TTI: 0-6968

Texas A&M Transportation Institute

MASH TL-3 EVALUATION OF TXDOT EXTRA-LARGE MAILBOXES

ISO 17025 Laboratory
Testing Certificate # 2821.01

Crash testing performed at:
TTI Proving Ground
3100 SH 47, Building 7091
Bryan, TX 77807

Test Report 0-6968-R9

Cooperative Research Program

TEXAS A&M TRANSPORTATION INSTITUTE
COLLEGE STATION, TEXAS

TEXAS DEPARTMENT OF TRANSPORTATION

in cooperation with the
Federal Highway Administration and the
Texas Department of Transportation
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16. Abstract

The purpose of the testing reported herein was to assess the performance of TxDOT's extra-large mailboxes according to the safety-performance evaluation guidelines included in AASHTO *MASH* for Test Level Three (TL-3) for support structures. The mailboxes tested were the single extra-large mailbox on Type 4 support, two architectural mailboxes and two medium mailboxes on a bent pipe support, and a single extra-large mailbox on Type 3 support.

The single Centennial model #950020B extra-large mailbox on Type 4 support performed acceptably for *MASH* Test 3-61.

The multiple mailboxes on a bent pipe support also showed the installation to performed acceptably for *MASH* Test 3-61.

The windshield of the test vehicle deformed 4.6 inches into the occupant compartment and the laminate was torn during *MASH* Test 3-61 on the single Centennial model #950020B extra-large mailbox on Type 3 support. The installation failed criterion D of *MASH*.

In a re-test after applying a modification to the connection bracket of the single Centennial model #950020B extra-large mailbox, the Type 3 support performed acceptably for *MASH* Test 3-61.

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and the
Federal Highway Administration

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DISCLAIMER

This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the FHWA or TxDOT. This report does not constitute a standard, specification, or regulation.

This report is not intended for construction, bidding, or permit purposes. The engineer (researcher) in charge of the project was Roger P. Bligh, P.E. TX#78550.

The United States Government and the State of Texas do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

TTI PROVING GROUND DISCLAIMER

The results of the crash testing reported herein apply only to the article being tested.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5(F-32)/9 or (F-32)/1.8	Celsius	°C
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	Square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lb/in^2

*SI is the symbol for the International System of Units

CHAPTER 1: INTRODUCTION

The purpose of the testing reported herein was to assess the performance of extra-large mailboxes according to the safety-performance evaluation guidelines included in AASHTO *MASH* for Test Level Three (TL-3) for support structures. The mailboxes tested were the single extra-large mailbox on Type 4 support, two architectural mailboxes and two medium mailboxes on a bent pipe support, and a single extra-large mailbox on Type 3 support (two tests).

CHAPTER 2: TEST REQUIREMENTS AND EVALUATION CRITERIA

2.1 CRASH TEST MATRIX

Table 2.1 shows the test conditions and evaluation criteria for *MASH* TL-3 for support structures. The impact performance of the mailbox supports was evaluated using *MASH* Test 3-61 with the 1100C small passenger car. The small passenger car is considered the critical design vehicle based on the mailbox mounting height that is dictated by the United States Postal Service. *MASH* Test 3-62 with the 2270P pickup truck was not performed. The taller hood height and longer wrap-around distance (i.e., the distance from the ground, around the front end, and across the hood to the base of the windshield) of the 2270P pickup truck significantly decreases the probability of windshield impact and occupant compartment intrusion.

MASH Test 3-61, performed on the mailboxes reported herein, involves an 1100C vehicle weighing 2420 lb ±55 lb and impacting the test article at an impact speed of 62 mi/h ±2.5 mi/h and critical impact angle (CIA) of 0-25° ±1.5°.

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

Test Article	Test Designation	Test Vehicle	Impact Conditions		Evaluation Criteria
			Speed	Angle	
Support Structures	3-60	1100C	19 mi/h	CIA	B, D, F, H, I, N
	3-61	1100C	62 mi/h	CIA	B, D, F, H, I, N
	3-62	2270P	62 mi/h	CIA	B, D, F, H, I, N

The crash tests and data analysis procedures were in accordance with guidelines presented in *MASH*. Chapter 3 presents brief descriptions of these procedures.

2.2 EVALUATION CRITERIA

The appropriate safety evaluation criteria from Tables 2-5 and 5-1 of *MASH* were used to evaluate the crash test reported herein. The test conditions and evaluation criteria required for *MASH* Test 3-61 are listed in Table 2.1, and the substance of the evaluation criteria in Table 2.2. Evaluations of the crash test results are presented in detail under the section Assessment of Test Results.

Table 2.2. Evaluation Criteria Required for *MASH* TL-3 Support Structures.

Evaluation Factors	Evaluation Criteria	
	B.	*The test article should readily activate in a predictable manner by breaking away, fracturing, or yielding.*
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.*
	F.	*The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.*
	H.	*Occupant impact velocities (OIV) should satisfy the following limits: Preferred value of 30 ft/s, or maximum allowable value of 40 ft/s.*
	I.	*The occupant ridedown accelerations should satisfy the following: Preferred value of 15.0 g, or maximum allowable value of 20.49 g.*
Post-Impact Vehicular Response	*N.*	*Vehicle trajectory behind the test article is acceptable.*

CHAPTER 3: TEST CONDITIONS

3.1 TEST FACILITY

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

The test facilities of the TTI Proving Ground are located on the Texas A&M University System RELLIS Campus, which consists of a 2000-acre complex of research and training facilities situated 10 miles northwest of the flagship campus of Texas A&M University. The site, formerly a United States Army Air Corps base, has large expanses of concrete runways and parking aprons well suited for experimental research and testing in the areas of vehicle performance and handling, vehicle-roadway interaction, durability and efficacy of highway pavements, and evaluation of roadside safety hardware and perimeter protective devices. The site selected for installation and testing of the mailboxes and supports was in a cleared block within 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 test vehicle was towed into the test installation using a steel cable guidance and reverse tow system. A steel cable for guiding the test vehicle was tensioned along the path, anchored at each end, and threaded through an attachment to the front wheel of the test vehicle. An additional steel cable was connected to the test vehicle, passed around a pulley near the impact point, through a pulley on the tow vehicle, and then anchored to the ground such that the tow vehicle moved away from the test site. A 2:1 speed ratio between the test and tow vehicle existed with this system. Just prior to impact with the installation, the test vehicle was released and ran unrestrained. The vehicle remained freewheeling (i.e., no steering or braking inputs) until it cleared the immediate area of the test site (no sooner than 2 s after impact), after which the brakes were activated, if needed, to bring the test vehicle to a safe and controlled stop.

3.3 DATA ACQUISITION SYSTEMS

3.3.1 Vehicle Instrumentation and Data Processing

Each test vehicle was instrumented with a self-contained, on-board data acquisition system. The signal conditioning and acquisition system is a 16-channel, Tiny Data Acquisition System (TDAS) Pro produced by Diversified Technical Systems, Inc. The accelerometers, which measure the x, y, and z axis of vehicle acceleration, are strain gauge type with linear millivolt output proportional to acceleration. Angular rate sensors, measuring vehicle roll, pitch, and yaw rates, are ultra-small, solid state units designed for crash test service. The TDAS Pro hardware and software conform to the latest SAE J211, Instrumentation for Impact Test. Each of the 16 channels can provide 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 values per second with a resolution of one part in 65,536. Once data are recorded, internal batteries back these up inside the unit should the primary battery cable be severed. Initial contact of the pressure switch on the vehicle bumper provides a time zero mark and initiates the recording process. After each test, the data are downloaded from the TDAS Pro unit into a laptop computer at the test site. The Test Risk Assessment Program (TRAP) software then processes the raw data to produce detailed reports of the test results.

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

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

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

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 the side opposite of impact in the 1100C vehicle. The dummy was not instrumented.

3.3.3 Photographic Instrumentation and Data Processing

Photographic coverage of each test included two digital high-speed cameras:

- One placed behind the installation at an angle.
- One placed to have a field of view perpendicular to and aligned with the installation.

A flashbulb on the impacting vehicle was activated by a pressure-sensitive tape switch to indicate the instant of contact with the 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.

CHAPTER 4:
MASH TEST 3-61 ON CENTENNIAL MODEL EXTRA-LARGE MAILBOX ON TYPE 4 SUPPORT

4.1 TEST ARTICLE AND INSTALLATION DETAILS

The test installation consisted of an Architectural Mailboxes© Centennial model #950020B extra-large mailbox mounted on a 2⅜-inch OD × 0.095-inch wall white steel tube post. The mailbox was attached to the post using a model DHT# 161443 mailbox bracket. Two steel plate washers (each measuring 2×5½×⅛-inch thick) and four $^{5}/_{16}$-inch diameter hex bolts that secured the bracket assembly to the floor of the mailbox, and a $^{5}/_{16}$-inch bolt secured the bracket to the post.

The post was inserted into a plastic socket and secured with a plastic wedge. This wedge socket was set in an un-reinforced cylindrical concrete foundation measuring 12-inches in diameter × 30-inches deep. The bottom of the mailbox was located 42 inches above grade.

Figure 4.1 presents overall information on the single Centennial model extra-large mailbox on a Type 4 support, Figure 4.2 shows the connection details, and Figure 4.3 provides photographs of the installation. Appendix A.1 provides further details of the mailbox installation.

4.2 DESIGN MODIFICATIONS DURING TESTS

No modifications were made to the installation during the testing phase.

4.3 MATERIAL SPECIFICATIONS

The drawings in Appendix A.1 indicate properties of the materials used to install/construct the Centennial model extra-large mailbox on a Type 4 support.

4.4 SOIL CONDITIONS

The test installation was set in an un-reinforced concrete cylinder in standard soil meeting AASHTO standard specifications for “Materials for Aggregate and Soil Aggregate Subbase, Base and Surface Courses,” designated M147-65(2004), grading B.

4.5 TEST DESIGNATION AND ACTUAL IMPACT CONDITIONS

MASH Test 3-61 involves an 1100C vehicle weighing 2420 lb ±55 lb impacting the support structure at an impact speed of 62 mi/h ±2.5 mi/h and a CIA of 0° ±1.5°. The target impact point for *MASH* Test 3-61 on the Centennial model extra-large mailbox on a Type 4 support was the vehicle’s right (passenger’s side) approximate quarter point, which was aligned with the centerline of the support.

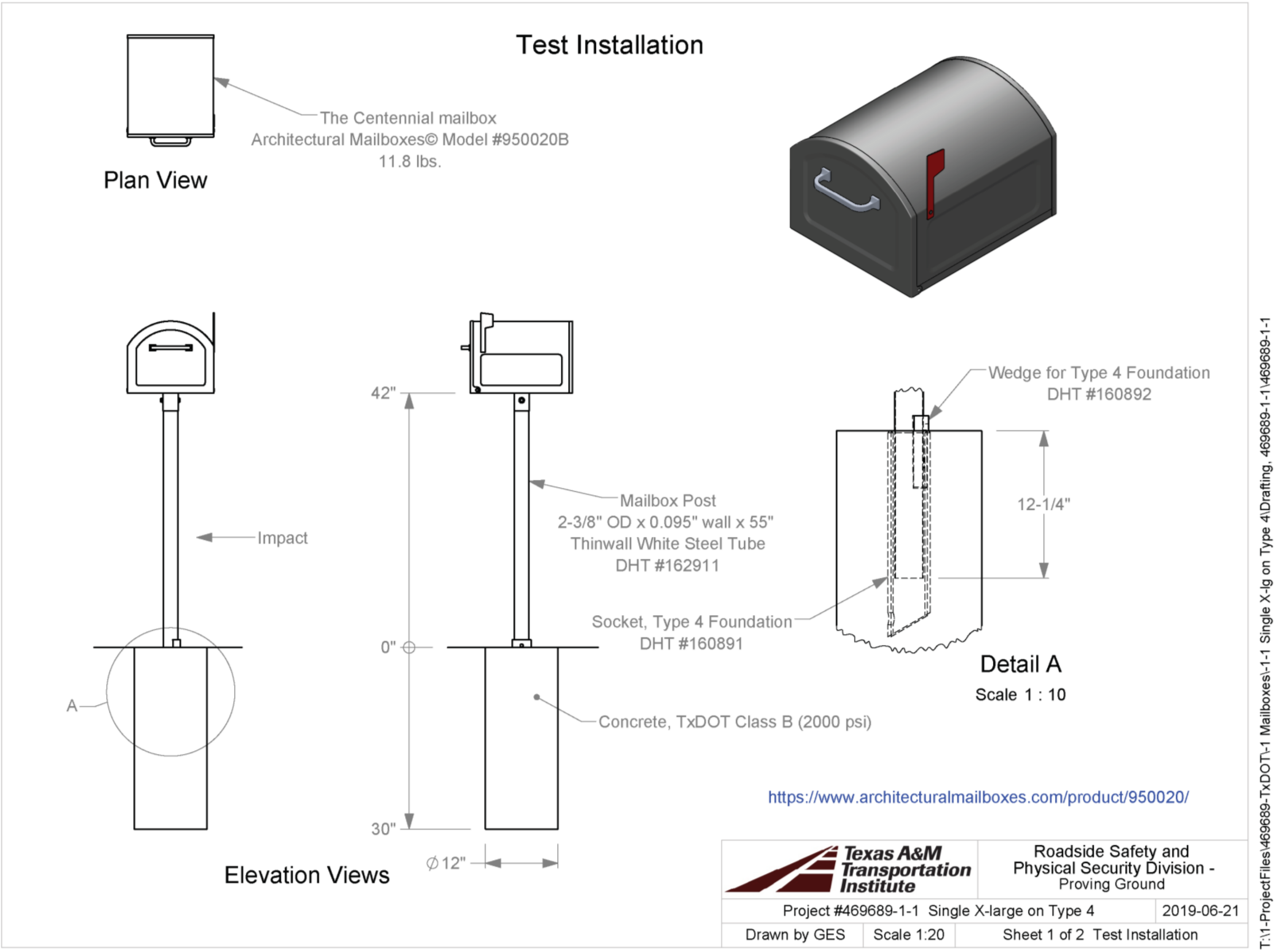


Figure 4.1. Overall Details of Centennial Model Extra-Large Mailbox on Type 4 Support.

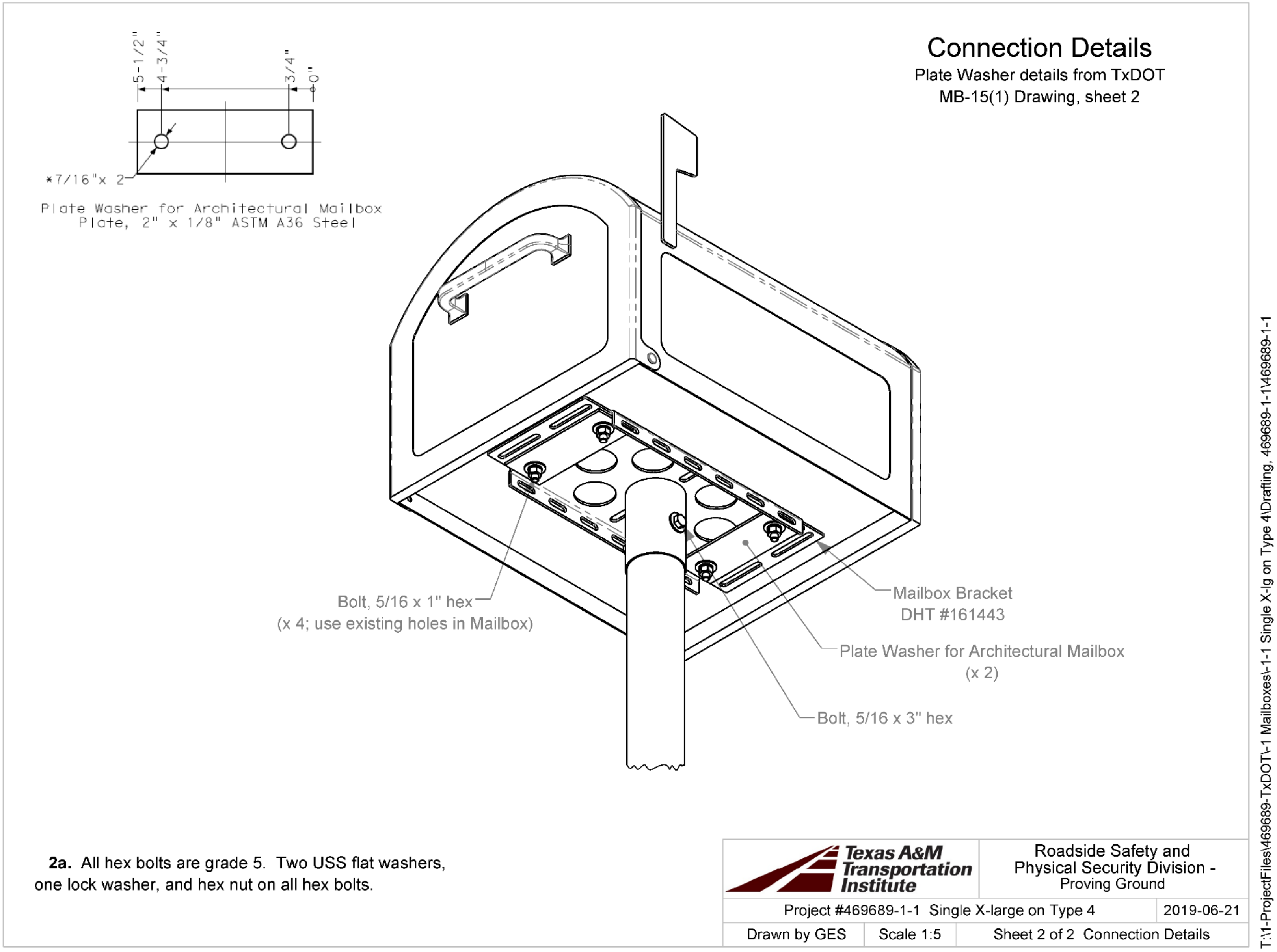


Figure 4.2. Connection Details for Centennial Model Extra-Large Mailbox on Type 4 Support.

Figure 4.3. Centennial Model Extra-Large Mailbox on Type 4 Support prior to Testing.

The 2008 Kia Rio* used in the test weighed 2432 lb, and the actual impact speed and angle were 63.6 mi/h and 0°, respectively. The actual impact point was the right (passenger's side) quarter point of the front of the vehicle aligned with the centerline of the support. Minimum target kinetic energy (KE) was 288 kip-ft, and actual KE was 329 kip-ft.

* The 2008 model vehicle used is older than the 6-year age noted in *MASH* and was selected based upon availability. An older model vehicle is permitted by AASHTO as long as it is otherwise *MASH* compliant. Other than the vehicle's year model, this 2008 model vehicle met the *MASH* requirements.

4.6 WEATHER CONDITIONS

The test was performed on the morning of June 27, 2019. Weather conditions at the time of testing were as follows: wind speed: 1 mi/h; wind direction: 192° (vehicle was traveling at magnetic heading of 180°); temperature: 83°F; relative humidity: 90 percent.

4.7 TEST VEHICLE

Figures 4.4 and 4.5 show the 2008 Kia Rio used for the crash test. The vehicle's test inertia weight was 2432 lb, and its gross static weight was 2597 lb. The height to the lower edge of the vehicle bumper was 7.75 inches, and height to the upper edge of the bumper was 21.5 inches. Table A.1 in Appendix A.2 gives additional dimensions and information on the vehicle. The vehicle was directed into the installation using the cable reverse tow and guidance system, and was released to be freewheeling and unrestrained just prior to impact.

Figure 4.4. Mailbox/Test Vehicle Geometrics for Test No. 469689-1-1.

Figure 4.5. Test Vehicle before Test No. 469689-1-1.

4.8 TEST DESCRIPTION

The test vehicle was traveling at an impact speed of 63.6 mi/h when it contacted the mailbox support with the right quarter point of the front of the vehicle aligned with the centerline of the support at an impact angle of 0°. Table 4.1 lists events that occurred during Test No. 469689-1-1. Figure A.1 in Appendix A.3 presents sequential photographs during the test.

Table 4.1. Events during Test No. 469689-1-1.

TIME (s)	EVENTS
0.0000	Vehicle contacts mailbox support
0.0060	Mailbox support begins to lift out of base
0.0250	Mailbox support separates from base
0.0270	Mailbox impacts hood of vehicle
0.0740	Vehicle loses contact with mailbox and support while traveling at 62.3 mi/h

Brakes on the vehicle were applied at 0.9 s after impact, and the vehicle subsequently came to rest 270 ft downstream of the impact.

4.9 DAMAGE TO TEST INSTALLATION

Figure 4.6 shows the damage to the mailbox. The post pulled out of the socket. The mailbox separated into three pieces. The top, sides, and back stayed together and landed 99 ft downstream, and the mailbox door landed 102 ft downstream and 25 ft left. The bottom of the mailbox remaining attached to the post, which stayed engaged with the front of the test vehicle until it stopped, then slid to a stop 7 ft past the vehicle.

4.10 DAMAGE TO TEST VEHICLE

Figure 4.7 shows the damage sustained by the vehicle. There was a 2-inch dent in the front bumper at the right quarter point. The hood received a 33-inch × 23-inch dent in the right side of the hood with a 0.5-inch × 3-inch cut and a 0.5-inch × 1.5-inch cut. The right upper windshield sustained a 1-inch × 1-inch break near the roof line. Maximum exterior crush to the vehicle was 2.0 inches in the front plane at the right quarter point at bumper height. No occupant compartment deformation or intrusion was observed. Figure 4.8 shows the interior of the vehicle. Tables A.2 and A.3 in Appendix A.2 provide exterior crush and occupant compartment measurements.

4.11 OCCUPANT RISK FACTORS

Data from the accelerometer, located at the vehicle center of gravity, were digitized for evaluation of occupant risk and are shown in Table 4.2. Figure 4.9 summarizes these data and other pertinent information from the test. Figure A.2 in Appendix A.4 shows the vehicle angular displacements, and Figures A.3 through A.5 in Appendix A.5 show accelerations versus time traces.

Figure 4.6. Mailbox after Test No. 469689-1-1.

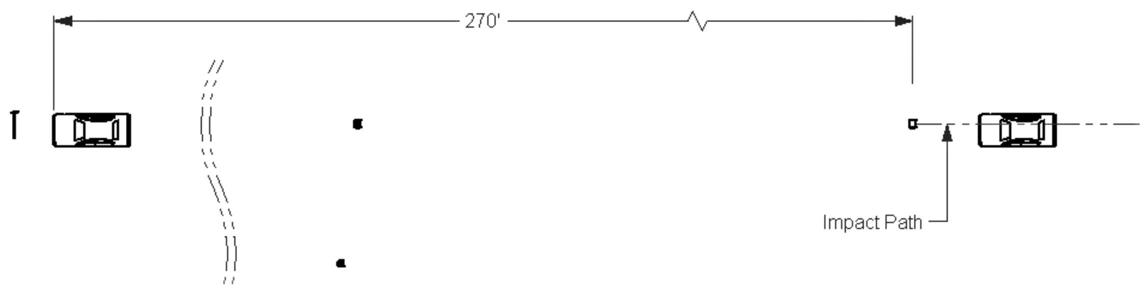
Figure 4.7. Test Vehicle after Test No. 469689-1-1.

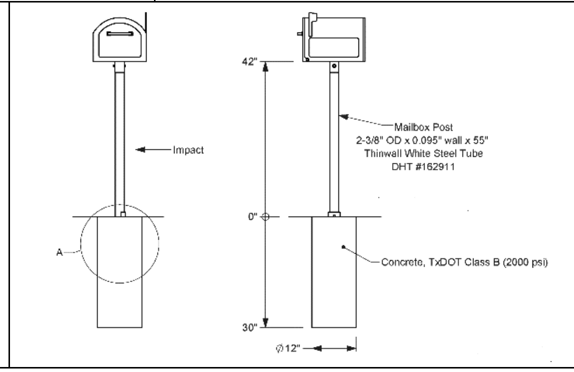
Figure 4.8. Interior of Test Vehicle after Test No. 469689-1-1.

Table 4.2. Occupant Risk Factors for Test No. 469689-1-1.

Occupant Risk Factor	Value	Time
Occupant Impact Velocity (OIV)		
Longitudinal	**2.0 ft/s**	at 0.8275 s on left side of interior
Lateral	**1.6 ft/s**	
Occupant Ridedown Accelerations		
Longitudinal	**0.8 g**	0.9703–0.9803 s
Lateral	**0.3 g**	0.9502–0.9602 s
Theoretical Head Index Velocity (THIV)	**2.8 km/h**	at 0.7897 s on left side of interior
Post Head Deceleration (PHD)	**0.8 g**	0.9703–0.9803 s
Acceleration Severity Index (ASI)	**0.12**	0.0101–0.0601 s
Maximum 50-ms Moving Average		
Longitudinal	**−1.1 g**	0.0000–0.0500 s
Lateral	**−0.4 g**	0.0257–0.0757 s
Vertical	**0.9 g**	0.0258–0.0758 s
Maximum Roll, Pitch, and Yaw Angles		
Roll	**2°**	1.0000 s
Pitch	**1°**	0.9930 s
Yaw	**4°**	1.0000 s

0.000 s | 0.050 s | 0.100 s | 0.150 s





General Information
- Test Agency .... Texas A&M Transportation Institute (TTI)
- Test Standard Test No. .... MASH Test 3-61
- TTI Test No. 469689-1-1
- Test Date 2019-06-27

Test Article
- Type .... Support Structure – Mailbox
- Name .... Centennial Extra-Large Mailbox
- Installation Height .... 42 inches to the bottom of the mailbox
- Material or Key Elements .... Single Centennial Model Extra-Large Mailbox on Type 4 Support

Soil Type and Condition .... Concrete foundation in AASHTO M147-65(2004), grading B Soil

Test Vehicle
- Type/Designation 1100C
- Make and Model .... 2008 Kia Rio
- Curb .... 2477 lb
- Test Inertial .... 2432 lb
- Dummy .... 165 lb
- Gross Static .... 2597 lb

Impact Conditions
- Speed .... 63.6 mi/h
- Angle .... 0°
- Location/Orientation .... Right Qtr Point

Impact Severity .... 329 kip-ft

Exit Conditions
- Speed .... 62.3 mi/h
- Angle .... NA

Occupant Risk Values
- Longitudinal OIV .... 2.0 ft/s
- Lateral OIV .... 1.6 ft/s
- Longitudinal Ridedown .... 0.8 g
- Lateral Ridedown .... 0.3 g
- THIV .... 2.8 km/h
- PHD .... 0.8 g
- ASI 0.12

Max. 0.050-s Average
- Longitudinal .... -1.1 g
- Lateral .... -0.4 g
- Vertical .... 0.9 g

Post-Impact Trajectory
- Stopping Distance .... 270 ft

Vehicle Stability
- Maximum Yaw Angle .... 4°
- Maximum Pitch Angle .... 1°
- Maximum Roll Angle .... 2°

Test Article Debris Scatter
- Longitudinal .... 277 ft
- Lateral .... 25 ft

Vehicle Damage
- VDS 12FR1
- CDC 12FREN1
- Max. Exterior Deformation .... 2.0 inches
- OCDI FS0000000
- Max. Occupant Compartment Deformation .... None

Figure 4.9. Summary of Results for *MASH* Test 3-61 on Single Centennial Model Extra-Large Mailbox on Type 4 Support.

CHAPTER 5: *MASH* TEST 3-61 ON MULTIPLE MAILBOXES ON BENT PIPE SUPPORT

5.1 TEST ARTICLE AND INSTALLATION DETAILS

The test installation consisted of two Architectural Mailboxes© Oasis Jr. Elite model #620010B-10 and two No. 1-A standard mailboxes (medium) model #E1600B00 mounted on a bent post.

Each standard mailbox was attached to the bent post via angle brackets using a model DHT# 148939 mailbox bracket and one bracket extension, which were secured to the lower side flanges of the mailbox with six (three each side) ¼-inch diameter hex bolts.

Each Oasis Jr. mailbox was attached to the bent post via angle brackets using a model DHT# 148939 mailbox bracket. Two steel plate washers (each measuring 2×5½×⅛-inch thick) and four ⅜-inch diameter hex bolts that secured the bracket assembly to the floor of the mailbox.

The bent post was fabricated from 2-inch × 0.1090 (12-gauge) HSS round, inserted into a V-wing socket and held in place with a wedge for the V-wing socket. The V-wing socket was cast in a nonreinforced cylindrical concrete foundation measuring 12-inch diameter × 30-inch deep. The bottoms of the mailboxes were located 42 inches above grade.

TxDOT investigated the crashworthiness behavior of locking architectural mailboxes and standard mailboxes on the same type of multiple-mount support with use of an 11-gauge steel tube under project 9-1002-15-7 (*2*). A 12-gauge was preferred for the same type of multiple-mount support for this project, given that the 12-gauge support is readily available, while the 11-gauge would need to be fabricated upon request and would be a more costly product. With the 12-gauge support being thinner than the 11-gauge support, TTI researchers needed to verify the proper crashworthiness behavior of the 12-gauge system under high-speed impact conditions. Based on mailbox weight and dimension comparison, the tested mailbox combination installation was considered to be more critical from a crashworthiness perspective under high-speed impacts.

Figure 5.1 presents overall information on the multiple mailboxes on bent pipe support, Figure 5.2 shows the connection details, and Figure 5.3 provides photographs of the installation. Appendix B.1 provides further details of the mailbox installation.

5.2 DESIGN MODIFICATIONS DURING TESTS

No modifications were made to the installation during the testing phase.

5.3 MATERIAL SPECIFICATIONS

The drawings in Appendix B.1 indicate properties of the materials used to install/construct the multiple mailboxes on bent pipe support.

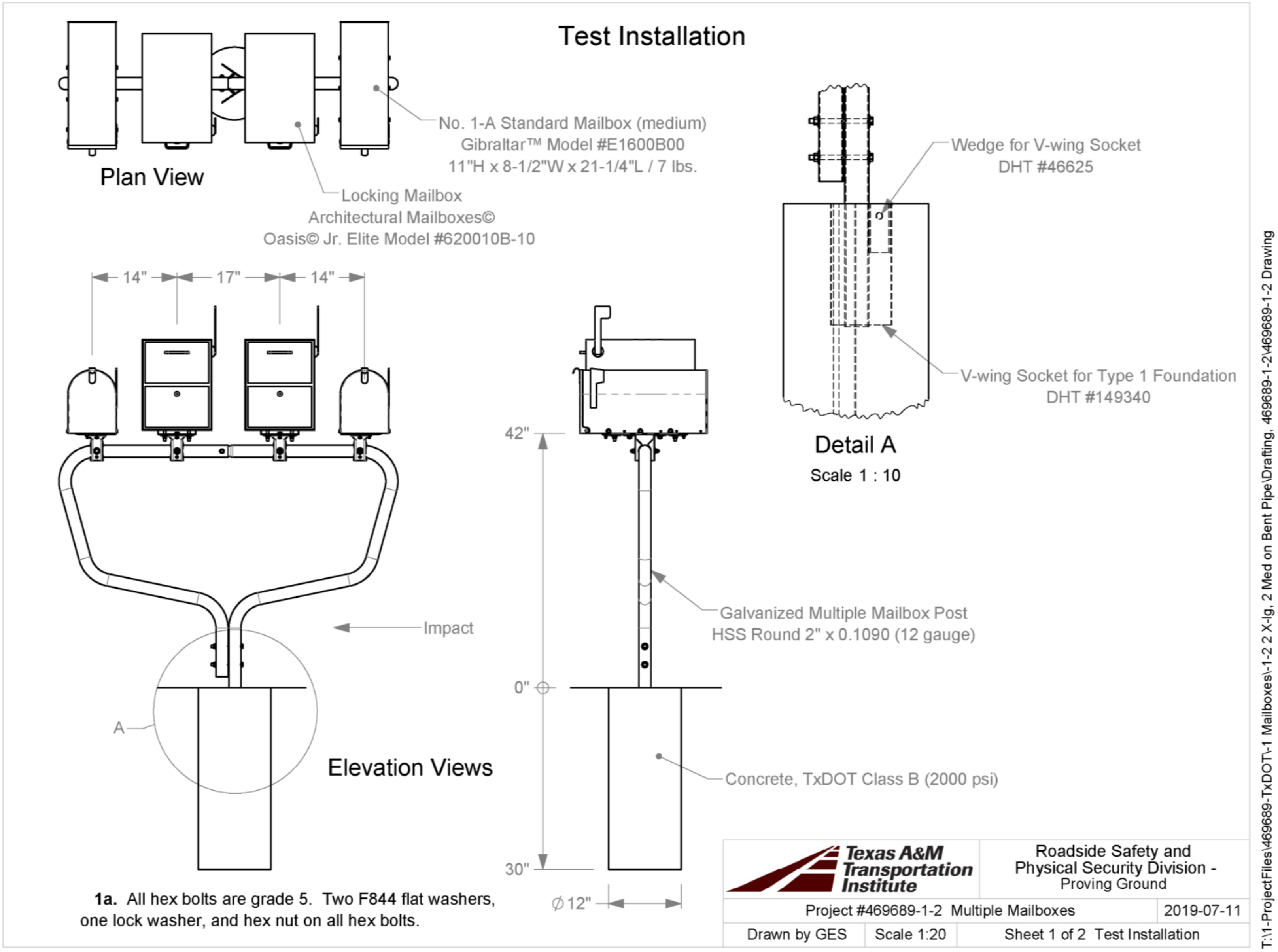


Figure 5.1. Overall Details of Multiple Mailboxes on Bent Pipe Support.

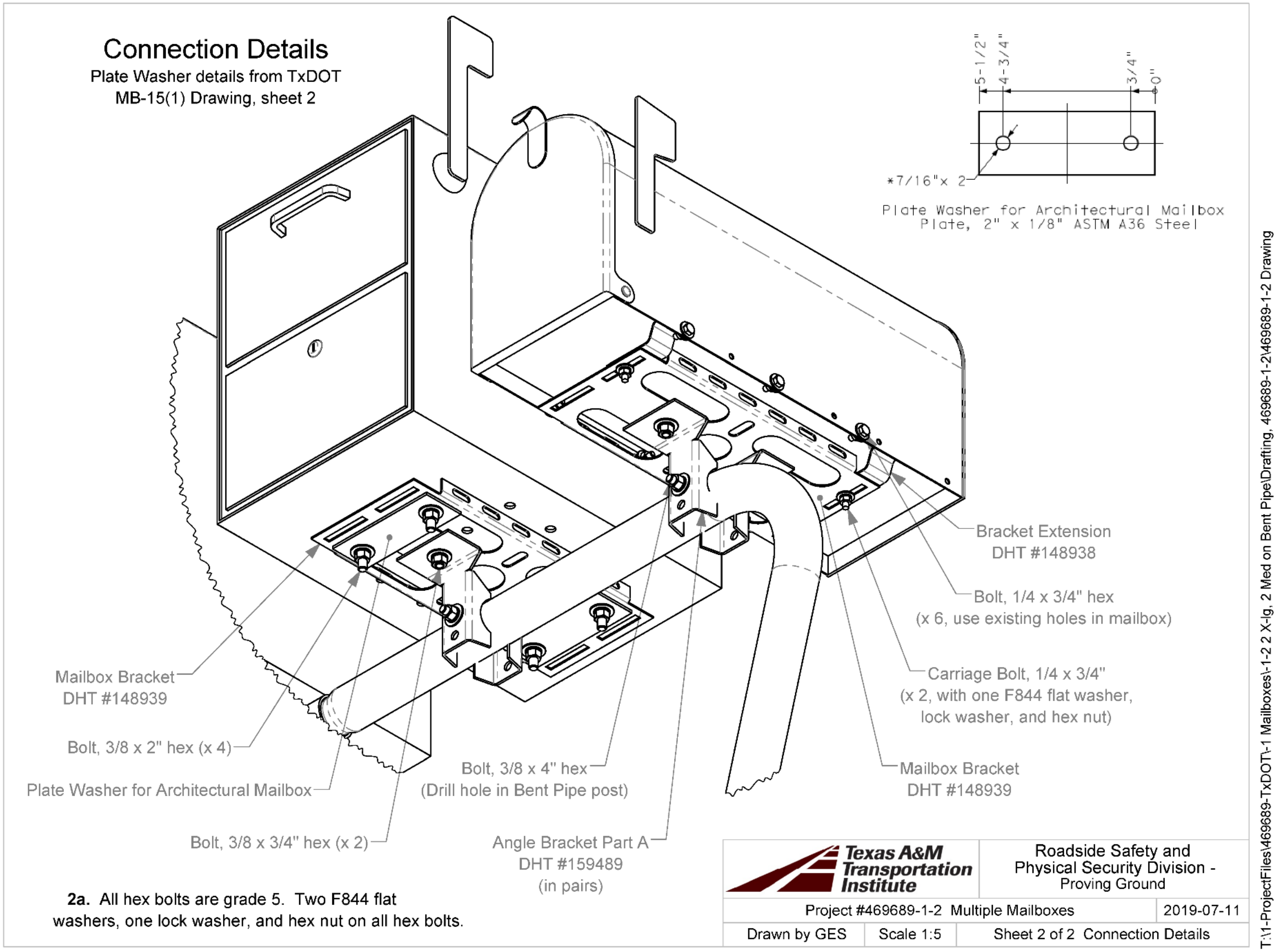


Figure 5.2. Connection Details of Multiple Mailboxes on Bent Pipe Support.

Figure 5.3. Multiple Mailboxes on Bent Pipe Support prior to Testing.

5.4 SOIL CONDITIONS

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

5.5 TEST DESIGNATION AND ACTUAL IMPACT CONDITIONS

MASH Test 3-61 involves an 1100C vehicle weighing 2420 lb ±55 lb impacting the support structure at an impact speed of 62 mi/h ±2.5 mi/h and a CIA of 0° ±1.5°. The target impact point for *MASH* Test 3-61 on the multiple mailboxes on a bent pipe support was the left (driver's side) approximate quarter point aligned with the centerline of the support.

The 2008 Kia Rio* used in the test weighed 2442 lb, and the actual impact speed and angle were 61.6 mi/h and 0°, respectively. The actual impact point was the left (driver's side) quarter point aligned with the centerline of the support. Minimum target KE was 288 kip-ft, and actual KE was 310 kip-ft.

5.6 WEATHER CONDITIONS

The test was performed on the morning of August 23, 2019. Weather conditions at the time of testing were as follows: wind speed: 4 mi/h; wind direction: 192° (vehicle was traveling at magnetic heading of 180°); temperature: 85°F; relative humidity: 82 percent.

5.7 TEST VEHICLE

Figures 5.4 and 5.5 show the 2008 Kia Rio used for the crash test. The vehicle's test inertia weight was 2442 lb, and its gross static weight was 2607 lb. The height to the lower edge of the vehicle bumper was 7.75 inches, and height to the upper edge of the bumper was 21.5 inches. Table B.1 in Appendix B.2 gives additional dimensions and information on the vehicle. The vehicle was directed into the installation using the cable reverse tow and guidance system, and was released to be freewheeling and unrestrained just prior to impact.

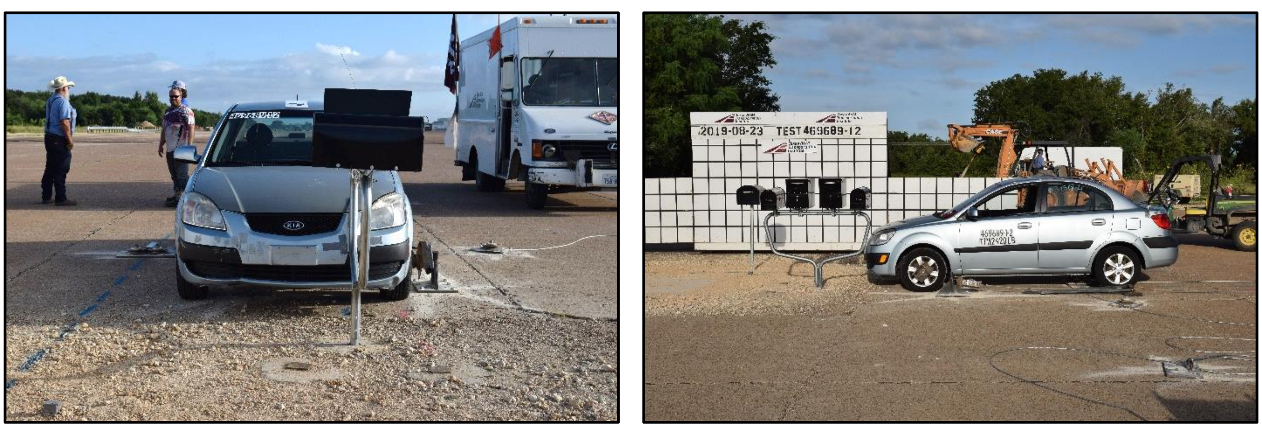


Figure 5.4. Mailboxes/Test Vehicle Geometrics for Test No. 469689-1-2.

