



U.S. Department
of Transportation
**Federal Highway
Administration**

400 Seventh St., S.W.
Washington, D.C. 20590

March 1, 2005

In Reply Refer To: HSA-10/B-133

Ronald K. Faller, Ph.D., P.E.
Research Assistant Professor
Midwest Roadside Safety Facility
P.O. Box 880601
Lincoln, NE 68588-0601

Dear Dr. Faller:

In your letter dated January 24, 2005, you requested formal Federal Highway Administration acceptance of a non-proprietary strong-post W-beam guardrail, named the Midwest Guardrail System (MGS), as an NCHRP Report 350 test level 3 (TL-3) longitudinal barrier. In support of this request, you sent copies of your September 2004 report prepared under the direction of the Midwest States' Regional Pooled Fund Program, entitled "Development of the Midwest Guardrail System (MGS) for Standard and Reduced Post Spacing and in Combination with Curbs" and video and digital films of the tests you conducted.

The MGS barrier, as shown in Enclosure 1, consists of standard 12-gauge W-beam sections installed with the top of the rail set at a nominal height of 787 mm (31 inches). Note that this drawing depicts the rail element at its recommended **maximum** height rather than at its **nominal** height. It is mounted on standard W152x13.4 steel posts that are 1829-mm (6-feet) long and set on 1905-mm (75-inch) centers. To obtain the additional rail height, each post is raised approximately 100 cm (4 inches), resulting in slightly less embedment than the posts in a standard W-beam installation. The rail is offset from these posts with 152-mm wide x 305-mm deep x 356-mm long (6-inch x 12-inch x 14-inch) wood offset blocks. For the test installation, these blocks were made from two separate blocks screwed together to obtain the design depth, but it is anticipated that production blocks will be a single piece. Routed or toenailed blocks may also be used to prevent block rotation over time, but neither feature was used in your tests. Finally, the rail splices are located at mid-span between adjacent posts rather than at each post as in a traditional W-beam installation.

The MGS barrier was tested successfully with the 820-kg car and the 2000-kg pickup truck in its standard configuration, behind a 152-mm (6-inch) AASHTO Type B curb with the pickup truck (Enclosure 2), and with a reduced post spacing of 476 mm (18.75 inches). Summaries of each test are shown on Enclosure 3. I noted that the initial test with the 820-kg car was run with the top of rail set at 813 mm (32 inches) thus establishing the maximum recommended height of the MGS to preclude wheel snagging by the small car. Since standard W-beam remains acceptable at a nominal top rail height of 686 mm (27 inches), the recommended minimum height of the MGS barrier is likewise 686 mm (27 inches). I noted also that in the test with the curb, the face of the MGS barrier was set 178 mm (7 inches) from the toe of the curb. In a separate discussion, you advised that the face of the rail could be moved forward over the toe of the curb, but advised against moving it further back without additional testing.



Using a BARRIER VII analysis calibrated from the standard and ¼ post spacing tests; you estimated the design deflection of the MGS barrier with a 953-mm (37.5-inch) or half-post spacing. From your testing and analysis, you recommended that the minimum distances at which the face of an MGS installation be placed from the face of a rigid obstacle (e.g., bridge pier or overhead sign support) be 1.25 m (49 inches), 1.12 m (44 inches), and 0.90 m (35 inches) for standard, ½, and ¼ post spacings, respectively. These offsets are based on the “working width” deflections seen in the crash tests/analysis and include some degree of pickup truck penetration beyond the vertical plane of the barrier’s dynamic deflection. As with all traffic barriers, larger offset distances would be required to shield similar features from vehicles with higher centers of gravity, such as single-unit trucks or as buses, because of the relatively high roll angles seen with these vehicles in rigid and semi-rigid barrier tests of similar height.

Based on staff review of the information you submitted, I agree that the tested designs satisfy NCHRP Report 350 evaluation criteria for a longitudinal barrier at TL-3 and that each of these designs may be used on the National Highway System. Based on your discussions with and recommendations to Mr. Richard Powers of my staff, I also agree the MGS system, in any of the configurations described herein, may be used with standard 1829-mm (6-foot) long timber posts in lieu of the tested steel post design.

