



Test Report No. 611971-02-1

Test Report Date: June 2020

***MASH* TEST 3-11 EVALUATION OF COMBINATION TRAFFIC-
PEDESTRIAN-BICYCLE BRIDGE RAILING**

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16. Abstract <p>The purpose of this research was to test and evaluation of a 42-inch tall combination traffic-pedestrian-bicycle bridge rail system for use at <i>MASH</i> TL-3 conditions. Design of the new barrier considered utilization of a 36-inch single slope concrete barrier with a 6-inch bullet-profile aluminum rail mounted on top.</p> <p>A full-scale crash test was performed according to <i>MASH</i> Test 3-11 impact conditions, which involves a 5000-lb pickup truck impacting the bridge rail at a nominal impact speed of 62 mi/h and at a nominal impact angle of 25°. This test evaluates the bridge rail's ability to successfully contain and redirect the pickup truck and occupant risk.</p> <p>This report provides details of the 42-inch tall combination traffic-pedestrian-bicycle bridge rail system, detailed documentation of the crash test and results, and an assessment of the performance of the 42-inch tall combination traffic-pedestrian-bicycle bridge rail system for <i>MASH</i> Test 3-11 evaluation criteria.</p> <p>The 42-inch tall combination traffic-pedestrian-bicycle bridge rail system passed the performance criteria for <i>MASH</i> Test 3-11.</p>			
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APPROXIMATE CONVERSIONS TO SI UNITS				
Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in ²	square inches	645.2	square millimeters	mm ²
ft ²	square feet	0.093	square meters	m ²
yd ²	square yards	0.836	square meters	m ²
ac	acres	0.405	hectares	ha
mi ²	square miles	2.59	square kilometers	km ²
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft ³	cubic feet	0.028	cubic meters	m ³
yd ³	cubic yards	0.765	cubic meters	m ³
NOTE: volumes greater than 1000L shall be shown in m ³				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
°F	Fahrenheit	5(F-32)/9 or (F-32)/1.8	Celsius	°C
FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N
lbf/in ²	poundforce per square inch	6.89	kilopascals	kPa
APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
AREA				
mm ²	square millimeters	0.0016	square inches	in ²
m ²	square meters	10.764	square feet	ft ²
m ²	square meters	1.195	square yards	yd ²
ha	hectares	2.47	acres	ac
km ²	Square kilometers	0.386	square miles	mi ²
VOLUME				
mL	milliliters	0.034	fluid ounces	oz
L	liters	0.264	gallons	gal
m ³	cubic meters	35.314	cubic feet	ft ³
m ³	cubic meters	1.307	cubic yards	yd ³
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000lb)	T
TEMPERATURE (exact degrees)				
°C	Celsius	1.8C+32	Fahrenheit	°F
FORCE and PRESSURE or STRESS				
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lb/in ²

*SI is the symbol for the International System of Units

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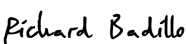
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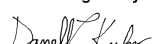
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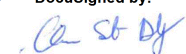
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Chapter 1. INTRODUCTION

As Florida Department of Transportation (FDOT) transitions away from the 32-inch F-shape barrier as the standard shape for permanent concrete barriers to a 36-inch single slope shape, the existing 42-inch combination traffic-pedestrian-bicycle bridge rail system needed to be revised and appropriately modified to be compatible with the new barrier profile and height.

The purpose of this research was to evaluate a 42-inch tall combination traffic-pedestrian-bicycle bridge rail system to American Association of State Highway and Transportation Officials (AASHTO) *Manual for Assessment of Safety Hardware (MASH)* Test 3-11 testing and evaluation conditions (1). Design of the barrier considered utilization of a 36-inch single slope concrete barrier with a 6-inch tall bullet-profile aluminum rail mounted on top.

A full-scale crash test was performed according to *MASH* Test 3-11 impact conditions, which involves a 5000-lb pickup truck impacting the bridge rail at a nominal impact speed of 62 mi/h and at a nominal impact angle of 25°. This test evaluates the bridge rail's ability to successfully contain and redirect the pickup truck and occupant risk.

This report provides details of the 42-inch tall combination traffic-pedestrian-bicycle bridge rail system, detailed documentation of the crash test and results, and an assessment of the performance of the 42-inch tall combination traffic-pedestrian-bicycle bridge rail system for *MASH* Test 3-11 evaluation criteria.

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Chapter 2. SYSTEM DETAILS

2.1. TEST ARTICLE AND INSTALLATION DETAILS

The installation consisted of four sections of concrete barrier. The first two sections were single slope roadside concrete barriers, 14½ inches at the bottom, sloping up on the traffic side towards the field side for a width of 9 inches at the top. The field side consisted of two vertical sections offset from each other 1½ inches at 45 degrees. The other two barrier sections were single slope concrete median barrier. All four barriers had a height of 36 inches, and were secured to the concrete apron using Hilti RE 500 V3 epoxy anchor bars embedded to a depth of 6 inches. A single, half-elliptical, aluminum rail supported by short aluminum posts spaced at 96 inches was mounted on these barriers. The total installation length was 120 ft, and the overall rail height was 42 inches.

Figure 2.1 presents overall information on the 42-inch tall combination traffic-pedestrian-bicycle bridge rail system, and Figure 2.2 provides photographs of the installation. Appendix A provides further details of the 42-inch tall combination traffic-pedestrian-bicycle bridge rail system. Drawings were developed by TTI, and construction was performed by Tucker Construction.

2.2. DESIGN MODIFICATIONS DURING TESTS

No modification was made to the installation during the testing phase.

2.3. MATERIAL SPECIFICATIONS

Concrete compressive strength was specified to be 3400 psi. On the day of the test, barriers 2 and 4 had an average compressive strength of 4507 psi at 32 days of age, and barriers 1 and 3 had an average compressive strength of 5127 psi at 28 days of age.

Appendix B provides certification documents for the materials used to install/ construct the 42-inch tall combination traffic-pedestrian-bicycle bridge rail system.

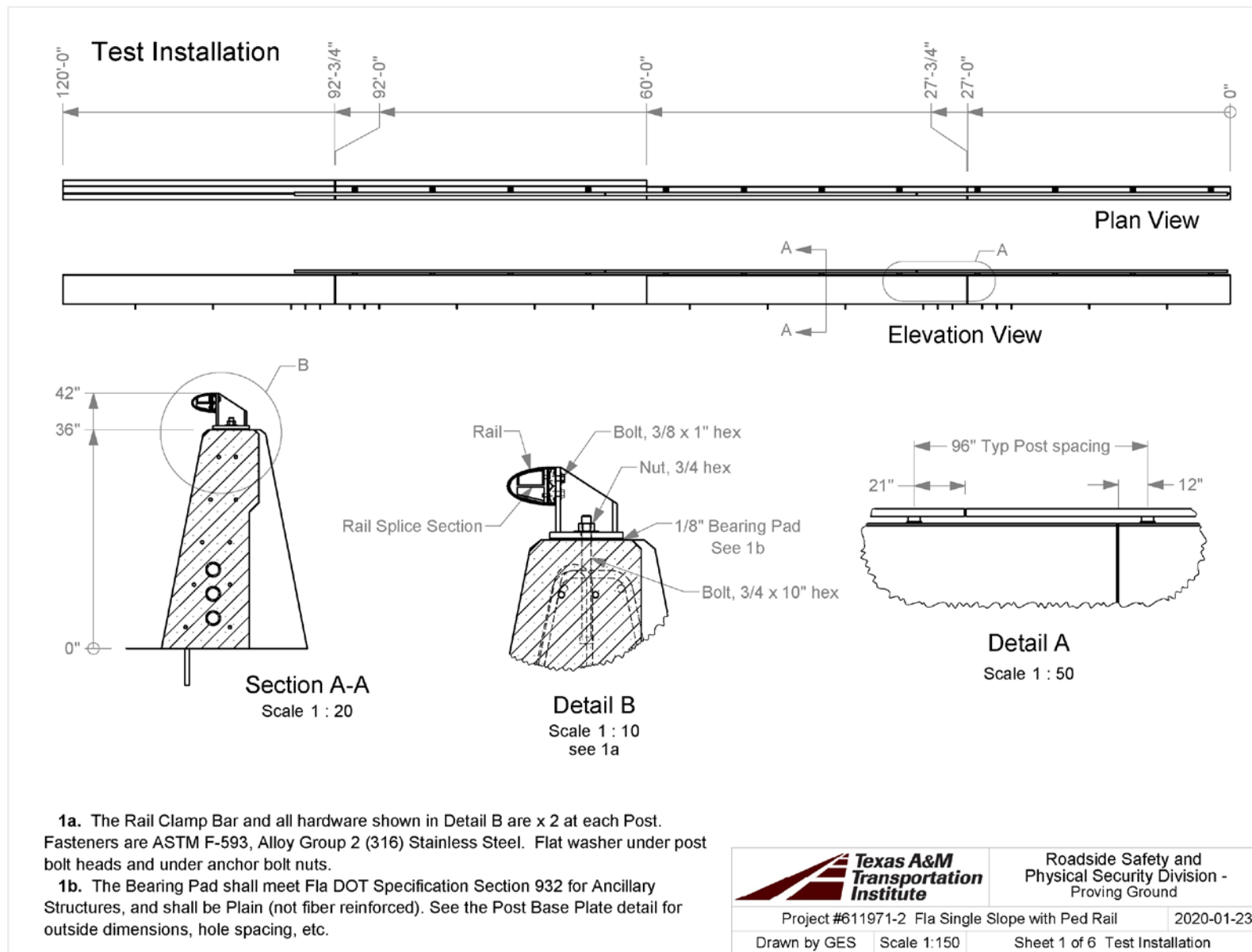


Figure 2.1. Details of 42-inch Tall Combination Traffic-Pedestrian-Bicycle Bridge Rail System.



Figure 2.2. 42-inch Tall Combination Traffic-Pedestrian-Bicycle Bridge Rail System prior to Testing.

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Chapter 3. TEST REQUIREMENTS AND EVALUATION CRITERIA

3.1. CRASH TEST PERFORMED / MATRIX

Table 3.1 shows the test conditions and evaluation criteria for *MASH* TL-3 for longitudinal barriers. *MASH* Test 3-11 involves a 2270P vehicle weighing 5000 lb \pm 110 lb and impacting the critical impact point (CIP) of the barrier at an impact speed of 62 mi/h \pm 2.5 mi/h and an angle of 25° \pm 1.5°. The target CIP was determined using the information provided in *MASH* Section 2.2.1, Section 2.3.2, Figure 2-1, and Table 2-7. Figure 3.1 shows the target CIP for *MASH* Test 3-11 on the 42-inch tall combination traffic-pedestrian-bicycle bridge rail system.

Table 3.1. Test Conditions and Evaluation Criteria Specified for *MASH* TL-3 Longitudinal Barriers.

Test Article	Test Designation	Test Vehicle	Impact Conditions		Evaluation Criteria
			Speed	Angle	
Longitudinal Barrier	3-10	1100C	62 mi/h	25°	A, D, F, H, I
	3-11	2270P	62 mi/h	25°	A, D, F, H, I

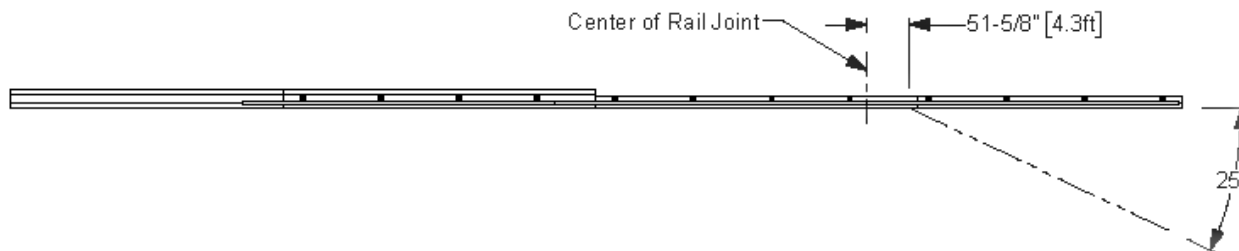


Figure 3.1. Target CIP for *MASH* Test 3-11 on 42-inch Tall Combination Traffic-Pedestrian-Bicycle Bridge Rail System.

The crash test and data analysis procedures were in accordance with guidelines presented in *MASH*. Chapter 4 presents brief descriptions of these procedures.

3.2. EVALUATION CRITERIA

The appropriate safety evaluation criteria from Tables 2-2 and 5-1 of *MASH* were used to evaluate the crash test reported herein. The test conditions and evaluation criteria required for *MASH* Test 3-11 are listed in Table 3.1, and the substance of the evaluation criteria in Table 3.2. An evaluation of the crash test results is presented in detail under the section Assessment of Test Results.

Table 3.2. Evaluation Criteria Required for MASH Test 3-11 for Longitudinal Barriers.

Evaluation Factors	Evaluation Criteria
Structural Adequacy	A. <i>Test article should contain and redirect the vehicle or bring the vehicle to a controlled stop; the vehicle should not penetrate, underride, or override the installation although controlled lateral deflection of the test article is acceptable.</i>
Occupant Risk	D. <i>Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present undue hazard to other traffic, pedestrians, or personnel in a work zone.</i> <i>Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.2.2 and Appendix E of MASH.</i>
	F. <i>The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.</i>
	H. <i>Occupant impact velocities (OIV) should satisfy the following limits: Preferred value of 30 ft/s, or maximum allowable value of 40 ft/s.</i>
	I. <i>The occupant ridedown accelerations should satisfy the following: Preferred value of 15.0 g, or maximum allowable value of 20.49 g.</i>

Chapter 4. TEST CONDITIONS

4.1. TEST FACILITY

The full-scale crash test reported herein was performed at Texas A&M Transportation Institute (TTI) Proving Ground, an International Standards Organization (ISO)/International Electrotechnical Commission (IEC) 17025-accredited laboratory with American Association for Laboratory Accreditation (A2LA) Mechanical Testing Certificate 2821.01. The full-scale crash test was performed according to TTI Proving Ground quality procedures, and according to the *MASH* guidelines and standards.

The test facilities of the TTI Proving Ground are located on the Texas A&M University System RELLIS Campus, which consists of a 2000-acre complex of research and training facilities situated 10 miles northwest of the flagship campus of Texas A&M University. The site, formerly a United States Army Air Corps base, has large expanses of concrete runways and parking aprons well suited for experimental research and testing in the areas of vehicle performance and handling, vehicle-roadway interaction, durability and efficacy of highway pavements, and evaluation of roadside safety hardware and perimeter protective devices. The site selected for construction and testing of the 42-inch tall combination traffic-pedestrian-bicycle bridge rail system was the surface of an out-of-service apron. The apron consists of an unreinforced jointed-concrete pavement in 12.5-ft × 15-ft blocks nominally 6 inches deep. The aprons were built in 1942, and the joints have some displacement, but are otherwise flat and level.

4.2 VEHICLE TOW AND GUIDANCE SYSTEM

The vehicle was towed into the test installation using a steel cable guidance and reverse tow system. A steel cable for guiding the test vehicle was tensioned along the path, anchored at each end, and threaded through an attachment to the front wheel of the test vehicle. An additional steel cable was connected to the test vehicle, passed around a pulley near the impact point, through a pulley on the tow vehicle, and then anchored to the ground such that the tow vehicle moved away from the test site. A 2:1 speed ratio between the test and tow vehicle existed with this system. Just prior to impact with the installation, the test vehicle was released and ran unrestrained. The vehicle remained freewheeling (i.e., no steering or braking inputs) until it cleared the immediate area of the test site.

4.3 DATA ACQUISITION SYSTEMS

4.3.1 Vehicle Instrumentation and Data Processing

The test vehicle was instrumented with a self-contained, on-board data acquisition system. The signal conditioning and acquisition system is a 16-channel, Tiny Data Acquisition System (TDAS) Pro produced by Diversified Technical Systems, Inc. The accelerometers, which measure the x, y, and z axis of vehicle acceleration, are strain gauge type with linear millivolt output proportional to acceleration. Angular rate sensors, measuring vehicle roll, pitch, and yaw rates, are ultra-small, solid state units designed for crash test service. The TDAS Pro hardware and

software conform to the latest SAE J211, Instrumentation for Impact Test. Each of the 16 channels is capable of providing precision amplification, scaling, and filtering based on transducer specifications and calibrations. During the test, data are recorded from each channel at a rate of 10,000 samples per second with a resolution of one part in 65,536. Once data are recorded, internal batteries back these up inside the unit should the primary battery cable be severed. Initial contact of the pressure switch on the vehicle bumper provides a time zero mark and initiates the recording process. After each test, the data are downloaded from the TDAS Pro unit into a laptop computer at the test site. The Test Risk Assessment Program (TRAP) software then processes the raw data to produce detailed reports of the test results.

Each of the TDAS Pro units is returned to the factory annually for complete recalibration and all instrumentation used in the vehicle conforms to all specifications outlined by SAE J211. All accelerometers are calibrated annually by means of an ENDEVCO® 2901, precision primary vibration standard. This standard and its support instruments are checked annually and receive a National Institute of Standards Technology (NIST) traceable calibration. The rate transducers used in the data acquisition system receive a calibration via a Genisco Rate-of-Turn table. The subsystems of each data channel are also evaluated annually, using instruments with current NIST traceability, and the results are factored into the accuracy of the total data channel, per SAE J211. Calibrations and evaluations are also made any time data are suspect. Acceleration data are measured with an expanded uncertainty of $\pm 1.7\%$ at a confidence factor of 95% ($k=2$).

TRAP uses the data from the TDAS Pro to compute occupant/compartiment impact velocities, time of occupant/compartiment impact after vehicle impact, and the highest 10-millisecond (ms) average ridedown acceleration. TRAP calculates change in vehicle velocity at the end of a given impulse period. In addition, maximum average accelerations over 50-ms intervals in each of the three directions are computed. For reporting purposes, the data from the vehicle-mounted accelerometers are filtered with an SAE Class 180-Hz low-pass digital filter, and acceleration versus time curves for the longitudinal, lateral, and vertical directions are plotted using TRAP.

TRAP uses the data from the yaw, pitch, and roll rate transducers to compute angular displacement in degrees at 0.0001-s intervals, then plots yaw, pitch, and roll versus time. These displacements are in reference to the vehicle-fixed coordinate system with the initial position and orientation of the vehicle-fixed coordinate systems being initial impact. Rate of rotation data is measured with an expanded uncertainty of ± 0.7 percent at a confidence factor of 95 percent ($k=2$).

