Midwest States Pooled Fund Program Consulting Quarterly Summary

Midwest Roadside Safety Facility

01-01-2006 to 04-01-2006

Questions on MGS Implementation

Question
State: NE
Date: 01-25-2006

NDOR asked a series of questions regarding the MGS system.
(1) The thrie-beam bridge approach sections:
- Is the mounting height for thrie-beam moving down from 31 5/8" to 31"?
- Do we add just the 12.5' nested Thrie-beam to the bridge, or is 6'-6" enough?
- Is the bridge approach acceptable @ 27 5/8" too?
(2) 1/2 post spacing: placing a post on the splice or gap the splice?
(3) 1/4 post spacing in photo appears to show the post on a splice.
(4) What is the post spacing when I want to transition from 75" MGS to 1/4 post spacing? Phase through 1/2 post for 12'?
(5) What is the radius to 7:1 tapers, posts are moved to the 1/4 and 3/4 points?
(6) I assume the 6" curb is acceptable closer to the face and behind the face of the MGS?
(7) Are the end treatments acceptable behind curbs? Or what is the transition to 4"? Or no curb?
(8) "First & only NCHRP 350 system to be successfully tested 6" behind a 6" tall curb"?
- I thought MinnDOT had a test pass(fall 2002) with 6" curb face directly under regular w-beam.
(9) MGS performance summary:
What is the working width? back of posts? or vehicle extension beyond the rail?
(10) Future testing concerns:
- Long Span Testing: If this uses a drop-off at a given distance and passes is the drop-off only allowed at that distance?
- 8:1 slopes: Can the MGS start on a 10:1 and transition to the 8:1?
(11) Please supply the pooled fund states with dimensions of the Y-shape transition. Or submit it to manufacturers to work out any problems with manufacturing.
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Additional items:
(12) "40 in. embedment depth"
- Embedment depth varies as curb height/non-curbed varies. The 6' post covers the hardware used.
(13) Can I use the same attachment to concrete box culvert with the MGS?
(14) 7:1 flare rate: End Terminals for this?

Response

Date: 02-17-2006

(1) The thrie-beam bridge approach sections:

- Is the mounting height for thrie-beam moving down from 31 5/8" to 31"?

Over the last decade, several thrie beam approach guardrail transition systems have been successfully developed according to the NCHRP Report No. 350 criteria. For these systems, the top mounting height has utilized either the 31 in. or 31.65 in. upper rail dimension. This range occurred due to two reasons. First, early corrugated steel beam guardrail systems used a 20.875 in. or 21 in. (when rounded up) center rail height, thus resulting in top of rail thrie beam heights of 31 in. Second, the more recent corrugated steel beam guardrail systems utilized a 550 mm or 21.65 in. center height which occurred during the metrication of roadside safety hardware in the late 1980's to early 1990's. As a result, the top of rail thrie beam height for these systems became 31.65 in. Since both small car and pickup truck crash tests have been successful performed into thrie beam approach guardrail transitions using both mounting heights, we are not concerned with the downward shift of 0.65 in. Even though it will require changing the height of the transition system, reducing the height to 31 in. might provide the simplest overall design. Alternatively, you could raise the height of the MGS to 31 5/8 in. over the last 2 or 3 post spans.

- Do we add just the 12.5' nested Thrie-beam to the bridge, or is 6'-6" enough?

Many of the existing thrie beam approach guardrail transition systems have utilized a 12-ft 6-in. long, nested section of 12-gauge thrie beam rails, followed by the symmetrical, W-beam to thrie beam transition section. The new approach guardrail transition system has been configured with an additional 6-ft 3-in. long, single (non-nested) 12-gauge thrie beam rail, followed by the new asymmetrical, 10-gauge W-beam to thrie beam transition section. It is our current opinion that all of the prior nested thrie beam transition systems should be modified to include the additional 6-ft 3-in. thrie beam section as well as the asymmetrical transition section. In addition, the existing approach guardrail transition systems will require a longer transition length for which the support posts are installed and using a reduced post spacing. As part of another change, W6x12 steel posts were implemented in order to provide a more gradual change in lateral stiffness of the overall guardrail system. Final design details for this new, longer transition system will be included in a future research report, or in electronic draft form at your request.

- Is the bridge approach acceptable @ 27 5/8" too?

No.

(2) 1/2 post spacing: placing a post on the splice or gap the splice?

