Midwest States Pooled Fund Program Consulting Quarterly Summary

Midwest Roadside Safety Facility

04-01-2009 to 07-01-2009

Questions on Thrie beam transitions, nesting of beam guard and thrie beam barrier

Question

State: WI
Date: 04-10-2009

I have some questions about transitions to concrete barrier, nesting of rails, and thrie beam barrier.
Transitions to Concrete Barrier
When I look at our detail drawings for thrie beam transitions, I notice that we are requiring a minimum 4' embedment. In TRP-03-69-98 "Two Approach Guardrail Transitions for Concrete Safety Shape Barriers" posts 1-7 have 4'-4" of embedment.
I'm planning on updating our details to match TRP-03-69-98 for posts 1-7. However, there is note 2 on the detail sheet 1 indicates that if the grading behind the thrie beam transition cannot be provided that the field staff is to use post that are 4'-6" or longer.
I believe using longer post would be warranted in reduced grading situations, but I do not believe that what is in the detail is sufficiently long enough to provide the needed soil resistance to rotation. What would be MwRSF's recommendation for post length for reduced grading for a structural transition?
I'm planning on adding the 4" tall by 8" wide dike that is below the rail between post 1 to 7. Discussions with staff have indicated that it may be problematic having the post of the transition flush with the dike. They are concerned that it may not be possible to drive the post flush. Is there some tolerance to how close the post can be to the back of the dike?
In some existing installation, staff has omitted a post or posts between posts 1 and 7 to accommodate drainage structures. I will be writing some guidance to discourage the practices, but there could existing installations or unique site-specific situations that may require post or posts to be omitted. In these situations, does MwRSF have a recommendation on what to do?
On page 2 and 3 of the SDD, we currently allow the use of beam guard on the down stream end of a concrete barrier installation. I'm have some concerns that transitioning from concrete barrier to beam guard may be too abrupt. Does MwRSF have any recommendations on what to do on downstream ends of concrete barrier?
Nesting of rails for Beam Guard
I'm currently writing up design guidance requiring the uses of nested beam guard when using 4" mountable curb. One of the questions that has come up is deals with the structural transition. Would using nested beam guard change the overall design of the thrie beam transition?
The second question is: Would using nested beam guard effect how a beam guard end treatment would be attached to the nest beam guard system?

The third question would be: Would a special transition be needed between standard beam guard and nested beam guard?
My first answer to the three question proposed was to say no. However, if MwRSF would provide comment it would be appreciated.
Thrie beam
If a situation developed where 2' of grading could not be provided behind a Thrie beam barrier run (i.e. not a structural thrie beam transition just regular thrie beam), could the guidance for beam guard with reduce grading (i.e. longer posts at ½ post spacing) be and equal alternative to providing the 2' of grading behind the post?

Attachment: http://mwrsf-qa.unl.edu/attachments/ecf7fa6112382d1bc6a04201a4389f2c.pdf

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Response

Date: 04-13-2009
See my comments below inred on the various topics.

Transitions to Concrete Barrier
When I look at our detail drawings for thrie beam transitions, I notice that we are requiring a minimum 4' embedment. In TRP-03-69-98 "Two Approach Guardrail Transitions for Concrete Safety Shape Barriers" posts 1-7 have 4'-4" of embedment.
I'm planning on updating our details to match TRP-03-69-98 for posts 1-7. However, there is note 2 on the detail sheet 1 indicates that if the grading behind the thrie beam transition cannot be provided that the field staff is to use post that are 4'-6" or longer.
I believe using longer post would be warranted in reduced grading situations, but I do not believe that what is in the detail is sufficiently long enough to provide the needed soil resistance to rotation. What would be MwRSF's recommendation for post length for reduced grading for a structural transition?
Currently, MwRSF is exploring the necessary embedment depth of a 6"x8" post on a 2:1 slope to match the force-deflection characteristics of a standard MGS post (40 in. embedment). From recent component testing for the MGS on 2:1 slope project, MwRSF had concluded that a 9 ft long W6x9 was adequate to replace the standard 6 ft long post used in the MGS on flat terrain. However, a test impacting a 9-ft long 6"x8" wood posts on the 2:1 slope resulted in the post breaking early on in the test " (The same result was observed during a test with an 8-ft long wood post on a 3:1 slope). Therefore, the post embedment and/or the post size may need to be altered to achieve the required force-deflection characteristics. Until the data is fully analyzed and a solution is prepared, the bogie testing had been put on hold. This problem should be answered in the near future.
I'm planning on adding the 4" tall by 8" wide dike that is below the rail between post 1 to 7. Discussions with staff have indicated that it may be problematic having the post of the transition flush with the dike. They are concerned that it may not be possible to drive the post flush. Is there some tolerance to how close the post can be to the back of the dike?
I would recommend installing the posts before pouring the curb " that was how the test installation was constructed. In doing so there may be a ½" " 1" gap between the posts and curb from the concrete form. This size of gap would be acceptable. Anything larger could affect the response of the system.
In some existing installation, staff has omitted a post or posts between posts 1 and 7 to accommodate drainage structures. I will be writing some guidance to discourage the practices, but there could existing installations or unique site-specific situations that may require post or posts to be omitted. In these situations, does MwRSF have a recommendation on what to do?