4.3.2 Anthropomorphic Dummy Instrumentation

According to *MASH*, use of a dummy in the 2270P vehicle is optional. However, it is recommended a dummy be used when testing “any longitudinal barrier with a height greater than or equal to 33 inches.” Use of the dummy in the 2270P vehicle is recommended for tall rails to evaluate the “potential for an occupant to extend out of the vehicle and come into direct contact with the test article.” Although this information is reported, it is not part of the impact performance evaluation. Since the rail height of the combination traffic-pedestrian-bicycle bridge rail system was 42 inches, a dummy was placed in the front seat of the 2270P vehicle on the impact side and restrained with lap and shoulder belts.

4.3.3 Photographic Instrumentation Data Processing

Photographic coverage of the test included three digital high-speed cameras:

- One overhead with a field of view perpendicular to the ground and directly over the impact point;
- One placed upstream the installation at an angle to have a field of view of the interaction of the rear of the vehicle with the installation; and
- A third placed to have a field of view parallel to and aligned with the installation at the downstream end.

A flashbulb on the impacting vehicle was activated by a pressure-sensitive tape switch to indicate the instant of contact with the 42-inch tall combination traffic-pedestrian-bicycle bridge rail system. The flashbulb was visible from each camera. The video files from these digital high-speed cameras were analyzed to observe phenomena occurring during the collision and to obtain time-event, displacement, and angular data. A digital camera recorded and documented conditions of each test vehicle and the installation before and after the test.

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Chapter 5. *MASH* TEST 3-11 (CRASH TEST NO. 611971-02-1)

5.1 TEST DESIGNATION AND ACTUAL IMPACT CONDITIONS

MASH Test 3-11 involves a 2270P vehicle weighing 5000 lb \pm 110 lb impacting the CIP of the longitudinal barrier at an impact speed of 62 mi/h \pm 2.5 mi/h and an angle of 25° \pm 1.5°. The CIP for *MASH* Test 3-11 on the 42-inch tall combination traffic-pedestrian-bicycle bridge rail system was 4.3 \pm 1 ft upstream of the centerline of the first splice in the metal rail element. Figures 3.1 and 5.1 depict the target impact setup.



Figure 5.1. Bridge Rail/Test Vehicle Geometries for Test No. 611971-02-1.

The 2270P vehicle used in the test weighed 5029 lb, and the actual impact speed and angle were 61.8 mi/h and 24.5°. The actual impact point was 4.8 ft upstream of the first splice in the metal rail element. Minimum target impact severity (IS) for *MASH* Test 3-11 is 106 kip-ft, and actual IS was 110 kip-ft.

5.2 WEATHER CONDITIONS

The test was performed on the morning of April 3, 2020. Weather conditions at the time of testing were as follows: wind speed: 4 mi/h; wind direction: 142° (vehicle was traveling at a magnetic heading of 330°); temperature: 73°F; relative humidity: 89%.

5.3 TEST VEHICLE

Figure 5.2 shows the 2014 RAM 1500 pickup truck used for the crash test. The vehicle's test inertia weight was 5029 lb, and its gross static weight was 5194 lb. The height to the lower edge of the vehicle bumper was 11.75 inches, and height to the upper edge of the bumper was 27.0 inches. The height to the vehicle's center of gravity was 29.0 inches. Tables C.1 and C.2 in Appendix C1 give additional dimensions and information on the vehicle. The vehicle was directed into the installation using a cable reverse tow and guidance system, and was released to be freewheeling and unrestrained just prior to impact.



Figure 5.2. Test Vehicle before Test No. 611971-02-1.

5.4 TEST DESCRIPTION

Table 5.1 lists events that occurred during Test No. 611971-02-1. Figure C.1 in Appendix C2 present sequential photographs during the test.

Table 5.1. Events during Test No. 611971-02-1.

TIME (s)	EVENTS
0.000	Vehicle impacts bridge rail
0.033	Vehicle begins to redirect
0.107	Front left tire lifts off pavement
0.217	Rear left tire lifts off pavement
0.181	Vehicle traveling parallel to barrier
0.187	Rear right bumper contacts barrier
0.395	Vehicle loses contact with bridge rail at a trajectory of 6.2° and heading of 7.4°
0.489	Front right tire contacts pavement
0.628	Front left tire contacts pavement

For longitudinal barriers, it is desirable that the vehicle redirects and exits the barrier within the exit box criteria (not less than 32.8 ft downstream from loss of contact for cars and pickups). The test vehicle exited within the exit box criteria defined in *MASH*. Brakes on the vehicle were applied at 2.0 s after impact. After loss of contact with the barrier, the vehicle came to rest 205 ft downstream of the impact point and 7 ft toward traffic lanes.

5.5 DAMAGE TO TEST INSTALLATION

Figure 5.3 shows the damage to the 42-inch tall combination traffic-pedestrian-bicycle bridge rail system. There were scuff marks on the concrete at the site of contact. A crack was noted on the barrier's traffic side base, beginning at the field joint and extending along the base for 33 ft before stopping at the butt joint. Also, a piece of concrete broke off of the field side at

post 5, exposing the anchors. Working width* was 23.3 inches, and height of working width was 68.2 inches (vehicle side mirror). Maximum dynamic deflection of the metal rail during the test was 3.1 inches, and maximum permanent deformation was 2.25 inches.



Figure 5.3. Bridge Rail after Test No. 611971-02-1.

* Per *MASH*, “The working width is the maximum dynamic lateral position of any major part of the system or vehicle. These measurements are all relative to the pre-impact traffic face of the test article.” In other words, working width is the total barrier width plus the maximum dynamic intrusion of any portion of the barrier or test vehicle past the field side edge of the barrier.

5.6 DAMAGE TO TEST VEHICLE

Figure 5.4 shows the damage sustained by the vehicle. The front bumper, hood, grill, radiator and support, right front fender, right frame rail, right lower control arm, right front tire and rim, right front floor pan, right front door and window glass, right rear door, right rear cab corner, right rear exterior bed, right rear rim, and rear bumper were damaged. The windshield was cracked along the right A-post. No fuel tank damage was observed. Maximum exterior crush to the vehicle was 14.0 inches in the side plane at the right front corner at bumper height. Maximum occupant compartment deformation was 4.0 inches in the right front floor pan. Figure 5.5 shows the interior of the vehicle. Tables C.3 and C.4 in Appendix C1 provide exterior crush and occupant compartment measurements.



Figure 5.4. Test Vehicle after Test No. 611971-02-1.



Figure 5.5. Interior of Test Vehicle after Test No. 611971-02-1.

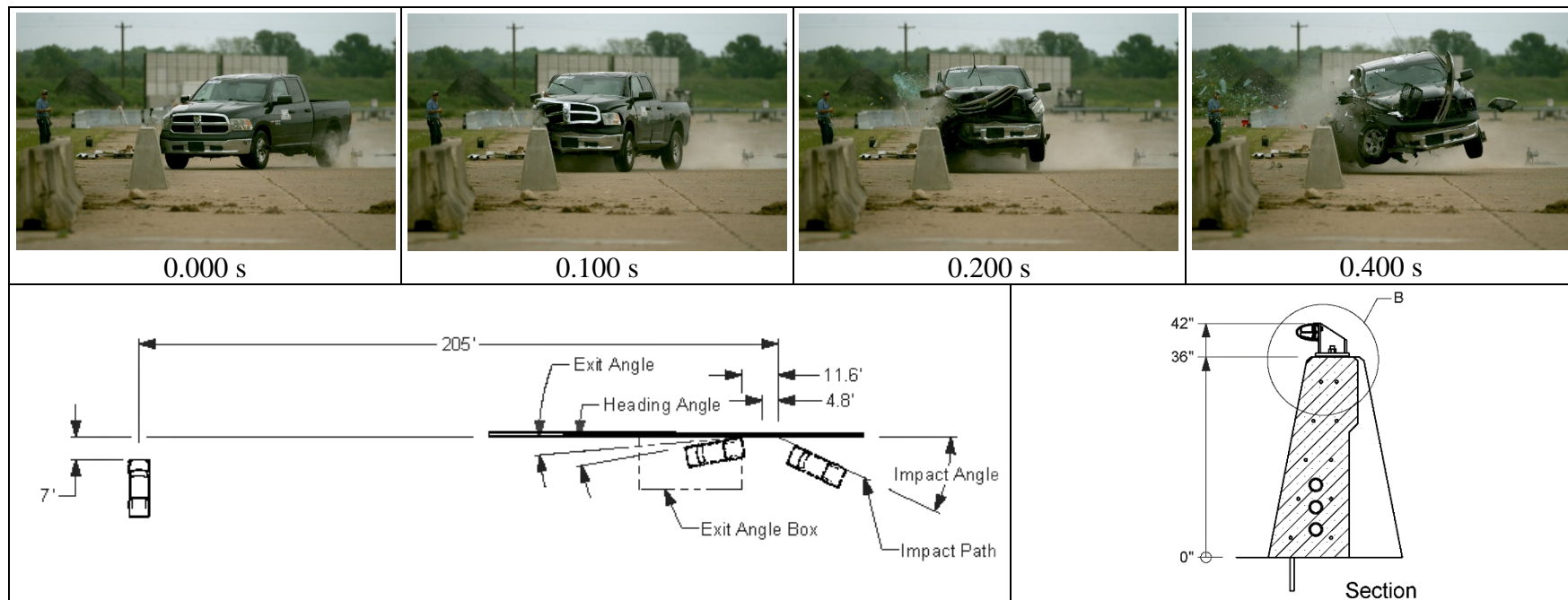
5.7 OCCUPANT RISK FACTORS

Data from the accelerometers were digitized for evaluation of occupant risk, and the results are shown in Table 5.2. Figure C.2 in Appendix C3 shows the vehicle angular

displacements, and Figures C.3 through C.5 in Appendix C4 show acceleration versus time traces. Figure 5.6 summarizes pertinent information from the test.

Table 5.2. Occupant Risk Factors for Test No. 611971-02-1.

Occupant Risk Factor	Value	Time
Occupant Impact Velocity (OIV)		
Longitudinal	15.4 ft/s	at 0.0985 s on right side of interior
Lateral	24.6 ft/s	
Occupant Ridedown Accelerations		
Longitudinal	5.4 g	0.0985 – 0.1085 s
Lateral	10.4 g	0.1885 – 0.1985 s
Theoretical Head Impact Velocity (THIV)	8.8 m/s	at 0.0958 s on right side of interior
Acceleration Severity Index (ASI)	1.6	0.0579 – 0.1079 s
Maximum 50-ms Moving Average		
Longitudinal	-6.8 g	0.0195 – 0.0695 s
Lateral	-12.2 g	0.0372 – 0.0872 s
Vertical	-3.9 g	0.0151 – 0.0651 s
Maximum Roll, Pitch, and Yaw Angles		
Roll	16°	0.5761 s
Pitch	6°	0.6161 s
Yaw	40°	0.8948 s

**General Information**

Test Agency Texas A&M Transportation Institute (TTI)
 Test Standard Test No. MASH Test 3-11
 TTI Test No. 611971-02-1
 Test Date 2020-04-03

Test Article

Type Longitudinal Barrier – Bridge Rail
 Name 42-inch tall combination traffic-pedestrian-bicycle bridge rail system
 Installation Length 120 ft
 Material or Key Elements 36-inch single slope barrier with aluminum rail atop

Foundation Type

..... Anchored to concrete with anchor bars embedded 6 inches in concrete

Test Vehicle

Type/Designation 2270P
 Make and Model 2014 RAM 1500 pickup truck
 Weight 4952 lb
 Test Inertial 5029 lb
 Dummy 165 lb
 Gross Static 5194 lb

Impact Conditions

Speed 61.8 mi/h
 Angle 24.5°
 Location/Orientation 4.8 ft upstream of splice

Impact Severity

..... 110 kip-ft

Exit Conditions

Speed Not obtainable
 Trajectory/Heading Angle 6.2° / 7.4°

Occupant Risk Values

Longitudinal OIV 15.4 ft/s
 Lateral OIV 24.6 ft/s
 Longitudinal Ridedown 5.4 g
 Lateral Ridedown 10.4 g
 THIV 8.8 m/s
 ASI 1.6

Max. 0.050-s Average

Longitudinal -6.8 g
 Lateral -12.2 g
 Vertical -3.9 g

Post-Impact Trajectory

Stopping Distance 205 ft downstream
 7 ft twd traffic lanes

Vehicle Stability

Yaw Angle 40°
 Maximum Pitch Angle 6°
 Maximum Roll Angle 16°
 Vehicle Snagging No
 Vehicle Pocketing No

Test Article Deflections

Dynamic 3.1 inches
 Permanent 2.25 inches
 Working Width 23.3 inches
 Height of Working Width 68.2 inches

Vehicle Damage

VDS 01RFQ5
 CDC 01FREW4
 Max. Exterior Deformation 14.0 inches
 OCDI RF0030000
 Max. Occupant Compartment Deformation 4.0 inches

Figure 5.6. Summary of Results for MASH Test 3-11 on 42-inch Tall Combination Traffic-Pedestrian-Bicycle Bridge Rail System.

Chapter 6. SUMMARY AND CONCLUSIONS

6.1. ASSESSMENT OF TEST RESULTS

The crash test reported herein was performed in accordance with *MASH* Test 3-11, which involves a 2270P vehicle impacting the bridge rail at a target impact speed and impact angle of 62 mi/h and 25°. An assessment of the test based on the applicable safety evaluation criteria for *MASH* Test 3-11 for longitudinal barriers is provided in Table 6.1.

6.2 CONCLUSIONS

Table 6.2 shows the 42-inch tall combination traffic-pedestrian-bicycle bridge rail system passed the performance criteria for *MASH* Test 3-11 for longitudinal barriers.

Table 6.1. Performance Evaluation Summary for MASH Test 3-11 on 42-inch Tall Combination Traffic-Pedestrian-Bicycle Bridge Rail System.

Test Agency: Texas A&M Transportation Institute

Test No.: 611971-02-1

Test Date: 2020-04-03

MASH Test 3-11 Evaluation Criteria	Test Results	Assessment
<u>Structural Adequacy</u> A. <i>Test article should contain and redirect the vehicle or bring the vehicle to a controlled stop; the vehicle should not penetrate, underride, or override the installation although controlled lateral deflection of the test article is acceptable.</i>	The 42-inch tall combination traffic-pedestrian-bicycle bridge rail system contained and redirected the 2270P vehicle. The vehicle did not penetrate, underride, or override the installation. Maximum dynamic deflection of the aluminum rail element during the test was 3.1 inches.	Pass
<u>Occupant Risk</u> D. <i>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.</i> <i>Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.2.2 and Appendix E of MASH.</i>	No detached elements, fragments, or other debris were present to penetrate or show potential for penetrating the occupant compartment, or to present hazard to others in the area. Maximum occupant compartment deformation was 4.0 inches in the right front floor pan.	Pass
F. <i>The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.</i>	The 2270P vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 16° and 6°.	Pass
H. <i>Occupant impact velocities (OIV) should satisfy the following limits: Preferred value of 30 ft/s, or maximum allowable value of 40 ft/s.</i>	Longitudinal OIV was 15.4 ft/s, and lateral OIV was 24.6 ft/s.	Pass
I. <i>The occupant ridedown accelerations should satisfy the following limits: Preferred value of 15.0 g, or maximum allowable value of 20.49 g.</i>	Maximum longitudinal ridedown acceleration was 5.4 g, and maximum lateral ridedown acceleration was 10.4 g.	Pass

Table 6.2. Assessment Summary for *MASH* Test 3-11 on 42-inch Tall Combination Traffic-Pedestrian-Bicycle Bridge Rail System.

Evaluation Factors	Evaluation Criteria	Test No. 611971-02-1
Structural Adequacy	A	S
Occupant Risk	D	S
	F	S
	H	S
	I	S
Test No.		<i>MASH</i> Test 3-11
Pass/Fail		Pass

Note: S = Satisfactory

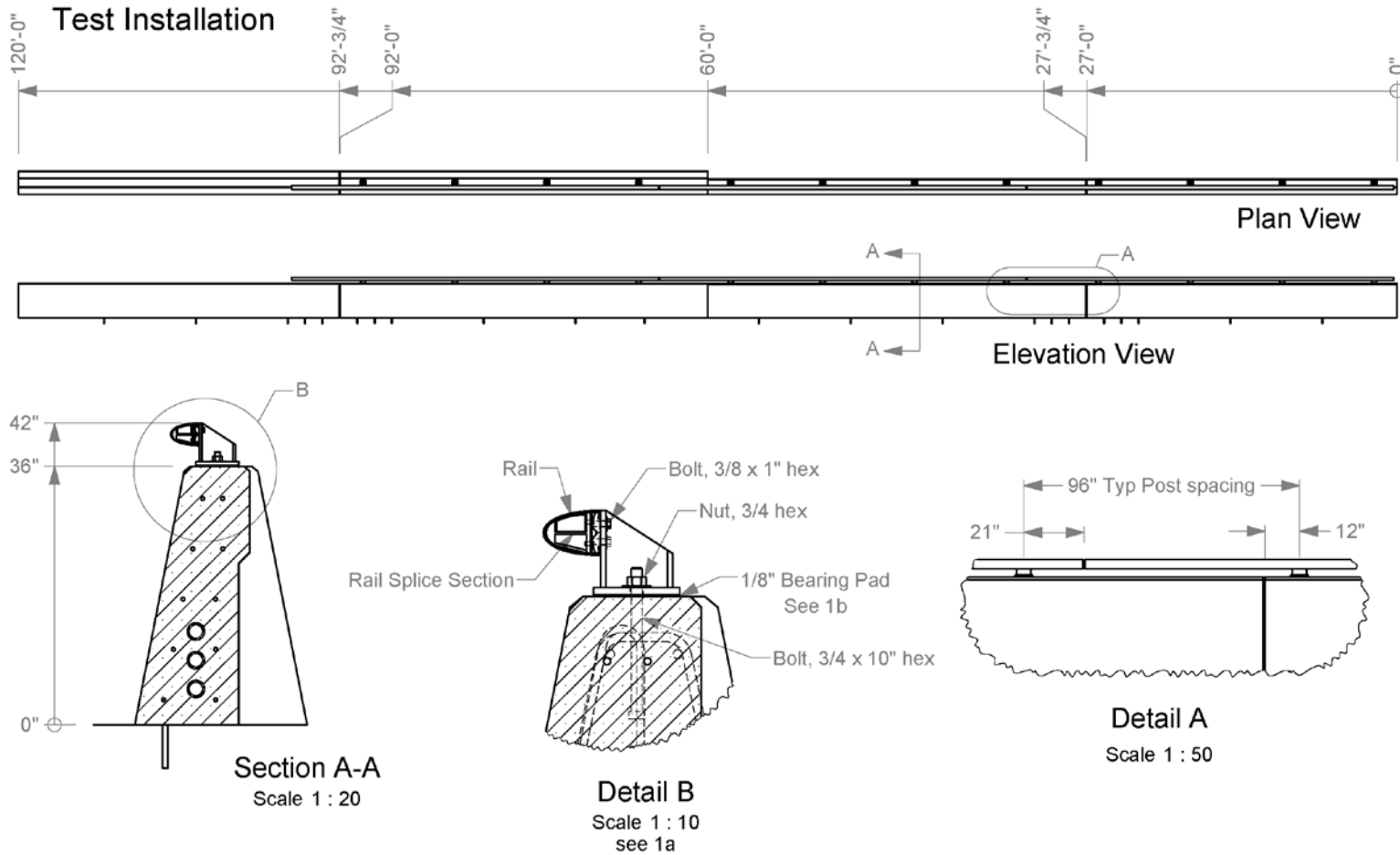
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1. AASHTO. *Manual for Assessing Roadside Safety Hardware, Second Edition*. American Association of State Highway and Transportation Officials: Washington, DC, 2016.

