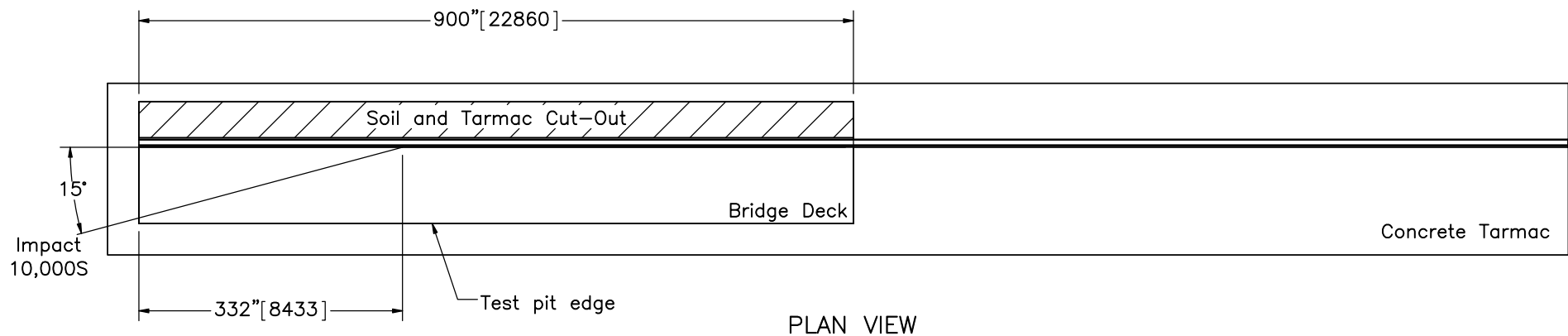


- Notes: (1) Test shall be performed according to test designation no. 4-12 using MASH 2016 criteria.
- (2) The impact location is 332" [8,433] downstream from the upstream end of the bridge deck.
- (3) The bridge rail will be constructed using only interior reinforcement details for the crash testing program. End reinforcement details will be provided in the research report.
- (4) When forming the cold joint, the longitudinal reinforcement should extend past the form end a distance equal to or greater than the minimum lap length for that reinforcing bar.



Midwest Roadside
Safety Facility

TL-4 Bridge Rail
Test No. 4CBR-1

Overall View

DWG. NAME.
4CBR-1_R14

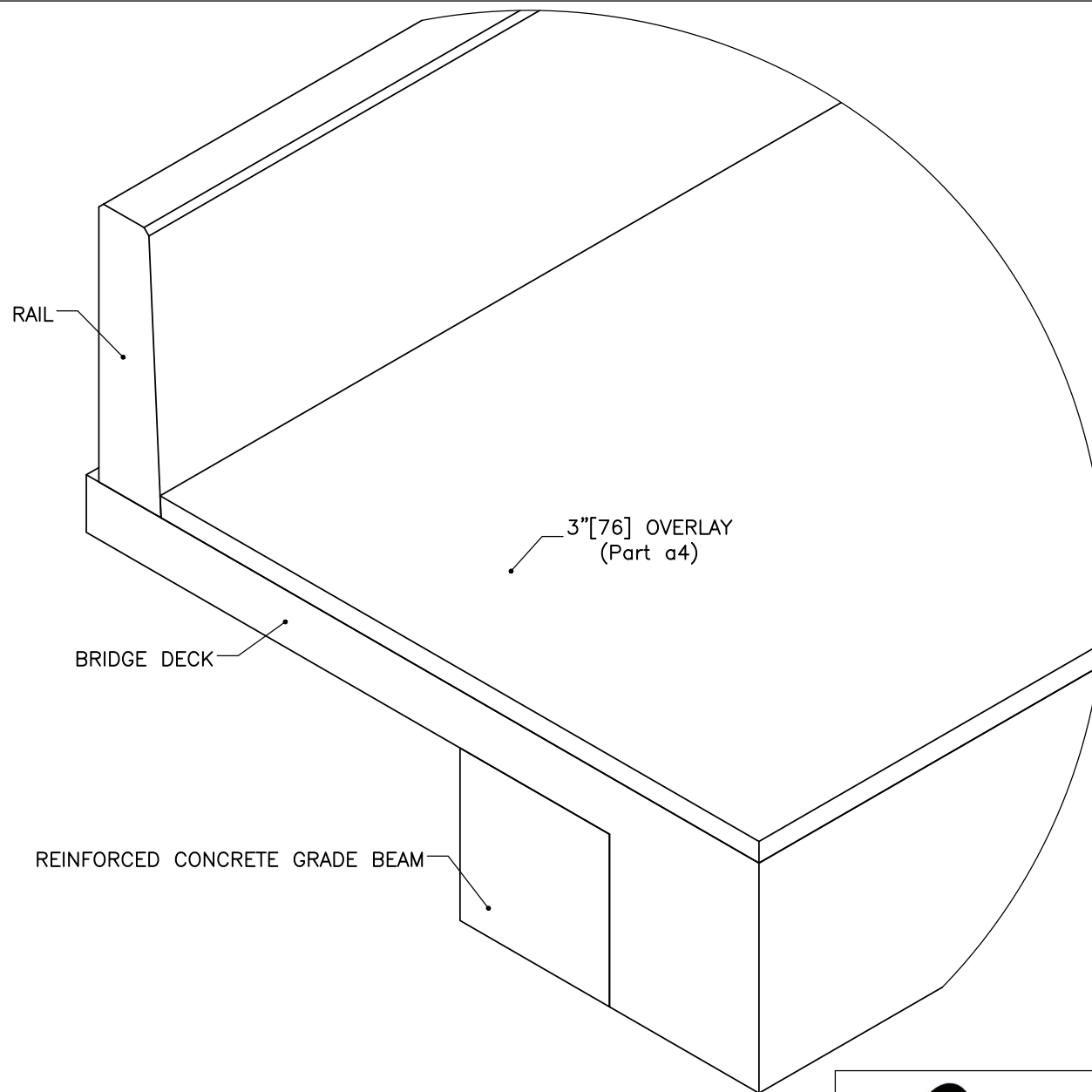
SCALE: 1:200
UNITS: in.[mm]

SHEET:
1 of 15

DATE:
9/13/2018

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MES/JEK

REV. BY:
JEK/JD/RKF
/JCH



ISOMETRIC CROP VIEW



Midwest Roadside
Safety Facility

TL-4 Bridge Rail
Test No. 4CBR-1

Isometric View

DWG. NAME.
4CBR-1_R14

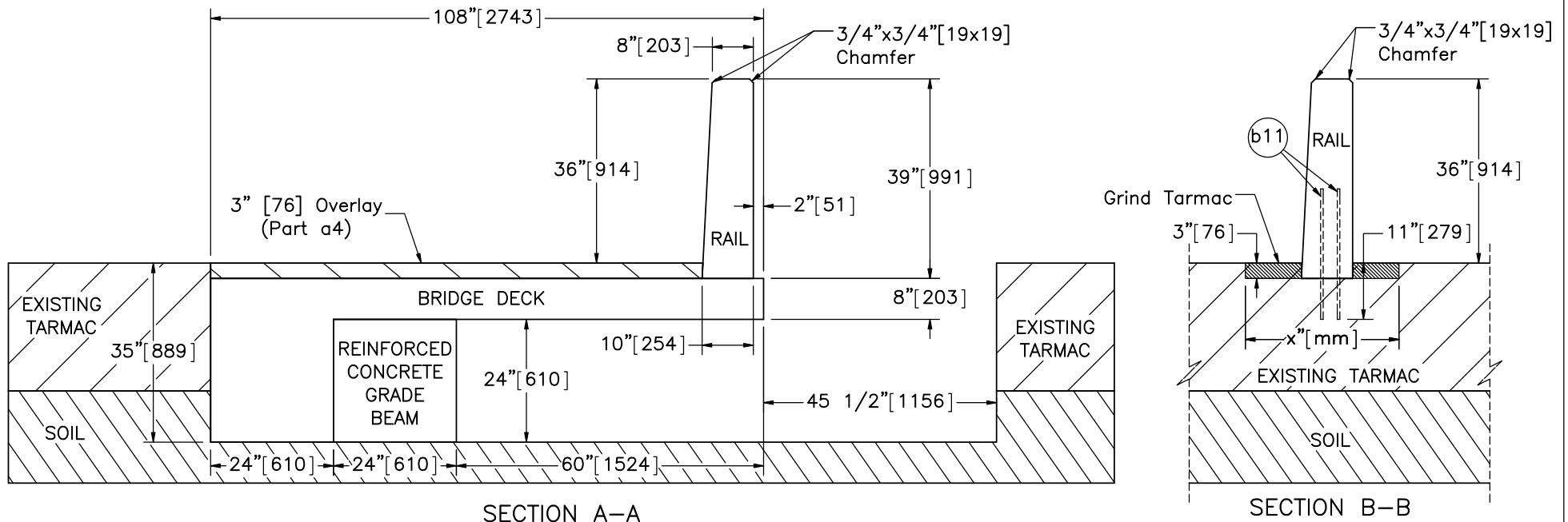
SCALE: 1:19
UNITS: in.[mm]

