TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Suppl. #19	☐Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) ☐Quarter 3 (July 1 – September 30) ☑Quarter 4 (October 4 – December 31)

Project Title:		
Phase II - Guidelines for Post-Socketed Foundations for 4-Cable, High-Tension, Barrier System		
Name of Project Manager(s): Reid, Sicking, Faller, Rosenbaugh	**Phone Number:** 402-472-9324	**E-Mail** srosenbaugh2@unl.edu
Lead Agency Project ID: 2611211026001	**Other Project ID (i.e., contract #):** RPFP-10-CABLE-1	**Project Start Date:** 7/1/2009
Original Project End Date: 7/31/2012	**Current Project End Date:** 4/30/2014	**Number of Extensions:** 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
$92,207	$70,847	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
	$4,020	

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.):

The report containing the design, testing, and analysis for socketed foundations supporting Midwest Weak Posts (MWPs) was made final in July 2014, and sent to the project sponsors in September 2014.

Work continued on reporting the foundation designs for S3x5.7 posts, and a first draft was completed. The draft is now in internal review.

Anticipated work next quarter:

The draft of the S3x5.7 post foundation report will be reviewed and edited internally before being sent out to the project sponsors for review.

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 Gr. B).

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

Round 4 of testing utilized larger 15" diameter foundations to support S3x5.7 posts. The larger shafts increased the foundations shear strength and prevented concrete cracking/spalling. An embedment depth of 30" was found to limit foundation movement to less than 3/4"

Round 5 of testing proved that a 4" asphalt pad prevented cracking in 12" foundations supporting S3x5.7 posts.

Objectives/Tasks:	% Completed (Phase II)
1. Design new socket foundations for barrier posts.	100%
2. Fabrication and dynamic testing of socketed foundations.	100%
3. Analysis of test data and evaluation of socketed foundation designs.	100%
4. Written report documenting all work 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).

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

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

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

Potential Implementation:

Upon successful completion of this project, State DOT's will have the option to use a socketed post foundation for cable barrier system posts (non-proprietary systems / posts). These socketed foundations will allow for quick, easy, and inexpensive repairs to damaged sections of cable barrier 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.#21	**Transportation Pooled Fund Program - Report Period:** ☐Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) ☐Quarter 3 (July 1 – September 30) ☑Quarter 4 (October 4 – December 31)

Project Title:
Additional Funding to Complete Development of a Crash-Worthy Terminal for Midwest Four-Cable, HT, Barrier System

Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Sicking, Faller	402-472-3084	jreid@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
RPFP-10-CABLE-3	2611211028001	July 1, 2009
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
July 31, 2012	April 30, 2015	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
$159,193	$136,758	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
	$4,640	

Project Description:

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

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

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

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

Task 4.
Further simulation continued on the end terminal model with a reverse 25-degree impact with an 1100C vehicle. The post spacing was 16 ft. An impact point was selected between post nos. 2 and 3, at a point where it is unknown whether the barrier will gate or redirect the car. At the current status, the top cable release from the cable anchor bracket. However the other cables, remain intact with the cable anchor bracket and interlock with the car's bumper. Several modeling techniques were used to improve the cable contact with the vehicle, but the simulation still had an error before it could be determined if the vehicle would be redirected or if the system would gate. The reverse 25-degree impact was also modeled with an 820C vehicle to determine if the cable contact would improve with a different vehicle. While the cable contact with the 820C vehicle was somewhat improved over the 1100C vehicle, none of the cables released from the cable anchor bracket. The lowest cable passed underneath the vehicle and the upper three cables were engaged with the vehicle body. However, the simulation had an error before the vehicle reached the cable anchor bracket, so it is uncertain what the vehicle trajectory will be.

Anticipated work next quarter:

Task 4.
Simulation of the reverse direction impact will continue to be evaluated. A detailed evaluation of the current performance of the cable end terminal system will be summarized and changes may be made if warranted.Other CIPs will need to be evaluated. Writing will commence on the third report which will summarize the cable end terminal design, simulation, and evaluation. The MWPs and post spacing that are part of the cable end terminal will be updated as needed to reflect the changes made to the cable median barrier length of need system. While it is desired that the end terminal posts adjacent to the cable anchor bracket are the same as the length of need system, the post spacing and/or base of the post may need to be varied to allow the posts to deform easily when impacted in the weak axis.

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.

Report TRP-03-294-14 documenting part 2 of this project was published March 21, 2014.

Simulations of a bogie vehicle impacting the end terminal system at 0 and 15 degrees released the cables quickly and easily with minimal damage to the cable anchor bracket and cable release lever.

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

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

$64,736 of the project funds have been re-allocated to PF-Yr 24 Cable Project. $64,736 of that re-allocation has been reflected on page 1 of this quarter report under "Total Amount of Funds Expended This Quarter".

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, 2015	**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
$166,953	$166,953	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
	$20,517	

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.):

The remaining funds in this project were used for contingency spending.

Anticipated work next quarter:

The project is completed. This is the final quarter report.

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 were 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.#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:** September 30, 2014	**Number of Extensions:** 1

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$35,901	$35,901	100%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
0	$3,313	0

Project Description:

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

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

The research on implementation of the detailed tire model in the reduced Silverado model was completed.

Researchers at MwRSF now have three versions of the reduced Silverado model that differ in the way the tires are modeled. Tire model 1 is a simple model with significantly stiffer behavior than an actual tire. However, it is very stable and useful for impacts where the tire does not play a significant role in the overall behavior. Tire model 2 is also a simple model, but it is softer and adds a little bit of complexity over tire model 1. Its behavior is more realistic than tire model 1, but can go unstable in certain impact situations. Tire model 3 is a detailed tire model and behaves pretty realistically in several situations. Unfortunately its complexity leads to instabilities. However, in some impacts the improved behavior is important and worth the extra time and care needed to keep it stable during simulation, like curbs and riprap.

Anticipated work next quarter:

This project is completed. This is the final quarter report.

Significant Results:

Researchers at MwRSF now have three versions of the reduced Silverado model that differ in the way the tires are modeled. Tire model 1 is a simple model with significantly stiffer behavior than an actual tire. However, it is very stable and useful for impacts where the tire does not play a significant role in the overall behavior. Tire model 2 is also a simple model, but it is softer and adds a little bit of complexity over tire model 1. Its behavior is more realistic than tire model 1, but can go unstable in certain impact situations. Tire model 3 is a detailed tire model and behaves pretty realistically in several situations. Unfortunately its complexity leads to instabilities. However, in some impacts the improved behavior is important and worth the extra time and care needed to keep it stable during simulation, like curbs and riprap.

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

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

Potential Implementation:

Researchers at MwRSF now have three versions of the reduced Silverado model that differ in the way the tires are modeled. Tire model 1 is a simple model with significantly stiffer behavior than an actual tire. However, it is very stable and useful for impacts where the tire does not play a significant role in the overall behavior. Tire model 2 is also a simple model, but it is softer and adds a little bit of complexity over tire model 1. Its behavior is more realistic than tire model 1, but can go unstable in certain impact situations. Tire model 3 is a detailed tire model and behaves pretty realistically in several situations. Unfortunately its complexity leads to instabilities. However, in some impacts the improved behavior is important and worth the extra time and care needed to keep it stable during simulation, like curbs and riprap.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Suppl. #40	☐Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) ☐Quarter 3 (July 1 – September 30) ☑Quarter 4 (October 4 – December 31)

Project Title:		
Length of Need - B/C Analysis		
Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Albuquerque, Sicking, Faller, Stolle	402-472-4233	csstolle@huskers.unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211060001		7/1/2011
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/2014	3/31/2015	1

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$113,499	$153,020	100%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$1,096	

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.):

None as all work has been completed.

This project will close.

Anticipated work next quarter:

None

Significant Results:

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

Objective / Task	% Complete
1. Literature review	100%
2. Data collection	100%
3. Accident data analysis	100%
4. RSAP analysis	100%
5. Written report containing all analysis and conclusions	100%
6. Review and revise written report	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 project demanded significantly more work during both vehicle crash data collection and RSAPv3 analyses than was originally predicted and budgeted. Researchers originally had planned to only collect data from Kansas's highway I-70. As the study progressed, it became apparent that additional data was needed. Thus, additional guardrail, hazard, and traffic volume data from all guardrail sites located on all Interstate highways in the State of Kansas was collected. This effort consumed a significant amount of resources.

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

The fund in this project were exhausted prior to the completion of the project. Therefore, the overrun budget is being posted to Project No. TPF-5(193) Suppl. #16 and Project No. TPF-5(193) Suppl. #43. To date, $5,490 has been posted to Project No. TPF-5(193) Suppl. #16 and $32,945 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	3/31/2015	1

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$234,629	$183,597	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
	$49,777	

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.):

Fabrication of the modified welded concept where the post was welded directly to the base plate and the vertical spindles spanned from the top horizontal rail to the bottom horizontal rail and passed through the middle horizontal rail was completed for full-scale crash testing.

On October 24, 2014, the Pedestrian Rail system was subjected to AASHTO MASH TL-2 longitudinal channelizer test conditions using a 1100C small car vehicle (test designation 2-90). In test no. APR-1, the small car impacted the system at a speed and angle of 45.2 mph and 25.1 degrees, respectively, resulting in an impact severity of 29.7 kip-ft. The system fractured as intended and the vehicle penetrated through the system as anticipated with five panels fracturing away during the impact. The occupant impact velocities and occupant ridedown accelerations were within the suggested limits provided in MASH. The test was acceptable according to the safety performance criteria of AASHTO MASH for test designation no. 2-90.

On November 12, 2014, the Pedestrian Rail system was subjected to AASHTO MASH TL-2 longitudinal channelizer test conditions using a 1100C small car vehicle (test designation 2-90). In test no. APR-2, the small car impacted the system at a speed and angle of 44 mph and 90 degrees (end-on impact), respectively. The vehicle traversed through the first five panels with the panels fracturing but not as quickly as intended. When the vehicle encountered the sixth panel, the panel was actually leaning on the seventh panel which caused the vehicle to experience high decelerations. Since the numbers obtained from the two different accelerometer units straddled the maximum limits in MASH, FHWA was contacted to determine how to interpret/choose the value to report.

Documentation of the design effort including all rail, posts, and connections for the three welded aluminum concepts and

Anticipated work next quarter:

Anticipated receiving a response from FHWA on how to report the acceleration value.

Documentation of the design effort including all rail, posts, and connections for the three welded aluminum concepts and the modular concept and the bogie tests will be completed. The results of the full-scale crash testing will be completed.

Significant Results:

Based on the results of the six bogie tests, the critical impact orientation is believed to be the end-on orientation. All of the systems when impacted at a 25 degree angle broke away and did not exhibit much potential for vehicle intrusion. A system that has the posts, rails, and spindles welded appeared to perform better than if they are held together with a set screw or just inserted into the rail.

Objectives / Tasks	% Complete
1. Literature review	100%
2. Identification of rail needs and design criteria	100%
3. Pedestrian rail design concepts	100%
4. Component testing of design concepts	100%
5. Summary report of design concepts	70%
6. Finalize system details	100%
7. Full-scale crash testing (MASH 2-91)	100%
8. Full-scale crash testing (MASH 2-90)	100%
9. Written report documenting analysis, design, testing, and conclusions	45%

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 2010 version of the Aluminum Design Manual introduced new welded factors which had to be taken into consideration during the connection design development.

Fabrication of the aluminum systems is taking much longer than anticipated due to limited local aluminum fabricators and the small quantity.

Seven bogie tests were conducted and only four were initially budgeted. These were necessary in order to evaluate the concepts prior to selecting the most promising design for full-scale testing.

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. #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:** 3/31/2015	**Number of Extensions:** 1

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$199,502	$121,406 ($34,041 for Suppl. #40, $2	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
	$2,317 ($1,096 for Suppl. #40)	

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.):

The report was made final and disseminated to the sponsoring agency.

Preparation of a poster presentation for the TRB paper.

Anticipated work next quarter:

TRB paper will be presented in a poster session at the Transportation Research Board's annual meeting.

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	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).

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

Due to the amount of work remaining, this project is projected to have extra funds remaining at the time the project is complete. The funds in Project Nos. TPF-5(193) Suppl. #40 and TPF-5(193) Suppl. #42 were exhaust prior to the completion of the project. Therefore, the overrun budgets for Project Nos. TPF-5(193) Suppl. #40 and TPF-5(193) Suppl. #42 are being posted to this project. To date, $34,041 has been posted for Project No. TPF-5(193) Suppl. #40 and $2,813 has been posted for Project No. TPF-5(193) Suppl. #42.

