Roadside Safety Pooled Fund

Texas A&M Transportation Institute
Proving Ground

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MASH TL-3 EVALUATION OF MODIFIED MERRITT PARKWAY GUIDERAIL WITH NO CURB

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16. Abstract

With the adoption of the AASHTO/FHWA Joint Implementation Agreement for *MASH* in 2016, specific implementation dates were defined to determine crashworthiness of roadside safety systems to be implemented on projects on the NHS using the 2016 edition of *MASH*. CTDOT was interested in including this guardrail system within its standards as an available roadside safety hardware. However, prior to adding this system to the CTDOT standards, it was necessary to have a *MASH* compliant system. CTDOT proposes to full-scale crash test and evaluate the Merritt Parkway Guiderail system performance in accordance to the guidelines specified in the 2016 edition of *MASH*.

The Modified Merritt Parkway Guiderail with 4-inch curb met the performance criteria for *MASH* TL-3 longitudinal barriers, and the Merritt Parkway Guiderail Transition met the performance criteria for *MASH* TL-3 transitions,

17. Key Words	18. Distribution Statement
Guiderail, guardrail, longitudinal barrier, transition, steel post, curb, curbless, timber rail, crash testing, roadside safety	

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SI* (MODERN METRIC) CONVERSION FACTORS

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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Chapter 1. INTRODUCTION

1.1. PROBLEM STATEMENT

With the adoption of the American Association of State Highway Transportation Officials (AASHTO)/Federal Highway Administration (FHWA) Joint Implementation Agreement for *Manual for Assessing Safety Hardware* (*MASH*) in 2015, specific implementation dates were defined to determine crashworthiness of roadside safety systems to be implemented on projects on the National Highway System (NHS) using the 2016 edition of AASHTO *MASH* (*1*, *2*). Connecticut Department of Transportation (CTDOT) proposed to review, full-scale crash test, and evaluate the Merritt Parkway Guiderail system performance in accordance to the guidelines specified in the 2016 edition of *MASH*.

1.2. BACKGROUND

The State of Connecticut designed an aesthetic guiderail system for use on the Merritt Parkway. Bullard et al. (1996) evaluated this design in accordance to the guidelines specified in National Cooperative Highway Research Program (NCHRP) *Report 350* to allow its implementation on the NHS (*3*, *4*). The Merritt Parkway steel-backed timber guiderail met all *NCHRP Report 350* evaluation criteria for test designations 3-11 (length of need (LON) performance with and without curb), 3-10 (LON performance without curb), and 3-21 (performance of the transition section between the LON of the guiderail and a concrete parapet).

In all tests performed, the Merritt Parkway steel-backed timber guiderail contained and redirected the vehicle through controlled lateral deflection. The vehicle did not penetrate, or go over or under the installation. In all tests, there were no detached elements or debris from the test article to show potential for penetrating the occupant compartment or presenting undue hazard to others in the area. The rail performed in all tests in a manner such that serious injury caused by the deformation of the occupant compartment was not probable. The vehicles remained upright and stable during and after collision with the guiderail. In most cases, there was minimal, if any, intrusion into adjacent traffic lanes. The occupant risk factors were within the limits specified in *NCHRP Report 350*.

The crash test program conducted in 1996 by Bullard et al. demonstrated that this aesthetic guiderail system complied with guidelines specified in *NCHRP Report 350* and was suitable for use by the State of Connecticut on the Merritt Parkway.

With the adoption of the AASHTO/FHWA Joint Implementation Agreement for *MASH* in 2016, specific implementation dates were defined to determine crashworthiness of roadside safety systems to be implemented on projects on the NHS using the 2016 edition of *MASH*. CTDOT was interested in including this guardrail system within its standards as an available roadside safety hardware. However, prior to adding this system to the CTDOT standards, it was necessary to have a *MASH-2016* compliant system. CTDOT proposes to full-scale crash test and evaluate the Merritt Parkway Guiderail system performance in accordance to the guidelines specified in the 2016 edition of *MASH*.

1.3. OBJECTIVE

The testing research objectives are to:

1. Full-scale crash test and evaluate the Merritt Parkway Guiderail LON performance per *MASH* Tests 3-11 and 3-10;
2. Full-scale crash test and evaluate the Merritt Parkway Guiderail LON performance with installation of a curb in front of the guiderail (*MASH* Tests 3-11 and 3-10); and
3. Full-scale crash test and evaluate the performance of the transition section between the LON of the Merritt Parkway Guiderail and a concrete parapet (*MASH* Tests 3-21 and 3-20).

If the results of the full-scale crash tests are deemed successful per *MASH* standards, this research would generate documentation needed to support a request for an FHWA eligibility letter.

1.4. WORK PLAN

1.4.1. Task 1 – System Drawings and Construction

The TTI research team worked closely with the project Technical Representative to determine the construction characteristics (and the details) of the Merritt Parkway Guiderail system, including details for curb and transition to concrete parapet. The proposed construction characteristics were approved by CTDOT before being considered for construction. A total of six full-scale crash tests were to be conducted according to *MASH* Test Level 3 (TL-3) standard.

1.4.2. Task 2 – Full-Scale Crash Test (Test 3-11 on LON, no Curb)

This full-scale crash test involves a 5000-lb pickup truck impacting the Merritt Parkway Guiderail LON at 62 mi/h nominal speed and at nominal orientation of 25 degrees (*MASH* Test 3-11). The test investigates vehicle stability, occupant risk, and evaluates the likelihood for the vehicle to experience pocketing or snagging, and undergo excessive occupant compartment deformation. As part of this Task, critical impact point (CIP) was determined according to pertinent information contained in *MASH*.

1.4.3. Task 3 – Full-Scale Crash Test (Test 3-10 on LON, no Curb)

This full-scale crash test involves a 2420-lb passenger car impacting the Merritt Parkway Guiderail LON at 62 mi/h nominal speed and at nominal orientation of 25 degrees (*MASH* Test 3-10). The test investigates vehicle stability, occupant risk, and evaluates the likelihood for the vehicle to experience pocketing or snagging, and undergo excessive occupant compartment deformation. As part of this Task, CIP was determined according to pertinent information contained in *MASH*.

1.4.4. Task 4 – Full-Scale Crash Test (Test 3-11 on LON, with Curb)

This full-scale crash test involves a 5000-lb pickup truck impacting the Merritt Parkway Guiderail LON, with a curb installed in front of the guiderail. The pickup truck vehicle impacts the system at 62 mi/h nominal speed and at nominal orientation of 25 degrees (*MASH* Test 3-11).

The test will investigate vehicle stability, occupant risk and evaluates the likelihood for the vehicle to experience pocketing or snagging, and undergo excessive occupant compartment deformation. As part of this Task, CIP was determined according to pertinent information contained in *MASH*.

1.4.5. Task 5 – Full-Scale Crash Test (Test 3-10 on LON, with Curb)

This full-scale crash test involves a 2420-lb passenger car impacting the Merritt Parkway Guiderail LON, with a curb installed in front of the guiderail. The passenger car vehicle impacts the system at 62 mi/h nominal speed and at nominal orientation of 25 degrees (*MASH* Test 3-10). The test investigates vehicle stability, occupant risk, and evaluates the likelihood for the vehicle to experience pocketing or snagging, and undergo excessive occupant compartment deformation. As part of this Task, CIP was determined according to pertinent information contained in *MASH*.

1.4.6. Task 6 – Full-Scale Crash Test (Test 3-21 on Transition)

This full-scale crash test involves a 5000-lb pickup truck impacting the transition system connecting the Merritt Parkway Guiderail to the concrete parapet. The pickup truck vehicle will impact the system at 62 mi/h nominal speed and at nominal orientation of 25 degrees (*MASH* Test 3-21). The test investigates vehicle stability, occupant risk and evaluates the likelihood for the vehicle to experience pocketing or snagging, and undergo excessive occupant compartment deformation. As part of this Task, CIP was determined according to pertinent information contained in *MASH*.

1.4.7. Task 7 – Full-Scale Crash Test (Test 3-20 on Transition)

This full-scale crash test involves a 2420-lb passenger car impacting the transition system connecting the Merritt Parkway Guiderail to the concrete parapet. The passenger car vehicle impacts the system at 62 mi/h nominal speed and at nominal orientation of 25degrees (*MASH* Test 3-20). The test investigates vehicle stability, occupant risk, and evaluates the likelihood for the vehicle to experience pocketing or snagging, and undergo excessive occupant compartment deformation. As part of this Task, CIP was determined according to pertinent information contained in *MASH*.

1.4.8. Task 8 – Report and Recommendations

The TTI research team generated this final report of the findings from the research testing. Results are reported in terms of the system performance, vehicle stability, and occupant risk factors, and was compared with respect to *MASH* crashworthiness criteria. The TTI research team provided drawings of the railing system and of each of their components.

If the results of the full-scale crash tests are deemed successful per *MASH*, this project will culminate with a request for a FHWA eligibility letter(s) for the tested and evaluated systems.

This report provides details on the Merritt Parkway Guiderail with no curb, the crash tests and results, and the performance assessment of the Merritt Parkway Guiderail with no curb for *MASH* TL-3 longitudinal barrier evaluation criteria.

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Chapter 2. TEST REQUIREMENTS AND EVALUATION CRITERIA

2.1. CRASH TEST PERFORMED/MATRIX

Table 2.1. shows the test conditions and evaluation criteria for *MASH* TL-3 for longitudinal barriers and transitions. The target CIPs for each test were determined using the information provided in *MASH* Section 2.2.1 and Section 2.3.2. **Error! Reference source not found.** and **Error! Reference source not found.** show the target CIPs for *MASH* Tests on the Modified Merritt Parkway Guiderail with no curb, and Figure 2.3 and Figure 2.4 show the target CIPs for the *MASH* tests on the Merritt Parkway Guiderail Transition.

Table 2.1. Test Conditions and Evaluation Criteria Specified for *MASH* TL-3 Longitudinal Barriers and Transitions.

Test Article	Test Designation	Test Vehicle	Impact Conditions		Evaluation Criteria
			Speed	Angle	
Longitudinal Barriers	3-10	1100C	62 mi/h	25°	A, D, F, H, I
	3-11	2270P	62 mi/h	25°	A, D, F, H, I
Transitions	3-20	1100C	62 mi/h	25°	A, D, F, H, I
	3-21	2270P	62 mi/h	25°	A, D, F, H, I
	3-21	2270P	62 mi/h	25°	A, D, F, H, I

Figure 2.1. Target CIP for *MASH* Test 3-10 on Merritt Parkway Guiderail with Curb (Test No. 612061-03-1.

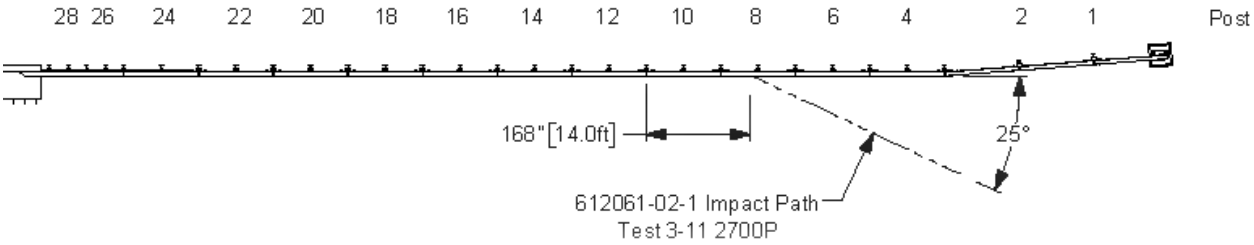

Figure 2.2. Target CIP for *MASH* Test 3-11 on Modified Merritt Parkway Guiderail with Curb (Test No. 612061-03-1.

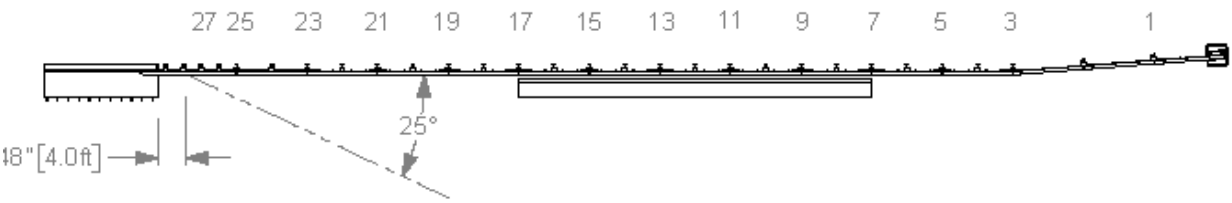

Figure 2.3. Target CIP for *MASH* Test 3-20 on Merritt Parkway Guiderail Transition (Test No. 612061-07-1.

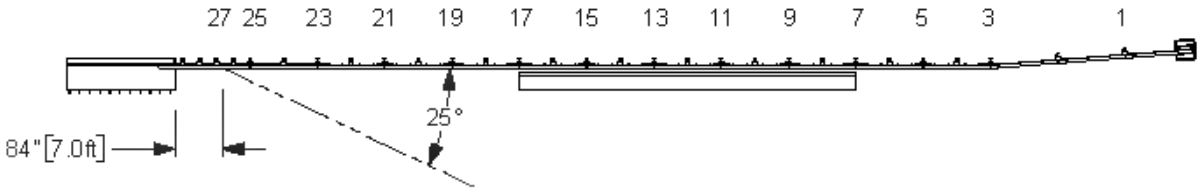

Figure 2.4. Target CIP for *MASH* Test 3-21 on Merritt Parkway Guiderail Transition (Test No. 612061-06-1.

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

2.2. EVALUATION CRITERIA

The appropriate safety evaluation criteria from Tables 2-2 and 5-1 of *MASH* were used to evaluate the crash tests reported herein. Table 2.1. lists the test conditions and evaluation criteria required for *MASH* TL-3, and Table 2.2 provides detailed information on the evaluation criteria. An evaluation of the crash test results is presented in Chapter 7.

Table 2.2. Evaluation Criteria Required for *MASH* TL-3 Longitudinal Barriers and Transitions.

Evaluation Factors	Evaluation Criteria	*MASH* Test
Structural Adequacy	*A. 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.*	*10, 11, 20, 21*
Occupant Risk	*D. Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present undue hazard to other traffic, pedestrians, or personnel in a work zone.* *Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.2.2 and Appendix E of MASH.*	*10, 11, 20, 21*
	F. The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.	*10, 11, 20, 21*
	H. Occupant impact velocities (OIV) should satisfy the following limits: Preferred value of 30 ft/s, or maximum allowable value of 40 ft/s.	*10, 11, 20, 21*
	I. The occupant ridedown accelerations should satisfy the following: Preferred value of 15.0 g, or maximum allowable value of 20.49 g.	*10, 11, 20, 21*

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Chapter 3. TEST CONDITIONS

3.1. TEST FACILITY

The full-scale crash tests reported herein were performed at the 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 tests were performed according to TTI Proving Ground quality procedures, as well as *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 mi 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, highway pavement durability and efficacy, and roadside safety hardware and perimeter protective device evaluation. The site selected for construction and testing of the Merritt Parkway Guiderail installation was along the edge 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.

3.2. VEHICLE TOW AND GUIDANCE SYSTEM

Each 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 and 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.

3.3. DATA ACQUISITION SYSTEMS

3.3.1. Vehicle Instrumentation and Data Processing

Each test vehicle was instrumented with a self-contained onboard 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 in case the primary battery cable is 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 to ensure that all instrumentation used in the vehicle conforms to the 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 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 anytime data are suspect. Acceleration data are measured with an expanded uncertainty of ±1.7 percent at a confidence factor of 95 percent (k = 2).

TRAP uses the data from the TDAS Pro to compute the occupant/compartment impact velocities, time of occupant/compartment impact after vehicle impact, and 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, and 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 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).

3.3.2. Anthropomorphic Dummy Instrumentation

An Alderson Research Laboratories Hybrid II, 50th percentile male anthropomorphic dummy, restrained with lap and shoulder belts, was placed in the front seat on the impact side of the 1100C vehicle. The dummy was not instrumented.

According to *MASH*, use of a dummy in the 2270P vehicle is optional, and no dummy was used in the test. However, *MASH* recommends that a dummy be used when testing "any longitudinal barrier with a height greater than or equal to 33 inches." More specifically, 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 concrete parapet was 33 inches, a dummy was placed in the front seat of the 2270P vehicle on the impact side and restrained with lap and shoulder belts.

3.3.3. Photographic Instrumentation Data Processing

Photographic coverage of each 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 from the installation at an angle to have a field of view of the interaction of the rear of the vehicle with the installation.
- A third placed with 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 guiderail/transition installation. 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 4. MERRITT PARKWAY GUIDERAIL WITH CURB

4.1. TEST ARTICLE DETAILS

4.1.1. Installation Details

The installation was comprised of a timber single rail system supported by timber blockouts attached to steel W6×15 by 78-inch long posts embedded 49¼ inches below grade. The top of the rail was 30 inches above grade. The timber rails were secured to blockouts and posts with a standard steel backup plate attached to the field side of the timbers, which were in turn both attached to a splice plate attached to the posts and blockouts. A concrete parapet with an adjoining transition section was constructed on the downstream end of the system, and a sloped and flared anchor section was constructed on the upstream end. The total length of the system measured 166 ft-0 inches.

The parapet measured 16 ft long, 33 inches high above grade, and 12 inches wide at the top, stepping to 10½ inches wide at the base on the field side at 20 inches above grade. The concrete parapet was anchored with U-bars to a 16-ft long, 56-inch wide, and 18-inch deep concrete slab cast below grade.

The timber rail transition section extended 21 ft-2 inches upstream from the end of the parapet with four post spacings at 30 inches and two post spacings at 60 inches. A terminal curb section extended from the parapet approximately 20 feet upstream. It commenced 8 inches above grade, sloped downward, and terminated flush with grade just downstream of post 13.

The LON measured 100 ft with eleven posts (Nos. 3–13) spaced on 10-ft centers. The upstream anchor section measured 29 ft-½ inch in length and flared 34¼ inches to the field side while sloping down before terminating into an anchor block located below grade. The concrete anchor block measured approximately 36×36 inches × 39 inches tall and was cast 59½ inches deep into the surrounding soil.

Figure 4.1presents the overall information on the Merritt Parkway Guiderail, and Figure 4.2 provides photographs of the installation. Appendix A.1 provides further details on the Merritt Parkway Guiderail. Drawings were provided by the Texas A&M Transportation Institute (TTI) Proving Ground, and construction was performed by Bryan Construction and DMA Construction, Inc., and supervised by TTI Proving Ground personnel.

4.1.2. Design Modifications during Tests

No modification was made to the installation during this testing phase. No modification was made to the installation during this testing phase. However, due to the results of this testing phase, modifications were made to the system as described in Chapter 5 of this report.

Figure 4.1. Details of Merritt Parkway Guiderail with No Curb.

Figure 4.2. Merritt Parkway Guiderail with No Curb prior to Testing.

4.1.3. Material Specifications

The specified minimum compressive strengths of concrete were as follows:

- Parapet and foundation – 3600 psi.
- Parapet terminal transition curb – 3000 psi.
- 50 ft curb in LON – 4000 psi.
- Anchor block – 3000 psi.

Concrete samples from the parapet foundation were broken on 2020-06-01. Concrete samples from the parapet, transition curb, 50 ft curb, and anchor block were broken on 2020-07-07. The average compressive strengths of the concrete were as follows:

- Parapet foundation: 4893 psi at 32 days of age.
- Parapet: 5573 psi at 46 days of age. parapet terminal transition curb: 5573 psi at 46 days of age.
- 50 ft curb in LON: 4573 psi at 26 days of age.
- Anchor block: 5573 psi at 46 days of age

Appendix B provides material certification documents for the materials used to install/construct the Merritt Parkway Guiderail.

4.1.4. Soil Conditions

The test installation was installed in standard soil meeting grading B of AASHTO standard specification M147-65(2004) "Materials for Aggregate and Soil Aggregate Subbase, Base and Surface Courses." A soil strength test was not performed.

4.2. *MASH* TEST 3-11 (CRASH TEST NO. 612061-02-1)

4.2.1. Test Designation and Actual Impact Conditions

MASH Test 3-11 involves a 2270P vehicle weighing 5000 lb ± 110 lb impacting the CIP of the longitudinal barrier at an impact speed of 62 mi/h ± 2.5 mi/h and an angle of 25 degrees ± 1.5 degrees. The CIP for *MASH* Test 3-11 on the Merritt Parkway Guiderail with no curb was 14.0 ft ± 1 ft upstream of centerline of post 11. Figure 2.1 and **Error! Reference source not found.** depict the target impact setup.

Figure 4.3. Merritt Parkway Guiderail/Test Vehicle Geometrics for Test No. 612061-02-1.

The 2270P vehicle weighed 5012 lb, and the actual impact speed and angle were 62.4 mi/h and 24.3 degrees. The actual impact point was 13.6 ft upstream of the centerline of post 11. Minimum target impact severity (IS) was 106 kip-ft, and actual IS was 111 kip-ft.

4.2.2. Weather Conditions

The test was performed on the morning of December 17, 2020. Weather conditions at the time of testing were as follows: wind speed: 4 mi/h; wind direction: 196 degrees (vehicle was traveling at a heading of 195 degrees); temperature: 44°F; relative humidity: 80 percent.

4.2.3. Test Vehicle

Error! Reference source not found. shows the 2014 RAM 1500 pickup truck used for the crash test. The vehicle's test inertia weight was 5012 lb, and its gross static weight was 5177 lb. The height to the lower edge of the vehicle bumper was 11.8 inches, and height to the upper edge of the bumper was 27.0 inches. The height to the vehicle's center of gravity was 28.5 inches. Tables A.6 and A.7 in Appendix A.4.1 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 4.4. Test Vehicle before Test No. 612061-02-1.

4.2.4. Test Description

Error! Reference source not found. lists events that occurred during Test No. 612061-02-1. Figures A.7 and A.8 in Appendix A.4.2 present sequential photographs during the test.

Table 4.1. Events during Test No. 612061-02-1.

Time (s)	Events
0.0000	Vehicle impacts the installation
0.0160	Post 9 and 8 begins to deflect toward field side
0.0380	Post 8 and 10 begins to deflect back toward field side
0.0470	Vehicle begins to redirect
0.1470	Upstream end of rail at post 11 impacts front of vehicle
0.2890	Forward momentum of truck ceased and truck begins to yaw clockwise
1.0000	Vehicle loses contact with guide rail while traveling at 8.4 mi/h, trajectory of 86.2 degrees, and heading of 75.6 degrees

For longitudinal barriers, it is desirable for the vehicle to redirect and exit 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*. After loss of contact with the guide rail, the vehicle came to rest 17.5 ft downstream of the point of impact and against 5 ft toward traffic lanes.

4.2.5. Damage to Test Installation

Error! Reference source not found. through **Error! Reference source not found.** show the damage to the Merritt Parkway Guiderail with no curb. The traffic face of the wood rail was scuffed and gouged at impact. The rail between posts 9 and 11 had extensive damage and was shattered with large pieces removed that came to rest 25 ft behind the rail in line with post 12. Post 8 was leaning 6 degrees toward the field side from vertical, and there was a 3½-inch gap in the soil on the traffic side. Post 9 was leaning 10 degrees toward the field side from vertical, and there was a 2-inch gap in the soil on the field side. Post 10 was leaning 28 degrees toward the field side and downstream from vertical, and the blockout was split in half vertically. Post 11 was severely deformed and was leaning 51 degrees toward field side and downstream from vertical. Post 12 was leaning 6 degrees toward field side from vertical, and there was a 2½-inch gap in the soil on the traffic side. Post 13 had a ¼-inch gap in the soil on both the traffic and field side. Working width* was 44.8 inches, and height of working width was 46.3 inches. Maximum dynamic deflection during the test was 22.6 inches. The maximum permanent deformation of the metal backup rail was 22.9 inches.

* 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.

Figure 4.5. Merritt Parkway Guiderail after Test No. 612061-02-1.

Figure 4.6. Damage at Posts 8 through 13 after Test No. 612061-02-1.

Figure 4.7. Field Side of Guiderail after Test No. 612061-02-1.

4.2.6. Damage to Test Vehicle

Error! Reference source not found. shows the damage sustained by the vehicle. The front bumper, hood, grill, radiator and support, right front fender, right frame rail, right upper and lower control arms, right front tire and rim, right A-post, right front door, right front floor pan, right rear cab corner, right exterior bed, and rear rear spring were damaged. The windshield had stress cracks radiating upward and inward from the right lower corner. The windshield sustained stress cracks radiating upward and inward from the lower right corner. No fuel tank damage was observed. Maximum exterior crush to the vehicle was 16.0 inches in the front plane at the right front corner at bumper height. Maximum occupant compartment deformation was 6.0 inches in the right front firewall/toe pan area. **Error! Reference source not found.** shows the interior of the vehicle. Tables A.9 and A.10 in Appendix A.4.1 provide exterior crush and occupant compartment measurements.

4.2.7. Occupant Risk Factors

Data from the accelerometers were digitized for evaluation of occupant risk, and the results are shown in **Error! Reference source not found.**. Figure A.9 in Appendix A.4.3 shows the vehicle angular displacements, and Figures A.10 through A.12 in Appendix A.4.4 show acceleration versus time traces. **Error! Reference source not found.** summarizes pertinent information from the test.

Figure 4.8. Test Vehicle after Test No. 612061-02-1.

Figure 4.9. Interior of Test Vehicle after Test No. 612061-02-1.

Table 4.2. Occupant Risk Factors for Test No. 612061-02-1.

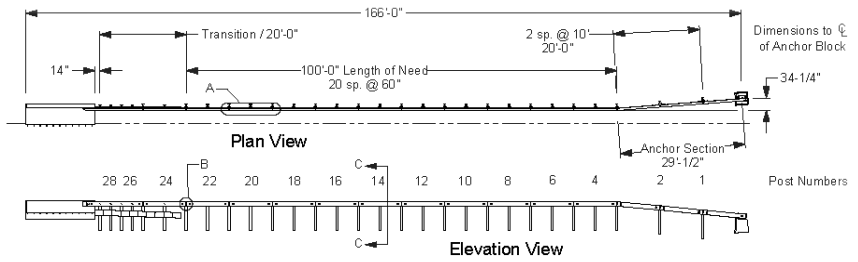
Occupant Risk Factor	Value	Time
Occupant Impact Velocity (OIV)		
Longitudinal	23.3 ft/s	at 0.1386 s on right side of interior
Lateral	14.4 ft/s	
Occupant Ridedown Accelerations		
Longitudinal	25.0 g	0.1516 - 0.1616 s
Lateral	10.6 g	0.1473 - 0.1573 s
Theoretical Head Impact Velocity (THIV)	7.7 m/s	at 0.1319 s on right side of interior
Acceleration Severity Index (ASI)	1.2	0.1564 - 0.2064 s
Maximum 50-ms Moving Average		
Longitudinal	−14.0 g	0.1803 - 0.2303 s
Lateral	−5.4 g	0.0408 - 0.0908 s
Vertical	−5.3 g	1.1199 - 1.1699 s
Maximum Yaw, Pitch, and Roll Angles		
Roll	19 degrees	1.5955 s
Pitch	16 degrees	0.6788 s
Yaw	60 degrees	1.2362 s

0.000 s

0.200 s

0.400 s

0.600 s



General Information
- Test Agency ..... Texas A&M Transportation Institute (TTI)
- Test Standard Test No. ..... *MASH* Test 3-11
- TTI Test No. 612061-02-1
- Test Date 2020-12-17

Test Article
- Type ..... Longitudinal Barrier—Guardrail
- Name ..... Merritt Parkway Guiderail with no curb
- Installation Length ..... 166 ft
- Material or Key Elements ..... Metal back timber rail on steel posts and timber blockouts

Soil Type and Condition ..... AASHTO M147-65, grading B Soil (crushed limestone)

Test Vehicle
- Type/Designation 2270P
- Make and Model ..... 2014 RAM 1500 Pickup
- Curb ..... 4962 lb
- Test Inertial ..... 5012 lb
- Dummy ..... 165 lb
- Gross Static ..... 5177 lb

Impact Conditions
- Speed ..... 62.4 mi/h
- Angle ..... 24.3°
- Location/Orientation ..... 13.6 ft upstream of post 11

Impact Severity ..... 111 kip-ft

Exit Conditions
- Speed ..... 8.4 m/h
- Trajectory/Heading Angle ..... 86.2°/75.6°

Occupant Risk Values
- Longitudinal OIV ..... 23.3 ft/s
- Lateral OIV ..... 14.4 ft/s
- Longitudinal Ridedown ..... 25.0 g
- Lateral Ridedown ..... 10.6 g
- THIV ..... 7.7 m/s
- ASI 1.2

Max. 0.050-s Average
- Longitudinal ..... −14.0 g
- Lateral ..... −5.4 g
- Vertical ..... −5.3 g

Post-Impact Trajectory
- Stopping Distance ..... 17.5 ft downstream 5 ft twd traffic lanes

Vehicle Stability
- Maximum Roll Angle ..... 19°
- Maximum Pitch Angle ..... 16°
- Maximum Yaw Angle ..... 60°
- Vehicle Snagging ..... Yes
- Vehicle Pocketing ..... Yes

Test Article Deflections
- Dynamic ..... 22.6 inches
- Permanent ..... 22.9 inches-backup
- Working Width ..... 44.8 inches
- Height of Working Width ..... 46.3 inches

Vehicle Damage
- VDS 01RFQ5
- CDC 01FREW3
- Max. Exterior Deformation ..... 16.0 inches
- OCDI RF0020000
- Max. Occupant Compartment Deformation ..... 6.0 inches

Figure 4.10. Summary of Results for *MASH* Test 3-11 on Merritt Parkway Guiderail with No Curb.

4.3. DISCUSSION

MASH Test 3-11 for longitudinal barriers was performed on the Merritt Parkway Guiderail with no curb. During this test, the longitudinal occupant ridedown acceleration of 25.0 g exceeded the limit of 20.49 g specified in *MASH*. Therefore, modifications were made to the design and the guiderail was retested.

Chapter 5. MODIFIED MERRITT PARKWAY GUIDERAIL WITH NO CURB

5.1. TEST ARTICLE DETAILS

5.1.1. Installation Details

The Modified Merritt Parkway Guiderail incorporated 21 posts in the LON such that the post spacing was decreased from 10 ft to 5 ft. Furthermore, the ten additional posts (with blockouts) were not bolted to the timber rails and steel backup plates. To wit:

The installation was comprised of a timber single rail system supported by timber blockouts attached to steel W6×15 by 78-inch long posts embedded 53¼ inches below grade. The top of the rail was 30 inches above grade. For odd numbered posts (Nos. 3-23), the timber rails were secured to blockouts and posts with a standard steel backup plate attached to the field side of the timbers, which were in turn both attached to a splice plate attached to the posts and blockouts. For even numbered posts (Nos. 4-22) the timber rail and steel backup plates were not bolted to the posts and blockouts. A concrete parapet with an adjoining transition section was constructed on the downstream end of the system, and a sloped and flared anchor section was constructed on the upstream end. The total length of the system measured 166 ft-0 inches.

The parapet measured 16 ft long, 33 inches high above grade, and 12 inches wide at the top, stepping to 10½ inches wide at the base on the field side at 20 inches above grade. The concrete parapet was anchored with U-bars to a 16-ft long, 56-inch wide, and 18-inch deep concrete slab cast below grade.

The timber rail transition section extended 21 ft-2 inches upstream from the end of the parapet with four post spacings at 30 inches and two post spacings at 60 inches. A terminal curb section extended from the parapet approximately 20 feet upstream. It commenced 8 inches above grade, sloped downward, and terminated flush with grade just downstream of post 23.

The LON measured 100 ft with eleven posts (Nos. 3–23) spaced on 5 ft centers. A 50-foot long curb section (spanning from posts Nos. 7-17) was constructed with its face located 12 inches from the traffic side of the rail. The top of the curb was at grade as referenced to the rail height. The bottom of the curb was 4 inches below grade at the roadway elevation. The 4-inch tall, sloped-face curb was 5¾ inches wide at the bottom with a 12-inch deep by 31¾-inch wide base below grade.

The upstream anchor section measured 29 ft-½ inch in length and flared 34¼ inches to the field side while sloping down before terminating into an anchor block located below grade. The concrete anchor block measured approximately 36×36 inches × 39 inches tall and was cast 59½ inches deep into the surrounding soil.

Figure 4.1presents the overall information on the Modified Merritt Parkway Guiderail, and Figure 4.2 provides photographs of the installation. Appendix C.1 provides further details on the Modified Merritt Parkway Guiderail. Drawings were provided by the Texas A&M Transportation Institute (TTI) Proving Ground, and construction was performed by Bryan Construction and DMA Construction, Inc., and supervised by TTI Proving Ground personnel.

Figure 5.1. Details of Merritt Parkway Guiderail with No Curb.

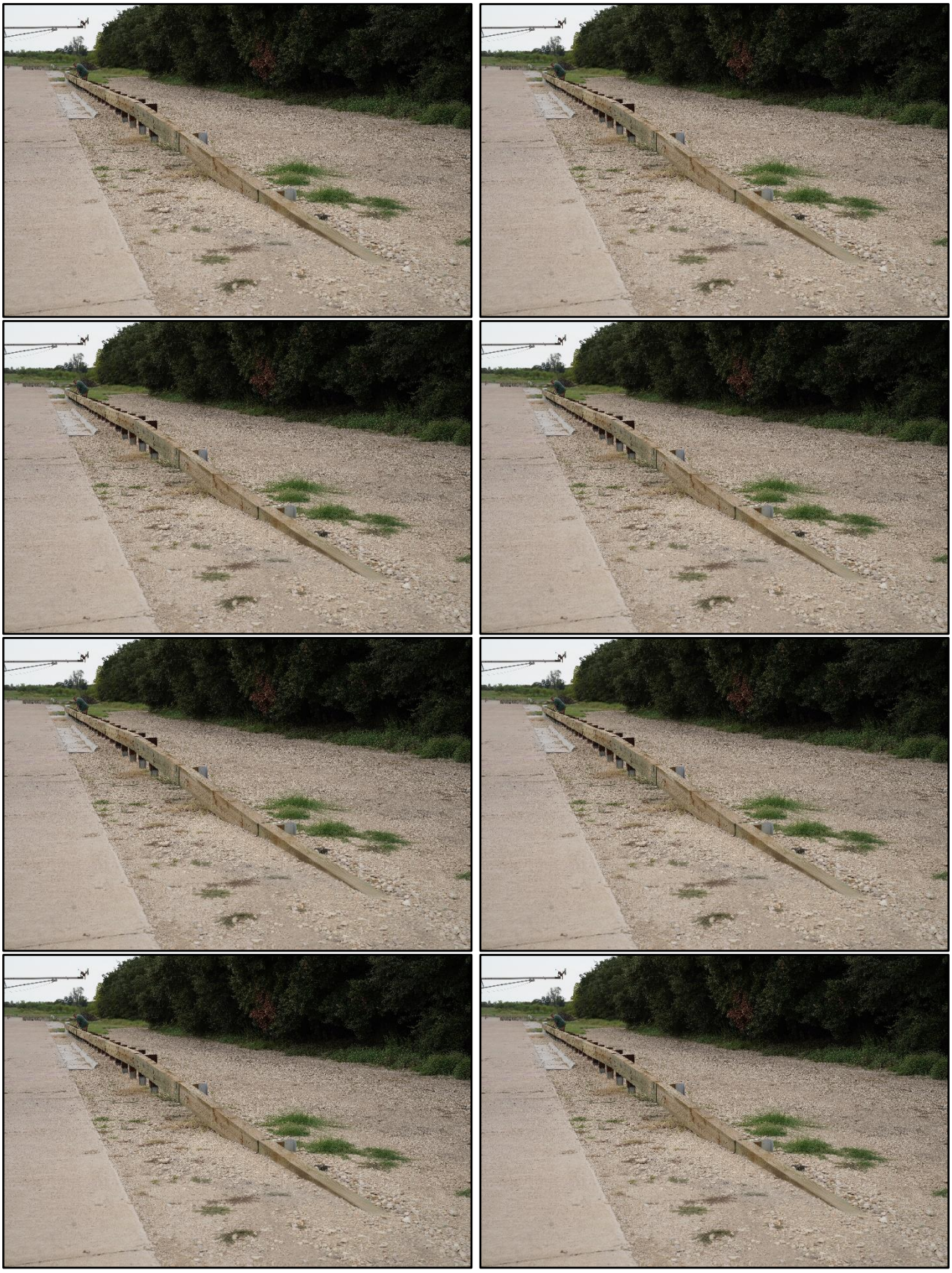


Figure 5.2. Modified Merritt Parkway Guiderail with No Curb prior to Testing.

5.1.2. Design Modifications during Tests

Other than described above, no additional modifications were made to the Modified Merritt Parkway Guiderail with no curb during this testing phase.

5.1.3. Material Specifications

The specified minimum compressive strengths of concrete were as follows:

- Parapet and foundation – 3600 psi.
- Parapet terminal transition curb – 3000 psi.
- 50 ft curb in LON – 4000 psi.
- Anchor block – 3000 psi.

Concrete samples from the parapet foundation were broken on 2020-06-01. concrete samples from the parapet, transition curb, and anchor block were broken on 2020-07-07. The reconstructed 50 ft Curb samples were broken on 2020-09-02. The average compressive strengths of the concrete were as follows:

- Parapet foundation: 4893 psi at 32 days of age.
- Parapet: 5573 psi at 46 days of age. parapet terminal transition curb: 5573 psi at 46 days of age.
- 50 ft curb in LON: 5187 psi at 43 days of age.
- Anchor block: 5573 psi at 46 days of age

Appendix B provides material certification documents for the materials used to install/construct the Modified Merritt Parkway Guiderail with no curb.

5.1.4. Soil Conditions

The test installation was installed in standard soil meeting grading B of AASHTO standard specification M147-65(2004) "Materials for Aggregate and Soil Aggregate Subbase, Base and Surface Courses."

In accordance with Appendix B of *MASH*, soil strength was measured the day of the crash test. During installation of the Merritt Parkway Guiderail for full-scale crash testing, two 6-ft long W6×16 posts were installed in the immediate vicinity of the Merritt Parkway Guiderail using the same fill materials and installation procedures used in the test installation and the standard dynamic test. Table C.1 in Appendix C.2 presents minimum soil strength properties established through the dynamic testing performed in accordance with *MASH* Appendix B.

As determined by the tests summarized in Appendix C.2, Table C.1, the minimum post loads required for deflections at 5 inches, 10 inches, and 15 inches, measured at a height of 25 inches, are 3940 lb, 5500 lb, and 6540 lb (90 percent of static load for the initial standard installation).

On the day of Crash Test No. 612061-02-1A, October 2, 2020, loads on the post at deflections of 5 inches, 10 inches, and 15 inches were 8543 lbf, 8333 lbf, and 8030 lbf. On the

day of the rash Test No. 612061-03-1, September 2, 2020, loads on the post at deflections of 5 inches, 10 inches, and 15 inches were 10,909 lbf, 9848 lbf, and 7575 lbf. Table C.2 and Table C.3in Appendix C.2 show the strength of the backfill material in which the Merritt Parkway Guiderail was installed met minimum *MASH* requirements for soil strength.

5.2. *MASH* TEST 3-11 (CRASH TEST NO. 612061-02-1A)

5.2.1. Test Designation and Actual Impact Conditions

MASH Test 3-11 involves a 2270P vehicle weighing 5000 lb ± 110 lb impacting the CIP of the longitudinal barrier at an impact speed of 62 mi/h ± 2.5 mi/h and an angle of 25 degrees ± 1.5 degrees. The CIP for *MASH* Test 3-11 on the Modified Merritt Parkway Guiderail with no curb was 14.0 ft ± 1 ft upstream of centerline of post 11. **Error! Reference source not found.** and Figure 5.3 depict the target impact setup.

Figure 5.3. Modified Merritt Parkway Guiderail with No Curb/Test Vehicle Geometrics for Test No. 612061-02-1A.

The 2270P vehicle weighed 5033 lb, and the actual impact speed and angle were 61.5 mi/h and 25.1 degrees. The actual impact point was 14.2 ft upstream of the centerline of post 11. Minimum target IS was 106 kip-ft, and actual IS was 115 kip-ft.

5.2.2. Weather Conditions

The test was performed on the afternoon of September 2, 2020. Weather conditions at the time of testing were as follows: wind speed: 1 mi/h; wind direction: 252 degrees (vehicle was traveling at a heading of 195 degrees); temperature: 84°F; relative humidity: 75 percent.

5.2.3. Test Vehicle

Figure 5.4 shows the 2014 RAM 1500 pickup truck used for the crash test. The vehicle's test inertia weight was 5033 lb, and its gross static weight was 5033 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 29.5 inches. Tables C.1 and C.2 in Appendix C.3.1 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 5.4. Test Vehicle before Test No. 612061-02-1A.

5.2.4. Test Description

Table 5.1 lists events that occurred during Test No. 612061-02-1A. Figures C.1 and C.2 in Appendix C.3.2 present sequential photographs during the test.

Table 5.1. Events during Test No. 612061-02-1A.

Time (s)	Events
-0.011	Vehicle right front tire contacts curb
0.000	Vehicle impacts guiderail
0.018	Post 9 and 8 deflect toward field side
0.040	Vehicle begins to redirect
0.065	Wooden rail element between post 9 and 11 fractured
0.092	Front of vehicle contacts post 10
0.163	Front of vehicle contacts upstream end of rail between post 11 and 12
0.355	Vehicle forward momentum stopped and begins rotating clockwise

For longitudinal barriers, it is desirable for the vehicle to redirect and exit 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 not applied. The vehicle came to rest 17 ft downstream of the point of impact and against the traffic face of the guiderail.

5.2.5. Damage to Test Installation

Figure 5.5 through Figure 5.7 show the damage to the Modified Merritt Parkway Guiderail. There was no movement noted between posts 1 through 4 and 6. The soil was disturbed at post 5. Post 7 had a ⅛-inch gap in the soil at both the traffic and field side of the post, and was it leaning 1 degree from vertical toward field side. Post 8 had a 1½-inch gap in the soil on the traffic side, and ¼-inch gap on the field side, with the post leaning 3 degrees from vertical toward the field side. Post 9 had a 3½-inch gap in the soil at the back, and was leaning

2 degrees from vertical toward field side. Post 10 was detached from the rail, rotated 90 degrees clockwise, and was leaning 32 degrees from vertical over. Post 11 was similarly detached from the rail, rotated 90 degrees clockwise, and was leaning 48 degrees from vertical.. Post 12 had a 1-inch gap in the soil at the front, and was leaning 1.6° degrees from vertical toward the field side. The rail at post 12 was 9¾ inches from the front face of the blockout. Post 13 had a ½-inch gap in the soil on the field side, and was leaning 1 degree from vertical toward the filed side. The upstream rail at this post was 2 inches from the front face of the blockout. Posts 14 through 17 had a slight soil disturbance, and no movement was noted from post 18 to the end. The debris field extended from impact toward the field side of the rail, and ended at post 16. A large section of the wooden rail came to rest 20 ft behind the posts and 16 ft downstream from impact. There was another smaller section of rail that came to rest 43 ft behind and in line with post 16. Working width* was 70.1 inches, and height of working width was 35.5 inches. Maximum dynamic deflection during the test was 30.4 inches. The maximum permanent deformation of the installation was 12.5 inches at 4 ft downstream of post 9.

Figure 5.5. Modified Merritt Parkway Guiderail after Test No. 612061-02-1A.

* 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.

Figure 5.6. Damage at Posts 5 through 8 after Test No. 612061-02-1A.

Figure 5.7. Field Side of Guiderail after Test No. 612061-02-1A.

5.2.6. Damage to Test Vehicle

Figure 5.8 shows the damage sustained by the vehicle. The front bumper, hood, grill, radiator and support, fan, water pump, right frame rail, right upper and lower control arms, right front tire and rim, right front fender, right front floor pan, and right front door. The windshield had a few stress cracks radiating upward and inward from the right lower corner. No fuel tank damage was observed. Maximum exterior crush to the vehicle was 12.0 inches in the side plane at the right front corner at bumper height. Maximum occupant compartment deformation was 4.25 inches in the right front firewall area. Figure 5.9 shows the interior of the vehicle. Tables C.3 and C.4 in Appendix C.3.1 provide exterior crush and occupant compartment measurements.

5.2.7. 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.3 in Appendix C.3.3 shows the vehicle angular displacements, and Figures C.4 through C.6 in Appendix C.3.4 show acceleration versus time traces. Figure 5.10 summarizes pertinent information from the test.

Figure 5.8. Test Vehicle after Test No. 612061-02-1A.

Figure 5.9. Interior of Test Vehicle after Test No. 612061-02-1A.

Table 5.2. Occupant Risk Factors for Test No. 612061-02-1A.

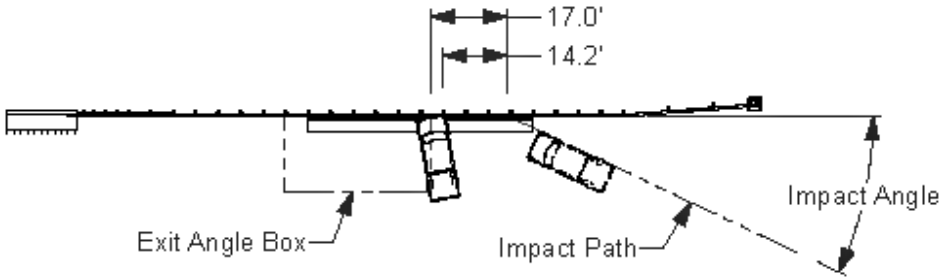
Occupant Risk Factor	Value	Time
Occupant Impact Velocity (OIV)		
Longitudinal	27.9 ft/s	at 0.1280 s on right side of interior
Lateral	14.4 ft/s	
Occupant Ridedown Accelerations		
Longitudinal	15.6 g	0.2228 – 0.2328 s
Lateral	5.9 g	0.1494 – 0.1594 s
Theoretical Head Impact Velocity (THIV)	9.7 m/s	at 0.1354 s on right side of interior
Acceleration Severity Index (ASI)	1.1	0.2156 – 0.2656 s
Maximum 50-ms Moving Average		
Longitudinal	−12.3 g	0.1885 – 0.2385 s
Lateral	−6.8 g	0.0533 – 0.1033 s
Vertical	4.3 g	0.1906 – 0.2406 s
Maximum Yaw, Pitch, and Roll Angles		
Yaw	43°	1.8577 s
Pitch	27°	0.8183 s
Roll	37°	1.5956 s

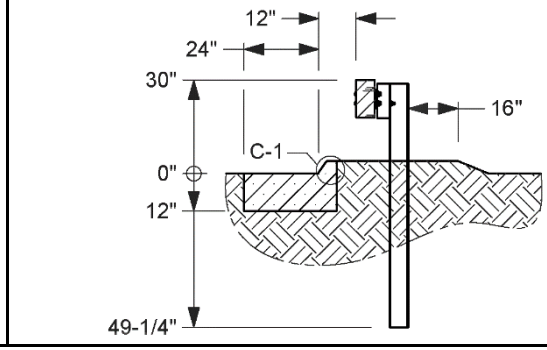

0.000 s


0.300 s


0.600 s


0.900 s





General Information
- Test Agency ..... Texas A&M Transportation Institute (TTI)
- Test Standard Test No. ..... *MASH* Test 3-11
- TTI Test No. 612061-02-1A
- Test Date 2020-09-02

Test Article
- Type ..... Longitudinal Barrier—Guardrail
- Name ..... Modified Merritt Parkway Guiderail with 4-inch Curb
- Installation Length ..... 166 ft
- Material or Key Elements ..... Metal back timber rail on steel posts and timber blockouts

Soil Type and Condition ..... AASHTO M147-65, grading B Soil (crushed limestone)

Test Vehicle
- Type/Designation 2270P
- Make and Model ..... 2014 RAM 1500 Pickup
- Curb ..... 5040 lb
- Test Inertial ..... 5033 lb
- Dummy ..... No dummy
- Gross Static ..... 5033 lb

Impact Conditions
- Speed ..... 61.5 mi/h
- Angle ..... 25.1°
- Location/Orientation ..... 14.2 ft upstream of post 11

Impact Severity ..... 115 kip-ft

Exit Conditions
- Speed ..... Stopped
- Trajectory/Heading Angle ..... Against rail

Occupant Risk Values
- Longitudinal OIV ..... 27.9 ft/s
- Lateral OIV ..... 14.4 ft/s
- Longitudinal Ridedown ..... 15.6 g
- Lateral Ridedown ..... 5.9 g
- THIV ..... 9.7 m/s
- ASI 1.1

Max. 0.050-s Average
- Longitudinal ..... −12.3 g
- Lateral ..... −6.8 g
- Vertical ..... 4.3 g

Post-Impact Trajectory
- Stopping Distance ..... 17 ft downstream Against rail

Vehicle Stability
- Maximum Yaw Angle ..... 43°
- Maximum Pitch Angle ..... 27°
- Maximum Roll Angle ..... 37°
- Vehicle Snagging ..... Yes
- Vehicle Pocketing ..... Yes

Test Article Deflections
- Dynamic ..... 30.4 inches
- Permanent ..... 12.5 inches
- Working Width ..... 70.1 inches
- Height of Working Width ..... 35.5 inches

Vehicle Damage
- VDS 01RFQ5
- CDC 01FREW3
- Max. Exterior Deformation ..... 12.0 inches
- OCDI FR0010000
- Max. Occupant Compartment Deformation ..... 4.25 inches

Figure 5.10. Summary of Results for *MASH* Test 3-11 on Modified Merritt Parkway Guiderail.

5.3. *MASH* TEST 3-10 (CRASH TEST NO. 612061-03-1)

5.2.1. Test Designation and Actual Impact Conditions

MASH Test 3-10 involves a 1100C vehicle weighing 2420 lb ± 55 lb impacting the CIP of the longitudinal barrier at an impact speed of 62 mi/h ± 2.5 mi/h and an angle of 25 degrees ± 1.5 degrees. The CIP for *MASH* Test 3-10 on the Modified Merritt Parkway Guiderail was 5.0 ft ± 1 ft upstream of the centerline of post 9. **Error! Reference source not found.** and Figure 5.11 depict the target impact setup.

Figure 5.11. Modified Merritt Parkway Guiderail/Test Vehicle Geometrics for Test No. 612061-03-1.

The 1100C vehicle weighed 2421 lb, and the actual impact speed and angle were 63.0 mi/h and 24.8 degrees. The actual impact point was 4.5 ft upstream of the centerline of post 9. Minimum target IS was 51 kip-ft, and actual IS was 57 kip-ft.

5.2.2. Weather Conditions

The test was performed on the morning of October 2, 2020. Weather conditions at the time of testing were as follows: wind speed: 7 mi/h; wind direction: 63 degrees (vehicle was traveling at a heading of 195 degrees); temperature: 73°F; relative humidity: 45 percent.

5.2.3. Test Vehicle

Figure 5.12 shows the 2014 Nissan Versa used for the crash test. The vehicle's test inertia weight was 2421 lb, and its gross static weight was 2586 lb. The height to the lower edge of the vehicle bumper was 7.0 inches, and the height to the upper edge of the bumper was 22.25 inches. Table C.5 in Appendix C.4.1 gives 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 5.12. Test Vehicle before Test No. 612061-03-1.

5.2.5. Test Description

Table 5.3 lists events that occurred during Test No. 612061-03-1. Figures C.7 and C.8 in Appendix C.4.2 present sequential photographs during the test.

Table 5.3. Events during Test No. 612061-03-1.

Time (s)	Events
-0.015	Vehicle right front tire contacts curb
0.000	Vehicle contacts rail
0.024	Post 8 and 9 deflect toward field side
0.028	Vehicle begins to redirect
0.055	Post 10 deflects toward field side
0.217	Vehicle traveling parallel with rail
0.426	Vehicle loses contact with guardrail while traveling 34.3 mi/h, trajectory of 9.2 degrees, and heading of 12.1 degrees

For longitudinal barriers, it is desirable for the vehicle to redirect and exit 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*. After loss of contact with the barrier, the vehicle came to rest 120 ft downstream of the point of impact and 36 ft toward traffic lanes.

5.2.5. Damage to Test Installation

Figure 5.13 through Figure 5.14 show the damage to the Modified Merritt Parkway Guiderail. The soil was disturbed at posts 2, 3, 5, 7, and 11. Post 8 had a 2½-inch gap in the soil on the traffic side, and the post was leaning 3 degrees back from vertical. Post 9 had a 6-inch gap on the traffic side, a 1½-inch gap on the field side, and was leaning 12 degrees back from vertical. The upstream traffic side of post 9 had a slight deformation. Post 10 was leaning 16 degrees back from vertical and had a slight clockwise rotation. The blockout at post 10 was split in half vertically. There was also gouging noted on the rail for the duration of contact.

Working width* was 34.4 inches, and height of working width was 24.0 inches. Maximum dynamic deflection during the test was 16.1 inches. The maximum permanent deformation of the installation was 11.25 inches.

Figure 5.13. Modified Merritt Parkway Guiderail after Test No. 612061-03-1.

* 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.

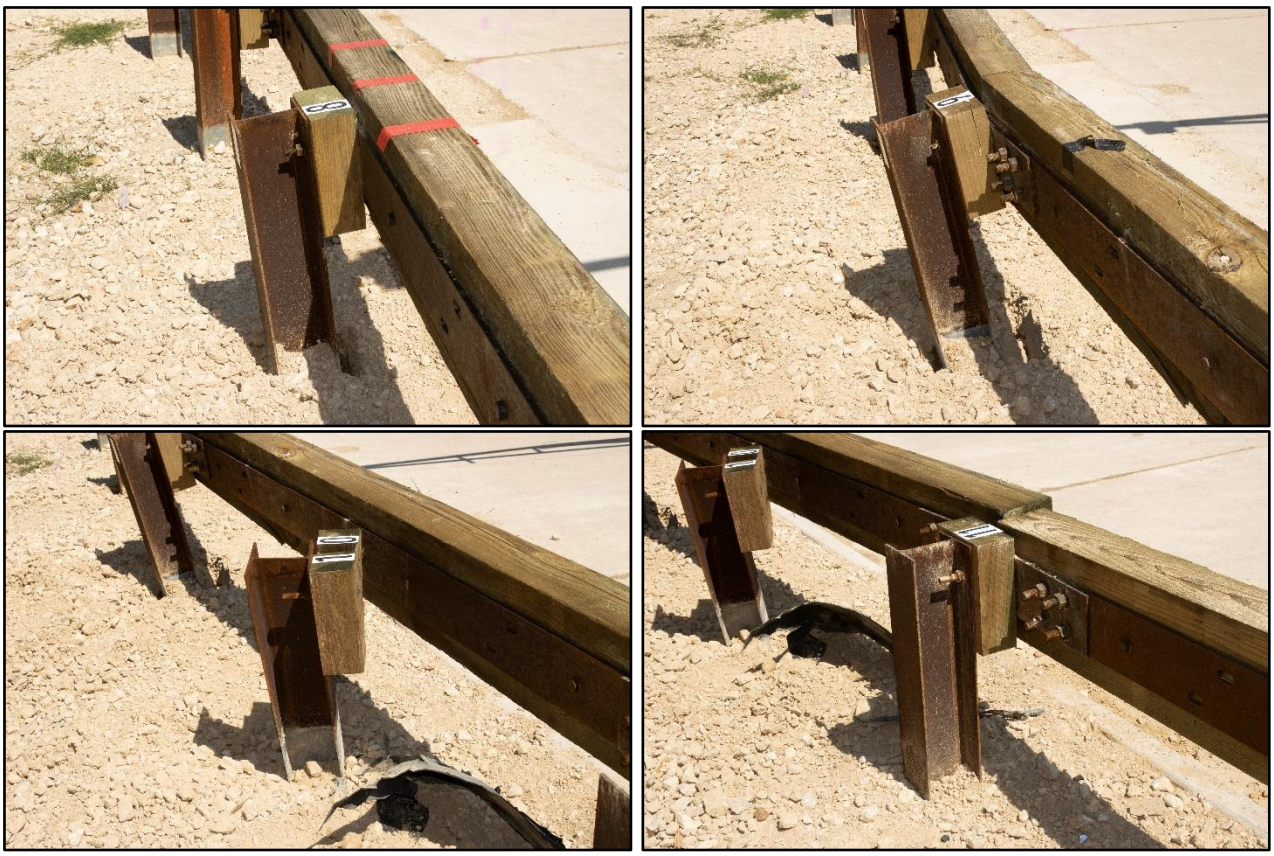


Figure 5.14. Damage from Post 8 to Post 11 after Test No. 612061-03-1.

5.2.6. Damage to Test Vehicle

Figure 5.15 shows the damage sustained by the vehicle. The front bumper, hood, grill, radiator and support, right front strut and tower, right front tire and rim, right control arm, right front fender, right front floor pan, right front and rear doors, right rear quarter panel, and rear bumper were damaged. The windshield sustained stress cracks radiating upward and inward from the right lower corner. No fuel tank damage was observed. Maximum exterior crush to the vehicle was 9.0 inches in the side plane at the right front corner at bumper height. Maximum occupant compartment deformation was 3.0 inches in the right front kick panel. Figure 5.16 shows the interior of the vehicle. Tables C.6 and C.7 in Appendix C.4.1 provide exterior crush and occupant compartment measurements.

5.2.7. Occupant Risk Factors

Data from the accelerometers were digitized for evaluation of occupant risk, and the results are shown in Table 5.4. Figure C.8 in Appendix C.4.3 shows the vehicle angular displacements, and Figures C.9 through C.11 in Appendix C.4.4 show acceleration versus time traces. Figure 5.17 summarizes pertinent information from the test.

Figure 5.15. Test Vehicle after Test No. 612061-03-1.

Figure 5.16. Interior of Test Vehicle after Test No. 612061-03-1.

Table 5.4. Occupant Risk Factors for Test No. 612061-03-1.

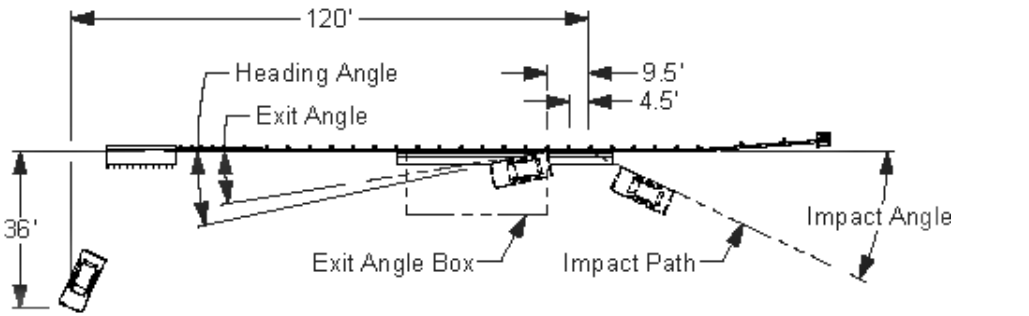
Occupant Risk Factor	Value	Time
OIV		
Longitudinal	24.0 ft/s	at 0.1054 s on right side of interior
Lateral	23.0 ft/s	
Occupant Ridedown Accelerations		
Longitudinal	13.8 g	0.1392 – 0.1492 s
Lateral	8.7 g	0.1213 – 0.1313 s
THIV	9.7 m/s	at 0.1021 s on right side of interior
ASI	1.3	0.0517 – 0.1017 s
Maximum 50-ms Moving Average		
Longitudinal	−9.9 g	0.0389 – 0.0889 s
Lateral	−10.2 g	0.0342 – 0.0842 s
Vertical	2.6 g	0.0182 – 0.0682 s
Maximum Yaw, Pitch, and Roll Angles		
Yaw	41°	0.8146 s
Pitch	6°	0.5203 s
Roll	9°	0.1758 s

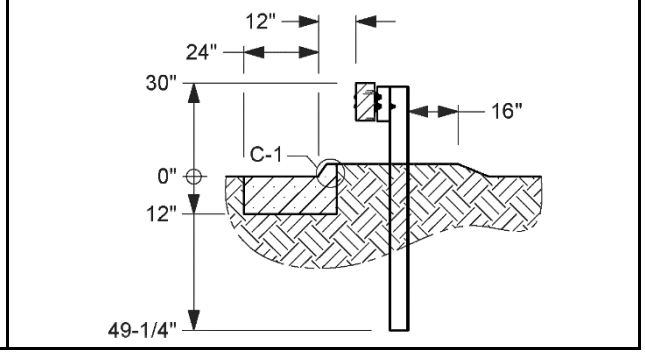

0.000 s


0.200 s


0.400 s


0.600 s





General Information
- Test Agency ..... Texas A&M Transportation Institute (TTI)
- Test Standard Test No. ..... *MASH* Test 3-10
- TTI Test No. 612061-03-1
- Test Date 2020-10-02

Test Article
- Type ..... Longitudinal Barrier—Guardrail
- Name ..... Modified Merritt Parkway Guiderail w/4-inch Curb
- Installation Length ..... 166 ft
- Material or Key Elements ..... Metal back timber rail on steel posts and timber blockouts
- **Soil Type and Condition** ..... AASHTO M147-65, grading B Soil (crushed limestone)

Test Vehicle
- Type/Designation .....
- Make and Model 1100C
- Curb ..... 2014 Nissan Versa
- Test Inertial ..... 2444 lb
- Dummy ..... 2421 lb
- Gross Static ..... 165 lb / 2586 lb

Impact Conditions
- Speed ..... 63.0 mi/h
- Angle ..... 24.8°
- Location/Orientation ..... 4.5 ft upstream of post 9

Impact Severity ..... 57 kip-ft

Exit Conditions
- Speed ..... 34.3 mi/h
- Trajectory/Heading Angle ..... 9.2°/12.1°

Occupant Risk Values
- Longitudinal OIV ..... 24.0 ft/s
- Lateral OIV ..... 23.0 ft/s
- Longitudinal Ridedown ..... 13.8 g
- Lateral Ridedown ..... 8.7 g
- THIV ..... 9.7 m/s
- ASI 1.3

Max. 0.050-s Average
- Longitudinal ..... −9.9 g
- Lateral ..... −10.2 g
- Vertical ..... 2.6 g

Post-Impact Trajectory
- Stopping Distance ..... 120 ft downstream 36 ft twd traffic lanes

Vehicle Stability
- Maximum Yaw Angle ..... 41°
- Maximum Pitch Angle ..... 6°
- Maximum Roll Angle ..... 9°
- Vehicle Snagging ..... No
- Vehicle Pocketing ..... No

Test Article Deflections
- Dynamic ..... 16.1 inches
- Permanent ..... 11.25 inches
- Working Width ..... 34.4 inches
- Height of Working Width ..... 24.0 inches

Vehicle Damage
- VDS 01RFQ4
- CDC 01FREW4
- Max. Exterior Deformation ..... 9.0 inches
- OCDI RF0000010
- Max. Occupant Compartment Deformation ..... 3.0 inches

Figure 5.17. Summary of Results for *MASH* Test 3-10 on Modified Merritt Parkway Guiderail with Curb.

Chapter 6. MERRITT PARKWAY GUIDERAIL TRANSITION

6.1. TEST ARTICLE DETAILS

6.1.1. Installation Details

The timber rail Transition Section that abutted a concrete parapet extended 21 ft-2 inches upstream from the end of the parapet with four post spacings at 30 inches and two post spacings at 60 inches. A terminal curb section extended from the parapet approximately 20 feet upstream. It commenced 8 inches above grade, sloped downward, and terminated flush with grade just downstream of post 23.

The remained of the installation was that of the Modified Merritt Parkway Guiderail with Curb as utilized under tests 612061-02-1A (*MASH* 3-11) and -03-1 (*MASH* 3-10). To wit:

The installation was comprised of a timber single rail system supported by timber blockouts attached to steel W6×15 by 78-inch long posts embedded 53¼ inches below grade. The top of the rail was 30 inches above grade. For odd numbered posts (Nos. 3-23), the timber rails were secured to blockouts and posts with a standard steel backup plate attached to the field side of the timbers, which were in turn both attached to a splice plate attached to the posts and blockouts. For even numbered posts (Nos. 4-22) the timber rail and steel backup plates were not bolted to the posts and blockouts. A concrete parapet with an adjoining transition section was constructed on the downstream end of the system, and a sloped and flared anchor section was constructed on the upstream end. The total length of the system measured 166 ft-0 inches.

The parapet measured 16 ft long, 33 inches high above grade, and 12 inches wide at the top, stepping to 10½ inches wide at the base on the field side at 20 inches above grade. The concrete parapet was anchored with U-bars to a 16-ft long, 56-inch wide, and 18-inch deep concrete slab cast below grade.

The timber rail transition section extended 21 ft-2 inches upstream from the end of the parapet with four post spacings at 30 inches and two post spacings at 60 inches. A terminal curb section extended from the parapet approximately 20 feet upstream. It commenced 8 inches above grade, sloped downward, and terminated flush with grade just downstream of post 23.

The LON measured 100 ft with eleven posts (Nos. 3–23) spaced on 5 ft centers. A 50-foot long curb section (spanning from posts Nos. 7-17) was constructed with its face located 12 inches from the traffic side of the rail. The top of the curb was at grade as referenced to the rail height. The bottom of the curb was 4 inches below grade at the roadway elevation. The 4-inch tall, sloped-face curb was 5¾ inches wide at the bottom with a 12-inch deep by 31¾-inch wide base below grade.

The upstream anchor section measured 29 ft-½ inch in length and flared 34¼ inches to the field side while sloping down before terminating into an anchor block located below grade. The concrete anchor block measured approximately 36×36 inches × 39 inches tall and was cast 59½ inches deep into the surrounding soil.

Figure 4.1 presents the overall information on the Merritt Parkway Guiderail Transition, and Figure 6.2 provides photographs of the installation. Appendix D.1 provides further details on the Merritt Parkway Guiderail Transition. Drawings were provided by the Texas A&M

Transportation Institute (TTI) Proving Ground, and construction was performed by Bryan Construction and DMA Construction, Inc., and supervised by TTI Proving Ground personnel.

6.1.2. Design Modifications during Tests

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

6.1.3. Material Specifications

The specified minimum compressive strengths of concrete were as follows:

- Parapet and foundation – 3600 psi.
- Parapet terminal transition curb – 3000 psi.
- 50 ft curb in LON – 4000 psi.
- Anchor block – 3000 psi.

Concrete samples from the parapet foundation were broken on 2020-06-01. concrete samples for the parapet, transition curb, and anchor block were broken on 2020-07-07. The reconstructed 50 ft Curb samples were broken on 2020-09-02. The average compressive strengths of the concrete were as follows:

- Parapet foundation: 4893 psi at 32 days of age.
- Parapet: 5573 psi at 46 days of age.
- Parapet terminal transition c: 5573 psi at 46 days of age.
- 50 ft curb in LON: 5187 psi at 43 days of age.
- Anchor block: 5573 psi at 46 days of age

Appendix B provides material certification documents for the materials used to install/construct the Merritt Parkway Guiderail.

6.1.4. Soil Conditions

The test installation was installed in standard soil meeting grading B of AASHTO standard specification M147-65(2004) "Materials for Aggregate and Soil Aggregate Subbase, Base and Surface Courses."

In accordance with Appendix B of *MASH*, soil strength was measured the day of the crash test. During installation of the Merritt Parkway Guiderail for full-scale crash testing, two 6-ft long W6×16 posts were installed in the immediate vicinity of the Merritt Parkway Guiderail Transition using the same fill materials and installation procedures used in the test installation and the standard dynamic test. Table D.1 in Appendix D.2 presents minimum soil strength properties established through the dynamic testing performed in accordance with *MASH* Appendix B.

As determined by the tests summarized in Appendix D.2, Table D.1, the minimum post loads required for deflections at 5 inches, 10 inches, and 15 inches, measured at a height of 25 inches, are 3940 lb, 5500 lb, and 6540 lb (90 percent of static load for the initial standard installation).

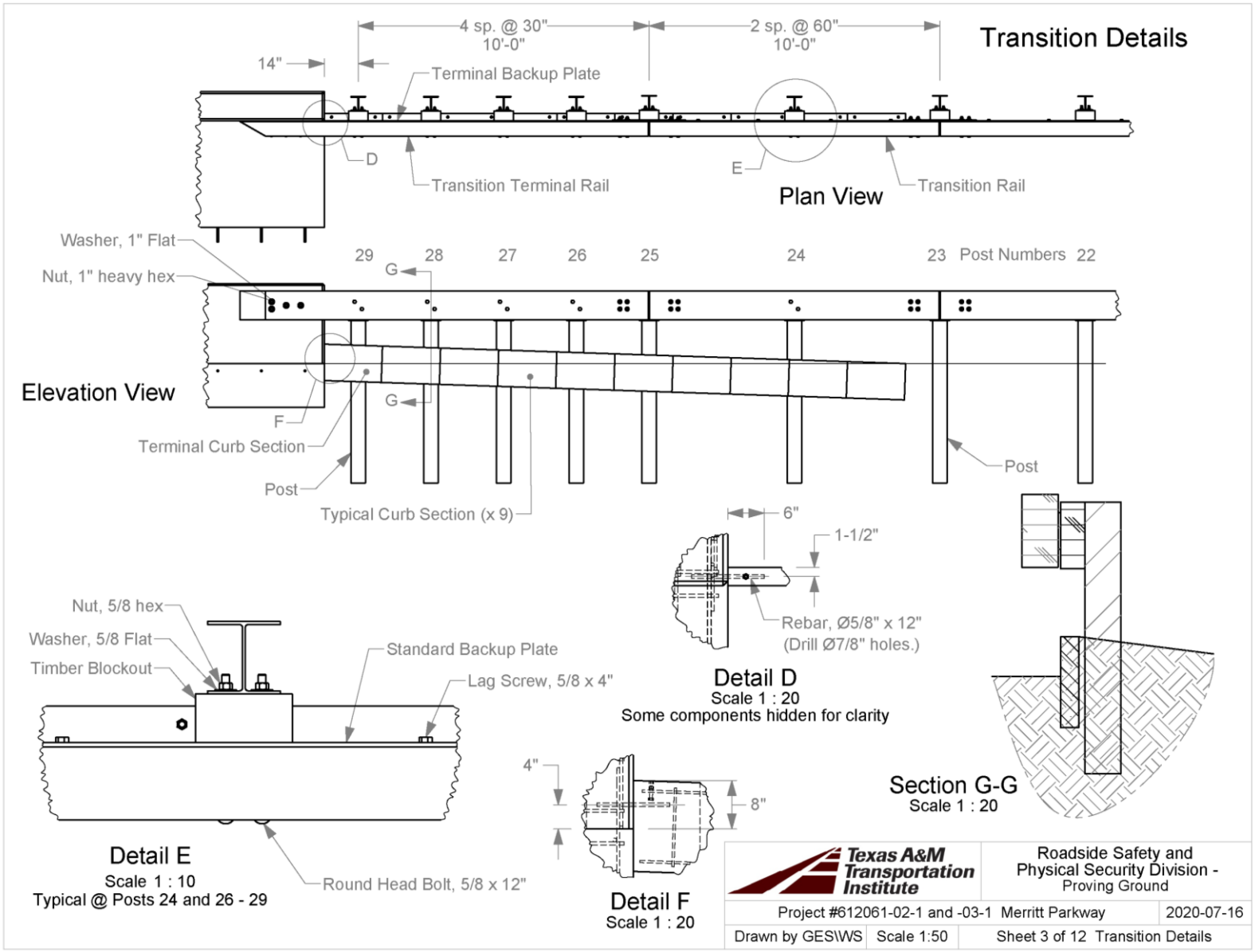


Figure 6.1. Merritt Parkway Guiderail Transition Details.