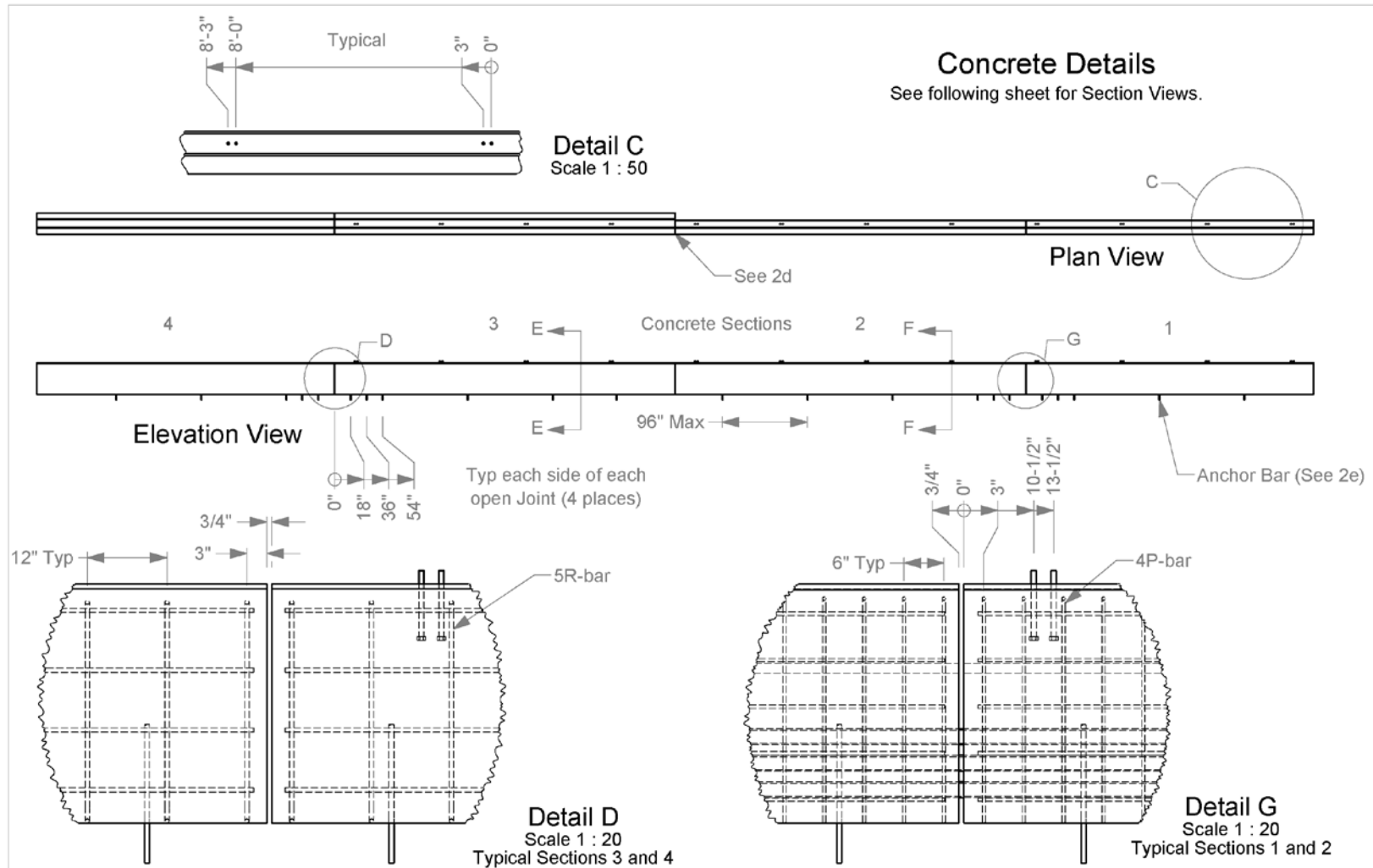
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APPENDIX A. DETAILS OF BRIDGE RAIL



- 1a.** The Rail Clamp Bar and all hardware shown in Detail B are x 2 at each Post. Fasteners are ASTM F-593, Alloy Group 2 (316) Stainless Steel. Flat washer under post bolt heads and under anchor bolt nuts.
- 1b.** The Bearing Pad shall meet Fla DOT Specification Section 932 for Ancillary Structures, and shall be Plain (not fiber reinforced). See the Post Base Plate detail for outside dimensions, hole spacing, etc.

	Roadside Safety and Physical Security Division - Proving Ground
Project #611971-2 Fla Single Slope with Ped Rail	2020-01-23
Drawn by GES	Scale 1:150
Sheet 1 of 6	Test Installation



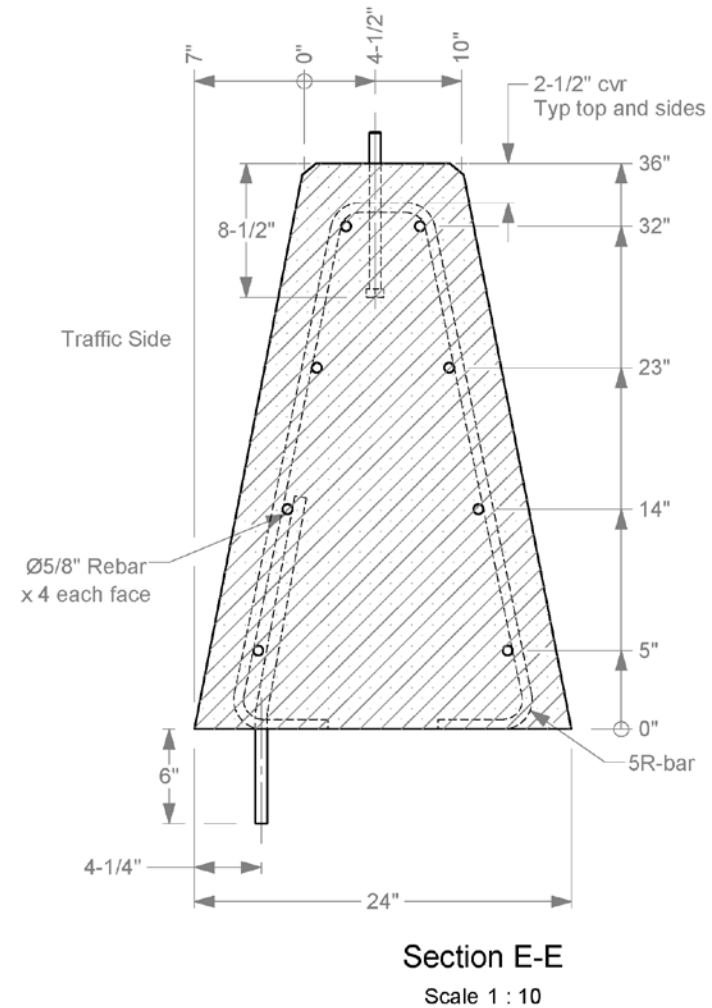
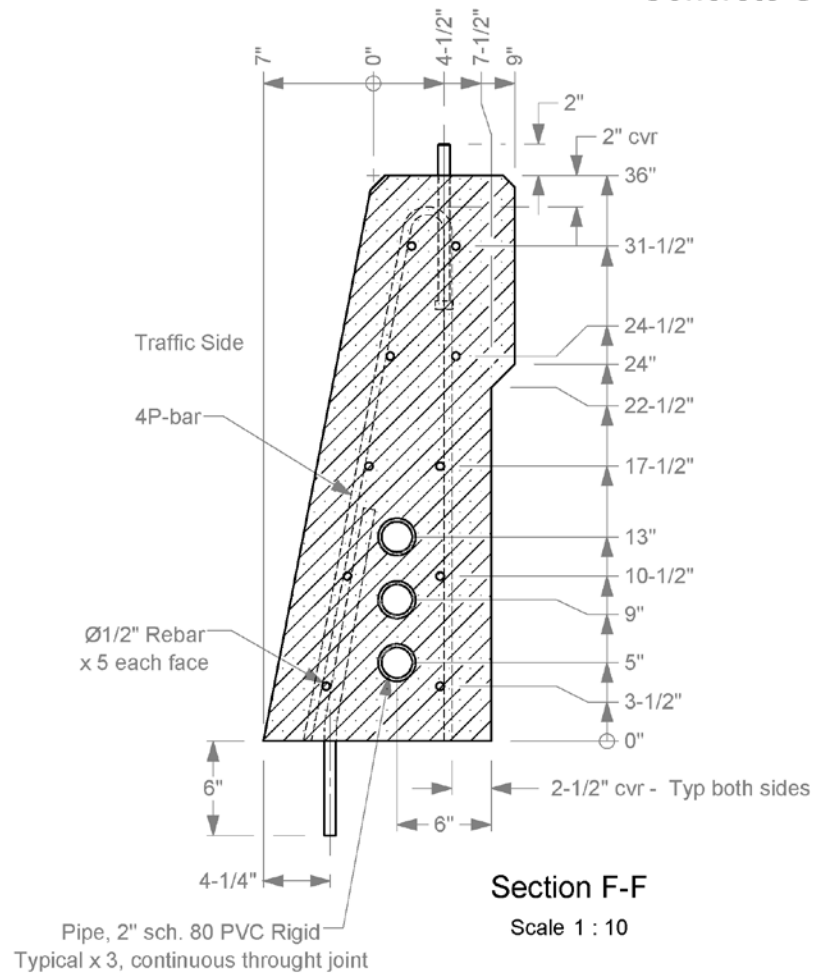
- 2a.** Concrete shall be 3400 psi. Chamfer top edges of Parapets 3/4".
- 2b.** Rebar dimensions are to the centerline unless otherwise indicated by cvr (cover).
- 2c.** Minimum rebar lap is 17" for #4 bars and 21" for #5 bars. All rebar is grade 60.
- 2d.** Cold joint between profiles, with no space.
- 2e.** Secure in existing concrete with Hilti HIT-RE 500 V3 epoxy according to manufacturer's instructions. See next sheet for additional dimensions.



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Project #611971-2 Fla Single Slope with Ped Rail	2020-01-23
Drawn by GES	Scale 1:150
Sheet 2 of 6 Concrete Details	

Concrete Section Views



- 3a.** Concrete shall be 3400 psi. Chamfer top edges 3/4".
3b. Minimum rebar lap is 24" for #4 bars and 26" for #5 bars. All rebar is grade 60.
3c. Rebar dimensions are to the centerline unless otherwise indicated by cvt (cover). Bolt locations are to centerline.



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Proving Ground

Project #611971-2 Fla Single Slope with Ped Rail	2020-01-23
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Sheet 3 of 6	Concrete Section Views

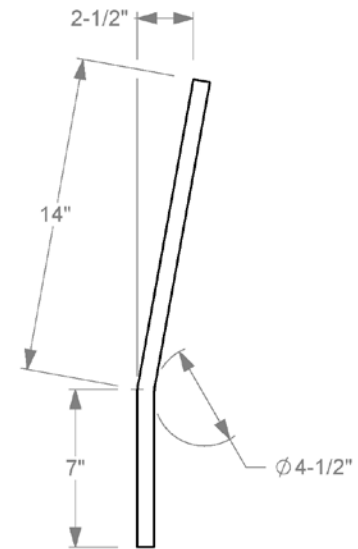


5R-bar
Ø5/8" Grade 60 Rebar



4P-bar
Ø1/2" Grade 60 Rebar

Rebar Details



Anchor Bar
Ø3/4" Grade 60 Rebar



Roadside Safety and
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Proving Ground

Project #611971-2 Fla Single Slope with Ped Rail

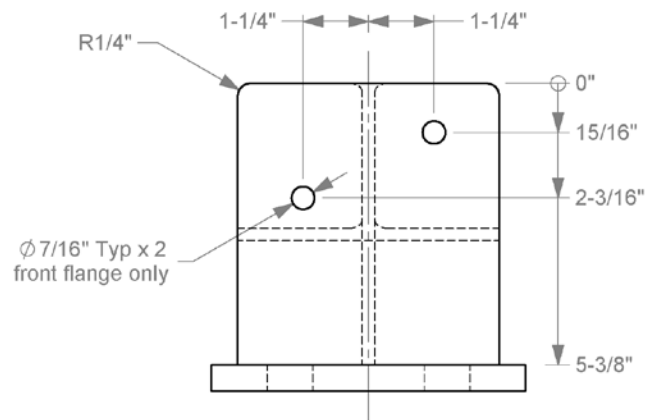
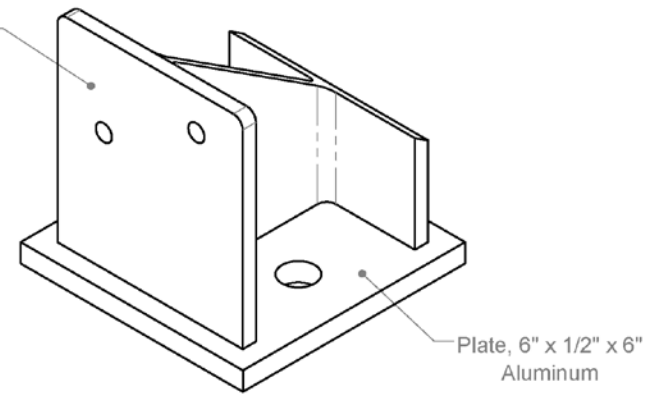
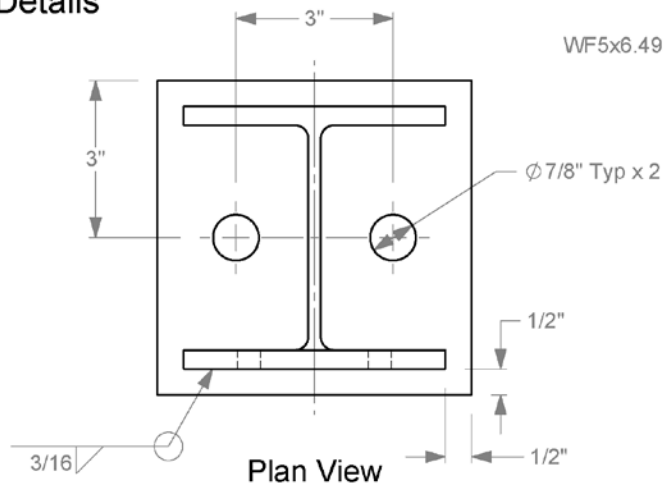
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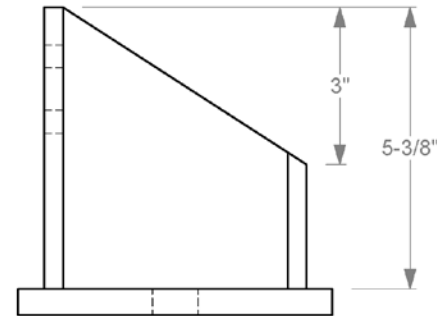
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Sheet 4 of 6 Rebar Details

Post Details

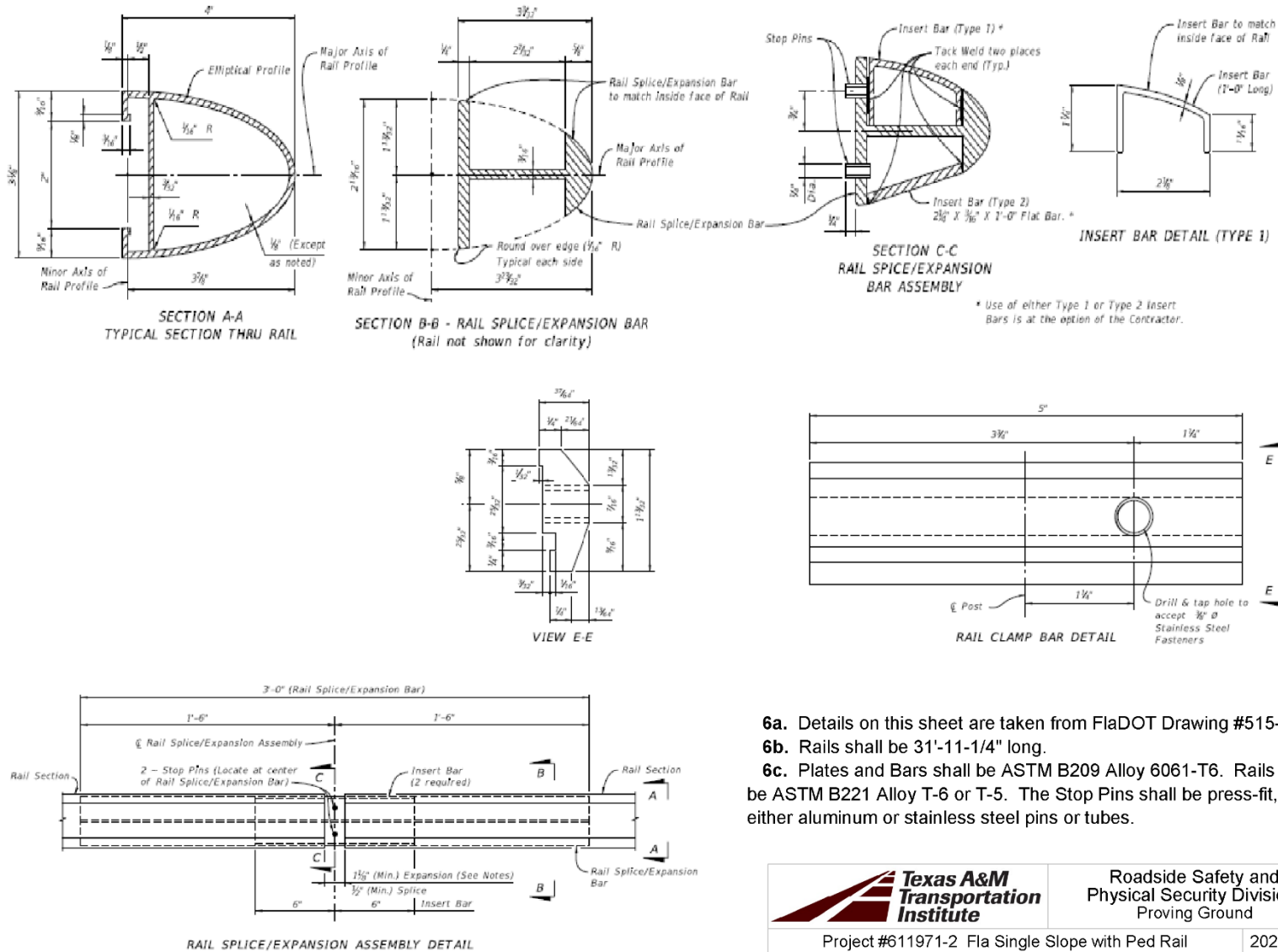


Elevation Views



		Roadside Safety and Physical Security Division - Proving Ground
Project #611971-2 Fla Single Slope with Ped Rail		2020-01-23
Drawn by GES	Scale 1:3	Sheet 5 of 6 Post Details

Rail and Clamp Bar Details



- 6a.** Details on this sheet are taken from FlaDOT Drawing #515-022.
- 6b.** Rails shall be 31'-11-1/4" long.
- 6c.** Plates and Bars shall be ASTM B209 Alloy 6061-T6. Rails shall be ASTM B221 Alloy T-6 or T-5. The Stop Pins shall be press-fit, and either aluminum or stainless steel pins or tubes.



