Midwest States Pooled Fund Program Consulting Quarterly Summary

Midwest Roadside Safety Facility

01-01-2009 to 04-01-2009

Butterfly Delineators

Question

State: KS
Date: 01-15-2009

I wanted to get your opinion on the use of butterfly delineators (metal or plastic) that slip under the bolt on guardrail.
We have contended that slipping these delineators under the bolt will cause this to act like a washer. Do you have any comments about this (performance, any study, etc)?

Below is a link to a website for our approved delineators along with the KDOT specification. KDOT uses a plastic type delineators as mentioned in the spec. We do state in our spec that these delineators need to be 350 approved. KDOT is placing these guardrail delineators on the maintenance side. However, I have attached our standard drawing that shows them to be riveted and these are being placed in the construction plans on the design side.

http://www.aktinc.com/guardraildelineators.htm

If you read down the email chain, FHWA checked with their office and said that there were no 350 approval letters. Also, they indicated that there is not a concern with the use of these delineators (assuming under a guardrail bolt). Anyway, I want to make sure that there is not a performance issue since we are saying it should be 350 compliant. Typically the maintenance personnel install these by sliding the plastic delineators under the guardrail bolt.
It appears alot of states use these but I have no firm documentation from anyone that there will not be an issue and they are 350 compliant. I have not agreed with everyone yet that these delineators should be used because of this concern. I would think installing a metal delineator under the guardrail bolt would be a concern too. Anyway, please give me your thoughts on this and thanks a lot for your help on this issue.

Attachment: https://mwrsf-qa.unl.edu/attachments/2494fcc3ebf286fcb474519d87973ff6.pdf

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Response

Date: 01-15-2009

The delineators should not be a concern for becoming a projectile and posing risk to oncoming traffic or to the occupants of the vehicle impacting the barrier. However, the delineators may imitate the behavior of the old steel washers and allow the rail to remain attached to the post and possibly become pulled down during impact events. The steel variety may seem to be a greater concern than those made with polycarbonate material. As an alternative, would KsDOT be willing to place the devices on the rail at non-post locations, on posts, or even glue/bond them to the rail?

Response

Date: 01-15-2009

The location could be discussed internally again but I believe the easiest for maintenance folks (probably installing under guardrail bolt) will prevail if there are not any issues. We tried the glue years ago and it did not work. First snow, the delineators were knocked off. We found the rivet option worked.

I think there are many manufactures that describe placing these under the guardrail bolts like the link I sent you. The picture for the steel version from this manufacturer's site states "install quickly using existing guardrail bolts" by the detail showing the guardrail and delineator. (this is for the steel version) The attached email has further comments from the FHWA. I appreciate everyone weighing in on this and can you explain the effects of using a washer too in order to pass this along.

I have also attached a picture of the plastic version. Again, they indicate to install under guardrail bolts. No mention of performance or 350 compliance.

http://www.interwestsafety.com/store/265.aspx

I called the supplier about specific details and they are checking into it. The only thing they could give me is listed on the product sheets below and I summarized this. Also, I asked this supplier for any testing or 350 compliance but I don't think they had a clue about what that meant (checking into it though). I did not see any mention of compliance on any website for these things.

AKT Plastic version (717):
- 5 ¼" x 3"
- approx. 0.085" thick
- High impact polycarbonate

AKT Steel version (567):
- 5 ¼" x 2 ¼"
- 12 guage galvanized steel

Attachment: https://mwrsf-qa.unl.edu/attachments/b414833b76cf1a26e232285e00f993e2.gif

Attachment: https://mwrsf-qa.unl.edu/attachments/edc22457dec45e3c67c6b7fd47eede0f.jpg

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Response

Date: 02-05-2009

Please note that the slot dimensions or washer plate size are not shown below. I have considered this issue more and still have concerns with the 12-gauge, steel galvanized component when used under the head of a guardrail bolt. As you are aware, the use of 3/16" rectangular guardrail plate washers have been highly discouraged with the use of strong-post guardrails. Although this component is thinner, 0.105 vs. 0.188", and has one end open, the potential remains for it to increase rail to block/post attachment. At rail splice locations, this device would add another rail thickness. At non-splice locations, it would simulate a two-ply splice. As such, I would not recommend the use of the steel device at rail splice locations. In addition, I am concerned about effectively adding plate washers, although thinner than prior designs, to the non-rail-splice locations. If crash testing demonstrates that the use of the steel components provide an acceptable safety performance, then use them as needed.