MwRSF would also strongly discourage this practice. Eliminating a post from a transition can result in drastically changing the stiffness characteristics of the transition and can lead to the creation of hazardous pocketing locations. I would try to avoid these situations by moving either: (1) the drainage structure, or (2) extending the concrete barrier to the drainage structure so that the transition does not span over the obstacle.
On page 2 and 3 of the SDD, we currently allow the use of beam guard on the down stream end of a concrete barrier installation. I'm have some concerns that transitioning from concrete barrier to beam guard may be too abrupt. Does MwRSF have any recommendations on what to do on downstream ends of concrete barrier?
The transition of concrete to w-beam rail is not a problem unless there is a possibility of vehicle's traveling in the opposite direction impacting this transition (thus, making it a w-beam to concrete transition). This is detailed on page 1 of these drawings in which an undivided roadway should contain thrie beam transitions at all 4 locations .
Nesting of rails for Beam Guard
I'm currently writing up design guidance requiring the uses of nested beam guard when using 4" mountable curb. One of the questions that has come up is deals with the structural transition. Would using nested beam guard change the overall design of the thrie beam transition?
The thrie beam transition drawings you have sent already prescribe nested thrie beam, so I am unclear on your question. If you are asking if you can use only a single rail instead of nesting the rail... this would have to be evaluated/tested for the particular system in question.
The second question is: Would using nested beam guard effect how a beam guard end treatment would be attached to the nest beam guard system?
YES. End treatments are specifically design for a particular rail. Thus, unless the end treatment was designed for nested rail, only single rail segments should be hung adjacent to the end terminal
The third question would be: Would a special transition be needed between standard beam guard and nested beam guard?
If you are asking if special treatment is needed when going from w-beam to nested w-beam (or thrie to nested thrie), this has not been done previously. However, if this is going to change a transition system design, I would not recommend it without further analysis/testing.
My first answer to the three question proposed was to say no. However, if MwRSF would provide comment it would be appreciated.
Thrie beam
If a situation developed where 2' of grading could not be provided behind a Thrie beam barrier run (i.e. not a structural thrie beam transition just regular thrie beam), could the guidance for beam guard with reduce grading (i.e. longer posts at ½ post spacing) be and equal alternative to providing the 2' of grading behind the post?
See response above about current work for posts on slope break points.

Response
Date: 04-13-2009
With regards to the nested rail question, the question is: If I have nested beam guard (i.e. I'm not using standard beam guard) going into a "normal" thrie beam transition (i.e. as per the detail), do I need to do something different with the "normal" thrie beam transition because the nested beam guard is stiffer than normal beam guard.

Response
Date: 04-14-2009

Going from nested guardrail into a transition system with only a single thrie rail should not be a problem. Transitions are sensitive because they go from a relatively "weak" rail section to stiff or "strong" rail section. However, having a nested rail on the front end, or the "weak" section, reduces the difference in stiffness or strength between the two sections, making the transition easier.

Double Blockouts with MGS

Question

State: NE
Date: 04-23-2009

Can double blockout be used with the MGS in situations where individual posts cannot be installed at the normal offset to the rail due to some obstruction that prevents proper embedment of the post?

