Texas A&M Transportation Institute
PROVING GROUND

Test Report No. 622421-01-1

MASH TEST 3-21 OF FREE-STANDING-TO-ANCHORED F-SHAPE PCB TRANSITION SYSTEM WITH VERTICAL ANCHORS ON ASPHALT

Sponsored by
Roadside Safety Pooled Fund

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16. Abstract

The purpose of this project was to evaluate the performance of a new free-standing-to-anchored F-shape portable concrete barrier (PCB) transition system. The anchored portion of the PCB system utilized vertical anchors installed in asphalt pavement. The evaluation was conducted in accordance with the safety-performance assessment procedures outlined in *the Manual for Assessing Safety Hardware (MASH), Second Edition*, published by the American Association of State Highway and Transportation Officials (AASHTO) (*1*). A full-scale crash test was carried out following MASH Test 3-21 impact conditions, which specify an impact of the transition system by a 5,000-lb pickup truck traveling at 62 mi/h and striking the barrier at an angle of 25 degrees.

This report provides details of the free-standing-to-anchored F-shape PCB transition system, the crash test procedures and results, and the performance assessment of the transition system in accordance with *MASH* Test 3-21 evaluation criteria. The new free-standing-to-anchored F-shape PCB transition system met the performance criteria for *MASH* Test 3-21.

The optional *MASH* Test 3-20, involving a small passenger car, was not considered critical for evaluating the transition system and was not conducted. Based on the results of the crash testing, the free-standing-to-anchored F-shape PCB is considered compliant with *MASH* Test Level 3 criteria.

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The results reported herein apply only to the article tested. The full-scale crash test was performed according to TTI Proving Ground quality procedures and American Association of State Highway and Transportation Officials (AASHTO) Manual for Assessing Safety Hardware, Second Edition (*MASH*) guidelines and standards.

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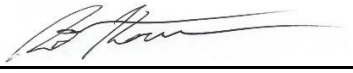

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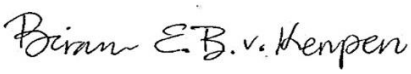

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SI* (MODERN METRIC) CONVERSION FACTORS				
APPROXIMATE CONVERSIONS TO SI UNITS				
Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		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 objective of this project was to evaluate the performance of a newly developed free-standing–to–anchored F-shape portable concrete barrier (PCB) transition system. This transition system was designed to connect California Department of Transportation's (Caltrans) free-standing F-shape PCB barrier to anchored F-shape PCB barrier. The anchored portion of the system incorporated vertical anchors installed in asphalt pavement. The anchored F-shape PCB system with vertical anchors installed in asphalt pavement was previously crash tested under MASH Test Level 3 (TL-3) conditions (*2*).

The evaluation of the new transition system was performed in accordance with the safety-performance assessment procedures outlined in the *Manual for Assessing Safety Hardware (MASH), Second Edition*, published by the American Association of State Highway and Transportation Officials (AASHTO) (*1*). A full-scale crash test was conducted following the *MASH* Test 3-21 impact conditions, which specify a 5,000-lb pickup truck impacting the barrier at a speed of 62 mi/h and an angle of 25 degrees.

Details of the transition system design are presented in Chapter 2. Chapters 3 and 4 provide details of the MASH evaluation criteria and the testing procedures. Test results are provided in Chapter 5. Summary and conclusions from the testing performed under this project are provided in Chapter 6.

CHAPTER 2.

SYSTEM DETAILS

2.1. TEST ARTICLE AND INSTALLATION DETAILS

The installation was 157 feet long, comprised of thirteen 12-ft. long F-shape "pin-and-loop" reinforced concrete barrier segments. The barrier segments were 9-1/2 inches wide at top, 24 inches wide at bottom, and 32 inches tall, and connected to each other with 1-inch diameter connection pins. Barrier segments 1-8 were placed on compacted 2-inch-thick asphalt that was constructed over 6-inch-thick crushed limestone base. Barrier segments 9-13 were placed on compacted 4-inch-thick asphalt that was constructed over 12-inch-thick crushed limestone base.

All barrier segments were fabricated with six slots for hosting anchor pins, three on each side of the barrier. Barrier segments 1-8 were free-standing, i.e., no anchor pins were installed to restrict movement of these barrier segments. Barrier segment 9 was secured to the asphalt with two anchor pins. These pins were installed in the two downstream end slots, one on each side of the barrier segment. Barrier segments 10-13 were secured to the asphalt with four anchor pins each. Two of these anchor pins were in the upstream end and two in the downstream end slots of each barrier segment. No pins were installed in the center slots of any of the barrier segments.

The anchor pins were 1-1/2 inches in diameter and were fabricated with ASTM A36 steel. The pins were 36 inches long, inclusive of a 2-inch tip. A 3-inch x 3-inch x ½-inch ASTM A36 plate washer was welded to the top of the anchor pins. To facilitate anchor pin installation, 1-3/4-inch pilot holes were drilled through the asphalt and the underlying soil prior to driving in the pins.

Figure 2.1 presents the overall information on the free-standing-to-anchored PCB transition system, and Figure 2.2 thru Figure 2.7 provide photographs of the installation. Appendix A provides further details on the free-standing-to-anchored PCB transition system. Drawings were provided by the Texas A&M Transportation Institute (TTI) Proving Ground, and construction of the barriers were performed by Summit Precast Concrete, anchor pin construction was done by Custom Fabricators and Repairs Inc., asphalt pad was constructed by Brazos Paving Industries, and TTI Proving Ground personnel assembled the test installation.

2.2. DESIGN MODIFICATIONS DURING TESTS

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

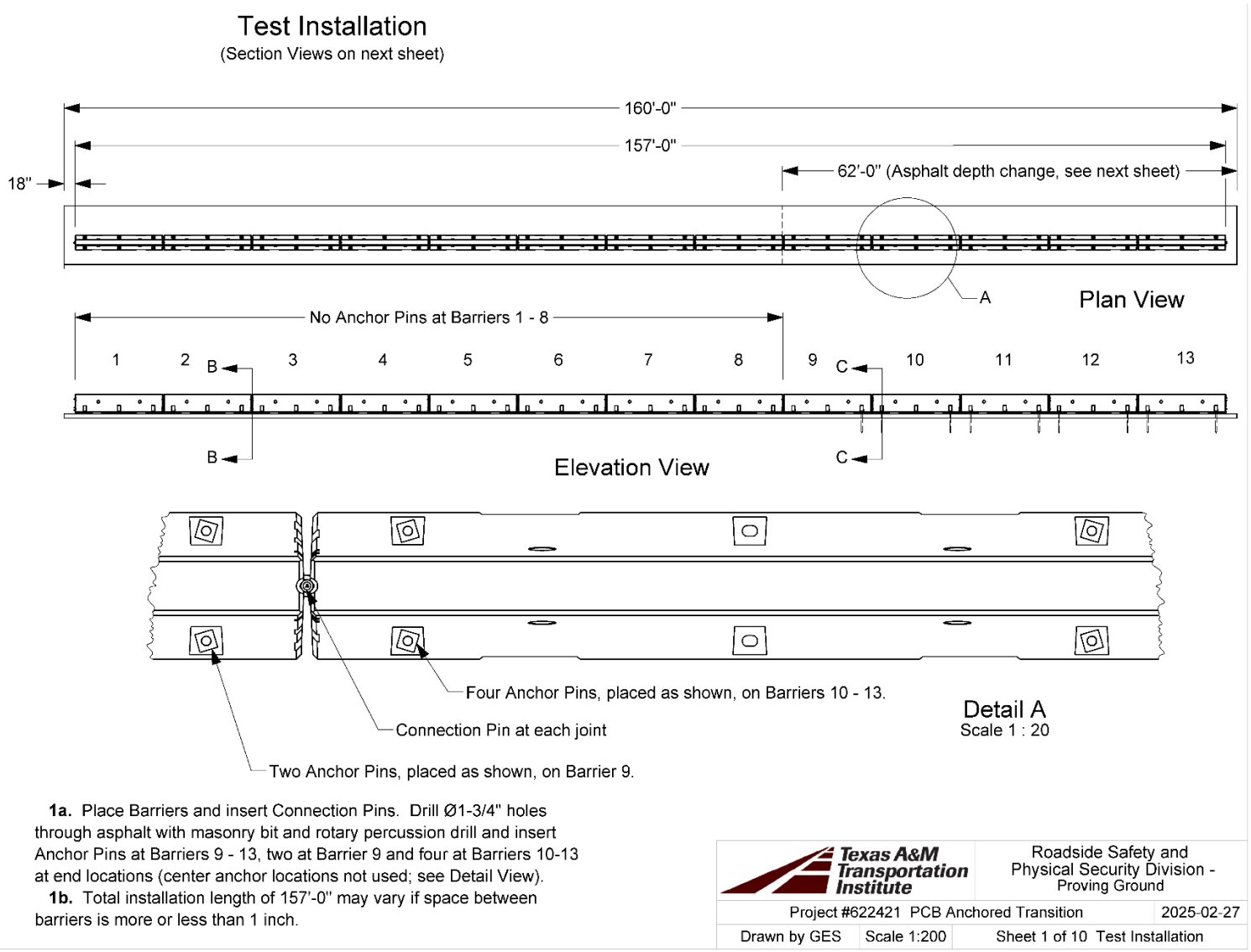


Figure 2.1. Details of the Free-Standing-to-Anchored PCB Transition System.

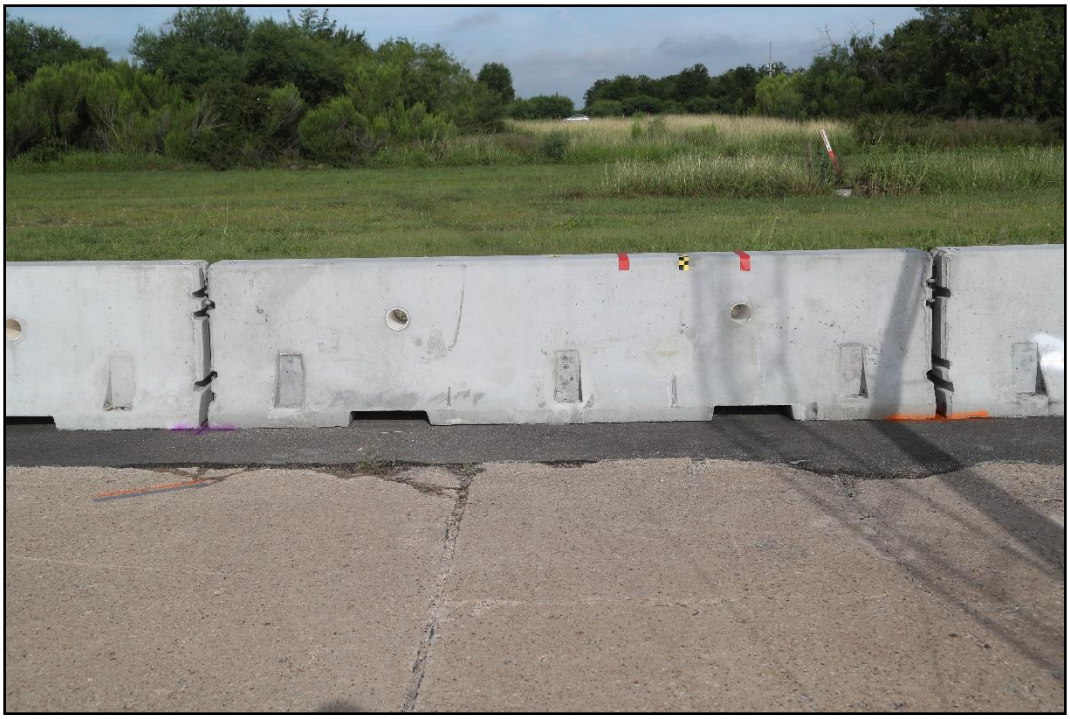


Figure 2.2. Free-Standing-to-Anchored PCB Transition System Prior to Testing.

Figure 2.3. Downstream In-Line View of the Free-Standing-to-Anchored PCB Transition System Prior to Testing.

Figure 2.4. Closeup View of Joint Between Barriers 7 and 8 Prior to Testing.


Figure 2.5. Upstream End of the Test Installation Prior to Testing.

Figure 2.6. Field Side View of the Transition System at Joint Between Segments 9 and 10 Prior to Testing.

Figure 2.7. Closeup View of Installed Anchor Pin Prior to Testing.

2.3. MATERIAL SPECIFICATIONS

Appendix B provides material certification documents for the materials used to install/construct the free-standing-to-anchored PCB transition system. Table 2.1 shows the compressive strengths of the concrete from core samples which were taken after the test.

Table 2.1. Concrete Strength.

Location	Design Strength (psi)	Avg. Strength (psi)
Barrier 8	4000	5800
Barrier 9	4000	6070

CHAPTER 3.

TEST REQUIREMENTS AND EVALUATION CRITERIA

3.1. CRASH TEST PERFORMED/MATRIX

Table 3.1 shows the test conditions and evaluation criteria for *MASH TEST 3-21* for Longitudinal Barrier.

Table 3.1. Test Conditions and Evaluation Criteria Specified for *MASH TEST 3-21* Longitudinal Barrier.

Test Designation	Test Vehicle	Impact Speed (mi/h)	Impact Angle (°)	Evaluation Criteria
3-21	2270P	62	25	A, D, F, H, I

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

3.2. EVALUATION CRITERIA

The appropriate safety evaluation criteria from Tables 2-2 and 5-1 of *MASH* were used to evaluate the crash test reported herein. Table 3.1 lists the test conditions and evaluation criteria required for *MASH TEST 3-21.* Table 3.2 provides detailed information on the evaluation criteria.

Table 3.2. Evaluation Criteria Required for *MASH* Testing.

Evaluation Factors	Evaluation Criteria
A.	Test article should contain and redirect the vehicle or bring the vehicle to a controlled stop; the vehicle should not penetrate, underride, or override the installation although controlled lateral deflection of the test article is acceptable.
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.

CHAPTER 4.

TEST CONDITIONS

4.1. TEST FACILITY

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

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

4.2. VEHICLE TOW AND GUIDANCE SYSTEM

The 2270P 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 and through a pulley on the tow vehicle, and then anchored to the ground such that the tow vehicle moved away from the test site. A 2:1 speed ratio between the test and tow-vehicle existed with this system. Just prior to impact with the installation, the test vehicle was released and moved unrestrained. The vehicle remained freewheeling (i.e., no steering or braking inputs were applied) until it cleared the immediate area of the test site.

4.3. DATA ACQUISITION SYSTEMS

4.3.1. Vehicle Instrumentation and Data Processing

The test vehicle was instrumented with a self-contained onboard data acquisition system. The signal conditioning and acquisition system is a multi-channel data acquisition system (DAS) 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 data acquisition hardware and software conform to the *MASH* recommended version of SAE J211, Instrumentation for Impact Test. Each of the 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 samples per second with a resolution of one part in 65,536. Once data are recorded, internal batteries back these up inside the unit in case the primary battery cable is severed. Initial contact of the pressure switch on the vehicle bumper provides a time zero mark and initiates the recording process. After each test, the data are downloaded from the DAS 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 DAS is returned to the factory annually for complete recalibration and to ensure that all instrumentation used in the vehicle conforms to the specifications outlined by SAE J211. All accelerometers are calibrated annually by means of an ENDEVCOÒ 2901 precision primary vibration standard. This standard and its support instruments are checked annually and receive a calibration traceable to the International System of Units (SI). Measurement Uncertainties have been determined for critical parameters involved in this testing and are available upon request by the sponsor.

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

TRAP uses the data from the yaw, pitch, and roll rate transducers to compute angular displacement in degrees at 0.0001-s intervals, and then plots yaw, pitch, and roll versus time. These displacements are in reference to the vehicle-fixed coordinate system with the initial position and orientation being initial impact.

4.3.2. Anthropomorphic Dummy Instrumentation

According to *MASH*, use of a dummy in the 2270P vehicle is optional, and no dummy was used in the test.

4.3.3. Photographic Instrumentation Data Processing

Photographic coverage of the test included 3 digital high-speed cameras:

- One placed overhead with a field of view perpendicular to the ground and directly over the impact point.
- One placed with a field of view parallel to and aligned with the installation at the downstream end.
- One placed at an oblique angle upstream from the installation on the impact side.

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

CHAPTER 5.

MASH TEST 3-21 (CRASH TEST 622421-01-1)

5.1. CRITICAL IMPACT POINT LOCATION

The Critical Impact Point (CIP) for Test 3-21 was determined using finite element modeling and simulation and was 195.6 inches [16.3 feet] upstream from the centerline of the joint between barrier segments 9 and 10. Figure 5.1 shows the target CIP for test 622421-01-1. The target impact angle was 25 degrees in accordance with MASH Test 3-21 evaluation criteria. Figure 5.2 and Figure 5.3 depict the vehicle at the CIP prior to test 622421-01-1.

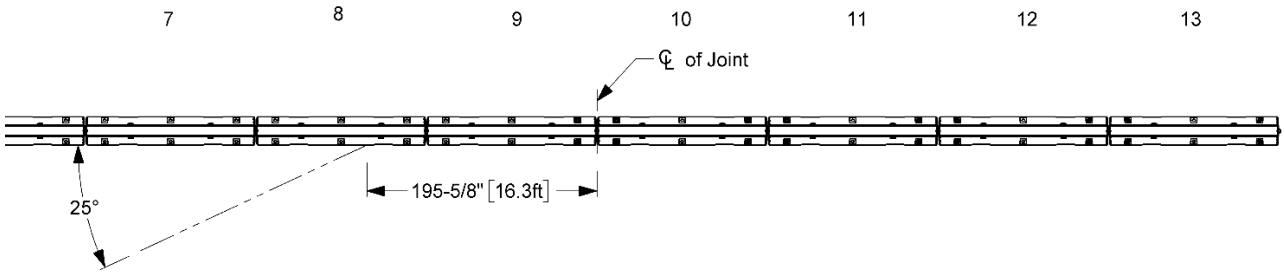


Figure 5.1. Target CIP for *MASH* Test 3-21 on Free-Standing-to-Anchored PCB Transition System.

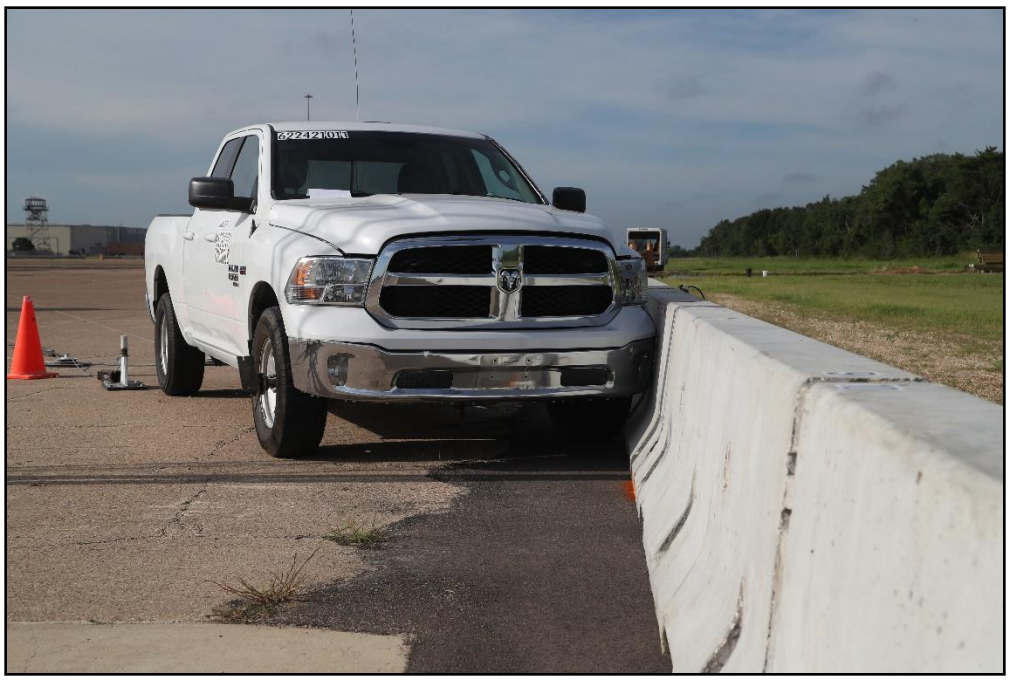


Figure 5.2. Front View of Test Vehicle Impact Location for Test 622421-01-1.

Figure 5.3. Rear View of Test Vehicle Impact Location for Test 622421-01-1.

5.2. TEST VEHICLE DETAILS PRIOR TO IMPACT

Table 5.1 shows test vehicle measurements. Figure 5.4 and Figure 5.5 show the 2019 RAM 1500 used for the crash test. Figure C.1 in Appendix C.1 gives additional dimensions and information on the vehicle.

Table 5.1. Vehicle Measurements for Test 622421-01-1.

Test Parameter	Specification	Tolerance	Measured
Dummy Mass (if applicable)[a] (lb)	165	N/A	N/A
Inertial Mass (lb)	5000	±110	5006
Gross Static[a] Mass (lb)	5000	±110	5006
Wheelbase (inches)	148	±12	140.5
Front Overhang (inches)	39	±3	40.3
Overall Length (inches)	237	±13	229.0
Overall Width (inches)	78	±2	78.5
Hood Height (inches)	43	±4	46.0
Track Width[b] (inches)	67	±1.5	68.3
CG aft of Front Axle[c] (inches)	63	±4	59.4
CG above Ground[c,d] (inches)	≥28	N/A	28.3

Note: N/A = not applicable; CG = center of gravity.

[a] If a dummy is used, the gross static vehicle mass should be increased by the mass of the dummy.

[b] Average of front and rear axles.

[c] For test inertial mass.

[d] 2270P vehicle must meet minimum CG height requirement.

Figure 5.4. Impact Side of Test Vehicle before Test 622421-01-1.

Figure 5.5. Opposite Impact Side of Test Vehicle before Test 622421-01-1.

5.3. TEST DESCRIPTION

5.3.1. Weather Conditions

Table 5.2 provides the weather conditions for Test 622421-01-1. Values for wind direction and vehicle travel are in reference to the degrees on a compass, with North being 0 degrees.

Table 5.2. Weather Conditions for Test 622421-01-1.

Date of Test	6/25/2025
Wind Speed	7 mi/h
Wind Direction	156°
Temperature	85°F
Relative Humidity	80 %
Vehicle Traveling	325°

5.3.2. Test Events

Table 5.3 lists events that occurred during Test 622421-01-1. Figures in Appendix C.2 present sequential photographs during the test.

Table 5.3. Events during Test 622421-01-1.

