Midwest States Pooled Fund Program Consulting Quarterly Summary

Midwest Roadside Safety Facility

07-01-2009 to 10-01-2009

Concrete Barrier Alignment

Question

State: WI
Date: 07-09-2009

I was reading the quarterly reports that indicate that a 4" gap between barriers with chamfering may be considered to be acceptable. Has there been research on far one face of barrier can be out of alignment to the adjacent face (see picture)?

Attachment: http://mwrsf-qa.unl.edu/attachments/49c91c1cf7b0dd717e55b9a819a64723.pdf

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Response

Date: 07-09-2009
With regards to permanent concrete barrier, we would recommend keeping the lateral offset or alignment offset minimized to eliminate snag. Variations of 1" or less would be preferred.

For the temporary barrier installation shown in your photo, we would prefer that the alignment gap be 1" or less, but we believe that gaps as large as 2" are likely permissible. The rationale behind the larger alignment gap allowance is that temporary barrier segments will move when impacted and cause changes in the alignment gap as the impacting vehicle reaches the barrier joint. Thus, a joint that has a given initial alignment will move change alignment as the barrier is impacted. This allows for more tolerance for the temporary barrier gap. Alignments gaps larger than 2" would indicate problems with the temporary barrier joint and would require investigation.

TL-2 - Low Profile Barrier

Question

State: WI
Date: 07-09-2009

Wisconsin was interested in installing a TL-2, low profile bridge rail that will be backfilled with soil and were looking for guidance pertaining to the foundation/anchorage requirements. The barrier in question was the TL-2 concrete barrier designed by MwRSF in report TRP-03-109. It was planned for use in both median or roadside applications. The backfill was expected to be 21 feet in median applications, and the roadside application may place a 6:1 on the backside. The roadway in question was being reconstructed. In the median, the expected barrier placement was at least 2' from edge of lane, and on the roadside the region is pushing for 10' shoulder on the outside, but may not get it.

Response

Date: 07-14-2009
To adapt the low profile, TL-2, concrete bridge rail to roadside applications, I see three options. These options are shown in the PDF file in the folder noted below. Also, 2 digital videos of the full-scale crash test are in the folder.
(1) Place the barrier on top of the shoulder and tie the vertical steel directly into the shoulder slab. This, to me, seems like the easiest and most efficient method. Even if the shoulder slab is only 6" thick (shorter than the development length of the rebar, and shorter than the 8" embedment depth used during the crash test), the combination of overturning resistance provided by the rebar and the resistance provided by the soil backfill should create adequate strength to redirect a vehicle. Also, the rebar ties should prevent the barrier from lateral and rotational movement due to lateral soil pressure. Again, I would recommend this method.
(2) Place the barrier adjacent to the shoulder slab, extend the barrier downward, and tie in the internal steel to the slab through the end. This should also provide adequate strength to resist impacts and lateral movement due to soil pressure. However, the internal steel reinforcement must be designed correctly to carry the load and it will be more difficult to cast with the bends.
(3) The barrier is not in contact with the shoulder in any way. For this method, the barrier must be attached to a footer, as shown. The footer would need to be at least 12" in depth and run the length of the barrier. Calculations for the necessary internal steel can be done using the design method described in the MwRSF report " "Development of a Stand-Alone Concrete Pier Protection System" Report No. TRP-03-190-09. This will proof to be the most costly design.

Attachment: http://mwrsf-qa.unl.edu/attachments/2b58461bfbb0e9cfbdbfbe30047bedaa.jpg

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Termination and Anchorage for TCB

Question

State: IL
Date: 07-09-2009

With regards to the termination and anchorage for the F-shape temporary concrete barrier that was recently tested, the soil conditions are not representative of many field installation locations. Our soils would typically be much weaker and require significantly longer piles or other measures to provide equal performance. Would this require site specific design? Or would it be feasible to design for a worst case (weak soil)? Designing a standard application for a weak soil condition might result in over strengthening the anchorage, leading back to excessive loads? This seems to be a practical problem for application of the design. Could the report include a recommendation on how to address this?

In addition, I have some questions regarding installations where the barrier would end on a pavement. In many cases, if we carry the barrier out to the earth beyond the pavement or shoulder we may impede contractor access to the work area. A version of this for anchorage to a paved area would be worth more consideration. Also, we usually require a pad for the sand barrels. Perhaps a leave out area could be defined to accommodate the piles, with the area topped with a compacted aggregate?

Response

Date: 09-23-2009

The anchorage we used in this design was developed previously as part of a low tension cable anchorage. It was developed for use in general roadside fill conditions and tested in soil that meets the specifications for MASH. We believe that the anchorage will perform well given normal variations in soil conditions. We do not believe that the anchorage would need to be modified unless extreme soil conditions were present.

Anchoring the barrier in the paved area presents more challenges. When the anchor is loaded, energy is absorbed through deflection of the anchor in the soil. Anchoring the barrier to concrete would reduce the deflection and increase the loads for the same level of energy absorption. We do believe that this can be done, but it will require further study. As far as the size of the leave out required, I believe that is defined on the report in the recommendations section and is shown in the CAD in Figure 47.

New Jersey Shape PCB Anchorage

Question

State: OH
Date: 07-13-2009

Here are the drawings for New Jersey shaped PCB that is anchored on our structures. These standards are followed on structures or if there is limited deflection.
The run of New Jersey shaped PCB before anchored pieces do not have to be anchored and have a deflection of 5.5'. Here is the drawing for that.
I will not be in the office very much this week, no hurry on this. Thanks for your time. Let me know if you need any additional information.

