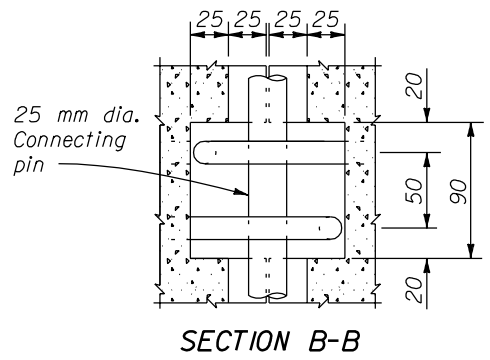
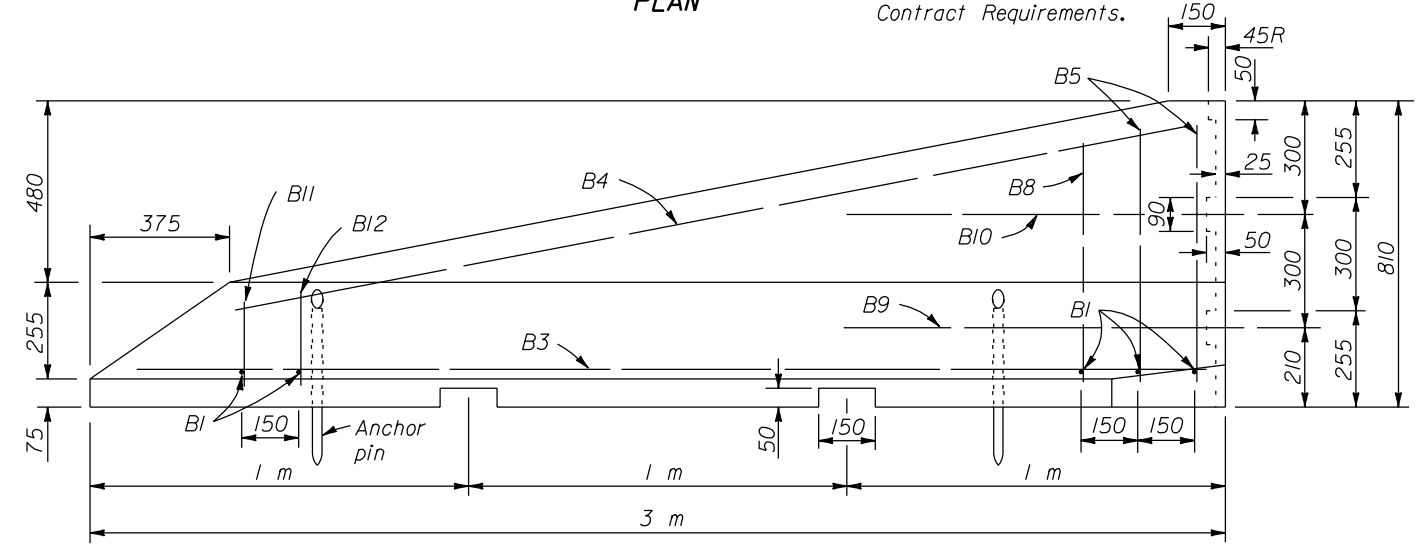
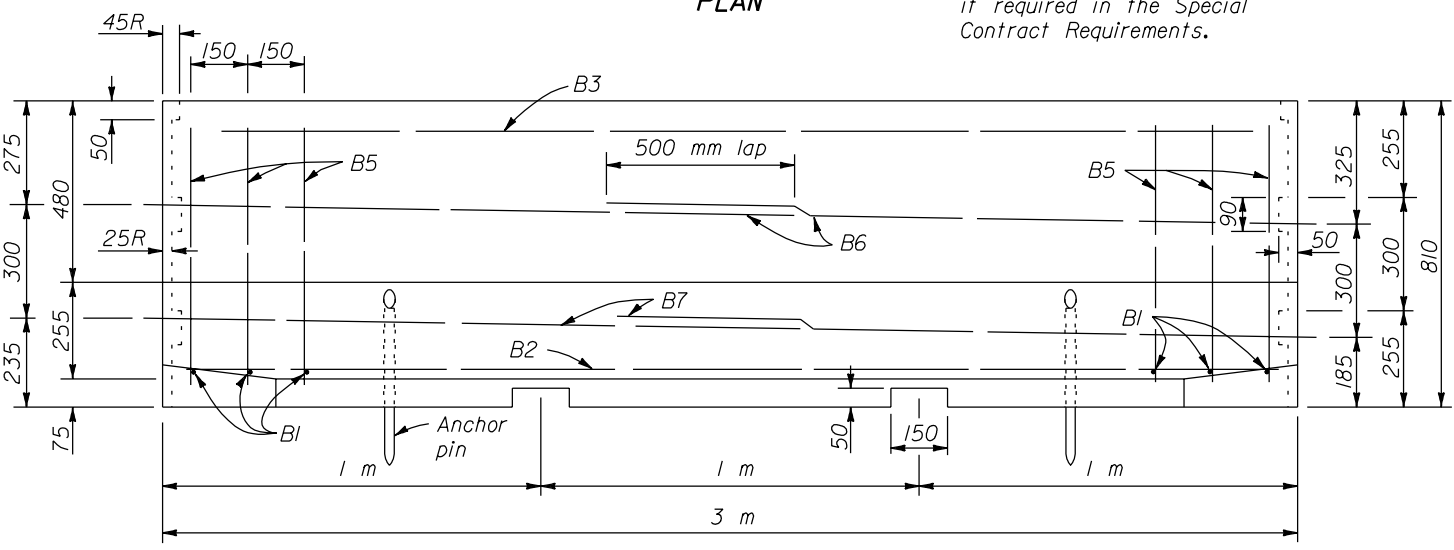
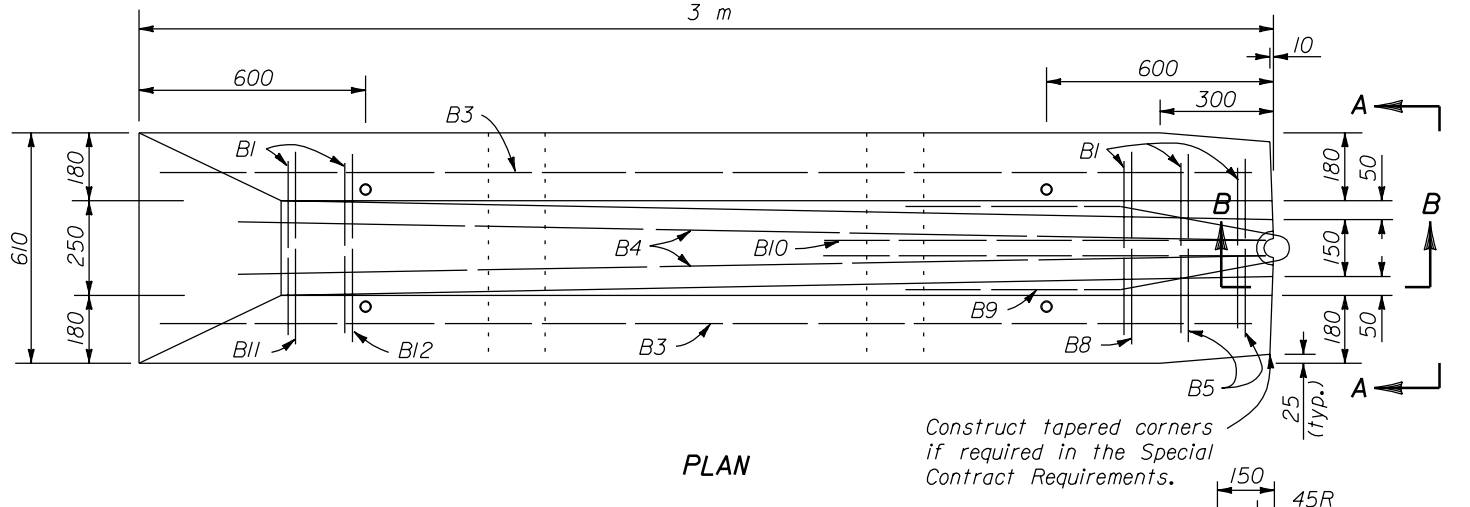
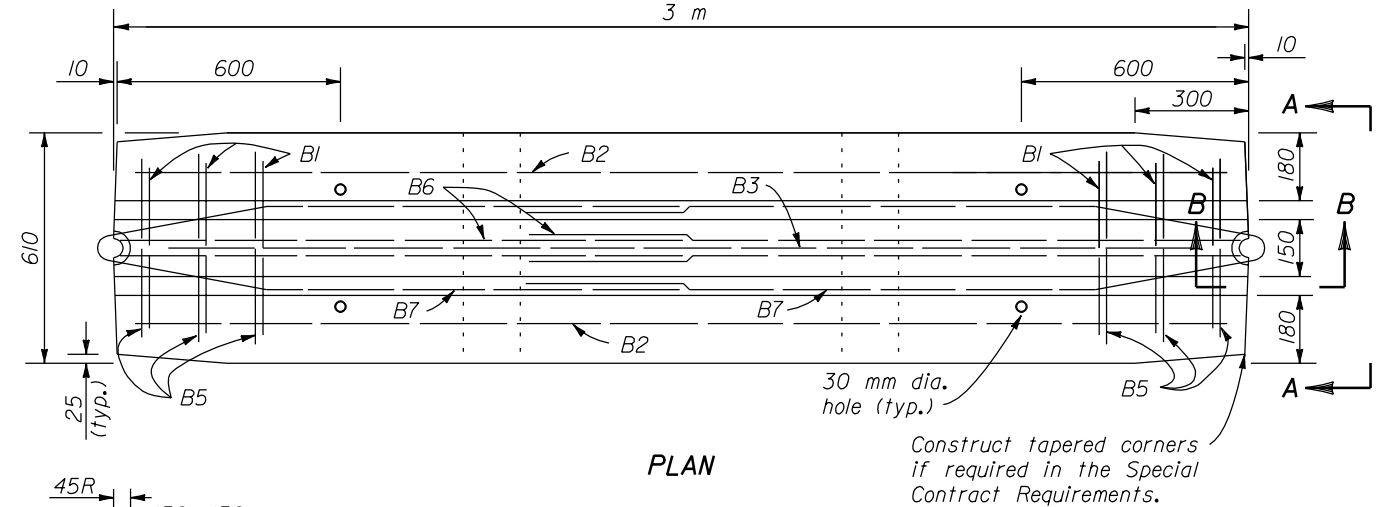
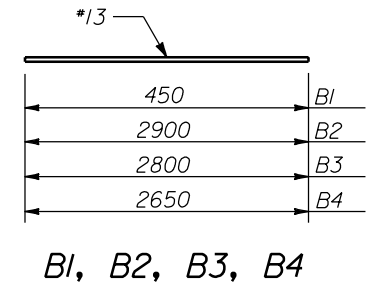


- NOTE:**
- Dimensions not labeled are in millimeters.
  - Provide for a clear cover of 50 mm for all reinforcing steel except as noted.
  - Galvanized anchor pin, connecting pin and area shown on reinforcement bars B6, B7, B9, and B10 in accordance with AASHTO M232 after fabrication.
  - Embedded inserts may be used for lifting and handling. Submit details for the inserts for approval.



