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PROFESSIONAL RECOMMENDATION MEMORANDUM

Project Name: **Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States**

Sponsor: **Roadside Safety Pooled Fund**

Task 22-16: **Illinois Transition Angle for 2-Tube Bridge Rail Thrie Beam Transition**

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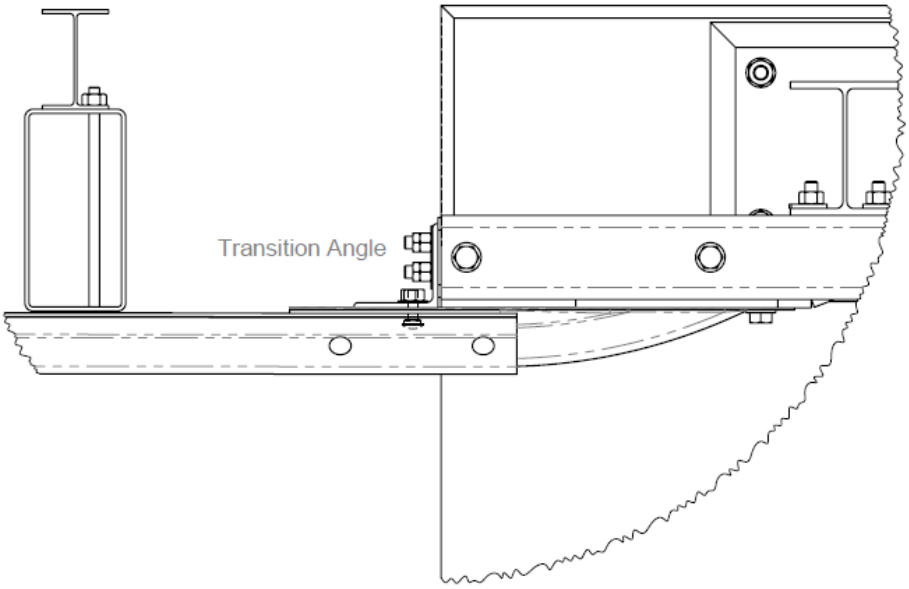
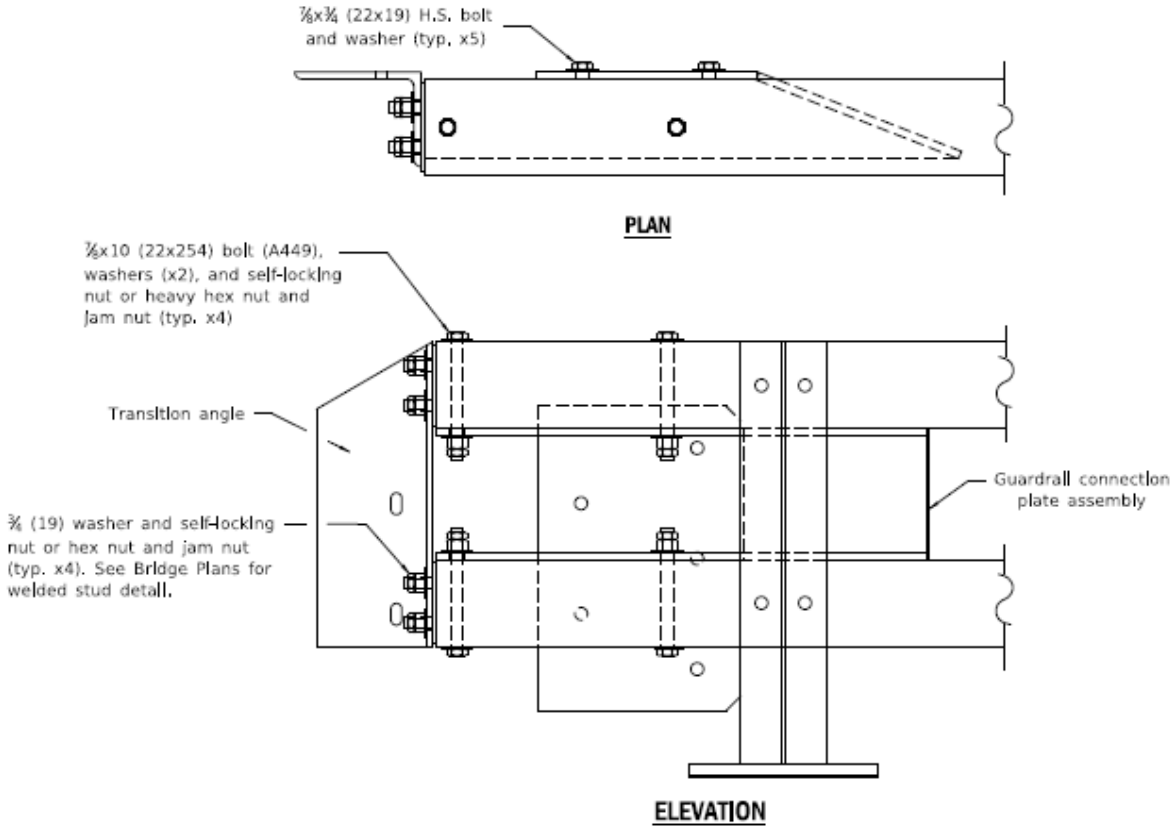
Overview/Problem Statement