Roadside Safety and
Physical Security Division -
Proving Ground

Project #611971-2 Fla Single Slope with Ped Rail

2020-01-23

Drawn by GES

Scale 1:50

Sheet 6 of 6 Rail and Clamp Bar Details

APPENDIX B. SUPPORTING CERTIFICATION DOCUMENTS



Phone: 800-547-6758 | Fax: 503-227-4634
3441 NW Guam Street, Portland, OR 97210
Web: www.portlandbolt.com | Email: sales@portlandbolt.com

+-----+
| CERTIFICATE OF CONFORMANCE |
+-----+

For: CUSTOM FABRICATORS & REPAIRS
PB Invoice#: 128987
Cust PO#: TUCKER 25587
Date: 2/19/2020
Shipped: 2/19/2020

We certify that the following items were manufactured and tested in accordance with the chemical, mechanical, dimensional and thread fit requirements of the specifications referenced.

Description: 3/4 X 10 GALV ASTM A307A HEX BOLT

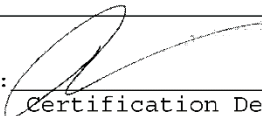
+-----+		Base Steel: A36		Diam: .68	
Heat#: 1202014242					
+-----+					
Source: NUCOR STEEL		Proof Load:		0	
C : .120	Mn: .620	P : .004	Hardness:	0	
S : .036	Si: .180	Ni: .120	Tensile:	65,600 PSI	RA: 57.00%
Cr: .170	Mo: .030	Cu: .300	Yield:	49,400 PSI	Elong: 28.00%
Pb: .000	V : .001	Cb: .000	Sample Length:	8 INCH	
N : .000		CE: .2531	Charpy:	CVN Temp:	

Nuts:
ASTM A563A HEX

Washers:
ASTM F436-1 RND

Coatings:
ITEMS HOT DIP GALVANIZED PER ASTM F2329/A153C

Other:
ALL ITEMS MELTED & MANUFACTURED IN THE USA

By: 
Certification Department Quality Assurance
Dane McKinnon



Mill Certification

07/12/2019

MTR#:220744-1
Lot #:120201424260
W CEMETERY ROAD
PLYMOUTH, UT 84330 US
800-453-2886
Fax: 435-458-2309

Sold To: PORTLAND BOLT & MFG INC
3441 NW GUAM AVE
PORTLAND, OR 97208 US

Ship To: PORTLAND BOLT & MFG INC
3441 NW GUAM AVE
PORTLAND, OR 97208 US

Customer PO	41273	Sales Order #	12026334 - 1.2
Product Group	Hot Roll - Merchant Bar Quality	Product #	3008569
Grade	F1554 Gr 36	Lot #	120201424260
Size	0.68"	Heat #	1202014242
BOL #	BOL-307820	Load #	220744
Description	Hot Roll - Merchant Bar Quality Round 0.68" F1554 Gr 36 20' 0" [240"] 2001-6000 lbs	Customer Part #	
Production Date	07/09/2019	Qty Shipped LBS	60912
Product Country Of Origin	United States	Qty Shipped EA	2464
Original Item Description		Original Item Number	

I hereby certify that the material described herein has been manufactured in accordance with the specifications and standards listed above and that it satisfies those requirements.

Melt Country of Origin : United States

Melting Date: 07/01/2019

C (%)	Mn (%)	P (%)	S (%)	Si (%)	Ni (%)	Cr (%)	Mo (%)	Cu (%)	V (%)	Nb (%)
0.12	0.62	0.004	0.036	0.18	0.12	0.17	0.03	0.30	0.001	0.000

Other Test Results

Yield (PSI) : 49400

Yield (PSI) : 48600

Tensile (PSI) : 65600

Tensile (PSI) : 65800

Elongation in 8" (%) : 28.0

Elongation in 8" (%) : 27.0

Reduction of Area (%) : 57

Comments:

ASTM A36/A36M-14, ASTM F1554-17e1 Gr36

Nucor-Plymouth is an ISO-9001 and an ABS certified mill. CMTR complies with DIN EN 10204 - 3.1 All manufacturing processes of the steel materials in this product, including melting, casting, and hot rolling have occurred in the United States. All products produced are weld free. Mercury, in any form, has not been used in the production or testing of this material.

Bryden Morris, Chief Metallurgist



DECKER MANUFACTURING CORPORATION
708 N. Clark Street
Albion, Michigan 48224
P: 517.629.5955 • F: 517.629.3536

PORTLAND BOLT & MFG CO
3441 N W GUAM STREET
PORTLAND, OR 97210

Printed: 5/31/2018 3:21:18 PM
May 31, 2019

PRODUCT MATERIAL CERTIFICATION

CUSTOMER PART NUMBER : 16275
CUSTOMER P.O. NUMBER : 39371

INVOICE: 514038

LOT NUMBER: 19-40-006

DESCRIPTION: 3/4-10 HX NUT DC .020

DATE: Sep 19, 2018

QUANTITY: 10,200

HEAT NUMBER: 10573200

MATERIAL SUPPLIER: CHARTER STEEL

MATERIAL: STEEL - C1015

We certify the product above was manufactured at DECKER MANUFACTURING CORPORATION from the specified raw material and that said product is certified to be manufactured, randomly sampled, tested and/or inspected and conforms to applicable specifications. We additionally certify that said raw material was domestically manufactured in the United States of America and that said raw material was manufactured free of mercury contamination.

The items were processed under the Decker Quality Manual. The current revision is dated January 12, 2005
No welding was performed.

This document accurately represents values and statements provided by our suppliers accredited testing facility.
The original metallurgical test report shall be retained on file by DECKER MANUFACTURING CORPORATION for a period of not less than (10) years.

CHEMICAL ANALYSIS BY MATERIAL SUPPLIER

CARBON : 0.140

PHOSPHOROUS : 0.007

MANGANESE : 0.380

SULFUR : 0.008

DECKER MANUFACTURING CORPORATION

Russel L. Wilson
Quality Assurance Manager

The above results pertain only to the items tested. This report shall not be reproduced except in full without the approval of this testing facility.

39371-3

DECKER

SINCE 1927

www.deckernut.com

DECKER MANUFACTURING CORPORATION
703 N. Clark Street
Albion, Michigan 49224
P: 517.629.3855 • F: 517.629.3535

LABORATORY AND TESTING FACILITY
Reaffirmed to be in compliance to current Rev Level, Form 8.0
ORIGINAL LABORATORY AND/OR INSPECTION REPORT
THIS IS A LEGAL DOCUMENT

NAME AND ADDRESS OF CLIENT: _____
PAGE 1 OF 2 DATE OF MANUFACTURE: 02-26-19
LAB FILE ID NUMBER/LOT NUMBER: 19-40-006
DMC PART NUMBER #: 026-1210-26
ITEM DESCRIPTION: 3/4" x 1/2" 28 HEX NUT + 02-0
GRADE ID MARK AND INSIGNIA: DMC
NAME (S) OF PERSON (S) SAMPLING: S. FAYELLE SAMPLING
PROCEDURES ARE UNDER THE SUPERVISION OF DECKER MANUFACTURING CORPORATION'S
QUALITY DEPARTMENT.
PRODUCTION LOT SIZE: <200M SUITABILITY/CONDITION OF TEST SPECIMENS: ACCEPTABLE
TOTAL NO. OF SAMPLES INSPECTED AND/OR TESTED (8) EIGHT
INSPECTIONS AND/OR TESTS:
INSPECTION/TEST DATE (S): 3-19-19 3-18-19
DESCRIPTION (S): ROCKWELL HRB PROOFLOAD
SPECIFICATION (S): ASTM E12 ASTM E606
REQUIREMENTS: ASTM A563 GRADE A @ HRB 89 MIN @ HRB 32 MAX ASTM A563 GRADE B @ 30,000 LBF
EQUIPMENT ID: # PH10000120120012 # 184280

UNIT OF MEASUREMENT: <u>HRB W</u>				UNIT OF MEASUREMENT: <u>LBF</u>			
(1)	<u>86.95</u>	(5)	<u>89.45</u>	(1)	<u>30,800</u>	(5)	<u>31,200</u>
(2)	<u>89.4</u>	(6)	<u>88.75</u>	(2)	<u>31,000</u>	(6)	<u>31,000</u>
(3)	<u>86.9</u>	(7)	<u>89.25</u>	(3)	<u>31,300</u>	(7)	<u>30,800</u>
(4)	<u>89.85</u>	(8)	<u>89.4</u>	(4)	<u>30,900</u>	(8)	<u>31,000</u>

RESULTS OBTAINED FROM: Wearmax Plus
SPECIFICATION OR MATERIAL GRADE AS EVIDENCED: C-1010
REMARKS OR DEVIATIONS: MEET AND EXCEED ASTM A563 (02) GRADE A REQUIREMENTS
PER ASTM E606 SECTION 4 THE HARDNESS OF EACH SAMPLE IS THE AVERAGE OF TWO READINGS.
HEAT TREAT, SURFACE TREATMENT, COATING, ETC.: None and Samples Were Grounded
All parts reported on this document were manufactured at this location in the United States from domestic materials.

TO THE SPECIFICATIONS ABOVE, THE SAMPLES INSPECTED AND/OR TESTED
CONFORM: X ARE RESULTS ONLY: _____ DO NOT CONFORM: _____

APPROVED SIGNATORY
QUALITY MANAGER

Russell L. Wilson MK

INSPECTED AND/OR TESTED BY:

Michael J. Heaton
Authorized Lab Technician

I CERTIFY THAT THE ABOVE DATA WAS OBTAINED IN ACCORDANCE WITH THE ABOVE STATED SPECIFICATION (S) AND
THAT THE RESULTS ARE CORRECT AS ENTERED. THE ABOVE RESULTS ONLY PERTAIN TO THE SAMPLES TESTED.
OFF THE QUALITY MANUAL FOR MANUFACTURING DECKERS CORPORATION. THIS DOCUMENT SHALL NOT BE REPRODUCED IN FULL
WITHOUT THE APPROVAL OF DECKER MANUFACTURING CORPORATION. DO NOT BRING OR ALTER ANY ERRORS - DRAW A
CORRECTION LINE THROUGH AND INITIAL. SEE REVERSE OF THIS DOCUMENT FOR THE TERMS AND CONDITIONS OF THIS
TEST REPORT. THE DECISION RULE IS SIMPLE EXCEPTANCE. (BY DECISION RULE IS SIMPLE EXCEPTANCE).



TESTING CERT # 0499-01

LABORATORY AND TESTING FACILITY
Addendum to FORM 8.x
ROCKWELL DATA COLLECTION WORKSHEET

Form 8.4

PAGE 2 OF 2
LAB FILE ID NUMBER/LOT NUMBER: 19-40-006 DATE OF MANUFACTURE: _____
DMC PART NUMBER #: 026-120-26
ITEM DESCRIPTION: 3/4" x 10 38 HEX NUT + 020
NAMES(S) OF PERSON(S) SAMPLING: R. HARRIS S. ESTEY SAMPLING PROCEDURES ARE
UNDER THE SUPERVISION OF DECKER MANUFACTURING CORPORATION'S QUALITY DEPARTMENT.
INSPECTION/TEST DATE (S): 3-19-09
DESCRIPTION (S): ROCKWELL HRR
SPECIFICATION (S): ASTM F-18
REQUIREMENTS: ASTM A-563 B @ HRR 69 MIN & HRC 32 MAX.
EQUIPMENT ID: # FH-10000170120012

INSPECTION / TEST RESULTS:

UNIT OF MEASUREMENT: HRR

Individual readings	Total	Mean Average
(1) <u>87.1</u> <u>86.8</u> :	<u>173.9</u> :	<u>86.95</u> :
(2) <u>89.1</u> <u>89.7</u> :	<u>178.8</u> :	<u>89.4</u> :
(3) <u>85.6</u> <u>88.2</u> :	<u>173.8</u> :	<u>86.9</u> :
(4) <u>90.0</u> <u>89.7</u> :	<u>179.7</u> :	<u>89.85</u> :
(5) <u>88.9</u> <u>90.0</u> :	<u>178.9</u> :	<u>89.45</u> :
(6) <u>87.5</u> <u>90.0</u> :	<u>177.5</u> :	<u>88.75</u> :
(7) <u>88.9</u> <u>89.6</u> :	<u>178.5</u> :	<u>89.25</u> :
(8) <u>88.2</u> <u>90.1</u> :	<u>178.8</u> :	<u>89.4</u> :

READINGS OBTAINED FROM W WRENCH FLATS: _____ BEARING SURFACE: _____ CORE: _____
PER ASTM F408 PARAGRAPH 4.12 THE REPORTED HARDNESS IS THE AVERAGE OF 2 READINGS OF EACH TEST SAMPLE.
IN ADDITION ALL READINGS SHALL BE WITHIN HARDNESS VALUES LISTED IN THE PRODUCT SPECIFICATION.

INSPECTED AND/OR TESTED BY:

Michael J. Miller
Authorized Lab Technician

I CERTIFY THAT THE ABOVE DATA WAS OBTAINED IN ACCORDANCE WITH THE ABOVE STATED SPECIFICATION (S) AND
THE RESULTS ARE CORRECT AS REPORTED. THE ABOVE RESULTS ONLY PERTAIN TO THE SAMPLE (S)ES TESTED.
USE THE QUALITY MANUAL FOR ADDITIONAL REPORT GUIDANCE. THIS DOCUMENT SHALL NOT BE REPRODUCED IN ANY
MANNER WITHOUT THE APPROVAL OF DECKER MANUFACTURING CORPORATION. DO NOT DUPLICATE OR ALTER THE RESULTS - FROM A
COPY OF THE TEST REPORT AND INITIAL. SEE INSTRUCTIONS OF THIS DOCUMENT FOR THE CORRECT AND COMPLETION OF THIS
TEST REPORT. THE SECTION RULE IS APPLICABLE TO THIS REPORT.





**CHARTER
STEEL**

A Division of
Charter Manufacturing Company, Inc.

EMAIL

1658 Cold Springs Road
Saukville, Wisconsin 53080
(262) 269-2400
1-800-437-6789
Fax (262) 269-2570

Melted in USA Manufactured in USA

CHARTER STEEL TEST REPORT

Decker Manufacturing Corp.
703 N. Clark St.
Albion, MI-48224

Cust P.O.	997
Customer Part #	1.062 1015
Charter Sales Order	30158420
Heat #	10673200
Ship Lot #	4650626
Grade	1015 A AK FG RHQ 1-1/16 RND COIL
Process	HRCC
Finish Size	1-1/16
Ship date	16-SEP-18

I hereby certify that the material described herein has been manufactured in accordance with the specifications and standards listed below and that it satisfies these requirements. The recording of false, fictitious and fraudulent statements or entries on this document may be punishable as a felony under federal statute.

Lab Code: 7388

Test results of Heat Lot # 10673200

CHEM	C	MN	P	S	SI	NI	CR	MO	CU	SN	V
%Wt	.14	.36	.007	.008	.080	.04	.08	.01	.08	.006	.001
	AL	N	B	TI	NS						
	.022	.0080	.0001	.001	.001						

Test results of Rolling Lot # 1252038					
	# of Tests	Min Value	Max Value	Mean Value	
ROCKWELL B (HRBW)	1	84	84	84	RB LAB = 0369-02
RDD SIZE (Inch)	4	1.056	1.086	1.061	
RDD OUT OF ROUND (Inch)	2	.009	.010	.010	

REDUCTION RATIO=34:1

Specifications: Manufactured per Charter Steel Quality Manual Rev Date 06/12/17
Charter Steel certifies this product is indistinguishable from background radiation levels by having process radiation detectors in place to measure for the presence of radiation within our process & products.
Meets customer specifications with any applicable Charter Steel exceptions for the following customer documents:
Customer Document = ASTM A29/A29M Revision = 16 Dated = 01-DEC-16

Additional Comments:

Melt Source:
Charter Steel
Saukville, WI, USA

Trip: 1305334



Page 1 of 2

This MTR supersedes all previously dated MTRs for this order

Janice Barnard
Janice Barnard Division Mgr. of Quality Assurance
barnardj@chartersteel.com
Printed Date : 09/18/2018

The following statements are applicable to the material described on the front of this Test Report:

1. Except as noted, the steel supplied for this order was melted, rolled, and processed in the United States meeting DFARS compliance, LEEDS compliance, REACH compliance, ROHS-WEEE compliance, and Conflict Materials Restrictions.
2. Mercury was not used during the manufacture of this product, nor was the steel contaminated with mercury during processing.
3. Unless directed by the customer, there are no welds in any of the coils produced for this order.
4. The laboratory that generated the analytical or test results can be identified by the following key:

Certificate Number	Lab Code	Laboratory	Address
0358-01	7388	CSSM Charter Steel Melting Division	1658 Cold Springs Road, Saukville, WI 53080
0358-02	8171	CSSR/ CSSP Charter Steel Rolling/ Processing Division	1658 Cold Springs Road, Saukville, WI 53080
0358-03	123633	CSFP Charter Steel Ohio Processing Division	6255 US Highway 23, Rising Sun, OH 43457
0358-04	125544	CSCM/ CSCR Charter Steel Cleveland	4300 E. 49th St., Cuyahoga Heights, OH 44125-1004
*	*	—	Subcontracted test performed by laboratory not in Charter Steel System

5. When run by a Charter Steel laboratory, the following tests were performed according to the latest revisions of the specifications listed below, as noted in the Charter Steel Laboratory Quality Manual:

Test	Specifications	CSSM	CSSR/ CSSP	CSFP	CSCM/ CSCR
Chemistry Analysis	ASTM E415; ASTM E1019	X			X
Macroetch	ASTM E381	X			X
Hardenability (Jominy)	ASTM A255; SAE J405; JIS G0561	X			X
Grain Size	ASTM E112	X	X	X	X
Tensile Test	ASTM E8; ASTM A370		X	X	X
Rockwell Hardness	ASTM E18; ASTM A370	X	X	X	X
Microstructure (spheroidization)	ASTM A892		X	X	
Inclusion Content (Methods A, E)	ASTM E45		X		X
Decarburization	ASTM E1077		X	X	X

Charter Steel has been accredited to perform all of the above tests by the American Association for Laboratory Accreditation (A2LA). These accreditations expire 01/31/19. All other test results associated with a Charter Steel laboratory that appear on the front of this report, if any, were performed according to documented procedures developed by Charter Steel and are not accredited by A2LA.

