



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

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

July 13, 2010

In Reply Refer To:
HSSD/B-207

Carl Eugene Buth, Ph.D., P.E.
Assistant Agency Director
Texas Transportation Institute
The Texas A&M University System
3135 TAMU
College Station, TX 77843-3135

Dear Dr. Buth:

This letter is in response to your most recent request for the Federal Highway Administration (FHWA) acceptance of the following proposed retrofit design of an existing Ohio Department of Transportation (ODOT) Standard Bridge Railing for use on the National Highway System (NHS).

Name of system: Modified Ohio DOT (ODOT) Deep Beam Bridge Railing (Guardrail Barrier)
Type of system: Post and Tube with W-Beam Permanent Barrier
Test Level: NCHRP Report 350 Test Level 3 (TL-3)
Testing conducted by: Acceptance based on Equivalence via Strength Analysis and nonlinear finite element simulation using LS-DYNA as conducted by Texas Transportation Institute
System Designator: SBB08c
Date of request: May 15, 2010

Requirements

Roadside safety systems should meet the guidelines contained in the National Cooperative Highway Research Program (NCHRP) Report 350, "Recommended Procedures for the Safety Performance Evaluation of Highway Features". The FHWA memorandum "ACTION: Identifying Acceptable Highway Safety Features" of July 25, 1997, provides further guidance on crash testing requirements of longitudinal barriers. In addition, roadside safety system structural analysis of bridge railings for crashworthiness is also permissible as per the May 16, 2000 FHWA memo entitled Bridge Rail Analysis.

Description

The ODOT Deep Beam Bridge Guardrail Barrier is a post and tube with w-beam panel permanent barrier system measuring 30 inches high. This bridge barrier is listed as the Ohio Box Beam Rail in the FHWA memorandum for Bridge Rails dated August 28, 1986, and was successfully crash tested



under NCHRP Report 230 as a Performance Level 1 (PL1) bridge barrier. The PL1 railing has an equivalency of Test Level 2 (TL-2) per FHWA memorandum "Crash Testing of Bridge Railings" dated May 30, 1997. A combination of analytical study and computer simulation was utilized to evaluate the performance of the ODOT Deep Beam Bridge Guardrail Barrier. The final product is a modified design of the ODOT Deep Beam Bridge Guardrail Barrier system (retrofit) to bring this modified system into compliance with the NCHRP Report 350 performance criteria for TL-3.

The existing bridge rail design was reviewed to investigate the performance aspects of all similar railing systems successfully crash tested as per NCHRP Report 350. The investigation revealed railing systems that share some of the characteristics of the ODOT Deep Beam bridge rail including the Texas Department of Transportation (TxDOT) Type T101, the Illinois side-mount rail and the Oregon side-mount bridge rail. The Illinois side-mount bridge rail design was chosen for the analysis comparison. The Illinois Side-Mount barrier consists of W6x25 (W 150x37.1) posts spaced at 6 ft-3 in. (1.905 m) with two tubular rails, TS 8x4x5/16 in. (203x102x8 mm) for the top rail and TS 6x4x1/4 in. (152x102x6 mm) for the lower rail. The height of the top rail above the asphalt surface is 32 inches (813 mm). The railing was mounted to the side of a concrete deck using four (4) AASHTO M164 anchors bolts. The Illinois side mounted bridge rail was successfully tested to AASHTO PL-2 including the single unit truck.

After review and analysis of the existing ODOT Deep Beam Bridge Railing (Guardrail Barrier) system, the suggested retrofit is the addition of two (2) additional tubular members to help improve the performance of the ODOT Deep Beam bridge rail. The following two rail members have been added to in such a way as to utilize the current bridge rail hardware and minimize retrofitting the existing bridge rail post.

- A. One tubular member added at 8 in. (230 mm) above the pavement surface to improve the crash performance for the small car (820C) in NCHRP Report 350 TL-3 conditions.
- B. One tubular member added to top of existing tubular block out to increase the overall height to 31 in. (787.4 mm) above the pavement surface. Increasing the height of the bridge rail is considered to be an improvement in crash performance by the design team particularly for impact conditions that involve the pick-up truck (2000P).

Strength analyses were then conducted to determine the strength of the retrofit rail design with respect to AASHTO Bridge Design Specification. Developed details for analysis of the 16 in. (406.4 mm) concrete deck were approved by ODOT and incorporated into the analyses for the retrofit bridge rail design. The 2004 AASHTO LRFD Bridge Design Specifications, Table 13.7.2-1 and Table A13.2-1 were used to calculate the strength of the modified ODOT Deep Beam Bridge Guardrail Barrier system, and is included as an enclosure with this correspondence.

A detailed LS-DYNA finite element model was built for the ODOT deep beam post assembly. The assembly includes the W6x25 (W150x37.1) post, the stiffening plates, the 1-1/4 in. (31.75 mm) diameter A325 anchor bolt, the 16 in. (406.4 mm) deck and the detailed reinforcement per the system drawings enclosed with this correspondence.

Based on the LS-DYNA numerical analysis and engineering analysis, it is expected the post-deck assembly would have the capacity to withstand the 54kips (240 kN) load imparted by the 2000P test vehicle (per NCHRP Report 350 TL-3) without significant damage.

A full model of a representative installation of the modified ODOT Deep Beam bridge rail per NCHRP Report 350 test requirements for rigid barrier was built. The model consists of a 75 ft (22.86 m) long rail that includes six w-beam rail segments and 13 (thirteen) post assemblies.

The system was able to contain and redirect the vehicle per the finite element simulation. The vehicle had a moderate roll angle (18 degrees) around 0.52 seconds (sec) but it became upright late in the simulation. The simulation calculated the maximum tensile force in the deck anchors to be 88.91 kips (395 kN). This is below the yield rating of these anchors of 99 kips (440.4 kN) as presented in strength analysis. The summary of results of TL-3-11 simulation is also enclosed with this correspondence.

Findings

We concur that based upon equivalence and computation the modified ODOT Deep Beam Bridge Guardrail Barrier meets all barrier structural adequacy and vehicle trajectory criteria as outlined in NCHRP Report 350 and is acceptable for use on the NHS as a TL-3 barrier when allowed by the highway agency. Please note the following standard provisions that apply to FHWA letters of acceptance:

- This acceptance is limited to the crash worthiness characteristics of the system and does not cover their structural features, nor conformity with the Manual on Uniform Traffic Control Devices.
- Any changes that may adversely influence the crashworthiness of the system will require a new acceptance letter.
- Should the FHWA discover that the qualification testing was flawed, that in-service performance reveals unacceptable safety problems, or that the system being marketed is significantly different from the version that was crash tested, we reserve the right to modify or revoke our acceptance.
- You will be expected to supply potential users with sufficient information on design and installation requirements to ensure proper performance.
- You will be expected to certify to potential users that the hardware furnished has essentially the same chemistry, mechanical properties, and geometry as that submitted for acceptance, and that it will meet the crashworthiness requirements of the FHWA and the NCHRP Report 350.
- To prevent misunderstanding by others, this letter of acceptance is designated as number B-207 and shall not be reproduced except in full. This letter and attached computational documentation upon which it is based are public information. All such letters and documentation may be reviewed at our office upon request.
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Sincerely yours,

David A. Nicol, P.E.
Director, Office of Safety Design
Office of Safety

FHWA:HSSD:WLongstreet:tb:60087:7/7/10

File: s://directory folder/WLongstreet/Modified Ohio DOT Deep Bam Bridge Guardrail Barrier_070710 .doc

cc: HSSI (Reader, HSA; Chron File, HSSD; WLongstreet, HSSD; DNicol, HSSD; MMcDonough, HSSD)



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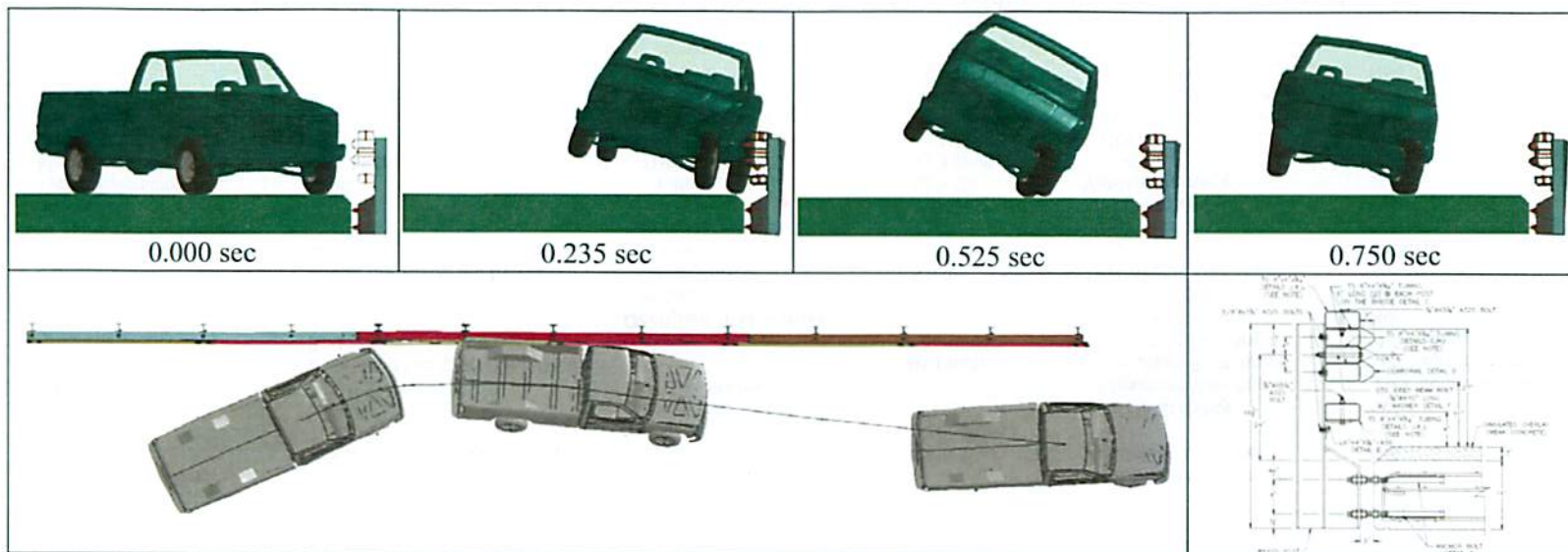
- This acceptance is limited to the crash worthiness characteristics of the system and does not cover their structural features, nor conformity with the Manual on Uniform Traffic Control Devices.
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FHWA is neither prepared nor required to become involved in issues concerning patent law. Patent issues, if any, are to be resolved by the applicant.

Sincerely yours,

A handwritten signature in blue ink, appearing to read "George Eric".Handwritten initials "for" in blue ink.

David A. Nicol, P.E.
Director, Office of Safety Design
Office of Safety



General Information

Test Agency..... Texas Transportation Institute
 Test No. TL-3-11
 Date

Test Article N/A
 Type.....
 Name 31 in. Modified Ohio Deep Beam
 Installation Length Bridge Rail
 Material or Key Elements 75 ft
 bridge rail supported by W6x25
 steel post

Soil Type and Condition.....

Test Vehicle

Type/Designation.....
 Make and Model..... 2000P
 Curb..... C2500 detailed vehicle
 Test Inertial..... 4408 lb
 Dummy 4408 lb
 Gross Static..... No. Dummy
 4408 lb

Impact Conditions

Speed 62 mi/h
 Angle..... 25 degrees
 Location/Orientation.....

Exit Conditions

Speed 46.3 mi/h
 Angle..... 5 degrees

Occupant Risk Values

Impact Velocity
 Longitudinal 25.9 ft/s
 Lateral.....-28.2 ft/s

Ridedown Accelerations
 Longitudinal-10.9 Gs
 Lateral..... 9.1 Gs

THIV..... 40.4 km/h
 PHD 12.5 Gs

Max. 0.050-s Average
 Longitudinal-11.3 Gs
 Lateral..... 13.7 Gs
 Vertical.....-5.7 Gs

Post-Impact Trajectory

Stopping Distance N/A

Vehicle Stability

Maximum Yaw Angle..... 29.4 degrees @ 0.294 s
 Maximum Pitch Angle.....-4.1 degrees @ 0.432 s
 Maximum Roll Angle.....-18.5 degrees @ 0.439 s
 Vehicle Snagging.....No
 Vehicle Pocketing No

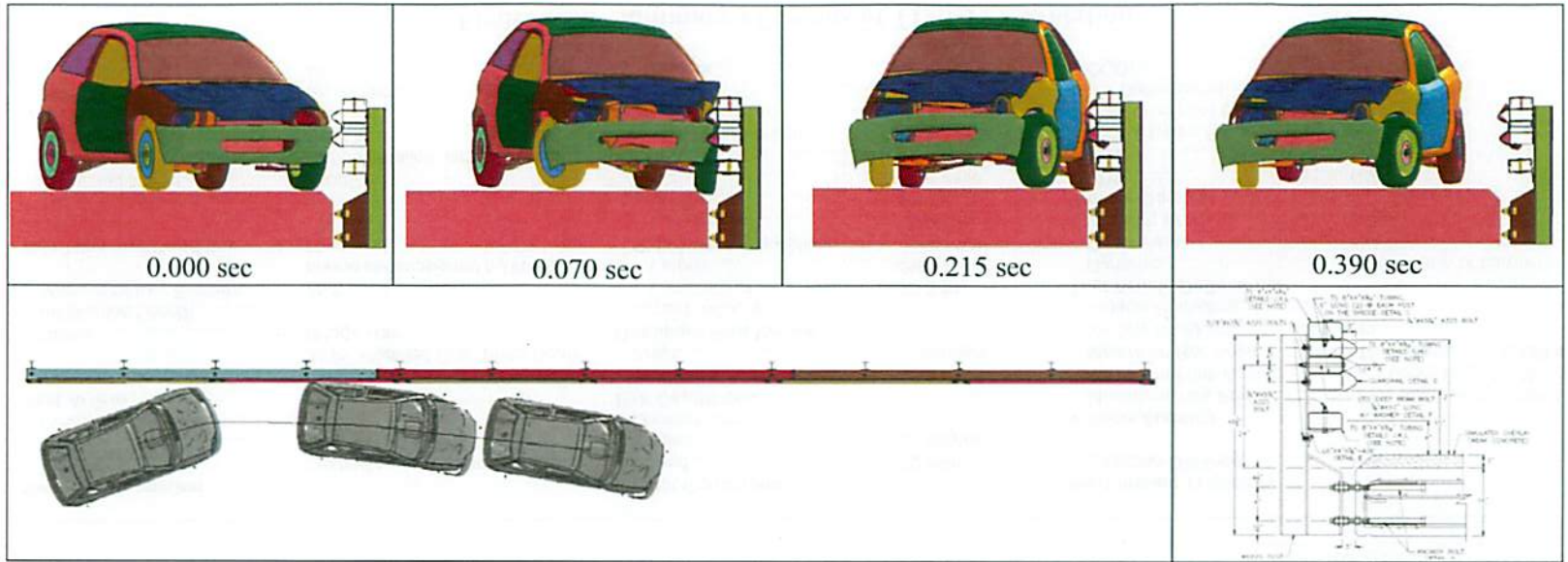
Test Article Deflections

Dynamic.....2.56 in. (top of barrier)
 Permanent N/A
 Working Width2.56 in.

Vehicle Damage

VDS N/A
 CDC N/A
 Max. Exterior Deformation.....N/A
 Max. Occupant Compartment
 Deformation..... N/A
 OCDI..... N/A

Figure 5.28 Summary of results of TL-3-11 Simulation



General Information

Test Agency..... Texas Transportation Institute
 Test No. TL-3-10
 Date N/A

Test Article

Type..... 31 in. Modified Ohio Deep Beam
 Bridge Rail
 Name
 Installation Length 75 ft
 Material or Key Elements bridge rail supported by W6x25
 steel post

Soil Type and Condition.....

Test Vehicle

Type/Designation..... 820C
 Make and Model Geo Metro
 Curb 1807 lb
 Test Inertial..... 1807 lb
 Dummy No. Dummy
 Gross Static..... 1807 lb

Impact Conditions

Speed 62 mi/h
 Angle..... 20 degrees
 Location/Orientation.....

