



U.S. Department
of Transportation
**Federal Highway
Administration**

1200 New Jersey Ave., SE
Washington, D.C. 20590

Sept 7, 2012

In Reply Refer To:
HSST/CC-115A

Mr. Brian Smith
Trinity Highway Products, LLC
2525 North Stemmons Freeway
Dallas, Texas 75207

Dear Mr. Smith:

This letter is in response to your request for the Federal Highway Administration (FHWA) to review a roadside safety system for eligibility for reimbursement under the Federal-aid highway program.

Name of system: Trinity SOFT-STOP Terminal for line posts with 8" wood offset blocks and a 1-foot offset from tangent (flare rate of 50:1).

Type of system: W-Beam Guardrail Terminal

Test Level: MASH Test Level 3 (TL-3)

Testing conducted by: Original testing by Texas Transportation Institute

Task Force 13 Designator: SEW22

Date of request: August 18, 2012

Date initially acknowledged: August 23, 2012

Date of completed package: August 28, 2012

Decision:

The following device is eligible, with details provided in the form which is attached as an integral part of this letter:

- Trinity SOFT-STOP Terminal for line posts with 8" wood offset blocks and a 1-foot offset from tangent (50:1 flare rate)

Based on a review of previous crash tests submitted by the manufacturer certifying the device described herein meets the crash test and evaluation criteria of the American Association of State Highway and Transportation Officials' Manual for Assessing Safety Hardware (MASH), the device is eligible for reimbursement under the Federal-aid highway program. Eligibility for reimbursement under the Federal-aid highway program does not establish approval or endorsement by the FHWA for any particular purpose or use.

The FHWA, the Department of Transportation, and the United States Government do not endorse products or services and the issuance of a reimbursement eligibility letter is not an endorsement of any product or service.

Requirements

To be found eligible for Federal-aid funding, roadside safety devices should meet the crash test and evaluation criteria contained in the American Association of State Highway and Transportation Officials' Manual for Assessing Safety Hardware (MASH).

Description

The device and supporting documentation are described in the attached form.

Summary and Standard Provisions

Therefore, the system described and detailed in the attached form is eligible for reimbursement and may be installed under the range of conditions tested.

Please note the following standard provisions that apply to FHWA eligibility letters:

- This letter provides a AASHTO/ARTBA/AGC Task Force 13 designator that should be used for the purpose of the creation of a new and/or the update of existing Task Force 13 drawing for posting on the on-line 'Guide to Standardized Highway Barrier Hardware' currently referenced in AASHTO Roadside Design Guide.
- This finding of eligibility does not cover other structural features of the systems, nor conformity with the Manual on Uniform Traffic Control Devices.
- Any changes that may influence system conformance with MASH will require a new reimbursement eligibility letter.
- Should the FHWA discover that the qualification testing was flawed, that in-service performance reveals safety problems, or that the system is significantly different from the version that was crash tested, we reserve the right to modify or revoke this letter.
- You are expected to supply potential users with sufficient information on design and installation requirements to ensure proper performance.
- You are expected to certify to potential users that the hardware furnished has the same chemistry, mechanical properties, and geometry as that submitted for review, and that it will meet the test and evaluation criteria of the MASH.
- To prevent misunderstanding by others, this letter of eligibility is designated as number CC-115A and shall not be reproduced except in full. This letter and the test documentation upon which it is based are public information. All such letters and documentation may be reviewed at our office upon request.
- This letter shall not be construed as authorization or consent by the FHWA to use, manufacture, or sell any patented system for which the applicant is not the patent holder. The FHWA does not become involved in issues concerning patent law. Patent issues, if any, are to be resolved by the applicant.

- The Trinity SOFT-STOP Terminal is a patented product and considered proprietary. If proprietary systems are specified by a highway agency for use on Federal-aid projects: (a) they must be supplied through competitive bidding with equally suitable unpatented items; (b) the highway agency must certify that they are essential for synchronization with the existing highway facilities or that no equally suitable alternative exists; or (c) they must be used for research or for a distinctive type of construction on relatively short sections of road for experimental purposes. Our regulations concerning proprietary products are contained in Title 23, Code of Federal Regulations, Section 635.411.

Sincerely yours,



Michael S. Griffith
Director, Office of Safety Technologies
Office of Safety

Enclosures

Request for Federal Aid Reimbursement Eligibility Of Highway Safety Hardware

Submitter	Date of Request:	August 16, 2012	<input checked="" type="radio"/> New <input type="radio"/> Resubmission
	Name:	Don Gripne	
	Company:	TRINITY HIGHWAY PRODUCTS, LLC	
	Address:	2525 STEMMONS FREEWAY, DALLAS, TX 75207	
	To:	Michael S. Griffith, Director FHWA, Office of Safety Technologies	

I request the following devices be considered eligible for reimbursement under the Federal-aid highway program.

System Type	Device Name / Variant	Testing Criterion	Test Level
'CC': Crash Cushions, Attenuators, & T	TRINITY SOFT-STOP TERMINAL	AASHTO MASH	TL3

By submitting this request for review and evaluation by the Federal Highway Administration, I certify that the product(s) was (were) tested in conformity with the AASHTO Manual for Assessing Safety Hardware and that the test / evaluation results meet the appropriate evaluation criteria in the MASH.

Identification of the individual or organization responsible for the product:

Contact Name:	BRIAN SMITH
Company Name:	TRINITY HIGHWAY PRODUCT, LLC
Address 1:	2525 STEMMONS FREEWAY
Address 2:	
City/State/Zip:	DALLAS/TX/75207
Country:	USA

PRODUCT DESCRIPTION

Modification to Existing Hardware Non-Significant - Effect is positive or Inconsequential
The original crash test of the Trinity Soft Stop (TTI Crash Report 2009) as per Eligibility Letter CC-115 dated December 9, 2011 specified steel post and w-beam guardrail using 12-inch wood block out. The crash test report was conducted by Texas Transportation Institute (TTI) entitled NCHRP 350 Crash Testing and Evaluation of the Vertical Squisher' dated February 2009 (TTI Crash Report 2009).
This request is to modify the as-tested article as per CC-115 to include 8-inch wood block out for both line posts and post no 2 within the Trinity Soft Stop Terminal system. This modification also includes an offset 1-foot from tangent of the Trinity Soft Stop Terminal system as a flare rate of 50:1.
This modification is considered Non-significant, Effect is Positive or Inconsequential.

Required Test Number	Narrative Description	Evaluation Results
3-30 (1100C)	As per TTI Crash Report 2009, an IIOOC (24251b) passenger car impacting the terminal end-on at a nominal impact speed and angle of 62 mi/h and 0 degree, respectively, with the quarter point of the vehicle aligned with the center line of the nose of the terminal. This test is primarily intended to evaluate occupant risk and vehicle trajectory criteria. The SOFT -STOP slowed and redirected the IIOOC vehicle. No occupant compartment deformation occurred. The IIOOC vehicle remained upright during and after the collision event. Maximum roll was 25 degrees, and maximum pitch was 7 degrees. Occupant risk factors were within the limits specified for MASH test 3-30. The vehicle subsequently came to rest 27 feet downstream of impact and 34 feet toward traffic lanes. The SOFT-STOP performed acceptably according to the evaluation criteria of MASH test 3-30.	WAIVER REQUES
3-31 (2270P)	As per TTI Crash Report 2009, A 2270P (5000 lb) pickup truck impacting the terminal end-on at a nominal impact speed and angle of 62 mi/h and 0 degree, respectively, with the center line of the vehicle aligned with the center line of the nose of the terminal. This test is primarily intended to evaluate occupant risk and vehicle trajectory criteria. The SOFT-STOP brought the 2270P vehicle to a controlled stop. No occupant compartment deformation occurred. The 2270P vehicle remained upright during and after the collision event. Maximum roll was 4 degrees, and maximum pitch was -3 degrees. Occupant risk factors were within the limits specified for MASH test 3-31. The 2270P vehicle came to rest within the installation. The SOFT-STOP performed acceptably according to the evaluation criteria of MASH test 3-31.	WAIVER REQUES
3-32 (1100C)	As per TTI Crash Report 2009, an IIOOC (24251b) passenger car impacting the terminal end-on at a nominal impact speed and angle of 62 mph and 5/15 degrees, respectively, with the center line of the vehicle aligned with the center line of the nose of the terminal. This test is primarily intended to evaluate occupant risk and vehicle trajectory criteria. The SOFT -STOP slowed and stopped the IIOOC vehicle. No occupant compartment deformation occurred. The IIOOC vehicle remained upright during and after the collision event. Maximum roll was 28 degrees, and maximum pitch was -26 degrees. Occupant risk factors were within the limits specified for MASH test 3-32. The vehicle subsequently came to rest with the front of the vehicle adjacent to post 4 of the terminal, with most of the vehicle toward the field side. The SOFT -STOP performed acceptably according to the evaluation criteria of MASH test 3-32.	WAIVER REQUES
3-33 (2270P)	As per TTI Crash Report 2009, the 2000P vehicle, traveling at an impact speed of 62.7 mi/h, impacted the nose of the Vertical Squisher end-on at an impact angle of 16.3 degrees. At 0.044 s after impact, the head of the terminal began to move along the rail, and at 0.093 s, the 2000P vehicle began to redirect toward the field side. The front right tire contacted the terminal at 0.207 s. The vehicle began to travel parallel with the guardrail at 0.285 s, at a speed of 48.2 mi/h (77.6 km/h). At 0.372 s, the 2000P vehicle overrode the terminal and lost contact with the guardrail and was traveling at an exit speed and angle of 51.7 mi/h (83.2 km/h) and 1.8 degrees, respectively. After completely exiting the installation, the 2000P vehicle partially traversed a steep mound of soil and came to rest on its right side 242 ft downstream and 30 ft toward the field side.	WAIVER REQUES

CRASH TESTING

A brief description of each crash test and its result:

Required Test Number	Narrative Description	Evaluation Results
3-34 (1100C)	<p>As per TTI Crash Report 2009, an IIOOC (24251b) passenger car impacting the terminal at a nominal impact speed and angle of 62 mi/h and 15 degrees, respectively, with the corner of the vehicle bumper aligned with the critical impact point (CIP) of the length of need (LON) of the terminal. This test is primarily intended to evaluate occupant risk and vehicle trajectory criteria. The SOFT-STOP contained and redirected the IIOOC vehicle. The vehicle did not penetrate or override the installation. Maximum dynamic deflection was 1.96 feet and the head fed through 6.2 feet of w-beam rail element. Maximum occupant compartment deformation was 1.0 inch inward in the area of the instrument panel on the left side. The IIOOC vehicle remained upright during and after the collision event. Maximum roll was 10 degrees, and maximum pitch was -4 degrees. Occupant risk factors were within the limits specified for MASH test 3-34. The vehicle subsequently came to rest 15 feet toward traffic lanes in front of post 8. The SOFT -STOP performed acceptably according to the evaluation criteria of MASH test 3-34.</p>	WAIVER REQUES
3-35 (2270P)	<p>As per TTI Crash Report 2009, a 2270P (5000 lb) pickup truck impacting the terminal at a nominal impact speed and angle of 62 mi/h and 25 degrees, respectively, with the corner of the vehicle bumper aligned with the beginning of the LON of the terminal. This test is primarily intended to evaluate structural adequacy and vehicle trajectory criteria. The SOFT-STOP contained and redirected the 2270P. The vehicle did not under ride or override the installation. Although the w-beam rail anchorage released late in the impact event, the vehicle did not penetrate the installation. While the vehicle was in contact with the w-beam, the maximum dynamic deflection was 10.4 feet. However, the upstream anchor released and as the vehicle lost contact with the w-beam, the w-beam continued to deflect, reaching a maximum displacement of 11.6 feet. The kickpanel of the left side was deformed inward 0.4 inch. The 2270P vehicle remained upright during and after the collision event. Maximum roll was -30 degrees, and maximum pitch was -12 degrees. Occupant risk factors were within the preferred limits specified for MASH test 3-31. The 2270P vehicle exited within the exit box. The SOFT -STOP performed acceptably according to the evaluation criteria of MASH test 3-35.</p>	WAIVER REQUES
3-36 (2270P)	<p>As per TTI Crash Report 2009, a 2270P (5000 lb) pickup truck impacting the terminal at a nominal impact speed and angle of 62 mi/h and 25 degrees, respectively, with the corner of the vehicle bumper aligned with the CIP with respect to the transition to the stiff barrier or backup structure. As a w-beam guardrail terminal, the SOFT-STOP will never be attached directly to a backup structure, and the transition to a stiff barrier is basically at Post 3. Therefore, Trinity feels that Test 3-36 is irrelevant and was therefore not conducted.</p> <p>Eligibility Letter CC-115 indicated that MASH test 3-36 may be waived because the SOFT-STOP will not be connected to any stiffer device than W-beam guardrail.</p>	WAIVER REQUES

3-37 (2270P)	As per TTI Crash Report 2009, a 2270P (5000 lb) pickup truck impacting the terminal at a nominal impact speed and angle of 62 mi/h and 25 degrees, respectively, mid-point between the nose and the end of the terminal in the reverse direction. This test is intended to evaluate the performance of a terminal for a "reverse" hit. However, researchers at TTI believe that the reverse direction impact would be more critical for the II OOC (2425 lb) passenger car than for the 2270P pickup. Therefore, an II OOC (2425 lb) passenger car was used in Test 3-37. Eligibility Letter CC-115 indicated that the substitution of the IIOOC vehicle to evaluate the reverse direction impact was appropriate.	WAIVER REQUES
3-38 (1500A)	As per TTI Crash Report 2009, a 1500A (33071b) passenger car impacting the terminal end-on at a nominal impact speed and angle of 62 mi/h and 0 degree, respectively, with the center line of the vehicle aligned with the center line of the nose of the terminal. This test is primarily intended to evaluate the performance of the staged attenuator/terminal when impacted by a mid-size vehicle. The SOFT-STOP is not a staged device. Therefore Test3-38 was not conducted. However, as per Appendix G of MASH, calculations based on Test 3-31 have been performed to predict the occupant risk values for the 1500A (33071b) vehicle. The results of these calculations (shown on the enclosed document) predict that in crash testing with the 1500A (33071b) vehicle, the SOFT-STOP Terminal, would perform acceptably according to the Test Level 3 (TL-3) evaluation criteria set out in the MASH guidelines for terminals. Eligibility Letter CC-115 indicates that test 3-38 is not necessary because the SOFT-STOP is not a staged device and that manufacturers calculations predict crash worthy performance with the 1500A vehicle.	WAIVER REQUES
3-40 (1100C)	Does not apply to non-gating/energy absorbing devices.	
3-41 (2270P)	Does not apply to non-gating/energy absorbing devices.	
3-42 (1100C)	Does not apply to non-gating/energy absorbing devices.	
3-43 (2270P)	Does not apply to non-gating/energy absorbing devices.	
3-44 (2270P)	Does not apply to non-gating/energy absorbing devices.	
3-45 (1500A)	Does not apply to non-gating/energy absorbing devices.	

