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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 21-08: **Lengthening Splice Bolt Slots in Thrie Beam Transition**

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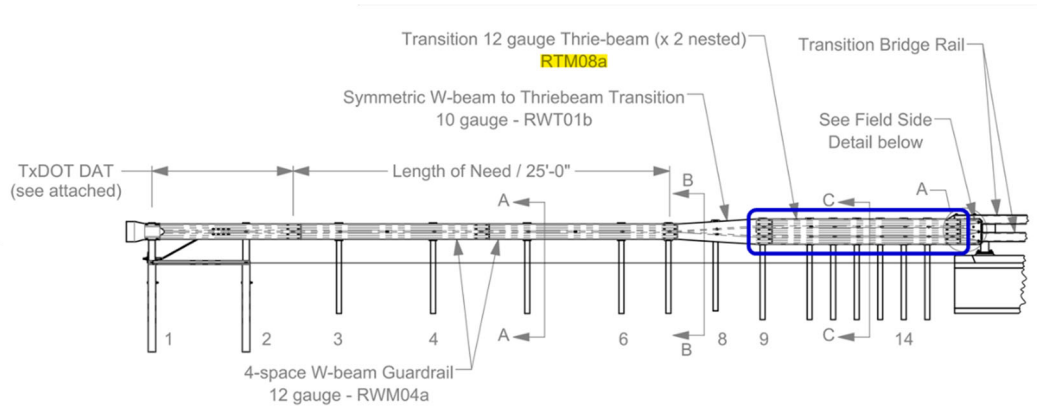
Overview/Problem Statement

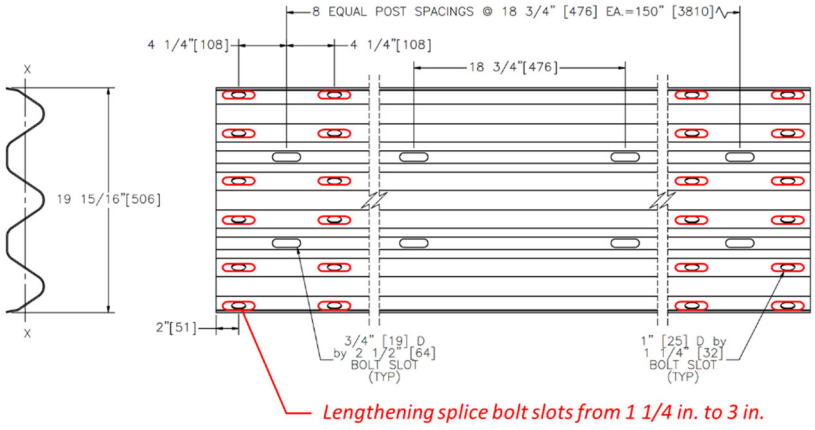
The purpose of this project was to investigate the lengthening splice bolt slots on thrie beam guardrail elements on the new Alaska 2-Tube Bridge Rail Transition (Test Report No. 608331-4-6). Figure 1 shows an overview of the bridge rail transition. The thrie beam guardrail highlighted in the figure has two lines of splice bolts at the connection ends. The original length of the slots for splice bolts is 1 1/4 in. Alaska DOT would like to increase the length of these slots to 3.0 inches to make it easier to install and construct the transition in the field.

Deformation of Thrie Beam Transition with Longer Slots

Figure 2 shows an enlarged view of the splice bolt in the slots for the different lengths. The thrie beam will subject to crash loads resulting in lateral and tension forces on the thrie beam rail element. Lengthening the length of the slots will accommodate more lateral displacement in the transition rail element before the tension force is transferred to adjacent rail elements. As shown in Figure 2, the excess travel of the guardrail bolt centered in the slot in thrie beam in original 1 1/4 in. long slots are 5/16 in. Whereas for the lengthened 3 in. long slot, the possible travel is 1 3/16 in. More travel of the thrie beam will induce more deformation of the thrie beam at the center of the span. Figure 3 depicts the theoretical lateral deformation of the thrie beam at the center of the span for the two different lengths of slots. The deformed thrie beam is simplified as a triangular shape.



