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

by

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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 basteel post, curb, curbless, timber ra	Copyrighted. Not to be copied or reprinted without			
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SI* (MODERN METRIC) CONVERSION FACTORS				
Symbol				Symbol
Symbol	When You Know	Multiply By LENGTH	To Find	Symbol
in ft yd mi	inches feet yards miles	25.4 0.305 0.914 1.61	millimeters meters meters kilometers	mm m m km
	mileo	AREA	Kilohiotolo	KIII
in ² ft ² yd ² ac mi ²	square inches square feet square yards acres square miles	645.2 0.093 0.836 0.405 2.59	square millimeters square meters square meters hectares square kilometers	mm ² m ² m ² ha km ²
		VOLUME		
fl oz gal ft ³ yd ³	fluid ounces gallons cubic feet cubic yards NOTE: volum	29.57 3.785 0.028 0.765 es greater than 1000L	milliliters liters cubic meters cubic meters shall be shown in m ³	mL L m ³ m ³
		MASS		
oz Ib T	ounces pounds short tons (2000 lb)	28.35 0.454 0.907	grams kilograms megagrams (or metric ton")	g kg Mg (or "t")
		MPERATURE (exac		
°F	Fahrenheit	5(F-32)/9 or (F-32)/1.8	Celsius	°C
	FORC	E and PRESSURE	or STRESS	
lbf	poundforce	4.45	newtons	Ν
lbf/in ²	poundforce per square incl		kilopascals	kPa
Symbol	When You Know	Multiply By	IS FROM SI UNITS To Find	Symbol
Symbol		LENGTH	TOFING	Symbol
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	in²
m²	square meters	10.764	square feet	ft ²
m ²	square meters	1.195	square yards	yd²
ha	hectares	2.47	acres	ac
km²	Square kilometers	0.386	square miles	mi ²
		VOLUME		
mL	milliliters	0.034	fluid ounces	oz
L	liters	0.034 0.264	gallons	gal
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L	liters	0.034 0.264 35.314 1.307	gallons	gal
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*SI is the symbol for the International System of Units

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TABLE OF CONTENTS

	Page
	ii
Report Auth	norizationx
0	resxvi
List of Table	esxix
Chapter 1.	Introduction1
1.1. Pro	blem Statement
	ckground1
	jective2
1.4. Wo	ork Plan2
1.4.1	
1.4.2	
1.4.3	
1.4.4	
1.4.5	
1.4.6	
1.4.7	
1.4.8	
Chapter 2.	Test Requirements and Evaluation Criteria5
	ash Test Performed/Matrix5
	aluation Criteria
Chapter 3.	Test Conditions
	st Facility9
	hicle Tow and Guidance System
	ta Acquisition Systems
3.3.1	8
3.3.2	
3.3.3	
Chapter 4.	Merritt Parkway Guiderail with Curb
	st Article Details
4.1.1	
4.1.2	8
4.1.3	1
4.1.4	
	<i>ASH</i> Test 3-10 (Crash Test No. 612061-03-1)
4.2.1	
defin	
4.2.2	
4.2.3	
4.2.5	1
4.2.5	
4.2.6	e
4.2.7	Occupant Risk Factors Error! Bookmark not defined.

TABLE OF CONTENTS (CONTINUED)

					Page
4.3.	MASH	Test 3-11 (Crash Test No. 612061-02-1)	.Error!	Bookmark not o	lefined.
4	.3.1.	Test Designation and Actual Impact Condition	ıs	Error! Bookm	ark not
d	lefined.				
4	.3.2.	Weather Conditions	.Error!	Bookmark not o	lefined.
4	.3.3.	Test Vehicle	.Error!	Bookmark not o	lefined.
4	.3.4.	Test Description	.Error!	Bookmark not o	lefined.
4	.3.5.	Damage to Test Installation	.Error!	Bookmark not o	lefined.
4	.3.6.	Damage to Test Vehicle	.Error!	Bookmark not o	lefined.
4	.3.7.	Occupant Risk Factors	.Error!	Bookmark not o	lefined.
Chapter	· 5. M	Iodified Merritt Parkway Guiderail with Cu	rb	••••••••••••••••••••••	
_		rticle Details			25
5	.1.1.	Installation Details			25
5	.1.2.	Design Modifications during Tests			
5	.1.3.	Material Specifications			
5	.1.4.	Soil Conditions			
5.2.	MASH	Test 3-11 (Crash Test No. 612061-02-1A)			
5	.2.1.	Test Designation and Actual Impact Condition	ıs		
5	.2.2.	Weather Conditions			
5	.2.3.	Test Vehicle			
5	.2.4.	Test Description			
5	.2.5.	Damage to Test Installation			
5	.2.6.	Damage to Test Vehicle			
5	.2.7.	Occupant Risk Factors			
5.3.	MASH	Test 3-10 (Crash Test No. 612061-03-1)			
5	.2.1.	Test Designation and Actual Impact Condition	18		
5	.2.2.	Weather Conditions			
5	.2.3.	Test Vehicle			
5	.2.5.	Test Description			
5	.2.5.	Damage to Test Installation			
5	.2.6.	Damage to Test Vehicle			
5	.2.7.	Occupant Risk Factors			
Chapter	· 6. N	Ierritt Parkway Guiderail Transition	•••••	••••••	
6.1.	Test A	rticle Details			
6	.1.1.	Installation Details			
6	.1.2.	Design Modifications during Tests			
6	.1.3.	Material Specifications			
6	.1.4.	Soil Conditions			
6.2.		Test 3-20 (Crash Test No. 612061-07-1)			
6		est Designation and Actual Impact Conditions.			
6		Veather Conditions			
6	.2.3 T	est Vehicle			
6	.2.4 T	est Description			
6	.2.5 D	amage to Test Installation			

LISTOF FIGURES (CONTINUED)

		Pa	age
6.2	2.6 D	Damage to Test Vehicle	. 50
6.2	2.7 C	Occupant Risk Factors	. 51
6.3.	MASH	H Test 3-21 (Crash Test No. 612061-06-1)	. 55
6.	3.1 T	Fest Designation and Actual Impact Conditions	. 55
6.	3.2 V	Weather Conditions	. 55
6.	3.3 T	Fest Vehicle	. 55
6.	3.4 T	Fest Description	. 56
6.	3.5 D	Damage to Test Installation	. 56
6.	3.6 D	Damage to Test Vehicle	. 58
6.	3.7 C	Occupant Risk Factors	. 59
Chapter '		Summary and Conclusions	
7.1.		sment of Test Results	
		Merritt Parkway Guiderail with 4-inch Curb	
7.	1.2 N	Modified Merritt Parkway Guiderail with 4-inch Curb	. 63
		Merritt Parkway Guiderail Transition	
7.2.	Conch	lusions	. 63
		Ierritt Parkway Guiderail with Curb	
		ls of Installation	
		Properties	
A.3.	MASH	H Test 3-10 (Crash Test No. 612061-03-1) Error! Bookmark not defin	
	.3.1.	Vehicle Properties and Information Error! Bookmark not defin	
	.3.2.		
	.3.3.		
	.3.4.	Vehicle Accelerations Error! Bookmark not defin	
		H Test 3-11 (Crash Test No. 612061-02-1)	
	.4.1.	Vehicle Properties and Information	
	.4.2.	Sequential Photographs	
	.4.3.	Vehicle Angular Displacements	
	.4.4.	Vehicle Accelerations	
		upporting Certification Docments1	
**		Iodified Merritt Parkway Guiderail with Curb1	
		ls of Installation1	
		Properties	
		H Test 3-11 (Crash Test No. 612061-02-1A)	
	3.1.	Vehicle Properties and Information	
	3.2.	Sequential Photographs2	
	3.3. 3.4.	Vehicle Angular Displacements	

LISTOF FIGURES (CONTINUED)

			Page
C.4.	MASH	Test 3-10 (Crash Test No. 612061-03-1)	
С	.4.1.	Vehicle Properties and Information	
С	.4.2.	Sequential Photographs	
С	.4.3.	Vehicle Angular Displacements	
С	.4.4.	Vehicle Accelerations	
Appendi	x D. M	erritt Parkway Guiderail Transition	
D.1.	Details	s of Installation	
D.2.	Soil Pr	operties	
D.3	MASH	Test 3-20 (Crash Test No. 612061-07-1)	
D	.3.1.	Vehicle Properties and Information	
D	.3.2.	Sequential Photographs	
D	.3.3.	Vehicle Angular Displacements	
D	.3.4.	Vehicle Accelerations	
D.4	MASH	Test 3-21 (Crash Test No. 612061-06-1)	
D	.4.1.	Vehicle Properties and Information	
D	.4.2.	Sequential Photographs REPLACE	
D	.4.3.	Vehicle Angular Displacements	
D	.4.4.	Vehicle Accelerations	

LIST OF FIGURES

	Page
Figure 2.1.	Target CIP for <i>MASH</i> Test 3-10 on Merritt Parkway Guiderail with Curb
Figure 2.2.	(Test No. 612061-02-1
8	with Curb (Test No. 612061-03-1
Figure 2.3.	Target CIP for MASH Test 3-10 on Modified Merritt Parkway Guiderail
	with Curb (Test No. 612061-02-1A Error! Bookmark not defined.
Figure 2.4.	Target CIP for MASH Test 3-11 on Modified Merritt Parkway Guiderail
	with Curb (Test No. 612061-03-1 Error! Bookmark not defined.
Figure 2.5.	Target CIP for MASH Test 3-20 on Merritt Parkway Guiderail Transition
	(Test No. 612061-07-1
Figure 2.6.	Target CIP for MASH Test 3-21 on Merritt Parkway Guiderail Transition
	(Test No. 612061-06-1
Figure 4.1.	Merritt Parkway Guiderail with Curb Details
Figure 4.2.	Merritt Parkway Guiderail with Curb prior to Testing
Figure 4.3.	Merritt Parkway Guiderail/Test Vehicle Geometrics for Test No. 612061-
	03-1Error! Bookmark not defined.
Figure 4.4.	Test Vehicle before Test No. 612061-03-1 Error! Bookmark not defined.
Figure 4.5.	Merritt Parkway Guiderail after Test No. 612061-03-1Error! Bookmark not defined.
Figure 4.6.	Damage from Post 5 to Post 6 after Test No. 612061-03-1.Error! Bookmark not defined.
Figure 4.7.	Damage from Post 6 to Post 7 after Test No. 612061-03-1.Error! Bookmark not defined.
Figure 4.8.	Test Vehicle after Test No. 612061-03-1 Error! Bookmark not defined.
Figure 4.9.	Interior of Test Vehicle after Test No. 612061-03-1Error! Bookmark not defined.
Figure 4.10.	Summary of Results for <i>MASH</i> Test 3-10 on Merritt Parkway Guiderail with Curb
Figure 4.11.	Merritt Parkway Guiderail/Test Vehicle Geometrics for Test No. 612061-
-	02-1Error! Bookmark not defined.
Figure 4.12.	Test Vehicle before Test No. 612061-02-1 Error! Bookmark not defined.
Figure 4.13.	Merritt Parkway Guiderail after Test No. 612061-02-1Error! Bookmark not defined.
Figure 4.14.	Damage at Posts 5 through 8 after Test No. 612061-02-1. Error! Bookmark not defined.
Figure 4.15.	Field Side of Guiderail after Test No. 612061-02-1Error! Bookmark not defined.
Figure 4.16.	Test Vehicle after Test No. 612061-02-1 Error! Bookmark not defined.
Figure 4.17.	Interior of Test Vehicle after Test No. 612061-02-1Error! Bookmark not defined.
Figure 4.18.	Summary of Results for <i>MASH</i> Test 3-11 on Merritt Parkway Guiderail Error! Bookmark not defined.
Figure 5.1.	Merritt Parkway Guiderail with Curb Details
Figure 5.2.	Merritt Parkway Guiderail with Curb prior to Testing

Figure 5.3.	Modified Merritt Parkway Guiderail/Test Vehicle Geometrics for	
	Test No. 612061-02-1A	29
Figure 5.4.	Test Vehicle before Test No. 612061-02-1A.	30
Figure 5.5.	Modified Merritt Parkway Guiderail after Test No. 612061-02-1A	31
Figure 5.6.	Damage at Posts 5 through 8 after Test No. 612061-02-1A	32
Figure 5.7.	Field Side of Guiderail after Test No. 612061-02-1A	33
Figure 5.8.	Test Vehicle after Test No. 612061-02-1A	34
Figure 5.9.	Interior of Test Vehicle after Test No. 612061-02-1A	34

LIST OF FIGURES (CONTINUED)

P	a	g	e

Figure 5.10.	Summary of Results for MASH Test 3-11 on Modified Merritt Parkway	0
-	Guiderail	35
Figure 5.11.	Modified Merritt Parkway Guiderail/Test Vehicle Geometrics for Test No.	
C	612061-03-1	37
Figure 5.12.	Test Vehicle before Test No. 612061-03-1	38
Figure 5.13.	Modified Merritt Parkway Guiderail after Test No. 612061-03-1	39
Figure 5.14.	Damage from Post 8 to Post 11 after Test No. 612061-03-1	
Figure 5.15.	Test Vehicle after Test No. 612061-03-1	
Figure 5.16.	Interior of Test Vehicle after Test No. 612061-03-1	
Figure 5.17.	Summary of Results for MASH Test 3-10 on Modified Merritt Parkway	
	Guiderail with Curb.	
Figure 6.1.	Merritt Parkway Guiderail Transition Details	45
Figure 6.2.	Merritt Parkway Guiderail Transition prior to Testing.	47
Figure 6.3.	Transition/Test Vehicle Geometrics for Test No. 612061-07-1	48
Figure 6.4.	Test Vehicle before Test No. 612061-07-1	49
Figure 6.5.	Transition after Test No. 612061-07-1.	50
Figure 6.6.	Test Vehicle after Test No. 612061-07-1	51
Figure 6.7.	Interior of Test Vehicle after Test No. 612061-07-1.	51
Figure 6.8.	Summary of Results for MASH Test 3-20 on Merritt Parkway Guiderail	
e	Transition.	53
Figure 6.9.	Transition/Test Vehicle Geometrics for Test No. 612061-06-1	55
Figure 6.10.	Test Vehicle before Test No. 612061-06-1	56
Figure 6.11.	Transition after Test No. 612061-06-1.	
Figure 6.12.	Field Side of Transition after Test No. 612061-06-1	58
Figure 6.13.	Test Vehicle after Test No. 612061-06-1	59
Figure 6.14.	Interior of Test Vehicle after Test No. 612061-06-1.	
Figure 6.15.	Summary of Results for MASH Test 4-21 on Merritt Parkway Guiderail	
e	Transition.	61
Figure A.1.	Sequential Photographs for Test No. 612061-03-1 (Overhead and Frontal	
	Views) Error! Bookmark not def	ined.
Figure A.2.	Sequential Photographs for Test No. 612061-03-1 (Rear View)En	rror!
	Bookmark not defined.	
Figure A.3.	Vehicle Angular Displacements for Test No. 612061-03-1.Error! Bookmar	k not
	defined.	
Figure A.4.	Vehicle Longitudinal Accelerometer Trace for Test No. 612061-03-1	
	(Accelerometer Located at Center of Gravity)Error! Bookmark not def	ined.
Figure A.5.	Vehicle Lateral Accelerometer Trace for Test No. 612061-03-1	
	(Accelerometer Located at Center of Gravity)Error! Bookmark not def	ined.
Figure A.6.	Vehicle Vertical Accelerometer Trace for Test No. 612061-03-1	
	(Accelerometer Located at Center of Gravity)Error! Bookmark not def	ined.
Figure A.7. Se	equential Photographs for Test No. 612061-02-1 (Overhead and Frontal	
	Views)	95
Figure A.8.	Sequential Photographs for Test No. 612061-02-1 (Rear View)	97
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)	99
	LIST OF FIGURES (CONTINUED)	

Page

Figure A.11.	Vehicle Lateral Accelerometer Trace for Test No. 612061-02-1	
	(Accelerometer Located at Center of Gravity)	100
Figure A.12.	Vehicle Vertical Accelerometer Trace for Test No. 612061-02-1	
	(Accelerometer Located at Center of Gravity)	101
Figure C.1.	Sequential Photographs for Test No. 612061-02-1A (Overhead and	
	Frontal Views)	
Figure C.2.	Sequential Photographs for Test No. 612061-02-1A (Rear View).	217
Figure C.3.	Vehicle Angular Displacements for Test No. 612061-02-1A	218
Figure C.4.	Vehicle Longitudinal Accelerometer Trace for Test No. 612061-02-1A	
	(Accelerometer Located at Center of Gravity)	219
Figure C.5.	Vehicle Lateral Accelerometer Trace for Test No. 612061-02-1A	
	(Accelerometer Located at Center of Gravity)	220
Figure C.6.	Vehicle Vertical Accelerometer Trace for Test No. 612061-02-1A (Acceleron	neter
	Located at Center of Gravity).	221
Figure C.7.	Sequential Photographs for Test No. 612061-03-1 (Overhead and Frontal	
	Views)	225
Figure C.8.	Vehicle Angular Displacements for Test No. 612061-03-1.	227
Figure C.9.	Vehicle Longitudinal Accelerometer Trace for Test No. 612061-03-1	
	(Accelerometer Located at Center of Gravity)	228
Figure C.10.	Vehicle Lateral Accelerometer Trace for Test No. 612061-03-1	
-	(Accelerometer Located at Center of Gravity).	229
Figure C.11.	Vehicle Vertical Accelerometer Trace for Test No. 612061-03-1	
	(Accelerometer Located at Center of Gravity).	230
Figure D.1. Se	equential Photographs for Test No. 612061-07-1 (Overhead and Frontal	
-	Views)	252
Figure D.2.	Sequential Photographs for Test No. 612061-07-1 (Rear View)	254
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)	256
Figure D.5.	Vehicle Lateral Accelerometer Trace for Test No. 612061-07-1	
-	(Accelerometer Located at Center of Gravity)	257
Figure D.6.	Vehicle Vertical Accelerometer Trace for Test No. 612061-07-1	
U	(Accelerometer Located at Center of Gravity)	258
Figure D.7.	Sequential Photographs for Test No. 612061-06-1 (Overhead and Frontal	
-		263
Figure D.8.	Sequential Photographs for Test No. 612061-06-1 (Rear View)	265
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	
2	(Accelerometer Located at Center of Gravity)	268
Figure D.11.	Vehicle Lateral Accelerometer Trace for Test No. 612061-06-1	
-	(Accelerometer Located at Center of Gravity).	269
	• *	

Figure D.12.	Vehicle Vertica	al Accelerometer Trace for Test No. 612061-06-1	
	(Acceleromete	er Located at Center of Gravity)2	270

LIST OF TABLES

	Pag	;e
Table 2.1.	Test Conditions and Evaluation Criteria Specified for MASH TL-3	
	Longitudinal Barriers and Transitions	5
Table 2.2.	Evaluation Criteria Required for MASH TL-3 Longitudinal Barriers and	_
	Transitions	7
Table 4.1.	Events during Test No. 612061-03-1 Error! Bookmark not defined	
Table 4.2.	Occupant Risk Factors for Test No. 612061-03-1.Error! Bookmark not defined	
Table 4.3.	Events during Test No. 612061-02-1 Error! Bookmark not defined	
Table 4.4.	Occupant Risk Factors for Test No. 612061-02-1.Error! Bookmark not defined	
Table 5.1.	Events during Test No. 612061-02-1A	
Table 5.2.	Occupant Risk Factors for Test No. 612061-02-1A3	
Table 5.3.	Events during Test No. 612061-03-1	8
Table 5.4.	Occupant Risk Factors for Test No. 612061-03-14	
Table 6.1.	Events during Test No. 612061-07-14	
Table 6.2.	Occupant Risk Factors for Test No. 612061-07-15	
Table 6.3.	Events during Test No. 612061-06-15	
Table 6.4.	Occupant Risk Factors for Test No. 612061-06-1	0
Table 7.1.	Performance Evaluation Summary for MASH Test 3-10 on Merritt	
	Parkway Guiderail	4
Table 7.2.	Performance Evaluation Summary for MASH Test 3-11 on Merritt	
	Parkway Guiderail	5
Table 7.3.	Performance Evaluation Summary for MASH Test 3-10 on Modified	
	Merritt Parkway Guiderail6	6
Table 7.4.	Performance Evaluation Summary for MASH Test 3-11 on Modified	
	Merritt Parkway Guiderail6	7
Table 7.5.	Performance Evaluation Summary for MASH Test 3-10 on Merritt	
	Parkway Guiderail Transition	8
Table 7.6.	Performance Evaluation Summary for MASH Test 3-21 on Merritt	
	Parkway Guiderail Transition	9
Table 7.7.	Assessment Summary for MASH TL-3 Tests on Modified Merritt Parkway	
	Guiderail7	0
Table 7.8.	Assessment Summary for MASH TL-3 Tests on Merritt Parkway Guiderail	
		0
Table A.1.	Summary of Strong Soil Test Results for Establishing Installation	
	Procedure	7
Table A.2.	Test Day Static Soil Strength Documentation for Test No. 612061-03-1	8
Table A.2.	Test Day Static Soil Strength Documentation for Test No. 612061-02-1	
Table A.3.	Vehicle Properties for Test No. 612061-03-1 Error! Bookmark not defined	1.
Table A.4.	Exterior Crush Measurements for Test No. 612061-03-1Error! Bookmark no)t
	defined.	
Table A.5.	Occupant Compartment Measurements for Test No. 612061-03-1 Error	r!
	Bookmark not defined.	
Table A.6.	Vehicle Properties for Test No. 612061-02-19	1

Table A.7.	Measurements of Vehicle Vertical Center of Gravity for Test No. 612061-	
	02-1	92
Table A.8.	Exterior Crush Measurements for Test No. 612061-02-1	93
	LIST OF TABLES (CONTINUED)	

Page

Table A.9.	Occupant Compartment Measurements for Test No. 612061-02-1	94
Table C.1.	Summary of Strong Soil Test Results for Establishing Installation	
	Procedure.	. 208
Table C.2.	Test Day Static Soil Strength Documentation for Test No. 612061-03-1	. 209
Table C.3.	Test Day Static Soil Strength Documentation for Test No. 612061-02-1A	.210
Table C.1.	Vehicle Properties for Test No. 612061-02-1A	.211
Table C.2.	Measurements of Vehicle Vertical Center of Gravity for Test No. 612061-	
	02-1A	.212
Table C.3.	Exterior Crush Measurements for Test No. 612061-02-1A	.213
Table C.4.	Occupant Compartment Measurements for Test No. 612061-02-1A	.214
Table C.5.	Vehicle Properties for Test No. 612061-03-1.	. 222
Table C.6.	Exterior Crush Measurements for Test No. 612061-03-1	. 223
Table C.7.	Occupant Compartment Measurements for Test No. 612061-03-1	. 224
Table D.1.	Summary of Strong Soil Test Results for Establishing Installation	
	Procedure.	. 246
Table D.2.	Test Day Static Soil Strength Documentation for Test No. 612061-07-1	. 247
Table D.3.	Test Day Static Soil Strength Documentation for Test No. 612061-06-1	. 248
Table D.1.	Vehicle Properties for Test No. 612061-07-1.	. 249
Table D.2.	Exterior Crush Measurements for Test No. 612061-07-1	. 250
Table D.3.	Occupant Compartment Measurements for Test No. 612061-07-1	. 251
Table D.6.	Vehicle Properties for Test No. 612061-06-1.	. 259
Table D.7.	Measurements of Vehicle Vertical Center of Gravity for Test No.	
	612061-06-1	. 260
Table D.8.	Exterior Crush Measurements for Test No. 612061-06-1	. 261
Table D.9.	Occupant Compartment Measurements for Test No. 612061-06-1	. 262

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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.

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

 Table 2.1. Test Conditions and Evaluation Criteria Specified for MASH TL-3

 Longitudinal Barriers and Transitions.

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

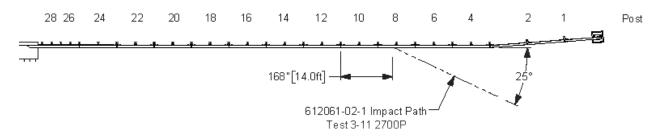


Figure 2.2. Target CIP for *MASH* Test 3-11 on Modified Merritt Parkway Guiderail with Curb (Test No. 612061-03-1.



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

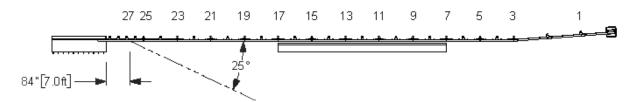


Figure 2.4. Target CIP for *MASH* Test 3-21 on Merritt Parkway Guiderail Transition (Test No. 612061-06-1.

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.

Evaluation Factors	Evaluation Criteria	MASH Test		
Structural Adequacy				
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		
	<i>F.</i> 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		

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

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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 Rateof-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 $10\frac{1}{2}$ 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 34½ 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 $\times 39$ inches tall and was cast 59½ inches deep into the surrounding soil.

Figure 4.1 presents the overall information on the Merritt Parkway Guiderail, 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.

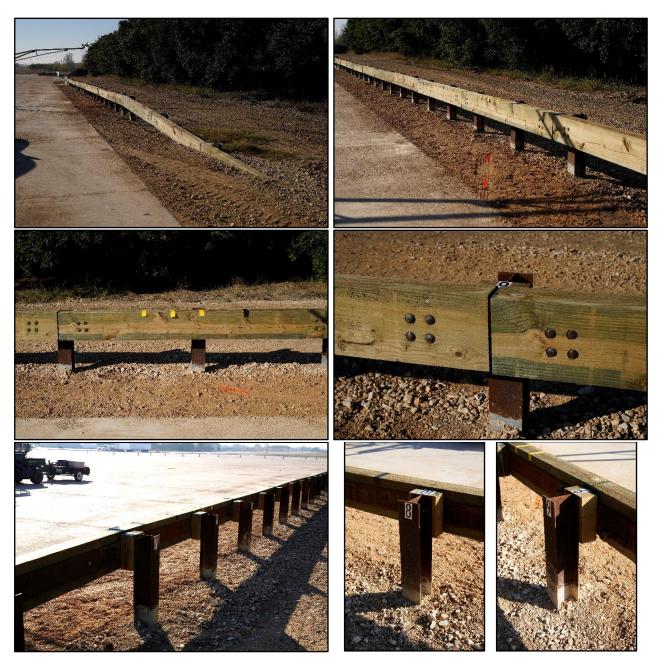


Figure 4.2. Merritt Parkway Guiderail with No Curb prior to Testing.

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 \pm 110 lb impacting the CIP of the longitudinal barrier at an impact speed of 62 mi/h \pm 2.5 mi/h and an angle of 25 degrees \pm 1.5 degrees. The CIP for *MASH* Test 3-11 on the Merritt Parkway Guiderail with no curb was 14.0 ft \pm 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.

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 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.



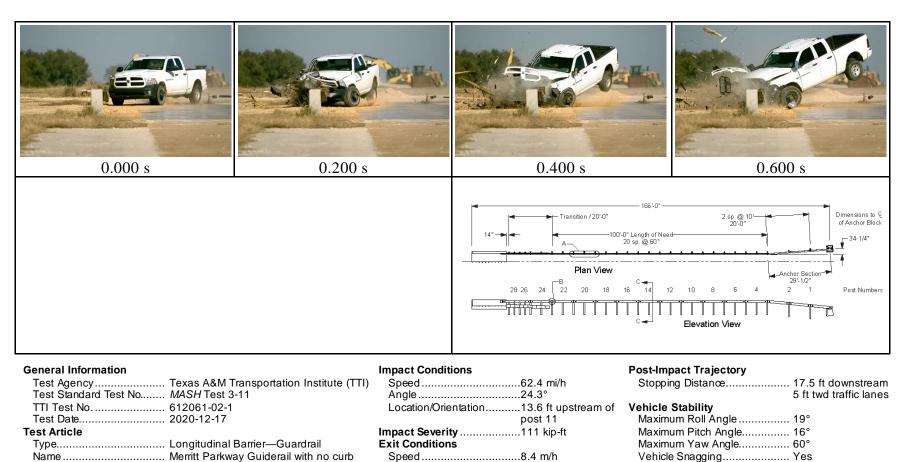
Figure 4.8. Test Vehicle after Test No. 612061-02-1.



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

Occupant Risk Factor	Value	Time		
Occupant Impact Velocity (OIV)				
Longitudinal	23.3 ft/s	at 0 1286 a on right side of interior		
Lateral	14.4 ft/s	at 0.1386 s on right side of interior		
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		

Table 4.2. Occupant	Risk	Factors for	r Test	No.	612061-02-1.
- asie mai o coupanie					012001 01 10



Gross Static 5177 lb	Vertical5.3 g	Max. Occupant Compartment Deformation
Figure 4.10. Summary of Results f	for <i>MASH</i> Test 3-11 on Merritt Par	rkway Guiderail with No Curb.

Max. 0.050-s Average

Occupant Risk Values

Trajectory/Heading Angle ... 86.2°/75.6°

Longitudinal OIV23.3 ft/s

Lateral OIV.....14.4 ft/s

Longitudinal Ridedown25.0 g Lateral Ridedown......10.6 g

Longitudinal.....-14.0 g

Lateral.....-5.4 g

ASI.....1.2

Vehicle Pocketing...... Yes

Dynamic...... 22.6 inches

Height of Working Width...... 46.3 inches

VDS......01RFQ5

CDC......01FREW3

Max. Exterior Deformation 16.0 inches OCDI..... RF0020000

Permanent...... 22.9 inches-backup Working Width 44.8 inches

6.0 inches

Test Article Deflections

Vehicle Damage

Test Vehicle

Installation Length..... 166 ft

Type/Designation..... 2270P

Curb..... 4962 lb

Test Inertial..... 5012 lb

Dummy...... 165 lb

Material or Key Elements.... Metal back timber rail on steel posts and

Soil Type and Condition AASHTO M147-65, grading B Soil

Make and Model..... 2014 RAM 1500 Pickup

timber blockouts

(crushed limestone)

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 <u>not</u> 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 $10\frac{1}{2}$ 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 50foot 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 5³/₄ inches wide at the bottom with a 12-inch deep by 31³/₄-inch wide base below grade.

The upstream anchor section measured 29 ft- $\frac{1}{2}$ inch in length and flared 34 $\frac{1}{4}$ inches to the field side while sloping down before terminating into an anchor block located below grade. The concrete anchor block measured approximately 36 \times 36 inches \times 39 inches tall and was cast 59 $\frac{1}{2}$ inches deep into the surrounding soil.

Figure 4.1 presents 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.

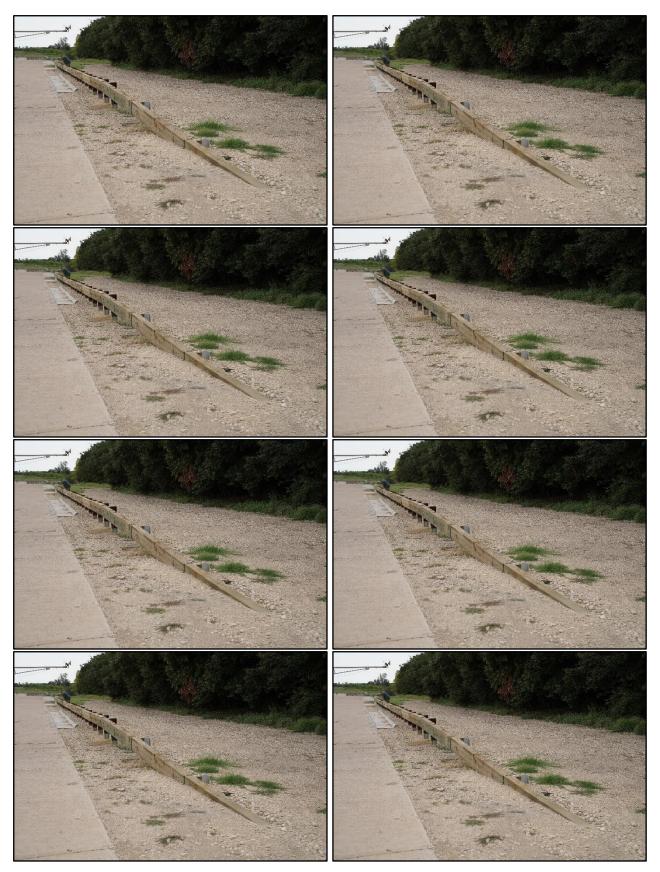


Figure 5.2. Modified Merritt Parkway Guiderail with No Curb prior to Testing.

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 $W6\times16$ 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 \pm 110 lb impacting the CIP of the longitudinal barrier at an impact speed of 62 mi/h \pm 2.5 mi/h and an angle of 25 degrees \pm 1.5 degrees. The CIP for *MASH* Test 3-11 on the Modified Merritt Parkway Guiderail with no curb was 14.0 ft \pm 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.

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

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

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 ¹/₈-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 1¹/₂-inch gap in the soil on the traffic side, and ¹/₄-inch gap on the field side, with the post leaning 3 degrees from vertical toward the field side. Post 9 had a 3¹/₂-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 field 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.



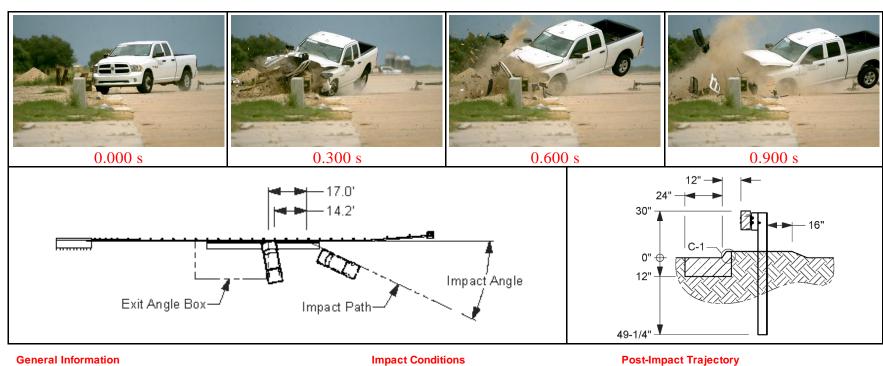
Figure 5.8. Test Vehicle after Test No. 612061-02-1A.



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 a an right side of interior
Lateral	14.4 ft/s	at 0.1280 s on right side of interior
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



TR No. 612061-08-01

General Information

	Texas A&M Transportation Institute (TTI)	Speed
Test Standard Test No		Angle
TTI Test No	612061-02-1A	Location/Orie
Test Date	2020-09-02	
Test Article		Impact Severit
Туре	Longitudinal Barrier—Guardrail	Exit Condition
Name	Modified Merritt Parkway Guiderail with	Speed
	4-inch Curb	Trajectory/He
Installation Length	166 ft	Occupant Risk
Material or Key Elements	Metal back timber rail on steel posts and	Longitudinal C
	timber blockouts	Lateral OIV
Soil Type and Condition	AASHTO M147-65, grading B Soil	Longitudinal I
	(crushed limestone)	Lateral Rided
Test Vehicle		THIV
Type/Designation	2270P	ASI
Make and Model	2014 RAM 1500 Pickup	Max. 0.050-s A
Curb	5040 lb	Longitudina
Test Inertial	5033 lb	Lateral
Dummy	No dummy	Vertical
Gross Static		

Speed	61.5 mi/h
Angle	25.1°
Location/Orientation	
	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	
Vertical	4.3 g
	-

Post-Impact Trajectory

	· · · · · · · · · · · · · · · · · · ·
Stopping Distance	17 ft downstream
	Against rail
Vehicle Stability	3
	100
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 \pm 55 lb impacting the CIP of the longitudinal barrier at an impact speed of 62 mi/h \pm 2.5 mi/h and an angle of 25 degrees \pm 1.5 degrees. The CIP for *MASH* Test 3-10 on the Modified Merritt Parkway Guiderail was 5.0 ft \pm 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.

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

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

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.

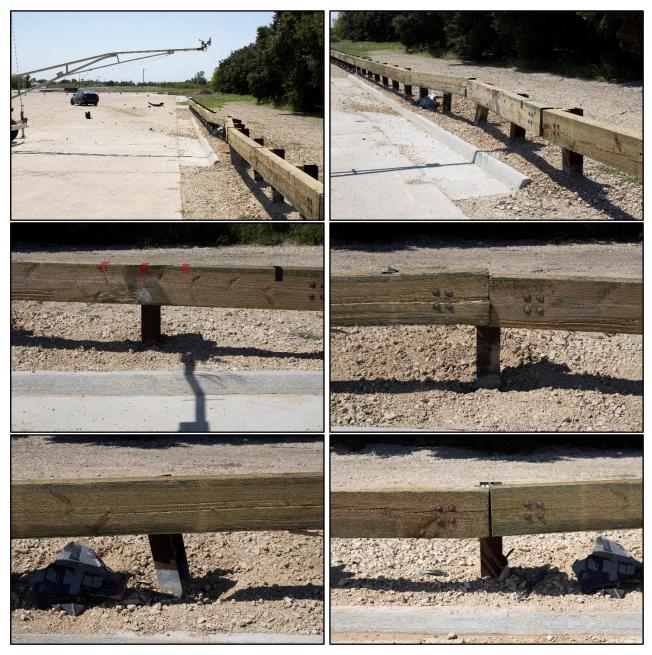


Figure 5.13. Modified Merritt Parkway Guiderail after Test No. 612061-03-1.

^{*} 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.