Attachment: http://mwrsf-qa.unl.edu/attachments/98c9e1160a19a88789479dbfe781947c.pdf

Attachment: http://mwrsf-qa.unl.edu/attachments/79d4e4347b1a6bd51e844b5482e6ba66.pdf

Attachment: http://mwrsf-qa.unl.edu/attachments/f3de432081a8c319584a6d36cceecc03.pdf

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Response

Date: 07-16-2009
We developed just such an approach transition for the Kansas F-shape PCB. MwRSF Report no. TRP-03-180-06 details the transition.
While the transition we designed worked successfully with the Kansas F-shape barrier, we have concerns with regards to how it will function with your PCB design. I will try to lay out these concerns below.

1. First, we do not believe that the anchorage system on your PCB is equivalent to the anchorage used in the transition we developed. Your barrier uses 1" dia. high-strength steel rods embedded 6.5" into the concrete with a grout mixture. Our experience with this type of anchorage is that it is not sufficient to develop much of the strength of a 1" dia. high-strength steel rod. We believe that these anchors will pull out of the concrete surface much more easily than the anchors we tested with. This will change the stiffness and deflection of the anchored barriers as compared to the ones use in the transition we tested.
2. We did recognize that you have more anchors than use used in our anchored barriers, but that is another cause for concern. We do not recommend placing anchors on the backside of barriers. There are concerns that placing anchorage on back side of the barrier can induce increased vertical rotation of the barrier segments which could increase the potential for vehicles to climb the sloped barrier face and become unstable. Thus, we would recommend no anchorage on the backside of your barrier.
3. Barrier reinforcement in your barrier is not sufficient to derive the full strength of the 1" dia. high-strength steel rod used. In our anchored barriers, the anchor pockets have reinforcement loops that go around the packet to contain the anchors. Without this type of reinforcement, we do believe your anchors will fracture through the anchor pocket and become ineffective.

4. I also noted that you allow the use of JJ-Hooks barrier segment connections with your PCB. We would not recommend this connection for use in an anchored barrier system. The JJ-Hooks connection is fine for free-standing systems. However, to be safely used in an anchored barrier or approach transition, the barrier joints must have comparable or greater torsional rigidity about the longitudinal barrier axis when compared to that of the as-tested configuration. JJ Hooks connection is not similar in torsion to the Kansas barrier joint, and the JJ Hooks connection is also non-symmetric in that it has different capacities depending on the direction it is loaded.

At this time, if you need to have anchored barrier sections and an approach transition from free-standing barrier, we would suggest using the Kansas F-shape design and the transition and tie-down systems we have tested with it.

In order to adapt your barrier to safely use the approach transition, we would recommend that you change your current barrier and anchorage system to:

1. Remove backside anchors.
2. Increase anchorage of front anchors to develop the full strength of the threaded rods.
3. Reinforce the anchor pockets.
4. Disallow the use of JJ-hooks in the anchored configuration

Attachment: http://mwrsf-qa.unl.edu/attachments/fd91350ca3b13235426dde2f75805335.pdf

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MGS with Gutter Curb

Question

Date: 07-16-2009

I have another question about the MGS. See attached for the IL Tollway standards for gutter used adjacent to MGS. On our mainline high-speed sections, G-3 gutter is used where necessary to handle the pavement drainage and/or to prevent sideslope erosion. We currently offset the guardrail post 6" behind the back of gutter, which means that the distance from the flowline to the face of rail is 11.75". What are your thoughts on this configuration versus the 6" high curb with a 6" offset that was tested?

For your information, the post used to be at the back of gutter and we used a 6" blockout for the guardrail. When we switched to the MGS, we decided to keep the offset to the rail the same as it was and push the post back.

Attachment: http://mwrsf-qa.unl.edu/attachments/b2ed12a0c9652962eeabba41d2877392.pdf

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Response

Date: 07-20-2009

Dean Sicking, John Reid and I have reviewed the attached CAD details that pertain to the MGS with alternative curbs used within the Illinois Tollway. As you recall, the MGS was successfully crash tested with a 6-in. tall, AASHTO Type B curb. In this scenario, the MGS was installed with the rail face placed 6 in. behind the midpoint of the curb face, or 7 in. behind the curb toe. The rail height was 31 in. above the level roadway surface.

In the IL Tollway detail, the MGS rail face is positioned 11.25 in. behind the toe of the G-3 gutter. In addition, the top of the rail is positioned 32.5 in. above the roadway relative to the bottom of the curb or swale. The curb height is 5.25 in. tall, as measured between the curb toe and the back of the curb.

Although there are slight differences between the successfully crash-tested system and the IL Tollway detail, we believe that the noted system with MGS in combination with the G-3 curb would provide a crashworthy system. However, we do not have physical or scientific evidence to support this opinion and would like to conduct a brief analysis to investigate the alternative scenario. As such, we used LS-DYNA to evaluate and compare the two scenarios since we have experimental data to validate the 6" Type B curb cases.

Dr. John Reid has made a very brief comparison between the two noted curb geometries " the 6-in. tall AASHTO Type B curb and the Illinois Tollway's wedge-shaped curb. This initial investigation included both an examination of vehicle trajectories and motions with and without the guardrail in place behind the curb. From this study, the use of the wedge-shaped curb in combination with the MGS (located per your prior CAD details) does not appear to degrade barrier performance over that observed for the MGS with the 6" Type B curb. As such, MwRSF is not concerned with placing the MGS behind the wedge-shaped curb using the previously noted details.

