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 Ml64 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 (Wl50x37.1) 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:

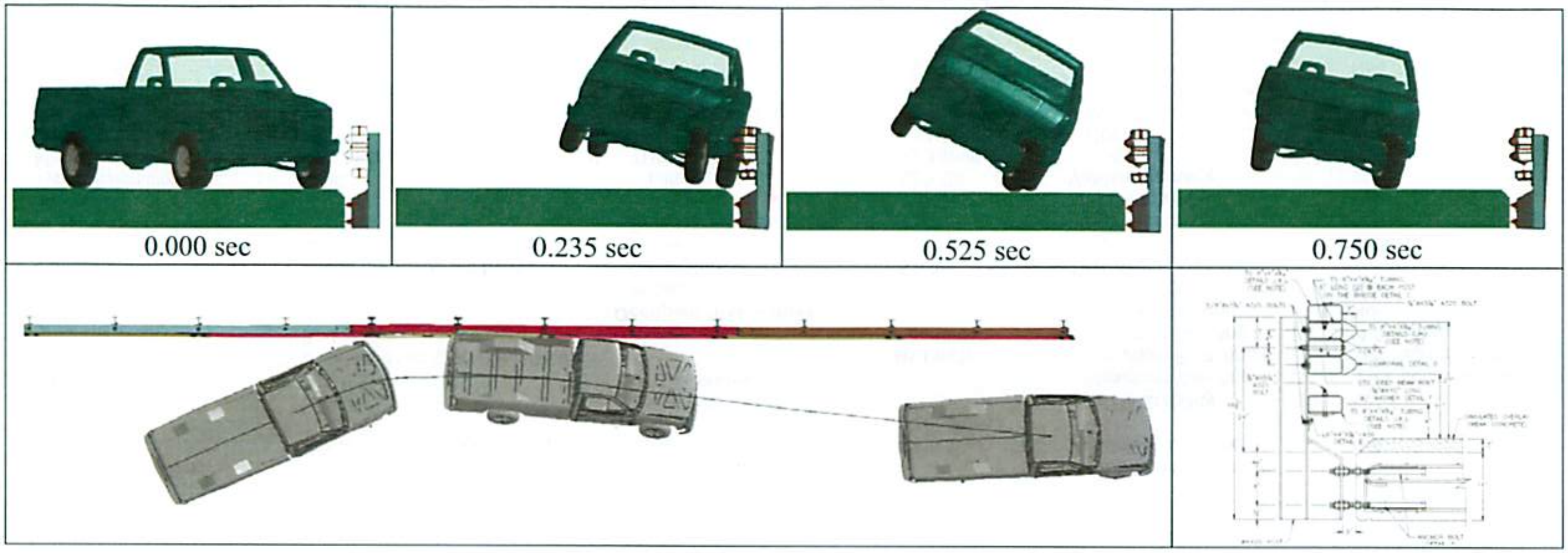
- This acceptance is limited to the crash worthiness characteristics of the system and does not cover their structural features, nor conformity with the Manual on Uniform Traffic Control Devices.
- Any changes that may adversely influence the crashworthiness of the system will require a new acceptance 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.
- This acceptance 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 acceptance letter is limited to the crashworthiness characteristics of the candidate system, and the

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,

George E. Rice, Jr.

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

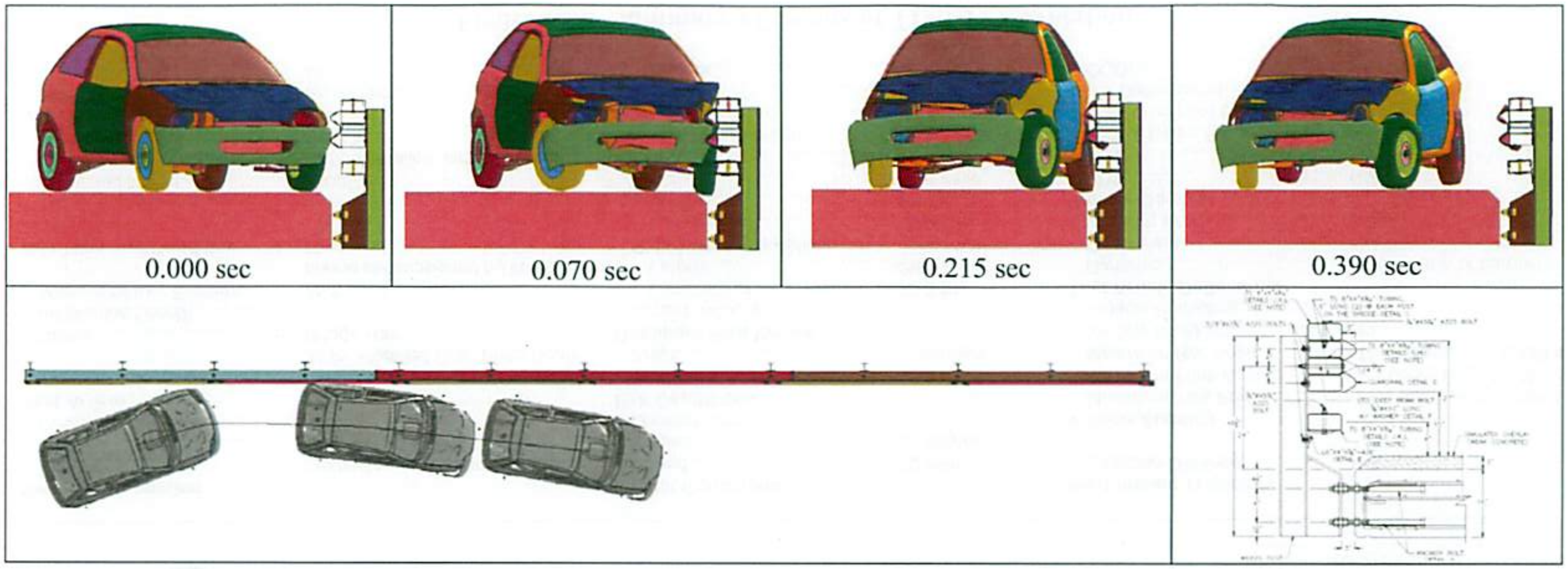


General Information
Test Agency .... Texas Transportation Institute
Test No. TL-3-11
Date ....
Test Article N/A
Type ....
31 in. Modified Ohio Deep Beam
Name .... Bridge Rail
Installation Length ....
Material or Key Elements .... 75 ft
bridge rail supported by W6x25
Soil Type and Condition .... steel post
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 Width .... 2.56 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
- Speed: 48.1 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

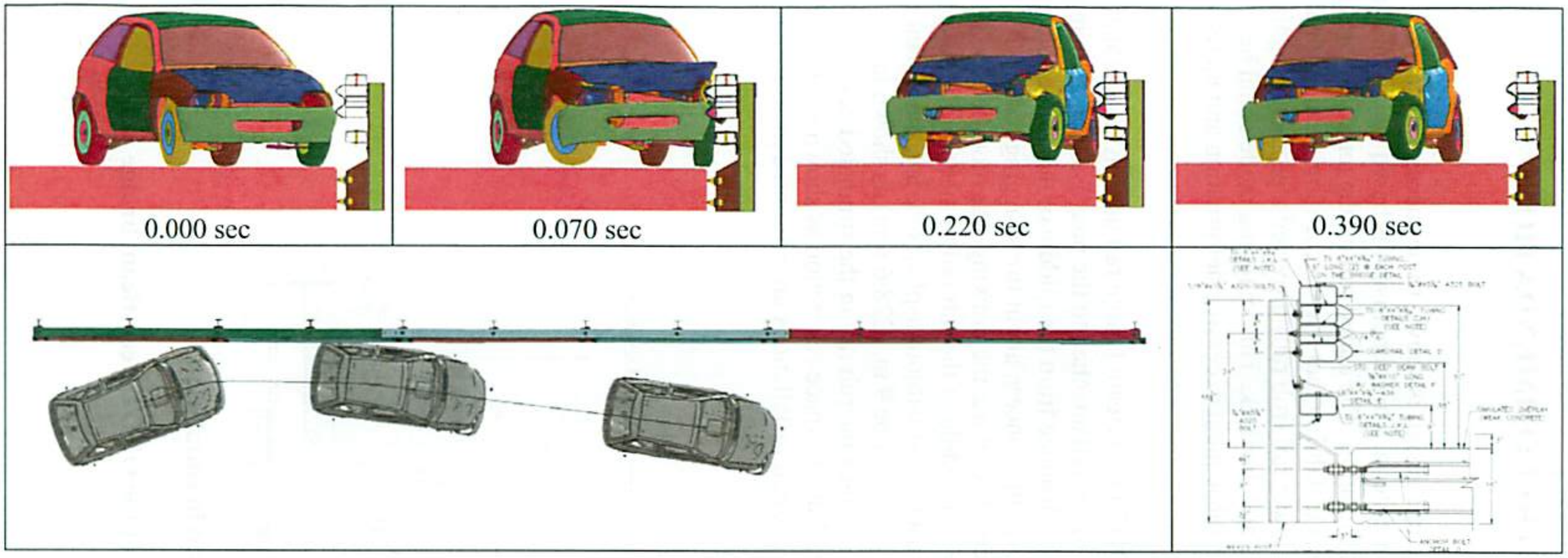
Post-Impact Trajectory
- Stopping Distance: N/A

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



General Information
- Test Agency .... Texas Transportation Institute
- Test No. .... Simulation
- Date ....

Test Article
- Type .... 34 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
- 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

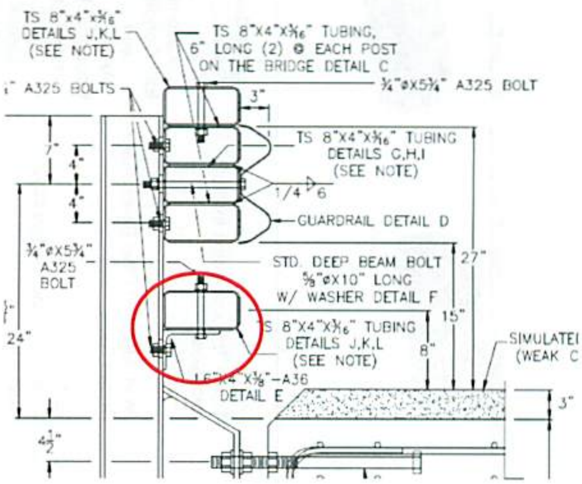
Vehicle Damage
- VDS .... N/A
- CDC .... N/A
- Max. Exterior Deformation .... N/A
- Max. Occupant Compartment Deformation .... N/A
- OCDI .... N/A

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

6. CONCLUSIONS AND RECOMMENDATIONS

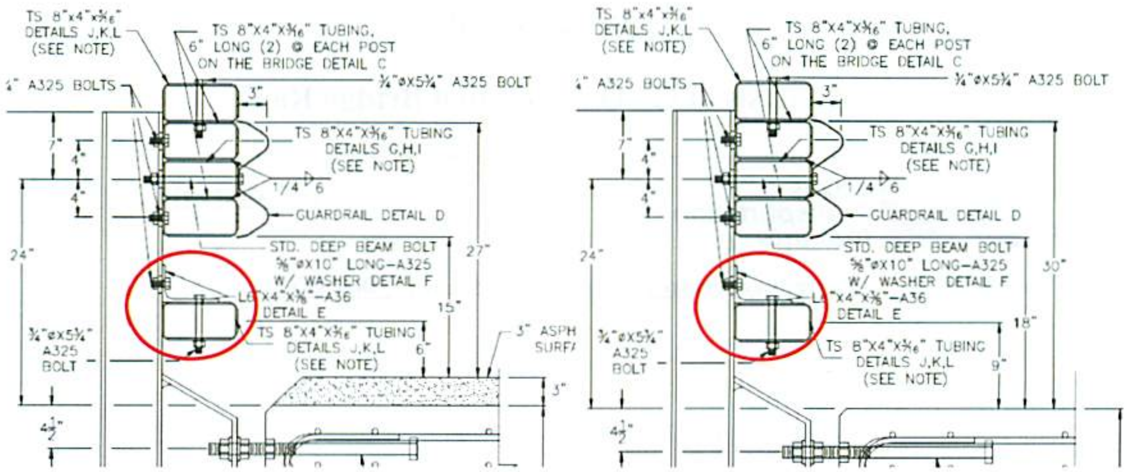
The modified ODOT Deep Beam bridge rail design is shown to be successfully able to pass NCHRP Report 350 test level 3 assessment criteria. This conclusion is based on engineering strength analysis and nonlinear finite element simulation. The added rail on the top of the bridge rail helped reduced potential 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. (230 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.

APPENDIX B

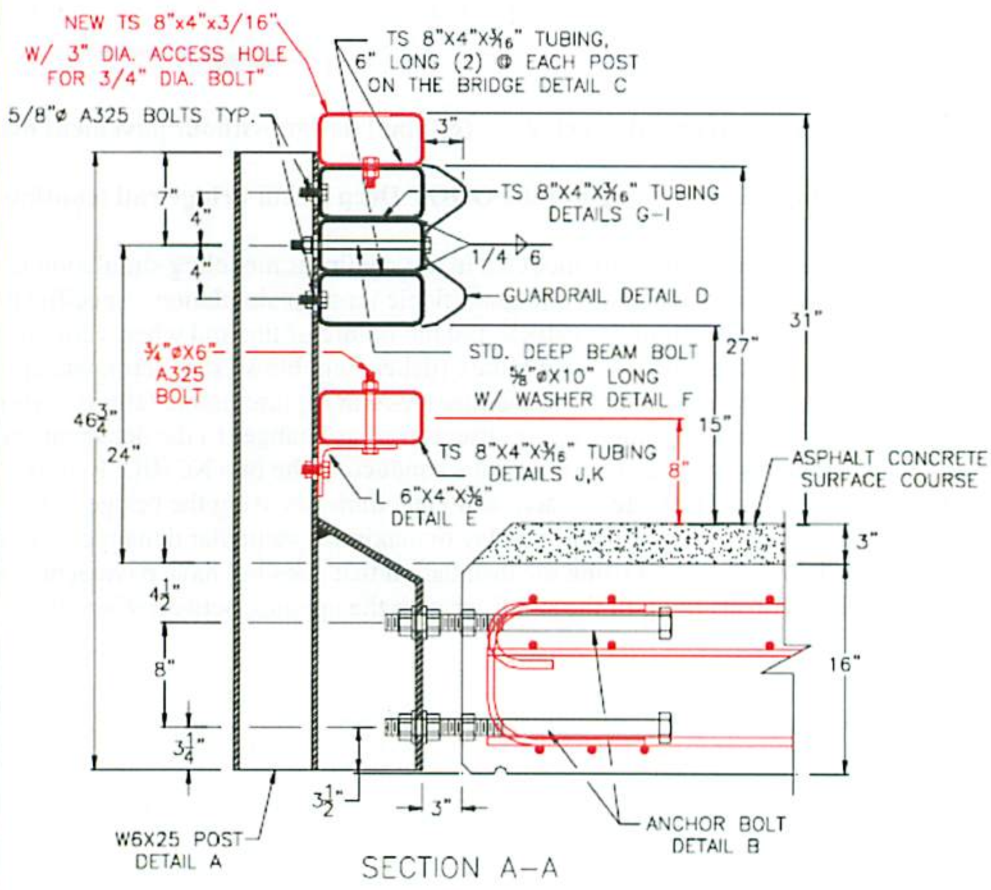
Analysis of ODOT Modified Bridge Rail

Texas Transportation Institute

Project #: 476890-01

Subject: Ohio TL-3 Deep Beam Bridge Guardrail

Sponsor: Ohio DOT



OhioTL-3BridgeRailLRFDWFW.xmcd
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William Williams, P.E.
979-862-2297
w-williams@tamu.edu

1

Figure B 1 Analysis of Modified ODOT Deep Beam Bridge Rail 1

Texas Transportation Institute

Project #: 476890-01

Subject: Ohio TL-3 Deep Beam Bridge Guardrail

Sponsor: Ohio DOT

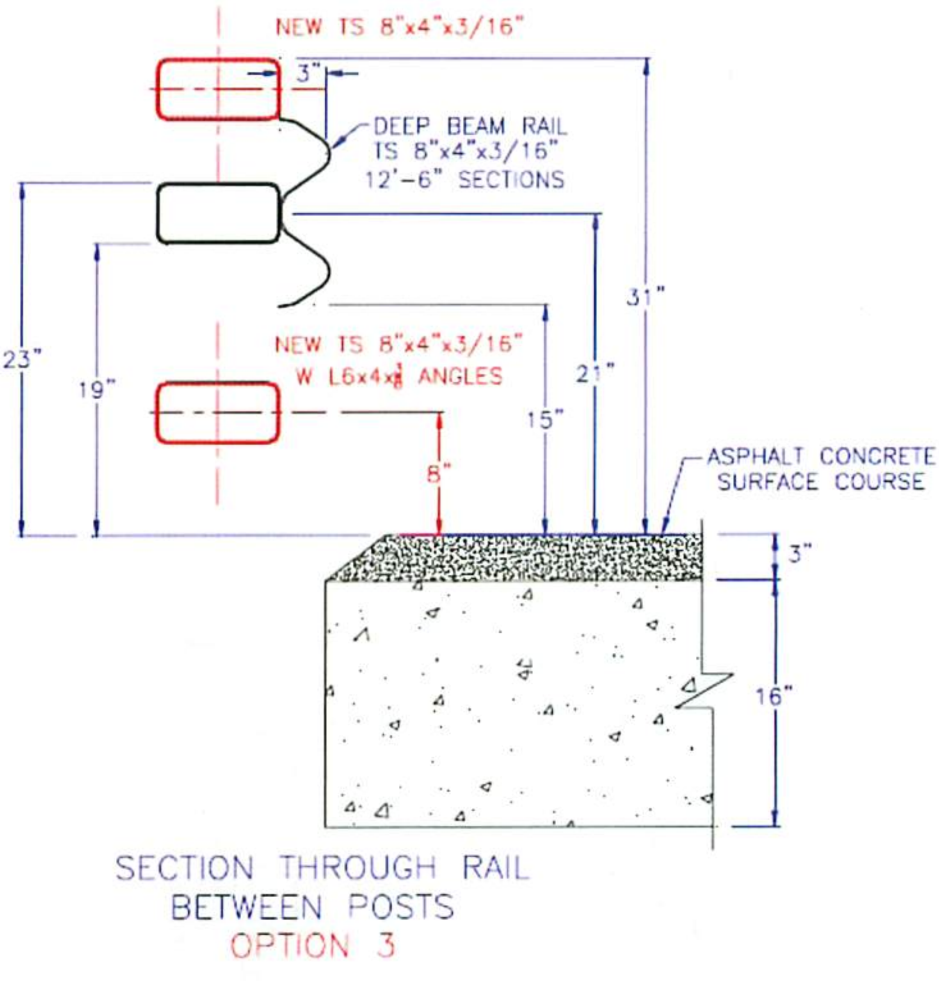

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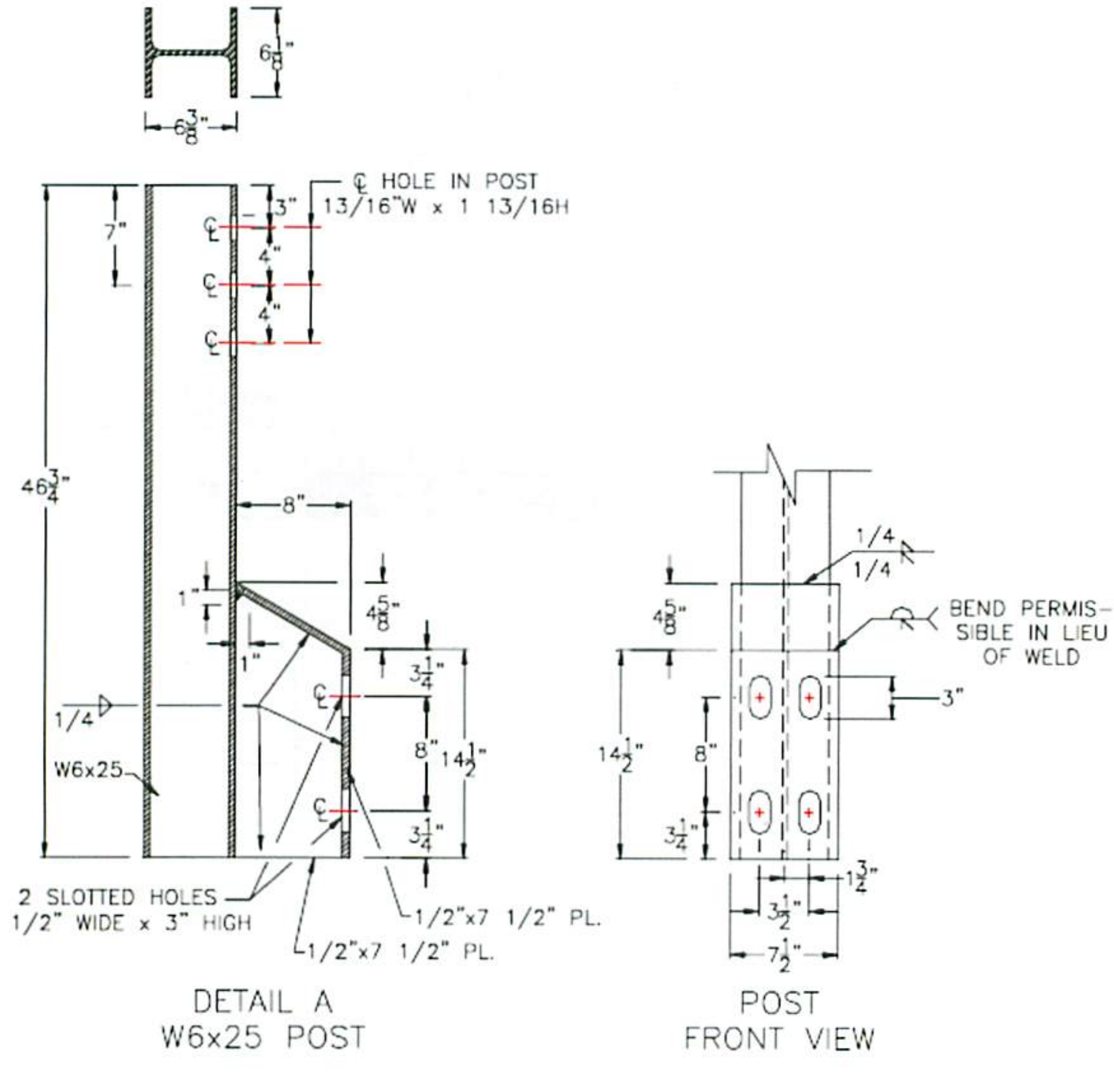
Figure B 2 Analysis of Modified ODOT Deep Beam Bridge Rail 2

