Midwest States Pooled Fund Program Consulting Quarterly Summary

Midwest Roadside Safety Facility

10-01-2011 to 12-31-2011

Anchoring/Stacking F Shape Barrier

Question
State: FL
Date: 10-04-2011

FDOT is phasing out the FDOT 415 (Jersey Shape). The existing anchoring plate we use in Florida are not crash tested and FDOT is proposing using the anchoring holes on the F shape to stake the barrier end unit when they are attached to crash cushions or if the barrier is on the trailing end.

Attachment: https://mwrsf-qa.unl.edu/attachments/bf6295cda3a6542a8ae0a56920d73478.pdf

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Response
Date: 10-04-2011
I have looked through your detail for transitioning from the F-shape PCB (your type K) to a crash cushion. In general the details look pretty good. We do have a couple of comments.

1. I don't have any details on the type of crash cushion you are using, but I am assuming that the design is fixed on the end to some sort of rigid end post or support. The staked PCB transition was not designed with the intent of providing anchorage and support for end mounted crash cushions. There would be concerns if you were planning to use the staked PCB sections in that manner.
2. There needs to be some care taken when connecting the PCB to the end of the crash cushion. This connection is critical because it must be capable of developing and transferring the necessary shear and tensile loads between two barriers as well as prevent snag at the barrier joint. The transition we tested had nested 12 gauge thrie beam across both sides of the joint. These thrie beam sections were capable of developing shear and tension across the joint as well as preventing snag of the vehicle on the joint. With that in mind, we would recommend that the connection between the crash cushion and the PCB in your detail have similar or greater capacity and be capable of preventing snag across the barrier joint.
3. On the downstream end of your opposing traffic, your detail shows using the stakes to anchor the downstream end of the barrier. Use of the stakes in this manner to create a downstream anchor has never been tested. There is some concern that impacts on the end barriers may cause barrier rotations and deflections that would promote vehicle instability. Typically, we have recommended extending the downstream end of PCB runs a minimum of 8 segments past the length of need and then flaring the end outside of the clear zone.

Fish Hatchery Road - temporary concrete barrier and bicyclist protection

Question

State: WI
Date: 10-14-2011

The message below is from one of our project teams. We would appreciate your feedback.
We are looking to modify the standard temporary precast concrete barrier to provide protection to bicyclists during reconstruction of the Fish Hatchery Rd bridge over the beltline. As seen in the attached plan sheets, we have a 4' wide bike lane next to temporary precast concrete barrier during Stage 2 and 4 of construction.
We propose modifying the barrier by adding chain link fence to the outside face of barrier to provide a minimum 42" high combination barrier / fencing. Given the 30 mph speed limit, need to protect bicyclists from falling onto the beltline, and temporary nature of this condition, we believe this to be a reasonable solution. Please let us know if you concur.

Attachment: https://mwrsf-qa.unl.edu/attachments/16816682cd1fb41e64d3f24b7f264076.pdf

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Response

Date: 10-18-2011
We have found some a reference involving the chain link fence on concrete barrier:

7. Buth, C.E. and Megnes, W.L., Crash Testing and Evaluation of Retrofit Bridge Railings and Transition, Report No. FHWA-RD-96-032, Submitted to the Office of Safety and Traffic Operations R&D, Federal Highway Administration, Performed by Texas Transportation Institute, Texas A&M University, College Station, Texas, January 1997.

Some other pedestrian rail reference suggestions include:

Bullard, D.L., Jr., Menges, W.L., and Buth, C.E., "Development of Combination Pedestrian-Traffic Bridge Railings," Paper No. 940617, Presented at the 73rd Annual Meeting of the Transportation Research Board, Washington, D.C., January 1994.

Hirsch, T.J., Buth, C.E., and Campise, W., "Aesthetically Pleasing Concrete Combination Pedestrian-Traffic Bridge Rail - Texas Type C411," Report No.
FHWA/TX-91/1185-3F or TTI-2-5-89/90-1185-3F, Submitted to the Texas State Department of Highways and Public Transportation, Performed by Texas Transportation Institute, Texas A&M University, February 1991/Revised.

Hirsch, T.J., and Buth, C.E., "Aesthetically Pleasing Combination Pedestrian-Traffic Bridge Rail," Transportation Research Record No. 1367, Transportation Research Board, National Research Council, Washington, D.C., 1992.

Washington State has a list of approved pedestrian rails, and I'm not sure some of these have been crash tested. Maybe so, but they don't give federal approval letter notice or reference to a crash test.

http://www.wsdot.wa.gov/eesc/bridge/drawings/index.cfm?fuseaction=drawings&section_nbr=8&type_id=26

TXDOT has their own pedestrian rail, but once again no crash testing reference:

ftp://ftp.dot.state.tx.us/pub/txdot-info/cmd/cserve/standard/roadway/prd06.pdf

FHWA list of barriers which include NJ barriers with rails:

http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/barriers/bridgerailings/docs/appendixb5.pdf

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Mow Strips with MGS posts

Question

State: DE
Date: 10-14-2011

A state DOT recently came to us inquiring about mowstrips around guardrail posts. In addition, they forwarded the attached photos regarding their existing standard detail. As you can see from photos, the post has failed at point of asphalt overlay. Their current spec calls for 2" hot-mix over 6" GABC**[Graded Aggregate Base Course]**. They are also a state that is currently considering MGS guardrail, and wanted to know if this current spec would be OK to use with the MGS.(?)

We believe their current spec is too stiff for post to move upon impact, barring any cut-out behind the post. We also believe that specifying 18" subbase (2A modified) with a 2" overlay would perhaps better perform in allowing the post to push backward crushing 2" asphalt surface before post fails (as shown in photos).

Question: In regards to mow strips, what would you specify with MGS?

