# Midwest States Pooled Fund Program Consulting Quarterly Summary

## Midwest Roadside Safety Facility

**01-01-2015 to 04-01-2015**

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## RE: G-4 Guardrail: Clear Spanning of shorter distances, 18'9" & 12'

### Question

State: UT
Date: 01-06-2015

I have been asked to research
possible solutions to the the NCHRP 350 testing failure of the 18' 9"
clear span using w-beam,TTI Report/Test #405160-1-1, dated May 24, 2006.

UDOT currently uses 18'9" & 12'6"spanned guardrail systems that
were approved using the 230 testing criteria. UDOT currently also uses the
25' span as tested and accepted under NCHRP-350, acceptance #B-58.

I am asking if the posts immediately prior to the span and after the span were
replaced using CRT post with 2 blocks would that be an acceptable alternative
to the current design of standard posts? I have modified 2 of the details
to show my proposal using crt posts and 2 blocks for your review. See
attached Span Proposal.pdf drawing.

Std. Dwg BA 4H1 has 3 details, Std. Dwg BA 4H2 has 2 details,
if I'm remembering the discussions with Don Gripney correctly the splice
location appeared to be an issue during 230 testing. I have also included
BA 4HI and BA 4H2 for reference.

Under the 350 testing of the 25 ft. span using CRT post and 2 blocks, the splice joint did not appear to be an issue where it was placed in the run..

If these are not acceptable changes can you offer any suggestions that may work in these situations?

Thanks for any assistance you can provide.

Attachment: https://mwrsf-qa.unl.edu/attachments/b23f6339025e71285277dad6d2245ea0.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/2220e3e28c55474da4bfec79251027bb.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/4151abd21caca59efe14f5fb90988ac6.pdf

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## Response

Date: 01-06-2015

We have some comments regarding the use of omitted posts in G4(1S) guardrail systems.

We have addressed this topic with the states in the past and have a current project underway to investigate the omission of a single post in the MGS system. Previous research into G4(1S) long span guardrail systems with various lengths have found that the G4(1S) system require nested guardrail if posts are removed from the system, as noted in the TTI research you reference. As such, we have typically recommended that all G4(1S) systems with unsupported spans use nested rail. We have provided recommendations as to the length required nested rail. This can be found in the link below.

http://mwrsf-qa.unl.edu/view.php?id=493

With respect to the use of CRT posts in the G4(1S) system, we have typically recommended that the three CRT posts be used on each side of the unsupported span to reduce the potential for snag and pocketing when posts are omitted. It is possible that the use of CRTs could be eliminated for shorter spans or that fewer CRTs could be used. However, there is not sufficient research to fully support that at this time. Thus, we have taken a conservative approach with the recommendation.

http://mwrsf-qa.unl.edu/view.php?id=836

Thus, we would recommend that you modify your proposed installation to include the nested rail and three CRT posts adjacent to each side of the unsupported span. We do not believe that the location of a splice in the unsupported region is cause for concern.

Let me know if you have further questions.

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# Inertial Barrier System

## Question

State: KS
Date: 01-16-2015

KDOT
is planning to simplify our Inertial Barrier Standard Drawing (current drawing attached) to have only two options for IBS layouts; one for low speed (less than or equal to 45 mph TL-2) and one for high speed (greater than 45 mph TL-3). Through conversations with Scott, he indicated MwRSF may have a program or spreadsheet to evaluate different configurations. Can you take a look at the current layouts we have shown for 45 mph, 65 mph, and greater than or equal to 70 mph and let me know if the current configurations are sufficient for a TL-2 (45 mph) or TL-3 (65 or greater than or equal to 70 mph) type hit? If you have any questions or want to discuss further let me know or give me a call.

Attachment: https://mwrsf-qa.unl.edu/attachments/3cf5953cc69f990d0637cfcdcb768fd1.pdf

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## Response

Date: 01-23-2015

We have done an analysis on the sand barrel array configurations that you sent us. The analysis consisted of the following NCHRP Report 350 configurations.

1. We analyzed each system at its design speed shown in the following cases. The 40 mph array was evaluated at 40mph, the 45 mph array was evaluated at 45 mph, and so on… We ran all of the analyses with the barrels oriented parallel to the roadway rather than the 0-10 degree orientation shown as an option in the detail. It was believed that the 0 degree orientation parallel to the roadway was more critical.

    a. Test no. 3-40 using an 820C vehicle centered on the end of the array rather than the ¼ point offset as the center impact would maximize the decelerations.

    b. Test no. 3-41 with the 2000P vehicle

    c. Test no. 3-42 using an 820C vehicle

    d. Test no. 3-43 with the 2000P vehicle

    e. Test no. 3-44 with the 2000P vehicle

2. We also ran the reverse direction impacts along the barrier with the 820C and 2000P vehicle to evaluate its performance for that type of impact.

3. We also analyzed the 65 mph configuration under the TL-3 impact speed – 62.1 mph.

From these analyses, we found the following.

1. Almost all of the arrays were acceptable under the required NCHRP 350 impact tests for the design speeds listed.

2. For the 65 mph array, our analysis found that the array was not quite long enough to bring the 2000P vehicle below a critical velocity prior to the end of the concrete parapet for test no. 3-41. Typically we design the arrays to drop the vehicle velocity below 10 mph and then place a final row of barrels beyond that point to ensure safe vehicle deceleration. In the case of the 65 mph array, the vehicle velocity was still slightly above the 10 mph cutoff when it reached the last row of two 2100 lb barrels. Thus, you may consider modifying this array slightly to alleviate this issue by changing rows 4 and 5 from 200 lbs and 400 lbs to 400 lbs and 700 lbs, respectively. See attached. The addition of one additional row of barrels past the 10 mph velocity point is not necessarily required, but is mentioned as an option in the RDG and is recommended by some of the manufactures.

3. Analysis of the 65 mph at the TL-3 impact speed of 62.1 mph found that the array was acceptable under the required NCHRP 350 impact tests.

4. Analysis of the 60 mph array under the 60 mph design found a similar issue to the above 65 mph case in that the array was not quite long enough to bring the 2000P vehicle below a critical velocity prior to the end of the concrete parapet for test no. 3-41. Depending on your preference, we could attempt to adjust that array as well.

5. The 55 mph array analysis found that the acceleration limits were exceeded for test no. 3-44 with the 2000P vehicle. This is a function of the length of the array changing the impact point for the test to a more critical location. The impact point for test no. 3-44 is the length of the array divided by two. Thus, the shorter array used here places the impact point further down the array. Again, we can look into adjustment of that array if you desire.

Take a look at this information and let me know what you think. I also have some additional thoughts that we can discuss on the phone if you want to give me a call.

Attachment: https://mwrsf-qa.unl.edu/attachments/d8503d8297e74dd06d9fbcd8848f18b6.jpg

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# spanning an old culvert

## Question

State: WI
Date: 01-20-2015

We have a minor project were a very old box culvert is near a roadway.  The overall roadway is in poor condition and in the next 5 years the roadway, box culvert and near by intersections will be worked on.