Figure 6.2. Merritt Parkway Guiderail Transition prior to Testing.

On the day of the Crash Test No. 612061-07-1, October 7, 2020, loads on the post at deflections of 5 inches, 10 inches, and 15 inches were 9898 lbf, 10,101 lbf, and 10,404 lbf. On the day of the Crash Test No. 612061-06-1, October 12, 2020, loads on the post at deflections of 5 inches, 10 inches, and 15 inches were 7676 lbf, 8434 lbf, and 6540 lbf. Table D.2 and Table D.3 in Appendix D.2 show the strength of the backfill material in which the Merritt Parkway Guiderail Transition was installed met minimum *MASH* requirements for soil strength.

6.2. *MASH* TEST 3-20 (CRASH TEST NO. 612061-07-1)

6.2.1 Test Designation and Actual Impact Conditions

MASH Test 3-20 involves a 1100C vehicle weighing 2420 lb ± 55 lb impacting the CIP of the longitudinal barrier transition at an impact speed of 62 mi/h ± 2.5 mi/h and an angle of 25 degrees ± 1.5 degrees. The CIP for *MASH* Test 3-20 on the Merritt Parkway Guiderail Transition was 4 ft ± 1 ft upstream of edge of concrete parapet. Figure 2.3 and Figure 6.3 depict the target impact setup.

Figure 6.3. Transition/Test Vehicle Geometrics for Test No. 612061-07-1.

The 1100C vehicle weighed 2420 lb, and the actual impact speed and angle were 62.5 mi/h and 25.6 degrees. The actual impact point was 3.6 ft upstream of edge of concrete parapet. Minimum target IS was 51 kip-ft, and actual IS was 59 kip-ft.

6.2.2 Weather Conditions

The test was performed on the afternoon of October 7, 2020. Weather conditions at the time of testing were as follows: wind speed: 2 mi/h; wind direction: 44 degrees (vehicle was traveling at a heading of 195 degrees); temperature: 85°F; relative humidity: 45 percent.

6.2.3 Test Vehicle

Figure 6.4 shows the 2014 Nissan Versa used for the crash test. The vehicle's test inertia weight was 2420 lb, and its gross static weight was 2585 lb. The height to the lower edge of the vehicle bumper was 7.0 inches, and the height to the upper edge of the bumper was 22.25 inches. Table D.1 in Appendix D.3.1 gives 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.

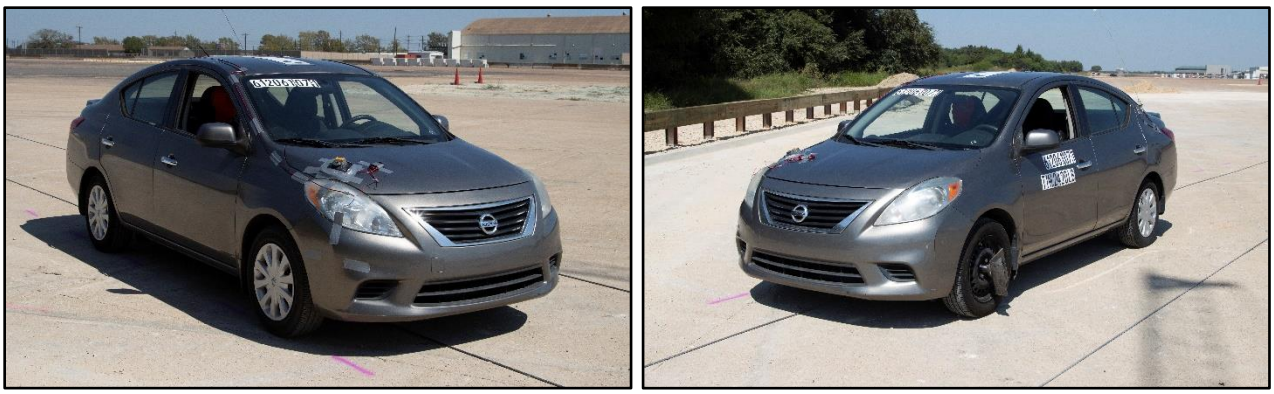


Figure 6.4. Test Vehicle before Test No. 612061-07-1.

6.2.4 Test Description

Table 6.1 lists events that occurred during Test No. 612061-07-1. Figures D.1 and D.2 in Appendix C.3.2 present sequential photographs during the test.

Table 6.1. Events during Test No. 612061-07-1.

Time (s)	Events
0.000	Vehicle impacts transition
0.031	Vehicle begins to redirect
0.210	Right left tire lifts off the ground
0.288	Vehicle travelling parallel to transition
0.310	Rear bumper contacts the parapet
0.444	Vehicle loses contact with transition while traveling at 41.1 mi/h, trajectory of 3.9 degrees, and heading 4.3 degrees

For longitudinal barriers, it is desirable for the vehicle to redirect and exit 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 after the vehicle exited the test site, and the vehicle subsequently came to rest 176 ft downstream of the point of impact and 95 ft toward traffic lanes.

6.2.5 Damage to Test Installation

Figure 6.5 shows the damage to the transition. There was a ⅛-inch gap in the soil on the field side of posts 28 and 29. The curb section at post 28 was pushed ½-inch back, and there was spalling and exposed rebar on the concrete curb section at post 29. The rail at post 29 was splintered and scuffed, and there was some cracking present on the concrete parapet. Working width* was 19.9 inches, and height of working width was 33.0 inches. Maximum dynamic deflection during the test was 1.5 inches, and no permanent deformation was observed.

* 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,

Figure 6.5. Transition after Test No. 612061-07-1.

6.2.6 Damage to Test Vehicle

Figure 6.6 shows the damage sustained by the vehicle. The front bumper, hood, radiator and support, right front fender, right front strut and tower, right front control arm, right CV joint and shaft, sway bar, tie rod end, right front tire and rim, right A-post, right front floor pan, right front door and window glass, right rear door, right rear quarter panel, and rear bumper were

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.

damaged. The roof was deformed over the right B-post, and the windshield was shattered due to deformation in the right front A-post. No fuel tank damage was observed. Maximum exterior crush to the vehicle was 12.0 inches in the side plane at the right front corner at bumper height. Maximum occupant compartment deformation was 7.25 inches in the kick panel area on the right front side. Figure 6.7 shows the interior of the vehicle. Tables D.2 and D.3 in Appendix D.3.1 provide exterior crush and occupant compartment measurements.

Figure 6.6. Test Vehicle after Test No. 612061-07-1.

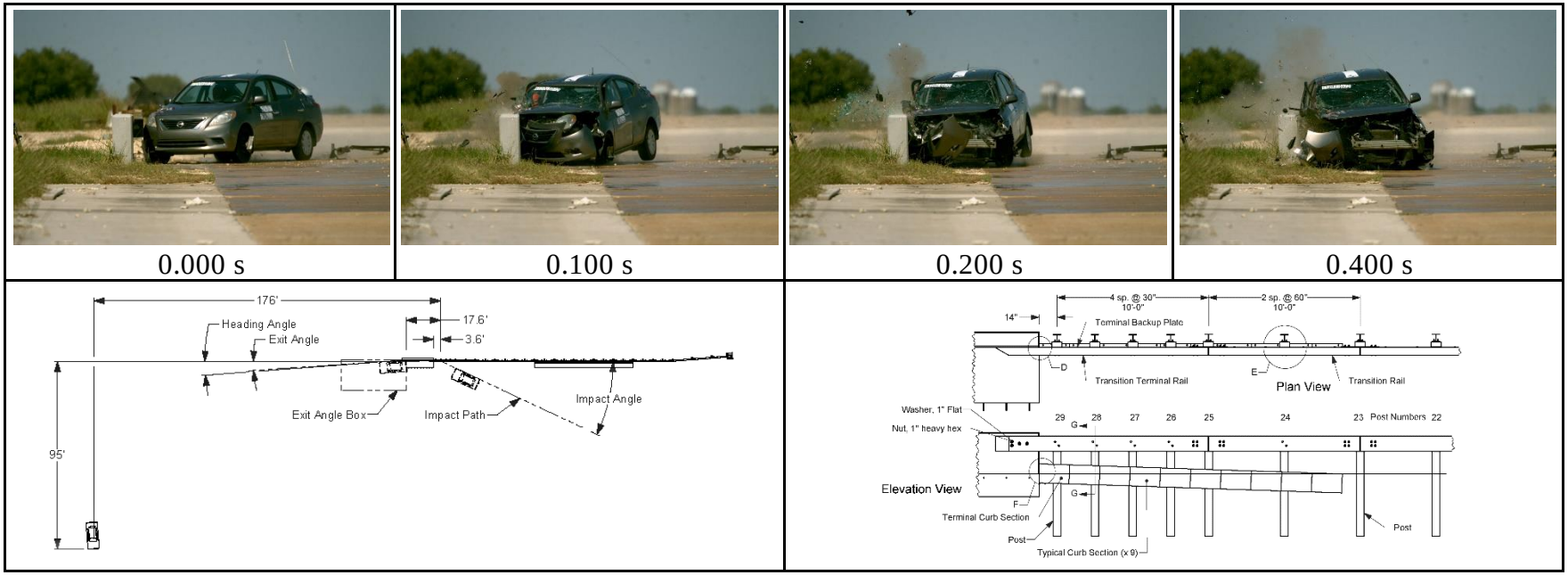
Figure 6.7. Interior of Test Vehicle after Test No. 612061-07-1.

6.2.7 Occupant Risk Factors

Data from the accelerometers were digitized for evaluation of occupant risk, and the results are shown in Table 6.2. Figure D.3 in Appendix D.3.3 shows the vehicle angular displacements, and Figures D.4 through D.6 in Appendix D.3.4 show acceleration versus time traces. Figure 6.8 summarizes pertinent information from the test.

Table 6.2. Occupant Risk Factors for Test No. 612061-07-1.

Occupant Risk Factor	Value	Time
OIV		
Longitudinal	28.9 ft/s	at 0.0862 s on right side of interior
Lateral	31.5 ft/s	
Occupant Ridedown Accelerations		
Longitudinal	6.1 g	0.0863 – 0.0963 s
Lateral	9.2 g	0.0862 – 0.0962 s
THIV	13.3 m/s	at 0.0843 s on right side of interior
ASI	2.6	0.0556 – 0.1056 s
Maximum 50-ms Moving Average		
Longitudinal	−16.1 g	0.0276 – 0.0776 s
Lateral	−17.5 g	0.0345 – 0.0845 s
Vertical	5.6 g	0.0118 – 0.0618 s
Maximum Yaw, Pitch, and Roll Angles		
Yaw	41°	1.8716 s
Pitch	8°	1.9835 s
Roll	8°	1.3041 s



General Information
- Test Agency ..... Texas A&M Transportation Institute (TTI)
- Test Standard Test No. ..... *MASH* Test 3-20
- TTI Test No. 612061-07-1
- Test Date 2020-10-07

Test Article
- Type ..... Longitudinal Barrier—Transition
- Name ..... Merritt Parkway Guiderail Transition
- Installation Length ..... 166 ft
- Material or Key Elements ..... Metal back timber rail on steel posts and timber blockouts

Soil Type and Condition ..... AASHTO M147-65, grading B Soil (crushed limestone)

Test Vehicle
- Type/Designation 1100C
- Make and Model ..... 2014 Nissan Versa
- Curb ..... 2414 lb
- Test Inertial ..... 2420 lb
- Dummy ..... 165 lb
- Gross Static ..... 2585 lb

Impact Conditions
- Speed ..... 62.5 mi/h
- Angle ..... 25.6°
- Location/Orientation ..... 3.6 ft upstream of edge of concrete

Impact Severity ..... 59 kip-ft

Exit Conditions
- Speed ..... 41.1 mi/h
- Trajectory/Heading Angle ..... 3.9°/4.3°

Occupant Risk Values
- Longitudinal OIV ..... 28.9 ft/s
- Lateral OIV ..... 31.5 ft/s
- Longitudinal Ridedown ..... 6.1 g
- Lateral Ridedown ..... 9.2 g
- THIV ..... 13.3 m/s
- ASI 2.6

Max. 0.050-s Average
- Longitudinal ..... −16.1 g
- Lateral ..... −17.5 g
- Vertical ..... 5.6 g

Post-Impact Trajectory
- Stopping Distance ..... 176 ft downstream 95 ft twd traffic lanes

Vehicle Stability
- Maximum Yaw Angle ..... 41°
- Maximum Pitch Angle ..... 8°
- Maximum Roll Angle ..... 8°
- Vehicle Snagging ..... No
- Vehicle Pocketing ..... No

Test Article Deflections
- Dynamic ..... 1.5 inches
- Permanent ..... None
- Working Width ..... 19.9 inches
- Height of Working Width ..... 33.0 inches

Vehicle Damage
- VDS 01RFQ5
- CDC 01FREW5
- Max. Exterior Deformation ..... 12.0 inches
- OCDI RF1101020
- Max. Occupant Compartment Deformation ..... 7.25 inches

Figure 6.8. Summary of Results for *MASH* Test 3-20 on Merritt Parkway Guiderail Transition.

6.3. *MASH* TEST 3-21 (CRASH TEST NO. 612061-06-1)

6.3.1 Test Designation and Actual Impact Conditions

MASH Test 3-21 involves a 2270P vehicle weighing 5000 lb ± 110 lb impacting the CIP of the longitudinal barrier at an impact speed of 62 mi/h ± 2.5 mi/h and an angle of 25 degrees ± 1.5 degrees. The CIP for *MASH* Test 3-21 on the Merritt Parkway Guiderail Transition was 7 ft ± 1 ft upstream of the edge of the concrete parapet. Figure 2.4 and Figure 6.9 depict the target impact setup.

Figure 6.9. Transition/Test Vehicle Geometrics for Test No. 612061-06-1.

The 2270P vehicle weighed 5006 lb, and the actual impact speed and angle were 63.0 mi/h and 25.2 degrees. The actual impact point was 7.1 ft upstream of the edge of the concrete parapet. Minimum target IS was 106 kip-ft, and actual IS was 120 kip-ft.

6.3.2 Weather Conditions

The test was performed on the morning of October 12, 2020. Weather conditions at the time of testing were as follows: wind speed: 8 mi/h; wind direction: 305 degrees (vehicle was traveling at a heading of 195 degrees); temperature: 82°F; relative humidity: 77 percent.

6.3.3 Test Vehicle

Figure 6.10 shows the 2014 RAM 1500 pickup truck used for the crash test. The vehicle's test inertia weight was 5006 lb, and its gross static weight was 5171 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 28.0 inches. Tables D.6 and D.7 in Appendix D.4.1 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 6.10. Test Vehicle before Test No. 612061-06-1.

6.3.4 Test Description

Table 6.3 lists events that occurred during Test No. 612061-06-1. Figures D.7 and D.8 in Appendix D.2 present sequential photographs during the test.

Table 6.3. Events during Test No. 612061-06-1.

Time (s)	Events
0.000	Vehicle impacts transition
0.015	Vehicle begins to redirect
0.030	Left front tire contacts the rail and curb
0.119	Left rear tire leaves the ground
0.182	Left front tire leaves the ground
0.220	Vehicle traveling parallel with transition
0.360	Vehicle loses contact with transition while traveling at 42.1 mi/h, trajectory of 5.5 degrees, and heading of 6.9 degrees

For longitudinal barriers, it is desirable for the vehicle to redirect and exit 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 4.25 s after impact. The vehicle subsequently came to rest 166 ft downstream of the point of impact and 24 ft toward the field side.

6.3.5 Damage to Test Installation

Figure 6.11 and Figure 6.12 show the damage to the transition. There was no movement noted from post 1 through post 25. The downstream rail at post 25 was lifted ⅞-inch up from level. Post 26 had a ¼-inch gap in the soil on the field side, and it was leaning 1° toward the field side from vertical. Post 27 also had a ¼-inch gap on the field side, and it was leaning 1° toward field side from vertical. Post 28 had a ½-inch gap on the field side, and was leaning 3° toward the field side from vertical. Post 29 had a ¼-inch gap on the field side and was leaning 2° toward the field side from vertical. The rail bolts at post 29 were deformed but remained attached to the post. The curb between post 27 and 28 was pushed toward the field side ¾-inch and large

portions of the curb were broken off and rebar exposed due to the right front tire becoming lodged between the curb and rail at the upstream end of post 28. The bolts connecting the rail to the concrete barrier were deformed and bent downstream. There was some cracking on the barrier, and the rail was splintered, gouged, and had several large pieces broken off. There were two large pieces lying on the roadway at impact measuring 46½ inches and 41 inches. A piece of 34-inch long wooden rail came to rest 37 ft downstream and 36 ft toward traffic lanes. A 34½-inch long piece of rail came to rest 50 ft downstream and in-line with the rail. A 37½-inch long piece of rail came to rest 60 ft downstream and 4 ft toward traffic lanes. Working width* was 28.4 inches, and height of working width was 52.0 inches. Maximum dynamic deflection during the test was 4.7 inches, and maximum permanent deformation was undeterminable.

Figure 6.11. Transition after Test No. 612061-06-1.

* 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.

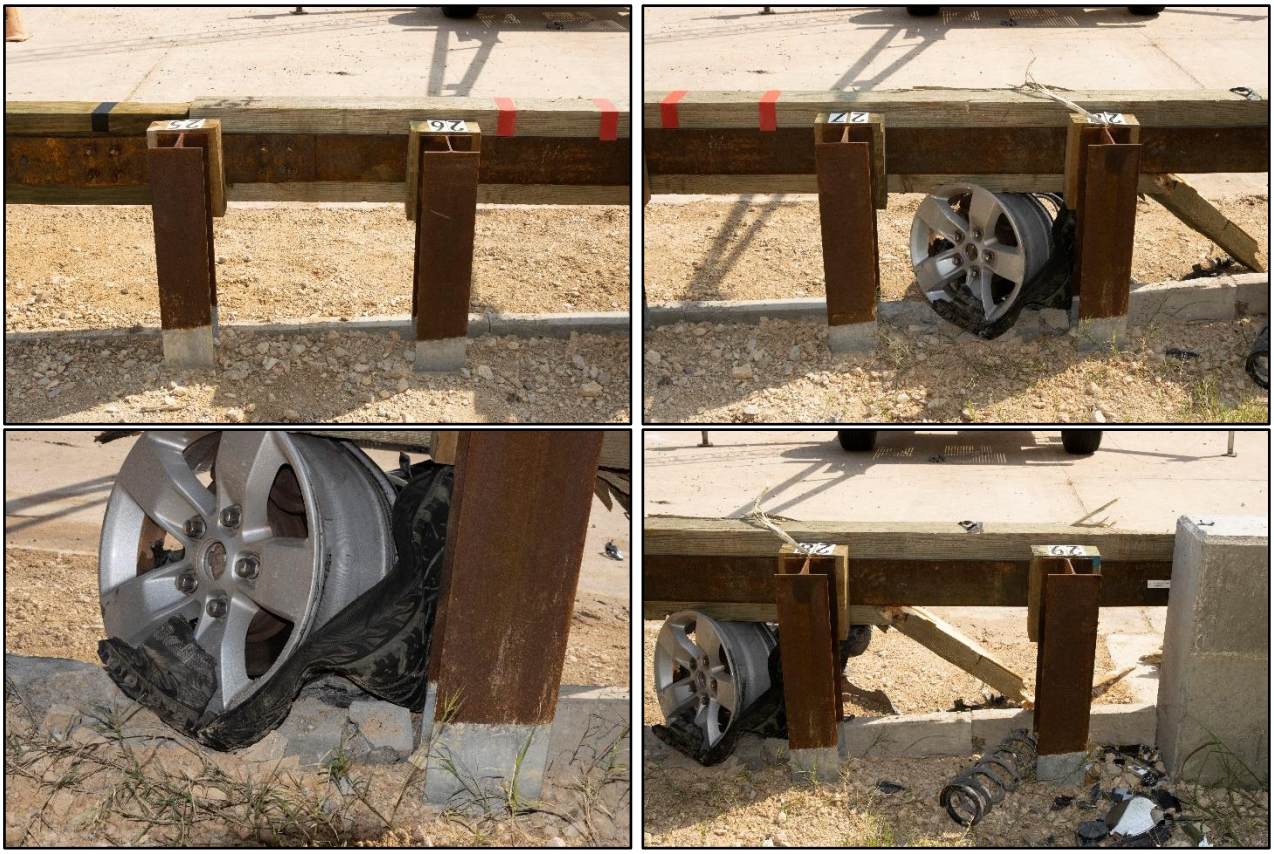


Figure 6.12. Field Side of Transition after Test No. 612061-06-1.

6.3.6 Damage to Test Vehicle

Figure 6.13 shows the damage sustained by the vehicle. The front bumper, hood, grill, radiator and support, right frame rail, right front upper and lower control arms, sway bar, right tie rod, right front tire and rim, right front fender, right front floor pan, right front door and window glass, right rear door, right rear cab corner, right rear exterior bed, and right rear tire and rim were damaged. The windshield sustained stress cracks radiating upward along the lower right edge of the frame. No fuel tank damage was observed. Maximum exterior crush to the vehicle was 18.0 inches in the front plane at the right front corner at bumper height. Maximum occupant compartment deformation was 6.5 inches in the right front kick panel area. Figure 6.14 shows the interior of the vehicle. Tables D.8 and D.9 in Appendix D.4.1 provide exterior crush and occupant compartment measurements.

Figure 6.13. Test Vehicle after Test No. 612061-06-1.

Figure 6.14. Interior of Test Vehicle after Test No. 612061-06-1.

6.3.7 Occupant Risk Factors

Data from the accelerometers were digitized for evaluation of occupant risk, and the results are shown in Table 6.4. Figure D.9 in Appendix D.4.3 shows the vehicle angular displacements, and Figures D.10 through D.12 in Appendix D.4.4 show acceleration versus time traces. Figure 6.15 summarizes pertinent information from the test.

Table 6.4. Occupant Risk Factors for Test No. 612061-06-1.

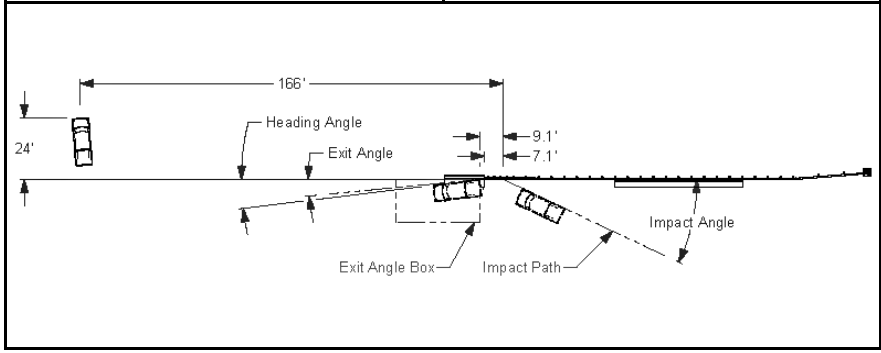
Occupant Risk Factor	Value	Time
Occupant Impact Velocity (OIV)		
Longitudinal	25.3 ft/s	at 0.1123 s on right side of interior
Lateral	25.3 ft/s	
Occupant Ridedown Accelerations		
Longitudinal	9.8 g	0.2598 – 0.2698 s
Lateral	8.5 g	0.1123 – 0.1223 s
Theoretical Head Impact Velocity (THIV)	10.8 m/s	at 0.1092 s on right side of interior
Acceleration Severity Index (ASI)	1.4	0.0978 – 0.1478 s
Maximum 50-ms Moving Average		
Longitudinal	−10.1 g	0.0186 – 0.0686 s
Lateral	−10.0 g	0.0596 – 0.1096 s
Vertical	4.1 g	0.2725 – 0.3225 s
Maximum Yaw, Pitch, and Roll Angles		
Yaw	45°	0.9265 s
Pitch	10°	0.4281 s
Roll	21°	0.7154 s

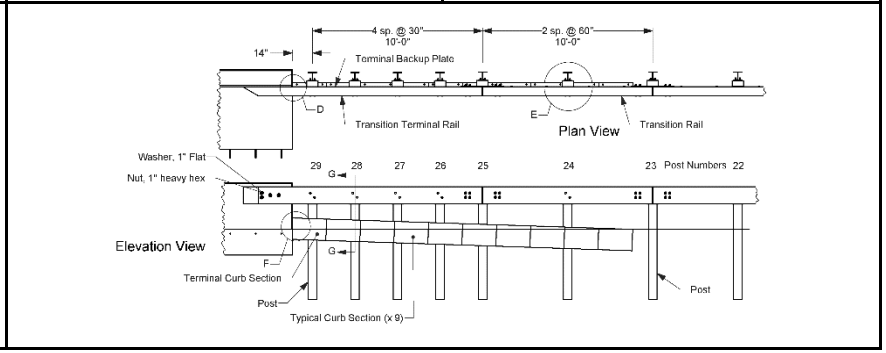
0.000 s

0.100 s

0.200 s

0.400 s





General Information
- Test Agency ..... Texas A&M Transportation Institute (TTI)
- Test Standard Test No. ..... *MASH* Test 4-21
- TTI Test No. 612061-06-1
- Test Date 2020-10-12

Test Article
- Type ..... Longitudinal Barrier—Transition
- Name ..... Merritt Parkway Guiderail Transition
- Installation Length ..... 166 ft
- Material or Key Elements ..... Metal back timber rail on steel posts and timber blockouts

Soil Type and Condition ..... AASHTO M147-65, grading B Soil (crushed limestone)

Test Vehicle
- Type/Designation 2270P
- Make and Model ..... 2014 RAM 1500 Pickup
- Curb ..... 5076 lb
- Test Inertial ..... 5006 lb
- Dummy ..... 165 lb
- Gross Static ..... 5171 lb

Impact Conditions
- Speed ..... 63.0 mi/h
- Angle ..... 25.2°
- Location/Orientation ..... 7.1 ft upstream of edge of concrete

Impact Severity ..... 120 kip-ft

Exit Conditions
- Speed ..... 42.1 mi/h
- Trajectory/Heading Angle ..... 5.5°/6.9°

Occupant Risk Values
- Longitudinal OIV ..... 25.3 ft/s
- Lateral OIV ..... 25.3 ft/s
- Longitudinal Ridedown ..... 9.8 g
- Lateral Ridedown ..... 8.5 g
- THIV ..... 10.8 m/s
- ASI 1.4

Max. 0.050-s Average
- Longitudinal ..... −10.1 g
- Lateral ..... −10.0 g
- Vertical 4.1

Post-Impact Trajectory
- Stopping Distance ..... 166 ft downstream 24 ft twd field side

Vehicle Stability
- Maximum Yaw Angle ..... 45°
- Maximum Pitch Angle ..... 10°
- Maximum Roll Angle ..... 21°
- Vehicle Snagging ..... No
- Vehicle Pocketing ..... No

Test Article Deflections
- Dynamic ..... 4.7 inches
- Permanent ..... Undeterminable
- Working Width ..... 28.4 inches
- Height of Working Width ..... 52.0 inches

Vehicle Damage
- VDS 01 RFQ5
- CDC 01FREW5
- Max. Exterior Deformation ..... 18.0 inches
- OCDI RF0031330
- Max. Occupant Compartment Deformation ..... 6.5 inches

Figure 6.15. Summary of Results for *MASH* Test 4-21 on Merritt Parkway Guiderail Transition.

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Chapter 7. SUMMARY AND CONCLUSIONS

7.1. ASSESSMENT OF TEST RESULTS

7.1.1 Merritt Parkway Guiderail with 4-inch Curb

Two crash tests were performed on the Merritt Parkway Guiderail with 4-inch curb. These tests were in accordance with *MASH* Tests 3-10 and 3-11 for longitudinal barriers. Table 7.2 and Table 7.2 provide an assessment of each test based on the applicable safety evaluation criteria for *MASH* TL-3 longitudinal barriers. The Merritt Parkway Guiderail with 4-inch curb performed acceptably for *MASH* Test 3-10. However, during *MASH* Test 3-11, the longitudinal occupant ridedown acceleration exceeded the limit specified in *MASH*.

7.1.2 Modified Merritt Parkway Guiderail with 4-inch Curb

The Merritt Parkway Guiderail with 4-inch curb was modified by decreasing the post spacing in the LON from 10 ft to 5 ft by adding extra posts that are not attached to the Guiderail between each pair of posts that are bolted to the guiderail.

MASH Tests 3-10 and 3-11 were performed on the Modified Merritt Parkway Guiderail with 4-inch curb. Table 7.3 and Table 7.4 provide an assessment of each test.

7.1.3 Merritt Parkway Guiderail Transition

Two crash tests were performed on the Merritt Parkway Guiderail Transition. These tests were in accordance with *MASH* Tests 3-20 and 3-21 for transitions. Table 7.5 and Table 7.6 provide an assessment of each test based on the applicable safety evaluation criteria for *MASH* TL-3 transitions.

7.2. CONCLUSIONS

Table 7.7 shows that the Modified Merritt Parkway Guiderail with 4-inch curb met the performance criteria for *MASH* TL-3 longitudinal barriers. Table 7.8 shows that the Merritt Parkway Guiderail Transition met the performance criteria for *MASH* TL-3 transitions.

Table 7.1. Performance Evaluation Summary for *MASH* Test 3-10 on Merritt Parkway Guiderail.

Test Agency: Texas A&M Transportation Institute Test No.: 612061-03-1 Test Date: 2020-07-08

MASH Test 3-10 Evaluation Criteria	Test Results	Assessment
Structural Adequacy		
A. 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.	The Merritt Parkway Guiderail with 4-inch curb contained and redirected the 1100C vehicle. The vehicle did not penetrate, underride, or override the installation. Maximum dynamic deflection during the test was 16.4 inches.	Pass
Occupant Risk		
D. Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone.	No detached elements, fragments, or other debris were present to penetrate or show potential for penetrating the occupant compartment, or present undue hazard to others in the area.	Pass
Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.2.2 and Appendix E of MASH.	Maximum occupant compartment deformation was 3.5 inches in the right front kick panel.	
F. The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.	The 1100C vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 7° and 6°.	Pass
H. Occupant impact velocities (OIV) should satisfy the following limits: Preferred value of 30 ft/s, or maximum allowable value of 40 ft/s.	Longitudinal OIV was 23.6 ft/s, and lateral OIV was 19.7 ft/s.	Pass
I. The occupant ridedown accelerations should satisfy the following limits: Preferred value of 15.0 g, or maximum allowable value of 20.49 g.	Longitudinal occupant ridedown acceleration was 11.8 g, and lateral occupant ridedown acceleration was 10.7 g.	Pass

Table 7.2. Performance Evaluation Summary for *MASH* Test 3-11 on Merritt Parkway Guiderail.

Test Agency: Texas A&M Transportation Institute Test No.: 612061-02-1 Test Date: 2020-07-10

***MASH* Test 3-11 Evaluation Criteria**		**Test Results**	**Assessment**
Structural Adequacy			
A.	*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.*	The Merritt Parkway Guiderail with 4-inch curb contained and redirected the 2270P vehicle. The vehicle did not penetrate, underride, or override the installation. Maximum dynamic deflection during the test was 26.2 inches.	Pass
Occupant Risk			
D.	*Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone.*	None of the fragments, or other debris from the test article penetrated or showed potential for penetrating the occupant compartment, or present undue hazard to others in the area.	Pass
	Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.2.2 and Appendix E of MASH.	Maximum occupant compartment deformation was 2.0 inches in the right front firewall area.	
F.	*The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.*	The 2270P vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 17° and 17°.	Pass
H.	*Occupant impact velocities (OIV) should satisfy the following limits: Preferred value of 30 ft/s, or maximum allowable value of 40 ft/s.*	Longitudinal OIV was 19.4 ft/s, and lateral OIV was 14.4 ft/s.	Pass
I.	*The occupant ridedown accelerations should satisfy the following limits: Preferred value of 15.0 g, or maximum allowable value of 20.49 g.*	Longitudinal occupant ridedown acceleration was 25.5 g, and lateral occupant ridedown acceleration was 14.2 g.	Fail

Table 7.3. Performance Evaluation Summary for *MASH* Test 3-10 on Modified Merritt Parkway Guiderail.

Test Agency: Texas A&M Transportation Institute Test No.: 612061-03-1 Test Date: 2020-10-02

MASH Test 3-10 Evaluation Criteria	Test Results	Assessment
Structural Adequacy		
A. 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.	The Modified Merritt Parkway Guiderail with 4-inch curb contained and redirected the 1100C vehicle. The vehicle did not penetrate, underride, or override the installation. Maximum dynamic deflection during the test was 16.1 inches.	Pass
Occupant Risk		
D. Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone.	No detached elements, fragments, or other debris were present to penetrate or show potential for penetrating the occupant compartment, or present undue hazard to others in the area.	Pass
Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.2.2 and Appendix E of MASH.	Maximum occupant compartment deformation was 3.0 inches in the right front kick panel.	
F. The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.	The 1100C vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 9° and 6°.	Pass
H. Occupant impact velocities (OIV) should satisfy the following limits: Preferred value of 30 ft/s, or maximum allowable value of 40 ft/s.	Longitudinal OIV was 24.0 ft/s, and lateral OIV was 23.0 ft/s.	Pass
I. The occupant ridedown accelerations should satisfy the following limits: Preferred value of 15.0 g, or maximum allowable value of 20.49 g.	Longitudinal occupant ridedown acceleration was 13.8 g, and lateral occupant ridedown acceleration was 8.7 g.	Pass

Table 7.4. Performance Evaluation Summary for *MASH* Test 3-11 on Modified Merritt Parkway Guiderail.

Test Agency: Texas A&M Transportation Institute Test No.: 612061-02-1A Test Date: 2020-09-02

MASH Test 3-11 Evaluation Criteria	Test Results	Assessment
Structural Adequacy		
A. 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.	The Modified Merritt Parkway Guiderail with 4-inch curb contained and redirected the 2270P vehicle. The vehicle did not penetrate, underride, or override the installation. Maximum dynamic deflection during the test was 30.4 inches.	Pass
Occupant Risk		
D. Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone.	None of the fragments, or other debris from the test article penetrated or showed potential for penetrating the occupant compartment, or present undue hazard to others in the area.	Pass
Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.2.2 and Appendix E of MASH.	Maximum occupant compartment deformation was 4.25 inches in the right front firewall area.	
F. The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.	The 2270P vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 37° and 27°.	Pass
H. Occupant impact velocities (OIV) should satisfy the following limits: Preferred value of 30 ft/s, or maximum allowable value of 40 ft/s.	Longitudinal OIV was 27.9 ft/s, and lateral OIV was 14.4 ft/s.	Pass
I. The occupant ridedown accelerations should satisfy the following limits: Preferred value of 15.0 g, or maximum allowable value of 20.49 g.	Longitudinal occupant ridedown acceleration was 15.6 g, and lateral occupant ridedown acceleration was 5.9 g.	Pass

Table 7.5. Performance Evaluation Summary for *MASH* Test 3-10 on Merritt Parkway Guiderail Transition.

Test Agency: Texas A&M Transportation Institute Test No.: 612061-07-1 Test Date: 2020-10-07

MASH Test 3-20 Evaluation Criteria	Test Results	Assessment
Structural Adequacy		
A. 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.	The Merritt Parkway Guiderail Transition contained and redirected the 1100C vehicle. The vehicle did not penetrate, underride, or override the installation. Maximum dynamic deflection during the test was 1.5 inches.	Pass
Occupant Risk		
D. Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone.	No detached elements, fragments, or other debris were present to penetrate or show potential for penetrating the occupant compartment, or present undue hazard to others in the area.	Pass
Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.2.2 and Appendix E of MASH.	Maximum occupant compartment deformation was 7.25 inches in the kick panel area on the right front side.	
F. The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.	The 1100C vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 8° and 8°.	Pass
H. Occupant impact velocities (OIV) should satisfy the following limits: Preferred value of 30 ft/s, or maximum allowable value of 40 ft/s.	Longitudinal OIV was 28.9 ft/s, and lateral OIV was 31.5 ft/s.	Pass
I. The occupant ridedown accelerations should satisfy the following limits: Preferred value of 15.0 g, or maximum allowable value of 20.49 g.	Longitudinal occupant ridedown acceleration was 6.1 g, and lateral occupant ridedown acceleration was 9.2 g.	Pass

Table 7.6. Performance Evaluation Summary for *MASH* Test 3-21 on Merritt Parkway Guiderail Transition.

Test Agency: Texas A&M Transportation Institute Test No.: 612061-06-1 Test Date: 2020-10-12

MASH Test 3-21 Evaluation Criteria	Test Results	Assessment
Structural Adequacy		
A. 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.	The Merritt Parkway Guiderail Transition contained and redirected the 2270P vehicle. The vehicle did not penetrate, underride, or override the installation. Maximum dynamic deflection during the test was 4.7 inches.	Pass
Occupant Risk		
D. Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone.	No detached elements, fragments, or other debris were present to penetrate or show potential for penetrating the occupant compartment, or present undue hazard to others in the area.	Pass
Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.2.2 and Appendix E of MASH.	Maximum occupant compartment deformation was 6.5 inches in the right front kick panel area.	
F. The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.	The 2270P vehicle remained upright during and after the collision event. Maximum roll and pitch angles were 21° and 10°.	Pass
H. Occupant impact velocities (OIV) should satisfy the following limits: Preferred value of 30 ft/s, or maximum allowable value of 40 ft/s.	Longitudinal OIV was 25.3 ft/s, and lateral OIV was 25.3 ft/s.	Pass
I. The occupant ridedown accelerations should satisfy the following limits: Preferred value of 15.0 g, or maximum allowable value of 20.49 g.	Longitudinal occupant ridedown acceleration was 9.8 g, and lateral occupant ridedown acceleration was 8.5 g.	Pass

Table 7.7. Assessment Summary for *MASH* TL-3 Tests on Modified Merritt Parkway Guiderail.

Evaluation Factors	Evaluation Criteria	Test No. 612061-03-1	Test No. 612061-02-1A
Structural Adequacy	A	S	S
Occupant Risk	D	S	S
	F	S	S
	H	S	S
	I	S	S
	Test No.	***MASH* Test 3-10**	***MASH* Test 3-11**
	Pass/Fail	Pass	Pass

Note: S = Satisfactory; N/A = Not Applicable.

Table 7.8. Assessment Summary for *MASH* TL-3 Tests on Merritt Parkway Guiderail Transition.

Evaluation Factors	Evaluation Criteria	Test No. 612061-07-1	Test No. 612061-06-1
Structural Adequacy	A	S	S
Occupant Risk	D	S	S
	F	S	S
	H	S	S
	I	S	S
	Test No.	***MASH* Test 3-20**	***MASH* Test 3-21**
	Pass/Fail	Pass	Pass

Note: S = Satisfactory; N/A = Not Applicable.

REFERENCES

1. AASHTO/FHWA Joint Implementation Agreement for Manual for Assessing Safety Hardware (*MASH*). https://design.transportation.org/wp-content/uploads/sites/21/2018/06/*MASH*-Implementation-Agreement-Final.pdf, January 7, 2016 (last access 2020-10-21.

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

3. D. Lance Bullard, Wanda L. Menges, and Dean C. Alberson. *Testing and Evaluation of the Merritt Parkway Guiderail*. Test Report 405501. Texas A&M Transportation Institute, College Station, TX, April 1996.

4. H. E. Ross, Jr., D. L. Sicking, and R. A. Zimmer, "Recommended Procedures for the Safety Performance Evaluation of Highway Features," *NCHRP Report 350*. National Cooperative Highway Research Program, Washington, DC, 1993.

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APPENDIX A. MERRITT PARKWAY GUIDERAIL WITH NO CURB

Notes

1a. Drill Ø24" holes for Posts. Backfill Post holes and around Anchor Block with AASHTO M147-65(2004), grade B crushed limestone road base, compacted to MASH standard.

1b. Threads not shown on Bolts, Nuts, etc for clarity.

1c. Material:

Steel: All steel posts, back-up rails, splice plates and channel rubrails which are to be used as "Weathering Steel", shall meet the requirements of ASTM A588. The fabricator shall notify the manufacturer that it is "Weathering Steel" (structural steel for use in bare, unpainted applications) and that the steel shall not be marked with paint or steel die stamped, but identification shall be stenciled with permanent ink. The dimensions of each component shall conform to the plans and ASTM A6. All steel posts shall be galvanized after fabrication to meet the requirements of ASTM A123 and conform to the galvanizing limits and tolerances shown on the plans. A single ¾" diameter hole may be drilled 2" from the top of each post, in the center of the web, to facilitate the galvanizing process on the bottom of all posts.

Timber: All timber rail and block-out components shall conform with the following:

a) Commercial lumber grade No. 1 or better after treatment;

b) AASHTO M 168;

c) Minimum stress rating of 1350 psi

d) Rough sawn (non-planed) or S4S (surface four side) Southern Yellow Pine or Douglas Fir- Larch with nominal dimensions as indicated on the plans. Variations in the size of any dimension shall not be more than ± ¼"

e) All timber components shall be pressure treated with CCA or ACZA depending on species supplied conforming to AWPA Standard P5 to a minimum net retention of 0.60lb/cubic foot in the assay zone in accordance with AWPA Standard C14.

f) All timber components shall be fabricated (including but not necessarily limited to cutting, drilling, dapping and chamfering) prior to treatment.

g) All timber components shall be free of excess preservative and solvent at the conclusion of the treating process. Post treatment cleaning shall be by expansion bath or steaming in accordance with AWPA Standard C2;

h) Kiln or air dried to a maximum moisture content of 25% after treatment (KDAT - 25);

i) Grade-marked after treatment by an agency certified by the American Lumber Standard Committee (ALSC).

Fasteners:

a) Round head bolts shall be manufactured in accordance with the sizes designated on the plans, the geometric specifications included in ANSI B18.5.1.2.2 and the material specifications for ASTM A588 steel. All round head bolts shall be marked with the manufacturers symbol and A588.

b) Hex Lag Screws shall be manufactured in accordance with ASTM A307 Grade A specifications. All Hex Lag Screws shall be hot-dipped galvanized in accordance with ASTM A153 Class C.

c) Nuts, and Washers shall be ASTM A588 steel.

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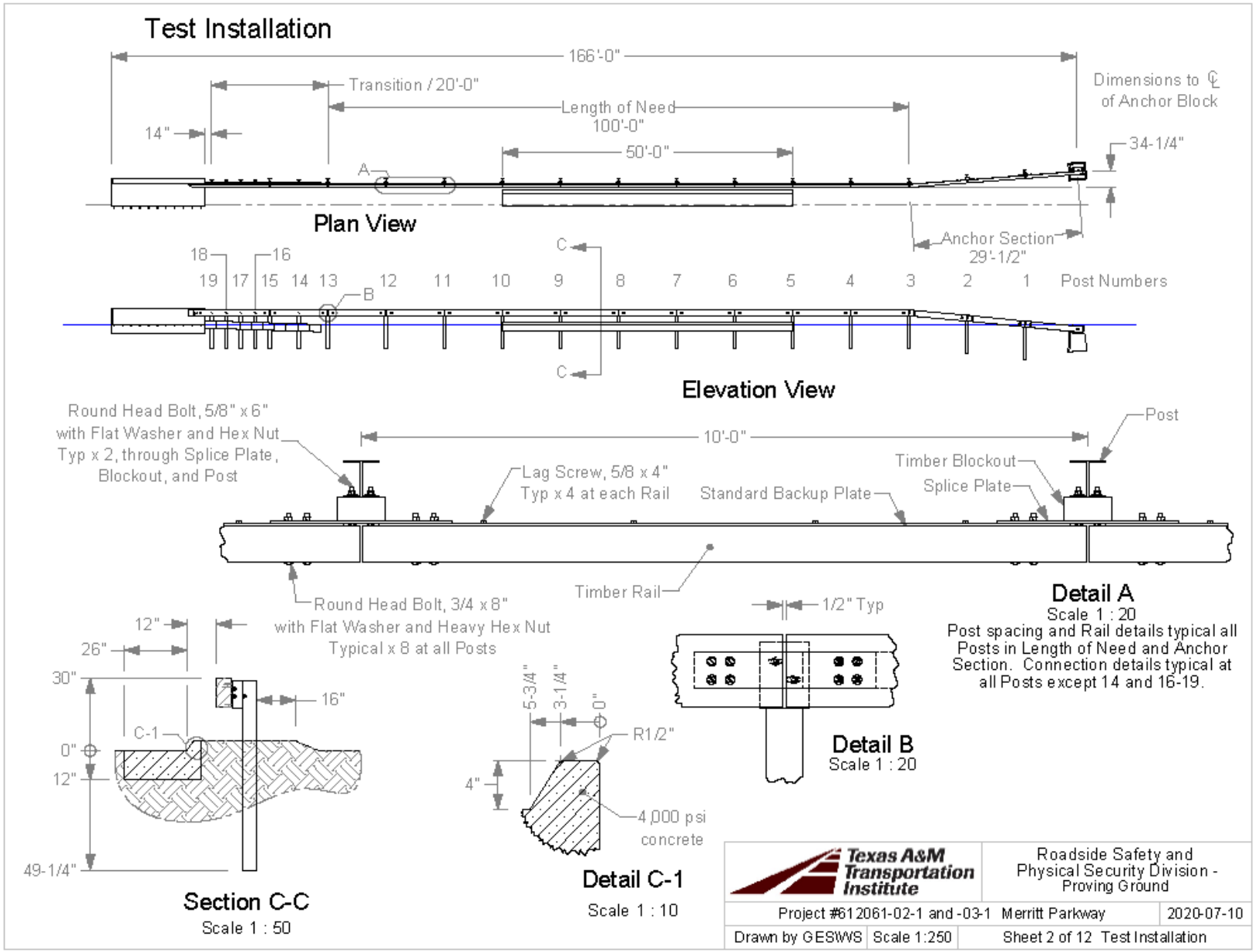
Test Installation
166'-0"
Transition / 20'-0"
Length of Need
100'-0"
50'-0"
14"
34-1/4"
Dimensions to ℄
of Anchor Block
A
Plan View
Anchor Section
29'-1/2"
18
16
19 17 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 Post Numbers
B
C
C
Elevation View
Round Head Bolt, 5/8" x 6"
with Flat Washer and Hex Nut
Typ x 2, through Splice Plate,
Blockout, and Post
10'-0"
Post
Timber Blockout
Splice Plate
Lag Screw, 5/8 x 4"
Typ x 4 at each Rail
Standard Backup Plate
Timber Rail
Round Head Bolt, 3/4 x 8"
with Flat Washer and Heavy Hex Nut
Typical x 8 at all Posts
Detail A
Scale 1 : 20
Post spacing and Rail details typical all Posts in Length of Need and Anchor Section. Connection details typical at all Posts except 14 and 16-19.
1/2" Typ
Detail B
Scale 1 : 20
12"
26"
30"
16"
C-1
0"
12"
49-1/4"
Section C-C
Scale 1 : 50
5-3/4"
3-1/4"
0"
R1/2"
4"
4,000 psi
concrete
Detail C-1
Scale 1 : 10
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Sheet 2 of 12 Test Installation
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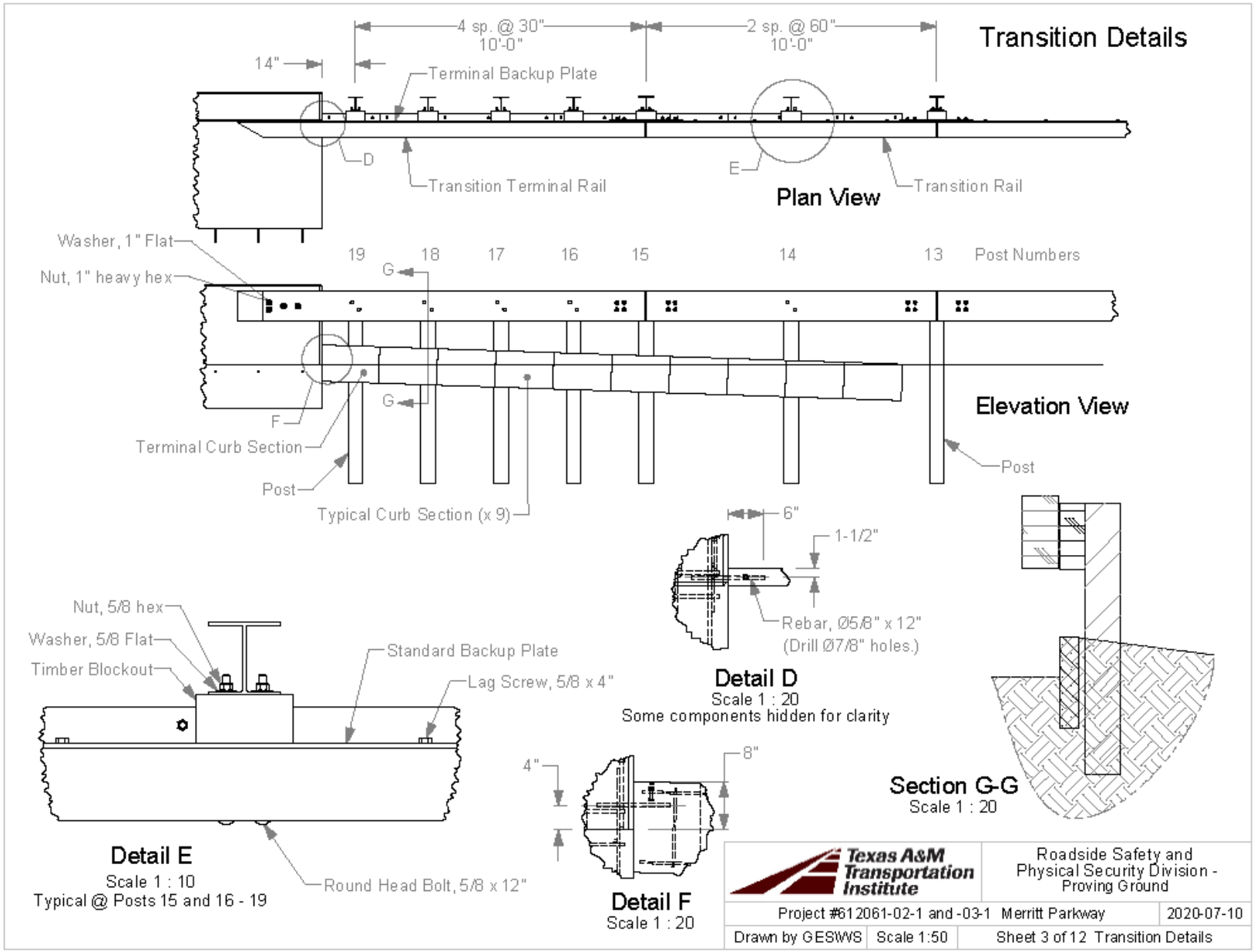
Transition Details
4 sp. @ 30"
10'-0"
2 sp. @ 60"
10'-0"
14"
Terminal Backup Plate
D
E
Transition Terminal Rail
Transition Rail
Plan View
Washer, 1" Flat
Nut, 1" heavy hex
19
18
17
16
15
14
13
Post Numbers
G
G
F
Terminal Curb Section
Post
Typical Curb Section (x 9)
Elevation View
Post
6"
1-1/2"
Rebar, Ø5/8" x 12"
(Drill Ø7/8" holes.)
Detail D
Scale 1 : 20
Some components hidden for clarity
Nut, 5/8 hex
Washer, 5/8 Flat
Timber Blockout
Standard Backup Plate
Lag Screw, 5/8 x 4"
Detail E
Scale 1 : 10
Typical @ Posts 15 and 16 - 19
Round Head Bolt, 5/8 x 12"
4"
8"
Detail F
Scale 1 : 20
Section G-G
Scale 1 : 20
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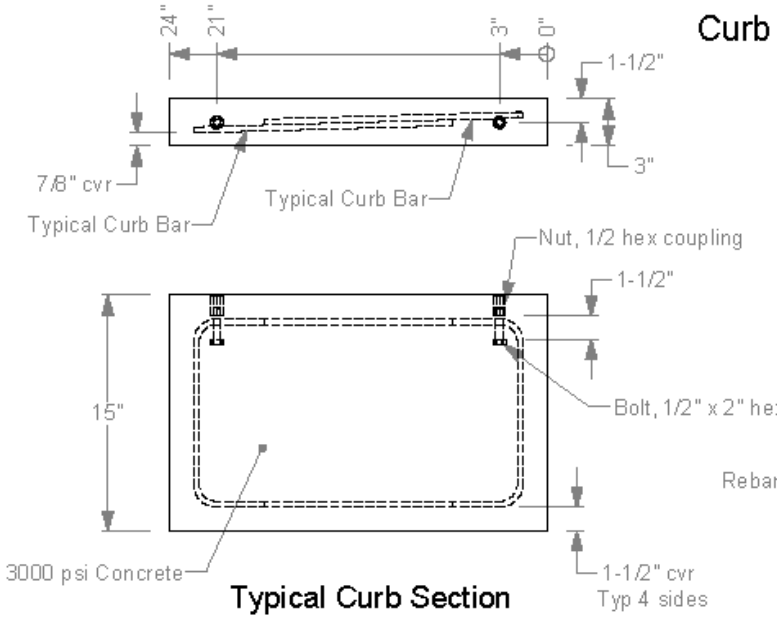
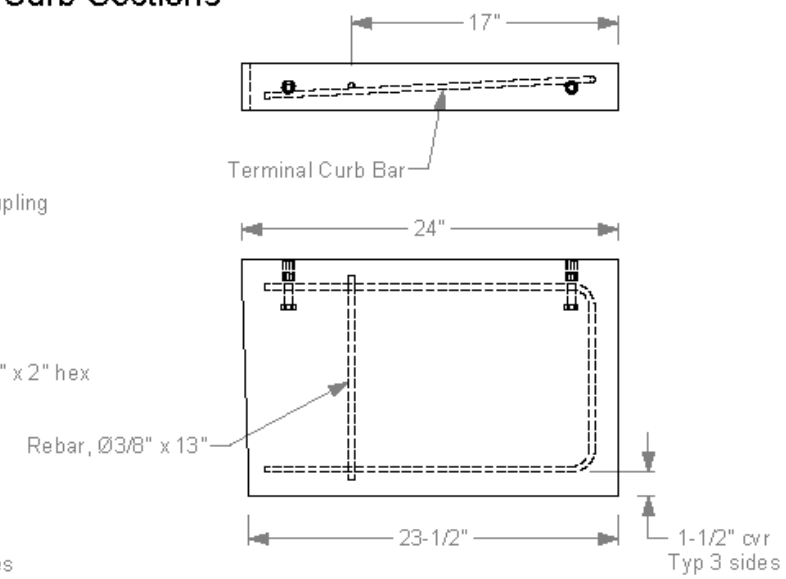
Curb Sections

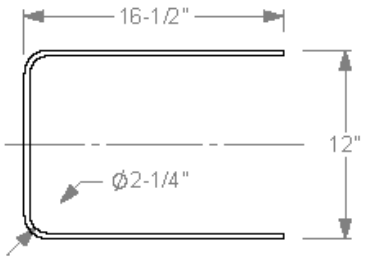


Typical Curb Section



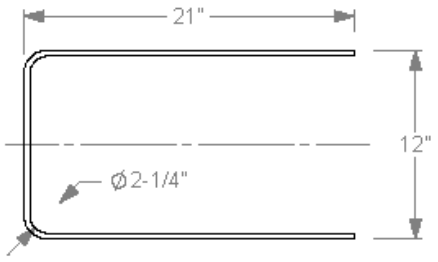
Terminal Curb Section

(see Typical Curb Section for all details not shown here)



Typical Curb Bar

Ø3/8" Rebar



Terminal Curb Bar

Ø3/8" Rebar

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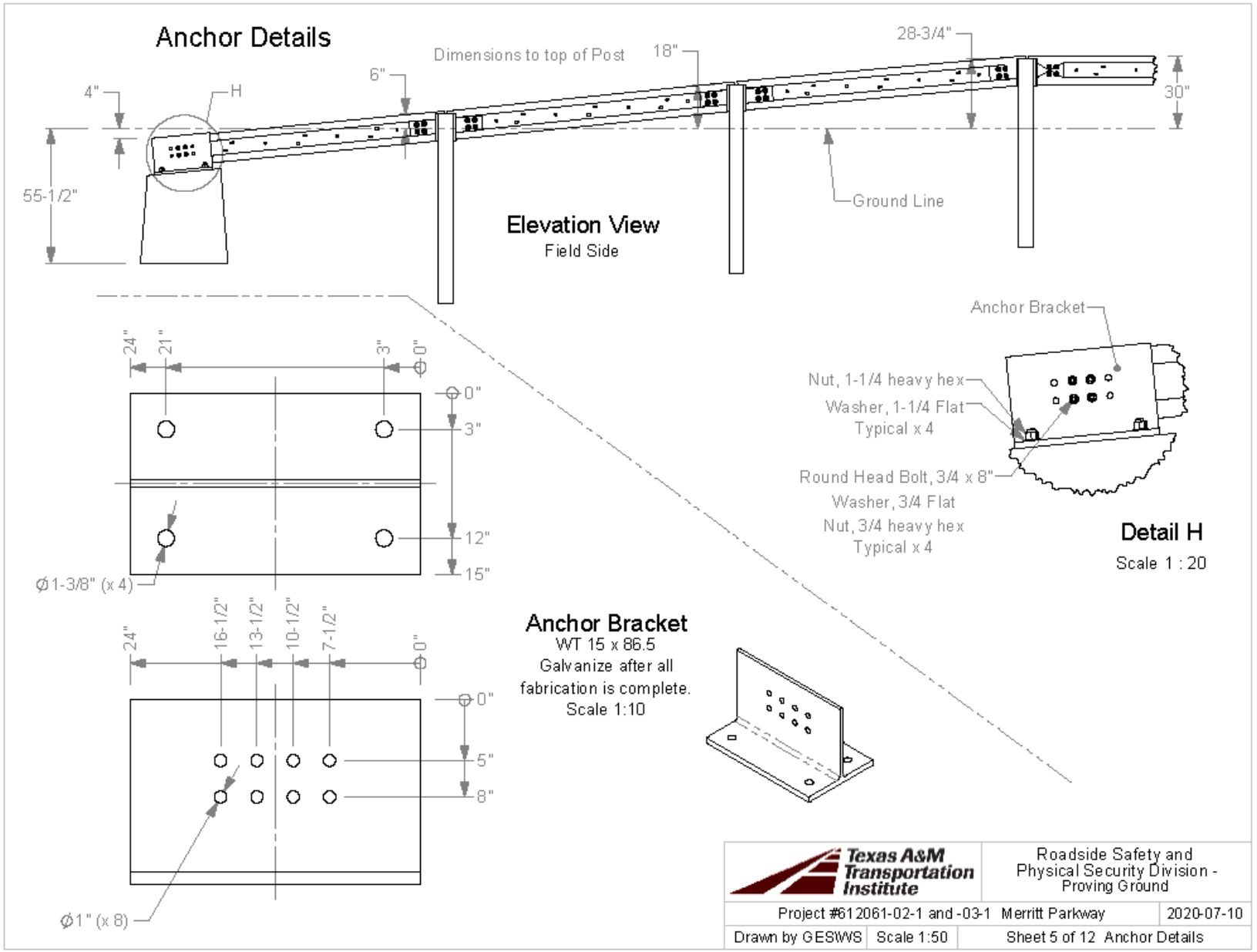
Anchor Details
Dimensions to top of Post
4"
H
6"
18"
28-3/4"
30"
55-1/2"
Ground Line
Elevation View
Field Side
24"
21"
3"
0"
0"
3"
12"
15"
Ø1-3/8" (x 4)
Anchor Bracket
Nut, 1-1/4 heavy hex
Washer, 1-1/4 Flat
Typical x 4
Round Head Bolt, 3/4 x 8"
Washer, 3/4 Flat
Nut, 3/4 heavy hex
Typical x 4
Detail H
Scale 1 : 20
24"
16-1/2"
13-1/2"
10-1/2"
7-1/2"
0"
0"
5"
8"
Ø1" (x 8)
Anchor Bracket
WT 15 x 86.5
Galvanize after all
fabrication is complete.
Scale 1:10
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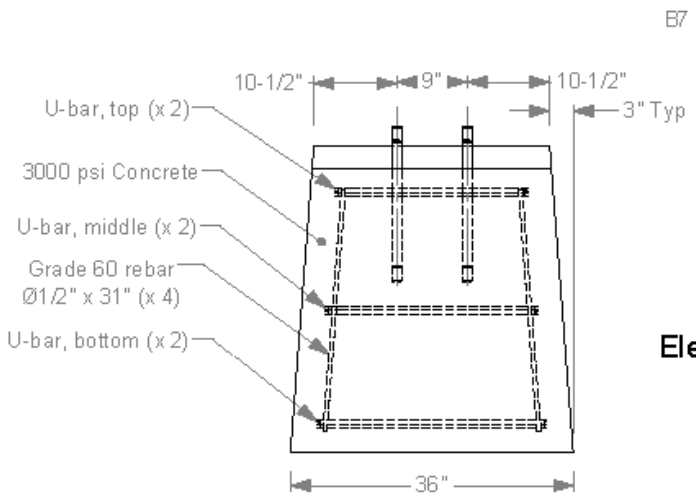
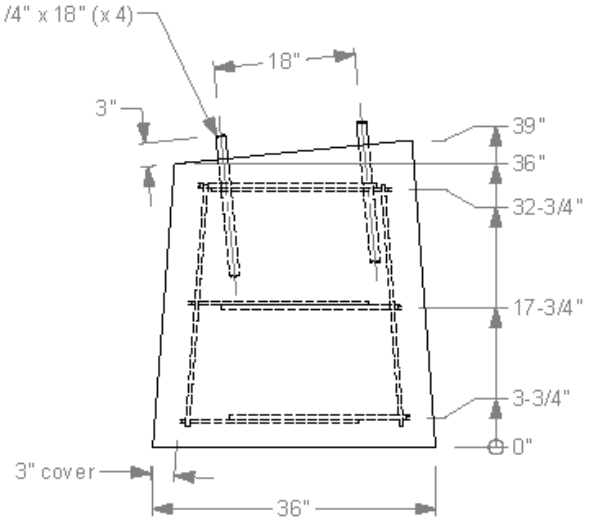
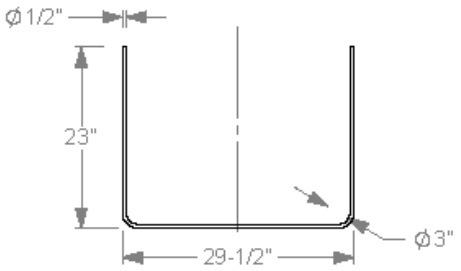
Anchor Block