With regard to the thin polymer version, I believe that the head of the guardrail bolt would easily pull through the washer region.

Response

Date: 03-24-2009

After review of the plastic and steel butterfly delineator designs, MwRSF, FHWA and KsDOT agreed that the plastic delineators posed little concern for adversely affecting guardrail performance due to their low thickness and material strength. However, there concern with the steel design acting like a washer could not be eliminated. Thus, the group recommended use of the plastic butterfly delineator designs until further research or testing verified the steel butterfly delineator performance.

MwRSF TCB

Question

Date: 01-23-2009

One of our contractors is in the process of relocating a run of the MwRSF TCB that was pinned through the asphalt with the 38mm dia x 978mm long A36 steel pins. They are having a very difficult time pulling the pins out, most likely due to the extreme cold temperatures we are having. For future installations we would like to consider specifying slightly larger diameter holes, say up to 45mm (1-3/4") diameter holes, to ensure pins could be pulled easier in future. We would also like to consider a threaded top on the pin in order to use double nuts and square plate washer as an alternative to the welded steel top plate. This would allow other devices to be attached to the pin during removal.

Please advise if you and/or contractors using the MwRSF TCB have experienced similar problems during pin removal, and their solution.

Please also advise if it would be advisable to allow larger diameter holes in the asphalt, and/or allow a threaded top on pin for a double nut and washer as an alternative to the welded top plate.

On another matter, have you run a TL-2 crash test or simulation test on the MwRSF TCB? We would be interested to know the approximate deflection distance for a TL-2 freestanding installation for designer information.

Attachment: https://mwrsf-qa.unl.edu/attachments/03f5fef5a6e6169df67d77d1c29ced27.pdf

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Response

Date: 01-26-2009

I don't see any issues with threading the top of the pin and using double nuts if that helps you with extraction. I would recommend that the washer plate have the same thickness and dimensions as the plate used on the tested pin.

We can't allow larger holes in the pavement because it could potentially allow larger deflections and more vertical pullout of the pins. Both of these behaviors would be detrimental to the performance of the system.

As far as deflection limits, of the MwRSF TCB under TL-2 impact conditions, we have not explicitly determined those limits. We have however provided some guidance for barrier deflections based on accident data in TRP-03-113-03. The report basically gives guidance for lower barrier deflection expectations based on accident data. Let me know if I can give you any more assistance.

4" Mountable Curb and Standard Beam Guard

Question

State: WI
Date: 01-28-2009

A representative from FHWA resource center is asking for the report that MwRSF ran that involved 4" mountable curb and standard beam guard. He also was wondering why NCHRP Report 537 indicates that standard barrier can be installed at a zero offset and MwRSF's failed crash tests with standard beam guard.
If MwRSF could get me the report number and title and MwRSF's opinion on NCHRP 537 recommendation.

Response

Date: 01-28-2009
MwRSF performed two research studies for the Midwest Pooled Fund Program regarding standard strong-post W-beam guardrail installed over 4" concrete curbs. The research results from these studies are published in the following reports: TRP-03-83-99 and TRP-03-105-00. I will email you these reports in separate emails using the UNL DROPBOX SYSTEM.
MwRSF found that a steel post, wood-blockout, w-beam guardrail would rupture when placed over a 4-in. wedge-shaped, concrete curb. TTI found that a wood post, w-beam guardrail would redirect a pickup truck when placed over a 4-in. asphalt dike. MwRSF later obtained a successful test result when the single rail was replaced with a nested guardrail.
NCHRP 537 makes the statement regarding 4-in. curbs being placed flush with the guardrail face based on prior crash test data noted above, LS-DYNA simulations performed in the study, and the lower speed validation crash tests performed for NCHRP 537. As such, NCHRP 537 is silent on the issue of which W-beam rail system modified G4(1s) or G4(2W) can be used with single rail or nested rail.
Later, MwRSF demonstrated that the Midwest Guardrail System (MGS) could be used with a 6-in. curb placed slightly forward of the rail face.

