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 valid.

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

Plan View

Elevation View

Section B-B

Scale 1:10

Detail A

Scale 1:10

See 1a

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

U-bolt for Picket Rail

Ø 1/2" ASTM A36 Steel
10" long before bending

Nut, 7/8 A563 heavy hex with F436 Washer

Nut, 1/2 A563 heavy hex with Lock Washer x 2

Plate Washer for U-bolt

Plate, 2" x 5/16" x 2"
ASTM A36 Steel
with Ø9/16" hole at center x 2

Rectangular Rail

Round Bridge Rail

Picket Panel

See Field Side detail below for Picket Panel attachment. Typ 12 places.

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

Traffic Side

Field Side

C

1-1/16" x 6, Field Side face only

Ø 1-1/16" x 6, Field Side face only

Ø 1-1/16" x 6, Field Side face only

Ø 2" x 6, bottom face only

Ø 5/8" x 6, Field Side face only

1-1/16" x 6, Field Side face only

2" x 6, bottom face only

Roadside Safety and Physical Security Division - Proving Ground

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

Preliminary Drawing - Not Approved for Construction or Fabrication
Preliminary Drawing - Not Approved for Construction or Fabrication

1-1/16" x 6, Field Side face only

5/8" x 6, Field Side face only

37-1/2"

20-1/4"

24-3/4"

8'-7-1/2"

9'-8-1/4"

10'-3/4"

11'-1-1/2"

14'-1-1/2"

16'-7-1/2"

17'-8-1/4"

18'-3/4"

19'-9"

19'-18" 18'-8"

16'-7-1/2" 14'-1-1/2"

11'-1-1/2"

8'-7-1/2"

73-1/2"

37-1/2"

13"

8-7/8"

19'-9"

18'-8"

2 x φ 3/4" THRU ALL

φ 2" x 6, bottom face only

Section C-C

Scale 1 : 5

Rectangular Bridge Rail

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

Plan and Elevation Views

Round Bridge Rail

Same details as on previous sheet

Elevation View

Traffic Side

Field Side

1-3/4"

1"

1-3/8"
### Bridge Post

#### Plan View

#### Elevation Views

#### Isometric View

#### Table: Bridge Post Details

<table>
<thead>
<tr>
<th>#</th>
<th>Body Name</th>
<th>Description</th>
<th>Length</th>
<th>Material</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Base Plate</td>
<td>Plate, 12&quot; x 3/4&quot;</td>
<td>14&quot;</td>
<td>ASTM A572 Grade 50</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Side Plate</td>
<td>Plate, 9&quot; x 3/4&quot;</td>
<td>31 1/4&quot;</td>
<td>ASTM A572 Grade 50</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Rail Plate, Top</td>
<td>Plate, 2&quot; x 3/4&quot;</td>
<td>11 3/4&quot;</td>
<td>ASTM A36 Steel</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Rail Plate, Lower</td>
<td>Plate, 2&quot; x 3/4&quot;</td>
<td>14&quot;</td>
<td>ASTM A36 Steel</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Picket</td>
<td>Plate, 5/8&quot; x 5/8&quot;</td>
<td>27 3/4&quot;</td>
<td>ASTM A36 Steel</td>
<td>1</td>
</tr>
</tbody>
</table>

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

4b. Galvanize after fabrication is complete.

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**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

1. Base Plate
   Plate, 12" x 3/4"
   Plan View

2. Side Plate
   Plate, 9" x 3/4"
   Elevation View

3. Rail Plate, Top
   Plate, 2" x 3/4"
   Elevation View
   Slot, 15/16" x 1-3/4"
   Typ x 2, both Rail Plates

4. Rail Plate, Lower
   Plate, 2" x 3/4"
   Elevation View

5. Picket
   Plate, 5/8" x 5/8"

Preliminary Drawing - Not Approved for Construction or Fabrication
Picket Panel

Elevation View
from Traffic Side

Detail E
Scale 1:5

Section F-F

Isometric View

Plate, 5/8" x 5/8" x 28-7/8"
ASTM A36

L 2 x 1-1/2 x 3/16 x 73 1/8"
ASTM A36

Plate, 1 1/2" x 3/8" x 73-1/8"
ASTM A36

29-7/8"
28-7/8"
16-1/8"
6"
0"