Potential Implementation:

This research will provide designers with a tool that simplifies and expedites the process of designing roadside slope geometry. In addition, the guidelines developed herein will provide a uniform policy for roadside design throughout the state of Wisconsin, thus improving the consistency and safety of the roadside slope geometries in the state. A recent implementation was developed wherein the highway classification process can be improved through objective reasoning, divorcing the process from federal aid requirements and antiquated classification traditions, thus providing accurate measures of classification for use in the roadside safety community. 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): 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, 2015	**Number of Extensions:** 1

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$36,543	$60	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	$60	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) 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	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
$212,730 + suppl $36,605	$76,238	30%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$8,902	

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 - completed
3. Design modifications to extend unsupported length - completed
4. Full scale crash testing of new design (two MASH 3-11 tests) - in-progress
5. Data analysis and evaluation
6. Written report documenting all design work, simulation, testing, and conclusions - in-progress

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

Task 4.

No progress - the full-scale tests for this project are in the testing queue waiting for higher priority projects to be completed first.

Task 6.

The draft report documenting the simulation effort and selection of the 31¼-ft span length for the MGS long-span system was reviewed by the states.

Anticipated work next quarter:

Task 4.

Because of anticipated winter weather conditions and MwRSF testing priorities, it is predicted that full-scale crash testing will not begin until Spring.

Task 6.

Reviews from the states on the draft report documenting the simulation effort and selection of the 31¼-ft span length for the MGS long-span system will be implemented in the report and the report will be published.

Significant Results:

Initial simulations of an increased span length indicate successful redirection at a span length of 31.25-ft and 37.5-ft.

The 43.75-ft and 50-ft span lengths were ruled out as potential span lengths for future full-scale crash testing due to questionable vehicle capture and severe impacts with the downstream wing wall.

The 31.25-ft span system will proceed to full-scale crash testing. The wood CRT posts will be replaced with universal breakaway steel posts.

Objectives / Tasks	% Complete
1. Literature review of previous long-span systems	100%
2. Simulation of both original and any new long-span system designs	100%
3. Design modifications to extend unsupported length	100%
4. Full scale crash testing of new design (two MASH 3-11 tests)	15%
5. Data analysis and evaluation	0%
6. Written report documenting all design work, simulation, testing, and conclusions	25%

The simulation and design phase was the basis for Nick Weiland's Master Thesis. Nick graduated in August 2014 and his Thesis "Increased Span Length of the MGS Long-Span Guardrail System" was published June 17, 2014.

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

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

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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. #57	**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: Weak-Post W-beam Guardrail Installed in Mow Strips		
Name of Project Manager(s): Reid, Sicking, Faller, Bielenberg, Lechtenberg	**Phone Number:** 402-472-9324	**E-Mail** srosenbaugh2@unl.edu
Lead Agency Project ID: 2611211083001	**Other Project ID (i.e., contract #):** RPFP-13-MGS-5	**Project Start Date:** 7/1/2012
Original Project End Date: 6/30/2015	**Current Project End Date:**	**Number of Extensions:**

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$162,896	$32,613	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
	$14,388	

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.):

Previously, a component test was conducted on dual 24" deep sockets spaced 37.5" apart within a 4" thick asphalt pad. The bogie impacted both posts at the same time and resulted in the asphalt breaking apart behind the sockets. As a result, the sponsors decided to increase the socket depth to 30" and increase the asphalt thickness to 6" in an attempt to prevent asphalt failure during impacts.

The full-scale crash test on the weak post guardrail system was conducted on December 5th. The S3x5.7 posts were spaced at 37.5" and installed within 4"x4" steel sockets measuring 30" deep. these sockets were driven into the center line of a 4' wide, 6" deep asphalt mow strip. Although the system successfully captured and redirected the 2270P vehicle, the asphalt behind the system fractured. A 2-3 inch wide crack ran along the post line throughout the impact area as the back half of the asphalt translated. Additionally, the tops of the sockets translated up to 2 inches.

Anticipated work next quarter:

Based on the full-scale testing results, it appears as though asphalt is too weak of a material to prevent damage during significant impacts. Thus, the final design recommendations will focus on concrete mow strips. As such, a dual post test is desired to evaluate the possible shear failures that have occurred in the previous dual post bogie test and full scale test with asphalt mow strips. This test is scheduled for next quarter.

Additionally, work on the report documenting all design, component testing, and full-scale testing will continue.

Significant Results:

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

When a 10" wide shear plate was welded to the back of 24"-30" deep sockets, both lateral and longitudinal tests resulted in minimal damage to the 4" asphalt mow strip and minimal displacements to the socket. However, an impact of dual 24" sockets spaced at 37.5" within 4" of asphalt resulted in asphalt fracture socket rotations.

A full-scale test was conducted on the weak-post guardrail system placed within 30" deep sockets spaced at 17.5" along the centerline of a 4' wide, 6" deep asphalt mow strip. The system successfully redirected the 2270P vehicle, but the asphalt behind the posts was damaged. A 2"-3" crack opened along the post line throughout the impact region of the system and the asphalt behind it was pushed back and cracked further.

Objectives / Tasks	% Complete
1. State survey of existing mow strip practices	100%
2. System design and analysis	95%
3. Dynamic bogie component testing	85%
4. Full scale crash testing (MASH 3-10 and 3-11 tests)	100%
5. Data analysis and evaluation	50%
6. Written report documenting all design work, simulation, testing, and conclusions	15%

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

Matching funding in the amount of $60,000 was obtained through the Mid-American Transportation Center. Thus, additional component testing can occur to explore various options for installing the S3x5.7 posts within both concrete and asphalt mow strips. Since the MATC project closes in December 2014 (before the Pooled Fund project), all design, evaluation, and component testing since September 2013 has been charged to the MATC project. This explains why minimal Pooled Fund project funds were spent this quarter.

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl. #60	**Transportation Pooled Fund Program - Report Period:** ☐Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) ☐Quarter 3 (July 1 – September 30) ☑Quarter 4 (October 4 – December 31)	
Project Title: Pooled Fund Center for Highway Safety		
Name of Project Manager(s): Reid, Faller, Lechtenberg, Bielenberg	**Phone Number:** 402-472-9070	**E-Mail** kpolivka2@unl.edu
Lead Agency Project ID: 2611211086001	**Other Project ID (i.e., contract #):** RPFP-13-PFCHS	**Project Start Date:** 7/1/2012
Original Project End Date: 6/30/2015	**Current Project End Date:** 6/30/2015	**Number of Extensions:** 0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$10,958	$10,947	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
	$4,790	

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.):

Maintenance, repair, and upkeep of the website continued.

All completed projects in the fourth quarter 2014 were added to the research archive site.

Development of a page dedicated to the Pooled Fund to include historical information, state contacts, active projects, and problem statement submission continued. Prototype of the Pooled Fund page is anticipated by the end of December.

All funds from this project have been exhausted, all remaining work and progress will be reported under Project No.: RPFP-14-PFCHS – TPF-5(193) Supplement #66, Project Title: Pooled Fund Center for Highway Safety

Anticipated work next quarter:

None as all funds have been exhausted, all remaining work and progress will be reported under Project No.: RPFP-14-PFCHS – TPF-5(193) Supplement #66, Project Title: Pooled Fund Center for Highway Safety

This project will be closed.

Significant Results:

Several newly completed projects were added to the research archive.

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 is a continuation of funding for the original project started in Pooled Fund Year 22, Project No.: RPFP-12-PFCHS-1 – TPF-5(193) Supplement #48, Project Title: Pooled Fund for Highway Safety.

Note: Funds of $11 were returned.

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): Wisconsin DOT

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl # 62	**Transportation Pooled Fund Program - Report Period:** ☐Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) ☐Quarter 3 (July 1 – September 30) ☑Quarter 4 (October 4 – December 31)	
Project Title: Safety Investigation & Design Guidance for Curb & Gutter Near Energy-Absorbing Terminals		
Name of Project Manager(s): Schmidt, Bielenberg, Faller, Reid	**Phone Number:** (402) 472-0870	**E-Mail** jdschmidt@huskers.unl.edu
Lead Agency Project ID: 2611211094001	**Other Project ID (i.e., contract #):**	**Project Start Date:** 7/1/2013
Original Project End Date: 6/30/2016	**Current Project End Date:** 6/30/2016	**Number of Extensions:** 0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$173,716	$41,672	24%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
$21,214 (12%)	$21,214	24%

Project Description:

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

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

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

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

A 31" tall end terminal model was developed. The system was impacted with the 820C Geo Metro model and the results seem reasonable compared to available full-scale crash testing. One particular behavior noted was that the end of the chute tips up since the 820C vehicle impacts lower on the impact face. This behavior has been seen some in a full-scale crash test, but not to the extent as in the simulation. Most end terminals also have not been tested at the 31" height, so there is limited crash testing data to confirm if this behavior is real or a just problem in the simulation. The system was also impacted with the 2270P Chevrolet Silverado model to determine if the chute behavior seen with the Geo also occurred with a vehicle with a higher center of gravity. During the simulations with the 2270P impacts, many problems have arose with the BCT and CRT post bolts releasing from the guardrail. The simulations up until the point where errors occurred appear to be reasonable, and the chute does not tip up as seen with 820C impacts. Simulation techniques to enhance bolt release from the guardrail and improve contacts within the model are being explored.

Anticipated work next quarter:

Work will continue on the 31" system to improve post bolt release from the guardrail when impacted by the 2270P vehicle. Simulations with 1100C vehicle impacts on the 31" tall system may also determine if any other problems with the model arise. The end terminal system will then be changed to 27 3/4 in. tall guardrail and impacted end-on with the 820C and 2000P vehicles. The simulations will be compared to available full-scale crash tests.

Significant Results:

Met with end terminal manufacturers to obtain consensus on the anticipated project plan. An end terminal model was developed. The 31" tall end terminal system has been evaluated with 820C vehicle impacts, and evaluation has begun with 2270P vehicle impacts.

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

None.

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Suppl. #63 Pooled Fund Project RPFP-14-AGT-1	☐Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) ☐Quarter 3 (July 1 – September 30) ☑Quarter 4 (October 4 – December 31)

Project Title:

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

Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Faller, Bielenberg, Lechtenberg	402-472-9070	kpolivka2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211095001	RPFP-14-AGT-1	7/1/2013
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/2016	6/30/2016	0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$59,946	$12,110	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
	$894	

Project Description:

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

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

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

Objectives & Tasks

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

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

The hardware guide drawings were initiated and are undergoing internal review.

Anticipated work next quarter:

The hardware guide drawings will be completed. It is anticipated toward the end of the next quarter, the request for FHWA eligibility will be submitted.

Significant Results:

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

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

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

Objectives/Tasks	% Complete
1. Full-scale crash testing (MASH test designation nos. 3-20 and 3-21).	100%
1a. Full-scale crash test of modified transition (MASH test no. 3-20)	100%
2. Data analysis and evaluation.	100%
3. Report documenting R&D effort, including redesign, crash testing, and conclusions	100%
4. TF-13 Hardware Guide Drawings	75%

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

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

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

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Supplement #64	☐Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) ☐Quarter 3 (July 1 – September 30) ☑Quarter 4 (October 4 – December 31)

Project Title:		
Continued Development of the Midwest Four-Cable, High-Tension, Median Barrier (Continuation Funding)		
Name of Project Manager(s): Reid, Faller, Lechtenberg, Bielenberg	**Phone Number:** 402-472-9070	**E-Mail** kpolivka2@unl.edu
Lead Agency Project ID: 2611211096001	**Other Project ID (i.e., contract #):** RPFP-14-CABLE1	**Project Start Date:** 7/1/13
Original Project End Date: 6/30/16	**Current Project End Date:** 6/30/16	**Number of Extensions:** 0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$375,513 (+$264,372 from Yrs 20 & 22)	$289,014 ($88,177 R&D/Reporting C	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
	$68,700 ($49,806 R&D/Reporting Cc	

Project Description:

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

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

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

The reports containing the folded C-channel posts and Midwest Weak Posts and the component testing of the shear plate brackets continued to be written. The report containing the full-scale crash tests (test nos. MWP-1 through MWP-3) was initiated.

Construction of the modified Midwest high-tension cable median barrier system on level terrain with 10' post spacing, 38" top cable height, 15.5" bottom cable height, and 7.5" cable spacing in between was completed. On October 20, 2014, MwRSF conducted one pickup crash test (test no. MWP-4) into the modified Midwest high-tension cable median barrier with the Midwest Weak Post using a 2270-kg Dodge QuadCab according to the TL-3 safety performance guidelines of MASH, specifically test designation no. 3-11. The pickup was captured by the top (4th) and 2nd cables and was safely redirected.

Following the completion of this full-scale crash test of the modified Midwest high-tension cable median barrier, a conference call was held on October 24, 2014 to discuss observations regarding the results of test no. MWP-4 and determine the project direction. Discussion with the state DOTs in attendance indicated that there was desire to further reduce system deflections by returning to a system with an 8' post spacing. It was noted that post spacing reductionmay cause issues with both the small car and pickup truck impacts, including the potential for increased vehicle instability and lack of vehicle capture. Since the 2270P test at 8' post spacing failed, test designation no. 3-11 with the 2270P vehicle would need to be repeated. However, further reduction in system deflection and working width was very important to the state DOTs and the overall implementation of the cable system in the field, and a range of post spacing between 8'-16' provided the most utility for the states. Thus, the 8'-16' post spacing range was chosen for further system evaluation.