Summary of Maximum Deflections for Beam Guard and Thrie Beam

Question

State: WI
Date: 01-29-2009

I was looking at the deflection values in Table 5.4 of the RDG (page 5-25). I'm confused where these deflection values are measured from. Are they deflection values or working width (e.g. barrier width plus deflection). If they are just deflection do I just and the width of the system to get working width?

Response

Date: 02-02-2009
The values in the table come from several sources. To the best of my knowledge, the simulations were performed by Kitty Hancock using the NARD code. At the time of this analysis, our industry was not yet using the working width terminology. As such, I believe that the simulation results just depict dynamic deflections. Some crash test results are also referenced in the table. These MwRSF tests were also very dated. As such, dynamic deflections were likely used as well.

SSCB Thrie Beam Transition

Question

State: WI
Date: 02-09-2009

Attached is a draft copy of our thrie beam anchorage. If MwRSF has any comments, please let me know.

Attachment: https://mwrsf-qa.unl.edu/attachments/d7fabad27a5f95e2273d1d6cbfd00734.pdf

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Response

Date: 02-10-2009
For your new detail, I briefly glanced through the pages but did not see anything glaringly out of order. However, please note that I did not check dimensions, bar sizes, bar locations, or bar quantities. It appears that you have adapted transition details from a wood post variation of the Iowa Pooled Fund design from the mid- to late 90s. It is also recognized that you utilized the steel adaptor plate from a prior Missouri Pooled Fund design from the mid 90s. Various cross sectional views are also provided. However, I do not see where they are shown on the plans. In addition, it may be worth considering the use of some vertical bars over the first 4-5 ft to the left of the cold joint since a significant change in geometry occurs here when considering the loss of the foundation system.
At the present time, Bob is looking into alternatives for attaching the thrie beam end shoe and adaptor plate to the single slope barrier face. It should be noted that the embedded anchors utilized in the research study may no longer be available. For roadside applications, through bolts may be used as an option. We should wait to see what Bob comes up with for other anchorage options.
On another point, will the WsDOT be implementing the MGS guardrail in the future. If you anticipate this, you may consider the fact that modifications to the transition will be forthcoming after the project reports are completed.

Response

Date: 02-11-2009
I have been looking into your question on the anchorage of the approach transition and I have some comments.

First, the original transition that was tested anchored the thrie beam to the single slope barrier using 7/8" diameter A325 bolts with "self-drilling" Redhead anchors. These anchors had a listed capacity of 20.5 kips in pullout/tension and 24.32 kips in shear. The higher grade bolt was required to address bending of the bolt. The issue that arises is that this anchorage is no longer made. Thus, we looked through the available alternatives.

1. There are not currently available drop-ins or wedge bolt type anchors that are 7/8" diameter nor are any made in high grade steel. It is possible to get 3/4" diameter anchors the meet the 20.5 and 24.32 kip anchor loads, but the bolts will not handle the same bending loads as those in the original design.

2. There are 7/8" diameter mechanical stud anchors available, but neither is available in high grade steel. Thus, they may not be strong enough for the bending loads.
   Also, studs are not as easy to use as the original anchors and there is some snag potential on the heads.
3. Bolting through is a potential option and is likely the best option for a roadside installation. For median installations, the ends of the bolt present a snag potentials similar to the stud anchors mentioned above.
4. Another option for attachment would be epoxied threaded rod. 7/8" diameter, B7 threaded rod would be stronger than the bolts in the original design and could be epoxied into the concrete. Based on a review of the available epoxies from Powers Fasteners and RedHead, it appears that they would require approximately 7 7/8" of embedment. This may be difficult to embed based on the width of the barrier. Also, there would be potential for snag on the threaded rod similar to the stud option.
5. Dayton Richmond and Williams Form engineering produce and design cast-in-place anchors. It is likely that they could help you develop a template to cast anchors with similar shear and tensile capacities to the originally tested anchors and that would work with 7/8" A325 bolts.
6. An alternative to all of these options would be to cast a vertical face on the end of the single-slope that matches the mounting plate used in the testing. This would eliminate the bolt bending and allow for the use of drop-ins with 3/4" diameter A325 bolts. These anchors exist and we have good experience with them. You could also use a wedge-bolt mechanical anchor in this type of option.

