

Second Quarter 2003 Progress Report
Midwest Roadside Safety Facility
Mid-States Regional Pooled Fund
June 12, 2003

YEAR 9

Tie-Down System for Existing F-shape Temporary Barrier Rail (TBR)

Bielenberg, B.W., Faller, R.K., Reid, J.D., Holloway, J.C., Rohde, J.R., and Sicking, D.L., ***Development of a Tie-Down System for Temporary Concrete Barriers***, Final Report to the Midwest State's Regional Pooled Fund Program, Transportation Research Report No. TRP-03-115-02, Project No. SPR-3(017)-Year 9, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, August 16, 2002.

Guidelines for Evaluating Attachments to Bridge Rails

Keller, E.A., Faller, R.K., Sicking, D.L., Rohde, J.R., and Polivka, K.A., ***Guidelines for Attachments to Bridge Rails and Median Barriers***, Final Report to the Midwest State's Regional Pooled Fund Program, Transportation Research Report No. TRP-03-98-01, Project No. SPR-3(017) - Year 9, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, February 26, 2003.

Evaluation of Missouri Standards for Placement of Steel and Wood Guardrail Posts in Rock or at Obstructions to NCHRP 350 Specifications.

Herr, J.E., Rohde, J.R., Sicking, D.L., Reid, J.D., Faller, R.K., Holloway, J.C., and Polivka, K.A., ***Development of Standards for Placement of Steel Guardrail Posts in Rock***, Final Report to the Midwest State's Regional Pooled Fund Program, Transportation Research Report No. TRP-03-119-03, Project No. SPR-3(017)-Year 9, Project Code: RPPF-99-01(a), Midwest Roadside Safety Facility, University of Nebraska-Lincoln, May 30, 2003.

Test and Evaluate Missouri Thrie-Beam Bridge Rail to W-beam Transition to NCHRP 350 Specifications

Polivka, K.A., Faller, R.K., Reid, J.D., Sicking, D.L., Rohde, J.R., Keller, E.A., and Holloway, J.C., ***Development of an Approach Guardrail Transition Attached to a Thrie Beam and Channel Bridge Railing***, Final Report to the Midwest State's Regional Pooled Fund Program, Transportation Research Report No. TRP-03-91-99, Project No. SPR-3(017)-Year 6, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, March 21, 2000.

Minimum Soil Support Required for Seven Foot Strong Post Guardrail Systems

Polivka, K.A., Faller, R.K., Sicking, D.L., Rohde, J.R., Holloway, J.C., and Keller, E.A., ***Development of a W-Beam Guardrail System for Use on a 2:1 Slope***, Final Report to the Midwest State's Regional Pooled Fund Program, Transportation Research Report No. TRP-03-99-00, Project No. SPR-3(017)-Years 9 & 10, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, October 16, 2000.

Bridge Rails and Transitions for Pedestrian Protection

Hiser, N.R., Faller, R.K., Sicking, D.L., Rohde, J.R., Reid, J.D., and Polivka, K.A., ***Bridge Rails and Transitions for Pedestrian Protection***, Final Report to the Midwest State's Regional Pooled Fund Program, Transportation Research Report No. TRP-03-113-02, Project No. SPR-3(017) – Year 9, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, February 20, 2003.

Modification of the TL-3 Temporary Barrier to Reduce Dynamic Deflection

Sicking, D.L., Reid, J.D., and Polivka, K.A., ***Deflection Limits for Temporary Concrete Barriers***, Final Report to the Midwest State's Regional Pooled Fund Program, Transportation Research Report No. TRP-03-113-02, Project No. SPR-3(017)-Years 9, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, March 11, 2002. ***MwRSF researchers are in the process of modifying the report to include additional comments provided by NDOR.*

Embankment Widening and Slopes Required for Gating Type End Terminals

Paulsen, T.J., Sicking, D.L., and Holloway, J.C., **Embankment Widening and Slopes Required for Gating Type End Terminals**, Final Report to the Midwest State's Regional Pooled Fund Program, Transportation Research Report No. TRP-03-126-02, Project No. SPR-3(017) – Year 9, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, February 7, 2003.

