TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Wisconsin DOT

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. #15	☐ 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:		
Development of a Low Deflection Temporary Concrete Barrier		
Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Bielenberg, Faller, Reid, Sicking	(402) 472-9064	rbielenberg2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211022001		7/1/2009
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/2011	12/31/2013	3

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**
$178,914	$173,731.00	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**
	$28,410.00	

Project Description:

The objective of this research effort is to develop a joint stiffening mechanism for use in reducing the deflection of temporary concrete barrier installations without requiring anchorage of the barrier segments to the road surface. The joint stiffening mechanism will be developed for use with the Midwest Pooled Fund States 12.5-ft long, F-shape, temporary concrete barrier. The temporary concrete barrier joint stiffening mechanism will be designed and evaluated to meet the TL-3 requirements set forth in MASH-08.

Task	% completed
1. Project Planning and Literature Search	100
2. LS-DYNA Analysis of Barrier Offsets	100
3. Development of Design Concepts	100
4. LS-DYNA Analysis of Concept Designs	100
5. Fabrication of Design	100
6. TL-3 Full-scale Crash Testing with 2270P Vehicle	100
7. Analysis and Refinement of Design	100
8. Fabrication of Revised Design	100
5. TL-3 Full-scale Crash Testing with 2270P Vehicle	100
6. Summary Report	85

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

In the fourth Quarter of 2013, MwRSF two main tasks were completed. First, additional simulation modeling of the final deflection limiting design was undertaken to to investigate the safe barrier offset for non-critical installations. LS-DYNA simulations of a pickup truck striking the low-deflection TCB system at the 85th percentile impact severity were conducted to estimate the deflection of the barrier. The predicted deflection was then be used to set placement criteria for non-critical installations. Previous research at MwRSF had suggested that it was feasible to use deflection limits for TCB systems in non-critical areas based on the estimated deflection of the TCB system when impacted at the 85th percentile IS value, as determined from accident data. A similar analysis was performed on the barrier system developed herein and found that the deflection of the low-deflection TCB system at the 85th percentile IS was in the range between 18.2 in. (463 mm) and 23.6 in. (600 mm). It was conservatively recommended that installation in critical locations be limited to 24 in. (610 mm) until further data regarding lower severity impacts was collected.

Additionally, the summary report for the research was completed in draft form and will be sent to the sponsor for review. Completion of the draft report did not allow for time for the sponsor to review and comment with edits. Thus, a contract extension was requested to allow for sponsor comments to be incorporated during the first quarter of 2014.

Anticipated work next quarter:

In the First Quarter of 2014, MwRSF will complete review and editing of the summary report of the research effort, thus finishing the research project.

Significant Results:

The simulation of barrier offsets and the draft report summarizing the research were completed.

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).

Currently MwRSF has developed and full-scale crash tested an initial design concept for reducing the deflection of PCB segments without constraining them to the pavement. The crash test of the initial design concept was successful and the design is currently undergoing refinement for a second test. As such, further analysis, design, and crash testing remain to be completed. Remaining work includes (1) analysis and refinement of the low-deflection PCB design tested in the first full-scale crash test for the project; (2) fabrication of the revised design; (3) a second TL-3 full-scale crash testing with the 2270P vehicle on the revised design; (4) the preparation of a final report with the implementation of WisDOT edits and comments; (5) the submission of published report copies to the sponsor; and (6) data archive.

Additionally, system fabrication costs for the full-scale test were higher than anticipated and additional, un-budgeted component testing was required as part of the research effort to better define the friction properties of the concrete barriers. Thus, with the remaining project tasks, it is expected that the project may exceed the current budget during the remainder of the research effort. Therefore, MwRSF requested permission to charge future excess expenditures for the work described above be applied to the surplus funds in completed Project Nos. MwRSF RPFP-WISC-5 and RPFP-WISC-3.

At this time, it was also expected that the remaining tasks for this project cannot be completed within the current time limit. Thus, we requested and received a no-cost time extension of 12 months for this project, moving the closing date to June 30, 2014.

Potential Implementation:

Development of a joint stiffening mechanism for use in reducing the deflection of temporary concrete barrier will provide designers with a means to install temporary concrete barriers in limited deflection applications without anchoring the barriers to the roadway surface. This will reduce installation costs and damage to the road surface. In addition, installation and removal of the barrier system would be more efficient, thus reducing worker exposure.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Wisconsin DOT

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)* TPF-5(193) Suppl. #16	**Transportation Pooled Fund Program - Report Period:** ☐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: Synthesis of Crash Cushion Guidance		
Name of Project Manager(s): Schrum, Sicking, Reid, Faller	**Phone Number:** 402-472-6864	**E-Mail** rfaller1@unl.edu
Lead Agency Project ID: 2611211023001	**Other Project ID (i.e., contract #):**	**Project Start Date:** July 1, 2009
Original Project End Date: June 30, 2011	**Current Project End Date:** December 31, 2013	**Number of Extensions:** 3

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
$ 112,275	$80,636 ($7,608 for Suppl #26, $5,94	100%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$191	

Project Description:

Early in the design process, engineers typically have to select a crash cushion for a given location. However, there is little guidance to help designers to decide what type of crash cushion system to install (low maintenance crash cushions, non-gating crash cushions, gating crash cushions, sand barrels, etc...) based on the given conditions. This would include guidance as to which system would be suitable for installation at a given location based on factors such as ADT, number of lanes, and geometries. The selection of a given system can have a significant impact on the design of a location, and can also impact the construction, maintenance and user costs.
This project aims to provide guidelines for the selection of appropriate crash cushion designs for various installations.

The research objectives for this study consist of the following items:

1. Collect and synthesize guidance from various states on crash cushion use - concluded
2. Collect crash cushion construction and repair costs - to be updated w/ revised cost data
3. Conduct an economic evaluation of crash cushions - to be updated w/ revised cost data
    a. RSAP analysis of gating versus non-gating crash cushions
    b. Comparison of initial construction, maintenance and repair costs for low-maintenance versus conventional crash cushions
4. Develop a decision matrix for designers to select an appropriate system for a given location - to be updated w/ revised cost data

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

The report has been published, and a paper has been accepted for publication in the Journal of Transportation Safety & Security.

Anticipated work next quarter:

None.

Significant Results:

A paper was reviewed by industry peers and accepted in the Journal of Transportation Safety & Security.

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).

Manufacturers were given the chance to review the results of the findings following the implementation of the updated repair cost data. Numerous comments were received, thus it delayed publishing the final report which in turn delayed the project close date. An extension with a new end date of 12/31/13 was requested and approved.

A subcontract in the amount of $996 was established for Dr. Dean Sicking to review the report.

At the time of completion of this project, $67,088 of the project funds had been spent for this project. Due to the project having extra funds remaining at the time of project completion, an extension was requested to utilize the remaining funds for two projects, Project No. TPF-5(193) Suppl. #26 and TPF-5(193) Suppl. #40, which had their funds exhausted prior to the completion of the projects. Therefore, the overrun budgets for Project No. TPF-5(193) Suppl. #26 and TPF-5(193) Suppl. #40 are being posted to this project. To date, $7,608 has been posted for Project No. TPF-5(193) Suppl. #26 and $5,940 has been posted for Project No. TPF-5(193) Suppl. #40.

Potential Implementation:

The guidelines implemented in this project will provide a useful tool for the selection of appropriate crash cushion designs for various installations.

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. #19	☐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:		
Phase II - Guidelines for Post-Socketed Foundations for 4-Cable, High-Tension, Barrier System		
Name of Project Manager(s): Reid, Sicking, Faller, Rosenbaugh	**Phone Number:** 402-472-9324	**E-Mail** srosenbaugh2@unl.edu
Lead Agency Project ID: 2611211026001	**Other Project ID (i.e., contract #):** RPFP-10-CABLE-1	**Project Start Date:** 7/1/2009
Original Project End Date: 7/31/2012	**Current Project End Date:** 4/30/2014	**Number of Extensions:** 2

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**
$92,207	$34,853	70%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$8,148	

Project Description:

This project is the second Phase of a project which was undertaken the year previous - split up due to available funds in previous year not being sufficient to cover entire project.

High-tension cable barriers often incorporate socketed post foundations to simplify repair of the system after an accident. Barrier posts are designed to slide in and out of a ground socket for easy replacement of damaged components. Unfortunately, there have been numerous examples of socketed post foundations that are damaged during a cable barrier crash. In most cases, socket damage requires repair crews to either replace the socket itself or drive a post directly into the soil adjacent to the damaged component. Either situation defeats the purpose of using sockets and greatly increases the time necessary to restore a damaged barrier. The increased repair time translates into higher maintenance costs and increased risk to repair crews working adjacent to high-speed facilities.

Many existing socketed post foundation designs are constructed by drilling a hole in the soil, placing a steel sleeve in the hole, and backfilling with Portland cement concrete. Many of these designs do not have sufficient reinforcement to resist impact loads that are transmitted into the socket. Further, many of the sockets are too short to resist frost heave that can push the posts out of the ground. Thus, there is a need for general design guidelines that states can incorporate to assure that socketed post foundations perform as intended when used in the field.

Objectives/Tasks:

1. Design new socket foundations for barrier posts.
2. Fabrication and dynamic testing of socketed foundations.
3. Analysis of test data and evaluation of socketed foundation designs.
4. Written report documenting all work and conclusions.

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

After completing component testing utilizing the new Midwest Weak Post in concrete foundation sleeves, a significant amount of project funds remained. Thus, further testing of foundations supporting S3x5.7 posts was requested to explore possible design alterations that would prevent concrete shear cracking during impacts. Both asphalt confinement around the top of the foundation and increasing the diameter of the socketed foundation will be explored. Socket foundations to evaluate these options were fabricated and are currently in queue for component testing.

Work has also continued toward completing the project report documenting all testing, conclusions, and recommendations. Phase two of this project has been divided into two separate reports, one for S 3x5.7 posts and a second for the MWPs as each post type will have different conclusions and final designs.

Anticipated work next quarter:

Component testing on the increase diameter foundations and the foundations encased in asphalt shall occur early in 2014. It is envisioned that 2-4 tests will be necessary to determine the size and confinement requirements to prevent damage to socketed foundations. Additionally, work will continue on the project reports documenting all testing, conclusions, and recommendations.

Significant Results:

Phase I of this project included the evaluation of 4 new socketed foundation designs. All 4 of these first round designs experienced heavy damage in the form of concrete fracture and plastic deformation of the reinforcing steel. As a result, 4 new reinforcement designs were configured to provide additional strength to the socketed foundation.

Round 2 of testing saw four foundations designs evaluated in sand. Although concrete shear failure occurred in all designs, the 60" embedment proved adequate to resist rotation in weak/saturated/sandy soils. Round 3 of testing determined 36" was the required embedment depth for 12" diameter foundations placed in strong soil (AASHTO Grade B).

Round 4 of testing was conducted utilizing the Midwest Weak Post as opposed to the S3x5.7 posts used previously. The weaker post resulted in virtually no damage to the foundation while allowing for reduced reinforcement. When utilizing the MWP, minimum embedment depths of 24 in. and 36 in. were specified for standard strong soils and sandy soils, respectively.

Objectives/Tasks:	% Completed (Phase II)
1. Design new socket foundations for barrier posts.	85%
2. Fabrication and dynamic testing of socketed foundations.	85%
3. Analysis of test data and evaluation of socketed foundation designs.	80%
4. Written report documenting all work and conclusions.	25%

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).

Additional (matching) funds for Phase-I of this project were obtained through a Mid-America Transportation Center program. This matching funding was used during the first round of design, testing, and evaluation for the socketed foundations. Thus, some of the original Phase-I funding remained as it was not used until the MATC funding was depleted. As a result, the continuing work which would have been conducted under Phase II of the project was charged to the Phase I project until the funds were gone. Although the test charges from Round 2 of testing have been placed on this project's budget, significant time was charged to the Phase II project beginning only in mid 2013.

This project was originally set to close on July 31, 2012. However, the additional funding obtained for Phase-I of the project has resulted in remaining funds in the Phase-I project and nearly all of the funds remaining for Phase-II. Therefore, an extension was granted extending the closing date to 4/30/2013.

A significant delay was also the result of a change to the post in the non-proprietary cable system being developed by MwRSF. The new posts were to be significantly weaker than the original S3x5.7 posts, so continued development of the foundation with the S3x5.7 would result in an overly conservative design. Thus, it was decided to wait until the new post design was finalize before further foundation design and testing was conducted.

Potential Implementation:

Upon successful completion of this project, State DOT's will have the option to use a socketed post foundation for cable barrier system posts. The socketed foundation will allow for quick, easy, and inexpensive repairs to damaged sections of the barrier.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl.#21	**Transportation Pooled Fund Program - Report Period:** ☐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:
Additional Funding to Complete Development of a Crash-Worthy Terminal for Midwest Four-Cable, HT, Barrier System

Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Sicking, Faller	402-472-3084	jreid@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
RPFP-10-CABLE-3	2611211028001	July 1, 2009
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
July 31, 2012	April 30, 2014	2

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**
$159,193	$40,549	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**
	$5,506	

Project Description:

Objective: Redesign the cable release mechanism and foundation of the three cable end terminal to accommodate four high tension cables.

Tasks
1. Background and literature review - completed
2. Design and analysis, including bogie testing part 1 - completed
3. Report part 1 - completed
4. Design and analysis, including bogie testing part 2 - in-progress
5. Full-scale testing
6. Report

This is Phase II of the project. Phase I was funded in Year 17: SPR-3(017) Suppl.#38 - "Testing of Cable Terminal for High Tension Cable (1100C & 2270P)"

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

Task 4.
The draft report TRP-03-294-13 was completed and is currently under internal review.

A meeting was held in October to discuss possible changes to the cable end terminal design. New concepts were drawn that should alleviate concerns that arose with previous low-tension and high-tension cable end terminal designs.

Anticipated work next quarter:

Task 4.
Design concepts will be finalized and simulation and/or bogie tests will be defined to assess the behavior of the improved cable barrier terminal.

Significant Results:

Report TRP-03-268-12 documenting part 1 of this project was published July 17, 2012.
"Development and Recommendations for a Non-Proprietary, High-Tension Cable End Terminal System"

History of cable terminal design changes were documented in a Midwest Roadside Safety Facility internal document, June 2013.

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).

Final design details and full-scale testing for this project cannot be conducted until the High Tension Cable Barrier System is completed. Because of timing in that project, this project is behind schedule.

$64,746 of the project funds have been re-allocated to PF-Yr 24 Cable Project. That re-allocation is not reflected on page 1 of this quarter report.

Potential Implementation:

The revised terminal will provide a non-proprietary end terminal for high tension barrier cable systems.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:
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Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX))* TPF-5(193) Suppl.#22	**Transportation Pooled Fund Program - Report Period:** ☐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: Maximum MGS Guardrail Height		
Name of Project Manager(s): Reid, Sicking, Faller	**Phone Number:** 402-472-3084	**E-Mail** jreid@unl.edu
Lead Agency Project ID: RPFP-10-MGS	**Other Project ID (i.e., contract #):** 2611211029001	**Project Start Date:** July 1, 2009
Original Project End Date: July 31, 2012	**Current Project End Date:** April 30, 2014	**Number of Extensions:** 2

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**
$166,953	$142,920	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**

Project Description:

Objective: Identify an upper bound on the acceptable height of the Midwest Guardrail System (MGS).

Tasks
1. Full-scale crash testing - completed
2. Report on full-scale crash testing - completed, Report TRP-03-255-12 published March 9, 2012
3. Analysis phase - completed

Note: The analysis phase of this project was supplemented by NDOR project SPR-1(12) M318,"Maximum Safe Guardrail Height."

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

No work was done on this project during this quarter.

Anticipated work next quarter:

The project is essentially completed. There are a few project clean-up items left, including writing a TRB paper.

Significant Results:

On June 29, 2010, MwRSF conducted one small car crash test (test no. MGSMRH-1) into a 34-in. tall Midwest Guardrail System (MGS) using an 1100-kg Kia Rio according to the TL-3 safety performance guidelines of MASH. The small car was successfully contained and redirected.

On September 9, 2010, a second small car test (test no. MGSMRH-2) was conducted into a 36-in. tall Midwest Guardrail System (MGS) using an 1100-kg Kia Rio according to the TL-3 MASH safety performance guidelines. Again, the small car was successfully contained and redirected.

Report TRP-03-255-12 documenting the above crash tests was published March 9, 2012.

A recent investigation showed that for newer vehicle models there is a consistent trend among the most important car manufacturers to increase the cowl height. The results from the simulations indicated that a higher cowl high will likely improve the safety performance of a guardrail system, thus potentially increasing the safety margin of the identified critical height for the MGS.

Report TRP-03-274-12 documenting the analysis phase was published December 5, 2012.

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).

The supplemental project, NDOR project SPR-1(12) M318, was being worked on before completing this project. Results from that project were used to help direct and complete this project. The NDOR project has been completed and closed.

Remaining funds will be used as pooled fund contingency funds.

Potential Implementation:

Clearly defined limits on the upper height for MGS guardrail will allow states to accurately determine when a guardrail is too high, either as a result of improper installation or frost heave. Further, a clearly defined upper height will be very helpful when determining acceptable MGS placement guidelines on moderate slopes or behind curbs.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Midwest Roadside Safety Facility, UNL

INSTRUCTIONS:

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Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Supplement #27	**Transportation Pooled Fund Program - Report Period:** ☐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: Short-Radius Guardrail with Large Radii		
Name of Project Manager(s): Bielenberg, R., Faller, R., Reid, J., & Sicking, I	**Phone Number:** 402-472-9064 (Bielenberg)	**E-Mail** rbielenberg2@unl.edu
Lead Agency Project ID: 2611211042001	**Other Project ID (i.e., contract #):** TPF-5(193) Supplement #27	**Project Start Date:** June 30, 2010
Original Project End Date: June 30, 2013	**Current Project End Date:** December 31, 2013	**Number of Extensions:** 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
$57,929.00	$54,451	99

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$11,144	

Project Description:

The objective of this research effort is to develop modified details for the Washington State short-radius guardrail system with a radius size up to 70 ft. The modified system would not be applicable for any other type of curved guardrail or similar installation. It should also be noted that these details will be based on engineering analysis and judgment. The recommended design will not be crash tested or considered to meet any test standard, such as NCHRP Report No. 350 or MASH.

Tasks	% completed
Review and summarize design details and prior crash testing on Washington State short-radius guardrail (WA-SRG)	100
Send summary to Wisconsin to decide on which short-radius system to model	100
Develop LS-DYNA FEA model of Yuma County-SRG system	100
Determine acceptable speed for 2000P crashes into Yuma County-SRG with LS-DYNA	100
Modify FEA model of WA-SRG to incorporate 70-ft radius	100
LS-DYNA analysis and design modifications for Yuma County-SRG with 70-ft radius	100
Prepare draft and final research reports	100
Identify possible intermediate heights for optimum rail performance	100
Evaluate impacts with 2000P for alternative rail height designs	100
Obtain FHWA acceptance for modified Yuma County-SRG with 70-ft radius	0

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

The draft research report was completed and revised, and is undergoing a final revision before sending to sponsors.

Anticipated work next quarter:

Research report will be sent to sponsors for review and revision. Report will then be finalized and published. Researchers have decided not to pursue FHWA acceptance of the larger radius design at this time.

Significant Results:

Systems with 27-in. tall top mounting heights may perform acceptably with radii as small as 8 ft, but may contribute to vehicular vaulting and override for light truck vehicles for radii between 20 and 70 ft. However, for very large radii greater than 50 ft, light trucks were successfully captured or redirected more commonly than for smaller radii. Thus, there exists some small and large radii for which many impacts may be acceptable, even with a nominally low mounting height.

Some impact conditions contributed to vaulting more commonly than others. Impacts between the beginning of the upstream LON and the 1/3-point of the radius were generally more severe and contributed to higher rates of vaulting than impacts between the 1/3-point and 2/3-point of the radius. Impacts near the center of the nose were frequently the least severe, with the highest deflections and lowest 50-ms average decelerations. Impacts between the 2/3-point of the radius and the guardrail-to-stiff bridge rail transition contributed to higher decelerations and higher rates of vaulting than impacts near the midpoint of the radius. Three phases of vehicle capture were identified: predominantly membrane tension; mixed membrane tension and guardrail pocketing; and predominantly guardrail pocketing. For 27-in. tall guardrails without blockouts, overrides occurred predominantly during phase I; with blockouts, all overrides occurred during phase II.

Vehicle geometries were critical in the performance of the radius. Impacts in which the impacting 2000P light truck vehicle bumper only interacted with the top rail corrugation which flattened before slipping below the bumper, interacting with the wheels, and forming a ramp. Impacts in which the bumper interacted with the bottom corrugation caused the rail to slide up the bumper and become interlocked with the radiator, headlights, and grill. Thus, to prevent vaulting, the rail should be located at a height in which the center of the top corrugation is above the top surface of the bumper.

