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Retrofit of Existing Statewide Louisiana Safety Walk Bridge Barrier Railing Systems

INTRODUCTION

Louisiana has approximately 200 miles of 1960s vintage concrete safety walk bridge rail systems currently in use on bridges throughout Louisiana. Many of these systems do not meet the current crash performance requirements of the American Association of State Highways and Transportation Officials (AASHTO) *Manual for Assessing Safety Hardware*, Second Edition (MASH) Specifications for Test Level 3 (TL-3). A retrofit design is needed for these vintage concrete safety walk bridge rail systems that meets MASH TL-3.

OBJECTIVE

A retrofit bridge rail system that anchors to the top or sides of the existing concrete parapets, and that meets the current safety performance criteria of MASH TL-3, is needed for Louisiana's vintage concrete railings. The retrofit bridge rail must meet the current safety requirements of MASH TL-3 and continue to accommodate use of the concrete safety walk areas. The existing safety walk areas on these vintage concrete bridges are needed for proper and safe bridge inspection, bridge maintenance, access for stranded drivers, and general pedestrian safety. The objective of this project was to develop a retrofit bridge rail design for the two most common types of bridge railing systems that are currently used by Louisiana Department of Transportation and Development (DOTD). This new retrofit design shall also maintain the safety walk areas and meet the performance requirements of MASH TL-3. The two most common types of barriers are concrete post and beam and solid concrete parapet bridge rails installed with the 18-in. wide by 10-in. high safety walk curb. The purpose of this research was to design and test a new retrofit bridge rail system that can be used on these two common bridge rail types that meets MASH TL-3 requirements. In addition to the design and testing, researchers wanted to provide the information necessary to fabricate and construct the retrofit bridge rail design on Louisiana bridges using the vintage safety walk bridge rail systems. The new retrofit bridge rail that was designed and developed for this project was successfully crash tested in accordance with MASH TL-3 specifications for Task 7A of this project. All material specifications used to fabricate and construct the successful crash tested design and information on the proper installation of the new retrofit design are also provided in the final report for this project.

SCOPE

The researchers at Texas A&M Transportation Institute (TTI) completed a literature review of various bridge railing retrofits on similar safety walk barriers used throughout the United States and abroad. TTI researchers also performed a review of the DOTD database for all available designs used specifically in Louisiana. Two common types of bridge rail systems used in Louisiana (concrete post and beam and solid concrete parapet) were selected for analyses, design, and detailing of retrofit railings options for MASH TL-3. Several options were considered for these common railing types. Option 1, which consisted of a large structural tube anchored to the top of the concrete post and beam bridge rail, was fabricated, constructed, and crashed tested to MASH TL-3 specifications. Due to the unsuccessful outcome of Option 1 testing, the researchers developed a second option that anchored to the top of the concrete post and beam bridge rail and extended out in front of the concrete post and beam bridge rail system. The researchers performed further strength analyses to develop the Option 2 design. Option 2 was then fabricated, constructed, and crash tested to MASH TL-3 specifications. The crash testing of the Option 2 design was successful with respect to MASH TL-3 specifications. The researchers developed retrofit methods for adequately fabricating and constructing the retrofit bridge rail design developed as part of this research.

METHODOLOGY

Researchers at TTI conducted a full literature review of various bridge railing retrofits that have been successfully crash tested to MASH TL-3 and TL-4 specifications and used throughout the United States and abroad. A literature review search was performed using the TRIS database to document the pertinent findings of other retrofit designs that could be used for this project. TTI researchers also obtained all available design information and details of vintage safety walk barriers used throughout Louisiana. Two of the most common types of vintage bridge railings

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with safety walks were selected for further analysis and design of new retrofit options. These included a concrete post and rail system with a sidewalk and a solid concrete parapet system with a sidewalk. Several retrofit design options were considered that could be used on both of these common rail types used in Louisiana.

