



---

**NCHRP REPORT 350 TEST 3-11 OF THE  
WIRE ROPE BARRIER WITH MARION STEEL  
6 kg/m U-CHANNEL POSTS**

by

D. Lance Bullard, Jr., P.E.  
Associate Research Engineer

Dean C. Alberson, P.E.  
Associate Research Engineer

William F. Williams, P.E.  
Assistant Research Engineer

Wanda L. Menges  
Associate Research Specialist

and

Rebecca R. Haug  
Research Assistant

Contract No. P2002007  
Project No. 400001-MS2

Sponsored by  
**Marion Steel Company**

---

**February 2002**

**TEXAS TRANSPORTATION INSTITUTE  
THE TEXAS A & M UNIVERSITY SYSTEM  
COLLEGE STATION, TEXAS 77843**

1. Report No.		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle NCHRP REPORT 350 TEST 3-11 OF THE WIRE ROPE BARRIER WITH MARION STEEL 6 kg/m U-CHANNEL POSTS				5. Report Date February 2002	
				6. Performing Organization Code	
7. Author(s) D. Lance Bullard, Jr., Dean C. Alberson, William F. Williams, Wanda L. Menges, and Rebecca R. Haug				8. Performing Organization Report No. 400001-MSC2	
9. Performing Organization Name and Address Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135				10. Work Unit No. (TRAIS)	
				11. Contract or Grant No. P2002007	
12. Sponsoring Agency Name and Address Marion Steel Company 912 Cheney Avenue Marion, OH 43302				13. Type of Report and Period Covered Test Report June 2001 - February 2002	
				14. Sponsoring Agency Code	
15. Supplementary Notes Research Study Title: Full-Scale Crash Testing of Wire Rope Guardrail System Name of Contacting Representative: Steven J. Conway or Rick Mauer					
16. Abstract  <p>The objective of the test reported herein was to evaluate a cable guardrail system using the 6 kg/m steel U-channel post, as manufactured by Marion Steel Company, with new cable release posts and steel yielding terminal post, developed at TTI, and to determine if this system combination would reduce barrier deflections. Post spacing and cable heights were the same as previously tested systems. Therefore, the remaining issue is the capacity of the system when utilizing the new barrier terminal and the 6 kg/m steel U-channel posts. The test performed, <i>National Cooperative Highway Research Program (NCHRP) Report 350</i> test designation 3-11, involves a 2000-kg pickup truck impacting the LON of the barrier at a nominal speed and angle of 100 km/h and 25 degrees, respectively. The test is intended to evaluate the structural strength of the barrier and its ability to contain and redirect the 2000-kg pickup truck.</p> <p>The cable barrier with Marion Steel 6 kg/m U-channel posts and TTI's new terminal with cable release posts and steel yielding terminal post met the requirements for <i>NCHRP Report 350</i> test 3-11.</p>					
17. Key Words Cable barrier, guardrail, median barrier, steel post, wire rope, crash testing, roadside safety			18. Distribution Statement Copyrighted. Not to be copied or reprinted without consent from Marion Steel Company.		
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages	22. Price

## SUMMARY AND CONCLUSIONS

### ASSESSMENT OF TEST RESULTS

An assessment of the test based on the applicable *NCHRP Report 350* safety evaluation criteria is provided below.

#### **!** Structural Adequacy

- A. *Test article should contain and redirect the vehicle; the vehicle should not penetrate, underride, or override the installation although controlled lateral deflection of the test article is acceptable.*

Results: The cable barrier with Marion Steel 6 kg/m U-channel posts contained and redirected the pickup truck. Maximum dynamic deflection was 1990 mm.

#### **!** Occupant Risk

- D. *Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone. Deformation of, or intrusions into, the occupant compartment that could cause serious injuries should not be permitted.*

Results: The detached posts did not penetrate, nor show potential for penetrating the occupant compartment, nor did they present undue hazard for others in the area. Maximum occupant compartment deformation was 7 mm in the lower kickpanel area.

- F. *The vehicle should remain upright during and after collision although moderate roll, pitching, and yawing are acceptable.*

Results: The pickup truck remained upright during and after the collision period.

**! Vehicle Trajectory**

- K. *After collision, it is preferable that the vehicle's trajectory not intrude into adjacent traffic lanes.*

Results: The vehicle came to rest entrapped between the cables of the barrier and did not intrude into adjacent traffic lanes.

- L. *The occupant impact velocity in the longitudinal direction should not exceed 12 m/s and the occupant ridedown acceleration in the longitudinal direction should not exceed 20 G's.*

Results: Longitudinal occupant impact velocity was 3.0 m/s and longitudinal ridedown acceleration was -6.0 g's.

