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)* SPR-P1(13) M326	**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: Development of a TL-3 Transition between Temporary Concrete Barrier and Guardrail		
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: 2611211075001	**Other Project ID (i.e., contract #):** TSPTI-06	**Project Start Date:** 7/1/2012
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
$91,814.00	$8,413.00	40%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$177.00	

Project Description:

The overall objective of this research effort is to develop a MASH TL-3 transition design between TCBs and the MGS. The design of the transition would focus on a representative selection of state DOTs highest priority configuration. Due to the large number of unknowns, this phase of the project will focus on the development of design concepts for the highest priority transition need. Full-scale crash testing of the proposed transition design is not a part of this project and may be performed in a future phase of the project.

This research effort will begin with identifying and quantifying the most pressing TCB to guardrail transition needs. Although a need to develop configurations for most, if not all, of the TCB to guardrail transition needs may exist, this project will address the highest priority need. Thus, the state DOTs of the Midwest States Pooled Fund Program will be surveyed to identify the highest priority TCB to guardrail transition need. After the critical transition need is identified, potential transition concepts and prototype designs will be brainstormed. Computer simulations with LS-DYNA, a non-linear explicit finite element code, will be used to investigate and evaluate the concepts and prototype designs. CAD details for the proposed transition design will be prepared. A summary report detailing the research effort will be compiled and will include recommendations for future full-scale crash testing of the TCB to guardrail transition as well as recommendations for further development of TCB to guardrail transitions.

Major Task List:

1. Project planning, correspondence, and literature search
2. Survey NDOR and other Pool Fund States to identify TCB to guardrail transition needs
3. Selection of highest priority transition need
4. Brainstorming of design concepts
5. Meeting with TAC members to review potential concepts

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

A TAC meeting was held with NDOR representatives on 4-3-13. In this meeting the results of the simulation analysis from the First Quarter of 2013 where shown to the committee and input on further development of the system was given by the TAC.

During the 2nd Quarter of 2013, MwRSF continued simulation work on the development of a TL-3 transition between portable concrete barriers and W-beam guardrail. The next step after a simple overlap of the two systems was to connect the W-beam guardrail to the PCB system with an end shoe. The purpose of this connection was to develop downstream tension in the W-beam guardrail system that would aid in the capture of the vehicle. This system also utilized two of guardrail posts from the W-beam guardrail system in front of the flared PCB system. The purpose of having these posts in front of the PCB system was to initiate displacement of the PCBs caused by post rotation.

This connected system was simulated and analyzed for impact at several locations. For impacts downstream of the upstream end of the PCB system, the backward post rotation initiated PCB displacement as intended. However, the posts tended to wedge against the face of the PCB and act as ramps for the tires of the pickup truck. This caused vehicle instability and, in most cases, rollover. For impacts upstream of the upstream end of the PCB system, the W-beam guardrail system showed a propensity for pocketing. Upon impact, the tension in the guardrail caused rotation of the PCB segment that it was attached to. This rotation caused bowing of the guardrail system, late post rotation and subsequently pocketing in the W-beam guardrail system. Another concern was the height of the G4(1s) guardrail system and its capability to capture and redirect the pickup truck.

In order to address both of these concerns, it was determined that a transition to the more robust and taller thrie beam guardrail was the next step. Installation of the thrie beam hardware into the model and simulation are currently underway.

Anticipated work next quarter:

In the 3rd Quarter of 2013, MwRSF will continue the development of design concepts for the guardrail to PCB transition system. Design modifications will be added incrementally to the thrie beam guardrail transition currently being simulated during this quarter in order to improve it performance without adding unnecessary complexity to the design. These modifications could include removal of posts in front of the PCB system, increased offset and flaring of the barrier systems, and additional hardware designed to prevent snag and improve the barrier transition.

A TAC meeting is anticipated in the late summer early fall time frame to show the proposed transition designs as determined by the simulation and design effort.

Significant Results:

Simulations of a transition between W-beam guardrail and PCBs using a W-beam end shoe connection were conducted. The results from these simulations indicated that further modifications to the transition would be required in order to ensure safe performance.

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 funding for this research project was done jointly with funds from both NDOR and the Smart Work Zone Deployment Initiative (SWZDI). The completed research effort is on schedule and slated for completion 12/31/2013. However, the SWZDI portion of the project has a termination date of 6/30/2013. In order to align the completion and progress of the combined research effort, MwRSF will request a no-cost extension of the SWZDI portion of the project until 12/31/2013.

Potential Implementation:

The research study is directed toward improving the safety by minimizing the risk for the motoring public traveling within our nation's work-zones and on our highways and roadways. Since W-beam guardrail has proven to provide better safety performance than temporary concrete barriers, the development of an effective transition between the two can help preserve guardrails outside the immediate work-zone area, thus providing an overall higher level of safety for motorists. The new transition would also eliminate the use of an unproven connection between guardrail and temporary barriers. Further, limiting the use of temporary concrete barriers strictly to the work zone area will also minimize the traffic disruption that these barriers can create to motorists passing in work zones.

MwRSF will work closely with NDOR engineers and the TAC committee throughout the concept development of a MASH TL-3 transition design between TCBs and the MGS in order to ensure that the system is practical, able to be constructed, and cost efficient. This should ensure that the system is viable for NDOR as well as state DOT's across the country.

The dissemination of the research results will be made through the use of a final report describing the transition development and recommendation for full-scale crash testing and publication of a paper in a refereed journal, if warranted. Following the completion of the study, results from this study will be disseminated by MwRSF personnel in future NDOR transportation presentations given to State DOTs and to participants of technical engineering conferences, industry meetings, trade shows, and conventions so that dissemination and distribution of the final research results will provide the most significant impact in terms of safety benefit for the motoring public.

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)* SPR-P1(13) M332	**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: New Conceptual Development of an Impact Attenuation System for Intersecting Roadways		
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: 2611211076001	**Other Project ID (i.e., contract #):** RHE-08	**Project Start Date:** 7/1/2012
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
$120,469.00	$5,514.00	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
	$4,256.00	

Project Description:

The objective of this study is to pursue the long term development of a MASH compliant attenuation system for intersecting roadways utilizing as small a footprint for the device as possible. This initial phase would consist of development of design concepts, analysis of those concepts, and recommendations as to their feasibility. The project is proposed as an initial conceptual design phase such that the Nebraska Department of Roads (NDOR) can limit the research money for this phase and re-evaluate in the future until a viable design is at hand and a more substantial investment can be made in compliance testing. Full-scale compliance testing of any proposed system would require additional funding.

This study would involve developing several new concepts which incorporate end terminals, cable elements, arrestor systems, and/or other energy absorbing devices. Critical components of the most promising concepts would then be subjected to dynamic testing in order to verify failure mechanisms and quantify failure load. The most promising designs will then be subjected to high-speed bogie tests to examine the dynamic performance and structural adequacy for the impact condition believed to produce the greatest risk of failure.

Major Task List

1. Literature review of previous short-radius designs as well as potential terminal, crash cushion, and arrestor systems that may be used in the design concepts
2. Review of NDOR standards for intersecting roadways to identify general site constraints
3. Concept Development - Brainstorming of new design concepts. Limited development and analysis of promising concepts.
4. Meeting with TAC members to review and comment on potential design concepts.
5. Dynamic Bogie Tests - Four dynamic tests of new components used in future impact attenuation system for intersecting roadways.

