Midwest States Pooled Fund Program Consulting Quarterly Summary

Midwest Roadside Safety Facility

04-01-2008 to 07-01-2008

Strong Post W Beam Guardrail Placed Adjacent to Steep Slope

Question

State: SD
Date: 04-09-2008

We have a situation as shown in the pdf. Please provide guidance or a recommendation regarding the W Beam Guardrail Wood post spacing and length of posts. This situation did not fall into the categories as stated on pages 28 and 29 of the recent Pooled Fund Quarterly Report.

Attachment: https://mwrsf-qa.unl.edu/attachments/7ea0459146a113fee673d43d9eef8047.pdf

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Response

Date: 04-11-2008
I looked at your schematic of the w-beam guardrail installation on what appears to be a 3:1 slope with a 1:1 or a 2:1 slope behind it. Missouri had a similar issue in the past. We recommended to them that they use 9' posts at ½ post spacing (3'-1 ½"). I have attached the detail they made based on this recommendation.
We would recommend a similar post length and spacing for your installation.
I looked at the energy of the TL-2 impact, and I believe that you can use 7' long post at ½ post spacing in this installation for TL-2. That should help you out quite a bit.

Beam Guard Question

Question

State: WI
Date: 04-15-2008

I have to beam guard questions.
1. What is the deflection distance for a standard beam guard system using 7'
long steel post spaced at 3' 1.5" on a 2:1 slope that starts at the middle of the steel post?
2. I've been trying to find the crash test report from TTI that used an asphalt curb near beam guard. Unfortunately, I and our library staff are having a hard time finding a copy of this report. Does MwRSF have a copy?
Could MwRSF provide me with a PDF detail of the curb and gutter and its'
installation near the beam guard?
I believe the report was titled: "NCHRP 350 Test 3-11 on the G4 (2W) Strong Post Beam Guard with 100mm High Asphalt Curb" done by Bullard and Menges.

Response

Date: 04-16-2008
Within the report/paper, I have found that the dynamic deflection of the barrier system on a 2:1 slope was found to be 821 mm (32.3). I do not have a working width value at this time.
I do not have a pdf copy of the TTI report. I know we have a copy of the report in our library somewhere. I will look for it and find the number you are seeking.

Cable Guardrail Next to Slopes

Question

State: WY
Date: 04-15-2008

I know the pooled fund did a crash test and report with low tension cable guardrail placed in four feet in front of a 1V:1 1/2H slope using a four foot post spacing. Is it possible to correlate your results to a high tension cable guardrail system. For example, we are using Trinity's TL-3 system with the C-Channel post. Deflection is reported to be 9 ft. at a standard post spacing of 16'-6". I was wondering what post spacing would be necessary for it to work similar to MwRSF's test.
I know the reported deflection in the crash test was around 9 feet, but I also remember Dean Sicking saying deflection is greater on a slope than flat ground, therefor presumably the low tension system would have been a bit stiffer than the 9 foot deflection as seen in the slope test.

Our field guys are wanting to use some high tension cable barrier for shoulder applications so we need to develop some criteria.