MGS Blockout Depth

Question

Date: 07-16-2009

An issue has come up concerning the size of wood blockouts used with the MGS for IDOT and the Illinois Tollway. We have a contractor that has placed 2-piece wood blockouts that measure 11.5" from back of rail to front face of steel post. The standard clearly shows that this dimension should be 12".
The contractor is throwing around nominal versus actual and construction tolerances. What is your opinion on this? I would assume that it would test ok, but how much wiggle room is there in the dimensions?
It is my opinion that they should be replaced with the correct size, but the contractor is obviously resisting.

Response

Date: 07-16-2009
Recently, I have received many calls and emails on this topic in Illinois from the DOT, guardrail installers, fabricators, etc. From what I have noted to all of them, MwRSF addressed this issue in 2007 during an email discussion regarding the implementation of the MGS. In that email discussion, MwRSF noted the following:
October 19, 2007
"Therefore, it would make sense to specify a timber blockout with the full 12-in. depth or two blocks " one 6x8 and the other 6x4. MwRSF researchers also believe that the reduced depth of 11 ¼ and 11 5/8 in., as determined for fabricated and single rough-sawn blocks, would provide acceptable performance within the MGS. However, crash test results with reduced-depth blocks in the MGS are not available at this time. A reduction of ¾ or 3/8 of an inch in blockout depth may fall within the noise level in performance and may not allow us to discern much difference if multiple tests were performed. In any event, we feel that the 12-in. blockout depth provides the safest alternative of the three depth options (i.e., 12, 11 5/8, and 11 ¼)."
From my recent discussion and email correspondence with ILDOT, it now appears that the DOT will be contacting fabricators in order to obtain input before determining the acceptable tolerance on blockout dimensions. Although it is desired to use a 12-in. offset, it is also important to request a product that is economically reasonable. The ILDOT is beginning this investigative effort now.
In terms of your comments and questions noted below, it is correct to say that the blockout dimensions may vary depending on whether the blocks are supplied at full sawn, rough sawn, or dressed. However, it still would be preferable to utilize the full, 12-in. lateral offset purely from a safety performance perspective. If the MGS has been installed with a 11.5-in. blockout, I would not be inclined to swap out those existing blocks with deeper 12-in. blocks.
On another note, I am aware of a plastic block manufacturer having its routed block crash tested with the MGS. I believe that the block was 12-3/8-in. with a 3/8-in route on the post side, thus resulting in a true 12-in. lateral offset.

Wood and Steel Posts in a Run of Beam Guardrail

Question

State: WI
Date: 07-21-2009

In our current specifications we do not permit the mixing of wood and steel post within a run of beam guard. I have not found published guidance indicating that the mixing of steel and wood post is a problem. Is there an issue in mixing wood and steel post within a run of beam guard? My first guess is that the wood and steel post react differently during an impact and mixing them could cause a potential pocketing situation, but I don't know for sure.

We require the EATs and the Thrie Beam Structure Approaches to use only wood post. This can lead to wood being installed at the ends of a beam guard run that uses steel posts. If we shouldn't allow the intermixing of wood and steel within a beam guard run, switching back to wood for the EAT and the Thrie Beam Structure Approach appears to be problematic.

For the EAT, I could see that we need the post to fail during a head on impact with the EAT and therefore break a way post would be needed. I just don't know if there is a similar argument for the Thrie Beam Structure Approach.

Any insight that MwRSF could provide would be greatly appreciated.

Response

Date: 08-26-2009

Generally speaking, W-beam guardrail systems have been crash tested with one post type placed throughout the major length of the barrier system. For each test, either wood posts or steel posts were likely used and not the combined or alternating use of wood and steel posts within the impact region. Many of these W-beam barrier systems have been found to have similar dynamic performance. If barrier performances were found to be similar when using the steel and wood posts, then I would not be too concerned with allowing the replacement of damaged posts with a post of an alternative material type, wood for steel and steel for wood assuming the post performances were found to be similar. For approach guardrail transitions, the same general philosophy would be used, but it is important to try to match the post-soil behavior to that used in the original system. For guardrail end treatments, the use of alternative post materials should be addressed by the manufacturer since most of these systems are proprietary.

Guardrail Over Culvert Weld Detail

Question

State: IL
Date: 08-11-2009

ILDOT has
a question about the weld detail for the guardrail attached to the top of a culvert slab. I'm wondering if we have misinterpreted the intent of the weld detail. The intent is to attach the post to a ½ inch plate such that the plate is deformed during a crash. A strong weld was needed for this, and we understand that this is a three pass 5/16 inch weld. Is the three pass 5/16 inch weld intended to express the total final dimension? We had interpreted it as three passes, each 5/16. We are getting industry feedback suggesting that this is a problem. (See weld detail.)

Attachment: http://mwrsf-qa.unl.edu/attachments/da53fb92a319954cafcf05f6c58ab152.jpg

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Response

Date: 08-12-2009
From my recollection on this issue, a single pass weld was used in some of the early dynamic component tests. For some of these tests, the posts tore off of the base plate due an inadequate weld. Later, a three pass weld was utilized in the dynamic component testing program, thus resulting in the post remaining attached to the plate as well as the ability for plate deformation and energy dissipation.
I have reviewed the CAD details and photographs from the successful dynamic component test, test no. KCB-7. I have attached selected photographs from this bogie test as well. From the photographs and CAD details, it is my opinion that the intent was to utilize a 3-pass weld to achieve a weld size that would meet the 5/16" size in total for the front and back edges of the front (traffic-side) flange. This same weld detail was used for the steel posts that were attached to the actual concrete box culvert for the crash testing program. However, I am unable to determine the size of the three individual weld passes that were used to complete the weld process. Due to the results obtained from the original seven bogie tests, MwRSF cannot recommend the use of the single pass weld at this time. If a single pass weld is desired in the future, MwRSF would need to perform similar bogie testing on the post-plate assembly fabricated according to your alternative design to ensure that similar behavior is provided.

