MIDWEST POOLED FUND PROGRAM

Progress Report - Fourth Quarter 2009
October 1st to December 31st
Midwest Roadside Safety Facility
Nebraska Transportation Center
University of Nebraska-Lincoln

December 14, 2009

Pooled Fund Projects with Bogie or Full-Scale Crash Testing in Past Quarter

Development of a TL-4, Four-Cable, High-Tension, Barrier System for 4:1 V-Ditch Applications – Program Years 12, 14, 18, 19, and 20

In the Fourth Quarter, MwRSF continued the LS-DYNA modeling effort and evaluated potential design modifications to the bracket. Two dynamic component tests were performed – test nos. HTCC-1 (October 8, 2009) and HTCC-2 (October 27, 2009). Based on the tests results, it was deemed necessary to increase the strength of the bracket by modifying the grade of steel. In addition, the thread length for the bracket was to be modified. At this time, MwRSF is awaiting a fabrication quote for the modified brackets from the Bennett Bolt Co. Once the brackets are obtained, additional dynamic component tests would be performed. If these tests are successful, the 1100C small car re-test would be scheduled for the First Quarter of 2010.

Performance Limits for a 6-in. High, AASHTO Type B Curb Placed in Advance of the MGS – Program Year 17

On November 10, 2009, a 2270P crash test (test no. MGSC-6) was performed at the TL-2 impact conditions on the MGS placed 6 ft behind a 6-in tall curb with a 37-in. rail height relative to the roadway. During the test, the vehicle was contained and smoothly redirected. The test results were found to meet the TL-2 safety performance criteria provided in MASH. Since inadequate project funding remained within the current project budget to run the 2270P test, existing contingency funds will be requested to complete the data analysis, documentation, and reporting. In addition, the research team will provide recommendations pertaining to the safety performance of the 1100C vehicle as well as the potential need for small car testing in the future.

Impact Evaluation of Free-Cutting Brass Breakaway Couplings – Program Year 20

Following discussions with FHWA and the Illinois Department of Transportation, it was determined that two low-speed, crushable-nose, pendulum tests were required on various luminaire poles in order to investigate the impact performance of a new, free-cutting, breakaway, brass coupling. The brass coupling is planned for use as replacement to existing, higher-cost couplers.

On November 17, 2009, two low-speed pendulum tests were performed. The first pendulum test (test no. BBC-1) was performed on a heavy steel pole with attached brass couplers in order to evaluate vehicle deceleration and velocity change characteristics for heavy poles. The 50-ft tall steel pole with twin 12-ft mast arms weighed approximately 979 lb. The maximum allowable weight for pendulum testing is 992 lb. The second pendulum test (test no. BBC-2) was performed on a weaker, light-weight pole in order to evaluate the ability for the brass couplers to break away. A 30-ft tall aluminum pole with a 6-ft mast arm was selected for this pendulum test. According to the NCHRP Report No. 350 criteria, the maximum allowable change in velocity was exceeded in both pendulum tests. In 2010, a detailed test report will be written to document the test results. At this time, the ILDOT is exploring potential modifications to the brass coupler system.

Pooled Fund Projects with Pending Bogie or Full-Scale Crash Testing

Phase I and II – Guidelines for Post-Socket Foundations for Four-Cable, High-Tension, Barrier Systems – Program Years 19 and 20

Initially, researchers investigated and examined the existing design configurations for post-socket foundations used with high-tension, cable barrier systems. Subsequently, a design limit or peak load condition was determined for configuring future post-socket foundations. A prototype 12-in. diameter, reinforced concrete foundation system with a steel sleeve insert was designed using various embedment depths. Three preliminary specimens were constructed using 2, 3, and 5 ft lengths. For the project, the test specimens will be subjected to dynamic bogie testing in both weak and strong soil conditions. The bogie testing will evaluate the structural capacity and deformation of the loaded foundation systems.

Previously, three dynamic component tests were performed on the initial prototype foundation system when placed in a weak soil condition (sand). Concrete fracture was observed in the 5-ft long test specimen, while only concrete cracking of the shaft was observed in the 3-ft long specimen. Following the three tests, design modifications were implemented. One test (test no. HTCB-4) was performed on the 5-ft long revised concrete specimen placed in a weak soil condition on September 23, 2009. Due to the rupture of the concrete shaft, the design criteria are currently being evaluated.

Testing of End Terminal for Four-Cable, High-Tension Barrier (1100C & 2270P) – Program Years 17 and 20

Work on this project will commence after crash testing has been completed on the high-tension, four cable barrier system. It is planned to adapt the breakaway cable lever arm technology, developed during the low tension testing, into the high-tension barrier system. Project funding has been made available to two program years.

Maximum MGS Guardrail Height – Program Year 20

The literature review was completed with the major findings as follows:

All of the systems discussed in the literature review were deemed acceptable according to the respective standards to which they were tested. However, some tests provided undesirable results in the areas of vehicle underride and wheel snag. Test no. FR-3 (flare rate test w/ small car) showed the propensity for wheel snag. In test no. FR-5 (flare rate test w/ small car), there was definite wheel snag which caused the vehicle to rotate about the post on which it snagged. However, these flare rate tests were more severe than prior small car tests conducted on standard W-beam guardrail systems according to NCHRP Report No. 350. The small car tests on the flared MGS barriers occurred at effective angles ranging between 29 and 32 degrees whereas small car testing under NCHRP 350 uses a 20-degree angle.

For test no. 2214MG-3 under MASH, slight wheel snag occurred that did not abruptly stop the small car vehicle but caused it to yaw away from the barrier. The rail also had the potential of sliding up the engine hood, but it snagged under the hood and the quarter panel. Although the standard and flared MGS systems met the required standards, these issues could be accentuated when the rail height is increased.

Simulations of the 1100-kg Neon and 900-kg Geo into the standard MGS system were performed. Initial results indicate significant discrepancies between the results obtained from simulation and the most similar physical testing. The primary concern at this point is the deformation behavior of the vehicle models. This result is not surprising since these models were known to be of concern and that significant effort would be required to get them in working order for this application.

Paper Studies

Cost-Effective Measures for Roadside Design on Low-Volume Roads – Program Year 16

The analysis, evaluation, and documentation for treating culverts and trees have been completed. The analysis of bridges, slopes, and ditches for low-volume roadways was completed in the Third Quarter of 2009. A draft report of the analysis and evaluation was completed in the Third Quarter of 2009 and is currently under internal review.

Submission of Pooled Fund Guardrail Developments to AASHTO TF-13 Hardware Guide

To date, 15 components and 21 systems have been submitted to TF-13 for review and approval. Eighteen systems and fifteen components have been approved for the Guide over the last 2 years. The three additional systems were reviewed at the fall 2009 AASHTO Task Force 13 meeting in Delaware. However, it should be noted that funding for this effort has been depleted as of November 2008, and additional funding will be needed to complete the currently planned effort. No additional funding was provided in the Year 20 Program.

Cost-Effective Upgrading of Existing Guardrail Systems – Program Year 17

In June 2009, an MwRSF field investigation team conducted a field survey of selected barrier installations throughout the State of Kansas. As part of this weeklong investigation, more than 60 specific sites were visited, measured, photographed, and documented. A review and compilation of the field survey information was completed in the Fourth Quarter. An analysis of the field data was initiated in the Fourth Quarter of 2009 and is planned for completion in the First and Second Quarters of 2010. The RSAP analysis will be initiated in this same period.

Safety Performance Evaluation of Vertical and Safety Shaped Concrete Barriers – Program Year 16

An additional 6 years of accident data was collected and tabulated in the Third Quarter of 2009. The narrative and diagram for every additional single–vehicle accident was reviewed, and information extracted from those documents was compiled into the accident database. This information was then merged with additional driver, vehicle, injury, and roadway information that were initially categorized in different files, thus forming one large database. Due to the size of the data set, advanced analysis techniques were required. During the Fourth Quarter, MwRSF personnel garnered access and capability to utilize more advanced statistical software and analysis techniques. Thus, the research effort will now be re-started in the First Quarter of 2010.

MGS Implementation – Program Year 18

In 2007, consulting funds were used to assist states with the MGS implementation effort. MwRSF began the effort with a review of CAD details from the Illinois and Washington DOTs. Project correspondence occurred via email with a pre-determined Technical Working group. To date, three subject areas were covered and are as follows: (1) Standard, Half, and Quarter Post Spacing; (2) MGS w/ Curbs and MGS on 2:1 Slopes; and (3) MGS w/ Culvert Applications. A fourth category, MGS Stiffness Transition, will be initiated after the simplified, wood-post transition project is completed. It is estimated that the reporting of the simplified, steel-post, approach guardrail transition system attached to the MGS will likely be completed in January 2010. Therefore, the MGS implementation effort will commence in the First Quarter of 2010.

LS-DYNA Modeling Enhancement Funding – Program Year 18

No work was performed on this project during the reporting period.

Projects Funded by Individual State DOTs and Routed Through NDOR and/or Pooled Fund Program

Development of a New, TL-4 Precast Concrete Bridge Railing System (Nebraska Department of Roads)

For this project, a TL-4, aesthetic, open concrete bridge railing was developed for use on cast-in-place decks as well as precast deck panels. Due to many factors, existing project funds were insufficient to complete the construction and crash testing phases of this research study. MwRSF-UNL researchers have sought funds from alternative sources including the NCHRP IDEA program and the 2009 Midwest States Pooled Fund Program. In 2010, MwRSF will seek funding from the FHWA highways for Life Program as well as consider re-submitting the proposal to the Pooled Fund program in April 2010 due to its high ranking amongst the unfunded projects.

Qualification of Type II and Type I End Terminals for Box Beam (New York DOT)

In 2007, three 1100C full-scale vehicle crash tests were performed on two NYSDOT box beam terminal systems. Previously, a draft test report was prepared, submitted to NYSDOT, and edited. In 2008, a continuation project provided funding for additional crash testing. Three 2270P and one 1100C crash tests were performed. The reporting and documentation for the last four crash tests was added to the original test report. The combined, internal draft report was reviewed by New York personnel in the Second Quarter of 2009. A draft final report, incorporating all of the NYSDOT comments for the last four crash tests was completed in the Third Quarter. In the Third Quarter of 2009, MwRSF completed the third phase of the crash testing program using one 1100C vehicle and one 2270P vehicle according to the TL-3 safety performance guidelines found in MASH.

A draft research report containing the results from NYBBT-1 through 9 was completed in the Fourth Quarter of 2009. The draft report will be submitted to NYSDOT for review and comment in December. The final report will be completed in January 2010.

Universal Breakaway Steel Post for Guardrail (Minnesota DOT)

The modified bullnose median barrier system was modified and reconstructed in the Fourth Quarter of 2009. The 2000P re-test is planned for the Fourth Quarter of 2009 or the First Quarter of 2010, pending favorable weather conditions.

In the Second Quarter of 2009, an internal draft report was prepared to document the component testing of breakaway post concepts as well as the first 2000P crash test. The draft Phase I research and test report was submitted to the sponsor in the Third Quarter of 2009. A final Phase I report will be prepared in the First Quarter of 2010. The Phase II report will be prepared following the completion of the 2000P retest.

Dynamic Testing and Evaluation of a New TCB for FRP Bridge Deck Applications (Kansas DOT)

The project consisted of the crash testing and evaluation of a vertical-face, precast concrete parapet attached to an FRP composite bridge deck system. A final report was prepared in the Fourth Quarter of 2009.