ELEVATION BARRIER SECTION



ELEVATION TERMINAL SECTION

U.S. DEPARTMENT OF TRANSPORTATION  
FEDERAL HIGHWAY ADMINISTRATION  
FEDERAL LANDS HIGHWAY

METRIC STANDARD

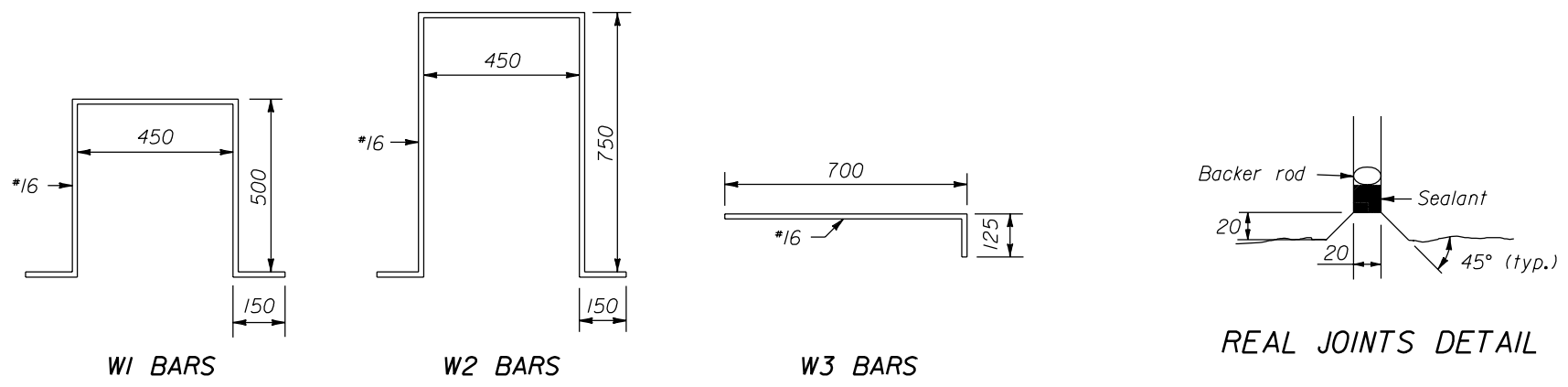
CONCRETE BARRIER

STANDARD APPROVED FOR USE 3/1996  
REVISED: 12/1998

STANDARD  
M618-1

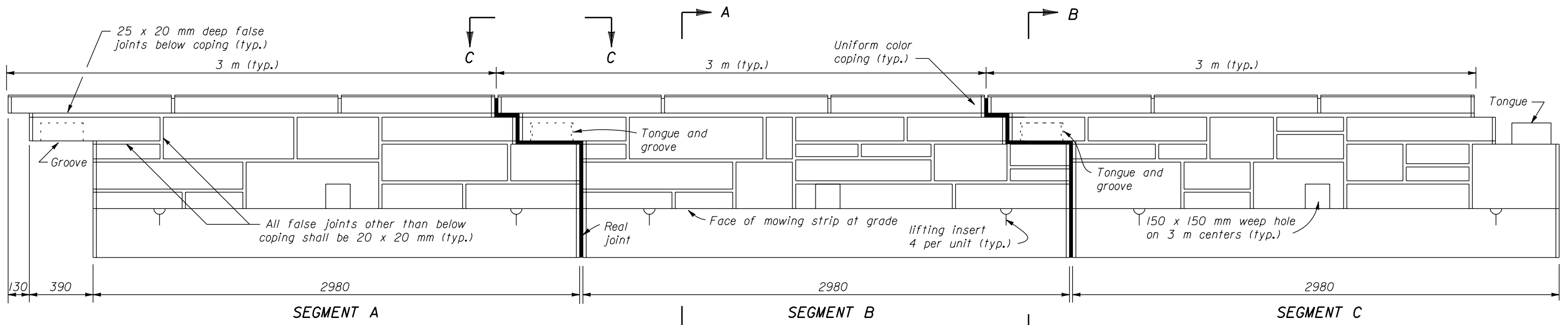
NO SCALE

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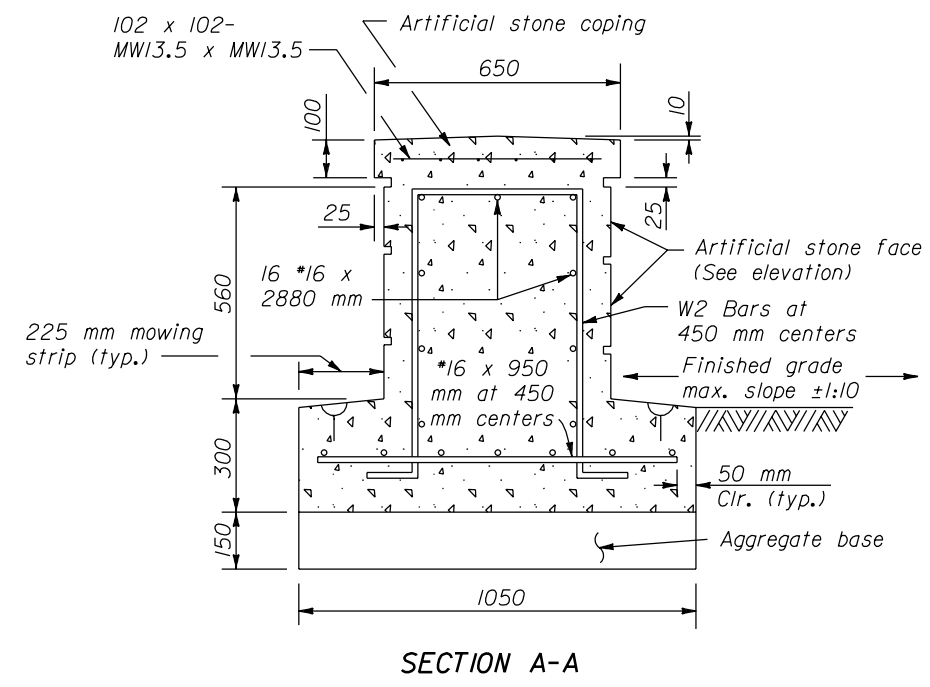


BENDING DIAGRAMS

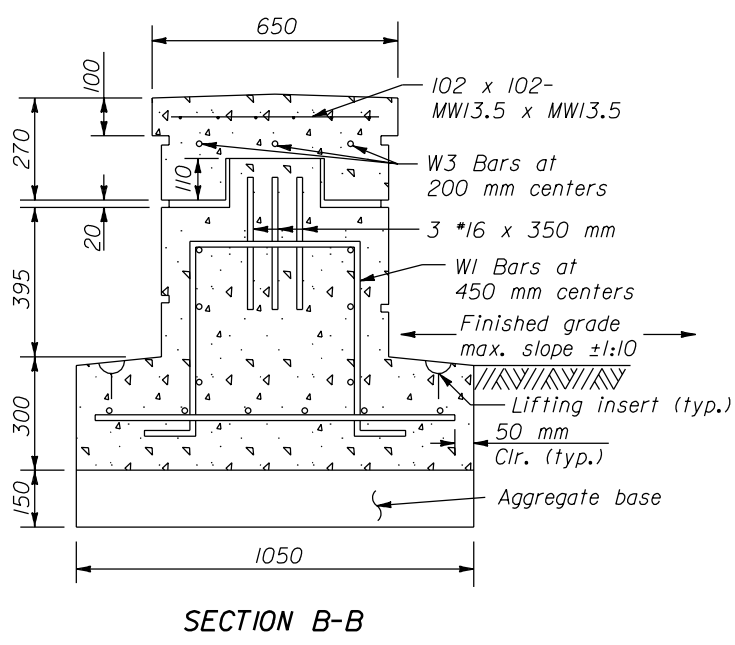
- NOTE:**
- Dimensions not labeled are in millimeters.
  - Each unit consists of three segments each of which have a different random masonry pattern as shown. All three segments are to interlock with each other to vary the order.
  - Sealant for the real joint covers the perimeter joint of the capstone, sides, and top and sides of the footing.
  - Precast the entire wall section, no cast-in-place is allowed.
  - Minimum concrete cover 50 mm unless shown otherwise.



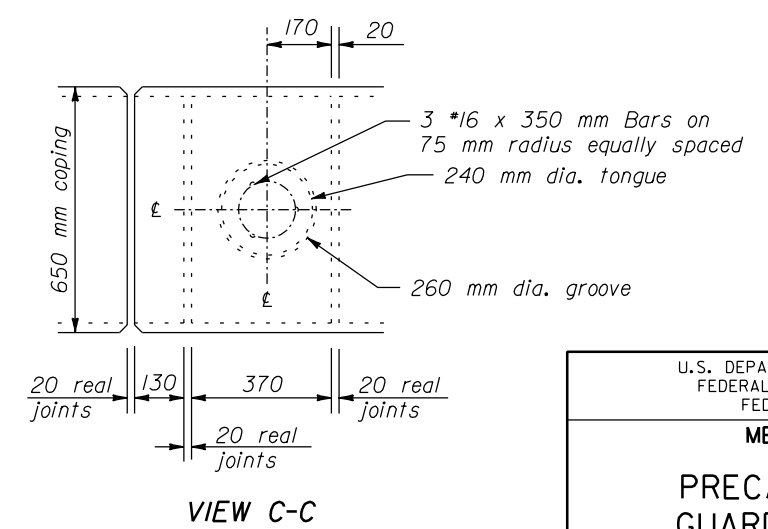
ELEVATION  
PRECAST CONCRETE GUARDWALL



SECTION A-A



SECTION B-B



VIEW C-C

U.S. DEPARTMENT OF TRANSPORTATION  
FEDERAL HIGHWAY ADMINISTRATION  
FEDERAL LANDS HIGHWAY

**METRIC STANDARD**

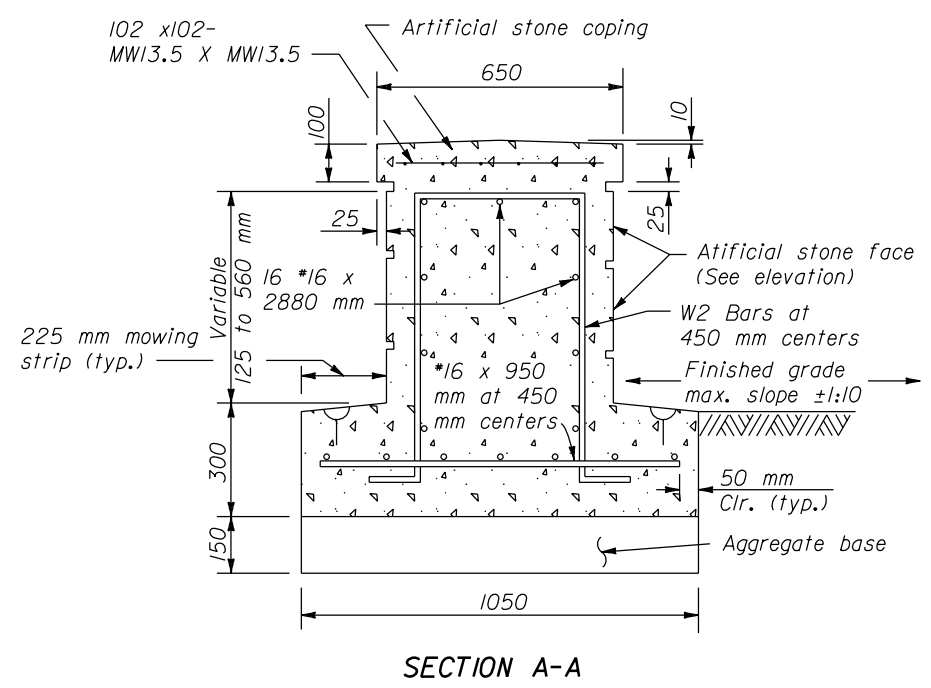
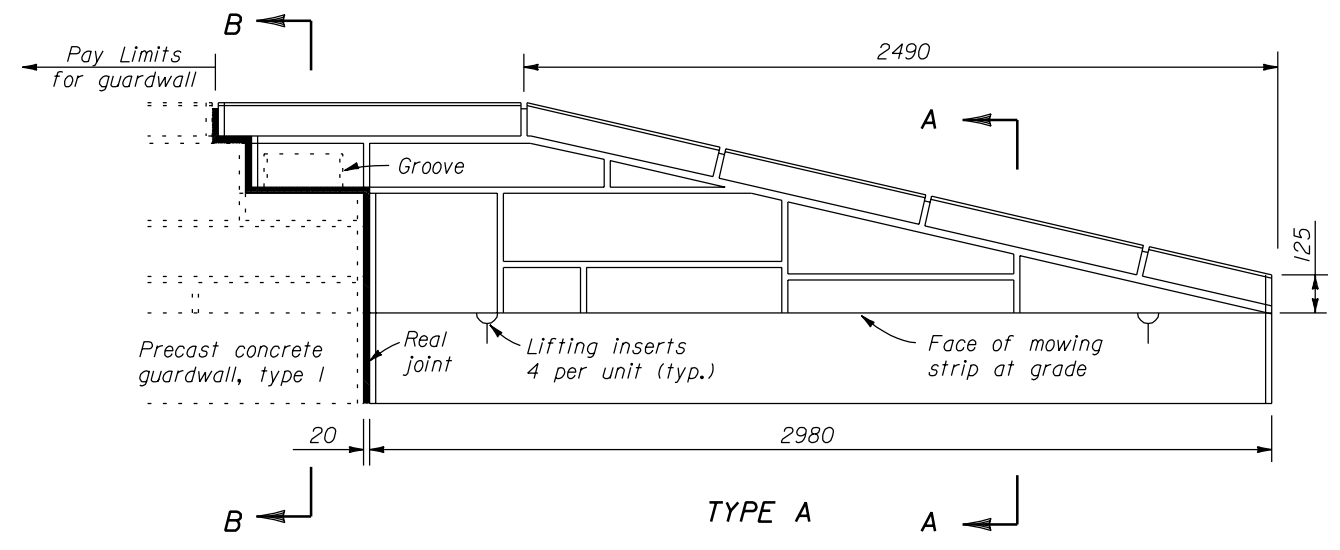
**PRECAST CONCRETE  
GUARDWALL, TYPE I**