In the interim, the existing beam guard does not have the correct height, is in poor condition, lacks sufficient grading and uses down turned end terminals.

The box culvert is very narrow and only a few feet high (making it almost impossible to get into).  Making using a top bolted not viable.  In addition given the age of the box culvert the culvert itself may not be in good condition or have the strength required

A long span will not properly fit in at this location because of grading/right-of-way/environmental concerns.

Note that the web page will not let me attach 2 other photos

Attachment: https://mwrsf-qa.unl.edu/attachments/110ae138e9d766e1951c592fbbac92ff.pdf

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## Response

Date: 02-03-2015

We looked through this and the proposed detail. We believe that the proposed detail is a little too complicated and that the reduced spacing adjacent to the culvert doesn't improve things.

Instead, we would recommend that you treat the box culvert obstruction as a small long span system with the MGS and place 3 CRT posts on each side of the culvert. This should alleviate the potential for degradation of the performance over the culvert.

You may not need the long span CRT's  at all if you can get the posts to straddle the culvert at standard spacing.

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# Minimum length of guardrail

## Question

State: IL
Date: 01-25-2015

At TRB I mentioned that we would like to revise our criteria concerning the minimum length of guardrail for a free-standing run.

This is an excerpt from the IL Tollway Traffic Barrier Guidelines:

The 168.75' minimum length of a “free-standing" run of guardrail is based on the system length that has been crash tested. If using a Type T1 (Special) Terminal on the upstream end, 34.38' can be applied toward the 168.75' requirement. For example, a typical free-standing installation usually includes a Type T1 (Special) Terminal on the upstream end and a Type T2 Terminal on the downstream end. For this example, the minimum length of guardrail required between these two terminals is 137.5'.

I would love to reduce the minimum length shown in yellow. What is the minimum that you are comfortable with? Can it be 75'?

Thanks again.

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## Response

Date: 01-26-2015

Previously, MwRSF has done two research studies that relate to this issue. The first was a study for the MGS system that investigated potential minimum system lengths for the system under MASH TL-3 impact conditions (http://mwrsf.unl.edu/researchhub/files/Report281/TRP-03-276-13.pdf). The second was a study that investigated the crashworthiness and redirective length of the downstream anchorage that is typically used with the MGS (http://mwrsf.unl.edu/researchhub/files/Report279/TRP-03-279-13.pdf).

In the minimum length study, computer simulation and full-scale testing indicated that a 75' long MGS system would be capable of redirecting a 2270P vehicle under the MASH TL-3 impact conditions. Test no. MGSMIN-1, was performed on the 75-ft long MGS with a top rail mounting height of 31 in. A 4,956-lb pickup truck impacted the barrier system at a speed of 63.1 mph and at an angle of 24.9 degrees. The test results met all of the MASH safety requirements for test designation no. 3-11. The tested system had a total of 13 posts as shown below.

A performance comparison was conducted between 75-ft MGS (test no. MGSMIN-1) and 175-ft MGS. The dynamic deflection for the 175-ft (53.3-m) MGS was slightly higher than observed for the shortened system, but this difference could be due to variations in soil compaction between tests. The working width was nearly indistinguishable. In general, the 75-ft MGS in test no. MGSMIN-1 performed as desired and closely resembled the standard 175-ft MGS.

The second study regarding downstream anchoring of the MGS found that the MGS would successfully redirect 2270P vehicles impacting at 6 posts or more upstream of the end of the system for a MASH TL-3 impact on a 175-ft long MGS system.

Based on previous testing and the results of test no. MGSMIN-1, MASH TL-3 vehicles impacting between post nos. 3 and 8 of the 75-ft long system should be redirected. Vehicles impacting downstream of post no. 8 may be redirected, but the system would also be expected to gate based on the downstream anchor research.

Although the 75-ft (22.9-m) MGS performed successfully, several factors, including Lateral Extent of the Area of Concern and the Guardrail Runout Length, must be considered when determining the overall barrier length for shielding a roadside hazard. Only a few roadside hazards can be properly shielded by short guardrail installations. Thus, longer guardrail installations are still required for shielding many hazards.

In order to estimate the actual redirective lengths of the shortened system, it was assumed that the shorter 75' system would potentially continue to redirect errant vehicles impacting at 6 posts or more upstream of the end of the system similar to the 175-ft long system. This has not been proven through testing, but we believe that the performance should be similar. In addition, the beginning of the length of need is typically identified as post no. 3, or 12.5 ft from the upstream end for most terminals. Thus, redirection was assumed for MASH TL-3 vehicles impacting between post nos. 3 and 8 of the 75-ft long system for a length of 31.25 ft. This limits the use of the system to relatively narrow, discrete hazards where proper runout length and length of need can be achieved.

Similar analysis was done for 62.5-ft and 50-ft long systems, as noted in the reports. However, that worked is based only on simulation and has not been tested.

The scope of the research did not include evaluation of the performance of end terminals on a reduced-length guardrail system. Further study may be needed to evaluate reduced system length in conjunction with guardrail end terminals in redirective impacts as well as end-on terminal impacts. Guardrail end terminals may have weaker post sections and/or anchorage than what was utilized in test no. MGSMIN-1. Thus, shorter guardrail lengths may not have the same redirection envelope found in this study and the posts may not resist the rail forces in end-on impacts. Since guardrail end terminals are mostly proprietary, they were not evaluated in this study.

To the best of our knowledge, the shortest installation lengths for compression based terminal testing was conducted on 131.25-ft long system. We believe that this length could be shortened some based on our current knowledge of guardrail compression forces. We have used a reduction in longitudinal rail force of approximately 1-1.2 kips at each post in a guardrail due to the connection between the post and the rail. Current terminal designs tend to have impact head compressive forces that average about 15 kips. This would mean that a minimum of 12-13 posts would be needed to develop the compression load. Of course the end terminal takes out some posts during its compression. However, most of the velocity drop occurs in the first 25-31.25 feet of the compression. Thus, we can assume that if we allow for 31.25 ft of compression and 13 posts to develop the compressive load, an estimated minimum system length for the development of the end terminal compressive loads would be 112.5 ft (13*6.25+31.25).

Because we did not have additional funds or terminal testing and evaluation in the above research, we would recommend minimum system lengths of 112.5 ft in order to be conservative. This would extend the redirective length for the system using the assumptions above to 68.75 ft.

One last factor to consider with the use of terminals on these short systems is the deflection of the terminal when impacted on the end relative to the hazard. As noted above, we believe that the system will redirect the vehicle beginning at post no. 3 in the system. However, in an end on impact of the terminal, the vehicle may deflect down the rail between 37.5 ft – 50 ft. Thus, hazards near the back of the guardrail may still be impacted by end terminal impacts even when they are in the redirective area of the guardrail system. As such, you have to consider both the deflection of the terminal, the redirective region of the LON, and the runout length considerations when designing the placement of short guardrail system.

Let me know if that answers your questions.

Attachment: https://mwrsf-qa.unl.edu/attachments/d4fdd711c8ce309d56fe55a969312246.jpg

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# Guardrail Height

## Question

State: NE
Date: 01-26-2015

FHWA web site

http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/ctrmeasures/wbeam/

First Sentence:

Recent research on standard 27-inch strong steel-post W-beam guardrail shows that it does not meet NCHRP Report 350 Test Level 3 criteria.