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

During the Second Quarter of 2013, MwRSF prepared schematics with varied intersection geometries and approach conditions in order to determine a protection area that must be treated by the new system. These schematics also included the typical clear zones for the intersections. Following determination of the protection area, MwRSF has worked on developing more detailed designs for concept nos. 1A, 1B, and 1C. As part of development of more detailed designs, MwRSF investigated a wide range of existing technologies for use in the design concepts. This included existing crash cushion and end terminal systems, TMA and TTMA designs, arrestor nets, and defense barriers. Review of these concepts found that some of the TMA and arrestor net technologies may be feasible for use in concept nos. 1A, 1B, and 1C. MwRSF is currently in the process of contacting the manufacturers of these system with design criteria to get more detailed information for use in the systems. MwRSF has also begun to layout more detailed configurations of concept nos. 1A, 1B, and 1C.

Preliminary discussions on the component testing desired for evaluating the feasibility of the concepts has also been underway. As more detailed specific on the energy absorbing systems are obtained, the details of these component tests are being developed with the goal of testing the critical component tests by the end of summer.

Anticipated work next quarter:

In the Third Quarter of 2013, MwRSF will continue the development of a new treatment for intersecting roadways. Continued development of the design concepts is underway and further refinement is planned. Parallel to that effort, MwRSF will devise and conduct component testing on the critical system components to determine their feasibility in the system by the end of summer. The results from those tests will be analyzed and used to further refine the design concepts. A TAC meeting is planned in late summer/early fall to review the component testing and the current design iterations with the sponsor. It is also anticipated that portions of the summary report will be developed over the coming quarter.

Significant Results:

Further developed design concepts, laid out the intersection geometry and protection area, and investigated potential existing technologies for use in concept nos. 1A, 1B, and 1C.

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).

It was originally anticipated that MwRSF would get the needed intersection geometry and standard information in the first quarter of the research project. MwRSF did not receive the information until midway through the current quarter. As such, there has been some delay in formulation of the initial design concepts for NDOR to review. MwRSF will attempt to compensate for lost time as the project moves forward. However, the delay in receiving some of the materials may cause some of the project task time constraints to change.

Potential Implementation:

Short radius designs are intended to protect motorists from the difficult problem created when an intersection is placed near a bridge railing. Currently, there are no safety treatments for this situation that have been successfully tested for high-speed applications. A design that can safely treat this situation along high-speed roadways is sorely needed. In addition, the development of a new design concept for short-radius barrier can focus on the site and space restraints associated with intersecting roadways and adapt a design that best meets those constraints.

MwRSF will work closely with NDOR engineers and the TAC committee throughout the concept development of a new short-radius barrier system in order to ensure that the system is practical, able to be constructed, and cost efficient. This should ensure that the system is viable for NDOR as well as state DOT's across the country.

Once the a new, TL-3 short-radius barrier system has been crash tested, evaluated, and accepted by FHWA, the NDOR and other State DOTs can implement the new design into its Standards and/or Special Plans for intersecting roadways. At the conclusion of this research project, it is recommended that NDOR designate an intersecting roadway location that will use this new technology in order to evaluate a "real-world" installation and make any necessary improvements.

Finally, the publication and dissemination of the research results and demonstration program, in the form of newsletters, research reports, and refereed journal papers, will aid the rapid transfer of this new technology to all interested organizations.

Iowa Department of Transportation

Form 541001.pdf (9/08)

Research Quarterly Progress Report

For Quarter Ending 06/15/2013

QPR Project Number (RTXXX)	Other Project Numbers (addendum, IHRB etc.)	Project Title
RT 14074		Development of a TL-3 Transition between Temporary Cor

Principal Investigator Name	Email Address
Ron Faller	rfaller1@unl.edu
Co-Principal Investigator Name(s)	**Email Address**
Robert Bielenberg	rbielenberg2@unl.edu

Principal Investigator Organization Name/Address

Midwest Roadside Safety Facility, 130 Whittier Bldg, 2200 Vine St., Lincoln, NE 68583-0853

DOT Office	DOT Contact Name	Email Address
	Tom McDonald	tmcdonal@iastate.edu

Project Start Date	Original Project End Date	Extended Project End Date
07/01/12	06/30/13	

Dollars Allocated	Dollars Paid	Percent Project Completed
$50,000.00	$28,046.00	40

Project Tasks	Scheduled Start Date	Scheduled End Date	Date Completed
1. Project Planning, Correspondence, and Literature Search	07/01/2012	09/30/2012	09/30/2012
2. Survey Pool Fund States to Identify TCB to Guardrail Tran	07/01/2012	09/30/2012	09/30/2012
3. Selection of Highest Priority Transition Need	07/01/2012	09/30/2012	09/30/2012
4. Brainstorming of Design Concepts	07/01/2012	12/31/2012	12/31/2012
5. Development of Candidate Transition Designs	07/01/2012	12/31/2012	12/31/2012
6. LS-DYNA Simulation of Concepts	07/01/2012	06/30/2012	
7. Preparation of CAD Details of the Transition Designs	07/01/2012	06/30/2012	
8. Preparation of Research Report and Recommendation for Fu	07/01/2012	06/30/2012	
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Iowa Department of Transportation

Research Quarterly Progress Report

Technical Advisory Committee Names	Email Addresses
• Dan Waddle	dan.waddle@nebraska.gov
• Matt Neemann	matt.neemann@nebraska.gov
• Phil TenHulzen	phil.tenhulzen@nebraska.gov
• Mark Osborn	mark.osborn@nebraska.gov

Last TAC Meeting Date	04/03/2013

PI Concerns, Problems, Needs, or No-Cost Extension Requests

The funding for this research project was done jointly with funds from both NDOR and the Smart Work Zone Deployment Initiative (SWZDI). The completed research effort is on schedule and slated for completion 12/31/2013. However, the SWZDI portion of the project has a termination date of 6/30/2013. In order to align the completion and progress of the combined research effort, MwRSF will request a no-cost extension of the SWZDI portion of the project until 12/31/2013.

A copy of the letter requesting the extension is attached to this form.

Project Progress To-Date and other Pertinent Information

During the 2nd Quarter of 2013, MwRSF continued simulation work on the development of a TL-3 transition between portable concrete barriers and W-beam guardrail. The next step after a simple overlap of the two systems was to connect the W-beam guardrail to the PCB system with an end shoe. The purpose of this connection was to develop downstream tension in the W-beam guardrail system that would aid in the capture of the vehicle. This system also utilized two of guardrail posts from the W-beam guardrail system in front of the flared PCB system. The purpose of having these posts in front of the PCB system was to initiate displacement of the PCBs caused by post rotation.