Full Scale Crash Testing was done in compliance with MASH by the following accredited crash test laboratory (cite the laboratory's accreditation status as noted in the crash test reports.):

Laboratory Name:	Texas Transportation Institute
Laboratory Contact:	Dean Alberson
Address:	3135 TAMU, College Station, TX. 77843-3135
Country:	USA
Accreditation Certificate Number and Date:	Mechanical 2821.01, Current date April 30, 2013

ATTACHMENTS

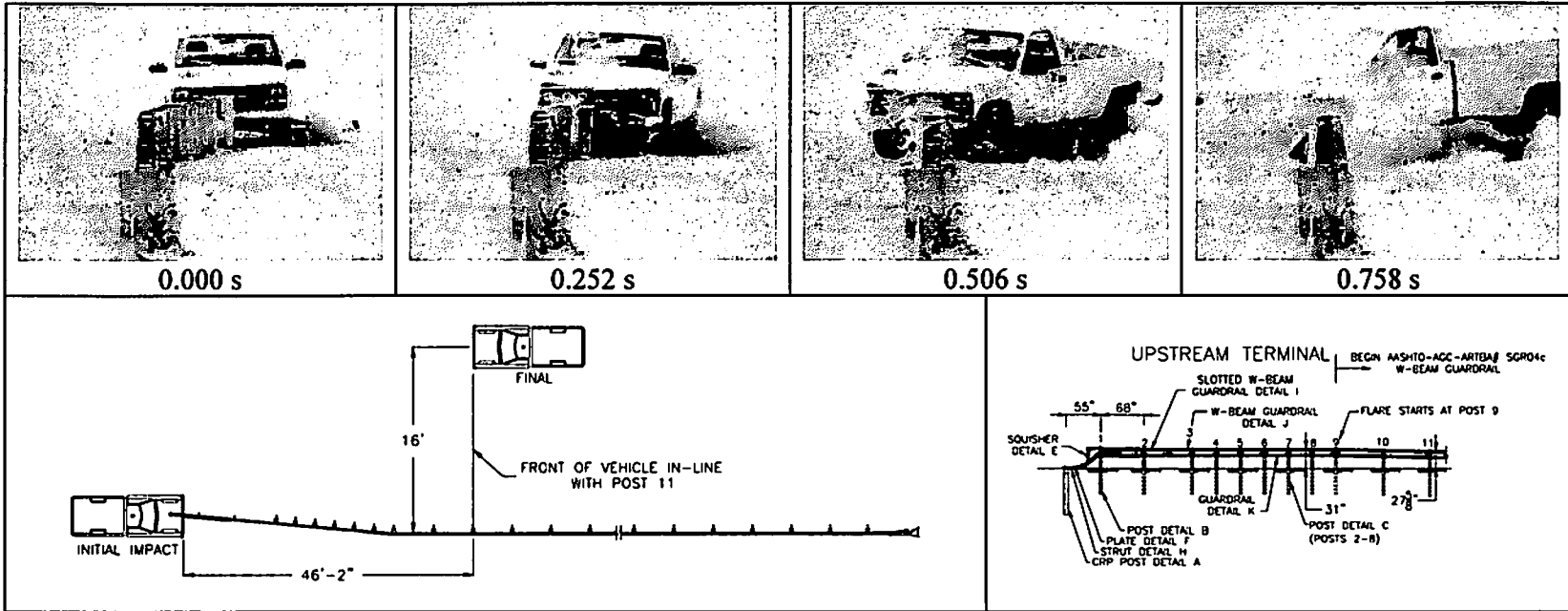
Attach to this form:

- 1) A copy of the Test Data Summary Sheet for each test conducted in support of this request.
- 2) A drawing or drawings of the device(s) that conform to the Task Force-13 Drawing Specifications [Hardware Guide Drawing Standards]. For proprietary products, a single isometric line drawing is usually acceptable to illustrate the product, with detailed specifications, intended use, and contact information provided on the reverse. Additional drawings (not in TF-13 format) showing details that are key to understanding the performance of the device should also be submitted to facilitate our

review.

FHWA Official Business Only:

Eligibility Letter		AASHTO TF13	
Number	Date	Designator	Key Words
CC-115A	August 31, 2012	SEW22	non-gating/energy absorbing terminal, tensioned w-beam guardrail terminal, steel yielding terminal posts, deflector terminal head.



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General Information

Test Agency..... Texas Transportation Institute
 Test No. 220513-2-15
 Date 2008-09-01

Test Article

Type..... Terminal
 Name Vertical Squisher
 Installation Length 147 ft-9 inches
 Material or Key Elements Tensioned 12-gauge W-beam guardrail terminal

Soil Type and Condition..... Standard Soil, Damp

Test Vehicle

Type/Designation..... 2000P
 Make and Model..... 1997 Chevrolet C2500 Pickup
 Curb..... 4683
 Test Inertial..... 4594
 Dummy No dummy
 Gross Static..... 4594

Impact Conditions

Speed62.6 mi/h
 Angle0.4 degrees
 Location/OrientationEnd-on

Exit Conditions

SpeedN/A
 Angle145.5 degrees

Occupant Risk Values

Impact Velocity
 Longitudinal21.3 ft/s
 Lateral2.6 ft/s
 Ridedown Accelerations
 Longitudinal-8.1 g's
 Lateral6.6 g's
 THIV23.6 km/h
 PHD8.3 g's
 Max. 0.050-s Average
 Longitudinal-6.2 g's
 Lateral3.3 g's
 Vertical-2.8 g's

Post-Impact Trajectory

Stopping Distance46.1 ft downstream
16 ft behind

Vehicle Stability

Maximum Yaw Angle..... 150 degrees
 Maximum Pitch Angle..... 10 degrees
 Maximum Roll Angle..... 18 degrees

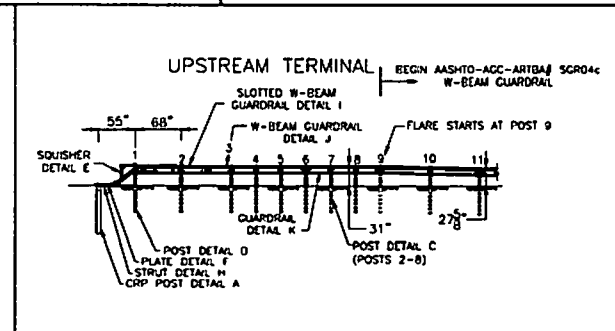
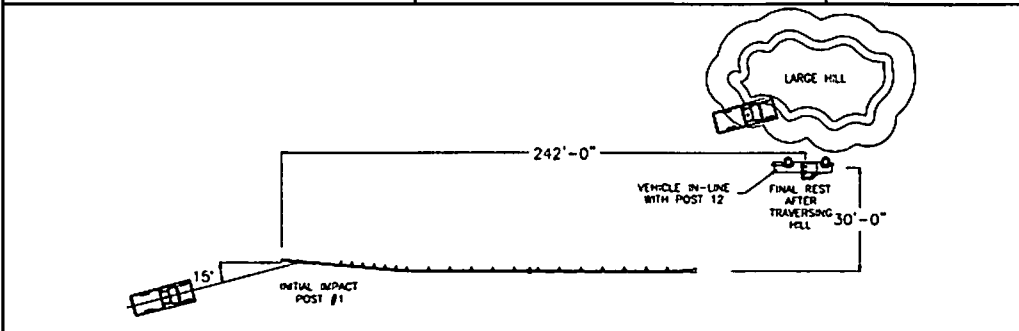
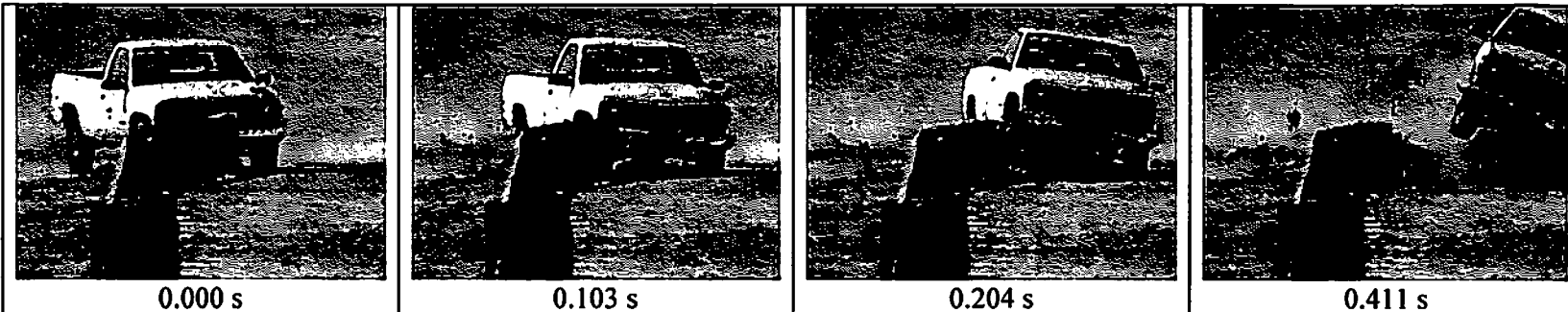
Test Article Deflections

Dynamic.....30.0 ft
 Permanent.....30.0 ft
 Working Width22.2 ft

Vehicle Damage

VDS12FC2
 CDC12FCEW2
 Max. Exterior Deformation..... 17.7 inches
 Max. Occupant Compartment Deformation..... 0
 OCDI.....FS0000000

Figure 24. Summary of results for NCHRP Report 350 test 3-31 on the Vertical Squisher.



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General Information

Test Agency..... Texas Transportation Institute
 Test No. 220513-2-17
 Date 2008-09-30

Test Article

Type..... Terminal
 Name Vertical Squisher
 Installation Length 14 ft 9 inches
 Material or Key Elements Tensioned 12-gauge W-beam guardrail terminal

Soil Type and Condition..... Standard Soil, Dry

Test Vehicle

Type/Designation..... 2000P
 Make and Model 1999 Chevrolet C2500 Pickup
 Curb 4753 lb
 Test Inertial..... 4506 lb
 Dummy No dummy
 Gross Static..... 4506 lb

Impact Conditions

Speed62.7 mi/h
 Angle16.3 degrees
 Location/OrientationEnd-on

Exit Conditions

Speed51.7 mi/h
 Angle 1.8 degrees

Occupant Risk Values

Impact Velocity
 Longitudinal18.4 ft/s
 Lateral 7.2 ft/s
 Ridedown Accelerations
 Longitudinal-3.7 g/s
 Lateral-4.9 g/s
 THIV21.4 km/h
 PHD 5.9 g/s
 Max. 0.050-s Average
 Longitudinal-6.7 g/s
 Lateral 2.5 g/s
 Vertical-4.1 g/s

Post-Impact Trajectory

Stopping Distance242 ft downstream
 30 ft behind

Vehicle Stability

Maximum Yaw Angle 36 degrees
 Maximum Pitch Angle..... -5 degrees
 Maximum Roll Angle.....-33 degrees

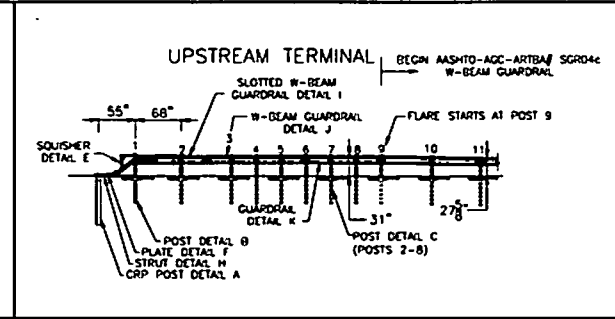
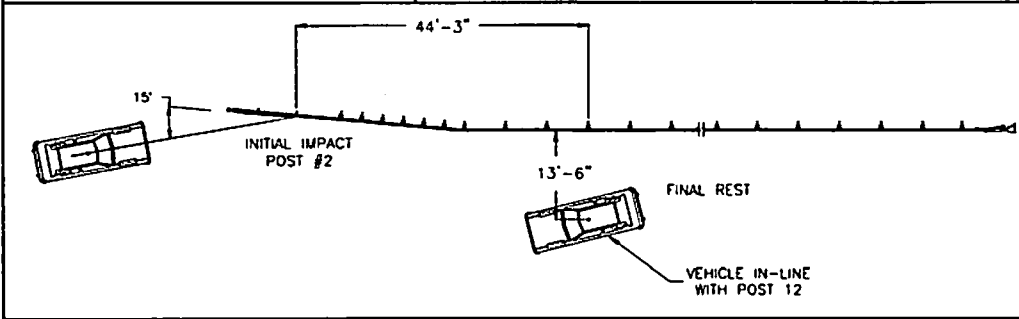
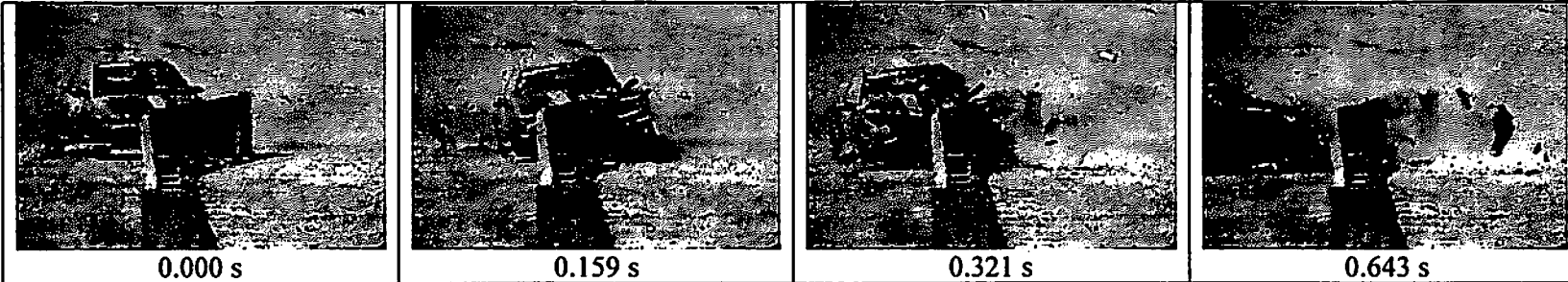
Test Article Deflections

Dynamic..... 7.44 ft
 Permanent..... 7.44 ft
 Working Width 30 ft

Vehicle Damage

VDS 12FC3
 CDC 12FCEW2
 Max. Exterior Deformation..... 13.4 inches
 Max. Occupant Compartment Deformation..... 0
 OCDI..... FS0000000

Figure 38. Summary of results for NCHRP Report 350 test 3-33 on the Vertical Squisher.



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General Information

Test Agency..... Texas Transportation Institute
 Test No. 220513-2-16
 Date 2008-09-23

Test Article

Type..... Terminal
 Name Vertical Squisher
 Installation Length 147 ft 9 inches
 Material or Key Elements Tensioned 12-gauge W-beam guardrail terminal

Soil Type and Condition..... Standard Soil, Dry

Test Vehicle

Type/Designation..... 820C
 Make and Model 1995 Chevrolet Metro
 Curb 1878 lb
 Test Inertial..... 1823 lb
 Dummy 170 lb
 Gross Static..... 1993 lb

Impact Conditions

Speed61.7 mi/h
 Angle13.6 degrees
 Location/Orientation

Exit Conditions

Speed23.0 mi/h
 Angle61.1 degrees

Occupant Risk Values

Impact Velocity
 Longitudinal.....21.3 ft/s
 Lateral18.4 ft/s
 Ridedown Accelerations
 Longitudinal.....-14.1 g's
 Lateral 10.5 g's
 THIV27.6 km/h
 PHD17.3 g's
 Max. 0.050-s Average
 Longitudinal.....-10.1 g's
 Lateral 6.6 g's
 Vertical -2.2 g's

Post-Impact Trajectory

Stopping Distance43.75 ft downstream
 13.5 ft forward

Vehicle Stability

Maximum Yaw Angle.....-172 degrees
 Maximum Pitch Angle..... 5 degrees
 Maximum Roll Angle..... 6 degrees

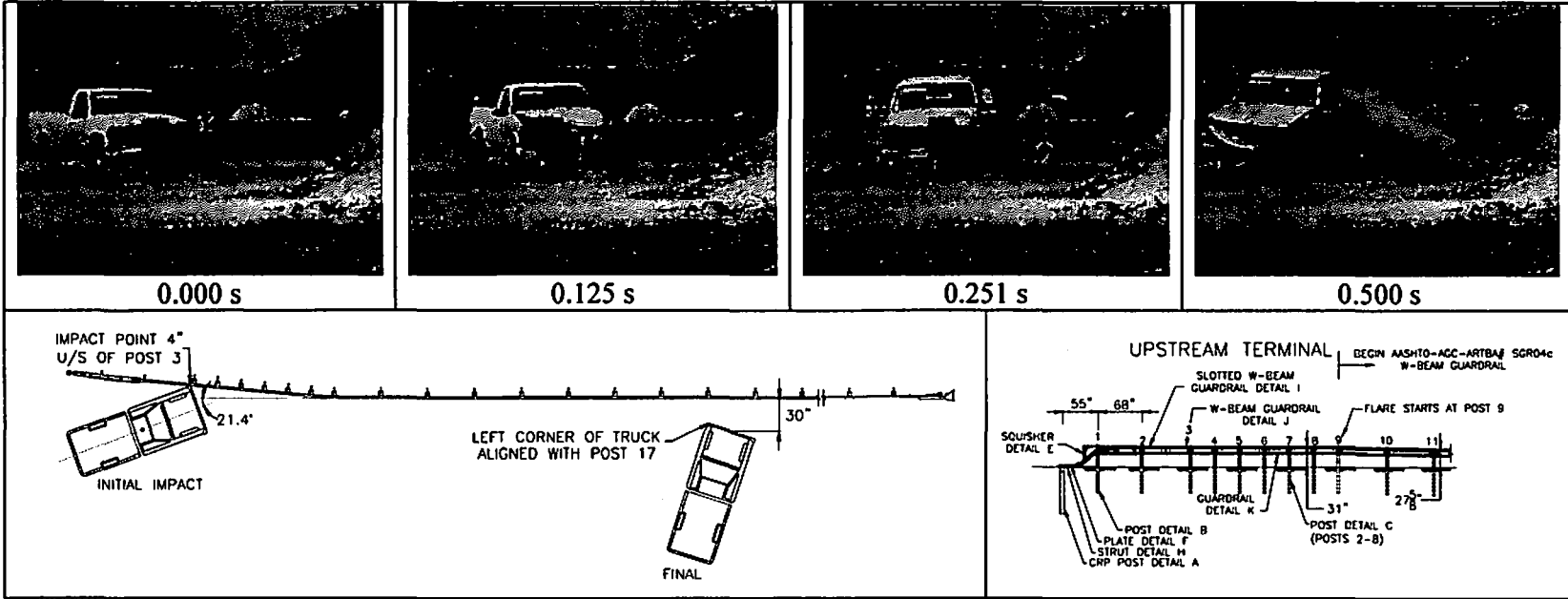
Test Article Deflections

Dynamic.....1.48 ft
 Permanent.....1.47 ft
 Working Width2.19 ft

Vehicle Damage

VDS 11LFQ4
 CDC 11FLEW3
 Max. Exterior Deformation 13.4 inches
 Max. Occupant Compartment
 Deformation.....3.5 inches
 OCDI..... LF0021000

Figure 31. Summary of results for NCHRP Report 350 test 3-34 on the Vertical Squisher.



