Engineering Support Services and Recommendations for Roadside Safety Issues or Problems for Member States

Pooled Fund Program TPF-5(343)

Task Order TPF4541-ER , TTI Project 617731

Engineering Opinion No. 202402A

MASH TL-3 COMPLIANCE OF 50-INCH TALL FREE-STANDING F-SHAPE PORTABLE CONCRETE BARRIER

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March, 2024

Introduction and Objectives

This report provides an assessment of a 50-inch tall free-standing and unrestrained F-shape portable concrete barrier (PCB) system with regards to its compliance with American Association of State Highway Transportation Officials' (AASHTO) Manual for Assessing Safety Hardware (MASH) for Test Level 3 (TL-3). This assessment was made based on past crash testing.

System Overview and Scope

Pennsylvania Department of Transportation (PennDOT) currently uses a 54-inch tall F-shape PCB system that is restrained by embedding 4 inches in pavement. This PCB system is comprised of 12-ft to 50-ft long barrier segments which are interconnected with a pin-and-loop connection. The pin-and-loop connection is comprised of three sets of three loops that are connected using a 1-inch diameter steel pin that passes through them. The barrier system in Figure 1 presents the key details of the embedded system and further details can be found in the Attachment A.

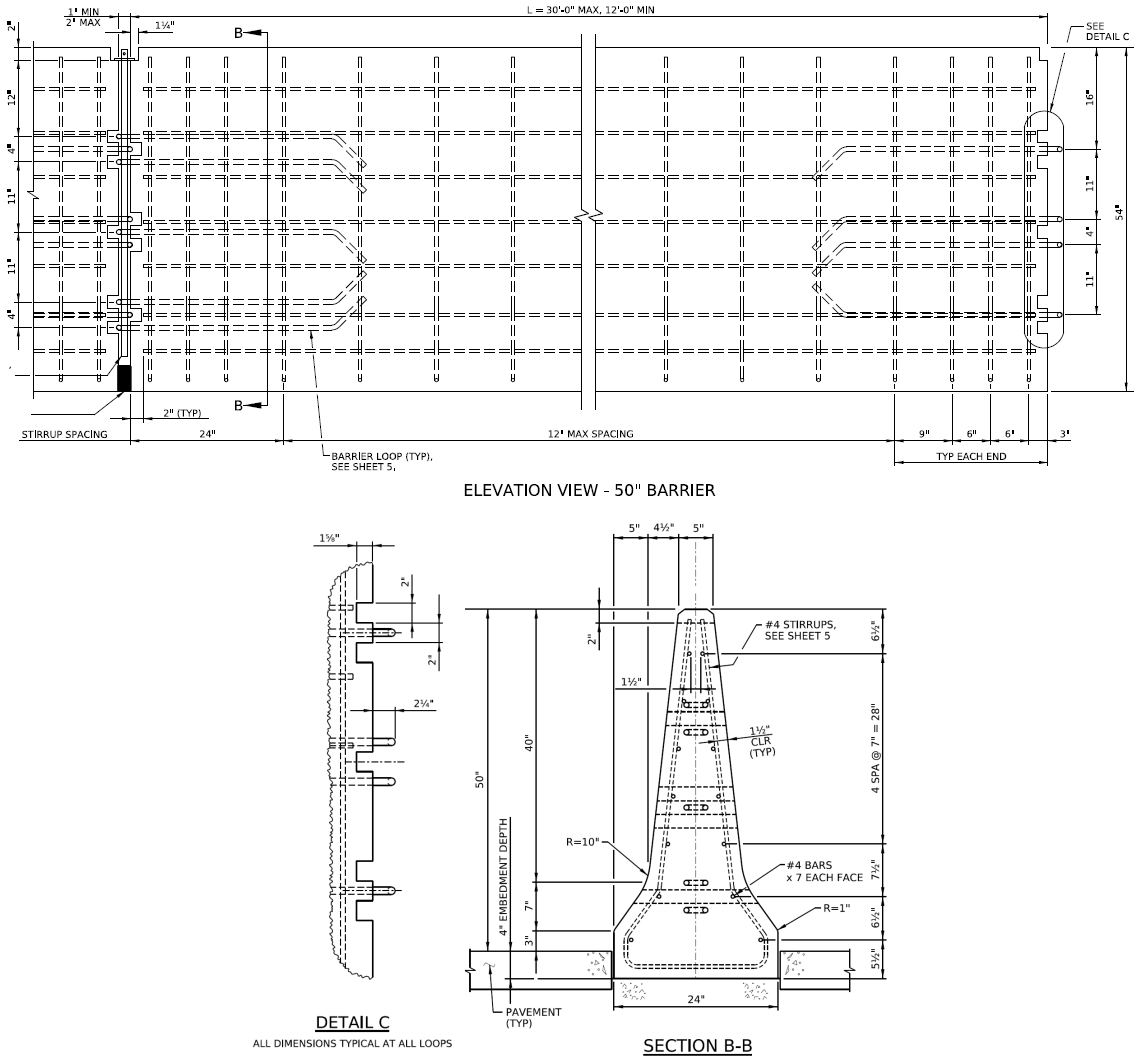


Figure 1. PennDOT's embedded 54-inch PCB system to be modified to achieve the 50-inch tall free-standing PCB system.