- M. *The exit angle from the test article preferably should be less than 60 percent of the test impact angle, measured at time of vehicle loss of contact with the test device.*

Results: The pickup became entrapped between the cables and did not lose contact with the installation.

The following supplemental evaluation factors and terminology, as presented in the FHWA memo entitled "Action: Identifying Acceptable Highway Safety Features," were used for visual assessment of test results:

**◆ PASSENGER COMPARTMENT INTRUSION**

**1. Windshield Intrusion**

- |  |  |
|--|--|
| a. <u>No windshield contact</u>                            | e. Complete intrusion into passenger compartment |
| b. Windshield contact, no damage                           | f. Partial intrusion into passenger compartment  |
| c. Windshield contact, no intrusion                        |  |
| d. Device embedded in windshield, no significant intrusion |  |

**2. Body Panel Intrusion**

yes or no

- ◆ **LOSS OF VEHICLE CONTROL**
  1. Physical loss of control
  2. Loss of windshield visibility
  3. Perceived threat to other vehicles
  4. Debris on pavement

- ◆ **PHYSICAL THREAT TO WORKERS OR OTHER VEHICLES**
  1. Harmful debris that could injure workers or others in the area
  2. Harmful debris that could injure occupants in other vehicles

The detached posts did not pose a threat to others in the area.

- ◆ **VEHICLE AND DEVICE CONDITION**

**1. Vehicle Damage**

- |                                      |  |
|--------------------------------------|--|
| a. None                              | d. <u>Major dents to grill and body panels</u> |
| b. Minor scrapes, scratches or dents | e. Major structural damage                     |
| c. Significant cosmetic dents        |  |

**2. Windshield Damage**

- |  |   |
|--|---|
| a. <u>None</u>   | e. Shattered, remained intact but partially dislodged |
| b. Minor chip or crack   | f. Large portion removed                              |
| c. Broken, no interference with visibility                         | g. Completely removed                                 |
| d. Broken and shattered, visibility restricted but remained intact |   |

**3. Device Damage**

- |   |  |
|---|--|
| a. None                                 | d. <u>Substantial, replacement parts needed for repair</u> |
| b. Superficial                          | e. Cannot be repaired                                      |
| c. Substantial, but can be straightened |  |

**CONCLUSIONS**

The cable barrier with Marion Steel 6 kg/m U-channel posts and new steel breakaway terminal posts met the requirements for *NCHRP Report 350* test 3-11, as shown in table 1.



Table 1. Performance evaluation summary for test 400001-MSC2, *NCHRP Report 350* test 3-11.

Test Agency: Texas Transportation Institute

Test No.: 400001-MSC2

Test Date: 11/12/2001

<b><i>NCHRP Report 350</i> Evaluation Criteria</b>	<b>Test Results</b>	<b>Assessment</b>
<p><b><u>Structural Adequacy</u></b></p> <p>A. Test article should contain and redirect the vehicle; the vehicle should not penetrate, underide, or override the installation although controlled lateral deflection of the test article is acceptable.</p>	<p>The cable barrier with Marion Steel 6 kg/m U-channel posts contained and redirected the pickup truck. Maximum dynamic deflection was 1990 mm.</p>	<p>Pass</p>
<p><b><u>Occupant Risk</u></b></p> <p>D. Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone. Deformations of, or intrusions into, the occupant compartment that could cause serious injuries should not be permitted.</p>	<p>The detached posts did not penetrate, nor show potential for penetrating the occupant compartment, nor did they present undue hazard for others in the area. Maximum occupant compartment deformation was 7 mm in the lower kickpanel area.</p>	<p>Pass</p>
<p>F. The vehicle should remain upright during and after collision although moderate roll, pitching, and yawing are acceptable.</p>	<p>The pickup truck remained upright during and after the collision period.</p>	<p>Pass</p>
<p><b><u>Vehicle Trajectory</u></b></p> <p>K. After collision, it is preferable that the vehicle's trajectory not intrude into adjacent traffic lanes.</p>	<p>The vehicle came to rest entrapped between the cables of the barrier and did not intrude into adjacent traffic lanes.</p>	<p>Pass*</p>
<p>L. The occupant impact velocity in the longitudinal direction should not exceed 12 m/s and the occupant ridedown acceleration in the longitudinal direction should not exceed 20 g's.</p>	<p>Longitudinal occupant impact velocity was 3.0 m/s and longitudinal ridedown acceleration was -6.0 g's.</p>	<p>Pass</p>
<p>M. The exit angle from the test article preferably should be less than 60 percent of test impact angle, measured at time of vehicle loss of contact with test device.</p>	<p>The pickup became entrapped between the cables and did not lose contact with the installation.</p>	<p>Pass*</p>

\*Criterion K and M are preferable, not required.