Dynamic Evaluation of New York State's Pinned Temporary Concrete Barrier (New York DOT)

The project consisted of the crash testing and evaluation of New York State Department of Transportation's New Jersey shape, temporary concrete barriers attached to a concrete slab using vertical pins on the back-side face. A follow-on study was funded to re-test the TCB when continuously pinned along the back-side barrier face. In the Third Quarter of 2009, one 2270P pickup truck crash test (NYTCB-5) was successfully performed according to the MASH guidelines. In the Fourth Quarter, a draft report was prepared to document the recent 2270P crash test. The draft report will be submitted to NYSDOT for review and comment in December. The final report will be completed in January 2010.

Dynamic Evaluation of New York's State's Aluminum Pedestrian Signal Pole (New York DOT)

In the Third Quarter of 2009, one low-speed, crushable-nose, pendulum test was conducted according to test designation no. 3-60 of NCHRP Report No. 350. An aluminum pole and base was evaluated without the use of a traditional breakaway assembly. During the test, the welds which attach the pole to the base plate assembly fractured, and the pole was dislodged away from the base. The accelerometer data was analyzed and indicated that the impact event resulted in acceptable levels of occupant risk, deceleration, and change in velocity. However, the remaining stub height of the base plate measured 4.5 in., thus violating the 4-in. threshold value established by FHWA and AASHTO. Approximately 0.5 in. of the 4.5 in. stub height pertained to the thickness of the leveling nuts. In the Fourth Quarter, the test results were documented in a draft test report. The draft report was submitted to the NYSDOT for review and comment. A final report was prepared after incorporating the sponsor feedback. MwRSF provided design recommendations for potentially placing the pole base within a depression placed in the reinforced concrete foundation, thus allowing for the minimum stub height requirements to be met.

Awaiting Reporting

Phase I & II Development of a TL-3 MGS Bridge Rail – Program Years 18 and 19

The MGS bridge railing and reinforced concrete deck systems, including the upstream and downstream semi-rigid guardrails and simulated end terminals, were constructed in the Second Quarter of 2009. Two TL-3 full-scale vehicle crash tests were successfully performed according to the MASH guidelines. The draft reporting of this research study was completed in the Fourth Quarter of 2009 in terms of a Master's Thesis by Mr. Jeff Thiele, M.S.C.E. In the First Quarter of 2010, the thesis document will be converted into a draft research/test report and subsequently submitted to the Pooled Fund Member States for review and comment.

Development of a Temporary Concrete Barrier Transition – Program Year 16

Two pickup truck crash tests were successfully performed on a transition between temporary concrete barrier and permanent concrete median barrier. The evaluation was performed using the MASH-08 guidelines. A draft report was completed in the Fourth Quarter of 2009 and submitted to the Pooled Fund members for review and comment.

Standardizing Posts and Hardware for MGS Transition – Program Years 18 and 19

In the Fourth Quarter, a draft report was prepared for the simplified, steel-post, approach guardrail transition system attached to the MGS. The draft report is planned for completion in January 2010.

No work was performed on the simplified, wood-post, approach guardrail transition system. In the First Quarter of 2010, BARRIER VII computer modeling will be performed to evaluate system performance using the upper and lower post-soil characteristics. It should be noted that the 8-in. x 10-in. post size is being considered as a replacement for W6x15 steel posts used in approach guardrail transitions. A second report will contain the results of the wood-post transition system. This follow-on effort will be completed in the Second Quarter of 2010.

Midwest Guardrail System Placed at the Breakpoint of a 2:1 Slope – Bogie Testing Project Using Year 14 Contingency Funds

An MGS system utilizing 9-ft long, W6X9 steel posts spaced at 6-ft 3-in. centers was successfully crash tested utilizing a 2270P Dodge Quad Cab vehicle. A draft report was sent to the States in the Fourth Quarter of 2009.

Previously, several member states noted a desire for a wood-post alternative for the MGS placed on a 2:1 slope. As such, a dynamic bogie testing program was conducted in order to determine the appropriate length of a 6-in. x 8-in. wood post for placement at the slope breakpoint of a 2:1 fill slope. A second draft report was initiated in the Fourth Quarter of 2009 which contains the results from the wood-post, component testing program as well as some additional steel post tests for comparison purposes.

Draft Reports - Pooled Fund

Wiebelhaus, M.J., Terpsma, R.J., Lechtenberg, K.A., Reid, J.D., Faller, R.K., Bielenberg, R.W., Rohde, J.R., and Sicking, D.L., ***Development of a Temporary Concrete Barrier to Permanent Concrete Median Barrier Approach Transition***, Draft Report to the Midwest States Pooled Fund Program, Transportation Research Report No. TRP-03-208-09, Project No.: SPR-3(017), Project Code: RPFP-06-07 and RPFP-06-09 - Year 16, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, Nebraska, December 14, 2009.

Wiebelhaus, M.J., Lechtenberg, K.A., Faller, R.K., Sicking, D.L., Bielenberg, R.W., Reid, J.D., Rohde, J.R., and Dey, G., ***Development and Evaluation of the Midwest Guardrail System (MGS) Placed Adjacent to a 2:1 Fill Slope***, Draft Report to the Midwest State's Regional Pooled Fund Program, Transportation Research Report No. TRP-03-185-09, Project No.: SPR-3(017), Project Code: RPFP-05-09 – Year 15, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, Nebraska, October 21, 2009.

Final Reports - Pooled Fund

Thiele, J.C., Lechtenberg, K.A., Reid, J.D., Faller, R.K., Sicking, D.L., and Bielenberg, R.W., ***Performance Limits for 6-In. (152-mm) High Curbs Placed in Advance of the MGS Using MASH-08 Vehicles - Part II: Full-Scale Crash Testing***, Final Report to the Midwest State's Regional Pooled Fund Program, Transportation Research Report No. TRP-03-221-09, Project No.: SPR-3(017), Project Code:

RPFP-07-03 - Year 17, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, Nebraska, October 30, 2009.

Rosenbaugh, S.K., Bielenberg, R.W., Faller, R.K., Reid, J.D., Rohde, J.R., Sicking, D.L., Lechtenberg, K.A., and Holloway, J.C., ***Termination and Anchorage of Temporary Concrete Barriers***, Final Report to the Midwest State's Regional Pooled Fund Program, Transportation Research Report No. TRP-03-209-09, Project No.: SPR-3(017), Project Code: RPFP-06-02 - Year 16, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, Nebraska, October 29, 2009.

Draft Reports - Individual State DOT and Routed Through NDOR/Pooled Fund

Stolle, C.J., Zhu, L., Lechtenberg, K.A., Bielenberg, R.W., Faller, R.K., Sicking, D.L., Reid, J.D., and Rohde, J.R., ***Performance Evaluation of Type II and Type IIA Box Beam End Terminals***, Draft Report to the New York State Department of Transportation, Transportation Research Report No. TRP-03-203-09, Project No.: C-06-16, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, Nebraska, December 18, 2009.

Lechtenberg, K.A., Faller, R.K., Reid, J.D., and Sicking, D.L., ***Dynamic Evaluation of a Pinned Anchoring System for New York State's Temporary Concrete Barriers – Phase II***, Draft Report to the New York State Department of Transportation, Transportation Research Report No. TRP-03-216-09, Sponsor Agency Code: TPF-5(193) Supplement No. 11, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, Nebraska, December 18, 2009.

Rosenbaugh, S.K., Faller, R.K., Lechtenberg, K.A., Bielenberg, R.W., Sicking, D.L., and Reid, J.D., ***Dynamic Evaluation of New York State's Aluminum Pedestrian Signal Pole System***, Draft Report to the New York State Department of Transportation, Transportation Research Report No. TRP-03-223-09, Sponsor Agency Code: TPF-5(193) Supplement No. 10, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, Nebraska, November 19, 2009.

Final Reports - Individual State DOT and Routed Through NDOR/Pooled Fund

Schmidt, J.D., Faller, R.K., Lechtenberg, K.A., Sicking, D.L., and Reid, J.D., ***Development and Testing of a New Vertical-Faced Temporary Concrete Barrier for Use on Composite Panel Bridge Decks***, Final Report to the Kansas Department of Transportation, Transportation Research Report No. TRP-03-220-09, Sponsor Agency Code: SPR-3(017) Supplement No. 57, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, October 13, 2009.

Pooled Fund Consulting Summary

Midwest Roadside Safety Facility
October 2009 – January 2010

This is a brief summary of the consulting problems presented to the Midwest Roadside Safety Facility over the past quarter and the solutions we have proposed.

Problem # 1 –Alternative Connections for the F-shape PCB

State Question:

Several states have been approached regarding the use of alternative connection designs with the F-shape PCB developed by the Midwest States Pooled Fund.

MwRSF Response:

I am writing in response to some questions you raised regarding the use of alternative connection designs with the F-shape PCB developed by the Midwest States Pooled Fund. When looking at this issue, one has to consider the use of the barrier in both its free-standing and tie-down configurations. Currently, the F-shape PCB has been tested to NCHRP 350 and MASH in its free-standing configuration and has also been tested in several different tie-down configurations including a steel strap tie-down, and asphalt pin tie-down, and a concrete bolt tie-down. These tie-down systems have been applied to develop approach transitions between the F-shape PCB and rigid hazards on both the roadside and the median.

When we consider the use of alternative connections and the free-standing PCB design, it is likely that many different connections will perform acceptably. The main function of the connection in free-standing PCB's is to develop tension and moment at the joint during impact with the barrier. To a lesser degree, the joint needs to have the ability to resist torsional loads along the barrier axis and shear loads at the joint. When the free-standing barrier is impacted, the barrier segments deflect and are held together based on the tension in the connection. When the barriers have deflected sufficiently, the corners of the barrier segments come into contact creating a compressive load that is combined with the tensile load in the joint connections to create a moment. This is the main load on the free-standing barrier connection, and it is the main force providing the continuity of the PCB system. Because the critical loading of the joint is a tensile load, there are several connection designs that may work adequately for a given barrier section. I believe that the FHWA has generally approved alternative, free-standing barrier connections to be used on previously tested PCB designs as long as the reinforcement of the barrier is equal to or greater than the tested barrier and that the development of the connection reinforcement is sufficient. I think that this is a rational approach for free-standing barrier given the loading conditions. However, it should be noted that it is difficult to infer the performance of alternative barrier connections without more analysis and full-scale testing. I would recommend using a connection with shear, tensile, moment, and torsional capacities equal or greater to the connection you are replacing.

When consider the use of alternative barrier segment connections with the tie-down and approach transition applications, the loading of the barrier connection is significantly different, and the use of alternative connection designs with the F-shape PCB becomes more hazardous. Tie-down barriers have some form of constraint on the barrier. In the case of the tie-downs used in the F-shape PCB, the tie-downs consist of anchors that pass through the toes of the barrier and constrain lateral an longitudinal movement. This greatly affects the joint loading. When a tie-down barrier segment is impacted, the lateral and longitudinal translation of the barrier is limited by the anchors. Thus, the barrier edges do not generally contact and develop high tensile and moment loads at the joint. The majority of the tensile loads are developed by the tie-down. Because of the constraint and the lack of tension developed between the barrier segments, the behavior of the barrier system is such that the impacted barrier tends to deflect laterally and rotate back along its longitudinal axis. The barriers downstream of the impact have that motion transferred to them based on the shear and torsional loading of the barrier connection. Thus, as the first impacted barrier segment deflects laterally and rotates, the constrained, downstream barrier segments do not move until the shear and torsional loads are transferred through the joint. This creates a potential for vehicle snag on the end of the downstream barrier segment as it is exposed by the deflection and rotation of the impacted barrier unless the barrier connection can effectively transfer the shear and torsional loads to cause the downstream barrier to begin moving as well. This can be seen schematically in the attached picture.