Exit Conditions

Speed48.1 mi/h
 Angle.....8 degrees

Occupant Risk Values

Impact Velocity
 Longitudinal 5.8 ft/s
 Lateral -8.8 ft/s
 Ridedown Accelerations
 Longitudinal -7.0 Gs
 Lateral 12.3 Gs
 THIV 35.3 km/h
 PHD 12.4 Gs
 Max. 0.050-s Average
 Longitudinal -10.8 Gs
 Lateral 16.0 Gs
 Vertical..... -4.1 Gs

Post-Impact Trajectory

Stopping Distance N/A

Vehicle Stability

Maximum Yaw Angle 29.2 degrees @ 0.399 s
 Maximum Pitch Angle 3.0 degrees @ 0.226 s
 Maximum Roll Angle 4.0 degrees @ 0.314 s
 Vehicle Snagging No
 Vehicle Pocketing No

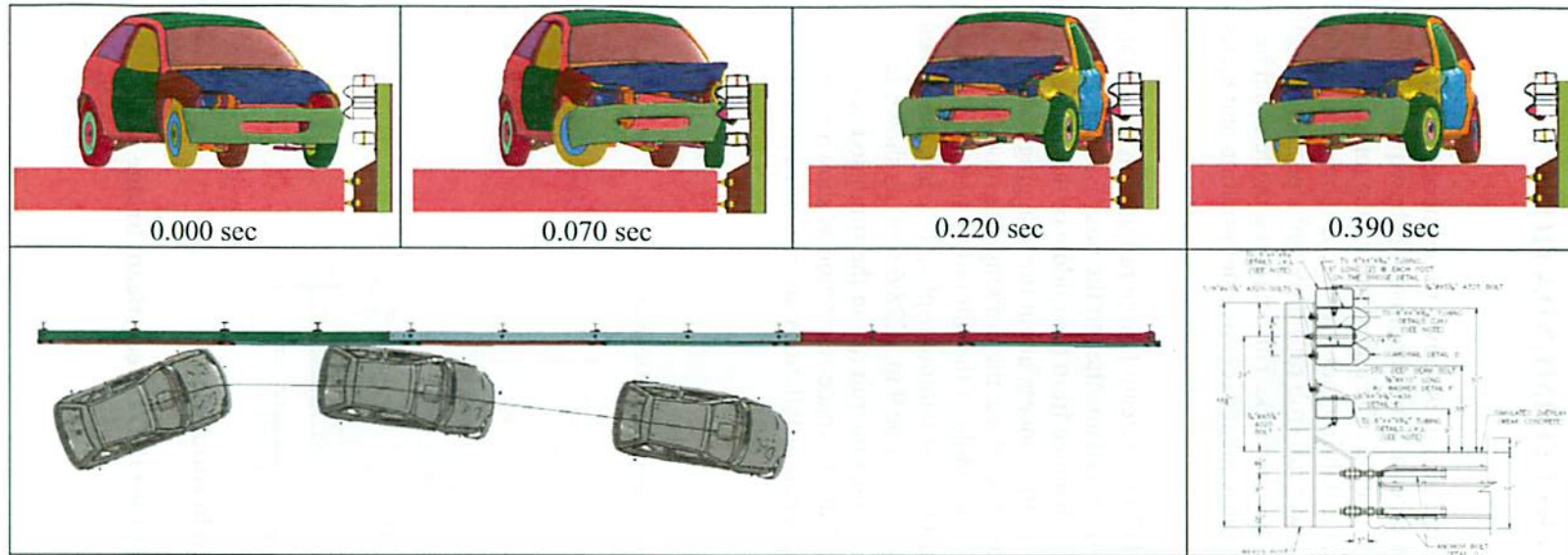
Test Article Deflections

Dynamic..... 0.758 in
 Permanent..... N/A
 Working Width N/A

Vehicle Damage

VDS N/A
 CDC N/A
 Max. Exterior Deformation..... N/A
 Max. Occupant Compartment
 Deformation..... N/A
 OCDI..... N/A

Figure 5.35 Summary of results of 3-10 simulation of the bridge rail with pavement overlay



46

General Information

Test Agency..... Texas Transportation Institute
 Test No. Simulation
 Date

Test Article

Type..... 34 in. Modified Ohio Deep Beam
 Bridge Rail
 Name

Soil Type and Condition.....

Test Vehicle

Type/Designation..... 820C
 Make and Model Geo Metro
 Curb 1807 lb
 Test Inertial..... 1807 lb
 Dummy No. Dummy
 Gross Static..... 1807 lb

Impact Conditions

Speed 62 mi/h
 Angle..... 20 degrees
 Location/Orientation.....

Exit Conditions

Speed 49 mi/h
 Angle..... 10 degrees

Occupant Risk Values

Impact Velocity
 Longitudinal 5.3 ft/s
 Lateral..... -8.6 ft/s
 Ridedown Accelerations
 Longitudinal -6.2 Gs
 Lateral..... 12.6 Gs
 THIV..... 34.9 m/s
 PHD 12.6 Gs
 Max. 0.050-s Average
 Longitudinal -10.3 Gs
 Lateral..... 15.6 Gs
 Vertical..... -3.9 Gs

Post-Impact Trajectory

Stopping Distance N/A.

Vehicle Stability

Maximum Yaw Angle..... 28.4 degrees @ 0.493 s
 Maximum Pitch Angle..... 3.2 degrees @ 0.213 s
 Maximum Roll Angle..... 3.7 degrees @ 0.155 s
 Vehicle Snagging..... No
 Vehicle Pocketing No

Test Article Deflections

Dynamic..... 0.55 in. (top of barrier)
 Permanent..... N/A
 Working Width N/A

Vehicle Damage

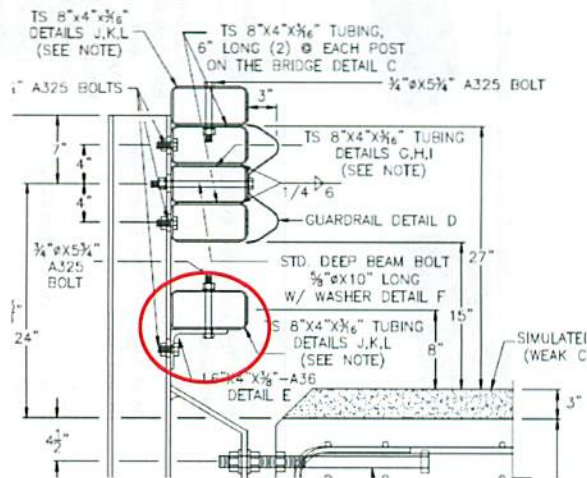
VDS..... N/A
 CDC N/A
 Max. Exterior Deformation..... N/A
 Max. Occupant Compartment
 Deformation..... N/A
 OCDI..... N/A

Figure 5.42 Summary of results of 3-10 simulation of the bridge rail without pavement overlay

6. CONCLUSIONS AND RECOMMENDATIONS

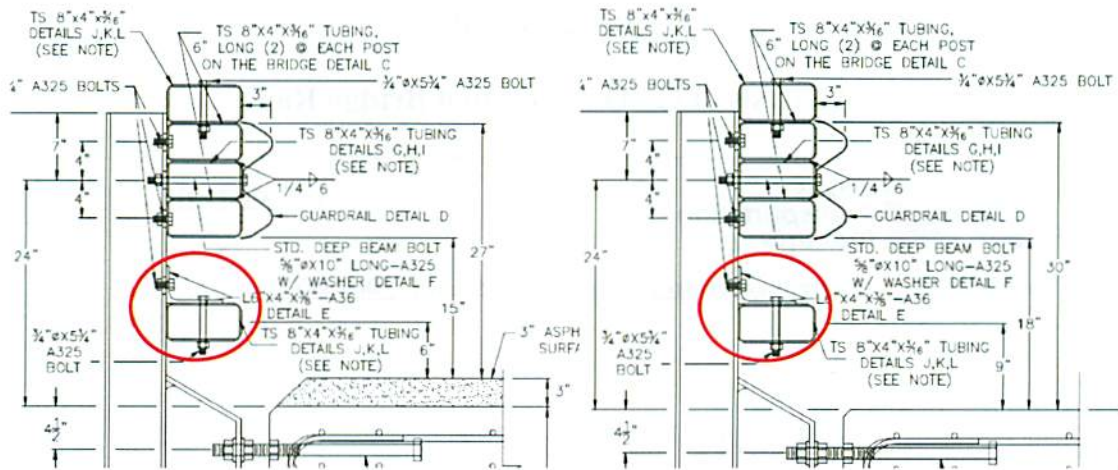
The modified ODOT Deep Beam bridge rail design is shown to be successfully able to pass NCHRP Report 350 test level 3 assessment criteria. This conclusion is based on engineering strength analysis and nonlinear finite element simulation. The added rail on the top of the bridge rail helped reduced potential vehicular dynamics instability that may occur if only the original rail (less height) was used. Also, the additional lower rail (rub rail) provided a protection against tire snagging in the opening below the main rail and the deck. This snagging mode could be detrimental for small vehicle impacts due to the subsequent excessive deformation and increased ridedown acceleration.

The set of drawings of the modified ODOT Deep Beam bridge rail used in the simulation models is shown in APPENDIX C. In this set, lower rail attached to the post using an A36 angle shaped steel plate as shown in Figure 6.1(a). The distance from the middle of this rail to the top of the asphalt overlay is 8 in. (203 mm). However the concern about tire snagging led the researchers to recommend reducing that distance. Therefore, the drawing was modified as shown in Figure 6.1 (b) to reduce the distance from middle of the rub rail to the top of the asphalt overlay to 6 in. (152.4 mm). In the case of an installation without asphalt overlay, the distance from the middle of the rub rail to the top of the deck will be 9 in. (228.6 mm) as shown in Figure 6.1 (c). Consequently, the shelf angle that holds the rub rail in the simulated design would have to be located on the top of the rub rail due to space restriction as shown in Figure 6.1 (b) and (c). The full sets of drawings for the suggested installations are presented in APPENDIX D and APPENDIX E.



(a) Design used in simulation

Figure 6.1 Comparison of design of the ODOT Deep Beam bridge rail



(b) Final design with pavement overlay

(c) Final design without pavement overlay

Figure 6.1 Comparison of design of the ODOT Deep Beam bridge rail (continued)

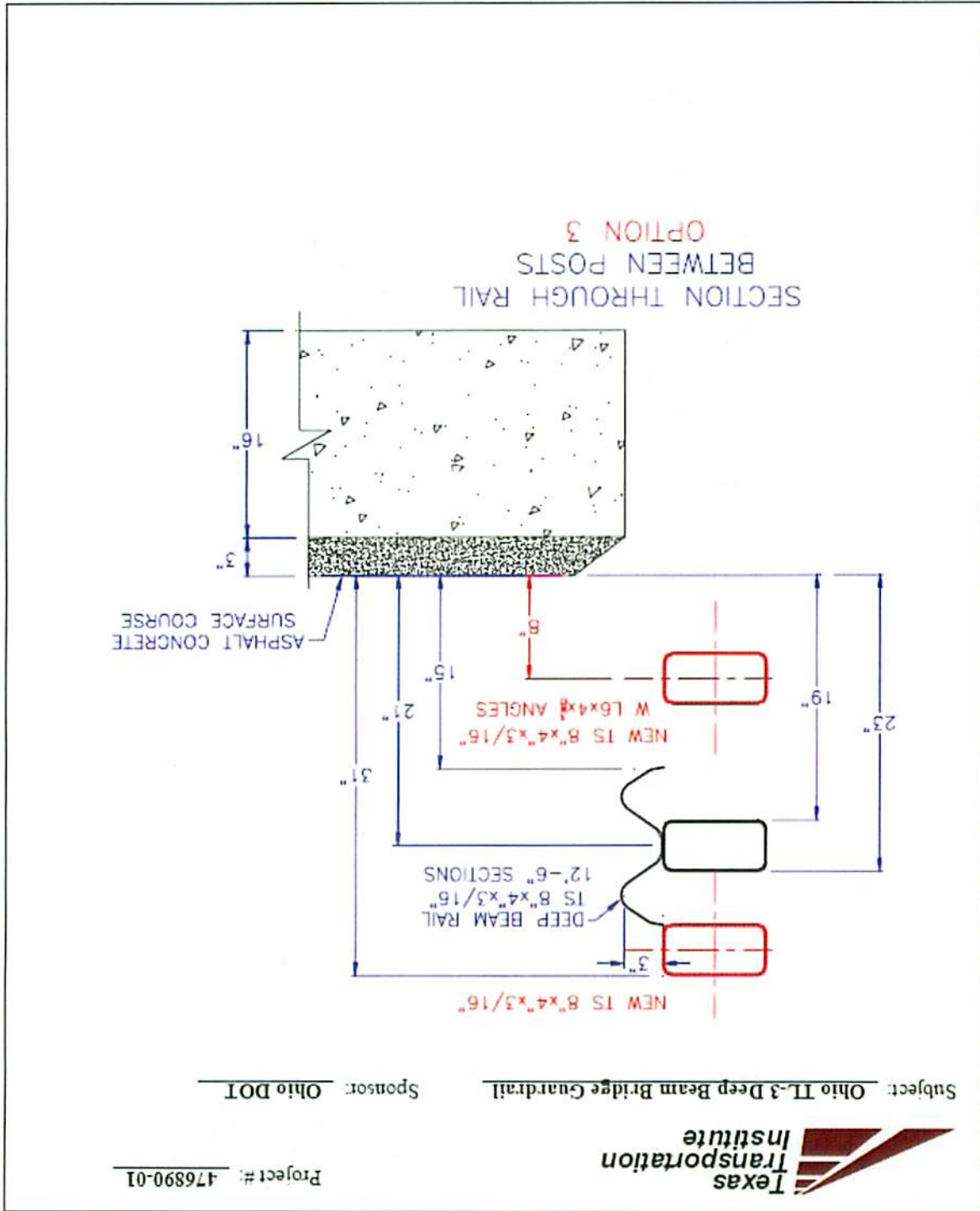
Although details were explicitly modeled in the nonlinear modeling simulation task of this research, some uncertainties are still not quantifiable through simulation. Specifically, damage to the suspension system of the vehicle and the failure of tire and wheels are not represented in current vehicles models. Tire failure (debeading, blown out...etc), wheel failure (rim separation and damage), and suspension failure (A-Arm rupture, joints failure ...etc) can lead to a variation of vehicular dynamical response as well as changes to the occupant severity of a given test. Hence, the research team recommends conducting the two NCHRP Report 350 tests (3-11 and 3-10). For the 3-11 test, the research team recommends using the bridge rail installation that incorporates the pavement overlay to maximize vehicular dynamics. For the 3-10 test, the research team recommends using the installation that does not have pavement overlay to maximize the potential of snagging of the small car with the opening between the rub rail and the top of the deck.