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).

Other high-priority projects delayed revision of the draft research report. An additional extension was requested for this project.

Potential Implementation:

Based on preliminary results of simulations with a 29-in. top rail height, short radius systems with radii between 20 and 70 ft may capture errant vehicles with impact speeds up to 50 mph. Higher impact speeds may be acceptable if the length of rail is increased beyond the modeled beginning of the LON. Simulations of 24-ft and 48-ft radii indicated that, for a 90-degree radius, the system was at or near total capacity for impacts at 50 mph. Simulations of the 72-ft radius indicated that there was additional reserve capacity at 50 mph, but that impacts at 55 mph would likely require additional guardrail LON upstream of the modeled anchor to capture errant vehicles. Longer upstream lengths may allow each of the rail designs to be used for speeds up to 55 mph. The recommended system with a 29 in. rail height and 8-in. blockouts on 6 in. x 8 in. x 72 in. CRT posts is not recommended for crash testing or implementation whenever TL-3 impact conditions may occur.

For intersections which do not encompass a 90-degree angle, it is recommended that at least the same number of posts should be installed as were simulated for each of the radii considered.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Wisconsin DOT

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)* TPF-5(193) Suppl. #28	**Transportation Pooled Fund Program - Report Period:** ☐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: Downstream Anchoring Requirements for MGS		
Name of Project Manager(s): Faller R., Sicking D., Reid J.	**Phone Number:** (402)-472-6864	**E-Mail** rfaller@unl.edu
Lead Agency Project ID: 2611211043001	**Other Project ID (i.e., contract #):**	**Project Start Date:** July 1, 2010
Original Project End Date: June 30, 2013	**Current Project End Date:** December 31, 2013	**Number of Extensions:** 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
$ 235,065	$ 214,625	99%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$ 3,097	

Project Description:

Although downstream anchors are widely used on access-controlled freeways, these designs have never been crash tested under the current guidelines. Most states utilize an adaptation of various upstream terminals that incorporate at least one breakaway post and a cable anchor bracket. Because of the similarity of this design to upstream anchors that have been tested with a 2000P vehicle in the reverse direction, it is generally believed that existing downstream anchors will perform adequately when struck by light trucks. However, there is still some concern that these designs may not perform well when impacted by a small car. Further, the point at which these barriers can begin to contain and redirect an impacting vehicle (the end of length of need) has yet to be adequately determined. This project aims to determine: (i) the safety performance of the MGS close to the end anchorage and (ii) the end of the length of need for the MGS barrier.

Tasks:

1) Literature review and survey of State DOTs current plans for trailing end guardrail anchorage - concluded
2) Bogie tests to determine anchors strengths - concluded
3) Evaluate anchorage capacity and potential for vehicle snag for selected standard designs using LS-DYNA - concluded
4) Develop standard designs for downstream anchor systems - concluded
5) Prepare final CAD details for preferred downstream anchorage system - concluded
6) Assessment of the most critical system w/ two TL-3 full-scale crash tests under MASH - concluded
   a) 2270P
   b) 1100C
7) Summary report - under review
8) Journal paper - one journal paper is in progress, one is completed

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

During this quarter, the summary report was revised and finalized. The final report was printed. A journal paper was revised and a target journal was selected.

Anticipated work next quarter:

Hardware guide drawings will be completed and submitted. An FHWA eligibility request for the downstream anchorage system will be prepared and submitted.

Significant Results:

The downstream location of the end of the length of need was determined to be the sixth post from the end of the barrier. In general, BCT bearing bracket interaction with the small car and large truck suspensions did not cause instability, excessive occupant risk, or demonstrate occupant compartment deformation. Both 1100C and 2270P vehicles were smoothly redirected, and the 2270P and 1100C tests were determined to be successful. Therefore, the MGS end anchorage was determined to be successful according to MASH TL-3 impact conditions.

An internal review of the summary results of the bogie testing program provided valuable load-deflection characteristics of the BCT soil foundation tube, which was used to update and validate additional post-in-soil models. Also, results of the bogie tests were compared to other wood post tests to evaluate the strength of BCT posts. The new observations and modeling results were included in the draft of the test report and in the subsequent journal paper specifically addressing these findings.

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).

Due to unexpected delays involving internal review and additional high-priority research efforts conducted, progress on the report, FHWA eligibility request, and hardware guide drawings were delayed. Despite this delay, the project is still below the budget for this research effort. As a result, a project extension through June 2014 was requested and approved to complete internal and external reviews of the draft report and journal paper.

Potential Implementation:

The results obtained from this project will give practitioners useful information about the safety performance of guardrail systems, in particular the MGS, at locations close to the downstream end anchorage. This information is summarized in proposed guidelines for shielding hazards located in proximity of the tested downstream end anchorage.
Also, the results of this project will provide a clear identification of the end of the length of need (LON) at the downstream segment of the MGS system. Wood post strengths in splitting and torsional loadings were also determined from bogie testing, which will be instrumental in development of more accurate computer simulation models of wood in the future. Dynamic soil properties will be simulated and implemented in more advanced post-in-soil models for additional guardrail simulation studies.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): NE 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)* TPF-5(193) Suppl. #29	**Transportation Pooled Fund Program - Report Period:** ☐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: Minimum Effective Guardrail Length for MGS		
Name of Project Manager(s): Reid, Sicking, Faller, Bielenberg, Lechtenberg	**Phone Number:** 402-472-3084	**E-Mail** jreid@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):** 2611211044001	**Project Start Date:** June 30, 2010
Original Project End Date: June 30, 2013	**Current Project End Date:** December 31, 2013	**Number of Extensions:** 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
$122,444	$101,850	85%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$433	

Project Description:

Objective: Determine the effective working width and overall performance of the Midwest Guardrail System (MGS) shorter than the current 175' test length.

Tasks:
1. Review prior TL-3 pickup truck crash tests into the MGS - completed
2. LS-DYNA simulations to evaluate performance of MGS with system lengths of 175 ft and shorter - completed
3. Select minimum effective length of MGS and prepare system CAD details - completed
4. Construct MGS with reduced length - completed
5. Crash testing and evaluation program under MASH (one 2270P test) - completed
6. Additional simulations to predict barrier deflections and working widths for varying system lengths - completed
7. Draft and final research reports - completed

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

No work was done on this project during this quarter.

Anticipated work next quarter:

The project is essentially completed. There are a few project clean-up items left, including writing a TRB or other journal paper.

Significant Results:

On April 5, 2012, MwRSF conducted one pickup truck crash test (test no. mgsmin-1) into a 75-ft long 31-in. tall Midwest Guardrail System (MGS) using an 2270-kg Dodge Ram according to the TL-3 safety performance guidelines of MASH. The truck was successfully contained and redirected, and met all relevant test criteria.

Barrier VII results indicated that the 62-ft 6-in. MGS system would produce similar rail loads and deflections, and anchor loads and displacements as the 75-ft MGS, at the MASH Test Level 3 conditions. LS-DYNA simulations performed on the 50-ft MGS suggest impacts between post nos. 3 and 6 will effectively redirect the 2270P vehicle and successfully shield a hazard. Because of limitations in the simulations, full-scale crash testing is recommended if systems less than 75-ft in length are desired.

Report TRP-03-276-13 was published August 12, 2013.
"Minimum Effective Guardrail Length for the MGS"

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).

No problems have been encountered to date.

Potential Implementation:

This study will provide guardrail design guidelines for barrier lengths shorter than 175 ft. Designers will have full-scale crash testing evidence that very short guardrails function as intended as well as guidelines for estimating maximum barrier deflection as a function of guardrail length and impact location.

Simulations indicated successful redirection of an errant vehicle according to the MASH Test Level-3 conditions, for the MGS at 62 ft-6 in and 50 ft. Although the results of these simulations suggested successful redirection over a range of impact locations, full-scale testing is required for both the 62-ft 6-in MGS and 50-ft MGS before implementation could be recommended.

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 #31	☐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: Wood Post for MGS		
Name of Project Manager(s): Reid, Sicking, Faller, Lechtenberg, Bielenberg	**Phone Number:** 402-472-9070	**E-Mail** kpolivka2@unl.edu
Lead Agency Project ID: 2611211045001	**Other Project ID (i.e., contract #):** RPFP-11-MGS-1	**Project Start Date:** 7/1/10
Original Project End Date: 12/31/13	**Current Project End Date:** 12/31/13	**Number of Extensions:** 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
$121,215	$97,388	99

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$945	

Project Description:

Although the Federal Highway Administration has approved the use of the MGS with both W6x9 steel and 6x8-in. wood posts, no rectangular standard southern yellow pine post designs have been subjected to full-scale crash testing according to the MASH criteria. Eventually this testing needs to be conducted to verify the MGS performance with the most common wood post used in the United States.

Objective: Verify that 6x8-in. southern yellow pine wood post option for MGS has similar characteristics to the steel post MGS.

Tasks:

1. Full-scale crash testing (MASH 3-10 and 3-11)
2. Analysis and documentation of test results
3. Research report
4. Hardware guide drawings and FHWA acceptance

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

The final report will be completed and disseminated to the Pooled Fund member states.

Anticipated work next quarter:

The FHWA eligibility request will be submitted.

Significant Results:

On August 3, 2011, MwRSF conducted one pickup crash test (test no. MGSSYP-1) into a 31-in. tall Midwest Guardrail System (MGS) with standard southern yellow pine wood posts using a 2270-kg Dodge QuadCab according to the TL-3 safety performance guidelines of MASH. The pickup was successfully contained and redirected.

On September 13, 2011, MwRSF conducted one small car test (test no. MGSSYP-2) into a 32-in. tall Midwest Guardrail System (MGS) using an 1100-kg Kia Rio according to the TL-3 MASH safety performance guidelines. Again, the small car was successfully contained and redirected.

Task	% Complete
1. Full-scale crash testing (MASH 3-10 and 3-11)	100%
2. Analysis and documentation of test results	100%
3. Research report	100%
4. Hardware guide drawings and FHWA acceptance	85%

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).

The same test pit was used for Project No.:RPFP-11-MGS-3 – TPF-5(193) Supplement #33, Project Title: MGS without Blockouts. The wood post MGS system was constructed and tested following the completion of the aforementioned project. However, there are no additional problems or issues to report at this time.

Due to excess funds remaining at the time of completion of the project, an extension will be requested to move the remaining funds to contingency.

Potential Implementation:

Full-scale crash testing and verification of the safety performance of the southern yellow pine post MGS system will provide designers with increased confidence when specifying a rectangular wood post option for the MGS. In addition, specifying wood posts can be a less costly alternative to steel posts in some areas, and wood posts may provide for a more aesthetic treatment.

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. #32	☐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: MGS Guardrail Attached to Culverts		
Name of Project Manager(s): Reid, Sicking, Faller, Rosenbaugh	**Phone Number:** 402-472-9324	**E-Mail** srosenbaugh2@unl.edu
Lead Agency Project ID: 2611211046001	**Other Project ID (i.e., contract #):** RPFP-11-MGS-2	**Project Start Date:** 7/1/2010
Original Project End Date: 12/31/2013	**Current Project End Date:** 9/30/2014	**Number of Extensions:** 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**
$91,071	$91,281	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**
	$4,935	

Project Description:

Some cross-drainage culverts are wider than 24 ft and therefore cannot be treated with a long-span guardrail system. Although it is acceptable to utilize the deformable, top-mounted post attachment design developed for metric height guardrail under NCHRP Report No. 350, many existing culverts are too narrow to accommodate the loss of roadway width that comes with a top mounted system. Recently, the MGS Bridge Railing system was successfully developed and crash tested using the TL-3 MASH guidelines. The bridge railing system attaches to the exterior, vertical edge of reinforced concrete decks. It is believed that this bridge railing system could be adapted to mount to the backside face of an existing culvert headwall. The objective of this research effort is to develop an MGS guardrail system that attaches to the outside vertical face of the culvert headwall for box culverts greater than 24 ft wide.

Objectives / Tasks

1. Literature review of current culvert designs
2. Design of MGS attachment to face of headwall
3. Dynamic bogie testing
4. Data analysis and evaluation
5. Written report documenting all design work, testing, and conclusions

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

Work this quarter continued to focus on completing the project report through internal edits. A draft report was submitted to the members of the Pooled Fund for review on November 27, 2013. Although reviewer were originally due December 13, 2013, multiple states requested additional time to review the report. Thus, reviewer comments will be received through January of 2014.

A journal paper previously written about the project and submitted to the Transportation Research Board was accepted for presentation at the 2014 annual meeting. Minor edits were made to the paper to address reviewer comments.

Anticipated work next quarter:

The project report will be finalized after addressing all reviewer comments. Additionally, Task Force 13 Hardware Guide drawings will be prepared, and a letter of eligibility will be prepared and submitted to FHWA.

Significant Results:

A complete review of culvert designs used by Pooled Fund member states revealed a critical culvert design for testing and evaluation. A simulated culvert matching this critical design was constructed at MwRSF's test site. Four attachment concepts were developed, fabricated, attached to the simulated culvert and bogie tested. These concepts included a single-bolt top-mounted concept, a double-bolt top-mounted concept, a side-mounted concept, and a concept that wrapped around the top of the headwall and attached to the inside face of the headwall. Both the single anchor top mounted design and the side mounted design satisfied all resistance and damage requirements during lateral and longitudinal testing. Thus, these two designs will be recommended as attachment designs for the MGS Bridge Rail system attached to culvert headwalls.

Objectives / Tasks	% Complete
1. Literature review of current culvert designs	100%
2. Design of MGS attachment to culvert headwall	100%
3. Dynamic bogie testing	100%
4. Data analysis and evaluation	100%
5. Written report documenting all design work, testing, and conclusions	90%

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).

The cost to construct the simulated culvert was underestimated in the original budget. As such, the project is currently over budget (currently by $210). The excess funds are being drawn from the Year 21 contingency fund.

Multiple members of the Pooled Fund program requested additional time to review the draft report. Thus, the project needed to be extended. Additionally, three other projects funded during Year 21 of the Pooled Fund program had remaining funds upon their completion. In order to reallocate those remaining funds to other projects and contingency funds, those projects also needed to be extended. Therefore, the entire Year 21 Pooled Fund program was extended to September 2014.

Potential Implementation:

Development of a new attachment for the MGS system to low-fill culverts will allow designers to install the MGS system on culverts wider than 24 ft without reducing the width of the overall roadway. In addition, it is anticipated that the new attachment design on the outside of the headwall will reduce construction and maintenance costs.

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 #33	☐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: Wood Post for MGS		
Name of Project Manager(s): Reid, Sicking, Faller, Lechtenberg, Holloway	**Phone Number:** 402-472-9070	**E-Mail** kpolivka2@unl.edu
Lead Agency Project ID: 2611211047001	**Other Project ID (i.e., contract #):** RPFP-11-MGS-3	**Project Start Date:** 7/1/10
Original Project End Date: 12/31/13	**Current Project End Date:** 12/31/13	**Number of Extensions:** 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
$157,655	$101,516	100

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$55	

Project Description:

The oversized blockout used with the MGS design is one reason that the guardrail has demonstrated a 100 percent increase in redirective capacity as compared to conventional guardrail systems. However, there are some locations where roadway width is insufficient to accommodate a 12-in. blockout. A number of proprietary adaptations of the MGS design have been developed that do not utilize a blockout, thereby providing more useable roadway in constricted sites. A non-blocked version of the MGS should be feasible for use in those locations with constricted roadway widths.

Objective: Develop a MASH version of the MGS without blockouts for standard steel posts using standard components. If modifications to the system such as post to rail attachment are deemed to be necessary, the new components should be able to replace the existing components for all new construction and repair applications. By changing the standard components in the supply chain, it should be possible to minimize the risk of utilizing the wrong components in a no blockout design.

Tasks:

1. Full-scale crash testing (MASH 3-10 and 3-11)
2. Analysis and documentation of test results
3. Research report
4. Hardware guide drawings and FHWA acceptance

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

None as all work was completed during the last quarter.

Anticipated work next quarter:

None as all work was completed.

Significant Results:

On May 15, 2011, MwRSF conducted one pickup crash test (test no. MGSNB-1) into the Midwest Guardrail System (MGS) without blockouts using a 2270-kg Dodge QuadCab according to the TL-3 safety performance guidelines of MASH. The pickup was successfully contained and redirected.

On June 15, 2011, MwRSF conducted one small car test (test no. MGSNB-2) into the Midwest Guardrail System (MGS) using an 1100-kg Kia Rio according to the TL-3 MASH safety performance guidelines. Again, the small car was successfully contained and redirected.

Task	% Complete
1. Full-scale crash testing (MASH 3-10 and 3-11)	100%
2. Analysis and documentation of test results	100%
3. Research report	100%
4. Hardware guide drawings and FHWA acceptance	100%

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).

Due to excess funds remaining at the time of completion of the project, an extension will be requested to move the remaining funds to contingency.

Potential Implementation:

Narrow roadways will benefit from a non-proprietary non-blocked out system by making more roadway width available while still providing acceptable guardrail performance. Additionally, a non-proprietary alternative to the existing non-blocked out guardrails would eliminate problems associated with identifying and properly repairing proprietary 31-in. tall guardrail systems.

It should be noted that, even if the MGS is made to function without a blockout, the 12-in. block would still be recommended where there was adequate space existing along the roadside. The blockout greatly improves the barrier's capacity to contain and redirect high-energy impacts with high c.g. vehicles.

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. #34	☐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: Assess Standard Weld Detail		
Name of Project Manager(s): Reid, Sicking, Faller, Rosenbaugh	**Phone Number:** 402-472-9324	**E-Mail** srosenbaugh2@unl.edu
Lead Agency Project ID: 2611211048001	**Other Project ID (i.e., contract #):** RPFP-11-MGS-4	**Project Start Date:** 7/1/2012
Original Project End Date: 12/31/2013	**Current Project End Date:**	**Number of Extensions:**

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**
$10,000	$10,000	100%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$0	

Project Description:

In 2001, the Midwest Roadside Safety Facility (MwRSF) successfully developed a guardrail connection for low-fill culverts according to the Test Level 3 (TL-3) safety performance guidelines found in NCHRP Report No. 350. After evaluating several base plates, bolts, and weld combinations with undesirable results, a final configuration was chosen which consisted of a ½-in. plate attached with a 5/16-in. three-pass fillet weld on the critical flange and a 1/4-in. fillet weld on the web and back-side flange. The final post design was successfully tested and evaluated using both dynamic component bogie testing and full-scale vehicle crash testing.

During the implementation of the W-beam guardrail system for attachment to concrete box culverts, various State Departments of Transportation have raised questions concerning the use of the three-pass fillet weld on the critical flange. As such, there exists a need to re-examine the use of the three-pass weld and determine whether a simplified alternative weld detail could be used in combination with the rigid post attachment.

Objectives / Tasks

1. Literature review of current practices
2. Design of new weld detail
3. Dynamic testing and analysis
4. Written Report containing design work, testing, and conclusions

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

The final project report was sent out to the Pooled Fund members on September 19, 2013. Note, this report also incorporates the testing and conclusions of the related project: TPF-5(193) Suppl. #47, RPFP-12 MGS 4. This project will close at the end of this quarter.

Anticipated work next quarter:

The project will be closed at the end of this quarter.

Significant Results:

Two weld designs were selected via popular vote from the Pooled Fund members. Both weld designs were evaluated through a dynamic bogie impact test. During the tests the base plates tore adjacent to the weld on the front flange. During the component testing for the related project, TPF-5(193) Suppl. #47, RPFP-12 MGS 4, the 3-pass weld again illustrated is satisfactory performance even as the post and plate material strengths were increased from 36 ksi steel to 50 ksi steel.

Objectives / Tasks	% Completed
1. Literature review of current practices	100%
2. Design of new weld detail	100%
3. Dynamic testing and analysis	100%
4. Written Report containing design work, testing, and conclusions	100%

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).

This project was done in conjunction with a related project: TPF-5(193) Suppl. #47, RPFP-12 MGS 4. The report covered testing and conclusions for both projects.

Potential Implementation:

The development of a simplified, standard weld detail will be compatible with the culvert-mounted, W-beam guardrail system and available for use on low-fill concrete box culverts.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): NE 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)* TPF-5(193) Suppl.#37	**Transportation Pooled Fund Program - Report Period:** ☐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: Annual LS-DYNA Modeling Enhancement Support		
Name of Project Manager(s): Reid, Sicking, Faller	**Phone Number:** 402-472-3084	**E-Mail** jreid@unl.edu
Lead Agency Project ID: RPFP-11-LSDYNA	**Other Project ID (i.e., contract #):** 2611211050001	**Project Start Date:** July 1, 2010
Original Project End Date: December 31, 2013	**Current Project End Date:** December 31, 2013	**Number of Extensions:** 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
$35,901	$18,191	50%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
0	$2,798	0

Project Description:

The objective of this research effort is to set up an annual modeling enhancement program funded by the Pooled Fund Program States to address specific modeling needs shared by many safety programs. Funding from this project would go towards advancement of LS-DYNA modeling capabilities at MwRSF. The exact nature of the issues to be studied would be determined by the most pressing simulation problems associated with current Pooled Fund projects.