Texas Transportation Institute

Project #: 476890-01

Subject: Ohio TL-3 Deep Beam Bridge Guardrail

Sponsor: Ohio DOT



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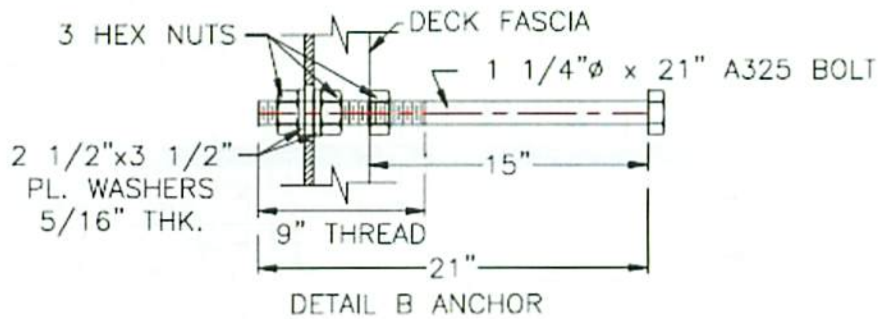
3

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

Texas Transportation Institute

Project #: 476890-01

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



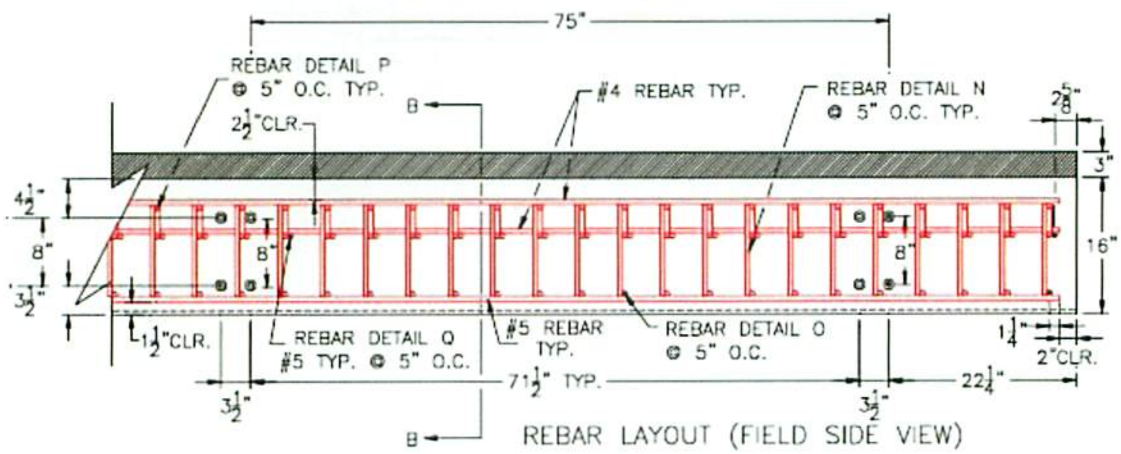


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Figure B 4 Analysis of Modified ODOT Deep Beam Bridge Rail 4

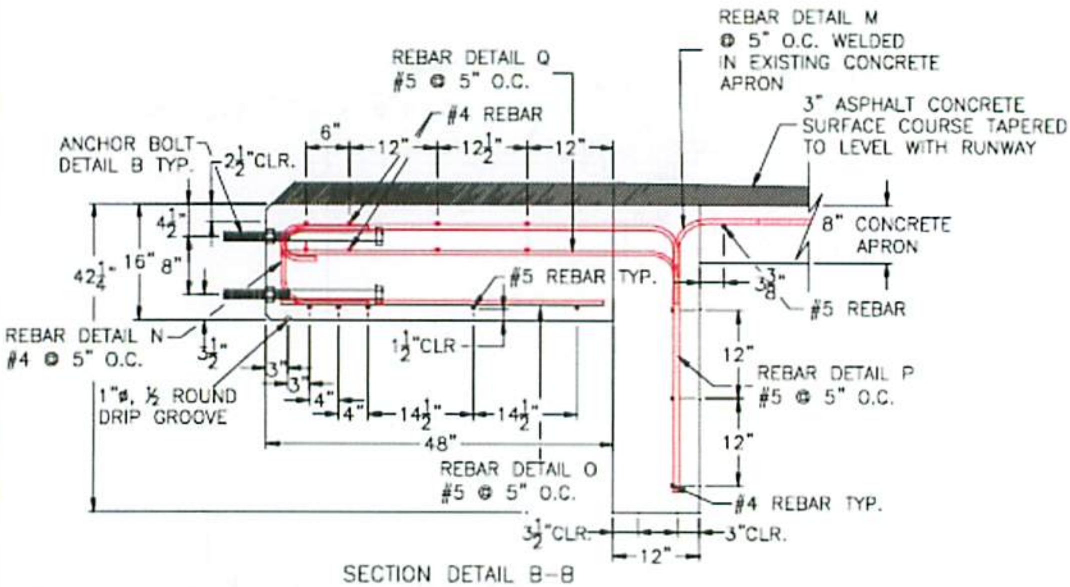

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Figure B 5 Analysis of Modified ODOT Deep Beam Bridge Rail 5

Texas Transportation Institute

Project #: 476890-01

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

**** 6 Span Case ****

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

$M_p = 115.142 \cdot kip \cdot ft$ $P_p = 17.829 \cdot kips$ $L = 1.905\, m$

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

$R_6 = 58.446 \cdot kips$ 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

OhioTL-3BridgeRailLRFDWFW.xmcd
12/9/2008
4:16 PM

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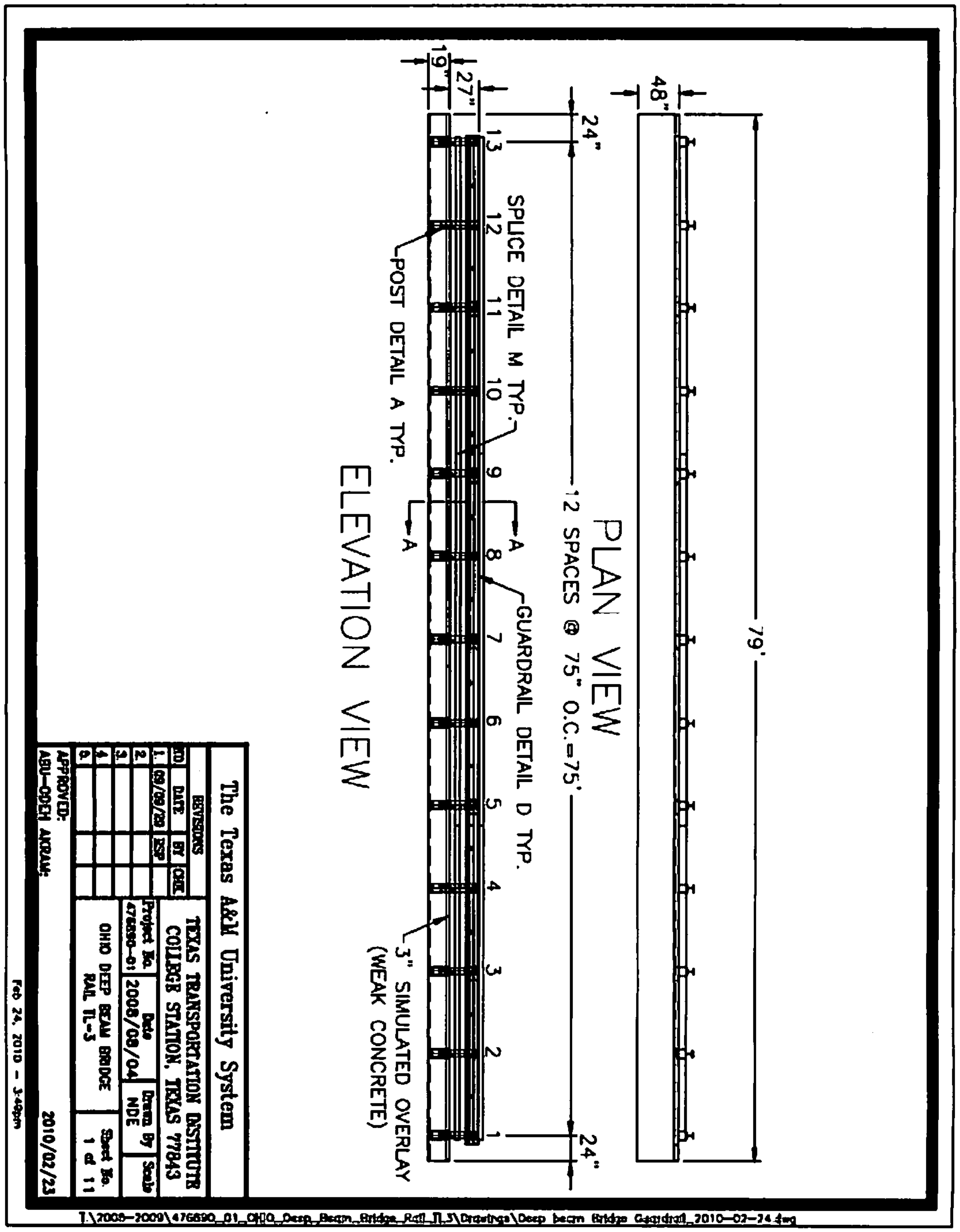
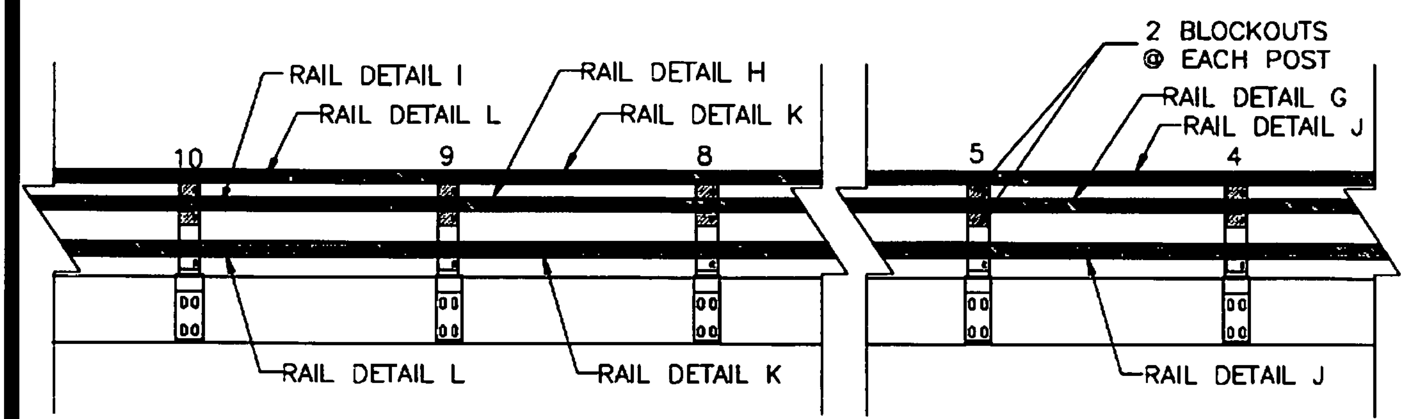
14

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

REVISIONS			
NO.	DATE	BY	CHK
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3.			
4.			
6.			

TEXAS TRANSPORTATION INSTITUTE
COLLEGE STATION, TEXAS 77843

Project No.	Date	Drawn By	Scale
476890–01	2008/08/04	NDE	

OHIO DEEP BEAM BRIDGE RAIL TL3 — Sheet No. 2 of 11

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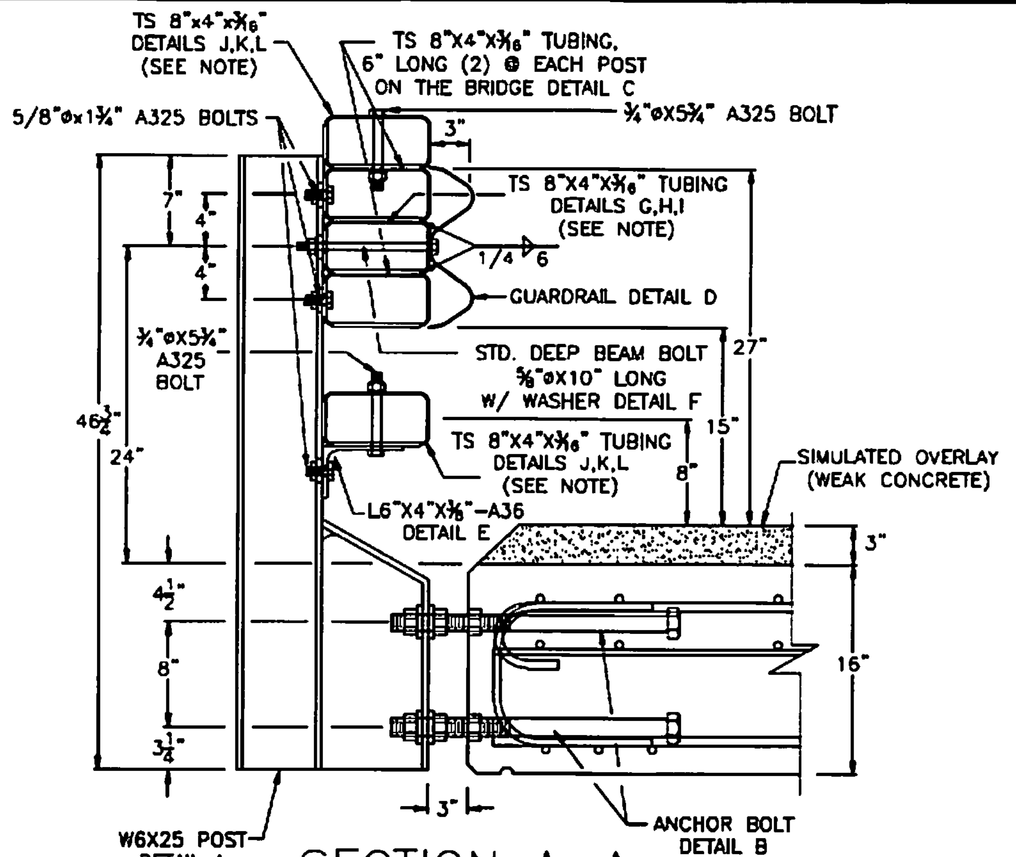