Time (seconds)	Events
0.0000	Vehicle impacted the installation
0.0310	Vehicle began to redirect
0.0350	Barrier segment 8 began to move toward non-impact-side
0.0840	Front passenger-side tire lifted above the ground
0.1390	Barrier segment 9 began to crack on the non-impact-side
0.2130	Rear passenger-side tire lifted above the ground
0.2320	Vehicle was parallel with the installation
0.4540	Vehicle exited the installation at 45.4 mi/h with a heading of 16.6 degrees and a trajectory of 11.9 degrees

5.4. TEST ACTUAL IMPACT CONDITIONS

Table 5.4 lists details of the impact conditions for this test and Table 5.5 lists the exit parameters.

Table 5.4. Impact Conditions for *MASH TEST 3-21*, Crash Test 622421-01-1.

Test Parameter	Specification	Tolerance	Measured
Impact Speed (mi/h)	62	±2.5	63.0
Impact Angle (°)	25	±1.5	25.5
Impact Severity (kip-ft)	106	≥106	123.1
Impact Location	195.6 inches upstream from the centerline of the joint between barrier segments 9 and 10	±1 foot (12 inches)	199.8 inches upstream from the centerline of the joint between barrier segments 9 and 10

Table 5.5. Exit Parameters for *MASH TEST 3-21*, Crash Test 622421-01-1.

Exit Parameter	Measured
Speed	45.4 mi/h
Trajectory	11.9°
Heading	16.6°
Brakes applied post impact	Not applied
Vehicle at rest position	178 ft downstream of impact point 27 ft to the impact side of the barrier
Comments:	Vehicle remained upright and stable. The vehicle met the exit box criteria[a] by crossing the exit box 52 feet downstream from loss of contact.

[a]Per the *MASH* guidelines in Section 5.2.3, the exit box for the 2270P used in this test was 16.8 ft toward the impact side as measured from the impact side toe of the barrier and 32.8 ft downstream from loss of contact.

5.5. DAMAGE TO TEST INSTALLATION

Table 5.6 describes the displacement of the joints between the barrier segments of the transition system. Table 5.7 provides the deflection and working width of the transition system. Figure 5.6 through Figure 5.9 show the damage to the transition system.

There was spalling at the base of the joint between barrier segments 8 and 9 on the impact side. There was a significant crack on the non-impact side of barrier segment 8. On barrier segment 9, the downstream impact side face of the barrier segment was raised 2.3 inches from grade, with the anchor pin raised 4.5 inches above the top surface of the pin slot. There were two major cracks and other spalling on barrier segment 9 (Figure 5.8). Both cracks were through the entire cross-section of the barrier segment, exposing rebar on the non-impact-side with major spalling (Figure 5.9). Barrier segments 8 and 9 did not lose continuity despite the concrete damage. On the upstream end of the test installation, barrier segment 1 was displaced 2 inches in the downstream direction (Figure 5.10).

On barrier segment 10 the upstream impact side anchor pin was raised 0.3 inches from grade, and the downstream impact side anchor pin was raised 2 inches. On barrier segment 11 the upstream impact-side anchor pin was raised 0.3 inches, and the downstream impact side anchor pin was raised 0.4 inches. Barriers 12 and 13 had no movement.

None of the barrier connection loops were broken. There were some deformation of the anchoring pins. Figure 5.11 shows the anchoring pins, the connection pin, and the extent of the damage to the underlying pavement at the joint of maximum barrier deflection (between barrier segments 8 and 9 after post-test disassembly of the transition system).

Table 5.6. Barrier Segment Displacements at Joint Locations for Test 622421-01-1.

Joint at Barrier Segments	Joint Displacement (in inches)	Comments
1 (u/s end of installation)	2 d/s, 0.5 i/s	----
1/2	2.5 d/s, 0.5 i/s	----
2/3	2 d/s, 0.5 i/s	----
3/4	2 d/s, 0.5 i/s	----
4/5	2 d/s	----
5/6	2 d/s, 0.5 i/s	----
6/7	2.5 d/s, 2 i/s	3-inch gap on the i/s at the top of barrier, 1.7 inches on the n/s
7/8	11 n/s, 1.2 d/s	1.2 inches gap on the i/s at top of barrier, 2.5 inches n/s
8/9	26.5 d/s, 1 d/s	1.8 inches gap on the i/s at the top of barrier, 3.3 inches n/s
9/10	3 i/s, 3 u/s	Barrier segment 10 pin raised 0.3 inches on i/s

Note: u/s = upstream; d/s = downstream; i/s = impact-side; n/s = non-impact side

Table 5.7. Deflections and Working Width for Test 622421-01-1.

Test Parameter	Measured
Permanent Deflection and Location	26.5 inches toward non-impact side at the joint between barrier segments 8 and 9
Dynamic Deflection	30.4 inches toward non-impact side at the joint between barrier segments 8 and 9
Working Width [a] and Height	51.3 inches, at a height of 3.0 inches at joint between barrier segments 8 and 9

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

Figure 5.6. Downstream In-Line View of the Transition System after Test 622421-01-1.

Figure 5.7. Upstream View of the Transition System after Test 622421-01-1.

Figure 5.8. Impact-Side View of Barrier Segment 9 after Test 622421-01-1.

Figure 5.9. Non-Impact-Side View of Barrier Segment 9 after Test 622421-01-1.

Figure 5.10. Upstream Barrier End after Test 622421-01-1.

Figure 5.11. Anchoring Pins, Connection Pin, and Asphalt Damage at Joint between Barrier Segments 8 and 9 Post-Disassembly after Test 622421-01-1.

5.6. DAMAGE TO TEST VEHICLE

Figure 5.12 and Figure 5.13 show the damage sustained by the vehicle. Figure 5.14 and Figure 5.15 show the interior of the test vehicle. Table 5.8 and Table 5.9 provide details on the occupant compartment deformation and exterior vehicle damage, respectively. Figure C.2 and Figure C.3 in Appendix C.1 provide exterior crush and occupant compartment measurements, respectively.

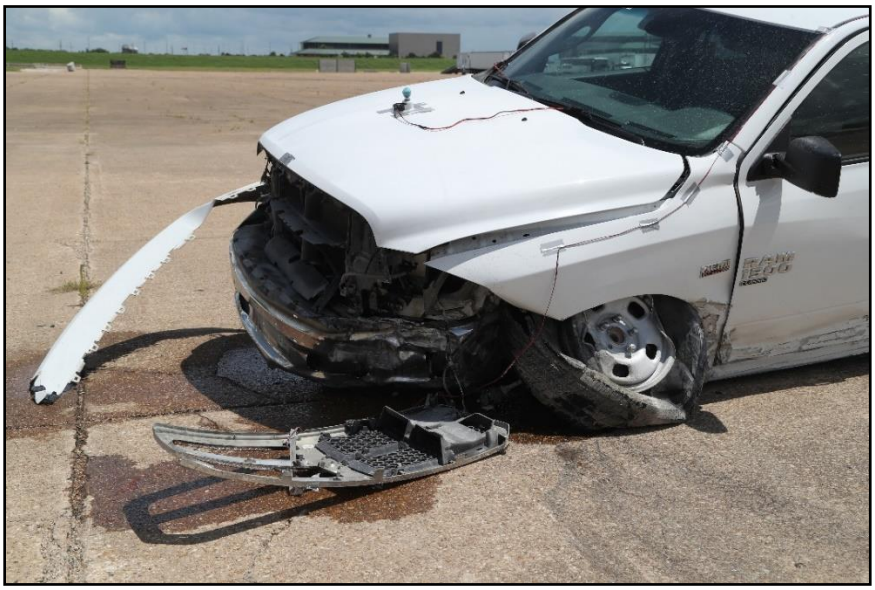


Figure 5.12. Impact Side of Test Vehicle after Test 622421-01-1.

Figure 5.13. Rear Impact Side of Test Vehicle after Test 622421-01-1.

Figure 5.14. Overall Interior of Test Vehicle after Test 622421-01-1.

Figure 5.15. Interior of Test Vehicle on Impact Side after Test 622421-01-1.

Table 5.8. Occupant Compartment Deformation 622421-01-1.

Test Parameter	Specification (inches)	Measured (inches)
Roof	≤4.0	0.0
Windshield	≤3.0	0.0
A and B Pillars	≤5.0 overall/≤3.0 lateral	0.0
Foot Well/Toe Pan	≤9.0	5.3
Floor Pan/Transmission Tunnel	≤12.0	1.0
Side Front Panel	≤12.0	0.8
Front Door (above Seat)	≤9.0	0.0
Front Door (below Seat)	≤12.0	0.0

Table 5.9. Exterior Vehicle Damage 622421-01-1.

Test Parameter	Details
Side Windows	Remained intact
Maximum Exterior Deformation	20 inches at front bumper
VDS	01LFQ2
CDC	01FLEN2
Fuel Tank Damage	None
Description of Damage to Vehicle:	The bumper, grill, fender, and both headlights dislodged. The left front wheel bent, the tire ruptured, and one lug nut stud was dislodged. There were abrasions and deformities on the lower portion of the left doors. The exterior left front door panel pulled back one inch at the bottom. The exterior left rear door panel pulled back two inches at the bottom. There was a one-inch gap at the top of the left front and rear doors. The left rear wheel was deformed and the tire ruptured. The left taillight dislodged, and the rear bumper was deformed. The tail gate dislodged on the passenger side but remained attached on the driver's side.

5.7. OCCUPANT RISK FACTORS

Data from the accelerometers were digitized for evaluation of occupant risk, and the results are shown in Table 5.10. Figure C.7 in Appendix C.3 shows the vehicle angular displacements, and Figure C.8 through Figure C.10 in Appendix C.4 show acceleration versus time traces.

Table 5.10. Occupant Risk Factors for Test 622421-01-1.

Test Parameter	Specification [a]	Measured	Time
OIV, Longitudinal (ft/s)	≤40.0 *≤30.0*	18.7	0.1067 seconds on left side of interior
OIV, Lateral (ft/s)	≤40.0 *≤30.0*	18.2	0.1067 seconds on left side of interior
Ridedown, Longitudinal (g)	≤20.49 *≤15.0*	5.9	0.2474 - 0.2574 seconds
Ridedown, Lateral (g)	≤20.49 *≤15.0*	11.4	0.2874 - 0.2974 seconds
Theoretical Head Impact Velocity (THIV) (m/s)	N/A	7.7	0.1029 seconds on left side of interior
Acceleration Severity Index	N/A	1.5	0.0536 - 0.1036 seconds
50-ms Moving Avg. Accelerations (MA) Longitudinal (g)	N/A	-9.9	0.0366 - 0.0866 seconds
50-ms MA Lateral (g)	N/A	9.9	0.0310 - 0.0810 seconds
50-ms MA Vertical (g)	N/A	-3.4	0.2475 - 0.2975 seconds
Roll (°)	≤75	41.2	0.8913 seconds
Pitch (°)	≤75	17.2	0.8896 seconds
Yaw (°)	N/A	62.3	1.4843 seconds

[a] *Values in italics are the preferred MASH values*

Note: N/A = Not Applicable

5.8. TEST SUMMARY

Figure 5.16 summarizes the results of *MASH* Test 622421-01-1.

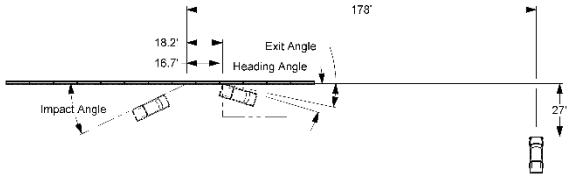
0.000 s

0.200 s

0.400 s

0.600s

GENERAL INFORMATION	
Test Agency:	Texas A&M Transportation Institute (TTI)
Test Standard/Test No.:	*MASH* 2016, Test 3-21
Project No.:	622421-01-1
Test Date:	6/25/2025
TEST ARTICLE	
Type:	Longitudinal Barrier
Name:	Free-standing-to-anchored F-shape PCB transition system
Length:	157 feet
Key Materials:	Galvanized ASTM A449, TxDOT Type D Asphalt, native soil, rebar grade 60, concrete barriers, galvanized anchor pins, and galvanized connection pins
Roadbase and Condition:	Type D Asphalt, damp
TEST VEHICLE	
Type/Designation:	2270P
Year, Make and Model:	2019 RAM 1500
Inertial Mass:	5006 lb
Dummy Mass:	N/A
Gross Static Mass:	5006 lb
IMPACT CONDITIONS	
Impact Speed:	63.0 mi/h
Impact Angle:	25.5°
Impact Location:	199.8 inches upstream from the centerline of the joint between barriers 9 and 10
Impact Severity:	123.1 kip-ft
EXIT CONDITIONS	
Exit Speed:	45.4 mi/h
Trajectory/Heading Angle:	11.9° / 16.6°
Exit Box Criteria:	The vehicle met the exit box criteria
Stopping Distance:	178 ft downstream 27 ft to the impact side
TEST ARTICLE DEFLECTIONS	
Dynamic:	30.4 inches
Permanent:	26.5 inches
Working Width:	51.3 inches
Working Width Height:	3.0 inches
VEHICLE DAMAGE	
VDS:	01LFQ2
CDC:	01FLEN2
Max Exterior Deformation:	20 inches at front bumper
Max Occupant Compartment Deformation:	5.3 inches in the foot well/toe pan
OCCUPANT RISK VALUES	
Longitudinal OIV:	18.7 ft/s
Lateral OIV:	18.2 ft/s
Longitudinal Ridedown:	5.9 g
Lateral Ridedown:	11.4 g
THIV:	7.7 m/s
ASI:	1.5
Max 50ms Longitudinal:	-9.9 g
Max 50ms Lateral:	9.9 g
Max 50ms Vertical:	-3.4 g
Max Roll:	41.2°
Max Pitch:	17.2°
Max Yaw:	62.3°



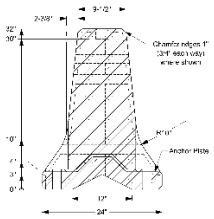


Figure 5.16. Summary of Results for *MASH* Test 3-21 on Free-Standing-to-Anchored F-shape PCB Transition system.

CHAPTER 6.

SUMMARY AND CONCLUSIONS

The crash test reported herein was performed on the free-standing-to-anchored F-shape PCB transition system in accordance with *MASH TEST 3-21*.

Table 6.1 shows that the free-standing-to-anchored F-shape PCB transition system met the performance criteria for *MASH TEST 3-21* for longitudinal barriers.

Table 6.1. Assessment Summary for *MASH TEST 3-21* Tests on free-standing-to-anchored PCB transition system.

Evaluation Criteria	Description[1]	Test 622421-01-1 *(MASH* Test 3-21)
A	Contain, Redirect, or Controlled Stop	S
D	No Penetration into Occupant Compartment	S
F	Roll and Pitch Limit	S
H	OIV Threshold	S
I	Ridedown Threshold	S
Overall	Evaluation	Pass

Note: S = Satisfactory; N/A = Not Applicable.
[1] See Table 3.2 for details

6.1. IMPLEMENTATION*

The optional *MASH* Test 3-20, involving a 2,420-lb small passenger car, was not considered critical for evaluating the transition system. Due to the lower vehicle mass, this test condition was not expected to produce higher impact loads on the transition system or

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

result in greater barrier deflections compared to the 5,000-lb pickup truck specified in *MASH* Test 3-21. Therefore, Test 3-20 was not conducted.

Based on the results of the crash testing presented herein, the free-standing-to-anchored F-shape PCB transition system is considered compliant with *MASH* Test Level 3 evaluation criteria.

REFERENCES

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

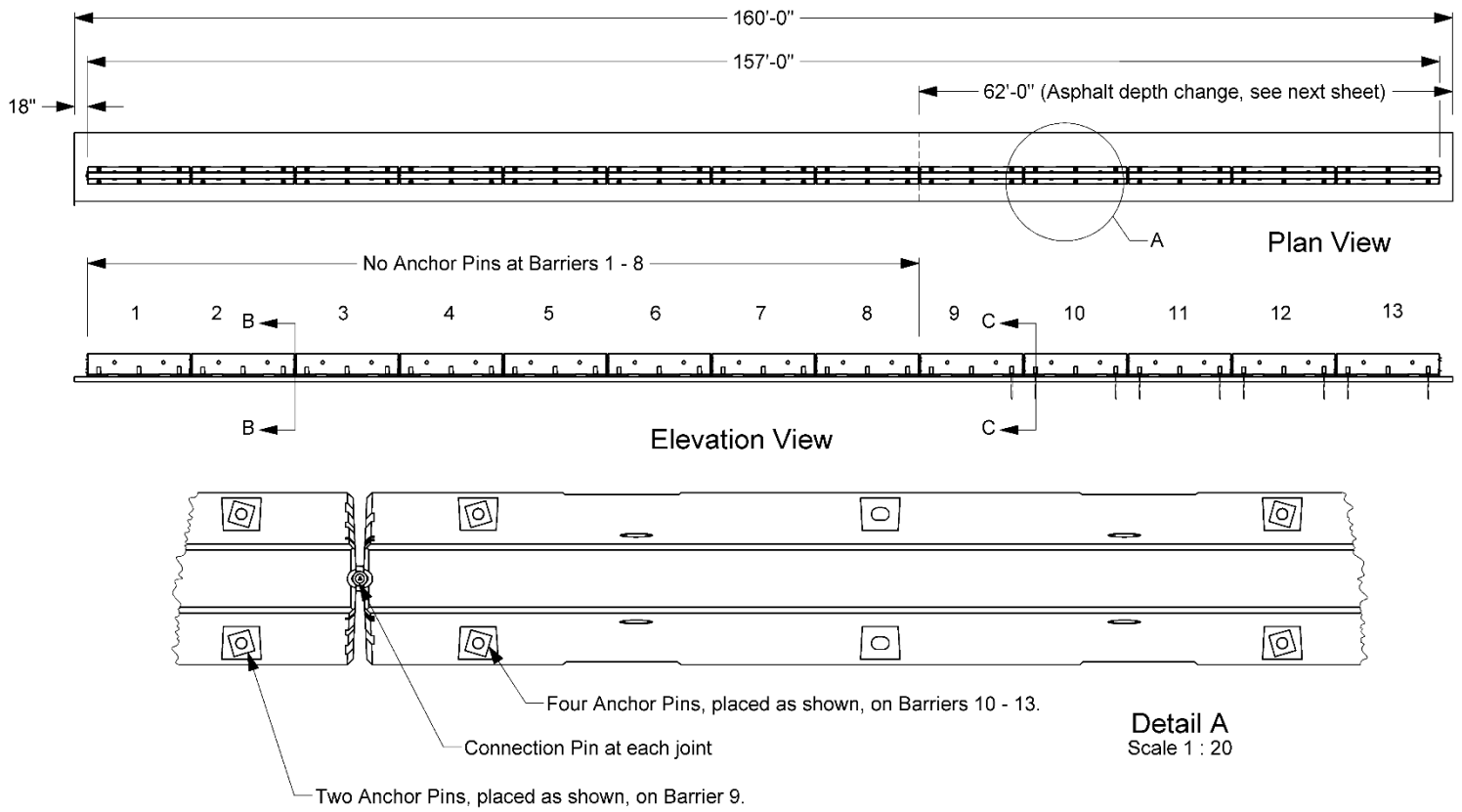
2. Sheikh, N.M, and W.J., Schroeder. *Design and Testing of MSH TL-3 Compliant Anchored F-shape Portable Concrete Barrier System with Vertical Anchors*. Texas A&M Transportation Institute. Report 616811-01 1-4, College Station, Texas, 2025.

APPENDIX A.

DETAILS OF FREE-STANDING-TO-ANCHORED PCB TRANSITION SYSTEM

Test Installation

(Section Views on next sheet)

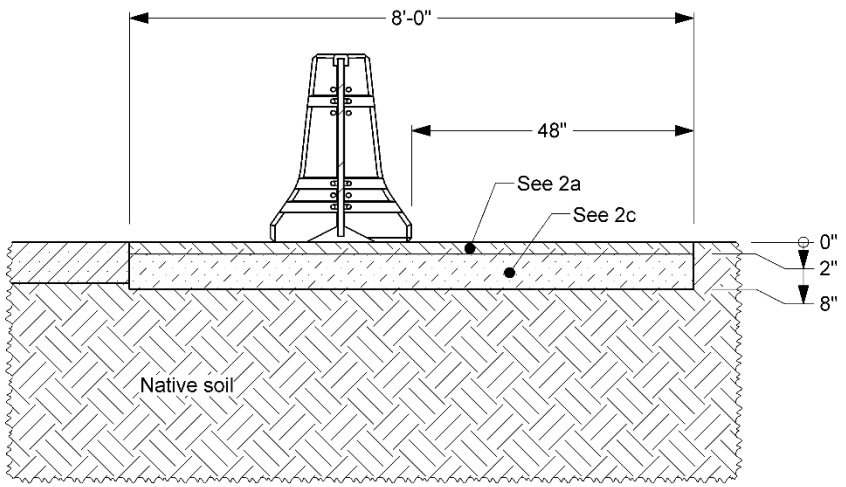


1a. Place Barriers and insert Connection Pins. Drill Ø1-3/4" holes through asphalt with masonry bit and rotary percussion drill and insert Anchor Pins at Barriers 9 - 13, two at Barrier 9 and four at Barriers 10-13 at end locations (center anchor locations not used; see Detail View).

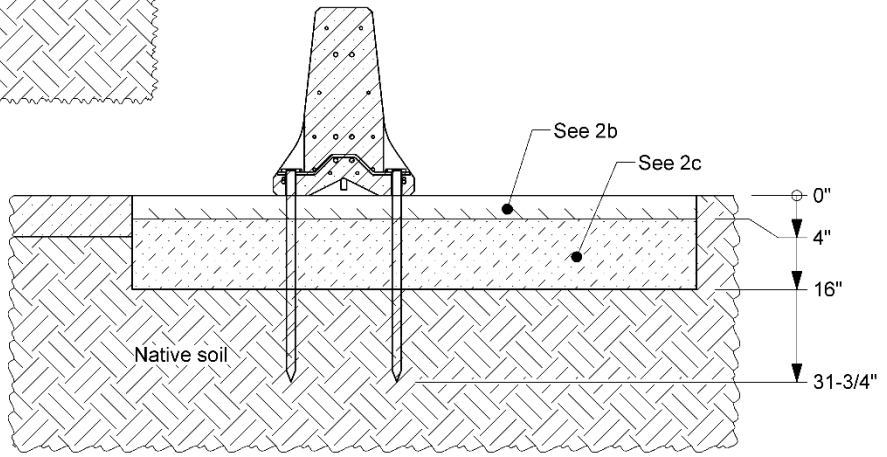
1b. Total installation length of 157'-0" may vary if space between barriers is more or less than 1 inch.

Texas A&M Transportation Institute		Roadside Safety and Physical Security Division - Proving Ground	
Project #622421 PCB Anchored Transition			2025-02-27
Drawn by GES	Scale 1:200	Sheet 1 of 10 Test Installation	

S:\Accreditation-17025-2017\EIR-000 Project Files\622421-01 - Free-Standing to Anchored Barriers - Sheikh\Drafting, 622421-1\622421-01 Drawing



Section B-B
Scale 1 : 25



Section C-C
Scale 1 : 25

2a. TxDOT Type D Asphalt. Prime the base with Tack Coat Binder and apply the asphalt.

