U.S. Department of Transportation
Federal Highway Administration

1200 New Jersey Avenue, SE.
Washington, DC 20590

July 17, 2008

In Reply Refer To: HSSD/B-146

Mr. Gerald M. McCarthy, Coordinator
New England Transportation Consortium
c/o Advanced Technology & Manufacturing Center
University of Massachusetts Dartmouth
151 Martine Street
Fall River, MA 02723

Dear Mr. McCarthy:

This letter is in response to your request for the Federal Highway Administration (FHWA) acceptance of the New England Transportation Consortium (NETC) roadside safety system for use on the National Highway System (NHS).

Name of systems:

1) NETC New Hampshire T2 Bridge Rail Transition
2) NETC New Hampshire T4 Bridge Rail Transition
3) NETC Massachusetts End Wall Transition to S3-TL4 Bridge Rail with Sidewalk
4) NETC Massachusetts End Wall Transition to S3-TL4 Bridge Rail Curb-Mounted

Type of systems:

1&2) W- to Thrie-Beam Transition direct to beam-and-post bridgerail
3&4) W- to Thrie-Beam Transition to concrete end wall

Test Level:

1&2) National Cooperative Highway Research Program (NCHRP) Report 350 Test Level 3 (TL-3)
3&4) NCHRP Report 350 TL-4

Testing conducted by: Texas Transportation Institute (TTI)
Date of request: February 1, 2006
Date of completed package: August 29, 2007 (NETC), June 26, 2008 (TTI)

You requested that we find these systems acceptable for use on the NHS under the provisions of the NCHRP Report 350 “Recommended Procedures for the Safety Performance Evaluation of Highway Features.” We appreciate your patience and cooperation while finalizing this acceptance package.

Requirements
Roadside safety systems should meet the guidelines contained in the NCHRP Report 350, "Recommended Procedures for the Safety Performance Evaluation of Highway Features". FHWA Memorandum "ACTION: Identifying Acceptable Highway Safety Features" of July 25, 1997 provides further guidance on crash testing requirements of longitudinal barriers.

Description
In the current project, the NETC developed bridge rail transitions for two bridge rail systems and for a concrete end wall, and desired to crash test them to TL-3 requirements of the NCHRP Report 350. Four transitions were developed:

1. Transition to the 2-Bar steel bridge rail with approach curb.
2. Transition to the 4-Bar steel bridge rail mounted on a sidewalk.
3. Transition to the concrete end wall with approach curb.
4. Transition to the concrete end wall mounted behind a sidewalk.

Transitions #1 and #2 were developed by New Hampshire Department of Transportation (NHDOT) and transitions #3 and #4 by Massachusetts Highway Department (MHD). The MHD transitions were designed for use with various bridge rail systems beyond the end wall.

Our office reviewed the four transitions and determined that two crash tests were required.

1. Test 3-21 on transition #1 to the 2-bar steel bridge rail with approach curb for TL-3.
2. Test 3-21 on transition #4 to the concrete end wall behind a sidewalk for TL-4.

The FHWA accepted transition #3 to the concrete end wall with approach curb for TL-3 based on crash tests of similar systems already performed by others, and will accept transition #2 to the 4-bar steel bridge rail mounted on a sidewalk pending successful testing of transition #1 to the 2-bar steel bridge rail system with approach curb.

The NETC decided that if the first test (using the 2000P vehicle) on transition #4 to a concrete end wall mounted behind a sidewalk was successful a TL-4 test with a single-unit truck (8000 kg vehicle) would be performed. If transition #4 was successful for TL-4, the FHWA indicated that they would accept transition #3 with an approach curb for TL-4 without testing.

Brief descriptions of the transitions follow:

New Hampshire Transitions
The NETC New Hampshire transition consisted of standard W-beam guardrail attached to a symmetric 10-gage W-beam to Thrie-beam transition section, attached to nested 12-gage Thrie beam, connected to the two tube transition rail by means of a Thrie-beam terminal connector. The two tube transition rails are the same tubular elements used in the bridge rail. A TS 8 x 4 x 5/16 rail element was attached to the top of the W6 x 25 steel posts at a height of 34 inches above the pavement surface (to the top of the rail) with two 6-inch long, 3/4-inch diameter round headed bolts. The TS 4 x 4 x 1/4 bottom rail was attached to the posts at a height of 20 inches with similar bolts. Wood posts throughout the transition were 6 inches x 8 inches x

7 feet long. The seven wood posts adjacent to the tubular transition rail were installed 18-3/4 inches on center, and the remainder of the posts in the transition were installed 37-1/2 inches on center. Posts in the w-beam section were installed at 6 foot 3-inch centers. The upstream end of the guardrail was anchored with an ET terminal. A 7-inch tall simulated granite curb was installed throughout the transition and extended in front of the rail tubes by 6 inches, and in front of the Thrie-beam by 1-1/4 inches.

Massachusetts Transitions

The Massachusetts S3-TL4 Steel Bridge Railing system is a beam and post system consisting of three tubular steel rail elements mounted on steel wide flange posts bolted to the concrete deck/sidewalk. It was mounted on a sidewalk a distance of 61 inches from the face of an 8-inch high curb. The bridge railing was attached to a concrete end wall that is part of the bridge abutment. The end wall flares away from the face by 8.8 inches over a distance of 2-feet, 10 inches. A collapsing tube assembly is located in this flared area. The Thrie-beam transition was attached to the straight portion of the concrete end wall with a Thrie-beam end shoe. Two sections of 12 gage Thrie-beam were nested and attached to the end shoe and wood support posts. Posts 1 through 4 were 6 x 8-inch x 7-foot long with 18-inch long blockouts of the same section, spaced 1-1/2 feet on center. Posts 5 and 6 were 6x8-inch x 6.5-foot long, with 18-inch blockouts (6 x 8) and spaced 3 feet on center. Post 7 was 6x8-inch, 6.5-foot long with a 14-inch blockout (6 x 8). A 10-gage symmetric Thrie-beam to W-beam transition was mounted on posts 5, 6, and 7. The sidewalk transitioned from 8 inches tall to 6 inches tall at post 8.

Testing

Full-scale truck testing was conducted on these transitions, as summarized in the tables below and detailed in the enclosed Crash Test Data Sheets for reference. The New Hampshire transition was tested to TL-3, whereas the Massachusetts transition was tested to TL-4.

Test Number	Test 3-21 401181-1	Test 4-21 401181-2	Test 4-22 401181-3
Transition	New Hampshire	Massachusetts	Massachusetts
Critical Impact Point Location	1635 mm from 1st bridgerail post	1570 mm from start of wall slope	1570 mm from start of wall slope
Mass of Test Vehicle	2135 kg (2000P)	2108 kg (2000P)	8106 kg (8000S)
Impact Speed	102.3 km/hr	101.2	82.2
Impact Angle	24.9 degrees	25.2 degrees	13.6 degrees
Occupant Impact Velocity	5.2 mps long. 7.5 mps lat.	5.1 mps long. 6.6 mps lat.	2.5 mps long. 3.0 mps lat.
Maximum Ridedown*	-8.3 g's long. 13.5 g's lat.	-19.3g's long. 17.4g's lat.	-4.5 g's long. 7.4 g's lat.
Working Width	580 mm	450 mm	539 mm
Max. Occup. Deform.**	44 mm	104 mm	N/A

*Maximum Ridedown: maximum longitudinal and lateral ridedown accelerations
**Max. Occup. Deform.: maximum occupant compartment deformation

Findings
In all three impacts, the test vehicles were smoothly redirected by the barrier, with maximum roll angles quite low or negligible. The results of the testing met the FHWA requirements and, therefore, the transitions described above and detailed in the enclosed drawings are acceptable for use on the NHS under the range of conditions tested, when proposed by a highway agency.

Findings
The systems described in the various requests above and detailed in the enclosed drawings are acceptable for use on the NHS under the range of conditions tested, when such use is acceptable to a highway agency. Specifically, the following scenarios are acceptable:

1. New Hampshire Transition to the 2-Bar steel bridge rail with approach curb.
2. New Hampshire Transition to the 4-Bar steel bridge rail mounted on a sidewalk.
3. Massachusetts Transition to the concrete end wall with approach curb.
4. Massachusetts Transition to the concrete end wall mounted behind a sidewalk.

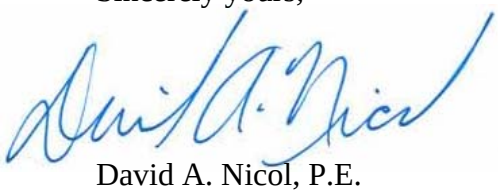
Please note that system #4 requires that either there be an existing sidewalk on the approach to the bridge, or that a gradual transition from the shoulder grade to the sidewalk is provided in conjunction with the transition.

Please also note the following standard provisions that apply to the FHWA letters of acceptance:

- This acceptance is limited to the crashworthiness characteristics of the systems 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.
- Users should ensure 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-146 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 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.

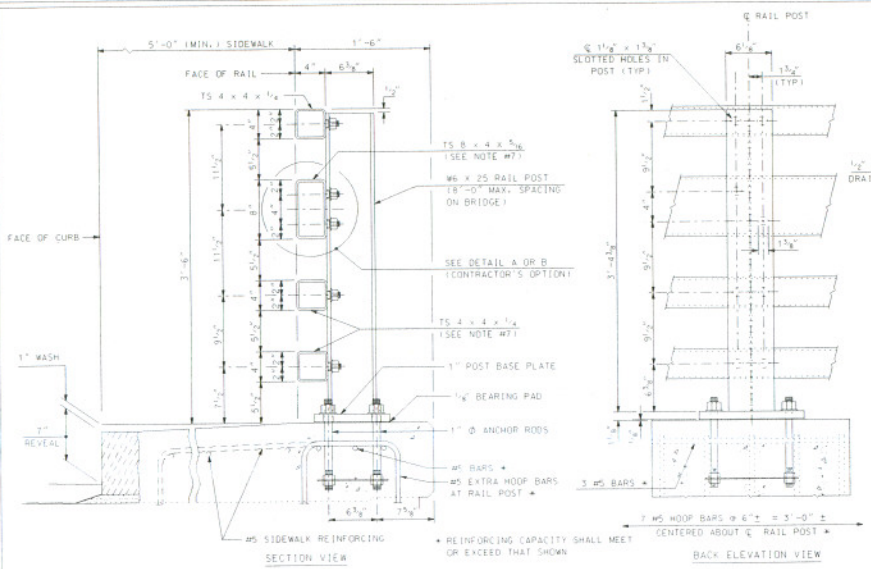
Sincerely yours,



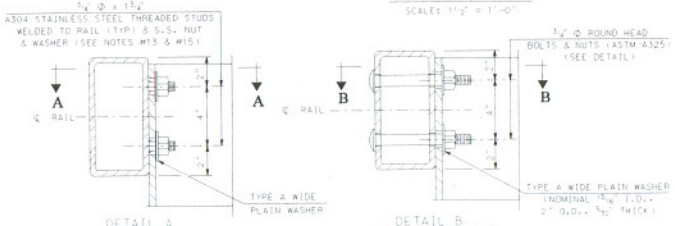
David A. Nicol, P.E.
Director, Office of Safety Design
Office of Safety

Enclosures

cc: Mr. James Sime
Manager of Research
Research & Materials
ConnDOT
280 West Street
Rocky Hill, CT 06067-0207

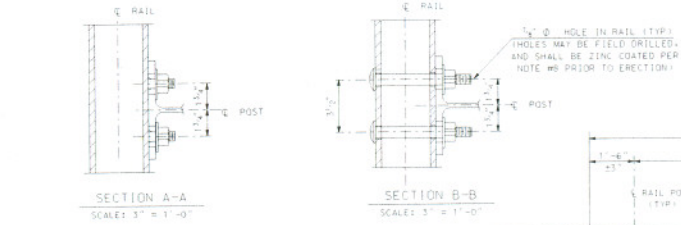


POST ASSEMBLY
SCALE: 1 1/2" = 1'-0"



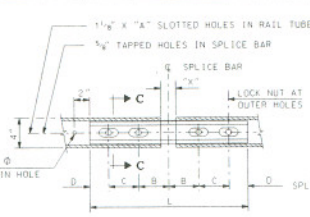
DETAIL A
SCALE: 3" = 1'-0"

DETAIL B
SCALE: 3" = 1'-0"

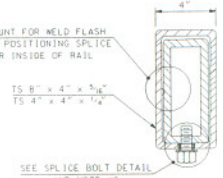


SECTION A-A
SCALE: 3" = 1'-0"

