Midwest States Pooled Fund Program
Quarterly Progress Report – First Quarter 2013
December 1, 2012 through February 28, 2013

DRAFT REPORTS – POOL FUND

None

FINAL REPORTS – POOL FUND

Schrum, K.D., Lechtenberg, K.A., Rosenbaugh, S.K., Faller, R.K., Reid, J.D., and Sicking, D.L., *Safety Performance Evaluation of the Non-Blocked Midwest Guardrail System (MGS)*, Final Report to the Midwest States Regional Pooled Fund Research Program, MwRSF Research Report No. TRP-03-262-12, Project No. TPF-5(193)-Year 21, Project Code: RPFP-11-MGS-3, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, Nebraska, January 24, 2013.

Julin, R.D., Reid, J.D., Faller, R.K., and Mongiardini, M., *Determination of the Maximum MGS Mounting Height – Phase II Detailed Analysis with LS-DYNA®*, Final Report to the Midwest States Regional Pooled Fund Research Program, MwRSF Research Report No. TRP-03-274-12, Project No. TPF-5(193)-Year 20, Project Code: RPFP-10-MGS, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, Nebraska, December 5, 2012.

DRAFT REPORTS – PROJECT RUN THROUGH POOL FUND, FUNDED BY INDIVIDUAL STATE

None

FINAL REPORTS – PROJECT RUN THROUGH POOL FUND, FUNDED BY INDIVIDUAL STATE

Schmidt, T.L., Lechtenberg, K.A., Meyer, C.L., Faller, R.K., Bielenberg, R.W., Reid, J.D., and Sicking, D.L., *Evaluation of the New York Low-Tension Curved Three-Cable Barrier*, Final Report to the New York State Department of Transportation, MwRSF Research Report No. TRP-03-263-12, Project No. TPF-5(193) Supplement Nos. 130 and 152, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, Nebraska, February 19, 2013.

Schmidt, T.L., Mongiardini, M. Bielenberg, R.W., Lechtenberg, K.A., Faller, R.K., and Reid, J.D., *Dynamic Testing of MGS W6x8.5 Posts at Decreased Embedment*, Final Report to the Nebraska Department of Roads, MwRSF Research Report No. TRP-03-271-12, Project No. SPR-P1(12) M318, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, Nebraska, December 17, 2012.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl. #54	**Transportation Pooled Fund Program - Report Period:** ☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)	
Project Title: Annual Consulting Services Support		
Name of Project Manager(s): Ron Faller, John Reid, Bob Bielenberg	**Phone Number:** 402-472-9064	**E-Mail** rbielenberg2@unl.edu
Lead Agency Project ID: 2611211080001	**Other Project ID (i.e., contract #):** RPFP-13-CONSULT	**Project Start Date:** 7/1/2012
Original Project End Date: 6/30/15	**Current Project End Date:** 6/30/15	**Number of Extensions:** 0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$39,992.00	$29,040.00	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
	$11,665.00	

Project Description:

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

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

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

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

Anticipated work next quarter:

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

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

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.

Midwest States Pooled Fund Program Consulting Quarterly Summary

Midwest Roadside Safety Facility

12-16-2012 to 03-14-2013

Tie Down Straps on thin HMA Pavements

Question

State: MO
Date: 12-14-2012

Like most states, Missouri has been faced with an increasing need to tie down barriers on Portland cement concrete pavement (PCCP) that has been overlain with hot mix asphalt (HMA) pavement. The MwRSF has developed methods to tie to PCCP, or HMA on base, but a solution to the composite pavement still eludes the industry.

An upcoming project in the St. Louis area will require that freeway traffic on an 8-lane freeway to be run head to head (separated by Type F concrete barrier) in 6 of the lanes. This particular segment of highway has a 3-3/4 in. overlay of HMA.

Questions:

1. Would it be a reasonable variance of the tested and approved tie-down strap method to remove the asphalt pavement at each joint and pin directly to concrete by way of an elongated strap? (see attached diagram)

2. If this is a possibility, what would be considered a practical limit as to the thickness of asphalt layer for which this anchorage would be feasible?

3. A similar proposal involves milling a 2 ft. wide trench the entire length of the barrier run and pinning directly to the concrete by way of the conventional length strap. Would the Type F barrier still be functional if its effective height is decreased by 3-3/4 in.?

Attachment: http://mwrsf-qa.unl.edu/attachments/fab63f23199066f51e802bbdae64a334.jpg

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Response

Date: 12-17-2012
1. There are several unknowns with this type of installation of the tie-down strap. using the straps with a mill out as you have shown would prevent loading of the anchors through a layer of asphalt and provide similar anchor capacity to the tested design. However, doing so would require lengthening the sides of the strap. This change in geometry would likely affect the force-deflection and energy absorption of the strap to some degree and modify the loading of the anchors. The effect of these changes cannot be quantified without further study,

but could potentially increase barrier deflections and the anchor capacity as compared to he tested system. Thus, while the potential exists for this type of modification to work, we cannot accurately quantify the impact performance without further study.

2. As noted above, changing the length/geometry of the strap would affect the force-deflection and energy absorption of the strap. The deeper the asphalt thickness, more prominent those effects would be and the greater the expected change in system performance. Determination of an acceptable asphalt depth limits would require further study.

3. We cannot definitively say that the barrier system will or will not work with the reduced height when anchored, but our experience in testing the F-shape PCBÃ¢â‚¬â„¢s in anchored configurations leads us to have concerns for vehicle stability at the reduced height. If you look at our testing of the anchored F-shapes with 32Ã¢â‚¬Â• heights, you will note the degree of instability present. Reduction of the height to 28.25" would be significantly lower than previously tested TL-3 F-shape barriers, and would not be recommended.

Response
Date: 12-27-2012

Thank you for the prompt reply to my inquiry. I have shared your analysis with the project team and have the following questions by way of follow up.

1. Your response mentioned the change in geometry of the strap leading to an (as yet) incalculable effect on the force-deflection and energy absorption of the strap as well as the loading of the anchors. Would a thicker strap, perhaps 3/8 to 1/2 in., be sufficient to allay that effect?

1. Would my entire original inquiry perform sufficiently under TL-2 conditions?

Response
Date: 01-02-2013
Responses in Red.

1. Your response mentioned the change in geometry of the strap leading to an (as yet) incalculable effect on the force-deflection and energy absorption of the strap as well as the loading of the anchors. Would a thicker strap, perhaps 3/8 to 1/2 in., be sufficient to allay that effect?

Increasing the strap thickness is not a viable option. During the development of the strap tie-down, we investigated various strap thicknesses. It was observed that thicker straps tended to pry the anchors out of the concrete with very little energy absorption and made the system less effective.

1. Would my entire original inquiry perform sufficiently under TL-2 conditions?

There is increased potential for the proposed modifications working under TL-2 impact conditions. We believe that the first option to remove the asphalt pavement at each joint and pin directly to concrete by way of an elongated strap has a very good chance of performing well under TL-2. With the lower impact energy of the TL-2 impact, the effect of modifying the strap geometry becomes much less critical.

We would not be as confident in the second option to mill underneath the barriers and effectively lower the height 3 3/4". There has been very little research done on reduced height barriers with sloped faces for TL-2. The majority of the reduced height sections for TL-2 have been vertical face designs. As such, we would be

more wary of this option, especially when considering high CG vehicles and the potential for barrier climb That is not to say that it cannot work, but that our confidence is lower than the first option.

Retrofitting brush curb

Question

State: WI
Date: 11-16-2012

I was investigating concrete retrofits for brush curb. I was able to find in the RDG Iowa's concrete block retro fit.

Are there other concrete retrofit designs?

The Iowa detail in the RDG only shows a mid barrier cross section. Does the end sections of the Iowa design have more reinforcement?

Response

Date: 01-03-2013
I was unable to find any other tested designs for concrete barrier retrofits. There are other designs for retrofitting bridge rails, but they include steel and/or aluminum beam sections. Additionally, there are other designs out there that have been / are being used as concrete barrier retrofits, but they are untested.

You are correct in thinking that the end sections of the barrier have to be strengthened due to the lack of continuity. The original crash test report shows a 7 ft long end section that includes a thicker cross-section as well as additional reinforcement. Please refer to MwRSF report no. TRP-03-19-90. I believe the full drawing set for the barrier is available on Task Force 13's online Bridge Rail Guide also.

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post proximity to underground obstruction

Question

State: WI
Date: 01-24-2013

How close can an underground obstruction be to a MGS post before the obstruction influences post performance?
Attachment: http://mwrsf-qa.unl.edu/attachments/c1b0eaf217b1152042861f2f4863d7c7.pdf

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Response

Date: 02-04-2013
The effect of underground structures on post performance is related to several factors. These factors would include the size and type of the obstruction, the location of the obstruction relative to the post, the orientation of the obstruction relative to the post, and the embedment depth obstruction relative to the post.

For the culvert pipe installation shown on your detail, the effects should be less than if the pipe ran in front of or behind the posts. We would recommend a minimum offset of 12 inches from the post for this type of installation.

TL-5 Median barrier

Question

Date: 01-28-2013

Please accept my compliments on a very interesting and detailed new concept concrete barrier design.

Manitoba Infrastructure and Transportation is investigating options to replace an existing F Shape (TL4) concrete median barrier with a TL5 system. The cross section has yet to be finalised but the Vertical-Faced. Concrete Median Barrier Incorporating Head Ejection Criteria design that MwRSF developed has been part of our assessments. Construction of the new barrier is tentatively scheduled for summer 2013.

To help us with the new system for our Department, I am seeking your assistance to quantify and/or qualify a number of conditions and criteria for the TL5 concrete barrier as it relates to your barrier.

1) In the report on this barrier, it appears that an L4000 concrete mix (28 MPa) was used for both the foundation as well as the barrier itself. a. What is the complete mix design for the L4000 mix? (weight, volume, cement content, water content, aggregate composition, air content, slump, etc.)? b. What would be the recommended concrete mix design for a slip formed installation of this design?

2) What would be the consequences if the bottom of the barrier were not imbedded 75 mm below the finished grade of the adjacent asphalt pavement? I.e., the base of the concrete barrier is at finished grade (compacted aggregate or concrete pad). What size (diameter and length) of, and how many, vertical connecting pins (dowels) would be required to suitably attach the barrier to a concrete pad?

3) We have a number of overhead bridge sign structure supports that are located in a narrow median (approximately 900 mm wide). These supports cannot be removed and consist of approximately two - 220 mm diameter aluminium poles centred in the existing F Shape concrete median (see photo below). What would be the suggested means to provide some protection to vehicles and occupants from these installation using this barrier. E.g. increase the height of the barrier (to what height; at what slope should the top rise e.g.. 10:1, 20:1; would the cross section remain or would it change at the top)? An end anchor system would be required on either side of the structure. The opening could/would be treated in some form using standard guardrail components and hardware such as thrie beam.

4) Are there any special considerations needed for this barrier design to address bridge piers located in the median. These considerations would primarily related to a possible change in the cross section from a symmetrical cross section to an asymmetrical system (possible vertical back face)? A taller system or a system located further from the pier could be considered as possible design options to address vehicle roll. (See the photo below; the median shoulder is significantly wider at the piers.) We do not yet know what access is required to the bridge piers and/or footings.