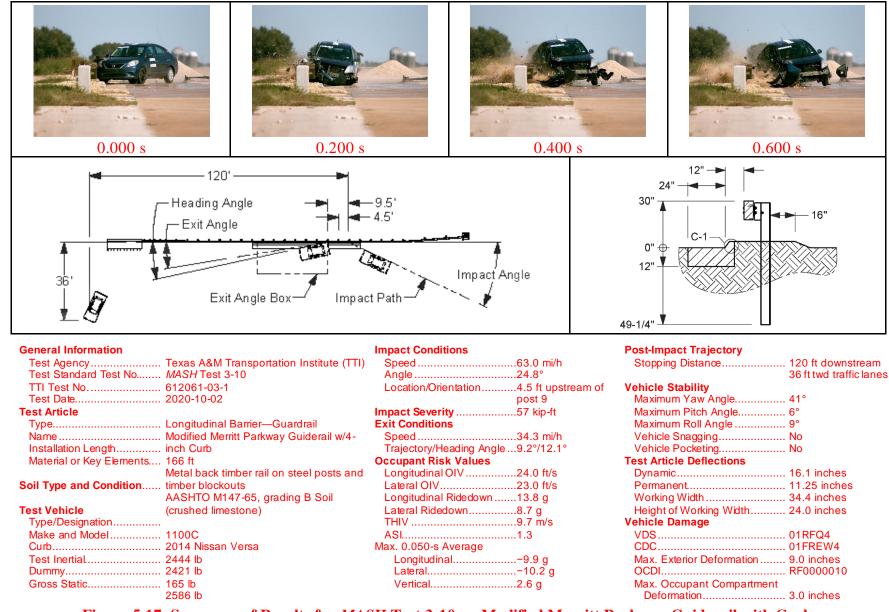
Figure 5.15. Test Vehicle after Test No. 612061-03-1.



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

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	

Table 5.4. Occupant	t Risk Factors for	Test No.	612061-03-1.
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42

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 $10\frac{1}{2}$ 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 50foot 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 $5\frac{3}{4}$ inches wide at the bottom with a 12-inch deep by $31\frac{3}{4}$ -inch wide base below grade.

The upstream anchor section measured 29 ft- $\frac{1}{2}$ inch in length and flared 34 $\frac{1}{4}$ inches to the field side while sloping down before terminating into an anchor block located below grade. The concrete anchor block measured approximately 36 \times 36 inches \times 39 inches tall and was cast 59 $\frac{1}{2}$ 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).



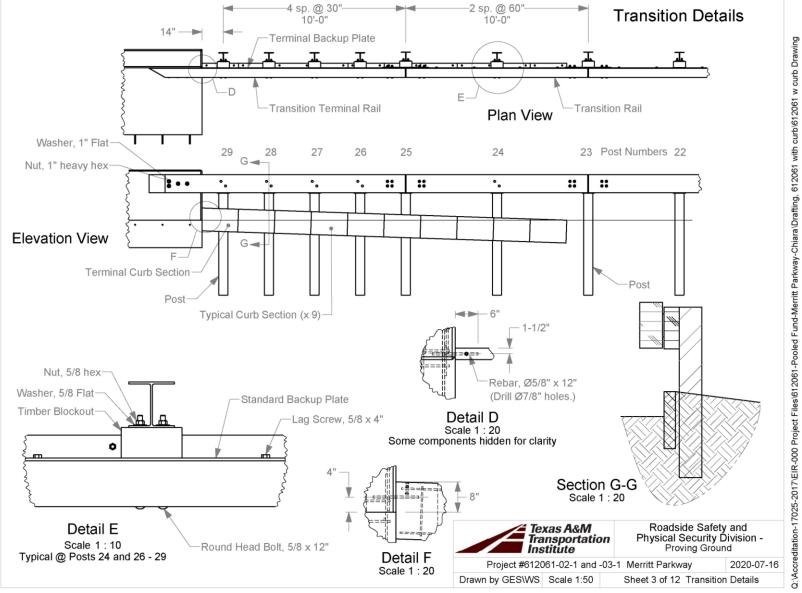


Figure 6.1. Merritt Parkway Guiderail Transition Details.

45



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 \pm 55 lb impacting the CIP of the longitudinal barrier transition at an impact speed of 62 mi/h \pm 2.5 mi/h and an angle of 25 degrees \pm 1.5 degrees. The CIP for *MASH* Test 3-20 on the Merritt Parkway Guiderail Transition was 4 ft \pm 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.

	0		
Time (s) Events			
0.000	Vehicle impacts transition		
0.031	Vehicle begins to redirect		
0.210	0.210 Right left tire lifts off the ground		
0.288	0.288 Vehicle travelling parallel to transition		
0.310	.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		

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

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 ¹/₈-inch gap in the soil on the field side of posts 28 and 29. The curb section at post 28 was pushed ¹/₂-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.



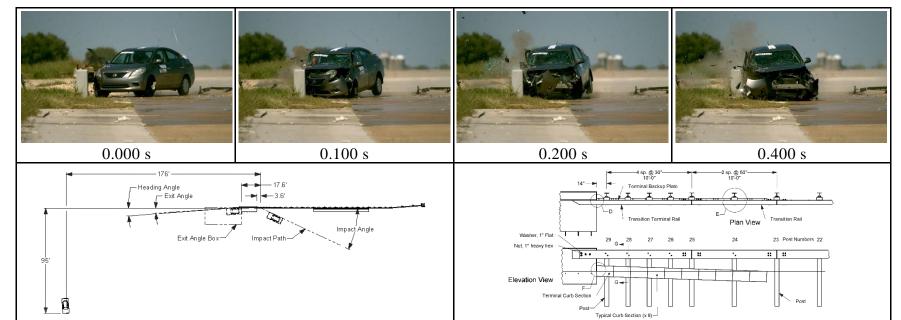
Figure 6.7. Interior of Test Vehicle after Test No. 612061-07-1.

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.

Occupant Risk Factor	Value	Time
OIV		
Longitudinal	28.9 ft/s	10.0862 s on right side of interior
Lateral	31.5 ft/s	at 0.0862 s on right side of interior
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

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



Test Agency	Texas A&M Transportation Institute (TTI)	Impact Conditions Speed	62.5 mi/h
Test Standard Test No	,	Angle	
TTI Test No.		Location/Orientation	
Test Date	2020-10-07		edge of concrete
Test Article		Impact Severity	
Туре	Longitudinal Barrier—Transition	Exit Conditions	•
	Merritt Parkway Guiderail Transition	Speed	41.1 mi/h
Installation Length	166 ft	Trajectory/Heading Angle	3.9°/4.3°
Material or Key Elements	Metal back timber rail on steel posts and	Occupant Risk Values	
	timber blockouts	Longitudinal OIV	28.9 ft/s
Soil Type and Condition	AASHTO M147-65, grading B Soil	Lateral OIV	
	(crushed limestone)	Longitudinal Ridedown	6.1 g
Test Vehicle		Lateral Ridedown	9.2 g
Type/Designation	1100C	THIV	13.3 m/s
Make and Model	2014 Nissan Versa	ASI	2.6
Curb	2414 lb	Max. 0.050-s Average	
Test Inertial		Longitudinal	−16.1 g
Dummy	165 lb	Lateral	−17.5 g
Gross Static	2585 lb	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 \pm 110 lb impacting the CIP of the longitudinal barrier at an impact speed of 62 mi/h \pm 2.5 mi/h and an angle of 25 degrees \pm 1.5 degrees. The CIP for *MASH* Test 3-21 on the Merritt Parkway Guiderail Transition was 7 ft \pm 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.

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	.119 Left rear tire leaves the ground	
0.182	182 Left front tire leaves the ground	
0.220	0.220 Vehicle traveling parallel with transition	
0.360	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	

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

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 ⁷/₈-inch up from level. Post 26 had a ¹/₄-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 ¹/₄-inch gap on the field side, and it was leaning 1° toward field side from vertical. Post 28 had a ¹/₂-inch gap on the field side, and was leaning 3° toward the field side from vertical. Post 29 had a ¹/₄-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 ³/₄-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.



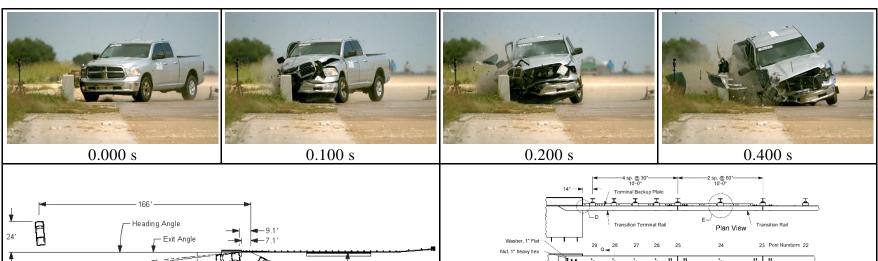
Figure 6.14. Interior of Test Vehicle after Test No. 612061-06-1.

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.

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	at 0.1125 s off fight side of filterior
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

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



General Information
Test Agency
Test Standard Test N
TTI Teet No

Impact Conditions

Impact Angle

Test Agency Texas A&M Transportation Institute (TTI)	:
Test Standard Test No MASH Test 4-21	1
TTI Test No 612061-06-1	, j
Test Date 2020-10-12	
Test Article	Im
TypeTransition	E>
Name Name Merritt Parkway Guiderail Transition	;
Installation Length 166 ft	•
Material or Key Elements Metal back timber rail on steel posts and	00
timber blockouts	I
Soil Type and Condition AASHTO M147-65, grading B Soil	I
(crushed limestone)	I
Test Vehicle	
Type/Designation 2270P	•
Make and Model 2014 RAM 1500 Pickup	4
Curb 5076 lb	Ma
Test Inertial 5006 lb	
Dummy 165 lb	
Gross Static 5171 lb	

Exit Angle Box-

Impact Path

Impact Conditions
Speed63.0 mi/h
Angle25.2°
Location/Orientation7.1 ft upstream of
edge of concrete
Impact Severity120 kip-ft
Exit Conditions
Speed42.1 mi/h
Trajectory/Heading Angle 5.5°/6.9°
Occupant Risk Values
Longitudinal OIV25.3 ft/s
Lateral OIV25.3 ft/s
Longitudinal Ridedown9.8 g
Lateral Ridedown8.5 g
THIV10.8 m/s
ASI1.4
Max. 0.050-s Average
Longitudinal10.1 g
Lateral10.0 g
Vertical4.1

Elevation View

Terminal Curb Section Pos

Typical Curb Section (x 9)

Post-Impact Trajectory

r ost-impact majectory	
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.

Tes	t Agency: Texas A&M Transportation Institute	Test No.: 612061-03-1 Te	est Date: 2020-07-08
	MASH Test 3-10 Evaluation Criteria	Test Results	Assessment
<u>Stru</u> A.	uctural Adequacy 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
Oco	cupant 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.	
<i>F</i> .	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
Η.	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
Ι.	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	t Agency: Texas A&M Transportation Institute	Test No.: 612061-02-1 Te	est Date: 2020-07-10
	MASH Test 3-11 Evaluation Criteria	Test Results	Assessment
<u>Stru</u> A.	actural Adequacy 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
<u>Occ</u> D.	<u>cupant Risk</u> 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
Н.	Decupant impact velocities (OIV) should satisfy the Collowing limits: Preferred value of 30 ft/s, or naximum allowable value of 40 ft/s.		Pass
Ι.	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	t Agency: Texas A&M Transportation Institute	Test No.: 612061-03-1 Te	est Date: 2020-10-02
	MASH Test 3-10 Evaluation Criteria	Test Results	Assessment
<u>Strı</u> A.	actural Adequacy 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
<u>Occ</u> D.	cupant Risk 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.	
<i>F</i> .	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
Н.	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
Ι.	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	t Agency: Texas A&M Transportation Institute	Test No.: 612061-02-1A Te	est Date: 2020-09-02
	MASH Test 3-11 Evaluation Criteria	Test Results	Assessment
<u>Strı</u> A.	<u>actural Adequacy</u> 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
<u>Occ</u> D.	Example 7 Detached elements, fragments, or other debris from <i>the test article should not penetrate or show potential</i> <i>for penetrating the occupant compartment, or present</i> <i>an undue hazard to other traffic, pedestrians, or</i> <i>personnel in a work zone.</i>	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.	
<i>F</i> .	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
Н.	Occupant impact velocities (OIV) should satisfy the following limits: Preferred value of 30 ft/s, or naximum allowable value of 40 ft/s.		Pass
Ι.	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	t Agency: Texas A&M Transportation Institute	Test No.: 612061-07-1 Te	est Date: 2020-10-07
	MASH Test 3-20 Evaluation Criteria	Test Results	Assessment
<u>Strı</u> A.	<u>actural Adequacy</u> 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
-	eupant 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
Н.	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
Ι.	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	t Agency: Texas A&M Transportation Institute	Test No.: 612061-06-1 Te	est Date: 2020-10-12	
	MASH Test 3-21 Evaluation Criteria	Test Results	Assessment	
<u>Strı</u> A.	<u>actural Adequacy</u> 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	
Occ	cupant 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.	<i>buld remain upright during and after</i> The 2270P vehicle remained upright during and after <i>naximum roll and pitch angles are not</i> after the collision event. Maximum roll and pitch		
Η.	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	
Ι.	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	

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

Table 7.7. Assessment Summary for MASH TL-3 Testson Modified Merritt Parkway Guiderail.

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	А	S	S
	D	S	S
Occupant	F	S	S
Risk	Н	S	S
	Ι	S	S
Test No.		MASH Test 3-20	MASH Test 3-21
	Pass/Fail	Pass	Pass

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

REFERENCES

- AASHTO/FHWA Joint Implementation Agreement for Manual for Assessing Safety Hardware (MASH). <u>https://design.transportation.org/wp-</u> <u>content/uploads/sites/21/2018/06/MASH-Implementation-Agreement-Final.pdf</u>, 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.
- 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 %" 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 0.60 b/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).

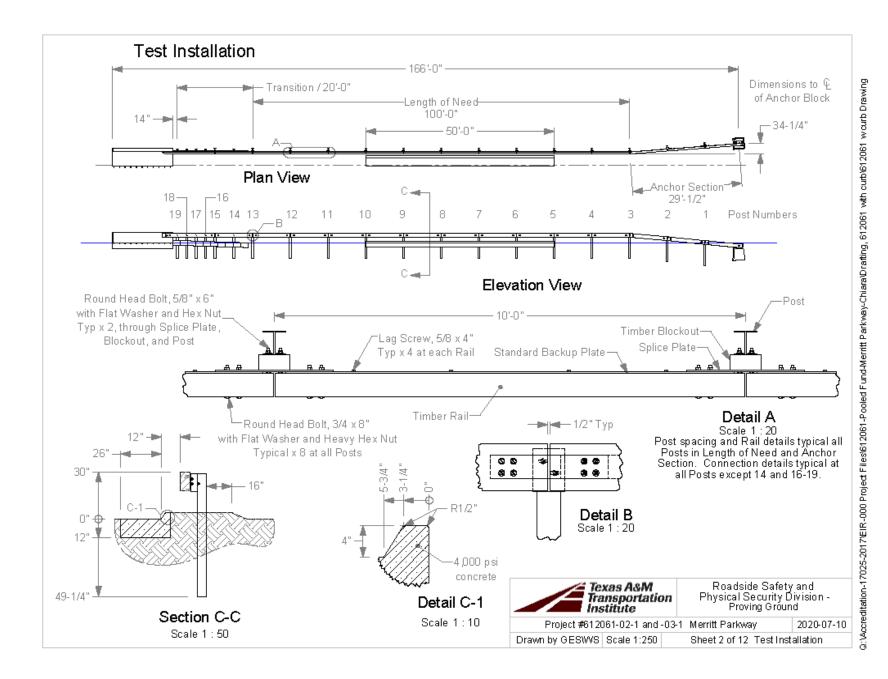
Fasteners:

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

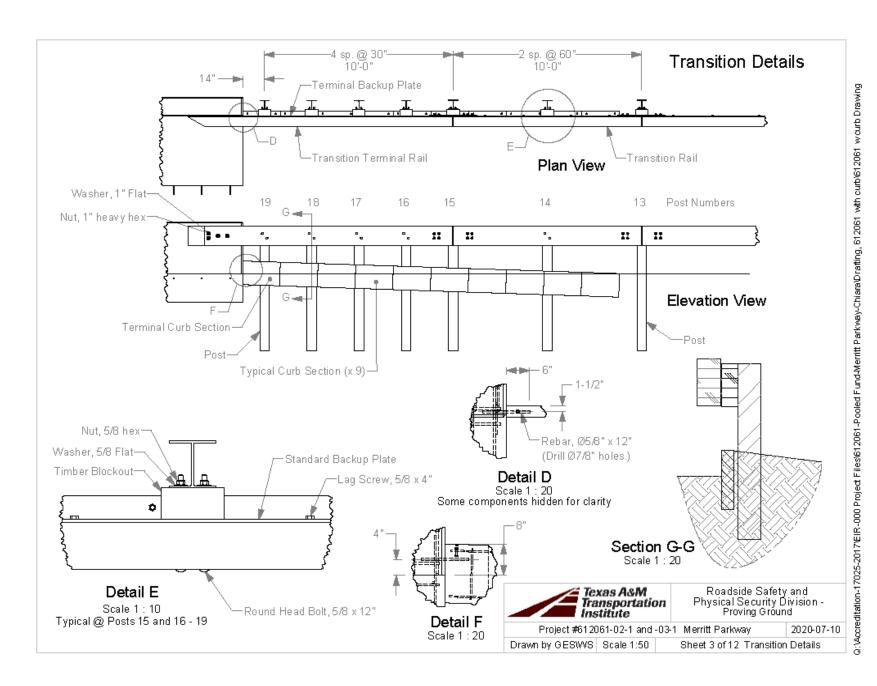
galvanized in accordance with ASTM A153 Class C.

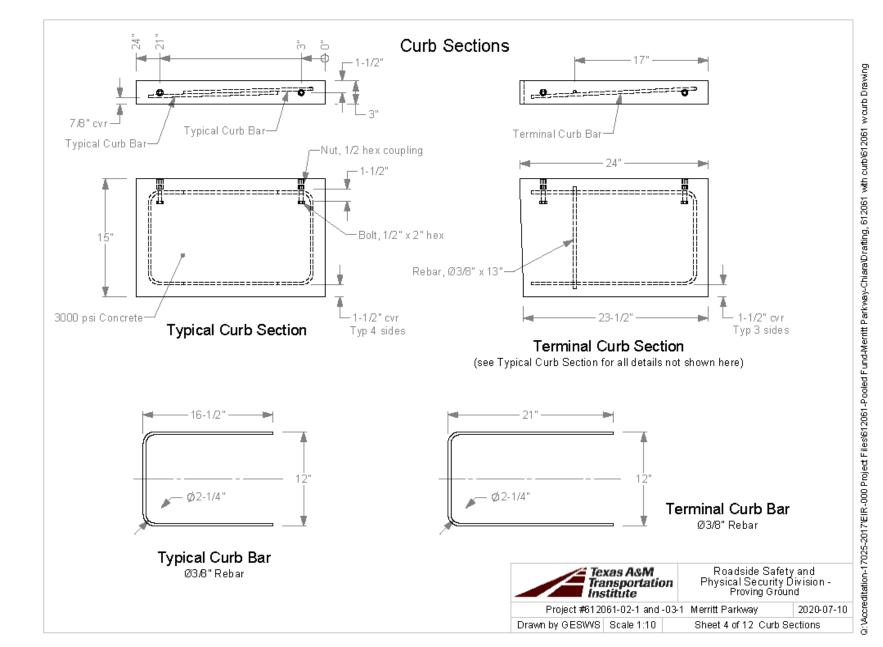
c) Nuts, and Washers shall be ASTM A588 steel.

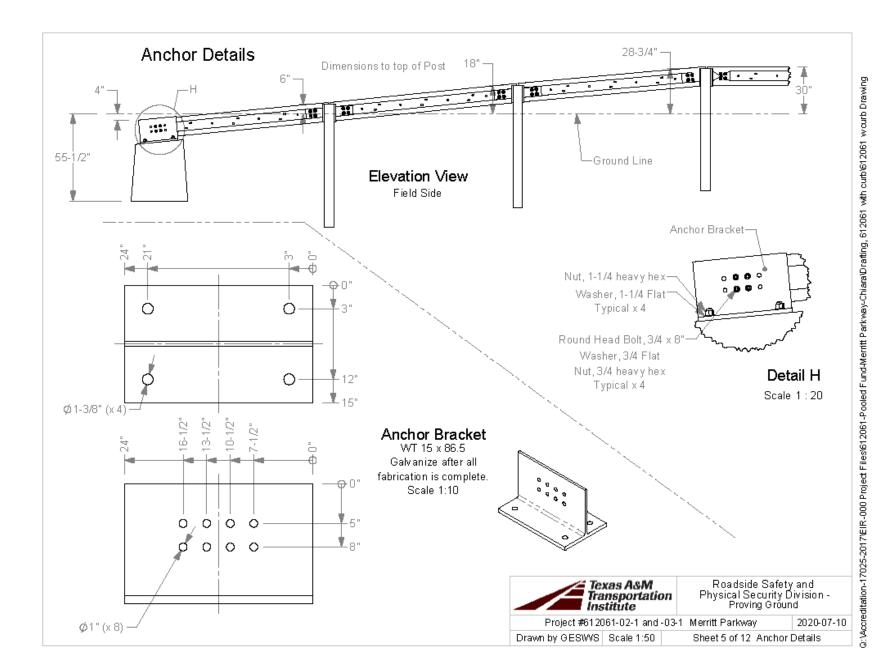
Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #612061-02-1 and -03	3-1 Merritt Parkway	2020-07-10
Drawn by GESWVS Scale 1:250 Sheet 1 of 12 Notes		es

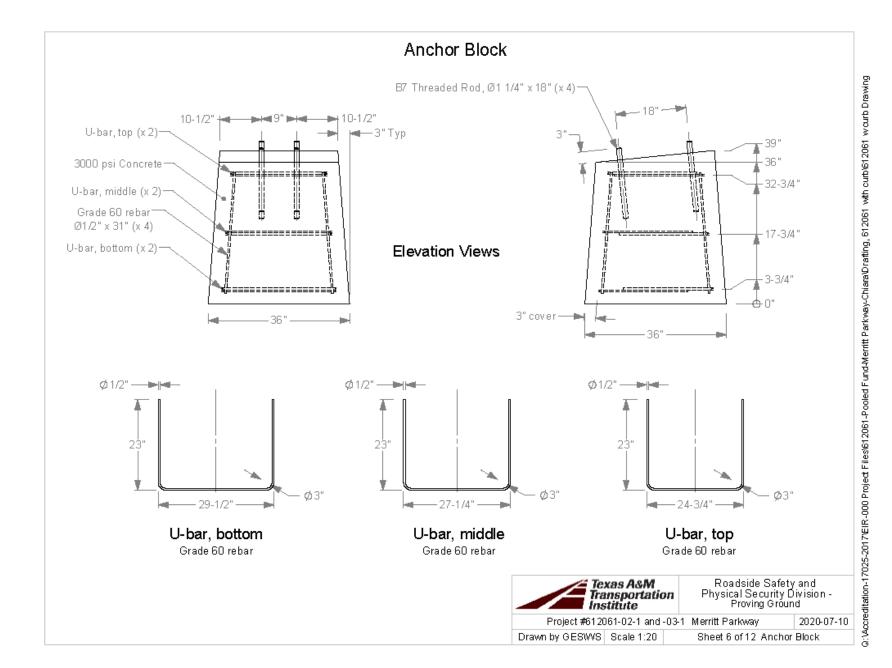


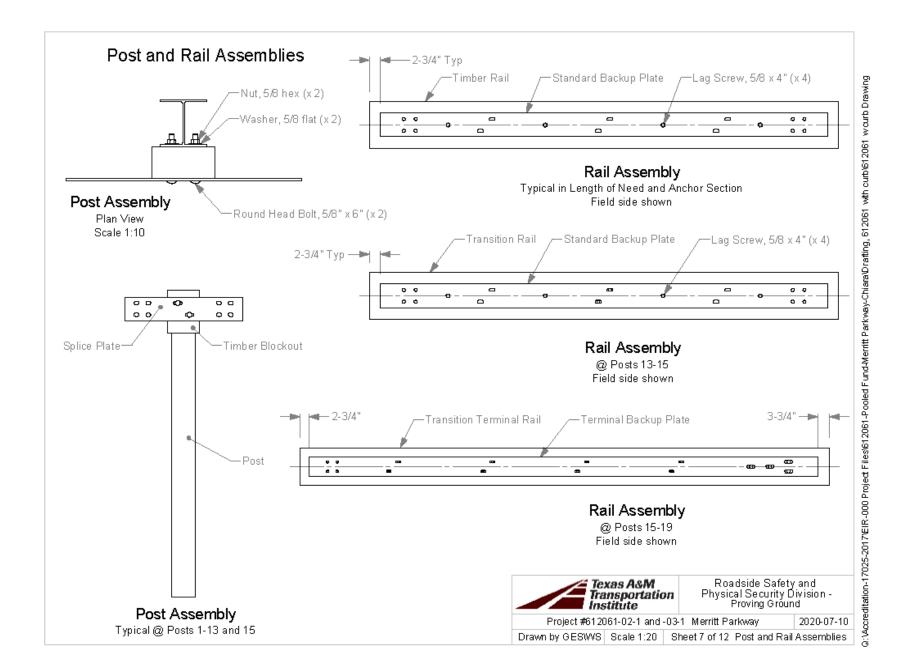








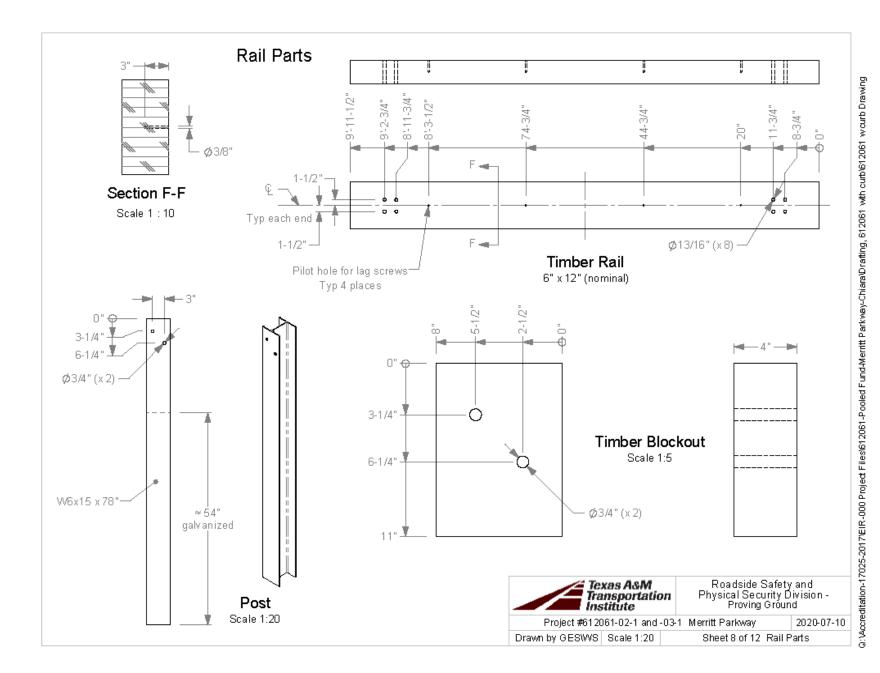


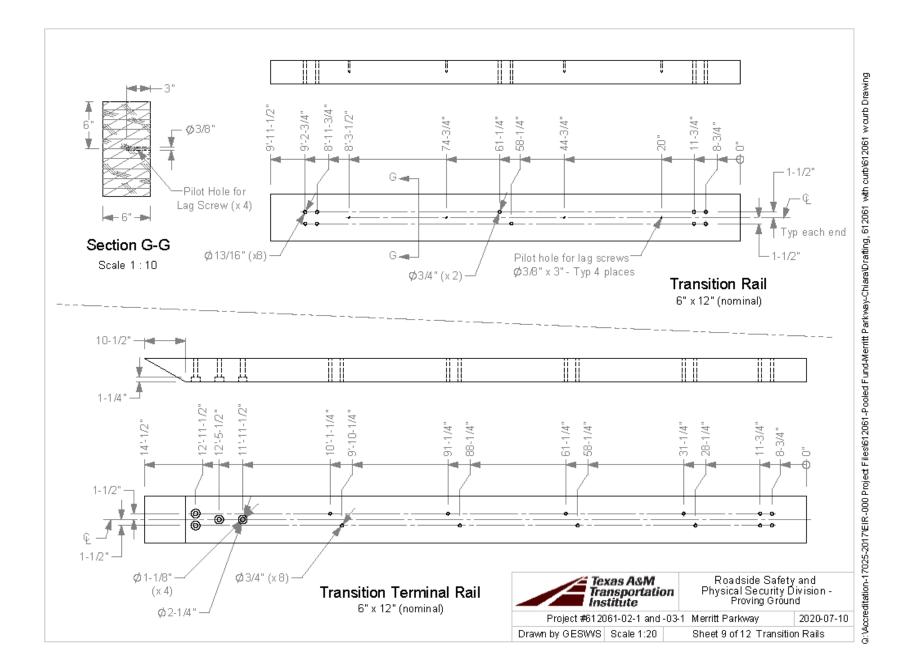


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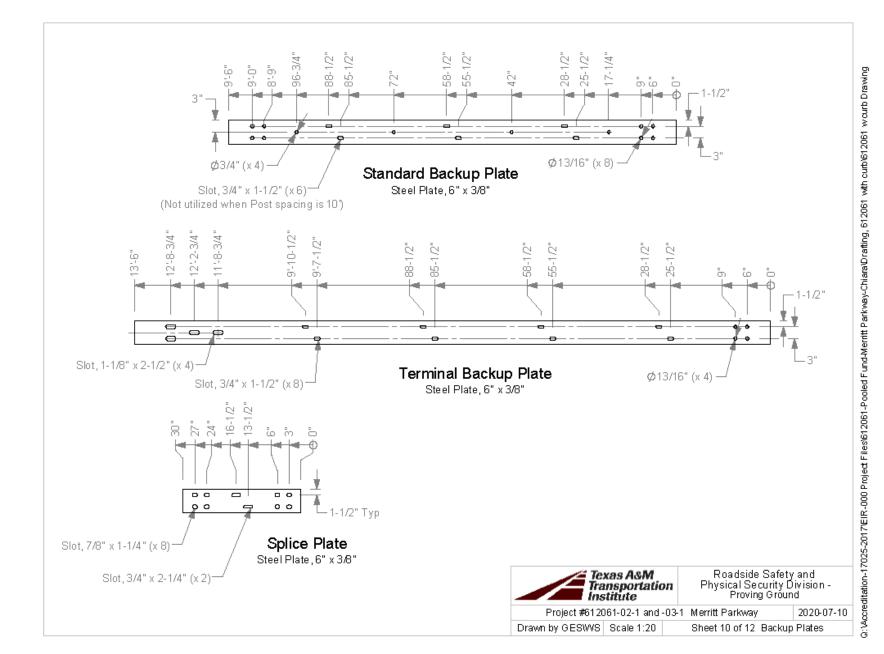




TR No. 612061-08-01

82

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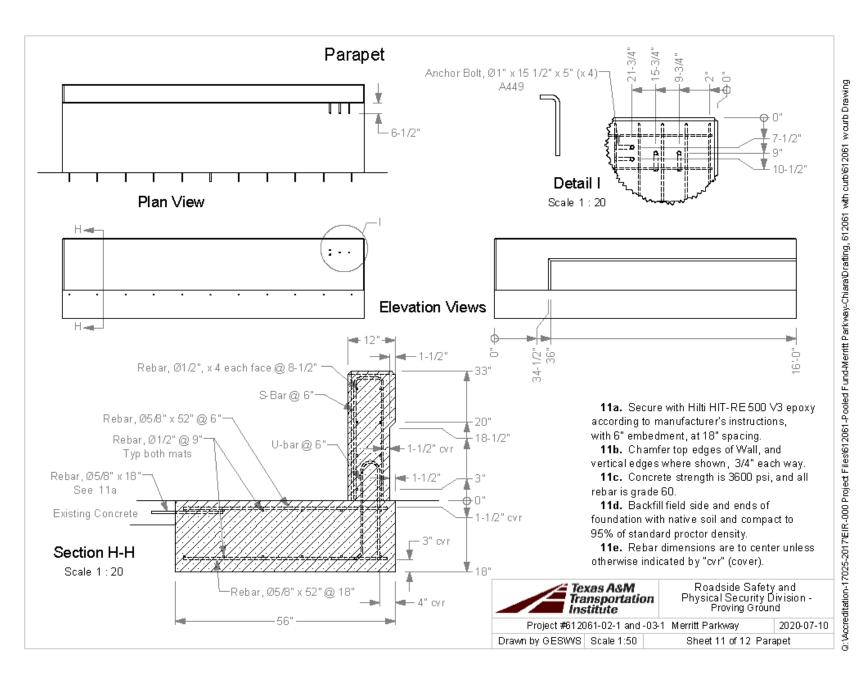


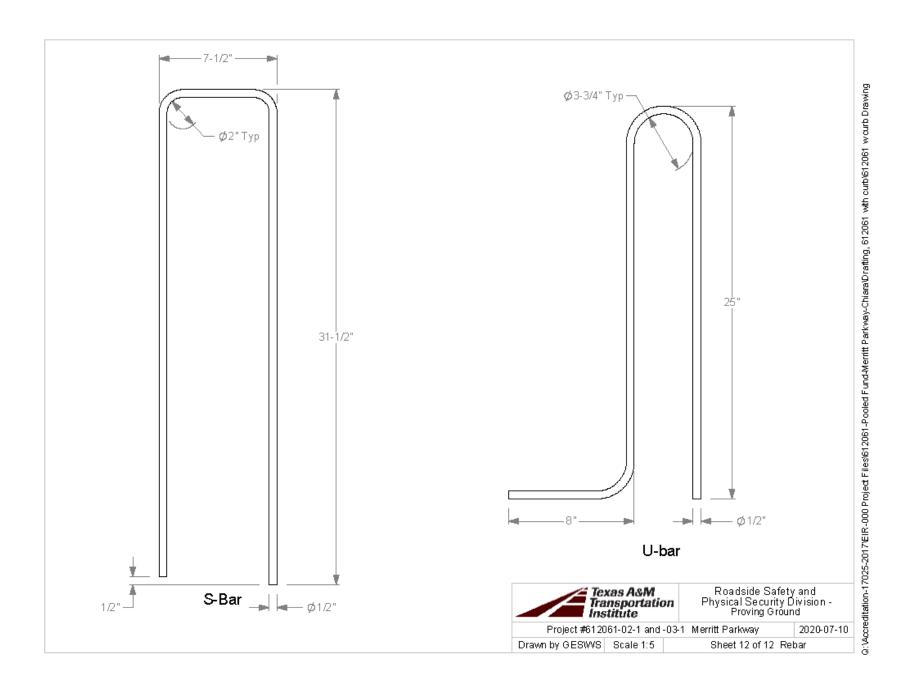
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83

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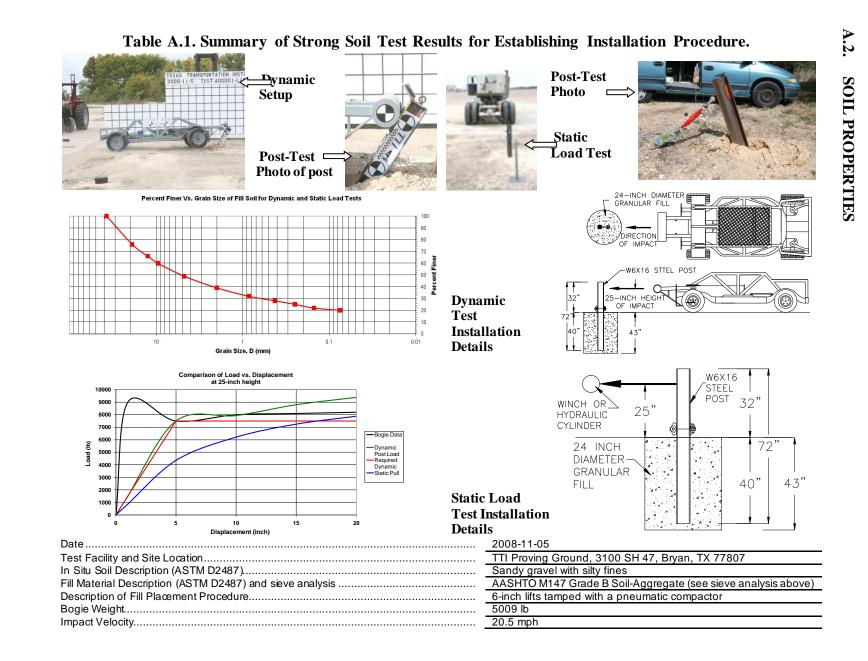






58

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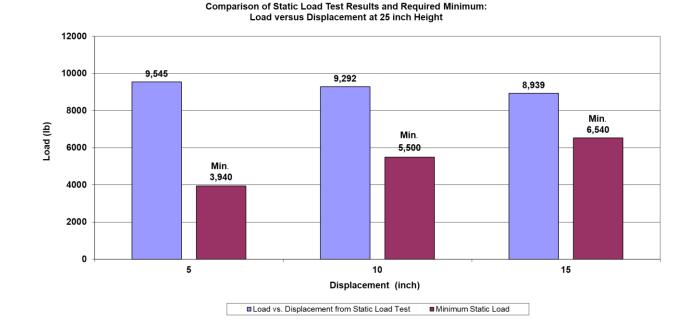


Table A.2. Test Day Static Soil Strength Documentation for Test No. 612061-03-1.