Response

Date: 04-29-2008
I have reviewed your request for guidance on placement of the CASS system adjacent to steep slopes. You stated that you are using the CASS with 16'-6" (5-m) post spacing. Review of the FHWA approval letter for the CASS with that configuration showed that the CASS system had a dynamic deflection of 2.8 m. The CASS uses a top cable height of 750 mm and a C-section post embedded 813-mm into the soil. The system is a high tension system.
The cable adjacent to steep slope research at MwRSF was conducted on a low-tension cable system with a top cable height of 813 mm. The system used S3x5.7 posts with 813-mm embedment and a 203-mm wide soil plate. Post spacing for the system was 1.22-m (4'), and the system was offset 1.22-m from the slope breakpoint. Dynamic deflection for this system was approximately 3.16 m.
Comparison of the two systems shows that the MwRSF system had a top cable height approximately 63-mm (2.5") higher than that of the CASS and had 1/4 post spacing. While the two systems displayed similar dynamic deflections, the CASS system was tested on a relatively short installation on flat ground, while the MwRSF low-tension system was tested with a 494-ft installation adjacent to a steep slope. Thus, we expect that the deflection for the CASS system would increase if installed under similar conditions.
In order for the CASS system to function safely adjacent to a steep slope, the deflection of the system may need to be reduced in order to assume that the the cables effectively interlock with the front and rear corners of the vehicle. Because the CASS has a lower top cable height and we expect the it to have higher deflections in this type of installation, as mentioned above, we would recommend a reduced post spacing for the CASS with a 1.22-m offset from the slope similar to the MwRSF testing. The CASS has been successfully tested with reduced post spacing's of 2-m and 3-m with dynamic deflections of 2.06-m and 2.4-m, respectively. We could recommend that CASS systems adjacent to steep slopes use the 3-m post spacing with a 1.22-m offset from the slope breakpoint. While this recommendation is believed to be conservative, it should account for the effect of the lower cable height on capture and the higher deflections expected for the CASS when installed adjacent to a slope.

Response

Date: 04-29-2008
Great analysis! That was the recommendation I was looking for. I would rather be a little on the conservative side without actually crash testing.

One additional question I have. Has there been any evaluation as to what a minimum post spacing would be for the S3x5.7 post (both for cable and other applications)? We use that post for box beam guardrail as well. We have usually regarded 4 ft. as the minimum spacing. Does that sound appropriate? I realize it may depend on the post release mechanism. It appears it worked well on the low tension cable system, but that was the pickup test. I thought I saw one state specify up to a 3 ft. spacing to limit deflections, that seems a little much.

Response

Date: 04-30-2008
To my knowledge, there has been no cable testing with post spacing less than 4 ft. I have always recommended this as a minimum spacing to limit the possibility of post interaction. When we tested closely spaced flanged channel u-posts for mail box supports, we saw interaction that produced rollover in a small car. If I recall correctly, this behavior disappeared at a spacing of about 4 ft.

Hence we would recommend a 4 ft minimum spacing.

Any other input is welcome.

FHWA Short Radius Beam Guard Technical Memo

Question

State: WI
Date: 05-28-2008

I have some questions about the FHWA short radius beam guard technical memo. From the FHWA technical memo the top of rail is 27 1/8" from the ground. The Roadside Design Guide indicates that the top of a beam guard rail should be 27" or 28" (page 5-13 Roadside Design Guide and Figure B4.b in Appendix B) from the ground. WisDOT standard detail drawing uses a top rail height of 27 3/4".
Would it be acceptable to adjust the rail height of the FHWA short radius system to match WisDOT's use of the 27 3/4" rail height?
If WisDOT would switch to the MGS system, would it be acceptable to adjust the top of rail height for the FHWA technical memo to match the 31" of the MGS system? Because the MGS system places the lap of the rail in the middle of the span between posts, would the FHWA short radius system need to be lapped similarly?
Are the specifications for the Wood Break Away Post on page 10 of the FHWA technical memo standard for all Wood Break Away Post (e.g. stress grade...)?
Are there standards for the CRT and regular beam guard post similar to the Wood Break Away Post (e.g. stress grade...)?
The FHWA details are using "A Guide to Standardized Highway Barrier Rail Hardware from 1979. I assume that this book was the previous guide for "A Guide to Standardized Highway Barrier Hardware". The problem I'm having is that the old nomenclature used in 1979 is not synchronized with the Online barrier hardware guide at:
http://aashtotf13.tamu.edu/Guide/nameindex2.html
For an example F-3 from the FHWA technical memo does not match any of the fastener hardware designations in the online manual. Is there a translation key from the 1979 manual to the online version (i.e F-3 in the tech memo = FBB04)?
I was reviewing the Yuma County detail, I assume that the two CRT post that are 2-3 feet behind the railing are there to slow impact vehicle. Would a similar set up of CRT posts help prevent the pick-up truck from sliding over the thrie beam rail in the MwRSF thrie beam system?
I'm guessing that MwRSF has looked into adding multiple CRT post behind the rail like Yuma County and decided that it would not work. I would appreciate it if MwRSF could explain to me why the addition of CRT post behind the rail would not work with the MwRSF thrie beam system, or how the Yuma system uses the CRT post behind the rail during an impact. I'm just trying to get a better handle on how these systems work.