5) Our local contractors have been contacted regarding this proposed slip form barrier construction. They have indicated to us that a minimum cover over the reinforcing steel should be 100 mm (4 inches). What would be the consequences, or benefits, to this barrier if the stirrups and longitudinal reinforcing were modified to accommodate the suggested 100 mm of cover as opposed to this barrier's design of 65 mm? I appreciate you may not be in a position to answer these questions without detailed analysis and possibly testing but your learned opinion would be appreciated in this regard. Please do not hesitate to contact me at your convenience if you need any clarification. Thank you in advance for your time and consideration of my questions.

Attachment: http://mwrsf-qa.unl.edu/attachments/d9f1111289e15ff28ed962a8bd6a23e9.jpg

Attachment: http://mwrsf-qa.unl.edu/attachments/d7358e905a840b42c554f5565006d0c1.jpg

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Response

Date: 01-30-2013

To help us with the new system for our Department, I am seeking your assistance to quantify and/or qualify a number of conditions and criteria for the TL5 concrete barrier as it relates to your barrier.

1) In the report on this barrier, it appears that an L4000 concrete mix (28 MPa) was used for both the foundation as well as the barrier itself.
    a. What is the complete mix design for the L4000 mix? (weight, volume, cement content, water content, aggregate composition, air content, slump, etc.)?
    b. What would be the recommended concrete mix design for a slip formed installation of this design?

The barrier was designed with a minimum concrete compressive strength (f'c) of 4,000 psi (28 Mpa). Cylinder testing indicated that we received a concrete mix with an f'c over 5,000 psi (35 MPa). However, this increase in concrete strength would only result in a 2% increase in barrier strength. Therefore, a minimum f'c of 4,000 psi (28 MPa) is still recommended.

Since the barrier was only 200 ft long, we did not slipform the test installation. Slipforming would have increased the test costs greatly for such a short segment of barrier. As such, the exact mixture we used would not be ideal for slipforming. I would recommend discussing the mixture ratios with contractor / slipformers as they know much more about concrete mixtures than I do. The only important thing about the mixture is that it results in a minimum f'c of 4,000 psi (28 MPa).

2) What would be the consequences if the bottom of the barrier were not imbedded 75 mm below the finished grade of the adjacent asphalt pavement? I.e., the base of the concrete barrier is at finished grade (compacted aggregate or concrete pad). What size (diameter and length) of, and how many, vertical connecting pins (dowels) would be required to suitably attach the barrier to a concrete pad?

We have had discussions like this previously with various State DOTs. I will refer you to our company's Q&A website in which this topic has been discussed and options were sketched. Please visit http://mwrsf-qa.unl.edu and search for Question ID No. 629 from June of 2012.

3) We have a number of overhead bridge sign structure supports that are located in a narrow median (approximately 900 mm wide). These supports cannot be removed and consist of approximately two - 220 mm diameter aluminium poles centred in the existing F Shape concrete median (see photo below). What would be the suggested means to provide some protection to vehicles and occupants from these installation using this barrier. E.g. increase the height of the barrier (to what height; at what slope should the top rise e.g.. 10:1, 20:1; would the cross section remain or would it change at the top)? An end anchor system would be required on either side of the structure. The opening could/would be treated in some form using standard guardrail components and hardware such as thrie beam.

I'm assuming that the concrete barriers are going to be replaced with the TL-5 barrier being discussed here. Yes, end section would need to be present on both sides of the structure. Increasing the barrier height may limit trailer-box roll into the barrier, thus minimizing the possibility of box impacts to the support poles. See below for common practices on height increases. However, the barrier would have to get wider to accomplish an increase in height.

I see two options for shielding this support:

(1) Transition the barriers to single faced sections (again see below). The barrier would need to be brought in front of the poles and may terminate on the downstream side of the poles. This would incorporate two independent barrier segments that are not connected. Each free end would face downstream and be protected from end on hits by the opposite barrier. We refer to this as a â€œfish scale" scheme as the protection is continuous upstream but open downstream of the hazard. For this option, you may need a wider median as it requires a barrier on each side of the support poles, so a minimum of 9" + 20" + 20" = 49 inches (54" by the time you include space between the poles and the barriers). This option would provide TL-5 protection.

(2) You could use thrie beam elements or structural tubes on both sides of the median to bridge the gap between each barrier end. Of course, the rail elements would need to be tapered (end shoe design for thrie beam) to prevent vehicle snag. This design would not likely meet TL-5 and may not meet TL-4 depending on the rail strength and height location. However, it would provide protection for passenger vehcles.

4) Are there any special considerations needed for this barrier design to address bridge piers located in the median. These considerations would primarily related to a possible change in the cross section from a symmetrical cross section to an asymmetrical system (possible vertical back face)? A taller system or a system located further from the pier could be considered as possible design options to address vehicle roll. (See the photo below; the median shoulder is significantly wider at the piers.) We do not yet know what access is required to the bridge piers and/or footings.

I have seen similar designs to what you are proposing here. Single sided versions of this barrier have been developed by a few State DOTs (sorry I can't find the drawings right now) for uses in pier protection, slope separation, and sign bridge protection (like #3 above with a wider median). Vertical back faces were used in most of these situations. To accomplish this while still keeping the strength, the flat top portion of the barrier was extended backward. Thus, the barrier width remained at 20 in. (508 mm).

Taller systems to reduce trailer-box roll over the barrier have also been configured for pier protection installations. This was accomplished by extending the top sloped portion of the barrier upward. Holding this slope constant ensures the head ejection envelope is not violated. I do not have a grasp on the quantity of trailer-box extent behind the barrier as a function of barrier height, only the general idea that taller barriers reduce the roll and extent of the box. I have heard of State DOTs extending up to as high as 54 in. (1,372 mm).

5) Our local contractors have been contacted regarding this proposed slip form barrier construction. They have indicated to us that a minimum cover over the reinforcing steel should be 100 mm (4 inches). What would be the consequences, or benefits, to this barrier if the stirrups and longitudinal reinforcing were modified to accommodate the suggested 100 mm of cover as opposed to this barrier's design of 65 mm?

If an increase in clear cover is desired, the internal steel would likely need to be increased (larger bars or more bars) to account for the loss in depth. A new reinforcement design would need to be configured such that the barrier strength remained the same as the original, as tested, version.

Ballasting Work Zone Devices

Question

State: MO
Date: 01-30-2013

MoDOT encounters a wide variety of ballasts across a number of work zone devices and isn't always sure that they're acceptable. The Roadside Design Guide (RDG) does not have a great deal to say on the issue of ballast for work zone devices. It speaks only of channelizing devices and says, â€œThe ballast should not present an obstruction if the cone is struck" and then goes on to list double-stacking, heavier devices, sandbags or recycled tire rings as acceptable solutions. The only other mention is that rocks and chunks of concrete are not acceptable. Questions: â€¢ Are there any general rules of thumb (material? Height? Weight?, etc.) for ballast that would allow an agency to conduct a visual inspection and deem an installation appropriate? â€¢ Is the RDG guidance enough? â€¢ Do the rules apply to other devices such as moveable barricades and X-base portable sign supports? â€¢ Are the ballasts shown in the attached .pdf acceptable?

Attachment: http://mwrsf-qa.unl.edu/attachments/aa3791f5a18fd3d65637d46a851b338b.pdf

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Response

Date: 02-28-2013
We are not aware of any formal guidance on ballasts for channelizing devices, moveable barricades, nor X-stand portable sign supports. Based on the guidance in the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*, the maximum stub height is 4 inches. Therefore, the height to the top of the ballast should not be more than 4 inches above the roadway surface. In addition, the ballast should not be elevated nor should it interfere with the breakaway features of the device. In addition to the RDG guidance, ballasting should be deployed in a similar manner to either the tested configuration or the manufacturer's recommendation for ballasting

Common ballasts we have seen are sandbags and recycled rings as you have shown in the attached pictures. I would have concerns with placing recycled rings around the center of an X-stand as shown on the second page of the attached photos. This ballast placement could potentially affect the performance of the breakaway mechanism when impacted.

These general rules could be applied to all work zone devices, such as channelizing devices, moveable barricades, and X-stand portable sign supports.

Deflection for MGS - Distance from the Front Face of Rail to a Fixed Object Hazard

Question

State: WY
Date: 01-30-2013

To all Pooled Fund Members and MwRSF: We are completing our details to implement MGS and I have a question about the distance to fixed object hazards which is very confusing in the roadside design guide. In the old days prior to the definition of working width, we specified the distance from the back of the guardrail system to the hazard as at least the dynamic deflection distance. The new Roadside Design Guide has several values for deflection of MGS. It also has values for working width, which is typically the width of a system (in the case of MGS, approximately 23 inches from the rail face to the back of the posts) plus the dynamic deflection. However the working widths fluctuate all over the board. What I would like to as, is what should we be using as the clear distance from the front face of the rail to a fixed object hazard behind the rail so the fixed object hazard is not struck. I would like to have values for the standard post spacing, half post spacing and quarter post spacing. I don't recall if we talked about deflection in our past review of various state standards for MGS. I would have normally posed the question on the Pooled Fund Website, but I am interested in both MwRSF take on this as well as what other states are using.

Response

Date: 01-31-2013
The deflections and working widths listed in the RDG for the MGS do fluctuate, even for the steel post version with standard 6'-3" post spacing. This fluctuation in the working widths is a reflection of several factors.

1. First, there has been a transition in the soil resistive forces that we use in our full-scale crash tests under MASH. Thus, the original crash testing of the MGS with the 2270P vehicle under 22-14 would have likely used a soil foundation that was less stiff than the soil recommendations that were eventually incorporated into MASH. Thus, there will be some variation of deflection and working width based on the change in the foundation conditions.

2. Second, the RDG presents tests with both the 2000P and 2270P vehicle types. Again the MGS was developed and tested during the transition between NCHRP 350 and MASH. Thus, the change in pickup truck vehicles represents an approximately 13.5% increase in kinetic energy. This change in impact conditions also accounts for some of the variation you are observing between the working widths and deflections in the full-scale testing.

3. Third, the RDG shows deflections for a wide range of MGS systems, including wood and steel post versions as well as several special applications. Thus, the use of different post types, post spacing, slopes, flares, etcâ€¦ affect the working width numbers.

4. Finally, full-scale crash tests are not an exact science. We have tried over the years to develop test procedures to make crash test results more consistent and repeatable. The current soil standard in MASH is one part of that effort. However, even with these efforts, there is a certain degree of variation from test-to-test that is difficult to

avoid. Thus, full-scale crash tests of two identical MGS systems may result in deflections that vary. This is simply difficult to avoid given all of the potential variation in materials, environmental conditions, soils, and other factors.

