U.S. Department of Transportation
Federal Highway Administration

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

May 18, 2010

In Reply Refer To:
HSSD/CC-107

Mr. Pratip Lahiri
Specifications and Standards Section, POD 23
New York State Department of Transportation
50 Wolf Road
Albany, New York 12232

Dear Mr. Lahiri:

This letter is in response to your request for the Federal Highway Administrations (FHWA) acceptance of a roadside safety system for use on the National Highway System (NHS).

Name of system:	Type IIA Box Beam End Terminal
Type of system:	End Terminal
Test Level:	Modified MASH TL-3
Testing conducted by:	Midwest Roadside Safety Facility
Date of request:	November 10, 2009
Date of completed package:	April 13, 2010
Request initially acknowledged:	November 19, 2009

You requested that we find this system acceptable for use on the NHS under the provisions of the American Association of State Highway and Transportation Officials (AASHTO) Manual for Assessing Safety hardware (MASH).

Requirements
Roadside safety devices should meet the guidelines contained in the AASHTO MASH. The FHWA Memorandum "Identifying Acceptable Highway Safety Features" of July 25, 1997, provides further guidance on crash testing requirements of longitudinal barriers.

Description
The subject Type IIA End Terminal is a re-directive gating end terminal which is used with the New York State generic box beam guiderail (6 in. x 6 in. x 3/16 in. steel tube box beam). The cross section of the end terminal is identical to the generic box beam. The effective length of the Type IIA end terminal is 25 ft., 4 in., which includes a 17 ft., 11 7/8 in. shop-curved section and

8 ft., 3 1/16 in. straight section. The curved section has a radius of 35 ft. and 43 inches of the leading end of the straight section is turned down at a 1:2 slope. The end terminal requires 8 posts which are spaced approximately 3 ft. apart. Enclosure 1 shows the general layout of the New York State DOT Type IIA and details of each component.

Crash Testing

According to MASH, test 3-30 through test 3-38 are to be conducted for end terminals. The point of impact in tests 3-30, 3-31, 3-32, and 3-33 are the face of the ramped part of the end terminal. However, New York State Department of Transportation's (NYSDOT) intention is to utilize the Type IIA End Terminal at locations where the available clear zone is limited to less than 5 feet behind the leading end of the terminal (e.g., relatively tight radius driveways). Due to the flared design of the end terminal, it is unlikely that a vehicle can collide with the face of the ramped part of the system. Even if such a collision occurs and the vehicle is not contained, the vehicle will enter the hazard free area. Consequently, we agree that these four tests can be waived if the end terminal is properly installed and its use is confined to locations described.

Different variations of the Type IIA end terminal were crash tested by the Midwest Roadside Safety Facility. The variation described above and shown in Enclosure 1 was crash tested according to MASH test 3-34. The test article passed the test. Enclosure 2 shows a summary of the test results.

The point of impact for Test 3-34 is the Critical Impact Point (CIP). By definition, the CIP is where the behavior of the test article changes from redirecting the impacting vehicle to either capturing the vehicle or allowing it to gate through the system. Normally the CIP is determined through detailed analysis of the end terminal or use of relevant computer programs. However, in the test conducted, the CIP was assumed and then verified by a full scale crash test.

Test 3-35 was conducted on a variation of the final Type IIA End Terminal and the test article passed the test (Enclosure 3). The difference between this test article and the final Type IIA end terminal is that post 2 and 4 were moved to the back side of the rail for the final Type IIA End Terminal. This change is not expected to have a significant effect on the performance of the terminal and we concur that the final design would also be expected to pass the test.

A modified version of test 3-35 was also conducted on the end terminal described above because the NYSDOT staff considered the modified test more critical than the test recommended in MASH due to the fact that the end terminal is flared back rather than straight. The difference between the modified 3-35 and MASH 3-35 is the point of impact. In the former, the point of impact was upstream of the beginning of Length of Need (LON) (the fifth post in Enclosure 1) and in the latter it was the beginning of LON. The test article passed the test and Enclosure 4 summarizes the test results.

Test 3-36 is required where the end terminal is attached to rigid barriers or other very stiff features. As long as the Type IIA End Terminal is used with the New York State generic box beam guiderail, this test is not applicable.

Test 3-37 is to examine the behavior of the end terminal during reverse direction impact. This test was not performed. The reason for this is that the device is not intended to be utilized in a location that can result in a reverse direction impact. This acceptance letter is provided with recognition that the described Type IIA End Terminal cannot be installed in locations where there is a potential for reverse direction impacts to encounter the flared /curved portion of the end terminal, such as a median.

Test 3-38 is not required because the subject end terminal does not possess significant attenuation capability.

Findings
The system described above and detailed in the enclosed drawings is acceptable for use on the NHS under the range of conditions tested, when such use is acceptable to a highway agency, and when installed in a manner consistent with the following limitations:

1) The Type IIA End Terminal is limited to locations where the available clear zone is less than 5 feet behind the leading end of the terminal (e.g., relatively tight radius driveways).

2) The Type IIA End Terminal cannot be extended beyond an abrupt shoulder break such as a ditch because there is a higher potential for underride in such circumstances.

3) Because the Type IIA End Terminal was subjected to a reduced MASH test matrix, the use of these terminals should be supervised to ensure that they are not being placed in inappropriate locations. Also, installations shall be monitored to ensure that in-service performance results in improved crash behavior compared to box beam guiderail terminals currently in use.

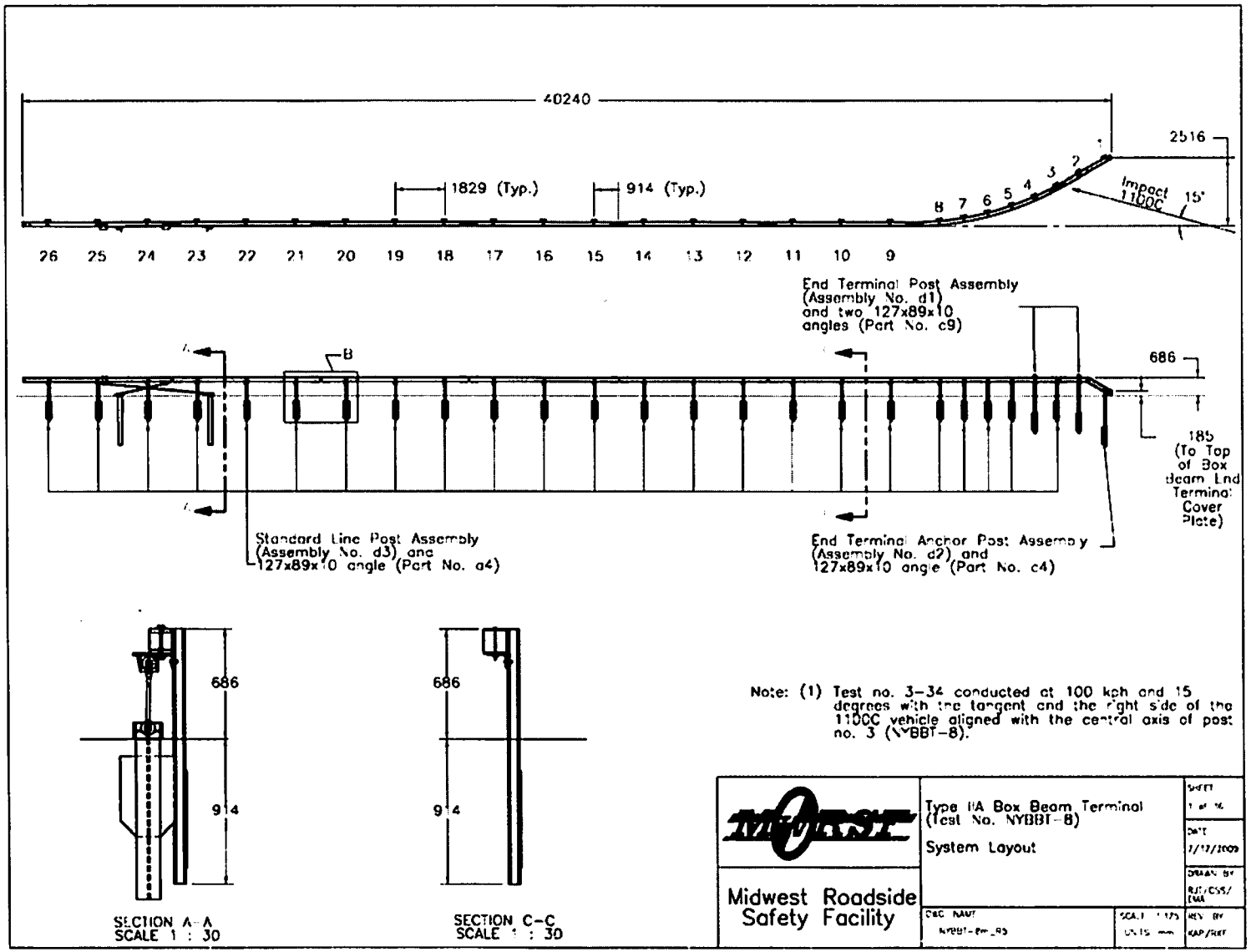
Please note the following standard provisions that apply to FHWA letters of acceptance:

- This acceptance is limited to the crashworthiness characteristics of the systems and does not cover their structural features, or 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 CC-107 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.