Construction of the further modified Midwest high-tension cable median barrier system with 8' post spacing was initiated.

Anticipated work next quarter:

The report containing the folded C-channel posts and Midwest Weak Posts will continue to be written and reviewed. There is a potential the draft report may be sent to the member states for review toward the end of the next quarter.

The report containing the component testing of the shear plate brackets will continue to be written. It is anticipated that internal review of the draft report will be initiated. There is a potential the draft report may be sent to the member states for review toward the end of the next quarter.

The report containing the full-scale crash tests (test nos. MWP-1 through MWP-3) will continue to be written.

Construction of the modified cable system placed on level terrain 8' post spacing 8" top cable height, 15.5" bottom cable height, and 7.5" cable spacing in between will be completed. Test designation no. 3-10 with the 1100C will be completed. Following the completion of test designation no. 3-10 with reduced post spacing, the results of the test will be reviewed and presented to the states. If successful, the system will be rebuilt and test designation no. 3-11 with the 2270P will be pursued.

The results of the testing of the non-bolted connection concepts will be presented to the states to determine if any of the options seem promising and further work is desired. Documentation of the test results in a formal report will be initiated.

Significant Results:

On March 26, 2014, MwRSF conducted a 1500A crash test (test no. MWP-1) into the Midwest high-tension cable median barrier with the Midwest Weak Post placed at the slope break point of a 6:1 slope using a 1500-kg Ford Taurus according to the TL-3 safety performance guidelines of MASH, specifically test designation no. 3-17. The vehicle was successfully contained and redirected.

On April 18, 2014, MwRSF conducted one pickup crash test (test no. MWP-2) into the Midwest high-tension cable median barrier with the Midwest Weak Post using a 2270-kg Dodge QuadCab according to the TL-3 safety performance guidelines of MASH, specifically test designation no. 3-11. The pickup was successfully contained and redirected. However, the member states had concerns about the dynamic deflections of the system. Thus, the system was further modified by reducing the post spacing to 8' to attempt to reduce the system deflections and reducing the number of keyways and holes to make the post stronger.

On July 11, 2014, MwRSF conducted one pickup crash test (test no. MWP-3) into the Midwest high-tension cable median barrier with the Midwest Weak Post with 8' post spacing and a reduction in the number of keyways and holes using a 2270-kg Dodge QuadCab according to the TL-3 safety performance guidelines of MASH, specifically test designation no. 3-11. The pickup overrode the cables and eventually rolled over. Hence, the system was further modified by reducing the top cable height to 38", increasing the bottom cable height to 15.5", adjusting the inner cable spacing to 7.5", and increasing the post spacing to 10'.

On October 20, 2014, MwRSF conducted one pickup crash test (test no. MWP-4) into the modified Midwest high-tension cable median barrier with the Midwest Weak Post using a 2270-kg Dodge QuadCab according to the TL-3 safety

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

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

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

To date, total funds spent are from the following project funds:
$64,736 from Project No.: RPFP-10-CABLE-3 – TPF-5(193) Supplement #21
$199,626 from Project No.: RPFP-12-CABLE1&2 – TPF-5(193) Supplement #46
$24,653 from this project, Project No.: RPFP-14-CABLE-1 - TPF-5(193) Supplement #64

In addition, Contingency Funds from several prior years have been designated for Cable R&D and Cable Reporting. To date, $88,177 has been posted to the contingency funds for Cable R&D and Cable Reporting.

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl. #65	**Transportation Pooled Fund Program - Report Period:** ☐Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) ☐Quarter 3 (July 1 – September 30) ☑Quarter 4 (October 4 – December 31)

Project Title: Annual Consulting Services Support		
Name of Project Manager(s): Ron Faller, John Reid, Bob Bielenberg	**Phone Number:** 402-472-9064	**E-Mail** rbielenberg2@unl.edu
Lead Agency Project ID: 2611211097001	**Other Project ID (i.e., contract #):** RPFP-14-CONSULT	**Project Start Date:** 7/1/2013
Original Project End Date: 6/30/16	**Current Project End Date:** 6/30/16	**Number of Extensions:** 0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$48,803.00	$48,795.00	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
	$8,740.00	

Project Description:

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

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

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

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

Anticipated work next quarter:

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

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

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

Significant Results:

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

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

None.

Potential Implementation:

None.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Suppl. #66	☐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**
Reid, Faller, Lechtenberg, Bielenberg	402-472-9070	kpolivka2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211086001	RPFP-14-PFCHS	7/1/2013
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/2016	6/30/2016	0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	**Total Cost to Date for Project**	**Percentage of Work Completed to Date**
$11,519	$2,959	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**
	$2,959	

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.):

Maintenance, repair, and upkeep of the website continued.

All completed projects in the fourth quarter 2014 were added to the research archive site.

Development of a page dedicated to the Pooled Fund to include historical information, state contacts, active projects, and problem statement submission continued. Prototype of the Pooled Fund page is anticipated by the end of December.

Anticipated work next quarter:

Continue maintenance, repair, and upkeep of the website.
Continue updating the archive with completed projects as they are completed.

Continue the development of the dedicated Pooled Fund page.

Significant Results:

Several newly completed projects were added to the research archive.

project or budget. (Please describe any challenges encountered or anticipated that letion of the project within the time, scope and fiscal constraints set forth in the recommended solutions to those problems).

This is funding for the original project started in Pooled Fund Year 22, Project No.: RPFP-12-PFCHS-1 – TPF-5(1 t #48, Project Title: Pooled Fund for Highway Safety. Funding from Project No.: RPFP-13-PFCHS – TPF-5(1 ent #60, Project Title: Pooled Fund for Highway Safety will be used prior to starting this project.

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Supplement #67	☐Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) ☐Quarter 3 (July 1 – September 30) ☑Quarter 4 (October 4 – December 31)

Project Title:		
Annual Fee to Finish TF-13 and FHWA Standard Plans		
Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Faller, Lechtenberg, Bielenberg	402-472-9070	kpolivka2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211099001	RPFP-14-TF13	7/1/13
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/16	6/30/16	0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$3,695	$2,061	55

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$627	

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.):

Continue updating the drawings reviewed online by the barrier and component review group during the AASHTO TF-13 meetings.

Anticipated work next quarter:

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

Significant Results:

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

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

Summary of original list of Barrier Drawing through 2014 Quarter 3:
31 systems - 31 approved
41 components - 41 approved
2 systems submitted to Bridge Rail Guide
1 component submitted to Luminaire Guide

Task	% Complete
1. Prepare CAD details for Hardware Guide	55%

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

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

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl. #68	**Transportation Pooled Fund Program - Report Period:** ☐Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) ☐Quarter 3 (July 1 – September 30) ☑Quarter 4 (October 4 – December 31)	
Project Title: Minimum Offset for Standard MGS Adjacent to 2H:1V Slope		
Name of Project Manager(s): Ron Faller, John Reid, Bob Bielenberg	**Phone Number:** 402-472-9064	**E-Mail** rbielenberg2@unl.edu
Lead Agency Project ID: 2611211100001	**Other Project ID (i.e., contract #):** RPFP-14-MGS-8	**Project Start Date:** 7/1/2013
Original Project End Date: 6/30/16	**Current Project End Date:** 6/30/16	**Number of Extensions:** 0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$89,991.00	$71,891.00	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
	$33,306.00	

Project Description:

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

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

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

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

MwRSF completed the full-scale crash test of the MGS guardrail system with 6-ft long W6x8.5 posts spaced at 75 in. on centers adjacent to a 2H:1V fill slope. On August 14th, the standard MGS (6-ft W6x8.5 posts and 12" blockouts) installed with the centerline of the posts at the slope break point of a 2:1 slope was subjected to AASHTO MASH TL-3 test conditions using a 2270P pickup truck vehicle (test designation 3-11). In test no. MGSS-1, the pickup truck impacted the system at a speed and angle of 61.6 mph and 26.2 degrees, respectively, resulting in an impact severity of 123.7 kip-ft. The system adequately contained and safely redirected the pickup truck. The occupant impact velocities and occupant ridedown accelerations were within the suggested limits provided in MASH. The maximum lateral deflection of the system and working width of the system were approximately 73 in. and 77.5 in., respectively. The test was acceptable according to the safety performance criteria of AASHTO MASH for test designation no. 3-11.

The final documentation of that crash test has been completed and the effort to write the research report has been started.

Anticipated work next quarter:

In the upcoming quarter, MwRSF will continue work on the research report documenting the tested system.

Significant Results:

One full-scale crash test of the MGS guardrail system with 6-ft long W6x8.5 posts spaced at 75 in. on centers adjacent to a 2H:1V fill slope was completed and the results met the MASH safety 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).

None.

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX))*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Suppl. #69 MwRSF Project No. RPFP-14-MGS-11	☐ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☑ Quarter 4 (October 4 – December 31)

Project Title:		
MGS Working Width for Lower Speed Impacts		
Name of Project Manager(s): Reid, Faller, Bielenberg, Lechtenberg	**Phone Number:** 402-472-9324	**E-Mail** srosenbaugh2@unl.edu
Lead Agency Project ID: 2611211101001	**Other Project ID (i.e., contract #):** RPFP-14-MGS-11	**Project Start Date:** 7/1/2013
Original Project End Date: 6/30/2016	**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
$49,044	$12,400	50%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$7,627	

Project Description:

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

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

Objectives / Tasks:

Phase I - Evaluation of Standard MGS (Completed)

1. LS-DYNA computer simulation
2. Summary Report

Phase II - Evaluation of MGS installed with a 6" curb (In Progress)

1. LS-DYNA computer simulation
2. Summary Report

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

Work on this project was focused on completing the analysis and write-up of the level-terrain MGS simulations at TL-3, TL-2, and TL-1 speeds using LS-DYNA. Simulation results for all three of the investigated impact speeds were extensively reviewed and the validated models were determined to provide a conservative estimate of working width. A working draft of the summary report for level terrain findings was completed and revised. Baseline models of MGS guardrail placed on curbs were completed and analysis was started to calibrate those models.

Anticipated work next quarter:

Work will continue on the second phase of this project, consisting of simulations of pickup impacts with guardrail located behind curbs. A draft of the final report will be created and submitted for internal revisions.

Significant Results:

The MGS model has been validated and calibrated against TL-3 impacts. Simulations of lower speed impacts have begun, but definitive results have not yet been recorded.

Objectives / Tasks:	% Complete
Phase I - Evaluation of Standard MGS	
1. LS-DYNA computer simulation	100%
2. Summary Report	95%
Phase II - Evaluation of MGS installed with a 6" curb	
1. LS-DYNA computer simulation	10%
2. Summary Report	0%

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

None

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Iowa DOT

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Suppl. #73	☐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:		
Attachemnt of Combination Rails to Concrete Parapets Utilizing Epoxy Adhesive Anchors - Phase I		
Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Bielenberg, Faller, Reid, Rosenbaugh	(402) 472-9064	rbielenberg2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611130087001		2/1/2014
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
7/31/2015	7/31/2015	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
$50,891.00	$35,409.00	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
	$19,267.00	

Project Description:

The research objective is to design and evaluate alternative epoxy adhesive anchorages for use in the IaDOT BR27C combination bridge rail system. The alternative epoxy adhesive anchorages would be developed to have equal or greater capacity than the current cast-in-place anchorage, so that they can be used in new construction or as a retrofit to modify existing bridge railings. The proposed epoxy attachment designs will be evaluated through dynamic component testing.

The research effort will consist of redesign, testing, and evaluation of alternative epoxy adhesive anchorage systems for attaching the beam and post system to the concrete parapet according to the details for the BR27C combination bridge railing. This first task in this effort would be for MwRSF to review the current cast-in-place anchorage design and develop alternative epoxy adhesive anchorage configurations. This effort could include an inline anchor system and/or a four anchor system similar to the cast in place configuration but with spacing more compatible with the clearances required for a drill in system. The alternative epoxy adhesive anchorage systems would be submitted to IaDOT for review and selection of the one or two preferred systems to be tested and evaluated.

Dynamic component testing will be used to evaluate the proposed epoxy adhesive anchorages and to demonstrate that the capacity of the proposed epoxy anchorages was equal to or greater than the existing cast-in-place anchorage system. The capacity of the current cast-in-place anchorage has not been fully quantified with testing. Thus, one dynamic component test would be performed on the post using the current cast-in-place anchorage configuration. Additional dynamic component tests would also be performed on the proposed alternative epoxy adhesive anchorage systems. The target impact conditions for all tests would be identical. The tests would be configured so that the applied impact load would occur at a height on the post/rail in order to produce a bending moment in the post and combined loading on the anchorage system similar to that provided during vehicle crash events. The force versus deflection, energy dissipated versus deflection, and failure modes would be documented for each test and compared to one another. These comparisons would be used to verify that the proposed anchorages provided equal or greater capacity than the current

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

MwRSF has yet to send the updated research costs reflecting the revised project scope as denoted in previous progress reports to IaDOT. They will be submitted this quarter or first quarter of 2015.

