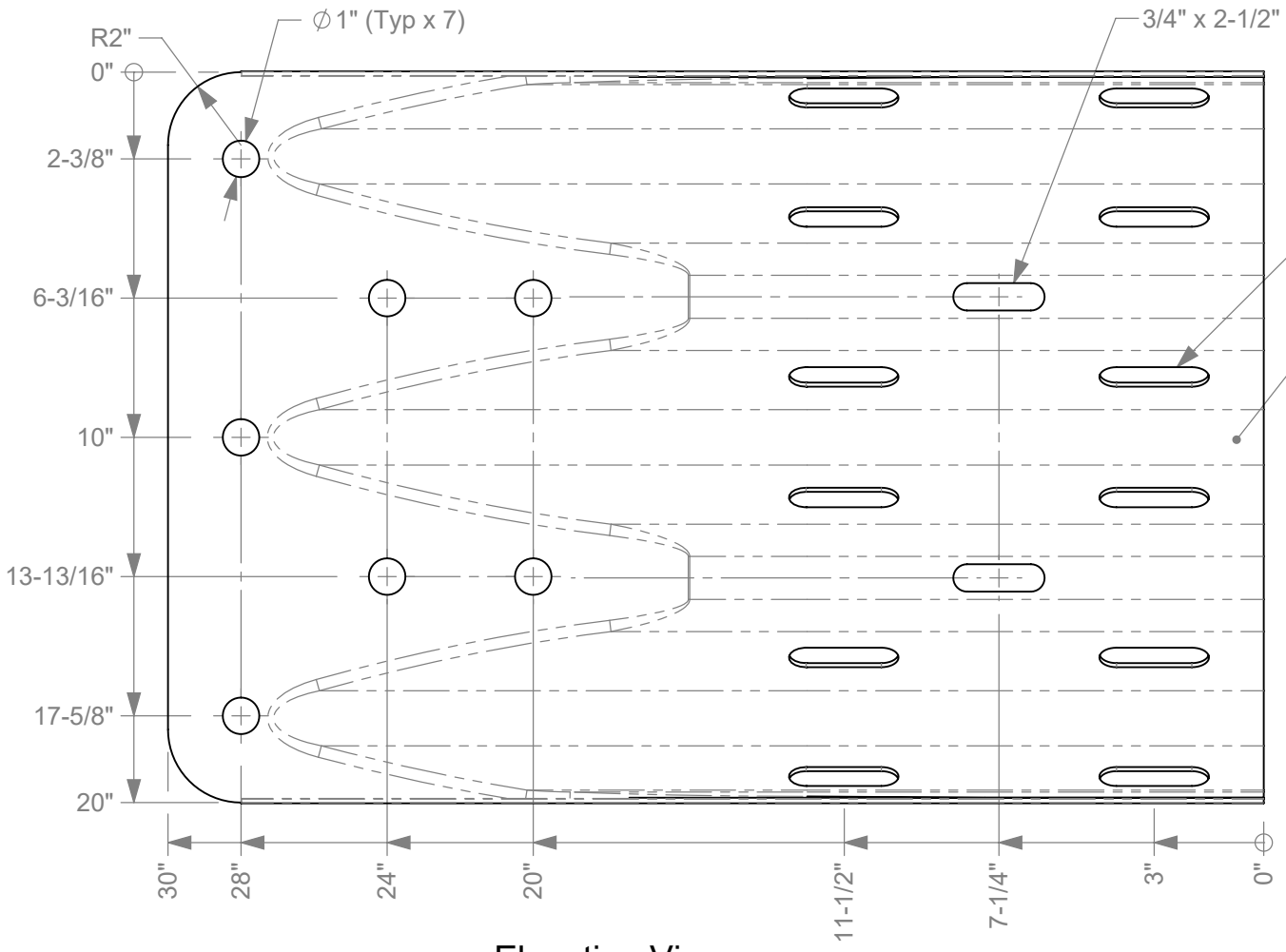
See W-beam Drawing

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
W- to Thrie-beam Connection		2020-09-04
Drawn by GES	Scale 1:10	Sheet 1 of 1

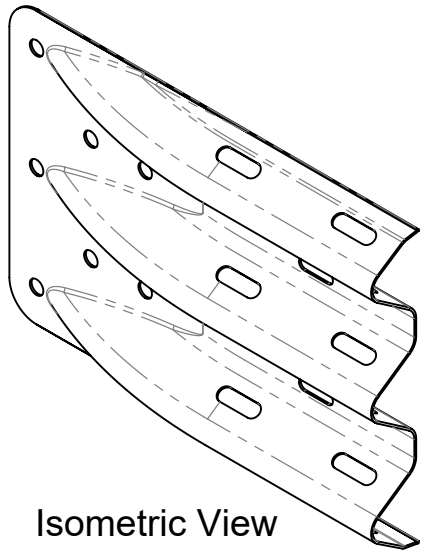
T:\Drafting Department\Solidworks\Standard Parts\Guardrail Parts and Subs\Guardrail Drawings\W- to Thrie-beam, asymmetric