TR No. 612061-08-01

 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

 6-inch lifts tamped with a pneumatic compactor

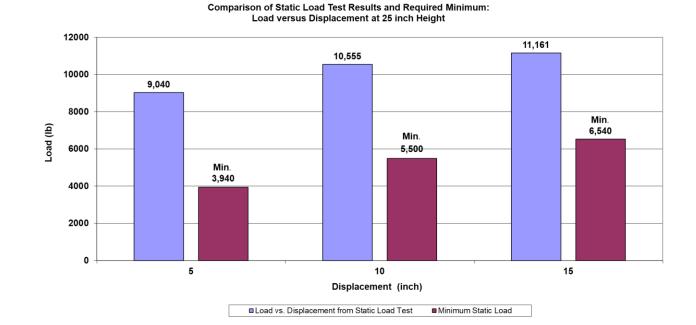


Table A.2. Test Day Static Soil Strength Documentation for Test No. 612061-02-1.

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

68

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

A.3.1. Vehicle Properties and Information

Date:2	020-12-17	Test No.:	612061-	02-1	VIN No.:	1C	66RFT8ES1	00464
Year:	2014	Make	RAM	1	Model:		1500	
Tire Size:	265/70 R 17	,		Tire I	nflation Pre	ssure:	35	psi
Tread Type:	Highway				Odo	meter: 2	10267	
Note any dam	hage to the ve	hicle prior to t	est: <u>None</u>					
 Denotes ad 	celerometer	location		ľ	▲X	•		
		00001011.						
NOTES: No	ne		_ Î †		$\uparrow \uparrow \downarrow$			
			A M -					
Engine Type:	V-8		WHEEL TRACK					
Engine CID:	5.7 L							WHEEL TRACK
Transmission	Type [.]				J	عركم	/	
Auto	or [Manual		₩Q	-	7	-TEST INERTIAL C. M.	
🔲 FWD	RWD	4WD		R				•
Optional Equi	nment:		P					=
None	priierit.		4	6			0	Д В
				-FAG			Hal	
Dummy Data: Type:	: 50th perc	entile male				* * .	∇	
Mass:		65 lb		- F			S	
	n: Front pas	senger		-		Е ———		
				V	M		M REAR	
Geometry:	inches	10.00		-		- C		-
A 78.	·	40.00	К	20.00	- P_	3.0	× .	26.75
B74.		28.50	L	30.00	_ Q _	30.5		30.25
C <u>227.</u>		61.75	M	68.50	_ R _	18.0	<u> </u>	61.75
D		11.75	N	68.00	S	13.0	<u> </u>	79.00
E 140.		27.00		46.00	- T_	77.0		
Wheel Cen Height Fr		14.75 Cle	Wheel Well arance (Front)		6.00	Bottom Height		12.50
Wheel Cen Height Re		14.75 Cle	Wheel Well arance (Rear)		9.25	Bottom Height		22.50
-	-	13 inches; E=148 ±12 i		nes; G = > 28 ir		-		7 ±1.5 inches
GVWR Ratin	as:	Mass: Ib	Curb)	Test	nertial	Gro	<u>ss Static</u>
	5700	Mfront		2859		2809		2894
Back 3	900	M _{rear}	2	2103		2203		2283
	700	M _{Total}	4	962		5012		5177
Mass Distrib	ution:			(Allowable	Range for TIM and	GSM = 5000 lb	±110 lb)	
lb	LF	1396	RF:	1413	LR:	1132	RR:	1071

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

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

Date:2020-1	12-17 T	est No.: _	612061-	02-1	VIN:	1C66RFT8ES100464			4
Year:201	4	Make:	RAM	RAM			1:	500	
Body Style: _Q	uad Cab				Mileage:	2	210267		
Engine: <u>5.7 L</u>	١	√-8		Trans	smission:	Autor	matic		
Fuel Level: E	mpty	Ball	ast: <u>170</u>					(440) lb max)
Tire Pressure:	Front: <u>a</u>	35 ps	i Rea	ır: <u>35</u>	psi S	Size:	265/70 R ⁻	17	
Measured Vel	nicle Wei	ghts: (ll	b)						
LF:	1396		RF:	1413		F	ront Axle:	2809	
LR:	1132		RR:	1071		R	Rear Axle:	2203	
Left:	2528		Right:	2484				5012 110 lb allowed	
							5000 I		
VVh	eel Base:	140.50	inches	Track: F:	68.50	inch	es R:	68.00	inches
	148 ±12 inch	es allowed			Track = (F+F	R)/2 = 6	7 ±1.5 inches	allowed	
Center of Grav	vity , SAE	J874 Sus	pension M	ethod					
X :	61.76	inches	Rear of F	ront Axle	(63 ±4 inches	s allowe	ed)		
Y:	-0.30	inches	Left -	Right +	of Vehicle	e Cer	nterline		
Z :	28.50	inches	Above Gr	ound	(minumum 28	8.0 incl	nes allowed)		
Hood Heig	ht:	46.00	inches	Front	Bumper H	eight	:	27.00 i	inches
-		nches allowed	•		-	2			
Front Overha	ng:	40.00	inches	Rear	Bumper H	eight	:	30.00 i	nches
	39 ±3 i	nches allowed							
Overall Leng	th:	227.50	inches						
	237 ±1	3 inches allow	ed						

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

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

VEHICLE CRUSH MEASUREMENT SHEET¹

Complete Wh	en 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)	$X1+X2$ _
< 4 inches	2
\geq 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.

a '6		Direct I	Damage								
Specific Impact Number	Plane* of C-Measurements	Width** (CDC)	Max*** Crush	Field L**	C_1	C ₂	C3	C4	C_5	C_6	±D
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										

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

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

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

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

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

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

Date:2020-12-17 Tes	t No.: 612061-02-1	VIN No.:	1C66RFT8ES100464		
Year: 2014 Mal	ke: RAM	Model:	1500	<u>с</u>	
(, +	──↓┌╋──╋ो┌══	OCCUPANT DEFORMATIO			
F		Before	After (inches)	Differ.	
	E3 E4	1 65.00	65.00	0.00	
6	A	63.00	63.00	0.00	
Н		3 65.50	65.50	0.00	
	E	45.00	45.00	0.00	
	E	32 38.00	38.00	0.00	
	E	33 45.00	45.00	0.00	
		39.50	39.50	0.00	
B1-3	A1-3	35 43.00	43.00	0.00	
D1-3	<i>.11</i> E	39.50	39.50	0.00	
		26.00	26.00	0.00	
	C	2 0.00	0.00	0.00	
	C	26.00	20.00	-6.00	
	C)1 11.00	11.00	0.00	
	C	0.00	0.00	0.00	
)3 11.50	11.50	0.00	
B2,5	E	61.50	64.25	2.75	
B1,4	B3,6E	63.50	63.50	0.00	
- E1-4 -		3 63.50	63.50	0.00	
	E	4 63.50	63.50	0.00	
	F	59.00	59.00	0.00	

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

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

0.00

0.00

-1.00

-5.00

94

59.00

37.50

37.50

25.00

G

Н

L

J*

59.00

37.50

36.50

20.00

A.4.2. Sequential Photographs

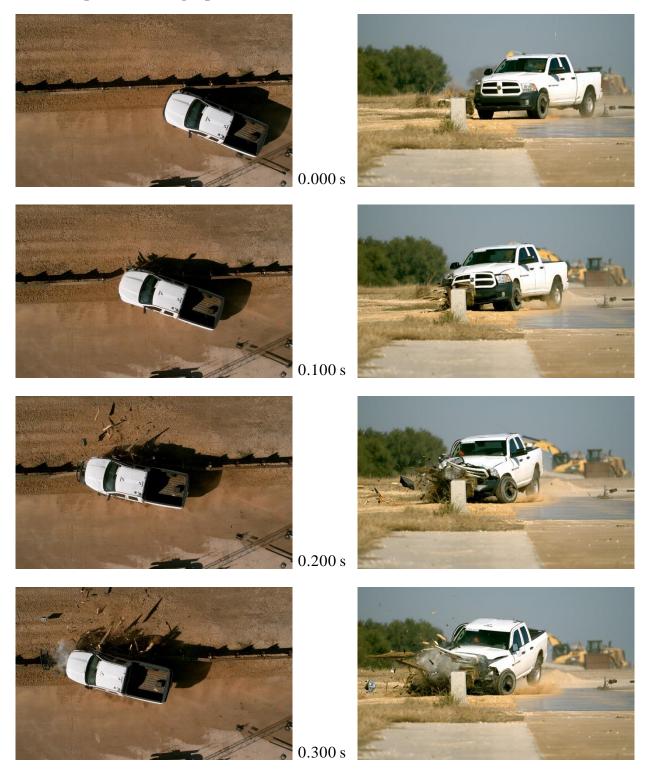


Figure A.7. Sequential Photographs for Test No. 612061-02-1 (Overhead and Frontal Views).







0.500 s









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



0.000 s



0.100 s

0.200 s



0.400 s



0.500 s



0.600 s



0.300 s

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

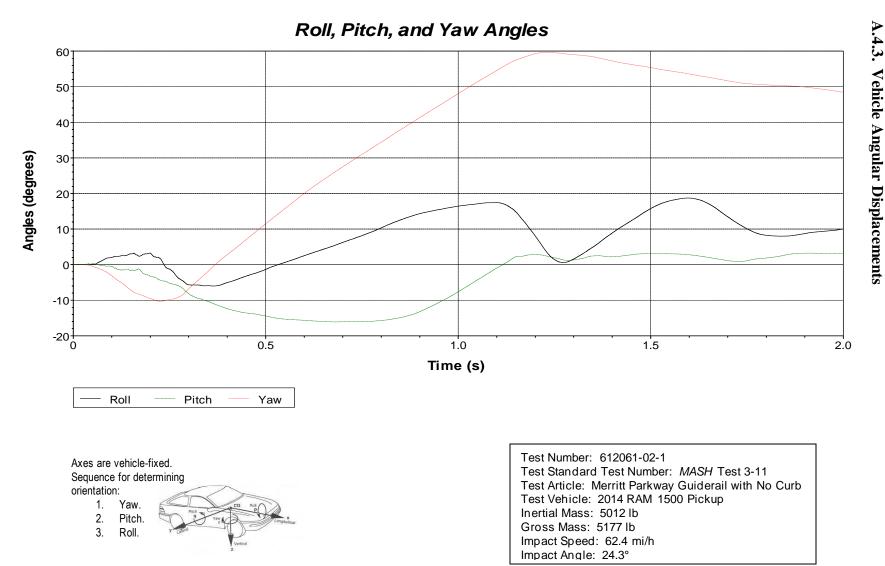


Figure A.9. Vehicle Angular Displacements for Test No. 612061-02-1.

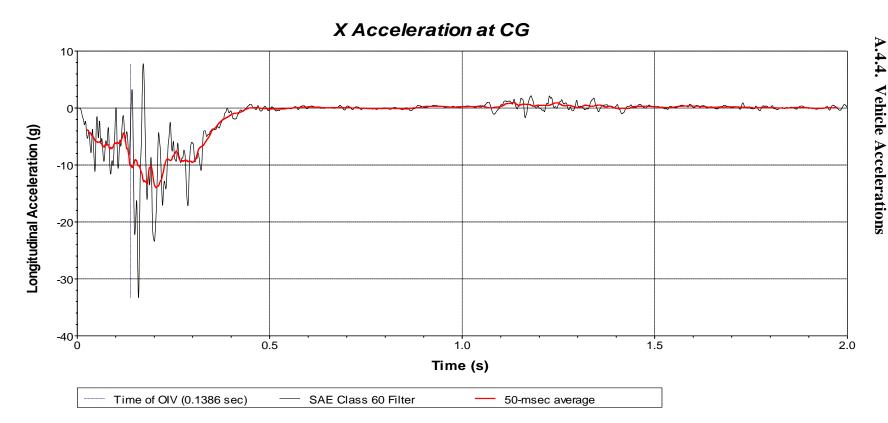


Figure A.10. Vehicle Longitudinal Accelerometer Trace for Test No. 612061-02-1 (Accelerometer Located at Center of Gravity).

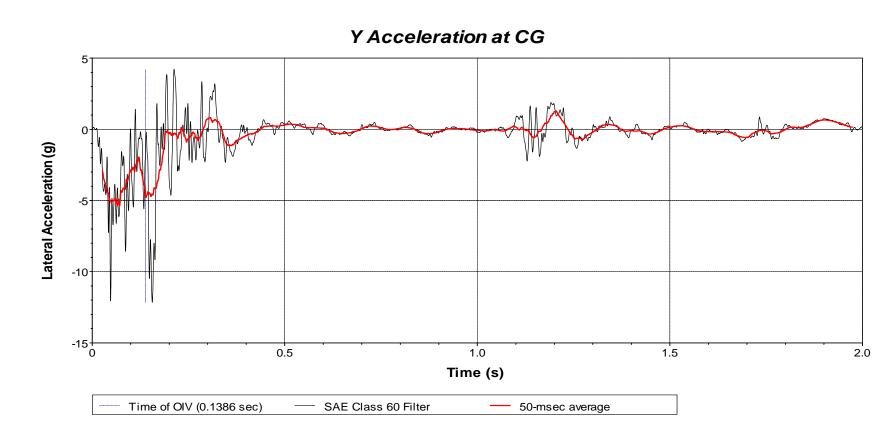
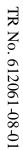


Figure A.11. Vehicle Lateral Accelerometer Trace for Test No. 612061-02-1 (Accelerometer Located at Center of Gravity).



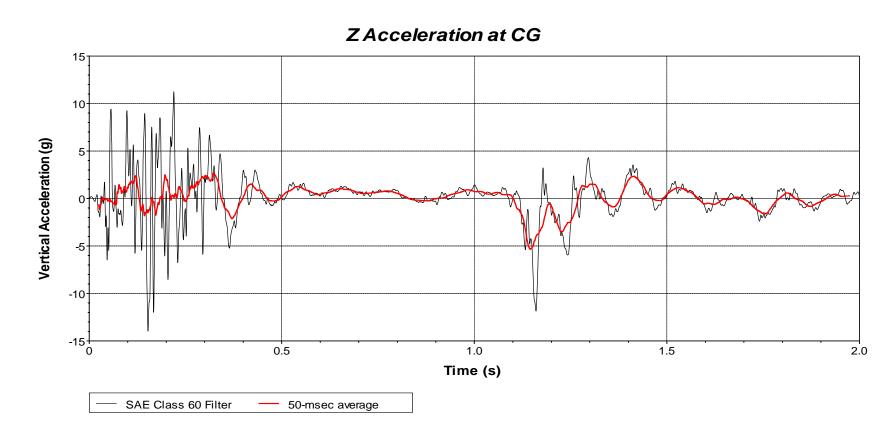


Figure A.12. Vehicle Vertical Accelerometer Trace for Test No. 612061-02-1 (Accelerometer Located at Center of Gravity).

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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**

27719332,27719330,27719331,27719333,27719334,27719335,

HEAT#: 32016780/STEEL DYNAMICS, INC. - FLAT ROLLED

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

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>

TAG#:

MC #

MS #

		-			and the second of the second second second	
YIELD STRENGTH	MIN:	60800	PSI	LAAV		
TENSILE STRENGTH		00000	FOI	MAX	60800	PSI
I LINGILE STRENGTH	MIN:	76100	PSI	MAX	70100	DOL
ELONGATION 2"	MINI.				76100	PSI
	MIN:	34	%	MAX	34	%
						10

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

27719336,27719337,27719338

27699054

20B528734

Quann formay

Branch Certification Manager

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

USER: REPORTS@SEMSP01 REPORT: ST_MSR_OSI

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

METALLURGICAL TEST REPORT

>>>>>>

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

	COS Name: AMERICAN TIMBER AND STEEL
Desci	ription 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

LANNA Konny

Branch Certification Manager

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

USER: REPORTS@SEMSP01 REPORT: ST_MSR_OSI

American Timber and Steel Co. 4832 Plank Rd. P.O. Box 767 Norwalk, OH 44857 PHONE: 419-668-1810 FAX: 419-668-7535



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.:
 253300

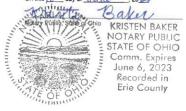
MILL SERIAL# / HEAT#	LOT#	QUANTITY	PART DESCRIPTION	MATERIAL	DATE OF MANUFACTURE
32016780 247973 B160675/5305477807 / B166884 / B160678 A175660 / B175825 / B171455 247973 DL17105803 JK17100300 198520 0017266 DL14104775 62148230 0010783 227667 / 198520 9515612/9514538 / 21933130 75006813 75070687 / 82750628 9315612/9514538 / 21933130 75006813 32016780 32016780 DL18104710 DL18104710 DL17105083 10575880 DL18105963	27719330 - 27719338 27528646 - 27528651 	39 2 48 2 2 24 4 96 4 96 4 96 4 304 20 304 20 304 20 304 20 304 20 31 37 3 10 62 234 12	3/8" x 6" x 114" MP RAIL PLATE (LORTEN) - 4906114-3400 3/8" x 6" x 114" MP RAIL PLATE (HCG) - 4906114-3200 3/8" x 6" x 114" MP RAIL PLATE (HCG) - 4906114-3200 Wext 54 = 6" MP (24) HBEAM POST (CORTEN/HCG) - MP00078-7901 Wext 54 = 6" MP (24) HBEAM POST (CORTEN/HCG) - MP00078-7901 Wext 54 = 6" MP (24) HBEAM POST (HCG) - 4096070-3701 3/8" x 6" x 30" MP SPLICE PLATE (HDG) - 4096070-3700 5/8" FLAT WASHER (CORTEN) DOM - 4958070-2400 5/8" FLAT WASHER (CORTEN) DOM - 4958070-2400 5/8" FLAT WASHER (CORTEN) DOM - 4958070-2400 5/8" FLAT WASHER (CORTEN) DOM - 4958070-3900 5/8" HEX NUT (CORTEN) DOM - 4958070-3900 5/8" HEX NUT (CORTEN) DOM - 4953000-6101 3/4" x 8-1/2" CARRIAGE BOLT (CORTEN) DOM - 4934080-9900 3/4" x 8-1/2" CARRIAGE BOLT (CORTEN) DOM - 4934000-9900 3/4" HEX NUT (HOG) DOM - 4934000-6101 3/4" HEX NUT (HOG) DOM - 4334000-9900 3/4" HEX NUT (HOG) DOM - 435000-9900 3/6" x 4" LAG BOLT (HOG) DOM - 4393000-49930	1492 A606 A1018 / A36 A588 A992 A1018 / A36 A242 F1554-36 F844 AWWA C111 A563 AWWA C111 A325 F436 T3 F436 T3 F436 T3 F436 T3 A565 A566 A566 A566 A566 A566 A566 A566 A566 A566 A566 A566 A566 A566 A566 A567 A577 A577 A577 A577 A5777 A57777777777	4/28/2020 4/28/2020 5/15/2020 5/15/2020

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

Jah 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 1 to be 2020



(260) 6 Quality and M Recycled (A Dynamics, inc roducts Group x xd Red Dester 25-8100 (260) 625-883 y Steel 100% EAF anufactured in the content: PC = 75.0%, I	SB FAX Meited e USA Pl = 22.0%	CERTII Ship to: The A588 & A572 S 785 Arch Street Cannegie PA, 15106 US Athr. Denise Yanussi	Custo	L TEST REI mer# 000469	Bill to: THE A5 133 Seba Sewickley	88 & A572 S 10 Lake Drive PA, 15143 US Gunzburg	Produced: 0	7 / 21 / 2019 7 / 15 / 2019
	01:2015 and ABS Cert complies with EN 102								
GENERAL, IN	FORMATION	SPECIFICA	TIONS Standarda	4	irades"	SHIPMENT DET	AILS	BOL # 0000557190 - 144	00.00 bs
	Wide Flange Boam	AST	A A6/A6M - 17a	-		Bundle / ASN #	Length po	cs Cust PO Job/	Polorenco
Size	W6X15	1	A568/A583M - 15 A709M - 17e1		IAS88M grB	061090419		2 23057	Nevergince
	W150X22.5		M270MM270 - 15		50W/g345W ur345W/50W	061090417	40 0" 1	2 23057	
Heat Number			A G40.21-13		14350A				
Condition(s)	As-Rolled Fine Grained								
	Fully Killed								
	No Weld Repair	A709-36, M270-36,	he requirements of ASTM A91 CSA300W, CSA346WM, CSA	92, A572-50, A929-60, A350W.	A700-60, M270-60, A30,				
CHEMICAL A	NALYSIS (weight pe	rcent)		Arangon grant and a 1997 Million Arangan grant and a state of the second second second second second second se					
<u>C</u> <u>Mn</u> .07 1.13	P S S			mannant of a binner more statements	103 .002 .014	B *C1	*C2 *C3		alysis Type Heat
Streng Test los / M 1 51 / 3 2 54 / 3 3 4	Ipp Ipi / MPa 50 82/565	fy/fa ratio .62 .69	% Elong. Test _(2° gage) 1 23 2 25 3 4 5 6 7	F/C Spec	inen <u>1</u> Specimen 2	Specimen 3 A	werage <u>A</u>	Aintrum_	
and built appreciation	concellated to graft	Lol Abmuterheader an	Contraction Index (I) (ASTM G10 In+V)64(0H+Cut)15 CE3 (CET)	11]- 26.01(Cu)+3.66(NI)+ - C + (NINE) + (SI24) + (1.20(Cr)+1.49(51)+17.29(P)-7.2 (Cr)5) + (MBHB) +(MBHB) + (MP14	9(Cu)/M}-0.10(W)/P}-30.39(Cu*	Fom(406) - Col	5/30+Min20+Cu/20+NW/0+Cz/20+	mar15+W10+68
Specification by the e	he material described her Heatric and forstane/confin s of American Bareno of S	Gous dast anoceas a	and lastied in accordance		ABS CERTIFICA	TION			× • • • • • • • • • • • • • • • • • • •
5 - 4		art are accurate ar	d correct. All tests and		State of Indiana,	County of Whitley S	worn to and s	ubscribed before me	2
I horeby certify that	t the content of this rep	a distant series in the second				·			
I horeby certify that operations perform	ned by this meterial man	ufacturer are in co	rchaser designated requi	rements.		alma a mil			
I horeby certily that operations perform requirements of the Signed: TC	e material specifications	ufacturer are in co and applicable pu	rohaser designated requi	R	Signed:	day of		mmission expires:	
I horeby certily that operations perform requirements of the Signed: TC	e meterial specifications odd Bas Gustity Manager ASTM A6 - 14.6: A 1	adiacturer ares in eco e end applicable pu hford	inchaser designated requi		Signed:	otary Public	_ My cor		
I horeby certily that operations perform requirements of the Signed: TC	e meterial specifications odd Bas Gustity Manager ASTM A6 - 14.6: A 1	adiacturer ares in eco e end applicable pu hford	Inchaser designated requi		Signed:	otary Public	_ My cor		
I horeby certily that operations perform requirements of the Signed: TC	e meterial specifications odd Bas Gustity Manager ASTM A6 - 14.6: A 1	adiacturer ares in eco e end applicable pu hford	inchaser designated requi		Signed:	otary Public	_ My cor	mmission expires:	

			CUSTOMER SE	ар то		CUSTOMER BILL T	AL TEST REPOR		GRADE		SHA	PE / SIZE		Page 1/1 DOCUMENT
GÐ C	iERD	DAU	A588 & A572 62 ARCH ST	STEEL COMPA	UNY I	A588 & A572 STE 133 SEBAGO LAI	EL COMPANY E DR		A588-B		W5d 22.5	e Flange Beam. / 6		0000200904
JS-ML-CARTERS 84 OLD GRASSD		NE	CARNEGIE,P USA	A 15106-2040		SEWICKLEY,PA USA	5143-9374		LENGTH 40'00"	1	PCS 75	WEIGHT 45,000 LB		7/BATCH 4776/07
CARTERSVILLE, (ISA			SALES ORD/ 6931811/0000			CUSTOMER N 48.80 W GRAD			SPECIFI ASTM AS ASTM AM		TE or REVI	NOR	and for the former	
CUSTOMER PURCI 21809	HASE ORDER	NUMBER		BILL OF LA 1323-000012		DAT 10/2	E 2/2018		ASTM A7	709-17				
CHEMICAL COMPOS	Ma Ma 0.93	P 0.018	\$ 0.021	\$i 0.34	Çn 0.31	Ni 0.11	Ç7 0.56	<u>پر</u> 0.0	27	\$ <u>p</u> 0.010	X 0.026	ND- 0,000		
MECHANICAL PROP YS 0.2% PSI 64900	ĒRTIĒS	¥.	[\$	3	70				GL		F	llgarg.		
65300		921	00	4	75 192 46		635 635		8,000		1	18.80		
65300		921 902	00	4	1974 46 50		635 622		hich 8.000 8.00D		1			
65300 COMEMENTS (NOTES		921 902	00	4	46		622 		8,000		1	18.80		
65300		921 902	00	4	46		622 		8,000		1	18.80		
65300	The above	902	00 00	4 4	250 200 200 200 200 200 200 200 200 200	stained in the perce		mpany. W	8.000 8.000	at these data a		18.80		
65300	The above specified re	902	00 00 ified chamical a is material, incl	4 4	ecords 25 cm was milited :	stained in the perce	202021 FRECORDS OF CO	mpany. W	8.000 8.000	at these data a	re connect and	18.80 18.90		

2001 S. Gov Columbia (21 (200) 025-81	Long /too Streaws and My Road 7 My Indiana- Do (200) 1 tees 100 content: 2015 and	654 8004 6735 800 10725 125-8930 F 125-8930 F 125-8950	* FAX Melted # 9%, PI = tilled	and Ma	usufactum	ed in ti	1	Ship to: The A51 785 Arch : Camegic i	18 & A Street PA, 1511	572 St		EST Islomer		69	133 Saba Sewickley	88 & A5 go Lake D PA, 1514 (Gunzburn	a US	eel- P	Produc	=	/ 22 / 20 / 19 / 20
GENER	RAL IN	ORMA	TION	T	SPECIF									SHIPME	TDET	AILS	E	OL # 000	0568788	3 - 26800	.00 ibs
Đ.	malaunt	Inc. P					ndarda 6/AGM - 1	7=			Grade				www.commiliedd						
8-1	oduct Size			am			88/A588	• 27			A588/A588	And		Bundle	ASN #	Leng	th pcs	: Cu	st PO	Job/R	eferenc
	SHEE	W5X1					09M - 17				A709 g50WA			06113	2020.02	40 0	-				
Heat Na	mbor	R1668					ZTOMANIZZ				M270 gr345			06113		40' 0'					
		B1660				CSA C	¥0.21-13				50A/350			06113		407-07					
Condit	1011(S)	Fine G	1 - Carlos -											06113	1014	40 0	12	23398			
		Fuilty N																			
		No We	ki Repai	S A	501-MULTI n 709-36, M27	ieets the i 0-36, CSJ	tequineraen N300W. CS	is of ASTN Asasmu	6982, A	572-60, A N.	529-50, A709-5	D. 14270-50	A26,								
CHEMI		ALYS	S (weig																		
С	Mn	Р	S	Si	Cu	Ni	Cr	Мо	Sn	v	Nb/Cb	AI	2.2	в	*/*4	100	-	*00	#1		
.06	1.15	.019	.008	.19	.38	.25	47	64	016	.035	002	.003	N .0119	8	*C1	434	*C3	*PC	6.47		ysis Ty Heat
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Test	icai / M	Pa	tai f l	MPa	ങ്ങള	5	9" gags}	. 1					and a second second	A A A A A A A A A A A A A A A A A A A		werege	100				
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2	55/3	30	80/	550	.66		24	3													
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CET AME-C	Calculation (Monthly C	North Catho	in Equivale	His (CI, CZ, C	3, PC), C		ET () (ASTA	G101)- 2	E.DI(Co)+	3.66(HQ+1.80(Cr) (58264)+ (C2/5)+ (1.49(30+17.	29(17)-7.29(0	24(HQ-9.18(M))	7-33.39(Cef	Pom(AN	5} - CrSV	30 AND 20 A		HCI20HM	x15+W90+6
hereby ca	tily that t	e maioria	describe	d harelo	has been m	ade to th	le applicat	de .		funnel) 4 (Concerning with the state of the	CERT		ON							
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I hereby a	ertify that	the cont	cot of the	s renort	are accura				d						lat had =						
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2001 S. Cou Columbia Ci (200) 825-81 Quality S	Long Prod Sincu X se mty Road 7 by Indiana (00 (200) bleel 100 content: 2015 and	Ucts Group r Rut Drusie 00 East 48725 825-8950 F % EAF I PC = 75.0 ABS Cor	AX Neited an 1%, PI = 22 Mied	d Manu	factured	i in the	S	hip to: he A58	8 & A	572 Ste			REPC # 00046	69 E 1 1 5	33 Saba iowickley	88 & A5 go Lake E 'PA, 1514 Gunzbur	Xive I3 US		Produc	ied: 08 / 20 / 2 xed: 07 / 15 / 2
GENE	RAL IN	ORMA	TION	SP	ECIFIC						Creation			SHIPMEN	T DET	AILS		BOL#00	0056128	5 - 7560.00 lbs
D	mduct	Wide Cl.	ange Beam		AS	Stand TM A6/A	and the second second	'a			Grades									
171		W6X1	-			TMAS88					A588/A5888	l grB		Bundle /	and the second s	de 10-Millionard a Mill.	seconts Planes	-	at PO	Job/Referen
	-r m.45	W150	-		A7	09/A709	M - 17e	ri -		1	1709 g50W/g	345W		061054	1/66	42'0	12	23227		
Heat N	umber	B1606			AASH	TO M270	MM27	0 - 15		1	4270 gr3454	i/SOW								
Condi		As-Rol																		
		Fine G																		
		Fully K No We	illed Id Repair	"50H	MULTI mer	its the req	ulrement	s of ASTM	A992, A	572-50, AS	29-50, A709-5), M270-60	A30,							
CHEM					38, M270-	ni, CSA3	KW, CS	JANNA,	CSA350N	m.										
			S (weight		_	6.82	0-		0-		-			-	104	****			¢1	
<u>C</u>	<u>Mn</u> 1.16	P	<u>S</u> 025	<u>Si</u> 22	<u>Cu</u> 34	<u>Ni</u> 22	Cr 51	MO 04	<u>Sn</u> .020		Nb/Cb	AI 002	N	0004	<u></u>	-C2	- <u>C3</u>	-PC	<u></u>	Analysis Ty Heat
Test 1 2 3 4	Yield Stren Jal / M 50 / 3 54 / 3	gth IPa 145	Tenpile (Streng lai / MF 83 / 57 79 / 54	th Pan D	fy / fm ratio .61 .68	{8 "	Bong. gage) 24 24	Test 1 2 3 4 6 6 7	Te		TESTS (a Uncorbed En Specimen 1	ergy	R-bi/J imen 2	Specimen		Wenage	-	nimum		
Hotes:	"Caladaled	Chemistry V.		Squaralente:	(C1, C2, C3	PC), Cam	minn Inde		G101}-2	6.01(Ca)+3	.00(Mije 1.20(Cr) 9(24) + (Cr/5) + (1,49(85)+17.	28(P)-7.28(C	wj(Noj-9.10(N2)(F	9-33.38(Cr	7 PomjA	45] - C+SI	30+141/20+	Cu/20+4400	-Cz220-150-115+W104
I hereby or specification	utily that t on by the c	he materia Nectric arc	i described i Turtace/cor can Bureau	tervin has tinuous c	a been ma cast proce	de to the a ss and ter rith satisf	applicate sied in a	ie beardano		- francol + (;	Statement of the local division in which the local division in the	and the second division of the second divisio	FICATIO	DN			10 7 s 11			
			ent of this r						nd		Stat	e of Ind	iana, Co	unty of W	hitley S	worn to	and si	Ibscribe	ed befo	re me
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Signed					ord	_7	R	AB	-k	2	1	ed:		ary Public				missio	n expi re	PS:
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2601 S. Coun Columbia City (260) 625-810	Long Prod Structural and Ity Road 70 7, Indiana 4 20 (260) 6	u cts Group I Rail Division 10 East 16725 125-8950 Fi	n AX			Ship to Contra 48649 So Trucks to	tors S	iteel Co			REP (# 0000	097 B C 36	3555 Am vonia Mi	tors St rhein Rd. , 48150 L)		ted: 03 / 17 / 202 ed: 03 / 10 / 202
Quality St Recycled c ISO 9001:20 CMTR com	ontent: F 015 and .	PC = 75.0 ABS Cen)%, PI = 22.0% tified	Manufacture %	d in the US	Attn: Mik	MI, 4811 æM.	1 US				At	itn: Cath	iλ				
GENER	AL INF	ORMA	TION	SPECIFIC	ATIONS Standards				0			SHIPMEN	T DET/	AILS		BOL # 0	0058877	'2 - 7425.00 lbs
Pr	oduct	Wide Fla	ange Beam	A	STM A6/A6M				Grades	-								
		W6X1		» AS	TM A992/A99	2M - 11			A992 / A99	2M		Bundle / /			th pc	-		Job/Reference
		W150)	X22.5		M A572/A572				A572 gr50/g	r345		061208	018	55' 0	° 9	VB-13	598	
Heat Nu	mber	A1756			1 A709/A709				A709 gr50/g									
Conditi	ion(s)	As-Roll			TO M270M/N CSA G40.21-				M270 gr345	-								
		Fine Gr			CGA G40.21-	19			50WM/345	88 IVI								
		Fully Ki No Wel	illed Id Repair	"SDI-MULTI me A709-36, M270-	ats the requirem 36, CSA300W,	ients of ASTI CSA345WM	M A992, A8 , CSA350V	572-50, A£ N.	529-50, A709-5	D, M270-50), A36,							
CHEMI	CAL AN	IALYSI	S (weight pe	arcent)						a harrista a constantina								
С	Mn	Ρ	S S	i Cu	Ni Cr	Мо	Sn	V	Nb/Cb	A	N	В	*C1	*C2	*C3	*PC	*	Analysis Type
.06	1.05	.015	.029 .2	3 .36	.14 .15	.04	.014	.022	<.001	.003	.0134	4 .0003	.31	.349	.26	.16	5.97	Heat
MECHAI Test	Yield (Streng ksi / M 55 / 38	fy) th Pa 30	Tensile (fu) Strength ksi / MPa 76 / 525	fy / fu ratio .72	% Elon; {8" gage 29	g. Test } 1 2	Ter		<u>TESTS</u> (a Nosorbed En Specimen 1	ergy	e only wi ft-lbf / J simen 2	hen specifie Specimen 3		me of o		nimum		
2 3	51/35	50	81 / 560	.63	28	3												
4						5												
						6												
Notes: "CE1 (IIW)=C	Calculated C +Mn/8+(Cr+	Chemistry Va Mo+V)/5+(N	alues: Carbon Equi li+Cu)/15 GE2 (AV	ivalents (C1, C2, C3 NS}≃C+{Mn+Si¥6+(I	PC), Corroelon i Cr+Mo+V)/5+(Ni+I	ndex (I) (AST Cu)/15 CE3	M G101)= 20 (CET) = C +	6.01(Cu)+3 (Mn/6) + (S	.B8(Ni)+1.20(Cr)+ Si/24) + (Cr/5) + (I	1.49(Si)+17 NV40) +(Mo/	.29(P)-7.29(C 4) + (V/14)	Cu)(Ni)-9.10(Ni)(P)-	-33.39(Cu ^z)	Pcm(AV	VS} = C+Si	/30+Mn/20+	Cu/20+Ni/60	+Cr/20+ma/15+V/10+5B
specification	n by the el	lectric arc	fumace/contin	rein has been ma wous cast proce Shipping Rules v	ss and tested i	n accordano y results.	:0		ABS	CERT	IFICATI	ION						
				ort are accurate			nd		Stat	e of Ind	iana, Co	ounty of Wh	itlev S	worn to	and si	bscribe	d hefor	ré me
				nufacturer are in s and applicable			requireme	ents.				day of						0.110
<u>.</u>	То	hh	Rael	hford	Tot	TAR	she)										
Signed:		M M	Lusi	IIIVIU	10000	(-1)			Sinn	ori-					lu no-	nmissio		