In this quarter, the testing of the original BR27C attachment and the three proposed epoxy anchorage configurations was analyzed and compared. The damage to the anchorage system for each test was documented for the report and comparison purposes. The accelerometer data from the testing was analyzed to compare the force vs. deflection data for the four anchorage configurations. These comparisons were used to determine the feasibility of the alternative anchorages as compared to the current cast-in-place design.

Test no. IBP-1 - BR27C Cast-In-Place Anchorage

We began by conducting the baseline testing of the original cast-in-place anchorage for the BR27C on the 10" wide parapet, test no. IBP-1. In this test, shear cracks formed from the anchors to the backside of the parapet causing a significant damage to the parapet, but not causing the post to yield. This would suggest that the original cast-in-place anchorage may have had sufficient capacity to yield the BR27C post, but the parapet itself was not strong enough to develop the full loading of the anchor.

Following the baseline test, the tests of the alternative anchorages were run on the 12" wide parapet.

Test no. IBP-2 - Four Bolt Trapezoidal Spread Epoxy Anchorage

In test no. IBP-2, the post was loaded by the bogie and shear cracks formed diagonally from the anchors until reaching

Anticipated work next quarter:

In the upcoming quarter, MwRSF will continue the work to create a summary report to document the results of the study.

MwRSF will also provide the updated budget for the research effort to laDOT.

Significant Results:

All four of the proposed component tests on the original cast-in-place BR27C anchorage and the alternative epoxy anchorages were analyzed and compared. The analysis found that all three of the alternatives should be acceptable replacements for the original cast-in-place BR27C anchorage.

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 noted previously, changes to the project scope have affected the budget of the research to some degree. However, laDOT agreed to the revised scope and budget changes. MwRSF will work with laDOT with regards to any changes to the scope and budget.

Potential Implementation:

The development of alternative epoxy adhesive anchorage systems for use in laDOT combination bridge rails would provide for simpler and more cost-effective construction of combination bridge rails. The new designs would also provide more effective options for new and retrofit construction.

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. #74	**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: Redesign of Low-Tension, Cable Barrier Adjacent to Steep Slopes		
Name of Project Manager(s): Faller, Reid, Bielenberg	**Phone Number:** 402-472-9064	**E-Mail** rbielenberg2@unl.edu
Lead Agency Project ID: 2611211106001	**Other Project ID (i.e., contract #):**	**Project Start Date:** 7/1/2014
Original Project End Date: 12/31/15	**Current Project End Date:** 12/31/2015	**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
$124,345	$3,658	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
	$3,658	

Project Description:

Previously, the MwRSF investigated the performance of low-tension cable barrier adjacent to slopes as steep as 1.5H:1V. Full-scale crash testing of the standard, non-proprietary, cable system offset 12" from the slope breakpoint resulted in the 2000P vehicle overriding the barrier and rolling over. Subsequently, the post spacing was reduced from 16' to 4' and the barrier offset was increased to 4'. A second full-scale crash test on this modified system resulted in a successful TL-3 test with the 2000P. While the design modifications provided safe redirection, there were some drawbacks. The closely spaced posts have been difficult and costly to install, and the additional lateral offset from the slope break point can also be difficult to achieve in practice. Thus, a need exists to reconsider the cable barrier adjacent to slope design.

The objective of this study is to review the design of the low-tension cable barrier adjacent to a steep slope and determine design modifications to improve its Implementation, such as increased post spacing and reduced lateral barrier offset. Additionally, cable heights and tensions, attachment hardware, and even system posts may be altered to improve crash performance. Future full-scale vehicle crash testing according to MASH TL-3 criteria would be used to evaluate the modified system in Phase II of the project (currently unfunded)

Major Task List

1. Literature review of cable barrier on/adjacent to slopes
2. Concept Design
3. Component Testing of Post Configurations
4. LS-DYNA model development, validation, and calibration
5. LS-DYNA simulation of various cable barrier modifications
6. CAD details of proposed cable system designs
7. Preparation of research report and recommendations for future research
8. Preparation of Technical Brief for NDOR.

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

An intensive literature review was conducted covering full-scale crash tests on cable barrier systems located adjacent to or within roadside slopes. Characteristics of each system along with the impact conditions and testing results were summarized documented and recorded in a table. This table will be used as a historical reference, and will aid in the design process of the new system.

After reviewing NDOR's current cable adjacent to slope system as well as the other full-scale tests listed in the reference table, researchers came up a basic, preliminary design. It was decided to stay with the current hardware components, specifically S3x5.7 posts, J-bolt attachments, and a low-tension 3 cable layout. The post was selected over the new Midwest Weak Post (MWP) due to its additional strength that may help reduce deflections and keep the vehicle stable on steep slopes. J-bolts were selected as a cost effective alternative to the newer tabbed brackets utilized in the MwRSF's new high-tension cable system (which wouldn't serve much purpose when all the cables are on the same side of the post. Finally, a low-tension 3-cable system allows the use of NDOR's current anchorage system. If necessary, the components of this preliminary design may be later changed to satisfy performance standards.

Testing of the system will begin with dynamic post testing adjacent to the slope break point of a 2:1 slope. After 2 baseline tests of posts on level terrain, the posts will be incrementally shifted toward the slope break point until a significant loss of resistance is observed. additionally, the post's soil plate may be reconfigured to better optimize strength. The results of this testing will be utilized in assembling the LS-DYNA model of the system.

A TAC meeting was held on November 24th to discuss the initial system layout and the design methodology. It was agreed to proceed with the design and evaluation process outlined above.

Anticipated work next quarter:

Bogie testing shall begin on S3x5.7 posts on level terrain and adjacent to a 2:1 slope break point. The testing shall be used to determine an optimized soil plate design as well as the relationship between post offset (from the slope) and the resistance provided by the post.

Additionally, work shall begin on the development of the LS-DYNA model of the cable system adjacent to slope.

Significant Results:

Completion of the literature review of all full-scale tests on cable barrier systems adjacent to or within slopes - summarized in a table. A preliminary design was established, and a component testing methodology was determined.

Major Task List	% Complete
1. Literature review of cable barrier on/adjacent to slopes	100%
2. Concept Design	75%
3. Component Testing of Post Configurations	0%
4. LS-DYNA model development, validation, and calibration	0%
5. LS-DYNA simulation of various cable barrier modifications	0%
6. CAD details of proposed cable system designs	0%
7. Preparation of research report and recommendations for future research	0%
8. Preparation of Technical Brief for NDOR.	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:

Redesign of the low-tension cable barrier adjacent to steep slopes would provide roadway designers with a lower cost and more-easily implemented solution for shielding steep slopes that would still provide safe redirection of errant 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)* TPF-5(193) Suppl. #75	**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: Length of Need for Free-Standing, F-Shape, Portable 12.5' Concrete Protection Barrier		
Name of Project Manager(s): Ron Faller, Bob Bielenberg, John Reid	**Phone Number:** 402-472-9064	**E-Mail** rbielenberg2@unl.edu
Lead Agency Project ID: 2611211107001	**Other Project ID (i.e., contract #):** RHE-08	**Project Start Date:** 7/1/2014
Original Project End Date: 12/31/15	**Current Project End Date:** 12/31/15	**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
$189,820.00	$1,355.00	15%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$3,030.00	

Project Description:

The objective of this research effort is to investigate and evaluate the safety performance of the previously developed F-shape PCB system in order to determine minimum system length and the number of barriers required for the beginning and end of the length of need. It is proposed that the system be evaluated according to the TL-3 criteria set forth in MASH. Two full-scale crash tests would be conducted to evaluate the performance of PCB system in order to evaluate its safety performance and investigate its dynamic deflection. The research effort will be split into two phases. Phase I, will be conducted to investigate the F-shape PCB system through computer simulation modeling in order to determine minimum system length and the number of barriers required for the beginning and end of the length of need. Phase II, would consist of the full-scale crash testing required to validate the system length and beginning and end of length of need recommendations from Phase I.

Phase I

The research effort for Phase I will begin with LS-DYNA computer simulation of the F-shape PCB system. Previous research efforts at MwRSF involving the F-shape PCB have developed reasonably accurate computer simulation models of the free-standing F-shape PCB system. These models will be used to analyze PCB system length and beginning and end of the length of need requirements. Four cases are proposed for analysis.

1. Simulation of the minimum number of PCB segments required on the upstream end of the barrier installation for a long overall system length.
2. Simulation of the minimum number of PCB segments required on the downstream end of the barrier system for a long overall system length.
3. Simulation of the minimum number of PCB segments required on the upstream end of the barrier system for a minimum overall system length.

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

During this quarter, MwRSF completed development and validation of the baseline PCB model for use in the study. The LS-DYNA simulation model of the PCB system was 200 ft long and was compared to full-scale crash tests to build confidence in the simulation model. As part of the baseline model development, three different versions of the Chevy Silverado model were simulated with the F-shape PCB system, and variations in tire stiffness, wheel disengagement, vehicle steering, and friction values were evaluated. All of the models were evaluated using the RSVVP comparisons outlined in NCHRP 179.

Through the analysis of these model variations, a baseline model was developed that closely matched the full-scale test results in terms of vehicle and barrier behavior. Dynamic system deflections where within 2% of the full-scale test and the simulation met the RSVVP criteria. Thus, the baseline model was judged appropriate for the simulation of impacts on the upstream and downstream ends of the system and reduced system lengths.

The next phase of the research effort was to simulate impacts on the upstream and downstream ends of the 200 ft long barrier system to determine the length of need. Simulations have been conducted at seven impact points on the upstream of end of the barrier system and eight impact points on the downstream end of the barrier system. These simulations are currently being reviewed to determine where the length of need starts and ends for the long system. Additional models may be simulated with intermediate impact points to further refine the results.

Friction testing of the F-shape PCB on asphalt was also conducted this quarter. However, the results have not been processed at this time.

A TAC meeting was held on Nov. 24th to update the committee on the current progress.

Anticipated work next quarter:

In the next quarter, MwRSF will continue the simulation effort for determining minimum system length and the number of barriers required for the beginning and end of the length of need. The researchers will continue simulation and evaluation of impacts at various points near the beginning and end of the PCB system. These models will provide determination of the number of barrier segments needed on the upstream and downstream ends of the full length barrier system to safely redirect errant vehicles.

Once the beginning and end of the length of need is determined for the long PCB system, the length of the system will be reduced and the length of need points will be re-evaluated through computer simulation to determine the minimum system length. The simulations will also be used to determine deflections for the reduced system lengths.

Evaluation of the data from the static pull testing of a PCB segment on asphalt will be conducted to evaluate friction coefficients between the asphalt and PCB.

Significant Results:

Validation of the baseline PCB system model.

Simulations of various impact points on the upstream and downstream end of the PCB system for determining the length of need were completed and are being evaluated.

Friction testing of PCB on asphalt completed.

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

None.

Potential Implementation:

Evaluation of the F-shape PCB minimum system length and the number of barriers required for the beginning and end of the length of need will provide NDOR with improved and validated guidance for their PCB system configurations. These guidelines will improve the safety of PCB installations and may potentially shorten the number of barriers used in these types of installations. This will improve the flexibility of the PCB systems and reduce the number of impacts. The research would also define the increase in barrier deflection for shorter system lengths and better define necessary clear areas behind the PCB segments in work zones.

MwRSF will work closely with NDOR engineers and the TAC committee throughout the evaluation of the LON for PCB systems in order to ensure that the research effort meets the project goals and supplies adequate information to NDOR. This should ensure that the results of the study are 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 computer simulation and investigation of PCB system lengths and the full-scale testing used to evaluate the proposed guidelines. In addition, the results of the research effort will be published as a paper in a refereed journal, if warranted. Following the completion of the study, the results of the 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)* TPF-5(193) Suppl. #76	**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 Free-Standing, F-Shape 12.5' Concrete Protection Barrier and Gua		
Name of Project Manager(s): Ron Faller, Bob Bielenberg, John Reid	**Phone Number:** 402-472-9064	**E-Mail** rbielenberg2@unl.edu
Lead Agency Project ID: 2611211108001	**Other Project ID (i.e., contract #):** RHE-11	**Project Start Date:** 7/1/2014
Original Project End Date: 12/31/15	**Current Project End Date:** 12/31/15	**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
$213,677.00	$2,126.00	10%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$2,126.00	

Project Description:

The objective of this research is to evaluate the safety performance of the transition between guardrail and free-standing F-shape TCB developed in Phase I of the research effort. The safety performance evaluation is to be conducted according to the TL-3 impact safety standards published in MASH.