STANDARD APPROVED FOR USE 3/1996  
REVISED: 6/1997

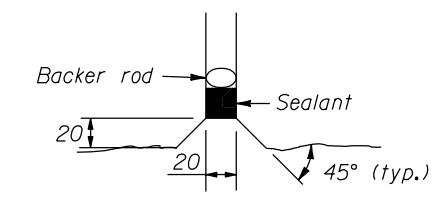
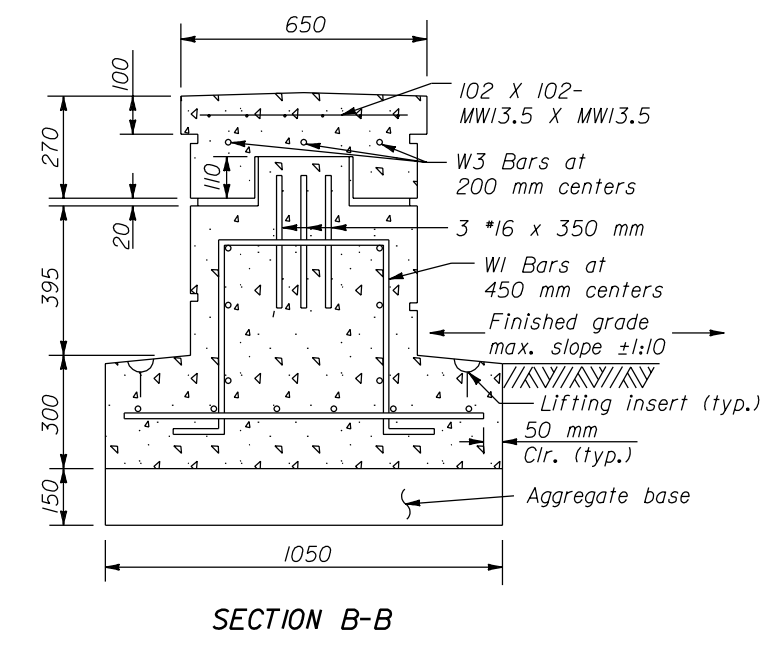
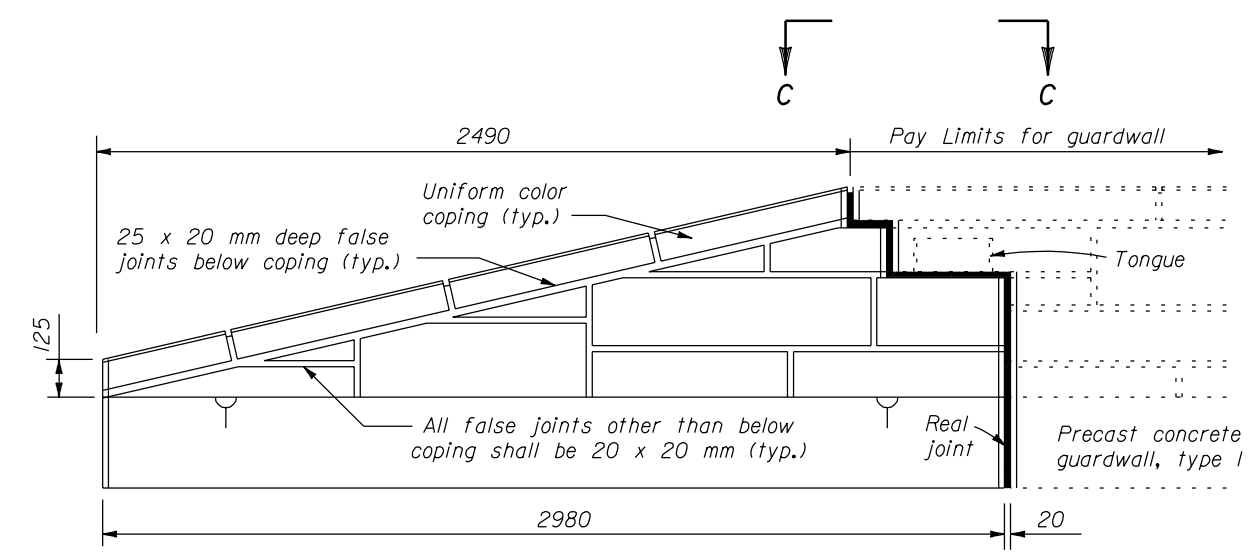
STANDARD  
M618-2

NO SCALE

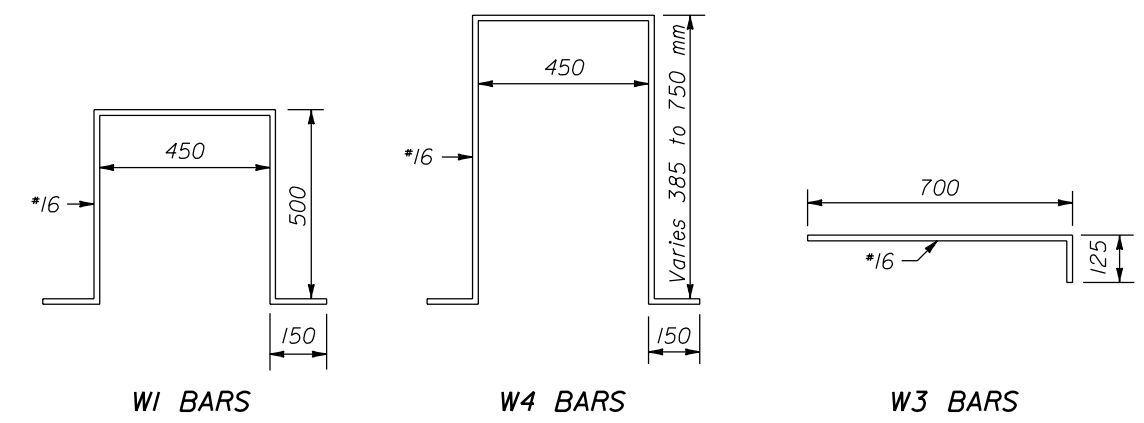
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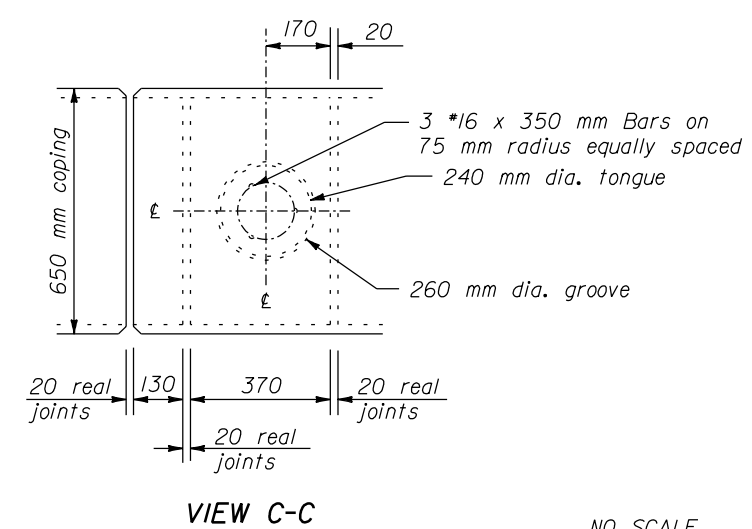
- NOTE:**
- Dimensions not labeled are in millimeters.
  - Terminal sections, Type A and Type B, are to interlock with any of the precast concrete guardwall segments.
  - Sealant for the real joint covers the perimeter joint of the capstone, sides, and top and sides of the footing.
  - Precast the entire wall section, no cast-in-place is allowed.
  - Unless located outside the clear zone, use terminal sections Type A and B with an earth berm as detailed on Standard M204-1, Earth Berm for Roadside Barrier Terminal Sections, and M204-2, Earth Berm for Median Barrier Terminal Sections.
  - Minimum concrete cover 50 mm unless shown otherwise.



REAL JOINTS DETAIL



BENDING DIAGRAMS



NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION  
FEDERAL HIGHWAY ADMINISTRATION  
FEDERAL LANDS HIGHWAY

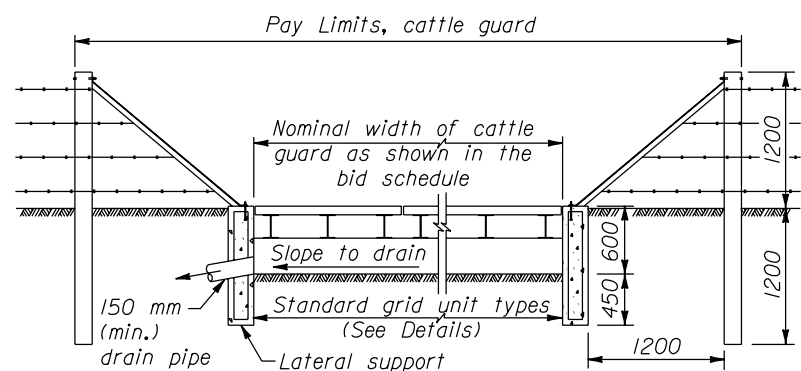
METRIC STANDARD

PRECAST CONCRETE GUARDWALL  
TYPE I TERMINAL SECTIONS,  
TYPES A AND B

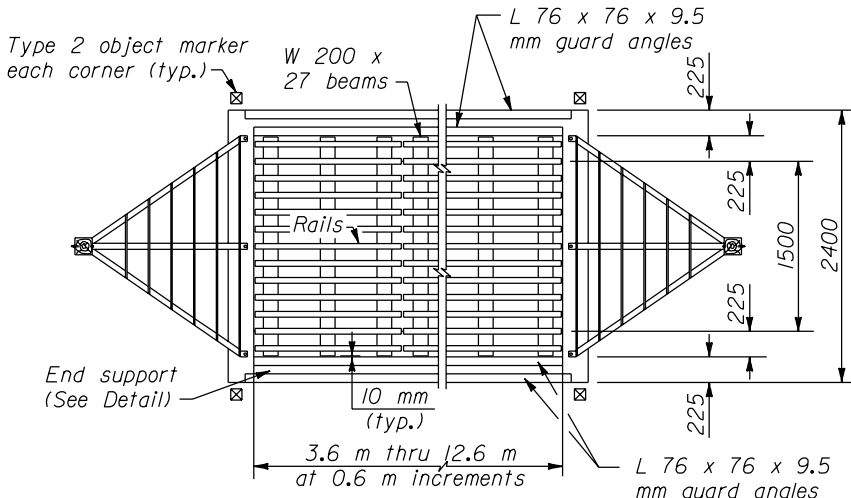
STANDARD APPROVED FOR USE 3/1996  
REVISED: 5/1997