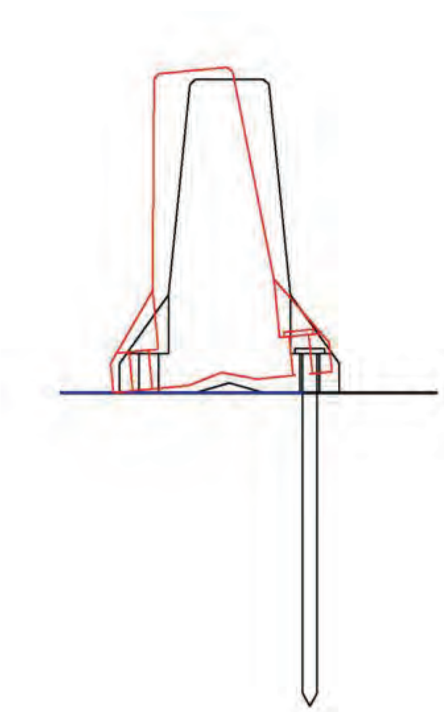


Figure 1. Pinned Barrier Rotation

Based on the different behavior and loading of the barrier connections in the tie-down configuration, we would not recommend using alternative barrier connection designs unless the barrier connection was shown to provide greater shear and torsional capacity along the longitudinal axis of the barrier than the pin and loop connection used in the tested design. In addition, the connection would need to develop those loads relatively quickly (i.e., the barrier connection would have to develop loads before excessive rotation of the impacted barrier segment caused potential snag). Failure to meet these conditions could potentially result in vehicle snag on an exposed barrier end and corresponding excessive vehicle decelerations and instability. We have observed some degree of vehicle snag in the tie-down and approach transition testing conducted on the F-shape PCB. The difference in the loading of the connection between free-standing and tie-down barrier systems makes it very difficult to infer the performance of alternative connections in tie-down applications without full-scale crash testing. Thus, we would not recommend alternative barrier connections for the tie-down F-shape barrier or its associated transition designs without detailed analysis of the load capacity and behavior of the alternative joint or full-scale crash testing.

Hopefully this provides some insight on our concerns with the use of alternative connections with the F-shape PCB. Please contact me with any further questions or concerns.

Thanks

Bob Bielenberg, MSME, EIT
Research Associate Engineer
Midwest Roadside Safety Facility

Problem # 2 –Cable Anchor and Foundation Design

State Question:

We are gearing up for our first cable barrier installation in March of next year. We are trying to meet a minimum anchor and post foundation design. Do you have some structural information and assumptions (soils, loads, etc) for your designs?

Scott King
KSDOT

MwRSF Response:

Hi Scott,

We actually put a TRB paper together on these topics. “Development of Guidelines for Anchor Design for High-Tension Cable Guardrails”. It will be presented at the 2010 winter meeting. We can send it to you upon request.

Hopefully it will address some of your problems.

We have not come up with recommendations for the post foundations yet. We have run some preliminary tests, but have not finished with the work. I will update you when we get more information.

Thanks

Bob Bielenberg, MSME, EIT
Research Associate Engineer
Midwest Roadside Safety Facility

Problem # 3 –Low Tension Cable End Terminal Details

State Question:

Bob,
We are drawing up the cable guardrail end treatment from reports TRP-03-155-05 & TRP-03-192-08 & need a little help with the details. Please see standard sheet attached.

For A (below) – will you agree to allow the exterior gussets be brought in, to 3/8" from the outside edges?

This is where we believe the 3/8" weld will work.

I assume all gusset plates are welded inside & out, or is a weld on the inside only.

For B (below) - will the welds be allowed for the 1 ¼" across the release lever plate connecting to the base plate?

The bracket plate or cable plate is the only 3/8" plate with the rest being ½". What is the reason for this?
Can it be changed to ½" so all plates in this assembly are the same?

Is there a reason for the holes in the triangle release lever plate gussets?
We found a bolt in these holes of report TRP-03-192-08 Figure A-2 Cable Terminal Detail, sheet 2 of 12.

Should there be a light weight tie down cable to keep the cable release lever from flying somewhere it shouldn't go?

This was used in the testing on the high tension cable.

Ron,
What is the length of need for the new cable end treatment system?

Phil

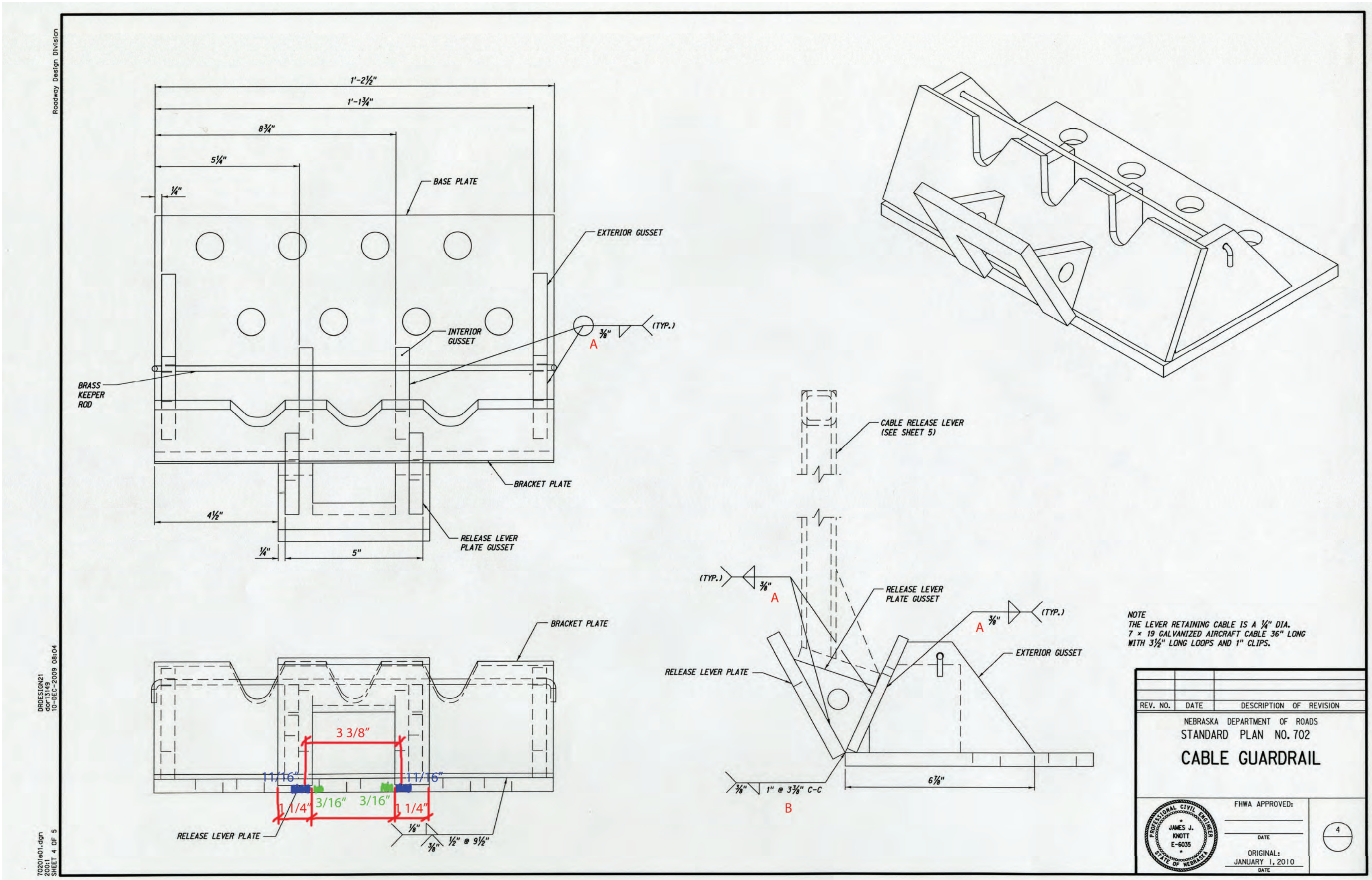


Figure 2. Low Tension Cable Terminal Details

MwRSF Response:

Hi Phil

I have responded to your questions below in red.

Bob Bielenberg, MSME, EIT
Research Associate Engineer
Midwest Roadside Safety Facility
527 Nebraska Hall
Lincoln NE, 68588-0529
402-472-9064
rbielenberg2@unl.edu

From: TenHulzen, Phil [mailto:Phil.Tenhulzen@nebraska.gov]
Sent: Thursday, December 10, 2009 4:32 PM
To: Bob Bielenberg (rbielenberg2@unl.edu); Ronald K. Faller
Subject: FW: cable guardrail questions

Bob,
We are drawing up the cable guardrail end treatment from reports TRP-03-155-05 & TRP-03-192-08 & need a little help with the details.
Please review the E-mail below & see standard sheet attached.

For A (below) – will you agree to allow the exterior gussets be brought in, to 3/8" from the outside edges?

- We believe there is no problem with moving the gussets in 1/8" to allow for the 3/8" weld. This is an error in our CAD.

This is where we believe the 3/8" weld will work.
I assume all gusset plates are welded inside & out, or is a weld on the inside only.

- Gussets are to be welded inside and out as well as the ends (all the way around).

For B (below) - will the welds be allowed for the 1 ¼" across the release lever plate connecting to the base plate?

- This is another error in our CAD. The weld callout should read " 1" @ 4 ¼" C-C". This will center the weld correctly on the release lever plate.

The bracket plate or cable plate is the only 3/8" plate with the rest being ½". What is the reason for this?
Can it be changed to ½" so all plates in this assembly are the same?

- We have no problem with using ½" plate for the cable plate. It should not adversely affect the design.

Is there a reason for the holes in the triangle release lever plate gussets?

- The holes in the plate are for a bolt to connect a retention cable for the release lever. The rationale behind this is detailed in TRP-03-131-08.
- The design calls for a 5/8" Grade 5 Hex Bolt.

We found a bolt in these holes of report TRP-03-192-08 Figure A-2 Cable Terminal Detail, sheet 2 of 12.

Should there be a light weight tie down cable to keep the cable release lever from flying somewhere it shouldn't go?

This was used in the testing on the high tension cable.

- Yes, there should be a retention cable. It should be ¼" diameter 7x19 aircraft cable. The cable should be 36" long and formed into a loop with 1" cable clips. See attached photos.

- One other note. The CAD details show the use of 2 washers on the end fittings that connect to the cable plate. This is incorrect. We used a minimum of three washers on the end fittings. As an alternative, we designed 3"x2.125"x0.5" plate washers for the high tension design. These would be acceptable as well.

Ron,

What is the length of need for the new cable end treatment system?

** Test no. CT-1 was conducted on a low-tension, three-cable barrier system according to test designation no. 3-35 of NCHRP Report No. 350. The test was successfully performed as a Length-of-Need (LON) evaluation at the target conditions of 100 kph and 20 deg. The test occurred at post no. 3 or approximately 15 ft from the upstream end of the barrier system. Based on the results obtained from the 2000P test (test no. CT-1), the length of need for the low-tension, three-cable barrier has been determined to be 15 ft.

