TECHSUMMARY *July 2023*

State Project No. DOTLT1000464 | LTRC Project No. 23-1ST

MASH TL-4 Engineering Analyses and Detailing of 36-Inch and 42-Inch High Median Barriers for LADOTD

INTRODUCTION

Single-slope median barriers are currently planned for several bridges in Louisiana. These new median barriers need to meet the safety performance criteria of the *2016 American Association of State Highway and Transportation Officials (AASHTO) Manual for Assessing Safety Hardware (MASH) Test Level 4 (TL-4)* specifications. For this project, both 36-in. high and 42-in. high single-slope median barriers are being considered. The 36-in. high single-slope design initially received for this project is shown in Figure 1. The proposed design shown in Figure 1 is similar in profile and height to the Texas Department of Transportation (TxDOT) single-slope traffic rail (SSTR), which was successfully crash tested to MASH TL-4 specifications in July 2010 (Texas A&M Transportation Institute Project 420020-9). The Louisiana Department of Transportation and Development (DOTD) has incorporated the TxDOT SSTR bridge rail height and profile for the median barrier design shown in Figure 1. A similar 42-in. high median barrier will also be used for this project. The same slope used for the 36-in. barrier will be used for the 42 in. high barrier, but the top width of the 42-in. high barrier will be reduced to 7 5/8 in. The profile, geometry, and reinforcing steel will also be similar for the 42-in. high median barrier—only taller. Two extra longitudinal bars will be used for the 42-in. median barrier.

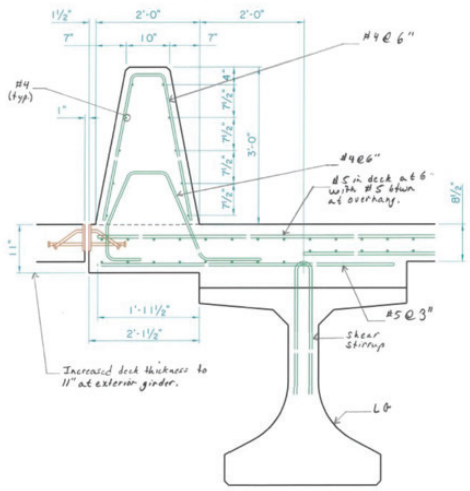

Figure 1. Proposed 36-in. median barrier design

OBJECTIVE

The objective of this research was to analyze the strengths of the four proposed retrofit designs considered for this project in accordance with AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications Section 13 for MASH TL-4 impact conditions. These designs are briefly described below and shown in Figure 1 (36-in. median barrier):

1. A 36-in. single-slope median barrier without the longitudinal open joint (as shown in Figure 1 except no longitudinal open joint).
2. A 36-in. single-slope median barrier with the longitudinal open joint (as shown in Figure 1).
3. A 42-in. single-slope median barrier without the longitudinal open joint (same as Figure 1 except 42 in. tall and 7 5/8 in. wide at top).
4. A 42-in. single-slope median barrier with the longitudinal open joint (same as Figure 1 except 42 in. tall and 7 5/8 in. wide at top).
5. Recommendations and improvements were made as necessary based on the analyses performed for this project to enhance the strength and performance of the barrier designs for MASH TL-4 impact conditions.

SCOPE

The scope of this project was to provide engineering analyses and details on the proposed retrofit designs and to prepare a technical report of the findings. A brief discussion of the tasks is presented below.

Task 1—Engineering Analysis and Details

For this task, engineering strength analyses were performed on the four proposed retrofit designs considered for this project in accordance with AASHTO LRFD Section 13 specifications for MASH TL-4 impact conditions. These designs are as follows:

1. An engineering strength analysis was performed using a 36-in. single-slope median barrier without a longitudinal open joint in the deck. The analysis considered an 8.5-in. thick deck supported between two concrete girders spaced 8 ft. on the centers. The barrier was anchored to the deck in the center between the two concrete girders. Additional information on the details and strength calculations is provided in the report.
2. Two engineering strength analyses were performed using a 36-in. single-slope median barrier with a longitudinal open joint in the deck similar to that shown in Figure 1. The analyses considered an 11-in. thick deck cantilever. The deck cantilever was 4 ft. 1½ in. wide from the centerline of the

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exterior girder to the edge of the deck. The barrier was anchored to the deck 1½ in. from the edge of the deck cantilever near the longitudinal joint. Two strength analyses were performed considering crash impact loading on each side of the barrier. Additional information on the details and strength calculations is provided in the report.

