Midwest States Pooled Fund Program Consulting Quarterly Summary

Midwest Roadside Safety Facility

10-01-2015 to 12-31-2015

Cable Barrier Heights

Question
State: WI
Date: 10-01-2015

We have a number of resurfacing project near previously installed cable barriers.

These project likely will change the cable height of the proprietary systems being used.

Does MwRSF know of acceptable variation in height for proprietary systems?

Does MwRSF know of acceptable modification to existing proprietary systems to get the cables at the appropriate height?

Has MwRSF had similar conversations with other states about this topic?

Thanks

Response
Date: 10-01-2015
Our current experience with development and testing of the non-proprietary, high-tension cable median barrier for the Midwest Pooled Fund has shown that cable median barriers can be sensitive to cable heights along with other factors. With respect to overlays, the greatest concern would lie with override of the cable barrier system. As the overlay increases the height of the roadway with respect to the barrier, the potential for the vehicle to impact higher relative to the cable locations increases and thus increases the potential for vehicle capture to be compromised and override the barrier. Additionally, the cable interaction and interlock height with respect to the vehicle will be affected even if the vehicle is captured which could promote increased vehicle instability.

We are not able to directly comment on specific proprietary cable barrier systems and what level of overlay they may be able to tolerate as these systems vary in cable height, cable position on the post, cable attachment to the post, and other factors. Additionally, testing of the Midwest cable median barrier system has largely been conducted to MASH according rather than NCHRP 350. But in a general sense, one would expect that the additional of a pavement overlay would degrade vehicle capture and increase the potential for barrier override and vehicle instability.

In terms of retrofitting the existing cable barrier systems, there is not simple answer. There may be potential means for adjusting the height of the cables in these systems without a complete re-install, but it is largely system dependent. A simple lifting of the post is not likely a good solution as this would raise all of the cable heights and may degrade vehicle capture and barrier performance for backside impacts or low angle hits that compress the vehicle suspension and cause the vehicle to engage the lower cables on the system. Similarly, retrofits that increased the height of the top cable to compensate for the overlay might help with override mitigation, but the increase in the cable spacing on the post could increase the potential for vehicle penetration.

At this time, MwRSF does not know of any acceptable height tolerances and/or potential retrofits for cable barrier systems to compensate for overlays. However, as noted above, there are concerns with the effects on barrier performance, and it seems be be a topic worthy of further consideration.

Expansion and contraction of the guardrail connection to a bridge parapet

Question

State: MN
Date: 09-24-2015

Two questions;

1. How concerned should we be with expansion and contraction of the guardrail connection to a bridge parapet. As you know from our recent questions, this has become a hot discussion issue, but I would think that each post connection must allow some movement with the bolt and slot design, otherwise we would be seeing problems on long runs.

2. If we do move the parapet/end post off the integral approach panel abutment, then how much of a gap can we allow before we have to start considering a cover plate. Attached is a consultant concept that illustrates the concept. Note that I told the consultant that they would not be able to use this concept without an acceptance letter from the FHWA.

Attachment: https://mwrsf-qa.unl.edu/attachments/98fa5fe4ed0dc09322d28201dc2d80d8.pdf

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Response

Date: 10-01-2015

I will try to respond to your questions noted below.

First, I will begin with question No. 2. We re-examined the issue of a critical gap size or length. When considering 25-degree approach angles for passenger vehicles, we believe that excessive gap length could lead to increased vehicle snag at open joints of rigid parapets. Historically, we have used a 2 in. limit for allowable wheel overlap on the upstream end of rigid buttresses when associated with acceptable snag under thrie beam attached to approach guardrail transitions. The affiliated gap length would be around 4.3 in. Thus, I might suggest holding the gap length to 4 in. maximum.

I recall that this issue was raised many years ago following our testing of an open concrete bridge railing for the State of Nebraska. I looked through our old Pooled Fund Consulting Q&A site and found the following inquiry and response. Years ago, we also recommended a maximum gap length of 4 in. and the use of chamfered corners/edges.

http://mwrsf-qa.unl.edu/view.php?id=386

With regard to question No. 1, we are somewhat concerned with large longitudinal movements in the steel guardrail near the bridge end. If bolts are located at the ends of rail slots, would it be possible for the rail to pull over posts in the same direction of weak-axis bending. Of more concern, we believe that excessive slot length at the buttress and end shoe location could allow for increased vehicle pocketing/snag on the buttress end as well as greater risk for vehicle instabilities during close impacts near the bridge but in AGT.

Please let me know if you have any further questions regarding the information noted above.

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Question

State: KS
Date: 09-29-2015

Bob – I called and left a voicemail earlier today in reference to the following and attached: KDOT has had several discussions on this topic with MwRSF previously and it recently occurred to me there may have been a miscommunication. Previously KDOT has asked whether there is an MGS installation for this type of short radius guardrail installation, which there is not. The MGS terminology is a little misleading. I think what we really wanted to know was; is there a 31" tall version of this type of short radius guardrail installation? I think NDOR has details for this, but I wasn't able to find them on their website. I did some searching on the Pooled Fund Site, but didn't find an answer to my specific questions. I know you and Cody Stolle did some investigating on this topic through a Wisconsin funded study in 2014 and found the short radius installation performed acceptably, or maybe even better in some regards, at a height of 31" compared with the 28" height.

As a result I wanted to revisit this topic again. I've attached several draft standard drawings. RD619 is the current short radius guardrail installation KDOT uses for a mounting height of 28". RD619A is a modified version of that drawing keeping the hardware through the curved section the same, but transitioning to MGS on either side of the curved portion. To avoid confusion I'm referring to RD619A as a modified short radius guardrail installation mounted at 31". This is not an MGS installation, but transitions to MGS hardware on either side of the curved section.

My goal is to develop something that will allow KDOT to avoid height transitions within an installation and minimize the different types of hardware we are using in our guardrail installations while still maintaining performance comparable to other TL-2 configurations for similar systems. Currently our practice is to use the old 4G1S AGT with the old 4G1S posts and hardware all mounted at 28" (shown on RD619) when a short radius installation cannot be avoided. As a result we have locations where 3 quadrants of the bridge is all MGS hardware and one quadrant that is 4G1S, which KDOT refers to as the Conventional Guardrail System (CGS). The other approach we've taken where we have space is to install the MGS and then transition to a lower height of 28" over 50 feet up to the curved section of the short radius installation. At that point the hardware switches back to the short radius hardware for the remainder of the installation unless there is room on the end terminal side (along the minor roadway) to transition the height and hardware back to MGS. For additional information I attached the updated post details and the MGS AGT details, which I reference on RD619A.

Just to cover what I found on the Pooled Fund Site during my search I included a short summary below:

1. Response to IA dated June 26, 2012 not recommending the short radius mounting height be raised to 31". A height transition over 50'-0" from 31" to 28" was suggested. The issue we've run into at KDOT is these systems are used only when an intersection is in close proximity to a bridge or a needed guardrail installation. In the case of the bridges there often is not enough room (less than 50'-0") to transition the height so you end up with one quadrant using the old hardware.
2. I found a similar response to NDOR dated January 2, 2012 regarding the 31" mounting height.
3. I also read through TRP-03-296-14 Extending TL-2 Short-Radius Guardrail to Larger Radii. That report seemed to suggest, if I understood it correctly, mounting the short radius at 31" was acceptable for the configurations shown in the report.

The details I've attached are yet another variation on the details shown in the report I referenced in number 3 above. I'd like to discuss this over the phone at your earliest convenience before any thorough review is completed. We coordinated the height transition option we currently use when there is space available with MwRSF previously. The new attached proposed drawings would be identical to that type of installation with the height transition omitted since it would not be needed with everything mounted at 31".