Phil

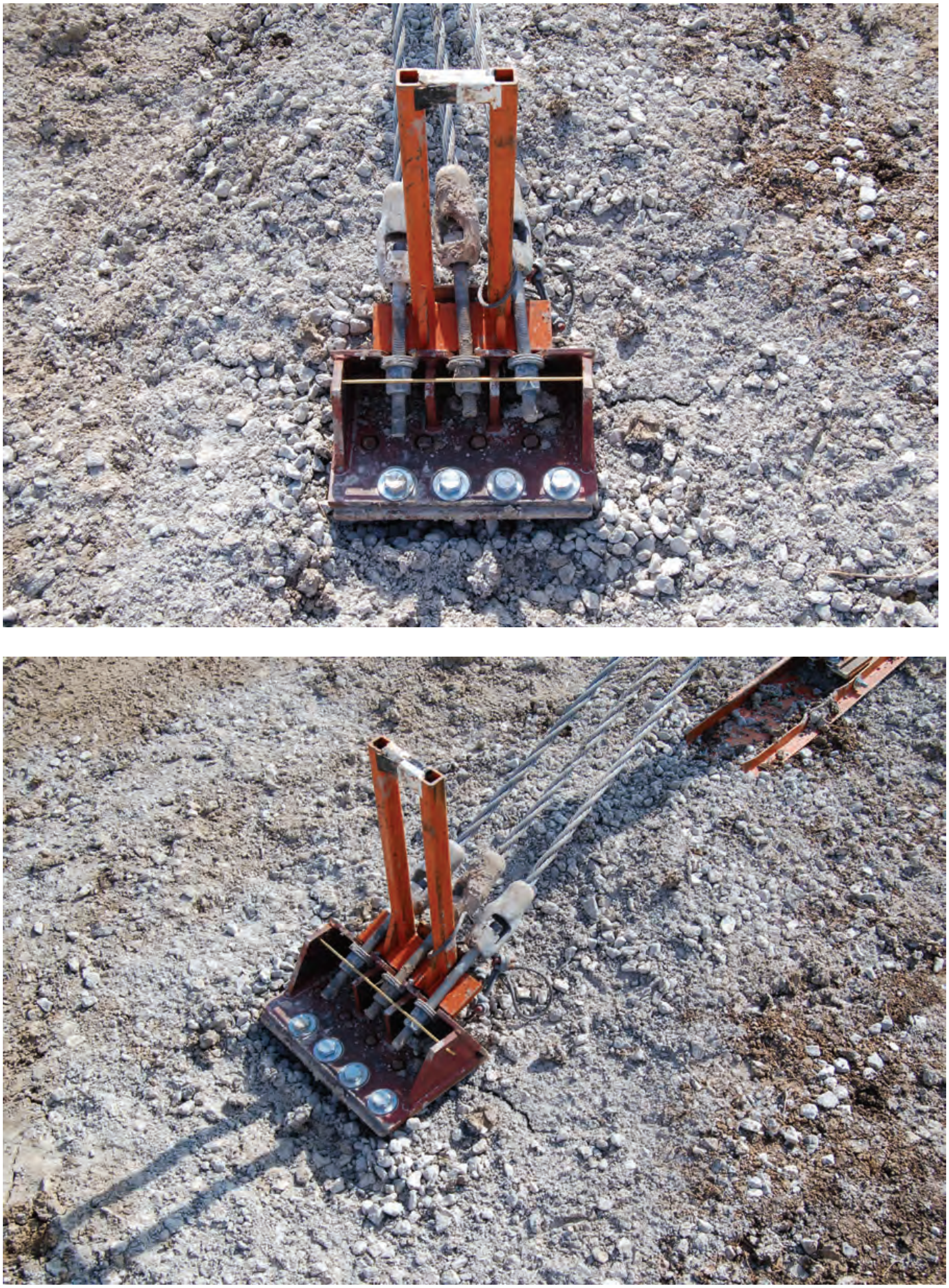


Figure 3. Low Tension Cable Terminal Lever Retention Cable

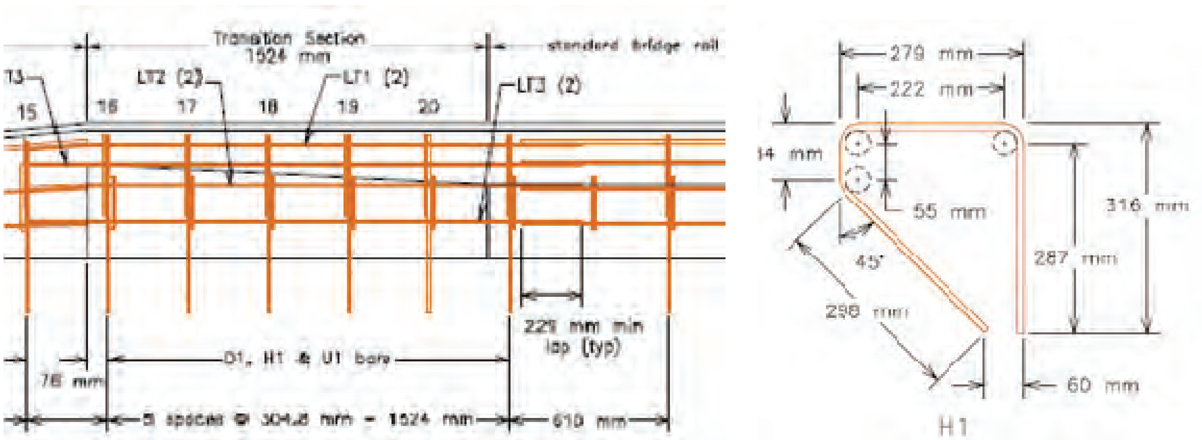
Problem # 4 –Low Profile Barrier End Reinforcement

State Question:

Quick question, we were detailing the low profile barrier and noticed about 5 extra H1 bars in the transition section with a total of 10 H1 bars. Can you explain the extra H1 bars in your table and the footnote a little more? The detail came from Iowa but originally came from MWRSF.

Thanks,

Scott



NOTES:
(1) Use Grade 60 reinforcement.
(2) Use minimum concrete strength of f'c=31.02 MPa.
(3) Use 38 mm minimum cover.
(4) Use 19 mm chamfer on top corners.
(5) Extra No. 3 bar placed along sloped H1 stirrup used for continuity near front face. (Position may be altered.)
(6) Minimum lap length for longitudinal bars is 229 mm.

Bill of Bars

	Quantity	Size	Description	Total Length
D1	20	No. 3	Vert. Trans. Dowel	673 mm
D2	30	No. 3	Vert. End Dowel	(see dimension)
H1	10	No. 3	Vertical Hoop Bar	956 mm
U1	20	No. 3	Vertical Trans. U	556 mm
U2	12	No. 3	Vertical End U	743 mm
U3	6	No. 3	Vertical End U	622 mm
R1	1	No. 3	Vert. End Rectangular	962 mm
R2	1	No. 3	Vert. End Rectangular	918 mm
R3	1	No. 3	Vert. End Rectangular	879 mm

Figure 4. Low Profile Barrier End Section Details

MwRSF Response:

Based on the detail you sent you have more H1 bars than you need in the transition section.

It appears that the report shows only 5 H1 bars in the transition section, but the table states there are 10. We believe that the table is in error and that the CAD is correct.

Sorry for the confusion.

Thanks

Bob Bielenberg, MSME, EIT
Research Associate Engineer
Midwest Roadside Safety Facility

Problem # 5 –PCB Tie-Down Applications

State Question:

Dear MwRSF,

I have a few questions about temporary concrete barrier.

1. When installing a crash cushion, should the temporary barriers after the crash cushion be pinned into position?
2. If the crash cushion needs to be pinned, what method should be used if
    a. Traffic is on one side (e.g. a lane shift)
    b. Traffic is on both sides (e.g. in a gore area)
3. In MwRSF, crash testing of a thrie beam transition from temporary barrier to permanent barrier, MwRSF used 4 barrier staked into asphalt. MwRSF also crash tested a temporary barrier run that was attached to a bridge deck using a tie-down strap. Is there a way of using the tie-down strap system to build a transition from temporary barrier to permanent barrier?
4. I believe that at one time I asked this question, the LON point of free standing temporary barrier is 8 pieces. Is this correct?

Sincerely,

Erik Emerson P.E.
Standards Development Engineer-Roadside Design
Wisconsin Department of Transportation

MwRSF Response:

HI Erik,

Replies to your questions are below in red.

Bob Bielenberg, MSME, EIT
Research Associate Engineer
Midwest Roadside Safety Facility
527 Nebraska Hall

Lincoln NE, 68588-0529
402-472-9064
rbielenberg2@unl.edu

From: Emerson, Erik - DOT [mailto:Erik.Emerson@dot.wi.gov]
Sent: Friday, September 18, 2009 10:52 AM
To: Bob Bielenberg (rbielenberg2@unl.edu); Dean L. Sicking (dsicking1@unl.edu); Karla Polivka (kpolivka2@unl.edu); Ron Faller (rfaller1@unl.edu)
Subject: Pinning temporary concrete barrier questions

Dear MwRSF,

I have a few questions about temporary concrete barrier.

1. When installing a crash cushion, should the temporary barriers after the crash cushion be pinned into position?

   Typically, we recommend that unprotected ends of TCB systems be extended out of the clear zone in order to reduce impacts with these ends. We also tend to recommend that sufficient barriers be placed outside of the clear zone to provide anchorage for the length of need. However, there are instances when this cannot be done and the end of the barrier system must be protected by some form of crash cushion. In the case of a proprietary crash cushion, we would recommend that you follow their guidelines for connecting the crash cushion to the system. If you are using sand barrels, MwRSF recently completely development of an upstream anchorage for the F-shape TCB used by most of the Pooled Fund states that can be used with sand barrels. We recently sent the draft report of that research out for review and I will have the final draft out by the end of the month. Thus, we are not recommending pinning the barriers at this time.

2. If the crash cushion needs to be pinned, what method should be used if

   a. Traffic is on one side (e.g. a lane shift)
   b. Traffic is on both sides (e.g. in a gore area)

   As mentioned above, we are not recommending that the barrier be pinned at this time.

3. In MwRSF, crash testing of a thrie beam transition from temporary barrier to permanent barrier, MwRSF used 4 barrier staked into asphalt. MwRSF also crash tested a temporary barrier run that was attached to a bridge deck using a tie-down strap. Is there a way of using the tie-down strap system to build a transition from temporary barrier to permanent barrier?

   We considered the use of the strap tie-down when we designed the temporary barrier transition especially the median transition because it performs similarly when impacted on either side of the barrier. We abandoned its use in the transition design because it was not possible to make the transition sufficiently stiff as you approach the rigid hazard with the strap tie-down. Recall that the strap tie-down allowed approximately 33 inches of dynamic deflection of the system. This amount of deflection of the system could not be allowed adjacent to the end of the barrier. Thus, no transition design exists using the strap tie-down. I suppose that it could be revisited though.

4. I believe that at one time I asked this question, the LON point of free standing temporary barrier is 8 pieces. Is this correct?

   That is correct. Without anchoring the barrier as I mentioned previously, we recommend 8 barriers adjacent to the length of need for anchorage.

Problem # 6 – Trailing End Terminal

State Question:

Tracy Borchardt with the IL Tollway called requesting guidance on the use of a trailing end terminal to protect the upstream end of the rigid concrete parapet.

MwRSF Response:

Tracy:

Recently, you inquired about the implementation of the MGS with trailing end terminal for use in protecting the upstream end of a rigid concrete parapet. For your special situation, the concrete parapet was positioned approximately 4 ft behind the back side of the steel line posts. It should also be noted that you were referencing the ILDOT Standard 631011-06, Traffic Barrier Terminal, Type 2.

It was stated that there are special situations where the parapet is farther away from the traveled way than desired for the guardrail offset. In addition, there may be other circumstances that do not allow for the guardrail to be flared back toward the upstream end of the parapet and anchored to it. Therefore, preliminary guidance was requested for safely positioning the downstream region of the MGS and trailing end terminal to longitudinally overlap the upstream end of the parapet so that the MGS would shield blunt end impacts on the parapet end. Based on engineering judgment and in the absence of crash test results, we believe that a reasonable positioning would be to align post no. 5 with the upstream end of the parapet. This configuration would place approximately 22 ft of guardrail past the upstream end of the parapet.