Figure B 2 Analysis of Modified ODOT Deep Beam Bridge Rail 2

12/9/2008
4:16 PM

Ohio IL-3 Bridge Rail RFD WFW:kmcd

William Williams, P.E.
979-862-2297
w-williams@tamu.edu



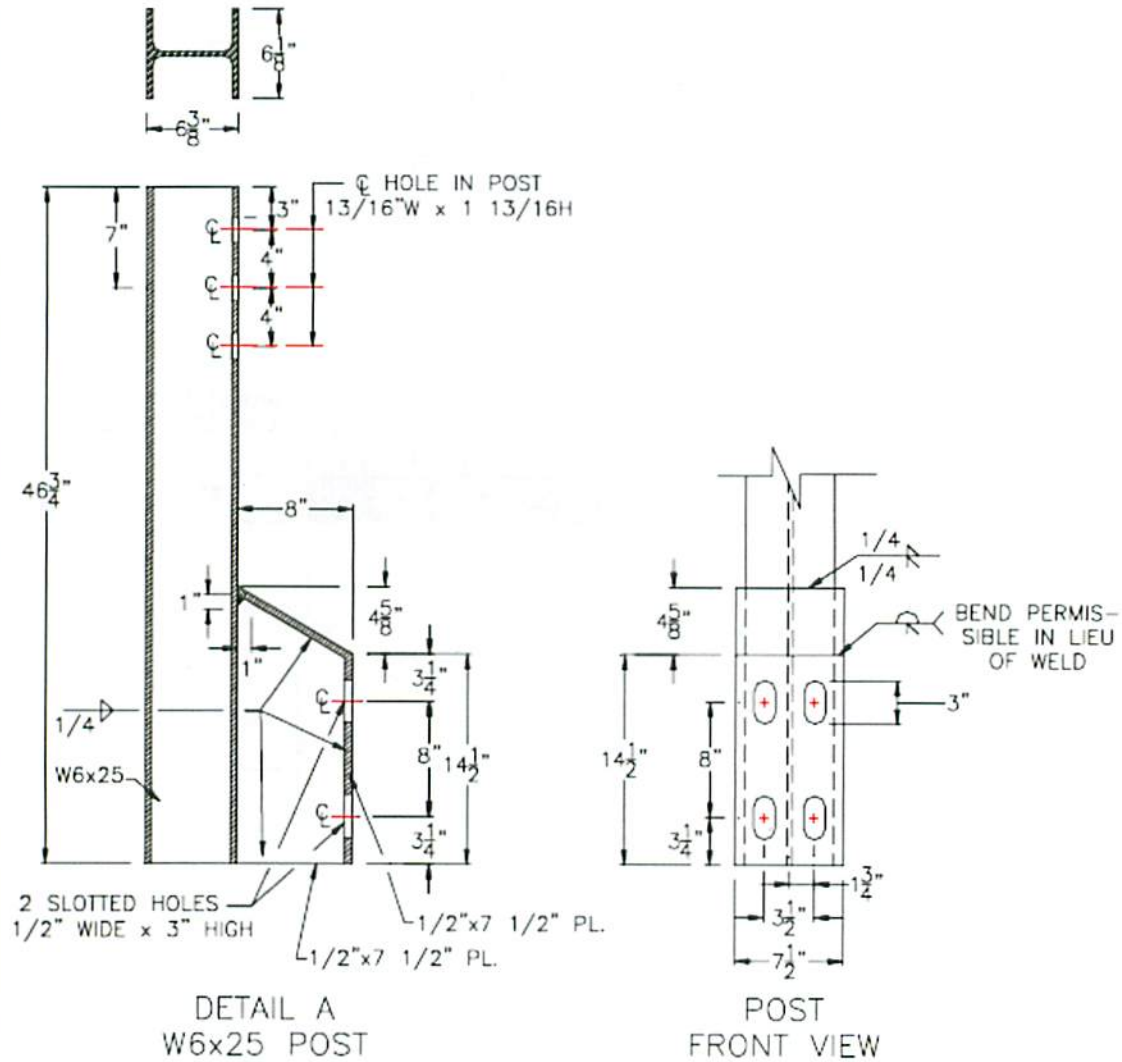


Figure B 3 Analysis of Modified ODOT Deep Beam Bridge Rail 3

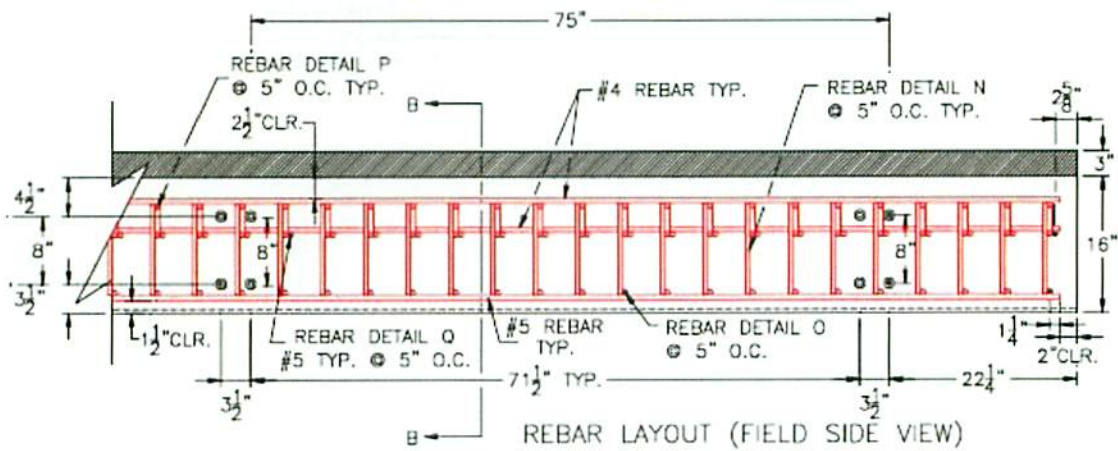
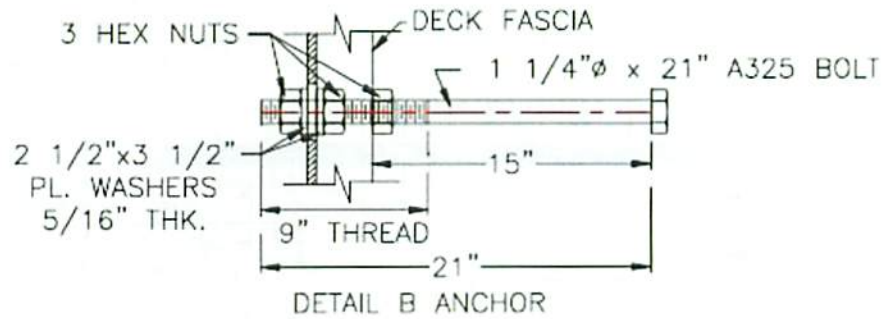


Figure B 4 Analysis of Modified ODOT Deep Beam Bridge Rail 4

Subject: Ohio TL-3 Deep Beam Bridge Guardrail Sponsor: Ohio DOT

**** 6 Span Case ****

$$N_6 := 6 \quad \text{6 Span Case} \quad Y_{\text{bar}} = 19.14 \cdot \text{in} \quad H = 27 \cdot \text{in}$$

$$M_p = 115.142 \cdot \text{kip} \cdot \text{ft} \quad P_p = 17.829 \cdot \text{kips} \quad L = 1.905 \cdot \text{m}$$

$$R_6 := \frac{16 \cdot M_p + N_6^2 \cdot P_p \cdot L}{2 \cdot N_6 \cdot L - L_t} \cdot \left(\frac{Y_{\text{bar}}}{H} \right)$$

$$R_6 = 58.446 \cdot \text{kips} \quad \text{Resistance for 6 Spans}$$

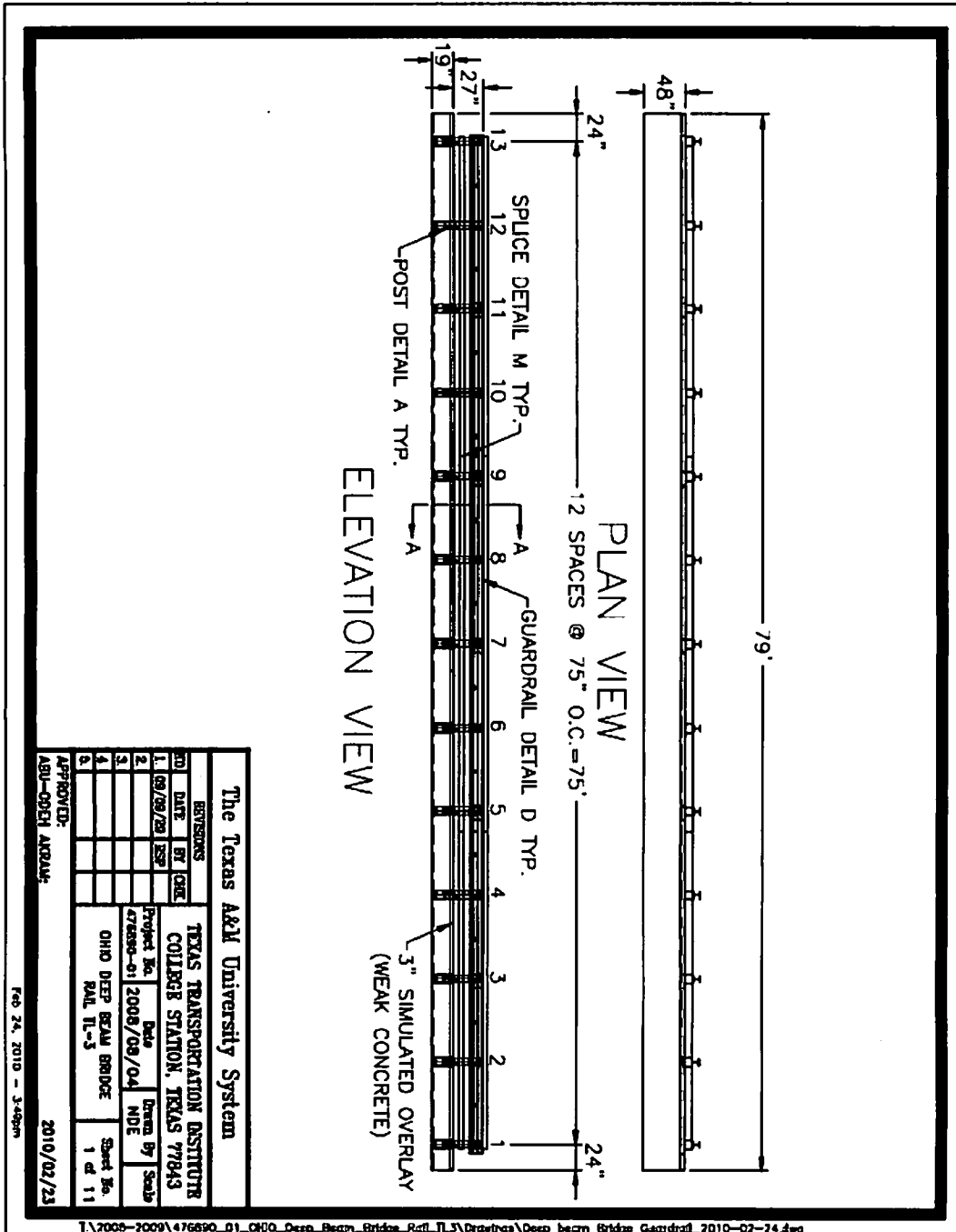
Summary: Resistance of multiple Spans is greater than 54 kips as specified in AASHTO LRFD Section 13 Specifications for Test Level 3

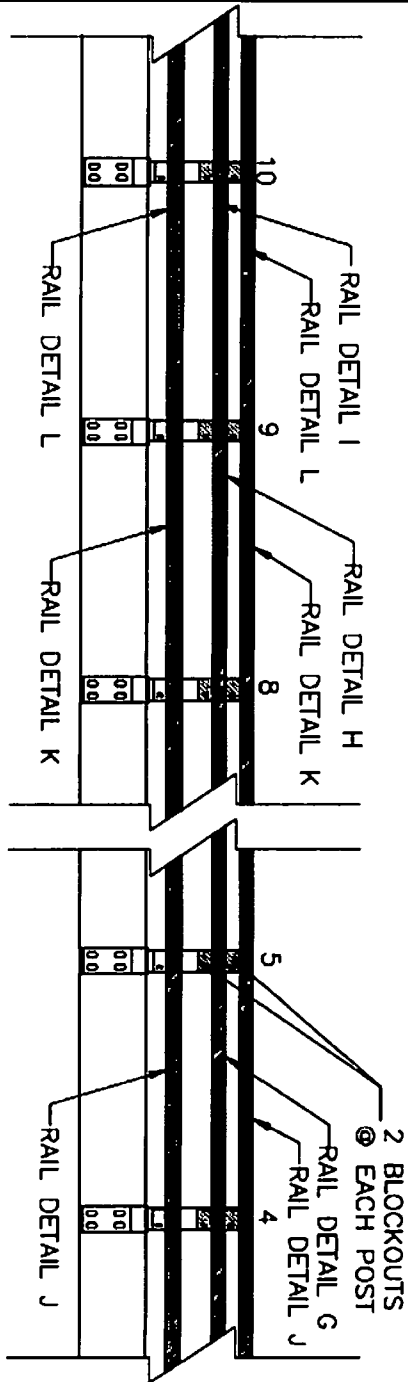
MCAD 14

Figure B 14 Analysis of Modified ODOT Deep Beam Bridge Rail 14

APPENDIX C

Drawing of ODOT Modified Bridge Rail Used in FEM



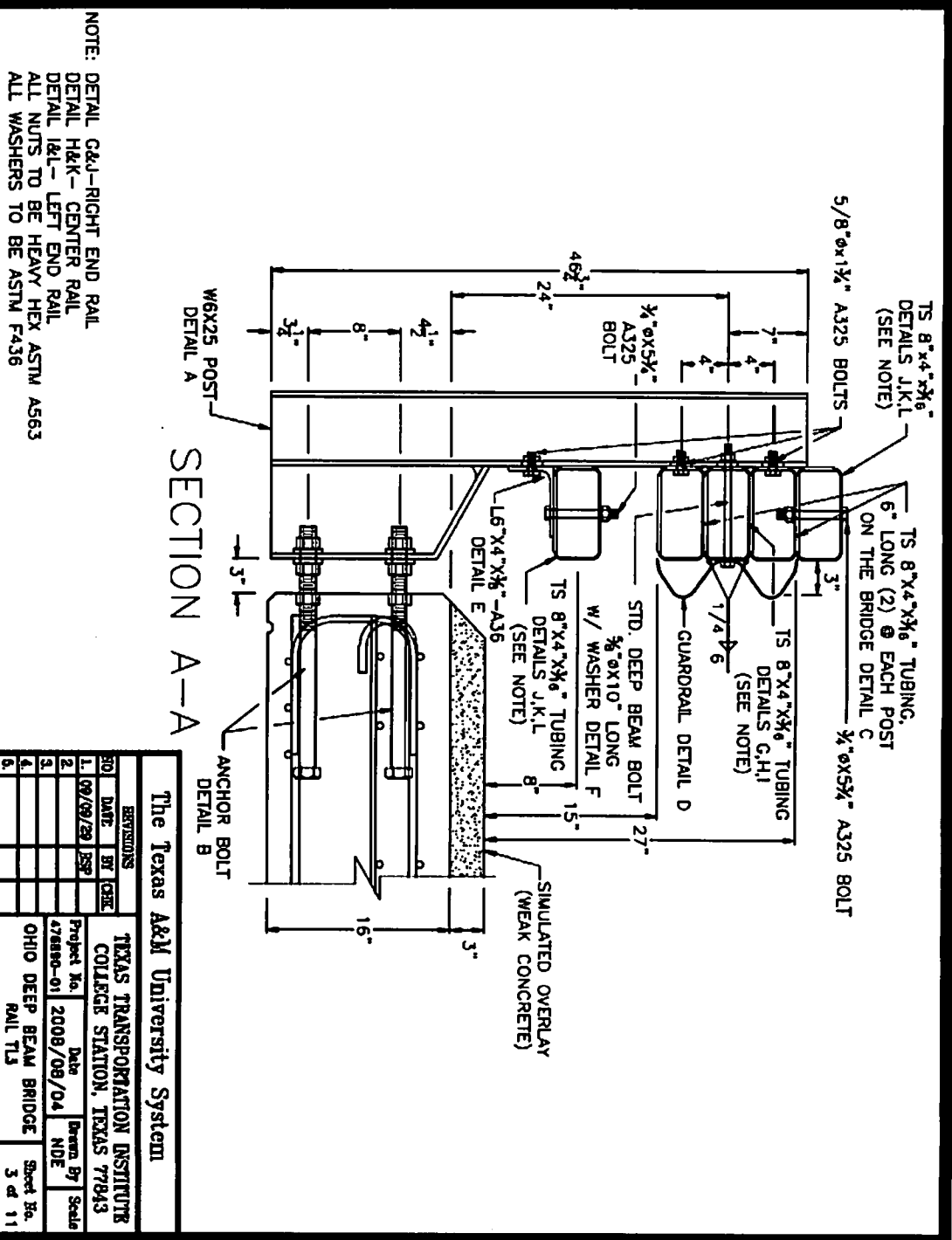


RAIL ELEVATION - DETAIL (WITHOUT W-BEAM)

The Texas A&M University System			
TEXAS TRANSPORTATION INSTITUTE			
COLLEGE STATION, TEXAS 77843			
NO	DATE	BY	CHK
1.	09/09/20	ESP	
2.			
3.			
4.			
5.			
6.			

Project No.	Date	Drawn By	Scale
476890-01	2008/08/04	NDE	
OHIO DEEP BEAM BRIDGE		Sheet No.	
RAIL T13		2 of 11	

Feb 24, 2010 - 3:46pm



NOTE: DETAIL G&J-RIGHT END RAIL
 DETAIL H&K-CENTER RAIL
 DETAIL I&L-LEFT END RAIL
 ALL NUTS TO BE HEAVY HEX ASTM A563
 ALL WASHERS TO BE ASTM F436

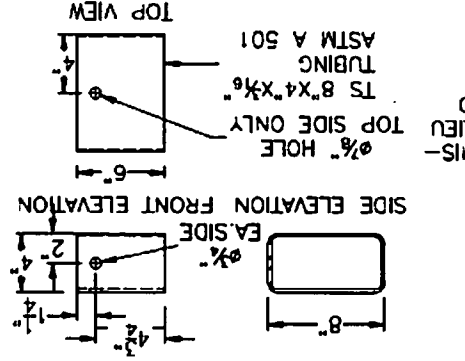
SECTION A-A

The Texas A&M University System		TEXAS TRANSPORTATION INSTITUTE	
COLLEGE STATION, TEXAS 77843		Project No. 2008/09/04	
OHIO DEEP BEAM BRIDGE		Date 2008/09/04	
RAIL TL3		Drawn By NDE	
Sheet No. 3 of 11		Scale	

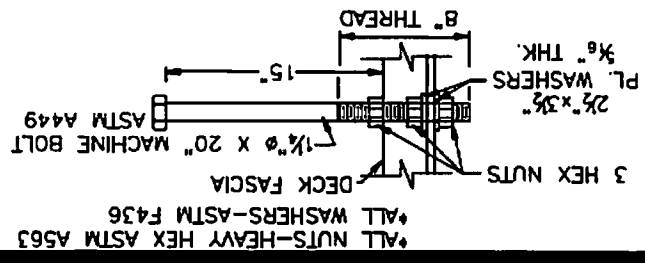
Feb 24, 2010 - 3:42pm

REVISIONS		Project No. 476880-01		Date 2008/08/04		Drawn By NDE		Sheet No. 4 of 11	
NO	DATE	BY	CHK	Texas Transportation Institute		COLLEGE STATION, TEXAS 77843		OHIO DEEP BEAM BRIDGE	
				The Texas A&M University System		RAIL TJS			

TUBULAR BLOCKOUT
DETAIL C

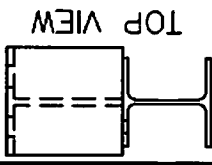
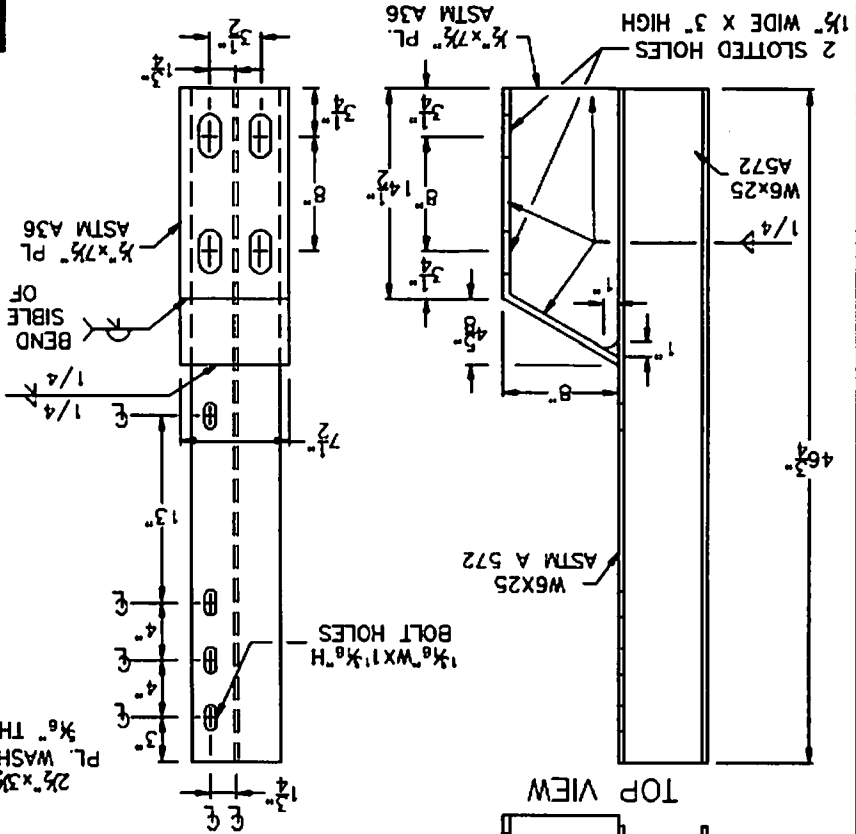