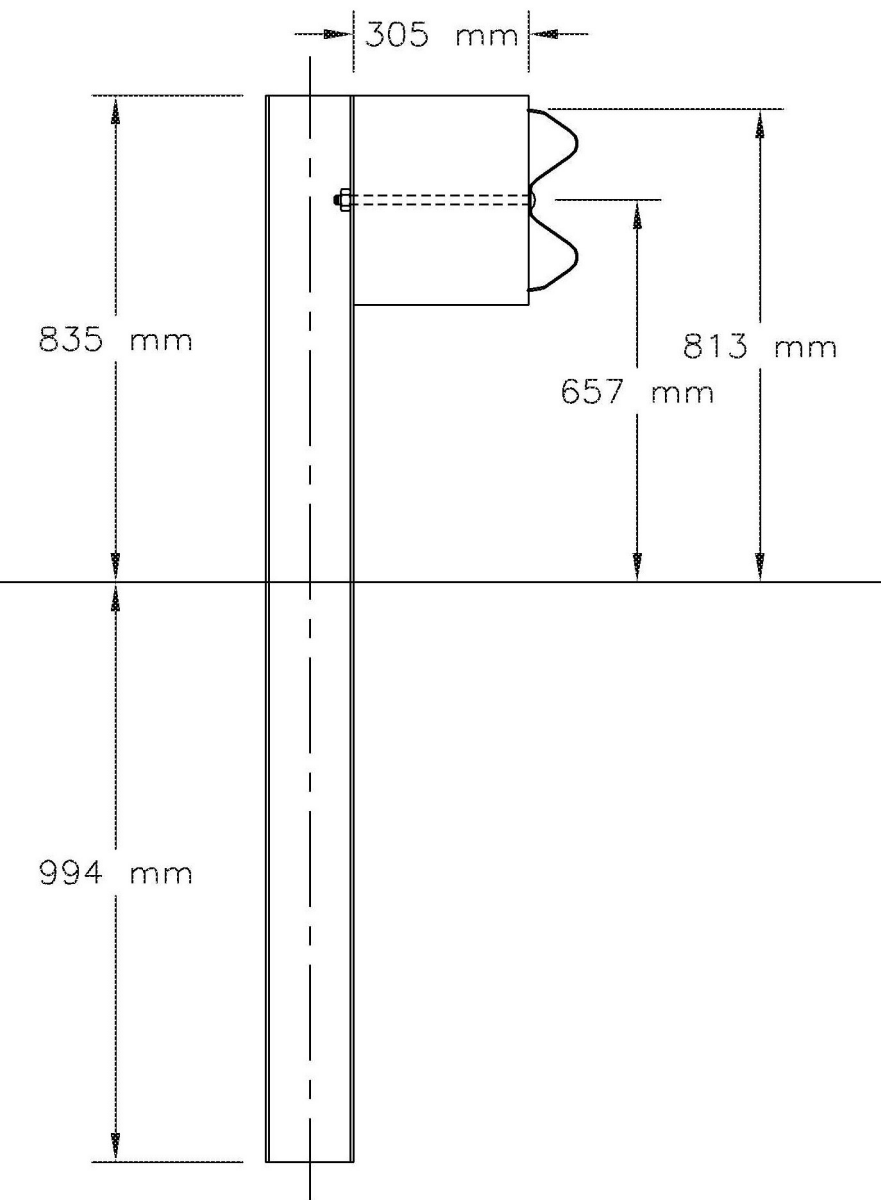
Sincerely yours,

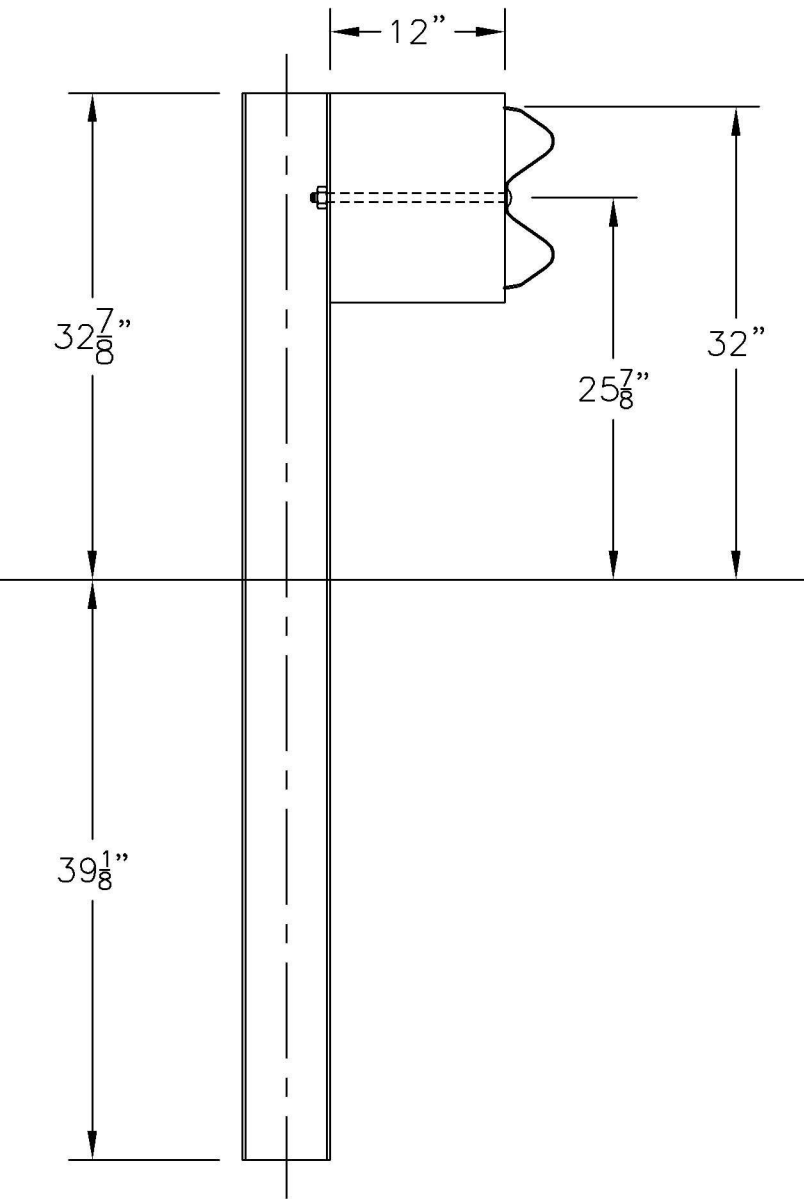