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

The following paragraph is a copy from the previous quarter report because such work continued during this quarter. Additionally, a concentrated effort on understanding and utilizing the NCHRP Verification & Validation Procedures relative to several MGS related projects was started.

Several MwRSF projects, which utilized the baseline MGS model as the starting point for the simulation portions of the projects, experienced difficulties when the baseline model was modified for each specific application. Those projects included a long span project, an MGS to TCB transition project, and a short radius project. The difficulties were primarily related to contacts between the vehicles and the modified MGS, and details associated with the rail attachment to the BCT posts at the anchors. Time was spent on this project in order to develop a more general solution to the difficulties encountered, as opposed to having each project develop band-aid type solutions.

Anticipated work next quarter:

Due to other project priorities, no work is anticipated for this project during the next quarter.

Significant Results:

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).

Due to the nature of this project, this project is worked on when the need arises or when there is a slack in other project priorities. Thus, the funds were not expended in the original project period. A no-cost time extension was requested during the quarter.

Potential Implementation:

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Wisconsin Department of Transportation

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. #40	☐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:		
Length of Need - B/C Analysis		
Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Albuquerque, Sicking, Faller, Stolle	402-472-4233	csstolle@huskers.unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211060001		7/1/2011
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/2014	6/30/2014	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**
$113,499	$141,282	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**
	$12,309	

Project Description:

Guardrail is used to shield motorists from collisions with roadside hazards and must extend long distances in advance of any roadside obstacle to minimize the risk of a vehicle traveling behind the barrier and striking the hazard. When the length of guardrail is increased, the risk that a vehicle will travel behind the barrier and strike the hazard is reduced. However, guardrail is also a roadside hazard that produces approximately 1,200 fatal crashes across the nation every year. Increasing the length of a guardrail installation increases the frequency of impacts with the barrier and thereby increases the risk of a serious crash. Further, the increase in barrier crash frequency associated with each incremental increase in guardrail length does not diminish as the guardrail is extended. At some point, the increase in the risk of serious injuries and fatalities associated with extending the guardrail outweighs the reduction in the risk of a vehicle traveling behind guardrail and producing serious injury or fatal impacts with the shielded hazard. Extending the guardrail beyond this optimal length will increase the overall risk that motorists will be involved in a serious injury or fatal crash.

The objective of this research effort is to quantify the probability of a vehicle traveling behind guardrail and striking a shielded hazard and its relationship to guardrail length. This probability will then be used to develop a revised procedure for determining optimal guardrail upstream length.

Objective / Task
1. Literature review
2. Guardrail, hazard and crash data collection
3. Data analysis
4. RSAP analysis
5. Written report containing all analysis and conclusions

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

An internal draft report was extensively revised and is under review. Comments received from review of the pertinent material will be implemented into the report prior to submission to the sponsor. A journal paper was submitted to the IRF international conference and was presented in November.

The project results were first presented to Wisconsin DOT on February 1, 2013. A subsequent review of the draft report by an engineering associate indicated that additional revisions were required. Once those revisions were incorporated into the document, the document was again internally reviewed and some revisions were submitted to the sponsors in October 2013.

Anticipated work next quarter:

Review and revision of the report will be completed. It is anticipated the draft report will be submitted to WisDOT for review and comment next quarter.

Significant Results:

An identification of the lowest-crash cost and highest-cost-effectiveness lengths-of-need (LONs) were pursued. It was determined that both the lowest-crash cost and highest-cost-effectiveness LONs were similar. Runout lengths corresponding to the optimum hazard and crash configurations were identified, and were observed to be approximately half as large as the runout lengths recommended in the 2006 Roadside Design Guide (RDG), and were significantly less than the recommended runout lengths presented in the 2011 RDG and Sicking and Wolford's recommendations.

Objective / Task	% Complete
1. Literature review	100%
2. Data collection	100%
3. Accident data analysis	100%
4. RSAP analysis	100%
5. Written report containing all analysis and conclusions	100%
6. Review and revise written report	85%

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).

The project demanded significantly more work during both vehicle crash data collection and RSAPv3 analyses than was originally predicted and budgeted. Researchers originally had planned to only collect data from Kansas's highway I-70. As the study progressed, it became apparent that additional data was needed. Thus, additional guardrail, hazard, and traffic volume data from all guardrail sites located on all Interstate highways in the State of Kansas was collected. This effort consumed a significant amount of resources.

In addition, researchers used the most recent version of the Roadside Safety Analysis Program, RSAPv3, in this study. Completion of nearly 1,000 simulations using RSAPv3 required an extensive amount of time to analyze and process the results. Although these factors have not negatively affected the project schedule, they have significantly affected the project budget.

The fund in this project were exhausted prior to the completion of the project. Therefore, the overrun budget is being posted to Project No. TPF-5(193) Suppl. #16 and Project No. TPF-5(193) Suppl. #43. To date, $5,490 has been posted to Project No. TPF-5(193) Suppl. #16 and $22,293 to Project No. TPF-5(193) Suppl. #43.

Potential Implementation:

The proposed research study would develop guardrail length design procedures calibrated to provide optimal safety for occupants of vehicles involved in ran-off-road crashes. These new procedures should provide both a reduction in the cost of guardrail construction and a reduction in the overall risk of motorist injury and fatality.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Wisconsin Department of Transportation

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. #41	☐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:		
Crashworthy Pedestrian Rail		
Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Sicking, Faller, Bielenberg, Lechtenberg	402-472-9070	kpolivka2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211061001		7/1/2011
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/2014	6/30/2014	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**
$234,629	$81,845	20%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$10,058	

Project Description:

Situations arise on the roadside where a barrier or rail is required to prevent pedestrians from crossing into a certain area which may be acceptable for an errant vehicle. Although these rails would not need to redirect or stop an errant vehicle, they must also not present additional hazards to the motoring public. These rails/fences should not cause excessive decelerations, vehicle snag points, vehicle instabilities, or produce fragments that may cause harm to other motorists when impacted. In addition, pedestrian rail systems must comply with the Americans with Disabilities Act (ADA). Therefore, a need may exist for a crashworthy pedestrian rail to protect pedestrians and prevent improper street crossings.

The objective of this research effort is development of a pedestrian rail to be ADA compliant and crashworthy. The objectives will be to identify the highest priority, crashworthy pedestrian rail need, to develop viable design concepts to meet that need, to finalize development of the crashworthy pedestrian rail system, and to perform the necessary MASH compliance tests for the system.

Objectives / Tasks
1. Literature review
2. Identification of rail needs and design criteria
3. Pedestrian rail design concepts
4. Component testing of design concepts
5. Summary report of design concepts
6. Finalize system details
7. Full-scale crash testing (MASH 2-91)
8. Full-scale crash testing (MASH 2-90)
9. Written report documenting design, testing, and conclusions

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

Three concepts were selected to be further developed. Connection designs (base and post-to-rail) for the aluminum welded concept were initiated. The 2010 version of the Aluminum Design Manual introduced new welded factors which had to be taken into consideration during the connection design development. Since it was desired that the system would not be heat treated, the post and rail members were redesigned and the sections increased. Numerous internal MwRSF meetings were held to discuss the various options for the connection designs.

Anticipated work next quarter:

The connection designs (base and post-to-rail) for the aluminum welded concept will be finalized. Once the aluminum welded connections are designed, the aluminum modular connections will be check to ensure they meet the design loads. After that the connection designs for PVC will be developed and finalized. It is anticipated that fabrication of the revised designs with all connections will be initiated. Component testing of the three concepts is anticipated for the end of the next quarter.

Significant Results:

None

Objectives / Tasks	% Complete
1. Literature review	95%
2. Identification of rail needs and design criteria	100%
3. Pedestrian rail design concepts	75%
4. Component testing of design concepts	0%
5. Summary report of design concepts	100%
6. Finalize system details	0%
7. Full-scale crash testing (MASH 2-91)	0%
8. Full-scale crash testing (MASH 2-90)	0%
9. Written report documenting analysis, design, testing, and conclusions	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).

None

Potential Implementation:

The results from this research will provide a cost effective, ADA compliant, crashworthy, pedestrian rail that prevents foot traffic from crossing but does not pose as a hazard to errant vehicles.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Wisconsin Department of Transportation

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. #42	☐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:		
Zone of Intrusion Concrete Barriers		
Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Sicking, Faller, Bielenberg, Lechtenberg	402-472-3084	jreid@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
	2611211062001	July 1, 2011
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
June 30, 2014	June 30, 2014	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
$58,942	$60,389	98%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$795	

Project Description:

In 2010, MwRSF performed a ZOI study for the Florida DOT. That study investigated a 40-in. high, F-shape concrete barrier under NCHRP Report 350 TL-3 criteria. LS-DYNA was used to simulate a 2000P vehicle model impacting the barrier under several conditions. Those being (1) without any tire/suspension failure, (2) with suspension failure, and (3) with tire air out after initial impact.

WisDOT has had some previous discussions with MwRSF about working width for the single sloped barrier. Those discussions were not documented in any sort of report. Because most crash testing with concrete barriers have been performed with barrier heights of 32", there is little crash test data for taller barrier heights. Based on those discussions and lack of test data, WisDOT took a conservative approach to working width and ZOI. Basically, the approach was to assume that the ZOI and working width would be no greater than those determined for a 32" height barrier values as the barrier height increased.

The objective of this research is to either verify that the current ZOI and working width values are sufficient or to recommend updated values based on LS-DYNA simulation.

Objectives / Tasks
1. Literature review of ZOI values
2. LS-DYNA Simulation of 2270P impacts on single slope barriers
3. Written reports documenting all work and conclusions

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

The final report was completed by addressing all sponsor comments.

Anticipated work next quarter:

Publish the final report.

Significant Results:

Objectives / Tasks	% Complete
1. Literature review of ZOI values	100%
2. LS-DYNA Simulation of 2270P impacts on single slope barriers	100%
3. Written reports documenting all work and conclusions	98%

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).

none

Potential Implementation:

Information gained from this project will provide WisDOT a higher confidence level in their concrete barrier working widths and ZIO dimensions.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Wisconsin Department of Transportation

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. #43	☐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: Roadside Grading Guidance - Phase II		
Name of Project Manager(s): Reid, Sicking, Faller, Bielenberg, Lechtenberg	**Phone Number:** 402-472-6864	**E-Mail** rfaller1@unl.edu
Lead Agency Project ID: 2611211063001	**Other Project ID (i.e., contract #):**	**Project Start Date:** 7/1/2011
Original Project End Date: 6/30/2014	**Current Project End Date:** 6/30/2014	**Number of Extensions:** 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
$199,502	$72,888 ($22,293 for Suppl #40, $1,4	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
	$14,163 ($12,309 for Suppl #40, $79	

Project Description:

Currently, it is difficult for designers to quantify the safety benefits of flattening roadway slopes. Consequently, a designer may not choose the most cost-effective roadside treatment for a given location. There are some tools to assist designers, however, these tools are difficult to use, time consuming, require training, and would be difficult to implement in a statewide policy. Therefore, there was a need to develop a tool (e.g. a series of graphs or charts) to help designers choose if flattening a slope for a given project is cost beneficial and, if so, identify the most appropriate method for providing slope flattening.

Previously, WisDOT funded a research study with the Midwest Roadside Safety Facility (MwRSF) to examine and update the severity values of roadside slopes, determine the range of slope conditions to be considered, and perform a benefit cost analysis to determine appropriate grading guidance. The total accident database contains approximately 20,000 accident cases, but the previous project analyzed only 1,500 of them due to budget limitations. The preliminary analysis of the data has only provided the average severity of slopes on rural arterials. These data cannot provide accurate correlation with speed limits and the depth of slope without expansion of the number of accident cases. It is believed that analysis of more accident data would allow determination of corresponding speed limits and slope depths. Thus, there is a need to expand this study with a second phase in order to improve the quality and accuracy of the slope grading guidance through analysis of as many of the available accident cases as possible.

Objectives / Tasks

1. Accident data collection
2. Data analysis and determination of critical elements
3. RSAP analysis
4. Written report documenting all analysis and conclusions

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

Discussion with the sponsoring agency was ongoing during this quarter in an effort to assist the agency with an initiative to reduce statewide spending. The report was thoroughly reviewed internally and externally, and a detailed task list was developed to strengthen the report. These tasks were ascertained from two conference calls held in late November and early December between Dr. Ron Faller, Dr. Dean Sicking, Kevin Schrum, and representatives from the Wisconsin Department of Transportation.

Anticipated work next quarter:

The final report will be edited and completed according to the requests of the sponsoring agency.

Significant Results:

Objectives / Tasks	% Completed
1. Accident data collection	100%
2. Data analysis and determination of critical elements	100%
3. RSAP analysis	100%
4. Written report documenting all analysis and conclusions	95%

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).

A subcontract was established for Dr. Dean Sicking in the amount of $25,649 in order for him to review and make edits on the report.

Due to the amount of work remaining, this project is projected to have extra funds remaining at the time the project is complete. The funds in Project Nos. TPF-5(193) Suppl. #40 and TPF-5(193) Suppl. #42 were exhaust prior to the completion of the project. Therefore, the overrun budgets for Project Nos. TPF-5(193) Suppl. #40 and TPF-5(193) Suppl. #42 are being posted to this project. To date, $22,293 has been posted to Project No. TPF-5(193) Suppl. #40 and $1,447 has been posted to Project No. TPF-5(193) Suppl. #42.

Potential Implementation:

This research will provide designers with a tool that simplifies and expedites the process of designing roadside slope geometry. In addition, the guidelines developed herein will provide a uniform policy for roadside design throughout the state of Wisconsin, thus improving the consistency and safety of the roadside slope geometries in the state. Finally, this research should provide for more cost effective use of limited state highway funds by defining the most cost effective slope designs.

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 #44	☐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: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase I		
Name of Project Manager(s): Reid, Sicking, Faller, Bielenberg, Lechtenberg	**Phone Number:** 402-472-9070	**E-Mail** kpolivka2@unl.edu
Lead Agency Project ID: 2611211064001	**Other Project ID (i.e., contract #):** RPFP-12-CABLE1&2	**Project Start Date:** 7/1/11
Original Project End Date: 6/30/14	**Current Project End Date:** 6/30/14	**Number of Extensions:** 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**
$233,262	$239,851 (+$100,449 Yr 21 Cont.)	70

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$3,047	

Project Description:

This project is an extension to previous projects (RPFP-08-02: Four-Cable Median Barrier in 4:1 V-Ditch; RPFP-09-01: New Funding for High-Tension Cable Barrier on Level Terrain with New Cable Attachment; and RPFP-10-CABLE-2: Replacement Funding for High-Tension Cable Barrier on Level Terrain).

Original Objective: To complete the development, testing, and evaluation of the four-cable, high-tension, median barrier system for use in 4H:1V sloped medians.

Revised Objective: To complete the development, testing, and evaluation of the four-cable, high-tension, median barrier system placed 0 to 4 ft away from the slope break point of a 6H:1V sloped medians.

Tasks:

1. Full-scale crash testing (MASH 3-10)
2. Full-scale crash testing (MASH 3-11)
3. Full-scale crash testing (Additional MASH 1500A)
4. Analysis and documentation of test results
5. Research report (s)
6. Hardware guide drawings and FHWA acceptance

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

The final report that includes the component tests conducted on the tabbed bracket and keyway bolt designs and the top cable attachment concepts and design was published and disseminated to the Pool Fund member states.

The report containing the folded C-channel posts and Midwest Weak Posts was undergoing internal review.

The prototypes for component testing of Concept C2 and Modified Concept C1 were fabricated. Component testing of isolated lateral and vertical load testing of the Concept C2 and Modified Concept C1 attachments to verify their performance was completed. On October 10, 2013, following these component tests, the states were contacted with the results of the component testing and to garner feedback on how they would like to proceed. The consensus of the States was to proceed with continued development of the shear plate attachment concept.

On October 28, 2013 another email requesting State feedback was sent out. Continued development of the modified version of Concept C1 with a spring type attachment arm was eliminated from the discussion. Analysis of several variations and options for this design have been investigated, and the conclusion was that this design would be very difficult using steel or other metals due to limitations on elastic deflection of the clip arm. This limited the design to a plastic part which may not meet the strength and durability requirements for the cable-to-post attachment. The options that remained were: (1) Fabrication and component testing of Chris Poole's key plate design; (2) Fabrication and component testing of Bill Wilson's version of Concept E1; (3) Evaluation of the bolted version of the tabbed bracket through full-scale testing with continued development of alternative attachments in parallel, as suggested by Bernie Clocksin; and (4) Evaluation of the bolted version of the tabbed bracket in full-scale testing and terminate continued development of alternative attachments. On November 27, 2013, an email detailing the results of the voting was sent to the member states. The results were to proceed with Option 3 which is evaluation of the bolted version of the tabbed

Anticipated work next quarter:

None as all funds have been exhausted.

Future work will be completed and reported under the project for the continued development of the Midwest Four-Cable, High-Tension, Median Barrier (Project No. RPFP-14-CABLE-1 - TPF-5(193) Supplement #64, Project Title: Continued Development of the Midwest Four-Cable, HT, Meidan Barrier) as well as Contingency Funds from several years designated for Cable R&D and Cable Reporting.

Significant Results:

As the result of the guidance from the member States in August 2011, it was decided the four-cable barrier system would be developed for use on sloped medians as steep as 6H:1V instead of 4H:1V but still placed 0 to 4 ft away from the slope break point (Plan B from letter dated August 15, 2011).

Task	% Complete
1. Full-scale crash testing (MASH 3-10)	0%
2. Full-scale crash testing (MASH 3-11) - 4CMB-5	100%
3. Full-scale crash testing (Additional MASH 1500A) - 4CMBLT-1	100%
4. Analysis and documentation of test results - 4CMB-5	100%
5. Analysis and documentation of test results - 4CMBLT-1	100%
6. Analysis and documentation of test results (MASH 3-10)	0%
7. Research report - 4CMB-4 and 4CMB-5	100%
8. Research report - 4CMBLT-1	100%
9. Research report	0%
10. Research report - Vehicle Trajectory Analysis	100%
11. Hardware guide drawings and FHWA acceptance	0%
12. Redesign of system	85%

Additional tasks added to the scope that are un-funded at this time:

13. R&D for a redesigned cable bracket
14. R&D for a larger diameter brace rod for top cable attachment

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).

The text has extends further than what is shown. Click within the box and scroll down.*

This project is an extension to previous projects (RPFP-08-02: Four-Cable Median Barrier in 4:1 V-Ditch; RPFP-09-01: New Funding for High-Tension Cable Barrier on Level Terrain with New Cable Attachment; and RPFP-10-CABLE-2: Replacement Funding for High-Tension Cable Barrier on Level Terrain).

It should be noted that the test conducted with the 1500A on the system placed on level terrain (Test No. 4CMBLT-1 conducted on June 14, 2011) was charged to the Project No.:RPFP-11-CONT – TPF-5(193) Supplement #39, Project Title: Pooled Fund Year 21 Contingency even though it was one of the tests funded in Project No.:RPFP-12-CABLE1&2 – TPF-5(193) Supplement #44, Project Title: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase I, V-Ditch. At the time this test was conducted, Year 22 funds were not available for use. The funds in the above mentioned contingency funds were available and were to be used to fund part of Phase II of this project.

As the result of the guidance from the member States in August 2011, it was decided the four-cable barrier system would be developed for use on sloped medians as steep as 6H:1V but still placed 0 to 4 ft away from the slope break point (Plan B from letter dated August 15, 2011). Depending on the simulation results and future modifications to the proposed MASH test matrices, up to seven full-scale crash tests may be required, including three level terrain tests.

Recall the development work was not originally a part of the current budget. Therefore, funds for the redesign work are being utilized from both this project as well as Project No.: RPFP-12-CABLE1&2 – TPF-5(193) Supplement #45, Project Title: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase I,

Potential Implementation:

The successful completion of the development, testing, and evaluation of the Midwest four-cable, high-tension, median barrier in sloped medians will allow the member states to implement a non-proprietary, high-tension, cable system along our nation's highways and roadways. The successful completion of this project along with the non-proprietary four-cable, high-tension, median barrier on level terrain and cable guardrail end terminal would help to assure acceptance by FHWA and improve its chances for widespread implementation.