2601 S. Cou Columbia Ci (260) 625-81	Long Proc Structural at inty Road 7 ty, Indiana 100 (260) teel 100 content: 2015 and	46725 625-8950 F % EAF I PC = 68.1 ABS Cei	p Ma FAX Meited a 1%, PI = rtified	and N	lanufactui	red in t	1	Ship to Contrac 3383 Boyl Fwinsburg	tors S Parkw	i teel C ay 087 US			REP # 000	097 Bill to: Contra 36555 An	i, 48150 US				nted: 04 / 07 / 2021 ced: 03 / 10 / 2021
GENE	RAL IN	FORMA	TION		SPECIF								4mm-111m	SHIPMENT DET	AILS	E	3OL # 0	0005918	87 - 9900.00 lbs
0	aduct	Mido El	anaa De				<u>indards</u> A6/A6M - '	19			Grades	-							
11	Size	Wide FI W6X1	· .	m	*/		992/A992				A992 / A99	2M		Bundle / ASN #			-		Job/Reference
	OILE	W150					72/A572M				A572 gr50/g			061207791	55' 0"	12	TW-13	7171	
Heat N	mhor	B1758	20		AS	TM A70	9/A709M -	17e1			A709 gr50/g								
Condit		As-Rol			AAS	SHTO M	270M/M27	0 - 15			M270 gr345	gr50							
ounde	wiita)	Fine G					G40.21-13				50WM/345								
		Fully K					36/A36M -		1000 21	70 10 11	A36 / A36								
1.000 000 Territor		No We	ld Repair								709-50, A529-50 , 345W and 350								
CHEM	CAL A	VALYSI	S (weig	ht per	cent)		-		20 M		And in the Designation of the					Suppose a			
C	Mn	Р	- S	Si	Cu	Ni	Cr	Мо	Sn	V	Nb/Cb	A	N	B *C1	*C2	*C3	*PC	*	Analysis Type
.08	.98	.009	.025	.22		.09	.08	.03	.012	.020	<.001	.002	.0098	and the second s	.327	.26	.15	5.01	Heat
	Yield (Streng ksi / M 53 / 3 52 / 3 Calculated (f y) Ith Pa 65 60 Xhemistry Va	Tensili Stren ksi / N 69 / 4 69 / 4	ngth APa 175 175) <u>{</u> ;3, PC), C		Test 1 2 3 4 5 6 7 * (I) (ASTM	Ter F / G101)= 26	np /	Absorbed En Specimen 1	Spec	ft-lbf / J imen 2 29(P)-7.29(0		werage	Mini	imum)+Mrv20+C	Cur20+N560	₩C#Z04ma/15+W10+58
specificatio	n by the e	lectric arc	furnace/c	ontinu	n has been m ous cast proc ilpping Rules	ess and with sat	tested in a	ccordance	ł		ABS	CERTI	FICATI	ON					
	-				1 are accura				d	iyaa ay arkaa ga	State	e of Indi	ana, Co	ounty of Whitley St	worn to a	ind sub	scribe	d befo	re me
					facturer are and applicat				quireme	nts.				day of					
Signed:	To	dd	Ba	sh	ford		Took	B	K	7		ed:		ary Public		y comn		ı expire	95:
Form F-6100-	002-054 rev				inature is po	t require	ad on the 1	ael renori	howeve	or the d	ocument chal	I cloarly i		ary Public e organization submitt	ing the read	ort			
		71071111												e organization submitt the content of the rep		UIL.	1	Page 5 o	f 5

2601 S. Cour Columbia Cit 260) 625-81	Long Prod Structural and hty Road 70 y, Indiana 4 00 (250) 6	d Rail Division d Rail Division 00 East 46725 325-8950 Fr	a FAX				Ship to Contra 8383 Boy Twinsbur	ctors S te Parkw	teel Co ay 087 US		EST R stomer #		97 E 3 L	6555 Am ivonia MI	:tors St mein Rd. 1, 48150 L				ted: 01 / 08 / 20 xed: 12 / 03 / 20
Quality Si Recycled c SO 9001:2 CMTR con	content: I	PC = 75.0 ABS Cen)%, PI = 2: tified	nd Man 2.0%	ufactured	in the USA	Altin: Tra	vis Lance)				A	tin: Cath	ıy				
GENER	RAL INF	ORMA	TION	5	PECIFIC				ingen beforenne	Oradaat			SHIPMEN	IT DET	AILS		80L # 0	00057837	78 - 5400.00 lbs
Pr	oduct	Wide El	ange Bear	_	AS	Standards TM A6/A6M	- 19			Grades	-				· · · ·	_			
		W6X1				FM A992/A99				A992 / A99	2M		Bundle /			th pcs	•		Job/Reference
	10100	W1502	-		AST	VI A572/A572	M - 18			A572 gr50/g	r345		061152	2194	30' 0	- 12	TW-13	2928	
Heat Nu	umber	B1714			ASTM	A709/A709%	l - 17e1			A709 gr50/g	r345								
Condit		As-Roll				O M270M/M				M270 gr345		1							
windit	.on(o)	Fine G				CSA G40.21-				50WM/345									
		Fully K		*07		IM A36/A36N Is the requirem		LE ADO? A	177.60 M	A36 / A36		A26							
		No We	ld Repair			6, CSA300W,				E9-00, M103-0	2, MZ70-00, I	100,							
CHEM	CAL A	ALYSI	S (weigh	t percen	it)											numente, A quipe	entre en al parte	10000	Northeastern and the second second
С	Mn	Ρ	S	Si	Cu	Ni Cr	Мо	Sn	V	Nb/Cb	AI	Ν	в	*C1	*C2	*C3	*PC	*[Analysis Typ
.07	1.04	.008	.018	.22	.37	12 .14	.04	.014	.022	.002	.002	.0120	.0004	.32	.353	.27	.16	5.81	Heat
Test 1 2 3 4	Streng ksi / M 56 / 3 59 / 4	IPa 85	Tensile Streng ksi / M 75 / 5 76 / 5	gth IPa 15	fy / fu ratio .75 .78	% Elong {8" gage 28 27	1444		mp / /C	Ibsorbed En Specimen 1	Specir	ft-lbf / J nen 2	Specimen	3 4	Average	M	nimum		
Notes: CE1 (IIW)=0	*Calculated C+Mn/8+(Cri	Chemistry Va Mo+V)/5+(N	alues: Carbor 4i+Cu)/15 GE	Equivalen 2 (AWS)=0	ts (C1, C2, C3, C+(Mn+Si)/6+(C	PC), Corresion I r+Mo+V)/5+(Ni+(ndex (I) (AST Su)/15 CE3	M G101)= 2 {CET} = C 1	6.01(Cu)+3 · (Mn/8) + ()	.88(Ni)+1.20(Cr)+	1.49(Si)+17.2 Ni/40) +(Mo/4)	9(P}-7.29(C + (V/14)	u)(Ni)-9.10(Ni)(F	P)-33.39(Cu	") Pcm(AV	VS}=C+Si	/30+Mn/20+	Cu/20+Ni/60	0+Cr/20+ma/15+V/10+5B
l hereby ce specificatio	rtify that ti on by the e	he materia electric arc	l described c furnace/co	l herein h ontinuou:	as been mai s cast proces	le to the appli is and tested i ith satisfactor Signe	cable n accordan y results.				CERTI		ON				n		
I hereby o	+					and correct.		ind		Stat	e of India	ana, Co	ounty of W	hitley S	worn to	and su	ubscrib	ed befo	re me
						compliance		and an other states						2					
operation	ents of th					purchaser d	esignated	requirem	ents.	this		C	lay of						
			in the second se		P	-11	11 -1		/										
operation	-	odd			ord	1000	(A.E	at the	<hr/>	Sigr	ied:		ary Public			Му сол	imissio	n expire	BS:

Birmingham Fastener Manufacturing

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

Pg 1 of 1

Certificate of Compliance

Customer :	AMERICAN TIMBER			<i>BFM</i> # :	1500031
P.O. #:	16997		Da	te Shipped :	6/25/2018
Quantity	Description	Lot#	Hout #	CiCti	

Description	Lot #	Heat #	Specification	Finish
5/8"-11 x 7" Carriage Bolt	217961	JK17100350	F1554-36	F2329
5/8"-11 x 7" Carriage Bolt	217962	DL17105083		Plain
5/0	-11 X / Carriage Bolt	-11 x 7 Carriage Bolt 217962	217962 DL17105083	-11 x 7" Carriage Bolt 217962 DL17105083 A242

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

0

Brian Hughes

a 1 55.000psi ightrom 37% in 2 sation 21% in 81	197 in 50 Simme 1% in 205 Server		Yield 2. 5	: 84,000ps i4 000ps n 351 in 2*	(* #150,8m	fre := tarey fi	Elong Tensil	ation 20% n.2. 84.000	in 61°+ in 203 Junio) psi
	7		With Block States, and the	(1990)				0.019%	0 005%
C Mi 0 15% 0.91	°⊷ C 0150°	S- D * 81%	S. 0 ((27%)	р. С 010%	Cu 0.32책	Cr 0.74%	Ni 0.28%	Мо	Ob
all Date: 8/11/201			Qly Shipped	LBS: 46,832	Qty Ship	ped Pcs; 1	,384		
ol) Date: 12/17/20	17 Meit Date 8	/11/2017	0	a transformer	1000000 and 10	internet source	neve and main watanes	hose services	Poir.
and a second real for the	Carls South Long Sample	Notes	Notes a los				Customer Part #	0.142/1	47.3
Gustomér Spec								1	
Description	A242BF		ege.				B.L. Number		and the second
Product	9°16°(.5625) Ro		2126				and the second se	LICE I I	2508302
Siza	9.16*+.5825+#0	1042/42 03			•••		Part Numbe	000000	503-16905-00
Grade	A242BF - ASTA						Sales Order	1000	
Product Group	Merchard Bar C					T			
BIR! (205	MINGHAM FASTE BOX 10323 MINGHAM AL 35/ 0555-351-0244 (2051591-0244	NER & SUP	PLY		Ship To		0023 [A5], AL 35202	SUPPLY	(843) 35 Fax, (843) 35
NUCOR ST	EEL SOUTH	CAROLIA		3/1	Certifica 5/2018	tion			MTR #. C1. 300 Sheel M DARLINGTON, SC

1 WELDING OR WELD REPAR 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

	In H Rem	
Added to provide a grade	James H Blow	
1781 (Durk unt Metsliurgist	Page t of t

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

	HAM, AL 35214- ta Sheets are available at www.nucorbar.com or t	by contacting	ı your inside	sales repre	sentative.	Flowood, I 800-723-1		~		Load I	Number:	158744 3-08 January 1	2010
LOT #			and the second se	SICAL TES					СH	EMICAL TES		a-ud January 1.	2012
HEAT #	DESCRIPTION	YIELD P.S.I.	TENSILE P.S.I.	ELONG % IN 8*	BEND	WT% DEF	C Ni	Mn Cr	PMo	SV	SiCb	Cu	с.
PO# => JK1710035001 JK17100350	M 70160 Nucor Steel - Jackson Inc 9/16" (.5625) Round 40' F1554 Gr36 ASTM F1554-15 Gr36	363MPa 52,575	74,310 512MPa 74,150 511MPa	21.3%			.15 17	.77 .23	.014 .042	.037 .016	.20 .002	.29	.3
PO# => JK1710035302 JK17100353	ROA% = 50 M 70160 Nucor Steel - Jackson Inc 9/16" (.5625) Round 40' F1554 Gr36 ASTM F1554-15 Gr36	392MPa 54,424	76,730 529MPa 75,110 518MPa	21.3%			.16 .10	.82 .18	.021 .025	.040 .018	.22 .002	.29	.32
PO# => JK1710232601 JK17102326	ROA% = 49 M 70160 Nucor Steel - Jackson Inc 9/16" (.5625) Round 40' F1554 Gr36 ASTM F1554-15 Gr36 ROA% = 71	55,743 384MPa 55,542	77,270 533MPa 77,550 535MPa	23.8% 23.8%			.17 .10	.80 .11	.015 .024	.033 .016	.22 .001	.39	.33
the specifications and sta	naterial described herein has been manufactured in accordance a enderos listed above and that it passfies those requirements.	vith							P ₅			chuit	

NUCOR

NUCOR STEEL JACKSON, INC.

CERTIFIED MILL TEST REPORT

Ship from: MTR #: 0000075451 Page: 1

115



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 Shirmert B01. 8219668 Steel Supplier: STEEL TECHNOLOGIES LLC Grade: SAE CF436 TYPE3 STEEL Lot: D7926 Heat: 198520 Carbon: 30 Purchase Order: 6211422 Manganese: .79 Phosphorous: .02 Sulfur: .003 Silicon: .24 Shipment BOL: B219698 Shipment ID: A0238117 Quantity: 24000 Manufacturers Marking: "P" SPECIFICATIONS TEST RESULTS HARDNESS: TEST METHOD: ASTM E18 HARDNESS: HRC 38 - 45 CHECKED TO ASTM F606 HRC 43 - 44 : : USS/SAE LC Washers are manufactured to the requiraments 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 Warrow, 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. FRAME SCHUBERT The test results only apply to the items tested. Quality Assurance Manager 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. 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 #: Mill Coil #: Heat #: Gauge: Mill coil weig Chemistry:	239 190 .13	752 96526 3520 6 500#						
C .3900	Mr 00.790		S 00 .0030	Al 00.0300	Si 0 .2400	Cu 00 .2630		
Cr .47500	Mo .01800	V .00500	Nb/Cb .00100	Ti .00200	N .00700	Ca .00100	B .00000	Sn .01100

· Paul J. Seogelink

Signature Quality Manager

Nucor Steel Indiana 4537 South Nucor Road		METALLURGICAL TE	STING CERTIFICATION			0078096
Crawfordsville, IN 47933-00	307				Certificate Nu Date Is:	mber: 825756 sued: 05/17/2019
Order Number: 314919 Order Dimensions: 0.1360 HRPA,C	- 0001 HOT ROLLED PICKLED & in X 51.0000 in UT,1040 WEATHERING	ANNEALED		Customer Name: Customer Address:	NOTICIT LINGUED LING THE	Page: 1 of 1
Coil Number 2396525.000 L-Yield (ks L-Tensile (ks Part Number 724148-240 TONS Weight: 42,720 LBS	i): 79.8	HEAD Rockwell B: 83		Release Order:	MILLANUKEE H35339	kΩ 53207
Heat Slab C 198520 04 0.39 Coil Humber 2396526.000 L-Yield (ks. L-Tensile (ks. L-Elong (1 Part Number 724.148-240 TONS Weight: 42,500 LBS	HEAD i): 60.8 i): 87.2	Cu Sn Ni	IEPIICAL ANALYSIS Cr: Mo Al 6 0.475 0.018 0.0		004 0.444	Sb CO1
Heat Slah r		CHE	EMICAL ANALYSIS			
Heat Slab C 198520 05 0.39	₩n P S Si 0.790 0.020 0.003 0.2⊭0	Cu Sn Ni 0.263 0.011 C.286	Cr Mo Al 0.475 0.018 0.00			Sb 001
QF-0261 04/01/2019	le hereby certify the above is % 1-800-777-	CONCONTRACTOR THE INC	05H	PORATION NUCOR QUALITY ASSU		Since Cello



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,

	CE / S.O.: 02 DMER P.O.:	09689 / 0157621 18524			REFERENC DATE SHIPI		/5/2018					
QTY:	HEAT/LOT	ITEM NUMBER: NO: YIELD:	CC: TENSILE:	%ELONG:	DESCRI	PTION: Mn:	P:	S:	SI:	CI:	Туре	ACW
58	BOLAGG062040 BOLAGG0620 0017265		62040	BOLT	G 0.62	i-11 x 0	4.000 GA	LV (5/8) A	307			
190	0017265	WAROG-062-LA	WAROG-062-LA		WASHE	ROUN	D 0.625	USS MO	LARGE	(6/8) F84	4 1-3/4 OD	x 1

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-S07 SPECIFICATIONS AND ARE GALVANIZED IN ACCORDANCE WITH ASTMA-153, UNLESS OTHERWISE STATED. NUTS COMPLY WITH ASTMA-S07 SPECIFICATIONS AND ARE GALVANIZED IN ACCORDANCE WITH ASTMA-153, UNLESS OTHERWISE STATED. COMPLY WITH ASTMA-563 SPECIFICATIONS AND ARE GALVANIZED IN ACCORDANCE WITH ASTMA-153, UNLESS OTHERWISE STATED. AUXSHERS COMPLY WITH ASTMA-563 AND/OR F-844 SPECIFICATIONS AND ARE GALVANIZED IN ACCORDANCE WITH ASTMA-153, UNLESS OTHERWISE STATED. CALL GUARDRAIL MEETS AASTATO M-160 AND ALL STRUCTURAL STEEL MEETS AASHTO M-270. ALL OTHER GALVANIZED ANTERIAL CONFORMS WITH ASTMA-123. ALL OTHER ITEMS COMPLY WITH ASHTO M-111, M-165, M-133, M-264, ASTMA-369, ASTMA-709, ASTMA-123, ASTMA 4505, AND ASTMA583 SPECIFICATIONS IF APPLICABLE. COMPLY MALL 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.

_____ DAY OF _____ NOV _____ 20____ 8

HIGHWAY SAFETY CORPORATION QUALITY ASSURANCE MANAGER

- -

NOTARIZED UFON REQUEST:

SWORN AND SUBSCRIBED BEFORE ME THIS Mangaur talwo

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

Page 1 - 0157621

Birmingham Fastener Manufacturing

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

Pg 1 of 1

Certificate of Compliance

Customer :	AMERICAN TIMBER			<i>BFM</i> # :	1682256
P.O. #:	21686		Da	te Shipped :	2/24/2020
Itom Quantity	Description	Lot#	Heat #	Specification	Finish

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:

[-__ Cody Calvert

____ Date:

06/05/2020

NUCC	R	LOT NO. 4070908				Post Office Box 61 Saint Joe, Indiana
FASTENER	DIVISION					Telephone 260/33
CUSTONER NO/NAME						
9320 BIRMINGHAM FASTE	NER MFG	NUCOR ORDER #	59465			
TEST REPORT SERIAL#	FB562877	CUST PART #				
TEST REPORT ISSUE DATE						
DATE SHIPPED	6/12/18	CUSTOMER P.O. 4	6178316			
NAME OF LAB SAMPLER:	PATRICIA SHAFER,					USA
**********************			化化化化化化			$\langle \bigcirc \rangle$
NUCOR PART ND QUAN		DESCRIPTION			6	
		5/8-11 GR A242 HV	HX NUT BL	ICK.		
MANUFACTURE DATE 4/10/	18	HEX NUT BLACK				
CHEMISTRY	MATERTAL	GRADE -A242NF				
HATERIAL HEAT		MPOSITION (WTX HE	AT ANALYSIS	O BY P		SUPPORT
NUMBER NUMBER		P S SI		NI	CR	NUCOR STEEL - SOUTH CAROL
RM030632 DL14104775		.005 .019 .18		.28	.72	
MECHANICAL PROPERTIES						
SURFACE CORE	PROOF LOAD	TENETI	E STRENGTH			
HARDNESS HARDNESS	9000 LBS		EG-WEDGE			
(R30N) (RC)	7000 183	(LBS)	STRESS	(PSI)		
N/A N/A	PASS	N/A	N/A			
N/A N/A	PASS	NZA	NZA			
N/A N/A	PASS	NZA	N/A			
N/A N/A	PASS	N/A	N/A			
N/A N/A	PASS	N/A	N/A			
AVERAGE VALUES FROM TEST	TS					
PRODUCTION LOT SIZE	66000 PCS					

NINIMUM 1.177 0.597

30x 6100 diana 46785 50/337-1600

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 CONFLIES WITH DFARS 252.225-7014, THE SAE AND THE PRODUCT WAS MANUFACTURED AND TESTED IN THE U.S.A. PRODUCT CONFLIES WITH DFARS 252.225-7014, THE SAE AND THE PRODUCT WAS MANUFACTURED AND TESTED IN THE U.S.A. THE STEEL WAS MELTED AND MANUFACTURED IN THE U.S.A. AND THE PRODUCT CONFLET WITH DFARS THE SAE AND THE PROMATION PROVIDED BY THE MATERIAL SUPPLIEM AND MAY NOT BE REPRODUCED EXCEPT IN FULL.

MAXIMUN 1.183 0.604



--DIMENSIONS PER ASNE B18.2.2-2010 CHARACTERISTIC #SAMPLES TESTED Width Across Corners 8 Thickness 32

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

NUCOR FASTENER A DIVISION OF NUCOR COMPORATION 7 BOB HAYWOOD QUALITY ASSURANCE SPERVISOR

Page 1 of 1

TR No. 612061-08-01

And and the state of the state	R			2/19/20	tification	1	MTR #: C1- 300 Steel M DARLINGTON, SC (843) 39 Fax: (843) 39			
NUCOR CORPO		OLINA		41 10/20	10				(843) 393-56 Fax: (843) 395-67	141 701
	FASTENER INDIAI 8100 IN 46785-0000 14828 I) 337-1726			s	Ship To: NU 672 81 (80 Fa)	COR FASTEN I COUNTY R JOE IN 4676 0) 955-0826 2 (219) 337-17	IER OAD 60 5 722			
Customer P.O.	158069					T	Sales Orde	r 239317.1		
Product Group		aliter					Part Numbe		MODMZB	-
						-	Lot i			-
Grade							Heat #			-
Size	1-1/84" (1.0156)	-					B.L. Numbe			-
Product		Round Coll	NI A242NF				Load Numbe		and the second	-
Description	A242NF						Customer Part			-
Customer Spec	1									_
I nereby certify that the mate	rial described herein has	been menufactu	red in accordance) with the specific	cations and stand	arca listed above s	and ther it satemes that	e requisemente.		
Roli Date: 2/17/2016	Melt Date: 7/30/:	2014 Qity	Shipped LB	3: 41,834	Qty Shipped	Pcs: 10				
IO COIL DELIVERIES IO COIL DELIVERIES Ioit Date: 7/30/2014	S VIA TRUCK DEC S VIA RAIL DECEN	EMBER 18T	"H - JANUAR • JANUARY 4	Y 4TH 4TH						
C Mn 0.13% 0.84%	V 0.0120%	Sł 0.18%	S 0.019%	P 0.005%	Cu 0.39%	Cr 0.72%	NI 0.28% 0		Cb CRNCMO 002% 1.410%	
CRNCMO: Cr + NI + C	u + Mo				and and a second of the					
Atmospheric Corr Res	Index: 6.6									
Roll Date: 2/17/2016										
			Terrelle	1.74.000mai			Florida	tion: 25% in 8	"(% in 203.3mm)	
rield 1: 62,000psl				1: 74,000psi				2: 74,000psl		
Elongation: 44% In 2"				51,000psl	W/0/ I- 60 8-	Cinni (me	10/10/1			
Elongation 25% in 6"(% in 203.3mm)		Elongati	on: 43% in 2	. (20 11 00.01	ing - toots				
Specification Commen										
1. WELDING OR WEI 2. MELTED AND MAI 3. MERCURY, RADIU	LD REPAIR WAS I NUFACTURED IN IM, OR ALPHA SO	NOT PERFO THE USA NURCE MATI	RMED ON T	HIS MATERI NY FORM H	IAL HAVE NOT B	EEN USED IM	N THE PRODUCT	TION OF THIS		
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30632

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e.

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

HARDNESS:

MILL	GRADE	HEAT#	C	Mn	P	S	Si	SPEC:	24-38
GERDAU	1045	62148230	.43	.70	.007	.025	.21	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

	CUSTOMER SHIP TO		the second s	ERIAL TEST REPOR	the second s					Page 1/1
GO GERDAU	UNYTITE INC LA	SALLE PLANT	CUSTOMER B UNVITTE IN 1 UNVITTE	ic		RADE 045M23FJ2N		PE / SIZE d Bar / 7/8"		DOCUM D: 00000282
US-MLST PAUL	LA SALLE, IL 61301 PERU, IL 61354-9710 USA USA					LENGTH WE 24'10" 39.				T / BATC
1678 RED ROCK ROAD SAINT PAUL, MN 33119 USA	SALES ORDER 7321959/000010		CUSTON BIO45SC	ER MATERIAL Nº 0.8750 A	RE	ECIFICATION 7 DAT SVISION	TE or		- <u>I</u>	
CUSTOMER PURCHASE ORDER NUMBER PO08180		ILL OF LADING 32-0000068102		DATE 03/12/2019		TM A576-17				
CHEMICAL COMPOSITION	5. 0.025 0.	SI Qu .21 0.20	Ni 20.00	Ci 8 0,17	Mo 0.016	\$p 0.024	0.022	Nb 0.001	Al 96	•
METALURGICAL CHARACTERISTICS FlueGr E381	\$.	E381 R		E381 C		2 3411				
HARDENABILITY DI A255 Inch	a	and a second		······································						
1.38					•					
COMMENTS / NOTES Material 100% molec and rolled in die USA, and hot rolling, have been performed är Gérda cast billets. Silicon küled (deoxidized) steel. Hgud at embiont tempetatures during processin	No weld repairmen ; No weld repairmen ; so or while in Gerete	78 Red Rock Road, performed. Steel	, Saint Paul, M NOT exposed to	finneson, USA. All p mercury or any liquid	product proch d alloy which	uced from strand			·	
Material 100% melted and rolled in die USA, and hot rolling, have been performed at Gérdia	W SL Pani Mill, 167 No weld repairmen j g or while in Gerdan without the expressed without the expressed meet specific applica e Grain (FG 5-8)	76 Red Rock Road, performed. Steel u St. Paul Mills p itseat of Gerdau St. i Written consent of	, Saint Paul, M not exposed to ossession. Any Paul Mill year	finnesota, USA. All p mercury or any liquid modification to this (product proda d alloy which certification a	uced from strand is is				
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124

2024-02-06

Birmingham Fastener Manufacturing

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

Pg 1 of 1

Plain

Certificate of Compliance

Cus	AMERICAN TIMBER				<i>BFM</i> # :	1628407
P.O. #: 20512			Dat	9/30/2019		
Item	Quantity	Description	Lot #	Heat #	Specification	Finish
1	869	3/4"-10 x 8 1/2" Carriage Bolt	86911	10592090	AWWAC111	l Plain

32361

10575880

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.

5/8"-11 x 4" Hex Lag Screw

Signed:

10,545

4

Date: 11/04/2019

AWWAC111

Brian Hughes



EMAIL

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

Melted in USA Manufactured in USA

CHARTER STEEL TEST REPORT

	Cust P.O.	6198448
	Customer Part #	336513
	Charter Sales Order	50058866
	Heat #	10592090
	Ship Lot #	4575439
Birmingham Fastener & Supply	Grade	A242 M SK FG IQ 11/16 RNDCOIL
931 Avenue W	Process	HRCC
Birmingham, AL-35234	Finish Size	11/16
Kind Attn :Blane Vines	Ship date	19-FEB-19

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				lest re	suns or Heal	LOT # 1059	2090					
CHEM %Wt	C .07	MN .55	P .017	S .013	\$1 .230	NI .36	CR .72	MO .05	CU .28	SN .008	V .003	
	AL.	N .0070	B .0001	TI .002	NB .002							

		Test results of	Rolling Lot # 1263788		
TENSILE (KSI) REDUCTION OF AREA (%)	# of Tests 1 1	Min Value 62.9 78	Max Value 62.9 78	Mean Value 62.9 78	TENSILE LAB = 0358-02 RA LAB = 0358-02
REDUCTION RATIO=81:	I				
Specifications: Ma	nufactured per Cha	rter Steel Quality Manua	Rev Date 05/12/17		

Manufactured per charter steel quality Manual Nev Date Up/2/17 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:		This MTR supersedes all previously dated MTRs for this order
Charter Steel		SanceBanned
Saukville, WI, USA		pricipannaus
		Janice Barnard Division Mgr. of Quality Assurance
	ACCREDITED	barnardJ@chartersteel.com
Trip: 1341333	Testing Laboratory	Printed Date : 02/19/2019
	Page 1 of 2	Finited Date : 02/10/2019
	age i o z	

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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.

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	Labora	tory	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 laborator	y 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			Х
Macroetch	ASTM E381	X			Х
Hardenability (Jominy)	ASTM A255; SAE J406; JIS G0561	X			Х
Grain Size	ASTM E112	X	X	Х	X
Tensile Test	ASTM E8; ASTM A370		Х	X	X
Rockwell Hardness	ASTM E18; ASTM A370	X	X	X	X
Microstructure (spheroidization)	ASTM A892		X	Х	
Inclusion Content (Methods A, E)	ASTM E45		X		X
Decarburization	ASTM E1077		X	Х	Х

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.

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
- 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.



Page 2 of 2

Birmingham Fastener Manufacturing

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

Pg 1 of 1

Certificate of Compliance

Customer :	AMERICAN TIMBER	<i>BFM</i> # :	1628407
P.O. #:	20512	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:

Brian Hughes

Date: 11/04/2019

NUCOR NUCOR CORPORATION NUCOR STEEL SOUTH CAROLINA					Mill Cert 7/25/20	tificatior 019)			MTR #: C 300 Steel DARLINGTON, (843) Fax: (843)	Mill Road SC 29540 393-584
P(Bl (2	D BOX 10 RMINGH 05) 595-3	AM. AL 35202-		,	ę	931 PO BIF (20	MINGHAM F AVE W BOX 10323 MINGHAM, , 5) 595-3511 : (205) 591-0		SUPPLY		
Custom	er P.O.	6207420			2000 000 0000 000000000000000000000000			Sales	Order 3	310039.5	
Product	Group	Merchant Bar	Quality					Part N	umber 3	30000680480DEQ0	
	Grade	A242BF - AST	M A242-03						Lot # [DL1810086102	
	Size	.680° Round						Н	eat# [DL18100861	
P	roduct	.680" Round 4	0' A242BF					B.L. Nu	mber (C1-791357	and a special and a second second
Des	cription	A242BF						Load Nu	mber (C1-473652	-
Custome	Spec							Customer	Part #		
I hereby cartify that	the materia	I described herein ha	is been manufec	tured in accordan	ce with the specific	cations and sland	ards listed above	and that it satisfie	a those requ	irements.	
Roll Date: 3/23	/2019	Melt Date: 2/6/	2018 Qty	Shipped LB	S: 14,831 G	ty Shipped	Pcs: 300				
Melt Date: 2/6/	2018		·								
С	Mn	V	Si	S	Р	Cu	Cr	Ni	Mo	СЬ	
0.15%	0.86%	0.0120%	0.17%	0.007%	0.006%	0.31%	0.72%	0.25%	0.0149	% 0.004%	
Roll Date: 3/23	/2019										
Yield 1: 53,000	psi			Tensile	1: 79,000psi			E	ongation:	22% in 8"(% in 203.3m	m)
Elongation: 35%	% in 2*(9	6 in 50.8mm)		Yield 2:	53,000psi			Те	nsile 2: 8	1,000psi	
Elongation 24%	in 8º/%	in 203.3mm)		Elongat	ion: 39% in 2	"(% in 50.8m	m) - test2				

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

H Alm

James H. Blew **Division Metallurgist**

Page 1 of 3

NBMG-10 October 1, 2017

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

MECHANICAL PROPERTIES

		PROOF	
	TENSILE	LOAD	HARDNESS
SPEC .:	120,000 psi	85,000 psi	34 MAX
ACTUAL:	135,300 psl	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

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, ILLINO'S WITH MATERAL WHICH WAS MELTED AND MANUFACTURED IN U.S.A. WE UTHITER CERTIFY THAT THIS IS A TRUE REPRESENTATION OF INFORMATION FROM BY THE MATERIALS SUPPLER AND THAT OUR PROCEDURES FOR THE CONTROL OF PRODUCT QUALITY MEET OR EXCEED ALL APPLICABLE TEST, PROCESSES, AND INSPECTION REQUIREMENTS PER THE BOX'S SPECIFICATION. THIS REPORT WAY NOT BE REPORT IN FULL, WITHOUT THE WRITTEN APPROVAL, OF ROCKFORD BOLT. THE REPORT MUST NOT BE USED BY THE CLENT TO CLAM PRODUCT CERTIFICATION, APPROVAL, OR ENDORSEMENT BY INLAP, MST, OR ANY ABENCY OF THE US. GOVERNMENT.

"THIS INFORMATION IS NOT COVERED BY ROCKFORD BOLT AND STEEL'S NVLAP ACCREDITATION."

				PAGE 1 OF	1
THIS REPORT CON		T WAS PROD	UCED UNDER	THE	
FOLLOWING SUBC			0004-0045	100 4404	
*Raw Material:	Not ISO 17			#98-1181	-03
	NOE 150 17	UZ5 ACCIEC	litated		
CUSTOMER N	AME:	AMERICA		& STEEL	
4832 PLANK R					
CUSTOMER P	O#: 21451		SHIPPER	#: 068659	
			DATE SHI	PPED: 04/	17/2020
CHEMICAL CO		MILL CERT	*		
HEAT # 10010	and a second				
GRADE	C	Mn	Р	Ş	Si
1045	X 100	X 100	X 1000	X 1000	·x100
SPEC.	.4350	.6090	.040 max	.050 max	.1535
ACTUAL	.50	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	.011	.018	.18
_	/				
\cap	1.1	11			
	//	Mai	L		\$/28/2020
APPROVED SIGNA	TORY				DATE
	/				



NVLAP LAB CODE 200255-0



	STEEL CO LLC STH AVE SE PARK, IL 60160 US 1-58695 Hot Roll - Engineere 1045CA4				1550 N 251	TEEL CO L THAVE PARK, IL 6		Fax	: 402-6
Product Group Grade Size	Hot Roll - Engineere	d Bar							
Product Group Grade Size	Hot Roll - Engineere	d Bar							
Grade Size	Contraction of the other section of the section of	d Bar				Sales	Order #	10023420	- 2.2
Size	1045CA4					P	roduct #	1071653	
							Lot #	100101783	321
BOL #	0.75"						Heat #	100101783	3
terror and an enter and an enter a second	BOL-410411						Load #	322914	
Description	Hot Roll - Engineere 6001-10000 lbs	d Bar Round 3/	4" 1045C	A4 24' 3" [291"}	Custom	er Part #	0	
Production Date	12/17/2019					Qty Ship		48120	
Product Country	United States							1320	
Of Origin Original Item	CINER DISIGS						oped EA	1320	
Description							nai Item Number		
	al described herein has been mar	ufactured in accordan	ce with the sp	ecifications and	standards listed	abovo and that it :	atislies those	requirements.	
Melt Country of Origi	in : United States					М	elting Date	e: 12/04/201	9
C (%) Mn (%	%) P(%) S{%;) SI (%)	NI (%)	Cr (%)	Mo (%)	Cu (%)	V (%)	Nb (%)	Zr (9
0.50 0.76	3 0.011 0.01	8 0.18	0,09	0.14	0.03	0.16	0.003	0.001	0.00
N (PPM) Sn (% 67 0.00			B (%) 0.0000	As (%) 0.004					
Ni + Cr + Mo (%) :	0.25								
Austenitic fine grain by Reduction Ratio 99.34	chemical analysis per th 4 : 1	e latest revision o	of ASTM A	29					
ASTM E45 Method A (Sulfides:T: 1.5 H	(Worst) {: 0.5 Alumina : T	: 1.0 H: 0	.5	Silicates T:	15 1	i: 0.0	Giobular T	· 1.0	H: 0.5
<u></u>							Giordiar	. 1.0	1.0.0
Other Test Results Macroetch E381 St	urface ; 1	Macroetc	h E381 Mi	d Aadius :	1	Macroele	ch E381 Ge	nter: 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 m	aterials in this pr	oduct, Incl	uding meltin	g, have beer	performed in	n the United	I States.	
All products produ	is not rolled in the United uced are weld free.								
	orm, has not been used in ASTM A29-16, ASTM E41					ble custome	r requireme	ints.	
	d at Nucor Steel Nebrael							1 T. T.	
		istry, Tensile, Bri	ne)) Hardn	ess, Rockwe	ali Hardness,	inclusion, an	id Grain Si	20.	
			Amili	iQ)					
NBMG-10 January 1	0010		*	n Mətallurgi	ot				Pag

NUCOR	Mill Certification 12/31/2019	MTR#:322914- Lot #:1001017832 2911 E NUCOR ROAD PO BOX 30 NORFOLK, NE 68701 US 402-844-020 Fax: 402-644-032
		ŝ.
) GS	
		~
NBMG-10 January 1, 2012	GimHiD Jim Hill, Division Metallurgist	Page 2 of 2

Birmingham Fastener Manufacturing

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

Pg 1 of 1

Certificate of Compliance

Customer :	AMERICAN TIMBER	<i>BFM</i> # :	1628407
P.O. #:	20512	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

				Chemic	al Anal	vsis		
Heat Number 227567	C 0.360	Mn 0.620	P 0.016	\$ 0.002	Si 0.276	0.467	Cu 0.266	Ni 0.257
Purchase Order Number 6187951	Part Description 3/4 F436 RD TYPI	E3 W F	fT		Date Shipp 07/17/2		ŝ)uantity hipped ,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. Poul J. Seggelink

Susan M. Daoust

Paul Seggelink Q.A. Manager Sworn and subscribed before me on July 18, 2018 My commission expires April 24, 2021

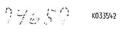


(036) TYPE 3, HT, F436 WW INTERNAL USE : 65866206/001/010928/47103

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

Nicor Sceel-Crawfordsville 4537 South Nicor Post Crawfordsville, IN 47933-0907

Order Rumber 225084 - 0001 Order Dimensions 0 1380 in X 51 3750 in HOT ROLLED BANG, 1040 MCRIMERING, MSL. METALLUNGER, TESTING CERTIFICATION



Certificate Humber: 407332 Date Issued: 02/14/2017 Page: 1 of 1

Customer Name: WROUGHT WASHER HUG. INC. Costomer Address 2100 SOUTH WAY STREET

MILLAUKEE WI 53207

Certified to ordered chemistry

Cust PO Number: H2364

Coil Number 1668849 DCC

Part Humber 724:148

CHEMICAL INFRASIS

Heat 51ab C Mm P 5 51 Cu Sn N1 Cr Mo Al N V No fi B Sh 227567 02 0.35 0.620 0.016 0.002 0.276 0.266 0.008 0.257 0.457 0.021 0.035 0.008 0.004 0.002 0.005 0.005 0.003

WE HERCEM DENTIFY THE ABOVE IS CORRECT AS LOMINIPED IN THE RECORDS OF THE CORPORATION MELTEL AND RALED DI THE USA NUCLY QUELITY ASSUMATE

the second second

Englithe -

CF-0261 09/19/2007

	Constant of the second s			OCES	SING	CHAR	Т	c	182	212								lfg., In			ş
CUSTOMER	3/4					TAG #								<u>wt. (</u>		2000 - C.					
LC.#	060	2924				LOT#		7103						CE#				-	Sel-up	Checklist	
ORDER#	271	426		0. D.	1.9	69	I.D.	. 8	13		тнк	.148	!	RC	SPECS	38-	45		Verifica	tion	
DATE	3-18	1		T	I																
	10	200		00		4 0.00	r	430		1											
TIME	1.1	R		3		¥		1		-											-
OPERATOR	453											-			1.000					1	+
CARBON	36													-							-
Mn	62											-		-	-						-
GAS FLOW RATE	125																				-
NITROGEN FLOW	1275																				-
DRAW TEMP	315													-							-
QUENCH %	620				I										-						
RETORT SPEED													l								-
BEND TEST												-	L								-
DYE PEN TEST																					-
RC TEST BLOCK	40				1					1	[L	1	L	L	L	1	l	1	I
2		Quench	Temp	Quench	Temp	Quench	Temp	Quench	Temp	Quench	Temp	Quench	Temp	Quench	Temp	Quench	Temp	Quench	Temp	Quench	Ter
	1	53	44	43-	41	55	42	1													
		55	117	85	43	53	42	1													
Sample	2		45	12	1	10									1	1					
Measurements	3	55	43	56	41	55	41				L						ļ		-		-
	4	55	43	55	42	55	41														
	1	54	44	17	42	14	42														
	5	14		70	1d	26				+				1		1					
Sum		272	217	2//	209	212	208			1											-
Average X		54	43	55	42	54	42						-								
	1	1	T	17	2	2	1														
Ranga R Notes		12			10						1										
Core Hardness	-							1													
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TR No. 612061-08-01

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2024-02-06



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.