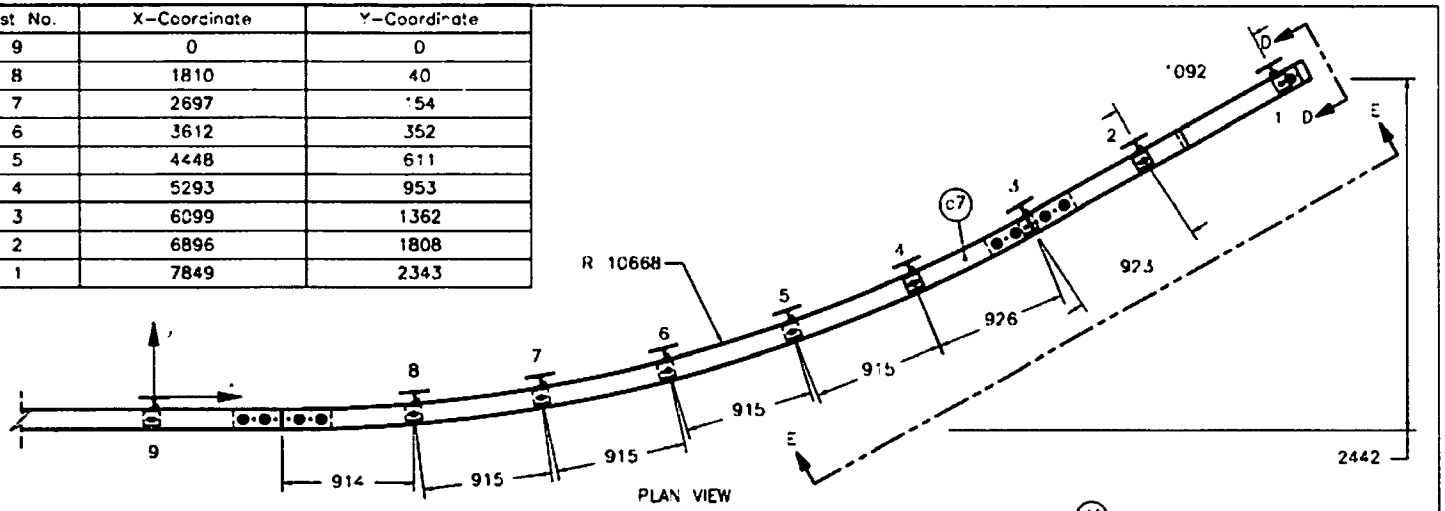
Sincerely yours,

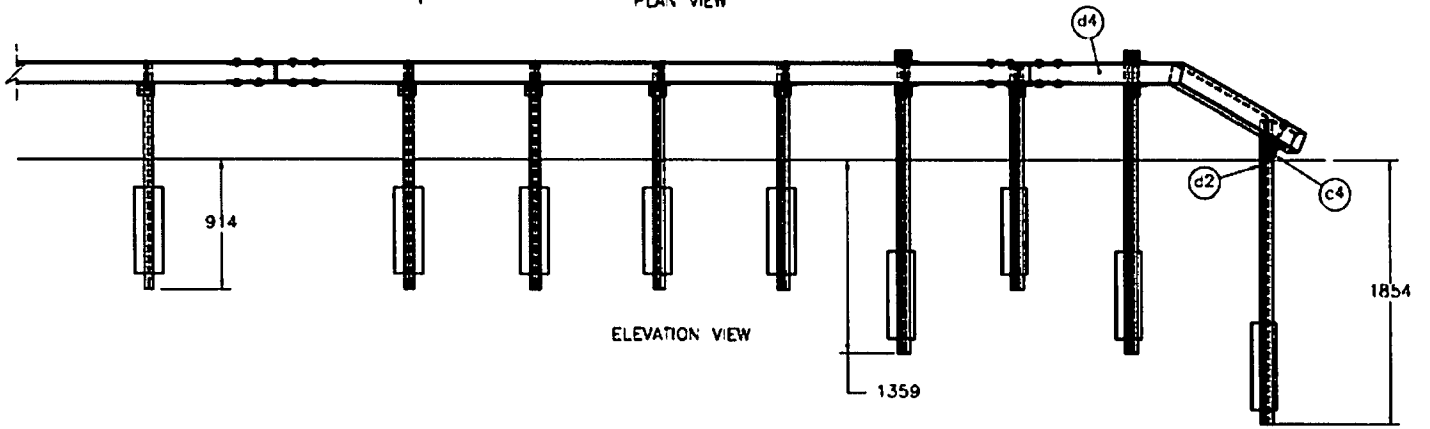
David A. Nicol, P.E.
Director, Office of Safety Design
Office of Safety



Enclosure 1: Type IIA Box Beam Terminal System Details

Post No.	X-Coordinate	Y-Coordinate
9	0	0
8	1810	40
7	2697	154
6	3612	352
5	4448	611
4	5293	953
3	6099	1362
2	6896	1808
1	7849	2343





Note: (1) All coordinates dimensioned from the centerline of post no. 9 to the centerline of each post.

Midwest Roadside Safety Facility

Type IIA Box Beam Terminal (Test No. NYBBT-8)

End Assembly

SHEET: 2 of 16

DATE: 7/17/2009

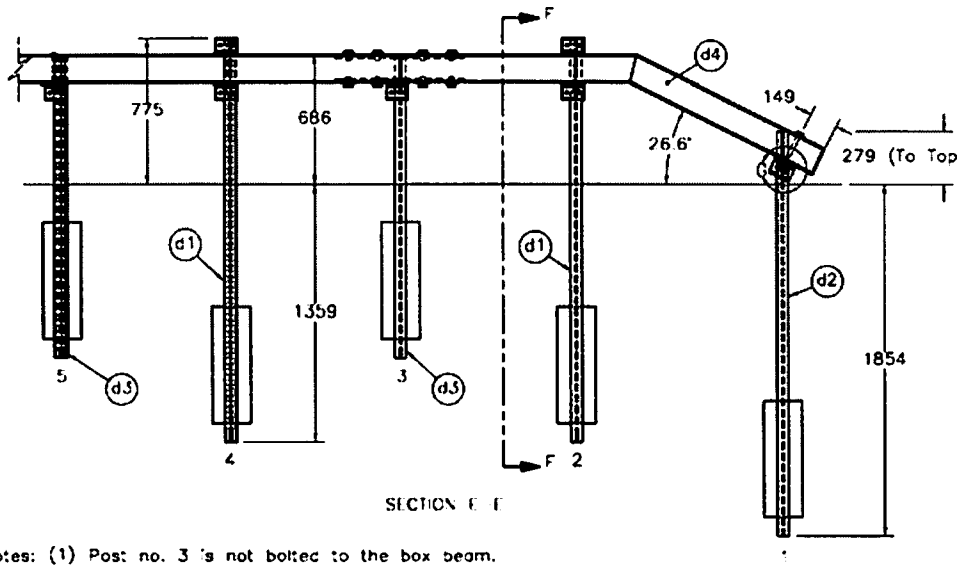
DRAWN BY: RJT/CSS/EMK

REV BY: KAP/tkf

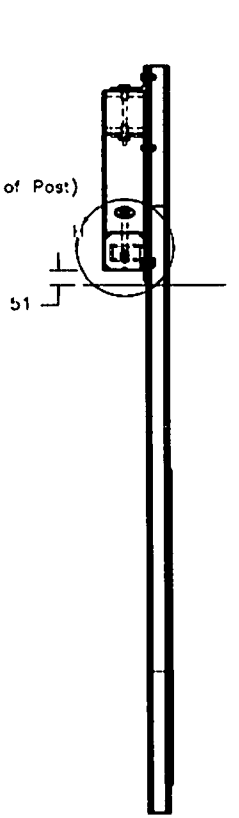
DWG NAME: NYBBT-8m_R5

SCALE: 1:40

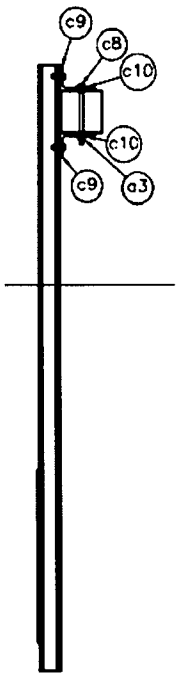
UNITS: mm



SECTION F-F



SECTION D-D
SCALE 1 : 20



SECTION E-E
SCALE 1 : 20

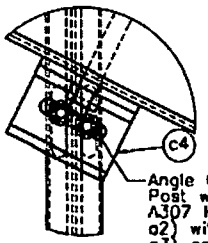
Notes: (1) Post no. 3 is not bolted to the box beam.

(2) Section view D-D encompasses the end terminal section only up to the first splice.

(3) Section view F-F extends 6'0 and only provides details for post no. 2.

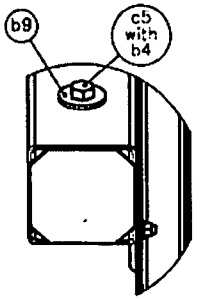
(4) Post components and hardware in Section view F-F pertain to post nos. 2 and 4.

(5) Ground line not shown in Detail G for clarity.



Angle Clip Connected to Post with Two M12x41 ASTM A307 Hex Bolts (Part No. a2) with One Nut (Part No. a3) and Two Washers (Part No. a5) Per Bolt

DETAIL G
SCALE 1 : 6



DETAIL H
SCALE 1 : 8

Midwest Roadside Safety Facility

Type IIA Box Beam Terminal (Test No. NYBBT-8)

End Section - Non-Ditch Detail

SHEET: 3 of 16

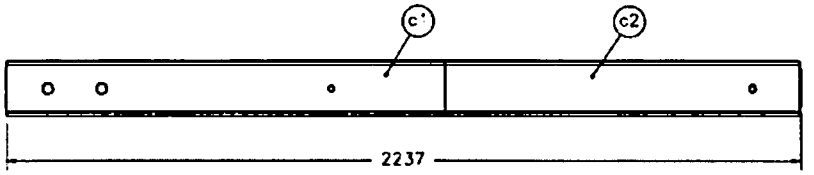
DATE: 7/17/2009

DRAWN BY: RJF/CSS/EMA

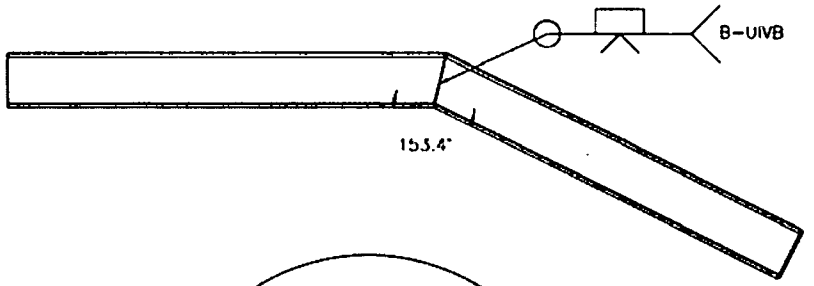
REV BY: KAP/RWF

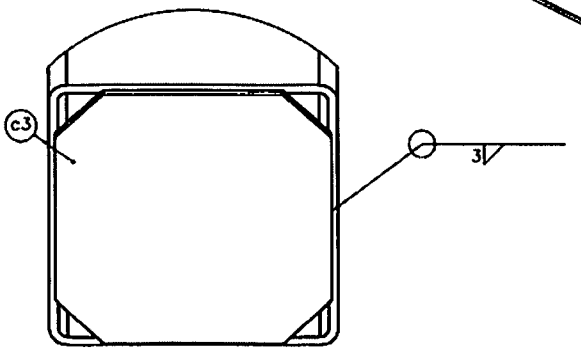
DWG NAME: NYBBT-8m_R3

SCALE: 1:30 (ANSI mm)

