Midwest States Pooled Fund Program Consulting Quarterly Summary

Midwest Roadside Safety Facility

10-01-2008 to 12-31-2008

Caltrans Barrier Request

Question

State: WI
Date: 09-30-2008

Has MwRSF looked into :
1. TL-3 Working widths for various heights of caltrans barrier?
2. A recommendation on what to do near fixed objects (e.g. go with taller barrier, go with vertical barrier, go with taller and vertical barrier) in areas where working width is reduced?

Response

Date: 10-02-2008
MwRSF has reviewed available information on the working widths and zone-of-intrusion (ZOI) values for the single-slope, concrete barriers evaluated by MwRSF and CALTRANS. Based on this information, the working width and zone-of-intrusion measures for the 32-in. tall, single-slope barrier are approximately 27 and 21 in., respectively. 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. The maximum effective height for this lateral extent was nearly 42 in. As such, a conservative approximation would be to use the 27-in. working width value from 32 to 42 in. Beyond the 42-in. barrier height, the ZOI would be approximately zero for TL-3 conditions and valid through the 56-in. barrier height. Thus, the working width for 42 to 56-in. tall, single-slope barriers would be the base barrier width or 24 in.
Please note that these ZOI values provide conservative results for the placement of fixed objects on and nearby the barrier system. Actually, a fixed object could be placed closer to the top-front corner of the barrier as long as acceptable crash performance was obtained.
Previously, MwRSF provided guidance for selecting the top geometry of taller vertical, or near vertical barriers, in an effort to prevent head contact with tall barriers. A head ejection envelope was provided. However, guidance was not provided for sloped-face barriers in terms of the recommended top-barrier geometry or head ejection envelope.
In summary, here are my suggestions:
SS Barrier Height WW ZOI
32" 27 21
36" 27 (assumed) ?? (measured from top front corner but unknown)
42" (27 (assumed) ?? (measured from top front corner but unknown)

42" (>) 24 (barrier width) 0
51" 24 (barrier width) 0
56" 24 (barrier width) 0
Vertical Barrier Height
32" 24 24 (vertical barrier has toe and front corner at same position)

IaDOT Questions

Question

State: IA
Date: 09-30-2008

1. Do you have a recommendation regarding the partial use of an existing w-beam bullnose installation? Specifically, we have a situation where an existing bullnose is protecting the open area in the median between two bridges. One of the bridges is being replaced and traffic will be head-to-head on the remaining bridge. So some of the bullnose will need to be removed in order for the contractor to replace the bridge. Question: how much, if any, of the remaining bullnose installation can we use as a standalone guardrail installation for the head-to-head traffic during the construction period? This would not be used long-term following construction.
2. I have attached a drawing of a bracket used to connect high tension cable to a concrete barrier or bridge end. Our intent is to use these brackets on the trailing end of bridges, instead of a ground anchor, to provide continuous protection for errant vehicles. For continuous median installations, this bracket would be located beyond the clear zone for opposing traffic. The manufacturer has informed me that the bracket is the same one that is used on a ground anchor, and it is almost identical to a low-tension bracket used by South Dakota (detail attached), but with larger bolt holes. This cable attachment portion of the bracket would be located behind the bridge rail where it cannot be hit. However, part of the bracket is exposed on the front side of the bridge rail and could possibly be a snag point. I was hoping you could give me your opinion on this design in general. Also, I would like to know whether you feel this setup would require additional crash testing. The manufacturer has told me that since this is an anchor, and not a terminal, that crash testing is not required.
3. I have also attached a drawing of what we call our "Permanent Road Closure Barricade." The design is based on that of a Type III Barricade. However, this design has more than two posts and the rails extend entirely across the width of the road. We are in the process of updating the drawing, and I am questioning the crashworthiness of this design. Specifically, I was unable to find any crashworthy Type III Barricades that were wider than 8 feet. Or is this barrier not subject to that restriction since it is not used in a work zone? Additionally, the change we are making to the drawing is a result of the reflective sheeting peeling off some of the installations. To combat this, we are proposing to have the sheeting applied to thin aluminum sign stock and that, in turn, would be bolted to the rails of the barricade. Would this change the structural integrity of the barricade and if so, the requirement that it be crash tested?