Response

Date: 04-23-2009
MwRSF believes that the MGS system can tolerate double blockouts on one or two posts in this situation. This will change the effective blockout depth from 12" to 24" which should allow for placement of the post outside many obstructions. The use of double blockouts will require the use of a longer post bolt.

MGS Post Bolt Hole Location

Question

State: IL
Date: 05-04-2009

I have a question (below) from a colleague from Highway Safety Corp. He notes that the IL Standard for the MGS shows the holes in the posts offset by 1 ¼" horizontally from the vertical centerline of the post. The AASHTO Standardized drawing, and the company drawing show this dimension as 1 1/8". I have taken a look at the drawings from the report for "Development of the Midwest Guardrail System (MGS) for Standard and Reduced Post Spacing and in Combination with Curbs" and don't find this dimension shown directly. However, the blockout consistently shows the hole as 1 11/16 from the outer edge of the 6" wide piece. This would leave 1 5/16" from the vertical centerline of the piece.
In the Fall of 2007 we had some discussion through the Pooled Fund group, and I cannot find that this issue was raised. Is this the intent to shift the hole location outward from the center of the post by 1/8" or 3/16"?

Attachment: http://mwrsf-qa.unl.edu/attachments/e93cf904ed50c5e981b77ae2376655c3.pdf

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Response

Date: 05-04-2009
I have reviewed our specs for the MGS posts and the previous hardware guide dimensions and have found the following.

1. I would agree that there are slight discrepancies between what we have shown on our blockout, what your attached details showed, and the hardware guide. I believe that most of the confusion is due to a combination of the use of metric units in the hardware guide, the width of the flange on the W6x9 being 3.94" versus 4", and measurement of the hole from the center of the post rather than the flange edge. I will attempt to clear this up .
2. I have attached our post and blockout details for the MGS. The post has a ¾" hole located ¾" from the edge of the flange. This would put the hole 1.22" from the center of the post. The hardware guide details for standard w-beam guardrail posts given dimensions of 20 mm form the edge of flange and 30 mm to the center of the post. This would be 0.7874" and 1.1811", respectively. Thus, these values agree fairly well when considering that the metric conversions often rounded up to the nearest mm. Thus ¾" in the hardware guide is listed as 20 mm. So we believe that our post details have the hole in the correct location. Our blockout details show the bolt hole 1.25" from the center of the block. This would mean that the block is not drawn perfectly centered on the post, but the 0.03" is not something we were going to quibble about.
3. The drawings you supplied show the hole as 1.25" or 1.125" from the center of the post. We believe that the 1.25" dimension is closer to the posts that we spec and tested with and is also closer to the original hardware guide details.
4. I should also note that PO-36 detail you attached shows the post bolt hole as 0.813". The hardware guide and MwRSF details show a ¾" diameter hole.
5. We would recommend that you use posts with the hole spacing and size similar to our details.

Attachment: http://mwrsf-qa.unl.edu/attachments/772abf6537d696a4afd737171673b2ae.pdf

Attachment: http://mwrsf-qa.unl.edu/attachments/1966e60f1af1b0fff6b1df6d1e2986e0.pdf

New MGS Transition and Wood Post Inventory

Question

State: IA
Date: 05-11-2009

Would you be able to provide me with the latest drawings of the simplified MGS bridge transition?
Also, I have had a question arise from our parts warehouse regarding 8x8 wood posts and blockouts. Is there still a need for us to stock these, or can we replace any 8x8 wood post and/or blockout with a 6x8 version instead? If so, could we replace only one at a time, or would we need to replace all posts and blockouts within the installation at the same time?