	BIRMINGHAM FASTENER & HANCEVILLE DIST CENTE 1100 MAIN ST HANCEVILLE, AL 35077			
Prestige Part:	3/4"F436 TYPE 3 6213872 B219698 A0238117 14400	Lot:	SAE CF436 T D7926 198520 .39 .79 .02 .003	
SPECIFICATIONS HARDNESS: TEST METH HRC 38 - 45 CHECK TO ASIM F60		TEST RESULTS HARDNESS: HRC 41 -	43	
US\$/SAE LC Weshers are manufactured to the real Chemistry is as reported from raw material cartific This product was produced under an ALTF 169A9 IATF 169A9 Certification No: 800334. Material was metsda dan manufactured in the U.S. This product was menufactured in Warran. Michigh This product orderms to all requirements for wos Sampling Plen per P-S.I W.I. # 5.4.18.0.15. The test results only apply to the items tested. This test report must not be reproduced except in Materials used to manufacture these products are Product Is RoNS compliant. No weld repairs made to material, All certified product is AIS compliant.	vation and does nat fall under Prestige Stampin Quelity Assurance System. A. an U.S.A. herr as produced according to A.S.T.M. F-43 full without prior written approval.			SCHUBERT Assurance Manager
Econ Information System	n 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 #: Mill Coil #: Heat #: Gauge: Mill coil weigh Chemistry:	<u>1475</u> 2396 <u>1985</u> .136 t: <u>42,50</u>	<u>526</u> 20						
С	Mn	Р	S	A	Si	Ċu	Ni	
.39000	.79000	.0200	0 .00300	.03000	.24000	.26300	.28600)
Cr	Mo	V	Nb/Cb	Ti	N	Ca	В	Sn
.47500	.01800	.00500	.00100	.00200	.00700	.00100	.00000	.01100

· Paul J. Soggelink

Signature Quality Manager METALLURGICAL TESTING CERTIFICATION

0078096

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

Page: 1 of 1

Customer Name: MROUGHT MASHER HEG INC Customer Address: 2100 S BAY ST

	MELLIAUKEE	धा	53207
Release Order:			
Cust PO Number:	H3539		

Coil Number 2396525.000	L-Yield (ksi): L-Tensile (ksi): L-Elong (%):	HEAD 52.0 79.8 30.0	
Part Number 724148-240 TC beight:		50.0	

Order Number: 314919 - 0001 HOT ROLLED PICKLED & PANEALED Order Dimensions: 0.1360 in X 51.0000 in

UT HERE AR

HRPA, CUT, 1040 MEATHERING

NLICOR'

4537 South Mucor Road

Crawfordsville, IN 47933-0907

CHEMICAL ANALYSIS

Heat Slab C Mn P S Si Cu Sn Mi Cr Mo AL М V No Ti 8 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

HEAD

Rockwell 8: 89

HEAD Rockwell B: 83

Coil Number MEAD 2396526.000 L-Yield (ksi): 60.8 L-Tensile (ksi): 87.2 L-Elong (%): 24.0 Part Number 724148-240 TOHS Weight: 42,500 L8S

CHEMICAL AWALYSIS

Heat Slab C Man P S Si Cu Sn Ni Cr Mo AL N V No Ti В Sb 198520 05 0.39 0.790 0.020 0.003 0.240 0.263 0.011 0.285 0.475 0.018 0.030 0.007 0.005 0.001 0.002 <0.0005 0.001

QF-0261 04/01/2019	be hereby certify the above is correct as Melted and	s contained in the records of the corr rolled in the USA	PORATION	San S. S. Sullar
a 0201 04/01/2019	1-800-777-0950 M	TR INC INCUTRIESON/COR.COM	NUCOR QUALITY ASSURANCE	
	1 000 111 0550 11	IN THO THEOTHERSMOOTH FOLL		

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

HARDNESS:

STEEL SUPPLIER	HEAT#	С	Mn	Р	S	SPEC:	RC38-45
ARCELORMITTAL	9515612	0.29	1.19	0.025	0.002	ACTUAL:	41 - 42
ARCELORMITTAL	9514538	0.31	1.21	0.011	0.003	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 Groesback Highwa Warren, Michigan 48089 (586)773-2700 * Par (56 www.PrestigeStamping.c	- 16) 7732298	PRODUCT CE CERTIFICATION 184	N NUMBER
	. • .		1) 	
THIS IS TO CERTIFY THE ORDER AS INDICATED AN				
Customer:	ROCKFORD BOLT AND 126 MILL ST ROCKFORD, 1L 6110		• **: •*	-
Customer Part: Prestige Part: Part Mame: Purchase Ordar: Shipment BOL: Shipment ID: Quantity: Manufacturers Marking:	P1480HP200 3/4*F436 M/G P38393 B210774 A0227178 4000	Grade: Lot: Beat Carbon: Manganase Phosphorous: Sulfur:	HORIZON STEEL CO. : CF436 GRADE STEEL : D5831 : 9515612 : .29 (.2257) : 1.19 (.6 - 1.6) : .025 (.04 Max.) : .002 (.05 Max.) : .23 (.15 Min.)	У П.
SPECIFICATIONS		TEST RESULTS	•	
HARDNESS: TEST METH HRC 38 - 45 CHECK TO ASTM F6		HARDNESS: HRC 41 -	42	
	· .	·	×	
PLATING: TEST METH 0.0022" Min. MECH GALV TO ASTI CLASS 55 TYPE 1		PLATING: 0.0022* - 0),0030" <u>.</u>	· ix
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USS/BAIL LC Washing are manufactured to the requ	itemants of ASTM F844 epacifications			
Chemistry is an reported from new material carding This product was produced under an 180/TB 16946 180/TS 16945 Carlification No: 0062933.	tion and close not fail Linder Presige St Quality Assumme Bystem.	amplag's accreditation.	AD,	4
Material was malled and manufactured in the U.S.A This product was manufactured in Warren, Michiga This product conforms to all memirements for wash	NUBA.	P-896-19.	- Xel	
Bampling Plan per P.S.I W.L. # 5.4.18.015, The test results only apply to the items tested.			FRAMK SCHUBER Quality Assurance	
This test report must not be reproduced ascept in A Majorials used to manufacture these products are as		i ≋		
Product in Rolls compliant. No weld repetts made to material. All cartified product is AIS compliant.		×		12
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50390 UT	ICA DRIVE	140948					OESBECK HWY. MI 48090			3513 GR			HWAY	
Phone: (5)	65) 532-213	MF:48315 5 Fect (586) 586-	3116	· · · ,		rupuzru,	NH HONAD		1.1	VARREN	i, mi 4 80	90		
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Chemist	ry Heat)	lumber 95158	112					-						
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Cr: 0.0300	Ti: 0.0			0.0020 0.0100	Si: 0.230 Ce:0.001	-	B: .0000*	Sn: 0.0120	V: 0.	.0040	31			
Cr: 0.0300 Tag No		020 N: 0.00		0.0100	Ca:0.001	-	B: .0000*	Sn: 0.0120 Yield			Ř-	N	Test	Pull
Tag No	Ti: '0.0 Product	020 N: 0.00)38 Mod Width		Cec0.001	5 . Rb	B: .0000*	Sn: 0.0120 Yield	V: 0. Mpa	Elong	31		Test Method	
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TR No. 612061-08-01

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	orizon Steel Co. DRIVE MISHIP, MI 48315 532-2135 Fact (586) 56	8-3116	VILL TO: PRESTIGE STAMPING 23513 GROESBECK HWY. WARREN, MI 48090	SHIP TO: PREST PRES 29513 GROESBED WARREN, MI 4909	
BOL# 6136 Ship Data: 4			32		•
	PHSLA .122 MIN	5.5000	5,380 92		N/A
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order.

Chaire C

Mary Claire Colina Quality Assurance

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ArcelorMilital Cleveland Flat Carbon Cleveland, OH 44115

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

Dear Jim,

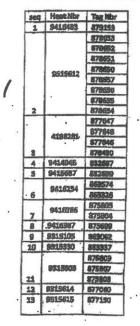
December 5, 2017

ArcelorMittal

I have reviewed our records and have confirmed that the following colls were manufactured from heats that were "melta/amolited" at the Cleveland Facility.

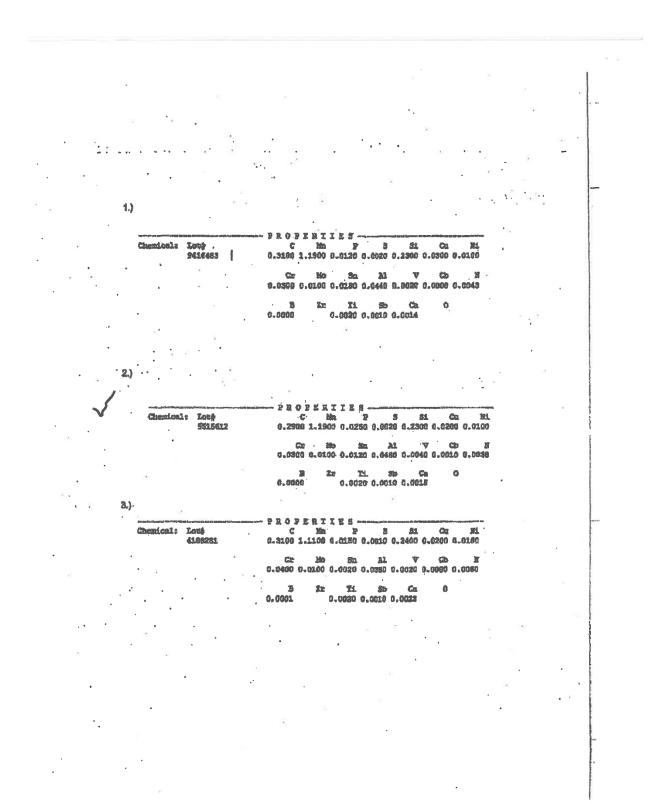
The heat numbers and the relating colls are stated below:

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TR No. 612061-08-01

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Prestige Stamping, Inc.	23513 Grossbeck Highway Warren, Michigan 48089 (586)773-2700 * Far (88 www.PrestigeStamping.co	(16) 773-2298 an		ION NUMBER	
	E PRODUCT STATED BEL				
Customer	ROCKFORD BOLT AND 126 MILL ST ROCKFORD, IL 6110			2	
Purchase Order Shipment BOI Shipment II	:: P1480HP200 :: 3/4"F436 M/G :: P38393 :: B210774 :: A0227178 :: 16000	Grade : Lot : Neat : Carbon : Manganese : Phosphorous : Sulfur :	HORIZON STEEL CO CF436 GRADE STEE D5811 9514538 .31 (.2257) 1.21 (.6 - 1.6) .011 (.04 Maz.) .003 (.05 Maz.) .24 (.15 Min.)		7
SPECIFICATIONS	•	TEST RESULTS			
HARDNESS: TEST ME HRC 38 - 45 CHECK TO ASTM F		HARDNESS: HRC 41 - 4	12	· : 、	
PLATING: TEST MET 0.0022" Min. MECH GALV TO AS CLASS 55 TYPE 1	IM B695	PLATING: 0.0022" - 0.	0030 ^{#.}		
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50390 UT	ICA DRIVE			•			SBECK HWY.			23513 GR	OESBE	CK HIGH		
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	ESC: HRPC) F436 GRADE lumber 951	4538	1FG IN USA	4*		Cu: 0.0400	AL 0.0420		0.0020	NE 0.0	1800	Nb/CE:0	0000*
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Quality Assurance

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TR No. 612061-08-01

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

P39299 R73245

CUSTOMER PO: 21451

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

LOT#:

PRESTIGE STAMPING: D7506

SPECIFICATION: ASTM SPECIFICATION F436-10 FOR HARDENED WASHERS

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

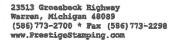
MECHANICAL GALV-PLATING: 120029-35

	CHEMICAL COMPOS	ITION				HARDN	ESS:
STEEL SUPPLIER	HEAT#	С	Mn	Р	S	SPEC:	HRC 38-45
STEEL DYNAMICS	21933130	0.52	0.7	0.011	0.001	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



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 Part Name: 3/4"F436 M/G Grade: CF436 GRADE STEEL Lot: D8936 Heat: 21933130 Purchase Order: P39299 Shipment BOL: B32295 Shipment BOL: B224643 Shipment ID: A0244690 Quantity: 20000 Manufacturers Marking: "P" Carbon: .52 Manganese: .70 Phosphorous: .011 Sulfur: .001 Silicon: .23 TEST RESULTS **SPECIFICATIONS** 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" ١ USS/SAE LC Weeham are manufactured to the requirements of ASTM F844 specifications Chamterry is as caported from raw matanial certification and does not fail under Prestige Stamping's scor This product was produced under an IAIP* 16849 Quality Assumance System. LAT* 16849 Certification Not: 800334. Material was meter and manufactured in the U.B.A. This product was manufactured in the U.B.A. This product conforms to all requirements for weaking as produced according to A.S.T.M. P-438-13. Sampling Plan per P.A.I.WJ. # S.4.15.015. The text meeting active active the harmon texted FRAME SCHUBERT The test report inust not be reproduced except in full without prior written approval. This test report inust not be reproduced except in full without prior written approval. Materiale used to menufacture these products are mercury, essestee and radio activity free. Quality Assurance Manager Product is RoHS compliant. No weld repelto mede to material. All centified product is AB compliant. R73245 02/28/20 CTHO PAGE 1 of 1 Econ Information System 14:17

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TR No. 612061-08-01

Birmingham Fastener Manufacturing

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

Pg 1 of 1

Certificate of Compliance

Customer :	AMERICAN TIMBER	<i>BFM</i> # :	1628407
P.O. #:	20512	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



TEST REPORT

 Cust PO
 6225994

 Lot Nbr
 799283

 Quantity
 18000

 Mfg Date
 02-26-18

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

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

	PA	RT INFORMATION
Part Number	75CNDHF/D	Finish PLAIN
Description	A563 DH3 HV 3/4-10 ASME B18.2.2 HEAVY HEX NUT MADE IN USA	Head Marking LE DH3 USA

- ANGER AND AND		RAWN	ATER	IAL ANALYSIS	3		Salah Basher Salah S
Steel Heat Nbr	Steel Supplier	Steel Grade	Code	Element	Rqd Min Pct	Rqd Max Pct	Percent
GER75068613-26	GERDAU MACSTEEL ING	C 4140 MOD	С	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

			MECH	ANICAL	PROPER
Wedge Angle					
Proof Load 58450	/175000 (lbs/Psi)	Q			
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



TEST REPORT

Operations Center 3281 West County Road 0 NS Frankfort, IN 46041-6966 T 765 654 0477 F. 765.654.0857



Applicable Standards, Specifications, and Sampling Schemes:

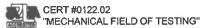
Test methods in accordance to ASTMF606/ISO 898-1 where applicable.Sampling plan in accordance to ASTM F1470. Thread fit and dimensional properties are compliant to ASME B18.2.1. Mechanical properties are according to SAE J429 or ISO 898-1 were applicable. Bolts passed a surface discontinuity inspection 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.

Iditional Information None

This lot has been found to conform to the requirements of the above standards and specifications

We certify The product furnished by Fonlane Fasteners, Inc. was manufactured, sempled, tested, and inspected in accordance with the standards and specifications listed above and with Fonlane ^{Resteners,} Inc. Quality Manual in effect as of the date of manufacture. The above data accurately represents values provided by Fonlane Fasteners. Inc. suppliers and/or values generated in one of Fonlane Fasteners, Inc. 2014 accredited tabove. This document may only be reproduced unaltered and may not be used for sny purpose other than the purpose of certifying the same or leaser suparity of the product specified herein. Reprovident on used of this document for any other purpose is prohibid, exceeding taboved on altered above. This document may only the reproduce the semplest provided in the refraction of normal fasteners, inc. 2014 and the purpose other than the purpose of certifying the same or leaser mainty of the product specified herein. Reprovident may any other purpose is prohibid, exceeding taboved and the semple set provided in the refraction of normal Fasteners, inc. Tables are the provided in the semple tested above. This document for any other purpose is prohibid, exceeding taboved and the semple set provided in the refraction of normal Fasteners, inc. Tables are the provided in the test and the set of the s particular purpose,

Quality Management System including Test Reports managed by: Josh Lowery - Quality Supervisor, Fontana Fasteners Inc.





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GERDAU SPECIAL STEEL NORTH AMERICA 5591 MORRILL ROAD JACKSON, MICHIGAN 49201

CERTIFIED MATERIAL TEST REPORT

				A second s
CUSTOMER ORDER NUMBER	CUSTONER PART NUMBER	HEAT NUMBER	WORK ORDER NUMBER	DATE
130651	95B223700A4	75068613	313378 101	9/25/17
		210mm Bil]	let	
REPORT TO		SEIP	то	
ACUMENT GLOBAI	TECH.	FONTANA FAST	TENERS INC-MFG	
DBA: FONTANA H	FASTENERS	3281 W COUNT	FY RD 0 NS	
3281 W COUNTRY	RD 0 NS			

FRANKFORT , IN 46041

FRANKFORT , IN 46041

	ORDERED	
grade 4140 MOD	SIEB 37.MM RND	20'
CHEMISTRY ONLY: AST	CUSTOMER SPECIFICATIONS	4-15 GRADE 2H
	CHEMICAL ANALYSIS	
C Mn H	S Si Ni C	Cr Mo Cu Sn Al
0,42 0.95 0.0	011 0.006 0.19 0.24 0.5	3 0.20 0.23 0.009 0.020
V Nb		
0.002 0.003		
HYDROGEN = 1.7 ppr	α	
GRAIN SIZE	SPECIFICATION ASTM E112 GRAIN	ISIZE 5-8
REDUCTION RATIO		
RATIO= 40.8 TO	L.O	
ARC FURNACE AND (BEEN REPAIRED BY TO MERCURY OR TO TEMPERATURES DURIN GERDAU MONITORS AND	TED AND MANUFACTURED IN THE U CONTINUOUS CASTING METHOD. T WELDING AND THIS MATERIAL ANY OTHER METAL ALLOY THAT NG PROCESSING OR WHILE IN OUR LL INCOMING SCRAP AND ALL HEA ARE FREE OF RADIOACTIVE MATER	THE PRODUCT HAS NOT HAS NOT BEEN EXPOSED IS LIQUID AT AMBIENT POSSESSION. ATS OF STEEL TO ENSURE THAT
PAGE 1 OF 1 We certify that ther Gerdau Monroe	e data are correct and in complia	ance with specified requirements.
3000 East Front Street Monroe, MI 48161		- Patrick Doyle 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#: 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

HARDNESS:

MILL	GRADE	HEAT#	C	Mn	Р	S	Si		
GERDAU	1045	75070667	.45	.77	.010	.035	.21	SPEC: ACTUAL:	24-38 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.

	v	UNYTI			Unytite, inc. One Unytite Drive Peru, IL 61354 USA Tel 815-224-2221 Fax 815-224-3434		·	•	Cus	tome	r Ship	per
Bill	-	126 Roc	Mili kford	St. I, IL 611	nd Steel Co. 101 nd Steel Co.	8	Ship	per No:	70061			
					10 10	·	5	Ship Date:	7/31/19			
								Carrier:	Customer Advis	e .		
		•					٦	Frailer No:				
					۰.	Shipping	g Tra	cking No:				
						1	Freig	ht Tenns:	Collect	•		
							Clas	s or Rate:	50			
			_	5		2		Pallets:	23			
Cust PO	Rel	Customer Part No	Rev		Part Name	Part No	Rev	Lot No.	Containers	Ship Qty	Net	Gross
38828	12		-			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
38836	12	V .		ASTM A	563 Heavy Hex Nut, H, Hot Dipped Galv,	A563 3/4-10 +0.020 DH HHN HDG BLUE DYE		30836- 75070667 (27)	(27) Keg (Can w/iid)	27,000	4,860 lbs	4,957
Total:		X			in di second			·····	207 Containers	206,837	35,252 lbs	36,704
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Cust	omer Part				and the second s						
Cus	tomer PO	No: P38	836						Ship	ped Qty:	
	Lot Num	ber: 308	36-75070667	,			,			•	
		and and a second									
		hankaa ja					College of the				1200
	Part	No: A56	3 3/4-10 +0.0	20 DH H	HN HDG BLU	EDYE					m
		141									
	Descript			vy Hex Ni	ut, Grade DH,	Hot Dipped					- Harden and Barrier
		Gar	r, Blue Dye	-							
Manufactu	ured Quan	tity: 37,7	39	nandi mane							wind blant to the
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SME B1.1					2003	ASME B				2015	
STM F232	the second state of the se	and the second		Annual 19	2011	ASTM A	563 506/606M			2015	
STM F812					2017					1010	
St Result	Mar III			an an				end sale quar			
BBI NO: 2017	1	1.	chanical Prope Comporing Ter		Bro	of Load	Chana	& Dimension	Thread	Precision	Visual AS
		/LIDCN	degree F I			ASTM Min LBS)		E B18.2.2		B18.1.1	F812
Description	Hardnoss	(ano)			5	0,100		Pass	P	888	Pass
	Hardness 29,		1,193								
Description Sample Inspection	29,	05				en kensami vit		118			
Sample Inspection Heat No	29,	05 Manufactur Gerdau Spec Steel Norf	ir Origin	C 0.4500	No	0.010	\$ 0.0350	81 0.2100	0.1600	NI 0.1100	Ctal 0,2000
Description Sample Inspection	29,4 Grade	05	ir Origin	C	No	P	8			N) 0.1100	Cu 0.2000
Sample Inspection Heat No 75070657	29,1 Grade 1048	Manufactur Gerdau Spec Steel Norf America	er Origin Iel USA	C 0.4500	Nn 0.7700	P	8 0,0350	SI 0.2100	0.1800		
Description Sample Inspection Heat No 75070857 fests are in e samples to	29,0 Grade 1045 ACCordance	05 Gerdau Spec Steel North America with the Jal	est revisions of	C 0.4500 f the methors scribed/list	Nn 0.7700 ods prescribed	0.010	8 0,0950 SAE and AS	84 0.2100 STM Specificat	0.1800 tions .	0,1100	0.2000
Description Sample Inspection Heat No 75070657 fests are in e samples to formed in th	29,0 Grade 1045 ACCordance	05 Gerdau Spec Steel North America with the Jal	est revisions of	C 0.4500 f the methors scribed/list	Nn 0.7700 ods prescribed	0.010	8 0,0950 SAE and AS	84 0.2100 STM Specificat	0.1800 tions .	0,1100	0.2000
Description Sample Inspection Heat No 75070857 fests are in e samples to formed in th oducts.	29, Grade 1048 ACCordance ested confor te productio	Menufactur Gerdau Spec Steel North America with the Jai m the spec n of the pro	est revisions of fications as de ducts. No heat	C 0.4500 f the metho recribed/list s to which	ods prescribed bienuth, Seler	0.010	6 0.0350 SAE and AS d free of m Lead was	SI 0.2100 STM Specifical ercury contam intentionally a	0.1800 tions .	0,1100	0.2000
Description Sample Inspection Reat No 76070657 tests are in e samples to formed in th dducts. e steel was in a cartify that	Grade 1045 accordance asted confor re production melted and in this data is	Manufactur Gerdau Spec Steal Norf Americe with the Jal m the spec n of the pro manufactur true reprea	est revisions or iffcations as de ducte. No heat ad in the U.S.A	c 0.4500 f the metho recribed/list s to which a and the p	Ne 0.7700 Dods prescribed ted above and Bismuth, Seler product was ma povided by the m	P 0.010 In the applicable S were manufacture- ium, Tellunium, or inufactured and te naterial supplier an	8 0,0950 SAE and AS d free of m Lead was sted in the	31 0.2100 STM Specificat ercury contam intentionally au U.S.A.	0.1880 Lions . Ination and t	0,1100 here is no w cen used to	0.2000 elding produce
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Description Sample Inspection Heat No F5070807 feets are in e samples to fformed in th ducts. e steel was a certify that	29, Grade 1045 accordance ested confor te production melted and in this data is the items lis	05 Menufacture Gerdau Spec Steel North America with the lat on the spec on of the pro- manufacture true represe- ted on the	est revisions or iffcations as de ducte. No heat ad in the U.S.A	c 0.4500 f the metho recribed/list s to which a and the p	Ne 0.7700 Dods prescribed ted above and Bismuth, Seler product was ma povided by the m	P 0.010 In the applicable S were manufacture- ium, Tellunium, or inufactured and te naterial supplier an	8 0,0950 SAE and AS d free of m Lead was sted in the	31 0.2100 STM Specificat ercury contam intentionally au U.S.A.	0.1880 Lions . Ination and t	0,1100 here is no w cen used to	o.2000 elding produce



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GERDAU SPECIAL STEEL NORTH AMERICA 5591 MORRILL ROAD JACKSON, MICHIGAN 49201

CERTIFIED MATERIAL TEST REPORT

CUSTOKER ORDER NUMBER	CUSTONER PART MUNPER	RBAT MONDER	WORK ORDER MONBER	DATE
P007419~2	B1045SC1.0000	75070667	319128 102	5/03/18
		210mm Bill	.et	
REPORT TO	*	SHIP	TO	
UNYTITE INC		UNYTITE, INC	3	
ONE UNYTITE DR	IVE	LASALLE PLAN	гг	

PERU , IL 61354-9710

325 CIVIC RD LASALLE , IL 61301

Outs 1" RND 24' 10 1/2" CONTRACT AND 1021 DATED 9/28/06 CHEMICAL ANALYSIS CHEMICAL ANALYSIS C Mn P S Si Ni Cr Mo Cu Sn A1 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 SPECIFICATION ASTM E112 FINE GRAIN 5-8 MICROCLEANLINESS SPECIFICATION ASTM E45 METH A A B C D AVERAGE 2.4 0.2 1.0 0.0 0.2 0.0 0.6 0.2 MACROSTRUCTURAL TEST PER A STM B St C D A A A A A A A A A A A A A B C D D D D D D D D D D<				0	RDERED				-	
OUTCOME #FEGE/CONTONE 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 A A S R C D T A A C D T T T T T T T T T T T T T T T		08	11	SIES	DI	-	-			
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GRAIN SIZE SPECIFICATION ASTM E112 FINE GRAIN 5-8 MICROCLEANLINESS SPECIFICATION ASTM E45 METH A A B C D T H T H T AVERAGE 2.4 0.2 1.0 0.0 0.2 0.0 0.6 0.2 MACROSTRUCTURAL TEST PER - ASTM E381 FRONT 1 1 1 MIDDLE 1 1 1	0.056	0.000								
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GERDAU SPECIAL STEEL NORTH AMERICA 5591 MORRILL ROAD JACKSON, MICHIGAN 49201

CERTIFIED MATERIAL TEST REPORT

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COSTORES AND ALLER MUNICIPAL	CUSTONIE PART NUMBER B1045SC1.0000	75070667	MORE ORDER AUGUST	5/03/18
		210mm Bil]	let	
REPORT TO		âHTP	10	
UNYTITE INC		UNYTITE, INC	2	
ONE UNYTITE DE	RIVE	LASALLE PLAN	T	

ONE UNYTITE DRIVE

PERU , IL 61354-9710

325 CIVIC RD LASALLE , IL 61301

		ORDERED	- 17 	
1045	1"	RND	24' 10 1/2"	
SAE 1045; ASTM E381	-17; RMS 021	CUSIONER SPECIFICATIONS DATED 9/28/06		
BACK 1 1	-		• =	
	PECIFICATION .			
F	TOTAL= 0.0	10		
REDUCTION RATIO				
RATIO= 86.7 TO 1	.0			
RESIDUAL MAX S	PECIFICATION	RMS 021		
Ni+Cr = 0.2690				
ARC FURNACE AND CO BEEN REPAIRED BY TO MERCURY OR TO A TEMPERATURES DURING	ONTINUOUS CAS WELDING AND ANY OTHER ME G PROCESSING AND ALL HEAT	TING METHOD. TH THIS MATERIAL TAL ALLOY THAT OR WHILE IN OUR S OF STEEL TO EN	S.A. BY THE ELECTRIC HE PRODUCT HAS NOT HAS NOT BEEN EXPOSED IS LIQUID AT AMBIENT POSSESSION. GERDAU MONITORS NSURE THAT PRODUCTS SHIPPED 100% RECYCLABLE.	
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PAGE 2 OF 2	a a seguritation		Dr. 1 A stranger	
			1 and Configure association	111

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 21451

CUSTOMER PO:

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

								HARDN	ESS:
MILL	GRADE	HEAT#	С	Mn	P	S	Si		
GERDAU	1045	62150514	.45	.72	.014	.014	.23	SPEC: ACTUAL:	24-38 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.

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STM F2329						2015		the second second second	F606/606M	<u> </u>		2016	
Description	Hardness	1	Tempe	ring Te	mp (800	Proof Los	d (Pa	ASTM		Dimension	Thread P		Visuel ASTM
Sample	29.		de	gree F 1,139		. N	lin LBS) 60,100			B18.2.2	ASME I	318.1.1	F812.
Inspection												15 1 1 1 1	Caroo .
Heat No 62150514	Oresta 1045	American American		nigin JGA	0,4600	0,720		P.014	<u>s</u> . 0.0140	0.2200	0.1700.	0.0800	0.2300
tests are in a	cordance	with the la	test.revis	sions of	the metho	de prescribe	d in the	applicable	B SAE and A	STM Specific	tions.		
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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

								HARDN	ESS:
MILL	GRADE	HEAT#	С	Mn	Р	S	Si	0)0	
GERDAU	1045	75078628	.44	.74	.006	.029	.24	SPEC: ACTUAL:	24-38 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.

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Cust PO	Rel	Customer Part No	Rev	Part Name		Part No	Rev	Lot No.	Containers	Ship Qty	Nét	Gross
9289	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
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LI3 bject	nature 194 to Uny te with	tite Inc, S	tand	lard Terms and Condition	ons -	Packing Slip of Sale, Documen	t Nur	nber 13-002	, dated 08-09-	06. Doc	ument is	subjec

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	Lot Num	ber: 32	205-7	5078628						•		
	Part	No: A5	63 3/4	4-10 +0.02	און אים מי	IN HOG BLL	IE DYE			Contractor Station (193		AND AND A DESIGN OF THE
		110, 70	00 014	-10 -0.06								
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ASME B18.2	6				and the second second second	2019	Contraction of the local division of the loc	V A563			2015	
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	and an and the second		ANTONIA			2011 2003251407/1	CHERREN CONTRACT		NSHIRR HEADOLE	·····································		
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Description	Hardness		The other Designation of the local division of the local divisiono	pering Ten degree F I	np (800		(Pass ASTI		Dimension B18.2.2	Thread P ASME E		Visual ASTM F812
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All tests are in a	scordance	with the	atest re	evisions of i	the metho	ds prescribed	in the applica	ble SAE and /	STM Specific	stions.		
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We certify that t	his data is i	rue repre	sentati	ion of inform	nation prov	vided by the m	naterial suppli	er and our tes	ing laboratory.	This certified	material te	st report
relates only to the	ne items lis	ted on thi	s docur	ment and m	ay not be	raproduced a	xcept in full.					
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										FIEX 0/20/2	U 10:00 AN	t cthorsen Page



GERDAU SPECIAL STEEL NORTH AMERICA 5591 MORRILL ROAD JACKSON, MICHIGAN 49201 USA

CERTIFIED MATERIAL TEST REPORT

OUSTOMER ORDER WIMBER	CUSTOMER PARTNUMBER	HEAT NUMBER	WORK ORDER MARLER	DATE
P008846	B1045SC1.0000	75078628	334801 101	1/28/20
		240mm Bloom	a	
REPORT TO	୍	SHIP TO	242	
UNYTITE INC	• •	UNYTITE, INC		
ONE UNYTITE DR	LIVE	LASALLE PLANT		
		325 CIVIC RD	2 2	
PERU , IL 6135	4-9710		61301	

production of the second state of the second s	URDERED	
ORADE	8028	LENGTH
1045	1" RND	24' 10 1/2"
	CUSTOMER SPECIFICATIONS	- les les
SAR 1045; ASTM 8381	1-17; RMS 021 REV 3 DATED)9/17/19
BACK 1 1	1	4 ³⁶
	-	
DECARB	SPECIFICATION ASTM E1077	RMS 021 REV 3
F	TOTAL= 0.009	
REDUCTION RATIO S	SPECIFICATION RMS 021 REV :	
RATIO= 113.7 TO 1		1
RATIO 113.7 10 1		
RESIDUAL MAX	SPECIFICATION RMS 021 REV	
		¥ 8
Ni+Cr = 0.1630		
ARC FURNACE AND O BEEN REPAIRED BY TO MERCURY OR TO TEMPERATURES DURIN ALL INCOMING SCRAI	IG PROCESSING OR WHILE IN (THE PRODUCT HAS NOT AL HAS NOT BEEN EXPOSED HAT IS LIQUID AT AMBIENT OUR POSSESSION. GERDAU MONITORS DENSURE THAT PRODUCTS SHIPPED
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PAGE 2 OF 2		1
	hat these data are correct and in complia	nce with apecified requirements.
Gerdau Monros		
3000 East Front Street		Patrick Dayle
Monroe, MI 48181		Talla Dayle Pat.Doyle@Gerdus.com
MINING 1111 40 10 1		Quality Assurance Re

Invoice No. 929064 Bill of Lading 358705 Customer No. 4429				ATO STE ALLE, AR 72			100% All Shaj killed a	pes p	roduce	nd Ma ad by N	anu Nuco	factu		n V.S	A.	llos br	ed to a	fully								
Customer P.O 116882]							Dat	te	20	018-:	12-11														
S CONTRACTORS STEEL CO 36555 AMRHEIN RD. LIVONIA MI 48150 USA				S H P T O	CONTRA 48649 SI BELLEVII USA	CHOONE	er dr.	OMP	ANY					A	STM A9 STM A7 STM A7 SA G40. STM A6	09/A70 09/A70 21-13	9M-15 9M-15 50WM (GR50 GR50S	(345) (3455)	GR50-:	IS					
					Mecha	inical Pro	operties											Chem	ical Pro	perties	_					
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			Ratio	MPa	MPa	8	°C	+	101	-	-															
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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 IN Perm= C+Si/30+Min/20+Cu/20+Ni Corrosion Index= 26.01(%Cu)+3, 3.10(%NI)(%P)-33.39(%Cu)+2 ISO 9001:2015 certified (Registra	/60+Cr/2/ 88(%Ni)+	0+Ma/15+1 1.2(%Cr)+1				%NI]-			ARBON Mercury This mat	has no	ot be	en use	d in the	direct	manuf	cturin	g of this	mater		lity Ma	nual.				1	
All mechanical testing is perform The Charpy machine striker geor	ed by the	Quality Te	esting Lab -Yamato	, which is in Steel is the 8	dependent 8 mm (0.31	t of the p LS")strike	eroductio er (KV ₈) (on de per A	partme STM A3	nts. 170 Sec	tion	22.1.2	and ISC) 148-1	Section	7.3.										
I hereby certify that the contern correct. All test results and oper manufacturer are in compliance material specifications, and whe meet the applicable coeffective	s of this r ations per with the n designa	eport are a formed by requirement	this mate	nd :rial	Jany						Sta Col	te of A unty of	rkansa: Mississ and sub	i ippl			/	81	ANA	Ŷ	١					

meet the applicable specifications.