STANDARD  
M618-3

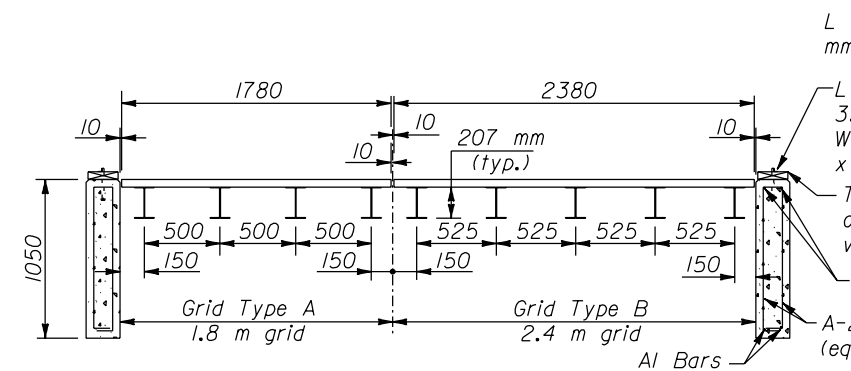
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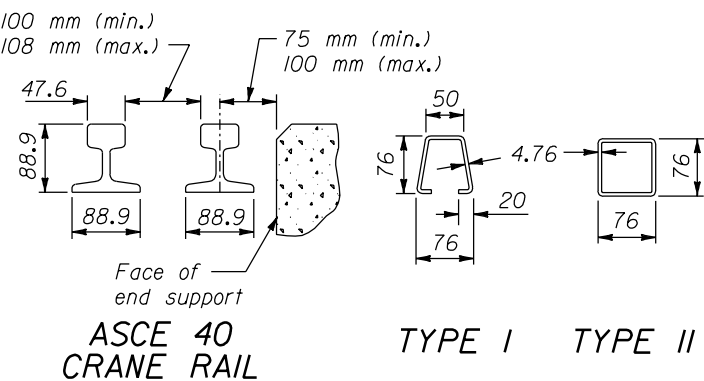
**SECTION VIEW**



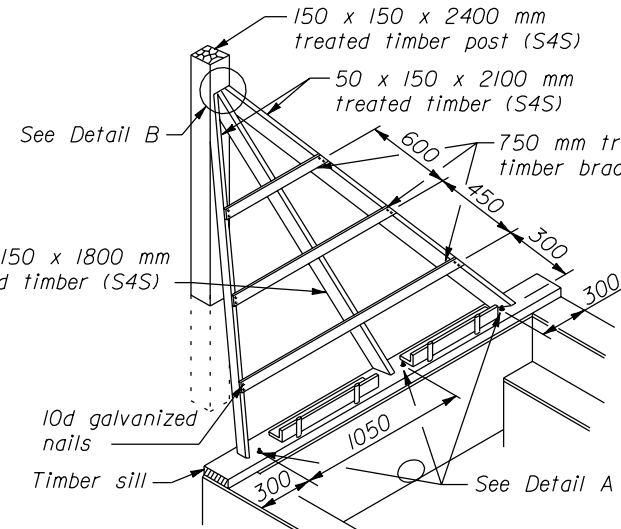
**PLAN**



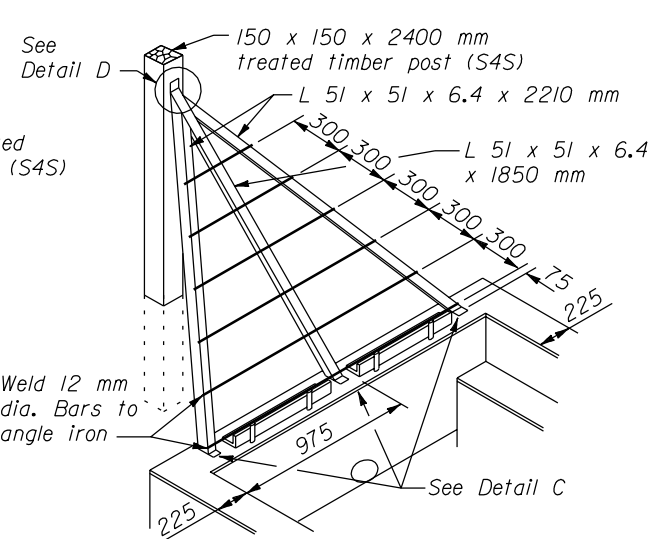
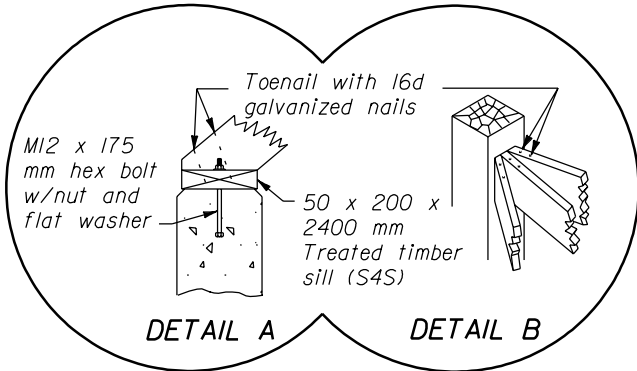
**STANDARD GRID UNIT TYPES**



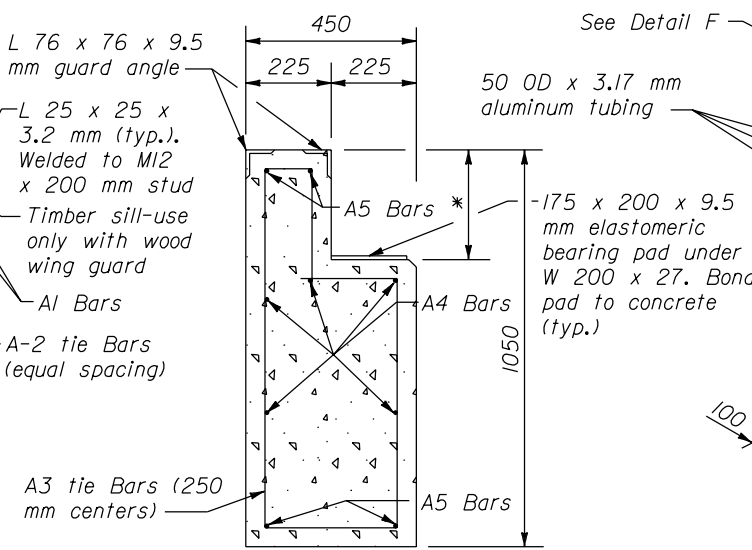
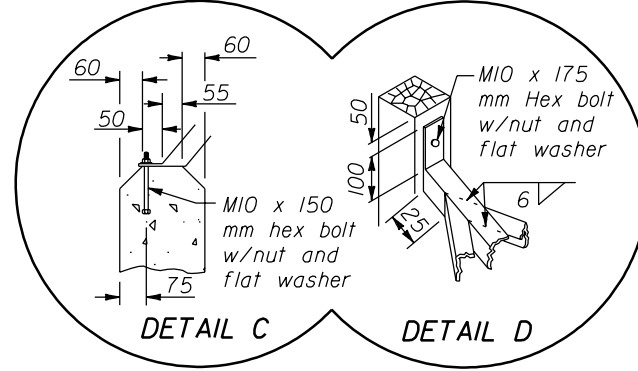
**ACCEPTABLE ALTERNATE RAIL**



**WOOD WING GUARD**

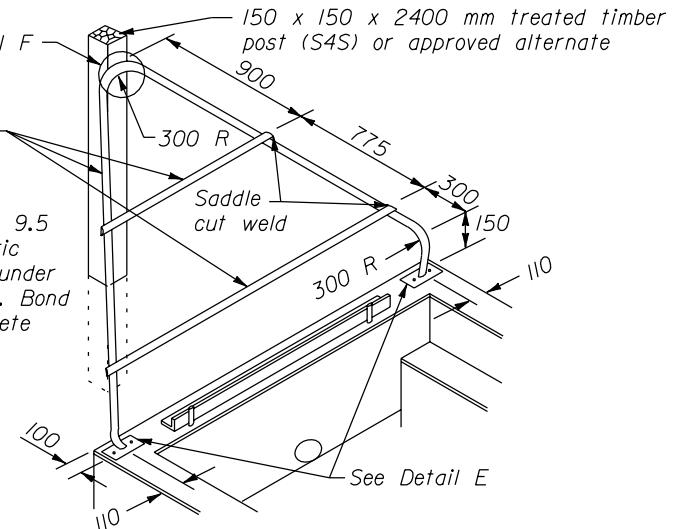


**ANGLE IRON WING GUARD**

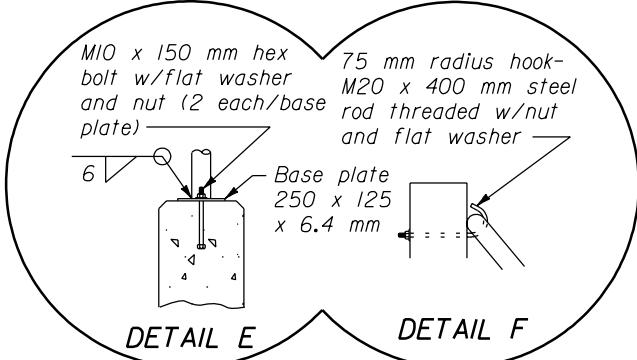


**END SUPPORT DETAIL**  
(\*13 Reinforcing Bars)

**GUARD ANGLE DETAIL**  
(4 required per cattle guard)



**ALUMINUM TUBING WING GUARD** NO SCALE



**NOTE:**

- Dimensions not labeled are in millimeters.
- LOADING: AASHTO MS18.
- CONCRETE: Chamfer exposed edges 20 mm unless otherwise shown. Give all concrete surfaces a Class 1 finish.
- STRUCTURAL STEEL: Rails conform to the requirements for ASCE 40 crane rail. Structural steel for alternate sections conforms to ASTM A 500, Grade B, Copper Steel or ASTM A 618, Grade 2. If the steel does not contain a minimum of 0.2 percent copper, galvanize the alternate sections. All other structural steel conforms to AASHTO M 183 and is painted.
- The minimum concrete cover to the face of any bar is 50 mm unless otherwise shown. All bars are #13.
- All welds are continuous 6 mm fillet shop welds. Weld rail or alternate sections on both sides to the W 200 x 27 beams at each intersection. All welding conforms to Section 555.
- Use aluminum alloy 6061-T6 or 6063-T6 for aluminum tubing.
- All timber conforms to AASHTO M 168, and is treated with chromated copper arsenate according to AASHTO M 133.
- Galvanize all hardware according to AASHTO M 111.
- Construct the cattle guard to conform with the finished roadway grade and template.
- Place one object marker at each corner of the cattle guard as shown. Mount object markers on 100 x 100 x 1950 mm posts with the reflector located 1050 mm above the elevation of the lateral support concrete.
- Install drain pipe as shown where required. Drain pipe is included in cattle guard unless otherwise shown.
- Unless otherwise shown in the special contract requirements, shop apply paint system 2 according to Section 555 and color the top coat according to Federal Standard 595B, Gray, 36231. Repair any damage to the paint system during installation.
- Install channels and wood blocking on cattle guards wider than 4.8 m to maintain grate spacing as shown on Standard M619-2.
- See Standard M619-3 for optional precast foundation details.