SECTION A–A

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

The Texas A&M University System

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TEXAS TRANSPORTATION INSTITUTE
COLLEGE STATION, TEXAS 77843

Project No.	Date	Drawn By	Scale
476890-01	2008/08/04	NDE	

OHIO DEEP BEAM BRIDGE RAIL TL3 — Sheet No. 3 of 11

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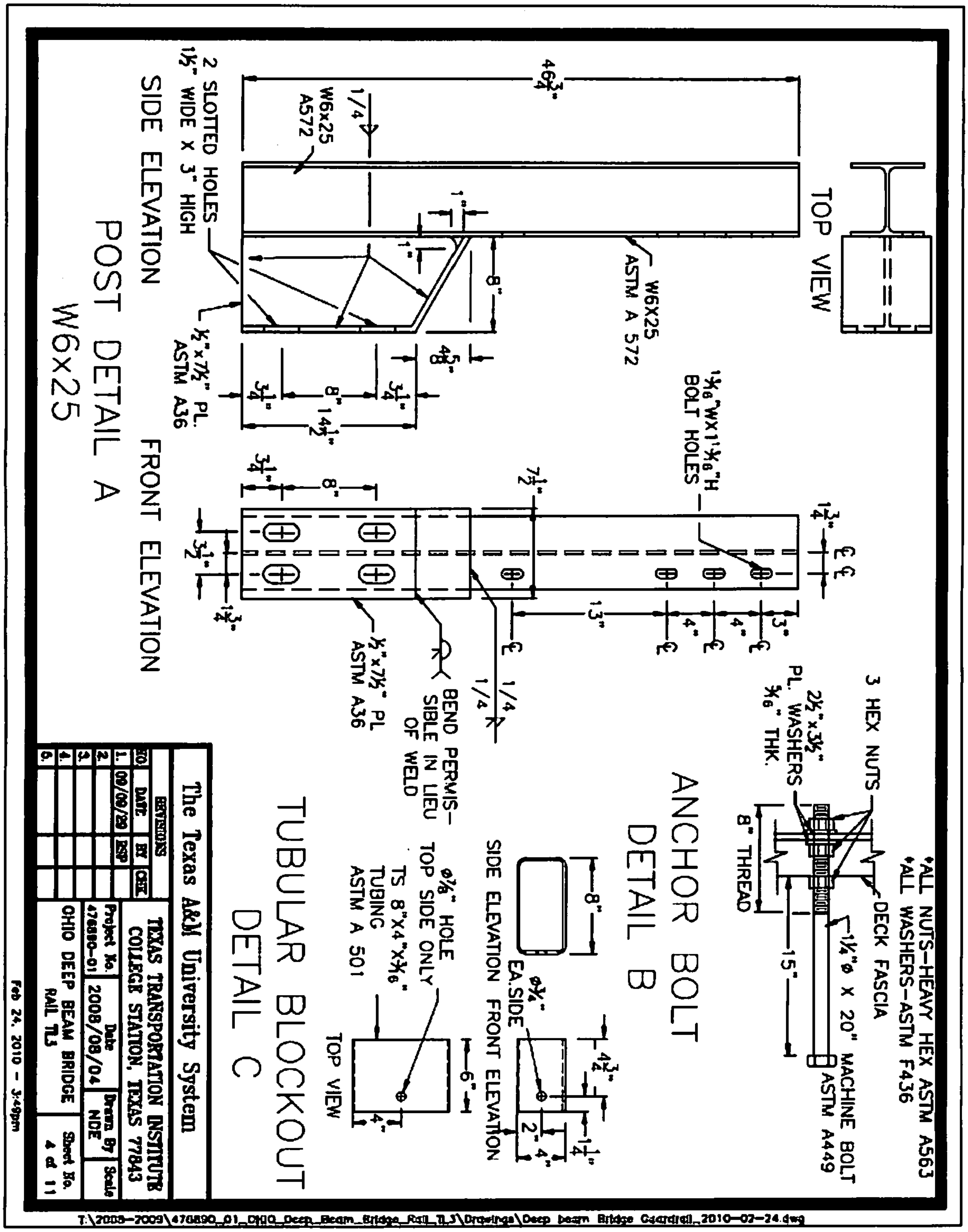
TOP VIEW
W6X25
ASTM A 572
46¾"
1/4
W6x25
A572
1"
1"
8"
4⅝"
3¼"
8"
3¼"
14½"
2 SLOTTED HOLES
1½" WIDE X 3" HIGH
½"x7½" PL.
ASTM A36
SIDE ELEVATION
1¹⁄₁₆"WX1¹⁵⁄₁₆"H
BOLT HOLES
1¾"
7½"
3¼"
8"
3½"
1¾"
3"
4"
4"
13"
1/4
1/4
BEND PERMISSIBLE IN LIEU OF WELD
½"x7½" PL
ASTM A36
FRONT ELEVATION
POST DETAIL A
W6x25
*ALL NUTS-HEAVY HEX ASTM A563
*ALL WASHERS-ASTM F436
3 HEX NUTS
2½"x3½" PL. WASHERS
5⁄16" THK.
DECK FASCIA
8" THREAD
15"
1¼"ø X 20" MACHINE BOLT
ASTM A449
ANCHOR BOLT
DETAIL B
8"
ø⅞" HOLE
TOP SIDE ONLY
TS 8"X4"X5⁄16"
TUBING
ASTM A 501
ø¾"
EA.SIDE
4¾"
6"
2"
4"
1½"
4"
SIDE ELEVATION
FRONT ELEVATION
TOP VIEW
TUBULAR BLOCKOUT
DETAIL C
The Texas A&M University System
TEXAS TRANSPORTATION INSTITUTE
COLLEGE STATION, TEXAS 77843
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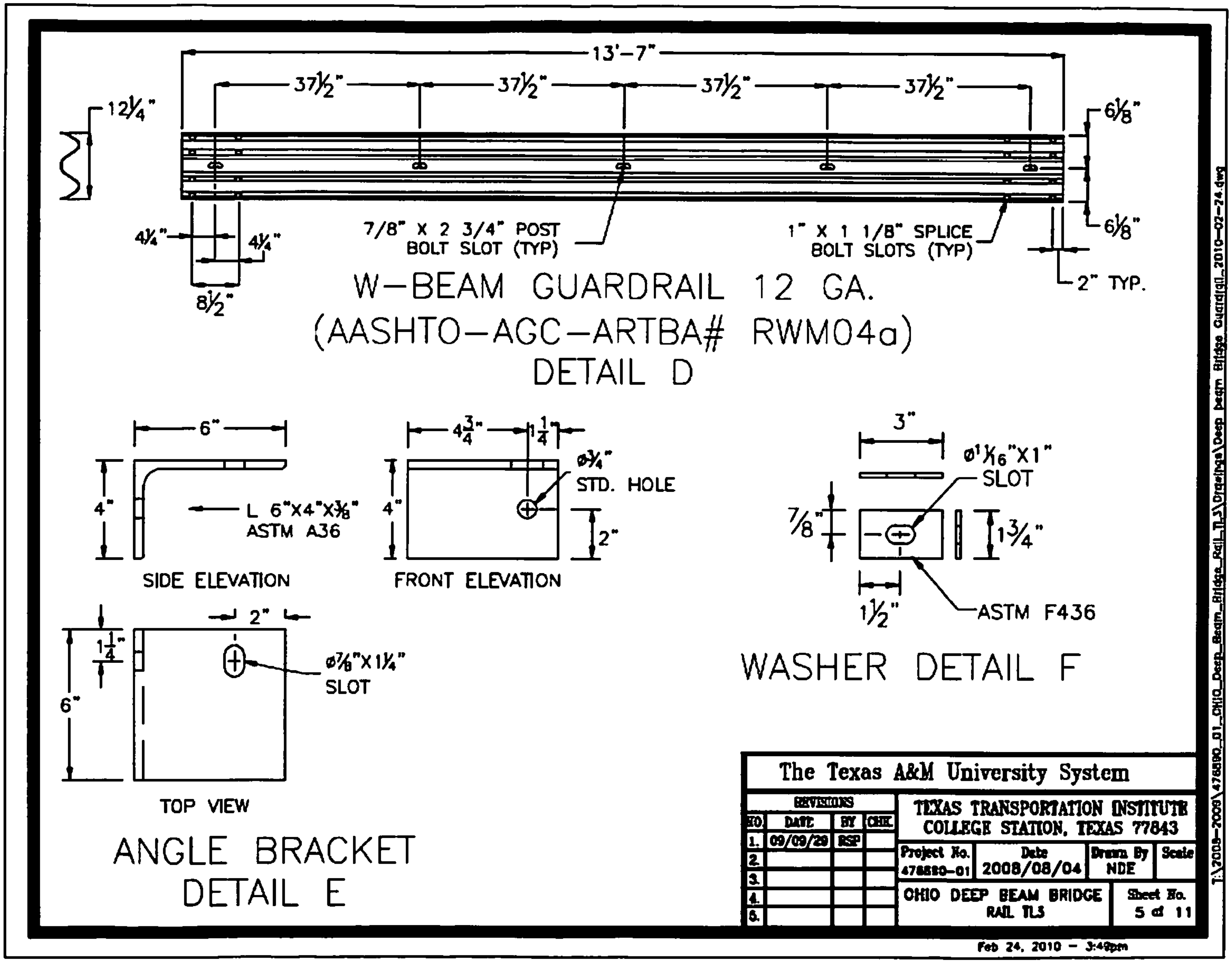

13'-7"
37½"
37½"
37½"
37½"
12¼"
6⅛"
6⅛"
4¼"
4¼"
8½"
7/8" X 2 3/4" POST BOLT SLOT (TYP)
1" X 1 1/8" SPLICE BOLT SLOTS (TYP)
2" TYP.
W-BEAM GUARDRAIL 12 GA.
(AASHTO-AGC-ARTBA# RWM04a)
DETAIL D
6"
4"
L 6"X4"X⅜"
ASTM A36
SIDE ELEVATION
4¾"
1¼"
4"
ø¾"
STD. HOLE
2"
FRONT ELEVATION
2"
1¼"
6"
ø⅞"X1¼"
SLOT
TOP VIEW
ANGLE BRACKET
DETAIL E
3"
ø1⁄16"X1"
SLOT
⅞"
1¾"
1½"
ASTM F436
WASHER DETAIL F
The Texas A&M University System
REVISIONS
NO. DATE BY CHK
1. 09/09/29 RSP
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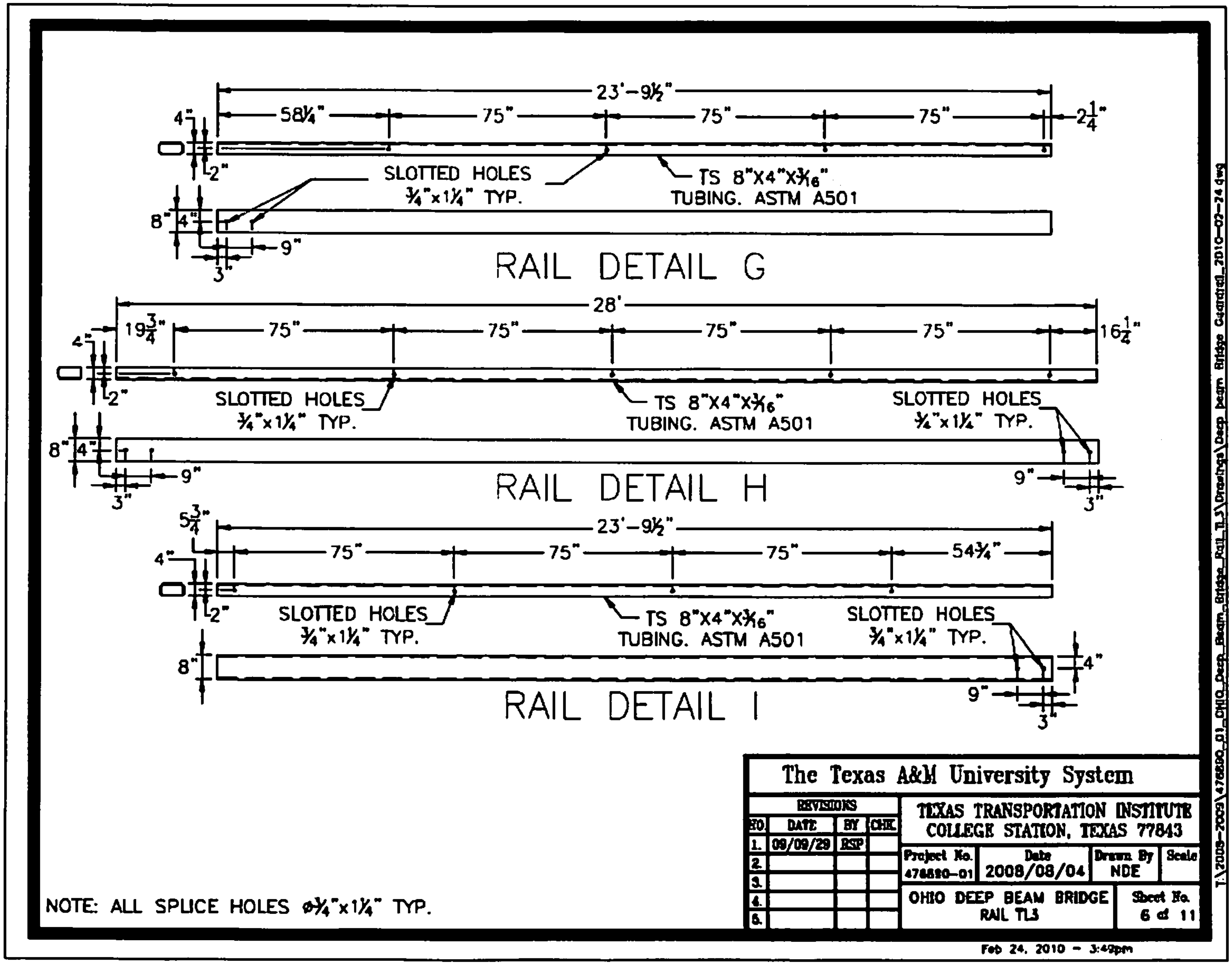
Project No. 476880-01
Date 2008/08/04
Drawn By NDE
Scale
OHIO DEEP BEAM BRIDGE RAIL TL3
Sheet No. 5 of 11
Feb 24, 2010 - 3:49pm
T:\2008-2009\476880_01_OHIO_Deep_Beam_Bridge_Rail_TL3\Drawings\Deep beam Bridge Guardrail_2010-02-24.dwg



23'-9½"
58¼"
75"
75"
75"
2¼"
4"
2"
SLOTTED HOLES
¾"x1¼" TYP.
TS 8"X4"X3/16"
TUBING. ASTM A501
8"
4"
9"
3"
RAIL DETAIL G
28'
19¾"
75"
75"
75"
75"
16¼"
4"
2"
SLOTTED HOLES
¾"x1¼" TYP.
TS 8"X4"X3/16"
TUBING. ASTM A501
SLOTTED HOLES
¾"x1¼" TYP.
8"
4"
9"
3"
9"
3"
RAIL DETAIL H
5¾"
23'-9½"
75"
75"
75"
54¾"
4"
2"
SLOTTED HOLES
¾"x1¼" TYP.
TS 8"X4"X3/16"
TUBING. ASTM A501
SLOTTED HOLES
¾"x1¼" TYP.
8"
4"
9"
3"
RAIL DETAIL I
NOTE: ALL SPLICE HOLES ϕ¾"x1¼" TYP.
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Scale
OHIO DEEP BEAM BRIDGE
RAIL TL3
Sheet No. 6 of 11
Feb 24, 2010 - 3:40pm
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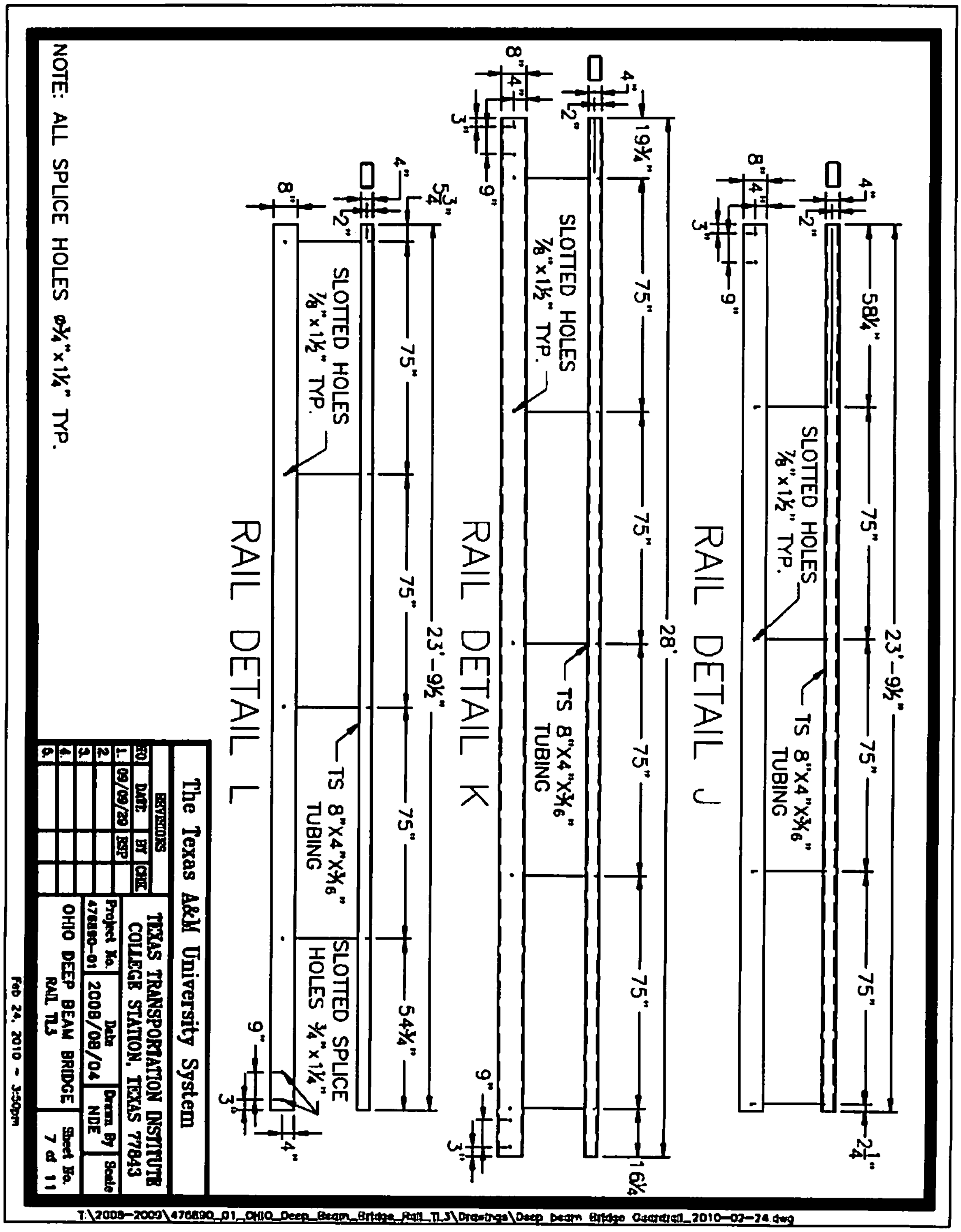
RAIL DETAIL J
RAIL DETAIL K
RAIL DETAIL L
SLOTTED HOLES ⅞"x1½" TYP.
TS 8"X4"X5/16" TUBING
SLOTTED SPLICE HOLES ¾"x1¼"
NOTE: ALL SPLICE HOLES ϕ¾"x1¼" TYP.
23'-9½"
28'
58¼"
75"
19¾"
54¾"
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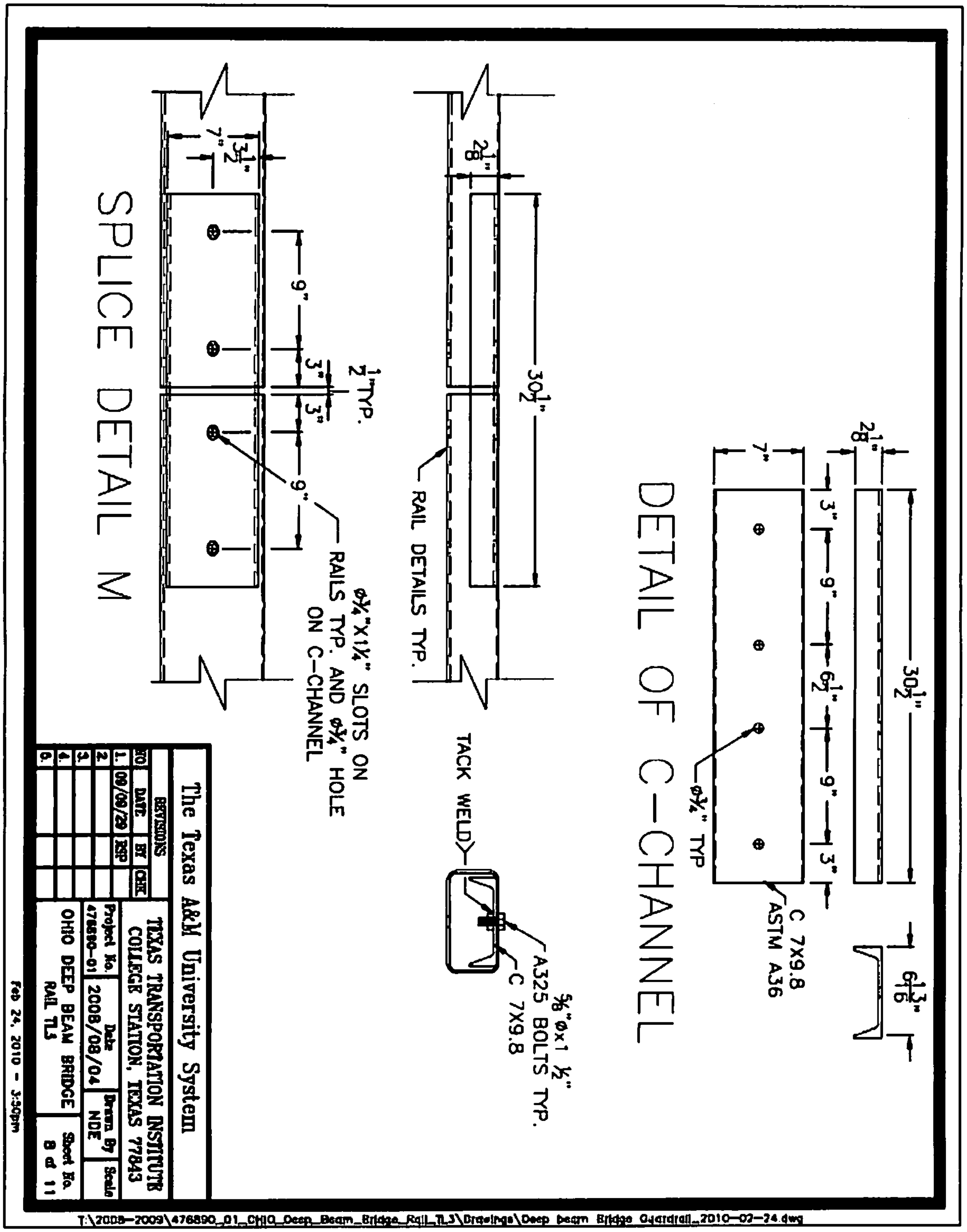
Scale
OHIO DEEP BEAM BRIDGE RAIL TL3
Sheet No. 7 of 11
Feb 24, 2010 - 3:50pm
T:\2008-2009\476890_01_OHIO_Deep_Beam_Bridge_Rail_TL3\Drawings\Deep beam Bridge Guardrail_2010-02-24.dwg