Attached is a detail I was able to track down that NDOR is using.
Attachment: https://mwrsf-qa.unl.edu/attachments/d613681324be40e5cea7cd9191e909b0.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/45a91280348fe5d285948504b9e5a219.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/339eae51de9991bb0bd500d732d34bcb.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/792b63264dac3443e1b558abdcdfd27d.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/370a3f204f2ccd08c7d3ae40e30c8951.pdf

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Response

Date: 09-30-2015

We currently are limited in what recommendations we can provide regarding short-radius type barrier systems. As you are aware, no short-radius system has met the crash testing criteria for MASH or NCHRP 350 at this time. TTI has recently done research on a MASH TL-3 thrie beam short-radius system, but to my knowledge that has not been approved by FHWA and we have some concerns regarding the test matrix and impact points used to evaluate that system. Thus, we are left with trying to make the best of the situation at hand.

The only short-radius system that has met FHWA eligibility is the 27" high TL-2 version of the Yuma county short-radius system that was analyzed by TTI. This is the system that has been implemented most recently by several states. Your system seems to vary from this design somewhat as it included additional cable anchorages near the nose section. I am not sure of the function of these additional anchorages, but you may want to reconsider them as they may not be consistent with any currently approved design.

Subsequent to that research at TTI, we conducted a simulation analysis for WisDOT regarding the performance of short-radius guardrail for larger radii under NCHRP Report 350. This study started with the Yuma county design and extended it to larger radii (over 25') This study found that the performance of 27" high short-radius guardrail was potentially limited in terms of capturing the 2000P vehicle and that 31" high larger radii short-radius systems had improved potential for pickup truck and high CG vehicle capture. The report also noted that the simulation analysis did not investigate small car interaction with the large radii short-radius systems at either 27" or 31" mounting heights. Passenger cars may underride the rail if a 31-in. mounting height is used despite a beneficial interaction with pickup truck vehicles. Previous thrie beam short-radius systems with 31-in. mounting heights culminated in small car underride and roof or windshield crush. No W-beam short-radius system has been tested and approved with a top mounting height higher than 27 in. Nonetheless, tangent guardrails as tall as 36 in. have redirected small cars at MASH TL-3 impact conditions. Based on these concerns, full-scale testing was highly recommended if a 31-in. (787-mm) tall system is to be used. Thus, while 31" rail height was shown to work acceptably in the study for a limited range of speeds and impact conditions, concerns were noted for small car capture that prevented us from fully endorsing a shift to 31". We did note that a 29" system may be a compromise between the two alternatives until further research is available.

As you noted in your email, we have made similar responses to Iowa and Nebraska regarding the height issue and have recommended limiting the height to the approved 27" for now even though we have some data that suggests that it may pose problems with high CG vehicle capture. This is due to concerns that the small vehicle capture may suffer. Thus we are currently limited to that guidance until further investigation or crash testing of the increased height short-radius systems are undertaken.

From your email, it appears that this is an issue because you are converting to the MGS system and the 27" height of the Yuma county system likely conflicts with some of the approach transition hardware for the MGS. Unfortunately, for the time being, we can only recommend the TTI/Yuma county system as it was granted eligibility at this time because we do not have sufficient information raise the height based on the concerns noted above. Thus, one may be forced to implement the current Yuma system and keep use older hardware.

Let me know if answers your question. I understand that this may not help much. The short-radius issue has been a big problem for several years and will continue to be until we can resolve it. We currently have and R&D effort with NDOR to evaluate a different treatment for intersecting roadways, but that work is still in the developmental phases.

Attachment: https://mwrsf-qa.unl.edu/attachments/b2308bea4ad6c813fde235052ea0dde1.pdf

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Response

Date: 09-30-2015

I will revisit our existing design and compare it to the TTI design you provided in the attachment. Is there anyone at MwRSF who might be able to do a quick review of the details once I have them put together just to get another set of eyes on them in case I missed anything?

Response

Date: 10-01-2015

Attached are the revised details. I removed all the details for the cable anchor assemblies, soil plates, etc. Since the TTI report noted any tested AGT/End Terminals meeting NCHRP 350 TL-2 or higher could be used outside the curved section I left the 4G1S AGT/End Terminals in the drawing. I attached the original drawing for comparison (RD619_Original). I also attached the other standard drawings I reference on the sheet for information. I did have a couple of questions:

1. I didn't see this in the TTI report, but I know there was some discussion of this in the work you and Cody did for Wisconsin. Can the STYP posts be used in lieu of the wood CRP posts?
2. I left the mounting height detail showing 28" rather than 27" since that is how tall KDOT's typical 4G1S w-beam is mounted. Is that acceptable?
3. Are the radii listed shown on KDOT's version of the drawing ok? I know from the TTI report it had a radius of 8'-0" (shown as 7.96' on KDOT's version to give a length of 12'-6" for the rail, which is evenly divisible by the post spacing). From the work you and Cody did it looks like radii of 23'-10.5", 47'-9", and 71'-7.5" is also ok. Are radii increments between these radii acceptable? Can those radii be adjusted slightly to give lengths of w-beam rail that are evenly divisible by the typical post spacing (i.e. 23'-10.5" would be ok shown as 25'-0")?

Thanks for your help on this.

Attachment: https://mwrsf-qa.unl.edu/attachments/240e25b1dad7a78be175f1f569a629a4.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/fa1c06ec75ed9f118885f4df7c96edc0.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/9c6836d43c5f02d44ac420444796724b.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/414a5f15d82b26d488930407414fe5b9.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/0cf111e0c0400832e80830d739b72e7b.pdf

Response

Date: 10-02-2015

I had another question that crossed my mind this morning after sending this info to you yesterday. Can the MGS guardrail and AGT be used instead of the 4G1S system outside the short radius installation if it is mounted at 27" or 28"?

Response

Date: 10-03-2015

I have commented to the questions below in red.

Comments are listed here with respect to the details you sent.

1. You details show a 2:1 slope starting 3' behind the short radius system. While I understand the reality of these slopes, no short-radius system has been successfully tested with these types of slopes and the approval of this system was based on level terrain testing. Based on previous testing and simulation done at MwRSF, we believe that the performance of the system will be degraded significantly with the presence of the steep slope behind the system in terms of vehicle capture and stability.

2. I saw no other significant deviations from the TL-2 approved Yuma County system.

I had another question that crossed my mind this morning after sending this info to you yesterday. Can the MGS guardrail and AGT be used instead of the 4G1S system outside the short radius installation if it is mounted at 27" or 28"?

I don't see any reason why the MGS cannot be used mounted at the lower height for this application. The midspan splices should improve the performance and the deeper blockouts should aid in vehicle capture as well. Obviously the benefits of the reduced post embedment would not be included as the height would not increase. Cody's work for WisDOT indicated that the blockouts may improve vehicle capture for the higher CG vehicles. The effect of the blockouts on small car capture is unknown, but TTI noted in the Yuma TL-2 system report that blockouts could be used even in the curved section. However they did not make a recommendation towards the larger blockout in the MGS.

With respect to the AGT, I think you would need to stay with the NCHRP TL-3 approved transitions noted in the TTI report. The MASH tested MGS transition essentially uses NCHRP 350 approved transitions on the downstream end adjacent to the bridge, so that part of the transition would not be different. The upstream end of the transition was designed to convert between the stiffness between the standard MGS and the AGT. It also used a asymmetric W-thrie transition piece. The upstream end of that transition has not been evaluated at the lower height, and if you recall, we experienced a rail rupture of that transition near the asymmetric W-thrie transition piece when we tested it with a curb and a 1100C vehicle, which forced us to nest the w-beam ahead of the asymmetric W-thrie transition piece when the AGT was used with a curb. Thus, a lower system may be sensitive to near the asymmetric W-thrie transition piece. Additionally, the asymmetric W-thrie transition piece would not allow for the correct thrie beam height for the AGT connection at the bridge.

Attached are the revised details. I removed all the details for the cable anchor assemblies, soil plates, etc. Since the TTI report noted any tested AGT/End Terminals meeting NCHRP 350 TL-2 or higher could be used outside the curved section I left the 4G1S AGT/End Terminals in the drawing. I attached the original drawing for comparison (RD619_Original). I also attached the other standard drawings I reference on the sheet for information. I did have a couple of questions:

1. I didn't see this in the TTI report, but I know there was some discussion of this in the work you and Cody did for Wisconsin. Can the STYP posts be used in lieu of the wood CRP posts?