Response

Date: 05-12-2009
I am copying this email to Karla so that she can direct a MwRSF staff member to get you the latest approach guardrail transition detail for the MGS attached to a thrie beam transition that utilizes a half-post spacing. In the future, MwRSF will provide details on how to adapt the noted transition to thrie beam transitions that use a quarter-post spacing.
With regard to wood posts and blockouts, MwRSF is still evaluating the appropriate wood post size and length for use as a substitute in the simplified, steel-post, stiffness transition. Results from this component testing and analysis should be available within 2-3 months.
As noted at the spring Pooled Fund meeting, 6"x8" by 6' long wood posts have been approved for use in the MGS as a substitute for the W6x9 by 6' long steel posts. Although we are confident of their use in the MGS, we were hopeful that the Pooled Fund group would fund the 2270P crash test. Unfortunately, that funding did not come to fruition in the recent meeting due to a prioritization of other projects, such as cable barrier projects. At any rate, Iowa could begin to implement the standard wood post size into the MGS based on the prior FHWA acceptance of the MGS. In addition, Iowa could also implement 6x8 blocks standard guardrail utilizing the 8x8 posts at any time. However, it would be acceptable to use the 6x8 blocks with metric height W-beam rail using 6x8 posts. Finally, you would want to use 6x12 blocks for any MGS installations using W6x8.5 and W6x9 steel posts, or 6"x8" wood posts.

Attachment: http://mwrsf-qa.unl.edu/attachments/bbb63bcd8f420dbd4b12439f0fdbf35f.pdf

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Iowa Transition Design Adaptation

Question

State: IA
Date: 05-18-2009

Not that Iowa is unwilling to change, but how would our current design be modified to apply the findings of your recent project? I have attached the most up-to-date version of our metric-height transition. If this becomes too complicated, we have no reservations about switching to the bigger posts and wider post spacing.

Attachment: http://mwrsf-qa.unl.edu/attachments/be0e749fc7cd82882da3ff63bf556437.pdf

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Response

Date: 05-19-2009
I have attached a PDF containing MwRSF's recommendations for the transition to the Iowa transition.
The top configuration is the one you sent us yesterday.
The bottom configuration is the transition to the transition that MwRSF tested last year.
The middle configuration takes the 7-ft posts @ 18.75" spacing from the Iowa transition and adds the MwRSF transition to the transition on the upstream end. Note, the U.S. end is now MGS rail and the W " to " thrie transition element has been updated accordingly
Attachment: http://mwrsf-qa.unl.edu/attachments/f96ce29f5b7f8d8e1df7dbf434a795bc.pdf

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Evaluation of Safety Treatments for Roadside Culverts Questions

Question

State: WI
Date: 05-26-2009

In your study on box culverts, I have some questions:

1. Did the presents of water at the box culvert affect the accident severity? Or did you only look at "dry" box culverts that occasionally fill with water during rain events (e.g. if Figure 6 on page 29 had always has a water depth of 5 to 10' verses 1' would that have an effect on the decision to grate/extend/shield?).
2. A 10x12 box culvert is a single cell 10' tall by 12' long box culvert. What impact would multiple cells of the same size have on the analysis?
3. In 3R situations, project staff has made the decision to extend the box culvert only to the minimum 18'clear zone. The 18' clear zone is from Special Report 214 Practices for Resurfacing, Restoration, and Rehabilitation (TRB). This report is the foundation for most states 3R standards design standards.
   In the report, MwRSF is using the values from the RDG for culvert extensions. Is MwRSF indicating that for larger drainage features, such as box culverts, an agency should strive to greater than 18' clear zone recommended by Special Report 214? If so, what is the basis for the recommendation?
4. Our structure's department is not hot on the idea of using grates because they are worried that they will "clog up with debris". Basically, if there is a forest in the watershed they do not want to use grates.
   Has there been studies on how often box culverts get clogged, or is there guidance on when it is O.K. to use grates even if there is a chance of the box being clogged?

Response

Date: 05-26-2009
Standard severities from RSAP were used to describe the box culvert hazard. Although these culvert severities probably were not intended to include water, all severities incorporated into RSAP have proven to be excessive. And it is reasonable to regard RSAP culvert severities to be representative of having some water in the box.

Adding two or three box culverts in a row would essentially create a longer hazard. Our sensitivity analysis showed that longer hazards create higher cost/benefit ratios for any given safety treatment. Further lengthening the hazard would make moving the culvert farther from the roadway more beneficial relative to the other two treatment options.

With regard to the clear zone offset requirements, the MsRSF had no intention to indicate that the clear zone should or should not be adjusted for 3R work relative to new construction. We chose clear zone limit its used by our sponsor, Iowa, in this study.