While it is clear that deflection and working width data taken from full-scale crash tests can vary for several reasons, we have still not answered your questions on what values you need to consider for your installations. Our advice here would be to review the available data from the crash tests of most similar systems and error on the side of being conservative. For example, if you have an MGS system installed on a 2:1 slope, then we would recommend using the working width guidance from the full-scale crash test of the 2:1 slope. For standard, steel post installations, we may suggest considering a working width of 60 in. The 60-in. working width corresponds with the upper end of the values observed in the full-scale testing and also allows for some tolerance if the soil for your real world installations in not as stiff as the soil currently specified in MASH. For the wood post versions of the standard MGS system, we would recommend that you refer to the crash tests of the specific wood post system and use those working widths if they are increased over the 60-in. For the Â½ post and Â¼ post spacing versions of the system, we would recommend using the tested working widths listed in the RDG.

Let me know if this addresses your concerns and if you have further questions.

Response
Date: 02-01-2013
Ohio introduced MGS to our standards just a couple of weeks ago. This is the table for the deflection values for our designers to accommodate. The minimum barrier clearance values are from face of rail to the hazard.

Links to our drawings if anyone wants to see what we've got so far:

â€œMGS" drawings
http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/roadway/Pages/StandardConstructionDra

Attachment: http://mwrsf-qa.unl.edu/attachments/13a0478d8f8d89a86b7d397ecbc7b8b1.jpg

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Response
Date: 02-01-2013

Wisconsin uses working with. For MGS we measure from face of rail.

Most designers just draw a line on the plan for beam guard. So they don't have a good idea where the post are.

Response
Date: 02-01-2013

So what values do you use then for each post spacing I mention?

Response

Date: 02-02-2013

Because we use weaker wood I had to use bigger working with values than what MwRSF recommendec The chart below is on the backside guidance of our standard drawings.

Attachment: http://mwrsf-qa.unl.edu/attachments/b7fbea420d833d8d880ce03d8465c771.jpg

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Barrier Scupper

Question

State: WI
Date: 01-30-2013

Dear MwRSF, Could you take a look at these drawings. I'm not quite familiar interpreting the chart that LRFD manual on snag. I found it hard to believe that opening did on influence the roll over (see FHWA letter). _____ Subject: Barrier Scupper Please see attached details for US 41 typical cross section for the Duck Creek to Lineville mainline. Barrier will be placed along the median and the outside adjacent to the existing frontage roads. We are proposing scuppers to be placed as curb flankers at the sag curves along the outside barriers. We would be proposing one scupper about 30 to 50 feet upstream from the low points. Therefore, there would be four scuppers at each low point. The scuppers are being proposed as a â€œfailsafe" measure to drain storm water in case the roadway inlets at the sag condition get clogged or can't drain out. Inlets and storm sewer is designed for the barrier-contained roadway. We do not plan to add scuppers along the continuous grade upstream of the sags. We would ideally be looking at a 4-inch x 18" scupper at the base of the 42-inch SSCB. Due to construction means and methods, we could consider a 3" high scupper x say 24" length. We do not believe the 3-inch or 4-inch scupper height introduce a snagging issue. Please advise if you have any concerns or require further justification. We are trying to include with the February 1 PS & E. Thanks for your attention. I look forward to hearing from you.
Attachment: http://mwrsf-qa.unl.edu/attachments/32f6ce338489eafa83590dc8070c37d9.pdf

Attachment: http://mwrsf-qa.unl.edu/attachments/ab2a28d9cbe52b7096865eb9e63f2702.pdf

Attachment: http://mwrsf-qa.unl.edu/attachments/7e675ace1558ffb4e0817d2fd6d315b3.pdf

Attachment: http://mwrsf-qa.unl.edu/attachments/903a66d673d079dbe81d90d4e81ccf37.pdf

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Response

Date: 01-31-2013
From Pooled Fund Consulting Summary Nos. 228, 263, and 439, it would appear that your hole heights of 3 or 4 in. would fall below our recommended upper bounds. As such, concerns related with wheel interaction with hole would likely be very limited.

Ron

MGS Post Leave-out Size in Mow Strips and Other Pavements

Question

State: WY
Date: 02-07-2013

TTI did some testing regarding "leave outs" for conventional w-beam guardrail (27 3/4" Height). The recommendation was to provide at least 7" free on the back side of the post. Are these recommendations valid with MGS or should the dimension be increased somewhat until further testing is completed. Likewise, the Pooled fund performed testing on posts in rocky conditions. Are these recommendations valid for MGS? Attached is a copy of a 2004 FHWA Memo regarding the subject.
Attachment: http://mwrsf-qa.unl.edu/attachments/f969f8932ccbebd03b67b5805632902e.pdf

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Response

Date: 02-07-2013
I believe that this issue has been dealt with previously in Question 171 on the website.

If this does not fully address your question, let me know.

http://mwrsf-qa.unl.edu/view.php?id=171

Thanks

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modifying TTI TL-2 31" guardrail

Question

State: WI
Date: 02-08-2013

I noticed TTI has a TL-2 beam guard transition to rigid barrier. I was wondering if it is possible to modify the transition to use nested rails verse 10 gauge thrie beam and using 12 inch deep blocks? I assume that the transition is the area in the square. Do you think that there is a minimum length of beam guard prior to the transition like the MGS TL-3 transition? report number FHWA/TX-12/9-1002-8
Attachment: http://mwrsf-qa.unl.edu/attachments/9950ec41bfae0f6be9e92e4502db92f1.pdf

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Response

Date: 02-11-2013
I do not forsee any issues with extending the blockout to 12" from the tested 8" blocks. This would only help minimize vehicle snaging potential.

Going from a 10 ga. thrie beam section to a nested 12 ga. section has been considered allowable in previous designs. Nested 12 ga. thrie beam has about a 50% increase in the cross section area, elastic section modlus, and plastic section modulus in comparison to 10 ga. thrie beam. Thus, it is a stronger section. The only issues that I can see arise from this switch would be increased pocketing at the connection between the w-to-thrie segement and the nested thrie. However, due to the short length of the thrie beam (only connects the bridge parapet to the 1st post) and the fact that this is a TL-2 system, I do not have much concern for an increase in pocketing.

To answer how much w-beam is necessary upstream of the transition, I will refer to and amend the 3 criteria listed on page 154 of the MwRSF TL-3 transition (TRP-03-210-10).

1. the first required a 12.5 ft seperation from the assemetrical w-to-thire transition segment and the downstream stroke of the energy absorbing terminal. this requirement will stay the same. However, the stroke of a TL-2 energy absorbing terminal will be less than that of a TL-3 terminal. Thus the total distance upstream of the transition segment will be less.

2. the second requirement called for a minimum of 46'-10.5" upstream of the assemetrical w-to-thrie transition segment. This distance was to ensure proper anchorage of the system. With the drop down to TL-2, this distance can be conservatively reduced by 12.5' to a distance of 34'-4.5".

3. the third requirement called for a 25 ft distance between the assemetrical w-to-thrie transition segment and the start of a flared guardrail terminal. Due to the reduction in impact energy with a TL-2 system (compared to TL-3), this distance can be conservatively reduced by 6'-3". Thus, a distance of 18'-9" should be seperating the transition segment and the start of a flare.

MGS Thrie Beam Curb

Question

State: KS
Date: 02-26-2013

KDOT has a project where we are installing corral rail on a low fill culvert. We will be attaching MGS guardrail to the corral rail and have some questions concerning the 4" edge curb we would typically install with our bridges when we attach guardrail to the corral rail. Please see the attached standard drawing for the curb location. The project is scheduled to go to letting in the near future and I would like to discuss a few alternatives we are considering with you. Please give me a call when you have an opportunity.

Response

Date: 02-26-2013

Over the last few months, we have been discussing KsDOT Drawing No. RD613A which pertains to a thrie beam approach guardrail transition with the new, simplified, steel-post MGS stiffness transition. This combined system is depicted with a lower 4" wedge curb under the first 12' 6" segment of nested thrie beam rail and adjacent to the concrete corral rail. An additional drawing, No. RD611A, provides details for the MGS.

The region adjacent to the bridge end is configured with half-post spacing of three W6x15 steel posts. Our original MWT test series utilized similar posts in this region but with the thrie beam attached to a thrie beam bridge railing that also utilized an upper channel rail. The upper channel rail was carried onto the first post or two and tapered down to shield an exposed end. When this approach guardrail transition is anchored to a concrete end, the upper channel rail would not exist, thus slightly reducing the lateral stiffness of the first W6x15 post or two.

Over the years, thrie beam AGTs with half-post spacing near the bridge end have been successfully crash tested and evaluated (or even grandfathered based on other prior testing) when attached to: (1) thrie beam bridge railings with additional upper tube or channel rails as well as W6x15 posts (Missouri and FPL systems), (2) concrete parapet with tapered end sections, a backup thrie beam, as well as large wood posts (CALTRANS system), and (3) NDOR concrete bridge end with good tapered geometry and larger steel posts at half-post spacing and one large span with simulated post via a horizontal tube and offset blockout. Per my recollection, these systems did not utilize a lower concrete curb and met NCHRP Report No. 350 impact safety standards. Although the upper channel/tube is not used with first two W6x15 steel posts, I believe that this half-post spacing system would be crashworthy with or without a lower concrete curb as long as a reasonably tapered concrete end were utilized to mitigate concerns for wheel contact and snag as well as any subsequent vehicular instabilities that lead to rollover.

In the late 90s, an Iowa thrie beam approach guardrail transition system with steel posts at quarter-post spacing near bridge end and with a lower 4" concrete curb was successfully crash tested under NCHRP Report No. 350. Later, this same thrie beam AGT with curb was successfully crash tested under MASH. Unfortunately, a similar version of this transition did not provide satisfactory safety performance when evaluated without the curb under NCHRP Report No. 350. More recently, another MASH crash test was performed on the identical system to the original Iowa transition but without the curb, and again the test results were unsatisfactory. As such, most quarter-post spacing designs adjacent to bridge end may likely require the use of a lower concrete curb. We do have a successful test on a thrie beam transition with quarter post spacing and without the curb. However, this system attached to a single-slope median end and used thrie beam on each side of the parapet.

I have also attached our comments that were previously provided to Ohio and Iowa on a similar issue. After you review the attached information, please feel free to call me to further discuss. We can set up a time for the call as well.

Attachment: http://mwrsf-qa.unl.edu/attachments/a302a0089237b8f098a604216a232c3e.zip

Attachment: http://mwrsf-qa.unl.edu/attachments/69dbcf3908aef5e4ce7bb5e1b459869b.pdf

Attachment: http://mwrsf-qa.unl.edu/attachments/e2b6150235ca2dc944fa0105b09aa739.pdf

Design Forces for Traffic Railings

Question

State: MN
Date: 03-01-2013

It was mentioned during the meeting that the new recommended minimum barrier height for TL-4 barriers is 36". Below is shown a table found in the AASHTO LRFD Bridge Design Specification. Table A13.2-1 - Design Forces for Traffic Railings Is there a similar table which shows equivalent values for MASH? If not, is there a corresponding equivalent load for the 36" height that is different from the current 54 kip?
Attachment: http://mwrsf-qa.unl.edu/attachments/6026a67e5bb6ec9b19f8b18624b40ece.jpg

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Response

Date: 03-02-2013
The short answer to your question isâ€¦ no, there is not a complete bridge rail design table for MASH similar to the one found in AASHTO's Bridge Guide. However, there are multiple pieces of this table to be found in various testing reports and journal papers. For example, TTI published a journal paper through the Transportation Research Board that summarizes recent MASH TL-4 testing into 32" and 36" tall parapets. Within this paper, they recommend a minimum height of 36" for TL-4 rails and a lateral force capacity of 75 kips. A reference to this paper is below:

Sheikh, N. M., Bligh, R. P., and Holt, J. M.,*Minimum Rail Height and Design Impact Load for Longitudinal Barriers that Meet Test Level 4 of MASH*, Transportation Research Record, Journal of the Transportation Research Board, No. 2309, January 2012.