Response

Date: 10-03-2008

1. Please send us details of the W-beam bullnose system along with a description of how much of the system is desired to be removed and/or detached from the bridge. Once we have this information, we will review the design and test reports to determine if your proposed changes would affect the results of those observed in testing.

2. The cable bracket is depicted on the front face of the parapet near the downstream end. This type of bracket would appear to provide concerns for vehicle snag on the bracket and anchored cables. You noted that it would be on the back-side face even though it is shown on the front face. It would be cleaner to attach the bracket on the back side. You note that the manufacturer stated the bracket is nearly identical to the SD DOT bracket used on low-tension designs and identical to their own ground anchor for HT or LT designs? The manufacturer plans to use this on high-tension designs as part of a system. If it already has been evaluated in HT cable barrier testing, then I do not see an issue with structural capacity. If it has not, then the manufacturer would need to provide some assurance that it would also work with HT systems through calculations, components tests, full-scale test, etc. The downstream cable anchorage scenario would not likely need to be re-tested as it is a rigid barrier transitioning into a flexible barrier.
3. I am not aware of any crash testing on such a design but will have a staff member review the designs and then get back to you.

Attachment: https://mwrsf-qa.unl.edu/attachments/512a4a6f3f8e42093dfe3297b33d72b6.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/e3b119a5bf2c50171fcedfd9395e4a14.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/69bf9f10342f92330803d4fc24915c8e.pdf

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Response

Date: 10-07-2008

I have attached details of our W-Beam bullnose system. We would like to be able to utilize half of the existing installation (shown as the "T" distance on RE-67) when traffic is head-to-head on the side of the roadway near the top of the page. I am unsure whether we would need to leave the 5-foot radius end section attached, or if we would need to replace that with some other type of end terminal.

Attachment: https://mwrsf-qa.unl.edu/attachments/6bd130bac52e2894ea2266d28617fa2e.jpg

Attachment: https://mwrsf-qa.unl.edu/attachments/533035b032cf6780c82f7b1f2623439d.jpg

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Response

Date: 10-30-2008

I have reviewed the materials that you have provided. Based on this review, I offer the following comments. First, I understand that two-way traffic will be utilizing the lanes provided at the top of the page (page RE-67), while the bridge at the bottom of the page is being replaced. As such, the hazard between the twin bridges still requires shielding. As I see it, you have two basic options.

Option 1 consists of removing the bullnose buffer end and guardail sections that connect the bullnose barrier to the lower bridge end. Once that material is removed, a crashworthy guardrail end terminal and anchorage system would be connected to the guardrail system shown at the top of the page. The flared guardrail length would be selected such that the system provides adequate shielding of the median hazard.

Option 2 consists of removing a portion of the lower approach guardrail transition (i.e., the section connecting the bullnose guardrail to the lower bridge end). The "STS" segment, measuring approximately 18.75' in length, could be removed to allow construction of the new bridge. Then, in the first two spans of remaining rail, an approved anchorage system could be installed such that anchorage is provided in both directions, thus simulating a rigid attachment to the bridge end. If this option is desirable, we could assist with this detail.

The basic design consists of a standard foundation tube with soil plate at the last two wood BCT posts. A standard steel channel strut is connected between the two posts/steel sleeves. No impact head would be needed in this region as no crashes would be expected at this far end and since the bridge/road is closed. Standard anchor cable hardware would be placed between the two wood posts and in both directions (reverse cables in first span). You would need to drill an extra set of holes to place the second cable anchor bracket on the rail close to the top of post 1, similar to that near the top of post 2. Now the rail would be anchored in both directions " tension and compression, thus simulating a rigid attachment to the bridge end. We have done this in our thrie beam bullnose testing as well as in recent box beam testing when we were unsure with load direction would occur.

