

**NCHRP REPORT 350 UPDATE, TEST 3-11
FULL-SCALE CRASH EVALUATION
OF A MOBILE BARRIER TRAILER,
REPORT REVISION 1**

NCHRP Report 350 Update, Test 3-11

**SwRI® Test No.
MBT-1**

SwRI® Project No. 18.13922, REV1

**By:
Steve Gomez-Leon, P.E.
Southwest Research Institute®**

**For:
Mobile Barriers LLC
24918 Genesee Trail Road,
Golden, Colorado 80401**



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April, 2008



APPROVED:

A handwritten signature in black ink, appearing to read 'Dan Pomerening', is written over a horizontal line.

**Dan Pomerening, Manager
Dynamics, Acoustics, and Reliability Engineering**

REVISION HISTORY		
Revision No.	Date	Description
1	03/18/2009	<p>Correct an incorrect statement about the construction of the Mobile Barrier Trailer. Correction is third sentence of the fifth paragraph of Section 2.2.</p> <p>Original statement: Three evenly spaced 254 x 102 x 6.4 mm (10 x 4 x 0.25 in) beams frame the outer wall (254 mm (10 in) vertical configuration – 228 mm (9 in) vertical spacing), over which a homogenous 6.4 mm (0.25 in) steel plate is attached.</p> <p>New statement: Three evenly spaced beams frame the outer wall (254 x 102 x 6.4 mm (10 x 4 x 0.25 in), 203 x 102 x 6.4 mm (8 x 4 x 0.25 in) and 203 x 102 x 9.5 mm (8 x 4 x 0.375 in), respectively top to bottom – 254 mm (10 in) vertical spacing), over which a homogenous 6.4 mm (0.25 in) steel plate is attached.</p>

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1.0 INTRODUCTION

The purpose of this test was to evaluate the performance of a Mobile Barrier Trailer manufactured by Mobile Barriers LLC. To test the performance of this barrier, a Test-Level-3, Test 3-11 was conducted from the National Cooperative Highway Research Program (NCHRP), Report 350 Update document. The test was identified as test MBT-1.

According to NCHRP Report 350 Update, Test 3-11 is intended to evaluate the strength of the barrier in containing and redirecting a 2270P test vehicle. The test, as prescribed in NCHRP Report 350 Update, consists of a 2270 kg pickup truck impacting the barrier at 100 km/hr at a 25-degree angle.

Crash test MBT-1 was conducted at a testing area located at Southwest Research Institute® (SwRI®) in San Antonio, Texas on April 3, 2008. This report presents information on the test parameters, a discussion of the test, and an assessment of the test results based on the criteria set forth in NCHRP Report 350 Update.

2.0 TEST PARAMETERS

2.1 *Test Facility*

The investigation was performed by Southwest Research Institute® (SwRI®) under the supervision of Mr. Steve Gomez-Leon, P.E. The testing was performed at a crash test facility on the SwRI grounds in San Antonio, Texas. Southwest Research Institute is located at the following address:

SOUTHWEST RESEARCH INSTITUTE
6220 Culebra Road
PO Box 28510
San Antonio, Texas 78228-0510

2.2 *Test Article*

The Mobile Barrier Trailer (MBT) is an integrated, rigid wall, semi-trailer that is used in conjunction with standard semi-tractors to provide mobile, improved, safety, and work environments for personnel at applicable maintenance, construction, and security sites. In interstate construction it provides mobile protected work zones. In airports and other environments it provides mobile entrance barriers, mobile areas for vehicular inspections, temporary areas for chaining up trucks and preparing equipment, etc. With optional configurations, it can serve as a mobile blast fence and can be adopted for numerous other purposes.

In the context of interstate construction, the MBT is specifically designed to reduce work zone incursions by passing traffic (fore, aft and side protection), to reduce the number of collateral vehicles and equipment needed at and within the work zone, and to improve lighting and ambient conditions. Essentially, the trailer is an extended, mobile, longitudinal barrier that provides a physical and visual wall between passing traffic and the maintenance and construction personnel. With integrated crash attenuation at the rear, a semi-tractor at the front, and a rigid wall on the side toward passing traffic, the Mobile Barrier Trailer will provide approximately 30.5 m (100 ft) of barrier and protected work area.

The MBT comes complete with integrated power, directional lighting, message board, safety lighting, work lighting, storage and supply areas, platforms, and other features intended to reduce the number of collateral vehicles and equipment typically needed on site. The MBT's design allows for relatively easy visual inspection, repair, and modular replacement in the case of an incident. One or more sections of the wall (each measuring 6.10 m (20 ft)) can be removed for shortened configurations and/or high speed transport. The MBT can be used to provide protected areas to either the right or the left side of the road depending on which end of the trailer the semi-tractor is attached.

The basic trailer is comprised of two platforms and up to three wall sections. Each of the platforms and wall sections are approximately 6.10 m (20 ft) in length. A standard semi-tractor can be attached at either end. The rear axle assembly ("caboose") attaches to the end opposite the tractor. An NCHRP 350 tested and approved truck mounted attenuator (TMA) must be used with the trailer and attached to the caboose. A 19.1 mm (0.75 in) plate for mounting the attenuator is provided at the rear of the caboose. The plate on the initial unit is configured for Traffix Devices Inc.'s Scorpion TMA per the client's request. Plate configurations for other TMA designs can be provided. The attenuation plate is welded directly to the 305 x 102 x 10 mm (12 x 4 x 0.375 in) main structural beams in the caboose.

The platforms are each 6.4 m (21 ft) in overall length, 2.54 m (100 in) wide and 1.22 m (4 ft) high (riding approximately 1.52 m (5 ft) high with 305 mm (12 in) of ground clearance). The platforms are framed with 254 x 102 mm (10 x 4 in) steel tube in a combination of 6.4 mm (0.25 in) and 9.5 mm (0.375 in) thicknesses. Three evenly spaced beams frame the outer wall (254 x 102 x 6.4 mm (10 x 4 x 0.25 in), 203 x 102 x 6.4 mm (8 x 4 x 0.25 in) and 203 x 102 x 9.5 mm (8 x 4 x 0.375 in), respectively top to bottom – 254 mm (10 in) vertical spacing), over which a homogenous 6.4 mm (0.25 in) steel plate is attached. An offset 635 x 1168 x 19 mm (25 x 46 x 0.75 in) steel end plate at the narrow end of the platforms provides connectivity for the wall sections. All aforesaid attachments are by permanent welds. Wall sections are bolted to the end plates and to each other with twelve 1 in diameter x 3 in long fine thread Grade 8 bolts. Internal cross bracing and support is provided, including for kingpin, storage, decking, and other associated functionality.

The wall sections are each 6.10 m (20 ft) long, 610 mm (24 in) wide, and 1.22 m (4 ft) high (riding approximately 1.52 m (5 ft) high with 305 mm (12 in) of ground clearance). The walls are framed with six evenly spaced 102 x 152 x 6.4 mm (4 x 6 x 0.25 in) steel tube (three to the outside, three to the inside – 102 mm (4 in) vertical configuration – 432 mm (17 in) vertical spacing). A 64 x 127 x 64 mm (2.5 x 5 x 2.5 in) (254 mm (10 in) flat bent with 64 mm (2.5 in) sides), rides between the two lower outer beams. Internal bracing includes two evenly spaced full size mid plates (610 x 1168 x 6.4 mm (24 x 46 x 0.25 in)), three half height mid plates (610 x 635 x 6.4 mm (24 x 25 x 0.25 in)) and a series of 64 x 64 x 6.4 mm (2.5 x 2.5 x 0.25 in) latticed cross bracing. 610 x 1168 x 19 mm (24 x 46 x 0.75 in) end plates provide connectivity to the platforms and other wall sections. A homogenous 6.4 mm (0.25 in) steel plate is welded to cover the outer side of each wall section. Each wall section abuts up against another of the platforms and is built the same to take an impact from either direction. There are no snag points at the seams. The outer 6.4 mm (0.25 in) plate and associated welds are ground beveled to transition from one to the other.

Figure 2.1 through Figure 2.8 present photographs of the Mobile Barrier Trailer. Drawings of the trailer, as provided by Mobile Barriers LLC, are presented in Appendix A.



Figure 2.1 – Mobile Barrier Trailer (Fully Assembled)



Figure 2.2 – Mobile Barrier Trailer (Assembled Top View)



Figure 2.3 – Mobile Barrier Trailer – Disassembled with Wall Panels Removed for High Speed Transport



Figure 2.4 – Assembly Process of Wall Panels



Figure 2.5 – Wall Panel Being Attached to another Wall Panel with Twelve Bolts (Unconnected Hydraulic and Electrical Lines are Also Shown)



Figure 2.6 – Forward Platform (Front and Rear View)



Figure 2.7 – Rear Platform (Front and Rear View)



Figure 2.8 – Wall Panels (Front and Rear Views)

2.3 Test Vehicle

The test vehicle was a 2002 Dodge Ram 1500 Quad Cab pickup truck. An anthropometric dummy was not required for this test and, thus, was not used. The gross vehicle weight, including the weight of instrumentation and all towing and guidance hardware, was 2,329 kg (5,135 lbs). The vehicle data sheet is provided in Appendix B. Figure 2.9 shows a photograph of the test vehicle. Figure 2.10 shows the test vehicle positioned at the impact point of the longitudinal barrier, showing the relationship between the height of the vehicle and the longitudinal barrier. Figure 2.11 shows an overhead view of the test vehicle positioned at the intended impact point of the Mobile Barrier Trailer.