U.S. DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION FEDERAL LANDS HIGHWAY	
<b>METRIC STANDARD</b>	
<b>CATTLE GUARD</b>	
STANDARD APPROVED FOR USE 3/1996	STANDARD
REVISED: 6/1997	<b>M619-1</b>

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### CATTLE GUARD

#### REINFORCING STEEL, CONCRETE, STRUCTURAL STEEL, AND GRID UNIT TABLE OF QUANTITIES

DESCRIPTION	NOMINAL CATTLE GUARD WIDTH																												REMARKS				
	3.6		4.2		4.8		5.4		6.0		6.6		7.2		7.8		8.4		9.0		9.6		10.2		10.8		11.4			12.0		12.6	
	QUAN.	LGTH.	QUAN.	LGTH.	QUAN.	LGTH.	QUAN.	LGTH.	QUAN.	LGTH.	QUAN.	LGTH.	QUAN.	LGTH.	QUAN.	LGTH.	QUAN.	LGTH.	QUAN.	LGTH.	QUAN.	LGTH.	QUAN.	LGTH.	QUAN.	LGTH.	QUAN.	LGTH.		QUAN.	LGTH.	QUAN.	LGTH.
*13 Reinforcing bars, A1	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	8	2300	
*13 Reinforcing bars, A2	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	20	2150	See bar bending detail
*13 Reinforcing bars, A3	32	2685	36	2685	40	2685	46	2685	50	2685	54	2685	60	2685	64	2685	70	2685	74	2685	80	2685	84	2685	90	2685	94	2685	98	2685	102	2685	See bar bending detail
*13 Reinforcing bars, A4	10	3900	10	4500	10	5100	10	5700	10	6300	10	6900	10	7500	10	8100	10	8700	10	9300	100	9900	10	10500	10	11100	10	11350	10	12300	10	12900	
*13 Reinforcing bars, A5	8	3550	8	4150	8	4750	8	5350	8	5950	8	6550	8	7150	8	7750	8	8350	8	8950	8	9550	8	10150	8	10750	8	11700	8	11950	8	12550	
Grid unit A (1.8 m)	2		1				3			2				1						5					6					7		See grid unit list of materials	
Grid unit B (2.4 m)			1		2				1		2		3		1		2				4		2			4		5				See grid unit list of materials	
Concrete lateral supports, m <sup>3</sup>	1.19		1.19		1.19		1.19		1.19		1.19		1.19		1.19		1.19		1.19		1.19		1.19		1.19		1.19		1.19		1.15		
Concrete end supports, m <sup>3</sup>	3.07		3.59		4.11		4.62		5.12		5.66		6.16		6.67		7.19		7.71		8.21		8.73		9.24		9.76		10.26		10.78		
Total concrete, m <sup>3</sup>	4.26		4.78		5.30		5.81		6.31		6.85		7.35		7.86		8.38		8.90		9.40		9.92		10.43		10.95		11.45		11.93		
W 200 x 27 beams	416		468		540		624		676		728		780		884		936		1040		1040		1144		1248		1248		1300		1456	Beams 27 kg/m	
Rail, ASCE 40	920		1073		1226		1380		1533		1686		1839		1993		2146		2300		2452		2606		2760		2912		3065		3220	19.82 kg/m	
Rail, Type I	360		420		480		540		600		660		720		780		840		900		960		1020		1080		1140		1200		1260	Approx. 7.77 kg/m	
Rail, Type II	472		552		632		708		788		868		945		1024		1104		1180		1264		1340		1416		1500		1580		1652	10.2 kg/m	
Reinforcing steel, kg	101.0		109.5		118.0		126.5		135.0		143.5		152.0		160.5		169.0		177.5		186.0		194.5		203.0		211.5		220.0		493	0.994 kg/m	

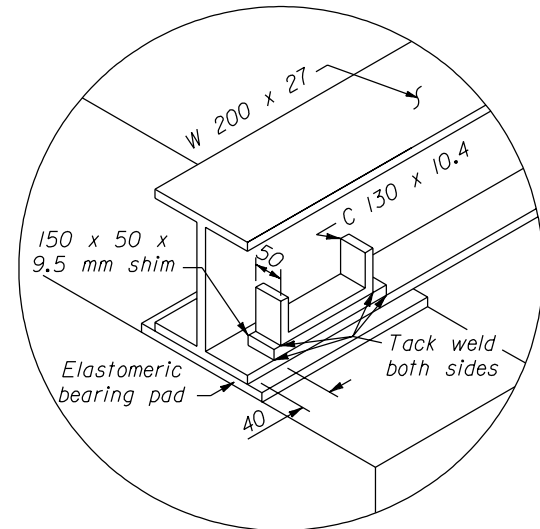
\* Weights do not include hardware or guard angle.

\*Structural steel, kg

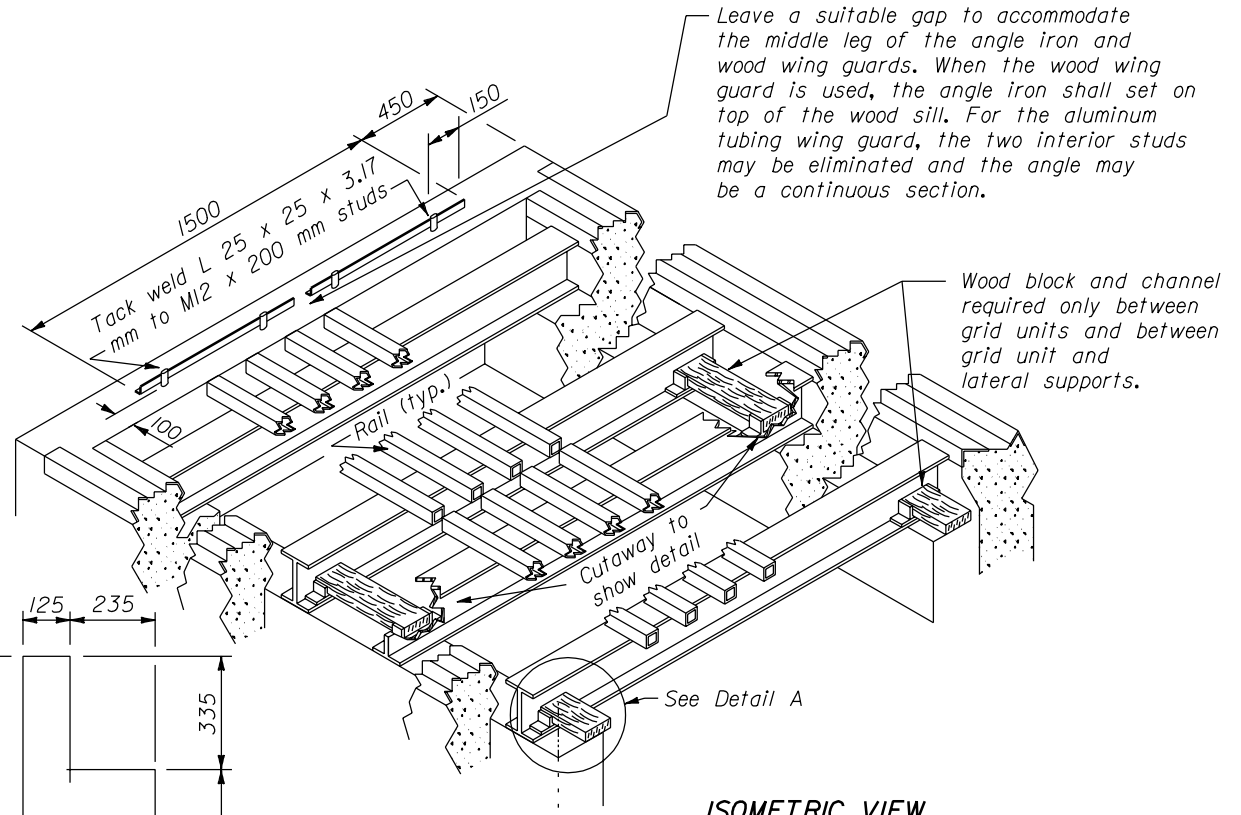
### CATTLE GUARD WING

#### LIST OF MATERIALS PER WING (TWO REQUIRED PER INSTALLATION)

PART DESCRIPTION	WOOD WING	ANGLE IRON WING	ALUMINUM TUBING WING
Outside diagonal supports	Two 50 x 150 x 2100 mm treated S4S	Two 51 x 51 x 6.4 x 2210 mm galvanized steel angle	One 50 mm OD x 3.17 x 4200 mm aluminum tubing
Middle support	One 50 x 150 x 1800 mm treated S4S	One 51 x 51 x 6.4 x 1850 mm galvanized steel angle	
Horizontal brace no.1	One 50 x 150 x 1675 mm treated S4S	One 12 mm x 1980 mm galvanized steel bar	One 50 mm OD x 3.17 x 1830 mm aluminum tubing
No. 2	One 50 x 150 x 1220 mm treated S4S	One 12 mm x 1675 mm galvanized steel bar	One 50 mm OD 3.17 x 760 mm aluminum tubing
No. 3	One 50 x 150 x 455 mm treated S4S	One 12 mm x 1370 mm galvanized steel bar	None
No. 4	None	One 12 mm x 990 mm galvanized steel bar	None
No. 5	None	One 12 mm x 610 mm galvanized steel bar	None
No. 6	None	One 12 mm x 225 mm galvanized steel bar	None
Post	150 x 150 x 2400 mm treated S4S	One 150 x 150 x 2100 mm treated S4S or approved alternate	One 150 x 150 x 2400 mm treated S4S or approved alternate
Top anchor assembly	Toenail diagonal supports to the post with 16d galvanized nails as required.	M10 x 150 mm galvanized hex bolt w/nut and flat washer	M20 x 1625 mm galvanized steel rod threaded on one end w/nut and washers & 75 mm radius hook in other end.
Bottom anchor assembly	50 x 200 x 2400 mm treated S4S sill attached to concrete w/3 each M12 x 175 mm hex bolts w/nuts 7 washers embedded in concrete. Toenail diagonal supports to wooden sill w/16d galvanized nails.	3 each M10 x 150 mm galvanized hex bolts embedded in concrete. Attach steel L iron to bolt w/flat washer and nut	2 each 6.4 x 125 x 250 mm flat irons welded to 100 mm tubing, 4 each M10 x 150 mm galvanized hex bolts embedded in concrete. Attach the flat iron plates to the bolts with washer & nuts.