MwRSF agrees with the 36" minimum rail height as our own crash simulations indicated the minimum height to be 35"-36". Additionally, both MwRSF and TTI have conducted MASH TL-4 impacts on 32" tall F-shape / Jersey shaped barriers that resulted in the 10000S vehicle rolling over the barrier. However, MwRSF feels that the 75 kips design load may be on the load end of the range. We have been designing MASH TL-4 barriers to a capacity of 90-100 kips based on numerical analysis, simulation, and crash testing results. Now, clearly, TTI's barrier with an 80 kip capacity successfully redirected the vehicle, but the calculated 80 kips value may vary depending on who is running the analysis and the methods applied. As we discussed over the phone, there are multiple ways/assumptions to calculate concrete bending strength and barrier strength. For example, including the compression steel in the bending strength calculations (TTI has historically only included the tensile steel, so I would assume this to be true of their 80 barrier design). Thus, their 80 kip design strength may calculate out to 85-90 kips if both layers of reinforcement were included in the design. Additional varying ways/assumptions made during calculations may include reduction factors, concrete strength, and barrier depth for irregular / non rectangular barrier cross sections. So, to sum up this paragraph, we are not saying that 75 kips is incorrect, but rather that it is on the low end of the MASH TL-4 design strength range and MwRSF is more comfortable with a more conservative 90-100 kip design strengthâ€¦ unless of course the barrier has been crash tested and shown adequate.

Similar to the above discussion, MwRSF has long felt that the design capacities listed in by AASHTO are on the low side. A complete analysis of TL-5 loads was previously conducted and documented in the attached report. From this analysis, the TL-5 design load was determined to be 210 â€“ 225 kips. Note, there was no change between NCHRP report 350 and MASH concerning TL-5 testing criteria. Of course, it would follow that AASHTO's TL-6 design load 175 kips was also low if the TL-5 design load is over 200 kips already.

MwRSF also feels the AASHTO TL-3 design load was on the low end of the range. For NCHRP Report 350 criteria, we had regularly witnessed TL-3 impact loads between 55 and 70 kips. Under MASH, the pickup truck increased in mass and the impact angle was also increased from 20 to 25 degrees. Thus, TL-3 impacts have an increased Impact Severity and would be expect to impart higher loads to the bridge rail. Subsequently, MwRSF has used a 70-80 kip range when designing MASH TL-3 bridge rails.

Hope this helps. Let me know if you have any questions.

Attachment: http://mwrsf-qa.unl.edu/attachments/bb0ff0def3b2d17efa7df24b6e4f0f92.pdf

4" Edge Curb (MGS Guardrail Approach Transition)

Question

State: KS
Date: 03-01-2013

After our meeting on Wednesday I checked the Nebraska and CALTRANS transition design and found the following information (See attachments for more detail). See page 3 in the Caltrans attachment and pages 3 and 4 in the Nebraska attachment. 3'-1.5" - KDOT distance from beginning of bevel to center of 1st post ? - Nebraska â€“ Unclear from details, but appears to be similar to Caltrans (i.e. less than 3'-1.5") 33" (953 mm) â€“ Caltrans distance from beginning of bevel to center of 1st post 3" KDOT â€“ distance from end of bevel to back of rail 14" (350 mm) Nebraska â€“ distance from end of bevel to back of rail 5" (125 mm) Caltrans â€“ distance from end of bevel to back of rail From this information it appears KDOT's 1st post is offset a greater distance from the bevel than the other two designs and the end of the bevel is located closer to the back of the thrie-beam than the other two designs. According to our discussion on Wednesday it's my understanding KDOT should not remove the curb in place with the transition design we currently use. Is this correct?

Response

Date: 03-01-2013

The Nebraska AGT detail uses a distance of approximately 37.5" based on center of splice to first simulated post via tube rail and blockout. The slope and lateral offset of tapered concrete end has worked well. An earlier version with less slope and offset was tried but resulted in excessive wheel snag and floorboard deformation.

Thus, it would be good for KDOT longitudinal distance to be similar or less than others.

It would be beneficial to have longer flatter flare with more offset that short steep flare with minimal offset. A larger lateral offset reduces tendency for wheel to impact on end of concrete. A flatter flare reduces scrubbing forces along the tapered section as well as helps to prevent a rapid wheel redirection which can contribute to vehicle roll during redirection. In other words, a wheel snag on the front face of a short taper may behave like a wheel contacting the upstream end.

For half-post spacing design, I believe that it could be installed with or without curb if end section contact is reduced, taper design is conservative, and distance to first post within range of those noted. Knowledge of crash tests of several systems gets us to this general opinion.

We also noted that standardization of concrete ends with half- and quarter-post spacing designs and w/ and w/o curbs would be desirable in future. Some MASH testing with 1100C and 2270P vehicles may possibly be necessary.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
SPR-3(017) Supplement #38	☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

Project Title: Cost Effective Upgrading of Existing Guardrail Systems		
Name of Project Manager(s): Reid, Rohde, Sicking, Faller, Lechtenberg	**Phone Number:** 402-472-9070	**E-Mail** kpolivka2@unl.edu
Lead Agency Project ID: 2611120090002	**Other Project ID (i.e., contract #):** RPFP-07-01	**Project Start Date:** 2/26/07
Original Project End Date: 12/31/10	**Current Project End Date:** 12/31/13	**Number of Extensions:** 2

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	**Total Cost to Date for Project**	**Percentage of Work Completed to Date**
$92,084	$92,229	95

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$10,518	

Project Description:

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

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

Tasks:

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

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

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

Anticipated work next quarter:

Internal review of the draft report will be completed. The draft report will be submitted to the Pooled Fund member states for review and comment. Review comments will be implemented and the final report will be published and disseminated to Pooled Fund member states.

Significant Results:

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

Task	% Complete
1. Field study of existing guardrail installations	100%
2. Compilation of field study findings	100%
3. Selection of installations to investigate	100%
4. Sensitivity study to decrease the size of the analysis matrix	100%
5. RSAP analysis	100%
6. Research report	85%

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

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

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

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX))* SPR-3(017) Suppl.#38	**Transportation Pooled Fund Program - Report Period:** ☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

Project Title: Testing of Cable Terminal for High Tension Cable (1100C & 2270P)		
Name of Project Manager(s): Reid, Rohde, Sicking, Faller	**Phone Number:** 402-472-3084	**E-Mail** jreid@unl.edu
Lead Agency Project ID: RPFP-07-06	**Other Project ID (i.e., contract #):** 2611120090007	**Project Start Date:** February 26, 2007
Original Project End Date: December 31, 2010	**Current Project End Date:** December 31, 2013	**Number of Extensions:** 2

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$100,563	$69,444	64%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$4,631	

Project Description:

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

Tasks

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

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

Task 4.

Analysis of the two bogie tests (HTCT-2 and HTCT-3) was completed. Documentation of the history of design changes to the cable end terminal was initiated.

Anticipated work next quarter:

Task 4. A report detailing the two bogie tests (HTCT-2 and HTCT-3) will be initiated. The historical design changes will be reviewed and design modifications will be investigated.

Charges from HT Level Terrain and Ditch projects (Project No.: RPFP-12-CABLE1&2 – TPF-5(193) Supplement #45, Project Title: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase I, Level Terrain and 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) will be applied to the funds in this project in order to use up the funds and close Pooled Fund Year 17 projects by April 30, 2013. The upcoming crash test on the cable median barrier will be charged to this project as needed to use the funds.

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"

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

Final design details and full-scale testing for this project cannot be conducted until the High Tension Cable Barrier System is completed. Because of timing in that project, this project received another no-cost time extension.

Charges from HT Level Terrain and Ditch projects (Project No.: RPFP-12-CABLE1&2 – TPF-5(193) Supplement #45, Project Title: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase I, Level Terrain and 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) will be applied to the funds in this project in order to use up the funds and close Pooled Fund Year 17 projects by April 30, 2013. The upcoming crash test on the cable median barrier will be charged to this project as needed to use the funds.

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): Midwest Roadside Safety Facility, UNL

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX))* SPR-3(017) Supplement #49	**Transportation Pooled Fund Program - Report Period:** ☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)	
Project Title: MGS Implementation (Year 18)		
Name of Project Manager(s): Reid, J.D., Sicking, D.L., & Faller, R.K.	**Phone Number:** 402-472-6864 (Faller)	**E-Mail** rfaller1@unl.edu
Lead Agency Project ID: RPFP-08-07 (2611120095008)	**Other Project ID (i.e., contract #):** SPR-3(017) Supplement #49	**Project Start Date:** September 1, 2007
Original Project End Date: December 31, 2009	**Current Project End Date:** December 31, 2013	**Number of Extensions:** 6

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$15,928 (original)	$16,497	77%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$4,185	

Project Description:

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

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

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

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

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

The MGS implementation activities continued. Technical review and support has been provided to the state DOTs on a case by case basis, including Ohio and Kansas.

In the First Quarter of 2013, little progress was made on this project. Deadlines for other projects, work related travel, and other commitments limited the amount of time that could be applied to furthering the research on this project.

Anticipated work next quarter:

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

Significant Results:

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

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

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

As of February 28, 2013, the total project funds were expended and $568 was charged to Pool Fund Year 17 contingency funds. Further work will also be charged to the Pool Fund Year 17 contingency funds.

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Wisconsin DOT

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Suppl. #15	☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

Project Title:		
Development of a Low Deflection Temporary Concrete Barrier		
Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Bielenberg, Faller, Reid, Sicking	(402) 472-9064	rbielenberg2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211022001		7/1/2009
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/2011	12/31/2013	2

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$178,914	$99,819.00	72

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$5,478.00	

Project Description:

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

Task	% completed
1. Project Planning and Literature Search	100
2. LS-DYNA Analysis of Barrier Offset to Drop-Off	30
3. Development of Design Concepts	90
4. LS-DYNA Analysis of Concept Designs	100
5. Fabrication of Design	100
6. TL-3 Full-scale Crash Testing with 2270P Vehicle	80
7. Analysis and Refinement of Design	40
8. Fabrication of Revised Design	0
5. TL-3 Full-scale Crash Testing with 2270P Vehicle	0
6. Summary Report	0

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

In the First Quarter of 2013, little progress was made on the analysis and refinement of the design for limiting concrete barrier deflection evaluated in the first full-scale crash test of this project. Deadlines for other projects, work related travel, and other commitments limited the amount of time that could be applied to furthering the research on this project. Work was continued on determining what design modifications can be made to further reduce the system deflections over those observed in test no. RDPCB-1. Work was initiated towards modifying the simulation model of test no. RDPCB-1 developed in the previous quarter with design changes to further limit deflections. These models have been started but the analysis has not been completed to date. The results from these simulations will be used to gauge the effectiveness of the proposed modifications.