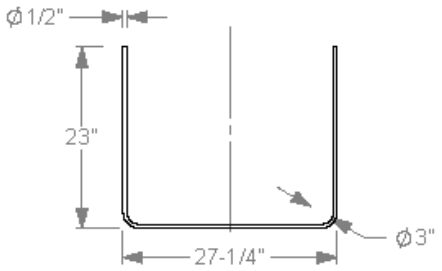


Elevation Views

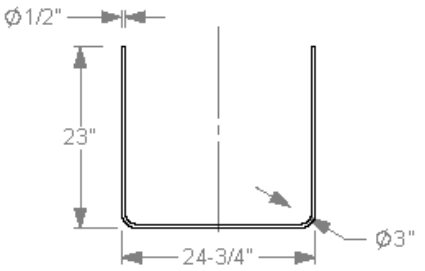




U-bar, bottom
Grade 60 rebar



U-bar, middle
Grade 60 rebar



U-bar, top
Grade 60 rebar

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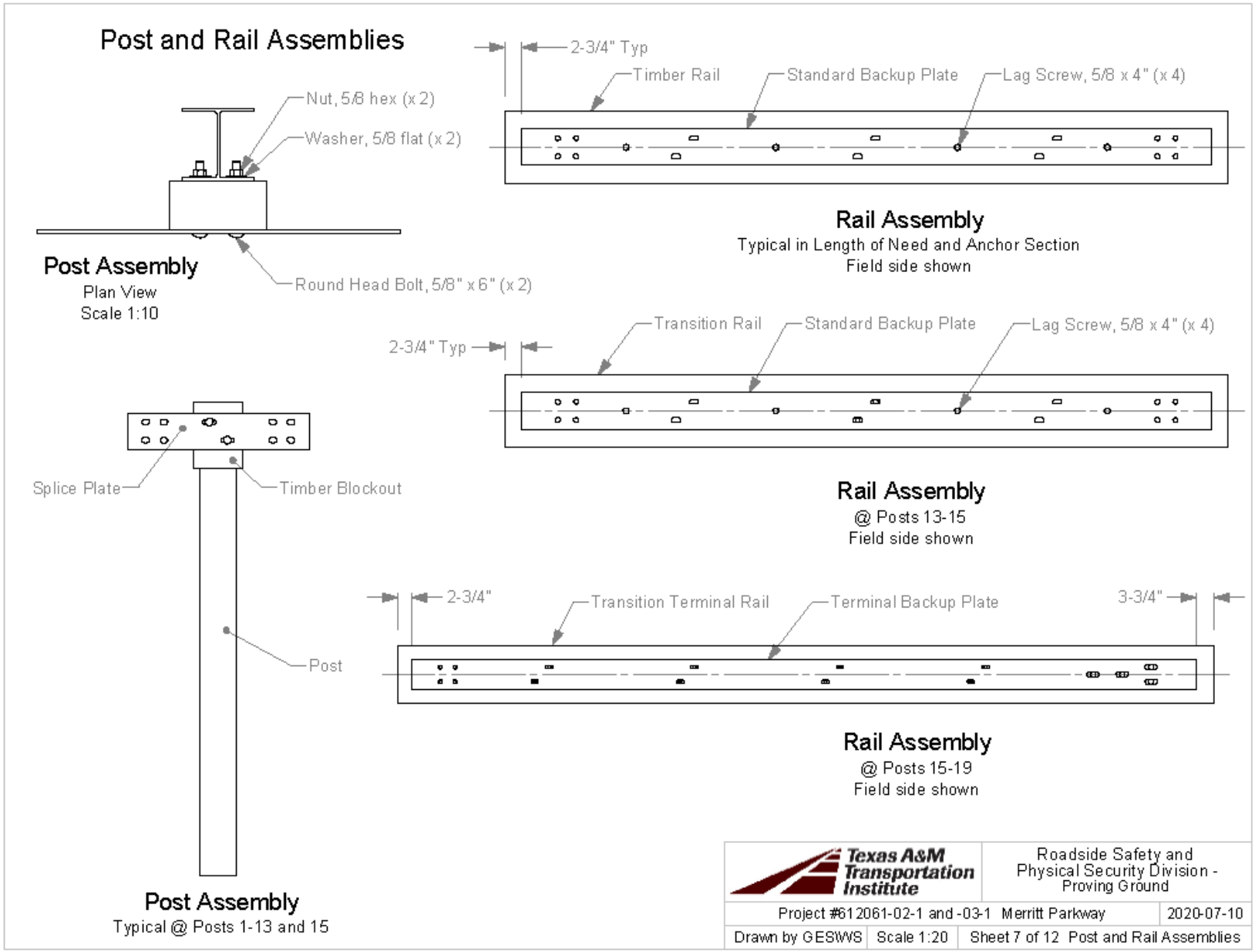
Post and Rail Assemblies
Nut, 5/8 hex (x 2)
Washer, 5/8 flat (x 2)
Round Head Bolt, 5/8" x 6" (x 2)
Post Assembly
Plan View
Scale 1:10
2-3/4" Typ
Timber Rail
Standard Backup Plate
Lag Screw, 5/8 x 4" (x 4)
Rail Assembly
Typical in Length of Need and Anchor Section
Field side shown
Transition Rail
Standard Backup Plate
Lag Screw, 5/8 x 4" (x 4)
2-3/4" Typ
Rail Assembly
@ Posts 13-15
Field side shown
Splice Plate
Timber Blockout
Post
2-3/4"
Transition Terminal Rail
Terminal Backup Plate
3-3/4"
Rail Assembly
@ Posts 15-19
Field side shown
Post Assembly
Typical @ Posts 1-13 and 15
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Sheet 7 of 12 Post and Rail Assemblies
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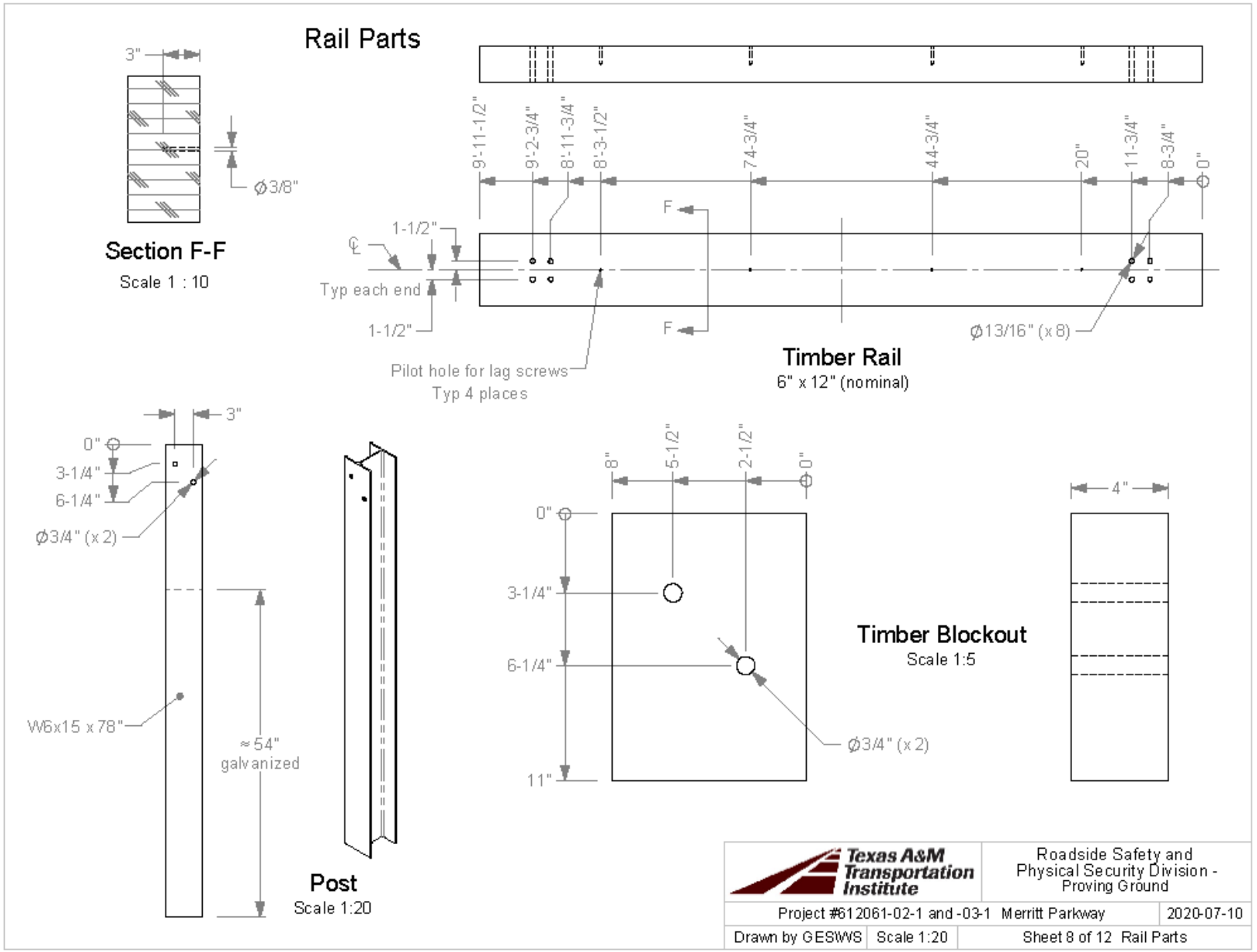
Rail Parts
3"
Ø3/8"
Section F-F
Scale 1 : 10
9'-11-1/2"
9'-2-3/4"
8'-11-3/4"
8'-3-1/2"
7'-4-3/4"
4'-4-3/4"
20"
11-3/4"
8-3/4"
0"
1-1/2"
℄
Typ each end
1-1/2"
F
F
Ø13/16" (x 8)
Pilot hole for lag screws
Typ 4 places
Timber Rail
6" x 12" (nominal)
3"
0"
3-1/4"
6-1/4"
Ø3/4" (x 2)
W6x15 x 78"
≈ 54"
galvanized
Post
Scale 1:20
8"
5-1/2"
2-1/2"
0"
0"
3-1/4"
6-1/4"
11"
Ø3/4" (x 2)
Timber Blockout
Scale 1:5
4"
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3"
6"
Ø3/8"
Pilot Hole for
Lag Screw (x 4)
6"
Section G-G
Scale 1 : 10
9'-11-1/2"
9'-2-3/4"
8'-11-3/4"
8'-3-1/2"
74-3/4"
61-1/4"
58-1/4"
44-3/4"
20"
11-3/4"
8-3/4"
0"
G
G
1-1/2"
Typ each end
1-1/2"
Ø13/16" (x8)
Ø3/4" (x 2)
Pilot hole for lag screws
Ø3/8" x 3" - Typ 4 places
Transition Rail
6" x 12" (nominal)
10-1/2"
1-1/4"
14'-1/2"
12'-11-1/2"
12'-5-1/2"
11'-11-1/2"
10'-1-1/4"
9'-10-1/4"
91-1/4"
88-1/4"
61-1/4"
58-1/4"
31-1/4"
28-1/4"
11-3/4"
8-3/4"
0"
1-1/2"
1-1/2"
Ø1-1/8"
(x 4)
Ø2-1/4"
Ø3/4" (x 8)
Transition Terminal Rail
6" x 12" (nominal)
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Sheet 9 of 12 Transition Rails
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9'-6"
9'-0"
8'-9"
96-3/4"
88-1/2"
85-1/2"
72"
58-1/2"
55-1/2"
42"
28-1/2"
25-1/2"
17-1/4"
9"
6"
0"
3"
1-1/2"
3"
Ø3/4" (x 4)
Slot, 3/4" x 1-1/2" (x 6)
(Not utilized when Post spacing is 10')
Ø13/16" (x 8)
Standard Backup Plate
Steel Plate, 6" x 3/8"
13'-6"
12'-8-3/4"
12'-2-3/4"
11'-8-3/4"
9'-10-1/2"
9'-7-1/2"
88-1/2"
85-1/2"
58-1/2"
55-1/2"
28-1/2"
25-1/2"
9"
6"
0"
1-1/2"
3"
Slot, 1-1/8" x 2-1/2" (x 4)
Slot, 3/4" x 1-1/2" (x 8)
Ø13/16" (x 4)
Terminal Backup Plate
Steel Plate, 6" x 3/8"
30"
27"
24"
16-1/2"
13-1/2"
6"
3"
0"
1-1/2" Typ
Slot, 7/8" x 1-1/4" (x 8)
Slot, 3/4" x 2-1/4" (x 2)
Splice Plate
Steel Plate, 6" x 3/8"
Texas A&M Transportation Institute
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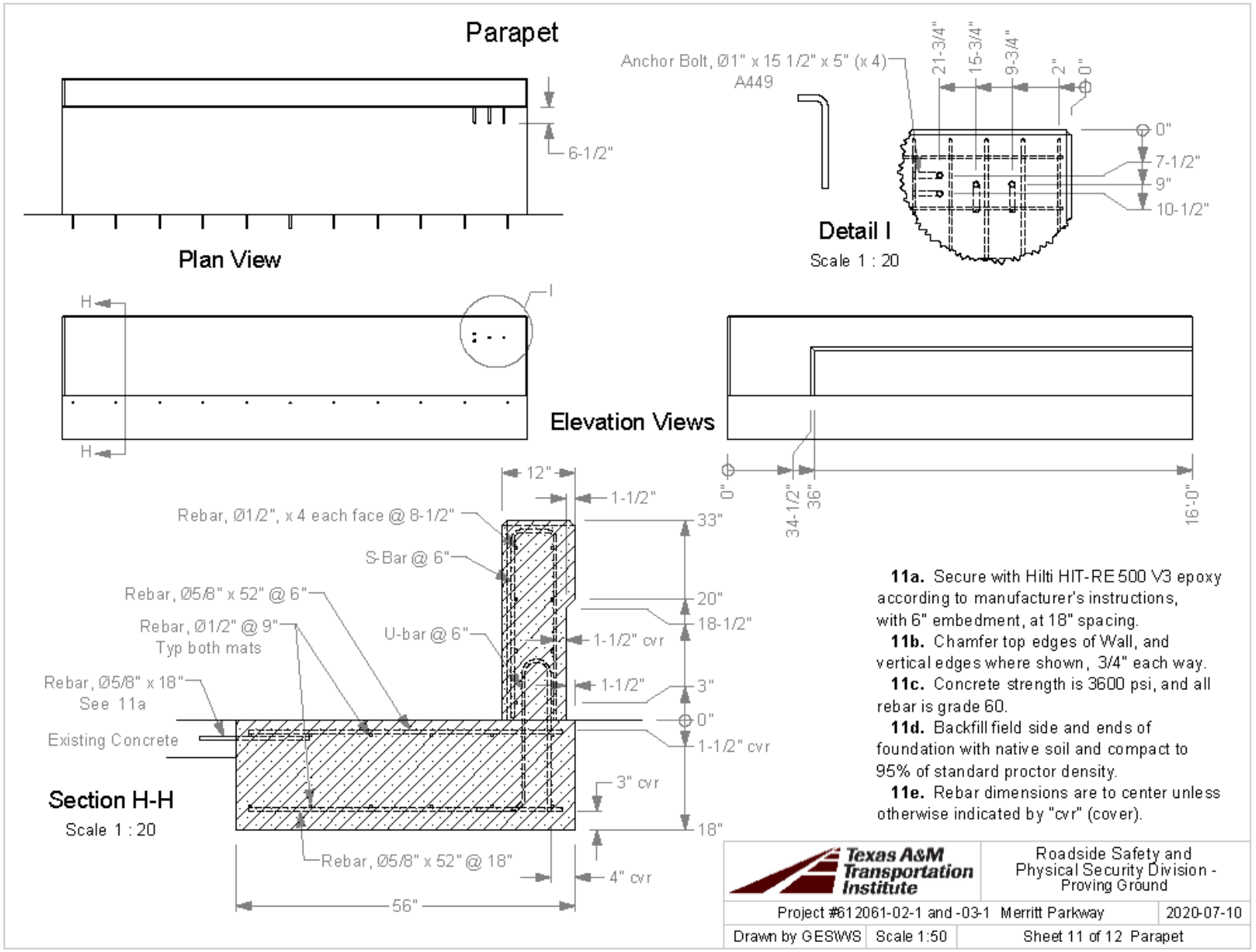

Parapet
6-1/2"
Plan View
H
I
H
Elevation Views
0"
34-1/2"
36"
16'-0"
Anchor Bolt, Ø1" x 15 1/2" x 5" (x 4)
A449
21-3/4"
15-3/4"
9-3/4"
2"
0"
0"
7-1/2"
9"
10-1/2"
Detail I
Scale 1 : 20
12"
1-1/2"
Rebar, Ø1/2", x 4 each face @ 8-1/2"
S-Bar @ 6"
Rebar, Ø5/8" x 52" @ 6"
Rebar, Ø1/2" @ 9"
Typ both mats
U-bar @ 6"
Rebar, Ø5/8" x 18"
See 11a
Existing Concrete
33"
20"
18-1/2"
1-1/2" cvr
1-1/2"
3"
0"
1-1/2" cvr
3" cvr
18"
Rebar, Ø5/8" x 52" @ 18"
4" cvr
56"
Section H-H
Scale 1 : 20
11a. Secure with Hilti HIT-RE 500 V3 epoxy according to manufacturer's instructions, with 6" embedment, at 18" spacing.
11b. Chamfer top edges of Wall, and vertical edges where shown, 3/4" each way.
11c. Concrete strength is 3600 psi, and all rebar is grade 60.
11d. Backfill field side and ends of foundation with native soil and compact to 95% of standard proctor density.
11e. Rebar dimensions are to center unless otherwise indicated by "cvr" (cover).
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
Project #612061-02-1 and -03-1 Merritt Parkway
2020-07-10
Drawn by GESWS
Scale 1:50
Sheet 11 of 12 Parapet
Q:\Accreditation-17025-2017\EIR-000 Project Files\612061-Pooled Fund-Merritt Parkway-Chiara\Drafting, 612061 with curb\612061 w curb Drawing

7-1/2"
Ø2" Typ
31-1/2"
1/2"
S-Bar
Ø1/2"
Ø3-3/4" Typ
25"
8"
Ø1/2"
U-bar
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
Project #612061-02-1 and -03-1 Merritt Parkway
2020-07-10
Drawn by GESWS
Scale 1:5
Sheet 12 of 12 Rebar
Q:\Accreditation-17025-2017\EIR-000 Project Files\612061-Pooled Fund-Merritt Parkway-Chiara\Dratting, 612061 with curb\612061 w curb Drawing

Table A.1. Summary of Strong Soil Test Results for Establishing Installation Procedure.

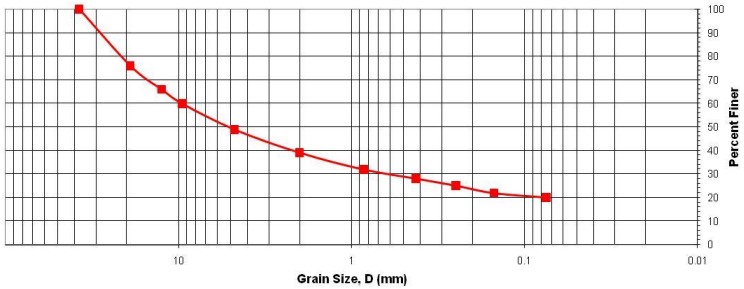
Dynamic Setup

Post-Test Photo of post

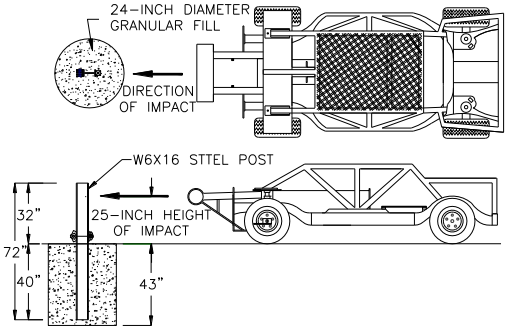
Static Load Test

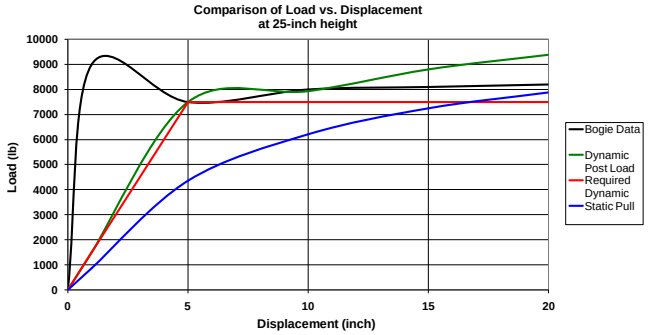
Post-Test Photo

Percent Finer Vs. Grain Size of Fill Soil for Dynamic and Static Load Tests

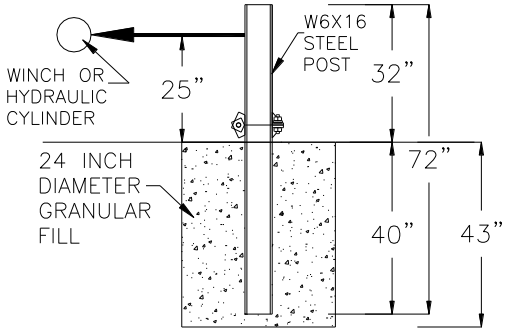


Dynamic Test Installation Details



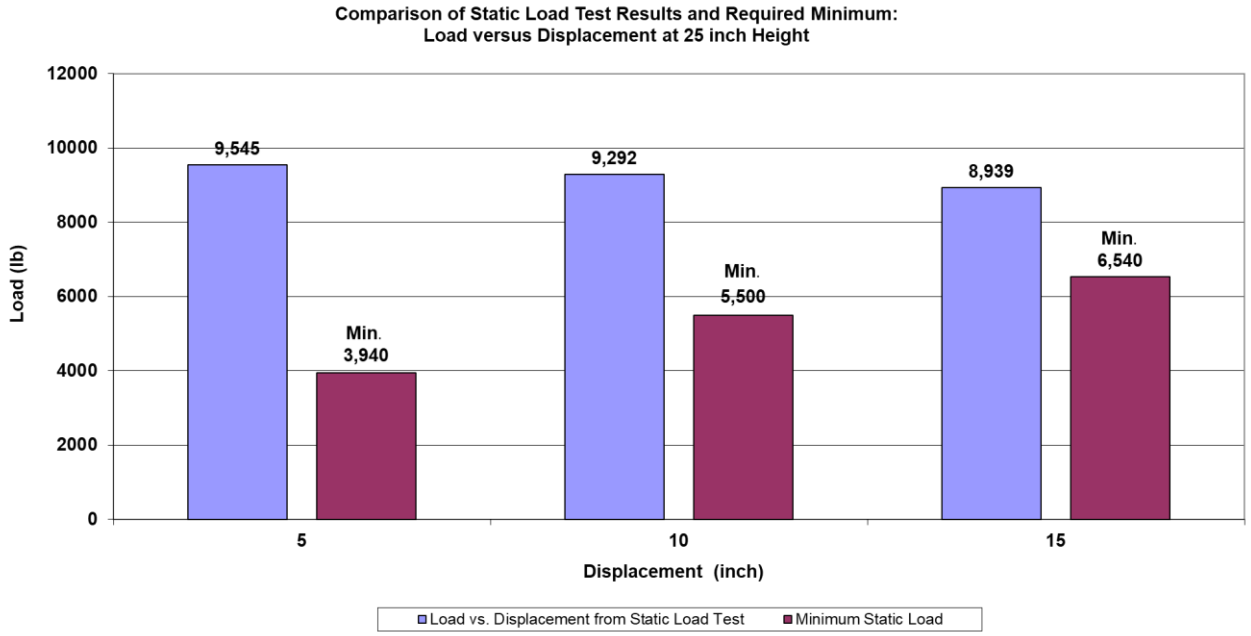


Static Load Test Installation Details



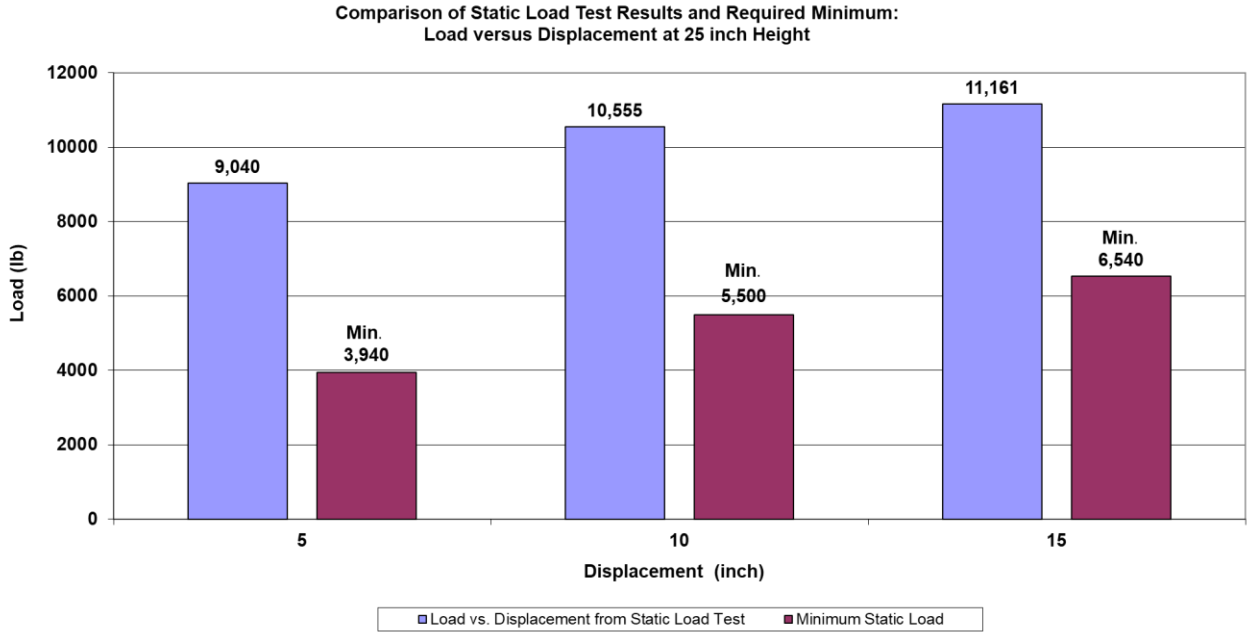
Date	2008-11-05
Test Facility and Site Location	TTI Proving Ground, 3100 SH 47, Bryan, TX 77807
In Situ Soil Description (ASTM D2487)	Sandy gravel with silty fines
Fill Material Description (ASTM D2487) and sieve analysis	AASHTO M147 Grade B Soil-Aggregate (see sieve analysis above)
Description of Fill Placement Procedure	6-inch lifts tamped with a pneumatic compactor
Bogie Weight	5009 lb
Impact Velocity	20.5 mph

Table A.2. Test Day Static Soil Strength Documentation for Test No. 612061-03-1.



Date	2020-07-08 for Test No. 612061-03-1
Test Facility and Site Location	TTI Proving Ground – 3100 SH 47, Bryan, Tx
In Situ Soil Description (ASTM D2487)	Sandy gravel with silty fines
Fill Material Description (ASTM D2487) and sieve analysis	AASHTO M147 Grade B Soil-Aggregate
Description of Fill Placement Procedure	6-inch lifts tamped with a pneumatic compactor

Table A.2. Test Day Static Soil Strength Documentation for Test No. 612061-02-1.



Date	2020-07-10 for Test No. 612061-02-1
Test Facility and Site Location	TTI Proving Ground – 3100 SH 47, Bryan, Tx
In Situ Soil Description (ASTM D2487)	Sandy gravel with silty fines
Fill Material Description (ASTM D2487) and sieve analysis	AASHTO M147 Grade B Soil-Aggregate
Description of Fill Placement Procedure	6-inch lifts tamped with a pneumatic compactor

A.3 *MASH* TEST 3-11 (CRASH TEST NO. 612061-02-1)

A.3.1. Vehicle Properties and Information

Table A.6. Vehicle Properties for Test No. 612061-02-1.

Date: 2020-12-17 Test No.: 612061-02-1 VIN No.: 1C66RFT8ES100464

Year: 2014 Make: RAM Model: 1500

Tire Size: 265/70 R 17 Tire Inflation Pressure: 35 psi

Tread Type: Highway Odometer: 210267

Note any damage to the vehicle prior to test: None

● Denotes accelerometer location.

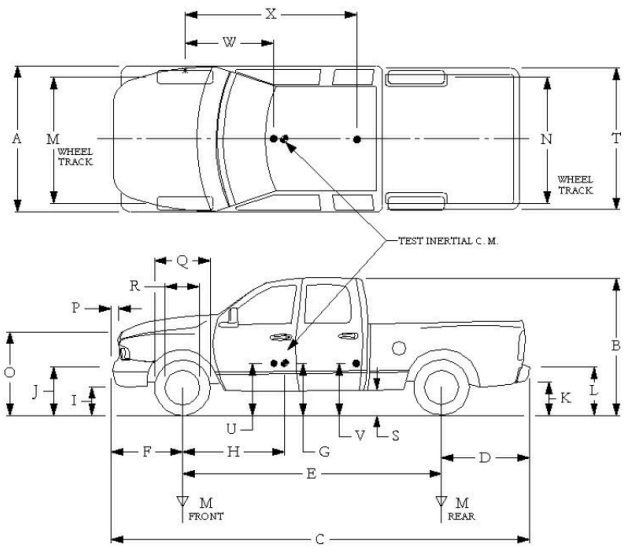
NOTES: None

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: Front passenger



Geometry: inches

A	78.50	F	40.00	K	20.00	P	3.00	U	26.75
B	74.00	G	28.50	L	30.00	Q	30.50	V	30.25
C	227.50	H	61.75	M	68.50	R	18.00	W	61.75
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

GVWR Ratings:		**Mass:** lb	Curb	Test Inertial	Gross Static
Front	3700	M_{front}	2859	2809	2894
Back	3900	M_{rear}	2103	2203	2283
Total	6700	M_{Total}	4962	5012	5177

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

Mass Distribution:
lb LF: 1396 RF: 1413 LR: 1132 RR: 1071

Table A.7. Measurements of Vehicle Vertical Center of Gravity for Test No. 612061-02-1.

Date: 2020-12-17 Test No.: 612061-02-1 VIN: 1C66RFT8ES100464

Year: 2014 Make: RAM Model: 1500

Body Style: Quad Cab Mileage: 210267

Engine: 5.7 L V-8 Transmission: Automatic

Fuel Level: Empty Ballast: 170 (440 lb max)

Tire Pressure: Front: 35 psi Rear: 35 psi Size: 265/70 R 17

Measured Vehicle Weights: (lb)									
LF:	1396		RF:	1413		Front Axle:	2809		
LR:	1132		RR:	1071		Rear Axle:	2203		
Left:	2528		Right:	2484		Total:	5012		
							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:	61.76	inches	Rear of Front Axle	(63 ±4 inches allowed)					
Y:	-0.30	inches	Left -	Right +	of Vehicle Centerline				
Z:	28.50	inches	Above Ground	(minumum 28.0 inches allowed)					

Hood Height: 46.00 inches
43 ±4 inches allowed

Front Bumper Height: 27.00 inches

Front Overhang: 40.00 inches
39 ±3 inches allowed

Rear Bumper Height: 30.00 inches

Overall Length: 227.50 inches
237 ±13 inches allowed

Table A.8. Exterior Crush Measurements for Test No. 612061-02-1.

Date:	2020-12-17	Test No.:	612061-02-1	VIN No.:	1C66RFT8ES100464
Year:	2014	Make:	RAM	Model:	1500

VEHICLE CRUSH MEASUREMENT SHEET[1]

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

Note: Measure C_1 to C_6 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	12	16	48	-	-	-	-	-	-	10
2	Side plane at bmp ht	12	12	48	-	-	-	-	-	-	68
	Measurements recorded										
	☑ **inches or** ☐ **mm**										

[1]Table 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.

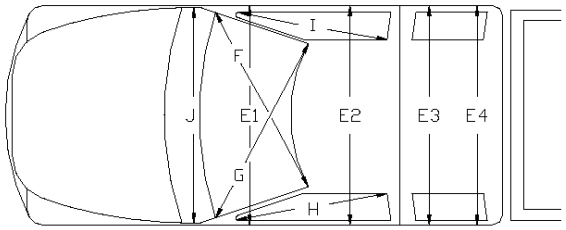
**Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle).

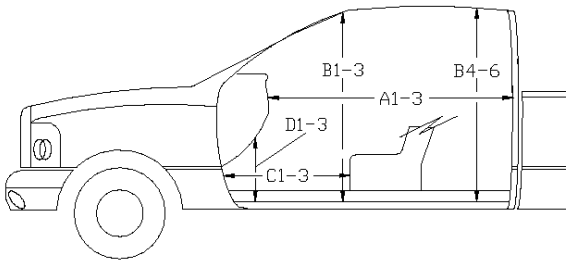
***Measure and document on the vehicle diagram the location of the maximum crush.

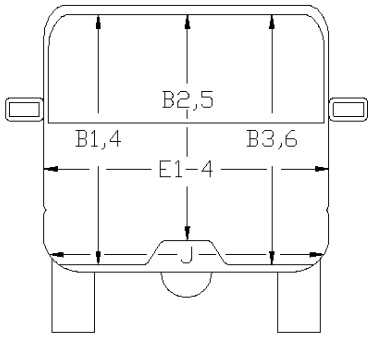
Note: Use as many lines/columns as necessary to describe each damage profile.

Table A.9. Occupant Compartment Measurements for Test No. 612061-02-1.

Date:	2020-12-17	Test No.:	612061-02-1	VIN No.:	1C66RFT8ES100464
Year:	2014	Make:	RAM	Model:	1500







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

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	20.00	-6.00
D1	11.00	11.00	0.00
D2	0.00	0.00	0.00
D3	11.50	11.50	0.00
E1	61.50	64.25	2.75
E2	63.50	63.50	0.00
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	36.50	-1.00
J*	25.00	20.00	-5.00

A.4.2. Sequential Photographs

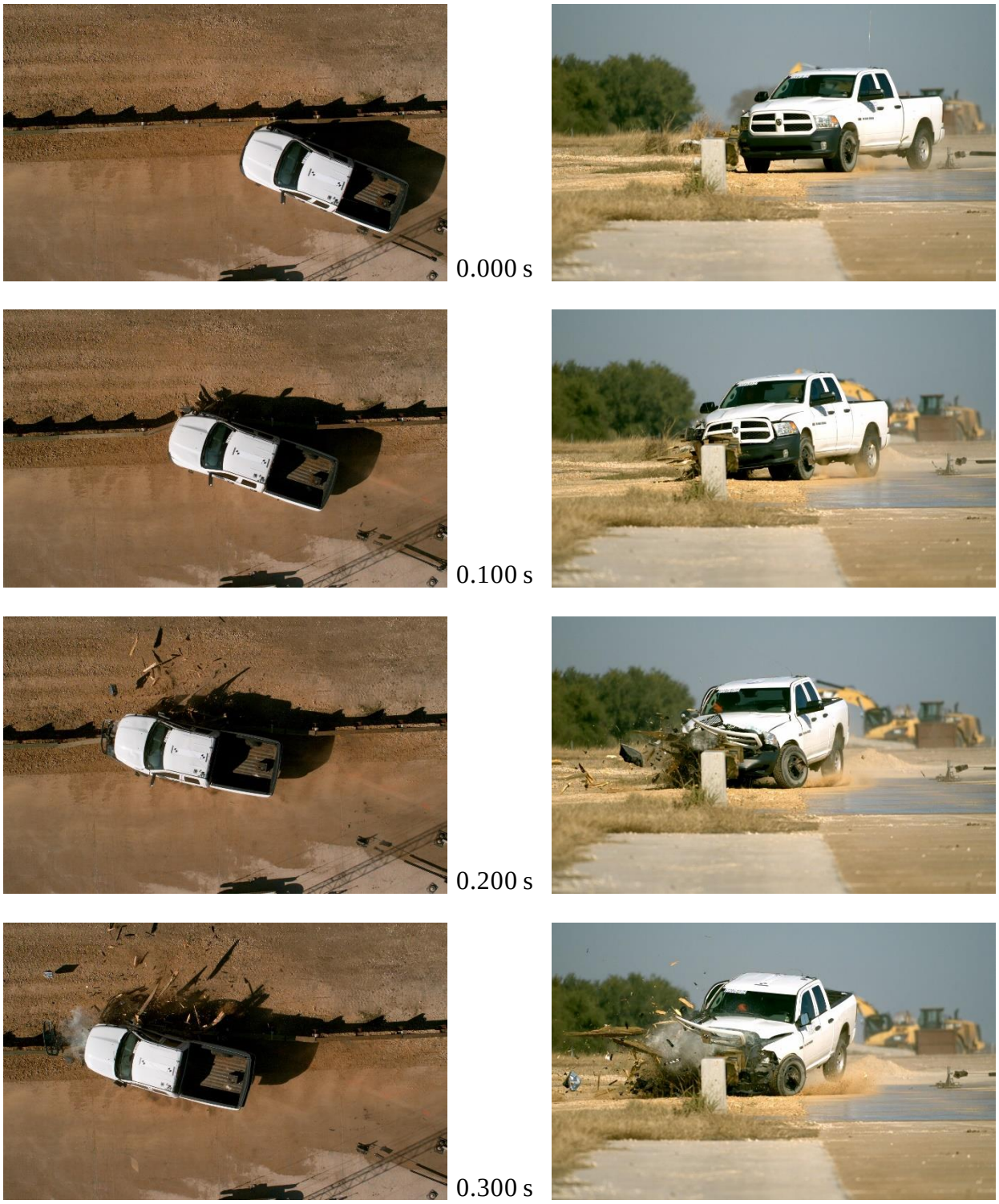


Figure A.7. Sequential Photographs for Test No. 612061-02-1 (Overhead and Frontal Views).


0.400 s


0.500 s


0.600 s

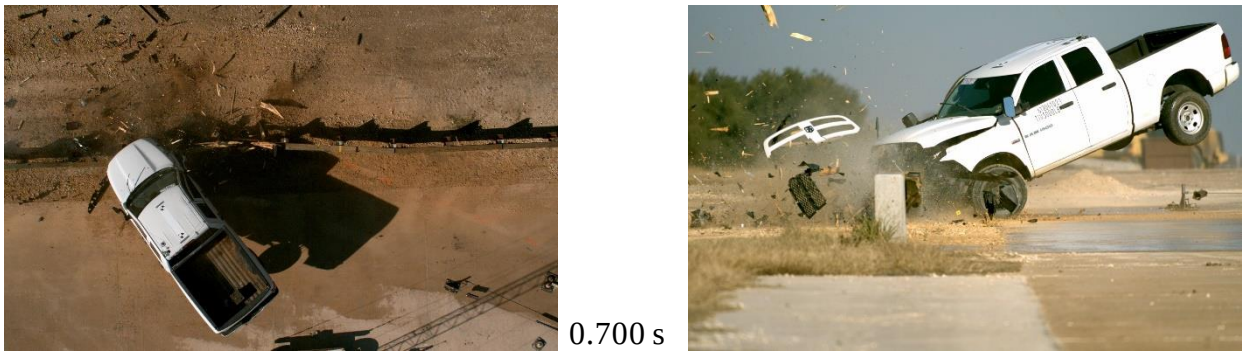

0.700 s

Figure A.7. Sequential Photographs for Test No. 612061-02-1 (Overhead and Frontal Views) (Continued).

0.000 s

0.400 s

0.100 s

0.500 s

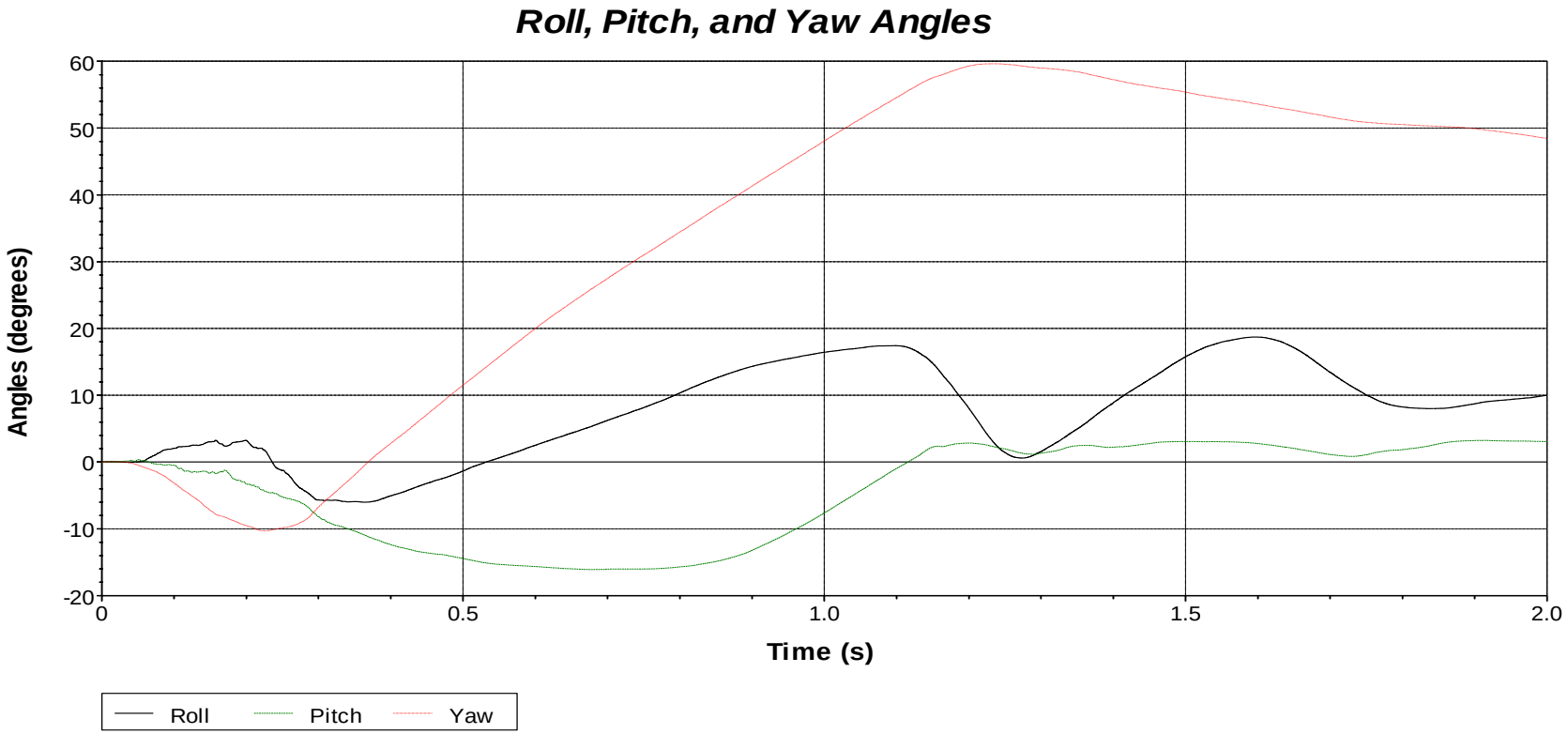
0.200 s

0.600 s

0.300 s

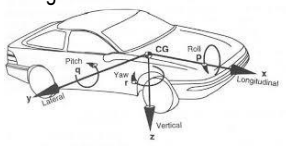
0.700 s

Figure A.8. Sequential Photographs for Test No. 612061-02-1 (Rear View).



Axes are vehicle-fixed.
Sequence for determining orientation:

1. Yaw.
2. Pitch.
3. Roll.



Test Number: 612061-02-1
Test Standard Test Number: *MASH* Test 3-11
Test Article: Merritt Parkway Guiderail with No Curb
Test Vehicle: 2014 RAM 1500 Pickup
Inertial Mass: 5012 lb
Gross Mass: 5177 lb
Impact Speed: 62.4 mi/h
Impact Angle: 24.3°

Figure A.9. Vehicle Angular Displacements for Test No. 612061-02-1.

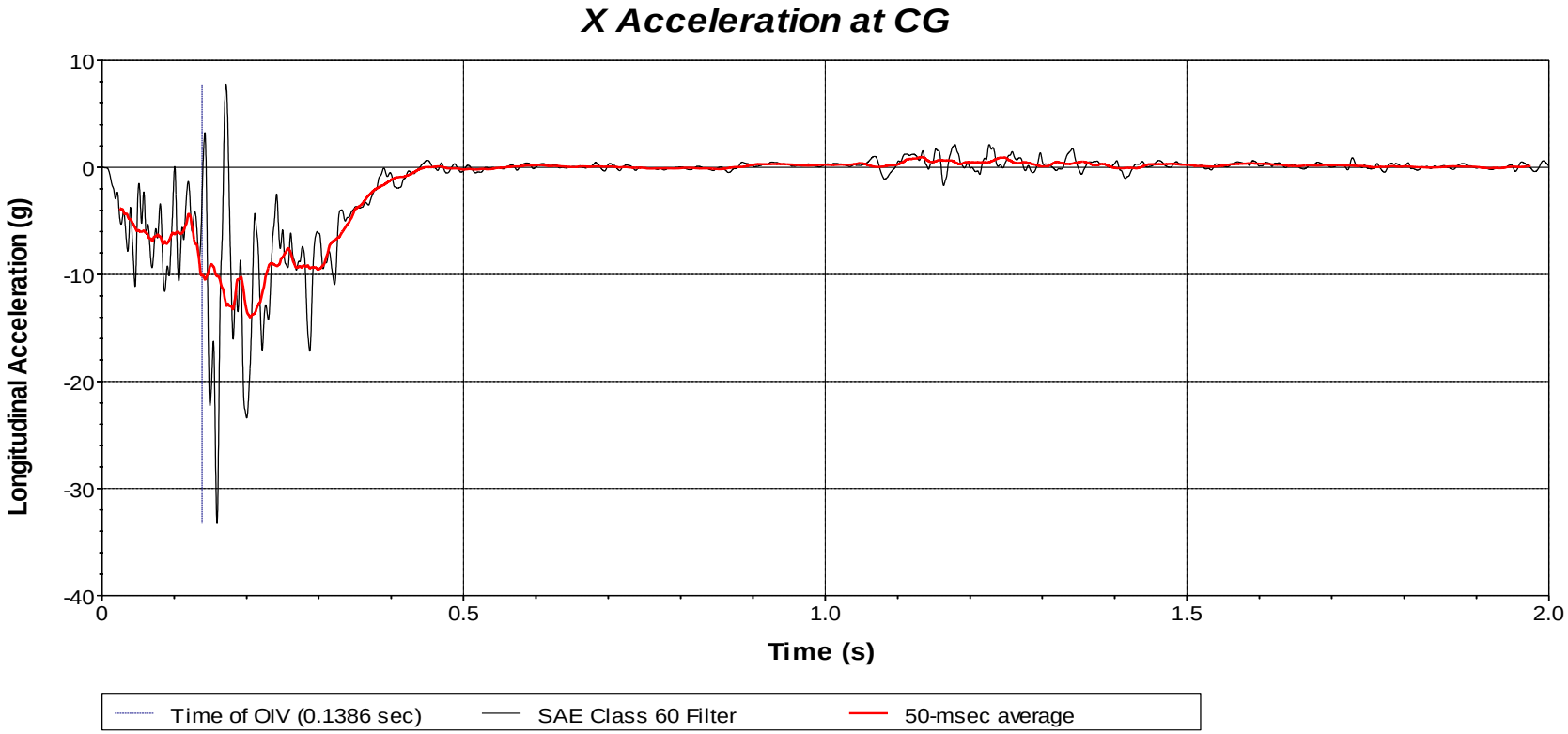


Figure A.10. Vehicle Longitudinal Accelerometer Trace for Test No. 612061-02-1 (Accelerometer Located at Center of Gravity).

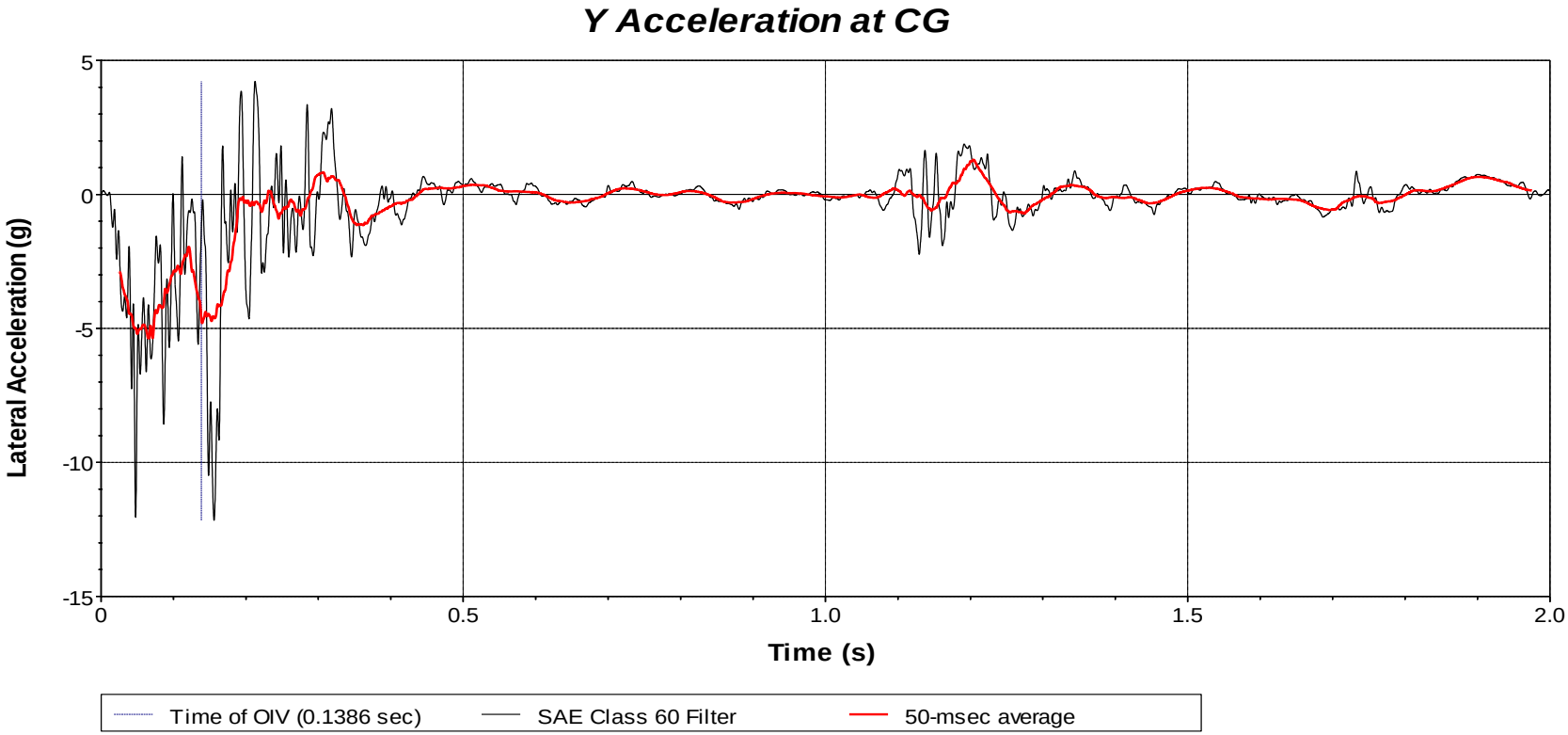


Figure A.11. Vehicle Lateral Accelerometer Trace for Test No. 612061-02-1 (Accelerometer Located at Center of Gravity).

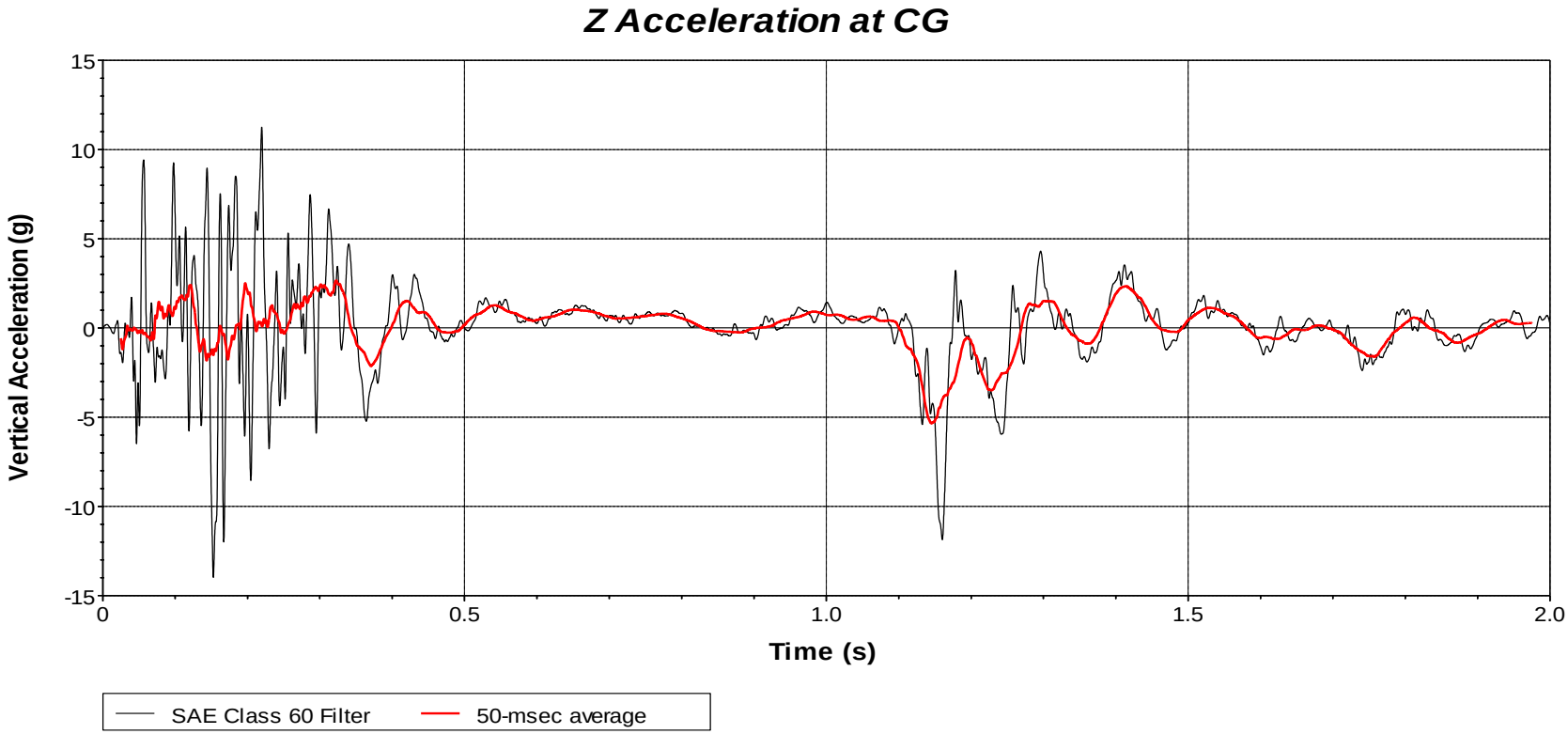


Figure A.12. Vehicle Vertical Accelerometer Trace for Test No. 612061-02-1 (Accelerometer Located at Center of Gravity).

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APPENDIX B. SUPPORTING CERTIFICATION DOCMENTS

OLYMPIC STEEL
5080 RICHMOND ROAD
BEDFORD HEIGHTS, OH 44146 USA
PHONE: 216-292-3800

METALLURGICAL TEST REPORT

>>>>>> CERTIFICATE OF ANALYSIS AND TESTS <<<<<<

Sold To: AMERICAN TIMBER AND STEEL
4832 PLANK RD.
NORWALK, OH 44857

Ship To: AMERICAN TIMBER AND STEEL
4832 PLANK RD.
NORWALK, OH 44857

Sales Order: 614083 - 02 B/L No: 983730 Release: 3 Date: 20-May-2020
Reference: FORRAI, HALLIE (11855) 2nd B/L: Cus Ord #: 21885
Cus Name: AMERICAN TIMBER AND STEEL

Description of Material and Specification

Hot Rolled Sheet A606/606
.375IN x 48IN x 117IN

TAG#:
27719332,27719330,27719331,27719333,27719334,27719335,
27719336,27719337,27719338
HEAT#: 32016780/STEEL DYNAMICS, INC. - FLAT ROLLED
MC # 27699054
MS # 20B528734

Chem Elem Symbol / Elem Content Value:

<C : .05> <MN : .86> <P : .02> <S : .001> <SI : .45> <AL : .035> <V : .031> <CB : .002> <CU : .33> <NI : .16>
<CR : .43> <MO : .02> <N : .009> <TI : .001> <B : 0> <CA : .002> <ZR : .0008> <PB : 0> <SN : .006>

YIELD STRENGTH	MIN:	60800	PSI	MAX	60800 PSI
TENSILE STRENGTH	MIN:	76100	PSI	MAX	76100 PSI
ELONGATION 2"	MIN:	34	%	MAX	34 %

We hereby certify the above is correct as contained in the records of the corporation

Branch Certification Manager

USER: REPORTS@SEMSP01
REPORT: ST_MSR_OSI

20-May-2020 4:44 AM
Page 2 of 2

OLYMPIC STEEL
5080 RICHMOND ROAD
BEDFORD HEIGHTS, OH 44146 USA
PHONE: 216-292-3800

METALLURGICAL TEST REPORT

>>>>>> CERTIFICATE OF ANALYSIS AND TESTS <<<<<<

Sold To: AMERICAN TIMBER AND STEEL
4832 PLANK RD.
NORWALK, OH 44857

Ship To: AMERICAN TIMBER AND STEEL
4832 PLANK RD.
NORWALK, OH 44857

Sales Order: 601477 - 02 B/L No: 962816 Release: 2 Date: 18-Feb-2020
Reference: FORRAI, HALLIE (11855) 2nd B/L: Cus Ord #: 21392
Cus Name: AMERICAN TIMBER AND STEEL

Description of Material and Specification

Hot Rolled Sheet A1018/A36
.375IN x 49IN x 117IN

TAG#:
27528647,27528648,27528649,27528646,27528650,27528651

HEAT#: 247973/NORTH STAR BLUESCOPE STEEL LLC
MC # 27494860
MS # 1995323

Chem Elem Symbol / Elem Content Value:

<C : .2> <MN : .53> <P : .01> <S : .002> <SI : .08> <AL : .02> <V : .001> <CU : .12> <NI : .06> <CR : .07> <MO : .01> <N : .006> <TI : .001> <B : 0> <CA : .001> <SN : 0> <NB : 0>

YIELD STRENGTH	MIN:	43600	PSI	MAX	54000 PSI
TENSILE STRENGTH	MIN:	74100	PSI	MAX	75200 PSI
ELONGATION 2"	MIN:	40.4	%	MAX	42 %

We hereby certify the above is correct as contained in the records of the corporation

Branch Certification Manager

USER: REPORTS@SEMSP01
REPORT: ST_MSR_OSI

18-Feb-2020 6:05 PM
Page 2 of 2

TR No. 612061-08-01

105

2024-02-06

American Timber and Steel Co.
4832 Plank Rd. P.O. Box 767
Norwalk, OH 44857
PHONE: 419-668-1610 FAX: 419-668-7535

American Timber and Steel

MATERIAL TEST REPORT

Customer: Bryan Construction Company
P.O. Box 4087
Bryan, TX 77805

Customer P.O. 302-10
Shipped to: Bryan, TX
Project: #302 TTI Merritt Parkway
ATS Order No.: 263300

MILL SERIAL# / HEAT#	LOT#	QUANTITY	PART DESCRIPTION	MATERIAL TYPE	DATE OF MANUFACTURE
32016780	27719330 - 27719338	39	3/8" x 6" x 114" MP RAIL PLATE (CORTEN) - 4906114-3400	A606	4/28/2020
247973	27528646 - 27528651	2	3/8" x 6" x 114" MP RAIL PLATE (HDG) - 4906114-3200	A1018 / A36	4/28/2020
B160675 / 5505477607 / B166884 / B160678	--	48	W6x15# - 6' 6" MP (2H) I-BEAM POST (CORTEN/HDG) - MP00078-7901	A588	5/15/2020
A175660 / B175825 / B171455	--	2	W6x15# - 6' 6" MP (2H) I-BEAM POST (HDG) - MP00078-7201	A992	5/15/2020
247973	27528646 - 27528651	2	3/8" x 6" x 30" MP SPLICE PLATE (HDG) - 4906030-31MP	A1018 / A36	4/28/2020
DL17105083	217962	24	5/8" x 7" CARRIAGE BOLT (CORTEN) DOM - 4958070-2400	A242	--
JK17100350	217961	4	5/8" x 7" CARRIAGE BOLT (HDG) DOM - 4958070-2201	F1554-36	--
198520	D7926	96	5/8" FLAT WASHER (CORTEN) DOM - 4958001-9909	F436	--
0017266	--	4	5/8" FLAT WASHER (HDG) DOM - 4958000-6101	F844	--
DL14104775	407090B	96	5/8" HEX NUT (CORTEN) DOM - 4958110-9900	AWWA C111	--
62148230	P38707 R71433-01	4	5/8" HEX NUT (HDG) DOM - 4958000-8101	A563	--
10592090 / DL18100861	86911 / 107531	304	3/4" x 8-1/2" CARRIAGE BOLT (CORTEN) DOM - 4934090-9900	AWWA C111	--
100101783	32693	20	3/4" x 8-1/2" CARRIAGE BOLT (HDG) DOM - 4934085-2101	A325	--
227567 / 198520	296127 / D7926	304	3/4" FLAT WASHER (CORTEN) DOM - 4934000-9900	F436 T3	--
9515612/9514538 / 21933130	P38393 R69206 / P39299 R73245	20	3/4" FLAT WASHER (HDG) DOM - 4934000-6101	F436-10	--
75068613	5/10/4088	304	3/4" HEX NUT (CORTEN) DOM - 4934100-9900	A563	--
75070667 / 62150514 / 75078628	P38836 R71968 / P38996 R72790 / P39289 R73494	20	3/4" HEX NUT (HDG) DOM - 4934000-8101	A563	--
481990	--	1	WT15x86.5# - 24" MP END ANCHOR T MOUNT (HDG) - MPWT150-9101	A992	5/4/2020
32016780	27719330 - 27719338	37	3/8" x 6" x 30" MP SPLICE PLATE (CORTEN) - 4906030-34MP	A606	4/28/2020
32016780	27719329	3	3/8" x 6" x 162" MP LEADING END PLATE (CORTEN) - 4906162-3401	A606	5/26/2020
DL18104710	92212	10	5/8" x 12" CARRIAGE BOLT (CORTEN) DOM - 4958120-2401	A242	--
DL17105083	217962	62	5/8" x 6" CARRIAGE BOLT (CORTEN) DOM - 4958060-2400	A242	5/27/2020
10575880	32361	234	5/8" x 4" LAG BOLT (CORTEN) DOM - 4958040-9900	AWWA C111	--
DL18105063	32688	12	5/8" x 4" LAG BOLT (HDG) DOM - 4958040-3101	A325	--

All steel used in the manufacture is of Domestic Origin, "Made and Melted in the United States"
Supporting documentation included for verification of of Mill Test Reports

By:
Tristan Hildebrandt
Project Engineer
American Timber and Steel Corp.

STATE OF OHIO: COUNTY OF HURON
Sworn to and subscribed before me, a Notary Public,
On this 10th day of June, 2020

Notary Public, State of Ohio

KRISTEN BAKER
NOTARY PUBLIC
STATE OF OHIO
Comm. Expires
June 6, 2023
Recorded in
Erie County

TR No. 612061-08-01

106

2024-02-06

Steel Dynamics, Inc.
Long Products Group
Structural and Rail Division
(260) 625-8100 (260) 625-8950 FAX
Quality Steel 100% EAF Melted and Manufactured in the USA
Recycled content: PC = 75.0%, PI = 22.8%
ISO 9001:2015 and ABS Certified
CMTR complies with EN 10204 3.1.

CERTIFIED MILL TEST REPORT

Printed: 07 / 21 / 2019
Produced: 07 / 15 / 2019

Ship to:
The A588 & A572 Steel Co
785 Arch Street
Carnegie PA, 15106 US
Attn: Denise Yarussi

Customer # 000469

Bill to:
THE A588 & A572 STEEL- PA
133 Sebago Lake Drive
Sewickley PA, 15143 US
Attn: Rick Gunzburg

GENERAL INFORMATION

Product	Wide Flange Beam
Size	W6X15
	W150X22.5
Heat Number	B160675
Condition(s)	As-Rolled
	Fine Grained
	Fully Killed
	No Weld Repair

SPECIFICATIONS

Standards	Grades*
ASTM A6/A6M - 17a	
» ASTM A588/A588M - 15	A588/A588M grB
A709/A709M - 17e1	A709 gr50W/gr345W
AASHTO M270M/M270 - 15	M270 gr345W/50W
CSA G40.21-13	50A/350A

*SDI-MULTI meets the requirements of ASTM A992, A572-50, A529-50, A709-50, M270-50, A36, A709-36, M270-36, CSA300W, CSA345WM, CSA350W.

SHIPMENT DETAILS

BOL # 0000557190 - 14400.00 lbs

Bundle / ASN #	Length	pcs	Cust PO | Job/Reference
061090419	40' 0"	12	23057
061090417	40' 0"	12	23057

CHEMICAL ANALYSIS (weight percent)

C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Sn	V	Nb/Cb	Al	N	B	*C1	*C2	*C3	*PC	*I	Analysis Type
.07	1.13	.010	.025	.19	.34	.22	.48	.04	.020	.032	.003	.002	.0145	.0004	.41	.438	.32	.18	6.32	Heat

MECHANICAL TESTING

Test	Yield (fy) Strength ksi / MPa	Tensile (fu) Strength ksi / MPa	fy / fu ratio	% Elong. (8" gage)
1	51 / 350	82 / 565	.62	23
2	54 / 370	79 / 545	.69	25
3				
4				

CHARPY IMPACT TESTS (available only when specified at time of order)

Test	Temp F / C	Absorbed Energy ft-lbf / J Specimen 1	Specimen 2	Specimen 3	Average	Minimum
1						
2						
3						
4						
5						
6						
7						

Notes: *Calculated Chemistry Values: Carbon Equivalents (C1, C2, C3, PC), Corrosion Index (I) (ASTM G101)= 26.01(Cu)+3.88(Ni)+1.20(Cr)+1.49(Si)+17.28(P)-7.29(Cu)(Ni)-9.10(Ni)(P)-33.39(Cu²) Fom(AWS) = C+Si/30+Nb/20+Cu/20+Ni/60+Cr/20+mo/15+V/10+5B
CE1 (IIW)=C+MN/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE2 (AWS)=C+(Mn+Si)/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE3 (CET) = C + (MN/6) + (SI/24) + (CR/5) + (NI/40) +(Mo/4) + (V/14)

I hereby certify that the material described herein has been made to the applicable specification by the electric arc furnace/continuous cast process and tested in accordance with the requirements of American Bureau of Shipping Rules with satisfactory results.

Signed:

ABS CERTIFICATION

I hereby certify that the content of this report are accurate and correct. All tests and operations performed by this material manufacturer are in compliance with the requirements of the material specifications and applicable purchaser designated requirements.

Signed: **Todd Bashford** Todd A. Bashford
Quality Manager

State of Indiana, County of Whitley Sworn to and subscribed before me this _____ day of _____

Signed: _____ My commission expires: _____
Notary Public

Form F-6100-002-054 rev 0

ASTM A6 - 14.6: A signature is not required on the test report; however, the document shall clearly identify the organization submitting the report. Notwithstanding the absence of a signature, the organization submitting the report is responsible for the content of the report

TR No. 612061-08-01

107

2024-02-06

GERDAU

US-ML-CARTERSVILLE
384 OLD GRASSDALE ROAD NE
CARTERSVILLE, GA 30121
USA

CERTIFIED MATERIAL TEST REPORT

CUSTOMER SHIP TO	CUSTOMER BILL TO
A588 & A572 STEEL COMPANY 62 ARCH ST CARNEGIE,PA 15106-2040 USA	A588 & A572 STEEL COMPANY 133 SEBAGO LAKE DR SEWICKLEY,PA 15143-9374 USA

GRADE	SHAPE / SIZE	DOCUMENT ID:
A588-B	Wide Flange Beam / 6 X 15# / 150 X 22.5	0000200904

LENGTH	PCS	WEIGHT	HEAT / BATCH
40'00"	75	45,000 LB	55054776/07

SALES ORDER	CUSTOMER MATERIAL N°
6931811/000010	48.80 W GRADE EXTRA

SPECIFICATION / DATE or REVISION
ASTM A588-15
ASTM A6-17
ASTM A709-17

CUSTOMER PURCHASE ORDER NUMBER	BILL OF LADING	DATE
21809	1323-0000122232	10/29/2018

CHEMICAL COMPOSITION

C %	Mn %	P %	S %	Si %	Cu %	Ni %	Cr %	Mo %	Sn %	V %	Nb %
0.17	0.93	0.018	0.021	0.34	0.31	0.11	0.56	0.027	0.010	0.026	0.000

MECHANICAL PROPERTIES

YS 0.2% PSI	UTS PSI	YS MPa	UTS MPa	G/L inch	Elong %
64900	92100	448	635	8.000	18.80
65300	90200	450	622	8.000	18.90

COMMENTS / NOTES

The above figures are certified chemical and physical test records as contained in the permanent records of company. We certify that these data are correct and in compliance with specified requirements. This material, including the billets, was melted and manufactured in the USA. CMTR complies with EN 10204 3.1.

BHASKAR YALAMANCHILI
QUALITY DIRECTOR
Phone: (409) 267-1071 Email: Bhaskar.Yalamanchili@gerdau.com

YAN WANG
QUALITY ASSURANCE MGR.
Phone: (770) 387 5718 Email: yan.wang@gerdau.com

TR No. 612061-08-01

108

2024-02-06

Steel Dynamics, Inc.
Long Products Group
Structural and Rail Division
2601 S. County Road 700 East
Columbia City, Indiana 46725
(260) 625-8100 (260) 625-8950 FAX

CERTIFIED MILL TEST REPORT

Printed: 10 / 22 / 2019
Produced: 10 / 19 / 2019

Ship to:
The A588 & A572 Steel Co
785 Arch Street
Carnegie PA, 15106 US
Attn: Denise Yerussi

Customer # 000469

Bill to:
THE A588 & A572 STEEL- PA
133 Sebago Lake Drive
Sewickley PA, 15143 US
Attn: Rick Gunzburg

Quality Steel 100% EAF Melted and Manufactured in the USA
Recycled content: PC = 75.0%, PI = 22.8%
ISO 9001:2015 and ABS Certified
CMTR complies with EN 10204 3.1.

GENERAL INFORMATION

Product	Wide Flange Beam
Size	W6X15
	W150X22.5
Heat Number	B166884
Condition(s)	As-Rolled
	Fine Grained
	Fully Killed
	No Weld Repair

SPECIFICATIONS

Standards	Grades*
ASTM A6/A6M - 17a	
• ASTM A568/A568M - 15	A568/A568M grB
A709/A709M - 17e1	A709 gr50W/gr345W
AASHTO M270M/M270 - 15	M270 gr345W/50W
CSA G40.21-13	50A/350A

*SDI-MULTI meets the requirements of ASTM A992, A572-50, A529-50, A709-50, M270-50, A36, A709-36, M270-36, CSA300W, CSA345W1M, CSA350W.

SHIPMENT DETAILS

BOL # 0000566788 - 26800.00 lbs

Bundle / ASN #	Length	pcs	Cust PO / Job/Reference
061131015	40' 0"	12	23399
061131016	40' 0"	12	23399
061131018	40' 0"	12	23399
061131014	40' 0"	12	23399

CHEMICAL ANALYSIS (weight percent)

C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Sn	V	Nb/Cb	Al	N	B	*C1	*C2	*C3	*PC	*I	Analysis Type
.06	1.15	.019	.008	.19	.38	.25	.47	.04	.016	.035	.002	.003	.0119	.0003	.40	.434	.32	.18	6.47	Heat

MECHANICAL TESTING

Test	Yield (fy) Strength ksi / MPa	Tensile (fu) Strength ksi / MPa	fy / fu ratio	% Elong. (8" gage)
1	52 / 360	81 / 560	.64	27
2	55 / 380	80 / 550	.68	24
3				
4				

CHARPY IMPACT TESTS (available only when specified at time of order)

Test	Temp F / C	Absorbed Energy ft-lbf / J Specimen 1	Specimen 2	Specimen 3	Average	Minimum
1						
2						
3						
4						
5						
6						
7						

Notes: *Calculated Chemistry Values: Carbon Equivalents (C1, C2, C3, PC), Corrosion Index (I) (ASTM G101)= 26.01(Cu)+3.88(Ni)+1.20(Cr)+1.49(Si)+17.28(P)-7.29(Cu)(Ni)-9.10(Ni)(P)-33.39(Cu²) Pcm(AWS) = C+Si/30+Mn/20+Cu/20+Ni/60+Cr/20+Mo/15+V/10+5B
CE1 (IIW)=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE2 (AWS)=C+(Mn+Si)/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE3 (CET) = C + (Mn/6) + (Si/24)+ (Cr/9) + (Ni/40) +(Mo/4) + (V/14)

I hereby certify that the material described herein has been made to the applicable specification by the electric arc furnace/continuous cast process and tested in accordance with the requirements of American Bureau of Shipping Rules with satisfactory results.

Signed:

ABS CERTIFICATION

I hereby certify that the content of this report are accurate and correct. All tests and operations performed by this material manufacturer are in compliance with the requirements of the material specifications and applicable purchaser designated requirements.

Signed: **Todd Bashford** Todd A Bashford
Quality Manager

State of Indiana, County of Whitley Sworn to and subscribed before me this _____ day of _____

Signed: _____ My commission expires: _____
Notary Public

Form F-5100-002-054 rev 9

ASTM A6 - 14.6: A signature is not required on the test report; however, the document shall clearly identify the organization submitting the report. Notwithstanding the absence of a signature, the organization submitting the report is responsible for the content of the report

TR No. 612061-08-01

109

2024-02-06

Steel Dynamics, Inc.
Long Products Group
Structural and Rail Division
2601 S. County Road 700 East
Columbia City, Indiana 46725
(260) 625-8100 (260) 625-8950 FAX

CERTIFIED MILL TEST REPORT

Printed: 08 / 20 / 2019
Produced: 07 / 15 / 2019

Ship to: Customer # 000469
The A588 & A572 Steel Co
785 Arch Street
Carnegie PA, 15106 US
Attn: Denise Yarussi

Bill to:
THE A588 & A572 STEEL - PA
133 Sabago Lake Drive
Sewickley PA, 15143 US
Attn: Rick Gunzburg

Quality Steel 100% EAF Melted and Manufactured in the USA
Recycled content: PC = 75.0%, PI = 22.8%
ISO 9001:2015 and ABS Certified
CMTR complies with EN 10204 3.1.

GENERAL INFORMATION

Product	Wide Flange Beam
Size	W6X15
	W150X22.5
Heat Number	B160678
Condition(s)	As-Rolled
	Fine Grained
	Fully Killed
	No Weld Repair

SPECIFICATIONS

Standards	Grades*
ASTM A6/A6M - 17a	
» ASTM A588/A588M - 15	A588/A588M grB
A709/A709M - 17e1	A709 gr50W/g345W
AASHTO M270M/M270 - 15	M270 gr345W/50W

*SDI-MULTI meets the requirements of ASTM A992, A572-50, A529-50, A709-50, M270-50, A36, A709-36, M270-36, CSA350W, CSA345WM, CSA350W.