I am enclosing CAD details for a new MnDOT bullnose R&D project currently within MwRSF. For this effort, we have placed both the standard and reverse direction cable anchorages on the downstream end. In prior bullnose testing efforts, we switched the direction of the single cable anchorage from one test to another. In future testing, we will place two anchor cables on the downstream end " one in each direction.

It should be noted that this double anchorage should be used on any bullnose design that incorporates a free end that requires anchorage.

Our CAD details show the use of a 6-ft long tube without a soil plate but with a channel strut between two tubes. An alternative would be to use the shorter BCT tubes that incorporate soil plates and use the channel strut.

Sloped End Treatment for a Raised Median

Question

State: MN
Date: 10-14-2008

We are requesting guidance on the use of a sloped end treatment for concrete barrier installed on a raised median.
Attached is a PDF file containing all the geometric information you wanted. This file has 3 pages, showing different information. Page one (35 MPH) and page two (50 MPH) are the locations we need recommendations for. Page three is the entire project.
FYI - Curbs are vertical faced and 4 to 6 inches tall.

Attachment: https://mwrsf-qa.unl.edu/attachments/34a855ab27416c4b3df0f4e749738772.pdf

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Response

Date: 10-14-2008
Thanks for the layout drawings and median barrier drawings. Based on what I have seen, I have some recommendations.

1. Given you installation speeds and median barrier type, we cannot recommend that you use a sloped concrete end terminal for the installations you have shown. Previous computer simulations of the sloped end treatment, as shown in NCHRP Report 358, found that the sloped end treatment for a 32" high barrier can cause overturn of the vehicle for impact speeds of 30 mph or greater. Both of your installations have designs speeds over 30 mph, so this is not likely to be a good alternative for you. In addition, used of the sloped end would have required removal of the median curb in front of the end treatment for approximately 65' in order to prevent interaction with the curb front affecting the terminal performance. This would have placed an significant gap between the end terminal and the median curb that I don't believe you would like.
2. One alternative option would be to install the available low height TL-2 barriers rather than your current 32" design. These systems have available sloped end terminals that have been tested to TL-2.We can help get you details on these systems if you would like them.
3. The only other alternative that we have is to install a crash cushion on the end of the barrier. However, you would need to consult with the manufacturer with regards to there use with you median layout.

Tie-Down Temporary Barrier with Asphalt Overlay â€" Additional Options

Question

Date: 10-16-2008

I recently received a copy through AASHTO TCRS of the Progress Report for Third Quarter of the Midwest States Regional Pooled Fund Program dated September 15/08. I note your answer and detail for a pipe sleeve under Problem #10 to address the asphalt overlay issue we had discussed previously. Is a 3" asphalt overlay the absolute maximum thickness for this detail or could the thickness of the overlay be increased at least to 4", or even 6"?

Response

Date: 10-17-2008

The bolt through tie-down in asphalt retrofit we came up with should work for deeper asphalt depths if needed. The issue is that the pipe size needed and thus the hole in the concrete becomes larger. I have come up with tube specs for larger asphalt depths. There is a spec for the smallest tube size I could make work as well as the smallest standard schedule pipe I could find. These pipes were sized based on expected maximum shear and bending loads expected.

For 4" asphalt

1. 4" Schedule 100 pipe (yield strength = 35 ksi) 2. 3.25" OD x 0.625" thick x 2.00" ID 1026 CD round tube (yield strength = 72 ksi)

For 6" asphalt

1. 5" Schedule 100 pipe (yield strength = 35 ksi) 2. 3.75" OD x 0.625" thick x 2.5" ID DOM (Drawn Over Mandrel) round tube (yield strength = 75 ksi)

Another thing to note is that the larger tube sizes shown here will require a corresponding increase in the plate washers used in the system.