ANCHOR BOLT
DETAIL B



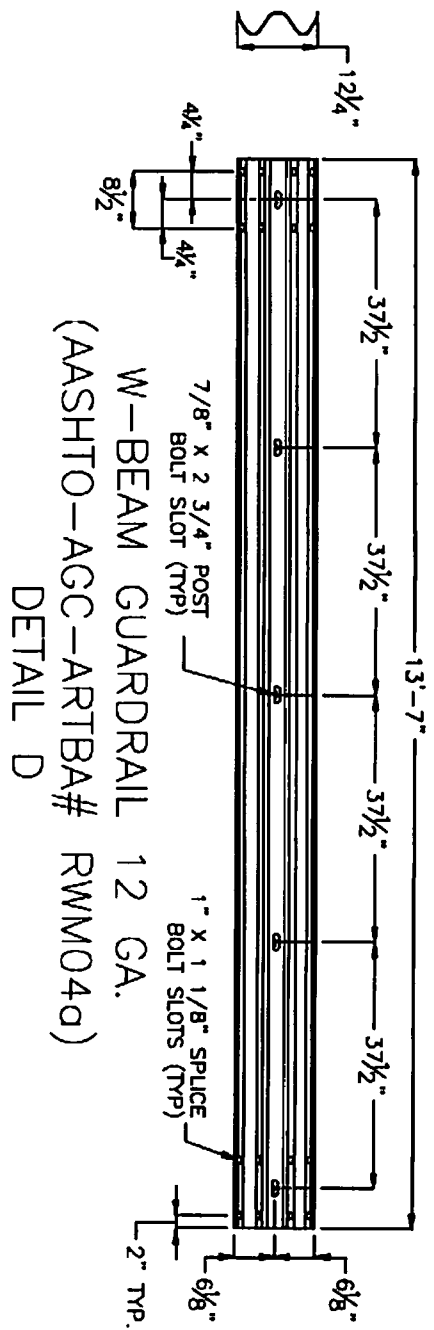
POST DETAIL A
W6x25

FRONT ELEVATION SIDE ELEVATION

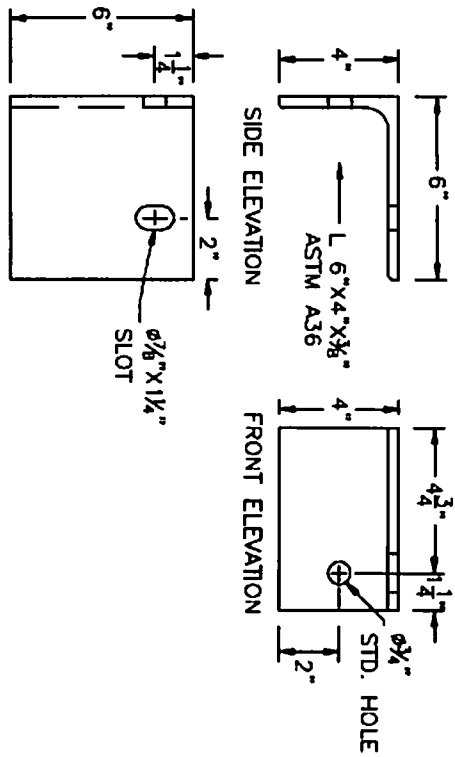


1:2008-2009 (174980, 01), OHIO Deep Beam Bridge, Rail, T.J. Durrigga Deep Beam Bridge, C444444, 2010-02-24.dwg

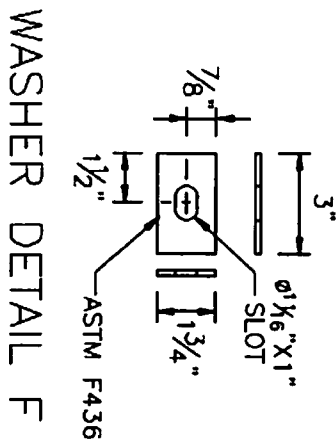
Feb 24, 2010 - 3:49pm



W-BEAM GUARDRAIL 12 GA.
(AASHTO-AGC-ARTBA# RWM040)
DETAIL D



ANGLE BRACKET
DETAIL E

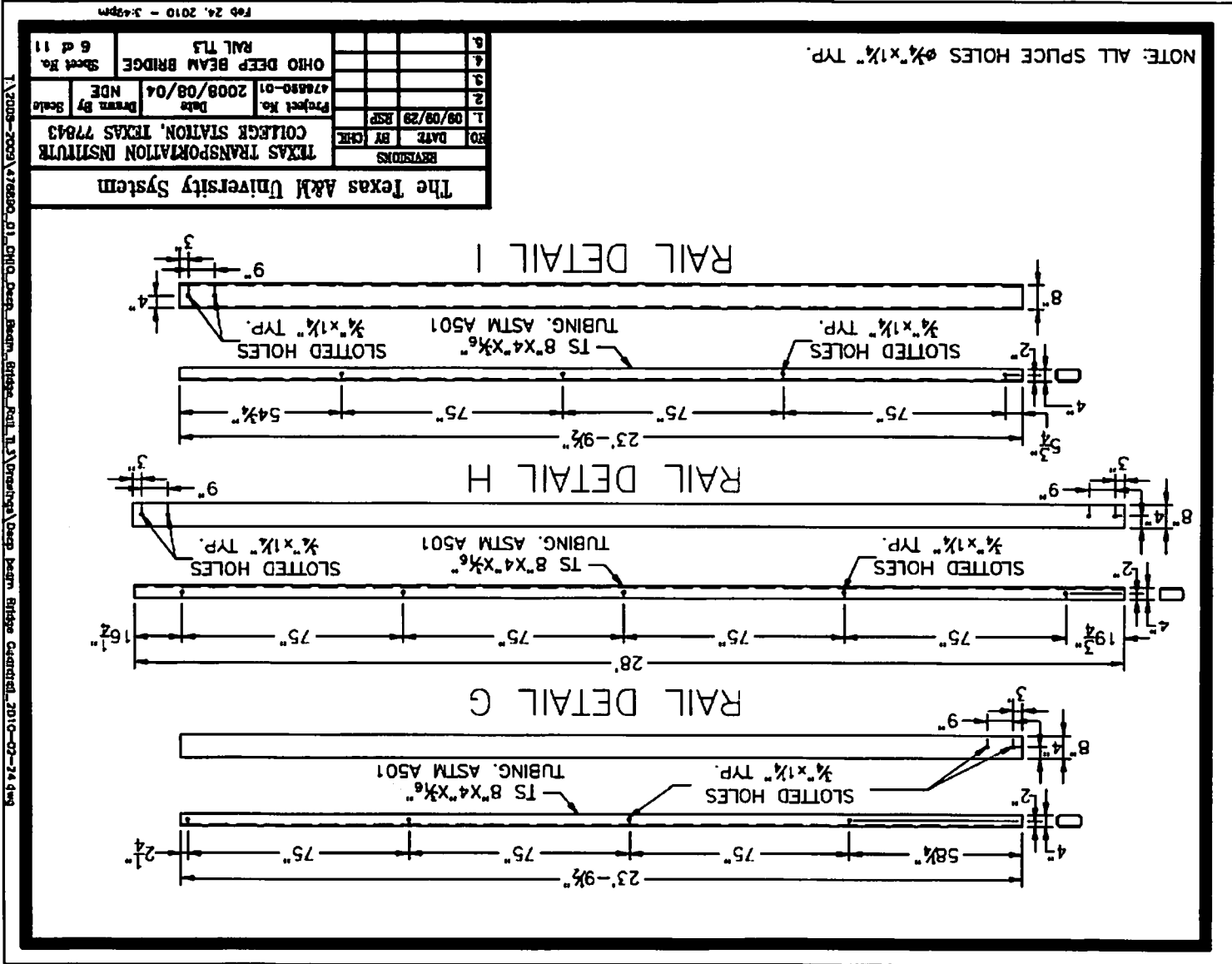


WASHER DETAIL F

REVISIONS		The Texas A&M University System	
NO	DATE	BY	CHK
1	09/09/20	ESP	
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5			

TEXAS TRANSPORTATION INSTITUTE		Project No. 474880-01	
COLLEGE STATION, TEXAS 77843		Date 2008/08/04	
Drawn By NDE		Scale	
OHIO DEEP BEAM BRIDGE		Sheet No. 5 of 11	
RAIL TJS			

Feb 24, 2010 - 3:46pm

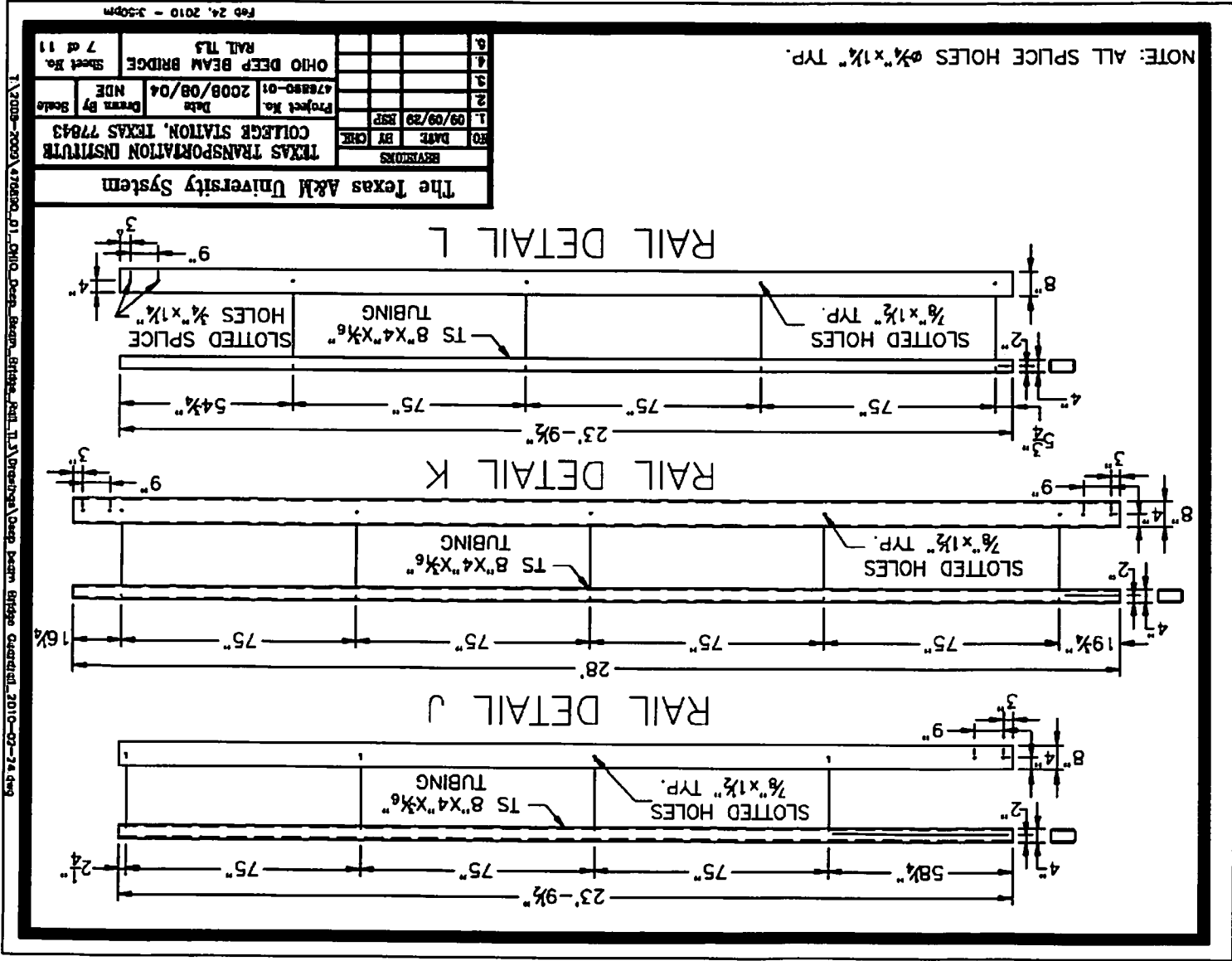


NOTE: ALL SPICE HOLES $\frac{3}{8}$ "x $\frac{1}{4}$ " TYP.

REVISIONS		THE TEXAS A&M UNIVERSITY SYSTEM	
NO	DATE	BY	CHK
1	09/09/20	KSP	
TEXAS TRANSPORTATION INSTITUTE			
COLLEGE STATION, TEXAS 77843			
Project No.	Date	Drawn By	Scale
47688-01	2008/08/04	NDE	
OHIO DEEP BEAM BRIDGE		RAIL T3	
Sheet No.	6 of 11		

Feb 24, 2010 - 3:43pm

T:\2008-2009\47688-01_OHIO_Deep_Beam_Bridge_Rail_T3_Drawing\Deep_Beam_Bridge_Cardinal_2010-02-24.dwg



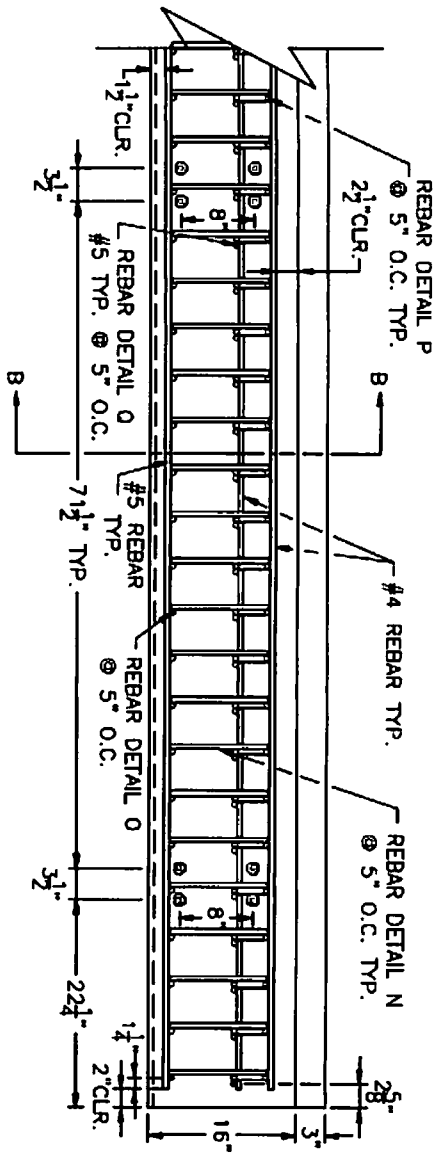
NOTE: ALL SPICE HOLES $\frac{3}{4}$ "x $\frac{1}{2}$ " TYP.