    I am assuming that you are referring to replacement of the timber CRT posts used in the approved system with Steel Yielding Posts (SYP) developed by TTI. We did not comment on this in the WisDOT study, but we do not recommend replacement of the timber CRT posts with any of the steel breakaway posts at this time. The SYP post is a yielding post that bends at a lower load that the standard W6x8.5 section rather than breaking away at the base like a CRT. This behavior may create a ramp for the vehicle to climb in the nose section which could increase the propensity for override of the rail and vehicle instability. The UBSP post that was developed through the Midwest Pooled Fund is likely a better option as it was used successfully in the bullnose and tends to break way at the base. Component testing of that post compared well with CRT's. However, we have not recommended the use of that section in any system without full-scale testing as it may be sensitive to applications outside of the bullnose. In the case of the Yuma county short-radius system, it is unlikely that it will ever be subjected to a full-scale crash test to evaluate that potential application.

2. I left the mounting height detail showing 28" rather than 27" since that is how tall KDOT's typical 4G1S w-beam is mounted. Is that acceptable?

    I will leave the mounting height decision up to you and KDOT, because the guidance in this area is mixed. TTI received approval on the Yuma county system based on the 27" height. Thus, from the standpoint of FHWA eligibility, the 27" height has been recommended by both TTI and FHWA. As I noted in the previous email, the simulation effort we did for WisDOT showed found mixed results for the varying rail heights. Cody's simulations of a 5,000 lb pickup truck on the 27" high Yuma county system with an 8' radius that were conducted to validate the modeling effort found that the pickup was captured. However, a simulation of the a 4,409 lb pickup truck under the same impact conditions overrode the rail. Additionally, as we simulated larger radii at the 27" height, the 2000P vehicle vaulted over the guardrail in 100, 100, and 80 percent of impact conditions simulated for 24, 48, and 72 ft radii, respectively. Blockouts were added to the CRT posts, and the vaulting override rates were reduced to 80, 36, and 50 percent of simulated impact conditions for 24, 48, and 72 ft radii, respectively. Thus, while the 27" height was listed in the TTI report, our study found that it potentially may have capture issues with the higher CG vehicles. We also simulated 29" and 30" rail heights and found much better capture of the 2000P vehicle. However, increasing the rail height leads to concerns for small car underride which were not investigated in the WisDOT study. Thus, we noted that a 29" rail height might be a compromise, but further study was needed to ensure that small car underride was not an issue.

For you, the decision will be what level of variation from the TTI approved system you can tolerate. The work Cody did seems to suggest that increased rail heights are better for higher CG vehicles, but the concerns for small cars exist. That said, the TTI study was a paper study that did not test the Yuma system under the TL-2 impact conditions. So neither of the current guidance is founded in a solid crash test. I would think that the 28" height you propose is a minimal variation from the TTI system and may improve the high CG vehicle performance based on what we currently know.

3. Are the radii listed shown on KDOT's version of the drawing ok? I know from the TTI report it had a radius of 8'-0" (shown as 7.96' on KDOT's version to give a length of 12'-6" for the rail, which is evenly divisible by the post spacing). From the work you and Cody did it looks like radii of 23'-10.5", 47'-9", and 71'-7.5" is also ok. Are radii increments between these radii acceptable? Can those radii be adjusted slightly to give lengths of w-beam rail that are evenly divisible by the typical post spacing (i.e. 23'-10.5" would be ok shown as 25'-0")?

In the TTI report on the Yuma county short-radius, they do not note changing of the radius of the system as one of the acceptable system modifications. This is likely because alteration of the radius may affect capture of the vehicle and energy dissipation. As noted above, Cody's study indicated that larger radii may be an issue as well (however, some of that may have been tied to the height of the rail). Previous recommendations by FHWA have allowed short radius with radii up to 35'. However, that has not been formally verified through a crash test. Thus, it is difficult to recommend larger radii for the Yuma County system. TTI and our research don't seem to suggest that it should be done, but the previous FHWA memo allowed it, so I am sure many states still have the larger radii in their standard. The best option may be to stick with the 8' radius and extend the tangent sides of the system. If you chose to allow the larger radii, the intermediate values should be acceptable.

Guardrail Connector Plate

Question

State: MN
Date: 09-16-2015

MnDOT, is in the final phases of developing a new AGT standard. It's the thrie-beam version with the first three larger posts (sized at 84" – W6 X 15) before the concrete end parapet connection. See the attached proposed standard plan (694_AGT_type31_SingleSlope.pdf).
Most newer bridge designs will have an integral abutment with the approach panel. The expansion/contraction joint will be as the end of the approach panel and the parapet.
A concern has been brought to our attention concerning the thrie-beam anchorage plate (see attached standard 8350A). The concern is that the 1 1/8" slotted holes will not allow enough room for expansion/contraction and that the guardrail will be push back and forth, which would move the posts out of vertical. While we do not know if this is a valid concern, we do have an existing standard for a w-beam rail anchorage plate with 3" slots (see attached standard 8318C).
Our question; would a modification of our 8350A standard, to include a 3" (or less) slot, be acceptable for our proposed 694_AGT_type31_SingleSlope.pdf design?
I look forward to your response. Please feel free to give me a call if you have any questions or need additional information.

Attachment: https://mwrsf-qa.unl.edu/attachments/00f9e32d43bc9b3555499917fc3885e5.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/575de1d94ad6db47b4300e40ddf86c7c.pdf

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Response

Date: 09-17-2015

I have accumulated some feedback from my colleagues. Here are a few thoughts.

Karla Summary:

In the hardware guide, RWE02a-b is the W-beam Terminal Connector. When comparing the RWE02a-b slots to the slots in MNDOT's standard 8318C, they are similar. The hole diameter in the MNDOT drawing is a little smaller. Slot dimensions for RWE02a-b is 31/32" x 3", while slot dimension for MN 8318C is 29/32" x 3".

RTE01b is the Thrie-Beam Terminal Connector. When comparing the RTE01b slots to the slots in MNDOT's standard 8350A, they are different. The RTE01b shows the slots at a 50-degree angle, and they are 31/32" x 1¾". However, it is noted that the slots could be oriented parallel to the longitudinal axes rather than at the 50-degrees. MNDOT's standard has a smaller diameter and a shorter length, 13/16" x 1â...›".

Therefore, I would say MNDOT could at least increase the slot size to what the hardware guide shows without any concerns. I know that this doesn't get to 3".

Scott Summary:

First thoughts – a 3" slot is large. During impacts, it may take quite a while for the rail to shift enough, develop tensile loads, and create the membrane action typically associated with guardrail redirections. This shift could lead to pocketing/snag issues. On the other side of the argument, transitions rely more on lateral force loads provided by posts and rail bending. So maybe enlarged slots don't cause any issues. Without tests, I'm unsure what effect this has on performance.

An idea to strengthen their transition with 3" slots may include shortening the unsupported length of the thrie beam between the concrete parapet and Post 1 (shift the guardrail system DS). Reduce this length from 29" to say 15"-18". I would feel better about reduced snag concerns on the concrete end with a reduced distance.

I would be more comfortable if the expansion/contraction joint had concrete on both sides of it – which I believe is more common amongst our Pooled Fund States. Ideally, the 7-ft long standardized buttress would be on the upstream side of the joint. However, they may be trying to shorten the length of the transition system and thus, have spanned the thrie beam across the joint. Not sure they want to add an additional 7 ft.

Last thought, I hope that any potential enlarged slots would be punched into the end shoe during fabrication, not cut by hand just prior to installation. Are they working with a manufacturer to produce the part?

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Based on the above feedback, there are some concerns with extending slots more than used in historical crash-tested systems. Increased slot length could lead to increased lateral deflection in advance of the rigid end. With a longer slot at the end shoe splice location, the rail tension will not develop as quickly. I concur with Scott on this issue. Instead, the rail may more easily move back even though resisted by posts and rail bending capacity due to overlap on parapet. At this time, we unfortunately do not know how much longitudinal shift is acceptable before rail tension is developed. I am aware from prior BARRIER VII modeling efforts that rail tension can be greater than some expect and near the buttress end, say up to 80 to 90 kips during high-energy impact events. Excess rail deflections can lead to pocketing and/or wheel snag as well as increased propensity for vehicle instabilities.