The research effort for Phase II would consist of final design, fabrication, and testing of the TL-3 transition between temporary concrete barrier and guardrail selected by the sponsor from Phase I. Design details of the proposed transition would be fully developed in three-dimensional CAD software. Next, fabrication and installation of the transition system would be completed at the MwRSF's full-scale crash test facility. It is anticipated that three full-scale crash tests would be required to fully evaluate the transition system. These tests would include MASH test designation nos. 3-20 and 3-21 which are tests to evaluate the design of the barrier transition with 1100C small car and 2270P pickup truck vehicles. In addition, it is anticipated that a reverse direction impact of test designation no. 3-21 with the 2270P vehicle would be required for evaluation of the transition for installations that require two-way traffic adjacent to the barrier. Following the completion of the full-scale crash testing, a summary report will be completed detailing the evaluation effort as well as providing guidance for implementation of the new transition design. MwRSF will also prepare a technical brief and a PowerPoint presentation of the research results to NDOR at the completion of the project.

Major Task List:

1. Project planning and correspondence
2. Development of design details in 3D CAD and review by TAC
3. Fabrication of hardware and installation at MwRSF test site.
4. Three full-scale crash tests according to TL-3 of MASH.

a. MASH test no. 3-20 with the 1100C small car

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

During this quarter, MwRSF developed CAD details for the first full-scale test of the guardrail to PCB transition system. Recall that work in the previous quarter led to development of various attachment options between the PCB's and the guardrail. NDOR TAC representatives reviewed these options and agreed to use the proposed guardrail to PCB attachment and the folded plate blockout attachment for testing and evaluation.

The first full-scale test will be MASH test designation no. 3-21, which will evaluate the transition from the guardrail to the PCB system by impacting upstream of the connection between the two systems. The test matrix is listed below.

1. Test no. 3-21 - Impact of the 2270P vehicle on the centerline of the fifth guardrail post upstream from the end-shoe attachment at a speed of 62 mph and an angle of 25 degrees.
2. Test no. 3-21R - Reverse direction impact of the 2270P vehicle 12 ft – 6 in. upstream from the end-shoe attachment at a speed of 62 mph and an angle of 25 degrees.
3. Test no. 3-20 - Impact of the 1100C vehicle on the critical impact point of the guardrail to PCB transition at a speed of 62 mph and an angle of 25 degrees. MASH procedures and engineering analysis will be used to determine the critical impact point.

A TAC meeting was held on 11-24-2014 and the project status was reviewed satisfactorily.

Anticipated work next quarter:

In the upcoming quarter, the CAD details for full-scale crash testing will be set to the outdoor test facility and put into the testing que for scheduling. The actual date for the full-scale crash testing will be determined once the test facility personnel have reviewed the details and ordered materials. The testing of the guardrail to PCB transition will be conducted as soon as resources are available. However, completion of the testing is dependent on the schedule of existing crash testing commitments and may not occur if projects with higher priority in the testing que prevent the test from being completed.

Significant Results:

CAD details were developed for the first full-scale test.

TAC meeting held on 11-24-2014.

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 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): 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 # 77	**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: Phase IIA Vehicle Dynamics Testing, Validation of Vehicle Models & Computer Simulation of Rock Ditch Liners		
Name of Project Manager(s): Reid, Bielenberg, Faller, and Lechtenberg	**Phone Number:** (402) 472-3084	**E-Mail** jreid@unl.edu
Lead Agency Project ID: 2611130089001	**Other Project ID (i.e., contract #):**	**Project Start Date:** 6/30/2014
Original Project End Date: 6/30/2017	**Current Project End Date:** 6/30/2017	**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
$110,000	$965	1%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$965	

Project Description:

The primary research objective for this study includes the continued development of safety guidelines for use in the design and placement of ditch liners and check dams along highways and roadways. During the Phase I effort and as part of the initial research funding, preliminary safety guidelines were proposed along with a preparation of a research plan for use in their future evaluation. At this time, the Wisconsin Department of Transportation has deemed the preliminary guidelines viable and has requested that continued research be performed to further evaluate and modify the guidelines using computer simulation and full-scale vehicle crash testing.

Due to the significant scope of this ongoing research program, the study has been split into multiple phases. The objective for each specific phase is listed below:

Phase I - Develop preliminary guidelines for the safe construction of rock ditch liners and rock check dams – (Completed 2011)

Phase II - Conduct LS-DYNA computer simulation to develop critical crash testing matrix for evaluating vehicular impacts into rock ditch liners and rock ditch checks.

This current project is a subset of Phase II. This subset is limited to simulation of a 1100c vehicle over a 1:1 slope ground rock ditch liner and one full-scale crash test of such.

Phase III - Perform a series of full-scale crash tests on rock ditch liners and check dams placed in a traversable ditch.

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

An initial investigation on how to model a 1:1 sloped ground rock ditch liner was performed. This included LS-Dyna simulation with the Toyota Yaris 1100c model. SolidWorks was used to create two different 3D models of the rip rap that makes up the rock ditch liner. Simulation results showed promising behavior but it is recognized that the 3D surface models of the rip rap are just an approximation of the real thing. Once an actual ditch liner is constructed, we will have a much better example of what one actual should look like. This should help in creating a more realistic LS-Dyna model.

Anticipated work next quarter:

Based on simulation results and discussion, a full-scale test speed will be determined. The speed will be 30, 45 or 60 mph. Design drawings for the full-scale test will be initiated.

Significant Results:

None to date.

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:

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Wisconsin DOT

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Suppl # 78	☐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: Transition from Free-Standing TCB to Reduced Deflection TCB		
Name of Project Manager(s): Schmidt, Bielenberg, Faller, and Reid	**Phone Number:** (402) 472-0870	**E-Mail** jdschmidt@huskers.unl.edu
Lead Agency Project ID: 2611130090001	**Other Project ID (i.e., contract #):**	**Project Start Date:** 6/30/2014
Original Project End Date: 6/30/2017	**Current Project End Date:** 6/30/2017	**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
$95,852	$1,028	1%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
$1,028 (1%)	$1,028	

Project Description:

Recently, the Wisconsin Department of Transportation sponsored a research project to develop a retrofit design for reducing deflections for temporary concrete barriers (TCB) without anchoring the barriers to the bridge deck or roadway. This research was successful in reducing the deflection of the TCB system, as the addition of steel tubes to both the front and back sides of the barrier reduced the deflection of the TCB system by roughly 50 percent. However, the effort was focused on developing the length-of-need of the system and did not include design of a transition between the reduced deflection TCB system and standard F-shape TCB segments. Thus, a need exists to develop a transition between the new reduced deflection system and free-standing TCB segments.

The objective of this research effort is to develop a MASH TL-3 transition between the recently developed reduced deflection TCB system and free-standing, F-shape TCB segments. The research effort will focus on development of a design that safely transitions between the stiffness and deflection of the two barrier systems while maintaining vehicle stability. The design will also focus on minimizing the length of the transition and additional hardware components. Phase I of this project will involve initial development and computer simulation of the transition design (work described herein). Phase II of the project (currently unfunded) will include full-scale crash testing to evaluate the transition.

Main Objectives/Tasks

1. Literature Review
2. Concept Development
3. Selection of Transition Design
4. LS-DYNA Analysis and Evaluation
5. Project Report

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

The literature review has begun on this project including examining existing transitions between temporary concrete barriers and other temporary and permanent concrete barriers. Existing methods to taper box beam sections down have also been reviewed.

Anticipated work next quarter:

The literature review will be completed, and brainstorming will begin to develop the transition between a free-standing temporary concrete barrier and the reduced-deflection temporary concrete barrier.

Significant Results:

None to date.

Main Objectives/Tasks	% Complete
1. Literature Review	50%
2. Concept Development	0%
3. Selection of Transition Design	0%
4. LS-DYNA Analysis and Evaluation	0%
5. Project Report	0%

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

None

Potential Implementation:

Development of a crashworthy transition system between the reduced-deflection TCB system and freestanding TCBs would provide states with a robust TCB system capable of reducing deflections without anchoring to the road surface. In addition, the system can be used in median applications and could be attached to standard, free-standing TCB segments on each end to allow for easier implementation and integration with existing work zones.

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 #79	☐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: TL-4 Evaluation of the Midwest High-Tension, 4-Cable Barrier		
Name of Project Manager(s): Reid, Faller, Lechtenberg, Bielenberg, Rosenb	**Phone Number:** 402-472-9070	**E-Mail** kpolivka2@unl.edu
Lead Agency Project ID: 2611211096001	**Other Project ID (i.e., contract #):** RPFP-15-CABLE-1	**Project Start Date:** 8/1/14
Original Project End Date: 7/31/17	**Current Project End Date:** 7/31/17	**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
$408,235	$0	0

Quarterly Project Statistics:

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

Project Description:

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

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

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

None.

This is additional funding to continue the development of the Midwest Four-Cable, High-Tension, Median Barrier once the funds from the other projects are exhausted (Project No.: RPFP-12-CABLE1&2 – TPF-5(193) Supplement #44, Project Title: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase I, V-ditch, Project No. RPFP-12-CABLE1&2 – TPF-5(193) Supplement #45, Project Title: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase II, Level Terrain, and Project No.: RPFP-14-CABLE-1 - TPF-5(193) Supplement #64, Project Title: Continued Development of the Midwest Four-Cable, HT, Median Barrier (Continuation)).

See Project No.: RPFP-14-CABLE-1 – TPF-5(193) Supplement #64, Project Title: Continued Development of the Midwest Four-Cable, HT, Median Barrier (Continuation) for a detailed explanation of the work completed this quarter.

Anticipated work next quarter:

None

Significant Results:

None

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

This project is an extension to previous projects (RPFP-08-02: Four-Cable Median Barrier in 4:1 V-Ditch; RPFP-09-01: New Funding for High-Tension Cable Barrier on Level Terrain with New Cable Attachment; RPFP-10-CABLE-2: Replacement Funding for High-Tension Cable Barrier on Level Terrain; RPFP-12-CABLE1&2: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase I, V-Ditch; RPFP-12-CABLE1&2: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase II, Level Terrain; RPFP-14-CABLE-1 - TPF-5(193) Supplement #64, Project Title: Continued Development of the Midwest Four-Cable, HT, Median Barrier (Continuation)).

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Suppl. #80	☐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 with an Omitted Post		
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:**
2611211112001	RPFP-15-MGS-5	8/1/2014
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
7/31/2017	7/31/2017	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
$99,973.00	$1,168.00	10%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$1,168.00	

Project Description:

The objective of this research effort is to develop guidelines for MGS installations with a single omitted post for clearance of obstacles. The research would attempt to focus on the omission of a post without the use of CRT posts adjacent to the unsupported span. Full-scale crash testing would be conducted to evaluate the use of a single omitted post according to the TL-3 impact safety requirements in MASH. Following successful full-scale crash testing, additional analysis would be conducted to evaluate the potential for omission of a single post in multiple locations in a run of guardrail and the corresponding minimum spacing between the omitted posts.

The research effort will begin with the construction of the MGS with a single omitted post at the MwRSF Outdoor Test Facility for evaluation. The system will be evaluated according to the MASH guidelines for test designation no. 3-11 with the 2270P pickup truck vehicle. It is believed that the 1100C vehicle test can be waived for this system because the 2270P vehicle will provide a more stringent test of the failure modes expected in with the omitted posts such as excessive dynamic deflection, pocketing, vehicle snag, and rail rupture. The CIP for this test will be selected based on maximizing the potential for vehicle pocketing and post snag using the CIP charts in MASH and the researchers engineering judgment. The full-scale vehicle crash test will be conducted, documented, and evaluated by MwRSF personnel and in accordance with the MASH guidelines.

Following the successful full-scale crash testing, results from the crash testing will be applied to estimate potential concerns associate with multiple single omitted posts that are spaced apart in a run of MGS guardrail. Results from the full-scale test would also be analyzed to provide further guidance on allowable spacing between omitted posts based on the behavior of the guardrail system during the test.

After completion of the full-scale crash testing, a summary report of the research project will be completed detailing the tested barrier system, full-scale crash test results, evaluation of barrier performance, additional analysis, and

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

Previously, MwRSF began the research effort to investigate the MGS with a single omitted post. Prior to conducting a full-scale crash test, MASH requires selection of a critical impact point (CIP) for the test. In order to determine the CIP for the MGS with a single omitted post, BARRIER VII was used to simulate impacts a various points along an MGS system with a single post removed. The BARRIER VII analysis looked at several factors, including maximum rail deflection, maximum rail tensile forces, vehicle snag on posts, and pocketing of the barrier. Based on this analysis, it was determined that an impact ¾ of the way between post nos. 11 and 12 was critical as it displayed the highest level of vehicle snag and rail deflection and the the second highest rail forces. Pocketing was not significant for any impact point.