2" F

3/16 Typ

3 x 9/16" X 3-1/2" THRU ALL

2020-09-03

Preliminary Drawing - Not Approved for Construction or Fabrication
Section I-I

Ø5/8" Rebar x 4 in curb. Bend traffic side bars as shown below at ends.

D Bar, 6 sp @ 3" each end, then @ 6"

Ø1/2" longitudinal rebar in top mat @ 12" and as shown

5/8" Rebar x 33" @ 6" (skip at anchor bars)

Existing Concrete

5/8" Rebar x 40 1/2" @ 18"

See 8a

Bottom Traffic Side Bar
Typical each end
Plan View

Top Traffic Side Bar
Typical each end
Plan View

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.
D-bars @ 6"

D-bars 6 sp. @ 3"
18"

Z-1 bar x 4, in pairs placed horizontal at 2" and 4" above the Deck

Z bar, same orientation as @ center Post

Z bar, rotated to maintain clearance at curb flare

D-bar at Ends

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

Z bar, same orientation as @ center Post

D Bar
D-1 Bar
D-2 Bar
D-3 Bar
D-4 Bar
D-5 Bar

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

Rebar at Ends

Plan View

Elevation View

Anchor Bars not shown for clarity

Isometric View
Anchor Bolt Assembly
Threads not shown for clarity

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

Isometric View
Bolt, 7/8 x 10 1/2" hex
A449
x 4

1"
2-1/6"
1-1/2"
0"
7/8"
2"
4-1/2"
5-5/8"
6-1/2"

0"

Typ

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
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.
Transition Details

some Detail Views on next sheet

Plan View

Box Beam Rail

Elevation View

Type T-2 Post
Typ @ 23 - 27

Type R Post
Typ @ 16 - 18

Type T-1 Post
Typ @ 19 - 22

Type A Post

Bolt, 3/4 x 8" hex A325
with A194-2HM Hex Nut
and F436 Washers (2)

Bolt, 3/4 x 2" hex A325
with A194-2HM Hex Nut
and F436 Washers (2)

Bolt, 3/4 x 4" hex A325
with A194-2HM Hex Nut
and F436 Washers (2)

Washer, 3/4 F844

Washer, 3/4 F844

Washer, 3/4 F844

Washer, 3/4 F844

Detail E
Scale 1 : 20

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

3 places

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

Bolt, 3/4 x 1/2" hex A325
with A194-2HM Hex Nut
and F436 Washers (2)

2 places

Bolt, 3/4 x 3 1/2" hex A325
with A194-2HM Hex Nut
and F436 Washers (2)

2 places
Transition Detail Views

Detail D
Scale 1:10

Bolt, 3/8 x 3 1/2" hex A307 with A563 Hex Nut and F844 Washers (2)

Bolt, 1/2" x 1 1/2" hex A307 with A563 Hex Nut and F844 Washers (2)

Detail H
Scale 1:10

Bolt, 3/4 x 3 1/2" hex A325 with A194-2HM Hex Nut and F436 Washers (2) 4 places

Bolt, 3/8 x 3 1/2" hex A307 with A563 Hex Nut and F844 Washers (2)

Bolt, 1/2" x 1 1/2" hex A307 with A563 Hex Nut and F844 Washers (2)

Detail G
Scale 1:20
See 3a

Bolt, 1/2" x 1 1/2" hex A307 with A563 Hex Nut and F844 Washers (2)

Bolt, 3/4 x 3 1/2" hex A325 with A194-2HM Hex Nut and F436 Washers (2)

4 places

See previous sheets.