× 1 Chief Metallurgist

on 2018-12-11 Julicial Hu Rider My commission expires on 07/17/2023

NOTARY PUBLIC



METALLURGICAL TEST REPORT

3

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>>>>> CERTIFICATE OF ANALYSIS AND TESTS	<<<<<
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Sold To: AMERICAN TIMBER AND STEEL 4832 PLANK RD. NORWALK, OH 44857

>

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

614083 - 01 FORRAI, HALLIE (11855)		983730	Release: Cus Ord #:	2 21885	Date: 20-May-2020
			Cus Name:	AMERICAN	TIMBER AND STEEL
Desc	cription	of Materia	and Specif	ication	

Hot Rolled Sheet A606/606 .375IN x 48IN x 192IN	TAG	#: 2 1	7719329
	HEA	F#: :	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>

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YIELD STRENGTH	MIN:	60800	PSI	MAX	00000 0	
TENOV E OTOENOTO		00000	1.01	IVIAA	60800 P	SI
TENSILE STRENGTH	MIN:	76100	PSI	MAX	76100 P	
ELONGATION 2"				110.01	70100 P	31
ECONDATION 2	MIN:	34	%	MAX	34 %	<u></u>

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

Dianna homeny

Branch Certification Manager

20-May-2020 4:44 AM Page 1 of 2

USER: REPORTS@SEMSP01 REPORT: ST_MSR_OSI

TR No. 612061-08-01

Birmingham Fastener Manufacturing

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

Pg 1 of 1

Plain

Certificate of Compliance

Customer :	AMERICAN TIMBER			<i>BFM</i> # :	1579744
P.O. #:	19191		Da	te Shipped :	5/10/2019
Item Quantity	Description	Lot #	Heat #	Specification	Finish

92212

DL18104710

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.

5/8"-11 x 12" Carriage Bolt

14

Signed:

519

1

Date: 06/05/2020

ASTM A242

Cody Calvert

NUCOR
NUCOR CORPORATION
NUCOR STEEL SOUTH CAROLINA

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

Mill Certification 4/23/2019

MTR #: C1-466062 300 Steel Mill Road DARLINGTON, SC 29540 (843) 393-5841 Fax: (843) 395-8701

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	and the second	Customer Part #	

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 0.15%	Mn 0.90%	V 0.0120%	Si 0.18%	S 0.028%	P 0.014%	Cu 0.32%	Cr 0.79%	Ni 0.26%	Mo 0.026%	Cb 0.003%
Roll Date: 7	19/2018	n (1) i generali i na materia agenerali (1) generali i na materia (1) generali (1) generali (1)								
Yield 1: 52,0	00psi			Tensile	1: 82,000psi			Ek	ongation: 23%	in 8°(% in 203.3mm)
Elongation: 3	35% in 2"(%	in 50.8mm)		Yield 2:	52,000psi			Te	ensile 2: 83,00	Opsi
Elonoation 2	2% in 8"(%	in 203.3mm)		Elongat	ion: 34% in 2	"(% in 50.8m	m) - test2			

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

H Alm

James H. Blew **Division Metallurgist**

Page 1 of 3

NBMG-10 October 1, 2017

Birmingham Fastener Manufacturing

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

Pg 1 of 1

Plain

Certificate of Compliance

Cusi	tomer :	AMERICAN TIMBER			<i>BFM</i> # :	1628407
<i>P.O</i> .	#:	20512		Dai	te Shipped :	9/30/2019
Item	Quantity	Description	Lot #	Heat #	Specification	Finish

32361

10575880

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.

5/8"-11 x 4" Hex Lag Screw

Signed:

10,545

4

Date: 11/04/2019

AWWAC111

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

vember , 20 19

Approved SIGNATORY DATE

 \sim Official Seal Merry F Shane Notary Public State of Illinois My Commission Expires 10/03/2022 2

C	HAK					EMAIL		5		16	58 Cold Spr	ngs koi
CHARTER S	HAR									Sauku	ville, Wiscon	sin 5308
STEEL 3	TEEL										(262)	268-240
AD	vision of /										1-800	437-87
	ter Manufacturin	g Company, In	nc,								Fax (262)	268-25
eited in USA	Vlanufạctui	red in US	SA	CHA	RTER ST	TEEL TE	ST RE	PORT				
						Cust P.O.						P385
						omer Part #						1001
					Charter S	Sales Order Heat #)0885)5758
						Ship Lot #						15530
Rockfor	d Bolt & St	eel				Grade			A242	A SK FG IC		
126 Mill	St.					Process						HR
	d,IL-61101					Finish Size						.19
Kind At	in :Linda M	cComas				Ship date					02-	OCT
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The following statements are applicable to the material described on the front of this Test Report:

 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.

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 colls produced for this order.

4. The laboratory that generated the analytical or test results can be identified by the following key:

Certificate Number		Laborat	tory	Address
0358-01 7388 CSSM Charter Steel Melting Division		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
*	*	an dia	Subcontracted test performed by laborator	y 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.

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.



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

MECHANICAL PROPERTIES

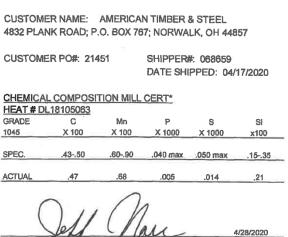
		LIVILO						
		PROOF						
	TENSILE	LOAD	HARDNESS					
SPEC .:	120,000 psi	85,000 psi	HRC 34 MAX					
ACTUAL:	133,200 psi 137,900 psi 135,600 psi	85,100 psi 85,100 psi 85,100 psi	27.40 28.25 27.73					

THESE PARTS CONFORM TO ABOVE SPECIFICATIONS.

Tension Testing: ASTM F606 Proof Load Testing: ASTM F606 Hardness Testing: ASTM F606 WE HEREBY CERTIFY THE AGOVE BOLTS HAVE BEEN MANUFACTURED BY ROCKFORD BOLT & STEEL IN OUR FACILITY IN ROCKFORD, ILLINGING WITH MATERIAL, WHICH WAS WELTED AND MANUFACTURED IN U.S.A. WE FURTHER CERTIFY THAT THEIR SA TURE REPRESENTATION OF INFORMATION PROVIDED BY THE MATERIALS SUPPLIER AND THAT OUR PROCEDURES FOR THE CONTROL OF PRODUCT QUALITY MEET OR EXCEED ALL APPLICABLE TEST, FROCESSES, AND INSPECTION REQUIREMENTS PRE THE ABOVE SPECIFICATION. THIS REPORT MAY NOT BE REPRODUCED EXCEPT IN FULL, WITHOUT THE WRITTEN APPROVAL OF ROCKFORD BOLT. THE REPORT MUST NOT BE USED BY THE CLENT TO CLAIM PRODUCT CERTIFICATION, APPROVAL, OR ENDORSEMENT BY INVLAP, NIST, OR ANY AGENCY OF THE U.S.GOVERNMENT.

APPROVED

"THIS INFORMATION IS NOT COVERED BY ROCKFORD BOLT AND STEEL'S NVLAP ACCREDITATION."



THIS REPORT CONTAINS DATA THAT WAS PRODUCED UNDER THE

Not ISO 17025 Accreditated

*Raw Mate G3 (GRAND BLANC) -ISO 9001:2015 #C2019-00846

FOLLOWING SUBCONTRACTORS:



DATE

PAGE 1 OF 1

NVLAP LAB CODE 200255-0

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	Alsip IL 60803	20			Ship Date		JA:22119	
	708-388-6300 F	ax 708-388-6467			Page	e:	1	
					Customer Phone	e: 248-	524-0192	
					Customer Fa	x: 248-	524-0406	
BILL	G3 Steel Group 1465 Brown Road Drien, MI 48359-2267 USA ATTN: Ron Nowak		S H I P	Rockford Bolt 125 Mill Street Rockford, IL 6 USA ATTN: Ron N	t 1101			
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CAROLINA	300 Steel Mill Road DARLINGTON, SC 2954 843-393-5841	Ø		Bill of Lading No.: 782750 Rev 0
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(348) 524-	0192	£.	Nođe :, Truck		Children, of min approach provident of traight and at provide charges.		
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THE COPPATION NUCOR CORFORATION NUCOR STEEL SOUTH CAROLINA

33 STEEL GROUP ATTN STEVE MABON 1455 BROWN ROAD ORION M148359-226 248) 524-0192 Fax. (248) 524-0408 N90 7 y

Mil Certification 4/8/2019



Ship To 33 STEEL GROUP 1485 BROWN RD ORION MI 46359 US

Customer P.O	IKE 38760	Sales Order	308549.1
Product Group	Rođ	Pari Number	32000625000DYAA
Grade	1045	tol# i	DL1810506303
Size	5/8" (.6250) Wire Rod	Heat #	DL18105063
Product	5/8" (:5250) Wire Rod Coil 1045CGP	B.L. Number	C1-782750
Description	1045CGP	Load Number	C1-454227
Customer Spec		Customer Pari #	

Roll Date: 311(2019 Malt Date: 7131/2016 Oty Shipped LBS: 46,771 Oty Shipped Pos: 11

Nett Date: 7/31/2018

C 0:47% Al 0.002%	Nn 0.58% B 0.0003%	P 0.005% N 0.9059%	S 0.01494 CRINCINO 0.81096	51 0.21%	 ò'0ë⊭04? ∧	Nii 0.08%	Cr 0.07%	Mp .0.017%	Ci2 0,14%	\$R 0.006%6	RD .0:009198
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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

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						.80965 H. Blew www.oo.Metailumusi				THUR "	4 ·
-94 ⁻¹¹	, n. ²³ 4	8								5	

-	Texas A&M Transportati Tansportati College Station. TX. 7784 Phone 970-848-6376] ality · Formo	3¶	Prepared by: Approved by:	.3-01 ·· Concret Sampling¤ Wanda L. · Menges¶ Darrell L. · Kuhn¤ Ground ¶	œ.	Doc. ·No.¶ ¶ QF·7.3-01¤ Revision: - 6¤	Issue Date: → ↓ 2018-06-18□ ↓ Page:¶ 1.of·1□
Project No:	612061-3 and 4	с	asting Date:	4/30/2020	Mix De	esign (psi):	4000 psi
Name of Technician Taking Sample	Tera	acon		Name of Technician Breaking Sample		Tera	con
Signature of Technician Taking Sample	Tera	acon		Signature of Technician Breaking Sample		Tera	con
Load No. Truck No. Ticket No.					ion (fro	m concrete	map)
T1	8162		6038645		1009	% of deck	
Load No.	Break Date	Су	linder Age	Total Load (lbs)	Bre	eak (psi)	Average
		See a	ttached Repo	orts from Terracon			

		- Le	CU	STOME	R'S COPY			TICI	KET NO.	
			N.A							
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	Martin	a	150		Freeway	1				
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TEST CYLINDER TA	KEN 🖸 YES	NO BY			DELIVER	Y OF THE	SE MATE	RIALS IS SUBJED	CT TO THE 1	ERMS AN
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ADDITIONAL WAT	TER ADDED TO	THIS CONCRE	TE WILL RI	EDUCE	SIGNATU	IRE ABO	VE.			
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		L.	11	Mar Carl	DRIVERNAME				DATE	
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5.00 CY	DS RS		CONT. HUS	72,408	5021		<u>8918</u>	9	1000 U.S. 10	
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SPECIAL DELIVERY INST SOLUTION 201 INTO RELL DANGER! MAY CAUS	RUCTIONS 8. RIGHT ISSTRAIGH		P. RIGHT	T ON H	50.94 no, RE	e LEFT	SALES	UNIT PRICE	AMOU	
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SPECIAL DELIVERY INST SOUTH 281 INTO RELL DANGER! MAY CAUS SEE WARNINGS ON SEE WARNINGS ON THUCK 8162 Load Size 5.00 OXD Raterial	RUCTIONS 8. RIGHT ISSTRAIGH SE ALKALI BURNS I REVERSE SIDE DELVA 745154 Mix Cod 8 ROZAGES	LEONARD RI T TO GATI	D, RIGHT E AND TH AND TH Anneu, A	T ON H EY WI Sp Ti 338645 OT 5 X Var	SODA NO, RE WY 47, LLMEET CKet N	LEFT YOU IN Age	SALES TOTA	UNIT PRICE	AMOU RM:	
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SPECIAL DELIVERY INST SOUTH 281 INTO RELL DANGER! MAY CAUS SEE WARNINGS ON SEE WARNINGS ON Atertal 155 3,496 5,000 AXD Atertal 175 3,496 5,400 Matertal 175 175 175 175 175 175 175 175 175 175	RUCTIONS 8, RIGHT ISSTRAIGH SE ALKALI BURNS I REVERSE SIDE DELVER REVERSE SIDE I ALS IS SIGN DE SIGN D	LEOMARD RI T TO GATI LEOMARD RI T TO GATI S. User also Reputred S. S. S. S. S. S. S. S. S. S. S. S. S.	D, RIGHT AND THE AND T	сон н не у мл то, егу у уат о, егу ч, егу егу ч, егу ч, егу есу с есу с есу с есу есу есу есу есу	SODA NO, RE WY 47, LLMEET Cket N Kotsin Rotan South	LEFT VOU	SALES TOTA OR OFFICE	UNIT PRICE	AMOU RM:	NT
SPECIAL DELIVERY INST SOUTH 281 INTO RELL CANGERI MAY CAUS SEE WARNINGS ON SEE WARNINGS ON SEE WARNINGS ON Into RELL CAUSE SEE SUBJECT SEE	RUCTIONS 8, RIGHT ISSTRAIGH SE ALKALI BURNS I REVERSE SIDE DELVER REVERSE SIDE I ALS IS SIGN DE SIGN D	LEOMARD RI T TO GATI LEOMARD RI T TO GATI S. User also Reputred S. S. S. S. S. S. S. S. S. S. S. S. S.	D, RIGHT AND THE AND T	сон н не у мл то, егу у уат о, егу ч, егу егу ч, егу ч, егу есу с есу с есу с есу есу есу есу есу	SODA NO, RE WY 47, LLMEET Cket N Kotsin Rotan South	LEFT VOU	SALES TOTA OR OFFICE	UNIT PRICE	AMOU RM:	NT

CONCRETE COMPRESSIVE STRENGTH TEST REPORT

Report Number: A1171057.0113 Service Date: 04/30/20 Report Date: 07/08/20 Revision 1 -Task: PO #612061



Client	Project								
Texas Transportation Institute	Riverside Campus								
Attn: Gary Gerke	Riverside Campus								
TTI Business Office	Bryan, TX								
3135 TAMU									
College Station, TX 77843-3135	Project Number: A1171057								
Material Information	Sample Information								
Specified Strength: 4,000 psi @ 28 days	Sample Date: 04/30/20 Sampl	e Time: 1145							

Specified Stre	ength:	4,000	psi @	28 days
Mix ID:	R9z40	625		
Supplier:	Martin	Marrie	ta	
Batch Time:	1050		Plant:	617
Truck No.:	8162		Ticket No.:	6038245

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.):		

Sample Date:	04/30/20	Sample Time:	114			
Sampled By:	Matcek, James					
Weather Conditions:	Sunny					
Accumulative Yards:	5.0	Batch Size (cy):	5			
Placement Method:	Direct Disc	harge				
Water Added Before (gal):	0	-				
Water Added After (gal):	0					
Sample Location:	Centerline					
Placement Location:	Merritt Par	kway				
		-				

Laboratory Test Data

Labo	ratory Te	st Data				Age at	Maximum	Compressive		
Set	Specimen	Avg Diam.	Area	Date	Date	Test	Load	Strength	Fracture	Tested
No.	ID	(in)	(sq in)	Received	Tested	(days)	(lbs)	(psi)	Type	By
1	A	6.01	28.37	05/01/20	06/01/20	32	136,210	4,800	3	SLS
1	В	6.01	28.37	05/01/20	06/01/20	32	142,080	5,010	1	SLS
1	С	6.01	28.37	05/01/20	06/01/20	32	138,130	4,870	2	SLS
						Aver	age (32 days)	4,890		
1	D			05/01/20		Hold				
Initial	Cure: Outsi	ide		Final C	ure: Field Cu	red				

Comments: Average compressive strength of 32 day cylinders complies with the specified strength.

Samples Made By: Terracon Obtain samples of fresh concrete at the placement locations (ASTM C 172), perform required field tests and cast, cure, and Services: test compressive strength samples (ASTM C 31, C 39, C 1231). Terracon Rep.: Matcek, James Start/Stop: 0945-1215 Reported To: Contractor: Report Distribution: **Reviewed By:** (1) Texas Transportation Institute, Gary Gerke (1) Terracon Consultants, Inc., Alex Dunigan, P.E. Alexander Dunigan (1) Texas Transportation Institute, Bill Griffith

Project Manager

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

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

CR0001, 11-16-12, Rev.6

Page 1 of 1

• Qua	3100 SH 47, Bidg-70011 College-Station, TX, 778431 Bryen, TX, 778071 Phone 979-845-03751 Quality Formo The information contained in this document is configuration.			3-01Concret Sampling¤ Vanda·LMenges¶ Darrell·LKuhn¤ Bround ¶	œ.	Doc. ·No.¶ ¶ <i>QF·7.3-01</i> □ Revision: ++ 6□	Issue Date: + 2018-06-18¤ Page:¶ 1 of 1¤		
Project No:	612061	с	asting Date:	5/22/2020	Mix De	esign (psi): <u>4</u>	000 psi		
Name of Technician Taking Sample	Terac	on		Name of Technician Breaking Sample		Terac	acon		
Signature of Technician Taking Sample	Terac	on		Signature of Technician Breaking Sample		Terac	on		
Load No.	Truck No.	Т	icket No.	Locat	ion (fro	om concrete i	nap)		
T1	8120	6	5080436	Anchor Block, Pa	arapet,	and terminal	Curb to barrier		
Load No.	Break Date	Су	linder Age	Total Load (lbs)	Bre	eak (psi)	Average		
	s	iee a	ttached Repo	orts from Terracon					

		-	CUSTOMER	'S COP	Y		TICKE	ſNO.
	Martin Marietta	1	So3 LBJ Suite Dallas, T	Freewa 400	ay		6.08.04	36
	70.100	ARRIVE JOB SITE	BEGIN PO		FINISH	POUR 1	LEAVE JOB SITE	ARRIVE PLANT
LOAD TIME	то јов 8:40	9:00	BEGIN FY	JUN	:			:
WATER ADDED ON JOB AT CUSTOMER'S REQUESTGAL. ALLOWABLE WATER (withheld from batch)GAL. TEST CYLINDER TAKEN IN YES INO BY CYLINDER TAKEN IN BEFORE IN AFTER WATER ADDITIONAL WATER ADDED TO THIS CONCRETE WILL REDUCE ITS STRENGTH. ANY WATER ADDED IN EXCESS OF SPECIFIED								
CUSTOMER NAME A	STOMER'S RISK.			CUSTOME	TRUCK 2 B120 AME AME R NUMBER 3195	ORDER NO.	SLUMP P.O. 5.0 302- 5/22 CUM. 0TY	DATE ORDERED OTY
LOAD QUANTITY	PRODUCT CODE DES	SCRIPTION		- Jan	4.00		UNIT PRICE	AMOUNT
	18, RIGHT LE					SALES	а тах	
DANGER! MAY CA	USE ALKALI BURNS.	TO GATE AND	THEY W	ILLME.		TOT		M.
SEE WARNINGS (ON REVERSE SIDE.		An and			FOR OFFICE	E USE ONLY FOR	<u>vi.</u>
Load Biz 4.00 CV Material 1"R6 378"P6 5RMD-1 CMT-1/II FLYMSH-C H20 1Y-610	1463 10 585 394 16 157 131 16 52 250 16 67 16 62 7	Returned mired Batched 8 1b 5260 8 1b 2200 1b 5260 1b 2 1b 5880 1b 525 1b 5 1b 525 5 1b 568 9 62 80	Ott y x Var + 0.625 -1.475 0.485 0.895 0.195 -1.055 1.525	s. 801 0.30 0.299 4.10	Mix Ag sture Ac M M M	e 50 D tual Vat 2 gl 1 gl 29 gl 80 gl	eq Load 84327	
Actual Load Total: Slump: 5.00	Num Batches: 1 15928 16 Desi In # Water in T	gn 0.476 Hater/Eemer ruck: 0.0 gl Adju	nt 0.473 T et Mater: 0.	0 gl /	esign 119.8 Load Trim	gl Nater: -1.9	Actual 111.5 gl 9 gl/ CYD	To Addi 8.3 gr

CONCRETE COMPRESSIVE STRENGTH TEST REPORT

Report Number:	A1171057.0118
Service Date:	05/22/20
Report Date:	05/22/20
Task:	PO #612061

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

Client			Project						
Texas Transportation Inst	titute		Riverside Campus						
Attn: Gary Gerke			Riverside Campus						
TTI Business Office			Bryan, TX						
3135 TAMU									
College Station, TX 7784	43-3135		Project Number: A1171057						
Material Informatio	n		Sample Information						
Specified Strength: 4,0	000 psi @ 2	8 days	Sample Date:	05/22/20	Sample Time:	0907			
		-	Sampled By:	Jacob Epps					
Mix ID: R9Z40625	5		Weather Conditions:	Cloudy, wi	ndy				
Supplier: Martin Ma	arietta		Accumulative Yards:	4/4	Batch Size (cy):	4			
Batch Time: 0829	Plant:	617	Placement Method:	Direct Disc	harge				
Truck No.: 8120	Ticket No.:	6080436	Water Added Before (gal):	0	-				
EVILLE A DAG			Water Added After (gal):	0					
Field Test Data			Sample Location:	Bottom 1/3	of guard rail wall				
Test	Result	Specification	Placement Location:	Merritt Par	kway guard rail wal	1,			
Slump (in):	3 3/4	Not Specified		anchor, and	d terminal curb secti	ons			
Air Content (%):	1.5	Not Specified							
Concrete Temp. (F):	88	40 - 95							
Ambient Temp. (F):	84	40 - 95							

Laboratory Test Data

Plastic Unit Wt. (pcf):

Yield (Cu. Yds.):

Labo	ratory le	st Data				Age at	Maximum	Compressive		
Set	Specimen	Avg Diam.	Area	Date	Date	Test	Load	Strength	Fracture	Tested
No.	ID	(in)	(sq in)	Received	Tested	(days)	(lbs)	(psi)	Туре	By
1	A	6.00	28.27	05/26/20	07/07/20	46 F	149,250	5,280	2	SLS
1	В	6.00	28.27	05/26/20	07/07/20	46 F	161,690	5,720	6	SLS
1	С	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: Outsi	ide		Final C	ure: Field Cu	red				

Not Specified

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 **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

148.4

Reviewed By:

Start/Stop: 0800-1030 Hexander Dunigan

Project Manager

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

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

CR0001, 11-16-12, Rev.6

Page 1 of 1

Proving-Ground¶ 3100-SH 47, 846-7091¶ Bryan, TX-77807		Q1 /	.3- <u>01…Concret</u> Sampling¤	e • ¶ <i>QF-7.3-01</i> □ Revision: •	Issue Date: ← c ← 2018-06-18¤
-	lity·Form¤	Approved by:	Wanda L. Menges¶ ∙Darrell L. Kuhn¤	6⊂ Kevision: ↔	Page:¶ ⊏ 1 of 1¤
	ned-in-this-document-is-confi 612061			Mix Design (psi): 4	000 psi
Name of Technician Taking Sample	Teraco	n	Name of Technician Breaking Sample	Terac	on
Signature of Technician Taking Sample	Teraco	n	Signature of Technician Breaking Sample	Terac	on
Load No.	Truck No.	Ticket No.	Locat	ion (from concrete r	nap)
T1	9019	6113686		100% of curb	
Load No.	Break Date	Cylinder Age	Total Load (lbs)	Break (psi)	Average
	Se	e attached Rep	orts from Terracon		

	CUSTOME	a's cop	Y		TICK	ET NO.
Martin Marietta 1	503 LBJ Suite Dallas, T	Freewa 400	ay			586.
LOAD TIME TO JOB ARRIVE JOB SITE	BEGIN P	OUR	FINISH P	OUR	LEAVE JOB SITE	ARRIVE PLANT
10:57 11:04 11:27	11:	30	:		:	:
	CAL	CUSTOM	ER SIGNATURE			1
ATER ADDED ON JOB AT CUSTOMER'S REQUEST	GAL.	x				
TEST CYLINDER TAKEN YES INO BY	GAL.					TTO THE TERMS A
CYLINDER TAKEN DEFORE AFTER WATER			TIONS ON		VERSE SIDE HER	EOF AS ACCEPTED
ADDITIONAL WATER ADDED TO THIS CONCRETE WILL ITS STRENGTH. ANY WATER ADDED IN EXCESS OF S		SIGNA	TUNE ADD			
SLUMP IS AT CUSTOMER'S RISK.		PLANT	TRUCK	O RDER NO	. SLUMP	P.0. #/JOB/LOT GRID
BRYAN CONSTRUCTION C			9019	202		
RELLIS CAMPUS/TTI, CO		DRIVERN	TE, ROJ			DATE
		CUSTOME	RNUMBER	PROJECT	CUM, CTY	
and the second se		50	195	923	32 7.	00 7.00
PECIAL DELIVERY INSTRUCTIONS SOUTH 2818, RIGHT LEONARD RD, RIG INTO RELLISCAMPUS, GO STRAIGHT TO	SHT ON I	ныү 4	7, LEFT		LES TAX	
MEET YOU THERE					TOTAL	DRM-
EE WARNINGS ON REVERSE SIDE.				FOR OFF	ILE USE ONLY I	
Truck Driver User 9019 726255 user Load Size Mix Code Returned 7.000 CYD5 R9Z406255 Material Design Oty Required Batched ''B5 1303 lb 9156 lb 9160 lb ''B5 1303 lb 9158 lb 9160 lb ''B5 596 lb 3558 lb 3020 lb ''B5 1403 lb 10220 lb 10220 lb ''B5H-1 1403 lb 10230 lb 10220 lb ''B5H-6 131 lb 917 lb 925 lb ''B5H-6 131 lb 917 lb 925 lb ''B6H-6 131 lb 917 lb 925 lb ''B6H-6 166 oz 165 oz 165 oz	Disp T 611368 Oty 4 Var 0.035 0.625 -0.105 -0.105 + 0.675 + 0.675 + 0.675 + 0.675 + 0.675	× Ho	Mix Ag	ricket 13705 10 tual Wat 49 gl 142 gl	ID Time 10137 Seq Loa D 847	Date 6/11/20 d ID 95
Actual Num Batches: 1 Load Total: 27809 1b Design 0.476 Water/Cement Sluep: 500 in W Mater in Truck: 0.0 gl Adjust	0.479 T Waters 0.	1 fg 6.	esign 209.7 Load Trie	gl Bateri -	Actual 197.0	gl Te field: 12.5

CONCRETE COMPRESSIVE STRENGTH TEST REPORT

Report Number: A1171057.0120 Service Date: 06/11/20 Report Date: 06/11/20 Task: PO #612061

Client

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

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

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.):		

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

Sample Information 06/11/20 Sample Time: 1200 Randolph E. Rohrbach Clear, light wind Batch Size (cy): 7 7/7Direct Discharge Water Added Before (gal): 0 Water Added After (gal): 0 Center section Barricade curb

Labora	itory	Test	Data
--------	-------	------	------

Set No.	Specimen ID	Avg Diam. (in)	Area (sq in)	Date Received	Date Tested	Test (days)	Load (lbs)	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	в	6.00	28.27	07/07/20	07/07/20	26 F	134,650	4,760	2	SLS
1	С	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: Outsi	ide		Final C	ure: Field Cu	red				

Project

Bryan, TX

Sample Date:

Sampled By:

Weather Conditions:

Accumulative Yards:

Placement Method:

Sample Location:

A ac at

Maximum

Compressive

Placement Location:

Riverside Campus

Riverside Campus

Project Number: A1171057

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

Reported To:

Contractor:

Report Distribution: (1) Texas Transportation Institute, Gary Gerke

(1) Texas Transportation Institute, Bill Griffith

Reviewed By: (1) Terracon Consultants, Inc., Alex Dunigan, P.E.

Start/Stop: 1130-1315 Hexander Dunigan

Project Manager

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

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

CR0001, 11-16-12, Rev.6

Page 1 of 1

-	Texas A&M Transportation Texas A&M University College Station, TX-778431 Phone 979-845-837511 htty:Formo		Prepared by: Approved by:	.3-01Concret Sampling: Wanda:LMenges¶ Darrell:LKuhn= Ground ¶	œ.	Doc. No.¶ ¶ QF-7.3-01¤ Revision: + 6¤	Issue Date: ⊷ C ↔ 2018-06-18¤	
	612061			7/21/2020	Mix De	esign (psi): 4	000 psi	
Name of Technician Taking Sample	Teraco	on		Name of Technician Breaking Sample		Terac	on	
Signature of Technician Taking Sample	Teraco	on		Signature of Technician Breaking Sample		Terac	on	
Load No.	Truck No.	Ti	cket No.	Locat	ion (fro	m concrete	map)	
T1	7211	6	179946	100% of curb				
Load No.	Break Date	Cyl	inder Age	Total Load (lbs)	Bre	ak (psi)	Average	
	s	iee at	tached Repo	orts from Terracon				

				LE COP	r					
Martin Marietta Marietta Martin Marietta 1503 LBJ Freeway Suite 400 Dallas, Tx 75234										
			11							
LOAD TIME	1				N IN M			111 1881		
	TO JOB	ARRIVE JOB SITE	BEGINT		the second se			S		
10129	10:43				FINISH PC	PUR	LEAVE JOB	SITE	ARRIVE PLANT	
WATER ADDED OF		11:03	11:	07	1		:			100
ALLOWARIE WAT	JOB AT CUSTOMER'S	CUSTOM	ER SIGNATURE							
			GAL.	x						100
CYLINDER TAKEN	AKEN I YES INO	BY	- 252	DELIVE	RY OF THE	SE MATE	RIALS IS S	UBJECT	TO THE TERMS AN	n
ADDITIONAL WA	BEFORE	AFTER WATER		CONDI	TIONS ON	THE REI	ERSE SIDE	HEREO	F AS ACCEPTED B	Y
SLUMP IS AT CUS	TER ADDED TO THI ANY WATER ADDE STOMER'S RISK.	S CONCRETE WILL D IN EXCESS OF S	REDUCE	SIGNA	TURE ABOV	Έ.				
CUSTOMER NAME AN	D DELIVERY ADDRESS			PLANT	TRUCK	O RDER NO	SLUMP.	P.0.	MJOBLOT GRID	
	MPUS/TTL, CO									
				DRIVER N					DATE	
					R NUMBER	PROJECT	CUM	, aty	ORDERED GTY	
				50						
LOAD QUANTITY PR	ODUCT CODE DESC	RIPTION					UNITPRIC	E	AMOUNT	
					1					
SPECIAL DELIVERY INSTRUCTIONS BOUTH 2818, RIGHT LEDNARD RD, RIGHT ON HWY 47, LEFT INTO RELLISCAMPUS, GO STRAIGHT TO THE GATETHEY WILL MEET YOU THERE										
ANGER! MAY CAUSE	ALKALI BURNS.	4				FOR O	FFICE USE C	ONLY F	ORM:	
7211	Driver 777135		617994	icket 6	Num Mix A		t ID Seq	110:25	Date 9 7/21/20 ad 10	
Load Size 6.50 CYDS	R9840636			ar 164.	and the second second		D			
Haterial Desig 3/8706 15 5000-1 15 001-1/11 4	n Oty Require 75 15 10268 1 55 15 10541 1	b 10320 1b b 10550 1b	% Var 0.50% 0.37%	-0m		44 9				
DIT-1/11 4. FLYASH-0 14 H28 21 ZY-618	1254 1	b 2820 10 b 948 1b b 1246 1b z 176 oz	+ -0.27% -0.67% 0.21%		NS H NS N	149 1	1			
	Batches: 1 Ib Design 8 Water in Truck	,460 Water/Cement : 0.0 gl Adjust	0,462 T Water: 0	.0 gl /	Design 208. Load Tri	0 gl is Mater	: -1.5 gl/	1 197.4 CVD N	gl To Addi Note: Manual feed	2.00

CONCRETE COMPRESSIVE STRENGTH TEST REPORT

.0121

Report Number:	A1171057.01
Service Date:	07/21/20
Report Date:	07/21/20
Task:	PO #612061

Client

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

Material Information

Specified Str	ength:	4,000	psi @	28 days		
Mix ID:	R9844	0636				
Supplier:	Martin Marietta					
Batch Time:	1029		Plant:	617		
Truck No.:	7211		Ticket No.:	6179946		

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.):		

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

Project Number: A1171057 Sample Information 07/21/20 Sample Time: 1137 Adam Hill cloudy, low wind 6.5/6.5 Batch Size (cy): 6.5 Direct Discharge Water Added Before (gal): 0 Water Added After (gal): 0 Direct middle of 10 yd length PO #612061, Main runway, SW end, curb/box

Laboratory Test Data

		ot Butu				Age at	Maximum	Compressive		
Set No.	Specimen ID	Avg Diam. (in)	Area (sq in)	Date Received	Date Tested	Test (days)	Load (lbs)	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	в	6.00	28.27	07/22/20	09/02/20	43	146,820	5,190		SLS
1	С	6.00	28.27	07/22/20	09/02/20	43	145,110	5,130		SLS
						Aver	age (43 days)	5,190		
1	D			07/22/20		Hold				
Initial	Cure: Outs	ide		Final C	ure: Field Cu	red				
-							1.01 3			

Project

Bryan, TX

Sample Date:

Sampled By:

Weather Conditions:

Accumulative Yards:

Placement Method:

Sample Location:

Placement Location:

Riverside Campus

Riverside Campus

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: Reviewed By:** (1) Texas Transportation Institute, Gary Gerke (1) Terracon Consultants, Inc., Alex Dunigan, P.E. Hexander Dunigan (1) Texas Transportation Institute, Bill Griffith Project Manager

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

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

CR0001, 11-16-12, Rev.6

Page 1 of 1

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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 ³/₄" 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) <u>prior</u> 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);

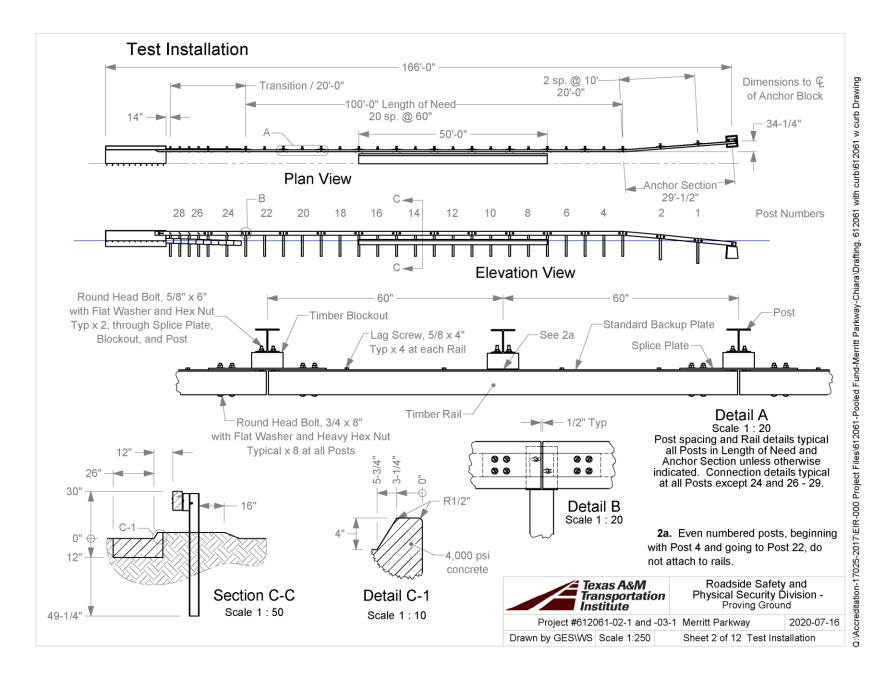
i) Grade-marked after treatment by an agency certified by the American Lumber Standard Committee (ALSC).