Anticipated work next quarter:

In the Second Quarter of 2013, MwRSF will continue the process of redesigning the reduced deflection PCB system. MwRSF will apply design changes to the model developed in this quarter in an effort to further reduce deflections. Some concepts that will be evaluated are reduction of the barrier gap at the joints, increased thickness and section of the structural elements, the use of additional attachment points between the barrier and the reduced deflection hardware, and increasing the barrier-to-ground friction.

Once these design modifications have been evaluated and their effectiveness estimated a revised design will be developed and presented to the sponsor. Once WisDOT has approved the revised design, MwRSF will conduct a second full-scale test using the revised design.

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).

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

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

At this time, it was also expected that the remaining tasks for this project cannot be completed within the current time limit. Thus, we requested and received a no-cost time extension of 12 months for this project, moving the closing date to December 31, 2013.

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Wisconsin DOT ✳

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl. #16	**Transportation Pooled Fund Program - Report Period:** ☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)	
Project Title: Synthesis of Crash Cushion Guidance		
Name of Project Manager(s): Albuquerque D., Schrum K., and Sicking D.	**Phone Number:** 402-472-6864	**E-Mail** rfaller1@unl.edu
Lead Agency Project ID: 2611211023001	**Other Project ID (i.e., contract #):**	**Project Start Date:** July 1, 2009
Original Project End Date: June 30, 2011	**Current Project End Date:** December 31, 2013	**Number of Extensions:** 3

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$ 112,275	58,767 ($7,608 for Suppl #26)	95%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	7,476	

Project Description:

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

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

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

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

Manufacturers and State DOT representatives were given the opportunity to review the report, which included FHWA crash test repair cost estimates. A vast majority of the comments were from manufacturers, and each comment was documented and responded to accordingly.

A proposed change in the names of the categories of crash cushions was made. "Low Maintenance" systems were referred to as redirecting low repair cost (LRC) systems. "Sacrificial Redirecting" systems were referred to as redirecting moderate repair cost (MRC) systems. "Sacrificial Nonredirecting" systems were referred to as nonredirecting high repair cost (HRC) systems.

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

Anticipated work next quarter:

An incremental BC analysis will be conducted in addition to the index approach developed in the study. The report will be updated according to internal discussions. The revised report will be sent for review by State DOTs and manufacturers.

Significant Results:

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

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

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

Due to the amount of work remaining, this project is projected to have extra funds remaining at the time the project is complete. The funds in Project No. TPF-5(193) Suppl. #26 were exhausted prior to the completion of the project. Therefore, the overrun budget for Project No. TPF-5(193) Suppl. #26 is being posted to this project. To date, $7,608 has been posted for Project No. TPF-5(193) Suppl. #26.

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

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl. #19	**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 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:** 4/30/2013	**Number of Extensions:** 1

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	**Total Cost to Date for Project**	**Percentage of Work Completed to Date**
$92,207	$12,743	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**
	$1,424	

Project Description:

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

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

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

Objectives/Tasks:

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

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

Previously, dynamic bogie testing was conducted on concrete foundations in stiff soil (AASHTO grade B). The 12" diameter concrete foundations continued to see damage in the form of large concrete pieces breaking free from the top - back side of the foundation during testing. From these tests, 36 inches appears to be the minimum embedment depth to limit deflections. Additionally, work has continued on the report documenting all testing and conclusions.

Recently, the new, non-proprietary, cable median barrier being developed by MwRSF has been going through some major design changes, including the post cross section. The original S3x5.7 posts are going to be replaced with a weaker, bent plate C- or Z-shaped post. It is envisioned that the new post may provide half the strength of the S3x5.7 posts. Thus, work on the socketed foundation design was halted until the post design was finalized.

Anticipated work next quarter:

Upon the selection of a new post for use in the new, non-proprietary, cable median barrier system, the foundation design will be re-evaluated and redesigned. The new posts are to be significantly weaker that the previous S3x5.7 posts, so the existing socketed foundation design may get smaller and/or have reduced internal steel.

Additionally, a critical mow strip design will be selected for evaluation with the socketed post foundations. The foundation design may be modified to reflect the increase in confinement strength that the mow strip will provide. New designs will be dynamically tested to evaluate performance.

Significant Results:

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

Round 2 of testing saw four foundations designs evaluated in sand. Although concrete shear failure occurred in all designs, the 60" embedment proved adequate to resist rotation in weak/saturated/sandy soils.

Round 3 of testing determined 36" was the required embedment depth for 12" diameter foundations placed in strong soil (AASHTO Grade B).

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

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

Additional (matching) funds for Phase-I of this project were obtained through a Mid-America Transportation Center program. This matching funding was used during the first round of design, testing, and evaluation for the socketed foundations. Thus, some of the original Phase-I funding remains 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 is being charged to the Phase I project until the funds are gone. Limited time has been charged to the Phase II project to date, but the test charges from Round 2 of testing have been placed on this project's budget.

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

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

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl.#21	**Transportation Pooled Fund Program - Report Period:** ☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

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

Name of Project Manager(s):	**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, 2013	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**
$159,193	$29,701	20%

Quarterly Project Statistics:

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

Project Description:

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

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)"

No reporting on this phase of the project will be done until Phase I is complete; see that project for status.

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

Anticipated work next quarter:

Significant Results:

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

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

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): 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, 2013	**Number of Extensions:** 1

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$166,953	$142,897	95%

Quarterly Project Statistics:

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

Project Description:

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

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

Note: The analysis phase of this project is being 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 final report documenting the analysis phase was sent to the states.

Anticipated work next quarter:

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

Significant Results:

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

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

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

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

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

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

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

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl.#24	**Transportation Pooled Fund Program - Report Period:** ☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)	
Project Title: LS-DYNA Modeling Year 4		
Name of Project Manager(s): Reid, Sicking, Faller	**Phone Number:** 402-472-3084	**E-Mail** jreid@unl.edu
Lead Agency Project ID: RPFP-10-LSDYNA	**Other Project ID (i.e., contract #):** 2611211031001	**Project Start Date:** July 1, 2009
Original Project End Date: July 31, 2012	**Current Project End Date:** April 30, 2013	**Number of Extensions:** 1

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$37,634	$34,412	90%

Quarterly Project Statistics:

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

Project Description:

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

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

Due to other project priorities, no work was planned or done for this project during this quarter.

Anticipated work next quarter:

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

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

Significant Results:

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

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

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

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

No problems have been encountered to date.

Potential Implementation:

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Supplement #27	**Transportation Pooled Fund Program - Report Period:** ☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)	
Project Title: Short-Radius Guardrail with Large Radii		
Name of Project Manager(s): Bielenberg, R., Faller, R., Reid, J., & Sicking, D	**Phone Number:** 402-472-9064 (Bielenberg)	**E-Mail** rbielenberg2@unl.edu
Lead Agency Project ID: 2611211042001	**Other Project ID (i.e., contract #):** TPF-5(193) Supplement #27	**Project Start Date:** June 30, 2010
Original Project End Date: June 30, 2013	**Current Project End Date:** June 30, 2013	**Number of Extensions:**

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$57,929.00	$12,549	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
	$6,923.00	

Project Description:

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

Tasks	% completed
Review and summarize design details and prior crash testing on Washington State short-radius guardrail (WA-SRG)	100
Send summary to Wisconsin to decide on which short-radius system to model	100
Develop LS-DYNA FEA model of Yuma County-SRG system	100
Determine acceptable speed for 2000P crashes into Yuma County-SRG with LS-DYNA	20
Modify FEA model of WA-SRG to incorporate 70-ft radius	60
LS-DYNA analysis and design modifications for Yuma County-SRG with 70-ft radius	60
Prepare draft and final research reports	10
Obtain FHWA acceptance for modified Yuma County-SRG with 70-ft radius	0

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

During the first quarter of 2013, the model of the Yuma County short radius guardrail system was validated. Modifications required to validate the Yuma County system were applied to systems with larger radii, and critical impact locations for larger systems was explored.

Initial models of the Yuma County system resulted in excessive post damage and final system damage. Evaluation of the wood post CRT models indicated that the models had strong-axis strengths near the upper range of wood post CRT post tests, but were at or near the bottom of the weak-axis strength range. Since posts in the Yuma County system predominantly failed in weak-axis bending, it was determined that altering the weak-axis geometry could produce large increases in weak-axis strength without excessive increases in strong-axis strength. The new surrogate wood post geometries were simulated in the same bogie test conditions used in the initial wood post simulations, and the results were compared. A suitable geometry was determined to be 15% wider in the weak axis, such that the surrogate post section was effectively 8 in. x 6.9 in. Once inserted into the Yuma County model, the Yuma County system performance was validated by comparing vehicle positions throughout the simulation, resulting system damage, and vehicle final position. Instabilities in system design and construction were noted, which occasionally produced tendencies of the vehicle to vault over the system.

Using the validated models of the Yuma County system, models of the larger radii were updated and initial simulations were conducted to determine critical impact locations which would maximize the risk of vaulting, penetration, or rollover. Multiple simulations were used to determine critical impact locations which could maximize the risk of vaulting.

Anticipated work next quarter:

In the Second Quarter of 2013, simulations of larger radii designs will be completed, and the final report detailing the work completed on this project will be prepared. It is expected that at least one journal paper could be produced as a result of this work, which will be prepared during this quarter as well.

Significant Results:

Surrogate CRT post models were generated which more accurately reflected CRT post strengths in weak and strong axes. The Yuma County short radius model was validated against physical testing.

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:

No results indicating implementation potential at this time.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): Wisconsin DOT

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl. #28	**Transportation Pooled Fund Program - Report Period:** ☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)	
Project Title: Downstream Anchoring Requirements for MGS		
Name of Project Manager(s): Faller R., Reid J., Sicking D., Stolle C.	**Phone Number:** (402)472-6864	**E-Mail** rfaller1@unl.edu
Lead Agency Project ID: 2611211043001	**Other Project ID (i.e., contract #):**	**Project Start Date:** July 1, 2010
Original Project End Date: June 30, 2013	**Current Project End Date:** June 30, 2013	**Number of Extensions:** 0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$ 235,065.00	$ 195,223	90%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$ 2,478	

Project Description:

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

Tasks:

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

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

The draft report underwent major revisions. Internal review was initiated.

A journal paper on this project was presented at the 2013 Annual Meeting of the Transportation Research Board. The paper was also accepted to be published in the 2013 Transportation Research Board's Transportation Research Record.

A journal paper detailing the results of the bogie testing and wood post properties was outlined and drafted.

Anticipated work next quarter:

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

Significant Results:

The pickup truck test resulted in a smooth vehicle redirection with considerable damage to the barrier system. This test indicated that the selected impact point was at or close to the end of the length of need.

The small car test revealed that considerable snag occurred near the downstream end of the cable anchorage system. This result confirmed initial concerns of increased snag at the downstream end, as observed in LS-DYNA simulations.

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).