It should be noted that future research should be directed toward determining the length of need where downstream guardrail systems with trailing end terminals are effective in safely containing and redirecting high-energy impacts with pickup trucks as well as small cars under the MASH safety guidelines.

If you have any questions regarding this information, please feel free to contact me at your earliest convenience. Thanks again!

Ron

Ronald K. Faller, Ph.D., P.E.
Research Assistant Professor

Problem # 7 – Trailing End Terminal

State Question:

Ron,

Post #12 (the middle post in the asymmetrical transition piece) was omitted to avoid conflict with a drainage structure. See attachments. Is this allowed or what recommendation would you have for this detail?

Thanks,
Tracy Borchardt
IL Tollway GEC

MwRSF Response:

Tracy:

Over the last year or so, I have fielded a few inquiries regarding the inability to place a post in a transition region due to a pipe culvert flowing out of an curb inlet. In past inquiries and depending on the transition used, I have suggested using a simulated post at such a location. I believe you are depicting the transition that used W6x12s by 90 in. long in the noted region. If we wanted to replace the midspan capacity, it would seem reasonable to use two W6x9s by 72 in. long posts – one on each side of the lateral pipe and behind the rail. Then, a WF beam would be placed between the two posts. This beam would be used to support a deep blockout and allow the two smaller and shorter posts to serve a one post where it could not be placed. Of course, this surrogate system has not been actually designed for your case but would be a concept that likely would work in this scenario. It would give back the resistive capacity at a location in the transition that may be prone to vehicle pocketing and snag. Let me know what you think.

Ron

Ronald K. Faller, Ph.D., P.E.
Research Assistant Professor

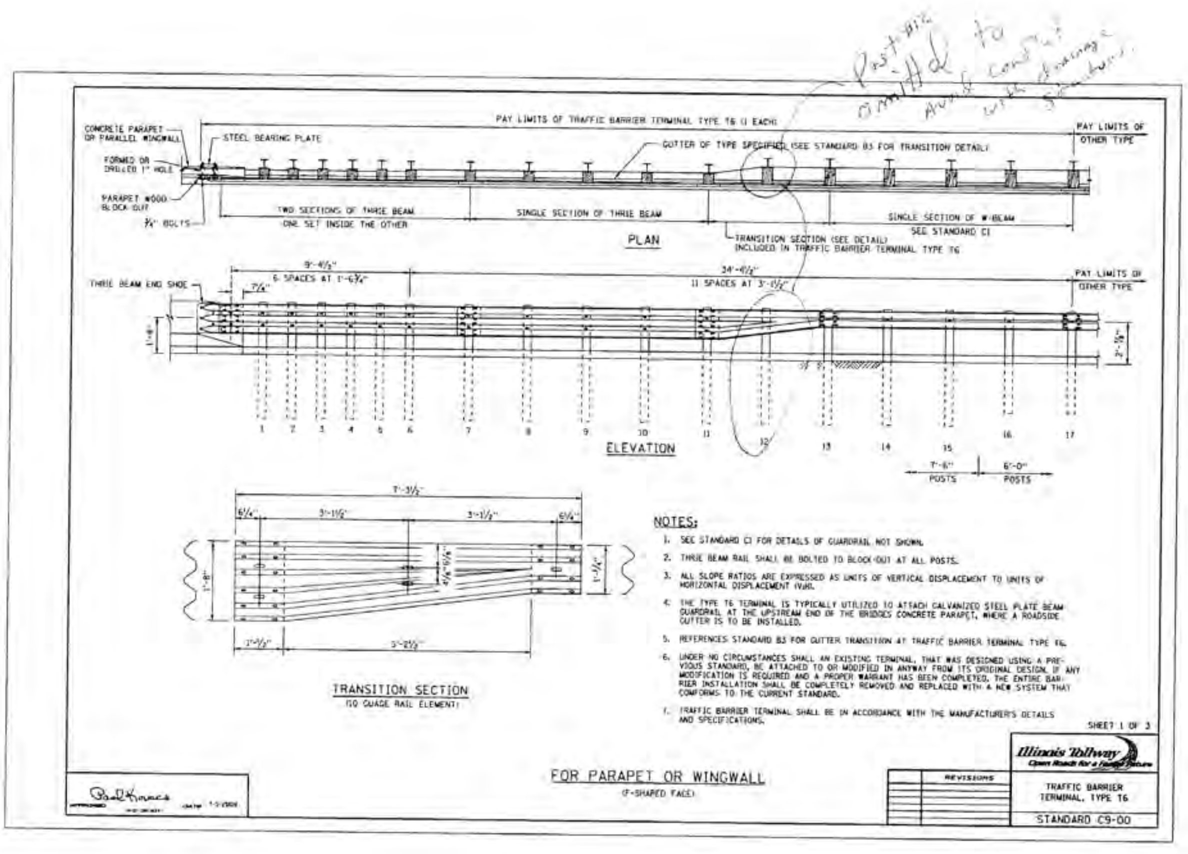


Figure 5. MGS Approach Transition with Omitted Post

Problem # 8 – MGS Posts in Asphalt

State Question:

Ron,

We have a Weigh-in-motion enforcement site being constructed along I-90. The designer proposed essentially widening the asphalt shoulder by 30' for the State Police to use to pull overweight vehicles over to check with portable scales. This area has tapers on each end and is several hundred feet long. The State Police had requested that the area be "protected" with guardrail, so the designer proposed a run of guardrail parallel to the mainline, between the mainline shoulder and the enforcement area. The pavement is 9" asphalt and they are proposing to drive the posts thru it.

questions: will the guardrail react properly when placed in that thick of pavement? I thought that the posts needed to be able to rotate in the soil to absorb the energy. That is why we are telling all of the designers that the posts cannot be placed in concrete. Wouldn't they just snap off or bend at the top of pavement?

If 9" of pavement is too much around the posts, how much is acceptable? has this been tested?

Thanks for your help.

Tracy Borchardt
AECOM
Chicago
312-823-5005

MwRSF Response:

Tracy:

Prior testing of W-beam guardrail systems with thick asphalt (or rigid concrete) surrounding the posts has been shown to degrade guardrail performance. Several years ago, TTI researchers developed a methodology for placing guardrail posts in a cutout to allow for adequate post rotation (Report No. 1 and ASCE Paper). Details for this method are contained in the attached FHWA acceptance letter (B64b.pdf). Within this letter, FHWA also included details for placing posts in situations where subsurface rock is encountered, per a research study by MwRSF (Report No. 2). In the MwRSF study, additional details were provided for the configuring the size of asphalt leave-outs.

More recently, TTI researchers have continued to develop leave-out alternatives for guardrail posts placed in mow strips. Although that research is continuing or recently completed, I will try to find either a recent progress report and/or draft report that summarizes the most recent findings and acceptable practices for posts placed in mow strips or over subsurface rock (Report Nos. 3 and 4).

You are correct in noted that it is desirable for guardrail posts to rotate in the soil and dissipate a portion of the vehicle's kinetic energy. When premature wood post fracture occurs, other behavior may occur, such increased barrier deflections, vehicle pocketing, or vehicle instabilities upon redirection. Similarly, steel posts may yield with limited displacement at the ground line, thus changing the loading to the rail as well as the rail movement while deflecting. For steel posts, rail rupture can occur as well as barrier override. For now, we must provide leave-outs in the rigid pavement in order to allow the posts to behave as they would in compacted soils. TTI has developed some alternative leave-outs that may be worth considering, as presented in the latter reports. Finally, you are correct in noting that 9-in. asphalt pads are excessive and would result in wood post fracture or immediate steel post yielding and twisting.

If you have any questions on these topics after you have reviewed the noted materials, please feel free to contact me at your earliest convenience.

Ron

Report No. 1:

The file 'Guardrail in Mow Strips 0-4162-2.pdf' (14.7 MB) is available for download at
<http://dropbox.unl.edu/uploads/20090907/0493fc0ef55b7ac4/Guardrail%20in%20Mow%20Strips%200-4162-2.pdf>
for the next 7 days.
It will be removed after Monday, September 7, 2009.

Report No. 2:

The file 'TRP-03-119-03.pdf' (3.3 MB) is available for download at
<http://dropbox.unl.edu/uploads/20090907/17298b7b52bd5229/TRP-03-119-03.pdf>
for the next 7 days.
It will be removed after Monday, September 7, 2009.

Report No. 3:

The file 'TM-GuardrailPostInstallationinRock-rev2.pdf' (2.1 MB) is available for download at
<http://dropbox.unl.edu/uploads/20090907/f2573a035eb649f1/TM-GuardrailPostInstallationinRock-rev2.pdf>
for the next 7 days.
It will be removed after Monday, September 7, 2009.

Report No. 4:

The file '405160-14-1.pdf' (2.9 MB) is available for download at
<http://dropbox.unl.edu/uploads/20090907/bbf1a3f8e1d88bc1/405160-14-1.pdf>
for the next 7 days.
It will be removed after Monday, September 7, 2009.

Respectfully,

Ron

Ronald K. Faller, Ph.D., P.E.
Research Assistant Professor

Problem # 9 – MGS Posts in Asphalt – Part II

State Question:

Ron,
Several weeks ago you sent me a considerable amount of information on guardrail posts in concrete and guardrail when used in mow strips.

I have gone thru most of what you sent. There seems to be a range of values for the leave-out area around the posts.

The 2004 report by TTI recommends an 18" x 18" area, which only leaves 9" behind the post, but this was not the MGS. I think I saw somewhere else that it should be as much as 2 feet behind the post.

Using the MGS, what value are you comfortable with from the back of the post to the edge of the leave-out hole? I am thinking of using an 18" x 24" leave-out area, which provides 15" behind the post.

Thanks for your help.

Tracy Borchardt
IL Tollway GEC

MwRSF Response:

Tracy:

A distance of 15” behind the post would be more than adequate. I could comfortably live with 12” as well.

Ron

Ronald K. Faller, Ph.D., P.E.
Research Assistant Professor

Problem # 10 – TCB to Bridge Rail Connection

State Question:

Ron,

As we spoke on the phone, I have a question regarding the roadside TCB to bridge connection utilizing thrie-beam panels. Do you or Bob have any rules of thumb regarding how the length of thrie-beam sections should be distributed onto the bridge and the first TCB section? For example, I would like to connect the thrie-beam end shoe to the bridge through existing bolt holes. This would place a significant majority of the thrie-beam length onto the first TCB section (see attached file). Do you see any issues with this approach?