Thrie-beam End Shoe

10 gauge (0.1345" before galvanizing)



Elevation View

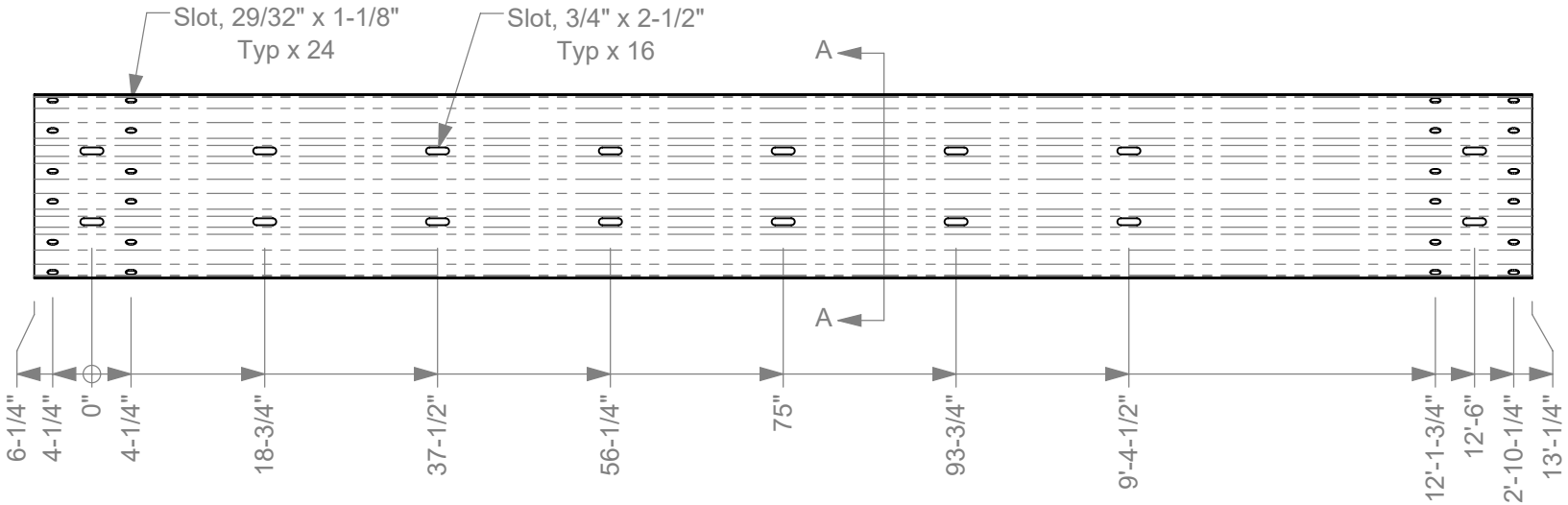


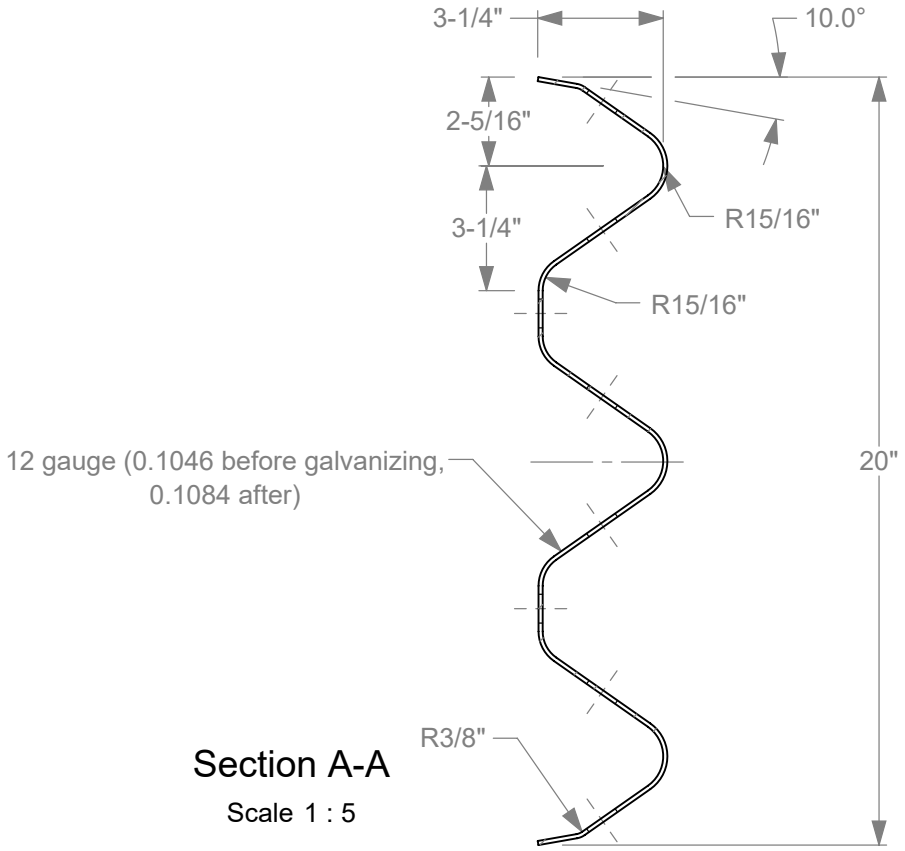
Isometric View

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Thrie-beam Terminal Connector		2019-07-29
Drawn by GES	Scale 1:5	Sheet 1 of 1