SHEET:
2 of 15

DATE:
9/13/2018

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MES/JEK

REV. BY:
JEK/JD/RKF
/JCH



- Notes:
- (1) Reinforcement not shown for clarity in section A-A.
 - (2) Reinforcement bar no. b11 is shown in section B-B and is to be anchored into the existing tarmac with chemical epoxy adhesive with a minimum bond strength of 1,450 psi [10.0 MPa].
 - (3) Use a releasing agent/medium (polyethylene plastic) between overlay and bridge deck.
 - (4) The epoxy anchoring of bar no. b11 into the tarmac is for testing purposes only and does not reflect the recommended barrier installation.
 - (5) Grind tarmac to a depth of 3" [76] and a width of x" [mm] to allow for recess of bridge rail on tarmac and installation of concrete formwork. After removal of formwork, fill voids with low-strength concrete.



Midwest Roadside
Safety Facility

TL-4 Bridge Rail
Test No. 4CBR-1

System Profile View

DWG. NAME.
4CBR-1_R14

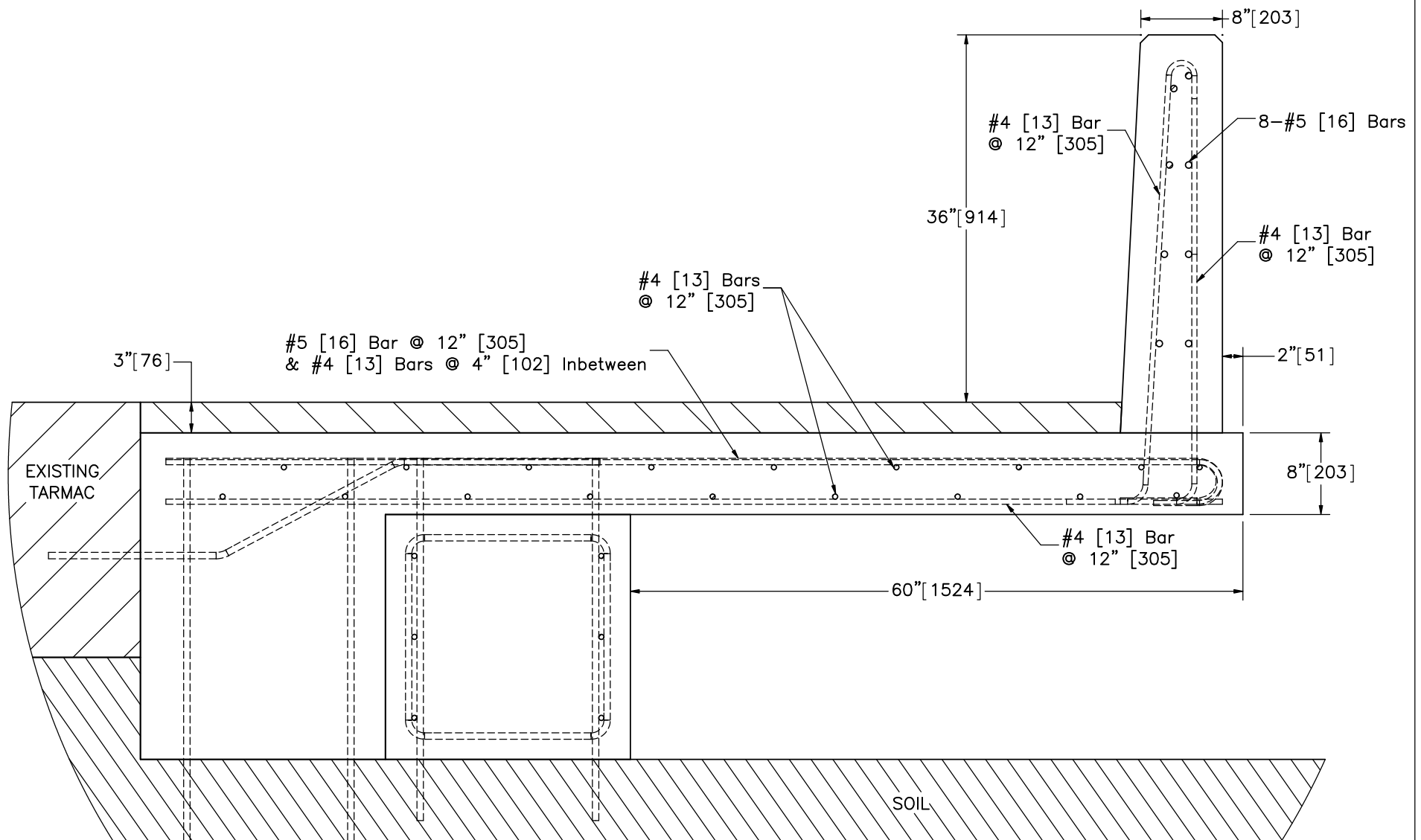
SCALE: 1:30
UNITS: in./mm

SHEET:
3 of 15

DATE:
9/13/2018

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REV. BY:
JEK/JD/RKF
/JCH



Midwest Roadside
Safety Facility

TL-4 Bridge Rail
Test No. 4CBR-1

Design Details

DWG. NAME.
4CBR-1_R14

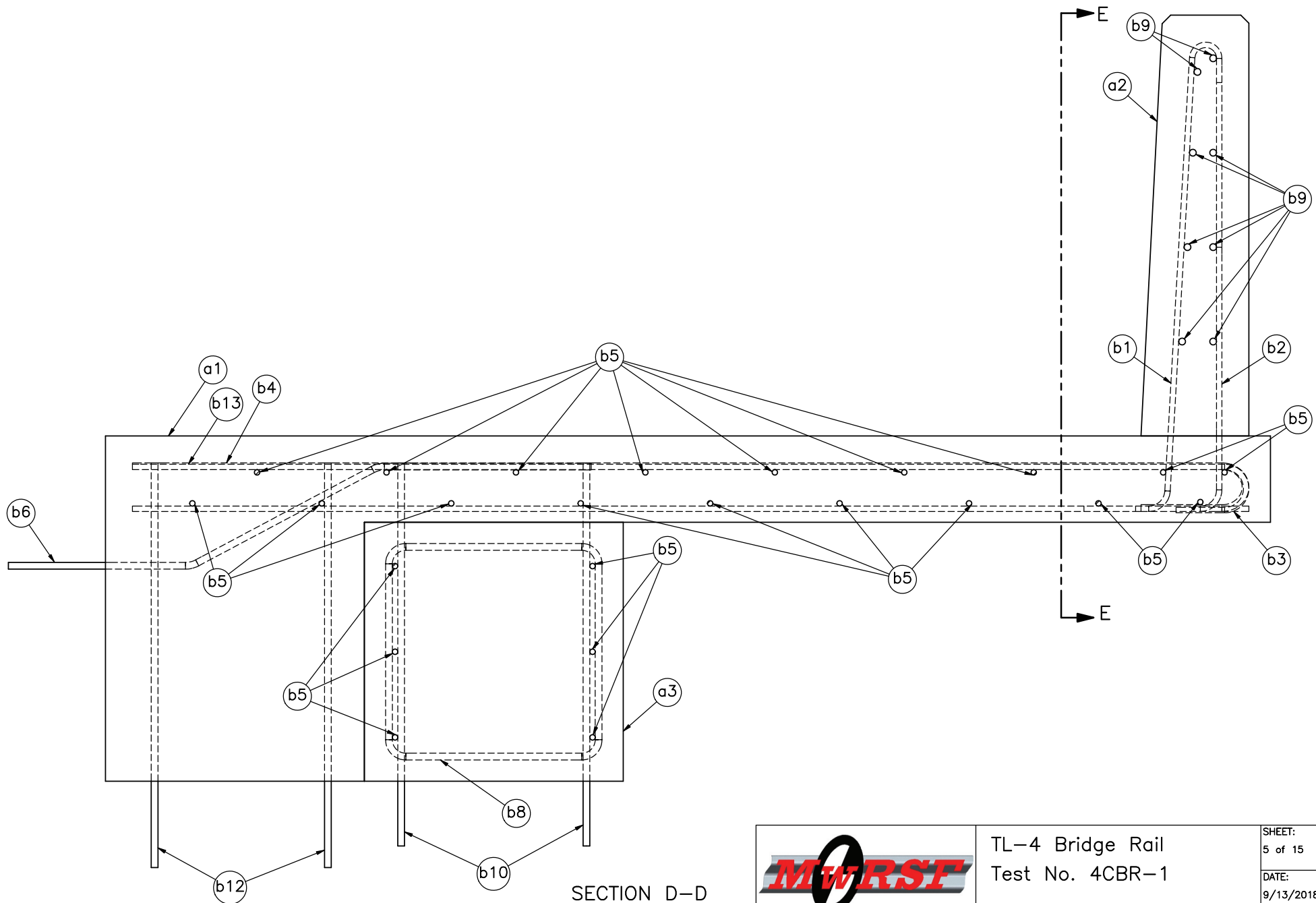
SCALE: 1:14
UNITS: in.[mm]