The MGS was designed using three different post spacing - standard (6 ft - 3 in.), half (3 ft - 1 1/2 in.), and quarter (1 ft - 6 3/4 in.). In the standard MGS, guardrail splices are not to be placed at the post locations. However, guardrail splices will be located at post locations in the two reduced post spacing configurations. Note that stiffening the guardrail by adding posts reduces the stress on the rail and allows the barrier to function adequately, even though there is a post at the splice.

(3) 1/4 post spacing in photo appears to show the post on a splice.

As noted previously, the MGS in combination with either half or quarter post spacing will require that guardrail splices be located at post locations.

(4) What is the post spacing when I want to transition from 75" MGS to 1/4 post spacing? Phase through 1/2 post for 12'?

At this time, a stiffness transition has not been developed nor tested for use in switching between the standard MGS and the quarter-post spacing version of MGS. Until a transition is determined with the aid of an engineering and numerical analysis, or possibly crash testing, it is recommended that four half-post spaces be utilized in order to allow for a more gradual transition in lateral stiffness between barrier systems. As such, this stiffness transition would likely occur over approximately 12 ft - 6 in.

(5) What is the radius to 7:1 tapers, posts are moved to the 1/4 and 3/4 points?

First, we have assumed that you have asked what radius is used make the gradual bend from the tangent roadside guardrail to the guardrail flared away from the roadway at a 7:1 rate. Based on this question, we measured the actual radius that was used in the field installation via an overhead film analysis. From this analysis, we have estiamted the radius at the knee to range between 88 and 91 ft. Posts remained at the full post spacing at the location of the knee.

(6) I assume the 6" curb is acceptable closer to the face and behind the face of the MGS?

Yes.

(7) Are the end treatments acceptable behind curbs? Or, what is the transition to 4"? Or, no curb?

To date, no full-scale vehicle crash tests have been performed on guardrail end terminals placed behind curbs. As such, it is not recommended that existing guardrail end terminals be installed behind curbs until satisfactory safety performance has been demonstrated according to the NCHRP Report No. 350 guidelines. Terminal manufacturers might be able to provide guidelines for use of their systems behind a curb. General guidance on the transitioning of curbs behind guardrail end terminals is provided in a MwRSF research report no. TRP-03-127-03 entitled, "Bridge Rails and Transitions for Pedestrian Protection." Other options may also exist that are based on the engineering judgment but are not provided herein.

(8) "First & only NCHRP 350 system to be successfully tested 6" behind a 6" tall curb"?

- I thought MinnDOT had a test pass(fall 2002) with 6" curb face directly under regular W-beam.

The MinnDOT design had the face of the curb flush with the face of the guardrail.

(9) MGS performance summary:

What is the working width? back of posts? or vehicle extension beyond the rail?

Working width is defined as the distance measured from the original front face of the longitudinal barrier system to either the rearmost part of the barrier at the maximum dynamic barrier deformation (i.e., back side of rail, post, etc.) or the farthest vehicle extend beyond the barrier system, whichever is greater. For the MGS, this dimension was normally measured to the back of one of the posts, such that a 17 in. barrier deflection produces a 17 in. + 3 in. rail depth + 12 in. blockout + 6 in. post = a working width of 38 in.

(10) Future testing concerns:

- Long Span Testing: If this uses a drop-off at a given distance and passes is the drop-off only allowed at that distance?

The vertical drop-off could be no closer than in the test. The drop-off could be farther from the rail.

- 8:1 slopes: Can the MGS start on a 10:1 and transition to the 8:1?

Future crash testing is planned for the MGS using an 8:1 approach slope. Approach slopes of 10:1 or flatter are deemed acceptable and do not require crash testing. If the 8:1 slope test passes, starting on a 10:1 and transitioning to an 8:1 would be acceptable.

(11) Please supply the pooled fund states with dimensions of the Y-shape transition. Or submit it to manufacturers to work out any problems with manufacturing.

Detailed drawings have been supplied to the manufacturers. MwRSF will send them to the Pooled Fund States.

Additional items:

(12) "40 in. embedment depth"

- Embedment depth varies as curb height/non-curbed varies. The 6' post covers the hardware used.

For the MGS curb combination, it is understood that an additional post embedment depth would result due to the 6-in. curb height. Recall that when used over a curb, stiffer guardrails perform better. Hence the posts are designed to be embedded farther.