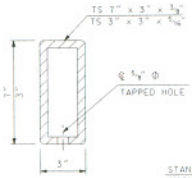
SECTION B-B
SCALE: 3" = 1'-0"



RAIL SPLICE (BOTTOM VIEW)
SCALE: 1 1/2" = 1'-0"

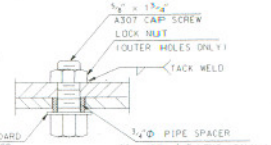


SECTION C-C

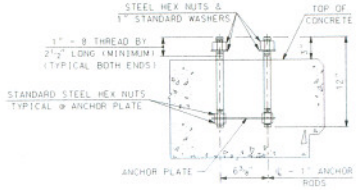


SPLICE BAR SECTION

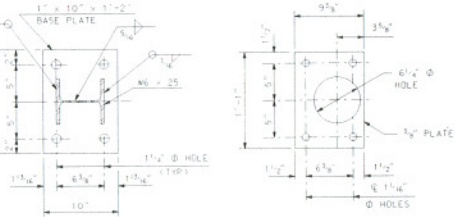
RAIL SPLICE DETAILS
SCALE: 3" = 1'-0"



SPLICE BOLT DETAIL
SCALE: 6" = 1'-0"

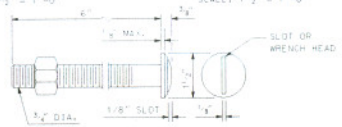


POST ANCHOR ASSEMBLY
SCALE: 1 1/2" = 1'-0"



POST BASE PLATE
SCALE: 1 1/2" = 1'-0"

ANCHOR PLATE
SCALE: 1 1/2" = 1'-0"



A325 ROUND HEAD BOLT DETAIL
SCALE: 6" = 1'-0"

STUD WELD DETAIL
SCALE: 6" = 1'-0"

RAIL NOTES

(1) ITEM 563.24, BRIDGE RAIL T4 (F), SHALL INCLUDE POSTS, BASE PLATES, ANCHOR PLATES, ANCHOR RODS, PREFORMED PADS, RAIL ASSEMBLY BOLTS, NUTS, WASHERS, STUDS, STRUCTURAL TUBING, SPLICE BARS, PIPE SPACERS, ALL APPURTENANCES, AND GALVANIZING.

(2) BRIDGE RAIL POSTS SHALL BE SET NORMAL (90 DEGREES) TO THE PROFILE GRADE, EXCEPT ON GRADES OVER 5% WHERE POSTS SHALL BE SET VERTICAL.

(3) ENDS OF RAIL TUBE SECTIONS SHALL BE SAWED OR MILLED AND SHALL BE TRUE AND SMOOTH. ALL CUT EDGES OF ALL MATERIAL SHALL BE GROUND SMOOTH.

(4) EACH PIECE OF RAIL TUBING SHALL BE ATTACHED TO A MINIMUM OF THREE (3) POSTS.

(5) BOLT HOLES SHALL BE DRILLED OR PUNCHED. FLAME CUTTING MAY BE USED TO FINISH SLOTTED HOLES IF MECHANICALLY GUIDED.

(6) AT INTERIOR SPLICES, PIPE SPACERS SHALL BE USED ON ONLY ONE SIDE OF THE SPLICE TO ALLOW MOVEMENT ON THAT SIDE. ALL RAILS IN A SPLICE SHALL RECEIVE THE SAME TREATMENT. AT END SPLICES PIPE SPACERS SHALL BE USED ON BOTH SIDES OF THE SPLICE TO ALLOW MOVEMENT ON EACH SIDE.

(7) MILL OR SHOP TRANSVERSE WELDS SHALL NOT BE PERMITTED ON ANY RAIL ELEMENT. RAIL ELEMENTS USED ON CURVES SHALL USE 3/8" WALL TUBES AND SHALL BE SHOP FORMED TO THE REQUIRED CURVATURE.

(8) NO PUNCHING, DRILLING, CUTTING OR WELDING SHALL BE PERMITTED AFTER GALVANIZING, EXCEPT AS ALLOWED IN DETAILS A AND B. DAMAGED AREAS OF GALVANIZING SHALL BE THOROUGHLY CLEANED, PRETREATED, AND PAINTED WITH TWO COATS OF ORGANIC ZINC-RICH GALVANIZING REPAIR PAINT, HAVING MIN. 94% ZINC BY WEIGHT, TO A THICKNESS EQUAL TO THE ORIGINAL COATING ACCORDING TO THE STANDARD SPECIFICATIONS AND ASTM A780.

(9) NUTS FOR 1" Ø THREADED ANCHOR RODS CONNECTING THE BASE PLATE TO THE CONCRETE SHALL BE TIGHTENED TO A SNUG FIT AND GIVEN AN ADDITIONAL 1/6 TURN.

(10) THREADS FOR ANCHOR RODS MAY BE ROLLED OR CUT. IF CUT THREADS ARE USED, BOLT DIAMETER SHALL NOT BE LESS THAN NOMINAL DIAMETER. IF ROLLED THREADS ARE USED, ROD DIAMETER SHALL NOT BE LESS THAN ROOT DIAMETER OF THREADS.

MATERIAL NOTES

(11) STRUCTURAL TUBING SHALL CONFORM TO THE REQUIREMENTS OF ASTM A500, GRADE B, STRUCTURAL STEEL TUBING. RAIL TUBING SHALL MEET THE LONGITUDINAL CHARPY V-NOTCH REQUIREMENTS OF 15 FT. LBS. AT 0° F. FOR ASTM A500, GRADE B. THE TEST SAMPLES SHALL BE TAKEN AFTER FORMING THE TUBES. CHARPY V-NOTCH IS NOT REQUIRED FOR SPLICE TUBES.

(12) RAIL POSTS AND BASE PLATES SHALL CONFORM TO THE REQUIREMENTS OF ASTM A572 GR 50, EXCEPT ANCHOR PLATES MAY BE ASTM A36.

(13) THREADED STUDS AND MATCHING NUTS FOR RAIL-TO-POST ATTACHMENT (DETAIL A) SHALL CONFORM TO ASTM A276 TYPE 304 STAINLESS STEEL, AND SHALL BE TORQUE TESTED PER AWS D1.5, 7.7.1. DETAIL B BOLTS SHALL BE ASTM A325 OR A449. ALL OTHER BOLTS AND NUTS SHALL CONFORM TO ASTM A307 AND ASTM 563 GRADE A RESPECTIVELY OR BETTER, EXCEPT THAT ASTM A307 NUTS MAY BE USED ON THE BOTTOM OF ANCHOR ASSEMBLY. WASHERS SHALL BE HARDENED STEEL COMMERCIAL TYPE A PLAIN WIDE WASHERS AND SHALL MEET THE DIMENSIONAL REQUIREMENTS OF A.N.S.I. B18.22. ANCHOR RODS SHALL CONFORM TO ASTM A449.

(14) ALL STEEL COMPONENTS (EXCEPT STAINLESS) SHALL BE GALVANIZED AFTER FABRICATION IN CONFORMANCE TO AASHTO M232 (ASTM A153) AND AASHTO M111 (ASTM A123). THE GALVANIZING KETTLE SHALL HAVE 0.05 TO 0.09 PERCENT NICKEL. GALVANIZED SURFACES SHALL HAVE A UNIFORM APPEARANCE AND GALVANIZED MATERIAL SHALL BE PROPERLY STORED. IF PAINTING IS REQUIRED SEE SPECIAL PROVISIONS FOR 708.

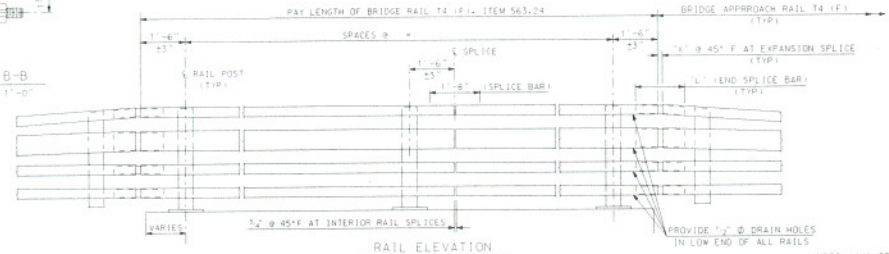
(15) DETAIL A STUDS SHALL BE WELDED ON AFTER TUBES ARE GALVANIZED BY SPOT GRINDING OFF GALVANIZING, WELDING ON STUDS, THEN TOUCH UP GALVANING PER NOTE #8 ABOVE.

(16) PREFORMED BEARING PADS (1/8" THICK) SHALL CONFORM TO AASHTO M251.

(17) THIS BRIDGE RAIL SYSTEM WAS SUCCESSFULLY CRASH TESTED FOR AASHTO PL2 IN 1997 BY THE NEW ENGLAND TRANSPORTATION CONSORTIUM.

SPLICE BAR DIMENSION TABLE							
T	A	B	C	D	X	L
INTERIOR	2 1/2"	4"	4"	2"	3/4"	1'-8"
≤ 3 1/4"	2 1/2"	4"	4"	2"	2"	1'-8"
* 3 1/4" < T ≤ 5 1/4"	3 1/2"	5"	5"	2 1/2"	3"	2'-4 1/2"

T = TOTAL MOVEMENT OF BRIDGE
* = END SPLICE BAR



RAIL ELEVATION
SCALE: 1/2" = 1'-0"

NETC 4/1/03

SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE
Standards\NETC	T4BR-NETC	AS NOTED

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

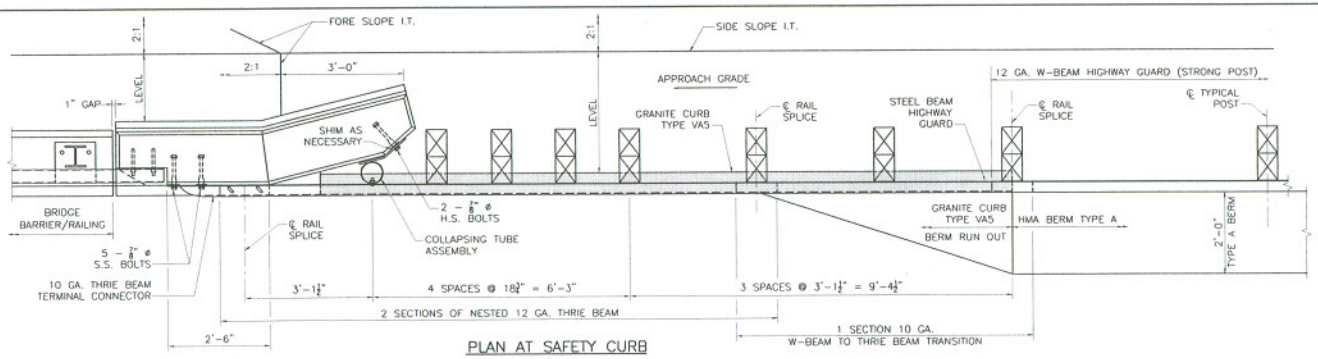
TOWN | BRIDGE NO. | STATE PROJECT

LOCATION

T4 STEEL BRIDGE RAIL (PL2)