* The 2008 model vehicle used is older than the 6-year age noted in *MASH* and was selected based upon availability. An older model vehicle is permitted by AASHTO as long as it is otherwise *MASH* compliant. Other than the vehicle's year model, this 2008 model vehicle met the *MASH* requirements.

Figure 5.5. Test Vehicle before Test No. 469689-1-2.

5.8 TEST DESCRIPTION

The test vehicle was traveling at an impact speed of 61.6 mi/h when it contacted the mailbox installation with the left (driver's side) quarter point aligned with the centerline of the support at an impact angle of 0°. Table 5.1 lists events that occurred during Test No. 469689-1-2. Figure B.1 in Appendix B.3 presents sequential photographs during the test.

Table 5.1. Events during Test No. 469689-1-2.

TIME (s)	EVENTS
0.0000	Vehicle contacts mailboxes on bent pipe support
0.0120	Bent post begins to pull out of V-Wing socket
0.0320	Bent post fully out of socket
0.0890	Vehicle loses contact with mailboxes and bent pipe support

Brakes on the vehicle were applied at 2.5 s after impact, and the vehicle subsequently came to rest 360 ft downstream of the impact.

5.9 DAMAGE TO TEST INSTALLATION

Figure 5.6 shows the damage to the mailbox installation. The bent post pulled out of the V-Wing Socket. The post and mailbox assembly remained intact and landed 115 ft downstream from the impact point.

5.10 DAMAGE TO TEST VEHICLE

Figure 5.7 shows the damage sustained by the vehicle. The front bumper, radiator support, and left headlight were damaged. The hood sustained a 19-inch × 28-inch × 9-inch deep indentation on the front left half of the hood. Maximum exterior crush to the vehicle was 9.0 inches in the hood. No occupant compartment deformation or intrusion was observed.

Figure 5.8 shows the interior of the vehicle. Tables B.2 and B.3 in Appendix B.2 provide exterior crush and occupant compartment measurements.

Figure 5.6. Mailboxes after Test No. 469689-1-2.

Figure 5.7. Test Vehicle after Test No. 469689-1-2.

Figure 5.8. Interior of Test Vehicle for Test No. 469689-1-2.

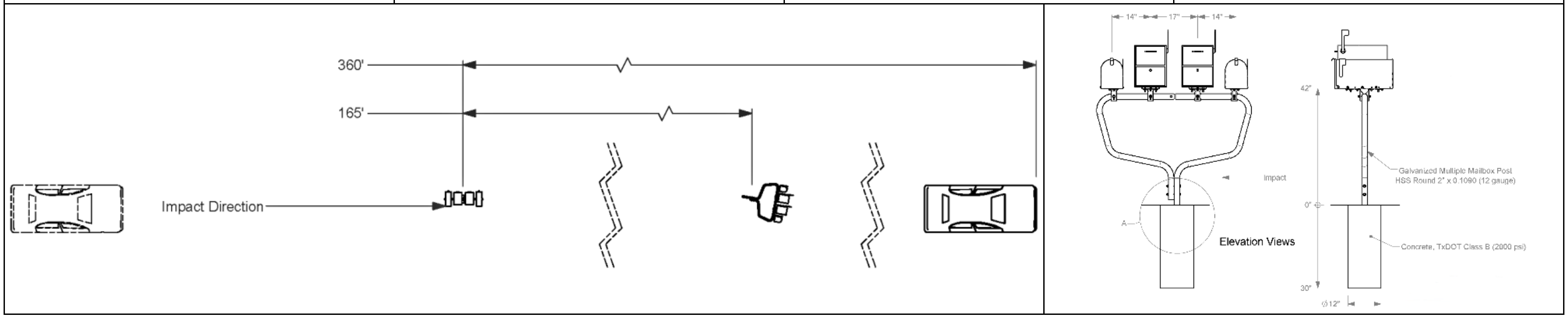
5.11 OCCUPANT RISK FACTORS

Data from the accelerometer, located at the vehicle center of gravity, were digitized for evaluation of occupant risk and are shown in Table 5.2. Figure 5.8 summarizes these data and other pertinent information from the test. Figure B.2 in Appendix B.4 shows the vehicle angular displacements, and Figures B.3 through B.5 in Appendix B.5 show accelerations versus time traces.

Table 5.2. Occupant Risk Factors for Test No. 469689-1-2.

Occupant Risk Factor	Value	Time
OIV		
Longitudinal	**3.6 ft/s**	at 0.5963 s on front of interior
Lateral	**0.0**	
Occupant Ridedown Accelerations		
Longitudinal	**0.3 g**	0.9787–0.9887
Lateral	**0.6 g**	0.6062–0.6162 s
THIV	**4.0 km/h**	at 0.5957 s on front of interior
PHD	**0.6 g**	0.6060–0.6160 s
ASI	**0.21**	0.0134–0.0634 s
Maximum 50-ms Moving Average		
Longitudinal	**−1.9 g**	0.0018–0.0518 s
Lateral	**−0.5 g**	0.0761–0.1261 s
Vertical	**−1.2 g**	0.0301–0.0801 s
Maximum Roll, Pitch, and Yaw Angles		
Roll	**4°**	2.0000 s
Pitch	**2°**	1.6547 s
Yaw	**3°**	0.3983 s

0.000 s | 0.050 s | 0.100 s | 0.200 s



General Information

Test Agency	Texas A&M Transportation Institute (TTI)
Test Standard Test No.	MASH Test 3-61
TTI Test No.	469689-1-2
Test Date	2019-08-23
Test Article	
Type	Support Structure – Mailbox
Name	Multiple Mailboxes on Bent Pipe Support
Installation Height	42 inches to bottom of mailboxes
Material or Key Elements	2 inch × 0.1090 (12-gauge) HSS round, inserted into a V-Wing Socket and held in place with a Wedge for the V-Wing Socket
Soil Type and Condition	Concrete foundation in AASHTO M147-65(2004), grading B Soil
Test Vehicle	
Type/Designation	1100C
Make and Model	2008 Kia Rio
Curb	2477 lb
Test Inertial	2442 lb
Dummy	165 lb
Gross Static	2607 lb

Impact Conditions

Speed	61.6 mi/h
Angle	0°
Location/Orientation	Apx. Left Qtr Point
Impact Severity	310 kip-ft
Exit Conditions	
Speed	59.0 mi/h
Angle	0°
Occupant Risk Values	NA
Longitudinal OIV	3.6 ft/s
Lateral OIV	0.0 ft/s
Longitudinal Ridedown	0.3 g
Lateral Ridedown	0.6 g
THIV	4.0 km/h
PHD	0.6 g
ASI	0.21
Max. 0.050-s Average	
Longitudinal	−1.9 g
Lateral	−0.5 g
Vertical	−1.2 g

Post-Impact Trajectory

Stopping Distance	360 ft downstream

Vehicle Stability

Maximum Yaw Angle	3°
Maximum Pitch Angle	2°
Maximum Roll Angle	4°

Test Article Debris Scatter

Longitudinal	115 ft
Lateral	3 ft

Vehicle Damage

VDS	12LF2
CDC	12FLEN2
Max. Exterior Deformation	9.0 inches
OCDI	FL0000000
Max. Occupant Compartment Deformation	None

Figure 5.9. Summary of Results for *MASH* Test 3-61 on Multiple Mailboxes on Bent Pipe Support.

CHAPTER 6:
MASH TEST 3-61 ON CENTENNIAL MODEL EXTRA-LARGE MAILBOX ON TYPE 3 SUPPORT

6.1 TEST ARTICLE AND INSTALLATION DETAILS

The test installation consisted of a single Architectural Mailboxes© Centennial model #950020B extra-large mailbox mounted on a 2-lb/ft perforated U-channel post. The mailbox was attached to the post via angle brackets using a model DHT# 148939 mailbox bracket. Two steel plate washers (each measuring 2×5½×⅛-inch thick) and four $^{5}/_{16}$-inch diameter hex bolts secured the bracket assembly to the floor of the mailbox.

The post was embedded 30 inches into the soil. The bottom of the mailbox was located 42 inches above grade.

Figure 6.1 presents overall information on the single Centennial model extra-large mailbox on a Type 3 support, Figure 6.2 shows the connection details, and Figure 6.3 provides photographs of the installation. Appendix C.1 provides further details of the mailbox installation.

6.2 DESIGN MODIFICATIONS DURING TESTS

No modifications were made to the installation during the testing phase.

6.3 MATERIAL SPECIFICATIONS

The drawings in Appendix C.1 indicate properties of the materials used to install/construct the Centennial Model #950020B extra-large mailbox on a Type 3 support.

6.4 SOIL CONDITIONS

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

6.5 TEST DESIGNATION AND ACTUAL IMPACT CONDITIONS

MASH Test 3-61 involves an 1100C vehicle weighing 2420 lb ±55 lb impacting the support structure at an impact speed of 62 mi/h ±2.5 mi/h and a CIA of 0° ±1.5°. The target impact point for *MASH* Test 3-61 on the Centennial extra-large mailbox on a Type 3 support was the left (driver's side) quarter point aligned with the centerline of the support.

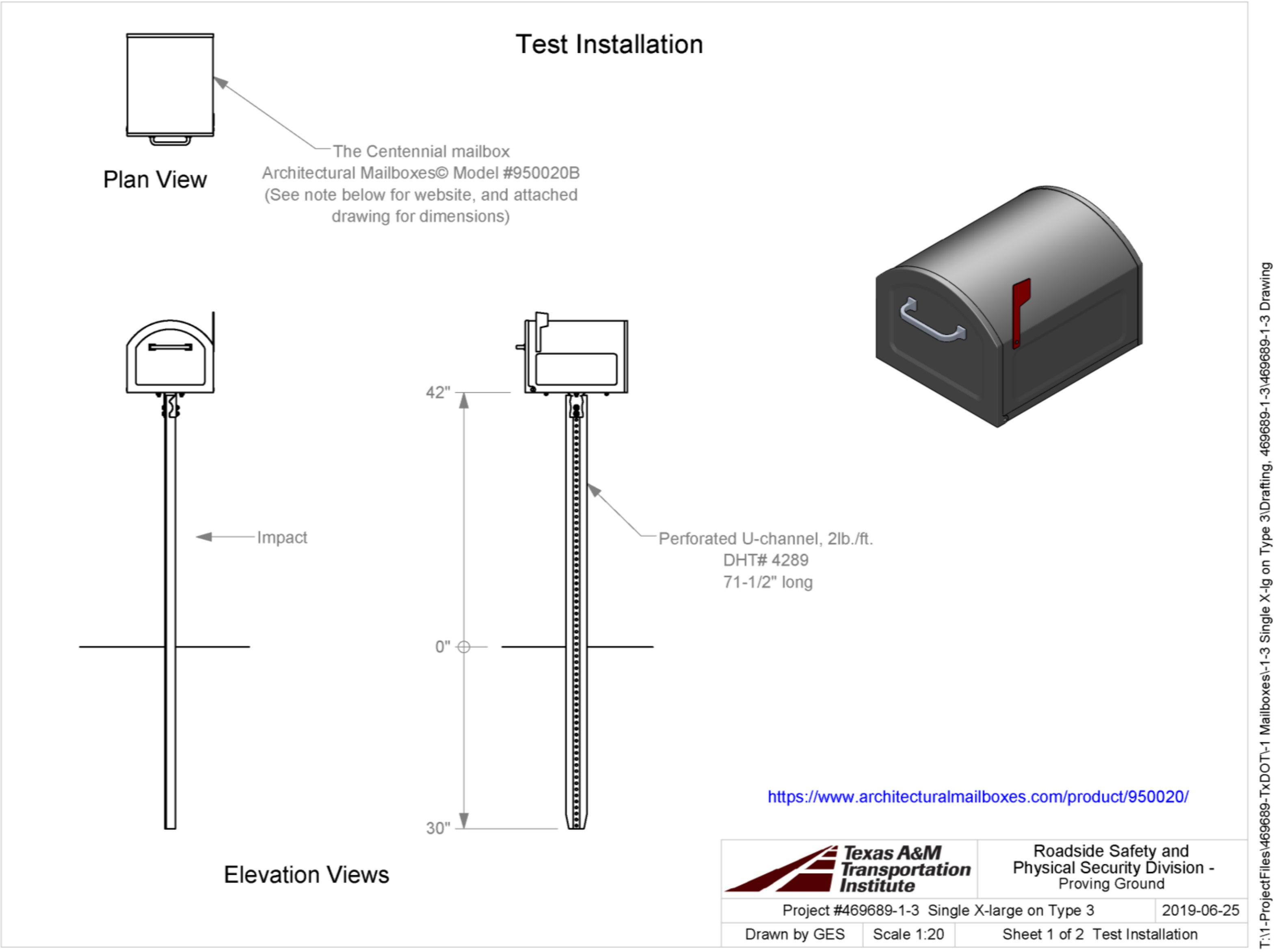


Figure 6.1. Overall Details of Centennial Model Extra-Large Mailbox on Type 3 Support.

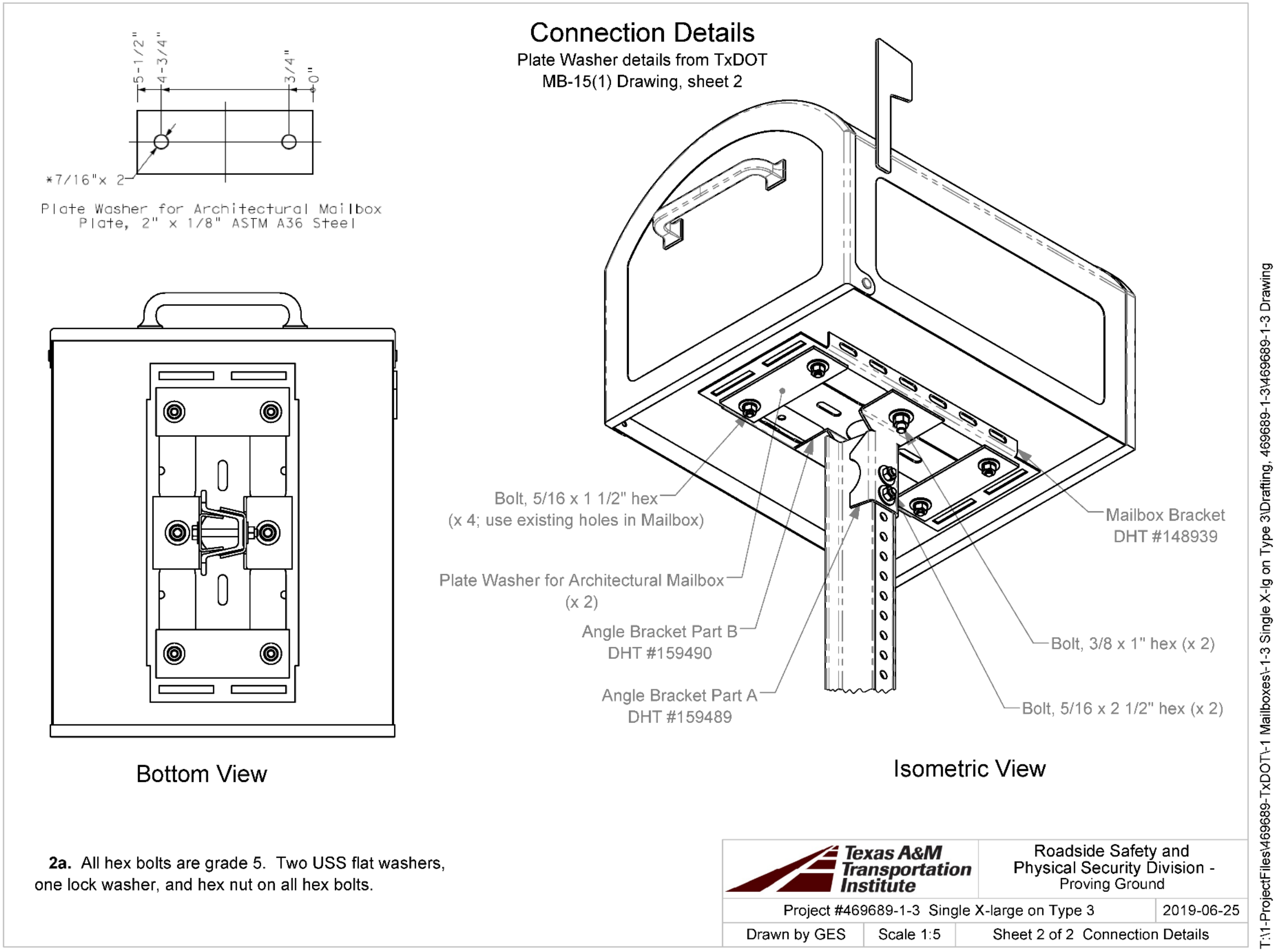


Figure 6.2. Connection Details of Centennial Model Extra-Large Mailbox on Type 3 Support.

Figure 6.3. Mailbox prior to Test No. 469689-1-3.

The 2011 Kia Rio[*] used in the test weighed 2436 lb, and the actual impact speed and angle were 63.9 mi/h and 0°, respectively. The actual impact point was the left quarter point aligned with the centerline of the support. Minimum target KE was 288 kip-ft, and actual KE was 333 kip-ft.

[*] The 2011 model vehicle used is older than the 6-year age noted in *MASH* and was selected based upon availability. An older model vehicle is permitted by AASHTO as long as it is otherwise *MASH* compliant. Other than the vehicle's year model, this 2011 model vehicle met the *MASH* requirements.

6.6 WEATHER CONDITIONS

The test was performed on the afternoon of June 27, 2019. Weather conditions at the time of testing were as follows: wind speed: 2 mi/h; wind direction: 136° (vehicle was traveling at magnetic heading of 180°); temperature: 91°F; relative humidity: 67 percent.

6.7 TEST VEHICLE

Figures 6.4 and 6.5 show the 2011 Kia Rio used for the crash test. The vehicle's test inertia weight was 2436 lb, and its gross static weight was 2601 lb. The height to the lower edge of the vehicle bumper was 7.75 inches, and height to the upper edge of the bumper was 21.5 inches. Table C.1 in Appendix C.2 gives additional dimensions and information on the vehicle. The vehicle was directed into the installation using the cable reverse tow and guidance system, and was released to be freewheeling and unrestrained just prior to impact.

Figure 6.4. Mailbox/Test Vehicle Geometrics for Test No. 469689-1-3.

Figure 6.5. Test Vehicle before Test No. 469689-1-3.

6.8 TEST DESCRIPTION

The test vehicle was traveling at an impact speed of 63.9 mi/h when it contacted the mailbox with the left (driver's side) quarter point aligned with the centerline of the support at an impact angle of 0°. Table 6.1 lists events that occurred during Test No. 469689-1-3. Figure C.1 in Appendix C.3 presents sequential photographs during the test.

Table 6.1. Events during Test No. 469689-1-3.

TIME (s)	EVENTS
0.0000	Vehicle contacts mailbox support
0.0180	Support pulled from the ground
0.0280	Mailbox contacts vehicle hood
0.0430	Mailbox contacts vehicle windshield
0.0940	Support rebounds from vehicle bumper while vehicle traveling at 62.8 mi/h

Brakes on the vehicle were applied at 1.25 s, and the vehicle subsequently came to rest 282 ft downstream of the impact.

6.9 DAMAGE TO TEST INSTALLATION

Figure 6.6 shows the damage to the mailbox. The support pulled out of the soil. The mailbox separated into four pieces. The bottom of the mailbox remaining mounted to the support and landed 177 ft downstream and 22 ft left. The other pieces landed from 12 ft right to 25 ft left and from 84 ft to 210 ft downstream.

6.10 DAMAGE TO TEST VEHICLE

Figure 6.7 shows the damage sustained by the vehicle. The left quarter point of the front bumper sustained a 3.0-inch deep dent, and the left side of the hood was deformed with a 1.0-inch × 3-inch long cut. The windshield was shattered over an area of 36 inches × 33 inches with 4.6 inches of deformation into the occupant compartment. The windshield laminate was also torn. Maximum exterior crush to the vehicle was 3.0 inches in the front plane at the left quarter point at bumper height. Maximum occupant compartment deformation was 4.6 inches in the windshield area. Figure 6.8 shows the interior of the vehicle. Tables C.2 and C.3 in Appendix C.2 provide exterior crush and occupant compartment measurements.

6.11 OCCUPANT RISK FACTORS

Data from the accelerometer, located at the vehicle center of gravity, were digitized for evaluation of occupant risk and are shown in Table 6.2. Figure 6.9 summarizes these data and other pertinent information from the test. Figure C.2 in Appendix C.4 shows the vehicle angular displacements, and Figures C.3 through C.5 in Appendix C.5 show accelerations versus time traces.

Figure 6.6. Mailbox after Test No. 469689-1-3.

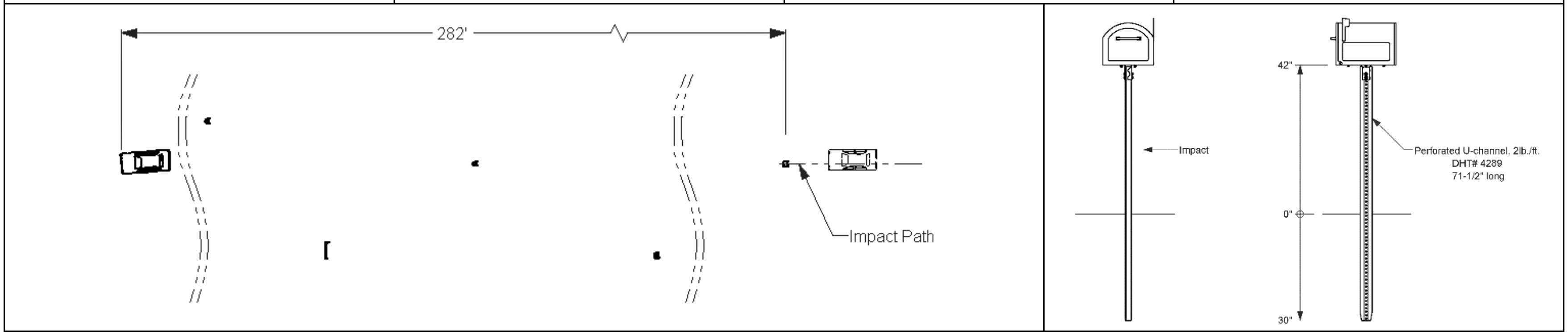
Figure 6.7. Test Vehicle after Test No. 469689-1-3.

Figure 6.8. Interior of Test Vehicle after Test No. 469689-1-3.

Table 6.2. Occupant Risk Factors for Test No. 469689-1-3.

Occupant Risk Factor	Value	Time
OIV		Theoretically, the occupant does not impact the interior of the vehicle.
Longitudinal	**No contact**	
Lateral	**No contact**	
Occupant Ridedown Accelerations		
Longitudinal	**NA**	
Lateral	**NA**	
THIV	**NA**	
PHD	**NA**	
ASI	**0.06**	0.0051–0.0551 s
Maximum 50-ms Moving Average		
Longitudinal	**−0.6 g**	0.0003–0.0503 s
Lateral	**0.5 g**	0.0137–0.0637 s
Vertical	**0.5 g**	0.0035–0.0535 s
Maximum Roll, Pitch, and Yaw Angles		
Roll	**3°**	0.7275 s
Pitch	**1°**	0.2752 s
Yaw	**1°**	0.7413 s

0.000 s | 0.050 s | 0.100 s | 0.150 s



General Information

Test Agency	Texas A&M Transportation Institute (TTI)
Test Standard Test No.	MASH Test 3-61
TTI Test No.	469689-1-3
Test Date	2019-06-27

Test Article

Type	Support Structure – Mailbox
Name	Centennial Extra-Large Mailbox
Installation Length	42 inches to bottom of mailbox
Material or Key Elements	Single Centennial Model Extra-Large Mailbox on Type 3 Support
Soil Type and Condition	Embedded in AASHTO M147-65(2004), grading B Soil (crushed limestone)

Test Vehicle

Type/Designation	1100C
Make and Model	2011 Kia Rio
Curb	2481 lb
Test Inertial	2436 lb
Dummy	165 lb
Gross Static	2601 lb

Impact Conditions

Speed	63.9 mi/h
Angle	0°
Location/Orientation	Left Qtr Point
Impact Severity	333 kip-ft

Exit Conditions

Speed	62.8 mi/h
Angle	NA

Occupant Risk Values

Longitudinal OIV	No Contact
Lateral OIV	No Contact
Longitudinal Ridedown	NA
Lateral Ridedown	NA
THIV	NA
PHD	NA
ASI	0.06
Max. 0.050-s Average	
Longitudinal	-0.6 g
Lateral	0.5 g
Vertical	0.5 g

Post-Impact Trajectory

Stopping Distance	282 ft downstream

Vehicle Stability

Maximum Yaw Angle	1°
Maximum Pitch Angle	1°
Maximum Roll Angle	3°

Test Article Debris Scatter

Longitudinal	210 ft
Lateral	37 ft

Vehicle Damage

VDS	12FL1
CDC	12FLEN5
Max. Exterior Deformation	3.0 inches
OCDI	FS0000000
Max. Occupant Compartment Deformation	4.6 inches (windshield)

Figure 6.9. Summary of Results for *MASH* Test 3-61 on Single Centennial Model Extra-Large Mailbox on Type 3 Support.

CHAPTER 7: *MASH* TEST 3-61 ON SINGLE CENTENNIAL MODEL EXTRA-LARGE MAILBOX ON TYPE 3 SUPPORT

7.1 TEST ARTICLE AND INSTALLATION DETAILS

The test installation consisted of a single Architectural Mailboxes© Centennial model #950020B mailbox mounted on a 2 lb/ft perforated U-channel post. The mailbox was attached to the post via angle brackets using a model DHT# 148939 mailbox bracket four slotted L brackets (each measuring $2\times6\times\frac{7}{8}\times\frac{1}{8}$-inch thick), and two steel plate washers (each measuring $2\times5\frac{1}{2}\times\frac{1}{8}$-inch thick). Four $^{5}/_{16}$-inch diameter hex bolts secured the plate washers, L brackets, and the mailbox bracket assembly to the floor of the mailbox, and four ¼-inch hex bolts secured the L brackets to the lower side flanges of the mailbox.

The post was embedded 30 inches into the soil. The bottom of the mailbox was located 42 inches above grade.

Figure 7.1 presents overall information on the single Centennial model extra-large mailbox on Type 3 support, Figure 7.2 shows connection details, and Figure 7.3 provides photographs of the installation. Appendix B.1 provides further details of the mailbox installation.

7.2 DESIGN MODIFICATIONS DURING TESTING

Test No. 469689-1-4 was a repeat of testing installation and impact conditions from Test No. 469689-1-3. The only design modification applied for Test No. 469689-1-4 was the inclusion of an additional connection bracket between the extra-large mailbox and the support. The connection bracket design previously tested under Test Nos. 469689-1-1 and 469689-1-3 specifically connected the extra-large mailbox floor to the mailbox support structure. For both Test Nos. 469689-1-1 and -1-3, the extra-large mailbox body fractured as a result of the high-speed vehicle impact, resulting in a separation between the mailbox floor and the mailbox sides was noted. After separation, the mailbox side became test article debris projected against the vehicle body and impacted the windshield. While in Test No. 469689-1-1 the contact between the mailbox side and the windshield did not affect the system crashworthiness, in Test No. 469689-1-3 the mailbox side caused a windshield deformation greater than the maximum allowed in *MASH*.

It became clear that a bracket that would connect the support, the mailbox floor, and the mailbox side was a possible solution to avoid separation of the mailbox floor from the rest of the mailbox body. Thus, four L brackets were integrated into the mailbox support assembly as described above. Figures 7.1 through 7.4 show the details of these brackets.

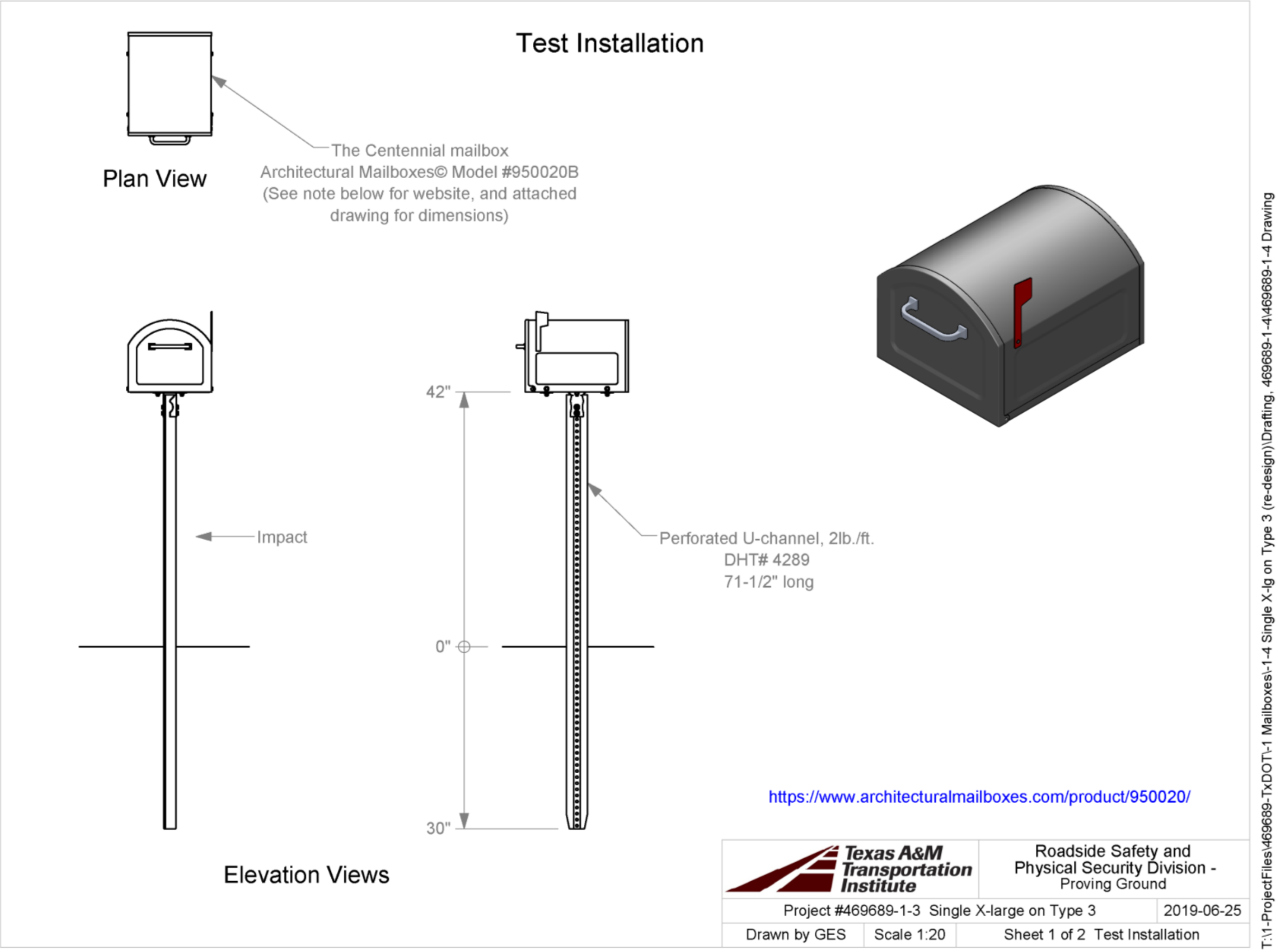


Figure 7.1. Overall Details of Centennial Model Extra-Large Mailbox on Type 3 Support.

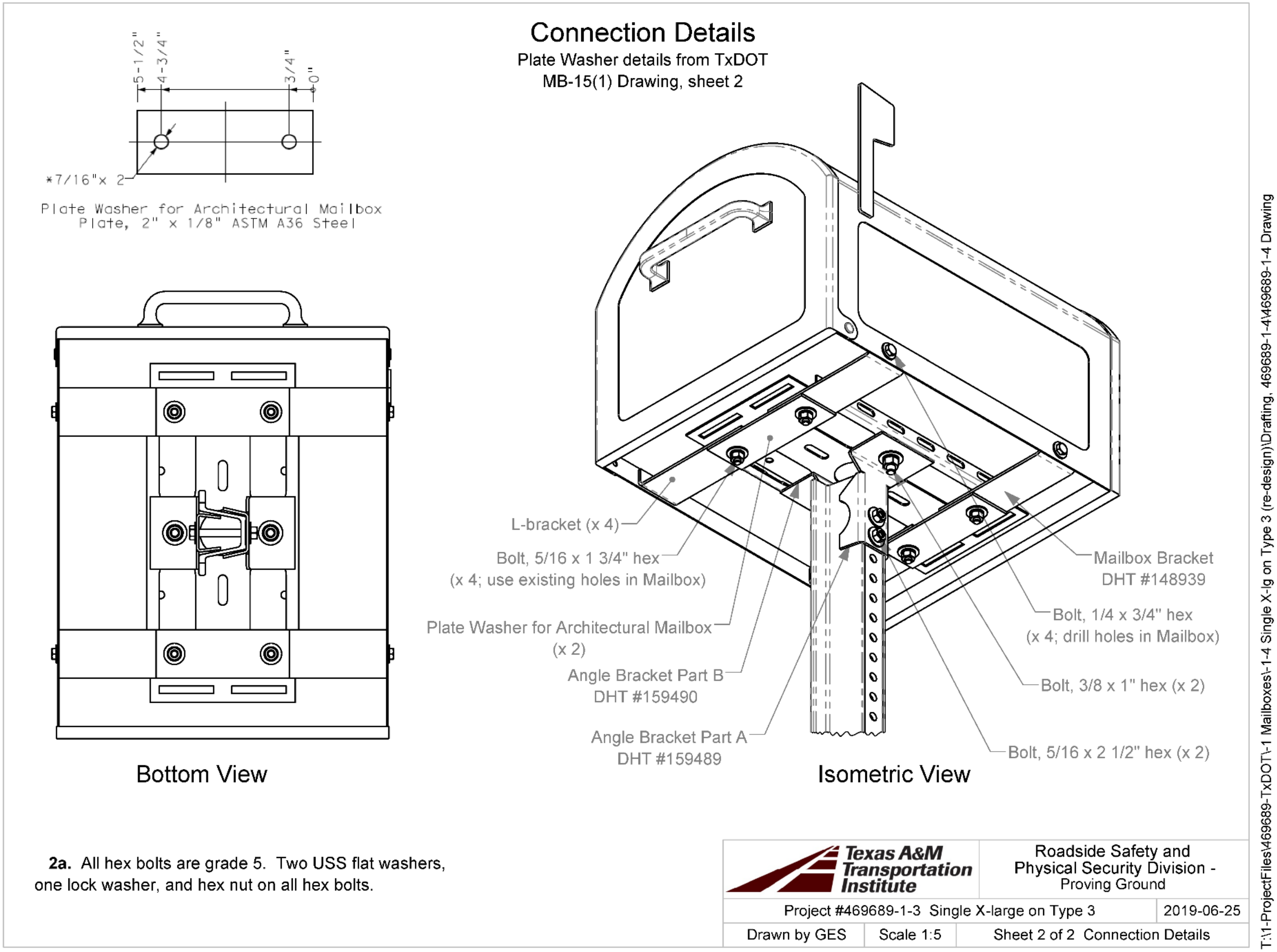


Figure 7.2. Connection Details of Centennial Model Extra-Large Mailbox on Type 3 Support.

Figure 7.3. Centennial Model Extra-Large Mailbox on Type 3 Support prior to Testing.

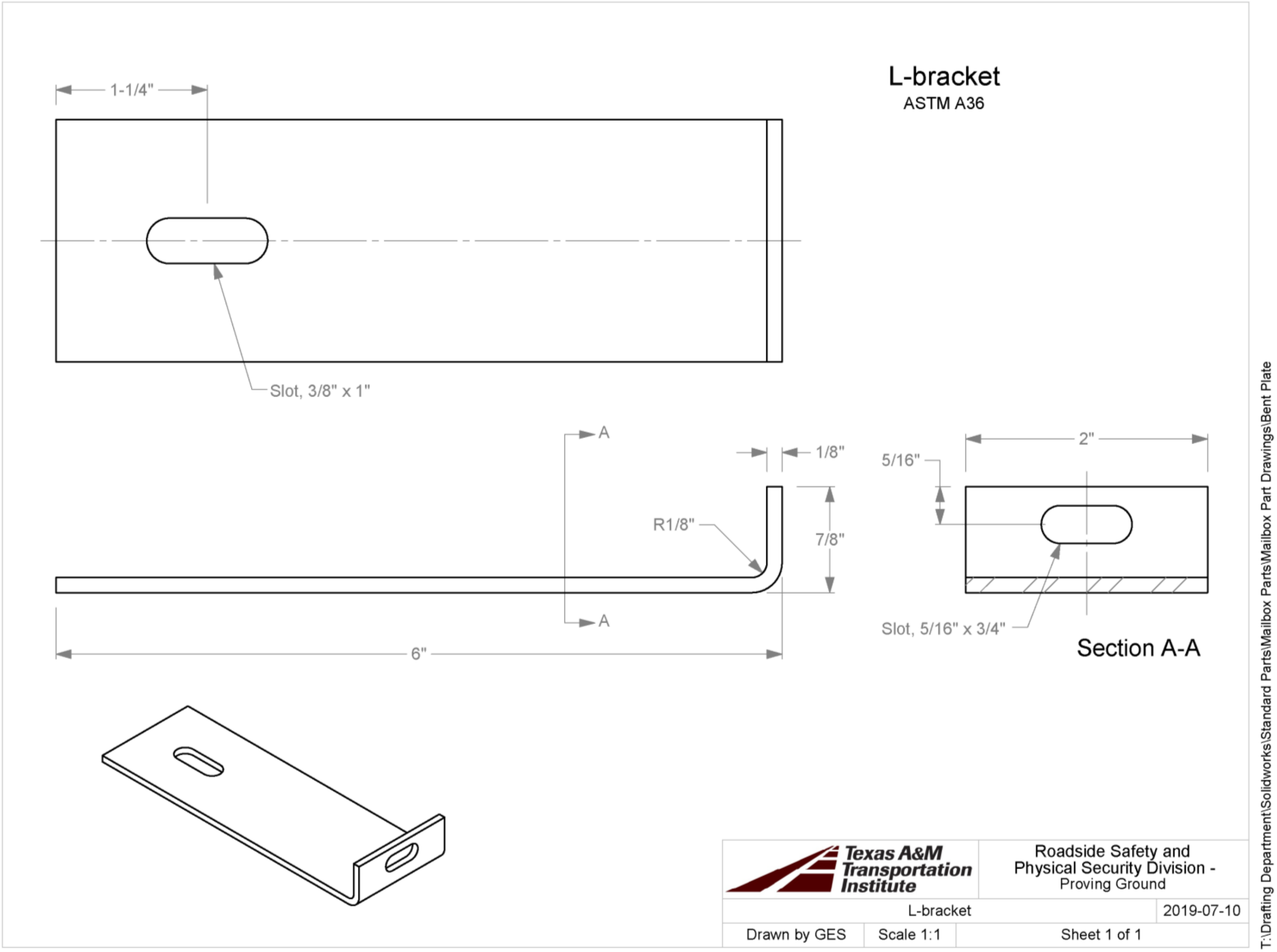


Figure 7.4. Details of Bracket Used on Centennial Model Extra-Large Mailbox on Type 3 Support.

7.3 MATERIAL SPECIFICATIONS

The drawings in Appendix D.1 indicate properties of the materials used to install/construct the Centennial model extra-large mailbox on Type 3 Support.

7.4 SOIL CONDITIONS

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

7.5 TEST DESIGNATION AND ACTUAL IMPACT CONDITIONS

MASH Test 3-61 involves an 1100C vehicle weighing 2420 lb ±55 lb impacting the support structure at an impact speed of 62 mi/h ±2.5 mi/h and a CIA of 0° ±1.5°. The target impact point for *MASH* Test 3-61 on the Centennial model extra-large mailbox on a Type 3 support was the right (passenger's side) quarter point aligned with the centerline of the support.