Figure 2.9 – Test Vehicle



Figure 2.10 – Test Vehicle Bumper Height



Figure 2.11 – Overhead View of Test Vehicle Impact Angle

2.3.1 Test Vehicle Guidance

To navigate the test vehicle, the unmanned vehicle was towed into the barrier by a series of pulleys and sheaves. A steel cable was attached to a quick-release pin under the front of the vehicle and was passed around a sheave and secured to the rear of a tow vehicle. The tow vehicle was equipped with an adjustable ignition restrictor that attenuated the tow vehicle engine RPM when a pre-set speed was attained. The test vehicle was guided by means of a steel cable, which ran parallel to the impact path of the test vehicle. The steel guide cable was attached to a sliding shoe that was attached to the front spindle of the test vehicle for steering guidance. Just prior to impact, the sliding shoe and tow cable were stripped from the vehicle, and the test vehicle was allowed to free wheel into the barrier in an untethered condition.

2.3.2 Test Vehicle Data Acquisition

The data acquisition consisted of recording the acceleration and angular velocities of the test vehicle. The measurement of these two parameters allowed SwRI engineers to perform an occupant risk assessment. The device used to record the vehicle acceleration and angular velocities was an Instrumented Sensor Technology's Panther EDR-4 recorder unit.

The EDR-4 recorder unit is a compact package used for stand-alone recording of shock and vibration. The unit is able to record six channels of data. For the crash tests, three channels were reserved for acceleration data and three channels were reserved for angular velocity data. The three acceleration channels were recorded from a built-in triaxial accelerometer used to record the test vehicle's accelerations in three orthogonal directions (x , y , and z) and the three angular velocity

channels were recorded from built-in turn-rate transducers to record the test vehicle's turn rates in three orthogonal directions (roll, pitch, and yaw).

The data acquisition package was rigidly attached to the test vehicle. To do this, a metal bracket was welded onto the test vehicle's body. This bracket was attached inside the passenger compartment of the vehicle, as close as possible to the vehicle's center of gravity, without significantly modifying the vehicle's interior components (i.e., center console, bench seats). Because of the bench seats, the data acquisition bracket was mounted 0.11 m (4.3 in) forward of the center of gravity. The data acquisition package was then bolted to the metal bracket that was welded onto the vehicle and oriented within the vehicle so the data collected complied with the sign convention given in NCHRP Report 350 Update. The sign convention is as follows:

X:	Positive in the normal forward motion direction
Y:	Positive toward the right
Z:	Positive vertically downward
ROLL:	Positive using right hand rule about +X direction
PITCH:	Positive using right hand rule about +Y direction
YAW:	Positive using right hand rule about +Z direction

The EDR-4 recorder unit was configured with a sample rate of 1920 samples per second (per channel), and with a low pass filter setting of SAE Class 180 filtering. After the data had been downloaded from the data acquisition package, the data was processed using Test Risk Assessment Program (TRAP) Version 2.1, (Texas Transportation Institute and Capsher Technology, Inc.). The TRAP program was designed to determine the effectiveness of a roadside safety feature by analyzing data from a vehicle crash test of the feature and calculating standardized occupant risk factors. TRAP calculates occupant risk factors in accordance with the NCHRP Report 350 Update guidelines.

2.4 Soil Conditions

The test item was a mobile barrier trailer. The trailer was mounted on concrete for the test, thus the soil conditions were not a factor for this particular test. The concrete surface was dry at the time of the impact test.

3.0 TEST CONDITIONS AND RESULTS

3.1 Test Description

The purpose of this test was to evaluate the performance of a Mobile Barrier Trailer manufactured by Mobile Barriers LLC. To test the performance of this barrier, a Test-Level-3, Test 3-11 was conducted from the National Cooperative Highway Research Program (NCHRP), Report 350 Update document. The test was identified as test MBT-1.

According to NCHRP Report 350 Update, Test 3-11 is intended to evaluate the strength of the barrier in containing and redirecting a 2270P test vehicle. The test, as prescribed in NCHRP Report 350 Update, consists of a 2270 kg pickup truck impacting the barrier at 100 km/hr at a 25-degree angle.

The weather on the day of the test was overcast, with temperatures ranging from 20 to 29 degrees Celsius (67 to 84 degrees Fahrenheit). The temperature at the time of the test was 25 degrees Celsius (77 degrees Fahrenheit). The test was performed with the test article parked on a concrete surface; thus, soil conditions do not apply to this test. The concrete was dry at the time of impact.

3.2 Impact Description

Sequential photographs, shown in Figure 3.1 through Figure 3.3, show that the test vehicle impacted the mobile barrier trailer 0.51 m (1.67 ft) upstream of the joint connecting the second and third barrier section (the barrier platform is referred to as the first barrier section and the first wall panel as referred to as the second barrier section, etc) at 23.5 degrees, and laterally deflected the barrier 0.61 m (2.0 ft) (dynamically). Impact velocity of the test vehicle was measured using high-speed film analysis, and was determined to be 102.3 km/hr (63.6 mph).

For a nominal Test 3-11 test, the nominal impact severity for a 2270 kg vehicle impacting a barrier at 100 km/hr at 25 degrees is 156.4 KJ. The actual impact severity of Test MBT-1 was 149.6 kJ, a deviation of -6.8 kJ from the nominal impact severity recommended in NCHRP Report 350 Update.

$$\text{Impact Severity} = 0.5 M (V \sin \Theta)^2 = 0.5 (2329 \text{ kg}) [(28.42 \text{ m/s}) \sin (23.5)]^2 = 149.6 \text{ kJ}$$

The redirection measurements are shown in Table 3.1. The redirection measurements were determined by measuring the location of the driver side front-tire tracks in relation to the original plane (impact side) of the longitudinal barrier. The contact length along the barrier during impact was approximately 18.8 m (61.7 ft).



Time = 0.000 seconds (Impact)



Time = 0.050 seconds



Time = 0.100 seconds



Time = 0.150 seconds



Time = 0.200 seconds



Time = 0.250 seconds



Time = 0.300 seconds



Time = 0.350 seconds



Time = 0.400 seconds

Figure 3.1 – Sequential Photographs, as Viewed from Overhead



Time = 0.000 seconds (Impact)



Time = 0.100 seconds



Time = 0.200 seconds



Time = 0.300 seconds



Time = 0.400 seconds



Time = 0.500 seconds



Time = 0.600 seconds



Time = 0.700 seconds



Time = 0.800 seconds

Figure 3.2 – Sequential Photographs, as Viewed from Upstream



Time = 0.000 seconds (Impact)



Time = 0.100 seconds



Time = 0.200 seconds



Time = 0.300 seconds



Time = 0.400 seconds



Time = 0.500 seconds



Time = 1.000 seconds



Time = 1.500 seconds



Time = 2.000 seconds

Figure 3.3 – Sequential Photographs, as Viewed from Downstream

Table 3.1 – Redirection of Test Vehicle

Measurement Location (measured from start of trailer)	Redirection (+ indicates lateral translation into barrier)
11.7 m (38.3 ft)	0 cm (0 in)
12.2 m (40.0 ft)	5 cm (2 in)
14.2 m (46.7 ft)	23 cm (9 in)
16.3 m (53.3 ft)	31 cm (12 in)
18.3 m (60.0 ft)	25 cm (10 in)
20.3 m (66.7 ft)	20 cm (8 in)
22.4 m (73.3 ft)	15 cm (6 in)
24.4 m (80.0 ft)	10 cm (4 in)
26.4 m (86.7 ft)	5 cm (2 in)
28.4 m (93.3 ft)	0 cm (0 in)
30.5 m (100.0 ft)	0 cm (0 in)
Location where Test Vehicle Came to Rest	
69.3 m (227.5 ft)	9.1 m (30 ft)

After processing the data gathered from the onboard data acquisition system, it was determined that the test vehicle experienced a maximum 50 millisecond moving average acceleration of -6.5 g's in the longitudinal direction, 11.3 g's in the lateral direction, and -3.0 g's in the vertical direction. Occupant risk factors were determined to be an impact velocity of 4.0 m/s in the longitudinal direction, and -6.4 m/s in the lateral direction; and a ridedown acceleration of -7.9 g's in the longitudinal direction, and 11.1 g's in the lateral direction. In Appendix C, Table C.1 presents a summary of the data gathered from the onboard data acquisition system, and Figures C.1 through C.5 provide plots of the accelerometer and angular velocity transducers.

3.3 Barrier Damage

When the test vehicle impacted the Mobile Barrier Trailer, the test vehicle dynamically deflected the barrier 0.61 m (2.0 ft). Figure 3.4 through Figure 3.12 show pictures of the barrier after being impacted by the test vehicle. The mobile barrier trailer experienced minimal damage. Structurally, the barrier did not experience any structural damage. All the steel beams and plates which comprise the Mobile Barrier Trailer were undamaged and none of the welds failed. The only evident structural deformation was of the plates making up the mating surfaces of the wall section joints. The joint plates plastically deformed slightly (as shown in Figure 3.9 to Figure 3.12), but not to a degree that would affect the performance or the assembly of the Mobile Barrier Trailer.