DETAIL OF C-CHANNEL
30½"
2⅛"
7"
3"
9"
6½"
9"
3"
6 13/16"
⌀¾" TYP
C 7X9.8
ASTM A36
⅝"⌀x1 ½" A325 BOLTS TYP.
C 7X9.8
TACK WELD
RAIL DETAILS TYP.
30½"
2⅛"
SPLICE DETAIL M
3½"
7"
9"
3"
3"
9"
½" TYP.
⌀¾"X1¼" SLOTS ON RAILS TYP. AND ⌀¾" HOLE ON C-CHANNEL
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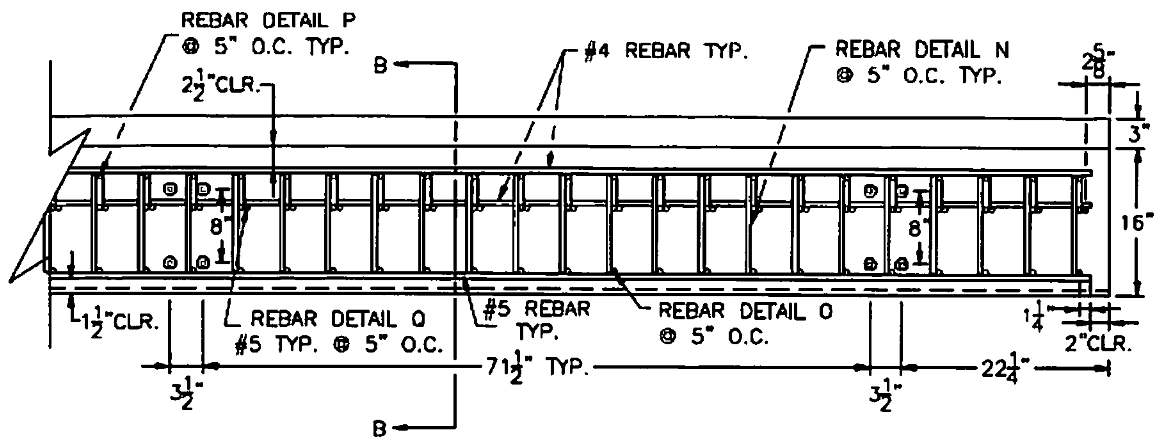
5.
Project No. 476890-01
Date 2008/08/04
Drawn By NDE
Scale
OHIO DEEP BEAM BRIDGE RAIL TL3
Sheet No. 8 of 11
Feb 24, 2010 - 3:50pm
T:\2008-2009\476890_01_OHIO_Deep_Beam_Bridge_Rail_TL3\Drawings\Deep beam Bridge Guardrail_2010-02-24.dwg



REBAR LAYOUT

DECK-ELEVATION VIEW

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3.			
4.			
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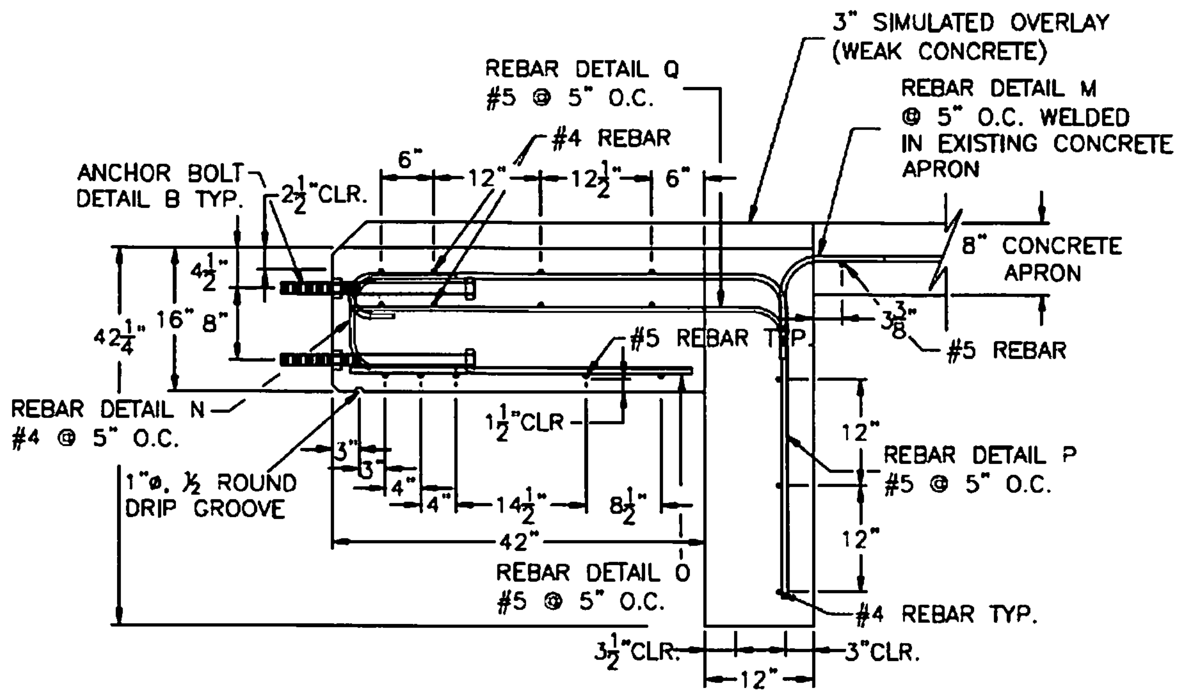
476890-01	2008/08/04	NDE	

OHIO DEEP BEAM BRIDGE RAIL TL3

Sheet No. 9 of 11

Feb 24, 2010 - 3:50pm

T:\2008-2009\476890_01_OHIO_Deep_Beam_Bridge_Rail_TL3\Drawings\Deep beam Bridge Guardrail_2010-02-24.dwg



SECTION DETAIL B-B

The Texas A&M University System

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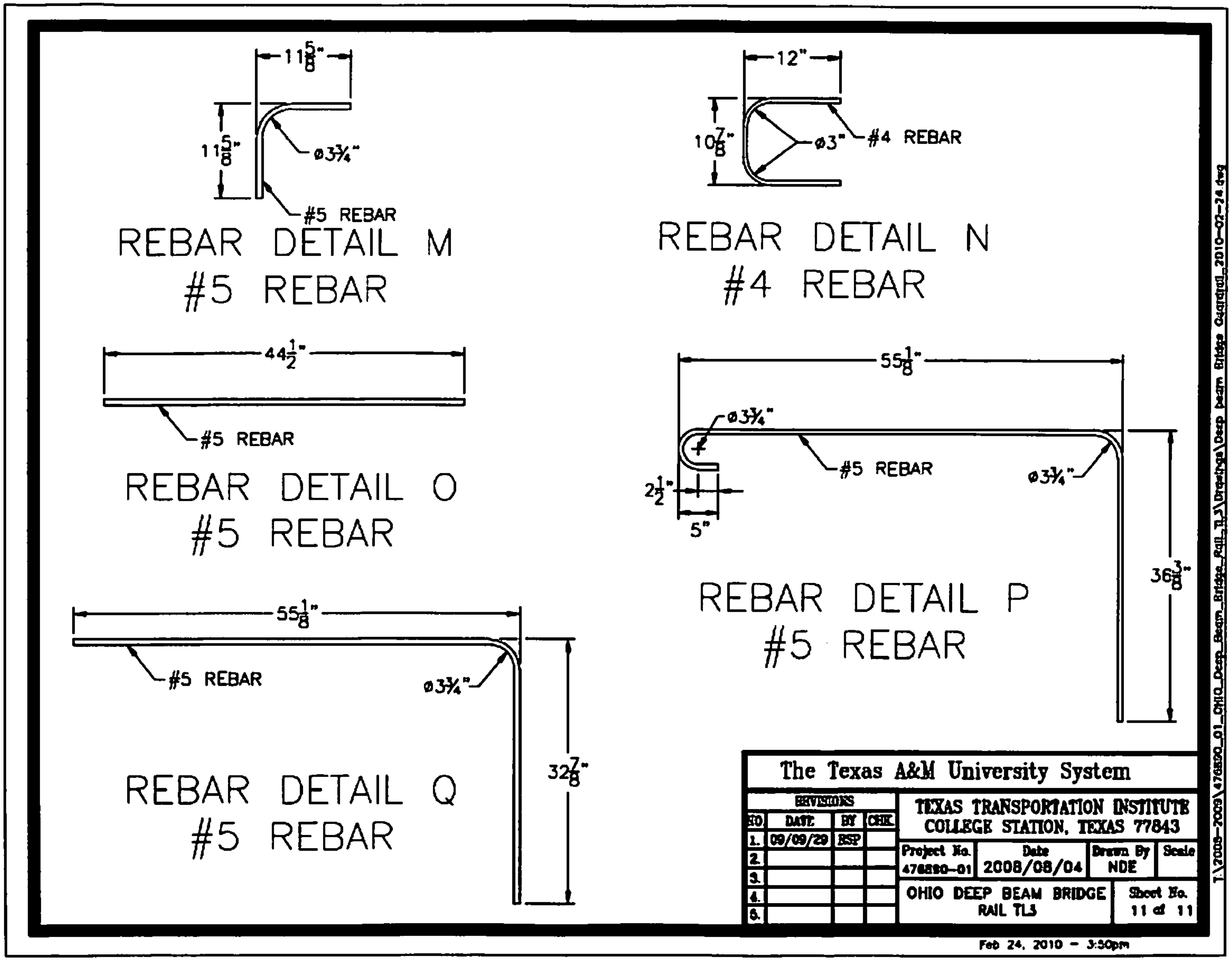
Project No.	Date	Drawn By	Scale
476890-01	2008/08/04	NDE	

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

Feb 24, 2010 – 3:50pm

T:\2008-2009\476890_01_OHIO_Deep_Beam_Bridge_Rail_TL3\Drawings\Deep beam Bridge Guardrail_2010-02-24.dwg



11 5/8"
11 5/8"
ø3¾"
#5 REBAR
REBAR DETAIL M
#5 REBAR
12"
10 7/8"
ø3"
#4 REBAR
REBAR DETAIL N
#4 REBAR
44 1/2"
#5 REBAR
REBAR DETAIL O
#5 REBAR
55 1/8"
ø3¾"
#5 REBAR
2 1/2"
5"
ø3¾"
36 3/8"
REBAR DETAIL P
#5 REBAR
55 1/8"
#5 REBAR
ø3¾"
32 7/8"
REBAR DETAIL Q
#5 REBAR
The Texas A&M University System
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2.
3.
4.
5.
TEXAS TRANSPORTATION INSTITUTE
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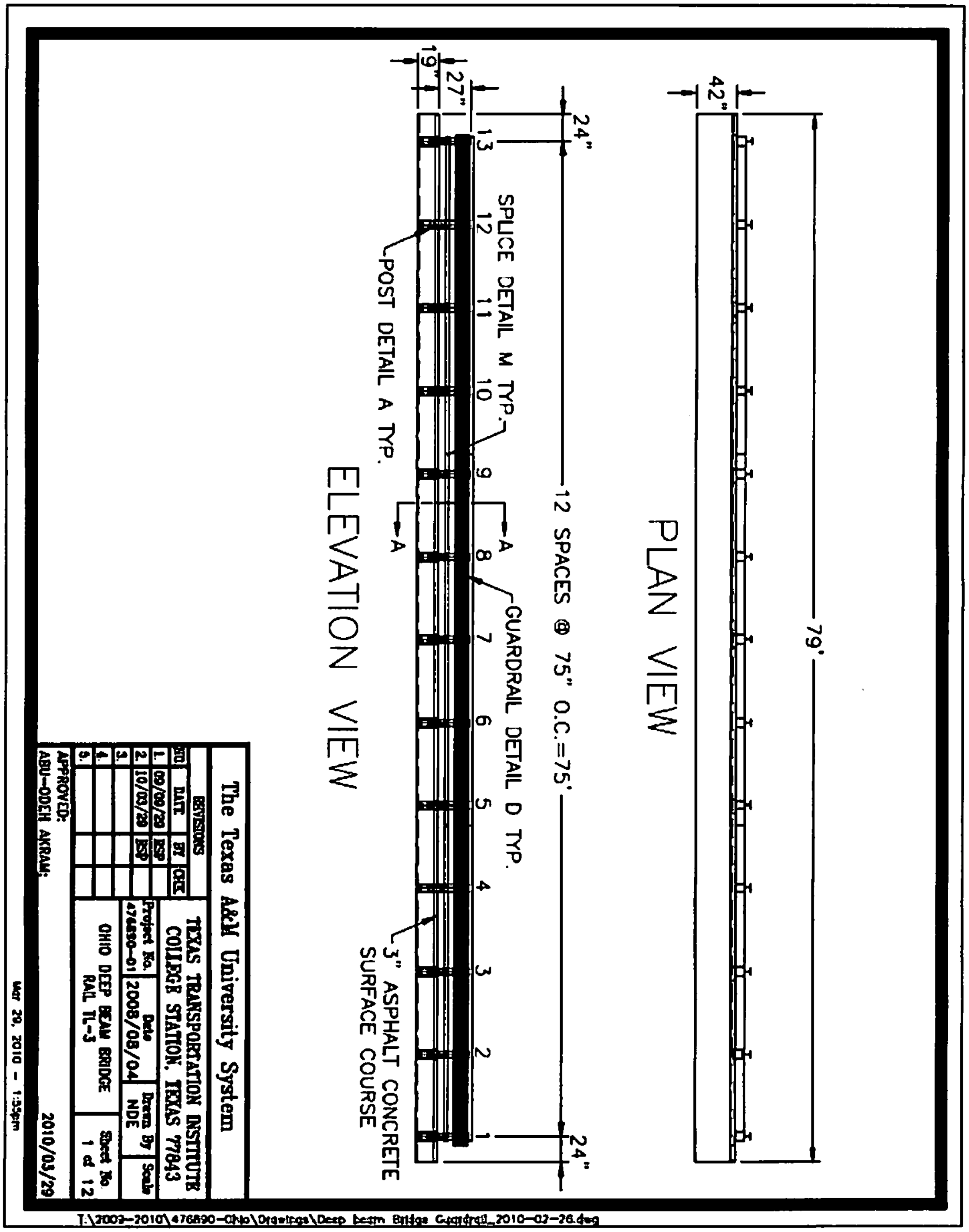
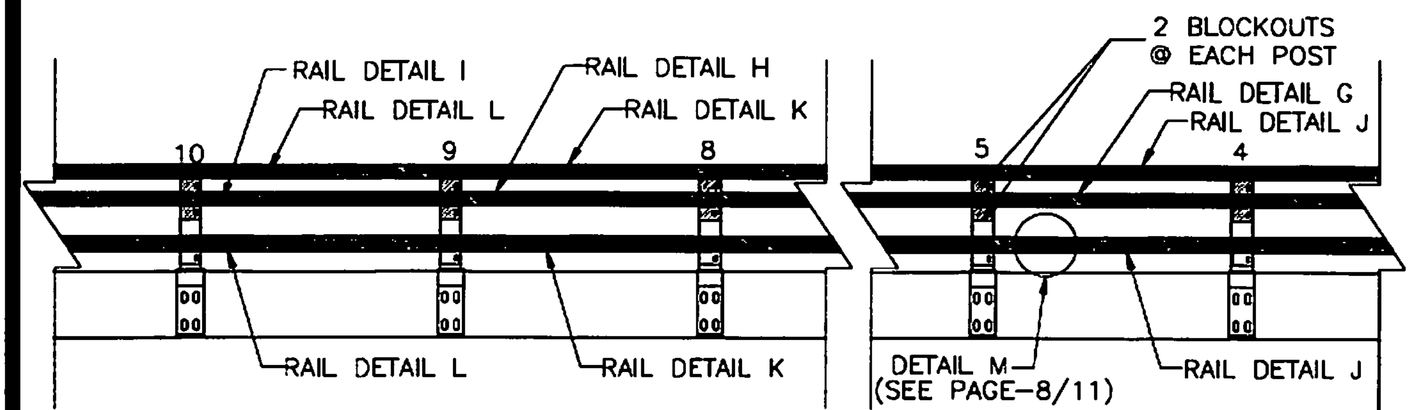
Project No. 476880-01
Date 2008/08/04
Drawn By NDE
Scale
OHIO DEEP BEAM BRIDGE RAIL TL3
Sheet No. 11 of 11
Feb 24, 2010 - 3:50pm
T:\2008-2009\476880_01_OHIO_Deep_Beam_Bridge_Rail_TL3\Drawings\Deep beam Bridge Guardrail_2010-02-24.dwg

APPENDIX D

Drawing of ODOT Modified Bridge Rail with Pavement Overlay





RAIL ELEVATION–DETAIL

(WITHOUT W–BEAM)

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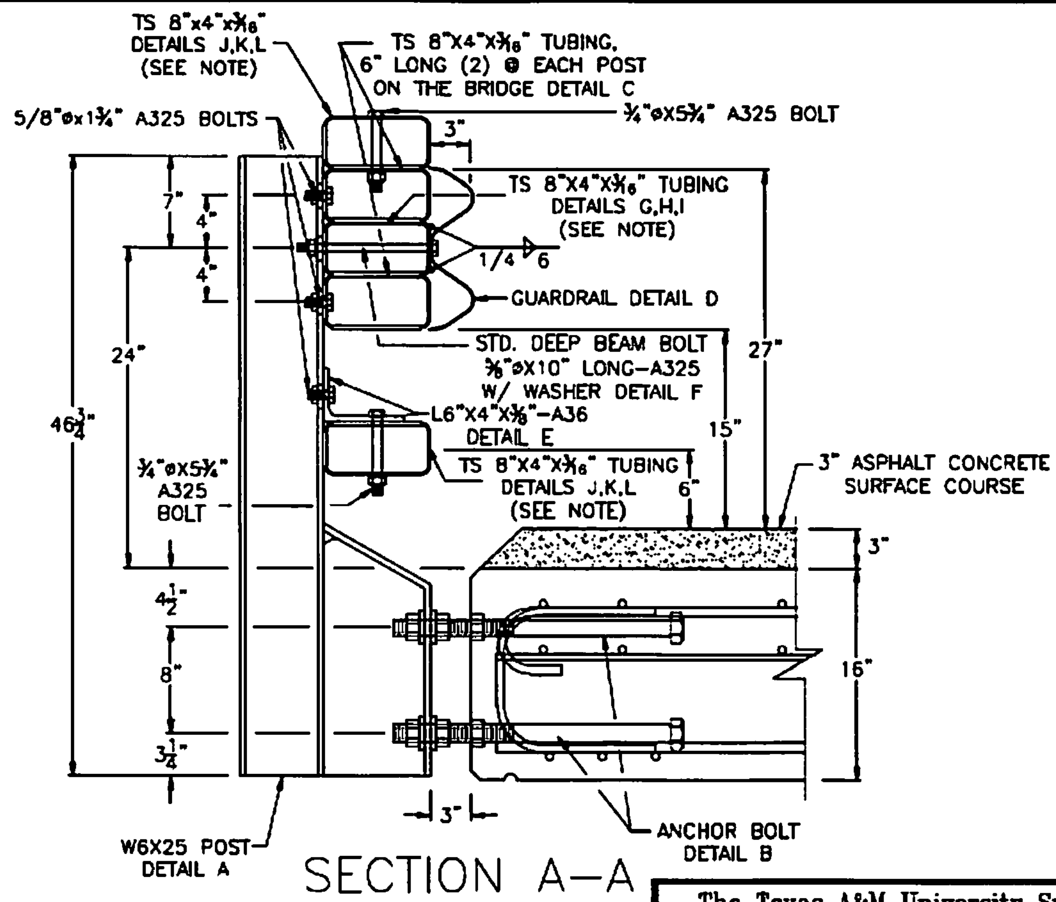
REVISIONS				TEXAS TRANSPORTATION INSTITUTE COLLEGE STATION, TEXAS 77843			
NO.	DATE	BY	CHK.	Project No. 476880-01	Date 2010/02/24	Drawn By RSP	Scale
1.				OHIO DEEP BEAM BRIDGE RAIL TL3		Sheet No. 2 of 12	
2.							
3.							
4.							
5.							