The 2-tube bridge rail thrie beam transition with a transition angle of 5/16" thickness was previously crash tested by TTI (TTI Project 608331-4-6 [1]) and passed safety evaluation criteria for the MASH TL-3 [2]. Illinois DOT has used a transition angle thickness of 7/16" for a similar thrie beam transition system (Standard 631066). As shown in Figure 1, the bridge rail connection details of TTI crash tested and Standard 631066 are very similar but different in size and thickness. TTI researchers understand that Illinois DOT would prefer to use a L8"x6"x1/2" thick angle instead of the L5"x5"x5/16" thickness that was crash tested under TTI Project 608331-4-6. For this project, TTI researchers investigated the adequacy of two options for implementing a thicker transition angle in a 2-tube bridge rail thrie beam transition at the request of Illinois DOT. TTI researchers focused on this transition angle only, and other details of bridge rail transition connection are outside the scope of this professional opinion.



(a) TTI Crash-Tested Design Project 608331-4-6

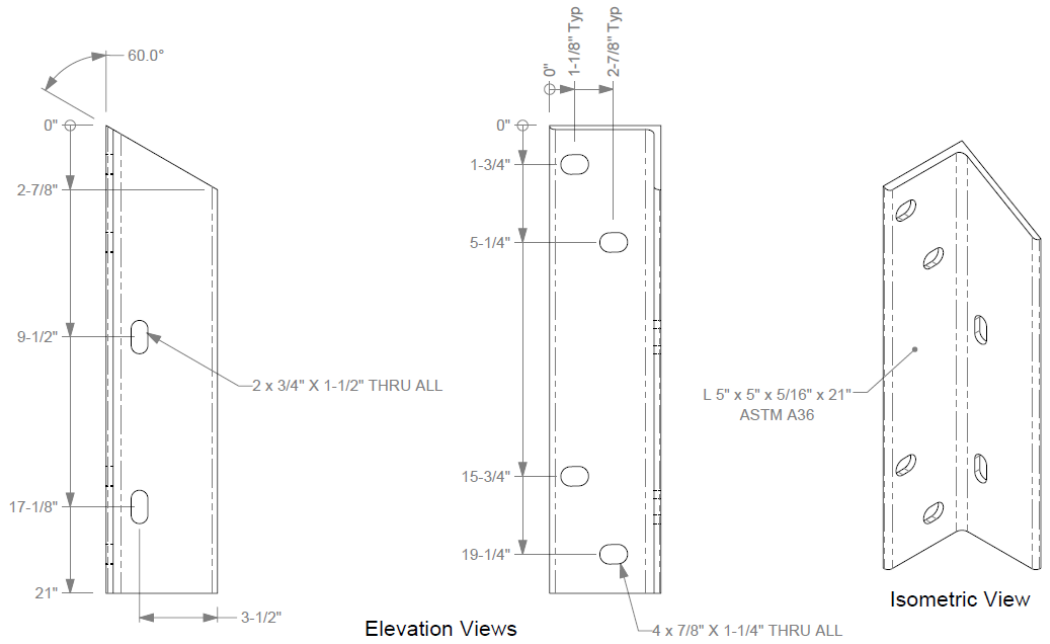


(b) Standard 631066

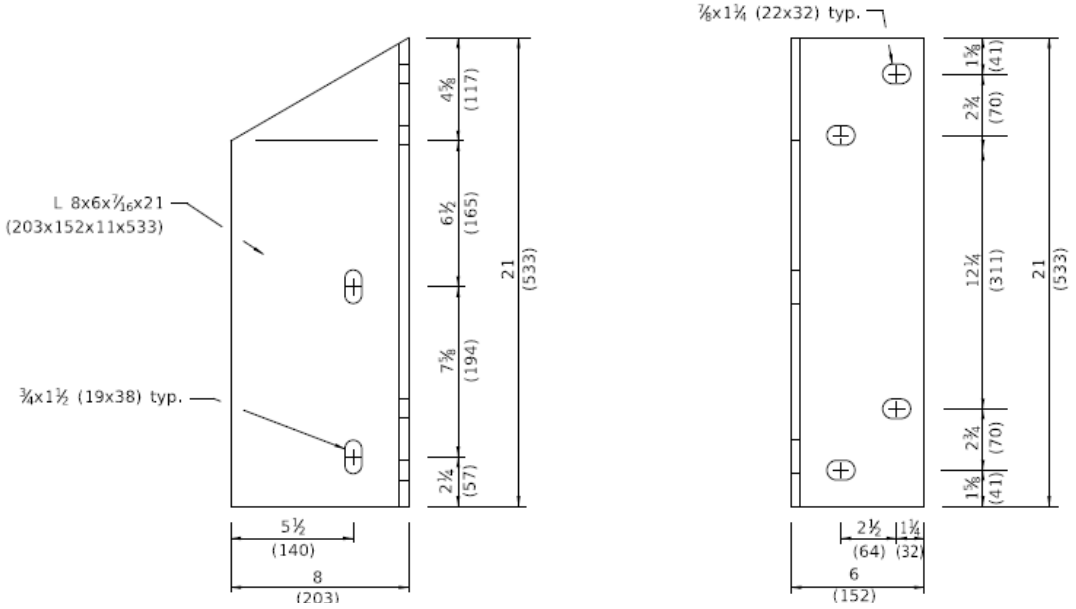
Figure 1. Comparison of Bridge Rail Connection Details

Figure 2 compares the (a) TTI crash tested and (b) Illinois DOT standard transition angles. As shown in the figure, while TTI crash-tested transition connection angle is made of L5"x5"x5/16" angle, the Illinois DOT Standard 631066 currently uses L8"x6"x7/16" but it is preferred to use a