YEAR 10

Short Radius – Testing Phase I

The report for these two tests will be developed as a part of the next phase of this project.

Non-Proprietary Guardrail – Phase I

The report of Year 10 work will be completed along with the crash test results in the report of the Year 11 project.

W-Beam Guardrail Over Curb

Polivka, K.A., Faller, R.K., Sicking, D.L., Rohde, J.R., Reid, J.D., and Holloway, J.C., **Guardrail and Guardrail Terminals Installed Over Curbs - Phase II**, Final Report to the Midwest State's Regional Pooled Fund Program, Transportation Research Report No. TRP-03-105-00, Project No. SPR-3(017)-Year 10, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, November 5, 2001.

Guardrail Attached to Culverts

Polivka, K.A., Faller, R.K., Sicking, D.L., Rohde, J.R., Reid, J.D., and Holloway, J.C., **NCHRP 350 Development and Testing of a Guardrail Connection to Low-Fill Culverts**, Final Report to the Midwest State's Regional Pooled Fund Program, Transportation Research Report No. TRP-03-114-02, Project No. SPR-3(017)-Year 10, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, November 1, 2002.

Breakaway Luminaire Supports

Nelson, R.M., Sicking, D.L., and Polivka, K.A., **Analysis of Sign Attachments to Breakaway Luminaire Supports**, Final Report to the Midwest States' Regional Pooled Fund Program, Project No. SPR-3(017), Transportation Report No. TRP-03-122-02, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, October 23, 2002.

Three Cable Barrier on Sloped Fill

Testing of the system was completed on November 1, 2001. The system was set one foot in front of a 1.5:1 slope. The instability caused by the left side of the vehicle leaving the level ground induced a roll that caused the vehicle to roll over the top of the guardrail. From initial evaluation of the high-speed video, it is clear that slope angles substantially less than 1.5:1 would have the same effect. Note that this barrier utilized a new driven steel post anchorage system. The new anchor performed as expected, and it did not contribute to the vehicle rollover. Funding in Year 13 will be utilized to re-run this test, this test result will be reported with the result of the Year 13 test.

Note: As all of the projects in Years 9 & 10 are either complete, or pending work and reporting in subsequent years, this is the last progress report that will include them.

YEAR 11

Steel H-Beam Temporary Barrier Rail and Connections

Polivka, K.A., Bielenberg, R.W., Faller, R.K., Sicking, D.L., Rohde, J.R., Reid, J.D., and Holloway, J.C., *Development of a Steel H-Section Temporary Barrier for Use in Limited Deflection Applications*, Final Report to the Midwest State's Regional Pooled Fund Program, Transportation Research Report No. TRP-03-120-03, Project No. SPR-3(017)-Year 11, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, May 30, 2003.

Development of a Guardrail Treatment at Intersecting Roadways

A full-scale test (SR-4) was performed at a critical impact location (parallel with the transition section) with the flared system on September 19, 2002. The system stability redirected the truck, but at the point where the truck was about to exit the system, the three-beam buckled and impacted the driver's side floorboard, intruding into the occupant compartment. All other salient safety criteria were met in this test. Currently, investigation into possible solutions to the system is being undertaken. After discussion at the Annual meeting of the Pooled Fund States, it was decided to continue development of the TL-3 system. Several options discussed included further increasing the length of the system and providing additional anchorage. After significant simulation it was decided that an anchorage system similar to that being developed for the cable release system would significantly enhance the ability of the system to selectively capture or redirect a vehicle impacting near the nose section of the system. A draft report for this project through test SR-4 is currently under internal review. Continued testing of the system will utilize funding under Year 13 of the pooled fund program.