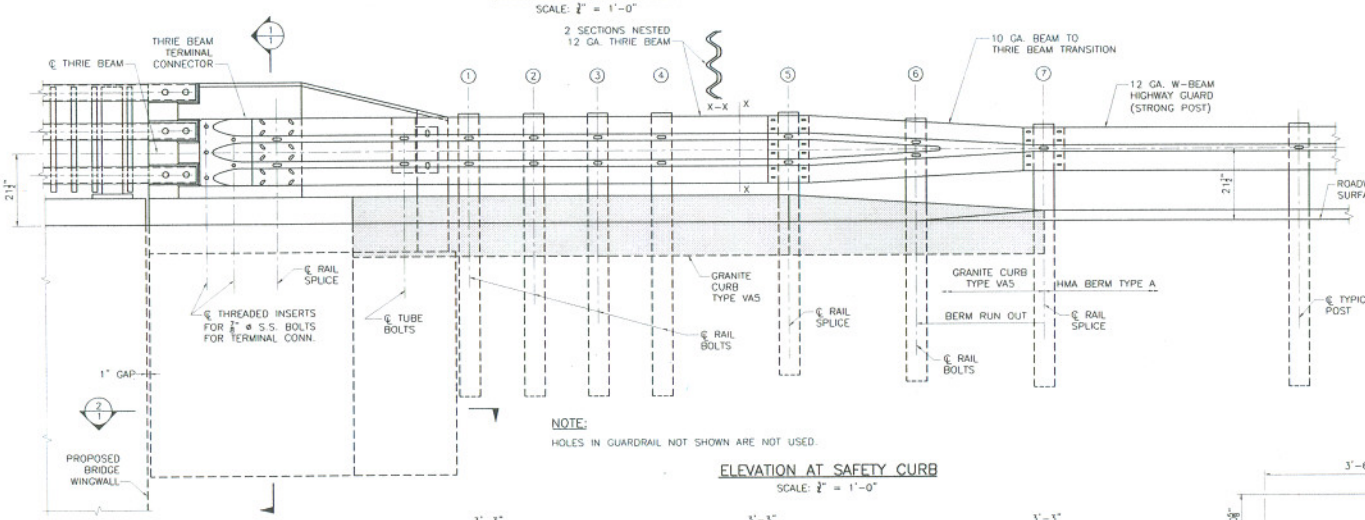
BRIDGE SHEET OF

REVISIONS AFTER PROPOSAL	BY	DATE		BY	DATE
DESIGNED NETC/JSZ	3/02	CHECKED NHDOT			FILE NUMBER
DRAWN PJP	4/03	CHECKED JSZ	4/03		
QUANTITIES		CHECKED			
ISSUE DATE		FEDERAL PROJECT NO.		SHEET NO.	TOTAL SHEETS
REV. DATE 4/1/03					



PLAN AT SAFETY CURB

SCALE: 1/2" = 1'-0"

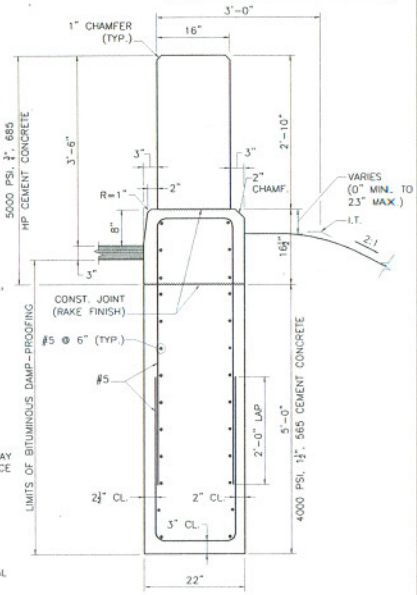


NOTE:

HOLES IN GUARDRAIL NOT SHOWN ARE NOT USED.

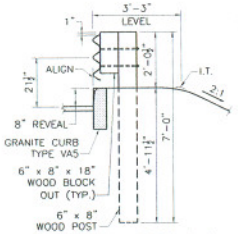
ELEVATION AT SAFETY CURB

SCALE: 1/2" = 1'-0"

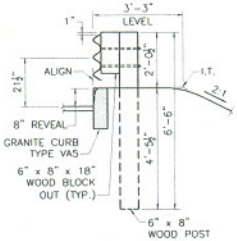


SECTION 1

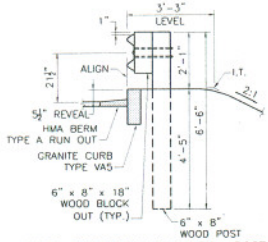
SCALE: 1" = 1'-0"



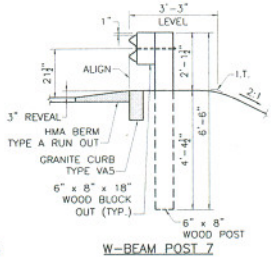
THRIE BEAM POSTS 1-4



THRIE BEAM POST 5



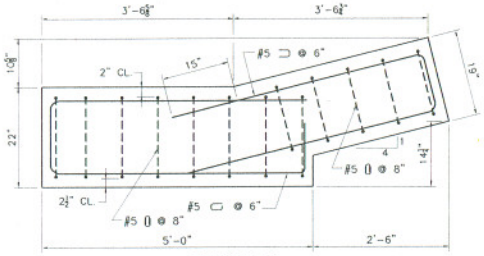
W TO THRIE BEAM TRANSITION POST 6



W-BEAM POST 7

SECTIONS AT NUMBERED POSTS

SCALE: 1/2" = 1'-0"



SECTION 2

SCALE: 1" = 1'-0"

STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
MASS.	XXX-XXXX (XXX)	200X	XX	XX
PROJECT FILE NO. XXXXXX				

MONTH DD, YYYY	ISSUED FOR CONSTRUCTION
DATE	DESCRIPTION
USE ONLY PRINTS OF LATEST DATE	

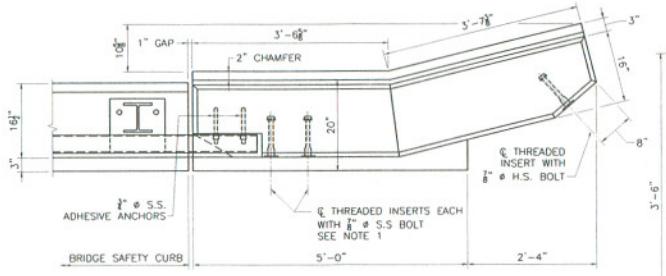
NETC CONCRETE BRIDGE RAIL TO HIGHWAY GUARDRAIL TRANSITION AT SAFETY CURB

SHEET 1 OF 7 SHEETS BRIDGE NO. X-XX-XXX (XXX)

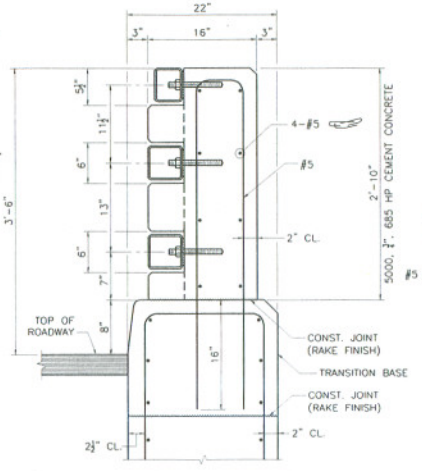
PRELIMINARY

Date: March 11, 2005

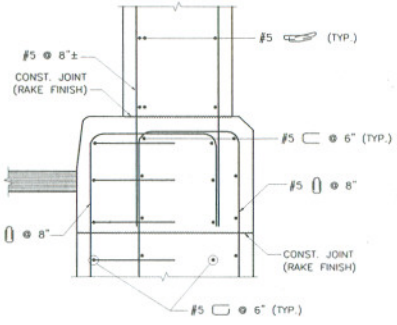
STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
MASS.	XXX-XXXX (XXX)	200X	XX	XX
PROJECT FILE NO. XXXXXX				



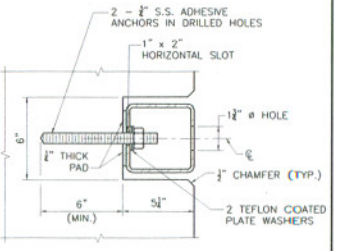
PARTIAL PLAN AT SAFETY CURB
SCALE: 1" = 1'-0"



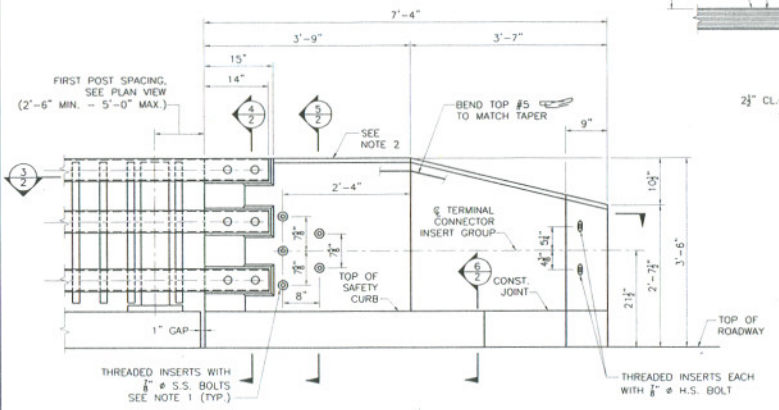
SECTION 4
SCALE: 1½" = 1'-0"



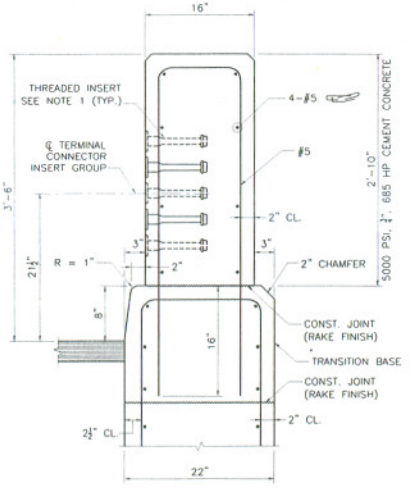
SECTION 6
SCALE: 1½" = 1'-0"



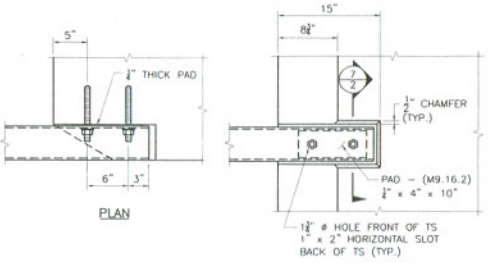
SECTION 7
SCALE: 3" = 1'-0"



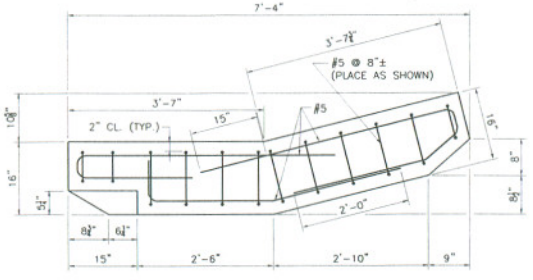
PARTIAL ELEVATION AT SAFETY CURB
SCALE: 1" = 1'-0"



SECTION 5
SCALE: 1½" = 1'-0"



RAIL ATTACHMENT
SCALE: 1½" = 1'-0"



SECTION 3
SCALE: 1" = 1'-0"

NOTES:

1. THREADED INSERTS SHALL BE PREQUALIFIED BY THE MANUFACTURER AS BEING CAPABLE OF DEVELOPING AN ULTIMATE SHEAR CAPACITY OF 20 KIPS PER ¾" ø S.S. BOLT. S.S. BOLTS SHALL BE ⅞" ø x 1½" LONG FULLY THREADED AISI TYPE 304N STAINLESS STEEL. INSERTS FOR ⅞" S.S. BOLTS SHALL BE CAST-IN-PLACE AND GALVANIZED.
2. TOP OF GUARDRAIL TRANSITION AND RAIL POCKETS SHALL BE SLOPED TO MATCH THE PROFILE GRADE.