6. The test results on the front of this report are the true values measured on the samples taken from the production lot. They do not apply to any other sample.
7. This test report cannot be reproduced or distributed except in full without the written permission of Charter Steel. The primary customer whose name and address appear on the front of this form may reproduce this test report subject to the following restrictions:
 - It may be distributed only to their customers
 - Both sides of all pages must be reproduced in full
8. This certification is given subject to the terms and conditions of sale provided in Charter Steel's acknowledgement (designated by our Sales Order number) to the customer's purchase order. Both order numbers appear on the front page of this Report.
9. Where the customer has provided a specification, the results on the front of this test report conform to that specification unless otherwise noted on this test report.



✓ Sale C
JH

INDIANA GALVANIZING, LLC

Hot-Dip Galvanizing
51702 Lovejoy Dr.
Middlebury IN, 46540
Phone: 574-822-9102 Fax: 574-822-9106

Customer
Decker Manufacturing Corporation
703 North Clark Street
Albion MI 49224

PO: 1757
DATE: 4/1/2019

Hot-Dip Galvanizing Certification

Indiana Galvanizing certifies that samples representing listed lot(s) have been tested and inspected as required by applicable specifications. The results of this inspection and testing demonstrates that the requirements for ASTM F2329, including the requirements ASTM A153 Class D, Class C that are referenced within the specification, have been met and have been galvanized in Middlebury, Indiana of the United States of America. Indiana Galvanizing LLC is RoHS compliant.

Kettle Temperature (Must be between 815 and 850 Degrees Fahrenheit)

840

Mill Readings

Part Number	Lot Number	Quantity	High	Low	Average
035-1031-92	19-42-007	20,126	3.90	2.40	3.30
035-1031-92	19-52-012	40,684	3.95	2.45	3.25
035-1031-92	19-52-013	20,103	3.95	2.40	3.30
035-1031-92	19-52-017	19,598	4.00	2.30	3.20
026-1608-92	19-44-001	12,085	3.90	2.40	3.25
026-1210-92	19-40-006	77,782	3.95	2.10	3.15
026-0813-92	19-39-006	39,250	3.80	2.15	3.10
026-0813-92	19-39-008	41,639	3.85	2.25	3.25
026-0616-92	19-36-008	228,134	3.90	2.25	3.15

Amy Jarzynski

Quality Manager or Assignee



TECHNICAL STAMPING, INC.

50600 E. RUSSELL SCHMIDT BLVD.
(CHESTERFIELD) TWP., MI 48051
PH(586)948-3285 / FX(586)948-3286

MATERIAL CERTIFICATION

CUSTOMER NAME			CUSTOMER ORDER NUMBER			DATE		
Portland Bolt & Mfg Co			43577			11/25/19		
PART NUMBER - CUSTOMER LOT NO.			LOT NUMBER			QUANTITY		
3/4" F436 Hdg 16445			0719-210			20,000		
STEEL GRADE	HEAT	C	MN	P	S	SI	AL	REVISION
	B53150	.52	.68	.011	.001	.17	.046	ASTM F-436-10
SPECIFICATION		ACTUAL				GAUGE		
O.D - 1.436 - 1.500		1.445 - 1.448				CALIPER		
I.D - .813 - .845		.824 - .827				CALIPER, PIN GAUGE		
THICKNESS- .122 - .177		.128 - .131				MICROMETER		
FLAT- Max .010		.004				CALIPER		
HEAT TREAT - 38 - 45 HRC		40 - 42						
PLATING-		See Attached Cert						
OTHER		N/A						

WE HEREBY CERTIFY THIS PRODUCT WAS PRODUCED UNDER A ISO-9001 QUALITY ASSURANCE SYSTEM. ISO-9001 CERTIFICATION NUMBER-1266 - DATE OF REGIS. JAN. 9, 2003
ALL MATERIALS ARE MADE AND MELTED IN THE U.S.A. THIS PRODUCT WAS MANUFACTURED IN CHESTERFIELD, MICHIGAN, U.S.A. THIS PRODUCT CONFORMS TO ALL REQUIREMENTS
FOR WASHERS AS PRODUCED ACCORDING TO A.S.T.M. F-436-10. THE ABOVE TEST RESULTS APPLY ONLY TO THE ITEMS TESTED. THIS TEST REPORT MUST NOT BE REPRODUCED
EXCEPT IN FULL WITHOUT PRIOR WRITTEN APPROVAL.

Shirley Nelson

AUTHORIZED SIGNATURE

CERTIFIED ISO 9001:

"MADE AND MANUFACTURED IN THE USA"

ISO-9001 Rev. 2 11/26/01

43577-3

1529

INDUSTRIAL STEEL TREATING COMPANY, INC

613 Carroll Street Jackson, MI 49202
P.O. Box 98 Jackson MI, 49204
Voice: 517-787-6312 Fax: 517-787-5441

HEAT TREAT CERTIFICATION

Customer:
TECHNICAL STAMPING, INC.
Attn: SHANNON COX
50600 E. RUSSELL SCHMIDT
CHESTERFIELD, MI 48051

Certification Date:
07/31/2019

Page: 1 of 1

Order Details

Part Number: F0034
Packing Slip: 7184
Purchase Order:
IST Order Number: 762970-1
Lot Number: 0719-210
Heat Number: B53150

Blue Print Rev: 1279
Material Type: 1030 - 1050
Quantity: 296,569
Net Weight: 11,151.0
Part Desc: WASHER
Comments: 7 TUBS#988, C110, 104, B601,
1214, C44, C117

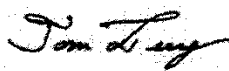
SPECIFICATIONS

HRC 38 - 45
HEAT TREATED IN THE USA

RESULTS

HRC 40 - 42
HEAT TREATED IN THE USA

Approval:



Tom Levy - Quality Assurance Supervisor

Contact

Tom Levy - Quality Assurance Supervisor
Voice: 517-780-9043 Fax: 517-787-5441
E-Mail: tolevy@indstl.com

This Certification cannot be reproduced except in full, without written authorization from Industrial Steel Treating Company, LLC.

9291

CERTIFICATE OF CONFORMANCE

SABRE STEEL INC.
23880 RESEARCH DRIVE
FARMINGTON HILLS, MI 48335
248-615-0500



7/9/2019 2:52:13 PM

Sold To: TECHNICAL STAMPING
50800 E. RUSSELL SCHMIDT BLVD.
CHESTERFIELD TWP., MI 48051

Ship To: TECHNICAL STAMPING
50800 RUSSELL SCHMIDT BLVD.
CHESTERFIELD TWP., MI 48051

Cust PO: S91526

Ship Date: 7/11/2019

Sales Order: 76481

Weight: 98,770#

CHEMICAL ANALYSIS

Heat Number:	B53150		
C:	.52	Mn:	.68
Si:	.17	Ti:	.006
Cu:	.02	Al:	.045
Ni:	.01	B:	
		P:	.011
		Cr:	.06
		Co:	.001
		Sn:	
		S:	.001
		Mo:	
		Va:	.005
		N:	

PHYSICAL PROPERTIES

YS: TS: E:
Chemistry: C1050

Line: 1 Item: .122min x 5.68 HRPO C1050
Grade: HRP&O High Carbon
Cust Part: F0034M

Comment: Tags 65467 A thru Z Made & Melted in US

WE HEREBY CERTIFY THE ABOVE FIGURES ARE ACCURATELY STATED, MEET YOUR MATERIAL REQUIREMENTS AND ARE TRACEABLE IN OUR RECORDS BACK TO THE PRODUCER AND/OR AN ACCREDITED TEST LABORATORY.

Quality Assurance Manager

5/20/2019

CERTIFIED REPORT OF CHEMICAL ANALYSIS AND MECHANICAL TESTS

ArcelorMittal



This report shall not be reproduced in whole or in part without the prior written approval from ArcelorMittal USA LLC.

Page 1 of 1

SOLD TO		VENDOR										
SABRE STEEL 23680 RESEARCH DRIVE FARMINGTON HILLS MI		ArcelorMittal Riverdale LLC. 13500 South Perry Avenue Riverdale, IL 60827										
SHIP TO		ORDER INFORMATION										
SABRE STEEL C/O VOSS TAYLOR C/O VOSS STEEL CORP 7925 BEECH DALY RD TAYLOR MI		PO#: 65174/8 LoadID # 03162368 SO#: 162695 Carrier: COMMON CARRIER Date Of Issuance/ 5/14/2019 Invoice # 0500280566 Shipped:										
ORDERED DIMENSIONAL INFORMATION												
Heat	Coil	Thickness (in)	Width (in)	Weight (tons)	Reduction Ratio							
B53150	604418	0.124	48,000	23.9	94.27% (17:1)							
<small>HEAT NUMBER IS BEING USED AS CERTIFICATE NUMBER. Thickness and Width are ordered size. Weight of steel is not an A2LA accredited measurement. COUNTRY OF ORIGIN/EXPORT COUNTRY IS USA. FOR QUESTIONS CONCERNING IMPORTATION OF THIS MATERIAL PLEASE CONTACT: JOSE CASHEROS: 1 SOUTH DEARBORN ST., CHICAGO, IL 60683; TEL: 1-813-763-3756 FAX: Jose.Casheros@arcelormittal.com</small>												
PRODUCT INFORMATION												
Grade	Part Number	Product Description	Comments									
SAE 1050	HB1244800-	Hot Band Prime										
<small>This material was melted and manufactured in the USA. All products are strand cast and free of mercury or radioactive elements. Elongation based on 2" gage length.</small>												
MECHANICAL / PHYSICAL TEST RESULTS*												
Heat	Coil	Yield (ksi)	Tensile (ksi)	El (%)	Dir	N-Value	N-Range	Hardness	Flt-lbs	*E	See	Dir
<small>* Material tested in accordance with ISO-17025 by an accredited lab.</small>												
CHEMICAL TEST RESULTS												
Heat	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Cb	V	Al
B53150	.52	.68	.011	.001	.17	.02	.01	.05	.00	.000	.005	.048
	N	Sn	B	Ti	Ca	Sb						
	.0033	.005	.0001	.0060	.0013	.0010						

Chemical analysis was performed by ArcelorMittal Riverdale, Inc. in accordance with the Current Version of ASTM E415 and E1019.

We hereby certify the above is correct as contained in the records of the corporation and in compliance with the requirements of the order. All tests performed to the current standard to date unless otherwise noted. Uncertainties of measurements estimated and are available upon request. These results relate only to the items tested. Test results marked with an asterisk (*) were reported by an external accredited lab. Test certificates are prepared in accordance with procedures outlined in DIN EN 10204:2006 Type 3.1.

Web:
vLIN

Timothy S. Kaurich | Manager - Quality
13500 South Perry Ave., Riverdale IL 60827
T (708)392-1016 | Tim.Kaurich@ArcelorMittal.com



September 17, 2019

Technical Stamping
50600 E. Russell Schmidt
Chesterfield TWP, MI 48051

To Whom It May Concern:

This is to certify that the hot dip galvanizing of the following washers on your Purchase Order number 1648 conforms to specification ASTM A-153. The following sizes and lot numbers comply with the coating, workmanship, finish, and appearance requirements of ASTM F2329 specifications. The hot dip galvanizing is ROHS compliant. The galvanizing process was conducted in a temperature range of 830F to 855F.

<u>PIECES</u>	<u>PART# & SIZE</u>	<u>LOT NUMBER</u>	<u>AVERAGE ZINC COATING IN MILS</u>
294910	F0034 3/4" Washer	0719-210	5.76

This certification in no way implies anything other than the quality of our hot dip galvanizing as it pertains to your order.

This product was galvanized in Rockford, IL USA

Yours very truly,

AZZ Galvanizing Rockford, IL

A handwritten signature in cursive script, appearing to read 'Peggy Doering'.

Peggy Doering
Office Manager

PD:mt



CMC STEEL TEXAS
1 STEEL MILL DRIVE
SEGUIN TX 78155-7510

CERTIFIED MILL TEST REPORT
For additional copies call
830-372-8771

We hereby certify that the test results presented here
are accurate and conform to the reported grade specification


Rolando A. Davila

Quality Assurance Manager

HEAT NO.:3094043 SECTION: REBAR 13MM (#4) 20'0" 420/60 GRADE: ASTM A615-18e1 Gr 420/60 ROLL DATE: 01/13/2020 MELT DATE: 01/11/2020 Cert. No.: 82958476 / 094043A130		S O L D T O	CMC Construction Svcs College Stati 10650 State Hwy 30 College Station TX US 77845-7950 979 774 5900	S H I P T O	CMC Construction Svcs College Stati 10650 State Hwy 30 College Station TX US 77845-7950 979 774 5900	Delivery#: 82958476 BOL#: 73382608 CUST PO#: 838790 CUST P/N: DLVRY LBS / HEAT: 41629.000 LB DLVRY PCS / HEAT: 3116 EA
Characteristic	Value	Characteristic		Value	Characteristic	Value
C	0.44%	Bend Test Diameter		1.750IN	<p>The Following is true of the material represented by this MTR:</p> <p>*Material is fully killed</p> <p>*100% melted and rolled in the USA</p> <p>*EN10204:2004 3.1 compliant</p> <p>*Contains no weld repair</p> <p>*Contains no Mercury contamination</p> <p>*Manufactured in accordance with the latest version of the plant quality manual</p> <p>*Meets the "Buy America" requirements of 23 CFR635.410, 49 CFR 661</p> <p>*Warning: This product can expose you to chemicals which are known to the State of California to cause cancer, birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov</p>	
Mn	0.73%					
P	0.008%					
S	0.039%					
Si	0.17%					
Cu	0.34%					
Cr	0.11%					
Ni	0.21%					
Mo	0.088%					
V	0.000%					
Cb	0.002%					
Sn	0.014%					
Al	0.001%					
Yield Strength test 1	64.5ksi					
Tensile Strength test 1	100.9ksi					
Elongation test 1	17%					
Elongation Gage Lgth test 1	8IN					
Tensile to Yield ratio test1	1.56					
Bend Test 1	Passed					

REMARKS :



CMC STEEL TEXAS
1 STEEL MILL DRIVE
SEGUIN TX 78155-7510

CERTIFIED MILL TEST REPORT
For additional copies call
830-372-8771

We hereby certify that the test results presented here
are accurate and conform to the reported grade specification


Rolando A Davila

Quality Assurance Manager

HEAT NO.:3093615 SECTION: REBAR 13MM (#4) 40'0" 420/60 GRADE: ASTM A615-18e1 Gr 420/60 ROLL DATE: 12/30/2019 MELT DATE: 12/23/2019 Cert. No.: 82948507 / 093615A371	S O L D T O	CMC Construction Svcs College Stati 10650 State Hwy 30 College Station TX US 77845-7950 979 774 5900	S H I P T O	CMC Construction Svcs College Stati 10650 State Hwy 30 College Station TX US 77845-7950 979 774 5900	Delivery#: 82948507 BOL#: 73368452 CUST PO#: 837870 CUST P/N: DLVRY LBS / HEAT: 19881.000 LB DLVRY PCS / HEAT: 744 EA
Characteristic	Value	Characteristic	Value	Characteristic	Value
C	0.43%	Bend Test Diameter	1.750IN	<p>The Following is true of the material represented by this MTR:</p> <p>*Material is fully killed</p> <p>*100% melted and rolled in the USA</p> <p>*EN10204:2004 3.1 compliant</p> <p>*Contains no weld repair</p> <p>*Contains no Mercury contamination</p> <p>*Manufactured in accordance with the latest version of the plant quality manual</p> <p>*Meets the "Buy America" requirements of 23 CFR635.410, 49 CFR 661</p> <p>*Warning: This product can expose you to chemicals which are known to the State of California to cause cancer, birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov</p>	
Mn	0.87%				
P	0.011%				
S	0.042%				
Si	0.24%				
Cu	0.31%				
Cr	0.11%				
Ni	0.09%				
Mo	0.029%				
V	0.000%				
Co	0.001%				
Sn	0.008%				
Al	0.001%				
Yield Strength test 1	66.8ksi				
Tensile Strength test 1	102.8ksi				
Elongation test 1	14%				
Elongation Gage Lgth test 1	8IN				
Tensile to Yield ratio test1	1.54				
Bend Test 1	Passed				

REMARKS :



CMC STEEL TEXAS
1 STEEL MILL DRIVE
SEGUIN TX 78155-7510

CERTIFIED MILL TEST REPORT
For additional copies call
830-372-8771

We hereby certify that the test results presented here
are accurate and conform to the reported grade specification