The wall plates on the outer surface of the wall section did not experience any structural damage. The wall plates were not torn, punctured, or gouged. The test vehicle did not snag the wall panels and the vehicle impact did not create any snag points for future vehicle impacts. The only evident damage to the wall plates was aesthetic, where the test vehicle's paint and tires made marks on the barrier. The wheels scratched the barrier, but the wall panels remained smooth. Table 3.2 summarizes the damage sustained by the test article.

After the crash test, the Mobile Barrier Trailer was disassembled to transport back to Mobile Barriers, LLC's facility. The Mobile Barrier Trailer was disassembled easily without any problems

resulting from the crash test (or for any other reason). Once the wall panels were removed, the front and rear platforms were connected easily and the wall panels were packed onto the platforms. Once assembled for transport, the barrier was pulled by the semi-tractor without any difficulty.



Figure 3.4 – Mobile Barrier Trailer after the Crash Test

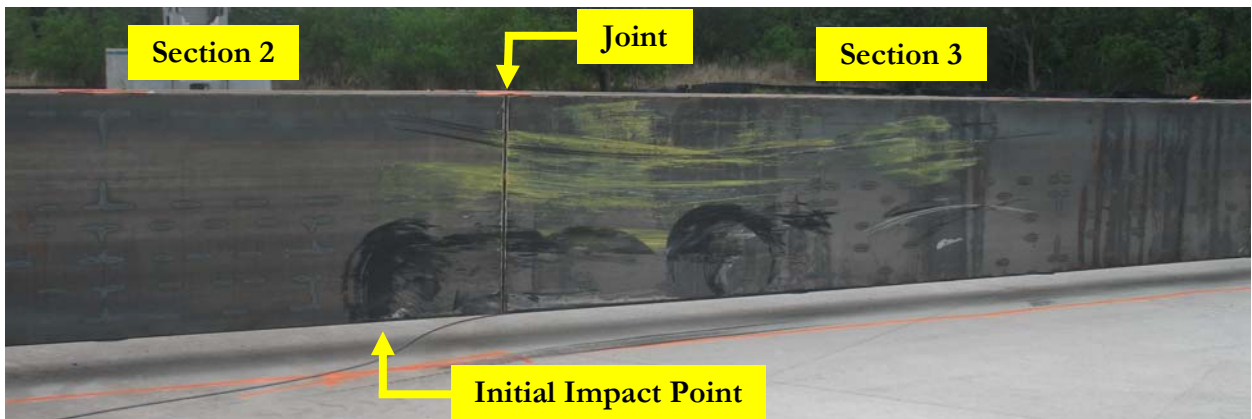


Figure 3.5 – Initial Impact Point of Test Vehicle (At Joint Connecting Sections 2 and 3)



Figure 3.6 – Mobile Barrier Trailer after the Crash Test (Joint Connecting Sections 3 and 4)



Figure 3.7 –Mobile Barrier Trailer after the Crash Test (Joint Connecting Sections 4 and 5)



Figure 3.8 – Overhead View of Mobile Barrier Trailer after the Crash Test

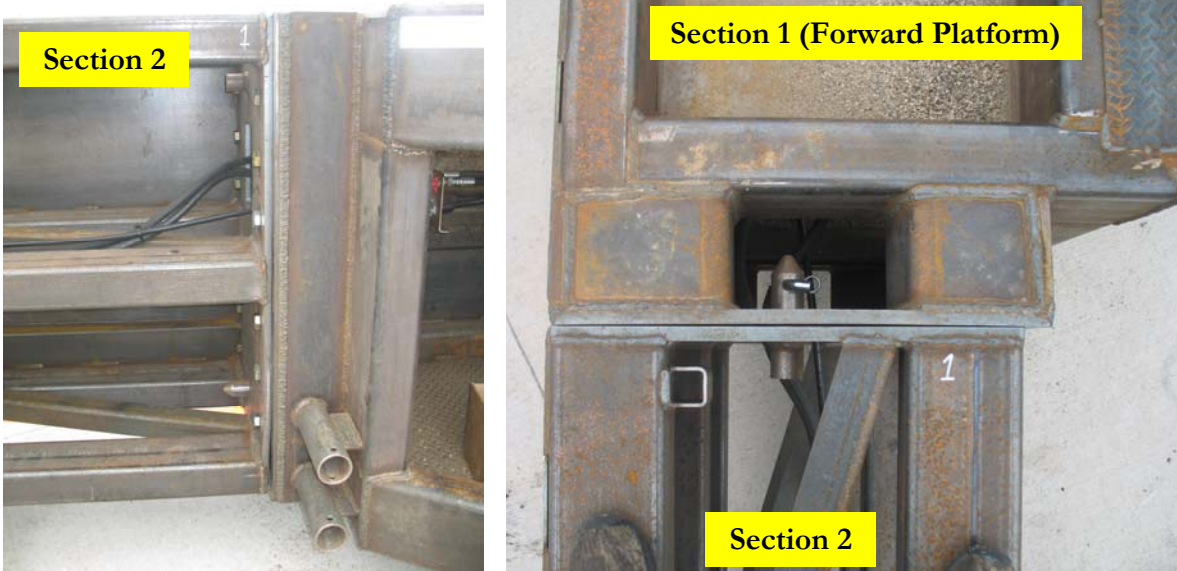


Figure 3.9 – Post Impact Condition of Joint 1 (Connecting Sections 1 and 2)

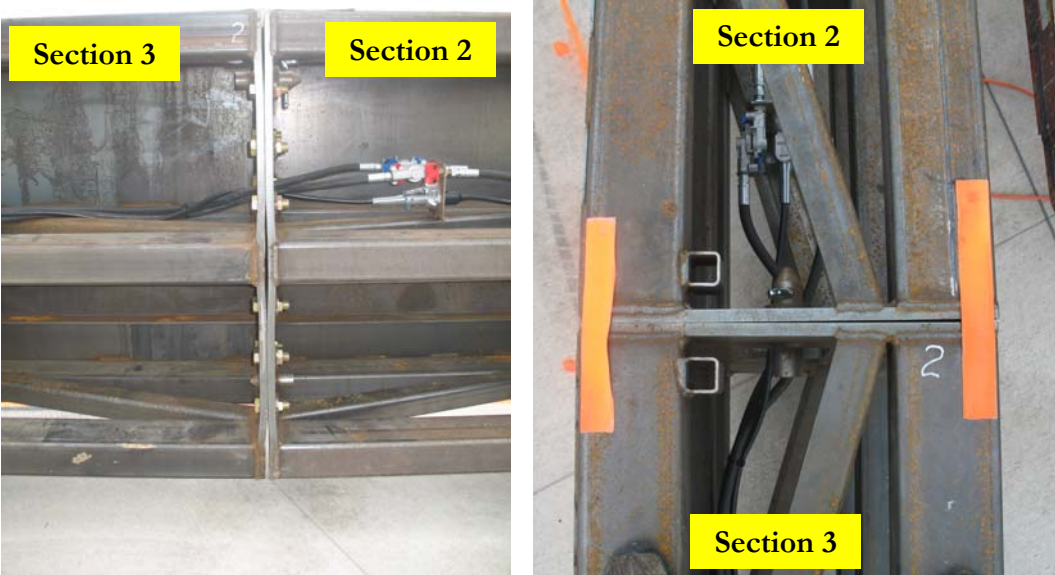


Figure 3.10 – Post Impact Condition of Joint 2 (Connecting Sections 2 and 3)

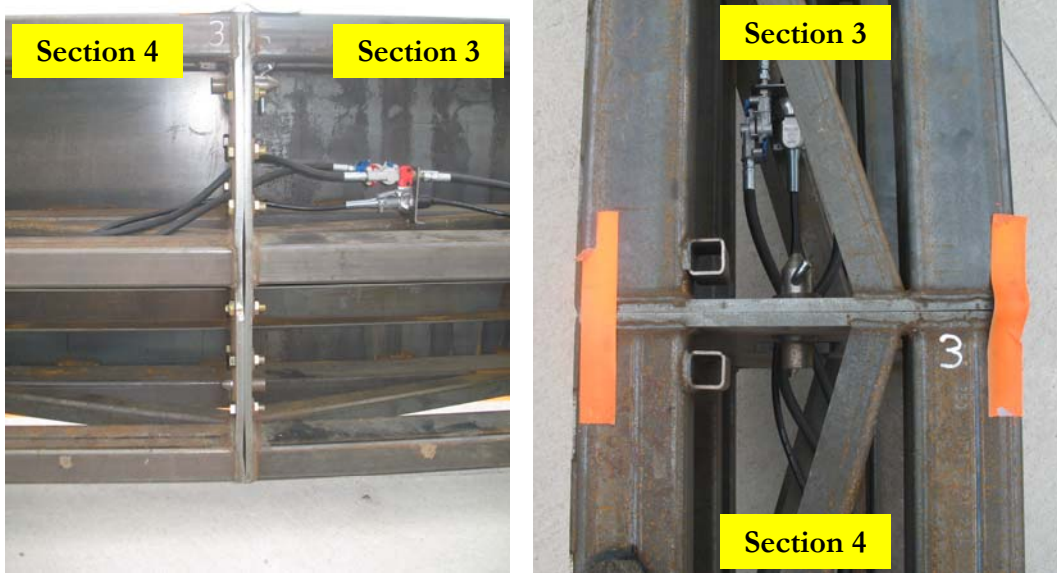


Figure 3.11 – Post Impact Condition of Joint 3 (Connecting Sections 3 and 4)