SHEET:
4 of 15

DATE:
9/13/2018

DRAWN BY:
MES/JEK

REV. BY:
JEK/JD/RKF
/JCH



- Notes: (1) Reinforcement bar nos. b10 and b12 are driven into soil.
 (2) Reinforcement bars no. b6 are anchored into the existing tarmac with chemical epoxy adhesive with a minimum bond strength of 1,450 psi [10.0 MPa].



Midwest Roadside
Safety Facility

TL-4 Bridge Rail
Test No. 4CBR-1

Concrete Rail, Deck and Box
Beam Assembly

DWG. NAME.
4CBR-1_R14

SCALE: 1:12
UNITS: in.[mm]

SHEET:
5 of 15

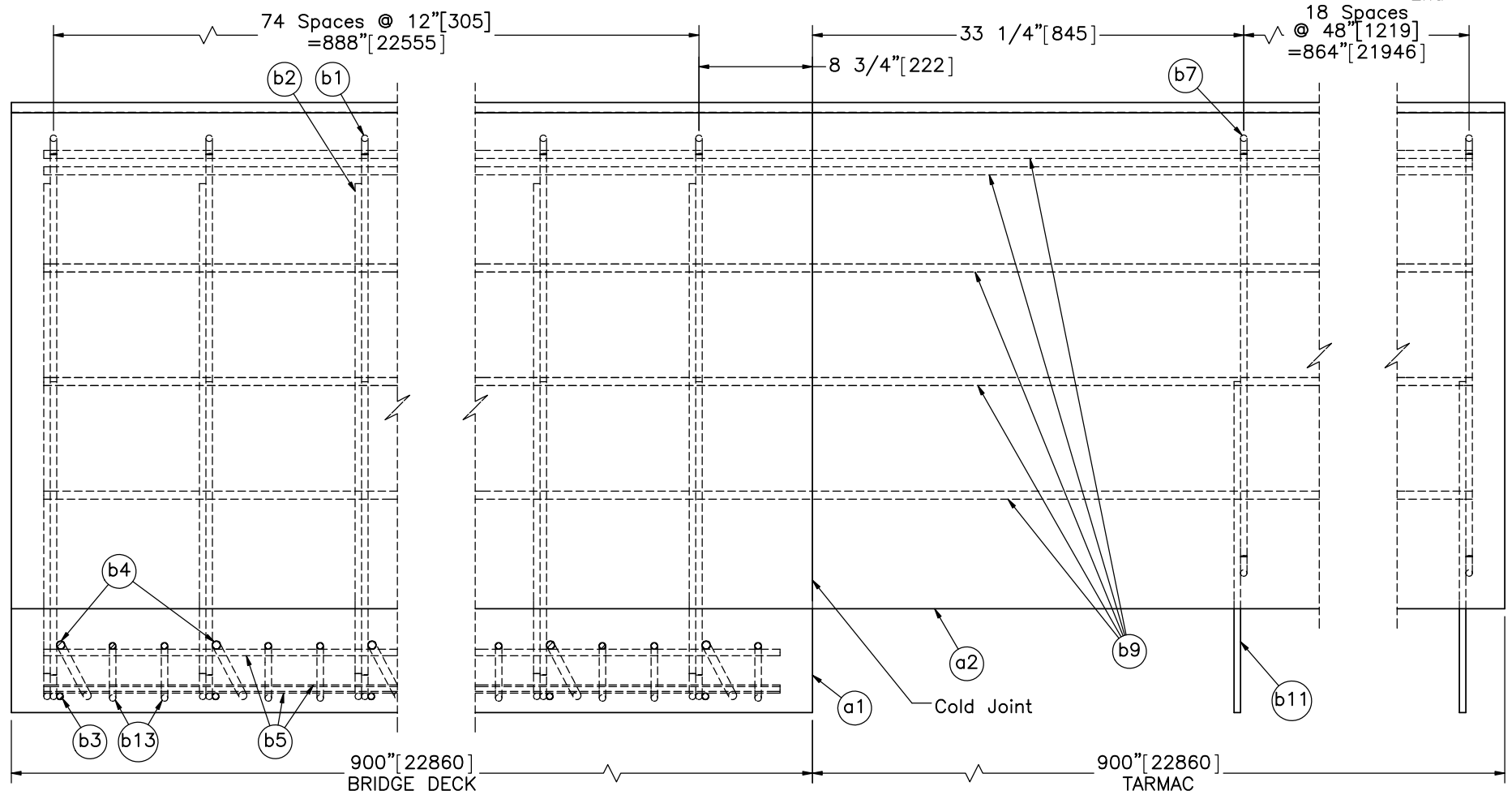
DATE:
9/13/2018

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MES/JEK

REV. BY:
JEK/JD/RKF
/JCH

Upstream
End

Downstream
End



SECTION E-E



Midwest Roadside
Safety Facility

TL-4 Bridge Rail
Test No. 4CBR-1

Bridge Deck and Rail Section

DWG. NAME.
4CBR-1_R14

SCALE: 1:12
UNITS: in.[mm]