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 #45	☐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:

Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase II

Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Sicking, Faller, Bielenberg, Lechtenberg	402-472-9070	kpolivka2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211065001	RPFP-12-CABLE1&2	7/1/11
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/14	6/30/14	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
$91,800	$101,179 (+$100,449 Yr 21 cont.)	0

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$14,684	

Project Description:

The Midwest Roadside Safety Facility (MwRSF) has been conducting research for the Midwest States Regional Pooled Fund Program to develop a non-proprietary, high-tension, four-cable, median barrier that is capable of being used anywhere in a V-ditch with 4H:1V side slopes. Three tests still remain to complete the test matrix of the cable barrier system in a V-ditch. In addition, the four-cable, high-tension, median barrier has never been tested on level terrain. There is a concern that FHWA may not approve this design without testing on flat ground, especially when considering the wide cable spacing and increased cable heights. Further, the barrier deflections observed in crash tests performed in a 4H:1V V-ditch are likely higher than would be observed on flat ground. Crash testing of the barrier installed on level terrain would identify barrier deflections and working widths that can be expected when the barrier is used in narrow medians with gentle slopes and would allow for better performance comparisons between the Midwest four-cable barrier and other proprietary systems.

Objective: To complete the development, testing, and evaluation of the four-cable, high-tension, median barrier system for use on level terrain.

Tasks:

1. Full-scale crash testing (MASH 3-10 and 3-11)
2. Analysis and documentation of test results
3. BARRIER VII calibration and analysis for alternate configurations
4. Research report
5. Hardware guide drawings and FHWA acceptance

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

None

Priorities set by the Pooled Fund member States are for the continued development of a high-tension, cable barrier system for relatively-flat and sloped median applications was to focus on the four-cable barrier system for use on sloped medians as steep as 6:1 but still placed 0 to 4 ft away from the slope break point.

Recall development work was not originally a part of this current budget nor that of Project No.: RPFP-12-CABLE1&2 – TPF-5(193) Supplement #44, Project Title: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase I, V-ditch Therefore, funds for the redesign work are being utilized from both this project as well as Project No.: RPFP-12-CABLE1&2 – TPF-5(193) Supplement #44, Project Title: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase I, V-ditch since the redesign will apply to both the V-ditch and level terrain scenarios.

See Project No.: RPFP-12-CABLE1&2 – TPF-5(193) Supplement #44, Project Title: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase I, V-ditch for a detailed explanation of the work completed.

All future reporting and funds posted will be made to Year 24, Project No. TPF-5(193) Suppl. #64 and Contingency Funds from several years designated for Cable R&D and Cable Reporting.

Anticipated work next quarter:

None.

Priorities set by the Pooled Fund member States are for the continued development of a high-tension, cable barrier system for relatively-flat and sloped median applications was to focus on the four-cable barrier system for use on sloped medians as steep as 6:1 but still placed 0 to 4 ft away from the slope break point.

All future reporting and funds posted will be made to Year 24, Project No. TPF-5(193) Suppl. #64 and Contingency Funds from several years designated for Cable R&D and Cable Reporting.

Significant Results:

Task	% Complete
1. Full-scale crash testing (MASH 3-10 and 3-11)	0%
2. Analysis and documentation of test results	0%
3. BARRIER VII calibration and analysis for alternate configurations	0%
4. Research report	0%
5. Hardware guide drawings and FHWA acceptance	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).

The text has extends further than what is shown. Click within the box and scroll down.*

A portion of this project ($91,089 is not included in the project budget shown on page 1) will be funded with Project No.: RPFP-11-CONT – TPF-5(193) Supplement #39, Project Title: Pooled Fund Year 21 Contingency.

It should be noted that the test conducted with the 1500A on the system placed on level terrain (Test No. 4CMBLT-1 conducted on June 14, 2011) was charged to the above mentioned contingency funds even though it was one of the tests funded in Project No.:RPFP-12-CABLE1&2 – TPF-5(193) Supplement #44, Project Title: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase I, V-Ditch. At the time this test was conducted, Year 22 funds were not available for use. The funds in the above mentioned contingency funds were available and were to be used to fund part of this project (Phase II).

As the result of the guidance from the member States in August 2011, it was decided the four-cable barrier system would be developed for use on sloped medians as steep as 6:1 but still placed 0 to 4 ft away from the slope break point (Plan B from letter dated August 15, 2011). Depending on the simulation results and future modifications to the proposed MASH test matrices, up to seven full-scale crash tests may be required, including three level terrain tests.

Recall development work was not originally a part of this current budget nor that of Project No.: RPFP-12-CABLE1&2 – TPF-5(193) Supplement #44, Project Title: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase I, V-ditch Therefore, funds for the redesign work are being utilized from both this project as well as Project No.: RPFP-12-CABLE1&2 – TPF-5(193) Supplement #44, Project Title: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase I, V-ditch since the

Potential Implementation:

The successful completion of the development, testing, and evaluation of the Midwest four-cable, high-tension, median barrier on level terrain will allow the member states to implement a non-proprietary, high-tension, cable system along our nation's highways and roadways. In addition, the crash testing of the four-cable, high-tension, median barrier on level terrain would also provide a more complete understanding of barrier performance (i.e., dynamic deflections, working width, etc.) when used in relatively flat, narrow medians. The crash results from the level terrain testing will be used in combination with computer simulation to evaluate the effects of reduced post spacing. The successful completion of this project along with the non-proprietary four-cable, high-tension, median barrier in V-ditch and cable guardrail end terminal would help to assure acceptance by FHWA and improve its chances for widespread implementation.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): NE 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)* TPF-5(193) Suppl. #46	**Transportation Pooled Fund Program - Report Period:** ☐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: Midwest Four-Cable, High-Tension, Median Barrier - Phase III, End Terminal		
Name of Project Manager(s): Reid, Sicking, Faller, Bielenberg	**Phone Number:** 402-472-3084	**E-Mail** jreid@unl.edu
Lead Agency Project ID: RPFP-12-CABLE	**Other Project ID (i.e., contract #):** 2611211066001	**Project Start Date:** July 1, 2011
Original Project End Date: June 30, 2014	**Current Project End Date:** June 30, 2014	**Number of Extensions:** 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
$199,626	0	0

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date

Project Description:

Project funds have been re-allocated to PF-Yr 24 Cable Project. Thus, this project is completed and will not be reported upon again.

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

Anticipated work next quarter:

Significant Results:

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).

Project funds have been re-allocated to PF-Yr 24 Cable Project. Thus, this project is completed and will not be reported upon again.

Potential Implementation:

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. #47	☐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: MGS Culvert Attachment with Epoxied Rods		
Name of Project Manager(s): Reid, Sicking, Faller, Bielenberg, Rosenbaugh	**Phone Number:** 402-472-9324	**E-Mail** srosenbaugh2@unl.edu
Lead Agency Project ID: 2611211067001	**Other Project ID (i.e., contract #):** RPFP-11-MGS-4	**Project Start Date:** 7/1/2011
Original Project End Date: 6/30/2014	**Current Project End Date:**	**Number of Extensions:**

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
$19,935	$15,552	99%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$238	

Project Description:

MwRSF has previously developed a TL-3 guardrail system for use on low-fill culverts and according to the NCHRP Report No. 350 safety performance criteria. In this application, the steel guardrail posts were anchored to the top of the culvert slab using through bolts in combination with a base plate that is welded to the bottom of the posts. However, problems can arise when the guardrail post coincides with the location of a vertical support wall found inside the culvert. For this scenario, through bolts cannot be utilized to anchor the guardrail posts to the culvert slab since there is unavailable space to place the lower bearing plate or access the lower end of the through bolt. Instead, it is necessary to use an alternative anchorage option, such as a threaded rod anchored into the culvert slab and upper region of the vertical wall. Unfortunately, no design recommendations exist for using epoxied anchor rods to attach the steel posts to the top of the culvert slab. A small research study is needed to evaluate suitable epoxied anchor rods for use with the W-beam guardrail over culvert system.

In 2010, the Midwest Pooled Fund States funded a small project to determine an alternative, standard weld detail which simplifies the post-plate attachment for the guardrail system mentioned above and to evaluate the new weld detail through both analysis and bogie testing. The proposed project herein is to act as a supplement to the current project, RFPF-11-MGS-4.

Objectives / Tasks

1. Literature review
2. Design of epoxied anchors
3. Dynamic testing and analysis of design
4. Written report containing all design, analysis and conclusions

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

The final project report was sent out to the Pooled Fund members on September 19, 2013. Note, this report also incorporates the testing and conclusions of the related project TPF-5(193) Suppl. #34, RPFP-11 MGS 4 as they both deal with attachment of the top mounted culvert post to culvert slabs.

Anticipated work next quarter:

The Task Force 13 Hardware Guide drawings for this system will be updated to reflect the conclusions formed during this project (acceptable steel grades and epoxy anchorage options).

Significant Results:

The first dynamic bogie impact test conducted on a post assembly anchored by rods embedded 6" into the tarmac resulted in the anchors pulling out of the concrete. The second test was conducted on a post utilizing an 8" embedment depth. During the second test, both the anchors and the post-to-plate weld held and the post was plastically deformed. Thus, 8 inches of embedment will be required for proper attachment of the top-mounted culvert post in locations where epoxy anchors are desired over the original bolt-through design.

Objectives / Tasks	% Completed
1. Literature review	100%
2. Design of epoxied anchors	100%
3. Dynamic testing and analysis of design	100%
4. Written report containing all design, analysis and conclusions	100%

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).

Minor edits to the Hardware Guide drawings are yet to be completed. However, most likely there will be some money left in the project after it is completed. It is anticipated that a request will be sent to the member States to transfer any remaining money from this project to the contingency fund for other projects.

Potential Implementation:

The development of an epoxied anchor rod alternative to the original through bolt anchorage of the culvert guardrail posts will allow the system to be installed anywhere across the top slab of the concrete culvert, regardless of the location of interior, culvert walls.

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)* TPF-5(193) Suppl. #48	**Transportation Pooled Fund Program - Report Period:** ☐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: Pooled Fund Center for Highway Safety		
Name of Project Manager(s): Ron Faller, John Reid, Bob Bielenberg	**Phone Number:** 402-472-9064	**E-Mail** rbielenberg2@unl.edu
Lead Agency Project ID: 2611211068001	**Other Project ID (i.e., contract #):** RPFP-12-PFCHS-1	**Project Start Date:** 7/1/2011
Original Project End Date: 6/30/14	**Current Project End Date:** 6/30/14	**Number of Extensions:** 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
$24,859.00	$15,956.00	85%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$1,756.00	

Project Description:

Many of MwRSF's inquiries from members of the Midwest States Pooled Fund program can be answered based upon prior pooled fund or other research. Further, even though answers to pooled fund inquiries are normally routed to all pooled fund states in the quarterly progress report, there are numerous repeat questions every year. The quarterly summaries are helpful to member states, but they are temporary and not well organized by the type of question or specific topic. Many pooled fund inquiries could be answered through the development of a Center of Highway Safety web site. This web site would provide an organized and searchable summary for all State inquiries and MwRSF reports as well as CAD details pertaining to Pooled Fund crash tested systems. This safety center would also be helpful to non-member states with problems or inquiries similar to those identified by the member states.

A dedicated and well-maintained Pooled Fund Center for Highway Safety web site would provide for all of these needs. It would provide for a searchable database of previous MwRSF inquiries and solutions, a searchable online listing of downloadable research reports, and a searchable archive of CAD details for crash tested and/or approved systems and features. Through MwRSF's relationship with the Nebraska Transportation Center (NTC), experienced personnel can be hired to perform website design, programming, as well as provide reliable website hosting facilities. However, the development, maintenance, operation, and hosting of the web site will require funding. It is anticipated that the costs to develop, operate, maintain, and host a Pooled Fund Center for Highway Safety web site would be $24,859.00 in funding for FY 22.

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

The MwRSF Pooled Fund Center for Highway Safety web site has been made functional in the second quarter of 2013. MwRSF's web site developers at UNL have created a web site that will house all of the MwRSF research reports and CAD details in a searchable format for downloading. The web site will tie in with both the existing MwRSF web site and the recently finished MwRSF Pooled Fund Consulting web site. The web site address is http://mwrsf.unl.edu/researchhub.php and the site can also be accessed directly from the "Tech Transfer" tab on the main MwRSF web site.

During this quarter, MwRSF continued to upload of all of MwRSF's latest research reports to the web site. In addition, MwRSF is working on modification of the main search page to include a listing of the most recent reports completed in the last six months. As noted in previous progress reports, all of the corresponding CAD files for the systems developed in the research reports were collected, and the archive of CAD files is in the process of being reviewed to ensure that the correct versions are uploaded to the site. Once the review of the CAD files is complete, the CAD files will be uploaded and made available as well.

Anticipated work next quarter:

MwRSF plans to finish populating the web site archive with CAD files during the first quarter of 2014. This would complete this first phase of the research effort. Follow on phases have been funded to keep the web site up to date and to allow for archiving of additional materials desired by the Midwest Pooled Fund.

Significant Results:

The web site has been completed and all of the reports continue to be uploaded as they are completed. Corresponding CAD files have been collected and are in the process of being reviewed prior to being placed on the site.

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).

None.

Potential Implementation:

The Pooled Fund Center for Highway Safety web site would provide immediate access to a wide library of roadside safety materials for designers and engineers, including reports, CAD details, etc. It would also provide a searchable database of previous solutions and responses to prior Pooled Fund inquiries and problems. The web site would also be available through controlled access to state DOT's around the country which would promote improved roadside safety.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Midwest Roadside Safety Facility, UNL

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)* SPR-3(017) Supplement #49	**Transportation Pooled Fund Program - Report Period:** ☐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: MGS Implementation (Year 18)		
Name of Project Manager(s): Reid, J.D., Sicking, D.L., & Faller, R.K.	**Phone Number:** 402-472-6864 (Faller)	**E-Mail** rfaller1@unl.edu
Lead Agency Project ID: RPFP-08-07 (2611120095008)	**Other Project ID (i.e., contract #):** SPR-3(017) Supplement #49	**Project Start Date:** September 1, 2007
Original Project End Date: December 31, 2009	**Current Project End Date:** July 31, 2013	**Number of Extensions:** 7

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
$15,928 (original)	$17,267	77%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$0	

Project Description:

This project consists of MGS implementation assistance and guidance for the Pooled Fund member states. Four general categories were initiated for the MGS. They are as follows:

Task	% Completed
Standard, Half, and Quarter Post Spacing	100
MGS with Curbs and MGS with 2:1 Slopes	100
MGS with Culvert Applications	100
MGS Stiffness Transition	5

In 2007, Pooled Fund consulting funds were used to assist states with the MGS implementation effort. MwRSF began the effort with a review of CAD details from the Illinois and Washington DOTs. Project correspondence occurred via email with a pre-determined Technical Working group. To date, three subject areas were covered and are as follows: (1) Standard, Half, and Quarter Post Spacing; (2) MGS with Curbs and MGS on 2:1 Slopes; and (3) MGS with Culvert Applications. A fourth category, MGS Stiffness Transition, was delayed in order to await the completion of a simplified, steel-post and wood-post approach guardrail transition.

The final reporting of the simplified, steel-post, approach guardrail transition system attached to the MGS was completed in the Fourth Quarter of 2010. The final reporting of wood post R&D effort was completed in November 2011, including dynamic bogie post testing and Barrier VII analysis. The MGS implementation activities commenced in the 1st Quarter of 2012 with the updating of the discussion group members and request for MGS standards for each State DOT.

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

No progress was made on this project. Deadlines for other projects, work related travel, and other commitments limited the amount of time that could be applied to furthering the research on this project.

Anticipated work next quarter:

The MGS implementation efforts will continue and will require the use of contingency funds.

Significant Results:

To date, MwRSF has provided review and comment regarding the MGS standard plans for Washington, Illinois, Kansas, Nebraska, and Ohio and for the first three categories and part of the fourth category. Since much of this effort began several years ago, the first three categories will be re-reviewed as many states are actively preparing and updating MGS details.

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).

As of November 30, 2012, approximately $12,312 of the $15,928 total project funds have been expended. It is expected that the remaining project funds in the amount of $3,616 will be utilized in December 2012 for continued MGS implementation activities. However, the MGS implementation efforts will continue into the First Quarter of 2013 and require the use of contingency funds.

As of February 28, 2013, the total project funds were expended. Thus, further work was charged to the Pool Fund Year 17 contingency funds. To date, $670 was charged to Pool Fund Year 17 contingency funds.

Potential Implementation:

MwRSF's review and comment has assisted several State DOTs with the advance implementation of the MGS and its design variations.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): NE 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)* TPF-5(193) Suppl. #51	**Transportation Pooled Fund Program - Report Period:** ☐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: Annual LS-DYNA Modeling Enhancement Support		
Name of Project Manager(s): Reid, Sicking, Faller, Bielenberg	**Phone Number:** 402-472-3084	**E-Mail** jreid@unl.edu
Lead Agency Project ID: RPFP-12-LSDYNA	**Other Project ID (i.e., contract #):** 2611211071001	**Project Start Date:** July 1, 2011
Original Project End Date: June 30, 2014	**Current Project End Date:** June 30, 2014	**Number of Extensions:** 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
$36,543	0	0

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
0	0	0

Project Description:

This is a continuation of TPF-5(193) Suppl.#37, "Annual LS-DYNA Modeling Enhancement Support" and thus, no progress to report until funds are exhausted in that project.

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

Anticipated work next quarter:

Significant Results:

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).

Potential Implementation:

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 #53	☐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: Annual Fee to Finish TF-13 and FHWA Standard Plans		
Name of Project Manager(s): Reid, Sicking, Faller, Lechtenberg	**Phone Number:** 402-472-9070	**E-Mail** kpolivka2@unl.edu
Lead Agency Project ID: 2611211079001	**Other Project ID (i.e., contract #):** RPFP-13-TF13	**Project Start Date:** 7/1/12
Original Project End Date: 6/30/15	**Current Project End Date:** 6/30/15	**Number of Extensions:** 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**
$3,983	$3,983	100

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$1,578	

Project Description:

Each year, the Midwest States Pooled Fund program sponsors several roadside safety studies at the Midwest Roadside Safety Facility (MwRSF) of the University of Nebraska-Lincoln. Some of these research efforts result in the development of new roadside safety features. As part of this effort and on behalf of the member states, MwRSF seeks FHWA acceptance for those devices or systems meeting current impact safety standards. In the future, FHWA will require standard Task Force (TF) 13-format CAD details along the typical system details when requests for hardware acceptance are made.

MwRSF prepares 2-D and/or 3-D CAD details for newly developed roadside safety features that are subjected to full-scale vehicle crash testing. The CAD details used to describe the as-tested systems or components are not always prepared and presented in the same format as now required by AASHTO TF 13 and FHWA. As such, additional CAD details and background information must be prepared when FHWA acceptance is sought under MASH or when the new system or associated components are submitted for inclusion in the electronic version of the barrier hardware guide.

Objective: For all new barrier hardware, the member states request that MwRSF seek formal FHWA acceptance and placement of standardized TF-13 CAD details in the electronic version of the highway barrier guide. This funding shall be used to supplement the preparation of the TF-13 format CAD details.

Tasks:

1. Prepare CAD details for Hardware Guide

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

Updated drawings based on comments received at the AASHTO TF-13 Spring and Fall 2013 meetings.

Anticipated work next quarter:

None.

The funds have been expended and the project will be closed.

Significant Results:

This project is used to supplement the preparation of the TF-13 format CAD details. Previously, it was determined that there are 14 systems and 11 components that need to be prepared in the TF-13 format. During discussions with the AASHTO TF-13 subcommittee in July 2011, new components had to be generated from the existing system drawings. Thus, the original 11 components became 32. Two of the systems and one component had limited work that need to be completed on the drawings as they were to be included in the Bridge Rail Guide and Luminaire Guide, respectively.

In evaluating the separation of the components, it was determined that some could be combined into one drawing based on the same type of component, but just one varying parameter.

Summary of Barrier Guide individual drawings to date:
31 systems - 26 approved, 5 to be reviewed
41 components - 31 approved, 10 to be reviewed
2 systems submitted to Bridge Rail Guide
1 component submitted to Luminaire Guide

Task	% Complete
1. Prepare CAD details for Hardware Guide	100%

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).

Funding from Project No.: RPFP-12-TF-13 – TPF-5(193) Supplement #49, Project Title: Annual Fee to Finish TF-13 and FHWA Standard Plans used prior to starting this project.

TF-13 is in the process of developing an online review system which will expedite the review process and allow more systems to be reviewed prior to their semi-annual meetings. Then at the TF-13 meetings it will be a final review and vote on if the drawings are ready to be implemented into the online guide.

Potential Implementation:

Newly-developed highway safety hardware will be contained in the electronic, web-based guide, thus promoting the standardization of barrier hardware across the U.S. and abroad.