Triple-Cable Barrier End Terminal and Anchorage Assemblies

Two full-scale crash tests were performed on this system in the 3rd Quarter. The first (CT-1) was a LON test with a pickup truck to test the anchorage system. The system performed well, meeting all salient NCHRP 350 criteria, with a maximum dynamic deflection of 651 mm. The second test (CT-2) was a test of the cable release mechanism. The mechanism performed as designed by releasing the cables. However as the vehicle rolled over the system's lever arm, it dug into the soil and caused the right rear of the vehicle to vault, ultimately causing the vehicle to roll. After the data analysis, we are convinced that this system will work well, but that the release mechanism needs to be retained at the anchor plate. The new release mechanism has been fabricated and will be tested in conjunction with the 4 cable median barrier being developed. This additional test is proposed in the Year 14 proposal to the pooled fund.

Transition from Standard W-Beam Guardrail to Stiffened Bridge Transition

As discussed in the last progress report, a final design has been reviewed by the States and is constructed at the test site. If and when the rain will stop, we are planning on testing the system. Notification of the test will be sent, but currently we are anticipating the week of June 16th, 2003.

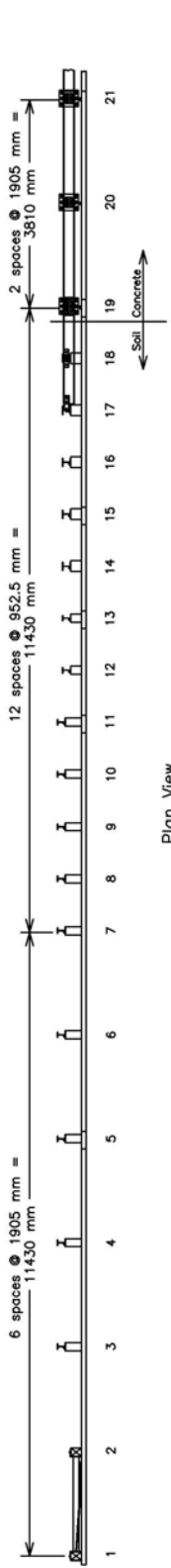
Three-Strand Cable Median Barrier (NOW 4-Cable)

Bogie testing of alternative posts and system modeling have nearly been completed. The final design is a woven 4 cable system, as pictured in the following figure. The system is currently under construction, and we anticipate testing in the second quarter or early in the third quarter of 2003.

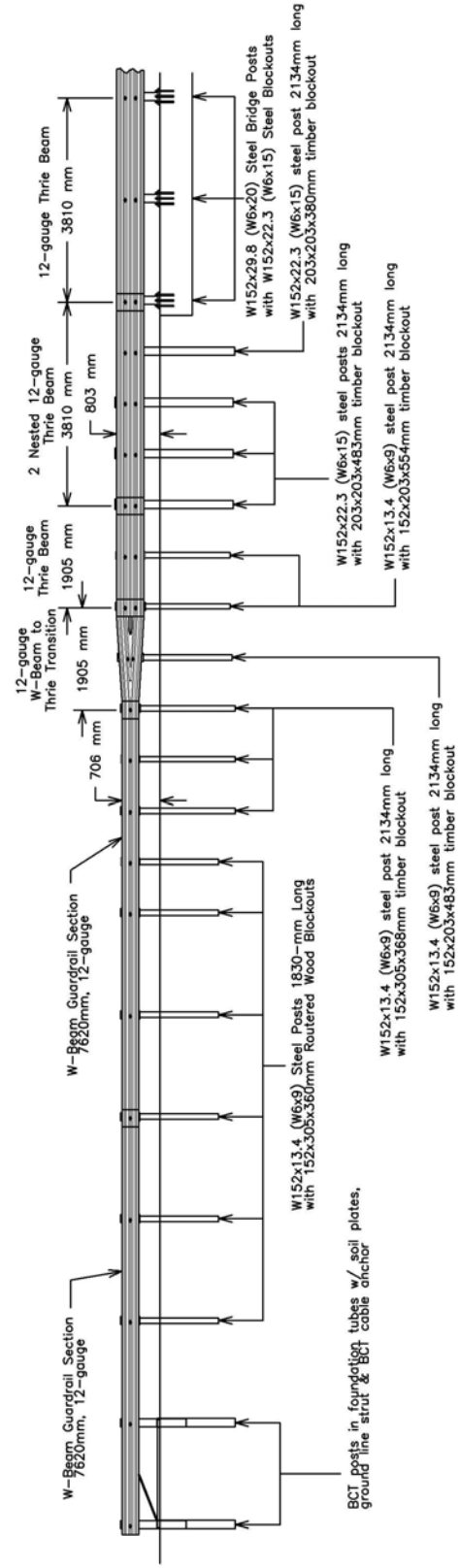
Low Profile Bridge Rail for Test Level 2 Applications