Thanks,

-Chris

,,,,,, ,,,,,, ,,,,,, ,,,,,, ,,,,,, ,,,,,,

Chris Poole, P.E.
Litigation/Roadside Safety Engineer
Office of Design
Iowa Department of Transportation

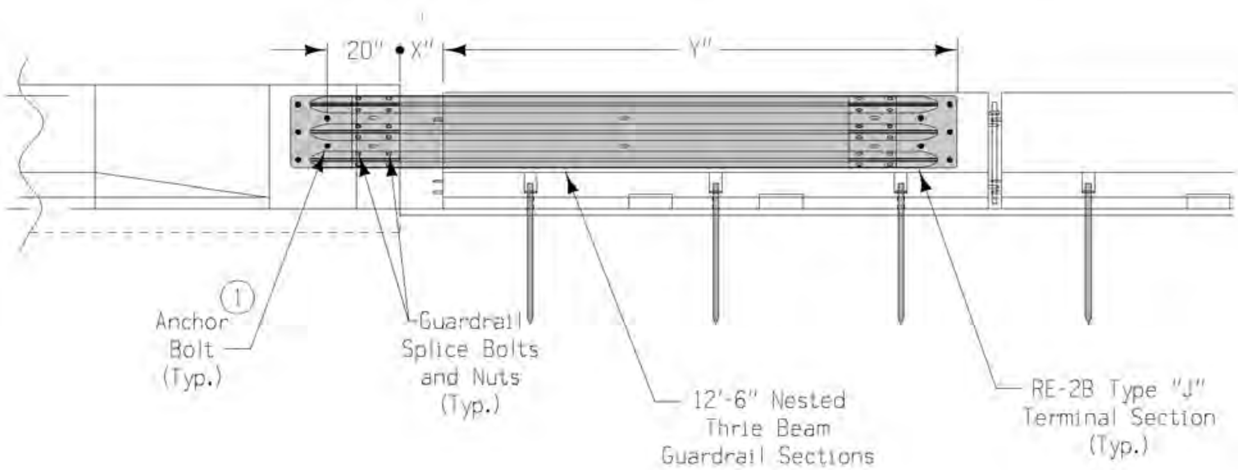


Figure 6. Proposed Iowa Layout for TCB to Bridge Rail Connection

MwRSF Response:

Hi Chris,

The thrie beam connection shown in your schematic should be acceptable and I don't see any problems with the attachment as you have it shown.

The schematic you sent me is acceptable even with a gap as large as 12" between the final PCB and the bridge transition piece as long as the there is only one way traffic on the roadway. We would recommend gaps smaller than 12" if at all possible. If traffic is moving from the PCB's towards the bridge in your schematic, then the chance for snagging on the end of the bride is minimal, and the thrie beam sections should possess sufficient capacity to hold the joint between the bridge transition and the PCB together even with the larger gap.

If the traffic is moving the other direction, we would recommend filling the overlap area with concrete to reduce the snag potential. This is necessary and quite critical. It may be your best option to fill that area for now, but you may want to think about a redesigned transition section in the future to reduce the snag potential. In general, we would recommend not running two way traffic in this type of installation unless the snag issues can be sufficiently eliminated.

Thanks

Bob Bielenberg, MSME, EIT
Research Associate Engineer
Midwest Roadside Safety Facility

Problem # 11 – TCB to Bridge Rail Connection-Part II

State Question:

Hi Bob,

Upon further inspection, I realized that my scaling was off on the thrie-beam section I showed in my drawing. Having corrected that, and using the dimensions to the existing bolt holes in the bridge rail and a 12-inch gap between the bridge and the first PCB, I am now showing that the thrie-beam piece will extend entirely beyond the first PCB section. I assume this is an issue (maybe not?).

Minimizing the gap between the bridge and the first PCB would allow bolting the rail into both the first and second PCBs. Would this be acceptable? Are there any other spacings or modifications you might recommend, such as using a shorter thrie-beam section?

Thanks,

-Chris

MwRSF Response:

Hi Chris,

I don't like the idea of extending the thrie beam past the end barrier in either of those schematics. If we do so, the thrie beam is no longer tied to the end barrier. In addition, the 12" gap detail would create a snag hazard on the thrie beam end shoe.

I have attached details of the connection that Florida uses. They have many different variations of the thrie beam connection to permanent railing that they worked out with us when the transition was first developed. Will these details work for you?

Thanks

Bob Bielenberg, MSME, EIT
Research Associate Engineer
Midwest Roadside Safety Facility

Problem # 12 – TCB to Bridge Rail Connection-Part III

State Question:

Bob,

I've been using Florida's details as a guide. Unfortunately, they don't have anything that would solve this particular issue. Since my main goal is to try and utilize the existing bolt holes in the bridge end post, the only other option to make it work would be to use a thrie-beam section SHORTER than 12'-6". What are your thoughts on that?

If that's not allowable, I'm just gonna have to bite the bullet and drill new holes.

Thanks for all the time you've spent on this.

-Chris

MwRSF Response:

Hi Chris,

We do not have a problem with using shorter thrie beam sections, such as 6'-3" sections, rather than the 12.5' sections we tested with. We went with the longer section because it was more common.

Thanks

Bob Bielenberg, MSME, EIT
Research Associate Engineer
Midwest Roadside Safety Facility

Problem # 13 – MGS Bridge Approach Transition

State Question:

Ron,
We are attempting to switch to MGS/ 31” w-beam guardrail height.
Re. In light of the MGS 31” guardrail using 12” blockouts & changing post spacing away from the joints...
Should the bridge approach section use 12” Blockouts?
If it was tested with 8” blockouts & these should stay 8”, where should the transition to 12” blockouts take place?

The original design tested did not include posts 10 & 12.
With the post spacing changing away from the joint, are Posts 10 & 12 required?
Or should 10 & 12 be placed to start the transition to stiffen the area?

What end treatments are available for 31” guardrail?

Thanks for your review.
Phil TenHulzen PE
Design Standards Engineer
Nebraska Dept. of Roads

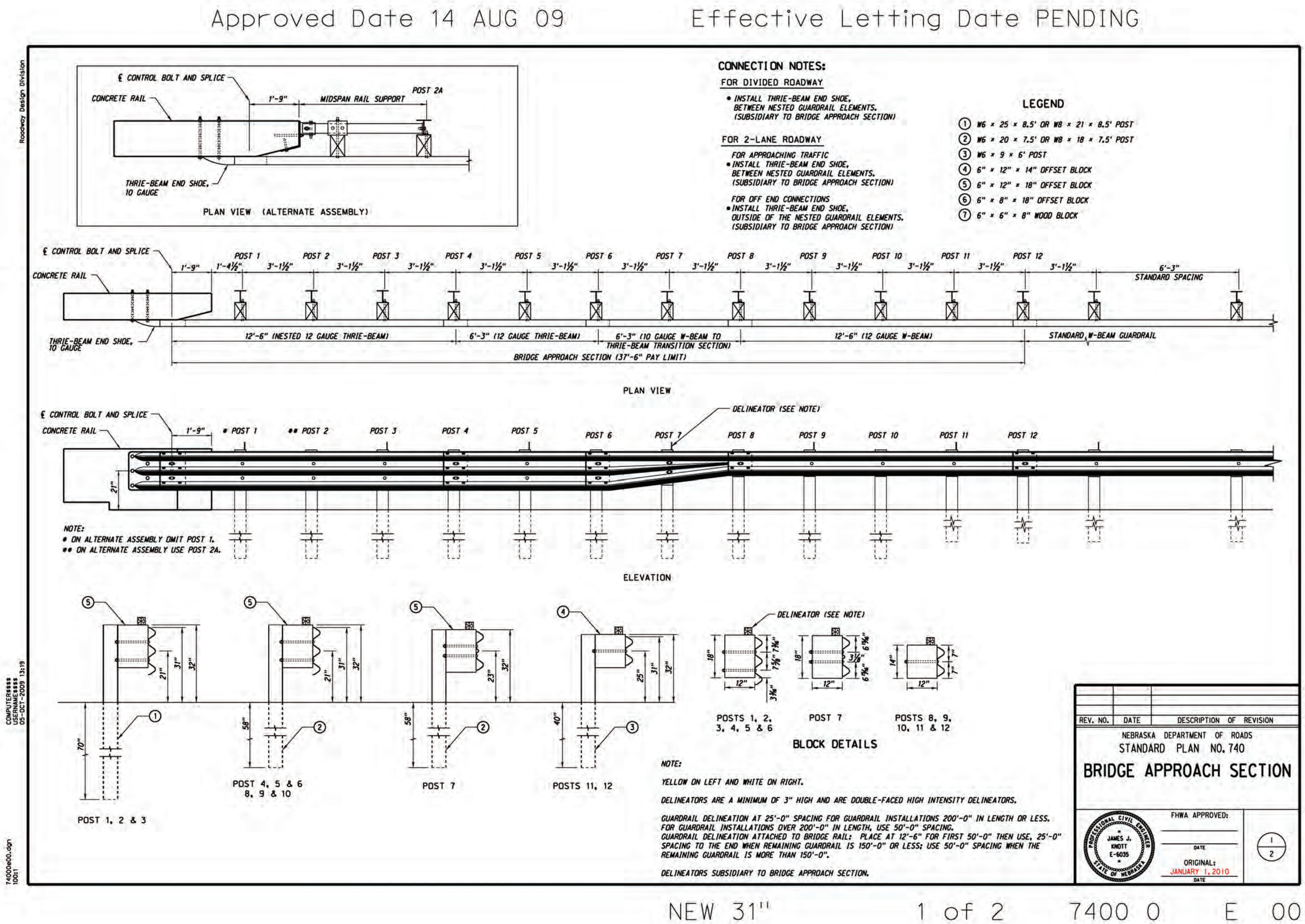


Figure 7. NDOR MGS Approach Transition

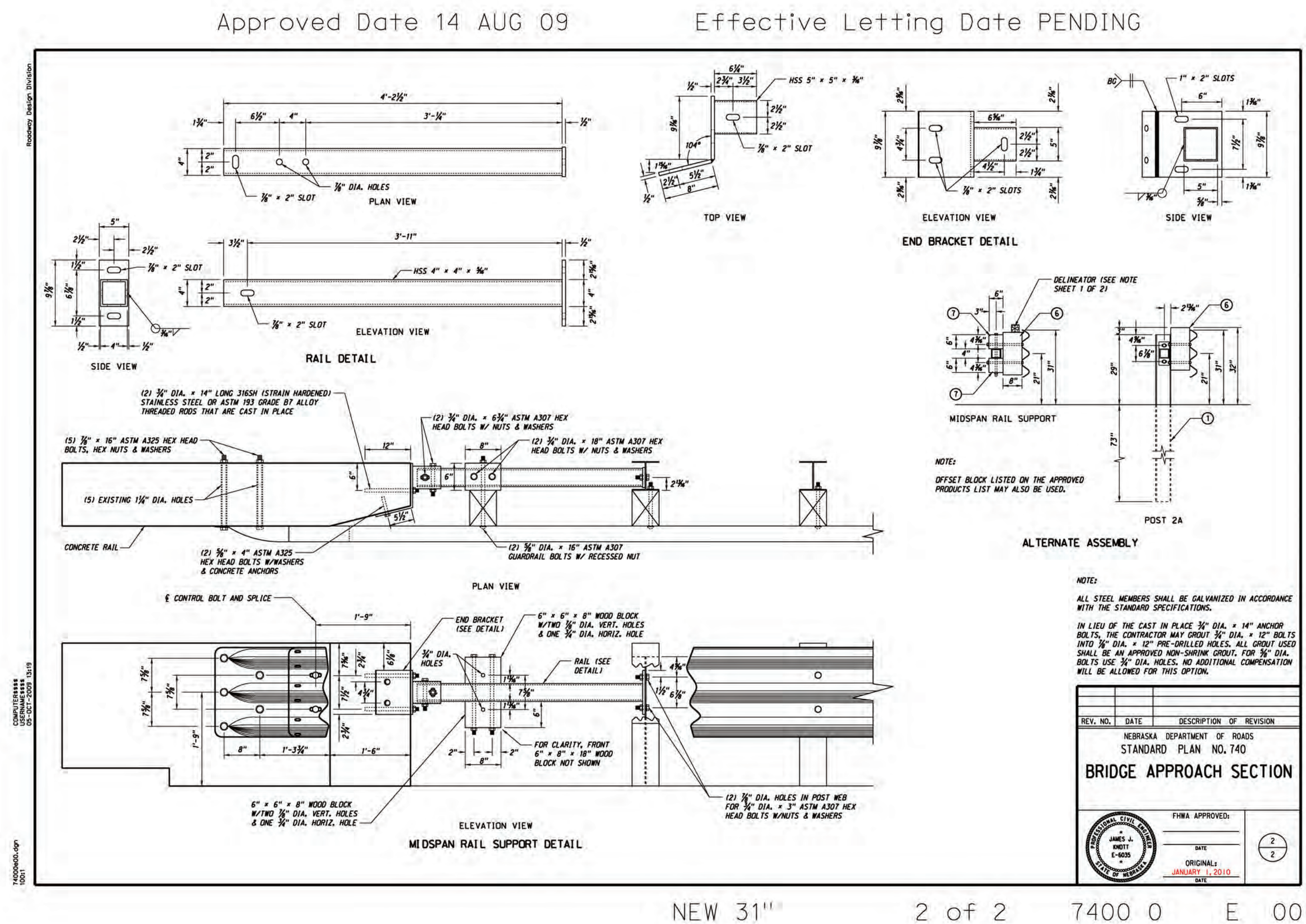


Figure 8. NDOR MGS Approach Transition

MwRSF Response:

Phil,

We have successfully crash tested two steel post, thrie beam approach guardrail transition alternatives for the Midwest States Pooled Fund Program. These two transition designs were based on starting with a thrie beam system that was supported by W6x15 steel posts near the bridge end and spaced on 3 ft – 1.5 in. centers. See the attached for the two approach transitions successfully crash tested by MwRSF.