The 2011 Kia Rio[*] used in the test weighed 2443 lb, and the actual impact speed and angle were 63.3 mi/h and 0°, respectively. The actual impact point was the right (passenger's side) approximate quarter point aligned with the centerline of the support. Minimum target KE was 288 kip-ft, and actual KE was 327 kip-ft.

7.6 WEATHER CONDITIONS

The test was performed on the morning of August 23, 2019. Weather conditions at the time of testing were as follows: wind speed: 3 mi/h; wind direction: 334° (vehicle was traveling at magnetic heading of 180°); temperature: 90°F; relative humidity: 69 percent.

7.7 TEST VEHICLE

Figures 7.5 and 7.6 show the 2011 Kia Rio used for the crash test. The vehicle's test inertia weight was 2443 lb, and its gross static weight was 2608 lb. The height to the lower edge of the vehicle bumper was 7.75 inches, and height to the upper edge of the bumper was 21.5 inches. Table D.1 in Appendix D.2 gives additional dimensions and information on the vehicle. The vehicle was directed into the installation using the cable reverse tow and guidance system, and was released to be freewheeling and unrestrained just prior to impact.

[*] The 2011 model vehicle used is older than the 6-year age noted in *MASH* and was selected based upon availability. An older model vehicle is permitted by AASHTO as long as it is otherwise *MASH* compliant. Other than the vehicle's year model, this 2011 model vehicle met the *MASH* requirements.

Figure 7.5. Mailbox Installation/Test Vehicle Geometrics for Test No. 469689-1-4.

Figure 7.6. Test Vehicle before Test No. 469689-1-4.

7.8 TEST DESCRIPTION

The test vehicle was traveling at an impact speed of 63.3 mi/h when it contacted the mailbox with the right (passenger's side) quarter point aligned with the centerline of the support at an impact angle of 0°. Table 7.1 lists events that occurred during Test No. 469689-1-2. Figure D.1 in Appendix D.3 presents sequential photographs during the test.

Table 7.1. Events during Test No. 469689-1-2.

TIME (s)	EVENTS
0.0000	Vehicle contacts Mailbox post
0.0070	Mailbox post begins to pull out of ground
0.0180	Mailbox post separated from remaining post in ground
0.0750	Mailbox and post no longer in contact with vehicle

Brakes on the vehicle were applied at 2.2 s after impact, and the vehicle subsequently came to rest 373 ft downstream of the impact.

7.9 DAMAGE TO TEST INSTALLATION

Figure 7.7 shows the damage to the mailbox installation. The post fractured approximately 2 inches below grade. The mailbox remained intact and attached to the upper portion of the post, and this assembly landed 180 ft downstream.

7.10 DAMAGE TO TEST VEHICLE

Figure 7.8 shows the damage sustained by the vehicle. The front bumper sustained a small indentation 14 inches to the right of centerline, and the hood was deformed over an area 35 inches × 25 inches and 1.5 inches deep. Maximum exterior crush to the vehicle was 1.5 inches in the hood. No occupant compartment deformation or intrusion was observed. Figure 7.9 shows the interior of the vehicle. Tables D.2 and D.3 in Appendix D.2 provide exterior crush and occupant compartment measurements.

Figure 7.7. Mailbox after Test No. 469689-1-4.

Figure 7.8. Test Vehicle after Test No. 469689-1-4.

Figure 7.9. Interior of Test Vehicle for Test No. 469689-1-4.

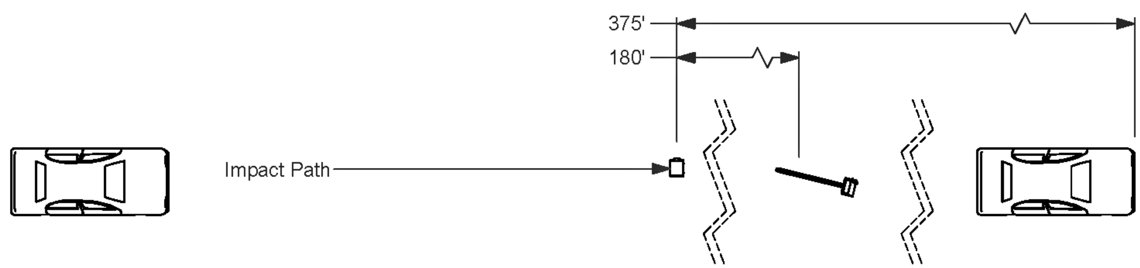
7.11 OCCUPANT RISK FACTORS

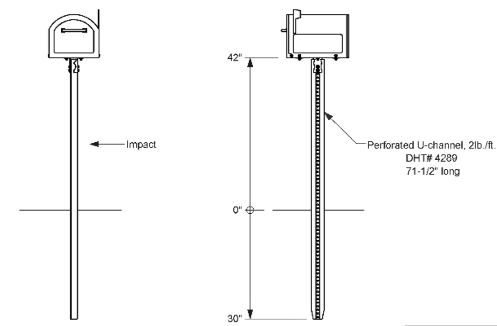
Data from the accelerometer, located at the vehicle center of gravity, were digitized for evaluation of occupant risk and are shown in Table 7.2. Figure 7.10 summarizes these data and other pertinent information from the test. Figure D.2 in Appendix D.4 shows the vehicle angular displacements, and Figures D.3 through D.5 in Appendix D.5 show accelerations versus time traces.

Table 7.2. Occupant Risk Factors for Test No. 469689-1-4.

Occupant Risk Factor	Value	Time
OIV		
Longitudinal	**0.3 ft/s**	at 0.9328 s on right side of interior
Lateral	**2.3 ft/s**	
Occupant Ridedown Accelerations		
Longitudinal	**0.3 g**	1.5377–1.5477
Lateral	**0.4 g**	1.6796–1.6896 s
THIV	**2.6 km/h**	at 0.9307 s on right side of interior
PHD	**0.4 g**	1.6795–1.6895 s
ASI	**0.08**	0.0385–0.0885 s
Maximum 50-ms Moving Average		
Longitudinal	**−0.6 g**	0.0015–0.0515 s
Lateral	**−0.3 g**	0.0088–0.0588 s
Vertical	**0.7 g**	0.0158–0.0658 s
Maximum Roll, Pitch, and Yaw Angles		
Roll	**1°**	0.2498 s
Pitch	**2°**	2.0000 s
Yaw	**1°**	1.8654 s

0.000 s	0.050 s	0.100 s	0.200 s





General Information	
Test Agency	Texas A&M Transportation Institute (TTI)
Test Standard Test No.	MASH Test 3-61
TTI Test No.	469689-1-4
Test Date	2019-08-23
Test Article	
Type	Support Structure – Mailbox
Name	Centennial Extra-Large Mailbox
Installation Length	42 inches to bottom of mailbox
Material or Key Elements	Single Centennial Model Extra-Large Mailbox on Type 4 Support with modified connection bracket
Soil Type and Condition	Concrete foundation in AASHTO M147-65(2004), grading B Soil
Test Vehicle	
Type/Designation	1100C
Make and Model	2011 Kia Rio
Curb	2544 lb
Test Inertial	2443 lb
Dummy	165 lb
Gross Static	2608 lb

Impact Conditions	
Speed	63.3 mi/h
Angle	0°
Location/Orientation	Apx. Right Qtr Point
Impact Severity	327 kip-ft
Exit Conditions	
Speed	62.6 mi/h
Angle	NA
Occupant Risk Values	
Longitudinal OIV	0.3 ft/s
Lateral OIV	2.3 ft/s
Longitudinal Ridedown	0.3 g
Lateral Ridedown	0.4 g
THIV	2.6 km/h
PHD	0.4 g
ASI	0.08
Max. 0.050-s Average	
Longitudinal	−0.6 g
Lateral	−0.3 g
Vertical	0.7 g

Post-Impact Trajectory	
Stopping Distance	373 ft downstream
Vehicle Stability	
Maximum Yaw Angle	1°
Maximum Pitch Angle	2°
Maximum Roll Angle	1°
Test Article Debris Scatter	
Longitudinal	180 ft
Lateral	12 inches
Vehicle Damage	
VDS	12FR2
CDC	12FREN2
Max. Exterior Deformation	1.5 inches
OCDI	FR0000000
Max. Occupant Compartment Deformation	None

Figure 7.10. Summary of Results for *MASH* Test 3-61 on Single Centennial Model Extra-Large Mailbox on Type 3 Support.

CHAPTER 8: SUMMARY AND CONCLUSIONS

8.1 ASSESSMENT OF TEST RESULTS

An assessment of each test based on the applicable safety evaluation criteria for *MASH* Test 3-61 for support structures is provided in Tables 8.1 through 8.4 and summarized below.

8.1.1 Single Centennial Model Extra-Large Mailbox on Type 4 Support

The mailbox and post readily activated by pulling out of the support socket. The detached pieces of mailbox contacted the hood and windshield. The hood sustained a 0.5-inch × 3-inch cut and a 0.5-inch × 1.5-inch cut. The windshield was shattered but not torn or deformed into the occupant compartment. No occupant compartment deformation or intrusion occurred. The 1100C remained upright during and after the collision event. Maximum roll and pitch angles were 2° and 1°, respectively. Occupant risk factors were within the preferred limits specified in *MASH* for support structures. The 1100C vehicle came to rest 270 ft behind the initial location of the installation.

8.1.2 Multiple Mailboxes on Bent Pipe Support

The mailbox and support readily activated by pulling out of the V-wing socket. The detached pieces of mailbox contacted the hood, causing a 19-inch × 28-inch × 9-inch deep indentation on the front left half of the hood. The mailbox did not damage the windshield. No occupant compartment deformation or intrusion occurred. The 1100C remained upright during and after the collision event. Maximum roll and pitch angles were 4° and 2°, respectively. Occupant risk factors were within the preferred limits of *MASH* for support structures. The 1100C vehicle came to rest 360 ft behind the initial location of the installation.

8.1.3 Single Centennial Model Extra-Large Mailbox on Type 3 Support

The mailbox and post readily activated by pulling out of the ground. The detached pieces of mailbox contacted the hood and windshield. The hood sustained a 1-inch × 3-inch cut. The windshield was shattered, the glass deformed 4.6 inches into the occupant compartment, and the laminate was torn. No other occupant compartment deformation or intrusion occurred. The 1100C remained upright during and after the collision event. Maximum roll and pitch angles were 3° and 1°, respectively. No occupant contact on the interior of the vehicle occurred. The 1100C vehicle came to rest 282 ft behind the initial location of the installation.

8.1.4 Single Centennial Model Extra-Large Mailbox on Type 3 Support – Modified Connection Bracket Design

The mailbox and post readily activated by pulling out of the ground. The detached pieces of mailbox contacted the hood, causing a 35-inch × 25-inch × 1.5-inch deep indentation on the front right half of the hood. The mailbox did not damage the windshield. No occupant compartment deformation or intrusion occurred. The 1100C remained upright during and after the collision event. Maximum roll and pitch angles were 2° and 1°, respectively. Occupant risk factors were within the preferred limits of *MASH* for support structures. The 1100C vehicle came to rest 373 ft behind the initial location of the installation.

Table 8.1. Performance Evaluation Summary for *MASH* Test 3-61 on Single Centennial Model Extra-Large Mailbox on Type 4 Support.

Test Agency: Texas A&M Transportation Institute | Test No.: 469689-1-1 | Test Date: 2019-06-27

***MASH* Test Evaluation Criteria**	**Test Results**	**Assessment**
Structural Adequacy *B. The test article should readily activate in a predictable manner by breaking away, fracturing, or yielding.*	The mailbox and post readily activated by pulling out of the support socket.	Pass
Occupant Risk *D. Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone.*	The detached pieces of mailbox contacted the hood and windshield. The hood sustained a 0.5-inch × 3-inch cut and a 0.5-inch × 1.5-inch cut. The windshield was shattered but not torn or deformed into the occupant compartment.	Pass
Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.3 and Appendix E of MASH.	No occupant compartment deformation or intrusion occurred.	
F. The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.	The 1100C remained upright during and after the collision event. Maximum roll and pitch angles were 2° and 1°, respectively.	Pass
H. Longitudinal and lateral occupant impact velocities should fall below the preferred value of 10 ft/s, or at least below the maximum allowable value of 16.4 ft/s.	Longitudinal OIV was 2.0 ft/s, and lateral OIV was 1.6 ft/s.	Pass
I. Longitudinal and lateral occupant ridedown accelerations should fall below the preferred value of 15.0 Gs, or at least below the maximum allowable value of 20.49 Gs.	Maximum longitudinal occupant ridedown acceleration was 0.8 g, and maximum lateral occupant ridedown acceleration was 0.3 g.	Pass
Vehicle Trajectory *N. Vehicle trajectory behind the test article is acceptable.*	The 1100C vehicle came to rest 270 ft behind the installation.	Pass

Table 8.2. Performance Evaluation Summary for *MASH* Test 3-61 on Multiple Mailboxes on Bent Pipe Support.

Test Agency: Texas A&M Transportation Institute | Test No.: 469689-1-2 | Test Date: 2019-08-23

***MASH* Test Evaluation Criteria**	**Test Results**	**Assessment**
Structural Adequacy *B. The test article should readily activate in a predictable manner by breaking away, fracturing, or yielding.*	The mailbox and support readily activated by pulling out of the V-Wing socket.	Pass
Occupant Risk *D. Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone.*	The detached pieces of mailbox contacted the hood, causing 19-inch × 28-inch × 9-inch deep indentation on the front left half of the hood. The mailbox did not damage the windshield.	Pass
Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.3 and Appendix E of MASH.	No occupant compartment deformation or intrusion occurred.	Pass
F. The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.	The 1100C remained upright during and after the collision event. Maximum roll and pitch angles were 4° and 2°, respectively.	Pass
H. Longitudinal and lateral occupant impact velocities should fall below the preferred value of 10 ft/s, or at least below the maximum allowable value of 16.4 ft/s.	Longitudinal OIV was 3.6 ft/s, and lateral OIV was 0.0 ft/s.	Pass
I. Longitudinal and lateral occupant ridedown accelerations should fall below the preferred value of 15.0 Gs, or at least below the maximum allowable value of 20.49 Gs.	Maximum longitudinal occupant ridedown acceleration was 0.3 g, and maximum lateral occupant ridedown acceleration was 0.6 g.	Pass
Vehicle Trajectory *N. Vehicle trajectory behind the test article is acceptable.*	The 1100C vehicle came to rest 360 ft behind the installation.	Pass

Table 8.3. Performance Evaluation Summary for *MASH* Test 3-61 on Single Centennial Model Extra-Large Mailbox on Type 3 Support.

Test Agency: Texas A&M Transportation Institute | Test No.: 469689-1-3 | Test Date: 2019-06-27

***MASH* Test Evaluation Criteria**	**Test Results**	**Assessment**
Structural Adequacy *B. The test article should readily activate in a predictable manner by breaking away, fracturing, or yielding.*	The mailbox and post readily activated by pulling out of the ground.	Pass
Occupant Risk *D. Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone.* *Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.3 and Appendix E of MASH.*	The detached pieces of mailbox contacted the hood and windshield. The hood sustained a 1-inch × 3-inch cut. The windshield was shattered, the glass deformed 4.6 inches into the occupant compartment, and the laminate was torn. No other occupant compartment deformation or intrusion occurred.	Fail
F. The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.	The 1100C remained upright during and after the collision event. Maximum roll and pitch angles were 3° and 1°, respectively.	Pass
H. Longitudinal and lateral occupant impact velocities should fall below the preferred value of 10 ft/s, or at least below the maximum allowable value of 16.4 ft/s.	No theoretical contact occurred.	Pass
I. Longitudinal and lateral occupant ridedown accelerations should fall below the preferred value of 15.0 Gs, or at least below the maximum allowable value of 20.49 Gs.	No theoretical contact occurred	Pass
Vehicle Trajectory *N. Vehicle trajectory behind the test article is acceptable.*	The 1100C vehicle came to rest 282 ft behind the installation.	Pass

Table 8.4. Performance Evaluation Summary for *MASH* Test 3-61 on Single Centennial Model Extra-Large Mailbox on Type 3 Support with Modified Connection Bracket Design.

Test Agency: Texas A&M Transportation Institute | Test No.: 469689-1-4 | Test Date: 2019-08-23

MASH **Test Evaluation Criteria**	**Test Results**	**Assessment**
Structural Adequacy		
B. *The test article should readily activate in a predictable manner by breaking away, fracturing, or yielding.*	The mailbox and post readily activated by pulling out of the ground.	Pass
Occupant Risk		
D. *Detached elements, fragments, or other debris from the test article should not penetrate or show potential for penetrating the occupant compartment, or present an undue hazard to other traffic, pedestrians, or personnel in a work zone.*	The detached pieces of mailbox contacted the hood, causing a 35-inch × 25-inch × 1.5-inch deep indentation on the front right half of the hood. The mailbox did not damage the windshield.	Pass
Deformations of, or intrusions into, the occupant compartment should not exceed limits set forth in Section 5.3 and Appendix E of MASH.	No occupant compartment deformation or intrusion occurred.	Pass
F. *The vehicle should remain upright during and after collision. The maximum roll and pitch angles are not to exceed 75 degrees.*	The 1100C remained upright during and after the collision event. Maximum roll and pitch angles were 2° and 1°, respectively.	Pass
H. *Longitudinal and lateral occupant impact velocities should fall below the preferred value of 10 ft/s, or at least below the maximum allowable value of 16.4 ft/s.*	Longitudinal OIV was 0.3 ft/s, and lateral OIV was 2.3 ft/s.	Pass
I. *Longitudinal and lateral occupant ridedown accelerations should fall below the preferred value of 15.0 Gs, or at least below the maximum allowable value of 20.49 Gs.*	Maximum longitudinal occupant ridedown acceleration was 0.3 g, and maximum lateral occupant ridedown acceleration was 0.4 g.	Pass
Vehicle Trajectory		
N. *Vehicle trajectory behind the test article is acceptable.*	The 1100C vehicle came to rest 373 ft behind the installation.	Pass

8.2 CONCLUSIONS

8.2.1 Single Centennial Model Extra-Large Mailbox on Type 4 Support

The single Centennial model extra-large mailbox on Type 4 support performed acceptably for *MASH* Test 3-61.

8.2.2 Multiple Mailboxes on Bent Pipe Support

The bent pipe support with multiple mailboxes performed acceptably for *MASH* Test 3-61.

8.2.3 Single Centennial Model Extra-Large Mailbox on Type 3 Support

During *MASH* Test 3-61 on the single Centennial model extra-large mailbox on Type 3 support, the windshield of the test vehicle deformed 4.6 inches into the occupant compartment, and the laminate was torn. The installation failed criterion D of *MASH*.

8.2.4 Single Centennial Model Extra-Large Mailbox on Type 3 Support – Modified Connection Bracket Design

A newly designed connection bracket detail was utilized to connect the extra-large mailbox to the Type 3 support. With the new connection detail, the single Centennial model extra-large mailbox on Type 3 support performed acceptably for *MASH* Test 3-61.

CHAPTER 9: IMPLEMENTATION*

The small passenger car is considered the critical design vehicle for evaluation of mailbox support systems based on the mounting height regulated for mailboxes by the United States Postal Service. At the required mounting height, any interaction between the mailbox and the windshield of the pickup truck design vehicle is improbable. The taller hood height and longer wrap-around distance (i.e., the distance from the ground, around the front end, and across the hood to the base of the windshield) of the 2270P pickup truck significantly decreases the probability of windshield impact and occupant compartment intrusion. Therefore, Test 3-62 with the pickup truck was considered unnecessary for the *MASH* evaluation of the TxDOT mailbox systems.

The *MASH* test matrix for breakaway supports includes two tests with the 1100C small passenger car: a low-speed test at 19 mi/h (Test 3-60) and a high-speed test at 62 mi/h (Test 3- 61). In the low speed small car test, *MASH* testing has shown that the mailbox support assembly will be pushed forward by the impacting vehicle (*2*, *3*). Under the lower impact severity, it is unlikely that the mailbox will separate from the support or that the support assembly will interact with the vehicle windshield.

The most critical test for evaluation of mailbox systems is *MASH* test designation 3-61. This test evaluates both the structural adequacy of the mailbox connection hardware and the interaction of the mailbox support assembly with the vehicle windshield. If the mailbox remains attached during this high-speed test, it is not expected to detach in the low-speed test.

Three different mailbox support systems were selected for *MASH* testing and evaluation during this project. Separate tests were performed for each system. These include: a single extra-large mailbox system on a recycled rubber post with Type 4 foundation, multiple mailbox systems (two external standard medium mailboxes and two internal lockable mailboxes) on a 12-gauge bent pipe, and a single extra-large mailbox system on a perforated steel U-channel post with Type 3 foundation.

The single extra-large mailbox system with the original connection bracket system on a perforated U-channel post and Type 3 foundation did not pass *MASH* Test 3-61, as detachment of the side from the mailbox floor was observed, which led to an undesirable impact of the mailbox on the vehicle windshield. Each of these systems is considered *MASH* compliant and suitable for continued implementation, when the newly designed connection bracket between the extra-large mailbox and the mailbox support is used.

Systems that were tested with a single mailbox should be implemented with a single mailbox only.

TxDOT standard MB 15(1) does not permit the use of large mailboxes on the outside positions of the multiple mailbox mount. Therefore, the 12-gauge multiple mailbox mount in Type 4 foundation system was tested with two medium mailboxes in the outer mounting positions and two locking architectural mailboxes in the inner mounting positions. This is considered the most critical permissible configuration, given that the locking architectural

* The opinions/interpretations identified/expressed in this section of the report are outside the scope of TTI Proving Ground's A2LA Accreditation.

mailboxes are heavier than the extra-large mailboxes. Other combinations of small, medium, and extra-large mailboxes are considered less critical, and can therefore be considered *MASH* compliant based on the successful testing of the critical configuration.

Implementation of the mailbox systems can be achieved by the Maintenance Division through updating of mailbox standard MB-15(1) (as necessary) to reflect the details presented in this report.

REFERENCES

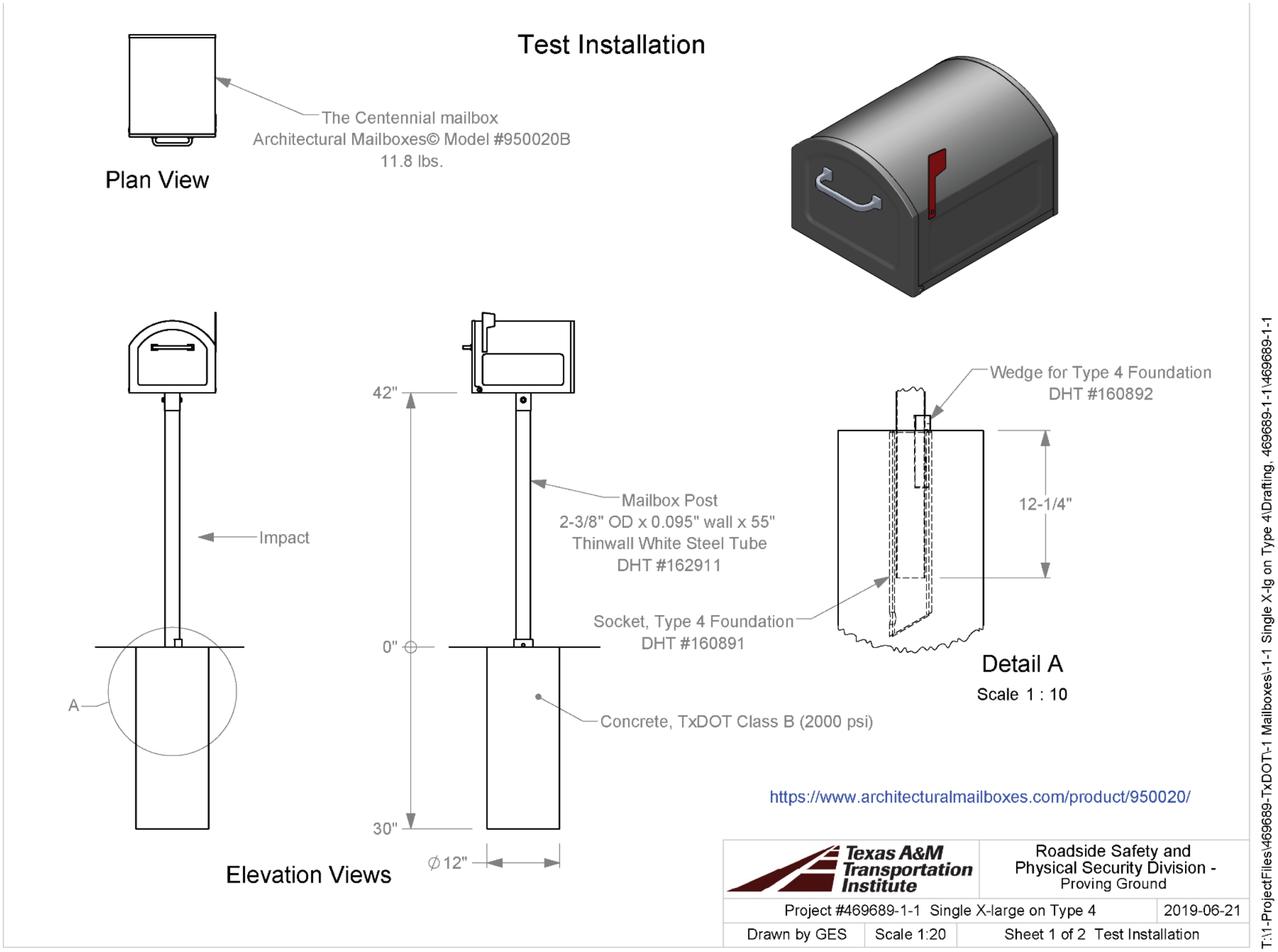
1. AASHTO. *Manual for Assessing Roadside Safety Hardware.* Second Edition, 2016, American Association of State Highway and Transportation Officials: Washington, DC.

2. C.S. Dobrovolny, R.P. Bligh, and W.L. Menges, Crash Test and Evaluation of Multiple Mailbox Supports for Use with Locking Architectural Mailboxes, Report No. 9-1002-15-7, Texas A&M Transportation Institute, College Station, TX, February 2017.

3. R.P. Bligh, W.L. Menges, and D.L. Kuhn, Crash Test and Evaluation of Locking Architectural Mailboxes, Report No. 9-1002-12-9, Texas A&M Transportation Institute, College Station, TX, September 2014.

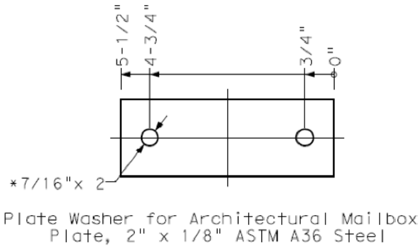
APPENDIX A. CRASH TEST NO. 469689-1-1

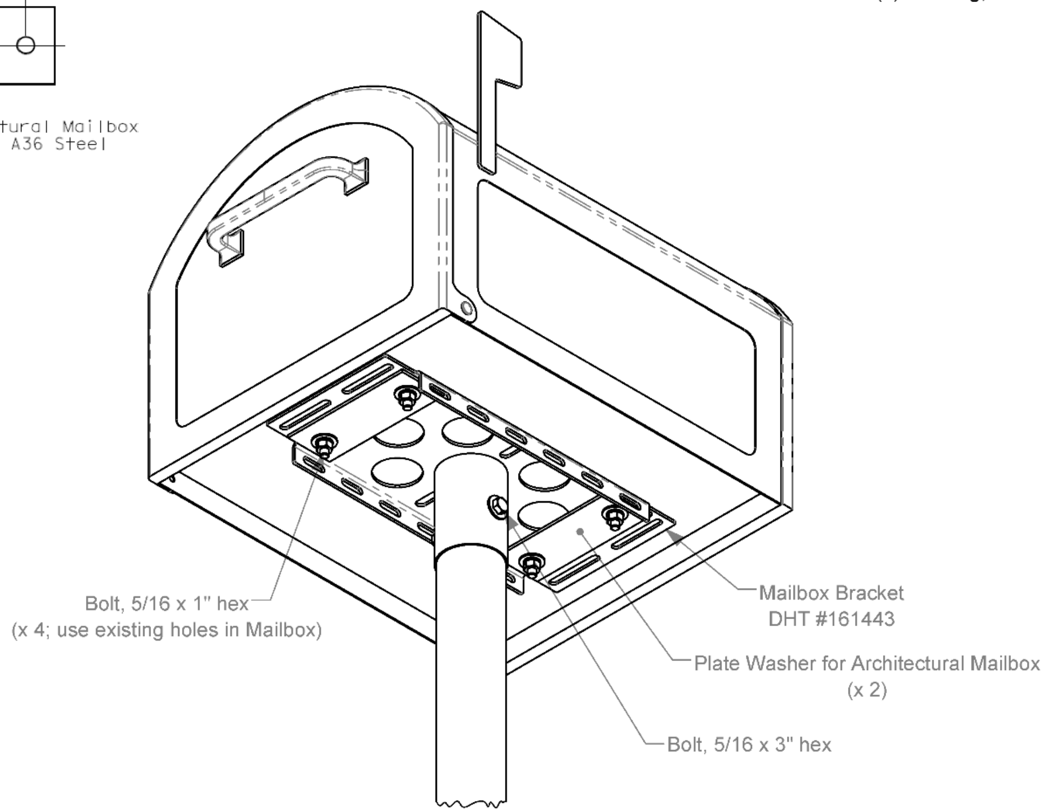
A.1 DETAILS OF TEST ARTICLE



Connection Details

Plate Washer details from TxDOT
MB-15(1) Drawing, sheet 2





2a. All hex bolts are grade 5. Two USS flat washers, one lock washer, and hex nut on all hex bolts.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #469689-1-1 Single X-large on Type 4		2019-06-21
Drawn by GES	Scale 1:5	Sheet 2 of 2 Connection Details

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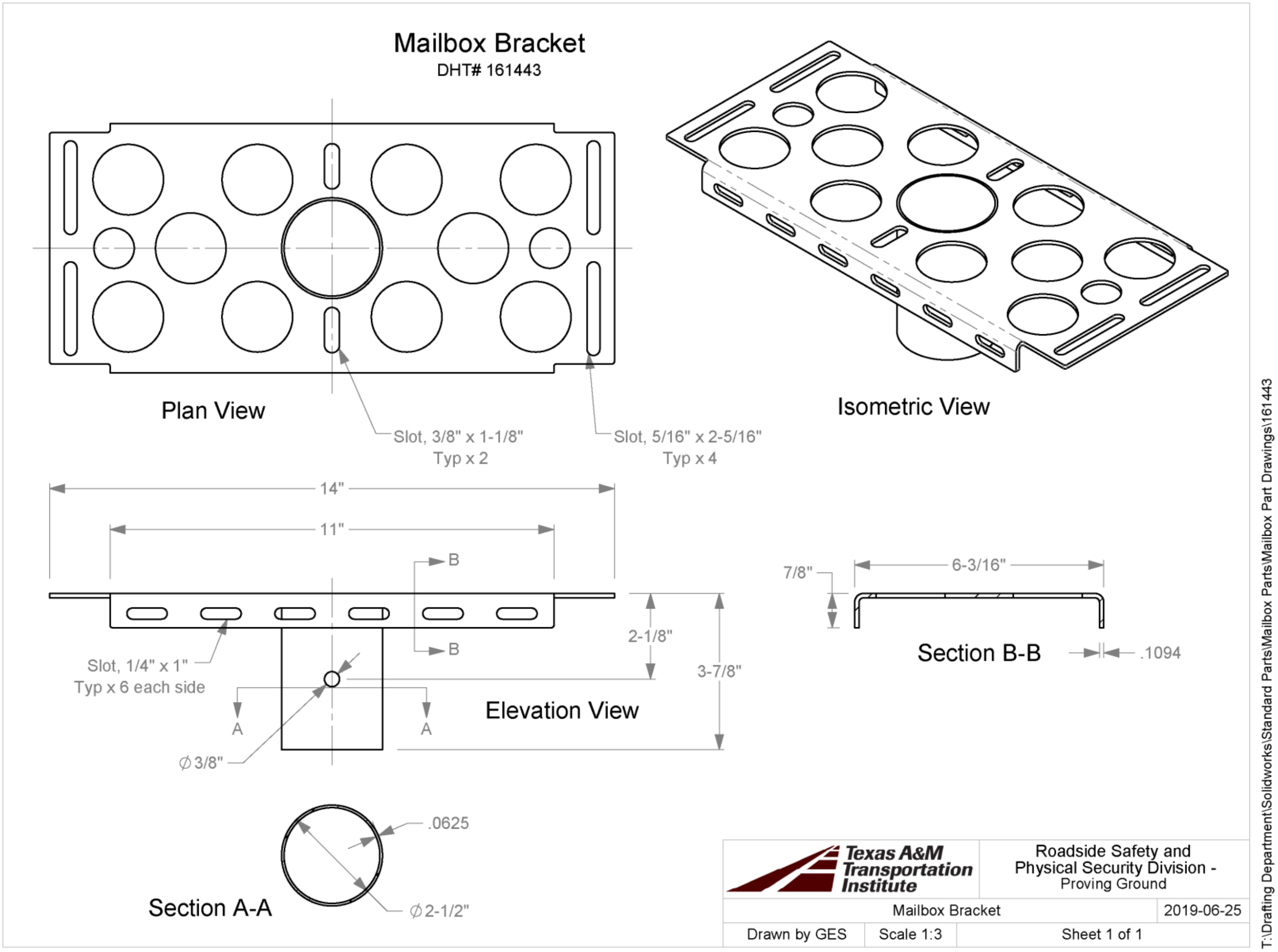
Mailbox Bracket
DHT# 161443
Plan View
Slot, 3/8" x 1-1/8"
Typ x 2
Slot, 5/16" x 2-5/16"
Typ x 4
Isometric View
14"
11"
B
B
Slot, 1/4" x 1"
Typ x 6 each side
A
A
2-1/8"
3-7/8"
∅3/8"
Elevation View
7/8"
6-3/16"
Section B-B
.1094
.0625
∅2-1/2"
Section A-A
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
Mailbox Bracket
2019-06-25
Drawn by GES
Scale 1:3
Sheet 1 of 1
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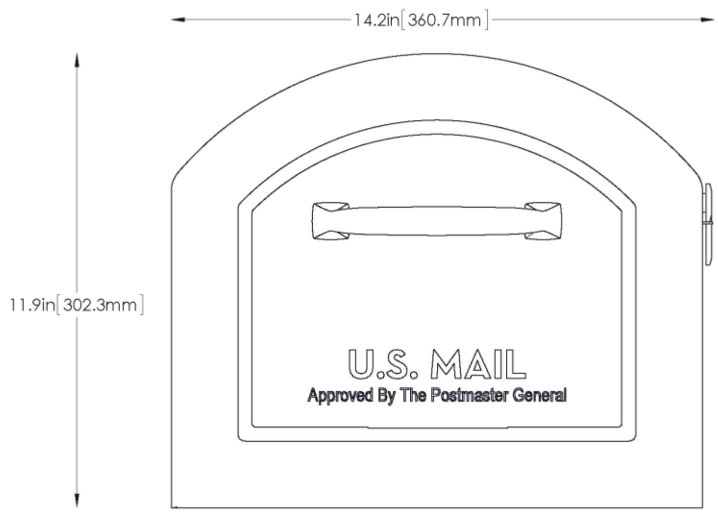
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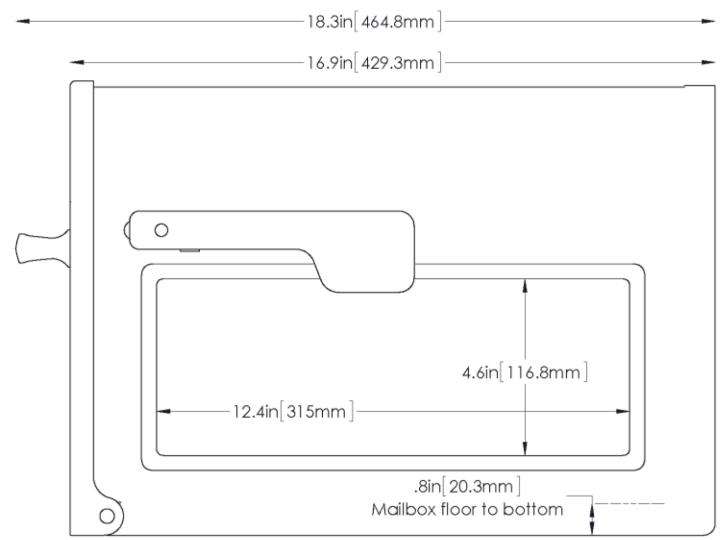
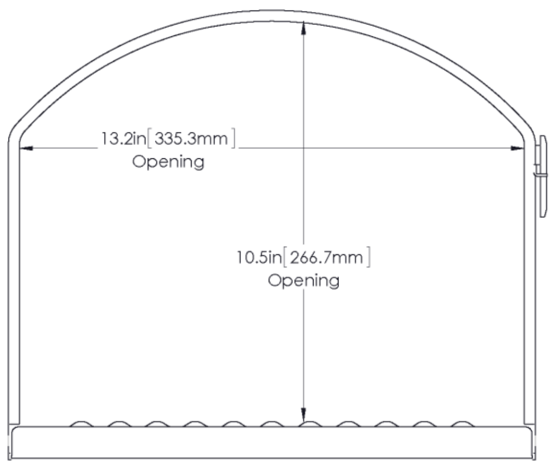
11.9in[302.3mm]
U.S. MAIL
Approved By The Postmaster General


18.3in[464.8mm]
16.9in[429.3mm]
4.6in[116.8mm]
12.4in[315mm]
.8in[20.3mm]
Mailbox floor to bottom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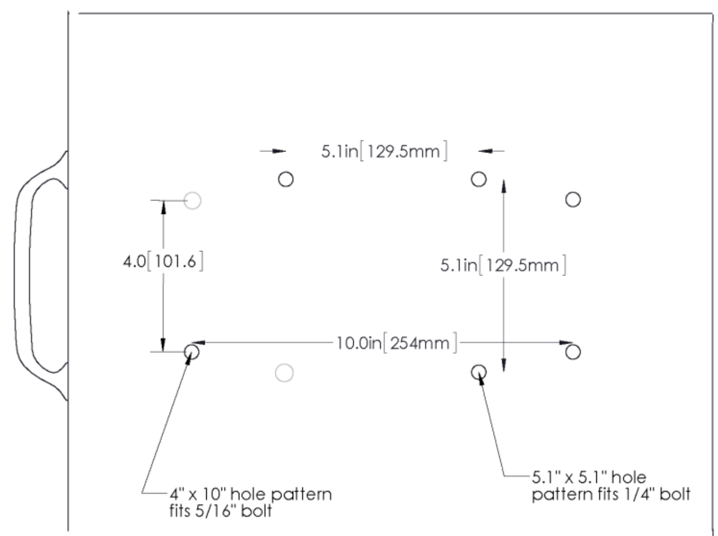
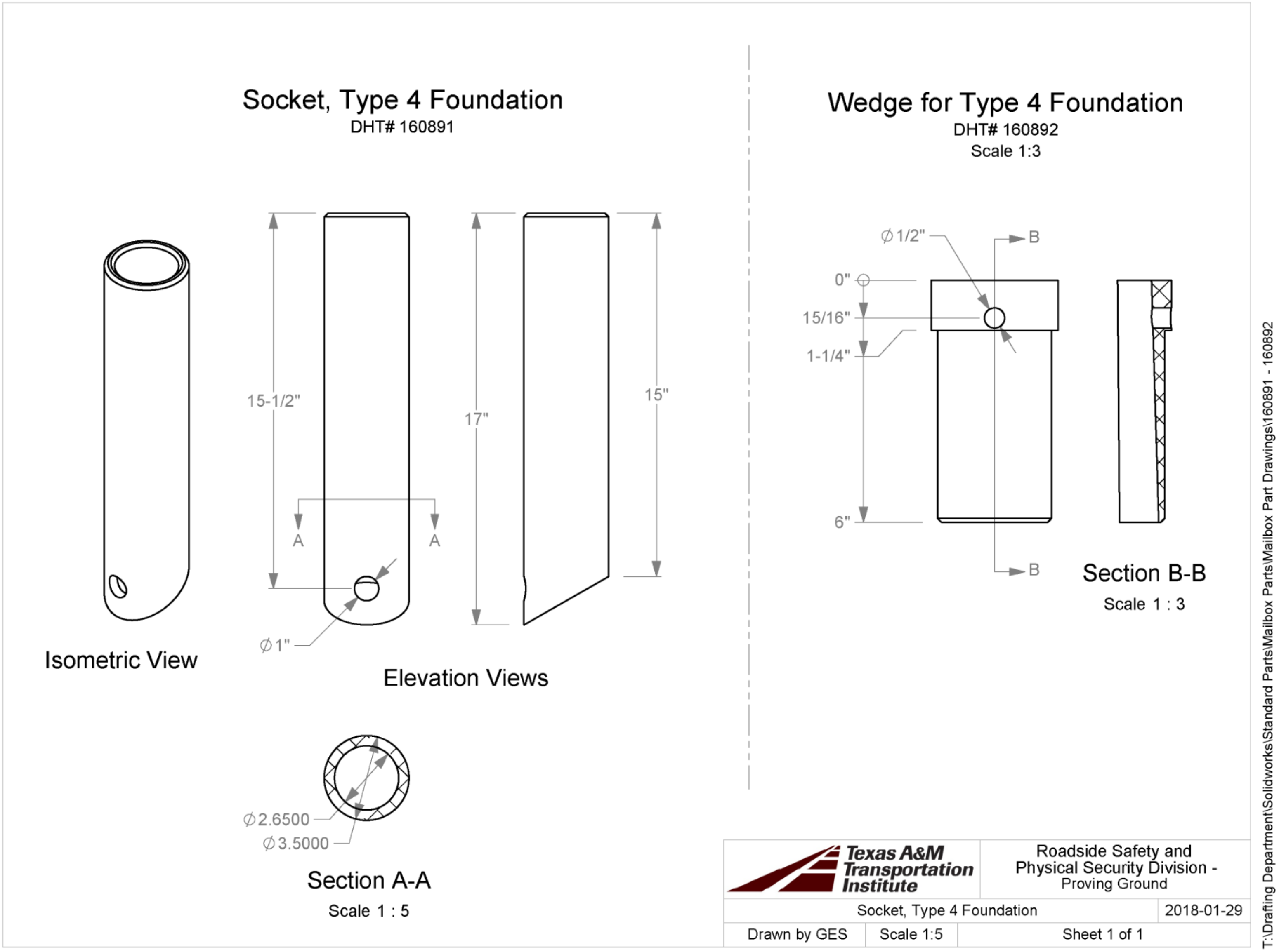
Opening
10.5in[266.7mm]
Opening


5.1in[129.5mm]
4.0[101.6]
5.1in[129.5mm]
10.0in[254mm]
4" x 10" hole pattern
fits 5/16" bolt
5.1" x 5.1" hole
pattern fits 1/4" bolt


Socket, Type 4 Foundation
DHT# 160891
15-1/2"
17"
15"
A
A
⌀1"
Isometric View
Elevation Views
⌀2.6500
⌀3.5000
Section A-A
Scale 1 : 5
Wedge for Type 4 Foundation
DHT# 160892
Scale 1:3
⌀1/2"
B
B
0"
15/16"
1-1/4"
6"
Section B-B
Scale 1 : 3
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
Socket, Type 4 Foundation
2018-01-29
Drawn by GES
Scale 1:5
Sheet 1 of 1
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A.2 VEHICLE PROPERTIES AND INFORMATION

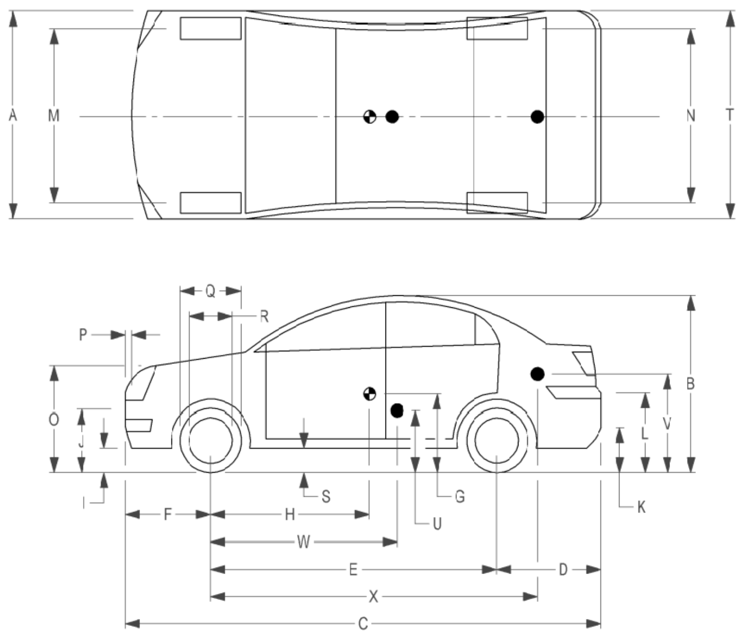
Table A.1. Vehicle Properties for Test No. 469689-1-1.