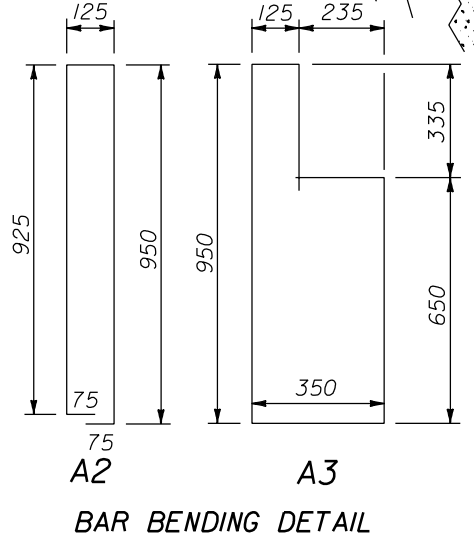


DETAIL A



ISOMETRIC VIEW

GRID UNIT LIST OF MATERIALS	
GRID UNIT TYPE A	
4 each W 200 x 27 x 1925 mm long 13 each ASCE 40 crane rail (with minimum spacing), or 11 tubular cross bar sections, (with minimum spacing), Type I or Type II, 1780 mm	
GRID UNIT TYPE B	
5 each W 200 x 27 x 1925 mm long 13 each ASCE 40 crane rail (with minimum spacing), or 11 tubular cross bar sections, (with minimum spacing), Type I or Type II, 2380 mm	



BAR BENDING DETAIL

NO SCALE

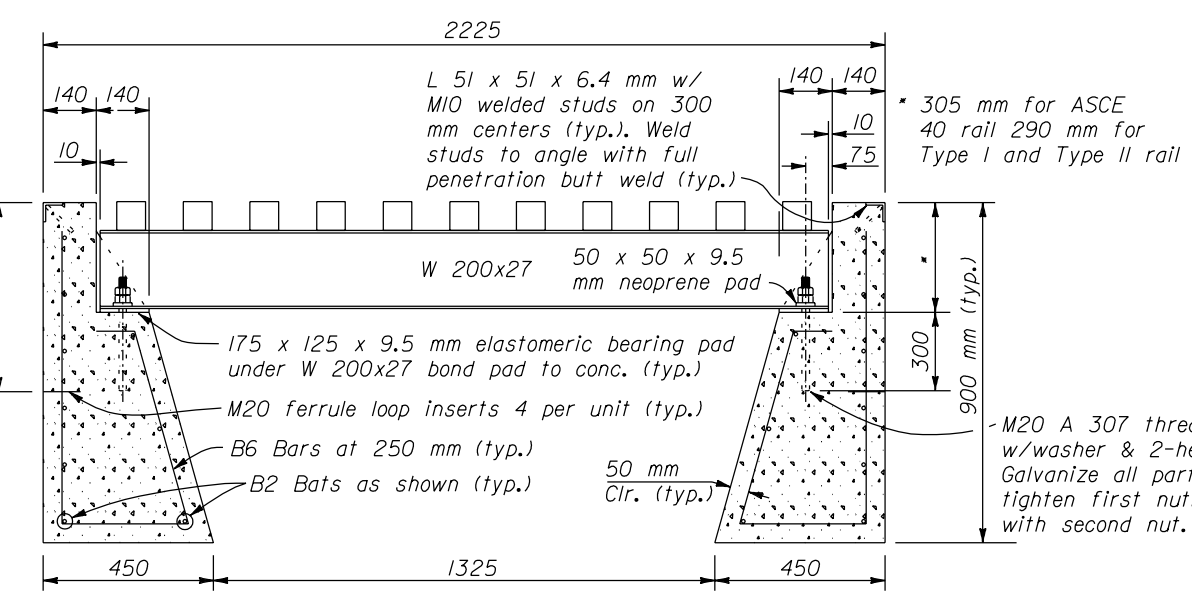
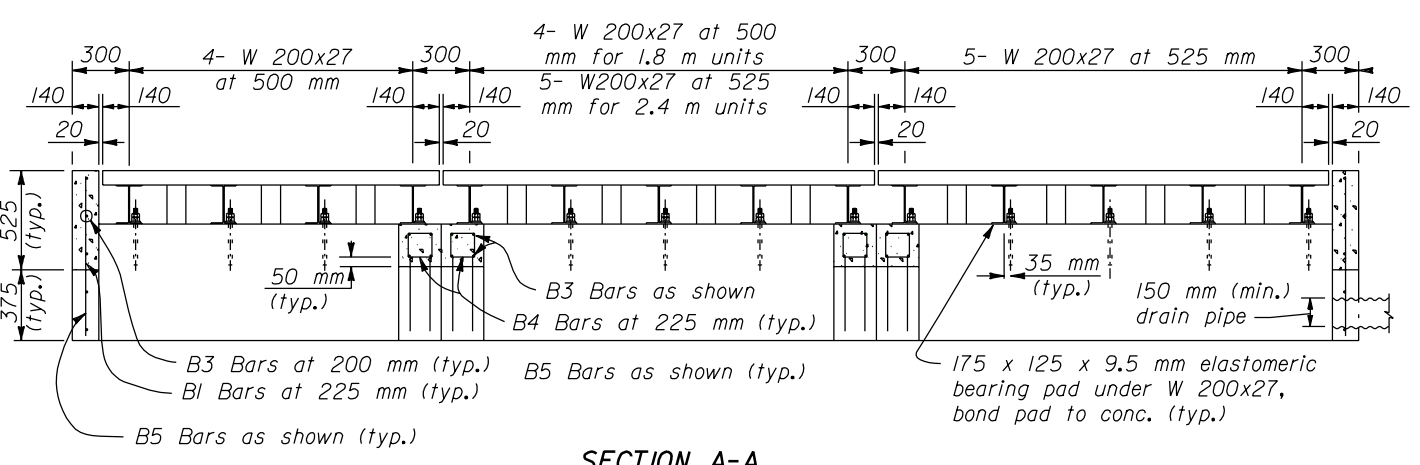
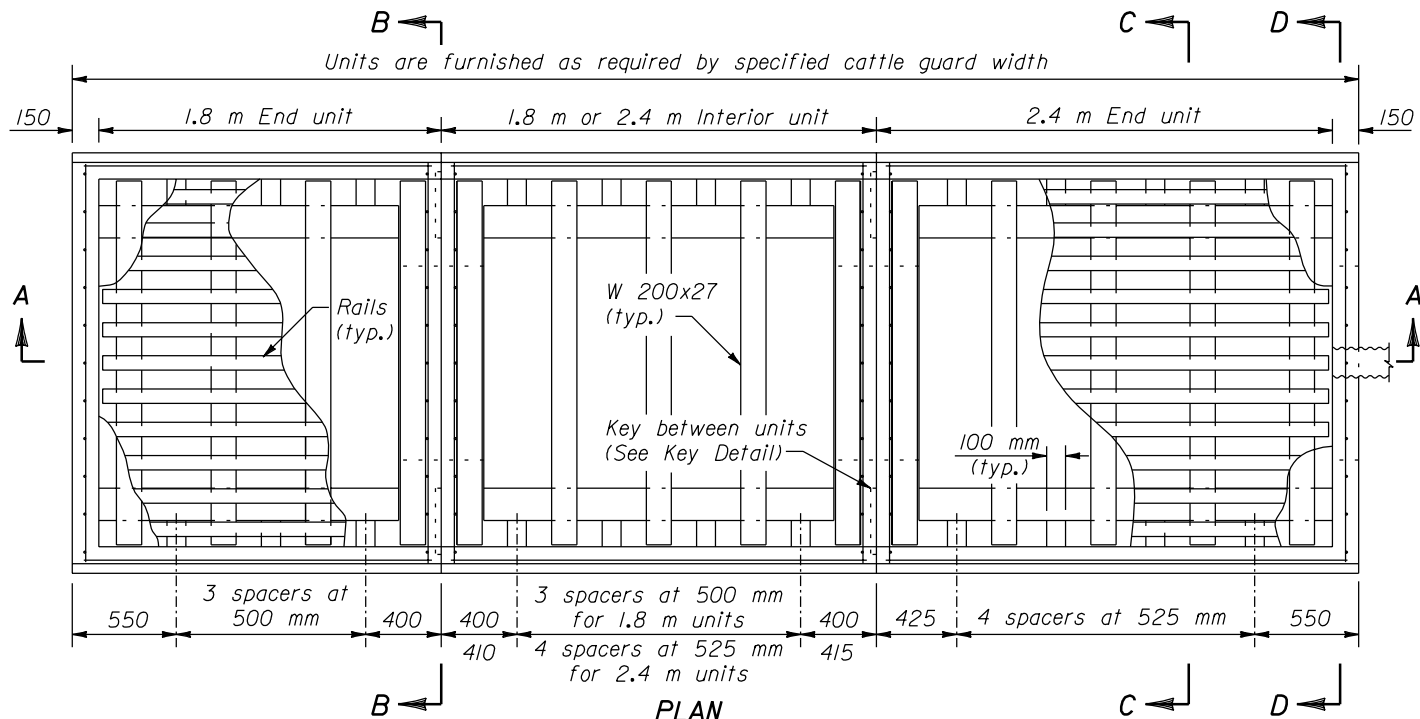
U.S. DEPARTMENT OF TRANSPORTATION  
FEDERAL HIGHWAY ADMINISTRATION  
FEDERAL LANDS HIGHWAY

**METRIC STANDARD**

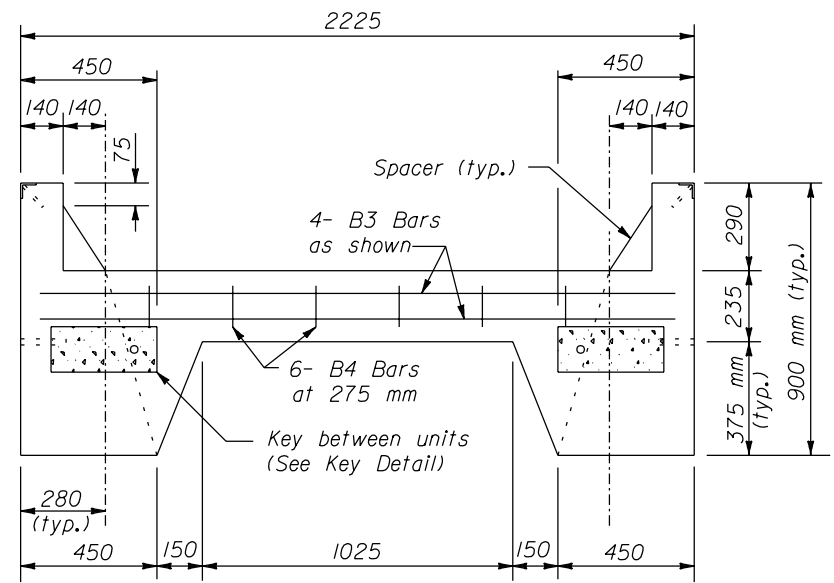
**CATTLE GUARD**

STANDARD APPROVED FOR USE 3/1996  
REVISED: 5/1997

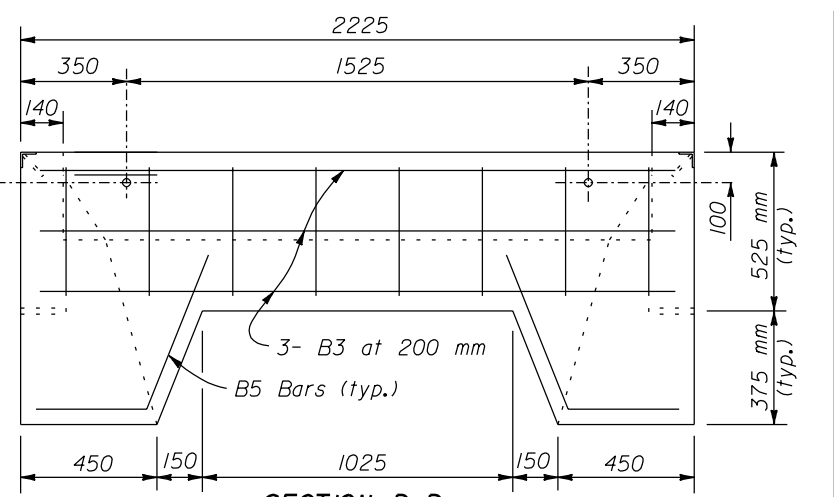
STANDARD  
**M619-2**



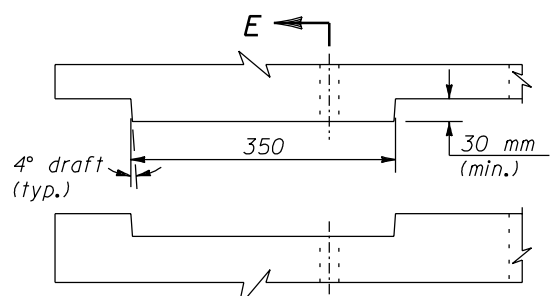
SECTION C-C



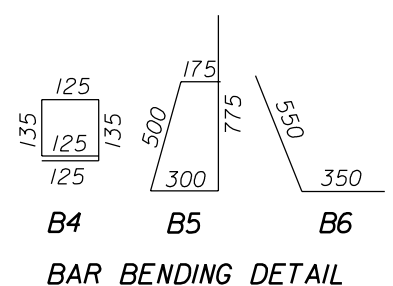
SECTION B-B



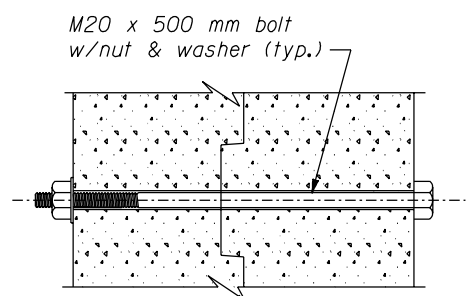
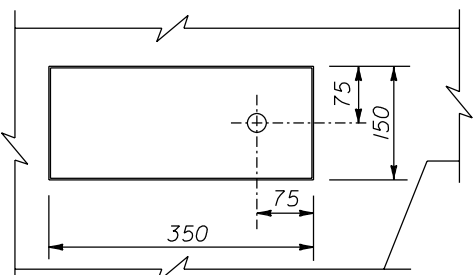
SECTION D-D