SSCB Thrie Beam Transition

Question

State: WI
Date: 02-10-2009

Wisconsin DOT had a question regarding the Missouri single-slope approach guardrail transition developed at MwRSF (TRP-03-47-95). In that report, the thrie beam end shoe is anchored to the single-slope with "self-drilling" RedHead anchors and 7/8" A325 bolts. Wisconsin could not find similar anchors available from RedHead, and asked what their potential alternatives would be.

Response

Date: 02-10-2009
Here is a quick summary of the alternatives for this problem.
The original single slope approach guardrail transition used 7/8" diameter A325 bolts with "self-drilling" Redhead anchors. These anchors had a listed capacity of 20.5 kips in pullout/tension and 24.32 kips in shear. The higher grade bolt was required to address bending of the bolt.
The issue that arises is that this anchorage is no longer made. Thus, we looked through the available alternatives.

1. There are not currently available drop-ins or wedge bolt type anchors that are 7/8" diameter or are any made in high grade steel. I can get 3/4" diameter anchors the meet the 20.5 and 24.32 kip anchor loads, but the bolts will not handle the same bending loads as those in the original design.
2. There are 7/8" diameter mechanical stud anchors available, but neither is available in high grade steel. Thus, they may not be strong enough for the bending loads. Also, studs are not as easy to use as the original anchors and there is some snag potential on the heads.
3. Bolting through is a potential option.
4. Another option for attachment would be epoxied threaded rod. 7/8" diameter, B7 threaded rod would be stronger than the bolts in the original design and could be epoxied into the concrete. Based on a review of the available epoxies from Powers Fasteners and RedHead, it appears that they would require approximately 7 7/8" of embedment. This may be difficult to embed based on the width of the barrier. Also, there would be potential for snag on the threaded rod similar to the bolt through option.
5. Anchors could also be cast into the barrier as long as they had similar or greater capacity to the 7/8" A325 bolts used in the original design.

The ¾" anchors may potentially be sufficient, but we could not guarantee the same capacity as the originally tested system. Thus, they would require additional research or testing.

Road Closure Gate

Question

State: WI
Date: 03-23-2009

Wisconsin DOT asked for assistance in analyzing variations of a previously designed and tested road closure gate. The gate system was tested at TTI and is reported in TRR 1528 article titled "Wyoming Road Closure Gate." The luminaire pole used to support the gate arm was equipped with a four bolt slip base design and an 8-ft long mast arm (with light) at the top. The article stresses the importance of a high center of gravity and large mass moment of inertia to prevent the pole / gate system from crushing the top of the vehicle after impact.

Wisconsin wanted to use a variation of this closure gate system in future projects. Some of these variations are listed below:

- Eliminate the light / mast from the top of the pole
- Replace the slip bolt base with another breakaway mechanism
- Adding an electric powered winch to operate the gate
- Addition of solar panels near top
- Addition of control cabinet / battery near base

Response

Date: 03-23-2009

Alterations would only be allowable if the C.G. height and the mass moment of inertia values met or exceeded the values of the tested system. MwRSF was asked to analyze multiple different luminaire pole types and sizes along with various attachments to the pole for this comparison.

The last design that came from Wisconsin DOT is attached in PDF form. It incorporates a slightly larger pole, solar panel, control cabinet, and a steel collar near the top to replace the light. However, in order to satisfy the C.G. height requirement the weight of the collar must be increased from 83 pounds (as shown) to 141 pounds. The mass moment of inertia is satisfactory. More details are available upon request.

The additional weight of the collar brings the total weight of the pole / gate system to 750 pounds. The originally tested pole had a weight of 543 pounds. This corresponds to a 38% increase in weight. Now, the ORD and OIV values from the tests were low, so it is unlikely that the increased weight will cause detrimental decelerations to the vehicle. Also, the solar panel is mounted high enough that it should fall behind the vehicle when impacted and not cause and damage to the occupant compartment.

The breakaway mechanism at the base of the pole was also being changed. The behavior of the pole/gate may be significantly altered after changing the breakaway mechanism and adding over 200 pounds. Wisconsin was going to run this new design by FHWA to see if the closure gate would still be approved with the different breakaway mechanism as well as the added components.

Attachment: https://mwrsf-qa.unl.edu/attachments/47002dfd4cf72794018f1bf0409e0431.pdf

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