Executive Summary, Research Readiness Level Assessment, and Technology Transfer

Approach Guardrail Transition Retrofit to Existing Buttresses and Bridge Rails

Research Objectives

The objective of this project is to develop retrofit options for attachment of 31-in. tall thrie beam AGT systems to existing NDOT bridge rails and concrete parapets. The retrofits may involve the addition of connection plates to attach the thrie beam to the parapet, the addition of deflector plates to prevent vehicle snag, and/or overlapping the AGT on the parapet to prevent contact with the end of the parapet. However, the existing concrete structures are not to be modified except for the installation of anchorage hardware. The new retrofit designs will improve the overall safety of the barrier systems by ensuring its performance satisfies the Manual for Assessing Safety Hardware (MASH) Test Level 3 (TL-3) performance criteria, while preventing costly replacements of concrete structures.

Research Benefits

Development of crashworthy retrofit options for the attachment of thrie beam AGT systems to existing NDOT bridge and concrete parapets will provide NDOT with a safe and cost-effective solution for upgrading guardrail and AGT systems without requiring difficult and costly modifications to the concrete parapets themselves or the addition of a new end buttress adjacent to the current end of the parapet. Further, the retrofit design will reduce installation times and limit the amount of lane closures and exposed workers as compared to reconstructing the concrete parapets. The availability of these retrofit attachments would also improve the long-term safety of the bridge and approach section by conforming to the safety performance criteria of MASH TL-3.

Principal Investigator

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NDOT Lead TAC Member

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Background

When a roadway/bridge is resurfaced with an overlay, NDOT plans to replace the AGT adjacent to the bridge with a MASH TL-3 crashworthy design. To minimize repair costs, NDOT does not desire to replace or alter any bridge rails with adequate structural capacity and height. Bridge rails installed under NCHRP 230 or earlier standards are likely too short for current standards and need to be replaced, but bridge rails installed to NCHRP Report 350 standards should meet MASH TL-3 criteria and could remain in place. However, this creates a problem of attaching new, 31-in. tall AGTs to existing concrete bridge rails and parapets (after an overlay) that were not designed for such connections and the resulting system may not be crashworthy to current safety standards. Therefore, the development of cost-effective retrofit options are desired for attaching new, 31-in. tall AGTs to existing NDOT bridge rail and parapet designs.

Conclusion

The Nebraska Department of Transportation (NDOT) frequently applies roadway overlays to the surface of bridges to extend the bridge's lifespan. To minimize repair costs, NDOT does not desire to replace or alter any bridge rails with adequate structural capacity and height. Bridge rails installed to NCHRP Report 350 or MASH standards are likely to remain in place, though their effective heights would be reduced by the overlay. This creates a problem of attaching new, 31-in. tall approach guardrail transitions (AGTs) to existing concrete bridge rails and buttressess (after an overlay) that were not designed for such connections and the resulting system may not be crashworthy to current safety standards. The objective of this project was to develop retrofit options for attachment of thrie-beam AGT systems to existing NDOT bridge railings and buttresses. The project began with a review of existing bridge railings and end buttresses used by NDOT to identify issues related to connection hardware alignment and crash safety performance. Retrofit options were then developed to address these issues while adhering to established design criteria. A new connector plate assembly was designed to facilitate the attachment of the thrie-beam terminal connector to these bridge railings and buttresses. Additionally, three retrofit concepts, including concrete fill, a steel assembly, and a curb, were considered to mitigate concerns related to vehicle snag below the thrie beam. These selected retrofit concepts were evaluated through a combination of structural analysis and computer simulated crash tests. All simulations of the AGT attached to these buttresses through these retrofit concepts met MASH TL-3 safety performance criteria.

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NDOT Recommendations Based Off Research Project

The information provided by this research is being implemented into NDOT's Roadway Special Plan. The retrofit provided in this research will allow for time and money savings, as well as increase the safety of construction workers and the public by reducing construction time. This research allows the use of a connection plate at the existing concrete buttresses to connect to the guardrail. Previously, the concrete buttresses had to be completely removed and reconstructed to allow for the connection to the guardrail when an asphalt overlay was placed on the bridge. In fact, the development of cost-effective retrofit options was confirmed by attaching a new, 31-in. tall AGTs to existing NDOT bridge rail and parapet designs. With the addition of special provisions to the NDOT Roadway Special Plan, responsibility of this research is handed over to the Roadway Design Division. This research has a cost saving estimate of $600,000 in the 2026 fiscal year alone, with similar estimates savings in other upcoming fiscal years.

- *As provided by Emilie Hudon and Matthew Wieseler, TAC Members*

Research Readiness Level (RRL) Assessment

RRL 5

Level 5: Standard Practice/Fully Understood
Research adopted; no evaluation is required.

Technology Transfer

Principal Investigator did not have any technology transfer for this research project.

This brief summarizes Project SPR-FY21(004)
"Approach Guardrail Transition Retrofit to Existing Buttresses and Bridge Rails"