SHIPMENT DETAILS

BOL # 0000561285 - 7560.00 lbs

Bundle / ASN #	Length	pcs	Cust PO | Job/Reference
061054766	42' 0"	12	23227

CHEMICAL ANALYSIS (weight percent)

C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Sn	V	Nb/Cb	Al	N	B	*C1	*C2	*C3	*PC	*I	Analysis Type
.07	1.16	.012	.025	.22	.34	.22	.51	.04	.020	.035	.003	.002	.0145	.0004	.42	.454	.33	.19	6.41	Heat

MECHANICAL TESTING

Test	Yield (fy) Strength ksi / MPa	Tensile (fu) Strength ksi / MPa	fy / fu ratio	% Elong. (8" gage)
1	50 / 345	83 / 570	.61	24
2	54 / 370	79 / 545	.68	24
3				
4				

CHARPY IMPACT TESTS (available only when specified at time of order)

Test	Temp F / C	Absorbed Energy ft-lbf / J Specimen 1	Specimen 2	Specimen 3	Average	Minimum
1						
2						
3						
4						
5						
6						
7						

Notes: *Calculated Chemistry Values: Carbon Equivalents (C1, C2, C3, PC), Corrosion Index (I) [ASTM G101]= 26.01(Cu)+3.88(Ni)+1.20(Cr)+1.49(Si)+17.28(P)-7.29(Cu)(Ni)-9.10(Ni)(P)-33.39(Cu²) Pcm[AWS] = C+S/30+Mn/20+Cu/20+Ni/60+Cr/20+mo/15+W/60+5B
CE1 [IIW]=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE2 [AWS]=C+(Mn+Si)/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE3 [CET] = C + (Mn/6) + (Si/24) + (Cr/5) + (Ni/40) + (Mo/4) + (V/14)

I hereby certify that the material described herein has been made to the applicable specification by the electric arc furnace/continuous cast process and tested in accordance with the requirements of American Bureau of Shipping Rules with satisfactory results.

Signed:

ABS CERTIFICATION

I hereby certify that the content of this report are accurate and correct. All tests and operations performed by this material manufacturer are in compliance with the requirements of the material specifications and applicable purchaser designated requirements.

Signed: **Todd Bashford** Todd A. Bashford
Quality Manager

State of Indiana, County of Whitley Sworn to and subscribed before me this _____ day of _____

Signed: _____ My commission expires: _____
Notary Public

Form F-6160-002-054 rev 8

ASTM A6 - 14.6: A signature is not required on the test report; however, the document shall clearly identify the organization submitting the report. Notwithstanding the absence of a signature, the organization submitting the report is responsible for the content of the report

TR No. 612061-08-01

110

2024-02-06

Steel Dynamics, Inc.
Long Products Group
Structural and Rail Division
2601 S. County Road 700 East
Columbia City, Indiana 46725
(260) 625-8100 (260) 625-8950 FAX

Quality Steel 100% EAF Melted and Manufactured in the USA
Recycled content: PC = 75.0%, PI = 22.0%
ISO 9001:2015 and ABS Certified
CMTR complies with EN 10204 3.1.

CERTIFIED MILL TEST REPORT

Printed: **03 / 17 / 2020**
Produced: **03 / 10 / 2020**

Ship to: Customer # 000097
Contractors Steel Co.
48649 Schooner Dr.
Trucks to enter from
Belleville MI, 48111 US
Attn: Mike M.

Bill to:
Contractors Steel Co
36555 Amrhein Rd.
Livonia MI, 48150 US
Attn: Cathy

GENERAL INFORMATION

Product	Wide Flange Beam
Size	W6X15
	W150X22.5
Heat Number	A175660
Condition(s)	As-Rolled
	Fine Grained
	Fully Killed
	No Weld Repair

SPECIFICATIONS

Standards	Grades*
ASTM A6/A6M - 19	
» ASTM A992/A992M - 11	A992 / A992M
ASTM A572/A572M - 18	A572 gr50/gr345
ASTM A709/A709M - 17e1	A709 gr50/gr345
AASHTO M270M/M270 - 15	M270 gr345/gr50
CSA G40.21-13	50WM/345WM

*SDI-MULTI meets the requirements of ASTM A992, A572-50, A529-50, A709-50, M270-50, A36, A709-36, M270-36, CSA300W, CSA345WM, CSA350W.

SHIPMENT DETAILS

BOL # 0000588772 - 7425.00 lbs

Bundle / ASN #	Length	pcs	Cust PO | Job/Reference
061208018	55' 0"	9	VB-133598

CHEMICAL ANALYSIS (weight percent)

C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Sn	V	Nb/Cb	Al	N	B	*C1	*C2	*C3	*PC	*I	Analysis Type
.06	1.05	.015	.029	.23	.36	.14	.15	.04	.014	.022	<.001	.003	.0134	.0003	.31	.349	.26	.16	5.97	Heat

MECHANICAL TESTING

Test	Yield (fy) Strength ksi / MPa	Tensile (fu) Strength ksi / MPa	fy / fu ratio	% Elong. {8" gage}
1	55 / 380	76 / 525	.72	29
2	51 / 350	81 / 560	.63	28
3				
4				

CHARPY IMPACT TESTS (available only when specified at time of order)

Test	Temp F / C	Absorbed Energy ft-lbf / J Specimen 1	Specimen 2	Specimen 3	Average	Minimum
1						
2						
3						
4						
5						
6						
7						

Notes: *Calculated Chemistry Values: Carbon Equivalents (C1, C2, C3, PC), Corrosion Index (I) (ASTM G101)= 26.01(Cu)+3.88(Ni)+1.20(Cr)+1.49(Si)+17.29(P)-7.29(Cu)(Ni)-9.10(Ni)(P)-33.39(Cu²) Pcm(AWS) = C+Si/30+Mn/20+Cu/20+Ni/60+Cr/20+mo/15+V/10+5B
CE1 (IIW)=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE2 (AWS)=C+(Mn+Si)/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE3 (CET) = C + (Mn/6) + (Si/24) + (Cr/5) + (Ni/40) +(Mo/4) + (V/14)

I hereby certify that the material described herein has been made to the applicable specification by the electric arc furnace/continuous cast process and tested in accordance with the requirements of American Bureau of Shipping Rules with satisfactory results.

Signed:

ABS CERTIFICATION

I hereby certify that the content of this report are accurate and correct. All tests and operations performed by this material manufacturer are in compliance with the requirements of the material specifications and applicable purchaser designated requirements.

Signed: **Todd Bashford** Quality Manager

Form F-8100-002-054 rev 8

State of Indiana, County of Whitley Sworn to and subscribed before me this _____ day of _____

Signed: _____ My commission expires: _____
Notary Public

ASTM A6 - 14.6: A signature is not required on the test report; however, the document shall clearly identify the organization submitting the report. Notwithstanding the absence of a signature, the organization submitting the report is responsible for the content of the report

Steel Dynamics, Inc.
Long Products Group
Structural and Rail Division
2601 S. County Road 700 East
Columbia City, Indiana 46725
(260) 625-8100 (260) 625-8950 FAX

CERTIFIED MILL TEST REPORT

Printed: 04 / 07 / 2020
Produced: 03 / 10 / 2020

Ship to:
Contractors Steel Co.
8383 Boyle Parkway
Twinsburg OH, 44087 US
Attn: Travis Lance

Customer # 000097

Bill to:
Contractors Steel Co
36555 Amrhein Rd.
Livonia MI, 48150 US
Attn: Cathy

Quality Steel 100% EAF Melted and Manufactured in the USA
Recycled content: PC = 68.0%, PI = 27.0%
ISO 9001:2015 and ABS Certified
CMTR complies with EN 10204 3.1.

GENERAL INFORMATION

Product	Wide Flange Beam
Size	W6X15 W150X22.5
Heat Number	B175825
Condition(s)	As-Rolled Fine Grained Fully Killed No Weld Repair

SPECIFICATIONS

Standards	Grades*
ASTM A6/A6M - 19	
» ASTM A992/A992M - 11	A992 / A992M
ASTM A572/A572M - 18	A572 gr50/gr345
ASTM A709/A709M - 17e1	A709 gr50/gr345
AASHTO M270M/M270 - 15	M270 gr345/gr50
CSA G40.21-13	50WM/345WM
ASTM A36/A36M - 19	A36 / A36M

*SDI-MULTI meets the requirements of ASTM A992, A572-50, A709-50, A529-50, A36 and A709-36; AASHTO M270-50 and M270-36; CSA 300W, 345W and 350W.

SHIPMENT DETAILS

BOL # 0000591887 - 9900.00 lbs

Bundle / ASN #	Length	pcs	Cust PO | Job/Reference
061207791	55' 0"	12	TW-137171

CHEMICAL ANALYSIS (weight percent)

C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Sn	V	Nb/Cb	Al	N	B	*C1	*C2	*C3	*PC	*I	Analysis Type
.08	.98	.009	.025	.22	.23	.09	.08	.03	.012	.020	<.001	.002	.0098	.0003	.29	.327	.26	.15	5.01	Heat

MECHANICAL TESTING

Test	Yield (fy) Strength ksi / MPa	Tensile (fu) Strength ksi / MPa	fy / fu ratio	% Elong. (8" gage)
1	53 / 365	69 / 475	.76	30
2	52 / 360	69 / 475	.76	31
3				
4				

CHARPY IMPACT TESTS (available only when specified at time of order)

Test	Temp F / C	Absorbed Energy ft-lbf / J Specimen 1	Specimen 2	Specimen 3	Average	Minimum
1						
2						
3						
4						
5						
6						
7						

Notes: *Calculated Chemistry Values: Carbon Equivalents (C1, C2, C3, PC), Corrosion Index (I) (ASTM G101)= 26.01(Cu)+3.88(Ni)+1.20(Cr)+1.49(Si)+17.29(P)-7.29(Cu)(Ni)-9.10(Ni)(P)-33.39(Cu²) Pcm(AWS) = C+Si/30+Mn/20+Cu/20+Ni/60+Cr/20+ma/15+V/10+5B CE1 (IIW)=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE2 (AWS)=C+(Mn+Si)/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE3 (CET) = C + (Mn/6) + (Si/24) + (Cr/5) + (Ni/40) +(Mo/4) + (V/14)

I hereby certify that the material described herein has been made to the applicable specification by the electric arc furnace/continuous cast process and tested in accordance with the requirements of American Bureau of Shipping Rules with satisfactory results.

Signed:

ABS CERTIFICATION

I hereby certify that the content of this report are accurate and correct. All tests and operations performed by this material manufacturer are in compliance with the requirements of the material specifications and applicable purchaser designated requirements.

Signed: **Todd Bashford** Quality Manager

Form F-6100-002-054 rev 8

State of Indiana, County of Whitley Sworn to and subscribed before me

this _____ day of _____

Signed: _____ My commission expires: _____
Notary Public

ASTM A6 - 14.6: A signature is not required on the test report; however, the document shall clearly identify the organization submitting the report. Notwithstanding the absence of a signature, the organization submitting the report is responsible for the content of the report

TR No. 612061-08-01

112

2024-02-06

Steel Dynamics, Inc.
Long Products Group
Structural and Rail Division
2601 S. County Road 700 East
Columbia City, Indiana 46725
(260) 625-8100 (260) 625-8950 FAX

CERTIFIED MILL TEST REPORT

Printed: 01 / 08 / 2020
Produced: 12 / 03 / 2019

Ship to: Customer # 000097
Contractors Steel Co.
8383 Boyle Parkway
Twinsburg OH, 44087 US
Attn: Travis Lance

Bill to:
Contractors Steel Co
36555 Amrhein Rd.
Livonia MI, 48150 US
Attn: Cathy

Quality Steel 100% EAF Melted and Manufactured in the USA
Recycled content: PC = 75.0%, PI = 22.0%
ISO 9001:2015 and ABS Certified
CMTR complies with EN 10204 3.1.

GENERAL INFORMATION

Product	Wide Flange Beam
Size	W6X15
	W150X22.5
Heat Number	B171455
Condition(s)	As-Rolled
	Fine Grained
	Fully Killed
	No Weld Repair

SPECIFICATIONS

Standards	Grades*
ASTM A6/A6M - 19	
» ASTM A992/A992M - 11	A992 / A992M
ASTM A572/A572M - 18	A572 gr50/gr345
ASTM A709/A709M - 17e1	A709 gr50/gr345
AASHTO M270M/M270 - 15	M270 gr345/gr50
CSA G40.21-13	50WM/345WM
ASTM A36/A36M - 14	A36 / A36M

*SDI-MULTI meets the requirements of ASTM A992, A572-50, A529-50, A709-50, M270-50, A36, A709-36, M270-36, CSA300W, CSA345WM, CSA350W.

SHIPMENT DETAILS

BOL # 0000578378 - 5400.00 lbs

Bundle / ASN #	Length	pcs	Cust PO | Job/Reference
061152194	30' 0"	12	TW-132928

CHEMICAL ANALYSIS (weight percent)

C	Mn	P	S	Si	Cu	Ni	Cr	Mo	Sn	V	Nb/Cb	Al	N	B	*C1	*C2	*C3	*PC	*I	Analysis Type
.07	1.04	.008	.018	.22	.37	.12	.14	.04	.014	.022	.002	.002	.0120	.0004	.32	.353	.27	.16	5.81	Heat

MECHANICAL TESTING

Test	Yield (fy) Strength ksi / MPa	Tensile (fu) Strength ksi / MPa	fy / fu ratio	% Elong. (8" gage)
1	56 / 385	75 / 515	.75	28
2	59 / 405	76 / 525	.78	27
3				
4				

CHARPY IMPACT TESTS (available only when specified at time of order)

Test	Temp F / C	Absorbed Energy ft-lbf / J Specimen 1	Specimen 2	Specimen 3	Average	Minimum
1						
2						
3						
4						
5						
6						
7						

Notes: *Calculated Chemistry Values: Carbon Equivalents (C1, C2, C3, PC), Corrosion Index (I) (ASTM G101)= 26.01(Cu)+3.88(Ni)+1.20(Cr)+1.49(Si)+17.29(P)-7.29(Cu)(Ni)-9.10(Ni)(P)-33.39(Cu²) Pcm(AWS) = C+Si/30+Mn/20+Cu/20+Ni/60+Cr/20+mo/15+V/10+5B
CE1 (IIW)=C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE2 (AWS)=C+(Mn+Si)/6+(Cr+Mo+V)/5+(Ni+Cu)/15 CE3 (CET) = C + (Mn/6) + (Si/24) + (Cr/5) + (Ni/40) +(Mo/4) + (V/14)

I hereby certify that the material described herein has been made to the applicable specification by the electric arc furnace/continuous cast process and tested in accordance with the requirements of American Bureau of Shipping Rules with satisfactory results.

Signed:

ABS CERTIFICATION

I hereby certify that the content of this report are accurate and correct. All tests and operations performed by this material manufacturer are in compliance with the requirements of the material specifications and applicable purchaser designated requirements.

Signed: **Todd Bashford**
Quality Manager

State of Indiana, County of Whitley Sworn to and subscribed before me this _____ day of _____

Signed: _____ My commission expires: _____
Notary Public

Form F-6100-002-054 rev 8

ASTM A6 - 14.6: A signature is not required on the test report; however, the document shall clearly identify the organization submitting the report. Notwithstanding the absence of a signature, the organization submitting the report is responsible for the content of the report

Birmingham Fastener Manufacturing

P.O. Box 10323
Birmingham, Alabama 35202
(205) 595-3512

Certificate of Compliance

Customer : AMERICAN TIMBER
P.O. # : 16997

BFM # : 1500031
Date Shipped : 6/25/2018

	Quantity	Description	Lot #	Heat #	Specification	Finish
	212	5/8"-11 x 7" Carriage Bolt	217961	JK17100350	F1554-36	F2329
	2,500	5/8"-11 x 7" Carriage Bolt	217962	DL17105083	A242	Plain

Birmingham Fastener Manufacturing. hereby certifies that the material furnished in reference to the above purchase order number will meet or exceed the above assigned specifications.

Signed: _____ *Date:* 07/18/2018
Brian Hughes

NUCOR

NUCOR CORPORATION
NUCOR STEEL SOUTH CAROLINA

Mill Certification

3/15/2018

MTR #: C1-427479
300 Steel Mill Road
DARLINGTON, SC 29540
(843) 393-5841
Fax, (843) 395-8701

Sold To: BIRMINGHAM FASTENER & SUPPLY
PO BOX 10323
BIRMINGHAM, AL 35202-0323
(205) 595-3511
Fax, (205) 591-0244

Ship To: BIRMINGHAM FASTENER & SUPPLY
931 AVE W
PO BOX 10323
BIRMINGHAM, AL 35202
(205) 595-3511
Fax, (205) 591-0244

Customer P.O.	61689421		
Product Group	Merchant Bar Quality	Sales Order	279531.8
Grade	A242BF - ASTM A242-03	Part Number	30000583-480DEQ0
Size	9/16" (.5625) Round	Lot #	DL1710508302
Product	9/16" (.5625) Round 40' A242BF	Heat #	DL17105083
Description	A242BF	B.L. Number	C1-747408
Customer Spec		Load Number	C1-427479
		Customer Part #	

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.

Roll Date: 12/17/2017 **Melt Date: 8/11/2017** **Qty Shipped LBS: 46,832** **Qty Shipped Pcs: 1,384**

Melt Date: 8/11/2017

C	Mn	V	Si	S	P	Cu	Cr	Ni	Mo	Cb
0.15%	0.91%	0.0150%	0.18%	0.027%	0.010%	0.32%	0.74%	0.28%	0.019%	0.005%

Roll Date: 12/17/2017

Yield 1: 55,000psi
Elongation: 37% in 2"% in 50.8mm
Elongation: 21% in 8"% in 203.3mm

Tensile 1: 84,000psi
Yield 2: 54,000psi
Elongation: 35% in 2"% in 50.8mm (test2

Elongation: 20% in 8"% in 203.3mm
Tensile 2: 84,000psi

Specification Comments

1. WELDING OR WELD REPAIR WAS NOT PERFORMED ON THIS MATERIAL
2. MELTED AND MANUFACTURED IN THE USA
3. MERCURY, RADIUM, OR ALPHA SOURCE MATERIALS IN ANY FORM HAVE NOT BEEN USED IN THE PRODUCTION OF THIS MATERIAL

James H. Blew
Division Metallurgist

Page 1 of 1

TR No. 612061-08-01

115

2024-02-06

SOLD TO: BIRMINGHAM FASTENER & SUPPLY
PO BOX 10323
BIRMINGHAM, AL 35202-0323

SHIP TO: BIRMINGHAM FASTENER & SUPP
931 AVE W ENSLEY
BIRMINGHAM, AL 35214-

NUCOR
NUCOR STEEL JACKSON, INC.

CERTIFIED MILL TEST REPORT

Ship from:
MTR #: 0000075451
Nucor Steel Jackson, Inc.
3630 Fourth Street
Flowood, MS 39232
800-723-1623

Date: 30-Jun-2017
B.L. Number: 438623
Load Number: 158744

Material Safety Data Sheets are available at www.nucorbar.com or by contacting your inside sales representative.

NBMG-08 January 1, 2012

LOT # / HEAT #	DESCRIPTION	PHYSICAL TESTS					CHEMICAL TESTS							
		YIELD P.S.I.	TENSILE P.S.I.	ELONG % IN 8"	BEND	WT% / DEF	C / Ni	Mn / Cr	P / Mo	S / V	Si / Cb	Cu / Sn	C.E.
PO# =>	M 70160												
JK1710035001	Nucor Steel - Jackson Inc	52,687	74,310	21.3%			.15	.77	.014	.037	.20	.29	.31
JK17100350	9/16" (.5625) Round	363MPa	512MPa				.17	.23	.042	.016	.002		
	40' F1554 Gr36	52,575	74,150	21.3%									
	ASTM F1554-15 Gr36	362MPa	511MPa										
	ROA% = 50												
PO# =>	M 70160												
JK1710035302	Nucor Steel - Jackson Inc	56,906	76,730	20.0%			.16	.82	.021	.040	.22	.29	.32
JK17100353	9/16" (.5625) Round	392MPa	529MPa				.10	.18	.025	.018	.002		
	40' F1554 Gr36	54,424	75,110	21.3%									
	ASTM F1554-15 Gr36	375MPa	518MPa										
	ROA% = 49												
PO# =>	M 70160												
JK1710232601	Nucor Steel - Jackson Inc	55,743	77,270	23.8%			.17	.80	.015	.033	.22	.39	.33
JK17102326	9/16" (.5625) Round	384MPa	533MPa				.10	.11	.024	.016	.001		
	40' F1554 Gr36	55,542	77,550	23.8%									
	ASTM F1554-15 Gr36	383MPa	535MPa										
	ROA% = 71												

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.
1.) Weld repair was not performed on this material
2.) Melted and Manufactured in the United States
3.) Mercury, Radium, or Alpha source materials in any form have not been used in the production of this material

QUALITY ASSURANCE Christopher Smith

Prestige Stamping, LLC

23513 Groesbeck Highway
Warren, Michigan 48089
(586)773-2700 * Fax (586)773-2298
www.PrestigeStamping.com

PRODUCT CERTIFICATION

CERTIFICATION NUMBER

201110

THIS IS TO CERTIFY THE PRODUCT STATED BELOW WAS FABRICATED AND PROCESSED TO THE ORDER AS INDICATED AND CONFORMS TO THE APPLICABLE SPECIFICATIONS AND STANDARDS.

Customer: BIRMINGHAM FASTENER & SUPPLY
HANCEVILLE DIST CENTER
1100 MAIN ST
HANCEVILLE, AL 35077

Customer Part: 5/8" TYPE 3 F436
Prestige Part: P1383CH00
Part Name: 5/8"F436 TYPE 3
Purchase Order: 6211422
Shipment BOL: B219698
Shipment ID: A0238117
Quantity: 24000
Manufacturers Marking: "P"

Steel Supplier: STEEL TECHNOLOGIES LLC
Grade: SAE CF436 TYPE3 STEEL
Lot: D7926
Heat: 198520
Carbon: .39
Manganese: .79
Phosphorous: .02
Sulfur: .003
Silicon: .24

SPECIFICATIONS	TEST RESULTS
HARDNESS: TEST METHOD: ASTM E18	HARDNESS:
HRC 38 - 45	HRC 43 - 44
CHECKED TO ASTM F606	
:	:

USS/SAE LC Washers are manufactured to the requirements of ASTM F844 specifications
Chemistry is as reported from raw material certification and does not fall under Prestige Stamping's accreditation.
This product was produced under an IATF 16949 Quality Assurance System.
IATF 16949 Certification No: 800334.
Material was melted and manufactured in the U.S.A.
This product was manufactured in Warren, Michigan U.S.A.
This product conforms to all requirements for washers as produced according to A.S.T.M. F-436-13.
Sampling Plan per P.S.I W.I. # 5.4.18.015.
The test results only apply to the items tested.
This test report must not be reproduced except in full without prior written approval.
Materials used to manufacture these products are mercury, asbestos and radio activity free.
Product is RoHS compliant.
No weld repairs made to material.
All certified product is AIS compliant.

FRANK SCHUBERT
Quality Assurance Manager

Econ Information System 07/12/19 15:50 DTRO PAGE 1 of 1

D7926

Wrought Washer Mfg., Inc.

2100 S. Bay St., Milwaukee, Wisconsin 53207
Phone: (414) 744-0771 Fax: (414) 744-4811

Processed for:

Prestige Stamping
23513 Groesbeck Hwy
Warren, MI 48089

The following coil was processed at Wrought Washer located in the USA on May 24, 2019 and shipped to Prestige Stamping on June 10, 2019.

Coil #:	14752
Mill Coil #:	2396526
Heat #:	198520
Gauge:	.136
Mill coil weight:	42,500#
Chemistry:	

C	Mn	P	S	Al	Si	Cu	Ni
.39000	.79000	.02000	.00300	.03000	.24000	.26300	.28600

Cr	Mo	V	Nb/Cb	Ti	N	Ca	B	Sn
.47500	.01800	.00500	.00100	.00200	.00700	.00100	.00000	.01100

Paul J. Sappelink

Signature
Quality Manager

NUCOR

Nucor Steel Indiana
4537 South Nucor Road
Crawfordsville, IN 47933-0907

METALLURGICAL TESTING CERTIFICATION

0078096

Certificate Number: 825756
Date Issued: 05/17/2019

Order Number: 314919 - 0001 HOT ROLLED PICKLED & ANNEALED
Order Dimensions: 0.1360 in X 51.0000 in
HRPA,CUT,1040 WEATHERING

Customer Name: WROUGHT WASHER MFG INC
Customer Address: 2100 S BAY ST
MILWAUKEE WI 53207

Release Order:
Cust PO Number: H3539

Coil Number
2396525.000

	HEAD
L-Yield (ksi):	52.0
L-Tensile (ksi):	79.8
L-Elong (%):	30.0

HEAD
Rockwell B: 83

Part Number
724148-240 TONS
Weight: 42,720 LBS

CHEMICAL ANALYSIS

Heat	Slab	C	Mn	P	S	Si	Cu	Sn	Ni	Cr	Mo	Al	N	V	Nb	Ti	B	Sb
198520	04	0.39	0.790	0.020	0.003	0.240	0.263	0.011	0.286	0.475	0.018	0.030	0.007	0.005	0.001	0.002	<0.0005	0.001

Coil Number
2396526.000

	HEAD
L-Yield (ksi):	60.8
L-Tensile (ksi):	87.2
L-Elong (%):	24.0

HEAD
Rockwell B: 89

Part Number
724148-240 TONS
Weight: 42,500 LBS

CHEMICAL ANALYSIS

Heat	Slab	C	Mn	P	S	Si	Cu	Sn	Ni	Cr	Mo	Al	N	V	Nb	Ti	B	Sb
198520	05	0.39	0.790	0.020	0.003	0.240	0.263	0.011	0.286	0.475	0.018	0.030	0.007	0.005	0.001	0.002	<0.0005	0.001

WE HEREBY CERTIFY THE ABOVE IS CORRECT AS CONTAINED IN THE RECORDS OF THE CORPORATION
MELTED AND ROLLED IN THE USA

QF-0261 04/01/2019

1-800-777-0950 MTR_IND_INQUIRIES@NUCOR.COM

NUCOR QUALITY ASSURANCE

Eric E. Stelle
Manager

HIGHWAY SAFETY CORP

P.O. BOX 358
GLASTONBURY, CT 06033

CERTIFICATE OF COMPLIANCE/ANALYSIS REPORT

SOLD TO:
AMERICAN TIMBER AND STEEL
4832 PLANK ROAD
PO BOX 809
Norwalk, OH, USA

SHIP TO:
AMERICAN TIMBER AND STEEL
4832 PLANK ROAD
Norwalk,

INVOICE / S.O.: 0209689 / 0157621
CUSTOMER P.O.: 18524

REFERENCE:
DATE SHIPPED: 11/5/2018

QTY:	ITEM NUMBER:	CC:	DESCRIPTION:
HEAT/LOT NO:	YIELD:	TENSILE: %ELONG:	C: Mn: P: S: Si: Cl: Type ACW
58	BOLAGG062040	BOLAGG062040	BOLT LAG 0.625-11 x 04.000 GALV (5/8) A307
0017266			
180	WAROG-062-LA	WAROG-062-LA	WASHER ROUND 0.625 USS MG LARGE (5/8) F844 1-3/4 OD x 1
0017266			

ALL STEEL USED IN MANUFACTURING IS MADE AND MELTED IN THE USA, INCLUDING HARDWARE FASTENERS, AND COMPLIES WITH THE BUY AMERICA ACT. ALL COATINGS PROCESSES ARE PERFORMED IN THE USA AND COMPLY WITH THE BUY AMERICA ACT. BOLTS COMPLY WITH ASTMA-307 SPECIFICATIONS AND ARE GALVANIZED IN ACCORDANCE WITH ASTMA-153, UNLESS OTHERWISE STATED. NUTS COMPLY WITH ASTMA-563 SPECIFICATIONS AND ARE GALVANIZED IN ACCORDANCE WITH ASTMA-153, UNLESS OTHERWISE STATED. WASHERS COMPLY WITH ASTM F-436 AND/OR F-844 SPECIFICATIONS AND ARE GALVANIZED IN ACCORDANCE WITH ASTMA-153, UNLESS OTHERWISE STATED. ALL GUARDRAIL MEETS AASHTO M-180 AND ALL STRUCTURAL STEEL MEETS AASHTO M-270. ALL OTHER GALVANIZED MATERIAL CONFORMS WITH ASTMA-123. ALL OTHER ITEMS COMPLY WITH AASHTO M-111, M-165, M-133, M-265, ASTM A36, ASTMA-709, ASTMA-123, ASTM A505, AND ASTMA568 SPECIFICATIONS IF APPLICABLE. COMPLIANCE WITH ALL SPECIFICATIONS OF DEPARTMENT OF PUBLIC WORKS, DEPARTMENT OF HIGHWAYS AND TRANSPORTATION, DIVISION OF ROADS AND BRIDGES AND STATE HIGHWAY ADMINISTRATION IS MET IN ALL RESPECTS.

HIGHWAY SAFETY CORPORATION

QUALITY ASSURANCE MANAGER

NOTARIZED UPON REQUEST:
STATE OF CONNECTICUT COUNTY OF HARTFORD
SWORN AND SUBSCRIBED BEFORE ME THIS 19th DAY OF Nov. 20 18

Margaret J Satalino
Notary Public

MARGARET J. SATALINO
NOTARY PUBLIC
MY COMMISSION EXPIRES OCT. 31, 2021

Birmingham Fastener Manufacturing

P.O. Box 10323
Birmingham, Alabama 35202
(205) 595-3512

Certificate of Compliance

Customer : AMERICAN TIMBER
P.O. # : 21686
BFM # : 1682256
Date Shipped : 2/24/2020

Item	Quantity	Description	Lot #	Heat #	Specification	Finish
1	3,000	5/8"-11 Heavy Hex Nut	407090B	DL14104775	AWWA C111	Plain

Birmingham Fastener Manufacturing. hereby certifies that the material furnished in reference to the above purchase order number will meet or exceed the above assigned specifications.

Signed: _____ **Date:** 06/05/2020
Cody Calvert

NUCOR
FASTENER DIVISION

LOT NO.
407090B

Post Office Box 6100
Saint Joe, Indiana 46785
Telephone 260/337-1600

CUSTOMER NO/NAME
9320 BIRMINGHAM FASTENER MFG
TEST REPORT SERIAL# FB562877
TEST REPORT ISSUE DATE 4/18/18
DATE SHIPPED 6/12/18
NAME OF LAB SAMPLER: PATRICIA SHAFER, LAB TECHNICIAN
NUCOR ORDER # 59465
CUST PART #
CUSTOMER P.O. # 6178316

**********CERTIFIED MATERIAL TEST REPORT**********

NUCOR PART NO	QUANTITY	LOT NO.	DESCRIPTION
941060	65470	407090B	5/8-11 GR A242 HV HX NUT BLACK
MANUFACTURE DATE 4/10/18			HEX NUT BLACK

--CHEMISTRY MATERIAL GRADE -A242NF

MATERIAL NUMBER	HEAT NUMBER	**CHEMISTRY COMPOSITION (WT% HEAT ANALYSIS) BY MATERIAL SUPPLIER								
		C	MN	P	S	SI	CU	NI	CR	NUCOR STEEL - SOUTH CAROL
RM030632	DL14104775	.13	.84	.005	.019	.18	.39	.28	.72	

--MECHANICAL PROPERTIES

SURFACE HARDNESS (R30N)	CORE HARDNESS (RC)	PROOF LOAD 9000 LBS	TENSILE STRENGTH (LBS)	DEG-WEDGE STRESS (PSI)
N/A	N/A	PASS	N/A	N/A
N/A	N/A	PASS	N/A	N/A
N/A	N/A	PASS	N/A	N/A
N/A	N/A	PASS	N/A	N/A
N/A	N/A	PASS	N/A	N/A

AVERAGE VALUES FROM TESTS

PRODUCTION LOT SIZE 66000 PCS

--DIMENSIONS PER ASME B18.2.2-2010

CHARACTERISTIC	#SAMPLES TESTED	MINIMUM	MAXIMUM
Width Across Corners	8	1.177	1.183
Thickness	32	0.597	0.604

ALL TESTS ARE IN ACCORDANCE WITH THE LATEST REVISIONS OF THE METHODS PRESCRIBED IN THE APPLICABLE SAE AND ASTH SPECIFICATIONS. THE SAMPLES TESTED CONFORM TO THE SPECIFICATIONS AS DESCRIBED/LISTED ABOVE AND WERE MANUFACTURED FREE OF MERCURY CONTAMINATION.
THE STEEL WAS MELTED AND MANUFACTURED IN THE U.S.A. AND THE PRODUCT WAS MANUFACTURED AND TESTED IN THE U.S.A.
PRODUCT COMPLIES WITH DFARS 252.225-7014. WE CERTIFY THAT THIS DATA IS A TRUE REPRESENTATION OF INFORMATION PROVIDED BY THE MATERIAL SUPPLIER AND OUR TESTING LABORATORY. THIS CERTIFIED MATERIAL TEST REPORT RELATES ONLY TO THE ITEMS LISTED ON THIS DOCUMENT AND MAY NOT BE REPRODUCED EXCEPT IN FULL.

A2LA ACCREDITED
MECHANICAL FASTENER
CERTIFICATE NO. A2LA 0139.01
EXPIRATION DATE 12/31/19

NUCOR FASTENER
A DIVISION OF NUCOR CORPORATION
BOB HAYWOOD
QUALITY ASSURANCE SUPERVISOR

30632

NUCOR
NUCOR CORPORATION
NUCOR STEEL SOUTH CAROLINA

Mill Certification
2/19/2016

MTR #: C1-364318
300 Steel Mill Road
DARLINGTON, SC 29540
(843) 393-5641
Fax: (843) 395-8701

Sold To: NUCOR FASTENER INDIANA
PO BOX 8100
ST JOE, IN 46785-0000
(800) 955-6826
Fax: (219) 337-1726

Ship To: NUCOR FASTENER
6730 COUNTY ROAD 60
ST JOE IN 46785
(800) 955-6826
Fax: (219) 337-1722

Customer P.O.	158069	Sales Order	239317.1
Product Group	Special Bar Quality	Part Number	31001015000DMZB
Grade	A242NF - ASTM A242-13	Lot #	DL1410477502
Size	1-1/64" (1.0156) Round Coil	Heat #	DL14104775
Product	1-1/64" (1.0156) Round Coil A242NF	B.L. Number	C1-364356
Description	A242NF	Load Number	C1-364318
Customer Spec		Customer Part #	C25010

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.

Roll Date: 2/17/2016 **Melt Date: 7/30/2014** **Qty Shipped LBS: 41,834** **Qty Shipped Pcs: 10**

NO COIL DELIVERIES VIA TRUCK DECEMBER 18TH - JANUARY 4TH
NO COIL DELIVERIES VIA RAIL DECEMBER 28TH - JANUARY 4TH

Melt Date: 7/30/2014

C	Mn	V	Si	S	P	Cu	Cr	Ni	Mo	Cb	CRNCMO
0.13%	0.84%	0.0120%	0.18%	0.019%	0.005%	0.39%	0.72%	0.28%	0.020%	0.002%	1.410%

CRNCMO: Cr + Ni + Cu + Mo

Atmospheric Corr Res Index: 8.6

Roll Date: 2/17/2016

Yield 1: 52,000psi
Elongation: 44% in 2"(% in 50.8mm)
Elongation 25% in 8"(% in 203.3mm)

Tensile 1: 74,000psi
Yield 2: 51,000psi
Elongation: 43% in 2"(% in 50.8mm) - test2

Elongation: 25% in 8"(% in 203.3mm)
Tensile 2: 74,000psi

Specification Comments:

1. WELDING OR WELD REPAIR WAS NOT PERFORMED ON THIS MATERIAL
2. MELTED AND MANUFACTURED IN THE USA
3. MERCURY, RADIUM, OR ALPHA SOURCE MATERIALS IN ANY FORM HAVE NOT BEEN USED IN THE PRODUCTION OF THIS MATERIAL

Chemistry Verification Checks

Part# C2501D RM# 30632

	Checked By	Date
Receiving OK:	JH	2-23-16
Certifications OK:	375	2-23-16

James H. Blew
Division Metallurgist

NBMG-10 January 1, 2012

CERTIFICATE OF COMPLIANCE

ROCKFORD BOLT & STEEL CO.
126 MILL STREET
ROCKFORD, IL 61101
815-968-0514 FAX# 815-968-3111

CUSTOMER NAME: AMERICAN TIMBER & STEEL

CUSTOMER PO: 21451

SHIPPER #: 068659
DATE SHIPPED: 04/17/2020

LOT#: P38707 R71433-01
UNYTITE LOT #: 30455-6214823003

SPECIFICATION: ASTM A563, GRADE DH HEAVY HEXAGONAL NUT

COATING: ASTM SPECIFICATION F-2329 HOT DIP GALVANIZE

UNIVERSAL GALVANIZING: 30455-6214823003

CHEMICAL COMPOSITION

MILL	GRADE	HEAT#	C	Mn	P	S	Si
GERDAU	1045	62148230	.43	.70	.007	.025	.21

HARDNESS:

SPEC:	24-38
ACTUAL:	27.90

QUANTITY AND DESCRIPTION:

1,200 PCS 5/8" HEAVY HEX NUT

WE HEREBY CERTIFY THE ABOVE PARTS HAVE BEEN MANUFACTURED IN THE U.S.A. WITH DOMESTIC STEEL. WE FURTHER CERTIFY THAT THIS DATA IS A TRUE REPRESENTATION OF INFORMATION PROVIDED BY THE MATERIALS SUPPLIER, AND THAT OUR PROCEDURES FOR THE CONTROL OF PRODUCT QUALITY ASSURE THAT ALL ITEMS FURNISHED ON THIS ORDER MEET OR EXCEED ALL APPLICABLE TESTS, PROCESS, AND INSPECTION REQUIREMENTS PER ABOVE SPECIFICATION.

TR No. 612061-08-01

124

2024-02-06

CERTIFIED MATERIAL TEST REPORT

GERDAU

US-ML-ST PAUL
1678 RED ROCK ROAD
SAINT PAUL, MN 55119
USA

CUSTOMER SHIP TO	CUSTOMER BILL TO
UNYTITE INC LASALLE PLANT 325 CIVIC ROAD LA SALLE,IL 61301 USA	UNYTITE INC 1 UNYTITE DR PERU,IL 61354-9710 USA

GRADE	SHAPE / SIZE	DOCUMENT ID:
1045M23F2N	Round Bar / 7/8"	0000028294

LENGTH	WEIGHT	HEAT / BATCH
24'10"	39,912 LB	6214823003

SALES ORDER	CUSTOMER MATERIAL N°	SPECIFICATION / DATE or REVISION
7321959/000010	B1045SC0.8750 A	ASTM A29-16 ASTM A576-17

CUSTOMER PURCHASE ORDER NUMBER	BILL OF LADING	DATE
P008180	1332-0000058102	03/12/2019

CHEMICAL COMPOSITION

C %	Mn %	P %	S %	Si %	Cu %	Ni %	Cr %	Mo %	Sn %	V %	Nb %	Al %
0.43	0.70	0.007	0.025	0.21	0.20	0.08	0.17	0.016	0.024	0.022	0.001	0.005

METALLURGICAL CHARACTERISTICS

FineGr	E381 S	E381 R	E381 C
	1	1	1

HARDENABILITY

DI A255 Inch
1.38

COMMENTS / NOTES

Material 100% melted and rolled in the USA. Manufacturing processes for this steel, which may include scrap melted in an electric arc furnace and hot rolling, have been performed at Gerdau St. Paul Mill, 1678 Red Rock Road, Saint Paul, Minnesota, USA. All product produced from strand cast billets. Silicon killed (deoxidized) steel. No weld repairmen performed. Steel not exposed to mercury or any liquid alloy which is liquid at ambient temperatures during processing or while in Gerdau St. Paul Mills possession. Any modification to this certification as provided by Gerdau-St. Paul Mill without the expressed written consent of Gerdau St. Paul Mill negates the validity of this test report. This report shall not be reproduced except in full, without the expressed written consent of Gerdau St. Paul Mill. Gerdau St. Paul Mill is not responsible for the inability of this material to meet specific applications.
Roll batch 6214823003 roll date 2/8/2019 Fine Grain (FG 5-8)
Quality Program Manual Rev. 8, Implemented date 7/13/2018

DEBRA L. KARIESCH
Notary Public-Minnesota
My Commission Expires Jan 31, 2020

The above figures are certified chemical and physical test records as contained in the permanent records of company. We certify that these data are correct and in compliance with specified requirements. This material, including the billets, was melted and manufactured in the USA. CMTR complies with EN 10204 3.1.

BHASKAR YALAMANCHILI
QUALITY DIRECTOR
Phone: (409) 267-1071 Email: Bhaskar.Yalamanchili@gerdau.com

ALEA BRANDENBURG
QUALITY ASSURANCE MGR.
Phone: (651) 731-5662 Email: Alea.Brandenburg@gerdau.com

Birmingham Fastener Manufacturing

P.O. Box 10323
Birmingham, Alabama 35202
(205) 595-3512

Certificate of Compliance

Customer : AMERICAN TIMBER
P.O. # : 20512
BFM # : 1628407
Date Shipped : 9/30/2019

Item	Quantity	Description	Lot #	Heat #	Specification	Finish
1	869	3/4"-10 x 8 1/2" Carriage Bolt	86911	10592090	AWWAC111	Plain
4	10,545	5/8"-11 x 4" Hex Lag Screw	32361	10575880	AWWAC111	Plain

Birmingham Fastener Manufacturing. hereby certifies that the material furnished in reference to the above purchase order number will meet or exceed the above assigned specifications.

Signed: _____ **Date:** 11/04/2019
Brian Hughes

CHARTER STEEL
A Division of
Charter Manufacturing Company, Inc.

EMAIL

1658 Cold Springs Road
Saukville, Wisconsin 53080
(262) 268-2400
1-800-437-8789
Fax (262) 268-2570

CHARTER STEEL TEST REPORT

Melted in USA Manufactured in USA

Cust P.O.	6198448
Customer Part #	336513
Charter Sales Order	50058866
Heat #	10592090
Ship Lot #	4575439
Grade	A242 M SK FG IQ 11/16 RNDCOIL
Process	HRCC
Finish Size	11/16
Ship date	19-FEB-19

Birmingham Fastener & Supply
931 Avenue W
Birmingham,AL-35234
Kind Attn :Blane Vines

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.

Test results of Heat Lot # 10592090

Lab Code: 7388

CHEM	C	MN	P	S	SI	NI	CR	MO	CU	SN	V
%Wt	.07	.55	.017	.013	.230	.36	.72	.05	.28	.008	.003
	AL	N	B	TI	NB						
	.026	.0070	.0001	.002	.002						

Test results of Rolling Lot # 1263788

	# of Tests	Min Value	Max Value	Mean Value	
TENSILE (KSI)	1	62.9	62.9	62.9	TENSILE LAB = 0358-02
REDUCTION OF AREA (%)	1	78	78	78	RA LAB = 0358-02

REDUCTION RATIO=81:1

Specifications: Manufactured per Charter Steel Quality Manual Rev Date 05/12/17
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 = BF A242 Revision = Dated = 07-JUL-08

Additional Comments:

Melt Source:
Charter Steel
Saukville, WI, USA

Trip: 1341333

ACCREDITED
Testing Laboratory

This MTR supersedes all previously dated MTRs for this order

Janice Barnard Division Mgr. of Quality Assurance
barnardJ@chartersteel.com
Printed Date : 02/19/2019

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 J406; JIS G0561	X			X
Grain Size	ASTM E112	X	X	X	X
Tensile Test	ASTM E8; ASTM A370		X	X	X
Rockwelll 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 01/31/21. 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.

ACCREDITED
Testing Laboratory

Birmingham Fastener Manufacturing

P.O. Box 10323
Birmingham, Alabama 35202
(205) 595-3512

Certificate of Compliance

Customer : AMERICAN TIMBER
P.O. # : 20512
BFM # : 1628407
Date Shipped : 10/28/2019

Item	Quantity	Description	Lot #	Heat #	Specification	Finish
1	9,131	3/4"-10 x 8 1/2" Carriage Bolt	107531	DL18100861	AWWAC111	Plain
2	3,000	3/4" Str Rd Washer	296127	227567	ASTM F436 T3	Plain
2	6,000	3/4" Str Rd Washer	D7926	198520	ASTM F436 T3	Plain
3	7,000	3/4"-10 Heavy Hex Nut	799283	75068613	ASTM A563 DH	Plain
4	4,300	5/8"-11 x 4" Hex Lag Screw	32361	10575880	AWWAC111	HDG

Birmingham Fastener Manufacturing. hereby certifies that the material furnished in reference to the above purchase order number will meet or exceed the above assigned specifications.

Signed: _____ **Date:** 11/04/2019
Brian Hughes

NUCOR

NUCOR CORPORATION
NUCOR STEEL SOUTH CAROLINA

Mill Certification
7/25/2019

MTR #: C1-473652
300 Steel Mill Road
DARLINGTON, SC 29540
(843) 393-5841
Fax: (843) 395-8701

Sold To: BIRMINGHAM FASTENER & SUPPLY
PO BOX 10323
BIRMINGHAM, AL 35202-0323
(205) 595-3511
Fax: (205) 591-0244

Ship To: BIRMINGHAM FASTENER & SUPPLY
931 AVE W
PO BOX 10323
BIRMINGHAM, AL 35202
(205) 595-3511
Fax: (205) 591-0244

Customer P.O.	6207420	Sales Order	310039.5
Product Group	Merchant Bar Quality	Part Number	30000680480DEQ0
Grade	A242BF - ASTM A242-03	Lot #	DL1810086102
Size	.680" Round	Heat #	DL18100861
Product	.680" Round 40' A242BF	B.L. Number	C1-791357
Description	A242BF	Load Number	C1-473652
Customer Spec		Customer Part #	

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.

Roll Date: 3/23/2019 Melt Date: 2/6/2018 Qty Shipped LBS: 14,831 Qty Shipped Pcs: 300

Melt Date: 2/6/2018

C	Mn	V	Si	S	P	Cu	Cr	Ni	Mo	Cb
0.15%	0.86%	0.0120%	0.17%	0.007%	0.006%	0.31%	0.72%	0.25%	0.014%	0.004%

Roll Date: 3/23/2019

Yield 1: 53,000psi
Elongation: 35% in 2"(% in 50.8mm)
Elongation 24% in 8"(% in 203.3mm)
Tensile 1: 79,000psi
Yield 2: 53,000psi
Elongation: 39% in 2"(% in 50.8mm) - test2
Elongation: 22% in 8"(% in 203.3mm)
Tensile 2: 81,000psi

Specification Comments:

1. WELDING OR WELD REPAIR WAS NOT PERFORMED ON THIS MATERIAL
2. MELTED AND MANUFACTURED IN THE USA
3. MERCURY, RADIUM, OR ALPHA SOURCE MATERIALS IN ANY FORM HAVE NOT BEEN USED IN THE PRODUCTION OF THIS MATERIAL

James H. Blew
Division Metallurgist

NBMG-10 October 1, 2017

TR No. 612061-08-01

130

2024-02-06

INSPECTION CERTIFICATE

ROCKFORD BOLT AND STEEL CO.
126 MILL STREET
ROCKFORD, IL 61101
815-968-0514 FAX: 815-968-3111

LOT# 32693

Batch Qty: 15,213
Sample Qty: 6
Date of Manufacture: 02/04/2020

SPECIFICATION: ASTM A325 2014, Specification For Structural Bolts
Head markings: "A325" and "01AE"
ASTM A153, Class C Hot Dip Galvanization

DESCRIPTION: 3/4" -11 x 8.5" Carriage Bolt

QUANTITY: 14,886 PCS

THIS REPORT CONTAINS DATA THAT WAS PRODUCED UNDER THE FOLLOWING SUBCONTRACTORS:
*Raw Material: KREHER STEEL - ISO 9001:2015 #98-1181-03
Not ISO 17025 Accreditated

CUSTOMER NAME: AMERICAN TIMBER & STEEL
4832 PLANK ROAD; P.O. BOX 767; NORWALK, OH 44857

CUSTOMER PO#: 21451

SHIPPER#: 068659
DATE SHIPPED: 04/17/2020

MECHANICAL PROPERTIES

	TENSILE	PROOF LOAD	HARDNESS
SPEC.:	120,000 psi	85,000 psi	34 MAX
ACTUAL:	135,300 psi	85,100 psi	29.60
	129,100 psi	85,100 psi	28.63
	132,800 psi	85,100 psi	29.55
	129,000 psi	85,100 psi	27.60
	124,100 psi	85,100 psi	26.83
	126,300 psi	85,100 psi	27.45

CHEMICAL COMPOSITION MILL CERT*

HEAT # 100101783

GRADE	C	Mn	P	S	Si
1045	X 100	X 100	X 1000	X 1000	x100
SPEC.	.43-.50	.60-.90	.040 max	.050 max	.15-.35
ACTUAL	.50	.76	.011	.018	.18

APPROVED SIGNATORY

4/28/2020
DATE

THESE PARTS CONFORM TO ABOVE SPECIFICATIONS.

Tension Testing:
ASTM F606
Proof Load Testing:
ASTM F606
Hardness Testing:
ASTM F606

WE HEREBY CERTIFY THE ABOVE BOLTS HAVE BEEN MANUFACTURED BY ROCKFORD BOLT & STEEL IN OUR FACILITY IN ROCKFORD, ILLINOIS WITH MATERIAL WHICH WAS MELTED AND MANUFACTURED IN U.S.A. WE FURTHER CERTIFY THAT THIS IS A TRUE REPRESENTATION OF INFORMATION PROVIDED BY THE MATERIALS SUPPLIER AND THAT OUR PROCEDURES FOR THE CONTROL OF PRODUCT QUALITY MEET OR EXCEED ALL APPLICABLE TEST, PROCESSES, AND INSPECTION REQUIREMENTS PER THE ABOVE SPECIFICATION. THIS REPORT MAY NOT BE REPRODUCED EXECEPT IN FULL, WITHOUT THE WRITTEN APPROVAL OF ROCKFORD BOLT. THE REPORT MUST NOT BE USED BY THE CLIENT TO CLAIM PRODUCT CERTIFICATION, APPROVAL, OR ENDORSEMENT BY NVLAP, NIST, OR ANY AGENCY OF THE U.S. GOVERNMENT.
THIS INFORMATION IS NOT COVERED BY ROCKFORD BOLT AND STEEL'S NVLAP ACCREDITATION.

NVLAP® TESTING

NVLAP LAB CODE 200255-0

NUCOR

Mill Certification

12/31/2019

MTR#:322914-1
Lot #:10010178321
2911 E NUCOR ROAD
PO BOX 309
NORFOLK, NE 68701 US
402-644-0200
Fax: 402-644-0329

Sold To: KREHER STEEL CO LLC
1550 N 25TH AVE
MELROSE PARK, IL 60160 US

Ship To: KREHER STEEL CO LLC
1550 N 25TH AVE
MELROSE PARK, IL 60160 US

Customer PO	1-58695	Sales Order #	10023420 - 2.2
Product Group	Hot Roll - Engineered Bar	Product #	1071653
Grade	1045CA4	Lot #	10010178321
Size	0.75"	Heat #	100101783
BOL #	BOL-410411	Load #	322914
Description	Hot Roll - Engineered Bar Round 3/4" 1045CA4 24' 3" [291"] 6001-10000 lbs	Customer Part #	
Production Date	12/17/2019	Qty Shipped LBS	48120
Product Country Of Origin	United States	Qty Shipped EA	1320
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: 12/04/2019

C (%)	Mn (%)	P (%)	S (%)	Si (%)	Ni (%)	Cr (%)	Mo (%)	Cu (%)	V (%)	Nb (%)	Zr (%)
0.50	0.76	0.011	0.018	0.18	0.09	0.14	0.03	0.16	0.003	0.001	0.002
N (PPM)	Sn (%)	Al (%)	Pb (%)	Ca (%)	B (%)	As (%)					
67	0.007	0.03	0.000	0.002	0.0000	0.004					

Ni + Cr + Mo (%) : 0.25

Austenitic fine grain by chemical analysis per the latest revision of ASTM A29
Reduction Ratio 99.34 : 1

ASTM E45 Method A (Worst)
Sulfides:T: 1.5 H: 0.5 Alumina : T: 1.0 H: 0.5 Silicates T: 0.5 H: 0.0 Globular T: 1.0 H: 0.5

Other Test Results
Macroetch E381 Surface : 1 Macroetch E381 Mid Radius : 1 Macroetch E381 Center : 2
DI Calculated (IN) : 1.47

Comments:

ASTM A576-90B
JDM AO QL-2
EN 10204 3.1
EN 10204 3.1
All manufacturing processes of the steel materials in this product, including melting, have been performed in the United States.
Finished product is hot rolled 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.
Test conform to ASTM A29-16, ASTM E415 and ASTM E1019-resulphurized grades or applicable customer requirements.
All material melted at Nucor Steel Nebraska is produced in an Electric Arc Furnace.
Strand Cast
Tests included in ISO 17025 scope: Chemistry, Tensile, Brinell Hardness, Rockwell Hardness, Inclusion, and Grain Size.
Exporting Country-USA
Sales@nucorne.com

NBMG-10 January 1, 2012

Jim Hill, Division Metallurgist

NUCOR

Mill Certification
12/31/2019

MTR#:322914-1
Lot #:10010178321
2911 E NUCOR ROAD
PO BOX 309
NORFOLK, NE 68701 US
402-644-0200
Fax: 402-644-0329

NBMG-10 January 1, 2012

Jim Hill, Division Metallurgist

Birmingham Fastener Manufacturing

P.O. Box 10323
Birmingham, Alabama 35202
(205) 595-3512

Certificate of Compliance

Customer : AMERICAN TIMBER
P.O. # : 20512
BFM # : 1628407
Date Shipped : 10/28/2019

Item	Quantity	Description	Lot #	Heat #	Specification	Finish
1	9,131	3/4"-10 x 8 1/2" Carriage Bolt	107531	DL18100861	AWWAC111	Plain
2	3,000	3/4" Str Rd Washer	296127	227567	ASTM F436 T3	Plain
2	6,000	3/4" Str Rd Washer	D7926	198520	ASTM F436 T3	Plain
3	7,000	3/4"-10 Heavy Hex Nut	799283	75068613	ASTM A563 DH	Plain
4	4,300	5/8"-11 x 4" Hex Lag Screw	32361	10575880	AWWAC111	HDG

Birmingham Fastener Manufacturing. hereby certifies that the material furnished in reference to the above purchase order number will meet or exceed the above assigned specifications.

Signed: _____ **Date:** 11/04/2019
Brian Hughes

STAMPING THE FUTURE

WROUGHT WASHER MFG., INC.

July 18, 2018

Certification of Compliance

008816
BIRMINGHAM FASTENER & SUPPLY
PO BOX 10323
BIRMINGHAM, AL 35202

Wrought Washer Ordr/Lot Number
296127

HT ORDER 271426

Chemical Analysis

Heat Number	C	Mn	P	S	Si	Cr	Cu	Ni
227567	0.360	0.620	0.016	0.002	0.276	0.467	0.266	0.257

Purchase Order Number	Part Description	Date Shipped	Quantity Shipped
6187951	3/4 F436 RD TYPE 3 W HT	07/17/2018	9,000

We hereby certify that the subject parts conform to the requirements of the applicable specification indicated for the subject parts and are in complete conformance to F436-11. We hereby certify that the subject parts were hardened to RC 38-45.

We hereby certify that all statutory requirements as to American Production and Labor Standards and all conditions of purchase applicable to the transaction have been complied with and that the subject parts were melted and manufactured in the U.S.A. No weld repairs were made to the material.

Truly yours,
Wrought Washer Mfg., Inc.

Paul J. Seggelink

Paul Seggelink
Q.A. Manager

Susan M. Daoust

Sworn and subscribed before me on July 18, 2018
My commission expires April 24, 2021

SUSAN M. DAOUST NOTARY PUBLIC STATE OF WISCONSIN

(036) TYPE 3, HT, F436
WW INTERNAL USE : 65866206/001/010928/47103

1901 CHICORY RD. • MOUNT PLEASANT, WI 53403 • PHONE (262) 554-9550 • FAX (262) 554-9584
VISIT OUR WEBSITE: www.wroughtwasher.com

NUCOR
SHEET MILL GROUP

METALLURGICAL TESTING CERTIFICATION

97659 K033542

Certificate Number: 17/332
Date Issued: 02/14/2017
Page: 1 of 1

Nucor Steel-Crawfordsville
4537 South Nucor Road
Crawfordsville, IN 47933-0907

Order Number 225084 - 0001
Order Dimensions: 0.1380 in X 51.3750 in
HOT ROLLED BAND, 1040 WEATHERING, MILL

Certified to ordered chemistry

Customer Name: WROUGHT WASHER MFG. INC.
Customer Address: 2100 SOUTH BAY STREET
MILWAUKEE WI 53207

Cust PO Number: H2364

Coil Number
1668849.000

Part Number
724148

CHEMICAL ANALYSIS

Heat	Slab	C	Mn	P	S	Si	Cu	Sn	Ni	Cr	Mo	Al	N	V	Nb	Ti	B	Sb
227567	02	0.35	0.620	0.016	0.002	0.276	0.266	0.008	0.257	0.457	0.021	0.036	0.008	0.004	0.002	0.005	<0.0005	0.003

WE HEREBY CERTIFY THE ABOVE IS CORRECT AS CONTAINED IN THE RECORDS OF THE CORPORATION
MELTED AND ROLLED IN THE USA

QF-0261 09/19/2007

NUCOR QUALITY ASSURANCE

HEAT TREAT PROCESSING CHART

Wrought Washer Mfg., Inc.

CUSTOMER 3/4 TYPE 3 | TAG # 989718 | WT. 1865 | PG. ___ Of ___

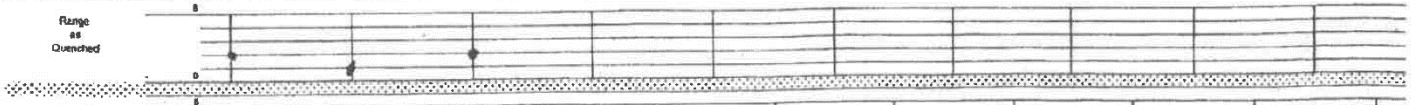
I.C. # 060924 | LOT # 47103 | FURNACE # 2007 | Set-up Checklist

ORDER # 271426. | O.D. 1.469 | I.D. .813 | THK .148 | RC SPECS 38-45 | Verification

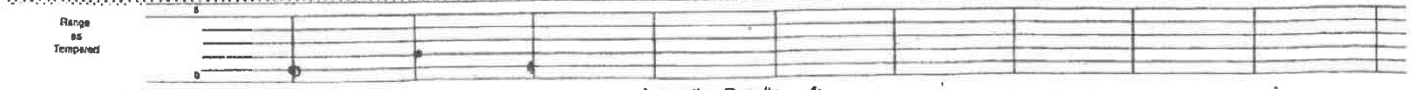
DATE	3-18																				
TIME		2:00		3:00		4:00		4:30													
OPERATOR #	455																				
CARBON	36																				
Mn	62																				
GAS FLOW RATE	125																				
NITROGEN FLOW	1275																				
DRAW TEMP	815																				
QUENCH %	62																				
RETORT SPEED																					
BEND TEST																					
DYE PEN. TEST																					
RC TEST BLOCK	40																				

		Quench	Temp	Quench	Temp	Quench	Temp	Quench	Temp	Quench	Temp	Quench	Temp	Quench	Temp	Quench	Temp	Quench	Temp	Quench	Temp
Sample Measurements	1	53	44	55	41	55	42														
	2	55	43	55	43	53	42														
	3	55	43	56	41	55	41														
	4	55	43	55	42	55	41														
	5	54	44	56	42	54	42														
Sum		272	217	277	209	272	208														
Average X		54	43	55	42	54	42														
Range R		2	1	1	2	2	1														
Notes																					
Core Hardness																					

Range as Quenched



Range as Tempered



Surface RC: 41-42 | Core RC: 40-42 | Inspection Results | Inspected By: [signature] | Date: 3-18-13

Prestige Stamping, LLC

23513 Groesbeck Highway
Warren, Michigan 48089
(586)773-2700 * Fax (586)773-2298
www.PrestigeStamping.com

PRODUCT CERTIFICATION

CERTIFICATION NUMBER

201114

THIS IS TO CERTIFY THE PRODUCT STATED BELOW WAS FABRICATED AND PROCESSED TO THE ORDER AS INDICATED AND CONFORMS TO THE APPLICABLE SPECIFICATIONS AND STANDARDS.

Customer: BIRMINGHAM FASTENER & SUPPLY
HANCEVILLE DIST CENTER
1100 MAIN ST
HANCEVILLE, AL 35077

Customer Part: 3/4" TYPE3 F436
Prestige Part: P1480CH00
Part Name: 3/4"F436 TYPE 3
Purchase Order: 6213872
Shipment BOL: B219698
Shipment ID: A0238117
Quantity: 14400
Manufacturers Marking: "P"

Steel Supplier: STEEL TECHNOLOGIES LLC
Grade: SAE CF436 TYPE3 STEEL
Lot: D7926
Heat: 198520
Carbon: .39
Manganese: .79
Phosphorous: .02
Sulfur: .003
Silicon: .24

SPECIFICATIONS	TEST RESULTS
HARDNESS: TEST METHOD: ASTM E18	HARDNESS:
HRC 38 - 45	HRC 41 - 43
CHECK TO ASTM F606	

USS/SAE LC Washers are manufactured to the requirements of ASTM F844 specifications
Chemistry is as reported from raw material certification and does not fall under Prestige Stamping's accreditation.
This product was produced under an IATF 16949 Quality Assurance System.
IATF 16949 Certification No: 800334.
Material was melted and manufactured in the U.S.A.
This product was manufactured in Warren, Michigan U.S.A.
This product conforms to all requirements for washers as produced according to A.S.T.M. F-436-13.
Sampling Plan per P.S.I W.I. # 5.4.18.015.
The test results only apply to the items tested.
This test report must not be reproduced except in full without prior written approval.
Materials used to manufacture these products are mercury, asbestos and radio activity free.
Product is RoHS compliant.
No weld repairs made to material.
All certified product is AIS compliant.

FRANK SCHUBERT
Quality Assurance Manager

Econ Information System 07/12/19 15:50 DTRO PAGE 1 of 1

D7926

Wrought Washer Mfg., Inc.

2100 S. Bay St., Milwaukee, Wisconsin 53207
Phone: (414) 744-0771 Fax: (414) 744-4811

Processed for:

Prestige Stamping
23513 Groesbeck Hwy
Warren, MI 48089

The following coil was processed at Wrought Washer located in the USA on May 24, 2019 and shipped to Prestige Stamping on June 10, 2019.

Coil #:	14752
Mill Coil #:	2396526
Heat #:	198520
Gauge:	.136
Mill coil weight:	42,500#
Chemistry:	

C	Mn	P	S	Al	Si	Cu	Ni
.39000	.79000	.02000	.00300	.03000	.24000	.26300	.28600

Cr	Mo	V	Nb/Cb	Ti	N	Ca	B	Sn
.47500	.01800	.00500	.00100	.00200	.00700	.00100	.00000	.01100

Paul J. Seagelink

Signature
Quality Manager

TR No. 612061-08-01

139

2024-02-06

NUCOR

Nucor Steel Indiana
4537 South Nucor Road
Crawfordsville, IN 47933-0907

METALLURGICAL TESTING CERTIFICATION

0078096

Certificate Number: 825756
Date Issued: 05/17/2019

Order Number: 314919 - 0001 HOT ROLLED PICKLED & ANNEALED
Order Dimensions: 0.1360 in X 51.0000 in
HRPA,CUT,1040 WEATHERING

Customer Name: WROUGHT WASHER MFG INC
Customer Address: 2100 S BAY ST
MILWAUKEE WI 53207
Release Order:
Cust PO Number: H3539

Coil Number
2396525.000

	HEAD
L-Yield (ksi):	52.0
L-Tensile (ksi):	79.8
L-Elong (%):	30.0

	HEAD
Rockwell B:	83

Part Number
724148-240 TONS
Weight: 42,720 LBS

CHEMICAL ANALYSIS

Heat	Slab	C	Mn	P	S	Si	Cu	Sn	Ni	Cr	Mo	Al	N	V	Nb	Ti	B	Sb
198520	04	0.39	0.790	0.020	0.003	0.240	0.263	0.011	0.286	0.475	0.018	0.030	0.007	0.005	0.001	0.002	<0.0005	0.001

Coil Number
2396526.000

	HEAD
L-Yield (ksi):	60.8
L-Tensile (ksi):	87.2
L-Elong (%):	24.0

	HEAD
Rockwell B:	89

Part Number
724148-240 TONS
Weight: 42,500 LBS

CHEMICAL ANALYSIS

Heat	Slab	C	Mn	P	S	Si	Cu	Sn	Ni	Cr	Mo	Al	N	V	Nb	Ti	B	Sb
198520	05	0.39	0.790	0.020	0.003	0.240	0.263	0.011	0.286	0.475	0.018	0.030	0.007	0.005	0.001	0.002	<0.0005	0.001

WE HEREBY CERTIFY THE ABOVE IS CORRECT AS CONTAINED IN THE RECORDS OF THE CORPORATION
MELTED AND ROLLED IN THE USA

NUCOR QUALITY ASSURANCE

QF-0261 04/01/2019

1-800-777-0950 MTR_IND_INQUIRIES@NUCOR.COM

CERTIFICATE OF COMPLIANCE

ROCKFORD BOLT & STEEL CO.
126 MILL STREET
ROCKFORD, IL 61101
815-968-0514 FAX# 815-968-3111

CUSTOMER NAME: AMERICAN TIMBER & STEEL

CUSTOMER PO: 21451

SHIPPER #: 068659
DATE SHIPPED: 04/17/2020

LOT#: P38393 R69206

PRESTIGE STAMPING: D5831, D5811

SPECIFICATION: ASTM SPECIFICATION F436-10 FOR HARDENED WASHERS

COATING: ASTM B695, CLASS 55, TYPE I MECHANICAL GALVANIZATION

MECHANICAL GALV-PLATING: 518053, 518051

CHEMICAL COMPOSITION

STEEL SUPPLIER	HEAT#	C	Mn	P	S
ARCELORMITTAL	9515612	0.29	1.19	0.025	0.002
ARCELORMITTAL	9514538	0.31	1.21	0.011	0.003

HARDNESS:

SPEC: RC38-45
ACTUAL: 41 - 42
ACTUAL: 41 - 42

QUANTITY AND DESCRIPTION:

8,800 PCS 3/4" STRUCTURAL WASHER

WE HEREBY CERTIFY THE ABOVE PARTS HAVE BEEN MANUFACTURED IN THE U.S.A. WITH DOMESTIC STEEL. WE FURTHER CERTIFY THAT THIS DATA IS A TRUE REPRESENTATION OF INFORMATION PROVIDED BY THE MATERIALS SUPPLIER, AND THAT OUR PROCEDURES FOR THE CONTROL OF PRODUCT QUALITY ASSURE THAT ALL ITEMS FURNISHED ON THIS ORDER MEET OR EXCEED ALL APPLICABLE TESTS, PROCESS, AND INSPECTION REQUIREMENTS PER ABOVE SPECIFICATION.

Prestige Stamping, Inc.
23513 Groesbeck Highway
Warren, Michigan 48089
(586)773-2700 * Fax (586)773-2298
www.PrestigeStamping.com

PRODUCT CERTIFICATION

CERTIFICATION NUMBER

184881

THIS IS TO CERTIFY THE PRODUCT STATED BELOW WAS FABRICATED AND PROCESSED TO THE ORDER AS INDICATED AND CONFORMS TO THE APPLICABLE SPECIFICATIONS AND STANDARDS.

Customer: ROCKFORD BOLT AND STEEL CO
126 MILL ST
ROCKFORD, IL 61101

Customer Part: 095763-MG
Prestige Part: P1480HP200
Part Name: 3/4"F436 M/G
Purchase Order: P38393
Shipment BOL: B210774
Shipment ID: A0227178
Quantity: 4000
Manufacturers Marking: "P"

Steel Supplier: HORIZON STEEL CO.
Grade: CF436 GRADE STEEL
Lot: D5831
Heat: 9515612
Carbon: .29 (.22 - .57)
Manganese: 1.19 (.6 - 1.6)
Phosphorous: .025 (.04 Max.)
Sulfur: .002 (.05 Max.)
Silicon: .23 (.15 Min.)

SPECIFICATIONS	TEST RESULTS
HARDNESS: TEST METHOD: ASTM E18 HRC 38 - 45 CHECK TO ASTM F606	HARDNESS: HRC 41 - 42
PLATING: TEST METHOD: ASTM B499 0.0022" Min. MECH GALV TO ASTM B695 CLASS 55 TYPE 1	PLATING: 0.0022" - 0.0030"

USS/SAE LC Washers are manufactured to the requirements of ASTM F844 specifications
Chemistry is as reported from raw material certification and does not fall under Prestige Stamping's accreditation.
This product was produced under an ISO/TS 16949 Quality Assurance System.
ISO/TS 16949 Certification No: 0002883.
Material was melted and manufactured in the U.S.A.
This product was manufactured in Warren, Michigan U.S.A.
This product conforms to all requirements for washers as produced according to A.S.T.M. F-436-13.
Sampling Plan per P.S.I W.I. # 5.4.16.015.
The test results only apply to the items tested.
This test report must not be reproduced except in full without prior written approval.
Materials used to manufacture these products are mercury, asbestos and radio activity free.
Product is RoHS compliant.
No weld repairs made to material.
All certified product is ASN compliant.

