Issue No. 2

Roadside Review

Midwest Roadside Safety Facility, University of Nebraska-Lincoln

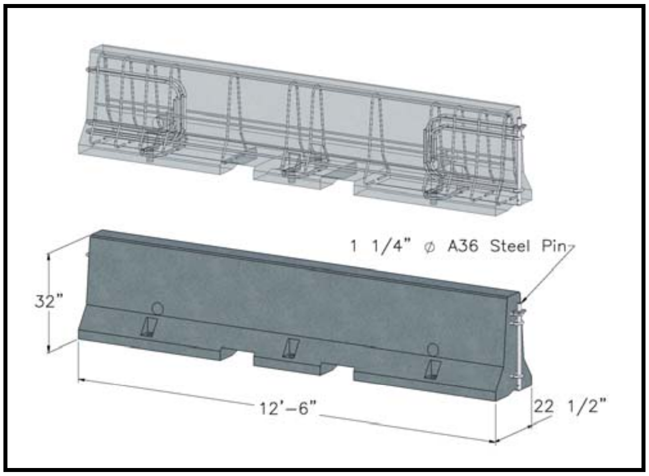
MAY 2006

ISSUE FEATURE:

Temporary Concrete Barrier System

INSIDE THIS ISSUE:

Temporary Concrete Barrier System



Specifics:

- Standard 32-in. Tall F-Shape Temporary Concrete Barrier
- 12 1/2-ft Long
- 22 1/2-in. Base Width
- Simple Pinned-Loop Connection
- Various Tie-Down Options
- Free-Standing to Rigid Transition
- Non-Proprietary

Temporary Barrier isometric view.

The current MwRSF F-shape temporary concrete barrier system has been tested successfully in both free-standing and tied-down applications. In addition, a transition has been developed between the temporary barriers and rigid concrete barriers for use in roadside applications. Combining these developments makes the concrete temporary barrier system the most complete temporary barrier system available to date.

Tie-down methods have been developed for several different applications and surfaces including concrete pavement, asphalt pavement, and concrete bridge decks. The three tie-down methods have also been tested near the edge of a drop-off, proving their performance capabilities in those situations.

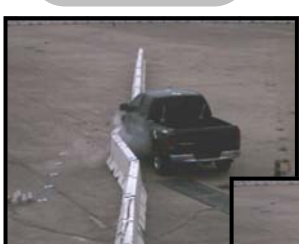
The system and its many variations were developed and tested with funding from the Midwest States Pooled Fund Program and the Florida Department of Tranportation. As listed, the temporary barrier system utilizes no patented parts and conforms with the NCHRP Report 350 TL-3 requirements. The free-standing system has also been tested successfully to the proposed NCHRP 350 Update criteria, using a 5,000 lb pickup.

Unlike the majority of temporary concrete barriers, which are 24 in. wide, this system is 22 1/2 in. wide, saving valuable space in construction zones and other tight areas.

Future developments planned for the temporary concrete barrier system include the development of an end anchorage system, the determination of length of need with this anchorage, and the development of a rigid concrete barrier transition for median applications. These developments will help to further increase the system's versatility.

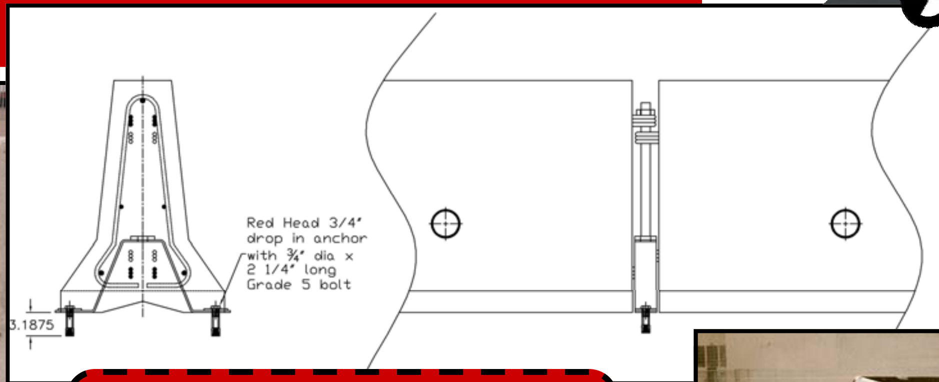
The development of the temporary concrete barrier and its variations have been reported in TRR Paper Nos. 03-3146, *Design and Testing of Tie-Down Systems for Temporary Barriers*, and 06-1276, *Tie-Downs and Transitions for Temporary Concrete Barriers*. It was also reported in several MwRSF research reports which are referenced on the back page of this newsletter.