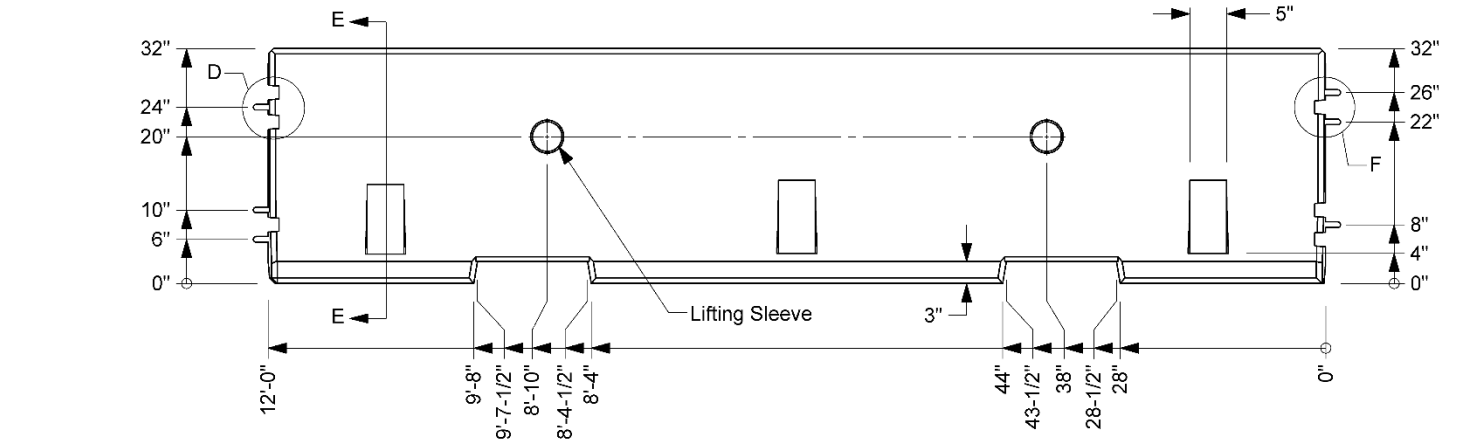
2b. TxDOT Type D Asphalt. Prime the base with Tack Coat Binder and apply the asphalt in two equal lifts.

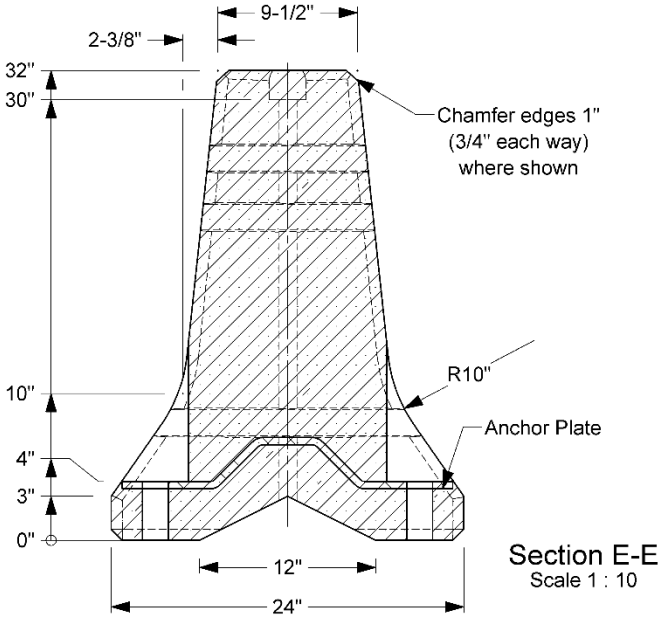
2c. Type A Grade 1 crushed limestone road base, compacted to 90% of standard proctor density.

Texas A&M Transportation Institute		Roadside Safety and Physical Security Division - Proving Ground	
Project #622421 PCB Anchored Transition			2025-02-27
Drawn by GES	Scale 1:200	Sheet 2 of 10 Section Views	

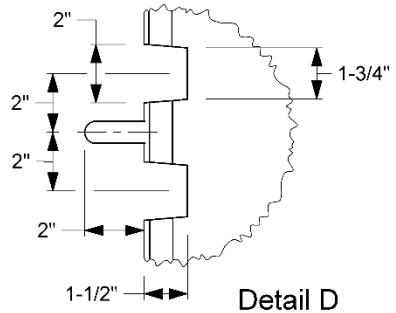
S:\Accreditation-17025-2017\EIR-000 Project Files\622421-01 - Free-Standing to Anchored Barriers - Sheikh\Drafting, 622421-1\622421-01 Drawing

Barrier Elevation

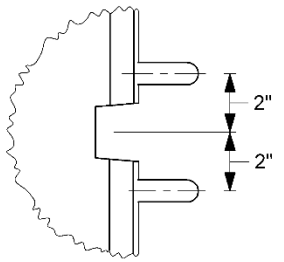




Section E-E
Scale 1 : 10



Detail D
Scale 1 : 5

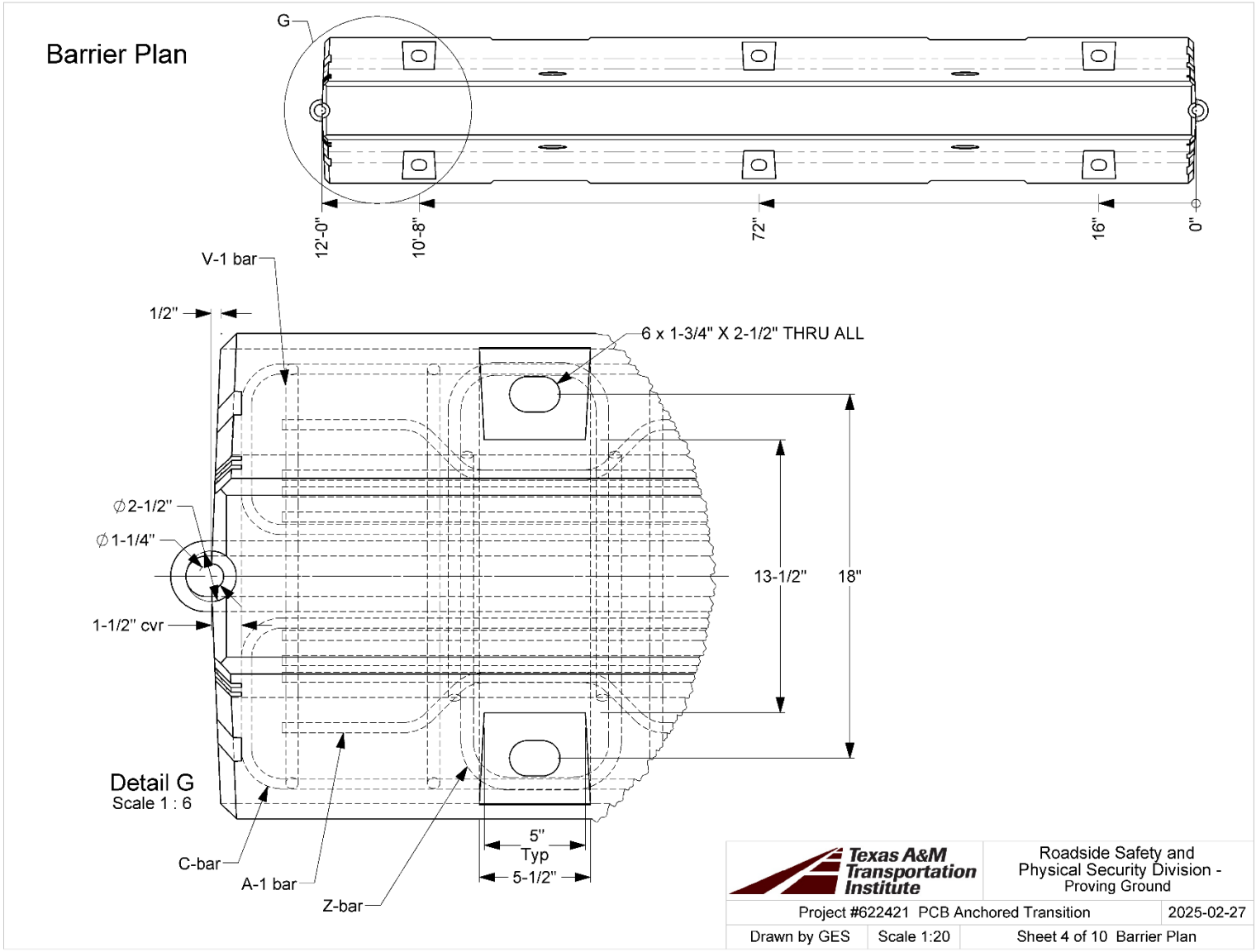


Detail F
Scale 1 : 5

3a. Concrete strength is minimum 4,000 psi.
3b. Dimensions in Detail Views are typical at all Connection Loop locations.

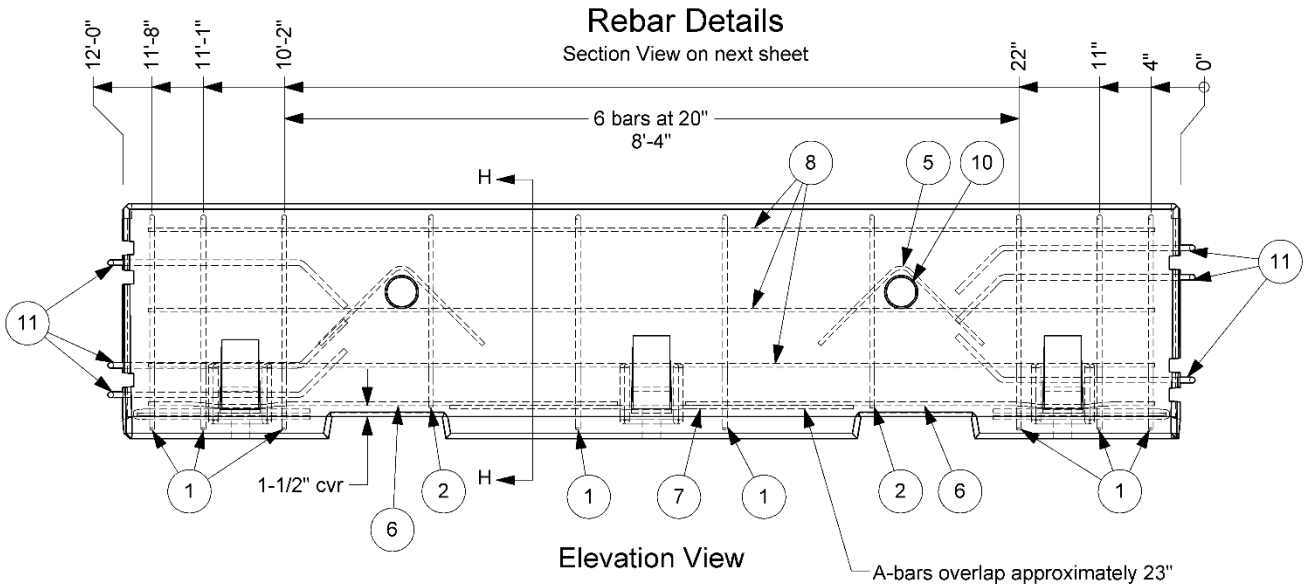
Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #622421 PCB Anchored Transition		2025-02-27
Drawn by GES	Scale 1:20	Sheet 3 of 10 Barrier Elevation

S:\Accreditation-17025-2017\EIR-000 Project Files\622421-01 - Free-Standing to Anchored Barriers - Sheikh\Drafting, 622421-1\622421-01 Drawing


Barrier Plan
G
12'-0"
10'-8"
72"
16"
0"
V-1 bar
1/2"
6 x 1-3/4" X 2-1/2" THRU ALL
∅2-1/2"
∅1-1/4"
1-1/2" cvr
13-1/2"
18"
Detail G
Scale 1 : 6
C-bar
A-1 bar
Z-bar
5"
Typ
5-1/2"
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
Project #622421 PCB Anchored Transition
2025-02-27
Drawn by GES
Scale 1:20
Sheet 4 of 10 Barrier Plan
S:\Accreditation-17025-2017\EIR-000 Project Files\622421-01 - Free-Standing to Anchored Barriers - Sheikh\Drafting, 622421-1\622421-01 Drawing

Rebar Details

Section View on next sheet



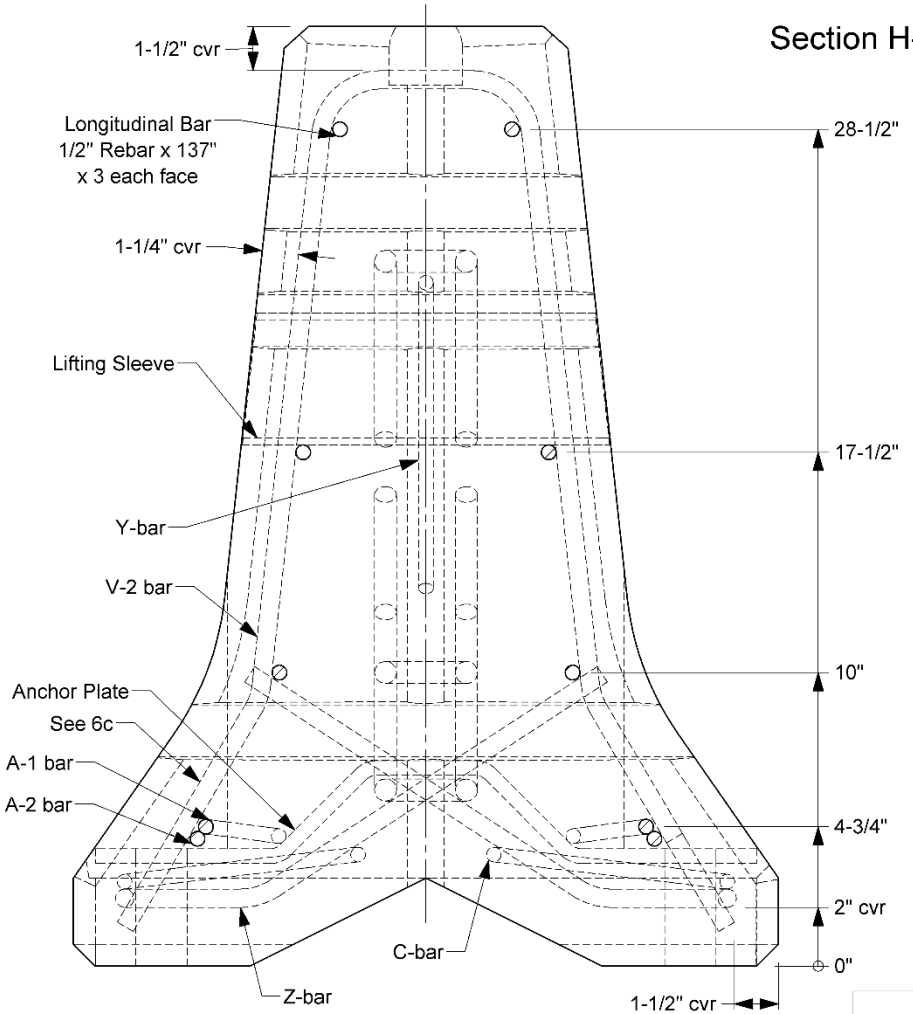
Elevation View

#	Part Name	QTY.
1	V-1 bar	8
2	V-2 bar	2
3	C-bar	4
4	Z-bar	6
5	Y-bar	2
6	A-1 bar	4
7	A-2 bar	2
8	Longitudinal Bar	6
9	Anchor Plate	3
10	Lifting Sleeve	2
11	Connection Loop	6

5a. All rebar dimensions are to center of bar unless otherwise indicated by "cvr" (cover).
5b. Rebar is grade 60.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #622421 PCB Anchored Transition		2025-02-27
Drawn by GES	Scale 1:20	Sheet 5 of 10 Rebar Details

S:\Accreditation-17025-2017\EIR-000 Project Files\622421-01 - Free-Standing to Anchored Barriers - Sheikh\Drafting, 622421-1\622421-01 Drawing



Section H-H

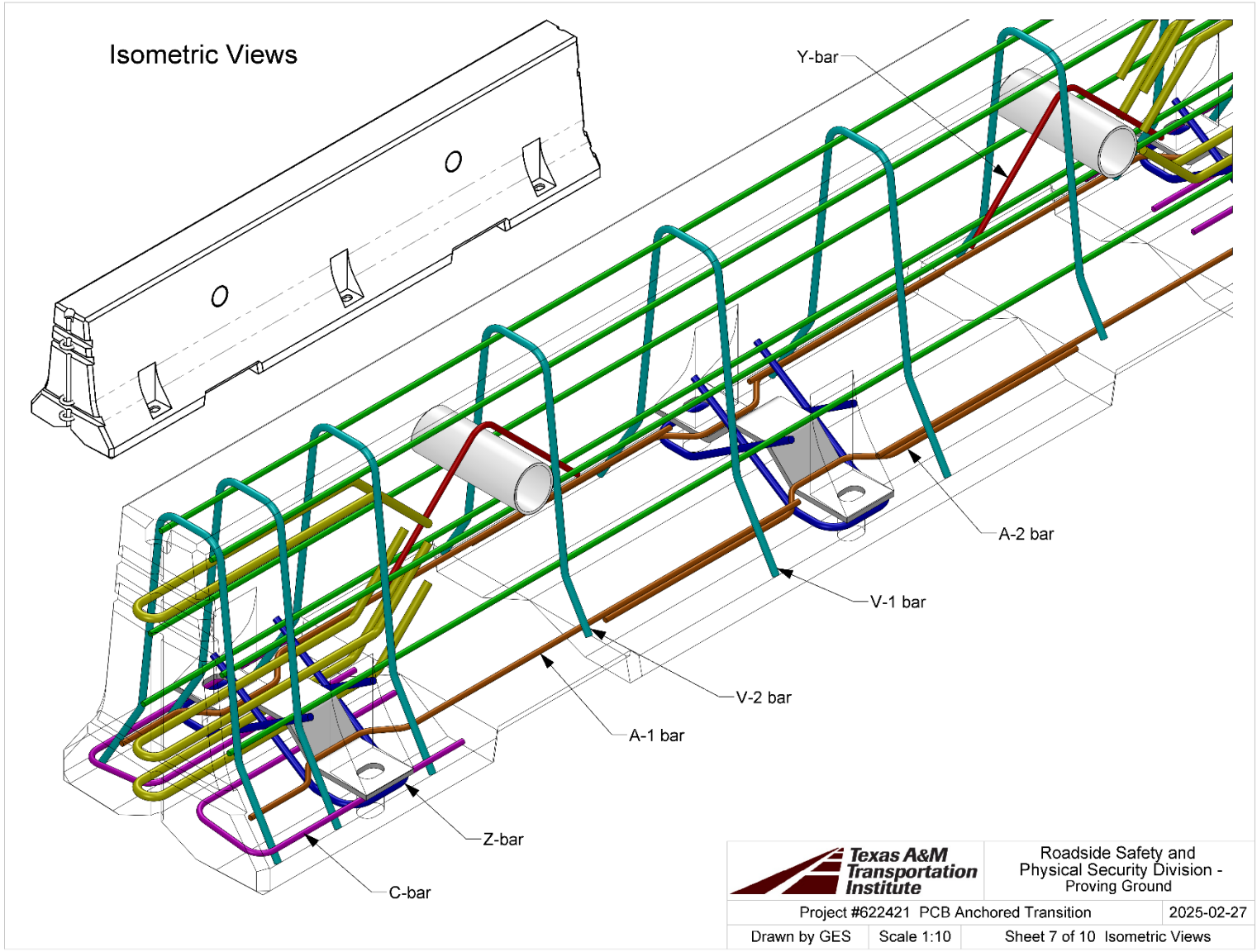
6a. All rebar dimensions are to center of bar unless otherwise indicated by "cvr" (cover).

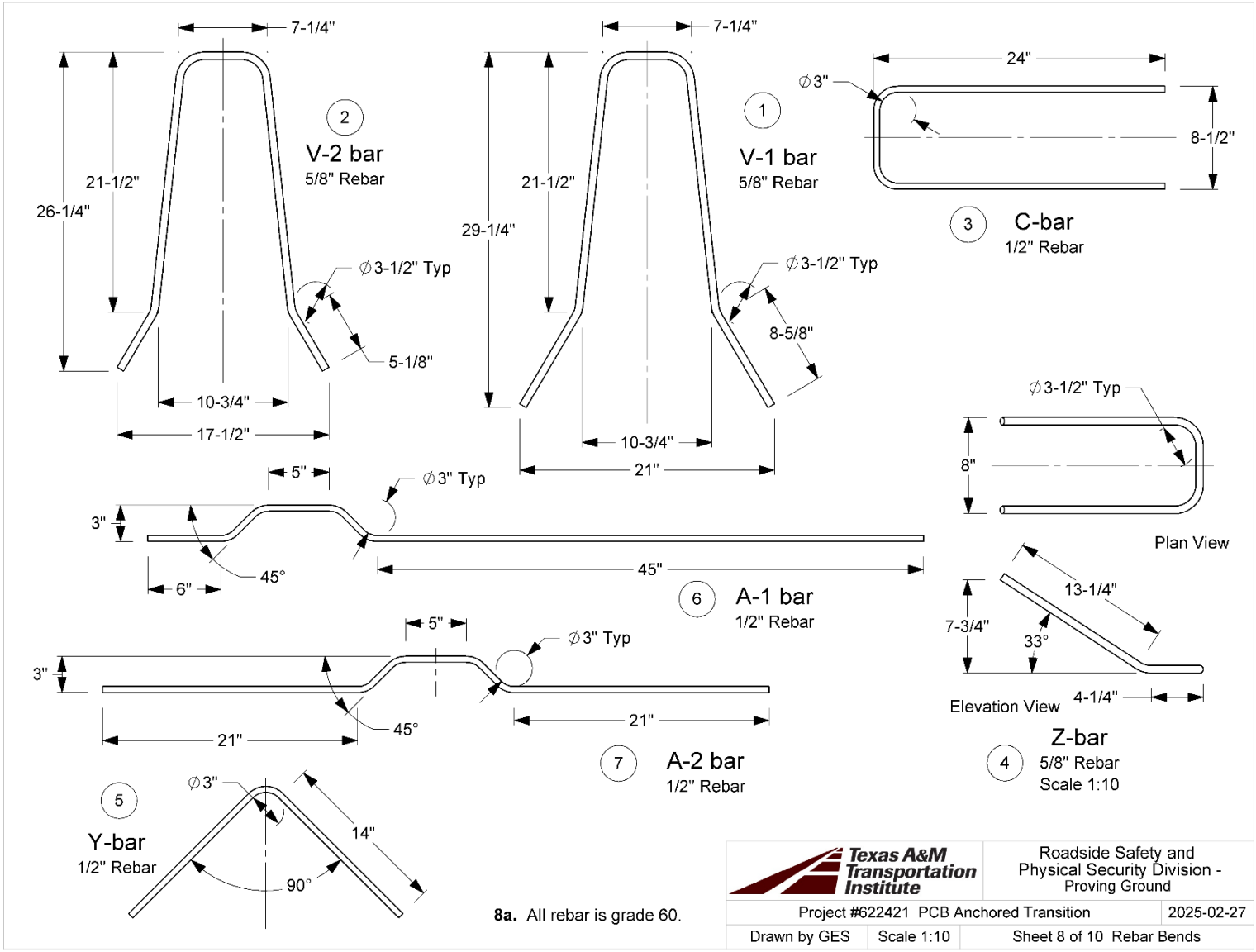
6b. Rebar is grade 60.