Kearney Bypass Crash Cushion/Impact Attenuator

Question

State: NE
Date: 08-11-2009

I am working on the Kearney Bypass project. I believe they've discussed with you our concern with head-on crashes at an interchange on this project. I have attached some drawings of the area.

A description of the pdf files is given below:

- Kearney Bypass 60 scale.pdf is a plan view of the area at a 60 scale. This exhibit has a few dimensions and leaders describing the linework.
- Kearney Bypass 30 scale.pdf is a plan view of the area at a 30 scale.
- Kearney Bypass section.pdf shows sections of the roadway as a truck is traveling south over the bridge and to the 3-way intersection. The first section (option 7) shows what we are proposing " a jersey barrier on the outside of the shoulder, but probably with a reinforced slope of 1:1.5.

Grading and paving of the current design may be flexible to achieve the distance we need for the crash cushion/impact attenuator.

The attached drawing (at a scale of 1:40) is a simplified sketch of the south section of the interchange.
In order to allow for WB-62 truck turning movements, the current design provides about 21' for a crash cushion/impact attenuator in front of the jersey barrier. Please let us know if there is a device that will protect or lessen head-on impacts within this limited space.
Attachment: http://mwrsf-qa.unl.edu/attachments/9579137023569fea1f365dbcaf754d04.jpg

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Response

Date: 08-11-2009
I've attached my recommended configuration for the sand barrel crash cushion. It takes a lot of barrels to protect such a wide area!
Some key items to note:
(1) Barrels are 3 ft in diameter and should be spaced 6 in. apart.
(2) The gray line in the drawing represents the 24 in. clear space recommended between sand barrels and the hazard .
(3) The black line has the same dimensions as the yellow hatched area on your drawings.
(4) The head-on impact scenario requires 6 rows of barrels to safely stop errant vehicles " thus the 21 ft length shown in your drawing (yellow hatching) needs to be extended 1.5 ft to 22.5 ft.

(5) Most rows contain only 1 type (weight) of barrel, but there are 2 exceptions. Rows 2 and 3 have lighter barrels on the ends. This is designed for end in impacts (not necessary for on ramp, but included to make system symmetric.
The rows break down as follows
Row 1: 31 " 200 lb. barrels
Row 2: 31 " 400 lb. barrels and 2 " 200 lb. barrels (1 on each end)
Row 3: 29 " 700 lb. barrels and 2 " 400 lb. barrels (1 on each end)
Row 4: 23 " 1400 lb. barrels
Row 5: 15 " 2100 lb. barrels
Row 6: 7 " 2100 lb. barrels

Attachment: http://mwrsf-qa.unl.edu/attachments/46bbad636542570ffe6976e156989dc5.pdf

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MGS Posts in Asphalt

Question

Date: 08-31-2009

We have a Weigh-in-motion enforcement site being constructed along I-90. The designer proposed essentially widening the asphalt shoulder by 30' for the State Police to use to pull overweight vehicles over to check with portable scales. This area has tapers on each end and is several hundred feet long. The State Police had requested that the area be "protected" with guardrail, so the designer proposed a run of guardrail parallel to the mainline, between the mainline shoulder and the enforcement area. The pavement is 9" asphalt and they are proposing to drive the posts thru it.
questions: will the guardrail react properly when placed in that thick of pavement? I thought that the posts needed to be able to rotate in the soil to absorb the energy. That is why we are telling all of the designers that the posts cannot be placed in concrete. Wouldn't they just snap off or bend at the top of pavement?
If 9" of pavement is too much around the posts, how much is acceptable? has this been tested?

Response

Date: 08-31-2009
Prior testing of W-beam guardrail systems with thick asphalt (or rigid concrete) surrounding the posts has been shown to degrade guardrail performance. Several years ago, TTI researchers developed a methodology for placing guardrail posts in a cutout to allow for adequate post rotation (Report No. 1 and ASCE Paper). Details for this method are contained in the attached FHWA acceptance letter (B64b.pdf). Within this letter, FHWA also included details for placing posts in situations where subsurface rock is encountered, per a research study by MwRSF (Report No. 2). In the MwRSF study, additional details were provided for the configuring the size of asphalt leave-outs.

More recently, TTI researchers have continued to develop leave-out alternatives for guardrail posts placed in mow strips. Although that research is continuing or recently completed, I will try to find either a recent progress report and/or draft report that summarizes the most recent findings and acceptable practices for posts placed in mow strips or over subsurface rock (Report Nos. 3 and 4).

You are correct in noted that it is desirable for guardrail posts to rotate in the soil and dissipate a portion of the vehicle's kinetic energy. When premature wood post fracture occurs, other behavior may occur, such increased barrier deflections, vehicle pocketing, or vehicle instabilities upon redirection. Similarly, steel posts may yield with limited displacement at the ground line, thus changing the loading to the rail as well as the rail movement while deflecting. For steel posts, rail rupture can occur as well as barrier override. For now, we must provide leave-outs in the rigid pavement in order to allow the posts to behave as they would in compacted soils. TTI has developed some alternative leave-outs that may be worth considering, as presented in the latter reports. Finally, you are correct in noting that 9-in. asphalt pads are excessive and would result in wood post fracture or immediate steel post yielding and twisting.

Report No. 1:

The file 'Guardrail in Mow Strips 0-4162-2.pdf' (14.7 MB) is available for download at
for the next 7 days.
It will be removed after Monday, September 7, 2009.

Report No. 2:

The file 'TRP-03-119-03.pdf' (3.3 MB) is available for download at
for the next 7 days.
It will be removed after Monday, September 7, 2009.