File "MWT FD R0" shows the design which utilized 3 W6x15's (7 ft long), 7 W6x12's (7 ft long), and 2 W6x9's (6 ft long). The transition length of this system – as defined in your drawing as the distance from the bridge rail to the DS end of standard MGS rail segment (additional post at this location) – is 37.5 ft.

File "MWT-SP R4" shows the design which utilized 3 W6x15's (7 ft long) and 7 W6x9's (6 ft long). The transition length of this system – as defined in your drawing as the distance from the bridge rail to the DS end of standard MGS rail segment (additional post at this location) – is 25 ft.

The system that you have sent (file "7400e00") have the same rail elements and post spacings / locations as MwRSF's first approach transition design (file "MWT FD R0"). However, the posts used in the 2 designs are very different. The transition you are working with was designed with long heavy posts near the bridge rail (designed to accommodate the circumstance of Post 1 being omitted) and did not consider the upstream end – or the approach transition. Thus, NDOT's transition utilizes three 8.5 ft long W6x25's followed by seven 7.5 ft long W6x20's. (In comparison were the MwRSF transition has three 7 ft long W6x15's followed by seven 7.5 ft long W6x12's.) Although we see no problem with the transition from 8.5 ft long W6x25's to 7.5 ft long W6x20's, major problems are likely at the beginning of the transition where the 7.5 ft W6x20's are adjacent to 6 ft W6x9's. This large difference in stiffness would likely create critical pocketing and snagging. Therefore, I recommend softening the front end of the approach transition.

In order to soften the approach transition but still keep the large W6x25's, the transition length will have to be increased. As stated previously, I like the transition between the W6x25's and the W6x20's, so nothing will change on the DS end of the transition. To attach either MwRSF designed approach transition, the W6x20's will be used to represent the W6x15's of the tested MwRSF system. Both W6x20's and W6x15's have 6 in. wide flanges and the embedment depth of the two posts is only changed by 0.5 ft. The additional stiffness provided to the W6x15's by rail cap used in the MwRSF system should make the total stiffness similar to the W6x20's with a slightly deeper embedment.

Therefore, using the relation described in the previous paragraph, the 2 approach transitions designed by MwRSF can be attached to the DS end of NDOR's current transition. These attachments will result in the transition being extended for an additional 6 ft – 3 in. (the length of the segment supported by W6x25's), as shown in the attached sketches titled "Nebraska Transition Design Adaptations". What do you think of these 2 designs?

One note: MwRSF has previously adapted the approach transition to Iowa's transition. Although the posts are very different, the result was the same in that the total length of the transition was extended 6 ft – 3 in. see attached PDF.

To answer your blockout question: I would keep the blockout depth at 12 in. for the W6x25's and W6x20's (I'm assuming that was the blockout depths of the system as tested). Thus, the DS end remains the same as tested and accepted. Additionally, the increased blockout depth of 4 in. (12 in. deep blockouts on the W6x20's are replacing the 8 in. deep blockouts on the W6x15's used in the MwRSF system) can be thought of as an extra safeguard to prevent snagging between the untested transition between the W6x20's and the approach guardrail transitions.

I hope this answers all of your questions. Let me know if I left something out or you have additional questions/concerns.

Scott Rosenbaugh
Midwest Roadside Safety Facility (MwRSF)
University of Nebraska – Lincoln

Problem # 14 – Concrete Barrier Protrusion

State Question:

Ron,

What is the maximum protrusion along a concrete median barrier that would be acceptable? We have some sections of median barrier wall that no longer line up with the light pole foundations. There is now a snag point where a vehicle sliding along the wall would hit. For some reason, I thought that 1" was allowable. Does it matter if the edge is beveled?

Thanks,
Tracy Borchardt
IL Tollway GEC – AECOM

MwRSF Response:

Tracy:

Previously, MwRSF provided guidance noting that it was preferred to have the maximum lateral barrier misalignment limited to 1" or less. In addition, I believe that it would be preferred to utilize chamfered corners or edges to assist in mitigating vehicle snag on any exposed sharp edges. I have attached a pdf copy of a prior Pooled Fund Progress Report and Consulting Summary which contained this general guidance.

Ron

Ronald K. Faller, Ph.D., P.E.
Research Assistant Professor

Problem # 15 – Termination and Anchorage for TCB

State Question:

With regards to the termination and anchorage for the F-shape temporary concrete barrier that was recently tested, the soil conditions are not representative of many field installation locations. Our soils would typically be much weaker and require significantly longer piles or other measures to provide equal performance. Would this require site specific design? Or would it be feasible to design for a worst case (weak soil)? Designing a standard application for a weak soil condition might result in over strengthening the anchorage, leading back to excessive loads? This seems to be a practical problem for application of the design. Could the report include a recommendation on how to address this?

In addition, I have some questions regarding installations where the barrier would end on a pavement. In many cases, if we carry the barrier out to the earth beyond the pavement or shoulder we may impede contractor access to the work area. A version of this for anchorage to a paved area would be worth more consideration. Also, we usually require a pad for the sand barrels. Perhaps a leave out area could be defined to accommodate the piles, with the area topped with a compacted aggregate?

David L. Piper, P.E.
Safety Design Engineer
Bureau of Safety Engineering

MwRSF Response:

The anchorage we used in this design was developed previously as part of a low tension cable anchorage. It was developed for use in general roadside fill conditions and tested in soil that meets the specifications for MASH. We believe that the anchorage will perform well given normal variations in soil conditions. We do not believe that the anchorage would need to be modified unless extreme soil conditions were present.

Anchoring the barrier in the paved area presents more challenges. When the anchor is loaded, energy is absorbed through deflection of the anchor in the soil. Anchoring the barrier to concrete would reduce the deflection and increase the loads for the same level of energy absorption. We do believe that this can be done, but it will require further study. As far as the size of the leave out required, I believe that is defined on the report in the recommendations section and is shown in the CAD in Figure 47.

Thanks

Bob Bielenberg, MSME, EIT
Research Associate Engineer
Midwest Roadside Safety Facility

Problem # 16 – Iowa Approach Transition Connection

State Question:

Jay Chiglo with HDR in Chicago, IL had questions regarding the proper connection between the Iowa approach guardrail transition and various concrete parapets.

MwRSF Response:

Jay:

Per our recent phone conversation, I have reviewed the research and development effort regarding the approach guardrail transition system for safety shape parapets. The original study was funded by the Midwest State's Pooled Fund Program and dated May 15, 1998. The report no. is TRP-03-68-98. I am attaching a link for you to download this report. In the study, it is apparent that five 7/8-in. diameter, ASTM A325 bolts were used to attach the thrie beam end shoe to the parapet with the use of a special steel connector plate with a sloped end to mitigate concerns for vehicle snag. The special steel connector plate was also used to keep the thrie beam vertical and not twisted when attached to the parapet. The final design was crash tested and evaluated with both wood and steel post options and using the NCHRP Report No. 350 impact safety standards.

The file 'TRP-03-69-98.PDF' (7.1 MB) is available for download at
<http://dropbox.unl.edu/uploads/20091007/4e274b685cc90f46/TRP-03-69-98.PDF>
for the next 7 days.
It will be removed after Wednesday, October 7, 2009.

Later, MwRSF performed an additional crash test on the steel post option when completing NCHRP Project No. 22-14(2) which led to the new Manual for Assessing Safety Hardware (MASH) guidelines. One 2270-kg pickup truck crash test was successfully performed on the same design as noted above. The report no. is TRP-03-175-06 and dated October 12, 2006. I have attached a link for you to download the noted report. Once again, five 7/8-in. diameter, ASTM A325 bolts were used to attach the thrie beam end shoe to the parapet with the use of a special steel connector plate with a sloped end to mitigate concerns for vehicle snag.

The file 'TRP-03-175-06.pdf' (9.0 MB) is available for download at
<http://dropbox.unl.edu/uploads/20091007/47ec30bbdfdf820e/TRP-03-175-06.pdf>
for the next 7 days.
It will be removed after Wednesday, October 7, 2009.

In the pdf file that you had provided, it was apparent that the thrie beam end shoe was blocked out off of the parapet with a wood shim block. You also noted that the end shoe was attached using five ¾-in. diameter, ASTM A307 bolts. Both the shim block and bolt hardware differ from the crash tested system details.

At this time, I am unaware of any successful crash testing on thrie beam approach guardrail transitions where the thrie beam end shoe has been twisted to match the slope of the upper parapet region. As such, it is my opinion that the existing crashworthy design details should be utilized when installing this transition system. For trailing end locations, the wood shim block would potentially lead to vehicle snag on the raised end shoe. Thus, the wood shim block should be replaced with the special, sloped, steel connector plate to mitigate snag concerns and to comply with the design that received FHWA acceptance. Second, the use of a special steel connector plate can cause some of the connection bolts to be subjected to combined loading – shear and bending. With that in mind, the five bolts were upgraded in the crash tested design and utilized 7/8-in. diameter, ASTM A325 hardware. In the absence of any other test results, it is my opinion that the connection hardware should comply with that utilized in the crash testing program.

Please let me know if you have any other questions or comments regarding the information contained herein.