(13) Can I use the same attachment to concrete box culvert with the MGS?

Although we believe that the MGS attached to the top of concrete box culverts would provide adequate safety performance. Future full-scale vehicle crash testing would be required to demonstrate that the system would perform in an acceptable manner. In addition, further research may allow designers to either optimize the existing design or move it closer to the front face of the concrete headwall.

(14) 7:1 flare rate: End Terminals for this?

For now, it is appropriate to use standard guardrail end terminals in this flared configuration.

Questions on Tie-Down System for F-Shape Temporary Concrete Barrier

Question

State: WI
Date: 02-14-2006

We are making some corrections to the above referenced detail. Some questions came up when we were comparing WisDOT's detail with the recommended details from MwRSF Research Report No. TRP-03-134-03 "Evaluation of a Tie-Down System for the Redesigned F-Shape Concrete Temporary Barrier", dated August 22, 2003, and with the SDD's from IA, KS, MN, and MO.
* KS, MN, and MO show an optional 3/8" hole and retainer bolt at the
bottom of the CONNECTION PIN. MO requires the use of a retainer bolt on transition sections. IA shows a 5/8" hole with 1/2"x10" retainer bolt, which they require for connections with 2-loop barriers (their old design). Fig. 3 on p.15 of the MwRSF report shows the CONNECTION PIN without a hole.
Did MwRSF consider using a retainer bolt?
* Under RECOMMENDATIONS on p.59 of the MwRSF report it says that
"...this tie-down system is not recommended for use on a bridge deck with an asphalt overlay."
What is recommended for bridge decks with asphalt overlays?
* On p.12 of the MwRSF report it says that "... each anchor bolt was
epoxied into the concrete to an embedment depth of approximately 305 mm (12in.)... "
Is this the recommended minimum embedment length?
* Fig. 36 on p.62 of the MwRSF report shows a 1-1/4" x 40" steel stake
for staking down a barrier on asphalt pavement
Is there an ASTM spec for this stake?

Response

Date: 02-15-2006
It appears that you have performed a significant review of barrier design standards for the surrounding State DOT's who presently use the design noted above. One additional State that has prepared excellent design details using this barrier is the State of Florida. I highly recommend that you review their details since I believe that they are accessible on line. If they are not, please call Mr. Charles Boyd for additional information and using the contact information provided below. I have also attached a draft FL DOT file for your review and comment.
(1) With regard to your first question, you are correct that MwRSF, in cooperation with several Midwestern States, modified the original temporary barrier details after the first section was developed in the 1995-1997 time period. One change that you had noted was the omission of the retainer bolt and horizontal hole in the vertical drop pin in conjunction with a modified loop configuration. This overall change was made after it had been demonstrated that the Oregon temporary concrete barrier could meet the TL-3 impact safety standards without the use of a retainer bolt but with a pin and loop detail that placed the upper and lower pin locations in double shear. Therefore, a decision was made to leave out the retainer bolt for pin and loop connections that incorporated a double shear loading condition for the pin.

(2) The tie-down system described in the referenced report was intended for use on reinforced concrete bridge decks that did not include asphalt overlays. With overlays in place, the loaded barrier may allow the vertical anchor bolts to plow through the asphalt roadway material instead of being restrained by the rigid concrete deck, thus resulting in a longer moment arm and increased bending moment for the bolt region found at the asphalt-concrete interface. This change in loading and capacity may potentially decrease the safety performance of the existing, crashworthy tied-down barrier design. As such, we can not at this time recommend using this detail on bridge decks that contain an asphalt overlay. Although it may be possible that this design, or one very similar to it, may provide acceptable performance, we believe that future research is needed to investigate and evaluate various temporary tied-down barrier systems for this special application. Finally, we are not aware of any other temporary barrier solutions for bridge decks with asphalt overlays.
(3) For crash testing purposes, the vertical anchor rods were epoxied into a thick, un-reinforced concrete tarmac using a 12-in. embedment depth. For actual bridge applications, the vertical anchor rods or bolts also could be installed using either of two different methods: (a) rods epoxied into the bridge deck using acceptable anchoring methods that develop the ultimate strength of the rod or (b) rods installed using a through-bolt system that anchors the rods on the underside of the deck. To the best of my recollection, both Kansas and Florida have provided specifications for these alternative anchoring options within their standard plans. If desirable, I will try to obtain a summary of this prior correspondence between MwRSF and selected DOT's and forward it to your attention.
(4) After completing the MwRSF report noted above as well as the draft detail shown on page 62, MwRSF embarked on a new research project to develop a staked, tie-down system for use on roadway shoulders configured with a thin asphalt layer. This research study was funded by the States of Florida and Kansas. The results of this study led to a pinned through asphalt and roadside fill, tied-down barrier system as well as a transition between free-standing TBR's and rigid concrete barriers using this asphalt pinned system. Details of this research was presented at the 2006 Annual Meeting of the Transportation Research Board last month. I will attach an electronic copy of this paper within this email. In addition, if you would like to obtain additional information on these two systems, please let me know so that I can forward to you that information, CAD details, and test documentation (i.e., photographs and videos). Please note that a research report should also be available sometime this spring.