Full-scale crash testing of Free-standing Temporary Barrier with 2270P (5,000 lb), proposed NCHRP 350 Update vehicle.



Reports, papers, and drawings can be found on our website: www.mwrsf.unl.edu

Steel Strap Tie-Down System

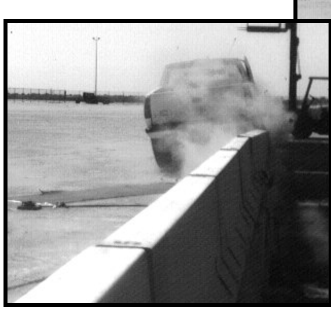


Full-scale crash testing of Temporary Barrier Steel Strap Tie-Down System. Successful performance under NCHRP Report 350 test designation 3-11.

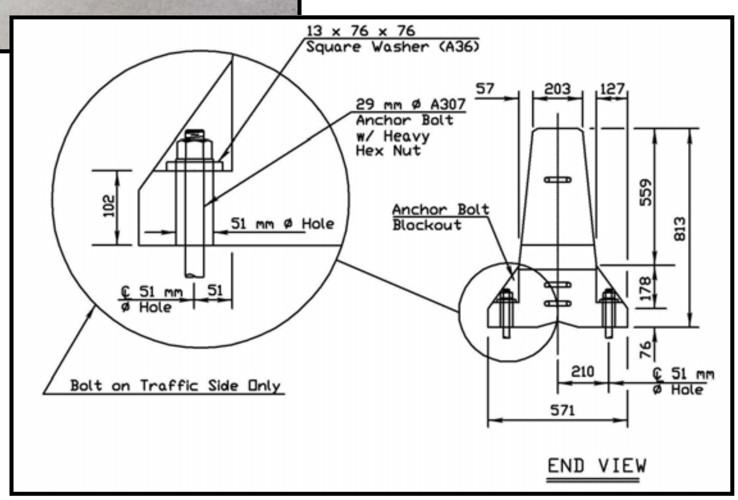
Temporary Barrier Performance Summary

System	Test	Deflection (in.)	Working Width (in.)	Recommended Edge Distance (in.)
Free Standing	3-11	45.3	67.8	NA
Steel Strap Tie-Down	3-11	37.8	57.5	6
Bolted Tie-Down	3-11	11.3	21.0	1
Asphalt Pinned	3-11	21.8	44.3	6
Free-Standing to Rigid Transition	3-11	18.4	26.3	NA
Report 350 Update Proposed Vehicles				
Free Standing	3-11	79.7	102.2	NA

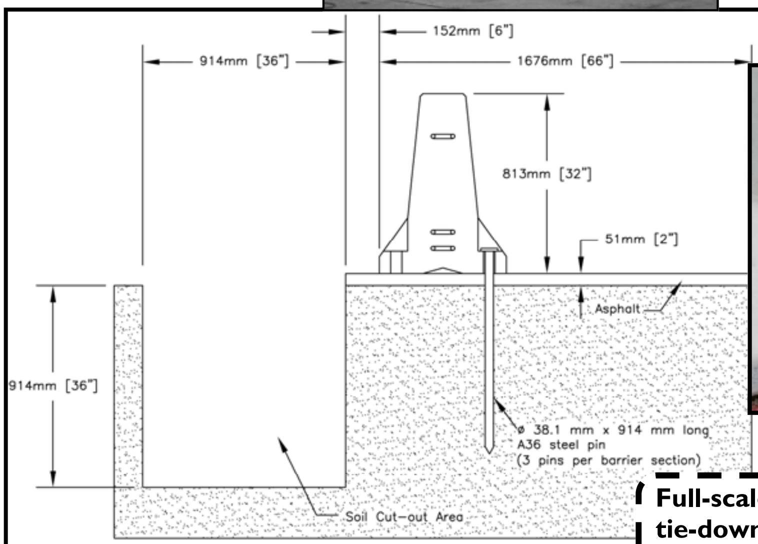
Bolt Through Tie-Down System

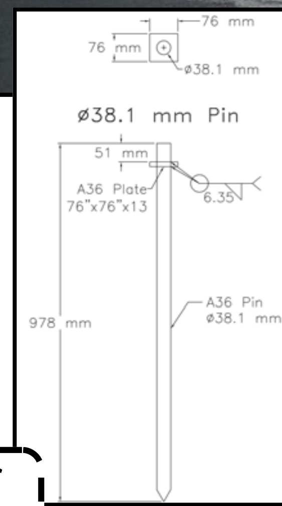


Full-scale crash testing of Temporary Barrier Bolt Through Tie-Down System. System performed successfully under NCHRP Report 350 test designation 3-11.