Tie-Down Temporary Barrier with Asphalt Overlay

Question

State: WI
Date: 11-03-2008

I was asked by a construction engineer, if it O.K. to bolt the 12.5-foot temporary concrete barrier to a bridge deck that has an asphalt overlay.
Currently, our detail does not allow this. Why does the barrier need to rest on concrete? If there is an asphalt overlay on the bridge deck, is there some other modification to the design that we should do?

Response

Date: 11-03-2008
Our concern with installation the bolt-through tie-down in asphalt is that the asphalt increases the moment arm on the bolt and the corresponding bending stresses. We have come up with a retrofit using a pipe sleeve in the asphalt and concrete that should eliminate this issue. See the attached schematic.

Attachment: https://mwrsf-qa.unl.edu/attachments/b39d2b7e717776c3338d365d211c9855.jpg

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Cable Guardrail Next to Slopes

Question

State: WY
Date: 11-04-2008

Since MwRSF did the testing on flat ground with the low tension cable system, would you change your recommendation if the cable was placed on 1V:6H or 1V:8H slopes in front of and up to 4 ft. behind the cable before starting on a 1V:2H fill slope. It would seem the vehicle would strike the barrier higher, so it may be necessary to constrain deflection even more.

Response

Date: 02-24-2012

I have reviewed you question regarding the use of the CASS adjacent to a steep slope with an 1:6H or 1:8H approach slope.

Previously we had given you guidance for using the CASS adjacent to a steep slope. We had suggested using a 4ft offset to the slope and reducing the post spacing of the CASS to 3 m. Your new question was whether or not these recommendations would hold true when the cable barrier was installed on a 1:6H or 1:8H approach slope. In order to address this issue, I looked into the performance of the CASS system, analysis of bumper trajectories for 2000P pickup trucks encroaching on approach slopes, and previous testing of cable barrier on approach slopes. Based on this analysis I have the following comments.

1. We have concerns with placement of the CASS on a 1:6H approach slope adjacent to a steep slope. This concern is based on effective capture of the vehicle by the CASS system. Previous testing was conducted on 30" high, low-tension cable barrier placed on a 1:6H slope with a 6 ft offset from the edge of shoulder. Two tests were conducted. The first was a test (3569-5) of a 1974 Plymouth sedan that weighed 4500 lbs and impacted the barrier at 59.6 mph and an angle of 24.75 degrees. The second test (3569-6) was a test of a 1974 Chevy Vega that weighed 2250 lbs and impacted the barrier at 58.4 mph and an angle of 17.25 degrees. Both of these tests showed safe redirection of the vehicle. However, the sedan and small car vehicles in this testing had bumper heights of approximately 18". Typical bumper heights for the 2000P and 2270P vehicles are around 26". Thus, there is concern that the capture and redirection of the vehicles observed in these tests would not be as likely with the higher bumper heights of the current test vehicles and vehicle fleet. The RDG recommendations for approach slopes are based on this testing, but do not take into account the higher bumper heights and CG heights of the current vehicle fleet. The reference for this testing is given below.

Ross, H.E., Smith, D.G., Sicking, D.L., and Hall, P.R., Development of Guidelines for Placement of Longitudinal Barriers on Slopes, Research Report 3659-2 (DOT-FH-11-9343), Texas Transportation Institute, May 1983.

In addition, I reviewed some analysis that we conducted on bumper trajectories of 2000P vehicles running off slopes and compared these trajectories with the cable heights of the CASS System. A chart is attached. In the chart, the green lines are the cable heights, the pink line is the slope, and the navy blue line is the truck bumper trajectory. You can see from the chart that vehicle encroaching on a 1:6H slope could have bumper heights higher than the top cable height of the CASS system which could lead to the potential for override of the system. Similar analysis performed by TTI on 1:6H slopes with the 2000P vehicle also indicated bumper heights that would exceed the top cable height of the CASS depending on the barrier offset (http://tti.tamu.edu/documents/0-5210-3.pdf).

Based on the existing test data and analysis of vehicles encroaching on 1:6H slopes, we are concerned about the use of cable barrier adjacent to steep slopes due to uncertainty about the effective capture and redirection of the vehicle.