REVISIONS		THE TEXAS A&M UNIVERSITY SYSTEM	
NO	DATE	BY	CHK
1	09/09/29	RSP	
PROJECT NO. 2008/08/04		DATE 08/04/04	
DRAWN BY NDE		SCALE	
SHEET NO. 7 of 11		OHIO DEEP BEAM BRIDGE RAIL T.L.S	

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Feb 24, 2010 - 3:50pm

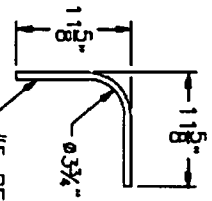
C-7



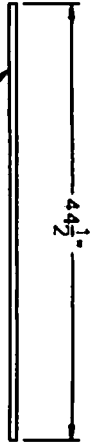
REBAR LAYOUT
DECK-ELEVATION VIEW

The Texas A&M University System			
TEXAS TRANSPORTATION INSTITUTE			
COLLEGE STATION, TEXAS 77843			
NO	DATE	BY	CHKD
1	09/09/20	ESP	
2			
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Project No.		Date	Drawn by
476890-01		2008/08/04	NDE
OHIO DEEP BEAM BRIDGE		Scale	Sheet No.
RAIL TL3			9 of 11

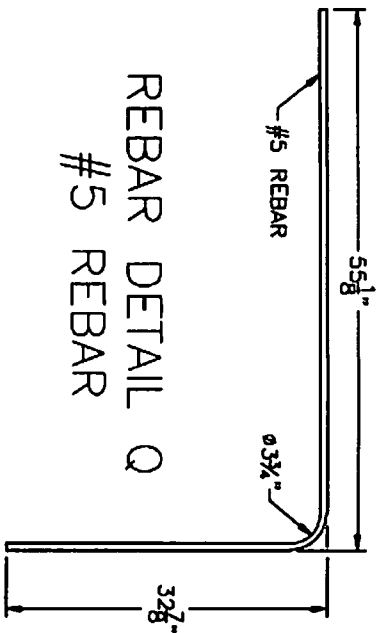
Feb 24, 2010 - 3:50pm



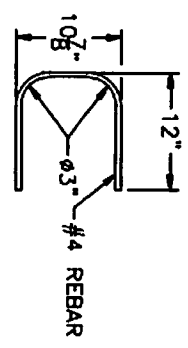
REBAR DETAIL M
#5 REBAR



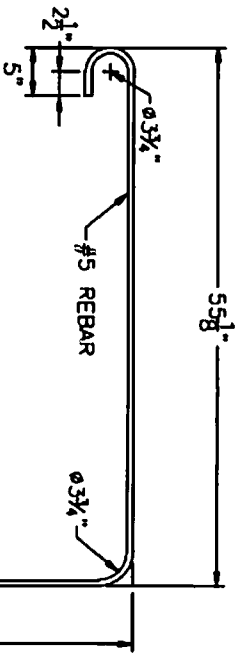
REBAR DETAIL O
#5 REBAR



REBAR DETAIL Q
#5 REBAR



REBAR DETAIL N
#4 REBAR



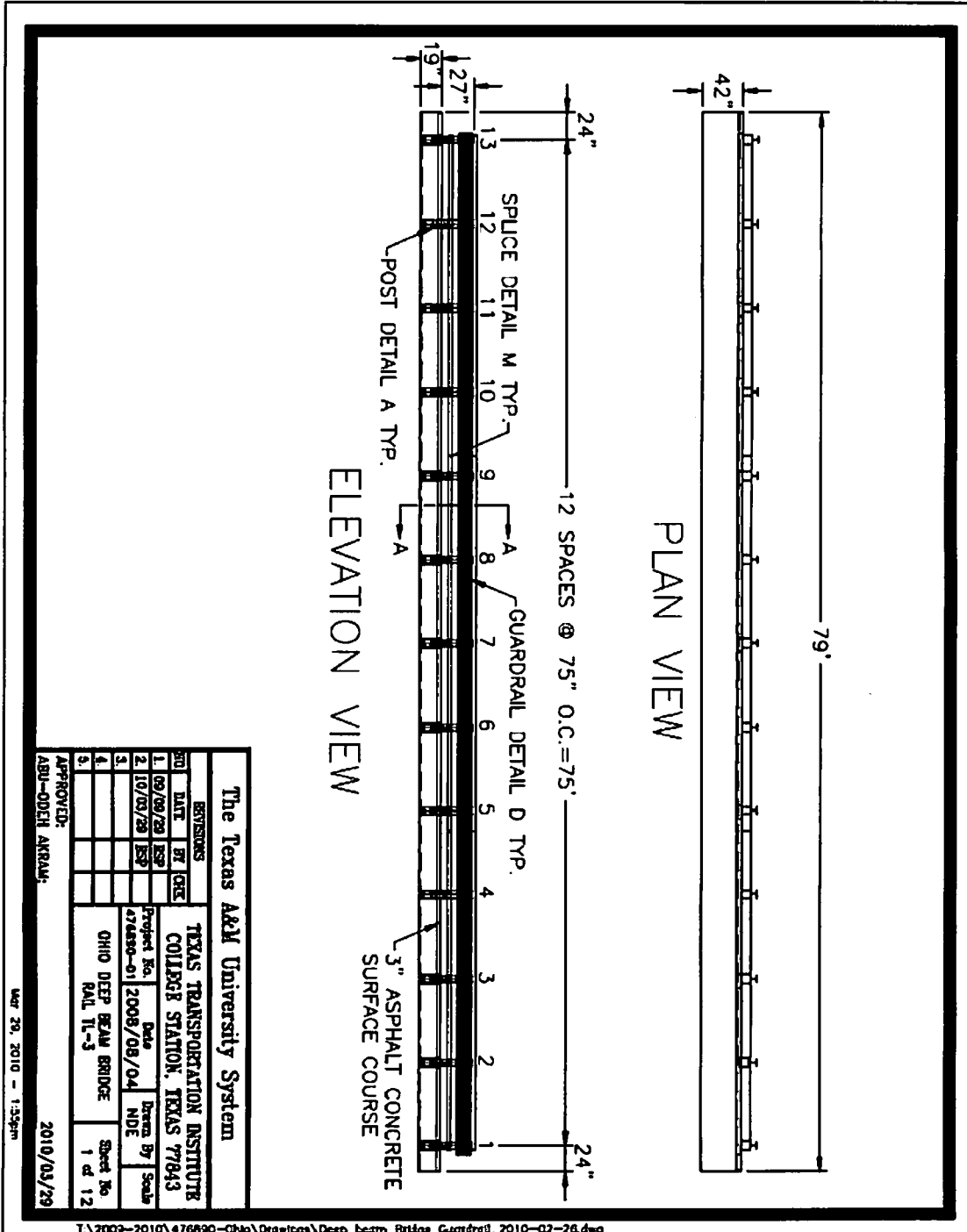
REBAR DETAIL P
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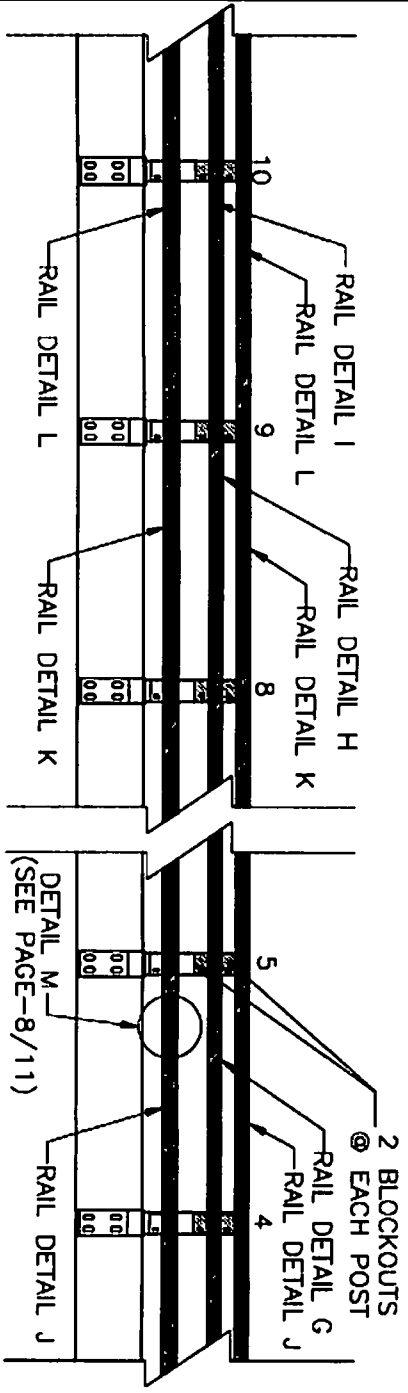
The Texas A&M University System			
TEXAS TRANSPORTATION INSTITUTE			
COLLEGE STATION, TEXAS 77843			
REV	DATE	BY	DESC
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2			
3			
4			
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Project No.		Date	Drawn By
476820-01		2008/08/04	NDE
OHIO DEEP BEAM BRIDGE		Sheet No.	Scale
RAIL TL3		11 of 11	

Feb 24, 2010 - 3:50pm

APPENDIX D

Drawing of ODOT Modified Bridge Rail with Pavement Overlay



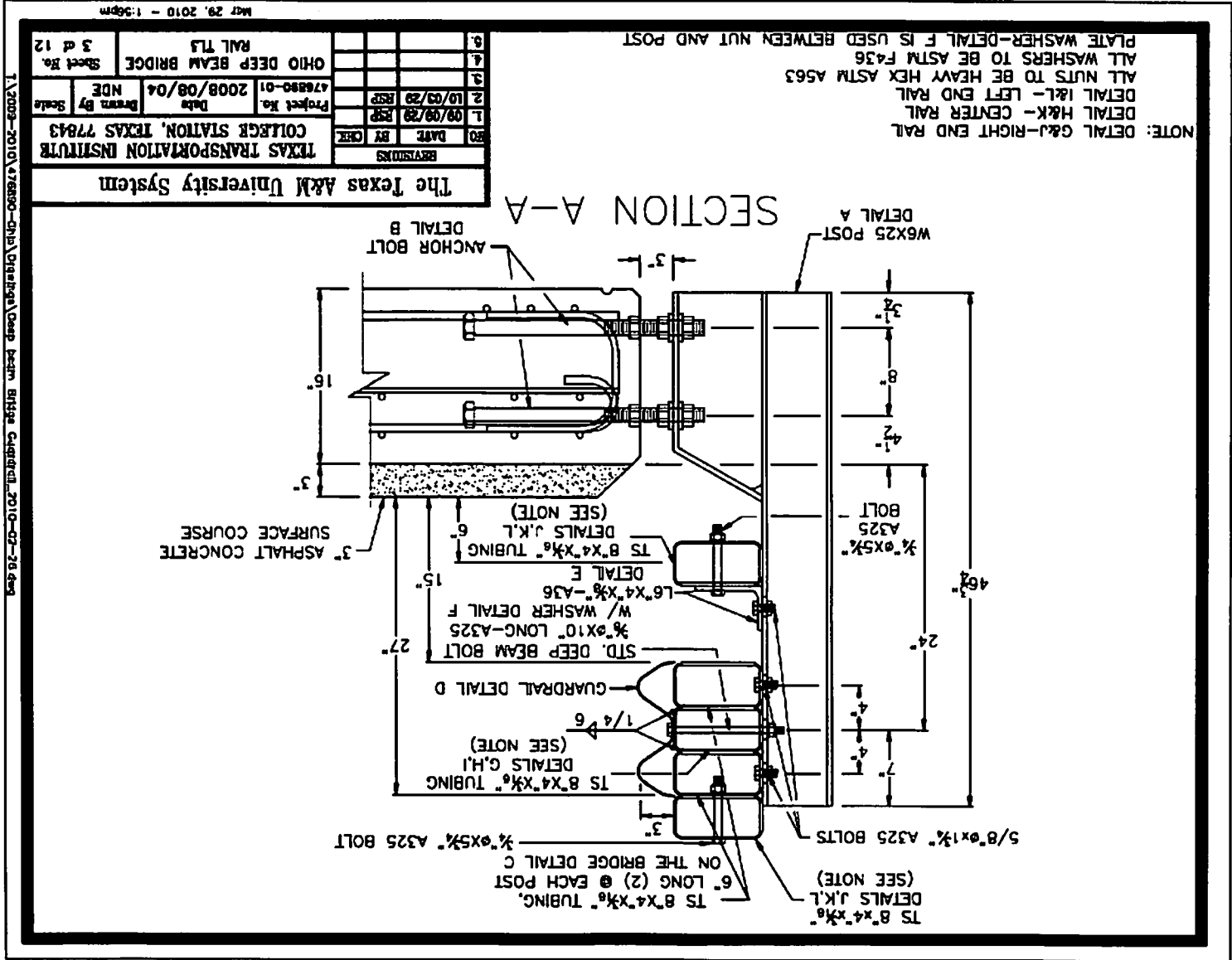


RAIL ELEVATION - DETAIL
(WITHOUT W-BEAM)

The Texas A&M University System			
REVISIONS			
NO	DATE	BY	DESC
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2			
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Project No.		Date	
476880-01		2010/02/24	
OHIO DEEP BEAM BRIDGE		Drawn By	
RAIL T13		RSP	
		Scale	
		Sheet No.	
		2 of 12	

Mar 29, 2010 - 1:56pm



NOTE: DETAIL G&J-RIGHT END RAIL
 DETAIL H&K-CENTER RAIL
 DETAIL I&L-LEFT END RAIL
 ALL NUTS TO BE HEAVY HEX ASTM A563
 ALL WASHERS TO BE ASTM F436
 PLATE WASHER-DETAIL F IS USED BETWEEN NUT AND POST

REVISIONS		THE TEXAS A&M UNIVERSITY SYSTEM	
NO	DATE	BY	CHK
1	09/09/29	RSP	
2	10/03/29	RSP	
3			
4			
5			

Project No.	476880-01	Date	2008/08/04
Drawn By	NDE	Scale	
TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843			
Sheet No. 3 of 12 OHIO DEEP BEAM BRIDGE RAIL TL3			

1:2008-2010\476880-01\Drawings\Deep beam Bridge Cap\Detail 2010-07-28.dwg

Mod 29, 2010 - 1:56pm

REVISIONS		NO	DATE	BY	CHK
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2	10/03/09	RSP			
3	07/20/09	RSP			
4	08/08/04	NDE			
Project No. 47680-01		Date 2008/08/04		Drawn By NDE	
Sheet No. 4 of 12		OHIO DEEP BEAM BRIDGE		RAL TLJ	

The Texas A&M University System
 TEXAS TRANSPORTATION INSTITUTE
 COLLEGE STATION, TEXAS 77843

172008-2010\47680-01\Drawings\Deep Beam Bridge\Cardinal_2010-07-26.dwg
 172008-2010\47680-01\Drawings\Deep Beam Bridge\Cardinal_2010-07-26.dwg

OHIO DEEP BEAM BRIDGE
 COLLEGE STATION, TEXAS 77843

ALL NUTS-HEAVY HEX ASTM A563
 ALL WASHERS-ASTM F436
 3 HEX NUTS
 DECK FASCIA
 1 1/2" x 20" HEX BOLT
 ASTM A449

2 1/2" x 3 1/2"
 PL WASHERS
 3/8" THK.
 PL. WASHERS
 8" THREAD
 15"

