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PROFESSIONAL RECOMMENDATION MEMORANDUM

Project Name: **Engineering Support Services and Recommendations for Roadside Safety Issues/Problems for Member States**

Sponsor: **Roadside Safety Pooled Fund**

Task 17-5: **Michigan Temporary Concrete Barrier Limited Deflection**

DATE: **July 24, 2020**

FROM: **William Williams, P.E.**, Associate Research Engineer

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Overview/Problem Statement

The Michigan Department of Transportation seeks to gain MASH TL-3 acceptance for an F-Shape temporary concrete barrier using 12'6" long barrier segments and pinned connections with limited deflection. Reduced/limited deflection in the barrier system is accomplished using a box beam structural shape anchored across the barrier joints. The purpose of this study/review is to determine if this design as presented herein is acceptable based on MASH TL-3 impact conditions. The information used to make this determination is provided as follows.

NYS Concrete Barrier with Box Beam Stiffener FHWA Eligibility Letter B239 (ref. 1) – In November 2012, FHWA issued Eligibility Letter B-239. This letter stated that the New York State Temporary Concrete Barrier (TCB) with Box Beam Stiffener as tested on July 24, 2007 at Mid-West Roadside Safety Facility (MwRSF) meets the crash test and evaluation criteria of MASH TL-3 and is eligible for reimbursement under the Federal-aid highway program for MASH TL-3. The barrier design might be installed under a range of conditions. Provisions were provided in the letter for installing the barrier system under different conditions. Details of the barrier design are provided in Figures 1 and 2.