SHEET:
6 of 15

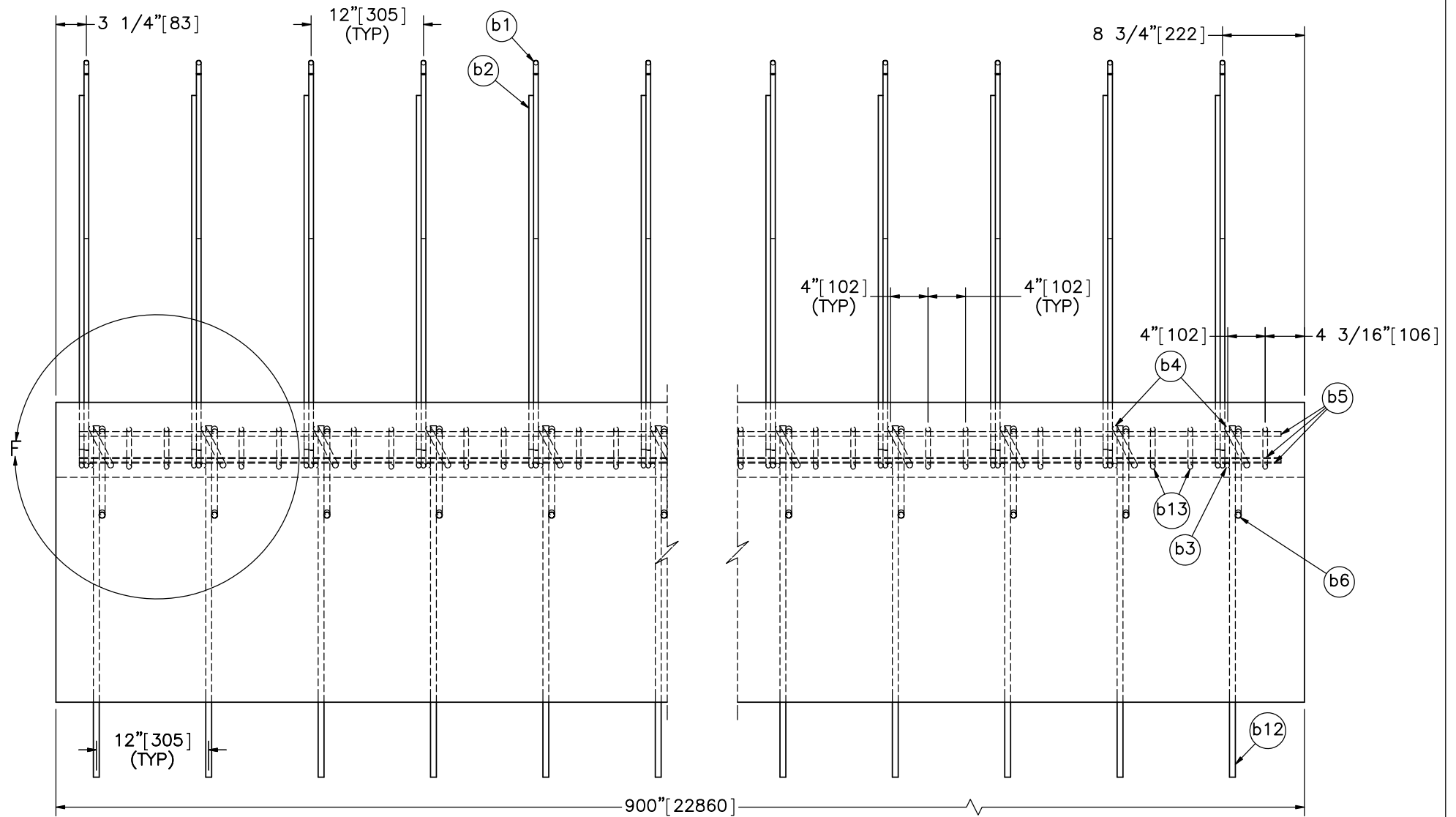
DATE:
9/13/2018

DRAWN BY:
MES/JEK

REV. BY:
JEK/JD/RKF
/JCH

Upstream
End

Downstream
End



ELEVATION VIEW

Note: (1) Only interior reinforcement details are shown herein for the crash testing program. End reinforcement details will be provided in the research report.



Midwest Roadside
Safety Facility

TL-4 Bridge Rail
Test No. 4CBR-1

Bridge Deck Assembly

DWG. NAME.
4CBR-1_R14

SCALE: 1:15
UNITS: in.[mm]

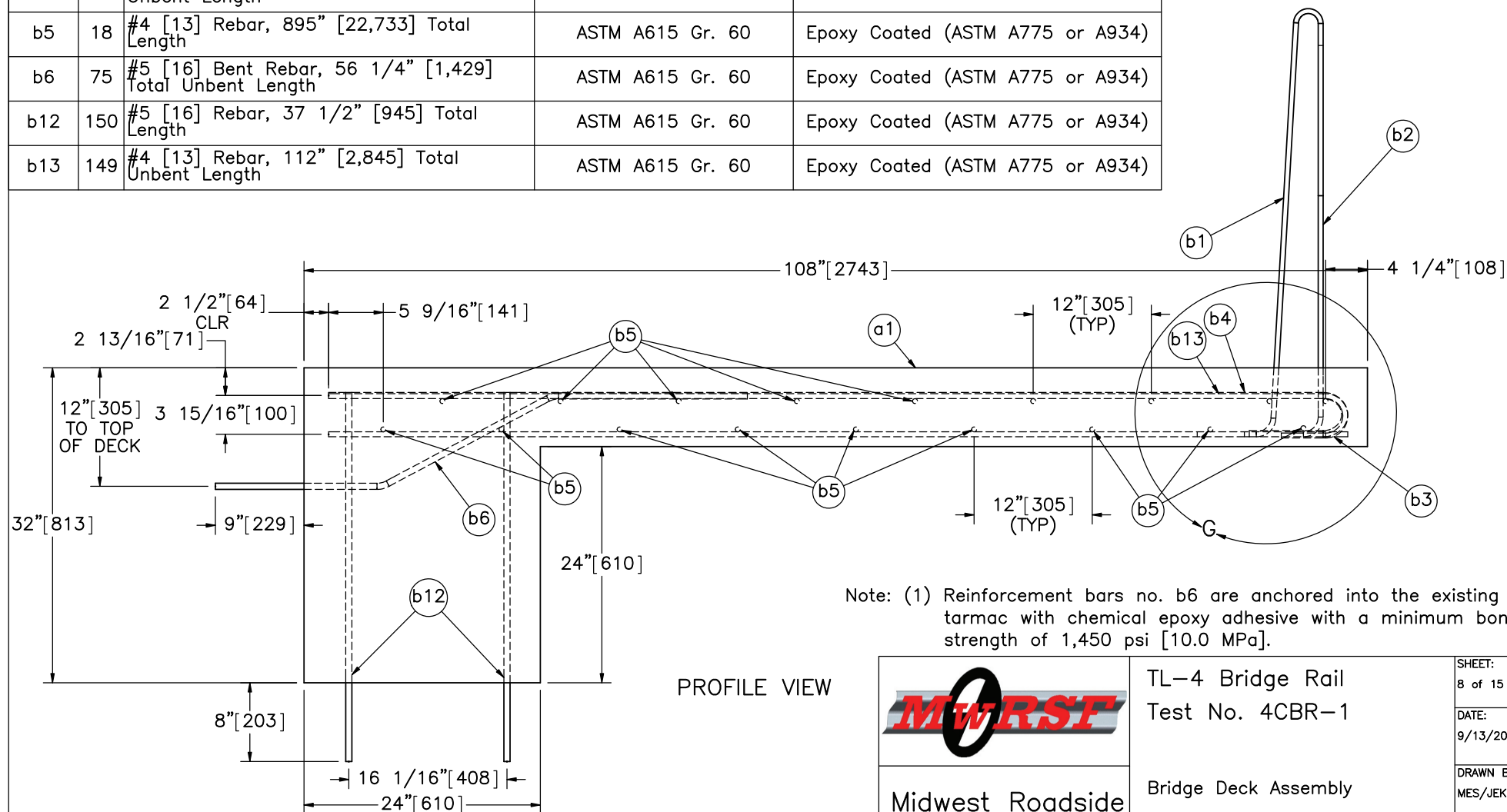
SHEET:
7 of 15

DATE:
9/13/2018

DRAWN BY:
MES/JEK

REV. BY:
JEK/JD/RKF/JCH

Item No.	QTY.	Description	Material Specification	Treatment Specification
—	1	Concrete Bridge Deck Assembly	—	—
a1	1	Bridge Deck Concrete	Min. $f'_c = 5,000$ psi [34.5 MPa] NE Mix L5500	—
b1	75	#4 [13] Rebar, 70 1/4" [1,784] Total Unbent Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b2	75	#4 [13] Rebar, 46 1/2" [1,181] Total Unbent Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b3	75	#4 [13] Rebar, 103 1/2" [2,629] Total Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b4	75	#5 [16] Rebar, 115 3/8" [2,931] Total Unbent Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b5	18	#4 [13] Rebar, 895" [22,733] Total Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b6	75	#5 [16] Bent Rebar, 56 1/4" [1,429] Total Unbent Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b12	150	#5 [16] Rebar, 37 1/2" [945] Total Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b13	149	#4 [13] Rebar, 112" [2,845] Total Unbent Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)



Note: (1) Reinforcement bars no. b6 are anchored into the existing tarmac with chemical epoxy adhesive with a minimum bond strength of 1,450 psi [10.0 MPa].