Report No. 3:

The file 'TM-GuardrailPostInstallationinRock-rev2.pdf' (2.1 MB) is available for download at
for the next 7 days.
It will be removed after Monday, September 7, 2009.

Report No. 4:

The file '405160-14-1.pdf' (2.9 MB) is available for download at
for the next 7 days.
It will be removed after Monday, September 7, 2009.

Attachment: http://mwrsf-qa.unl.edu/attachments/ebe1221b57ba0b949bdda0da1d163dab.pdf

Attachment: http://mwrsf-qa.unl.edu/attachments/a31416c9165a0575161bc938eaa37a2a.pdf

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Response

Date: 09-23-2009
Several weeks ago you sent me a considerable amount of information on guardrail posts in concrete and guardrail when used in mow strips.

I have gone thru most of what you sent. There seems to be a range of values for the leave-out area around the posts.

The 2004 report by TTI recommends an 18" x 18" area, which only leaves 9" behind the post, but this was not the MGS. I think I saw somewhere else that it should be as much as 2 feet behind the post.

Using the MGS, what value are you comfortable with from the back of the post to the edge of the leave-out hole? I am thinking of using an 18" x 24" leave-out area, which provides 15" behind the post.

Response

Date: 09-25-2009
A distance of 15" behind the post would be more than adequate. I could comfortably live with 12" as well.

MGS Posts in Asphalt

Question

Date: 08-31-2009

We have a Weigh-in-motion enforcement site being constructed along I-90. The designer proposed essentially widening the asphalt shoulder by 30' for the State Police to use to pull overweight vehicles over to check with portable scales. This area has tapers on each end and is several hundred feet long. The State Police had requested that the area be "protected" with guardrail, so the designer proposed a run of guardrail parallel to the mainline, between the mainline shoulder and the enforcement area. The pavement is 9" asphalt and they are proposing to drive the posts thru it.
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More recently, TTI researchers have continued to develop leave-out alternatives for guardrail posts placed in mow strips. Although that research is continuing or recently completed, I will try to find either a recent progress report and/or draft report that summarizes the most recent findings and acceptable practices for posts placed in mow strips or over subsurface rock (Report Nos. 3 and 4).
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Attachment: http://mwrsf-qa.unl.edu/attachments/35f5ffe9772bde9cdae0c21515308a03.pdf

Attachment: http://mwrsf-qa.unl.edu/attachments/14f828dd0cc4f2794605bb4b6cd7bfcb.pdf

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TCB to Bridge Rail Connection

Question

State: IA
Date: 09-02-2009

As we spoke on the phone, I have a question regarding the roadside TCB to bridge connection utilizing thrie-beam panels. Do you have any rules of thumb regarding how the length of thrie-beam sections should be distributed onto the bridge and the first TCB section? For example, I would like to connect the thrie-beam end shoe to the bridge through existing bolt holes. This would place a significant majority of the thrie-beam length onto the first TCB section (see attached file). Do you see any issues with this approach?

Attachment: http://mwrsf-qa.unl.edu/attachments/f8267cbeceb5b854e171d91784dd9dbf.pdf

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Response

Date: 09-28-2009
The thrie beam connection shown in your schematic should be acceptable and I don't see any problems with the attachment as you have it shown.
The schematic you sent me is acceptable even with a gap as large as 12" between the final PCB and the bridge transition piece as long as the there is only one way traffic on the roadway. We would recommend gaps smaller than 12" if at all possible. If traffic is moving from the PCB's towards the bridge in your schematic, then the chance for snagging on the end of the bride is minimal, and the thrie beam sections should possess sufficient capacity to hold the joint between the bridge transition and the PCB together even with the larger gap.
If the traffic is moving the other direction, we would recommend filling the overlap area with concrete to reduce the snag potential. This is necessary and quite critical. It may be your best option to fill that area for now, but you may want to think about a redesigned transition section in the future to reduce the snag potential. In general, we would recommend not running two way traffic in this type of installation unless the snag issues can be sufficiently eliminated.

Response

Date: 09-29-2009
Upon further inspection, I realized that my scaling was off on the thrie-beam section I showed in my drawing. Having corrected that, and using the dimensions to the existing bolt holes in the bridge rail and a 12-inch gap between the bridge and the first PCB, I am now showing that the thrie-beam piece will extend entirely beyond the first PCB section. I assume this is an issue (maybe not?).

Minimizing the gap between the bridge and the first PCB would allow bolting the rail into both the first and second PCBs. Would this be acceptable? Are there any other spacings or modifications you might recommend, such as using a shorter thrie-beam section?

Attachment: http://mwrsf-qa.unl.edu/attachments/11279963928d24f4a50463b8ac08f448.pdf

Attachment: http://mwrsf-qa.unl.edu/attachments/42d5d3439f7c94018536a3ff5ab55434.pdf

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Response

Date: 10-01-2009
I don't like the idea of extending the thrie beam past the end barrier in either of those schematics. If we do so, the thrie beam is no longer tied to the end barrier. In addition, the 12" gap detail would create a snag hazard on the thrie beam end shoe.

I have attached details of the connection that Florida uses. They have many different variations of the thrie beam connection to permanent railing that they worked out with us when the transition was first developed. Will these details work for you?

Attachment: http://mwrsf-qa.unl.edu/attachments/0212002b5af7d05d30ace2ee731c81bf.pdf

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Response

Date: 10-01-2009
I've been using Florida's details as a guide. Unfortunately, they don't have anything that would solve this particular issue. Since my main goal is to try and utilize the existing bolt holes in the bridge end post, the only other option to make it work would be to use a thrie-beam section SHORTER than 12'-6". What are your thoughts on that?