Do you know what are they referring to?

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## Response

Date: 01-26-2015

There were a number of historical crash tests that demonstrated problems with many versions of 27" tall W-beam guardrail. In addition, some variations even had problems at a 27¾" height. This discussion has been ongoing for the last 8 or more years. Over the last 3 or 4 years, FHWA has been discussing and presenting options for raising guardrail height. I believe that they raised this issue at our Pooled Fund meeting, the joint meeting between the Pooled Fund and AASHTO TF13, and several AASHTO TF13 meetings. We had a NCHRP 22-14 crash test on the G41s that showed it marginally met AASHTO MASH at 27¾" height under Test Level 3.

FHWA prepared and released a lengthy memo on this topic many years ago. I can send a copy of this memo after locating if desired. Also, I can send a copy of a 2007 TRB paper that we prepared after doing the AASHTO MASH update study.

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# Missing Post in Double Faced Run of 8" Blockout MGS

## Question

State: NH
Date: 02-04-2015

Good afternoon.  I hope that all is well with you and yours.

Keith Cota suggested that I contact you as I have a question regarding the MGS system with an 8" offset block.  We have a project with a gas transmission line that we must avoid while installing median guardrail.  This is a double faced installation.  We need to omit one post if possible.  In the past I would have been inclined to say no problem and just do it but as I have seen the MASH tests with existing systems I am more wary of this simple approach.  I do not know how introducing a more flexible area in the midst of a run that is otherwise more semi-rigid could affect the behavior of the impacting vehicle.  I would hate to think of it somewhat acting like a slingshot, with the vehicle overturning.  And I am talking a MASH TL-3 scenario.  I am thinking of a 12'-6" span but could reduce that to 9'-4"?  Any thoughts that you would care to share with me?

Oh yes, I should state that the Department is not using high tension cable guardrail so that is not an alternative.

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## Response

Date: 02-04-2015

I have thought some of your situation and further discussed with my colleagues.

My simple response would be to treat the situation using the same philosophy that is used for roadside obstructions. We typically recommend that when 1 to 3 posts cannot be installed due to subsurface obstructions, use the MGS Long-Span System. For the 31" tall MGS LS, three timber CRT posts are installed on both the upstream and downstream sides of the longer unsupported length, for a total of six CRT posts. We also use 12" blockouts, which were part of the original design. As such, I would expect that the MGS median system with 12" blocks could also be modified to accommodate at least 1 missing post as long as three CRT are placed on each side of longer span.

Further and based on significant MGS R&D as well as knowledge of other median guardrail tests on proprietary systems, we sought eligibility of a median version of the MGS, which utilized 12" blocks. I have attached the link and a pdf copy of this letter.

**MwRSF Eligibility Request w/ 12" Blocks**

http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/listing.cfm?code=long

When using 12" blocks for a median variation of MGS, it should be manageable to replace six W6x9 posts with six CRT posts. You will have lost 2" of internal space that needs to be addressed. One thought would be to adjust blockout depth over the 12 to 18 ft on each side of span using 10", 11", and 12" special blocks with 3 CRT posts.

Now, if you do not have the MGS median system with 12" blocks but rather the 8" blocks shown in the TTI report below, I might also suggest the use of a stepping of blockouts over the 3 CRT posts. I understand that this solution requires a few special blockout sizes and varied bolt lengths. However, it provides a reasonable solution for these special circumstances. For me personally, I am more comfortable with the use of 12" blocks in combination with CRT posts in combination with increased span systems. Unfortunately, it may be more difficult to integrate 12" blocks when one started a median system with 8" blocks, unless one starts a blockout stepping process much farther away from span with omitted post.

TTI Report – Median MGS w/ 8" Blocks

http://tti.tamu.edu/publications/catalog/record/?id=39225

Please let me know if you have any further questions or comments.

Attachment: https://mwrsf-qa.unl.edu/attachments/319090c54ab5c34005881d5f10a24009.pdf

**Response**
Date: 02-05-2015

Your response is very, very much appreciated! Your guidance and that of your colleagues really helps.

I certainly agree that a few custom offset blocks should not be a big deal.

NHDOT is trying to avoid the use of wood posts as much as is practical for the reasons that follow. We have had posts appear sound above ground and practically had no post 6" below ground. Some posts have been found to not be treated as advertised and have been eaten by insects in the central section of the posts. Those conditions are not always readily discernible. I won't even speculate about how often they may be "field shortened" where the soil conditions make driving difficult. They are considered a solid waste requiring disposal at specific (expensive) sites. Which leads to my subsequent question.

Regarding the wood CRT posts, I know that the TRP-03-288-14 report (Universal Breakaway Steel Post for Other Applications) indicated great promise for the universal breakaway steel post. Has any further testing been done to "prove" the design. And if so, has a letter gone to FHWA?

I do not mean to take more of your and your colleagues' time but the long span solution using CRT wood posts prompts the question. If I wood is the answer, fine. But if the other post could be used, that would be great as well.

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**Response**
Date: 02-06-2015

You are doing very well in moving thoughts on to the Universal Breakaway Steel Post (sometimes noted as Universal Steel Breakaway Post). We already demonstrated its viability in the thrie beam bullnose system. Based on its prior success as well as the results from another MGS Long-Span study (system with CRTs showed potential promise during simulated impacts on span lengths greater than 25 ft), our Pooled Fund agreed to test and evaluate longer unsupported lengths under MASH with UBSP posts in lieu of CRTs. However, we are at the stage of programing construction/testing within our overall field project queue. This year, we will be testing UBSP posts in combination with a 31.25-ft long-span system.

Again and based on dynamic component testing, we believe that the UBSPs compare well to CRT posts and can likely serve as a surrogate in other designs (i.e., MGS Long Span, MGS Downstream Anchorages/Trailing Ends, etc.). However, we want to further demonstrate acceptable performance in actual crash testing, similar to what was done on the bullnose and currently planned for MGS Long-Span.

For your particular scenario and if all goes well, the UBSP post would not create any dimensional issues for median systems as the depth for the upper portion of the post is identical existing steel guardrail posts.

I have attached the FHWA Eligibility Letter for the thrie beam bullnose with UBSP posts as well as the AASHTO TF13 details for the roadside hardware guide. See below for additional information regarding other attachments.

Ron,

I went through the components list in SET03a-b (which is the system drawing for both the wood and UBSP versions) and tried to include all the new component drawings that would not have been in the printed version of the Hardware Guide. If you need the already existing ones that were in the printed version of the Hardware Guide we will have to have a student scan them into a PDF. Let me know.

Karla

Attachment: https://mwrsf-qa.unl.edu/attachments/b25db039d17db1e07b0009b9063557fe.zip

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# TXDOT TL-3 Transition Crash Test Report

## Question

State: LA
Date: 02-04-2015

I have been talking with Paul
Fossier over at Louisiana DTOD about their TL-3 transition design.

They would like to review the
crash test report on the TXDOT TL-3 transition with the curb.