Many DOT's have expressed concern over culvert grates becoming clogged and leading to flooding. In a study conducted many years ago, TTI explored this problem and found no evidence of clogging. Unfortunately TxDOT chose not to publish that report. Recall that great bars are 30 inches apart and can span lengths of 20 feet or more. TTI's findings indicated that 2-1/2 foot wide by 20 foot long openings are difficult to clog, even in heavily wooded areas. Iowa has been using grades for a number of years. Perhaps you could contact them to see if clogging has been a problem.

Guardrail Bolt Length

Question

State: WI
Date: 05-29-2009

I received this question from our maintenance staff. It has to deal with bolt length on the back side of beam guard installation. If MwRSF could provide input it would be appreciated.

Issue: The specs call for no more than ½ inch of anchor bolt to protrude beyond the fastening nut. When this spec has been exceeded the guidance is to cut them off, chamfer and restore with zinc coating.
Question: Wondering what the issue is with bolt length and consequences thereof such as performance of the guard rail system if they are not cut? The system in question is on a CTH system utilizing state funding in an effort to bring guard rail up to standards for a detour route. Metal posts and plastic blockouts were used.

Response

Date: 06-15-2009
I have reviewed the information provided below and am uncertain as to the direction of the question. Are you referring to the guardrail splice bolts or the guardrail post bolt? For connecting rail ends at a guardrail splice, standard guardrail bolts are used and are specified in AASHTO-AGC-ARTBA hardware guide. There should be no reason to cut or modify these bolts if ordered using the standard hardware. For placing rail and blockouts to posts, standard post bolts are also used to make this connection. These bolts have a specified thread length and should not require cutting or modification when the appropriate length is ordered. For rail to post attachment, the length of the threads extending out of the nut would not need to be limited to 0.5 in. or less for performance reasons. In rare circumstances, a unreasonable long rod could potentially contact the hazard face sooner than if the proper length bolt were used. However, I do not see this as being a big concern. If too long of a bolt were used, it would be difficult to use since the thread length is limited, thus not allowing the nut to be tightened. Are contractors trying to use non-standard bolts which require field modification in order to install the nut? If yes, I recommend that proper bolt length be used with standard guardrail bolts to avoid these field issues.

Steel Bridge Railing Question

Question

State: IA
Date: 06-03-2009

What would be your opinion of installing a steel bridge railing (Illinois 2399 curb-mount) at standard post spacing (6'-3" as tested), but increasing the post spacing at four locations on the bridge in order to accommodate some structural members? Our consultant feels they can limit the maximum post spacing at these locations to 7'-6". Do you think allowing the larger post spacing at these locations would be feasible without additional testing, or should we be investigating other options?

There would be only 1 spacing of 7'-6" at each of the four locations on the bridge.

Response

Date: 06-15-2009
MwRSF feels that increasing the post spacing from 6'-3" to 7'6" in only a few non-adjacent spans is a possible task. However, the bridge rail must be stronger to accommodate the 20% increase in moment due to the elongated post spacing. As such, we recommend the following:
Replace the 4"x4" bottom tube with another 8"x4" tube (the top tube). Thus, the bridge rail would consist of 2 8"x4" tubes. Assuming the top and bottom rail carry equal loads (which it really doesn't " top takes more load), this small change would provide a 30% increase in rail strength - enough to accommodate the 20% increase in moment.
This rail combination should be used throughout the bridge to ensure rail continuity and prevent snag points
Also, keep the bottom of the lower tube at 14" above the roadway. Thus the top of the lower tube is 22" above the roadway (2" gap between rails). This will allow the lower rail to better interact with an impacting vehicle and absorb more of the impact load.

Response

Date: 06-16-2009
We have an additional question to follow up the attached email which recommended that an 8" x 4" tube be used on the bottom rail throughout the bridge.

Since this bridge is relatively long, using an 8" x 4" tube for the bottom rail over the entire length would result in a significant increase in the steel quantity and cost. (The length of bridge to receive new rail is about 3,000 feet and the weight difference between a 8 x 4 x 5/16 tube and a 4 x 4 x 1/4 tube is 11.14 pounds per foot. Thus there would be an increase in steel of about 2 x 3,000 feet x 11.14 lb./ft. = 66,840 pounds.) Also, we would like to minimize the additional total dead load that is added to the bridge since the weight capacity of the bridge is an issue. (We are even planning to use lightweight concrete for the curbs on this project.)