PennDOT desires to use a modified version of this embedded 54-inch tall barrier segment by shortening it to a 50-inch tall barrier. This reduction in height is to be achieved by eliminating the bottom 4 inches of the 54-inch barrier segment that is currently used while embedded in asphalt. The resulting 50-inch barrier segment will have the same profile as the above-grade profile of the 54-inch tall embedded barrier. Furthermore, the 50-inch barrier segments will be installed unrestrained without any embedment. Figure 2 shows the cross-section of the desired 50-inch tall barrier segment. Note that the reinforcement design will be changed by PennDOT to adjust for the height reduction. The above-grade heights of the connection loops, however, will remain the same as in the 54-inch tall barrier segment.

PennDOT would like to use this modified 50-inch tall free-standing PCB system as a MASH TL-3 system. This PCB system has not been crash tested. However, crash test results of other similar MASH TL-3 tested barrier systems can be used to justify the MASH compliance of the 50-inch tall free-standing PCB, as discussed in this report.

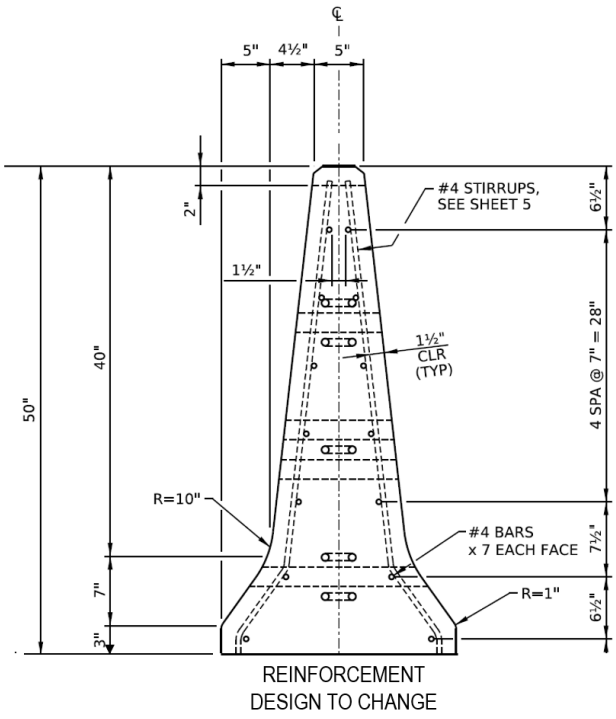


Figure 2. Cross-section of the 50-inch tall free-standing segment considered for MASH TL-3 compliance.

MASH Compliance Assessment

MASH TL-3 criteria for longitudinal barriers requires performing Test 3-11 (5,000-lb pickup truck impacting the barrier at 62 mph speed and 25-degree angle) and Test 3-10 (2,270-lb small passenger car impacting the barrier at 62 mph speed and 25-degree angle).

Texas A&M Transportation Institute (TTI) performed MASH Test 3-11 and Test 3-10 with a 32-inch tall F-shape PCB system that was comprised of 12.5-ft long barrier segments *(1)*. The barrier segments were 32-inches tall, 24 inches wide at the base, 9.5 inches wide at the top, and had the standard F-shape profile. Adjacent barrier segments were connected using 1-inch diameter connecting pins that passed

through steel loops protruding out of the barrier segments. The barrier connection had two set of three loops at each joint. The barrier was tested as a free-standing, unrestrained system. This barrier performed acceptably for MASH Test 3-11 and Test 3-10.

Even though the desired PennDOT PCB system has taller 50-inch barrier segments, the profile of the barrier segments is comprised of approximately the same slopes, bottom width, and toe design as the 32-inch tall barrier tested by TTI. Due to the similarities in the barrier profile, the kinematics of the impacting vehicle during redirection is expected to be similar to the previously tested 32-inch tall barrier system.