This connected system was simulated and analyzed for impact at several locations. For impacts downstream of the upstream end of the PCB system, the backward post rotation initiated PCB displacement as intended. However, the posts tended to wedge against the face of the PCB and

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

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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:** ☐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: Adaptation of the SAFER Barrier for Roadside and Median Applications		
Name of Project Manager(s): Ron Faller, John Reid, & Jennifer Schmidt	**Phone Number:** 402-472-6864	**E-Mail** rfaller1@unl.edu
Lead Agency Project ID: 2611211036001	**Other Project ID (i.e., contract #):** DPU-TWD(94)	**Project Start Date:** 7/1/2009
Original Project End Date: 6/30/2011	**Current Project End Date:** 6/30/2013	**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
$990,000.00	$276,711	28%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
$26,084 (2.6%)	$26,084	28%

Project Description:

Concrete barriers have gained widespread application along our nation's highways and roadways, primarily as median barriers and bridge railings. Most of these barriers are largely maintenance free and can provide the capacity to contain high-energy truck impacts at much lower construction costs than metal barriers. However, accident data has shown that impacts with these barriers cause more fatalities than observed with flexible guardrails. Vehicular impacts into rigid concrete barriers often impart high decelerations to vehicles and their occupants. Thus, there is a need for an energy-absorbing roadside/median barrier that lowers vehicle decelerations but still has the capacity to contain high-energy truck impacts without significant increases in cost. The objectives of the research are to identify the most promising highway application for SAFER Barrier technology and adapt the barrier system to this highway application. The adapted barrier design must provide optimized energy management for highway vehicles, consider construction costs in comparison to existing barrier technologies, be more damage resistant, and require no to limited routine maintenance and repair. The research will be accomplished through the following tasks.

1. Identify target applications.
2. Analyze energy management and deformation of current SAFER barrier during high-speed impacts to guide selection of new highway barrier.
3. Brainstorm and develop concepts for the design of the new barrier and energy absorbers.
4. Evaluate the best concepts and energy absorbers with finite element analysis and static, dynamic, and durability tests.
5. Develop and simulate a preferred final design concept.
6. Construct barrier prototypes for full-scale crash tests and refine finite element simulations & designs as needed:
a. MASH TL-3 with 2270P vehicle; b. MASH TL-3 with 1100C vehicle; c. MASH TL-3 with either 2270P or 1100C vehicle if re-design is necessary; d. MASH TL-4 with 10000S vehicle; & e. retests as needed.
7. Prepare final report to document the research, development, testing, and evaluation effort.

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

The Phase 1 report was submitted to the sponsor for review and comment on May 10, 2013. Static testing that was completed in the first and second quarters was reported and added to the Phase 2 report, which is under internal review.

Four 10-in. x 11 5/8-in. x 15 3/4-in. shear fenders spaced at 4 ft were offset and staggered and heated to 130 degrees Fahrenheit. The system was stable with at least a 5,000-lb load, or 312 lb/ft, and the system deflected less than 0.5 in. The concrete rail shape was optimized to reduce the dead load on the shear fender posts. Four more static tests were conducted on the 10-in. shear fender posts. First, four posts spaced at 5 ft were loaded to over 7,000 lb., or 438 lb/ft, and the system was completely stable. Then, four posts spaced at 5ft were loaded to 3,500 lb on a 14% grade, and the system was stable. The same test was repeated with offset and staggered posts, and the stability of the system improved. Lastly, three posts spaced at 7 ft were loaded to approximately 6,500 lb before showing any instability. Therefore, the concerns of the shear fender posts not being able to support the dead load of the concrete rail were reduced. However, an optimized, lighter weight rail was still pursued. The final design includes a lightweight concrete rectangular section with a steel tube rail on top that is at a height of 38 in. above ground to capture and redirect the single-unit truck. SolidWorks drawings were completed to simulate the final design in LS-DYNA. Concrete Industries has been consulted for their input on using lightweight concrete and overall geometric design of the concrete rail.

Anticipated work next quarter:

The Phase 1 interim research report will be final after sponsor comments are received and implemented. The Phase 2 interim research report will be be sent to the sponsor to review soon, and comments will be implemented shortly thereafter. Concrete Industries Inc. of Lincoln, Nebraska, will be consulted regarding the final design of the interior concrete rail segments. LS-DYNA computer simulation will be performed on the final barrier design to verify acceptable vehicle acceleration reductions as well as capture and redirection of vehicles at the TL-4 impact conditions. Parts and materials will be ordered for a MASH TL-3 2270P pickup truck crash test. The 2270P pickup truck crash test will be completed in the next quarter.

Significant Results:

The Phase 1 report was sent to the sponsor for review. Several static component tests were completed on the 10-in. x 11 5/8-in. x 15 3/4-in. shear fender posts. The stability concerns from previous static tests were reduced, and a new barrier design was pursued. The concrete rail section was optimized to be lighter and have an easy-to-replace top steel tube in the event that it is damaged during a single-unit or tractor-trailer impact. Concrete Industries was consulted for their expertise in concrete beam design and fabrication. A design was selected for crash testing, and preparations have begun for a MASH TL-3 2270P full-scale crash test.

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).

Since the rubber shear fender posts showed instabilities in supporting the weight of a concrete rail during static testing, the original design concept was modified. Smaller, more closely spaced shear fender posts were stable over a variety of temperatures. The barrier was redesigned to obtain a more successful performance in a variety of environmental conditions and to optimize the concrete and steel rail. Therefore, no full-scale crash tests have been performed to date. A full-scale crash test with the 2270P pickup truck impacting at 62 mph and 25 degrees will be conducted as soon as the simulation shows the potential for significant lateral vehicle acceleration reductions and it will work during temperature extremes. The full-scale crash testing program and report will not be completed before the current project end date.

Potential Implementation:

Details on the study of rubber material models under high-velocity impacts will be available to future researchers to use in other investigative efforts. The shear fender open concrete median barrier concept has shown a significant reduction in lateral vehicle accelerations and occupant risk values for passenger vehicles in simulations. The barrier also demonstrated the ability to contain TL-4 single-unit truck impacts. The current barrier design has a top steel rail that can be removed and replaced easily if a single-unit or tractor-trailer truck cause significant damage. Severe injuries and fatalities could be reduced if the shear fender open concrete median barrier was installed in lieu of current concrete median barriers in urban areas where severe injuries and/or fatalities have occurred.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Wisconsin DOT

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. #15	**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: Development of a Low Deflection Temporary Concrete Barrier		
Name of Project Manager(s): Bielenberg, Faller, Reid, Sicking	**Phone Number:** (402) 472-9064	**E-Mail** rbielenberg2@unl.edu
Lead Agency Project ID: 2611211022001	**Other Project ID (i.e., contract #):**	**Project Start Date:** 7/1/2009
Original Project End Date: 6/30/2011	**Current Project End Date:** 12/31/2013	**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
$178,914	$101,828.00	78

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$2,009.00	

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 Offset to Drop-Off	30
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	85
8. Fabrication of Revised Design	0
5. TL-3 Full-scale Crash Testing with 2270P Vehicle	0
6. Summary Report	0

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

In the Second Quarter of 2012, a significant amount of work was completed on the revised design for the second test of the low-deflection TCB system. Recall that test no. RDPCB-1 had dynamic lateral deflections of 43 in. For the second test, it was desired to reduce those deflections to a lower level in an economical manner with the hope of obtaining deflections below 36".

In order to investigate the design modifications, a model of test RDPCB-1 was developed and validated. Subsequent models were created to evaluate various design modifications and their corresponding effect on dynamic deflections. The design modifications evaluated included.

1. Increased barrier to ground friction through the use of neoprene bearing pads adhered to the bottom of the barrier.
2. Increased thickness of the 5"x5"x2/16" tubes.
3. Increased thickness of the saddle or cap that spans the TCB segment joint.
4. Implementation of spacers in the TCB segment gap to reduce rotation of the joint under load.
5. Installation of additional anchorage of the tubes along the length of the barrier section.

A summary of the simulation results as compared to the full-scale test deflections from test no. RDPCB-1 is shown below.