CAD details for the tested system were completed and the details were sent to the MwRSF Outdoor Test Facility for placement in the test que. The test will be conducted as soon as resources and priority are available.

Anticipated work next quarter:

In the upcoming quarter, MwRSF will prepare testing of this system if it reaches a high enough priority in the test que. The testing of the MGS with a single omitted post will be conducted as soon as resources are available. However, completion of the testing is dependent on the schedule of existing crash testing commitments and may not occur if projects with higher priority in the testing que prevent the test from being completed.

Significant Results:

Selection of the CIP for the testing of the MGS with a single omitted post was completed and CAD details were completed and sent to test 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 successful development and evaluation of a MGS guardrail with omitted posts would provide states with a potentially simpler and less-costly alternative for dealing with post conflicts within a run of guardrail.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

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

Project Title:		
Standardized Concrete Parapet for Use in Thrie Beam AGT's		
Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Faller, Bielenberg, Rosenbaugh	402-472-9324	srosenbaugh2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211113001	RPFP-15-AGT-1	8/1/2014
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
7/31/2017	7/31/2017	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
$125,906	$1,268	10%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$1,268	

Project Description:

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

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

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

Objectives / Tasks:

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

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

A literature review was conducted gathering all full-scale crash testing results on approach guardrail transitions between W-beam guardrail and concrete parapets. Characteristics of the individual systems, testing conditions, and test results were summarized into a table. This table served as a historical reference and guided the design and development of a preliminary design for the end buttress.

The preliminary design of the end buttress includes:

a vertical front geometry to maximize vehicle stability and eliminate any vehicle interaction with a barrier toe
a 32" barrier height to match the top of the thrie beam guardrail without snag potential
a 4"x4" chamfer along the US-front corner of the buttress behind the thrie beam to minimize vehicle snag
a 4"x12" chamfer along the lower 12" of the same corner to minimize vehicle tire snag

The vertical shaped barrier will be able to transition to other shapes further DS of the thrie beam connection.

Additionally, the IA transition (developed at MwRSF in the 90's) was selected for testing purposes. It represents a weaker transition system allowing higher deflections than other thrie beam AGTs. Additionally, this system has been show to be sensitive to small geometric changes that have resulted in failures - specifically, the removal of the curb and the use of a single slope parapet. The AGT will be evaluated without a curb for this project.

This preliminary design will be discussed at the Dec. 17th meeting of the Pooled Fund States.

Anticipated work next quarter:

Pending the approval of the Pooled Fund representatives, CAD drawings of the buttress design and the weak AGT system will be completed and sent to the MwRSF test site for construction and full-scale testing.

Significant Results:

An extensive literature review of all AGTs to concrete parapets was summarized in a reference table. The table was utilized during the design process to develop a buttress that minimizes snag while maximizes vehicle stability.

Objectives / Tasks:	% Complete
1. Literature Review	100%
2. Parapet Design and Analysis	75%
3. System CAD Details	20%
4. System Construction	0%
5. Full-scale Crash Test	0%
6. System Removal	0%
7. Data Analysis	0%
8. Design Recommendations	0%
9. Written Project Report - First Draft	0%
10. Written Project Report - Edits and Finalization	0%
11. Hardware Guide Drawings	0%
12. FHWA Approval Letter	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:

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

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.#82	**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: Tree Removal Marketing Program		
Name of Project Manager(s): Reid, Faller, Lechtenberg, Bielenberg	**Phone Number:** 402-472-6864	**E-Mail** rfaller1@unl.edu
Lead Agency Project ID: RPFP-15-TREE-1	**Other Project ID (i.e., contract #):** 26112110114001	**Project Start Date:** August 1, 2014
Original Project End Date: July 31, 2017	**Current Project End Date:** July 31, 2017	**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
$80,815	$262	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
$262 (0%)	$262	0%

Project Description:

Over the last 30 years, numerous studies have been conducted that resulted in guidance on tree removal and/or protection. However, this information is spread across many research reports. Consequently, decision makers often do not have all of the facts and research when deciding to remove or plant new trees. Thus, they are often making decisions without assessing the involved safety risks.

The objective of this research effort is to develop marketing strategies that would advise state DOTs and the public about the statistics and safety risks associated with roadside trees. In addition, this research should investigate methods for prioritizing treatment of the hazard posed by roadside and median trees.

Task 1 Literature Review: Review completed and ongoing studies addressing guidelines and recommendations related to roadside treatments and collisions with trees or other landscaping as well as risks associated with vehicle-tree collisions.

Task 2 State Crash Data: Review and compile selected state DOT and/or city data related to roadside tree crashes.

Task 3 Survey States: Survey all state DOTs to determine success stories for marketing and involving the use of clear zone concept, implementation of tree removal, and/or tree shielding.

Task 4 Marketing: Contact UNL-based or private marketing firms to propose approaches for compilation of data into usable marketing materials and approaches.

Task 5 Summary Report: Compile a summary report of literature search and state DOT survey results. The report will also contain information on potential firms for development of outreach materials.

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

Internal discussion was held to discuss possible marketing companies to partner with.

Anticipated work next quarter:

Initial contact will be made with potential marketing companies to develop a project plan. The literature review will commence.

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:

Numerous studies exist which provide recommendations on protection or removal of trees along roadsides. However, state DOTs do not have a good way to disseminate this information to their staff and the public. In addition, there is a need to make the public aware of the statistics involved with tree impacts and the safety issue that roadside and median trees pose. The collection and improved presentation of data would provide states with effective methods for educating designers, politicians, and the driving public as well as advance efforts to reduce the number of roadside trees and the associated hazard they pose to motorists.

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. #83	**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: 2611211115001	**Other Project ID (i.e., contract #):** RPFP-15-CONSULT	**Project Start Date:** 8/1/2014
Original Project End Date: 7/31/17	**Current Project End Date:** 7/31/17	**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
$50,001.00	$2,105.00	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
	$2,105.00	

Project Description:

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

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

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

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

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

None.

Potential Implementation:

None.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl. #84	**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): Reid, Faller, Lechtenberg, Bielenberg, Rosenb	**Phone Number:** 402-472-9070	**E-Mail** kpolivka2@unl.edu
Lead Agency Project ID: 2611211116001	**Other Project ID (i.e., contract #):** RPFP-15-PFCHS	**Project Start Date:** 8/1/2014
Original Project End Date: 7/31/2017	**Current Project End Date:** 7/31/2017	**Number of Extensions:** 0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$11,468	$0	0%

Quarterly Project Statistics:

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

Project Description:

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.):

None.

This project will not be started until the completion of Project No.: RPFP-14-PFCHS – TPF-5(193) Supplement #66, Project Title: Pooled Fund for Highway Safety.

Anticipated work next quarter:

None

Significant Results:

None.

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

This is a continuation of funding for the original project started in Pooled Fund Year 22, Project No.: RPFP-12-PFCHS-1 – TPF-5(193) Supplement #48, Project Title: Pooled Fund for Highway Safety. Funding from Project No.: RPFP-13-PFCHS – TPF-5(193) Supplement #60, Project Title: Pooled Fund for Highway Safety and Project No.: RPFP-14-PFCHS – TPF-5 (193) Supplement #66, Project Title: Pooled Fund for Highway Safety will be used prior to starting this project.

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Supplement #85	☐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, Faller, Lechtenberg, Bielenberg, Rosenb	402-472-9070	kpolivka2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211099001	RPFP-15-TF13	8/1/14
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
7/31/17	7/31/17	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
$3,602	$0	0

Quarterly Project Statistics:

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

Project Description:

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.):

None

This project will not be started until the completion of Project No.: RPFP-14-TF13 – TPF-5(193) Supplement #67, Project Title: Annual Fee to Finish TF-13 and FHWA Standard Plans.

Anticipated work next quarter:

None

Significant Results:

This project is used to supplement the preparation of the TF-13 format CAD details.

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

Funding from Project No.: RPFP-14-TF13 – TPF-5(193) Supplement #67, Project Title: Annual Fee to Finish TF-13 and FHWA Standard Plans will be used prior to starting this project.

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**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:** 6/30/2015	**Number of Extensions:** 4

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	$653,031	66%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
$82,643 (8.3%)	$82,643	66%

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 system was reassembled to move damaged segments out of the impact area for the next single-unit truck crash test. The single-unit truck is being prepped for the crash test.

The first draft of the third volume of the research report series, which details all system design and simulation as well as further component tests that were conducted leading up to the first full-scale crash test, was almost completed. It will be processed within internal review. The first draft of the fourth volume of reports, which details the first two full-scale crash tests, was almost completed. It will also be within internal review shortly. Writing also began on a fifth report, which will detail the initial background and development of a future stiffness transition to a rigid concrete parapet.

Design criteria were established and very preliminary concepts were brainstormed to help with the eventual development of a stiffness transition between the deformable barrier and a TL-4 rigid concrete parapet end or buttress.

Anticipated work next quarter:

A full-scale crash test with the 10000S single-unit truck will be conducted according to TL-4 of AASHTO MASH. The results from all three crash tests will then be evaluated to determine if the barrier system provides: satisfactory safety performance according to the MASH TL-3/4 evaluation criteria; a desired reduction in lateral acceleration; and a permissible level of barrier damage. The results will be analyzed to determine what modifications and refinements are necessary, followed by any additional analysis, design, and LS-DYNA computer simulation if warranted.

At this time, crash tests to evaluate potential barrier modifications/refinements may be recommended in the future with additional project funding and include 1100C, 2270P, or 10000S vehicles. It is anticipated that the third and fourth reports will be sent to the sponsor for review. The stiffness transition design concepts will be refined and evaluated according to the design criteria including: snag mitigation with impacts from 1100C, 2270P, and 10000S vehicles, structural integrity to transition and transfer TL-4 loads to a rigid parapet, construction tolerances, etc.

Significant Results:

Report TRP-03-281-13 documenting phase 1 of this project was published July 16, 2013.
Report TRP-03-280-13 documenting phase 2 of this project was published February 6, 2014.
Test no. SFH-1 was conducted on July 2, 2014 and was successful.
Test no. SFH-2 was conducted on August 11, 2014 and was successful.

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).

Throughout the project, several concerns regarding the use of rubber posts have arose and have been addressed. The barrier was redesigned multiple times in advance of the first crash test in order to obtain a more successful performance in a variety of environmental conditions, to optimize the concrete and steel rail, and to have greater confidence for a successful crash test result. Installation concerns were also addressed, which will allow the barrier to be installed in a larger range of conditions in the real world. Therefore, the start of the full-scale crash testing program was delayed. The full-scale crash test with the single-unit truck did not occur this quarter as other soil-dependent systems had priorities and project closing deadlines to meet. However, it is anticipated that the remaining crash test and further evaluation can be completed by the current project end date. The budget of the project has not been affected.

Potential Implementation:

Study findings on rubber material models under high-velocity impacts are available to future researchers to use in other investigative efforts. The shear-fender, open concrete median barrier concept has demonstrated a significant reduction in lateral vehicle accelerations and occupant risk values for passenger vehicles in numerical simulations. The barrier also has demonstrated the ability to contain simulated TL-4 single-unit truck impacts under MASH test conditions. The current barrier design has a top steel rail that can be removed and easily replaced if a single-unit truck cause significant damage. The barrier should otherwise be restorable and virtually maintenance free for impacts with passenger vehicles ranging from small cars to light trucks. It is anticipated that severe injuries and fatalities could be reduced with the shear-fender, open concrete median barrier installed in lieu of current rigid concrete median barriers along urban, high-speed roadways.

Midwest States Pooled Fund Program Consulting Quarterly Summary

Midwest Roadside Safety Facility

09-15-2014 to 12-10-2014

Strut to Median Barrier Slope Question

Question
State: MN
Date: 09-16-2014

Attached is a sketch for a 72" pier protection strut going down to meet a 54" glare-screen median barrier. We are wondering what slope should be used to transition from the 72" strut down to the 54" median barrier? We also are wondering if there needs to be anything special done to go from a 36" wide vertical pier protection strut transitioning to the 54" tall "F" style median barrier.
Attachment: http://mwrsf-qa.unl.edu/attachments/555b57fd15ea26501056e69b55801459.pdf

---

Response
Date: 09-17-2014
In general, we have recommended the use of 8H:1V height transitions for permanent concrete barriers in order to reduce the propensity for vehicle gouging and snag on the upper concrete surface. We also noted this vertical slope in a prior Pooled Fund consulting inquiry found below.

http://mwrsf-qa.unl.edu/view.php?id=265

In terms of the location where the 54" tall barrier transitions down to 36" barrier, I might suggest the use of the same 100 ft longitudinal distance recommended in the weblink above and for 54" tall barrier in advance of the multi-pier configuration.

Please let me know if you have any further questions. Thanks!

Guardrail Post Bolt Hole Size

Question
State: WI
Date: 09-17-2014

My question is about placing a slotted hole in the post flange that is larger than what was used in the crash test. This is shown on the attachment. Thanks.