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General Information

Test Agency..... Texas Transportation Institute
 Test No. 220513-2-14
 Date 2008-08-15

Test Article

Type..... Terminal
 Name Vertical Squisher
 Installation Length 147 ft-9 inches
 Material or Key Elements Tensioned 12-gauge W-beam guardrail terminal

Soil Type and Condition..... Standard Soil, Moist

Test Vehicle

Type/Designation..... 2000P
 Make and Model 1997 Chevrolet C2500
 Curb 4683
 Test Inertial..... 4608
 Dummy No dummy
 Gross Static..... 4608

Impact Conditions

Speed62.3 mi/h
 Angle21.4 degrees
 Location/OrientationPost 3

Exit Conditions

Speed25.8 mi/h
 Angle12.1 degrees

Occupant Risk Values

Impact Velocity
 Longitudinal.....21.3 ft/s
 Lateral17.4 ft/s
 Ridedown Accelerations
 Longitudinal.....-7.8 g's
 Lateral 8.4 g's
 THIV27.9 km/h
 PHD8.4 g's

Max. 0.050-s Average

Longitudinal.....-7.5 g's
 Lateral 6.3 g's
 Vertical-4.3 g's

Post-Impact Trajectory

Stopping Distance 62.5 ft downstream
 2.5 ft fwd of traffic face

Vehicle Stability

Maximum Yaw Angle..... 37 degrees
 Maximum Pitch Angle..... -4 degrees
 Maximum Roll Angle.....-11 degrees

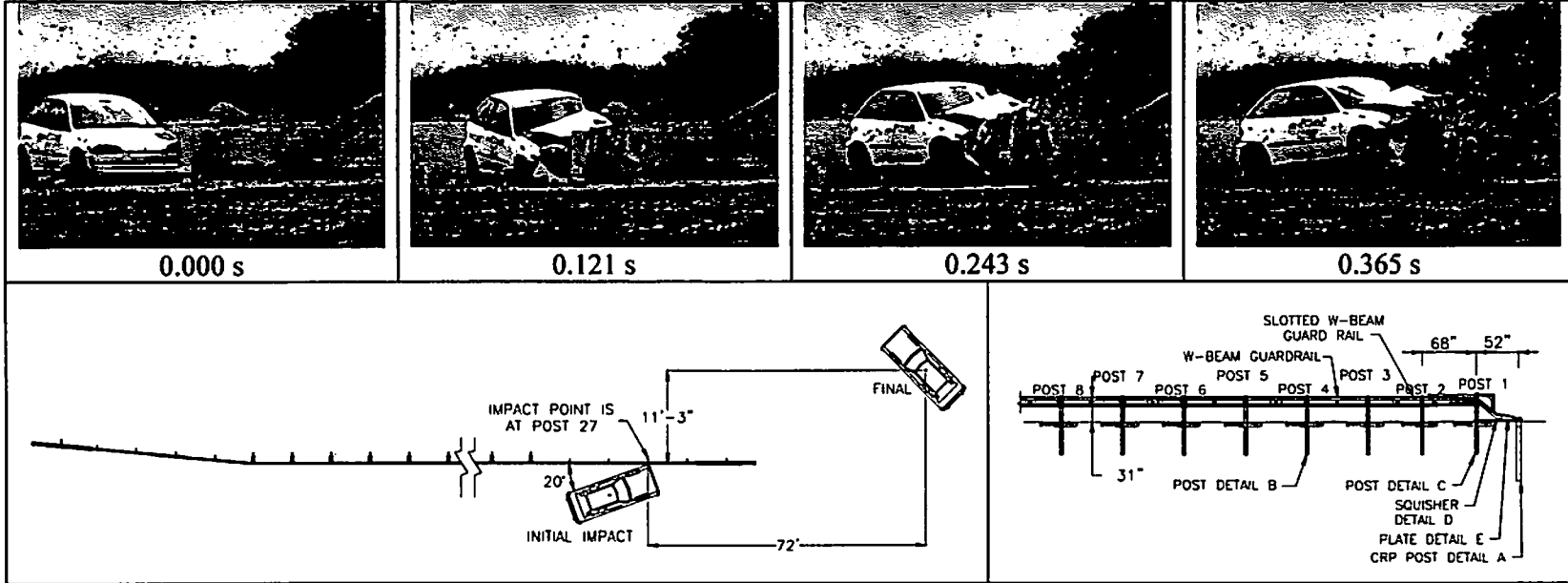
Test Article Deflections

Dynamic.....2.5 ft
 Permanent..... 1.5 ft
 Working Width 3.2 ft

Vehicle Damage

VDS 11LFQ4~
 CDC..... 11FLEW3
 Max. Exterior Deformation..... 16.5 inches
 Max. Occupant Compartment Deformation..... 1.2 inches
 OCCDI..... LF0002000

Figure 17. Summary of results for NCHRP Report 350 test 3-35 on the Vertical Squisher.



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General Information

Test Agency..... Texas Transportation Institute
 Test No. 220513-2-9
 Date 2008-02-04

Test Article

Type..... Terminal
 Name Vertical Squisher
 Installation Length 176 ft-3 inches
 Material or Key Elements Tensioned 12-gauge W-beam guardrail terminal

Soil Type and Condition..... Standard Soil, Moist

Test Vehicle

Type/Designation..... 2000P
 Make and Model..... 2000 Chevrolet Geo
 Curb..... 1885
 Test Inertial..... 1832
 Dummy 176
 Gross Static..... 2008

Impact Conditions

Speed62.1 mi/h
 Angle21.3 degrees
 Location/OrientationPost 3/reverse

Exit Conditions

Speed32.6 mi/h
 Angle41.2 degrees

Occupant Risk Values

Impact Velocity
 Longitudinal37.7 ft/s
 Lateral14.1 ft/s
 Ridedown Accelerations
 Longitudinal-7.2 g's
 Lateral 3.4 g's
 THIV42.2 km/h
 PHD10.9 g's
 Max. 0.050-s Average
 Longitudinal-15.3 g's
 Lateral 8.4 g's
 Vertical -4.9 g's

Post-Impact Trajectory

Stopping Distance67 ft downstream
 12.5 behind

Vehicle Stability

Maximum Yaw Angle.....-79 degrees
 Maximum Pitch Angle..... 8 degrees
 Maximum Roll Angle..... 12 degrees

Test Article Deflections

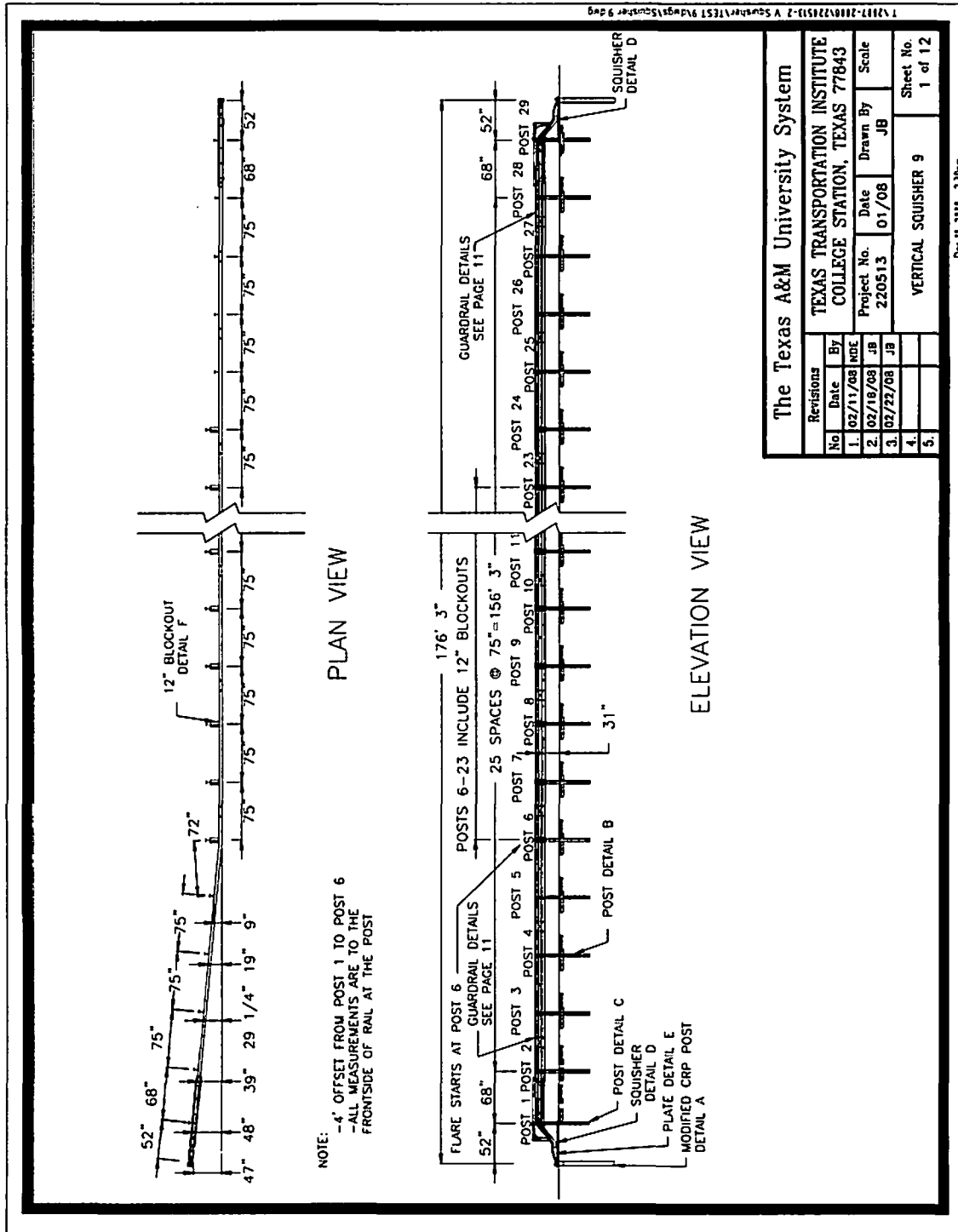
Dynamic.....2.9 ft
 Permanent.....1.6 ft
 Working Width5.3 ft

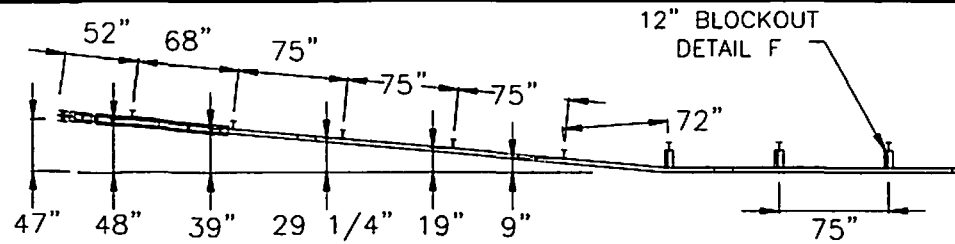
Vehicle Damage

VDS 11LFQ4
 CDC 11FLEW3
 Max. Exterior Deformation..... 14.6 inches
 Max. Occupant Compartment
 Deformation.....3.0 inches
 OCDI LF0120000

Figure 10. Summary of results for NCHRP Report 350 modified test 3-39 on the Vertical Squisher.

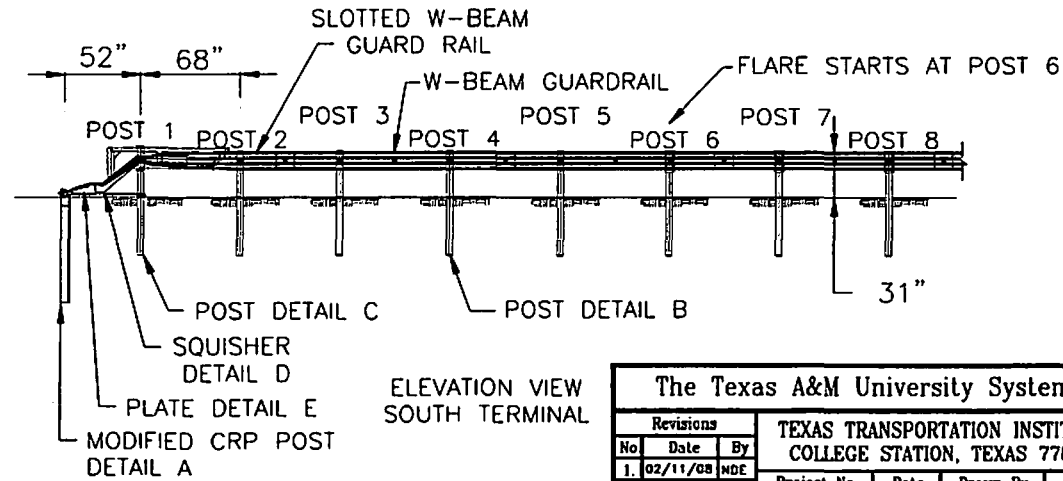
APPENDIX A. DETAILED DRAWINGS OF VERTICAL SQUISHER FOR TEST 220513-2-9





PLAN VIEW

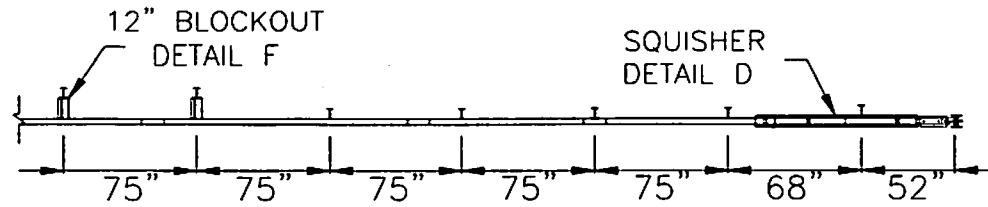
NOTE: -4' OFFSET FROM POST 1 TO POST 6
 -ALL MEASUREMENTS ARE TO THE
 BACKSIDE OF RAIL AT THE POST



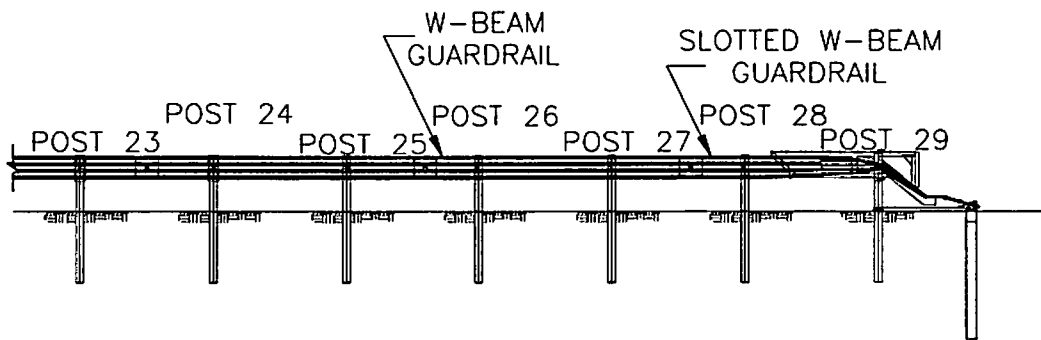
ELEVATION VIEW
 SOUTH TERMINAL

The Texas A&M University System					
TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843					
Revisions		Project No.	Date	Drawn By	Scale
No.	Date	By			
1.	02/11/08	NDF	220513	01/08	JB
2.	02/18/08	JB			
3.	02/22/08	JB			
4.					
5.					
VERTICAL SQUISHER 9				Sheet No. 2 of 12	