RDPCB-2 Modification Comparisons

Test/Run No.	Estimated Actual Delfection (in.)	% Difference
RDPCB-1	43.0	0.0
RDPCB-2 Friction - Run 1 - μ = 0.76	29.6	-31.2
RDPCB-2 Friction - Run 2 - μ = 0.62	33.7	-21.8
RDPCB-2 Tube - Run 1 - t = 0.375"	30.3	-29.6

Anticipated work next quarter:

In the Third Quarter of 2013, MwRSF will complete of the CAD details of the design for the second crash test. The plans will be sent to WisDOT for review. Once they have been approved, MwRSF will prepare and conduct the second full-scale crash test in the research project.

After completion of the full-scale test, additional modeling to investigate the safe barrier offsets will be conducted and the summary report for the research will be compiled.

Significant Results:

Potential design modifications for further reducing barrier deflections were investigated and a design modifcation was selected for the second full-scale crash test.

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 December 31, 2013.

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): Albuquerque D., Schrum K., and Sicking D.	**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	$77,218 ($7,608 for Suppl #26, $5,9	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
	18,451	

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.):

An incremental BC analysis was conducted in addition to the index approach developed in the study. The report was edited according to comments from DOTs, manufacturers, and other industry experts as well as internal discussions. In response to some comments, the QuadGuard was resimulated to correct the length of the system in the RSAP runs. The organization of the report was adjusted to present all costs (installation and repair) first, then categorization descriptions, then RSAP model descriptions including the sensitivity analysis, then the results were presented for optimal solutions and all cost-effective solutions, then examples were given using the RSAP results, then pure maintenance costs were considered and an example was included, then conclusions and recommendations were made, followed by limitations of the project.

The revised report was sent for review by State DOTs and manufacturers in May 2013.

A paper from this research was submitted for publication to the Journal of Transportation Safety & Security in April 2013.

Anticipated work next quarter:

State DOTs and manufacturers comments will be reviewed and pertinent changes will be made to the report. The report will be finalized and disseminated to the sponsor agency.

Significant Results:

After rerunning the BC analysis with the updated repair cost information submitted by the manufacturers, the recommendations inferred from the analysis did not change. Only the minimum impact frequency at which to recommend a low maintenance system was affected.

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.

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 No. TPF-5(193) Suppl. #26 and TPF-5(193) Suppl. #40 were 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):	**Phone Number:**	**E-Mail**
Reid, Sicking, Faller, Rosenbaugh	402-472-9324	srosenbaugh2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211026001	RPFP-10-CABLE-1	7/1/2009
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
7/31/2012	4/30/2014	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**
$92,207	$13,158	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**
	$621	

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.):

Previously, dynamic bogie testing was conducted on concrete foundations in both weak sandy soil and stiff soil (AASHTO grade B). From these tests, 60 inches and 36 inches appear to be the minimum embedment depth to limit deflections in weak and strong soils, respectively. However, the 12" diameter concrete foundations continued to see damage in the form of large concrete pieces breaking free from the top - back side of the foundation during testing.

Over the last 6 months, the new, non-proprietary, cable median barrier being developed by MwRSF has been going through some major design changes, including a post cross section. The original S3x5.7 posts are going to be replaced with a weaker, bent plate post, presently being called the Midwest Weak Post. Testing of the new post showed that it provided about half the strength of the S3x5.7 posts. Thus, the MWP may reduce the impact loads to the point that the concrete foundations are not damaged during impact. In recognition of the potential of this new post, the Pooled Fund States have elected to proceed with testing utilizing the new MWP design. A new bogie testing matrix was assembled including multiple embedment depth and reinforcement variations for the 12" diameter socketed foundations. The foundations have been cast / fabricated and are currently awaiting testing.

Anticipated work next quarter:

Testing of the concrete foundations in combination with the new MWP will occur. Based on the results of these tests, new embedment and reinforcement recommendations will be made.

If the next round of bogie testing provides positive results, testing may also begin with the socketed foundations installed in mow strips. The foundation design may be modified to reflect the increase in confinement strength that the mow strip will provide.

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).

Due to a change in the post utilized for the new non-proprietary, cable barrier, the socketed foundations have been redesigned and a new testing matrix was created. The new designs shall be tested soon.

Objectives/Tasks:	% Completed (Phase II)
1. Design new socket foundations for barrier posts.	40%
2. Fabrication and dynamic testing of socketed foundations.	40%
3. Analysis of test data and evaluation of socketed foundation designs.	30%
4. Written report documenting all work and conclusions.	20%

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 wee gone. Limited time has been charged to the Phase II project to date, but the test charges from Round 2 of testing have been placed on this project's budget.

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:

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.#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): Reid, Sicking, Faller	**Phone Number:** 402-472-3084	**E-Mail** jreid@unl.edu
Lead Agency Project ID: RPFP-10-CABLE-3	**Other Project ID (i.e., contract #):** 2611211028001	**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
$159,193	$29,701	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:

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.):

See Phase I for this quarter progress. Year 17: SPR-3(017) Suppl.#38 - "Testing of Cable Terminal for High Tension Cable (1100C & 2270P)." Funds were exhausted in that project this quarter. The project now switches to this Phase II.

Anticipated work next quarter:

Task 4. The draft report for bogie tests HTCT-2 and HTCT-3 will be completed. Design modifications to the terminal will be developed and bogie tests will be defined to asses 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 received another no-cost time extension.

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:

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.#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	$142,897	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): 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.#24	**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: LS-DYNA Modeling Year 4		
Name of Project Manager(s): Reid, Sicking, Faller	**Phone Number:** 402-472-3084	**E-Mail** jreid@unl.edu
Lead Agency Project ID: RPFP-10-LSDYNA	**Other Project ID (i.e., contract #):** 2611211031001	**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
$37,634	$34,521	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
	$109	

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.):

Due to other project priorities, no work was done on this project during this quarter.

Anticipated work next quarter:

The behavior of wood, specifically for guardrail posts (bct and crt) and blockouts, is complicated. MwRSF has bogie tested thousands of wood posts over the past 15 years of various sizes and types. The variability of the wood behavior has been shown to be large and non-predictable in some regards. However, some patterns can be discerned from the data.

LS-Dyna simulation of wood has been done by using many different modeling techniques, none of which have proven very satisfactory. Thus, it is planned to take a comprehensive look at wood post and blockout modeling techniques and try to develop up-to-date modeling practices for such. That project should begin next quarter.

Significant Results:

The 1100c Toyota Yaris model is now ready for other Pooled Fund projects that require simulation of the 1100c vehicle.

The updated 2270p Chevy Silverado model is now ready for other Pooled Fund projects that require simulation of the 2270p vehicle where a more accurate steering mechanism is required.

The reduced 2270p Chevy Silverado model is now ready for other Pooled Fund projects that require simulation of the 2270p vehicle where a less detailed model is sufficient, saving a significant amount of cpu requirements.

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:

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)* 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:** June 30, 2013	**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
$57,929.00	$30,286	80

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$17,737	

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	90
Modify FEA model of WA-SRG to incorporate 70-ft radius	90
LS-DYNA analysis and design modifications for Yuma County-SRG with 70-ft radius	90
Prepare draft and final research reports	50
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.):

During the second quarter of 2013, models of short radius guardrail systems with larger radii were modeled. Critical impact locations were identified which contributed to vehicular instabilities and vaulting. Modifications were added to the 27-in. tall systems to improve overall performance.