2. No testing was available with cable barrier on 1:8H slopes. However, I did look at our bumper trajectory relative to the CASS system for an 1:8H slope. See the attached chart. In the case of the 1:8H slope, you can see that the bumper trajectory analysis indicated that there is an improved likelihood of vehicle capture as the bumper does not exceed the height of the top cable. This would indicate potential for capture and redirection. When using the CASS on an 1:8H slope adjacent to a steep slope, we would still recommend that you use the 4 ft offset from the cable barrier to the steep slope and also use the reduced CASS post spacing of 3 m.

Attachment: https://mwrsf-qa.unl.edu/attachments/cb36cd8858686ea4ddacc30139581125.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/71b885de3871fd38a04caa80bd5f5c54.pdf

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A Guide to Standardized Highway Barrier Hardware, 2nd Edition

Question

State: WI
Date: 11-14-2008

Is there a more current version of the Guide to Standardized Highway Barrier Hardware? The on-line version is from 1995 and AASHTO list 1995 as the publishing date for the paper version of the guide.
I know that MwRSF has submitted items to be place into the guide, and they have been approved. However, I don't know if someone has been keeping the on-line version up to date or if a updated paper copy exist elsewhere.

Response

Date: 11-14-2008
The 1995 AASHTO Hardware Guide is the latest in print. However, AASHTO Task Force 13 has been updating the CAD details for new components over the last several years. Old or existing parts are receiving little to no attention. Yes, MwRSF has been providing new CAD details for those roadside safety developments and components that were generated over a prior period through a prior Pooled Fund project. However, that effort is nearing completion and will need to be renewed if that effort is to continue. There is a web location where these details are being housed and where comments are added for consideration. The proboards site is as follows:
http://barrierguide.proboards31.com/index.cgi
Also, the final electronic CAD details will eventually be located on a TTI FTP site. That site is as follows:
http://www.aashtotf13.org/Barrier-Hardware.asp

Mounting Flexible Markers on Post 1 of EAT

Question

State: WI
Date: 12-02-2008

I've got a hold of a detail that one of our regions is using to install flexible markers on to post 1.

From reading manufactures data, we would be looking to install

- Any one of the flat or single curvature Carsonite models
- Either the 400 or 500 series Davidson models
- The FlexStake EZ Drive model (without the

The information form each manufacture is attached.

Does MwRSF see an issue with mounting any of these product to the 1st post of the EAT? Most of these posts would have a half circle cross section.

Response

Date: 12-04-2008
We do not have actual impact experience for these devices placed on guardrail end terminals. However, I do not believe that they pose significant safety concerns to impacting vehicles since they are light-weight and attached to the first post along its side. For end-on hits into the terminal, the lower delineator would be in front of the vehicle, potentially with a light-weight broken stub low to the ground.

Guardrail â€" Slope Question

Question

State: KS
Date: 12-09-2008

I wanted to pass a guardrail-slope question past you. KDOT uses 6"x8"x6'6" wood posts or W6x9x6'6" steel post for guardrail. Typically, we would use a 10:1 platform that is a minimum of 4' from the face of the rail to the slope break line. Below are details of our wood and steel post with the 4' minimum platform. Would it be acceptable on a guardrail site to allow a 3:1 slope graded from the back of post (no platform behind post) with our 6'6" posts at normal 6'3" post spacing or would it be preferable to use half post spacing (any nesting?) ? I recall your study grading a 2:1 slope with 7' posts on half post spacing. I believe you did not nest the rail either. Anyway, please give me your thoughts. I appreciate it!