FLEAT-MT

Question

State: KS
Date: 02-16-2006

See my responses below. Note that there is no full-scale crash testing of any of these options and the following is based solely on engineering judgment. By copy of this e-mail, I will ask Bob Bielenberg to review my recommendations and place them in the pooled fund summary that goes out to all the states.

That said, I don't have a problem with what you have proposed. I do have a few suggestions for your consideration in response to your question no. 4.

Let me know if you need further explanation.
Some questions include:
a) How much separation is required between posts so that one post does not have an effect on the rotation of another post?I recommend at least 1 ft.
b) What is your opinion of the use of non-standard guard rail lengths? - This is not a problem, provided the span is not greater than 9'-4&1/2".
c) What is your opinion of the use of custom block outs? This is not a problem, provided the block is at least as deep as the tested block and is made of an acceptable material.
d) Have you seen or studied any other configurations that you would recommend for use?

1. You might want to consider inserting a more-or-less standard 2.86 m (9'-4&1/2") piece of rail where you have your current 2.195 m (7'-3") piece of rail. These pieces are generally available at most GR distributors.
2. You might consider reducing the length of the tangent section, just upstream of the radius to about 4 meters instead of almost 8 m
3. .If you don't like option 2, I would recommend that you consider mounting both guardrails on the same post for another 3.81 m (12'-6").

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Attachment: https://mwrsf-qa.unl.edu/attachments/16542af82df88c268d92e6a6a46a5c1a.jpg

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Response

Date: 02-16-2006

I am contacting you on behalf of KDOT concerning some installation details for the FLEAT-MT (or similar product). Our concerns deal mostly with the area in which the guard rail diverges from a single post, double sided block out configuration, to a separate post for each run of guard rail.

Attached are several drawings depicting two scenarios.

The first requires a non-standard length section of guard rail (fleat-mt.pdf, fleat-mta.pdf, fleat-mtb.pdf and fleat-mt.dwg) in order to provide post separation in this area. (*It should be noted that the drawings do not accurately depict the true post locations; the depth of the w-beam is not taken into account*.)

The second (fleatrod.pdf) would require a large flare rate or the use of custom (larger than standard) block outs until separation is acquired.

Some questions include:

a) How much separation is required between posts so that one post does not have an effect on the rotation of another post?

b) What is your opinion of the use of non-standard guard rail lengths?

c) What is your opinion of the use of custom block outs?

d) Have you seen or studied any other configurations that you would recommend for use?

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Race Track Barriers

Question

State: KS
Date: 02-21-2006

KsDOT asked what type of race track barrier is appropriate for local race tracks.

Response

Date: 02-21-2006
I have attached a drawing of the barrier that we recommended for use at GM's Milford Proving Grounds in response to your inquiry regarding an appropriate barrier for use on a local race track. You gave me the following information regarding the race track in question and the vehicles operating on it.

Track corner radius = 3/8 mile.
Track banking = 10 degrees.
Maximum weight of race vehicle = 3200 lb.
Maximum speed of heaviest race vehicle = 90 mph.
Most common weight of race vehicle = 2800 lb.
Weight of fastest vehicle = 1800 lb
Fastest speed on track = 110 mph

The barrier designed for the GM proving grounds should have more than enough capacity for use at this race track. Note that the W-beam rail elements are 10 gauge instead of the 12 gauge normally used inKansas.

There are several minor changes that I recommend when adapting the barrier to the local track.