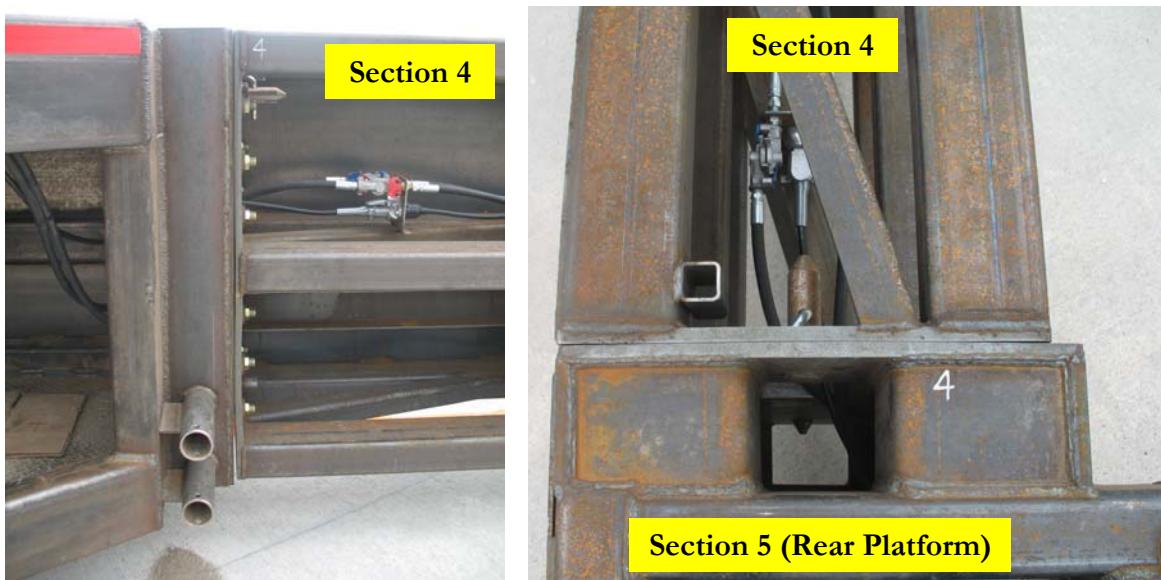


Figure 3.12 – Post Impact Condition of Joint 4 (Connecting Sections 4 and 5)

Table 3.2 – Test Article Damage

Wall Section 5.08 m (20 ft)	Static Deflection of Barrier Measured at base of barrier (+ indicates penetration into barrier)	Section Needs to be Replaced?	Vehicle Contact?	Notes
1	0 cm (0 in) measured at upstream end	NO	NO	<ul style="list-style-type: none"> Section undamaged.
	5.1 cm (2 in) measured at middle of section			
	7.6 cm (3 in) measured at downstream end			
2	7.6 cm (3 in) measured at upstream end	NO	YES	<ul style="list-style-type: none"> Point of impact 13 cm (5 in) from downstream end of wall section Cosmetic damage No structural damage
	8.9 cm (3.5 in) measured at middle of section			
	8.9 cm (3.5 in) measured at downstream end			
3	8.9 cm (3.5 in) measured at upstream end	NO	YES	<ul style="list-style-type: none"> Cosmetic damage No structural damage
	9.5 cm (3.8 in) measured at middle of section			
	8.9 cm (3.5 in) measured at downstream end			
4	8.9 cm (3.5 in) measured at upstream end	NO	YES	<ul style="list-style-type: none"> Cosmetic damage No structural damage
	8.9 cm (3.5 in) measured at middle of section			
	6.4 cm (2.5 in) measured at downstream end			
5	6.4 cm (2.5 in) measured at upstream end	NO	YES	<ul style="list-style-type: none"> Cosmetic damage No structural damage
	5.1 cm (2 in) measured at middle of section			
	2.5 m (1 in) measured at downstream end			

3.4 Vehicle Damage

The test vehicle sustained damage to the front bumper, front grill, hood, left headlight trim assembly, left front fender, left front door, left rear door, and left rear fender. The left front A-Frame suspension was damaged and collapsed. All the tires remained inflated. None of the windows cracked or shattered. The vehicle did not sustain any intrusion into the passenger compartment. Due to damage to the vehicle’s left front suspension, the vehicle was not mechanically operable after the test because the collapsed suspension would prevent the front tire from rolling freely or being steered. Photographs of the vehicle damage are shown in Figure 3.13 and Figure 3.14.



Figure 3.13 – Damaged Test Vehicle (Left Side)



Figure 3.14 – Damaged Test Vehicle (Right Side)

4.0 ASSESSMENT OF TEST RESULTS

A comparison of the test results with the evaluation criteria set forth in NCHRP Report 350 Update indicates compliance with all recommended criteria for the test that was performed. Table 4.1 summarizes the details of the test, and Table 4.2 evaluates the test results with the evaluation criteria set forth in NCHRP Report 350 Update.

Please note that the exit conditions in Table 4.1 were not determined from the high-speed camera analysis since the point of exit was out of the camera's view. Thus, the exit speed was calculated from the accelerometer data, and the exit angles were measured from the tangent line measured from the vehicle's tire tracks.

Table 4.1 – Summary of Test Results and Conditions



General Information

Test AgencySouthwest Research Institute
 Test Number.....MBT-1
 Test Date04/03/2008
 Test Category.....3-11 “Update”

Test Article

TypeLongitudinal Barrier
 Installation Length30.5 m (100 ft)
 Top-of-Barrier Height1.52 m (5 ft)
 Type of Primary BarrierMobile longitudinal barrier

Soil

Test performed on concrete

Test Vehicle

Type½ Ton Quad Cab Pickup
 Designation2270P
 Model.....2002 Dodge Ram 1500 Quad Cab
 Mass (kg)2329
 Inertial Mass(kg)2329
 Dummy Mass (kg)NA
 Gross Static Mass (kg)2329

Impact Conditions

Speed (km/hr)102.3
 Angle (degrees)23.5

Exit Conditions

Speed (km/hr)80 (calculated)
 Angle (degrees)0

Occupant Risk Values

Impact Velocity (m/s)
 x-direction.....4.0
 y-direction.....-6.4
 Ridedown Accelerations (g’s)
 x-direction.....-7.9
 y-direction.....11.1

Post Impact Vehicular Behavior (limited to events <1.000 seconds)

Maximum Roll Angle (degrees).....-7.8 @ 0.107 sec.
 Maximum Pitch Angle (degrees)2.3 @ 0.447 sec.
 Maximum Yaw Angle (degrees)29.3 @ 0.374 sec.

Test Article Deflection

Dynamic.....0.61 m (2.0 ft)
 Static9.5 cm (3.8 in)

Vehicle Damage

Exterior
 CDC11LFEW5
 VDS11-LFQ-4
 Interior
 OCDILF0000000
 Max. Deform. (mm).....0

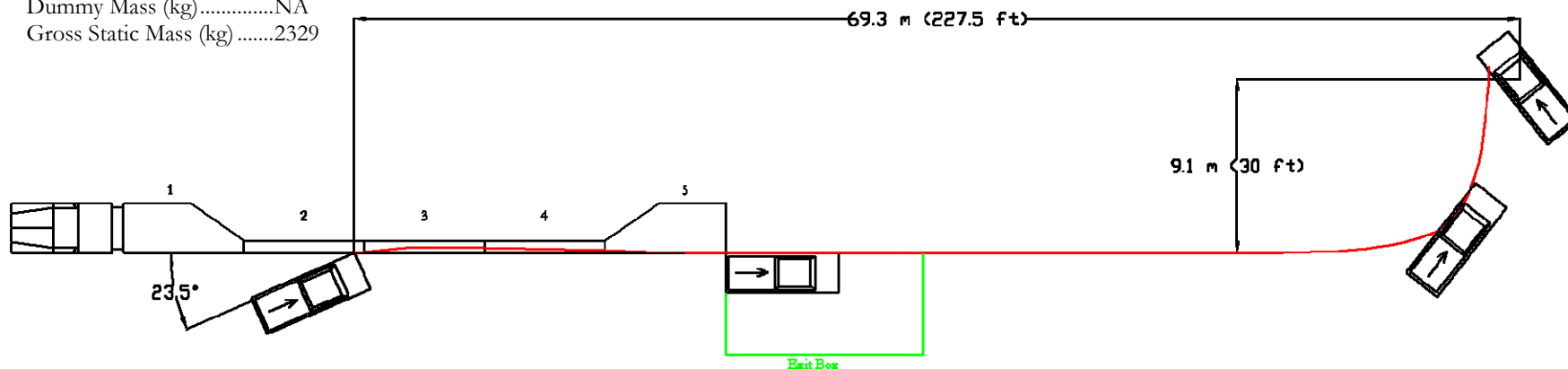


Table 4.2 – Summary of Test Evaluation Results – (NCHRP Report 350 Update Evaluation Criteria)