Problems related to the accuracy of the load cells delayed the execution of the bogie tests planned at the beginning of the project. A rupture occurred in the tow cable system that was used in a bogie test on the entire downstream anchorage system, thus causing a need for a re-test of the component test. A calibration of the wood material, necessary to reproduce a realistic failure of the BCT wood posts, caused some delay in the initial set-up of the numerical model. Finally, Dr. Mario Mongiardini took a new research position in Australia in October, thus the reporting process was delayed to await alternative personnel to take on the remaining efforts in 2013.

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl. #29	**Transportation Pooled Fund Program - Report Period:** ☑Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) ☐Quarter 3 (July 1 – September 30) ☐Quarter 4 (October 4 – December 31)	
Project Title: Minimum Effective Guardrail Length for MGS		
Name of Project Manager(s): Reid, Sicking, Faller, Bielenberg, Lechtenberg	**Phone Number:** 402-472-3084	**E-Mail** jreid@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):** 2611211044001	**Project Start Date:** June 30, 2010
Original Project End Date: June 30, 2013	**Current Project End Date:** June 30, 2013	**Number of Extensions:** 0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$122,444	$93,543	80%

Quarterly Project Statistics:

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

Project Description:

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

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

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

Task 7. The draft report underwent internal review #1 and was updated according to comments from that review. Internal review #2 began and is currently in progress.

Anticipated work next quarter:

Task 7. Update the draft research report based on the internal reviews. Submit report to WsDOT for review after all internal reviews have been completed.

Significant Results:

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

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

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

No problems have been encountered to date.

Potential Implementation:

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

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

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

Project Title:		
Wood Post for MGS		
Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Sicking, Faller, Lechtenberg, Bielenberg	402-472-9070	kpolivka2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211045001	RPFP-11-MGS-1	7/1/10
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
12/31/13	12/31/13	0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	**Total Cost to Date for Project**	**Percentage of Work Completed to Date**
$121,215	$88,541	75

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$2,513	

Project Description:

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

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

Tasks:

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

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

Review of the internal draft report continued.

Anticipated work next quarter:

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

Significant Results:

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

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

Task	% Complete
1. Full-scale crash testing (MASH 3-10 and 3-11)	100%
2. Analysis and documentation of test results	100%
3. Research report	85%
4. Hardware guide drawings and FHWA acceptance	60%

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

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

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Suppl. #32	☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

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

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	**Total Cost to Date for Project**	**Percentage of Work Completed to Date**
$91,071	$81,906	85%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$2,064	

Project Description:

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

Objectives / Tasks

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

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

All component testing had been previously completed.
Work this quarter was focused on documenting all testing and conclusions within the project report. An internal draft is approximately 75% completed.

Anticipated work next quarter:

Work shall continue on the written report to document the design, testing, and conclusions of this project.

Significant Results:

A complete review of culvert designs used by Pooled Fund member states revealed a critical culvert design for testing and evaluation. A simulated culvert matching this critical design was been constructed. Four attachment concepts were developed, fabricated, and tested. Both the single anchor top mounted design and the side mounted design satisfied all resistance and damage requirements during lateral and longitudinal testing. Thus, these two designs will be recommended as attachment designs for the MGS Bridge Rail system attached to culvert headwalls.

Objectives / Tasks	% Complete
1. Literature review of current culvert designs	100%
2. Design of MGS attachment to culvert headwall	100%
3. Dynamic bogie testing	100%
4. Data analysis and evaluation	90%
5. Written report documenting all design work, testing, and conclusions	50%

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

none

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Supplement #33	☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

Project Title: Wood Post for MGS		
Name of Project Manager(s): Reid, Sicking, Faller, Lechtenberg, Holloway	**Phone Number:** 402-472-9070	**E-Mail** kpolivka2@unl.edu
Lead Agency Project ID: 2611211047001	**Other Project ID (i.e., contract #):** RPFP-11-MGS-3	**Project Start Date:** 7/1/10
Original Project End Date: 12/31/13	**Current Project End Date:** 12/31/13	**Number of Extensions:** 0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	**Total Cost to Date for Project**	**Percentage of Work Completed to Date**
$157,655	$99,927	85

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$3,266	

Project Description:

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

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

Tasks:

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

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

A paper written from this research was presented at the TRB annual meeting in January 2013. The paper was chosen to be published in the Transportation Research Board's 2013 Transportation Research Record.

Review comments were implemented and the final report was published and sent to the Pooled Fund member states on February 27, 2013.

Anticipated work next quarter:

Request for FHWA eligibility will be submitted.

Significant Results:

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

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

Task	% Complete
1. Full-scale crash testing (MASH 3-10 and 3-11)	100%
2. Analysis and documentation of test results	100%
3. Research report	100%
4. Hardware guide drawings and FHWA acceptance	60%

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

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

Potential Implementation:

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

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Suppl. #34	☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

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

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$10,000	$10,000	95%

Quarterly Project Statistics:

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

Project Description:

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

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

Objectives / Tasks

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

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

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

Work this quarter continued on the the report documenting all testing and conclusions. Currently, an internal draft has been completed and is currently on its second round of edits. The report covers the results and conclusions for both projects.

Anticipated work next quarter:

A second round of edits will be completed on the internal draft report (covering both this project and the related TPF-5 (193) Suppl. #47, RPFP-12 MGS 4) . The subsequent revision shall be sent to the Midwest Pooled Fund States for review.

Significant Results:

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

Objectives / Tasks	% Completed
1. Literature review of current practices	100%
2. Design of new weld detail	100%
3. Dynamic testing and analysis	100%
4. Written Report containing design work, testing, and conclusions	90%

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

Although this project has no remaining funds, the report shall be finalized using the funds from the related project: TPF-5 (193) Suppl. #47, RPFP-12 MGS 4. The report will cover the testing and conclusions for both projects.

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl.#37	**Transportation Pooled Fund Program - Report Period:** ☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

Project Title: Annual LS-DYNA Modeling Enhancement Support		
Name of Project Manager(s): Reid, Sicking, Faller	**Phone Number:** 402-472-3084	**E-Mail** jreid@unl.edu
Lead Agency Project ID: RPFP-11-LSDYNA	**Other Project ID (i.e., contract #):** 2611211050001	**Project Start Date:** July 1, 2010
Original Project End Date: December 31, 2013	**Current Project End Date:** December 31, 2013	**Number of Extensions:** 0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$35,901	0	0

Quarterly Project Statistics:

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

Project Description:

This is a continuation of TPF-5(193) Suppl.#24, "LS-DYNA Modeling Year 4" and thus, no progress to report until funds are exhausted in that project.

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

Anticipated work next quarter:

Significant Results:

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

Potential Implementation:

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): 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	402-472-8600	dbenicio@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		

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	$113,379	85%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$21,994	

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.):

The data analysis was completed and documented. The draft report continued to be written.

The project results were presented to Wisconsin DOT on February 1, 2013. Comments were obtained during the presentation and were incorporated into the report. Sponsor reported that analyses and results answered research questions posed by project's proposal.

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

Anticipated work next quarter:

An internal draft of the report will be completed. Review of the internal draft report will be initiated. It is anticipated the draft report will be submitted to WisDOT for review and comment toward the end of the next quarter.

Significant Results:

None

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

The project demanded significantly more work during both vehicle crash data collection and RSAPv3 analyses than was originally predicted and budgeted. Researchers originally had planned to only collect data from Kansas's highway I-70. However, later on and in order to develop a database that would enable engineers to look at more meaningful and reliable results, researchers realized the need to collect more data. Thus, additional guardrail, hazard, and traffic volume data from all guardrail sites located on all Interstate highways in the State of Kansas was collected. This effort consumed a significant amount of resources.

In addition, researchers used the most recent version of the Roadside Safety Analysis Program, RSAP\v3, in this study. Since RSAPv3 is very new and researchers had no experience with it. They did not anticipate the tremendous amount of time it would take to run approximately 1,000 simulations.

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

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

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Suppl. #41	☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

Project Title:		
Crashworthy Pedestrian Rail		
Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Sicking, Faller, Bielenberg, Lechtenberg	402-472-9070	kpolivka2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211061001		7/1/2011
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/2014	6/30/2014	0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$234,629	$22,350	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
	$3,226	

Project Description:

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

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

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

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

The draft report with documentation of literature review findings continued.

A spreadsheet was created to evaluate potential systems of various material types and cross sections under load conditions set by AASHTO and ADA. Rails of HDPE, Steel, and FRP were left out of the study based on material properties, weight, or cost. Wood, Aluminum, and PVC were determined to still be viable materials for the rail fabrication. Design concepts and connections were developed and analyzed. Following this analysis, a preliminary set of design concepts which involve Wood, Aluminum, and PVC rails, were selected for further analysis and investigation. It should be noted that all design concepts have been designed to incorporate options of being either continuous or segmented systems.

Anticipated work next quarter:

Connection designs will continue to be developed. A design meeting within MwRSF will be held to select a concept to conduct limited component testing in order to investigate its viability to further our knowledge on how this type of system will perform during a dynamic impact. Following this component testing investigation and toward the end of the next quarter, MwRSF staff anticipates presenting the design concepts and the knowledge gained to WisDOT in order to garner feedback.

Documentation of literature search results and design concepts will continue.

Significant Results:

None

Objectives / Tasks	% Complete
1. Literature review	95%
2. Identification of rail needs and design criteria	100%
3. Pedestrian rail design concepts	75%
4. Component testing of design concepts	0%
5. Summary report of design concepts	40%
6. Finalize system details	0%
7. Full-scale crash testing (MASH 2-91)	0%
8. Full-scale crash testing (MASH 2-90)	0%
9. Written report documenting analysis, design, testing, and conclusions	0%

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

None

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Suppl. #42	☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

Project Title:		
Zone of Intrusion Concrete Barriers		
Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Sicking, Faller, Bielenberg, Lechtenberg	402-472-3084	jreid@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
	2611211062001	July 1, 2011
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
June 30, 2014	June 30, 2014	0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$58,942	$51,900	80%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$3,819	

Project Description:

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

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

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

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

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

Based on internal reviews of the two reports being written for this project, the project took a set back. Specifically, extrensive re-work was required for both the literature review (report 1) and the actual ZOI study (report 2).

The literature review report was edited and submitted for another internal review.

Work on the ZOI study addressing the review comments was begun and good progress was made.

Anticipated work next quarter:

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

Complete the work for the ZOI and Master Thesis associated with the ZOI. Begin conversion of the Master's Thesis document into MwRSF format.

Significant Results:

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

Objectives / Tasks	% Complete
1. Literature review of ZOI values	90%
2. LS-DYNA Simulation of 2270P impacts on single slope barriers	90%
3. Written reports documenting all work and conclusions	70%

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

none

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Suppl. #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):	**Phone Number:**	**E-Mail**
Reid, Sicking, Faller, Bielenberg, Lechtenberg	402-472-6864	rfaller1@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211063001		7/1/2011
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/2014		0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$199,502	$ 42,547	85%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$ 2,339	

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.):

A paper submitted to TRB was presented at the annual meeting in Washington, D.C., The title was "Correlation between Crash Severity and Embankment Geometry." In addition, further reviews of this paper were done internally.

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

Anticipated work next quarter:

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

A journal or journals will be sought out to submit the papers outlining the findings of this research.