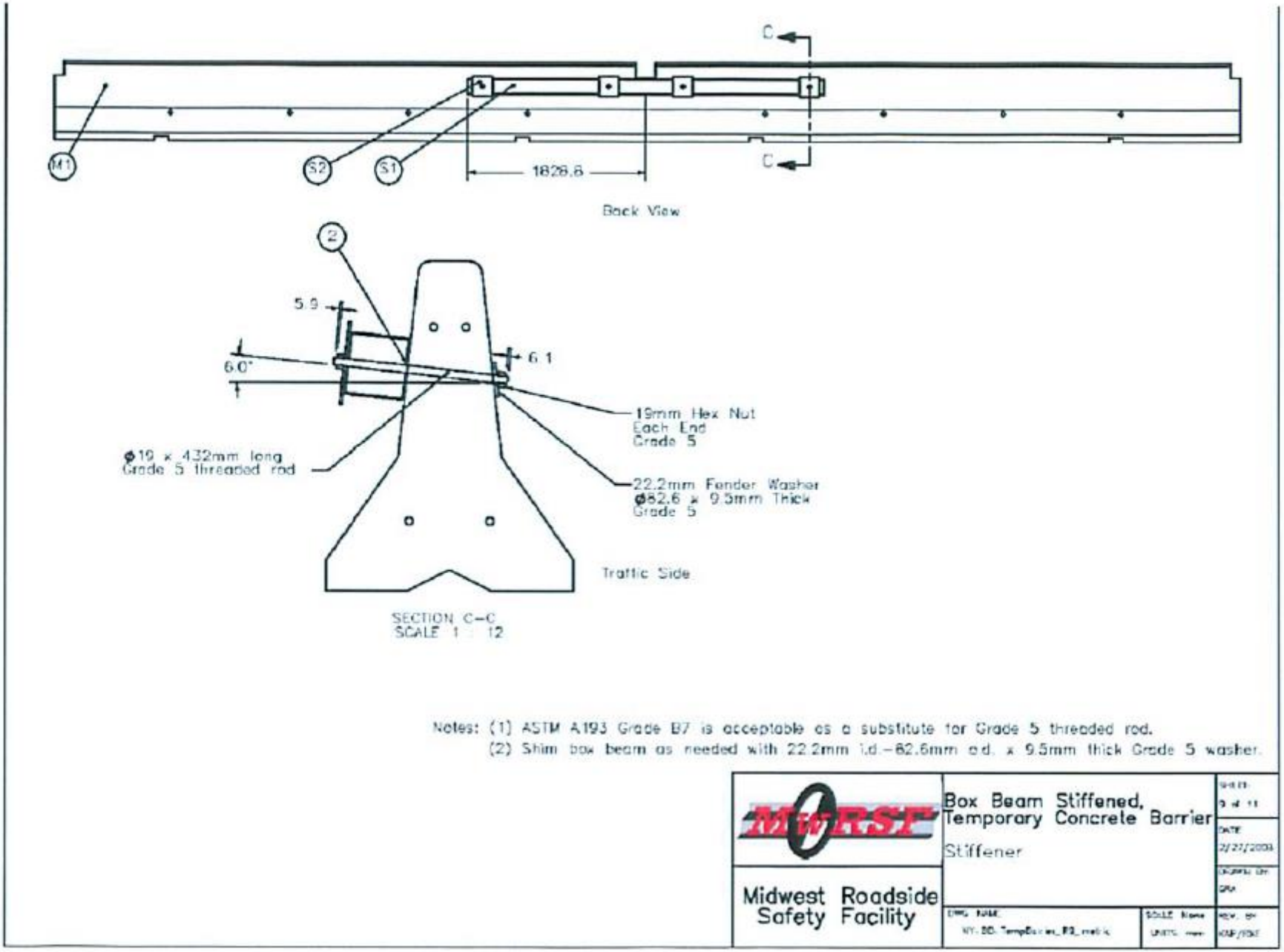


Figure 1. NYS Temporary Concrete Barrier with Stiffened Beam Connection Details

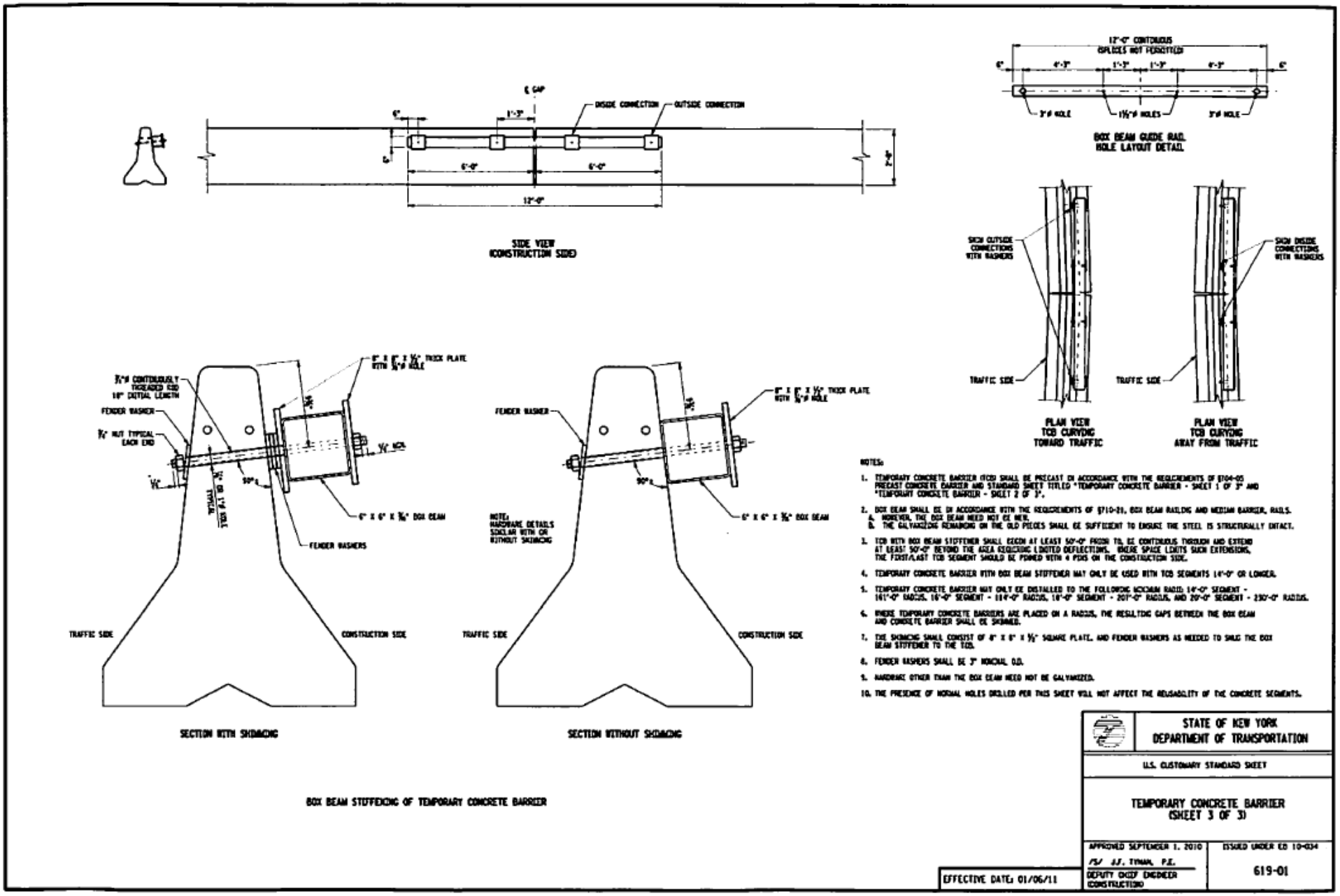
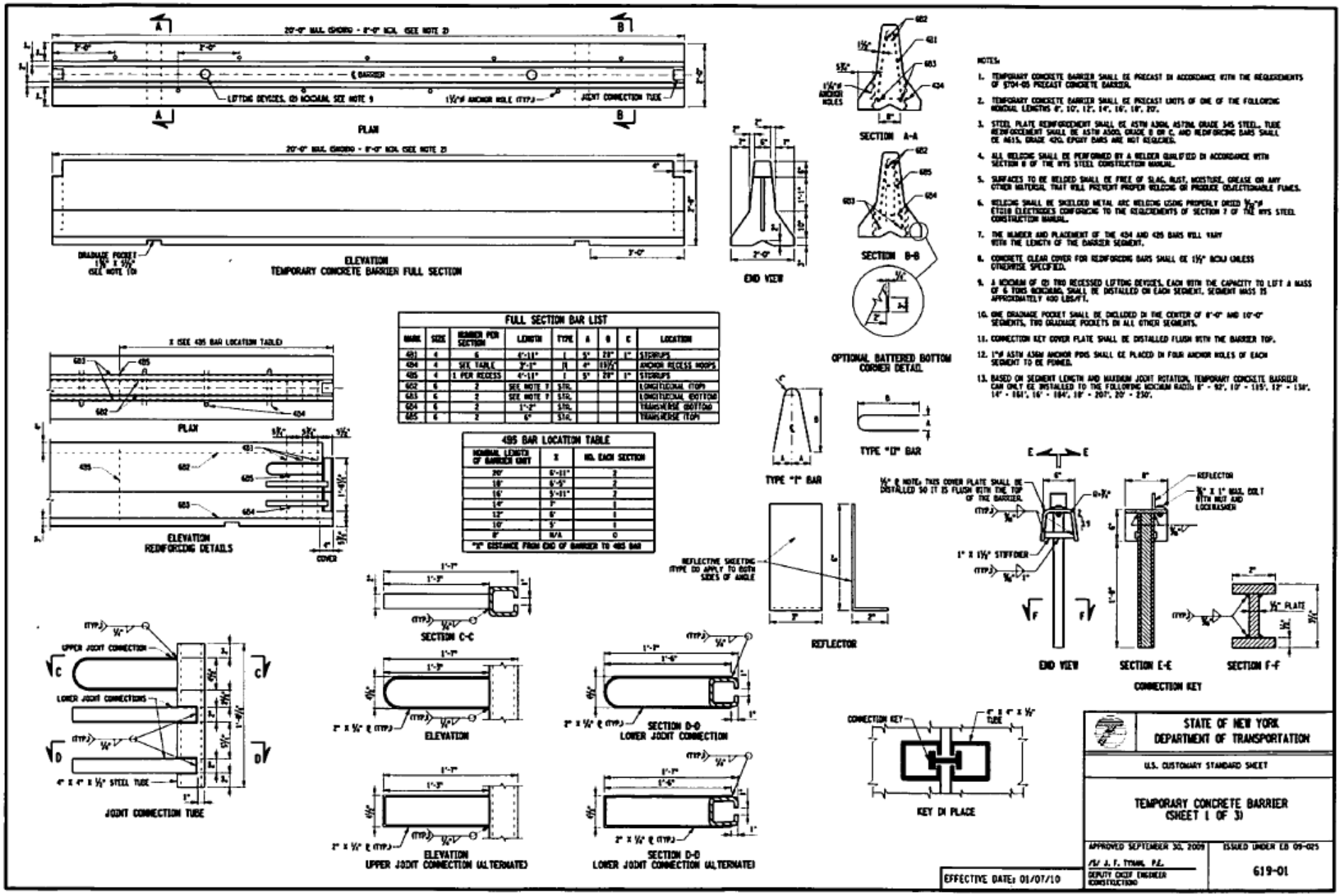


Figure 1. Cont'd. - NYS Temporary Concrete Barrier with Stiffened Beam Connection Details



FULL SECTION BAR LIST

MARK	SIZE	NUMBER PER SECTION	LENGTH	TYPE	A	B	C	LOCATION
433	4	6	6'-11"	L	5"	29"	1"	STIRRUPS
434	4	SEE TABLE	3'-1"	R	4"	11½"		ANCHOR RECESS HOOPS
435	4	1 PER RECESS	6'-11"	L	5"	29"	1"	STIRRUPS
602	6	2	SEE NOTE 7	STR.				LONGITUDINAL (TOP)
603	6	2	SEE NOTE 7	STR.				LONGITUDINAL (BOTTOM)
604	6	2	1'-2"	STR.				TRANSVERSE (BOTTOM)
605	6	2	6"	STR.				TRANSVERSE (TOP)