Attachment: https://mwrsf-qa.unl.edu/attachments/253c724fa05b70b3165f8b95e9ebb34b.png

Attachment: https://mwrsf-qa.unl.edu/attachments/9ebd40dcb75497f0eae876c6c5d43aaa.png

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Response

Date: 12-11-2008
As you noted, MwRSF has conducted two studies on the placement of strong-post, W-beam guardrail systems near fill slopes.
The first study involved the development and testing of metric height, W-beam rail (706 mm = 27-3/4") supported by W6x9 by 7' long steel posts spaced 37.5" on center. The center of each post was placed at the slope breakpoint for a 2:1 fill slope.
The second study involved the development and testing of the MGS, W-beam rail (787 mm = 31") supported by W6x9 by 9' long steel posts spaced 75" on center. The center of each post was placed at the slope breakpoint for a 2:1 fill slope.
Following this research and upon receiving requests for guidance on the placement of guardrail near slopes, Dean and Bob developed additional guidance for the two designs and for varying fill slopes and fill distances behind posts. This guidance was noted in MwRSF's prior Pooled Fund consulting summaries as well as in the 2007 discussions on MGS implementation. It is as follows:
MwRSF (10-29-2007 Email to MGS Implementation Routing List): Recently, the Mn DOT requested guidance for placement of standard and MGS guardrail adjacent to slopes of various configurations. In response to this request and using available crash test data as well as engineering judgment, Dr. Dean Sicking and Mr. Bob Bielenberg prepared the preliminary guidance, subject to refinement in the future. It is as follows:
For standard W-beam guardrail:

1. Standard W-beam guardrail placed adjacent to any slope with 2' of level soil behind the posts is acceptable.
2. For w-beam guardrail placed 1'-2' adjacent to a 6:1 or flatter slope, standard 6' W6x9 posts at standard spacing are recommended.
3. For w-beam guardrail placed 1'-2' adjacent to a 3:1 to 6:1 slope, 7' W6x9 posts at standard spacing are recommended.
4. For w-beam guardrail placed less than 1' adjacent to a 3:1 or steeper slope, 7' W6x9 posts at half spacing are recommended.

For MGS guardrail:

1. Standard MGS guardrail placed adjacent to any slope with 2' of level soil behind the posts is acceptable.
2. For MGS guardrail placed 1'-2' adjacent to a 6:1 or flatter slope, standard 6' W6x9 posts at standard spacing are recommended.
3. For MGS guardrail placed 1'-2' adjacent to a 3:1 to 6:1 slope, 7' W6x9 posts at standard spacing are recommended.
4. For MGS guardrail placed less than 1' adjacent to a 3:1 or steeper slope, 9' W6x9 posts at standard spacing are recommended.

Based on your inquiry, the KsDOT provides approximately 29" of fill behind the wood posts and 31" of fill behind the steel posts. For both KsDOT configurations, more than 2' of fill is provided behind the steel and wood posts, thus resulting in guidance that any slope could be used beyond the 24" of generally level terrain. This recommendation is based on the use of 6' long posts in standard W-beam and MGS systems. The use of 6'-6" posts would provide increased post-soil forces over those provided with the 6' long posts. In addition, the safety performance of the KsDOT W-beam guardrail systems using 6'-6" post lengths would be nearly identical for systems installed in level terrain as well as the terrain described in your email. Finally, the two guardrail systems shown below could utilize 6' post lengths instead of the current length of 6'-6" in standard installations with sufficient compacted soil fill is placed behind the posts.

Response

Date: 12-16-2008

I am not certain if I told the whole story about the post. I think my situation is close to #3.

3. For w-beam guardrail placed 1'-2' adjacent to a 3:1 to 6:1 slope, 7' W6x9 posts at standard spacing are recommended.

See the attached detail for our scenario. We want to avoid different post lengths from our typical 6'6" post in case these posts/guardrail get hit and the maintenance personnel replaces them with our typical 6' 6" posts. Since we are slightly different than your breakdown of recommendations, would the 6'6" shown in the detail with the 3:1 slope be adequate at normal post spacing?