Ron

Ronald K. Faller, Ph.D., P.E.
Research Assistant Professor

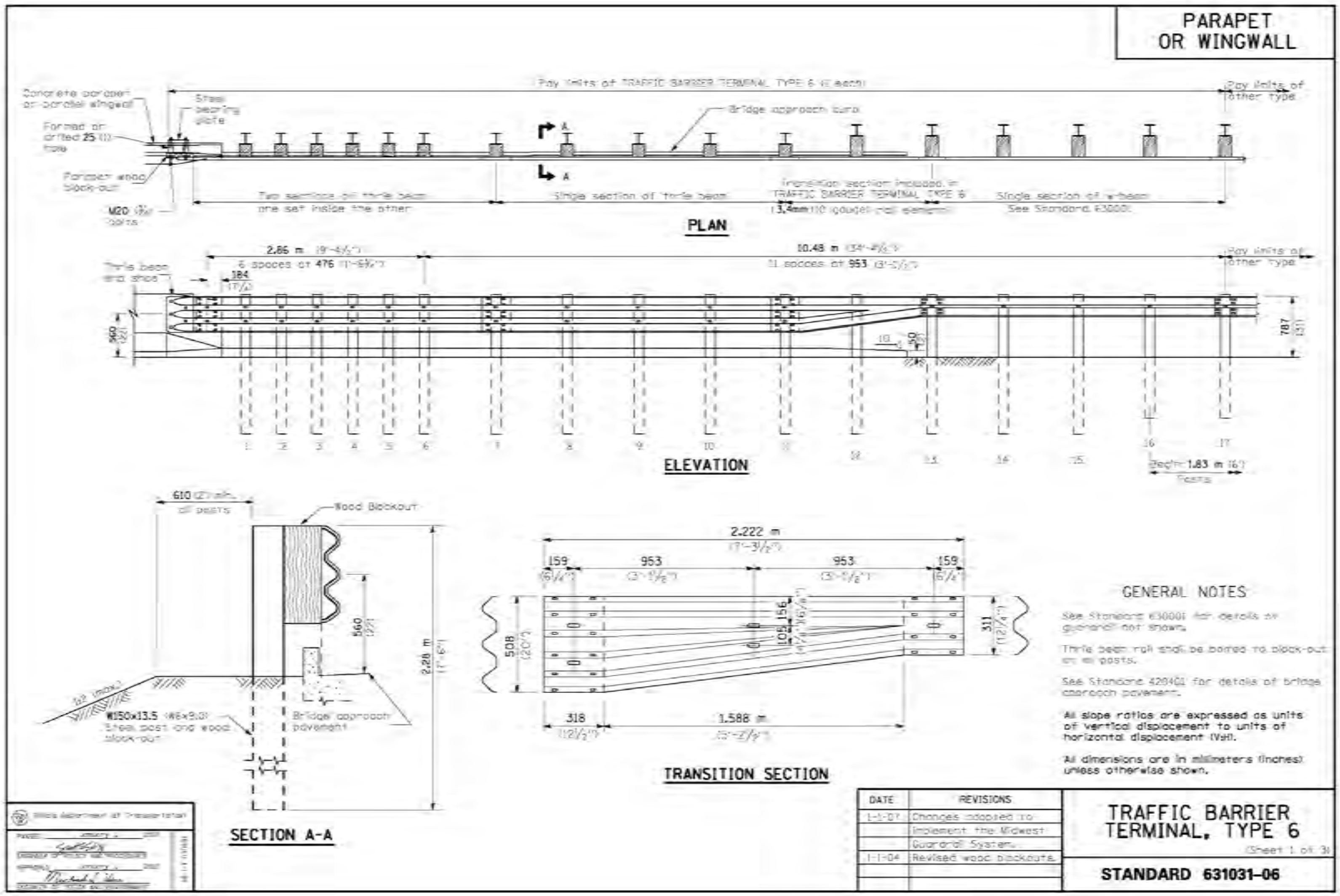


Figure 9. Type 6 Terminal Sections

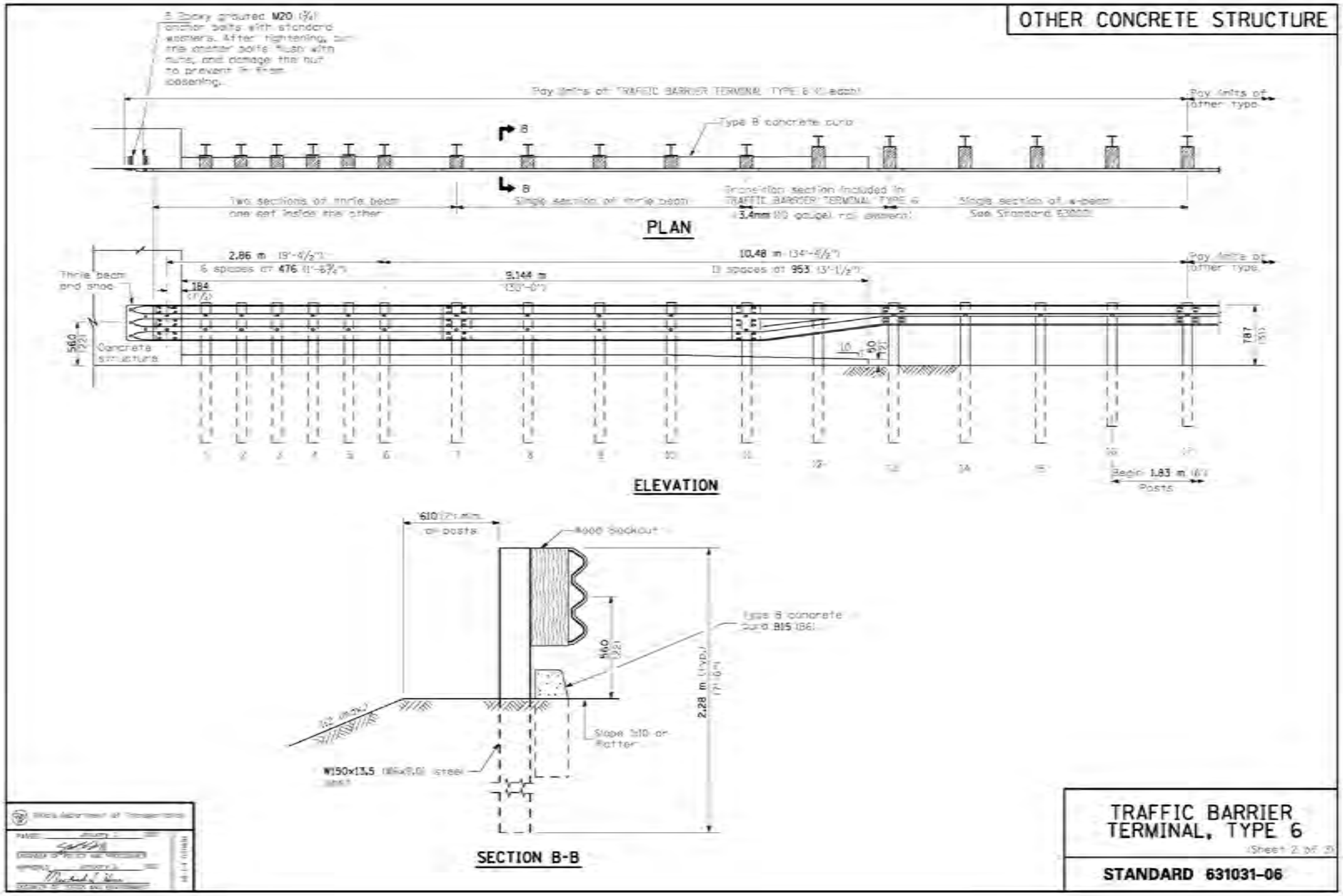


Figure 10. Type 6 Terminal Sections

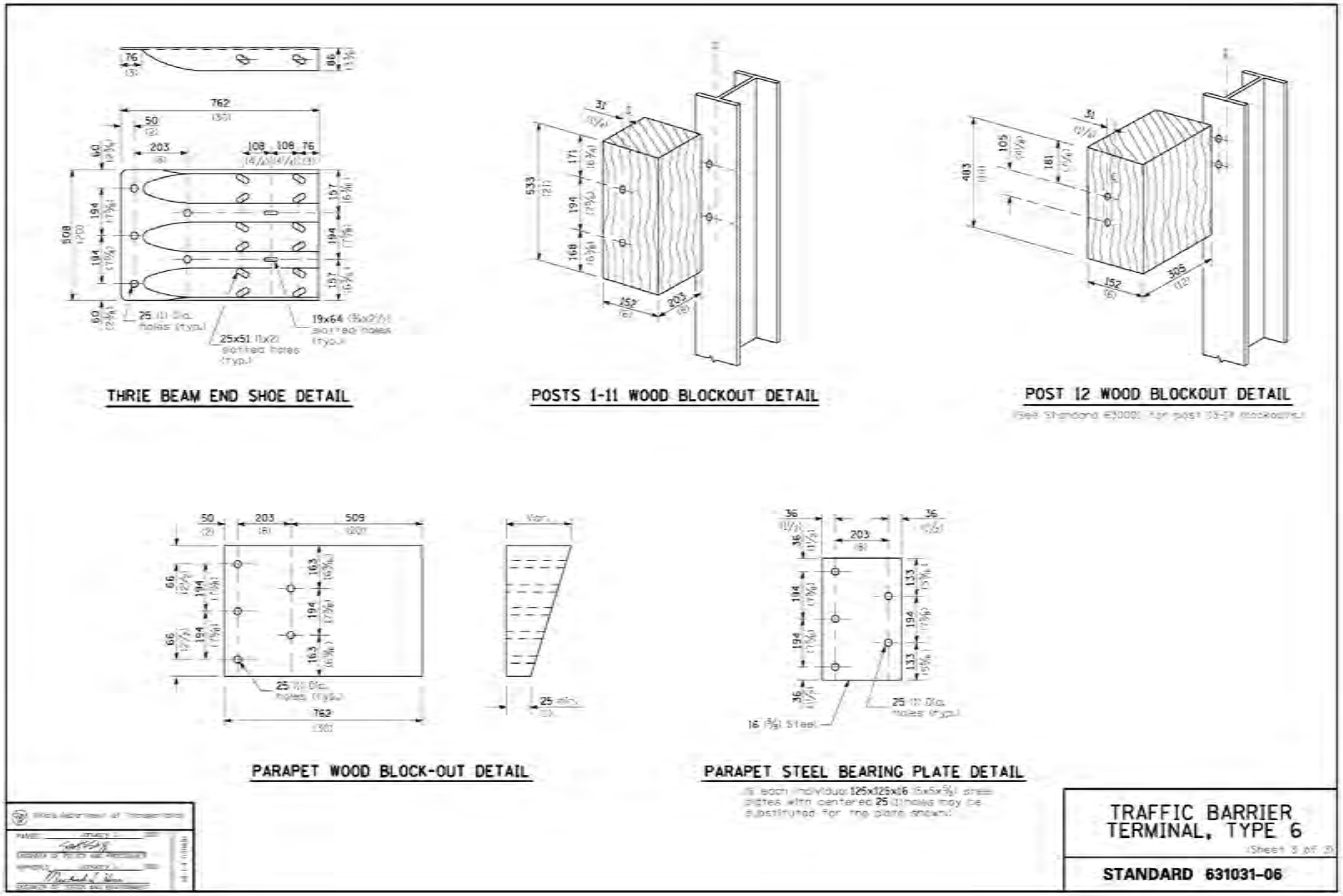


Figure 11. Type 6 Terminal Sections

Problem # 17 – Iowa Approach Transition Connection-Part II

State Question:

Ron,

Thank you for the response. One thing I just noticed was that the detail I sent you has been changed by the Illinois DOT. The one I sent you was dated January 1, 2007 as and was the correct detail at the time our project was let (designed). Without changing everything, and since the guardrail was placed in accordance with the appropriate standard I would like to go ahead and remove the wood shim on the trailing side of the guardrail only.

If we have a vertical face on our parapet, I believe we do not need a shim plate at all, is this correct?

If we have an F-shape parapet then the trailing side should have the shim plate attached to this e-mail inserted and the bolts should be increased to 7/8”. Correct? Thanks

jay

Jay Chiglo, P.E.
Vice President
HDR ONE COMPANY | Many Solutions
8550 W. Bryn Mawr, Suite 900
Chicago, IL 60631-3223

MwRSF Response:

You are correct. The steel connector plate would not be needed when the transition is attached to a vertical concrete parapet. However, the 4-in. lip curb was required by FHWA as it was included in the testing program.

The attachment bolts are to be 7/8-in. diameter and ASTM A325 bolts or equivalent. Also, the steel connector plate is required for NJ, F, and single slope barriers. We have developed one for NJ and SS shapes.

Slight modification may be needed for F shapes.

Ron

Ronald K. Faller, Ph.D., P.E.
Research Assistant Professor