T:\Drafting Department\Solidworks\Standard Parts\Guardrail Parts and Subs\Guardrail Drawings\Thrie-beam End Shoe

Thrie-Beam for Transition





Section A-A

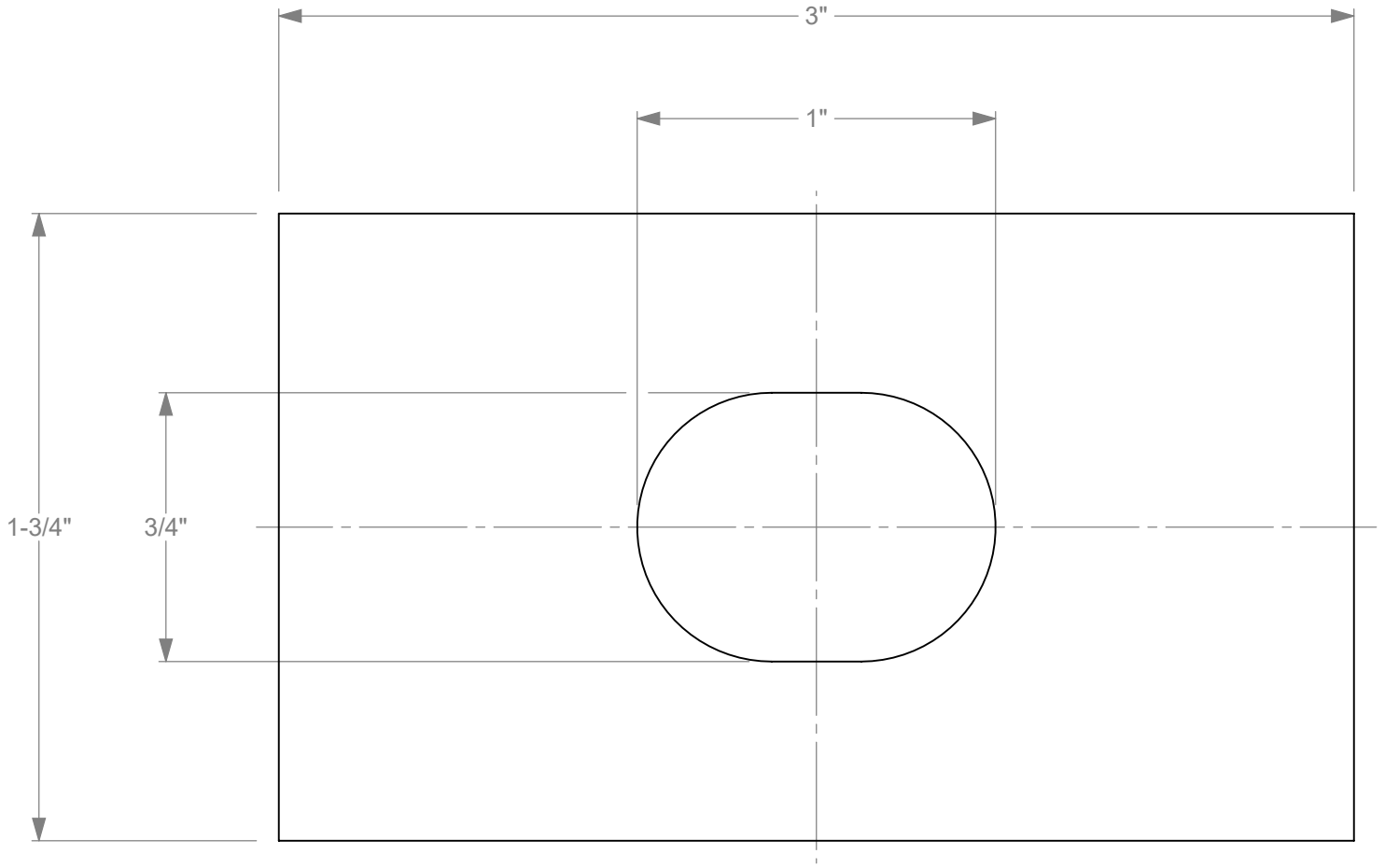
Scale 1 : 5

Texas A&M Transportation Institute		Roadside Safety and Physical Security Division - Proving Ground	
Transition 12 gauge Thrie-beam			2019-07-30
Drawn by GES	Scale 1:20	Sheet 1 of 1	