FRANK SCHUBERT
Quality Assurance Manager

Econ Information System 07/02/18 14:15 HSIE PAGE 1 of 1

R69206

Horizon Steel Co.
50390 UTICA DRIVE
SHELBY TOWNSHIP, MI 48315
Phone: (586) 532-2135 Fax: (586) 566-3116

BILL TO:
PRESTIGE STAMPING
23513 GROESBECK HWY.
WARREN, MI 48090

SHIP TO:
PREST PRESTIGE STAMPING, INC
23513 GROESBECK HIGHWAY
WARREN, MI 48090

BOL# 613604
Ship Date: 4/20/2018

Order Information

SO #: 906562 - 1
PART #: ZZ5500122
YOUR PART #: PART P1480H00
PART DESC : HRPO F436 GRADE *MELTED & MFG IN USA*

PO#:30803-02
END USE PO#:
REV #:

CPO#:
Use End User PO#:

Chemistry

Heat Number 9515612

C: 0.2900	Mn: 1.1900	P: 0.0250	S: 0.0020	Si: 0.2300	Cu: 0.0200	Al: 0.0480	V: 0.0040	Ni: 0.0100	Nb/CB: 0.0010
Cr: 0.0300	Ti: 0.0020	N: 0.0038	Mo: 0.0100	Ca: 0.0015	B: .0000*	Sn: 0.0120			

Tag No	Product	Gage	Width	Length	Weight	Rb	Tensile psi	Tensile Mpa	Yield psi	Yield Mpa	Elong	R-VAL	N VAL	Test Method	Pull Code
4374254	HP HSLA	.122 MIN	5.5000		5,224	92								N/A	
4374255	HP HSLA	.122 MIN	5.5000		5,256	92								N/A	
4374256	HP HSLA	.122 MIN	5.5000		5,266	92								N/A	
4374257	HP HSLA	.122 MIN	5.5000		5,266	92								N/A	
4374259	HP HSLA	.122 MIN	5.5000		5,240	92								N/A	
4374260	HP HSLA	.122 MIN	5.5000		5,266	92								N/A	
4374261	HP HSLA	.122 MIN	5.5000		5,282	92								N/A	
4374262	HP HSLA	.122 MIN	5.5000		5,294	92								N/A	
4374263	HP HSLA	.122 MIN	5.5000		5,262	92								N/A	
4374264	HP HSLA	.122 MIN	5.5000		5,186	92								N/A	
4374265	HP HSLA	.122 MIN	5.5000		5,210	92								N/A	
4374266	HP HSLA	.122 MIN	5.5000		5,234	92								N/A	
4374267	HP HSLA	.122 MIN	5.5000		5,220	92								N/A	
4374268	HP HSLA	.122 MIN	5.5000		5,290	92								N/A	

Horizon Steel Co.
50390 UTICA DRIVE
SHELBY TOWNSHIP, MI 48315
Phone: (586) 532-2135 Fax: (586) 566-3116

BILL TO:
PRESTIGE STAMPING
23513 GROESBECK HWY.
WARREN, MI 48090

SHIP TO:
PREST PRESTIGE STAMPING, INC
23513 GROESBECK HIGHWAY
WARREN, MI 48090

BOL# 613604
Ship Date: 4/20/2018

4374269	HP HSLA	.122 MIN	5.5000	5,380	92	N/A
4374270	HP HSLA	.122 MIN	5.5000	5,414	92	N/A
4374271	HP HSLA	.122 MIN	5.5000	5,410	92	N/A
4374272	HP HSLA	.122 MIN	5.5000	5,402	92	N/A

I certify that the test results shown are correct as contained in the records of Horizon Steel Co. and in compliance with the requirements of the order.

Mary Claire Collins

Mary Claire Collins
Quality Assurance

ArcelorMittal
Cleveland
Flat Carbon
Cleveland, OH 44116

ArcelorMittal

Horizon Steel Company
50390 Utica Dr.
Shelby Township, MI. 48315

Dear Jim,

December 5, 2017

I have reviewed our records and have confirmed that the following coils were manufactured from heats that were "melted/smelted" at the Cleveland Facility.

The heat numbers and the relating coils are stated below:

seq	Heat Nbr	Tag Nbr
1	9416483	879159
2	9515612	878653
		878652
		878651
		878650
		878657
		878656
		878655
		878654
3	4188281	877647
		877648
		877646
		878480
4	9414945	882697
5	9415687	882699
6	9416154	883574
		883528
7	9416986	875805
		875804
8	9416987	875699
9	9515105	883062
10	9515390	883957
11	9515605	875809
		875807
		875808
12	9515614	877060
13	9515615	877150

1.)

Chemical:	Lot#	PROPERTIES						
		C	Mn	P	S	Si	Cu	Ni
	9416483	0.3100	1.1900	0.0120	0.0020	0.2300	0.0300	0.0100
		Cr	Mo	Sn	Al	V	Cb	N
		0.0300	0.0100	0.0180	0.0440	0.0020	0.0000	0.0043
		B	Zr	Ti	Sb	Ca	O	
		0.0000		0.0020	0.0010	0.0014		

2.)

Chemical:	Lot#	PROPERTIES						
		C	Mn	P	S	Si	Cu	Ni
	9515612	0.2900	1.1900	0.0250	0.0020	0.2300	0.0200	0.0100
		Cr	Mo	Sn	Al	V	Cb	N
		0.0300	0.0100	0.0120	0.0480	0.0040	0.0010	0.0048
		B	Zr	Ti	Sb	Ca	O	
		0.0000		0.0020	0.0010	0.0015		

3.)

Chemical:	Lot#	PROPERTIES						
		C	Mn	P	S	Si	Cu	Ni
	4188281	0.3100	1.1100	0.0130	0.0010	0.2400	0.0200	0.0160
		Cr	Mo	Sn	Al	V	Cb	N
		0.0400	0.0100	0.0020	0.0380	0.0020	0.0000	0.0060
		B	Zr	Ti	Sb	Ca	O	
		0.0001		0.0020	0.0010	0.0023		

Prestige Stamping, Inc.
23513 Crossbeck Highway
Warren, Michigan 48089
(586)773-2700 * Fax (586)773-2296
www.PrestigeStamping.com

PRODUCT CERTIFICATION

CERTIFICATION NUMBER

184880

THIS IS TO CERTIFY THE PRODUCT STATED BELOW WAS FABRICATED AND PROCESSED TO THE ORDER AS INDICATED AND CONFORMS TO THE APPLICABLE SPECIFICATIONS AND STANDARDS.

Customer: ROCKFORD BOLT AND STEEL CO
126 MILL ST
ROCKFORD, IL 61101

Customer Part:	095763-MG
Prestige Part:	P1480HP200
Part Name:	3/4"F436 M/G
Purchase Order:	P38393
Shipment BOL:	B210774
Shipment ID:	A0227178
Quantity:	16000
Manufacturers Marking:	"P"

Steel Supplier:	HORIZON STEEL CO.
Grade:	CF436 GRADE STEEL
Lot:	D5811
Heat:	9514538
Carbon:	.31 (.22 - .57)
Manganese:	1.21 (.6 - 1.6)
Phosphorous:	.011 (.04 Max.)
Sulfur:	.003 (.05 Max.)
Silicon:	.24 (.15 Min.)

SPECIFICATIONS	TEST RESULTS
HARDNESS: TEST METHOD: ASTM E18 HRC 38 - 45 CHECK TO ASTM F606	HARDNESS: HRC 41 - 42
PLATING: TEST METHOD: ASTM B499 0.0022" Min. MECH GALV TO ASIM B695 CLASS 55 TYPE 1	PLATING: 0.0022" - 0.0030"

USS/SAE LC Washers are manufactured to the requirements of ASTM F844 specifications
Chimistry is as reported from raw material certification and does not fall under Prestige Stamping's accreditation.
This product was produced under an ISO/TS 16949 Quality Assurance System.
ISO/TS 16949 Certification No: 0052283.
Material was mined and manufactured in the U.S.A.
This product was manufactured in Warren, Michigan U.S.A.
This product conforms to all requirements for washers as produced according to A.S.T.M. F-436-13.
Sampling Plan per P.S.I W.I. # 8.4.18.015.
The test results only apply to the items tested.
This test report must not be reproduced except in full without prior written approval.
Materials used to manufacture these products are mercury, asbestos and radio activity free.
Product is RoHS compliant.
No weld repairs made to material.
All certified product is ASB compliant.

FRANK SCHUBERT
Quality Assurance Manager

Econ Information System 07/02/18 14:15 HSIE PAGE 1 of 1

Horizon Steel Co.
50300 UTICA DRIVE
SHELBY TOWNSHIP, MI 48315
Phone: (586) 532-2135 Fax: (586) 598-3116

BILL TO:
PRESTIGE STAMPING
23513 GROESBECK HWY.
WARREN, MI 48090

SHIP TO:
PREST PRESTIGE STAMPING, INC
23513 GROESBECK HIGHWAY
WARREN, MI 48090

BOL# 613454
Ship Date: 4/16/2018

Order Information

SO #: 904873 - 1 | PO#:30179-05 | CPO#:
PART #: ZZ5500122 | END USE PO#: | Use End User PO#:
YOUR PART #: PART P1480H00 | REV #:
PART DESC : HRPO F436 GRADE "MELTED & MFG IN USA"

Chemistry Heat Number 9514536

C: 0.3100	Mn: 1.2100	P: 0.0110	S: 0.0030	Si: 0.2400	Cu: 0.0400	Al: 0.0420	V: 0.0020	Ni: 0.0300	Nb/CB: 0.0000*
Cr: 0.0600	Ti: 0.0030	N: 0.0052	Mo:0.0100	Ca:0.0915	B: 0.0003	Sn: 0.0060			

Tag No	Product	Gage	Width	Length	Weight	Rb	Tensile psi	Tensile Mpa	Yield psi	Yield Mpa	Elong	R VAL	N VAL	Test Method	Pull Code
4373537	HP HSLA	.122 MIN	5.5000		5,312	93								N/A	
4373538	HP HSLA	.122 MIN	5.5000		5,362	93								N/A	
4373539	HP HSLA	.122 MIN	5.5000		5,348	93								N/A	
4373540	HP HSLA	.122 MIN	5.5000		5,338	93								N/A	
4373549	HP HSLA	.122 MIN	5.5000		5,278	93								N/A	
4373555	HP HSLA	.122 MIN	5.5000		5,332	93								N/A	
4373556	HP HSLA	.122 MIN	5.5000		5,330	93								N/A	
4373561	HP HSLA	.122 MIN	5.5000		5,282	93								N/A	
4373564	HP HSLA	.122 MIN	5.5000		5,282	93								N/A	

I certify that the test results shown are correct as contained in the records of Horizon Steel Co. and in compliance with the requirements of the order.

Mary Claire Collins
Quality Assurance

yadakim-494.19A

Printed By: Joyce Miller 4/16/2018 10:20:41

ArcelorMittal
Cleveland
Flat Carbon
Cleveland, OH 44105

ArcelorMittal

Horizon Steel Company
30390 Ulica Dr.
Shelby Township, MI 48315

Dear Jim,

June 26, 2017

I have reviewed our records and have confirmed that the following coil was manufactured from a heat that was "melted/smelted" at the Cleveland Facility.

The heat number and the relating coils are stated below:

- Heat number: 9614659 Coil numbers: 616143, 616157

PROPERTIES							
Chemical:	Heat	C	Mn	P	S	Si	Cu	Ni
	9614659	0.0100	1.2100	0.0110	0.0030	0.2400	0.0400	0.0300
		Cr	Mo	Sn	Al	V	Cb	N
		0.0600	0.0100	0.0060	0.0420	0.0020	0.0010	0.0052
		B	Zr	Ti	Sb	Ca	O	
		0.0002		0.0030	0.0010	0.0015		

Sincerely,

Shawna Kovacsy

Account Manager – Special Products
ArcelorMittal Cleveland
T +1 216 429 6063 | F +1 440 946 6546

CERTIFICATE OF COMPLIANCE

ROCKFORD BOLT & STEEL CO.
126 MILL STREET
ROCKFORD, IL 61101
815-968-0514 FAX# 815-968-3111

CUSTOMER NAME: AMERICAN TIMBER & STEEL

CUSTOMER PO: 21451

SHIPPER #: 068659
DATE SHIPPED: 04/17/2020

LOT#: P39299 R73245

PRESTIGE STAMPING: D7506

SPECIFICATION: ASTM SPECIFICATION F436-10 FOR HARDENED WASHERS

COATING: ASTM B695, CLASS 55, TYPE I MECHANICAL GALVANIZATION

MECHANICAL GALV-PLATING: 120029-35

CHEMICAL COMPOSITION

STEEL SUPPLIER	HEAT#	C	Mn	P	S
STEEL DYNAMICS	21933130	0.52	0.7	0.011	0.001

HARDNESS:

SPEC: HRC 38-45

ACTUAL: 41 - 43

QUANTITY AND DESCRIPTION:

6,200 PCS 3/4" STRUCTURAL WASHER

WE HEREBY CERTIFY THE ABOVE PARTS HAVE BEEN MANUFACTURED IN THE U.S.A. WITH DOMESTIC STEEL. WE FURTHER CERTIFY THAT THIS DATA IS A TRUE REPRESENTATION OF INFORMATION PROVIDED BY THE MATERIALS SUPPLIER, AND THAT OUR PROCEDURES FOR THE CONTROL OF PRODUCT QUALITY ASSURE THAT ALL ITEMS FURNISHED ON THIS ORDER MEET OR EXCEED ALL APPLICABLE TESTS, PROCESS, AND INSPECTION REQUIREMENTS PER ABOVE SPECIFICATION.

Prestige Stamping, LLC

23513 Groesbeck Highway
Warren, Michigan 48089
(586) 773-2700 * Fax (586) 773-2298
www.PrestigeStamping.com

PRODUCT CERTIFICATION

CERTIFICATION NUMBER

211453

THIS IS TO CERTIFY THE PRODUCT STATED BELOW WAS FABRICATED AND PROCESSED TO THE ORDER AS INDICATED AND CONFORMS TO THE APPLICABLE SPECIFICATIONS AND STANDARDS.

Customer: ROCKFORD BOLT AND STEEL CO
126 MILL ST
ROCKFORD, IL 61101

Customer Part:	095763-MG	**Steel Supplier:**	MARATHON METALS, LLC
Prestige Part:	P1480HP200	**Grade:**	CF436 GRADE STEEL
Part Name:	3/4"F436 M/G	**Lot:**	D8936
Purchase Order:	P39299	**Heat:**	21933130
Shipment BOL:	B224643	**Carbon:**	.52
Shipment ID:	A0244690	**Manganese:**	.70
Quantity:	20000	**Phosphorous:**	.011
Manufacturers Marking:	"P"	**Sulfur:**	.001
		Silicon:	.23

SPECIFICATIONS	TEST RESULTS
HARDNESS: TEST METHOD: ASTM E18 HRC 38 - 45 CHECK TO ASTM F606	HARDNESS: HRC 41 - 43
PLATING: TEST METHOD: ASTM B499 0.0022" Min. MECH GALV TO ASTM B695 CLASS 55 TYPE 1	PLATING: 0.0022" - 0.0030"

USS/SAE LC Washers are manufactured to the requirements of ASTM F844 specifications
Chemistry is as reported from raw material certification and does not fall under Prestige Stamping's accreditation.
This product was produced under an IATF 16949 Quality Assurance System.
IATF 16949 Certification No: 800334.
Material was melted and manufactured in the U.S.A.
This product was manufactured in Warren, Michigan U.S.A.
This product conforms to all requirements for washers as produced according to A.S.T.M. F-436-13.
Sampling Plan per P.S.I W.I. # 8.4.18.015.
The test results only apply to the items tested.
This test report must not be reproduced except in full without prior written approval.
Materials used to manufacture these products are mercury, asbestos and radio activity free.
Product is RoHS compliant.
No weld repairs made to material.
All certified product is ASB compliant.

FRANK SCHUBERT
Quality Assurance Manager

R73245

Econ Information System 02/28/20 14:17 CTHO PAGE 1 of 1

50

DR936

17Dec19 11:21 **TEST CERTIFICATE** No: MNP 8400

Sold By:
MARATHON METALS/MNP CORP
6440 MACK
DETROIT, MI 48207
Tel: 313-571-9544 Fax: 313-971-6449

P/O No 33352-01
Rel
S/O No MNP 61139-001
B/L No MNP 73301-001 Shp 17Dec19
Inv No Inv

Sold To: (913)
PRESTIGE STAMPING INC.
23813 GROESBECK HIGHWAY
WARREN MI 48090

Ship To: (001)
PRESTIGE STAMPING INC.
23513 GROESBECK HIGHWAY
P.O. BOX 1086
WARREN MI 48090

Tel: 586 773-2700 Fax: 586 773-2298

CERTIFICATE of ANALYSIS and TESTS Cert. No: MNP 8400
17Dec19

Part No P1480H00
P&O 1035 CARBON P436 Pce 16 Wgt 38,465
.122/.128 X 5.5000"

MILL CERTS
MELTED & MFG IN USA
ROCKWELL B90

Heat Number	Tag No	Pcs	Wgt
21933130	S20639	2	4,770
21933130	S20640	2	4,830
21933130	S20641	2	4,835
21933130	S20642	2	4,810
21933130	S20644	2	4,800
21933130	S20645	2	4,820
21933130	S20646	2	4,820
21933130	S20647	2	4,780

Cu

Heat Number	*** Chemical Analysis ***
21933130	C=0.6200 Mn=0.7000 P=0.0110 S=0.0010 Al=0.0270 Si=0.2300 Nb=0.0010 N=0.0080 V=0.0040 Ti=0.0020 Cu=0.1000 Cr=0.0700 Sn=0.0050 Ni=0.0400 Mo=0.0200 Ca=0.0020

Page: 1 .... Last

Steel Dynamics, Inc.
Flat Roll Group

4500 County Road 59
Butler, IN 46721 USA
Telephone (260) 868-8000
Fax (260) 868-8955

Metallurgical Certification

Cert

Ship To	Contact United States
Sold To	MNP c/o Marathon Metals 6440 Mack Detroit, MI 48207 United States Contact

Length	2,134 ft. / 650 m	Width	49.7500 in. / 1,264 mm	Chem Treat	No
Weight	45,230 lbs / 20,515.97 kg	Gauge	0.1220 in. / 3.10 mm | Min	Oiled	No

Coil #		Coil Alias	
Order #		Heat #	21933130
Line Item #	5	PO #	MNP
Part #	Washers		
Material Spec.	SAE 1050		
Product Desc.	Prime Processed Hot Rolled Band		
Cert Comment	Customer specified chemistry - SDI is not responsible for properties		
Surface Treatment			

Ladle Chemical Analysis (%)

C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Nb	Ti	B	Ca	Pb	Zr
0.52	0.70	0.011	0.001	0.23	0.027	0.10	0.04	0.07	0.02	0.005	0.008	0.004	0.001	0.002	0.0000	0.002	0.000	0.0004

Mechanical Properties (if applicable)

Tests on Sample	English	Metric

Hiroshi Kimura
Metallurgist

Shipped from Butler, IN, United States.

Melted, thin slab cast and rolled by proud Americans in Butler, IN, USA.

SDI does not weld or repair Prime Processed Hot Rolled Band products.

All tests were performed according to applicable standards and are correct as contained in the records of the company.

Birmingham Fastener Manufacturing

P.O. Box 10323
Birmingham, Alabama 35202
(205) 595-3512

Certificate of Compliance

Customer : AMERICAN TIMBER
P.O. # : 20512
BFM # : 1628407
Date Shipped : 10/28/2019

Item	Quantity	Description	Lot #	Heat #	Specification	Finish
1	9,131	3/4"-10 x 8 1/2" Carriage Bolt	107531	DL18100861	AWWAC111	Plain
2	3,000	3/4" Str Rd Washer	296127	227567	ASTM F436 T3	Plain
2	6,000	3/4" Str Rd Washer	D7926	198520	ASTM F436 T3	Plain
3	7,000	3/4"-10 Heavy Hex Nut	799283	75068613	ASTM A563 DH	Plain
4	4,300	5/8"-11 x 4" Hex Lag Screw	32361	10575880	AWWAC111	HDG

Birmingham Fastener Manufacturing. hereby certifies that the material furnished in reference to the above purchase order number will meet or exceed the above assigned specifications.

Signed: _____ **Date:** 11/04/2019
Brian Hughes

FONTANA FASTENERS
PLANT — FRANKFORT

TEST REPORT

Operations Center
3281 West County Road 0 NS
Frankfort, IN 46041-6966
T. 765.654.0477
F. 765.654.0857

Ship Date	10-22-19
Certification	LD13838*1*P20012048
Report Date	10-22-19

Cust PO	6225994
Lot Nbr	799283
Quantity	18000
Mfg Date	02-26-18

BIRMINGHAM FASTENER & SUPPLY
1100 MAIN STREET SE
HANCEVILLE, AL 35077

PART INFORMATION

Part Number	75CNDHF/D
Description	A563 DH3 HV 3/4-10 ASME B18.2.2 HEAVY HEX NUT MADE IN USA

Finish	PLAIN
Head Marking	LE DH3 USA

RAW MATERIAL ANALYSIS

Steel Heat Nbr	Steel Supplier	Steel Grade	Code	Element	Rqd Min Pct	Rqd Max Pct	Percent
GER75068613-26	GERDAU MACSTEEL INC	4140 MOD	C	Carbon	0.40	0.45	0.42
			Mn	Manganese	0.90	1.00	0.95
			P	Phosphorus	0.000	0.040	0.011
			S	Sulfur	0.000	0.050	0.006
			Si	Silicon	0.150	0.250	0.190
			Ni	Nickel	0.20	0.30	0.24
			Cr	Chromium	0.45	0.65	0.53
			Mo	Molybdenum	0.15	0.25	0.20
			Cu	Copper	0.20	0.30	0.23
			Al	Aluminum	0.015	0.035	0.020
			V	Vanadium	0.000	0.010	0.002

Certification test results include those reported by the following laboratories:
Fontana Fasteners, Inc., ISO17025-A2LA Cert#0122.02, 05-31-20

MECHANICAL PROPERTIES

Wedge Angle	
Proof Load	58450/175000 (lbs/Psi)

Test Performed	Required	High	Low	Average	Samples
NUT PROOF, PSI	175000 / 175000	175000	175000	175000	10
Core Hardness, HRC	32 / 38	34	26	30	13

FONTANA FASTENERS
PLANT FRANKFORT LE

TEST REPORT

Operations Center
3281 West County Road 0 NS
Frankfort, IN 46041-6966
T. 765.654.0477
F. 765.654.0857

Ship Date	10-22-19
Certification	LD13838*1*P20012048
Report Date	10-22-19

Cust PO	6225994
Lot Nbr	799283
Quantity	18000
Mfg Date	02-26-18

Applicable Standards, Specifications, and Sampling Schemes:

Test methods in accordance to ASTMF606/ISO 898-1 where applicable.Sampling plan in accordance to ASTM F1470. Thread fit and dimensional properties are compliant to ASME B18.2.1. Mechanical properties are according to SAE J429 or ISO 898-1 were applicable. Bolts passed a surface discontinuity inspection per ASTM F788. These bolts were manufactured in the USA from domestic material and were not produced from heat in which Bismuth, Selenium, Tellurim, or Lead was intentionally added. Bolts were not exposed to Mercury or any other metal alloy that is liquid at ambient temperature during processing or while in our possession.

The listed standards, specifications, and sampling schemes are of the revision in effect on the date of manufacture unless noted otherwise. Only those standards specifically noted under "test methods" or "additional test methods" are included on LE's scope of laboratory accreditation.

Additional Information

None

This lot has been found to conform to the requirements of the above standards and specifications

Quality Management System including Test Reports managed by: Josh Lowery - Quality Supervisor, Fontana Fasteners Inc

CERT #0122.02
"MECHANICAL FIELD OF TESTING"

GERDAU

GERDAU SPECIAL STEEL NORTH AMERICA
5591 MORRILL ROAD
JACKSON, MICHIGAN 49201

CERTIFIED MATERIAL TEST REPORT

CUSTOMER ORDER NUMBER	CUSTOMER PART NUMBER	HEAT NUMBER	WORK ORDER NUMBER	DATE
130651	95B223700A4	75068613	313378 101	9/25/17

210mm Billet

REPORT TO

ACUMENT GLOBAL TECH.
DBA: FONTANA FASTENERS
3281 W COUNTRY RD 0 NS

FRANKFORT , IN 46041

SHIP TO

FONTANA FASTENERS INC-MFG
3281 W COUNTY RD 0 NS

FRANKFORT , IN 46041

ORDERED

GRADE	SIZE	LENGTH
4140 MOD	37.MM RND	20'

CUSTOMER SPECIFICATIONS

CHEMISTRY ONLY: ASTM A563-15 GRADE DH3/ASTM A194-15 GRADE 2H

CHEMICAL ANALYSIS

C	Mn	P	S	Si	Ni	Cr	Mo	Cu	Sn	Al
0.42	0.95	0.011	0.006	0.19	0.24	0.53	0.20	0.23	0.009	0.020

V	Nb
0.002	0.003

HYDROGEN = 1.7 ppm

GRAIN SIZE SPECIFICATION ASTM E112 GRAINSIZE 5-8

REDUCTION RATIO

RATIO= 40.8 TO 1.0

** MATERIAL 100% MELTED AND MANUFACTURED IN THE U.S.A. BY THE ELECTRIC ARC FURNACE AND CONTINUOUS CASTING METHOD. THE PRODUCT HAS NOT BEEN REPAIRED BY WELDING AND THIS MATERIAL HAS NOT BEEN EXPOSED TO MERCURY OR TO ANY OTHER METAL ALLOY THAT IS LIQUID AT AMBIENT TEMPERATURES DURING PROCESSING OR WHILE IN OUR POSSESSION.
GERDAU MONITORS ALL INCOMING SCRAP AND ALL HEATS OF STEEL TO ENSURE THAT PRODUCTS SHIPPED ARE FREE OF RADIOACTIVE MATERIAL.

We certify that these data are correct and in compliance with specified requirements.

Gerdau Monroe
3000 East Front Street
Monroe, MI 48161

Patrick Doyle
Quality Assurance Representative

CERTIFICATE OF COMPLIANCE

ROCKFORD BOLT & STEEL CO.
126 MILL STREET
ROCKFORD, IL 61101
815-968-0514 FAX# 815-968-3111

CUSTOMER NAME: AMERICAN TIMBER & STEEL

CUSTOMER PO: 21451

SHIPPER #: 068659
DATE SHIPPED: 04/17/2020

LOT#: P38836 R71968
UNYTITE LOT: 30836-75070667

SPECIFICATION: ASTM A563, GRADE DH HEAVY HEXAGONAL NUT

COATING: ASTM SPECIFICATION F2329 HOT DIP GALVANIZE
UNIVERSAL GALVANIZING: 30836-75070667

CHEMICAL COMPOSITION

MILL	GRADE	HEAT#	C	Mn	P	S	Si
GERDAU	1045	75070667	.45	.77	.010	.035	.21

HARDNESS:

SPEC: 24-38
ACTUAL: 29.05

QUANTITY AND DESCRIPTION:

175 PCS 3/4" HEAVY HEXAGONAL NUT

WE HEREBY CERTIFY THE ABOVE PARTS HAVE BEEN MANUFACTURED IN THE U.S.A. WITH DOMESTIC STEEL. WE FURTHER CERTIFY THAT THIS DATA IS A TRUE REPRESENTATION OF INFORMATION PROVIDED BY THE MATERIALS SUPPLIER, AND THAT OUR PROCEDURES FOR THE CONTROL OF PRODUCT QUALITY ASSURE THAT ALL ITEMS FURNISHED ON THIS ORDER MEET OR EXCEED ALL APPLICABLE TESTS, PROCESS, AND INSPECTION REQUIREMENTS PER ABOVE SPECIFICATION.

UNYTITE INC.
INNOVATIVE FASTENING SYSTEMS

Unytite, Inc.
One Unytite Drive
Peru, IL 61354
USA
Tel 815-224-2221
Fax 815-224-3434

Customer Shipper

Bill/Ship To: Rockford Bolt and Steel Co.
126 Mill St.
Rockford, IL 61101

Buyer: Rockford Bolt and Steel Co.

Shipper No: 70061

Ship Date: 7/31/19
Carrier: Customer Advise
Trailer No:
Shipping Tracking No:
Freight Terms: Collect
Class or Rate: 50
Pallets: 23

Cust PO	Rel	Customer Part No	Rev	Part Name	Part No	Rev	Lot No.	Containers	Ship Qty	Net	Gross
P38828	12			AASHTO M180 Guard Rail, Double Recess, Hot Dipped Galv	AASHTO M180 5/8-11 +0.031 DBRC HDG G-RAIL NUT		30879-190519 (180)	(180) Keg (Can w/lid)	179,837	30,392 lbs	31,042 lbs
P38836	12	✓		ASTM A563 Heavy Hex Nut, Grade DH, Hot Dipped Galv, Blue Dye	A563 3/4-10 +0.020 DH HHN HDG BLUE DYE		30836-75070667 (27)	(27) Keg (Can w/lid)	27,000	4,860 lbs	4,957 lbs
Total:								207 Containers	206,837	35,252 lbs	36,704 lbs

Driver Signature
R71968

Packing Slip

Subject to Unytite Inc. Standard Terms and Conditions of Sale, Document Number 13-002, dated 08-09-06. Document is subject to change without notice.

UNYTITE INC.
INNOVATIVE FASTENING SYSTEMS
Unytite, Inc.
One Unytite Drive
Peru, IL 61354
Tel 815-224-2221
Fax 815-224-3434

INSPECTION CERTIFICATE

Customer: Rockford Bolt and Steel Company
Customer Part No:
Customer PO No: P38836
Lot Number: 30836-75070667

Ship To:
Shipped Qty:

Part No: A563 3/4-10 +0.020 DH HHN HDG BLUE DYE

Description: ASTM A563 Heavy Hex Nut, Grade DH, Hot Dipped Galv, Blue Dye

Manufactured Quantity: 37,739

Specification	Amend	Specification	Amend
ASME B1.1	2003	ASME B18.2.2	2015
ASME B18.2.6	2011	ASTM A563	2015
ASTM F2329/F2329M	2015	ASTM F606/606M	2016
ASTM F812	2017		

Test No: 20170 **Test:** A563 DH Mechanical Properties

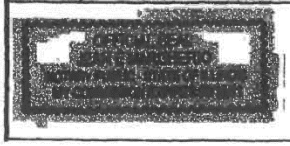
Description	Hardness (HRC)	Tempering Temp (800 degree F Min)	Proof Load (Pass/Fail) (ASTM Min LBS)	Shape & Dimension ASME B18.2.2	Thread Precision ASME B18.1.1	Visual ASTM F812
Sample Inspection	29.05	1,193	50,100	Pass	Pass	Pass

Heat No	Grade	Manufacturer	Origin	C	Mn	P	S	Si	Cr	Ni	Cu
75070667	1045	Gerdau Special Steel North America	USA	0.4500	0.7700	0.010	0.0350	0.2100	0.1600	0.1100	0.2000

All tests are in accordance with the latest revisions of the methods prescribed in the applicable SAE and ASTM Specifications.

The samples tested conform the specifications as described/listed above and were manufactured free of mercury contamination and there is no welding performed in the production of the products. No heats to which Bismuth, Selenium, Tellurium, or Lead was intentionally added have been used to produce products.
The steel was melted and manufactured in the U.S.A. and the product was manufactured and tested in the U.S.A.

We certify that this data is true representation of information provided by the material supplier and our testing laboratory. This certified material test report relates only to the items listed on this document and may not be reproduced except in full.



Thorsen, Chris - Supervisor, Quality

7/18/19
Date

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GERDAU

GERDAU SPECIAL STEEL NORTH AMERICA
5591 MORRILL ROAD
JACKSON, MICHIGAN 49201

CERTIFIED MATERIAL TEST REPORT

CUSTOMER ORDER NUMBER	CUSTOMER PART NUMBER	HEAT NUMBER	WORK ORDER NUMBER	DATE
P007419-2	B1045SC1.0000	75070667	319128 102	5/03/18

210mm Billet

REPORT TO

UNYTITE INC
ONE UNYTITE DRIVE

PERU , IL 61354-9710

SHIP TO

UNYTITE, INC
LASALLE PLANT

325 CIVIC RD
LASALLE , IL 61301

ORDERED

GRADE	SIZE	LENGTH
1045	1" RND	24' 10 1/2"

CUSTOMER SPECIFICATIONS

SAE 1045; ASTM E381-17; RMS 021 DATED 9/28/06

CHEMICAL ANALYSIS

C	Mn	P	S	Si	Ni	Cr	Mo	Cu	Sn	Al
0.45	0.77	0.010	0.035	0.21	0.11	0.16	0.04	0.20	0.010	0.003

V	Nb
0.056	0.002

GRAIN SIZE SPECIFICATION ASTM E112 FINE GRAIN 5-8

MICROCLEANLINESS SPECIFICATION ASTM E45 METH A

	A		B		C		D	
	T	H	T	H	T	H	T	H
AVERAGE	2.4	0.2	1.0	0.0	0.2	0.0	0.6	0.2

MACROSTRUCTURAL TEST PER - ASTM E381

PLATE I

	S	R	C
FRONT	1	1	1
MIDDLE	1	1	1

PAGE 1

Patrick Doyle

Patrick Doyle

CONTINUED ON PAGE 2

GERDAU

GERDAU SPECIAL STEEL NORTH AMERICA
5591 MORRILL ROAD
JACKSON, MICHIGAN 49201

CERTIFIED MATERIAL TEST REPORT

CUSTOMER ORDER NUMBER	CUSTOMER PART NUMBER	HEAT NUMBER	WORK ORDER NUMBER	DATE
P007419-2	B1045SC1.0000	75070667 210mm Billet	319128 102	5/03/18

REPORT TO

UNYTITE INC
ONE UNYTITE DRIVE

PERU , IL 61354-9710

SHIP TO

UNYTITE, INC
LASALLE PLANT

325 CIVIC RD
LASALLE , IL 61301

ORDERED

GRADE	SIZE	LENGTH
1045	1" RND	24' 10 1/2"

CUSTOMER SPECIFICATIONS

SAE 1045; ASTM E381-17; RMS 021 DATED 9/28/06

BACK 1 1 1

DECARB SPECIFICATION ASTM E1077

F TOTAL= 0.010

REDUCTION RATIO

RATIO= 86.7 TO 1.0

RESIDUAL MAX SPECIFICATION RMS 021

Ni+Cr = 0.2690

** MATERIAL 100% MELTED AND MANUFACTURED IN THE U.S.A. BY THE ELECTRIC ARC FURNACE AND CONTINUOUS CASTING METHOD. THE PRODUCT HAS NOT BEEN REPAIRED BY WELDING AND THIS MATERIAL HAS NOT BEEN EXPOSED TO MERCURY OR TO ANY OTHER METAL ALLOY THAT IS LIQUID AT AMBIENT TEMPERATURES DURING PROCESSING OR WHILE IN OUR POSSESSION. GERDAU MONITORS ALL INCOMING SCRAP AND ALL HEATS OF STEEL TO ENSURE THAT PRODUCTS SHIPPED ARE FREE OF RADIOACTIVE MATERIAL. MATERIAL IS 100% RECYCLABLE.

Patrick Doyle

CERTIFICATE OF COMPLIANCE

ROCKFORD BOLT & STEEL CO.
126 MILL STREET
ROCKFORD, IL 61101
815-968-0514 FAX# 815-968-3111

CUSTOMER NAME: AMERICAN TIMBER & STEEL

CUSTOMER PO: 21451

SHIPPER #: 068659
DATE SHIPPED: 04/17/2020

LOT#: P38996 R72790
UNYTITE LOT: 31631-6215051403

SPECIFICATION: ASTM A563, GRADE DH HEAVY HEXAGONAL NUT

COATING: ASTM SPECIFICATION F2329 HOT DIP GALVANIZE
UNIVERSAL GALVANIZING: 31631-6215051403

CHEMICAL COMPOSITION

MILL	GRADE	HEAT#	C	Mn	P	S	Si
GERDAU	1045	62150514	.45	.72	.014	.014	.23

HARDNESS:

SPEC: 24-38
ACTUAL: 29.11

QUANTITY AND DESCRIPTION:

13,975 PCS 3/4" HEAVY HEXAGONAL NUT

WE HEREBY CERTIFY THE ABOVE PARTS HAVE BEEN MANUFACTURED IN THE U.S.A. WITH DOMESTIC STEEL. WE FURTHER CERTIFY THAT THIS DATA IS A TRUE REPRESENTATION OF INFORMATION PROVIDED BY THE MATERIALS SUPPLIER, AND THAT OUR PROCEDURES FOR THE CONTROL OF PRODUCT QUALITY ASSURE THAT ALL ITEMS FURNISHED ON THIS ORDER MEET OR EXCEED ALL APPLICABLE TESTS, PROCESS, AND INSPECTION REQUIREMENTS PER ABOVE SPECIFICATION.

UNYTITE INC.

INNOVATIVE FASTENING SYSTEMS

Unytite, Inc.
One Unytite Drive
Peru, IL 61354
Tel 815-224-2221
Fax 815-224-3434

INSPECTION CERTIFICATE

Customer: Rockford Bolt and Steel Co.

Ship To:

Customer Part No:

Customer PO No: P38996

Shipped Qty:

Lot Number: 31631-6215051403

Part Information

Part No: A563 3/4-10 +0.020 DH HHN HDG BLUE DYE

Description: ASTM A563 Heavy Hex Nut, Grade DH, Hot Dipped Galv, Blue Dye

Manufactured Quantity: 101,864

Applicable Specifications

Specification	Amend	Specification	Amend
ASME B1.1	2003	ASME B18.2.2	2015
ASME B18.2.6	2011	ASTM A563	2015
ASTM F2329/F2329M	2015	ASTM F606/606M	2016
ASTM F812	2017		

Test Results

Test No: 20986 **Test:** A563 DH Mechanical Properties

Description	Hardness (HRC)	Tempering Temp (800 degree F Min)	Proof Load (Pass ASTM Min LBS)	Shape & Dimension ASME B18.2.2	Thread Precision ASME B18.1.1	Visual ASTM F812
Sample Inspection	29.11	1,139	50,100	Pass	Pass	Pass

Certified Chemical Analysis

Heat No	Grade	Manufacturer	Origin	C	Mn	P	S	Si	Cr	Ni	Cu
62150514	1045	Gerdau Ameristeel	USA	0.4600	0.7200	0.014	0.0140	0.2300	0.1700	0.0800	0.2300

All tests are in accordance with the latest revisions of the methods prescribed in the applicable SAE and ASTM Specifications.

The samples tested conform the specifications as described/listed above and were manufactured free of mercury contamination and there is no welding performed in the production of the products. No heats to which Bismuth, Selenium, Tellurium, or Lead was intentionally added have been used to produce products.

The steel was melted and manufactured in the U.S.A. and the product was manufactured and tested in the U.S.A.

We certify that this data is true representation of information provided by the material supplier and our testing laboratory. This certified material test report relates only to the items listed on this document and may not be reproduced except in full.

[redacted]

Thorsen, Chris - Supervisor, Quality

11/26/19

Date

Plax 11/26/19 3:02 PM cthorsen Page 1

R72790

GERDAU

US-ML-ST PAUL
1678 RED ROCK ROAD
SAINT PAUL, MN 55119
USA

CUSTOMER SHIP TO	CUSTOMER BILL TO	GRADE	SHAPE / SIZE	DOCUMENT ID:
UNYTITE INC LASALLE PLANT 325 CIVIC ROAD LA SALLE,IL 61301 USA	UNYTITE INC 1 UNYTITE DR PERU,IL 61354-9710 USA	1045M23FI2N	Round Bar / 1"	0000034265

LENGTH	WEIGHT	HEAT / BATCH
25'01.50"	5,698 LB	62190514/03

SALES ORDER	CUSTOMER MATERIAL Nº
7858716/000010	B1045SC1.0000 F

SPECIFICATION / DATE of REVISION
ASTM A29-16
ASTM A576-17

CUSTOMER PURCHASE ORDER NUMBER	BILL OF LADING	DATE
P008618	1332-0000073325	09/11/2019

CHEMICAL COMPOSITION

C %	Mn %	P %	S %	Si %	Cu %	Ni %	Cr %	Mo %	Sn %	V %	Nb %	Al %
0.45	0.72	0.014	0.023	0.23	0.23	0.08	0.17	0.020	0.009	0.032	0.001	0.005

HARDENABILITY

DI A255 Inch
1.31

COMMENTS / NOTES

Material 100% melted and rolled in the USA. Manufacturing processes for this steel, which may include scrap melted in an electric arc furnace and hot rolling, have been performed at Gerdau St. Paul Mill, 1678 Red Rock Road, Saint Paul, Minnesota, USA. All product produced from strand cast billets. Silicon killed (deoxidized) steel. No weld repairmen performed. Steel not exposed to mercury or any liquid alloy which is liquid at ambient temperatures during processing or while in Gerdau St. Paul Mills possession. Any modification to this certification as provided by Gerdau St. Paul Mill without the expressed written consent of Gerdau St. Paul Mill negates the validity of this test report. This report shall not be reproduced except in full, without the expressed written consent of Gerdau St. Paul Mill. Gerdau St. Paul Mill is not responsible for the inability of this material to meet specific applications.
Roll batch 62190514/03 Roll date 8/2/2019 Fine Grain (GG 5-8)
Quality Program Manual Rev. 8, implemented date 7/13/2018

Debra L. Kariesch
DEBRA L. KARIESCH
Notary Public-Minnesota
My Commission Expires Jan 31, 2020

The above figures are certified chemical and physical test records as contained in the permanent records of company. We certify that these data are correct and in compliance with specified requirements. Weld repair has not been performed on this material. This material, including the billets, was melted and manufactured in the USA. CMTR complies with EN 10204 3.1.

BHASKAR YALAMANCHILI
QUALITY DIRECTOR
Phone: (409) 267-1071 Email: Bhaskar.Yalamanchili@gerdau.com

ALEA BRANDENBURG
QUALITY ASSURANCE MGR
Phone: (651) 731-5662 Email: Alea.Brandenburg@gerdau.com

CERTIFICATE OF COMPLIANCE

ROCKFORD BOLT & STEEL CO.
126 MILL STREET
ROCKFORD, IL 61101
815-968-0514 FAX# 815-968-3111

CUSTOMER NAME: AMERICAN TIMBER & STEEL

CUSTOMER PO: 21451

SHIPPER #: 068659
DATE SHIPPED: 04/17/2020

LOT#: P39289 R73494
UNYTITE LOT: 32205-75078628

SPECIFICATION: ASTM A563, GRADE DH HEAVY HEXAGONAL NUT

COATING: ASTM SPECIFICATION F2329 HOT DIP GALVANIZE
UNIVERSAL GALVANIZING: 32205-75078628

CHEMICAL COMPOSITION

MILL	GRADE	HEAT#	C	Mn	P	S	Si
GERDAU	1045	75078628	.44	.74	.006	.029	.24

HARDNESS:

SPEC: 24-38
ACTUAL: 28.37

QUANTITY AND DESCRIPTION:

850 PCS 3/4" HEAVY HEXAGONAL NUT

WE HEREBY CERTIFY THE ABOVE PARTS HAVE BEEN MANUFACTURED IN THE U.S.A. WITH DOMESTIC STEEL. WE FURTHER CERTIFY THAT THIS DATA IS A TRUE REPRESENTATION OF INFORMATION PROVIDED BY THE MATERIALS SUPPLIER, AND THAT OUR PROCEDURES FOR THE CONTROL OF PRODUCT QUALITY ASSURE THAT ALL ITEMS FURNISHED ON THIS ORDER MEET OR EXCEED ALL APPLICABLE TESTS, PROCESS, AND INSPECTION REQUIREMENTS PER ABOVE SPECIFICATION.

UNYTITE INC.
INNOVATIVE FASTENING SYSTEMS

Unytite, Inc.
One Unytite Drive
Peru, IL 61354
USA
Tel 815-224-2221
Fax 815-224-3434

Customer Shipper

Bill/Ship To: Rockford Bolt and Steel Co.
126 Mill St.
Rockford, IL 61101

Buyer: Rockford Bolt and Steel Co.

Shipper No: 72877

Ship Date: 4/13/20
Carrier: A & B / Dohm
Trailer No:
Shipping Tracking No: steel nuts
Freight Terms: Collect
Class or Rate: 50
Pallets: 3

Cust PO	Rel	Customer Part No	Rev	Part Name	Part No	Rev	Lot No.	Containers	Ship Qty	Net	Gross
P39289	2/20/20			ASTM A563 Heavy Hex Nut; Grade DH, Hot Dipped Galv, Blue Dye	A563 3/4-10 +0.020 DH HHN HDG BLUE DYE		32205-75078628 (27)	(27) Keg (Can w/lid)	27,000	4,860 lbs	4,957 lbs
Total:								27 Containers	27,000	4,860 lbs	5,055 lbs

Driver Signature

R73194

Packing Slip

Subject to Unytite Inc. Standard Terms and Conditions of Sale, Document Number 13-002, dated 08-09-06. Document is subject to change without notice.

Plex 4/13/20 11:32 AM pkupperschmid Page 2

UNYTITE INC.
INNOVATIVE FASTENING SYSTEMS

Unytite, Inc.
One Unytite Drive
Peru, IL 61354
Tel 815-224-2221
Fax 815-224-3434

INSPECTION CERTIFICATE

Job No: 32205 — Job Information — Certified Date: 3/26/20

Customer: Rockford Bolt and Steel Co.
Ship To:
Customer Part No:
Customer PO No: P39289
Shipped Qty:
Lot Number: 32205-75078628

Part Information

Part No: A563 3/4-10 +0.020 DH HHN HDG BLUE DYE

Description: ASTM A563 Heavy Hex Nut, Grade DH, Hot Dipped Galv, Blue Dye

Manufactured Quantity: 124,752

Applicable Specifications

Specification	Amend	Specification	Amend
ASME B1.1	2003	ASME B18.2.2	2015
ASME B18.2.6	2019	ASTM A563	2015
ASTM F2329/F2329M	2015	ASTM F606/606M	2019
ASTM F812	2017		

Test Results

Test No: 21694 **Test:** A563 DH Mechanical Properties

Description	Hardness (HRC)	Tempering Temp (800 degree F Min)	Proof Load (Pass ASTM Min LBS)	Shape & Dimension ASME B18.2.2	Thread Precision ASME B18.1.1	Visual ASTM F812
Sample Inspection	28.37	1,040	50,100	Pass	Pass	Pass

Certified Chemical Analysis

Heat No	Grade	Manufacturer	Origin	C	Mn	P	S	Si	Cr	Ni	Cu
75078628	1045	Gerdau Special Steel North America	USA	0.4400	0.7400	0.0080	0.0290	0.2400	0.1000	0.0600	0.1600

Notes

All tests are in accordance with the latest revisions of the methods prescribed in the applicable SAE and ASTM Specifications.

The samples tested conform the specifications as described/listed above and were manufactured free of mercury contamination and there is no welding performed in the production of the products. No heats to which Bismuth, Selenium, Tellurium, or Lead was intentionally added have been used to produce products.
The steel was melted and manufactured in the U.S.A. and the product was manufactured and tested in the U.S.A.

We certify that this data is true representation of information provided by the material supplier and our testing laboratory. This certified material test report relates only to the items listed on this document and may not be reproduced except in full.

Thorsen, Chris - Supervisor, Quality — 3/26/20 Date

Plex 3/26/20 10:55 AM cthorsen Page 1

GERDAU

GERDAU SPECIAL STEEL NORTH AMERICA
5581 MORRILL ROAD
JACKSON, MICHIGAN 49201 USA

CERTIFIED MATERIAL TEST REPORT

CUSTOMER ORDER NUMBER	CUSTOMER PART NUMBER	HEAT NUMBER	WORK ORDER NUMBER	DATE
P008846	B1045SC1.0000	75078628	334801 101	1/28/20

240mm Bloom

REPORT TO

UNYTITE INC
ONE UNYTITE DRIVE

PERU , IL 61354-9710

SHIP TO

UNYTITE, INC
LASALLE PLANT

325 CIVIC RD
LASALLE , IL 61301

ORDERED

GRADE	SIZE	LENGTH
1045	1" RND	24' 10 1/2"

CUSTOMER SPECIFICATIONS

SAE 1045; ASTM E381-17; RMS 021 REV 3 DATED 09/17/19

BACK 1 1 1

DECARB SPECIFICATION ASTM E1077 RMS 021 REV 3

F TOTAL= 0.009

REDUCTION RATIO SPECIFICATION RMS 021 REV 3

RATIO= 113.7 TO 1.0

RESIDUAL MAX SPECIFICATION RMS 021 REV 3

Ni+Cr = 0.1630

** MATERIAL 100% MELTED AND MANUFACTURED IN THE U.S.A. BY THE ELECTRIC ARC FURNACE AND CONTINUOUS CASTING METHOD. THE PRODUCT HAS NOT BEEN REPAIRED BY WELDING AND THIS MATERIAL HAS NOT BEEN EXPOSED TO MERCURY OR TO ANY OTHER METAL ALLOY THAT IS LIQUID AT AMBIENT TEMPERATURES DURING PROCESSING OR WHILE IN OUR POSSESSION. GERDAU MONITORS ALL INCOMING SCRAP AND ALL HEATS OF STEEL TO ENSURE THAT PRODUCTS SHIPPED ARE FREE OF RADIOACTIVE MATERIAL. MATERIAL IS 100% RECYCLABLE.

We certify that these data are correct and in compliance with specified requirements.

Gerdau Monroe
3000 East Front Street
Monroe, MI 48161

Patrick Doyle
Pat.Doyle@Gerdau.com
Quality Assurance Re

Invoice No.	929064
Bill of Lading	358705
Customer No.	4429
Customer P.O	116882

NUCOR-YAMATO STEEL CO.
P.O. BOX 1228: BLYTHEVILLE, AR 72316

CERTIFIED MILL TEST REPORT
100% Melted and Manufactured in U.S.A
All Shapes produced by Nucor-Yamato Steel are cast and rolled to a fully killed and fine grain practice

Date 2018-12-11

SOLD TO
CONTRACTORS STEEL CO
36555 AMRHEIN RD.
LIVONIA MI 48150
USA

SHIP TO
CONTRACTORS STEEL COMPANY
48649 SCHOONER DR.
BELLEVILLE MI 48111
USA

ASTM A992/A992M-11 A572/A572M GR50-15
ASTM A709/A709M-15 GR50 (345)
ASTM A709/A709M-15 GR50S (345S)
CSA G40.21-13 50WM (345WM)
ASTM A6/A6M-14

Item#	Item Description	QTY	Heat#	Mechanical Properties								Chemical Properties													
				Yield to Tensile Ratio	Yield Strength	Tensile Strength	ELONG	Charpy Impact Temp	Charpy Impact Energy		Loc	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Cb	CE	Sn	Pcm	Cl
					KSI	KSI	%	° F	ft• lbf																	
					MPa	MPa	%	° C	J																	
1	W27X161.0 50 ft 0 in W690X240 (15.24 m)	1	499022	0.79 0.79	56 56 383 386	71 71 487 490	28 27					.08	1.11	.013	.027	.20	.31	.13	.16	.04	.01	.021	.34	.01	.17	
2	W30X173.0 50 ft 0 in W760X257 (15.24 m)	1	481990	0.78 0.78	54 55 375 382	70 71 482 490	28 28					.08	1.10	.008	.021	.22	.26	.09	.09	.02	.01	.025	.31	.01	.16	

ELONGATION BASED ON 8.00 INCH GAUGE LENGTH

Pcm= C+Si/30+Mn/20+Cu/20+Ni/60+Cr/20+Mo/15+V/10+5B(B=Approx .0005)

Corrosion Index= 26.01(%Cu)+3.88(%Ni)+1.2(%Cr)+1.49(%Si)+17.28(%P)-7.29(%Cu)(%Ni)-9.10(%Ni)(%P)-33.39(%Cu)^2

CARBON EQUIVALENT CE= C+Mn/6+(Cr+Mo+V)/5+(Ni+Cu)/15

Mercury has not been used in the direct manufacturing of this material

This material was produced in accordance with the Nucor-Yamato Steel Quality Manual.

ISO 9001:2015 certified (Registration # 0985-07).

All mechanical testing is performed by the Quality Testing Lab, which is independent of the production departments.

The Charpy machine striker geometry used by Nucor-Yamato Steel is the 8 mm (0.315")striker (KV_8) per ASTM A370 Section 22.1.2 and ISO 148-1 Section 7.3.

I hereby certify that the contents of this report are accurate and correct. All test results and operations performed by this material manufacturer are in compliance with the requirements of the material specifications, and when designated by the purchaser, meet the applicable specifications.

Chief Metallurgist

State of Arkansas
County of Mississippi
Sworn to and subscribed before me
on 2018-12-11
My commission expires on 07/17/2023

DEBORAH ANN RHODES Commission # 12394017 NOTARY PUBLIC STATE OF ARKANSAS-MISSISSIPPI COUNTY My Commission Expires 7-17-2023

OLYMPIC**STEEL**
5080 RICHMOND ROAD
BEDFORD HEIGHTS, OH 44146 USA
PHONE: 216-292-3800

METALLURGICAL TEST REPORT

>>>>>> CERTIFICATE OF ANALYSIS AND TESTS <<<<<<

Sold To: AMERICAN TIMBER AND STEEL
4832 PLANK RD.
NORWALK, OH 44857

Ship To: AMERICAN TIMBER AND STEEL
4832 PLANK RD.
NORWALK, OH 44857

Sales Order: 614083 - 01 B/L No: 983730 Release: 2 Date: 20-May-2020
Reference: FORRAI, HALLIE (11855) 2nd B/L: Cus Ord #: 21885
Cus Name: AMERICAN TIMBER AND STEEL

Description of Material and Specification

Hot Rolled Sheet A606/606
.375IN x 48IN x 192IN

TAG#: 27719329
HEAT#: 32016780/STEEL DYNAMICS, INC. - FLAT ROLLED
MC # 27699054
MS # 20B528734

Chem Elem Symbol / Elem Content Value:

<C : .05> <MN : .86> <P : .02> <S : .001> <SI : .45> <AL : .035> <V : .031> <CB : .002> <CU : .33> <NI : .16> <CR : .43> <MO : .02> <N : .009> <TI : .001> <B : 0> <CA : .002> <ZR : .0008> <PB : 0> <SN : .006>

YIELD STRENGTH	MIN:	60800	PSI	MAX	60800 PSI
TENSILE STRENGTH	MIN:	76100	PSI	MAX	76100 PSI
ELONGATION 2"	MIN:	34	%	MAX	34 %

We hereby certify the above is correct as contained in the records of the corporation

Branch Certification Manager

USER: REPORTS@SEMSP01
REPORT: ST_MSR_OSI

20-May-2020 4:44 AM
Page 1 of 2

Birmingham Fastener Manufacturing

P.O. Box 10323
Birmingham, Alabama 35202
(205) 595-3512

Certificate of Compliance

Customer : AMERICAN TIMBER
P.O. # : 19191
BFM # : 1579744
Date Shipped : 5/10/2019

Item	Quantity	Description	Lot #	Heat #	Specification	Finish
1	519	5/8"-11 x 12" Carriage Bolt	92212	DL18104710	ASTM A242	Plain

Birmingham Fastener Manufacturing. hereby certifies that the material furnished in reference to the above purchase order number will meet or exceed the above assigned specifications.

Signed: _____ **Date:** 06/05/2020
Cody Calvert

NUCOR

NUCOR CORPORATION
NUCOR STEEL SOUTH CAROLINA

Mill Certification
4/23/2019

MTR #: C1-466062
300 Steel Mill Road
DARLINGTON, SC 29540
(843) 393-5841
Fax: (843) 395-8701

Sold To: BIRMINGHAM FASTENER & SUPPLY
PO BOX 10323
BIRMINGHAM, AL 35202-0323
(205) 595-3511
Fax: (205) 591-0244

Ship To: BIRMINGHAM FASTENER & SUPPLY
931 AVE W
PO BOX 10323
BIRMINGHAM, AL 35202
(205) 595-3511
Fax: (205) 591-0244

Customer P.O.	6179624	Sales Order	301893.7
Product Group	Merchant Bar Quality	Part Number	30000563480DEQ0
Grade	A242BF - ASTM A242-03	Lot #	DL1810471001
Size	9/16" (.5625) Round	Heat #	DL18104710
Product	9/16" (.5625) Round 40' A242BF	B.L. Number	C1-784101
Description	A242BF	Load Number	C1-466062
Customer Spec		Customer Part #	

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.

Roll Date: 7/19/2018 Melt Date: 7/15/2018 Qty Shipped LBS: 7,208 Qty Shipped Pcs: 213

Melt Date: 7/15/2018

C	Mn	V	Si	S	P	Cu	Cr	Ni	Mo	Cb
0.15%	0.90%	0.0120%	0.18%	0.028%	0.014%	0.32%	0.79%	0.26%	0.026%	0.003%

Roll Date: 7/19/2018

Yield 1: 52,000psi
Elongation: 35% in 2"(% in 50.8mm)
Elongation 22% in 8"(% in 203.3mm)

Tensile 1: 82,000psi
Yield 2: 52,000psi
Elongation: 34% in 2"(% in 50.8mm) - test2

Elongation: 23% in 8"(% in 203.3mm)
Tensile 2: 83,000psi

Specification Comments:

1. WELDING OR WELD REPAIR WAS NOT PERFORMED ON THIS MATERIAL
2. MELTED AND MANUFACTURED IN THE USA
3. MERCURY, RADIUM, OR ALPHA SOURCE MATERIALS IN ANY FORM HAVE NOT BEEN USED IN THE PRODUCTION OF THIS MATERIAL

James H. Blew
Division Metallurgist

NBMG-10 October 1, 2017

Birmingham Fastener Manufacturing

P.O. Box 10323
Birmingham, Alabama 35202
(205) 595-3512

Certificate of Compliance

Customer : AMERICAN TIMBER
P.O. # : 20512
BFM # : 1628407
Date Shipped : 9/30/2019

Item	Quantity	Description	Lot #	Heat #	Specification	Finish
1	869	3/4"-10 x 8 1/2" Carriage Bolt	86911	10592090	AWWAC111	Plain
4	10,545	5/8"-11 x 4" Hex Lag Screw	32361	10575880	AWWAC111	Plain

Birmingham Fastener Manufacturing. hereby certifies that the material furnished in reference to the above purchase order number will meet or exceed the above assigned specifications.

Signed: _____ **Date:** 11/04/2019
Brian Hughes

CERTIFICATE OF COMPLIANCE

ROCKFORD BOLT & STEEL CO.
126 MILL STREET
ROCKFORD, IL 61101
815-968-0514 FAX# 815-968-3111

CUSTOMER NAME: BIRMINGHAM FASTENERS COMPANY

CUSTOMER PO: 6221129

SHIPPER #: 067290
DATE SHIPPED: 09/23/2019

LOT#: 32361

SPECIFICATION: ASTM A307, GRADE A STEEL BOLTS, MADE WITH ASTM A242 WEATHERING STEEL

COATING: N/A

CHEMICAL COMPOSITION

MILL	GRADE	HEAT#	C	Mn	P	S	Si	Cu	Ni	Cr
NUCOR	A242	10575880	.07	.55	.010	.014	.200	.28	.32	.73

QUANTITY AND DESCRIPTION:

14,924 PCS 5/8" X 4" HEXAGONAL HEADED LAG BOLT

WE HEREBY CERTIFY THE ABOVE BOLTS HAVE BEEN MANUFACTURED BY ROCKFORD BOLT AND STEEL IN ROCKFORD, ILLINOIS. THE MATERIAL USED WAS MELTED AND MANUFACTURED IN THE U.S.A. WE FURTHER CERTIFY THAT THIS DATA IS A TRUE REPRESENTATION OF INFORMATION PROVIDED BY THE MATERIALS SUPPLIER, AND THAT OUR PROCEDURES FOR THE CONTROL OF PRODUCT QUALITY ASSURE THAT ALL ITEMS FURNISHED ON THIS ORDER MEET OR EXCEED ALL APPLICABLE TESTS, PROCESS, AND INSPECTION REQUIREMENTS PER ABOVE SPECIFICATIONS.

STATE OF ILLINOIS
COUNTY OF WINNEBAGO
SIGNED BEFORE ME ON THIS
4th DAY OF November, 2019

Merry F Shane

Linda McComas
APPROVED SIGNATORY

11/4/19
DATE

Official Seal
Merry F Shane
Notary Public State of Illinois
My Commission Expires 10/03/2022

CHARTER STEEL
A Division of Charter Manufacturing Company, Inc.

EMAIL

1658 Cold Springs Road
Saukville, Wisconsin 53080
(262) 268-2400
1-800-437-8789
Fax (262) 268-2570

CHARTER STEEL TEST REPORT

Melted in USA Manufactured in USA

Cust P.O.	P38510
Customer Part #	100110
Charter Sales Order	70088529
Heat #	10575880
Ship Lot #	4553057
Grade	A242 M SK FG IQ 19/32 RNDCOIL
Process	HRCC
Finish Size	.19/32
Ship date	02-OCT-18

Rockford Bolt & Steel
126 Mill St.
Rockford,IL-61101
Kind Attn :Linda McComas

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.

Test results of Heat Lot # 10575880

Lab Code: 7388

CHEM	C	MN	P	S	SI	NI	CR	MO	CU	SN	V
%Wt	.07	.65	.010	.014	.200	.32	.73	.03	.28	.007	.001
	AL	N	B	TI	NB						
	.027	.0080	.0002	.001	.001						

Test results of Rolling Lot # 1253503

REDUCTION RATIO=109:1

Specifications: Manufactured per Charter Steel Quality Manual Rev Date 08/12/17
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 A242/A242M -13 Revision = Dated = 01-MAY-13

Additional Comments:

Melt Source:
Charter Steel
Saukville, WI, USA

Trip: 1311283

ACCREDITED
Testing Laboratory

This MTR supersedes all previously dated MTRs for this order

Janice Barnard Division Mgr. of Quality Assurance
barnard.J@chartersteel.com
Printed Date : 10/02/2018

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 J406; 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.

A2LA ACCREDITED
Testing Laboratory

TR No. 612061-08-01

177

2024-02-06

INSPECTION CERTIFICATE

ROCKFORD BOLT AND STEEL CO.
126 MILL STREET
ROCKFORD, IL 61101
815-968-0514 FAX: 815-968-3111

LOT# 32688

Batch Qty: 15,651
Sample Qty: 3
Date of Manufacture: 02/11/2020

SPECIFICATION: ASTM A325 2014, Specification For Structural Bolts
Head markings: "A325 and "01AE"
ASTM A153, Class C Hot Dip Galvanization

DESCRIPTION: 5/8" -11 x 4" Heavy Hexagonal Lag Bolt.

QUANTITY: 15,648

THIS REPORT CONTAINS DATA THAT WAS PRODUCED UNDER THE FOLLOWING SUBCONTRACTORS:
*Raw Mate G3 (GRAND BLANC) -ISO 9001:2015 #C2019-00846
Not ISO 17025 Accreditated

CUSTOMER NAME: AMERICAN TIMBER & STEEL
4832 PLANK ROAD; P.O. BOX 767; NORWALK, OH 44857

CUSTOMER PO#: 21451 SHIPPER#: 068659
DATE SHIPPED: 04/17/2020

MECHANICAL PROPERTIES

	TENSILE	PROOF LOAD	HARDNESS
SPEC.:	120,000 psi	85,000 psi	HRC 34 MAX
ACTUAL:	133,200 psi	85,100 psi	27.40
	137,900 psi	85,100 psi	28.25
	135,600 psi	85,100 psi	27.73

CHEMICAL COMPOSITION MILL CERT*

HEAT # DL18105063

GRADE	C	Mn	P	S	Si
1045	X 100	X 100	X 1000	X 1000	x100
SPEC.	.43-.50	.60-.90	.040 max	.050 max	.15-.35
ACTUAL	.47	.68	.005	.014	.21

APPROVED SIGNATORY

4/28/2020
DATE

THESE PARTS CONFORM TO ABOVE SPECIFICATIONS.

Tension Testing:
ASTM F606
Proof Load Testing:
ASTM F606
Hardness Testing:
ASTM F606

WE HEREBY CERTIFY THE ABOVE BOLTS HAVE BEEN MANUFACTURED BY ROCKFORD BOLT & STEEL IN OUR FACILITY IN ROCKFORD, ILLINOIS WITH MATERIAL WHICH WAS MELTED AND MANUFACTURED IN U.S.A. WE FURTHER CERTIFY THAT THIS IS A TRUE REPRESENTATION OF INFORMATION PROVIDED BY THE MATERIALS SUPPLIER AND THAT OUR PROCEDURES FOR THE CONTROL OF PRODUCT QUALITY MEET OR EXCEED ALL APPLICABLE TEST, PROCESSES, AND INSPECTION REQUIREMENTS PER THE ABOVE SPECIFICATION. THIS REPORT MAY NOT BE REPRODUCED EXECEPT IN FULL, WITHOUT THE WRITTEN APPROVAL OF ROCKFORD BOLT. THE REPORT MUST NOT BE USED BY THE CLIENT TO CLAIM PRODUCT CERTIFICATION, APPROVAL, OR ENDORSEMENT BY NVLAP, NIST, OR ANY AGENCY OF THE U.S. GOVERNMENT.
"THIS INFORMATION IS NOT COVERED BY ROCKFORD BOLT AND STEEL'S NVLAP ACCREDITATION."

NVLAP® TESTING

NVLAP LAB CODE 200255-0

PACKING LIST

Worth Steel and Machinery, Inc.
[illegible] 122nd St
Alsip IL 60803
708-388-6300 Fax 708-388-6467
www.worthsteel.com

Shipper No: [illegible]
Ship Date: 04/22/18
Page: 1
Customer Phone: 248-524-0192
Customer Fax: 248-524-0406

BILL
G3 Steel Group
1465 Brown Road
Orion, MI 48359-2267
USA

ATTN: Ron Nowak

SHIP
Rockford Bolt & Steel
125 Mill Street
Rockford, IL 61101
USA

ATTN: Ron Nowak

Sales Order No: 59922
Order Date: 04/09/18
Cust Code: G3SGRO
Job Number:

Purchase Order: P38760
Ship Via: JD LOGISTICS
FOB: ALSIP, IL
Salesperson: [illegible]

Line	Part Number	Description	Unit of Measure	Quantity	[illegible]
1	CUSTOMER.MAT.	.625" Diam. Hot Roll Rod 1045 x s/c 240" 2,183 pcs Length Tolerance +1.00"/-.000" 8,000 lbs Max. Bundles Oil Spray 11 Bundles	LB	45530	

Total Weight	Freight	Date Filled
Total Cubic Ft	Insurance	Filled By

STRAIGHT BILL OF LADING - NOT NEGOTIABLE

NUCOR
NUCOR CORPORATION
NUCOR STEEL SOUTH CAROLINA

Nucor Steel - South Carolina
300 Steel Mill Road
DARLINGTON, SC 29540
843-393-5841

Bill of Lading No.:
782750 Rev 0

PICKED: 04-08-2019 1:54 PM
PRINT: 8-Apr-2019 6:11 PM
SHIP: 04-08-2019 4:10 PM

SOLD TO: 000

G3 STEEL GROUP
ATTN STEVE MASON
1465 BROWN ROAD
ORION, MI 48359--226
(248) 534-0192

SHIP TO: 505

Worth Steel & Machinery
4001 W. 123rd St
Alsip, IL 60803

Freight Mode: Truck

Subject to section 7 of the terms and conditions of this bill of lading, if this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement:

The carrier may decline to make delivery of this shipment without payment of freight and all other lawful charges.

NUE
(Signature of Consignor)

Freight Charges are PREPAID unless marked collect.

CHECK BOX if COLLECT

CUSTOMER NO.	CUSTOMER ORDER NUMBER	OUR ORDER NUMBER	SHIPPER NUMBER	TERMS
15159	See Below	See Below	C1-464227	Collect

SHIP VIA	VEHICLE NUMBER	ROUTING
Nucor CPU Carrier	NUCOR NOVA LINE	

PCS				
11	11	5/8" (.6250) Wire Rod Coil 1045CGP Tag# 1 : DL1913027573 Lot #: DL1810506303 Heat #: DL18105063	12080625800DKAA Pieces: 1	4#,772 3,876
		Tag# 2 : DL1913027574 Lot #: DL1810506303 Heat #: DL18105063	Pieces: 1	4,344
		Tag# 3 : DL1913027575 Lot #: DL1810506303 Heat #: DL18105063	Pieces: 1	4,297
		Tag# 4 : DL1913027576 Lot #: DL1810506303 Heat #: DL18105063	Pieces: 1	4,307
		Tag# 5 : DL1913027578 Lot #: DL1810506303 Heat #: DL18105063	Pieces: 1	4,259
		Tag# 6 : DL1913027579 Lot #: DL1810506303 Heat #: DL18105063	Pieces: 1	4,396
		Tag# 7 : DL1913027580 Lot #: DL1810506303 Heat #: DL18105063	Pieces: 1	4,296
		Tag# 8 : DL1913027581 Lot #: DL1810506303 Heat #: DL18105063	Pieces: 1	4,282
		Tag# 9 : DL1913027582 Lot #: DL1810506303 Heat #: DL18105063	Pieces: 1	4,282
		Tag# 10 : DL1913027583 Lot #: DL1810506303 Heat #: DL18105063	Pieces: 1	4,369
		5/8" (.6250) Wire Rod Coil 1045CGP - Continued	12080625800DKAA	

Name of Carrier: Nucor CPU Carrier ... Carrier's No.: NUCOR NOVA LINE

RECEIVED, subject to the terms and conditions of this BILL of LADING
at 04-08-2019 4:10 PM

The property described above in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated above, which said carrier (the word carrier being understood throughout this contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to its usual place of delivery at said destination, if on its route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed, as to each carrier of all or any of said property over all or any portion of said route to destination, and as to each party at any time interested in all or any of said property, that every service to be performed hereunder shall be subject to all the terms and conditions in the applicable, THE BILL OF LADING IS NOT SUBJECT TO ANY CLASSIFICATION OR TARIFFS, WHETHER INDIVIDUALLY DETERMINED OR FILED WITH ANY FEDERAL OR STATE REGULATORY AGENCY, EXCEPT AS SPECIFICALLY AGREED TO IN WRITING BY THE SHIPPER AND CARRIER

If the shipment moves between two ports, by a carrier by water, the law requires that the bill of lading shall state whether it is "carrier's weight" or "shipper's weight"

The agreed-or declared value of the property is hereby specifically stated by the shipper to be not exceeding

_____ per _____

Carrier Certification:

Carrier acknowledges receipt of the property described above in good order and condition.