Did you guys crash test the
TXDOT Design (see attached TXDOT Details).

This transition uses a curb.

If so, could I get a copy of the
crash test report?

Please let me know.

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## Response

Date: 02-04-2015

MwRSF did crash test this AGT back in the mid to late 90s under NCHRP 350 using both steel and wood posts. This testing was completed prior to the development of the asymmetric W-beam to thrie beam transition segment. In addition, this testing was conducted prior to the design and testing of the simplified stiffness transition to the AGT. Later, this AGT was successfully crash tested under AASHTO MASH. Further, two different stiffness transitions were designed and tested on the upstream end of this AGT, thus future variations should integrate both regions. I will acquire links to the reports and forward those to you.

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## Response

Date: 02-05-2015

Here are the links to the noted systems described below.

Original Crash Testing – NCHRP 350

http://mwrsf.unl.edu/reportresult.php?reportId=61&search-textbox=transition%20iowa

Follow-Up Crash Testing – NCHRP 22-14(1) Update to NCHRP 350 (AASHTO MASH)

http://mwrsf.unl.edu/reportresult.php?reportId=148&search-textbox=transition%20iowa

Original Stiffness Transition to AGTs with Three Steel Post Types (350)

http://mwrsf.unl.edu/reportresult.php?reportId=108&search-textbox=transition

Simplified Stiffness Transition to AGTs with Standardized Steel Posts (MASH)

http://mwrsf.unl.edu/reportresult.php?reportId=38&search-textbox=transition

Wood-Post Alternative Stiffness Transition to AGTs (Bogie Testing)

http://mwrsf.unl.edu/reportresult.php?reportId=32&search-textbox=transition

Recent AASHTO MASH Testing of Stiffness Transition to Crashworthy Transitions with Curb (Led to nested segment of W-beam upstream from asymmetric setion)

http://mwrsf.unl.edu/reportresult.php?reportId=295&search-textbox=transition%20iowa

I have attached a copy of a paper that corresponded to the last research study. One should note that the upstream stiffness transition should be integrated onto the upstream end of prior, short, relatively stiff, crashworthy AGTs. Let us know if you have any further questions.

Attachment: https://mwrsf-qa.unl.edu/attachments/a94cfa0760d895448696f06945ad6a35.pdf

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# Short Radii Other than Tested - Bolts on Posts in Radius

## Question

State: WI
Date: 02-06-2015

Previously, MwRSF performed research related to the use of short radius guardrail with larger radii. Previously tested short-radius systems did not use guardrail to post connection bolts. Can you comment on this?

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## Response

Date: 02-06-2015

I had a chance to discuss the bolts on posts topic with Bob and Dr. Faller and we seem to be in agreement here. All the tested systems did not utilize a post with a bolt in the radiused section for concern that the post would remain attached to the rail for too long and drag the rail down. There doesn't appear to be a pressing need to add a bolt to those posts on the radius if the radius increases. Thus, we concur with omitting post-to-rail bolts for posts within the curved rail section. Please note that there should be adequate upstream length of rail on the secondary side of the system (and primary side too, if not anchored to a stiff structure or rail) to develop the required tension in the rail. According to what I found from the Wisconsin larger-radius guardrail simulations, the first point on a guardrail system that can capture or redirect a truck impacting with TL-2 conditions was 6 posts downstream from an anchor, or the $8^{th}$ post from the upstream end of the rail. I recommend that this point be approximately aligned with the beginning of the length of need.

Dr. Faller indicated he is more inclined toward the use of a small shelf bracket on the CRTs in lieu of a screw on the front of the post. I believe the bracket is more helpful to support the post because (1) it is easier to mount the rail and (2) to reduce the propensity for stress concentration and possible rail tear initiation at the screw. Nonetheless, mounting hardware is up to your determination.

Let me know if you have any additional questions.

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# Guardrail end terminals with raised curbs

## Question

State: FL
Date: 02-09-2015

We have a question regarding the performance of end terminals in conjunction with raised curbs.

Currently, we understand that a typical run of guardrail set at 6" behind the face of curb is acceptable. However, this curb configuration causes several issues near an end terminal and conflicts with the Roadside Design Guide's recommendations for flat grading surrounding the end terminal. Unfortunately, dropping the curb at the end terminal location is not always feasible when drainage issues are considered, so we're actively looking for solutions where curbed sections are needed (a frequent scenario).

Do you know of any recent studies or criteria that address this topic of end terminals working in conjunction with raised curbs?

We really appreciate your help!

**Response**
Date: 02-09-2015

At this time, no research has been performed on curbs used in conjunction with guardrail end terminals. Nonetheless, previously performed studies related to the interaction between curbs and crash cushions or barriers may provide useful information about the influence that a change in the vehicle trajectory may have on the safety of roadside hardware.

Several years ago and in 1979, CALTRANS researchers investigated the safety performance of sand barrel crash cushions in conjunction with 6-in. high curbed gores. In this study, eight live-driver, crash tests were conducted with small car and large passenger vehicles. These crash tests were performed head-on into curbed gore areas at speeds of 40 and 60 mph. These tests indicated that the highest rise in vehicle trajectory occurred with the small vehicle traveling at 40 mph. This peak rise was 9.5 in. above the top of the gore at a distance of 14.5 ft beyond the nose of the curbed gore. The performance of a sand barrel crash cushion, placed 5 ft back from the nose of the curbed gore, was not appreciably affected. This result was observed when evaluated by a vehicular impact which was deemed to produce the greatest potential for vehicle vaulting (i.e., small car at 40 mph and head-on). For both parts of this study, the raised asphalt concrete gore surface was bounded by a 6-in. high, sloping-face concrete curb, forming a gore about 50 ft long and having a nose radius of 5 ft.

Research has also been conducted to investigate the performance of guardrails placed in front of curbs. Barrier offset away from the curb has been shown to effect system performance through computer modeling and crash testing. Previous work with steel-post, nested W-beam guardrail has shown that a 4-in. high sloped curb with the toe of the curb placed at the front face of the W-beam guardrail is capable of meeting NCHRP Report No. 350 safety requirements. Further research with standard wood-post, W-beam guardrail has shown that a 4-in. high sloped curb with its toe set out 1 in. from the front face of the guardrail is also capable of meeting TL-3 requirements.

Investigation of curb-barrier combinations was also investigated in NCHRP Report No. 537, Recommended Guidelines for Curbs and Curb-Barrier Combinations. This study developed guidelines for the use of curbs and curb-barrier combinations on roadways with operating speeds greater than 37.3 mph. The study recommended that guardrail be installed flush with the face of the sloped curb or offset more than 8.2 ft behind the curb for operating speeds in excess of 37.3 mph. In addition, the study recommended that guardrail should not be offset behind sloped curbs for speeds greater than 62.1 mph.

The recent development and testing of the Midwest Guardrail System (MGS) has demonstrated that this system can be used with a 6-in. (152-mm) tall, American Association of State Highway Transportation Officials (AASHTO) Type B curb positioned 6 in. forward from the front of the face of the guardrail element. Additional research was conducted with respect to TL-3 impacts on the MGS system with larger curb offsets. This research did not yield clear guidance on larger curb offsets for the MGS under TL-3 impact conditions. Thus, the current guidance regarding curb placement near the MGS on high-speed facilities remains the 6-in. offset noted above.