T:\Drafting Department\Solidworks\Standard Parts\Guardrail Parts and Subs\Guardrail Drawings\Thrie-Beam for Transition

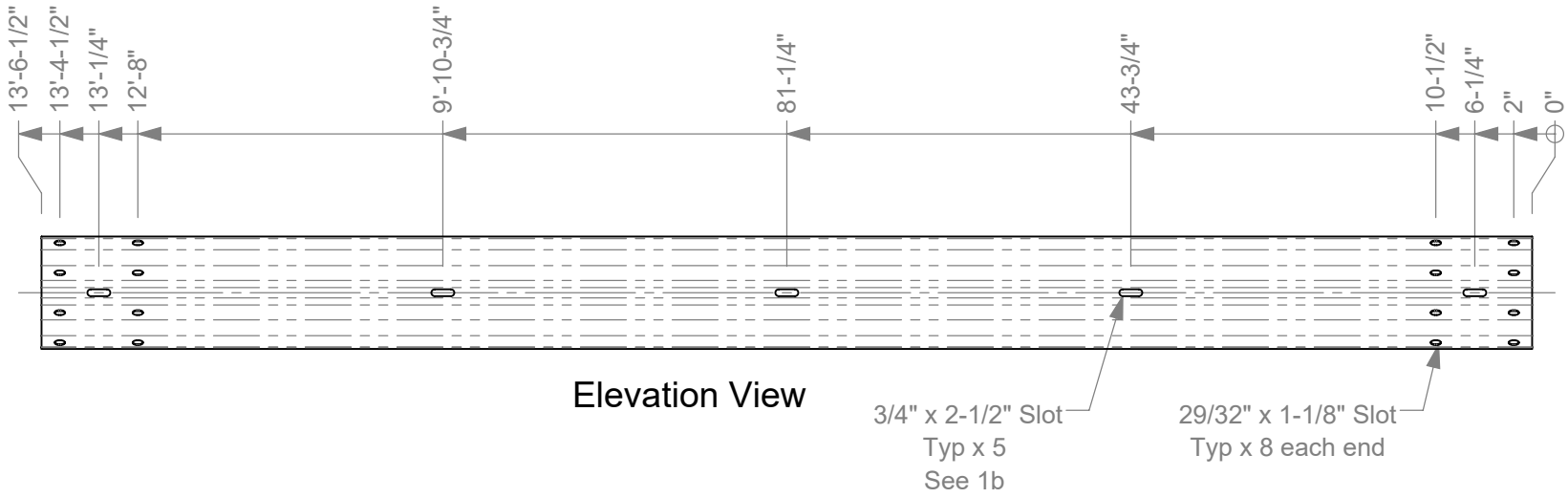
Rectangular Guardrail Washer

0.20" thick

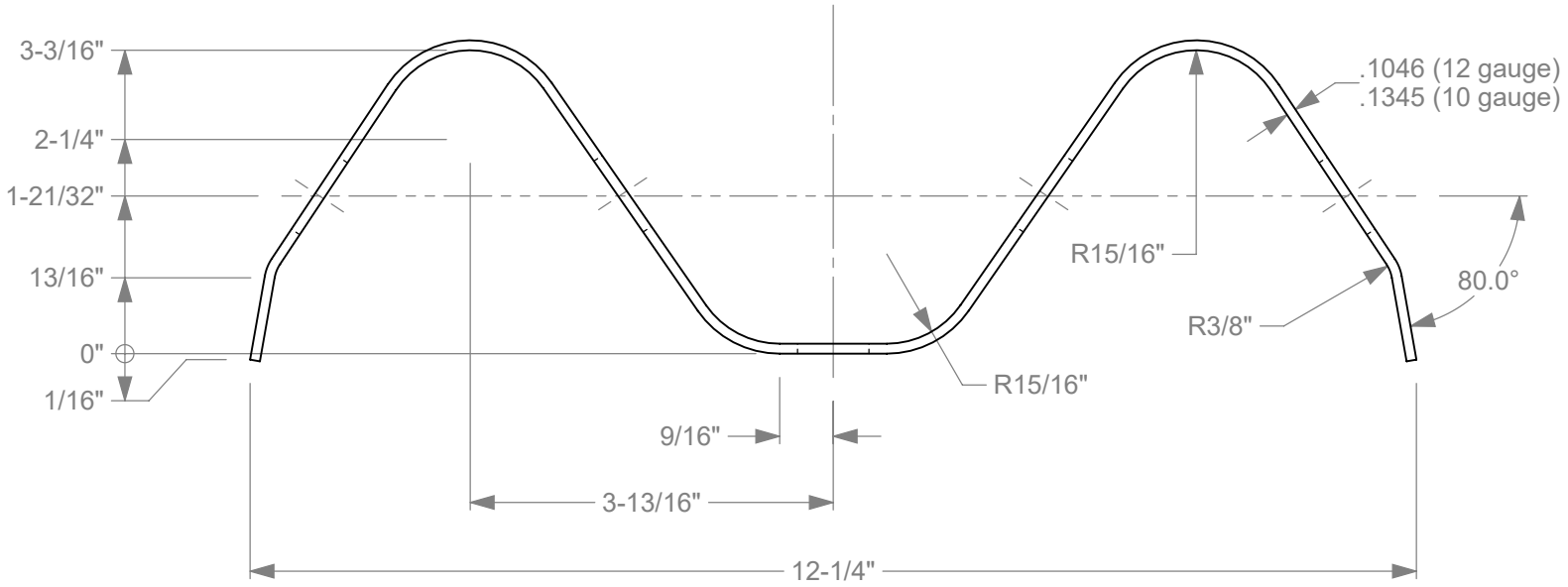


Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Rectangular Guardrail Washer		2019-08-08
Drawn by GES	Scale 2:1	Sheet 1 of 1

T:\Drafting Department\Solidworks\Standard Parts\Guardrail Parts and Subs\Guardrail Drawings\Washer, rect.



Elevation View



Section View

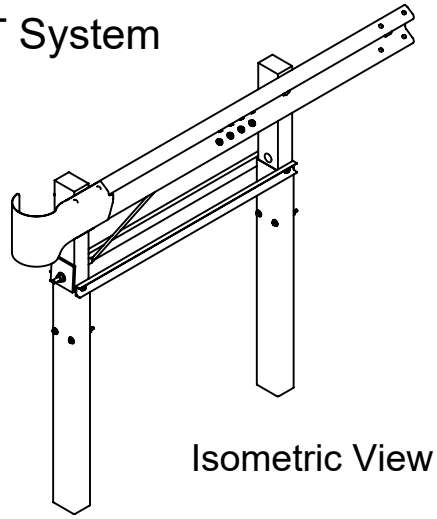