6c. Rebar coverage varies on lower slope of Barrier (minimum 1-1/4").

Texas A&M Transportation Institute		Roadside Safety and Physical Security Division - Proving Ground	
Project #622421 PCB Anchored Transition			2025-02-27
Drawn by GES	Scale 1:5	Sheet 6 of 10 Section View	

S:\Accreditation-17025-2017\EIR-000 Project Files\622421-01 - Free-Standing to Anchored Barriers - Sheikh\Drafting, 622421-1\622421-01 Drawing

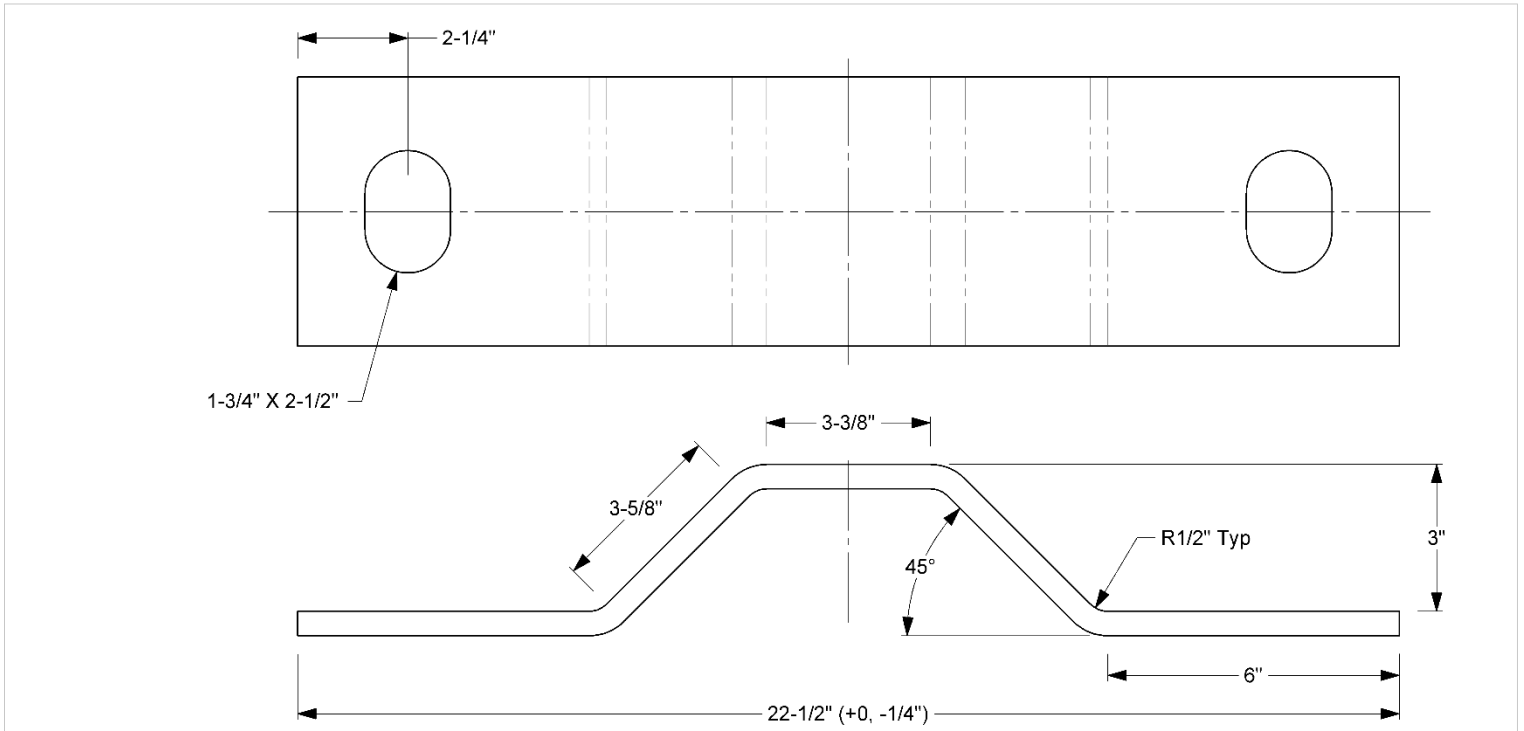

Isometric Views
Y-bar
A-2 bar
V-1 bar
V-2 bar
A-1 bar
Z-bar
C-bar
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
Project #622421 PCB Anchored Transition
2025-02-27
Drawn by GES
Scale 1:10
Sheet 7 of 10 Isometric Views
S:\Accreditation-17025-2017\EIR-000 Project Files\622421-01 - Free-Standing to Anchored Barriers - Sheikh\Drafting, 622421-1\622421-01 Drawing

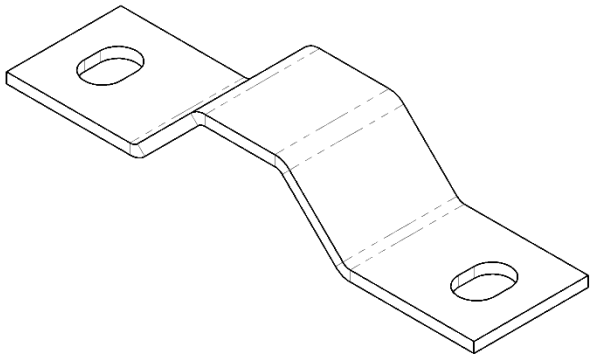


8a. All rebar is grade 60.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #622421 PCB Anchored Transition		2025-02-27
Drawn by GES	Scale 1:10	Sheet 8 of 10 Rebar Bends

S:\Accreditation-17025-2017\EIR-000 Project Files\622421-01 - Free-Standing to Anchored Barriers - Sheikh\Drafting, 622421-1\622421-01 Drawing



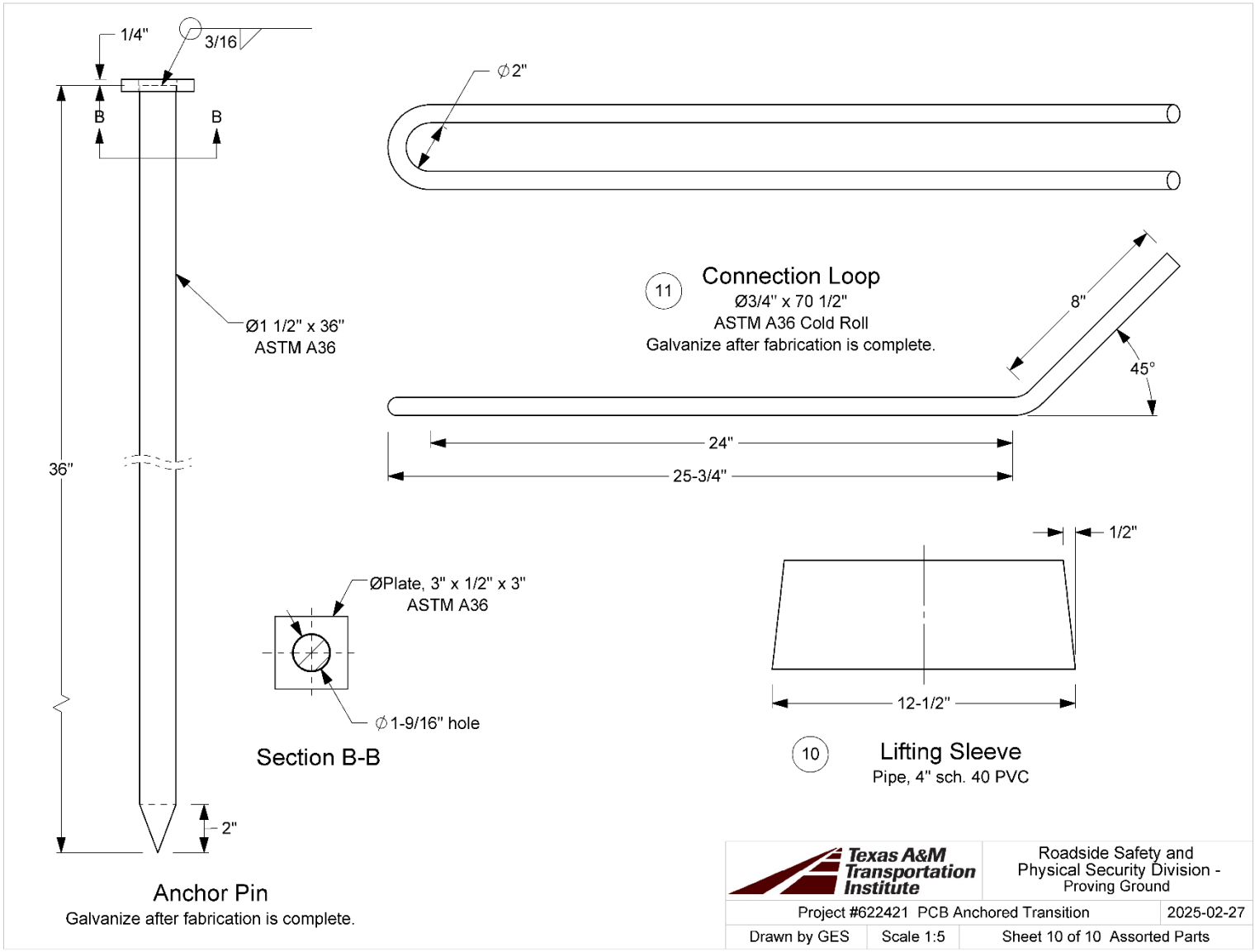


9 **Anchor Plate**

Plate, 5 1/2" x 1/2"
ASTM A572 Grade 50
Galvanize after fabrication is complete.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #622421 PCB Anchored Transition		2025-02-27
Drawn by GES	Scale 1:3	Sheet 9 of 10 Anchor Plate

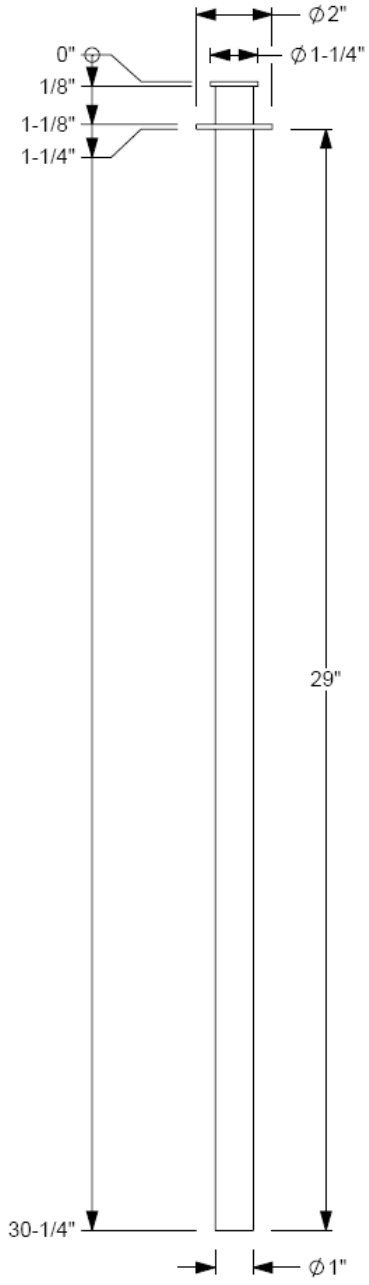
S:\Accreditation-17025-2017\EIR-000 Project Files\622421-01 - Free-Standing to Anchored Barriers - Sheikh\Drafting, 622421-1\622421-01 Drawing



Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Project #622421 PCB Anchored Transition		2025-02-27
Drawn by GES	Scale 1:5	Sheet 10 of 10 Assorted Parts

S:\Accreditation-17025-2017\EIR-000 Project Files\622421-01 - Free-Standing to Anchored Barriers - Sheikh\Drafting, 622421-1\622421-01 Drawing

Connection Pin



1a. Pin is forged by Portland Bolt Company (Part #18241), with no welding, and galvanized per ASTM F2329 and A153.
1b. Material is ASTM A449.

Texas A&M Transportation Institute	Roadside Safety and Physical Security Division - Proving Ground	
Forged Connection Pin		2022-10-06
Drawn by GES	Scale 1:4	Sheet 1 of 1

S:\Accreditation-17025-2017\Drafting Department\Solidworks\Standard Parts\Concrete Barriers\Forged Connection Pin

APPENDIX B.

SUPPORTING CERTIFICATION DOCUMENTS

Concrete Core Test Report

Report Number: A1171057.0333A
Service Date: 07/01/25
Report Date: 07/07/25
Task: 622421-01

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

Client

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

Project

Riverside Campus
Riverside Campus
Bryan, TX

Project Number: A1171057

Material Information

Specified Strength: 4000 psi @ 28 days
Specified Length:
Mix ID:
Nominal Maximum Size Aggregate:

Sample Information

Placement Date:
Date Tested: 07/01/25 **Time:** 0000
Sampled By:
Drill Directions: Vertical
Date Core Obtained: 07/01/25 **Time:** 0000
Date Ends Trimmed: 07/01/25 **Time:** 0000
Moisture Conditioning History: According to ASTM C-42

Laboratory Test Data

Core ID	Location	Cored Length (in)	Trim Length (in)	Capped Length (in)	Avg. Dia. (in)	Area (sq in)	Length / Diam. Ratio	Max Load (lbs)	Corr. Factor	Comp. Strength (psi)	Fracture Type	Density (pcf)
1	622421-01 A	12.65	8.00	8.22	4.01	12.63	2.05	73252	1.000	5800	3	
2	622421-01 B	10.64	5.78	6.10	4.01	12.63	1.52	79702	0.962	6070	3	

Comments:

Services:

Start/Stop:

Reported To:
Contractor:
Report Distribution:
(1) Texas Transportation Institute, Bill Griffith (1) Texas Transportation Institute, Adam Mayer

Reviewed By:
Justin Maass
Assistant Project Manager

Test Methods:

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

Portland Bolt
& MANUFACTURING COMPANY
800-547-6758 | www.portlandbolt.com

FOR	TEXAS A&M TRANSPORTATION INST
PB INVOICE	159775
CUSTOMER PO	618141
EST. SHIP DATE	3/8/2023

Certificate of Conformance

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

1" X 29" DOMESTIC HOT-DIP GALVANIZED ASTM A449 BARRIER PIN WITH NO THREAD

HEAT	3083933	BASE STEEL	1045AR	DIAMETER	1	SOURCE	COMMERCIAL METALS CO

C	MN	P	S	SI	NI	CR	MO	CU	PB	V	CB	N
0.450	0.760	0.009	0.031	0.220	0.090	0.080	0.024	0.310	-	0.001	-	-

TN	PROOF	HR
81,580 LBF	51,500	269 HBN

Lot#20863

Coatings

- ITEMS HOT-DIP GALVANIZED PER ASTM F2329

Other

- ALL ITEMS MELTED & MANUFACTURED IN THE USA

Certification Department Quality Assurance
Dane McKinnon

TR No. 622421-01-1

52

2025-11-05

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

CERTIFIED MILL TEST REPORT

For additional copies call
830-372-8771

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

Roland A Davila
Quality Assurance Manager

HEAT NO.:3083933 SECTION: ROUND 1 x 20'0" 1045 GRADE: AISI 1045 ROLL DATE: 10/16/2018 MELT DATE: 10/15/2018 Cert. No.: 82561780 / 083933A789	SOLD TO	Portland Bolt & Mfg 3441 Nw Guam St Portland OR US 97210-1613 5032275488 5032274634	SHIP TO	CPU Seguin 1 Steel Mill Dr Seguin TX US 78155-7510 9999999999	Delivery#: 82561780 BOL#: 1703616 CUST PO#: 38665 CUST P/N: DLVRY LBS / HEAT: 17944.000 LB DLVRY PCS / HEAT: 336 EA

Characteristic	Value
C	0.45%
Mn	0.76%
P	0.009%
S	0.031%
Si	0.22%
Cu	0.31%
Cr	0.08%
Ni	0.09%
Mo	0.024%
V	0.001%
Cb	0.002%
Sn	0.010%
Al	0.002%
N	0.0080%
Yield Strength test 1	64.9ksi
Tensile Strength test 1	106.1ksi
Elongation test 1	17%
Elongation Gage Lgth test 1	8IN
Reduction of Area test 1	35%

Characteristic	Value
Yield Strength test 2	63.0ksi
Tensile Strength test 2	102.3ksi
Elongation test 2	31%
Elongation Gage Lgth test 2	2IN
Bend Test Diameter	5.000IN
Bend Test 1	Passed
BHN @ Surface test 1	212BHN
Macro Etch Method	ASTM E381
Macro Surface Rating	2
Macro Random Rating	1
Macro Core Rating	2

The Following is true of the material represented by this MTR:

*Material is fully killed
*100% melted and rolled in the USA
*EN10204:2004 3.1 compliant
*Contains no weld repair
*Contains no Mercury contamination
*Manufactured in accordance with the latest version of the plant quality manual
*Meets the "Buy America" requirements of 23 CFR635.410
*Warning: This product can expose you to chemicals which are known to the State of California to cause cancer, birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov

REMARKS :

Portland Bolt
& MANUFACTURING COMPANY
800-547-6758 | **www.portlandbolt.com**

ORDER # 159775 rev. 1

DATE 2/17/2023
PAGE 1 of 1

sales@portlandbolt.com Phone: 800.547.6758 | Fax: 503.227.4634
www.portlandbolt.com 3441 NW Guam St. Portland OR, 97210

SALESPERSON **Kyle Pettijohn**
DIRECT PHONE 800.628.9472
EMAIL kyle@portlandbolt.com

SOLD TO	SHIP TO
TEXAS A&M TRANSPORTATION INST	Adam Mayer @ 5126353115
TTI FINANCIAL SERVICES	TTI
3135 TAMU	3100 HWY 47 South
COLLEGE STATION, TX, 77843-3135	BLDG 7091
Phone: 979.317.2755 | Fax: 979.227.7710	Bryan, TX, 77807

ATTN	**Adam Mayer** <a-mayer@tti.tamu.edu>	CUSTOMER PO	618141
SHIP DATE	**3/8/2023** (scheduled)	SHIP VIA	UPS Ground

LINE	QTY. ORDERED	DESCRIPTION
1	18	1" x 29" domestic hot-dip galvanized ASTM A449 barrier pin with no thread

***

Sentry 25-105

GERDAU

CERTIFIED MATERIAL TEST REPORT

US-ML-MIDLOTHIAN
300 WARD ROAD
MIDLOTHIAN, TX 76065
USA

CUSTOMER SHIP TO	CUSTOMER BILL TO
REGAL METALS INTERNATIONAL INC 207 SENTRY DR MANSFIELD,TX 76063-3609 USA	REGAL METALS INTERNATIONAL INC 207 SENTRY DR MANSFIELD,TX 76063-3609 USA

GRADE	SHAPE / SIZE	DOCUMENT ID:
60 (420)	Rebar / #4 (13MM)	0091240440

LENGTH	WEIGHT	HEAT / BATCH
40'00"	12,024 LB	S8065018/02

SALES ORDER	CUSTOMER MATERIAL N°
14902124/000030	

SPECIFICATION / DATE or REVISION
ASTM A615/A615M-24

CUSTOMER PURCHASE ORDER NUMBER	BILL OF LADING	DATE
Yard	1327-0000622081	04/10/2025

CHEMICAL COMPOSITION

C (%)	Mn (%)	P (%)	S (%)	Si (%)	Cu (%)	Ni (%)	Cr (%)	Mo(%)	Sn (%)	V (%)	Nb (%)	Al (%)	CEqvA706 (%)
0.45	1.01	0.016	0.027	0.21	0.27	0.13	0.18	0.026	0.010	0.003	0.003	0.002	0.65

MECHANICAL PROPERTIES

YS (PSI)	YS (MPa)	UTS (PSI)	UTS (MPa)	G/L (inches)	G/L (mm)	Elong. (%)	BendTest
69650	480	111350	768	8.000	200.0	12.20	OK

MECHANICAL PROPERTIES

UTS / YS
1.60

COMMENTS / NOTES

Gerdau's steel is 100% recyclable. Support the circular economy through our Metals Recycling Partnership. For details, visit www2.gerdau.com/metals-recycling, or contact metalsrecycling@gerdau.com.

The above figures are certified chemical and physical test records as contained in the permanent records of the company. We certify that these data are correct and in compliance with specified requirements. No weld repair was performed on this material. The material has not been in contact with mercury while in Gerdau's possession. For all products other than billets or beam blanks, this material was Melted & Poured (via Electric Arc Furnace and Continuous Caster) and produced (Hot Rolled and, if applicable, Cold-Drawn) in the USA. For billets or beam blanks, this material was Melted & Poured (via Electric Arc Furnace and Continuous Caster) in the USA. CMTR complies with EN 10204 3.1.

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

Wade A. Lumpkins
WADE LUMPKINS
QUALITY ASSURANCE MGR.
Phone: 972-779-3118 Email: Wade.Lumpkins@gerdau.com

TR No. 622421-01-1

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2025-11-05

GERDAU

US-ML-MIDLOTHIAN
300 WARD ROAD
MIDLOTHIAN, TX 76065
USA

CUSTOMER SHIP TO	CUSTOMER BILL TO
REGAL METALS INTERNATIONAL INC 207 SENTRY DR MANSFIELD,TX 76063-3609 USA	REGAL METALS INTERNATIONAL INC 207 SENTRY DR MANSFIELD,TX 76063-3609 USA

GRADE	SHAPE / SIZE	DOCUMENT ID:
60 (420)	Rebar / #5 (16MM)	0001237567

LENGTH	WEIGHT	HEAT / BATCH
40'00"	23,781 LB	**59122101/02**

SALES ORDER	CUSTOMER MATERIAL N°
14908124/000020	

SPECIFICATION / DATE or REVISION
ASTM A615/A615M-24

CUSTOMER PURCHASE ORDER NUMBER	BILL OF LADING	DATE
722687	1327-0000621069	04/04/2025

CHEMICAL COMPOSITION

C (%)	Mn (%)	P (%)	S (%)	Si (%)	Cu (%)	Ni (%)	Cr (%)	Mo(%)	Sn (%)	V (%)	Nb (%)	Al (%)	CEqvA706 (%)
0.44	0.89	0.019	0.029	0.23	0.25	0.11	0.23	0.031	0.009	0.028	0.002	0.002	0.62

MECHANICAL PROPERTIES

YS (PSI)	YS (MPa)	UTS (PSI)	UTS (MPa)	G/L (Inches)	G/L (mm)	Elong. (%)	BendTest
78218	539	110161	760	8.000	200.0	12.60	OK

MECHANICAL PROPERTIES

UTS / YS
1.41

COMMENTS / NOTES

Gerdau's steel is 100% recyclable. Support the circular economy through our Metals Recycling Partnership. For details, visit www2.gerdau.com/metals-recycling, or contact metalsrecycling@gerdau.com.