The greater height of the 50-inch barrier segment results in more mass per segment compared to the tested PCB system with the 32-inch tall barrier segments. This is likely to result in greater stability and reduced deflection of the barrier system due to an impact. The barrier system tested by TTI had 12.5-ft long segments, whereas PennDOT intends to use segment lengths ranging from 12 ft to 20 ft. For segment lengths greater than 12.5-ft, the 50-inch tall segments will result in more mass per segment and lesser number of joints over the length of the system. These changes are expected to increase the stability of the barrier system and have a positive influence on the performance of the barrier. For 50-inch barrier segments that are 12 ft to less than 12.5 ft long, the higher mass of the 50-inch barrier segment is expected to compensate for the small reduction in the segment length compared to the crash tested 12.5-ft segment length. Furthermore, another tested PCB system with a 12-ft barrier segment length has passed MASH TL-3, which implies that the 0.5-ft reduction in barrier segment length is not likely to deteriorate the PCB system's MASH performance (*2*).

The 50-inch barrier segment design incorporates a third set of loops in the barrier connection. The previously performed test with the 32-inch barrier segments had two sets of loops in the connection. The addition of a third set of loops in the 50-inch barrier segment design is expected to increase the stiffness of the barrier connection compared to the previously tested barrier. Consequently, this change is not expected to deteriorate the performance of the barrier in comparison to the previously tested barrier system.

Conclusion

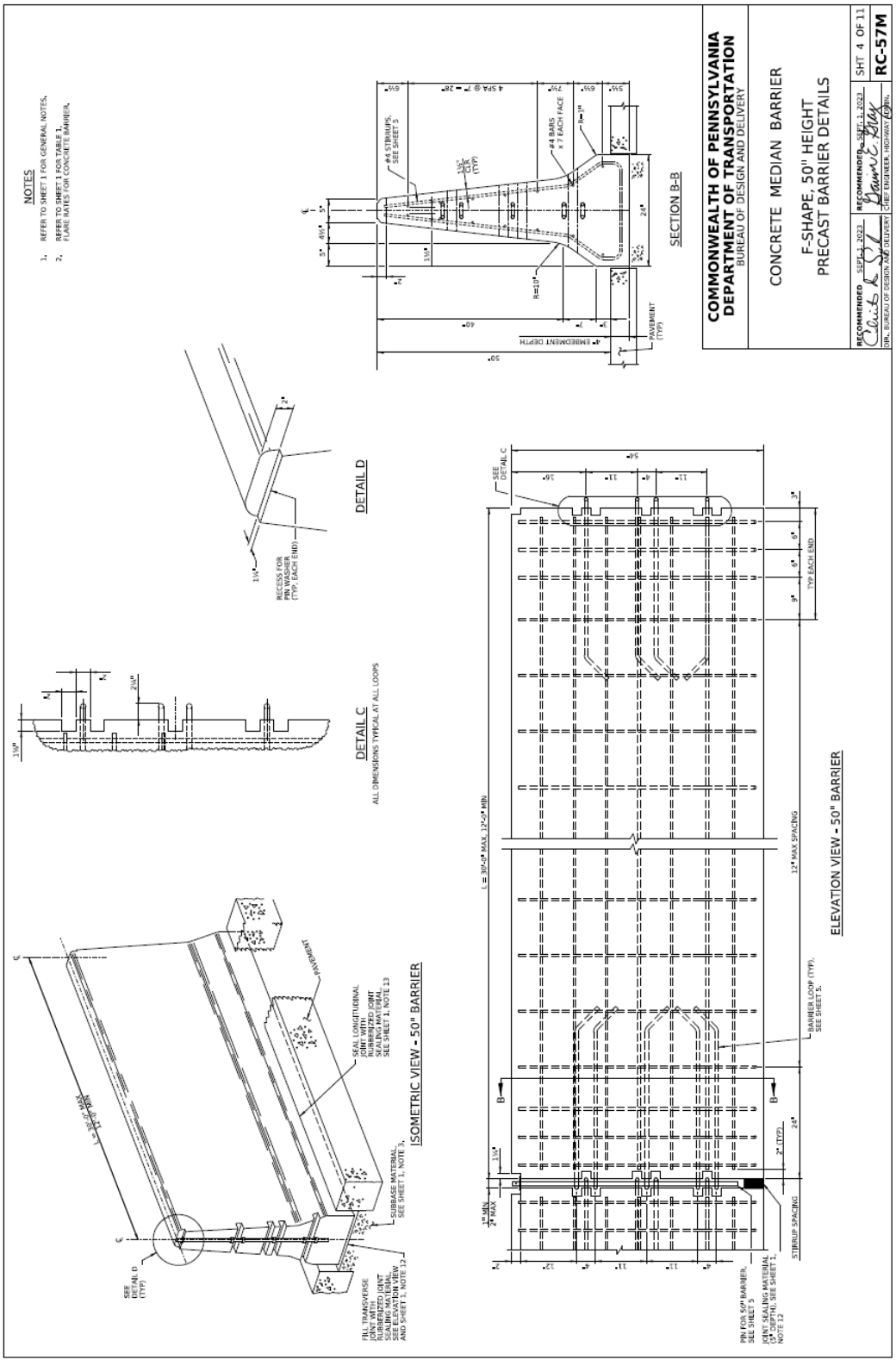
Based on the design review of PennDOT's desired 50-inch tall pin-and-loop PCB system and it's similarities to the previously crash tested PCB systems described herein, it is the assessment of the research team that the free-standing 50-inch tall pin-and-loop system of Figure 2 can be considered MASH TL-3 compliant. The reinforcement shown in Figure 2 is expected to change to accommodate the 50-inch segment height. The vertical (above-grade) placement of the connection loops, however, should be maintained as shown in Figure 1 and Figure 2.