Evaluation Factor	Evaluation Criteria	Crash Test Results	Pass/Fail
Structural Adequacy	A. Test article should contain and redirect the vehicle; the test vehicle should not penetrate, override, or override the installation although controlled lateral deflection of the test article is acceptable.	The Mobile Barrier Trailer redirected the vehicle back toward the roadway with only 0.61 m (2.0 ft) of maximum dynamic lateral deflection of the barrier.	Pass
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.	There were no fragments or other debris from the test article. There was no intrusion into the occupant compartment	Pass
	F. The vehicle should remain upright during and after collision although moderate roll, pitching, and yawing are acceptable.	The vehicle remained stable during and after the collision, with a maximum roll of -7.8 degrees, and a maximum pitch of 2.3 degrees.	Pass
Vehicle Trajectory	K. After collision it is preferable that the vehicle's trajectory not intrude into adjacent traffic lanes.	After impacting the barrier, the vehicle traveled alongside the barrier. The test vehicle met the Exit Box criterion. (See figure with Table 4.1)	Pass
	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.	Occupant impact velocities: Longitudinal: 4.0 m/s Occupant ridedown accelerations: Longitudinal: -7.9 g's	Pass
	M. The exit angle from the test article preferably should be less than 60 percent of the test impact angle, measured at the time of vehicle loss of contact with test device.	Impact angle: 23.5 degrees 60% of impact angle: 14.1 degrees Exit angle: 0 degrees	Pass

5.0 CONCLUSIONS

The performance of the Mobile Barrier Trailer was found to have sufficient capacity to contain and redirect an impacting 2,329 kg pickup truck safely under Test Level 3 conditions, as specified in NCHRP Report 350 Update, Test 3-11. For the 30.5 m (100 ft) barrier, the maximum observed dynamic deflection was 0.61 m (2.0 ft). A comparison of the test results, with the evaluation criteria set forth in NCHRP Report 350 Update, indicates compliance with the Structural Adequacy, Occupant Risk, and Vehicle Trajectory criteria. A summary of the test results can be found in Tables 4.1 and 4.2.

APPENDIX A

Test Article

(Contents of Appendix A submitted by Mobile Barriers LLC)

Overview

View as assembled with three wall sections



Shortened configuration prepared for transport w/ wall sections atop combined platforms.



Overall trailer length (with 3 wall sections): 102'

Overall length (with platforms only as shown above – no wall sections installed): 42'

(lengths exclusive of tractor & TMA assembly, not shown)

Width: 100"

Approx Weight: 65,000 lbs with tractor and misc accompaniments

Breakdown:

Platforms and rear axel assembly (“caboose”) – 20,000 lbs

Wall sections – 5,000 lbs (ea)

Counterweight – 5,000 lbs per wall section

Tractor and accompaniments – 20,000 lbs

Clearance: 9-12” (+/- 1”) depending on configuration

Height to top of platforms (as taped): approx. 5’ (58” with 12” of clearance)

Height to top of visual barrier (netting) or wall sections as stored above: approx 9’

Overview (cont)...

Length of platforms (2 shown attached): 21' ea

(“caboose” or rear axel assembly under platform opposite tractor)

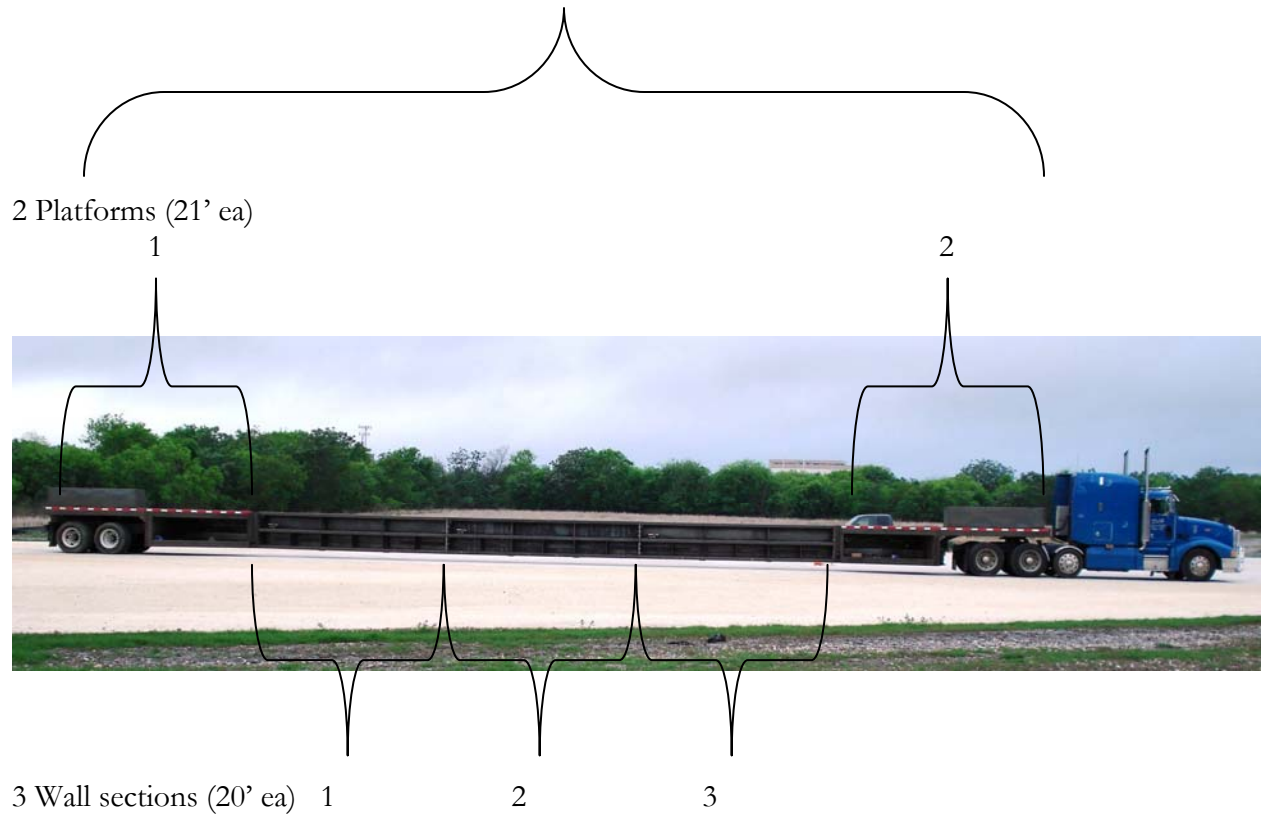
Length of wall sections (2 shown facing/1 on opposite side): 20' ea.

Configuration options: Platform and caboose with 0-3 wall sections

Must be used with an NCHRP Report 350 compliant TMA that has been tested and accepted at TL-3 or such other level as appropriate for applicable traffic speeds and deployment conditions (TMA not shown).

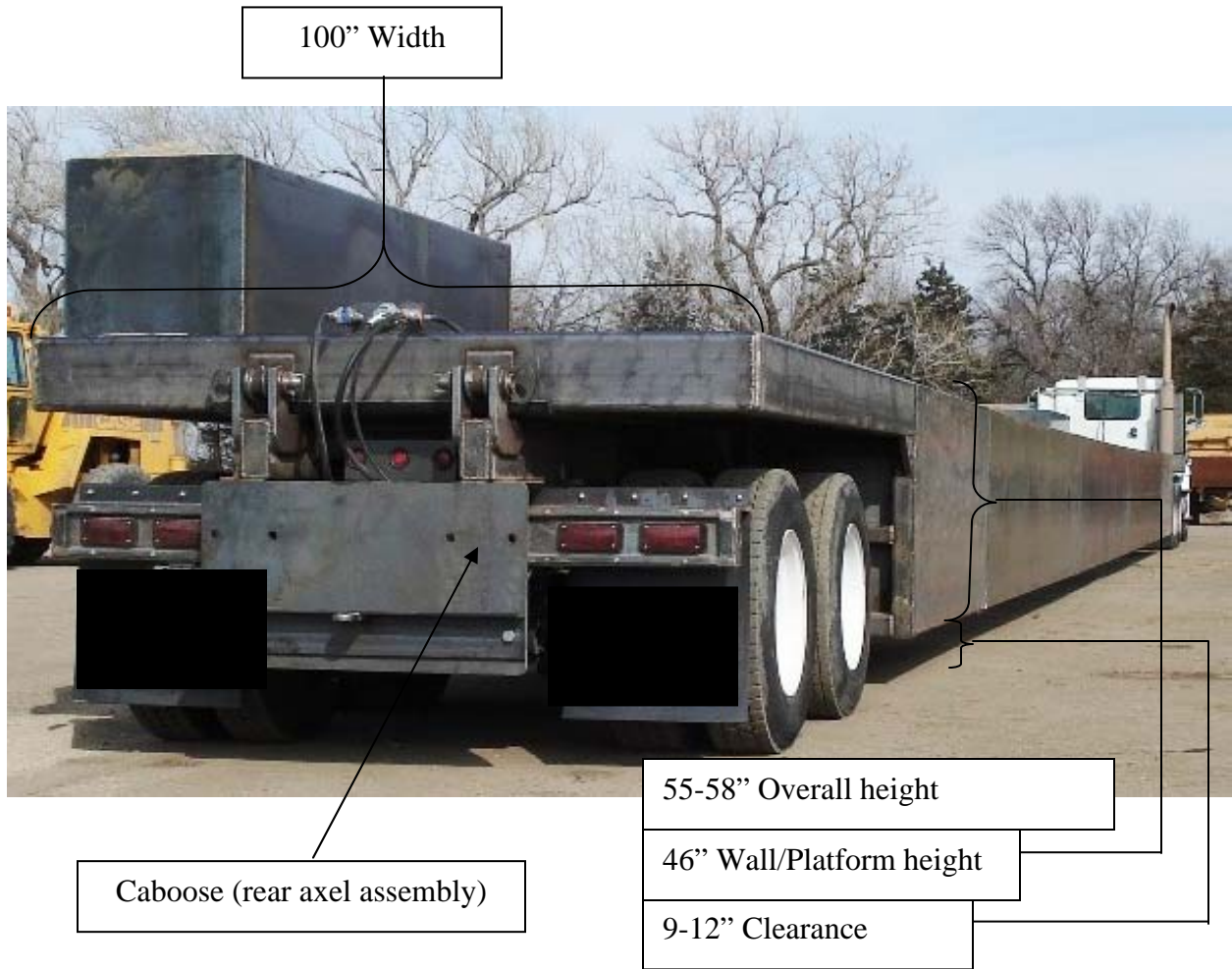
Dimensions...