ELEVATION KEY DETAIL



BAR BENDING DETAIL



SECTION E-E

- NOTE:**
- Dimensions not labeled are in millimeters.
  - See Standard M619-1 for reinforcing steel size and grade.
  - See Standard M619-2 for cattle guard wing details. Fabricate end units to accommodate selected cattle guard wing.
  - Minimum soil bearing 19 500 kg/m<sup>2</sup>. Place units in fine aggregate bed 75 mm thick over hand leveled soil compacted to not less than 95 percent density.
  - Chamfer exposed concrete edges 20 mm unless otherwise shown. Give all concrete surfaces a Class 1 finish.
  - Approved alternate designs may be used.

PRECAST CATTLE GUARD REINFORCING STEEL AND CONCRETE					
UNIT	No. of BARS	BAR MARK	LENGTH	MASS kg	CONCRETE m <sup>3</sup>
1.6 m END	7	B3	2100	11.5	1.23
	10	B2	1850	14.5	
	8	B1	425	4.7	
	6	B4	650	3.1	
	18	B6	1750	14.1	
1.6 m INTERIOR	6	B5	900	4.2	1.00
	8	B3	2100	13.2	
	10	B2	1650	13.0	
	12	B4	650	6.1	
	18	B6	1750	24.7	
2.4 m INTERIOR	8	B5	900	5.7	1.32
	8	B3	2100	13.2	
	10	B2	2250	17.7	
	12	B4	650	6.1	
	20	B6	1750	27.5	
2.4 m END	8	B5	900	5.7	1.56
	7	B3	2100	11.5	
	10	B2	2450	19.2	
	8	B1	425	4.7	
	6	B4	650	3.1	
	20	B6	1750	27.5	
	6	B5	900	4.2	

U.S. DEPARTMENT OF TRANSPORTATION  
FEDERAL HIGHWAY ADMINISTRATION  
FEDERAL LANDS HIGHWAY

**METRIC STANDARD**

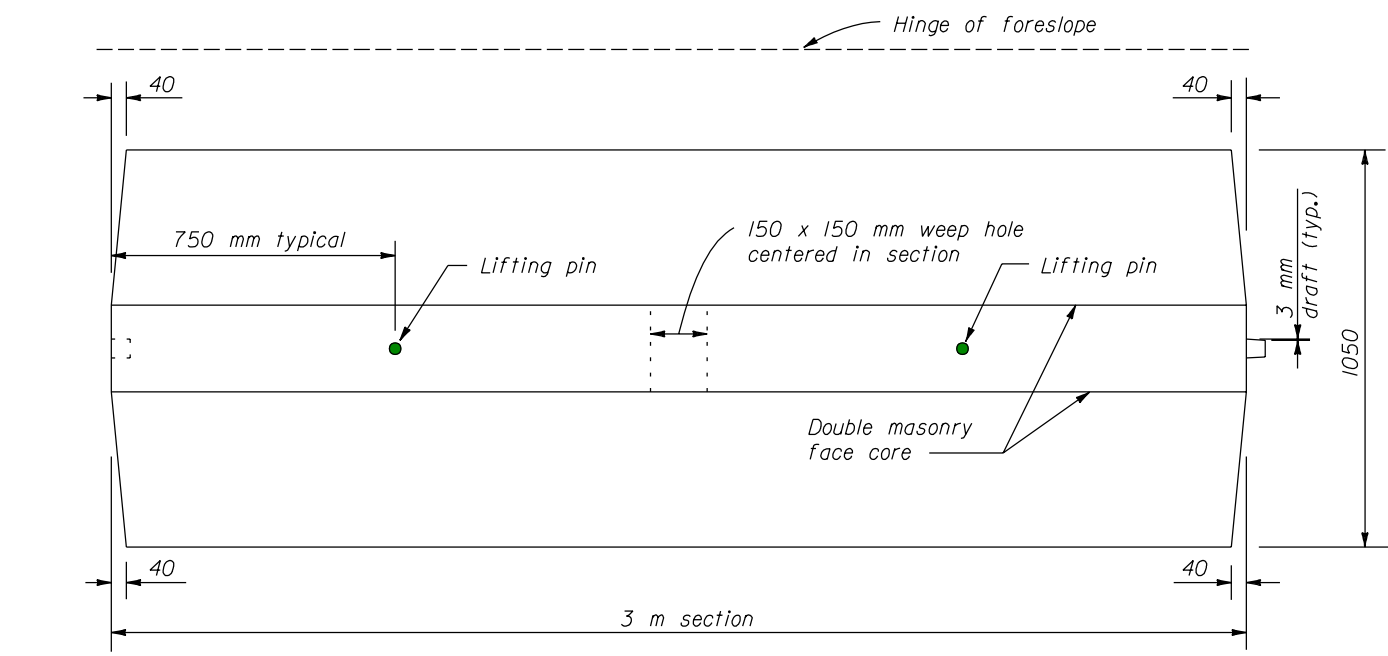
**CATTLE GUARD PRECAST FOUNDATION**

STANDARD APPROVED FOR USE 3/1996  
REVISED: 11/1997

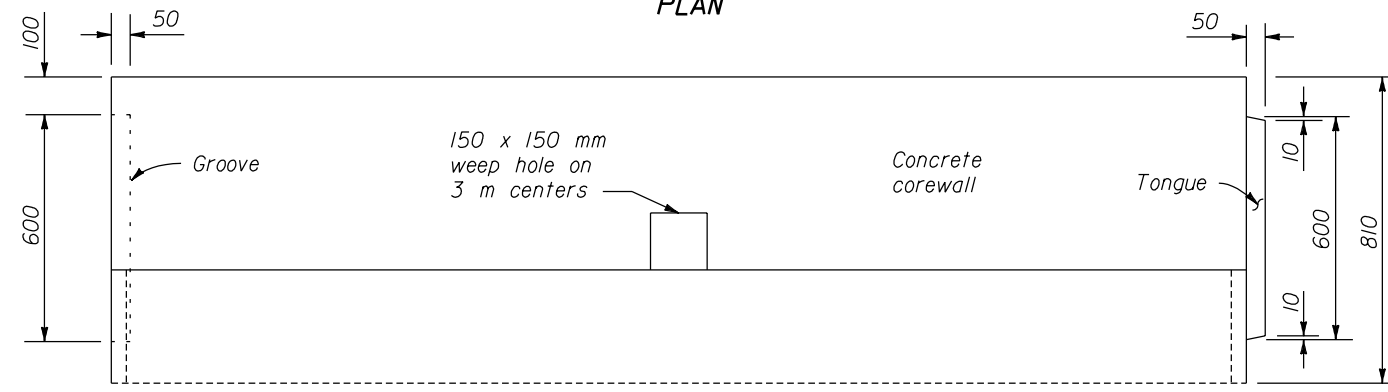
STANDARD  
**M619-3**

NO SCALE

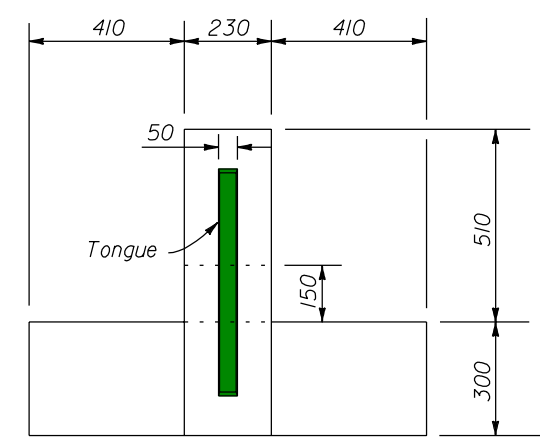
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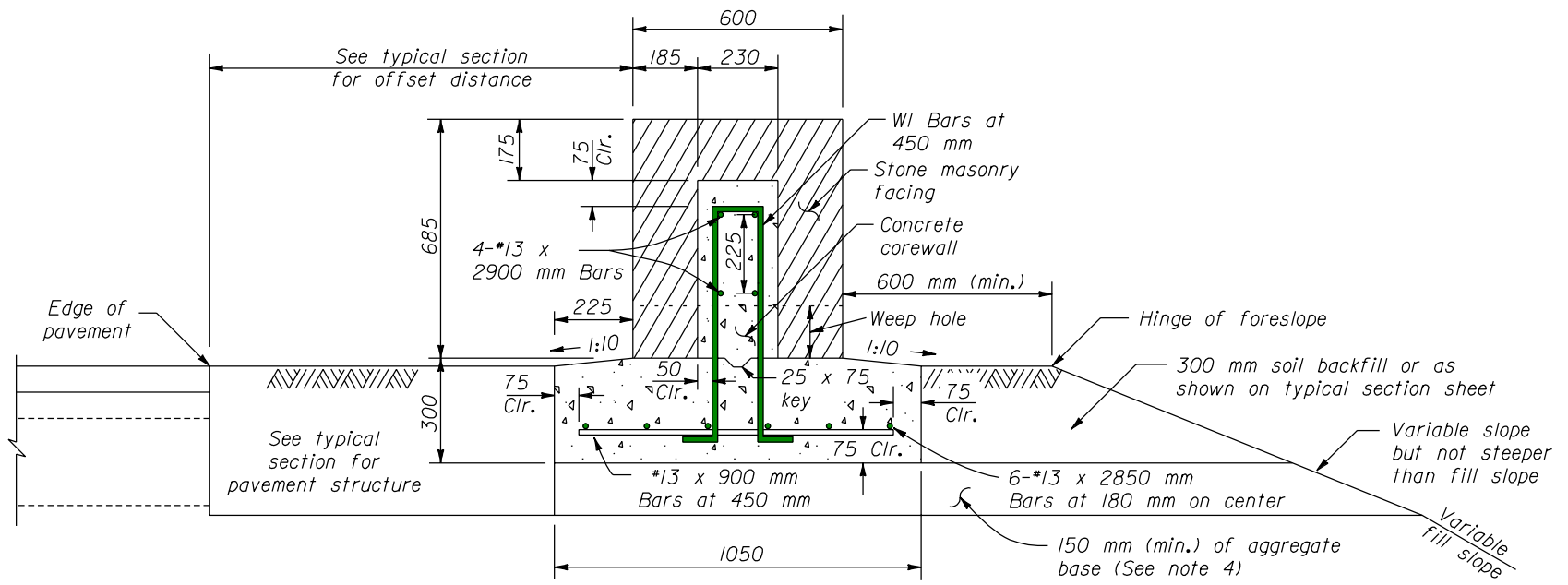
PLAN