435 BAR LOCATION TABLE

NOMINAL LENGTH OF BARRIER UNIT	X	NO. EACH SECTION
20'	6'-11"	2
18'	6'-5"	2
16'	5'-11"	2
14'	5"	1
12'	6"	1
10'	5"	1
8'	N/A	0

"X" DISTANCE FROM END OF BARRIER TO 435 BAR

Figure 2. Details of NYS Temporary Concrete Barrier

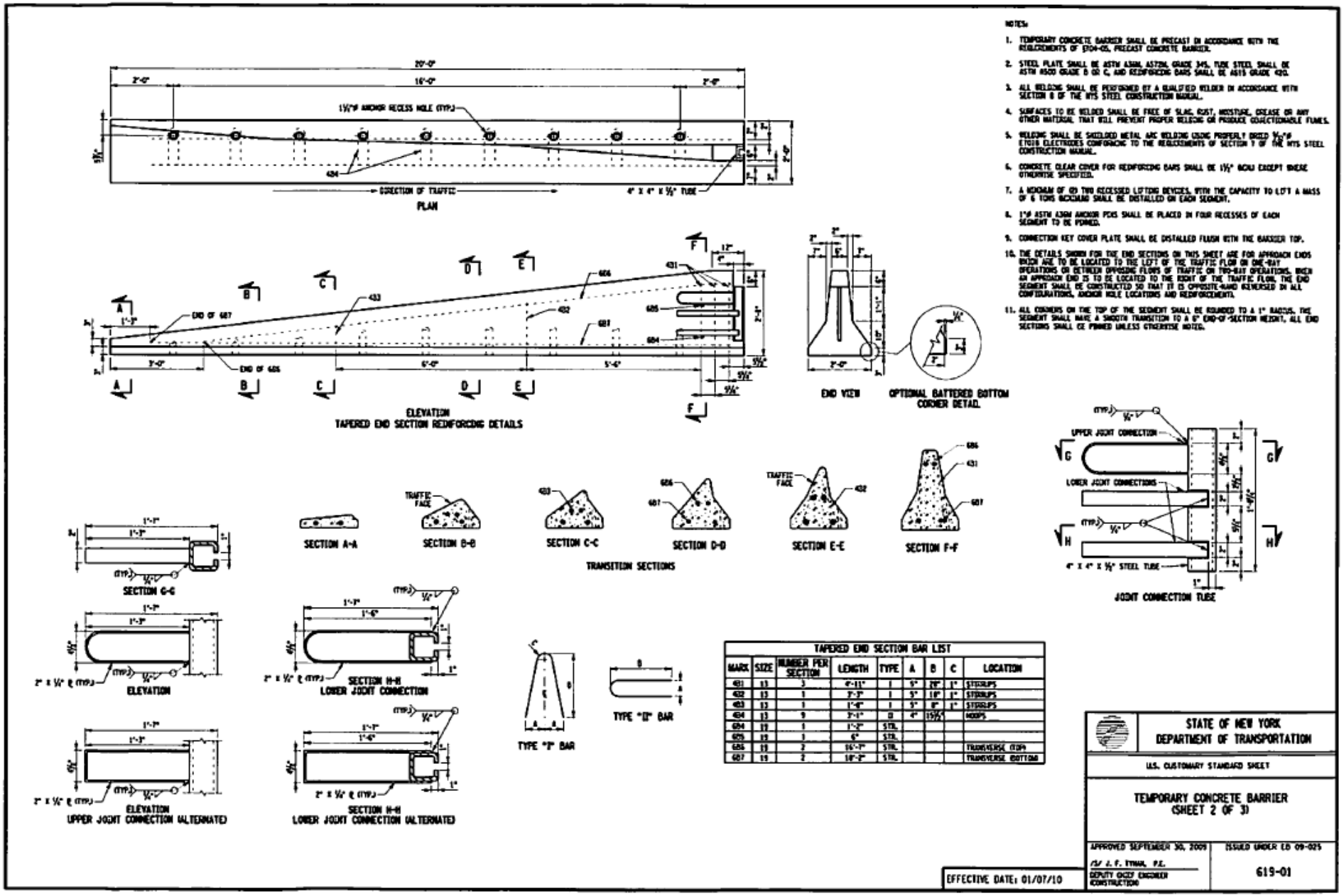


Figure 2. Cont'd. - Details of NYS Temporary Concrete Barrier

As stated previously, the system described and detailed in Letter B-239 may be installed under a range of conditions tested. The letter stated that the same stiffening method may be used to reduce the deflection of other portable concrete barrier systems with the following provisions:

1.) The length of the individual barrier segments is at least 20 feet long.
2.) The deflection of the system to be retrofit was no greater than 50 inches under NCHRP Report 350 Test Level 3 conditions.
3.) The barriers are anchored at both ends to achieve the limited deflection properties demonstrated in crash testing. If the end sections are not anchored then the barrier line, with stiffeners, should be extended until the barrier's desired deflection can be achieved.

F-Shape Concrete Barrier Tested to NCHRP Report 350 FHWA Eligibility Letter B-41 (ref. 2) – In October 1997, FHWA issued Eligibility Letter B-41. This letter stated that the 3800 mm long pin and loop barrier system (currently used by Michigan DOT) as tested on May 9, 1996 at Mid-West Roadside Safety Facility (MwRSF) meets the crash test and evaluation criteria of NCHRP Report 350 and is eligible for reimbursement under the Federal-aid highway program. The total length of the installation was 84 meters in length (approx. 275 feet). The height of the barrier was 810 mm (32 inches). Maximum dynamic deflections measured 1.14 meter (44.9 inches) and 1.15 meters (45.3 inches), respectively for permanent and dynamic conditions. Details of the barrier design are provided in Figure 3.