Unfortunately, I cannot easily determine the exact slot lengths, and bolt positions within those slots, that were used in prior crash test efforts of AGTs. What we can say is that standard thrie beam end shoes were used with the commercially-available, industry-accepted slot patterns and sizes, including some variations denoted in hardware guide.

Finally, if I had a choice, I would rather locate the expansion gap between the concrete rail end and the buttress end. However, it may be possible that the 3-in. slot length will not cause any problems in a crash testing program. Unfortunately, I am less certain regarding the system's safety performance with a change under MASH.

Please let me know if you want to further discuss this issue! Also, I need to look at a few other dimensions in the near future. Thanks!

Response
Date: 09-23-2015

We appreciate your (Karla and Scott, also) information and insight.

We are looking into using the TF-13 design RTE01b, and have a few questions.

Was the RTE01b version used in your research outlined in the Transition Report TRP-03-180-06? We have this as one of our standard options, but could not tell from the report.

I have seen both versions on other state standards, one similar to ours and the RTE01b.

Also, I am interested in the number of attachment holes for attachment to the barriers on the end. Ours has five 1" diameter holes and RTE01b has 9 (two ¾" and seven 1").

Why is there a difference. When would we ever need more than the five 1" holes?

You help is appreciated.

Response

Date: 10-01-2015

Hello Mike!

I will respond to your questions below. I have also provided a photograph from the noted reported to inform you of what bolt hole pattern was used in this test series. The end show have 5 bolt holes versus nine.

Photo from test 2, page 71, figure 46 of TRP-03-180-06.

Ronald K. Faller, Ph.D., P.E.

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From: Elle, Michael (DOT) [mailto:michael.elle@state.mn.us]
Sent: Wednesday, September 23, 2015 11:39 AM
To:

rfaller1@unl.edu
Cc: Brown, Timothy (DOT) <timothy.j.brown@state.mn.us>
Subject: RE: Guardrail Connector Plate

Rom,

We appreciate your (Karla and Scott, also) information and insight.

We are looking into using the TF-13 design RTE01b, and have a few questions.

Was the RTE01b version used in your research outlined in the Transition Report TRP-03-180-06? We have this as one of our standard options, but could not tell from the report.

**As shown above, the as-tested end shoe part used 5 mounting holes. It does appear as though the CAD details in figure 45, page 70, shows extra holes in the end shoe.

I have seen both versions on other state standards, one similar to ours and the RTE01b.

**The previously-provided TTI report revealed static testing on multiple versions of end shoes.

Also, I am interested in the number of attachment holes for attachment to the barriers on the end. Ours has five 1" diameter holes and RTE01b has 9 (two ¾" and seven 1").

Why is there a difference. When would we ever need more than the five 1" holes?

**Thrie beam end shoes are anchored with 5 bolts – three in column 1 and two in column 2 located 8 in. away from vertical centerline of column 1. Unfortunately, I do not know the history as to why some end shoes have 9 holes. I would suspect that a greater number of holes spaced close to one another could potentially lead to part fracture at slightly lower loads. At any rate, we use only 5 anchor bolts for these parts.

Let me know if you have any further questions regarding this information.

Concrete Median Barrier re-bar questions

Question

State: MN
Date: 10-09-2015

this has become an urgent constructability question that I need some answers for before a meeting on Monday morning.

Two Questions:

1. Two our three primary concrete contractors are claiming that their slip forming operations would go much better if the rebar clearance from the face of the barrier was more than two inches. I have seen other states with 2" or 2.5" minimum listed, but never a maximum. What should the maximum clearance be? Could we state 2" min and perhaps 3" or 4" maximum.

2. The current design allows for two vertical 8" bars on the base (every two feet) if the footing is poured separately. Could these be placed closer to the center to help in slip form operations? Better yet could they be placed one every foot, on center or perhaps 4" just off center alternating from side to side every foot?

Our draft standard single slope plan is attached. It is very similar to the Wisconsin, Washington, California and Texas designs (as well as our current f-shape footing design).

Differences of opinion are ok. We, as a state agency, will make the final determination (which sometimes can be polical decision as you know), but I just want to make sure we have your input before the decisons are made.

Thanks for prompt attention to this issue.

Attachment: https://mwrsf-qa.unl.edu/attachments/63455256baa778705f2bb3acb804b217.pdf

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Response

Date: 10-10-2015

I will provide my general comments below under the individual questions and realizing that Roger has already done a great job in addressing each item.

Ron

From: Elle, Michael (DOT) [mailto:michael.elle@state.mn.us]
Sent: Friday, October 09, 2015 10:13 AM
To: Bligh, Roger <RBligh@tamu.edu>; Ronald K. Faller <rfaller1@unl.edu>
Subject: Concrete Median Barrier re-bar questions

Roger and Ron,

I am sending this to both of you, as this has become an urgent constructability question that I need some answers for before a meeting on Monday morning.

Two Questions:

1. Two our three primary concrete contractors are claiming that their slip forming operations would go much better if the rebar clearance from the face of the barrier was more than two inches. I have seen other states with 2" or 2.5" minimum listed, but never a maximum. What should the maximum clearance be? Could we state 2" min and perhaps 3" or 4" maximum.

**Per my recollection, we have not experienced significant discussions on clear cover, except when developing the TL-5 barrier depicted in the attached report. This barrier was planned for implementation under slip-forming operations. For it and based on contractor feedback, we settled on a general clear cover of 2.5 in. I have not considered or recall seeing a maximum clear in standard plans. However, if both maximum and minimum clear covers are desired, the barrier capacity should be based on a maximum clear cover during testing or with design calculations. I am not overly found of clear covers of 4''. I would be more supportive of a 3" maximum clear cover as long as adequate structural capacity is provided.

2. The current design allows for two vertical 8" bars on the base (every two feet) if the footing is poured separately. Could these be placed closer to the center to help in slip form operations? Better yet could they be placed one every foot, on center or perhaps 4" just off center alternating from side to side every foot?

**Without some additional analysis, it is somewhat difficult for me to make further guidance pertaining to number of shear bars, resistance to overturning, placement, etc. Shear bars provide some overturning resistance, but the short length reduces effectiveness. Asphalt keyways on front and back can provide similar resistance to shear. I personally like to see vertical stirrups in barriers. Although the current plans show a particular dowel size, length, and spacing, it is unclear as to the background of these selections. I could further investigate next week if needed. I seem to recall that this configuration may have evolved from the results obtained in the SwRI 1976 barrier study.

I am sorry for the short response and can provide more thoughts next week if needed.

From: Bligh, Roger [mailto:R-Bligh@tti.tamu.edu]
Sent: Friday, October 09, 2015 12:33 PM
To: Elle, Michael (DOT) <michael.elle@state.mn.us>; Ronald K. Faller <rfaller1@unl.edu>
Subject: RE: Concrete Median Barrier re-bar questions

Hi Mike,

A few comments for your consideration in regard to your questions.

1). We noted on your current drawings that your clear cover is currently specified to be 2" +/- ½". Increasing the clear cover will slightly reduce the moment capacity of the barrier because it reduces the “d" distance to your tension steel. However, you may get some contribution from your compression steel that could counter some of this loss. You also have a relatively wide barrier section that helps provide capacity. For example, the 36 inch barrier is probably wider and stronger than it needs to be for TL-4 impacts. With all this in mind, we would be comfortable with a 3 inch clear cover. One note -- with increased clear cover (e.g., 3 inches) on the side and top of the barrier, there is an increased chance of having chunks of concrete lost at the top corners of the barrier during severe impacts.