Response

Date: 05-29-2008
I have some replies to your short-radius questions.
First, we cannot recommend changing the height of the Yuma County short radius guardrail. We do not have any basis for evaluating the effects of the change in rail height, and our estimation of the effects of any change in rail height would be extremely limited. We know that changing the height will affect the capture of sedans that the system was designed for as well as the capture of small car and pickup truck size vehicles. Thus, without further analysis, we would recommend leaving the rail height as stated in the memo.

Similarly we could not recommend a change to the 31" rail height of the MGS system. One of the critical issues in the design of a short radius system is capture of the vehicles. This is why our current design uses a slotted thrie beam section as the rail element. We want to maximize the ability of the system to capture both small cars and larger cg vehicles. We have seen in our current design that we are near the limit for effectively capturing the small car even with thrie beam. Thus, we would not recommend raising he w-beam height on the FHWA recommended system.

The posts shown on page 10 are standard BCT end terminal posts, so you can feel free to use whatever post spec you usually use when calling out BCT posts.

We did look at placing a series of posts behind the system in order to further slow down the vehicle, but we did not pursue it for two main reasons.

1. Testing with the small car vehicle showed that we are currently at or near the occupant risk limit for the small car. AS such, putting more posts behind the system will increase the deceleration of the small car and be detrimental.
2. We have shown in our pickup truck testing that we have issues with debris build up causing vehicle instability. As such, we were leery of placing more posts in the system and creating more debris.

The Yuma county system is old and did not have to meet our more stringent test demands with two vehicles. They used the extra posts to increase vehicle deceleration, but that is not a good option for our system.

Temporary Barrier Anchorage in Medians

Question

State: WI
Date: 05-29-2008

On a project on the interstate, a designer has indicated that the barriers need to be pinned to the concrete when traffic is on both sides of the barrier. Given that this is on the interstate (high speeds and ADT) the designer does not want the barrier to be deflected near the already narrow roadway lanes. I happen to think that the designer is making the right call in this situation.
The contractor has asked if they need to pin the barrier and install the connection pin. I don't there is much of an option about installing the connecting pin between barriers. I also, given the importance of the facility (main highway between Milwaukee and Madision and in the Milwaukee Metro area), I don't want to see the facility completely shut down because a barrier deflected too close to a lane.
Currently, WisDOT has only directions to pin the barrier when traffic is on one side of the barrier (see attached SDD sheets). Would the pinning requirements be the same for traffic on both sides of the barrier? If MwRSF could provide guidance on pinning the barrier in both directions it would be appreciated.

Response

Date: 05-29-2008
I have some recommendations/guidance with respect to your TCB installation issues.

1. Currently, we do not recommend pinning or anchoring both side of the TCB in a tie-down application. Anchoring the barrier on the both sides creates a pivot point on the non-impacted side of the barrier that promotes barrier rotation and tipping and thus promotes vehicle instability. We cannot eliminate this concern without further analysis and/or testing, so we would strongly recommend against it.
2. We do not believe that you need to tie-down the barriers in the installation shown. The installation in the detail has three 11' wide lanes separated by a 6' space between the opposing traffic lanes for the separating TCB. In MwRSF Research Report No. TRP-03-113-03 (attached), we recommend that the pooled fund states TCB can be installed with the assumption of a 2' deflection based on the 85th percentile impact expected. The 2' deflection is based on modeling with the impact conditions for the 85th percentile impact severity based on accident data. The basic argument behind the recommendation is that most impact in the work zone do not generate barrier deflections as large as those observed in full-scale crash tests. You have room for the 2' of deflection recommended in your 6' separation area.
3. In addition, potential higher deflections are not believed to be as critical for several reason in the type of installation you have. First, you have 11' wide lanes and vehicles tend to drive near the middle of those lanes not near the edge. This is much more prevalent in work zones were drivers tend to be more cautious and shy away from the barriers when placed close to the travel lane. This has been proven in an accident study in Iowa where they looked at accident rates in work zones when the barriers were placed very close to traffic. The accident frequency was very low. Then they moved the barriers farther away from the traffic and the accident rate increased. The outcome of the study found that placing barriers within 6' of traffic reduced the impact frequency and severity. Because of this factor, you effectively have more than the required two feet need for deflection.