Overall length with 3 wall sections: 102'

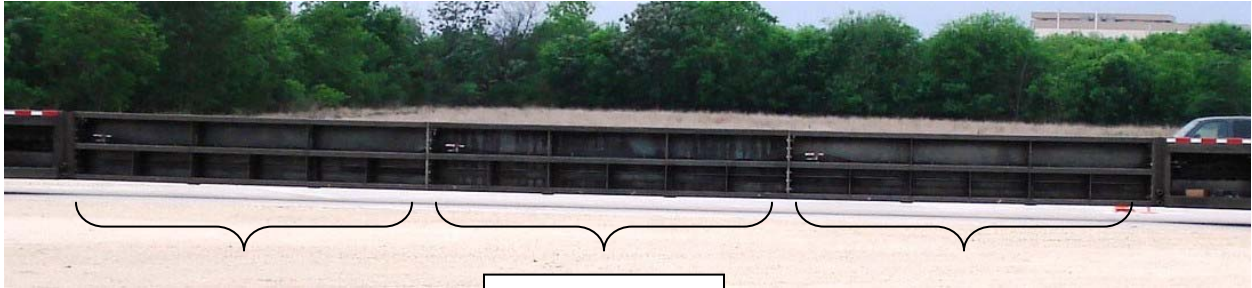


Dimensions (cont)...

Trailer & Caboose (rear axel assembly) as seen from rear traffic side - wheel cover panel and TMA not shown. (license plate and splashguards blacked out)



Wall construction...



Wall sections
1, 2, 3



Top, mid, and lower
beams with lower
channel – 46” height
(55-58” overall height
w/ 9-12” clearance)



Assembled

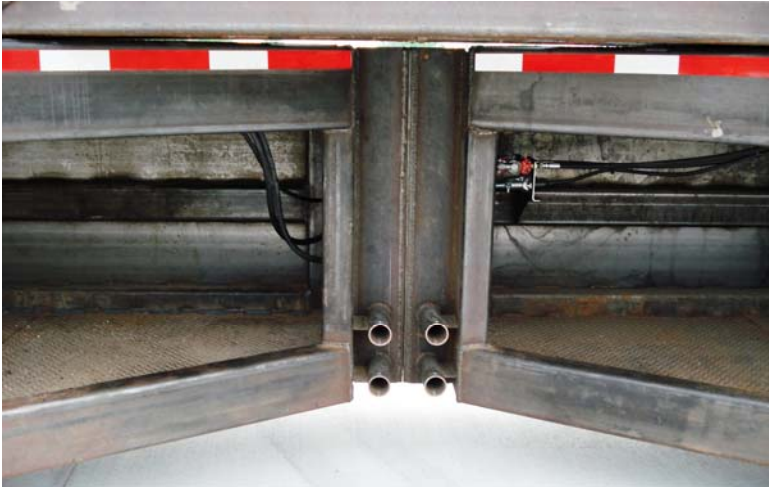


Preassembly as seen on end

Platform Construction...



Platforms connected and loaded for transport, shown open from work side.



Skeletal view.



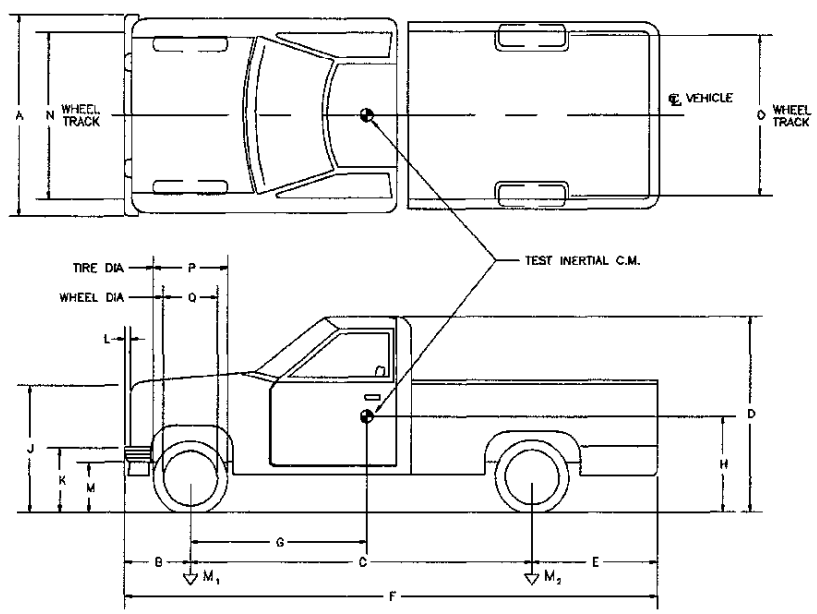
APPENDIX B

Test Vehicle Data Sheet

DATE: 4/1/2008 TEST NO.: MBT-1 VIN NO.: 307HA181N2G193480 MAKE: Dodge
 MODEL: Ram 1500 Pickup YEAR: 2002 ODOMETER: 156,246 GVW: 3016 kg
 TIRE SIZE: 265/70 R17 TIRE INFLATION PRESSURE: 60 PSI TREAD TYPE: Radial - All Weather

MASS DISTRIBUTION (kg) LF 693 RF 656 LR 494 RR 486

DESCRIBE ANY DAMAGE TO VEHICLE PRIOR TO TEST:



ENGINE TYPE: Gas
 ENGINE CID: 4.7 Liter
 TRANSMISSION TYPE:
 AUTO
 MANUAL
 OPTIONAL EQUIPMENT:

 DUMMY DATA:
 TYPE: N/A
 MASS: N/A
 SEAT POSITION: N/A

GEOMETRY - (cm)

A <u>198</u>	D <u>191</u>	G <u>140</u>	K <u>58</u>	N <u>171</u>	Q <u>46</u>
B <u>94</u>	E <u>119</u>	H <u>74</u>	L <u>9</u>	O <u>171</u>	
C <u>358</u>	F <u>572</u>	J <u>114</u>	M <u>37</u>	P <u>79</u>	

(G & H) = Location of Instrumentation Package

<u>MASS - (kg)</u>	<u>CURB</u>	<u>TEST INERTIAL</u>	<u>GROSS STATIC</u>
M ₁	_____	_____	_____
M ₂	_____	_____	_____
M _T	_____	_____	_____

Figure B.1 – Test Vehicle Data Sheet

APPENDIX C

Impact Data

Table C.1 – Test MBT-1 Summary Report

General Information

Test Agency:	Southwest Research Institute
Test Number:	MBT-1
Test Date:	04/03/08
Test Article:	Mobile Barrier Trailer

Test Vehicle

Description:	2002 Dodge Ram 1500 Quad Cab
Test Inertial Mass:	2329 kg
Gross Static Mass:	2329 kg

Impact Conditions

Speed:	102.3 km/hr
Angle:	23.5 degrees

Occupant Risk Factors

Impact Velocity (m/s) at 0.0917 seconds on left side of interior		
x-direction	4.0	
y-direction	-6.4	
THIV (km/hr):	23.9 at 0.0849 seconds on left side of interior	
THIV (m/s):	6.6	
Ridedown Accelerations (g's)		
x-direction	-7.9	(0.1012 - 0.1112 seconds)
y-direction	11.1	(0.2414 - 0.2514 seconds)
PHD (g's):	12.1	(0.2408 - 0.2508 seconds)
ASI:	1.35	(0.0198 - 0.0698 seconds)

Max. 50msec Moving Avg. Accelerations (g's)

x-direction	-6.5	(0.0042 - 0.0542 seconds)
y-direction	11.3	(0.0193 - 0.0693 seconds)
z-direction	-3.0	(0.1005 - 0.1505 seconds)

Max Roll, Pitch, and Yaw Angles (degrees)

Roll	-7.8	(0.1068 seconds)
Pitch	2.3	(0.4469 seconds)
Yaw	29.3	(0.3740 seconds)