Attachment: https://mwrsf-qa.unl.edu/attachments/892fcdd037ac78f942f2dfdb9af854b6.zip

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Response

Date: 10-20-2011

MwRSF Research

Several years ago, MwRSF developed a W-beam guardrail system for placement in soil/rock foundations. As part of this research effort, several design configurations were prepared to account for rock formations found below the soil surface and in the region where guardrail posts were to be embedded. These configurations included holes and/or slotted holes cut into the rock to allow for post embedment in combination with a special fill material (ASTM C33 coarse aggregate, size no. 57). Hole sizes varied as a function of rock depth. Under vehicular impacts, the steel posts were allowed to rotate in the soil/rock foundation system and allowed the metric-height, W-beam barrier to perform in an acceptable manner. This research was published in MwRSF Report No. TRP-03-119-03.

As part of this MwRSF effort and due to similarities to posts placed in subsurface rock, design guidance was also provided for the placement of steel or wood posts in pavement surfaces. For this scenario, MwRSF researchers recommended that leave-out sizes of 8"x18" and 10"x21" be provided for W6x9 steel posts and 6"x8" wood posts, respectively. In these configurations, the posts were positioned with the front face near the front side of the leave-out to allow room for adequate post rotation on toward the back of the hole. In addition, it was suggested that a backfill material with confined compression properties similar to ASTM C33 coarse aggregate, size no. 57, would possibly be acceptable for this application, although further testing should be conducted. These recommendations were also included in MwRSF Report No. TRP-03-119-03.

TTI Research

During this same general time period, TTI researchers were conducting research to investigate the dynamic response of guardrail posts placed in various mow strip configurations. From this research program, it was determined that wood and steel posts performed in an acceptable manner when:

(1) placed in mow strips with depths 8" or less (component testing program) and 5" (crash testing program),

(2) utilizing square leave-outs measuring 18"x18" or larger,
(3) installed with leave-out material having compression strength equal to or less than 120 psi (two-sack grout mix), and
(4) utilizing low-strength leave-out material with depths of 4" or less.
From the TTI program, W6x9 steel posts, 7" diameter round wood posts, and 6"x8" rectangular wood posts were all deemed acceptable for use in the above noted mow-strip and leave-out combination system. This research is published in TTI Report No. 0-4162-2.

FHWA Acceptance

The results from these two research programs were later combined into one FHWA acceptance letter, no. B-64B.

General Thoughts

To date, no dynamic post-soil testing has been performed with guardrail posts embedded in soil with an asphalt layer placed on the soil and measuring 2" thick or less. As such, it is difficult to know whether wood posts could rotate sufficiently without premature fracture or whether steel post rotation would be excessively inhibited. Over the years, MwRSF has had discussions with various state DOTs with the hope of conducting a bogie testing program with posts embedded in thin asphalt mow strips or mow-strip/leave-out combinations with 2" thick asphalt fill material. Unfortunately, this simple research program has never received funding.**As a result, MwRSF has continued to utilize the prior leave-out guidance for installing metric-height and 31" tall W-beam guardrail systems in mow strips in the absence of any component or full-scale crash testing with posts placed in 2" thick asphalt layers.**

On a side note, MwRSF is conducting a research study on a similar topic for the State of Wisconsin. In this ongoing effort, dynamic component testing is being performed on wood posts installed on slope terrain with a 2" asphalt layer placed over the soil surface to reduce erosion near bridge ends and within the approach guardrail transition. For this effort, component testing will occur with posts placed on 2:1 and 4:1 terrain. Unfortunately, no testing is budgeted for evaluating wood posts installed on level terrain with a 2" asphalt surface surrounding the posts.

Finally, we believe that the MGS could be installed in concrete or asphalt mow strips if configured with S3x5.7 weak steel posts spaced on 3 ft " 1½" centers. This opinion is based upon the prior successful crash testing program under MASH on the MGS bridge rail. For this system, S3x5.7 steel posts were inserted into steel tubular brackets which attached to the side of the RC bridge deck. In this configuration, acceptable barrier performance was obtained with both 1100C and 2270P vehicles at TL-3 of MASH. This testing would indicate that similar acceptable performance would be achieved with posts placed in rigid mow strips. Of course, additional considerations would be required in the terminal and transition regions which typically utilize stronger post sections as compared to S3x5.7 posts. However, it may be possible to utilize a half post-spacing in terminal regions as well.

Mitchell Interchange Standpipe Protection

Question

State: WI
Date: 10-18-2011

Below is an email from one of our major project teams who are building some tunnels as we speak. They are having an issue with the stand pipes. Do you have any suggestions?

_____

As discussed last week, the Mitchell Interchange Construction team is looking at options to enhance standpipe protection within Tunnel construction at the request of the City of Milwaukee Fire Department. MFD is requesting "the maximum, reasonable, protection and/or isolation of the standpipe outlets from vehicular damage". Currently the standpipe system has been protected with 7" (+/-) lateral offset to connection fittings in Tunnel 3. Tunnel 1 and 2 will have nearer to 10" of lateral offset to standpipe that is located about 18" above the top of barrier. Our construction team has dismissed the potential to change to vertical face barrier due to potential increased damage to vehicles involved in a crash.
Construction team has identified that we have met NFPA requirements:
9.3.3 " Fire department connections shall be protected from vehicular damage by means of bollards or other approved barriers.
9.4.3 " Hose connections shall be located so that they are conspicuous and convenient but still reasonably protected from damage by errant vehicles or vandals
Team has discussed locating bollard, or some physical protection on top of the barrier at the same offset as the standpipe fittings. You offered some hesitation with that alternative in our phone call last week, and also potential to look at other alternatives. Can you look into, and get me an assessment on physical protection alternatives " bollard and other?

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Attachment: https://mwrsf-qa.unl.edu/attachments/9f766e15bcd62e011a547f3f2a8a0ea2.jpg

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Response

Date: 10-24-2011

I am unaware of any special protection barrier systems that have been designed and tested for use in shielding water values which extend off of the tunnel side walls and above the vehicular barriers. However, if safety treatment is desired, it would seem possible to design steel or reinforced concrete structures which anchor to the top of the concrete parapet and possibly to tunnel wall in order to prevent vehicle snag, and even occupant snag, on the pipe hardware.