Date:	2019-06-27	Test No.:	469689-1-1	VIN No.:	KNADE123586375064
Year:	2008	Make:	Kia	Model:	Rio
Tire Inflation Pressure:	32 PSI	Odometer:	256263	Tire Size:	185/65R14

Describe any damage to the vehicle prior to test: None

● Denotes accelerometer location.

NOTES:



Engine Type: 4 CYL
Engine CID: 1.6 L
Transmission Type:
☐ Auto or ☐ Manual
☑ FWD ☐ RWD ☐ 4WD
Optional Equipment:
None

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

Geometry: inches

A	66.38	F	33.00	K	12.25	P	4.12	U	14.75
B	51.50	G		L	25.25	Q	22.50	V	20.75
C	165.75	H	35.80	M	57.75	R	15.50	W	35.80
D	34.00	I	7.75	N	57.70	S	8.25	X	71.50
E	98.75	J	21.50	O	27.00	T	66.20		

Wheel Center Ht Front 11.00 Wheel Center Ht Rear 11.00 W-H 0.00

RANGE LIMIT: A = 65 ±3 inches; C = 169 ±8 inches; E = 98 ±5 inches; F = 35 ±4 inches; H = 39 ±4 inches; O (Bottom of Hood Lip) = 24 ±4 inches
TOP OF RADIATOR SUPPORT = 28.25 inches; (M+N)/2 = 56 ±2 inches; W-H < 2 inches or use MASH Paragraph A4.3.2

GVWR Ratings:		**Mass:** lb	Curb	Test Inertial	Gross Static
Front	1718	M_{front}	1584	1550	1635
Back	1874	M_{rear}	893	882	962
Total	3638	M_{Total}	2477	2432	2597

Allowable TIM = 2420 lb ±55 lb | Allowable GSM = 2585 lb ± 55 lb

Mass Distribution:
lb LF: 779 RF: 771 LR: 452 RR: 430

Table A.2. Exterior Crush Measurements of Vehicle for Test No. 469689-1-1.

Date: 2019-06-27 Test No.: 469689-1-1 VIN No.: KNADE123586375064

Year: 2008 Make: Kia Model: Rio

VEHICLE CRUSH MEASUREMENT SHEET[1]

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

Note: Measure C_1 to C_6 from Driver to Passenger Side in Front or Rear Impacts – Rear to Front in Side Impacts.

Specific Impact Number	Plane* of C-Measurements	Direct Damage Width** (CDC)	Direct Damage Max*** Crush	Field L**	C_1	C_2	C_3	C_4	C_5	C_6	±D
	Front Plane at bumper height		2								
	Measurements recorded										
	☑ **inches** **or** ☐ **mm**										

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

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

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

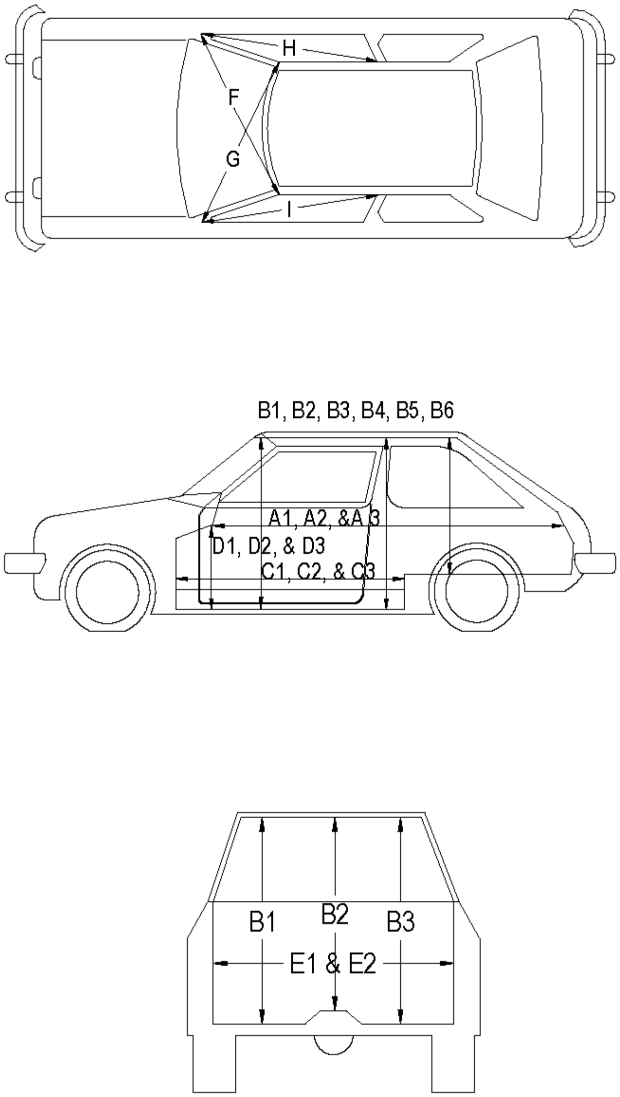
**Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle).

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

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

Table A.3. Occupant Compartment Measurements of Vehicle for Test No. 469689-1-1.

Date:	2019-06-27	Test No.:	469689-1-1	VIN No.:	KNADE123586375064
Year:	2008	Make:	Kia	Model:	Rio



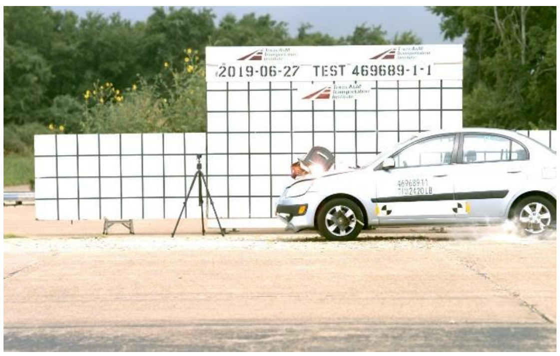
*Lateral area across the cab from
driver's side kick panel to passenger's side kick panel.

OCCUPANT COMPARTMENT DEFORMATION MEASUREMENT

	Before	After (inches)	Differ.
A1	67.50	67.50	0.00
A2	67.25	67.25	0.00
A3	67.75	67.75	0.00
B1	40.50	40.50	0.00
B2	39.00	39.00	0.00
B3	40.50	40.50	0.00
B4	36.25	36.25	0.00
B5	36.00	36.00	0.00
B6	36.25	36.25	0.00
C1	26.00	26.00	0.00
C2	0.00	0.00	0.00
C3	26.00	26.00	0.00
D1	9.50	9.50	0.00
D2	0.00	0.00	0.00
D3	9.50	9.50	0.00
E1	51.50	51.50	0.00
E2	51.00	51.00	0.00
F	51.00	51.00	0.00
G	51.00	51.00	0.00
H	37.50	37.50	0.00
I	37.50	37.50	0.00
J*	51.00	51.00	0.00

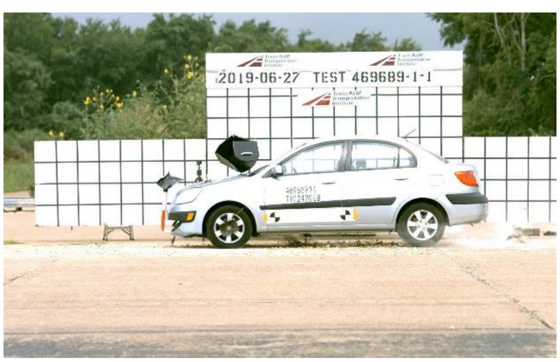
A.3 SEQUENTIAL PHOTOGRAPHS

0.000 s



0.025 s

0.050 s



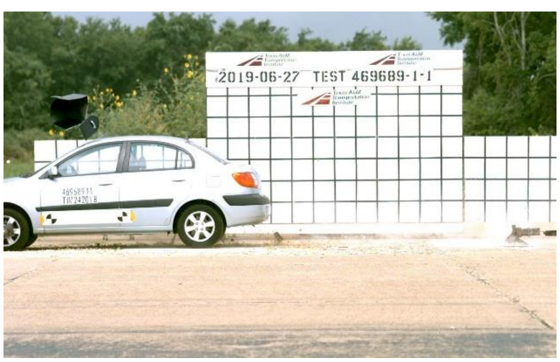
0.075 s

Figure A.1. Sequential Photographs for Test No. 469689-1-1 (Perpendicular and Oblique Views).

0.100 s

0.125 s

0.150 s



0.175s

Figure A.1. Sequential Photographs for Test No. 469689-1-1 (Perpendicular and Oblique Views) (Continued).

A.4 VEHICLE ANGULAR DISPLACEMENT

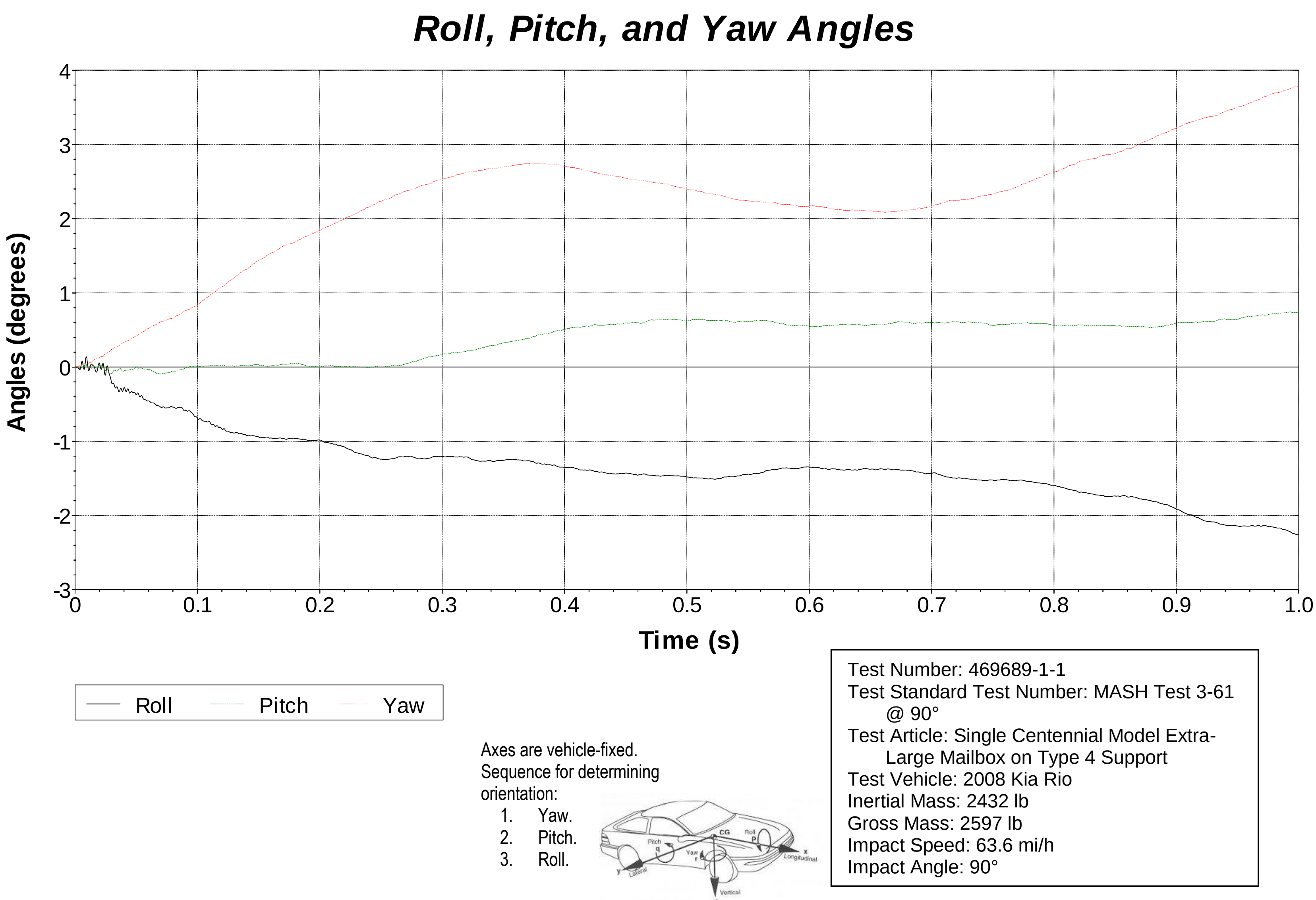


Figure A.2. Vehicle Angular Displacements for Test No. 469689-1-1.

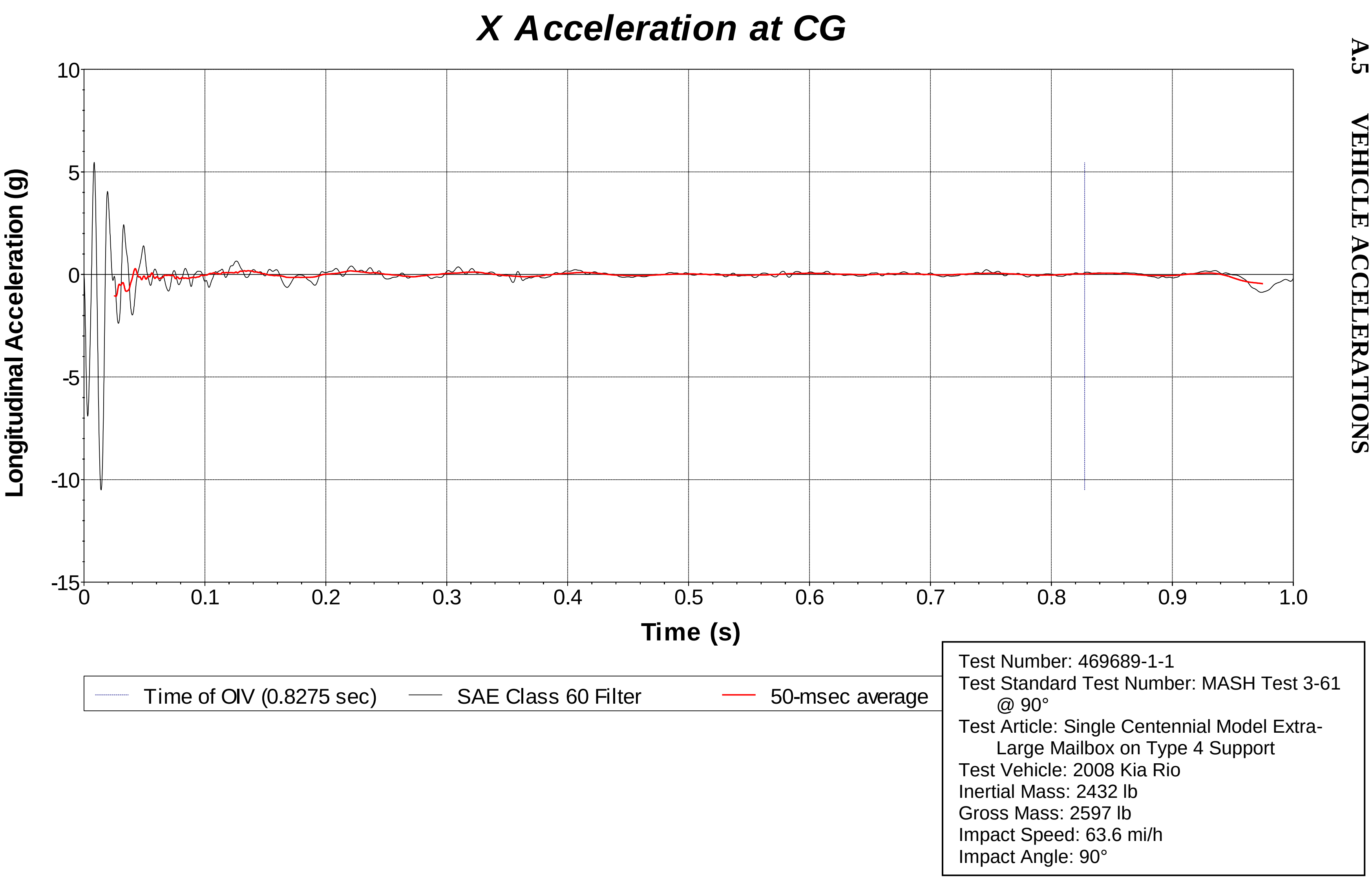


Figure A.3. Vehicle Longitudinal Accelerometer Trace for Test No. 469689-1-1 (Accelerometer Located at Center of Gravity).

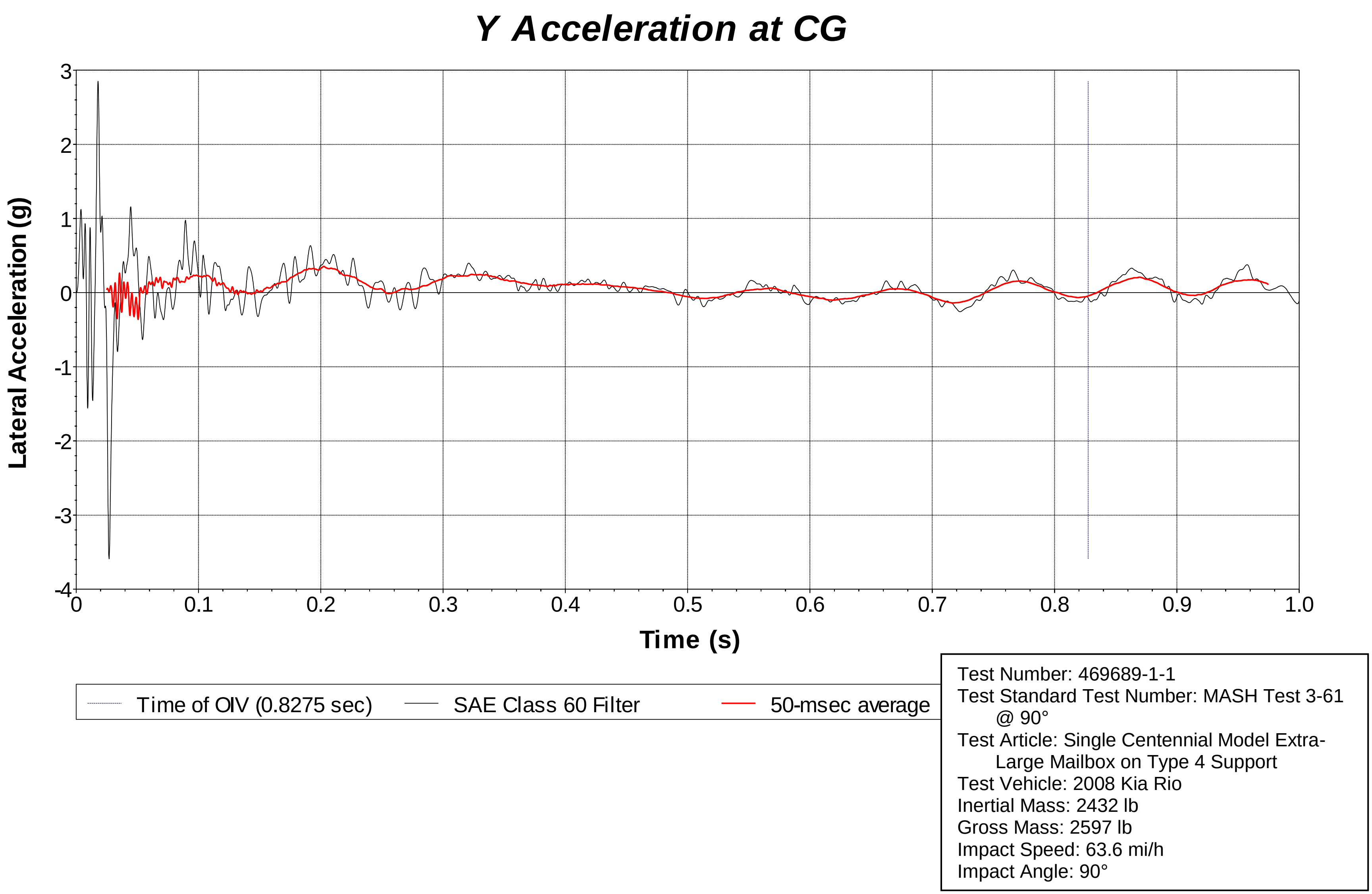


Figure A.4. Vehicle Lateral Accelerometer Trace for Test No. 469689-1-1 (Accelerometer Located at Center of Gravity).

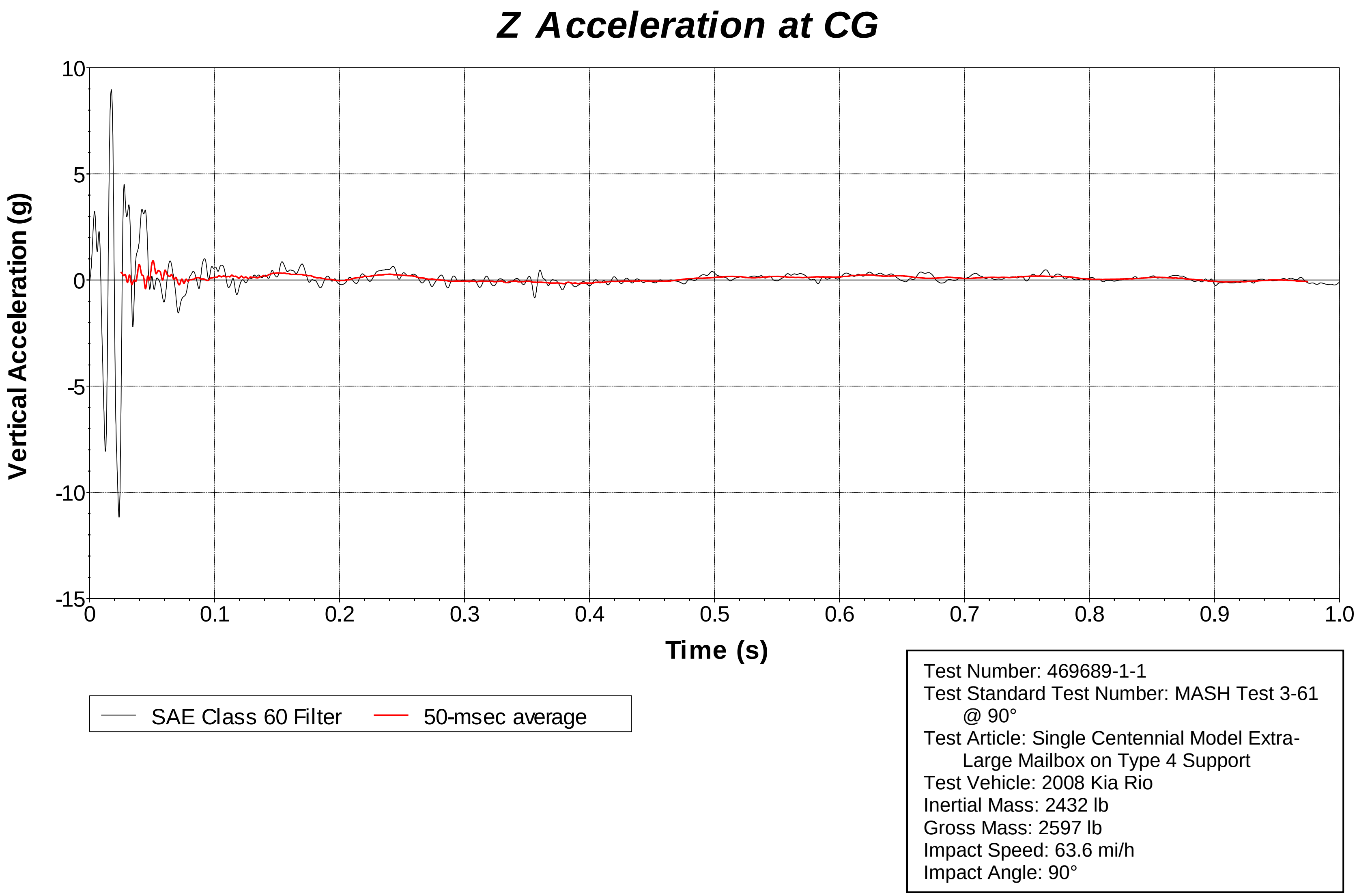
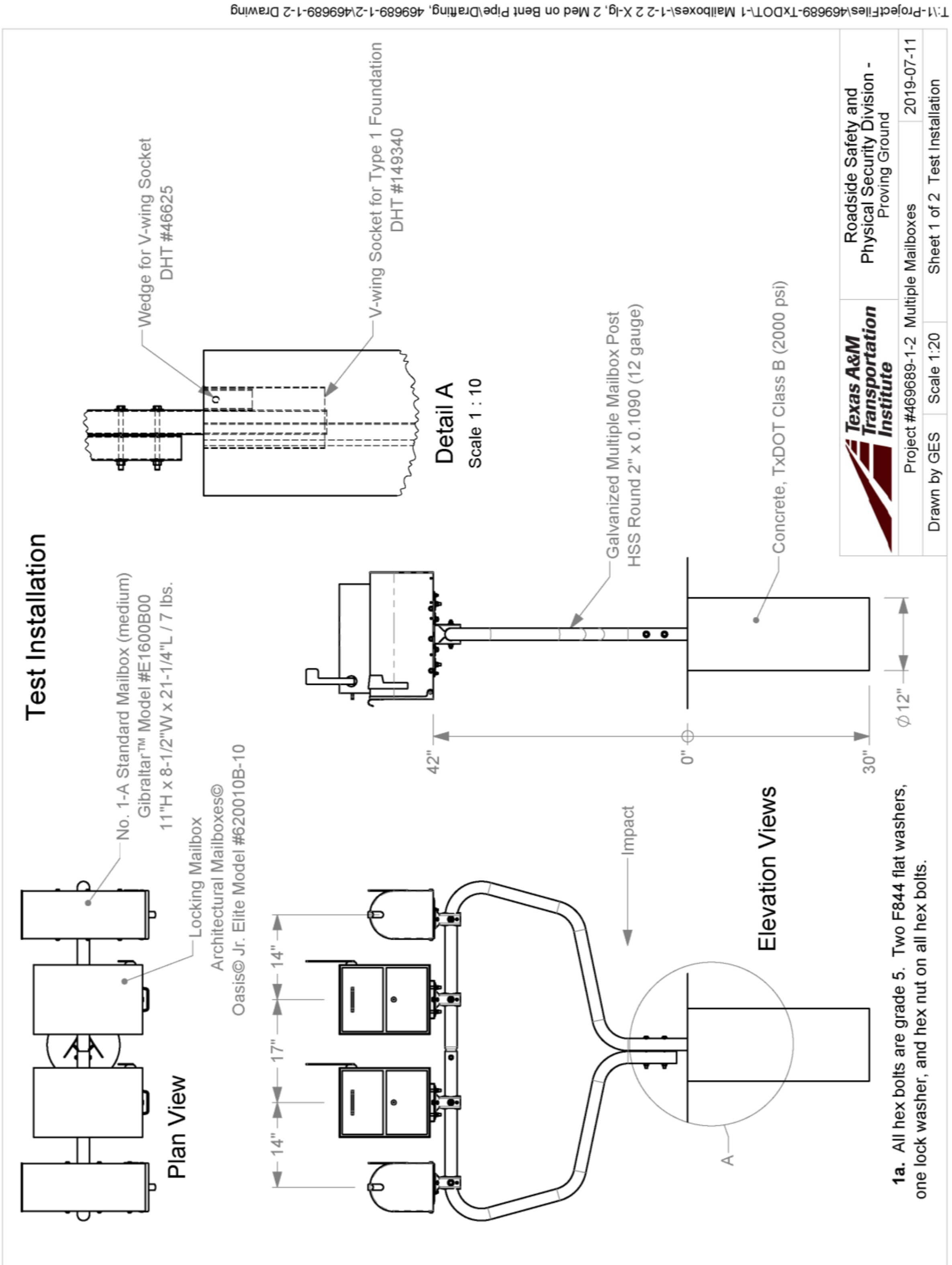


Figure A.5. Vehicle Vertical Accelerometer Trace for Test No. 469689-1-1 (Accelerometer Located at Center of Gravity).

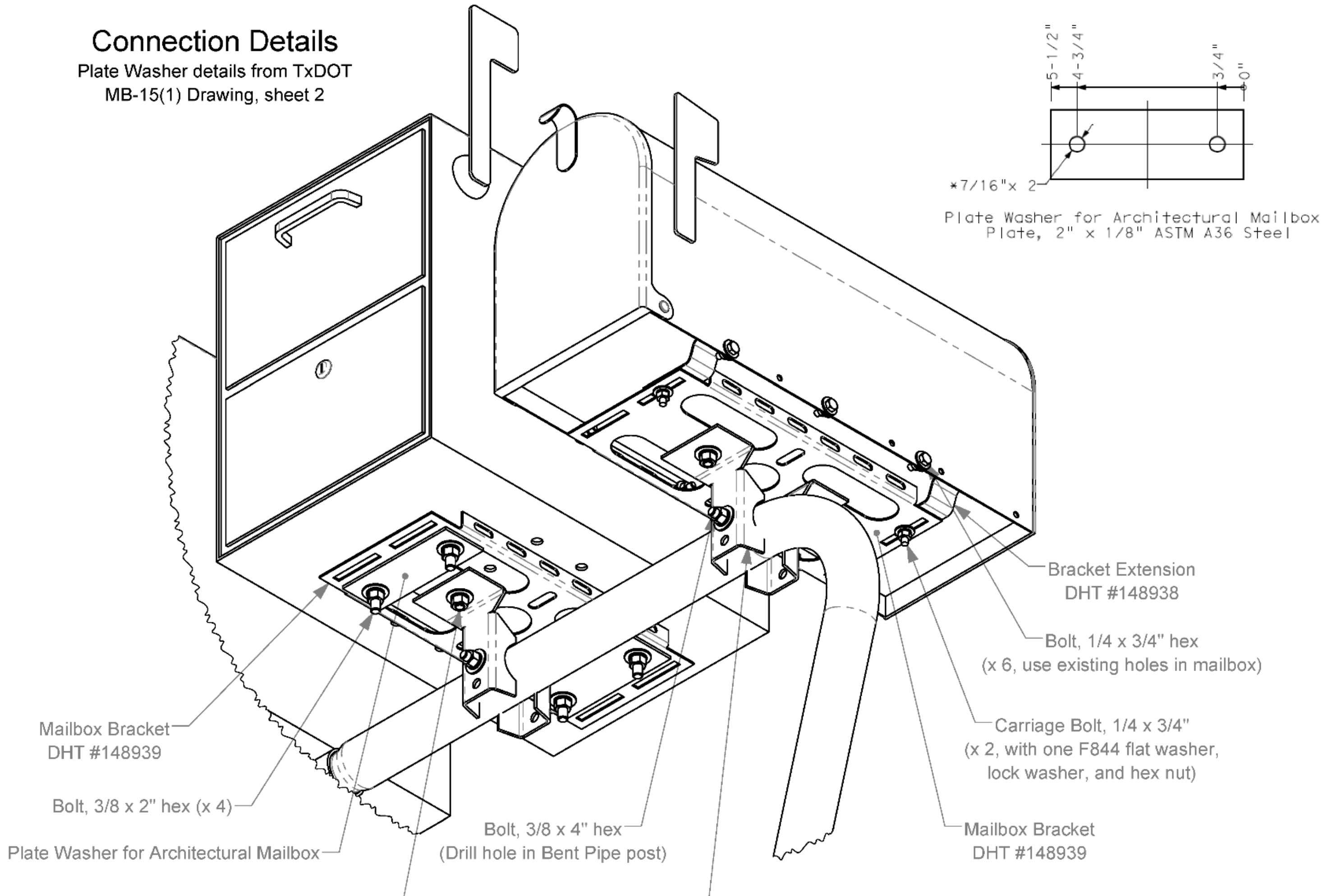
APPENDIX B. CRASH TEST 469689-1-2

B.1 DETAILS OF TEST ARTICLE



Connection Details

Plate Washer details from TxDOT
MB-15(1) Drawing, sheet 2

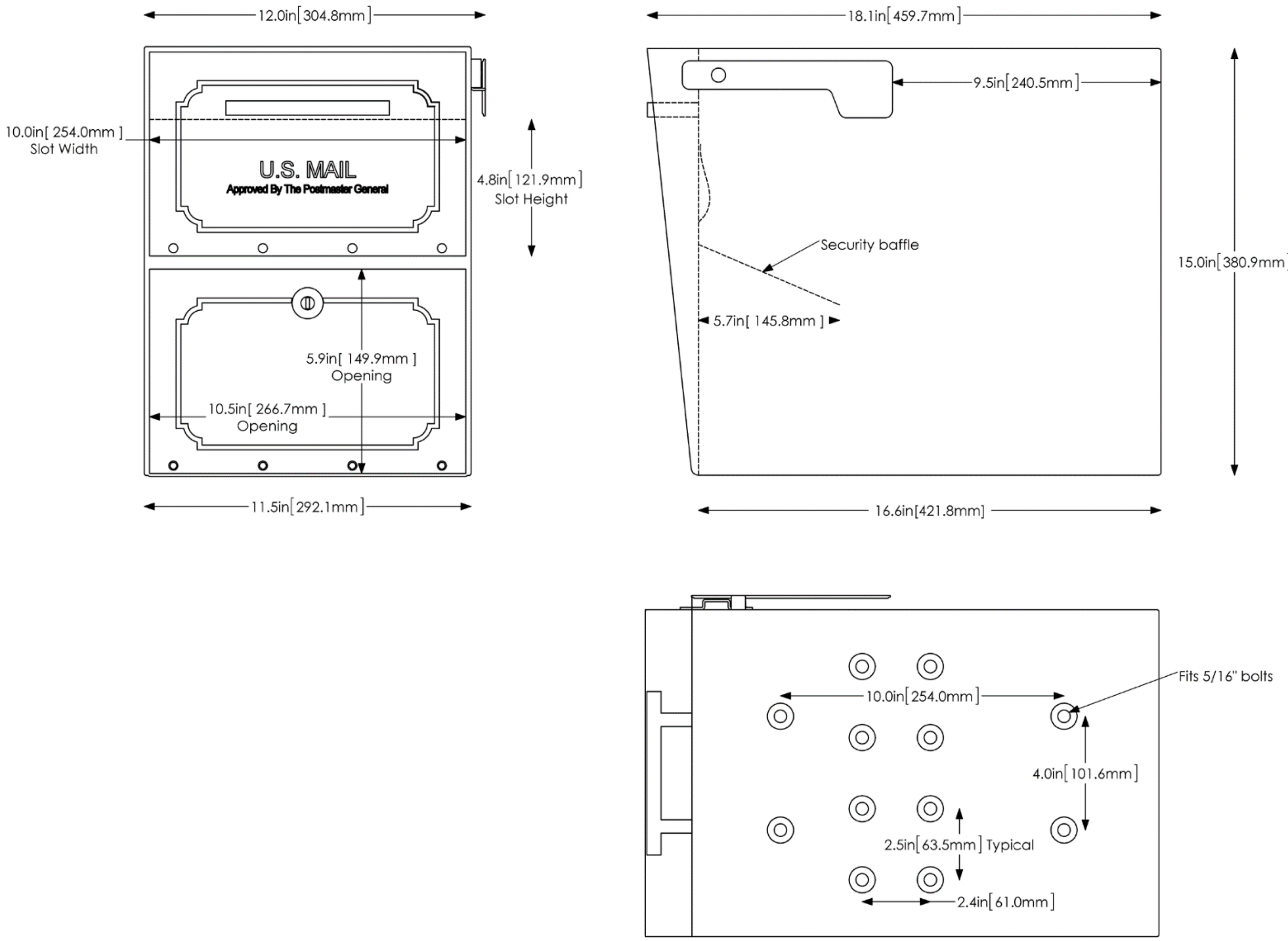


2a. All hex bolts are grade 5. Two F844 flat washers, one lock washer, and hex nut on all hex bolts.