PROFILE VIEW



Midwest Roadside
Safety Facility

TL-4 Bridge Rail
Test No. 4CBR-1

Bridge Deck Assembly

DWG. NAME.
4CBR-1_R14

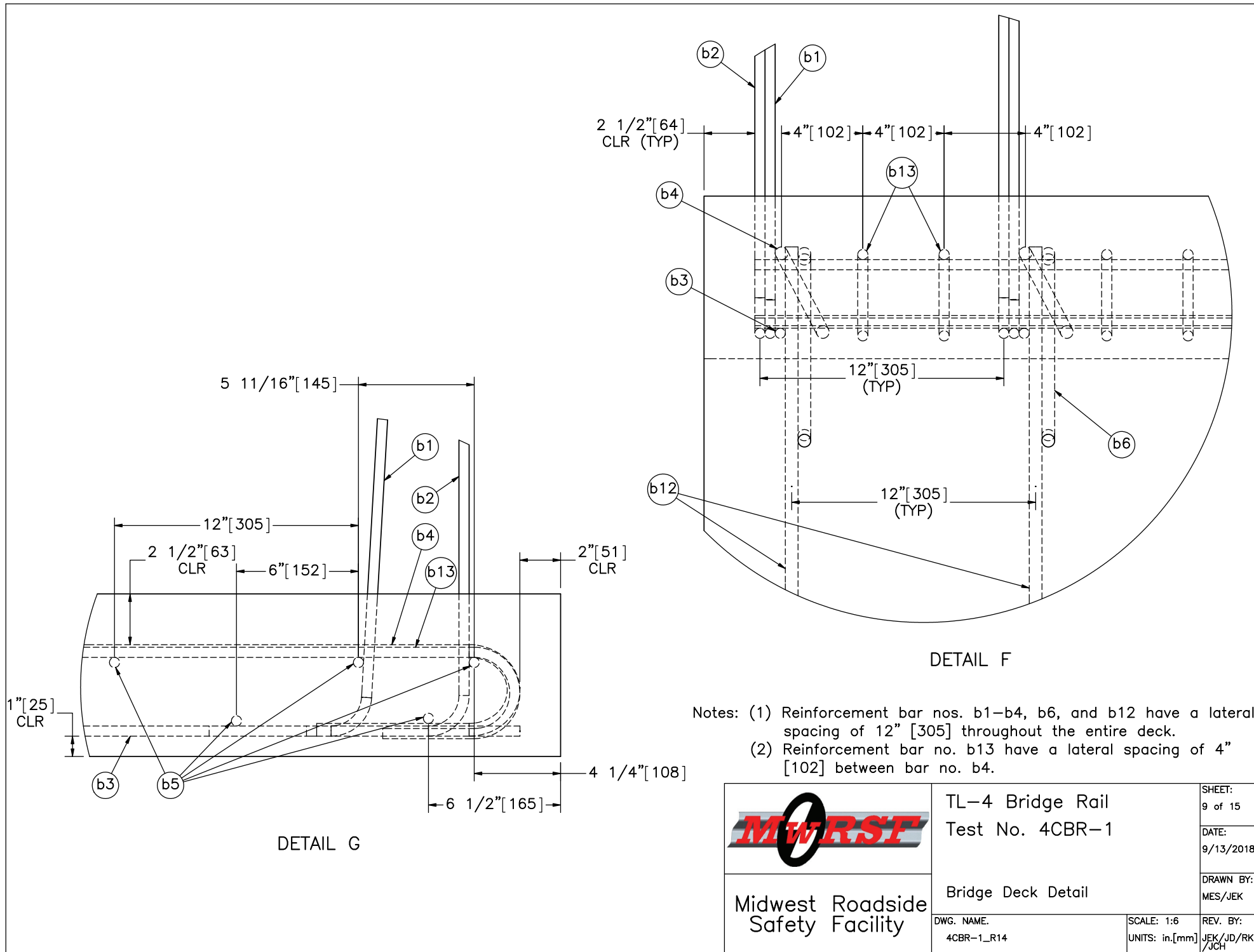
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UNITS: in.[mm]

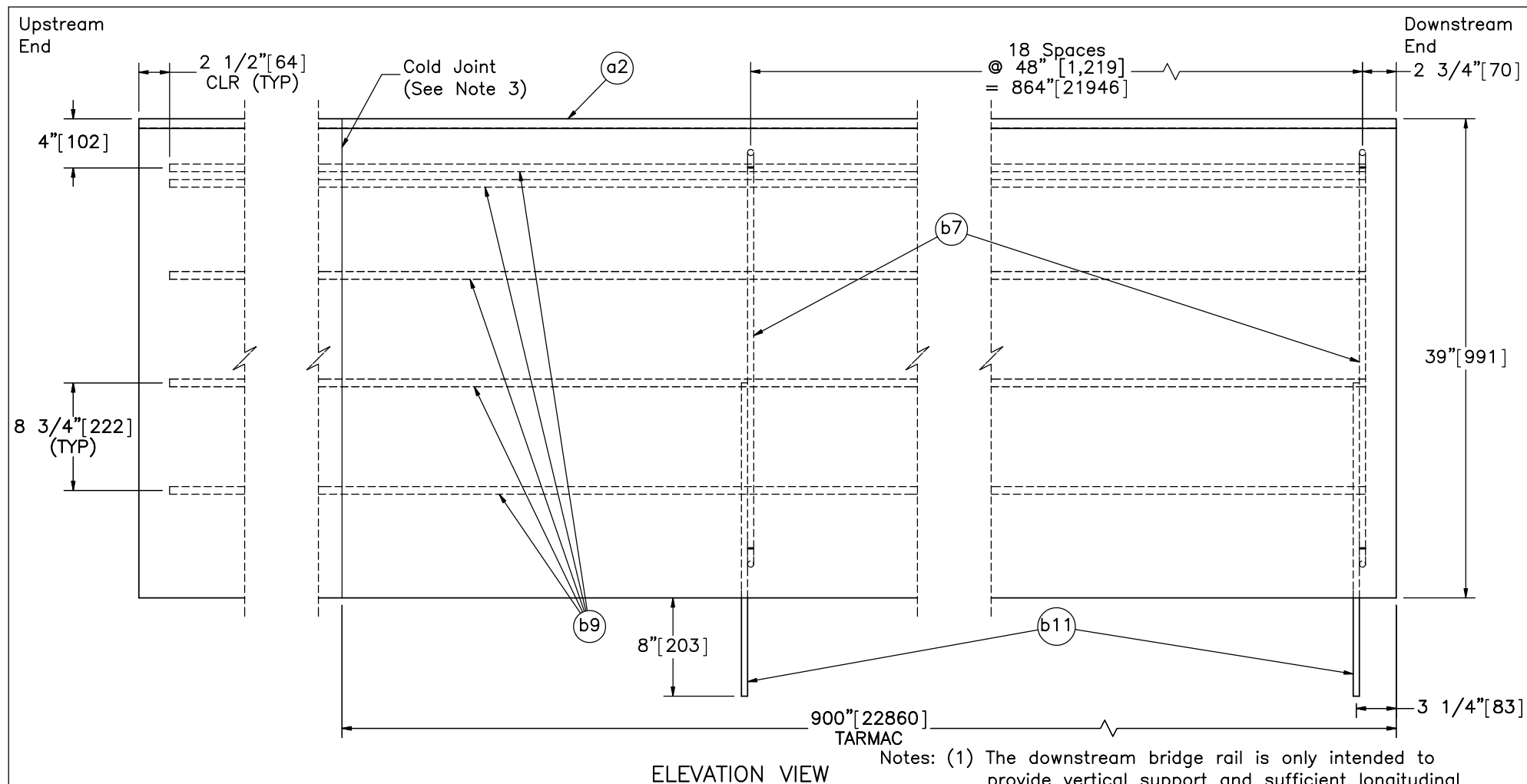
SHEET:
8 of 15

DATE:
9/13/2018

DRAWN BY:
MES/JEK

REV. BY:
JEK/JD/RKF/JCH





- Notes: (1) The downstream bridge rail is only intended to provide vertical support and sufficient longitudinal distance to evaluate vehicle stability beyond the primary impact event.
- (2) Bar no. b11 shall be epoxied into the tarmac.
- (3) When forming the cold joint, the longitudinal reinforcement should extend past the form end a distance equal to or greater than the minimum lap length for that reinforcing bar.

Item No.	QTY.	Description	Material Specification	Treatment Specification
—	1	Modified Bridge Rail Assembly	—	—
a2	1	Bridge Rail Concrete	Min. $f'_c = 5,000$ psi [34.5 MPa] NE Mix L5500	—
b7	19	#4 [13] Bent Rebar, 83 11/16" [2,126] Total Unbent Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b9	8	#5 [16] Rebar, 1,795" [45,593] Total Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b11	38	#4 [13] Rebar, 25 1/2" [648] Total Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)