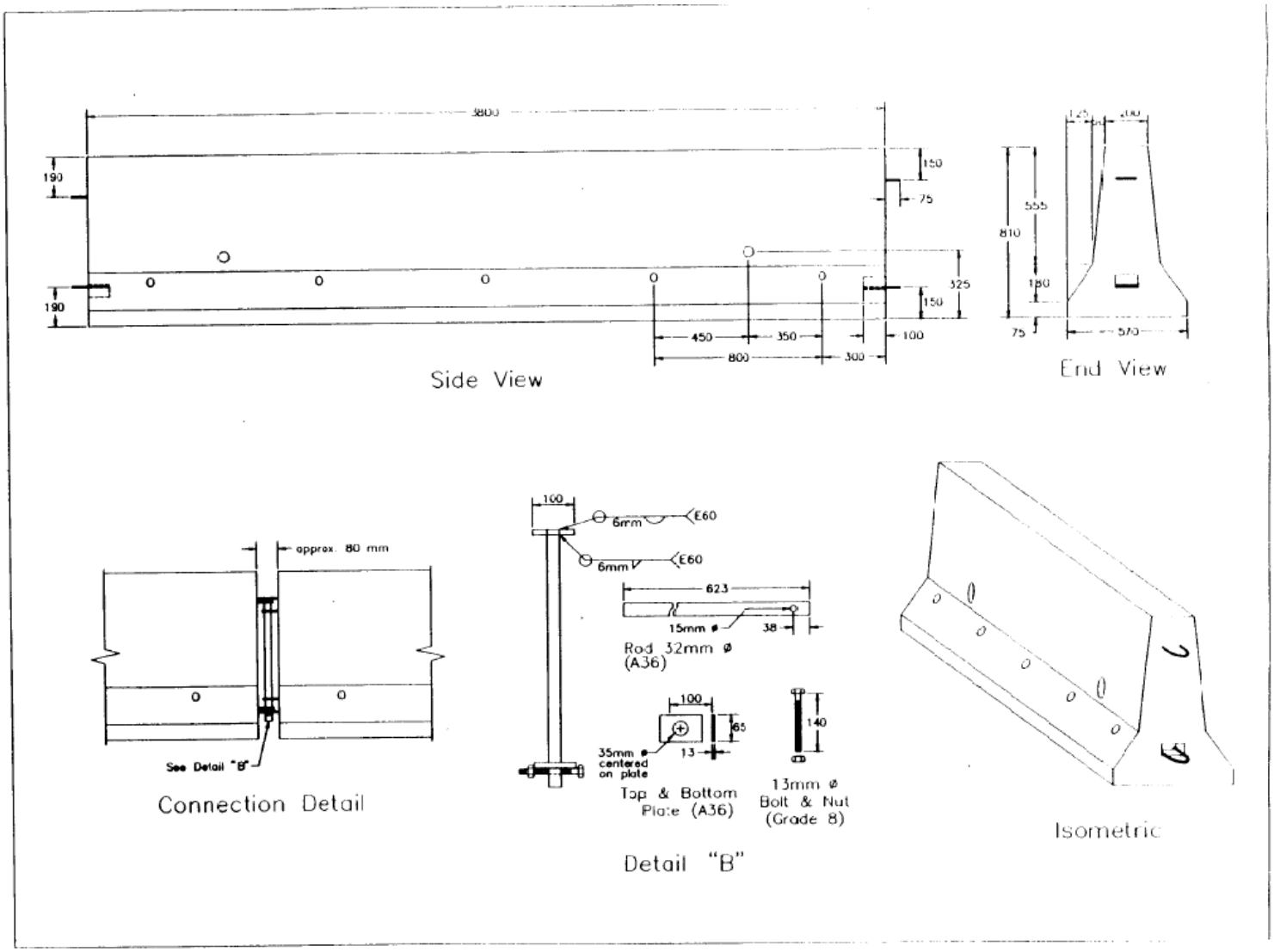


Figure 3. Details of F-Shape Barrier

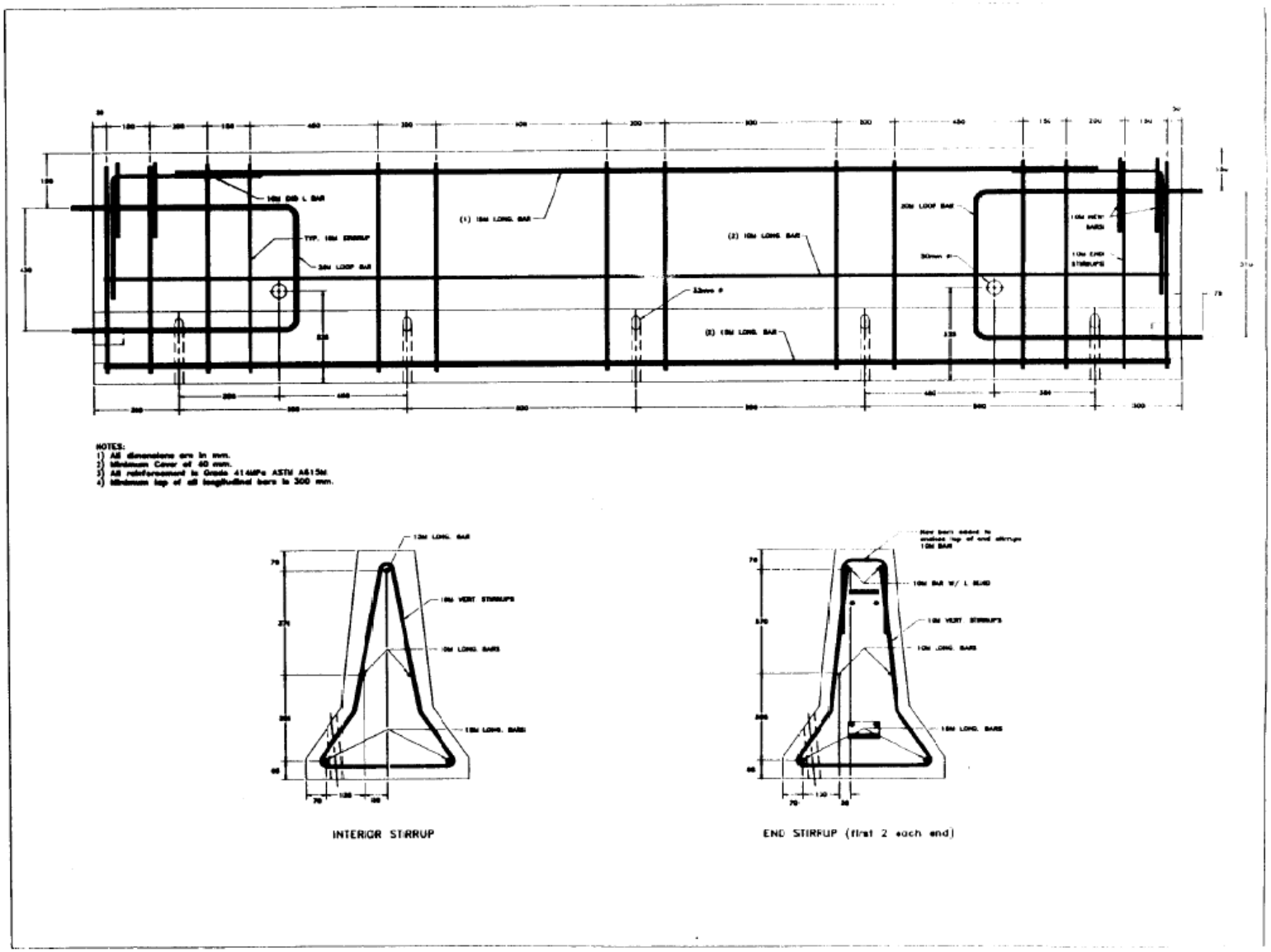


Figure 3. Details of F-Shape Barrier Cont'd.