Systems with radii between 24 and 72 ft were simulated. The overall extent of damage increased as radiuses were lengthened. In particular, overall rail damage was reduced, rail tensions were reduced, and more posts fractured. Larger radii exhibited longer 2000P vehicle stopping distances, smoother decelerations, and lesser vaulting tendencies than were observed with smaller-radius systems. However, larger systems also demonstrated susceptibility for the vehicle to undergo significant yaw displacements, and impacts contributed to extensive, unsupported guardrail lengths. Those unsupported guardrail lengths could contribute to vehicular override in real-world crash conditions.

31-in. tall guardrail systems were determined to be acceptable for all impact locations with 2000P vehicles at 45 mph. Simulated impact speeds were increased to 50 mph, and the systems continued to capture the vehicle, but damage to each system was extensive. Because it appeared that full system capacity was utilized with 50 mph impact speeds, further speed increases were not pursued. 27-in. tall systems were not successful for most impact conditions, regardless of radius. Blockouts were added to the 27-in. tall systems to improve performance for 2000P pickup truck impacting at 45 mph. The blockouts dramatically improved performance, frequently preventing signature vaulting from occurring. However, no 27-in. tall system passed all simulations involving the 2000P vehicle. As a result, speeds may be reduced to improve compliance, and blockouts will be recommended for all 27-in. tall short radius systems.

Anticipated work next quarter:

A no-cost project extension is requested to complete the report detailing findings in this research study. In addition, with remaining funds, small car simulations will be pursued with the 31-in. tall systems to evaluate underride propensity, and pickup truck impacts will be simulated with the centerline of the pickup aligned with the tangent line of the transition to evaluate potential risk of snagging.

Significant Results:

Models of systems with larger radii were simulated with 2000P pickups impacting at 25 degrees. 27-in. tall systems were simulated with an impact speed of 45 mph on systems with and without blockouts added to the CRT posts. Blockouts were determined to retain the guardrail mounting height for a longer duration, increasing the propensity of the system to capture the truck, and reducing vaulting propensity.

In addition, 31-in. tall systems were simulated with impact speeds of 45 and 50 mph. All radii with these speeds were determined to perform acceptably when impacted with a 2000P vehicle impacting at 25 degrees. However, both the 24 and 48 ft radius systems encountered critical damage by fracturing all of the CRT posts on the radius when struck by a 2000P simulated vehicle at 50 mph and 25 degrees. Higher-speed impacts are therefore not recommended due to a lack of available reserve capacity.

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).

Frequent and extended server downtime reduced the available time and capacity for concluding simulations. The researcher working on this project was also involved in other critical projects which reduced available time for completing the research report. A no-cost project extension through December of 2013 is requested to complete the report, internal review, and necessary document editing. In addition, with remaining funds, simulations will be conducted to evaluate the performance of small cars on 31-in. tall short radius systems, to evaluate the propensity for underride.

Potential Implementation:

No results indicating implementation potential at this time.

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): Mongiardini M., 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:** June 30, 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
$ 235,065.00	$ 197,333	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
	$ 2,111	

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 is continuing to be reviewed. An additional journal paper was outlined and the draft of the paper was started.

Anticipated work next quarter:

Due to unexpected delays involving internal review and additional high-priority research efforts conducted, progress on the report was delayed. Despite this delay, the project is still well below the budget limit projected for this research effort. As a result, a project extension will be requested to conclude internal and external reviews of the draft report, as well as drafting and submitting an additional journal paper for review to Wisconsin DOT. The extension will be requested through December of 2013.

In the next quarter, the draft report will be submitted to Wisconsin DOT, edited, and finalized. The submission of the final draft report is expected by the middle of the next quarter. In addition, a journal paper describing pertinent findings from the surrogate vehicle testing on BCT anchor posts will be completed and sent to Wisconsin for review before submitting for publication.

Significant Results:

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.

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).

Delays due to series of high-priority projects prevented early revision and submission of report.

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:** June 30, 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
$122,444	$97,660	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
	$4,117	

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 - draft completed, undergoing review by the sponsor

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

Task 7. All internal reviews have been completed for the draft report. The document is currently undergoing review by the sponsor.

Anticipated work next quarter:

Comments from the sponsor will be addressed and the final report will be submitted. The project is anticipated to end this quarter.

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.

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	$89,181	75

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$640	

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.):

Review of the internal draft report continued.

Anticipated work next quarter:

Review of the internal draft report will be completed. The draft report will be submitted to the Pooled Fund member states for review and comment.

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	90%
4. Hardware guide drawings and FHWA acceptance	60%

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.

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:**	**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
$91,071	$82,397	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
	$490	

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.):

All component testing had been previously completed.

Work this quarter was focused on writing the project report. An internal draft is approximately 70% completed.

Anticipated work next quarter:

The first draft of written report documenting all testing, conclusions, and recommendations shall be completed during the next quarter.

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	95%
5. Written report documenting all design work, testing, and conclusions	70%

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:

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	$101,095	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**
	$1,167	

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.):

Request for FHWA eligibility was submitted on May 28, 2013. All work on this project was completed.

Anticipated work next quarter:

None as all work was completed during this quarter.

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).

There are no problems or issues to report at this time.

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	97%

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.):

Previously, all four projected bogie tests (combined between this project and its related project TPF-5(193) Suppl. #47, RPFP-12 MGS 4) were conducted and analyzed. Similar to the original study, the 3-pass weld was the only weld to hold the impact force without fracturing or tearing the base plate.

During this quarter, a draft report documenting all testing and conclusions was completed and sent out to the member states on May 23rd for review.

Anticipated work next quarter:

Once comments have been received from the Pooled Fund representatives, the appropriate edits will be made to the project report. The report will then be finalized, printed, and sent out to the member states.

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	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).

Although this project has no remaining funds, the report shall be finalized using the funds from the related project: TPF-5 (193) Suppl. #47, RPFP-12 MGS 4. The report will cover the 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	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.#24, "LS-DYNA Modeling Year 4" 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:**
SPR-3(017) Supplement #38	☐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: Cost Effective Upgrading of Existing Guardrail Systems		
Name of Project Manager(s): Reid, Rohde, Sicking, Faller, Lechtenberg	**Phone Number:** 402-472-9070	**E-Mail** kpolivka2@unl.edu
Lead Agency Project ID: 2611120090002	**Other Project ID (i.e., contract #):** RPFP-07-01	**Project Start Date:** 2/26/07
Original Project End Date: 12/31/10	**Current Project End Date:** 12/31/13	**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
$92,084	$98,393	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
	$6,164	

Project Description:

Existing guardrail installations are often substandard in some way, such as low height, inappropriate post spacing, or inadequate length. Although it is desirable to upgrade substandard barriers to meet current guidelines, available funding is often insufficient to achieve this goal. However, the safety performance of many existing guardrail systems can be greatly improved by eliminating only the most significant deficiencies. In general it is often desirable to implement low cost/high benefit improvements at sites where a complete upgrade cannot be justified. Unfortunately, highway agencies have the potential for creating a liability risk when guardrail is upgrading without bringing it up to current guidelines. Therefore, agencies cannot make any improvements to an existing guardrail or terminal unless it is upgraded to meet current recommendations. As a result, many guardrail systems remain in place for many years with identifiable deficiencies.