If this barrier option is considered, then the upstream and downstream ends should be sloped to mitigate snag concerns as the additional protective barrier which falls within the zone of intrusion. As noted above, these systems could be attached to barrier or tunnel.

Alternatively, it may be reasonable to consider design changes to the pipe system, such as to recess more the structure (i.e., 2 outlets and handle for valve) within the tunnel side walls, thus greatly reducing concerns for vehicle snag, and even occupant snag, on the pipe structure.

Guard Rail Post Usage

Question

State: WA
Date: 10-19-2011

I am wondering if you can help us obtain some information concerning the type of material that states are using for posts in corrugated beam guardrail systems? In particular, we are trying to determine how many states specify only steel, how many specify wood only, and how many specify both material types. As you may know, we currently specify the use of only steel posts for new installation here at WSDOT. However, our current practice has come under scrutiny and we have been asked to see what other state practices are. We have been asked to respond to this inquiry as soon as possible. Thanks for any help you can offer.

Response

Date: 10-24-2011

Here are the results from a quick survey of our Pooled Fund states.

(1)Kansas " wood and steel posts acceptable
(2)Iowa " wood and steel posts acceptable
(3)Wyoming " wood and steel posts acceptable, most posts furnished as wood, fairly arid climate where do not experience much post rotting in field
(4)South Dakota " wood posts only
(5)Illinois " wood and steel posts acceptable
(6)Nebraska " wood and steel posts acceptable, NDOR requires Dense Select (DS) 65 grade SYP wood posts which are difficult & costly to obtain, thus they mostly are supplied steel posts
(7)Wisconsin " wood and steel posts acceptable, Wisconsin uses native wood species for beam guard " red and white pine
(8)Minnesota " only steel posts on new installations
(9)Ohio " wood and steel posts acceptable
(10)Missouri " wood and steel posts acceptable, however, wood is rarely supplied

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Back to back crash cushion installation

Question

State: WI
Date: 10-24-2011

Is it acceptable to install crash cushions back to back (see PDF)? Do you know of any crash testing done on this type of installation?

Response

Date: 10-24-2011

In my opinion, it may be acceptable to construct crash cushions in this manner if the following points are mostly true:

(1)the crash cushions were designed to provide adequate support for each other,
(2)vehicle snag concerns were mitigated with proper layering/orientation of rail splices,
(3)crash testing and/or design review by FHWA revealed no safety concerns.

Culvert Protection Advice

Question

State: MO
Date: 10-25-2011

We have a 7-mile length of road on which we intend to pave the 4 ft. earth shoulders as part of a U.S. bike route. The corridor has an ADT of around 4,000 and nearly 30 box culverts ranging in size from single 5x3 to double 10x10. Due to the traffic volume present, the vast majority of these structures would warrant guardrail based on the Wolford & Sicking model in Transportation Research Record No. 1599.

As treating such a large number of structures is entirely infeasible within the budget of this project, we intend to design except the majority of culverts, treating only the largest as shown below. We will mitigate the exceptions by installing continuous edge line rumble stripes and object markers at each location. There are no excessive ran-off road accident problems today, and we believe that an HSM analysis will predict a further crash reduction over the existing condition.

As this will be a designated bike route, we also intend to provide a 42 in. chain link fence at the edge of shoulder for each culvert, irrespective of the presence of guardrail

Given the existing conditions, I am confident that the direction described above represents a reasonably safe alternative for this corridor. I do have a few questions, however:

1. Do you agree with our general direction?

2. Is the guardrail solution described below adequate? The concern is the face of the rail being flush with the edge of the culvert.

3. Would a 42 in. chain link fence contacting the back side of the W-beam, significantly impair the function of the rail?

Attachment: https://mwrsf-qa.unl.edu/attachments/51e5352b974ea09d687d7909a1874692.gif

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Response

Date: 10-31-2011

We have reviewed the supplied information and offer the following questions and comments.
The attached guardrail detail depicts a standard strong-post, W-beam system which appears to be a combination of our metric-height long-span guardrail system and our metric-height guardrail for 2:1 slopes using half-post spacing. However, the detail does not show three CRT posts adjacent to the unsupported span and on each side. These CRT posts were incorporated to prevent concerns with vehicle pocketing. MwRSF has successfully developed and crash tested two W-beam guardrail systems to span across long concrete box culverts, such as those measuring up to 24 ft in length. For the first system, the metric-height W-beam guardrail was configured with a 27-3/4-in. top mounting height, while the Midwest Guardrail System (MGS) was utilized for the second configuration with a 31-in. top mounting height. For both designs, three 6-in. x 8-in. by 6-ft long wood CRT posts were placed adjacent to the long span using the 6-ft 3-in. post spacing. Beyond the CRT wood posts, the guardrail system was transitioned into a steel post, wood block, semi-rigid barrier system which also used 6-ft long posts and a 6-ft 3-in. post spacing. For both crash-tested systems, a region of level, or relatively flat, soil fill was provided behind the CRT wood posts prior to the slope break point.

If it is difficult to provide 2 ft of level, or mostly level, soil grading behind the wood CRT posts, then it may be beneficial to consider lengthening the wood CRT posts to account for the reduction in soil resistance resulting from an increased soil grade behind these six posts, especially when placed at the slope break point of a 2:1 fill slope.

As noted above, it may be necessary to consider options for both metric-height rail and 31" rail. Discussions on each rail height are included below:

MGS

Recently, MwRSF performed limited research to determine an acceptable MGS post length for a 6-in. x 8-in. solid wood post installed on 2:1 fill slopes. MwRSF determined that 7.5-ft long wood posts are an acceptable alternative to W6x9 by 9-ft long steel posts when considering the 31-in. tall MGS placed on a 2:1 fill slope using a 6-ft 3-in. post spacing.