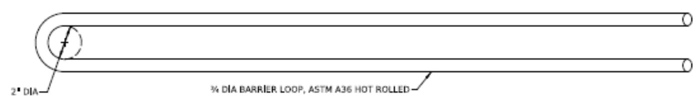
References

[1] N.M. Sheikh, W.L. Menges, and D.L. Kuhn, "MASH TL-3 Testing and Evaluation of Free-Standing Portable Concrete Barrier." Texas A&M Transportation Institute, Report 607911-1&2, College Station, Texas, 2017.

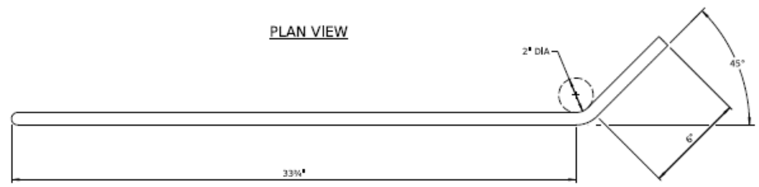
[2] FHWA Eligibility Letter HSST-1/B-300, Federal Highway Administration, Dated February 9, 2018.

ATTACHMENT A





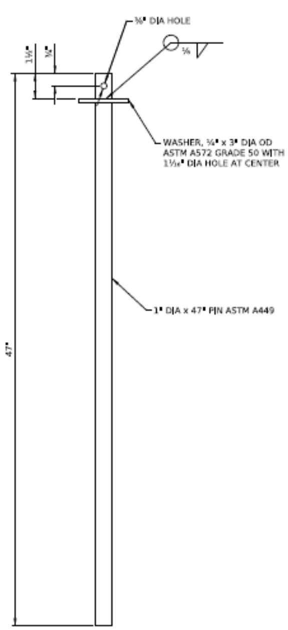
PLAN VIEW



ELEVATION VIEW

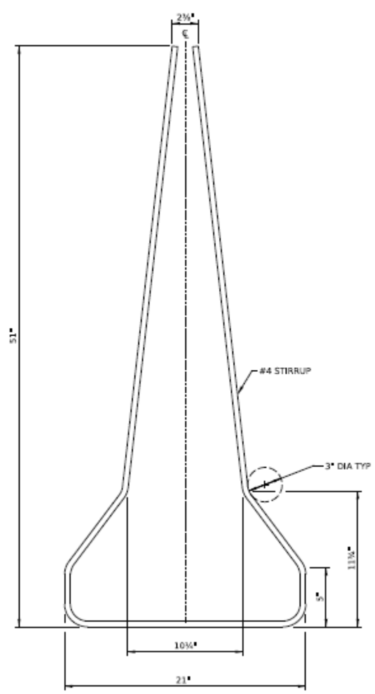
BARRIER LOOP

SEE NOTE 1



PIN FOR 50" BARRIER

SEE NOTE 2



STIRRUP FOR 50" BARRIER

SEE NOTE 3

NOTES

1. GALVANIZE BARRIER LOOP AFTER BENDING AS SPECIFIED IN PUBLICATION 408, SECTION 1105.02(s).
2. GALVANIZE PIN AND WASHER AFTER ALL FABRICATION IS COMPLETE AS SPECIFIED IN PUBLICATION 408, SECTION 1105.02(s).
3. FABRICATE REINFORCEMENT BARS AS SHOWN ON STANDARD DRAWING BC-736M, PUBLICATION 219M.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION
BUREAU OF DESIGN AND DELIVERY

CONCRETE MEDIAN BARRIER

F-SHAPE, 50" HEIGHT
PRECAST PARTS

RECOMMENDED SEPT. 1, 2023	RECOMMENDED SEPT. 1, 2023	SHT 5 OF 11
[signature] DIR., BUREAU OF DESIGN AND DELIVERY	[signature] CHIEF ENGINEER, HIGHWAY ADMIN.	**RC-57M**

FILE NAME: pw://PDEDCTNAPPW02.dev.penndot/Jd:TRN_DEVELOPMENT/Documents/WORKSETS/Standards/ORD RC Standards/rc-57m.dgn

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