F-Shape Concrete Barrier Tested to MASH TL-3 FHWA Eligibility Letter B-215 (ref. 3) – In February 2011, FHWA issued Eligibility Letter B-215. This letter stated that the 12'-6" long pin and loop barrier system (currently used by Michigan DOT) as tested on October 12, 2004 at Mid-West Roadside Safety Facility (MwRSF) meets the crash test and evaluation criteria of MASH TL-3 and is eligible for reimbursement under the Federal-aid highway program. The total length of the installation was approximately 205 feet. This barrier design is very similar to the barrier system tested under NCHRP 350 and presented in Letter B-41. The height of the barrier was 32 inches. Maximum dynamic deflections measured 73 inches and 79.65 inches, respectively for permanent and dynamic conditions. Details of the barrier design are provided in Figure 4. The data summary sheet for the MASH Test 3-11 is shown in Figure 5.

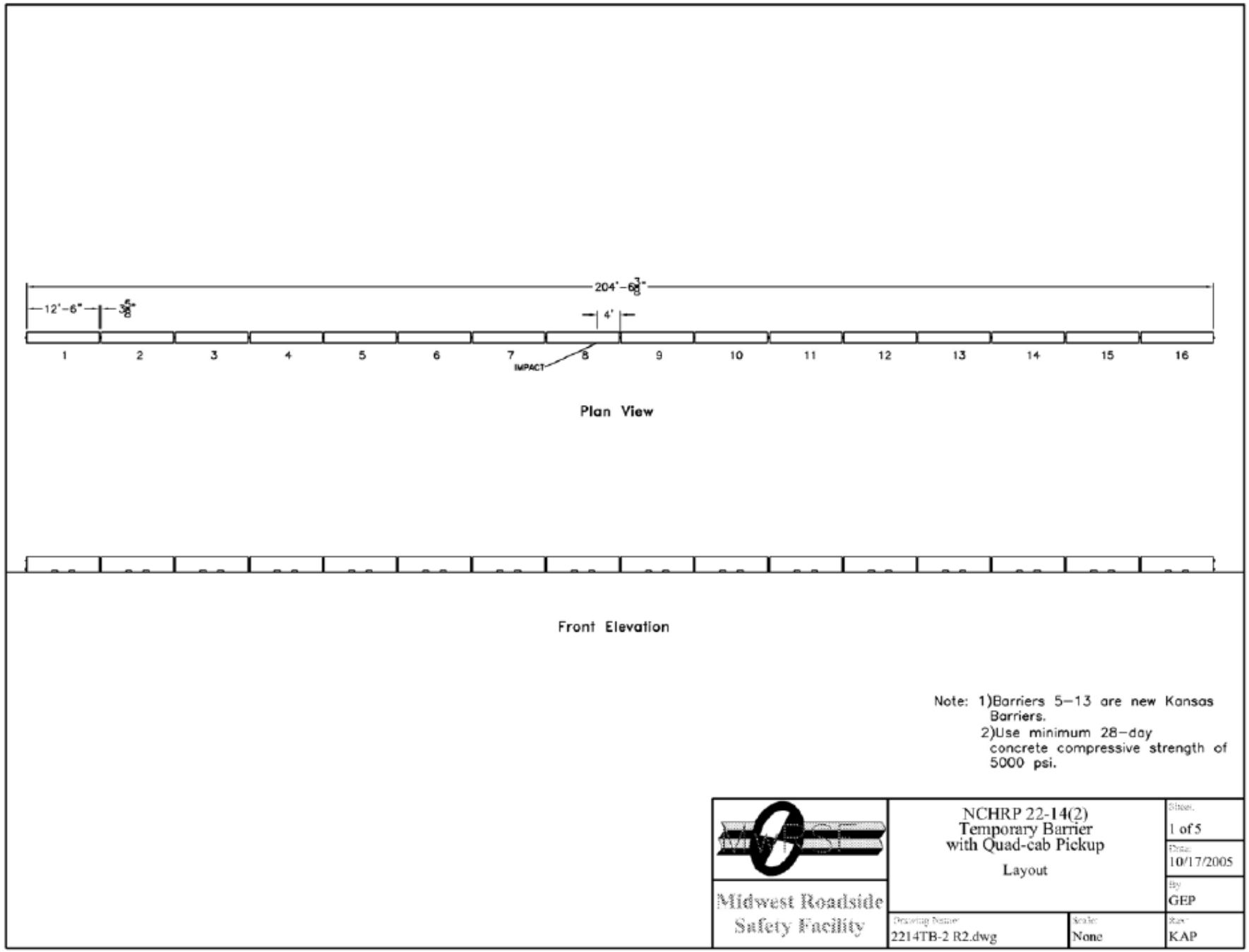


Figure 4. Details of F-Shape Barrier Tested to MASH TL-3

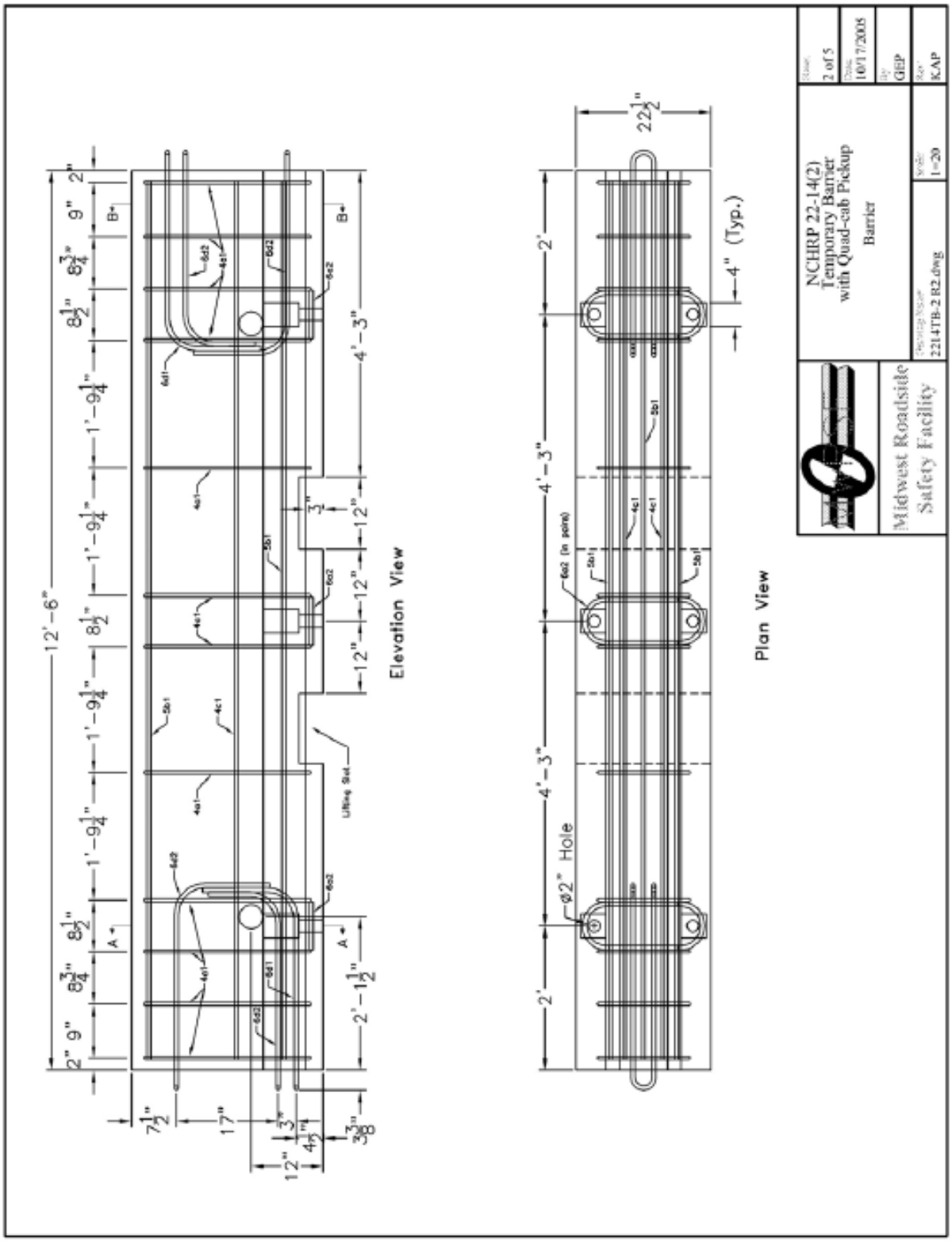


Figure 4. Details of F-Shape Barrier Tested to MASH TL-3 Cont.d.

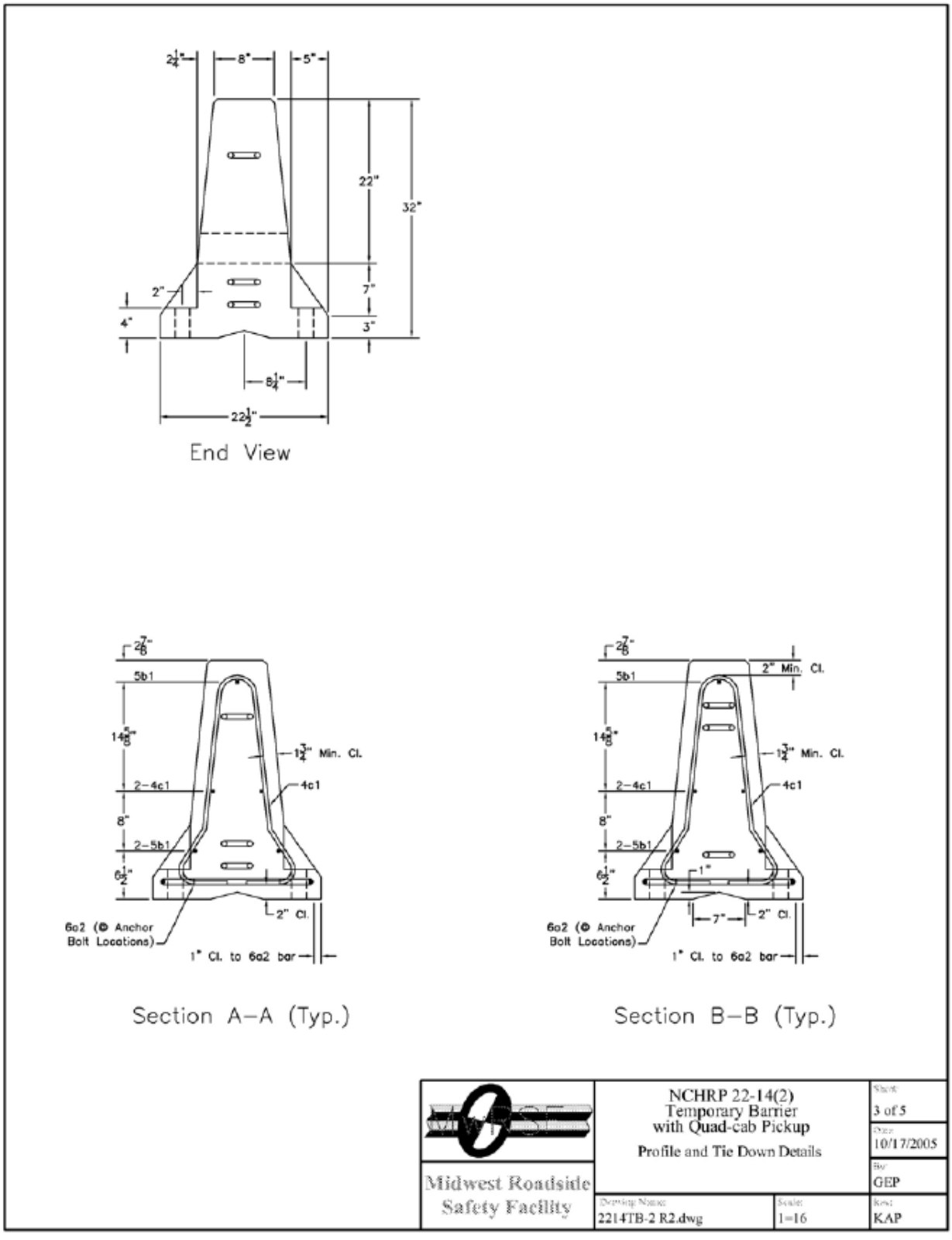
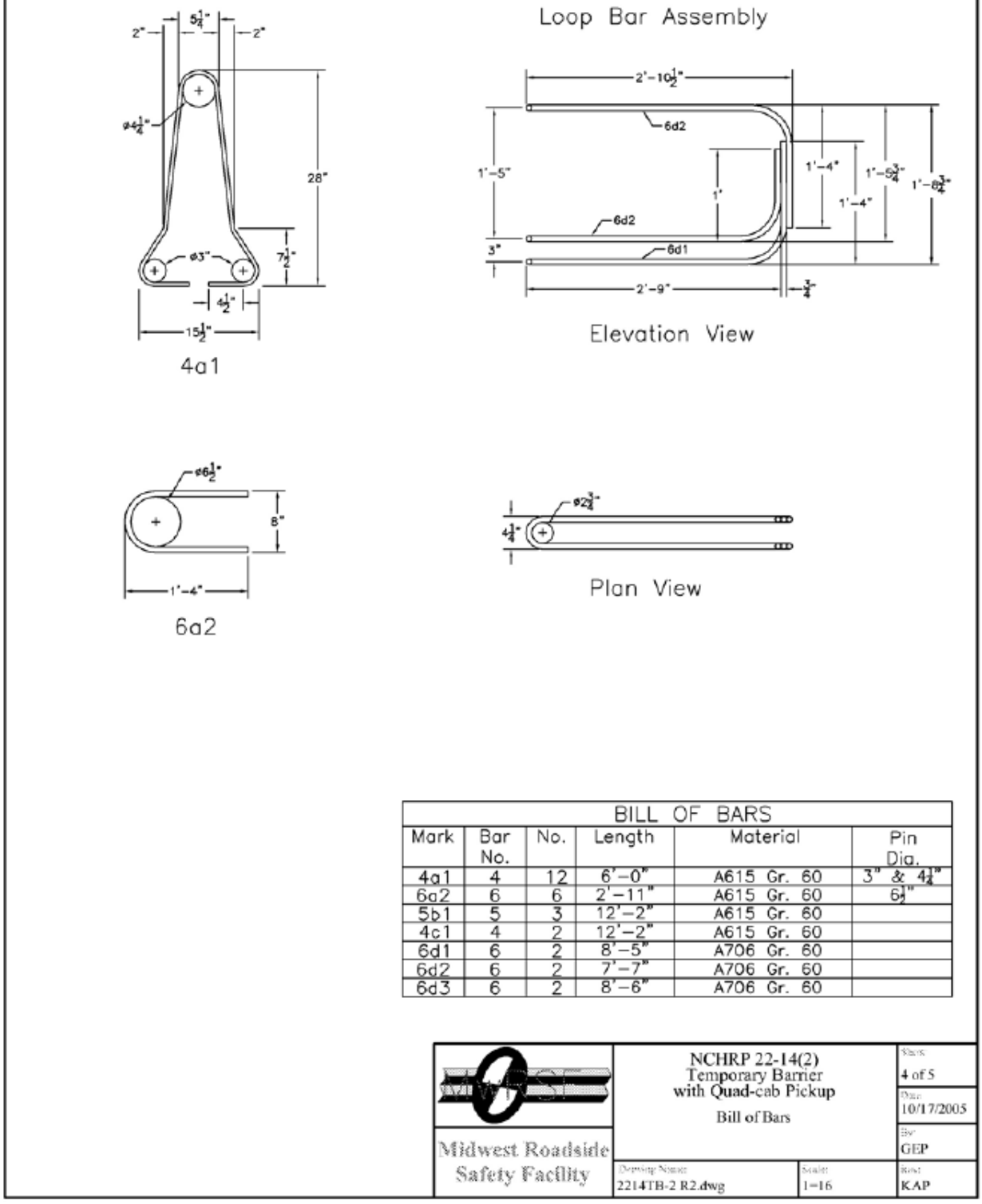