The MGS Long Span system utilizes six CRT wood posts. A CRT post's moment capacity about its strong axis of bending is approximately 81 percent of that provided by the standard wood post. In the absence of dynamic component test results, it is believed that the six CRT wood posts could also be fabricated with the 7.5-ft length when used in the MGS Long Span system. If the steep fill slopes continue beyond the location of the CRT posts, then the guardrail would transition to the MGS for 2:1 Fill Slopes using either 6-in. x 8-in. by 7.5-ft long wood posts or W6x9 by 9-ft long steel posts. This configuration allowed for posts to be placed at face of headwall.

Metric-Height W-beam

For the metric-height, W-beam guardrail system configured for long-span culverts, it would seem reasonable to utilize three 7-ft long wood CRT posts adjacent to each end of the box culvert if 2:1 fill slopes are present in this region. If the steep fill slopes continue beyond the location of the CRT posts, then the guardrail would transition to the metric-height, W-beam guardrail system for 2:1 fill slopes using W6x9 by 7-ft long steel posts spaced on 3-ft 1-1/2-in. centers. However, this half-post spacing system resulted in slightly decreased lateral barrier deflections as compared to those observed for standard W-beam barriers with 6-ft 3-in. post spacing. Thus, it would also seem appropriate to provide two 7-ft long W6x9 steel posts at 6-ft 3-in. spacing (i.e., 12 ft - 6 in.) between the last 7-ft long wood CRT post and the start of the half-post spacing. Therefore, all posts beyond the last wood CRT post would be configured as 7-ft long W6x9 steel posts placed at the slope break point of 2:1 fill slopes. This configuration utilized a 1.5 m lateral offset between back-side of guardrail and the front face of headwall.

Fences

The safety performance of a combination chain-link fence placed directly behind a guardrail system has not been evaluated using full-scale crash testing. As such, it is noted that there exists the potential for some increased risk to motorists and nearby pedestrians, including minor vehicle snag, minor vehicle instabilities, minor guardrail stiffening, and some additional fence debris scattered into the pedestrian region located behind the guardrail system. Of course, the effect that the nearby fence has on guardrail performance would depend on its configuration and relative lateral offset. The closer the fence to the guardrail and/or the more robust the design, the greater its potential influence on guardrail performance and other behaviors noted above.

It should be noted that this guidance is provided using our best engineering judgment in the absence of full-scale crash testing, computer simulation, dynamic component testing, or combination thereof. Due to the general need to place posts at the slope break point near culverts, it may be preferred to utilize MGS variations to protect the culvert hazards if culvert grating is not to be considered. If new information becomes available, MwRSF may deem it necessary to revise this guidance.

Vandal Protection Fence

Question

State: IL
Date: 10-28-2011

We have some questions reqgarding a vandal protection fence mounted on 32" barrier. Florida DOT has this fence in their specifications.

Can you provide some information on the background and testing of the vandal fence?

Response

Date: 10-28-2011
I have located and briefly reviewed the report which contains the crash test results for a vandal protection fence attached to a New Jersey safety shape concrete bridge railing. The report is titled,***Crash Testing and Evaluation of Retrofit Bridge Railings and Transition***. The report date is January 1997, while its number is FHWA-RD-96-032. Some of the key design parameters included:

-32" tall parapet
-6" wide parapet at top
-2.875" OD Schedule 40 pipe posts at 10' spacing
-three 1.66" OD Schedule 40 pipe rails at 3' spacing
-8.7' system height
-1"x1" wire fabric (11-gauge core wires with PVC coating)
-5/8" diameter anchor bolts
-¼" thick bent clamping plates
-back-side post mounting to parapet
-6" lateral offset from upper corner parapet to face of vandal protection fence
-AASHTO PL-2 pickup truck test was successful

From this review, several of these parameters are different than those later shown in the Florida DOT plans, including:

-variable-height concrete parapet
-unknown parapet width " F-shape and vertical
-3" (3.5" OD) Schedule 40 pipe posts with 0.216" wall thickness at 10' spacing
-two 2.5" (2.875" OD) Schedule 40 pipe rails with 0.203" wall thickness at 5'-5" spacing
-6' system height plus parapet height
-2"x2" wire fabric (9-gauge wires with zinc coating)
-5/8" diameter anchor bolts
-¼" thick bent clamping plates
-back-side and top-side post mounting to parapet
-unknown lateral offset from upper corner parapet to face of vandal protection fence " larger for F shape and smaller for vertical

Further, some changes may result in degraded safety performance as compared to that observed for the crash-tested system. No comparisons were made to end regions. Thus, we may want to continue discussion over the phone in near future.

Response

Date: 10-28-2011

We discussed checking with Florida regarding their NCHRP 350 TL3 modifications. Would you look into that as part of this discussion?

Response

Date: 11-03-2011

I have emailed and spoken to Mr. Charles Boyd, Structures Section, Florida DOT, regarding the vandal protection fence and its evolution. From our conversation, Charles noted that changes were implemented to accommodate a few concerns when considering its use under TL-3 pickup truck impact events according to NCHRP Report No. 350 where the approach angle is increased to 25 degrees. Years ago, Mr. Boyd noted that these changes were discussed with Dr. Dean Alberson, TTI, and Mr. Mark Bloschock, former bridge engineer with TxDOT and now with NTTA.

From their discussions, they eliminated the horizontal pipes and replaced them with tensioned cables due to concerns with dislodged pipes becoming hazardous projectiles for motorists and nearby pedestrians. I would assume that interior cables, longer pipe brackets, and/or insert bolts/pins could be used to mitigate these concerns as well. At any rate, the cables were used to address concerns raised after considering the 25-degree pickup truck test condition.

The vertical pipes were sized up to accommodate increased wind load conditions near Florida coastal regions. For Midwestern regions, Charles noted that the original sizes should be adequate and thus likely could be retained. In addition, the 2" wire mesh was used to more closely comply with a FDOT standard pedestrian mesh. However, he noted that some newer installations have used the 1" wire mesh as well and may reduce any concerns for increased vehicle snag into the larger mesh openings.