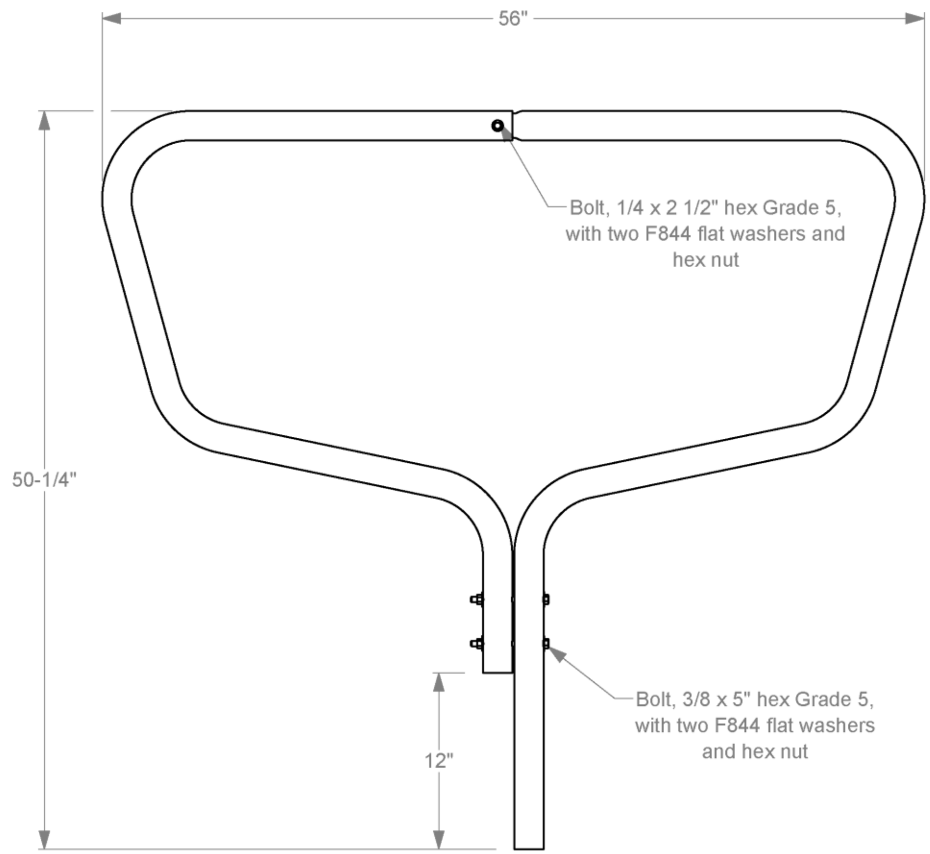
Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #469689-1-2 Multiple Mailboxes		2019-07-11
Drawn by GES	Scale 1:5	Sheet 2 of 2 Connection Details

T:\1-ProjectFiles\469689-TxDOT\-1 Mailboxes\-1-2 2 X-lg, 2 Med on Bent Pipe\Drafting, 469689-1-2\469689-1-2 Drawing

6200-website.jpg (8800×6800)



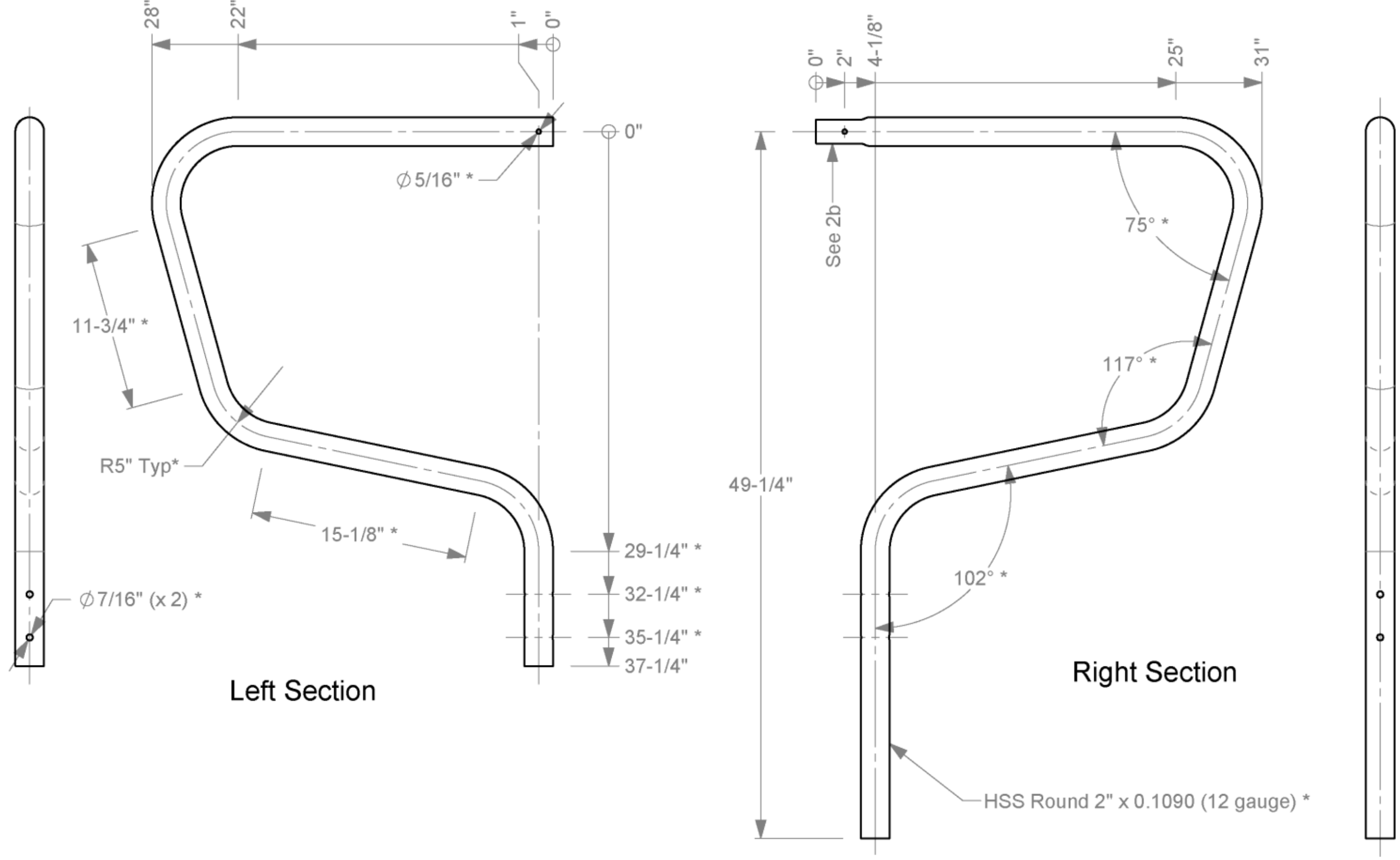
12 gauge Post Assembly



Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
12-gauge Bent Pipe Mailbox Post		2019-07-12
Drawn by GES	Scale 1:10	Sheet 1 of 2

T:\Drafting Department\Solidworks\Standard Parts\Mailbox Parts\Mailbox Part Drawings\Post, bent 12 gauge

12 gauge Post Parts



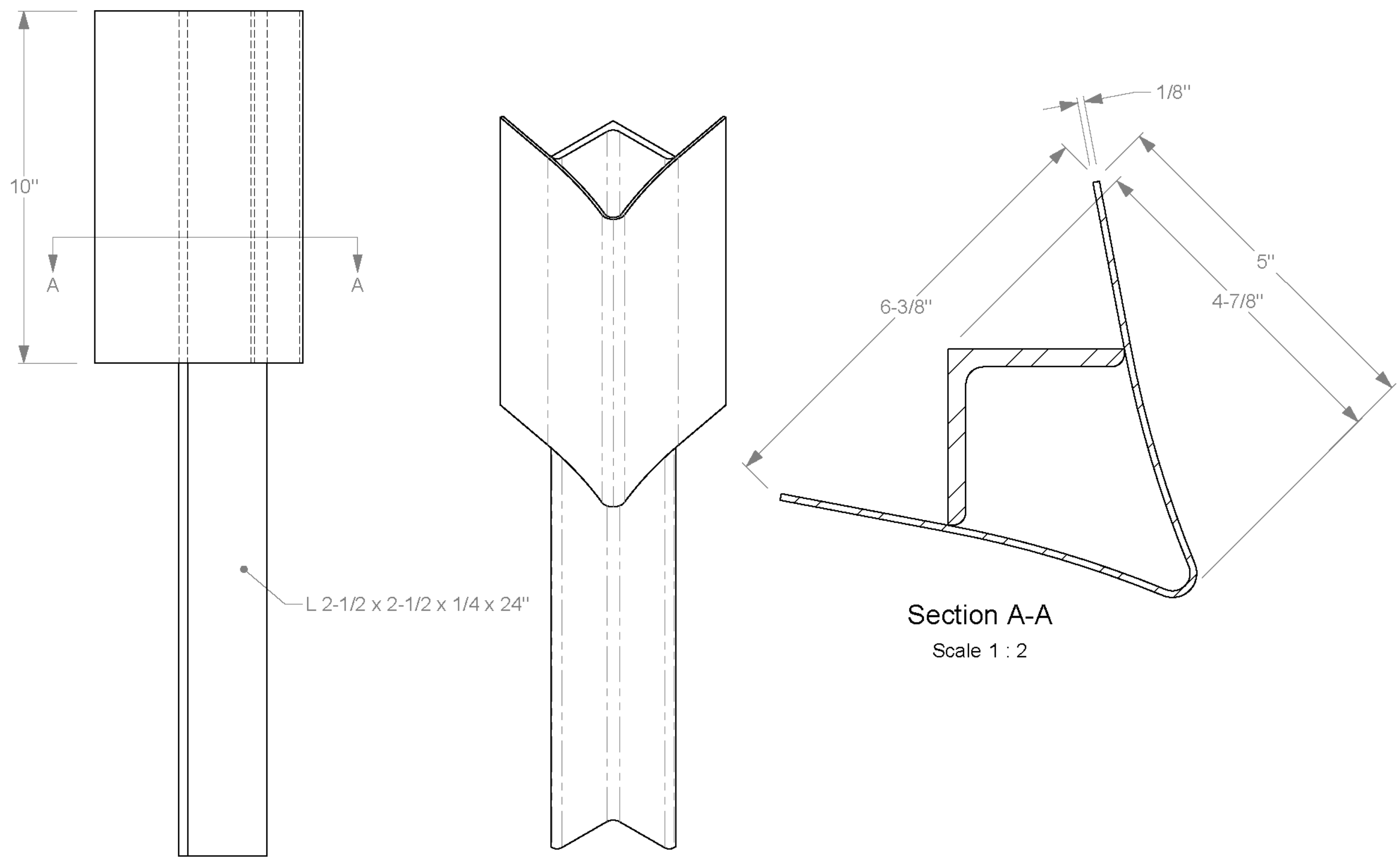
2a. Annotations marked with asterisk (*) are typical for Right and Left Sections.
2b. Crimp for snug fit in Left Section.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Galvanized Multiple Mailbox Post		2019-07-12
Drawn by GES	Scale 1:10	Sheet 2 of 2

T:\Drafting Department\Solidworks\Standard Parts\Mailbox Parts\Mailbox Part Drawings\Post, bent 12 gauge

V-wing Socket for Type 1 Foundation

DHT# 149340



Elevation View

Isometric View

Section A-A

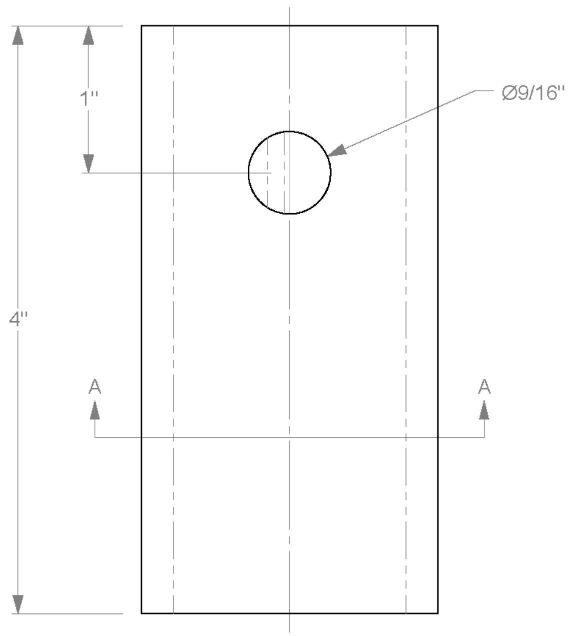
Scale 1 : 2

Texas A&M Transportation Institute		Roadside Safety and Physical Security Division - Proving Ground	
V-Wing Socket for Type 1 Foundation			2017-09-18
Drawn by GES	Scale 1:4	Sheet 1 of 1	

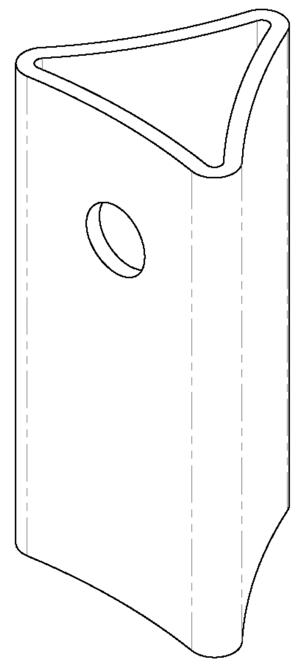
T:\Drafting Department\Solidworks\Standard Parts\Mailbox Parts\Mailbox Part Drawings\149340

Wedge for V-wing Socket

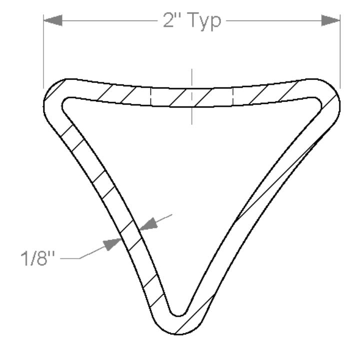
DHT# 46625



Elevation View



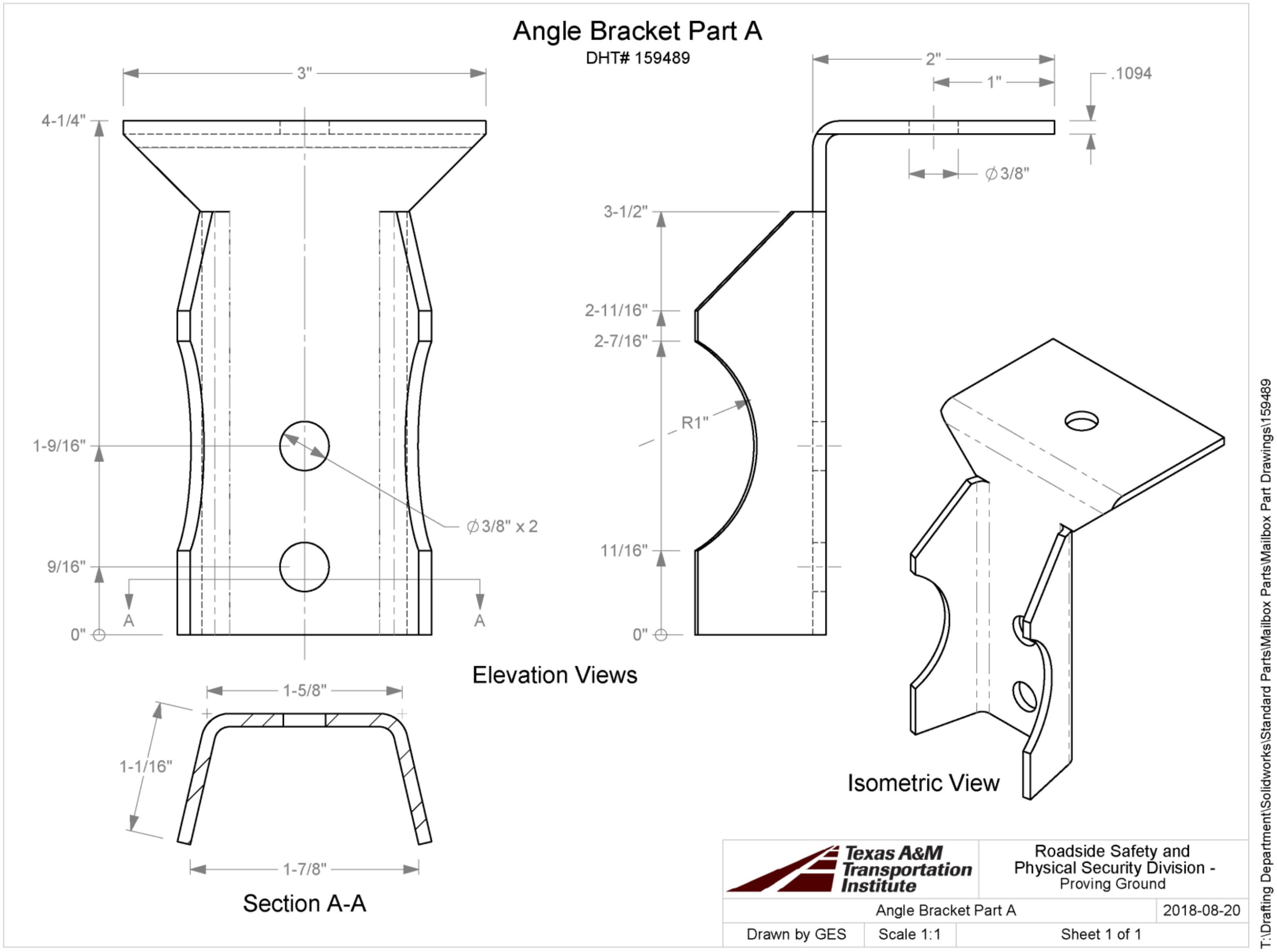
Isometric View



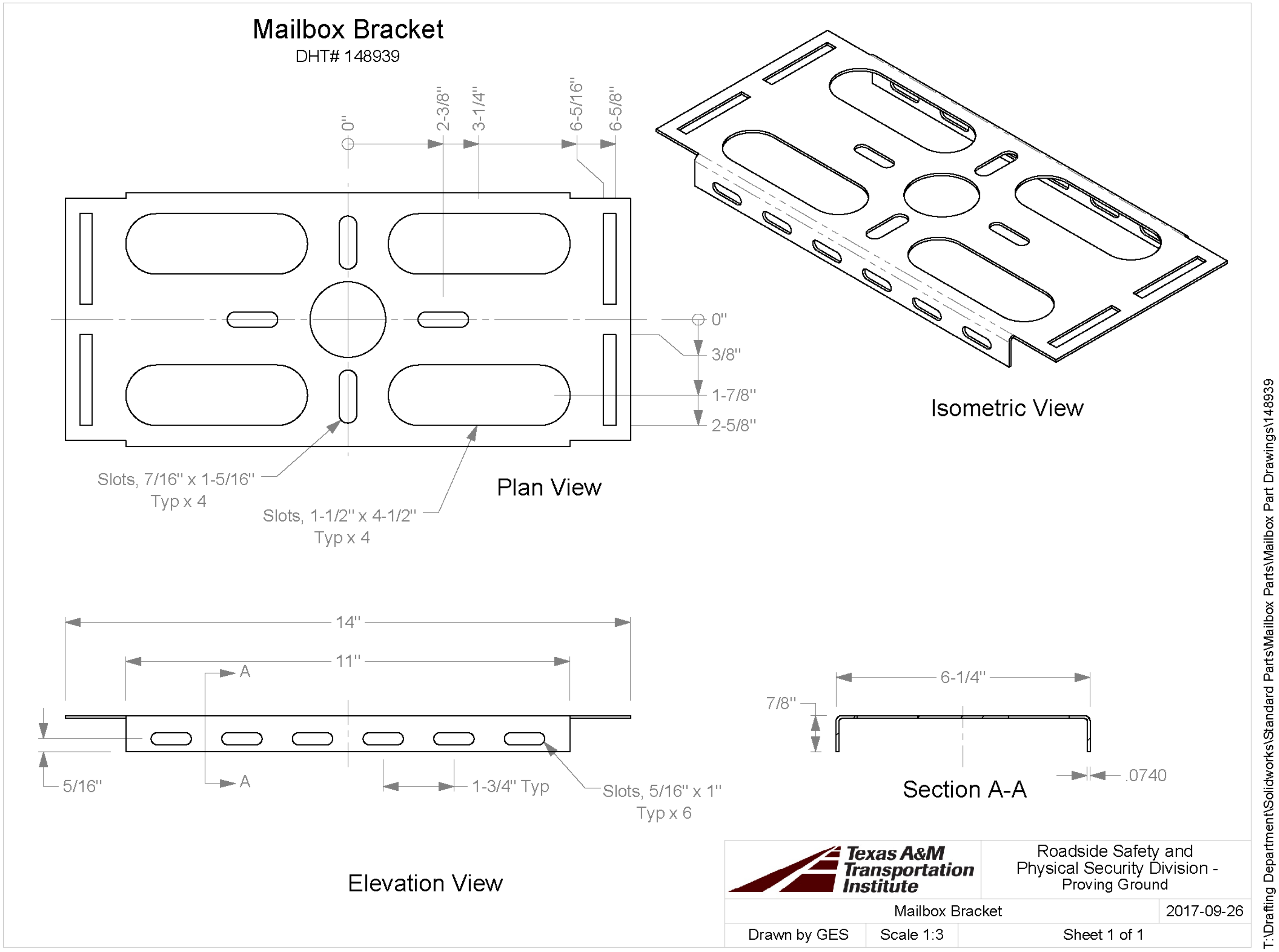
Section A-A

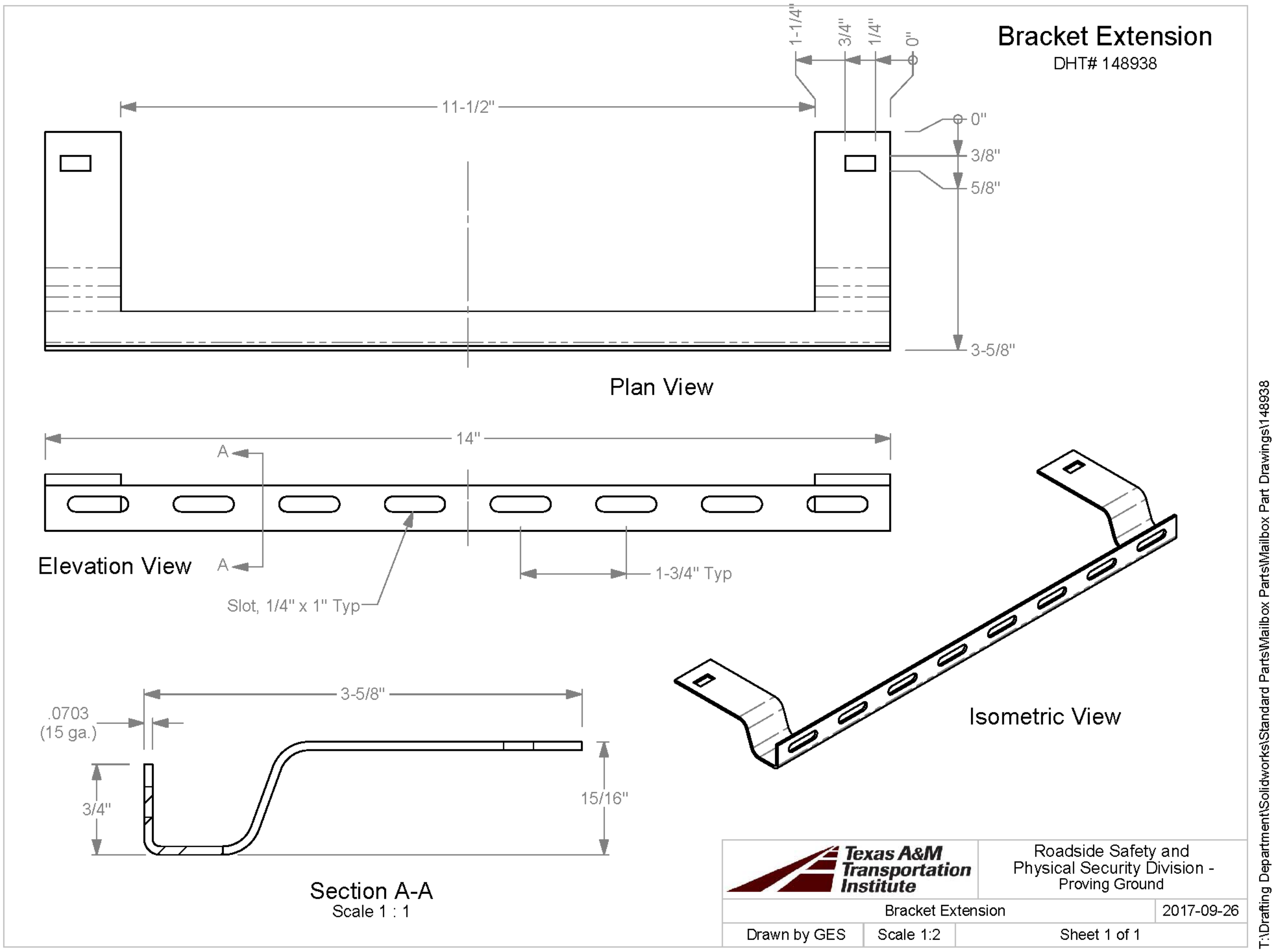
Texas A&M Transportation Institute		Roadside Safety and Physical Security Division - Proving Ground
Wedge for V-wing Socket		2017-09-18
Drawn by GES	Scale 1:1	Sheet 1 of 1

T:\Drafting Department\Solidworks\Standard Parts\Mailbox Parts\Mailbox Part Drawings\46625



Angle Bracket Part A
DHT# 159489
3"
4-1/4"
1-9/16"
9/16"
0"
A
A
∅3/8" x 2
2"
1"
.1094
∅3/8"
3-1/2"
2-11/16"
2-7/16"
R1"
11/16"
0"
Elevation Views
1-5/8"
1-1/16"
1-7/8"
Section A-A
Isometric View
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
Angle Bracket Part A
2018-08-20
Drawn by GES
Scale 1:1
Sheet 1 of 1
T:\Drafting Department\Solidworks\Standard Parts\Mailbox Parts\Mailbox Part Drawings\159489


Mailbox Bracket
DHT# 148939
0"
2-3/8"
3-1/4"
6-5/16"
6-5/8"
0"
3/8"
1-7/8"
2-5/8"
Slots, 7/16" x 1-5/16"
Typ x 4
Slots, 1-1/2" x 4-1/2"
Typ x 4
Plan View
Isometric View
14"
11"
A
A
5/16"
1-3/4" Typ
Slots, 5/16" x 1"
Typ x 6
Elevation View
6-1/4"
7/8"
.0740
Section A-A
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
Mailbox Bracket
2017-09-26
Drawn by GES
Scale 1:3
Sheet 1 of 1
T:\Drafting Department\Solidworks\Standard Parts\Mailbox Parts\Mailbox Part Drawings\148939


Bracket Extension
DHT# 148938
11-1/2"
1-1/4"
3/4"
1/4"
0"
0"
3/8"
5/8"
3-5/8"
Plan View
14"
A
A
Elevation View
Slot, 1/4" x 1" Typ
1-3/4" Typ
Isometric View
.0703
(15 ga.)
3-5/8"
3/4"
15/16"
Section A-A
Scale 1 : 1
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
Bracket Extension
2017-09-26
Drawn by GES
Scale 1:2
Sheet 1 of 1
T:\Drafting Department\Solidworks\Standard Parts\Mailbox Parts\Mailbox Part Drawings\148938

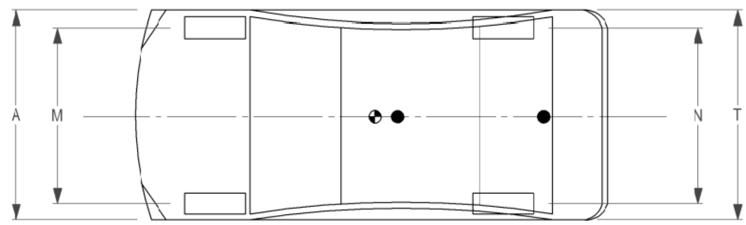
B.2 VEHICLE PROPERTIES AND INFORMATION

Table B.1. Vehicle Properties for Test No. 469689-1-2.

Date:	2019-08-23	Test No.:	469689-1-2	VIN No.:	KNADE123586375064
Year:	2008	Make:	Kia	Model:	Rio
Tire Inflation Pressure:	32 PSI	Odometer:	256264	Tire Size:	185/65R14

Describe any damage to the vehicle prior to test: None

● Denotes accelerometer location.



NOTES:

Engine Type: 4 CYL

Engine CID: 1.6 L

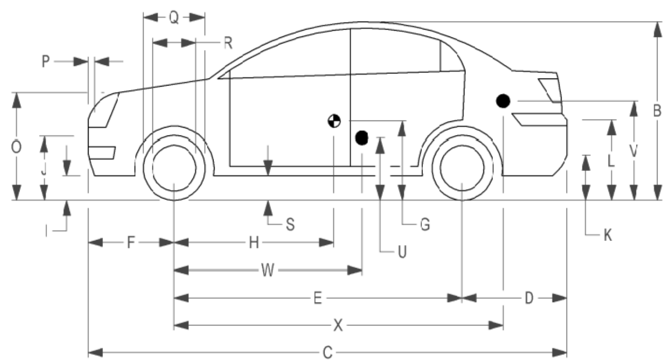
Transmission Type:

☑ Auto or ☐ Manual

☑ FWD ☐ RWD ☐ 4WD

Optional Equipment:

None



Dummy Data:

Type: 50th Percentile Male

Mass: 165 lb

Seat Position: OPPOSITE IMPACT

Geometry: inches

A	66.38	F	33.00	K	12.25	P	4.12	U	14.75
B	51.50	G		L	25.25	Q	22.50	V	20.75
C	165.75	H	35.67	M	57.75	R	15.50	W	35.60
D	34.00	I	7.75	N	57.70	S	8.25	X	71.50
E	98.75	J	21.50	O	27.00	T	66.20		

Wheel Center Ht Front 11.00 Wheel Center Ht Rear 11.00 W-H 0.00

RANGE LIMIT: A = 65 ±3 inches; C = 169 ±8 inches; E = 98 ±5 inches; F = 35 ±4 inches; H = 39 ±4 inches; O (Bottom of Hood Lip) = 24 ±4 inches
TOP OF RADIATOR SUPPORT = 28.25 inches; (M+N)/2 = 56 ±2 inches; W-H < 2 inches or use MASH Paragraph A4.3.2

GVWR Ratings:		**Mass:** lb	Curb	Test Inertial	Gross Static
Front	1718	M_{front}	1584	1561	1646
Back	1874	M_{rear}	893	881	961
Total	3638	M_{Total}	2477	2442	2607

Allowable TIM = 2420 lb ±55 lb | Allowable GSM = 2585 lb ± 55 lb

Mass Distribution:

lb LF: 777 RF: 784 LR: 456 RR: 425

Table B.2. Exterior Crush Measurements of Vehicle for Test No. 469689-1-2.

Date:	2019-08-23	Test No.:	469689-1-2	VIN No.:	KNADE123586375064
Year:	2008	Make:	Kia	Model:	Rio

VEHICLE CRUSH MEASUREMENT SHEET[1]

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

Note: Measure C_1 to C_6 from Driver to Passenger Side in Front or Rear Impacts – Rear to Front in Side Impacts.

Specific Impact Number	Plane* of C-Measurements	Direct Damage Width** (CDC)	Max*** Crush	Field L**	C_1	C_2	C_3	C_4	C_5	C_6	±D
	Hood		9								
	Measurements recorded										
	☑ **inches** **or** ☐ **mm**										

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

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

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

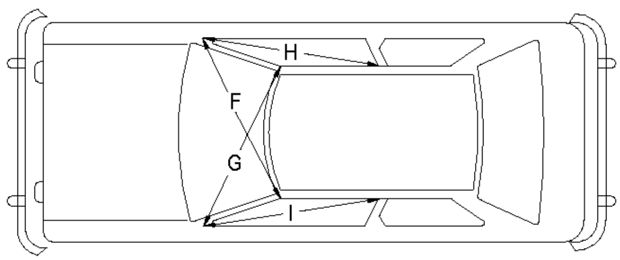
**Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle).

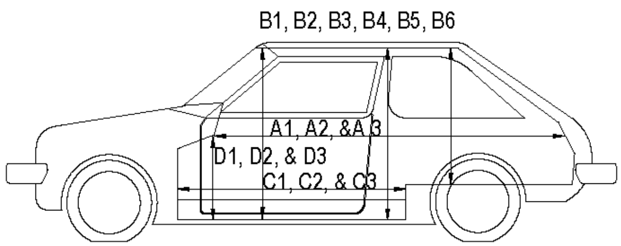
***Measure and document on the vehicle diagram the location of the maximum crush.

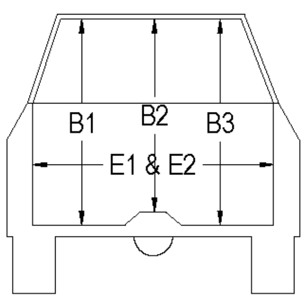
Note: Use as many lines/columns as necessary to describe each damage profile.

Table B.3. Occupant Compartment Measurements of Vehicle for Test No. 469689-1-2.

Date:	2019-08-23	Test No.:	469689-1-2	VIN No.:	KNADE123586375064
Year:	2008	Make:	Kia	Model:	Rio







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

OCCUPANT COMPARTMENT DEFORMATION MEASUREMENT

	Before	After (inches)	Differ.
A1	67.50	67.50	0.00
A2	67.25	67.25	0.00
A3	67.75	67.75	0.00
B1	40.50	40.50	0.00
B2	39.00	39.00	0.00
B3	40.50	40.50	0.00
B4	36.25	36.25	0.00
B5	36.00	36.00	0.00
B6	36.25	36.25	0.00
C1	26.00	26.00	0.00
C2	0.00	0.00	0.00
C3	26.00	26.00	0.00
D1	9.50	9.50	0.00
D2	0.00	0.00	0.00
D3	9.50	9.50	0.00
E1	51.50	51.50	0.00
E2	51.00	51.00	0.00
F	51.00	51.00	0.00
G	51.00	51.00	0.00
H	37.50	37.50	0.00
I	37.50	37.50	0.00
J*	51.00	51.00	0.00

B.3 SEQUENTIAL PHOTOGRAPHS

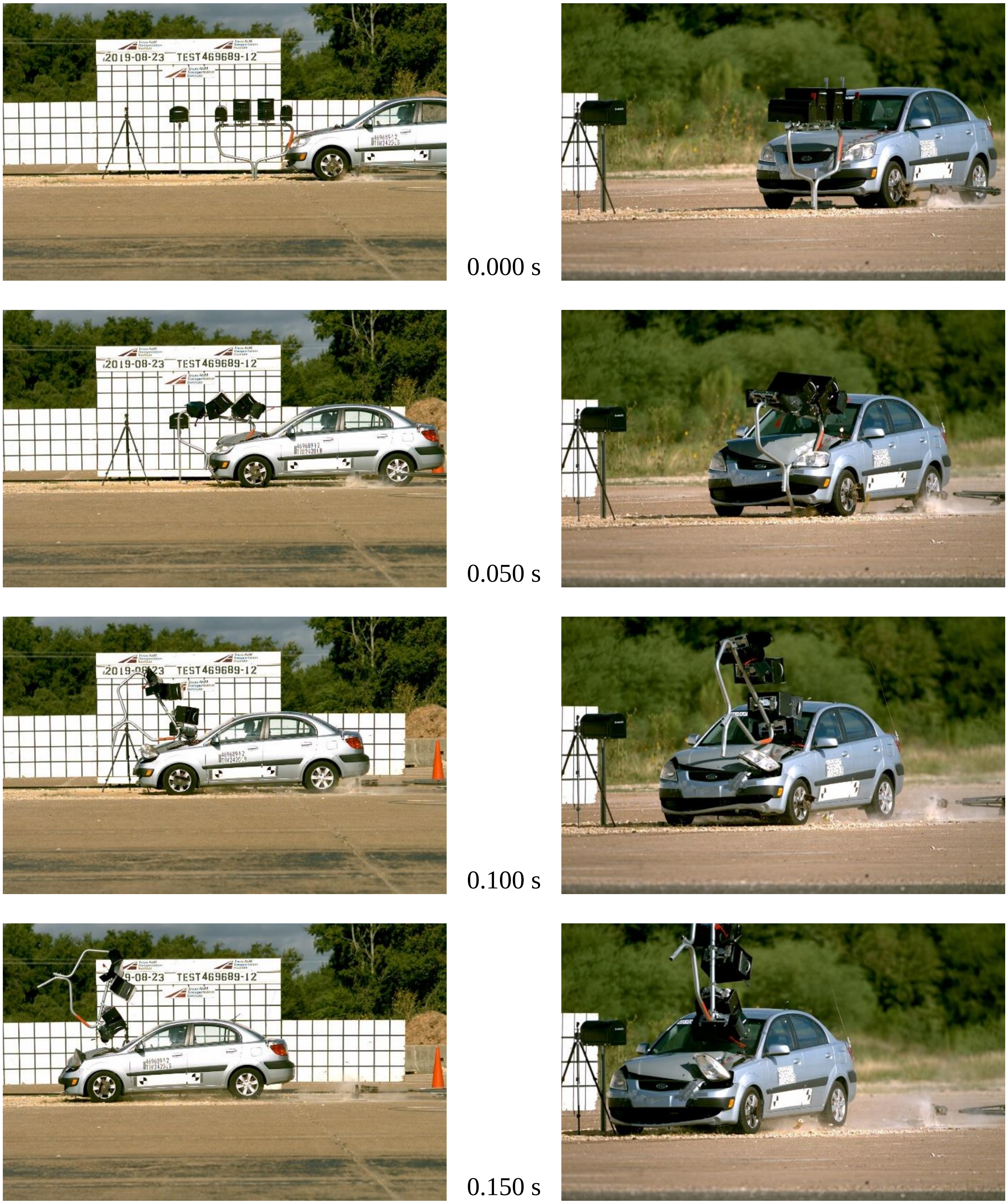


Figure B.1. Sequential Photographs for Test No. 469689-1-2 (Perpendicular and Oblique Views).