In view of this, would it be possible to strengthen the rail at only the few areas where the span would exceed 6' 3"? In order to accomplish this, could the rail be strengthened at just those longer rail spans and any necessary adjacent spans, while using a 4 x 4 x 1/4 tube for the bottom rail throughout the rest of the bridge? The following are some ideas for your consideration to accomplish this:

Increase the wall thickness of the standard top and bottom rails in order to get a 20 % or greater increase in the section modulus (S) for bending. This would result in no change in the outside railing geometry.

Install a tubular member inside of the standard top and bottom rails in order to get a 20 % or greater increase in the section modulus for bending. For example, a 4 x 4 x 1/4 tube has a S of 3.90 inches^3. If a 3 x 3 x 3/16 tube (S = 1.64 inches ^3) were inserted inside of the 4 x 4 tube, the total S for the bottom rail would be increased by 42 %. This would result in no change in the outside railing geometry.

Add another 4 x 4 x 1/4 tube directly above the standand 4 x 4 x 1/4 bottom rail to increase the bending strength. In order to avoid a snag point, this section would need special fabrication at the ends for a transition down to the typical bottom rail.

Replace the bottom rail with a 8 x 4 x 5/16 tube as recommended in the attached email, except fabricate a special transition down to a 4 x 4 x 1/4 tube at the ends in order to avoid a snag point.

Please let us know if any of the above concepts would be acceptable, and if so, we will ask the consultant to investigate further.

Response

Date: 06-24-2009

We do feel that we can strengthen the rail in the areas surrounding the extended post spacing only. With a 3,000 ft bridge, using the increased rail size for the entire system would be wasteful. Comments on the proposed solutions are discussed below.

(1). Using a thicker / stronger rail in certain areas will result in abrupt stiffness transition points at the connections between the two rail types. These stiffness transitions could lead to vehicle instabilities or snagging.

(3) & (4) Altering the shape of the rail in these locations can lead to more vehicle interaction problems (snagging, instabilities, wedging, etc...). As such, we do not favor the option of transitioning between different rail geometries without testing these transitions.

(2) MwRSF does like the tube-in-a-tube idea for strengthening the rail. The inserted tube should fit relatively snug inside the original tubes, so that the smaller tube develops load before the rail suffers larger deformations. The 3x3 tube inside of the lower rail (4x4x1/4) tube is a good fit. However the upper rail should also be reinforced. The same 3x3 tube could be used if its position could be centered inside the 8x4 (perhaps resting it between the attachment bolts, bolting through the 3x3 tube, or using spacers to position the 3x3 tube inside the 8x4 tube.

The inserted reinforcement tubes should be extended out from elongated spacing, though the adjacent spacing of 6'-3", and to the nearest ¼ spacing. The 1/4 points of the rail are recommended for the stiffness transition to prevent the tube end from occupying a point of maximum deflection / deformation (midspan) or a stress concentration point (at the posts). Thus, the inner tubes should be extended 94 inches past the posts of the longer spacing (6'-3" plus 19"). Total length of the inner tubes would then be 188 inches plus the length of the longer post spacing (approximately 7'-6" from your previous e-mail.

Response

Date: 07-14-2010

I've got one more (hopefully the last) request for you regarding our I-74 bridge rail replacement. Apparently our consultant, rather than incorporating your previous advice, has developed an alternate method for spanning the wide expansion joints on the I-74 bridge. This method places specially-designed posts on either side of the joint, spaced 5 feet apart.

Could you please review and comment on the attached drawings showing the proposed design? Just as before, this will be used at a total of four locations on the bridge - on both sides of the road at each of the two suspension towers.

The post spacing varies in order to avoid the vertical stringers located just beyond the edges of the bridge deck.

The consultant felt that he needed to space the corbels (and therefore the posts) in order to avoid the vertical trusses due to the tight tolerances (see the attached picture of the current bridge). The vertical trusses are located approximately 1'-5" behind the face of rail. Would you agree that even if a post were placed at a truss location, that the truss would lie outside the working width of the barrier?

The proposed spacings have not been analyzed. Do you feel the abrupt changes in post spacing throughout the bridge is concerning enough to warrant a possible redesign? If we could somehow reduce the depth of the corbels, perhaps that would allow them to be installed at truss locations?