Charles clarified and reiterated that the top-mounted detail with vertical-face parapet is not for use on vehicle barriers. Instead, only the back-mounted configuration attached to safety shape parapets is to be used as a combination vehicle-pedestrian-vandal protection barrier. In the future, FDOT personnel will try to clarify the details to help ensure that it is not misused. As I recall, the AASHTO TF13 bridge guide and the 2005 FHWA Bridge Railing Guide may have inappropriately shown the system as top-mounted and on a vertical-face parapet.

Cross Median Crash Rates Near Interchanges

Question

State: KS
Date: 10-31-2011

Can MwRSF provide some information on crash rates for cross median crashes near interchanges?

Response

Date: 10-31-2011
I have done a search in the literature and I found a few studies indicating that interchanges do have an impact on CMC frequency. Also, there is one study (see item 5) that determined crash rates for CMCs near interchanges.

1) Songrit Chayanan, et al., "Median Crossover Accident Analyses and the Effectiveness of Median Barriers", Washington State Transportation Center, University of Washington, Seattle, Washington 2004. -- **Shows that CMC frequency increases as the number of interchanges increases on a road section.**

2) Donnell, E.T, et al., "Cross Median Collisions on Pennsylvania Interstate and Expressways," Transportation Research Record 1784, Transportation Research Board, Washington, D.C., January 2002. --**Shows that CMCs appear more likely to occur downstream of interchange entrance ramps.**

3) Bane, T.R. (2008). Florida Department of Transportation. Personal Communication. 30 June 2008. -- **Shows that 62% of CMCs occurred within 0.5 miles of a ramp terminus while 82% occurred within a mile. This led to a recommendation that median barriers be installed for 1.5 miles on either side of all highway interchanges.**

4) Donnell, e.t, et al., " Methodology to Develop Median Barrier Warrant Criteria", Journal of Transportation Engineering, Volume 132, Issue 4, pp. 269-281 (April 2006) --**Shows that interchange entrance ramps influence the frequency of CMC crashes based on an interchange entrance ramp "zone of influence" which was defined as the distance between the gore area and 1,500 ft dowstream of the gore area.**

5) A recent study ("Median Crossover Crashes in the Vicinity of Interchanges on Utah Interstates" by Katherine E. Winters, December 2008) may be found at http://contentdm.lib.byu.edu/ETD/image/etd2657.pdf provides much information on CMCs close to interchanges.**Relevant information to look at:**

* Figure 4-12: Distribution of rural CMCs by distance from the interchange

* Figure 4-13: Distribution of urban CMCs by distance from the interchange

***Tables 4-9 through 4-16: present crash rates for CMCs on both urban and rural locations near interchanges.**

Weak-Post Guardrail Improvements

Question

State: NE
Date: 11-01-2011

We found this weak post guardrail approved on the FHWA web site & plan to use it soon.
http://www.aashtotf13.org/Files/Drawings/sgr02a.pdf
With the design showing washers in front of the w-beam should we build as is?
Now with the 31" MGS passed without blockouts we will switch to that in the future.

Response

Date: 11-09-2011

I am aware that this TL-2 weak-post, W-beam guardrail system was developed and successfully crash tested with a small, thin square washer placed on the front face of the rail. I recall that a smaller hex head bolt was also used with this system to attach the rail to the posts and allow for the rail to easily release away from the posts due to bolt fracture. The version noted below in the link is shown as a TL-2 barrier. However, I recall other modifications being incorporated into the system which resulted in acceptable safety performance under TL-3 within a study conducted for PennDOT. I have attached a draft copy of the TRB paper on this topic. I will see if I can obtain an electronic version of the final paper.

Attachment: https://mwrsf-qa.unl.edu/attachments/f3a1de6ea6030efceff99fc06cab48a8.pdf

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Modified MGS Bridge Rail

Question
State: IA
Date: 11-09-2011

We are developing a project where we are proposing to use a side-mounted version of the MGS bridge rail on a 17" thick slab bridge that is located on the NHS. Please review the attached memo, detail, and analysis and provide any comments or concerns. Note: adhesive anchor values are from the HILTI Product Technical Guide for the HIT-RE 500-SD Epoxy Adhesive Anchoring System.
I'm curious whether you think this minor change from the tested system would require approval from FHWA. Also, I'm open to any suggestions you might have!

Attachment: https://mwrsf-qa.unl.edu/attachments/e9b42a97b1eb968966cc19579a7d4877.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/39776bd5396b83b0c4ac7c35750844b8.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/ac5d4ae4790c248d4c9330f5e3c7525e.xlsb

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Response
Date: 11-10-2011
As Dr. Faller has indicated, we are currently in the process of adapting the side-mounted, weak post MGS system to culvert headwalls. The headwall we are attaching to is 18 in. in height. Thus, our current study is very similar to your situation. In fact, one of the 3 design concepts we are working with is very similar to the one you have proposed (we only use 4 attachment bolts were you have used 6).
My first question to you is... How soon do you need this system? I ask because we will be testing and evaluating our design concepts relatively soon (hopefully spring of 2012). If that timeline would work for you, I would recommend waiting for these test results and utilizing our tested side-mounted design configuration. If you need an answer quicker than that, we can take a close look at your proposed design.

Response
Date: 11-10-2011
If we were to wait and incorporate your system, do you see any potential issues with the fact that our slab is one inch shallower (17" vs. 18") than what you will be testing with?

Response
Date: 11-10-2011
If our side-mounted design proves to cause no significant damage to the culvert headwall, I do not see the 1" difference in thickness/height causing any issues. The current design does not extend to the bottom of the 18" tall headwall, thus all components would be the same for your situation.

Response
Date: 11-10-2011

I'll check with our Bridge Office and see if they'd like to hold off for awhile.