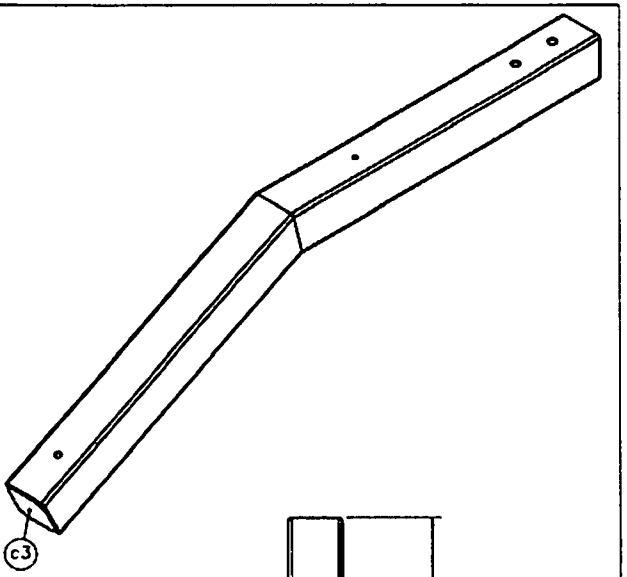


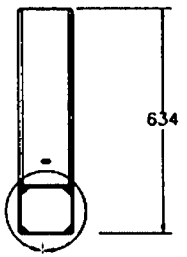
Box Beam End Terminal Assembly
Assembly d4





DETAIL 1
SCALE 1 : 3





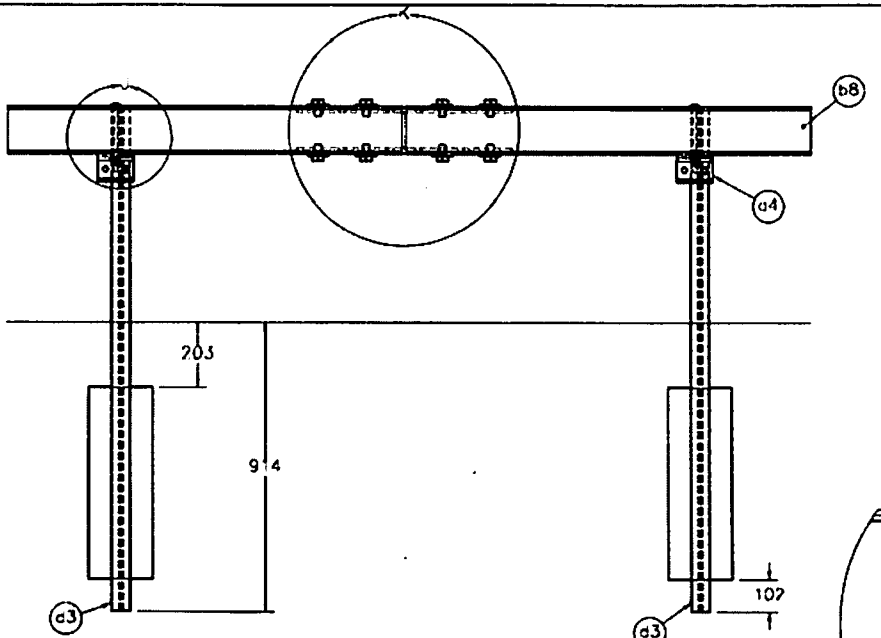
Midwest Roadside Safety Facility

Type IIA Box Beam Terminal
(Test No. NYBBT-8)

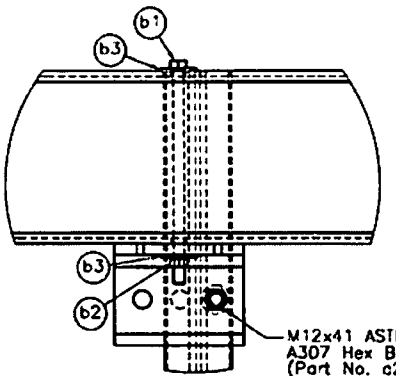
Bent Box Beam Assembly

SHEET: 4 of 16
DATE: 7/17/2009
DRAWN BY: RJT/CSS/LMA
REV BY: KAP/RKF
DOC. NAME: NYBBT-Bm_B5
SCALE: 1:16
UNITS: mm

December 23, 2009
MwRSF Report No. TRP-03-203-09

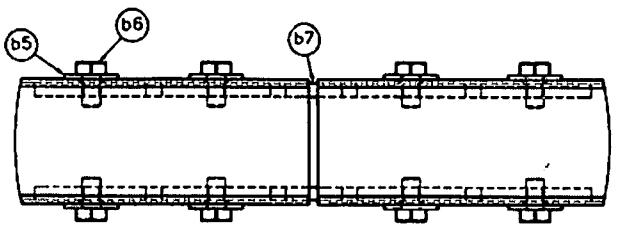


DETAIL B



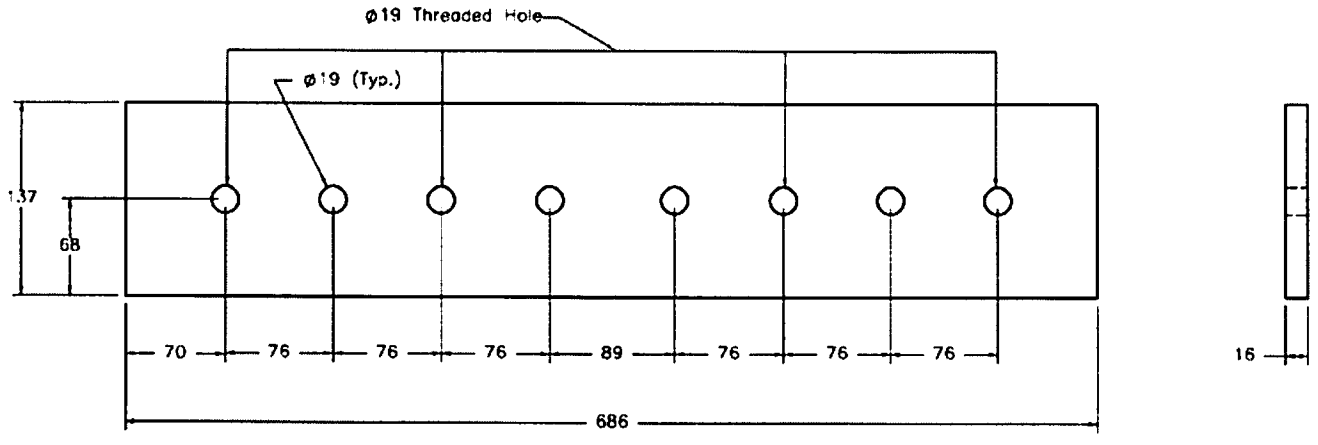
M12x41 ASTM A307 Hex Bolt (Part No. a2) with M12 Narrow Washer (Part No. a5) and Hex Nut (Part No. a3)

DETAIL J
SCALE 1 : 5

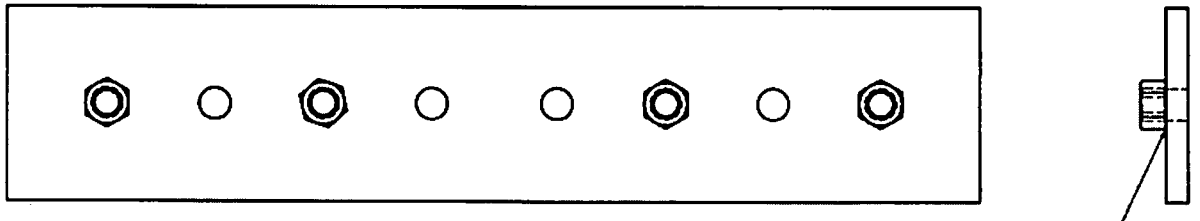


DETAIL K
SCALE 1 : 7
Traffic-Side View

Midwest Roadside Safety Facility	Type IIA Box Beam Terminal (Test No. NYBBT-B) Splice Specifications	SHEET 5 of 16
		DATE 7/17/2009
		DRAWN BY RJF/CSS/TMA
	DWG NAME NYBBT-Bm_R5 SCALE 1:15 UNITS mm	REV BY KAP/RKF



Splice Plate with Tapped Holes
Part b7



Splice Plate with Tack-Welded Nuts

Tack Weld All Nuts to Splice Plates Prior to Assembly

Note: (1) Splice plates with tack-welded nuts may be substituted for the splice plate with tapped holes.

Midwest Roadside Safety Facility

Type IIA Box Beam Terminal (Test No. NYBBT-B)