Fasteners:

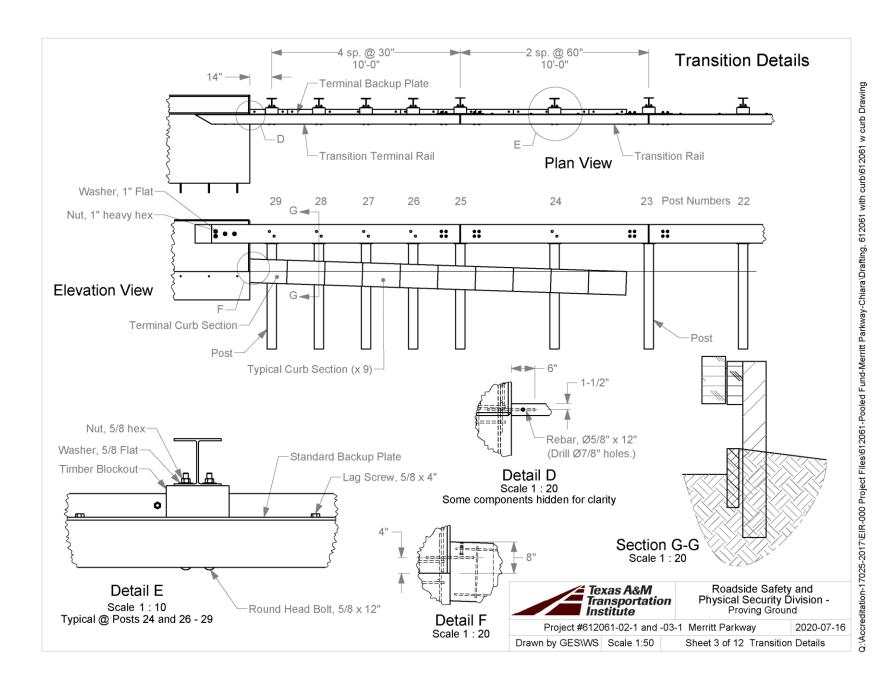
a) Round head bolts shall be manufactured in accordance with the sizes designated on the plans, the geometric specifications included in ANSI B18.5.1.2.2 and the material specifications for ASTM A588 steel. All round head bolts shall be marked with the manufacturers symbol and A588.
 b) Hex Lag Screws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

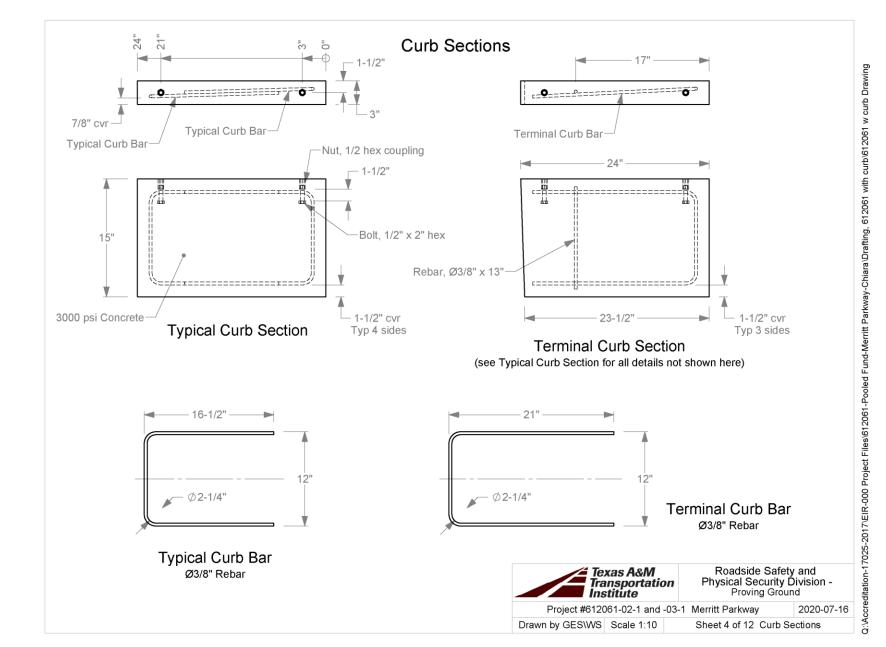






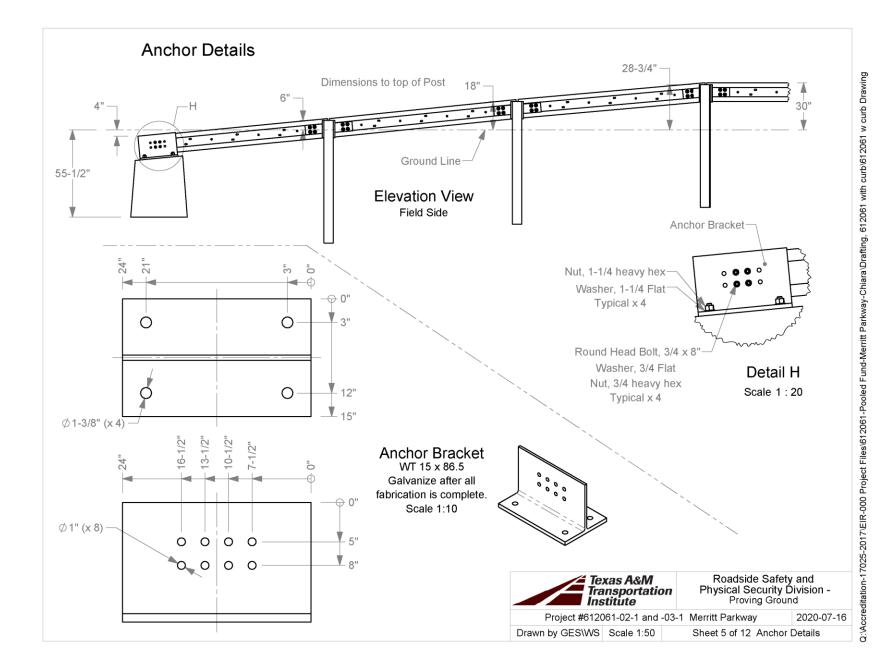


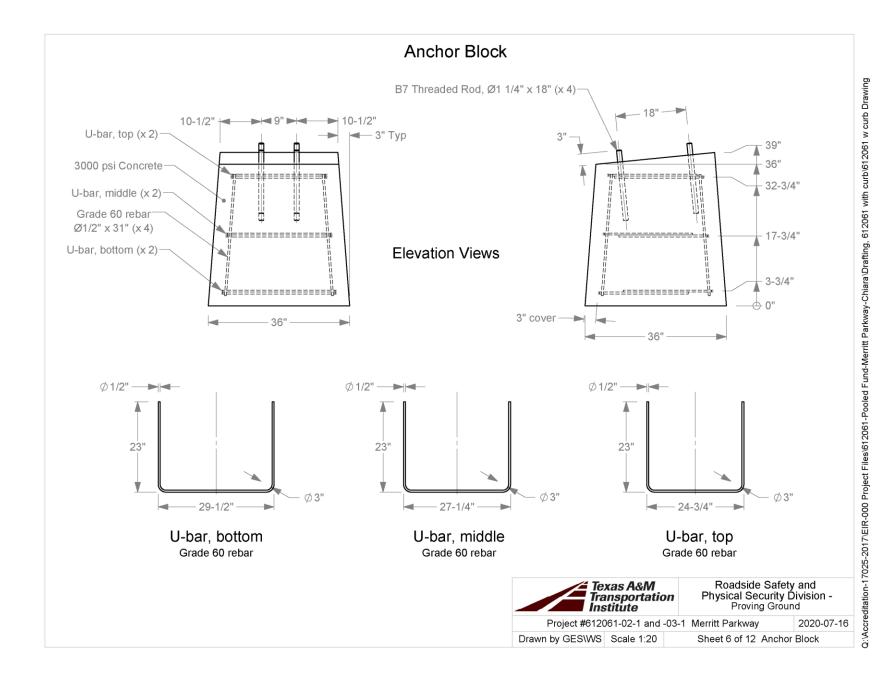
198

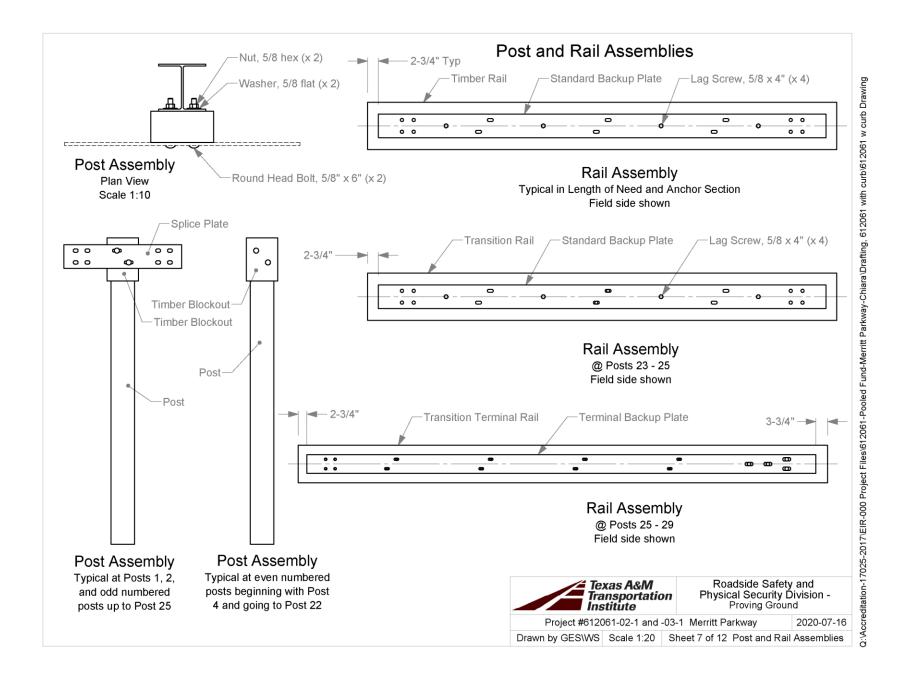


TR No. 612061-08-01

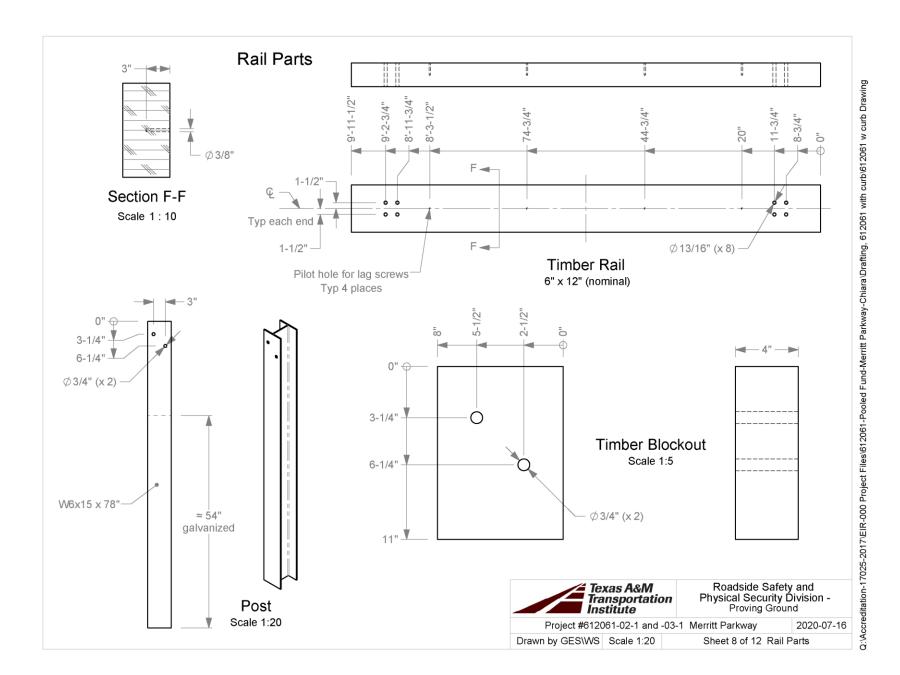
199

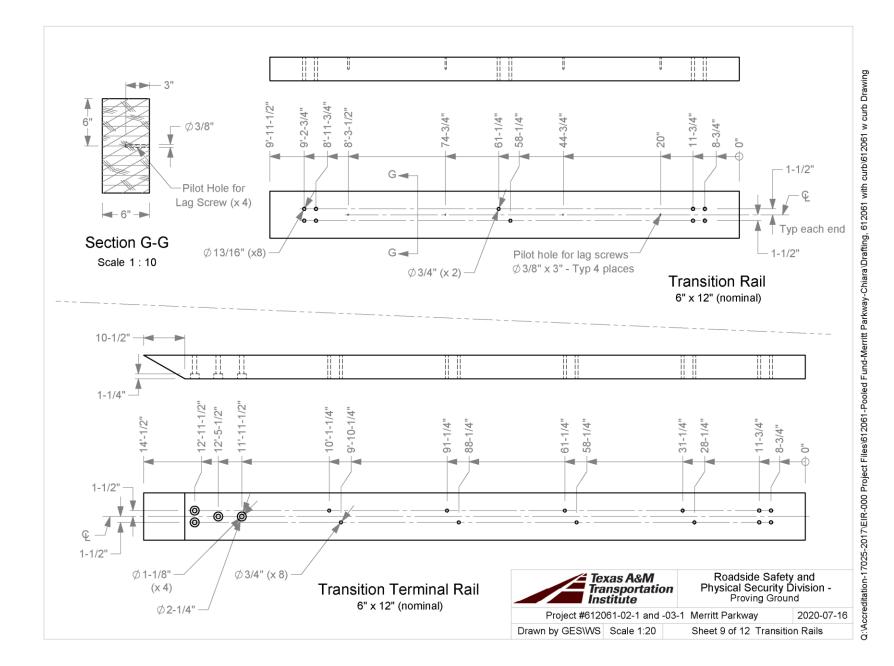






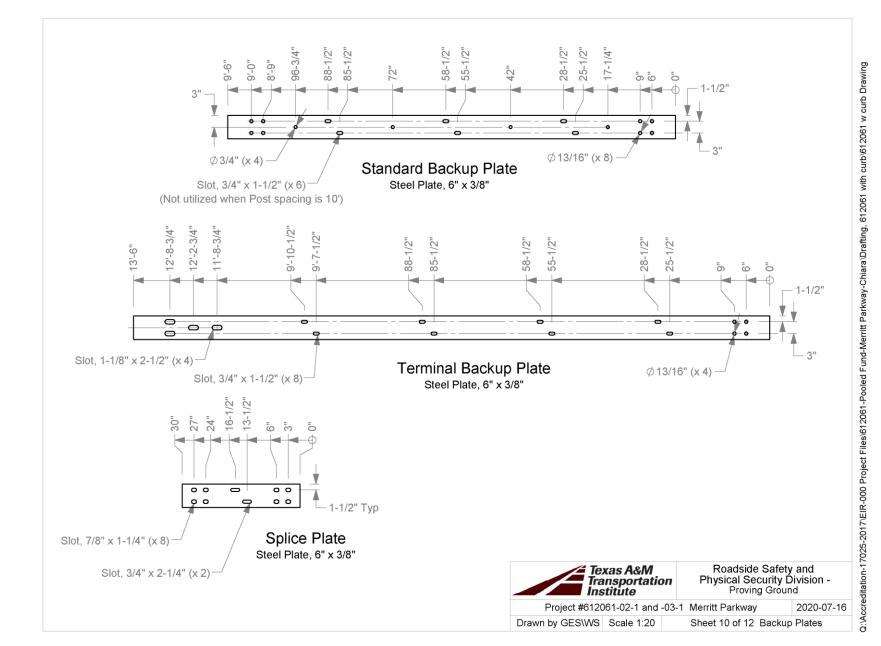
203

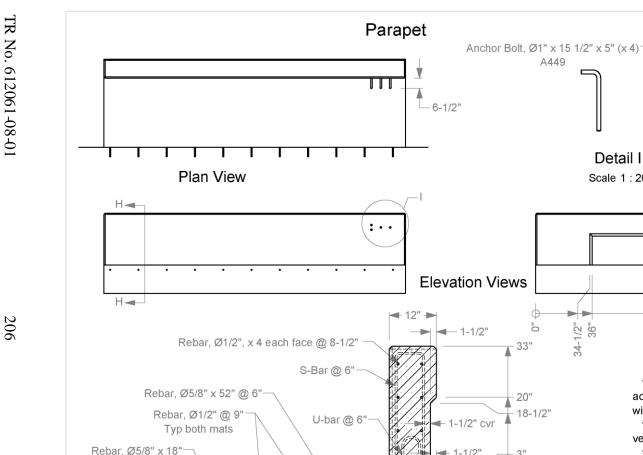




TR No. 612061-08-01

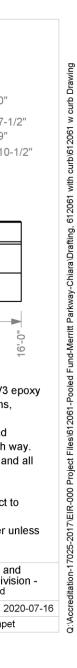
204





Rebar, Ø5/8" x 52" @ 18'

56"



16'-0"

21-3/4" 15-3/4" 9-3/4"

-0

Detail I

Scale 1:20

34-1/2" 36"

0

3

0'

18'

1-1/2" cvr

- 1-1/2'

3" cvr

4" cvr

Q ii 0

A449

" "o

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

11d. Backfill field side and ends of

95% of standard proctor density.

otherwise indicated by "cvr" (cover).

foundation with native soil and compact to

rebar is grade 60.

Project #612061-02-1 and -03-1 Merritt Parkway

Texas A&M Transportation Institute

Drawn by GES\WS Scale 1:50

vertical edges where shown, 3/4" each way.

11c. Concrete strength is 3600 psi, and all

11e. Rebar dimensions are to center unless

Roadside Safety and Physical Security Division -

Proving Ground

Sheet 11 of 12 Parapet

◄⊕

⊕ 0"

7-1/2" 9"

10-1/2'

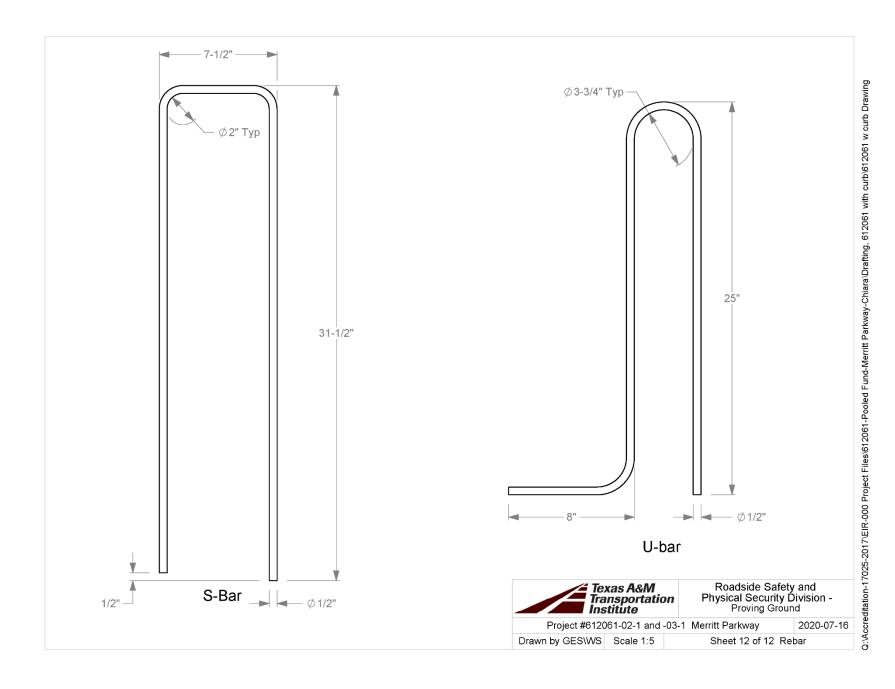
206

See 11a

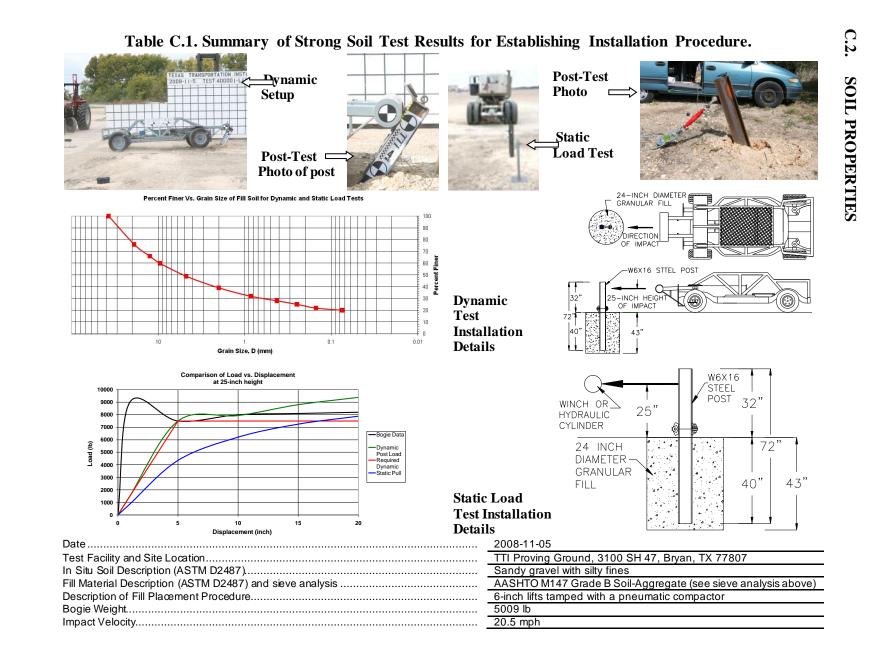
Existing Concrete

Section H-H

Scale 1 : 20



207



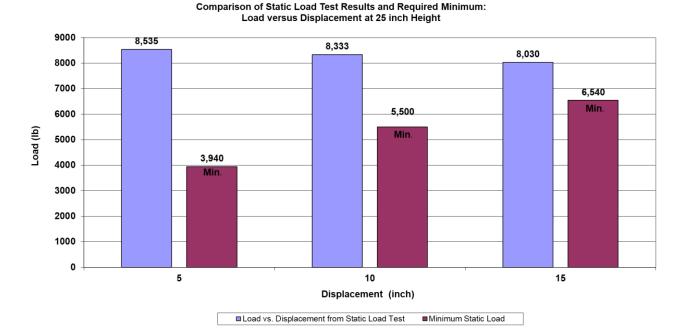


Table C.2. Test Day Static Soil Strength Documentation for Test No. 612061-03-1.

2020-10-02 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

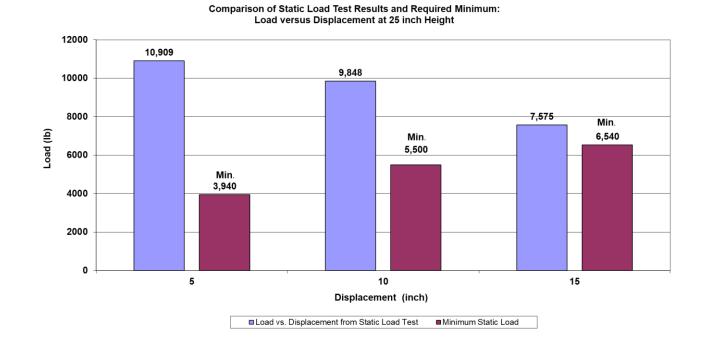


Table C.3. Test Day Static Soil Strength Documentation for Test No. 612061-02-1A.

TR No. 612061-08-01

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

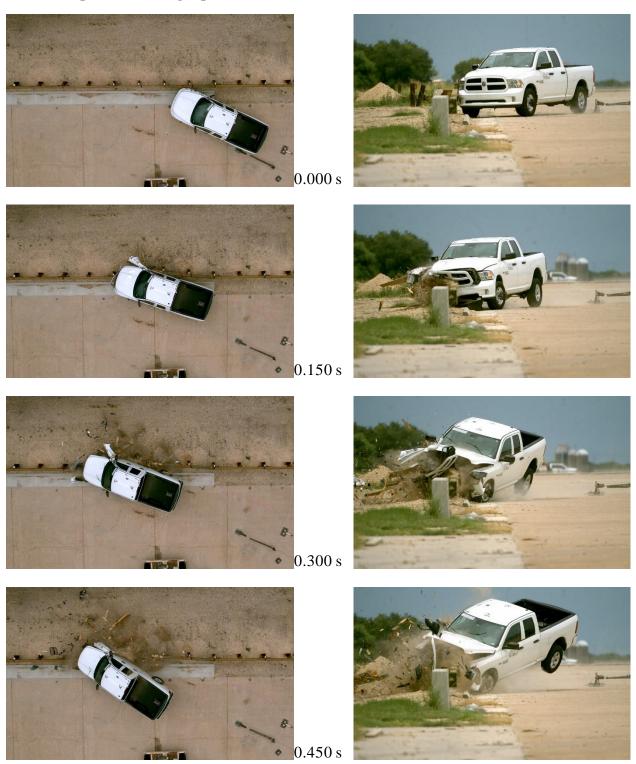


Figure C.1. Sequential Photographs for Test No. 612061-02-1A (Overhead and Frontal Views).

















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







0.150 s



0.300 s



0.600 s



0.750 s



0.900 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°

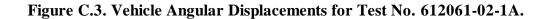


Figure C.4. Vehicle Longitudinal Accelerometer Trace for Test No. 612061-02-1A (Accelerometer Located at Center of Gravity).

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

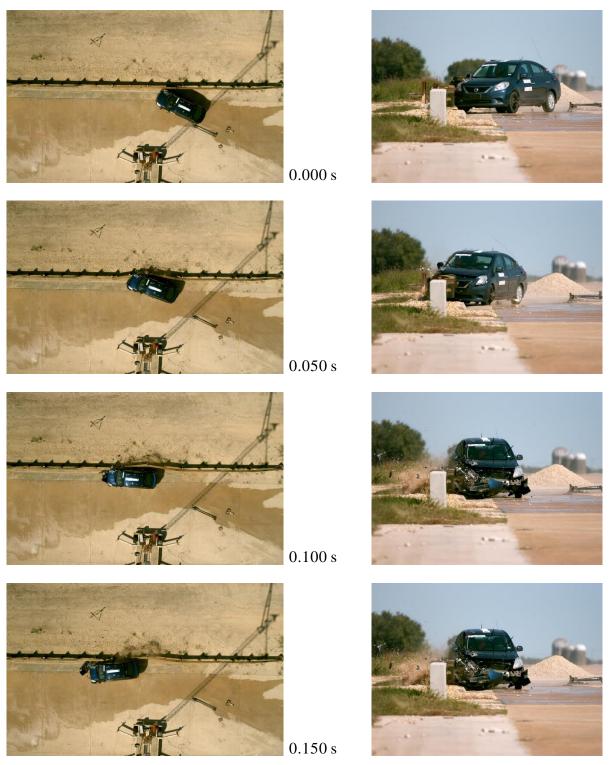


Figure C.7. Sequential Photographs for Test No. 612061-03-1 (Overhead and Frontal Views).



















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.

Figure C.9. Vehicle Longitudinal 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 ³/₄" 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);

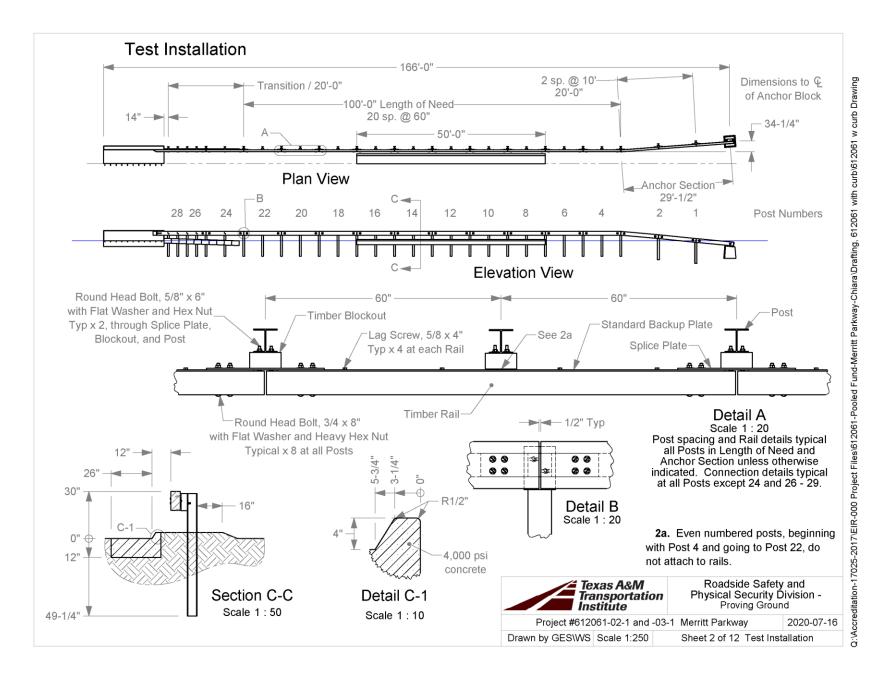
i) Grade-marked after treatment by an agency certified by the American Lumber Standard Committee (ALSC).

Fasteners:

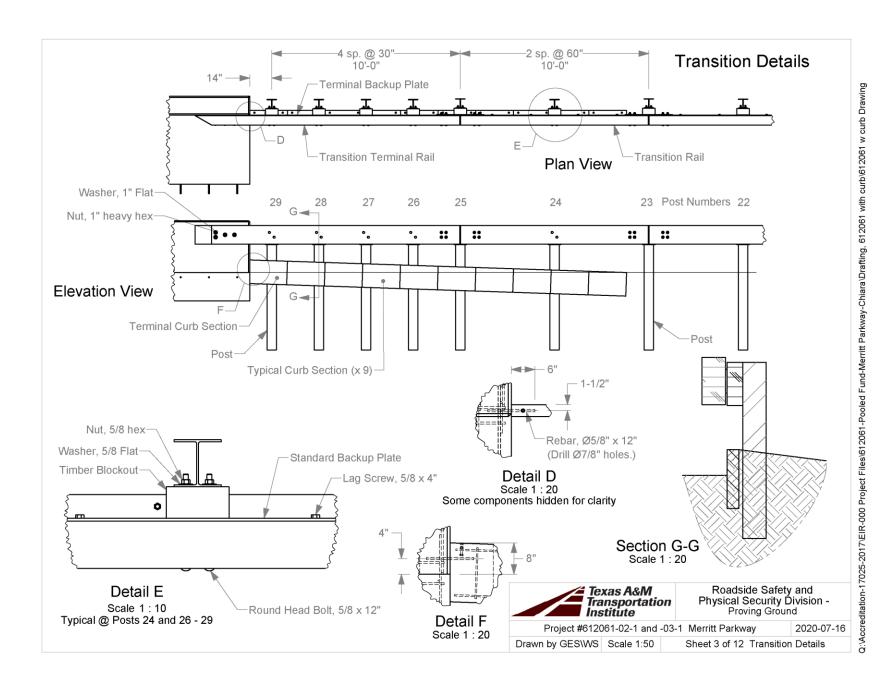
a) Round head bolts shall be manufactured in accordance with the sizes designated on the plans, the geometric specifications included in ANSI B18.5.1.2.2 and the material specifications for ASTM A588 steel. All round head bolts shall be marked with the manufacturers symbol and A588.
 b) Hex Lag Screws shall be manufactured in accordance with ASTM A307 Grade A specifications. All Hex Lag Screws shall be hot-dipped galvanized in accordance with ASTM Class C.

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

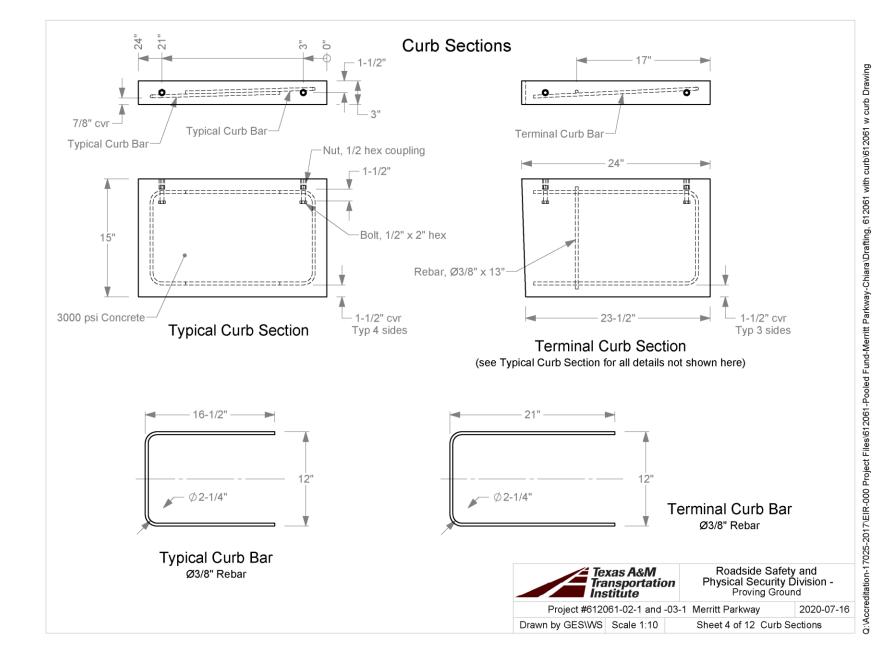








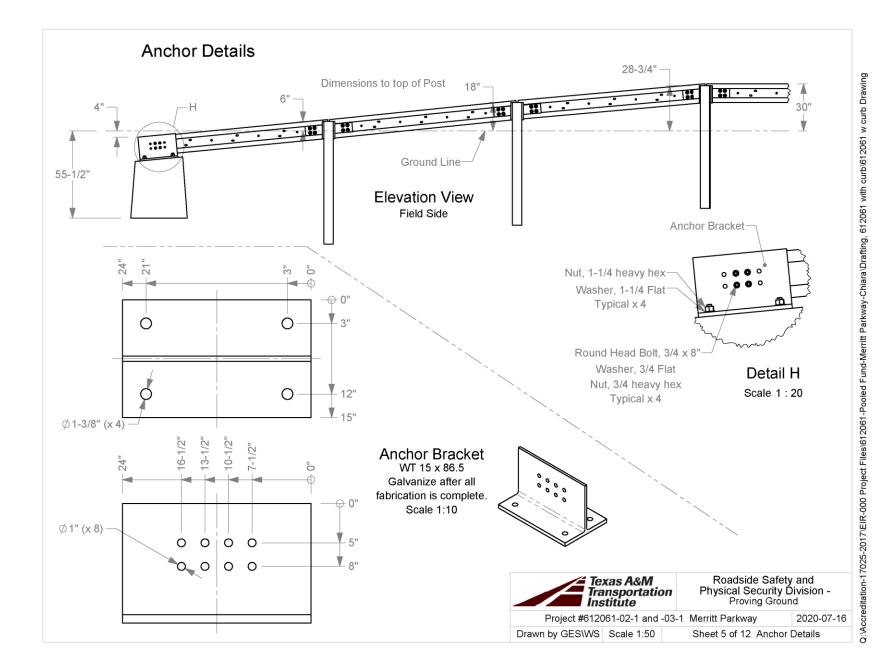
236

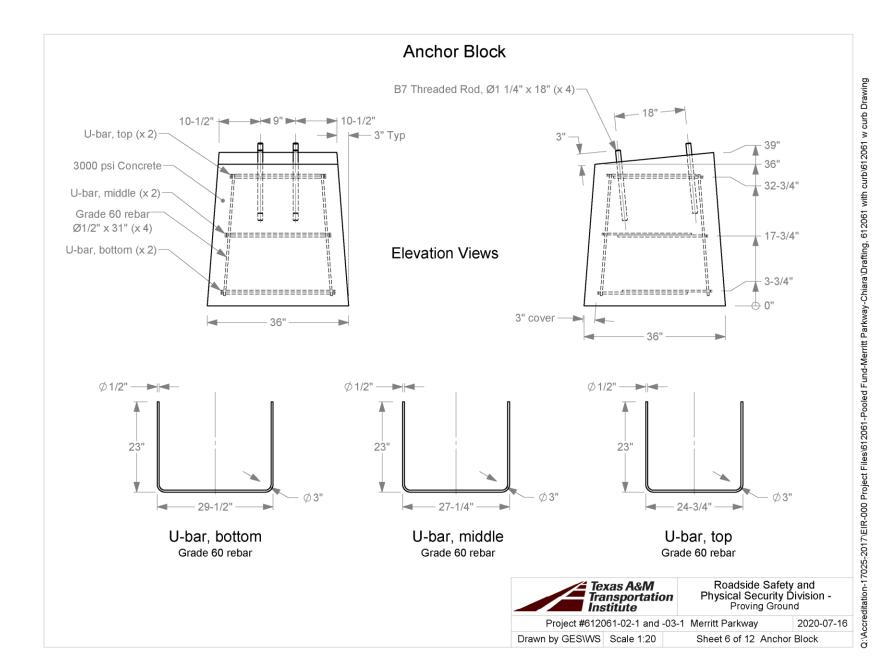


TR No. 612061-08-01

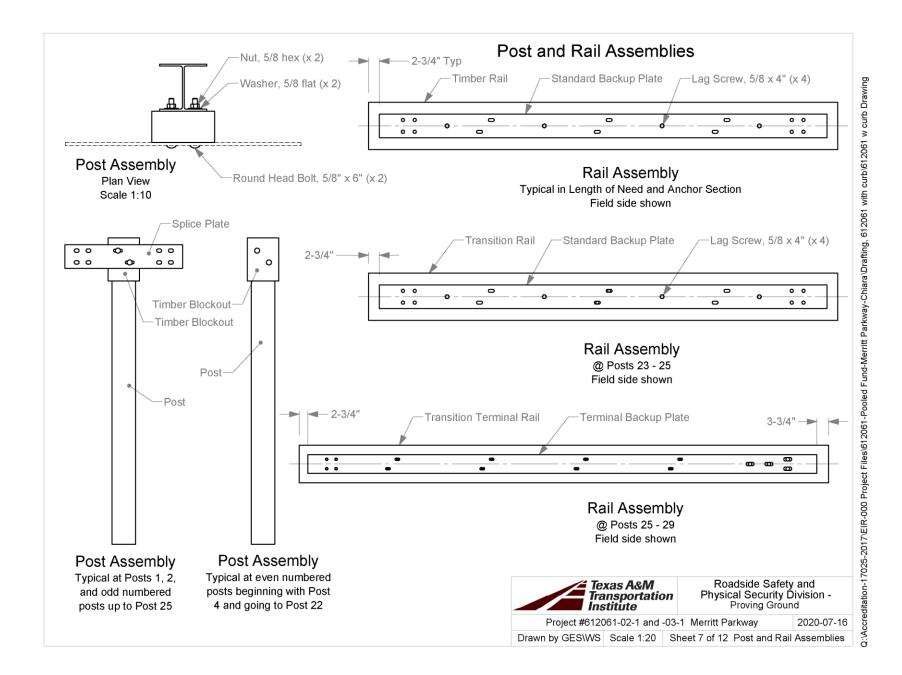
237

2024-02-06





TR No. 612061-08-01



Rail Parts 3" ii u IJ IJ ii V 9'-11-1/2" 9'-2-3/4" 8'-11-3/4" 8'-3-1/2" 74-3/4" 44-3/4" 11-3/4" 8-3/4" 20" Ø 3/8" F 🖛 1-1/2" Section F-F Ç 6 6 ø Scale 1:10 0 0 0 0 Typ each end F 🖛 Ø13/16" (x 8) 1-1/2" **Timber Rail** Pilot hole for lag screws 6" x 12" (nominal) Typ 4 places - 3" 5-1/2" 2-1/2" 0" 0 ō 3-1/4" **◄** 4" **→** 6-1/4" 0" 🕀 Ø 3/4" (x 2) 3-1/4" Ο Timber Blockout Scale 1:5 6-1/4" W6x15 x 78" ≈ 54" Ø 3/4" (x 2) galvanized 11" Roadside Safety and Physical Security Division -Proving Ground Texas A&M Transportation Institute Post Scale 1:20 Project #612061-02-1 and -03-1 Merritt Parkway 2020-07-16