Mar 29, 2010 – 1:55pm

T:\2009-2010\476800-Ohio\Drawings\Deep beam Bridge Guardrail_2010-02-26.dwg



SECTION A–A

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

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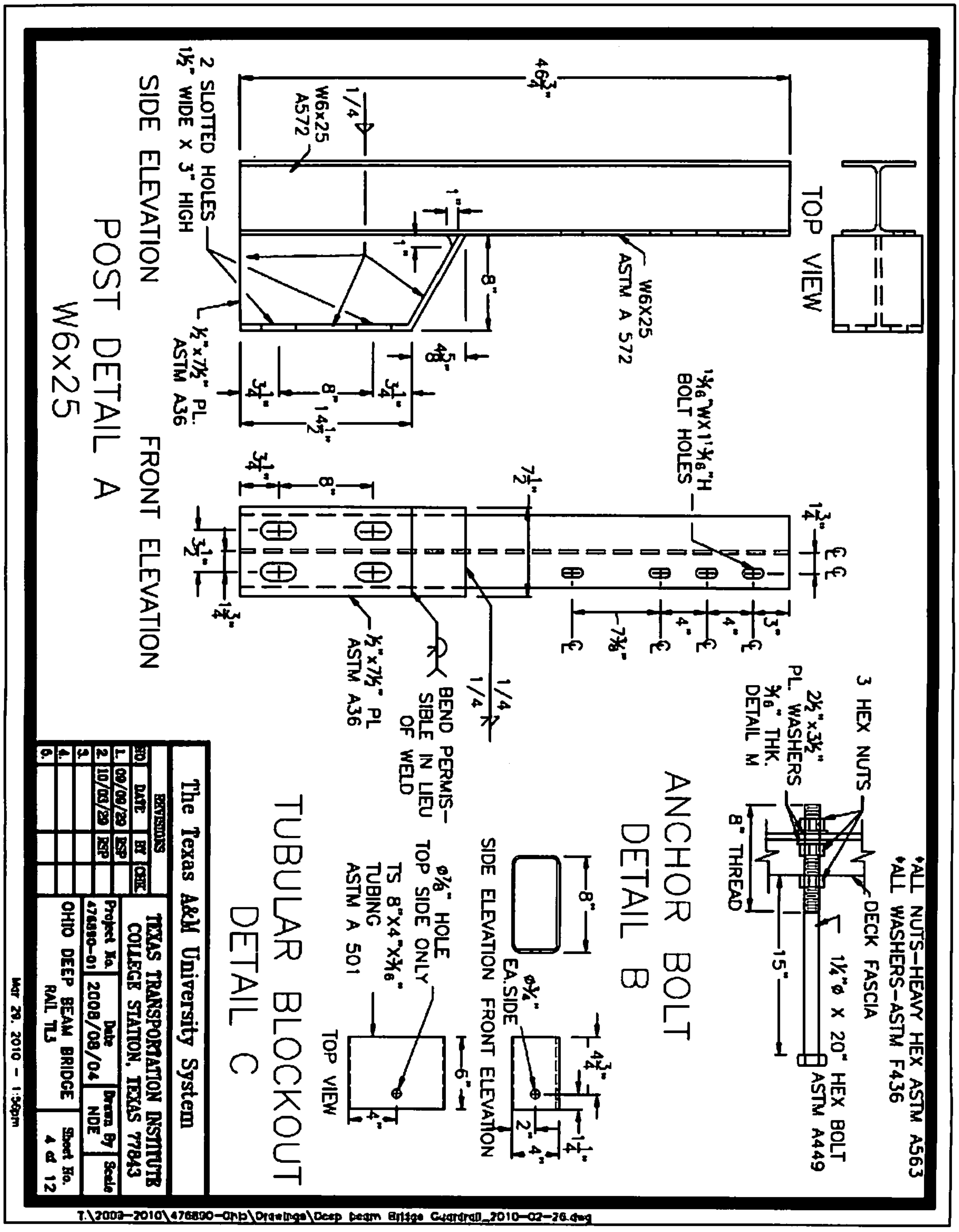
Project No.	Date	Drawn By	Scale
476890-01	2008/08/04	NDE	

OHIO DEEP BEAM BRIDGE RAIL TL3	Sheet No. 3 of 12

Mar 29, 2010 – 1:56pm

T:\2009–2010\476890–Ohio\Drawings\Deep beam Bridge Guardrail_2010–02–26.dwg


TOP VIEW
W6X25
ASTM A 572
2 SLOTTED HOLES
1½" WIDE X 3" HIGH
½"x7½" PL.
ASTM A36
SIDE ELEVATION
FRONT ELEVATION
POST DETAIL A
W6x25
BEND PERMISSIBLE IN LIEU OF WELD
*ALL NUTS-HEAVY HEX ASTM A563
*ALL WASHERS-ASTM F436
3 HEX NUTS
DECK FASCIA
8" THREAD
ANCHOR BOLT
DETAIL B
SIDE ELEVATION
FRONT ELEVATION
TOP VIEW
TS 8"X4"X3/16"
TUBING
ASTM A 501
TUBULAR BLOCKOUT
DETAIL C
The Texas A&M University System
TEXAS TRANSPORTATION INSTITUTE
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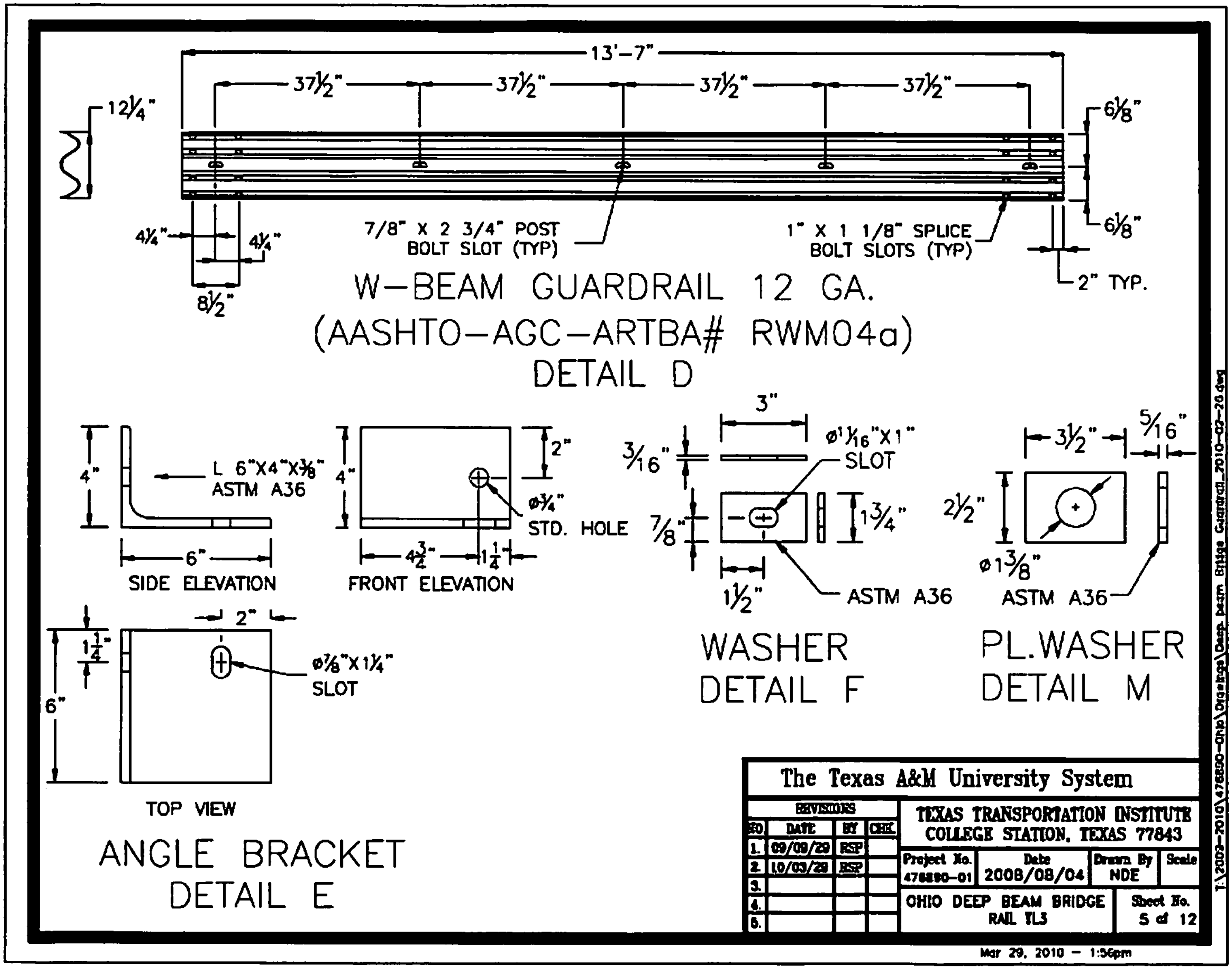
OHIO DEEP BEAM BRIDGE RAIL TL3
Sheet No. 4 of 12
Mar 26, 2010 - 1:56pm


13'-7"
37½"
37½"
37½"
37½"
12¼"
6⅛"
6⅛"
4¼"
4¼"
8½"
7/8" X 2 3/4" POST BOLT SLOT (TYP)
1" X 1 1/8" SPLICE BOLT SLOTS (TYP)
2" TYP.
W-BEAM GUARDRAIL 12 GA.
(AASHTO-AGC-ARTBA# RWM04a)
DETAIL D
4"
L 6"X4"X⅜" ASTM A36
6"
SIDE ELEVATION
4"
2"
ø¾" STD. HOLE
4½"
1¼"
FRONT ELEVATION
1¼"
2"
6"
ø⅞"X1¼" SLOT
TOP VIEW
ANGLE BRACKET
DETAIL E
3"
3/16"
ø1 1/16"X1" SLOT
7/8"
1¾"
1½"
ASTM A36
WASHER
DETAIL F
3½"
5/16"
2½"
ø1⅜"
ASTM A36
PL.WASHER
DETAIL M
The Texas A&M University System
REVISIONS
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2. 10/03/29 RSP
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4.
5.
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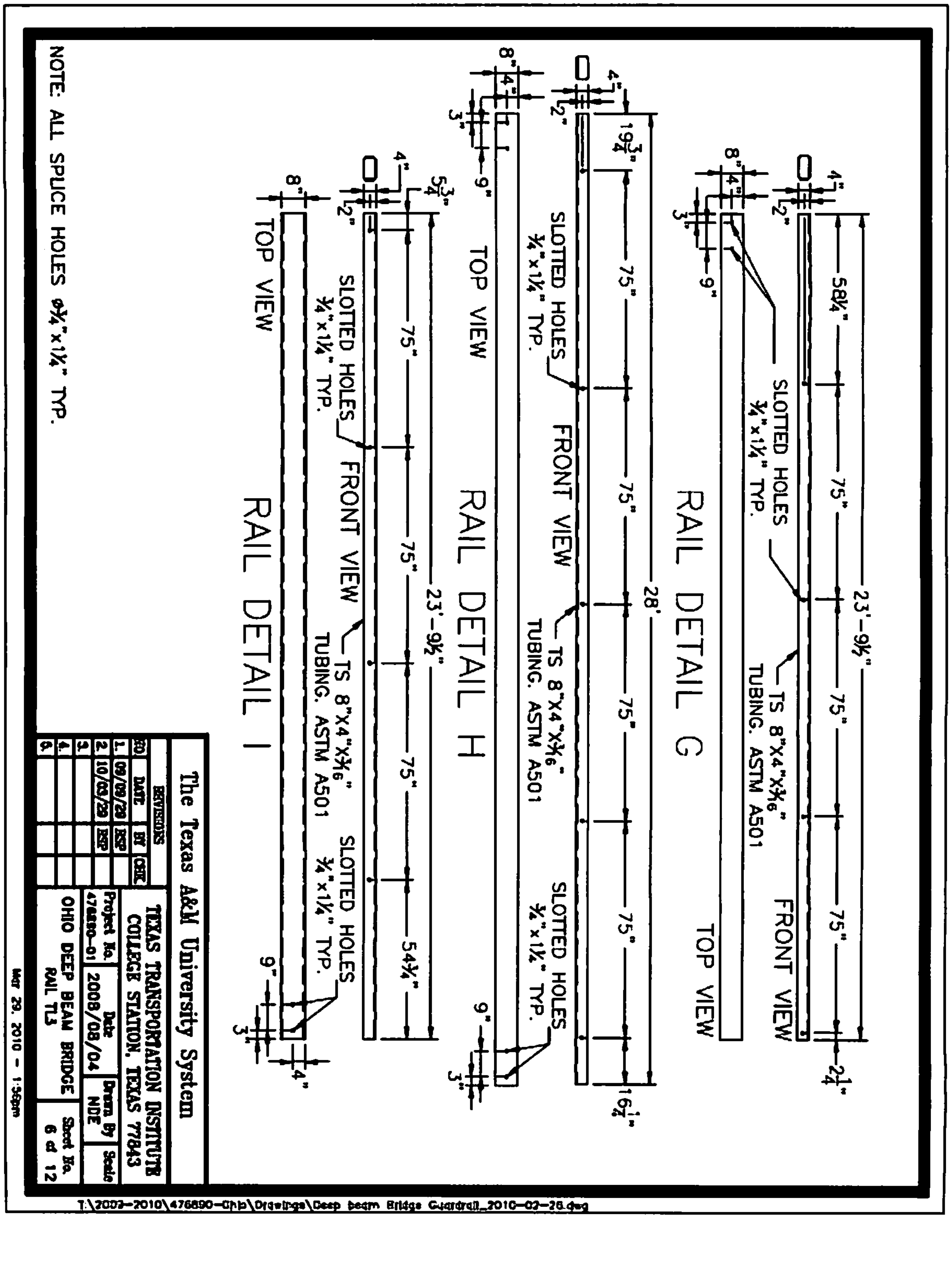
Project No. 476880-01
Date 2008/08/04
Drawn By NDE
Scale
OHIO DEEP BEAM BRIDGE RAIL TL3
Sheet No. 5 of 12
Mar 29, 2010 - 1:56pm
T:\2009-2010\476880-Ohio\Drawings\Deep beam Bridge Guardrail_2010-02-26.dwg



RAIL DETAIL G
TOP VIEW
FRONT VIEW
23'-9½"
58¼"
75"
2¼"
SLOTTED HOLES ¾"x1¼" TYP.
TS 8"X4"X3/16" TUBING. ASTM A501
RAIL DETAIL H
28'
19¾"
16½"
RAIL DETAIL I
54¾"
NOTE: ALL SPLICE HOLES φ¾"x1¼" TYP.
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REVISIONS
Project No. 476890-01
Date 2008/08/04
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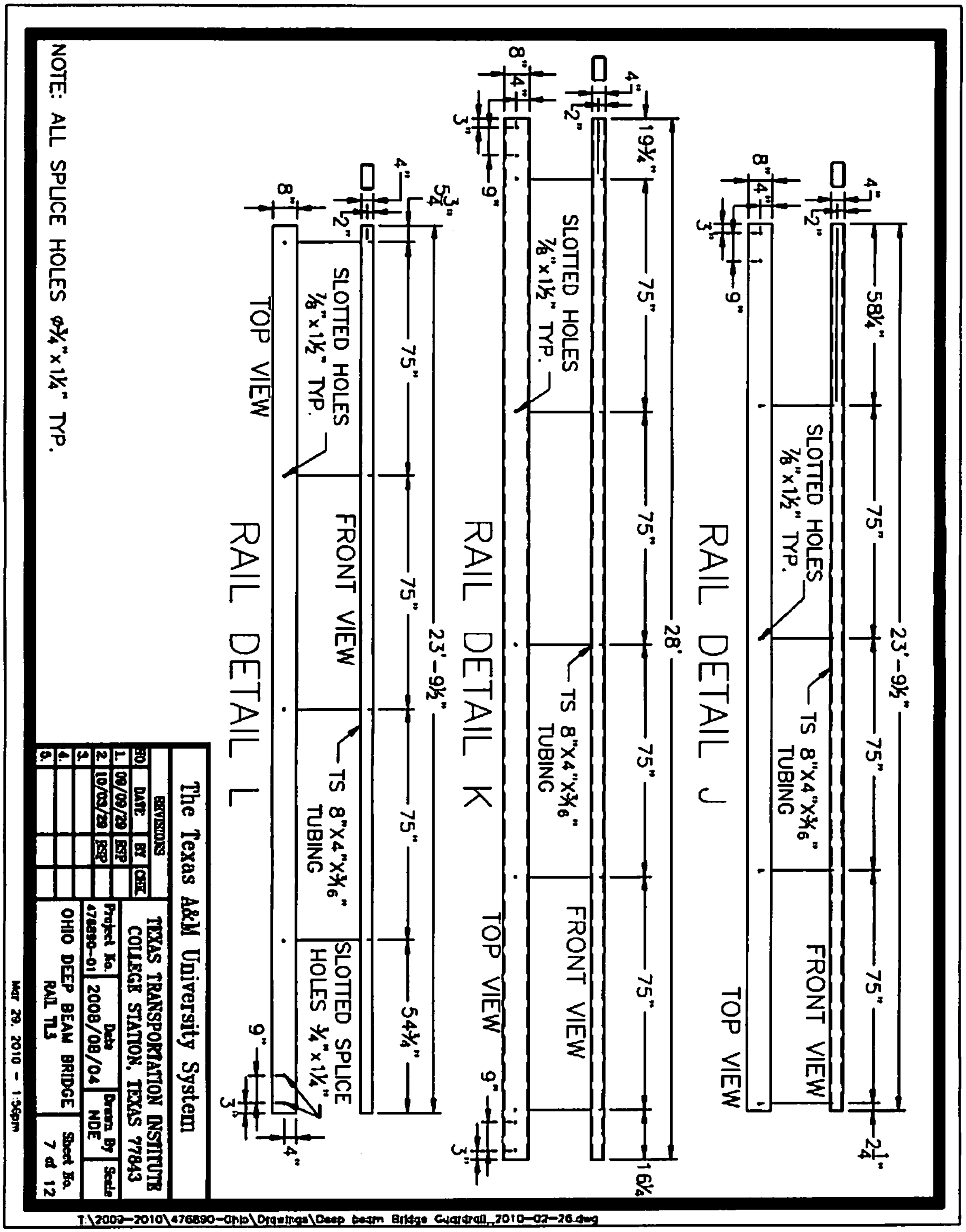
OHIO DEEP BEAM BRIDGE RAIL TL3
Sheet No. 6 of 12
Mar 29, 2010 - 1:56pm