Polivka, K.A., Faller, R.K., Sicking, D.L., Rohde, J.R., Reid, J.D., and Holloway, J.C., *Development of a Low-Profile Bridge Rail for Test Level 2 Applications*, Final Report to the Midwest State's Regional Pooled Fund Program, Transportation Research Report No. TRP-03-109-02, Project No. SPR-3(017)-Year 11, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, August 20, 2002.

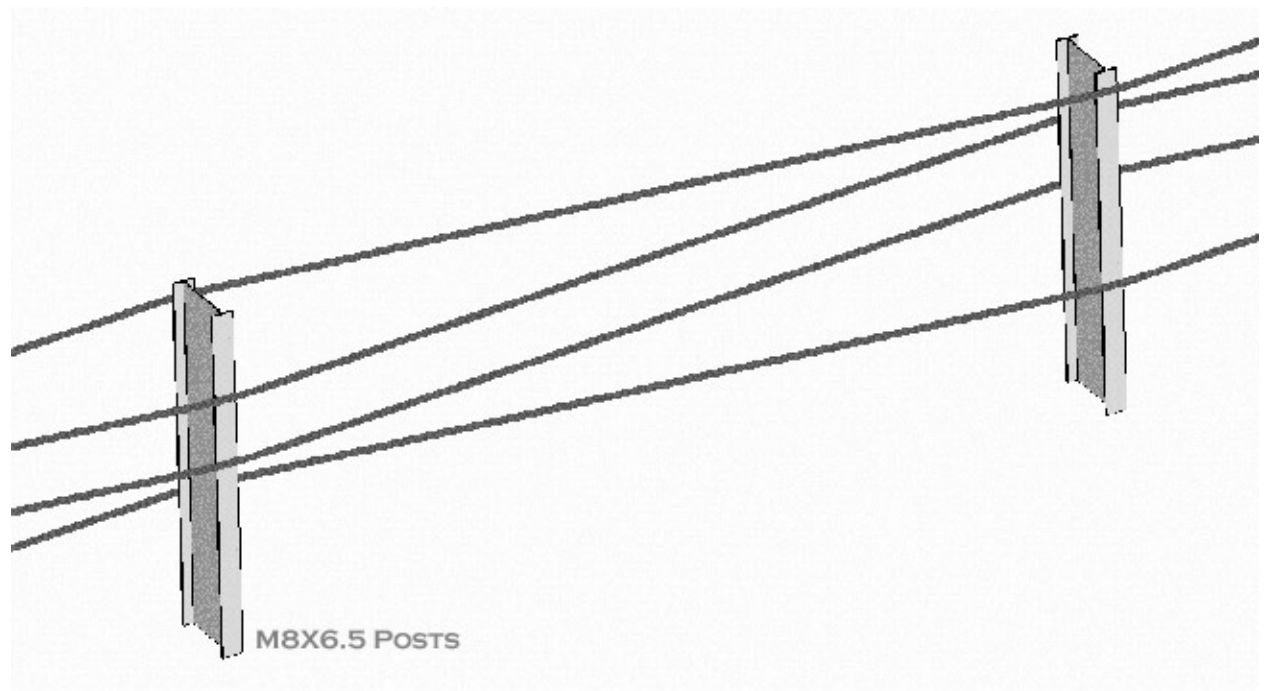
Based on a request from NDOR, MwRSF recently performed an analysis and re-design of this bridge railing system in order to include an expansion joint and small drainage slots.