Midwest Roadside
Safety Facility

TL-4 Bridge Rail
Test No. 4CBR-1

Modified Bridge Rail Assembly

DWG. NAME.
4CBR-1_R14

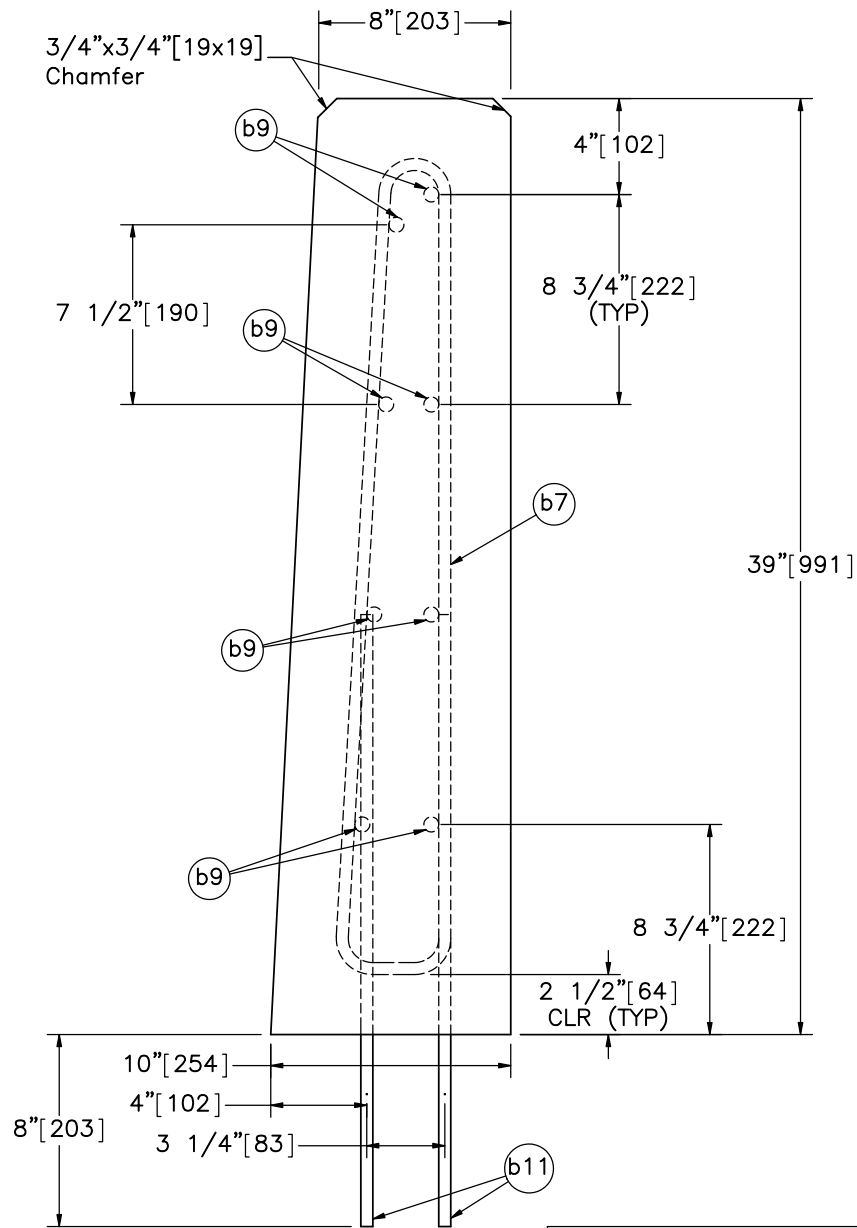
SCALE: 1:12
UNITS: in./mm

SHEET:
10 of 15

DATE:
9/13/2018

DRAWN BY:
MES/JEK

REV. BY:
JEK/JD/RKF/JCH



PROFILE VIEW

- Notes: (1) Reinforcement bar no. b11 is to be anchored into the existing tarmac with chemical epoxy adhesive with a min. bond strength of 1,450 psi [10.0 MPa].
- (2) The epoxy anchoring of bar no. b11 into the tarmac and rebar spacing is for testing purposes only and does not reflect the recommended barrier installation.
- (3) Wearing surface not shown. See sheet 3 for details.



Midwest Roadside
Safety Facility

TL-4 Bridge Rail
Test No. 4CBR-1

Bridge Rail Assembly

DWG. NAME.
4CBR-1_R14

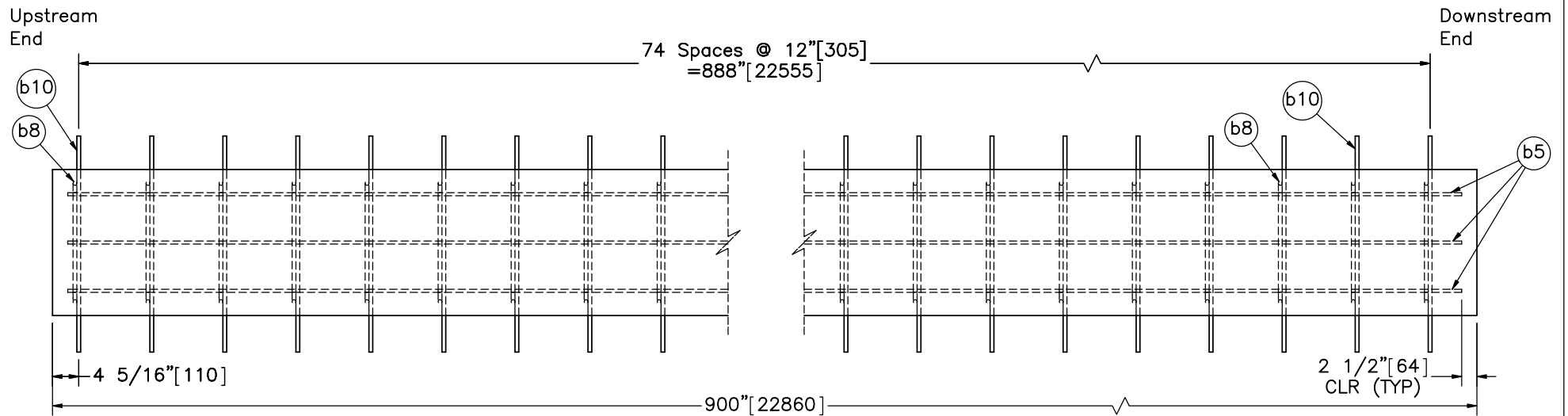
SCALE: 1:8
UNITS: in.[mm]

SHEET:
11 of 15

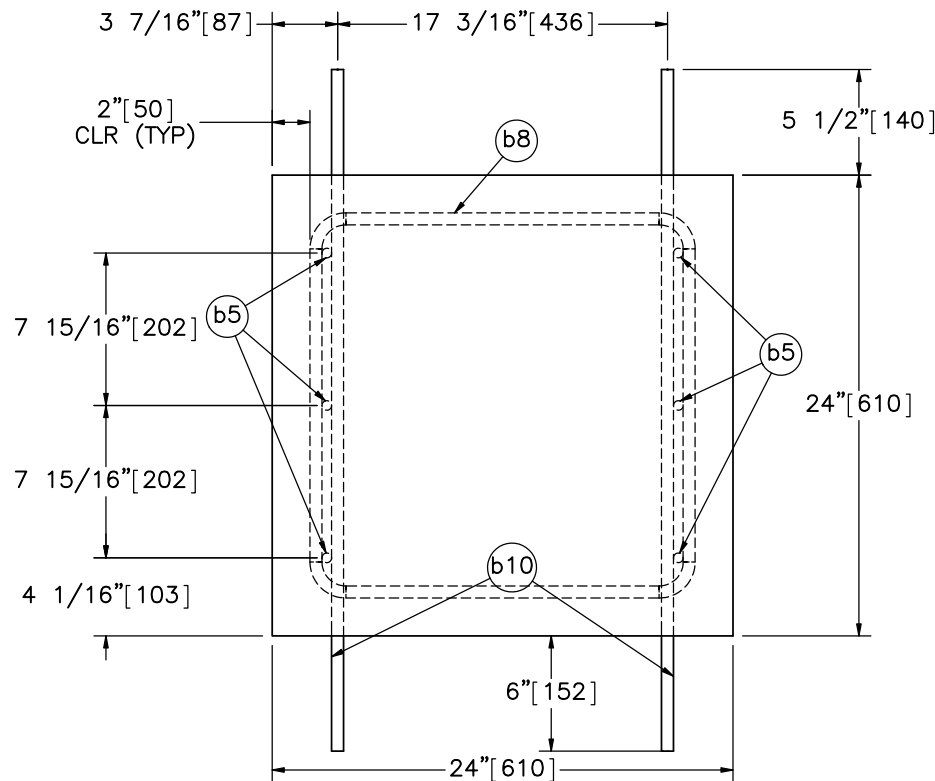
DATE:
9/13/2018

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MES/JEK

REV. BY:
JEK/JD/RKF
/JCH



ELEVATION VIEW



PROFILE VIEW
SCALE 1:10

Item No.	QTY.	Description	Material Specification	Treatment Specification
—	1	Concrete Grade Beam Assembly	—	—
a3	1	Grade Beam Concrete	Min. $f'_c = 4,000$ psi [27.6 MPa] NE Mix 47BD	—
b5	6	#4 [13] Rebar, 895" [22,733] Total Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b8	75	#5 [16] Bent Rebar, 87 1/16" [2,211] Total Unbent Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b10	150	#5 [16] Rebar, 35 1/2" [902] Total Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)