½” thickness for better availability. The TTI researchers believe the use of larger angle size will not adversely affect the crash performance of the transition design. It is recommended that the same 60-degree angle slope be used for the L8"x6"x7/16" angle size. With this larger angle size and same top slope, it is our opinion that this proposed angle size is acceptable for MASH TL-3 criteria.



(a) TTI Crash-Tested Design (608331-4-6)



(b) Standard 631066

Figure 2. Comparison of Transition Angles

Because of availability, we understand that steel suppliers prefer to supply a L8"x6"x 1/2" angle size. Due to the increase in angle thickness, modification of the connection is preferred. Illinois DOT suggested two options, which are slight modifications from the Illinois Standard details.

These modifications are necessary to accommodate the increased angle thickness. These proposed modifications include:

1) Change the location of the two 3/4" x 1-1/2" holes (from the outer surface) from 5-1/2" to 5-9/16" to secure more space to accommodate the 5/8" bolt while reducing interference with other bolts.
2) Use an open-end wrench instead of a socket wrench to avoid too many chain reaction changes to our base sheets while maintaining the hole location.

The evaluation of each option is provided below.

Option 1: Figure 3 shows a transition angle considering the change in the location of the hole for the bolt. As shown in the figure, the location of the hole is only 1/16" away from the original location. This is a minor change. It is our opinion that such a slight change will not affect the structural performance of the angle. This location still is within tolerance of AISC requirements regarding the minimum edge distance and spacing (7/8" for 5/8" bolt, AISC Table J3.4 [3]). Thus, the change of hole locations is considered acceptable with respect to AISC connecting requirements.