See previous sheets.

Transition Detail Views

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

Plan View

Wyoming DoT Class B Concrete (3250 psi)
30" x 30" x 24" deep
un-reinforced

Type I End Anchor Rail

Ground Line

Type A Post
Type A Post
Type C Post

Elevation View

Box Beam Rail

Nut, 3/4 heavy hex
with F436 Washer

Detail J
Scale 1:10

Anchor Bolt
Ø3/4" x 3" x 24"
with 3" of 3/4-10 threads
ASTM A572 Grade 50
x 2

Detail I
Scale 1:5
See previous sheets for connection hardware details.
5a. Galvanize all components after fabrication is complete.

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
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.
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.

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
Type T-1 Post
W6x9 x 64"
ASTM A992
Scale 1:10

Type T-2 Post
W6x9 x 64"
ASTM A992
Scale 1:10

8a. Galvanize all components after fabrication is complete.
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.

- **Type A Post**
  - Elevation View
  - Plate, 8" x 1/4" x 24"
  - ASTM A36

- **Type C Post**
  - Elevation View
  - See 9d

- **Type R Post**
  - Elevation View
  - See 9d
10a. All welding must be performed by certified welders using industry standard practices.
10b. Galvanize all components after fabrication is complete.
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.
12a. All welding must be performed by certified welders using industry standard practices.
12b. Galvanize after fabrication is complete.

<table>
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<tr>
<th>#</th>
<th>Body Name</th>
<th>Description</th>
<th>Length</th>
<th>MATERIAL</th>
<th>Qty</th>
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<td>Main Plate</td>
<td>Plate, 34 1/4&quot; x 1/4&quot;</td>
<td>38 3/8&quot;</td>
<td>ASTM A572 Grade 50</td>
<td>1</td>
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<tr>
<td>2</td>
<td>Main Rail Attachment</td>
<td>HSS 5&quot; x 5&quot; x 3/16&quot;</td>
<td>24&quot;</td>
<td>ASTM A500 Grade B</td>
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<tr>
<td>3</td>
<td>Rub Rail Attachment</td>
<td>Plate, 24 1/2&quot; x 3/16&quot;</td>
<td>6 1/16&quot;</td>
<td>ASTM A572 Grade 50</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Rub Rail Attachment</td>
<td>Plate, 24&quot; x 3/16&quot;</td>
<td>6 1/16&quot;</td>
<td>ASTM A572 Grade 50</td>
<td>1</td>
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<tr>
<td>5</td>
<td>Side Stiffener</td>
<td>Plate, 3&quot; x 1/4&quot;</td>
<td>61 7/8&quot;</td>
<td>ASTM A572 Grade 50</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Top Stiffener</td>
<td>Plate, 3&quot; x 1/4&quot;</td>
<td>10 5/16&quot;</td>
<td>ASTM A572 Grade 50</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Bottom Stiffener</td>
<td>Plate, 2 3/4&quot; x 1/4&quot;</td>
<td>9 7/8&quot;</td>
<td>ASTM A572 Grade 50</td>
<td>1</td>
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<tr>
<td>8</td>
<td>Gusset</td>
<td>Plate, 3&quot; x 1/4&quot;</td>
<td>5 3/8&quot;</td>
<td>ASTM A572 Grade 50</td>
<td>2</td>
</tr>
</tbody>
</table>
Main Plate is mirror image of the one on the Right Side part. All other components and details are identical.
Main Plate
Plate, 34 1/4" x 1/4" x 38 3/8"
ASTM A572 Grade 50
See 14a

Plan View

Left
Isometric Views

Right

Elevation Views

1-1/2" 3/4" x 3
0"
3"
12-1/4"
23"
34-1/4"

18-1/2" 16"
18-1/2"
8-1/2" 6"
3-3/4"

R1/4" Typ

90°
45°
25°

R2-1/2"

Normal to this face.
Normal to this face.
Normal to this face.