Splice Plate Details

SHEET 6 of 16

DATE 7/17/2009

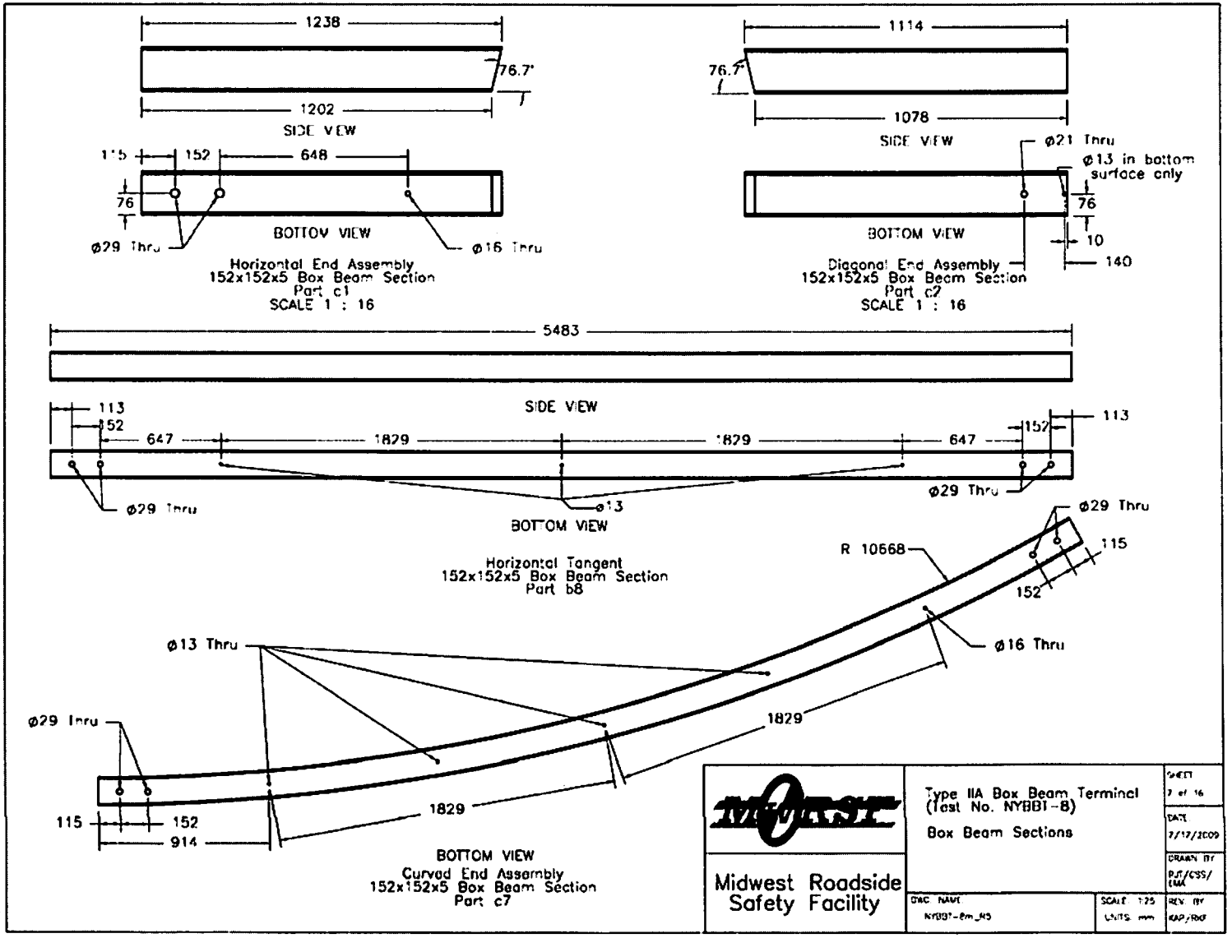
DRAWN BY RJF/CSS/EMA

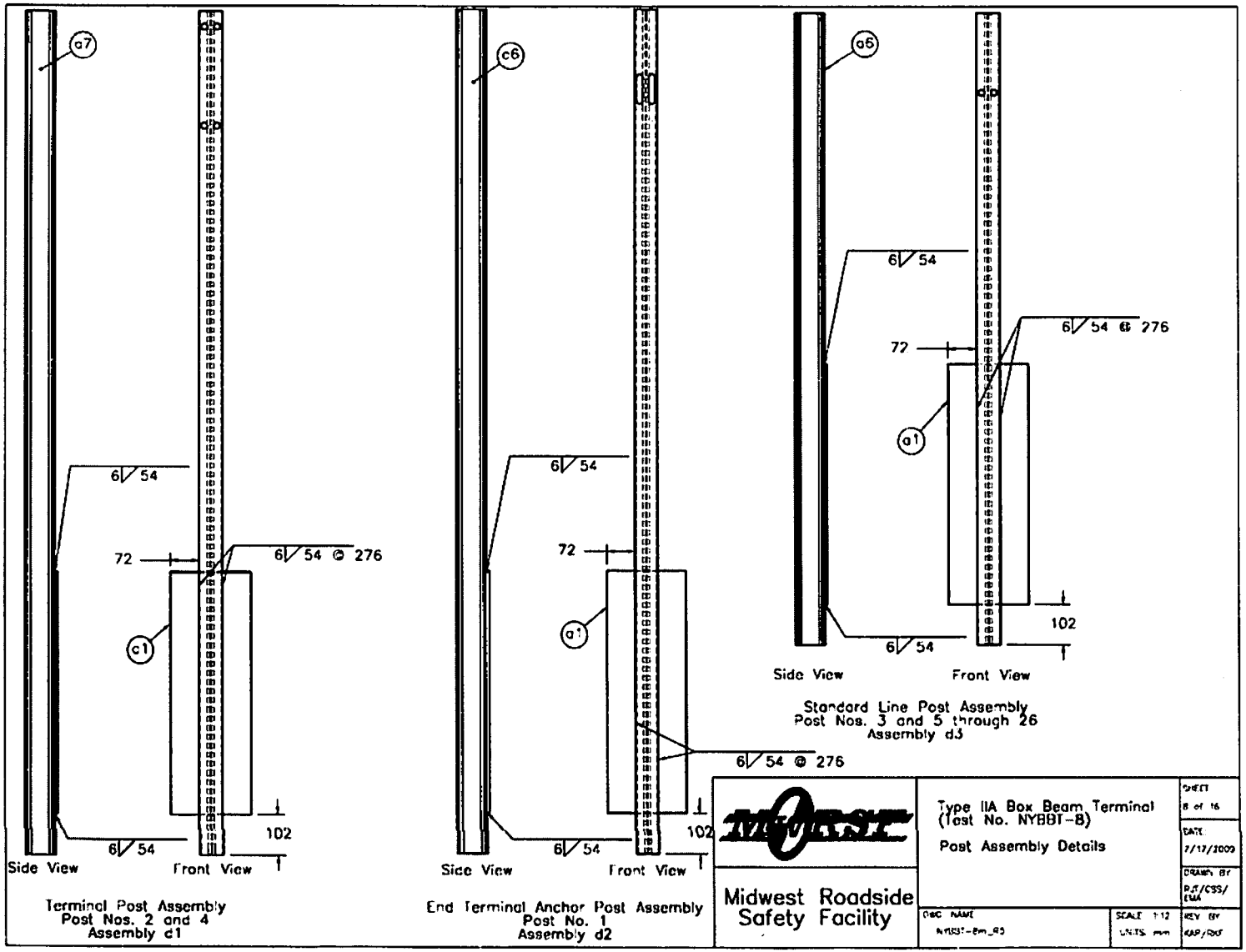
DWG NAME NYBBT-6m_M5

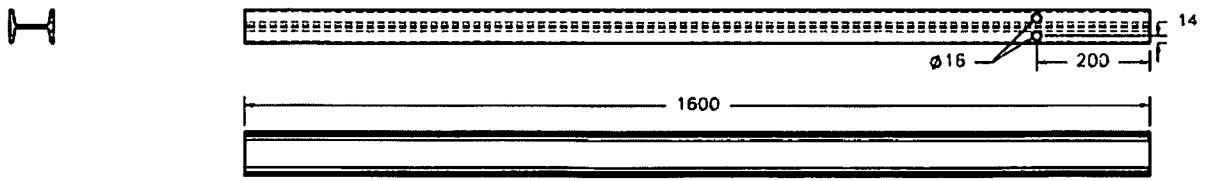
SCALE: 1:4

UNITS: mm

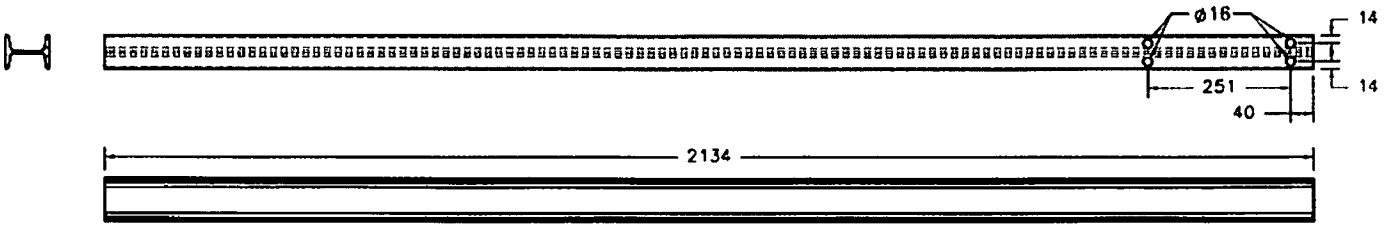
REV BY dAP/RKF


1238
76.7°
1202
SIDE VIEW
115
152
648
76
BOTTOV VIEW
ø29 Thru
ø16 Thru
Horizontal End Assembly
152x152x5 Box Beam Section
Part c1
SCALE 1 : 16
1114
76.7°
1078
SIDE VIEW
ø21 Thru
ø13 in bottom surface only
76
BOTTOM VIEW
10
140
Diagonal End Assembly
152x152x5 Box Beam Section
Part c2
SCALE 1 : 16
5483
SIDE VIEW
113
152
647
1829
1829
647
152
113
ø29 Thru
ø13
ø29 Thru
BOTTOM VIEW
Horizontal Tangent
152x152x5 Box Beam Section
Part b8
ø29 Thru
R 10668
115
152
ø13 Thru
ø16 Thru
ø29 Thru
1829
1829
115
152
914
BOTTOM VIEW
Curved End Assembly
152x152x5 Box Beam Section
Part c7
Midwest Roadside Safety Facility
Type IIA Box Beam Terminal
(Test No. NYBBT-8)
Box Beam Sections
SHEET
7 of 16
DATE
7/17/2009
DRAWN BY
PJT/CSS/
EMK
DWG NAME
NYBBT-8m_M5
SCALE 1:25
UNITS mm
REV BY
KAP/RKF

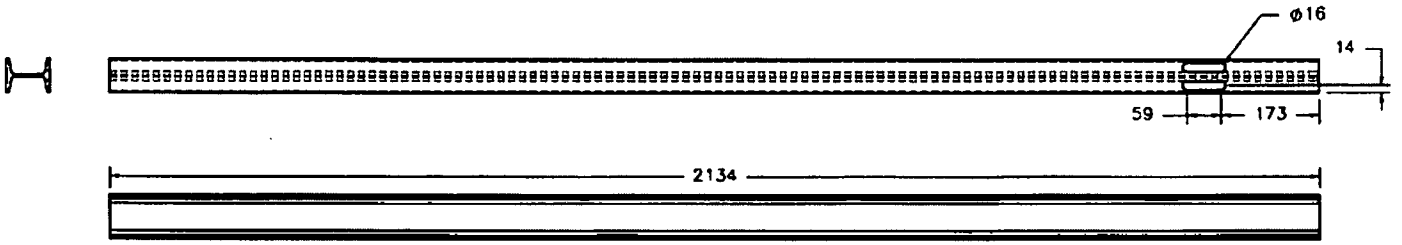

a7
6/54
72
6/54 @ 276
c1
102
6/54
Side View
Front View
Terminal Post Assembly
Post Nos. 2 and 4
Assembly c1
c6
6/54
72
a1
6/54 @ 276
102
6/54
Side View
Front View
End Terminal Anchor Post Assembly
Post No. 1
Assembly d2
a5
6/54
72
6/54 @ 276
a1
102
6/54
Side View
Front View
Standard Line Post Assembly
Post Nos. 3 and 5 through 26
Assembly d3
Midwest Roadside Safety Facility
Type IIA Box Beam Terminal
(Test No. NYBBT-8)
Post Assembly Details
SHEET
8 of 16
DATE
7/17/2009
DRAWN BY
RJT/CSS/EMA
DWG NAME
NYBBT-8m_R5
SCALE 1:12
UNITS mm
REV BY
KAP/RJT