This limitation on curb placement is critical as installation of a tangent end terminal within 6 in. of a curb would likely result in the impact head hanging into the roadway. Thus, placement of tangent end terminals adjacent to curbs may require some flaring of the terminal (flares of 1 ft over 50 ft are relatively common in Texas and other states).

We currently have a project at MwRSF to begin the study of curbs and energy-absorbing terminals that was sponsored by the Wisconsin DOT. The objective of this research effort is to develop guidance for the safe placement of curbs adjacent to energy-absorbing guardrail end terminals. Initially, computer simulation will be used to identify potential safety hazards, define critical curb and terminal impact scenarios, and select optimal curb placement. The impact conditions for the simulation and crash testing programs will correspond with those published for Test Level 3 (TL-3) in the MASH impact safety standards.

Thus, there is currently very little hard guidance one can give regarding curbs and end terminals. In general, shorter, wedge shaped curbs will likely be more forgiving based on previous research with curbs and other barrier types.

Let me know if you need any further information.

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**Response**

Date: 02-09-2015

We greatly appreciate your response and input. I think that we should be able to work with the past practices you've mentioned with possible limitations added.

In the future, we recommend further considering topics of:

1. Soil heights being raised at the terminal assembly posts as a result of the curb height
2. Curb effects on vehicle vaulting and stability for end terminal nose impacts at a shallow angle (head-on, moving near-parallel to curb)

Again, thank you for the background and input! As always, we look forward to learning the results of your next study.

Thank you,

# W Beam Cable transition

## Question

State: IA
Date: 02-12-2015

We have a request from the district to narrow the w beam terminal section on a cable to w beam transition. The project falls within a lager water shed and they are trying to stay within the existing footprint. We have our standard BA-206 (4 foot offset) designated for this transition. They are asking if they can use the BA-205 (2 foot offset). They are mainly trying to minimize the grading foot print.
I looked at the two terminals we have for the BA-206 and they are the FLEAT-MGS and the SRT-31. According to the manual I found the Fleat can go down to a 2'6" offset and the SRT can go down to 3 foot offset. To me it looked like we could easily go down to 3 feet of offset but did not know how that would affect the interaction of the cable and w beam.
If they really wanted to go down we could use the Fleat only and go go down to 2'6" but again did not kown how that would affect the interaction between the two. Any input would be greatly appreciated.

http://www.iowadot.gov/design/SRP/IndividualStandards/eba206.pdf

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## Response

Date: 02-13-2015

You are correct that we have tested two versions of the cable to W-beam transition system. The first test was conducted using the standard low-tension cable system transitioning to G4(1S) guardrail. The original cable to W-bean transition was tested with both a BCT end terminal and a  the second test used a FLEAT end terminal. The cable heights for the original system used a 27" top cable height with 3" cable spacing. This cable height and spacing correlated well with the W-beam barrier height used in the design and allowed the top cable to be run along the top of the W-beam and the bottom two cables to be run along the bottom of the W-beam as they were transitioned from one system to another.

http://mwrsf.unl.edu/researchhub/files/Report164/TRP-03-80-98.pdf

In both tested systems, the terminals were offset 4' laterally from the cable barrier. For both systems the testing of the 2000P vehicle showed the potential for vehicle instability when the system was impacted such that the vehicle contacted the terminal end and the cable system simultaneously. Thus, there is concern that moving the terminal ends closer to the cable barrier may increase the vehicle instability further. In addition, the vehicle could deflect the cable system ahead of the terminal end allow the vehicle to get behind the end of the terminal at the shorter offset. This may further degrade the system performance. As such, we have allowed the end terminal systems to be extended to larger offsets in the past, but we have not allowed shorter offsets as we believe that they would potentially adversely affect the transition.

Let me know if you need anything else.

Thanks

# Short Radius Controlled Releasing Post on Concrete Box Culvert

## Question

State: NE
Date: 02-13-2015

MwRSF Report No. TRP-03-288-14

What are your thoughts on the short radius being placed over a box culvert;

When one post(at the 6'3" spacing) would land on the box culvert:

Could the UBSP steel post be used?

Could the wood post be attached to the top of the culvert?

Could the steel breakaway post be used?

Here it is.

https://maps.google.com/maps?q=Scribner,+NE&hl=en&ll=41.669472,-96.672665&spn=0.001685,0.002411&sll=39.609127,-106.370444&sspn=0.027806,0.038581&oq=scribner&t=h&hnear=Scribner,+Dodge+County,+Nebraska&z=19

Attachment: https://mwrsf-qa.unl.edu/attachments/e365c518ba66c86529ddc1a3f4faa700.png

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## Response

Date: 02-13-2015

I have briefly looked over the materials and will make a few comments below.

What are your thoughts on the short radius being placed over a box culvert;

** I have reservations about the placement of a SRG over culvert hazard. Per the draft sketch, an impacting vehicle would likely deform the system and travel far more than the 6 to 7 ft distance to the obstacle being shielded. The accepted Yuma County system and grandfathered/modified TTI system have secondary lengths longer than that shown as I recall. For Yuma County, the pickup truck appears to have traveled up to 20+ ft into system at TL-2 conditions. For SRG designs, CRT posts are around and/or behind the nose section. These posts are founded in soil. A concrete box culvert would likely obstruct post placement as you noted, thus potentially altering its safety performance from what was observed many years ago. In summary, hazard seems close and barrier cannot be installed in similar manner to that tested previously.

When one post (at the 6'3" spacing) would land on the box culvert:

Could the UBSP steel post be used?

**We have verified the use of UBSPs in bullnose applications in lieu of CRTs. We are getting ready to verify their use in long-span guardrail systems. We do not know how they will perform in SRG systems. As we continue to investigate their use in barrier systems, we may eventually try UBSPs in such designs. However, some post rotation and energy dissipation occurs when placed in soil. When mounted to culvert slab, the behavior may not match that of CRTs in soil. In summary, we cannot justify its use in an alternative manner without adequate R&D. I guess one needs to know how much soil is over culvert slab.

Could the wood post be attached to the top of the culvert?

**I do not currently see how this attachment would be accomplished and provide similar behavior to CRTs in soil.

Could the steel breakaway post be used?

**I discussed the UBSP above.

---

# Guardrail Length Adjacent to AGT

## Question

State: IA
Date: 02-18-2015

We have been trying to upgrade some of our W beam guardrail with the minimal impact to the foot print possible. For a very long time we place 56 feet of rail on the end of our bridges. Now as we go back to update them we are trying to update the systems to our current standard. Our newer system is much long and can require significant grading in environmentally sensitive areas near bridges. One of our designers asked if we could use the BA-201(25') with the BA-206 (37.5') for and overall length of 62.5'. I know it is desirable to have another 25' of tangent between the 2 pieces but wondered on a special situations if we could go to that minimum length

http://www.iowadot.gov/design/SRP/IndividualStandards/eba201.pdf

http://www.iowadot.gov/design/SRP/IndividualStandards/eba206.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/09bbf8ee2261bd591f622bfa061e8fa6.pdf

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## Response

Date: 02-19-2015

First, in the BA-201 drawing there should be 1 more 6-ft long post upstream of the w-to-thrie transition piece at a 37.5" spacing. This also moves the post locations away from splices for the MGS. Don't know if that post is considered a part of the standard MGS (so it's on another drawing set), but I figured I would mention it.