Significant Results:

Objectives / Tasks	% Completed
1. Accident data collection	100%
2. Data analysis and determination of critical elements	100%
3. RSAP analysis	100%
4. Written report documenting all analysis and conclusions	80%

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

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

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Supplement #44	☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

Project Title:

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

Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Sicking, Faller, Bielenberg, Lechtenberg	402-472-9070	kpolivka2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211064001	RPFP-12-CABLE1&2	7/1/11
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/14	6/30/14	0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	**Total Cost to Date for Project**	**Percentage of Work Completed to Date**
$233,262	$205,322 (+$100,449 from Yr 21 Cor	70

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$40,161	

Project Description:

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

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

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

Tasks:

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

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

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

Review comments were implemented and the final report was published and sent to the Pooled Fund member states on December 21, 2012.

A report was initiated that includes the component tests conducted on the tabbed bracket and keyway bolt designs and the top cable attachment concepts and design. Another report was initiated that includes the folded C-channel posts and will include the additional post testing.

Design modifications of the bolted tabbed bracket design were investigated. The new designs aimed to further reduce the vertical release loads by extending the distance between the inside of the flange and the part of the top tab which rubs against it. Test nos. HTTB-17 through HTTB-40 involved five new versions of the tabbed bracket (version 5 through 10) and were completed in December 2012. The tabbed brackets worked very well. After comparing the loads, tabbed bracket version 10 with lateral and vertical release loads of 6,100 lb and 346 lb, respectively, was ultimately chosen. Tabbed bracket version 10 is a bolted tabbed bracket. It is made of 12-gauge sheet steel and is secured to the flange of the post by a bolt at its bottom. Its head sits in a keyway. When pulled laterally, the head catches in the keyway. When pulled vertically, it bends and its head releases through the keyway without any scraping along the inside of the flange. This is ideal behavior. Past bolt or bracket and keyway combinations exhibited significant scraping. As a result, their vertical release loads were much higher. For example, the A449 keyway bolts, used in the last full-scale crash test, had a vertical release of 1.18 kips. Lowering the vertical release load while maximizing the lateral release load was one of the main goals of the cable-to-post attachment investigation.

Anticipated work next quarter:

The report containing the tabbed bracket, keyway bolt, and top cable attachment concepts and designs will continue to be written. The report containing the folded C-channel posts (and additional new posts) will continue to be written.

The Midwest Weak Post will be component tested in mid-March and the results of those tests will be analyzed. Final design details will be decided upon, which include post spacing and cable tension. Once the component tests on the Midwest Weak Post have been analyzed, an email containing a questionaire will be sent to the states seeking feedback on the design in particular if the system used in a 6:1 V-ditch is required to be the same system that could be used in a 4:1 V-ditch.

If a consensus is reached with the states, it is anticipated that the redesigned system will be constructed and potentially tested in the next quarter.

Significant Results:

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

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

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

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

It should be noted that the test conducted with the 1500A on the system placed on level terrain (Test No. 4CMBLT-1 conducted on June 14, 2011) was charged to the Project No.:RPFP-11-CONT – TPF-5(193) Supplement #39, Project Title: Pooled Fund Year 21 Contingency even though it was one of the tests funded in Project No.:RPFP-12-CAB_E1&2 – TPF-5(193) Supplement #44, Project Title: Completion of the Development and Evaluation of the Midwest Four-Cable, High-Tension, Median Barrier Phase I, V-Ditch. At the time this test was conducted, Year 22 funds were not available for use. The funds in the above mentioned contingency funds were available and were to be used to fund part of Phase II of this project.

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

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

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Supplement #45	☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

Project Title:

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

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

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	**Total Cost to Date for Project**	**Percentage of Work Completed to Date**
$91,800 (+$91,089 from Yr 21 contingency)	$61,184 (+$100,449 from Yr 21 Cont	0

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$56,995	

Project Description:

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

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

Tasks:

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

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

None

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

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

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

Anticipated work next quarter:

None.

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

Significant Results:

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

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

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

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

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

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl. #46	**Transportation Pooled Fund Program - Report Period:** ☑Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) ☐Quarter 3 (July 1 – September 30) ☐Quarter 4 (October 4 – December 31)

Project Title: Midwest Four-Cable, High-Tension, Median Barrier - Phase III, End Terminal		
Name of Project Manager(s): Reid, Sicking, Faller, Bielenberg	**Phone Number:** 402-472-3084	**E-Mail** jreid@unl.edu
Lead Agency Project ID: RPFP-12-CABLE	**Other Project ID (i.e., contract #):** 2611211066001	**Project Start Date:** July 1, 2011
Original Project End Date: June 30, 2014	**Current Project End Date:** June 30, 2014	**Number of Extensions:** 0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$199,626	0	0

Quarterly Project Statistics:

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

Project Description:

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

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

This is Phase III of the project.

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

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

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

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

Anticipated work next quarter:

Significant Results:

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

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

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Suppl. #47	☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

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

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	**Total Cost to Date for Project**	**Percentage of Work Completed to Date**
$19,935	$13,614	95%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$2,322	

Project Description:

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

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

Objectives / Tasks

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

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

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

This quarter, work has continued on the report documenting all testing, analysis, and conclusions for this project. The testing report includes work form another project (TPF-5(193) suppl. #34) as they both deal with attachment of the top mounted culvert post to culvert slabs. An internal draft report has been completed and gone through the first round of internal review. A second round of edits is currently underway

Anticipated work next quarter:

The internal draft report (covering both this project and the related TPF-5(193) Suppl. #34, RPFP-11 MGS-4) will go through a second round of internal edits. The subsequent revision shall be sent to the Midwest Pooled Fund States for review/comment/edits.

Significant Results:

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

Objectives / Tasks	% Completed
1. Literature review	100%
2. Design of epoxied anchors	100%
3. Dynamic testing and analysis of design	100%
4. Written report containing all design, analysis and conclusions	90%

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

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl. #48	**Transportation Pooled Fund Program - Report Period:** ☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)	
Project Title: Pooled Fund Center for Highway Safety		
Name of Project Manager(s): Ron Faller, John Reid, Bob Bielenberg	**Phone Number:** 402-472-9064	**E-Mail** rbielenberg2@unl.ecu
Lead Agency Project ID: 2611211068001	**Other Project ID (i.e., contract #):** RPFP-12-PFCHS-1	**Project Start Date:** 7/1/2011
Original Project End Date: 6/30/14	**Current Project End Date:** 6/30/14	**Number of Extensions:** 0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$24,859.00	$1,096.00	40%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
	$567.00	

Project Description:

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

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

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

The MwRSF Pooled Fund Consulting web site is fully functional and MwRSF has continued work on the Pooled Fund Center for Highway Safety web site. MwRSF's web site developers at UNL and have created a web site that will house all of the MwRSF research reports and CAD details in a searchable format for downloading. The web site will tie in with both the existing MwRSF web site and the recently finished MwRSF Pooled Fund Consulting web site.

During this quarter, the web site development team at UNL and has completed the user interface and database framework for the Pooled Fund Center for Highway Safety web site. The web site has been created and is currently being populated with the MwRSF report archive. Following the completion of the report uploads, CAD files will be added to the archive.

Anticipated work next quarter:

MwRSF plans to finish populating the web site archive with CAD and report files during the first quarter of 2013. The site will be opened to users once the report files have been uploaded so that the state DOT's can have access to the reports and provide feedback on the web site. The site full functional and available to the Midwest Pooled Fund member states by early in the second quarter of 2013.

Again, at this time, the existing funds for the project should allow for archiving of MwRSF research reports and CAD details.

Significant Results:

The web site has been completed at this time aside from format changes to page layouts. Work has begun in uploading the archived data.

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

None.

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl. #48	**Transportation Pooled Fund Program - Report Period:** ☑Quarter 1 (January 1 – March 31) ☐Quarter 2 (April 1 – June 30) ☐Quarter 3 (July 1 – September 30) ☐Quarter 4 (October 4 – December 31)	
Project Title: Pooled Fund Center for Highway Safety		
Name of Project Manager(s): Ron Faller, John Reid, Bob Bielenberg	**Phone Number:** 402-472-9064	**E-Mail** rbielenberg2@unl.edu
Lead Agency Project ID: 2611211086001	**Other Project ID (i.e., contract #):** RPFP-13-PFCHS	**Project Start Date:** 7/1/2011
Original Project End Date: 6/30/14	**Current Project End Date:** 6/30/14	**Number of Extensions:** 0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$10,958.00	$0.00	0%

Quarterly Project Statistics:

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

Project Description:

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

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

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

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

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

Anticipated work next quarter:

The project funding herein will not be accessed until the Pooled Fund Center for Highway Safety web site is fully operational and addition updates and maintenance are required. It is anticipated that the web site will be functiona in early second quarter of 2013.

Significant Results:

None.

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

None.

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl. #51	**Transportation Pooled Fund Program - Report Period:** ☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)	
Project Title: Annual LS-DYNA Modeling Enhancement Support		
Name of Project Manager(s): Reid, Sicking, Faller, Bielenberg	**Phone Number:** 402-472-3084	**E-Mail** jreid@unl.edu
Lead Agency Project ID: RPFP-12-LSDYNA	**Other Project ID (i.e., contract #):** 2611211071001	**Project Start Date:** July 1, 2011
Original Project End Date: June 30, 2014	**Current Project End Date:** June 30, 2014	**Number of Extensions:** 0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$36,543	0	0

Quarterly Project Statistics:

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

Project Description:

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

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

Anticipated work next quarter:

Significant Results:

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

Potential Implementation:

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Supplement #52	☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

Project Title: Deflection of Curved Runs of Cable Guide Under MASH TL-3 Impact - Retest		
Name of Project Manager(s): Faller, Sicking, Reid, Lechtenberg, Bielenberg	**Phone Number:** 402-472-9070	**E-Mail** kpolivka2@unl.edu
Lead Agency Project ID: 2611211074001	**Other Project ID (i.e., contract #):**	**Project Start Date:** 12/15/11
Original Project End Date: 12/31/12	**Current Project End Date:** 3/31/13	**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**
$58,350	$46,246	90

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	**Total Amount of Funds Expended This Quarter**	**Total Percentage of Time Used to Date**
	$11,584	

Project Description:

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

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

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

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

Internal review of the draft report of Volume 1 which was the full-scale testing was completed. The draft report was sent to NY State DOT for review and comment. Review comments were implemented and the final report was published and sent to NY State DOT on 2/27/13.

Energy dissipation estimations were completed utilizing the three test results and prior component testing. Reasonable estimates for the barrier-vehicle friction and vehicle damage were developed. A draft research report of the energy analysis was completed. Internal review of the draft report was initiated.

Anticipated work next quarter:

Internal review of the draft report will be completed. The draft research report of the energy analysis will be completed and sent to NY State DOT for review and comment. Review comments will be implemented and the final report will be published and disseminated to NY State DOT.