Objective: Develop guidelines for upgrading of existing guardrail installations that do not meet current criteria.

Tasks:

1. Field study of existing guardrail installations
2. Compilation of field study findings
3. Selection of installations to investigate
4. Sensitivity study to decrease the size of the analysis matrix
5. RSAP analysis
6. Research report

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

Internal review of the draft report was completed. The draft report was submitted to the Pooled Fund member states for review and comment. Review comments were implemented and the final report was published and disseminated to Pooled Fund member states on May 9, 2013. All work on this project was completed.

Anticipated work next quarter:

None as all work was completed during this quarter. Thus, the project will be closed next quarter.

Significant Results:

A field survey of more than 60 barrier sites in Kansas revealed deviations from standard guardrail systems with guardrail height being the most prominent issue as well as different hazards that these systems were protecting. To account for the different guardrail height in the RSAP models containment index (CI) had to be changed. The CI was derived from past crash test results and LS-DYNA simulations of the MGS with 22" and 25" rail heights at speeds of 100, 70, and 60 km/h with the 2270P. The 22" and 25" rail heights contained the 2270P at impact speeds of 60 km/h and 70 km/h, respectively.

Task	% Complete
1. Field study of existing guardrail installations	100%
2. Compilation of field study findings	100%
3. Selection of installations to investigate	100%
4. Sensitivity study to decrease the size of the analysis matrix	100%
5. RSAP analysis	100%
6. Research report	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).

The original analysis was completed with the longer runout lengths. Thus, additional analysis was completed with the shorter runout lengths that were published in the updated Roadside Design Guide.

During review of the internal draft report, it was determined that incorrect terminal lengths were utilized during the analysis. Adjustments were made for the terminal lengths.

The fund in this project were exhausted prior to the completion of the project. Therefore, the overrun budget is being posted to Contingency Funds from Year 17, Project No. SPR-3(017) Suppl. #38. To date, $6,309 has been posted to contingency funds from Year 17, Project No. SPR-3(017) Suppl. #38.

Potential Implementation:

The guardrail removal and upgrading guidelines developed under this study will provide highway designers with a very important middle ground option between doing nothing and a complete upgrade of deficient guardrail. This middle ground option should provide most of the benefits of a complete upgrade at a much reduced cost. Further, the guidelines will eliminate the potential for increased liability currently associated with using a less-than-complete guardrail upgrade.

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)* SPR-3(017) Suppl.#38	**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: Testing of Cable Terminal for High Tension Cable (1100C & 2270P)		
Name of Project Manager(s): Reid, Rohde, Sicking, Faller	**Phone Number:** 402-472-3084	**E-Mail** jreid@unl.edu
Lead Agency Project ID: RPFP-07-06	**Other Project ID (i.e., contract #):** 2611120090007	**Project Start Date:** February 26, 2007
Original Project End Date: December 31, 2010	**Current Project End Date:** December 31, 2013	**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
$100,563	$100,563	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
	$31,119	

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

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

Task 4.
Documentation of the history of design changes to the cable end terminal was completed. Writing of report for bogie tests HTCT-2 and HTCT-3 was initiated.

Anticipated work next quarter:

Funds have been exhausted in this Phase I of the overall cable terminal project. Project reporting will now switch to Phase II project funding.

Phase II was funded in Year 20: TPF-5(193) Suppl.#21 - "Additional Funding to Complete Development of a Crash-Worthy Terminal for Midwest Four-Cable, HT, Barrier System"

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.

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): 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): Albuquerque, Sicking, Faller	**Phone Number:** 402-472-9070	**E-Mail** kpolivka2@unl.edu
Lead Agency Project ID: 2611211060001	**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**
$113,499	$123,940	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**
	$10,561	

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 of the report was completed. Review of the internal draft report was initiated.

MwRSF is waiting on a subcontract with Dean Sicking for him to review, edit, and make changes to the report.

Anticipated work next quarter:

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

Significant Results:

None

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	80%

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. However, later on and in order to develop a database that would enable engineers to look at more meaningful and reliable results, researchers realized the need to collect more data. 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, RSAP\v3, in this study. Since RSAPv3 is very new and researchers had no experience with it. They did not anticipate the tremendous amount of time it would take to run approximately 1,000 simulations.

Although these factors have not negatively affected the project schedule, they have significantly affected the project budget.

MwRSF is waiting on a subcontract with Dean Sicking for him to review, edit, and make changes to the report.

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 $4,951 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	$39,707	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
	$17,357	

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.):

The draft report with documentation of literature review findings and design concepts continued.

A design meeting within MwRSF was held to select concepts to further refine and fabricate. Seven design concepts were chosen for fabrication and evaluation. All designs concepts are in the process of being built.

Anticipated work next quarter:

Fabrication of the concepts will be completed. The concepts will be photographed and documented. MwRSF staff anticipates presenting the design concepts and the knowledge gained to WisDOT in order to garner feedback on concepts to continue to investigate. Base connection designs will be developed after obtaining feedback from WisDOT.

Documentation of literature search results and design concepts will continue.

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	40%
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): 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 #):** 2611211062001	**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
$58,942	$52,699	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
	$798	

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 latest version of the literature review report was reviewed internally, comments were provided back to the Author.

Cale Stolle's Master Thesis based on the ZOI study was completed.

Anticipated work next quarter:

Complete the internal reviews of the literature review report, update appropriately and submit to WsDOT for review.

Convert the Master's thesis into standard MwRSF report format and begin the review process.

Significant Results:

Extensive database of information for the literature review has been developed.

Objectives / Tasks	% Complete
1. Literature review of ZOI values	90%
2. LS-DYNA Simulation of 2270P impacts on single slope barriers	100%
3. Written reports documenting all work and conclusions	80%

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	$ 42,547 ($4,951 for Suppl #40)	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
	$ 10,286	

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.):

MwRSF is waiting on a subcontract with Dean Sicking for him to review, edit, and make changes to the report.

Two papers from this research were submitted for publication to the Journal of Transportation Safety & Security in April 2013.

Anticipated work next quarter:

Internal review of the draft project report is expected to be completed. As soon as the internal review is completed, the final report will be submitted to the sponsor 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	80%

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).

MwRSF is waiting on a subcontract with Dean Sicking for him to review, edit, and make changes to 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 No. TPF-5(193) Suppl. #40 were exhaust prior to the completion of the project. Therefore, the overrun budget for Project No. TPF-5(193) Suppl. #40 is being posted to this project. To date, $4,951 has been posted to Project No. TPF-5(193) Suppl. #40.

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):	**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:**
2611211064001	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
$233,262	$214,088 (+$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
	$8,766	

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 text of what was done this quarter extends further than what is shown. Click within the box and scroll down.

A report that includes the component tests conducted on the tabbed bracket and keyway bolt designs and the top cable attachment concepts and design was completed. Draft report was sent to the states for review and comment on May 7, 2013.

An internal draft report that includes the folded C-channel posts and the new Midwest Weak Post was completed. It is undergoing internal review.

Investigation into a weaker post continued. Based on simulation, a new post shape, a folded backward S, indicated it would perform as anticipated. The researchers are referring this shape as the Midwest Weak Post. The new post design was fabricated from 7-gauge steel and included the keyway holes. Three dynamic component tests (test nos. CPZ-1 through CPZ-3) were conducted in mid-March 2013. The results of these tests exhibited the same behavior as the simulation indicated. Thus, it was recommended to that the system design proceed with the Midwest Weak Post.