1a. Manufacture per AASHTO M180 specifications.

1b. 4-space Guardrail is shown. Slots typical x 3 for 2-space W-beam spaced at 75", and typical x 9 for 8-space W-beam spaced at 18-3/4". Slots are typical x 4 at 37-1/2" for 9'-4-1/2" span W-beam.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
4-space W-beam Guardrail		2020-06-05
Drawn by GES	Scale 1:20	Sheet 1 of 1

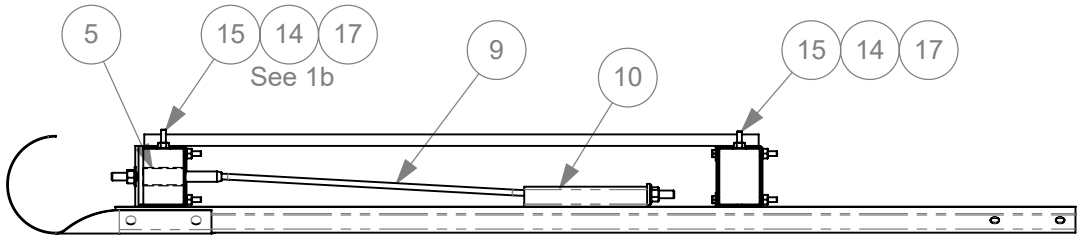
T:\Drafting Department\Solidworks\Standard Parts\Guardrail Parts and Subs\Guardrail Drawings\W-Beam Guardrail