Drawn by GES\WS Scale 1:20

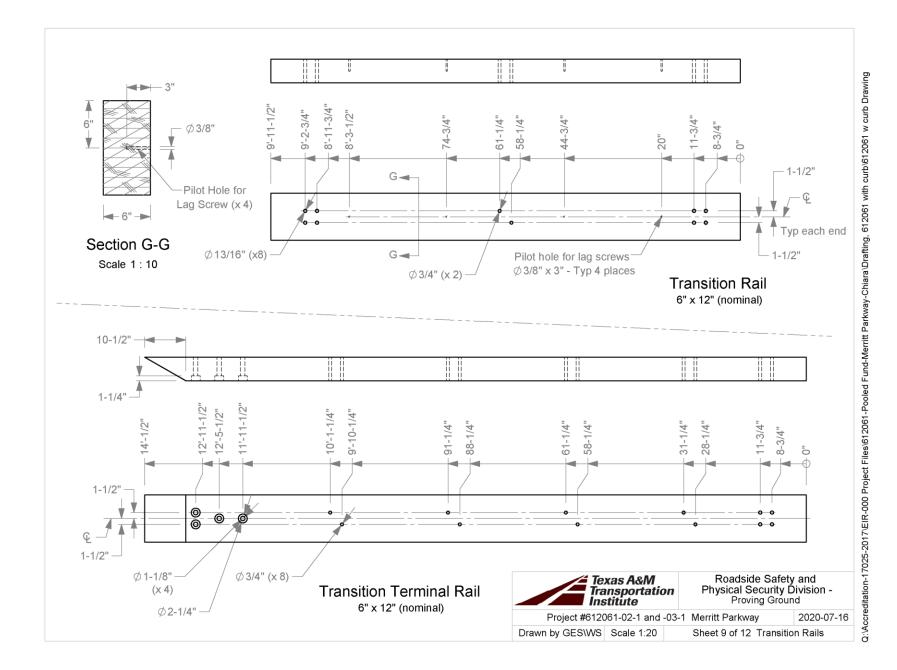
Q:\Accreditation-17025-2017\EIR-000 Project Files/612061-Pooled Fund-Merritt Parkway-Chiara\Drafting, 612061 with curb/612061 w curb Drawing

Sheet 8 of 12 Rail Parts

0

241

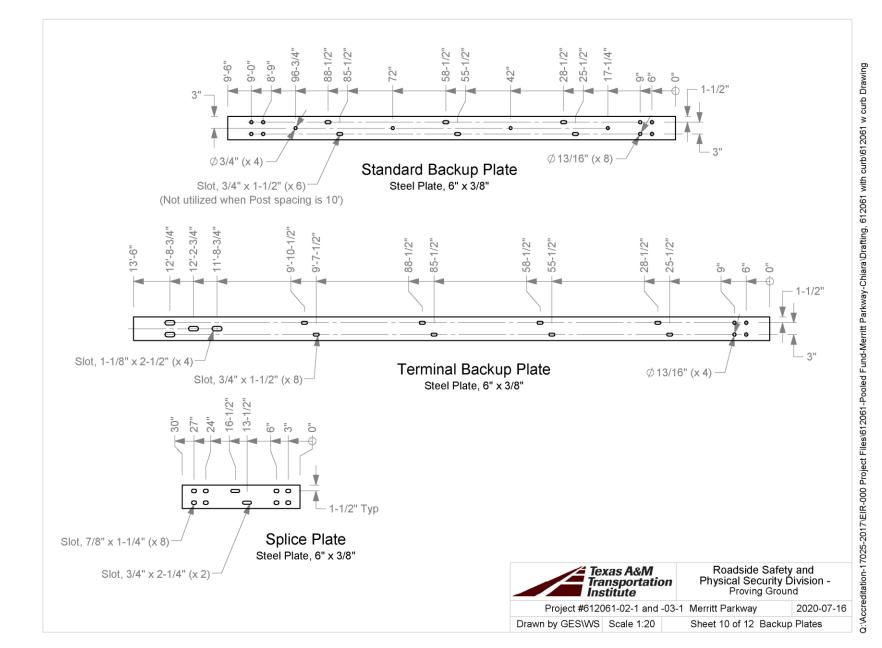
2024-02-06

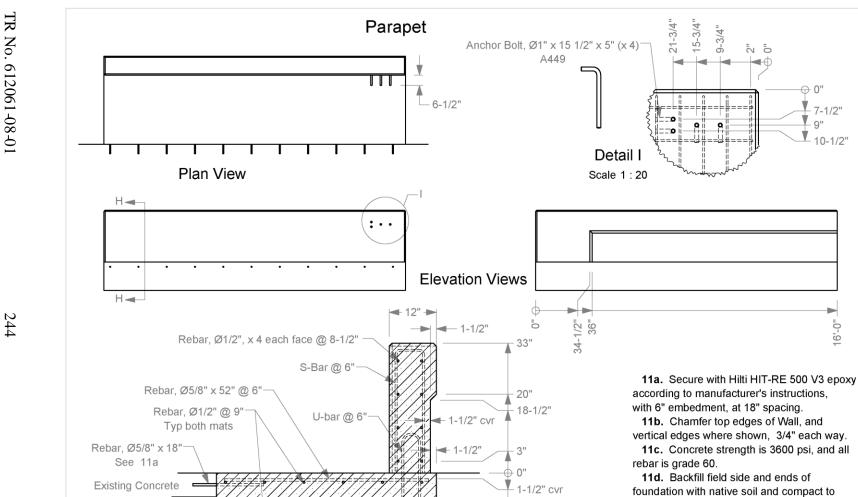


TR No. 612061-08-01

242

2024-02-06





Rebar, Ø5/8" x 52" @ 18'

56"

3" cvr

4" cvr

18'

16'-0"

21-3/4" 15-3/4" 9-3/4"

_0

Q ii 0

95% of standard proctor density.

Texas A&M Transportation Institute

Drawn by GES\WS Scale 1:50

Project #612061-02-1 and -03-1 Merritt Parkway

otherwise indicated by "cvr" (cover).

11e. Rebar dimensions are to center unless

Roadside Safety and Physical Security Division -

Proving Ground

Sheet 11 of 12 Parapet

2020-07-16

" "o

◄⊕

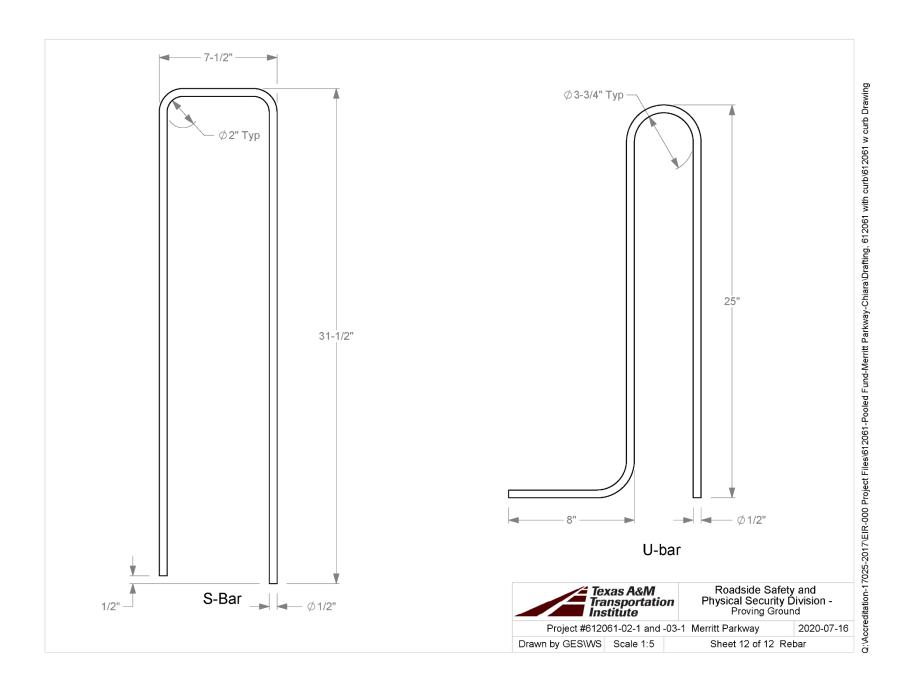
⊕ 0"

7-1/2" 9"

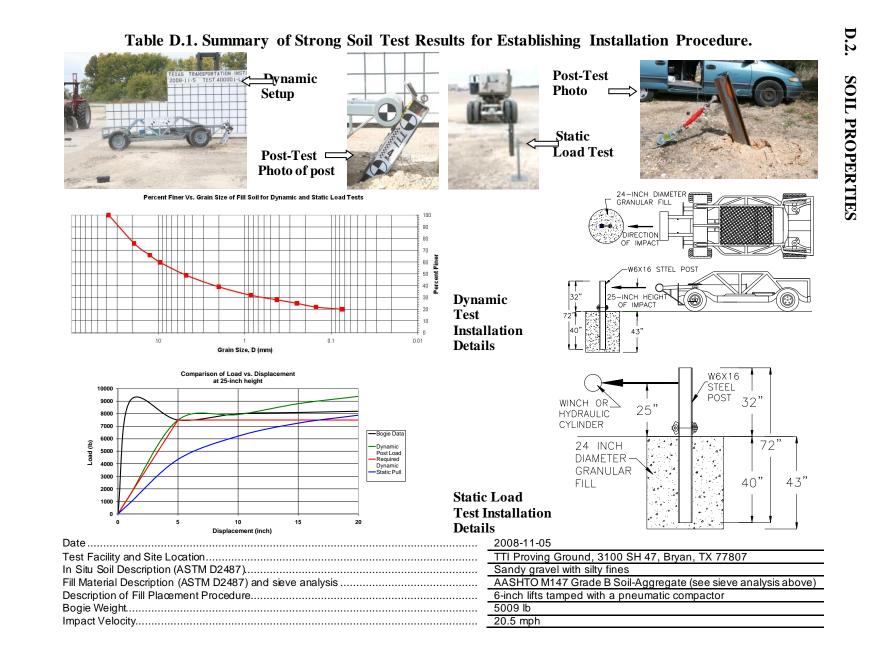
10-1/2'

Section H-H

Scale 1 : 20



245



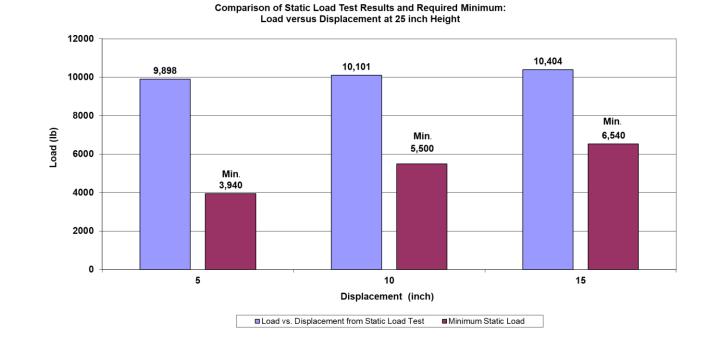


Table D.2. Test Day Static Soil Strength Documentation for Test No. 612061-07-1.

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

TR No. 612061-08-01

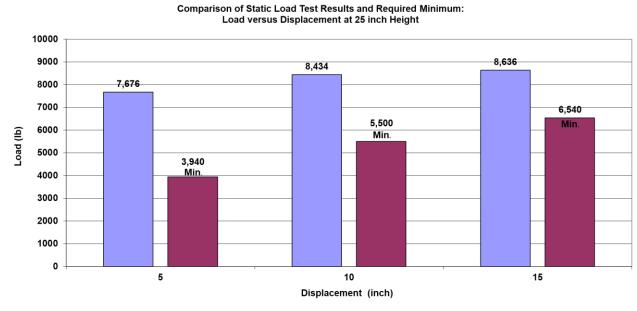


Table D.3. Test Day Static Soil Strength Documentation for Test No. 612061-06-1.

Load vs. Displacement from Static Load Test Minimum Static Load

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

TR No. 612061-08-01

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

D.3.1. Vehicle Properties and Information

Date:	2020-10-07	Test No.:	612061	VIN No.: 3	3N1CN7AP6EK451617
Year:	2014	Make:	NISSAN	Model:	VERSA
Tire Infl	ation Pressure: <u>36</u>	PSI	_ Odometer: <u>90082</u>	т	ire Size: <u>P185/65R15</u>
Describ	e any damage to the	e vehicle pric	or to test: <u>None</u>		
	ites accelerometer lo	ocation.		•	
$\overline{\mathbf{A}}$	CÍD: <u>1.6 L</u> iission Type: Auto or FWD <u></u> RWD al Equipment:	_Manual 4WD		R	
Dummy Type: Mass: Seat F	Data: <u>50th Percer</u> 165 lb Position: <u>IMPACT SII</u>		- F - F - F - F - F - F - F - F - F - F	н Ех	
Geome	try: inches		4	C	
A <u>66.7</u>	-	50	K _12.50	P 4.50	U <u>15.50</u>
В <u>59.6</u>	<u>o </u>		L <u>26.00</u>	Q <u>24.00</u>	V <u>21.25</u>
C <u>175.</u>	<u>40 H_41.</u>	51	M <u>58.30</u>	R <u>16.25</u>	W _41.50
D <u>40.5</u>	<u>0 </u>	0	N <u>58.50</u>	S <u>7.50</u>	X <u>79.75</u>
E <u>102.</u>	40 J <u>22.</u> :	25	O <u>30.50</u>	T <u>64.50</u>	
Whe	el Center Ht Front 1	1.50	Wheel Center Ht	Rear <u>11.50</u>	W-Н <u>-0.01</u>
RAI	NGE LIMIT: A = 65 ±3 inches; C		= 98 ±5 inches; F = 35 ±4 inches; H = inches; W-H < 2 inches or use MASH F		p of Radiator Support) = 28 ±4 inches
GVWR	Ratings:	Mass: Ib	<u>Curb</u>	<u>Test Ine</u>	ertial Gross Static
Front	1750	M _{front}	1442	1439	1524
Back	1687	M _{rear}	972	981	1061
Total	3389	MTotal	2414	2420	2585
			Allowable TIM = 242	0 lb ±55 lb Allowabl	e GSM = 2585 lb ± 55 lb
Mass D Ib)istribution: LF:	731	RF: <u>708</u>	LR: <u>495</u>	RR: <u>486</u>

Table D.1. Vehicle Properties for Test No. 612061-07-1.

Date:	2020-10-7	Test No.:	612061	VIN No.:	3N1CN7AP6EK451617
Year:	2014	Make:	NISSAN	Model:	VERSA

Table D.2. Exterior Crush Measurements for Test No. 612061-07-1.

VEHICLE CRUSH MEASUREMENT SHEET¹

Complete Wh	en 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)	X1+X2 _
< 4 inches	2
\geq 4 inches	

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

Specific		Direct I	Damage								
Specific Impact Number	Plane* of C-Measurements	Width** (CDC)	Max*** Crush	Field L**	C1	C ₂	C ₃	C4	C5	C ₆	±D
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										

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

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

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

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

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

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

Date:	2020-10-7	Test No.:	612061		VIN No.:	3N1CN7AP6EK451617			
Year:	2014	Make:	NISSAN		Model:	VERSA			
	H-					COMPART			
	F				Before	After (inches)	Differ.		
	Ğ			A1	75.00	75.00	0.00		
11		7		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		
	B1, B2, E	33, B4, B5, B6		В3	43.00	44.50	1.50		
A1, A2, &A3		B4	46.50	46.50	0.00				
		B5	42.50	42.50	0.00				
$d \in$	D1, D2, & D3 C1, C2,			B6	46.50	46.50	0.00		
		FT ((C1	26.00	26.00	0.00		
				C2	0.00	0.00	0.00		
				СЗ	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		
	B1 B	2 B3		E1	45.00	45.00	0.00		
	E1 8			E2	48.75	55.75	7.00		
				F	47.50	42.00	-5.50		
				G	47.50	47.50	0.00		
				Н	39.00	39.00	0.00		

Table D.3. Occupant Compartment Measurements for Test No. 612061-07-1.

*Lateral area across the cab from

driver's side kick panel to passenger's side kick panel.

0.00

-7.25

Ι

J*

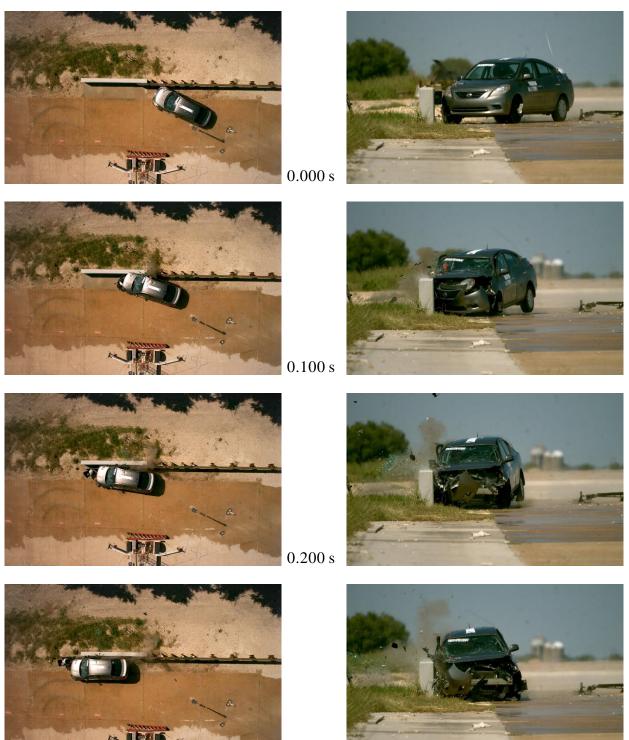
39.00

48.50

37.00

41.25

D.3.2. Sequential Photographs



0.300 s

Figure D.1. Sequential Photographs for Test No. 612061-07-1 (Overhead and Frontal Views).

















Figure D.1. Sequential Photographs for Test No. 612061-07-1 (Overhead and Frontal Views) (Continued).







0.100 s



0.200 s



0.200 s

Figure D.2. Sequential Photographs for Test No. 612061-07-1 (Rear View).



0.400 s



0.500 s



0.600 s



0.700 s

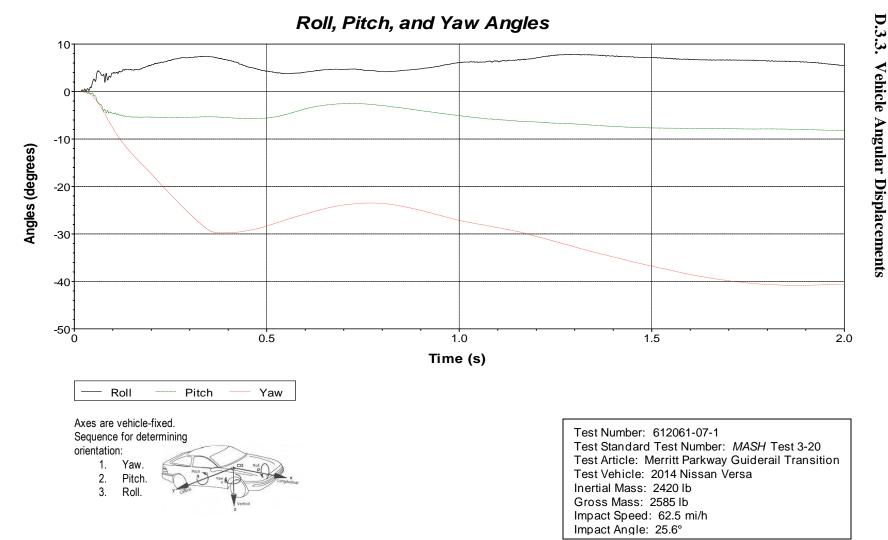


Figure D.3. Vehicle Angular Displacements for Test No. 612061-07-1.



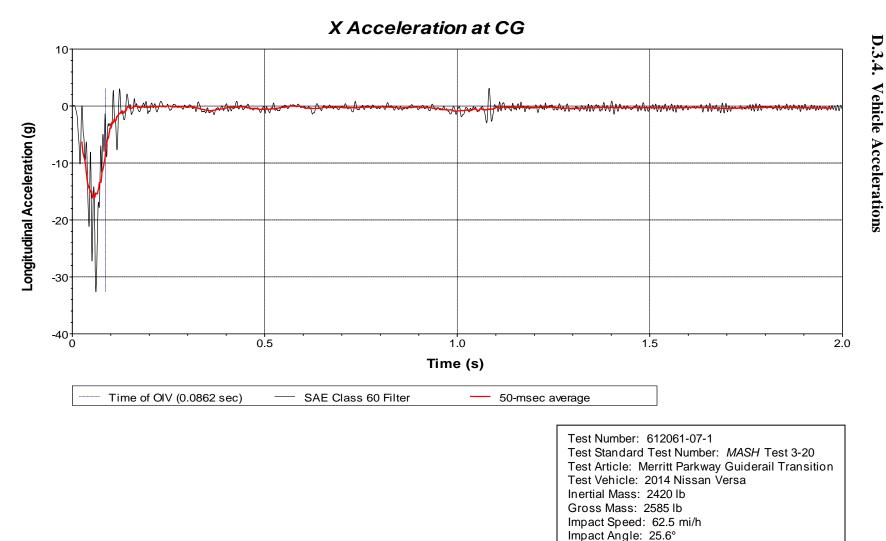
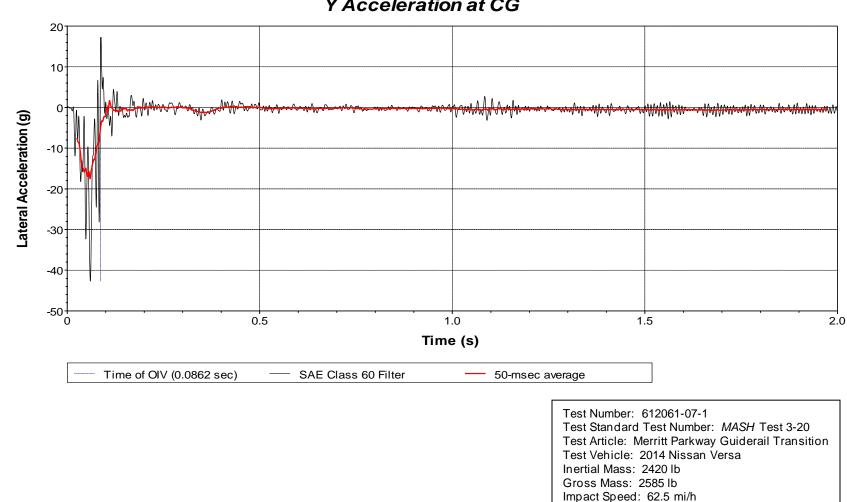


Figure D4. Vehicle Longitudinal Accelerometer Trace for Test No. 612061-07-1 (Accelerometer Located at Center of Gravity).

256





Y Acceleration at CG

Figure D.5. Vehicle Lateral Accelerometer Trace for Test No. 612061-07-1 (Accelerometer Located at Center of Gravity).

Impact Angle: 25.6°



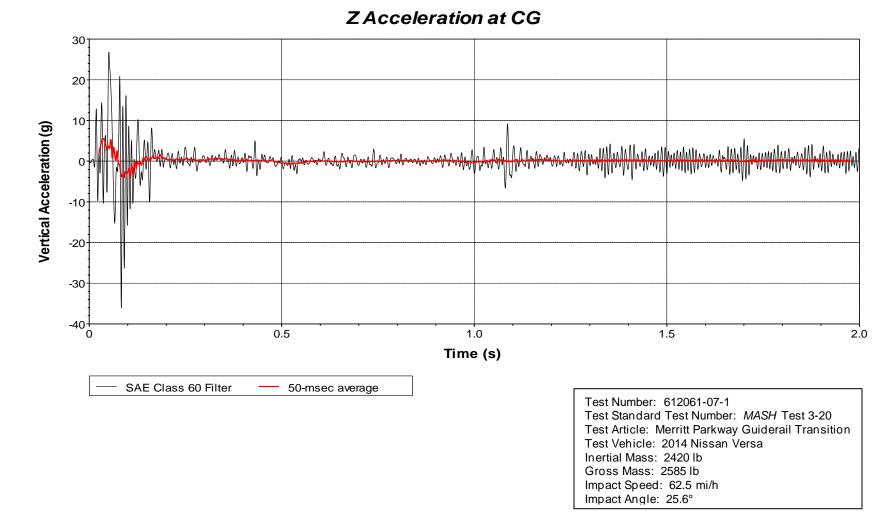


Figure D.6. Vehicle Vertical Accelerometer Trace for Test No. 612061-07-1 (Accelerometer Located at Center of Gravity).

258

D.4 *MASH* TEST 3-21 (CRASH TEST NO. 612061-06-1)

D.4.1. Vehicle Properties and Information

Date: 2	2020-10-12	Test I	No.: 61	2061-06-1	VIN No.:	1C6RR6	GT7ES2	11036
Year:	2014	Ma	ake:	RAM	Model:		1500	
Tire Size:	265/70 F	? 17		Tire	Inflation Pres	ssure:	35 p	si
Tread Type:	Highway				Odor	neter: <u>13036</u>	7	
Note any dar	mage to the	e vehicle pric	or to test:	None				
 Denotes a 	ccelerome	ter location.			▲X			
NOTES: No			4		*77			A
Engine Type Engine CID:	: V-8 5.7 L			M WHEEL TRACK			=1	N T
Transmission		—				-TEST IN	VERTIAL C. M.	· · ·
Auto FWD	or V RV	_ <u>L</u> Manu VD _□ 4		R	2+			
Optional Equ	lipment:		-	P-				a
None			[The second		2	
Dummy Data Type:	a: 50th P	ercentile Ma	le J-				P	-K L
Mass:		165 lb		◄ — F →	н		-D-	•
Seat Positio	on: <u>IMPAC</u>	T SIDE		7	м	E	√м	
Geometry:	inches			-	FRONT	- C	REAR	
A78	.50	F40.		20.00	_ P _	3.00	υ	26.75
В74	.00	G28	.00 L	30.00	_ Q _	30.50	V _	30.25
С227	.50	H59.		68.50	_ R _	18.00	W _	59.30
D44	.00	11.	.75 N	68.00	_ s _	13.00	х_	79.00
E <u>140</u>		J27.		46.00	_ T _	77.00	_	
Wheel Ce Height F		14.75	Whee Clearance (I		6.00	Bottom Frame Height - Fron		12.50
Wheel Ce Height R	nter	14.75	Whee Clearance (I Well	9.25	Bottom Frame Height - Rea	e	22.50
-				39 ±3 inches; G = > 28	-	0		-
GVWR Ratin	nas:	Mass	: lb	<u>Curb</u>	<u>Test li</u>	nertial	Gross	s Static
	3700	Mfror		2977		2892		2977
Back	3900	M _{rea}		2099		2114		2194
	6700	М _{тоt}		5076		5006		5171
Mass Distrit		LF: 145			-	35M = 5000 lb ±110 lb 1082		1032
lb		LF: 145	0 RF	. 1442	LR:	1002	RR:	1002

Table D.6. Vehicle Properties for Test No. 612061-06-1.

Table D.7. Measurements of Vehicle Vertical Center of Gravity for Test No.612061-06-1.

Date:202	20-1	10-12 T	est No.: _	612061-	06-1	VIN:		1C6RR6G	T7ES2110	36
Year:	2014 Make:		RAM	RAM Model: 1500			500			
Body Style:	Q	uad Cab				Mileage:	1	130367		
Engine: <u>5.7</u>	L	١	√-8		Trans	smission:	Autor	matic		
Fuel Level:	E	mpty	Ball	ast: <u>80</u>					(44	0 lb max)
Tire Pressu	re:	Front: <u>3</u>	<u>35 ps</u>	i Rea	ır: <u>35</u>	psi S	Size:	265/70 R	17	
Measured \	/eł	nicle Weig	ghts: (l	b)						
L	_F:	1450		RF:	1442		F	ront Axle:	2892	
L	.R:	1082		RR:	1032		R	ear Axle:	2114	
Le	eft:	2532		Right:	2474			Total:	5006	
								5000 I	I TO ID allowed	1
	Wh	eel Base:	140.50	inches	Track: F:	68.50	inche	es R:	68.00	inches
		148 ±12 inche	es allowed			Track = (F+R	R)/2 = 6	7 ±1.5 inches	s allowed	
Center of G	ira	vity, SAE	J874 Sus	pension M	ethod					
	X :	59.33	inches	Rear of F	ront Axle	(63 ±4 inches	s allowe	ed)		
	Y :	-0.40	inches	Left -	Right +	of Vehicle	e Cer	iterline		
	Z :	28	inches	Above Gr	ound	(minumum 28	B.0 inch	nes allowed)		
						_				
Hood H	eıg		46.00	-	Front	Bumper H	eight	:	27.00	inches
		43 ±4 II	nches allowed							
Front Over	har	-		-	Rear	Bumper H	eight	:	30.00	inches
		39 ±3 iı	nches allowed							
Overall Le	eng	th:	227.50	inches						
		237 ±1	3 inches allow	ed						

Date:	2020-10-12	Test No.:	612061-06-1	VIN No.:	1C6RR6GT7ES211036
Year:	2014	Make:	RAM	Model:	1500

Table D.8. Exterior Crush Measurements for Test No. 612061-06-1.

VEHICLE CRUSH MEASUREMENT SHEET¹

Complete Wh	en 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)	X1+X2
< 4 inches	2
≥ 4 inches	

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

	a		Damage								
Specific Impact Number	Plane* of C-Measurements	Width** (CDC)	Max*** Crush	Field L**	C_1	C_2	C_3	C_4	C_5	C_6	±D
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										

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

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

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

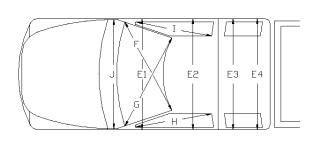
**Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle).

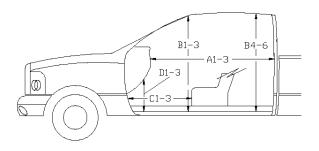
***Measure and document on the vehicle diagram the location of the maximum crush.

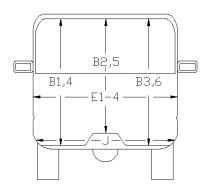
Note: Use as many lines/columns as necessary to describe each damage profile.

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
Н	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







0.100 s









Figure D.7. Sequential Photographs for Test No. 612061-06-1 (Overhead and Frontal Views).







0.500 s





0.600 s





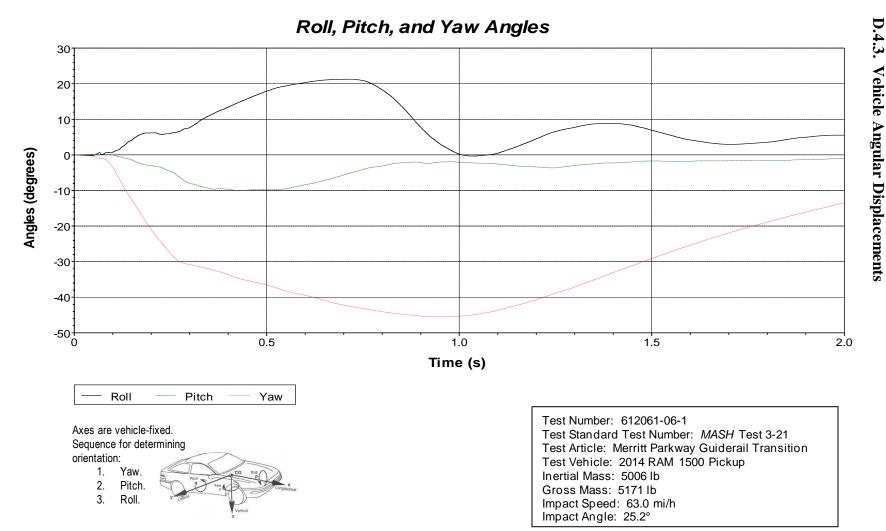


Figure D.7. Sequential Photographs for Test No. 612061-06-1 (Overhead and Frontal Views) (Continued).





Figure D.8. Sequential Photographs for Test No. 612061-06-1 (Rear View).



TR No. 612061-08-01

267

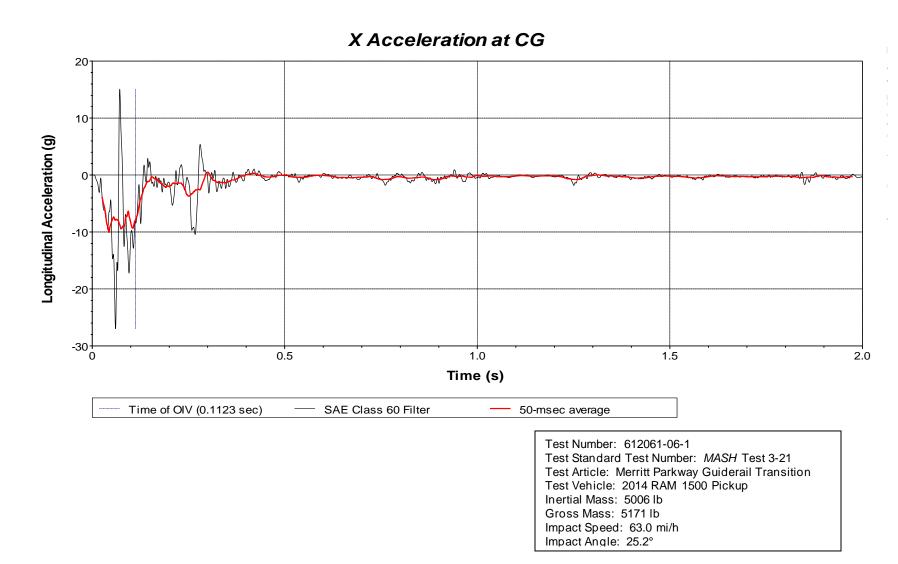
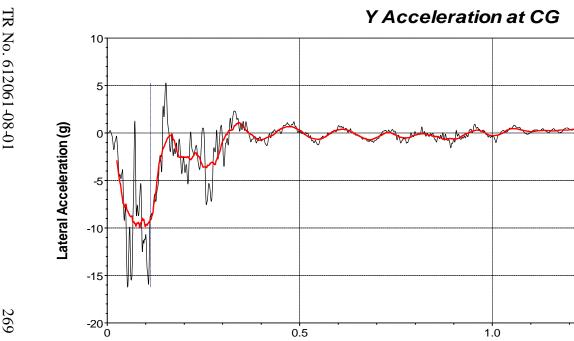


Figure D.10. Vehicle Longitudinal Accelerometer Trace for Test No. 612061-06-1 (Accelerometer Located at Center of Gravity).



0.5

1.0 Time (s)

Time of OIV (0.1123 sec) SAE Class 60 Filter 50-msec average

> 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°

1.5

2.0

Figure D.11. Vehicle Lateral Accelerometer Trace for Test No. 612061-06-1 (Accelerometer Located at Center of Gravity).

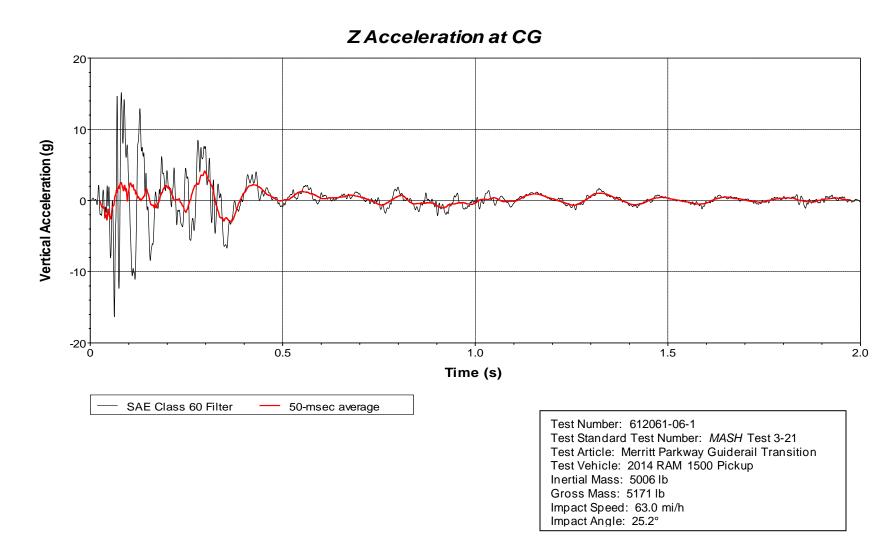


Figure D.12. Vehicle Vertical Accelerometer Trace for Test No. 612061-06-1 (Accelerometer Located at Center of Gravity).