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. #55	☐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:		
Increased Span Length of the MGS Long Span		
Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Sicking, Faller, Bielenberg, Lechtenberg	402-472-9324	srosenbaugh2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211081001	RPFP-13-UBSP	7/1/2012
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/2015		

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
$65,224	$36,471	90%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$4,236	

Project Description:

MwRSF has recently developed a Universal Breakaway Steel Post (UBSP) for use in the thrie beam bullnose system. The satisfactory performance of the UBSP in the bullnose median barrier system would suggest that there is potential for the UBSP to be used as a surrogate in other CRT applications, such as in the long-span guardrail system, guardrail end terminals, guardrail systems installed in subsurface rock foundations or rigid pavement mow strips, future short-radius guardrails, and new, reduced maintenance barrier systems. However, further analysis and testing would be required to verify its performance in these other guardrail applications. Thus, there exists a need to conduct further analysis and testing of the UBSP in order to investigate its feasibility for use in other barrier systems.

Objectives / Tasks
1. Dynamic bogie tests (8 total)
2. Data analysis and evaluation
3. Ulterior systems design recommendations
4. Written report documenting all testing, analysis, and conclusions

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

Previously, all eight dynamic bogie tests were conducted and analyzed.

Work this quarter was focused on finishing a first draft of the project report and conducting internal reviews of the report. The report currently remains in internal review.

Anticipated work next quarter:

Work will continue on the documentation report. Once revised, the draft report will be sent out to the Pooled Fund States for review, edits, and comments.

Significant Results:

All eight of the originally proposed dynamic bogie tests have been conducted and analyzed. The USBP and wooden CRT posts preformed similarly during the strong axis tests in terms of resistance force and displacement at time of fracture. During the weak axis tests, the USBPs demonstrated a quicker release/fracture than the CRT posts (recall CRT posts were designed to fracture during weak axis impacts so this could be considered an improvement to the CRT design). In general, the USBP shows promise for use in multiple systems in which CRT posts are currently utilized.

Objectives / Tasks	% Complete
1. Dynamic bogie tests (8 total)	100%
2. Data analysis and evaluation	100%
3. Ulterior systems design recommendations	100%
4. Written report documenting all testing, analysis, and conclusions	85%

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).

None

Potential Implementation:

Further analysis and development of the UBSP post would aid designers by providing a potential surrogate post design for current CRT applications. Because the UBSP design is fabricated from steel, its use offers several benefits over timber posts, including reduced variability, reduced concerns for deterioration over time, and alleviation of environmental concerns regarding disposal of wood posts with preservative treatment.

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. #56	☐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: Increased Span Length of the MGS Long Span		
Name of Project Manager(s): Reid, Sicking, Faller, Bielenberg, Lechtenberg	**Phone Number:** 402-472-3084	**E-Mail** jreid@unl.edu
Lead Agency Project ID: RPFP-13-MGS-3	**Other Project ID (i.e., contract #):** 2611211082001	**Project Start Date:** 7/1/2012
Original Project End Date: 6/30/2015	**Current Project End Date:**	**Number of Extensions:**

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**
$212,730	$29,377	12%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$10,528	

Project Description:

The current MGS long-span guardrail system provides the capability to span unsupported lengths up 25 ft. While this span length has many useful applications, many culvert structures exceed the span length of the MGS long-span system. Other solutions for mounting guardrail to culverts exist, but mounting hardware to culverts can also cause difficulties. If the long span can be adjusted to accommodate longer spans, the difficulties associated with mounting hardware to the culvert can be avoided.

The objective of this research effort is to design and evaluate the MGS long-span design for use with unsupported spans greater than 25 ft. The research effort could be focused in one of two directions. The research could focus on determination of the maximum unsupported span length for the current long-span design or it could focus on evaluating potential modifications that may allow for significantly longer unsupported spans. The increased unsupported span design would be designed to meet the TL-3 safety criteria set forth in MASH.

Objectives / Tasks

1. Literature review of previous long-span systems - completed
2. Simulation of both original and any new long-span system designs - in-progress
3. Design modifications to extend unsupported length
4. Full scale crash testing of new design (two MASH 3-11 tests)
5. Data analysis and evaluation
6. Written report documenting all design work, simulation, testing, and conclusions

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

Task 2.

The 31-ft 3-in. MGS Long span model was simulated at various impact locations to determine some of the more critical impact points. The last CRT post upstream(U.S.) of the unsupported length and the last missing post spacing at the downstream (D.S.) end of the unsupported length are two impact locations that have the propensity for difficulties. Impacting U.S. of the unsupported length allows the left-front tire to drop down below the culvert head wall and impact the D.S. wing wall of the culvert increasing the longitudinal decelerations. Impacts at the last missing post spacing at the D.S. end of the unsupported length provide the highest pocketing angles and largest dynamic deflection values.

The 37-ft 6-in. MGS Long span system has been developed and similar impact locations are being investigated. A span length of 37 ft - 6in. shows the possibility of successful redirection, however, the analysis is still ongoing. The rail loads, anchor loads, and pocketing angles are still being investigated to determine whether a span length of this magnitude could be successful in physical testing.

The subcomponent model developed for improving post-rail connections has achieved proper preload. To test the post and rail connection, the rail segment was subjected to longitudinal and lateral displacements to simulate loading of the rail. Further modeling efforts are aimed at getting the bolted connection to release the rail as a function of bolt preload as well as rail displacement.

Anticipated work next quarter:

Task 2.
Simulations of 37-ft 6-in. MGS Long span system, at various impact locations, will continue. The analysis of these simulations will attempt to either express confidence, that a span length of this size has reasonable potential to pass physical testing, or discredit a 37-ft 6-in. long unsupported length as a possible test case.

Physical test data is being accumulated to calibrate the rail release in the post and rail component model. The aim is to attempt to compare the simulation results against lateral pull tests as well as overhead film analysis. In addition, a comprehensive literature review will be conducted to review techniques for modeling previous post and rail connections as well as similar bolted joint connections.

Significant Results:

Initial simulations of an increased span length indicate successful redirection at a span length of 31 ft - 3 in.

Objectives / Tasks	% Complete
1. Literature review of previous long-span systems	100%
2. Simulation of both original and any new long-span system designs	50%
3. Design modifications to extend unsupported length	0%
4. Full scale crash testing of new design (two MASH 3-11 tests)	0%
5. Data analysis and evaluation	0%
6. Written report documenting all design work, simulation, testing, and conclusions	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).

This project has a cost of $249,335. There was insufficient funding in Pool Fund Year 23 to fund this entire amount. Thus, The budget for Year 23 is $212,730, and the remaining is being funded by contingency funds in Pool Fund Year 23.

Potential Implementation:

The MGS long-span system has the ability to perform safely without nested rail and with a minimal barrier offset. These features make the barrier a very functional, efficient, and safe option for protection of low-fill culverts. Development of an increased unsupported span length for the MGS long-span system will add to the flexibility of the design and provide for improved protection of culvert headwalls and vertical dropoffs with a length greater than 25 ft.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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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. #57	☐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:		
Increased Span Length of the MGS Long Span		
Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Sicking, Faller, Bielenberg, Lechtenberg	402-472-9324	srosenbaugh2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211083001	RPFP-13-MGS-5	7/1/2012
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/2015		

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**
$162,896	$18,115	20%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$0	

Project Description:

Over the years, it has become desirable to place a longitudinal concrete slab or continuous asphalt pavement under W-beam guardrail systems in order to reduce the time and costs for mowing operations around guardrail posts. Likewise, many times guardrail posts must be installed in un-yielding pavements. Unfortunately, the placement of guardrail posts in pavement restricts energy dissipation by restricting the posts from rotating through the soil. Thus, installations in pavements have incorporated a blocked-out area or "leave-out" that surrounds each post. These leave-outs allow post rotation in the soil and result in acceptable safety performances for standard W-beam guardrails.

Recently, the MGS Bridge Rail was developed and successfully crash tested under the TL-3 MASH guidelines. This system utilized weak steel posts placed in tubular steel sockets that were side-mounted to a concrete bridge deck. The energy dissipation mechanism for this system was designed as bending of the weak posts instead of post rotation through soil. Since the posts are installed in rigid sleeves, MwRSF believes that the MGS Bridge Rail could be adapted for use in guardrail applications where mow strips are required. In this situation, it would be unnecessary to provide large leave-outs around the posts of guardrail systems installed in un-yielding pavements. Thus, The objective of this research effort is to adapt the MGS Bridge Rail system for use in mow strips and other pavements.

Objectives / Tasks

1. State survey of existing mow strip practices
2. System design and analysis
3. Dynamic bogie component testing
4. Full scale crash testing (MASH 3-10 and 3-11 tests)
5. Data analysis and evaluation
6. Written report documenting all design work, simulation, testing, and conclusions

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

Previous component testing of S 3x5.7 posts installed in 4"x4" socket tubes which in turn were encased in a 4" asphalt mow strip resulted in the socket displacing 1.5" through the asphalt. Work this quarter focused on developing methods to better distribute and disperse the shear impact load from the socket to the surrounding asphalt and soil. A new socket tube equipped with a 1/4" thick shear plate welded to the top-back side was designed and fabricated. The new socket is currently in queue for component testing.

Anticipated work next quarter:

Additional dynamic component testing will be conducted on the post and socket installed within a 4" mow strip. The socket will incorporate steel shear plates in order to better distribute the load and reduce socket displacement.

Significant Results:

A survey of the Pooled Fund States revealed the critical mow strip to be 4 in. thick and 4 ft wide. Both asphalt and concrete versions of the mow strip shall be investigated through dynamic component tests. Component testing testing demonstrated that a 4" concrete pad has sufficient strength to withstand the imapct loads without damage. However, testing within the asphalt mow strips illustrated that the posts will push through the asphalt and displace up to 3 inches. Thus, a socket and load distributing plates will be necessary to anchor the posts and prevent damage within the asphalt mow strip.

Objectives / Tasks	% Complete
1. State survey of existing mow strip practices	100%
2. System design and analysis	55%
3. Dynamic bogie component testing	30%
4. Full scale crash testing (MASH 3-10 and 3-11 tests)	0%
5. Data analysis and evaluation	0%
6. Written report documenting all design work, simulation, testing, and conclusions	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).

Matching funding in the amount of $60,000 was obtained through the Mid-American Transportation Center. Thus, additional component testing can occur to explore various options for installing the S3x5.7 posts within both concrete and asphalt mow strips. Since the MATC project closes in December 2014 (before the Pooled Fund project), all design, evaluation, and component testing since September 2013 has been charged to the MATC project. This explains why no Pooled Fund project funds were spent this quarter.

Potential Implementation:

Adapting the MGS bridge rail to be placed in various pavements will allow designers to install the weak post, MGS system in mow strips without requiring leave-outs, breakaway posts, or other additional hardware. It is anticipated that the new post foundation design will significantly reduce labor and system costs associated with installation, repair, and maintenance of guardrail installed in mow strips and other pavements. Insight will also be gained regarding the potential performance of other weak post guardrail systems when installed in mow strips.

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 #58 Pooled Fund Project RPFP-13-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:

Dynamic Testing and Evaluation of Curb and Gutter Placed Under Asymmetrical Section of MGS Thrie Beam Transition

Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Sicking, Faller, Bielenberg, Lechtenberg	402-472-6864	rfaller1@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211084001	RPFP-13-AGT-1	7/1/2012
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/2015	6/30/2015	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**
$154,217	$154,217	85%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$1,124	

Project Description:

Recently, MwRSF researchers successfully developed and crash tested a simplified, steel-post stiffness transition for adapting the 31-in. tall Midwest Guardrail System (MGS) to existing, thrie beam approach guardrail transition systems. This system utilized an asymmetrical transition section, which maintained a top mounting height of 31 in. The system was successfully crash tested to TL-3 impact safety standards of MASH. However, this simplified stiffness transition system was not evaluated with a lower concrete curb placed below the rail.

Concrete curbs are often installed below approach guardrail transitions to increase hydraulic capacity, control water runoff, and mitigate concerns for soil erosion near bridge ends. As such, many states are interested in placing curbs underneath and throughout the length of common approach guardrail transitions. However, the addition of a curb below a transition rail element can potentially lead to severe consequences. Specifically, small car vehicles may become wedged between the bottom of the asymmetrical rail and the top of the curb. This snag event could lead to excessive vehicle decelerations, increased risk to occupants, and vehicular instabilities. Light truck passenger vehicles may climb the curb and contact the rail with the vehicle c.g. positioned higher than normal, thus potentially causing excessive vehicular instabilities, and even rollover, during redirection. Unfortunately, no crash testing has been performed near the upstream end of the new simplified stiffness transition to thrie beam approach guardrail transitions where curbs are placed directly below the asymmetrical transition element. Therefore, full-scale vehicle crash testing is deemed necessary to verify the safety performance of curb placement below the asymmetric transition element.

Objectives & Tasks

1. Full-scale crash testing (MASH test designation nos. 3-20 and 3-21).
   1a. Full-scale crash test of modified transition (MASH test no. 3-20) - project modification covered in Year 24**
2. Data analysis and evaluation.
3. Report documenting R&D effort, including brainstorming, redesign, construction, crash testing, conclusions, and

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

The preparation of the draft research and test report continued. Internal review of the draft report was initiated.

Anticipated work next quarter:

None as all funds have been expended. All future work will be posted to the follow-on project, Project No. RPFP-14-AGT-1 - TPF-5(193) Supplement #63, Project Title: Dynamic Testing and Evaluation of Curb and Gutter Placed Under Asymmetrical Section of MGS Thrie Beam Transition.

Significant Results:

Test no. MWTC-1 (MASH test designation no. 3-20) illustrated that the placement of a 4-in. tall curb in combination with the MGS stiffness transition with asymmetrical transition rail element can significantly degrade barrier performance from that observed when the curb was not installed. The 1100C full-scale crash test resulted in rail rupture at the upstream end of the asymmetrical W-beam to thrie beam transition element, and the vehicle snagged on several transition posts.

Test no. MWTC-2 (MASH test designation no. 3-20) demonstrated that the use of 12 ft - 6 in. of nested W-beam rail in advance of the asymmetrical segment was able to mitigate factors that led to guardrail rupture. In addition, this small car re-test showed that the MGS stiffness transition in combination with lower curb met the TL-3 MASH impact safety standards when used with 12 ft - 6 in. of nested W-beam rail.

Test no. MWTC-3 (MASH test designation no. 3-21) was conducted on the modified system on May 16, 2013 and satisfied all of the MASH safety performance criteria. The test demonstrated that the 2270P pickup truck was successfully contained and redirected by the MGS stiffness transition in combination with lower curb when used in combination with 12 ft - 6 in. of nested W-beam rail.

Objectives/Tasks	% Complete
1. Full-scale crash testing (MASH test designation nos. 3-20 and 3-21).	100%
1a. Full-scale crash test of modified transition (MASH test no. 3-20)	100%
2. Data analysis and evaluation.	100%
3. Report documenting R&D effort, including redesign, crash testing, and conclusions	50%

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).

Due to a failure in the first full-scale crash test, a second small car crash test was performed on a modified barrier system. A third test with a 2270P pickup truck was later conducted on the modified barrier system. This project originally contained only two budgeted crash tests - one 1100C small car and one 2270P pickup truck. However, a Year 24 Pooled Fund project was funded to cover the expenses for the small car re-test and additional construction, analysis, documentation, and reporting.

All future work will be posted to the follow-on project, Project No. RPFP-14-AGT-1 - TPF-5(193) Supplement #63, Project Title: Dynamic Testing and Evaluation of Curb and Gutter Placed Under Asymmetrical Section of MGS Thrie Beam Transition.

Potential Implementation:

The successful crash testing of the MGS stiffness transition with asymmetric transition element and lower concrete curb will allow State Departments of Transportation to provide continuous hydraulic runoff control between approach guardrail transitions and W-beam approach rails. The use of continuous concrete curb will help to mitigate soil erosion near bridge ends as well as its costly maintenance and repair.

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)* TPF-5(193) Suppl. #60	**Transportation Pooled Fund Program - Report Period:** ☐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: Pooled Fund Center for Highway Safety		
Name of Project Manager(s): Ron Faller, John Reid, Bob Bielenberg	**Phone Number:** 402-472-9064	**E-Mail** rbielenberg2@unl.edu
Lead Agency Project ID: 2611211086001	**Other Project ID (i.e., contract #):** RPFP-13-PFCHS	**Project Start Date:** 7/1/2012
Original Project End Date: 6/30/15	**Current Project End Date:** 6/30/15	**Number of Extensions:** 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
$10,958.00	$0.00	0%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$0.00	

Project Description:

Many of MwRSF's inquiries from members of the Midwest States Pooled Fund program can be answered based upon prior pooled fund or other research. Further, even though answers to pooled fund inquiries are normally routed to all pooled fund states in the quarterly progress report, there are numerous repeat questions every year. The quarterly summaries are helpful to member states, but they are temporary and not well organized by the type of question or specific topic. Many pooled fund inquiries could be answered through the development of a Center of Highway Safety web site. A dedicated and well-maintained Pooled Fund Center for Highway Safety web site would provide for all of these needs. It would provide for a searchable database of previous MwRSF inquiries and solutions, a searchable online listing of downloadable research reports, and a searchable archive of CAD details for crash tested and/or approved systems and features. This safety center would also be helpful to non-member states with problems or inquiries similar to those identified by the member states.

In Year 22, the Midwest States Pooled Fund states sponsored the development of a Pooled Fund Center for Highway Safety web site. This project allowed for the development of the first phase of the web site and archiving of materials on the web site. In the past year, a web site for the Midwest States Pooled Fund consulting questions and responses was developed and made available. The web site is currently operational and provides functions for submitting questions and inquiries to MwRSF as well as posting of the responses. It also provides a searchable database of previous MwRSF inquiries and solutions. The website is located at http://mwrsf-qa.unl.edu/.

In addition to the consulting web site, a searchable online listing of downloadable research reports, and a searchable archive of CAD details for crash tested and/or approved systems and features has been started. MwRSF is currently in the process of making this web site operational and uploading the archived reports and CAD. MwRSF anticipates that this archive will be fully functional in the near term. The report and CAD archive as well as the Midwest States Pooled Fund consulting web site will be integrated with the main MwRSF web site in the near future as well.

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

At this time, the Pooled Fund Center for Highway Safety web site is completed and the funding provided in this project has yet to be accessed for web maintenance and updating.

Anticipated work next quarter:

The project funding herein will not be accessed until the Pooled Fund Center for Highway Safety web site is fully operational and addition updates and maintenance are required.

Significant Results:

None.

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).

None.

Potential Implementation:

The Pooled Fund Center for Highway Safety web site would provide immediate access to a wide library of roadside safety materials for designers and engineers, including reports, CAD details, etc. It would also provide a searchable database of previous solutions and responses to prior Pooled Fund inquiries and problems. The web site would also be available through controlled access to state DOT's around the country which would promote improved roadside safety.

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)* TPF-5(193) Supplement #61	**Transportation Pooled Fund Program - Report Period:** ☐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: Dynamic Evaluation of Cable Guide Rail w/Strong and Standard J-Bolts Under MASH		
Name of Project Manager(s): Faller, Reid, Lechtenberg, Bielenberg, Stolle	**Phone Number:** 402-472-9070	**E-Mail** kpolivka2@unl.edu
Lead Agency Project ID: 261121109001	**Other Project ID (i.e., contract #):**	**Project Start Date:** 12/1/2012
Original Project End Date: 5/31/2014	**Current Project End Date:** 5/31/2014	**Number of Extensions:**

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**
$257,478	$208,271	85

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$79,392	

Project Description:

This project was intended to evaluate modifications to cable-to-post attachments intended to reduce the frequency of vehicular penetration through and under low-tension cable barriers by increasing the attachment strength.

Tasks of original project:

1. Development of remote braking test protocol to achieve depressed bumper height during MASH impact conditions
2. Conduct preliminary braking tests for front-end pitch and determine effective friction coefficients
3. Prepare CAD details of tangent, low-tension, 3-cable barrier system with 1/2-in. dia. hook bolts (600+ ft long)
4. Construct tangent, 3-cable barrier system with 1/2-in. dia. hook bolts
5. Full-scale test of 3-cable barrier with 1/2-in. dia. hook bolts with 1500A sedan and brakes engaged (modified MASH 3-10)
6. Analysis and documentation of test results (modified MASH 3-10)
7. Prepare CAD details of tangent, low-tension, 3-cable barrier system with 1/2-in. dia. hook bolts (600+ ft long)
8. Construct tangent, 3-cable barrier system with 1/2-in. dia. hook bolts
9. Full-scale test of 3-cable barrier with 1/2-in. dia. hook bolts with 2270P (MASH 3-11)
10. Analysis and documentation of test results (MASH 3-11)
11. Prepare CAD details of tangent, low-tension, 3-cable barrier system with 5/16-in. hook bolts (600+ ft long)
12. Construct tangent, 3-cable barrier system with 5/16-in. dia. hook bolts
13. Full-scale test of 3-cable barrier system with 5/16-in. dia. hook bolts with 2270P (MASH 3-11)
14. Analysis and documentation of test results (MASH 3-11)
15. Draft and final research reports

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

One full-scale crash test was conducted this quarter, consisting of a 2270P pickup truck impacting the system at approximately 62.1 mph and 25 degrees. The system was constructed with 1/2-in. J-bolts and measured approximately 608 ft long. The impact location was 12 in. upstream from post no. 17.