During the Year 24 Pooled Fund meeting in , a decision was made to pursue development of a revised cable to post attachment concept for the high tension cable median barrier design. The consensus of the group was that the current tabbed bracket design performed in an acceptable manner, but that there was a desire to revise the attachment method of a Grade 5 bolt and nut to a simpler attachment method which would reduce concerns for the need for tools and small, difficult to handle parts. MwRSF was asked to brainstorm revised attachment concepts to meet these goals while still providing the performance of the current attachment design. It was decided that MwRSF would compile a series of design concepts for the states to review, provide feedback, and brainstorm their own ideas from.

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.

Accumulate feedback from the member states on the revised cable-to-post attachment concepts. Select 1 or 2 of the potential concepts that would eliminate the bolt in the current tabbed bracket attachment design to pursue further design and testing.

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%

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): Reid, Sicking, Faller, Bielenberg, Lechtenberg	**Phone Number:** 402-472-9070	**E-Mail** kpolivka2@unl.edu
Lead Agency Project ID: 2611211065001	**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**
$91,800 (+$91,089 Yr 21 cont.)	$72,006	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**
	$10,822	

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.

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.

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:

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

In a previous Pooled Fund Project, a cable end terminal consisting of three cables was designed and successfully crash tested according to NCHRP Report 350 criteria. That end terminal was designed for a low tension system. Further, MwRSF has also been working to develop a non-proprietary, high-tension, cable barrier system. Thus, there is a need to adapt this terminal for use in high-tension cable systems while also being satisfying the safety performance standards of MASH.

This is Phase III 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)"

Phase II was funded in Year 20: TPF-5(193) Suppl.#21 - "Additional Funding to Complete Development of a Crash-Worthy Terminal for Midwest Four-Cable, HT, Barrier System"

No reporting on this phase of the project will be done until Phases I and II are completed; see those projects for status.

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).

Final design details and full-scale testing for this project cannot be conducted until the High Tension Cable Barrier System is completed.

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): 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	$14,435	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
	$821	

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.):

Previously, the bogie testing portion of this project (2 tests) was completed, documented, and analyzed.

This quarter, a draft of the written report documenting all testing, analysis, and conclusions for this project was completed and sent out to the Pooled Fund state representatives for review on May 23rd. The testing report includes work form another project (TPF-5(193) suppl. #34) as they both deal with attachment of the top mounted culvert post to culvert slabs.

Anticipated work next quarter:

Once comments have been received from the Pooled Fund representatives, the appropriate edits will be made to the project report. The report will then be finalized, printed, and sent out to the member states.

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	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).

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	$3,837.00	75%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$2,740.00	

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 completed upload of all of MwRSF's previous research reports to the web site. The reports can be accessed by searching for various search terms, report nos., and/or crash test nos. In addition, all of the corresponding CAD files for the systems developed in those reports were collected. The archive of CAD files is currently 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 third quarter of 2013. 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 have been uploaded. 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): 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. #48	☐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):	**Phone Number:**	**E-Mail**
Ron Faller, John Reid, Bob Bielenberg	402-472-9064	rbielenberg2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211086001	RPFP-13-PFCHS	7/1/2011
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
$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 just being 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. It is anticipated that the web site will be functional in early third quarter of 2013.

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): 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:** December 31, 2013	**Number of Extensions:** 6

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)	$16,597	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
	$101	

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.):

Little 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, $669 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 #52	☐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:		
Deflection of Curved Runs of Cable Guide Under MASH TL-3 Impact - Retest		
Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Faller, Sicking, Reid, Lechtenberg, Bielenberg	402-472-9070	kpolivka2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211074001		12/15/11
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
12/31/12	6/30/13	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
$58,350	$57,183	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
	$10,937	

Project Description:

This project was additional funding to retest the 440-ft radius system with the modified top cable height. The original project was TPF-5(193) Supplement #30, Lead Agency Project ID: 2611211054001.

Tasks of original project:
1. Prepare CAD details of 360-ft radius system
2. Construct 360-ft radius system
3. Full-scale test of 360-ft radius system (modified MASH 3-11)
4. Prepare CAD details of 440-ft radius system
5. Construct 440-ft radius system
6. Full-scale test of 440-ft radius system (modified MASH 3-11)
7. Analysis and documentation of test results
8. Draft and final research reports
9. Additional crash investigation and energy dissipation analysis
10. Draft and final report for additional analysis

Tasks for additional work added to original project:
11. Prepare CAD details of modified 440-ft radius system
12. Construct modified 440-ft radius system
13. Full-scale test of modified 440-ft radius system (modified MASH 3-11)

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

Internal review of the draft report of Volume 2 which was the energy analysis was completed. The draft report was sent to NY State DOT for review and comment. Review comments were implemented.

Anticipated work next quarter:

The final report will be published and disseminated to NY State DOT and the project will be closed.

Significant Results:

On August 2, 2011, MwRSF conducted one pickup crash test (test no. NYCC-1) into a 360-ft radius curved cable system according to the modified TL-3 safety performance guidelines of MASH. The pickup was successfully contained and redirected. On November 1, 2011, MwRSF conducted one pickup crash test (test no. NYCC-2) into a 440-ft radius curved cable system according to the modified TL-3 safety performance guidelines of MASH. The pickup was not contained nor redirected. Following the failed test of the 440-ft radius system, the NYSDOT decided to retest a modified system with a 2 in. higher top cable. On April 26, 2012, MwRSF conducted one pickup crash test (test no. NYCC-3) into a 440-ft radius curved cable system with a 29-in. top cable height according to the modified TL-3 safety performance guidelines of MASH. The pickup was successfully contained and redirected.

Tasks:	% Completed
1. Prepare CAD details of 360-ft radius system	100%
2. Construct 360-ft radius system	100%
3. Full-scale test of 360-ft radius system (modified MASH 3-11)	100%
4. Prepare CAD details of 440-ft radius system	100%
5. Construct 440-ft radius system	100%
6. Full-scale test of 440-ft radius system (modified MASH 3-11)	100%
7. Analysis and documentation of test results	100%
8. Draft and final research reports	100%
9. Additional crash investigation and energy dissipation analysis	100%
10. Draft and final report for additional analysis	99%
11. Prepare CAD details of modified 440-ft radius system	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).

The warmer temperatures during the 4th Quarter of 2010 and 1st Quarter of 2011 melted the snow and thawed the soil surface, thus resulting in a muddy work environment not conducive to post installation. In addition, the spring rains came early. Rains continued through the 2nd Quarter of 2011 and the wet conditions made construction quite difficult.

With the unsuccessful second test, NYSDOT requested a retest with raising the top cable height 2 inches. An addition to the original proposal was filed.

Funds for the original project, TPF-5(193) Supplement #30, Lead Agency Project ID: 2611211054001, have been exhausted. All further work will be conducted under this additional funding project.

Potential Implementation:

This will provide justification for limits that have been placed on the amount of curvature that could be used for a given post spacing for a curved cable system since operating speeds on freeways have continued to increase and vehicle weights have continued to grow. In addition, it will allow the New York State Department of Transportation to provide information to help the New York State Police performing accident reconstructions, particularly as it relates to determining impact speeds, such as how much energy is absorbed in the process of deforming a standard weak post.