Response

Date: 07-15-2010

The full scale testing on the original Illinois steel tube bridge shows a maximum dynamic deflection less than 3 inches. Also, although the working width of the system was not specified in the summary pages, the vehicle does not appear to extend more than 12 inches past the face of the rail. Thus, the 1'-15" of clear space between the face of rail and the vertical trusses provides enough room to minimize the risk of vehicle snag on the truss members. Further, the 17 inches of space matches that of the recommended offset from the head ejection envelope developed in TRP-03-194-07 for the 95th percentile passenger (14 in. + 3 in. = 17 in.).

With a maximum dynamic rail deflection

Bridge Rail Gap Size

Question

State: NE
Date: 06-03-2009

When we cross an expansion joint in a bridge and leave a gap in the bridge rail, what is the largest gap we can leave without considering it a snag point?
The rails are flush with each other, flat faced, and continue for several feet.
Should we allow 3" or a little more?
What width of gap is still acceptable?
Has there been testing to prove a snag or not?

Attachment: http://mwrsf-qa.unl.edu/attachments/2d0ff54f97d1883f910ff852a1a7db9f.jpg

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Response

Date: 06-08-2009
Many years ago, MwRSF conducted AASHTO PL-1 and PL-2 full-scale crash testing on NDOR's open concrete bridge railing. For this testing program, impacts were performed both at interior sections as well as upstream of an expansion gap. The expansion gap was 4.5" and utilized chamfered edges. The impact angles ranged from 15 to 20 degrees. Although vehicle snag occurred at the downstream exposed edges, it was not sufficient to cause a failure of the tests.
Under the current testing criteria, pickup truck testing is performed at 25 degrees. For the future MASH testing, the impact angle for both the small cars and pickup trucks is 25 degrees. As such, a slight increase in vehicle snag could occur due to the increase in impact angle. Therefore, I would be more inclined to keep the gap width to a maximum of 4". In addition, it is recommended that the edges of the railing at the gap locations be chamfered in order to reduce the propensity for vehicle snag.

Guardrail Blockouts

Question

State: WI
Date: 06-10-2009

I have some questions about beam guard blocks.

1. Should a block be allowed to extend below the rail element. See photo DSC00258.JPG. My first guess is that this should not be allowed because one of the purposes of the block is to prevent wheels from snagging on the post. If the block is allowed to extend below the rail, a vehicle may snag on the block.
2. Is having the block extend above the rail element an issue? See 2nd Photo.

Attachment: http://mwrsf-qa.unl.edu/attachments/2c38f4365496180ad252473d70d0ecab.jpg

Attachment: http://mwrsf-qa.unl.edu/attachments/d0033bfe2a4d52bd58a2f377f18ea7ab.jpg

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Response

Date: 06-11-2009

Traditionally, wood and plastic blockouts have extended both above and below the W-beam guardrail element. The blockouts have been either 14 or 14.25 in. long. As such, up to 1 in. of blockout may be exposed above and below the rail. For these situations, upper and lower surfaces are either cut to be horizontal or sloped inward as one moves to the back of the block. For thrie beam systems, we have used shortened blockouts or tapered blockouts to allow the lower corrugation to fold back some to reduce wheel/rim loading or to remain vertical when the rail deflects, thus reducing the potential for vehicle climb up the rail face.

Therefore, we do allow blockouts to extend above and below the rail element. For specific designs, we have modified blockouts to improve barrier performance. For your situations, the blockout size should correspond to those blocks approved for use with the guardrail systems in question.

W-Beam Guardrail Over Culvert

Question

State: KS
Date: 06-18-2009

In 2002, MwRSF published the test results on a guardrail system for use on concrete box culverts. For the design, 1" diameter, ASTM A307 through-bolts were used to anchor the post with welded base plate. However, there may be situations where the bolts cannot be placed through the culvert slab when they fall within the location of the culvert walls. What anchorage alternative would be used in lieu of the through bolts?