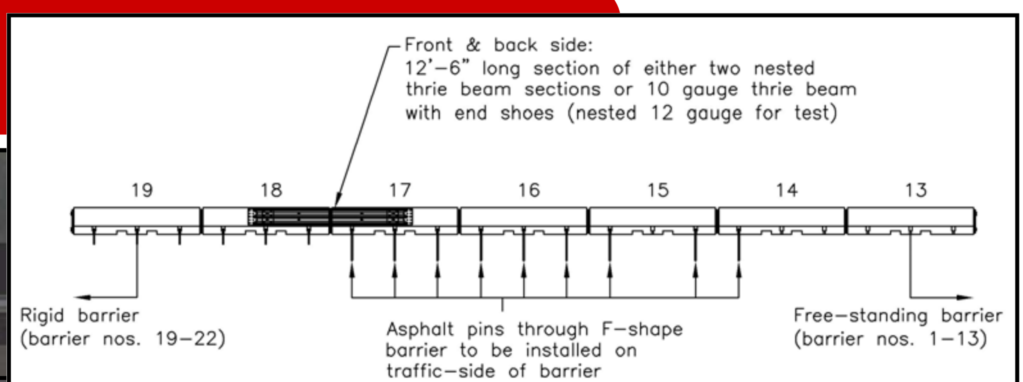
Asphalt Pin-Down System





Full-scale crash testing of temporary barrier tie-down system utilizing asphalt pin tie-downs. System performed successfully under NCHRP Report 350 test designation 3-11.

Free-Standing to Rigid Barrier Transition



Full-scale crash testing of Free-Standing to Rigid Barrier Transition System utilizing asphalt pins. System performed successfully under NCHRP Report 350 test designation 3-21.

MGS Comments and Clarifications

In response to MwRSF Roadside Review, Issue #1

Thrie-Beam Transition

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

  Historically thrie-beam guardrail systems were designed with a top rail height of 31 in. More recently, the metrication of roadside safety hardware resulted in a 31 5/8 in. top rail height. Since small car and pickup truck crash tests have been successful at both heights, the downward shift is not of concern. Alternatively, the height of the MGS could be increased to 31 5/8 in. over two or three post spans prior to the transition.

- **Has the length of the bridge rail approach guardrail transition been shortened?**

  No. Many existing thrie beam approach transitions have utilized a 12 1/2-ft long nested thrie beam section spanning between the rigid bridge rail and a symmetrical W-beam to thrie beam transition section. The new transition has an additional 6 1/4-ft long single (non-nested) thrie beam section between the nested section and a newly designed, asymmetrical W-beam to thrie beam transition piece. This actually makes it longer than many current transitions. However, the addition of a single, 6 1/4-ft long thrie beam section is being recommended for all existing transitions too. In addition, the length of W-beam guardrail on the upstream side of the asymmetrical W-beam to thrie beam transition piece has been extended. This allows for a more gradual transition by reducing the post spacing, increasing the capacity of the posts, and increasing their embedment depth.

- **Is the bridge approach section also acceptable at a 27 5/8-in. mounting height?**

  No.

Reduced Post Spacing

- **When using half post spacing, should the splice be placed on a post or a gap?**

  Although the standard system places the splices between posts, the half and quarter post spacing systems do not. This is because reducing the post spacing also reduces the stress on the rail and allows the barrier to function adequately, even though there is a post at the splice.

- **How should the post spacing transition between the standard spacing and quarter post spacing?**

  At this time, a stiffness transition has not been developed nor tested. Until one is developed, it is recommended that four half-post spaces be utilized to allow for a more gradual transition. As such, this stiffness transition would likely occur over 12 1/2 ft.

Curb System

- **Embedment depth will vary with curb height and transitions to non-curbed applications. Is this acceptable?**

  Yes, additional post embedment would result due to the addition of a curb. Recall that stiffer guardrails perform better when used over a curb, hence the posts are designed to be embedded farther.

- **Is the 6 in. curb acceptable closer to and behind the guardrail face in MGS?**

  Yes.