Project ID 1033-02-70/74: STH 20 Frontage Roads - Guardrail

Question

State: WI
Date: 11-14-2011

I have a project that has issues with a curved beam guard installation (see below). My initial comments to them are:
Should not use curved beam guard with curb and gutter because there is a good chance that the rail will fail during an impact.
Kinks in rail will concentrate stresses making it more likely that the rail will fail.
Plan (PDF title 40) has the beam guard too far back from the curb, making it likely that the errant vehicle will jump over or submarine the rail.
Beam guard flare near 68+75 LT on the plan is likely too steep and will likely fail during an impact.
Beam guard in radius should likely have breakaway holes installed. After a certain point during the impact the post should break away from the ground or the beam guard will become a ramp.
My questions to you are:
Are my recommendations above valid?
What are the typical radius that beam guard can be bent to (e.g. 5 or 10 ft increments)?
Can manufactures bend beam guards to any radius (e.g. 53' radius)?
As requested, I am sending some photos of the guardrail installation concerns and summary of the conversations had with Highway Landscapers and Gregory Products. The photos represent the southeast and southwest corners of CTH C and the Northeast Frontage Road. Bends in the guardrail were the result of pushing the rail into the posts to meet the existing radius. I have attached the plan page showing the radii to the flange of the curbs. We placed the guardrail along the face of the curb rather than at the provided radius so that they would perform appropriately. Therefore, the 55' and 60' radii would have been 53' and 58' for the face of curb. When we discussed our concerns with Highway Landscaping, they initially told us that only 20', 40, and 50' radii can be provided. I am not sure what they used, because the panels are not marked and checking the chord length would now represent the installed radius. Gregory Products is their supplier and I found the attached list on their website that shows 5' increments being available. I also spoke with the regional sales person from Gregory to confirm this was the case. He was reluctant to provide too much information because Highway is a customer of his. He noted that the installation method is common and kinks sometime occur, but also that they should have had the material sizes they needed for this particular radii.
We also have been having panels delivered that are not on the approved list. Highway tells us that these panels had only recently been tested in the yard, and that is why they are not on the list yet. On the EFR, we needed to test in the field because they were never tested at the yard. We are still waiting to see if we need to do the same on the WFR. One of our concerns is whether the contractor is getting the appropriate stockpiling of material in time to test properly and delivery correct radii to the specific projects. Our EFR was an urgent need as Highway replaced Andrews, and we wonder if they grabbed whatever they had available to get it installed in time. And, what they had available was not the radii identified in the plan.
From our findings at this point, we are proposing that we add to the project punch list that the SE and SW quadrants be replaced with appropriate radii for the EFR and CTH C guardrail. Any other suggestions, comments, questions?

Attachment: https://mwrsf-qa.unl.edu/attachments/78490bf1723e410b0026b02923e0db31.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/ded2eb6e79a727ee4b1fded6ad22ed8d.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/24c0640cbf33e7f48c50d744a7e4e0f0.JPG

Attachment: https://mwrsf-qa.unl.edu/attachments/59bc48e7e9faa802612bcc0cb29d61ff.JPG

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Attachment: https://mwrsf-qa.unl.edu/attachments/3677d8673e047100f6710e18a8127065.JPG

Attachment: https://mwrsf-qa.unl.edu/attachments/d0899fea86e314218c12099a77e7a7d8.JPG

Response

Date: 11-14-2011

1. The installation shown has radii in the 50' to 60' range for the curved sections. The radii shown here are too small to be treated as standard longitudinal barrier and its location adjacent to the intersection will potentially subject the rail to high angle impacts like a short-radius system. As you know, there are no acceptable, tested TL-3 short-radius guardrail designs at present. TTI has received FHWA acceptance of the Yuma Country short-radius guardrail for TL-2. Additional information on short-radius guardrail design was given by FHWA in the memo titled, "Curved W-Beam Guardrail Installations at Minor Roadway Intersections - T 5040.32". I cannot tell what design speeds you are dealing with for this installation, but I would recommend that the Yuma County system be used in this area as it currently represents our best guidance and state of practice with regards to short-radius guardrail systems. The radii here are larger than those in the FHWA memo or the standard Yuma county design. However, I believe that adapting the Yuma County design over to a larger radii is likely your best option. The TTI report and the design details is below.
   A. Abu-Odeh, K. Kim, D.C. Alberson. Evaluation of Existing T-Intersection Gaurdrail System for Equivalency with NCHRP Report 350 TL-2 Test Conditions. 405160-10. Texas Transportation Institute, College Station, TX. August 2010.
2. I would agree that the guardrail system not be used with a curb and gutter. Previous testing of standard w-beam guardrail with curb has shown the potential to either vault the vehicle over the rail if the offset from the curb is significant or the potential to increase rail loads and rupture the guardrail.
3. The kinks in the rail that you saw are not a huge concern in terms of stress concentrations. However, the rail manufacturers should be able to fabricate a rail that matches the design radii much more closely than what you have shown. In addition, it appears that the posts do not fit up to the rail in the correct locations, which is causing the system to be field modified with additional post bolt holes in the rail. This would be a cause for concern with respect to proper release of the post from the guardrail.
4. We would recommend that the rail flares outside the radii follow the guidance in the RDG. Thus, the recommended flare is likely very shallow.
5. The posts in the radius will perform better if they are breakaway posts. See the Yuma County details mentioned previously.
6. As I noted before, the manufacturers should be able to make various radii for the guardrail. We have ordered radiused guardrail several times in the past and have not had issues getting a certain size. However, manufacturers may want to limit the potential sizes to certain ranges to simplify fabrication.

Attachment: https://mwrsf-qa.unl.edu/attachments/e99b1fa758d6266fe8e7f194dd6ad340.pdf

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Mounting of Thrie Beam Railing on Brush Curb with Epoxy Anchors

Question

State: WI
Date: 11-29-2011

I have questions regarding the installation of a thrie beam bridge rail on a brush curb using epoxy anchors in lieu of the case in place anchors used in your standard. I wish to install the thrie beam bridge rail shown in the attached detail to near the front and on top of the brush curb shown in the second attached plan. The thickness of the bridge deck and curb at the proposed installation region is approximately 16". The standard for the thrie beam railing calls for four 7/8" dia. A325 anchor bolts to be cast in place into the concrete. Because this installation is a retrofit, that is not possible. Thus, the desire to install the railing with epoxy anchors. The speeds of the bridge in question are 35-45 mph which would suggest TL-2 impact conditions for the railing.