The above figures are certified chemical and physical test records as contained in the permanent records of the company. We certify that these data are correct and in compliance with specified requirements. No weld repair was performed on this material. The material has not been in contact with mercury while in Gerdau's possession. For all products other than billets or beam blanks, this material was Melted & Poured (via Electric Arc Furnace and Continuous Caster) and produced (Hot Rolled and, if applicable, Cold-Drawn) in the USA. For billets or beam blanks, this material was Melted & Poured (via Electric Arc Furnace and Continuous Caster) in the USA. CMTR complies with EN 10204 3.1.

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

WADE LUMPKINS
QUALITY ASSURANCE MGR.
Phone: 972-779-3118 Email: Wade.Lumpkins@gerdau.com

United Machine Works

Craig Godwin, Inc. dba

Certificate of Conformance

To: SUMMIT PRECAST CONCRETE, LP
9930 INDUSTRIAL DR
Navasota, TX 77868
USA

From: United Machine Works
P O Box 525
New Waverly, TX 77358
USA

Packing List No: 145032 **Today's Date:** 05/09/2025
Shipping Date: 05/09/2025 **PO Number:** 25-108

CERTIFICATION DOCUMENTS

PO Line No.	Number	Revision	Description	Job No.	Unit	Shipped	Ordered	Back Ordered
1	241156 TTI ANCHOR PL		ANCHOR PLATE	72607	EA	21	21	0
	Serial No.	25-108-1-1, 25-108-1-2, 25-108-1-3, 25-108-1-4, 25-108-1-5						
	Serial No.	25-108-1-6, 25-108-1-7, 25-108-1-8, 25-108-1-9, 25-108-1-10						
	Serial No.	25-108-1-11, 25-108-1-12, 25-108-1-13, 25-108-1-14, 25-108-1-15						
	Serial No.	25-108-1-16, 25-108-1-17, 25-108-1-18, 25-108-1-19, 25-108-1-20						
	Serial No.	25-108-1-21						
		CERT ENVELOPE						

COUNTRY OF ORIGIN: USA

The materials, processes, and workmanship all conform to the requirements of all applicable specifications, drawings, and the purchase order supplied to Craig Godwin, Inc. dba. The appropriate documentation providing traceability is on file at Craig Godwin, Inc. dba. It is available for review by authorized customer representatives.

Authorized Signature
Craig Godwin, Inc. dba

United Machine Works

Inspection Report

Purchase Order: 25-108	**Date: 4/14/2025**	**Special Notes:**
Part Number: 241156 TTI ANCHOR PL	**Revision:**	**Job# 72607**
Part Description: ANCHOR PLATE		Job # 3044
Operators:	**Inspector:** Konway Baird	

	Specification		Measured Dimension of Serialized Parts									
	Dimension	Tolerance	1	2	3	4	5	6	7	8	9	10
	Serial Number (if applicable)											
	Heat Log Number		UF4369									
1	2-1/4"	±.125"	2 1/4"	2 1/4"	2 1/4"	2 1/4"	2 1/4"	2 1/4"	2 1/4"	2 1/4"	2 1/4"	2 1/4"
2	1-3/4"	±.125"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 3/4"
3	2-1/2"	±.125"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"	2 1/2"
4	3-5/8"	±.125"	3 5/8"	3 5/8"	3 5/8"	3 5/8"	3 5/8"	3 5/8"	3 5/8"	3 5/8"	3 5/8"	3 5/8"
5	3-3/8"	±.125"	3 3/8"	3 3/8"	3 3/8"	3 3/8"	3 3/8"	3 3/8"	3 3/8"	3 3/8"	3 3/8"	3 3/8"
6	45°	±1/2°	45°	45°	45°	45°	45°	45°	45°	45°	45°	45°
7	R 1/2" TYP	±.125"	R ½	R ½"	R ½"	R ½"	R ½"	R ½"	R ½"	R ½"	R ½"	R ½"
8	3"	±.125"	3"	3"	3"	3"	3"	3"	3"	3"	3"	3"
9	6"	±.125"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"
10	22-1/2"	+0 -1/4"	22 ½"	22 ½"	22 ½"	22 ½"	22 ½"	22 ½	22 ½"	22 ½"	22 ½"	22 ½
11	5-1/2"	±.125"	5 ½"	5 ½"	5 ½"	5 ½"	5 ½"	5 ½"	5 ½"	5 ½"	5 ½"	5 ½"
12	1/2"	±.125"	½"	½"	½"	½"	½"	½"	½"	½"	½"	½"
13												
14												
15	Verify Stamping, Etching, tags	Verified by	AB									
16	Final Inspection	Verified by QC Inspector	AB									
17												
18												
19												
20												
21												

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United Machine Works

Inspection Report

Purchase Order: 25-108	**Date: 4/14/2025**	**Special Notes:**
Part Number: 241156 TTI ANCHOR PL	**Revision:**	**Job# 72607**
Part Description: ANCHOR PLATE		
Operators:	Inspector:	

	Specification		Measured Dimension of Serialized Parts									
	Dimension	Tolerance	11	12	13	14	15	16	17	18	19	20
	Serial Number (if applicable)											
	Heat Log Number		U74364									
1	2-1/4"	±.125"	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"	2¼"
2	1-3/4"	±.125"	1¾"	1¾"	1¾"	1¾"	1¾"	1¾"	1¾"	1¾"	1¾"	1¾"
3	2-1/2"	±.125"	2½"	2½"	2½"	2½"	2½"	2½"	2½"	2½"	2½"	2½"
4	3-5/8"	±.125"	3⅝"	3⅝"	3⅝"	3⅝"	3⅝"	3⅝"	3⅝"	3⅝"	3⅝"	3⅝"
5	3-3/8"	±.125"	3⅜"	3⅜"	3⅜"	3⅜"	3⅜"	3⅜"	3⅜"	3⅜"	3⅜"	3⅜"
6	45°	±1/2°	45°	45°	45°	45°	45°	45°	45°	45°	45°	45°
7	R 1/2" TYP	±.125"	R½"	R½"	R½"	R½"	R½"	R½"	R½"	R½"	R½"	R½"
8	3"	±.125"	3"	3"	3"	3"	3"	3"	3"	3"	3"	3"
9	6"	±.125"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"
10	22-1/2"	+0 -1/4"	22½"	22½"	22½"	22½"	22½"	22½"	22½"	22½"	22½"	22½"
11	5-1/2"	±.125"	5½"	5½"	5½"	5½"	5½"	5½"	5½"	5½"	5½"	5½"
12	1/2"	±.125"	½"	½"	½"	½"	½"	½"	½"	½"	½"	½"
13												
14												
15	Verify Stamping, Etching, tags	Verified by	AD									
16	Final Inspection	Verified by QC Inspector	AD									
17												
18												
19												
20												
21												

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United Machine Works

Inspection Report

Purchase Order: 25-108	**Date: 4/14/2025**	**Special Notes:**
Part Number: 241156 TTI ANCHOR PL	**Revision:**	**Job# 72607**
Part Description: ANCHOR PLATE		
Operators:	**Inspector:**	

	Specification		Measured Dimension of Serialized Parts	
	Dimension	Tolerance	21	
	Serial Number (if applicable)			
	Heat Log Number		UF-1316	
1	2-1/4"	±.125"	2 1/4"	
2	1-3/4"	±.125"	1 3/4"	
3	2-1/2"	±.125"	2 1/2"	
4	3-5/8"	±.125"	3 5/8"	
5	3-3/8"	±.125"	3 3/8"	
6	45°	±1/2°	45°	
7	R 1/2" TYP	±.125"	R 1/2	
8	3"	±.125"	3"	
9	6"	±.125"	6"	
10	22-1/2"	+0 -1/4"	22 1/2"	
11	5-1/2"	±.125"	5 1/2"	
12	1/2"	±.125"	1/2"	
13				
14				
15	Verify Stamping, Etching, tags	Verified by	AP	
16	Final Inspection	Verified by QC Inspector	AP	
17				
18				
19				
20				
21				

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UNI-FAB

CERTIFICATE OF MATERIAL

SPECIFICATIONS AND WORKMANSHIP

DATE: 5/7/25

PO# 143188

JOB: 72607

3044

PART NUMBER: 241156 TTI ANCHOR PL PART DESCRIPTION: ANCHOR PLATE

CUST PO: 25-108 LINE 1
S/N: TRACER 1 THRU 21
Material: A572GR50T1
HL: UF4369 /HT# KNAA81

QUANTITY: 21

SPECIAL PROCESS: MANUFACTURED PER PRINT

COUNTRY OF ORIGIN: United States of America

The materials, processes, and workmanship all conform to the requirements of all applicable specifications, drawings, and the purchase order supplied to Uni-Fab. The appropriate documentation providing traceablity is on file at Uni-Fab. It is available for review by authorized customer representatives.

CERTIFICATO DI CONTROLLO 3.1 / INSPECTION CERTIFICATE 3.1 - EN 10204:2004

METINVEST
METINVEST TRAMETAL SPA

(A) PROCESSO DI ELABORAZIONE / STEELMAKING PROCESS: E = ELECTRIC ; BO = BASIC OXYGEN
(B) STATO DI FORNITURA / DELIVERY CONDITION: AR = GREZZO DI LAMINAZIONE / AS ROLLED ;
N° = LAMINAZIONE A TEMPERATURA CONTROLLATA / NORMALIZING ROLLING ;
N = NORMALIZZATO / NORMALIZED at 910°C, 1.5 min/mm ; ARIA CALMA / STILL AIR;
R = RICOTTO / ANNEALED;
N+R = NORMALIZZATO + RINVENUTO / NORMALIZED + TEMPERED
(C) TRATTAMENTO TERMICO DEL CAMPIONE / HEAT TREATMENT OF SAMPLE:
N = 910°C, 1.5 min/mm ; ARIA CALMA / STILL AIR
R = 650°C, 1.5 min/mm ; ARIA CALMA / STILL AIR
(D) $Ceq_1 = C + Mn/6$; $Ceq_2 = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$;
$Pcm = C + Si/30 + (Mn + Cu + Cr)/20 + Ni/60 + Mo/15 + V/10 + B*5$
(1) POSIZIONE / LOCATION: 1 = TESTA / TOP ; 2 = PIEDE / BOTTOM
(2) POSIZIONE / LOCATION: C = CUORE / 1/2 THICKNESS ; P = PELLE / SURFACE ; D = 1/4 SPESSORE / THICKNESS
(3) DIREZIONE / DIRECTION: L = LONGITUDINALE / LONGITUDINAL ; T = TRASVERSALE / TRANSVERSE
(4) FORMA DEL PROVINO / SHAPE OF TEST PIECE: - P = PRISMATICO / PRISMATIC ; C = CILINDRICO / CYLINDRICAL
(5) ESITO PROVA DI PIEGA / RESULT: OK = COMPLYING ; NO = NOT COMPLYING

A01 Società per azioni con socio unico soggetta a direzione e coordinamento di Metinvest B.V
Registered office: Via XII Ottobre 1, 5° piano - 16121 Genova, Italy
Phone +39 010 5762911 - Fax +39 010 5762990
Works: Via E. Fermi, 44 - 33058 San Giorgio di Nogaro UD, Italy
Phone +39 0431 629989 - Fax +39 0431 629985
Cap. Soc. Euro 300.120.000,00 i.v.
C.F., P.IVA e Iscr. Reg. Imp. GE 05956630965 - REA 437720/GE
http://trametal.metinvestholding.com

A05 Cliente / Customer

INTSEL STEEL DISTRIBUTORS LLC
6000 JENSEN DRIVE
77026 Houston
US

A01 N° Certificato / Certificate no.	A21 Data / Date
597984	21/11/2023
A08 N° Ordine Trametal / Works order	A07 N° Ordine cliente / Customer's order
32304872	WLY-30909
DDT	del / date
BOL 32322081	20/11/2023
Pratica / File no.	
del / date	

B01/B02/B03

Prodotto / Product	Lamiere / Hot rolled plates
Qualità / Steel grade	A572GR50T1
Normativa / Specification	ASTM

B04 Marcatura di prodotto / Marking of the product
LAMIERA/ORDINE/N° INFORNAMENTO/DIMENSIONI/QUALITÀ/MARCHIO DEL PRODUTTORE
PLATE/ORDER/INTERNAL N°/DIMENSIONS/STEEL GRADE/MANUFACTURER'S MARK

B07 ITEM	B07 LAMIERA PLATE	B07 N° INFORN. INTERNAL NUMBER	B09/B11 DIMENSIONI [mm] DIMENSIONS	B12 MASSA TEORICA [t] THEORICAL WEIGHT	B07 LOTTO BATCH NO.	C70 PROCESSO ELAB. (A) STEELMAKING PROCESS	B04 STATO FORNITURA LAMIERA (B) DELIVERY CONDITION	C00 CAMPIONE SAMPLE	B05 TRATT. CAMPIONE (C) HEAT TREATMENT	C00 CAMPIONE PWHT SAMPLE	B05 PWHT TEMPERATURA INIZIO °C BEGINNING TEMPERATURE	VELOCITA' RISCALDO C/h HEATING RATE	TEMPERATURA TRATTAMENTO °C TEMPERATURE TREATMENT	HOLDING TIME	VELOCITA' RAFFREDDAMENTO °C/h COOLING RATE	TEMPERATURA FINE °C END TEMPERATURE	C00 N° CICLI / CYCLES	C00 B05 Q+T CAMPIONE Q+T SAMPLE	TEMPERATURA (Q) °C TEMPERATURE	HOLDING TIME (Q) Min PERMANENZA	COOLING RAFFREDDAMENTO	TEMPERATURA (T) °C TEMPERATURE	HOLDING TIME (T) Min PERMANENZA	COOLING RAFFREDDAMENTO
13	KNAA8106018	1903877	12.70X2438X6096	1,48	776935	BO	N	GM761																	
15	KNAA890601C	1903838	9.53X2438X6096	1,11	776965	BO	N	GM776																	
15	KNAA900405C	1903689	9.53X2438X6096	1,11	776991	BO	N	[GM802]																	
15	KNAA900405D	1903689	9.53X2438X6096	1,11	776991	BO	N	[GM802]																	
15	KNAA910205C	1903688	9.53X2438X6096	1,11	777000	BO	N	[GM811]																	
15	KNAA910205D	1903688	9.53X2438X6096	1,11	777000	BO	N	[GM811]																	
15	KNAA910305B	1903639	9.53X2438X6096	1,11	777000	BO	N	GM811																	
16	KNAA811104A	1903635	7.94X2438X6096	0,93	776961	BO	N	GM772																	
16	KNAA850304A	1903745	7.94X2438X6096	0,93	776978	BO	N	GM789																	
16	KNAA870204B	1903606	7.94X2438X6096	0,93	776973	BO	N	[GM784]																	
16	KNAA870304A	1903613	7.94X2438X6096	0,93	776973	BO	N	[GM784]																	
16	KNAA870404A	1903622	7.94X2438X6096	0,93	776973	BO	N	GM784																	
16	KNAA880305A	1903597	7.94X2438X6096	0,93	776988	BO	N	GM799																	
16	KNAA890204A	1903739	7.94X2438X6096	0,93	776966	BO	N	[GM777]																	
16	KNAA890205C	1903742	7.94X2438X6096	0,93	776966	BO	N	[GM777]																	
16	KNAA900505A	1903603	7.94X2438X6096	0,93	776980	BO	N	GM791																	
16	KNAA900505C	1903603	7.94X2438X6096	0,93	776980	BO	N	GM791																	
16	KNAA900506C	1903601	7.94X2438X6096	0,93	776980	BO	N	[GM791]																	

SUMMIT PRECAST CONCRETE
PO: 25-108
PART: 241156 TTI ANCHOR PLATE
ANCHOR PLATE

C71 / C92 COMPOSIZIONE CHIMICA DI COLATA / HEAT CHEMICAL ANALYSIS

B07	C71	C72	C73	C74	C75	C76	C77	C78	C79	C80	C81	C82	C83	C84	C85	C86	C87	C88	C89	C90	C91
COLATA	C	Mn	Si	P	S	Cu	Ni	Cr	Mo	Al	V	Nb	Ti	Sn	Ca	N	B	H	Ceq1	Ceq2	Pcm
HEAT	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	% (D)	% (D)	% (D)
A572GR50T1 Min 0.00 - 10.00		0,50																			
A572GR50T1 Max 0.00 - 10.00	0,23	1,35	0,40	0,040	0,050																

UF4369

C71/C92 COMPOSIZIONE CHIMICA DI COLATA / HEAT CHEMICAL ANALYSIS

B07	C71	C72	C73	C74	C75	C76	C77	C78	C79	C80	C81	C82	C83	C84	C85	C86	C87	C88	C89	C90	C91
COLATA	C	Mn	Si	P	S	Cu	Ni	Cr	Mo	Al	V	Nb	Ti	Sn	Ca	N	B	H	Ceq1	Ceq2	Pcm
HEAT	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	% (D)	% (D)	% (D)
A572GR50T1 Min 10.10 - 40.00		0,80																			
A572GR50T1 Max 10.10 - 40.00	0,23	1,35	0,40	0,040	0,050																
KNAA81	0,16	1,45	0,19	0,016	0,004	0,010	0,010	0,020	<0.005	0,039	0,002	0,036	0,002	<0.005	0,0000	0,0060	0,0002	0,0000	0,40	0,41	0,24
KNAA85	0,15	1,48	0,21	0,011	0,003	0,010	0,010	0,010	<0.005	0,037	0,002	0,029	0,001	<0.005	0,0000	0,0090	0,0002	0,0000	0,40	0,40	0,23
KNAA87	0,16	1,47	0,21	0,016	0,004	0,020	0,010	0,020	<0.005	0,038	0,002	0,027	0,002	<0.005	0,0000	0,0060	0,0002	0,0000	0,41	0,41	0,24
KNAA88	0,16	1,47	0,20	0,017	0,007	0,020	0,010	0,010	<0.005	0,035	0,002	0,036	0,001	<0.005	0,0000	0,0070	0,0002	0,0000	0,41	0,41	0,24
KNAA89	0,16	1,40	0,22	0,013	0,005	0,010	0,010	0,010	<0.005	0,041	0,002	0,033	0,001	<0.005	0,0000	0,0060	0,0002	0,0000	0,39	0,40	0,24
KNAA90	0,16	1,47	0,21	0,011	0,003	0,010	0,010	0,010	<0.005	0,041	0,001	0,028	0,001	<0.005	0,0000	0,0100	0,0002	0,0000	0,41	0,41	0,24
KNAA91	0,15	1,44	0,22	0,012	0,004	0,010	0,010	0,010	<0.005	0,043	0,002	0,030	0,001	<0.005	0,0000	0,0040	0,0002	0,0000	0,39	0,39	0,23

			PROVA DI TRAZIONE TENSILE TEST								PROVA DI RESILIENZA IMPACT TEST - CHARPY V-NOTCH TEST						PROVA DI PIEGA BEND TEST				PROVA DI DUREZZA HARDNESS TEST				PROVA DI STRIZIONE Z% TEST	
C09		C01	C01	C02	C03	C11	C17		C13	C14	C10	C41	C02	C03	C01	C42		C43	C02	C51	C52	C50	C01	C30	C31		C32	C53	C54
CAMPIONE SAMPLE	SPESSORE LAMIERA PLATE THICKNESS	POSIZIONE LOCATION (1)	POSIZIONE LOCATION (2)	DIREZIONE ORIENTATION (3)	TEMPERATURA TEST TEMPERATURE [°C]	ReH YIELD STRENGTH [Mpa]	Rm TENSILE STRENGTH [Mpa]	ReH/Rm	A% ELONGATION	Rp 0,2 PROOF/YIELD STRENGTH [Mpa]	FORMA PROVINO SHAPE OF TEST PIECE (4)	LARGHEZZA WIDTH [mm]	DIREZIONE ORIENTATION (3)	TEMPERATURA TEST TEMPERATURE [°C]	POSIZIONE LOCATION (2)	SINGOLI VALORI INDIVIDUAL VALUES [J]	MEDIA MEAN VALUE [J]	DIREZIONE ORIENTATION (3)	MANDRINO MANDREL [mm]	ANGOLO ANGLE [°]	ESITO RESULT (5)	POSIZIONE LOCATION (2)	METODO TEST METHOD	SINGOLI VALORI INDIVIDUAL VALUES		MEDIA MEAN VALUE	Z% SINGOLI VALORI Z% INDIVIDUAL VALUES	Z% VALORE MEDIO Z% MEAN VALUE
A572GR50T1 Min 0.00 - 20.00					20	345	450		18,0																				
A572GR50T1 Max 0.00 - 20.00					20																								
GM761	12,70	2	P	T	20	399	517		34,6		P	10,00			P	000	0												
GM772	7,94	2	P	T	20	413	524		34,0		P	7,50			P	000	0												
GM776	9,53	2	P	T	20	412	525		33,2		P	7,50			P	000	0												
GM777	7,94	2	P	T	20	405	513		31,1		P	7,50			P	000	0												
GM784	7,94	2	P	T	20	422	520		32,6		P	7,50			P	000	0												
GM789	7,94	2	P	T	20	420	509		32,0		P	7,50			P	000	0												
GM791	7,94	2	P	T	20	398	507		33,3		P	7,50			P	000	0												
GM799	7,94	2	P	T	20	415	509		32,2		P	7,50			P	000	0												
GM802	9,53	2	P	T	20	392	519		31,6		P	7,50			P	000	0												
GM811	9,53	2	P	T	20	405	519		34,1		P	7,50			P	000	0												

