TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Nebraska Department of Roads

INSTRUCTIONS:
Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Suppl. #81 MwRSF Project No. RPFP-15-AGT-1	☐ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☑ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

Project Title:		
Standardized Concrete Parapet for Use in Thrie Beam AGT's		
Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Faller, Bielenberg, Rosenbaugh	402-472-9324	srosenbaugh2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211113001	RPFP-15-AGT-1	8/1/2014
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
7/31/2017	7/31/2018	1

Project schedule status:

☐ On schedule ☑ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$125,906	$107,447	95%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$5,186	

Project Description:

Although most approach guardrail transitions (AGTs) look similar, each AGT has a unique combination of features including rail thickness, post size and spacing, use of a hydraulic curb, and downstream parapet or bridge rail in which it attaches to. However, due to the sensitivity of transition regions, these variables are not interchangeable between AGTs. Thus, each AGT is specific to its own features as well as the bridge railing or parapet to which it is anchored.

Crash testing has illustrated the sensitive nature of these AGT designs with recent failures occurring due to an alteration of an AGT feature (e.g., addition/removal of a curb or changes to the rigid parapet geometry and attachment hardware). The majority of these failures have been the result of excessive vehicle contact on the lower, upstream corner of the rigid parapet. This result indicates that the parapet toe and end geometry may be even more critical than previously believed. Thus, there exists a need to develop a standard concrete parapet end geometry for use with all thrie beam AGTs.

The objective of this research effort is to develop a standardized concrete parapet end section for attachment of various thrie beam AGTs.

Objectives / Tasks:

1. Literature Review
2. Parapet Design and Analysis
3. System CAD Details
4. System Construction
5. Full-scale Crash Test
6. System Removal
7. Data Analysis
8. Design Recommendations

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

The second full-scale crash test, test no. AGTB-2, was conducted on the revised version of the standardized buttress according to MASH 3-21 impact criteria. During the test, the 2270P pickup truck was smoothly redirected by the guardrail transition with limited snag on the standardized concrete buttress. Data analysis showed all accelerations fell within acceptable limits, so the test satisfied the MASH criteria. After the test, test installation was removed and materials were disposed of.

Work to complete the summary report, which will detail all design and testing of the standardized buttress, has begun. Additionally, a journal paper was written and submitted to the Transportation Research Board. The paper submission will be presented at the 2018 annual TRB meeting in Washington D.C. and was accepted for publication in 2018.

Anticipated work next quarter:

Work will continue to complete the project summary report.

Significant Results:

An extensive literature review of all AGTs to concrete parapets was summarized in a reference table. The table was utilized during the design process to develop a buttress that minimizes snag while maximizes vehicle stability. Through a voting process, the states selected a dual taper design over a single taper design. The bottom of the buttress (below the thrie beam) had 4"x12" chamfer to prevent tire snag, while the rest of the buttress had a 4"x4" chamfer to prevent vehicle snag. The length of the buttress was minimized at 7 ft to minimize the system length while also allowing room for geometric shape transitions to match up with various bridge rails. The height of the buttress was selected as 36" to match the height of MASH TL-4 bridge rails. The buttress height tapers down to 32" on the upstream end over a 24" length to prevent snag. Design details for the system including geometric shape and reinforcement were completed.
A test installation was constructed at the MwRSF test site and was subjected to 1 full-scale crash test in accordance with MASH test 3-21 with a 2270P. During the test, the pickup was contained and redirected. However, the vehicle floor pan and seat were displaced during the impact event - not enough to exceed occupant compartment deformations, but enough to cause erroneous data to be recorded by the accelerometers (which mount to the seat frames). Thus, a -30 g pulse was recorded in the longitudinal direction which exceed MASH ORA limits. The on board ACM recorded only a -20 g pulse, but it too was affected by the motion of the vehicle floor pan. Efforts were made to compare the data trace to high-speed video, but vehicle roll and pitch made tracking of the actual vehicle c.g. very difficult. Consequently, it could not be proven that the ORAs were below the 20.49 g limit in MASH.

Following the unsuccessful full-scale crash test, the geometry of the standardized buttress was redesigned to improve the performance of the system. The size of the lower taper was increase from a 4"12" taper to a 4.5"x18" taper. Also, the height of this lower taper was increased from 11" to 14". these changes were done to reduce wheel snag and loads into the axle of the vehicle. the upper taper was changed from 4"x4" to a 2"x4". this reduction in slope was intended to

Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

Extra data analysis was conducted in an attempt to validate the differing data traces obtained from the accelerometers and the high speed video for test no. AGTB-1. Unfortunately, none of the analysis methods converged.

A continuation study/project was funded in 2016 as part f the Year 27 Pooled Fund Program. This new project was aimed at redesigning the buttress and re-testing the system (MASH 3-21). As this effort is advanced, labor and materials will be charged to this Year 25 project until the funds are exhausted. The test charges were still applied to the YR 27 project instead of the original YR 25 project.

After the project had begun, FHWA issued a new memo/policy stating that it would only grant eligibility letters to systems that had completed the full test matrix as recommended in MASH. Since the project did not include testing with the small car (deemed non critical), the standardized buttress will not meet the criteria for FHWA eligibility letters. Thus, a submission will not be completed. Instead, MwRSF's opinion on the crashworthiness of the buttress will be explicitly written in the report and supported with details and references.

Potential Implementation:

A single design for the concrete parapet end section at the downstream end of AGTs will simplify state design standards. No longer will transitions be associated with only a single concrete parapet shape. All thrie beam transitions will be able to connect to the new parapet. The designer then only needs to transition the parapet to the proper shape and height of the bridge rail.