ANCHOR BOLT
 DETAIL B

ANCHOR BOLT
 DETAIL B

ANCHOR BOLT
 DETAIL B

ANCHOR BOLT
 DETAIL B

TUBULAR BLOCKOUT
 DETAIL C

TS 8" x 4" x 3/8"
 TUBING
 ASTM A 501
 TOP SIDE ONLY
 3/8" HOLE
 TOP VIEW

ANCHOR BOLT
 DETAIL B

ANCHOR BOLT
 DETAIL B

ANCHOR BOLT
 DETAIL B

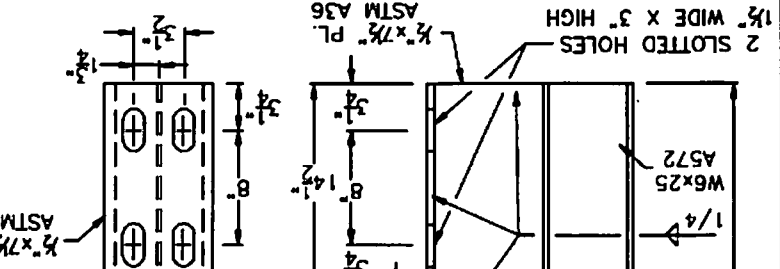
ANCHOR BOLT
 DETAIL B

ANCHOR BOLT
 DETAIL B

ANCHOR BOLT
 DETAIL B

ANCHOR BOLT
 DETAIL B

POST DETAIL A
 FRONT ELEVATION
 SIDE ELEVATION



W6x25
 1/4" WIDE X 3" HIGH
 2 SLOTTED HOLES
 1/2" x 7/8" PL.
 ASTM A36

ANCHOR BOLT
 DETAIL B

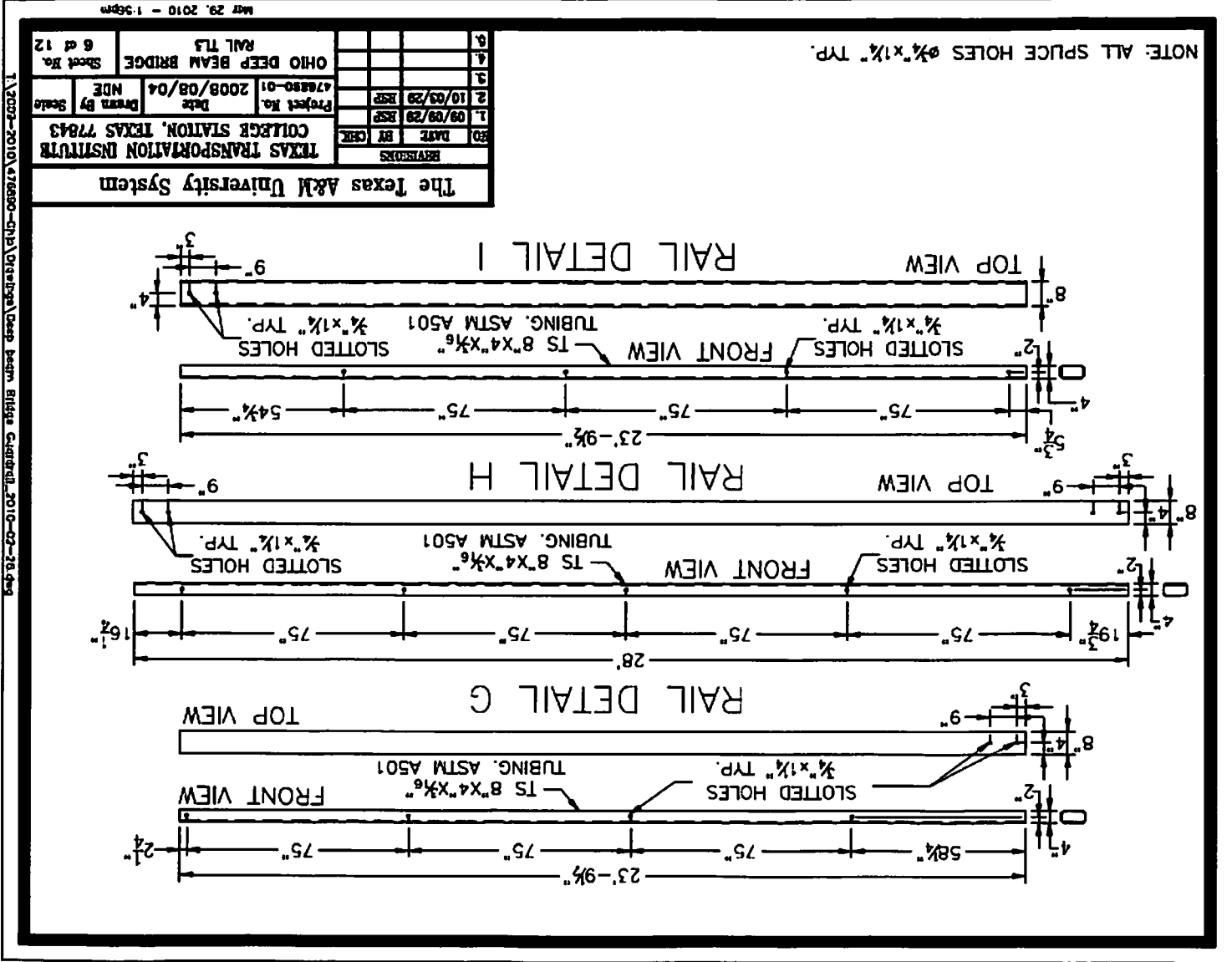
ANCHOR BOLT
 DETAIL B

ANCHOR BOLT
 DETAIL B

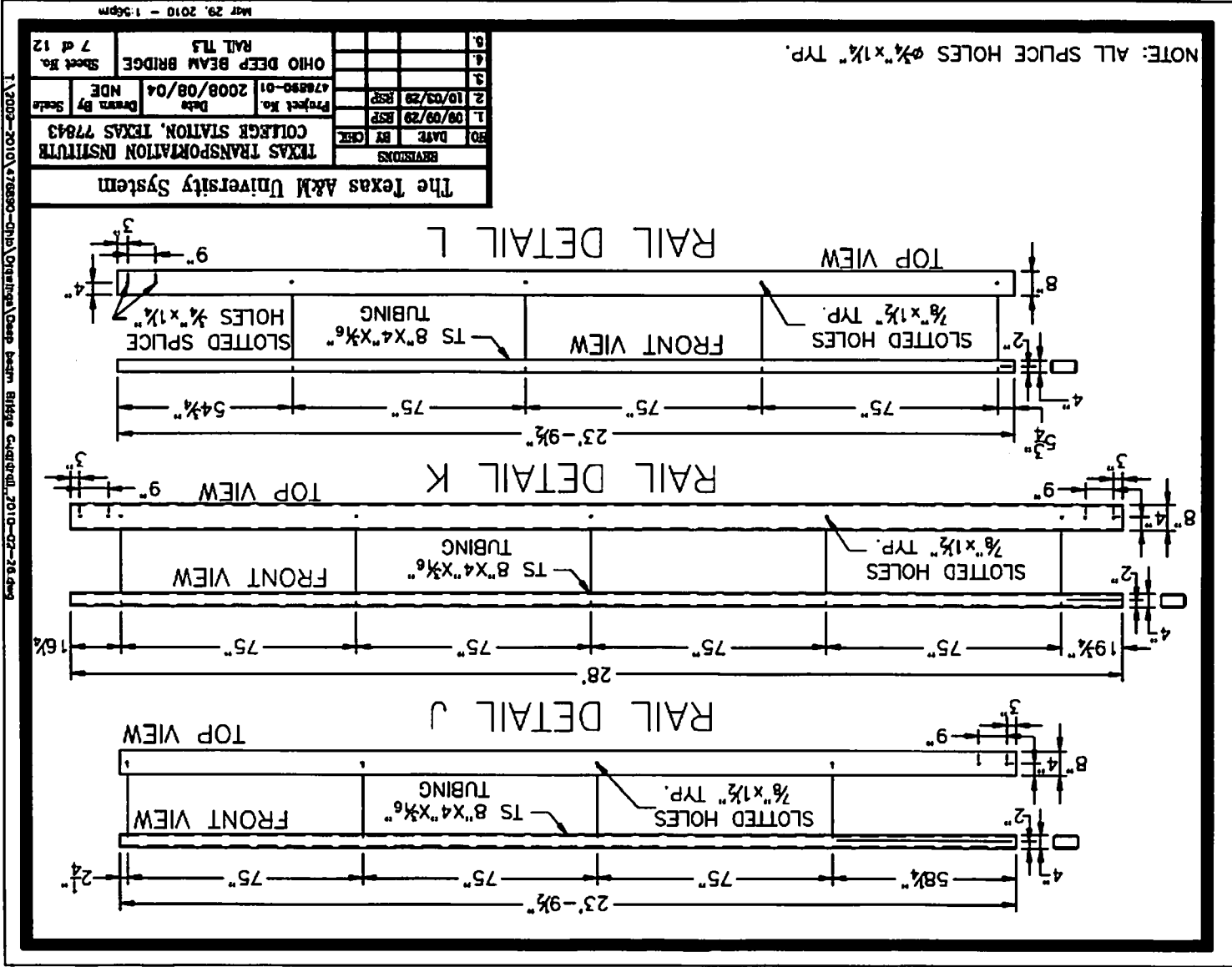
ANCHOR BOLT
 DETAIL B

ANCHOR BOLT
 DETAIL B

ANCHOR BOLT
 DETAIL B



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NOTE: ALL SPUCE HOLES $\phi \frac{3}{4} \times \frac{1}{4}$ " TYP.

REVISIONS		The Texas A&M University System	
30	DATE	BY	CHEK
1	08/09/20	ESP	
2	10/03/20	ESP	
Project No. 476890-01		Date 2008/08/04	
Drawn By NDE		Scale	
TEXAS TRANSPORTATION INSTITUTE			
COLLEGE STATION, TEXAS 77843			
Sheet No. OHIO DEEP BEAM BRIDGE		RAIL T13	
7 of 12			

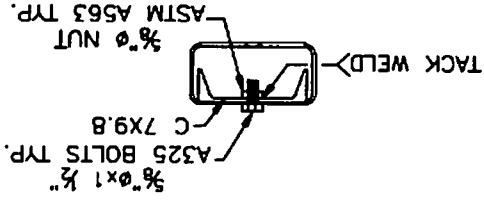
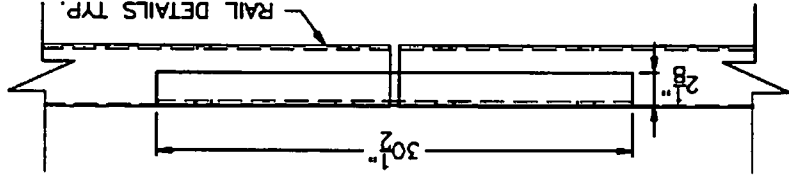
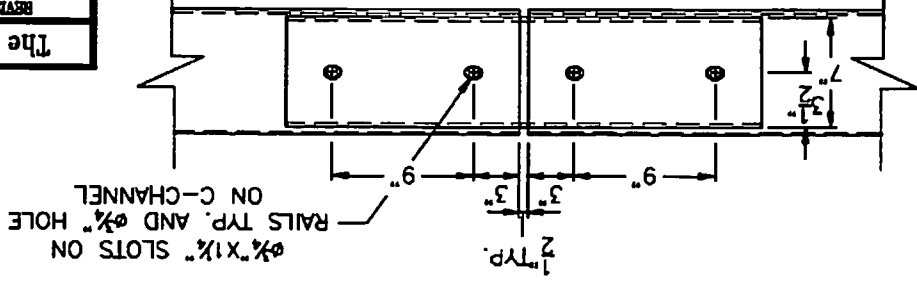
Mod 29, 2010 - 1:56pm

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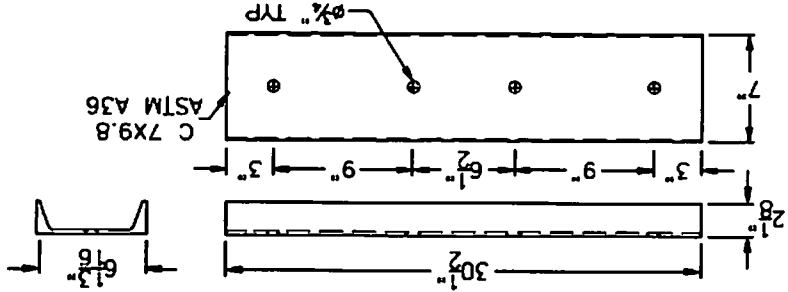
Mar 29, 2010 - 1:56pm

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4.					
3.					
2.	10/03/09	NSP	Project No.	2008/08/04	Drawn By
1.	09/08/09	NSP	Date		NDE
NO	DATE	BY	CHK	REVISIONS	
TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843					
The Texas A&M University System					
OHIO DEEP BEAM BRIDGE RAIL TL3 Sheet No. 8 of 12					

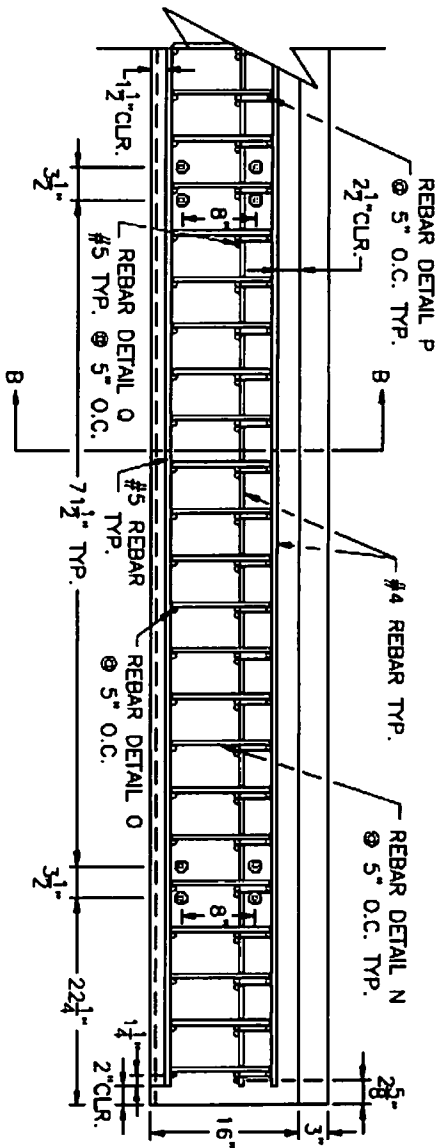
SPLICE DETAIL M



DETAIL OF C-CHANNEL



I:\2008-2010\47880-dhp\Drawings\Deep Beam Bridge\Detail_2010-07-28.dwg

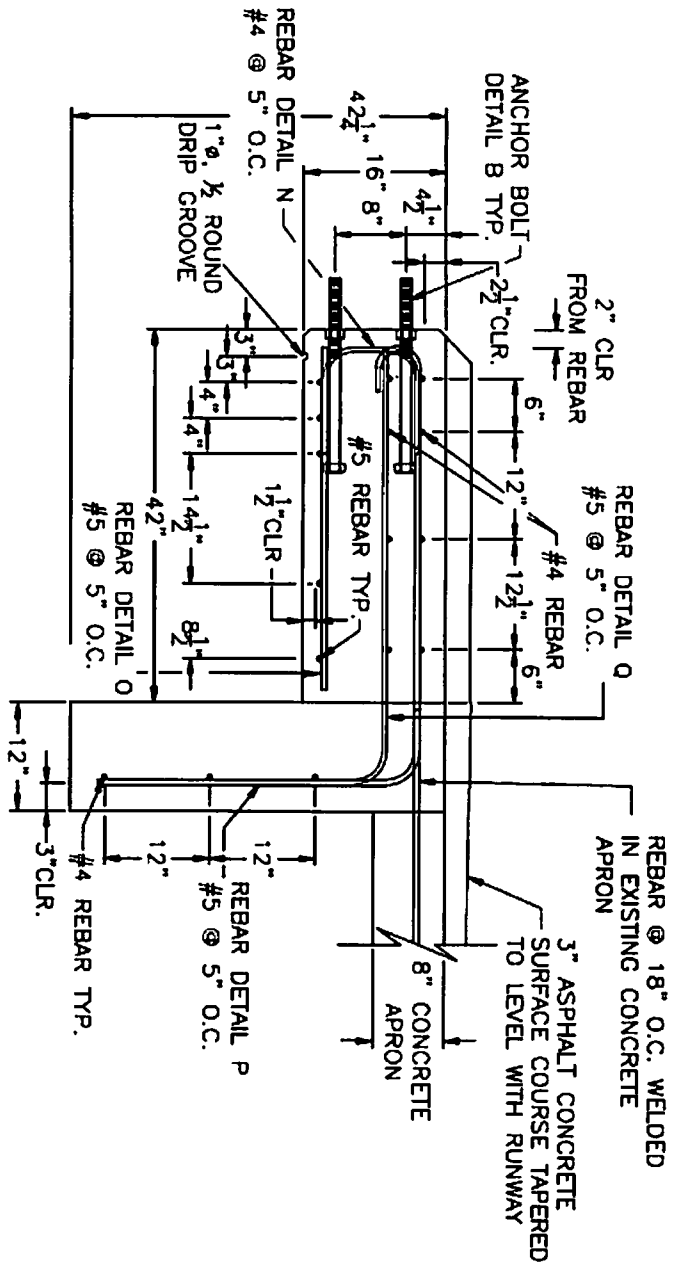


REBAR LAYOUT
DECK-ELEVATION VIEW

The Texas A&M University System			
TEXAS TRANSPORTATION INSTITUTE			
COLLEGE STATION, TEXAS 77843			
REV	DATE	BY	CHK
1	09/09/20	ESP	
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Project No. 2008/09/04		Date 08/09/04	
OHIO DEEP BEAM BRIDGE		NDI	
RAIL TL3		Sheet No. 9 of 12	

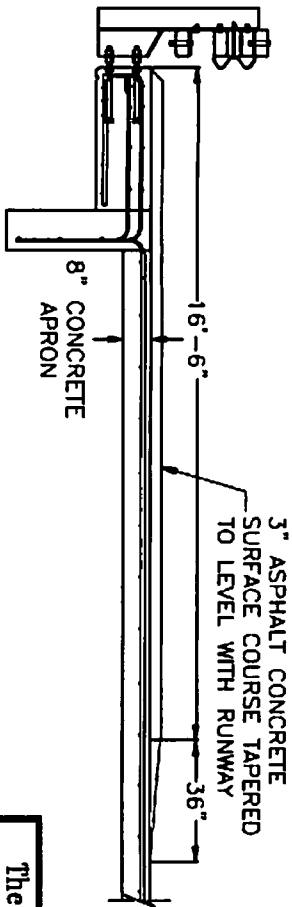
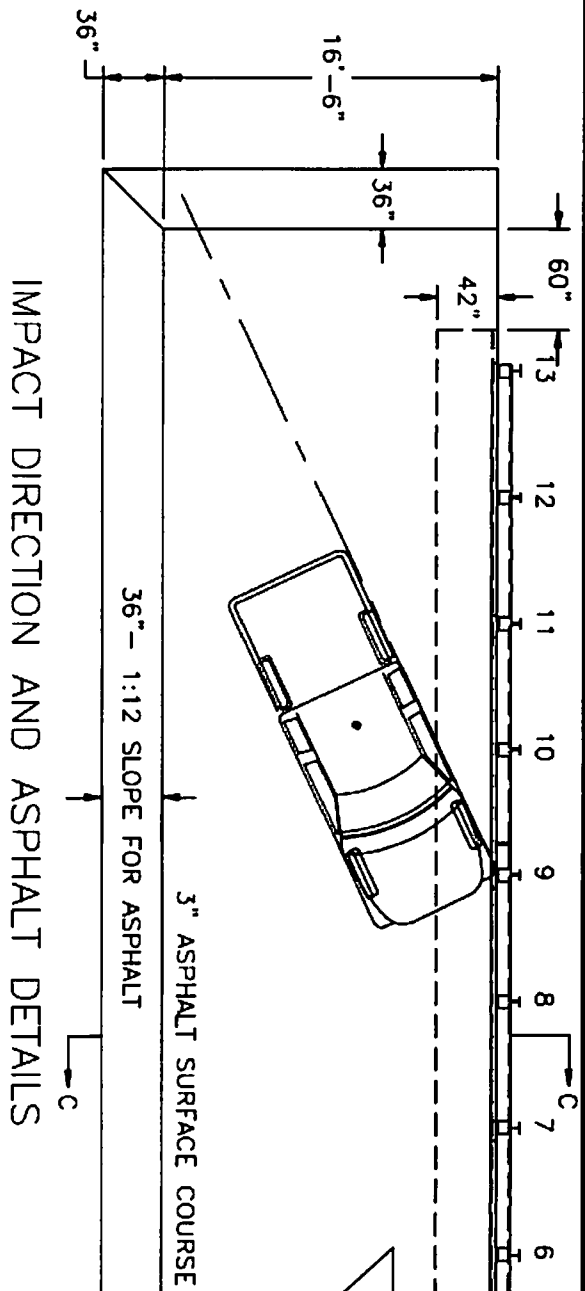
MAR 29, 2010 - 1:37PM

SECTION DETAIL B-B



The Texas A&M University System			
REVISIONS			
NO	DATE	BY	CHKD
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2	10/03/29	ESP	
3			
4			
5			
Texas Transportation Institute College Station, Texas 77843		Project No. 2008/08/04	
Date 2008/08/04		Drawn By NDE	
OHIO DEEP BEAM BRIDGE		Scale 10 of 12	
PALL T13			