Response

Date: 10-02-2009
We do not have a problem with using shorter thrie beam sections, such as 6'-3" sections, rather than the 12.5' sections we tested with. We went with the longer section because it was more common.

MGS Guardrail Repair

Question

State: IL
Date: 09-08-2009

Here's some feedback from the field on the MGS. In this case the rail was hit from the back and popped off a longer run. I don't think this is surprising, but would appreciate any comments.
One question this raises, is about re-using the rail element. The only damage appears to be a little deformation around the bolt hole where the button head pulled through. This could probably be straightened in the field.

Attachment: http://mwrsf-qa.unl.edu/attachments/83dac4b0d26b6ca9e1d82da7e61d6cca.JPG

Attachment: http://mwrsf-qa.unl.edu/attachments/8dc5617e244c2816c32f3889e4ba4637.JPG

Attachment: http://mwrsf-qa.unl.edu/attachments/4497bed5fa97acc137a7d7b4f65b2ba1.JPG

Response

Date: 09-08-2009
Thanks for the guardrail damage photographs. From the photographs, I only can see some minor deformation around the guardrail bolt slots. As long as there are not any fractures or cracks around the slotted holes, I am not too concerned about reusing the rail by re-mounting it to the posts/blocks. However, you may consider using the downstream side of the slot if the downstream hole can be used on each blockout/post.

PCB Tie-Down Applications

Question

State: WI
Date: 09-18-2009

I have a few questions about temporary concrete barrier.

1. When installing a crash cushion, should the temporary barriers after the crash cushion be pinned into position?
2. If the crash cushion needs to be pinned, what method should be used if
   a. Traffic is on one side (e.g. a lane shift)
   b. Traffic is on both sides (e.g. in a gore area)
3. In MwRSF, crash testing of a thrie beam transition from temporary barrier to permanent barrier, MwRSF used 4 barrier staked into asphalt. MwRSF also crash tested a temporary barrier run that was attached to a bridge deck using a tie-down strap. Is there a way of using the tie-down strap system to build a transition from temporary barrier to permanent barrier?
4. I believe that at one time I asked this question, the LON point of free standing temporary barrier is 8 pieces. Is this correct?

Response

Date: 09-21-2009
Replies to your questions are below in red.

1. When installing a crash cushion, should the temporary barriers after the crash cushion be pinned into position?

   Typically, we recommend that unprotected ends of TCB systems be extended out of the clear zone in order to reduce impacts with these ends. We also tend to recommend that sufficient barriers be placed outside of the clear zone to provide anchorage for the length of need. However, there are instances when this cannot be done and the end of the barrier system must be protected by some form of crash cushion. In the case of a proprietary crash cushion, we would recommend that you follow their guidelines for connecting the crash cushion to the system. If you are using sand barrels, MwRSF recently completely development of an upstream anchorage for the F-shape TCB used by most of the Pooled Fund states that can be used with sand barrels. We recently sent the draft report of that research out for review and I will have the final draft out by the end of the month. Thus, we are not recommending pinning the barriers at this time.

2. If the crash cushion needs to be pinned, what method should be used if

   a.Traffic is on one side (e.g. a lane shift)
   b.Traffic is on both sides (e.g. in a gore area)

   As mentioned above, we are not recommending that the barrier be pinned at this time.

3. In MwRSF, crash testing of a thrie beam transition from temporary barrier to permanent barrier, MwRSF used 4 barrier staked into asphalt. MwRSF also crash tested a temporary barrier run that was attached to a bridge deck using a tie-down strap. Is there a way of using the tie-down strap system to build a transition from temporary barrier to permanent barrier?

We considered the use of the strap tie-down when we designed the temporary barrier transition especially the median transition because it performs similarly when impacted on either side of the barrier. We abandoned its use in the transition design because it was not possible to make the transition sufficiently stiff as you approach the rigid hazard with the strap tie-down. Recall that the strap tie-down allowed approximately 33 inches of dynamic deflection of the system. This amount of deflection of the system could not be allowed adjacent to the end of the barrier. Thus, no transition design exists using the strap tie-down. I suppose that it could be revisited though.

4. I believe that at one time I asked this question, the LON point of free standing temporary barrier is 8 pieces. Is this correct?

That is correct. Without anchoring the barrier as I mentioned previously, we recommend 8 barriers adjacent to the length of need for anchorage.