(a) Overview



(b) Thrie beam transition

Figure 1. Schematic of Bridge Rail Transition

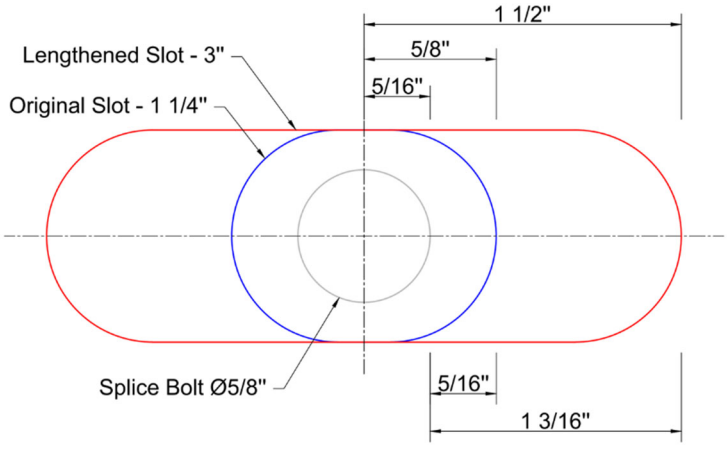


Figure 2. Possible Travel in Slots

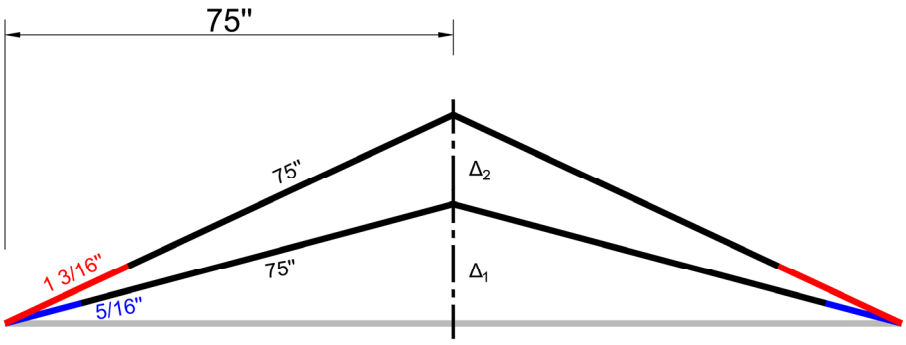


Figure 3. Deformation of Thrie Beam with Different Length of Slots

The deformation of the thrie beam, Δ_1 and Δ_2, can be calculated as:

$$\Delta_1 = \sqrt{(75 + 5/16)^2 - (75)^2} = 6.85\ in.$$

$$\Delta_1 + \Delta_2 = \sqrt{(75 + 1\ 3/16)^2 - (75)^2} = 13.4\ in.$$

$$\Delta_2 = 13.4\ - 6.85 = 6.55\ in.$$

As shown, lengthening the slots from 1 1/4 in. to 3 in. will increase the deformation of the thrie beam by 6.55 in. at the center of the span. The deformation of the thrie is almost doubled with the longer slots. Therefore, lengthening the splice bolt slots to 3 in. could adversely affect the crash performance of the as-tested thrie beam transition.

End Distance of Thrie Beam Transition

The end distance from the slot hole to the end tip, as shown in Figure 4, could be another issue affecting the performance of the thrie beam transition. The end distance with the lengthened slot hole will be decrease to 1/2 in. from 1 3/8 in, which could be critical when considering the manufacturing tolerance of ± 1/2 in.

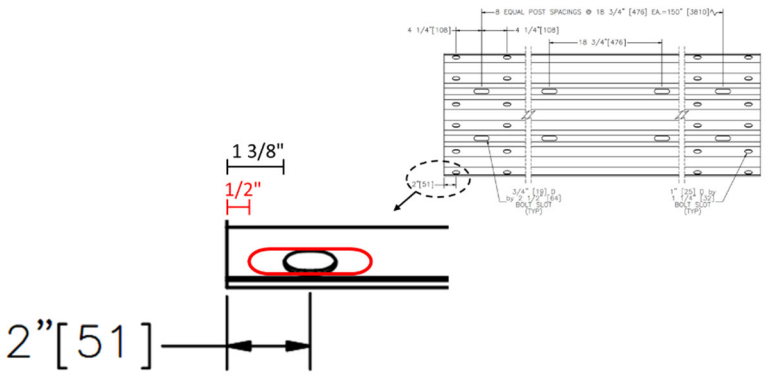


Figure 4. End Distance of Thrie Beam Transition with Lengthened Slot Hole

Summary and Recommendations

Based on this analysis, the lengthened splice bolt slots will induce almost doubled deformation to the thrie beam. Also, the end distance from the slot hole to the end tip of the thrie beam will be decreased to 1/2 in. with lengthened slot holes. Therefore, it is not recommended to use the long slots for this thrie beam transition without performing full-scale crash testing in the immediate transition area for both the small car and pickup truck tests (MASH Test 3-20 and 3-21, respectively).