Significant Results:

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

Tasks:	% Completed
1. Prepare CAD details of 360-ft radius system	100%
2. Construct 360-ft radius system	100%
3. Full-scale test of 360-ft radius system (modified MASH 3-11)	100%
4. Prepare CAD details of 440-ft radius system	100%
5. Construct 440-ft radius system	100%
6. Full-scale test of 440-ft radius system (modified MASH 3-11)	100%
7. Analysis and documentation of test results	100%
8. Draft and final research reports	100%
9. Additional crash investigation and energy dissipation analysis	100%
10. Draft and final report for additional analysis	75%
11. Prepare CAD details of modified 440-ft radius system	100%

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

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

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

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

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Supplement #53	☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

Project Title:

Annual Fee to Finish TF-13 and FHWA Standard Plans

Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Sicking, Faller, Lechtenberg	402-472-9070	kpolivka2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211079001	RPFP-13-TF13	7/1/12
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/15	6/30/15	0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	**Total Cost to Date for Project**	**Percentage of Work Completed to Date**
$3,983	$80	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.):

No work was completed on this project during the past quarter.

Anticipated work next quarter:

Continue to update drawings based on comments received at the AASHTO TF-13 Spring meeting held in April 2012 and Fall meeting held in October 2012.

Significant Results:

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

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

Summary of Barrier Guide individual drawings to date:
31 systems - 25 approved, 6 to be reviewed
41 components - 15 approved, 26 to be reviewed
2 systems submitted to Bridge Rail Guide
1 component submitted to Luminaire Guide

Task	% Complete
1. Prepare CAD details for Hardware Guide	50%

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

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

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

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl. #54	**Transportation Pooled Fund Program - Report Period:** ☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

Project Title: Annual Consulting Services Support		
Name of Project Manager(s): Ron Faller, John Reid, Bob Bielenberg	**Phone Number:** 402-472-9064	**E-Mail** rbielenberg2@unl.edu
Lead Agency Project ID: 2611211080001	**Other Project ID (i.e., contract #):** RPFP-13-CONSULT	**Project Start Date:** 7/1/2012
Original Project End Date: 6/30/15	**Current Project End Date:** 6/30/15	**Number of Extensions:** 0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$39,992.00	$29,040.00	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
	$11,665.00	

Project Description:

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

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

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

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

Anticipated work next quarter:

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

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

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

Significant Results:

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

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

None.

Potential Implementation:

None.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Suppl. #55	☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

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

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$65,224	$28,393	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
	$179	

Project Description:

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

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

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

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

Currently, the test results are residing in the report writing queue.

Anticipated work next quarter:

Work on the report documenting all testing, analysis, and conclusions shall begin. Additionally, conclusions shall be drawn concerning the use of steel breakaway posts instead of wood CRT posts in various barrier systems.

Significant Results:

All eight of the originally proposed dynamic bogie tests have been conducted. The data has not yet been analyzed.

Objectives / Tasks	% Complete
1. Dynamic bogie tests (8 total)	100%
2. Data analysis and evaluation	80%
3. Ulterior systems design recommendations	0%
4. Written report documenting all testing, analysis, and conclusions	0%

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

None

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)* TPF-5(193) Suppl. #56	**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: Increased Span Length of the MGS Long Span		
Name of Project Manager(s): Reid, Sicking, Faller, Bielenberg, Lechtenberg	**Phone Number:** 402-472-3084	**E-Mail** jreid@unl.edu
Lead Agency Project ID: RPFP-13-MGS-3	**Other Project ID (i.e., contract #):** 2611211082001	**Project Start Date:** 7/1/2012
Original Project End Date: 6/30/2015	**Current Project End Date:**	**Number of Extensions:**

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	**Total Cost to Date for Project**	**Percentage of Work Completed to Date**
$212,730	$2,459	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**
	$2,459	

Project Description:

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

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

Objectives / Tasks

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

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

Task 1. A comprehensive literature review of previous long-span systems has been completed. The review includes nine full-scale crash tests dating from1990 through 2006.

Task 2. A baseline model of the original MGS long-span design is in progress. Sub-components of the system have been calibrated with component testing.

Anticipated work next quarter:

Task 2. Finish development of the baseline MGS long-span model for the original long-span design. This includes validating the model with full-scale crash tests (LSC-1 and LSC-2). Once a full-scale, validated, baseline model is completed, research efforts will be focused on evaluating this model at unsupported lengths greater than 25 ft.

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

Significant Results:

None

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

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

This project has a cost of $249,335. There was insufficient funding in Pool Fund Year 23 to fund this entire amount. Thus, The budget for Year 23 is $212,730, and the remaining $36,605 is being funded by contingency funds in Pool Fund Year 23.

Potential Implementation:

The MGS long-span system has the ability to perform safely without nested rail and with a minimal barrier offset. These features make the barrier a very functional, efficient, and safe option for protection of low-fill culverts. Development of an increased unsupported span length for the MGS long-span system will add to the flexibility of the design and provide for improved protection of culvert headwalls and vertical dropoffs with a length greater than 24 ft.

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Suppl. #57	☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

Project Title: MGS Installed in Mow Strips & Other Un-Yielding Pavements

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

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	**Total Cost to Date for Project**	**Percentage of Work Completed to Date**
$162,896	$252	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**
	$252	

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.):

An email survey was sent out to the sponsor State DOTs to obtain knowledge on their current mow strip design. The responses to this survey will lead to the selection of critical mow strip configurations for testing.

Additionally, preliminary design concepts were developed and included with the survey email. Pooled Fund members were asked to vote for their most desirable designs, and the results of this survey will aid in the selection of concepts to begin the component testing portion of the project.

Anticipated work next quarter:

The survey responses will be tabulated, critical mow strips will be selected, and the most favorable design concepts will be identified. These concepts will then be further developed and fleshed out. Baseline testing of posts installed directly into the mow strips will also be planned.

Significant Results:

None

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

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

None

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Supplement #58 Pooled Fund Project RPFP-13-AGT-1	☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

Project Title:

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

Name of Project Manager(s):	**Phone Number:**	**E-Mail**
Reid, Sicking, Faller, Bielenberg, Lechtenberg	402-472-6864	srosenbaugh2@unl.edu
Lead Agency Project ID:	**Other Project ID (i.e., contract #):**	**Project Start Date:**
2611211084001	RPFP-13-AGT-1	7/1/2012
Original Project End Date:	**Current Project End Date:**	**Number of Extensions:**
6/30/2015	6/30/2015	0

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	**Total Cost to Date for Project**	**Percentage of Work Completed to Date**
$154,217	$103,790	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**
	$46,012	

Project Description:

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

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

Objectives / Tasks

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

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

Previously, test no. MWTC-1 (MASH test no. 3-20) was conducted and resulted in the guardrail tearing near the upstream end of the W-to-thrie transition segment. Subsequently, the system was modified to include 12'-6" of nested W-beam rail upstream of the W-to-thire transition segment. Test no. MWTC-2 (an originally unfunded re-test of MASH 3-20) was conducted on this modified system and satisfied all of the MASH performance criteria.

During this quarter and in the interest of saving time and funding, it was requested that the remaining project funds be used to rebuild the system and conduct the originally budgeted MASH 3-21 test with the 2270P vehicle. The Midwest States Pooled Fund members agreed to this plan of action with the intent of supporting an additional project to fund documentation, analysis, and reporting efforts in the future to complete the project. Thus, the modified MGS stiffness transition was rebuilt and is awaiting full-scale crash testing.

Anticipated work next quarter:

It is anticipated that the third full-scale crash test will be conducted during the next quarter. Once the testing has been conducted, the data will be analyzed and writing of the project report shall begin.

Significant Results:

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

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

Objectives/Tasks	% Complete
1. Full-scale crash testing (MASH test designation nos. 3-20 and 3-21).	50%
1a. Full-scale crash test of modified transisiton (MASH test no. 3-20)	100%
2. Data analysis and evaluation.	65%
3. Report documenting R&D effort, including redesign, crash testing, and conclusions	5%

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

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

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

Potential Implementation:

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

TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

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

INSTRUCTIONS:

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

Transportation Pooled Fund Program Project # *(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*	**Transportation Pooled Fund Program - Report Period:**
TPF-5(193) Supplement #61	☑ Quarter 1 (January 1 – March 31) ☐ Quarter 2 (April 1 – June 30) ☐ Quarter 3 (July 1 – September 30) ☐ Quarter 4 (October 4 – December 31)

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

Project schedule status:

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

Overall Project Statistics:

Total Project Budget	**Total Cost to Date for Project**	**Percentage of Work Completed to Date**
$257,478	$6,245	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**
	$6,245	

Project Description:

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

Tasks of original project:

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

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

A 2006 Ford Taurus test vehicle with anti-lock brakes was purchased. A test protocol to remotely brake the sedan was developed to allow for a precise braking time. The brake system was tested by conducting braking tests with a live driver braking and also with the remote system braking. Braking tests were conducted on concrete to practice with equipment, timing, and to test the effect of human vs. mechanical brake activation. Braking tests were also conducted on soil to determine representative conditions for full-scale crash testing. Results of the braking tests were analyzed to determine approximate friction coefficients of the Ford Taurus vehicle, vehicular pitch, and brake time activation.

CAD details of 600 feet of tangent, low-tension, 3-cable barrier system with 1/2-in. diameter hook bolts were completed. NYSDOT reviewed the CAD details. Material acquisition was initiated. Construction of concrete end anchor blocks was completed.

Anticipated work next quarter:

Construction of the 600-ft long, tangent, low-tension, 3-cable barrier system with 1/2-in. diameter hook bolts and no cable compensator will be completed. Completion of testing of the tangent system with a braked 1500A vehicle and documentation and analysis of the test results. Results of the braked 1500A test will be discussed with NYSDOT.

Significant Results:

Based on results of a previous study identifying critical vehicles for crash testing cable barriers, a 2006 Ford Taurus was selected for crash testing. Braking tests were conducted and friction coefficients for vehicle braking on soil were determined. The average friction coefficient of a vehicle with anti-lock brakes disabled, which is reflective of test vehicles with engines turned off during full-scale testing, was 0.656. The maximum front-end pitch observed in braking on soil was approximately 2 degrees. This was correlated to a drop in front-end bumper height of approximately 2 in.

Tasks:	% Completed
1. Development of remote braking test protocol	100%
2. Conduct braking tests to determine braking friction coefficients and vehicle pitch	100%
3. Prepare CAD details of tangent, low-tension, 3-cable barrier system with 1/2-in. dia. hook bolts	100%
4. Construct system with 1/2-in. dia. hook bolts	20%
5. Conduct crash test with 1500A vehicle (modified MASH 3-10)	0%
6. Analyze test results (modified MASH 3-10)	0%
7. Prepare CAD details of tangent, low-tension, 3-cable barrier system with 1/2-in. dia. hook bolts	0%
8. Construct system with 1/2-in. dia. hook bolts	0%
9. Conduct crash test with 2270P vehicle (MASH 3-11)	0%
10. Analyze test results (MASH 3-11)	0%
11. Prepare CAD details of tangent, low-tension, 3-cable barrier system with 5/16-in. dia. hook bolts	0%
12. Construct system with 5/16-in. dia. hook bolts	0%
13. Conduct crash test with 2270P vehicle (MASH 3-11)	0%
14. Analyze test results (MASH 3-11)	0%

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:

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