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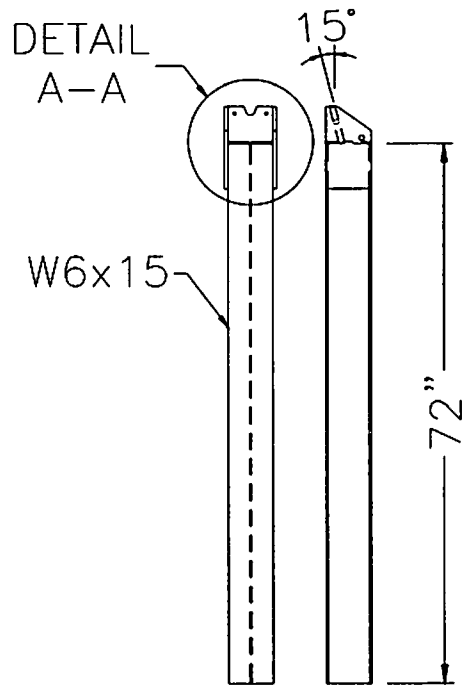
PLAN VIEW



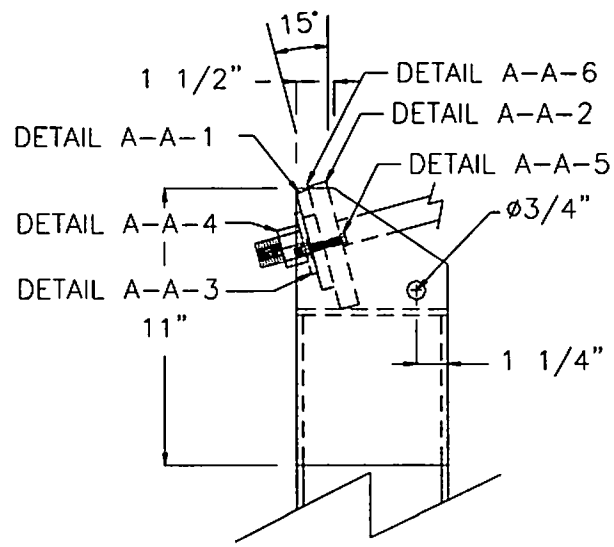
ELEVATION VIEW
REAR TERMINAL

The Texas A&M University System			
Revisions No. Date By			
1.	02/11/08	INDE	
2.	02/18/08	JB	
3.	02/22/08	JB	
4.			
5.			
TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843			
Project No.	Date	Drawn By	Scale
220513	01/08	JB	
VERTICAL SQUISHER 9			Sheet No. 3 of 12

T:\1101-21002\1101-2 V Squisher\TEST 9\dwg\1 Squisher 9.dwg



MODIFIED CRP
WITH 15° OFFSET
DETAIL A



ANCHOR ASSEMBLY
W/ 15° OFFSET
DETAIL A-A

The Texas A&M University System						
Revisions			TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843			
No	Date	By	Project No.	Date	Drawn By	Scale
1.	02/11/08	ndf	220513	01/08	JB	
2.						
3.						
4.						
5.						
VERTICAL SQUISHER 9						Sheet No. 4 of 12

I:\2007-2008\220513-2 V Squisher\TEST 9\dwg\15number 9.dwg

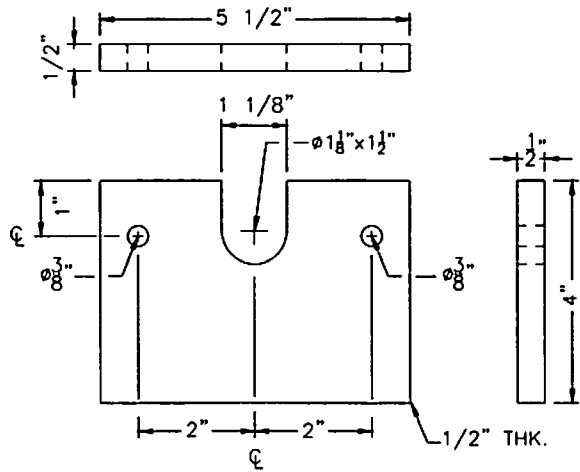
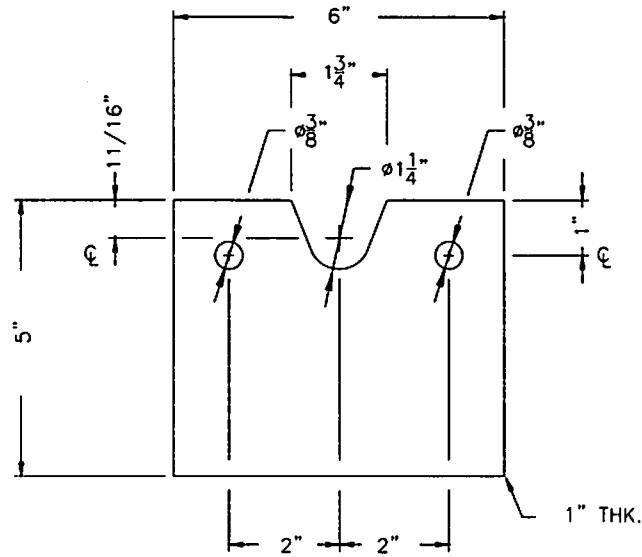
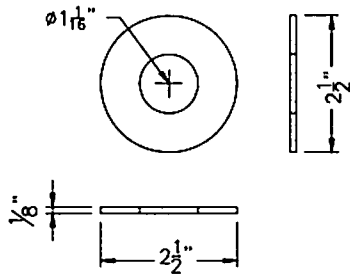


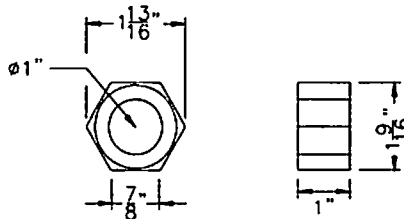
PLATE WASHER
DETAIL A-A-1



FLANGE PLATE
DETAIL A-A-2

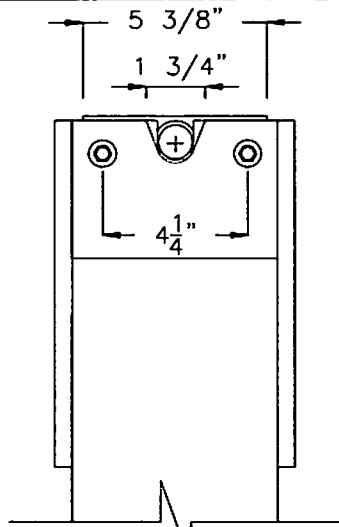


STD. WASHER
DETAIL A-A-3

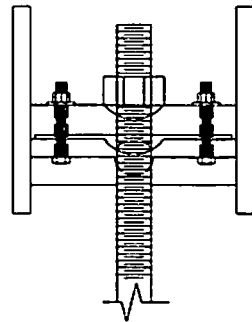


STD. NUT
DETAIL A-A-4

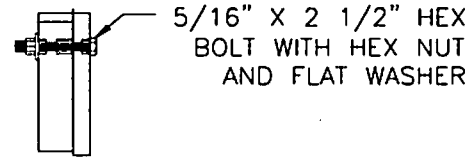
Revisions				The Texas A&M University System			
No.	Date	By		TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843			
1.	02/11/08	NDF		Project No.	Date	Drawn By	Scale
2.	02/18/08	JB		220513	01/08	JB	
3.				VERTICAL SQUISHER 9			Sheet No.
4.							5 of 12
5.							



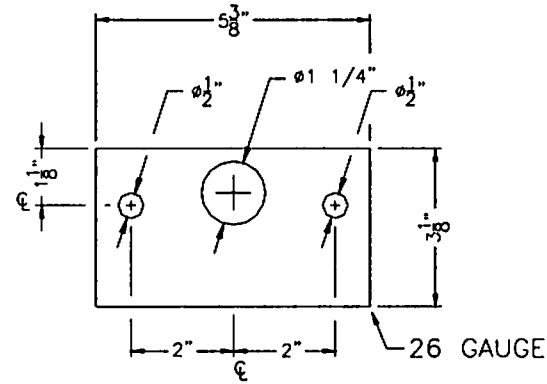
ELEVATION VIEW



PLAN VIEW
ROD DETAIL A-A-5

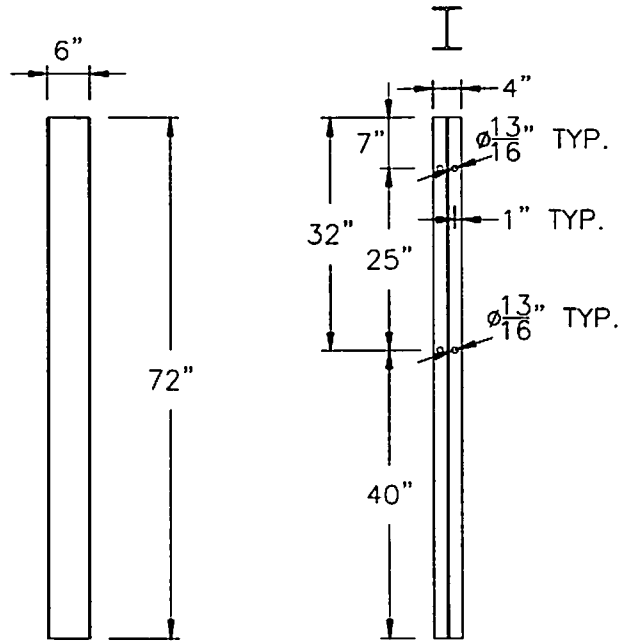


5/16" X 2 1/2" HEX
BOLT WITH HEX NUT
AND FLAT WASHER

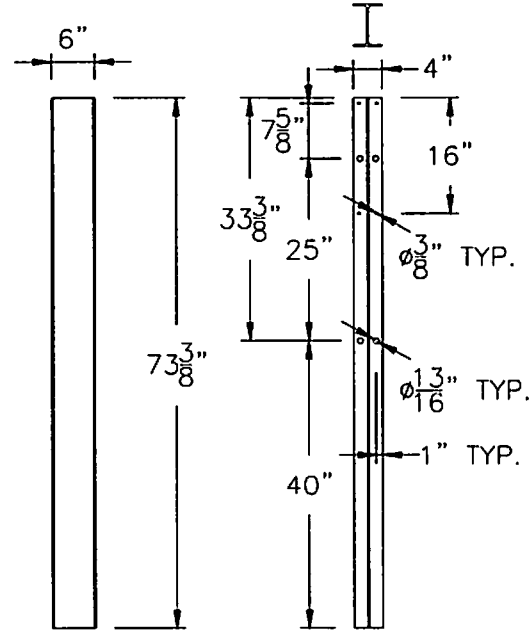


KEEPER PLATE
DETAIL A-A-6

The Texas A&M University System				TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843			
Revisions			Project No.	Date	Drawn By	Scale	Sheet No. 6 of 12
No	Date	By	220513	01/08	JB		
1.	02/11/08	NDE					
2.	02/18/08	JB					
3.							
4.							
5.							



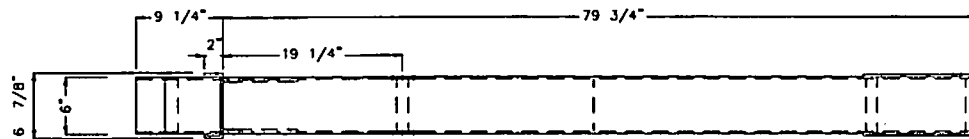
POSTS 2 THROUGH 28
SYTP-W6X8.5
DETAIL B



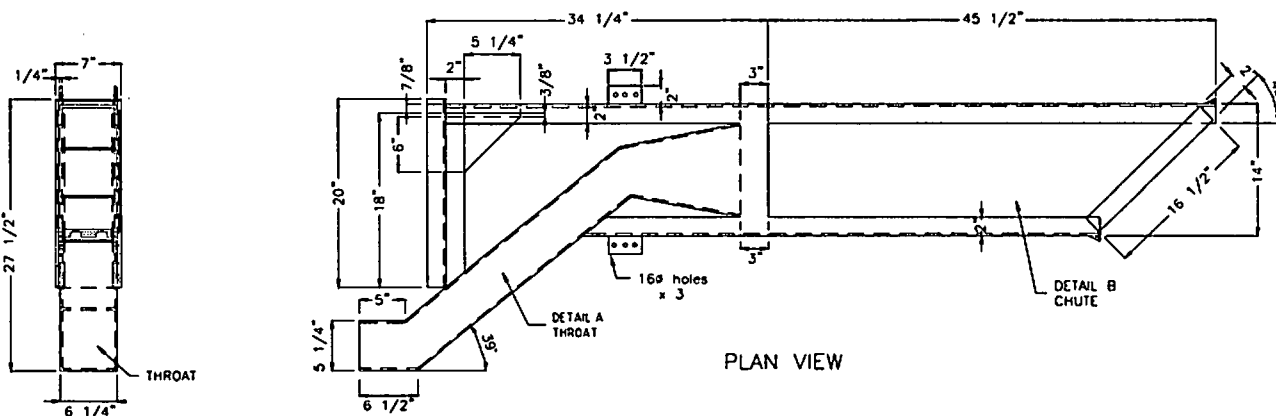
POSTS 1 AND 29
SYTP-W6X8.5
POST 1 DETAIL C

The Texas A&M University System			
Revisions			TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843
No	Date	By	
1.			Project No. 220513 Date 01/08 Drawn By JB Scale
2.			
3.			
4.			
5.			
VERTICAL SQUISHER 9			Sheet No. 7 of 12

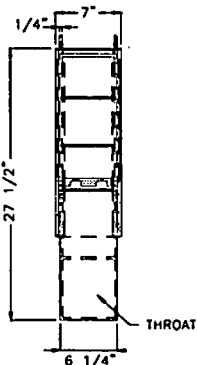
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ELEVATION VIEW



PLAN VIEW



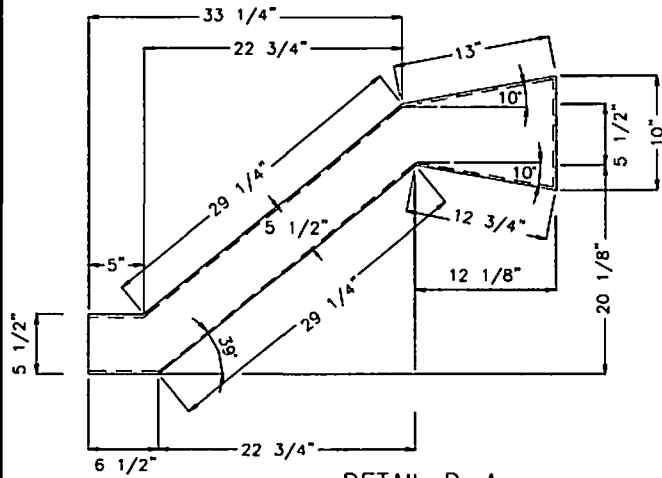
END VIEW

SQUISHER DETAIL D

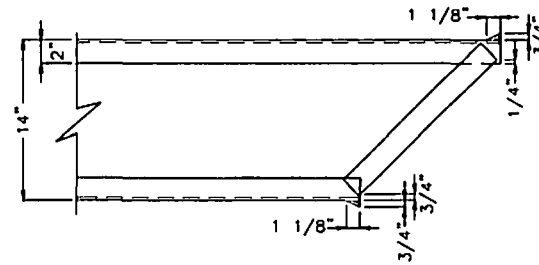
NOTE:
-ALL COMPONENTS ARE 6.35 THK. (1/4")

The Texas A&M University System																																				
<table border="1"> <thead> <tr> <th colspan="3">Revisions</th> <th colspan="4">TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843</th> </tr> <tr> <th>No</th> <th>Date</th> <th>By</th> <th>Project No.</th> <th>Date</th> <th>Drawn By</th> <th>Scale</th> </tr> </thead> <tbody> <tr> <td>1.</td> <td>02/11/08</td> <td>NOT</td> <td rowspan="5">220513</td> <td rowspan="5">01/08</td> <td rowspan="5">JB</td> <td rowspan="5"></td> </tr> <tr> <td>2.</td> <td>02/22/08</td> <td>JB</td> </tr> <tr> <td>3.</td> <td></td> <td></td> </tr> <tr> <td>4.</td> <td></td> <td></td> </tr> <tr> <td>5.</td> <td></td> <td></td> </tr> </tbody> </table>				Revisions			TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843				No	Date	By	Project No.	Date	Drawn By	Scale	1.	02/11/08	NOT	220513	01/08	JB		2.	02/22/08	JB	3.			4.			5.		
Revisions			TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843																																	
No	Date	By	Project No.	Date	Drawn By	Scale																														
1.	02/11/08	NOT	220513	01/08	JB																															
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5.																																				
VERTICAL SQUISHER 9					Sheet No. 8 of 12																															

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DETAIL D-A



DETAIL D-B

Revisions				The Texas A&M University System			
No	Date	By	TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843				
1.	02/11/08	NDE	Project No.	Date	Drawn By	Scale	
2.	02/18/08	JB	220513	01/08	JB		
3.	02/22/08	JB	VERTICAL SQUISHER 9			Sheet No.	
4.						9 of 12	
5.							