Attachment: https://mwrsf-qa.unl.edu/attachments/f711ef543066c2f2979687815c91e2ed.jpg

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Response

Date: 12-17-2008

Based on your new detail that was provided on 12-16-2008, it appears as though you have a 3:1 fill slope starting at the center of the post. This situation is different from what I assumed according to your previous email which showed a greater region of somewhat level terrain behind the posts. Your situation now appears to be closer to case 4 below for standard W-beam guardrail. For case 4, we have recommended the use of 7-ft long posts at a half-post spacing. However, as noted in the previous email, we tested standard height w-beam rail at the break point of a 2:1 slope with ½ post spacing and 7' long posts. For your installation, you are requesting to use 6'-6" long posts at ½ post spacing at the break point of a 3:1 slope. Based on our understanding of soil behavior with respect to embedment depths and slopes, we believe that this is this installation will have similar stiffness to the 7' posts at ½ post spacing on the 2:1 slope. Thus, we would recommend this configuration.

Please note that case 4 utilized metric height guardrail.

KsDOT Guardrail Question

Question

State: KS
Date: 12-09-2008

I wanted to pass a guardrail-slope question past you. KDOT uses 6"x8"x6'6" wood posts or W6x9x6'6" steel post for guardrail. Typically, we would use a 10:1 platform that is a minimum of 4' from the face of the rail to the slope break line. Below are details of our wood and steel post with the 4' minimum platform. Would it be acceptable on a guardrail site to allow a 3:1 slope graded from the back of post (no platform behind post) with our 6'6" posts at normal 6'3" post spacing or would it be preferable to use half post spacing (any nesting?) ?
I recall your study grading a 2:1 slope with 7' posts on half post spacing. I believe you did not nest the rail either.
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Attachment: https://mwrsf-qa.unl.edu/attachments/afc59fc0c808bf4fcd82202c3ca924d4.png

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Response

Date: 12-11-2008
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The second study involved the development and testing of the MGS, W-beam rail (787 mm = 31") supported by W6x9 by 9' long steel posts spaced 75" on center. The center of each post was placed at the slope breakpoint for a 2:1 fill slope.
Following this research and upon receiving requests for guidance on the placement of guardrail near slopes, Dean and Bob developed additional guidance for the two designs and for varying fill slopes and fill distances behind posts. This guidance was noted in MwRSF's prior Pooled Fund consulting summaries as well as in the 2007 discussions on MGS implementation. It is as follows:
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4. For w-beam guardrail placed less than 1' adjacent to a 3:1 or steeper slope, 7' W6x9 posts at half spacing are recommended.

For MGS guardrail:

1. Standard MGS guardrail placed adjacent to any slope with 2' of level soil behind the posts is acceptable.

2. For MGS guardrail placed 1'-2' adjacent to a 6:1 or flatter slope, standard 6' W6x9 posts at standard spacing are recommended.
3. For MGS guardrail placed 1'-2' adjacent to a 3:1 to 6:1 slope, 7' W6x9 posts at standard spacing are recommended.
4. For MGS guardrail placed less than 1' adjacent to a 3:1 or steeper slope, 9' W6x9 posts at standard spacing are recommended.

Based on your inquiry, the KsDOT provides approximately 29" of fill behind the wood posts and 31" of fill behind the steel posts. For both KsDOT configurations, more than 2' of fill is provided behind the steel and wood posts, thus resulting in guidance that any slope could be used beyond the 24" of generally level terrain. This recommendation is based on the use of 6' long posts in standard W-beam and MGS systems. The use of 6'-6" posts would provide increased post-soil forces over those provided with the 6' long posts. In addition, the safety performance of the KsDOT W-beam guardrail systems using 6'-6" post lengths would be nearly identical for systems installed in level terrain as well as the terrain described in your email. Finally, the two guardrail systems shown below could utilize 6' post lengths instead of the current length of 6'-6" in standard installations with sufficient compacted soil fill is placed behind the posts.