Your BA-601 plan shows the option for a curb under the transition. Recall, if a curb is present, then the guardrail placed immediately upstream of the w-to-thrie transition segment nested needs to be nested for 12.5 ft (refer to report TRP-03-291-14). You should note that in your drawing set.

Finally, there are recommendations for the necessary length of guardrail upstream of the transition within the conclusion sections of reports TRP-03-291-14 (page 137) and TRP-03-210-10. These reports are available on our website (mwrsf.unl.edu). Note, the recommendations are identical in reference to the W-to-thrie transition segment. Please refer to these recommendations as there are different criteria for (1) total length, (2) terminal length, and (3) length prior to a guardrail flare.

Let me know if you have further questions.

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# MoDOT Encapsulated Median Barrier

## Question

State: MO
Date: 02-26-2015

Here is a copy of our 32" Type B unreinforced median barrier curb (Standard Plan 617.10) rehabilitated by encapsulating in new reinforced concrete shell. The shell is shown not embedded but I think it is supposed. New and old concrete is 4,000 psi.

I talked to Scott about this a couple of days ago and he turned me onto using shear-fracture and flexural resistance calculation along failure lines; however, the possibilities are endless and how do you know the ‘right' strength.

For comparison with a crash-tested median barrier (which is why we asked you for the report), I was just going to show that flexural resistance about centroid is increased.

However, by observation one can see that the new barrier composite is stronger than original.

---

## Response

Date: 03-06-2015

Previously, Bob and I noted that the prior testing on the base system in the 1976/1977 SwRI Research Report. I believe that he or I  may have sent the reference and page range to you a week or so ago.

With regard to capacity, I definitely agree that the capacity of the composite system is much, much stronger than the original system. You are right that the number of ways to make comparisons may seem endless. The capacity of the new composite system could be estimated and compared a few different ways.

For shear capacity of the beam/wall section, one could look at punching shear at top of parapet where a triangular wedge section is potentially removed by punching backward. Maybe we assume a 6, 8, and 10 ft long segments that propagates down to midpoint, say 2/3 of height from top. Of course, coming up with an actual critical length may take some significant effort so making assumptions may be best for now. Two concrete surfaces have shear capacity, while the vertical steel pins at 24 in. centers have shear resistance on the front and back sides of parapet and over the number placed within an assumed length (6 ft, 8 ft, 10 ft, etc.). The base configuration has no vertical pins. One might simply estimate the punching shear capacity of the barrier/wall both before and after the retrofit. Some may debate as to whether it is appropriate to consider any longitudinal bars which pass through this assumed failure surfaces and which may resist punching shear. Regardless of an approach, the retrofit option is much stronger than the original configuration.

For flexural capacity, one could make a few different comparisons. First, one could simply make a comparison of the moment of inertias of the steel reinforcement layout in each case – one bar in middle of section versus six bars spaced off of vertical midpoint plus one bar on middle of section. Further, one could estimate overall flexural capacity of barrier/wall with one bar and for seven bars.

Without vertical reinforcement tied into a foundation, it is nearly impossible to attempt to determine the cantilevered capacity of the section at the base in both scenarios. In other words, there is no vertical steel effectively tieing either section to the ground. Thus, this term or capacity does not factor into a yield line analysis. There is a shear capacity for the barrier at the base, as provided by the original keyway. Finally, one could assume a contact or load length along the wall and also compare shear strength for three surfaces – two vertical and base at keyway. The base strength would be the same for both cases, but the vertical planes would be larger/stronger in the retrofit as compared to base condition.

In the end, there is may not be a perfect way to make such comparisons, as you noted below. One just has to select various assumed failure planes/mechanisms and make approximations to compare capacities as best as possible. Let us know if you want additional clarifications or desire for checks on calcs. Scott can further assist is desired.

---

# Bolt Specifications for Steel Strap TCB Tie-Down

## Question

State: KS
Date: 03-03-2015

We have a question submitted by one of our contractors regarding which bolts are acceptable for use in concrete safety barrier anchorage applications with tie down straps. Can you take a look at the attached information submitted to KDOT and the highlighted version of our Standard Drawing and let us know if you would have any concerns using ASTM A325 bolts in lieu of ASTM A449 bolts? I quickly reviewed the properties and they look virtually identical to me, but Scott King pointed out the different materials can sometimes be sensitive to temperature or may have different shear strengths so I wanted to check with you and get your thoughts.
Attachment: https://mwrsf-qa.unl.edu/attachments/e2cc67a762a5048f5bdd016abcf55b96.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/07a787587f17b853f12bec43f653e90d.pdf

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## Response

Date: 03-04-2015

ASTM A449 is virtually identical in chemistry and strength to ASTM A325 and SAE J429 grade 5. However, A449 is more flexible in the sense that it covers a larger diameter range and is not restricted by a specific configuration.

Thus, either spec can be used in this application.

---

# Maximum fiber stress in bending for beam guard posts

## Question

State: WI
Date: 03-05-2015

We have a requirement that our beam guard post have a maximum fiber stress $F_b$ of 1,200.    I believe that AASHTO has a similar requirement (AASHTO M168-6 is below).

*Guardrail*Posts-Guardrail posts shall be a stress grade of 8.2 MPa (1200 psi) or more,

conforming to the applicable standards contained in AASHTO-ARTBA-AGC,*A Standardized*

*Guide to Highway Barrier Hardware.*When a preservative is required, framing and boring shall

be completed prior to treatment in accordance with M 133.

What is the $F_b$ of white pine?

If the $F_b$ of white pine is lower than 1,200 do we need to be concerned about this even if there is a passing crash test?

---

## Response

Date: 03-05-2015

The fiber stress requirements noted exist to help ensure that timber posts used in guardrail systems possess sufficient capacity to deflect through strong soils and absorb energy during impact as intended. Posts with insufficient capacity pose the risk of fracturing prematurely and degrading the safety performance of the barrier system.

With respect to the MGS system, MwRSF conducted previous research with the white pine post (http://mwrsf.unl.edu/researchhub/files/Report41/TRP-03-241-11.pdf). In this research, it was noted that there were two approachesto implementing the white pine post, which has lower strength than the typical southern yellow pine post,. One approach was to revise the geometry of the post cross-section to provide similar capacity to the standard 6"x8" SYP post. The other approach was to full-scale crash test the standard post geometry with the white pine post to investigate its performance. The study chose to evaluate the white pine post with the standard geometry. The full-scale test of the white pine MGS system was successful according to MASH. Because the white pine post version of the standard LON system of the MGS was successful, there would be no reason not to use the system with white pine posts, even if the fiber strengths were lower than to specified values.

