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W-BEAM GUARDRAIL TRANSITION POSTS IN FLUME ADJACENT TO BRIDGE RAIL

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Introduction

This document provides an opinion on installation of some of the guardrail posts located in the transition region of Tennessee Department of Transportation's (TDOT) W-beam to concrete parapet transition in flume instead of soil. Flume material is generally stiffer than the soil material used in American Association of State Highway Transportation Officials' (AASHTO) Manual for Assessing Safety Hardware (MASH) crash test evaluation of guardrail transitions. By installing these posts in flume, there are concerns about changing the deflection behavior of these posts and the guardrail in a manner that can negatively influence the crash performance of the transition.

TDOT's standard W-beam guardrail to concrete parapet transition design is shown in Figure 1 (TDOT Standard S-GRC-4). It is comprised of the W-beam guardrail system transitioning to a nested thrie beam guardrail section via a shape transition section. The nested thrie beam section is then attached to the concrete parapet. The post spacing is reduced over the span of the transition such that the six posts adjacent to the concrete parapet are installed with 18.75-inch quarter post-spacing (Figure 1). These posts are installed with an embedment depth of 64 inches.

Figure 2 shows the five posts adjacent to the concrete parapet that need to be installed in the flume material. The effect of these posts being installed in flume instead of soil is assessed herein.

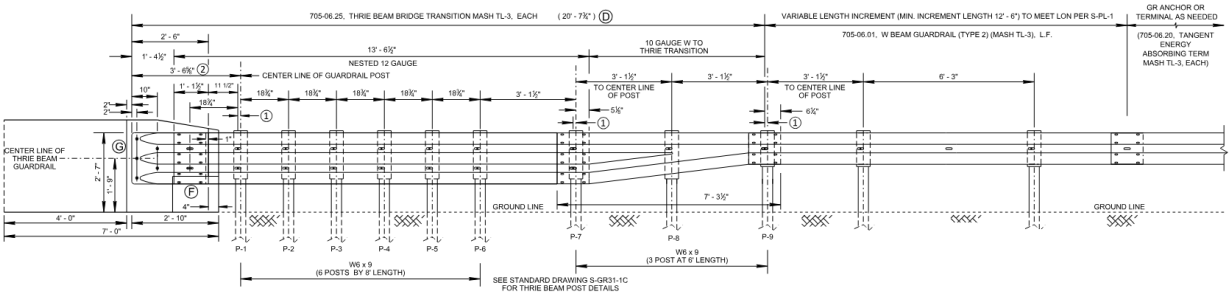

Figure 1. TDOT Guardrail Transition to Concrete Parapet for Highspeed Roadways – Standard S-GRC-4.

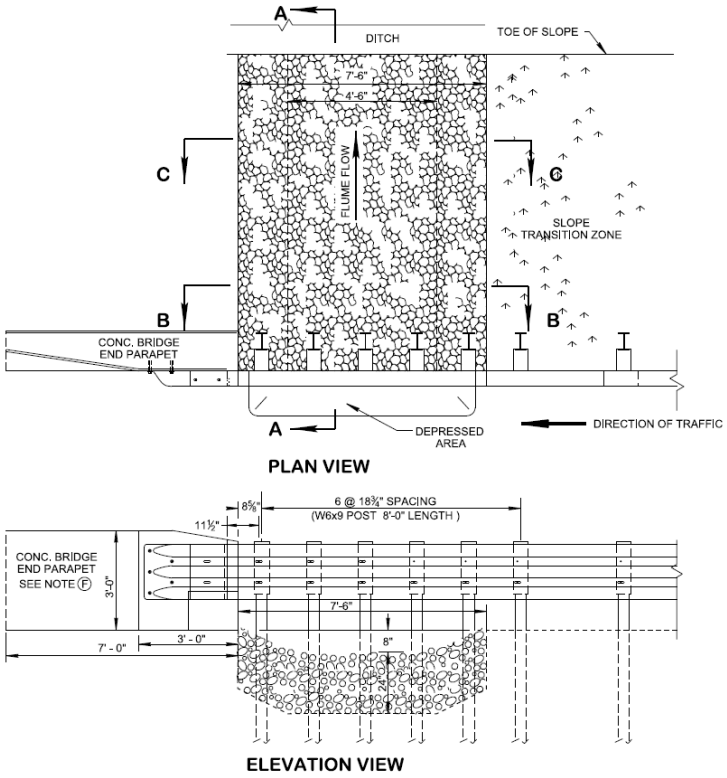

Figure 2. Modification of the Standard Transition Design with Posts Installed in Flume.