Attachment: https://mwrsf-qa.unl.edu/attachments/faaa0fd9a79fa7f1b62cf8c9704d49a3.pdf

Attachment: https://mwrsf-qa.unl.edu/attachments/3d27bbcf7bf321aaf36993967f41d71c.pdf

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Response

Date: 11-29-2011
I am writing to summarize our discussion over the phone regarding the installation of a thrie beam bridge rail on a brush curb using epoxy anchors in lieu of the case in place anchors used in your standard. To review, you wish to install the thrie beam bridge rail shown in the attached detail to near the front and on top of the brush curb shown in the second attached plan. The thickness of the bridge deck and curb at the proposed installation region is approximately 16". The standard for the thrie beam railing calls for four 7/8" dia. A325 anchor bolts to be cast in place into the concrete. Because this installation is a retrofit, that is not possible. Thus, the desire to install the railing with epoxy anchors. The speeds of the bridge in question are 35-45 mph which would suggest TL-2 impact conditions for the railing.
In order to determine the proper epoxy anchor configuration for the railing, I began by analyzing the existing 7/8" anchors. The 7/8" A325v anchor has yield and tensile strengths of 92 ksi and 120 ksi, respectively and a threaded area of 0.462 in^2. These capacities and areas provide a tensile yield force of 42.5 kips, an ultimate tensile force of 55.44 kips, and an ultimate shear strength of 32 kips. The spacing of the anchors from your place is 6".
We have recently been using HILTI RE-HIT-500 epoxy for the concrete barrier anchorage project that we are working on for WisDOT and have found that the published strengths of this material is very consistent with the results of our dynamic testing. Review of the ultimate strength data for HILTI RE-HIT-500 epoxy shows that a 7-7/8" embedment of a 7/8" dia. anchor with HILTI RE-HIT-500 epoxy is capable of developing a tensile load of 63.5 kips and a shear load of 72.86 kips. Reducing these capacities to adjust for the spacing of your anchors leads to an ultimate tensile load of 49.53 kips and a shear load of 56.71 kips. These values exceed the tensile yield and ultimate shear capacities of the 7/8" A325 anchor, but are approximately 10% less than the ultimate tensile capacity. We do not believe that the slight reduction in the ultimate tensile capacity is a concern in this situation as the railing was designed for TL-3 and the roadway speeds for this installation reflect a TL-2 impact condition as noted above. Thus, we would recommend that the thrie beam railing can be safely retrofitted on the brush curb shown using 7/8" dia. A325 anchors bolts or rods embedded a minimum of 7-7/8" into the brush curb. We could recommend the anchor rods or bolts be fully threaded to better develop strength in the epoxy.

Attachment: https://mwrsf-qa.unl.edu/attachments/bf6295cda3a6542a8ae0a56920d73478.pdf

W-Beam bridge barrier transition posts in concrete

Question

State: MO
Date: 12-07-2011

The attached picture shows a low-cost, TL-3, W-Beam bridge barrier transition that we have chosen to use on about 500 bridges that we are rebuilding.

A small number of these were inadvertently built as shown, with posts 1-5 set in concrete. One of our inspectors noticed the condition and asked me if we should insist on a retrofit. My initial reaction was to order the retrofit, given the increased stiffness introduced into the system, and the resulting increase in the likelihood of beam rupture.

Yesterday I spoke to the contractor and he pointed out that both MoDOT's internal policy, as well as that of the Roadside Design Guide point to special post settings in solid rock and pavement for regular runs of W-Beam guardrail only, not thrie beam, or stiffened W-Beam transition sections. After a little research of my own, I could only agree with his logic and told him I would render an opinion based on your advice.

My questions follow:

1. Does the concept of special post setting, *i.e.* a slot cast in the slab and backfilled with aggregate, apply to all posts, or just regularly spaced W-Beam posts in a roadside guardrail run?

2. If so, can an exception be made for a situation like the one shown here wherein the entire system is intentionally being stiffened anyway?

Attachment: https://mwrsf-qa.unl.edu/attachments/855b5382ca597b2b7ff8711e774b7f45.jpg

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Response

Date: 12-07-2011

In response to each question:

1. Does the concept of special post setting, *i.e.* a slot cast in the slab and backfilled with aggregate, apply to all posts, or just regularly spaced W-Beam posts in a roadside guardrail run?

Concrete or asphalt leave-outs could also be considered for closely-spaced posts found in approach guardrail transitions. These leave-outs should allow for greater post rotation within the compacted soil region which should be more representative of the post-soil behavior observed in the actual crash testing programs. Since most transition posts rotate less than that observed for standard guardrail with 6 ft " 3 in. post spacing, it would be appropriate to utilize the recommended leave-out sizes and placement guidance if comparable post cross sections are used.

2. If so, can an exception be made for a situation like the one shown here wherein the entire system is intentionally being stiffened anyway?

For posts placed in concrete pads, guardrail performance could be greatly affected in terms of increased wheel snag on posts and increased vehicle pocketing farther upstream as well as greater propensity for rail ruptures. Even though AGT posts deflect less than standard guardrail posts, changes in stiffness and strength from that used in actual testing programs could potentially degrade barrier performance at various locations. It would be my general recommendation to sawcut the concrete, jackhammer out the non-desirable concrete pad around

AGT posts, and configure appropriate leave-outs for AGT posts. Then, soil, crushed rock, or other low-strength leave-out material could be placed around the posts at the upper surface. How thick is the concrete around the posts?

Response

Date: 12-07-2011

The concrete around the post is 4" thick.