RAIL DETAIL J
RAIL DETAIL K
RAIL DETAIL L
FRONT VIEW
TOP VIEW
SLOTTED HOLES 7/8"x1 1/2" TYP.
TS 8"X4"X3/16" TUBING
SLOTTED SPLICE HOLES 3/4"x1 1/4"
23'-9 1/2"
28'
58 1/4"
75"
54 3/4"
19 3/4"
16 1/4
NOTE: ALL SPLICE HOLES φ3/4"x1 1/4" TYP.
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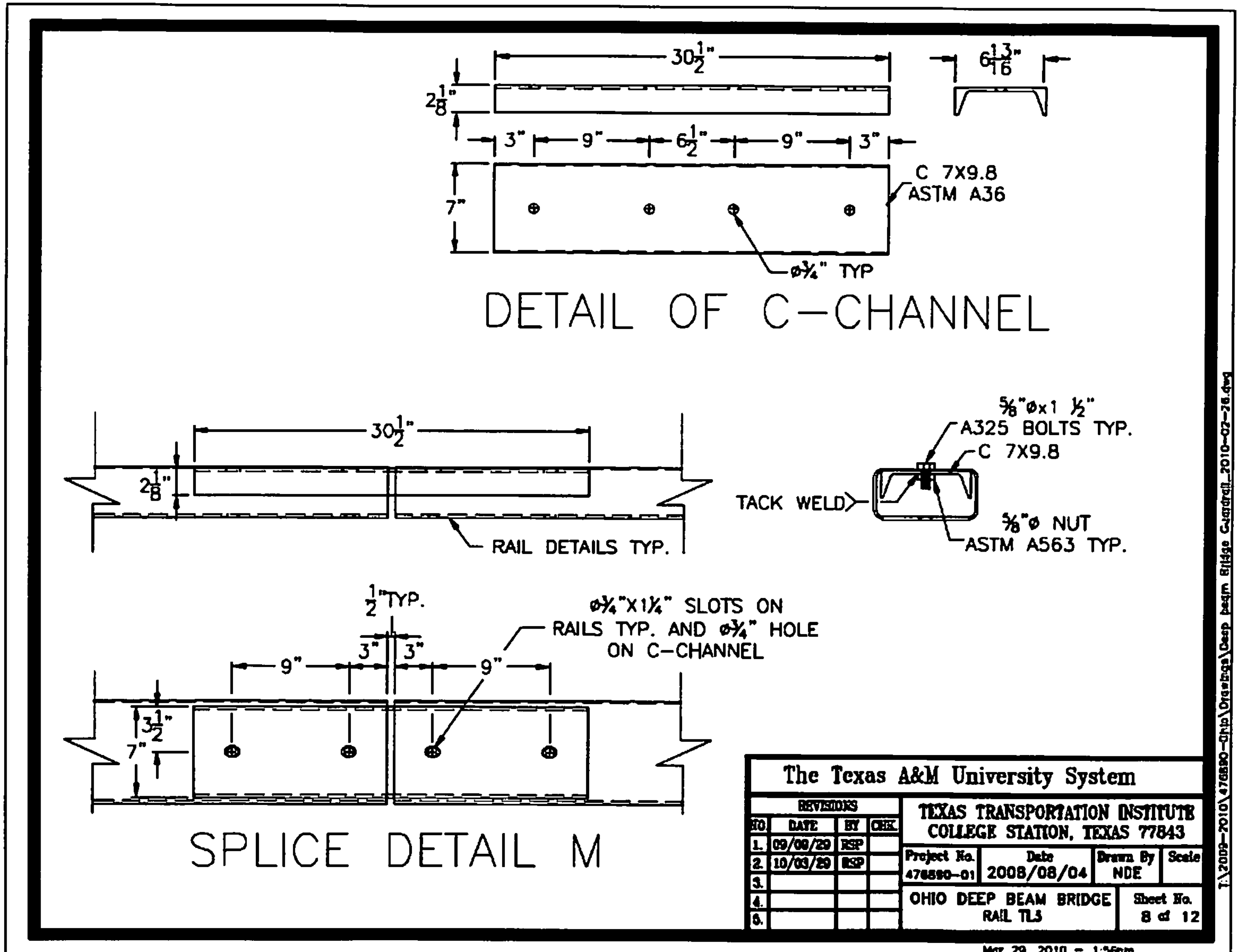
REVISIONS
NO DATE BY CHK
1. 09/09/29 BSP
2. 10/03/29 BSP
Project No. 476890-01
Date 2008/08/04
Drawn By NDE
Scale
OHIO DEEP BEAM BRIDGE RAIL TL3
Sheet No. 7 of 12
Mar 29, 2010 - 1:56pm
T:\2003-2010\476890-Ohio\Drawings\Deep beam Bridge Guardrail_2010-02-26.dwg



DETAIL OF C-CHANNEL
30 1/2"
2 1/8"
6 13/16"
3" 9" 6 1/2" 9" 3"
7"
C 7X9.8
ASTM A36
ø3/4" TYP
5/8"øx1 1/2"
A325 BOLTS TYP.
C 7X9.8
TACK WELD
5/8"ø NUT
ASTM A563 TYP.
RAIL DETAILS TYP.
1/2"TYP.
ø3/4"X1 1/4" SLOTS ON
RAILS TYP. AND ø3/4" HOLE
ON C-CHANNEL
9" 3" 3" 9"
3 1/2"
7"
SPLICE DETAIL M
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REVISIONS
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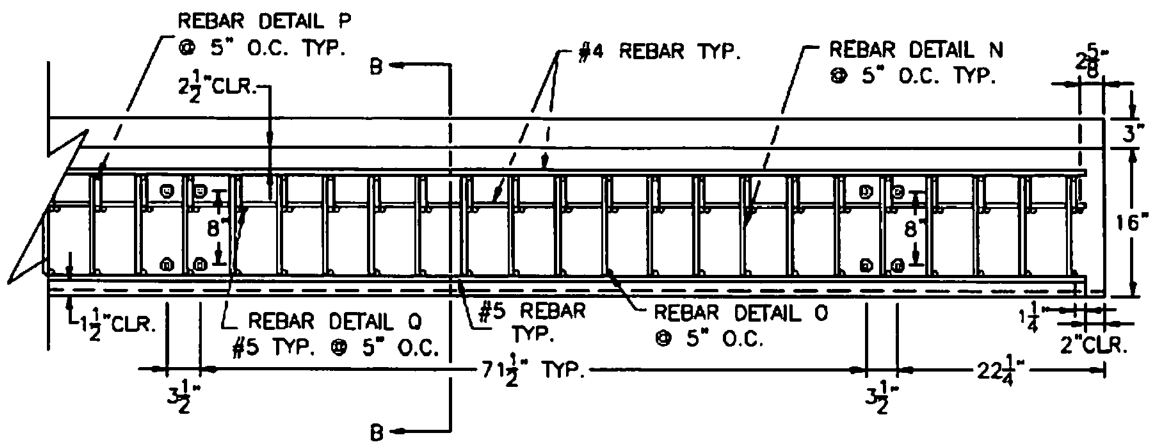
1. 09/09/29 RSP
2. 10/03/29 RSP
3.
4.
5.
Project No. 476890-01
Date 2008/08/04
Drawn By NDE
Scale
OHIO DEEP BEAM BRIDGE RAIL TL3
Sheet No. 8 of 12
Mar 29, 2010 - 1:56pm
T:\2009-2010\476890-Ohio\Drawings\Deep beam Bridge Guardrail_2010-02-26.dwg



REBAR LAYOUT

DECK-ELEVATION VIEW

The Texas A&M University System

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REVISIONS			
NO.	DATE	BY	CHK.
1.	09/09/29	BSP	
2.	10/03/29	BSP	
3.			
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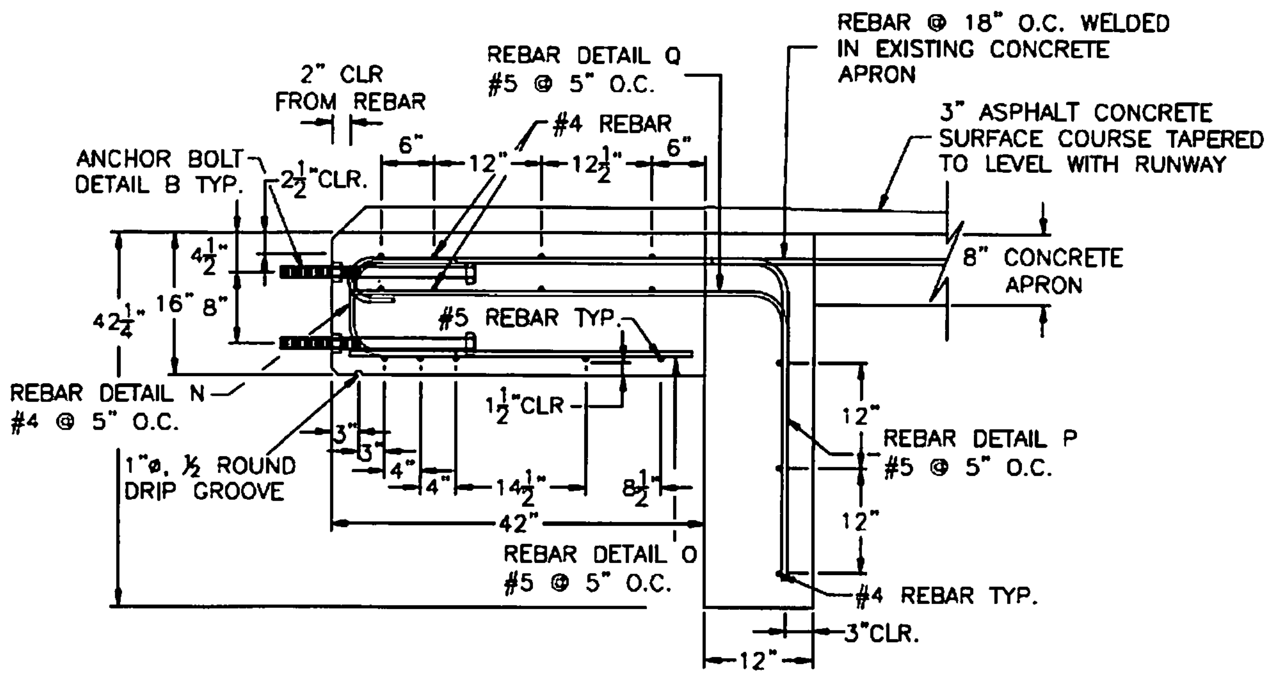
Project No.	Date	Drawn By	Scale
476890-01	2008/08/04	NDE	

OHIO DEEP BEAM BRIDGE RAIL TL3

Sheet No. 9 of 12

Mar 29, 2010 - 1:57pm

T:\2002-2010\476890-Ohio\Drawings\Deep beam Bridge Guardrail_2010-02-26.dwg



SECTION DETAIL B–B

The Texas A&M University System

REVISIONS			
NO	DATE	BY	CHK
1.	09/09/29	RSP	
2.	10/03/29	RSP	
3.			
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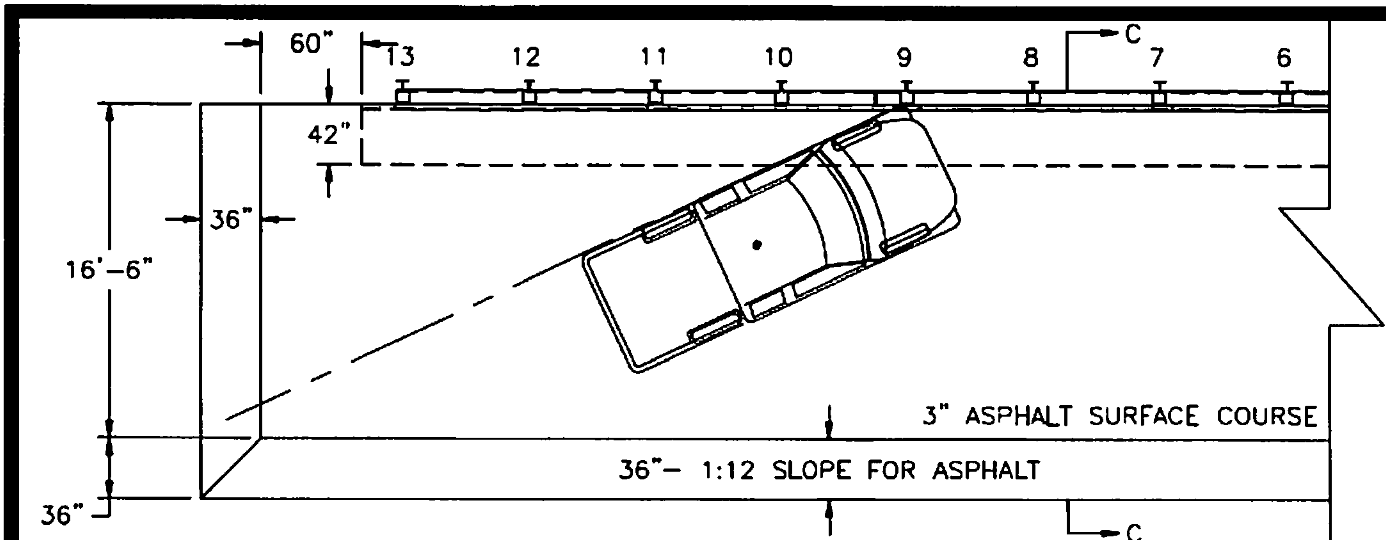
Project No.	Date	Drawn By	Scale
476890-01	2008/08/04	NDE	

OHIO DEEP BEAM BRIDGE RAIL TL3

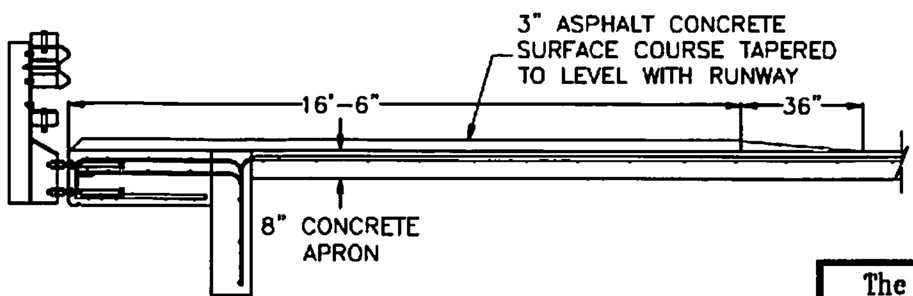
Sheet No. 10 of 12

Mar 29, 2010 – 1:57pm

T:\2009-2010\476890-Ohio\Drawings\Deep beam Bridge Guardrail_2010-02-26.dwg



IMPACT DIRECTION AND ASPHALT DETAILS



SECTION DETAIL C–C

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

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NO.	DATE	BY	CHK.
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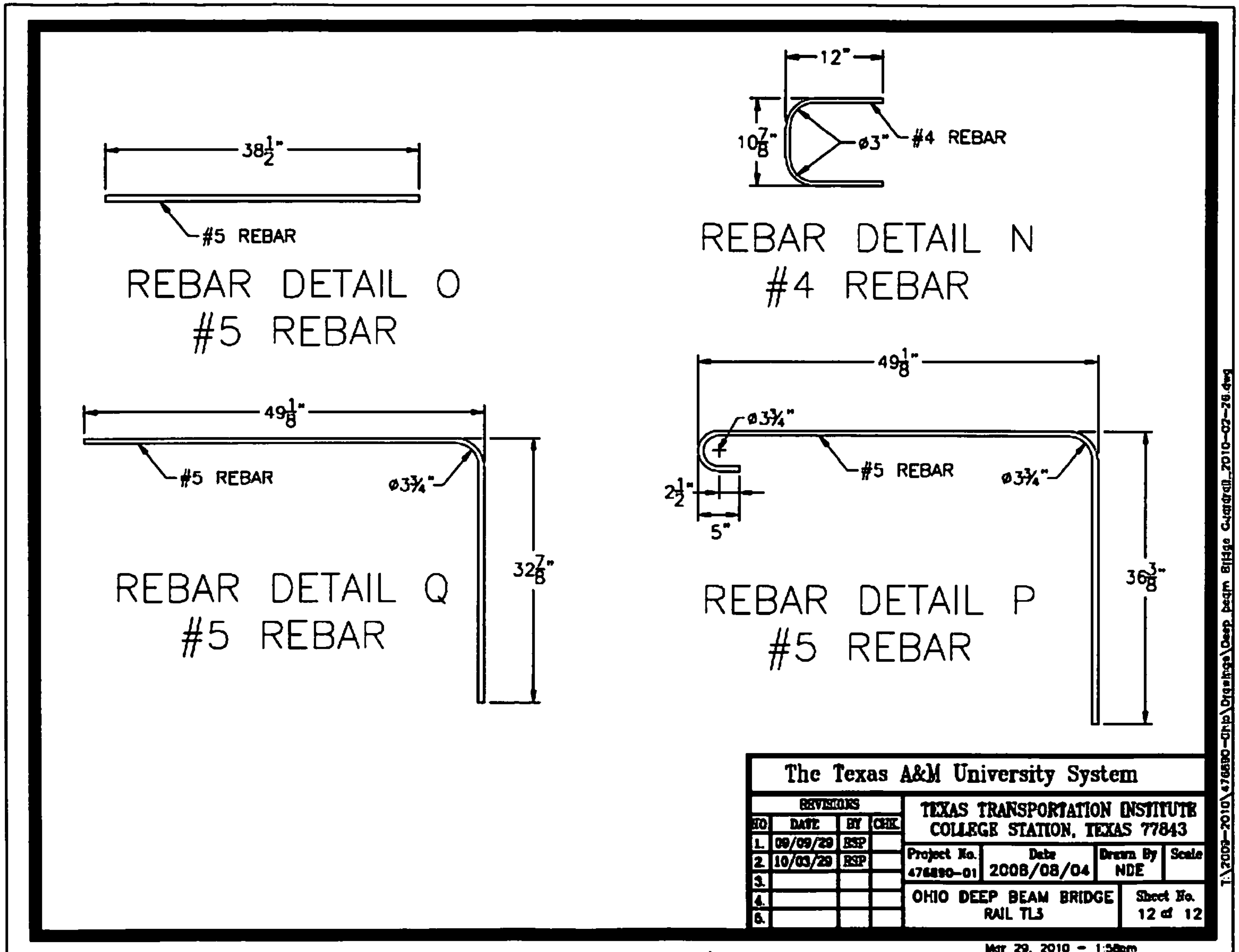
Project No.	Date	Drawn By	Scale
476890-01	2010/03/09	RSP	