4. Although larger deflections could begin to intrude into the normal paths of oncoming traffic, the risk of an accident involving opposing traffic is still relatively low. Even when a vehicle in the opposing lane strikes a deflected barrier, the impact angle associated with any resulting crash would be expected to be extremely low. For this situation, the consequences of exceeding the deflection limit are not catastrophic.

Based on my comments above, we would recommend that you use free-standing PCB's in the installation you have shown. We believe that free-standing barriers will provide adequate protection without intruding into adjacent lanes in an unsafe manner.

High-Tension Cable Barrier

Question

State: WI
Date: 05-29-2008

We have been contacted by Gibraltar about requiring the maximum post spacing of cable barriers being 15'. We based our 15-foot maximum post spacing (as many other states have) on an FHWA memo. Gibraltar has provided me with an email from the FHWA indicating that 20 foot spacing is O.K. based on crash testing.
Gibraltar is also indicating that it and other manufactures of HTCG believe that close post spacing leads to underrides. I was wondering what is MwRSF's opinion on post spacing and if narrower post spacing is leading to under rides?
Also we have required that the fittings for our cable barrier project have a minimum breaking strength of 39,000 lbs. Gibraltar is indicating that there are no fittings that meet the 39,000 lbs breaking strength. They do indicate that the 1-inch fittings have a 36,000 lbs breaking strength. They are also indicating that they have miles of cable barrier with 3/4-inch fittings (breaking strength of 26,000 lbs) that are working fine.
Personally, "a chain is only as strong as its' weakest link" is my theory (i.e. use 1-inch fittings) and I believe Dr. Faller and I have exchanged some emails on this topic. However, with information about cable barrier changing so fast, I wanted to make sure that I had the most current research on this topic.

Response

Date: 05-29-2008

1. I strongly disagree withGibraltar's opinion about close post spacing leading to under ride. In fact, I believe just the opposite, long post spacing is likely more to lead to under ride. I would like to hear any support they have for such a claim. ALthough we recommend a 16' maximum rather than 15', I think that in this range, shorter is generally better.

2. Couplers (splice components) rated at 26,000 lbs are too weak.
   We have tested these and they are much weaker than the cable.
   We tested Bennet Bolt's non-proprietary, reinforced couplers and found them to be as strong as the cable system (about 40kip dynamic).

3. The 3/4" end fittings are also too weak.

4. Make sure you specify that all connections should have strengths comparable to the cable, about 38-39Kips. These could be dynamic strengths, if necessary.

TL-5 Barrier Height

Question

State: WI
Date: 06-16-2008

Our structures department is in the process of developing guidance for their bridge designers. To comply with LRFD, the are asking me for a 54" tall TL5 barrier. Does MwRSF know of any TL5 crash tested barriers that are 54" tall?
Is it possible to modify the MwRSF TL5 barrier to be 54" tall? Does it make much sense to construct a 54" tall barrier verses a 42" barrier to protect a pier from a semi truck leaning over and striking the pier of a bridge? How far has TTI gotten with their research on the LRFD 400 KIP load requirement?