Plan View



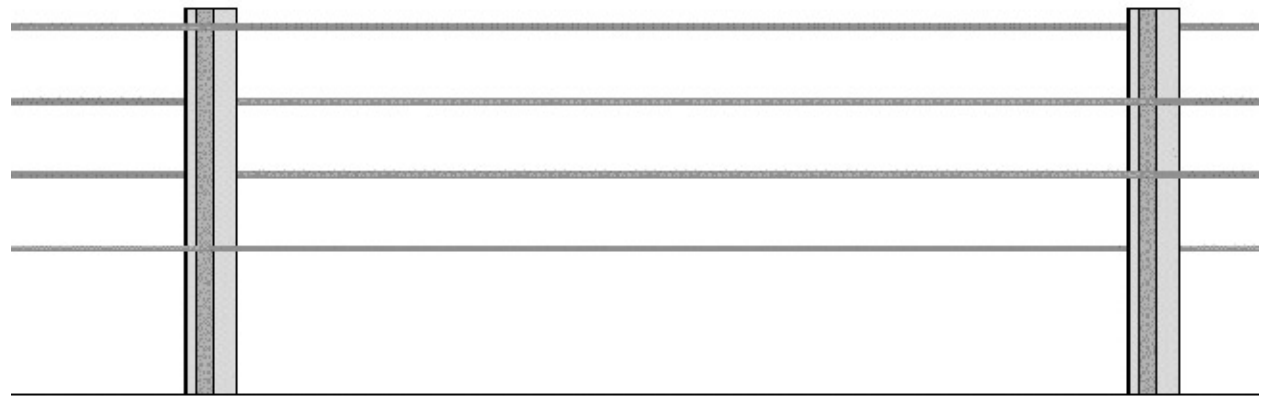
Front Elevation



PLAN VIEW



ELEVATION VIEW



YEAR 12

Non-Proprietary Steel Beam Guardrail System – Year 2

Results of this project will be reported in conjunction with Year 13 results.

Development of a Guardrail Treatment at Intersecting Roadways-Year 3

Work on this project will follow completion of work on Year 11.

Portable Aluminum Work Zone Signs

The bogie testing for this project has been completed. A submission to FHWA seeking approval has been sent. Polivka, K.A., Faller, R.K., Holloway, J.C., and Rohde, J.R., *Safety Performance Evaluation of Minnesota's Aluminum WorkZone Signs*, Final Report to the Midwest State's Regional Pooled Fund Program, Transportation Research Report No. TRP-03-107-01, Project No. SPR-3(017)-Year 11, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, January 29, 2002.

Currently, MwRSF researchers are coordinating with the MnDOT to conduct additional bogie and/or crash tests on other work-zone devices.

Single-Faced Concrete Barrier

Several steel reinforcement options were developed for the 42" and 51" heights for the ½-section safety shape parapet. Design of the barrier to foundation attachment details as well as the reporting will be completed in the 3rd quarter of 2003.

W-Beam to Thrie-Beam Transition Additional 820C Test

This test will be performed in conjunction with the Year 11 study, the test will utilize a asymmetrical w- to thrie transition. This test will be performed based on the successful completion of the test funded in Year 11.

Year 13

Generic W-Beam Guardrail with Curb

This system utilized a 6" type "B" curb, located 6" ahead of the face of the non-proprietary guardrail system. A full-scale test was performed on September 5th. The pickup was safely redirected and all salient criteria were acceptable. The maximum dynamic deflection of the system was about 40". A report for this test is anticipated in the 3rd quarter of 2003.

Open Railing Mounted on New Jersey Concrete Barrier (2'8")

The design of the railing system is currently underway. It is anticipated that a concept drawings will be sent to the States for review in the third quarter.