Two full-scale crash tests were performed on the retrofit design Options 1 and 2 anchored to the concrete post and rail system. Full-scale prototype installations were designed and constructed as part of this project. Option 1 as previously described was crash tested with respect to MASH TL-3 specifications. However, MASH Test 3-10 on the Louisiana Retrofit Post and Beam Bridge Rail with Safety Walk Option 1, was unsuccessful due to excessive occupant ridedown accelerations above the limit of 20.49 g as specified in MASH specifications. As a result, information was learned and used from this unsuccessful crash test and a second retrofit bridge rail option (Option 2) was designed and developed. Option 2 retrofit was fabricated and constructed on a new full-scale concrete post and beam with sidewalk test installation constructed for this project. After completion of the retrofit bridge rail installation for Option 2, MASH Tests 3-10 and 3-11 were performed (repeated) on this new design. The Louisiana Retrofit Post and Beam Bridge Rail with Safety Walk Option 2 design successfully met all the requirements for MASH TL-3 longitudinal barriers.

CONCLUSIONS

The purpose of the crash testing as reported in the final report for both retrofit Options 1 and 2, and described briefly herein, was to assess the performance of these retrofit designs with respect to the safety performance evaluation guidelines for MASH. The crash tests were performed in accordance with MASH Test Level 3, which involves an 1100C small car (MASH Test 3-10) and a 2270P pickup truck (MASH Test 3-11), impacting the retrofit bridge rails at critical impact locations. The target impact speed and impact angle for both these tests is 62 miles per hour and 25 degrees, respectively.

During MASH Test 3-10 on the Louisiana Retrofit Post and Beam Bridge Rail with Safety Walk Option 1, the vehicle experienced high occupant ridedown accelerations above the limit of 20.49 g as specified in MASH specifications. MASH Test 3-10 was not successful on the Option 1 design. As a result, information was learned and used from this unsuccessful crash test and a second retrofit bridge rail option (Option 2) was designed and developed. A full-scale prototype installation with concrete post and beam bridge rail with concrete safety walk was constructed with the new Option 2 bridge rail retrofit design. After completion of the new Option 2 test installation, MASH Tests 3-10 and 3-11 were performed (repeated) on this new design. The Retrofit Post and Beam Bridge Rail with Safety Walk Option 2, shown in Figure 1 below, met all the requirements for MASH Test Level 3 for longitudinal barriers.

RECOMMENDATIONS

The retrofit bridge rail Option 2 anchored to the safety walk concrete post and beam bridge rail, as shown herein in Figure 1 and reported herein, met all the safety and performance requirements of MASH Test Level 3 specifications. This retrofit bridge rail design is recommended for use on all concrete post and beam and solid concrete barriers with safety walks 10 in. high or less and 18 in. wide or less. The retrofit bridge rail should be installed as per the recommendations provided in the final research report submitted for this project. Please refer to the section entitled "Developing Retrofitting Methods and Procedures for Single Bridge Rail Design" in the final research report. The height of the retrofit bridge rail should always be 40 in. from the roadway surface as successfully crash tested for this research. The retrofit bridge rail shall be installed as per the specifications and procedures provided in the referenced section in the final research report. In cases where the retrofit bridge rail using the L6×4×½ angle brackets is lower than the as-tested height of 40 in., short steel baseplated posts, designed, detailed, and presented in the final report, shall be used instead of the L6×4×½ angle brackets. These posts are necessary to achieve the required height of 40 in. These short posts shall be W6×15 baseplated posts spaced on 6.0-ft. centers (maximum) as shown on the solid concrete parapet design drawings and presented in the final research report for the project. The post should be installed a minimum of 24 in. from the end of the concrete parapet. For the solid concrete parapet, the L6x4x1/2 angle bracket can be used if this bracket results in the steel tubes being mounted at the proper height (as-tested height of 40 in.). Please refer to the drawings and material specifications contained in the final research report for additional information.

Figure 1. Retrofit Post and Beam Bridge Rail with Safety Walk Option 2