S76x8.5 Line Post without Soil Plate
Part a6



S76x8.5 Post Nos. 2 and 4 without Soil Plate
Part a7



S76x8.5 Anchor Post without Soil Plate
Part a6

Midwest Roadside Safety Facility

Type IIA Box Beam Terminal (Test No. NYBBT-8)

General Post Details without Soil Plates

SHEET: 9 of 16

DATE: 7/17/2009

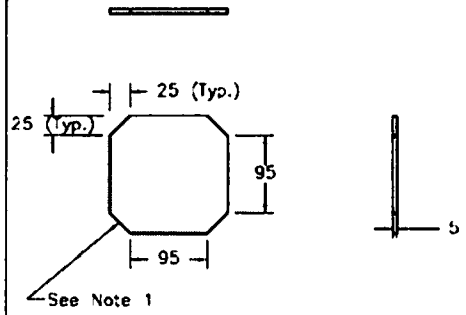
DRAWN BY: PJF/CSS/EMA

DWG NAME: NYBBT-Bm_R5

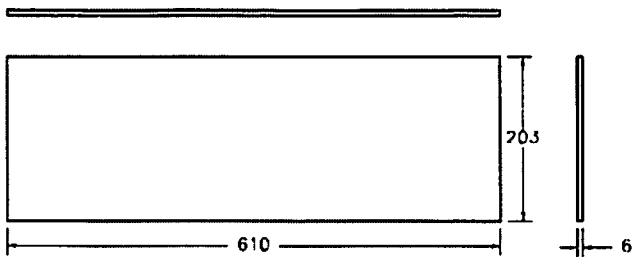
SCALE: 1:10

UNITS: mm

REV BY: KAP/RKF

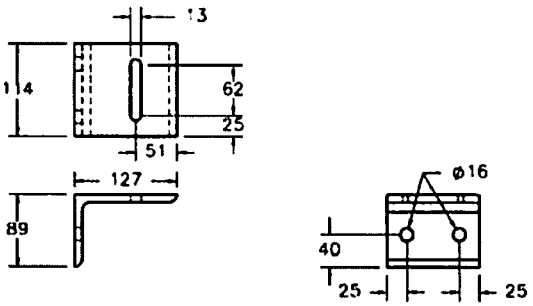


End Assembly Cover Plate
Part c3

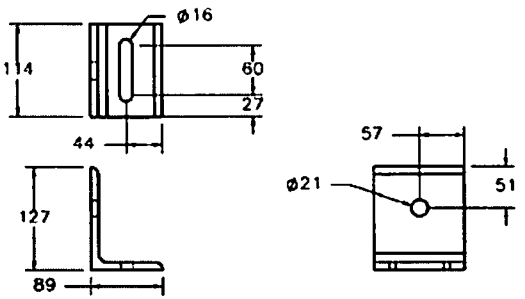


Soil Plate
Part a1

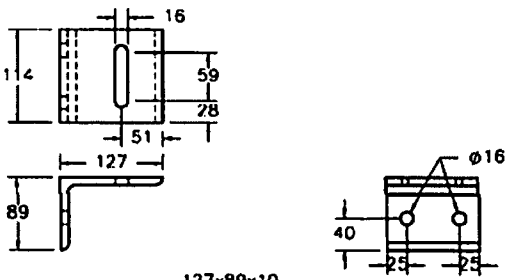
Note: (1) Corners of cover plate may be chamfered to assist drainage.



127x89x10
Box Beam Shelf Angle – Post Nos. 3 and 5 through 26
Part a4



127x89x10
End Assembly Box Beam Shelf Angle
Part c4

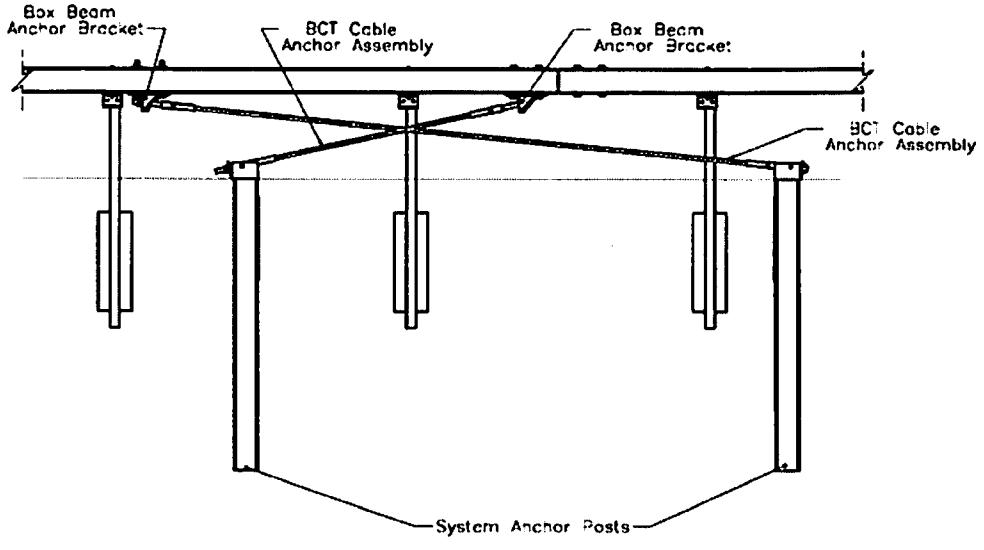


127x89x10
Box Beam Shelf Angle – Post Nos. 2 and 4
Part c9

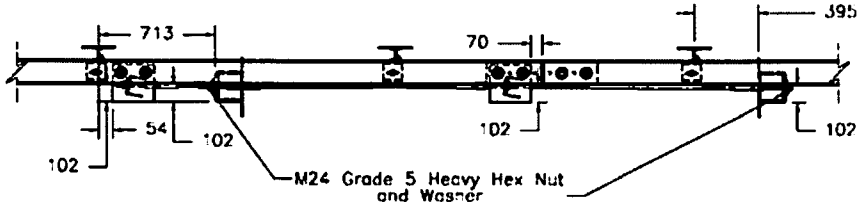
Midwest Roadside Safety Facility

Type IIA Box Beam Terminal
(Test No. NYBBT-8)
Terminal Component Details

SHEET: 10 of 10
DATE: 7/17/2009
DRAWN BY: P.F./CSS/EMA
DGC NAME: NYBBT-8m_R5
SCALE: 1:7
UNITS: mm
REV BY: KAP/RKF



ELEVATION VIEW



PLAN VIEW

Midwest Roadside Safety Facility

Type IIA Box Beam Terminal
(Test No. NYBBT-B)