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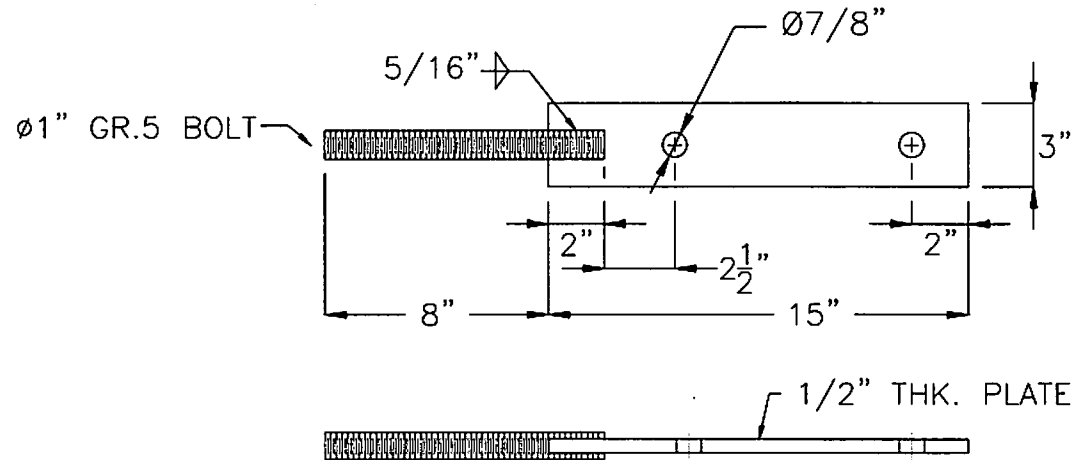
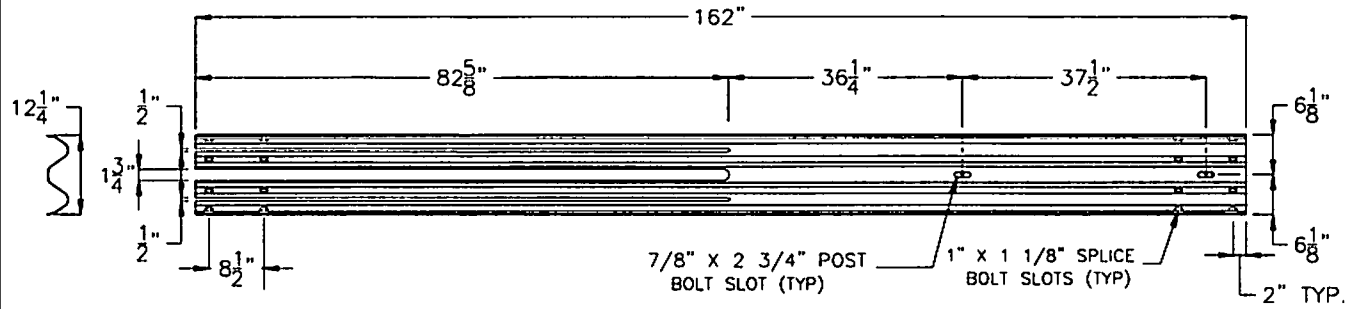


PLATE DETAIL E

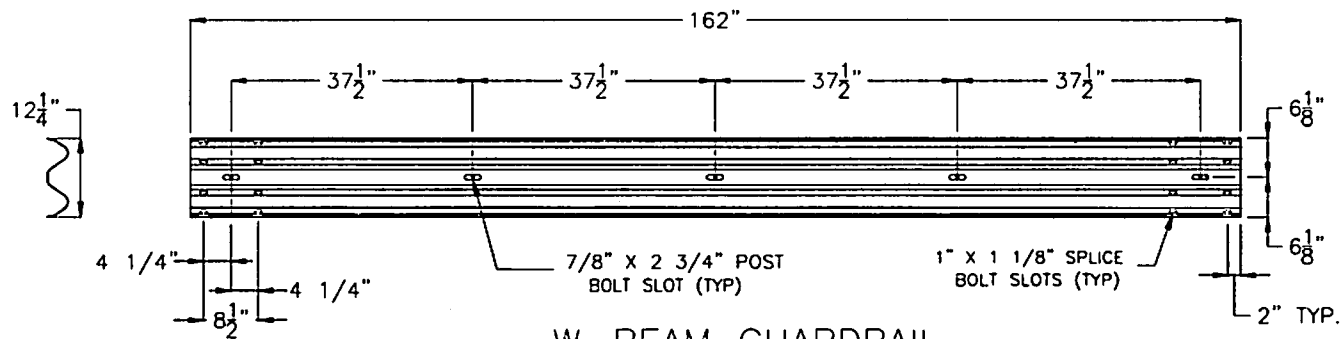
NOTE:

- USE 2-3/4" GR. 5 BOLTS
- 1/2" THK. PLATE IS NOTCHED TO RECEIVE A BOLT
- WELDS ARE ON BOTH SIDES OF PLATE

The Texas A&M University System						
Revisions			TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843			
No.	Date	By	Project No.	Date	Drawn By	Scale
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2.						
3.						
4.						
5.						
					VERTICAL SQUISHER 9	
					Sheet No. 10 of 12	

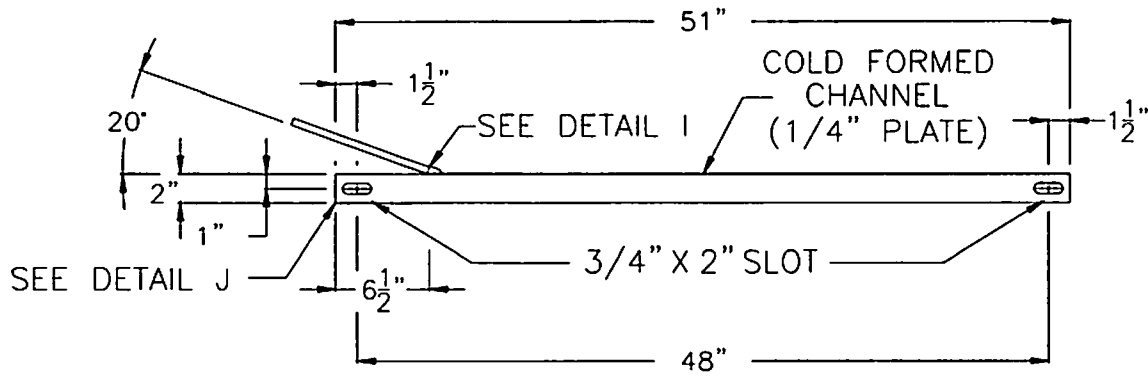


SLOTTED W-BEAM GUARDRAIL

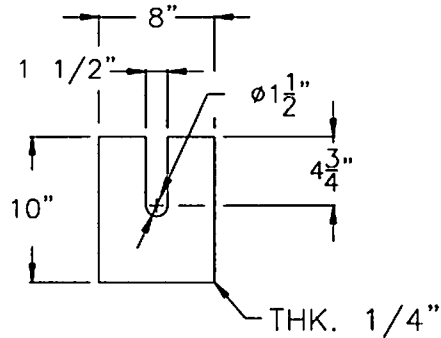


W-BEAM GUARDRAIL
ARTBA RWM04a

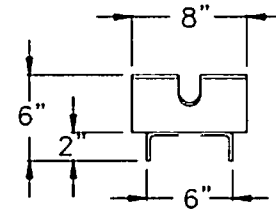
The Texas A&M University System							
Revisions			TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843				
No	Date	By	Project No.	Date	Drawn By	Scale	
1.	02/11/08	NDE	220513	01/08	JB		
2.	02/18/08	JB					
3.							
4.							
5.							
VERTICAL SQUISHER 9						Sheet No. 11 of 12	



STRUT SIDE VIEW
DETAIL H



STRUT PLATE
DETAIL I

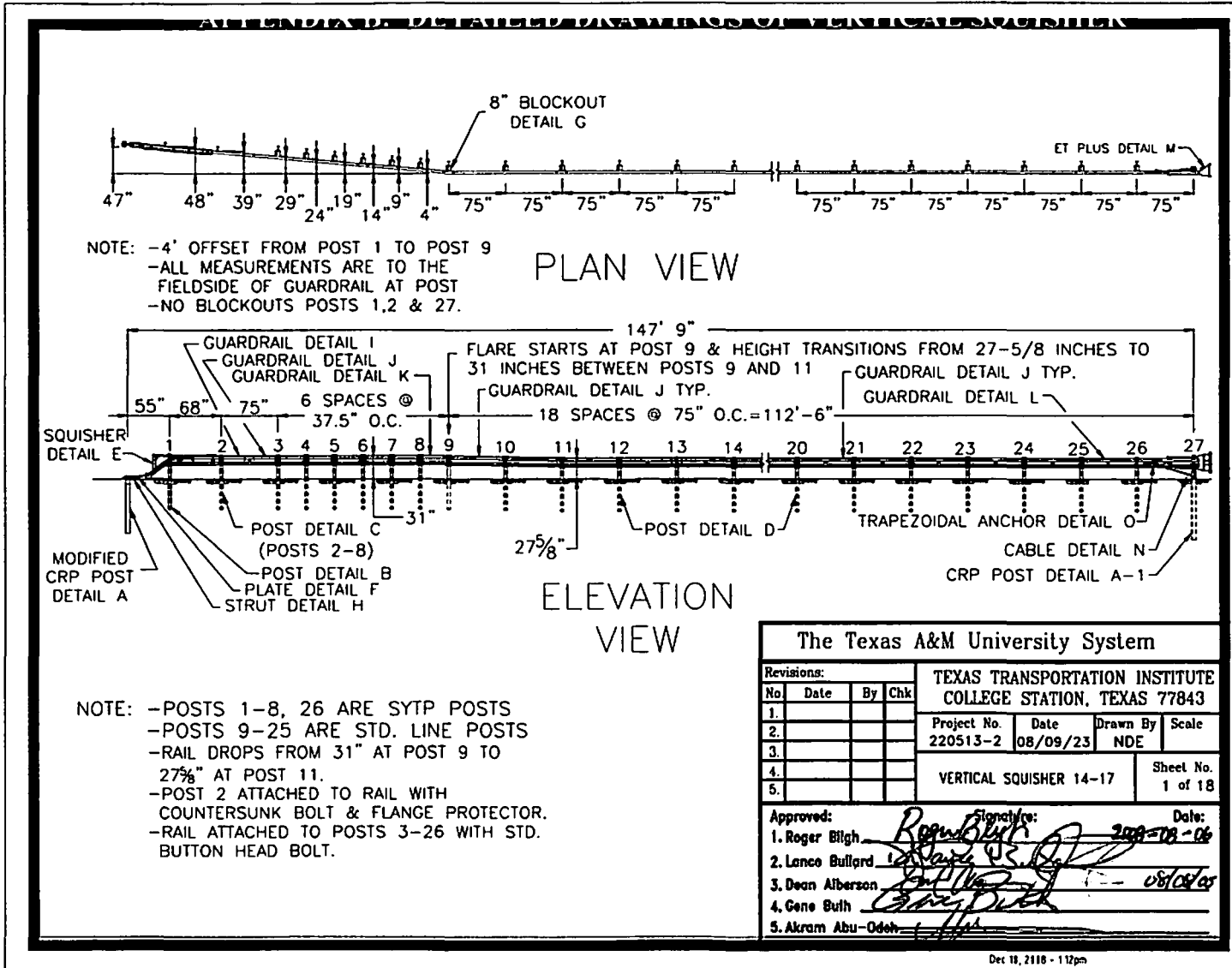


STRUT END VIEW
DETAIL J

Revisions			The Texas A&M University System			
No.	Date	By	TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843			
1.	02/11/08	NDE	Project No.	Date	Drawn By	Scale
2.			220513	01/08	JB	
3.			VERTICAL SQUISHER 9			Sheet No.
4.						12 of 12
5.						

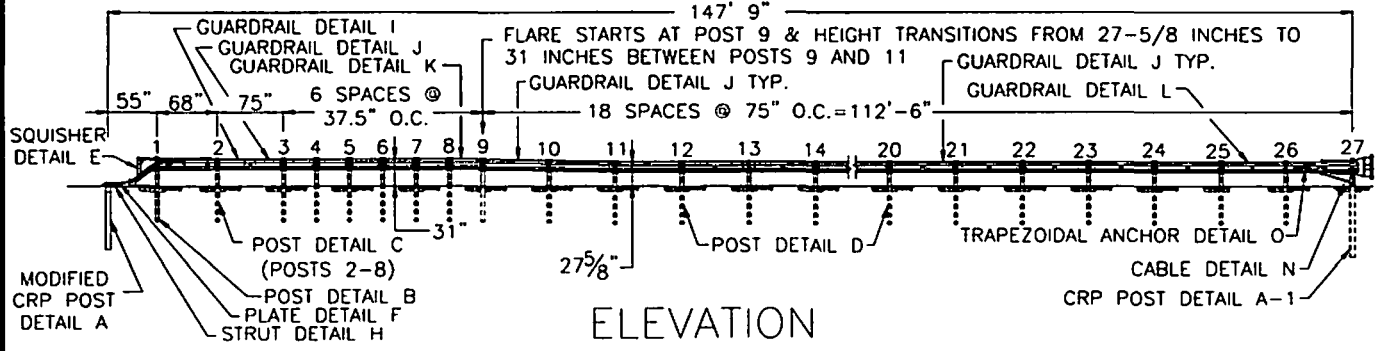
T:\2007-2008\220513-2 V Squisher\EST 9\wgsl Squisher 9.dwg

APPENDIX B. DETAILED DRAWINGS OF VERTICAL SQUISHER
FOR TEST 220513-2-14 THROUGH 220513-2-17A



NOTE: -4' OFFSET FROM POST 1 TO POST 9
-ALL MEASUREMENTS ARE TO THE FIELD SIDE OF GUARDRAIL AT POST
-NO BLOCKOUTS POSTS 1,2 & 27.

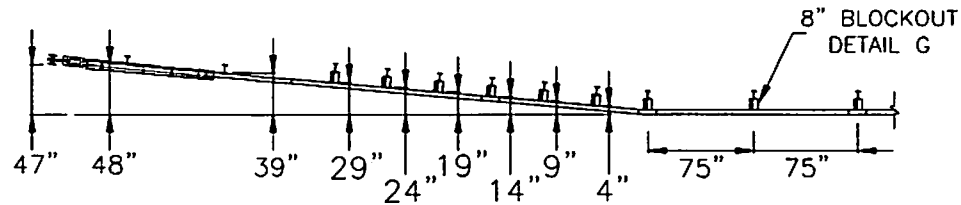
PLAN VIEW



ELEVATION VIEW

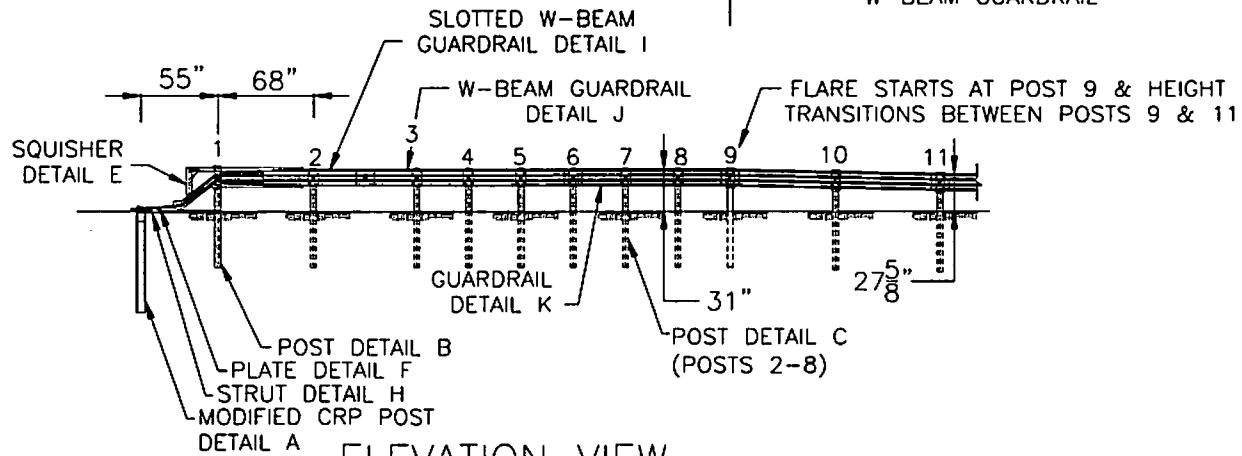
NOTE: -POSTS 1-8, 26 ARE SYTP POSTS
-POSTS 9-25 ARE STD. LINE POSTS
-RAIL DROPS FROM 31" AT POST 9 TO 27 5/8" AT POST 11.
-POST 2 ATTACHED TO RAIL WITH COUNTERSUNK BOLT & FLANGE PROTECTOR.
-RAIL ATTACHED TO POSTS 3-26 WITH STD. BUTTON HEAD BOLT.