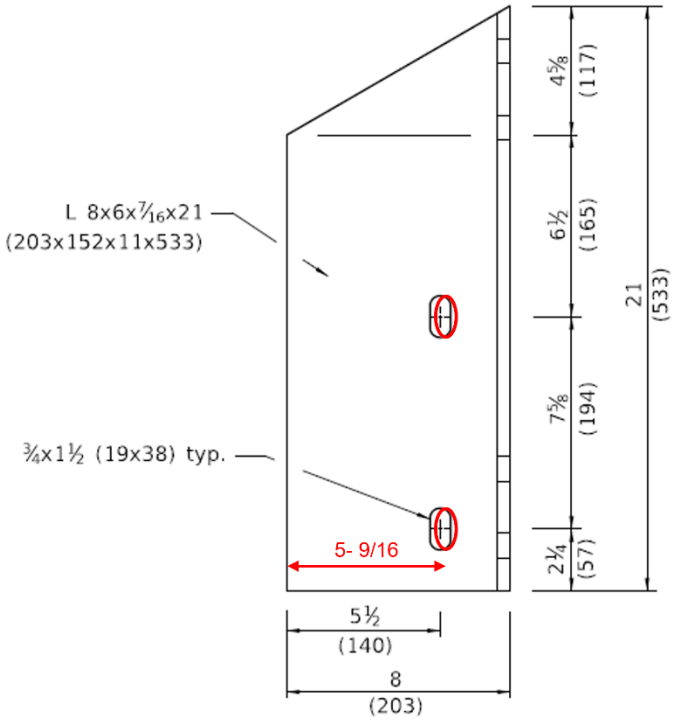


Figure 3. Change of hole location

Option 2: Figure 4 shows transition angle details with ¾-inch diameter bolts. As shown, both upper and lower connection bolts will likely have a tight connection tolerance due to the increased angle thickness. Please see the location of bolt holes shown in red below. The use of a socket

wrench will likely not be possible for both bolts. To facilitate making this connection, an open-end wrench can be used in lieu of a socket wrench. If an open-end wrench is used, it is recommended that sufficient tightening torque is used for both tightening options.

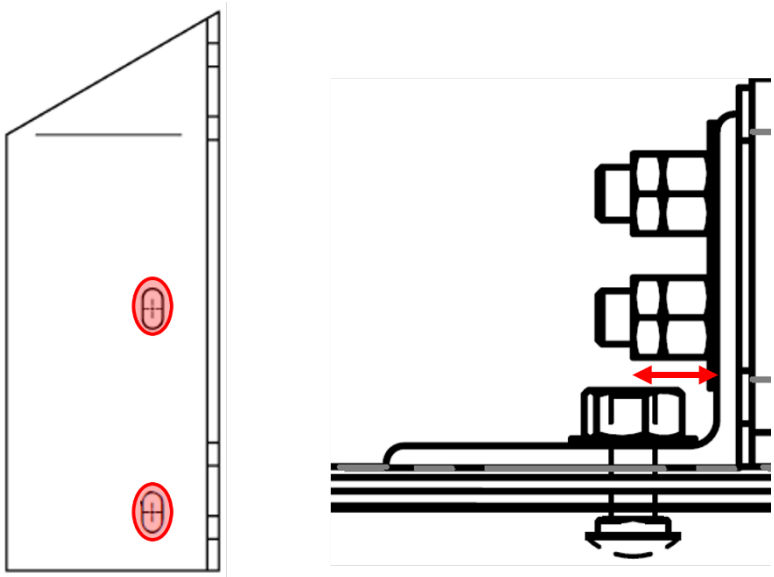


Figure 4. Transition angle details with bolts

Summary of Professional Opinion

1.) The use of the L8x6x1/2 angle in the transition with the 60-degree top slope like the angle crash test for TTI Project 608331-4-6 is acceptable for MASH TL-3.

2.) Both suggested options stated above to connect the angle to the transition components are acceptable for MASH TL-3.

References

[1] Williams, W. F., Menges, W. L., Schroeder, G. E., and Kuhn, D. L. (2020). "MASH TL-3 Evaluation of 2019 MASH 2-Tube Bridge Rail Thrie Beam Transition." Report No. 608331-4-6, Texas A&M Transportation Institute, College Station, TX.

[2] AASHTO. Manual for Assessing Roadside Safety Hardware, 2nd Edition. (2016). American Association of State Highway and Transportation Officials, Washington D.C.

[3] AISC. Steel Construction Manual, 15th Edition. (2017). American Institute of Steel Construction, Chicago, IL.