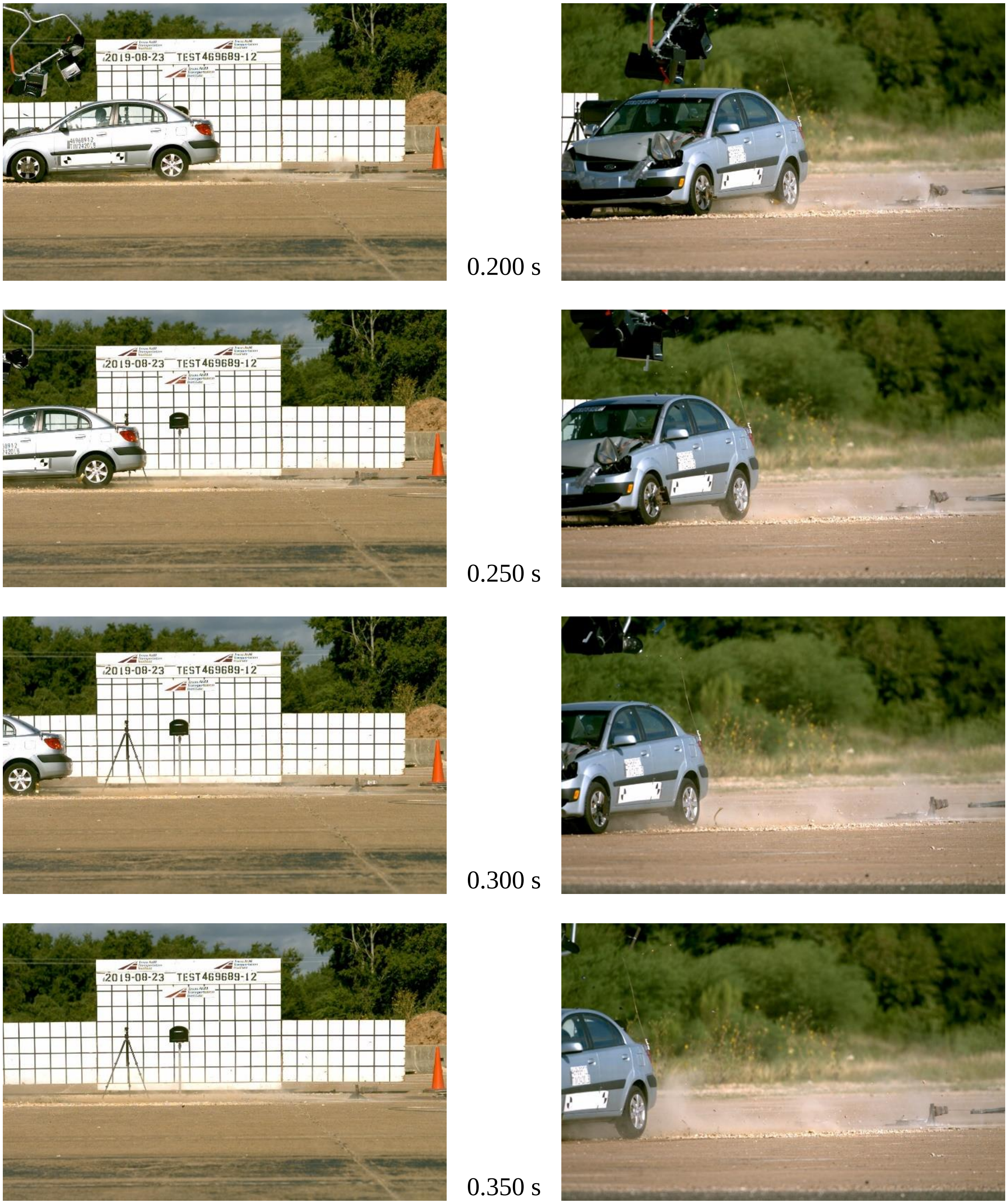
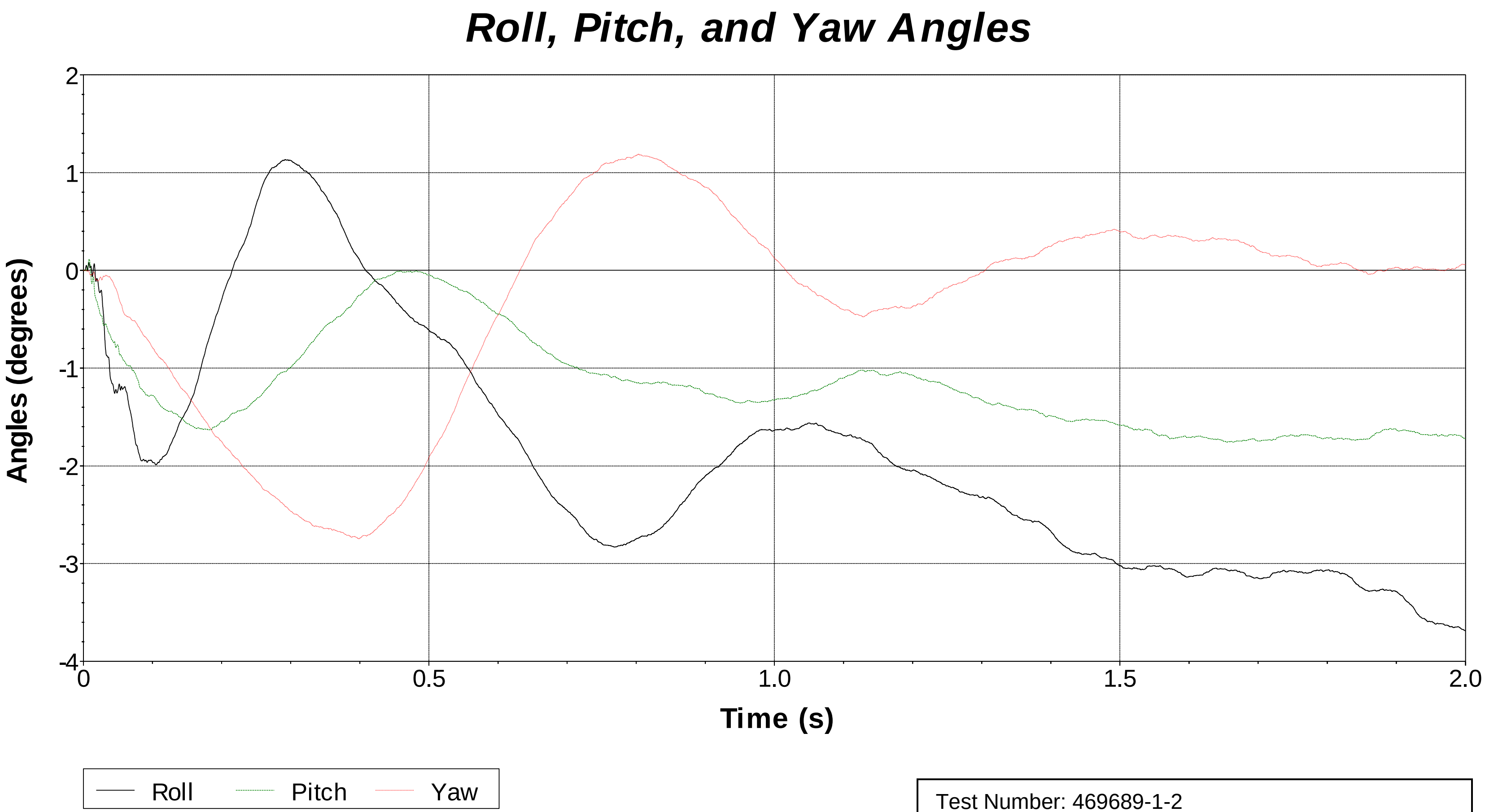
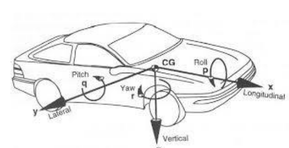


Figure B.1. Sequential Photographs for Test No. 469689-1-2 (Perpendicular and Oblique Views) (Continued).



Axes are vehicle-fixed.
Sequence for determining orientation:

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



Test Number: 469689-1-2
Test Standard Test Number: MASH Test 3-61
Test Article: Multiple Mailboxes on Bent Pipe Support
Test Vehicle: 2008 Kia Rio
Inertial Mass: 2442 lb
Gross Mass: 2607 lb
Impact Speed: 61.6 mi/h
Impact Angle: 90°

Figure B.2. Vehicle Angular Displacements for Test No. 469689-1-2.

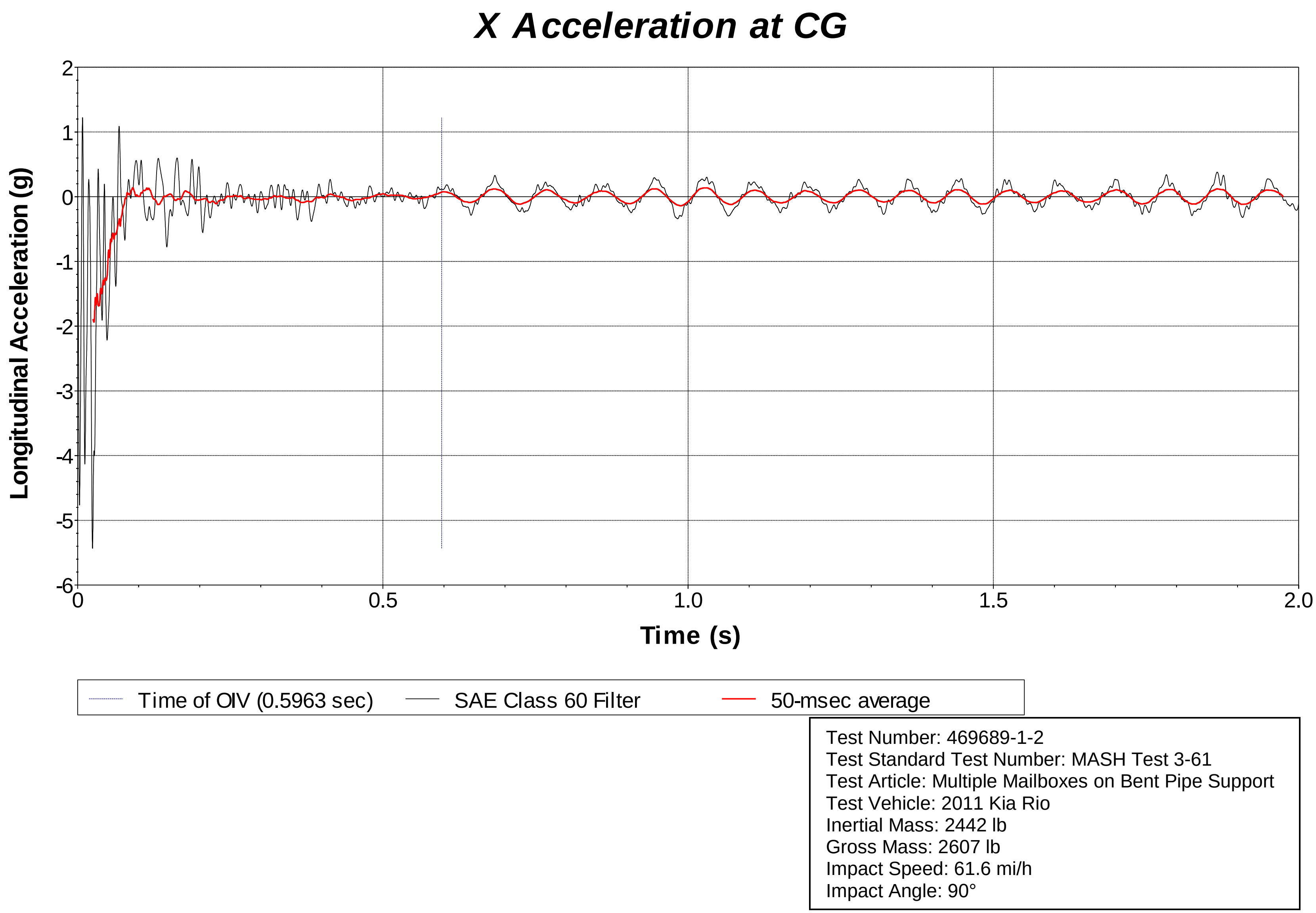


Figure B.3. Vehicle Longitudinal Accelerometer Trace for Test No. 469689-1-2 (Accelerometer Located at Center of Gravity).

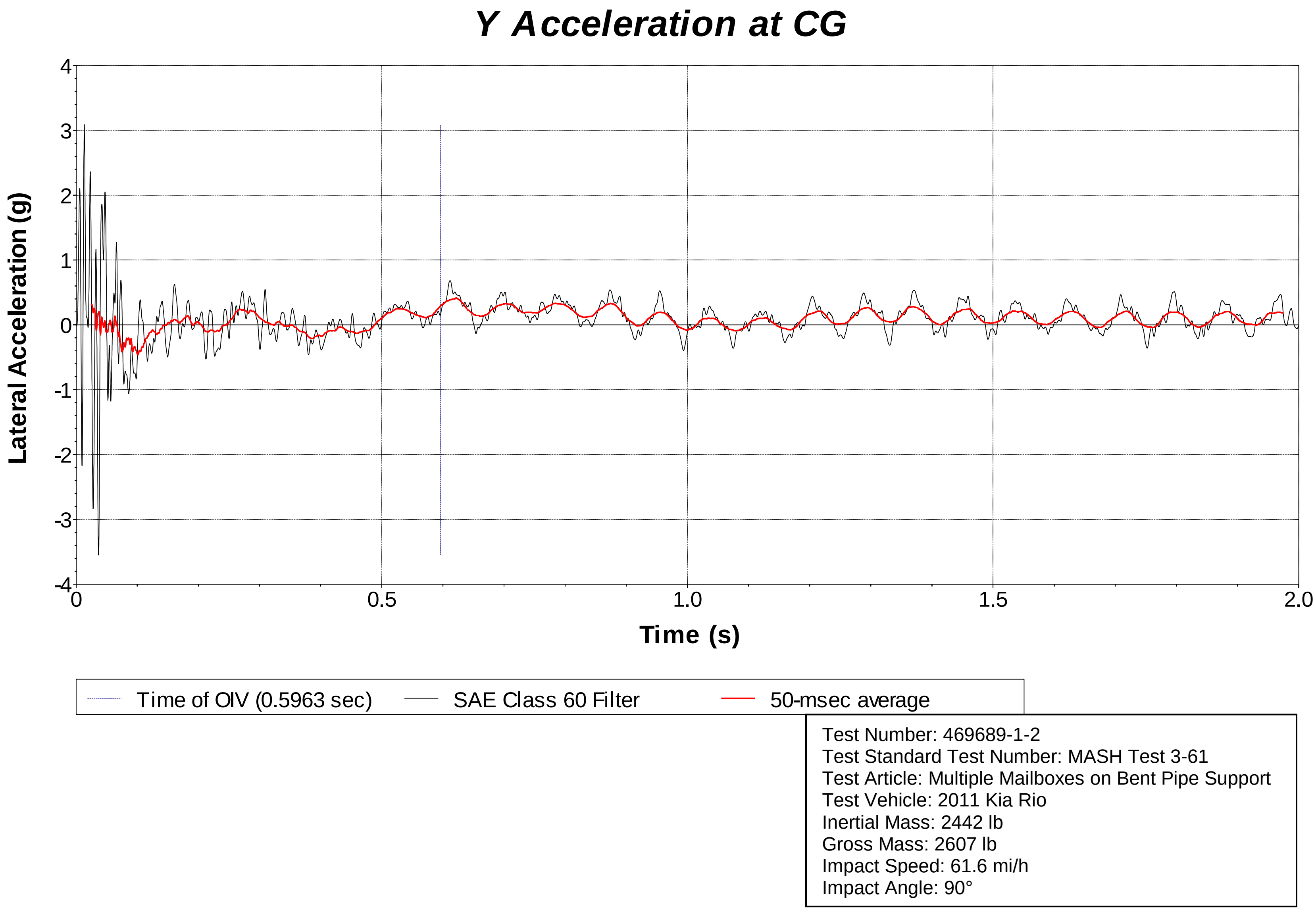


Figure B.4. Vehicle Lateral Accelerometer Trace for Test No. 469689-1-2 (Accelerometer Located at Center of Gravity).

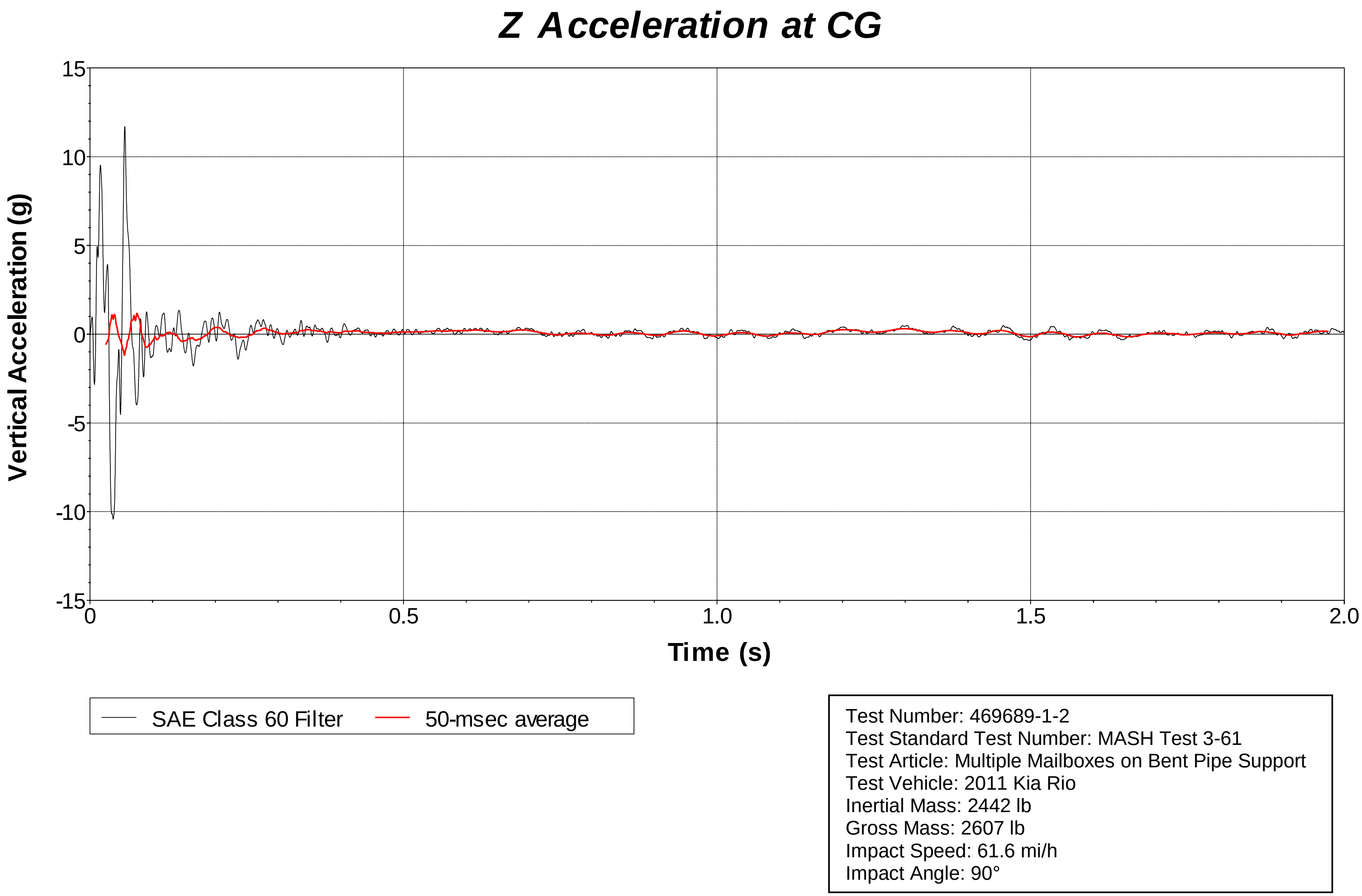
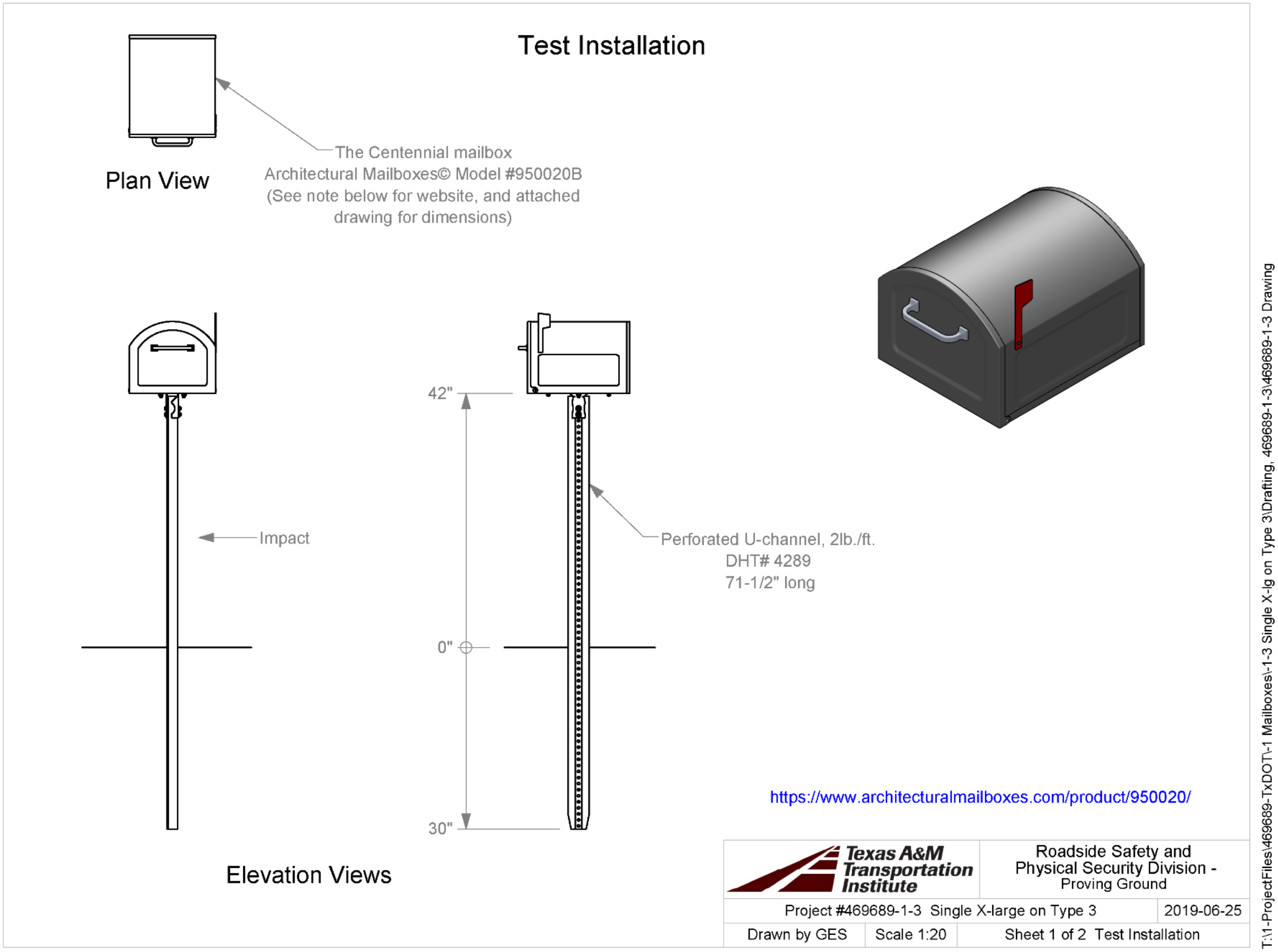


Figure B.5. Vehicle Vertical Accelerometer Trace for Test No. 469689-1-2 (Accelerometer Located at Center of Gravity).

APPENDIX C. CRASH TEST 469689-1-3

C.1 DETAILS OF TEST ARTICLE



Connection Details

Plate Washer details from TxDOT
MB-15(1) Drawing, sheet 2

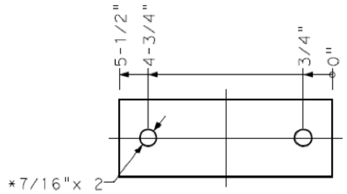
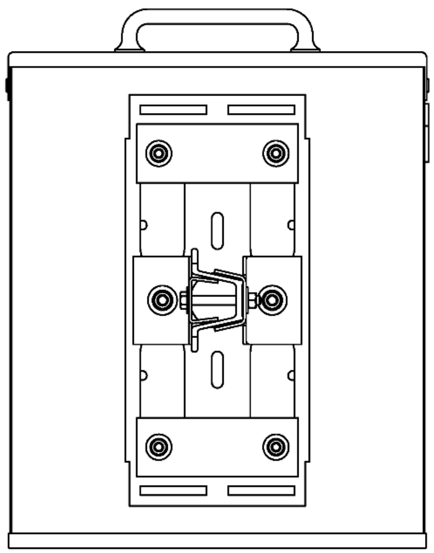
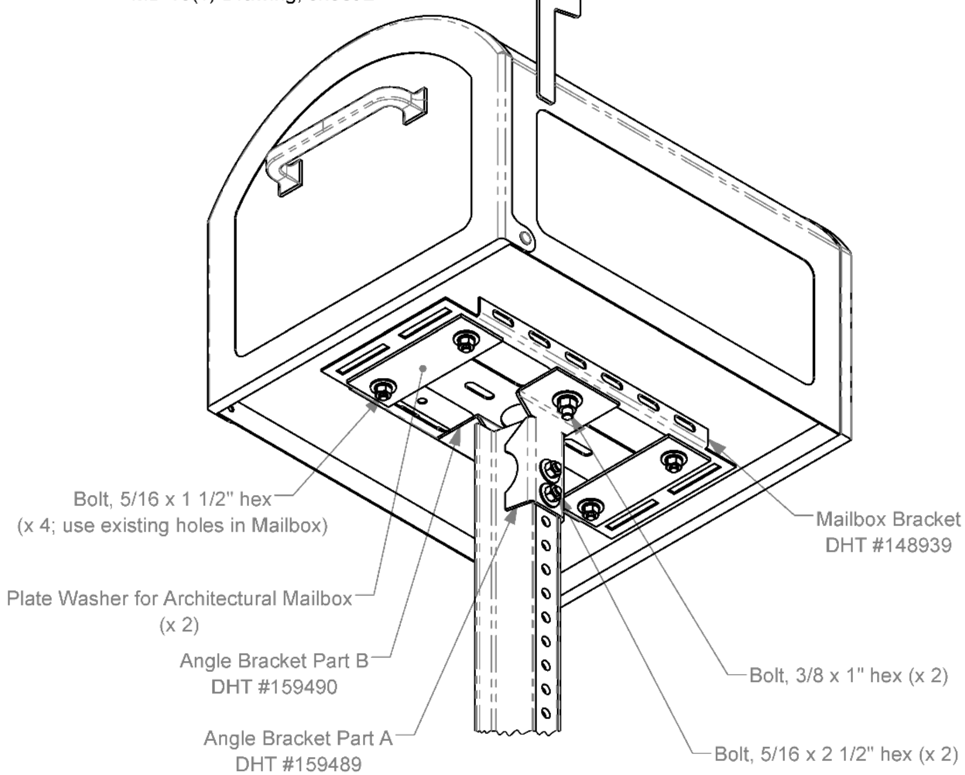


Plate Washer for Architectural Mailbox
Plate, 2" x 1/8" ASTM A36 Steel



Bottom View



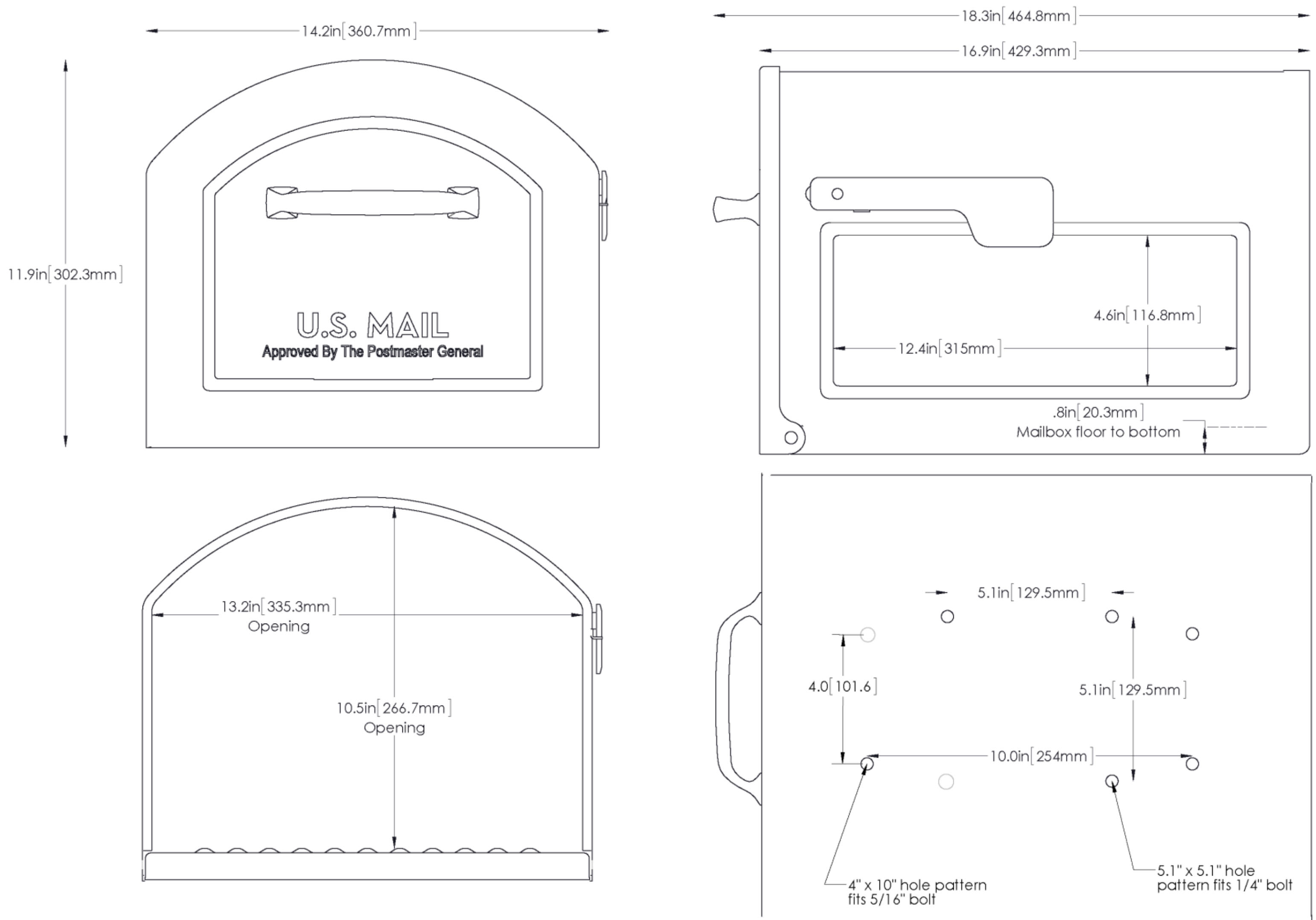
Isometric View

2a. All hex bolts are grade 5. Two USS flat washers, one lock washer, and hex nut on all hex bolts.

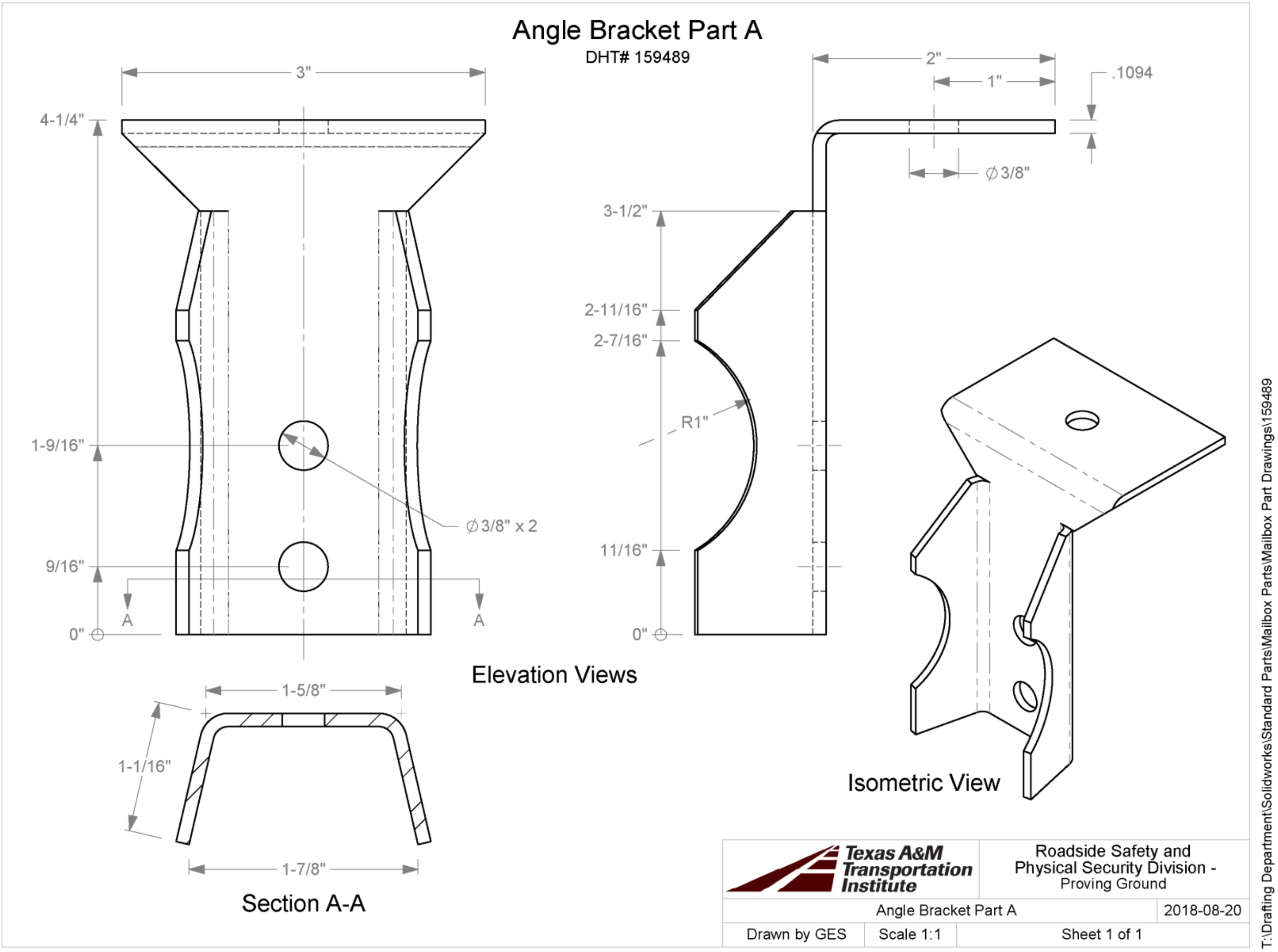
Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #469689-1-3 Single X-large on Type 3		2019-06-25
Drawn by GES	Scale 1:5	Sheet 2 of 2 Connection Details

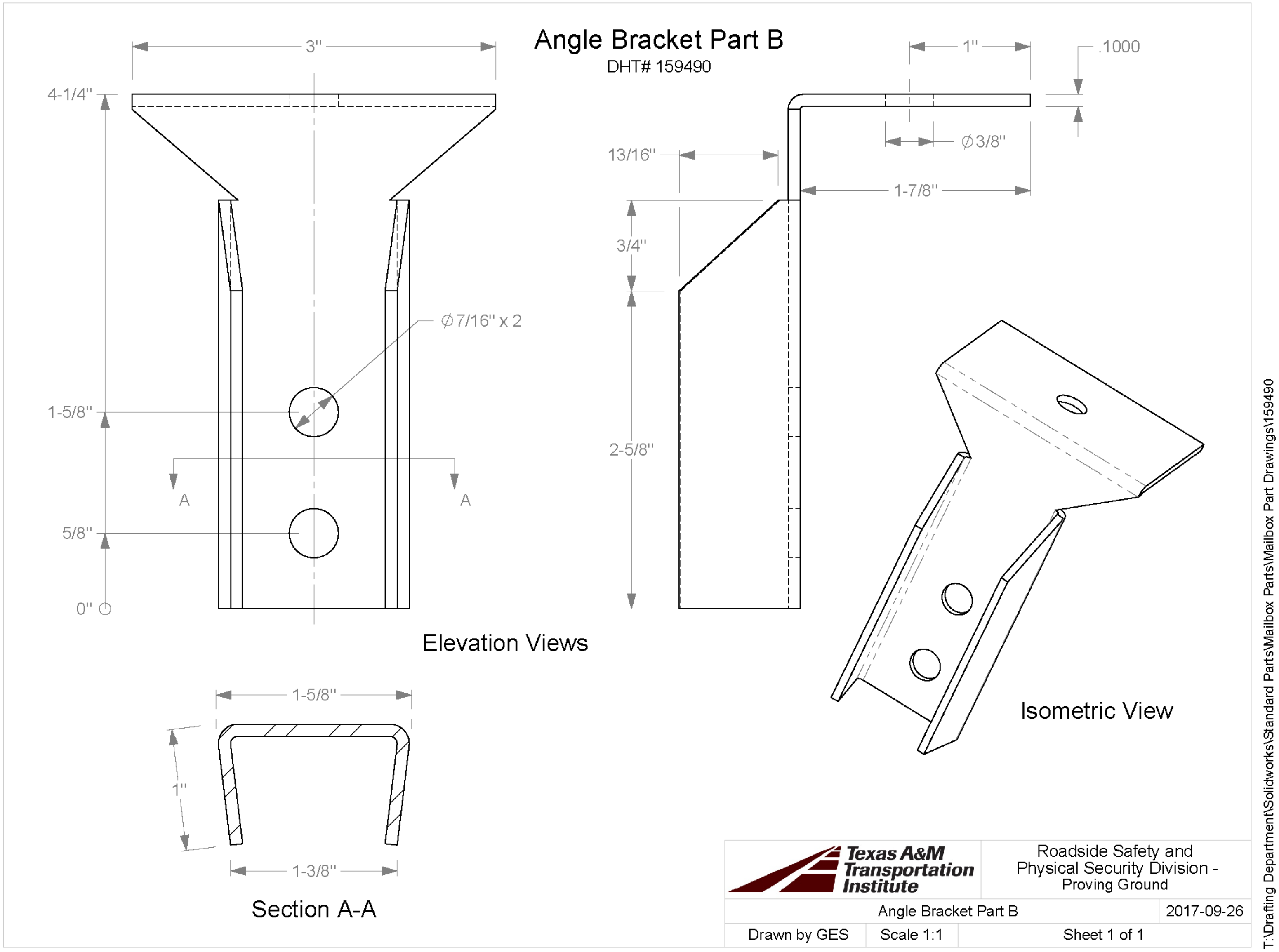
T:\1-ProjectFiles\469689-TxDOT\-1 Mailboxes\-1-3 Single X-lg on Type 3\Drafting, 469689-1-3\469689-1-3 Drawing

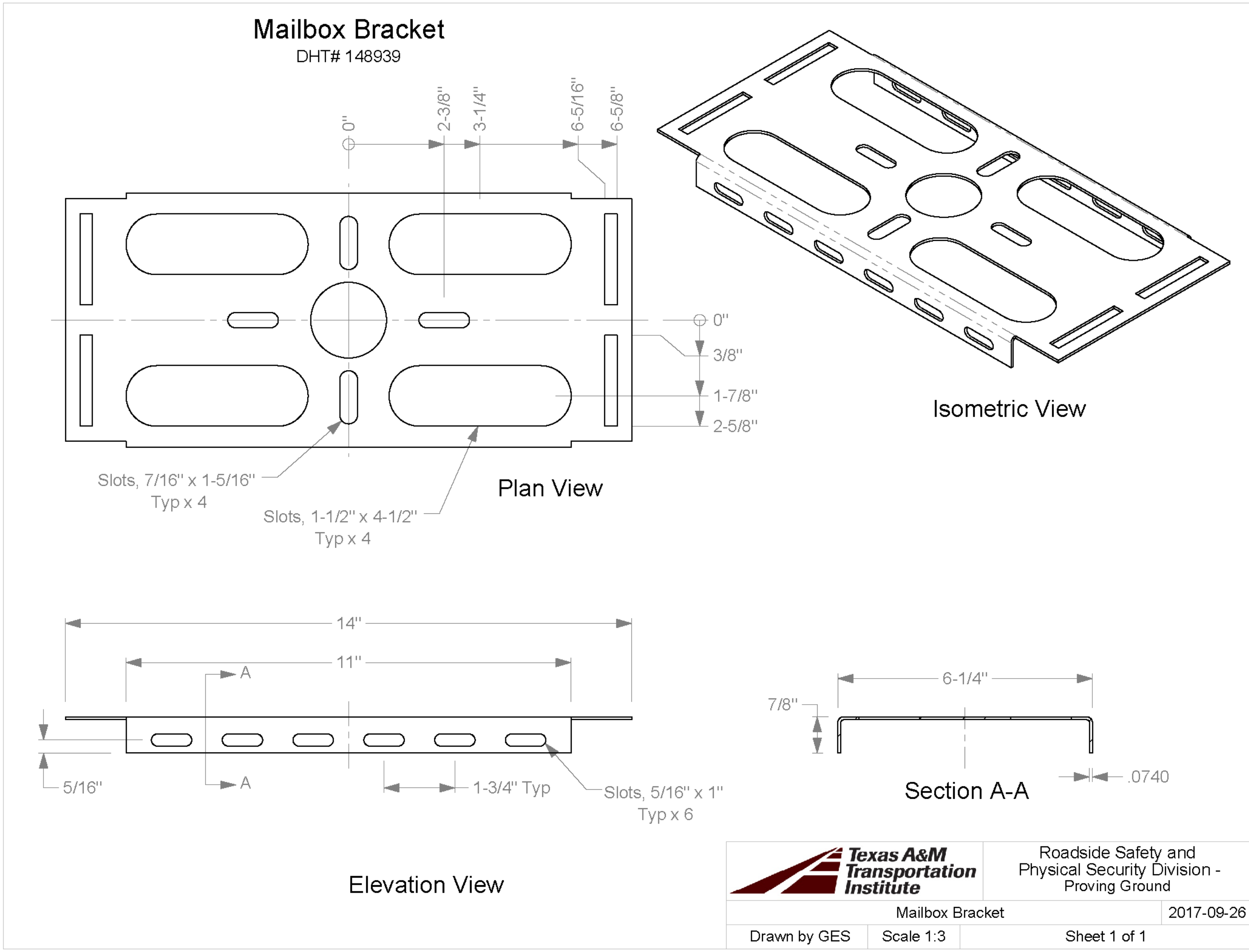
TR No. 0-6968-R9



2020-10-13


Angle Bracket Part A
DHT# 159489
3"
4-1/4"
1-9/16"
9/16"
0"
A
A
⌀3/8" x 2
2"
1"
.1094
⌀3/8"
3-1/2"
2-11/16"
2-7/16"
R1"
11/16"
0"
Elevation Views
1-5/8"
1-1/16"
1-7/8"
Section A-A
Isometric View
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
Angle Bracket Part A
2018-08-20
Drawn by GES
Scale 1:1
Sheet 1 of 1
T:\Drafting Department\Solidworks\Standard Parts\Mailbox Parts\Mailbox Part Drawings\159489


Angle Bracket Part B
DHT# 159490
3"
4-1/4"
1-5/8"
5/8"
0"
∅7/16" x 2
A
A
Elevation Views
1"
.1000
∅3/8"
13/16"
1-7/8"
3/4"
2-5/8"
Isometric View
1-5/8"
1"
1-3/8"
Section A-A
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
Angle Bracket Part B
2017-09-26
Drawn by GES
Scale 1:1
Sheet 1 of 1
T:\Drafting Department\Solidworks\Standard Parts\Mailbox Parts\Mailbox Part Drawings\159490



T:\Drafting Department\Solidworks\Standard Parts\Mailbox Parts\Mailbox Part Drawings\148939

C.2 VEHICLE PROPERTIES AND INFORMATION

Table C.1. Vehicle Properties for Test No. 469689-1-3.