The Texas A&M University System				
TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843				
Project No.		Date	Drawn By	Scale
220513-2		08/09/23	NDE	
VERTICAL SQUISHER 14-17				Sheet No. 1 of 18
Approved: _____ Date: _____				
1. Roger Bilgh _____ Signature: _____ Date: 2023-08-06				
2. Lance Bullard _____ Signature: _____ Date: 08/09/23				
3. Dean Albersson _____ Signature: _____ Date: 08/09/23				
4. Gene Bulth _____ Signature: _____ Date: _____				
5. Akram Abu-Odeh _____ Signature: _____ Date: _____				



PLAN VIEW
UPSTREAM TERMINAL

BEGIN AASHTO-AGC-ARTBA# SGR04c
W-BEAM GUARDRAIL

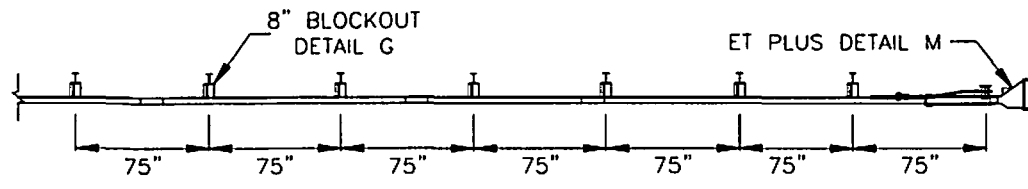


ELEVATION VIEW
UPSTREAM TERMINAL

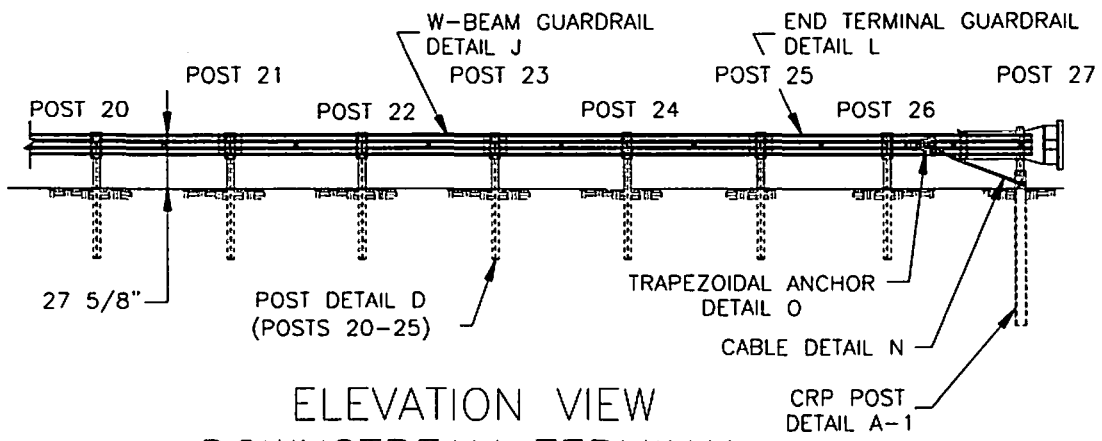
NOTE: -4' OFFSET FROM POST 1 TO POST 9.
-ALL MEASUREMENTS ARE TO THE
FIELD SIDE OF GUARDRAIL AT POST.
-NO BLOCKOUT AT POSTS 1&2.
-RAIL DROPS FROM 31" AT POST 9
TO 27 5/8" AT POST 11.

The Texas A&M University System			
Revisions:			
No	Date	By	Chk
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3.			
4.			
5.			
Project No.		Date	Drawn By
220513-2		08/09/23	NOE
Scale			Sheet No.
VERTICAL SQUISHER 14-17			2 of 18

1 N100-21021513-2 Vertical Squisher Upstream 14-17.dwg



PLAN VIEW
DOWNSTREAM TERMINAL

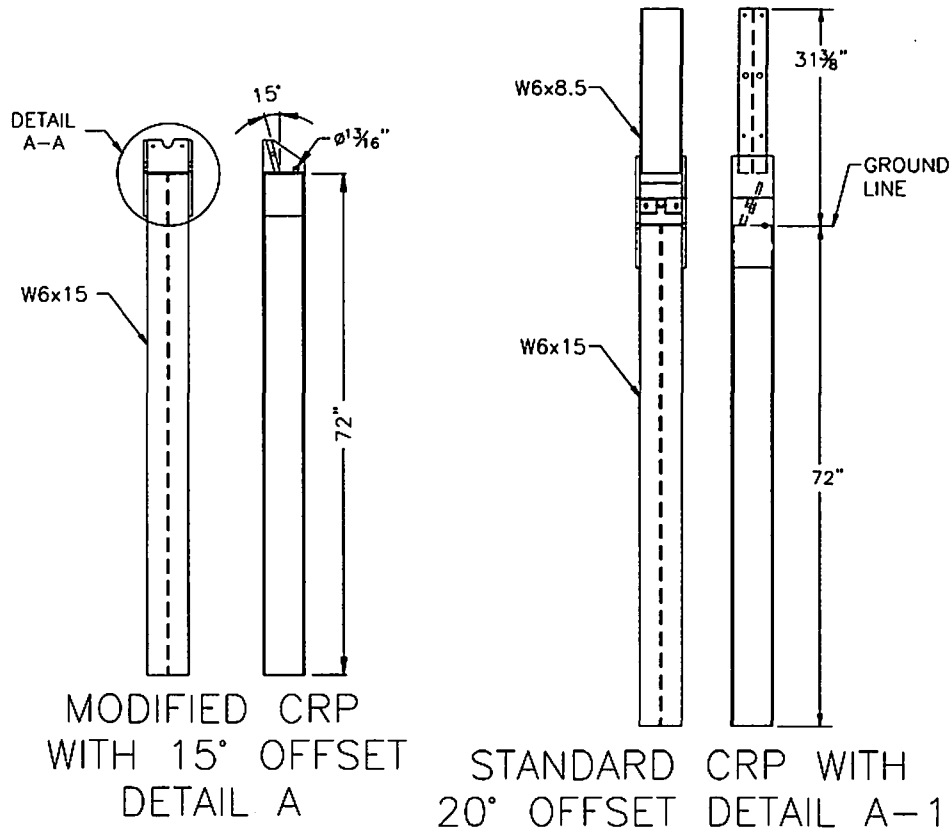


ELEVATION VIEW
DOWNSTREAM TERMINAL

NOTE: -NO BLOCKOUT AT POST 27

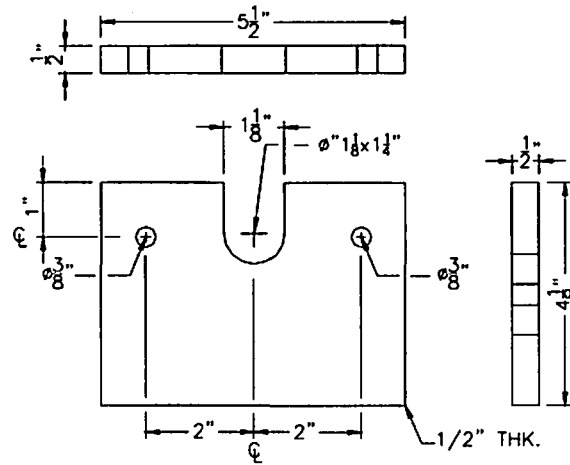
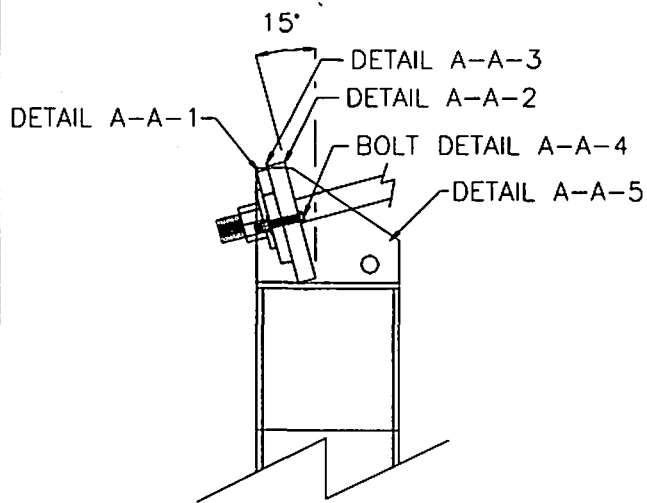
The Texas A&M University System			
Revisions:			
No.	Date	By	Chk
1.			
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5.			
TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843		Project No. 220513-2	Date 08/09/23
		Drawn By NOE	Scale
VERTICAL SQUISHER 14-17			Sheet No. 3 of 18

1. N100-2119221513-2 Vertical Squisher 14-17.dwg



The Texas A&M University System			
Revisions:			
No.	Date	By	Chk
1.			
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5.			
TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843			
Project No.	Date	Drawn By	Scale
220513-2	08/09/23	NDE	
VERTICAL SQUISHER 14-17			Sheet No. 4 of 18

1:12000-2020120513-2 Vertical Squisher 14-17.dwg

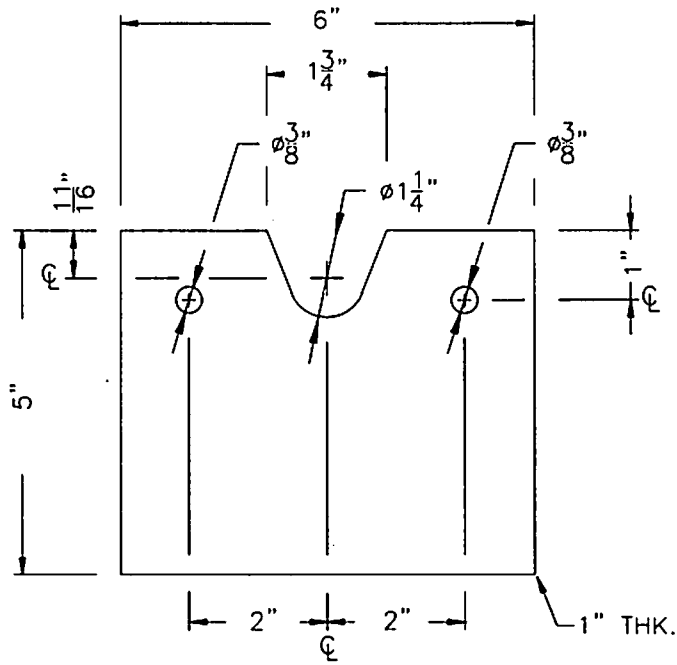


ANCHOR ASSEMBLY
WITH 15° OFFSET
DETAIL A-A

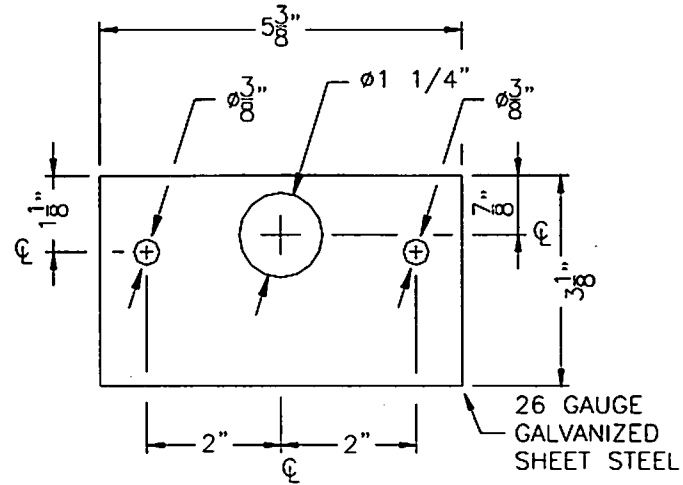
A-36 STEEL PLATE WASHER
DETAIL A-A-1

The Texas A&M University System					
Revisions:				TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843	
No.	Date	By	Chk.	Project No.	Date
1.				220513-2	08/09/23
2.				Drawn By	Scale
3.				NDE	
4.				VERTICAL SQUISHER 14-17	
5.				Sheet No. 5 of 18	

T 131108-2100121513-2 Vertical Squisher 14-17.dwg

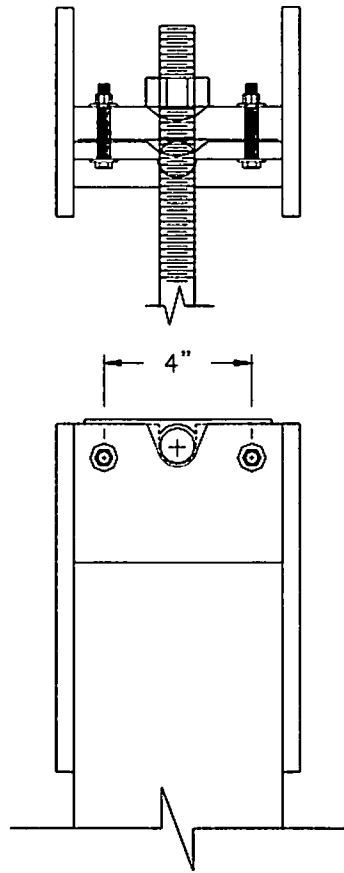


A-36 STEEL FLANGE PLATE
DETAIL A-A-2

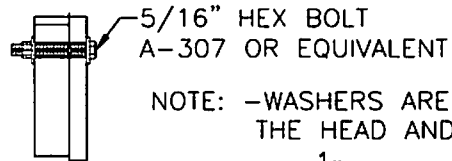


KEEPER PLATE
DETAIL A-A-3

The Texas A&M University System				
Revisions:				
No.	Date	By	Chk	
1.				
2.				
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4.				
5.				
TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843				
Project No.		Date	Drawn By	Scale
220513-2		08/09/23	NDE	
VERTICAL SQUISHER 14-17				Sheet No. 6 of 18



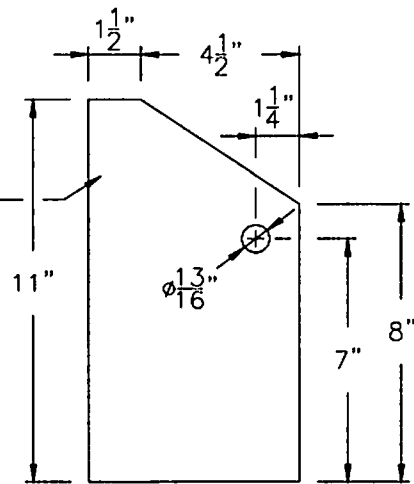
DETAIL A-A-4



5/16" HEX BOLT
A-307 OR EQUIVALENT

NOTE: -WASHERS ARE UNDER
THE HEAD AND THE NUT

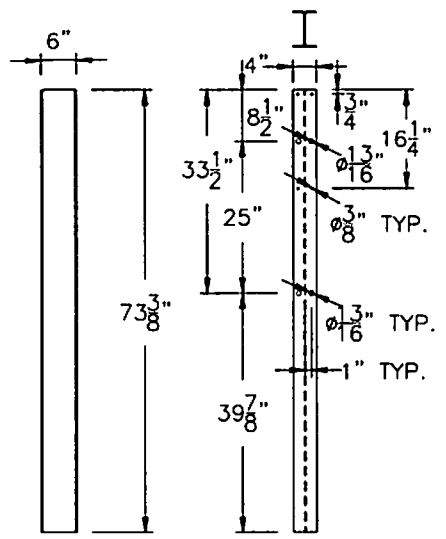
1/2" THK. A36
STL. PLATE



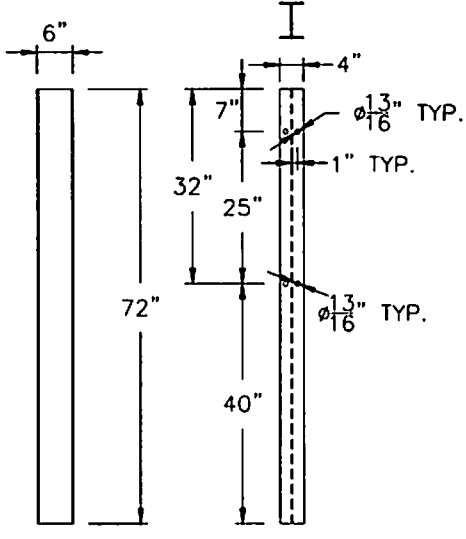
CRP SIDE PLATE
DETAIL A-A-5

The Texas A&M University System				
Revisions:				
No.	Date	By	Chk.	
1.				
2.				
3.				
4.				
5.				
TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843				
Project No.		Date	Drawn By	Scale
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VERTICAL SQUISHER 14-17				Sheet No.
				7 of 18