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).
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.
Stiffeners and Gussets

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

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

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

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

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Roadside Safety and Physical Security Division - Proving Ground

Project #611801  Wyoming Box Beam Transition  2020-09-02

Drawn by GES  Scale 1:4  Sheet 16 of 16  Stiffeners and Gussets
ATTACHMENT 2

MGS Transition Test Installation Details
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.
Transition Details
Section views on next sheet

Plan View

Elevation View

Detail C

Field Side

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

Bolt, 7/8 x 2" hex A325 with Heavy Hex Nut and F436 Washers (2) 4 places

2" Guardrail Bolt with Rectangular Guardrail Washer 12 places

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

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

MGS Transition Attachment
Section Views

Section C-C
Typ @ Posts 13 - 17

12 gauge 8-space Thrie-beam x 2, nested
Steel Blockout

2" Guardrail Bolt 12 places

1-1/4" Guardrail Bolt 2 places
Bolt, 5/8 x 1 1/2" hex 2 places

78" Transition Post

Section D-D
Typ @ Posts 18 - 23

Section E-E
@ Post 12

14" Guardrail Bolt 2 places
Thriebeam, 12 gauge 75" span
Transition Blockout

14" Guardrail Bolt

10 gauge

Transition Blockout

Nail, 20d galvanized common x 4
Thrie- to W-beam Transition

2020-10-21

Drawn by GES  Sheet 3 of 9  Section Views
4a. All welding must be performed by certified welders using industry standard practices.

4b. Galvanize after fabrication is complete.
Main Plate is mirror image of the one on the Right Side.
All other components and details are identical.
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).
Attachment Parts

1. Tab
   - L 3 x 3 x 1/4 x 4"
   - ASTM A36

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

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

4. Side Stiffener
   - Plate, 3" x 1/4" x 19 11/16"
   - ASTM A36

5. Side Stiffener
   - Plate, 12" x 1/4" x 23 1/8"
   - ASTM A36
Transition Posts

78" Transition Post
W6x8.5 ASTM A36

72" Transition Post
W6x8.5 ASTM A36
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
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.

25" Guardrail Bolt

18" Guardrail Bolt

14" Guardrail Bolt

10" Guardrail Bolt

1-1/4" Guardrail Bolt

2" Guardrail Bolt
1a. Material is ASTM A 563 Grade A.
72" Wide-Flange Guardrail Post

Isometric View

Elevation View

W6x8.5
ASTM A992

Section A-A

Scale 1 : 3

Roadside Safety and Physical Security Division - Proving Ground

72" Wide-Flange Guardrail Post

Drawn by GES | Scale 1:10 | Sheet 1 of 1
Thrie to W-Beam, asymmetric

10 gauge

Section A-A
See Thrie-beam Drawing

Section B-B
See W-beam Drawing

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
W- to Thrie-beam, asymmetric

10 gauge

Section A-A
See W-beam Drawing

Section B-B
See W-beam Drawing
Thrie-beam End Shoe
10 gauge (0.1345" before galvanizing)

Elevation View

Isometric View

See Thrie-beam drawing for cross-section.
Thrie-Beam for Transition

Section A-A

Scale 1 : 5

12 gauge (0.1046 before galvanizing, 0.1084 after)
Rectangular Guardrail Washer
0.20" thick

Dimensional Details:
- Length: 3"
- Width: 1"
- Height: 1-3/4"
- Thickness: 3/4"
- Hole Diameter: 3/4"

Additional Information:
- Drawn by GES
- Sheet 1 of 1
- Scale: 2:1
- Date: 2019-08-08
- Texas A&M Transportation Institute
- Roadside Safety and Physical Security Division - Proving Ground
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.
### Table of Parts

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

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.
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
**DAT Parts sheet 2**

**Anchor Cable Assembly**

- Nut, 1" A563 heavy hex
- Washer, 1" F844
- Standard Swedge Fitting and Stud
- 3/4" 6x19 Cable

**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