X Acceleration at CG

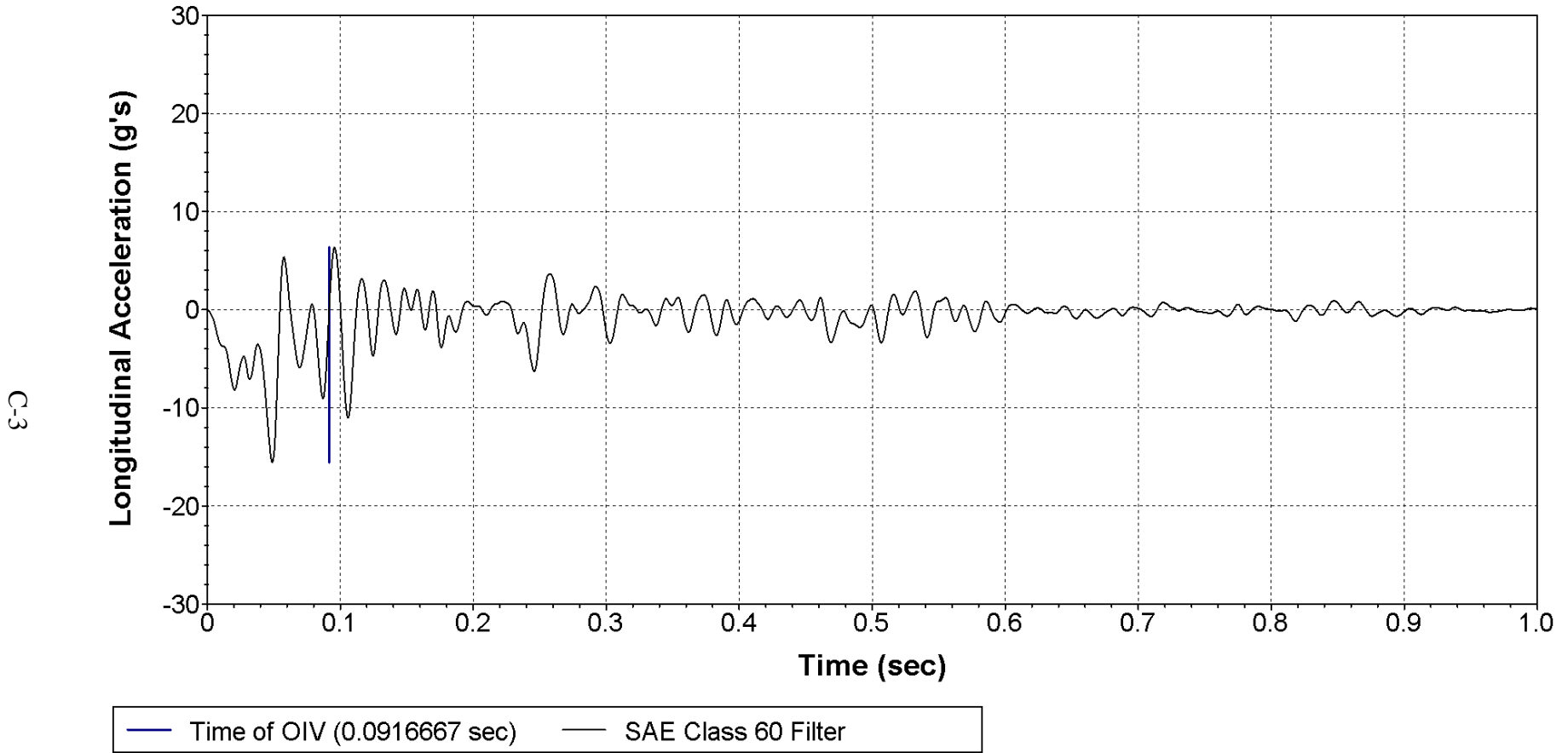


Figure C.1 – Longitudinal Accelerations

Y Acceleration at CG

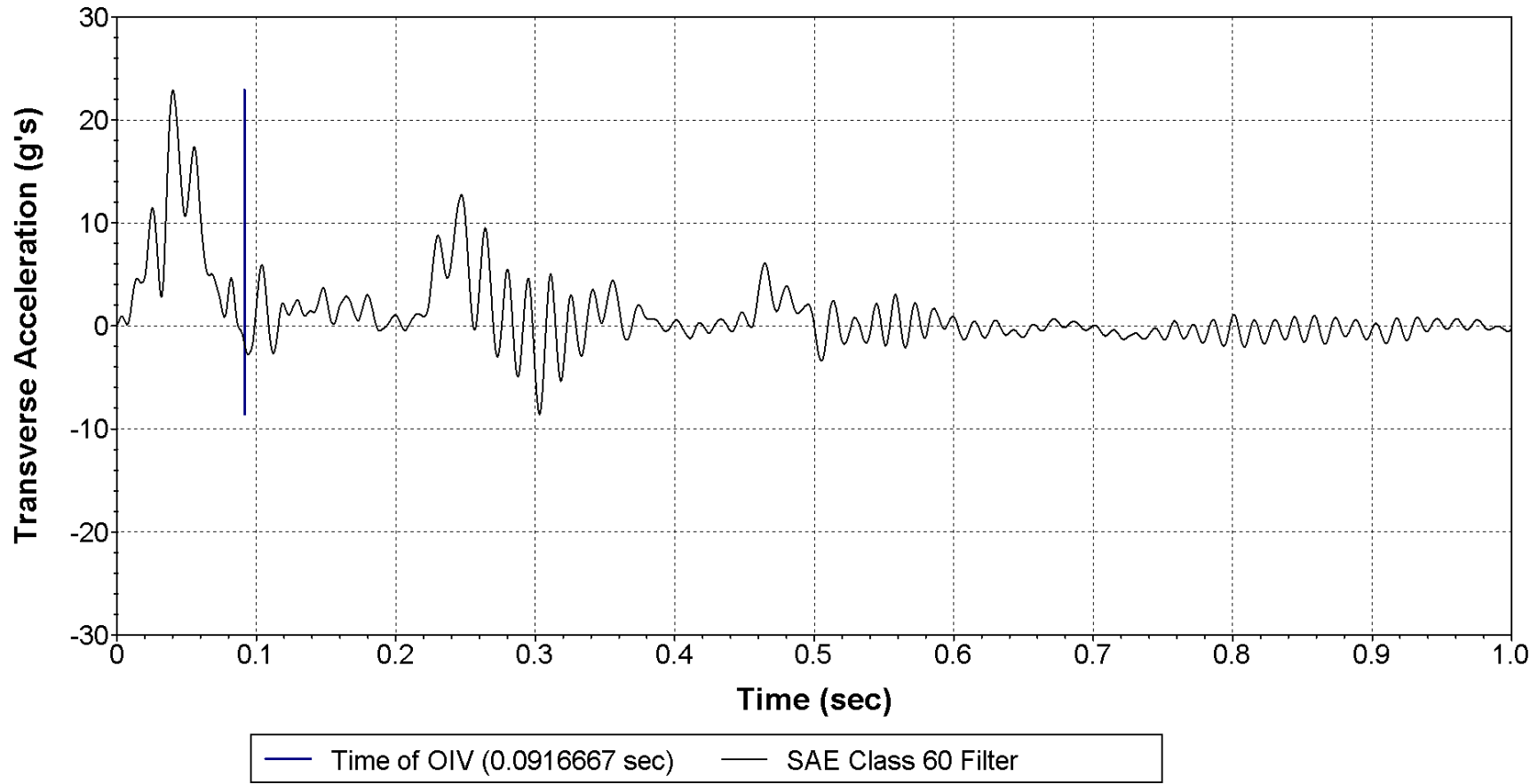


Figure C.2 – Lateral Accelerations

C-4

Z Acceleration at CG

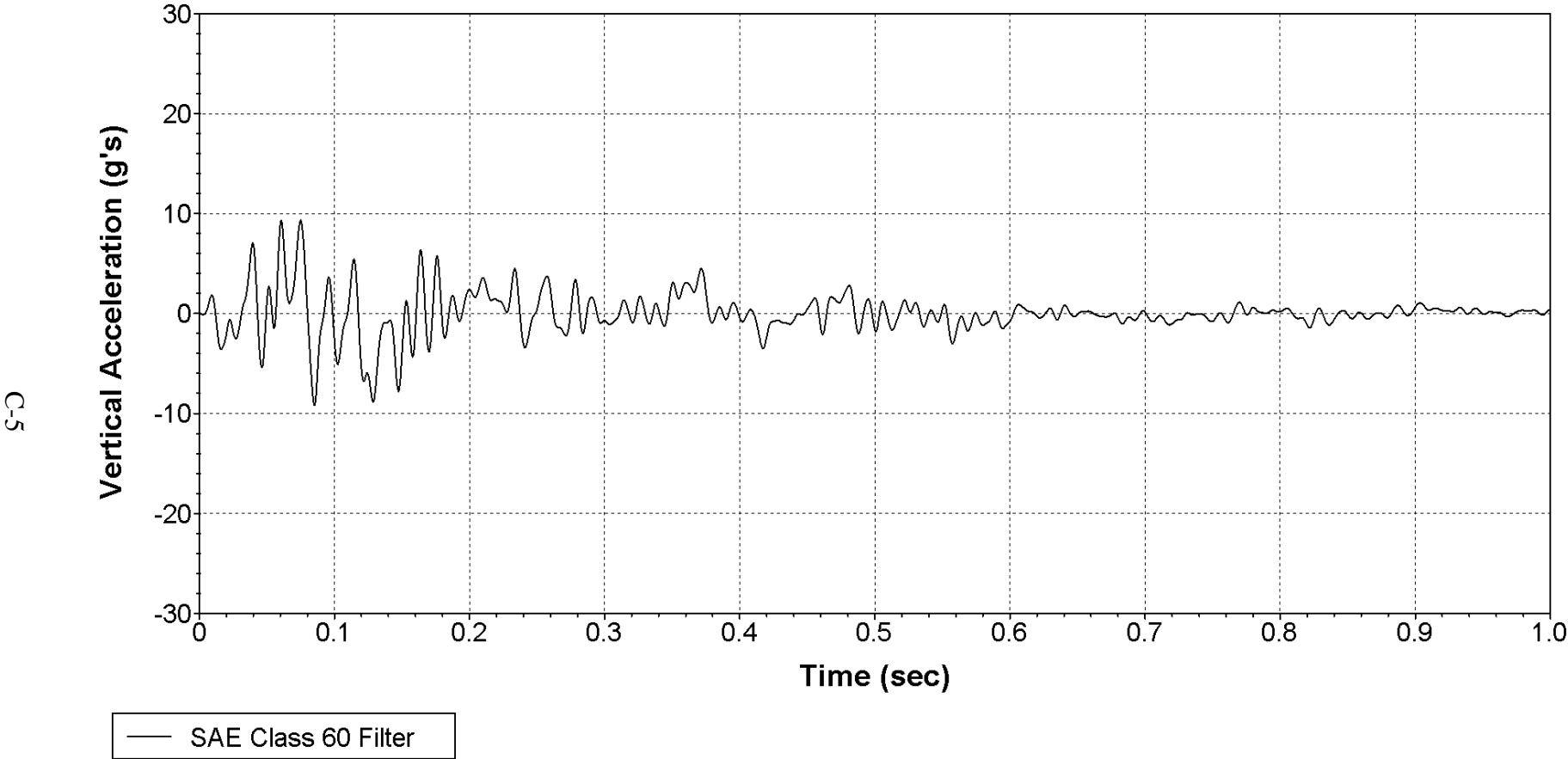