Figure 4. Details of F-Shape Barrier Tested to MASH TL-3 Cont.d.



BILL OF BARS					
Mark	Bar No.	No.	Length	Material	Pin Dia.
4a1	4	12	6'-0"	A615 Gr. 60	3" & 4¼"
6a2	6	6	2'-11"	A615 Gr. 60	6½"
5b1	5	3	12'-2"	A615 Gr. 60	
4c1	4	2	12'-2"	A615 Gr. 60	
6d1	6	2	8'-5"	A706 Gr. 60	
6d2	6	2	7'-7"	A706 Gr. 60	
6d3	6	2	8'-6"	A706 Gr. 60	

Midwest Roadside Safety Facility

NCHRP 22-14(2)
Temporary Barrier with Quad-cab Pickup
Bill of Bars

Sheet: 4 of 5
Date: 10/17/2005
By: GEP
Drawing Name: 2214TB-2 R2.dwg
Scale: 1=16
Revd: KAP

Figure 4. Details of F-Shape Barrier Tested to MASH TL-3 Cont.d.

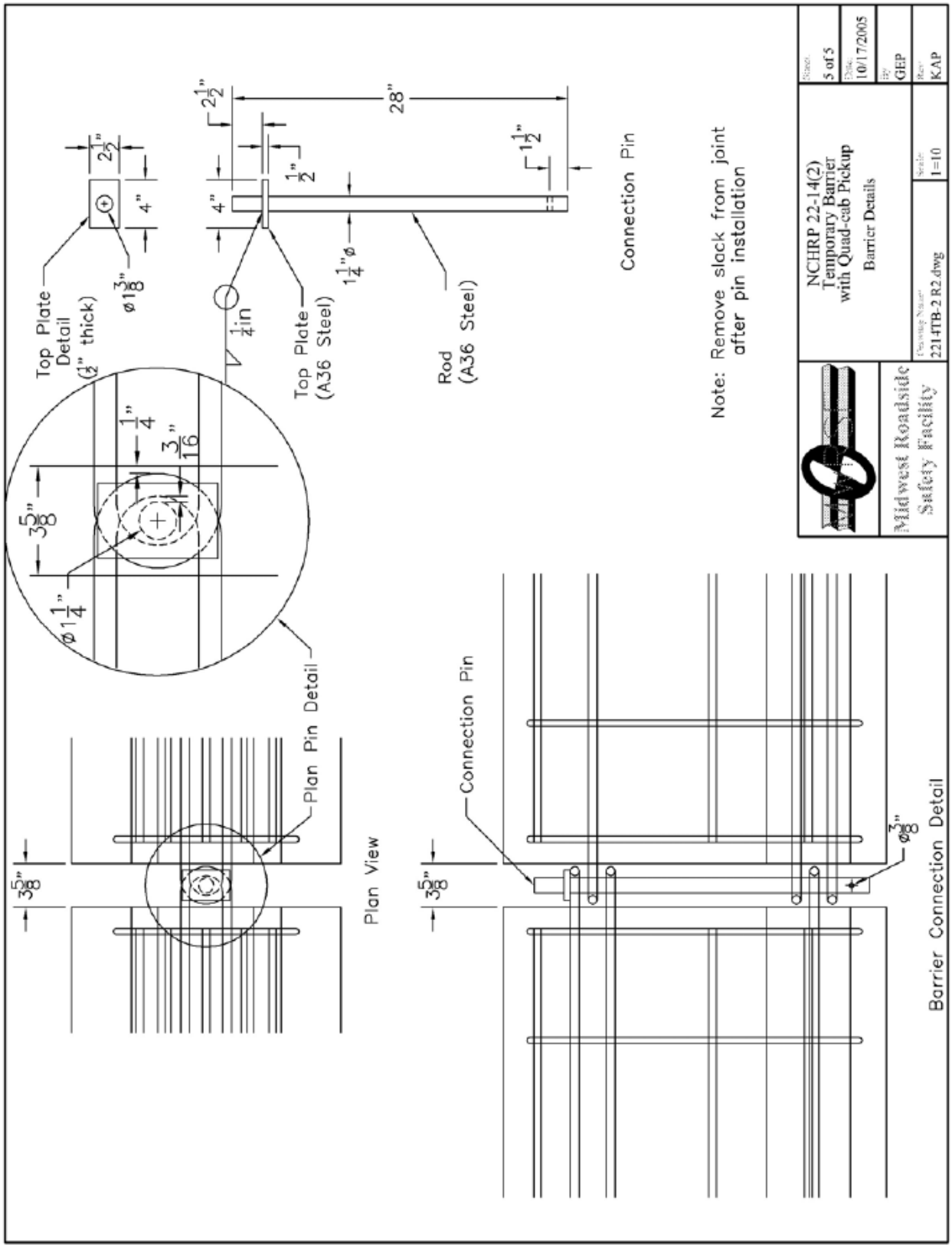


Figure 4. Details of F-Shape Barrier Tested to MASH TL-3 Cont.d.