Per _____

Shipper hereby certifies that he is familiar with all the terms and conditions of this bill of lading, including those on the back hereof, and the said terms and conditions are hereby agreed to by the shipper and accepted for itself and its assigns

STRAIGHT BILL OF LADING - NOT NEGOTIABLE

NUCOR
NUCOR CORPORATION
NUCOR STEEL SOUTH CAROLINA

Nucor Steel - South Carolina
300 Steel Mill Road
DARLINGTON, SC 29540
843-393-5841

Bill of Lading No..
782750 Rev 0

PICKED: 04-08-2019 1:54 PM
PRINT: 8-Apr-2019 4:11 PM
SHIP: 04-08-2019 4:10 PM

SOLD TO: 000

G3 STEEL GROUP
ATTN STEVE MASON
1465 BROWN ROAD
ORION, MI 48359--226
(248) 524-0192

SHIP TO: 505

Worth Steel & Machinery
4001 W. 123rd St
Alsip, IL 60803

Subject to section 7 of the terms and conditions of this bill of lading, if this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement:

The carrier may decline to make delivery of this shipment without payment of freight and all other lawful charges.

NUE
(Signature of Consignor)

Freight Charges are PREPAID unless marked collect.
CHECK BOX IF COLLECT

Freight Mode: Truck

CUSTOMER NO.	CUSTOMER ORDER NUMBER	OUR ORDER NUMBER	SHIPPER NUMBER	TERMS
15169	See Below	See Below	C1-464227	Collect

SHIP VIA	VEHICLE NUMBER	ROUTING
Nucor CPU Carrier	NOCB NOVA LINE	

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		OUR ORDER NUMBER - 308549/1 CUSTOMER PO# - IXB 32760 Tag# 11 : DL1513027584 Lot #: DL1810506303 Heat #: DL18105060	Pieces: 1	4,258
		Total Tags: 11	Total Pieces: 11	46,771

Name of Carrier Nucor CPU Carrier Carrier's No. NOCB NOVA LINE
RECEIVED, subject to the terms and conditions of this Bill of Lading
AT 04-08-2019 4:10 PM

The property described above in apparent good order, except as noted (contents and condition of contents of packages unknown), marked, consigned, and destined as indicated above, which said carrier (the word carrier being understood throughout this contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to its usual place of delivery at said destination, if on its route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed that every service to be performed hereunder shall be subject to all the terms and conditions of this bill of lading. THIS BILL OF LADING IS NOT SUBJECT TO ANY CLASSIFICATION OR TARIFFS, WHETHER INDIVIDUALLY DETERMINED OR FILED WITH ANY FEDERAL OR STATE REGULATORY AGENCY EXCEPT AS SPECIFICALLY AGREED TO IN WRITING BY THE SHIPPER AND CARRIER

If the shipment moves between two ports by a carrier by water, the law requires that the bill of lading shall state whether it is "carrier's weight" or "shipper's weight"

The agreed-on declared value of the property is hereby specifically stated by the shipper to be not exceeding

______ per ______

Carrier Certification:

Carrier acknowledges receipt of the property described above in good order and condition.

Per ______

Shipper hereby certifies that he is familiar with all the terms and conditions of this bill of lading, including those on the back hereof, and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns.

CMAF2V4566B4v1

NUCOR CORPORATION
NUCOR STEEL SOUTH CAROLINA

Mill Certification
4/8/2019

CARLINGTON, SC 29540
(843) 395-5[illegible]
Fax (843) 395-8[illegible]

Sold To: 33 STEEL GROUP
ATTN STEVE MASON
485 BROWN ROAD
ORION MI 48359-226
(248) 524-0192
Fax (248) 524-0408

Ship To: 33 STEEL GROUP
485 BROWN RD
ORION MI 48359 US

Customer P.O	IKE 38760	Sales Order	308549.1
Product Group	Rod	Part Number	32000625000DYAA
Grade	1045	Lot #	DL1810506303
Size	5/8" (.6250) Wire Rod	Heat #	DL18105063
Product	5/8" (.6250) Wire Rod Coil 1045CGP	B.L. Number	C1-782750
Description	1045CGP	Load Number	C1-464227
Customer Spec		Customer Part #	

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

Roll Date: 3/11/2019 Melt Date: 7/31/2018 Qty Shipped LBS: 46,771 Qty Shipped Pcs: 11

Melt Date: 7/31/2018

C	Mn	P	S	Si	V	Ni	Cr	Mo	Cu	Sn	Pb
0.47%	0.68%	0.005%	0.014%	0.21%	0.004%	0.06%	0.07%	0.017%	0.14%	0.005%	0.001%

Al	B	N	CR/CMO
0.002%	0.0003%	0.0156%	0.810%

CR/CMO: Cr + Ni + Cu + Mo

Roll Date: 3/11/2019

Min Tensile 110000psi Max Tensile 110000psi Average Tensile 110000psi

Reduction of Area: 42%

Specification Comments:

1. WELDING OR WELD REPAIR WAS NOT PERFORMED ON THIS MATERIAL
2. MELTED AND MANUFACTURED IN THE USA
3. MERCURY, RADIUM, OR ALPHA SOURCE MATERIALS IN ANY FORM HAVE NOT BEEN USED IN THE PRODUCTION OF THIS MATERIAL

James R. Allen
Division Metallurgist

Page [illegible]

Texas A&M Transportation Institute Proving Ground 3100 SH 47, Bldg 7091 Bryan, TX 77807 Texas A&M University College Station, TX 77843 Phone 979-845-6375	QF 7.3-01 Concrete Sampling	Doc. No. QF 7.3-01	Issue Date: 2018-06-18
Quality Form	Prepared by: Wanda L. Menges Approved by: Darrell L. Kuhn	Revision: 6	Page: 1 of 1

Project No: 612061-3 and 4 **Casting Date:** 4/30/2020 **Mix Design (psi):** 4000 psi

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

Load No.	Truck No.	Ticket No.	Location (from concrete map)
T1	8162	6038645	100% of deck

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

CUSTOMER'S COPY

TICKET NO. 6038645

Martin Marietta

1503 LBJ Freeway
Suite 400
Dallas, Tx 75234

LOAD TIME	TO JOB	ARRIVE JOB SITE	BEGIN POUR	FINISH POUR	LEAVE JOB SITE	ARRIVE PLANT
10:55	:	:	:	:	:	:

WATER ADDED ON JOB AT CUSTOMER'S REQUEST _____ GAL.
ALLOWABLE WATER (withheld from batch) _____ GAL.
TEST CYLINDER TAKEN ❑ YES ❑ NO BY _____
CYLINDER TAKEN ❑ BEFORE ❑ AFTER WATER

ADDITIONAL WATER ADDED TO THIS CONCRETE WILL REDUCE ITS STRENGTH. ANY WATER ADDED IN EXCESS OF SPECIFIED SLUMP IS AT CUSTOMER'S RISK.

CUSTOMER SIGNATURE
X

DELIVERY OF THESE MATERIALS IS SUBJECT TO THE TERMS AN CONDITIONS ON THE REVERSE SIDE HEREOF AS ACCEPTED B SIGNATURE ABOVE .

CUSTOMER NAME AND DELIVERY ADDRESS
BRYAN CONSTRUCTION C
RELLIS CAMPUS/TTI, CO

PLANT	TRUCK	ORDER NO.	SLUMP	P.O. #/JOB/LOT	GRID
617	8162	2047	5.0	830	

DRIVER NAME: ANDRA DARNELL — DATE: 4/30/20

CUSTOMER NUMBER	PROJECT	CUM. QTY	ORDERED QTY
503195	89128	5.00	5.00

LOAD QUANTITY	PRODUCT CODE	DESCRIPTION	UNIT PRICE	AMOUNT
5.00	CYDS	R9Z40625 COM,RG,2,4000,RE		

SPECIAL DELIVERY INSTRUCTIONS
SOUTH 2818, RIGHT LEONARD RD, RIGHT ON HWY 47, LEFT INTO RELLISSTRAIGHT TO GATE AND THEY WILLMEET YOU

SALES TAX

TOTAL

DANGER! MAY CAUSE ALKALI BURNS.
SEE WARNINGS ON REVERSE SIDE.

FOR OFFICE USE ONLY **FORM:**

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
8162	745154	user	6038645	82783	10:55	4/30/20

Load Size	Mix Code	Returned	Mix Age	Seq	Load ID
5.00 CYDS	R9Z40625			D	83864

Material	Design Qty	Required	✓	Batched	% Var	% Moisture	Actual Wat
1"RG	1303 lb	6541 lb		6549 lb	-0.02%	0.40% M	3 gl
3/8"PG	506 lb	2540 lb		2520 lb	-0.79%	0.40% M	1 gl
SAND-1	1403 lb	7346 lb		7360 lb	-0.20%	4.50% M	40 gl
CMT-T/II	394 lb	1970 lb		1950 lb	-1.02%		
FLYASH-C	131 lb	657 lb		650 lb	-0.76%		
H20	250 lb	750 lb		744 lb	-1.84%		89 gl
ZY-610	16 oz	99 oz		99 oz	0.51%		

Actual Num Batches: 1
Load Totals: 19770 lb Design 0.476 Water/Cement 0.481 T Design 149.8 gl Actual 133.2 gl To Add: 11.6 gl
Slump: 5.00 in % Water in Trucks: 5.0 gl Adjust Water: 0.0 gl / Load Tank Water: -2.6 gl / CYD

CONCRETE COMPRESSIVE STRENGTH TEST REPORT

Report Number: A1171057.0113
Service Date: 04/30/20
Report Date: 07/08/20 Revision 1 -
Task: PO #612061

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: 4,000 psi @ 28 days

Mix ID: R9z40625
Supplier: Martin Marrieta
Batch Time: 1050 **Plant:** 617
Truck No.: 8162 **Ticket No.:** 6038245

Sample Information

Sample Date: 04/30/20 **Sample Time:** 1145
Sampled By: Matcek, James
Weather Conditions: Sunny
Accumulative Yards: 5.0 **Batch Size (cy):** 5
Placement Method: Direct Discharge
Water Added Before (gal): 0
Water Added After (gal): 0
Sample Location: Centerline
Placement Location: Merritt Parkway

Field Test Data

Test	Result	Specification
Slump (in):	4 1/2	Not Specified
Air Content (%):	1.7	Not Specified
Concrete Temp. (F):	79	40 - 95
Ambient Temp. (F):	70	40 - 95
Plastic Unit Wt. (pcf):	150.2	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	6.01	28.37	05/01/20	06/01/20	32	136,210	4,800	3	SLS
1	B	6.01	28.37	05/01/20	06/01/20	32	142,080	5,010	1	SLS
1	C	6.01	28.37	05/01/20	06/01/20	32	138,130	4,870	2	SLS
						Average (32 days)		**4,890**		
1	D			05/01/20		Hold				

Initial Cure: Outside **Final Cure:** Field Cured

Comments: **Average compressive strength of 32 day cylinders complies with the specified strength.**

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.: Matcek, James **Start/Stop:** 0945-1215
Reported To:
Contractor:
Report Distribution:
(1) Texas Transportation Institute, Gary Gerke (1) Terracon Consultants, Inc., Alex Dunigan, P.E.
(1) Texas Transportation Institute, Bill Griffith

Reviewed By:
Alexander Dunigan
Project Manager

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

Texas A&M Transportation Institute Proving Ground 3100 SH 47, Bldg 7091 Bryan, TX 77807 Texas A&M University College Station, TX 77843 Phone 979-845-6375	QF 7.3-01 Concrete Sampling	Doc. No. QF 7.3-01	Issue Date: 2018-06-18
Quality Form	Prepared by: Wanda L. Menges Approved by: Darrell L. Kuhn	Revision: 6	Page: 1 of 1

Project No: 612061 **Casting Date:** 5/22/2020 **Mix Design (psi):** 4000 psi

Name of Technician Taking Sample: Teracon

Name of Technician Breaking Sample: Teracon

Signature of Technician Taking Sample: Teracon

Signature of Technician Breaking Sample: Teracon

Load No.	Truck No.	Ticket No.	Location (from concrete map)
T1	8120	6080436	Anchor Block, Parapet, and terminal Curb to barrier

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

CUSTOMER'S COPY

TICKET NO. 6080436

Martin Marietta

1503 LBJ Freeway
Suite 400
Dallas, Tx 75234

LOAD TIME	TO JOB	ARRIVE JOB SITE	BEGIN POUR	FINISH POUR	LEAVE JOB SITE	ARRIVE PLANT
8:29	8:40	9:00	:	:	:	:

WATER ADDED ON JOB AT CUSTOMER'S REQUEST _____ GAL.
ALLOWABLE WATER (withheld from batch) _____ GAL.
TEST CYLINDER TAKEN ❑ YES ❑ NO BY _____
CYLINDER TAKEN ❑ BEFORE ❑ AFTER WATER

ADDITIONAL WATER ADDED TO THIS CONCRETE WILL REDUCE ITS STRENGTH. ANY WATER ADDED IN EXCESS OF SPECIFIED SLUMP IS AT CUSTOMER'S RISK.

CUSTOMER SIGNATURE
X

DELIVERY OF THESE MATERIALS IS SUBJECT TO THE TERMS AND CONDITIONS ON THE REVERSE SIDE HEREOF AS ACCEPTED BY SIGNATURE ABOVE .

CUSTOMER NAME AND DELIVERY ADDRESS
BRYAN CONSTRUCTION C
RELLIS CAMPUS/TTI, CO

PLANT	TRUCK	ORDER NO.	SLUMP	P.O. #/JOB/LOT	GRID
617	8120	2033	5.0	302-10-13	

DRIVER NAME: Jeneay Freeman
DATE: 5/22/20

CUSTOMER NUMBER	PROJECT	CUM. QTY	ORDERED QTY
509195	92332	4.00	4.00

LOAD QUANTITY	PRODUCT CODE	DESCRIPTION	UNIT PRICE	AMOUNT
4.00	CYDS	R9Z40625 COM, RG, Z, 4000, RE		

SPECIAL DELIVERY INSTRUCTIONS
SOUTH 2818, RIGHT LEONARD RD, RIGHT ON HWY 47, LEFT INTO RELLISSTRAIGHT TO GATE AND THEY WILLMEET YOU

SALES TAX

TOTAL

DANGER! MAY CAUSE ALKALI BURNS.
SEE WARNINGS ON REVERSE SIDE.

FOR OFFICE USE ONLY **FORM:**

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
8120	936950	user	6080436	83242	8:29	5/22/20

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
4.00	CYDS R9Z40625				D	84327

Material	Design Qty	Required	Batched	% Var	% Moisture	Actual Wat
1"RS	1303 lb	5220 lb	5260 lb	+ 0.62%	0.30% M	2 gl
3/8"PS	506 lb	2030 lb	2000 lb	-1.47%	0.29% M	1 gl
SAND-1	1403 lb	5852 lb	5880 lb	0.48%	4.10% M	29 gl
CMT-I/II	394 lb	1576 lb	1590 lb	0.89%		
FLYASH-C	131 lb	524 lb	525 lb	0.19%		
H20	250 lb	675 lb	668 lb	-1.05%		80 gl
ZY-610	16 oz	79 oz	80 oz	1.52%		

Actual Num Batches: 1
Load Total: 15928 lb Design 0.476 Water/Cement 0.473 T Design 119.8 gl Actual 111.5 gl To Add: 8.3 gl
Slump: 5.00 in # Water in Truck: 0.0 gl Adjust Water: 0.0 gl / Load Trim Water: -1.9 gl/ CYD

CONCRETE COMPRESSIVE STRENGTH TEST REPORT

Report Number: A1171057.0118
Service Date: 05/22/20
Report Date: 05/22/20
Task: PO #612061

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: 4,000 psi @ 28 days

Mix ID: R9Z40625
Supplier: Martin Marietta
Batch Time: 0829 **Plant:** 617
Truck No.: 8120 **Ticket No.:** 6080436

Sample Information

Sample Date: 05/22/20 **Sample Time:** 0907
Sampled By: Jacob Epps
Weather Conditions: Cloudy, windy
Accumulative Yards: 4/4 **Batch Size (cy):** 4
Placement Method: Direct Discharge
Water Added Before (gal): 0
Water Added After (gal): 0
Sample Location: Bottom 1/3 of guard rail wall
Placement Location: Merritt Parkway guard rail wall, anchor, and terminal curb sections

Field Test Data

Test	Result	Specification
Slump (in):	3 3/4	Not Specified
Air Content (%):	1.5	Not Specified
Concrete Temp. (F):	88	40 - 95
Ambient Temp. (F):	84	40 - 95
Plastic Unit Wt. (pcf):	148.4	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	05/26/20	07/07/20	46 F	149,250	5,280	2	SLS
1	B	6.00	28.27	05/26/20	07/07/20	46 F	161,690	5,720	6	SLS
1	C	6.00	28.27	05/26/20	07/07/20	46 F	161,650	5,720	2	SLS
1	D			05/26/20		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.: Jacob Epps **Start/Stop:** 0800-1030
Reported To:
Contractor:
Report Distribution:
(1) Texas Transportation Institute, Gary Gerke (1) Terracon Consultants, Inc., Alex Dunigan, P.E.
(1) Texas Transportation Institute, Bill Griffith

Reviewed By: Alexander Dunigan
Project Manager

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

Texas A&M Transportation Institute Proving Ground 3100 SH 47, Bldg 7091 Bryan, TX 77807 Texas A&M University College Station, TX 77843 Phone 979-845-6375	QF 7.3-01 Concrete Sampling	Doc. No. QF 7.3-01	Issue Date: 2018-06-18
Quality Form	Prepared by: Wanda L. Menges Approved by: Darrell L. Kuhn	Revision: 6	Page: 1 of 1

Project No: 612061 **Casting Date:** 6/11/2020 **Mix Design (psi):** 4000 psi

Name of Technician Taking Sample: Teracon

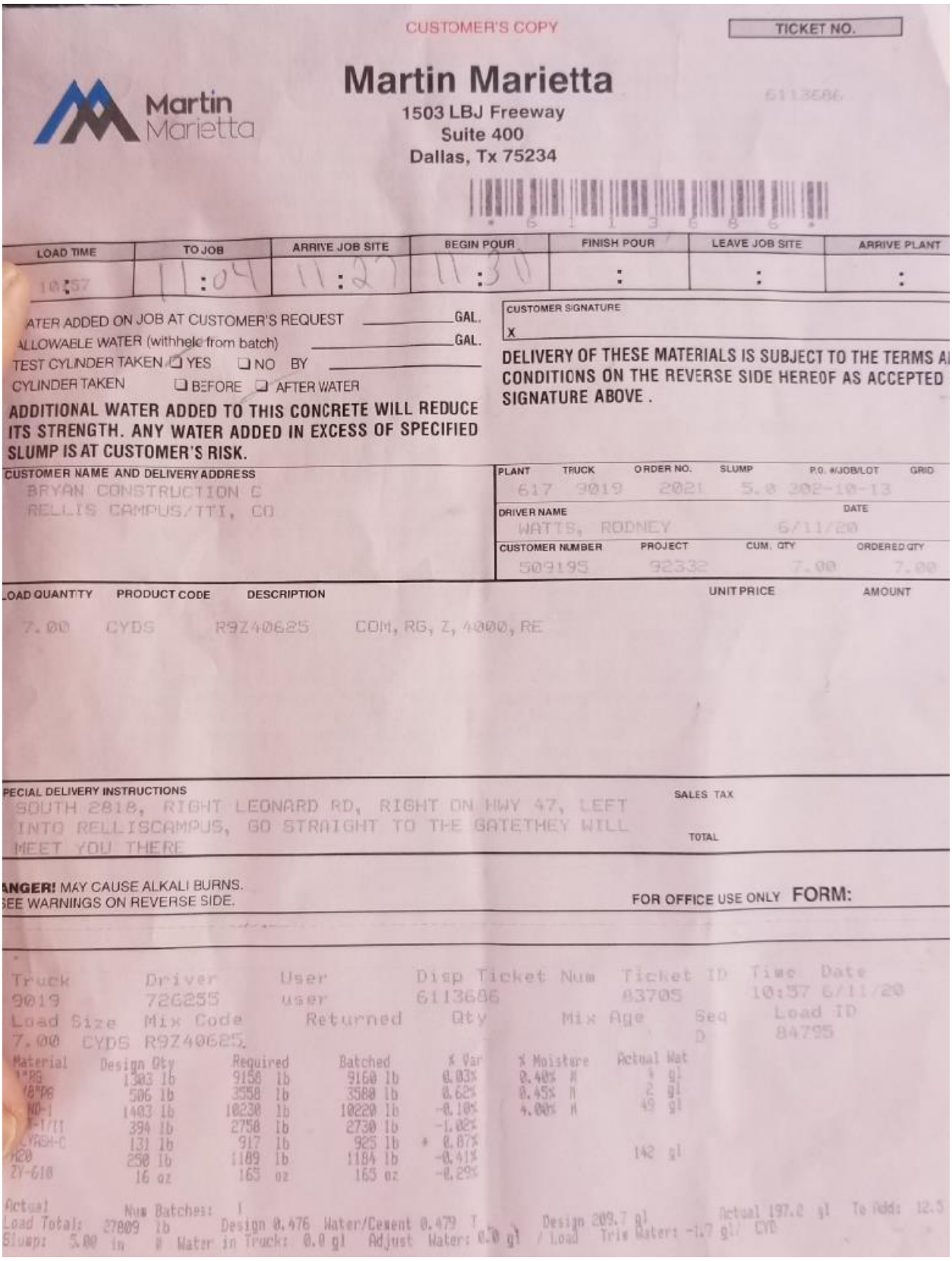
Name of Technician Breaking Sample: Teracon

Signature of Technician Taking Sample: Teracon

Signature of Technician Breaking Sample: Teracon

Load No.	Truck No.	Ticket No.	Location (from concrete map)
T1	9019	6113686	100% of curb

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



CUSTOMER'S COPY

TICKET NO. 6113686

Martin Marietta

1503 LBJ Freeway
Suite 400
Dallas, Tx 75234

LOAD TIME	TO JOB	ARRIVE JOB SITE	BEGIN POUR	FINISH POUR	LEAVE JOB SITE	ARRIVE PLANT
10:57	11:04	11:27	11:30	:	:	:

ATER ADDED ON JOB AT CUSTOMER'S REQUEST _____ GAL.
ALLOWABLE WATER (withheld from batch) _____ GAL.
TEST CYLINDER TAKEN ❑ YES ❑ NO BY _____
CYLINDER TAKEN ❑ BEFORE ❑ AFTER WATER

ADDITIONAL WATER ADDED TO THIS CONCRETE WILL REDUCE ITS STRENGTH. ANY WATER ADDED IN EXCESS OF SPECIFIED SLUMP IS AT CUSTOMER'S RISK.

CUSTOMER SIGNATURE
X

DELIVERY OF THESE MATERIALS IS SUBJECT TO THE TERMS A CONDITIONS ON THE REVERSE SIDE HEREOF AS ACCEPTED SIGNATURE ABOVE .

CUSTOMER NAME AND DELIVERY ADDRESS
BRYAN CONSTRUCTION C
RELLIS CAMPUS/TTI, CO

PLANT	TRUCK	ORDER NO.	SLUMP	P.O. #/JOB/LOT	GRID
617	9019	2021	5.0	302-10-13	

DRIVER NAME: WATTS, RODNEY — DATE: 6/11/20

CUSTOMER NUMBER	PROJECT	CUM. QTY	ORDERED QTY
509195	92332	7.00	7.00

LOAD QUANTITY	PRODUCT CODE	DESCRIPTION	UNIT PRICE	AMOUNT
7.00	CYDS	R9Z40625 COM, RG, Z, 4000, RE		

SPECIAL DELIVERY INSTRUCTIONS
SOUTH 2818, RIGHT LEONARD RD, RIGHT ON HWY 47, LEFT INTO RELLISCAMPUS, GO STRAIGHT TO THE GATETHEY WILL MEET YOU THERE

SALES TAX

TOTAL

ANGER! MAY CAUSE ALKALI BURNS.
SEE WARNINGS ON REVERSE SIDE.

FOR OFFICE USE ONLY FORM:

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time Date
9019	726255	user	6113686	83705	10:57 6/11/20

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
7.00	CYDS R9Z40625				D	84795

Material	Design Qty	Required	Batched	% Var	% Moisture	Actual Wat
1"RG	1303 lb	9156 lb	9160 lb	0.03%	0.40% H	4 gl
/8"PG	506 lb	3558 lb	3580 lb	0.62%	0.45% H	2 gl
NO-1	1403 lb	10230 lb	10220 lb	-0.10%	4.00% H	49 gl
-1/11	394 lb	2758 lb	2730 lb	-1.02%		
YRGH-C	131 lb	917 lb	925 lb	* 0.87%		
H20	250 lb	1189 lb	1184 lb	-0.41%		142 gl
ZY-610	16 oz	163 oz	165 oz	-0.29%		

Actual Load Total: 27009 lb — Num Batches: 1 — Design 0.476 Water/Cement 0.479 T — Design 209.7 gl / Load — Actual 197.2 gl — To Add: 12.5 gl/ CYD
Slump: 5.00 in — # Water in Truck: 0.0 gl — Adjust Water: 0.0 gl — Trim Water: -1.7 gl

CONCRETE COMPRESSIVE STRENGTH TEST REPORT

Report Number: A1171057.0120
Service Date: 06/11/20
Report Date: 06/11/20
Task: PO #612061

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: 4,000 psi @ 28 days

Mix ID:
Supplier: Martin Marietta Conc
Batch Time: 1057 **Plant:**
Truck No.: 9019 **Ticket No.:** 6113686

Sample Information

Sample Date: 06/11/20 **Sample Time:** 1200
Sampled By: Randolph E. Rohrbach
Weather Conditions: Clear, light wind
Accumulative Yards: 7/7 **Batch Size (cy):** 7
Placement Method: Direct Discharge
Water Added Before (gal): 0
Water Added After (gal): 0
Sample Location: Center section
Placement Location: Barricade curb

Field Test Data

Test	Result	Specification
Slump (in):	2 1/2	
Air Content (%):		
Concrete Temp. (F):	89	
Ambient Temp. (F):	87	
Plastic Unit Wt. (pcf):		
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	07/07/20	07/07/20	26 F	129,670	4,590	1	SLS
1	B	6.00	28.27	07/07/20	07/07/20	26 F	134,650	4,760	2	SLS
1	C	6.00	28.27	07/07/20	07/07/20	26 F	123,560	4,370	2	SLS
1	D			07/07/20		Hold				

Initial Cure: Outside **Final Cure:** Field Cured

Comments: Not tested for plastic unit weight. 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.: Randolph E. Rohrbach **Start/Stop:** 1130-1315
Reported To:
Contractor:
Report Distribution:
(1) Texas Transportation Institute, Gary Gerke
(1) Terracon Consultants, Inc., Alex Dunigan, P.E.
(1) Texas Transportation Institute, Bill Griffith

Reviewed By:
Alexander Dunigan
Project Manager

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

Texas A&M Transportation Institute Proving Ground 3100 SH 47, Bldg 7091 Bryan, TX 77807 Texas A&M University College Station, TX 77843 Phone 979-845-6375	QF 7.3-01 Concrete Sampling	Doc. No. QF 7.3-01	Issue Date: 2018-06-18
Quality Form	Prepared by: Wanda L. Menges Approved by: Darrell L. Kuhn	Revision: 6	Page: 1 of 1

Project No: 612061 **Casting Date:** 7/21/2020 **Mix Design (psi):** 4000 psi

Name of Technician Taking Sample: Teracon

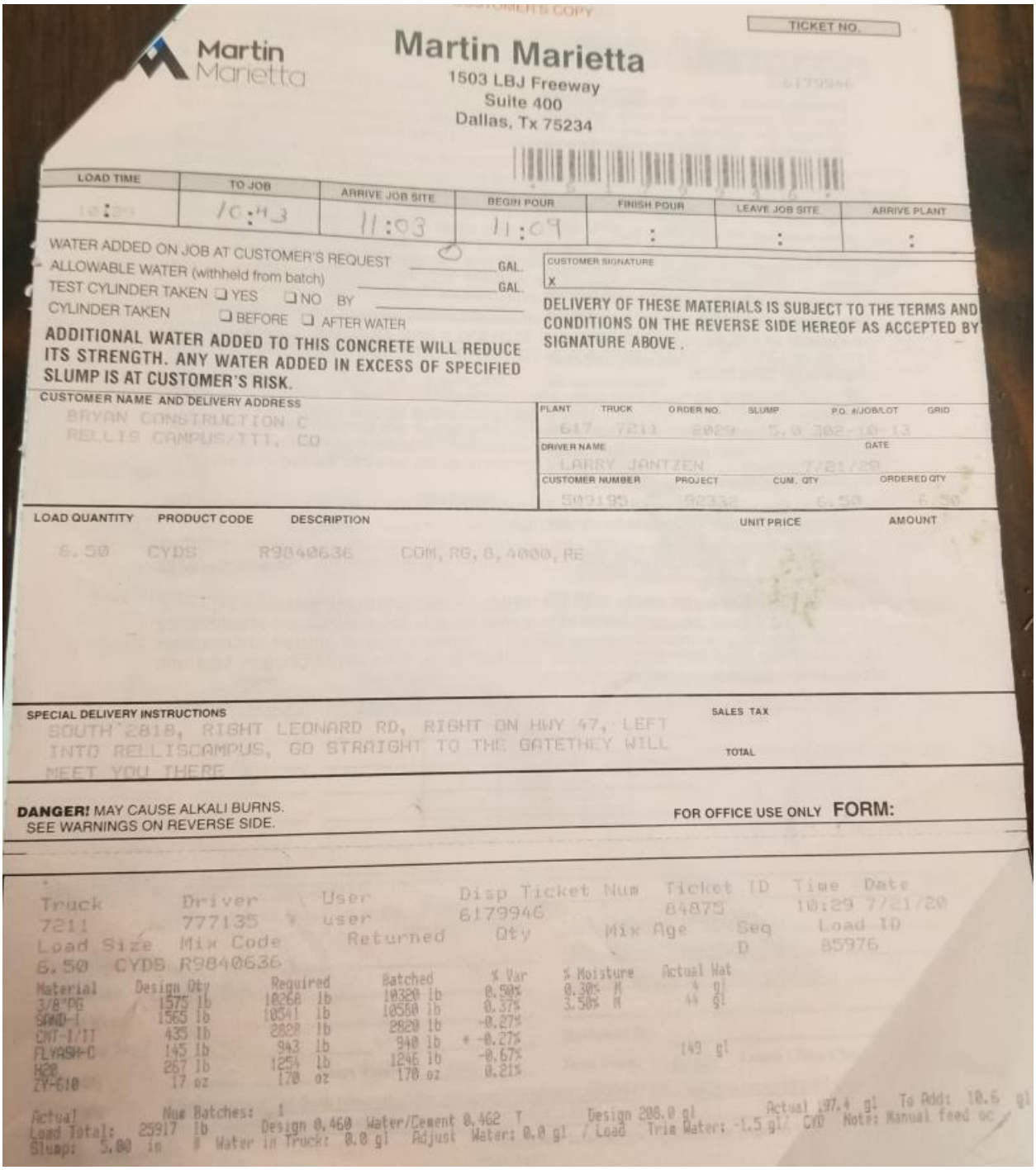
Name of Technician Breaking Sample: Teracon

Signature of Technician Taking Sample: Teracon

Signature of Technician Breaking Sample: Teracon

Load No.	Truck No.	Ticket No.	Location (from concrete map)
T1	7211	6179946	100% of curb

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



Martin Marietta

Martin Marietta
1503 LBJ Freeway
Suite 400
Dallas, Tx 75234

TICKET NO.

LOAD TIME	TO JOB	ARRIVE JOB SITE	BEGIN POUR	FINISH POUR	LEAVE JOB SITE	ARRIVE PLANT
:	10:43	11:03	11:09	:	:	:

WATER ADDED ON JOB AT CUSTOMER'S REQUEST _____ GAL.
ALLOWABLE WATER (withheld from batch) _____ GAL.
TEST CYLINDER TAKEN ❑ YES ❑ NO BY _____
CYLINDER TAKEN ❑ BEFORE ❑ AFTER WATER

ADDITIONAL WATER ADDED TO THIS CONCRETE WILL REDUCE ITS STRENGTH. ANY WATER ADDED IN EXCESS OF SPECIFIED SLUMP IS AT CUSTOMER'S RISK.

CUSTOMER SIGNATURE
X

DELIVERY OF THESE MATERIALS IS SUBJECT TO THE TERMS AND CONDITIONS ON THE REVERSE SIDE HEREOF AS ACCEPTED BY SIGNATURE ABOVE.

CUSTOMER NAME AND DELIVERY ADDRESS
BRYAN CONSTRUCTION C
RELLIS CAMPUS/TTI, CO

PLANT	TRUCK	ORDER NO.	SLUMP	P.O. #/JOB/LOT	GRID
617	7211	8029	5.0	302-18-13	

DRIVER NAME: LARRY JANTZEN — DATE: 7/21/20

CUSTOMER NUMBER	PROJECT	CUM. QTY	ORDERED QTY
503195	92332	6.50	6.50

LOAD QUANTITY	PRODUCT CODE	DESCRIPTION	UNIT PRICE	AMOUNT
6.50	CYDS	R9840636 COM,RG,B,4000,RE		

SPECIAL DELIVERY INSTRUCTIONS
SOUTH 2818, RIGHT LEONARD RD, RIGHT ON HWY 47, LEFT INTO RELLISCAMPUS, GO STRAIGHT TO THE GATETHEY WILL MEET YOU THERE

SALES TAX
TOTAL

DANGER! MAY CAUSE ALKALI BURNS. SEE WARNINGS ON REVERSE SIDE.

FOR OFFICE USE ONLY **FORM:**

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
7211	777135	user	6179946	84875	10:29	7/21/20

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
6.50	CYDS R9840636				D	85976

Material	Design Qty	Required	Batched	% Var	% Moisture	Actual Wat
3/8"PG	1575 lb	10268 lb	10320 lb	0.50%	0.38% M	4 gl
SAND-I	1565 lb	10541 lb	10560 lb	0.37%	3.58% M	44 gl
CNT-I/II	435 lb	2828 lb	2820 lb	-0.27%		
FLYASH-C	145 lb	943 lb	940 lb	* -0.27%		149 gl
H20	267 lb	1254 lb	1246 lb	-0.67%		
ZY-610	17 oz	170 oz	170 oz	0.21%		

Actual Load Total: 25917 lb — Num Batches: 1 — Design 0.460 Water/Cement 0.462 T — Design 208.0 gl — Actual 197.4 gl — To Add: 10.6 gl
Slump: 5.00 in — # Water in Truck: 0.0 gl — Adjust Water: 0.0 gl / Load — Trim Water: -1.5 gl / CYD — Note: Manual feed oc

CONCRETE COMPRESSIVE STRENGTH TEST REPORT

Report Number: A1171057.0121
Service Date: 07/21/20
Report Date: 07/21/20
Task: PO #612061

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: 4,000 psi @ 28 days

Mix ID: R98440636
Supplier: Martin Marietta
Batch Time: 1029 **Plant:** 617
Truck No.: 7211 **Ticket No.:** 6179946

Sample Information

Sample Date: 07/21/20 **Sample Time:** 1137
Sampled By: Adam Hill
Weather Conditions: cloudy, low wind
Accumulative Yards: 6.5/6.5 **Batch Size (cy):** 6.5
Placement Method: Direct Discharge
Water Added Before (gal): 0
Water Added After (gal): 0
Sample Location: Direct middle of 10 yd length
Placement Location: PO #612061, Main runway, SW end, curb/box

Field Test Data

Test	Result	Specification
Slump (in):	5 1/4	Not Specified
Air Content (%):	1.6	Not Specified
Concrete Temp. (F):	92	40 - 95
Ambient Temp. (F):	85	40 - 95
Plastic Unit Wt. (pcf):	142.9	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	07/22/20	09/02/20	43	148,100	5,240		SLS
1	B	6.00	28.27	07/22/20	09/02/20	43	146,820	5,190		SLS
1	C	6.00	28.27	07/22/20	09/02/20	43	145,110	5,130		SLS
						Average (43 days)		**5,190**		
1	D			07/22/20		Hold				

Initial Cure: Outside **Final Cure:** Field Cured

Comments: **Average compressive strength of 43 day cylinders complies with the specified strength.**

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.: Adam Hill **Start/Stop:** 1000-1200
Reported To: Gary Gerke
Contractor:
Report Distribution:
(1) Texas Transportation Institute, Gary Gerke (1) Terracon Consultants, Inc., Alex Dunigan, P.E.
(1) Texas Transportation Institute, Bill Griffith

Reviewed By:
Alexander Dunigan
Project Manager

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

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APPENDIX C. MODIFIED MERRITT PARKWAY GUIDERAIL WITH NO CURB

Notes

1a. Drill Ø24" holes for Posts. Backfill Post holes and around Anchor Block with AASHTO M147-65(2004), grade B crushed limestone road base, compacted to MASH standard.

1b. Threads not shown on Bolts, Nuts, etc for clarity.

1c. Material:

Steel: All steel posts, back-up rails, splice plates and channel rubrails which are to be used as "Weathering Steel", shall meet the requirements of ASTM A588. The fabricator shall notify the manufacturer that it is "Weathering Steel" (structural steel for use in bare, unpainted applications) and that the steel shall not be marked with paint or steel die stamped, but identification shall be stenciled with permanent ink. The dimensions of each component shall conform to the plans and ASTM A6. All steel posts shall be galvanized after fabrication to meet the requirements of ASTM A123 and conform to the galvanizing limits and tolerances shown on the plans. A single ¾" diameter hole may be drilled 2" from the top of each post, in the center of the web, to facilitate the galvanizing process on the bottom of all posts.

Timber: All timber rail and block-out components shall conform with the following:

a) Commercial lumber grade No. 1 or better after treatment;

b) AASHTO M 168;

c) Minimum stress rating of 1350 psi

d) Rough sawn (non-planed) or S4S (surface four side) Southern Yellow Pine or Douglas Fir- Larch with nominal dimensions as indicated on the plans. Variations in the size of any dimension shall not be more than ± ¼"

e) All timber components shall be pressure treated with CCA or ACZA depending on species supplied conforming to AWPA Standard P5 to a minimum net retention of 0.60lb/cubic foot in the assay zone in accordance with AWPA Standard C14.

f) All timber components shall be fabricated (including but not necessarily limited to cutting, drilling, dapping and chamfering) prior to treatment.

g) All timber components shall be free of excess preservative and solvent at the conclusion of the treating process. Post treatment cleaning shall be by expansion bath or steaming in accordance with AWPA Standard C2;

h) Kiln or air dried to a maximum moisture content of 25% after treatment (KDAT - 25);

i) Grade-marked after treatment by an agency certified by the American Lumber Standard Committee (ALSC).

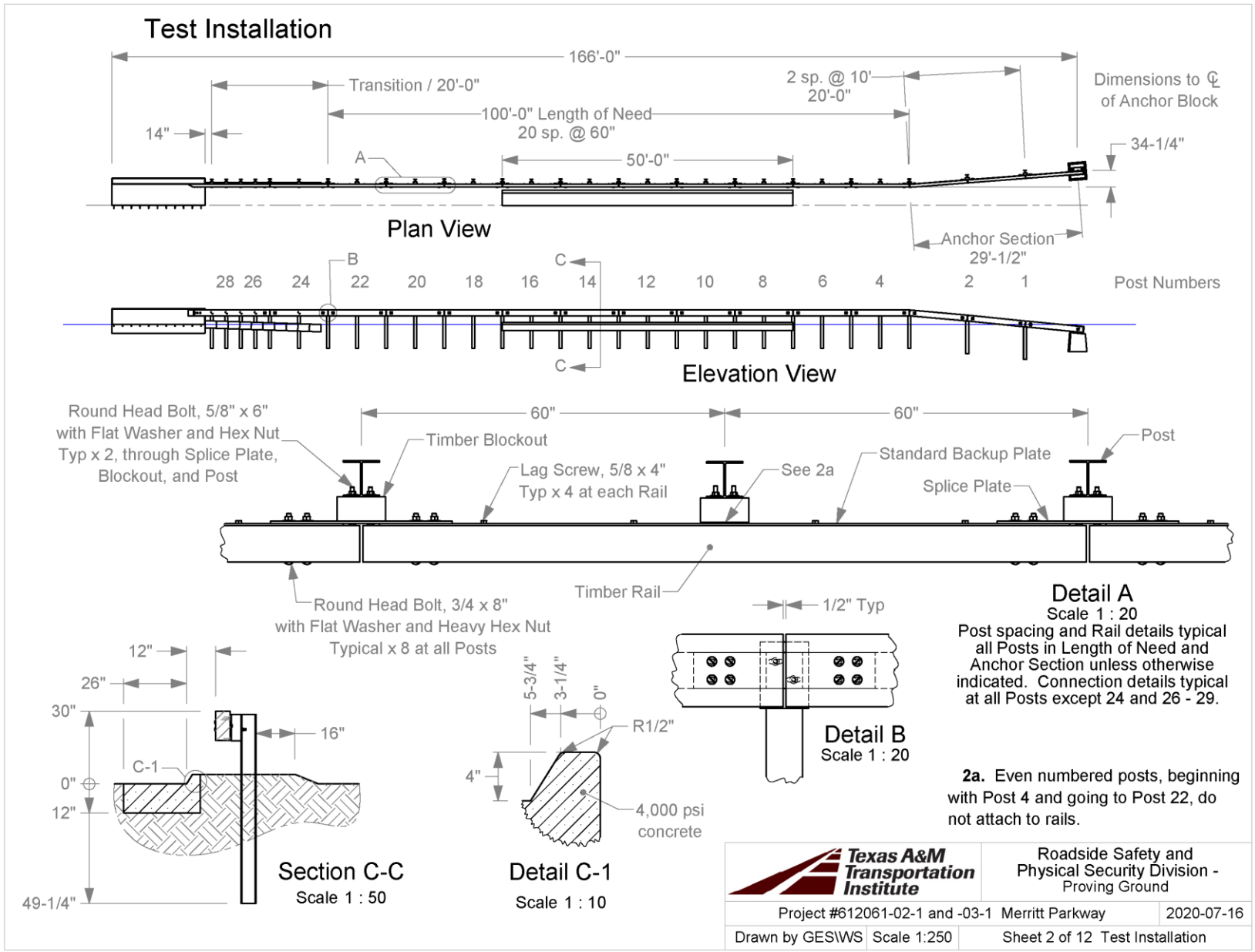
Fasteners:

a) Round head bolts shall be manufactured in accordance with the sizes designated on the plans, the geometric specifications included in ANSI B18.5.1.2.2 and the material specifications for ASTM A588 steel. All round head bolts shall be marked with the manufacturers symbol and A588.

b) Hex Lag Screws shall be manufactured in accordance with ASTM A307 Grade A specifications. All Hex Lag Screws shall be hot-dipped galvanized in accordance with ASTM A153 Class C.

c) Nuts, and Washers shall be ASTM A588 steel.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #612061-02-1 and -03-1 Merritt Parkway		2020-07-16
Drawn by GES\WS	Scale 1:250	Sheet 1 of 12 Notes



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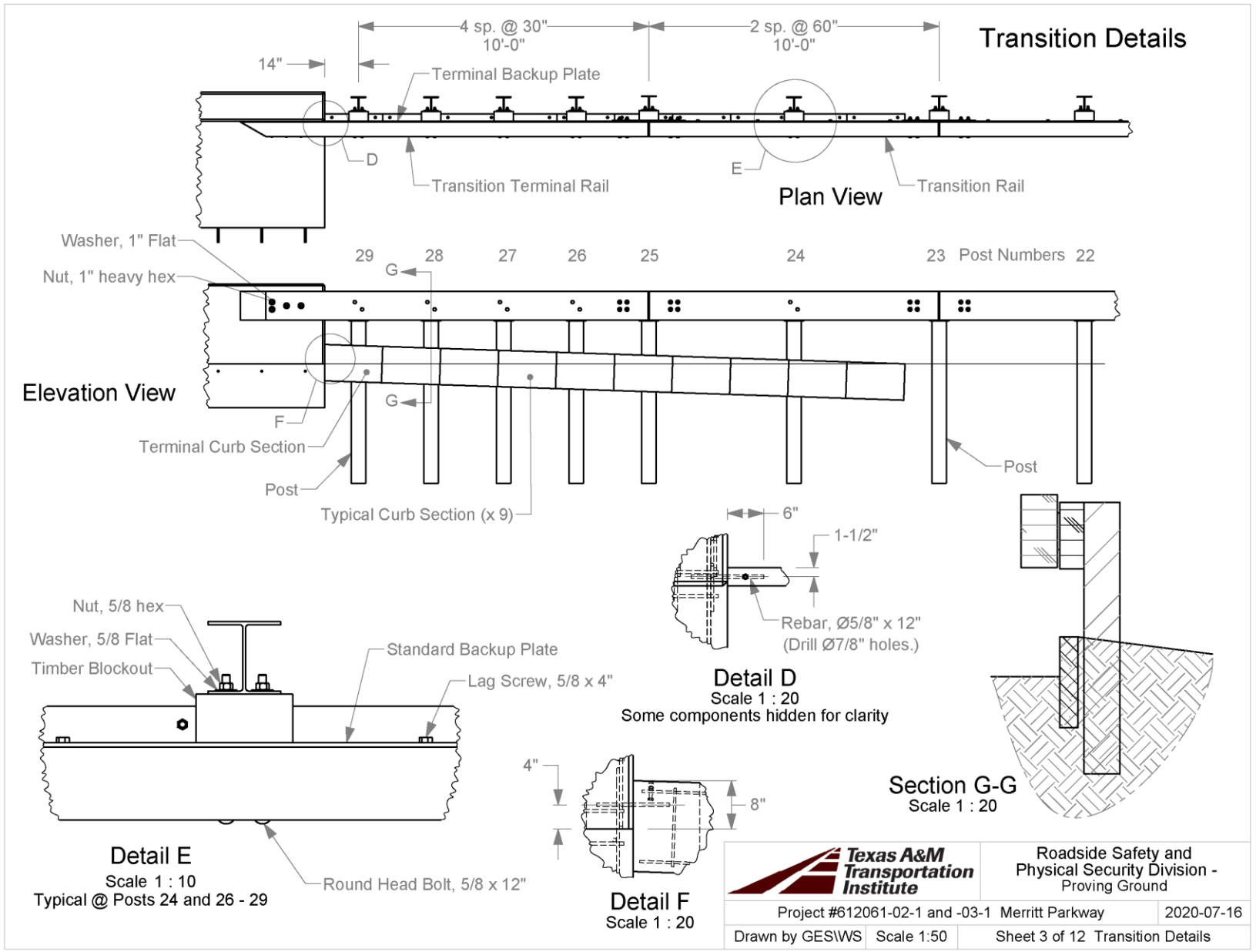

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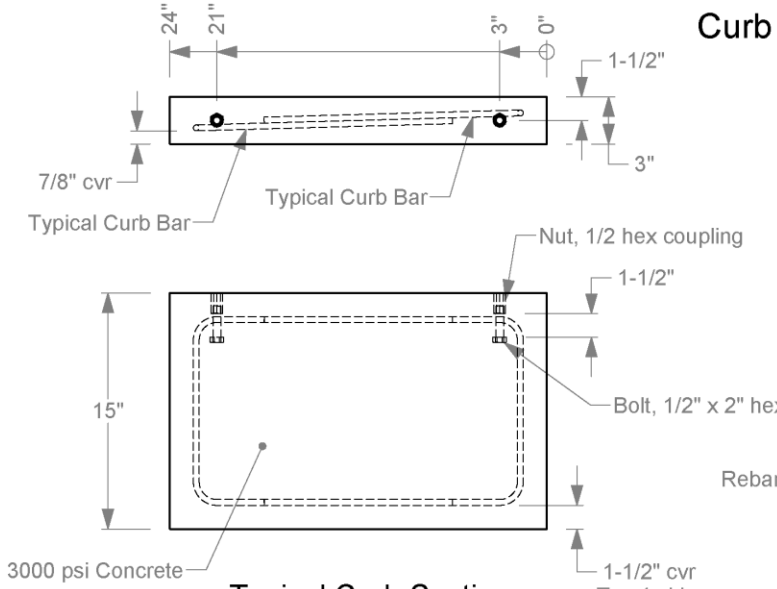
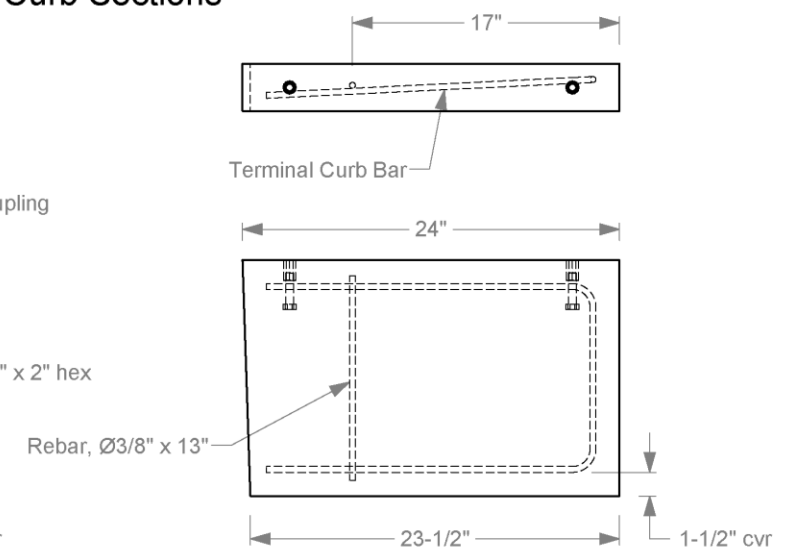
Curb Sections

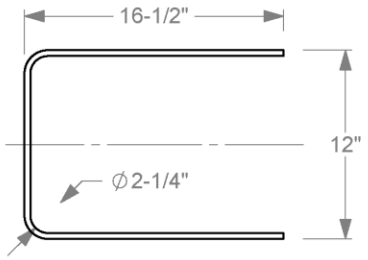


Typical Curb Section



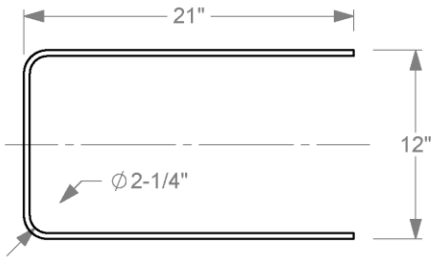
Terminal Curb Section

(see Typical Curb Section for all details not shown here)



Typical Curb Bar

Ø3/8" Rebar



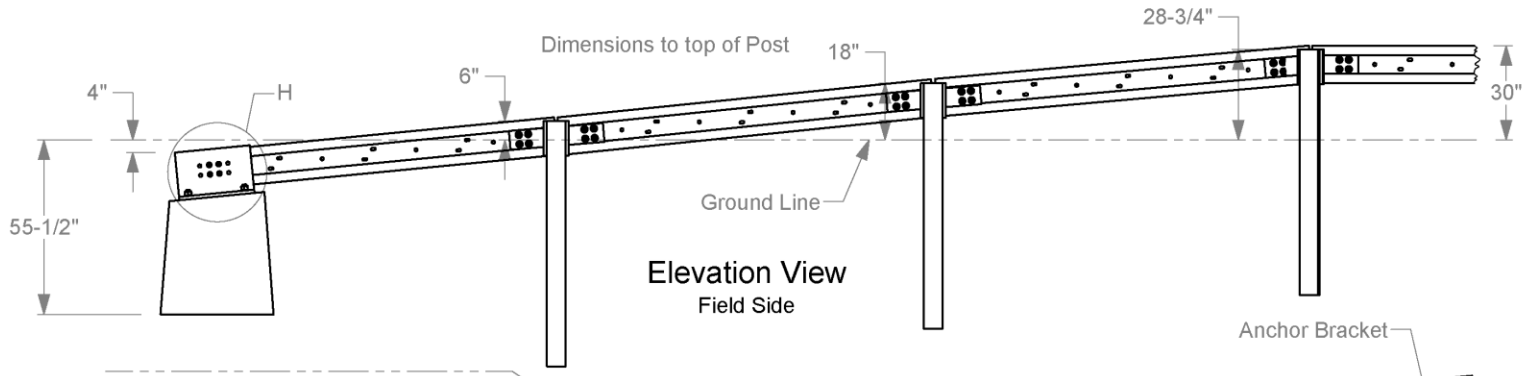
Terminal Curb Bar

Ø3/8" Rebar

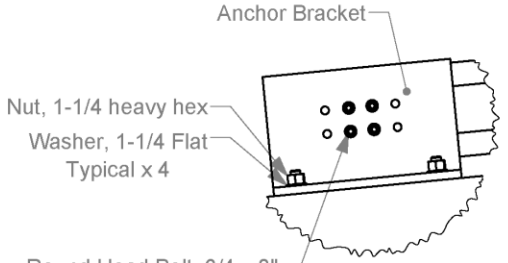
Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #612061-02-1 and -03-1 Merritt Parkway		2020-07-16
Drawn by GES\WS	Scale 1:10	Sheet 4 of 12 Curb Sections

Q:\Accreditation-17025-2017\EIR-000 Project Files\612061-Pooled Fund-Merritt Parkway-Chiara\Drafting, 612061 with curb\612061 w curb Drawing

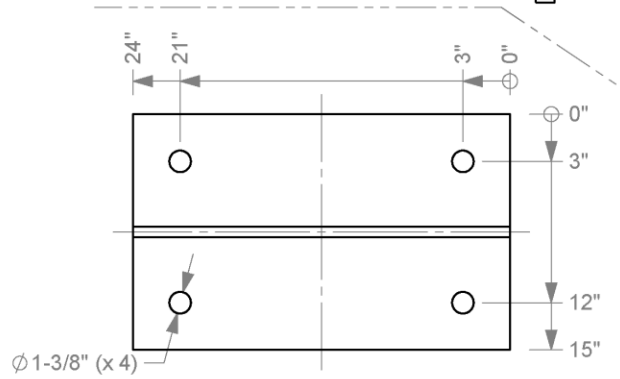
Anchor Details

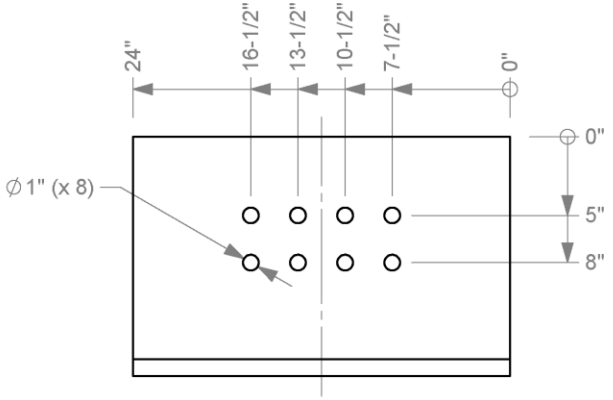


Elevation View
Field Side

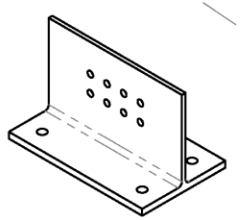


Detail H
Scale 1 : 20





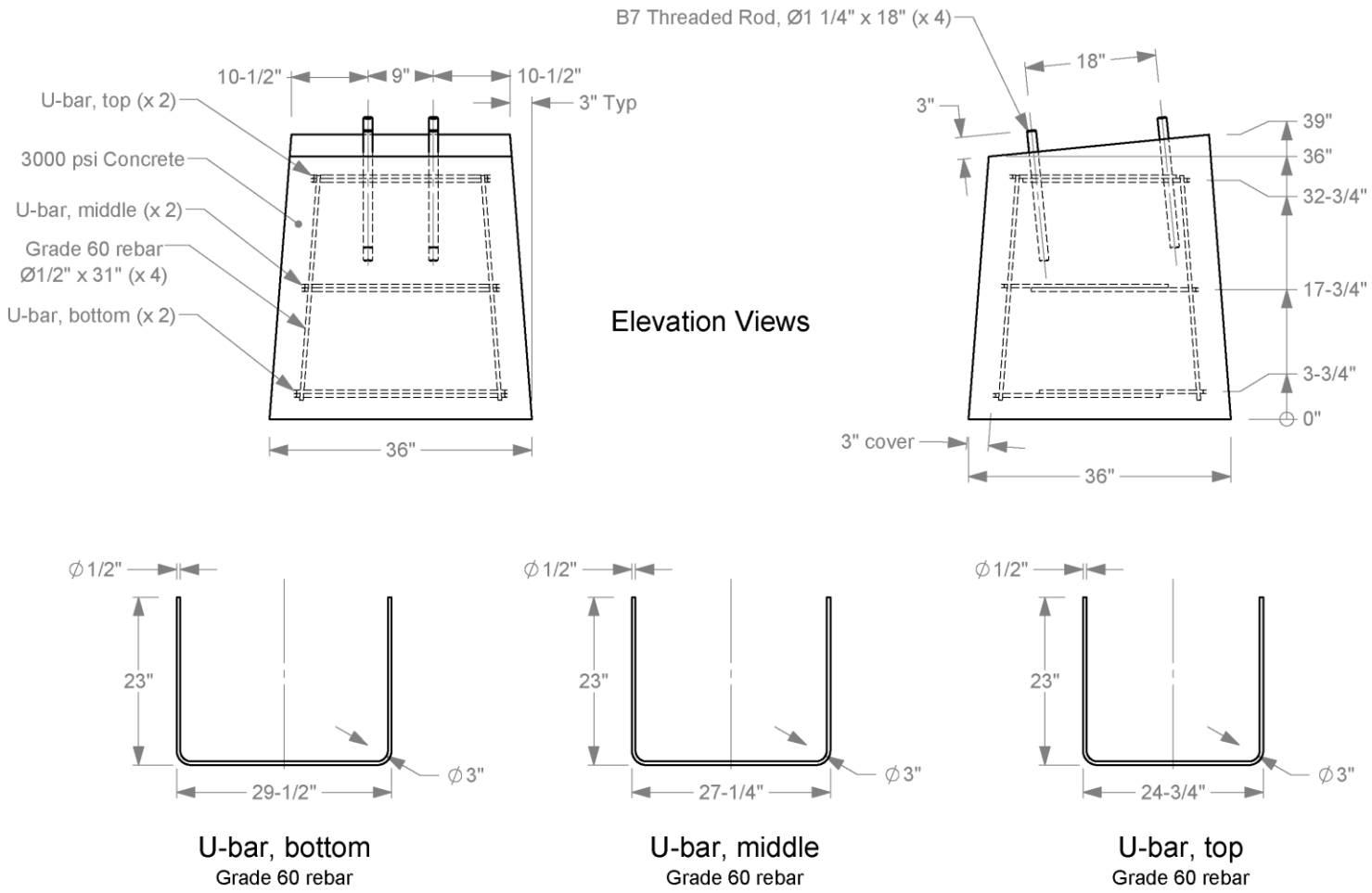
Anchor Bracket
WT 15 x 86.5
Galvanize after all fabrication is complete.
Scale 1:10



Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #612061-02-1 and -03-1 Merritt Parkway		2020-07-16
Drawn by GES\WS	Scale 1:50	Sheet 5 of 12 Anchor Details

Q:\Accreditation-17025-2017\EIR-000 Project Files\612061-Pooled Fund-Merritt Parkway-Chiara\Drafting, 612061 with curb\612061 w curb Drawing

Anchor Block



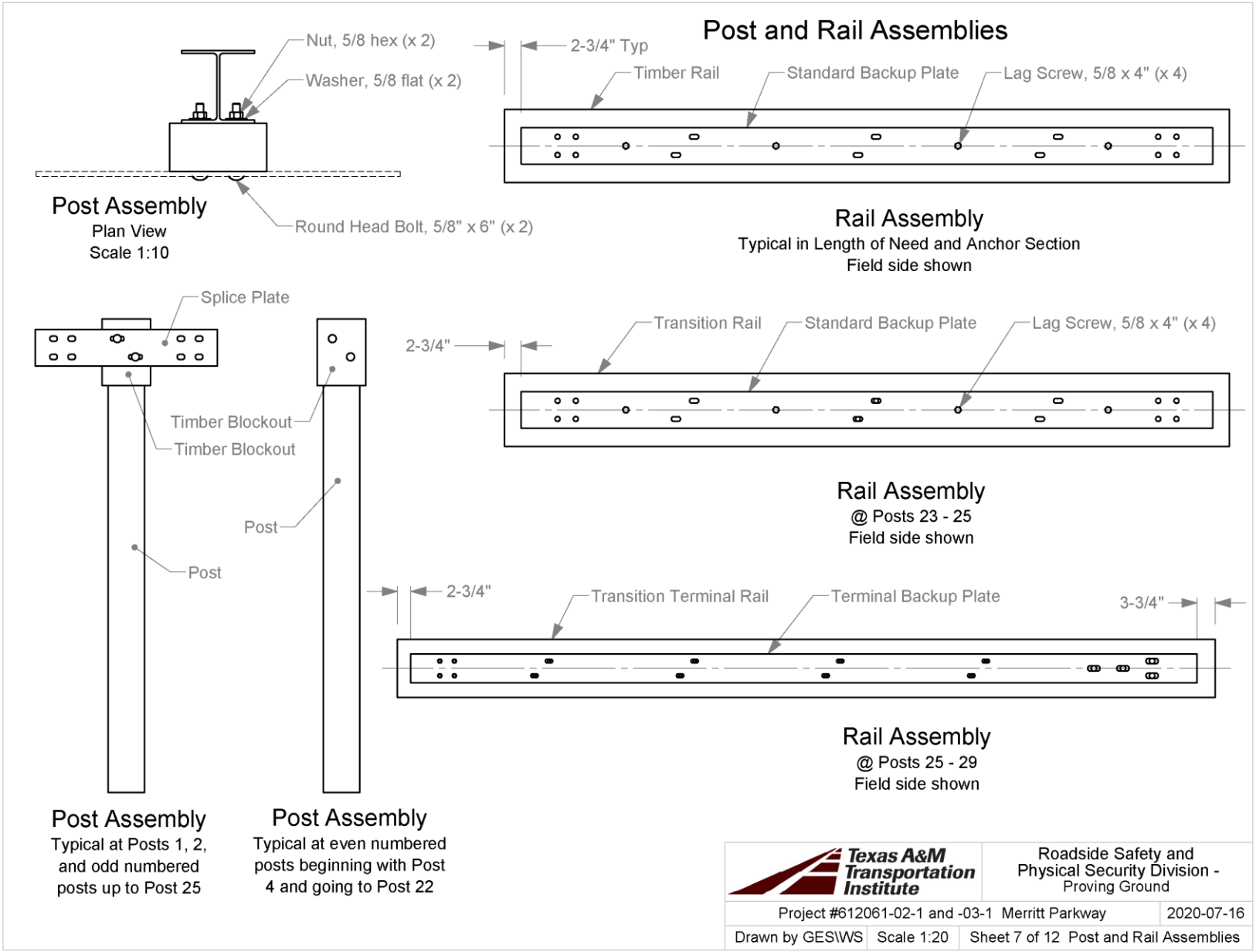
U-bar, bottom
Grade 60 rebar

U-bar, middle
Grade 60 rebar

U-bar, top
Grade 60 rebar

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #612061-02-1 and -03-1 Merritt Parkway		2020-07-16
Drawn by GES\WS	Scale 1:20	Sheet 6 of 12 Anchor Block

Q:\Accreditation-17025-2017\EIR-000 Project Files\612061-Pooled Fund-Merritt Parkway-Chiara\Drafting, 612061 with curb\612061 w curb Drawing


Post and Rail Assemblies
Nut, 5/8 hex (x 2)
Washer, 5/8 flat (x 2)
Round Head Bolt, 5/8" x 6" (x 2)
Post Assembly
Plan View
Scale 1:10
2-3/4" Typ
Timber Rail
Standard Backup Plate
Lag Screw, 5/8 x 4" (x 4)
Rail Assembly
Typical in Length of Need and Anchor Section
Field side shown
Splice Plate
Timber Blockout
Timber Blockout
Post
Post
Post Assembly
Typical at Posts 1, 2, and odd numbered posts up to Post 25
Post Assembly
Typical at even numbered posts beginning with Post 4 and going to Post 22
2-3/4"
Transition Rail
Standard Backup Plate
Lag Screw, 5/8 x 4" (x 4)
Rail Assembly
@ Posts 23 - 25
Field side shown
2-3/4"
Transition Terminal Rail
Terminal Backup Plate
3-3/4"
Rail Assembly
@ Posts 25 - 29
Field side shown
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
Project #612061-02-1 and -03-1 Merritt Parkway
2020-07-16
Drawn by GES\WS
Scale 1:20
Sheet 7 of 12 Post and Rail Assemblies
Q:\Accreditation-17025-2017\EIR-000 Project Files\612061-Pooled Fund-Merritt Parkway-Chiara\Drafting, 612061 with curb\612061 w curb Drawing

Rail Parts

Section F-F

Scale 1 : 10

Timber Rail

6" x 12" (nominal)

Post

Scale 1:20

Timber Blockout

Scale 1:5

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #612061-02-1 and -03-1 Merritt Parkway		2020-07-16
Drawn by GES\WS	Scale 1:20	Sheet 8 of 12 Rail Parts

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Texas A&M Transportation Institute

Roadside Safety and Physical Security Division - Proving Ground

Project #612061-02-1 and -03-1 Merritt Parkway		2020-07-16
Drawn by GES\WS	Scale 1:20	Sheet 9 of 12 Transition Rails

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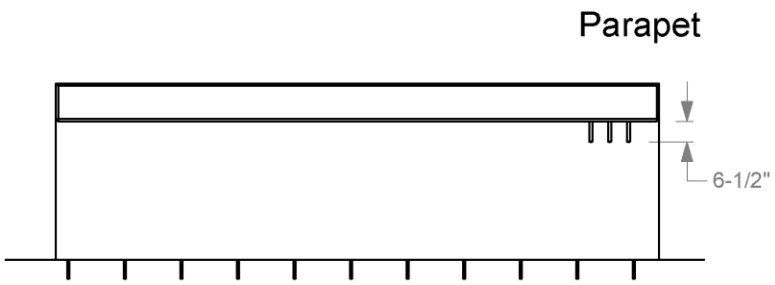

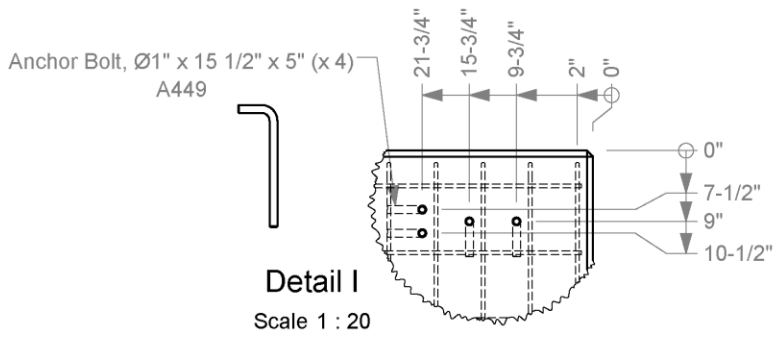

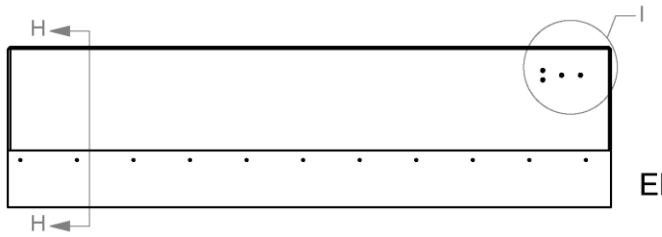

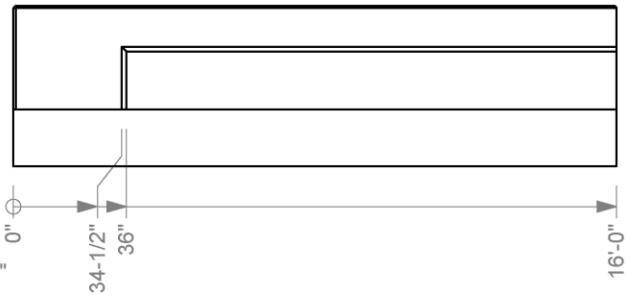

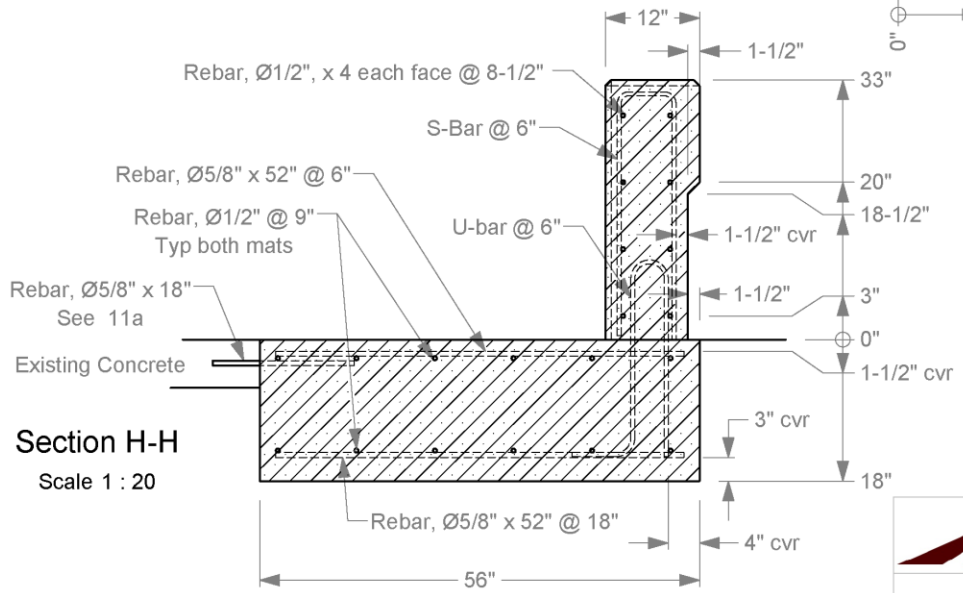

11a. Secure with Hilti HIT-RE 500 V3 epoxy according to manufacturer's instructions, with 6" embedment, at 18" spacing.