/Original Signed by Richard Powers/

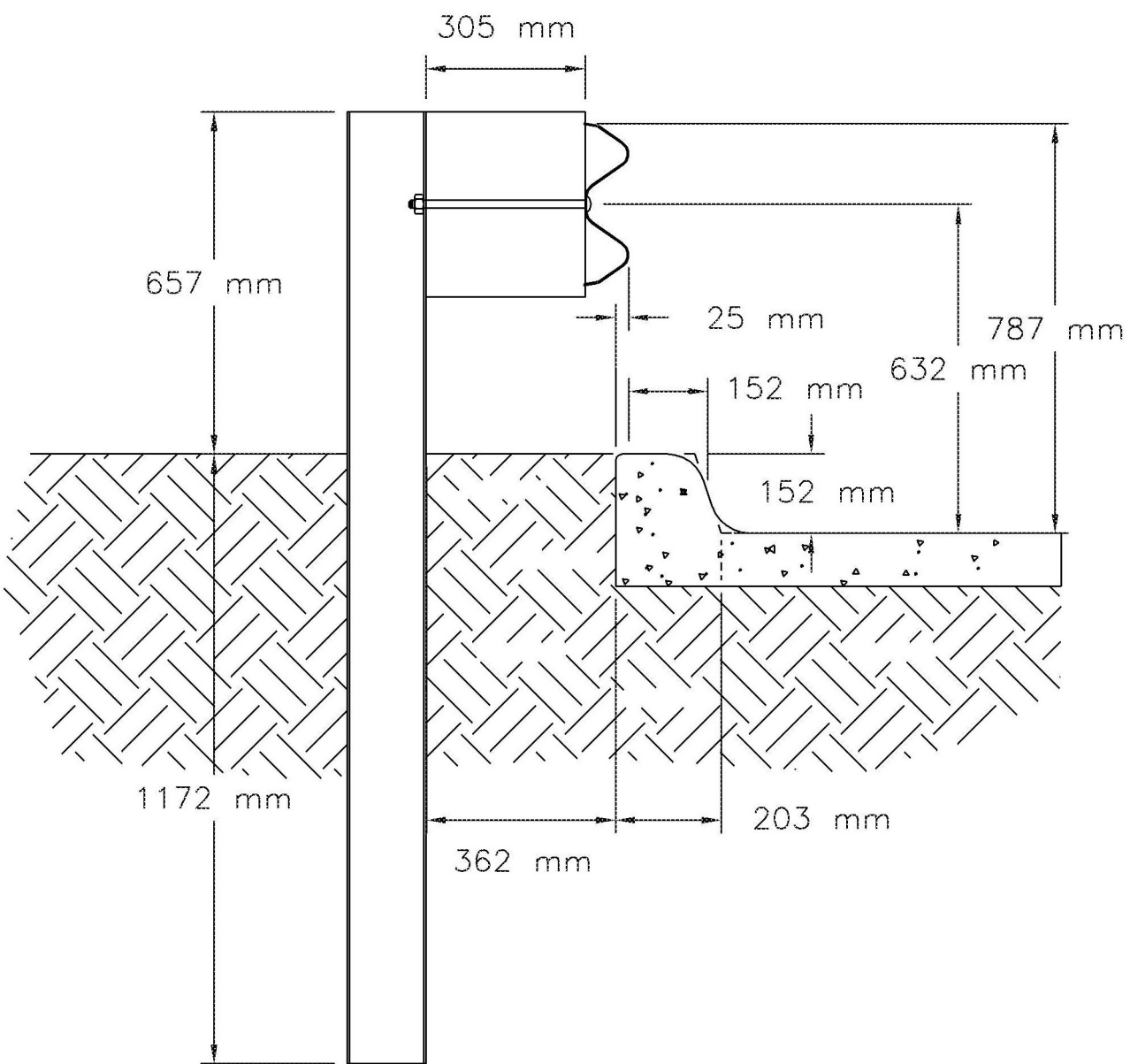
~for~

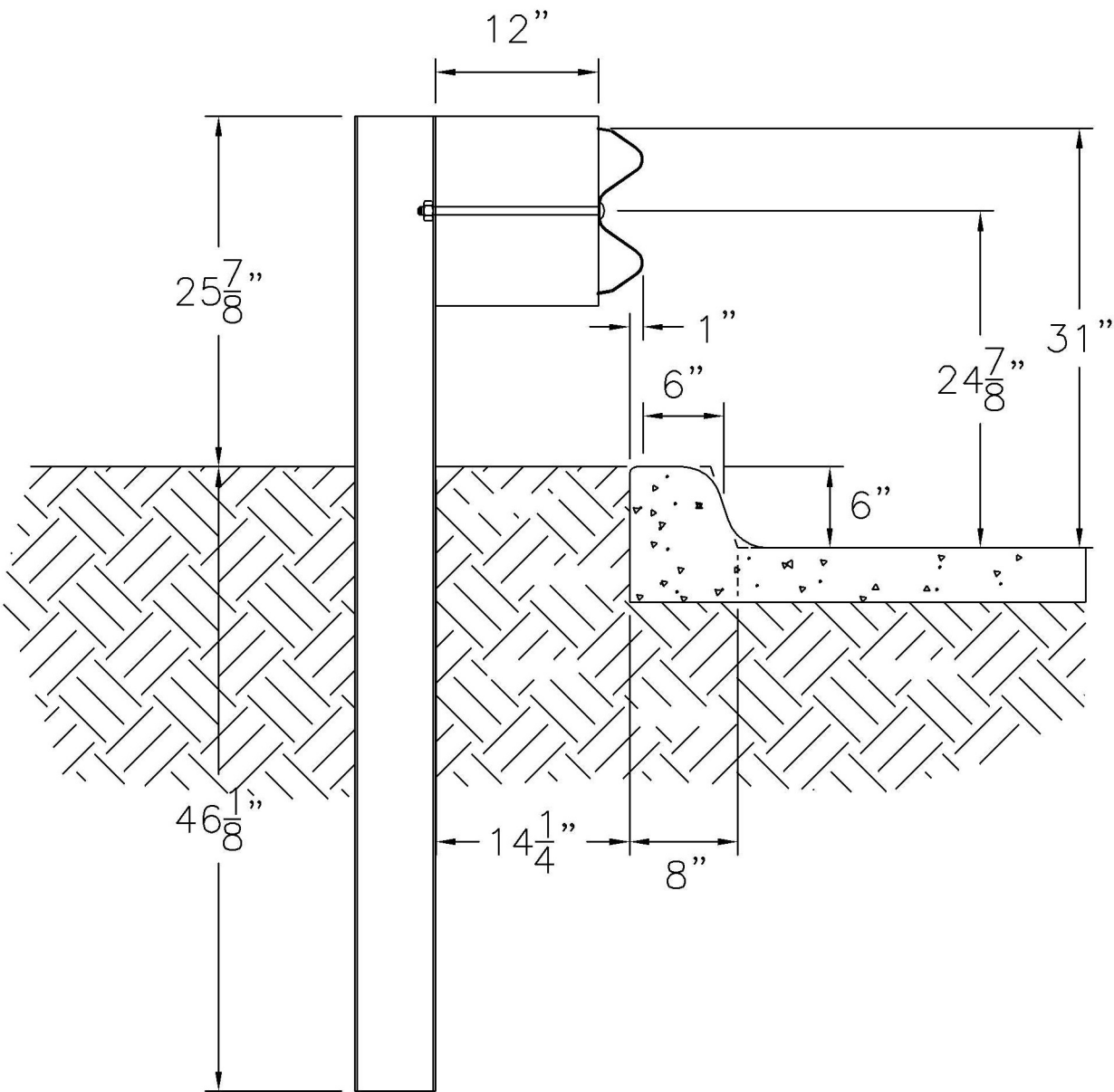