2). Having a continuous slip-formed barrier helps tremendously in developing required barrier capacity due to the inertial resistance offered by the large barrier mass. There is also a good deal of adhesion strength that exists between the two pours (footing and barrier) that is not accounted for in the design process. This being the case, either of your alternate anchorage options are likely o.k. However, it should be noted that the short 4" embedment will not come close to developing the strength of the #8 bars dowel bars. A better detail would be to use an “L" shaped bar with the leg of the “L" bar in the footer and with a taller vertical projection into the barrier. The size of the anchor bars can be reduced to something like a #6 bar and they could be placed along the center of the barrier at a wider spacing. I suspect that your contractors my simply “stab" the #8 dowel bars into the concrete footer after it has been placed. The “L" bars could still possibly be stabbed into the footer and perhaps tied together (if needed) using a #3 bar along the vertical leg. I noted that TxDOT is using #6 “L" bars on 8-ft centers when a single slope barrier is cast onto a concrete deck or pavement. They use a few bars at 2-ft spacing near the ends of the barrier run. I have attached a detail sheet for your reference.

Please note that these are general comments. Analyses can be performed to be more precise with recommendations, but this would require more time to complete. Please let me know if you have any additional questions or if we can be of any additional service.

Have a great weekend.

Best regards,

Roger

Approach Transition Posts Obstructed by Inlet

Question

State: NE
Date: 10-15-2015

What options to move posts do we have in this location?

Phil,

On the #1095Y Peru Spur project we have a conflict with a flume inlet and the new guard rail installation. I'm attaching a plan with an approx. area where the flume inlet is going to go in relation to guard rail post installation. I spoke with Curt M. & Tyler Chicoine regarding this issue yesterday. I wanted to run this issue by you to see what resolution would be availabble to make this work and still be compliant with the guard rail installation?

Attachment: https://mwrsf-qa.unl.edu/attachments/7cc876fbc27932d617bdb181733a7537.pdf

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Response

Date: 10-19-2015

We looked over the detail you sent. There are not a lot of good options with this setup, but we can give our best modification with the caveat that this has not been tested and represents only what we believe you can do to best fit the situation you have. If this installation has not been put in, the best option would be to shift the inlet to the region with 6'-3" post spacing where the inlet can be installed without concerns for the barrier performance.

The concern with the inlet as shown is that the obstruction of the two posts will change the AGT stiffness transition considerably and would likely lead to pocketing and poor safety performance. The best alternative installation we can consider is to offset the two obstructed posts longitudinally such that both posts are at least 6" from the sides of the inlet. This should allow for placement of the posts within 1' or so of their intended position. This will likely have the least drastic effect on barrier performance of any alternative we could devise. Relocation of these posts will require field fabrication and spray galvanizing of new holes. We would recommend that we make sure that the new holes land outside of the rail splice overlap.

We would also recommend adding an additional post on the upstream end of the transition. During the design of the AGT, we developed two designs for the transition. The design you have shown is the design we tested, Design K, which was more aggressive. We also had a Design L for the transition that had one additional post at ½ post spacing on the upstream end of the transition. This improved performance of the transition in our simulation models, but we chose the more aggressive version for testing. Because we are modifying the post spacing in this transition, we would recommend adding that additional post back into the system to make the design slightly more conservative. Additionally, the added post may stiffen the upstream end of the transition somewhat and help mitigate the effects of the increased post spacing near the inlet.

So, the options are as follows.

1. The best option would be to move the inlet to a less critical location.

2. A second option would be the modified post spacing and the addition of an additional upstream post as noted above. Again, this is not a tested or evaluated modification, but it represents our best current alternative for an inlet in that location. There are some concerns that the offsetting of the posts longitudinally may affect the stiffness of that region of the transition which may degrade system performance. However, the degree of the effect and the overall performance of the system with the modification is not something we can gauge without further study.

Thanks

Attachment: https://mwrsf-qa.unl.edu/attachments/aa43a52a1de4ea9c1b2117c1f31a3df2.jpg

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Response

Date: 10-20-2015

The inlet is built, the contractor is building the guardrail.

If we extend the thrie beam or nested thrie beam past the inlet … What post spacing would be needed to allow this inlet to stay in place?

Would using w8x15 posts thru this area help or spacing/ gap at the inlet?

Response

Date: 10-21-2015

If the inlet is in place, then the best option is the one noted below. This was to offset the two obstructed post so that they land just to each side of the inlet and add the additional post upstream from the Design L option.

Using W6x15 posts or extending the nested rail would likely stiffen the downstream end of the transition and increase the effect of the offset posts. Thus, it would not be preferred over the option below.

Thanks

Short Radius Questions

Question
State: WI
Date: 10-19-2015

Here are some questions I have about the short radius.

When we indicate that there is a radius in our plans, how accurate should be the radius (nearest ft, 2 ft 5 ft quarter of an inch)?

As I look at the FHWA drawings, it appears that there are two cables shown. One being 9' long and no information about the other cable.

1. Am I looking at this wrong?
2. Is the other cable just a standard BCT cable (see attached)? I have done some searching around and have not had much luck in finding that cable labeled.

Attachment: https://mwrsf-qa.unl.edu/attachments/9eb8ea2a2bf3ea353a7eeab3649acb66.pdf

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Response
Date: 10-19-2015

(1) Radii accuracy are dependent on construction tolerance etc. There is some leeway for radii between 8 and 16 ft, but whatever leeway you give you will end up stretching the rail a bit if the radius isn't close because you won't get the rail to exactly 90 degree turn. I think your tolerance is more on your rail curvature, so the total radius tolerance might be nearest foot, maybe less.

(2) The second cable he described is a normal BCT cable.

Concrete Pier Protection AGT attachment

Question
State: NE
Date: 10-22-2015

This installation problem has control bolts that will miss the bottom of a concrete rail along our piers.

Proposed solution; Can the control bolts be eliminated if we run the thrie-beam continuously along the face of the concrete rail 40' to 45'?
I would connect the trie-beam to the bridge approach section on each end of the concrete rail.
Reason this would give us tension in the rail, and only be connected to the wall at the 6'-3" post spacing's(one button head bolt … or not).
This would allow for easy resetting of guardrail when it will be overlaid 20 years from now.

What else is possible other than rebuilding the concrete?

Attachment: https://mwrsf-qa.unl.edu/attachments/07b072a589fceb3c9002878a0419a2b0.jpg

Attachment: https://mwrsf-qa.unl.edu/attachments/9d8d98fd45a95fec776d42e86a5be690.jpg

Attachment: https://mwrsf-qa.unl.edu/attachments/ea07e20c8327025058efe994d8978b03.pdf

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Response
Date: 10-22-2015

If the five anchorage/control bolts are eliminated, then there may be excessive slack available from the downstream guardrail, splices and soil anchorage system that may possibly increase pocketing/snag on the upstream side of the buttress. It may not be an issue, but I am uncertain at this time. Is it possible to construct a taller parapet in the future that allows for two sets of threaded inserts for bolt placement?

Response
Date: 10-23-2015

taller parapet?

It is already tooo tall.

Shouldn't the tension from the upstream & downstream anchors & the bridge approach section posts - keep the vehicle from pocketing/ snagging?

Response

Date: 10-24-2015

Approach guardrail transitions are rigidly anchored to the buttress end. There is only one guardrail joint at this location between the thrie beam end shoe and the nested thrie beam rails. The only joint slip downstream of this location occurs at the one splice location on the face of the buttress.

For a long run of guardrail downstream of this location, there would be multiple joints plus another anchorage. Additional slip could occur that could potentially allow for more rail deflection upstream of rigid buttress. I do not know how significant that this may be but only pointing out that we would not have exactly the same scenario as most testing programs. More rail rotation may occur when the rail is not clamped down to buttress face as well. That could potentially increase pocketing/snag as well; since, one bolt every 6 ft – 3 in. may not replicate the end shoe clamped behavior.

When I noted taller parapets, I was referring to future height to allow for an overlay with second set of 5 bolts.

Again, the long run of thrie beam may be okay. However, I am not as certain that other issues will not crop up.

Response

Date: 10-25-2015

Can the five bolt pattern be adjusted to keep them in the concrete.

Can the 5 bolts be in the top ¾ of the end shoe?