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):	**Phone Number:**	**E-Mail**
Reid, Sicking, Faller, Lechtenberg	402-472-9070	kpolivka2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211079001	RPFP-13-TF13	7/1/12
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/15	6/30/15	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	$820	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
	$740	

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 meeting held in April 2012 and Fall meeting held in October 2012.

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 - 25 approved, 6 to be reviewed
41 components - 15 approved, 26 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	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).

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)* TPF-5(193) Suppl. #54	**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: 2611211080001	**Other Project ID (i.e., contract #):** RPFP-13-CONSULT	**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
$39,992.00	$39,983.00	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
	$10,899.00	

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 will now be 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)*	**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	$29,654	60%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$1,082	

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 focused on writing the project report documenting all testing, analysis, and conclusions. Currently, about 90% of the report (first draft) has been written.

Anticipated work next quarter:

Work will continue on the documentation report. A completed draft will undergo internal reviews and edits before being sent out to the Pooled Fund States.

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	20%
4. Written report documenting all testing, analysis, 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).

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):	**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:**
RPFP-13-MGS-3	2611211082001	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**
$212,730	$6,468	3%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$4,009	

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. A baseline LS-Dyna model of the original MGS long-span design has been developed and has shown reasonable correlation to full-scale crash tests (LSC-1 and LSC-2).

Anticipated work next quarter:

Task 2. Research efforts will be focus on evaluating unsupported lengths greater than 25 ft using LS-Dyna simulation.

Task 3. Based on the evaluation of the original design in Task 2, if warranted, work will begin on potential design modifications to extend the unsupported length of the original MGS long-span system.

Significant Results:

None

Objectives / Tasks	% Complete
1. Literature review of previous long-span systems	100%
2. Simulation of both original and any new long-span system designs	25%
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 $36,605 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 24 ft.

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. #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	$4,350	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
	$4,099	

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.):

Responses were gathered from the previous email survey sent to the member states concerning mow strip design and system design concepts. From these responses, critical mow strip configurations were identified as 4" thick asphalt pavement and 4" thick non-reinforced concrete. Further, the critical placement of the posts was identified as the middle of a 4 foot wide mow strip. Component testing will utilized these critical mow strip configurations.

Additionally, responses were received concerning the preliminary design concepts and component testing will be conducted according to order of preference until a successful design is identified. Testing will begin with posts inserted directly into the mow strip (considered a baseline test). Sockets with bottom plates and shorter posts were preferred over tube sockets in which the post would be inserted and driven into the ground. The addition of shear plates or fins will only be done if necessary to prevent socket displacements during impacts. If all else fails, concrete shafts containing sockets will be placed within the mow strip.

The initial "baseline" testing matrix has been formulated and the critical mow strips are being poured at MwRSF's test site.

Anticipated work next quarter:

Baseline testing of posts installed directly into both the asphalt and concrete mow strips will be conducted. Based on the results of the baseline tests, the socketed design concepts will be fleshed out, fabricated and tested in the same mow strips.

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. The survey also established the design preferences of the member states: 1. Post driven through mow strip (no additional hardware), 2. Steel sockets embedded into the mow strip, 3. Steel sockets with shear plates embedded into the mow strip, and 4. socketed concrete foundation encased within the mow strip.

Objectives / Tasks	% Complete
1. State survey of existing mow strip practices	100%
2. System design and analysis	20%
3. Dynamic bogie component testing	0%
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).

None

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	srosenbaugh2@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	$136,796	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**
	$33,006	

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).
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.):

Test no. MWTC-3 (MASH 3-21) was conducted on the modified system on May 16, 2013 and satisfied all of the MASH performance criteria.

A research report on the testing was initiated.

Anticipated work next quarter:

All data analysis will be completed. The research report will continue to be written.

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.

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.	75%
3. Report documenting R&D effort, including redesign, crash testing, and conclusions	25%

** Task 1a. was added into the project scope only after the failure of test MWTC-1 required a system modification and an additional test.

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 is still needed to demonstrate acceptable safety performance for the modified MGS stiffness transition with lower curb. This project originally contained only two budgeted crash tests - one 1100C small car and one 2270P pickup truck. Although there is currently enough funding in the current project to conduct the pickup truck test, it is unlikely that the funds will be able to cover the full documentation, analysis, and reporting of the tests. Thus, additional funding is needed to complete this project. It is anticipated that a new proposal funding the additional work will be submitted at the Midwest States Pooled Fund annual meeting in April 2013 for consideration in the Year 24 research funding.

Additional funding to finish the project was funded in Pool Fund Year 24.

Potential Implementation:

The successful crash testing of the MGS stiffness transition with asymmetric transition element and lower concrete curb will allow state department of transportation personnel 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 #61	☐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	$54,242	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
	$47,997	

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.):

Results of the braking tests were further analyzed to identify an acceptable combination of speeds and brake timing that would produce the desired maximum vehicle pitch at impact. Results of the braking test were discussed with NYSDOT.

Construction of the 600-ft long, tangent, low-tension, 3-cable barrier system with 1/2-in. diameter hook bolts and no cable compensator was completed.

A review of cable barrier tension was completed. Based on NYSDOT specifications and MASH requirements to test at the tension corresponding to a 100-degree Fahrenheit day, a system tension of 500 lb was selected. A tension study was conducted to identify the tension corresponding to 1 in., 0.75-in., 0.50-in., and 0.25-in. of sag of the cables within one post span. Load cells located on both the upstream and downstream ends of the cables were used to gauge the consistency of the tension in the system when the system was tensioned from one end. A modified upstream tension value of 600 lb was selected to achieve the approximate system-average tension of 500 lb in the impact region.

Anticipated work next quarter:

The modified MASH 3-10 test will be conducted with a braked 1500A vehicle on the 600-ft long, tangent, low-tension, 3-cable barrier system with 1/2-in. diameter hook bolts and no cable compensator. Results of the full-scale test will be reviewed and analyzed to determine if the system performed acceptably according to MASH test criteria. Results of the braked 1500A test will be discussed with NYSDOT. Pending the outcome of the modified MASH 3-10 test, NYSDOT guidance will direct MwRSF as the next system to test. CAD details of the second system will be completed. NYSDOT will review the CAD details. Construction of the second system will be completed. Testing of the second system may be anticipated during the next quarter also.

Significant Results:

The average friction coefficient of a vehicle with anti-lock brakes disabled was 0.656. The maximum front-end pitch observed in braking on soil was approximately 2 degrees. This was correlated to a drop in front-end bumper height of approximately 2 in.

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)	0%
6. Analyze test results (modified MASH 3-10)	0%
7. Prepare CAD details of tangent, low-tension, 3-cable barrier system with 1/2-in. dia. hook bolts	0%
8. Construct system with 1/2-in. dia. hook bolts	0%
9. Conduct crash test with 2270P vehicle (MASH 3-11)	0%
10. Analyze test results (MASH 3-11)	0%
11. Prepare CAD details of tangent, low-tension, 3-cable barrier system with 5/16-in. dia. hook bolts	0%
12. Construct system with 5/16-in. dia. hook bolts	0%
13. Conduct crash test with 2270P vehicle (MASH 3-11)	0%
14. Analyze test results (MASH 3-11)	0%
15. Draft and final research reports	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 project is currently progressing according to budget. However, spring rains came and continued through the 2nd Quarter of 2013. The wet conditions have made construction and testing quite difficult.

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.