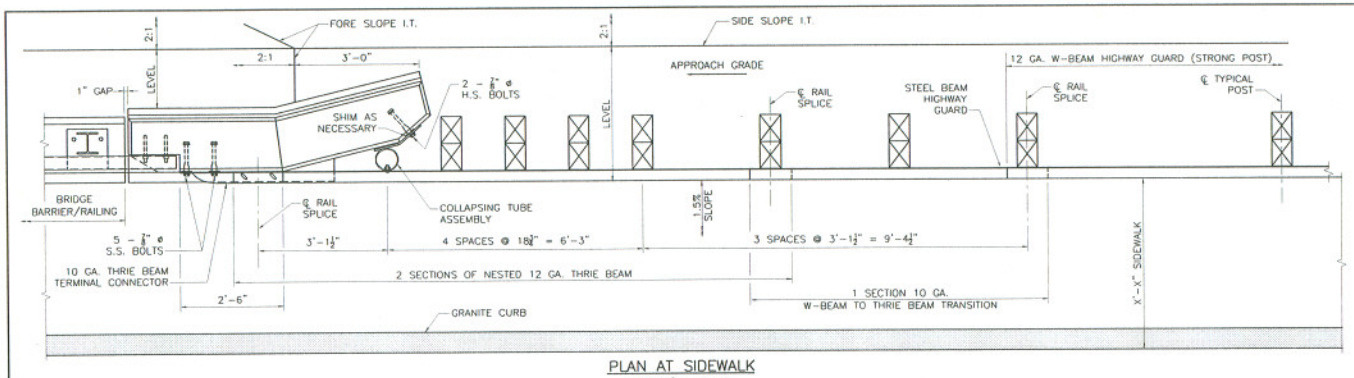
MONTH DD, YYYY	ISSUED FOR CONSTRUCTION
DATE	DESCRIPTION
USE ONLY PRINTS OF LATEST DATE	

NETC CONCRETE BRIDGE RAIL TO HIGHWAY GUARDRAIL TRANSITION – S3-TL4 RAILING AT SAFETY CURB

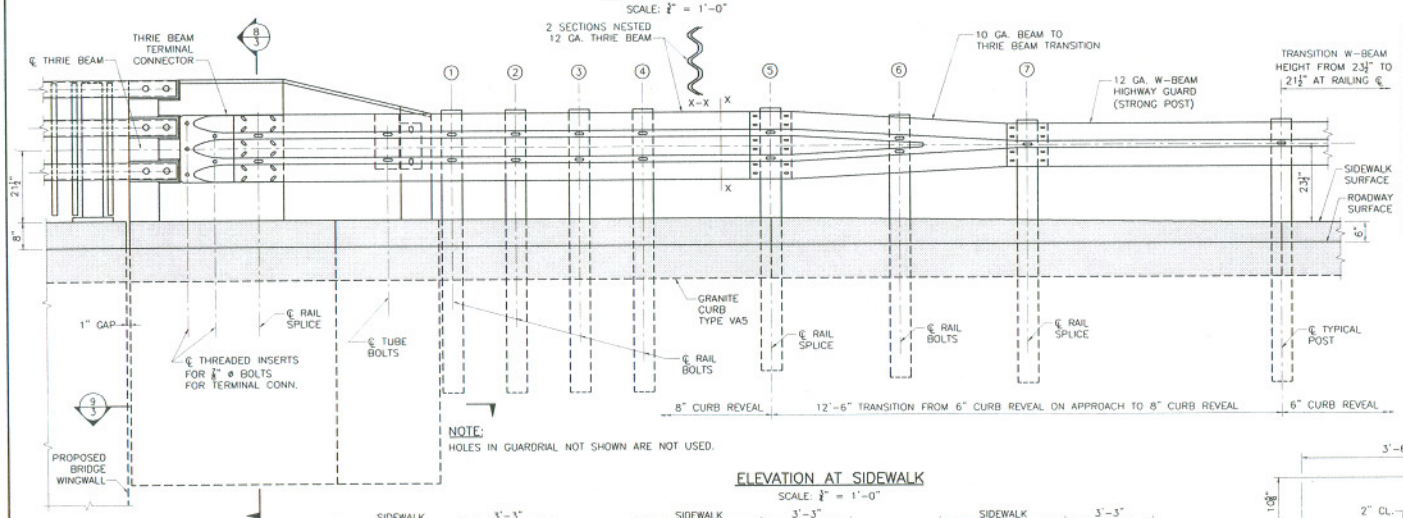
SHEET 2 OF 7 SHEETS BRIDGE NO. X-XX-XXX (XXX)

PRELIMINARY

Date: March 11, 2005

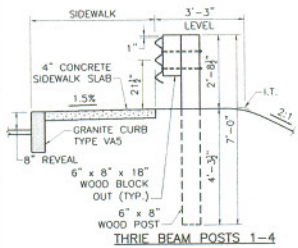


PLAN AT SIDEWALK
SCALE: ¾" = 1'-0"

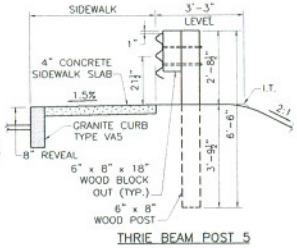


NOTE:
HOLES IN GUARDRIAL NOT SHOWN ARE NOT USED.

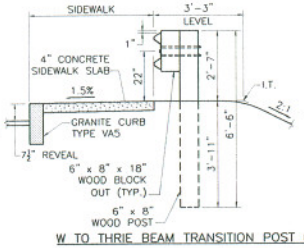
ELEVATION AT SIDEWALK
SCALE: ¾" = 1'-0"



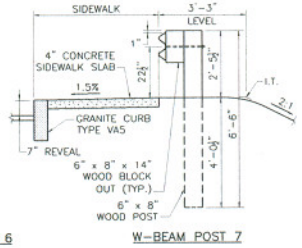
THRIE BEAM POSTS 1-4



THRIE BEAM POST 5

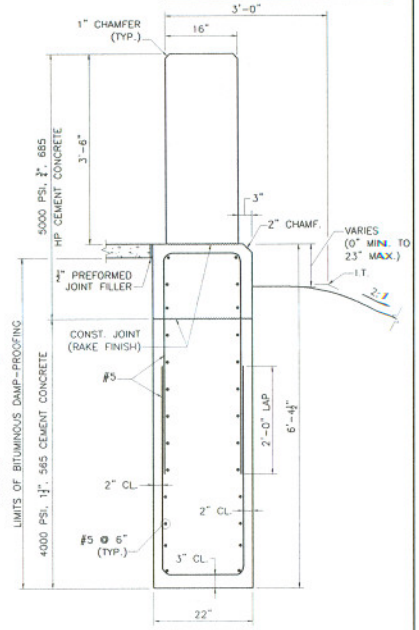


W TO THRIE BEAM TRANSITION POST 6

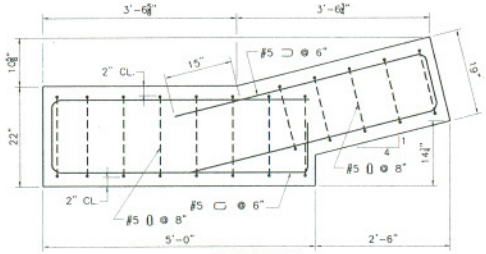


W-BEAM POST 7

SECTIONS AT NUMBERED POSTS
SCALE: ½" = 1'-0"



SECTION 8
SCALE: 1" = 1'-0"



SECTION 9
SCALE: 1" = 1'-0"

STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
MASS.	XXX-XXXX (XXX)	200X	XX	XX

PROJECT FILE NO. XXXXXX

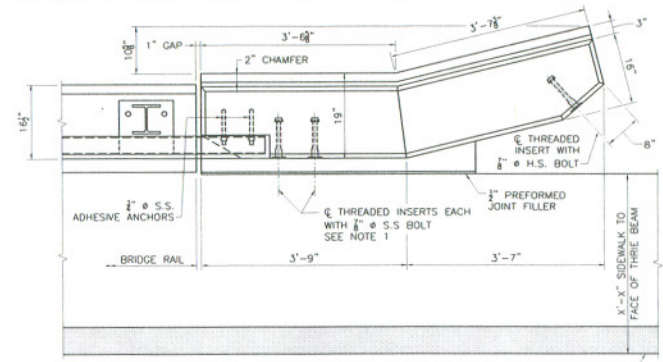
MONTH DD, YYYY	ISSUED FOR CONSTRUCTION
DATE	DESCRIPTION
USE ONLY PRINTS OF LATEST DATE	

NETC CONCRETE BRIDGE RAIL TO HIGHWAY GUARDRAIL TRANSITION AT SIDEWALK

SHEET 3 OF 7 SHEETS BRIDGE NO. X-XX-XXX (XXX)

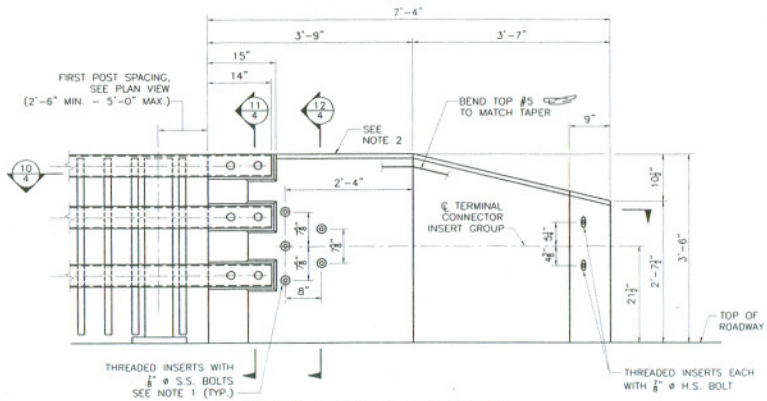
PRELIMINARY

Date: March 11, 2005



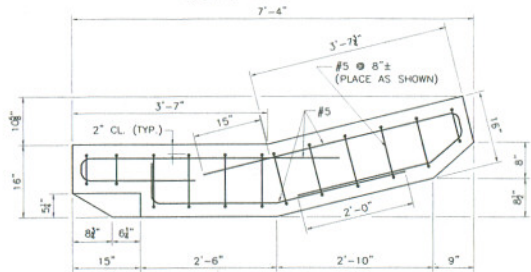
PARTIAL PLAN AT SIDEWALK

SCALE: 1" = 1'-0"



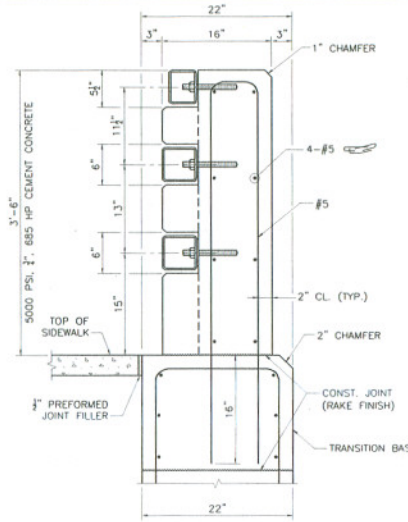
PARTIAL ELEVATION AT SIDEWALK

SCALE: 1" = 1'-0"



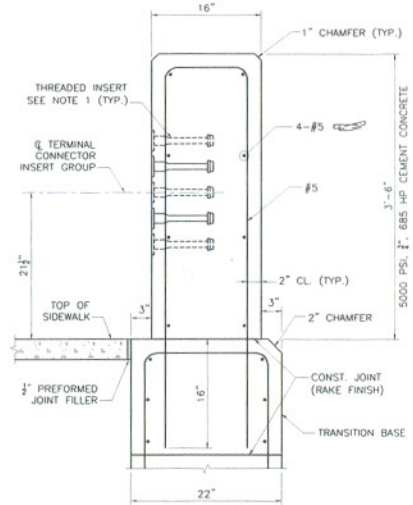
SECTION 10

SCALE: 1" = 1'-0"



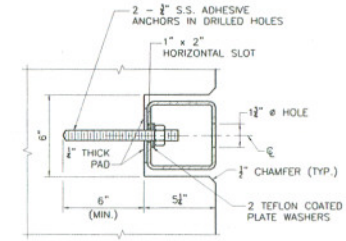
SECTION 11

SCALE: 1½" = 1'-0"



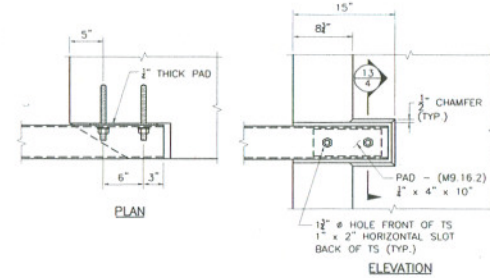
SECTION 12

SCALE: 1½" = 1'-0"



SECTION 13

SCALE: 3" = 1'-0"



RAIL ATTACHMENT

SCALE: 1½" = 1'-0"

NOTES:

1. THREADED INSERTS SHALL BE PREQUALIFIED BY THE MANUFACTURER AS BEING CAPABLE OF DEVELOPING AN ULTIMATE SHEAR CAPACITY OF 20 KIPS PER ⅞" ø S.S. BOLT. S.S. BOLTS SHALL BE ⅞" ø x 1½" LONG FULLY THREADED AISI TYPE 304N STAINLESS STEEL. INSERTS FOR ⅞" S.S. BOLTS SHALL BE CAST-IN-PLACE AND GALVANIZED.
2. TOP OF GUARDRAIL TRANSITION AND RAIL POCKETS SHALL BE SLOPED TO MATCH THE PROFILE GRADE.