John R. Baxter, P.E.
Director, Office of Safety Design
Office of Safety

3 Enclosures











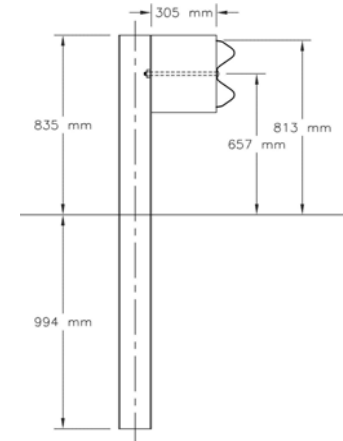
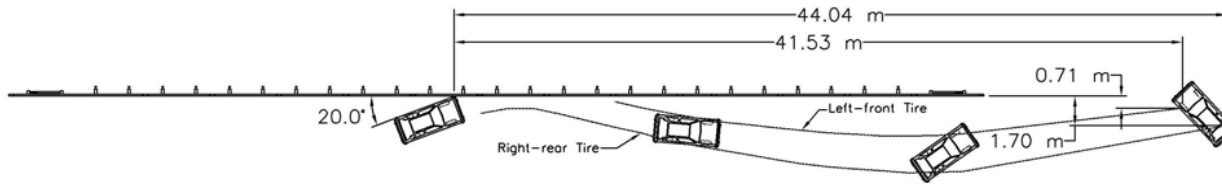
0.000 sec