- **Are end treatments acceptable behind curbs?**

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

Miscellaneous

- **In the successful 7:1 Flared MGS test, what is the radius between the tangent and the flared sections, and how is the post spacing affected?**

  The tested radius was estimated between 88 and 91 ft. Posts remained at full spacing throughout.

- **What is the working width?**

  Working width is defined as the distance measured from the original front face of the barrier system to the rearmost part of the barrier at maximum dynamic deformation, or the farthest vehicle extend beyond the barrier system, whichever is greater. For MGS, this is generally the back of the posts.

- **If the upcoming long-span test passes with a drop-off at a given distance behind the rail, is the drop-off only allowed at that distance?**

  No, the vertical drop off could be no closer than the test, but a drop-off farther away would be acceptable.

- **Can the MGS start on a 10:1 approach slope and transition to an 8:1 approach slope?**

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

- **Can the current concrete box culvert attachment be used with MGS?**

  Although we believe the MGS attached to the top of concrete box culverts would provide adequate safety performance, full-scale vehicle crash testing would be required to demonstrate that the system would perform in an acceptable manner.

- **What MGS terminals are acceptable for 7:1 flare rates?**

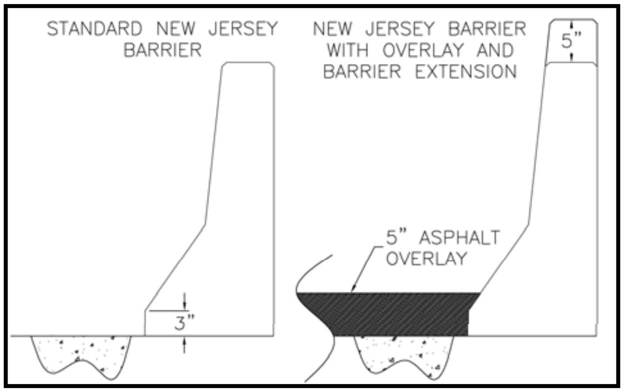
  For now, it is appropriate to use the approved MGS guardrail end terminals in this flared configuration.

Questions and Answers

Effects of Asphalt Overlays on the Performance of New Jersey Barriers

State Question:

An existing bridge has a 32" high New Jersey Shape concrete bridge rail. An asphalt overlay of 5" is proposed and an extension of 5" to the top of the barrier is the proposed solution. What effect does covering up the 3" lip at the bottom have on the barrier working as designed? Are there any other concerns?



MwRSF Response:

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 a 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 the New Jersey shape, F-shape, and single slope barriers. 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. We have also investigated the potential for impact of the occupant head with a vertical barrier due to head ejection and 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.

The Function and Importance of Blockouts on Guardrail Performance

State Question:

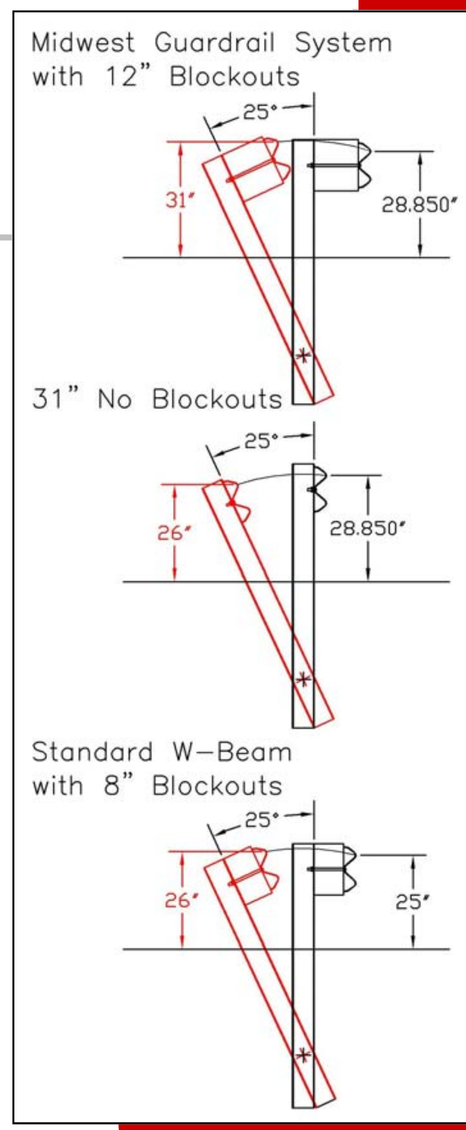
There is at least one alternative 31-in. high guardrail system that is currently available. This particular system does not utilize blockouts, and therefore may be less expensive to install. What is the function of the blockouts in the non-proprietary MGS, and can we expect similar improvements in performance with the alternative no-blockout system?