C10
ASME SA-370 FIG. 3 AND FIG. 10 / 11 - SAMPLE TAKEN AFTER PLATE HEAT TREATMENT

Z01

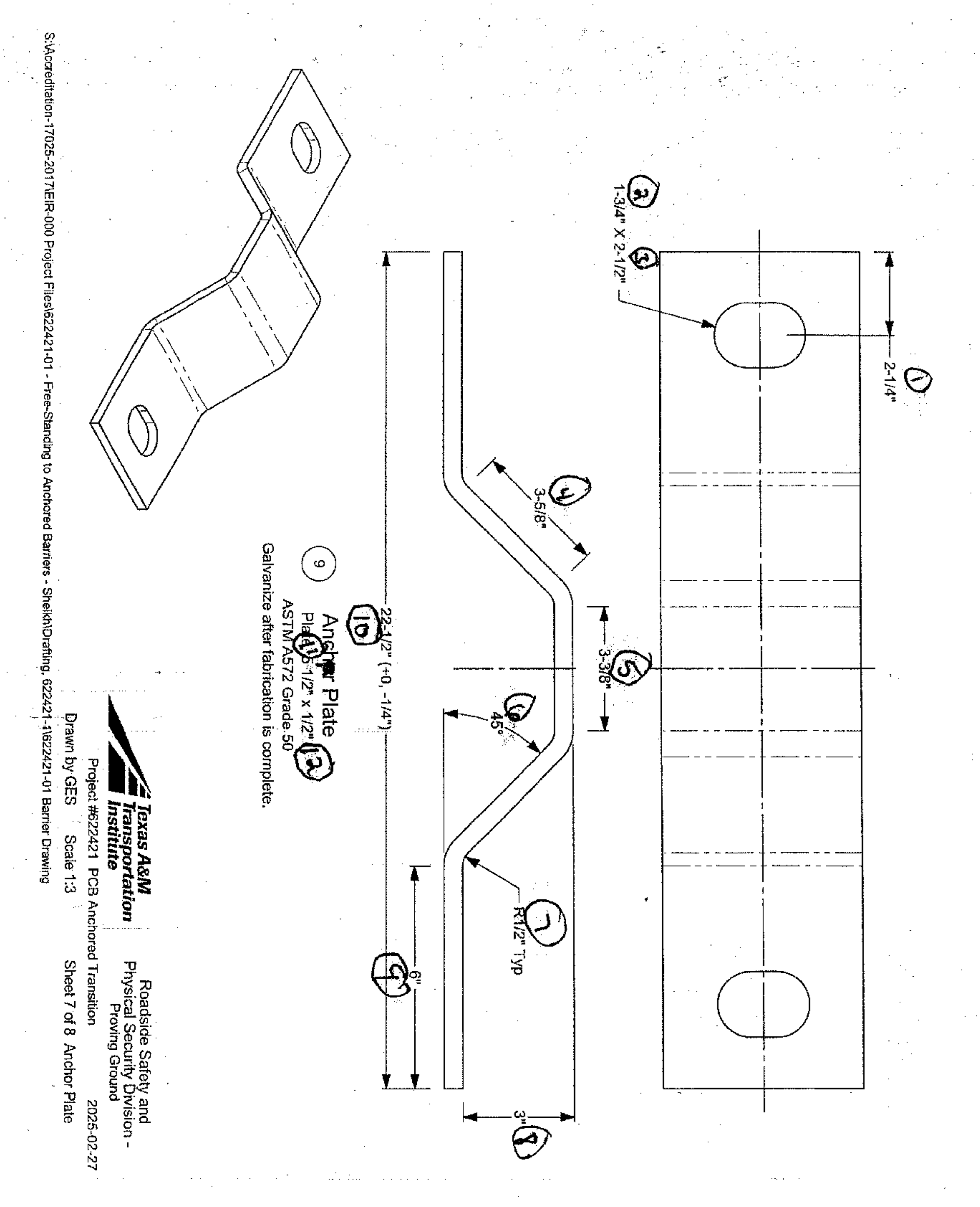
ITEM		TOLLERANZA DI SPESSORE TOLERANCE ON THICKNESS	TOLLERANZE DI LARGHEZZA TOLERANCE ON WIDTH	TOLLERANZE DI LUNGHEZZA TOLERANCE ON LENGTH	CONDIZIONI SUPERFICIALI SURFACE FINISH	PLANARITÀ FLATNESS
13		ASTM A6/A6M	EN 10029	EN 10029	ASTM A6/A6M	ASTM A6/A6M
15		ASTM A6/A6M	EN 10029	EN 10029	ASTM A6/A6M	ASTM A6/A6M
16		ASTM A6/A6M	EN 10029	EN 10029	ASTM A6/A6M	ASTM A6/A6M

CERTIFICHIAMO che le lamiere elencate sono conformi alla prescrizione dell'ordine, che i controlli della marcatura, dell'aspetto superficiale e dimensionale hanno dato esito positivo.
WE CERTIFY that the above mentioned plates are consistent with the order prescriptions: marking, inspection and measurement without objection.
DICHIARIAMO CHE LE LAMIERE SONO STATE CONTROLLATE IN ACCORDO ALLA NORMATIVA VIGENTE E CHE LE RADIAZIONI IONIZZANTI NON ECCEDONO IL VALORE DEL FONDO NATURALE.
WE DECLARE THAT THE PLATES WERE CONTROLLED ACCORDING TO STANDARD AND RADIATION DO NOT EXCEED THE NATURAL RADIATION.

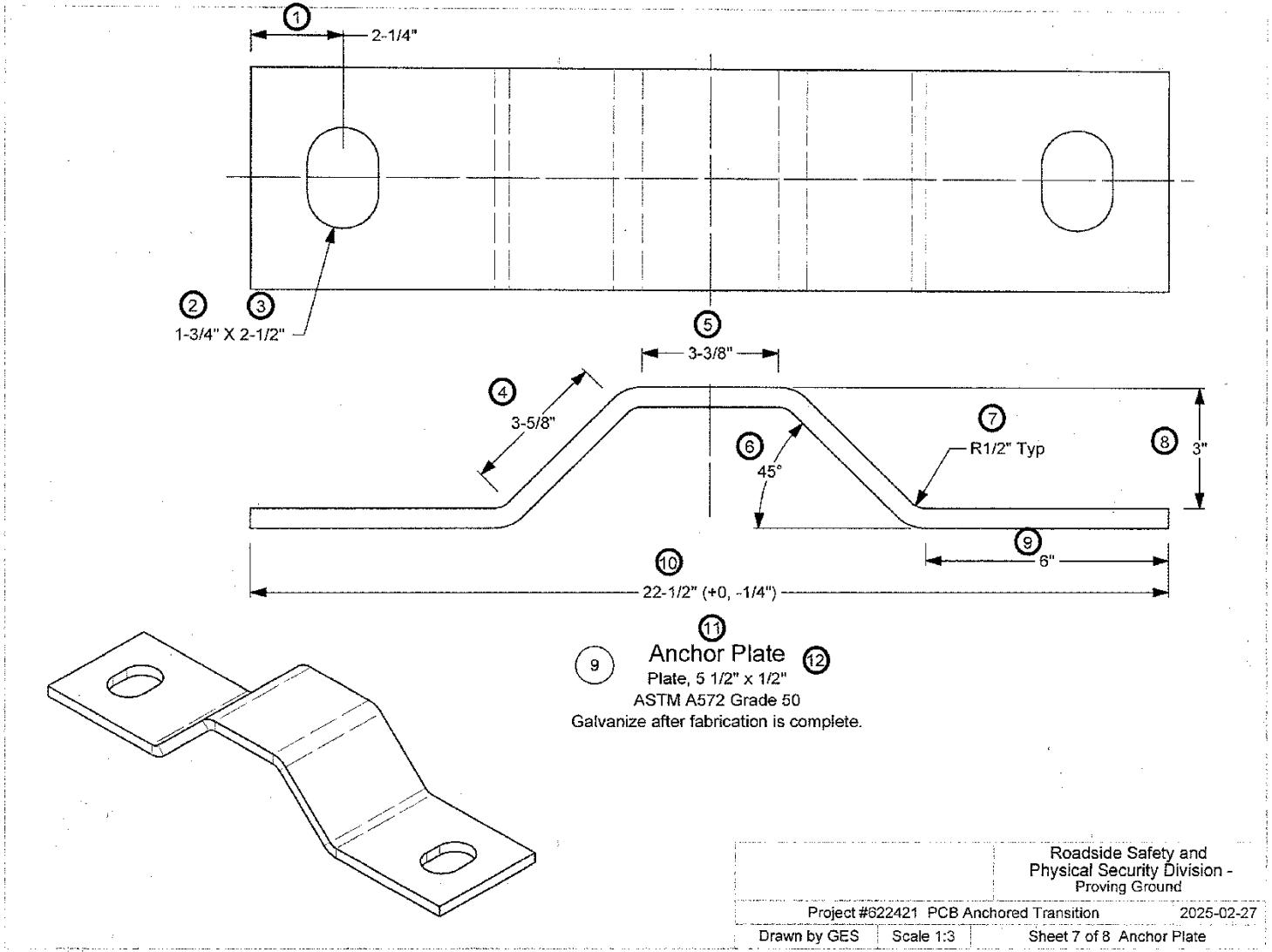
Z06

Z07	Z03 ENTE COLLAUDO / INSPECTION BODY	Z02
PRODUCED FROM CONTINOUS CAST SLAB AND HAVE A MINIMUN REDUCTION RATIO OF 3 TO 1. ACC. TO ASTM ED. 2022. FULLY KILLED, FINE GRAIN STEEL. Value of Mn maximun in derogation permitted up to 1.60%	TIMBRO DELL'ISPETTORE STAMP OF THE INSPECTION REPRESENTATIVE	METINVEST TRAMETAL S.p.A. F. Andrian CQ Manager

UF4369



1-3/4" X 2-1/2"
2-1/4"
3-5/8"
3-3/8"
45°
R1/2" Typ
6"
3"
22-1/2" (+0, -1/4")
9
Anchor Plate
ASTM A572 Grade 50
Galvanize after fabrication is complete.
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
Project #622421 PCB Anchored Transition
2025-02-27
Drawn by GES
Scale 1:3
Sheet 7 of 8 Anchor Plate
S:\Accreditation-17025-2017\EIR-000 Project Files\622421-01 - Free-Standing to Anchored Barriers - Sheikh\Drafting, 622421-1\622421-01 Barrier Drawing



		Roadside Safety and Physical Security Division - Proving Ground
Project #622421 PCB Anchored Transition		2025-02-27
Drawn by GES	Scale 1:3	Sheet 7 of 8 Anchor Plate

S:\Accreditation-17025-2017\EIR-000 Project Files\622421-01 - Free-Standing to Anchored Barriers - Sheikh\Drafting, 622421-1\622421-01 Barrier Drawing

United Machine Works

Craig Godwin, Inc. dba

Certificate of Conformance

To: SUMMIT PRECAST CONCRETE, LP
9930 INDUSTRIAL DR
Navasota, TX 77868
USA

From: United Machine Works
P O Box 525
New Waverly, TX 77358
USA

Packing List No: 145031 **Today's Date:** 05/09/2025
Shipping Date: 05/09/2025 **PO Number:** 25-108

CERTIFICATION DOCUMENTS

PO Line No.	Number	Revision	Description	Job No.	Unit	Shipped	Ordered	Back Ordered
2	241156 TTI CON LOOP		CONNECTION LOOPS	72608	EA	35	35	0
	Serial No.	25-108-2-1, 25-108-2-2, 25-108-2-3, 25-108-2-4, 25-108-2-5						
	Serial No.	25-108-2-6, 25-108-2-7, 25-108-2-8, 25-108-2-9, 25-108-2-10						
	Serial No.	25-108-2-11, 25-108-2-12, 25-108-2-13, 25-108-2-14, 25-108-2-15						
	Serial No.	25-108-2-16, 25-108-2-17, 25-108-2-18, 25-108-2-19, 25-108-2-20						
	Serial No.	25-108-2-21, 25-108-2-22, 25-108-2-23, 25-108-2-24, 25-108-2-25						
	Serial No.	25-108-2-26, 25-108-2-27, 25-108-2-28, 25-108-2-29, 25-108-2-30						
	Serial No.	25-108-2-31, 25-108-2-32, 25-108-2-33, 25-108-2-34, 25-108-2-35						
		CERT ENVELOPE						

COUNTRY OF ORIGIN: USA

The materials, processes, and workmanship all conform to the requirements of all applicable specifications, drawings, and the purchase order supplied to Craig Godwin, Inc. dba. The appropriate documentation providing traceability is on file at Craig Godwin, Inc. dba. It is available for review by authorized customer representatives.

Authorized Signature
Craig Godwin, Inc. dba

United Machine Works

Inspection Report

Purchase Order: 25-108 | **Date:** 4/14/2025 | **Special Notes:**

Part Number: 241156 TTI CON LOOP | **Revision:** | **Job# 72608**

Part Description: Connection Loop

Operators: | **Inspector:** Steven Carter

	Specification		Measured Dimension of Serialized Parts									
	Dimension	Tolerance	1	2	3	4	5	6	7	8	9	10
	Serial Number (if applicable)											
	Heat Log Number		UF4358	UF4358	UF4358	UF4358	UF4358	UF4358	UF4358	UF4358	UF4358	UF4358
1	2"	±.125"	2"	2"	2"	2"	2"	2"	2"	2"	2"	2"
2	Ø3/4"	±.125"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"
3	70-1/2"	±.125"	70 1/2"	70 1/2"	70 1/2"	70 1/2"	70 1/2"	70 1/2"	70 1/2"	70 1/2"	70 1/2"	70 1/2"
4	8"	±.125"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"
5	45°	±1/2°	45°	45°	45°	45°	45°	45°	45°	45°	45°	45°
6	24"	±.125"	24"	24"	24"	24"	24"	24"	24"	24"	24"	24"
7	25-3/4"	±.125"	25 3/4"	25 3/4"	25 3/4"	25 3/4"	25 3/4"	25 3/4"	25 3/4"	25 3/4"	25 3/4"	25 3/4"
8												
9												
10												
11												
12												
13												
14												
15	Verify Stamping, Etching, tags	Verified by	AB									
16	Final Inspection	Verified by QC Inspector	AB									
17												
18												
19												
20												
21												

F-824-001 Rev. A Inspection Report PAGE 1 OF 1

United Machine Works

Inspection Report

Purchase Order: 25-108	**Date: 4/14/2025**	**Special Notes:**
Part Number: 241156 TTI CON LOOP	**Revision:**	**Job# 72608**
Part Description: Connection Loop		
Operators:	**Inspector:** Steven Carter	

	Specification		Measured Dimension of Serialized Parts									
	Dimension	Tolerance	11	12	13	14	15	16	17	18	19	20
	Serial Number (If applicable)											
	Heat Log Number		UF4358	UF4358	UF4358	UF4358	UF4358	UF4358	UF4358	UF4358	UF4358	UF4358
1	2"	±.125"	2"	2"	2"	2"	2"	2"	2"	2"	2"	2"
2	Ø3/4"	±.125"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"
3	70 1/2"	±.125"	70 1/2"	70 1/2"	70 1/2"	70 1/2"	70 1/2"	70 1/2"	70 1/2"	70 1/2"	70 1/2"	70 1/2"
4	8"	±.125"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"
5	45°	±1/2°	45°	45°	45°	45°	45°	45°	45°	45°	45°	45°
6	24"	±.125"	24"	24"	24"	24"	24"	24"	24"	24"	24"	24"
7	25-3/4"	±.125"	25 3/4"	25 3/4"	25 3/4"	25 3/4"	25 3/4"	25 3/4"	25 3/4"	25 3/4"	25 3/4"	25 3/4"
8												
9												
10												
11												
12												
13												
14												
15	Verify Stamping, Etching, tags	Verified by	AB									
16	Final Inspection	Verified by QC Inspector	AB									
17												
18												
19												
20												
21												

F-824-001 Rev. A Inspection Report PAGE 1 OF 1

United Machine Works

Inspection Report

Purchase Order: 25-108 | **Date:** 4/14/2025 | **Special Notes:**

Part Number: 241156 TTI CON LOOP | **Revision:** | **Job#** 72608

Part Description: Connection Loop

Operators: | Inspector: Steven Carter

	Specification		Measured Dimension of Serialized Parts									
	Dimension	Tolerance	21	22	23	24	25	26	27	28	29	30
	Serial Number (if applicable)											
	Heat Log Number		UF4358	UF4358	UF4358	UF4358	UF4358	UF4358	UF4358	UF4358	UF4358	UF4358
1	2"	±.125"	2"	2"	2"	2"	2"	2"	2"	2"	2"	2"
2	Ø3/4"	±.125"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"
3	70-1/2"	±.125"	70 1/2"	70 1/2"	70 1/2"	70 1/2"	70 1/2"	70 1/2"	70 1/2"	70 1/2"	70 1/2"	70 1/2"
4	8"	±.125"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"
5	45°	±1/2°	45°	45°	45°	45°	45°	45°	45°	45°	45°	45°
6	24"	±.125"	24"	24"	24"	24"	24"	24"	24"	24"	24"	24"
7	25-3/4"	±.125"	25 3/4"	25 3/4"	25 3/4"	25 3/4"	25 3/4"	25 3/4"	25 3/4"	25 3/4"	25 3/4"	25 3/4"
8												
9												
10												
11												
12												
13												
14												
15	Verify Stamping, Etching, tags	Verified by	AB									
16	Final Inspection	Verified by QC Inspector	AB									
17												
18												
19												
20												
21												

F-824-001 Rev. A Inspection Report PAGE 1 OF 1

United Machine Works

Inspection Report

Purchase Order: 25-108	**Date: 4/14/2025**	**Special Notes:**
Part Number: 241156 TTI CON LOOP	**Revision:**	**Job# 72608**
Part Description: Connection Loop		
Operators:	**Inspector:** Steven Carter	

	Specification		Measured Dimension of Serialized Parts				
	Dimension	Tolerance	31	32	33	34	35
	Serial Number (if applicable)						
	Heat Log Number		UF4358	UF4358	UF4358	UF4358	UF4358
1	2"	±.125"	2"	2"	2"	2"	2"
2	Ø3/4"	±.125"	3/4"	3/4"	3/4"	3/4"	3/4"
3	70 1/2"	±.125"	70 1/2"	70 1/2"	70 1/2"	70 1/2"	70 1/2"
4	8"	±.125"	8"	8"	8"	8"	8"
5	45°	±1/2°	45°	45°	45°	45°	45°
6	24"	±.125"	24"	24"	24"	24"	24"
7	25-3/4"	±.125"	25 3/4"	25 3/4"	25 3/4"	25 3/4"	25 3/4"
8							
9							
10							
11							
12							
13							
14							
15	Verify Stamping, Etching, tags	Verified by	MB				MB
16	Final Inspection	Verified by QC Inspector	MB				MB
17							
18							
19							
20							
21							

F-824-001 Rev. A Inspection Report PAGE 1 OF 1

UNIFAB
MACHINE & FABRICATION

UNI-FAB

CERTIFICATE OF MATERIAL

SPECIFICATIONS AND WORKMANSHIP

DATE: 5/7/25

PO# 143188

JOB: 72608

3044

PART NUMBER: 241156 TTI CON LOOP PART DESCRIPTION: CONNECTION LOOPS

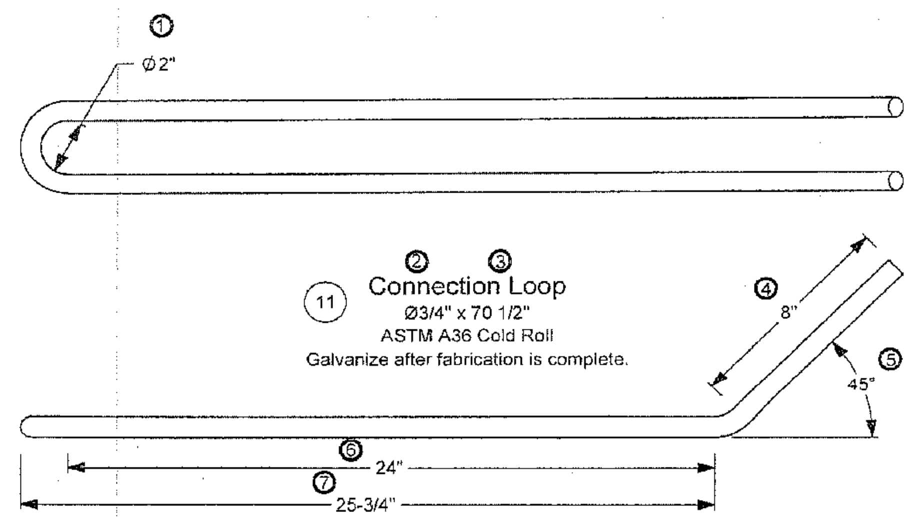
CUST PO: 25-108 LINE 2
S/N: TRACER 1 THRU 35
Material: A572GR50T1
HL: UF4358 /HT# 3135487

QUANTITY: 35

SPECIAL PROCESS: MANUFACTURED PER PRINT

COUNTRY OF ORIGIN: United States of America

The materials, processes, and workmanship all conform to the requirements of all applicable specifications, drawings, and the purchase order supplied to Uni-Fab. The appropriate documentation providing traceablity is on file at Uni-Fab. It is available for review by authorized customer representatives.