During the test, the top and middle cables engaged the bumper and the vehicle began to be redirected, and the bottom cable was overridden and engaged the undercarriage before becoming entangled with the suspension at the right-rear wheel. Shortly after impact, the upstream and downstream cable hanger posts bent toward impact, decreasing the angle between the next adjacent post and the cable anchor bracket. The reduced approach angle between the cables and the anchor bracket subjected the threaded rods to bending loads, which were extenuated when the threaded rods became wedged between the bracket and vertical J-hook studs embedded in the concrete anchor. The threaded cable anchor rods of the middle and top cables fractured and released the cables. As a result, the truck underrode the middle and top cables and came to rest in a ditch behind the cable barrier system. After the upstream cable hanger post bent over, load cells on the bottom cable of the upstream end of the system contacted the next downstream post and fractured, releasing the bottom cable. Bottom cable performance was not critical to the test outcome.

An analysis of test results was completed, and it was decided not to pursue the final test in the series involving a 2270P pickup truck impacting the system 12 ft upstream from post no. 17, using cable compensators and 5/16-in. J-bolts. The remaining $71,894 in final full-scale test charges will be returned to the New York State Department of Transportation, except for the cost of system removal. The cost of removal is not known at this time.

A draft report is currently in progress.

Anticipated work next quarter:

The internal draft report will be completed. Internal review will be initiated.

A journal paper will be drafted and revised. The paper will be submitted to the New York State Department of Transportation for review before submitting to a transportation journal.

Significant Results:

Key contributors to cable end fitter release were identified and rectified for test no. NYJ-2.

Tasks:	% Completed
1. Development of remote braking test protocol	100%
2. Conduct braking tests to determine braking friction coefficients and vehicle pitch	100%
3. Prepare CAD details of tangent, low-tension, 3-cable barrier system with 1/2-in. dia. hook bolts	100%
4. Construct system with 1/2-in. dia. hook bolts	100%
5. Conduct crash test with 1500A vehicle (modified MASH 3-10; test no. NYJ-1)	100%
6. Analyze test no. NYJ-1 results (modified MASH 3-10)	100%
6a. Identify critical features contributing to unacceptable cable release in test no. NYJ-1	100%
6b. Conduct crash test with 1500A vehicle (modified MASH 3-10; test no. NYJ-2)	100%
6c. Analyze test no. NYJ-2 results (modified MASH 3-10)	100%
7. Prepare CAD details of tangent, low-tension, 3-cable barrier system with 1/2-in. dia. hook bolts	100%
8. Construct system with 1/2-in. dia. hook bolts	100%
9. Conduct crash test with 2270P vehicle (MASH 3-11)	100%
10. Analyze test results (MASH 3-11)	100%
11. Prepare CAD details of tangent, low-tension, 3-cable barrier system with 5/16-in. dia. hook bolts	NA
12. Construct system with 5/16-in. dia. hook bolts	NA
13. Conduct crash test with 2270P vehicle (MASH 3-11)	NA
14. Analyze test results (MASH 3-11)	NA
15. Draft and final research reports	40%

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).

The disappointing results of test no. NYJ-3, combined with the windshield crush observed in test no. NYJ-2, indicated that there was little benefit in comparing the results of a system with standard 5/16-in. J-bolts, cable compensators, and modified end anchors to the results of test no. NYJ-3. As a result, further research on this system was suspended.

MwRSF will reimburse NYSDOT for the test charges budgeted for the final planned full-scale test. However, removal and cleanup after the test were included in the last test budget, and will still be required after test no. NYJ-3. The total reimbursement will be equal to $71,894 minus the cost of system removal and cleanup. $36,124 minus the cost of system removal and cleanup from this project (Project No. TPF-5(193) Supplement #61) and $35,770 from Project No. TPF-5 (193) Supplement #72 will be returned to NYSDOT.

Potential Implementation:

This will determine if the use of stronger J-bolts can reduce the dynamic deflections of New York State Department of Transportation's standard three-strand cable guide rail system. It will also determine if the stronger J-bolts will increase the ability of the system to capture a sedan with a low-profile, aerodynamic front end. Further, it will determine if there is an increase in propensity for barrier override of pickup trucks or vehicle decelerations with the cables more firmly attached to the posts. If the stronger J-bolt systems perform acceptable, this research will also provide the NYSDOT justification of dynamic barrier deflection for a common three-strand cable barrier system with an overall system length in excess of 600 ft. It will also provided justification for redesigning the end post stubs to limit the amount of damage.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Wisconsin DOT

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)* TPF-5(193) Suppl # 62	**Transportation Pooled Fund Program - Report Period:** ☐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: Safety Investigation & Design Guidance for Curb & Gutter Near Energy-Absorbing Terminals		
Name of Project Manager(s): Bielenberg, Faller, Reid, Sicking	**Phone Number:** (402) 472-9064	**E-Mail** rbielenberg2@unl.edu
Lead Agency Project ID: 2611211094001	**Other Project ID (i.e., contract #):**	**Project Start Date:** 7/1/2013
Original Project End Date: 6/30/2016	**Current Project End Date:** 6/30/2016	**Number of Extensions:** 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**
$173,716	$344	1%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$344	

Project Description:

AASHTO highway design policies discourage the use of curbs along high-speed roadways. This guidance is largely based on the fact that curbs may cause impacting vehicles to become airborne, thus resulting in loss of control by the driver. In the case of a laterally skidding vehicle, a rollover may also be induced upon striking the curb (i.e., tripping). However, safety appurtenances, such as guardrail end terminals and crash cushions, are often placed in combination with curbs. Nonetheless, curbs are often installed along high-speed roadways for several reasons, including restricted right-of-way, drainage considerations, access control and other curb function requirements. In these situations, eliminating existing curbs or laterally offsetting curbs away from the traveled way may represent an expensive or unattainable alternative.

Historically, the safety performance of energy-absorbing guardrail end terminals has been based on the results of full-scale crash tests performed on level terrain. However, very limited research has been performed to investigate the safety performance of these features when installed in combination with curbs. Thus, there is a need to investigate whether curb placement in advance of guardrail end terminals significantly degrades barrier performance as a result of the changes in vehicle trajectory prior to impact. In addition, design recommendations are necessary for determining the safe placement of curb and gutter installed adjacent to energy-absorbing guardrail end terminals.

The objective of this research effort is to develop guidance for the safe placement of curbs adjacent to energy-absorbing guardrail end terminals. A combination of computer simulation and full-scale crash tests will be used to identify potential safety hazards, define critical curb and terminal impact scenarios, and select optimal curb placement. The effort will focus on a single, representative energy-absorbing, guardrail end terminal configuration that is selected during the study effort. In addition, the impact conditions for the simulation and crash testing programs will correspond with those published for Test Level 3 (TL-3) in the MASH impact safety standards.

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

A meeting was held in November to discuss the project plan. The literature review began which included gathering information on energy-absorbing terminals (9 total systems per the FHWA resource charts), the current Standard Plans and Specifications in regards to curbs, guardrail, and end terminals for the Midwest Pooled Fund States, and past studies on guardrail/end terminals with curbs. A list of parameters needed for the simulation effort were noted, which will form the basis for the survey that will be sent to the Pooled Fund States.

Anticipated work next quarter:

In the First Quarter of 2014, MwRSF will complete the initial literature search of previous barrier and curb studies, current energy-absorbing guardrail end terminals, and current State specifications (if any) on using curbs with guardrail. The literature search will focus on guardrail-to-curb combinations, especially acceptable applications of both 4- and 6-in. curbs with W-beam guardrail systems. The effort will identify critical curb parameters when used in conjunction with highway barriers, such as curb height and shape, curb offset, and vehicle type and model. Next, MwRSF will conduct a survey of the Pooled Fund states to determine current practice, guidelines, and standards pertaining to the use of curb with other safety appurtenances found on high-speed roadways. The survey should also identify problems experienced by these agencies and any proposed solutions, such as the flaring of tangent terminals noted above. In addition, the literature search and state survey will provide the basic configuration and parameters for a computer simulation study of curb and energy-absorbing terminal installations.

Significant Results:

Identified possible end terminals systems for study. Collected information on prior studies, end terminals, and State specifications on the use of guardrail/end terminals and curbs.

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).

None.

Potential Implementation:

The development of design guidelines for the safe placement of energy-absorbing guardrail end terminals behind curbs will provide beneficial information for highway designers and engineers and reduce the risk of highway agencies adopting inadequate and potentially unsafe curb-barrier combinations. These guidelines would also serve to reduce inconsistencies in the recommendations from one highway agency to the next, inconsistencies which could be the source of significant tort risk. These guidelines could potentially reduce highway agency expenses associated with curb removal in front of guardrail end terminals if certain combinations are found to be safe and no longer prohibited. In addition to being costly, curb removal is hazardous to both workers who are exposed to highway traffic in construction zones and the motorists who must traverse a restricted travel way. Any funds which can be saved by avoiding curb removal could be used for implementing other cost-beneficial safety improvements.

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. #63 Pooled Fund Project RPFP-14-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:

Dynamic Testing and Evaluation of Curb Placed Under Asymmetrical MGS-to-Thrie Beam Transition (Continued Funding)

Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Faller, Bielenberg, Lechtenberg	402-472-6864	rfaller1@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211095001	RPFP-14-AGT-1	7/1/2013
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/2016	6/30/2016	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**
$59,946	$1,903	20%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$1,903	

Project Description:

Recently, MwRSF researchers successfully developed and crash tested a simplified, steel-post stiffness transition for adapting the 31-in. tall Midwest Guardrail System (MGS) to existing, thrie beam approach guardrail transition systems. This system utilized an asymmetrical transition section, which maintained a top mounting height of 31 in. The system was successfully crash tested to TL-3 impact safety standards of MASH. However, this simplified stiffness transition system was not evaluated with a lower concrete curb placed below the rail.

Many states are interested in placing curbs underneath and throughout the length of common approach guardrail transitions. However, the addition of a curb can potentially lead to severe consequences. Specifically, small car vehicles may become wedged between the bottom of the asymmetrical rail and the top of the curb leading to excessive vehicle decelerations, increased risk to occupants, and vehicular instabilities. Light truck passenger vehicles may climb the curb and contact the rail with the vehicle c.g. positioned higher than normal, thus potentially causing excessive vehicular instabilities, and even rollover. Unfortunately, no crash testing has been performed near the upstream end of the new simplified stiffness transition with the presence of curbs. Therefore, full-scale vehicle crash testing is deemed necessary to verify the safety performance of curb placement below the asymmetric transition element.

After a failure of MASH test designation no. 3-20 during the original Year 23 Pooled Fund project, this supplementary project was created to fund the re-design and re-test of the transition system with lower curb.

Objectives & Tasks

1. Full-scale crash testing (MASH test designation nos. 3-20 (2 tests) and 3-21(1 test).
2. Data analysis and evaluation.
3. Report documenting R&D effort, including brainstorming, redesign, construction, crash testing, conclusions, and recommendations.

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

The preparation of the draft research and test report continued. Internal review of the draft report was initiated.

Anticipated work next quarter:

Internal review of the draft report will be completed. The draft report will be submitted to the Pooled Fund members for review and comment.

Significant Results:

Test no. MWTC-1 (MASH test designation no. 3-20) illustrated that the placement of a 4-in. tall curb in combination with the MGS stiffness transition with asymmetrical transition rail element can significantly degrade barrier performance from that observed when the curb was not installed. The 1100C full-scale crash test resulted in rail rupture at the upstream end of the asymmetrical W-beam to thrie beam transition element, and the vehicle snagged on several transition posts.

Test no. MWTC-2 (MASH test designation no. 3-20) demonstrated that the use of 12 ft - 6 in. of nested W-beam rail in advance of the asymmetrical segment was able to mitigate factors that led to guardrail rupture. In addition, this small car re-test showed that the MGS stiffness transition in combination with lower curb met the TL-3 MASH impact safety standards when used with 12 ft - 6 in. of nested W-beam rail.

Test no. MWTC-3 (MASH test designation no. 3-21) was conducted on the modified system on May 16, 2013 and satisfied all of the MASH safety performance criteria. The test demonstrated that the 2270P pickup truck was successfully contained and redirected by the MGS stiffness transition in combination with lower curb when used in combination with 12 ft - 6 in. of nested W-beam rail.

Objectives/Tasks	% Complete
1. Full-scale crash testing (MASH test designation nos. 3-20 and 3-21).	100%
1a. Full-scale crash test of modified transition (MASH test no. 3-20)	100%
2. Data analysis and evaluation.	100%
3. Report documenting R&D effort, including redesign, crash testing, and conclusions	50%

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).

This project was created to supplement an existing project, Pooled Fund Year 23 - RPFP-13-AGT-1, which carries the same project title. A failure during the first full-scale crash test of the original study required a redesign and a retest of MASH test designation no. 3-20. Since the retest was not part of the original budget, this supplementary project was created to fund it.

To date, all work has been charged to the original project. However, funds in the original project were exhausted during the fourth quarter of 2013. Therefore, all remaining charges will be posted to this project.

Potential Implementation:

The successful crash testing of the MGS stiffness transition with asymmetric transition element and lower concrete curb will allow State Departments of Transportation to provide continuous hydraulic runoff control between approach guardrail transitions and W-beam approach rails. The use of continuous concrete curb will help to mitigate soil erosion near bridge ends as well as its costly maintenance and repair.

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 #64	☐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: Continued Development of the Midwest Four-Cable, High-Tension, Median Barrier (Continuation Funding)		
Name of Project Manager(s): Reid, Faller, Lechtenberg, Bielenberg	**Phone Number:** 402-472-9070	**E-Mail** kpolivka2@unl.edu
Lead Agency Project ID: 2611211096001	**Other Project ID (i.e., contract #):** RPFP-14-CABLE1	**Project Start Date:** 7/1/13
Original Project End Date: 6/30/16	**Current Project End Date:** 6/30/16	**Number of Extensions:** 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**
$375,513 (+$264,372 from Yrs 20 & 22)	$0 ($16,010 R&D/Reporting Cont.)	0

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$0 ($16,010 R&D/Reporting Cont.)	

Project Description:

The Midwest Roadside Safety Facility (MwRSF) has been conducting research for the Midwest States Regional Pooled Fund Program to develop a non-proprietary, high-tension, four-cable, median barrier that is capable of being used anywhere in a V-ditch with 4H:1V side slopes. Three tests still remain to complete the test matrix of the cable barrier system in a V-ditch. In addition, the four-cable, high-tension, median barrier has never been tested on level terrain. There is a concern that FHWA may not approve this design without testing on flat ground, especially when considering the wide cable spacing and increased cable heights. Further, the barrier deflections observed in crash tests performed in a 4H:1V V-ditch are likely higher than would be observed on flat ground. Crash testing of the barrier installed on level terrain would identify barrier deflections and working widths that can be expected when the barrier is used in narrow medians with gentle slopes and would allow for better performance comparisons between the Midwest four-cable barrier and other proprietary systems.

Objective: To complete the development, testing, and evaluation of the four-cable, high-tension, median barrier system for use on level terrain.

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

None.

This is additional funding to continue the development of the Midwest Four-Cable, High-Tension, Median Barrier once the funds from the other projects are exhausted (Project No.: RPFP-12-CABLE1&2 – TPF-5(193) Supplement #44, Project Title: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase I, V-ditch and Project No. RPFP-12-CABLE1&2 – TPF-5(193) Supplement #45, Project Title: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase II, Level Terrain).

See Project No.: RPFP-12-CABLE1&2 – TPF-5(193) Supplement #44, Project Title: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase I, V-ditch for a detailed explanation of the work completed this quarter.

Anticipated work next quarter:

The report containing the folded C-channel posts and Midwest Weak Posts will continue to be reviewed. It is anticipated that the draft report will be sent to the member states for review during the next quarter.

Drawings of the bolted tab bracket system drawing to be tested with a 1500A vehicle will be completed. Fabrication of the posts and bolted tab bracket will be initiated. Construction will be initiated as soon as posts and brackets are fabricated.

Significant Results:

None

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).

This project is an extension to previous projects (RPFP-08-02: Four-Cable Median Barrier in 4:1 V-Ditch; RPFP-09-01: New Funding for High-Tension Cable Barrier on Level Terrain with New Cable Attachment; RPFP-10-CABLE-2: Replacement Funding for High-Tension Cable Barrier on Level Terrain; RPFP-12-CABLE1&2: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase I, V-Ditch; and RPFP-12-CABLE1&2: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase II, Level Terrain).

A portion of this project ($264,372 is not included in the project budget shown on page 1) will be funded with the following projects:
$64,746 from Project No.: RPFP-10-CABLE-3 – TPF-5(193) Supplement #21, Project Title: Additional Funds to Complete Development of Crashworthy HT, 4-Cable Barrier Terminal
$199,626 from Project No.: RPFP-12-CABLE1&2 – TPF-5(193) Supplement #46, Project Title: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase III, End Terminal

In addition, Contingency Funds from several prior years have been designated for Cable R&D and Cable Reporting. To date, $16,010 has been posted to the contingency funds for Cable R&D and Cable Reporting.

Potential Implementation:

The successful completion of the development, testing, and evaluation of the Midwest four-cable, high-tension, median barrier on level terrain will allow the member states to implement a non-proprietary, high-tension, cable system along our nation's highways and roadways. In addition, the crash testing of the four-cable, high-tension, median barrier on level terrain would also provide a more complete understanding of barrier performance (i.e., dynamic deflections, working width, etc.) when used in relatively flat, narrow medians. The crash results from the level terrain testing will be used in combination with computer simulation to evaluate the effects of reduced post spacing. The successful completion of this project along with the non-proprietary four-cable, high-tension, median barrier in V-ditch and cable guardrail end terminal would help to assure acceptance by FHWA and improve its chances for widespread implementation.

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)* TPF-5(193) Suppl. #65	**Transportation Pooled Fund Program - Report Period:** ☐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: Annual Consulting Services Support		
Name of Project Manager(s): Ron Faller, John Reid, Bob Bielenberg	**Phone Number:** 402-472-9064	**E-Mail** rbielenberg2@unl.edu
Lead Agency Project ID: 2611211097001	**Other Project ID (i.e., contract #):** RPFP-14-CONSULT	**Project Start Date:** 7/1/2013
Original Project End Date: 6/30/16	**Current Project End Date:** 6/30/16	**Number of Extensions:** 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
$48,803.00	$11,661.00	35%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$9,136.00	

Project Description:

This project allows MwRSF to be a valuable resource for answering questions with regard to roadside safety issues. MwRSF researchers and engineers are able to respond to issues and questions posed by the sponsors during the year. Major issues discussed with the States have been documented in our Quarterly Progress Reports and all questions and support are accessible on a MwRSF Pooled Fund Consulting web site.

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

In the past quarter MwRSF has responded to a series of state inquiries. The Quarterly Progress Report summarizing these responses has been attached to this document. The summary will also be available for download at the recently completed MwRSF Pooled Fund Consulting web site - http://mwrsf-qa.unl.edu/

We are continuing to work with and improve the MwRSF Pooled Fund Consulting web site as our experience with it grows. We would ask that all Pooled Fund member states use the new site from this point forward for their inquiries and to contact us with any issues they experience with the web site.

Anticipated work next quarter:

MwRSF will continue to answer questions and provide support to the sponsors during the upcoming quarter.

We would ask that all questions be submitted through the web site so that they can be answered and archived therein.

http://mwrsf-qa.unl.edu/

Significant Results:

A quarterly summary of the consulting effort was provided and users can use the web site to search and find responses as well.

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).

None.

Potential Implementation:

None.

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)* TPF-5(193) Suppl. #66	**Transportation Pooled Fund Program - Report Period:** ☐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: Pooled Fund Center for Highway Safety		
Name of Project Manager(s): Ron Faller, John Reid, Bob Bielenberg	**Phone Number:** 402-472-9064	**E-Mail** rbielenberg2@unl.edu
Lead Agency Project ID: 2611211086001	**Other Project ID (i.e., contract #):** RPFP-14-PFCHS	**Project Start Date:** 7/1/2013
Original Project End Date: 6/30/16	**Current Project End Date:** 6/30/16	**Number of Extensions:** 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
$11,519.00	$0.00	0%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$0.00	

Project Description:

Many of MwRSF's inquiries from members of the Midwest States Pooled Fund program can be answered based upon prior pooled fund or other research. Further, even though answers to pooled fund inquiries are normally routed to all pooled fund states in the quarterly progress report, there are numerous repeat questions every year. The quarterly summaries are helpful to member states, but they are temporary and not well organized by the type of question or specific topic. Many pooled fund inquiries could be answered through the development of a Center of Highway Safety web site. A dedicated and well-maintained Pooled Fund Center for Highway Safety web site would provide for all of these needs. It would provide for a searchable database of previous MwRSF inquiries and solutions, a searchable online listing of downloadable research reports, and a searchable archive of CAD details for crash tested and/or approved systems and features. This safety center would also be helpful to non-member states with problems or inquiries similar to those identified by the member states.