TL-4 Bridge Rail
Test No. 4CBR-1

Midwest Roadside
Safety Facility

Concrete Grade Beam Assembly

DWG. NAME.
4CBR-1_R14

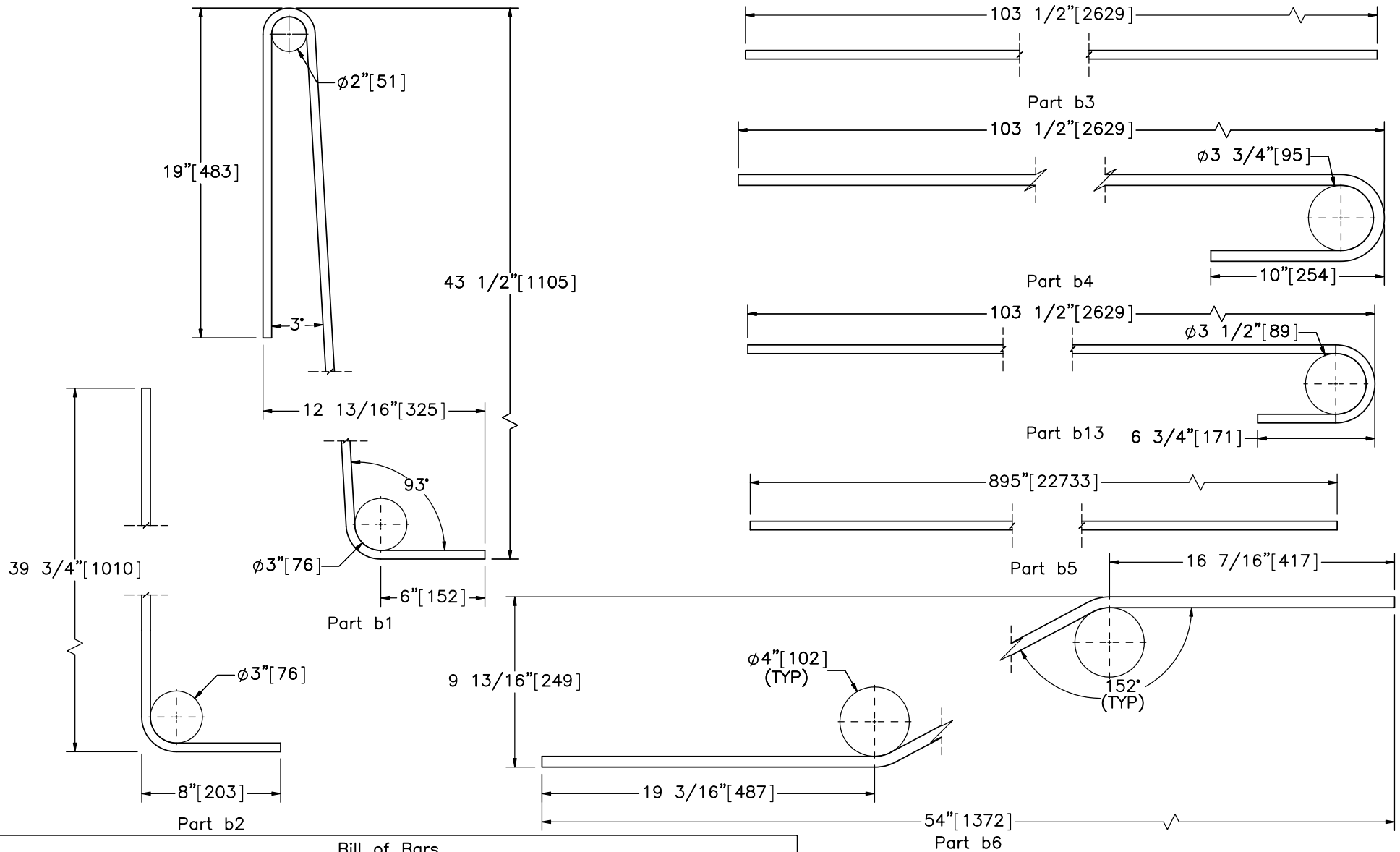
SCALE: 1:25
UNITS: in.[mm]

SHEET:
12 of 15

DATE:
9/13/2018

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MES/JEK

REV. BY:
JEK/JD/RKF/JCH



Bill of Bars

Bar	QTY	Size	Total Length	Min. Lap Length	Material
b1	75	#4 [13]	70 1/4" [1,784]	—	ASTM A615 Gr. 60
b2	75	#4 [13]	46 1/2" [1,181]	—	ASTM A615 Gr. 60
b3	75	#4 [13]	103 1/2" [2,629]	18" [457]	ASTM A615 Gr. 60
b4	75	#5 [16]	115 3/8" [2,931]	—	ASTM A615 Gr. 60
b5	24	#4 [13]	895" [22,733]	18" [457]	ASTM A615 Gr. 60
b6	75	#5 [16]	56 1/4" [1,429]	—	ASTM A615 Gr. 60
b13	149	#4 [13]	112" [2,845]	—	ASTM A615 Gr. 60



Midwest Roadside
Safety Facility

TL-4 Bridge Rail
Test No. 4CBR-1

System Rebar

DWG. NAME.
4CBR-1_R14

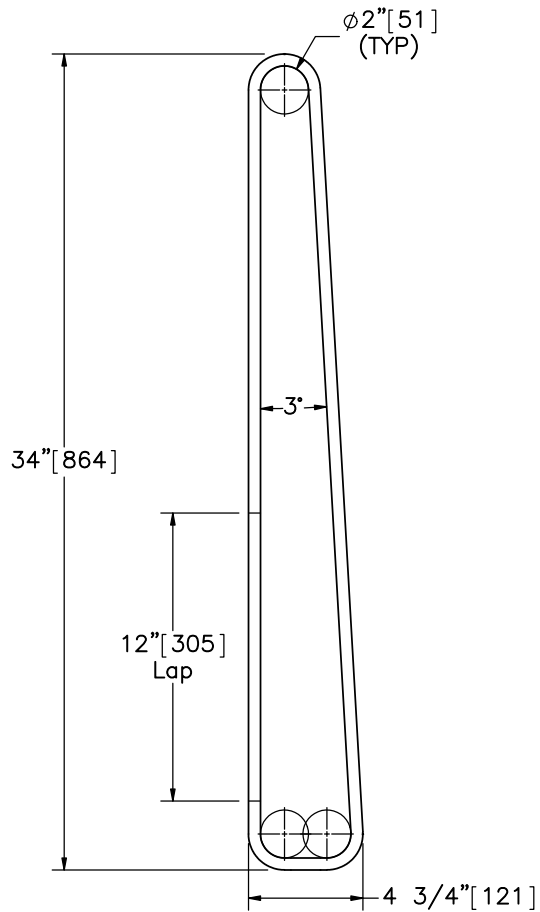
SCALE: 1:8
UNITS: in./mm

SHEET:
13 of 15

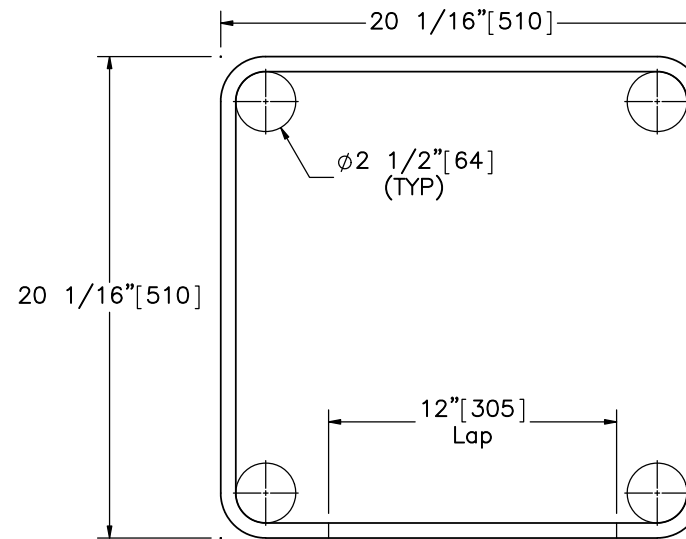
DATE:
9/13/2018

DRAWN BY:
MES/JEK

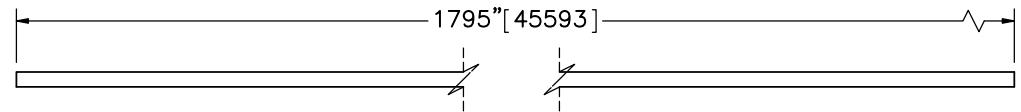
REV. BY:
JEK/JD/RKF/JCH



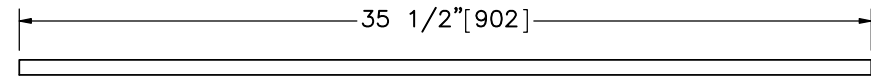
Part b7



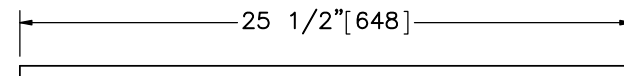
Part b8



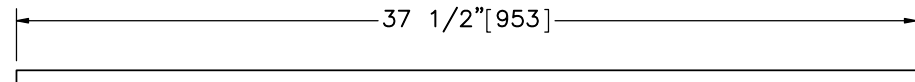
Part b9



Part b10



Part b11



Part b12

Bill of Bars

Bar	QTY	Size	Total Length	Min. Lap Length	Material
b7	19	#4 [13]	83 11/16" [2,126]	18" [457]	ASTM A615 Gr. 60
b8	75	#5 [16]	87 1/16" [2,211]	25 1/2" [648]	ASTM A615 Gr. 60
b9	8	#5 [16]	1,795" [45,593]	25 1/2" [648]	ASTM A615 Gr. 60
b10	150	#5 [16]	35 1/2" [902]	—	ASTM A615 Gr. 60
b11	38	#4 [13]	25 1/2" [648]	—	ASTM A615 Gr. 60
b12	150	#5 [16]	37 1/2" [945]	—	ASTM A615 Gr. 60