Guardrail and 1.5:1 Slope

Question

State: OH
Date: 12-17-2008

We have a pavement overlay project where the district wants to add 6 inches of pavement, which causes a sliver 1.5:1 slope at the guardrail. The district is balking at expending additional funds needed to extend the shoulder is this fill segment. See attached sheet, and refer to the outside shoulders.
The design currently calls for standard 6 foot post to be installed at the breakpoint of the slope, and not our standard installation of having 2 foot of shoulder behind the post before the break point. The existing guardrail would be raised 6 inches as shown on the sheet, but we are concerned about the sliver fill at that point and the 1.5:1 slope to catch the existing 2:1 embankment slope. Since the 6" fill at the guardrail would probably be just dumped and not compacted, I want to ensure we have sufficient post embedment for the 27 guardrail height.
I've reviewed MWRSF recommendations for W-beam system on a 2:1 slope and was wondering if the use of 9 foot posts (at half post spacing) on this project would compensate for the sliver? And could wood posts be substituted for the steel, even with the longer post lengths?

Response

Date: 12-17-2008
MwRSF has performed two studies involving W-beam guardrail placed on 2:1 fill slopes.
The first study involved the development and testing of metric height, W-beam rail (706 mm = 27-3/4") supported by W6x9 by 7' long steel posts spaced 37.5" on center. The center of each post was placed at the slope breakpoint for a 2:1 fill slope.
The second study involved the development and testing of the MGS, W-beam rail (787 mm = 31") supported by W6x9 by 9' long steel posts spaced 75" on center. The center of each post was placed at the slope breakpoint for a 2:1 fill slope.
Both MwRSF efforts, in cooperation with the Midwest States Pooled Fund Program, were successful.
Later and using available crash test data as well as engineering judgment, Dr. Dean Sicking and Mr. Bob Bielenberg prepared the preliminary guidance for guardrail placed on slopes, subject to refinement in the future. It was as follows:
For standard W-beam guardrail:
1. Standard W-beam guardrail placed adjacent to any slope with 2' of level soil behind the posts is acceptable.
2. For w-beam guardrail placed 1'-2' adjacent to a 6:1 or flatter slope, standard 6' W6x9 posts at standard spacing are recommended.
3. For w-beam guardrail placed 1'-2' adjacent to a 3:1 to 6:1 slope, 7' W6x9 posts at standard spacing are recommended.
4. For w-beam guardrail placed less than 1' adjacent to a 3:1 or steeper slope, 7' W6x9 posts at half spacing are recommended.
For MGS guardrail:
1. Standard MGS guardrail placed adjacent to any slope with 2' of level soil behind the posts is acceptable.
2. For MGS guardrail placed 1'-2' adjacent to a 6:1 or flatter slope, standard 6' W6x9 posts at standard spacing are recommended.
3. For MGS guardrail placed 1'-2' adjacent to a 3:1 to 6:1 slope, 7' W6x9 posts at standard spacing are recommended.

4. For MGS guardrail placed less than 1' adjacent to a 3:1 or steeper slope, 9' W6x9 posts at standard spacing are recommended.

In 2008, TTI researchers evaluated 27" tall, standard W-beam guardrail with half-post spacing placed 1ft off of a 2:1 fill slope using TL-3 of NCHRP 350. For this evaluation, the pickup truck rolled over in front of the barrier.

Based on the information provided above as well as the proposed OHDOT design detail, I recommend using one of two options. First and assuming a portion of the 6 in. of fill would be effective and remain in place over the years, it would be acceptable to use the Case 4 option for standard W-beam guardrail which consists of 7-ft long steel posts at half-post spacing although preferred to be at the metric height of 27-3/4 in. Alternatively, it would be acceptable to use the Case 4 option for MGS guardrail which consists of 9-ft long steel posts at full post spacing. The overall preferred option would be to use the MGS with 9-ft steel posts spaced on 75-in. centers. For the wood post option, MwRSF would need to evaluate longer posts in a 2:1 foreslope using dynamic bogie testing before recommending a suitable post length.

In the future, we recommend that the OHDOT begin to implement the MGS along with its crashworthy design variations, including systems for placement across culverts, adjacent to slopes, etc.