MwRSF Response:

The figure on the right illustrates our concern with the lack of blockouts. It is well acknowledged that blockouts serve two primary purposes in the strong post system. The first, and most important, is causing the rail to rise during an impact. As illustrated, during an impact, the rotation of the posts in conjunction with the blockout causes the rail to rise in both the Midwest Guardrail and Standard W-Beam Guardrail Systems. This is not the case for the 31-in. W-Beam Guardrail System without blockouts. The deeper blockout on the MGS has significantly improved performance in concert with the increased mounting height.

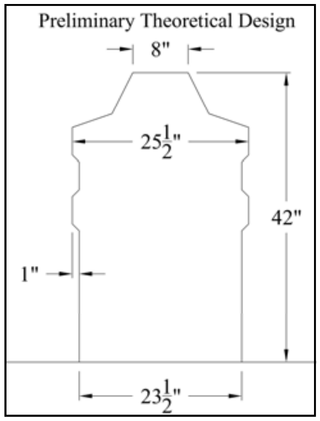
The 31-in. mounting height is only a component in the enhanced performance of the MGS. You will note that the lack of a blockout makes the rail height of the 31-in. initial mounting height and the existing metric standard about the same after 25 degrees of rotation, a distance that we need the posts to rotate to absorb the energy of the impacting vehicle.

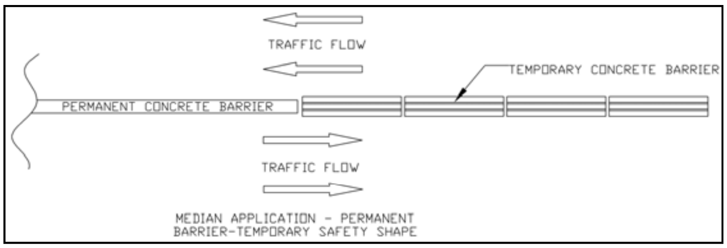
The second function is clearly to keep vehicles off of the posts, thus reducing the potential for wheel snag. While our surrogate vehicles may function without blockouts, there are many vehicles on the road that may suffer degraded performance when interacting with a no-blockout system.



Ongoing Concrete Barrier Research

- Development of new TL-5 concrete median barrier and anchor.
- Development of termination method for temporary concrete barrier system including the development of an anchorage system and the determination of length of need requirements.
- Development of temporary concrete barrier transition to permanent concrete longitudinal barriers in median applications.





- Evaluation of the safety performance of vertical and safety shaped concrete barriers.
- Development of modular precast concrete bridge rail for use with precast and cast-in-place bridge decks.

Concrete and Temporary Barrier Reports

TRP-03-20-89 Full-Scale Vehicle Crash Test on the Iowa Steel Temporary Barrier Rail

TRP-03-51-95 Performance Level 2 Tests on a 29-in. Open Concrete Bridge Rail

TRP-03-64-96 Development of a TL-3 F-Shape Temporary Concrete Median Barrier

TRP-03-120-02 Development of a Steel H-Section Temporary Barrier for Use in Limited Deflection Applications

TRP-03-115-02 Development of a Tie-Down System for Temporary Concrete Barriers

TRP-03-109-02 Development of a Low-Profile Bridge Rail for Test Level 2 Applications

TRP-03-134-03 Development and Evaluation of a Tie-Down System for the Redesigned F-Shape Concrete Temporary Barrier

TRP-03-149-04 TL-5 Development of 42- and 52-in. Tall, Single-Faced, F-Shape Concrete Barriers

TRP-03-133-04 Safety Performance Evaluation of the Nebraska Open Bridge Rail on an Inverted Tee Bridge Deck

TRP-03-148-05 Development, Testing, and Evaluation of NDOR's TL-5 Aesthetic Open Concrete Bridge Rail

*Check out the publications section of Midwest Roadside Safety Facility website to request copies of the reports

MIDWEST ROADSIDE SAFETY FACILITY
UNIVERSITY OF NEBRASKA-LINCOLN
E527 NEBRASKA HALL
LINCOLN, NE 68588-0529
(402) 472-0965
E-mail: mwrsf@unl.edu
www.mwrsf.unl.edu