Midwest Roadside
Safety Facility

TL-4 Bridge Rail
Test No. 4CBR-1

System Rebar

DWG. NAME.
4CBR-1_R14

SCALE: 1:8
UNITS: in./mm

SHEET:
14 of 15

DATE:
9/13/2018

DRAWN BY:
MES/JEK

REV. BY:
JEK/JD/RKF
/JCH

Item No.	QTY.	Description	Material Specification	Treatment Specification
a1	1	Bridge Deck Concrete	Min. f'_c = 5,000 psi [34.5 MPa] NE Mix L5500	—
a2	1	Bridge Rail Concrete	Min. f'_c = 5,000 psi [34.5 MPa] NE Mix L5500	—
a3	1	Grade Beam Concrete	Min. f'_c = 4,000 psi [27.6 MPa] NE Mix 47BD	—
a4	1	Overlay	Concrete NE Mix 9019 CITY	—
b1	75	#4 [13] Rebar, 70 1/4" [1,784] Total Unbent Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b2	75	#4 [13] Rebar, 46 1/2" [1,181] Total Unbent Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b3	75	#4 [13] Rebar, 103 1/2" [2,629] Total Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b4	75	#5 [16] Rebar, 115 3/8" [2,931] Total Unbent Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b5	24	#4 [13] Rebar, 895" [22,733] Total Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b6	75	#5 [16] Bent Rebar, 56 1/4" [1,429] Total Unbent Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b7	19	#4 [13] Bent Rebar, 83 11/16" [2,126] Total Unbent Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b8	75	#5 [16] Bent Rebar, 87 1/16" [2,211] Total Unbent Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b9	8	#5 [16] Rebar, 1,795" [45,593] Total Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b10	150	#5 [16] Rebar, 35 1/2" [902] Total Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b11	38	#4 [13] Rebar, 25 1/2" [648] Total Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b12	150	#5 [16] Rebar, 37 1/2" [945] Total Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
b13	149	#4 [13] Rebar, 112" [2,845] Total Unbent Length	ASTM A615 Gr. 60	Epoxy Coated (ASTM A775 or A934)
—	1	Epoxy	Min. bond strength = 1,450 psi [10.0 MPa]	—
—	1	Releasing Agent/Medium	1/4" [6] Thick Polyethylene Plastic ASTM D4397	—



Midwest Roadside
Safety Facility

TL-4 Bridge Rail
Test No. 4CBR-1

Bill of Materials

DWG. NAME.
4CBR-1_R14

SCALE: 1:200
UNITS: in./mm

SHEET:
15 of 15

DATE:
9/13/2018

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MES/JEK

REV. BY:
JEK/JD/RKF
/JCH

REV.	DATE OF ISSUE	Page	NATURE OF CHANGES	REVIEWER	REVISED BY
0	12/25/2018	–	Drawing created from drawings from Jeremiah.	–	MES
1	1/29/2018	1	Added annotations and source for section view B–B.	JEK	MES
		2	Added annotation.		
		3	Added new sheet with new section view B–B.		
		4	Edited annotations and notes 1 and 2.		
		5	Edited dimensions and note. Added note two.		
		6	Added note and corrected bill of materials.		
		7	Edited note one and dimension.		
		8	Edited annotations and corrected bill of materials		
		9	Edited dimensions and note one.		
		10	Edited annotations and corrected bill of materials		
		11	Edited dimensions and added lap lengths part nos. b3–b5.		
		12	Edited dimensions and added lap lengths part no. b9. Changed length and lap length for part nos. b7 and b8.		
		BOM	Edited description for part nos. a1–b2, b5, b7–b12.		
2	2/2/2018	1	Adjusted section views.	JEK/JD	MES
		2	Edited annotations. Added profile view. Dropped barrier 3" below tarmac and added overlay. Added notes 2–4.		
		3	Edited note 1 and 2.		
		4	Reduced end rebar spacing to a consistent 12" throughout deck.		
		5	Reduced end rebar spacing to a consistent 12" throughout deck. Edited note 1. Changed part quantity for part nos. b1, b2, and b4.		
		6	Edited note 1 and added note 2.		
		7	Changed rebar spacing to a consistent 48". Edited part quantity for part nos. b7 and b11. Added note 1.		
		8	Edited note 1 and added note 2. Shifted the traffic side top longitudinal rebar down to accomodate concrete size.		
		10	Edited dimensions. Removed lap length for part nos. b3 and b4. Edited size and length for part no. b6.		
		12	Edited dimensions. Corrected length for part nos. b7 and b12.		
		BOM	Edited part description for part nos. b6, b7, and b9. Changed part quantities for part nos. b1, b2, b4, b7, and b11.		
		2	General shift.		

3	2/5/2018	3	Note 2 edit.	JEK	JEK
		4	Note 1 remove.		
		6	Dim remove.		
		10	Lap length removed (b5).		
		11	Lap length removed (b9).		
4	2/12/2018	–	New pages: 2,4,6. Section/detail re-lettering.	RKF	JEK
		1	Note 3 add. Label add.		
		3	Note 2 edit. Note 5 add. Label edit. Ground down tarmac add/noted.		
		5	Note 1-2 edits. Section line add. Bubble adds.		
		7	Note 1 edit.		
		8	Note 1 edit.		
		9	Note 1 edit.		
		10	Note edits. Page title/assembly name edit.		
		11	Label add.		
		13-14	Quantity corrections.		
5	2/15/2018	3	Note 1 edit.	RKF	JEK
		8	Table shift.		
		9	Note 2 removed.		
		10	Note 3 removed.		
		13-14	Column with min. lap length added to bill of bars tables.		
6	3/7/2018	–	System flipped for construction location. US/DS labels swapped wherever applicable. Edits to top lateral bar (b4) and "crank" (b6).	JD/JCH	JEK
		4	Label for top lateral bar edited.		
		7	Additional b4 labels. B4 spacing dim add.		
		8	Dim add.		
		9	Note 1 edit. Note 2 add. Dim add. General shift.		
		13	Bar b4, b6 changes. Size change: b4. Length change: b3, b4, b6.		
		BOM	Qty: b4. Description: b3, b4, b6.		
7	3/12/2018	–	Drawing renamed from TL4_Bridge_Rail to 4CBR-1.	JCH	JEK
8	4/5/2018	4	Longitudinal barrier bar size corrected.	JD	JEK
		13	Qty: b4. Size: b5. Corrected to match BOM.		
9	4/5/2018	13-14	Updated rebar dimensioning to new standards.	JCH	JEK
10	4/6/2018	–	Cold joint notes and lines added. Dividing line wherever rail appears, notes on sheets 1 and 10.	JD	JEK

11	5/4/2018	—	Bar b4 rotated in deck.	JCH/JD	JEK
		2-3	Part a4 add to note.		
		13	Bar b4 edits. Bar b4 length edit. Additional lap lengths added to bill of bars table.		
		14	Additional lap lengths added to bill of bars table.		
		BOM	New: a4, epoxy, release agent. Description: b4. Mtrl: a1, a2.		
12	5/4/2018	3	Note 3 edit.	JD	JEK
		8	Part a1 material correction.		
13	5/17/2018	4	Callout edit.	JD	JEK
		5	Label add.		
		6	Label add/edits.		
		7	Label add/edits. Dim adds.		
		8	Label add. BOM add (b13).		
		9	Label add/edits. Note edits.		
		13	Part b13 add. Table edits.		
		BOM	New: b13. Qty: b4.		
14	9/13/2018	1	Impact location edit. Note 2 edit.	JD	JEK