Response

Date: 10-26-2015

Today, Scott and I were able to further discuss this immediate need involving pier protection adjacent roadway reconstruction. As we understand, the roadway adjacent to numerous bridge piers and concrete/guardrail protection systems was milled/removed and reconstructed. During this process, the new roadway is much lower than originally used relative to the barriers. As such, there are concerns with the replacement of the barriers as well as safety concerns regarding roadway elevation changes.

To effectively address these concerns, we believe the best solution involves the downward extension of the RC parapet below the existing parapet. Second and due to such variability between sites, it would be best to just extend the parapet to the current ground elevation. The RC parapet would be supported against the piers in a similar manner to that used for the existing parapet. If desired, one could utilize minimal attachment to the concrete ground surface, although not required. New anchorage hardware would be either cast into the new parapet or placed into old/new concrete with epoxy anchors. The old exposed anchors could be cut off to reduced snag hazards. On the upstream end of the flared buttress, you will likely have the concrete end extend above the thrie beam, which provides some snag hazard for vehicles extending over the thrie beam. If possible, we would prefer to have a top taper on this region to reduce snag risk. However, a taper could provide challenges in the future when the rail needs to be raised. We may want to further discuss options here and note that some risk would exist if you do nothing here.

Please let us know if you have further questions regarding the enclosed information or want to discuss other options. Thanks!

Attachment: https://mwrsf-qa.unl.edu/attachments/b00885d34b8bf4f2d3081dcbb8705775.pdf

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Response

Date: 10-26-2015

I would suggest not changing the 5-bolt pattern away from that used in the standard steel end shoe. Such changes may potentially cause different failure patterns or capacities to occur in the end shoe. The 5 bolts were likely placed to maximize tensile capacity and provide even distribution within the end shoe.

MGS barrier in a TWLTL

Question

State: OH
Date: 10-23-2015

Because of a crash problem, we would like to install an MGS barrier rail in the center of the two way left turn lane shown below. A guardrail contractor recommends removing 1' of pavement width, back filling and using steel posts. How much pavement should we remove to allow the guardrail posts to rotate properly?
Attachment: https://mwrsf-qa.unl.edu/attachments/87c31abd4b3f527315d5db2aed95e5bf.jpg

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Response

Date: 10-28-2015

With regards to the installation below, I am assuming that you are installing the MGS as a strong post median barrier system. This has been approved by FHWA with 12" blocks, and was subsequently tested at TTI using 8" blocks.

Installation of the strong guardrail posts in asphalt can be problematic as it limits the ability of the post to rotate in the soil and absorb energy. MwRSF and TTI have both conducted research related to this issue in the past.

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

http://tti.tamu.edu/documents/0-4162-2.pdf

In the MwRSF research, the researchers designed an evaluated a system for installation of guardrail posts in rock where full embedment was not possible and backfilled cavities were placed in the rock to allow for post rotation. As part of this effort, MwRSF also made recommendations regarding the placement of posts in road paving. If guardrail posts are to be installed in pavement, such as in shoulders alongside the roadway, it was recommended to blockout a portion of the pavement so that the post would have room to rotate backwards. This could be done for both W6x9 steel and 6-in. x 8-in. timber posts. The size of the blocked out portion of the pavement for the post was recommended by assuming the post would rotate around a point two-thirds the depth of full embedment, and the post would be allowed to deflect backwards 18 in. at the rail midpoint height before contact with the pavement. The figure below shows possible geometries for blockout portions of pavement. Backfill with confined compression properties similar to ASTM C33 coarse aggregate, size no. 57, would possibly be acceptable for this application, but it was noted that further testing should likely be conducted. Thus, based on this research a 18" wide portions of roadway would be recommended for a roadside system (with the post located 1" from the front of the removed pavement). If you have median traffic and impacts, the post would need to rotate both ways, so the blocked out pavement would need to be 28" wide to allow for the same motion of the post in both directions with the post in the center of the removed pavement.

Subsequent research at TTI looked at grout filled leavouts for mow strips. Both steel and wood post systems were tested with 18 in. × 18 in. square leave-outs. It was noted that a 18 in. diameter round leave-out provides approximately the same area of leave-out material around the post and was considered to be an acceptable alternative to the square leave-out. Without further testing, these were considered to be the minimum acceptable dimensions for the leave-outs. The material used to backfill the leave-outs was a standard two-sack grout mixture. Tests indicated a maximum 28-day compressive strength of 0.85 MPa (120 psi) for this material. Other leave-out backfill materials (e.g. foams) may be accepted as alternatives to the two-sack grout provided their compressive strength does not exceed that of the grout.

Thus, the TTI work came to a very similar conclusion regarding the size of pavement removed. Thus, we would likely recommend a 28" wide pavement removal with the posts installed in soil in the middle. If you wanted to use a leaveout backfill material in that area, the TTI recommendations for that material should be followed.

Let me know if that answers your question or if you need further information.

Attachment: https://mwrsf-qa.unl.edu/attachments/a04b6cf5e65c7945cc564da423b716b8.jpg

Attachment: https://mwrsf-qa.unl.edu/attachments/64ece7e8fd9a760651f2096226ae5e09.jpg

Attachment: https://mwrsf-qa.unl.edu/attachments/c7c9d6cafbe589a9c9eb76b1c1b39173.jpg

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Double thrie beam to two single faced thrie beams

Question

State: WI
Date: 10-28-2015

I did some stumbling around looking for double faced thrie beam to two single faced thrie beam. The details that I did find typically had one post with extra blocks. The next post had two steel posts very close together.

I'm worried that one steel post will interfere with rotation of the steel post struck. How much room between two steel posts is adequate?

I was thinking 2 feet when I drew up my PDF.

I don't know if there is a right answer. I know that adding a bunch of blocks has not be tested either.

Attachment: https://mwrsf-qa.unl.edu/attachments/edea01b9839370a30eaf2a9a254e2112.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/91805cb37d9706c715a60310b56926c5.jpg

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Response

Date: 10-28-2015

As a quick conservative thought, I might consider that the rail could deflect around 30 in. or more. We may not want the back of an impacted rail to deflect into the back side of an opposite-side steel post.

A single post with 12-in. blocks on each side would result in a gap of 30 in. (two 12-in. blocks plus 6 in. steel post). However, a dual-post system with 8-in. blocks would require a 44-in. gap to not allow posts to contact the backside of second rail using a 30-in. clear region.

If we extend two 8-in. blocks on each side of a single post, we end up with a 38-in. gap. This gap size still falls short of the 44-in. gap, or point where one may consider transition from 2 posts to 1 post.

I am less certain about using three 8-in. blocks on each side.

Note that these quick thoughts have not been tested/evaluated and may also be overly conservative.

As a second thought, another option would be to stager post pattern on dual-side region and use blockouts on both sides of dual posts. This options would mitigate concerns for rail rupture and may allow for narrower gap.

post placement for long spans

Question

State: WI
Date: 11-10-2015

We have a project where if the MGS Long-span is installed as crash tested will reduce the shoulder down to 1'.

We have room to install a longer MGS system (box is only a 6' 4" wide).

Could we install a longer span box culvert and have the face of rail closer to the head wall?

We would not have to worry about post rotation issues.

The only potential issue I do see is that we may allow more of the vehicle to extend over the box culvert during a crash. Extending how much the vehicle is over the culvert may increase the likelihood of the vehicle interacting with the wing walls.

The head wall does not extend above the ground line.

I have some photos of the culvert in question. They look pretty bad, but I understand that the culvert had some repair work done on it after it got hit.

Attachment: https://mwrsf-qa.unl.edu/attachments/bef5496cda33e22847f62afcbe33e9b5.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/8f13cd7cf8be17afeec0268ed4912323.docx

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Response

Date: 11-17-2015

After reviewing the proposed installation, we have concerns with respect to extending the long span an moving the system closer to the culvert. At this time, we have not performed any analysis or or testing that would shed light on the effects of moving the system closer to the edge of the culvert. The concern would lie mostly with the extension of the vehicle over the culvert and the potential for this to compromise the safety performance of the barrier. Keeping the the unsupported length less than the 25' that was full-scale crash tested may limit the extension somewhat, but the amount of the reduction is not quantified.