Attachment: http://mwrsf-qa.unl.edu/attachments/bf0bd590095b74ffaa098d69ab25faa1.pdf

---

Response
Date: 09-19-2014
In general, it is not a good idea to change a critical element of the design from its crash tested variation. An increased hole size in the critical front flange would reduce the capacity of the steel post to resist bending. Horizontal slots would exaggerate this reduction of post capacity, especially for those located closest to the base plate when moments are maximized. Of course, the overall effect that the slot versus hole has on a barrier system safety performance would depend on how conservative was the design initially. At this point, we have not been provided much information in terms of design/test level, construction details, and actual crash testing results. Further details and information would be needed to further explore this issue.

Alternatively, it may be possible to integrate slots into the rail at splice and/or post locations to improve constructability without decreasing capacity.

Thanks!

Slots in Steel Post and Rail Bridge Rail

Question
State: WI
Date: 09-24-2014

My question is about placing a slotted hole in the post flange that is larger than what was used in the crash test. This is shown on the attachment. Thanks.

Attachment: http://mwrsf-qa.unl.edu/attachments/1a1596e57d67184244a636bafde703c2.pdf

---

Response
Date: 09-24-2014

In general, it is not a good idea to change a critical element of the design from its crash tested variation. An increased hole size in the front flange would reduce the capacity of the steel post to resist bending. Horizontal slots would exaggerate this reduction of post capacity, especially for those located closest to the base plate when moments are maximized. Of course, the overall effect that the slot versus hole has on a barrier system safety performance would depend on how conservative was the design initially. At this point, we have not been provided much information in terms of design/test level, construction details, and actual crash testing results. Further details and information would be needed to further explore this issue.

Alternatively, it may be possible to integrate slots into the rail at splice and/or post locations to improve constructability without decreasing capacity. As such, We would recommend utilizing horizontal slots in the tubular rail sections to obtain the desired construction tolerances.

NH 5-3(103)129; Karrow to Mountainside; CN 2017001 - Two Tube Bridge rail to parapet detail

Question
State: WY
Date: 09-25-2014

Would you have any suggestions for this gentleman (Chris) from TDH engineering? He would like to construct a concrete parapet at the end of Wyoming's TL-4 Twin Steel Tube Railing for a project in Montana. It posses an interesting question since our rail cantilevers beyond the post. I thought I did see another state that used some kind of parapet at the end of the steel tube railing, but I don't know if it was secured to the railing. I am interested in the response as well.

Details at:
http://www.dot.state.wy.us/home/engineering_technical_programs/bridge/standard_details.html

I am working on the above MDT project where we are using the 2 tube TL-4 rail (MDT calls it W-830 rail) on a structure, and the road designers are calling for an impact attenuator instead of a bridge approach section due to space constraints off the end of the structure. My thought was that since attenuators can be backed up on concrete parapets, if there is a way to tie the 2 tube rail to a short concrete parapet, that might be a solution in this case. If you have any information about situations where 2 tube rail has been transitioned to concrete rail or parapet I would appreciate it if you could pass those on so we can review. If you have any other experience about utilizing an impact attenuator in conjunction with 2 tube rail (without an intervening bridge approach rail section) that would be great to hear about also. Thanks for any input you can provide.

Response
Date: 09-25-2014
We looked at a somewhat similar problem a while back for Iowa regarding transitioning of the BR27C bridge rail to a concrete parapet. See the discussion and solution at the link below.

http://mwrsf-qa.unl.edu/view.php?id=691

For the Wyoming TL-4 rail you have shown, we would propose a similar solution that attaches the rail to a flared parapet be cutting the tube to match the flare. Because the Wyoming bridge rail uses the tube rails to provide the majority of the redirective capacity of the barrier, unlike the Iowa BR27C rail which has a concrete parapet, we would recommend that base plates be attached to the flare cut tubes at the parapet to allow for anchoring of the tubes to the parapet. You may also want to consider keeping a bridge rail post relatively close to the parapet to limit the loading of the tubes and anchorage where they attach to the parapet. Note that the parapet design would need to consider impact loading from a vehicle as well as sufficient capacity to anchor the tube railing.

Let me know if that gets you going in the right direction or if you need more guidance.

Response
Date: 09-25-2014

I am not quite sure I understand what to do with the bottom railing.

I think they were thinking more in terms of a parapet shown in the following bridge rail end, although in this case, the concrete parapet would be downstream.

http://guides.roadsafellc.com/bridgeRailGuide/index.php?action=view&railing=129

Response
Date: 09-25-2014
The example I sent was for a combination bridge rail with only one tube and a concrete base, but the concept would be the same for a two tube design. Essentially, we recommend overlapping the parapet with the tubes. We recommend tapering the parapet and then cutting the tubes to match the taper. This is done to ensure that the impacting vehicle doesn't snag on the parapet end.

We have not recommended systems like the one in the link below for the downstream end due to concerns for vehicle snag on the end if the parapet. For upstream ends, the design shown may work because the vehicle is stepping down for the parapet to the tubes. However, on a downstream end, the vehicle would have a tendency to redirect along the front face of the tubes with some components of the vehicle protruding past the front face of the tubes. This could creat vehicle snag as it reaches the parapet end.

Let me know if that clears things up.

Response
Date: 09-26-2014

I was thinking of something like this.

Attachment: http://mwrsf-qa.unl.edu/attachments/0687e78a2d47db52775f5dba635d8420.jpg

---

Response
Date: 09-26-2014

I like this idea very much!

Thanks for your help!

Ragged edges in the guardrail slot

Question
Date: 10-07-2014

This is a picture from our field review. You can see the spur on this brand new GR just installed. I initially thought it was a rare anomaly. However we noted other locations on new installations a significant distance from this project.

You were saying these ragged edges can cause a focus point for the stress and recommend they be filed smooth. This appears that the slot just was not punched clean. I assume this slot was produced by the manufacturer and I guess if the field crew had to correct them, the manufacturer would be hearing from his client the contractor.

Attachment: http://mwrsf-qa.unl.edu/attachments/decf7198cea676d73bc4561499281914.jpg

---

Response
Date: 10-08-2014
During the early development of the MGS, we fabricated field slots on site by drilling two holes spaced apart and cutting out the area between with a jig saw. At times, there would be a few rough areas or stress risers where the cuts met up with the radii. During crash testing, we observed some tearing around the slot when the bolt head pulled through the rail slot. I recall that we later required the use of a small die grinder to pass around the slot to remove any leftover burrs and smooth the slot. From this experience, we realized that the fabrication of the slot should not include rough/sharp edges or burrs in order reduce concerns for tears initiating in this region. See page 32 of the attached TRR from 2007. It is preferred that we have clean, smooth slots in the rail and near the bolts.

Special Tempoary Barrier Design

Question
State: IA

Date: 10-15-2014

We have a bridge repair project with a unique temporary barrier need. The work involves replacing some finger joints on a river bridge. To do the work they need to have a 6 foot wide 1 foot tall work area at the bottom of the barrier. I have attached a PDF file that shows what they are proposing. The design has some concerns for me. I recommended that they use our H pile temporary barrier since it would be able to span over the work area. The designers felt that would not give then enough vertical clearance to get the finger joints in and out. The bridge is pretty narrow so they do not have the option of moving the barrier further over. They are also in a pretty big hurry to get this sorted out as their letting is in January. Would you be able to assist us with a design for this situation?
Attachment: http://mwrsf-qa.unl.edu/attachments/61cd6d6d26b92f9c121a53a250157e01.pdf

---

Response
Date: 10-15-2014
I am trying to get the installation straight in my head.

1. It appears that you have temporary barriers on the far upstream and far downstream ends. Are these free-standing or anchored?
2. Next you have two types of "special barrier " sections. Are these temporary barriers as well? Are they anchored or free-standing? What are the connections between the barrier sections.
3. On page 2, the special barrier sections appear to hang of the edge of the road surface? Is this correct or is the road surface only removed at the 6 ft opening?

Thanks

Response
Date: 10-15-2014

Please see my responses below. Thank you for you assistance.

Hi Brian,

I am trying to get the installation straight in my head.

1. It appears that you have temporary barriers on the far upstream and far downstream ends. Are these free-standing or anchored?

I understand they are not anchored to avoid holes in the bridge deck and they are not close to a drop off.

2. Next you have two types of "special barrier " sections. Are these temporary barriers as well? Are they anchored or free-standing? What are the connections between the barrier sections.

As above, I think these are not anchored. They are temporary barriers. One section is right in advance of the spanned are and the other one is outside the spanned area. I assume they are similar to our standard F shape barriers. I can ask for connection details if you like.

3. On page 2, the special barrier sections appear to hang of the edge of the road surface? Is this correct or is the road surface only removed at the 6 ft opening?

he road surface is only missing for the 6 foot section through the finger joint and only for half of the roadway.

Thanks

Response
Date: 10-16-2014

Thanks for the responses.

I have reviewed the detail you sent. In general, I think that the proposed solution can be made to work. I have a some comments and thoughts.

1. TTI recently designed and tested a median barrier gate that uses a tubular structure that is hinged to protect an opening in a permanent concrete median barrier. This system is somewhat related to what you are proposing, but it was for permanent barrier. The sizing and connection details may be useful.

    a. http://tti.tamu.edu/documents/9-1002-2.pdf

2. There are other gate systems such as the Armor Guard system that could be applied. However, it sounds like you need some clear area under the opening that these systems will not provide.

3. The tubes in your system are 8"x8"x5/8" tubes. These have slightly lower bending capacity than the TTI design which used 12"x12"x1/4" tubes. However, that is not believed to be an issue due to the shorter span length in your design.

4. The attachment of the tubes near the end of the concrete barrier appears to be done using a bent plate over the front of the tubes and some bolted brackets. It appears that this might be able to be simplified and made safer. The current bent plate bracket would have potential for vehicle snag on the vertical edge of the bracket. I have proposed a revised detail with at bent plate behind the tubes. The tubes would be welded to this plate and the plate could attach to the barrier at several locations. This would reduce vehicle snag and provide for a more positive attachment to the barrier.

5. There will likely need to be additional attachments from the tubes to the barrier than the two shown adjacent to the opening. In order to prevent the tubes from flexing or prying off of the face of the barrier we would recommend additional attachment of the tubes near the tapered ends. You may want to have an additional set of attachments near the start of the tube taper. It is best to be conservative in the attachment scheme given the system is not crash tested. You could use the an attachment similar to the one shown above. Alternatively, you could through bolt through the tubes and barrier in the tapered region as shown below.

6. The current configuration shown has tubes on only the impact side face of the barrier. While this does provide the redirective surface for the impacting vehicle, it is not optimal in terms of developing continuity across the barrier opening. For a system like this, you want to have the barrier act like a continuous unit across the gap. This means development of shear, tension and compression loads. Placement of the tubes on the front side only will handle the shear and compression, but may not be as effective in

development of the tensile bending stresses between the barriers. The tubes you have are very strong, so their capacity along may be sufficient to develop continuity as long as they are very effectively anchored to the concrete barriers. However, it may be better to place tubes on the front and back side of the installation or a steel plate across the backside of the installation in order to create a stronger span that engages more effectively with the TCB on each end.

7. Another concern would be snag of the vehicle on the tow of the concrete barriers you have shown. Currently you are transitioning from the sloped face TCB to at partially vertical face for mounting the tubes. However, the barrier tow that remains can be a significant snag hazard that can cause rapid vehicle deceleration and instability. We would recommend removal of the barrier tow and conversion to a purely vertical shape with the tube offset front the barrier sufficiently to prevent snag on the end of the concrete barriers.

8. The steel tubes are currently tapered down at the ends to prevent snag. The taper shown is approx. 4:1. We would taper it more gently. An 8:1 or shallower taper is more appropriate.

9. A simpler option for the design may be a specialized concrete barrier segment in lieu of the steel tubes. You could place the vertical cutout needed at the base of the barrier and not have to deal with all of the attachment concerns with the steel. The concrete section would need to have flared back sections on the ends of the vertical opening to prevent snag on exposed concrete. We do this on open concrete bridge rail posts and approach guardrail transition parapets.

10. Depending on the type of connection used, the size and weight of the barrier segments, and the potential speeds and impact angles in this area, we would expect this type of system to deflect a significant distance when impacted. TL-3 displacements have been over 2 meters for MASH tests of F-shape TCB systems. Thus, you will need to consider the barrier displacement and worker exposure and positioning in the design. If sufficient displacement distance cannot be achieved, one would need to consider anchoring of the barrier system.

Take a look at these comments and let me know if you have questions or want to discuss things further.