1. Keep the barrier perpendicular to the track surface. This means orient the guardrail posts 10 degrees off of vertical instead of the 26 degrees shown in the drawing.
2. Although not specifically shown on the drawing, guardrail splices should be placed at mid-span, not at a post.
3. The height of the top rail should be maintained at 36" above the track surface.
4. The top of the guardrail posts should be approximately 1-5/8" below the top of the guardrail.
5. The overall length of the posts should be reduced from 9'-6" to 9'-0" to maintain approximately the same soil resistance of the original design as the posts are made more vertical.
6. The area behind the guardrail should be relatively flat with only a modest slope (5% or less) away from the guardrail.

Our best guess is that this guardrail should be installed at a cost of about $30 per foot.
Let me know if you have any questions.

Attachment: https://mwrsf-qa.unl.edu/attachments/65c903a781fdec7924bf93d377dc1c15.pdf

Pier Protection

Question

State: KS
Date: 03-06-2006

This is the location at which we discussed using a steeper flare rate to save room on the barrier width transition. See attached PDFs. This is located in a rapidly developing area of Kansas City where traffic signals will be located about every ½ mile but the design speed will be 55 mph. The 42" crash wall will be transitioned down to 32" tall and will be protected with a 69" Wide Quadguard. As the drawing shows, there will be 450 mm (18") from the face of the 42" tall vertical crash wall to the bridge column. Is this offset enough or does this encroach on the zone of intrusion? The crash wall will be heavily reinforced and tied to the pavement. The space between the crash walls will be filled with aggregate (gravel). The thickness of the crash wall can be increased, if needed, but we prefer to provide as much shoulder as we can. The design of the project is nearly completed. If you have any questions, please let us know.

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Attachment: https://mwrsf-qa.unl.edu/attachments/8721f048af13b5d90e7316d7c0aeef1f.jpg

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Response

Date: 03-10-2006
An 18" ZOI distance with a 42 in. high barrier will meet TL-3.
Note that you don't have sufficient ZOI clearance for TL-4 or TL-5.
However, based upon your description of the roadway, I believe that TL-3 is appropriate. The rest of your installation, with the flared and tapered barrier appears to be reasonable.
However, you might consider writing a justification for using the steeper flare rate and put it in the file. I don't know whether exceeding the RDG nominal flare rate guidance for concrete barrier would necessitate an exception, but if it does, it should be easy to justify in this case.
Lengthening the barrier will increase crashes significantly without much reduction in severity for impacts in the flared region.

Jersey Shape Overlay

Question

State: NE
Date: 03-21-2006

Situation:
An existing bridge has a 32"Jersey Shape rail similar to this. An overlay of 5" is proposed and an extension of 5" to the top of the barrier is the proposed solution.
Question:
What effect does covering up the 3" lip at the bottom have on the barrier working as designed?
Any other concerns?

Response

Date: 03-21-2006
Covering up the 3" reveal has been shown to improve the safety performance of Safety Shaped Barriers. Recently, we developed several concepts for the cross-sectional geometry of the new TL-5 median barrier. We are proposing to use a vertical face barrier in order to reduce the propensity for vehicular instabilities which may occur during an impact event with the barrier system. Based on our review of the historical crash test data with small cars and pickup trucks, the vertical parapet geometry has proven to provide the lowest potential for vehicle climb and roll angles as compared to those observed in impacts into theNew Jersey shape, F-shape, and single slope barriers. Therefore, it is our opinion that the propensity for vehicle rollover can be decreased by minimizing barrier climb and vehicle roll angle during barrier impact events. Thus, the elimination of the 3" lip will improve the performance of the barrier as it will in effect make the barrier closer to a vertical shape.

In addition, as part of the initial investigation, numerous crash test videos were analyzed in order to determine a head ejection envelope corresponding to a 50th percentile male dummy seated in either the driver-side or passenger-side seats of both small cars and pickup trucks. Using the head ejection data, the barrier's proposed top geometry was setback or stepped in order to prevent an occupant's head from impacting the barrier surfaces as it is potentially ejected out a side window during an oblique barrier impact. Additionally, based on the head ejection envelope, we determined that no issues with head ejection were present for barriers below 35" in height.

Therefore, we can conclude that providing a 5" overlay and a 5" extension will only improve the performance of the safety shape. This of course assumes that the 5" extension has sufficient capacity to handle the barrier impact loads.