A better solution in this case my be to use the MGS mounted to culverts with the side mounted sockets for the S3x5.7 post. Note that we would recommend the extended backup plates on this design based on the results of the MGS in mow strip testing.

http://mwrsf.unl.edu/researchhub/files/Report293/TRP-03-277-14.pdf

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AGT Post Obstruction

Question

State: NE
Date: 11-12-2015

Post # 6 has a footing blocking the placement.
The footing is 2' below the ground.
What can be done with other post spacing to alleviate this?

Attachment: https://mwrsf-qa.unl.edu/attachments/5653f0cd4c2b3e9f93eea3f526e8da18.pdf

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Response

Date: 11-19-2015

I am not a big fan of moving either post #5 or post #6 approximately 8" or more when only placed within a span of 18.75" due to the potential for increased pocketing when striking just upstream from this location and near asymmetric transition segment. Instead, I would rather use the dual-post straddle and beam system that was developed for Erik Emerson and the Wisconsin DOT in a recent research study. Have you considered this system?

Now, as a last resort, I maybe could live with the post shift method if the transition were extended more upstream to include another thrie beam panel (6 ft – 3 in.) and more ¼-post spacings to mitigate any concerns with a shifted post of 8".

I will ask that Bob/Scott comment as well. Please let me know if you have any questions related to the information noted above. Thanks!

Response

Date: 11-20-2015

What about 2 more W6x15's @ 37.5" as in the clip – in the place of the standard posts at ¼ space.

For post 5 of our original sketch fix: the below would span the footing but we would use an additional 6'-3" of thrie beam & the 31" rail to the right as in our original sketch.

For post 6 fix: this would require moving the last W6x15 8" which would be behind the 6-‘-3" thrie beam
Attachment: https://mwrsf-qa.unl.edu/attachments/819e9d230bf605f68a2a04526d6b6929.jpg

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Response

Date: 11-21-2015

The noted transition below does not have include the transition to the standard AGT that is now used. However and in terms of our prior discussion, one could add a few more ½-post spacings of W6x15, another 6 ft 3 in. segment of thrie to include 12 ft 6 in. of single thrie, then the asymmetric segment, etc. The 37.5 in. span would straddle the hazard. You would still then have Scott's stiffness transition with 18.75" spacings and design K or L of prior report. Let me know if this makes sense. If not we could sketch on paper a few versions.

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adding wood planks to back of posts

Question
State: WI
Date: 11-23-2015

We have a number of installations of approach transitions to rigid barrier and beam guard where the sidewalk is directly or in close proximity to the back of post.

Some of our project teams have installed wood planks at about rail height at the back of post to prevent pedestrians or bikes from snagging into the posts.

It may stiffen up the system a little, but I don't see a problem with this so long as it is not within an end terminal.

There could also be some additional debris from an impact as well.

Many of these locations are 45 mph or less posted speed.

I'll try to find a drawing or photos of what they are doing.

What is your thoughts?

Attachment: https://mwrsf-qa.unl.edu/attachments/1316bd5112e89920e1414a022cedab1b.jpg

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Response
Date: 11-24-2015
In reviewing this type of installation, there are some concerns about debris and the potential for the backside 2x10 rail to detach from the back of the post during impact and become a hazard to the impacting vehicle.

As such, we would likely recommend that this type of installation be evaluated through full-scale crash testing for TL-3 applications. For TL-2 applications like the ones you note above, the concerns with debris and interaction of the rail with impacting vehicles is much lower. Thus, we believe that the timber railing has the potential to be used in lower speed applications without adversely affecting the safety performance of the guardrail or AGT.

TL-4 Thrie Beam Barrier

Question

State: WV
Date: 11-25-2015

I'm trying to contain a perpetual problem of tractor trailers with nested Thrie beam, reduced post spacing and anything short of a concrete barrier wall. The location is about 1900LF so cost isn't a primary concern, we're after TL-4 performance or better.

Was there any nesting of Thrie Beam considered in the development of the Bullnose? Or do You know of anyone testing these applications?

From the RDG, pasted below, is a summary of deflections from simulations for my interest. I would like to propose Run number 14 but sure wish I had actual testing to base it on. Run 18 doesn't produce much benefit for twice the post.

Any info on testing or other input would be much appreciated.

Attachment: https://mwrsf-qa.unl.edu/attachments/206eef5f0918922110886284412c8c2cf.png

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Response

Date: 11-26-2015

To the best of my knowledge, no one has evaluated any thrie beam barriers to MASH TL-4. TTI previously tested a 34" tall modified thrie beam system to NCHRP 350 TL-4. See attached. I believe that NUCOR had and NU-Guard W-beam barrier and Trinity had a T-39 barrier that were tested to NCHRP 350 TL-4.

NJDOT has contacted us regarding evaluation of the 34" tall modified thrie beam system to MASH TL-4, but it has not been formally put into a proposal. Additionally, we have had some interest from several states regarding adopting the MGS into a TL-4 system that potentially used thrie beam. However, that has not gotten priority for funding yet. We think the potential to do this exists.

TTI did test the standard G9 thrie beam system to MASH under 22-14(3). The system failed to meet MASH in that test with a 2270P vehicle due to rollover. This system used full length timber blockouts. We believe that the use of shortened timber blockouts would have improved the performance of that system. Our previous research on the bullnose and other transition has shown that the shorter thrie beam blockouts improve capture and stability.

In terms of the barrier in Run 18 below, this system would represent a very stiff thrie beam barrier system based on the post spacing and nested rail. This would essentially be as stiff as some of the thrie beam AGT's. That said, we would recommend the use of the shorter blockouts mentioned above for this system as well.

Attachment: https://mwrsf-qa.unl.edu/attachments/cd455ef0c794883dd579a47d948322a8.pdf

Triple Blockouts

Question

State: OH
Date: 12-01-2015

We have a guardrail replacement project that is wrapping up on Interstate 70 in Columbus. Because of an inlet, the contractor has used triple 12" blockouts at several approach locations to a structure. The inlet is in poor condition and the project engineer is concerned that the structure is too weak to properly support the load of an impact. From past questions I see that a triple 8" blockout can be used under certain conditions. Is a triple 12" blockout ever an option? If so, can it be used at a transition section such as this? Could some combination of triple blockout and steel post attached to the inlet be used? Is the only option in this case to remove the old inlet and use steel posts attached to the top of the new inlet? Thanks!
Attachment: https://mwrsf-qa.unl.edu/attachments/cb4b50311442ec93e99e898dbcb36188.JPG

Attachment: https://mwrsf-qa.unl.edu/attachments/acd0ce95fff7f85ff91908655a94eceb.JPG

Attachment: https://mwrsf-qa.unl.edu/attachments/2134370d30a7a9f7d5859cff9cac2a9e.JPG

Attachment: https://mwrsf-qa.unl.edu/attachments/cd11ed3a2b8e7b5f549c8b978ca7078d.JPG

Attachment: https://mwrsf-qa.unl.edu/attachments/c5c6cc210086ce2a99b5771a37c00c48.JPG

Response

Date: 01-25-2016
In the past, we have recommended no more than one triple 8" blockout installation very 50' for guardrail installations. This is based on concerns that the ability of the triple blockout to transmit load to the post would be compromised for large deflections. With regards to transitions, we have used a similar rationale and have limited the installation of triple blockouts to a single post in the transition at limited locations. For your installation shown, we believe that the number of consecutive triple blockouts is likely too many.

The MGS utilizes 12-in.deep blocks for standard applications as well as for special applications. For example, the MGS long span design utilizes one 12-in. wood block with three CRT posts instead of two stacked 12-in. deep blocks. For the MGS, it would seem reasonable that the use of two 12-in. deep stacked blocks could be accommodated at a few locations as well, thus also resulting in a rail offset of 24 in. However, it is uncertain as to whether the use of two 12-in. deep blocks may be too excessive when used continuously with the MGS.