Date: 2019-06-27 Test No.: 469689-1-3 VIN No.: KNADH4A34B6930314

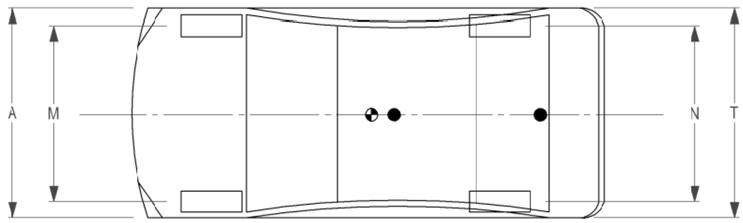
Year: 2011 Make: Kia Model: Rio

Tire Inflation Pressure: 32 PSI Odometer: 148912 Tire Size: 185/65R14

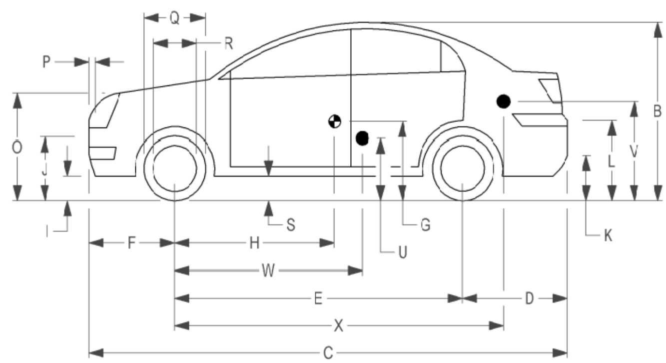
Describe any damage to the vehicle prior to test: None

● Denotes accelerometer location.

NOTES: None



Engine Type: 4 CYL
Engine CID: 1.6 L
Transmission Type:
☑ Auto or ☐ Manual
☑ FWD ☐ RWD ☐ 4WD
Optional Equipment:
None



Dummy Data:
Type: 50th Percentile Male
Mass: 165 lb
Seat Position: OPPOSITE IMPACT

Geometry: inches

A	66.38	F	33.00	K	12.25	P	4.12	U	14.75
B	51.50	G		L	25.25	Q	22.50	V	20.75
C	165.75	H	35.38	M	57.75	R	15.50	W	35.38
D	34.00	I	7.75	N	57.70	S	8.25	X	71.50
E	98.75	J	21.50	O	27.00	T	66.20		

Wheel Center Ht Front 11.00 Wheel Center Ht Rear 11.00 W-H 0.00

RANGE LIMIT: A = 65 ±3 inches; C = 169 ±8 inches; E = 98 ±5 inches; F = 35 ±4 inches; H = 39 ±4 inches; O (Bottom of Hood Lip) = 24 ±4 inches
TOP OF RADIATOR SUPPORT = 28.25 inches; (M+N)/2 = 56 ±2 inches; W-H < 2 inches or use MASH Paragraph A4.3.2

GVWR Ratings:		**Mass:** lb	Curb	Test Inertial	Gross Static
Front	1718	M_{front}	1586	1563	1648
Back	1874	M_{rear}	865	873	953
Total	3638	M_{Total}	2481	2436	2601

Allowable TIM = 2420 lb ±55 lb | Allowable GSM = 2585 lb ± 55 lb

Mass Distribution:
lb LF: 789 RF: 774 LR: 425 RR: 448

Table C.2. Exterior Crush Measurements of Vehicle for Test No. 469689-1-3.

Date:	2019-06-27	Test No.:	469689-1-3	VIN No.:	KNADH4A34B6930314
Year:	2011	Make:	Kia	Model:	Rio

VEHICLE CRUSH MEASUREMENT SHEET[1]

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

Note: Measure C_1 to C_6 from Driver to Passenger Side in Front or Rear Impacts – Rear to Front in Side Impacts.

Specific Impact Number	Plane* of C-Measurements	Direct Damage: Width** (CDC)	Direct Damage: Max*** Crush	Field L**	C_1	C_2	C_3	C_4	C_5	C_6	±D
	Front Plane at bumper ht		3								
	Windshield		4.6								
	Measurements recorded										
	☑ **inches** **or** ☐ **mm**										

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

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

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

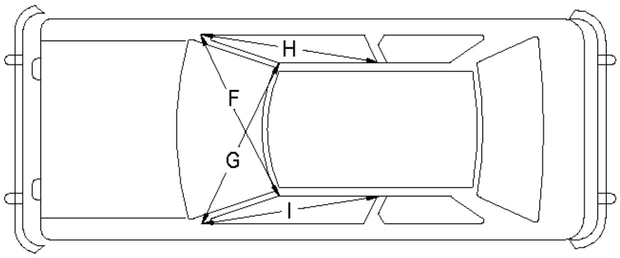
**Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle).

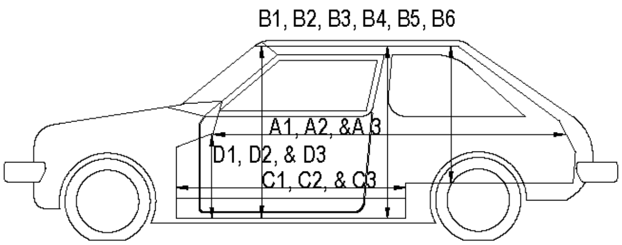
***Measure and document on the vehicle diagram the location of the maximum crush.

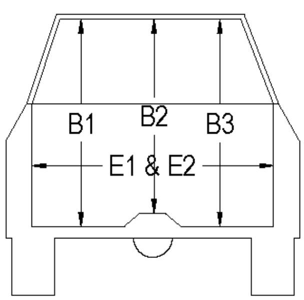
Note: Use as many lines/columns as necessary to describe each damage profile.

Table C.3. Occupant Compartment Measurements of Vehicle for Test No. 469689-1-3.

Date:	2019-06-27	Test No.:	469689-1-3	VIN No.:	KNADH4A34B6930314
Year:	2011	Make:	Kia	Model:	Rio







OCCUPANT COMPARTMENT DEFORMATION MEASUREMENT

	Before	After (inches)	Differ.
A1	67.50	67.50	0.00
A2	67.25	67.25	0.00
A3	67.75	67.75	0.00
B1	40.50	40.50	0.00
B2	39.00	39.00	0.00
B3	40.50	40.50	0.00
B4	36.25	36.25	0.00
B5	36.00	36.00	0.00
B6	36.25	36.25	0.00
C1	26.00	26.00	0.00
C2	0.00	0.00	0.00
C3	26.00	26.00	0.00
D1	9.50	9.50	0.00
D2	0.00	0.00	0.00
D3	9.50	9.50	0.00
E1	51.50	51.50	0.00
E2	51.00	51.00	0.00
F	51.00	51.00	0.00
G	51.00	51.00	0.00
H	37.50	37.50	0.00
I	37.50	37.50	0.00
J*	51.00	51.00	0.00

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

C.3 SEQUENTIAL PHOTOGRAPHS

0.000 s

0.025 s

0.050 s

0.075 s

Figure C.1. Sequential Photographs for Test No. 469689-1-3 (Perpendicular and Oblique Views).

0.100 s

0.125 s

0.150 s

0.175 s

Figure C.1. Sequential Photographs for Test No. 469689-1-3 (Perpendicular and Oblique Views) (Continued).

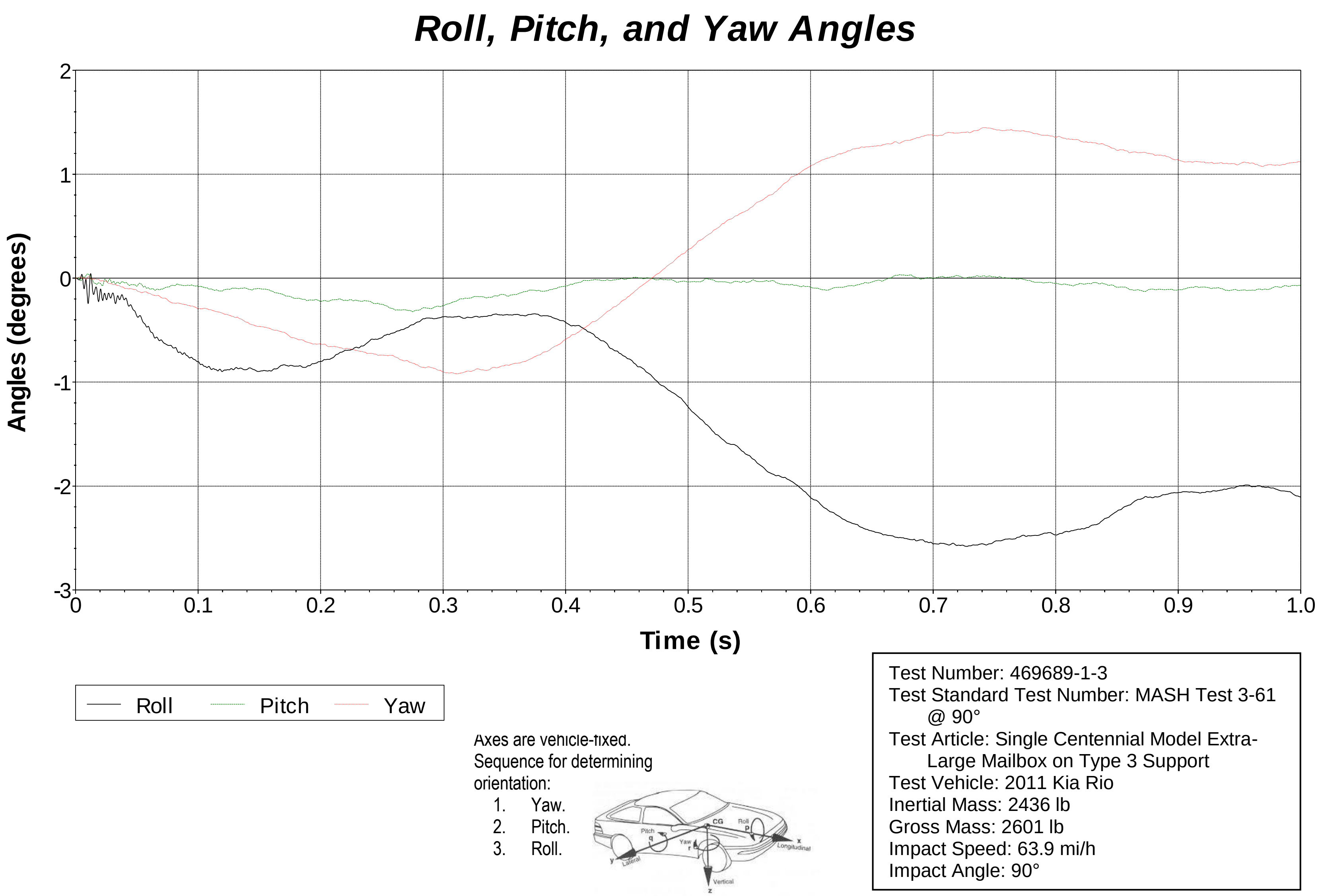
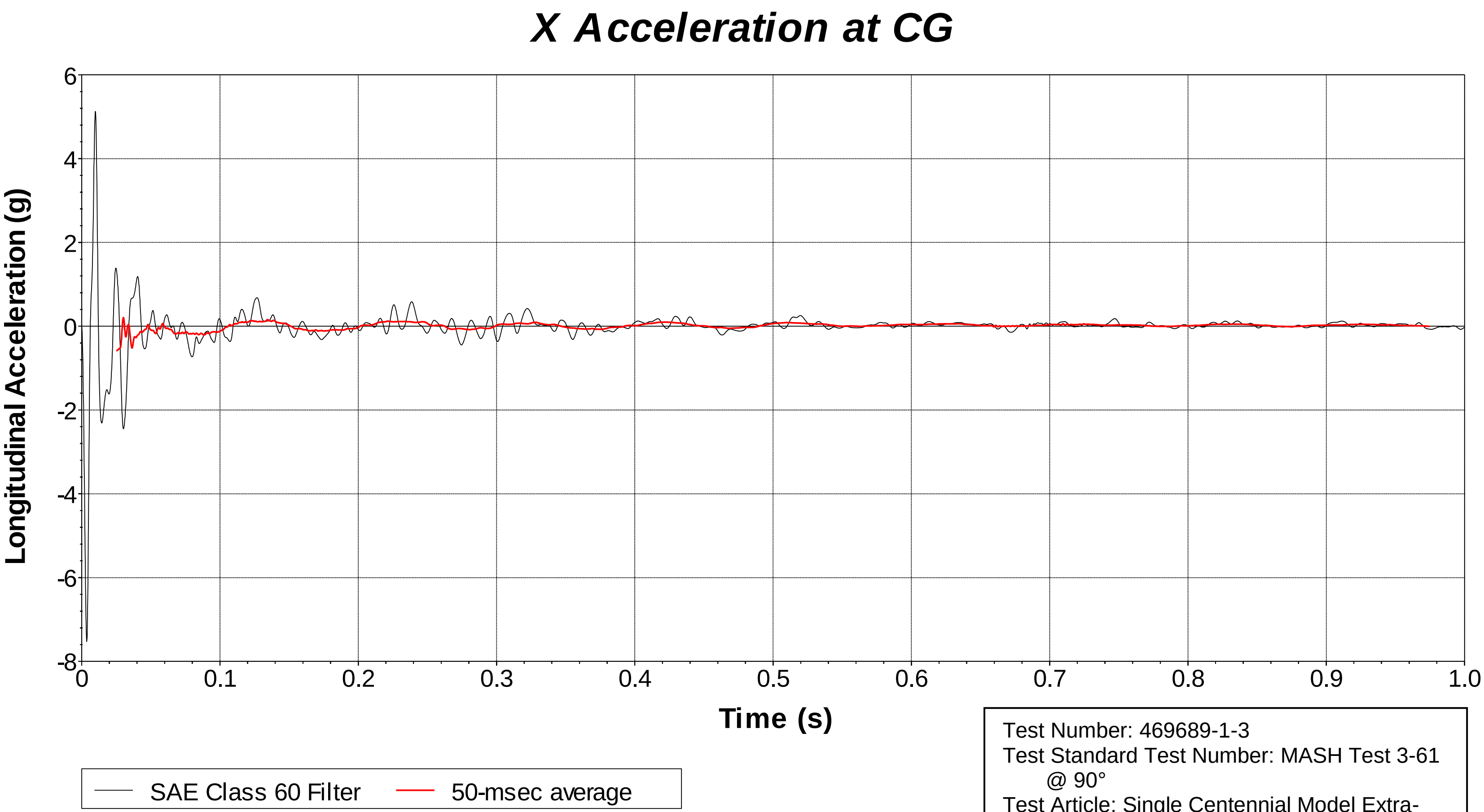


Figure C.2. Vehicle Angular Displacements for Test No. 469689-1-3.



Test Number: 469689-1-3
Test Standard Test Number: MASH Test 3-61 @ 90°
Test Article: Single Centennial Model Extra-Large Mailbox on Type 3 Support
Test Vehicle: 2011 Kia Rio
Inertial Mass: 2436 lb
Gross Mass: 2601 lb
Impact Speed: 63.9 mi/h
Impact Angle: 90°

Figure C.3. Vehicle Longitudinal Accelerometer Trace for Test No. 469689-1-3 (Accelerometer Located at Center of Gravity).

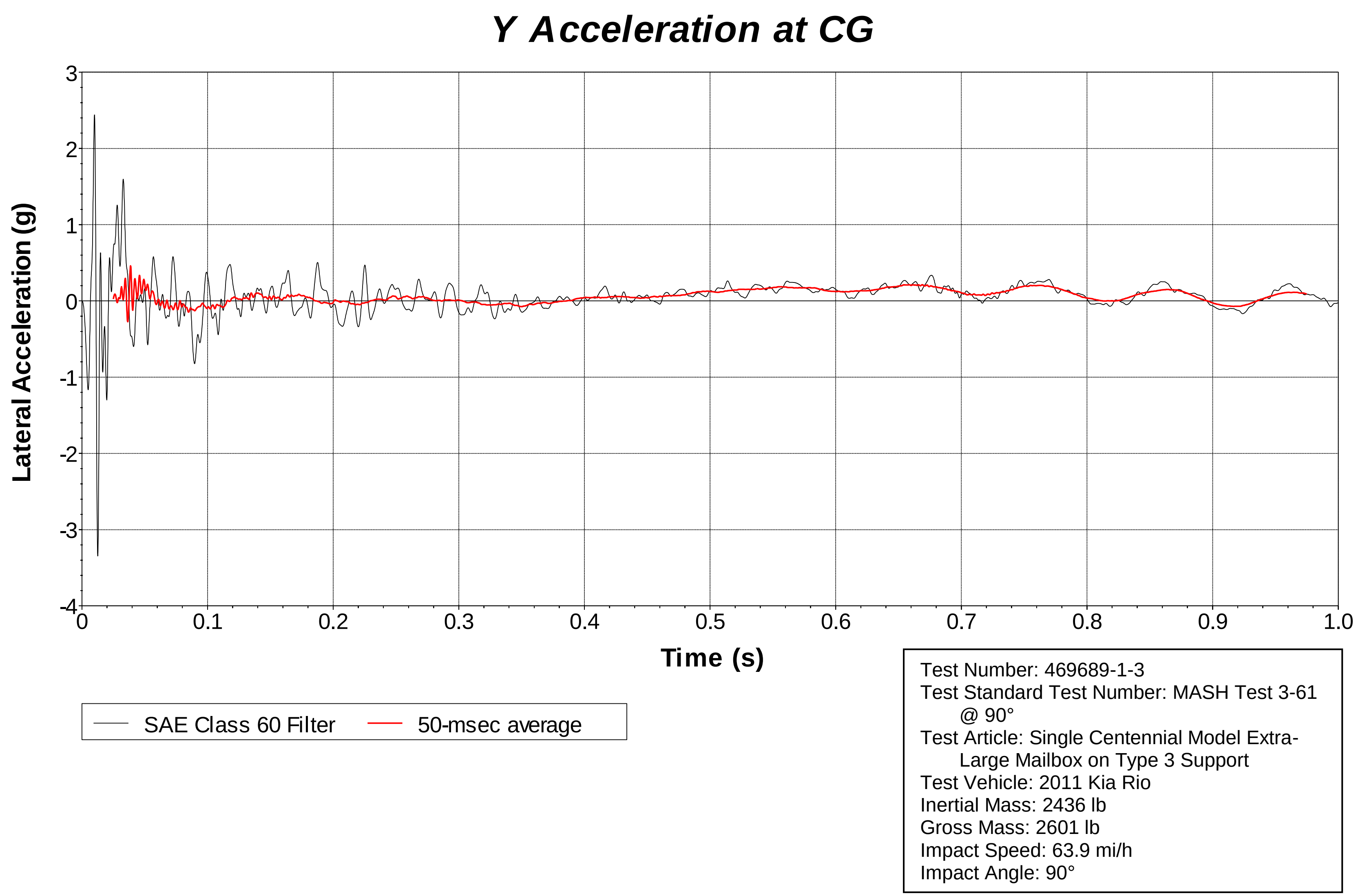


Figure C.4. Vehicle Lateral Accelerometer Trace for Test No. 469689-1-3 (Accelerometer Located at Center of Gravity).

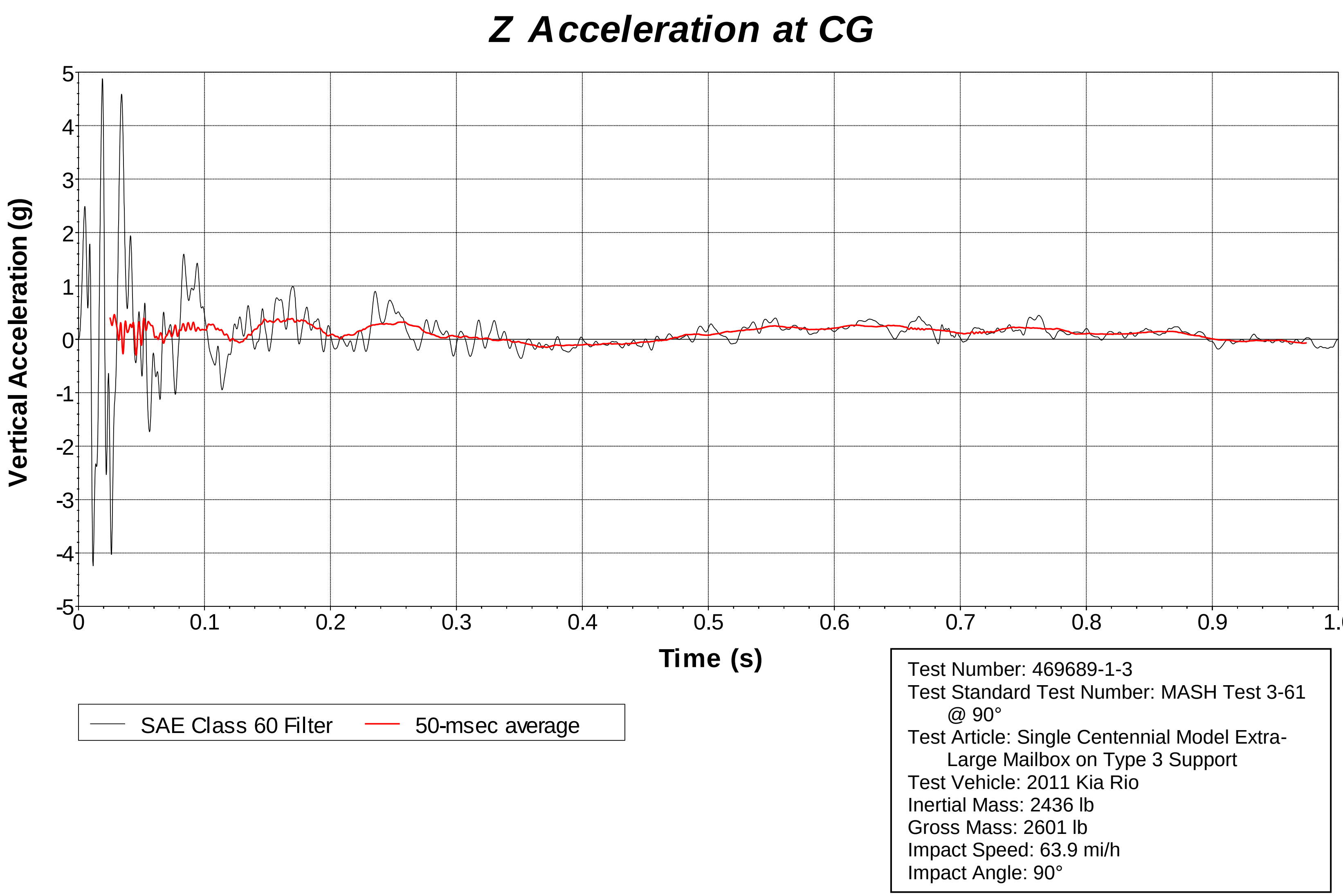
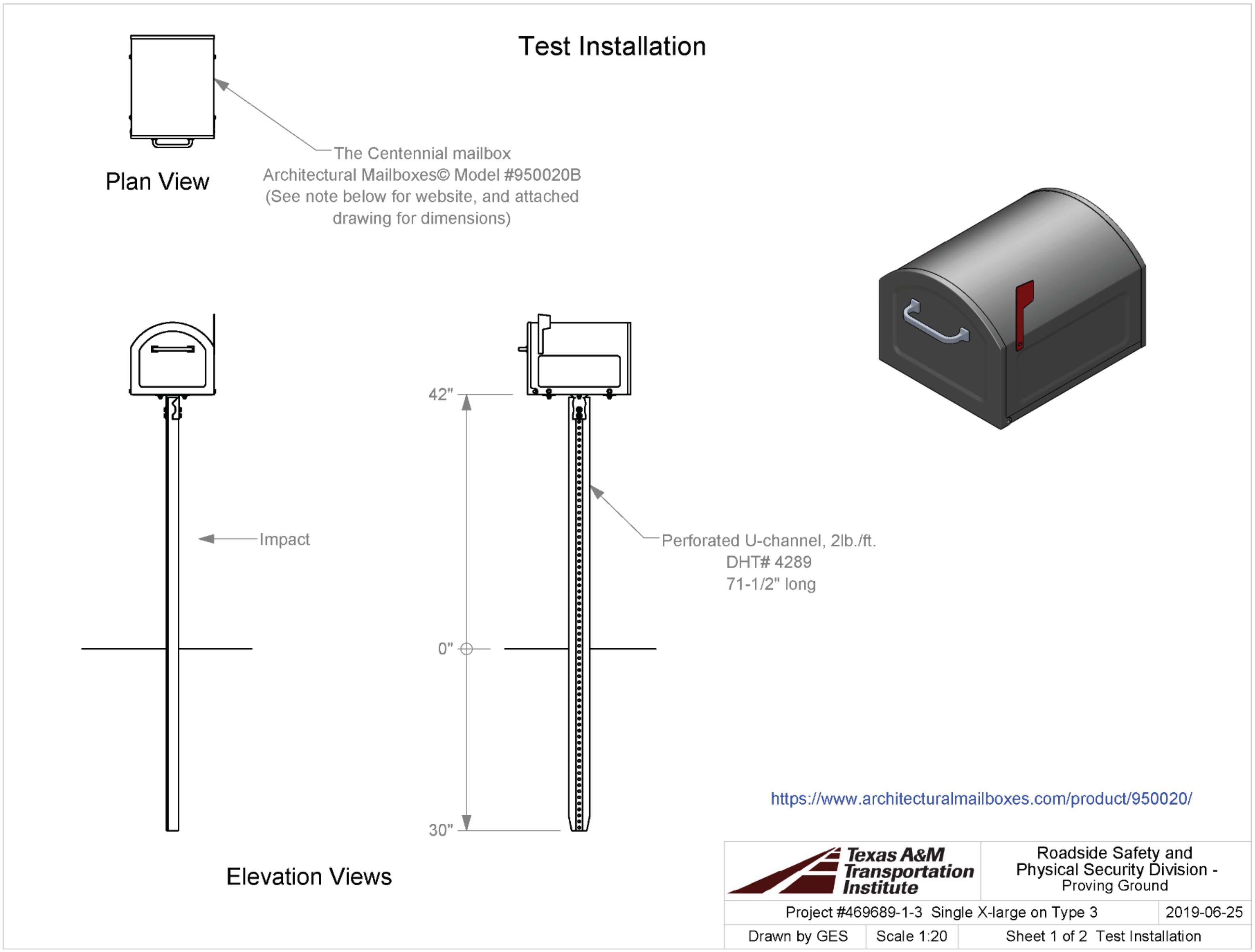


Figure C.5. Vehicle Vertical Accelerometer Trace for Test No. 469689-1-3 (Accelerometer Located at Center of Gravity).

APPENDIX D. CRASH TEST 469689-1-4

D.1 DETAILS OF TEST ARTICLE



T:\1-ProjectFiles\469689-TxDOT\-1 Mailboxes\-1-4 Single X-lg on Type 3 (re-design)\Drafting, 469689-1-4\469689-1-4 Drawing

Connection Details

Plate Washer details from TxDOT
MB-15(1) Drawing, sheet 2

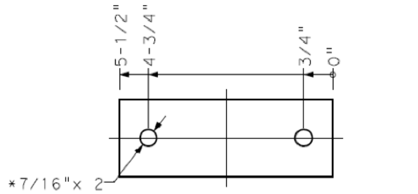
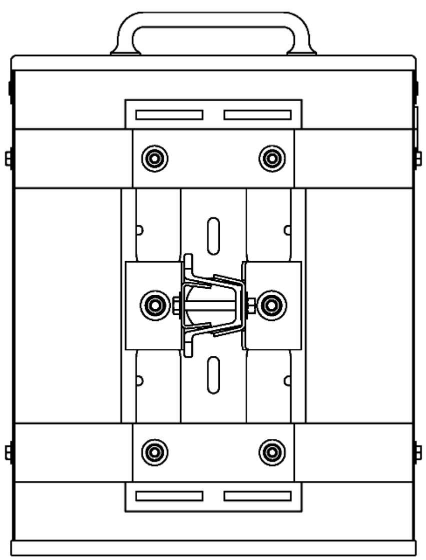
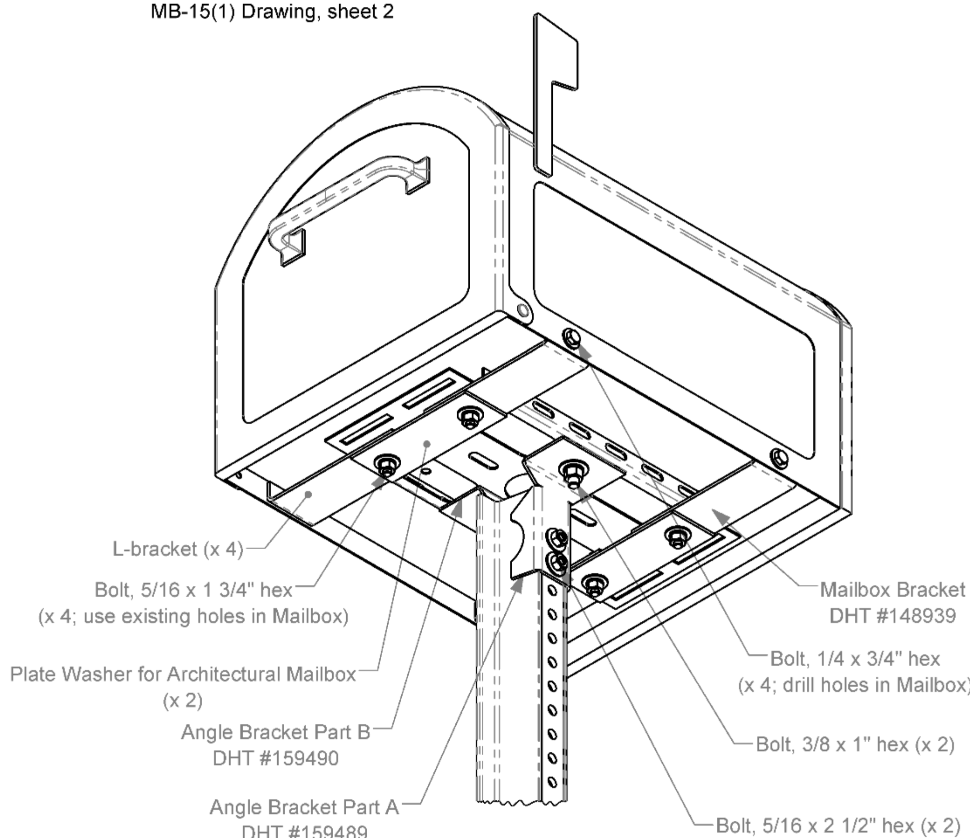


Plate Washer for Architectural Mailbox
Plate, 2" x 1/8" ASTM A36 Steel



Bottom View

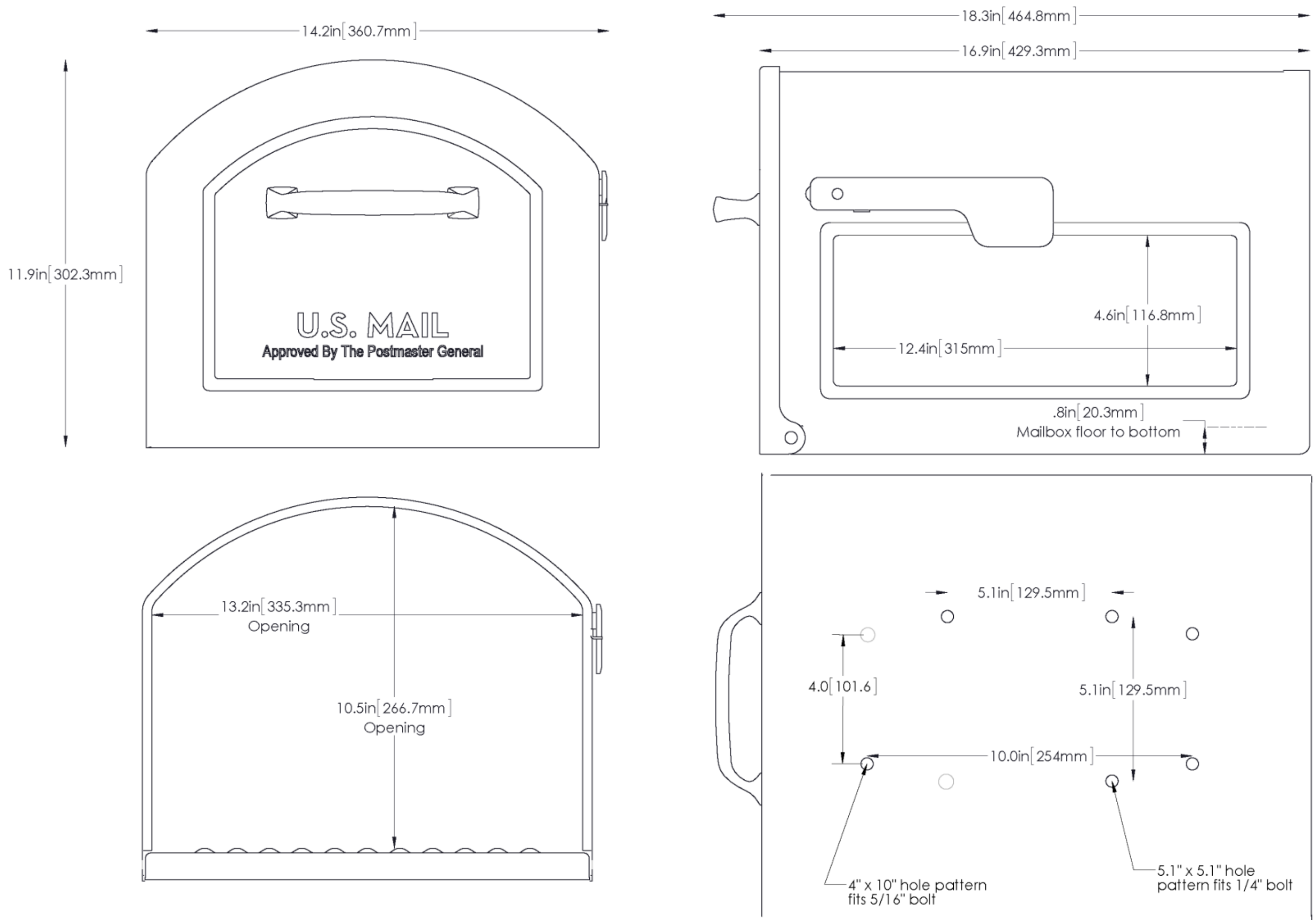


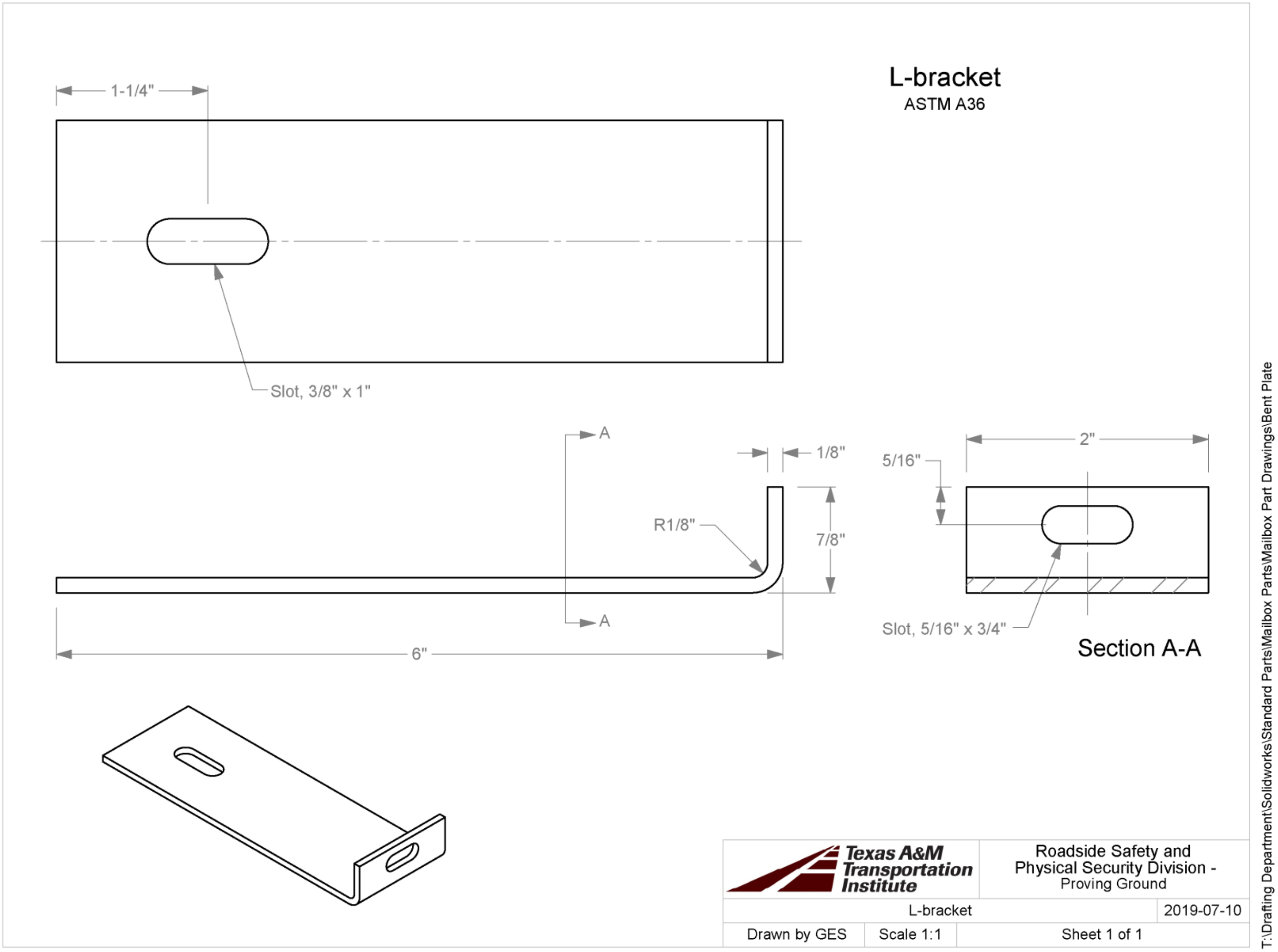
Isometric View

2a. All hex bolts are grade 5. Two USS flat washers, one lock washer, and hex nut on all hex bolts.

