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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 22-18: **WSDOT Low-Profile Median Barrier Evaluation**

DATE: **March 2023**

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Overview/Problem Statement

The Washington State Department of Transportation (WSDOT) is seeking to obtain MASH TL-2 acceptance for its permanent low-profile median barrier system, as illustrated in Figure 1. This system is composed of two back-to-back 32-inch-tall low-profile sections, as shown in Figure 2. The barrier sections are embedded 1 foot into the soil, with compacted soil filling the space between them. The total height of the barrier above the roadway is 20 inches.

As it is presented in Figure 2, one key feature of this barrier system is its negative slope profile shape on the traffic side. This design is intended to help redirect vehicles away from the barrier in the event of a collision, which can help to mitigate the severity of the impact and prevent more serious accidents from occurring. The barrier is reinforced with #4 rebars spaced at a maximum of 18 inches throughout the wall. The maximum distance between the expansion joints is 36 feet (Figure 3).

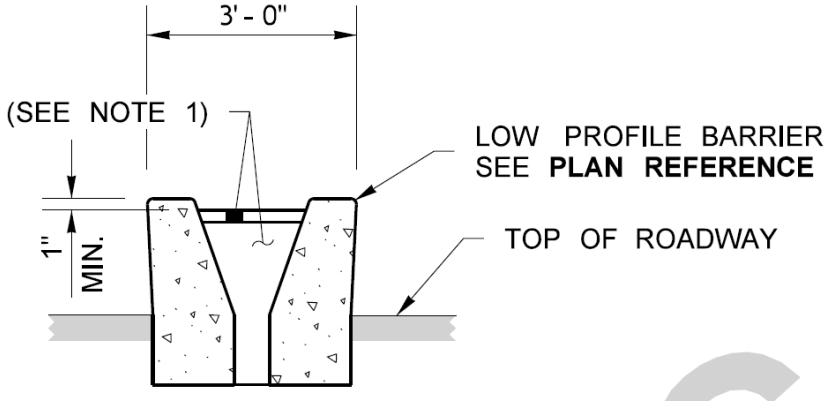

Figure 1 WSDOT Typical Low-Profile Median Barrier.

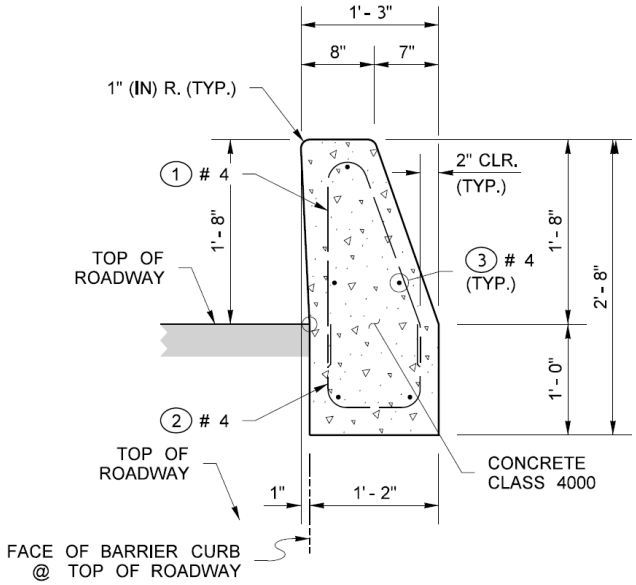

Figure 2 WSDOT Low-Profile Barrier Cross Section.

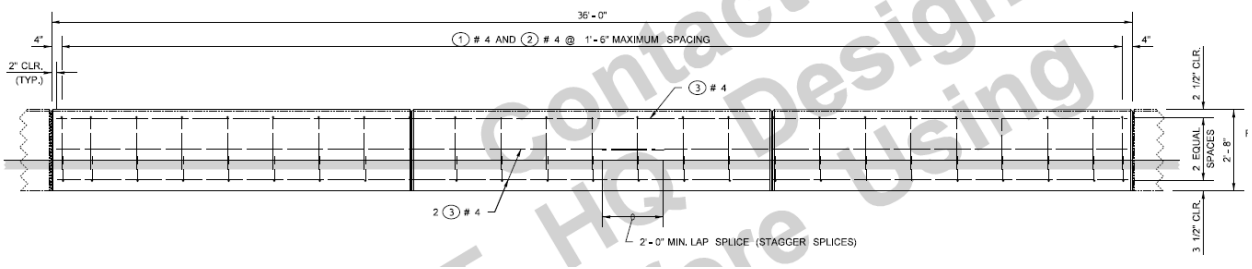

Figure 3 WSDOT Low-Profile Barrier Elevation View.