Figure C.3 – Vertical Accelerations

Roll, Pitch and Yaw Rates

C-6

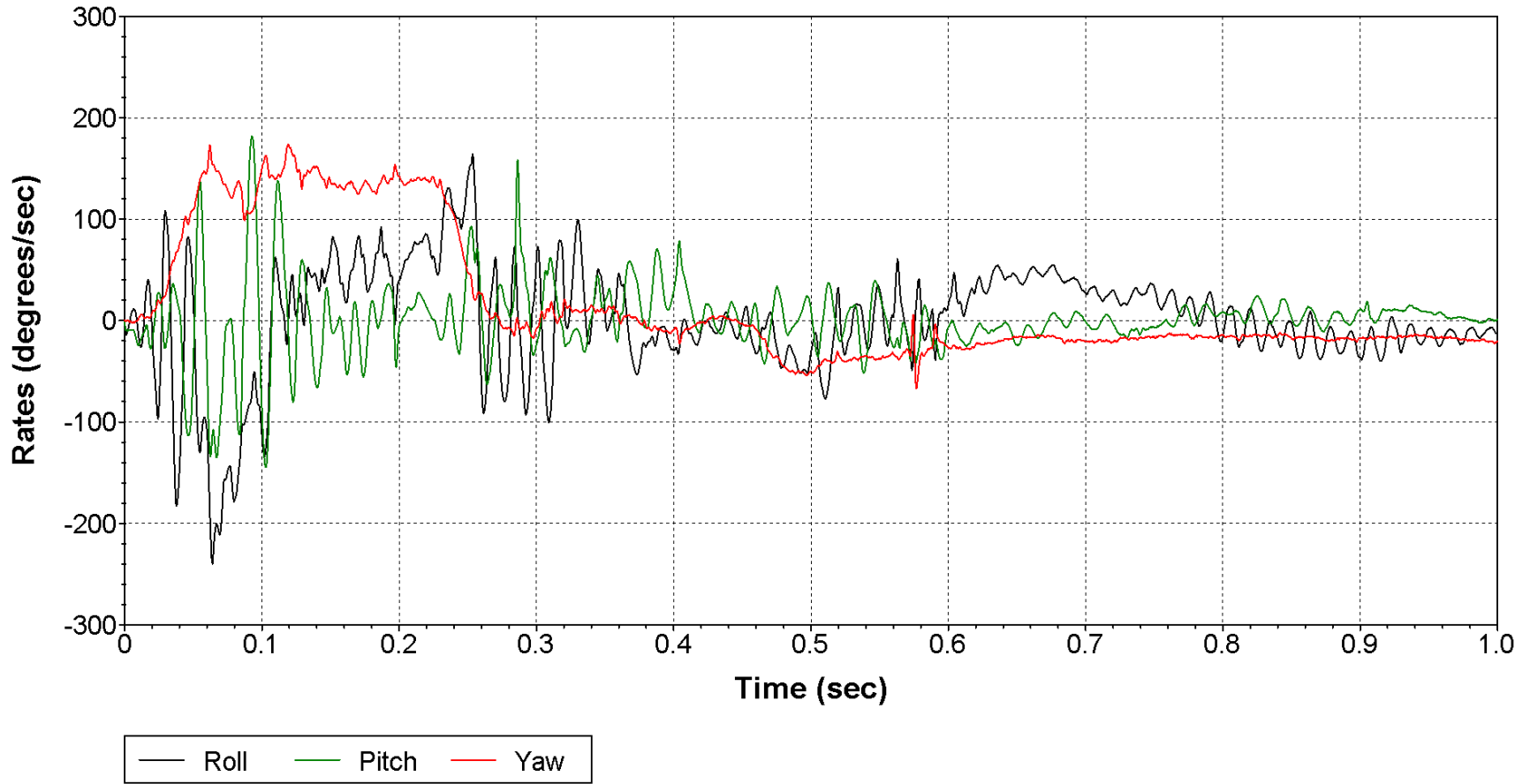


Figure C.4 – Roll, Pitch, and Yaw Angular Velocities

Roll, Pitch and Yaw Angles

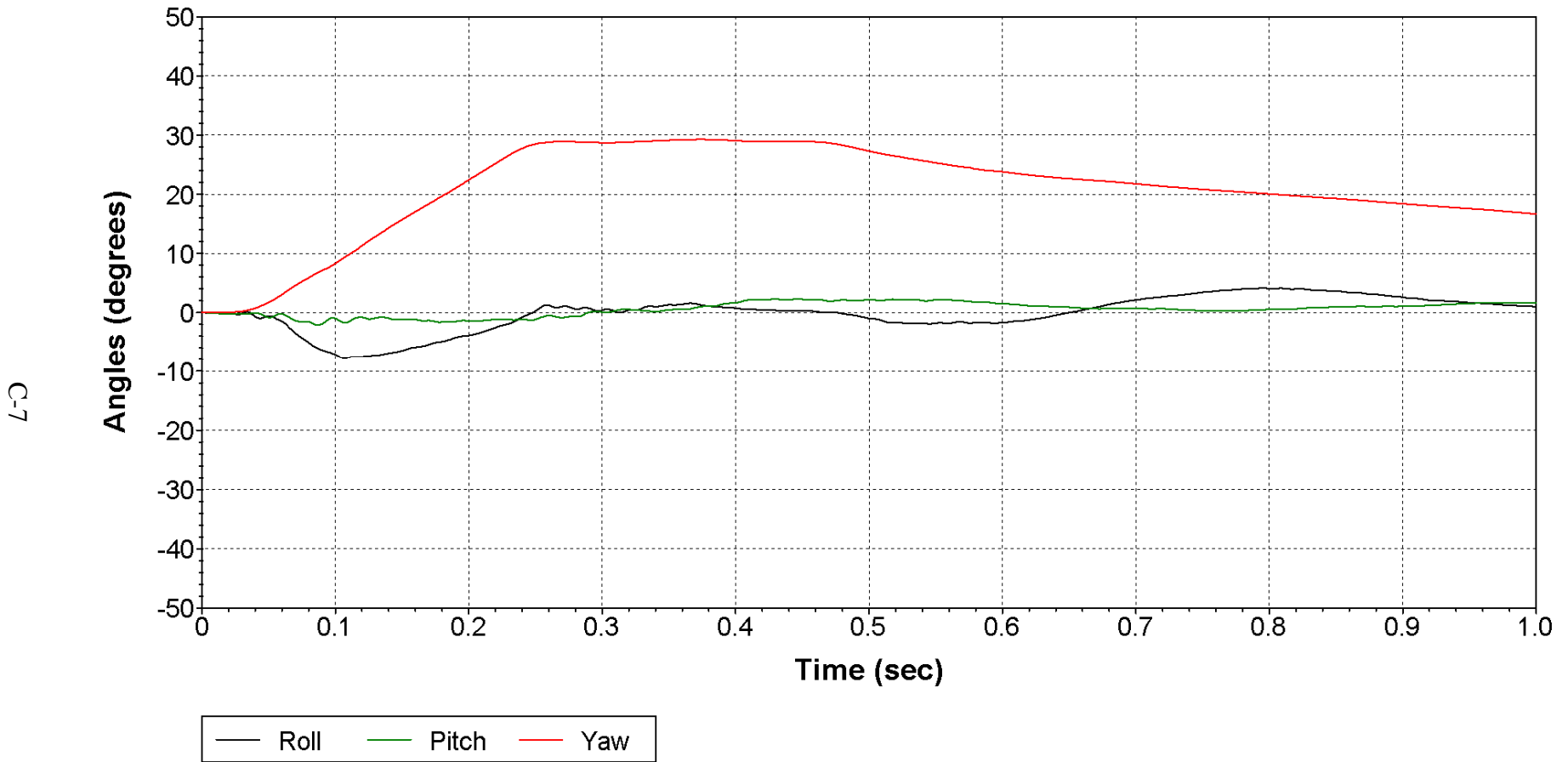


Figure C.5 – Roll, Pitch, and Yaw Angle