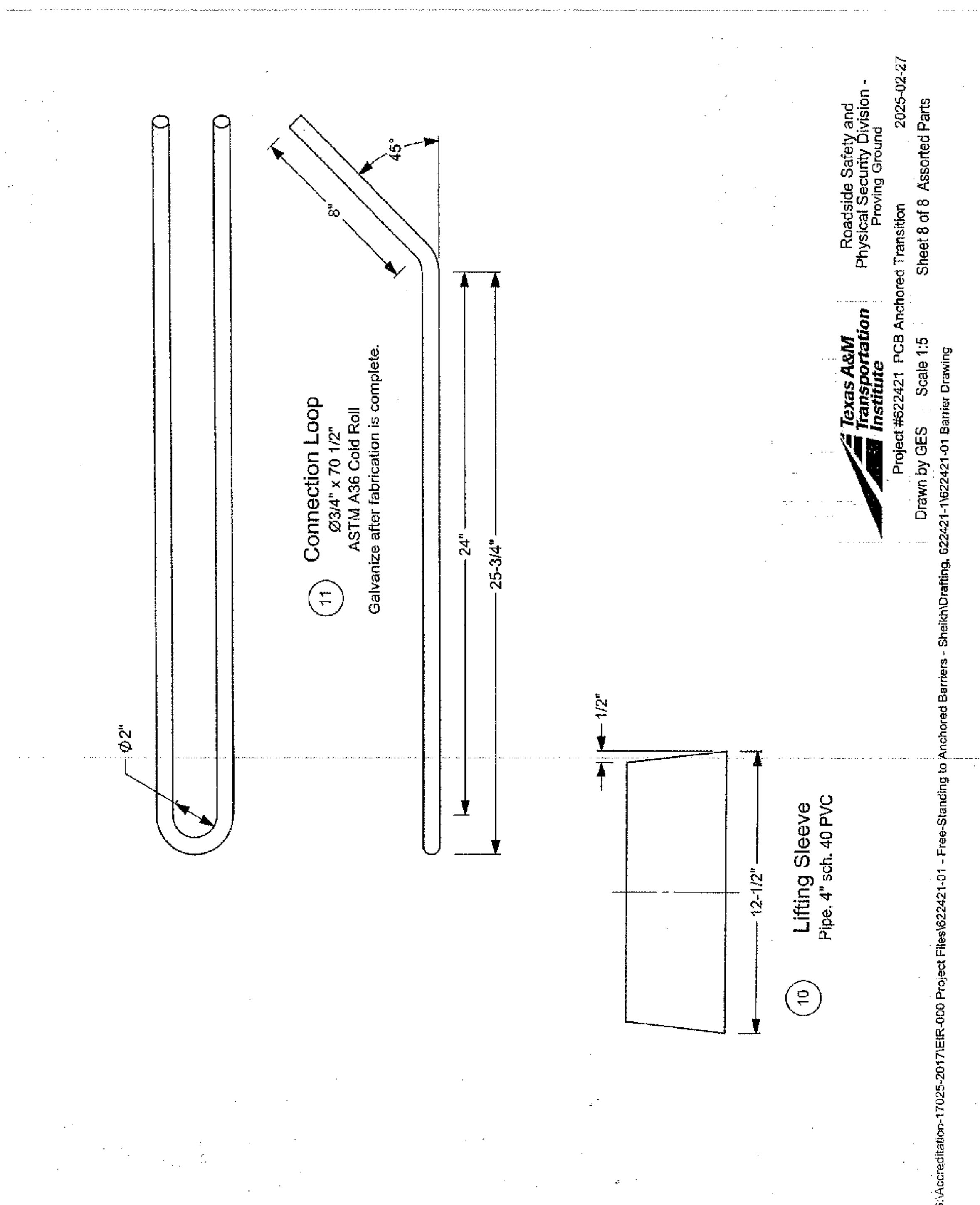


Roadside Safety and
Physical Security Division -
Proving Ground

Project #622421 PCB Anchored Transition 2025-02-27

Drawn by GES Scale 1:5 Sheet 8 of 8 Assorted Parts

S:\Accreditation-17025-2017\EIR-000 Project Files\622421-01 - Free-Standing to Anchored Barriers - Sheikh\Drafting, 622421-1\622421-01 Barrier Drawing


Ø2"
11 Connection Loop
Ø3/4" x 70 1/2"
ASTM A36 Cold Roll
Galvanize after fabrication is complete.
8"
45°
24"
25-3/4"
1/2"
12-1/2"
10 Lifting Sleeve
Pipe, 4" sch. 40 PVC
Texas A&M Transportation Institute
Roadside Safety and Physical Security Division - Proving Ground
Project #622421 PCB Anchored Transition
2025-02-27
Drawn by GES
Scale 1:5
Sheet 8 of 8 Assorted Parts
S:\Accreditation-17025-2017\EIR-000 Project Files\622421-01 - Free-Standing to Anchored Barriers - Sheikh\Drafting, 622421-1\622421-01 Barrier Drawing

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

CERTIFIED MILL TEST REPORT

For additional copies call
800-227-6489

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

Drew M Fischer
Quality Assurance Manager

1SERIES-BPS®

AT NO.:3135487 CTION: ROUND 3/4 x 20'0" A36/52950 ADE: ASTM A36-19/A529-19 Gr 50 RD LL DATE: 12/15/2024 LT DATE: 12/05/2024 rt. No.: 86186875 / 135487A457	SOLD TO: O'Neal Steel Inc 4530 MESSER AIRPORT HWY BIRMINGHAM AL US 35222-1627 2055998000	SHIP TO: O'Neal Steel 4005 Grand Lakes Way Grand Prairie TX US 75050-0000 9724027945	Delivery#: 86186875 BOL#: 76450524 CUST PO#: 722129 CUST P/N: 834718 DLVRY LBS / HEAT: 13698.000 LB DLVRY PCS / HEAT: 456 EA

Characteristic	Value
C	0.12%
Mn	0.91%
P	0.005%
S	0.019%
Si	0.22%
Cu	0.38%
Cr	0.10%
Ni	0.16%
Mo	0.048%
V	0.000%
Cb	0.011%
Sn	0.008%
Al	0.000%
N	0.0138%
Carbon Eq F1554	0.30%
Carbon Eq A529	0.38%
Yield Strength test 1	55.0ksi
Tensile Strength test 1	77.6ksi
Elongation test 1	27%

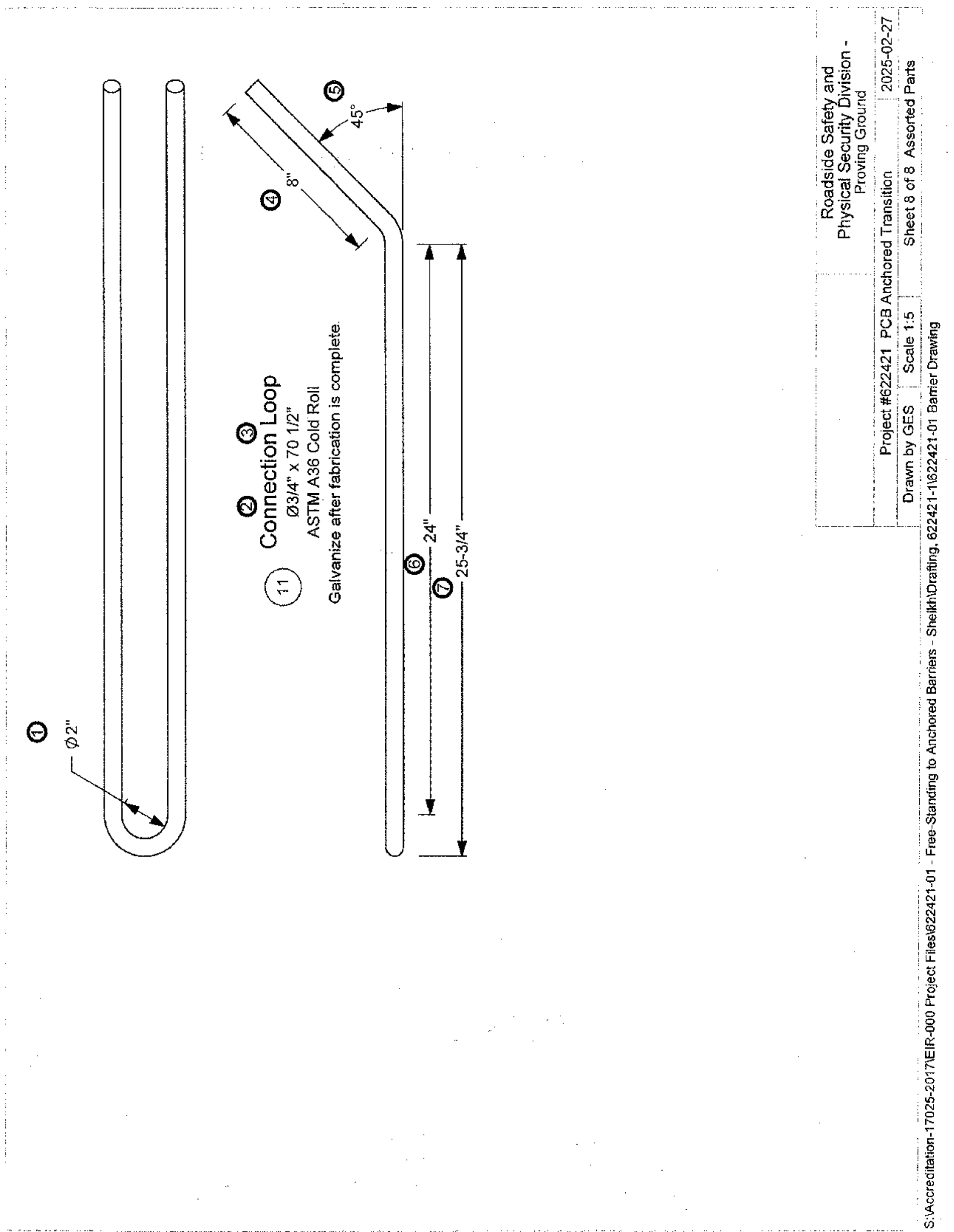
Characteristic	Value
Elongation Gage Lgth test 1	8IN
Reduction of Area test 1	64%
Yield to tensile ratio test1	0.71
Yield Strength test 2	55.8ksi
Tensile Strength test 2	77.6ksi
Elongation test 2	42%
Elongation Gage Lgth test 2	2IN
Reduction of Area test 2	65%
Yield to tensile ratio test2	0.72
BHN @ Surface test 1	149BHN

SUMMIT PRECAST CONCRETE
PO: 25-108
PART: 241156 TTI CON LOOP CONNECTION LOOPS

The Following is true of the material represented by this MTR:
*Material is fully killed and is Hot Rolled Steel
*100% melted, rolled, and manufactured in the USA
*EN10204:2004 3.1 compliant *Contains no weld repair
*Contains no Mercury contamination
*Manufactured in accordance with the latest version of the plant quality manual
*Meets the "Buy America" requirements of 23 CFR635.410, 49 CFR 661
*Warning. This product can expose you to chemicals which are known to the State of California to cause cancer, birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov
*THE RECORDING OF FALSE, FICTITIOUS OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTE

RKS : ALSO MEETS ASTM GRADE A36, A529-50, A572-50, A709-36, A709-50, A992, AASHTO M270-36, M270-50, CSA G40.21-04 44W, 50W
I MEETS THE REQUIREMENTS OF F1554 GRADE 36 SUPPLEMENT S1

UT 4358



Roadside Safety and
Physical Security Division -
Proving Ground
Project #622421 PCB Anchored Transition
2025-02-27
Drawn by GES
Scale 1:5
Sheet 8 of 8
Assorted Parts
S:\Accreditation-17025-2017\EIR-000 Project Files\622421-01 - Free-Standing to Anchored Barriers - Sheikh\Drafting, 622421-1\622421-01 Barrier Drawing
11
Connection Loop
Ø3/4" x 70 1/2"
ASTM A36 Cold Roll
Galvanize after fabrication is complete.
Ø2"
8"
45°
24"
25-3/4"

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
		user		69536	6:58	5/16/25

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
6.00 yd	N-N70130PMS				W3	9

Material	Design Qty	Required	Batched		% Var	% Moisture	Actual Wat
SAND	1518 lb	9472 lb	9560 lb		0.93%	4.00% M	44 gl
1"LS	1635 lb	9967 lb	9900 lb		-0.67%	1.60% M	19 gl
TYPE1/2	461 lb	2766 lb	2755 lb		-0.40%		
FLYASH	197 lb	1182 lb	1185 lb		0.25%		
WAT 1	24.8 gl	86.6 gl	86.0 gl	*	-0.66%		86.0 gl
PLASTIMENT	2.00 /C	78.96 oz	79.00 oz		0.05%		
VISO1000	10.00 /C	394.80 oz	396.00 oz		0.30%		

Actual		Num Batches: 1					Manual 6:58:32	
Load	24147 lb	Design W/C: 0.315	Water/Cement: 0.316 T	Design	149.0 gl	Actual	148.7 gl	To Add: 0.3 gl
Slump:	4.00 in	Water in Truck: 0.0 gl	Adjust Water: 0.0 gl / Load	Trim Water:	0.0 gl / yd			
Actual W/C Ratio: 0.315		Actual Water: 149 gl	Batched Cement: 3940 lb	Allowable Water:	0 lb			

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
		user		69737	12:32	5/20/25

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
6.00 yd	N-N70130PMS				W3	64

Material	Design Qty	Required	Batched	% Var	% Moisture	Actual Wat
SAND	1518 lb	9472 lb	9380 lb	-0.97%	4.00% M	43 gl
1"LS	1635 lb	9888 lb	9820 lb	-0.69%	0.80% M	9 gl
TYPE1/2	461 lb	2766 lb	2755 lb	-0.40%		
FLYASH	197 lb	1182 lb	1185 lb	0.25%		
WAT 1	24.8 gl	96.0 gl	96.0 gl	0.02%		96.0 gl
PLASTIMENT	2.00 /C	78.96 oz	79.00 oz	0.05%		
VISO1000	10.00 /C	394.80 oz	395.00 oz	0.05%		

Actual Num Batches: 1 Manual 12:32:51

Load 23971 lb Design W/C: 0.315 Water/Cement: 0.316 T Design 149.0 gl Actual 148.6 gl To Add: 0.5 gl

Slump: 4.00 in Water in Truck: 0.0 gl Adjust Water: 0.0 gl / Load Trim Water: 0.0 gl / yd Note: Manual feed occured

Actual W/C Ratio: 0.315 Actual Water: 149 gl Batched Cement: 3940 lb Allowable Water: 1 lb

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
		user		69773	13:29	5/21/25

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
6.00 yd	N-N70130FMS				W3	29

Material	Design Qty	Required	Batched	% Var	% Moisture	Actual Wat
SAND	1343 lb	8380 lb	8360 lb	-0.24%	4.00% M	39 gl
1"LS	1728 lb	10451 lb	10360 lb	-0.87%	0.80% M	10 gl
TYPE1/2	461 lb	2766 lb	2760 lb	-0.22%		
FLYASH	197 lb	1182 lb	1190 lb	0.68%		
WAT 1	24.9 gl	100.7 gl	100.0 gl	-0.71%		100.0 gl
VISO1000	10.00 /C	394.80 oz	394.00 oz	-0.20%		
PLASTIMENT	2.00 /C	78.96 oz	79.00 oz	0.05%		

Actual		Num Batches: 1					Manual 13:29:51	
Load	23534 lb	Design W/C: 0.316	Water/Cement: 0.315 T	Design	149.3 gl	Actual	148.4 gl	To Add: 0.9 gl
Slump:	4.00 in	Water in Truck: 0.0 gl	Adjust Water: 0.0 gl / Load	Trim Water:	0.0 gl / yd			
Actual W/C Ratio: 0.314		Actual Water: 148 gl	Batched Cement: 3950 lb	Allowable Water:	7 lb			

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
		user		69862	13:29	5/22/25

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
6.00 yd	N-N70130FMS				W3	56

Material	Design Qty	Required	Batched		% Var	% Moisture	Actual Wat
SAND	1343 lb	8380 lb	8320 lb		-0.72%	4.00% M	38 gl
1"LS	1728 lb	10430 lb	10340 lb		-0.86%	0.60% M	7 gl
TYPE1/2	461 lb	2766 lb	2770 lb		0.14%		
FLYASH	197 lb	1182 lb	1190 lb		0.68%		
WAT 1	24.9 gl	103.1 gl	102.0 gl	*	-1.05%		102.0 gl
VISO1000	10.00 /C	394.80 oz	394.00 oz		-0.20%		
PLASTIMENT	2.00 /C	78.96 oz	79.00 oz		0.05%		

Actual		Num Batches: 1						Manual 13:29:56	
Load	23501 lb	Design W/C: 0.315	Water/Cement: 0.314 T	Design 149.2 gl	Actual 147.7 gl	To Add: 1.4 gl			
Slump:	4.00 in	Water in Truck: 0.0 gl	Adjust Water: 0.0 gl / Load	Trim Water: 0.0 gl / yd	Note: Manual feed occured				
Actual W/C Ratio: 0.311		Actual Water: 148 gl	Batched Cement: 3960 lb	Allowable Water: 15 lb					

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
		user		69975	9:17	5/27/25

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
6.00 yd	N-N70130FMS				W3	30

Material	Design Qty	Required	Batched	% Var	% Moisture	Actual Wat
SAND	1343 lb	8380 lb	8420 lb	0.47%	4.00% M	39 gl
1"LS	1728 lb	10658 lb	10600 lb	-0.55%	2.80% M	35 gl
TYPE1/2	461 lb	2766 lb	2760 lb	-0.22%		
FLYASH	197 lb	1182 lb	1185 lb	0.25%		
WAT 1	24.9 gl	75.7 gl	75.0 gl	-0.99%		75.0 gl
VISO1000	10.00 /C	394.80 oz	395.00 oz	0.05%		
PLASTIMENT	2.00 /C	78.96 oz	79.00 oz	0.05%		

Actual		Num Batches: 1				Manual 9:17:25	
Load	23621 lb	Design W/C: 0.315	Water/Cement: 0.316 T	Design	149.2 gl	Actual 148.4 gl	To Add: 0.8 gl
Slump:	4.00 in	Water in Truck: 0.0 gl	Adjust Water: 0.0 gl / Load	Trim Water:	0.0 gl / yd		
Actual W/C Ratio: 0.314		Actual Water: 148 gl	Batched Cement: 3945 lb	Allowable Water:	5 lb		

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
		user		70184	8:27	5/30/25

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
6.00 yd	N-N60130FMS				W3	17

Material	Design Qty	Required	Batched	% Var	% Moisture	Actual Wat
SAND	1516 lb	9514 lb	9480 lb	-0.36%	4.60% M	50 gl
1"LS	1728 lb	10472 lb	10400 lb	-0.68%	1.00% M	12 gl
WAT 1	23.0 gl	75.4 gl	75.0 gl	-0.58%		75.0 gl
TYPE1/2	395 lb	2370 lb	2370 lb	0.00%		
FLYASH	169 lb	1014 lb	1015 lb	0.10%		
VISO1000	10.00 /C	338.40 oz	338.00 oz	-0.12%		
PLASTIMENT	2.00 /C	67.68 oz	67.00 oz	-1.00%		

Actual Num Batches: 1 Manual 8:27:05

Load 23916 lb Design W/C: 0.340 Water/Cement: 0.340 T Design 138.0 gl Actual 137.3 gl To Add: 0.7 gl

Slump: 4.00 in Water in Truck: 0.0 gl Adjust Water: 0.0 gl / Load Trim Water: 0.0 gl / yd Note: Manual feed occured

Actual W/C Ratio: 0.339 Actual Water: 137 gl Batched Cement: 3385 lb Allowable Water: 6 lb

Truck	Driver	User	Disp Ticket Num	Ticket ID	Time	Date
		user		71053	9:08	6/16/25

Load Size	Mix Code	Returned	Qty	Mix Age	Seq	Load ID
6.00 yd	N-N70130PMS				W3	26

Material	Design Qty	Required	Batched		% Var	% Moisture	Actual Wat
SAND	1471 lb	9223 lb	9300 lb		0.83%	4.50% M	48 gl
1"LS	1667 lb	10102 lb	10020 lb		-0.81%	1.00% M	12 gl
TYPE1/2	461 lb	2766 lb	2755 lb		-0.40%		
FLYASH	197 lb	1182 lb	1175 lb	*	-0.59%		
WAT 1	24.9 gl	89.6 gl	90.0 gl		0.47%		90.0 gl
PLASTIMENT	2.00 /C	78.96 oz	79.00 oz		0.05%		
VISO1000	10.00 /C	394.80 oz	396.00 oz		0.30%		

Actual			Num Batches:	1						Manual	9:08:17
Load	24031 lb	Design W/C:	0.315	Water/Cement:	0.315	A	Design	149.2 gl	Actual	149.9 gl	To Add: 0.0 gl
Slump:	4.00 in	Water in Truck:	0.0 gl	Adjust Water:	0.0 gl / Load		Trim Water:	0.0 gl / yd	Note: Manual feed occured		
Actual W/C Ratio:	0.315	Actual Water:	150 gl	Batched Cement:	3975 lb		Allowable Water:	2 lb			

APPENDIX C.

MASH TEST 3-21 (TEST 622421-01-1)

C.1. VEHICLE PROPERTIES AND INFORMATION

Date: 2025-06-25 Test No.: 622421-01-1 VIN No.: 1C6RR6GT7KS690392

Year: 2019 Make: RAM Model: 1500

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

Tread Type: Highway Odometer: 224576

Note any damage to the vehicle prior to test: None

• Denotes accelerometer location.

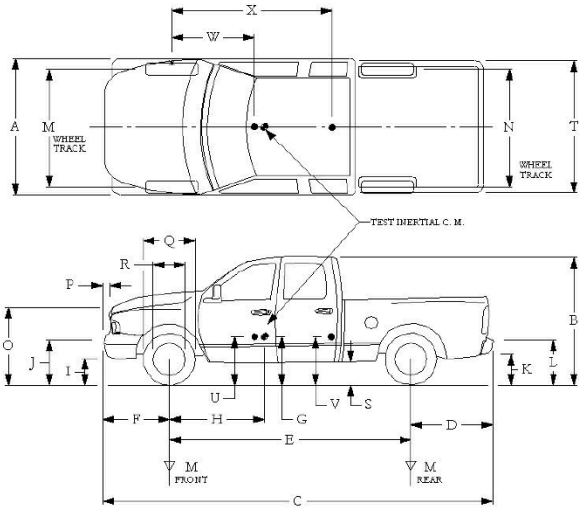
NOTES: None

Engine Type: V-8
Engine CID: 5.7 liter

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

Optional Equipment:
None

Dummy Data:
Type:
Mass:
Seat Position:



Geometry: inches

A	78.50	F	40.25	K	20.00	P	3.00	U	26.75
B	74.00	G	28.25	L	30.00	Q	30.50	V	30.25
C	229.00	H	59.40	M	68.50	R	18.00	W	59.50
D	48.25	I	11.75	N	68.00	S	13.00	X	79.00
E	140.50	J	27.00	O	46.00	T	77.00		

Wheel Center Height Front	14.75	Wheel Well Clearance (Front)	6.00	Bottom Frame Height - Front	12.50
Wheel Center Height Rear	14.75	Wheel Well Clearance (Rear)	9.25	Bottom Frame Height - Rear	22.50

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

GVWR Ratings:		**Mass:** lb	Curb	Test Inertial	Gross Static
Front	3700	M_{front}	2995	2890	
Back	3900	M_{rear}	2137	2116	
Total	6700	M_{Total}	5132	5006	5006

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

Mass Distribution:
lb LF: 1421 RF: 1469 LR: 1095 RR: 1021

Figure C.1. Vehicle Properties for Test 622421-01-1.

Date: 2025-06-25 Test No.: 622421-01-1 VIN No.: 1C6RR6GT7KS690392

Year: 2019 Make: RAM Model: 1500

VEHICLE CRUSH MEASUREMENT SHEET[1]

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

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

Specific Impact Number	Plane* of C-Measurements	Direct Damage Width** (CDC)	Direct Damage Max*** Crush	Field L**	C_1	C_2	C_3	C_4	C_5	C_6	±D
1	AT FRONT BUMPER	19	15	32	-	-	-	-	-	-	-14
2	SAME	19	20	50	-	-	-	-	-	-	67
	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.

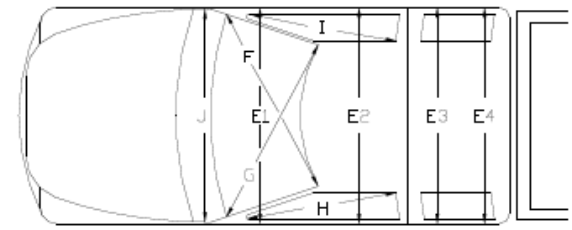
**Measure and document on the vehicle diagram the beginning or end of the direct damage width and field L (e.g., side damage with respect to undamaged axle).