Rolando A. Davila

Quality Assurance Manager

HEAT NO.:3093124 SECTION: REBAR 16MM (#5) 40'0" 420/60 GRADE: ASTM A615-18e1 Gr 420/60 ROLL DATE: 12/27/2019 MELT DATE: 12/03/2019 Cert. No.: 82940286 / 093124A765		S O L D T O	CMC Construction Svcs College Stati 10650 State Hwy 30 College Station TX US 77845-7950 979 774 5900	S H I P T O	CMC Construction Svcs College Stati 10650 State Hwy 30 College Station TX US 77845-7950 979 774 5900	Delivery#: 82940286 BOL#: 73355222 CUST PO#: 837155 CUST P/N: DLVRY LBS / HEAT: 48060.000 LB DLVRY PCS / HEAT: 1152 EA																																																																																																																																																												
<table><tr><td colspan="2">Characteristic</td><td>Value</td><td colspan="2">Characteristic</td><td>Value</td><td colspan="2">Characteristic</td><td>Value</td></tr><tr><td colspan="2"></td><td>C</td><td>0.43%</td><td colspan="2">Bend Test Diameter</td><td colspan="2">2.188IN</td><td rowspan="13">The Following is true of the material represented by this MTR: * Material is fully killed * 100% melted and rolled in the USA * EN10204:2004 3.1 compliant * Contains no weld repair * Contains no Mercury contamination * Manufactured in accordance with the latest version of the plant quality manual * Meets the "Buy America" requirements of 23 CFR635.410, 49 CFR 661 * Warning: This product can expose you to chemicals which are known to the State of California to cause cancer, birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov</td></tr><tr><td colspan="2"></td><td>Mn</td><td>0.90%</td><td colspan="4"></td></tr><tr><td colspan="2"></td><td>P</td><td>0.011%</td><td colspan="4"></td></tr><tr><td colspan="2"></td><td>S</td><td>0.033%</td><td colspan="4"></td></tr><tr><td colspan="2"></td><td>Si</td><td>0.18%</td><td colspan="4"></td></tr><tr><td colspan="2"></td><td>Cu</td><td>0.31%</td><td colspan="4"></td></tr><tr><td colspan="2"></td><td>Cr</td><td>0.13%</td><td colspan="4"></td></tr><tr><td colspan="2"></td><td>Ni</td><td>0.23%</td><td colspan="4"></td></tr><tr><td colspan="2"></td><td>Mo</td><td>0.070%</td><td colspan="4"></td></tr><tr><td colspan="2"></td><td>V</td><td>0.000%</td><td colspan="4"></td></tr><tr><td colspan="2"></td><td>Cb</td><td>0.001%</td><td colspan="4"></td></tr><tr><td colspan="2"></td><td>Sn</td><td>0.011%</td><td colspan="4"></td></tr><tr><td colspan="2"></td><td>Al</td><td>0.000%</td><td colspan="4"></td></tr><tr><td colspan="2">Yield Strength test 1</td><td>67.3ksi</td><td colspan="4"></td></tr><tr><td colspan="2">Tensile Strength test 1</td><td>106.7ksi</td><td colspan="4"></td></tr><tr><td colspan="2">Elongation test 1</td><td>15%</td><td colspan="4"></td></tr><tr><td colspan="2">Elongation Gage Lgth test 1</td><td>8IN</td><td colspan="4"></td></tr><tr><td colspan="2">Tensile to Yield ratio test1</td><td>1.59</td><td colspan="4"></td></tr><tr><td colspan="2">Bend Test 1</td><td>Passed</td><td colspan="4"></td></tr></table>							Characteristic		Value	Characteristic		Value	Characteristic		Value			C	0.43%	Bend Test Diameter		2.188IN		The Following is true of the material represented by this MTR: * Material is fully killed * 100% melted and rolled in the USA * EN10204:2004 3.1 compliant * Contains no weld repair * Contains no Mercury contamination * Manufactured in accordance with the latest version of the plant quality manual * Meets the "Buy America" requirements of 23 CFR635.410, 49 CFR 661 * Warning: This product can expose you to chemicals which are known to the State of California to cause cancer, birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov			Mn	0.90%							P	0.011%							S	0.033%							Si	0.18%							Cu	0.31%							Cr	0.13%							Ni	0.23%							Mo	0.070%							V	0.000%							Cb	0.001%							Sn	0.011%							Al	0.000%					Yield Strength test 1		67.3ksi					Tensile Strength test 1		106.7ksi					Elongation test 1		15%					Elongation Gage Lgth test 1		8IN					Tensile to Yield ratio test1		1.59					Bend Test 1		Passed				
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REMARKS :



CMC STEEL TEXAS
1 STEEL MILL DRIVE
SEGUIN TX 78155-7510

CERTIFIED MILL TEST REPORT
For additional copies call
830-372-8771

We hereby certify that the test results presented here
are accurate and conform to the reported grade specification


Rolando A Davila

Quality Assurance Manager

HEAT NO.:3093404 SECTION: REBAR 19MM (#6) 40'0" 420/60 GRADE: ASTM A615-18e1 Gr 420/60 ROLL DATE: 12/16/2019 MELT DATE: 12/15/2019 Cert. No.: 82948507 / 093404A307	S O L D T O	CMC Construction Svcs College Stati 10650 State Hwy 30 College Station TX US 77845-7950 979 774 5900	S H I P T O	CMC Construction Svcs College Stati 10650 State Hwy 30 College Station TX US 77845-7950 979 774 5900	Delivery#: 82948507 BOL#: 73368452 CUST PO#: 837870 CUST P/N: DLVRY LBS / HEAT: 23793.000 LB DLVRY PCS / HEAT: 396 EA
Characteristic	Value	Characteristic	Value	Characteristic	Value
C	0.42%	Bend Test Diameter	3.750IN	<p>The Following is true of the material represented by this MTR:</p> <p>*Material is fully killed</p> <p>*100% melted and rolled in the USA</p> <p>*EN10204:2004 3.1 compliant</p> <p>*Contains no weld repair</p> <p>*Contains no Mercury contamination</p> <p>*Manufactured in accordance with the latest version of the plant quality manual</p> <p>*Meets the "Buy America" requirements of 23 CFR635.410, 49 CFR 661</p> <p>*Warning: This product can expose you to chemicals which are known to the State of California to cause cancer, birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov</p>	
Mn	0.84%				
P	0.012%				
S	0.046%				
Si	0.19%				
Cu	0.35%				
Cr	0.14%				
Ni	0.25%				
Mo	0.101%				
V	0.000%				
Co	0.001%				
Sn	0.012%				
Al	0.000%				
Yield Strength test 1	70.3ksi				
Tensile Strength test 1	105.8ksi				
Elongation test 1	15%				
Elongation Gage Lgth test 1	8IN				
Tensile to Yield ratio test1	1.50				
Bend Test 1	Passed				

REMARKS :



Customer:
Eastern Metal Supply
3600 23rd Ave South
Lake Worth FL, 33461

Sale Order - Item: 109638 - 1
Customer PO: 362376
Manifest: 678863

Material Certification

KEYMARK CORP.
2540 Knights Station Rd.
Lakeland, FL 33810
Phone: (863) 858-5500
Fax: (863) 858-1800
WWW.KEYMARKCORP.COM

Die: FS04157
Part: DOT-61-130
Description: 3.093 X 2.75
BULLET RAIL INNER
SPICE

Specification Codes:

ASTM: B221

MILITARY: N/A

AMS: 4150, 4160, 4161, 4172, 4173,
AMS-QQ-A-200/8
ASME: SB-221

Complies with all applicable chemical composition and mechanical property limits as specified by ASTM B221, ASTM B308/B308M, ASTM B429/B429M, and the Aluminum Association Aluminum Standards & Data Manual. Complies with all dimensional tolerances as specified by ANSI B3.2 and the Aluminum Association Aluminum Standards & Data Manual. CONFORMS TO EUROPEAN UNION DIRECTIVE "Restrictions on the use of certain Hazardous Substances" (RoHS) AND ALL AMENDMENTS

Chemical Composition

The material produced on the item number(s) shown below were made from the alloy specified. The following chemical properties have been provided by the original manufacturer of the ingot supplied to extrude this material. It is compared to the standards for the specified alloy as set forth by the Aluminum Association:

Cast Number	Alloy	Type	Silicon (Si)	Iron (Fe)	Copper (Cu)	Manganese (Mn)	Magnesium (Mg)	Chromium (Cr)	Zinc (Zn)	Titanium (Ti)	Other	Aluminum
E8D5777A	6061	P	= 0.60	= 0.18	< 0.17	= 0.05	= 0.82	< 0.06	< 0.01	= 0.01	= 0.00	Remaining
Country Of Origin: DUBAI												
THIS PRODUCT IS MERCURY FREE												
R5797061	6061	P	= 0.67	= 0.20	= 0.20	= 0.07	= 0.90	= 0.07	= 0.00	= 0.21	= 0.00	Remaining
Country Of Origin: Bahrain												
This product is mercury free												

Mechanical Properties

Compositions are shown as a percentage by weight maximum unless shown as a range or a minimum. Representative samples of the material produced on this order from the section listed above have been tested according to the procedures set forth by the American Society for Testing Material Method listed below, and have attained or exceeded the minimum mechanical properties for this alloy and temper as specified by the Aluminum Association, and by the American Society for Testing Materials. Actual test result values are as follows:

Sample ID	Lot	Alloy / Temper	Test Date	Ultimate Tensile	Yield Tensile	Elongation % (min 2")	Hardness	Conductivity	Bend Test
1	1	6061 - T6	07/07/18	40.576	36.955	9.850	15.0		
2	1	6061 - T6	07/11/18	42.290	40.145	8.100	15.0		

Signed By:

Howard E. Pierce III

Quality Control Supervisor
Keymark Corporation
Lakeland, Florida



Hydro Extrusion USA, LLC
53 POTTSVILLE STREET

CRESSONA, PA
17929-0187

Certified Test Report

Sales Order Number	Line No.	Customer P/O	Cert Number	Page
1101509239	1	387939	HYDRO3059837	Page 1 of 2
			Cert Creation Date	Cert Print Date
			02-MAY-19	02-MAY-19

Invoice To Customer

EASTERN METAL SUPPLY
3600 23RD AVENUE SOUTH
ATTN: ACCOUNTS PAYABLE

LAKE WORTH, FL - 33461

Ship To Customer

EASTERN METAL SUPPLY
2224 4TH AVENUE NORTH

LAKE WORTH, FL - 33461

Quantity Shipped	Date Shipped	Item Description	Specification
2092 LB	02-MAY-19	Extruded Structural Angle 5.000 B x 5.000 H x 0.500 TK	ASTM B221 REV 14 Table 1 Chemical Composition Limits Table 2 Mechanical Property Limits
B/L	Item No.	SECT 788R 300.000 IN LN FIN M-MILL	ASME SB 221 REV 17 Table 1 Chemical Composition Limits Table 2 Mechanical Properties Limits
1012689	G03971441	WT 5.378 F3 CS 7.1 6061T6	AMS QQ-A-200/8 REV A AMS QQ-A-200/8 REV A
Delivery Id	Item No. Rev		
5096333			
Customer Part No.			
11-61-335			

Applicable Specifications, Revisions and Exceptions

COMPOSITION NOTE: The values for 'Others Each' and 'Others Total' have not the limits as shown on this certified inspection report. Remainder is Aluminum.

Hydro Extrusion USA, LLC hereby certifies that the extrusions covered in this report are within the acceptable ranges of the specification tables identified herein (excluding footnotes). Chemical composition may be based on results provided by external billet suppliers. Further information on processing, testing including ASTM B557, and inspection is available at www.hydroextrusions.com/industryspecifications. Sales are governed by the Extrusion North America Standard Terms and Conditions of Sale available at www.hydroextrusions.com/termsconditions, unless otherwise mutually agreed in writing.

Signature And Title

Darrell Weirich
Quality Manager

02-MAY-19

Quantities per Lot / Packages

Package Number	Lot Number	Quantity	COM	Weight	Net
G12-PKG3464154	23529754	9	PCS	1263	1255
G12-PKG3471822	R23529754	6	PCS	845	837

Composition Limits

Composition Limits														
Alloy Designation	Cu		Fe	C		Mn		Mg		Zn		Pb		
	Min	Max		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
6061	0.40	0.80	—	0.70	0.15	0.40	—	0.15	0.80	1.20	0.04	0.35	—	0.25



Hydro Extrusion USA, LLC
53 POTTSVILLE STREET
CRENSHAW, PA
17929-0187

Certified Test Report

Cert Number HYDRO3059837		Page Page 2 of 2	
Sales Order Number 1101509239	Line No. 1	Customer P/O 387939	Cert Creation Date 02-MAY-19
		Cert Print Date 02-MAY-19	

Alloy	Temp (°F)	Min	Max	Min	Max
6061	---	0.15	---	0.05	---

Composition Results

Heat/Cast	Si	Fe	Cu	Mn	Mg	Ce	Pb	Other Each	Other Total
2003192	0.71	0.34	0.28	0.05	0.90	0.05	0.04	0.02	---
3049001	0.75	0.31	0.29	0.05	0.91	0.06	0.04	0.02	---

Mechanical Property - Test Limits

			UTS - L		TYS - L		EL 4D-Long	
			KSI		KSI		PCT	
			MIN VALUE		MAX VALUE		MIN VALUE	
			MIN VALUE		MAX VALUE		MIN VALUE	
T6	23529754	1	41.0	41.9	38.9	38.9	18.0	18.0
			UTS - L		TYS - L		EL 4D-Long	
			KSI		KSI		PCT	
			MIN VALUE		MAX VALUE		MIN VALUE	
			MIN VALUE		MAX VALUE		MIN VALUE	
T6	R23529754	1	44.6	44.6	42.1	42.1	19.0	19.0

Notes

Mercury is not a normal contaminant in aluminum alloys and we do not knowingly use it in the manufacture of our goods

Extruded in the USA

Extrusions produced to -T6H1 temper also meet -T6 temper requirements

RAIL



WESTERN EXTRUSIONS
1735 Sandy Lake Rd
Carrollton, TX 75006-3612
(972) 245-7515

**CERTIFIED INSPECTION REPORT AND TEST RESULTS
FOR EXTRUDED PRODUCTS**

ORDER NUMBER	ITEM
254548	1

BILL TO 25465-Eastern Metal Supply	Call Length 30'0"	DET NUMBER 14824	DATE OF SHIPMENT 3/22/2018
SHIP TO 25478-Eastern Metal Supply	CUSTOMER PO 358760	ALLOY/TEMPER 6061/T6	SALESMAN Bill Potty
CERT CODE A9	Job Name	CUSTOMER PART NUMBER DOT-61-100	DESCRIPTION Bullet Rail Cap

Specifications ASTM B221

METALLURGIST

We hereby certify that the material covered by this report has been inspected in accordance with, and has been found to meet the applicable requirements described herein, including any specifications forming a part of the description, and that samples representative of the material met the composition limits and had the mechanical properties shown.

[Signature]
JORGE ENRIQUEZ

MANUFACTURED IN THE UNITED STATES OF AMERICA

Mechanical Properties

	Test Date	Ultimate Tensile Strength (KSI)	Yield Strength (KSI)	Percent Elongation	Hardness (HRB)
LOT 1A	3/23/18	43.6	39.1	12 %	91
LOT 1A	3/23/18	44.5	38.7	12 %	91
LOT 1B	3/23/18	44.0	39.5	12 %	92

Chemical Composition for Alloy 6061

Cast Num	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti
E7M6178A	0.54	0.17	0.20	0.03	0.83	0.06	0.01	0.01
E8A5477A	0.55	0.17	0.20	0.01	0.82	0.06	0.01	0.02



**CERTIFIED TEST REPORT
ALUMINUM EXTRUDED PRODUCTS**

LOCK Bm
HYDRO EXTRUDER, LLC
2906 OLD OAKWOOD ROAD
GAINESVILLE, GA 30604
(770)535-1349

CUSTOMER SHIP TO EASTERN METAL SUPPLY, LAKE LAND 4675 Drane field road Lakeland, FL 33811	ITEM DESCRIPTION DOT-61-140 HAND-RAIL CLAMP BAR	PCS SHIPPED
CAST# CUSTOMER PO 362375	ALLOY 6061 TEMPER T6 SALES ORDER 371018-01	PLANT 35
PRODUCT SPECIFICATIONS Extruded Rod, Bar, Shape or Tube ASTM B221-14 AMS QQ-A-200/8A	PART REVISION	DIE REVISION 1

MECHANICAL PROPERTIES

DIE NUMBER 049414	NO. OF TESTS 1	TENSILE STRENGTH*		YIELD**	
		Min	Max	Min	Max
		45.0 - 45.0 ksi	310 - 310 mpa	41.0 - 41.0 ksi	283 - 283 mpa
LOT NUMBER 371018-1		ELONGATION %***		CONDUCTIVITY	
		Min	Max	Min	Max
		15.0	15.0		

CHEMICAL COMPOSITION (%)

ELEMENT	Min	Max	ELEMENT	Min	Max	ELEMENT	Min	Max
SI	.4000	.8000	MN	.0000	1500	ZN	.0000	.2500
FE	.0000	.7000	MG	.8000	1,2000	TI	.0000	1500
CU	1500	.4000	CR	.0400	.3500	B	.0000	.0000

HYDRO EXTRUDER, LLC hereby certifies that the metal shipped under this report has been tested in accordance with the identified ASTM and/or ASME specifications and the results of the chemical analysis and mechanical properties tests are within the acceptable ranges of these specifications. Any product warranty is governed by the Extrusion North America Standard Terms and Conditions of Sale posted at www.hydroextrusions.com/termsconditions. Extruded in the USA. Mercury is not a normal contaminant in aluminum alloys and we do not knowingly use it in the manufacture of our goods.

* One ksi equals 1000 pounds per square inch.
** Yield strength determined by 0.2% offset method.
*** Gage length measured in 2.000" section.
*** Elongation taken at fracture.

AUTHORIZED SIGNATURE

5/26/18

Chris Walters
Quality Manager

BULLET RAIL END CAP



WESTERN EXTRUSIONS
1735 Sandy Lake Rd
Carrollton, TX. 75006-3612
(972) 245-7515

**CERTIFIED INSPECTION REPORT AND TEST RESULTS
FOR EXTRUDED PRODUCTS**

OUR ORDER NUMBER	ITEM
254548	1

BILL TO 25465-Eastern Metal Supply	Cut Length 30'0"	DIE NUMBER 14824	DATE OF SHIPMENT 3/22/2018
SHIP TO 25478-Eastern Metal Supply	CUSTOMER PO 356760	ALLOY/TEMPER 6061/T6	SALESMAN Bill Petty
CERT CODE A9	Job Name: DOT-61-100	CUSTOMER PART NUMBER DOT-61-100	DESCRIPTION Bullet Rail Cap

Specifications: ASTM B221

METALLURGIST

JORGE ENRIQUEZ

We hereby certify that the material covered by this report has been inspected in accordance with, and has been found to meet the applicable requirements described herein, including any specifications forming a part of the description, and that samples representative of the material met the composition limits and had the mechanical properties shown.

