Texas A&M Transportation Institute

PROJECT SUMMARY

Texas Department of Transportation

0-6954: Guardrail to Rigid Barrier Transition Attached to Bridge or Culvert Structure

Background

The current Texas Department of Transportation (TxDOT) high-speed transition is approximately 19 ft long, and the approximate length of metal beam guard fence end treatment is 50 ft long, for a total 69 ft in length. In situations where it is appropriate, if there is a transition from flexible rail to rigid rail that attaches to the top of a culvert, wing wall, or bridge deck, the rigid rail ends on the bridge before the end of the bridge, and starts the transition on the culvert, wing wall, or bridge deck. This allows TxDOT to reduce the required distance between the end of the bridge and the intersecting roadway or driveway to a maximum length of 50 ft. The purpose of this project was to develop a transition that can be anchored on top of a concrete deck or wingwall and thus reduce the length of transition needed off the bridge structure.

What the Researchers Did

Five tasks were undertaken to develop a crashworthy transition design that reduces the required distance between the end of the bridge and an intersecting roadway or driveway, and to meet the crash requirements of the American Association of State Highway and Transportation Officials *Manual for Assessing Safety Hardware* (*MASH*) Test Level 3 (TL-3).

Working in conjunction with the project team, researchers conducted a value-of-research assessment. Researchers identified sources for both qualitative and economic data, such as TxDOT construction bids (economic), material price lists from vendors (economic), pavement performance data (economic), and district personnel (qualitative).

Researchers performed an extensive literature review of bridge railing transitions crash-tested to *MASH* TL-3. Researchers incorporated the information obtained from this review into the design and details for the new transition testing developed for this project.

Researchers developed several post concepts for the new transition. These designs anchor the transition posts on a concrete slab or a concrete wingwall. Posts are located in the transition onto the concrete slab or wall. Researchers performed engineering analyses on the new post designs and developed engineering drawings of the new transition designs considered for this project. Researchers recommended these post designs to TxDOT for review. TxDOT selected two post designs for full-scale component testing. Researchers performed pendulum testing of the posts (three posts per design [six tests total]) and compared them to strength tests performed on embedded posts in soil.

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Project Completed:
5-14-2019

Researchers developed a full-scale three-dimensional finite element model of the guardrail transition. The modeling effort incorporated developing and validating a subcomponent-level model of the post installed on concrete. Once the subcomponent-level model was validated, researchers used it in the system-level finite element model to develop a full-system model of the guardrail to concrete barrier transition. Researchers processed the results and assessed the likelihood of the transition system passing all four *MASH* crash tests upon completion of the simulations. Researchers noted the design deficiencies and recommended design modifications to the system to mitigate those deficiencies.

Researchers developed full-scale test installation drawings of the design after the finite element model simulations were completed and all the results had been reviewed with favorable results. Similar to the simulation effort, the following four full-scale crash tests were performed on the full-scale test installation:

1. *MASH* Test 3-20, 1100C Small Car, 62 mi/h at a 25° impact angle on the upstream end of the transition design.
2. *MASH* Test 3-21, 2270P Pickup Truck, 62 mi/h at a 25° impact angle on the upstream end of the transition design.
3. *MASH* Test 3-20, 1100C Small Car, 62 mi/h at a 25° impact angle on the downstream end of the transition design.
4. *MASH* Test 3-21, 2270P Pickup Truck, 62 mi/h at a 25° impact angle on the downstream end of the transition design.

However, based on the final design details developed for this project, *MASH* Test 3-20 impacting the downstream end of the transition (item 3 in the previous list) was optional and therefore not performed.

What They Found

The guardrail to rigid barrier transition (Figure 1) attached to the bridge or culvert structure, used on the upstream and downstream ends, performed acceptably for *MASH* TL-3. Based on the transition design developed for the project, *MASH* Test 3-20 in the immediate area upstream of the concrete parapet did not present reasonable uncertainty of success, so this test was not performed (considered optional for *MASH*).

Figure 1. Guardrail to Rigid Barrier Transition.

What This Means

The testing met all the requirements of *MASH* for TL-3 guardrail terminals. However, other impact conditions were discovered that might be critical based on the final design developed for this project. These impact conditions (further testing) will be investigated under a new and separate project at a later date.

For More Information

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Keyword: Research