0.088 sec

0.147 sec

0.189 sec

0.251 sec



72

- Test Number NPG-1
- Date 6/29/01
- Appurtenance *Midwest Guardrail System*
 - Key Elements increased mounting height, blockout depth, and bolt slot length, mid-span splices
- Total Length 55.25 m
- Steel W-beam
 - Thickness 2.66 mm
 - Top Mounting Height 813 mm
 - Bolt Slot Length 102 mm
- Steel Posts
 - Post Nos. 3 - 27 W152 x 13.4 by 1,829-mm long
 - Spacing 1,905 mm
- Wood Posts
 - Post Nos. 1 - 2, 28 - 29 (BCT) 140 mm x 190 mm by 1,080-mm long
- Wood Spacer Blocks
 - Post Nos. 3 - 27 152 mm x 305 mm by 356-mm long
- Soil Type Grading B - AASHTO M 147-65 (1990)
- Vehicle Model 1994 Geo Metro
 - Curb 746 kg
 - Test Inertial 812 kg
 - Gross Static 887 kg
- Vehicle Speed
 - Impact 102.9 km/h
 - Exit (resultant) 92.3 km/h
- Vehicle Angle
 - Impact (trajectory) 20.0 deg
 - Exit (trajectory) 9 deg
- Vehicle Stability Satisfactory
- Occupant Ridedown Deceleration (10 msec avg.)
 - Longitudinal 6.13 g's < 20 g's
 - Lateral (not required) 7.97 g's
- Occupant Impact Velocity
 - Longitudinal 3.52 m/s < 12 m/s
 - Lateral (not required) 5.68 m/s
- Vehicle Damage Moderate
 - TAD³¹ 11-LFQ-3
 - SAE³² 11LFEW3
- Vehicle Stopping Distance 41.53 m downstream
 - 0.71 m traffic-side face
- Barrier Damage Moderate
- Maximum Rail Deflections
 - Permanent Set 238 mm
 - Dynamic 443 mm
- Working Width 1,023 mm

Figure 37. Summary of Test Results and Sequential Photographs, Test NPG-1



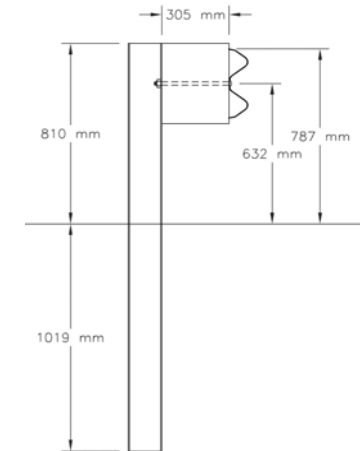
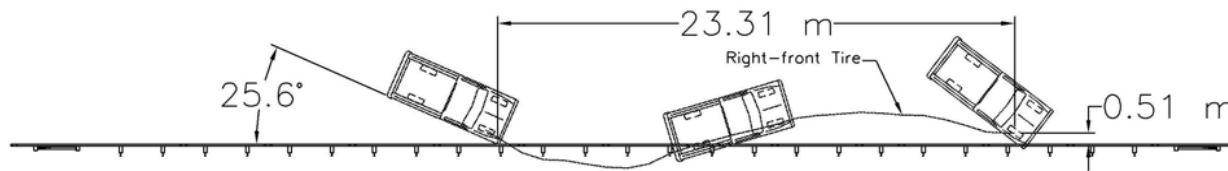
0.000 sec

0.101 sec

0.190 sec

0.323 sec

0.446 sec



141

- Test Number NPG-4
- Date 6/14/02
- Appurtenance *Midwest Guardrail System*
 - Key Elements increased mounting height, blockout depth, and foundation tube length, mid-span splices
- Total Length 55.25 m
- Steel W-beam
 - Thickness 2.66 mm
 - Top Mounting Height 787 mm
 - Bolt Slot Length 64 mm
- Steel Posts
 - Post Nos. 3 - 27 W152 x 13.4 by 1,829-mm long
 - Spacing 1,905 mm
- Wood Posts
 - Post Nos. 1 - 2, 28 - 29 (BCT) 140 mm x 190 mm by 1,080-mm long
- Steel Foundation Tube Length 1,829 mm
- Wood Spacer Blocks
 - Post Nos. 3 - 27 152 mm x 305 mm by 356-mm long
- Soil Type Grading B - AASHTO M 147-65 (1990)
- Vehicle Model 1995 GMC 2500 3/4-ton pickup
 - Curb 1,913 kg
 - Test Inertial 1,986 kg
 - Gross Static 1,986 kg
- Vehicle Speed
 - Impact 98.1 km/h
 - Exit (resultant) 55.1 km/h