Texas A&M Transportation Institute		Roadside Safety and Physical Security Division - Proving Ground	
Project #469689-1-3 Single X-large on Type 3			2019-06-25
Drawn by GES	Scale 1:5	Sheet 2 of 2 Connection Details	

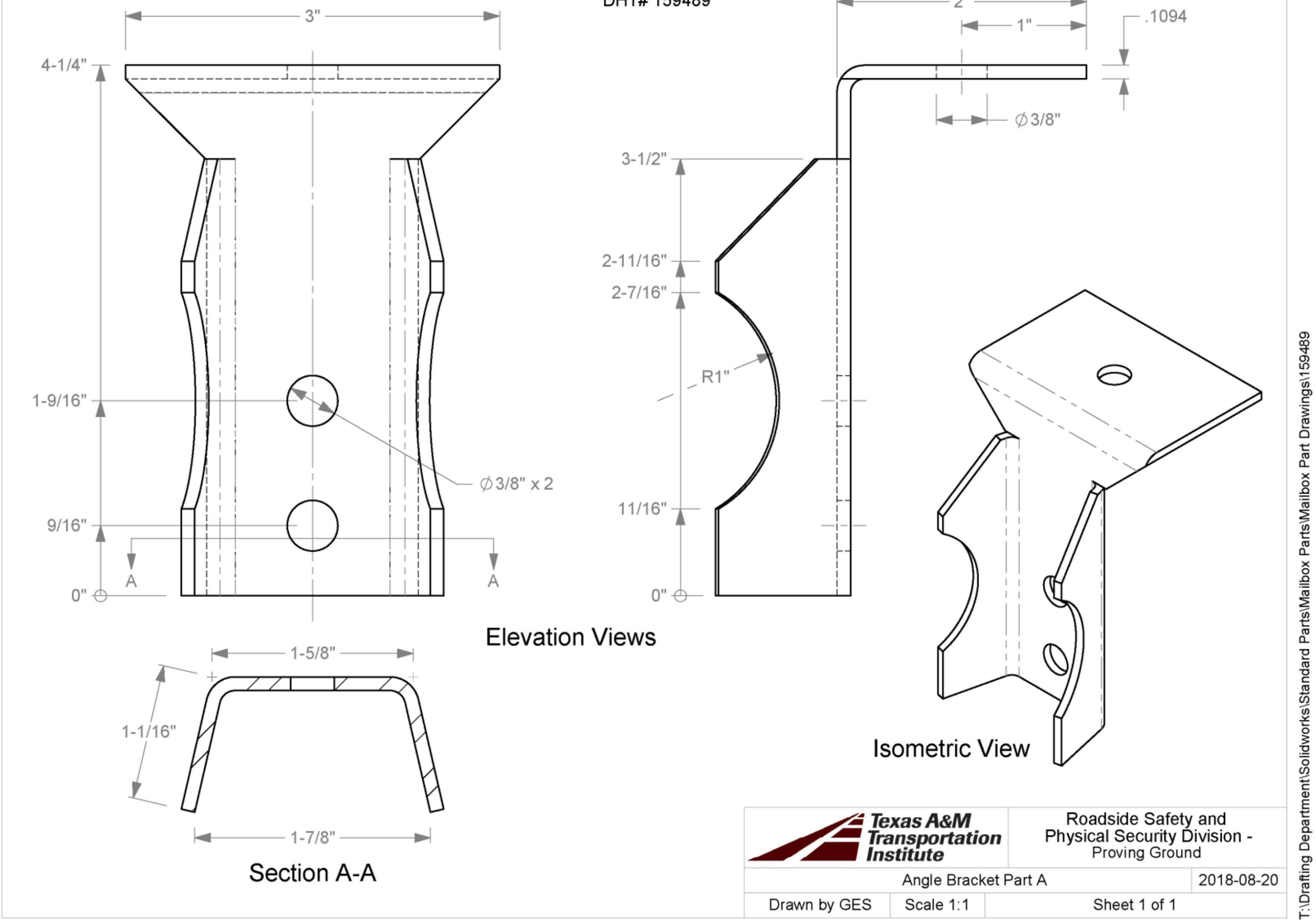
T:\1-ProjectFiles\469689-TxDOT\-1 Mailboxes\-1-4 Single X-lg on Type 3 (re-design)\Drafting, 469689-1-4\469689-1-4 Drawing

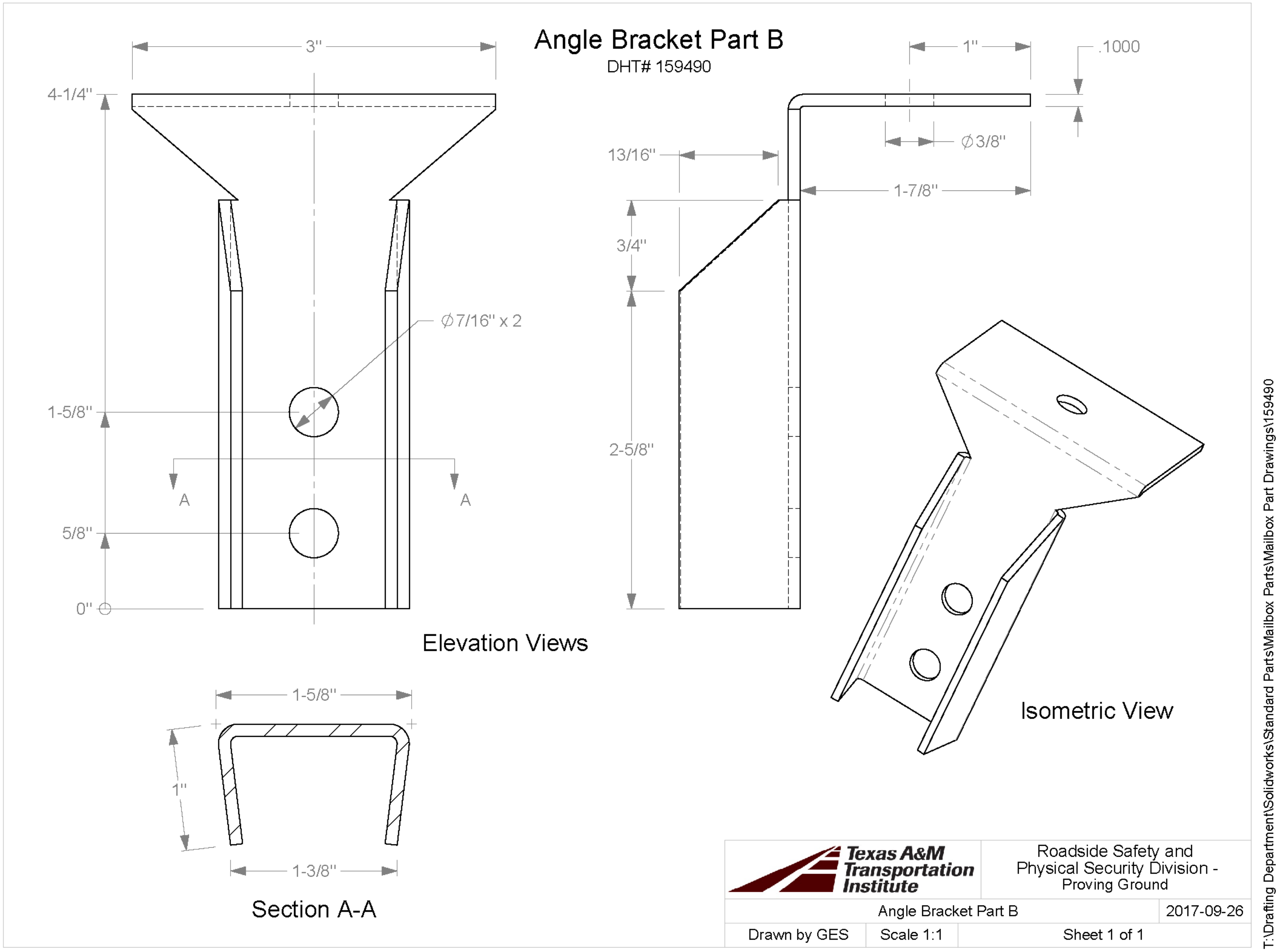

14.2in[360.7mm]
11.9in[302.3mm]
U.S. MAIL
Approved By The Postmaster General
18.3in[464.8mm]
16.9in[429.3mm]
4.6in[116.8mm]
12.4in[315mm]
.8in[20.3mm]
Mailbox floor to bottom
13.2in[335.3mm]
Opening
10.5in[266.7mm]
Opening
5.1in[129.5mm]
4.0[101.6]
5.1in[129.5mm]
10.0in[254mm]
4" x 10" hole pattern
fits 5/16" bolt
5.1" x 5.1" hole
pattern fits 1/4" bolt

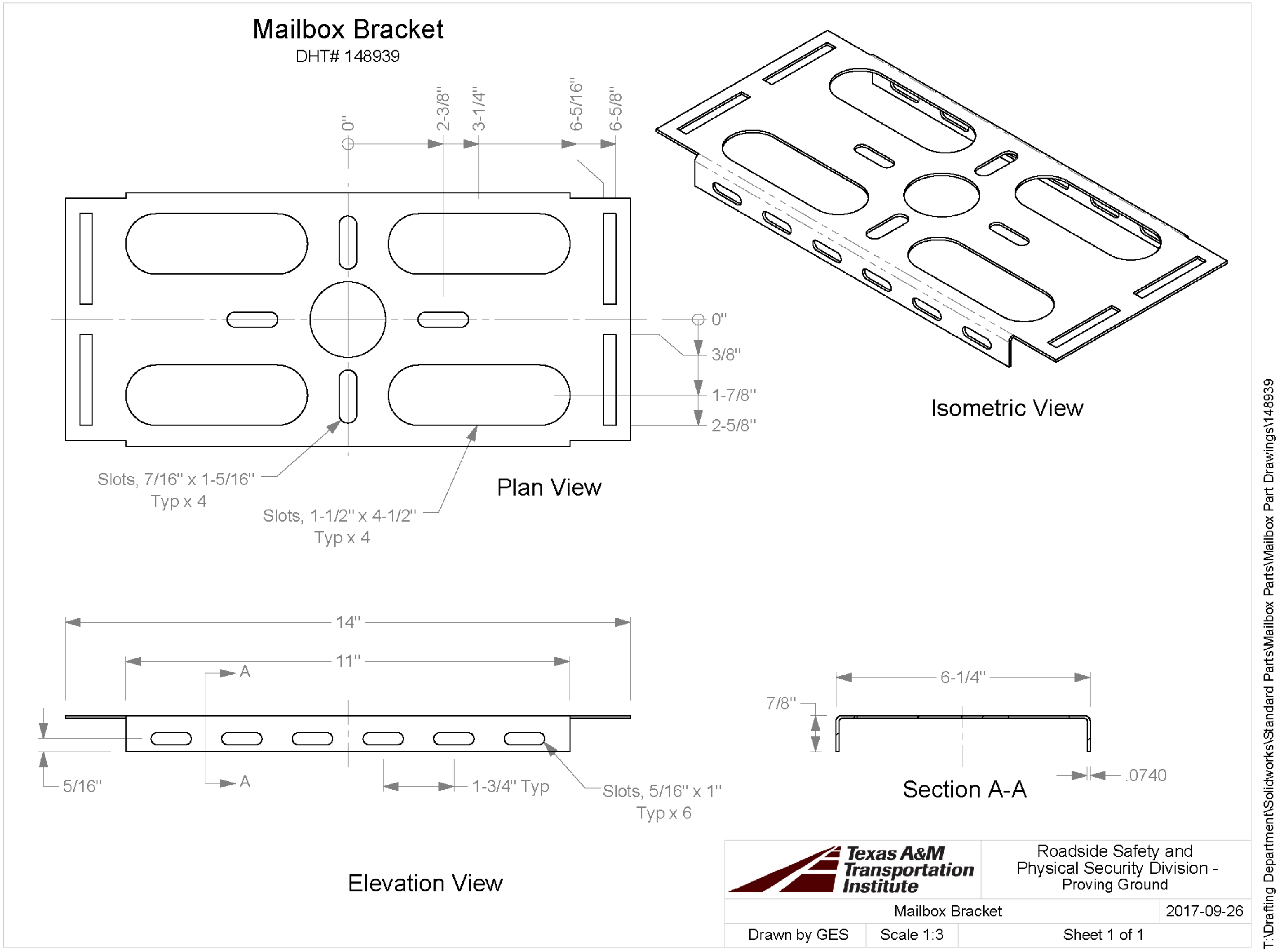

L-bracket
ASTM A36
1-1/4"
Slot, 3/8" x 1"
A
A
1/8"
R1/8"
7/8"
6"
2"
5/16"
Slot, 5/16" x 3/4"
Section A-A
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
L-bracket
2019-07-10
Drawn by GES
Scale 1:1
Sheet 1 of 1
T:\Drafting Department\Solidworks\Standard Parts\Mailbox Parts\Mailbox Part Drawings\Bent Plate

Angle Bracket Part A

DHT# 159489




Angle Bracket Part B
DHT# 159490
3"
4-1/4"
1-5/8"
5/8"
0"
∅7/16" x 2
A
A
Elevation Views
1"
.1000
∅3/8"
13/16"
1-7/8"
3/4"
2-5/8"
Isometric View
1-5/8"
1"
1-3/8"
Section A-A
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
Angle Bracket Part B
2017-09-26
Drawn by GES
Scale 1:1
Sheet 1 of 1
T:\Drafting Department\Solidworks\Standard Parts\Mailbox Parts\Mailbox Part Drawings\159490


Mailbox Bracket
DHT# 148939
0"
2-3/8"
3-1/4"
6-5/16"
6-5/8"
0"
3/8"
1-7/8"
2-5/8"
Slots, 7/16" x 1-5/16"
Typ x 4
Slots, 1-1/2" x 4-1/2"
Typ x 4
Plan View
Isometric View
14"
11"
A
A
5/16"
1-3/4" Typ
Slots, 5/16" x 1"
Typ x 6
Elevation View
6-1/4"
7/8"
.0740
Section A-A
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
Mailbox Bracket
2017-09-26
Drawn by GES
Scale 1:3
Sheet 1 of 1
T:\Drafting Department\Solidworks\Standard Parts\Mailbox Parts\Mailbox Part Drawings\148939

D.2 VEHICLE PROPERTIES AND INFORMATION

Table D.1. Vehicle Properties for Test No. 469689-1-4.

Date: 2019-08-23 Test No.: 469689-1-4 VIN No.: KNADH4A31B6714470

Year: 2011 Make: Kia Model: Rio

Tire Inflation Pressure: 32 PSI Odometer: 138332 Tire Size: 185/65R14

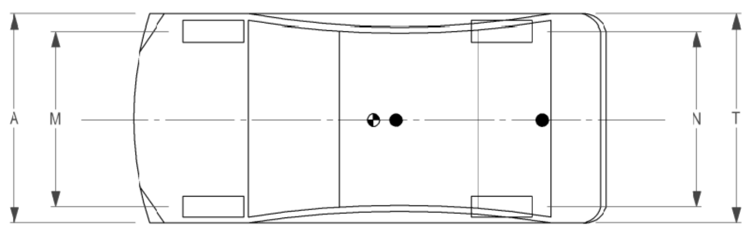
Describe any damage to the vehicle prior to test: None

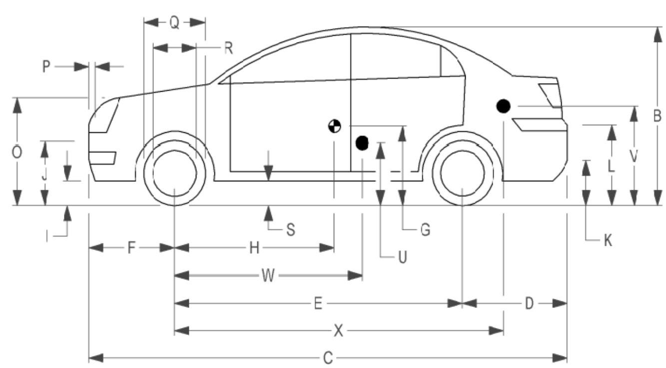
● Denotes accelerometer location.

NOTES:

Engine Type: 4 CYL
Engine CID: 1.6 L
Transmission Type:
☑ Auto or ☐ Manual
☑ FWD ☐ RWD ☐ 4WD
Optional Equipment:
None

Dummy Data:
Type: 50th Percentile Male
Mass: 165 lb
Seat Position: OPPOSITE IMPACT





Geometry: inches

A	66.38	F	33.00	K	12.25	P	4.12	U	14.75
B	51.50	G		L	25.25	Q	22.50	V	20.75
C	165.75	H	35.16	M	57.75	R	15.50	W	35.10
D	34.00	I	7.75	N	57.70	S	8.25	X	71.50
E	98.75	J	21.50	O	27.00	T	66.20		

Wheel Center Ht Front 11.00 Wheel Center Ht Rear 11.00 W-H 0.00

RANGE LIMIT: A = 65 ±3 inches; C = 169 ±8 inches; E = 98 ±5 inches; F = 35 ±4 inches; H = 39 ±4 inches; O (Bottom of Hood Lip) = 24 ±4 inches
TOP OF RADIATOR SUPPORT = 28.25 inches; (M+N)/2 = 56 ±2 inches; W-H < 2 inches or use MASH Paragraph A4.3.2

GVWR Ratings:		**Mass:** lb	Curb	Test Inertial	Gross Static
Front	1718	M_{front}	1637	1573	1658
Back	1874	M_{rear}	907	870	950
Total	3638	M_{Total}	2544	2443	2608

Allowable TIM = 2420 lb ±55 lb | Allowable GSM = 2585 lb ± 55 lb

Mass Distribution:
lb LF: 753 RF: 820 LR: 483 RR: 387

Table D.2. Exterior Crush Measurements of Vehicle for Test No. 469689-1-4.

Date:	2019-08-23	Test No.:	469689-1-4	VIN No.:	KNADH4A31B6714470
Year:	2011	Make:	Kia	Model:	Rio

VEHICLE CRUSH MEASUREMENT SHEET[1]

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

Note: Measure C_1 to C_6 from Driver to Passenger Side in Front or Rear Impacts – Rear to Front in Side Impacts.

Specific Impact Number	Plane* of C-Measurements	Direct Damage		Field L**	C_1	C_2	C_3	C_4	C_5	C_6	±D
		Width** (CDC)	Max*** Crush								
	Hood		1.5								
	Measurements recorded										
	☑ **inches** **or** ☐ **mm**										

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

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

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

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

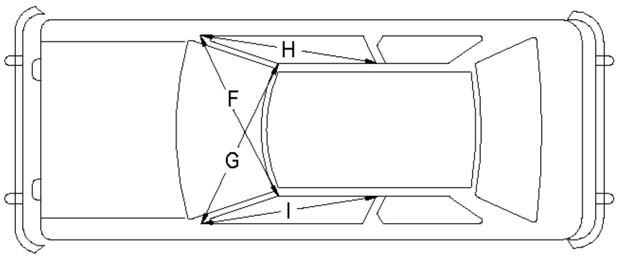
***Measure and document on the vehicle diagram the location of the maximum crush.

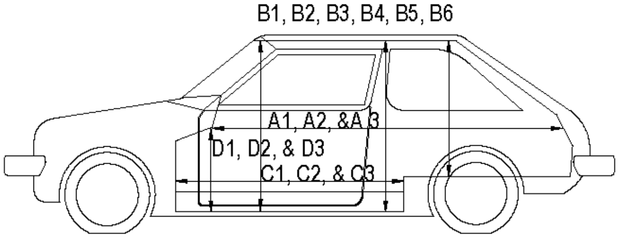
Note: Use as many lines/columns as necessary to describe each damage profile.

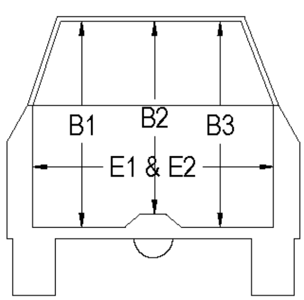
Table D.3. Occupant Compartment Measurements of Vehicle for Test No. 469689-1-4.

Date: 2019-08-23 Test No.: 469689-1-4 VIN No.: KNADH4A31B6714470

Year: 2011 Make: Kia Model: Rio







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

OCCUPANT COMPARTMENT DEFORMATION MEASUREMENT

	Before	After (inches)	Differ.
A1	67.50	67.50	0.00
A2	67.25	67.25	0.00
A3	67.75	67.75	0.00
B1	40.50	40.50	0.00
B2	39.00	39.00	0.00
B3	40.50	40.50	0.00
B4	36.25	36.25	0.00
B5	36.00	36.00	0.00
B6	36.25	36.25	0.00
C1	26.00	26.00	0.00
C2	0.00	0.00	0.00
C3	26.00	26.00	0.00
D1	9.50	9.50	0.00
D2	0.00	0.00	0.00
D3	9.50	9.50	0.00
E1	51.50	51.50	0.00
E2	51.00	51.00	0.00
F	51.00	51.00	0.00
G	51.00	51.00	0.00
H	37.50	37.50	0.00
I	37.50	37.50	0.00
J*	51.00	51.00	0.00

D.3 SEQUENTIAL PHOTOGRAPHS

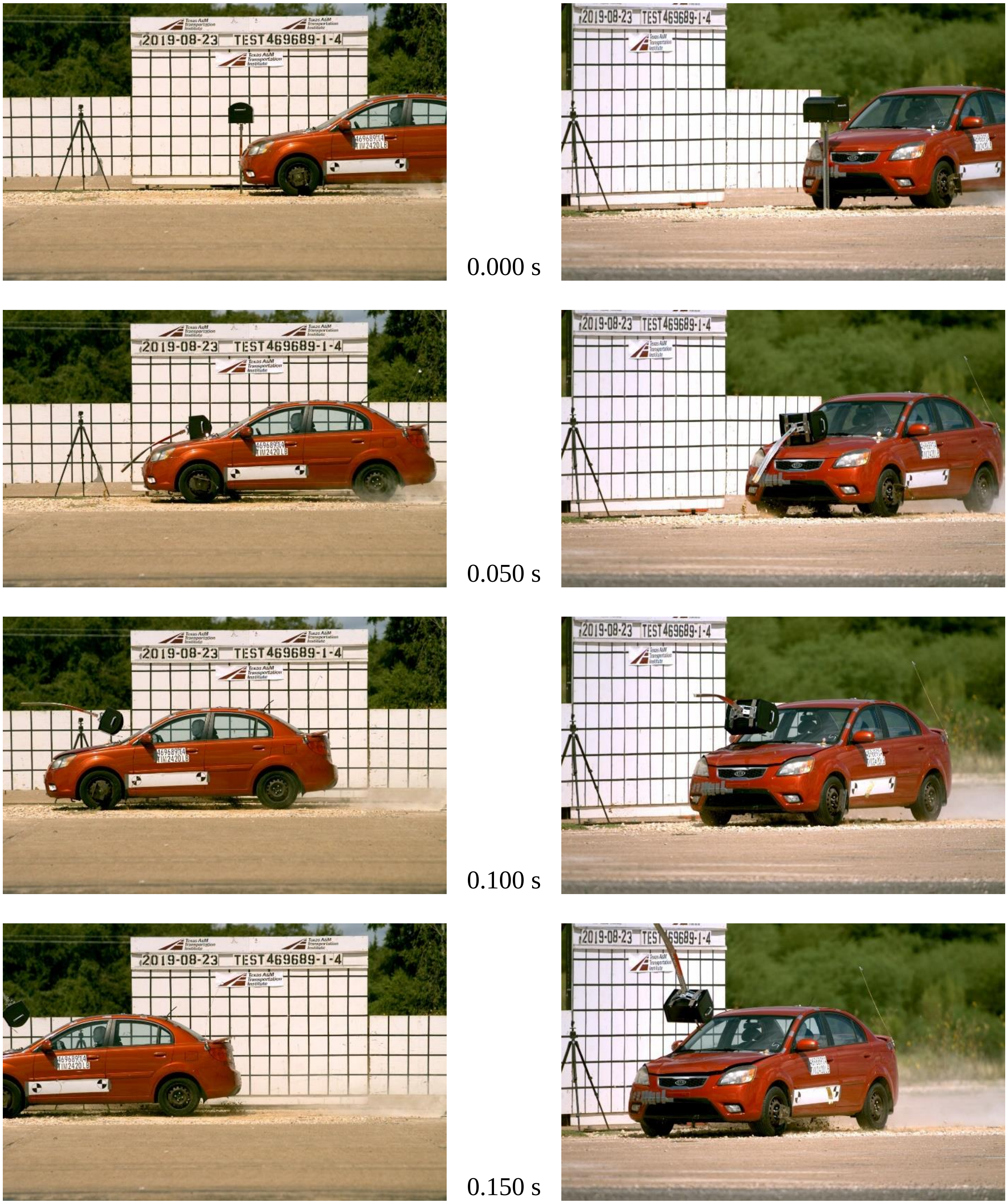


Figure D.1. Sequential Photographs for Test No. 469689-1-4 (Perpendicular and Oblique Views).

0.200 s

0.250 s

0.300 s

0.350 s

Figure D.1. Sequential Photographs for Test No. 469689-1-4 (Perpendicular and Oblique Views) (Continued).

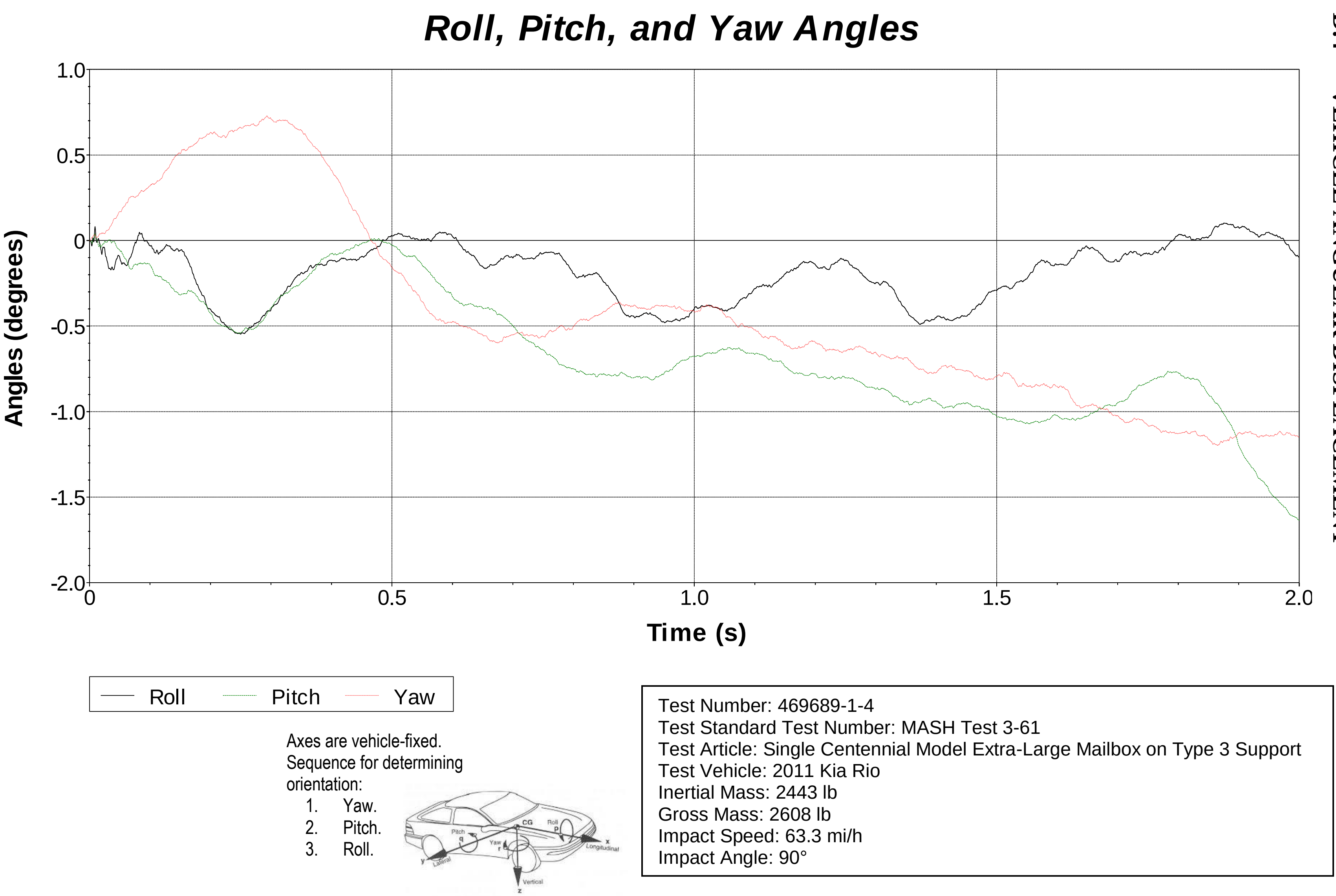


Figure D.2. Vehicle Angular Displacements for Test No. 469689-1-4.

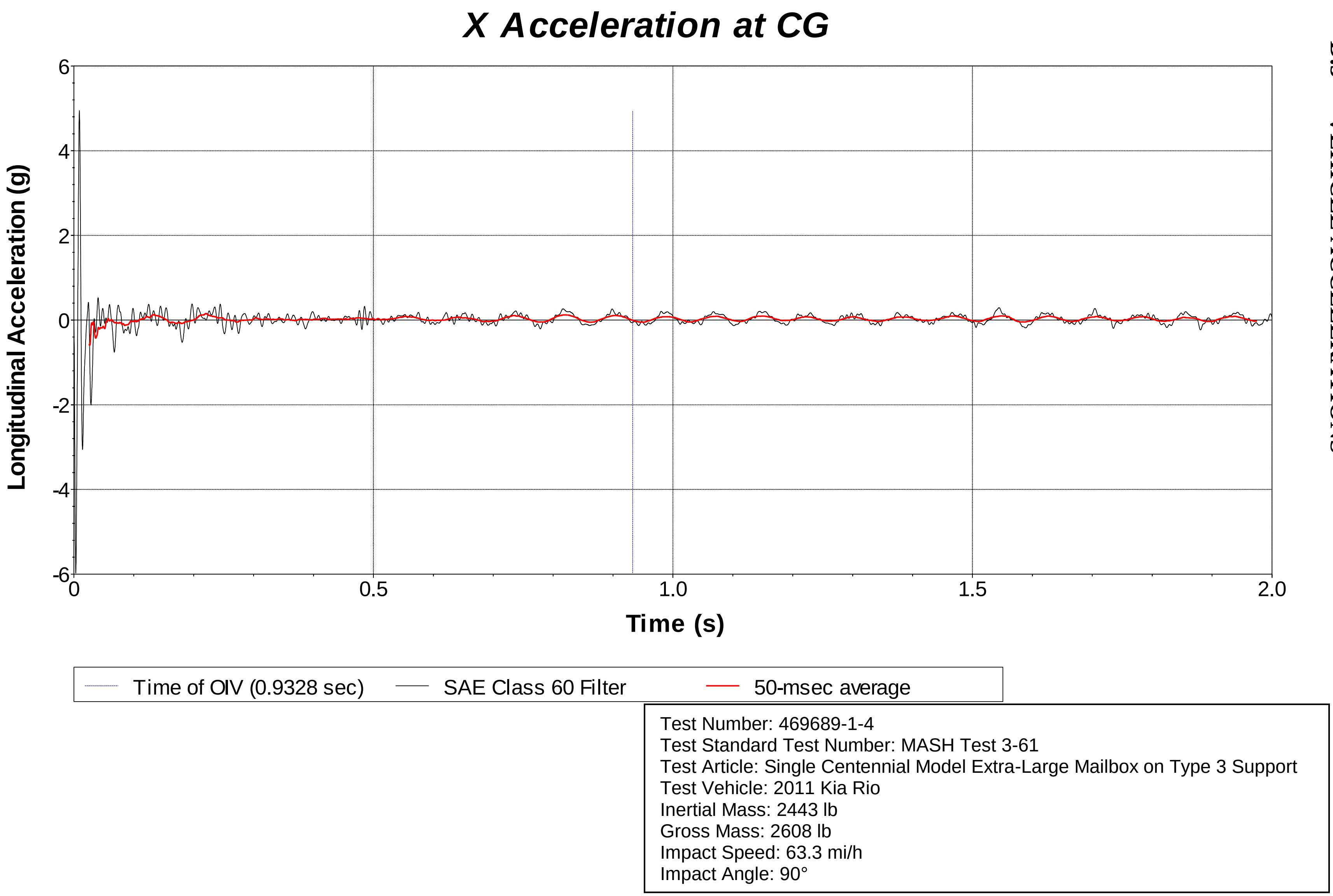


Figure D.3. Vehicle Longitudinal Accelerometer Trace for Test No. 469689-1-4 (Accelerometer Located at Center of Gravity).

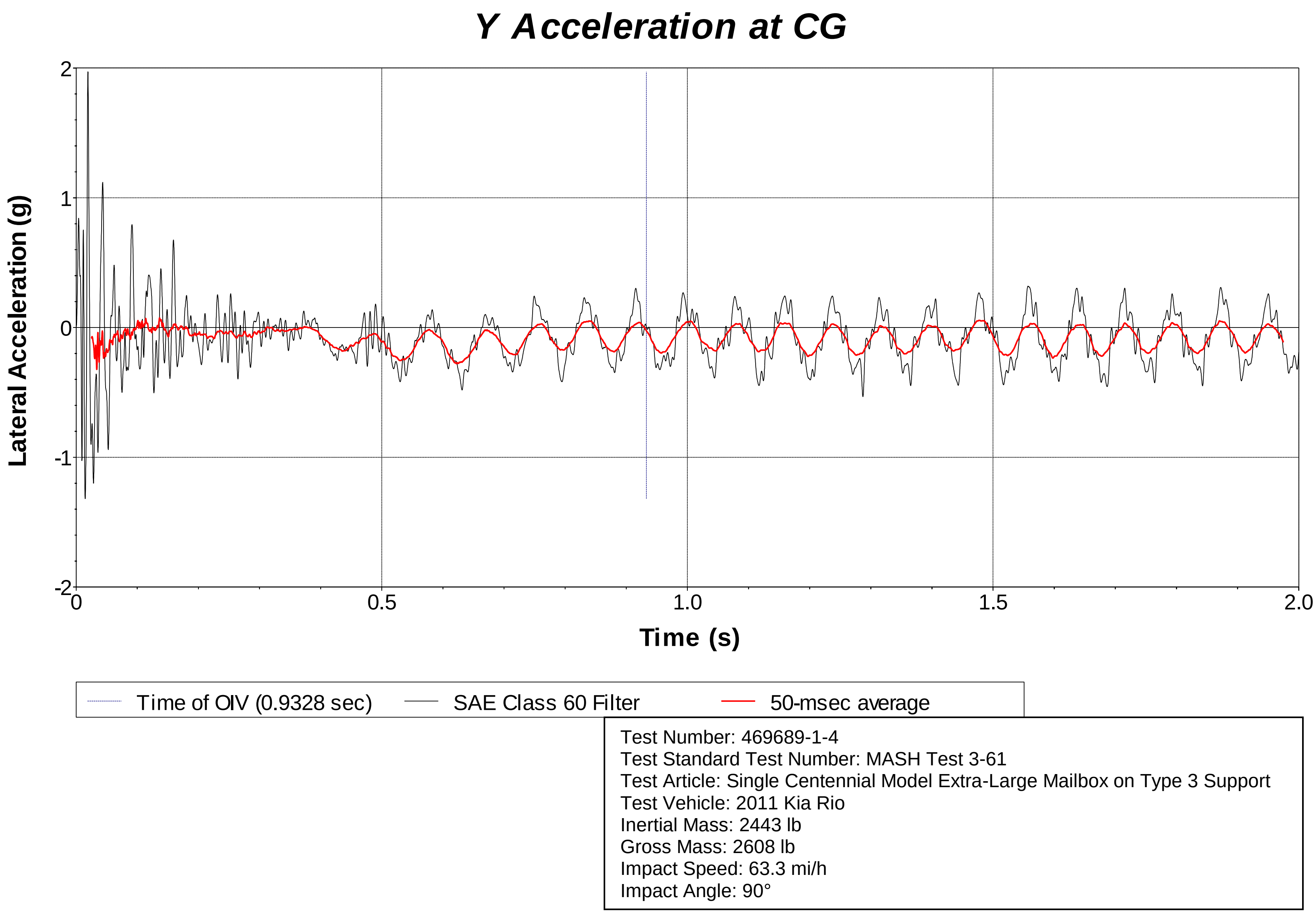


Figure D.4. Vehicle Lateral Accelerometer Trace for Test No. 469689-1-4 (Accelerometer Located at Center of Gravity).

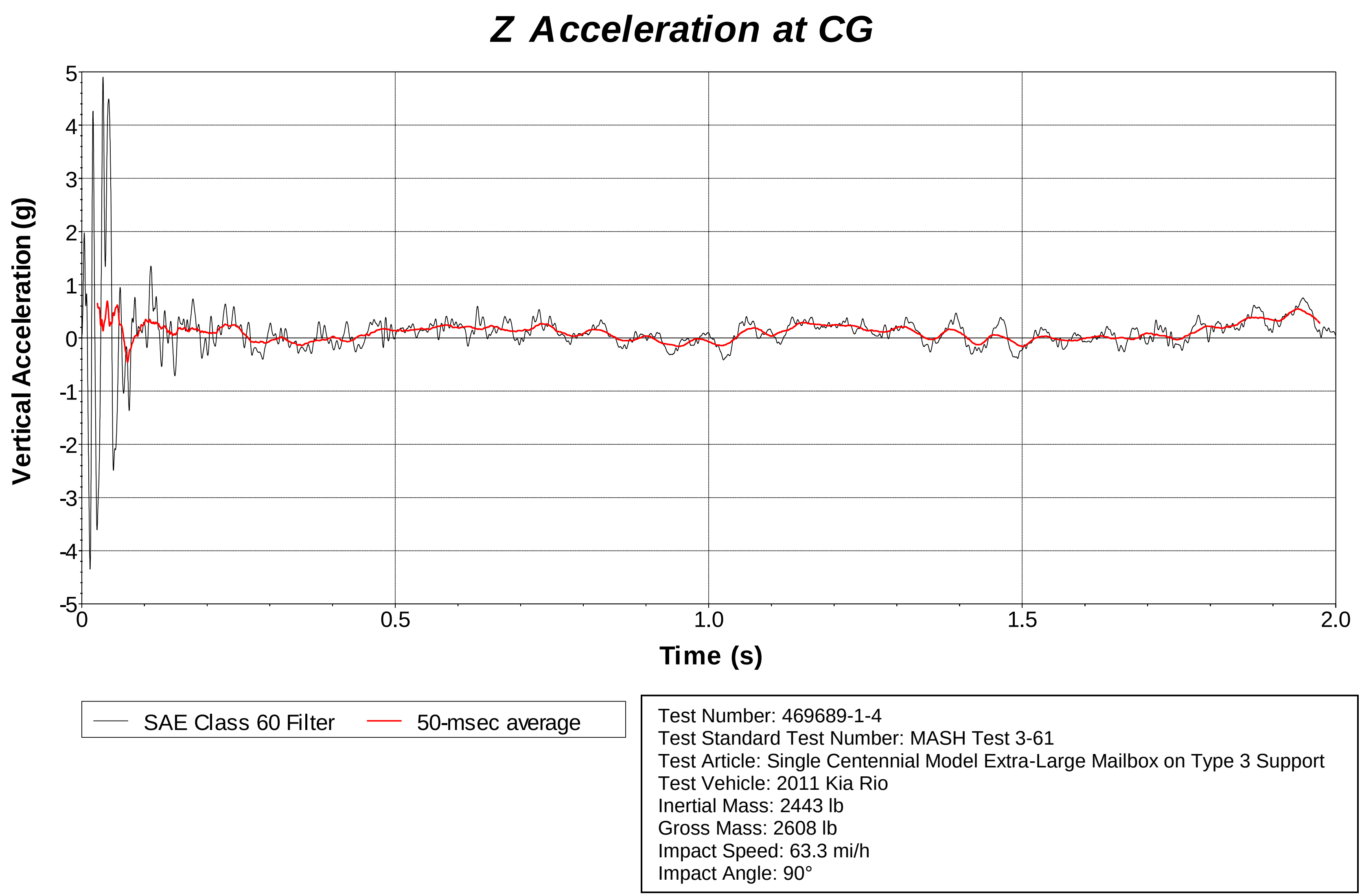


Figure D.5. Vehicle Vertical Accelerometer Trace for Test No. 469689-1-4 (Accelerometer Located at Center of Gravity).