DAT System

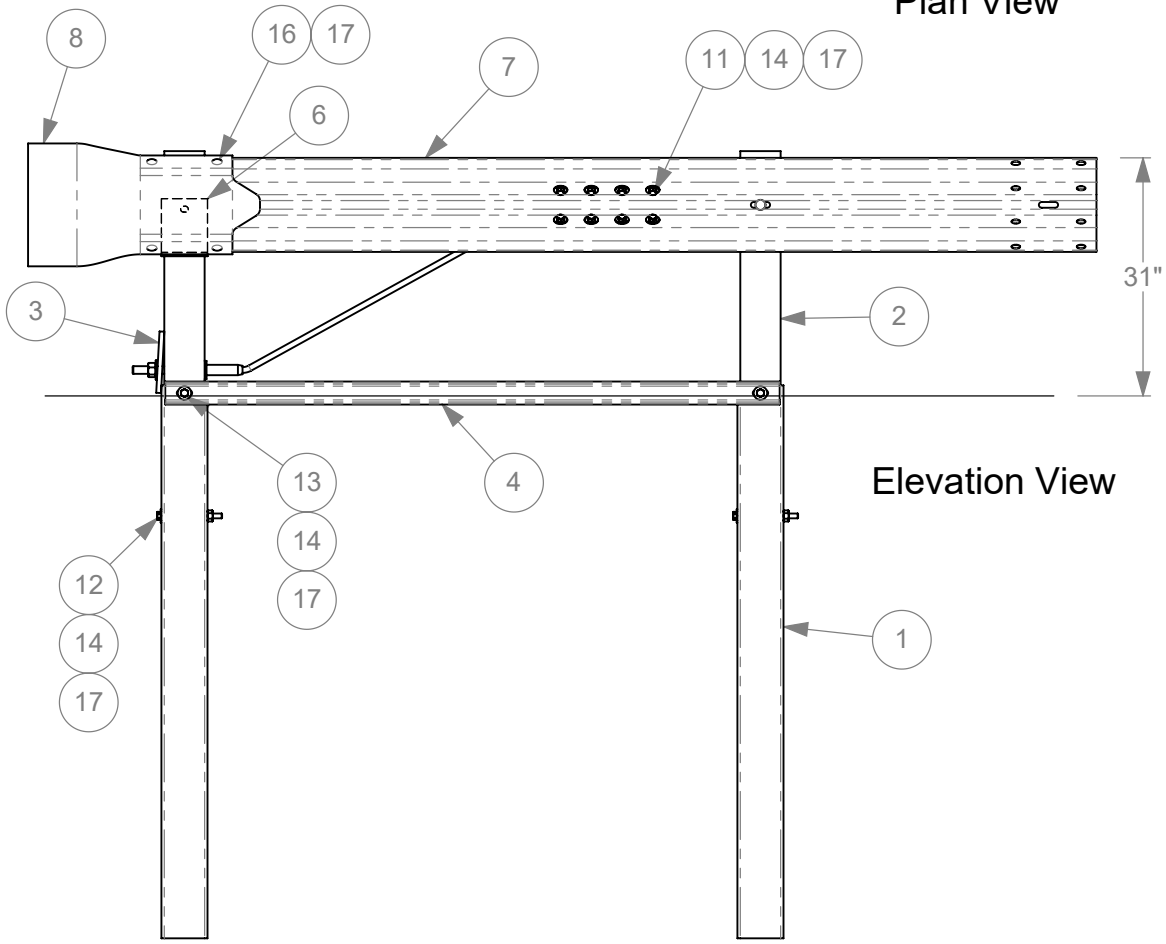


Isometric View

#	Part Name	Qty.
1	Foundation Tube	2
2	Terminal Timber Post	2
3	BCT Bearing Plate	1
4	DAT Strut	2
5	BCT Post Sleeve	1
6	Shelf Angle Bracket	1
7	DAT Terminal Rail	1
8	W-beam End Section	1
9	Anchor Cable Assembly	1
10	Guardrail Anchor Bracket	1
11	Bolt, 5/8 x 2" hex	8
12	Bolt, 5/8 x 8" hex	4
13	Bolt, 5/8 x 10" hex	2
14	Washer, 5/8 F844	16
15	10" Guardrail Bolt	2
16	1-1/4" Guardrail Bolt	4
17	Recessed Guardrail Nut	20



Plan View



Elevation View

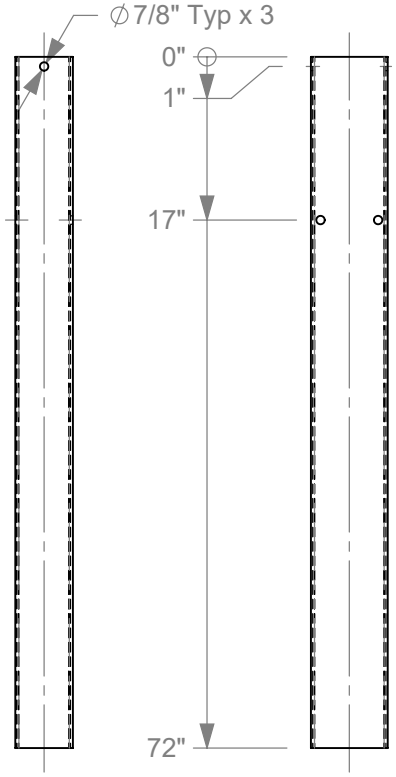
1a. All bolts are ASTM A307.