What are your thoughts for alternative anchor systems when through-bolting is not applicable?
Attachment: http://mwrsf-qa.unl.edu/attachments/6a236607ab67b1bf398303d531dae40f.jpg

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Response

Date: 06-24-2009

I have reviewed the archived material for the original R&D W-beam guardrail-culvert program. From this review, I was unable to find documentation on the embedment length for the threaded rods that were used in the bogie testing program on the concrete tarmac. I do believe that our policy has always been to use sufficient length to allow for the epoxy to develop the capacity of the rod material. Practically speaking, I can only assume from past experience that these 1-in. diameter rods would have been at least 10 to 12 in. long. As shown below, these rods would develop an axial capacity of more than 36 kips. Now, it may be possible that the rods did not experience this 36-kip load in each of the two tensile rods as the base plate was designed to yield and control the peak load imparted to the deck. However, it is difficult to determine the actual load imparted to the rods. We do know that the peak lateral post load was 14.68 kips.

If one were to assume that the post rotated about the back edge of the plate and the outer bolt row carried all of the uplift, then the outer tension row would be expected to carry a tension load equal to (14.68 k x 30.025 in.) / 9 in. = 48.97 kips. Thus, each bolt would see approximately 24.5 kips (bolts are closely spaced in the lateral direction too). In addition, if the base plate actually yields, then one would expect the load imparted to the bolts to be reduced somewhat. In any event, one would try to come up with alternatives to carry this axial load at a minimum to ensure that bolt fracture or release does not occur.

For thin concrete culvert slabs, it may be difficult to find anchors than carry this load for 1" diameter rods, especially when two rods must be located close to one another. As such, one solution may be to design a larger plate that can be anchored to the slab with through bolts on the sides of the culvert walls. Then, the post/base plate would need to be anchored to the large, thick plate. Now, it may be necessary to use structural beams and a plate to make the larger mounting system for which to anchor the post/base plate system on its upper surface. This type of system would also allow for bolt heads/nuts on the underside of the surface mounting system. This system would also require that some minimum thickness of soil be available on top of the culvert slab.

Transitioning 31

Question

State: DC
Date: 06-24-2009

I got the question below about transitions
between existing 27 inch high w-beam barriers and repairs made using 31 inch high versions. The specific question below also asks about using a 27 inch high terminal when the owner wants to use it to terminate a new 31 inch high LON barrier.

1) Based on your MGS research and your vast experience with 27 inch high barriers, is there an appropriate transition length over which you may "safely" raise or lower w-beam rail by 3 inches? 1a) Assume all other features are equal. 1b) Assume known differences like G4-1(S) transitioning to MGS or vice-versa.

2) If an owner thinks they can save money by specifying a 27-inch high w-beam terminal when using 31 inch high barriers, what is the "safe" place to begin the 3-inch rise?

These questions assume the owner is basically satisfied with the performance of 27-inch high barriers and or terminals but wants to begin moving to 31 inch systems whenever possible. If these are questions that should not be trifled with unless crash tested, that, too, is an answer.

Response

Date: 04-04-2012
See response below in red.

I got the question below about transitions
between existing 27 inch high w-beam barriers and repairs made using 31 inch high versions. The specific question below also asks about using a 27 inch high terminal when the owner wants to use it to terminate a new 31 inch high LON barrier.

1) Based on your MGS research and your vast experience with 27 inch high barriers, is there an appropriate transition length over which you may "safely" raise or lower w-beam rail by 3 inches? 1a) Assume all other features are equal. 1b) Assume known differences like G4-1(S) transitioning to MGS or vice-versa.

** For comparison purposes, I assume that you are referring to metric height guardrail placed with a 27.75" top rail height. My best recommendation would be to transition the 3.25" height differences over approximately 50 ft or two 25-ft long sections of W-beam guardrail. With this reasonable grade change, I am confident that there would not be any complications nor degrading effects on the barrier's safety performance. Only increasing the rail slope to 3.7 degrees should also allow for a relatively easy placement of the eight splice bolts within the lapped joints.

2) If an owner thinks they can save money by specifying a 27-inch high w-beam terminal when using 31 inch high barriers, what is the "safe" place to begin the 3-inch rise?
** To be reasonable sure that the safety performance is not degraded and without testing, I would "conservatively" recommend that the height difference not begin until the end of the downstream end of the terminal is reached.

These questions assume the owner is basically satisfied with the performance of 27-inch high barriers and or terminals but wants to begin moving to 31 inch systems whenever possible. If these are questions that should not be trifled with unless crash tested, that, too, is an answer.