- Vehicle Angle
 - Impact (trajectory) 25.6 deg
 - Exit (trajectory) 19.3 deg
- Vehicle Stability Satisfactory
- Occupant Ridedown Deceleration (10 msec avg.)
 - Longitudinal 9.50 g's < 20 g's
 - Lateral (not required) 6.94 g's
- Occupant Impact Velocity
 - Longitudinal 5.58 m/s < 12 m/s
 - Lateral (not required) 3.89 m/s
- Vehicle Damage Minimal
 - TAD³¹ 1-RFQ-4
 - SAE³² 01RFEW5
- Vehicle Stopping Distance 23.31 m downstream
 - 0.51 m traffic-side face
- Barrier Damage Moderate
- Maximum Deflections
 - Permanent Set 652 mm
 - Dynamic 1,094 mm
- Working Width 1,260 mm

Figure 87. Summary of Test Results and Sequential Photographs, Test NPG-4



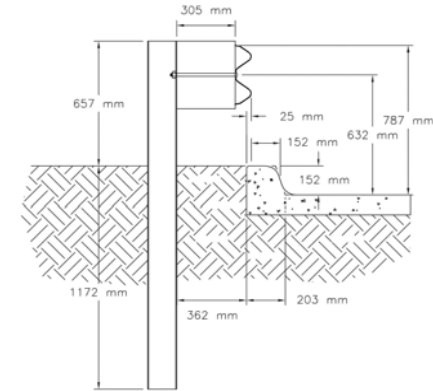
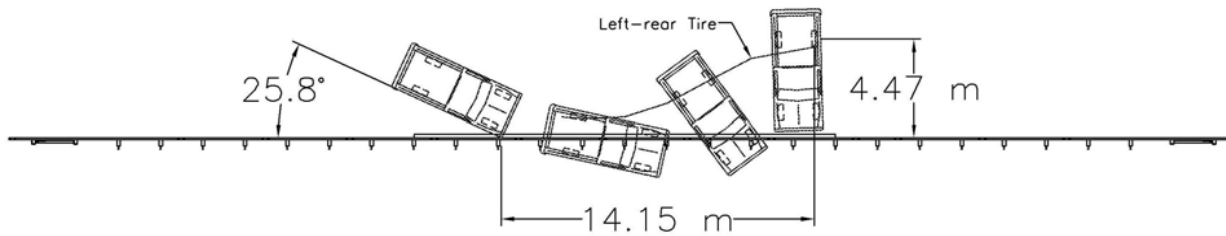
0.000 sec

0.080 sec

0.151 sec

0.237 sec

0.504 sec



196

- Test Number NPG-5
- Date 9/4/02
- Appurtenance *Midwest Guardrail System with Curb*
 - Key Elements increased mounting height, blockout depth, and foundation tube length, mid-span splices, and curb
- Total Length 55.25 m
- Steel W-beam
 - Thickness 2.66 mm
 - Top Mounting Height 787 mm
 - Bolt Slot Length 64 mm
- Steel Posts
 - Post Nos. 3 - 27 W152 x 13.4 by 1,829-mm long
 - Spacing 1,905 mm
- Wood Posts
 - Post Nos. 1 - 2, 28 - 29 (BCT) 140 mm x 190 mm by 1,080-mm long
- Steel Foundation Tube Length 1,829 mm
- Wood Spacer Blocks
 - Post Nos. 3 - 27 152 mm x 305 mm by 356-mm long
- Curb 152-mm tall Type B mounted 152 mm in front of guardrail face
- Soil Type Grading B - AASHTO M 147-65 (1990)
- Vehicle Model 1997 Chevrolet C2500 3/4-ton pickup
 - Curb 1,813 kg
 - Test Inertial 1,991 kg
 - Gross Static 1,991 kg
- Vehicle Speed
 - Impact 96.6 km/h
 - Exit (resultant) 48.0 km/h
- Vehicle Angle
 - Impact (trajectory) 25.8 deg
 - Exit (trajectory) 6.7 deg
- Vehicle Stability Satisfactory
- Occupant Ridedown Deceleration (10 msec avg.)
 - Longitudinal 10.50 g's < 20 g's
 - Lateral (not required) 8.66 g's
- Occupant Impact Velocity
 - Longitudinal 5.23 m/s < 12 m/s
 - Lateral (not required) 3.93 m/s
- Vehicle Damage Moderate
 - TAD³¹ 1-RFQ-4
 - SAE³² 01RFEW5
- Vehicle Stopping Distance 14.15 m downstream
 - 4.47 m traffic-side face
- Barrier Damage Moderate
- Maximum Deflections
 - Permanent Set 611 mm
 - Dynamic 1,024 mm
- Working Width 1,453 mm