Response

Date: 06-19-2008
To date, I am aware of one TL-5 barrier that was 54 in. tall and one TL-6 barrier that was 90 in. tall. These barriers are described and referenced in MwRSF Research Report No. TRP-03-149-04. A copy of this report is included in this email. Other TL-5 barriers are noted in this report as well. MwRSF developed two TL-5 bridge railings and median barriers that are not included in this report. Those barrier systems and associated reports have been sent to you previously. If you need additional copies, I can send them to you in pdf format.
For the MwRSF barrier, a 54 in. median version could be developed as long as the additional height did not penetrate the head ejection envelope. This change would cause the barrier width to increase significantly and without knowledge as to how much trailer lean would still occur over the barrier.
The upper barrier section would also get more complex and costly. What distance is available from the front face of a barrier to the front face of a pier? Are you more concerned with vehicles hitting the piers head on or from allowing the box to lean over and snag on the pier? Remember that the box lean will not impart as high as a load as would a head-on impact. Head on impacts could be prevent using long TL-5 barriers that provide adequate length of need protection. I recall that we had 1 or 2 Pooled Fund problem statements that addressed this issue but were held back to wait for the TTI/TxDOT study to be completed.
I received a note from Gene Buth with regard to the site where updates can be found pertaining to the TTI/TxDOT pier protection project. See link below:
It is TPF-5(106) and it is at:
http://www.pooledfund.org/projectdetails.asp?id=338&status=6

Attachment: https://mwrsf-qa.unl.edu/attachments/37421300c9eaba095e5af67fe5714735.pdf

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Thrie Beam Bridge Rail Termination

Question

State: WI
Date: 06-23-2008

Attached is a photo of a thrie beam bridge rail attached to a box culvert.
I was told that because this is a bridge rail, it does not need to have an end treatment on the downstream end to transfer the force of an impact to the ground. Is this correct? Or should it be treated with a transition, a section of guard rail and then a terminal that has a cable attached to some ground tubes?

Attachment: https://mwrsf-qa.unl.edu/attachments/f41b7c0322413175330bf6c5536ba653.jpg

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Response

Date: 06-23-2008
My first question is whether this bridge rail can be impacted by reverse direction traffic? If yes, then the bridge end requires treatment, likely occurring from an approach rail and guardrail end terminal. If not, then we can move on to the next question.

If this bridge rail was designed to redirect errant vehicles through membrane action (tensile capacity), moment transfer through rail/posts, and shear transfer, then downstream anchorage would be need to be provided. If hazard shielding is required within a few spans from the end of the barrier system but without anchorage, the rail system may not be capable of performing in an acceptable manner.
For rigid bridge railing systems that provide additional strength near the ends, downstream approaches may not necessarily be needed but would need to be determined based on the individual design.

Barrier Design for Off Road Applications

Question

State: WI
Date: 06-26-2008

I was doing some digging around in our library and found MwRSF's report on "Development of a Temporary Barrier System for Off Road applications".
Some questions:

1. Will the ski design attach to the current MwRSF barrier design?
2. What modifications are necessary for the barrier to accept the ski design?
3. What slopes would the ski design be acceptable to be installed on?
4. What is the working width of the barrier with the skis on it?

Response

Date: 06-26-2008
The ski-type backup system was developed for the Iowa F-shape temporary concrete barrier. The Iowa TCB was developed for the Pooled fund program in the mid-1900s. Later, the vertical holes in the toes were modified for the KS and FL versions of this barrier as well as the reinforcement surrounding the vertical holes. Horizontal lifting holes may also have been changed or eliminated. In addition, the TCB had undergone some standardization using comments from the Midwest states.
With regards to the ski attachment, this system has a strong potential for being used with the standardized TCB, now referred to as the KS/FL F-shape TCB. To be sure, we will need to evaluate the changes made to the barrier over the last decade. I will ask Karla, Bob, or Scott to review these changes for you next week and report back to you.
The TCB ski system was tested and evaluated on level terrain. Since the system is designed to resist barrier rotation, it may be reasonable to assume that it would perform in an acceptable manner when placed on roadside slopes on 1:12, or possibly 1:10. However, it would be recommended that the barrier be propped up to be perpendicular to level terrain by using the screw-jack system that is part of the ski hardware.
Since working width was likely not reported when this research was conducted, we would need to evaluate the overhead film data to determine the working width. Recall that working width is measured from the front face the barrier (toe) to the farther part of the barrier or vehicle during redirection. The back of the ski hardware would likely be this point. I will have our staff also determine this value.