Thus, based on previous testing of systems with deep or extended blockouts and an analysis of the contact lengths of typical MGS testing, MwRSF would recommend the following:

1. Double standard blockouts or combinations of blockouts up to 16-in. deep may be used continuously in a guardrail system.
2. Triple standard blockouts or combinations of blockouts up to 24-in. deep should be limited to one in any 75 ft of guardrail.

There is currently a problem statement in the Year 27 Pooled Fund Program to address this issue specifically, " Additional Options for Post Conflicts within the Approach Guardrail Transition".

With respect to attachment to the top of the inlet, that would depend on the connection to the inlet and the relative stiffness of that post configuration. One would also need to be sure that the inlet attachment had sufficient structural capacity as the short, stiff post may overload the top of the inlet.

Buttress Shape for NE Transition

Question

State: UT
Date: 12-08-2015

My question is in reference to TRP-03-210-10 report and the adapted Nebraska transition. For reference I have attached the Nebraska Std. Dwg.

Within the drawing they show the end of the concrete rail placed at a flare. My question is, can this transition be used on a constant slope barrier end with no flare? Second, as I understand the report this transition would not be used on New Jersey shape barrier?

Attachment: https://mwrsf-qa.unl.edu/attachments/60f4e37b8d887c1c643f69c1f33ed4bc.PDF

Response

Date: 12-08-2015

We recommend utilizing the same concrete buttress geometry as the tested and approved system. We do not recommend altering the concrete barrier design adjacent to the transition region as geometric changes can lead to vehicle snagging and/or instabilities. Numerous full-scale crash tests has shown that altering the geometric shape of the buttress can be the difference between passing and failing a crash test. Therefore, the taper/flare of the front edge of the concrete buttress should remain in place to prevent vehicle snag issues. Also, the buttress shape should remain as a vertical faced barrier in the transition region.

That being said, you could utilize a shape transition between the vertical faced buttress and a New Jersey shaped bridge rail. The shape transition could begin just downstream of the thrie beam end shoe and may be completed over a 7-8 ft distance. Thus, the total length of the concrete rail be get a little longer (due to the shape transition), but you could utilize this approach guardrail transition and buttress in combination with a New Jersey shaped bridge rail.

MGS transition on 2:1

Question

State: OH
Date: 12-21-2015

ODOT is upgrading existing guardrail to MGS on an Interstate route. For the attached location, the District would like to use long posts (7.5' -8') for posts 7-13 of the attached drawing and also for the transition at the trailing end of the structure. Previous research for Wisconsin addressed a retrofit option by placing additional posts behind the existing posts. I didn't see any guidance for new installations. Can an MGS transition be installed on a 2:1 with long posts? Are longer posts an option for posts 1-6 of the bridge transition?
Thanks!

Attachment: https://mwrsf-qa.unl.edu/attachments/ffd733cfe7fd5af1e64b2581e8e5691d.JPG

Attachment: https://mwrsf-qa.unl.edu/attachments/0a035519941ccd171fea2f4ccf9b3e12.JPG

Response

Date: 12-21-2015

I need to start this response by clarifying that evaluation of this transition placed on slopes has never been performed (testing or numerical analysis). The report you referred to on retrofitting transitions (TRP-03-266-12) was focused on two different transitions utilized by the the state of Wisconsin. Additionally, that project only focused on the downstream end of the transition. Evaluation of the w-to-thrie beam stiffness transition has never been performed on sloped terrain. Thus, a crashworthy transition system has never been developed for use on or adjacent to fill slopes. In order to ensure system crashworthiness, you would need to provide 2-ft of level grading behind the transition posts. Of course, it would be costly and labor intensive to add the required soil to the roadside. If you chose to install a transition without the required grading, the recommendations below are our best guess at what it would take to make the transition perform as intended. Please do not take these recommendations as a standard for new construction. Rather, these should only be utilized to improve existing systems without the possibility of significant grading work to the site.

Report TRP-03-266-12 provided guidance pertaining to additional posts to be driven behind existing 7-ft transition posts. These replacement posts were conservatively designed assuming the original posts would provide no additional resistance compared to the new post. Thus, the same "additional" posts would be recommended as replacement posts. As described in the report, the size and embedment depth of the replacement posts depends on the slope of the roadside. Steeper slopes will require larger posts. So, an 8.5-ft long W6x12 post was recommended for 3:1 slopes, while a 12-ft long W6x16 was recommended for 2:1 slopes. Please use this report to guide your selection of post for use as Post nos. 1-6 depending on the terrain slope on site.

The MGS has been successfully crash tested on 2:1 slopes with 6-ft, 8-ft, and 9-ft posts. Due to the lack of grading behind the posts, working widths and system deflection were increased due to the slope. However, increasing post lengths and embedment depths helped reduce the working width of the system back near values obtained for MGS on level terrain testing. Because transitions are sensitive to changes in lateral stiffness and can result in vehicle snag and pocketing when not designed properly, you want to install a post that best replicated the stiffness of a 6-ft W6x9 on level terrain. Therefore, we would recommend using the longer 9-ft posts to replace the standard 6-ft W6x9 posts in the transition region. This increased post length should be carried all the way through the transition region (post nos. 7-13 on your drawing set) and for the next 25 ft of MGS upstream of the w-to-thrie transition element.

Long Span Question

Question

State: WI
Date: 12-23-2015

Please review questions in the PDF. I have a region that does not like having water flow over the top of the box culvert. They are wondering if it is possible to do something like what I have attached.

What I have is a situation where there is a significant elevation difference between the shoulder by the beam guard long span and where the culvert headwall is located. The region staff wants to keep the headwall to prevent water from flowing over the head wall (I don't know why.).

The truck or car can only drop so much during an impact into a long span. For the sake of illustration, I'll pick an imaginary number of 2' of vehicle drop during a crash test. If the culverts headwall is 3' below the shoulder surface, the vehicle cannot interact with the headwall during an impact. It should be O.K. for the head wall to remain in place.

The question becomes, What is the truck or car's drop during an impact into a long-span. I pick the imaginary number of 2' out of a hat for the sake of illustration. But you smart people have the slow motion cameras, computer models, and other sorts of wizardry and probably could actually come up with a more accurate, scientific guess than I could.

Attachment: https://mwrsf-qa.unl.edu/attachments/5d6b008e826752b7be41b471c92b47dd.pdf

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Response

Date: 01-04-2016

If I understand correctly, you are wanting to install the long span at an offset from the head wall larger than what we tested, but with a slope and drop to the head wall behind it.

I don't see this as much of an issue as the long span was tested with a vertical drop off approximately 34" behind the face of the rail. I believe that we require the long span to have 24" behind the posts prior to a 2:1 slope. Assuming that you have continue that grading behind the unsupported span prior to the slope and head wall, I don't see this installation as more severe than what was tested. I believe that the slope to the head wall would only provide additional vertical support to the vehicle and improve stability.

If you plan to start the slope closer to the rail face we may need to discuss it further.

Response

Date: 01-05-2016

2' of grading behind the post is not a problem. But where the span is plan to be the 2:1 starts close to the back of rail.

Attachment: https://mwrsf-qa.unl.edu/attachments/62c828a478a7e0f5fd6cee01be5d938c.jpg

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Response

Date: 01-06-2016

I don't believe we can recommend the system as shown due to concerns with the drop of the slope relative to the rail position in the unsupported span.

In the long span testing, the posts were aligned with the back of the post flush with the face of the headwall. This placed the face of the guardrail in the unsupported span area approximately 34" in front of the headwall. Thus, during an impact in the unsupported span, the ground was supporting the wheels of the vehicle for approximately 3' prior to the vehicle dropping behind the headwall.

In the installation you have shown below, the slope begins directly behind the face of the guardrail. This would allow wheel drop much earlier than the tested system. Beginning of the wheel drop sooner may allow the vehicle to fall farther as it extends over the culvert which could compromise vehicle capture, vehicle stability, and cause issues with the vehicle climbing back over the headwall as the vehicle is redirected.

As such, we cannot recommend the installation shown below.