MANUFACTURED IN THE UNITED STATES OF AMERICA


Mechanical Properties

	Test Date	Ultimate Tensile Strength (KSI)	Yield Strength (KSI)	Percent Elongation	Hardness (HRE)
LOT 1A	3/23/18	43.6	39.1	12 %	91
LOT 1A	3/23/18	44.5	39.7	12 %	91
LOT 1B	3/23/18	44.0	39.5	12 %	92

Chemical Composition for Alloy 6061

Cast/Num	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti
E7MS178A	0.54	0.17	0.20	0.03	0.83	0.06	0.01	0.01
E8A5477A	0.55	0.17	0.20	0.01	0.82	0.06	0.01	0.02

Printed: 8/18/18 8:31 am \\NETFRAME\EPICS2000\CRW\Certs2014.rpt

 Texas A&M Transportation Institute <small>Proving Ground 3100 SH-47, Bldg. 7091 Bryan, TX 77807</small> <small>Texas A&M University College Station, TX 77843 Phone 979-845-6376</small>	QF-7.3-01 Concrete Sampling	Doc. No. QF-7.3-01	Issue Date: 2018-06-18
		Prepared by: Wanda L. Menges Approved by: Darrell L. Kuhn	Revision: 6 Page: 1 of 1

The information contained in this document is confidential to TTI Proving Ground.

Project No: 611971-02 **Casting Date:** 3/2/2020 **Mix Design (psi):** 3400 psi

Name of Technician Taking Sample: <u>Teracon</u> Signature of Technician Taking Sample: <u>Teracon</u>	Name of Technician Breaking Sample: <u>Teracon</u> Signature of Technician Breaking Sample: <u>Teracon</u>
---	---

Load No.	Truck No.	Ticket No.	Location (from concrete map)
T1	tucker	289	barriers 2 and 4, Northern most barrier is 1

Load No.	Break Date	Cylinder Age	Total Load (lbs)	Break (psi)	Average
See attached Reports from Terracon					

TUCKER CONCRETE

8930 LACY WELL RD CS
979-777-6749 VM1802

Job # TUCKER CONST
FLORIDA RAIL

TICKET # 289
START DATE: 03/02/2020 TIME: 08:16:32
STOP DATE: 03/02/2020 TIME: 08:56:09

MIX DESIGN B1350 4999
RAW CEMENT COUNTS 3717
RAW CONVEYOR COUNTS

TOTAL YARDS 8.45

MATERIAL	RATE	SETTING	TOTAL
CAPTYPE1	487.4	LBPM	3971.1 LBS
LRMSAND	6.5	GATE	11733.6 LBS
RGBLEND	7.8	GATE	16205.6 LBS
WATER	21.1	GPM	204.6 GAL
SIKA686	1.2	GPM	10.1 GAL
NC4	0.8	GPMM	6.8 OZ
MAX GPM 23.4		MAX GPY 22.53	

NAME
NOTES:

*Bullet R44
611971-02*

CONCRETE COMPRESSIVE STRENGTH TEST REPORT

Report Number: A1171057.0100
 Service Date: 03/02/20
 Report Date: 04/03/20 Revision 2 - 32-day results
 Task: PO #611971-02

Terracon

6198 Imperial Loop
 College Station, TX 77845-5765
 979-846-3767 Reg No: F-3272

Client

Texas Transportation Institute
 Attn: Gary Gerke
 TTI Business Office
 3135 TAMU
 College Station, TX 77843-3135

Project

Riverside Campus
 Riverside Campus
 Bryan, TX

Project Number: A1171057

Material Information

Specified Strength: 3,000 psi @ 28 days

Mix ID: B1350
 Supplier: Tucker Concrete
 Batch Time: 0833 Plant: Ticket No.: 289
 Truck No.: 1802

Sample Information

Sample Date: 03/02/20 Sample Time: 0833
 Sampled By: David Thompson
 Weather Conditions: Cloudy, no wind
 Accumulative Yards: 8.45/8.45 Batch Size (cy): 8.45
 Placement Method: Direct Discharge
 Water Added Before (gal): 0
 Water Added After (gal): 0
 Sample Location: 25' south of north end
 Placement Location: Barrier (PO #611971-02)

Field Test Data

Test	Result	Specification
Slump (in):	5 1/4	Not Specified
Air Content (%):	1.8	Not Specified
Concrete Temp. (F):	68	40 - 95
Ambient Temp. (F):	66	40 - 95
Plastic Unit Wt. (pcf):	144.0	Not Specified
Yield (Cu. Yds.):		

Laboratory Test Data

Set No.	Specimen ID	Avg Diam. (in)	Area (sq in)	Date Received	Date Tested	Age at Test (days)	Maximum Load (lbs)	Compressive Strength (psi)	Fracture Type	Tested By
1	A	6.00	28.27	03/03/20	04/03/20	32 F	123,630	4,370	5	BRS
1	B	6.00	28.27	03/03/20	04/03/20	32 F	123,940	4,380	2	BRS
1	C	6.00	28.27	03/03/20	04/03/20	32 F	135,000	4,770	5	BRS
1	D			03/03/20		Hold				

Initial Cure: Outside

Final Cure: Field Cured

Comments: F = Field Cured

Samples Made By: Terracon

Services: Obtain samples of fresh concrete at the placement locations (ASTM C 172), perform required field tests and cast, cure, and test compressive strength samples (ASTM C 31, C 39, C 1231).

Terracon Rep.: David Thompson

Start/Stop: 0730-1015

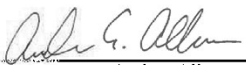
Reported To:

Contractor:

Report Distribution:


(1) Texas Transportation Institute, Gary Gerke (1) Terracon Consultants, Inc., Andrea Allen
 (1) Texas Transportation Institute, Bill Griffith

Reviewed By:


 Andrea Allen
 Project Manager

Test Methods: ASTM C 31, ASTM C143, ASTM C231, ASTM C1064

The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

 Texas A&M Transportation Institute <small>Proving Ground 3100 SH-47, Bldg. 7091 Bryan, TX 77807</small> <small>Texas A&M University College Station, TX 77843 Phone 979-845-6376</small>	QF-7.3-01-Concrete Sampling	Doc. No. QF-7.3-01	Issue Date: 2018-06-18
		Quality Form <small>The information contained in this document is confidential to TTI Proving Ground.</small>	Prepared by: Wanda L. Menges Approved by: Darrell L. Kuhn

Project No: 611971-02 **Casting Date:** 3/6/2020 **Mix Design (psi):** 3400 psi

Name of Technician Taking Sample _____ Signature of Technician Taking Sample _____ _____ Teracon	Name of Technician Breaking Sample _____ Signature of Technician Breaking Sample _____ _____ Teracon
--	--

Load No.	Truck No.	Ticket No.	Location (from concrete map)
T1	tucker	11725	barriers 1 and 3, Norther most barrier is 1

Load No.	Break Date	Cylinder Age	Total Load (lbs)	Break (psi)	Average
See attached Reports from Terracon					

TUCKER Concrete

8930 LACY WELL RD, 77845
979 777 6749 VM1801

Job # TUCKER CONSTRUCTION
TTI

TICKET # 11725
START DATE: 03/06/2020 TIME: 08:10:51
STOP DATE: 03/06/2020 TIME: 08:53:16

MIX DESIGN B1350
RAW CEMENT COUNTS 10235
RAW CONVEYOR COUNTS 3823

TOTAL YARDS 8.15

MATERIAL	RATE SETTING	TOTAL
CAPTYPE1	448.3LBPM	3828.9LBS
LRMSAND	6.3 GATE	11348.9LBS
RGBLND	7.5 GATE	15674.2LBS
WATER	19.4GPM	183.2GAL
SIKA686	1.1GPM	9.8GAL
SIKANC4	0.8OZPM	6.5OZ
MAX GPY 22.53 MAX GPM 21.5		

NAME _____
NOTES: _____

611571-02

CONCRETE COMPRESSIVE STRENGTH TEST REPORT

Report Number: A1171057.0101
 Service Date: 03/06/20
 Report Date: 04/03/20 Revision 2 - 28-day results
 Task: PO #611971-02

Terracon

6198 Imperial Loop
 College Station, TX 77845-5765
 979-846-3767 Reg No: F-3272

Client

Texas Transportation Institute
 Attn: Gary Gerke
 TTI Business Office
 3135 TAMU
 College Station, TX 77843-3135

Project

Riverside Campus
 Riverside Campus
 Bryan, TX

Project Number: A1171057

Material Information

Specified Strength: 3,000 psi @ 28 days

Mix ID: B1350
 Supplier: Tucker Concrete
 Batch Time: 0810 Plant: Ticket No.: 11725
 Truck No.:

Sample Information

Sample Date: 03/06/20 Sample Time: 0820
 Sampled By: Justin Maass
 Weather Conditions: Clear, moderate wind
 Accumulative Yards: 8.15/8.15 Batch Size (cy): 8.15
 Placement Method: Direct Discharge
 Water Added Before (gal): 0
 Water Added After (gal): 0
 Sample Location: East side barrier, center
 Placement Location: Median barrier, east side (PO #611971-02)

Field Test Data

Test	Result	Specification
Slump (in):	3	Not Specified
Air Content (%):	2.4	Not Specified
Concrete Temp. (F):	62	40 - 95
Ambient Temp. (F):	51	40 - 95
Plastic Unit Wt. (pcf):	149.3	Not Specified
Yield (Cu. Yds.):		

Laboratory Test Data

Set No.	Specimen ID	Avg Diam. (in)	Area (sq in)	Date Received	Date Tested	Age at Test (days)	Maximum Load (lbs)	Compressive Strength (psi)	Fracture Type	Tested By
1	A	6.00	28.27	03/09/20	04/03/20	28 F	149,030	5,270	5	BRS
1	B	6.00	28.27	03/09/20	04/03/20	28 F	136,890	4,840	5	BRS
1	C	6.00	28.27	03/09/20	04/03/20	28 F	148,960	5,270	4	BRS
1	D			03/09/20		Hold				

Initial Cure: Outside

Final Cure: Field Cured

Comments: F = Field Cured

Samples Made By: Terracon

Services: Obtain samples of fresh concrete at the placement locations (ASTM C 172), perform required field tests and cast, cure, and test compressive strength samples (ASTM C 31, C 39, C 1231).

Terracon Rep.: Justin Maass

Start/Stop: 0715-0945

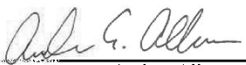
Reported To:

Contractor:

Report Distribution:

(1) Texas Transportation Institute, Gary Gerke (1) Terracon Consultants, Inc., Andrea Allen
 (1) Texas Transportation Institute, Bill Griffith

Reviewed By:


 Andrea Allen
 Project Manager

Test Methods: ASTM C 31, ASTM C143, ASTM C231, ASTM C1064

The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

APPENDIX C. MASH TEST 3-11 (CRASH TEST NO. 611971-02-1)

C1 VEHICLE PROPERTIES AND INFORMATION

Table C.1. Vehicle Properties for Test No. 611971-02-1.

Date: 2020-04-03 Test No.: 611971-02 VIN No.: 1C6RR6FT4ES314674
 Year: 2014 Make: RAM Model: 1500
 Tire Size: 265/70 R 17 Tire Inflation Pressure: 35 psi
 Tread Type: Highway Odometer: 98219
 Note any damage to the vehicle prior to test: None

• Denotes accelerometer location.

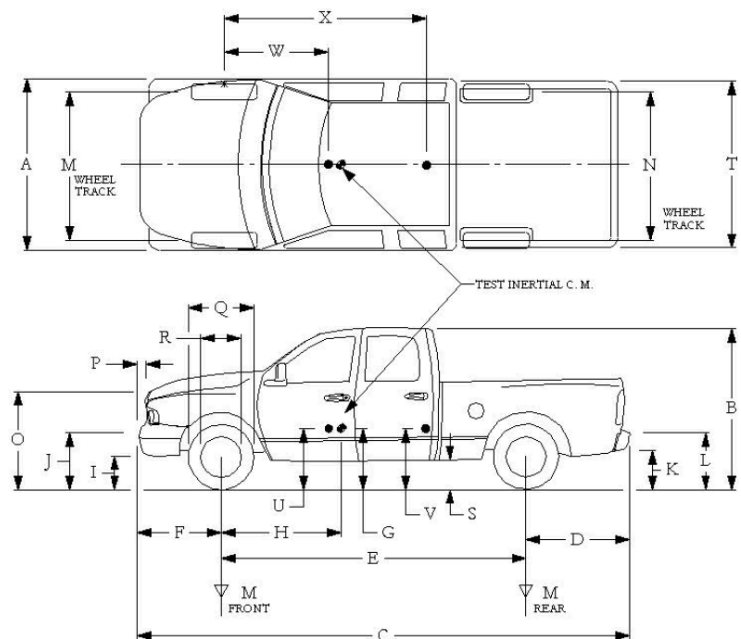
NOTES: None

Engine Type: V-8
 Engine CID: 5.7 L

Transmission Type:
☒ Auto or ☐ Manual
☐ FWD ☒ RWD ☐ 4WD

Optional Equipment:
None

Dummy Data:
 Type: 50th Percentile Male
 Mass: 165 lb
 Seat Position: Impact Side



Geometry: inches

A	78.50	F	40.00	K	20.00	P	3.00	U	26.75
B	74.00	G	29.00	L	30.00	Q	30.50	V	30.25
C	227.50	H	61.46	M	68.50	R	18.00	W	61.40
D	44.00	I	11.75	N	68.00	S	13.00	X	79.00
E	140.50	J	27.00	O	46.00	T	77.00		
Wheel Center Height Front	14.75	Wheel Well Clearance (Front)	6.00	Bottom Frame Height - Front	12.50				
Wheel Center Height Rear	14.75	Wheel Well Clearance (Rear)	9.25	Bottom Frame Height - Rear	22.50				

RANGE LIMIT: A=78 ±2 inches; C=237 ±13 inches; E=148 ±12 inches; F=39 ±3 inches; G = > 28 inches; H = 63 ±4 inches; O=43 ±4 inches; (M+N)/2=67 ±1.5 inches

GWR Ratings:		Mass: lb	Curb	Test Inertial	Gross Static
Front	3700	M _{front}	2911	2829	2914
Back	3900	M _{rear}	2041	2200	2280
Total	6700	M _{Total}	4952	5029	5194

(Allowable Range for TIM and GSM = 5000 lb ±110 lb)

Mass Distribution:
 lb LF: 1388 RF: 1441 LR: 1142 RR: 1058

Table C.2. Measurements of Vehicle Vertical CG for Test No. 611971-02-1.

Date: 2020-04-03 Test No.: 611971-02 VIN: 1C6RR6FT4ES314674
 Year: 2014 Make: RAM Model: 1500
 Body Style: Quad Cab Mileage: 98219
 Engine: 5.7 L V-8 Transmission: Automatic
 Fuel Level: Empty Ballast: 172 (440 lb max)
 Tire Pressure: Front: 35 psi Rear: 35 psi Size: 265/70 R 17

Measured Vehicle Weights: (lb)										
LF:	1388		RF:	1441		Front Axle:	2829			
LR:	1142		RR:	1058		Rear Axle:	2200			
Left:	2530		Right:	2499		Total:	5029			
						5000 ±110 lb allowed				
Wheel Base:		140.50	inches	Track: F:		68.50	inches	R:	68.00	inches
		148 ±12 inches allowed				Track = (F+R)/2 = 67 ±1.5 inches allowed				
Center of Gravity, SAE J874 Suspension Method										
X:	61.46	inches	Rear of Front Axle		(63 ±4 inches allowed)					
Y:	-0.21	inches	Left -	Right +	of Vehicle Centerline					
Z:	29.00	inches	Above Ground		(minumum 28.0 inches allowed)					

Hood Height: 46.00 inches Front Bumper Height: 27.00 inches
 43 ±4 inches allowed

Front Overhang: 40.00 inches Rear Bumper Height: 30.00 inches
 39 ±3 inches allowed

Overall Length: 227.50 inches
 237 ±13 inches allowed

Table C.3. Exterior Crush Measurements for Test No. 611971-02-1.

Date: 2020-04-03 Test No.: 611971-02 VIN No.: 1C6RR6FT4ES314674
 Year: 2014 Make: RAM Model: 1500

VEHICLE CRUSH MEASUREMENT SHEET¹

Complete When Applicable	
End Damage	Side Damage
Undeformed end width _____ Corner shift: A1 _____ A2 _____ End shift at frame (CDC) (check one) < 4 inches _____ ≥ 4 inches _____	Bowing: B1 _____ X1 _____ B2 _____ X2 _____ Bowing constant $\frac{X1 + X2}{2} = \underline{\hspace{2cm}}$

Note: Measure C₁ to C₆ from Driver to Passenger Side in Front or Rear Impacts – Rear to Front in Side Impacts.

Specific Impact Number	Plane* of C-Measurements	Direct Damage		Field L ***	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	±D
		Width*** (CDC)	Max**** Crush								
1	Front plane at bmp ht	14	10	30	0	1	3	6	8	10	7
2	Side plane at bmp ht	14	14	48	1.5	4	7	10	12	14	72
	Measurements recorded										
	<input checked="" type="checkbox"/> inches or <input type="checkbox"/> mm										

¹Table taken from National Accident Sampling System (NASS).

*Identify the plane at which the C-measurements are taken (e.g., at bumper, above bumper, at sill, above sill, at beltline, etc.) or label adjustments (e.g., free space).

Free space value is defined as the distance between the baseline and the original body contour taken at the individual C locations. This may include the following: bumper lead, bumper taper, side protrusion, side taper, etc. Record the value for each C-measurement and maximum crush.

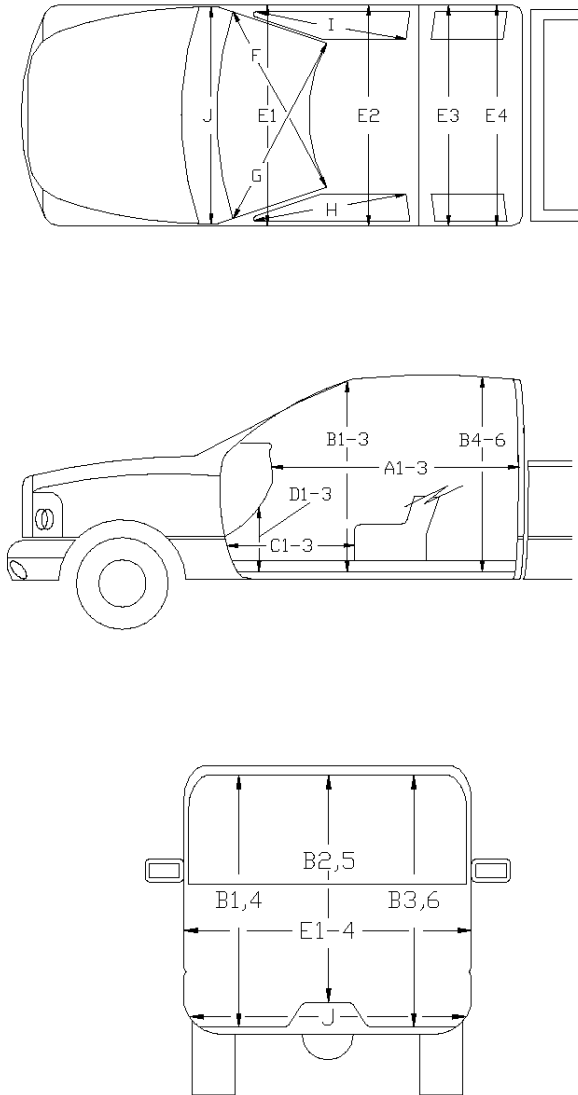
***Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle).