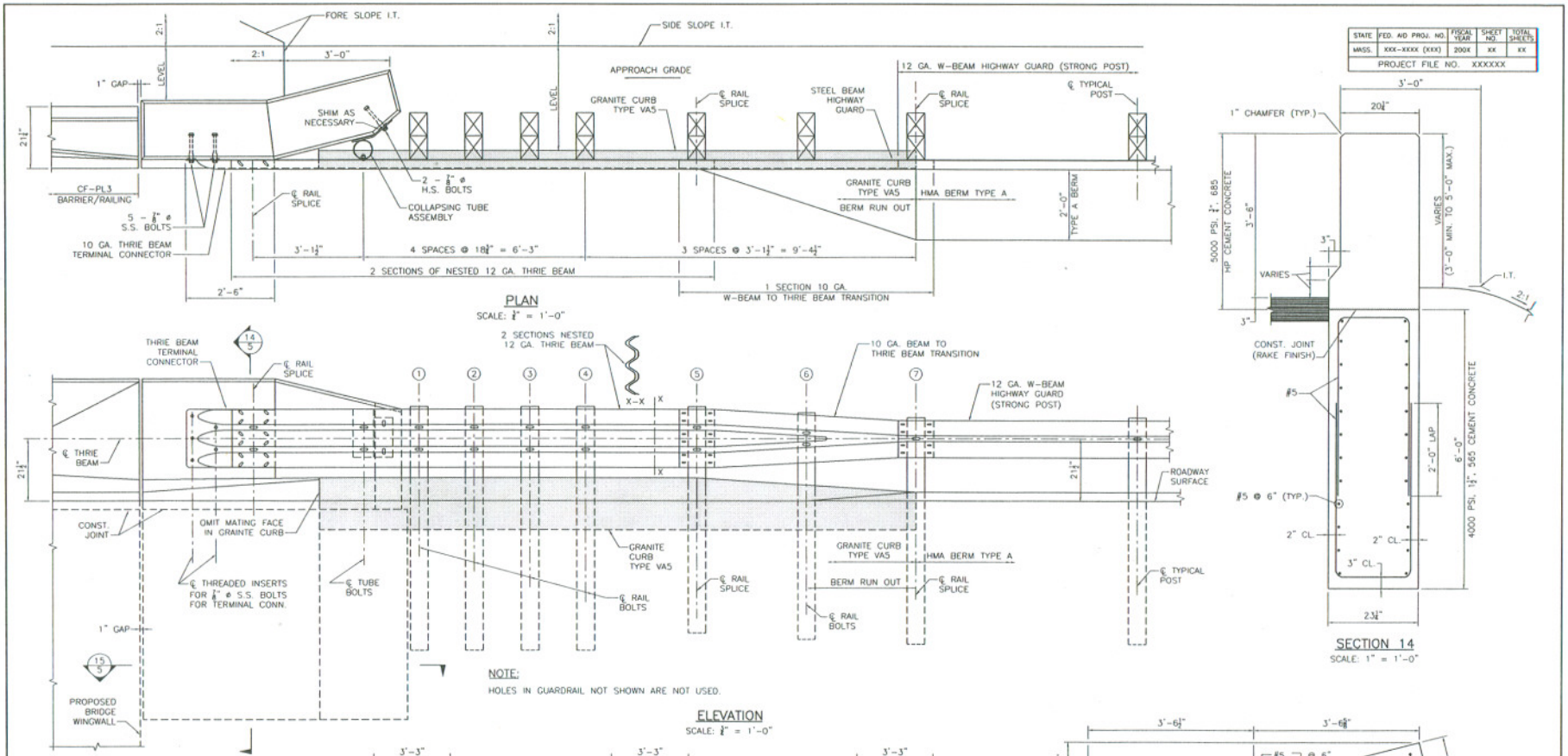
STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
MASS.	XXX-XXXX (XXX)	200X	XX	XX
PROJECT FILE NO. XXXXXX				

MONTH DD, YYYY	ISSUED FOR CONSTRUCTION
DATE	DESCRIPTION
USE ONLY PRINTS OF LATEST DATE	

NETC CONCRETE BRIDGE RAIL TO HIGHWAY GUARDRAIL TRANSITION – S3-TL4 RAILING AT SIDEWALK

PRELIMINARY

Date: March 11, 2005



STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
MASS.	XXX-XXXX (XXX)	200¢	XX	XX

PROJECT FILE NO. XXXXXX

MONTH DD, YYYY	ISSUED FOR CONSTRUCTION
DATE	DESCRIPTION

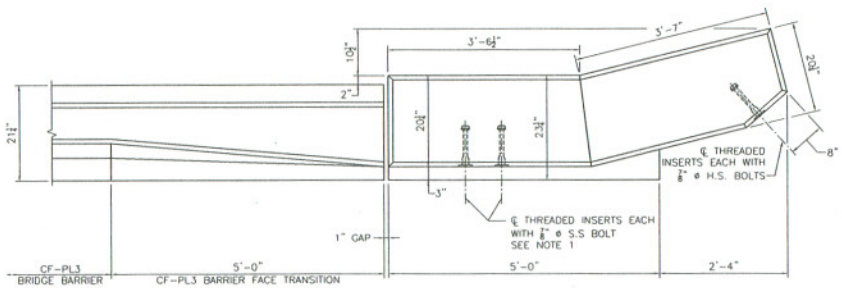
USE ONLY PRINTS OF LATEST DATE

NETC CONCRETE BRIDGE RAIL TO HIGHWAY GUARDRAIL TRANSITION – CF-PL3

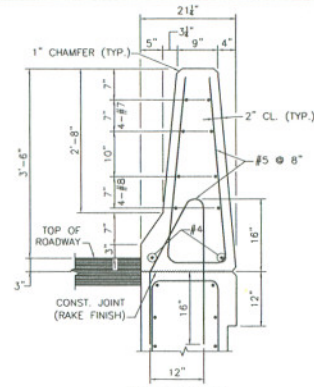
SHEET 5 OF 7 SHEETS BRIDGE NO. X-XX-XXX (XXX)

PRELIMINARY

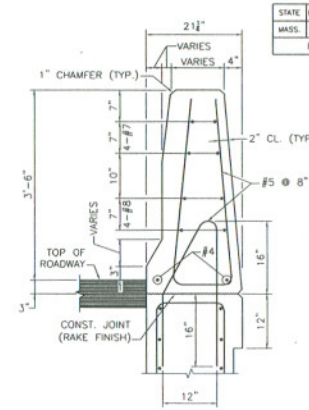
Date: March 11, 2005



PLAN
SCALE: 1" = 1'-0"

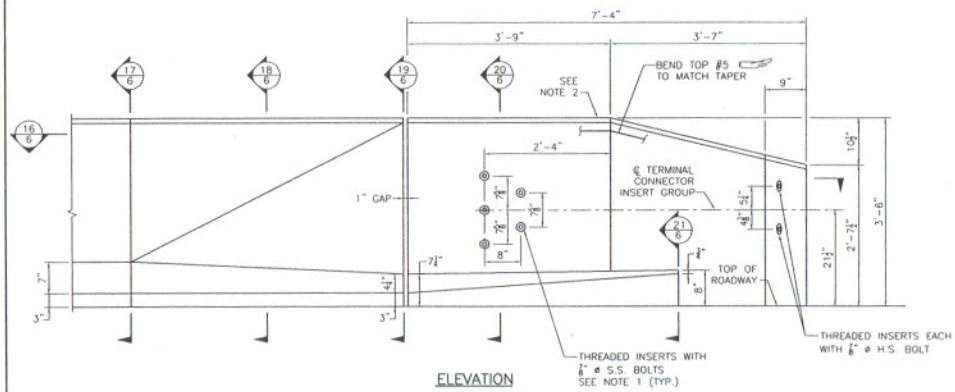


SECTION 17
TYPICAL CF-PL3
SCALE: 1" = 1'-0"

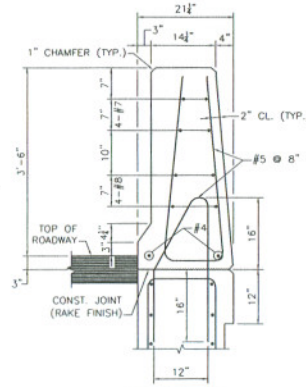


SECTION 18
SCALE: 1" = 1'-0"

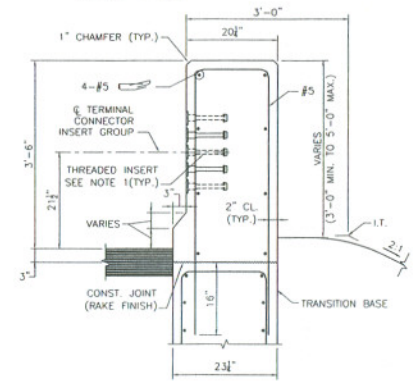
STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
MASS.	XXX-XXXX (XXX)	200X	XX	XX
PROJECT FILE NO. XXXXXX				



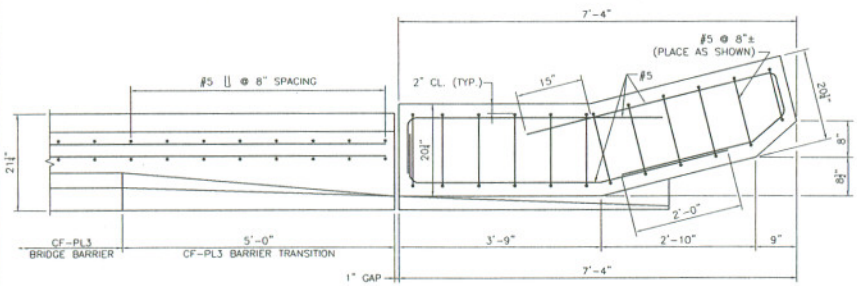
ELEVATION
SCALE: 1" = 1'-0"



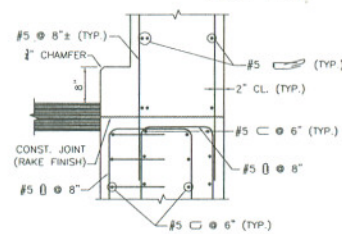
SECTION 19
SCALE: 1" = 1'-0"



SECTION 20
SCALE: 1" = 1'-0"



SECTION 16
SCALE: 1" = 1'-0"



SECTION 21
SCALE: 1" = 1'-0"

NOTES:

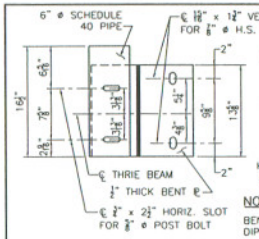
1. THREADED INSERTS SHALL BE PREQUALIFIED BY THE MANUFACTURER AS BEING CAPABLE OF DEVELOPING AN ULTIMATE SHEAR CAPACITY OF 20 KIPS PER 7/8" ø S.S. BOLT. S.S. BOLTS SHALL BE 7/8" ø x 1¾" LONG FULLY THREADED AISI TYPE 304N STAINLESS STEEL. INSERTS FOR 7/8" S.S. BOLTS SHALL BE CAST-IN-PLACE AND GALVANIZED.
2. TOP OF GUARDRAIL TRANSITION SHALL BE SLOPED TO MATCH THE PROFILE GRADE.
3. ALL CONCRETE ABOVE THE CONSTRUCTION JOINT OF THE HIGHWAY GUARDRAIL TRANSITION SHALL BE 5000 PSI, ¾", 685 HP CEMENT CONCRETE.

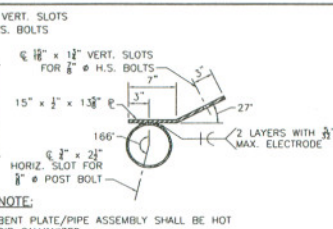
MONTH DD, YYYY	ISSUED FOR CONSTRUCTION
DATE	DESCRIPTION
USE ONLY PRINTS OF LATEST DATE	

NETC CONCRETE BRIDGE RAIL TO HIGHWAY GUARDRAIL TRANSITION – CF-PL3

PRELIMINARY

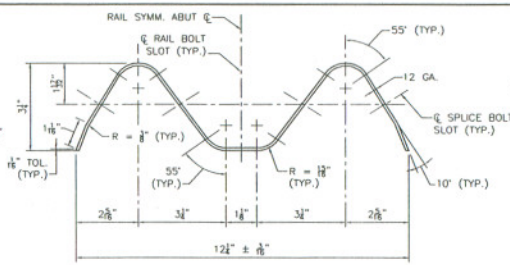
Date: March 11, 2005



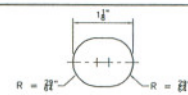


NOTE:
BENT PLATE/PIPE ASSEMBLY SHALL BE HOT DIP GALVANIZED.