11b. Chamfer top edges of Wall, and vertical edges where shown, 3/4" each way.

11c. Concrete strength is 3600 psi, and all rebar is grade 60.

11d. Backfill field side and ends of foundation with native soil and compact to 95% of standard proctor density.

11e. Rebar dimensions are to center unless otherwise indicated by "cvr" (cover).

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #612061-02-1 and -03-1 Merritt Parkway		2020-07-16
Drawn by GES\WS	Scale 1:50	Sheet 11 of 12 Parapet

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Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #612061-02-1 and -03-1 Merritt Parkway		2020-07-16
Drawn by GES\WS	Scale 1:5	Sheet 12 of 12 Rebar

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Table C.1. Summary of Strong Soil Test Results for Establishing Installation Procedure.

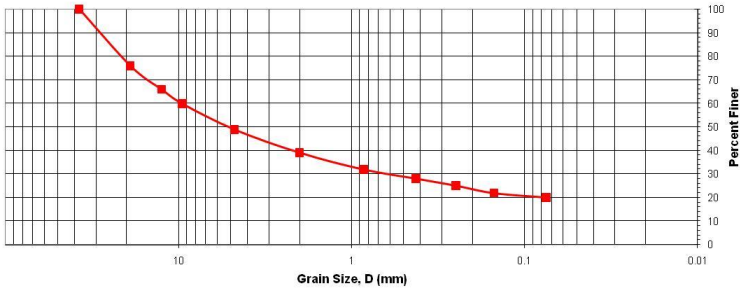
Dynamic Setup

Post-Test Photo of post

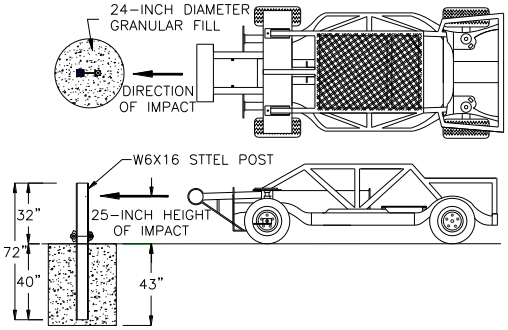
Static Load Test

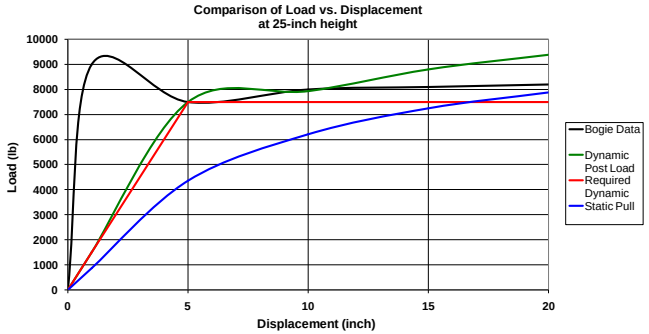
Post-Test Photo

Percent Finer Vs. Grain Size of Fill Soil for Dynamic and Static Load Tests

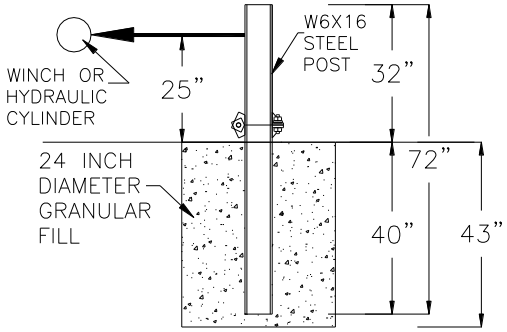


Dynamic Test Installation Details



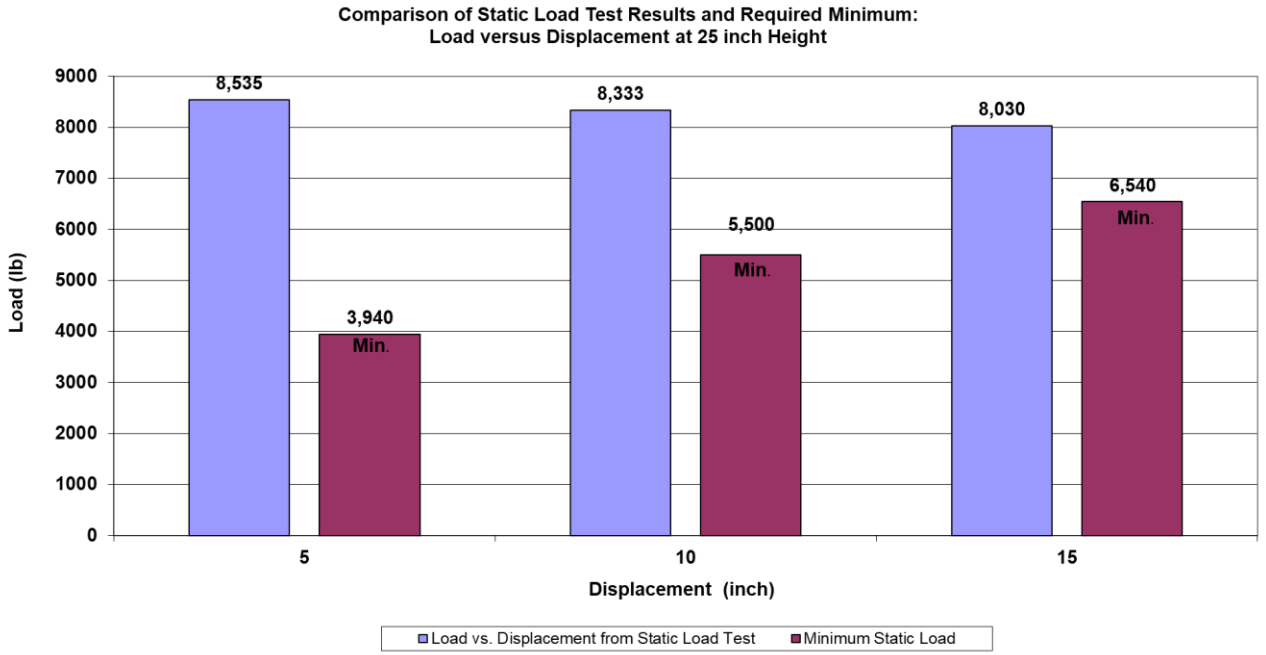


Static Load Test Installation Details



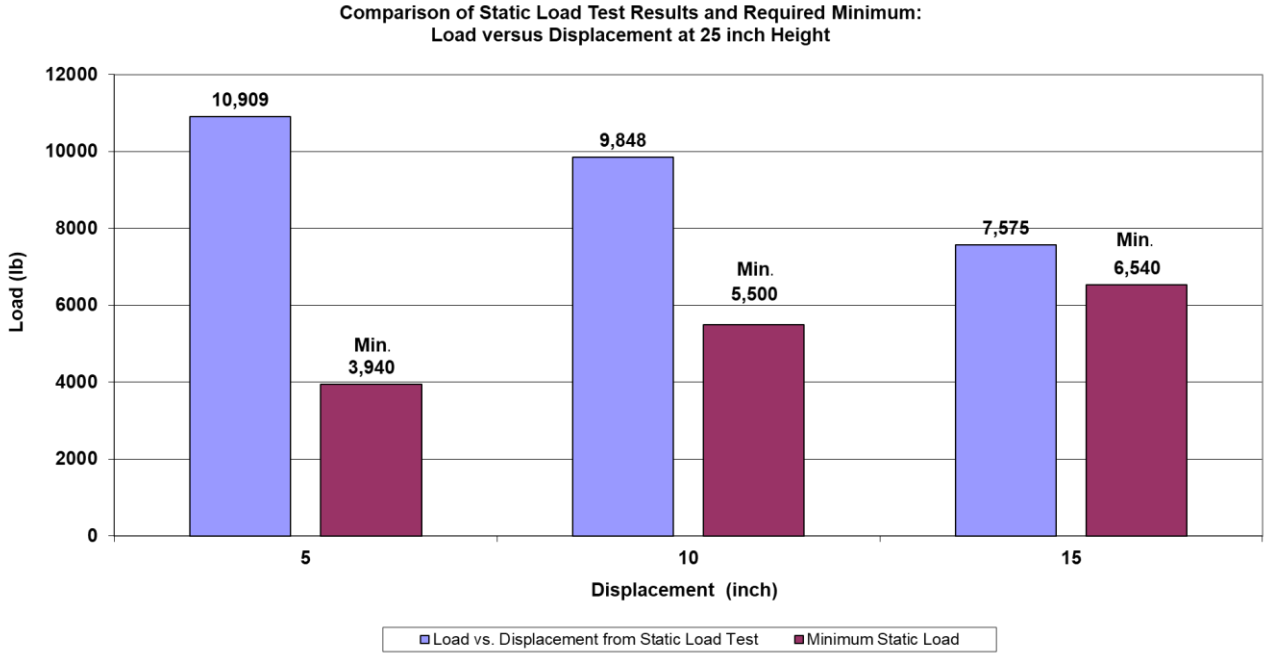
Date	2008-11-05
Test Facility and Site Location	TTI Proving Ground, 3100 SH 47, Bryan, TX 77807
In Situ Soil Description (ASTM D2487)	Sandy gravel with silty fines
Fill Material Description (ASTM D2487) and sieve analysis	AASHTO M147 Grade B Soil-Aggregate (see sieve analysis above)
Description of Fill Placement Procedure	6-inch lifts tamped with a pneumatic compactor
Bogie Weight	5009 lb
Impact Velocity	20.5 mph

Table C.2. Test Day Static Soil Strength Documentation for Test No. 612061-03-1.



Date	2020-10-02 for Test No. 612061-03-1
Test Facility and Site Location	TTI Proving Ground – 3100 SH 47, Bryan, Tx
In Situ Soil Description (ASTM D2487)	Sandy gravel with silty fines
Fill Material Description (ASTM D2487) and sieve analysis	AASHTO M147 Grade B Soil-Aggregate
Description of Fill Placement Procedure	6-inch lifts tamped with a pneumatic compactor

Table C.3. Test Day Static Soil Strength Documentation for Test No. 612061-02-1A.



Date	2020-09-02 for Test No. 612061-02-1A
Test Facility and Site Location	TTI Proving Ground – 3100 SH 47, Bryan, Tx
In Situ Soil Description (ASTM D2487)	Sandy gravel with silty fines
Fill Material Description (ASTM D2487) and sieve analysis	AASHTO M147 Grade B Soil-Aggregate
Description of Fill Placement Procedure	6-inch lifts tamped with a pneumatic compactor

C.3 *MASH* TEST 3-11 (CRASH TEST NO. 612061-02-1A)

C.3.1. Vehicle Properties and Information

Table C.1. Vehicle Properties for Test No. 612061-02-1A.

Table C.2. Measurements of Vehicle Vertical Center of Gravity for Test No. 612061-02-1A.

Table C.3. Exterior Crush Measurements for Test No. 612061-02-1A.

Table C.4. Occupant Compartment Measurements for Test No. 612061-02-1A.

C.3.2. Sequential Photographs

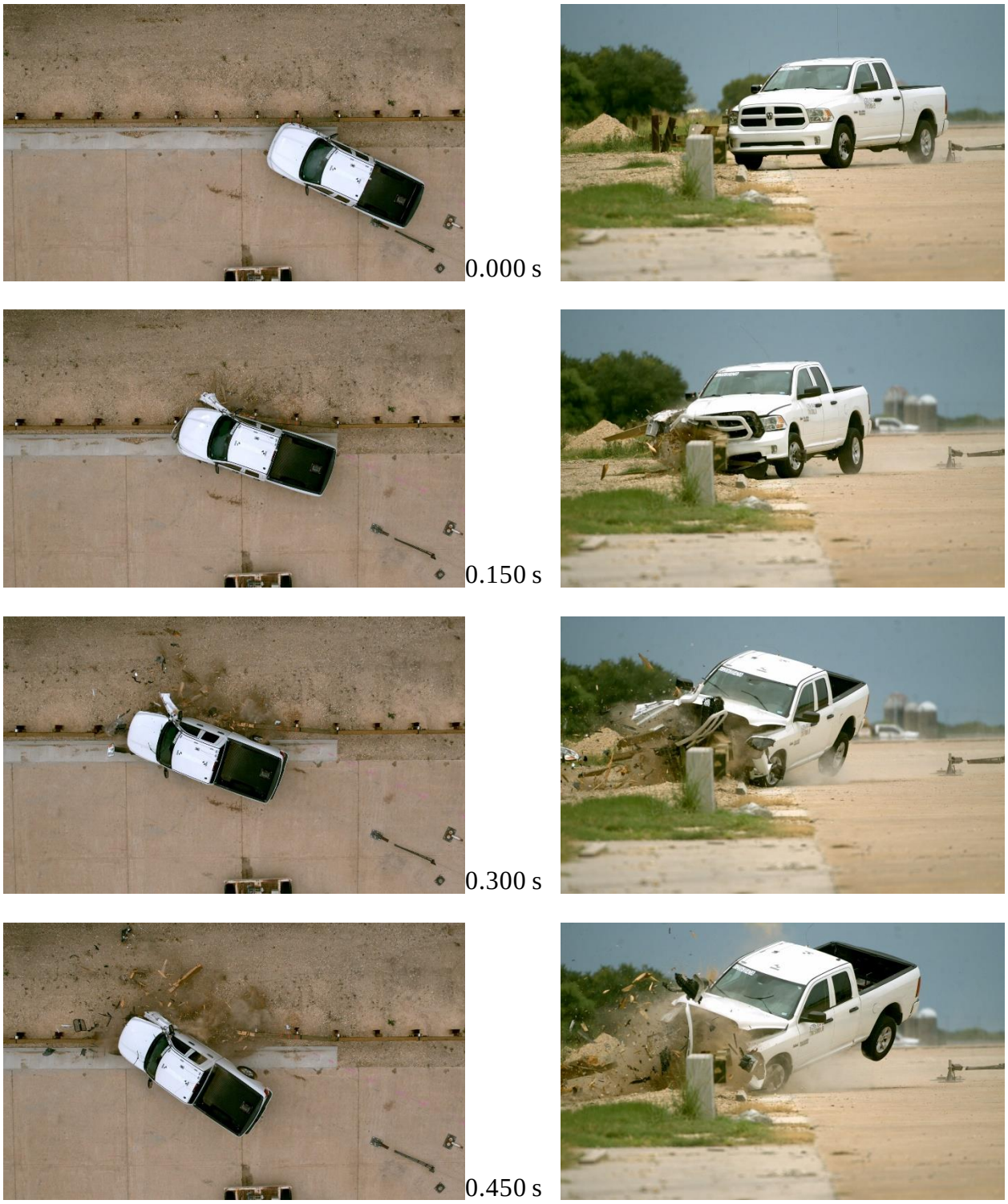
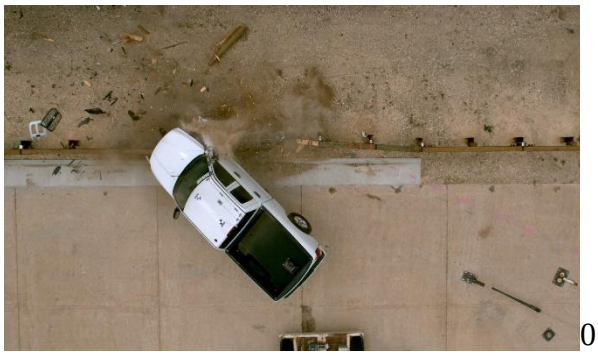
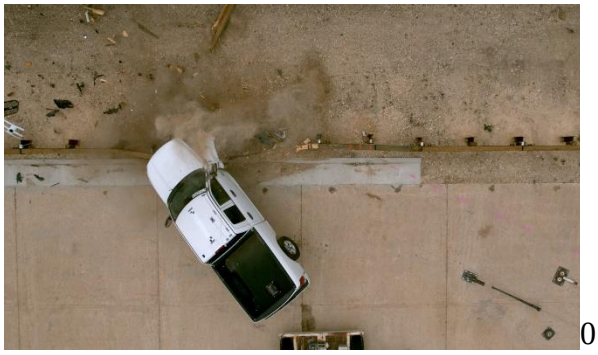


Figure C.1. Sequential Photographs for Test No. 612061-02-1A (Overhead and Frontal Views).




0.600 s




0.750 s


0.900 s


1.050 s

Figure C.1. Sequential Photographs for Test No. 612061-02-1A (Overhead and Frontal Views) (Continued).


0.000 s


0.600 s


0.150 s


0.750 s


0.300 s


0.900 s


0.450 s


1.050 s

Figure C.2. Sequential Photographs for Test No. 612061-02-1A (Rear View).

Axes are vehicle-fixed.
Sequence for determining orientation:

1. Yaw.
2. Pitch.
3. Roll.

Test Number: 612061-02-1A
Test Standard Test Number: *MASH* Test 3-11
Test Article: Merritt Parkway Guiderail
Test Vehicle: 20xx RAM 1500 Pickup
Inertial Mass: xxxx lb
Gross Mass: xxxx lb
Impact Speed: xx.x mi/h
Impact Angle: xx.x°

Figure C.3. Vehicle Angular Displacements for Test No. 612061-02-1A.

C.3.4. Vehicle Accelerations

Figure C.4. Vehicle Longitudinal Accelerometer Trace for Test No. 612061-02-1A (Accelerometer Located at Center of Gravity).

Figure C.5. Vehicle Lateral Accelerometer Trace for Test No. 612061-02-1A (Accelerometer Located at Center of Gravity).

Figure C.6. Vehicle Vertical Accelerometer Trace for Test No. 612061-02-1A (Accelerometer Located at Center of Gravity).

C.4. *MASH* TEST 3-10 (CRASH TEST NO. 612061-03-1)

C.4.1. Vehicle Properties and Information

Table C.5. Vehicle Properties for Test No. 612061-03-1.

Table C.6. Exterior Crush Measurements for Test No. 612061-03-1.

Table C.7. Occupant Compartment Measurements for Test No. 612061-03-1.

C.4.2. Sequential Photographs

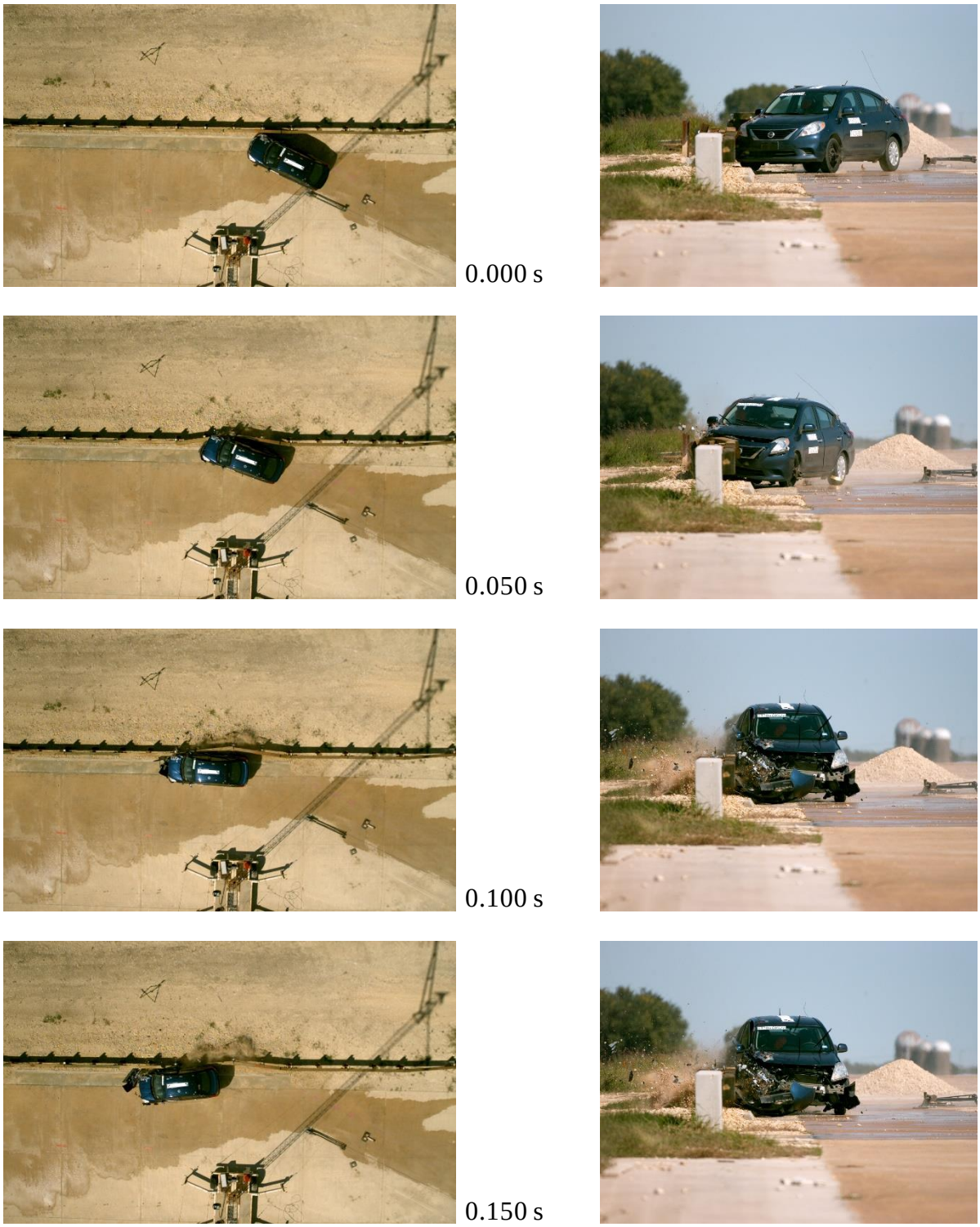
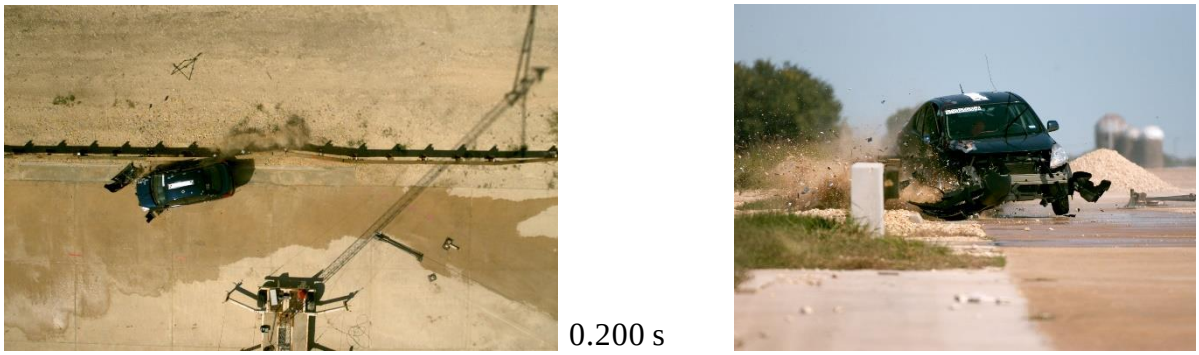
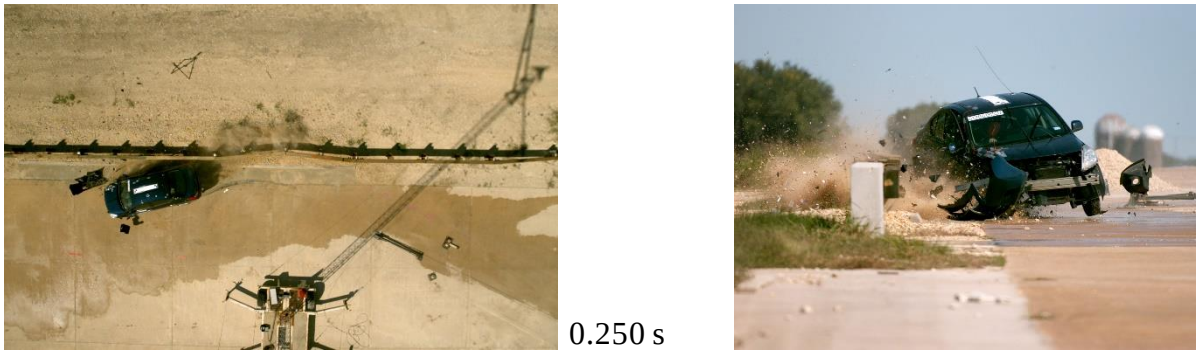
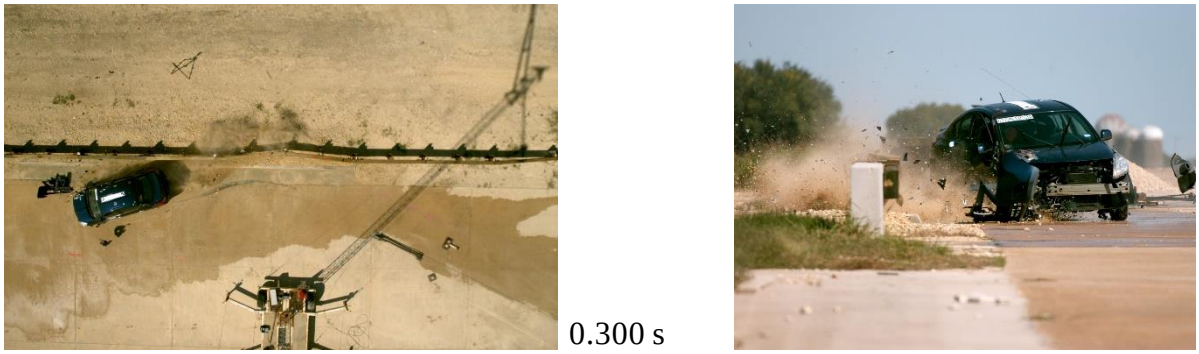


Figure C.7. Sequential Photographs for Test No. 612061-03-1 (Overhead and Frontal Views).


0.200 s


0.250 s


0.300 s

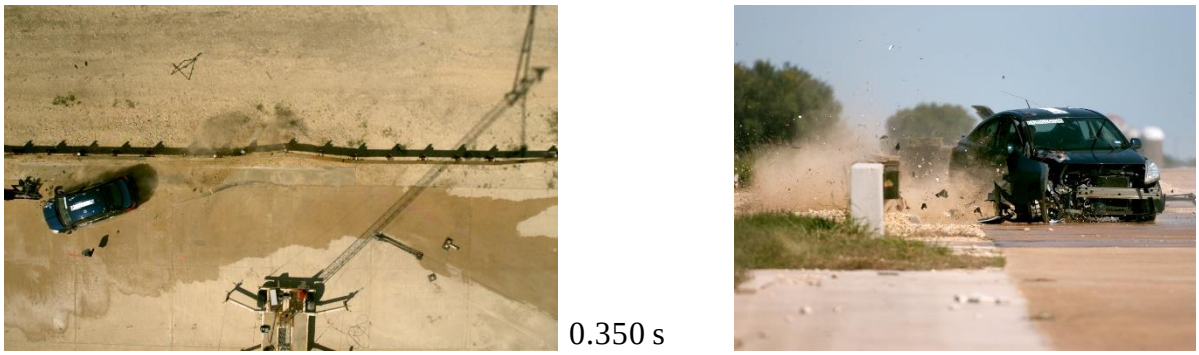

0.350 s

Figure C.7. Sequential Photographs for Test No. 612061-03-1 (Overhead and Frontal Views) (Continued).

Axes are vehicle-fixed.
Sequence for determining orientation:

1. Yaw.
2. Pitch.
3. Roll.

Test Number: 612061-03-1
Test Standard Test Number: *MASH* Test 3-10
Test Article: Merritt Parkway Guiderail with No Curb
Test Vehicle: xxxx Nissan Versa
Inertial Mass: xx lb
Gross Mass: xxx lb
Impact Speed: xx.x mi/h
Impact Angle: xx.x°

Figure C.8. Vehicle Angular Displacements for Test No. 612061-03-1.

C.4.4. Vehicle Accelerations

Figure C.9. Vehicle Longitudinal Accelerometer Trace for Test No. 612061-03-1 (Accelerometer Located at Center of Gravity).

Figure C.10. Vehicle Lateral Accelerometer Trace for Test No. 612061-03-1 (Accelerometer Located at Center of Gravity).

Figure C.11. Vehicle Vertical Accelerometer Trace for Test No. 612061-03-1 (Accelerometer Located at Center of Gravity).

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APPENDIX D. MERRITT PARKWAY GUIDERAIL TRANSITION

Notes

1a. Drill Ø24" holes for Posts. Backfill Post holes and around Anchor Block with AASHTO M147-65(2004), grade B crushed limestone road base, compacted to MASH standard.

1b. Threads not shown on Bolts, Nuts, etc for clarity.

1c. Material:

Steel: All steel posts, back-up rails, splice plates and channel rubrails which are to be used as "Weathering Steel", shall meet the requirements of ASTM A588. The fabricator shall notify the manufacturer that it is "Weathering Steel" (structural steel for use in bare, unpainted applications) and that the steel shall not be marked with paint or steel die stamped, but identification shall be stenciled with permanent ink. The dimensions of each component shall conform to the plans and ASTM A6. All steel posts shall be galvanized after fabrication to meet the requirements of ASTM A123 and conform to the galvanizing limits and tolerances shown on the plans. A single ¾" diameter hole may be drilled 2" from the top of each post, in the center of the web, to facilitate the galvanizing process on the bottom of all posts.

Timber: All timber rail and block-out components shall conform with the following:

a) Commercial lumber grade No. 1 or better after treatment;
b) AASHTO M 168;
c) Minimum stress rating of 1350 psi
d) Rough sawn (non-planed) or S4S (surface four side) Southern Yellow Pine or Douglas Fir- Larch with nominal dimensions as indicated on the plans. Variations in the size of any dimension shall not be more than ± ¼"
e) All timber components shall be pressure treated with CCA or ACZA depending on species supplied conforming to AWPA Standard P5 to a minimum net retention of 0.60lb/cubic foot in the assay zone in accordance with AWPA Standard C14.
f) All timber components shall be fabricated (including but not necessarily limited to cutting, drilling, dapping and chamfering) prior to treatment.
g) All timber components shall be free of excess preservative and solvent at the conclusion of the treating process. Post treatment cleaning shall be by expansion bath or steaming in accordance with AWPA Standard C2;
h) Kiln or air dried to a maximum moisture content of 25% after treatment (KDAT - 25);
i) Grade-marked after treatment by an agency certified by the American Lumber Standard Committee (ALSC).

Fasteners:

a) Round head bolts shall be manufactured in accordance with the sizes designated on the plans, the geometric specifications included in ANSI B18.5.1.2.2 and the material specifications for ASTM A588 steel. All round head bolts shall be marked with the manufacturers symbol and A588.
b) Hex Lag Screws shall be manufactured in accordance with ASTM A307 Grade A specifications. All Hex Lag Screws shall be hot-dipped galvanized in accordance with ASTM A153 Class C.
c) Nuts, and Washers shall be ASTM A588 steel.

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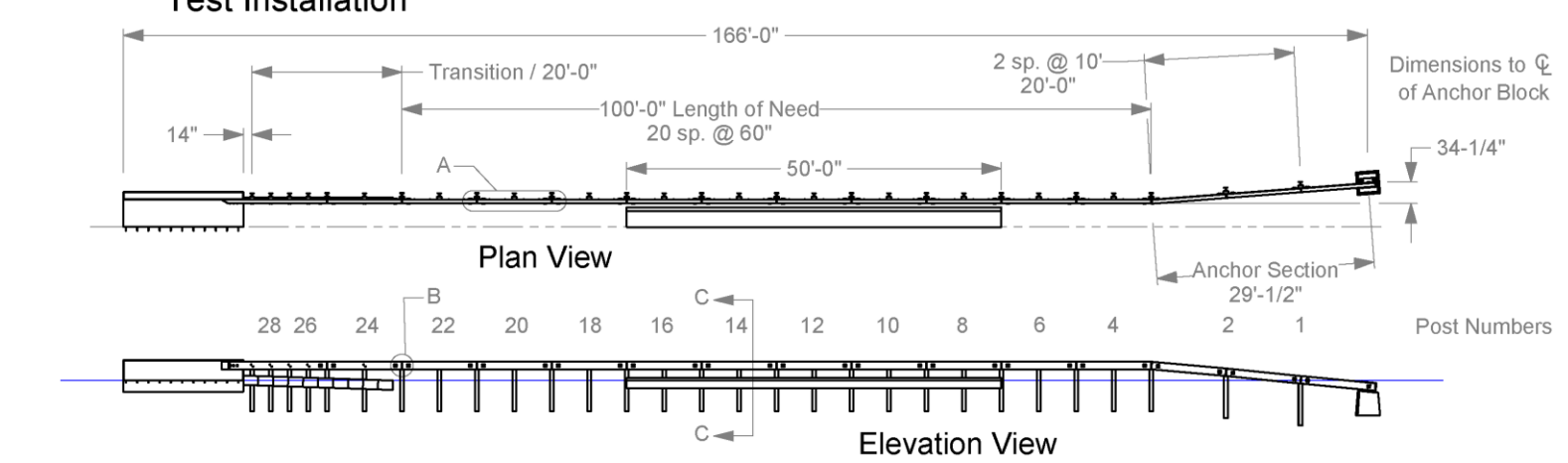
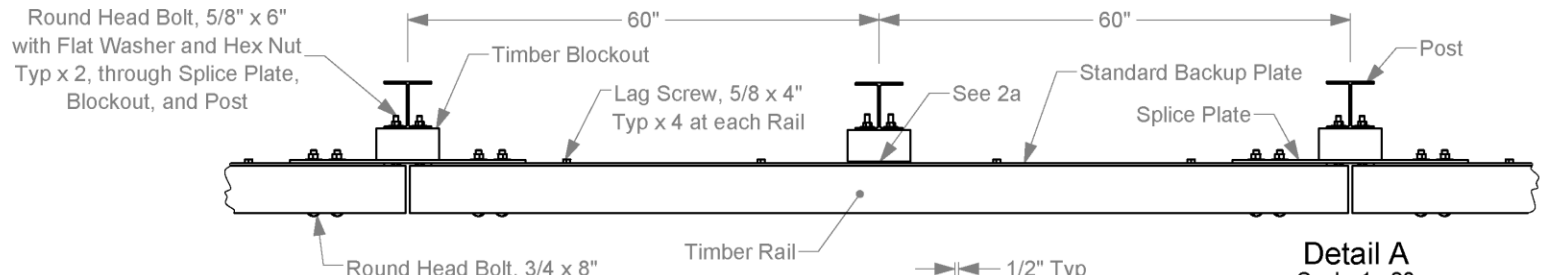
Drawn by GES\WS	Scale 1:250	Sheet 1 of 12 Notes

Test Installation

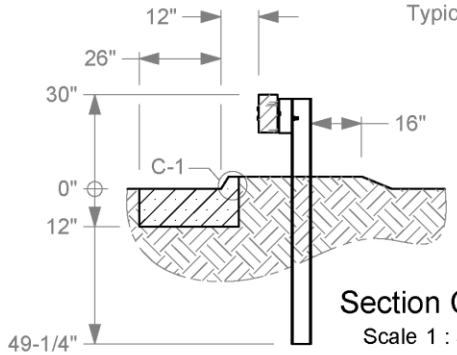




Detail A

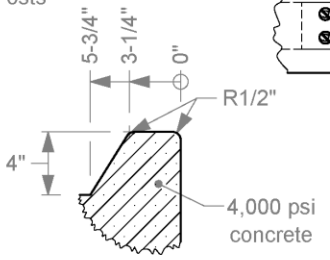
Scale 1 : 20

Post spacing and Rail details typical all Posts in Length of Need and Anchor Section unless otherwise indicated. Connection details typical at all Posts except 24 and 26 - 29.



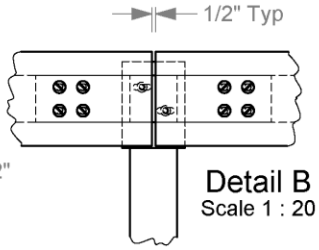
Section C-C

Scale 1 : 50



Detail C-1

Scale 1 : 10



Detail B

Scale 1 : 20

2a. Even numbered posts, beginning with Post 4 and going to Post 22, do not attach to rails.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
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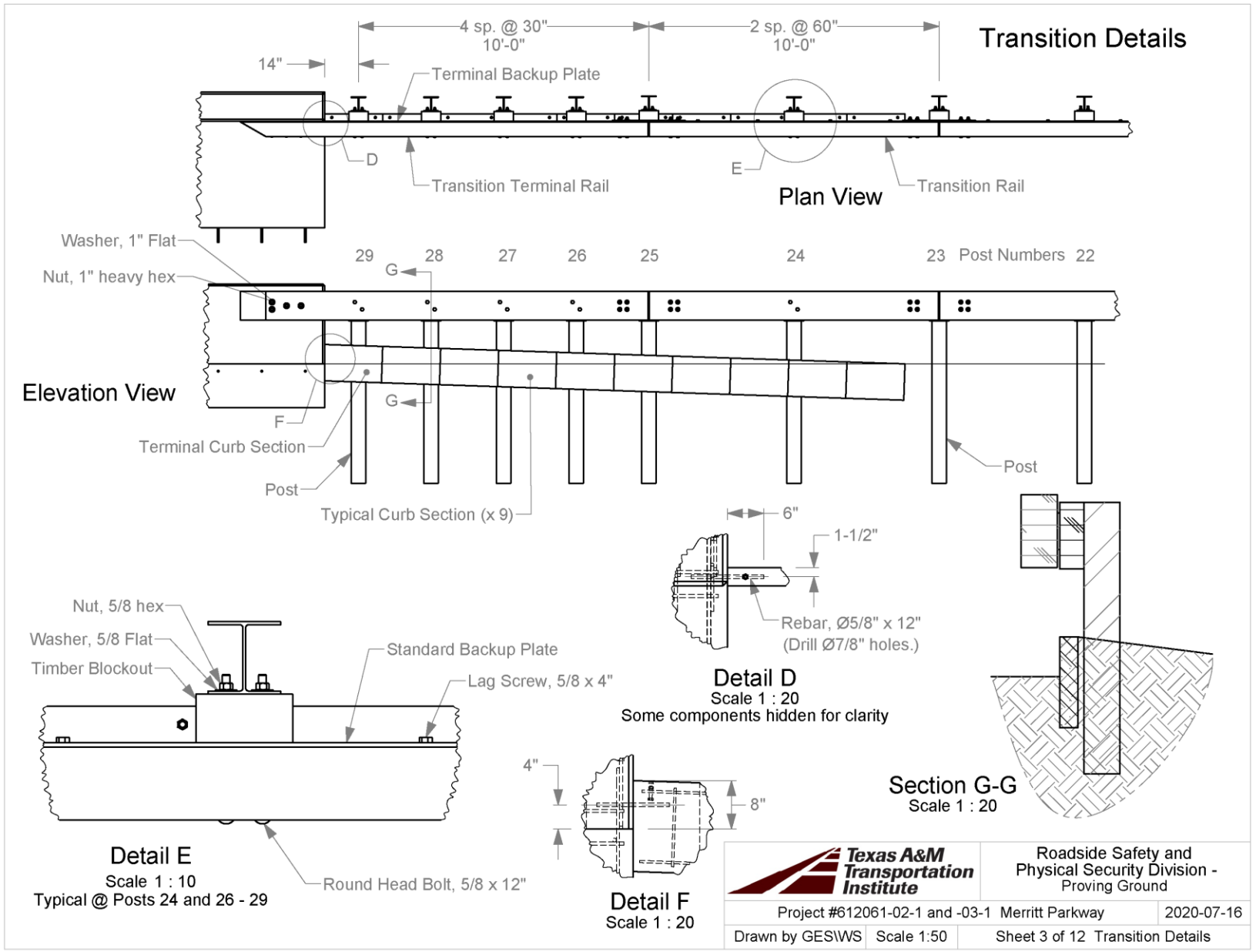
Q:\Accreditation-17025-2017\EIR-000 Project Files\612061-Pooled Fund-Merritt Parkway-Chiara\Drafting, 612061 with curb\612061 w curb Drawing



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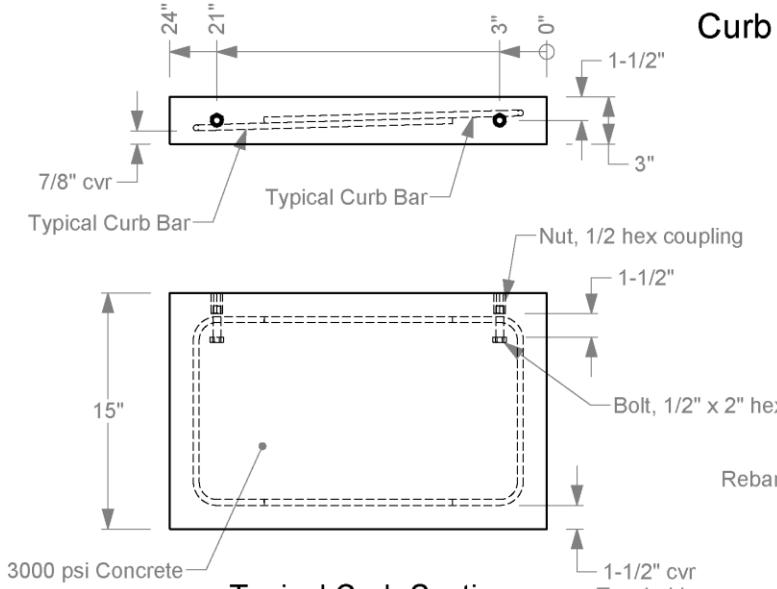
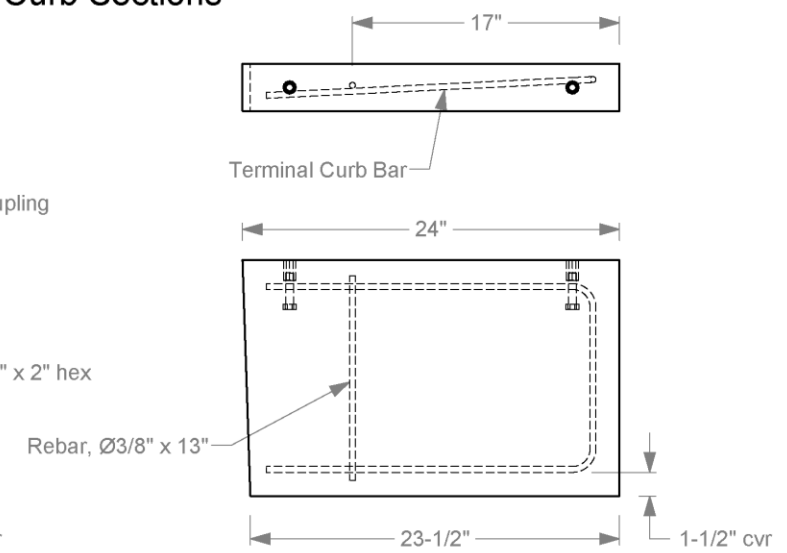
Curb Sections

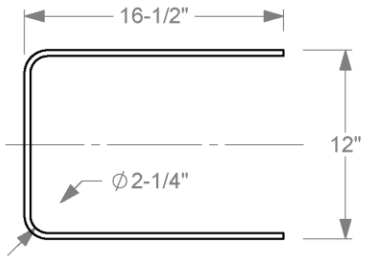


Typical Curb Section



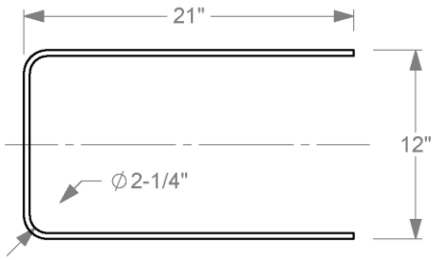
Terminal Curb Section

(see Typical Curb Section for all details not shown here)



Typical Curb Bar

Ø3/8" Rebar



Terminal Curb Bar

Ø3/8" Rebar

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
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Drawn by GES\WS	Scale 1:10	Sheet 4 of 12 Curb Sections

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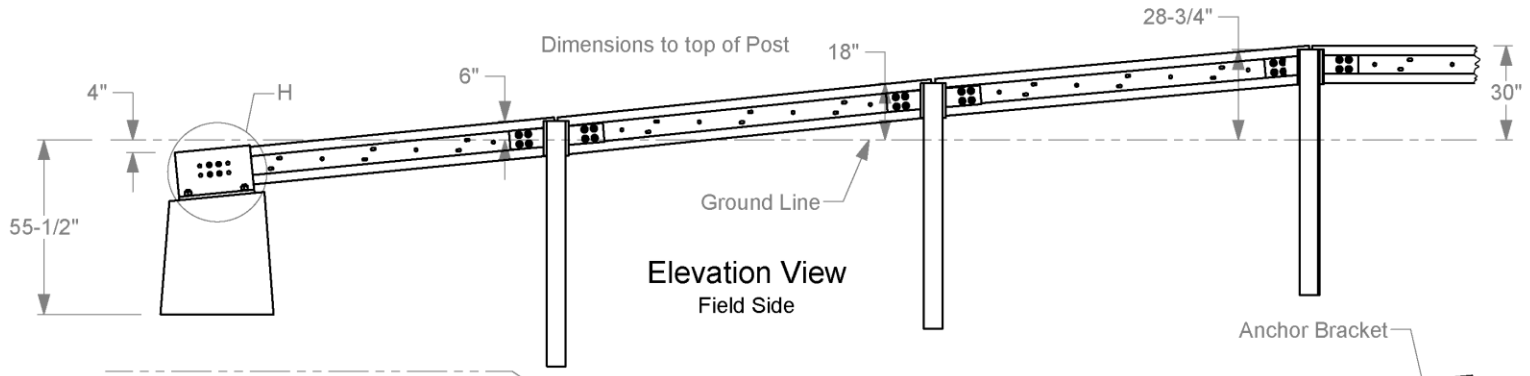
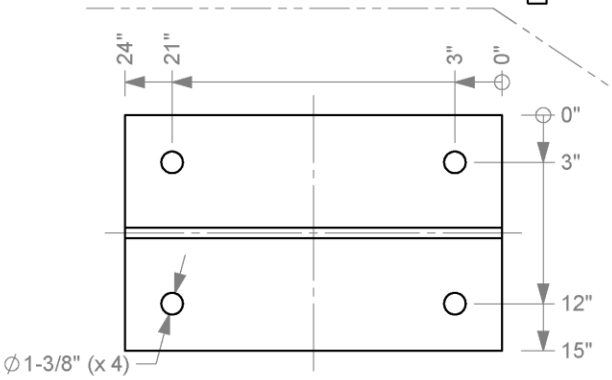
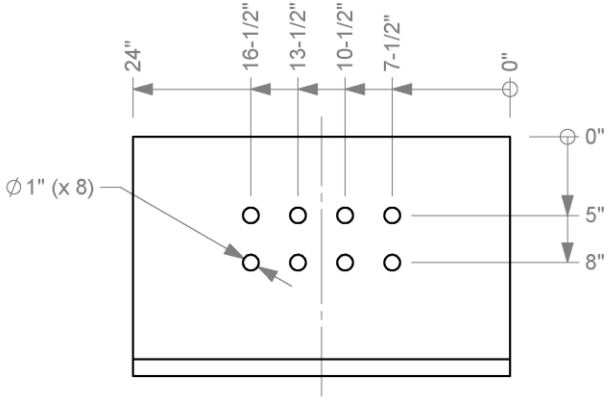
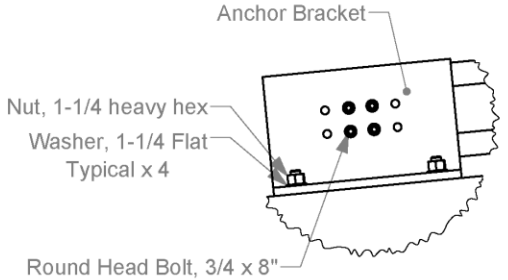
Anchor Details



Elevation View
Field Side



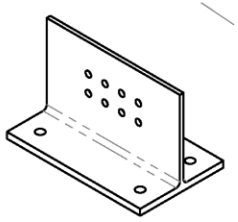




Detail H
Scale 1 : 20

Anchor Bracket

WT 15 x 86.5
Galvanize after all fabrication is complete.
Scale 1:10



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Drawn by GES\WS	Scale 1:50	Sheet 5 of 12 Anchor Details

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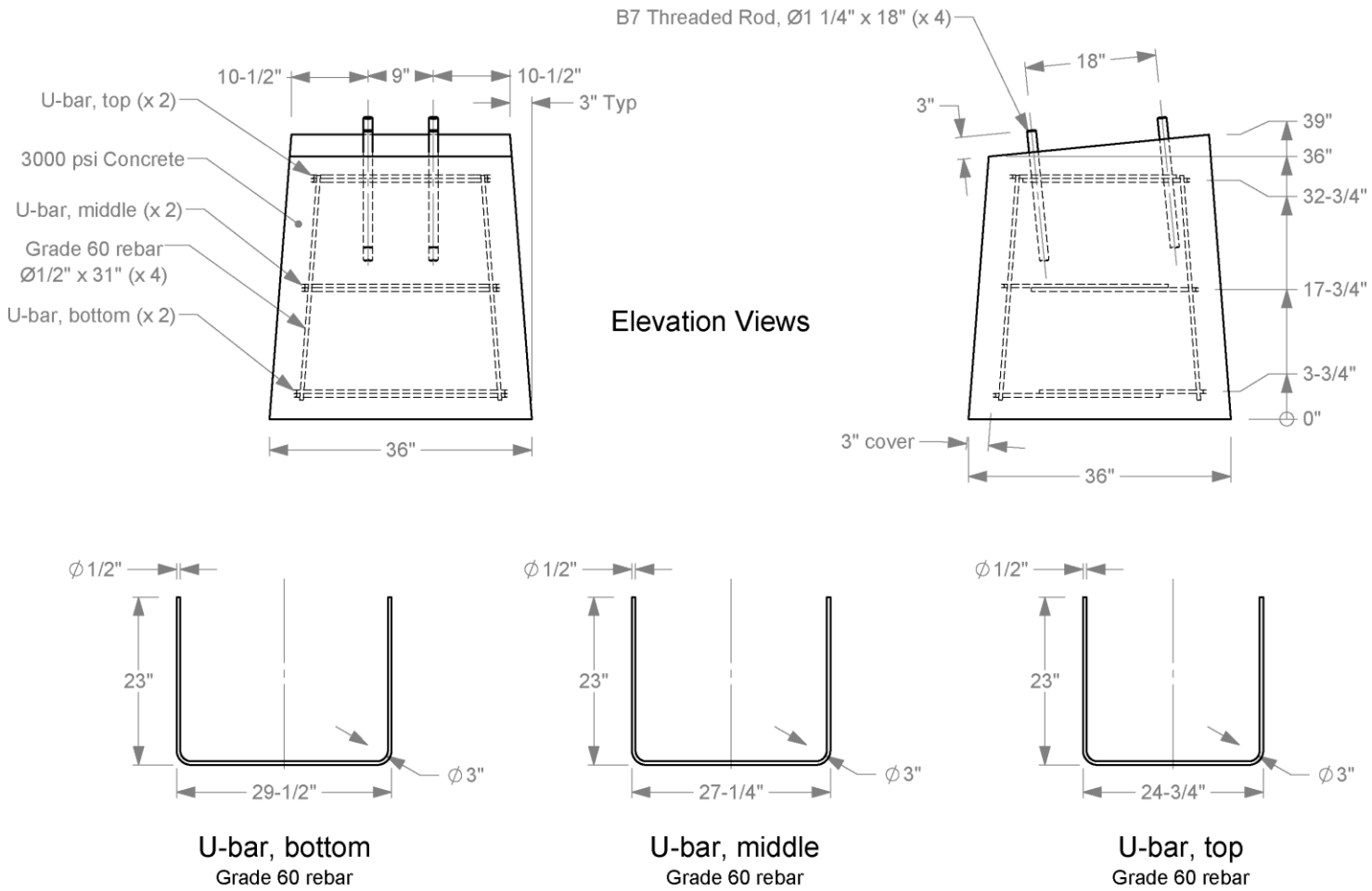
Anchor Block



U-bar, bottom
Grade 60 rebar

U-bar, middle
Grade 60 rebar

U-bar, top
Grade 60 rebar

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
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Drawn by GES\WS	Scale 1:20	Sheet 6 of 12 Anchor Block

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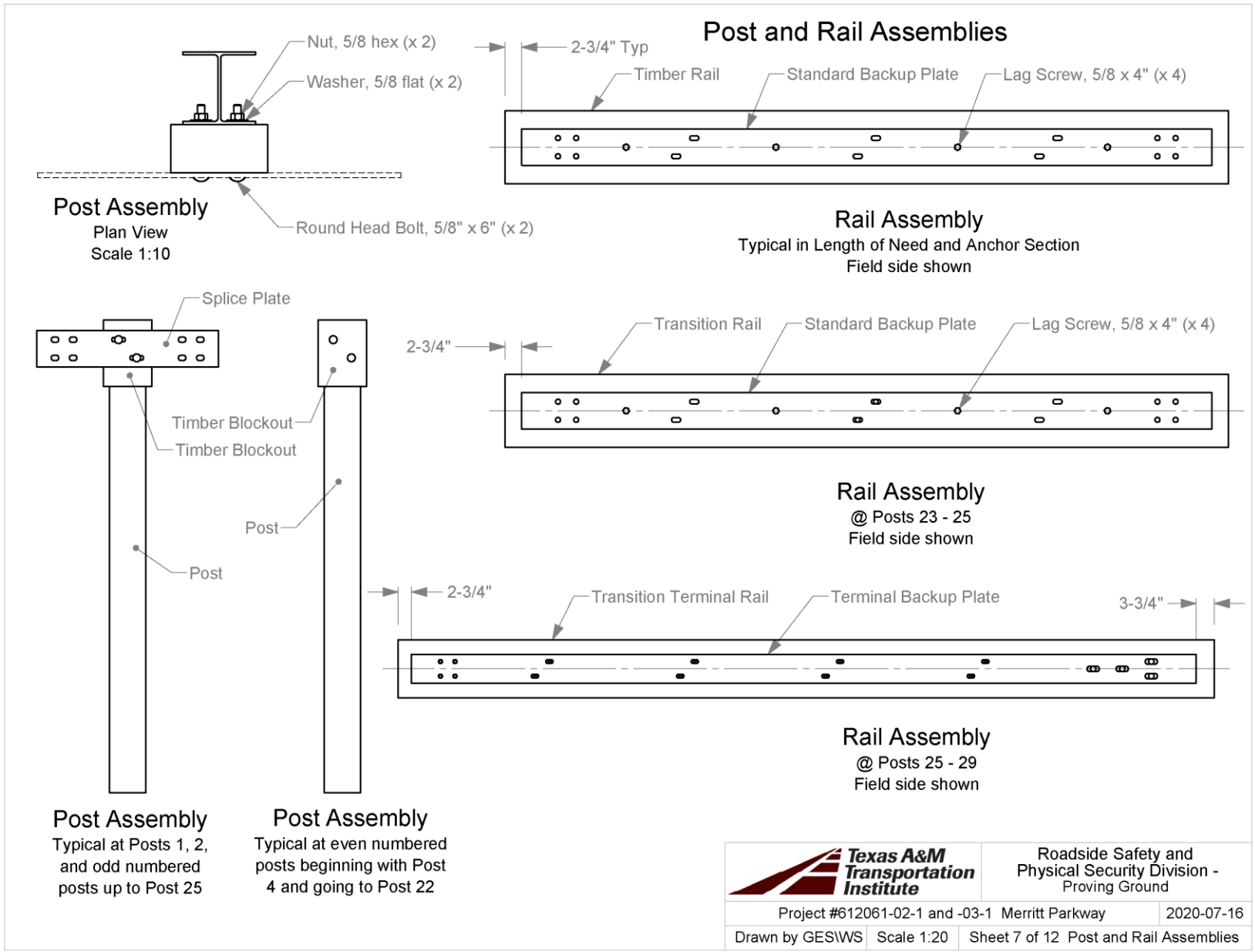
Post and Rail Assemblies
Nut, 5/8 hex (x 2)
Washer, 5/8 flat (x 2)
Round Head Bolt, 5/8" x 6" (x 2)
Post Assembly
Plan View
Scale 1:10
2-3/4" Typ
Timber Rail
Standard Backup Plate
Lag Screw, 5/8 x 4" (x 4)
Rail Assembly
Typical in Length of Need and Anchor Section
Field side shown
Splice Plate
Timber Blockout
Timber Blockout
Post
Post
Post Assembly
Typical at Posts 1, 2, and odd numbered posts up to Post 25
Post Assembly
Typical at even numbered posts beginning with Post 4 and going to Post 22
2-3/4"
Transition Rail
Standard Backup Plate
Lag Screw, 5/8 x 4" (x 4)
Rail Assembly
@ Posts 23 - 25
Field side shown
2-3/4"
Transition Terminal Rail
Terminal Backup Plate
3-3/4"
Rail Assembly
@ Posts 25 - 29
Field side shown
Texas A&M Transportation Institute
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Scale 1:20
Sheet 7 of 12 Post and Rail Assemblies
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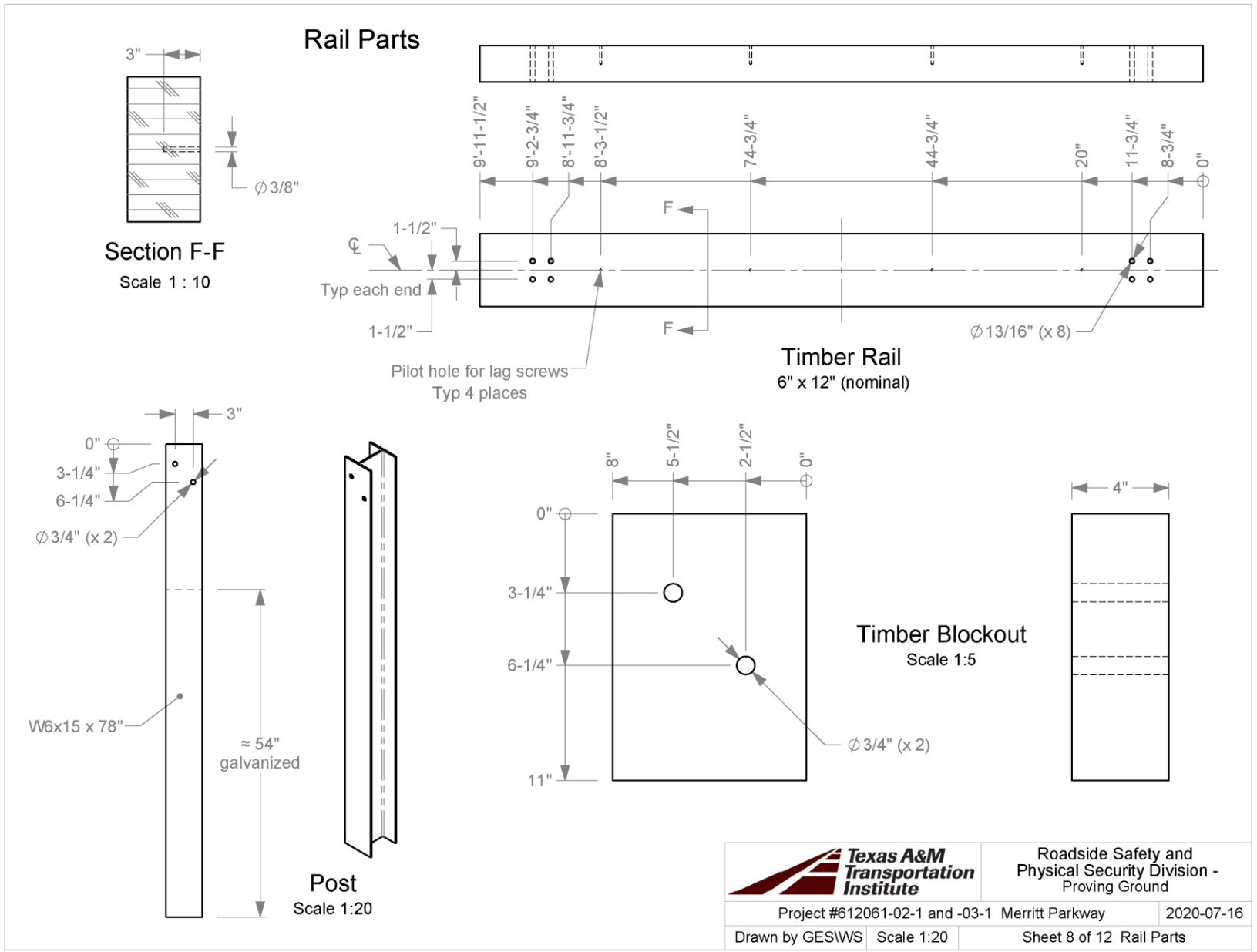

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Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
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Drawn by GES\WS	Scale 1:20	Sheet 9 of 12 Transition Rails

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9'-6"
9'-0"
8'-9"
96-3/4"
88-1/2"
85-1/2"
72"
58-1/2"
55-1/2"
42"
28-1/2"
25-1/2"
17-1/4"
9"
6"
0"
3"
1-1/2"
3"
∅3/4" (x 4)
∅13/16" (x 8)
Slot, 3/4" x 1-1/2" (x 6)
(Not utilized when Post spacing is 10')
Standard Backup Plate
Steel Plate, 6" x 3/8"
13'-6"
12'-8-3/4"
12'-2-3/4"
11'-8-3/4"
9'-10-1/2"
9'-7-1/2"
88-1/2"
85-1/2"
58-1/2"
55-1/2"
28-1/2"
25-1/2"
9"
6"
0"
1-1/2"
3"
Slot, 1-1/8" x 2-1/2" (x 4)
Slot, 3/4" x 1-1/2" (x 8)
∅13/16" (x 4)
Terminal Backup Plate
Steel Plate, 6" x 3/8"
30"
27"
24"
16-1/2"
13-1/2"
6"
3"
0"
1-1/2" Typ
Slot, 7/8" x 1-1/4" (x 8)
Slot, 3/4" x 2-1/4" (x 2)
Splice Plate
Steel Plate, 6" x 3/8"
Texas A&M Transportation Institute
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Scale 1:20
Sheet 10 of 12 Backup Plates
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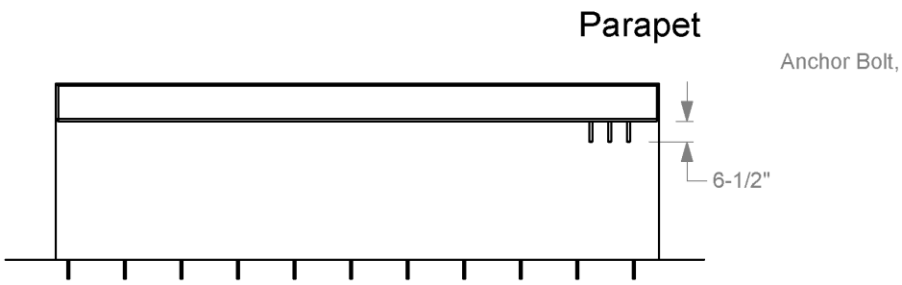

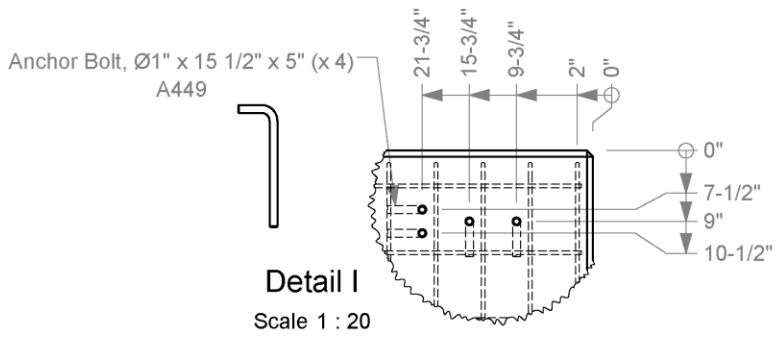

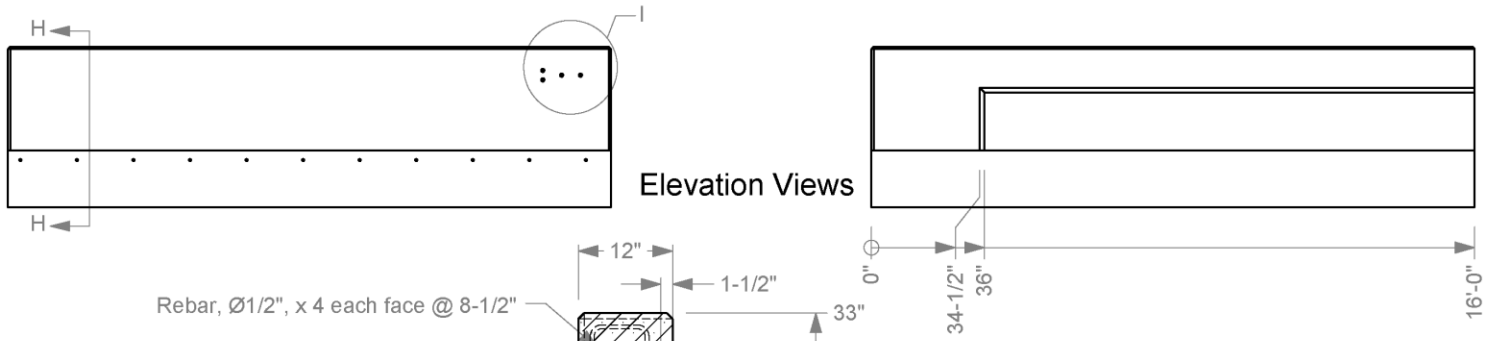

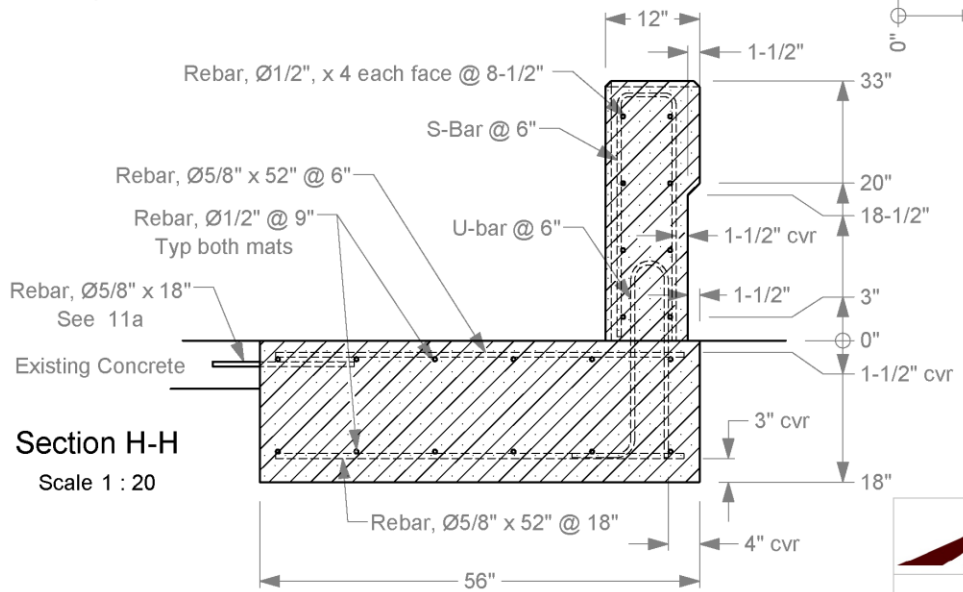

11a. Secure with Hilti HIT-RE 500 V3 epoxy according to manufacturer's instructions, with 6" embedment, at 18" spacing.

11b. Chamfer top edges of Wall, and vertical edges where shown, 3/4" each way.

11c. Concrete strength is 3600 psi, and all rebar is grade 60.

11d. Backfill field side and ends of foundation with native soil and compact to 95% of standard proctor density.

11e. Rebar dimensions are to center unless otherwise indicated by "cvr" (cover).

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Q:\Accreditation-17025-2017\EIR-000 Project Files\612061-Pooled Fund-Merritt Parkway-Chiara\Drafting, 612061 with curb\612061 w curb Drawing

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
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Drawn by GES\WS	Scale 1:5	Sheet 12 of 12 Rebar

Q:\Accreditation-17025-2017\EIR-000 Project Files\612061-Pooled Fund-Merritt Parkway-Chiara\Drafting, 612061 with curb\612061 w curb Drawing

Table D.1. Summary of Strong Soil Test Results for Establishing Installation Procedure.