Concrete barrier questions-ZOI for SSB and use of taller or vertical walls

Question

State: WI
Date: 09-18-2008

As Part of WisDOTs process to develop a new set of standard detail drawings for concrete barrier, WisDOT requires some additional assistance developing some details.
Issue 1: ZOI for various heights of Single Slope Concrete Barrier:
Reviewing the crash test report on the Single Slope Caltrans barrier did not indicate a ZOI. Discussions with Caltrans indicated that they have performed some crash test, but the report is not final. Not knowing when Caltrans will release the report, WisDOT is in proposing to do the following:
1. Because the slope of the Single slope barrier wall is constant, a vehicle should "ride up" the barrier regardless of wall height the same amount (e.g. if the truck rides up 3" during an impact to a 32" single slope barrier it should ride up 3" during an impact on a 56" barrier). This would allow someone to interpolate working width between two known working widths. In fact taller walls may have less deflection because vehicle contacts the upper part of the barrier, prevents the vehicle from lean on top of the wall.
2. Use the 27" working width of ZOI-2 crash test from MwRSF Research Report No. TRP-03-151-07 as the working width for the Caltrans 32" concrete barrier. Although there are differences between the 32" Caltrans barrier and the barrier used in the ZOI-2 test (ZOI-2 barrier has a narrower top and a flatter front face), WisDOT believes that these differences are small considering the variability of real world crash test.
3. It appears that in the Caltran's crash test of a 56" wall that the pickup truck did not lean over the barrier (i.e. 0 working width).
4. Therefore if one were to use a linear interpolation between working width of the 32" ZOI-2 crash test and the 56" Caltrans, WisDOT could calculate working widths for intermediate barrier heights of 36, 42 and 51.
WisDOT understands that crash testing would be the preferred method to determine working width. However, given MwRSF's experience in crash testing does this procedure sound reasonable? Or, does MwRSF have an alternative suggestion on how WisDOT can determine working width for the various barrier heights?
Issue 2 Use of taller walls or vertical barrier in confined locations:
There are going to be situations were designers, have limited space to install a barrier wall (typically near structures). In these locations, designer cannot get the require working width for a given barrier height or shape. Currently WisDOT allows designers to either install a taller barrier wall or vertical barrier.
Given MwRFS's experience in crash testing, is there a preferred alternative (e.g. install the vertical wall of same height, install a taller single slope wall, install a taller vertical wall...). If there is no general preferred alternative, what other factors should a designer consider when selection a barrier wall in these situations.

Response

Date: 09-19-2009
My responses to your questions are provided below inred.

Issue 1: ZOI for various heights of Single Slope Concrete Barrier:
Reviewing the crash test report on the Single Slope Caltrans barrier did not indicate a ZOI. Discussions with Caltrans indicated that they have performed some crash test, but the report is not final. Not knowing when Caltrans will release the report, WisDOT is in proposing to do the following:

** CALTRANS has several published reports on various crash testing of single-slope concrete and steel barriers using different test levels.

1. Because the slope of the Single slope barrier wall is constant, a vehicle should "ride up" the barrier regardless of wall height the same amount (e.g. if the truck rides up 3" during an impact to a 32" single slope barrier it should ride up 3" during an impact on a 56" barrier). This would allow someone to interpolate working width between two known working widths. In fact taller walls may have less deflection because vehicle contacts the upper part of the barrier, prevents the vehicle from lean on top of the wall.

** Two terms have been noted above " zone of intrusion (ZOI) and working width. The ZOI was termed by MwRSF researchers in a Pooled Fund study and refers to the maximum vehicle extent behind the top front corner of the barrier. ZOI was reported to vary by barrier shape/type and Test Level. Working width is the lateral distance from the original front face/toe of barrier to the greatest of vehicle extent, barrier deflection, or barrier width.

** Using the same test level and identical barriers, the taller barriers have the potential for reduced ZOI. However, the height where this reduction occurs may not be known. Even though the maximum vehicle extent may be reduced with increases in barrier height, the working width could technically increase since the barrier base would be wider.

2. Use the 27" working width of ZOI-2 crash test from MwRSF Research Report No. TRP-03-151-07 as the working width for the Caltrans 32" concrete barrier. Although there are differences between the 32" Caltrans barrier and the barrier used in the ZOI-2 test (ZOI-2 barrier has a narrower top and a flatter front face), WisDOT believes that these differences are small considering the variability of real world crash test.

** The working width for the single-face, single-slope, concrete barrier was approximately 27", as observed for Test ZOI-2 by MwRSF. Recall that this measurement was taken from the front toe of the barrier. Thus, an effective TL-3 ZOI measurement would have been about 21" for this test. The published ZOI value for the prior TL-3 impacts into 32" tall, sloped-face barriers is 18", while 24" was provided for vertical-face barriers. Actually, the single-slope barrier would likely fall between the two noted ZOI values, thus substantiating the 21" measurement from test no. ZOI-2.

3. It appears that in the Caltran's crash test of a 56" wall that the pickup truck did not lean over the barrier (i.e. 0 working width).

** If no truck lean over the top-front corner of the barrier was observed for pickup truck vehicle, then the ZOI would be zero. However, the working width would be the base width of the rigid parapet.

4. Therefore if one were to use a linear interpolation between working width of the 32" ZOI-2 crash test and the 56" Caltrans, WisDOT could calculate working widths for intermediate barrier heights of 36, 42 and 51.

** I am not sure whether you are seeking working widths or ZOIs for the varying height, single-slope barriers. Also, ZOI may not vary linearly as a sudden change may occur at a height sufficient to prevent vehicle extent over the top of the barrier. We would need to review all of the CALTRANS single-slope barrier tests to determine (estimate) the ZOI for each test and then provide a ZOI guide value for a given test level. In addition, MwRSF has shown how crash testing was used to demonstrate that fixed objects could be allowed within the ZOI. Please note that the original ZOI guidance was conservative and based on the premise that fixed objects would not be contacted if outside of the ZOI. However, fixed objects could be placed within the ZOI if proven to not cause undue risk to occupants or pedestrians nearby. Also, it should be noted that the ZOI concept has not been adopted by AASHTO but serves as a could guide to use to improve motorist safety.

** Are you seeking TL-3 or TL-4 ZOI values?

** Does the WsDOT desire to keep all fixed objects outside of the ZOI?

WisDOT understands that crash testing would be the preferred method to determine working width. However, given MwRSF's experience in crash testing does this procedure sound reasonable? Or, does MwRSF have an alternative suggestion on how WisDOT can determine working width for the various barrier heights?

** A preferred procedure would be to first review the single-slope, crash testing reports published by CALTRANS to determine whether the linear approach is reasonable. If it is, then no additional work would be needed. However, it there are concerns with this approach, then MwRSF would need to acquire film/video from CALTRANS to determine more accurate ZOI and/or working width values. This secondary effort may require considerable resources, that of which may quickly utilize a moderate portion of the Year 19 Pooled Fund consulting funding. If this level of effort is required, then we would first need to obtain Pooled Fund approval to proceed.