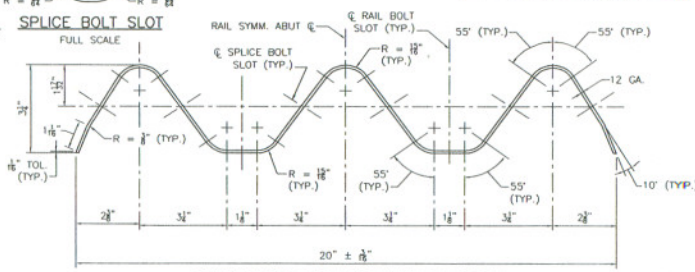
COLLAPSING TUBE ASSEMBLY
SCALE: 1 1/2" = 1'-0"



STEEL W-BEAM HIGHWAY GUARDRAIL
SCALE: 6" = 1'-0"

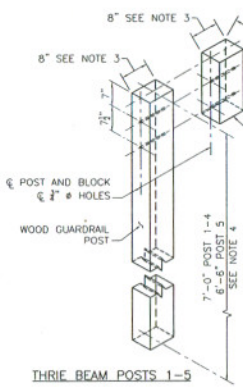


SPLICE BOLT SLOT
FULL SCALE

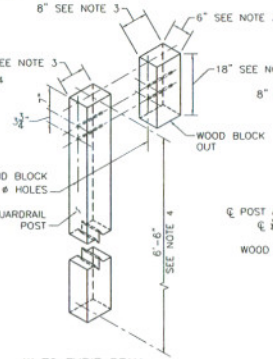


STEEL THRIE BEAM HIGHWAY GUARDRAIL
SCALE: 6" = 1'-0"

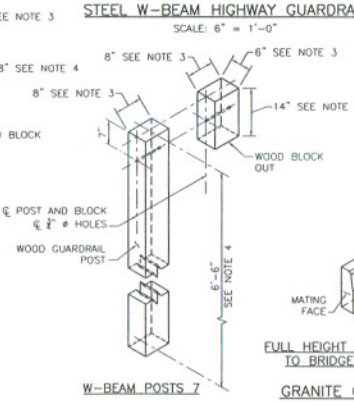
STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
MASS.	XXX-XXXX (XXX)	200X	XX	XX
PROJECT FILE NO. XXXXXX				



THRIE BEAM POSTS 1-5

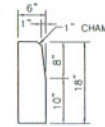


W TO THRIE BEAM TRANSITION POST 6

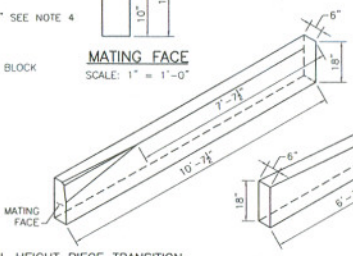


W-BEAM POSTS 7

WOOD POSTS AND BLOCK OUTS
SCALE: 3/4" = 1'-0"



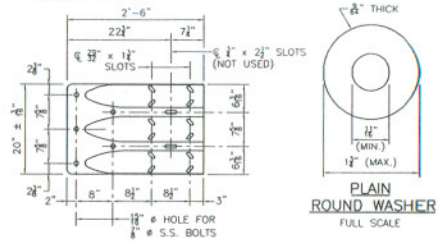
MATING FACE
SCALE: 1" = 1'-0"



FULL HEIGHT PIECE TRANSITION TO BRIDGE SAFETY CURB

VARIABLE HEIGHT PIECE TRANSITION TO TYPE A BERM

GRANITE CURB TYPE VA5 TRANSITION PIECES
SCALE: 1/2" = 1'-0"



TERMINAL CONNECTOR (HWY. ITEM)
SCALE: 1" = 1'-0"

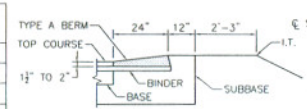
PLAIN ROUND WASHER
FULL SCALE

ITEM	COMP. DESIG.	QTY.	COMMENTS
GRANITE CURB TYPE VA5 AT SAFETY CURB	MHD M9.04.1	16'-10 1/2"	SHAPE AS SHOWN ON PLANS
GRANITE CURB TYPE VA5 AT SIDEWALK	MHD M9.04.1	AS REQ'D	VERTICAL FACE
STEEL W-BEAM HIGHWAY GUARDRAIL	ARTBA RWM02a	X PANL.	12 GA.
STEEL THRIE BEAM HIGHWAY GUARDRAIL	ARTBA RTM04a	2 PANL.	12 GA. CUT ADDIT. SHOTS AS SHOWN
W-BEAM TO THRIE BEAM TRANSITION SECTION	ARTBA RWT01b	1 PANL.	10 GA.
STEEL THRIE BEAM HIGHWAY GUARD RAIL TERMINAL CONNECTOR ATTACHMENT END	ARTBA RTE01b	1 EACH	10 GA.
RAIL BOLTS	MHD M8.07.0 (D)	X EACH	
SPLICE BOLTS	MHD M8.07.0 (D)	X EACH	
7/8" ø STAINLESS STEEL [S.S.] BOLT	AISI TYPE 304N	7 EACH	3/8" ø x 1 3/4" LONG FULLY THREADED FOR GALVANIZED THREADED INSERTS
ROUND WASHERS	ARTBA FWC16a	X EACH	
WOOD POSTS	MHD M8.07.0 (B.2)	X EACH	4 @ 7'-0" LONG, 3 @ 6'-6" LONG
WOOD OFFSET BLOCKS	MHD M8.07.0 (B.2)	X EACH	6 @ 18" LONG, X @ 14" LONG

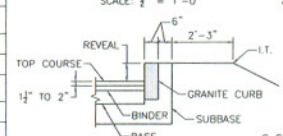
NETC HIGHWAY GUARDRAIL TRANSITION COMPONENT/HARDWARE SCHEDULE

NOTES:
1. ALL STEEL HIGHWAY GUARDRAIL COMPONENTS AND HARDWARE SHALL BE HOT DIP GALVANIZED EXCEPT THE STAINLESS STEEL BOLTS.
2. REFERENCED STANDARDS SHALL BE MODIFIED AS SHOWN ON THESE DRAWINGS.
3. WOOD POSTS AND OFFSET BLOCKS ARE FULL SAWN WITH THE ACTUAL DIMENSIONS INDICATED AND WITH TOLERANCES OF 1/4" IN WIDTH AND THICKNESS.
4. WOOD POSTS SHALL HAVE A TOLERANCE OF 1" ON THE LENGTH. THERE SHALL BE A 1/4" TOLERANCE ON THE LENGTH OF THE WOOD BLOCK OUTS.

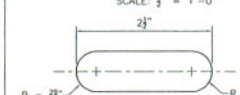
REFERENCE DOCUMENTS:
MHD – MASSACHUSETTS HIGHWAY DEPARTMENT – 1995 STANDARD SPECIFICATIONS FOR HIGHWAY AND BRIDGES.
ARTBA – AASHTO AGC ARTBA JOINT COMMITTEE – 1995 A GUIDE TO STANDARDIZED HIGHWAY BARRIER HARDWARE.
AISI – AMERICAN IRON AND STEEL INSTITUTE.



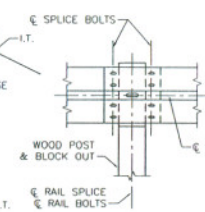
HMA BERM TYPE A TYPICAL INSTALLATION
SCALE: 1/2" = 1'-0"



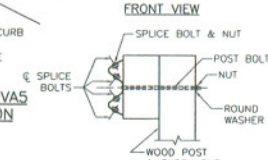
GRANITE CURB TYPE VA5 TYPICAL INSTALLATION
SCALE: 1/2" = 1'-0"



RAIL BOLT SLOT
FULL SCALE



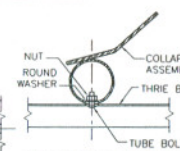
FRONT VIEW



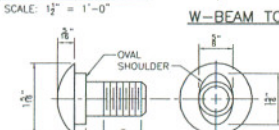
SIDE VIEW

NOTE:
W-BEAM SHOWN – THRIE BEAM SIMILAR.

RAIL ATTACHMENT DETAILS
SCALE: 1" = 1'-0"

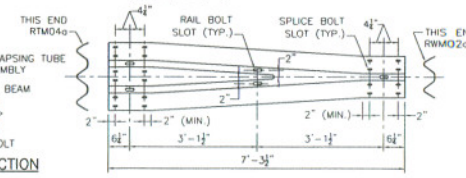


RAIL/TUBE CONNECTION
SCALE: 1 1/2" = 1'-0"

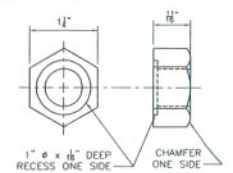


	L	T
RAIL BOLT	18"	2 1/2" (MIN.)
SPLICE BOLT	12" (MIN.)	1 1/2"
TUBE BOLT	2"	1 1/2"

RAIL SPLICE AND TUBE BOLT
FULL SCALE



W-BEAM TO THRIE BEAM TRANSITION SECTION
SCALE: 3/4" = 1'-0"



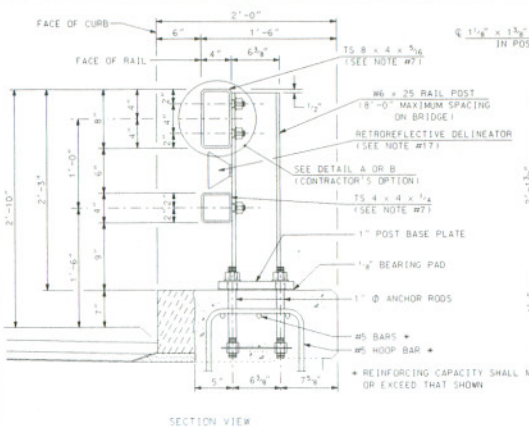
RAIL SPLICE AND TUBE NUT
FULL SCALE

MONTH DD, YYYY	ISSUED FOR CONSTRUCTION
DATE	DESCRIPTION
USE ONLY PRINTS OF LATEST DATE	

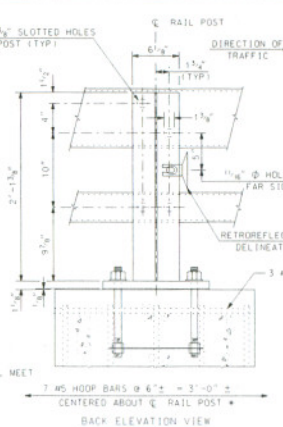
SHEET 7 OF 7 SHEETS BRIDGE NO. X-XX-XXX (XXX)

PRELIMINARY

Date: March 11, 2005

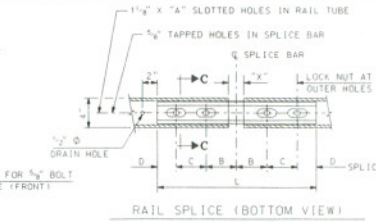


SECTION VIEW

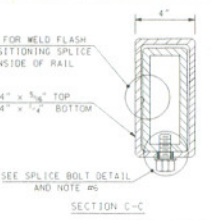


BACK ELEVATION VIEW

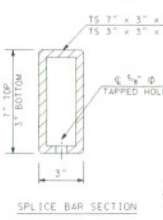
POST ASSEMBLY
SCALE: 1 1/2" = 1'-0"



RAIL SPLICE (BOTTOM VIEW)
SCALE: 1 1/2" = 1'-0"

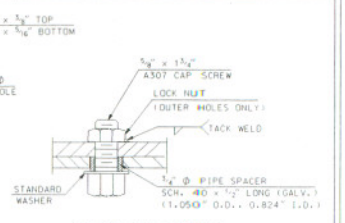


SECTION C-C



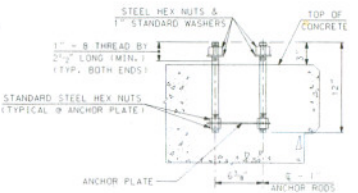
SPLICE BAR SECTION

RAIL SPLICE DETAILS
SCALE: 3" = 1'-0"



SPLICE BOLT DETAIL
SCALE: 6" = 1'-0"

DELINEATOR MOUNTING
N.T.S.