1b. Hardware secures Shelf Angle Bracket to Post. Rail is supported by Shelf Angle Bracket and does not attach directly to Post.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
DAT (Downstream Anchor Terminal)		2019-07-26
Drawn by GES	Scale 1:25	Sheet 1 of 3

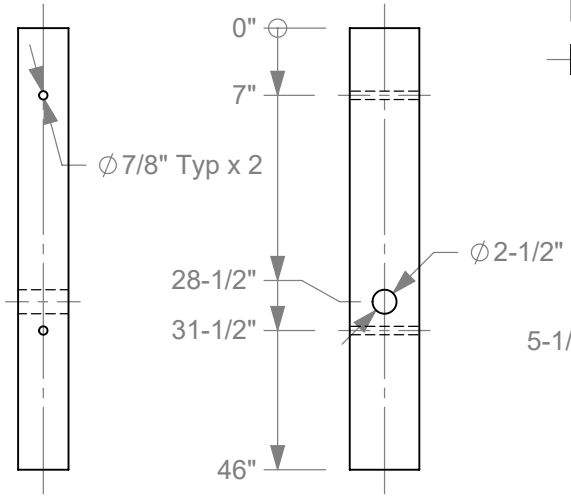
T:\Drafting Department\Solidworks\Standard Parts\Guardrail Parts and Subs\Guardrail Drawings\DAT

DAT Parts sheet 1



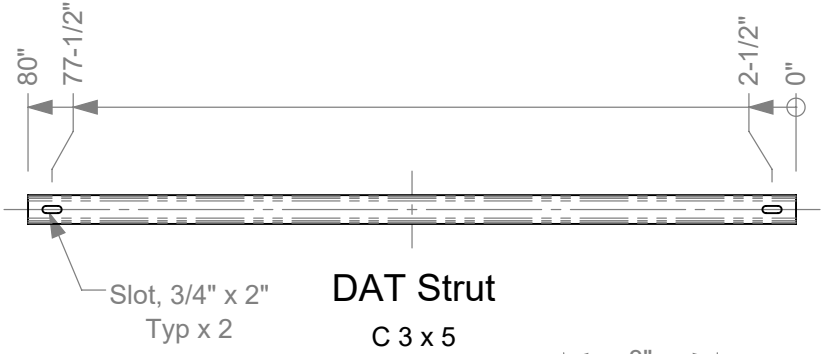
Foundation Tube

HSS 8" x 6" x 1/8"



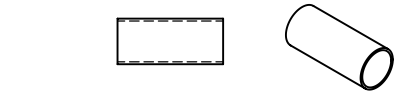
Terminal Timber Post

5-1/4" x 7-1/4"