Crashworthiness Assessment

To assess the effect on MASH Test Level 3 (TL-3) performance of the W-beam guardrail to concrete parapet transition due to the posts being installed in flume, the research team reviewed MASH Test 3-21 performed with a similar transition design by Midwest Roadside Safey Facility (MwRSF), Test AGTB-1 (*1*). Test 3-21 involves impacting the transition with a 5,000-lb pickup truck at an impact speed and angle of 62 mph and 25 degrees, respectively. In the MwRSF test, posts adjacent to the concrete parapet were installed in standard MASH soil and were embedded 49 inches. The top of the thrie beam rail was at 31 inches, as in the TDOT system. The concrete parapet design was also similar to the one used in TDOT's standard.

Figure 4 shows the damage to the transition system adjacent to the concrete parapet after the MASH Test 3-21. Very little lateral movement or rotation of these posts was observed in the test. Due to the tighter post spacing in the transition region upstream of the concrete parapet, the guardrail deflection in this region was not significant. This implies that if the posts are stiffened further by replacing the soil material around the posts with stiffer flume material, the effect on transition deflection would be minimal. In this region of the transition, lateral deflection of the guardrail is minimized by design. Adding more stiffness to the posts is not likely to change the performance of the transition.

Figure 4. Transition Damage After Test 3-21 (Source: MwRSF Report TRP-03-369-20).

For the reasons described above, it can be concluded that by installing the five posts adjacent to the concrete parapet in flume, as shown in Figure 2, the crash performance of the guardrail to concrete parapet transition design is not expected to deteriorate.

For low-speed highways with Test Level 2 (TL-2) service level, TDOT has a shorter W-beam transition standard, shown in Figure 3 (TDOT Standard S-GRC-6). The thrie beam section in this case is much shorter compared to the TL-3 system.

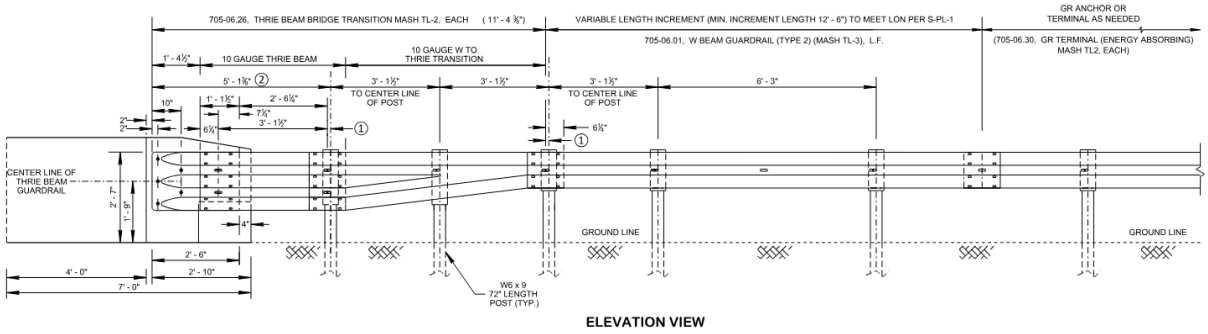

Figure 3. TDOT Guardrail Transition to Concrete Parapet for Low Speed Roadways – Standard S-GRC-6.

For this system, the posts adjacent to the concrete parapet are in the region of the upstream approach transition where the W-beam section transitions to the thrie beam section via a shape transition section. This upstream transition section has been tested at MASH TL-3 and there was lateral movement of the posts observed in the MASH testing (*2*). While acknowledging that the TL-2 impact speed is significantly less than the TL-3 impact speed (45 mph vs. 62 mph), since this upstream transition has not been tested with stiffer posts, it is not recommended to install posts in flume in this region without further crash testing.

If the TL-2 transition is extended by adding additional nested thrie beam section and posts installed in flume downstream of the post shown adjacent to the concrete parapet in Figure 3, the modified system would be considered MASH TL-2 compliant. Addition of the posts in flume downstream

from the W-beam to thrie beam shape transition is not expected to negatively impact the performance of the transition at TL-2 speeds.

Conclusions

Based on the discussion presented herein, it can be concluded that installing the five posts adjacent to the concrete parapet in flume material, as shown in (Figure 2) is not expected to deteriorate the crashworthiness performance of the transition system. For lower-speed design of the transition (Figure 3), additional nested thrie beam section should be added adjacent to the concrete parapet, and only the posts in this additional section may be installed in flume to retain the crashworthiness performance of the upstream W-beam to thrie-beam transition.

References

[1] Rosenbaugh, S.K., R.K. Faller, N. Asselin, and J.A. Hartwell, Development of a Standardized Buttress for Approach Guardrail Transitions, Report No. TRP-03-369-20, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, Nebraska, November 2020.

[2] Rosenbaugh, S.K., K.A. Lechtenberg, R.K. Faller, D.L. Sicking, R.W. Bielenberg, and J.D. Reid, Development of the MGS Approach Guardrail Transition Using Standardized Steel Posts, Report No. TRP-03-210-10, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, Nebraska, December 2010.