Downstream Anchorage Systems

SHEET 11 of 16

DATE 7/17/2009

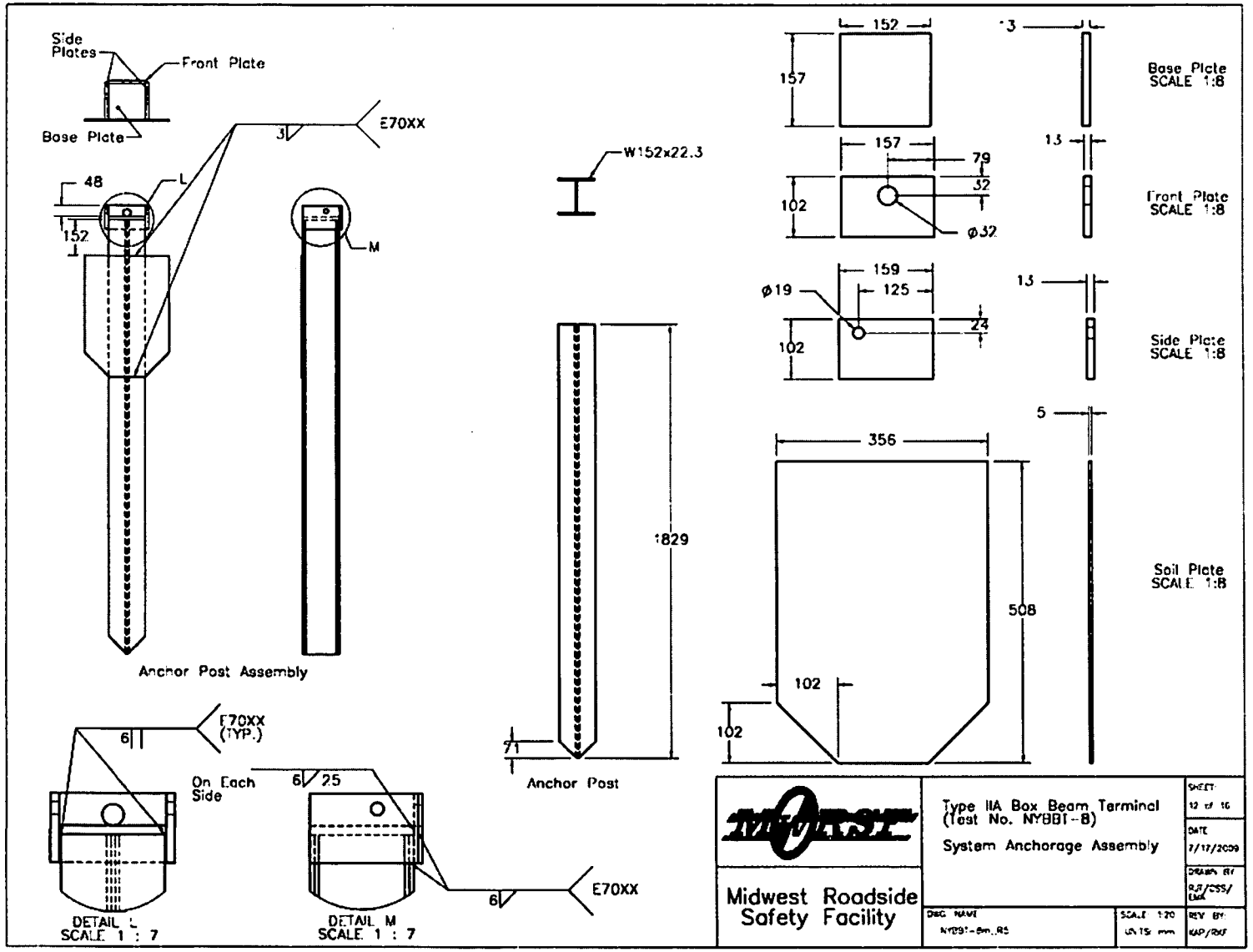
DRAWN BY PJT/CSS/EMA

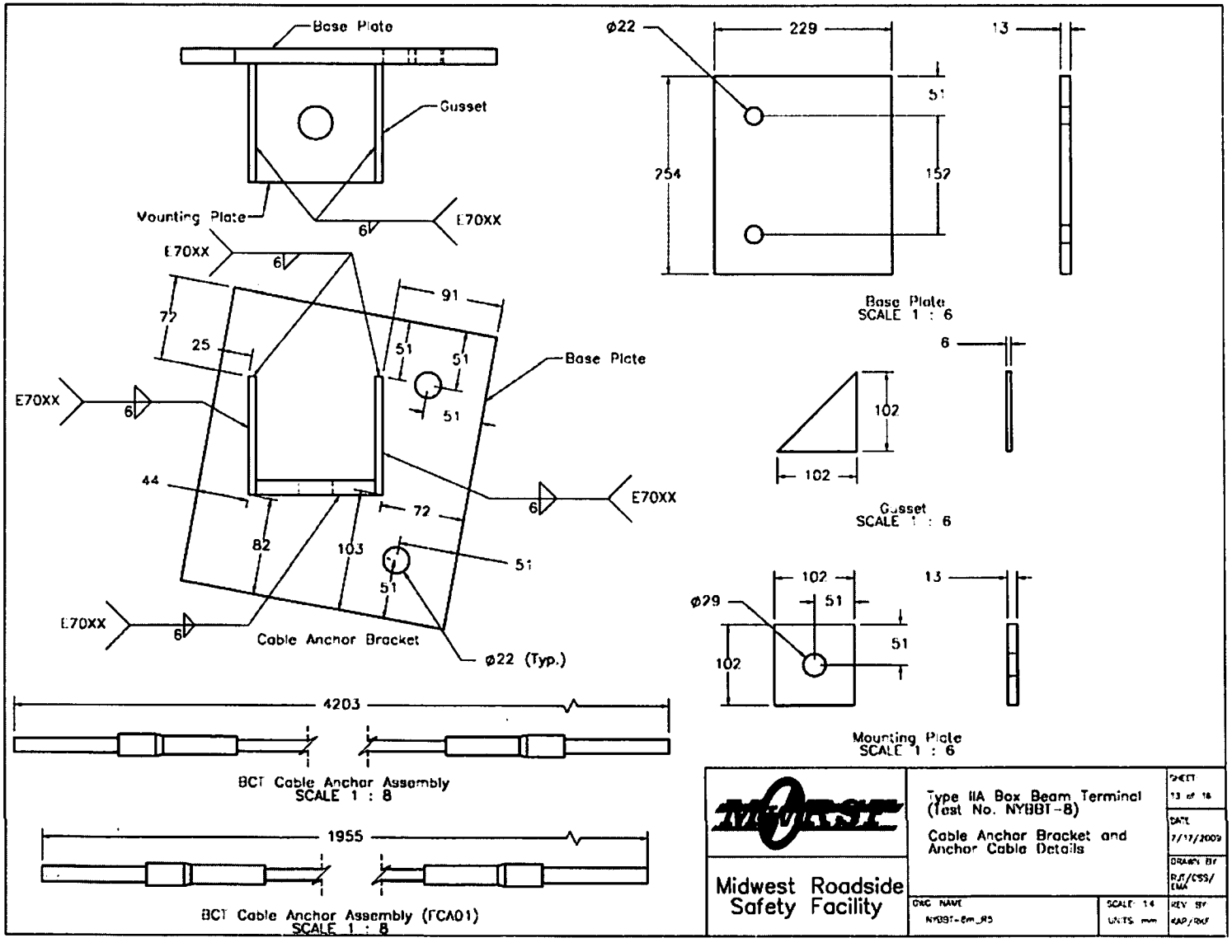
DGN NAME NYBBT-Bm_R5

SCALE 1:35

UNITS mm

REV BY KRP/RKF


Side Plates
Front Plate
Base Plate
3
E70XX
48
L
152
M
Anchor Post Assembly
W152x22.3
1829
71
Anchor Post
152
157
3
Base Plate
SCALE 1:8
157
79
32
102
Ø32
13
Front Plate
SCALE 1:8
159
125
Ø19
24
102
13
Side Plate
SCALE 1:8
5
356
508
102
102
Soil Plate
SCALE 1:8
6
E70XX
(TYP.)
On Each Side
6
25
6
E70XX
DETAIL L
SCALE 1 : 7
DETAIL M
SCALE 1 : 7
Midwest Roadside Safety Facility
Type IIA Box Beam Terminal
(Test No. NYBBT-8)
System Anchorage Assembly
SHEET:
12 of 16
DATE
7/17/2009
DRAWN BY
RJS/CSS/
EMK
DSG. NAME
NYBBT-8m_R5
SCALE 1:20
UNITS mm
REV BY:
KAP/RKF


Base Plate
Gusset
Mounting Plate
E70XX
6
91
72
25
51
44
82
103
Cable Anchor Bracket
ø22 (Typ.)
ø22
229
254
152
13
Base Plate
SCALE 1 : 6
102
Gusset
SCALE 1 : 6
ø29
Mounting Plate
SCALE 1 : 6
4203
BCT Cable Anchor Assembly
SCALE 1 : 8
1955
BCT Cable Anchor Assembly (TCA01)
SCALE 1 : 8
Midwest Roadside Safety Facility
Type IIA Box Beam Terminal
(Test No. NYBBT-8)
Cable Anchor Bracket and
Anchor Cable Details
SHEET
13 of 16
DATE
7/17/2009
DRAWN BY
RJT/CSS/
EMA
DWG NAME
NYBBT-8m_R5
SCALE 1:4
UNITS mm
REV BY
KAP/RKF

Test No. NYBBT-8			
Item No.	Quantity	Description	Material Specifications
a1	26	6 x 203 x 610mm steel soil plate	A36 Steel
a2	29	M12 coarse thread, 41mm long hex bolt	ASTM A307
a3	31	M12 hex nut	ASTM A307
a4	23	127 x 89 x 10mm box beam shelf angle	A36 Steel
a5	31	M12 narrow washer	ASTM A307
a6	23	S76 x 8.5, 1600mm long post	A36 Steel
a7	2	S76 x 8.5, 2134mm long post	A36 Steel
b1	22	M10 coarse thread, 191mm long hex bolt	ASTM A307
b2	22	M10 hex nut	ASTM A307
b3	44	M10 wide washer	ASTM A307
b4	1	M20 hex nut	ASTM A307
b5	56	M20 wide washer	ASTM A325
b6	56	M20 coarse thread, 38mm long hex bolt	ASTM A325
b7	14	686 x 137 x 16mm splice plate	A36 Steel
b8	6	152 x 152 x 5mm by 5483mm long box beam	ASTM A500 Grade B
b9	1	M20 wide washer	ASTM A307
c1	1	End assembly bent 152 x 152 x 5mm box beam	ASTM A500 Grade B
c2	1	End assembly diagonal 152 x 152 x 5mm box beam	ASTM A500 Grade B
c3	1	End assembly 5mm thick cover plate	A36 Steel
c4	1	127 x 89 x 10mm box beam anchor post shelf angle	A36 Steel
c5	1	M20 coarse thread, 197mm long hex bolt	ASTM A307
c6	1	S76 x 8.5, 2134mm long post anchor post	A36 Steel
c7	1	152 x 152 x 5mm, R 10.67m Curved Box Beam	ASTM A500 Grade B
c8	2	M12 coarse thread, 203mm long hex bolt	ASTM A307
c9	4	127 x 89 x 10mm box beam shelf angle with ø 16mm slot	A36 Steel
c10	4	M12 wide washer	ASTM A307
d1	2	Terminal Post Assembly	–
d2	1	Terminal Anchor Post Assembly	–
d3	23	Line Post Assembly	–
d4	1	Box Beam End Terminal Assembly	–

Midwest Roadside Safety Facility

Type IIA Box Beam Terminal (Test No. NYBBT-8)