OHIO DEEP BEAM BRIDGE RAIL TL3 — Sheet No. 11 of 12

Mar 29, 2010 – 1:57pm

T:\2009–2010\476890–Ohio\Drawings\Deep beam Bridge Guardrail_2010–02–26.dwg



REBAR DETAIL O
#5 REBAR
38 1/2"
#5 REBAR
REBAR DETAIL N
#4 REBAR
12"
10 7/8"
ø3"
#4 REBAR
REBAR DETAIL Q
#5 REBAR
49 1/8"
ø3 3/4"
32 7/8"
REBAR DETAIL P
#5 REBAR
49 1/8"
ø3 3/4"
2 1/2"
5"
36 3/8"
The Texas A&M University System
TEXAS TRANSPORTATION INSTITUTE
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REVISIONS
NO DATE BY CHK
1. 09/09/29 BSP
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Project No. 476890-01
Date 2008/08/04
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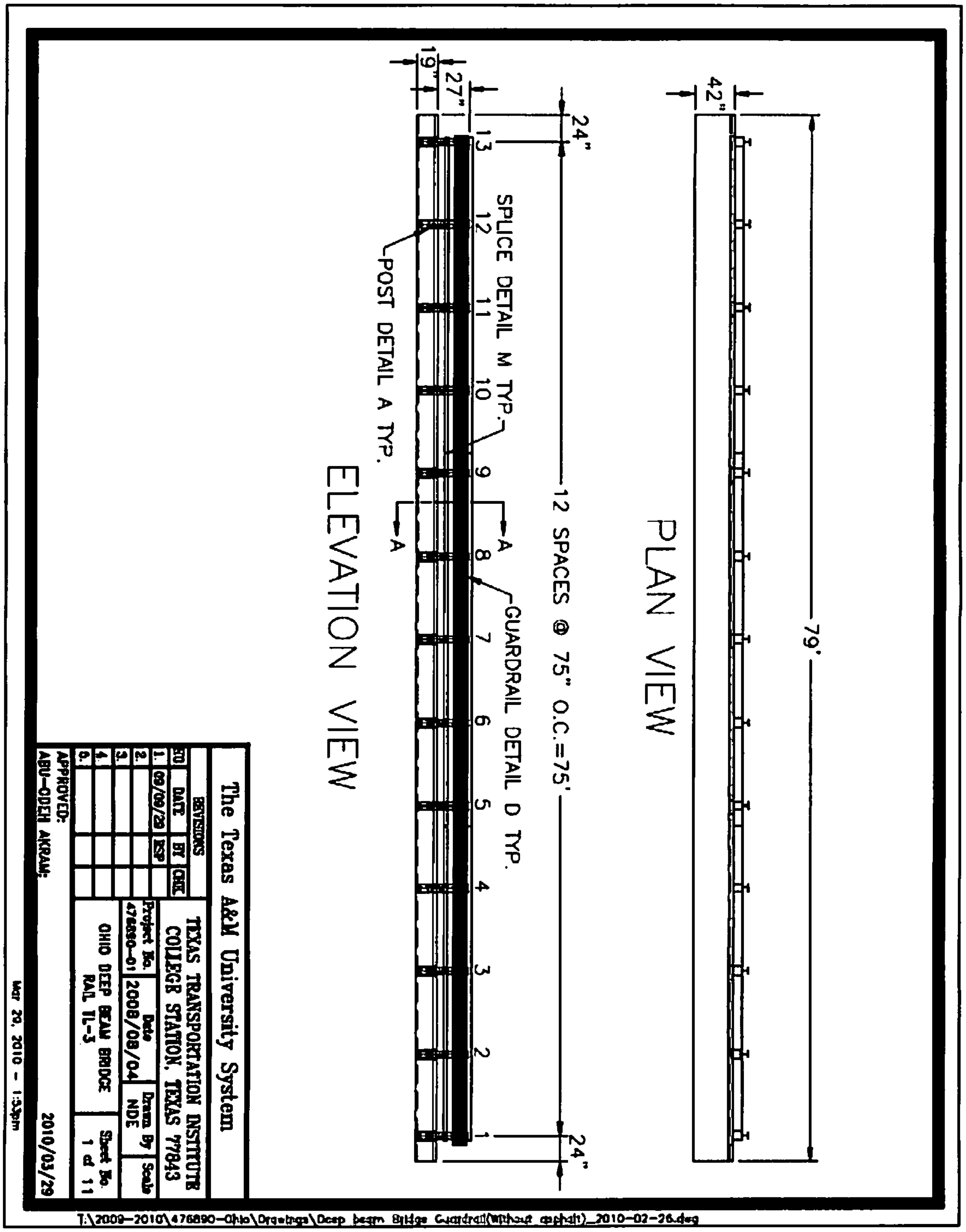
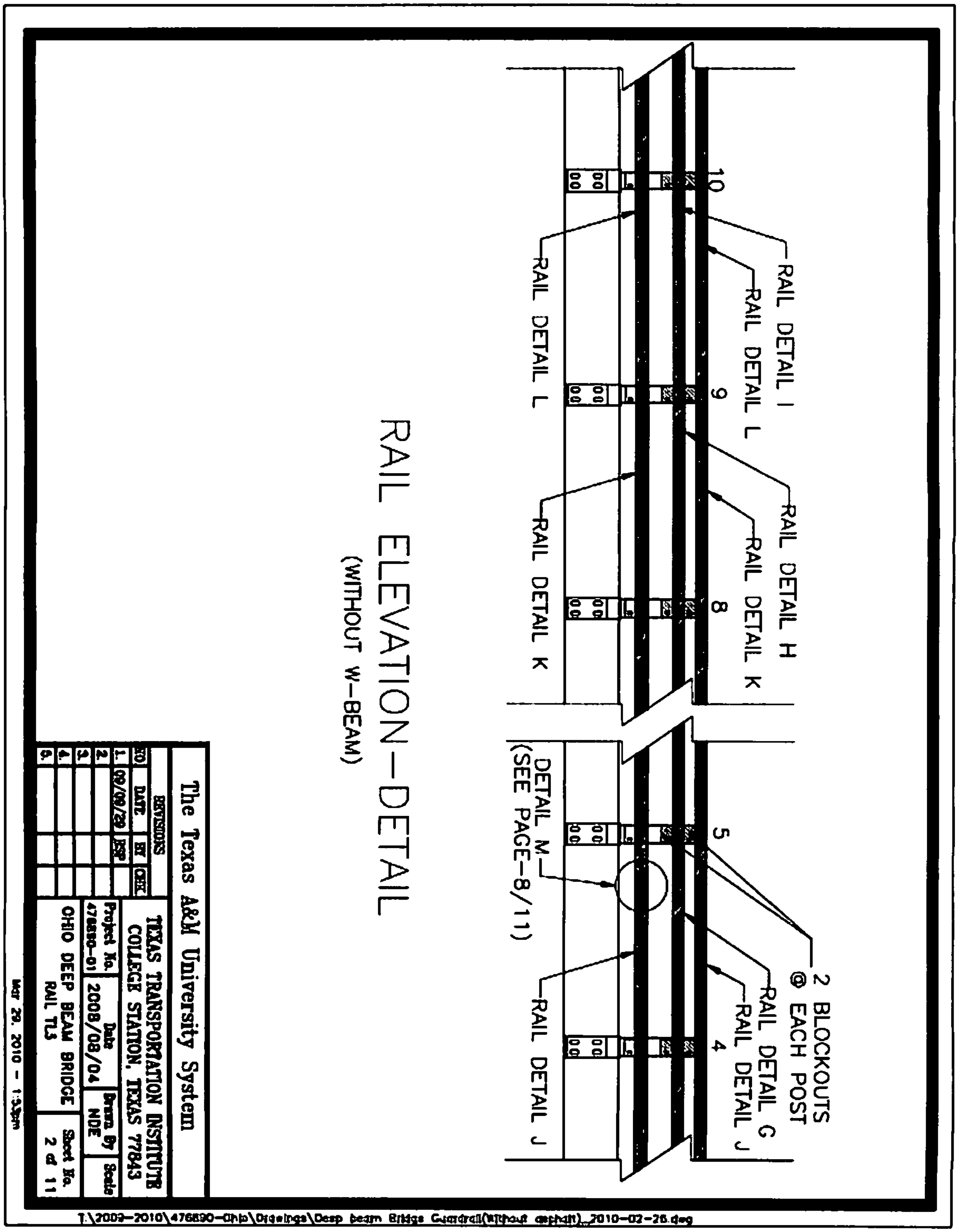
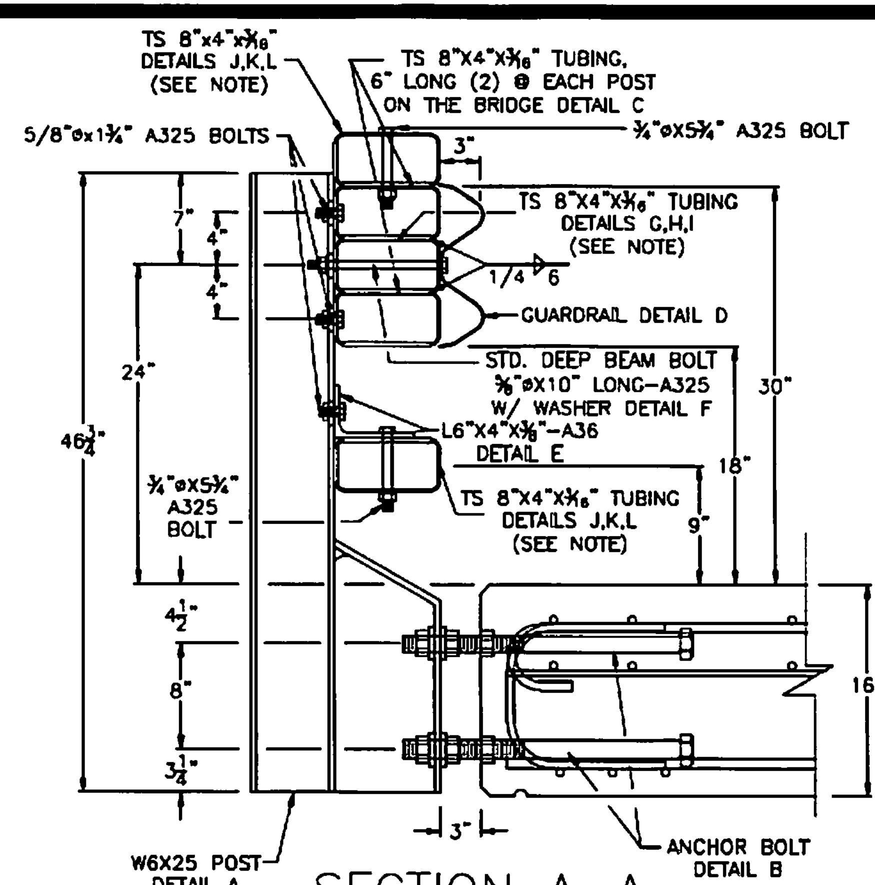
Scale
OHIO DEEP BEAM BRIDGE RAIL TL3
Sheet No. 12 of 12
Mar 29, 2010 - 1:58pm
T:\2009-2010\476890-Ohio\Drawings\Deep beam Bridge Guardrail_2010-02-26.dwg

APPENDIX E

Drawing of ODOT Modified Bridge Rail without Pavement Overlay




RAIL DETAIL I
RAIL DETAIL L
RAIL DETAIL H
RAIL DETAIL K
2 BLOCKOUTS @ EACH POST
RAIL DETAIL G
RAIL DETAIL J
10
9
8
5
4
RAIL DETAIL L
RAIL DETAIL K
DETAIL M (SEE PAGE-8/11)
RAIL DETAIL J
RAIL ELEVATION-DETAIL
(WITHOUT W-BEAM)
The Texas A&M University System
TEXAS TRANSPORTATION INSTITUTE
COLLEGE STATION, TEXAS 77843
REVISIONS
NO DATE BY CHK
1. 09/09/29 ESP
Project No. 476690-01
Date 2008/08/04
Drawn By NDE
Scale
OHIO DEEP BEAM BRIDGE RAIL TL3
Sheet No. 2 of 11
Mar 29, 2010 - 1:53pm



SECTION A–A

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

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1.	09/09/29	BSP	
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4.			
5.			

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Project No.	Date	Drawn By	Scale
476890-01	2008/08/04	NDE	

OHIO DEEP BEAM BRIDGE RAIL TL3	Sheet No. 3 of 11

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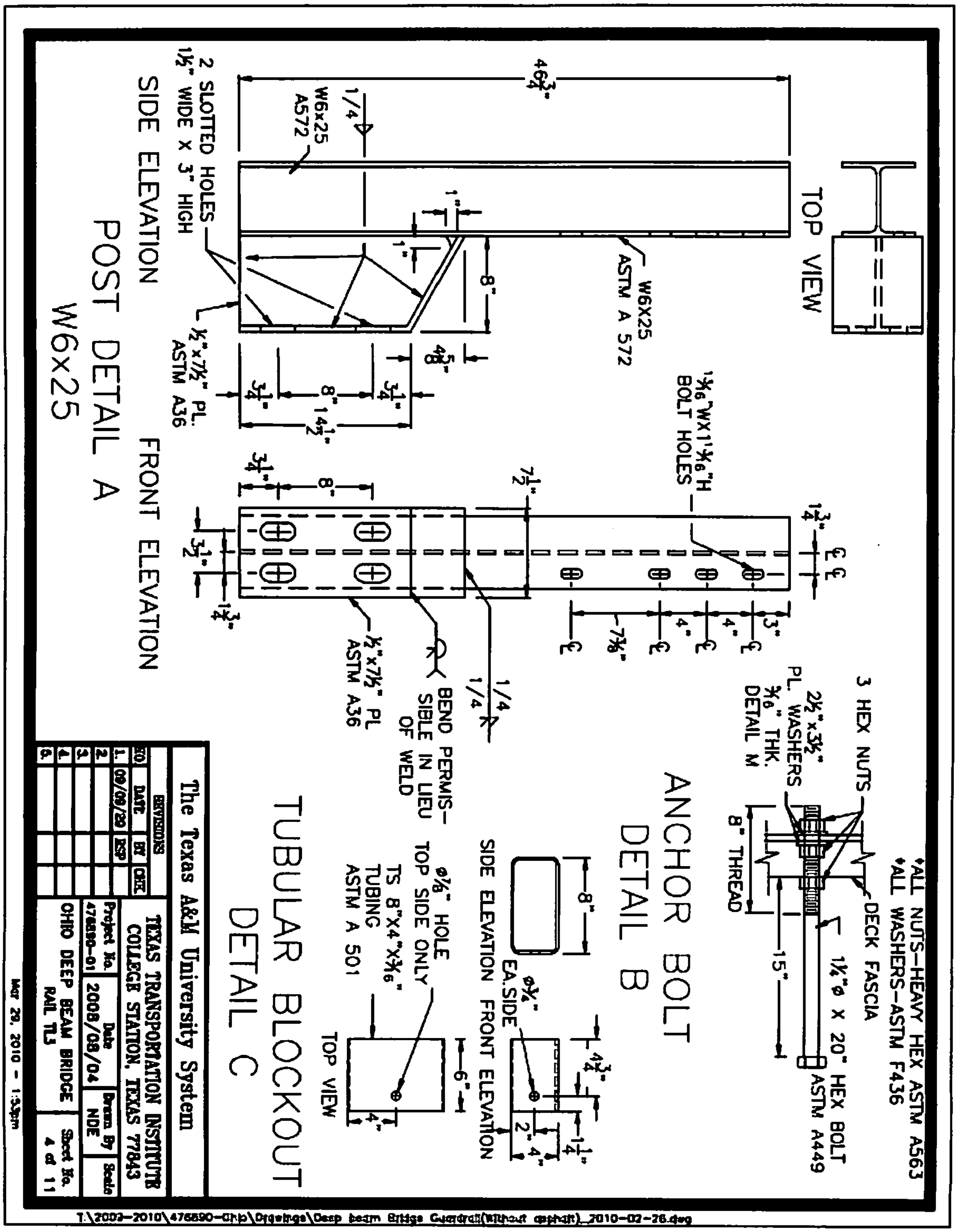
TOP VIEW
46 3/4"
W6X25 ASTM A 572
1/4
W6x25 A572
1"
8"
4 5/8"
3 1/4"
8"
14 1/2"
2 SLOTTED HOLES 1 1/2" WIDE X 3" HIGH
1/2"x7 1/2" PL. ASTM A36
SIDE ELEVATION
FRONT ELEVATION
POST DETAIL A
W6x25
13/16"WX1 13/16"H BOLT HOLES
7 1/2"
1 3/4"
3"
4"
7 7/8"
3 1/2"
1/2"x7 1/2" PL ASTM A36
BEND PERMISSIBLE IN LIEU OF WELD
*ALL NUTS-HEAVY HEX ASTM A563
*ALL WASHERS-ASTM F436
3 HEX NUTS
2 1/2"x3 1/2" PL. WASHERS 5/16" THK. DETAIL M
8" THREAD
DECK FASCIA
1 1/4"ø X 20" HEX BOLT ASTM A449
15"
ANCHOR BOLT DETAIL B
SIDE ELEVATION FRONT ELEVATION
ø3/4" EA.SIDE
4 1/4"
2"
4"
1 1/4"
6"
ø7/8" HOLE TOP SIDE ONLY
TS 8"X4"X5/16" TUBING ASTM A 501
TOP VIEW
TUBULAR BLOCKOUT DETAIL C
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REVISIONS
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Date 2008/08/04
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OHIO DEEP BEAM BRIDGE RAIL TL3
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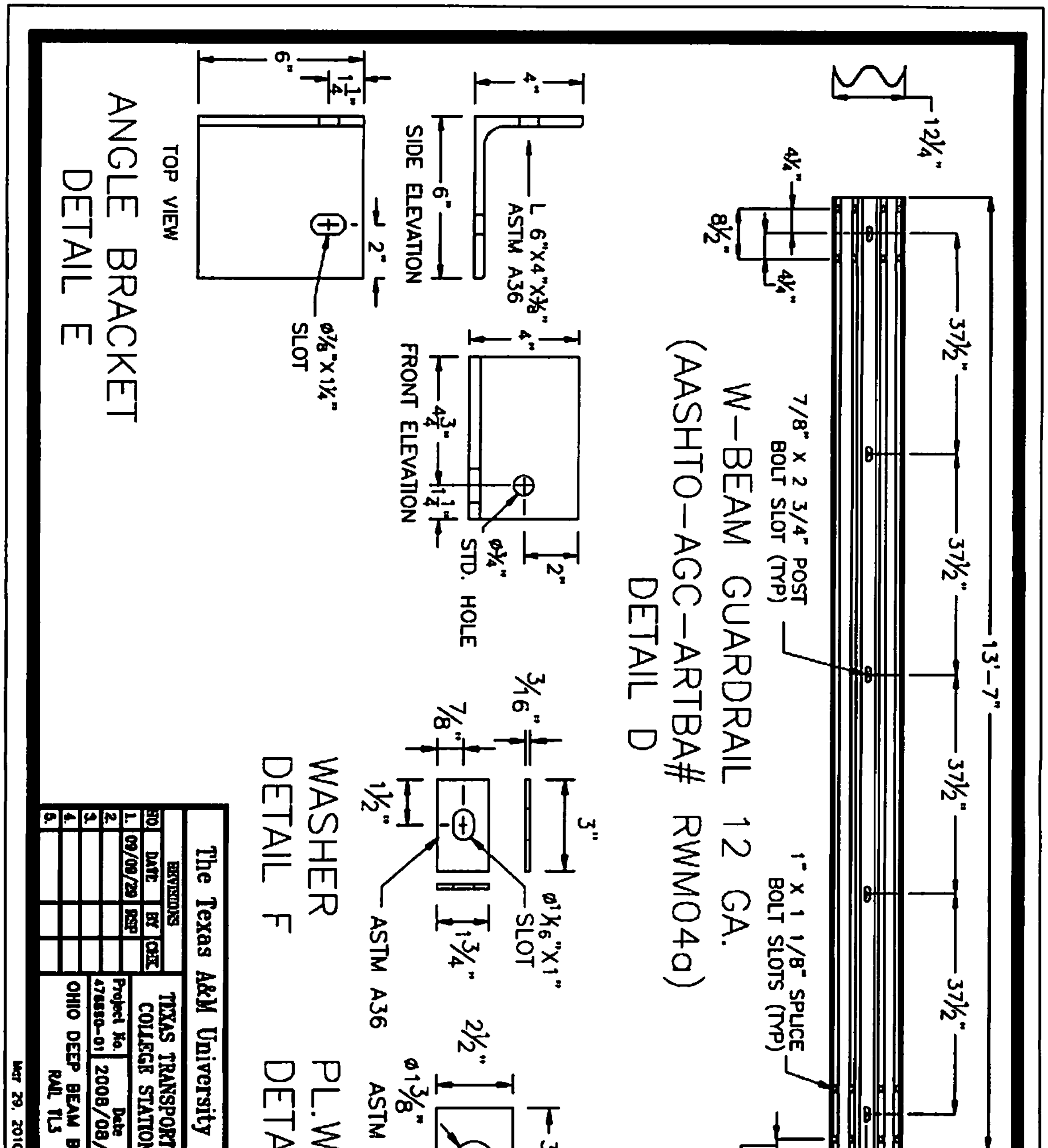
W-BEAM GUARDRAIL 12 GA.
(AASHTO-AGC-ARTBA# RWM04a)
DETAIL D
13'-7"
37½"
7/8" x 2 3/4" POST BOLT SLOT (TYP)
1" x 1 1/8" SPLICE BOLT SLOTS (TYP)
12¼"
2" TYP.
ANGLE BRACKET
DETAIL E
TOP VIEW
SIDE ELEVATION
FRONT ELEVATION
L 6"X4"X⅜" ASTM A36
STD. HOLE
SLOT
WASHER
DETAIL F
ASTM A36
PL.WASHER
DETAIL M
ASTM A36
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OHIO DEEP BEAM BRIDGE RAIL TL3
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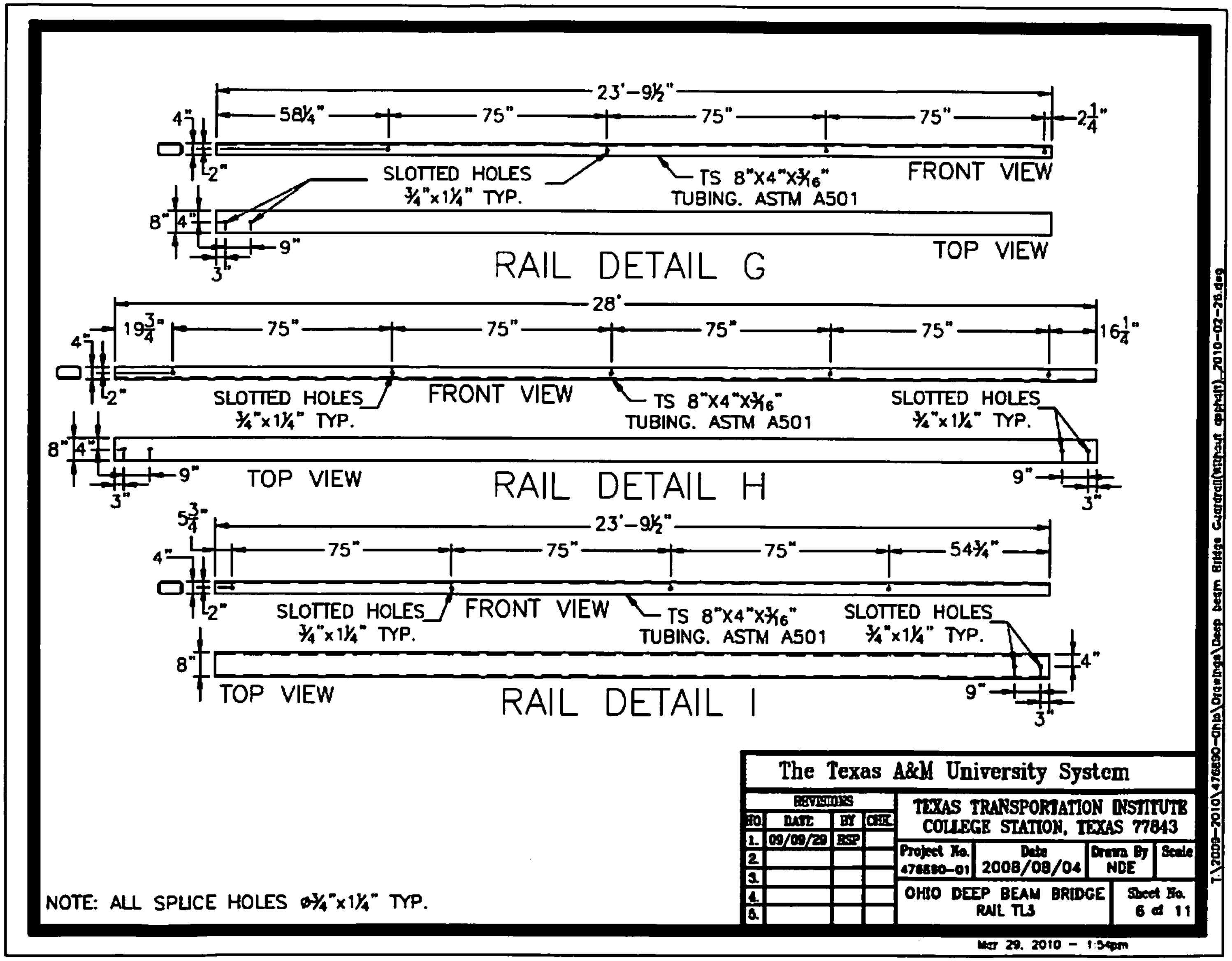
23'-9½"
58¼"
75"
75"
75"
2¼"
4"
2"
SLOTTED HOLES
¾"x1¼" TYP.
TS 8"X4"X3/16"
TUBING. ASTM A501
FRONT VIEW
8"
4"
3"
9"
TOP VIEW
RAIL DETAIL G
28'
19¾"
75"
75"
75"
75"
16¼"
4"
2"
SLOTTED HOLES
¾"x1¼" TYP.
FRONT VIEW
TS 8"X4"X3/16"
TUBING. ASTM A501
SLOTTED HOLES
¾"x1¼" TYP.
8"
4"
9"
3"
TOP VIEW
RAIL DETAIL H
9"
3"
5¾"
23'-9½"
4"
75"
75"
75"
54¾"
2"
SLOTTED HOLES
¾"x1¼" TYP.
FRONT VIEW
TS 8"X4"X3/16"
TUBING. ASTM A501
SLOTTED HOLES
¾"x1¼" TYP.
8"
4"
TOP VIEW
RAIL DETAIL I
9"
3"
NOTE: ALL SPLICE HOLES ø¾"x1¼" TYP.
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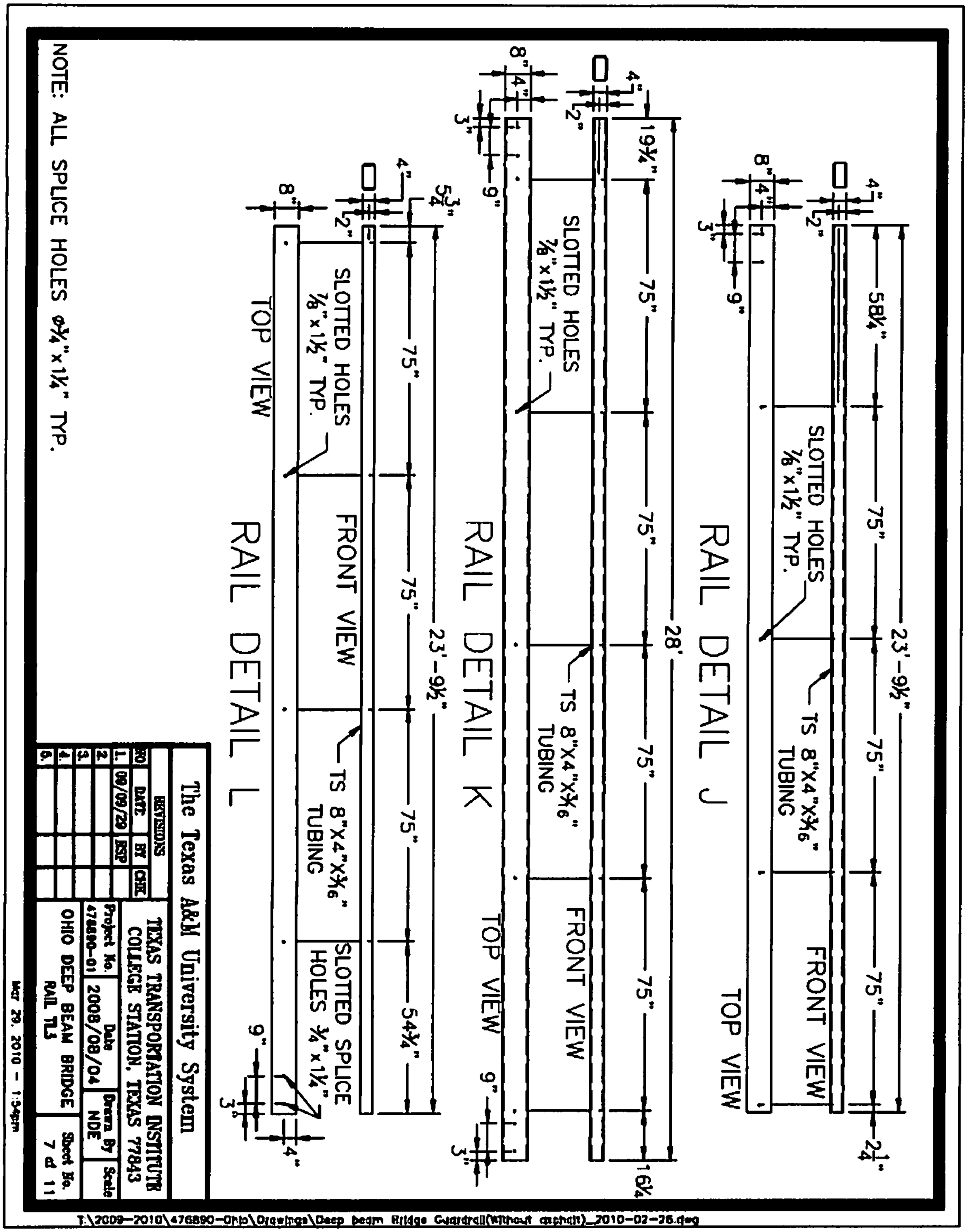
RAIL DETAIL J
TOP VIEW
FRONT VIEW
SLOTTED HOLES ⅞"x1½" TYP.
TS 8"X4"X3/16" TUBING
23'-9½"
58¼"
75"
2¼"
RAIL DETAIL K
TOP VIEW
FRONT VIEW
SLOTTED HOLES ⅞"x1½" TYP.
TS 8"X4"X3/16" TUBING
28'
19¾"
16¼
RAIL DETAIL L
TOP VIEW
FRONT VIEW
SLOTTED HOLES ⅞"x1½" TYP.
TS 8"X4"X3/16" TUBING
SLOTTED SPLICE HOLES ¾"x1¼"
23'-9½"
54¾"
5¾"
NOTE: ALL SPLICE HOLES ⌀¾"x1¼" TYP.
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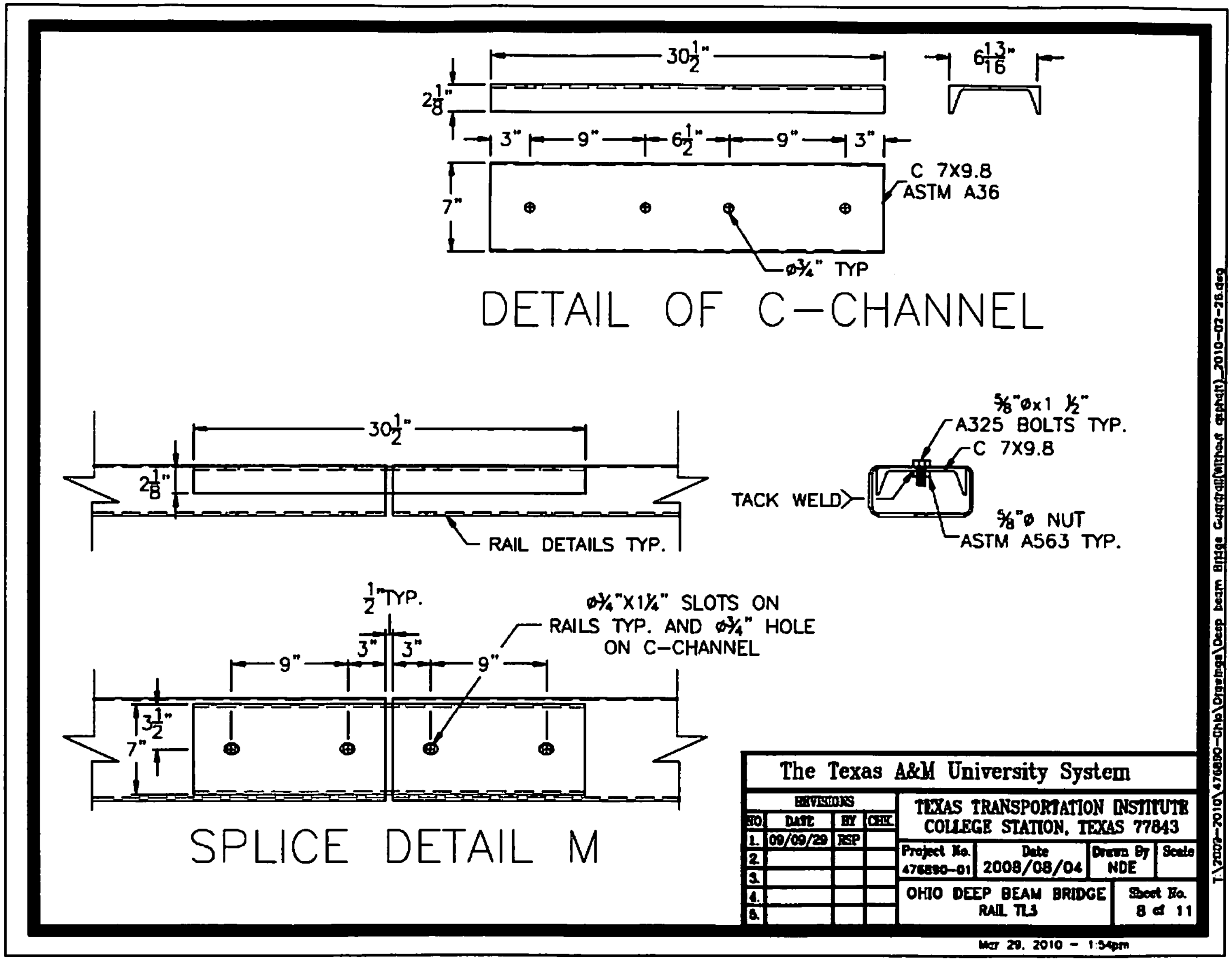