3. An engineering strength analysis was performed using a 42-in. single-slope median barrier without a longitudinal open joint in the deck. The analysis considered an 8.5 in. thick deck supported between two concrete girders spaced 8 ft. on the centers. The barrier was anchored to the deck in the center between the two concrete girders. Additional information on the details and strength calculations is provided in the report.
4. Two engineering strength analyses were performed using a 42-in. single-slope median barrier with a longitudinal open joint in the deck. The analyses considered an 11-in. thick deck cantilever. The width of the deck cantilever was 4 ft. 1½ in. wide from the centerline of the exterior girder to the edge of the deck. The barrier was anchored to the deck 1½ in. from the edge of the deck cantilever. Strength analyses were performed considering crash impact loading on each side of the barrier. Additional information on the details and strength calculations is provided in the report.

Engineering details were developed for each design, as necessary, to improve the strength and performance of the proposed designs with respect to MASH TL-4 impact conditions. The principal investigator worked closely with the DOTD and LTRC project team to develop the details used for this project. All six analyses generated for the retrofit designs developed for this project were generated using Mathcad Prime 8.0 and submitted to the DOTD and LTRC project team for their review and approval. These analyses are included in the final report for this project.

Task 2—Reporting

Generating a final report was part of the scope of this project. The report provides details and descriptions of the proposed retrofit designs developed for this project. The report is 508 compliant. The report contains all analyses in Mathcad 8.0 format developed and generated for this project. All details developed to improve the strength and performance of the retrofit barriers planned for this project are also provided in the report.

METHODOLOGY

The procedures outlined in Section 13 of the *AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, 9th Edition*, were used to perform the analyses on the median barrier designs for this project. The commercial software RISA-3D was used to perform finite element modeling of the median barrier designs and the concrete decks. Finite element modeling was performed on the barrier designs to determine the reactions from the barriers to the supporting concrete decks. The reactions from the barrier models were then used on separate finite element models for the supporting concrete deck structures.

The bending moments in the deck from the barrier reactions were recorded and used as the demand bending moments. For the different barrier cases, the demand bending moments in the deck from the MASH TL-4 impact conditions on the barrier were then compared to the actual design bending moments that were calculated based on the deck design parameters and conditions provided for this project.

Since the development of the crash testing specifications in MASH in 2009, the crash loads for TL-4 barriers have increased from those currently listed in Section 13 of the LRFD specifications. In 2017, a separate research project determined the magnitude and location of the resultant force from MASH crash vehicles (National Cooperative Highway Research Program 20-07 Task 395). The design loads from this study were used in place of the LRFD Section 13 design load specifications. The design loads used in the analyses for MASH TL-4 impact conditions were:

1. 36-in. Median Barrier—68 kip distributed over 4 ft. at a height of 25 in.
2. 42-in. Median Barrier—80 kip distributed over 5 ft. at a height of 30 in.

CONCLUSIONS

Based on the results of the analyses performed for this project, the details provided in the report for the 36-in. and 42-in. high median barriers are acceptable for MASH TL-4. These details are similar to those shown in Figure 1. The reinforcing steel shown on the drawings in the report for the concrete decks associated with the median barrier designs are also acceptable for MASH TL-4 impact conditions. Recommendations were provided for the spacing of the vertical reinforcement in the median barriers to meet the requirements of MASH TL-4 impact conditions. The drawings and details in the report provide additional information.

RECOMMENDATIONS

Based on the results of the analyses performed for this project, the details shown for the 36-in. and 42-in. high median barriers in the report (Appendix A) are acceptable for MASH TL-4. It was therefore recommended that these barriers, as detailed in Appendix A in the report, be used for MASH TL-4 impact conditions. The reinforcing steel shown on the drawings in the report for the concrete decks is also acceptable for MASH TL-4 impact conditions. For both the 36-in. and the 42-in. barriers planned for this project, the drawings and details in Appendix A of the final report provide additional information. A minimum barrier length of 40 ft. was recommended for the barriers analyzed for this project.