In Year 22, the Midwest States Pooled Fund states sponsored the development of a Pooled Fund Center for Highway Safety web site. This project allowed for the development of the first phase of the web site and archiving of materials on the web site. In the past year, a web site for the Midwest States Pooled Fund consulting questions and responses was developed and made available. The web site is currently operational and provides functions for submitting questions and inquiries to MwRSF as well as posting of the responses. It also provides a searchable database of previous MwRSF inquiries and solutions. The website is located at http://mwrsf-qa.unl.edu/.

In addition to the consulting web site, a searchable online listing of downloadable research reports, and a searchable archive of CAD details for crash tested and/or approved systems and features has been started. MwRSF is currently in the process of making this web site operational and uploading the archived reports and CAD. MwRSF anticipates that this archive will be fully functional in the near term. The report and CAD archive as well as the Midwest States Pooled Fund consulting web site will be integrated with the main MwRSF web site in the near future as well.

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

At this time, the Pooled Fund Center for Highway Safety web site is complete and the funding provided in this project has yet to be accessed for web maintenance and updating.

Anticipated work next quarter:

The project funding herein will not be accessed until the Pooled Fund Center for Highway Safety web site is fully operational and addition updates and maintenance are required.

Significant Results:

None.

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).

None.

Potential Implementation:

The Pooled Fund Center for Highway Safety web site would provide immediate access to a wide library of roadside safety materials for designers and engineers, including reports, CAD details, etc. It would also provide a searchable database of previous solutions and responses to prior Pooled Fund inquiries and problems. The web site would also be available through controlled access to state DOT's around the country which would promote improved roadside safety.

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 #67	☐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: Annual Fee to Finish TF-13 and FHWA Standard Plans		
Name of Project Manager(s): Reid, Faller, Lechtenberg, Bielenberg	**Phone Number:** 402-472-9070	**E-Mail** kpolivka2@unl.edu
Lead Agency Project ID: 2611211099001	**Other Project ID (i.e., contract #):** RPFP-14-TF13	**Project Start Date:** 7/1/13
Original Project End Date: 6/30/16	**Current Project End Date:** 6/30/16	**Number of Extensions:** 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**
$3,695	$86	5

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$86	

Project Description:

Each year, the Midwest States Pooled Fund program sponsors several roadside safety studies at the Midwest Roadside Safety Facility (MwRSF) of the University of Nebraska-Lincoln. Some of these research efforts result in the development of new roadside safety features. As part of this effort and on behalf of the member states, MwRSF seeks FHWA acceptance for those devices or systems meeting current impact safety standards. In the future, FHWA will require standard Task Force (TF) 13-format CAD details along the typical system details when requests for hardware acceptance are made.

MwRSF prepares 2-D and/or 3-D CAD details for newly developed roadside safety features that are subjected to full-scale vehicle crash testing. The CAD details used to describe the as-tested systems or components are not always prepared and presented in the same format as now required by AASHTO TF 13 and FHWA. As such, additional CAD details and background information must be prepared when FHWA acceptance is sought under MASH or when the new system or associated components are submitted for inclusion in the electronic version of the barrier hardware guide.

Objective: For all new barrier hardware, the member states request that MwRSF seek formal FHWA acceptance and placement of standardized TF-13 CAD details in the electronic version of the highway barrier guide. This funding shall be used to supplement the preparation of the TF-13 format CAD details.

Tasks:

1. Prepare CAD details for Hardware Guide

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

Updated drawings based on comments received at the AASHTO TF-13 Spring and Fall 2013 meetings.

Anticipated work next quarter:

Continue to update drawings based on comments received from online review of drawings.

Significant Results:

This project is used to supplement the preparation of the TF-13 format CAD details. Previously, it was determined that there are 14 systems and 11 components that need to be prepared in the TF-13 format. During discussions with the AASHTO TF-13 subcommittee in July 2011, new components had to be generated from the existing system drawings. Thus, the original 11 components became 32. Two of the systems and one component had limited work that need to be completed on the drawings as they were to be included in the Bridge Rail Guide and Luminaire Guide, respectively.

In evaluating the separation of the components, it was determined that some could be combined into one drawing based on the same type of component, but just one varying parameter.

Summary of Barrier Guide individual drawings to date:
31 systems - 26 approved, 5 to be reviewed
41 components - 31 approved, 10 to be reviewed
2 systems submitted to Bridge Rail Guide
1 component submitted to Luminaire Guide

Task	% Complete
1. Prepare CAD details for Hardware Guide	5%

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).

Funding from Project No.: RPFP-13-TF13 – TPF-5(193) Supplement #53, Project Title: Annual Fee to Finish TF-13 and FHWA Standard Plans will be used prior to starting this project.

Potential Implementation:

Newly-developed highway safety hardware will be contained in the electronic, web-based guide, thus promoting the standardization of barrier hardware across the U.S. and abroad.

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)* TPF-5(193) Suppl. #68	**Transportation Pooled Fund Program - Report Period:** ☐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: Minimum Offset for Standard MGS Adjacent to 2H:1V Slope		
Name of Project Manager(s): Ron Faller, John Reid, Bob Bielenberg	**Phone Number:** 402-472-9064	**E-Mail** rbielenberg2@unl.edu
Lead Agency Project ID: 2611211100001	**Other Project ID (i.e., contract #):** RPFP-14-MGS-8	**Project Start Date:** 7/1/2013
Original Project End Date: 6/30/16	**Current Project End Date:** 6/30/16	**Number of Extensions:** 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
$89,991.00	$9,598.00	15%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$9,598.00	

Project Description:

W-beam guardrail is often used to protect motorists from steep roadside slopes adjacent to high-speed roadways. A roadside slope placed immediately behind a guardrail system greatly reduces the soil resistance associated with lateral deflection of the barrier. This reduction in the post-soil forces greatly reduces a system's energy-absorption capability, significantly increases dynamic rail deflections, and can potentially produce issues with vehicle capture or vehicle override. Further, when the guardrail extends over the embankment, the gap between the bottom of the rail and the ground will be greatly magnified and thereby increase the risk of severe wheel snag.

The MGS guardrail system has greatly improved the safety performance and stability of guardrail installed at the slope breakpoint of slopes as steep as 2H:1V. However, current MGS installations adjacent to 2H:1V slopes utilize increased length posts in order to provide sufficient embedment to generate the proper soil resistive forces. This requirement creates issues with state DOT hardware inventories and maintenance due to the need to stock and maintain non-standard length posts. In order to reduce hardware inventories, states have chosen in some cases to install the standard MGS system at an offset from the slope. Current guidance requires a minimum offset of 1 ft to 2 ft from the back of the post to the the slope breakpoint for the standard MGS system with 6-ft long posts depending on the slope grade. This large offset maintains the safety performance of the system but creates a great deal of additional expense in terms of earthwork. Thus, a need exists to evaluate a minimum offset for the standard MGS guardrail system adjacent to a 2H:1V fill slope in order to reduce current issues with state hardware inventories and earthwork costs.

The objective of this research effort is to evaluate the minimum offset for installation of the standard MGS guardrail system with 6-ft long W6x9 posts spaced at 75 in. on centers adjacent to a 2H:1V fill slope. The evaluation will focus on a system with the posts installed at the slope break point of a 2H:1V slope. The minimum offset will be evaluated through one full-scale crash test according to the TL-3 impact criteria in MASH for test designation 3-11.

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

In this quarter, MwRSF has begun construction of the guardrail system for the full-scale crash test of the MGS guardrail system with 6-ft long W6x9 posts spaced at 75 in. on centers adjacent to a 2H:1V fill slope. Construction of the 2:1 slope is largely complete and testing is planned for the first first quarter of 2014.

Anticipated work next quarter:

The testing of the MGS guardrail system with 6-ft long W6x9 posts spaced at 75 in. on centers adjacent to a 2H:1V fill slope is planned for the next quarter. However, completion of the testing is dependent on the schedule of existing crash testing commitments and may not occur if projects with higher priority in the testing que prevent the test from being completed.

Significant Results:

None.

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).

None.

Potential Implementation:

Determination of the minimum offset for the standard MGS guardrail system adjacent to a 2H:1V fill slope will result reduced embankment earthwork required for guardrail installations on slopes and reduced state DOT hardware inventories for the MGS system. These benefits will provide for a decrease in project costs to the states while still providing a safe barrier system.

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. #69 MwRSF Project No. RPFP-14-MGS-11	☐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:		
Dynamic Testing and Evaluation of Curb Placed Under Asymmetrical MGS-to-Thrie Beam Transition (Continued Funding)		
Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Faller, Bielenberg, Lechtenberg	402-472-9324	srosenbaugh2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211101001	RPFP-14-MGS-11	7/1/2013
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/2016		

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**
$49,044	$825	5%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$825	

Project Description:

The Midwest Guardrail System (MGS) has been crash tested and accepted for use according to MASH TL-3 safety performance criteria. However, the MGS may be placed adjacent to roadways with reduced speed limits and ADT's that warrant a barrier with a lower test level, e.g., TL-1 or TL-2. Currently the same MGS system is used in these situations for consistency and ease of installation and maintenance. The working width required for the MGS is expected to be lower when evaluated at the TL-2 or TL-1 impact conditions. However, no research has been done to date to determine the dynamic deflections and working width values of the MGS at these lower test level conditions. Evaluation of these working widths may lead to significant savings on roadways warranting lower test level barriers where the clear space is not available.

The objective of this research effort is to provide dynamic deflection and working width recommendations for the standard MGS system and the MGS system installed adjacent to a 6-in. tall curb at the MASH TL-1 and TL-2 impact conditions. These deflections shall be determined through LS-DYNA computer simulation. It is anticipated that the research effort will be conducted in two phases. The first phase will evaluate the dynamic deflection and working width of the standard MGS system on level terrain. The second phase will evaluate the dynamic deflection and working width of the standard MGS system with a 6-in. offset from a 6-in. tall curb.

Objectives / Tasks:

Phase I - Evaluation of Standard MGS

1. LS-DYNA computer simulation
2. Summary Report

Phase II - Evaluation of MGS installed with a 6" curb

1. LS-DYNA computer simulation
2. Summary Report

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

Work has begun to calibrate and validate current LS-DYNA models against the most recent full-scale crash testing of the MGS. All previous full-scale testing has been conducted under TL-3 impact conditions of NCHRP Report 350 or MASH. This validation is being conducted in accordance with the V&V procedure fro NCHRP Report W-179.

Anticipated work next quarter:

Work next quarter shall continue with the calibration and validation of MGS LS-DYNA models. Once this process is completed, The impact conditions will be reduced to reflect MASH TL-1 and TL-2 criteria to evaluate the performance of the MGS under these lower energy conditions.

Significant Results:

Work has begun on the calibration and validation of the MGS models, but simulations pertaining to the performance of the MGS under reduced impact conditions have not yet begun.

Objectives / Tasks:	% Complete
Phase I - Evaluation of Standard MGS	
1. LS-DYNA computer simulation	10%
2. Summary Report	0%
Phase II - Evaluation of MGS installed with a 6" curb	
1. LS-DYNA computer simulation	0%
2. Summary Report	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).

None

Potential Implementation:

Determination of the dynamic deflection and working width of the MGS system with and without curbs at lower test levels would provide for more installation options of the MGS in areas where a lower test level barrier system is warranted but space for placement of the barrier is limited. In addition, installation costs may decrease as the need to move hazards and provide additional clear area behind the MGS system will be reduced.

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)* TPF-5(193) Supplement #72	**Transportation Pooled Fund Program - Report Period:** ☐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: Dynamic Evaluation of Cable Guide Rail w/Strong and Standard J-Bolts Under MASH with 1500A Retest		
Name of Project Manager(s): Faller, Reid, Lechtenberg, Bielenberg, Stolle	**Phone Number:** 402-472-9070	**E-Mail** kpolivka2@unl.edu
Lead Agency Project ID: 2611211105001	**Other Project ID (i.e., contract #):**	**Project Start Date:** 9/12/2013
Original Project End Date: 5/31/2014	**Current Project End Date:** 5/31/2014	**Number of Extensions:**

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
$35,770	$0	0

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$0	

Project Description:

This project was intended to evaluate modifications to cable-to-post attachments intended to reduce the frequency of vehicular penetration through and under low-tension cable barriers by increasing the attachment strength. This project was funding for the retest of the 1500A sedan test.

Tasks of original project:
1. Reconstruct tangent, 3-cable barrier system with 1/2-in. dia. hook bolts
2. Full-scale retest of 3-cable barrier with 1/2-in. dia. hook bolts with 1500A sedan and brakes engaged (modified MASH 3-10)
3. Analysis and documentation of test results (modified MASH 3-10)

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

None.

Retest was charged to the original project, Project No. TPF-5(193) Supplement #61.

Anticipated work next quarter:

None.

Significant Results:

None

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).

Following the results of test no. NYJ-3, combined with the windshield crush observed in test no. NYJ-2, indicated that there was little benefit in comparing the results of a system with standard 5/16-in. J-bolts, cable compensators, and modified end anchors to the results of test no. NYJ-3. As a result, further research on this system was suspended.

MwRSF will reimburse NYSDOT for the test charges budgeted for the final planned full-scale test. However, removal and cleanup after the test were included in the last test budget, and will still be required after test no. NYJ-3. The total reimbursement will be equal to $71,894 minus the cost of system removal and cleanup. $36,124 minus the cost of system removal and cleanup from Project No. TPF-5(193) Supplement #61 and $35,770 from this project (Project No. TPF-5 (193) Supplement #72) will be returned to NYSDOT.

Potential Implementation:

This will determine if the use of stronger J-bolts can reduce the dynamic deflections of New York State Department of Transportation's standard three-strand cable guide rail system. It will also determine if the stronger J-bolts will increase the ability of the system to capture a sedan with a low-profile, aerodynamic front end. Further, it will determine if there is an increase in propensity for barrier override of pickup trucks or vehicle decelerations with the cables more firmly attached to the posts. If the stronger J-bolt systems perform acceptable, this research will also provide the NYSDOT justification of dynamic barrier deflection for a common three-strand cable barrier system with an overall system length in excess of 600 ft. It will also provided justification for redesigning the end post stubs to limit the amount of damage.

Midwest States Pooled Fund Program Consulting Quarterly Summary

Midwest Roadside Safety Facility

09-16-2013 to 12-10-2013

Curb termination or transition below MGS stiffness transition

Question
State: WI
Date: 09-18-2013

When utilizing the 4" curb under the MGS stiffness transition to a thrie beam approach guardrail transition, where is the appropriate location to either terminate the curb or transition to a taller 6" curb (e.g., the MGS system designed to use behind a 6" curb)?

Response
Date: 09-18-2013

The 4" curb should be extended out from the bridge parapet, through the entire transition area including all 1/2 post (37.5") spacings, and continue through a minimum of one full post (75") spacing. Thus, termination of the curb or a transition to a 6" curb may occur within the 2nd full post spacing upstream of the stiffness transition.

Additionally, it is recommended to utilize a minimum length of 3 ft to transition from a 4" wedge shaped curb to a 6" high, AASHTO Type "B" curb. The 3 ft length would also apply for the termination length (transitioning from a 4" curb to no curb).

Roadside Barrier Adjacent to Union Pacific Bridge Pier

Question
State: WI
Date: 10-03-2013

Attached is a preliminary layout that avoids placing concrete barrier adjacent to the existing Union Pacific bridge pier (structure B-40-327) as part of the Appleton Avenue project (USH 41) ID 2010-10-70. The draft layout shown in the attachment reflects the discussion during this afternoon's phone conference. To summarize, MGS 3 guardrail with quarter-post spacing is provided along the face of roadway curb adjacent to and 25-feet beyond/south of the bridge pier (46-inches of working width is provided). A 12.5-foot length of MGS 3 half-post spacing is then provided followed by a thrie beam transition which is attached to single slope barrier wall. The single slope barrier wall then tapers at a 14:1 (taper rate in accordance with Roadside Design Table 5-9 for 50 MPH design speed). At the end of the barrier taper a crash cushion is shown. For the north bound direction the distances and tapers are similar.

Note: Potential impacts to existing storm sewer lines and lighting conduit in the area of the proposed guardrail installations will need to be reviewed.

Please provide any comments you may have regarding the proposed layout.

I was wondering if we have quarter post spacing leading into a transition, if it O.K. just to run quarter post spacing throughout the whole thrie beam transition.

Attachment: http://mwrsf-qa.unl.edu/attachments/7e22e574c57de982e1b85303b2c092cd.pdf

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Response
Date: 10-03-2013
I think that ¼-post spacing is acceptable before the ½-post spacing MGS & stiffness transition.

Steel Posts with additional holes

Question
State: WI
Date: 10-07-2013

Have you seen something like this before (especially post 2).
Attachment: http://mwrsf-qa.unl.edu/attachments/53662a2f64cbc535d10eaad24141ab15.JPG

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Response
Date: 10-07-2013

It is possible that they are placed for use with nails to control blockout rotation The edge distance to some holes seems narrow as well. The extra holes will not affect guardrail performance. The various holes in Photo 2 are unusual. Maybe these posts were punched incorrectly in line and then re-punched.

Thire beam transition to New York 3 and 4 rail

Question
State: WI
Date: 10-23-2013

WisDOT is looking to add two bridge parapet designs to our inventory. The railing are from New York two and four rail parapets found in

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http://guides.roadsafellc.com/Documents/SBB29d/OtherDocs/404531-NY-2-4RailBridgeRail.pdf >>

One of the issue that we are having is trying to adapt MGS to thrie beam transition to these alternatives. Our regular connection plates does not line up correctly.

Could we install a larger plate to allow for proper connection?

Response
Date: 10-29-2013

It is reasonable to expect that a plate used to connect thrie beam to a steel tube bridge rail may have to be altered for various bridge rail designs (especially the bolt hole locations to attach to the steel tubes). However, we would not recommend enlarging the plate to cover all of the steel tube rails. This would create unwanted snagging points for reverse direction impacts. Instead, any bridge rail components located at heights above or below the thrie beam should be safely flared back away from traffic and/or possibly down to connect to an adjacent tube rail that does go behind the thrie beam rail.

A good reference for this type of connection can be found in a recent TTI test report titled "MASH TL-3 Testing and Evaluation of the TxDOT T131RC Bridge Rail Transition" and dated March of 2013. It can be found on TTI's web site. This document provides details for a MASH TL-3 crash tested thrie beam transition and connection to a 2 tube, steel bridge rail. I believe the NY systems you are looking into are similar to this tested system. Again, the top and bottom rail of the 4-tube configuration would need to be flared to prevent snag and tire interactions.

Temporary Concrete Barrier

Question
State: IL
Date: 11-12-2013

Has there been any crash testing of Temporary Concrete Barrier (TCB), preferably F-shape, placed on top

of a raised concrete median with the edge of the TCB aligned with the face of the curb of the median? If so, what was the median height and what were the results of the crash testing? If not, what is your opinion regarding the effectiveness and safety of freestanding TCB placed on a raised, concrete median?

Response
Date: 11-15-2013

At this time, there has been not testing or research into the use of TCB installed on a raised median. However, there are concerns with doing so.

We know from research with other barrier types and curbs that the presence of the curb can affect the stability of the vehicle and the manner in which it interacts with the barrier. We also know that the sloped faces of most TCB designs tend to increase vehicle climb and instability. Thus, there would be concerns that using TCB on a raised median with a curb may create more vehicle climb and instability than desired.

Similar concerns would be present for backside hits in a median installation where the curb would be offset from the barrier face.

Another concern is the availability of relatively flat area behind the barrier to accommodate barrier translation during impact. We have typically recommended that users of TCB's provide 4-6 feet of relatively flat (< 10:1 slope) terrain behind the TCB to allow for dynamic deflection of the barriers. Thus, installation on a raised median would require similar area so that the barriers to not slide off the raise median and become unstable or tip. tipping of the barriers would increase the angle of the barrier face, promoting further vehicle instability.

Guardrail Post attached to Wing Wall

Question
State: IA
Date: 11-15-2013

See red.

1. Should I include washers on top side of the base plate for the threaded rods?

   Yes

2. Would it be okay to add a weep hole near the bottom of the post? If so, what size hole would you recommend and how high above the base plate?

   I would recommend a hole no bigger than ½" diameter and placed on the DS side of the post. You could also cap the top of the post tube to prevent water from entering.

3. For post locations immediately adjacent to the bridge, would you consider this attachment equivalent to the horizontally mounted surrogate post developed for WisDOT? Or would you recommend using the WisDOT design instead?

   They should be similar in performance since they were designed to replace the same transition post. If you have the option, I would utilize the horizontal post design – only because that one has actually been component tested to demonstrate performance.