30 1/2"
6 13/16"
2 1/8"
3" 9" 6 1/2" 9" 3"
7"
C 7X9.8
ASTM A36
ø3/4" TYP
DETAIL OF C-CHANNEL
30 1/2"
2 1/8"
RAIL DETAILS TYP.
5/8"øx1 1/2"
A325 BOLTS TYP.
C 7X9.8
TACK WELD
5/8"ø NUT
ASTM A563 TYP.
1/2" TYP.
ø3/4"X1 1/4" SLOTS ON
RAILS TYP. AND ø3/4" HOLE
ON C-CHANNEL
9" 3" 3" 9"
3 1/2"
7"
SPLICE DETAIL M
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OHIO DEEP BEAM BRIDGE
RAIL TL3
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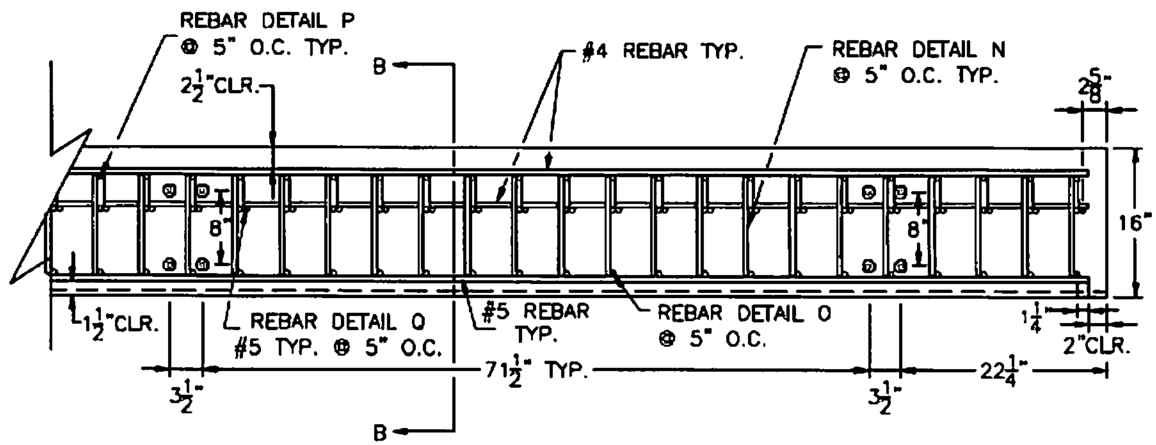

REBAR LAYOUT

DECK–ELEVATION VIEW

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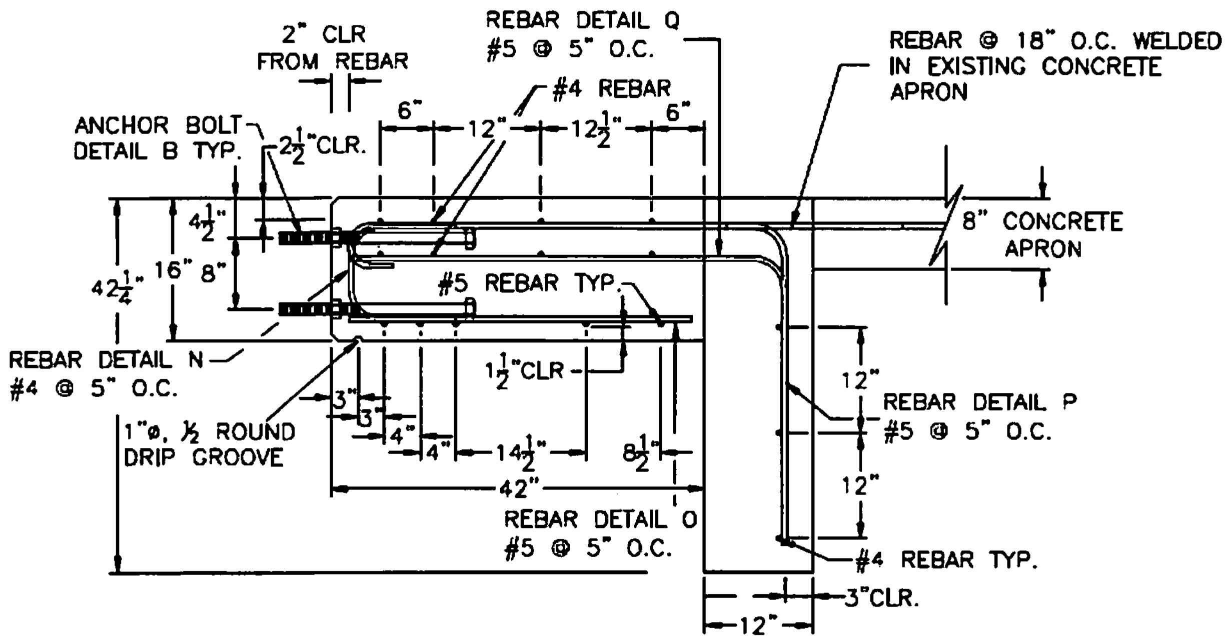

SECTION DETAIL B-B

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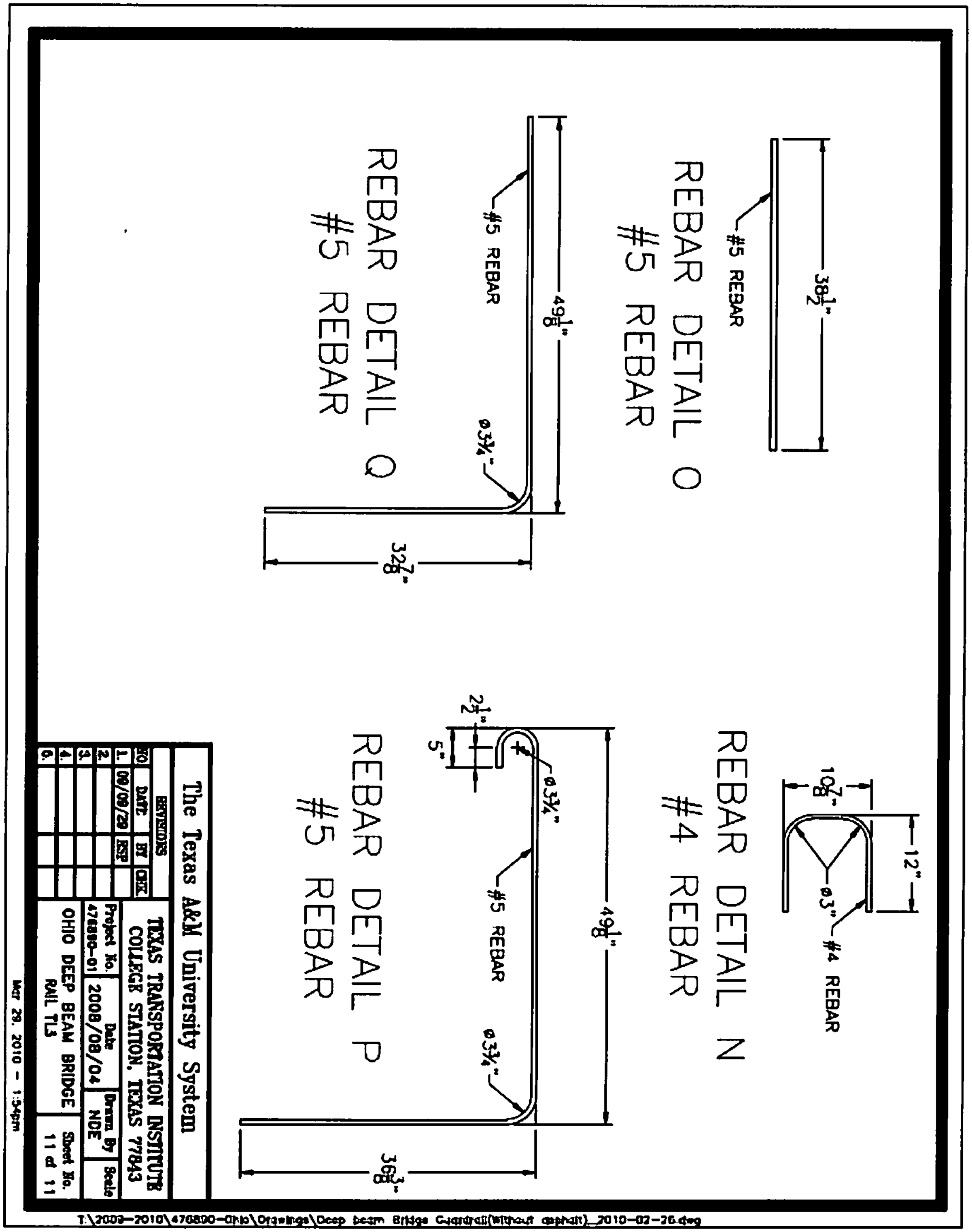
REBAR DETAIL O
#5 REBAR
#5 REBAR
38 1/2"
REBAR DETAIL Q
#5 REBAR
#5 REBAR
49 1/8"
ø3 3/4"
32 7/8"
REBAR DETAIL N
#4 REBAR
#4 REBAR
12"
10 7/8"
ø3"
REBAR DETAIL P
#5 REBAR
#5 REBAR
49 1/8"
2 1/2"
5"
ø3 3/4"
ø3 3/4"
36 3/8"
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