Response

Date: 12-07-2011

With a 4" thickness, it would be relatively easy to sawcut the concrete to provide a leave-out length similar to that provided for guardrail posts assuming similar post positioning in hole. If post cannot be made close to front of the leave-out, then increased length would be needed on back side of posts. It would be acceptable to cut one large opening for all 4 or 5 posts versus individual cutouts.

Box Beam Radius

Question

State: WI
Date: 12-09-2011

Can RDMO1 be bent to a radius? I have to have the box beam attached to a concrete barrier in a 1323' radius.

Response

Date: 12-12-2011

We do believe that box beam can be safely used in the radius you note below. It is also viable to have box beam bent to that size of radius without concerns for the structural integrity of the part.
I should note that when you bend the rail segments you need to keep the ends of the segments straight such that the splices will fit together properly.

Attachment: https://mwrsf-qa.unl.edu/attachments/855b5382ca597b2b7ff8711e774b7f45.jpg

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Sand Barrel Array layout

Question

State: WI
Date: 12-12-2011

I was asked by our maintenance department to develop a sand barrel array layout for a damaged crash cushion location. Could MwRSF review this layout and calculations. I believe that they are correct for a MASH TL-3 impact.
On concern I have is for the last row of barrels before the median barrier. I believe that the roadside design guide indicates that an additional row of lighter barrels could be installed to protect vehicle from directly engaging the 1,400 lbs barrel. I'm not sure how to approach this. What weight should be in this barrel? Should I have multiple rows of barrels with multiple weights (i.e. design for a head on impact).

Attachment: https://mwrsf-qa.unl.edu/attachments/965e466e1624bba28249deb11d6db195.pdf

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Response

Date: 12-13-2011
I looked though your sand barrel design. I believe that the array you have shown is sufficient. However it is longer than necessary. I have attached a spreadsheet with the numbers for an array that is three rows shorter and is still acceptable for a TL-3 MASH impact event with both the small car and pickup vehicles.
I would suggest that you go with the shorter array laid out in the spreadsheet to reduce the cost and number of potential impacts on the sand barrels.
As for the reverse direction impact barrels, The recommended configurations are attached for various design speeds.

Attachment: https://mwrsf-qa.unl.edu/attachments/ad07dda3f5c195aefa3cf4e1c83a3d97.jpg

Attachment: https://mwrsf-qa.unl.edu/attachments/57037b349ec85738a85bab3d948cbce5.jpg

Attachment: https://mwrsf-qa.unl.edu/attachments/3b0988c7266706df2d1c02ceb93b1fb0.xls

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MGS transition to quarter post spacing

Question

State: IA
Date: 12-14-2011

For MGS side obstacle protection on a divided highway, what is your suggested practice for transitioning from standard post spacing to quarter post spacing? Would you mirror the transition on the downstream side, even though this is a one-way situation?

Response

Date: 12-15-2011

As noted below, you inquired as to whether a stiffness transition should be utilized when connecting full-post spacing MGS to quarter-post spacing MGS.

Recall, the standard MGS is configured with guardrail splices located at a mid-span location of a 6 ft " 3 in. wide span. Further, we know that barrier stiffness increases with the use of reduced post spacing. Thus, dynamic barrier deflections would be expected to decrease when considering comparable vehicular impacts into the MGS with standard, half-, and quarter-post spacing variations.

Historically, common W-beam guardrail systems have been easily transitioned between full and half-post spacing variations as well as half- and quarter-post spacing configurations without changes to post lengths or rail configurations. When the MGS with quarter-post spacing is deemed necessary to shield hazards closer to the traveled way, the needs exists to connect full-post spacing MGS to quarter-post spacing MGS. Under this scenario, MwRSF has previously suggested that an intermediate stiffness transition be utilized to more gradually blend the varied lateral stiffness of the two systems. More specifically, MwRSF suggested that a 12-ft 6-in. long MGS segment with half-post spacing be used to gradually transition the lateral barrier stiffness and strength, thus resulting in four spans of half-post spacing between the two systems.

Although the standard MGS utilized mid-span locations for rail splices, it would be expected that rail splices would occur at post locations for the MGS variations which utilized a reduced post spacing. Thus, MwRSF has suggested that rail splices be configured to occur a minimum of 1 reduced span (3 ft - 1½-in.), and preferably 2 reduced spans (6 ft " 3in.), beyond the last or first MGS full-post spacing.

The stiffness transition noted above is suggested for situations where impacting vehicles first contact the full-post spacing MGS and subsequently engage the quarter-post spacing MGS. Therefore, it would not be necessary to apply a similar stiffness transition to the downstream ends of quarter-post spacing MGS unless prone to reverse-direction impacts.

Response

Date: 12-15-2011

Could you clarify the sentence highlighted below? I'm having trouble following. Also, how far upstream of the obstacle would you recommend the quarter-post spacing begin?

Thus, MwRSF has suggested that rail splices be configured to occur a minimum of 1 reduced span (3 ft - 1½-in.), and preferably 2 reduced spans (6 ft " 3in.), beyond the last or first MGS full-post spacing.

Response

Date: 12-15-2011

The quarter-post spacing MGS should begin a minimum longitudinal distance of approximately 12 ft " 6 in. in advance of the hazard.

In terms of rail splices locations, numerous rail splices occur at mid-span locations within the full-post spacing MGS. However, there will be a post where full-post spacing ends and half-post spacing begins. We are suggesting a preference to not locate a rail splice at this transition post. Instead, we would prefer that the first rail splice within the half-post spacing region occur either 1 or 2 posts away from where full-post spacing ends.

I hope that this helps to clarify the issue.

Safety barrier shape clarification

Question

State: OH
Date: 12-14-2011

Could you check out the question forwarded below, hopefully it is a simple one for ya... basically the crux of the question: is it necessary to have clear space above our barrier for any safety or head slap type issues? Mostly my initial thoughts are that as long as the barrier is poured/formed separately, and the object above doesn't affect the integrity of the barrier, does there need to be clear space above it? Could aesthetic treatments even be flush with the face of out barrier?