Attachment: http://mwrsf-qa.unl.edu/attachments/77ea1e73126a71ddb31a3529b7f8d6e6.pdf

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Response

Date: 11-15-2013

Could you guys take a quick look at this detail and provide any comments you might have? I also have a few specific questions for you:

1. Should I include washers on top side of the base plate for the threaded rods?
2. Would it be okay to add a weep hole near the bottom of the post? If so, what size hole would you recommend and how high above the base plate?
3. For post locations immediately adjacent to the bridge, would you consider this attachment equivalent to the horizontally mounted surrogate post developed for WisDOT? Or would you recommend using the WisDOT design instead?

Thanks for your help.

Attachment: http://mwrsf-

qa.unl.edu/attachments/77ea1e73126a71ddb31a3529b7f8d6e6.pdf

Temporary barrier to permanent barrier transition for undirectional traffic

Question
State: WI
Date: 11-15-2013

Dear MwRSF,

What modifications should be done to the temporary barrier transition to permanent barrier when there is traffic on both sides of the temporary barrier going the same direction? For example the temporary barrier is used to split traffic at a ramp gore.

I'm assuming that we would need some type of "toe plate" to prevent wheel snag.

Response
Date: 11-15-2013

Previously, MwRSF developed a median transition between free-standing TCB and a rigid concrete parapet. This system was designed for reverse direction traffic only and did not consider similar direction traffic on bolt sides.

In order to develop the transition to work with traffic moving the same direction on both sides, several issues would need to be considered. As noted above, the potential for vehicle snag on the rigid parapet would need to be considered. This would include both snag near the barrier toe and snag along any part of the exposed rigid parapet face. The original design of the system used nested thrie beam on both sides of the transition to reduce the potential for vehicle snag. The angle of that thrie beam and its attachment vary depending on the type of parapet that is connected to.

Thus it would be critical to ensure that the thrie beam and any toe cap that was designed have the correct geometry and capacity to prevent snag and provide safe redirection. Design of the toe plate, the thrie beam connection, potential changes to the alignment of the TCB with the parapet would likely need to be evaluated. In addition, it is likely that these modifications would need to be tested in in order to verify that they performed adequately.

Unanchored Stepped Concrete Median Barrier

Question
State: MO
Date: 11-15-2013

MoDOT regularly places permanent concrete traffic barrier with anchoring dowels omitted, as long as there are 1-3/4 inch minimum lifts of hot mix asphalt (HMA) abutting both barrier faces (Figure 1). The DOT also places stepped (separating different grades) concrete median barriers, but only when they can be doweled into concrete pavement (Figure 1).

A curve's superelevation on a recent add-a-lane project resulted in a hybrid of these two scenarios: a stepped barrier "pinched" in between lifts of HMA (Figure 2). There is a concern that the increased moment arm on the upper side would have a greater propensity to overturn the barrier in a crash.

Please answer the following questions:

1. Is the situation shown in Figure 2 likely to work?

2. If not, what steps should be taken ensure adequate performance?

Attachment: http://mwrsf-qa.unl.edu/attachments/3ec0a246271af1bd979eaf6033a9d1d1.jpg

Attachment: http://mwrsf-qa.unl.edu/attachments/01a17419e459df38fcb169855aa38dbe.jpg

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Response
Date: 11-18-2013

The layout shown in Figure 2 should be adequate to withstand most impacts. Heavy vehicle impacts (e.g., a tractor trailer - TL-5 impact) may cause barrier failures in the form of severe cracking/fracture or rotation/overturning due to the increased load height for impacts on the high side of the barrier. Judging by the reinforcement of the barrier (figure1), I will assume this not a TL-5 barrier. Thus, it should perform as intended. A few notes:

1) the transvers steel stirrups should be extended for the entire height of the barrier, so the height dimension for the V1 bars would vary depending on the median step height and the total height of the barrier.

2) Any barrier height change should not alter the strength of the top portion of the barrier, meaning the location of longitudinal bars should remain fixed with reference to the top of the barrier. If the barrier height is increased significantly, additional longitudinal bars should be added to the extended lower portion of the barrier in conjunction with the extended stirrups.

"Slight" Modification to IL F-shape Temporary Concrete Barrier

Question
State: IL
Date: 11-25-2013

Recent discussions with industry indicates they feel that modifying the corners of the toe of the IL F-shape Temporary Concrete Barrier (TCB) from a 90-degree angle to a 45-degree angle (the exact dimension of this "chamfered" area was not defined) would make TCB less likely to be damaged when setting and relocating. We understand the importance of engaging the corners being part of the crash testing, energy absorption, and deflection performance. How would such a modification by chamfering the corners affect performance results of prior crash testing results and subsequent approval of this barrier as a Test Level 3 device meeting NCHRP 350 requirements?

Response
Date: 11-25-2013

We have observed several other states providing similar types of chamfers on their barrier edges to limit damage to the sections during moving and placement.

Typically, we have seen and approved the use of 3/4" chamfers on the barrier edges and believe that the affect of that size of chamfer on barrier safety performance is minimal.

Similarly, we would not expect a 1" chamfer to affect safety performance and would consider it acceptable. However, larger chamfers (2" or greater) may begin to cause some concern.

TL-3 Railing for Timber Bridge

Question
State: WY
Date: 11-26-2013

We have a very old timber bridge which is not slated for replacement, but would like to upgrade the bridge and approach railing. It is located on a rural 2-lane highway with a posted speed of 65 mph. The length of the bridge is 23 feet. I have attached a few photographs and a very old and hard to read standard plan for which this structure was constructed.

Could you recommend some treatments for bridge railings for this structure? They do not have to be aesthetic in nature. We have considered the use of the MGS long span, but as nearly as I can tell, the structure width is only about 25 feet, so the railing needs to be as flush as possible with the end of the deck. The MGS long span normally requires a post and blockout width (20") plus an assumed wing wall width of around 8 or 9 inches, so it appears the railing would have to be placed around 28" inboard of the end of the deck.

The MGS Low Cost Bridge Rail might be an option if a mounting could be developed with would greatly reduce the stress normally transmitted to a concrete bridge deck, or in this case, to the wood stringers.

If you note in the photos, although there is a timber curb, the roadway appears to be built up above the curb (consequently the rail height is very low). Any help you could provide would be appreciated!

Attachment: http://mwrsf-qa.unl.edu/attachments/6006453ec54a9b364b686a6625cefdd8.pdf

Attachment: http://mwrsf-qa.unl.edu/attachments/58e0ecde38f74a422f3119e871b67326.JPG

Attachment: http://mwrsf-qa.unl.edu/attachments/81429530ffae8eb3741c36f773f49c8b.JPG

Response
Date: 12-10-2013

After a quick review of your pictures and drawings, we see two options for possible treatment of this timber bridge: (1) a long-span system, or (2) an adaptation of the weak-post, MGS bridge rail. Either system would be TL-3 crashworthy. Both have benefits and downfalls as described below.

The benefits of a long-span system would be that the rail itself would not be directly attached to the bridge. Thus, impact loads would not be imparted to the bridge elements. However, use of a long span system would most likely require some soil fill to be added around the abutments to ensure the adjacent posts were properly installed. In addition and as you have already mentioned, the offset of the rail and the edge of the bridge deck would result in a loss of roadway width.

Utilization of the weak-post, MGS bridge rail (or similar variations designed for attachment to culvert headwall) would help to maximize your roadway width by attaching to the outside face of the bridge deck / stringers. However, properly anchoring the sockets which attach the posts to the bridge could prove difficult as soil fill and asphalt overlays may prevent bolting options. Further, anchorage strength may be limited dependent upon the structural integrity of the timber elements you tie into.

Let us know if you would like us to further investigate the specifics for either of these treatment options.

Using a Blockout with MGS Bridge Rail

Question
State: IA
Date: 12-02-2013

In the MGS Bridge Rail report, it is suggested that a 4-inch deep blockout could be used to minimize the chance of snowplow damage to the deck-mounted through bolts. However, it goes on to say that "additional analysis or testing is required before alternate rail mounting details can be recommended." Has this analysis been completed, or is MwRSF in a position to suggest an alternate mounting method at this time? If not, would it be possible to utilize the existing mounting details with a blockout, except with a longer bolt?

Response
Date: 12-10-2013

We have not had the opportunity to investigate the use of blockouts with the MGS bridge rail. The current connection design is based on a connection used for weak post W-beam guardrail without blockouts and has not been evaluated with blockouts.

The concern with the using a blockout and the existing bolt and washer connection is that the small bolt in the design may not be sufficient to support the dead weight or that the disengagement may change. Thus, we believed that further study would be required to investigate the use of spacer blocks prior to introducing them into the design.

TTI has tested an alternative post connection for the MGS bridge rail that uses a deck mounted post. This attachment may not have the same degree of interference with snow plows. However, the design does intrude onto the deck more. See attached.

Attachment: http://mwrsf-qa.unl.edu/attachments/c4b5782a5de583c56f9a3b826c691357.PDF

Midwest States Pooled Fund Program Consulting Quarterly Summary

Midwest Roadside Safety Facility

09-16-2013 to 12-10-2013

Curb termination or transition below MGS stiffness transition

Question
State: WI
Date: 09-18-2013

When utilizing the 4" curb under the MGS stiffness transition to a thrie beam approach guardrail transition, where is the appropriate location to either terminate the curb or transition to a taller 6" curb (e.g., the MGS system designed to use behind a 6" curb)?

Response
Date: 09-18-2013

The 4" curb should be extended out from the bridge parapet, through the entire transition area including all 1/2 post (37.5") spacings, and continue through a minimum of one full post (75") spacing. Thus, termination of the curb or a transition to a 6" curb may occur within the 2nd full post spacing upstream of the stiffness transition.

Additionally, it is recommended to utilize a minimum length of 3 ft to transition from a 4" wedge shaped curb to a 6" high, AASHTO Type "B" curb. The 3 ft length would also apply for the termination length (transitioning from a 4" curb to no curb).

Roadside Barrier Adjacent to Union Pacific Bridge Pier

Question
State: WI
Date: 10-03-2013

Attached is a preliminary layout that avoids placing concrete barrier adjacent to the existing Union Pacific bridge pier (structure B-40-327) as part of the Appleton Avenue project (USH 41) ID 2010-10-70. The draft layout shown in the attachment reflects the discussion during this afternoon's phone conference. To summarize, MGS 3 guardrail with quarter-post spacing is provided along the face of roadway curb adjacent to and 25-feet beyond/south of the bridge pier (46-inches of working width is provided). A 12.5-foot length of MGS 3 half-post spacing is then provided followed by a thrie beam transition which is attached to single slope barrier wall. The single slope barrier wall then tapers at a 14:1 (taper rate in accordance with Roadside Design Table 5-9 for 50 MPH design speed). At the end of the barrier taper a crash cushion is shown. For the north bound direction the distances and tapers are similar.

Note: Potential impacts to existing storm sewer lines and lighting conduit in the area of the proposed guardrail installations will need to be reviewed.

Please provide any comments you may have regarding the proposed layout.

I was wondering if we have quarter post spacing leading into a transition, if it O.K. just to run quarter post spacing throughout the whole thrie beam transition.

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Date: 10-03-2013
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Steel Posts with additional holes

Question
State: WI
Date: 10-07-2013

Have you seen something like this before (especially post 2).
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Response
Date: 10-07-2013

It is possible that they are placed for use with nails to control blockout rotation The edge distance to some holes seems narrow as well. The extra holes will not affect guardrail performance. The various holes in Photo 2 are unusual. Maybe these posts were punched incorrectly in line and then re-punched.

Thire beam transition to New York 3 and 4 rail

Question
State: WI
Date: 10-23-2013

WisDOT is looking to add two bridge parapet designs to our inventory. The railing are from New York two and four rail parapets found in

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One of the issue that we are having is trying to adapt MGS to thrie beam transition to these alternatives. Our regular connection plates does not line up correctly.

Could we install a larger plate to allow for proper connection?

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Date: 10-29-2013

It is reasonable to expect that a plate used to connect thrie beam to a steel tube bridge rail may have to be altered for various bridge rail designs (especially the bolt hole locations to attach to the steel tubes). However, we would not recommend enlarging the plate to cover all of the steel tube rails. This would create unwanted snagging points for reverse direction impacts. Instead, any bridge rail components located at heights above or below the thrie beam should be safely flared back away from traffic and/or possibly down to connect to an adjacent tube rail that does go behind the thrie beam rail.

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Temporary Concrete Barrier

Question
State: IL
Date: 11-12-2013

Has there been any crash testing of Temporary Concrete Barrier (TCB), preferably F-shape, placed on top

of a raised concrete median with the edge of the TCB aligned with the face of the curb of the median? If so, what was the median height and what were the results of the crash testing? If not, what is your opinion regarding the effectiveness and safety of freestanding TCB placed on a raised, concrete median?

Response
Date: 11-15-2013

At this time, there has been not testing or research into the use of TCB installed on a raised median. However, there are concerns with doing so.

We know from research with other barrier types and curbs that the presence of the curb can affect the stability of the vehicle and the manner in which it interacts with the barrier. We also know that the sloped faces of most TCB designs tend to increase vehicle climb and instability. Thus, there would be concerns that using TCB on a raised median with a curb may create more vehicle climb and instability than desired.

Similar concerns would be present for backside hits in a median installation where the curb would be offset from the barrier face.

Another concern is the availability of relatively flat area behind the barrier to accommodate barrier translation during impact. We have typically recommended that users of TCB's provide 4-6 feet of relatively flat (< 10:1 slope) terrain behind the TCB to allow for dynamic deflection of the barriers. Thus, installation on a raised median would require similar area so that the barriers to not slide off the raise median and become unstable or tip. tipping of the barriers would increase the angle of the barrier face, promoting further vehicle instability.

Guardrail Post attached to Wing Wall

Question
State: IA
Date: 11-15-2013

See red.

1. Should I include washers on top side of the base plate for the threaded rods?

   Yes

2. Would it be okay to add a weep hole near the bottom of the post? If so, what size hole would you recommend and how high above the base plate?

   I would recommend a hole no bigger than ½" diameter and placed on the DS side of the post. You could also cap the top of the post tube to prevent water from entering.

3. For post locations immediately adjacent to the bridge, would you consider this attachment equivalent to the horizontally mounted surrogate post developed for WisDOT? Or would you recommend using the WisDOT design instead?

   They should be similar in performance since they were designed to replace the same transition post. If you have the option, I would utilize the horizontal post design – only because that one has actually been component tested to demonstrate performance.

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Response

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Temporary barrier to permanent barrier transition for undirectional traffic

Question
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Date: 11-15-2013

Dear MwRSF,

What modifications should be done to the temporary barrier transition to permanent barrier when there is traffic on both sides of the temporary barrier going the same direction? For example the temporary barrier is used to split traffic at a ramp gore.

I'm assuming that we would need some type of "toe plate" to prevent wheel snag.

Response
Date: 11-15-2013

Previously, MwRSF developed a median transition between free-standing TCB and a rigid concrete parapet. This system was designed for reverse direction traffic only and did not consider similar direction traffic on bolt sides.

In order to develop the transition to work with traffic moving the same direction on both sides, several issues would need to be considered. As noted above, the potential for vehicle snag on the rigid parapet would need to be considered. This would include both snag near the barrier toe and snag along any part of the exposed rigid parapet face. The original design of the system used nested thrie beam on both sides of the transition to reduce the potential for vehicle snag. The angle of that thrie beam and its attachment vary depending on the type of parapet that is connected to.

Thus it would be critical to ensure that the thrie beam and any toe cap that was designed have the correct geometry and capacity to prevent snag and provide safe redirection. Design of the toe plate, the thrie beam connection, potential changes to the alignment of the TCB with the parapet would likely need to be evaluated. In addition, it is likely that these modifications would need to be tested in in order to verify that they performed adequately.

Unanchored Stepped Concrete Median Barrier

Question
State: MO
Date: 11-15-2013

MoDOT regularly places permanent concrete traffic barrier with anchoring dowels omitted, as long as there are 1-3/4 inch minimum lifts of hot mix asphalt (HMA) abutting both barrier faces (Figure 1). The DOT also places stepped (separating different grades) concrete median barriers, but only when they can be doweled into concrete pavement (Figure 1).

A curve's superelevation on a recent add-a-lane project resulted in a hybrid of these two scenarios: a stepped barrier "pinched" in between lifts of HMA (Figure 2). There is a concern that the increased moment arm on the upper side would have a greater propensity to overturn the barrier in a crash.

Please answer the following questions:

1. Is the situation shown in Figure 2 likely to work?

2. If not, what steps should be taken ensure adequate performance?

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Response
Date: 11-18-2013

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1) the transvers steel stirrups should be extended for the entire height of the barrier, so the height dimension for the V1 bars would vary depending on the median step height and the total height of the barrier.

2) Any barrier height change should not alter the strength of the top portion of the barrier, meaning the location of longitudinal bars should remain fixed with reference to the top of the barrier. If the barrier height is increased significantly, additional longitudinal bars should be added to the extended lower portion of the barrier in conjunction with the extended stirrups.

"Slight" Modification to IL F-shape Temporary Concrete Barrier

Question
State: IL
Date: 11-25-2013

Recent discussions with industry indicates they feel that modifying the corners of the toe of the IL F-shape Temporary Concrete Barrier (TCB) from a 90-degree angle to a 45-degree angle (the exact dimension of this "chamfered" area was not defined) would make TCB less likely to be damaged when setting and relocating. We understand the importance of engaging the corners being part of the crash testing, energy absorption, and deflection performance. How would such a modification by chamfering the corners affect performance results of prior crash testing results and subsequent approval of this barrier as a Test Level 3 device meeting NCHRP 350 requirements?

Response
Date: 11-25-2013

We have observed several other states providing similar types of chamfers on their barrier edges to limit damage to the sections during moving and placement.

Typically, we have seen and approved the use of 3/4" chamfers on the barrier edges and believe that the affect of that size of chamfer on barrier safety performance is minimal.

Similarly, we would not expect a 1" chamfer to affect safety performance and would consider it acceptable. However, larger chamfers (2" or greater) may begin to cause some concern.

TL-3 Railing for Timber Bridge

Question
State: WY
Date: 11-26-2013

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Could you recommend some treatments for bridge railings for this structure? They do not have to be aesthetic in nature. We have considered the use of the MGS long span, but as nearly as I can tell, the structure width is only about 25 feet, so the railing needs to be as flush as possible with the end of the deck. The MGS long span normally requires a post and blockout width (20") plus an assumed wing wall width of around 8 or 9 inches, so it appears the railing would have to be placed around 28" inboard of the end of the deck.

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Response
Date: 12-10-2013

After a quick review of your pictures and drawings, we see two options for possible treatment of this timber bridge: (1) a long-span system, or (2) an adaptation of the weak-post, MGS bridge rail. Either system would be TL-3 crashworthy. Both have benefits and downfalls as described below.

The benefits of a long-span system would be that the rail itself would not be directly attached to the bridge. Thus, impact loads would not be imparted to the bridge elements. However, use of a long span system would most likely require some soil fill to be added around the abutments to ensure the adjacent posts were properly installed. In addition and as you have already mentioned, the offset of the rail and the edge of the bridge deck would result in a loss of roadway width.

Utilization of the weak-post, MGS bridge rail (or similar variations designed for attachment to culvert headwall) would help to maximize your roadway width by attaching to the outside face of the bridge deck / stringers. However, properly anchoring the sockets which attach the posts to the bridge could prove difficult as soil fill and asphalt overlays may prevent bolting options. Further, anchorage strength may be limited dependent upon the structural integrity of the timber elements you tie into.

Let us know if you would like us to further investigate the specifics for either of these treatment options.

Using a Blockout with MGS Bridge Rail

Question
State: IA
Date: 12-02-2013

In the MGS Bridge Rail report, it is suggested that a 4-inch deep blockout could be used to minimize the chance of snowplow damage to the deck-mounted through bolts. However, it goes on to say that "additional analysis or testing is required before alternate rail mounting details can be recommended." Has this analysis been completed, or is MwRSF in a position to suggest an alternate mounting method at this time? If not, would it be possible to utilize the existing mounting details with a blockout, except with a longer bolt?

Response
Date: 12-10-2013

We have not had the opportunity to investigate the use of blockouts with the MGS bridge rail. The current connection design is based on a connection used for weak post W-beam guardrail without blockouts and has not been evaluated with blockouts.

The concern with the using a blockout and the existing bolt and washer connection is that the small bolt in the design may not be sufficient to support the dead weight or that the disengagement may change. Thus, we believed that further study would be required to investigate the use of spacer blocks prior to introducing them into the design.

TTI has tested an alternative post connection for the MGS bridge rail that uses a deck mounted post. This attachment may not have the same degree of interference with snow plows. However, the design does intrude onto the deck more. See attached.

Attachment: http://mwrsf-qa.unl.edu/attachments/c4b5782a5de583c56f9a3b826c691357.PDF

Midwest States Pooled Fund Program
Quarterly Progress Report – Fourth Quarter 2013
September 1, 2013 through November 30, 2013

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None