****Measure and document on the vehicle diagram the location of the maximum crush.

Note: Use as many lines/columns as necessary to describe each damage profile.

Table C.4. Occupant Compartment Measurements for Test No. 611971-02-1.

Date: 2020-04-03 Test No.: 611971-02 VIN No.: 1C6RR6FT4ES314674
 Year: 2014 Make: RAM Model: 1500



**OCCUPANT COMPARTMENT
DEFORMATION MEASUREMENT**

	Before	After (inches)	Differ.
A1	65.00	65.00	0.00
A2	63.00	63.00	0.00
A3	65.50	65.50	0.00
B1	45.00	45.00	0.00
B2	38.00	38.00	0.00
B3	45.00	45.00	0.00
B4	39.50	39.50	0.00
B5	43.00	43.00	0.00
B6	39.50	39.50	0.00
C1	26.00	26.00	0.00
C2	0.00	0.00	0.00
C3	26.00	22.00	-4.00
D1	11.00	11.00	0.00
D2	0.00	0.00	0.00
D3	11.50	12.00	0.50
E1	58.50	59.50	1.00
E2	63.50	66.00	2.50
E3	63.50	63.50	0.00
E4	63.50	63.50	0.00
F	59.00	59.00	0.00
G	59.00	59.00	0.00
H	37.50	37.50	0.00
I	37.50	37.50	0.00
J*	25.00	22.00	-3.00

*Lateral area across the cab from driver's side kickpanel to passenger's side kickpanel.

C2 SEQUENTIAL PHOTOGRAPHS



0.000 s



0.100 s



0.200 s



0.300 s



Figure C.1. Sequential Photographs for Test No. 611971-02-1 (Frontal and Rear Views).



0.400 s



0.500 s



0.600 s



0.700 s



**Figure C.1. Sequential Photographs for Test No. 611971-02-1 (Frontal and Rear Views)
(Continued).**

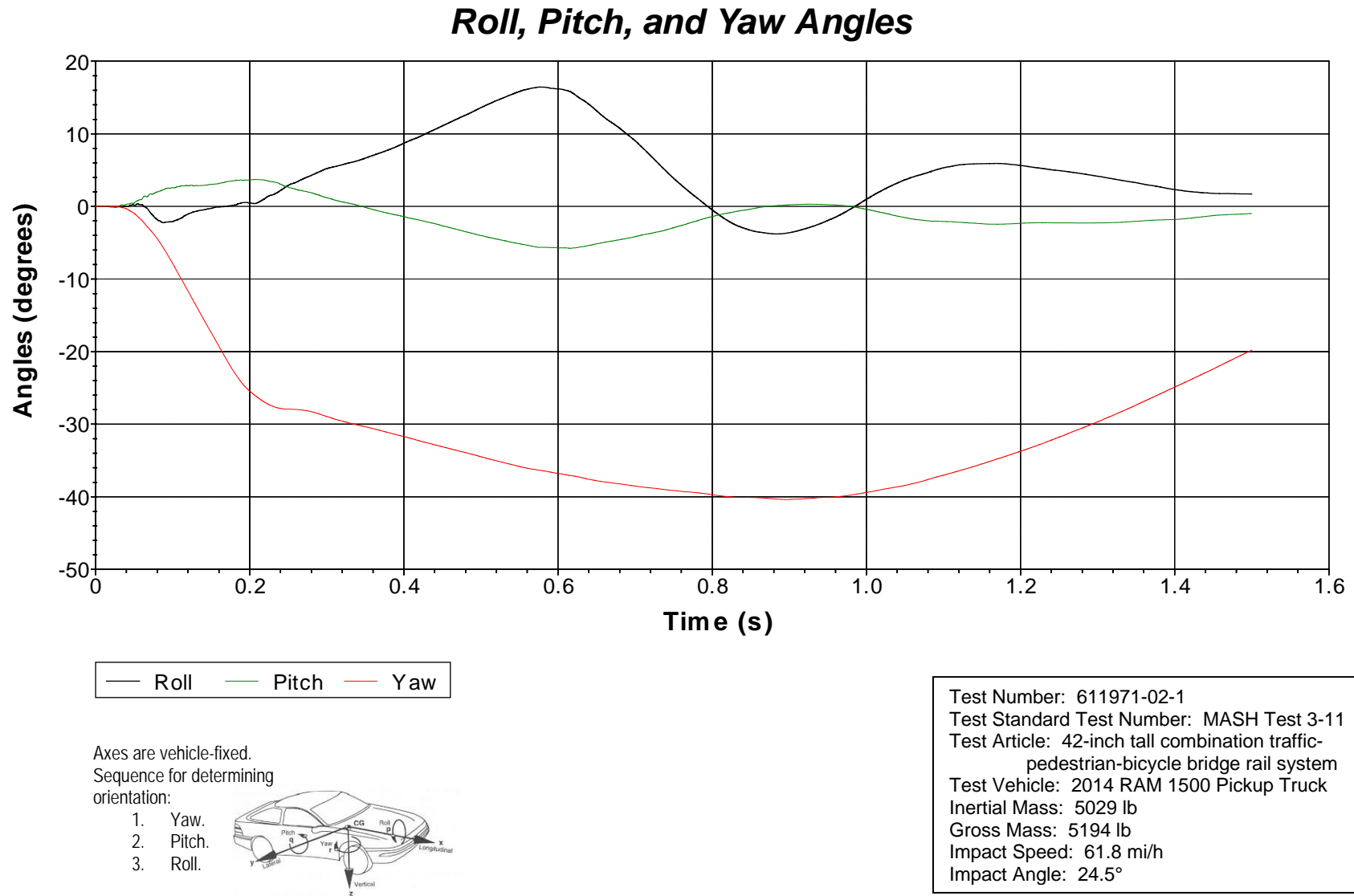
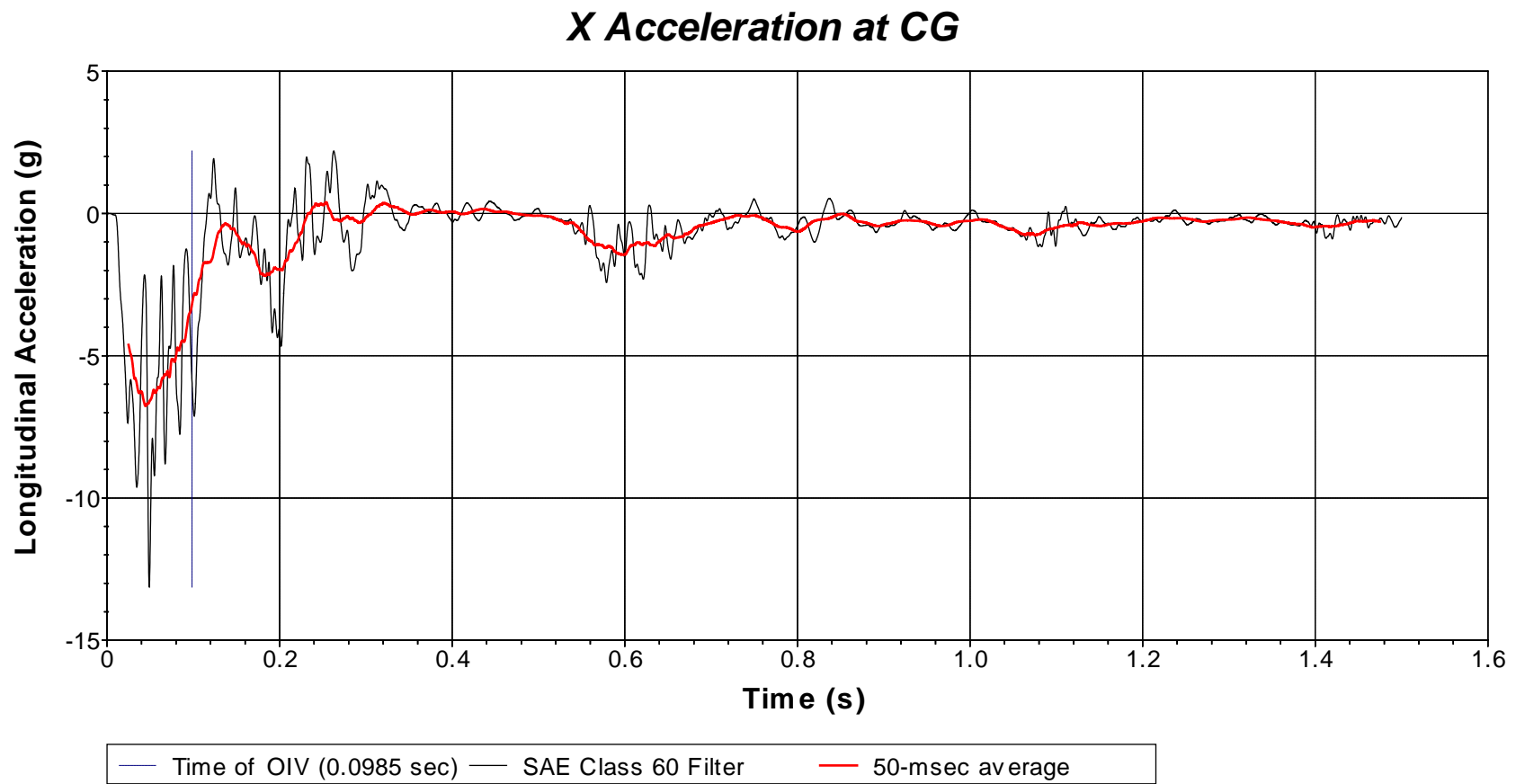
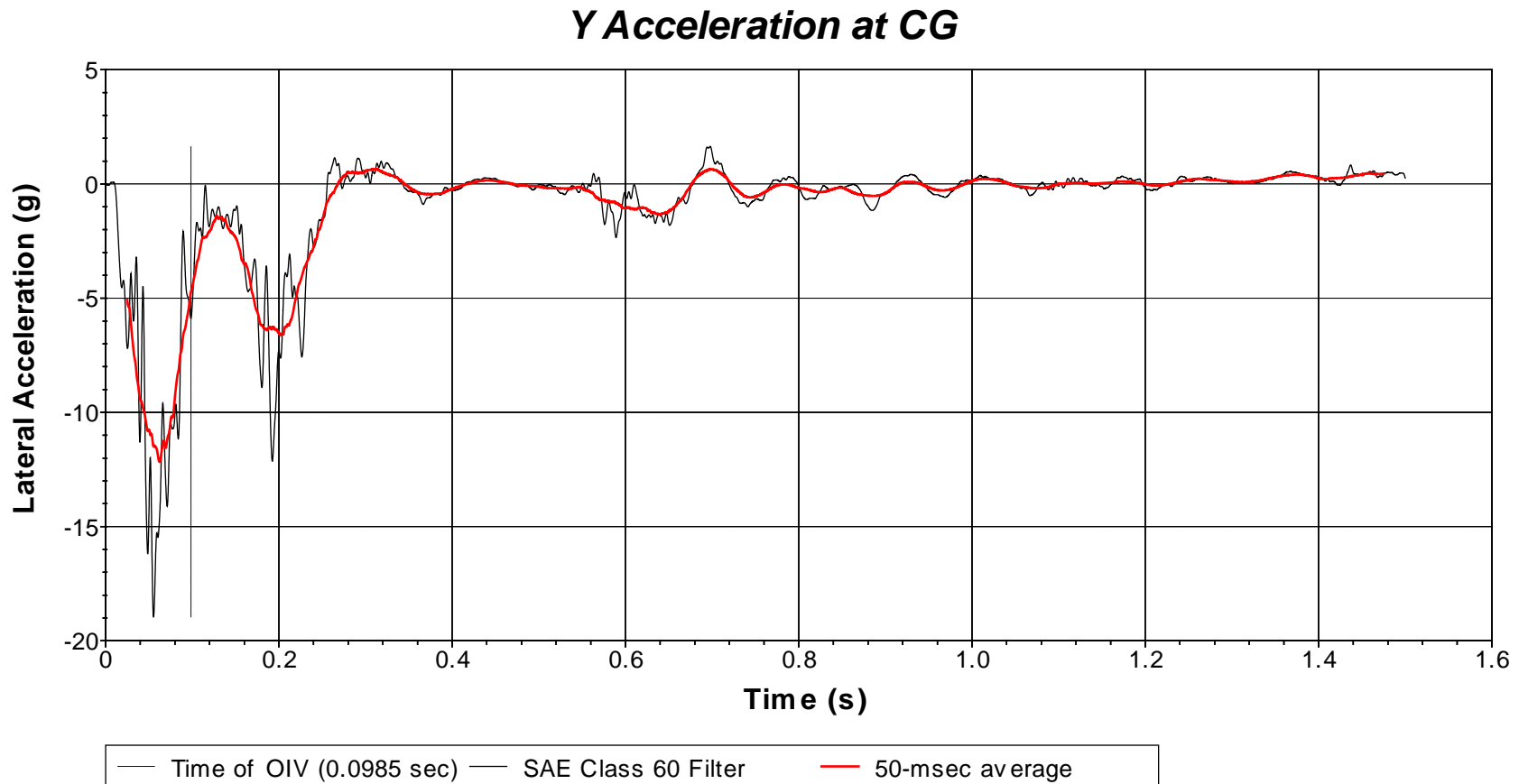


Figure C.2. Vehicle Angular Displacements for Test No. 611971-02-1.



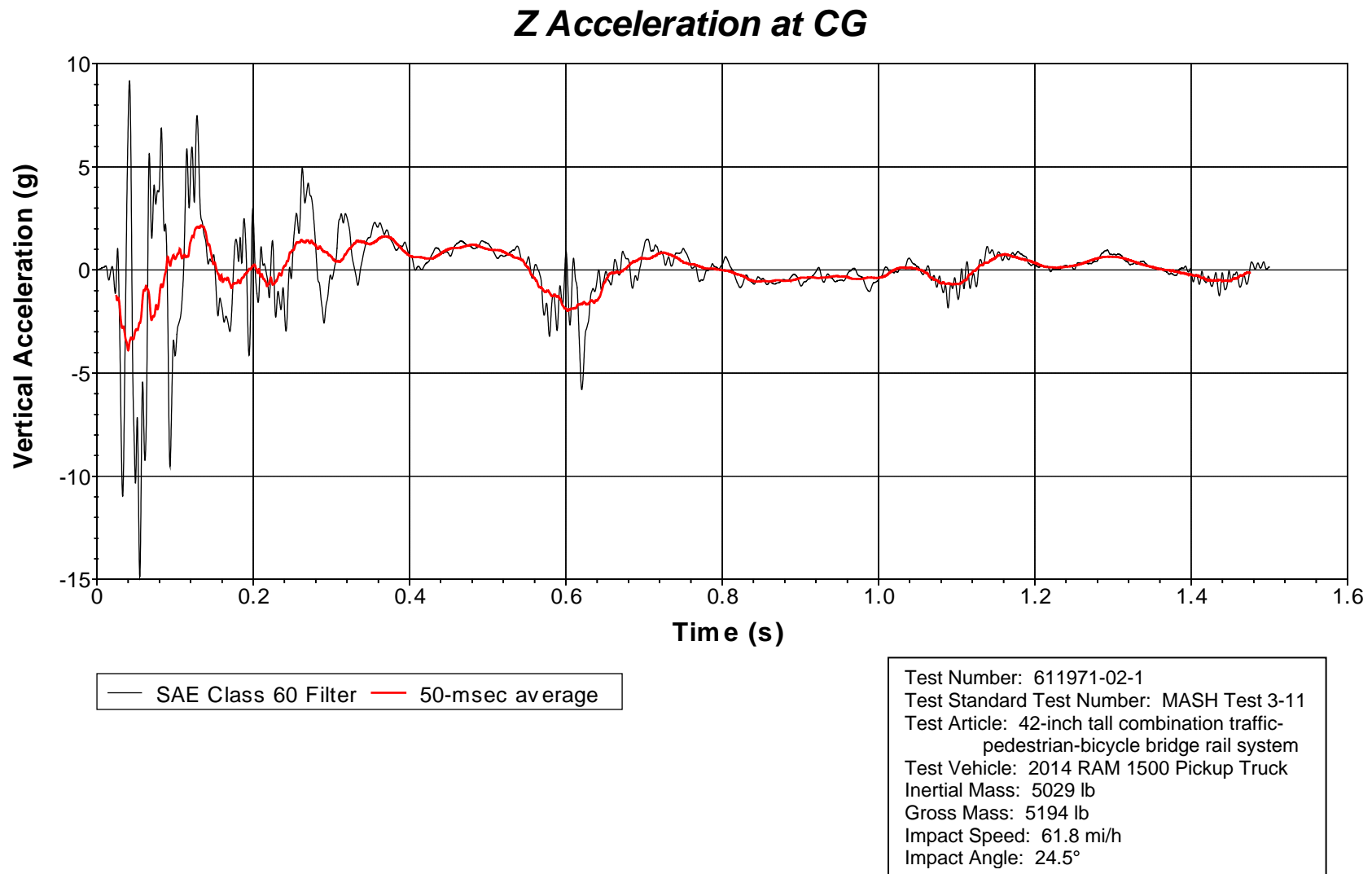
Test Number: 611971-02-1
Test Standard Test Number: MASH Test 3-11
Test Article: 42-inch tall combination traffic-
pedestrian-bicycle bridge rail system
Test Vehicle: 2014 RAM 1500 Pickup Truck
Inertial Mass: 5029 lb
Gross Mass: 5194 lb
Impact Speed: 61.8 mi/h
Impact Angle: 24.5°

**Figure C.3. Vehicle Longitudinal Accelerometer Trace for Test No. 611971-02-1
(Accelerometer Located at Center of Gravity).**



Test Number: 611971-02-1
Test Standard Test Number: MASH Test 3-11
Test Article: 42-inch tall combination traffic-
pedestrian-bicycle bridge rail system
Test Vehicle: 2014 RAM 1500 Pickup Truck
Inertial Mass: 5029 lb
Gross Mass: 5194 lb
Impact Speed: 61.8 mi/h
Impact Angle: 24.5°

**Figure C.4. Vehicle Lateral Accelerometer Trace for Test No. 611971-02-1
(Accelerometer Located at Center of Gravity).**



**Figure C.5. Vehicle Vertical Accelerometer Trace for Test No. 611971-02-1
(Accelerometer Located at Center of Gravity).**