There would only be a couple of caveats.

1. Use of other reduced strength wood species than white pine with the MGS would likely need to be evaluated. MwRSF has done some previous research on alternative species which can be found here.
http://mwrsf.unl.edu/researchhub/files/Report220/TRP-03-154-04.pdf
http://mwrsf.unl.edu/researchhub/files/Report125/TRP-03-179-07.pdf
2. The use of white pine would be for the MGS system and not previous metric height G4(2W) systems.

3. The report above provides recommendations for the use of white pine posts for special applications of the MGS that should be followed due to these systems potentially being more sensitive to variation of the wood strengh..

# 54 Inch Concrete Barrier

## Question

State: WY
Date: 12-10-2014

We have a single slope barrier from Caltrans that is 56" tall.  But I don't believe that it has the vertical reinforcement required for pier protection.

In most cases, we have convinced our structures department and FHWA to hardened new structures for the large truck impact loads.  It is cheaper to do and less of a hazard to the driving public.

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## Response

Date: 12-10-2014

Does anyone
have any details for a 54 inch single slope barrier they would care to share
with me?

---

## Response

Date: 12-10-2014

It's not quite a single slope barrier, but here are details for the (almost) vertical shape with head ejection criteria that we've used.

Attachment: https://mwrsf-qa.unl.edu/attachments/b8f0046bda78516614b3c49b61bda646.pdf

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## Response

Date: 12-10-2014

I would like this information as well, as we are looking to create a 54" (TL-5) single slope bridge pier protection design for Ohio...

Florida has a 54" safety shape design.http://www.dot.state.fl.us/rddesign/DS/10/IDx/411.pdf

---

## Response

Date: 12-10-2014

I have attached a link to a previous question on this topic from the Q&A website (ID #360).  The drawings are of a 54" F-shaped concrete barrier with a footing for both interior and exterior sections.  It was designed specifically for pier protection appilications (hence the footer). This could easily be converted to a single sloped shaped as long as the reinforcement remained the same (bar size, number of bars, and stirrup spacing) and the top with remained the same. I will caution against using this design as a vertical-faced barrier as the base would be narrow and may not provide enough over-turning moment strength.

http://mwrsf-qa.unl.edu/view.php?id=360

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## Response

Date: 12-10-2014

Our median barrier meets the criteria, but we were looking for a roadside version. Our structures folks also plan to reinforce new structures to avoid the need for such a barrier, but we do still have bridges that don't have redundant piers, so those will require the protection.

---

## Response

Date: 12-10-2014

What is the intended purposed for the 54" barrier? Is it for pier protection or glare screen/barrier combination?

We are currently working on new standards for single slope barriers and bridge rails. We are using the Texas (10.8 - 11 degree) sloped barrier. The heights will be 36", 42" and either a 54" or a 56".

The purpose of the 54" or 56" height is for a permanent glare screen on top of a barrier, not pier protection. Our current f-shaped concrete median barrier is 56" and our bridge version is 54", so we are currently trying to reconcile the two.

Bottom line, we will have (54" or 56") single slope, bridge rail and median barrier designs to share soon, but they will not be designed for pier protection. We will likely be considering them all MASH TL-4 barriers.

---

## Response

Date: 12-10-2014

Thank you all for your valuable input. I may have a few questions as the day goes on, but want to answer Mike's question first. This barrier is intended for bridge pier protection. In general, our bridge designers are designing to the LRFD loading (600 Kips I think), but as Maria said, we have many existing structures which are not and some are in vulnerable locations. We have used 42 inch single slope barrier in the past with the

Texas slope design, but we are curious if we should switch to either the steeper Caltrans design (9% ??) or Iowa's more vertical face with head ejection criteria.  I am not aware of head ejection being an issue with the Texas Design, at least for a 42 inch high barrier, but am curious if the Caltrans design is more at risk for head contact. Maybe **Scott** could weigh in on this.  I am a little concerned about the Iowa design being more difficult to construct, and also if the second, flatter face may allow tankers to slide up over the barrier? Also, it may be harder to transition down to 31 or 32 inches to connect to a crash cushion or MGS barrier.  Maybe **Scott and Chris** could weigh in on these issues.

---

## Response

Date: 12-10-2014

I would agree that Iowa's vertical-faced barrier is probably more difficult to construct than a single-slope shape due to the multiple angles.  For this same reason, it may be slightly more difficult to transition down to a shorter height barrier.  Having said that, however, the contractor on our first installation was able to construct the barrier and the transitions in accordance with our plans, and the end result looks good.  I can't really comment on the barrier's ability to redirect a tanker truck, as it's my understanding that 90 inches is the minimum height needed to redirect such a vehicle.

---

## Response

Date: 12-10-2014

Head ejection with the Texas version of the single slope barrier is tough to estimate.  Some tests have the vehicle ride a bit up the slope and cause the vehicle to roll away from the barrier.  Other tests show the vehicle tires staying down and the vehicle rolling slightly toward the barrier.  The risk of head slap is definitely less with the Texas single slope than it would be for more vertical shapes.  The magnitude of this reduction…  I don't have a good answer for.

---

## Response

Date: 12-10-2014

Was vehicle stability good in all of the tests you saw as the vehicle comes off the barrier (Texas design)?

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## Response

Date: 12-10-2014

I don't recall any vehicle rollovers, only a couple of pickup tests that had >25 degree roll angles.  Textured single slope barriers have caused vehicle instabilities for the CA single slope.  I would assume the same results would occur for textured TX single slopes.

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## Response

Date: 03-05-2015

I am a little late on the response but we do not have the single slope barrier.  Below is what our bridge staff uses.

Attachment: https://mwrsf-qa.unl.edu/attachments/240da23d56e5b3c6c15bdea36494be54.png

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# Illinois Type TP-1 Railing

## Question

State: IL
Date: 03-16-2015

We worked together about a year ago regarding a bicycle railing attachment to an F-Shape parapet. I would appreciate your suggestions and direction on the attached Illinois Type TP-1 Railing.

We only allow this railing on Local projects (not State or Federal routes). Since it is mounted in conjunction with and on the back side of an 8" sidewalk with no barrier in front of it, it would be used for low speed applications (posted speed limit ? 45 mph) per AASHTO 13.4. We have it listed as a TL-2 barrier but I don't have records that can verify this. Are railings mounted on the back side of raised sidewalks with posted speed limits ?45 crash tested and evaluated for an AASHTO Test Level similar to railings in direct contact with traffic?

The height of the railing (42" above the sidewalk) satisfies the geometric height requirement of AASHTO Article 13.8 but the spacing of the railing elements does not satisfy the geometric opening requirements. We offer a concrete stub wall with a metal railing mounted on top that can be used for these applications but our County Engineers prefer to have an open steel railing. Do you see any possible recourse in salvaging this railing?

Thank you again for your suggestions and direction.