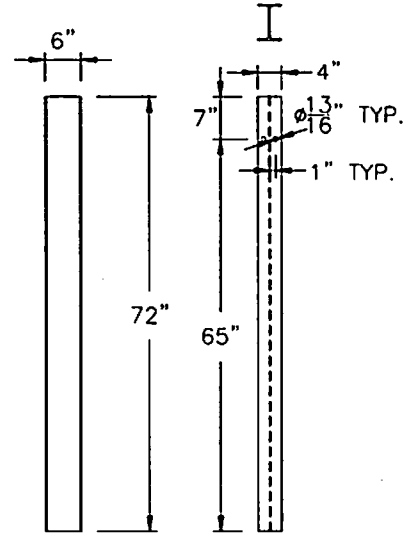
T:\1110-2110\2110-2 Vertical Squisher\Square.k-17.dwg



SYTP-W6X8.5
POST 1
DETAIL B



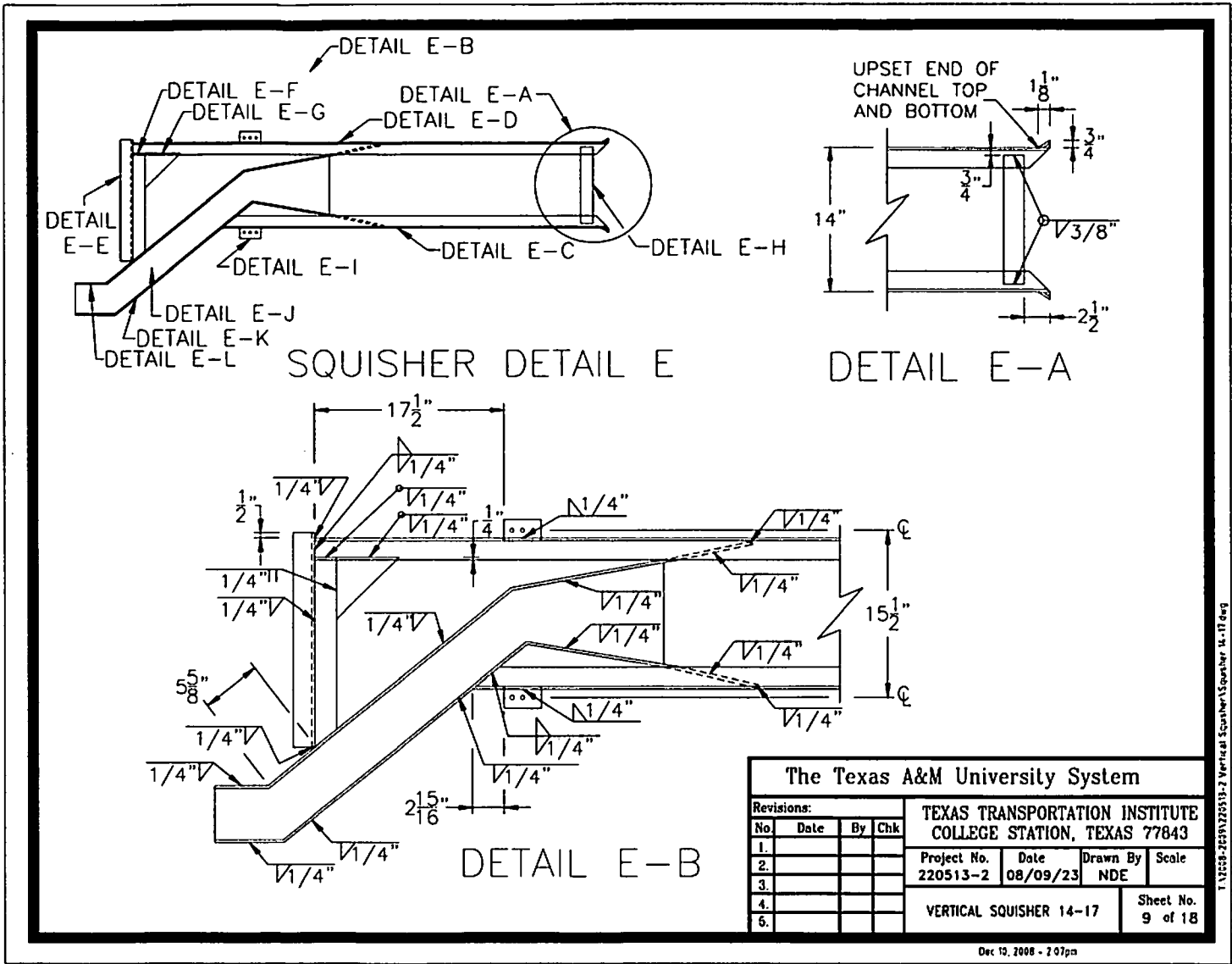
SYTP-W6X8.5
POSTS 2-8, 26
DETAIL C



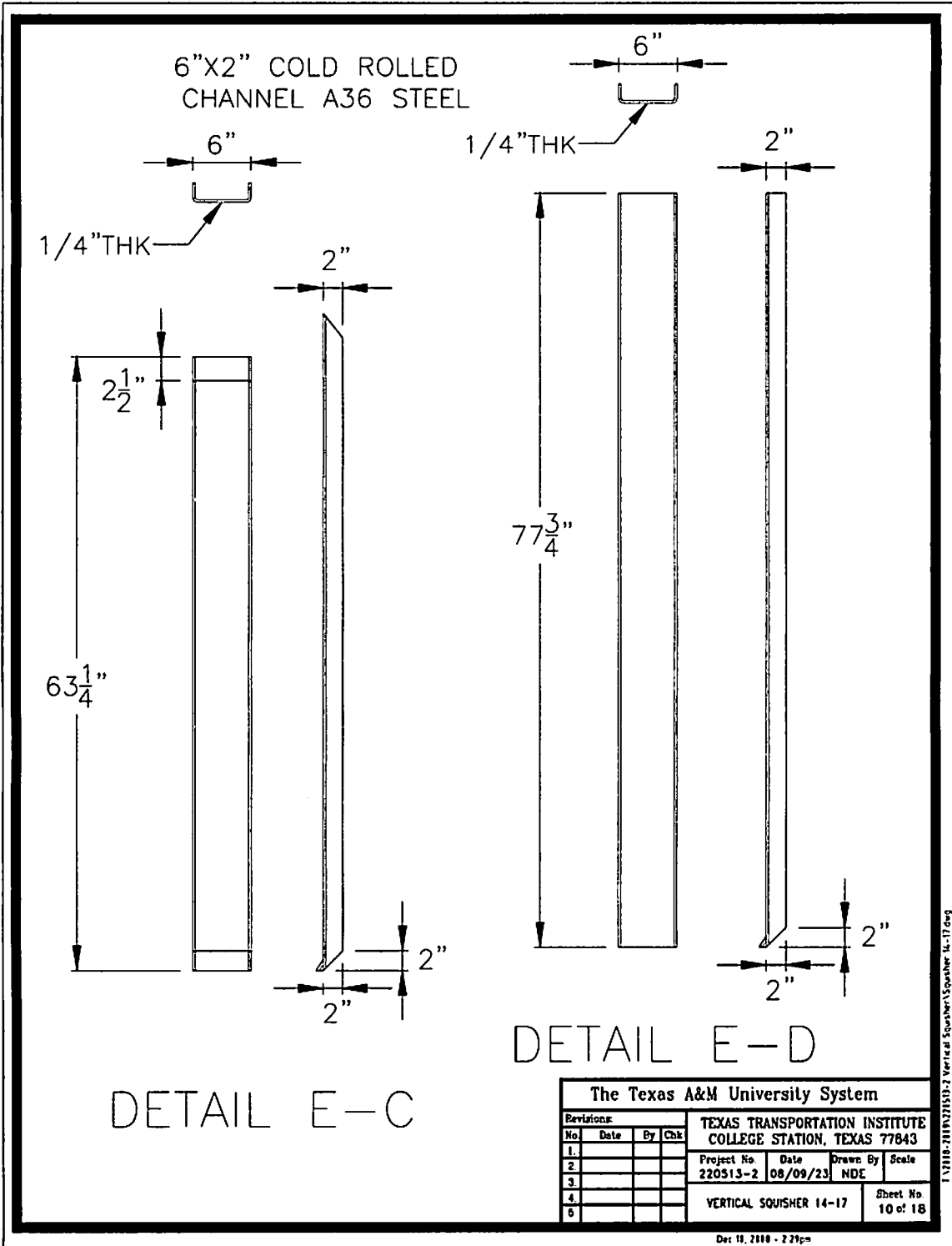
STD. LINE POSTS
W6X8.5
DETAIL D

The Texas A&M University System					
Revisions:				TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843	
No	Date	By	Chk	Project No.	Date
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3.				NDE	
4.				VERTICAL SQUISHER 14-17	
5.				Sheet No. 8 of 18	

T:\1305-2009\220513-2 Vertical Squisher\Separator M-17.dwg



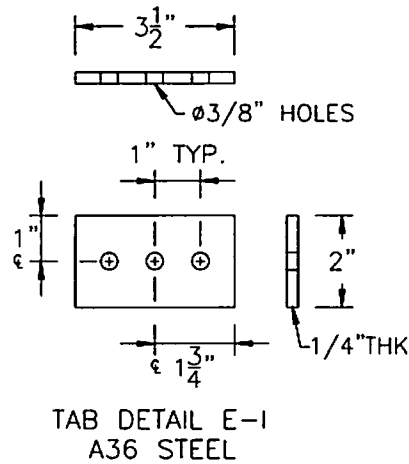
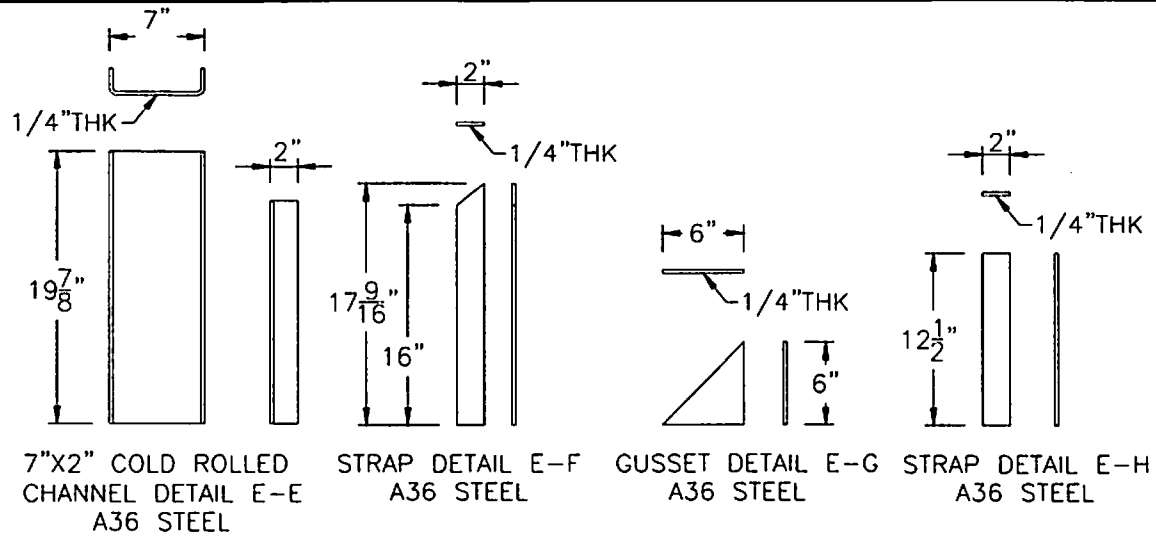
1. NCSB-2039120513-2 Vertical Squisher 14-17.dwg



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3.			Drawn By	Scale
4.			NDE	
5.			VERTICAL SQUISHER 14-17	Sheet No.
6.				10 of 18

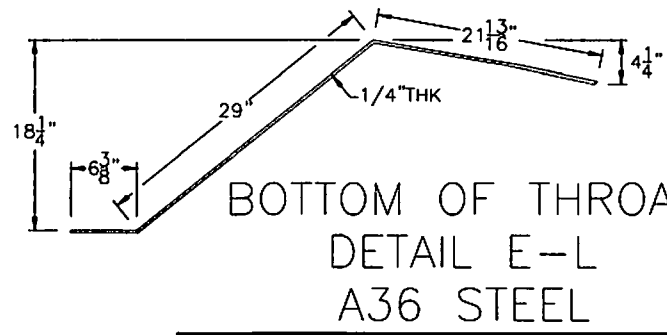
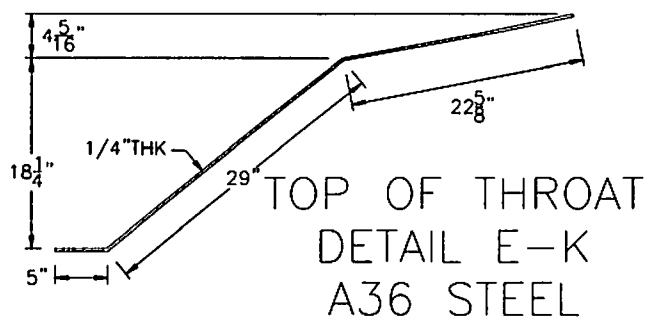
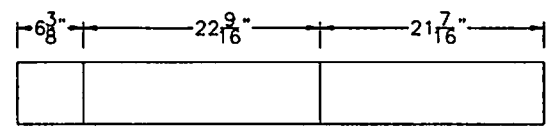
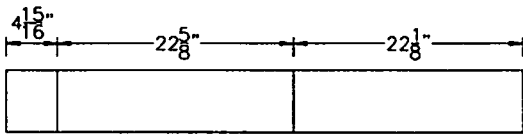
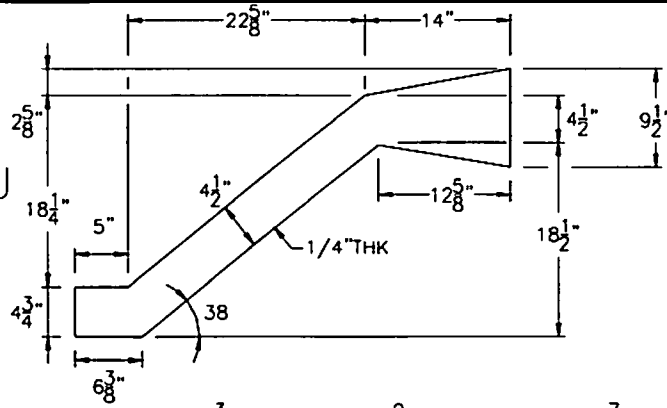
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THROAT DETAIL E-J
A36 STEEL