Issue 2 Use of taller walls or vertical barrier in confined locations:

There are going to be situations were designers, have limited space to install a barrier wall (typically near structures). In these locations, designer cannot get the require working width for a given barrier height or shape. Currently WisDOT allows designers to either install a taller barrier wall or vertical barrier.

Given MwRFS's experience in crash testing, is there a preferred alternative (e.g. install the vertical wall of same height, install a taller single slope wall, install a taller vertical wall...). If there is no general preferred alternative, what other factors should a designer consider when selection a barrier wall in these situations.

** The ZOI and working width measures for a rigid barrier system are generally of little concern when used in medians to prevent cross-median crashes. However, values for ZOI and working width may be more of concern when placed very close to rigid, fixed objects. Before I can answer the question above, it would be helpful to understand the type of hazards that are anticipated to be shielded by the family of single-slope barrier systems. In addition, it is imperative to know what test level is being considered for each barrier variation. Thanks!

** Of course, other factors that warrant consideration when placing these barriers include: end and interior anchorage for the barrier base, safety treatment for the barrier ends, propensity for head ejection out of side windows and head slap against rigid parapets and objected mounted on top or close behind.

Iowa Approach Transition Connection

Question

Date: 09-30-2009

HDR in Chicago, IL had questions regarding the proper connection between the Iowa approach guardrail transition and various concrete parapets.

Response

Date: 09-30-2009

I have reviewed the research and development effort regarding the approach guardrail transition system for safety shape parapets. The original study was funded by the Midwest State's Pooled Fund Program and dated May 15, 1998. The report no. is TRP-03-68-98. I am attaching a link for you to download this report. In the study, it is apparent that five 7/8-in. diameter, ASTM A325 bolts were used to attach the thrie beam end shoe to the parapet with the use of a special steel connector plate with a sloped end to mitigate concerns for vehicle snag. The special steel connector plate was also used to keep the thrie beam vertical and not twisted when attached to the parapet. The final design was crash tested and evaluated with both wood and steel post options and using the NCHRP Report No. 350 impact safety standards.

The file 'TRP-03-69-98.PDF' (7.1 MB) is available for download at

for the next 7 days.

It will be removed after Wednesday, October 7, 2009.

Later, MwRSF performed an additional crash test on the steel post option when completing NCHRP Project No. 22-14(2) which led to the new Manual for Assessing Safety Hardware (MASH) guidelines. One 2270-kg pickup truck crash test was successfully performed on the same design as noted above. The report no. is TRP-03-175-06 and dated October 12, 2006. I have attached a link for you to download the noted report. Once again, five 7/8-in. diameter, ASTM A325 bolts were used to attach the thrie beam end shoe to the parapet with the use of a special steel connector plate with a sloped end to mitigate concerns for vehicle snag.

The file 'TRP-03-175-06.pdf' (9.0 MB) is available for download at

for the next 7 days.

It will be removed after Wednesday, October 7, 2009.

In the pdf file that you had provided, it was apparent that the thrie beam end shoe was blocked out off of the parapet with a wood shim block. You also noted that the end shoe was attached using five ¾-in. diameter, ASTM A307 bolts. Both the shim block and bolt hardware differ from the crash tested system details.

At this time, I am unaware of any successful crash testing on thrie beam approach guardrail transitions where the thrie beam end shoe has been twisted to match the slope of the upper parapet region. As such, it is my opinion that the existing crashworthy design details should be utilized when installing this transition system. For trailing end locations, the wood shim block would potentially lead to vehicle snag on the raised end shoe. Thus, the wood shim block should be replaced with the special, sloped, steel connector plate to mitigate snag concerns and to comply with the design that received FHWA acceptance. Second, the use of a special steel connector plate can cause some of the connection bolts to be subjected to combined loading " shear and bending. With that in mind, the five bolts were upgraded in the crash tested design and utilized 7/8-in. diameter, ASTM A325 hardware. In the absence of any other test results, it is my opinion that the connection hardware should comply with that utilized in the crash testing program.

Attachment: http://mwrsf-qa.unl.edu/attachments/ccb97e30c3d893229fc9c3ff5084e906.jpg

Attachment: http://mwrsf-qa.unl.edu/attachments/1e2fc4eefdf93e4de00ba97ebd7f3904.jpg

Attachment: http://mwrsf-qa.unl.edu/attachments/4c46d4afd2e53be6d1b460d653de6333.jpg

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Response

Date: 09-30-2009

Thank you for the response. One thing I just noticed was that the detail I sent you has been changed by the Illinois DOT. The one I sent you was dated January 1, 2007 as and was the correct detail at the time our project was let (designed). Without changing everything, and since the guardrail was placed in accordance with the appropriate standard I would like to go ahead and remove the wood shim on the trailing side of the guardrail only.

If we have a vertical face on our parapet, I believe we do not need a shim plate at all, is this correct?

If we have an F-shape parapet then the trailing side should have the shim plate attached to this e-mail inserted and the bolts should be increased to 7/8". Correct?

Response

Date: 09-30-2009

You are correct. The steel connector plate would not be needed when the transition is attached to a vertical concrete parapet. However, the 4-in. lip curb was required by FHWA as it was included in the testing program.

The attachment bolts are to be 7/8-in. diameter and ASTM A325 bolts or equivalent. Also, the steel connector plate is required for NJ, F, and single slope barriers. We have developed one for NJ and SS shapes.

Slight modification may be needed for F shapes.