Evaluation

The WSDOT permanent low-profile barrier has not undergone MASH Test 2-10 and 2-11, while both tests have been successfully performed on the Florida Department of Transportation (FDOT) permanent low-profile barrier (1). Despite this difference, the WSDOT barrier, which stands at a height of 20 inches, satisfies the minimum height requirements for MASH TL-2. It is worth noting that the FDOT barrier's cross-sectional profile is more critical in terms of vehicle stability than the negative slope face of the WSDOT barrier. Nevertheless, the WSDOT permanent low-profile barrier is deemed satisfactory in terms of its profile shape.

However, the crucial criterion for evaluating the system is its structural adequacy. The WSDOT barrier is slightly under-reinforced when compared to the FDOT barrier. Therefore, a comprehensive analysis of the wall strength has been conducted by TTI researchers based on the American Association of State Highway and Transportation Officials (AASHTO) Load and Resistance Factor Design (LRFD) Section 13 Bridge Design Specifications (2). This analysis provides an assessment of the WSDOT barrier's ability to withstand the impact forces of a vehicle with respect to MASH TL-2 criteria.

According to the LRFD analysis, the WSDOT low-profile barrier is structurally adequate at the mid-wall region when 18-inch vertical rebar spacing is used. However, the analysis has identified that the end of the wall, particularly the area close to the joints, may require additional reinforcement to ensure adequate strength.

To provide the necessary structural support to the end of the wall, it is recommended to reduce the spacing between the vertical reinforcement elements to a maximum of 11 inches. The reduction in spacing should begin at a distance of 5 feet from the end of the wall segment (expansion joints). This will allow for the proper formation of a yield line, which is critical in ensuring the structural strength of the wall in this area.

In addition to the design features mentioned earlier, the WSDOT low-profile median barrier system has also been evaluated for its ability to withstand sliding and overturning upon impact. To ensure that the system meets MASH TL-2 standards, a method presented in NCHRP Project 22-20(02) was utilized (3).

The results of these assessments indicate that the system is more susceptible to overturning than sliding forces during impact. The minimum sliding length and minimum overturning length of the low-profile barrier system were calculated to be 27 ft and 30 ft, respectively. Therefore, to

provide a stable response to a MASH TL-2 impact, a minimum segment length of 30 ft between expansion joints is required to resist the overturning of the system during impact.

Summary

WSDOT requested a thorough evaluation of its permanent low-profile median barrier system to ensure that it meets the required safety standards under the MASH TL-2 evaluation criteria.

The analysis, conducted using LRFD methods, determined that the barrier is structurally sound and can withstand the required MASH test level 2 impact conditions at the mid-wall region. However, the analysis revealed that the end of the barrier requires additional reinforcement to ensure adequate strength. In particular, it was recommended that the spacing between the vertical reinforcement be reduced from the current maximum of 18 inches to a maximum of 11 inches to achieve the required level of reinforcement.

Aside from structural adequacy, the evaluation also examined the potential for sliding and overturning during MASH TL-2 impact. The study concluded that the system could be stabilized by ensuring a minimum length of 30 feet between expansion joints. By meeting this criterion, concerns regarding overturning the wall were eliminated, making the system a viable solution for improving safety on Washington State's highways.

References

1. C.S. Dobrovolny, M. Kiani, W. Schroeder, and D.L. Kuhn, Evaluation of a TL-2 Permanent Low-Profile Barrier, Report No. 616151, Texas A&M Transportation Institute, August 2022.
2. AASHTO LRFD Bridge Design Specifications, Seventh Edition, 2014.
3. Bligh, R.P., J.L. Briaud, A. Abu-Odeh, D.O. Saez B., L.S. Maddah, and K.M. Kim. Design Guidelines for Test Level 3 (TL-3) Through Test Level 5 (TL-5) Roadside Barrier Systems Placed on Mechanically Stabilized Earth (MSE) Retaining Wall. NCHRP Project No. 22-20(2). Texas A&M Transportation Institute, College Station, Texas, 2017.