Figure 5. Data Summary Sheet for MASH Test 3-11 on F-Shape Pin & Loop Barrier.

Summary and Recommendations

In summary:

1. FHWA Letter B-239 indicating that the box-beam stiffened method is eligible for federal aid reimbursement as a MASH TL-3 device. Alternatives to NYSDOT TCB may be used under specific conditions. Deflections in the free-standing barrier systems **must not be greater than 50 inches under NCHRP 350 TL-3 impact conditions**.
2. FHWA Letter B-41 for freestanding, 12.5' F-Shape TCB (e.g., Type S) under NCHRP 350 criteria. Barrier deflections under NCHRP 350, TL-3 were reported as:
    a. Permanent Set: 1.14m (44.88 inches)
    b. Dynamic: 1.15m (45.28 inches)
3. FHWA Letter B-215 for freestanding, 12.5' F-Shape TCB (e.g., Type S) under MASH criteria. Barrier deflections under MASH, TL-3:
    a. Permanent Set: 73 inches
    b. Dynamic: 79.65 inches

Based on the review of this information, the 12'-6" barrier units as shown in FHWA letters B-41 and B-215 with the stiffened box beam element as shown in Letter B-239 is recommended for use as an acceptable MASH TL-3 barrier system. The deflection of the free-standing system was within the 50 inches as shown in Letter B-41 (Item 2 above). Therefore, Detail 1 (box-beam stiffened method) from Michigan DOT Standard Plan R-53-A may be constructed with 12'-6" long (e.g., Type S from Standard Plan R-53-A) or 20'-0" long (e.g., Type L from Standard Plan R-53-A) temporary concrete barrier sections.

In addition, TTI has reviewed the anchoring details currently used by Michigan DOT. These details are provided in Michigan DOT Standard R-53-A page 4 of 22. These details are provided in Figure 6. We understand Michigan DOT would like to use these details as recommended in Letter B-239 for MASH TL-3 applications. This detail for anchoring the ends of free-standing barrier ends as recommended in FHWA Letter B-239 is acceptable for MASH TL-3. If anchoring is not desired for long runs of barrier units, it is recommended that a minimum of 150 feet beyond the length of need on each end of the barrier run be used without the use of end anchoring.

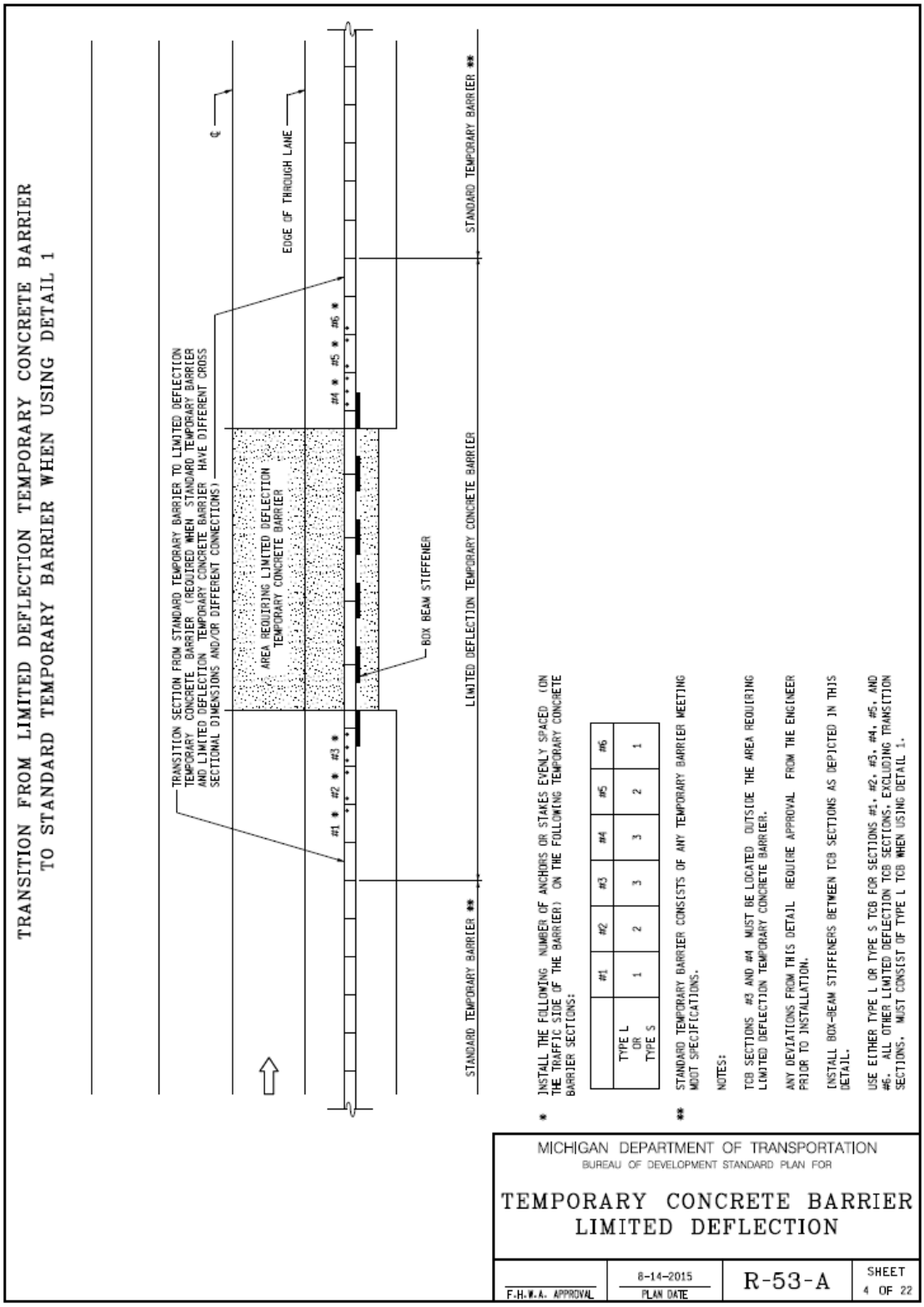


Figure 6. Recommended End Anchoring Details for Stiffened Temporary Concrete Barrier.

References

1. U.S. Department of Transportation, Federal Highway Administration Memorandum, Subject: Action: NYS Concrete Barrier with Box Beam Stiffener FHWA Eligibility Letter B-239, From Michael S. Griffith, Director, Office of Safety Technologies, Office of Safety, November 1, 2012.

2. U.S. Department of Transportation, Federal Highway Administration Acceptance Letter B-41, From Dwight A. Horne, Chief Federal-Aid and Design Division, October 10, 1997.

3. U.S. Department of Transportation, Federal Highway Administration Memorandum, Acceptance Letter for Free-Standing F-Shaped Temporary Concrete Barrier System for MASH TL-3, FHWA Eligibility Letter B-215, From Michael S. Griffith, Director, Office of Safety Technologies, Office of Safety, February 10, 2011.