Mar 29, 2010 - 1:37pm

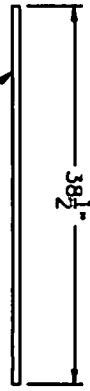


NOTE: ASPHALT LAID TILL THE OTHER END OF INSTALLATION
SLOPE NOTE TO PROVIDED ON THE OTHER END

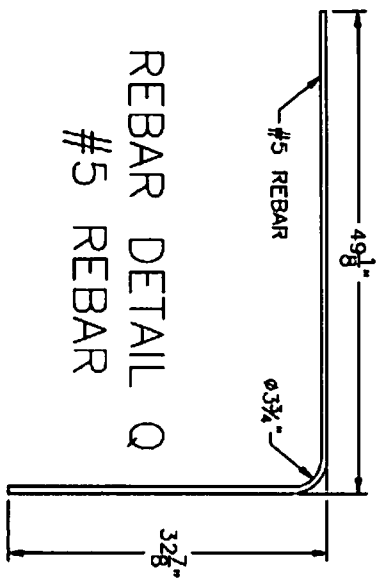
REVISIONS		The Texas A&M University System	
NO.	DATE	BY	CHK
1.			
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6.			
Project No.		TEXAS TRANSPORTATION INSTITUTE	
Date		COLLEGE STATION, TEXAS 77843	
2010/03/09		OHIO DEEP BEAM BRIDGE	
RSP		RAIL TL3	
Drawn By		Sheet No.	
RSP		11 of 12	

Mar 29, 2010 - 1:37pm

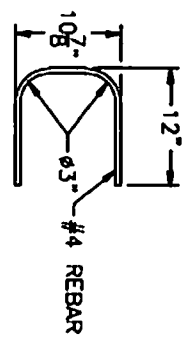
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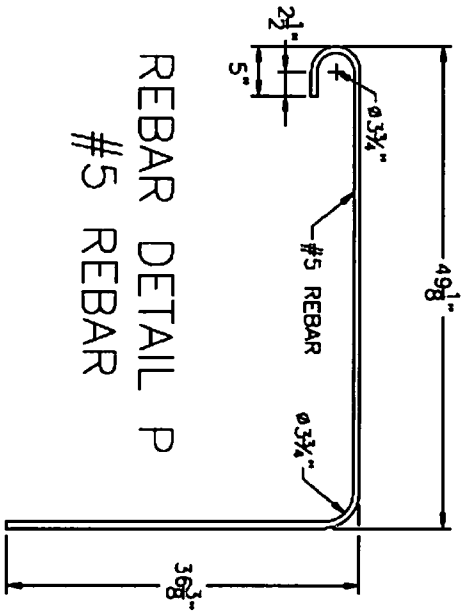
REBAR DETAIL O
#5 REBAR



REBAR DETAIL Q
#5 REBAR



REBAR DETAIL N
#4 REBAR



REBAR DETAIL P
#5 REBAR

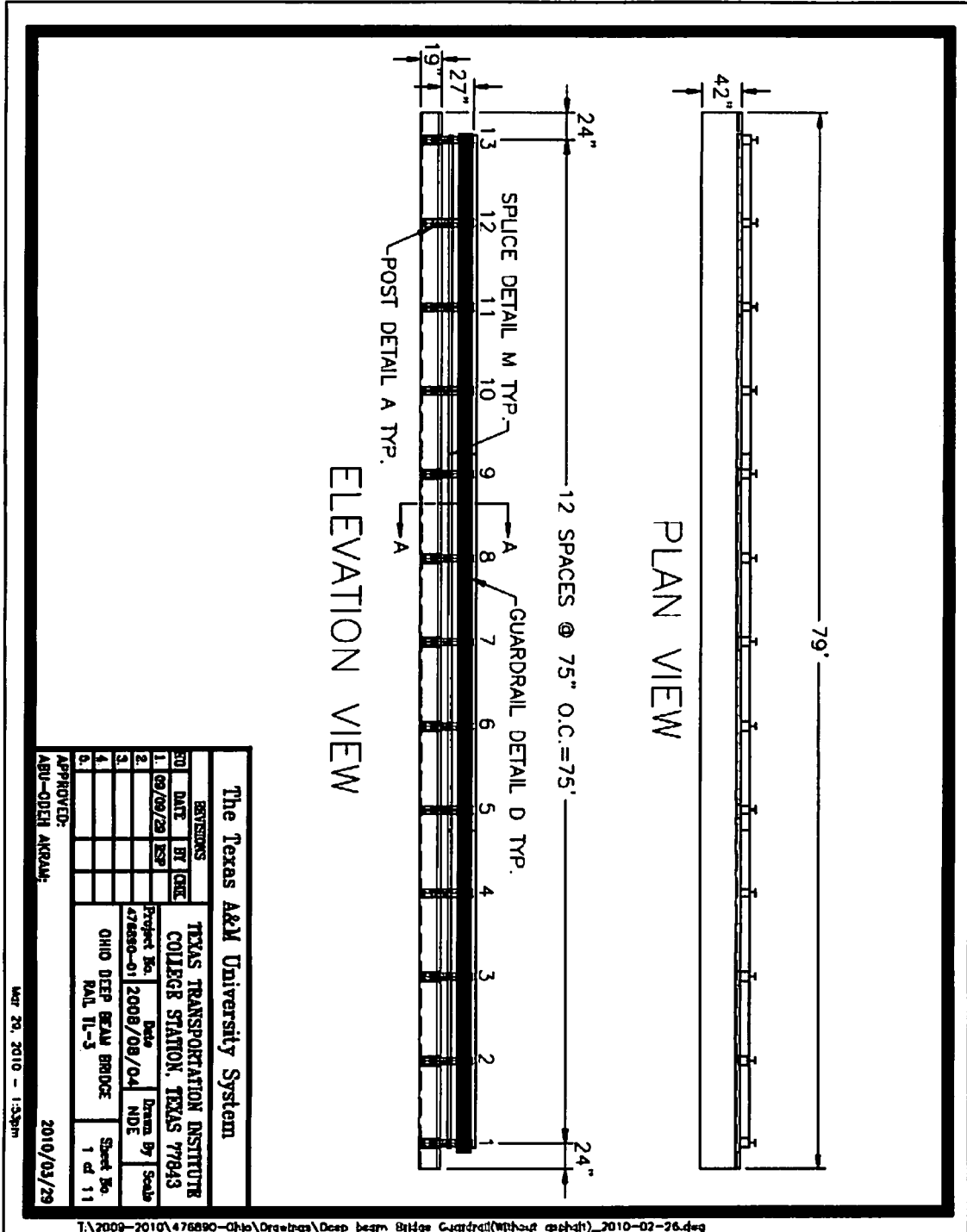
The Texas A&M University System			
TEXAS TRANSPORTATION INSTITUTE			
COLLEGE STATION, TEXAS 77843			
REV	DATE	BY	CHK
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2	10/03/29	ESP	
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Project No. 2008/08/04		Date	Drawn by
OHIO DEEP BEAM BRIDGE		NDK	Scale
RAIL TL3		Sheet No.	12 of 12

Mar 29, 2010 - 1:36pm

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APPENDIX E

Drawing of ODOT Modified Bridge Rail without Pavement Overlay



The Texas A&M University System		
TEXAS TRANSPORTATION INSTITUTE		
COLLEGE STATION, TEXAS 77943		
NO	DATE	BY / CHK
1	09/09/29	ESP
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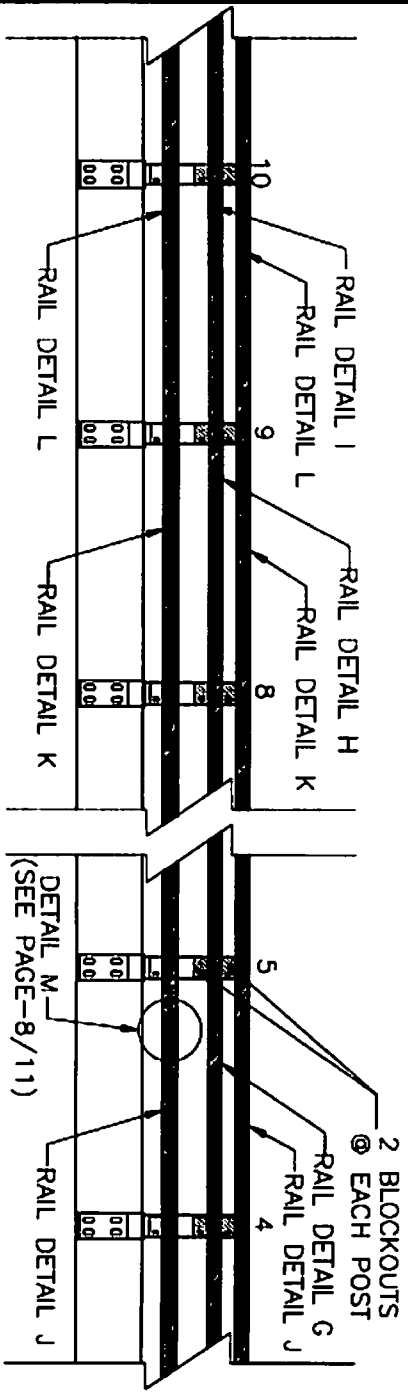
Project No.	Date	Drawn By	Scale
476690-01	2008/08/04	NDE	
OHIO DEEP BEAM BRIDGE			Sheet No.
RAIL TL-3			1 of 11

APPROVED: ABU-OJEN AKRAM

2010/03/29

Mar 29, 2010 - 1:33pm

T:\2009-2010\476690-Ohio\Drawings\Deep beam Bridge Guardrail (without asphalt)_2010-02-26.dwg



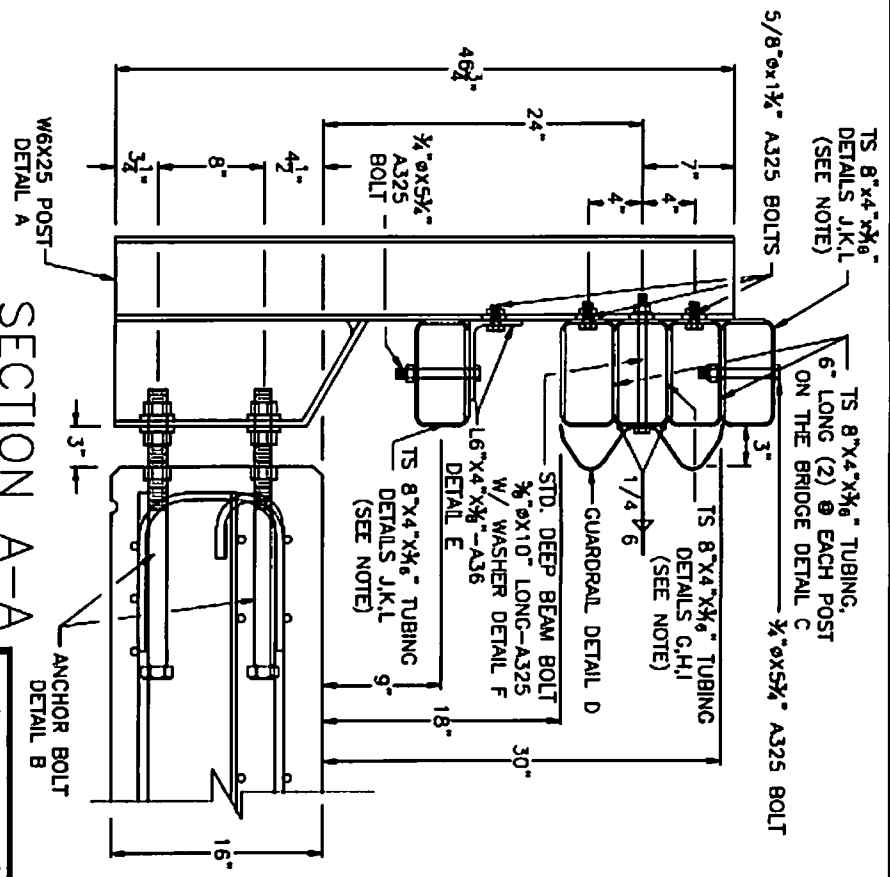
RAIL ELEVATION—DETAIL
(WITHOUT W-BEAM)

The Texas A&M University System			
TEXAS TRANSPORTATION INSTITUTE			
COLLEGE STATION, TEXAS 77843			
NO	DATE	BY	CHK
1	09/09/29	JSP	
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Project No.		Date	Drawn By
476890-01		2008/08/04	NDE
OHIO DEEP BEAM BRIDGE		Scale	Sheet No.
RAIL T13			2 of 11

MAR 29, 2010 - 1:33pm

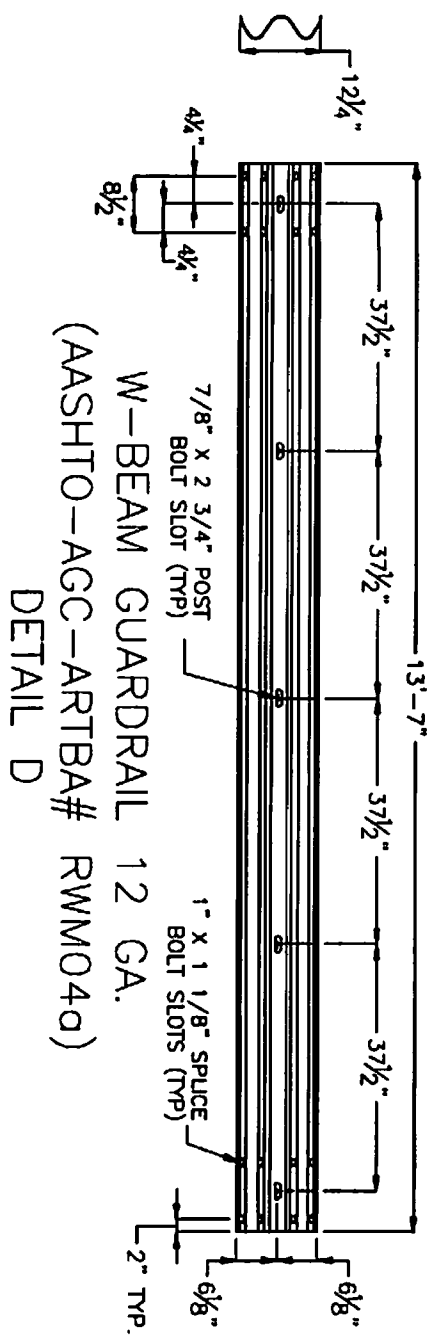
NOTE: DETAIL G&J--RIGHT END RAIL
 DETAIL H&K--CENTER RAIL
 DETAIL I&L-- LEFT END RAIL
 ALL NUTS TO BE HEAVY HEX ASTM A563
 ALL WASHERS TO BE ASTM F436
 PLATE WASHER--DETAIL F IS USED BETWEEN NUT AND POST

SECTION A-A

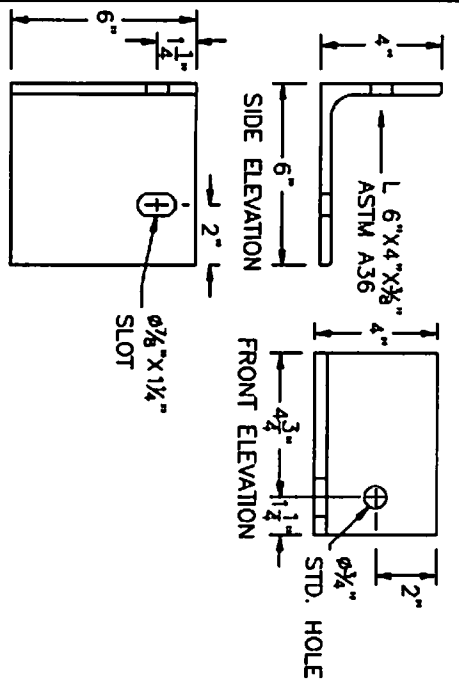


The Texas A&M University System			
TEXAS TRANSPORTATION INSTITUTE			
COLLEGE STATION, TEXAS 77843			
REV	DATE	BY	CHK
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Project No. 47880-01		Date	Drawn By
OHIO DEEP BEAM BRIDGE		2008/08/04	NDE
RAIL T13		Scale	Sheet No.
			5 of 11