POST ANCHOR ASSEMBLY
SCALE: 1 1/2" = 1'-0"

RAIL NOTES

(1) ITEM 563.22, BRIDGE RAIL T2 (F), SHALL INCLUDE POSTS, BASE PLATES, ANCHOR PLATES, ANCHOR RODS, PREFORMED PADS, RAIL ASSEMBLY BOLTS, NUTS, WASHERS, STUDS, STRUCTURAL TUBING, SPLICE BARS, PIPE SPACERS, ALL APPURTENANCES, AND GALVANIZING.

(2) BRIDGE RAIL POSTS SHALL BE SET NORMAL (90 DEGREES) TO THE PROFILE GRADE, EXCEPT ON GRADES OVER 5% WHERE POSTS SHALL BE SET VERTICAL.

(3) ENDS OF RAIL TUBE SECTIONS SHALL BE SAWED OR MILLED AND SHALL BE TRUE AND SMOOTH. ALL CUT EDGES OF ALL MATERIAL SHALL BE GROUND SMOOTH.

(4) EACH PIECE OF RAIL TUBING SHALL BE ATTACHED TO A MINIMUM OF THREE (3) POSTS.

(5) BOLT HOLES SHALL BE DRILLED OR PUNCHED. FLAME CUTTING MAY BE USED TO FINISH SLOTTED HOLES IF MECHANICALLY GUIDED.

(6) AT INTERIOR SPLICES, PIPE SPACERS SHALL BE USED ON ONLY ONE SIDE OF THE SPLICE TO ALLOW MOVEMENT ON THAT SIDE. THE TOP AND BOTTOM RAIL SHALL RECEIVE THE SAME TREATMENT. AT END SPLICES PIPE SPACERS SHALL BE USED ON BOTH SIDES OF THE SPLICE TO ALLOW MOVEMENT ON EACH SIDE.

(7) MILL OR SHOP TRANSVERSE WELDS SHALL NOT BE PERMITTED ON ANY RAIL ELEMENT. RAIL ELEMENTS USED ON CURVES SHALL USE 5/8" WALL TUBES AND SHALL BE SHOP FORMED TO THE REQUIRED CURVATURE.

(8) NO PUNCHING, DRILLING, CUTTING OR WELDING SHALL BE PERMITTED AFTER GALVANIZING, EXCEPT AS ALLOWED IN DETAILS A AND B, AND FOR INSTALLATION OF DELINEATORS. DAMAGED AREAS OF GALVANIZING SHALL BE THOROUGHLY CLEANED, PRETREATED, AND PAINTED WITH TWO COATS OF ORGANIC ZINC-RICH GALVANIZING REPAIR PAINT, HAVING A MINIMUM 94% ZINC BY WEIGHT, TO A THICKNESS EQUAL TO THE ORIGINAL COATING ACCORDING TO THE STANDARD SPECIFICATIONS AND ASTM A780.

(9) NUTS FOR 1" Ø THREADED ANCHOR RODS CONNECTING THE BASE PLATE TO THE CONCRETE SHALL BE TIGHTENED TO A SNUG FIT AND GIVEN AN ADDITIONAL 1/6 TURN.

(10) THREADS FOR ANCHOR RODS MAY BE ROLLED OR CUT. IF CUT THREADS ARE USED, BOLT DIAMETER SHALL NOT BE LESS THAN NOMINAL DIAMETER. IF ROLLED THREADS ARE USED, ROD DIAMETER SHALL NOT BE LESS THAN ROOT DIAMETER OF THREADS.

MATERIAL NOTES

(11) STRUCTURAL TUBING SHALL CONFORM TO THE REQUIREMENTS OF ASTM A500, GRADE B, STRUCTURAL STEEL TUBING. RAIL TUBING SHALL MEET THE LONGITUDINAL CHARPY V-NOTCH REQUIREMENTS OF 15 FT. LBS. AT 0°F. FOR ASTM A500, GRADE B. THE TEST SAMPLES SHALL BE TAKEN AFTER FORMING THE TUBES. CHARPY V-NOTCH IS NOT REQUIRED FOR SPLICE TUBES.

(12) RAIL POSTS AND BASE PLATES SHALL CONFORM TO THE REQUIREMENTS OF ASTM A572 GR 50. EXCEPT ANCHOR PLATES MAY BE ASTM A36.

(13) THREADED STUDS AND MATCHING NUTS FOR RAIL-TO-POST ATTACHMENT (DETAIL A) SHALL CONFORM TO ASTM A276 TYPE 304, STAINLESS STEEL, AND SHALL BE TORQUE TESTED PER AWS D1.5, 7.7.1. DETAIL B BOLTS SHALL BE ASTM A325 OR A449. ALL OTHER BOLTS AND NUTS SHALL CONFORM TO ASTM A307 AND ASTM A563 GRADE A RESPECTIVELY OR BETTER, EXCEPT THAT ASTM A307 NUTS MAY BE USED ON THE BOTTOM OF ANCHOR ASSEMBLY. WASHERS SHALL BE HARDENED STEEL COMMERCIAL TYPE A PLAIN WIDE WASHERS AND SHALL MEET THE DIMENSIONAL REQUIREMENTS OF A.N.S.I. B18.22. ANCHOR RODS SHALL CONFORM TO ASTM A449.

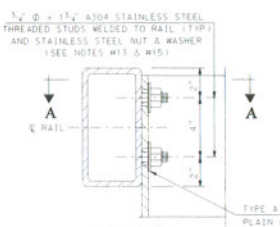
(14) ALL STEEL COMPONENTS (EXCEPT STAINLESS) SHALL BE GALVANIZED AFTER FABRICATION IN CONFORMANCE TO AASHTO M232 (ASTM A153) AND AASHTO M111 (ASTM A123). THE GALVANIZING KETTLE SHALL HAVE 0.05 TO 0.09 PERCENT NICKEL. GALVANIZED SURFACES SHALL HAVE A UNIFORM APPEARANCE AND GALVANIZED MATERIAL SHALL BE PROPERLY STORED. IF PAINTING IS REQUIRED SEE SPECIAL PROVISIONS FOR 708.

(15) DETAIL A STUDS SHALL BE WELDED ON AFTER TUBES ARE GALVANIZED BY SPOT GRINDING OFF GALVANIZING. WELDING ON STUDS, THEN TOUCH UP GALVANING PER NOTE #8 ABOVE.

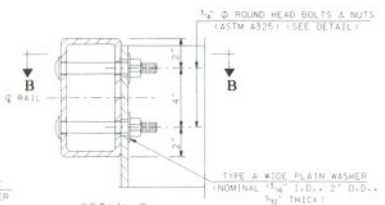
(16) PREFORMED BEARING PADS (1/8" THICK) SHALL CONFORM TO AASHTO M251.

(17) RETROREFLECTIVE DELINEATORS, BOLTS, NUTS, WASHERS AND FIELD DRILLING OF POSTS, INCLUDING GALVANIZING TOUCH-UP, SHALL BE SUBSIDIARY TO ITEM 563.22. SEE STANDARD PLANS FOR ROAD AND BRIDGE CONSTRUCTION 104-11 FOR ADDITIONAL DETAILS AND SPACING.

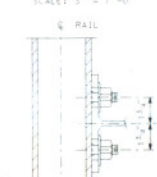
(18) THIS BRIDGE RAIL SYSTEM WAS SUCCESSFULLY CRASH TESTED FOR AASHTO PL2 IN 1994 BY THE NEW ENGLAND TRANSPORTATION CONSORTIUM.



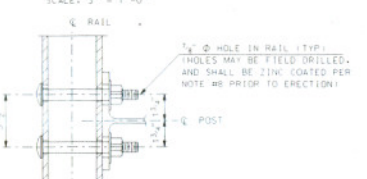
DETAIL A
SCALE: 3" = 1'-0"



DETAIL B
SCALE: 3" = 1'-0"

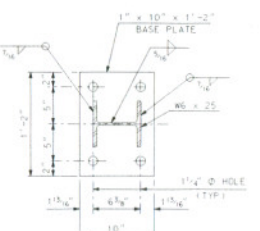


SECTION A-A
SCALE: 3" = 1'-0"

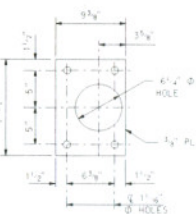


SECTION B-B
SCALE: 3" = 1'-0"

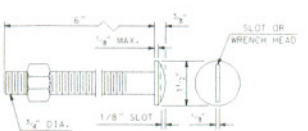
STUD WELD DETAIL
SCALE: 6" = 1'-0"



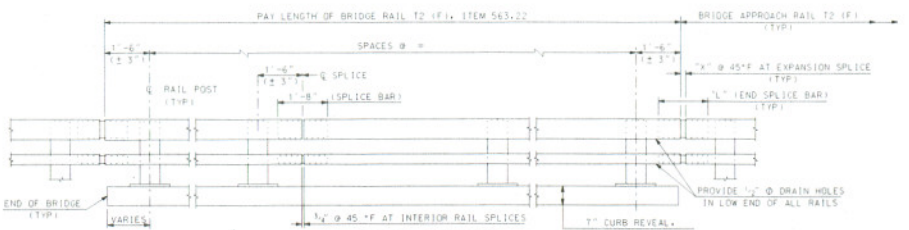
POST BASE PLATE
SCALE: 1 1/2" = 1'-0"



ANCHOR PLATE
SCALE: 1 1/2" = 1'-0"



A325 ROUND HEAD BOLT DETAIL
SCALE: 6" = 1'-0"



RAIL ELEVATION
SCALE: 1/2" = 1'-0"

SPLICE BAR DIMENSION TABLE

	T	A	B	C	D	X	L
	INTERIOR	2 1/2"	4"	4"	2"	3/4"	1'-8"
*	≤ 3 1/4"	2 1/2"	4"	4"	2"	2"	1'-8"
*	3 1/4" < Ts ≤ 5 1/4"	3 1/2"	5"	5"	2 1/2"	3"	2'-1"

T = TOTAL MOVEMENT OF BRIDGE
* = END SPLICE BAR

NETC 4/1/03

SUBDIRECTORY	.DGN LOCATOR	SHEET SCALE
Standards/NETC	T2BR-NETC	AS NOTED

STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION * BUREAU OF BRIDGE DESIGN

TOWN	BRIDGE NO.	STATE PROJECT
LOCATION		

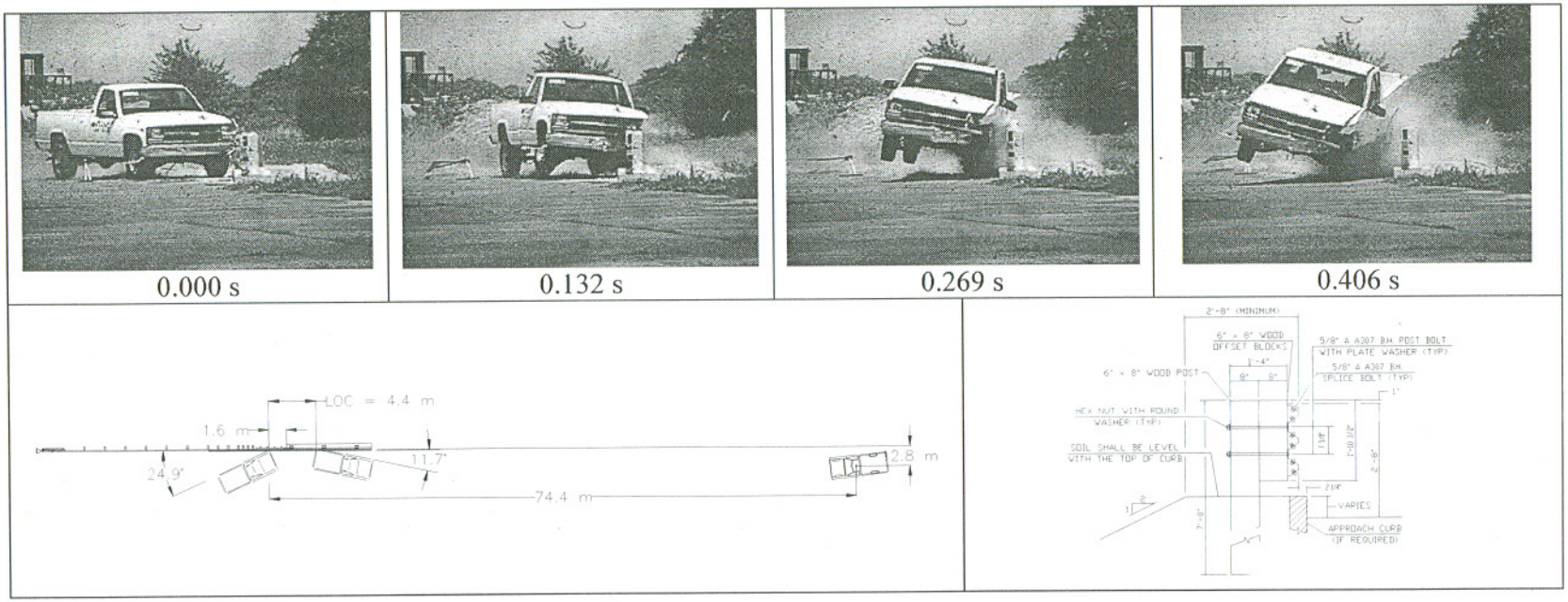
T2 STEEL BRIDGE RAIL (PL2)

