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) Supplement #104	☐ 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:		
Optimized TL-4 Concrete Bridge Rail		
Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Faller, Bielenberg, Lechtenberg, Rosenb	402-472-9324	srosenbaugh2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211133001	RPFP-17-CONC-2	10/1/2016
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
9/30/2019	9/30/2019	0

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
$247,654	$46,145	25%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$16,036	

Project Description:

Historically, rigid concrete barriers satisfying TL-4 criteria have typically been 32 in. tall. However, with the adoption of MASH and an increase in both mass and impact speed for the single-unit truck, TL-4 tests on 32-in. tall barriers have repeatedly resulted in the 10000S vehicle rolling over the barrier. As such, barriers taller than 32 in. are now required to meet the MASH TL-4 criteria.

Past research has indicated that certain barrier shapes, such as safety-shapes, increase the propensity for vehicle climb, instability, and rollover. An optimized barrier shape would minimize vehicle instabilities by utilizing a flat, near vertical face. However, tall vertical faced barriers pose the risk of occupant head slap during impact events. Thus, an optimized geometric shape that considers vehicle containment, vehicle stability, and occupant head ejection is desired for new taller TL-4 barriers. Additionally, the increased impact severity associated with MASH TL-4 criteria will increase impact loads to the deck and could lead to deck damage. Retrofitting stronger barriers onto existing bridge decks not designed for these increased loads may lead to deck damage during severe impacts.

The objective of this research effort is to develop a MASH-compliant TL-4 bridge railing. The railing will be optimized for strength, vehicle stability, installation costs, and head slap mitigation. Efforts will also be made to minimize load transfer into the deck and determine the minimum deck capacity, thereby minimizing the risk of deck damage.

Objectives / Tasks:

1. Literature Review
2. State Survey of TL-4 deck designs
3. Barrier Design and Structural Analysis
4. Deck Design and Structural Analysis
5. CAD Details
6. Development of Barrier End Sections and Transitions

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

The barrier optimization analysis was completed. Various barrier width and rebar configuration combinations were first analyzed using Yield Line Analysis to ensure a minimum strength capacity of 80 kips to satisfy MASH TL-4 impact loads. Additionally, the material and labor costs associated with both concrete and the steel reinforcement were estimated for each barrier configuration. A table of the lowest cost configurations to satisfy the 80 kip capacity was created for selection of the optimized system.

This analysis was completed twice, once for a single slope barrier configuration, and a second time for a barrier shape which contains large chamfer on the top-front corner to minimize the risk of head slap.

Anticipated work next quarter:

The results of the optimization analysis will be provided to the project sponsors, and they will be asked for feedback on the selection of the barrier design to be full-scale crash tested. CAD details for the selected barrier will be drawn. Design and analysis of the bridge deck will also begin.

Significant Results:

Multiple contractors and slipformers were contacted and surveyed concerning the cost to install concrete bridge rails. Specifically, the material and labor costs for the steel rebar and concrete were obtained. Average values for these costs will be utilized to optimize the barrier design.

A single slope barrier shape measuring 2-3 degrees from vertical was selected for the bridge rail to maximize vehicle containment and stability while also remaining constructible through slipforming. General reinforcement patterns were selected to provide cage stability during casting/slipforming and efficiently strengthen the barrier. Various barrier width and rebar configuration combinations were first analyzed using Yield Line Analysis to ensure a minimum strength capacity of 80 kips to satisfy MASH TL-4 impact loads. The material and labor costs associated with both concrete and the steel reinforcement were estimated for each barrier configuration. A table of the lowest cost configurations to satisfy the 80 kip capacity was created for selection of the optimized system. This analysis was completed twice, once for a single slope barrier configuration, and a second time for a barrier shape which contains large chamfer on the top-front corner to minimize the risk of head slap.

Details about TL-4 bridge decks (including thickness, reinforcement patterns, and cantilever/overhang distance) were gathered from the Pooled Fund member states. This information will be used to guide the deck design following the selection of the optimized barrier design.

Objectives / Tasks:	% Complete
1. Literature Review	100%
2. State Survey of TL-4 deck designs	100%
3. Barrier Design and Structural Analysis	95%
4. Deck Design and Structural Analysis	0%

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).

In a May 2017 memo, the FHWA declared that eligibility letters will now only be granted to systems that have completed the entire suite of tests within the MASH testing matrix. Since the small car and pickup truck tests (MASH 3-10 and 3-11) were previously deemed non-critical by MwRSF and the Pooled Fund States, they will not be conducted as part of this project. Thus, the concrete bridge rail will not meet FHWA's new criteria to qualify for a letter, and an application for a letter will not be submitted.

Potential Implementation:

Successful development of this optimized bridge railing would provide states with a MASH TL-4 bridge rail option when constructing new bridges or upgrading existing bridges. The barrier will provide unique benefits in that it will be optimized for vehicle containment and stability, load distribution into the deck, head slap mitigation, and cost while also allowing for future roadway overlays.