Mar 29, 2010 - 1:33pm



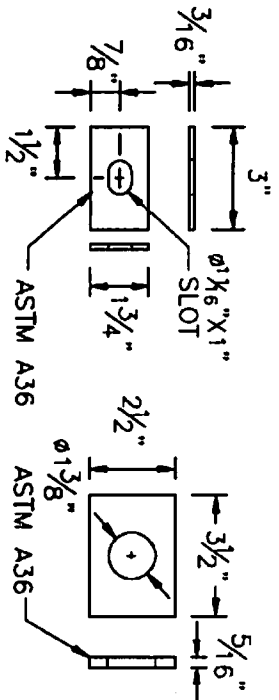
W-BEAM GUARDRAIL 12 GA.
 (AASHTO-AGC-ARTBA# RWM040)
 DETAIL D



ANGLE BRACKET
 DETAIL E

WASHER
 DETAIL F

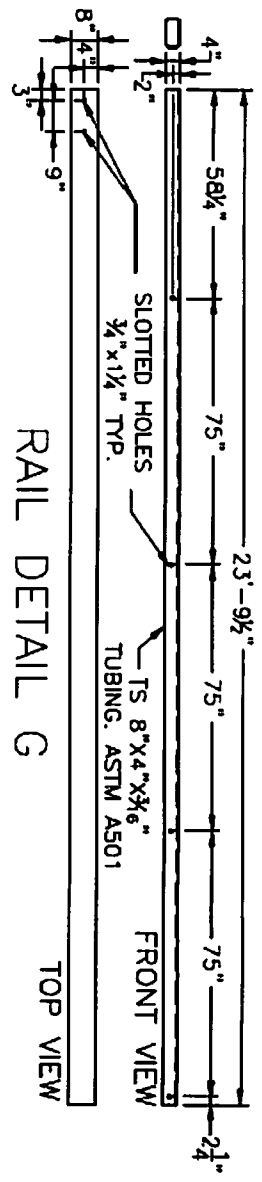
PL. WASHER
 DETAIL M



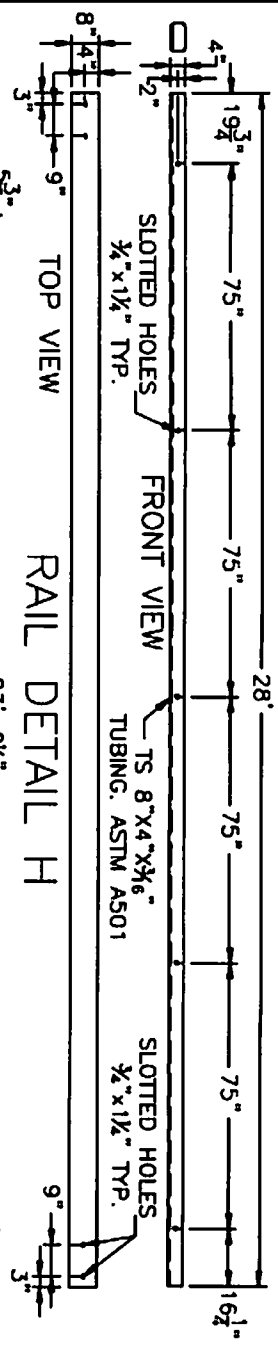
The Texas A&M University System	
TXAS TRANSPORTATION INSTITUTE	
COLLEGE STATION, TEXAS 77943	
REV	DATE
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Project No.	Date	Drawn By	Scale
478650-01	2008/08/04	NDE	
OHIO DEEP BEAM BRIDGE		Sheet No.	5 of 11
RAIL TL3			

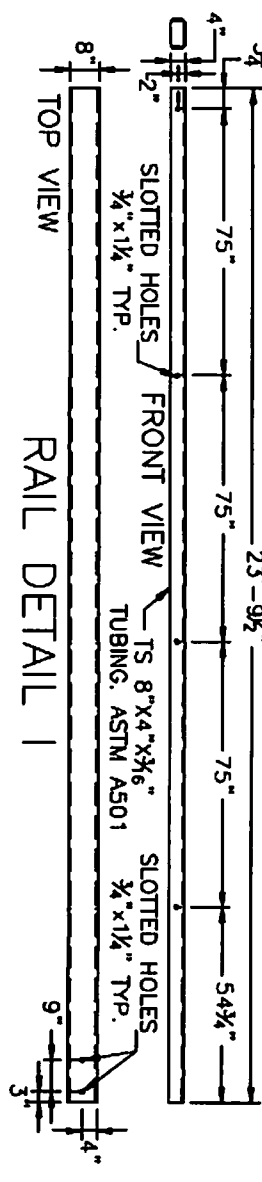
Mar 29, 2010 - 1:34pm



RAIL DETAIL G



RAIL DETAIL H

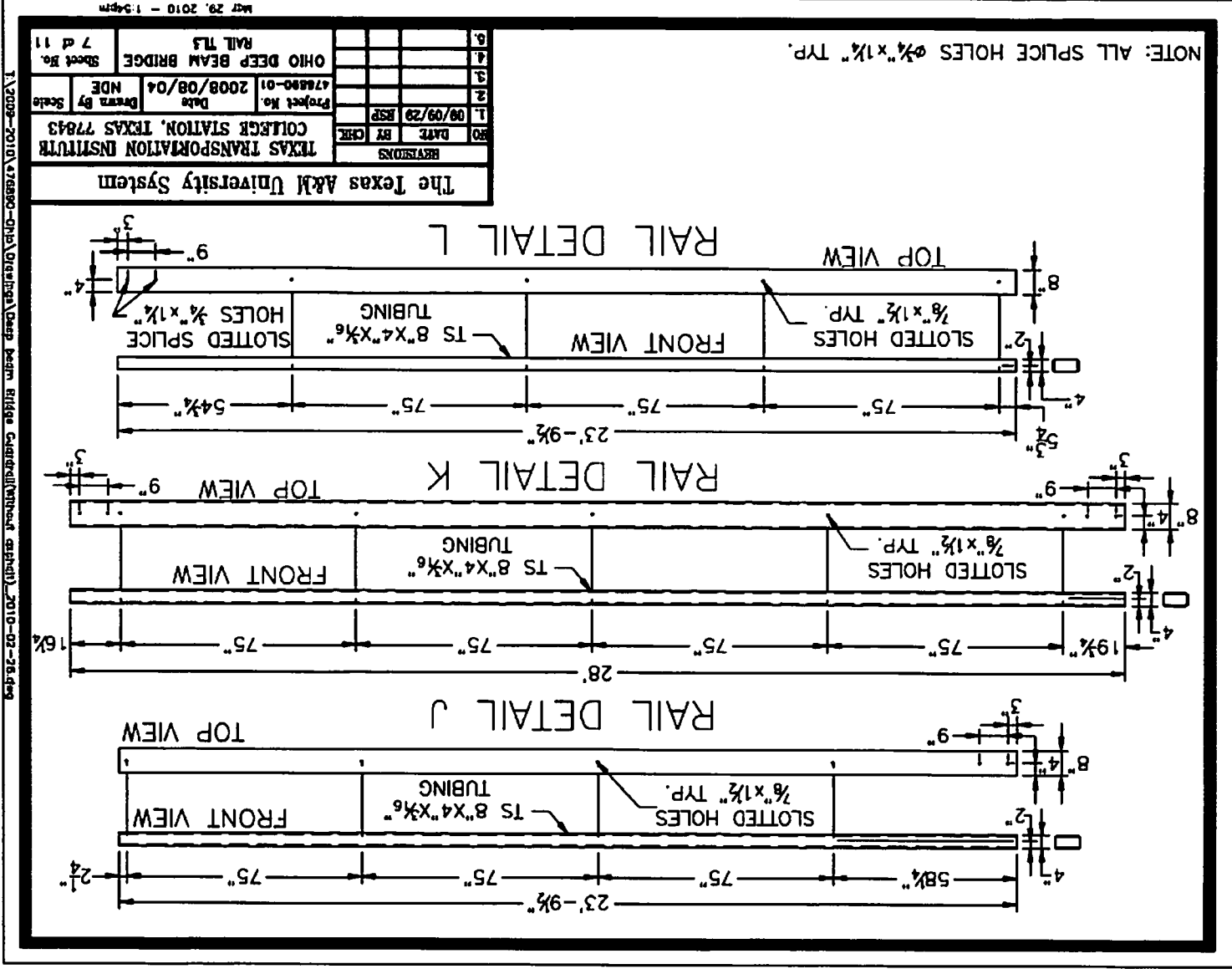


RAIL DETAIL I

NOTE: ALL SPLICE HOLES $\phi 7/8$ " x $1 1/4$ " TYP.

The Texas A&M University System			
REVISIONS			
NO	DATE	BY	CHK
1	09/09/20	ESP	
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TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843 Project No. 476890-01 Date 2008/08/04 OHIO DEEP BEAM BRIDGE Drawn by NDE RAIL T13 Sheet No. 6 of 11			

Mar 29, 2010 - 1:34pm



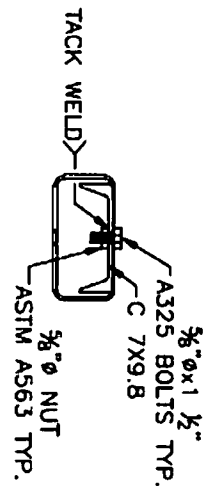
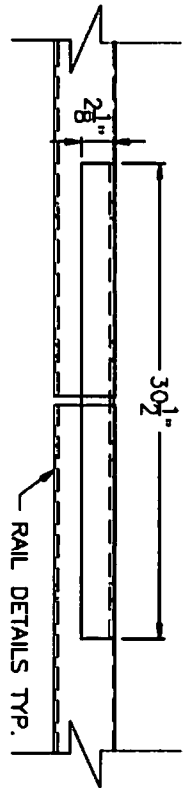
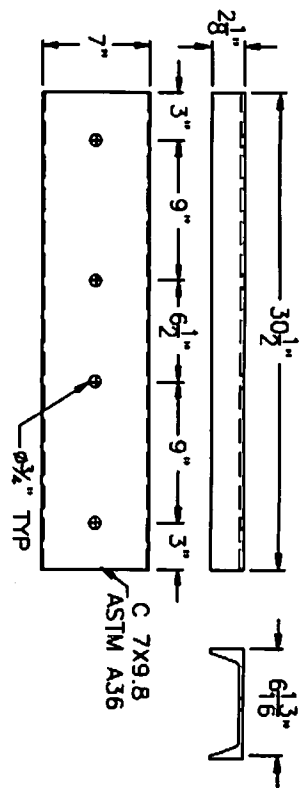
NOTE: ALL SPICE HOLES $\phi\frac{3}{4}$ " x $1\frac{1}{2}$ " TYP.

THE TEXAS A&M UNIVERSITY SYSTEM	
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COLLECT STATION, TEXAS 77043	
Project No.	476890-01
Date	2008/08/04
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Sheet No.	7 of 11
OHIO DEEP BEAM BRIDGE RAIL #13	

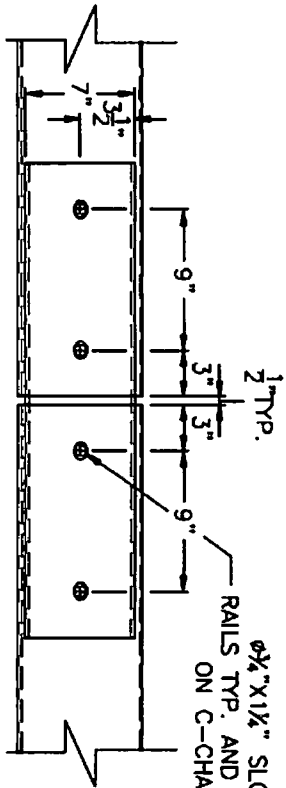
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DETAIL OF C-CHANNEL



$\phi\frac{1}{2}$ "X $1\frac{1}{2}$ " SLOTS ON RAILS TYP. AND $\phi\frac{1}{2}$ " HOLE ON C-CHANNEL



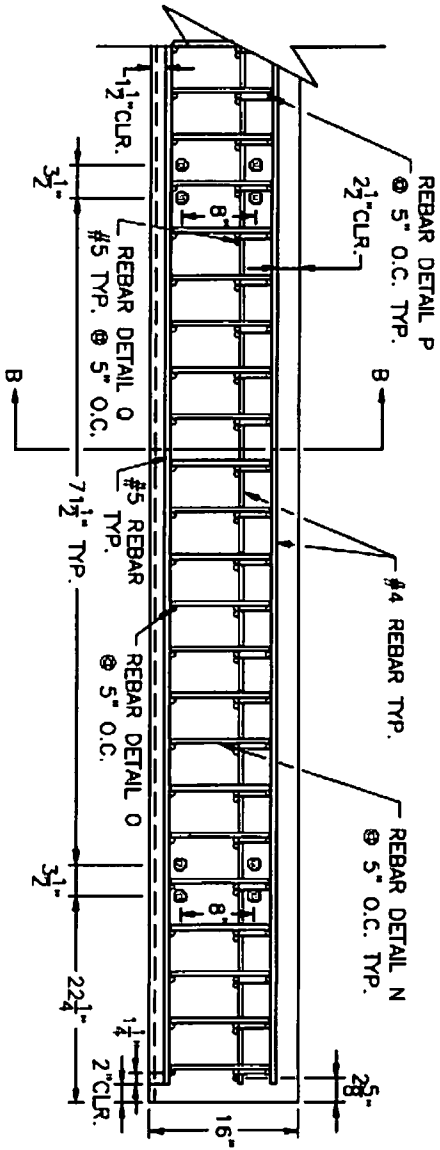
SPLICE DETAIL M

REVISIONS		The Texas A&M University System	
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COLLEGE STATION, TEXAS 77843		2008/08/04	
Date		NDE	
OHIO DEEP BEAM BRIDGE		Sheet No.	
RAIL TL3		8 of 11	

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REBAR LAYOUT
DECK-ELEVATION VIEW

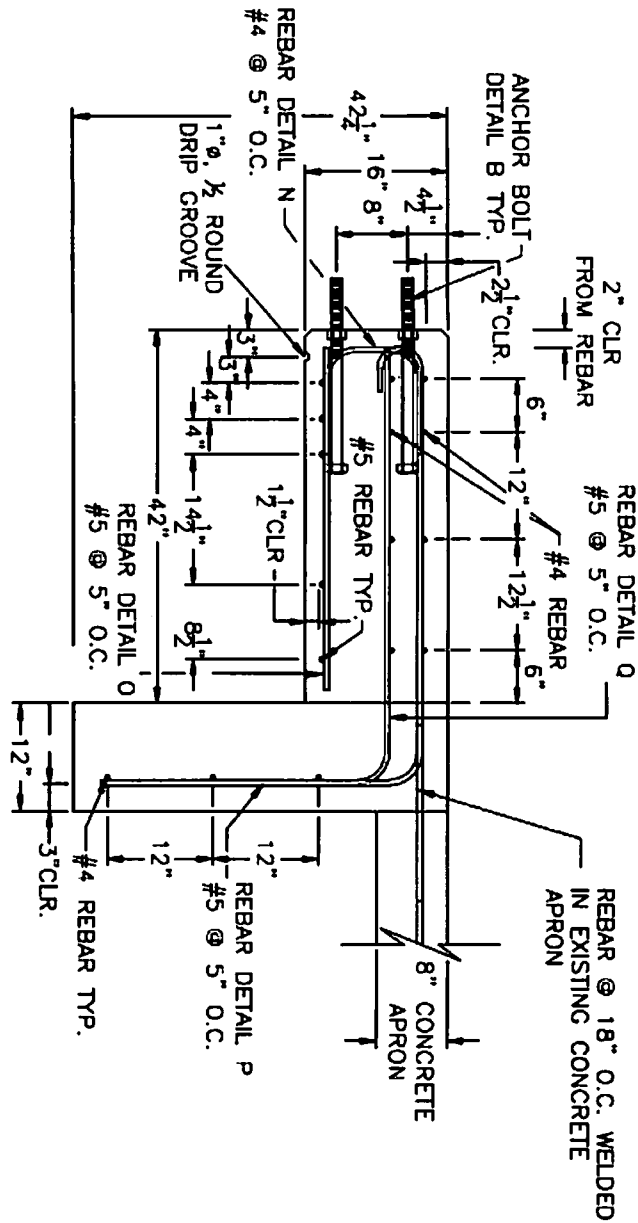


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COLLEGE STATION, TEXAS 77843	
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Drawn By	Scale
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Sheet No.	9 of 11
OHIO DEEP BEAM BRIDGE RAIL T13	

Mar 29, 2010 - 1:34pm

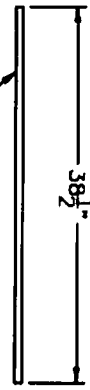
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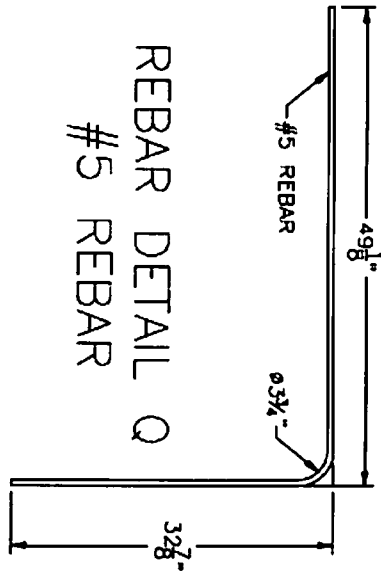


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OHIO DEEP BEAM BRIDGE		Sheet No.	
RAIL TL3		10 of 11	

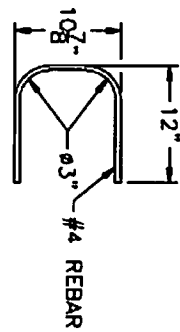
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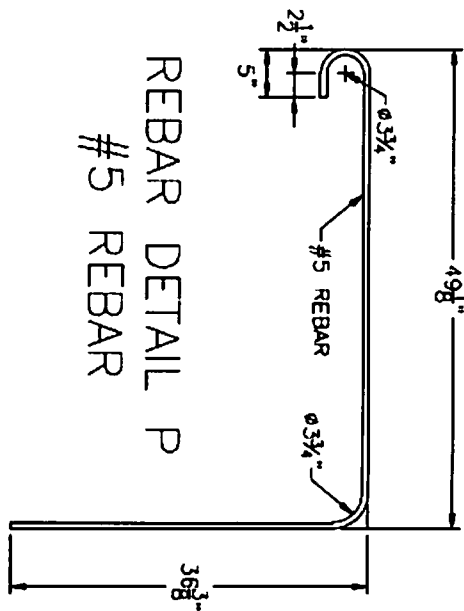
REBAR DETAIL O
#5 REBAR



REBAR DETAIL Q
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REBAR DETAIL N
#4 REBAR



REBAR DETAIL P
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