BRIDGE SHEET OF

REVISIONS AFTER PROPOSAL	BY	DATE		BY	DATE
	DESIGNED	NETC/JSZ	3/02	CHECKED	NHDOT
	DRAWN	PJP	4/03	CHECKED	JSZ 4/03
	QUANTITIES			CHECKED	
	ISSUE DATE		FEDERAL PROJECT NO.		SHEET NO.
	REV. DATE	4/1/03			

FILE NUMBER

TOTAL SHEETS



General Information
- Test Agency ..... Texas Transportation Institute
- Test No. 401181-1
- Date 04-14-2005

Test Article
- Type ..... Transition
- Name ..... NETC New Hampshire T2 Transition
- Installation Length (m) 21.5
- Material or Key Elements ..... W-beam to symmetric 10 gauge W-beam to thrie-beam transition section, to nested 12 gauge thrie-beam sections, to two tube transition by thrie-beam terminal connector
- **Soil Type and Condition** ..... Standard Soil, Dry

Test Vehicle
- Type ..... Production
- Designation 2000P
- Model ..... 2000 Chevrolet 2500 Pickup
- Mass (kg)
  - Curb 2156
  - Test Inertial 2135
  - Dummy ..... No dummy
  - Gross Static 2135

Impact Conditions
- Speed (km/h) 102.3
- Angle (deg) 24.9

Exit Conditions
- Speed (km/h) 85.1
- Angle (deg) 11.7

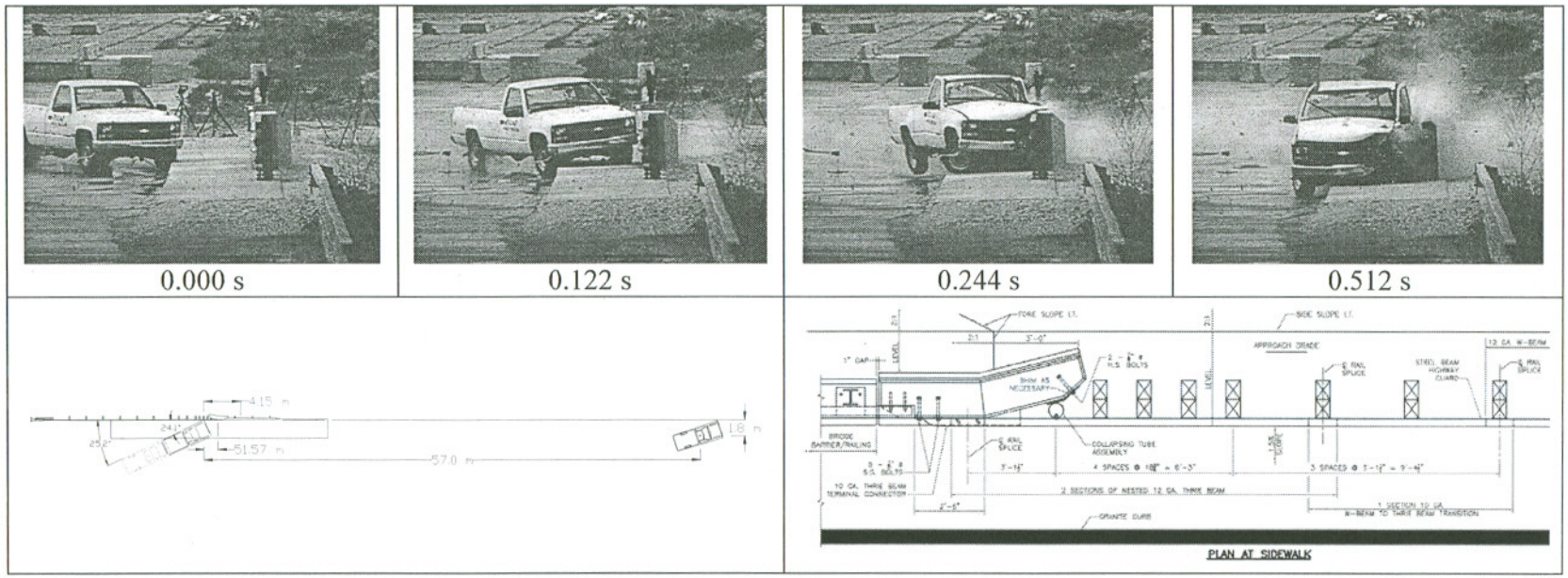
Occupant Risk Values
- Impact Velocity (m/s)
  - Longitudinal 5.2
  - Lateral 7.5
- THIV (km/h) 32.3
- Ridedown Accelerations (g's)
  - Longitudinal ..... -8.3
  - Lateral 10.0
- PHD (g's) 11.9
- ASI 1.74
- Max. 0.050-s Average (g's)
  - Longitudinal ..... -8.1
  - Lateral 13.5
  - Vertical ..... -7.6

Test Article Deflections (m)
- Dynamic 0.20
- Permanent 0.15
- Working Width 0.58

Vehicle Damage
- Exterior
  - VDS 11LFQ3
  - CDC 11FYEW2
  - Max. Exterior Vehicle Crush (mm) 530
- Interior
  - OCDI LF0114000
  - Max. Occupant Compartment Deformation (mm) 44

Post-Impact Behavior
(during 1.0 sec after impact)
- Max. Yaw Angle (deg) 56
- Max. Pitch Angle (deg) ..... -14
- Max. Roll Angle (deg) ..... -19

Summary of results for *NCHRP Report 350* test 3-21 on the New Hampshire transition.

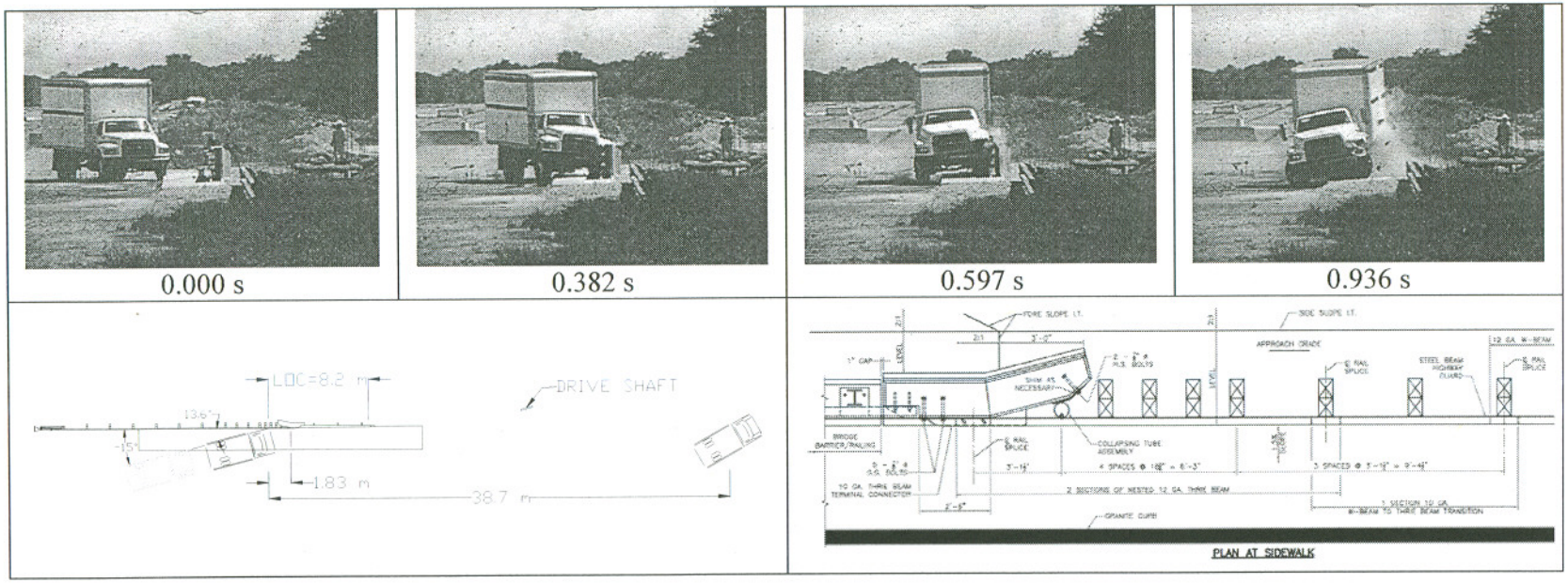


General Information	
Test Agency	Texas Transportation Institute
Test No.	401181-2
Date	04-15-2005
Test Article	
Type	Transition
Name	NETC Massachusetts End Wall Transition
Installation Length (m)	35.0
Material or Key Elements	Nested thrie-beam transition attached to straight portion of concrete transition with thrie-beam end shoe
Soil Type and Condition	Standard Soil, Dry
Test Vehicle	
Type	Production
Designation	2000P
Model	2000 Chevrolet 2500 Pickup
Mass (kg)	
Curb	2217
Test Inertial	2108
Dummy	No dummy
Gross Static	2108

Impact Conditions	
Speed (km/h)	96.9
Angle (deg)	25.2
Exit Conditions	
Speed (km/h)	73.4
Angle (deg)	2.8
Occupant Risk Values	
Impact Velocity (m/s)	
Longitudinal	5.1
Lateral	6.6
THIV (km/h)	29.5
Ridedown Accelerations (g's)	
Longitudinal	-19.3
Lateral	17.4
PHD (g's)	24.3
ASI	1.73
Max. 0.050-s Average (g's)	
Longitudinal	-10.0
Lateral	11.8
Vertical	-7.7

Test Article Deflections (m)	
Dynamic	N/A
Permanent	0.06
Working Width	0.45
Vehicle Damage	
Exterior	
VDS	11LFQ5
CDC	11FLEW3
Max. Exterior Vehicle Crush (mm)	650
Interior	
OCDI	LF0102000
Max. Occupant Compartment Deformation (mm)	104
Post-Impact Behavior	
(during 1.0 sec after impact)	
Max. Yaw Angle (deg)	30
Max. Pitch Angle (deg)	-6
Max. Roll Angle (deg)	16

Summary of results for *NCHRP Report 350* test 4-21 on the Massachusetts transition.



General Information

Test Agency	Texas Transportation Institute
Test No.	401181-3
Date	04-27-2005

Test Article

Type	Transition
Name	NETC Massachusetts End Wall Transition
Installation Length (m)	35.0
Material or Key Elements	Nested thrie-beam transition attached to straight portion of concrete transition with thrie-beam end shoe
Soil Type and Condition	Standard Soil, Dry

Test Vehicle

Type	Production
Designation	8000S
Model	1996 Ford F800 Single-Unit Truck
Mass (kg)	
Curb	5420
Test Inertial	8106
Gross Static	8106

Impact Conditions

Speed (km/h)	80.8
Angle (deg)	13.6

Exit Conditions

Speed (km/h)	N/A
Angle (deg)	1.8

Occupant Risk Values

Impact Velocity (m/s)	
Longitudinal	2.5
Lateral	3.0
THIV (km/h)	13.1
Ridedown Accelerations (g's)	
Longitudinal	-4.5
Lateral	7.4
PHD (g's)	7.4
ASI	0.34
Max. 0.050-s Average (g's)	
Longitudinal	-2.2
Lateral	2.7
Vertical	-2.9

Test Article Deflections (m)

Dynamic	N/A
Permanent	0.18
Working Width	N/A

Vehicle Damage

Exterior	
VDS	N/A
CDC	11FYEW5
Max. Exterior	
Vehicle Crush (mm)	530

Post-Impact Behavior

(during 1.0 sec after impact)	
Max. Yaw Angle (deg)	19
Max. Pitch Angle (deg)	3
Max. Roll Angle (deg)	12

Summary of results for *NCHRP Report 350* test 4-22 on the Massachusetts transition.