Attachment: https://mwrsf-qa.unl.edu/attachments/7d026e8ecc51622c49c74e3f363d4795.pdf

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## Response

Date: 03-17-2015

To answer your first question, sidewalk-mounted bridge railings have traditionally been crash tested and evaluated in a similar manner to those mounted directly to concrete bridge decks. In fact, I have seen crash tests on several bridge railings that offered both non-sidewalk and sidewalk mounting options, and testing was performed on each variations. Further, some of these systems were even tested at lower performance/test levels. To my best recollection, there have been tests on all-steel beam and post systems as well as combination parapets with upper beam and post systems. In summary, these crash tests have occurred on bridge rails mounted on sidewalks and curbs at multiple test levels as well as on a variety of bridge rail types. Of course, many more tests have been performed on non-sidewalk-mounted bridge rails than sidewalk-mounted bridge rails.

With regard to the second question, I assume that the geometric opening requirements for which you are referencing is tied to the size of sphere that shall not pass as a function of elevation along the height of barrier. If that is the case, then one could consider modifications to add rails, modify rails, etc. Historically, there have been other guidelines for rail offset from post, opening size for snag mitigation, and rail location, as I recall. Those guidelines led to development of many steel beam and post railing systems over last 20 to 30 years. As a first step, we could investigate whether this particular design is nearly identical to any other crashworthy designs under AASHTO PL-1 & PL-2, NCHRP Report No. 350 TL-2, TL-3, & TL-4, or AASHTO MASH TL-2, TL-3, & TL-4. From that review, it may be possible to estimate whether or not the TP-1 system would likely be crashworthy based on prior testing. Is that what you would like us to do? Please let me know if further investigation is desired. Thanks!

# Johnson County, BRF-001-5(106)--38-52, IA 1 over Ralston Creek bridge replacement

## Question

State: IA
Date: 03-16-2015

I received a question from our bridge office about how we should handle a city request for tubular rail to match another bridge on their route. Please see the image below and the attached KMZ fle. Is this something that should even be considered? The design they have does not look too bad to me other than a couple snag points. I could try to find a detailed design of the rail if that helps. Would it be possible to design something that would look similar and be crash worthy? The speed limit is 25 MPH.

Attachment: https://mwrsf-qa.unl.edu/attachments/1f9a9d8c5aaa85795d20083948085478.jpg

Attachment: https://mwrsf-qa.unl.edu/attachments/f440a82df7ecb14310c66c018a95cf4d.zip

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## Response

Date: 03-16-2015

The preferred option would be to consider a crashworthy system or at least mitigate against critical concerns, such as significant vehicle snag, launching/override, rollover, etc. In the end, it may be low enough of risk to have some leeway if posted speed or speed advisory sign denotes 25 mph or less. In the past we have been willing to give some on the urban roadside tree issue if posted speeds were 25 mph or less.

Thus, it might be feasible to post a speed advisory before bridge of 25 mph maximum. This discussion only pertains to inside separator rail.

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## Response

Date: 03-17-2015

I wondered if you were comfortable with also using the concrete end section shown in the photo below. It appears that the end section is only approximately 6' long which is much shorter than our standard IDOT concrete barrier tapered end section (which is 16' long - see attached). We are in the process of concepting a bridge replacement that has 4 adjacent entrances and using the tapered end section detail will result in having to relocate some of these entrances.

I appreciate your help!

---

## Response

Date: 03-18-2015

With regards to the end section, the response is largely the same. A crashworthy end section like the one shown in the attachment is preferred. However, if the speed is the area are kept below 25 mph, then concerns with vehicle vaulting or rapid deceleration upon impact with the end section shown would be reduced. That does not mean to say that the potential is eliminated, only that the use of the end section is more feasible if the speeds are limited.

# Retrofit, Low-Deflection, Temporary Concrete Barrier System

## Question
Date: 03-20-2015

I just looked at your recent research report Development of a Retrofit, Low-Deflection, Temporary Concrete Barrier System., It is very good on this important topic.

Couple questions,

One, Is the defection distance critical when the barrier is used to separate traffic during construction.

Two, Is it reasonable to use one of the concepts considered but not tested such as the composite with the thrie beam attached.

---

## Response
Date: 03-20-2015

. I have made comments below in red.

Thanks


Bob Bielenberg, MSME, EIT

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I just looked at your recent research report Development of a Retrofit, Low-Deflection, Temporary Concrete Barrier System., It is very good on this important topic.

Couple questions,

One, Is the defection distance critical when the barrier is used to separate traffic during construction.

The deflection distance is not as critical, but should be considered when separating traffic. Previous research at MwRSF investigated the TCB deflection limits for less critical TCB installations [http://mwrsf.unl.edu/researchhub/files/Report243/TRP-03-113-03%20(revised).pdf]. This research argued that when temporary concrete barriers are used on the edge of a bridge, the risk of the entire line of barriers falling off the deck requires that deflection limits be selected to preclude such behavior in almost all impact scenarios. Hence, it was recommended that at the edge of a bridge deck, design deflection limits should be selected to contain more than 95 percent of all crashes, basically the TL-3 impact conditions. In all other barrier applications, the consequences of a barrier exceeding the design deflection criteria are not severe. In these situations, a more modest deflection limit criterion based on an 85th percentile impact severity was deemed more appropriate.

In chapter 15 of report TRP-03-295-14, we did an analysis of deflections for the low-deflection TCB at the 85$^{th}$ percentile impact. Based on these results, the computer simulations indicated that dynamic deflections for the low-deflection TCB system would range between 18.2 in. (462 mm) and 23.6 in. (599 mm) at the 85th percentile impact condition. In order to be conservative, it is recommended that installations in non-critical locations use an estimated dynamic deflection value of 24 in. (610 mm) until further full-scale crash testing at reduced IS values or in-service evaluation of system damage for lower severity impacts indicate that lower deflection estimates are more appropriate. This deflection value would correspond to a working with of 46.5 in. (1181 mm). For critical installations adjacent to drop-off or bridge deck edges, the full-scale crash tested system deflection should be applied.

Two, Is it reasonable to use one of the concepts considered but not tested such as the composite with the thrie beam attached.

I would not recommend using one of the untested concepts at this time. It is feasible that one or more of the untested concepts may work, but without more analysis and testing we cannot be confident in their safety performance. In the case of the thrie beam stiffening you noted, that design has not been fully developed in terms of attachment details to the barrier sections and the amount of deflection reduction in undefined.

# Median bullnose guardrail weed prevention

## Question

State: WI
Date: 03-27-2015

Could you take a look at this.

We have had some people install rock inside a bullnose to minimize weed growth.

I have concerns about too large of rock could prevent post rotation or trip a vehicle.

Too small of rock could decelerate the vehicle too much and cause vehicle instability.

Attachment: https://mwrsf-qa.unl.edu/attachments/d60da6f33e94f3f1f9f457558748f874.pdf

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## Response

Date: 03-30-2015

We are not overly concerned about the vehicle tripping as the aggregate size is not overly large and the slopes in the area are relatively flat.

There is some concern about the mat and rock surrounding the posts affecting the rotation and energy dissipation of the posts in the system. To alleviate that issue, we would recommend that you use leave outs around the posts consistent with our previous recommendations for posts in rock.

http://mwrsf.unl.edu/researchhub/files/Report246/TRP-03-119-03.pdf

Thanks

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