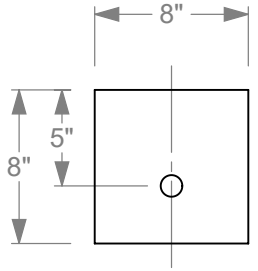
DAT Strut

C 3 x 5



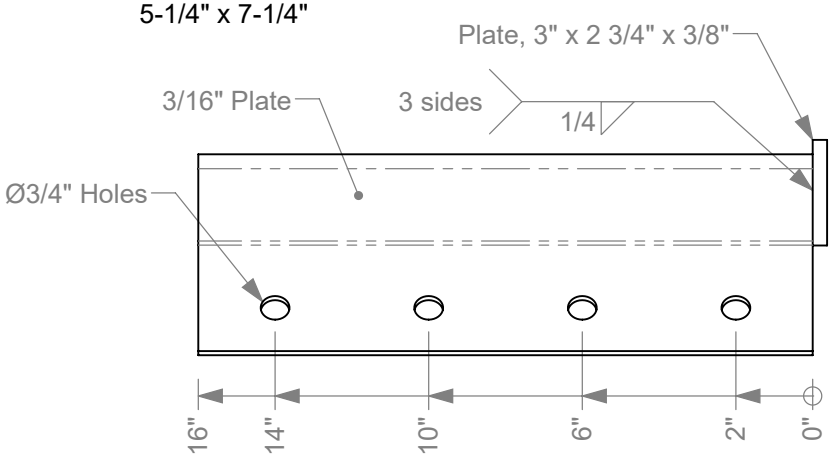
BCT Post Sleeve

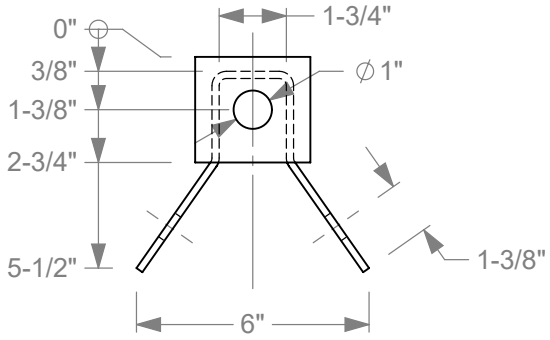
2" schedule 40 Pipe - Scale 1:10



BCT Bearing Plate

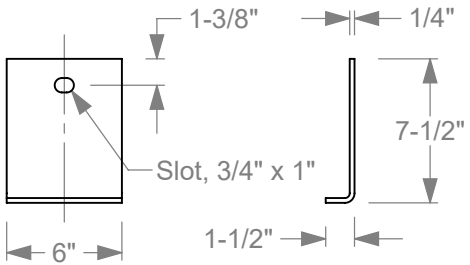
5/8" Plate - Scale 1:10





Guardrail Anchor Bracket

Scale 1:5



Shelf Angle Bracket

Scale 1:10

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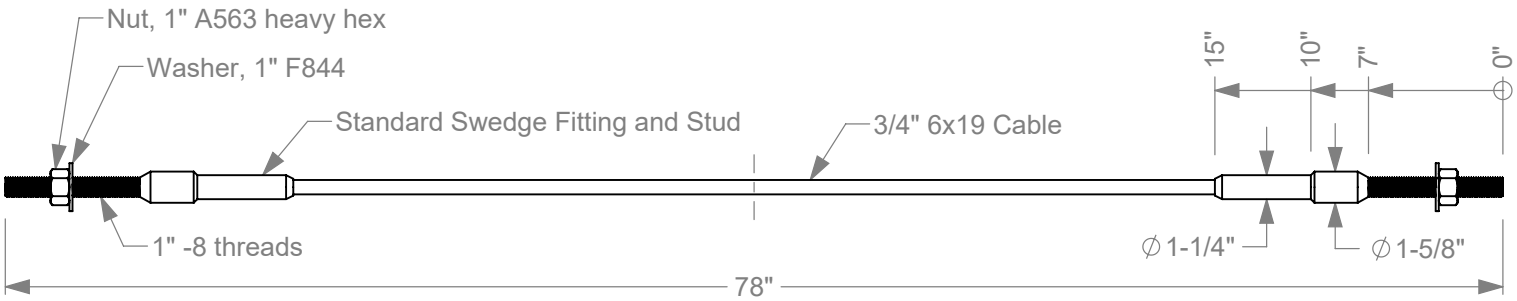
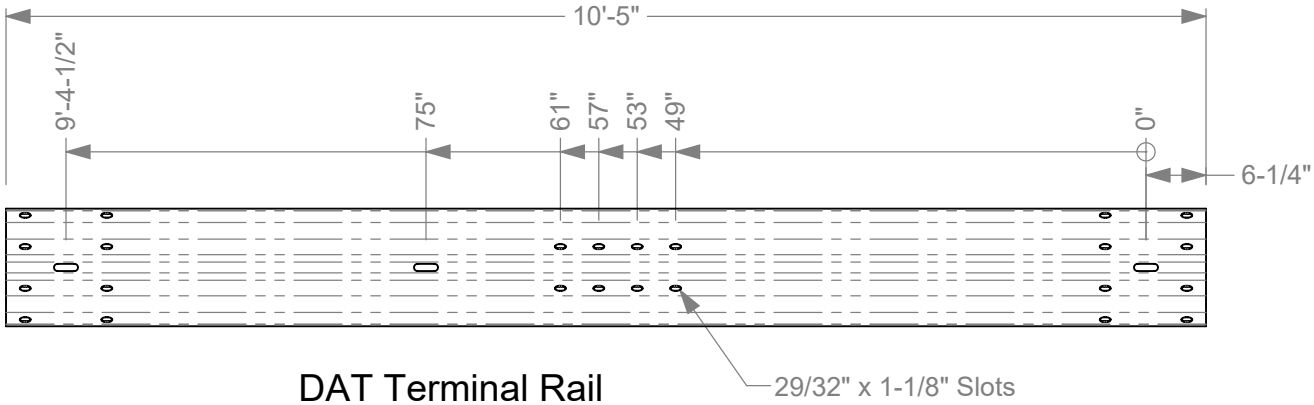
DAT Parts sheet 2

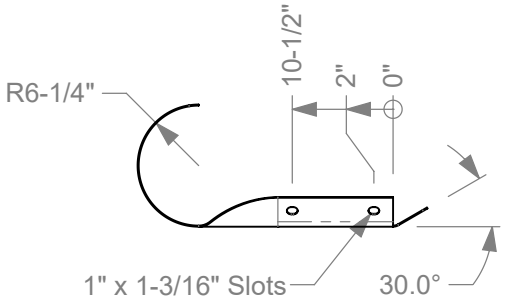


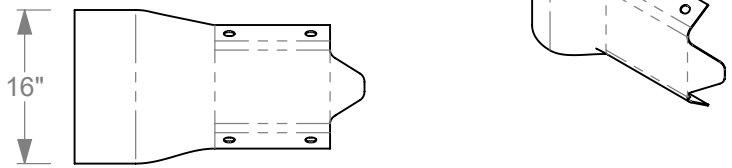
Anchor Cable Assembly



DAT Terminal Rail

Scale 1:20 - See 4-space W-beam Guardrail drawing for cross-section and other dimensions.





W-beam End Section

12 gauge steel - Scale 1:20

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