Attachment: http://mwrsf-qa.unl.edu/attachments/269e1514e89d03366eef26a3e7228265.png

Attachment: http://mwrsf-qa.unl.edu/attachments/afd69e5cc45e2de755a9dd5512a9b3fc.jpg

Attachment: http://mwrsf-qa.unl.edu/attachments/ba5a6f8ce17effa4956004477644fff9.jpg

Attachment: http://mwrsf-qa.unl.edu/attachments/a6f2473298e1a37b31ea5f6777d13f18.jpg

Attachment: http://mwrsf-qa.unl.edu/attachments/0b7d6076e1f2971d41c044e83cdd2f46.jpg

---

Response
Date: 10-17-2014

Thank you very much. You touched on all of the things that were giving be concern. I will pass this along to our consultant. If they have additional questions I will send you another note. The quick turnaround is greatly appreciated.

MGS Box Culvert Mounting

Question
State: NE
Date: 10-24-2014

Implementation of MGS mounted to culvert parapet.
I need to shorten the top mount.
The NDOR typical parapet is only 8" wide.
There should be more concrete behind this threaded rod from the top.
What should the strap length be?
Should the cover over the threaded rod be 2"? or centered in the parapet

---

Response
Date: 12-09-2014
For the culverts in which the headwall is narrow (yours are 8"), I would not utilize the top-mounted, single-anchor design to attach the socket to the outside of the headwall. For that design, it's important to maintain the 7" anchor offset from the outside face to prevent concrete damage. Unfortunately, that will not leave you enough concrete cover on the inside of the anchor, 2 inches is recommended. We never designed the top mounted attachments for offsets less than 7".

However, you could utilize either the wrap-around design, or the side-mounted design (through bolt). See pages 36-41 of the report (TRP-03-277-14) for the design details of these attachment options. The only difference you would need to make is the length of the strap or bolts to reflect the correct headwall width.

Note, although only 2 of the 5 design concepts were included in the final drawing details, MwRSF has confidence that all five of the concepts provide adequate strength to support the system. Thus, any of the five concepts can be utilized to satisfy the installation needs of existing culverts.

Adaptations for w-beam attachment to culverts

Question
State: NE
Date: 10-27-2014

I need to shorten the top strap for the MGS mounted to culvert parapet. The NDOR typical parapet is only 8" wide. What is the correct offset behind the threaded rod anchor? Should the cover over the threaded rod be 2"? or centered in the parapet? What should the strap length be?

Attachment: http://mwrsf-qa.unl.edu/attachments/b37e3c954fd29e5135ca67a6504e6129.pdf

---

Response
Date: 10-27-2014

For the culverts in which the headwall is narrow (yours are 8"), I would not utilize the top-mounted, single-anchor design to attach the socket to the outside of the headwall. For that design, it's important to maintain the 7" anchor offset from the outside face to prevent concrete damage. Unfortunately, that will not leave you enough concrete cover on the inside of the anchor, 2 inches is recommended. We never designed the top mounted attachments for offsets less than 7".

However, you could utilize either the wrap-around design, or the side-mounted design (through bolt). See pages 36-41 of the report (TRP-03-277-14) for the design details of these attachment options. The only difference you would need to make is the length of the strap or bolts to reflect the correct headwall width.

Note, although only 2 of the 5 design concepts were included in the final drawing details, MwRSF has confidence that all five of the concepts provide adequate strength to support the system. Thus, any of the five concepts can be utilized to satisfy the installation needs of existing culverts.

---

hardened verses unhardened washers for beam guard

Question
State: WI
Date: 11-06-2014

We had project where the contractor supplied unhardened washer for bolting the rail to the post on normal MGS.

I was trying to determine if unhardened washers are acceptable. If they are what material spec should be used?

Response
Date: 11-07-2014

We do not require any washer under the nut where the guardrail bolt attaches to the post flange. In fact there are no washers at all on the standard steel post versions of the MGS that have been full-scale crash tested. That said, there would be no adverse affect of including a washer between the nut and the flange on the back of the post.

The wood post version of the MGS does use a washer under the nut on the back of the post. The washer used is the ASTM F844 washer typically specified with the A307 post bolt.

Question on our BA-100 Standard Road Plan

Question
State: IA
Date: 11-19-2014

We have a situation due to the recent cold weather that the epoxy holding the pins in the pavement froze, well below 20 deg. It is unclear what pullout strength these pins will provide. Do you know what pullout strength would be required by the design? My assumption was that the pin mainly functions as a sheer device but Chris Poole told me it does serve a pullout propose too. We are trying to decide what length we need to go to correct the situation. The RCE is going to talk to the manufacture to see if the epoxy will develop sufficient strength once it is warmed up. If that does not turn out favorably and the pullout strength is important to the design, what would recommend to for correcting the problem with the barrier in place? Thank you in advance.

http://www.iowadot.gov/design/SRP/IndividualStandards/eba100.pdf

Attachment: http://mwrsf-qa.unl.edu/attachments/a6a1e054d63a13c8ece2767908f6edc7.png

---

Response
Date: 11-19-2014

We have looked briefly at the attached detail and have some thoughts.
1. What test level is this barrier designed for?

2. In looking at the design, the height, width, and reinforcement of the barrier suggest that the barrier would likely be sufficient to withstand TL-3 and TL-4 level impacts without counting on contributions from the epoxy adhesive anchors. If TL-5 is the target, we would need to perform additional calculations regarding the capacity.

3. If it turns out that the epoxy will not set following a warm up and additional capacity is required, the simplest solution for providing additional capacity would be to provide a 2" deep asphalt keyway on each side of the barrier. We have done similar setups in the past and they have worked acceptably.

Let me know if you need more information.

Response
Date: 11-19-2014
This is a TL-4 rail, so it sounds like we will be OK even if the epoxy does not make full strength. Thank you for getting back to me on this so quickly.

Extra Blockout on Steel Post Transitions to Bridges

Question
State: IL
Date: 11-25-2014

We have a question regarding the use of extra blockouts in a steel post transition to a bridge parapet. The subject location has an existing manhole with a conical top section that interferes with driving the second, third, and fourth posts from the end of the bridge parapet. These posts spaced at 1 ft 6 ¾ inches. A copy of our Highway Standard 630031 is attached, and depicts the particular bridge transition design. Also, several photos are attached that show the bridge rail transition, the curb alignment around the edge of the existing round inlet grating, the conflicting manhole, and the area immediately behind the curb. Please note that in photo "image009.jpg" the posts that are not driven, near the left side of the photo will be driven according to plan after some conflicting sleeper slab is removed at the joint of the bridge approach slab and the pavement.
It does appear feasible to add blockouts to produce a total offset from the back of the doubled thrie beam to the face of post of 24 inches (3 @ 8 inch blockouts or 2 @ 12

inch blockouts).

We have searched the consulting website for similar questions, but do not find one that is right on target for this issue. We do find the following:
June 15, 2011, ID = 205. Question about use of triple 8 inch steel blockouts in transition. This question is similar to our case, but is applicable to a w-beam section rather than the thrie beam application on our Highway Standard.
November 5, 2010, ID = 267. Question regarding use of extra blockouts in a run of guardrail (MGS.) This question is for guardrail, rather than bridge transition.
September 7, 2006, ID = 456. Question regarding use of extra blockouts in a w-beam transition to a bridge rail. The response acknowledges use of triple 8 inch blockouts with a thrie beam transition. However, this information is form 2006 and predates several changes to the bridge transition.

Our proposal is to use triple 8 inch blockouts or double 12 inch blockouts at posts 2, 3 ,and 4. Also, we have discussed ideas to compensate for possible increased deflection here:
- Adding a section or nested section of thrie beam rail across the backs of these three posts.
- Adding some form of diaphragm between the extended blockouts of posts 2, 3, and 4 (cross bracing, solid wood blocks, etc.)

Thanks for your help in advance.

Attachment: http://mwrsf-qa.unl.edu/attachments/b67ef7a3109803959388af95d60ea96e.zip

---

Response
Date: 12-02-2014

In the past, we have considered the use of deeper blockouts in limited cases dependent on system in question. We have used 16" deep blockouts in certain systems, but we have not used 24" deep blockouts in system due to concerns that the additional blockout depth may begin to affect the way the guardrail post is loaded and may increase the potential for later-torsion buckling of the post rather than the desired post loading modes of strong axis bending and rotation of the post through the soil. As such, we have limited these extended blockouts to a single post in a run of guardrail in order to deal with obstacles or other issues.

As you noted in the message you sent, we have allowed deeper blockouts in approach guardrail transitions in the past. The concern for altering the post loading is less prevalent for the transition posts as they tend to be closer spaced and deflect less, which lowers the concern for buckling of the post.

Thus, we believe that it would be possible to use large blockouts for post nos. 2-4 shown in your detail without adversely affecting performance due to the special circumstance you are faced with. However, for general installations we would recommend using the tested configuration as the use of the deeper blockouts has not been formally investigated or tested.

We have conducted research for WisDOT in the past on a related issue of spanning obstacles in a transition and came up with some potential solutions. Take a look at the report below. There is an option in it for deeper blockout posts with a beam spanning the gap that may work for you as well.

http://mwrsf.unl.edu/researchhub/files/Report5/TRP-03-266-12.pdf

A couple of other items to note. First, I am not familiar with the curb section that you are using with the transition. I believe this transition was testing with a 4" wedge curb. As such, other 4" curbs may work with the transition as well, but higher curb sections may require further investigation for use in the transition. The exact dimensions are not listed on the detail.

The detail you have shown also appears to be longer than the transition sections we have tested to MASH with the MGS system. You may have a rational for using a longer transition section, but I wanted you to be aware that the transition may be able to be shortened.

http://mwrsf.unl.edu/researchhub/files/Report38/TRP-03-210-10.pdf

Thanks

TL-2 Combination Rails

Question
State: WI
Date: 12-05-2014

Do you know of any TL-2 combination railings that are crash tested?

We have a municipality that wants to place a TL-2 combination railing about 2' behind vertical curb on a 25 mph roadway.

I was asked to come up with some alternatives that are similar to what they propose and other alternatives (i.e. no barrier, move barrier face to curb face…).

Thanks,

Response
Date: 12-08-2014

I don't know of any test TL-2 combination bridge rails offhand.

We have done or have seen related research in the past that Illinois is currently using.

In 1998, the MwRSF developed and full-scale crash tested a combination traffic / bicycle bridge railing to TL-4 of NCHRP Report No. 350. The bicycle railing consisted of steel posts and rail segments mounted to a 32-in. tall New Jersey shaped concrete barrier. The barrier system utilized steel cables strung through the longitudinal rail elements to retain fractured railing segments during severe impact events. However, during crash testing, numerous spindles were broken free from the larger longitudinal tubes.

Another research effort was conducted regarding pedestrian railings for Missouri Department of Transportation. Two combination traffic/bicycle bridge railings with horizontal, tubular steel rails for use

on a rigid, single-slope, concrete barrier were designed, constructed, and full-scale vehicle crash tested according to NCHRP Report No. 350. The first test consisted of a 2,015-kg (4,442-lb) 1998 GMC C2500 pickup truck impacting at an angle of 25.6 degrees and at a speed of 101.5 km/h (63.1 mph). The pickup snagged on the longitudinal rails during climb and eventually rolled, resulting in test failure. For the second test, modifications were made to the system in an attempt to reduce vehicle penetration and prevent rolling. The second test was also conducted with a 1998 GMC C2500 pickup truck. The pickup weighed 2,029 kg (4,473 lbs), and impacted the system at an angle of 25.6 degrees and at a speed of 102.7 km/h (63.8 mph). Once again, the pickup snagged as it climbed the barrier, resulting in vehicle roll and unsatisfactory results. The results indicated that the barrier system is not suitable for use on Federal-aid highways. However, it was noted that modifications could be made to the system in order to increase its chances of successfully meeting the requirements specified by NCHRP Report No. 350. One change was the use of an increased lateral offset for positioning the posts and rail farther away from the back side of the concrete barrier.

In 2013, the Illinois DOT began to develop a parapet-mounted bicycle railing system. Although Illinois DOT initially sought to utilize the barrier previously developed by MwRSF, concerns about the steel cables and vertical spindles led them to develop a new railing design based that combined the two combination traffic/bicycle rail systems described previously. The new design eliminated both the cables and the spindles while still satisfying AASHTO, FHWA, and Illinois specifications for bicycle and pedestrian railings. The steel rails were mounted and offset from the back of the parapet such that the rail faces were positioned 13-in. away from the front-top corner of the concrete parapet. Since this offset is greater than the Zone of Intrusion for TL-2 concrete barriers, MwRSF recommended its implementation as a TL-2 barrier without full-scale crash testing.

TTI has done several other TL-2 bridge rail tests, but I don't have all of the details for those. You may want to check the TF 13 bridge rail site and the 2006 FHWA bridge rail book (red).

http://www.aashtotf13.org/Bridge-Rail.php

http://guides.roadsafellc.com/bridgeRailGuide/index.php?action=view&railing=78

Let me know if you anything else.

Attachment: http://mwrsf-qa.unl.edu/attachments/374db1760e2d44b23077e6cf7c739f21.pdf