Figure 105. Summary of Test Results and Sequential Photographs, Test NPG-5



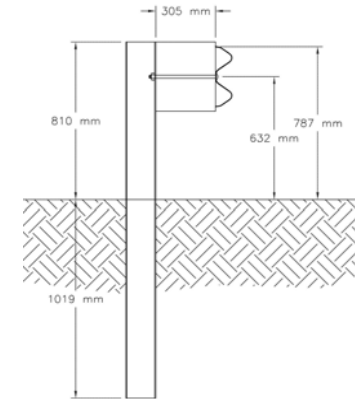
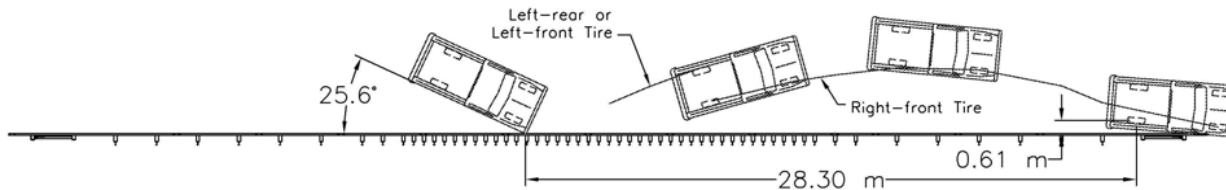
0.000 sec

0.077 sec

0.164 sec

0.295 sec

0.625 sec



191

- Test Number NPG-6
- Date 10/18/02
- Appurtenance *Midwest Guardrail System* with reduced post spacing
- Key Elements reduced post spacing, increased mounting height, blockout depth, and foundation tube length
- Total Length 55.25 m
- Steel W-beam
 - Thickness 2.66 mm
 - Top Mounting Height 787 mm
 - Bolt Slot Length 64 mm
- Steel Posts
 - Post Nos. 3 - 59 W152 x 13.4 by 1,829-mm long
- Steel Post Spacing
 - Post Nos. 3 - 8, 54 - 59 1,905 mm
 - Post Nos. 9 - 10, 52 - 53 953 mm
 - Post Nos. 11 - 51 476 mm
- Wood Posts
 - Post Nos. 1 -2, 60 - 61 (BCT) 140 mm x 190 mm by 1,080-mm long
- Steel Foundation Tube Length 1,829 mm
- Wood Spacer Blocks
 - Post Nos. 3 - 59 152 mm x 305 mm by 356-mm long
- Soil Type Grading B - AASHTO M 147-65 (1990)
- Vehicle Model 1997 GMC C2500 ¾-ton pickup
 - Curb 1,971 kg
 - Test Inertial 2,001 kg
 - Gross Static 2,001 kg

- Vehicle Speed
 - Impact 96.8 km/h
 - Exit (resultant) 59.5 km/h
- Vehicle Angle
 - Impact (trajectory) 25.6 deg
 - Exit (trajectory) 12.9 deg
- Vehicle Stability Satisfactory
- Occupant Ridedown Deceleration (10 msec avg.)
 - Longitudinal 10.67 g's < 20 g's
 - Lateral (not required) 8.97 g's
- Occupant Impact Velocity
 - Longitudinal 7.62 m/s < 12 m/s
 - Lateral (not required) 5.61 m/s
- Vehicle Damage Moderate
 - TAD³¹ 1-RFQ-5
 - SAE³² 01RYEW7
- Vehicle Stopping Distance 30.86 m downstream
0.61 m laterally
- Barrier Damage Moderate
- Maximum Deflections
 - Permanent Set 305 mm
 - Dynamic 447 mm
- Working Width 931 mm

Figure 124. Summary of Test Results and Sequential Photographs, Test NPG-6