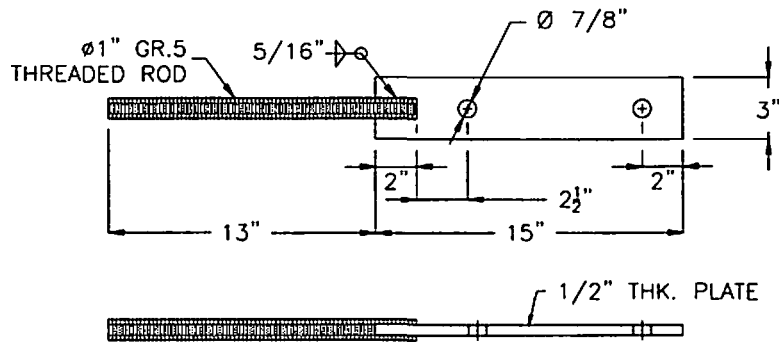


NOTE: -1/4" BEVEL FOR WELDING ON
DETAILS ?-J, ?-K, ?-L

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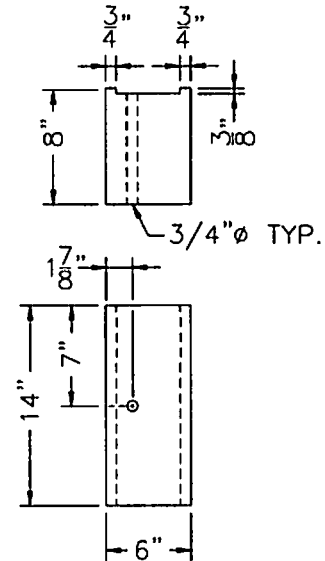
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VERTICAL SQUISHER 14-17						Sheet No. 12 of 18	

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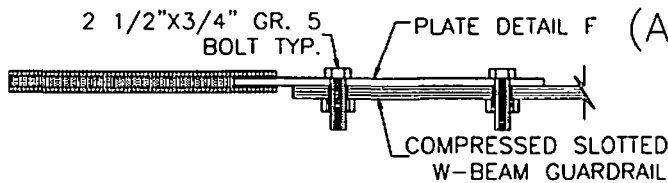


A-36 STEEL PLATE
DETAIL F

NOTE: -USE 2-2 1/2"x3/4" GR. 5 BOLTS
-1/2" THK. PLATE IS NOTCHED TO RECEIVE STUD

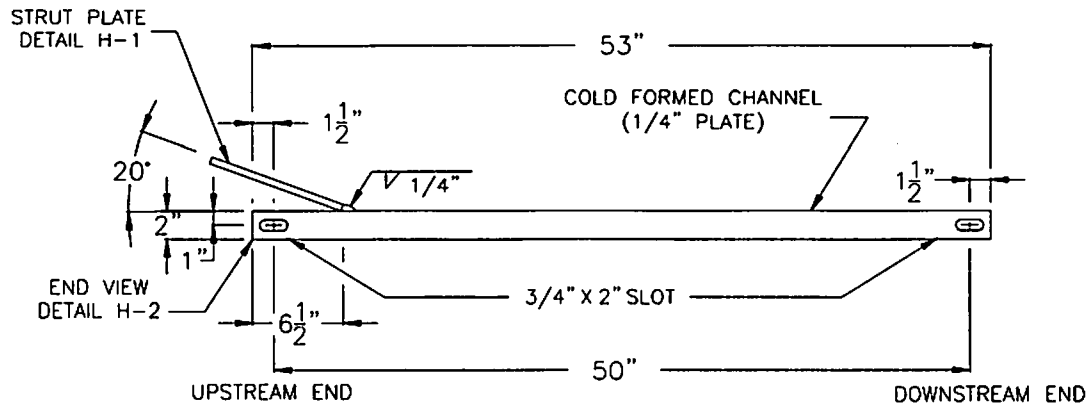


8" WOOD BLOCKOUT TYP.
(AASHTO-AGC-ARTBA# PDB01)
DETAIL G

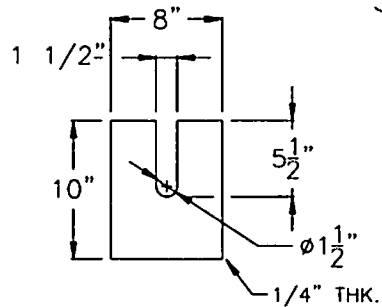


ASSEMBLY DETAIL F-A

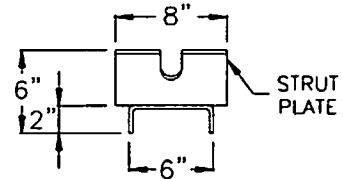
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STRUT SIDE VIEW
DETAIL H



STRUT PLATE
DETAIL H-1

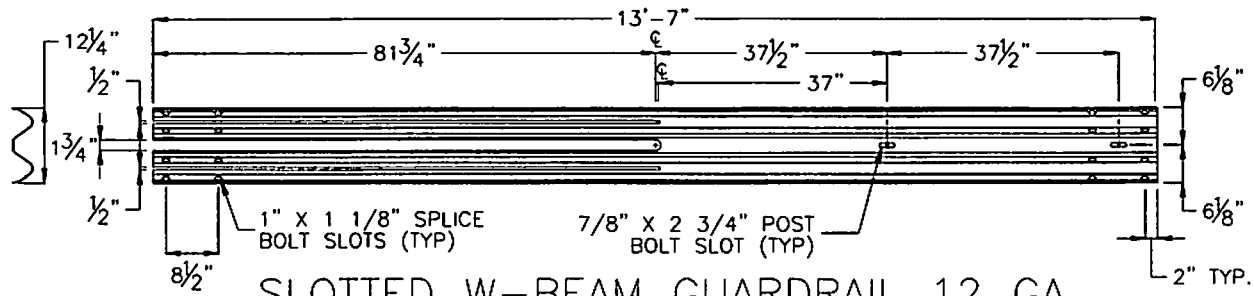


STRUT END VIEW
DETAIL H-2

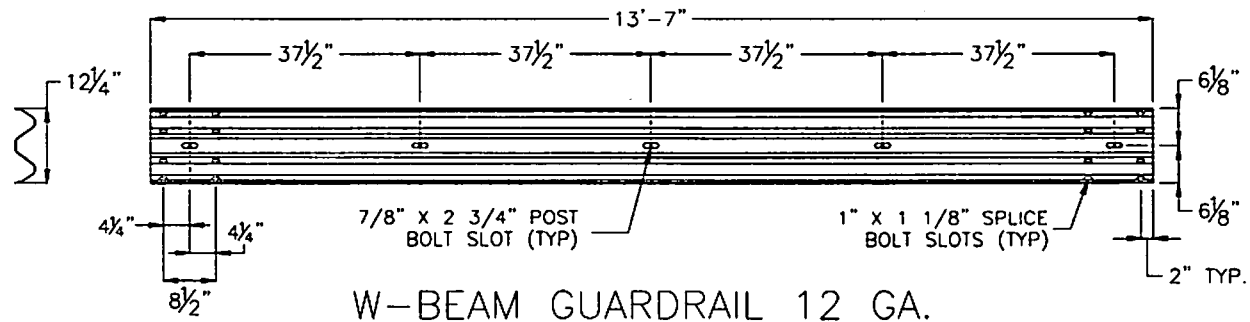
NOTE: -UPSTREAM END ATTACHED TO CRP POST DETAIL A WITH A 9"x5/8" ϕ A307 HEX HEAD BOLT.
 -DOWNSTREAM END ATTACHED TO POST 1 WITH A 1 1/2"x5/8" ϕ A307 HEX HEAD BOLT.

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VERTICAL SQUISHER 14-17			Sheet No. 14 of 18	

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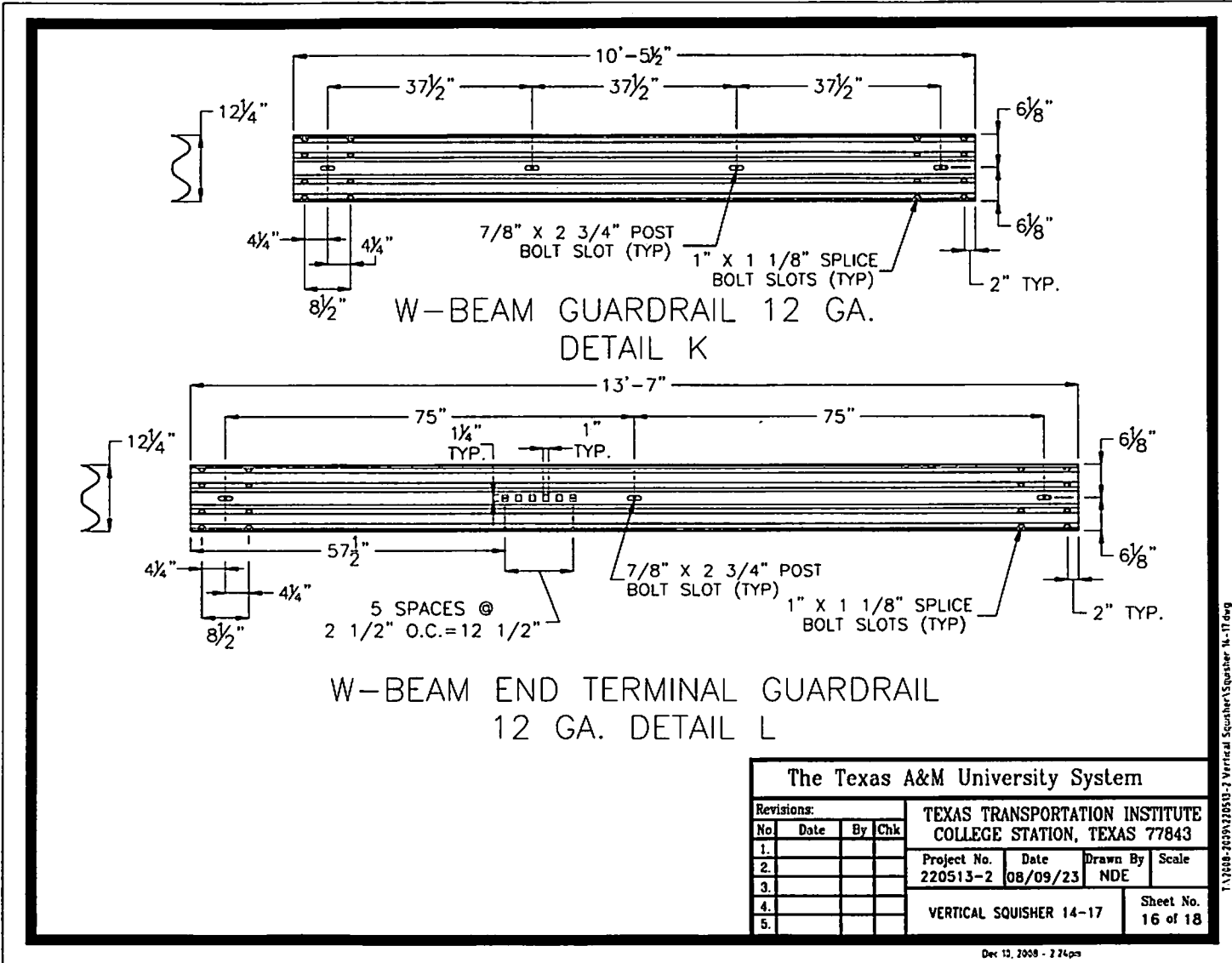
SLOTTED W-BEAM GUARDRAIL 12 GA.
(AASHTO M-180, CLASS A, TYPE 2)
DETAIL I



W-BEAM GUARDRAIL 12 GA.
(AASHTO-AGC-ARTBA# RWM04a)
DETAIL J

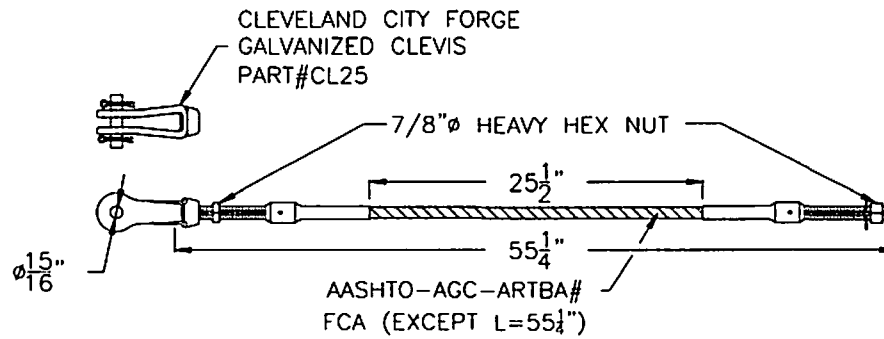
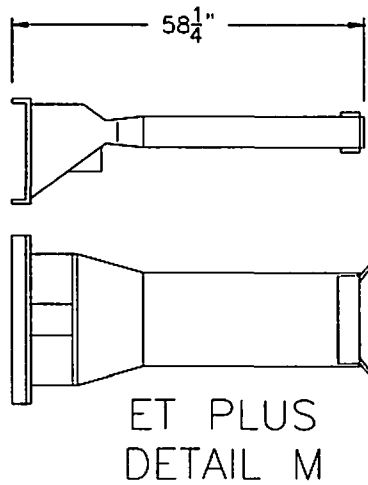
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Revisions:				TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843	
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3.				NDE	
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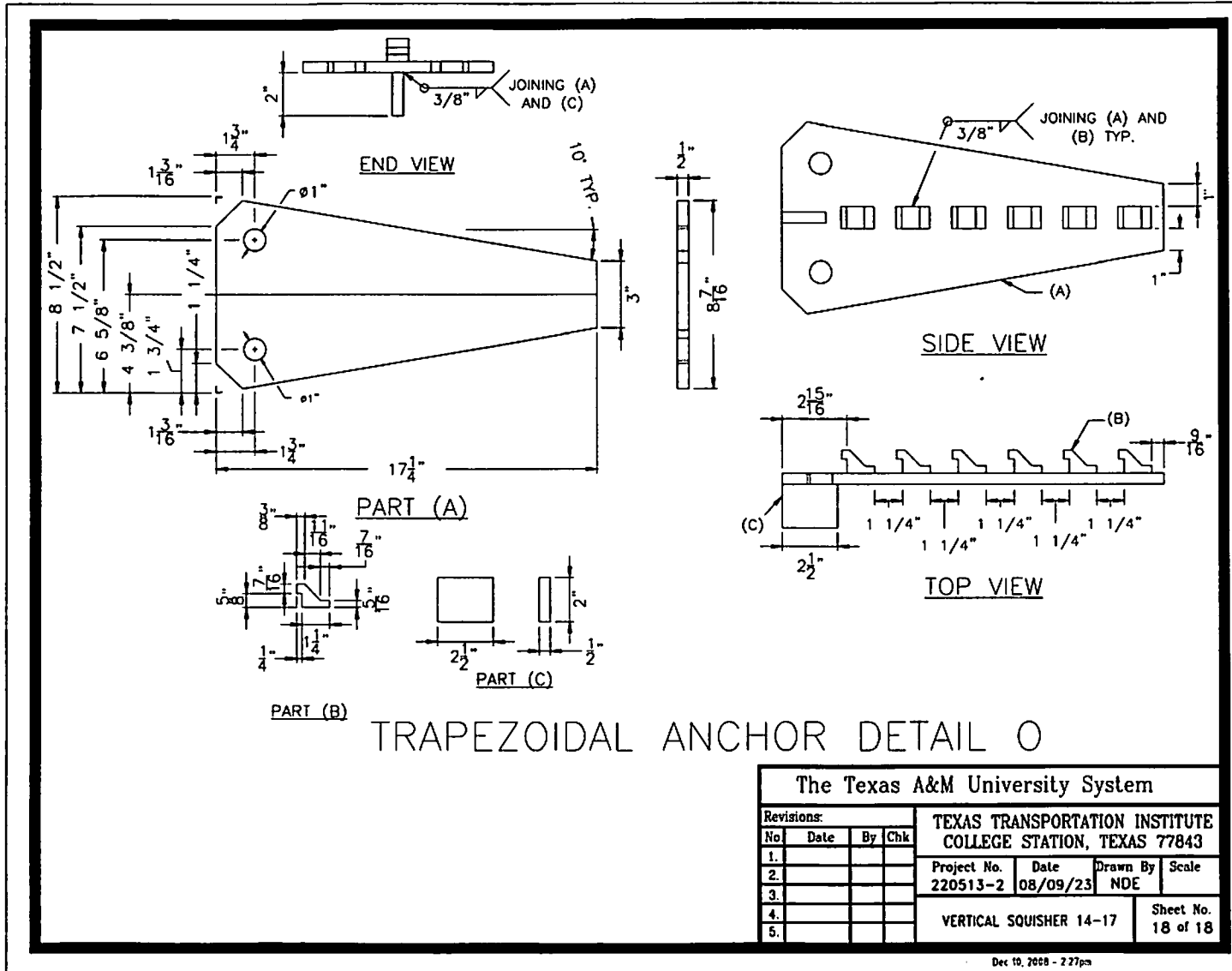
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1.				TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843 Project No. 220513-2 Date 08/09/23 Drawn By NDE Scale VERTICAL SQUISHER 14-17 Sheet No. 16 of 18
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CABLE FOR TRAPEZOIDAL ANCHOR
DETAIL N

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