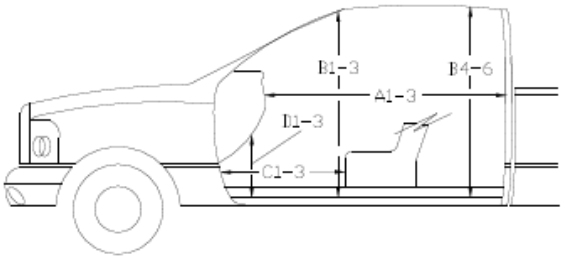
***Measure and document on the vehicle diagram the location of the maximum crush.

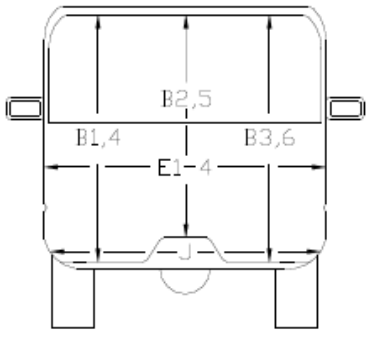
Note: Use as many lines/columns as necessary to describe each damage profile.

Figure C.2. Exterior Crush Measurements for Test 622421-01-1.

Date:	2025-06-25	Test No.:	622421-01-1	VIN No.:	1C6RR6GT7KS690392
Year:	2019	Make:	RAM	Model:	1500







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

OCCUPANT COMPARTMENT DEFORMATION MEASUREMENT

	Before	After (inches)	Differ.
A1	65.00	65.00	0.00
A2	63.00	63.00	0.00
A3	65.50	65.50	0.00
B1	45.00	45.00	0.00
B2	38.00	38.00	0.00
B3	45.00	45.00	0.00
B4	39.50	39.50	0.00
B5	43.00	43.00	0.00
B6	39.50	39.50	0.00
C1	26.00	20.75	-5.25
C2	0.00	0.00	0.00
C3	26.00	26.00	0.00
D1	11.00	10.00	-1.00
D2	0.00	0.00	0.00
D3	11.50	11.50	0.00
E1	58.50	58.50	0.00
E2	63.50	63.75	0.25
E3	63.50	63.50	0.00
E4	63.50	63.75	0.25
F	59.00	59.00	0.00
G	59.00	59.00	0.00
H	37.50	37.50	0.00
I	37.50	37.50	0.00
J*	25.00	24.25	-0.75

Figure C.3. Occupant Compartment Measurements for Test 622421-01-1.

C.2. SEQUENTIAL PHOTOGRAPHS

(a) 0.000 s (b) 0.1000 s

(c) 0.2000 s (d) 0.3000 s

(e) 0.4000 s (f) 0.5000 s

(g) 0.6000 s (h) 0.7000 s

Figure C.4. Sequential Photographs for Test 622421-01-1 (Overhead View).

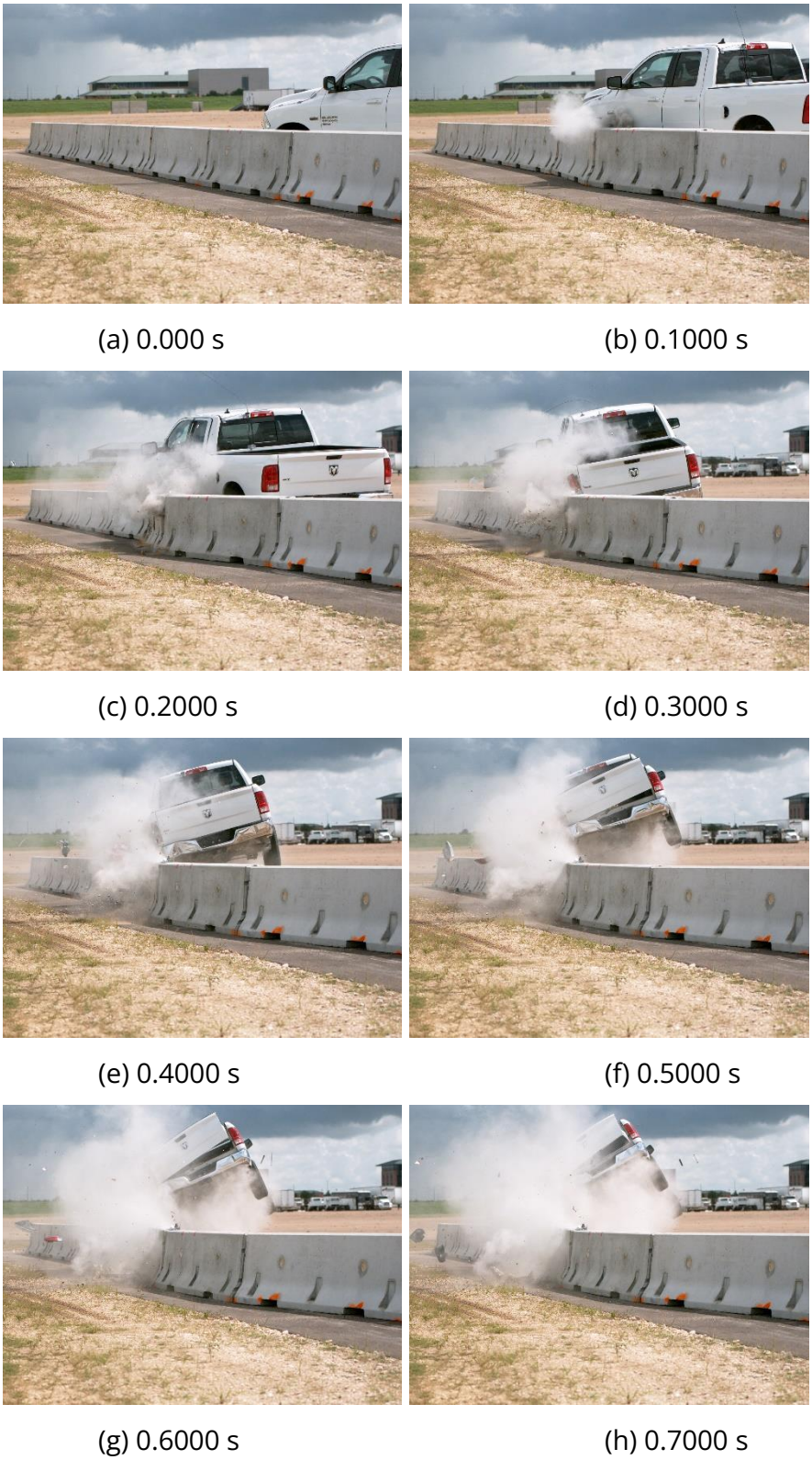
(a) 0.000 s (b) 0.1000 s

(c) 0.2000 s (d) 0.3000 s

(e) 0.4000 s (f) 0.5000 s

(g) 0.6000 s (h) 0.7000 s

Figure C.5. Sequential Photographs for Test 622421-01-1 (Downstream In-line View).



(a) 0.000 s (b) 0.1000 s

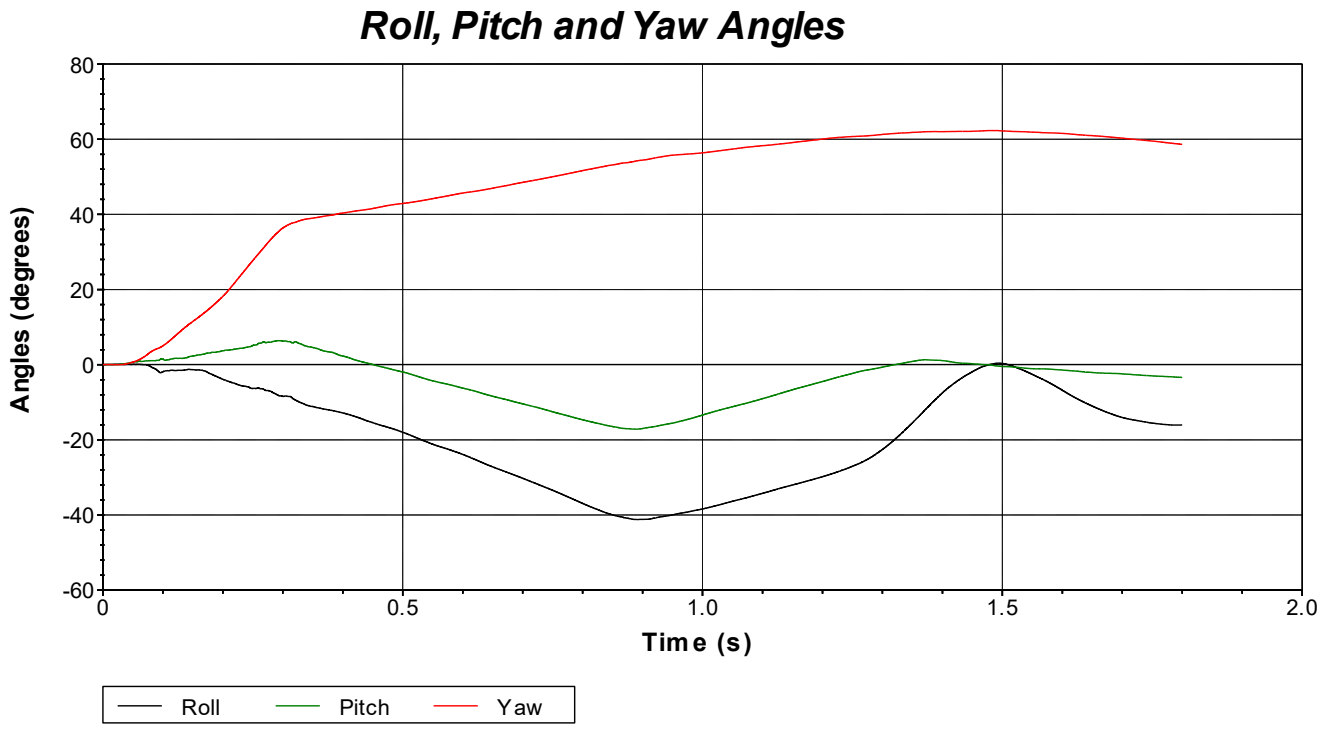
(c) 0.2000 s (d) 0.3000 s

(e) 0.4000 s (f) 0.5000 s

(g) 0.6000 s (h) 0.7000 s

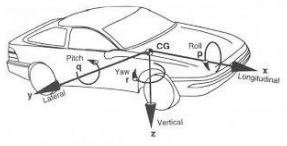
Figure C.6. Sequential Photographs for Test 622421-01-1 (Upstream Field Side Oblique View).

C.3. VEHICLE ANGULAR DISPLACEMENTS



Axes are vehicle-fixed.
Sequence for determining orientation:

1. Yaw.
2. Pitch.
3. Roll



Test Number: 622421-01-1
Test Standard Test Number: *MASH* Test 3-21
Test Article: Free-standing-to-anchored PCB transition system
Test Vehicle: 2019 RAM 1500
Inertial Mass: 5006 lb
Gross Mass: 5006 lb
Impact Speed: 63.0 mi/h
Impact Angle: 25.5°

Figure C.7. Vehicle Angular Displacements for Test 622421-01-1.

C.4. VEHICLE ACCELERATIONS

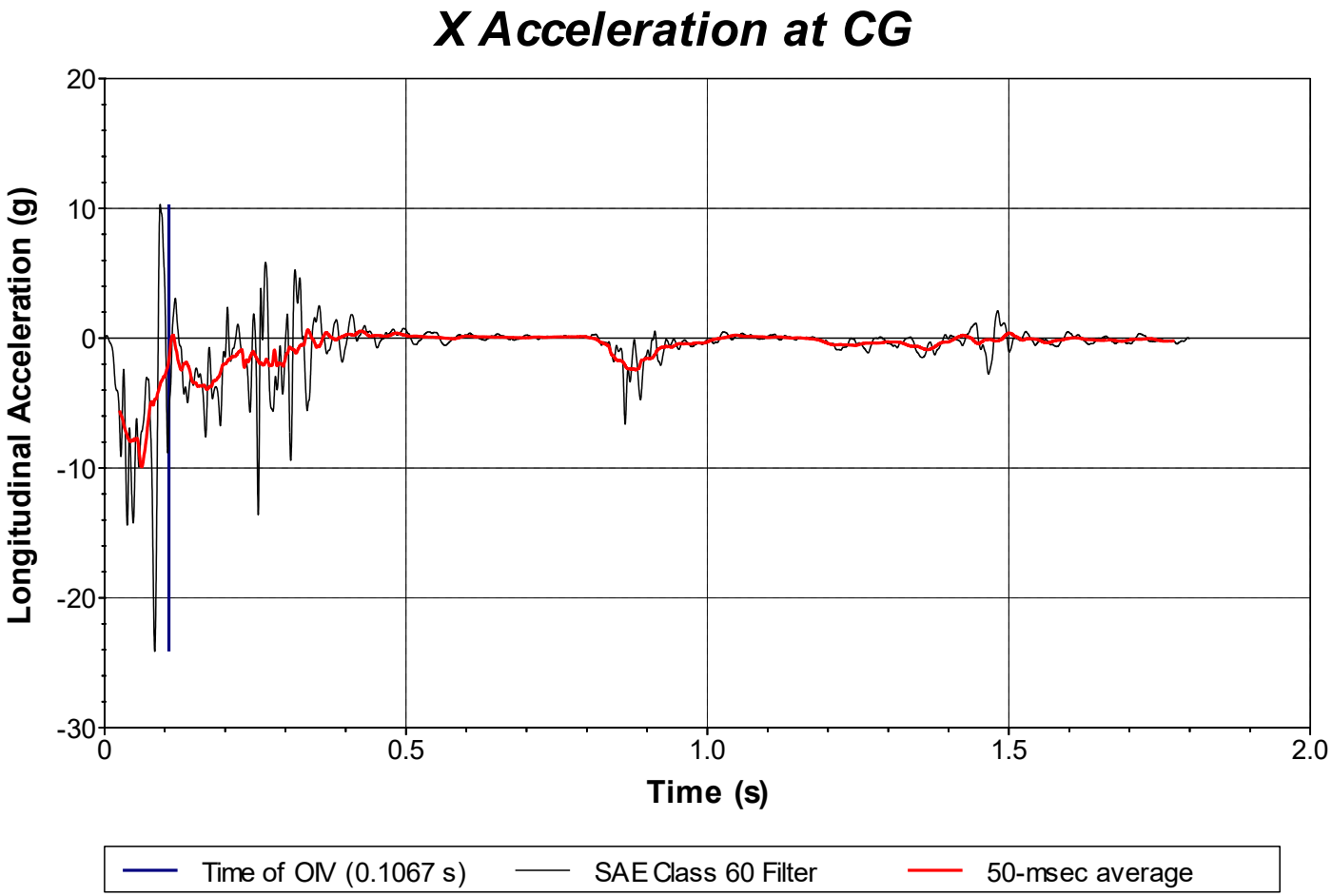


Figure C.8. Vehicle Longitudinal Accelerometer Trace for Test 622421-01-1 (Accelerometer Located at Center of Gravity).

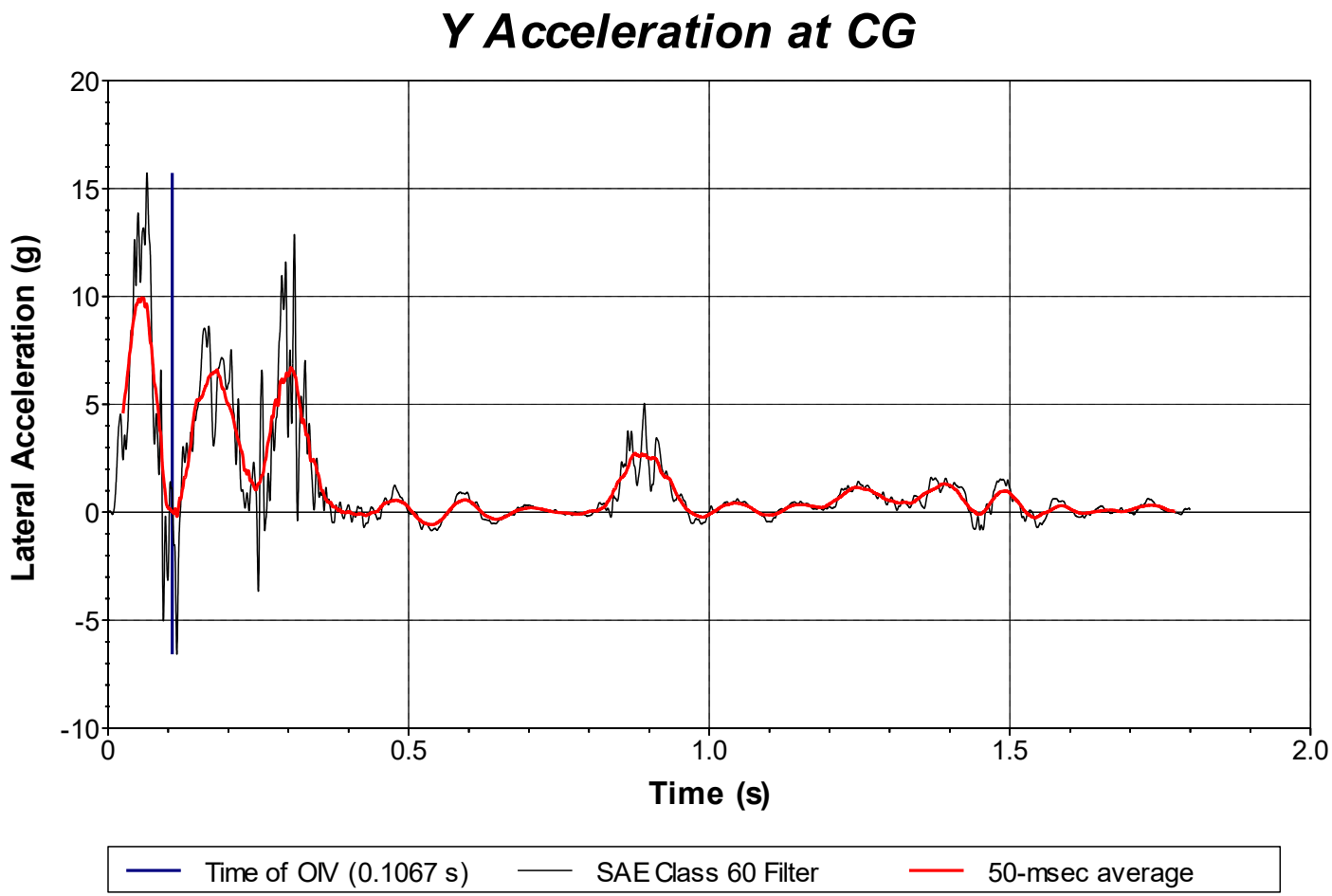


Figure C.9. Vehicle Lateral Accelerometer Trace for Test 622421-01-1 (Accelerometer Located at Center of Gravity).

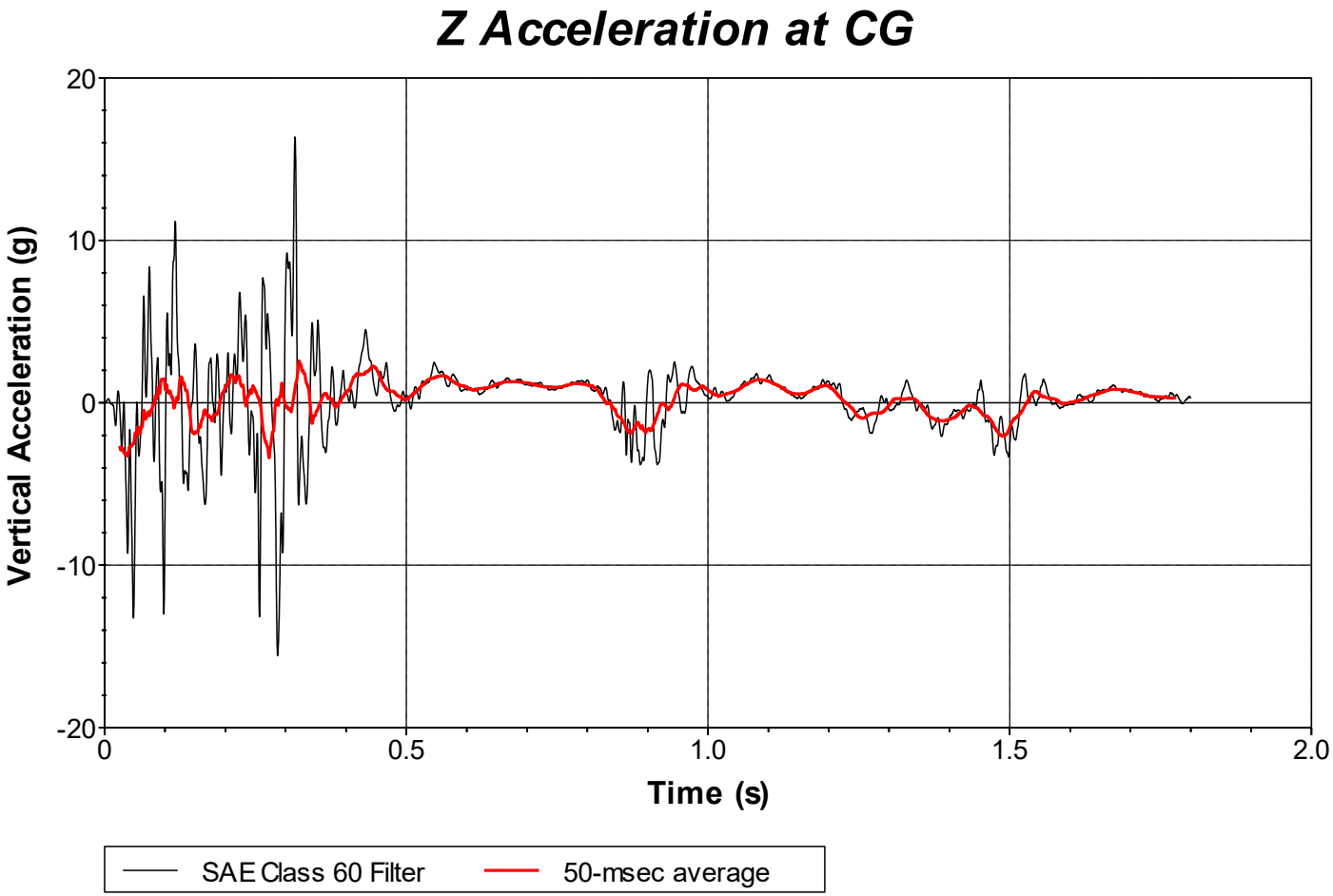


Figure C.10. Vehicle Vertical Accelerometer Trace for Test 622421-01-1 (Accelerometer Located at Center of Gravity).