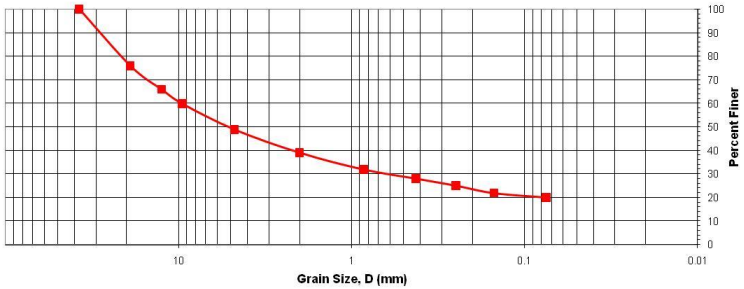
Dynamic Setup

Post-Test Photo of post

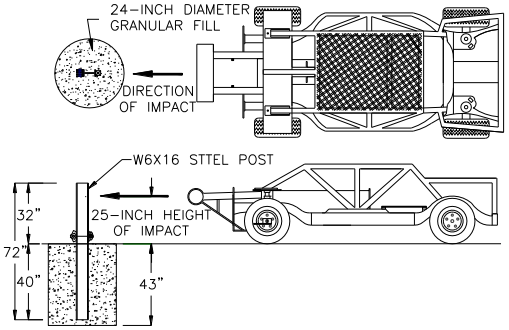
Static Load Test

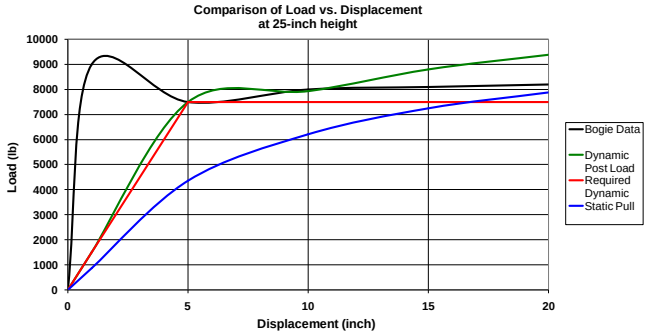
Post-Test Photo

Percent Finer Vs. Grain Size of Fill Soil for Dynamic and Static Load Tests

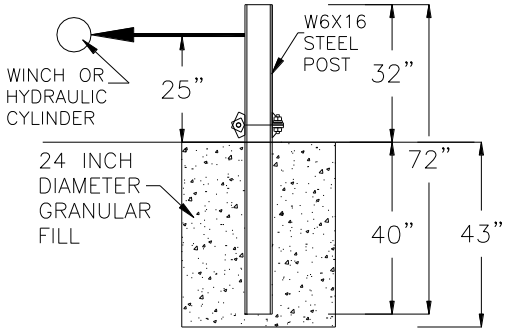


Dynamic Test Installation Details



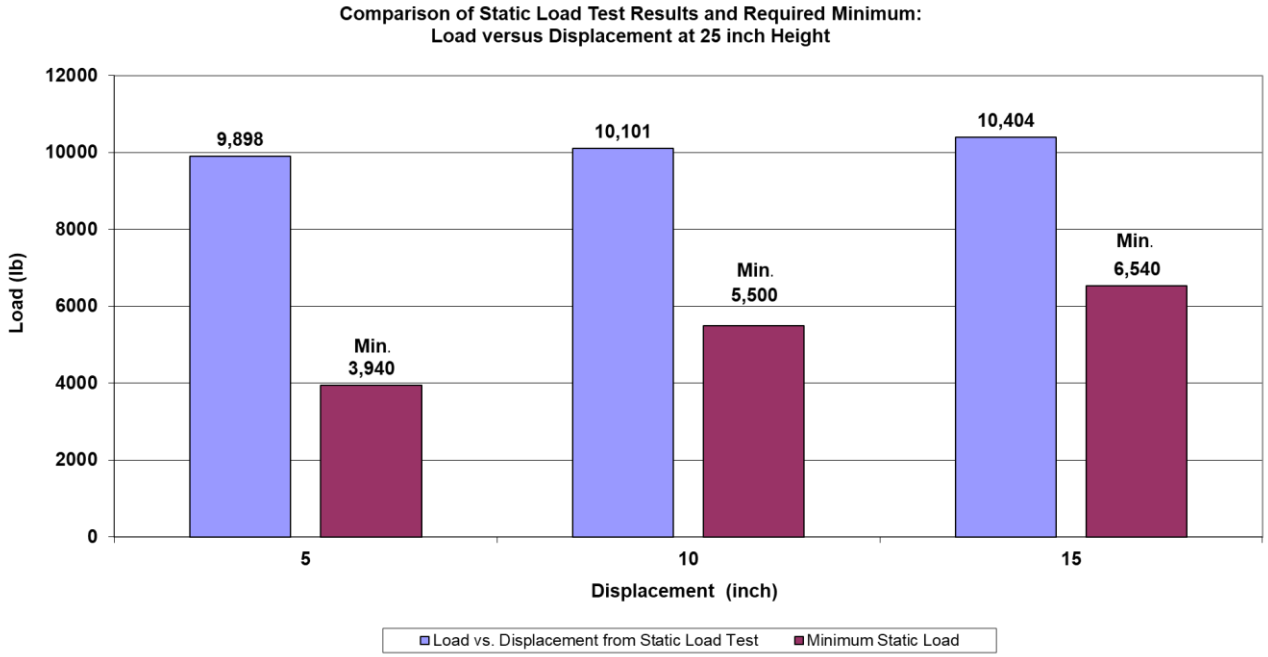


Static Load Test Installation Details



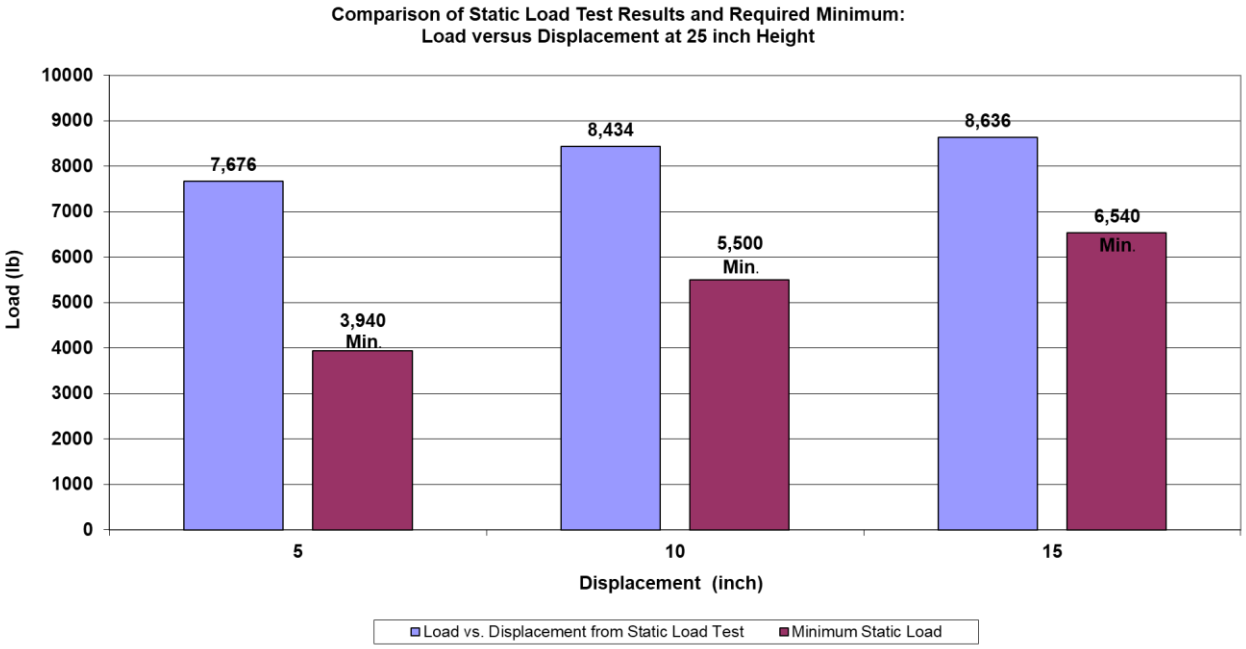
Date	2008-11-05
Test Facility and Site Location	TTI Proving Ground, 3100 SH 47, Bryan, TX 77807
In Situ Soil Description (ASTM D2487)	Sandy gravel with silty fines
Fill Material Description (ASTM D2487) and sieve analysis	AASHTO M147 Grade B Soil-Aggregate (see sieve analysis above)
Description of Fill Placement Procedure	6-inch lifts tamped with a pneumatic compactor
Bogie Weight	5009 lb
Impact Velocity	20.5 mph

Table D.2. Test Day Static Soil Strength Documentation for Test No. 612061-07-1.



Date	2020-10-07 for Test No. 612061-07-1
Test Facility and Site Location	TTI Proving Ground – 3100 SH 47, Bryan, Tx
In Situ Soil Description (ASTM D2487)	Sandy gravel with silty fines
Fill Material Description (ASTM D2487) and sieve analysis	AASHTO M147 Grade B Soil-Aggregate
Description of Fill Placement Procedure	6-inch lifts tamped with a pneumatic compactor

Table D.3. Test Day Static Soil Strength Documentation for Test No. 612061-06-1.



Date	2020-10-12 for Test No. 612061-06-1
Test Facility and Site Location	TTI Proving Ground – 3100 SH 47, Bryan, Tx
In Situ Soil Description (ASTM D2487)	Sandy gravel with silty fines
Fill Material Description (ASTM D2487) and sieve analysis	AASHTO M147 Grade B Soil-Aggregate
Description of Fill Placement Procedure	6-inch lifts tamped with a pneumatic compactor

D.3 *MASH* TEST 3-20 (CRASH TEST NO. 612061-07-1)

D.3.1. Vehicle Properties and Information

Table D.1. Vehicle Properties for Test No. 612061-07-1.

Date: 2020-10-07 Test No.: 612061 VIN No.: 3N1CN7AP6EK451617

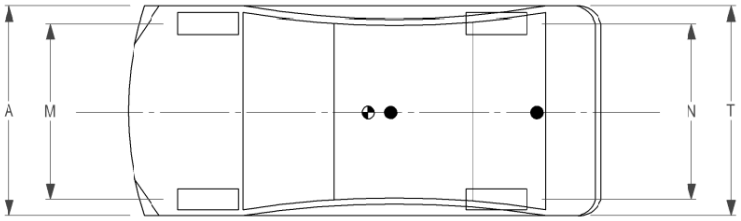
Year: 2014 Make: NISSAN Model: VERSA

Tire Inflation Pressure: 36 PSI Odometer: 90082 Tire Size: P185/65R15

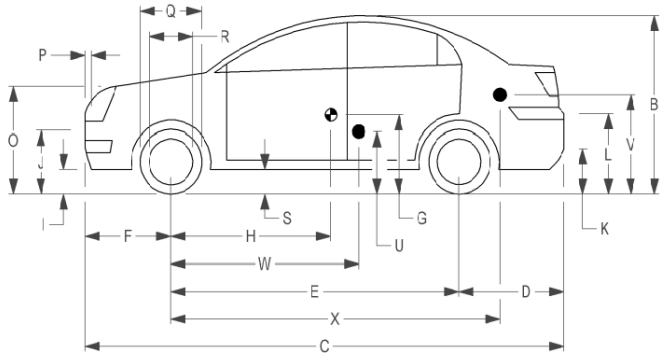
Describe any damage to the vehicle prior to test: None

● Denotes accelerometer location.

NOTES: None



Engine Type: 4 CYL
Engine CID: 1.6 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	66.70	F	32.50	K	12.50	P	4.50	U	15.50
B	59.60	G		L	26.00	Q	24.00	V	21.25
C	175.40	H	41.51	M	58.30	R	16.25	W	41.50
D	40.50	I	7.00	N	58.50	S	7.50	X	79.75
E	102.40	J	22.25	O	30.50	T	64.50		
	Wheel Center Ht Front	11.50		Wheel Center Ht Rear	11.50		W-H	-0.01	

RANGE LIMIT: A = 65 ±3 inches; C = 169 ±8 inches; E = 98 ±5 inches; F = 35 ±4 inches; H = 39 ±4 inches; O (Top of Radiator Support) = 28 ±4 inches
(M+N)/2 = 59 ±2 inches; W-H < 2 inches or use MASH Paragraph A4.3.2

GVWR Ratings:		**Mass:** lb	Curb	Test Inertial	Gross Static
Front	1750	M_{front}	1442	1439	1524
Back	1687	M_{rear}	972	981	1061
Total	3389	M_{Total}	2414	2420	2585

Allowable TIM = 2420 lb ±55 lb | Allowable GSM = 2585 lb ± 55 lb

Mass Distribution:
lb LF: 731 RF: 708 LR: 495 RR: 486

Table D.2. Exterior Crush Measurements for Test No. 612061-07-1.

Date:	2020-10-7	Test No.:	612061	VIN No.:	3N1CN7AP6EK451617
Year:	2014	Make:	NISSAN	Model:	VERSA

VEHICLE CRUSH MEASUREMENT SHEET[1]

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

Note: Measure C_1 to C_6 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	11	11	18	-	-	-	-	-	-	14
2	Side plane at bmp ht	11	12	43	-	-	-	-	-	-	62
	Measurements recorded										
	☑ **inches or** ☐ **mm**										

[1]Table 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.

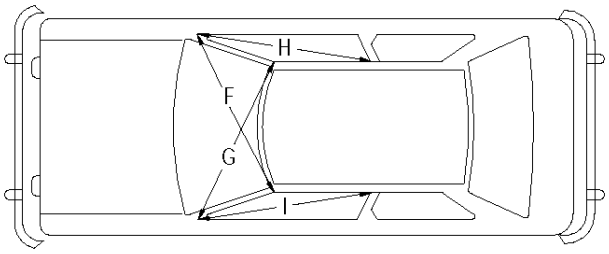
**Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle).

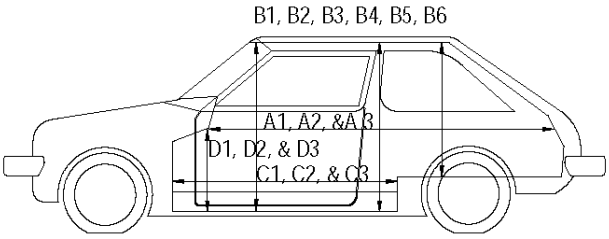
***Measure and document on the vehicle diagram the location of the maximum crush.

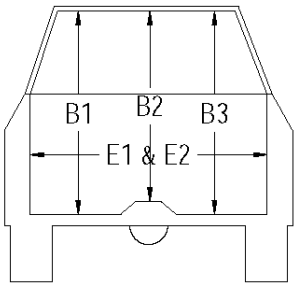
Note: Use as many lines/columns as necessary to describe each damage profile.

Table D.3. Occupant Compartment Measurements for Test No. 612061-07-1.

Date:	2020-10-7	Test No.:	612061	VIN No.:	3N1CN7AP6EK451617
Year:	2014	Make:	NISSAN	Model:	VERSA







OCCUPANT COMPARTMENT DEFORMATION MEASUREMENT

	Before	After (inches)	Differ.
A1	75.00	75.00	0.00
A2	74.00	74.00	0.00
A3	74.00	73.00	-1.00
B1	43.00	43.00	0.00
B2	37.00	37.00	0.00
B3	43.00	44.50	1.50
B4	46.50	46.50	0.00
B5	42.50	42.50	0.00
B6	46.50	46.50	0.00
C1	26.00	26.00	0.00
C2	0.00	0.00	0.00
C3	26.00	26.00	0.00
D1	12.50	12.50	0.00
D2	0.00	0.00	0.00
D3	10.00	13.00	3.00
E1	45.00	45.00	0.00
E2	48.75	55.75	7.00
F	47.50	42.00	-5.50
G	47.50	47.50	0.00
H	39.00	39.00	0.00
I	39.00	37.00	0.00
J*	48.50	41.25	-7.25

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

D.3.2. Sequential Photographs

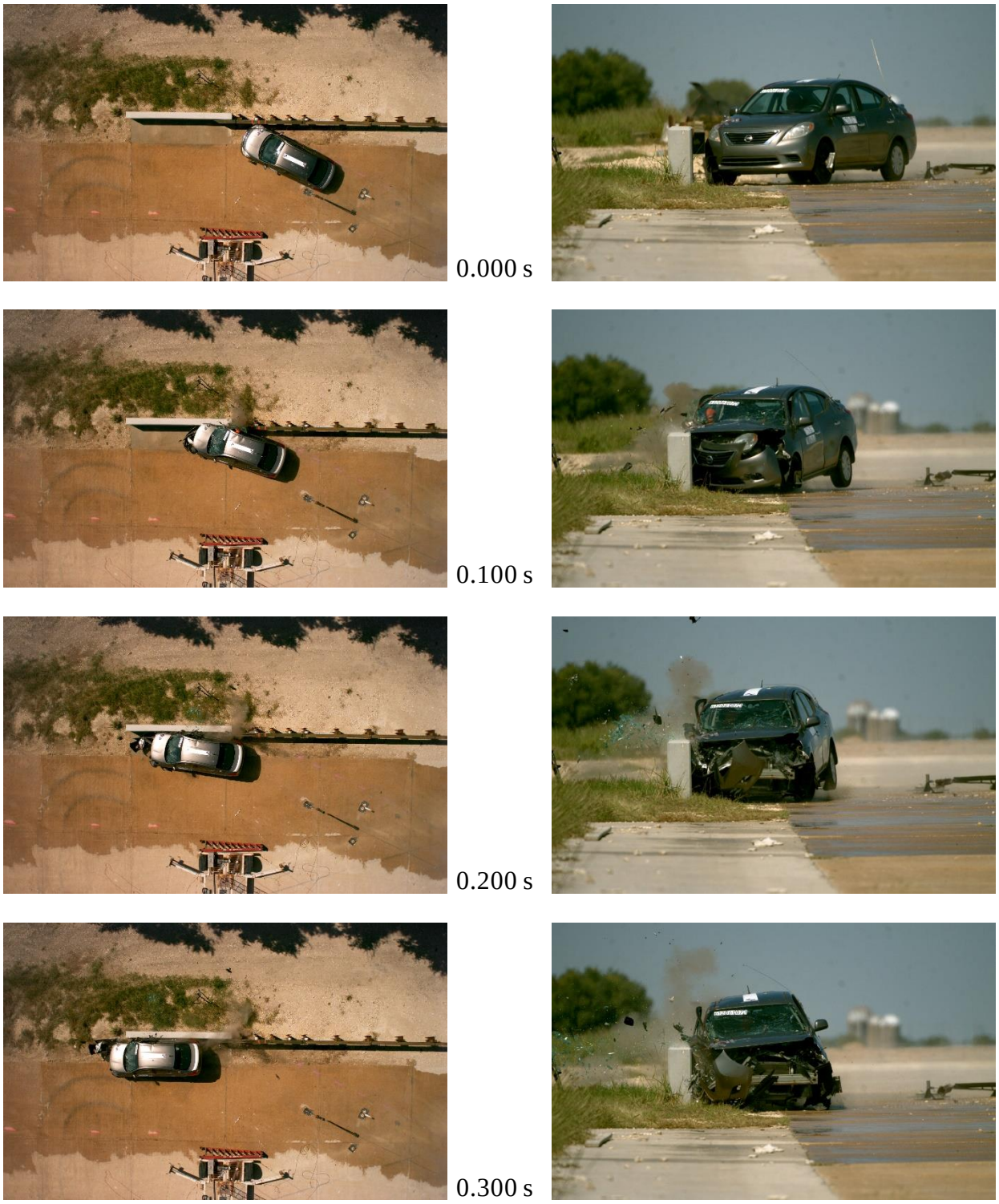
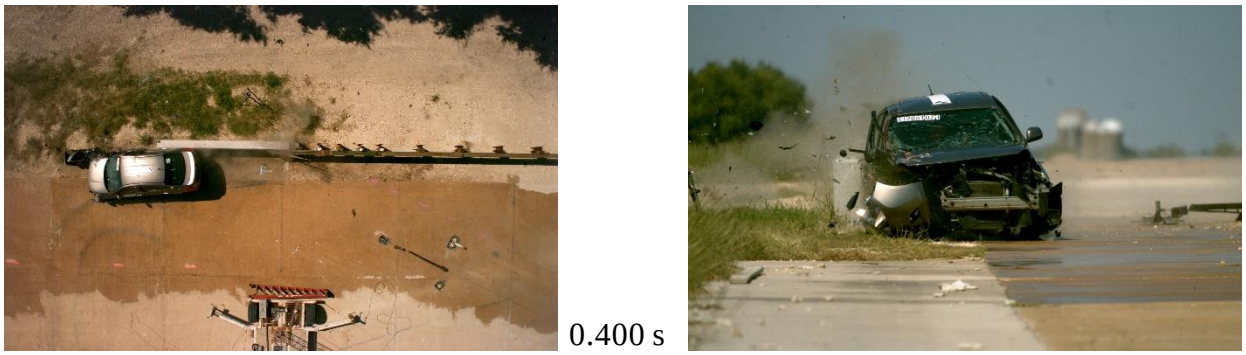
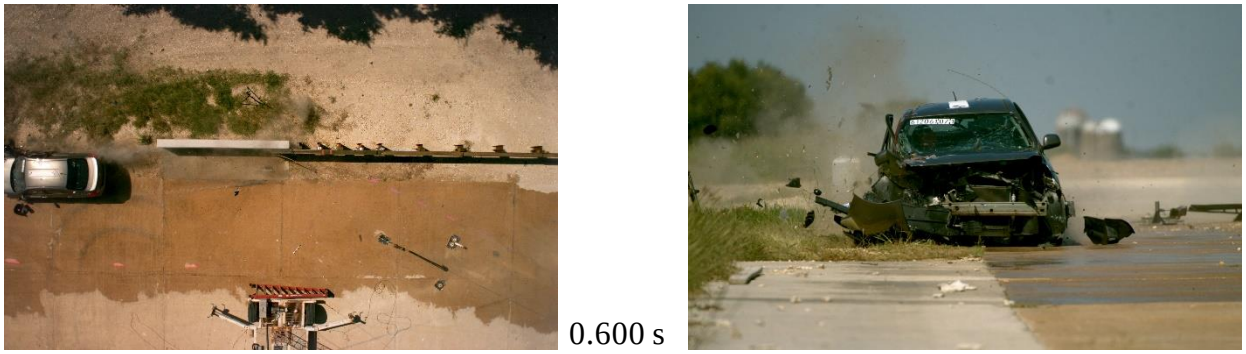


Figure D.1. Sequential Photographs for Test No. 612061-07-1 (Overhead and Frontal Views).


0.400 s


0.500 s


0.600 s


0.700 s

Figure D.1. Sequential Photographs for Test No. 612061-07-1 (Overhead and Frontal Views) (Continued).

0.000 s

0.400 s

0.100 s

0.500 s

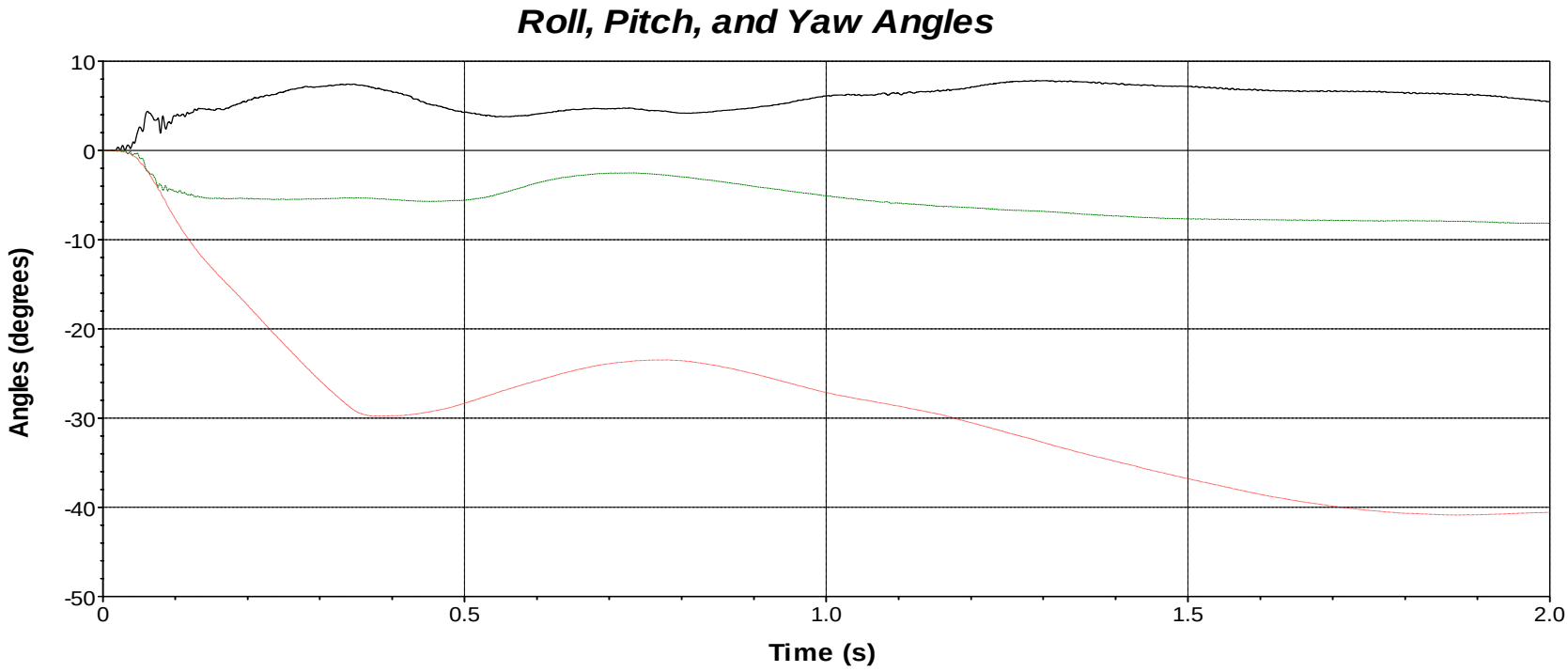
0.200 s

0.600 s

0.200 s

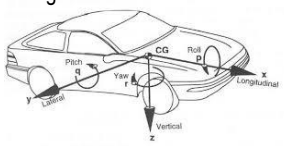
0.700 s

Figure D.2. Sequential Photographs for Test No. 612061-07-1 (Rear View).



Axes are vehicle-fixed.
Sequence for determining orientation:

1. Yaw.
2. Pitch.
3. Roll.



Test Number: 612061-07-1
Test Standard Test Number: *MASH* Test 3-20
Test Article: Merritt Parkway Guiderail Transition
Test Vehicle: 2014 Nissan Versa
Inertial Mass: 2420 lb
Gross Mass: 2585 lb
Impact Speed: 62.5 mi/h
Impact Angle: 25.6°

Figure D.3. Vehicle Angular Displacements for Test No. 612061-07-1.

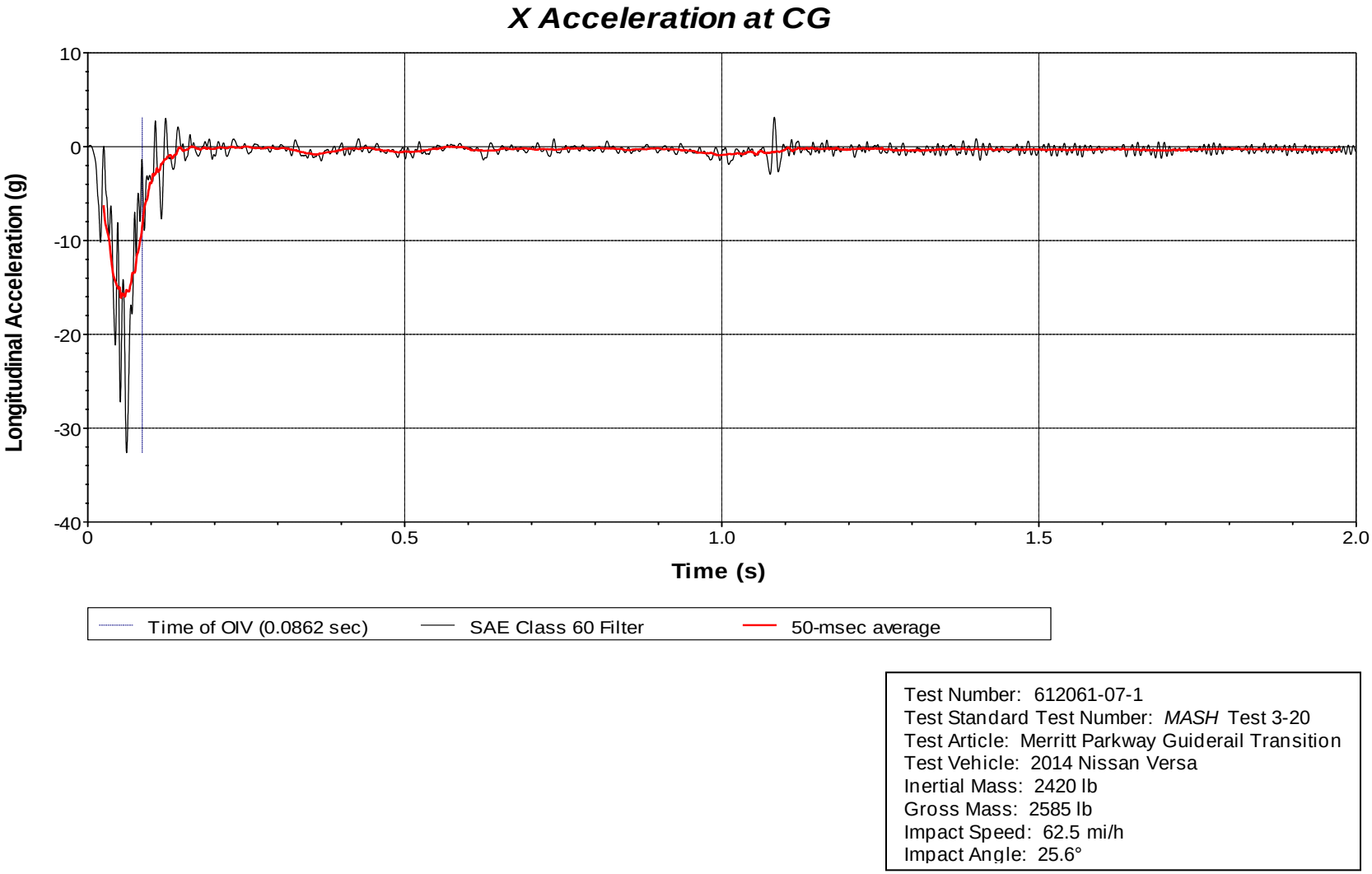


Figure D4. Vehicle Longitudinal Accelerometer Trace for Test No. 612061-07-1 (Accelerometer Located at Center of Gravity).

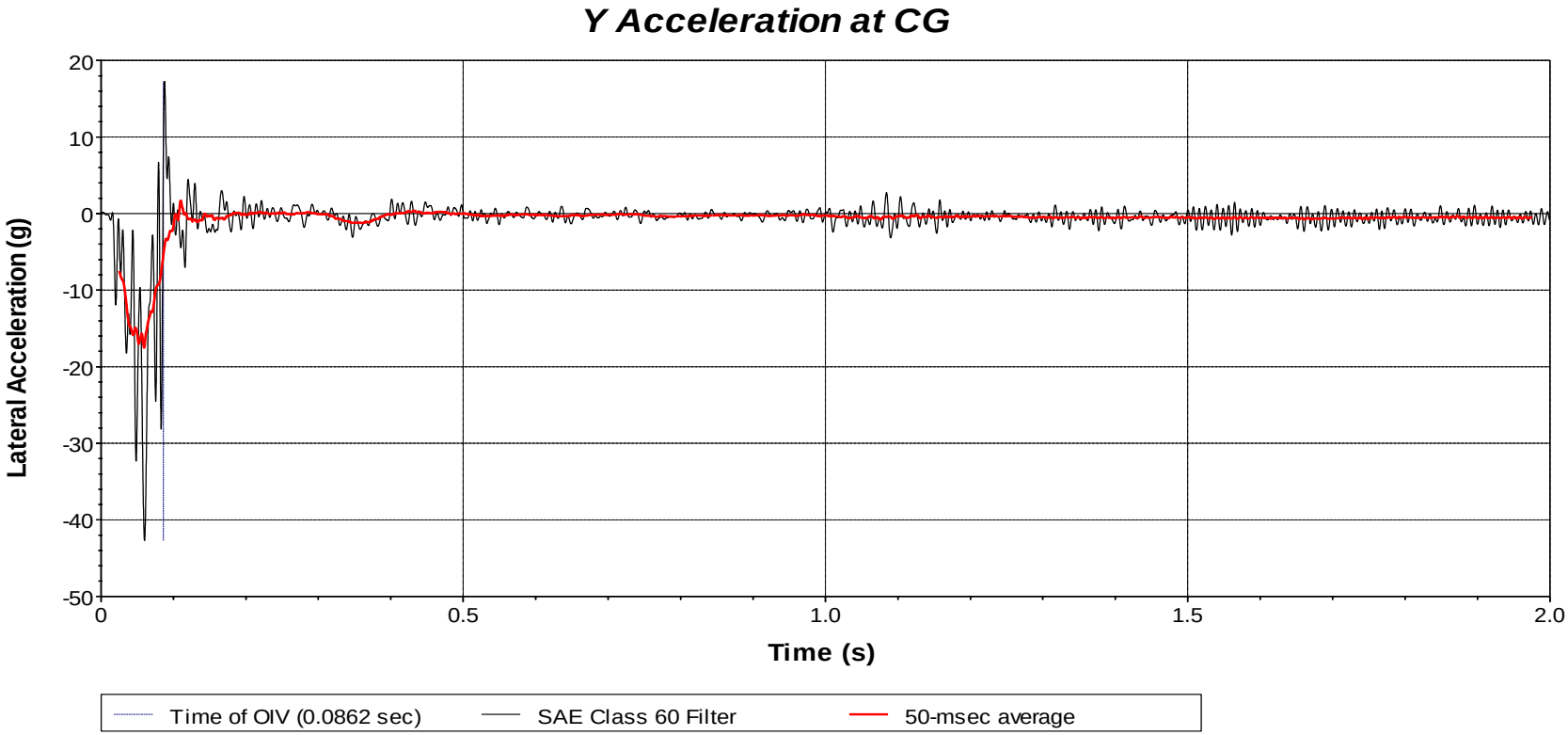


Figure D.5. Vehicle Lateral Accelerometer Trace for Test No. 612061-07-1 (Accelerometer Located at Center of Gravity).

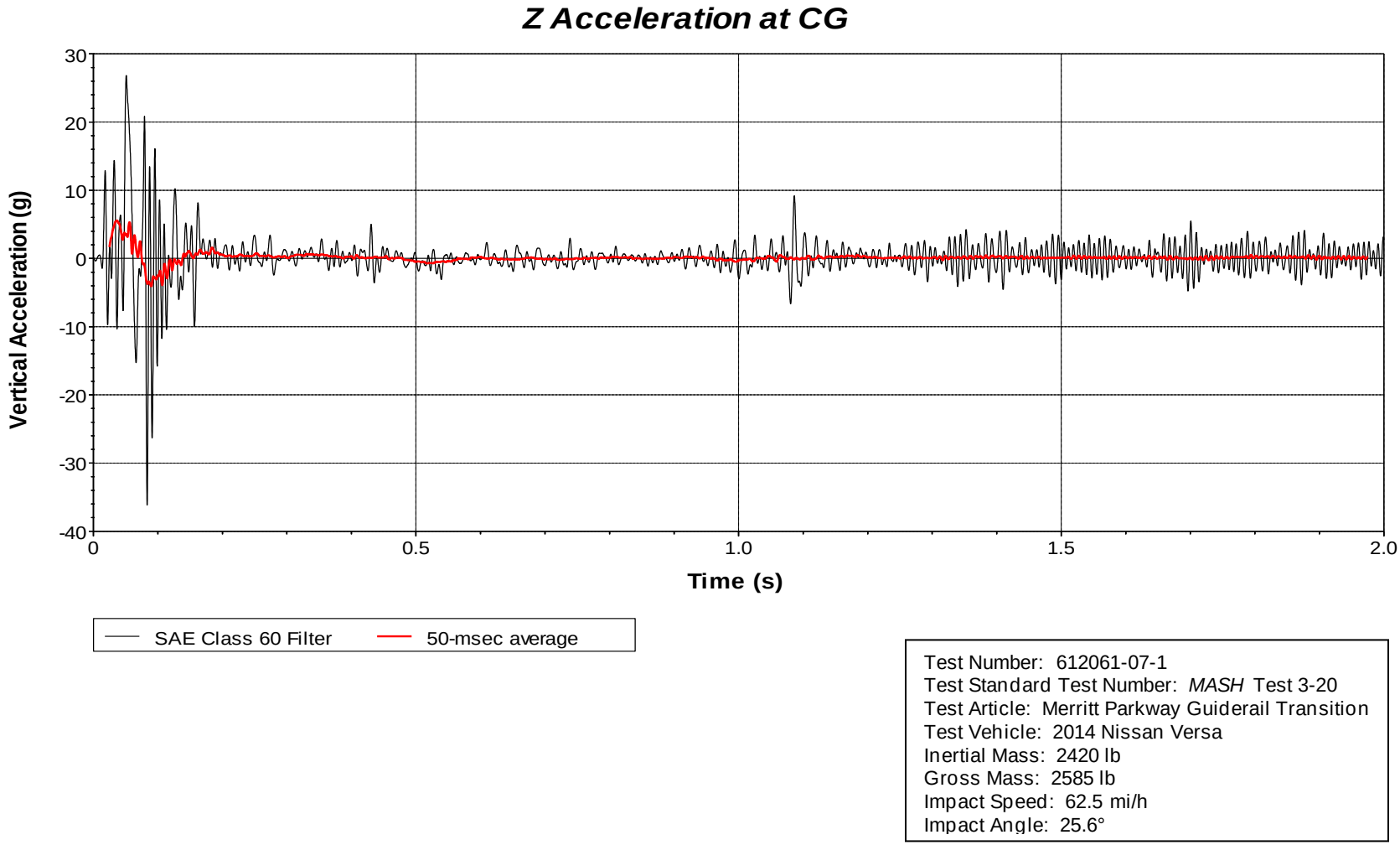


Figure D.6. Vehicle Vertical Accelerometer Trace for Test No. 612061-07-1 (Accelerometer Located at Center of Gravity).

D.4 *MASH* TEST 3-21 (CRASH TEST NO. 612061-06-1)

D.4.1. Vehicle Properties and Information

Table D.6. Vehicle Properties for Test No. 612061-06-1.

Date:	2020-10-12	Test No.:	612061-06-1	VIN No.:	1C6RR6GT7ES211036
Year:	2014	Make:	RAM	Model:	1500
Tire Size:	265/70 R 17			Tire Inflation Pressure:	35 psi
Tread Type:	Highway			Odometer:	130367

Note any damage to the vehicle prior to test: None

● Denotes accelerometer location.

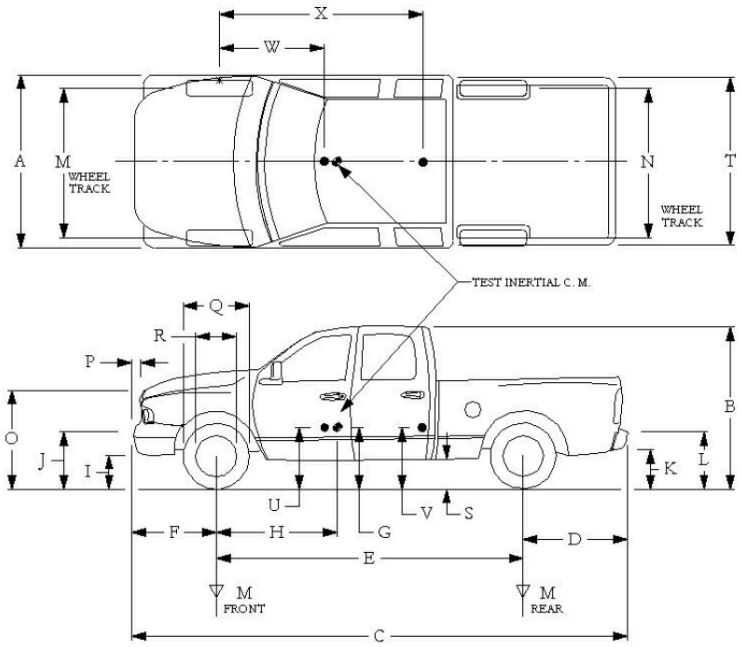
NOTES: None

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	28.00	L	30.00	Q	30.50	V	30.25
C	227.50	H	59.33	M	68.50	R	18.00	W	59.30
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

GVWR Ratings:		**Mass:** lb	Curb	Test Inertial	Gross Static
Front	3700	M_{front}	2977	2892	2977
Back	3900	M_{rear}	2099	2114	2194
Total	6700	M_{Total}	5076	5006	5171

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

Mass Distribution:
lb LF: 1450 RF: 1442 LR: 1082 RR: 1032

Table D.7. Measurements of Vehicle Vertical Center of Gravity for Test No. 612061-06-1.

Date: 2020-10-12 Test No.: 612061-06-1 VIN: 1C6RR6GT7ES211036

Year: 2014 Make: RAM Model: 1500

Body Style: Quad Cab Mileage: 130367

Engine: 5.7 L V-8 Transmission: Automatic

Fuel Level: Empty Ballast: 80 (440 lb max)

Tire Pressure: Front: 35 psi Rear: 35 psi Size: 265/70 R 17

Measured Vehicle Weights: (lb)									
LF:	1450		RF:	1442		Front Axle:	2892		
LR:	1082		RR:	1032		Rear Axle:	2114		
Left:	2532		Right:	2474		Total:	5006		
							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:	59.33	inches	Rear of Front Axle	(63 ±4 inches allowed)					
Y:	-0.40	inches	Left -	Right +	of Vehicle Centerline				
Z:	28	inches	Above Ground	(minumum 28.0 inches allowed)					

Hood Height: 46.00 inches
43 ±4 inches allowed

Front Bumper Height: 27.00 inches

Front Overhang: 40.00 inches
39 ±3 inches allowed

Rear Bumper Height: 30.00 inches

Overall Length: 227.50 inches
237 ±13 inches allowed

Table D.8. Exterior Crush Measurements for Test No. 612061-06-1.

Date:	2020-10-12	Test No.:	612061-06-1	VIN No.:	1C6RR6GT7ES211036
Year:	2014	Make:	RAM	Model:	1500

VEHICLE CRUSH MEASUREMENT SHEET[1]

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

Note: Measure C_1 to C_6 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	18	18	40	-	-	-	-	-	-	12
2	Side plane at bmp ht	18	8	68	-	-	-	-	-	-	79
	Measurements recorded										
	☑ **inches or** ☐ **mm**										

[1]Table 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.

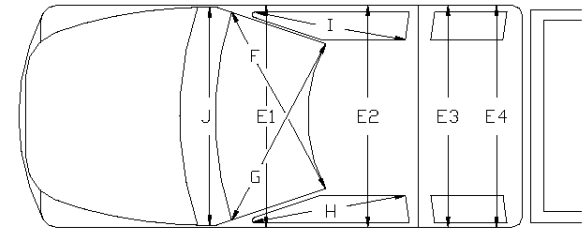
**Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle).

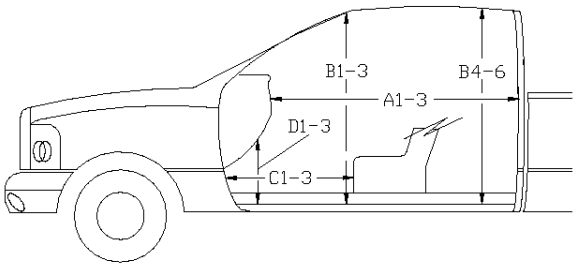
***Measure and document on the vehicle diagram the location of the maximum crush.

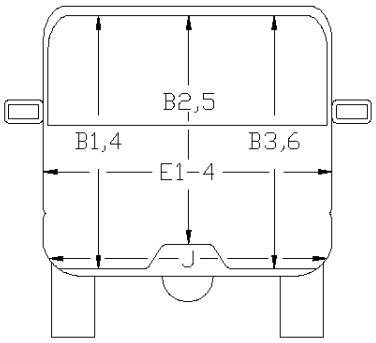
Note: Use as many lines/columns as necessary to describe each damage profile.

Table D.9. Occupant Compartment Measurements for Test No. 612061-06-1.

Date:	2020-10-12	Test No.:	612061-06-1	VIN No.:	1C6RR6GT7ES211036
Year:	2014	Make:	RAM	Model:	1500







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

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	21.50	-4.50
D1	11.00	11.00	0.00
D2	0.00	0.00	0.00
D3	11.50	10.00	-1.50
E1	61.00	55.50	-5.50
E2	63.50	66.00	2.50
E3	63.50	63.50	0.00
E4	63.50	63.50	0.00
F	59.00	58.50	-0.50
G	59.00	59.00	0.00
H	37.50	37.50	0.00
I	37.50	37.50	0.00
J*	25.00	18.50	-6.50

D.4.2. Sequential Photographs REPLACE

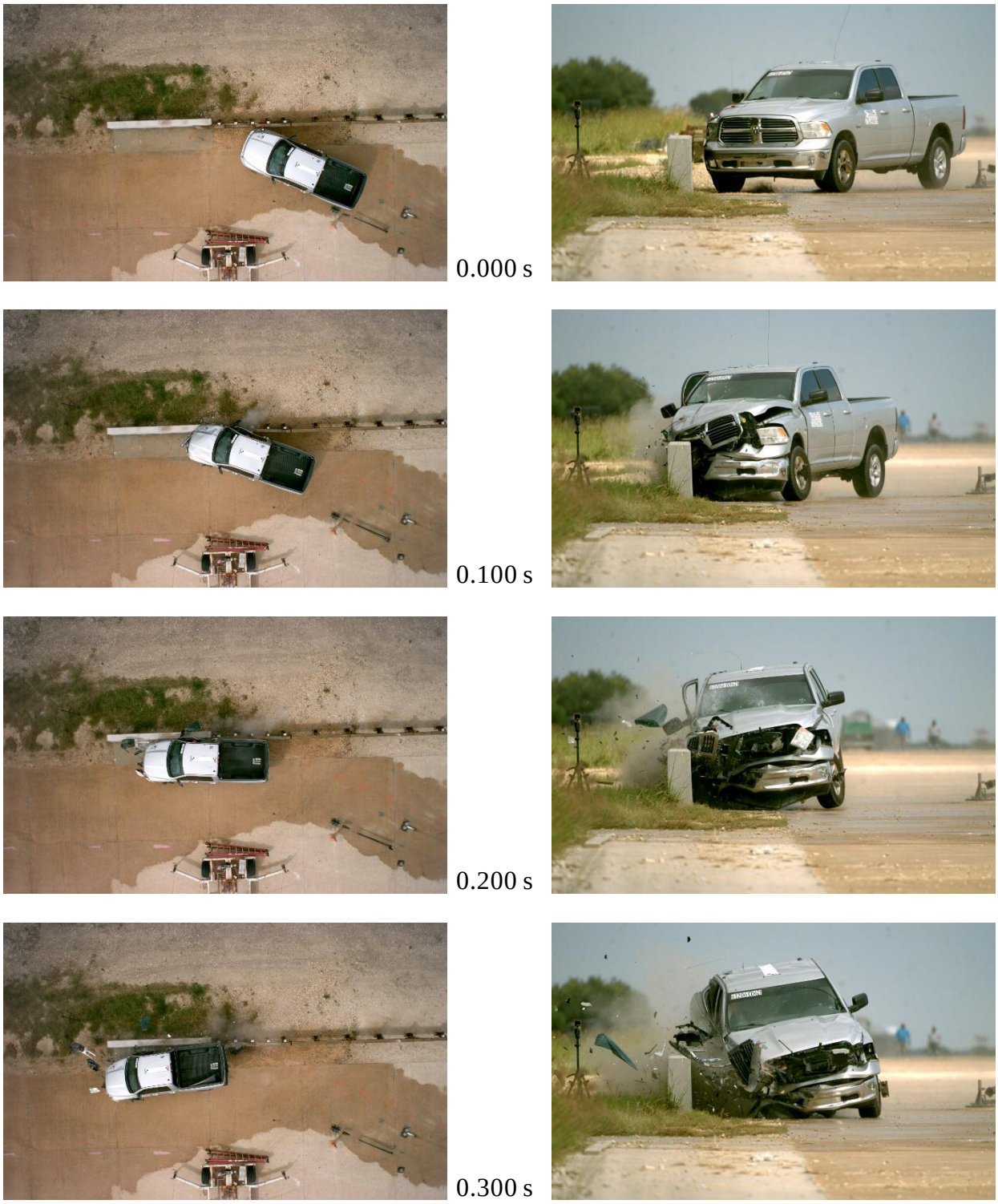
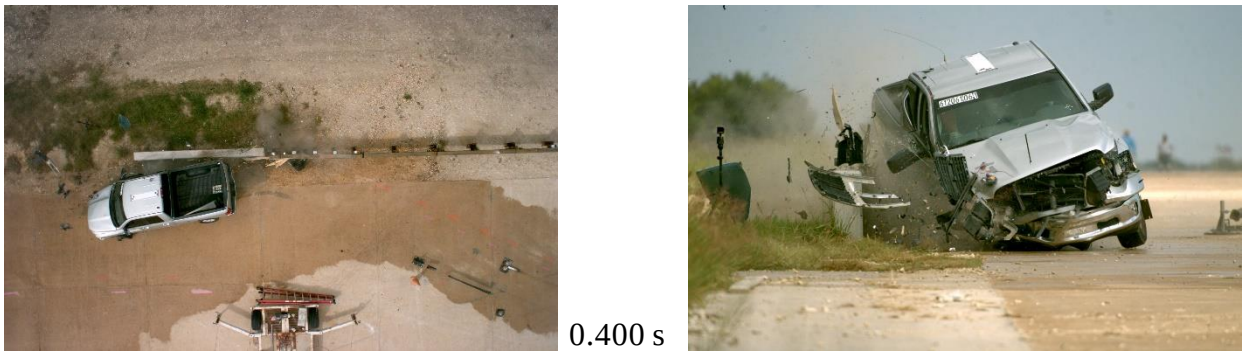


Figure D.7. Sequential Photographs for Test No. 612061-06-1 (Overhead and Frontal Views).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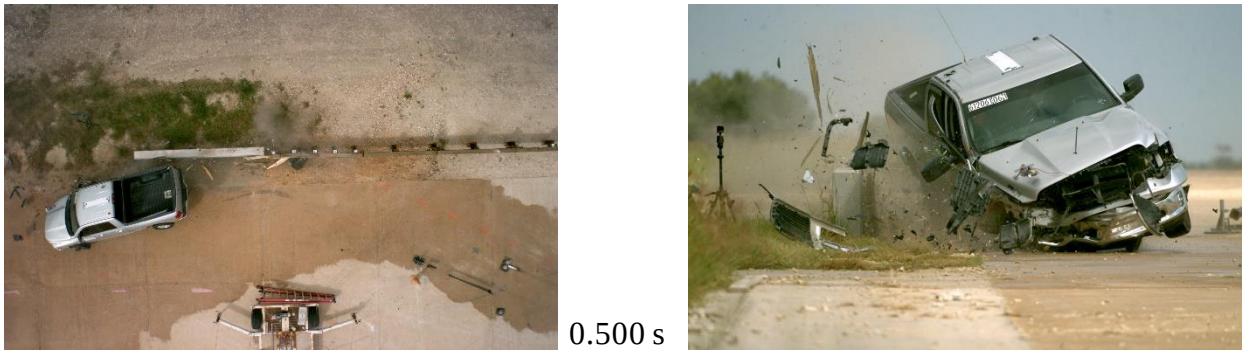
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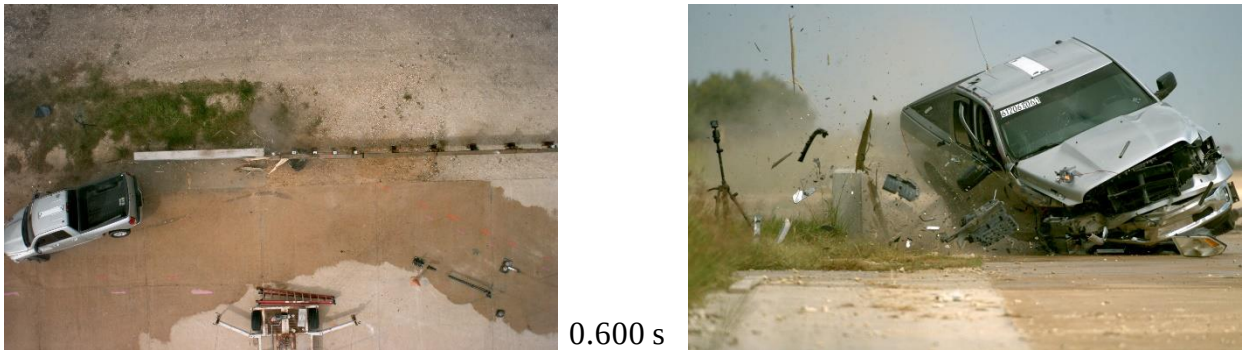

0.600 s

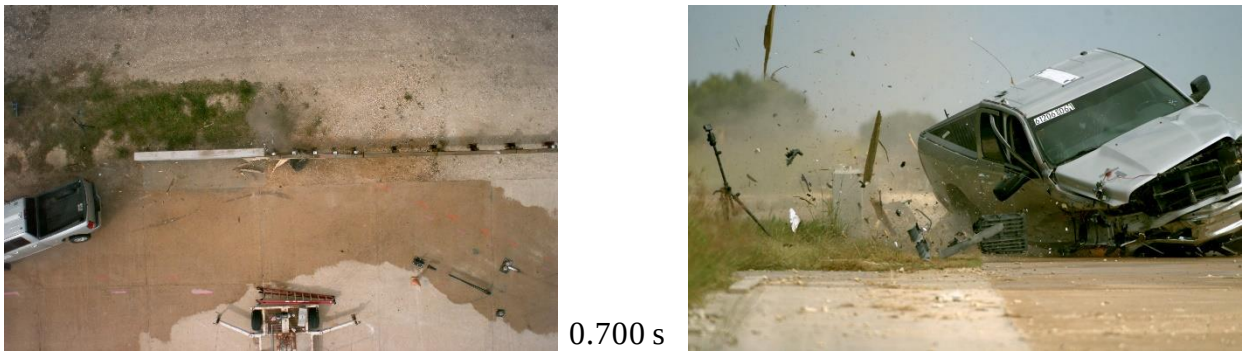

0.700 s

Figure D.7. Sequential Photographs for Test No. 612061-06-1 (Overhead and Frontal Views) (Continued).


0.000 s


0.400 s


0.100 s


0.500 s

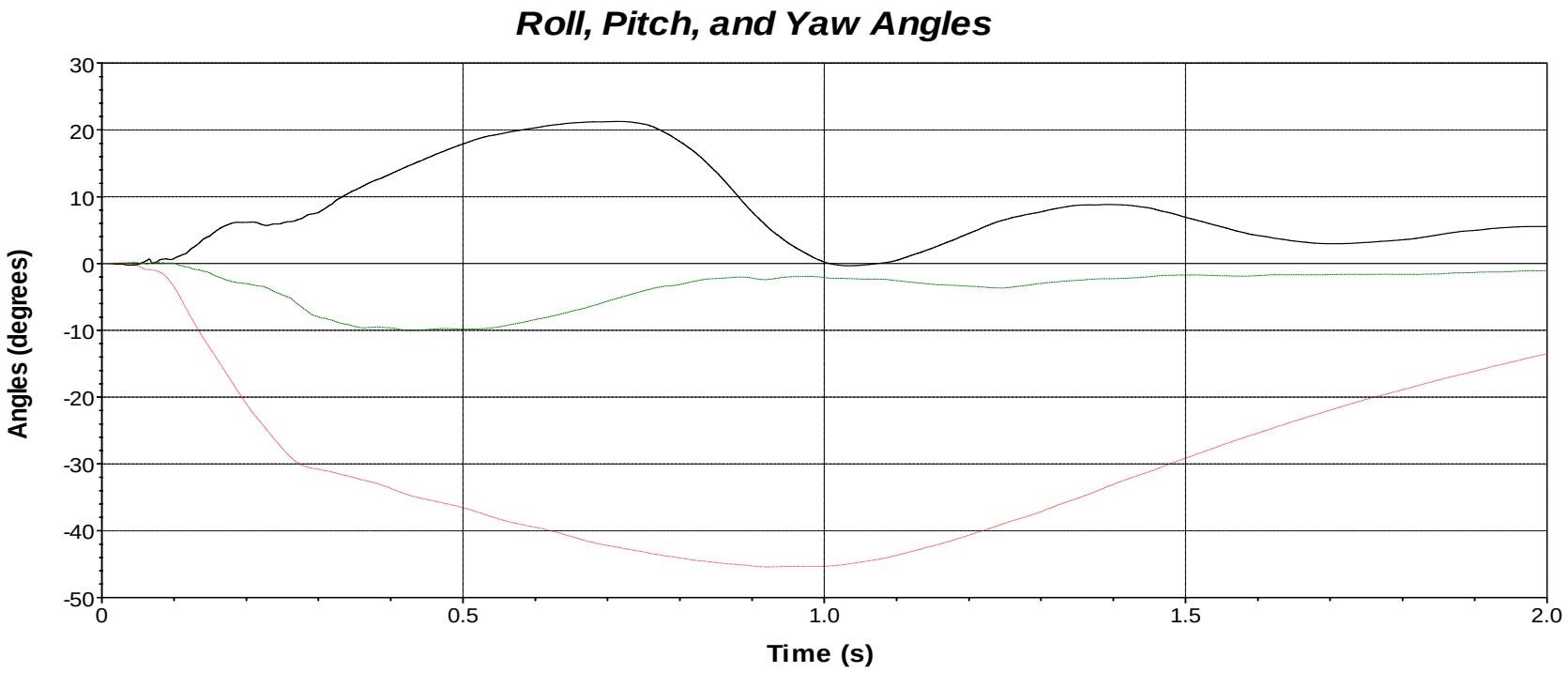

0.200 s


0.600 s


0.300 s

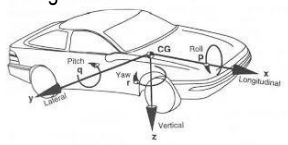

0.700 s

Figure D.8. Sequential Photographs for Test No. 612061-06-1 (Rear View).



Axes are vehicle-fixed.
Sequence for determining orientation:

1. Yaw.
2. Pitch.
3. Roll.



Test Number: 612061-06-1
Test Standard Test Number: *MASH* Test 3-21
Test Article: Merritt Parkway Guiderail Transition
Test Vehicle: 2014 RAM 1500 Pickup
Inertial Mass: 5006 lb
Gross Mass: 5171 lb
Impact Speed: 63.0 mi/h
Impact Angle: 25.2°

Figure D.9. Vehicle Angular Displacements for Test No. 612061-06-1.

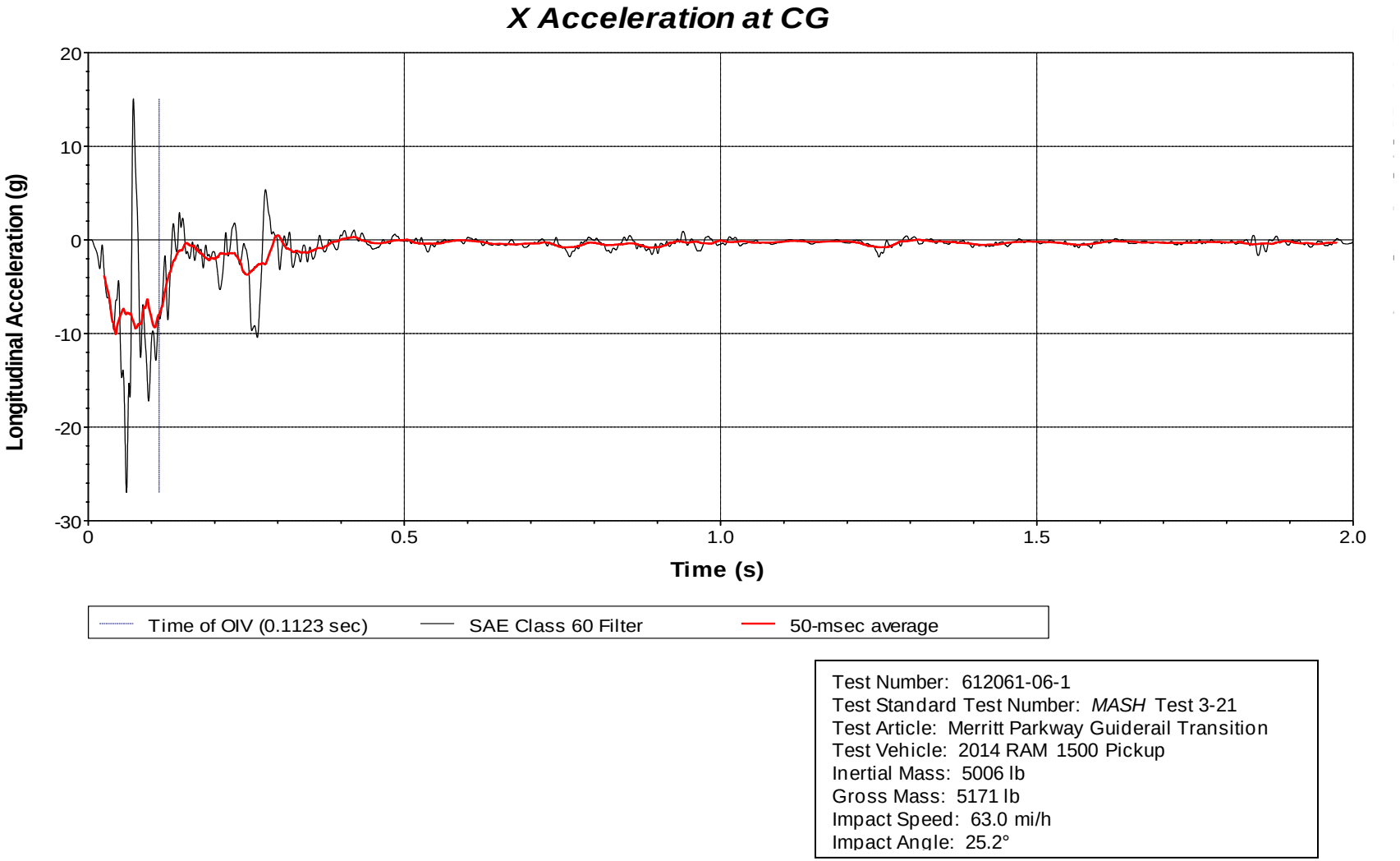
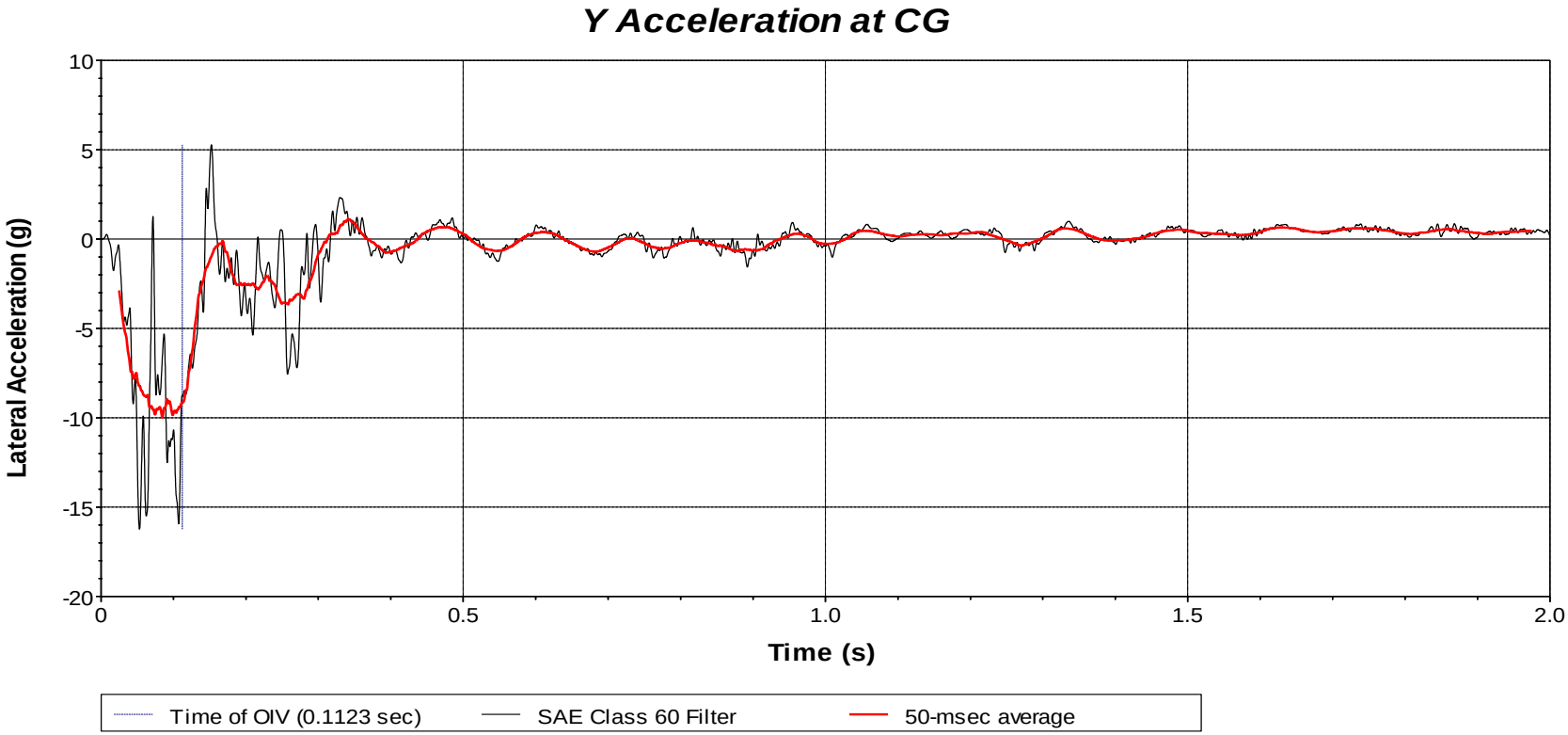


Figure D.10. Vehicle Longitudinal Accelerometer Trace for Test No. 612061-06-1 (Accelerometer Located at Center of Gravity).



Test Number: 612061-06-1
Test Standard Test Number: *MASH* Test 3-21
Test Article: Merritt Parkway Guiderail Transition
Test Vehicle: 2014 RAM 1500 Pickup
Inertial Mass: 5006 lb
Gross Mass: 5171 lb
Impact Speed: 63.0 mi/h
Impact Angle: 25.2°

Figure D.11. Vehicle Lateral Accelerometer Trace for Test No. 612061-06-1 (Accelerometer Located at Center of Gravity).

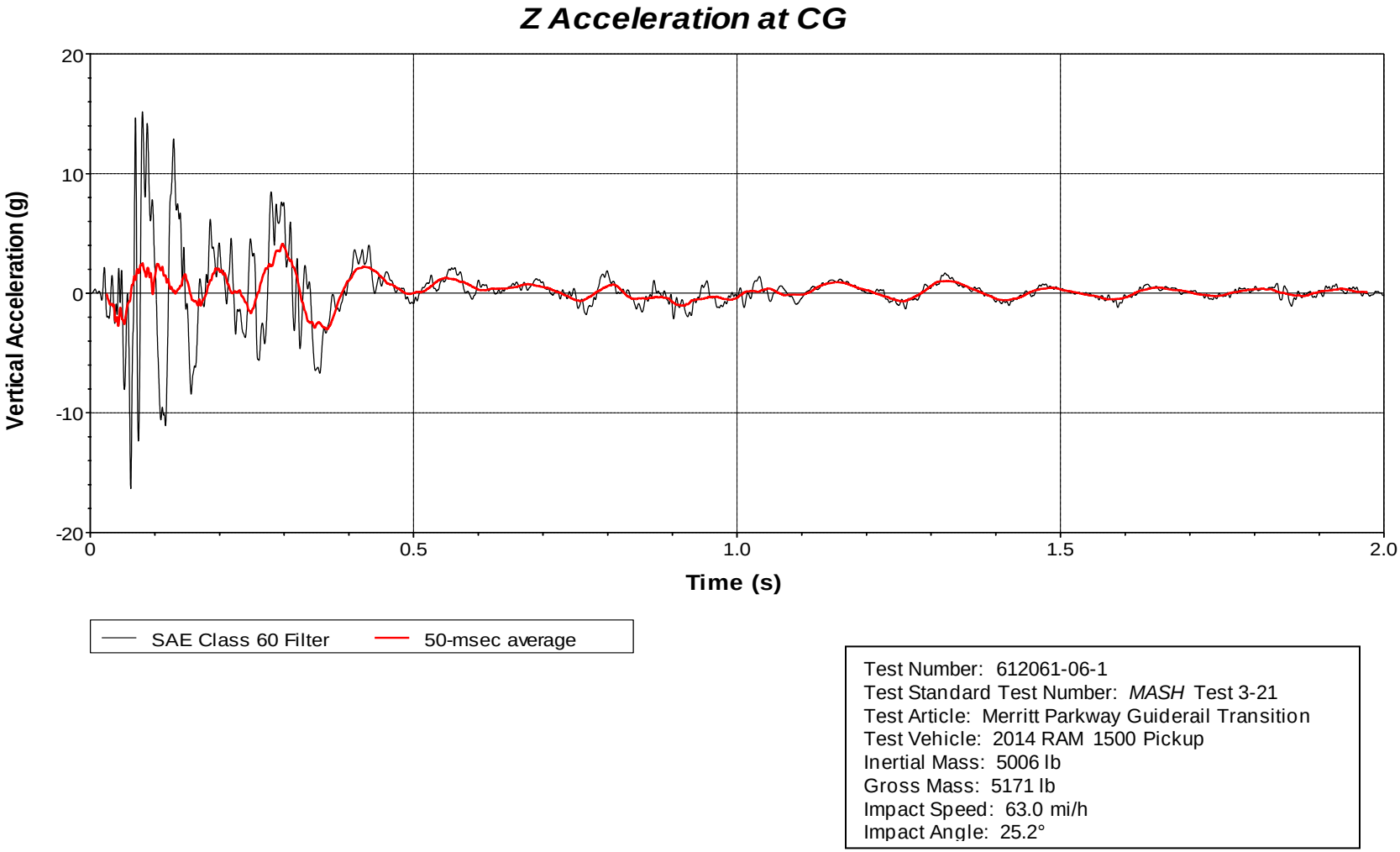


Figure D.12. Vehicle Vertical Accelerometer Trace for Test No. 612061-06-1 (Accelerometer Located at Center of Gravity).