Bill of Materials

SHEET 14 of 16

DATE 7/17/2009

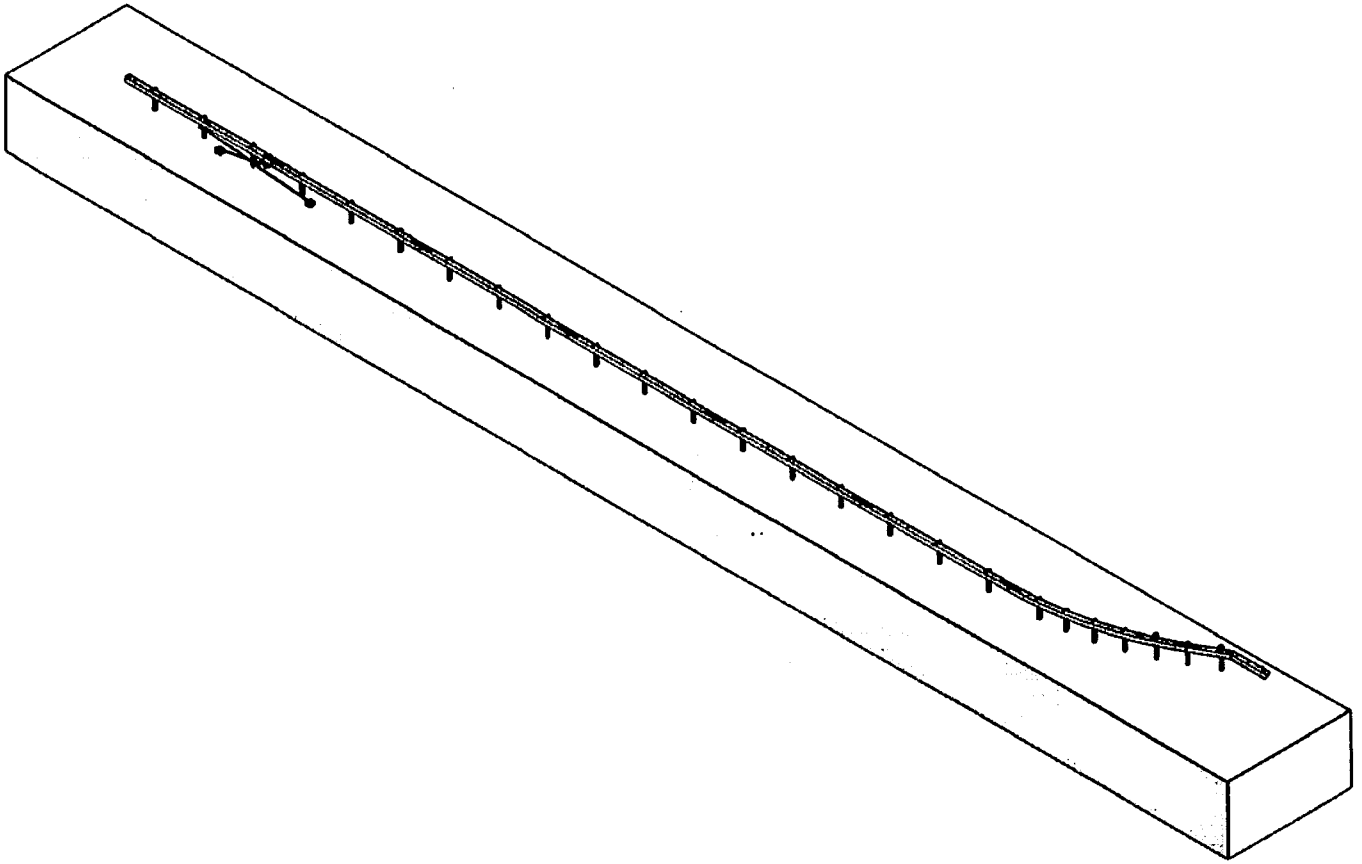
DRAWN BY RJT/CSS/EMA

DGC NAME NYBBT-Bm_BS

SCALE None

UNITS mm

REV BY KAP/RKF



Midwest Roadside Safety Facility

Type IIA Box Beam Terminal (Test No. NYBBT-8)

System Isometric

SHEET: 15 of 16

DATE: 7/17/2009

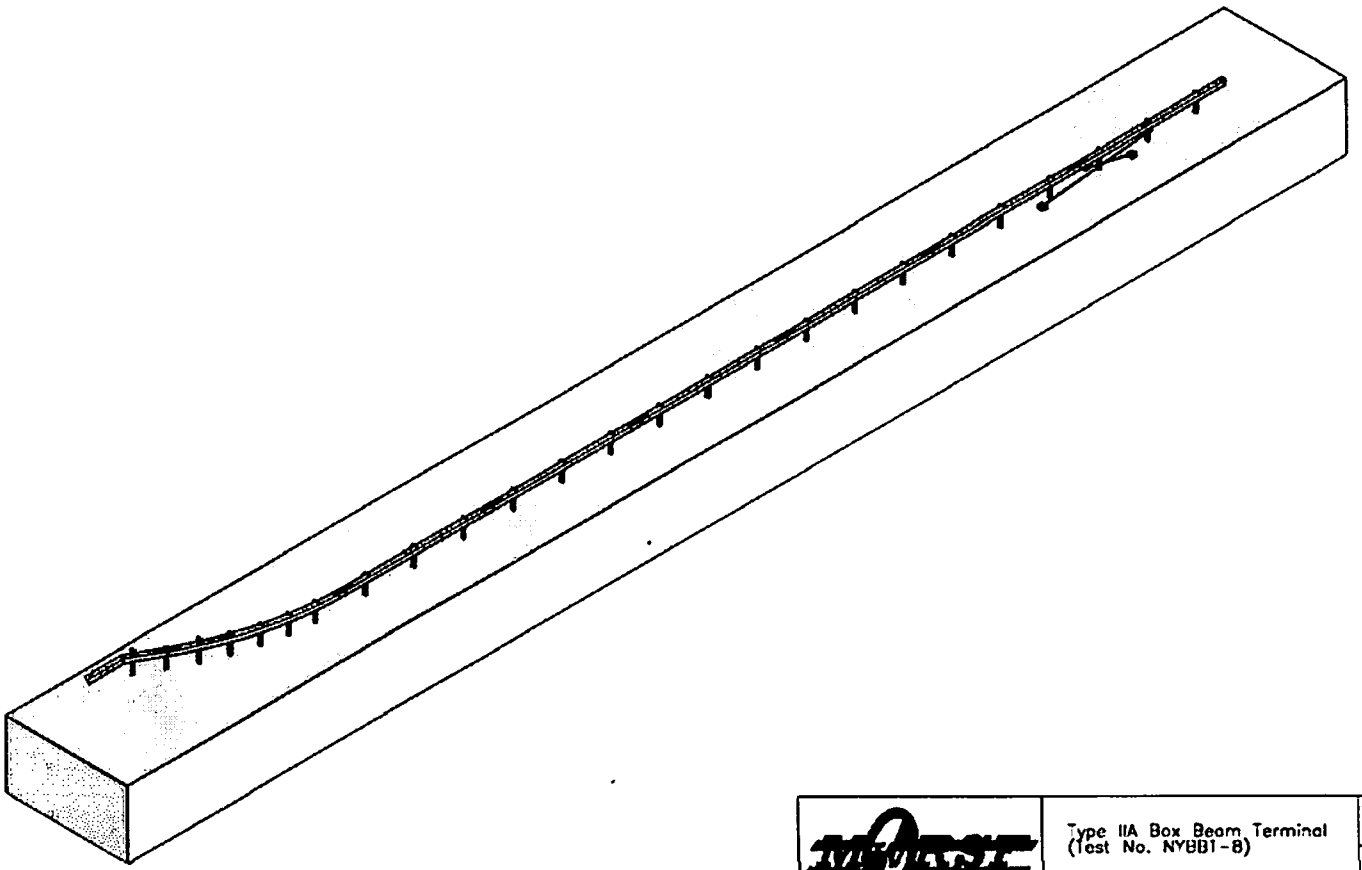
DRAWN BY: P.T./CSS/EMA

REV. BY: KAP/RWF

DWG NAME: NYBBT-8m_05

SCALE: 1:50

UNITS: mm



Midwest Roadside Safety Facility

Type IIA Box Beam Terminal (Test No. NYBB1-8)

System Isometric – As Built

SHEET 16 of 16

DATE 7/17/2009

DRAWN BY RJT/CSS/LMM

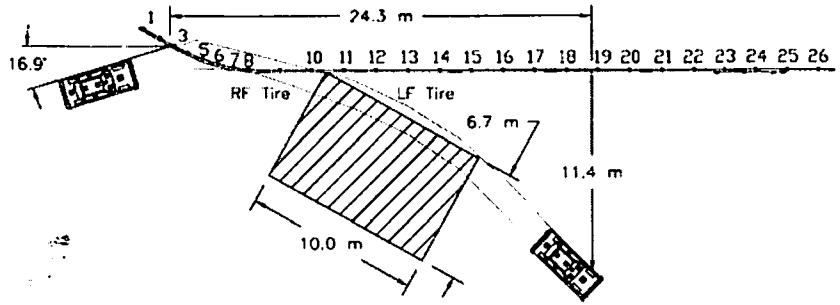
DWG NAME NYBB1-8m_03

SCALE 1:150 UNITS mm

REV BY KAP/RJT

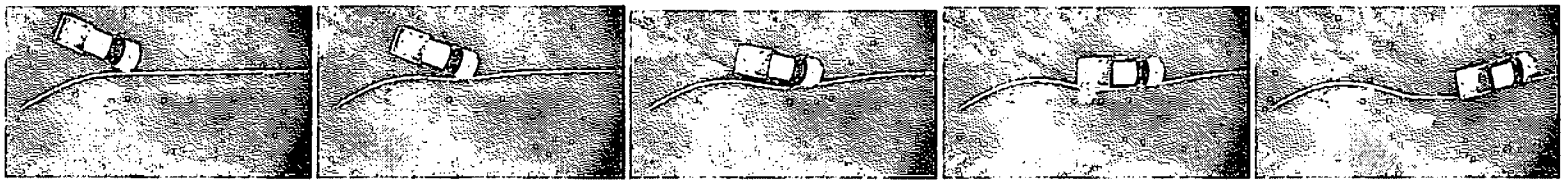
0.000 sec 0.090 sec 0.278 sec 0.468 sec 0.660 sec

- Test Agency ..... MwRSF
- Test Number NYBBT-8
- Date 7/15/09
- MASH Test Designation 3-34
- Appurtenance ..... Modified Type IIA End Terminal
- Total Length ..... 40.2 m
- Key Element – Steel Box Beam
  - Size ..... 152 mm x 152 mm x 4.8 mm
  - Length ..... 5,486 mm
  - Top Mounting Height ..... 686 mm
- Key Elements - Steel Post
  - Post Nos. 1, 2, 4 ..... S76x8.5 by 2,134 mm long
  - Post Nos. 3, 5-26 ..... S76x8.5 by 1,600 mm long
- Type of Soil ..... Grading B - AASHTO M 147-65 (1990)
- Test Vehicle
  - Type/Designation 1100C
  - Make and Model ..... 2003 Kia Rio
  - Curb ..... 1,104 kg
  - Test Inertial ..... 1,106 kg
  - Gross Static ..... 1,183 kg
- Impact Conditions
  - Speed ..... 101.5 km/h
  - Angle ..... 16.9 degrees
  - Target Impact Location ..... Centerline of post no. 3
  - Actual Impact Location ..... 25 mm upstream of centerline of post no. 3
- Exit Conditions
  - Speed ..... 41.1 km/h
  - Angle ..... 25.7 degrees
  - Exit Box Criterion ..... Pass
- Post-Impact Trajectory
  - Vehicle Stability ..... Satisfactory
  - Stopping Distance ..... 24.3 m downstream
    11.4 m laterally away traffic-side face
- Occupant Impact Velocity (EDR-3)
  - Longitudinal ..... -9.74 m/s < 12.2 m/s
  - Lateral ..... 4.36 m/s < 12.2 m/s