Evaluation of Rigid Hazards in Zone of Intrusion

The first 8000S test involving a luminaire pole mounted on the top of the barrier was performed on April 2nd, 2003. The vehicle impacted the barrier, with the impacting side climbing over the barrier so that the vehicle traveled down the barrier impacting the luminaire pole at approximately the left-front frame rail. The pole (which did not incorporate any breakaway mechanism) was separated from the mounting plate upon impact. There were no significant intrusions into the occupant compartment of the vehicle, and the pole landed adjacent to the barrier. Based on a safety assessment, this test was deemed to be a pass. Implications of the debris will of course have to be a design consideration for either median and/or bridge railing applications. Based on the results of this test as well as a discussion with the participants at the annual Pooled Fund meeting, it was decided that a TL-3 test involving a 2000P vehicle should be performed on this same system. If this test is successful, the placement of luminaire poles, similar in design to that used herein, would be shown to be compliant to current NCHRP Report 350 criteria. It is anticipated that this test will be performed in the third quarter of 2003.

Three-Cable Guardrail

We are currently evaluating several post options, as well as geometric considerations and are anticipating full scale testing in the third quarter of 2003.

Non-proprietary Guardrail System – Additional Test

The retest of the new guardrail system (NPG-4) was performed on June 14, 2002. This system utilized a 31" installation height, 12" blockouts (located off the splices), and 6' soil tubes. The system performed very well, smoothly redirecting the vehicle and all salient criteria were met. A draft report is anticipated in the third quarter of 2003. This test forms the basis of the both the curb and stiffening project in Year 13, as well as the transition projects in Years 11 and 12.

Kansas Temporary Barrier Redesign and Test

Polivka, K.A., Faller, R.K., Rohde, J.R., Holloway, J.C., Bielenberg, B.W., and Sicking, D.L., *Development and Evaluation of a Tie-Down System for the Redesigned F-shape Concrete Temporary Barrier*, Draft Report to the Midwest States Regional Pooled Fund Program, Transportation Report No. TRP-03-134-03, Project No. SPR-03(017)-Year 13, Sponsoring Agency Code RPRP-03-06, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, Lincoln, NE, June 6, 2003.

System for Stiffening New Guardrail System

The ¼-post space system was tested on October 18th, 2002. The system performed well, meeting all salient criteria. Maximum permanent set was approximately 18". A draft report for this project is anticipated in the 3rd quarter of 2003. In addition, Barrier VII computer simulation modeling is underway in order to validate the model with the full- (NPG-4) and ¼-post (NPG-6) spacing systems. Once a comparison is made, additional simulations will be performed to predict barrier performance for ½-post spacing systems.

OUTSTANDING ISSUES:

These projects from past Year's funding are still pending:

Strength Requirements for a Wood Post W-Beam Guardrail System

We have received and documented 60 red and white pine guardrail posts this quarter. It is anticipated that dynamic bogie testing of these samples will be completed late in the third quarter of 2003.

SUPPLEMENTAL PROJECTS:

Transitions and Deflection Limiting Modifications for the Kansas Type F3 Concrete Temporary Barrier

This project was initiated with two goals. First, it was necessary to develop a tie-down system to limit the deflection of the barrier system when placed on an asphalt concrete surface with some sort of restraint mechanism. Second, it was deemed necessary to transition from free standing barrier to barrier bolted to a bridge deck.

A simulation program is underway to define the necessary restraint required for adequate performance of the barrier system. As shown in the Figures below, LS-DYNA simulation is currently being undertaken to quantify the required performance of various restraint options. The current objective is to utilize the existing anchorage locations in the barrier. While the figures below show straight driven pins, it has not been determined to date if this type of system will adequately restrain the barrier system. During this quarter, a test setup to dynamically load pins driven into asphalt has been constructed, and three test sections comprising 2", 4", and 6" deep ACC have been placed at our test site. Late this quarter or early next quarter, dynamic load tests on various length and diameter pins will be undertaken to evaluate load-deflection properties. This data will be utilized in the LS-DYNA model to predict performance. It is anticipated that evaluation of these results will be forwarded to the States in the third quarter and discussion of viable options will form the basis for a full-scale test of the system.