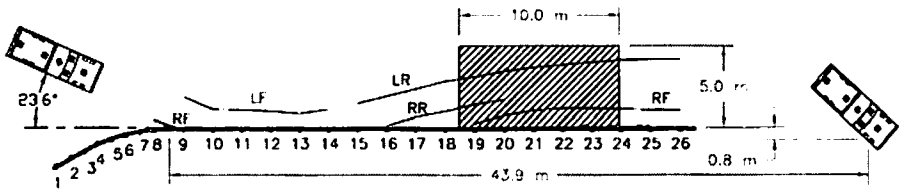


- Occupant Ridedown Acceleration (EDR-3)
  - Longitudinal ..... -11.15 g's < 20.49 g's
  - Lateral ..... 7.08 g's < 20.49 g's
- Occupant Impact Velocity (EDR-4)
  - Longitudinal ..... -9.34 m/s < 12.2 m/s
  - Lateral ..... 4.43 m/s < 12.2 m/s
- Occupant Ridedown Acceleration (EDR-4)
  - Longitudinal ..... -10.31 g's < 20.49 g's
  - Lateral ..... 5.62 g's < 20.49 g's
- THIV (EDR-4 - not required) ..... 9.51 m/s
- PHD (EDR-4 - not required) ..... 10.41 g's
- ASI (EDR-3 - not required) 1.24
- ASI (EDR-4 - not required) 1.16
- Test Article Damage ..... Moderate
- Test Article Deflections
  - Permanent Set ..... 2,842 mm
  - Dynamic ..... NA
  - Working Width ..... 6.6 m (estimate)
- Vehicle Damage ..... Moderate
  - VDS[12] 11-LFQ-6
  - CDC[13] 11-LYAW9
- Maximum Deformation ..... 102 mm at the front of the side panel
- Angular Displacement
  - Roll ..... 7 degrees
  - Pitch ..... -7 degrees
  - Yaw ..... 55 degrees

Enclosure 2: Summary of Test Results and Sequential Photographs, Test 3-34

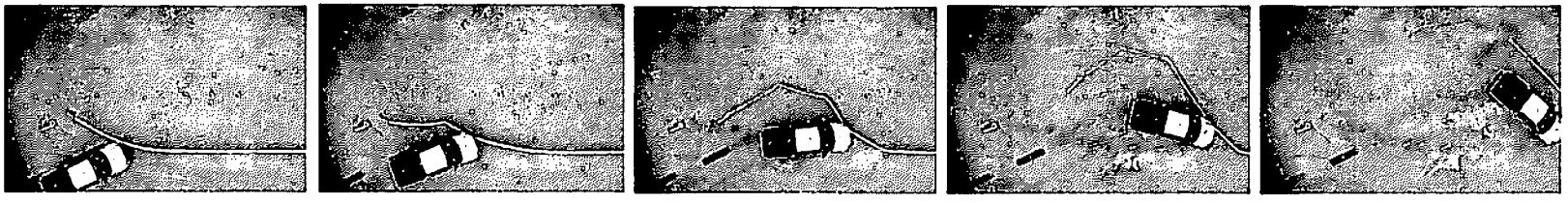


0.000 sec | 0.058 sec | 0.180 sec | 0.268 sec | 0.360 sec



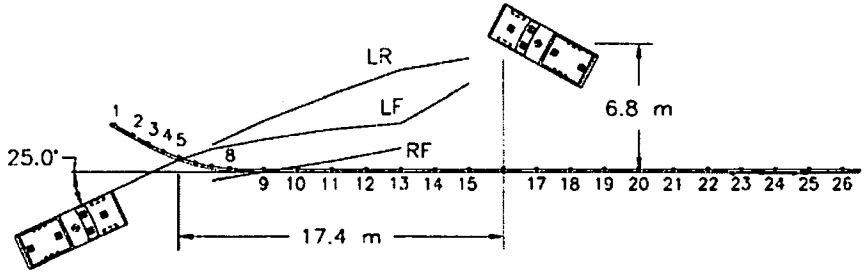
- Test Agency ..... MwRSF
- Test Number NYBBT-5
- Date 7/31/08
- MASH Test Designation 3-35
- Appurtenance ..... Modified Type IIA End Terminal
- Total Length ..... 40.2 m
- Key Element – Steel Box Beam
  - Size ..... 152 mm x 152 mm x 4.8 mm
  - Length ..... 5,486 mm
  - Top Mounting Height ..... 686 mm
- Key Elements - Steel Post
  - Post Nos. 1, 2, 4 ..... S76x8.5 by 2,134 mm long
  - Post Nos. 3, 5-26 ..... S76x8.5 by 1,600 mm long
- Type of Soil ..... Grading B - AASHTO M 147-65 (1990)
- Test Vehicle
  - Type/Designation 2270P
  - Make and Model ..... 2002 Dodge Ram 1500 Quad Cab Pickup
  - Curb ..... 2,326 kg
  - Test Inertial ..... 2,276 kg
  - Gross Static ..... 2,354 kg
- Impact Conditions
  - Speed ..... 99.9 km/h
  - Angle (trajectory) ..... 23.6 degrees
  - Target Impact Location ..... Midspan between post nos. 8 and 9
  - Actual Impact Location ..... 863 mm upstream of post no. 9
- Exit Conditions
  - Speed ..... 81.1 km/h
  - Angle ..... 4 degrees
  - Exit Box Criterion ..... Pass
- Post-Impact Trajectory
  - Vehicle Stability ..... Satisfactory
  - Stopping Distance ..... 43.9 m downstream
    0.8 m laterally behind traffic-side face
- Occupant Impact Velocity (EDR-3)
  - Longitudinal ..... -2.81 m/s < 12.2 m/s
  - Lateral ..... 4.12 m/s < 12.2 m/s
- Occupant Ridedown Acceleration (EDR-3)
  - Longitudinal ..... -4.85 g's < 20.49 g's
  - Lateral ..... 5.49 g's < 20.49 g's
- Occupant Impact Velocity (DTS)
  - Longitudinal ..... -2.78 m/s < 12.2 m/s
  - Lateral ..... 4.17 m/s < 12.2 m/s
- Occupant Ridedown Acceleration (DTS)
  - Longitudinal ..... -4.56 g's < 20.49 g's
  - Lateral ..... 6.51 g's < 20.49 g's
- THIV (DTS - not required) ..... 4.70 m/s
- PHD (DTS - not required) ..... 6.57 g's
- ASI (EDR-3 - not required) 0.50
- ASI (DTS - not required) 0.51
- Test Article Damage ..... Moderate
- Test Article Deflections
  - Permanent Set ..... 1,092 mm
  - Dynamic ..... 1,739 mm
  - Working Width ..... 2,504 mm
- Vehicle Damage ..... Moderate
  - VDS[12] 01-RFQ-3
  - CDC[13] 01-RDEN2
- Maximum Deformation ..... 13 mm at right-front floorboard
- Angular Displacement
  - Roll ..... -19 degrees
  - Pitch ..... -10 degrees
  - Yaw ..... 50 degrees

Enclosure 3: Summary of Test Results and Sequential Photographs, Test 3-35



0.000 sec 0.094 sec 0.268 sec 0.446 sec 0.636 sec

- Test Agency ..... MwRSF
- Test Number NYBBT-9
- Date 8/6/09
- MASH Test Designation ..... Modified 3-35
- Appurtenance ..... Modified Type IIA End Terminal
- Total Length ..... 40.2 m
- Key Element – Steel Box Beam
  - Size ..... 152 mm x 152 mm x 4.8 mm
  - Length ..... 5,486 mm
  - Top Mounting Height ..... 686 mm
- Key Elements - Steel Post
  - Post Nos. 1, 2, 4 ..... S76x8.5 by 2,134 mm long
  - Post Nos. 3, 5-26 ..... S76x8.5 by 1,600 mm long
- Type of Soil ..... Grading B - AASHTO M 147-65 (1990)
- Test Vehicle
  - Type/Designation 2270P
  - Make and Model ..... 2003 Dodge Ram 1500 Quad Cab Pickup
  - Curb ..... 2,283 kg
  - Test Inertial ..... 2,263 kg
  - Gross Static ..... 2,340 kg
- Impact Conditions
  - Speed ..... 101.9 km/h
  - Angle ..... 25.0 degrees
  - Target Impact Location ..... Centerline of vertical bolt at midpoint of rail at post no. 5
  - Actual Impact Location ..... 51 mm upstream of centerline of post no. 5
- Exit Conditions
  - Speed ..... 83.9 km/h
  - Angle ..... 31.0 degrees
  - Exit Box Criterion ..... NA
- Post-Impact Trajectory
  - Vehicle Stability ..... Satisfactory
  - Stopping Distance ..... 17.4 m downstream
    6.8 m laterally behind traffic-side face
- Occupant Impact Velocity (EDR-3)
  - Longitudinal ..... -4.37 m/s < 12.2 m/s
  - Lateral ..... 3.03 m/s < 12.2 m/s



- Occupant Ridedown Acceleration (EDR-3)
  - Longitudinal ..... -7.77 g's < 20.49 g's
  - Lateral ..... 4.38 g's < 20.49 g's
- Occupant Impact Velocity (DTS)
  - Longitudinal ..... -4.41 m/s < 12.2 m/s
  - Lateral ..... 2.81 m/s < 12.2 m/s
- Occupant Ridedown Acceleration (DTS)
  - Longitudinal ..... -7.37 g's < 20.49 g's
  - Lateral ..... 4.84 g's < 20.49 g's
- THIV (DTS - not required) ..... 4.84 m/s
- PHD (DTS - not required) ..... 7.67 g's
- ASI (EDR-3 - not required) 0.82
- ASI (DTS - not required) 0.73
- Test Article Damage ..... Extensive due to gating
- Test Article Deflections
  - Permanent Set ..... 1,080 mm
  - Dynamic ..... NA
  - Working Width ..... 17,820 mm
- Vehicle Damage ..... Moderate
  - VDS[12] 11-LFQ-3
  - CDC[13] 11-LFEW8
- Maximum Deformation ..... 19 mm at the left side of the dashboard
- Angular Displacement
  - Roll ..... -22 degrees
  - Pitch ..... -5 degrees
  - Yaw ..... 236 degrees

Enclosure 4: Summary of Test Results and Sequential Photographs, Test modified 3-35