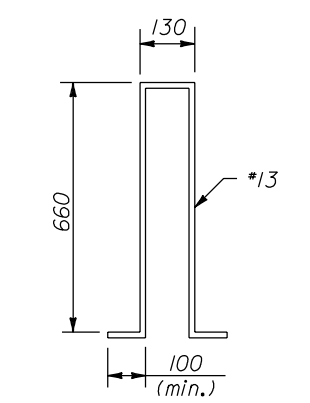
ELEVATION  
PRECAST CONCRETE COREWALL



END VIEW



TYPICAL GUARDWALL CROSS SECTION



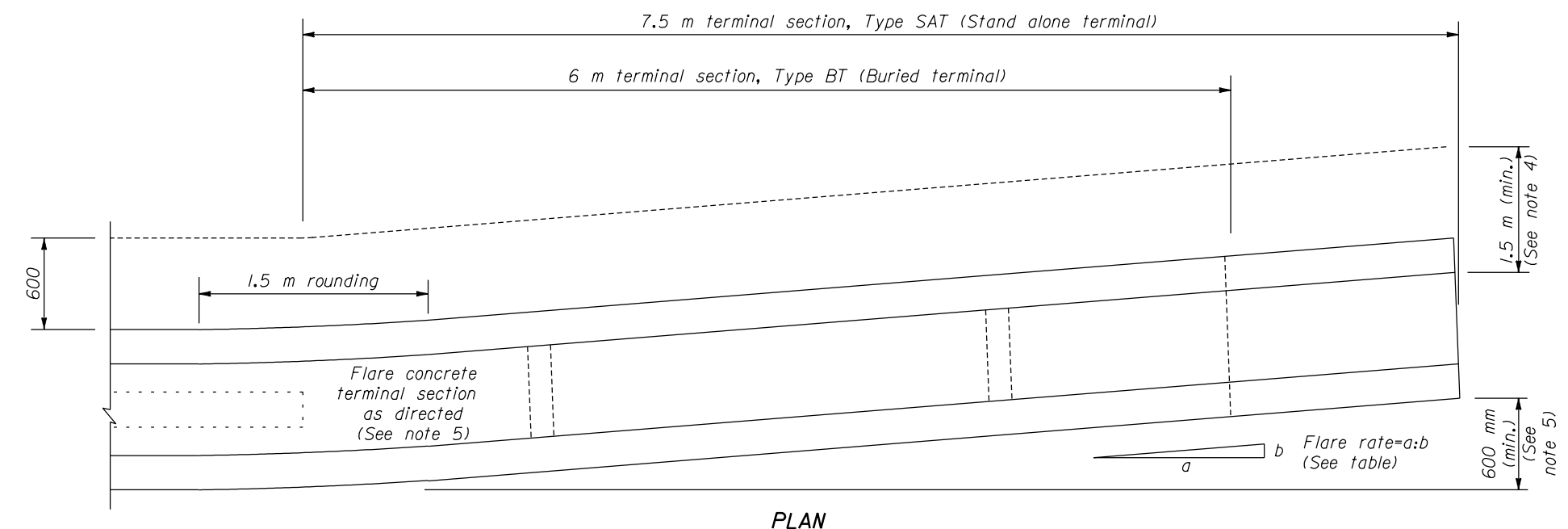
W1 BAR  
BENDING DIAGRAM

- NOTE:**
- Dimensions not labeled are in millimeters.
  - Form construction joints in the corewall at 9 m intervals or, at the option of the Contractor, the corewall may be constructed of precast concrete units.
  - On curves with radius less than 50 m, the corewall is to be cast-in-place.
  - The depth of base may be less than 150 mm as directed by the CO, when the foundation is on either rock fill or solid rock.
  - Set galvanized metal slots with anchors for the stone work or other approved type of metal anchors in the concrete. Equivalent attachment systems are allowed with the approval of the CO.

U.S. DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION FEDERAL LANDS HIGHWAY	
METRIC STANDARD	
STONE MASONRY GUARDWALL	
STANDARD APPROVED FOR USE 3/1996	STANDARD
REVISED: 12/1996 5/1997	M620-1

NO SCALE

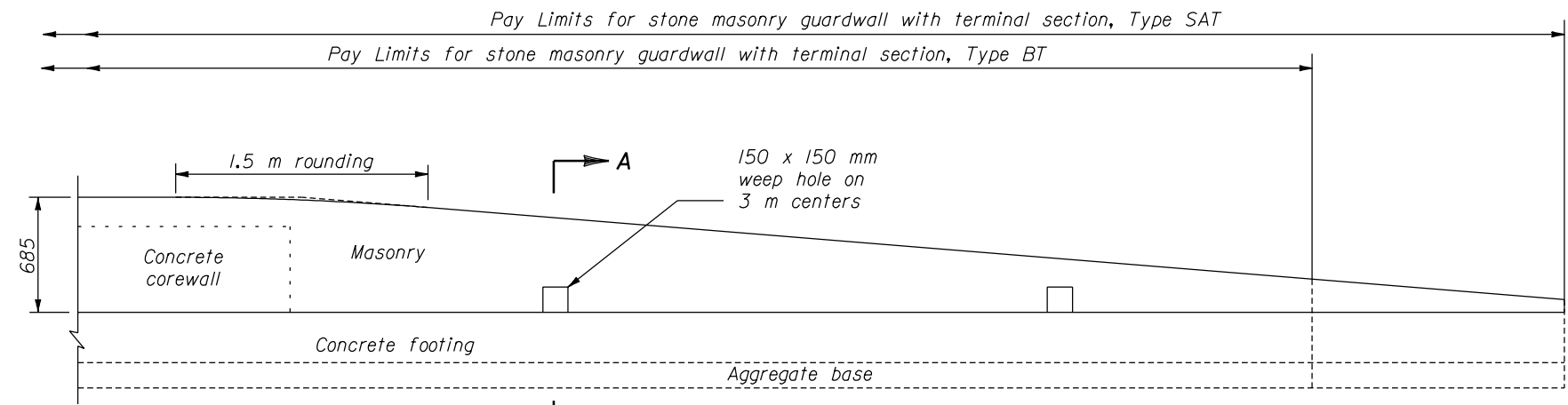
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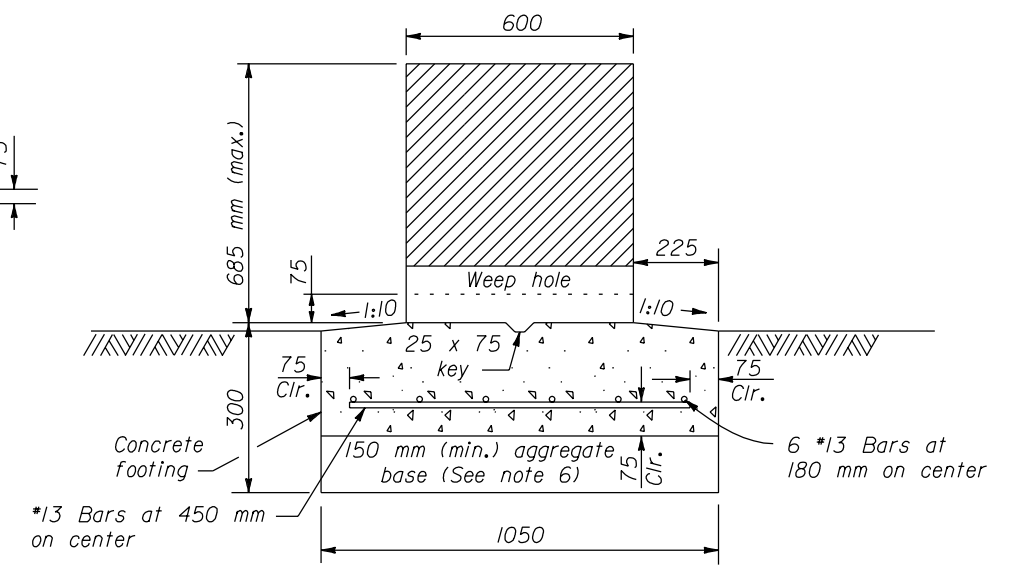
PLAN

**NOTE:**

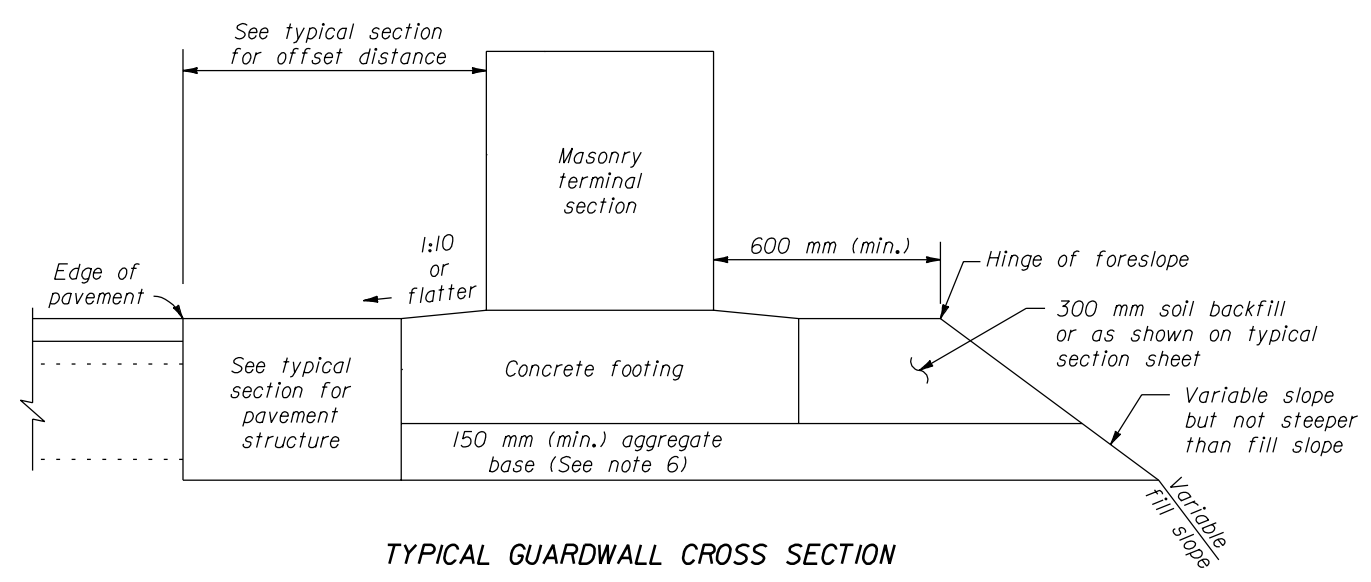
- Dimensions not labeled are in millimeters.
- The Type SAT (Stand alone terminal) terminal section or the Type BT (Buried terminal) terminal section to be used as specified.
- For the Type BT terminal section the last 1.5 m of the Type SAT terminal section is deleted. See Standard M204-1, Earth berm for roadside barrier terminal section, for construction of the earth berm.
- Extend the fill widening a minimum of 1.5 m behind the guardwall for the Type SAT terminal section, unless otherwise directed.
- The guardwall flare shown in the plan view is the minimum length and rate required. As directed by the CO, the guardwall should be flared as far as practical from the road at the maximum rate indicated in the Guardwall Flare Rates table.
- The depth of base may be less than 150 mm as directed by the CO, when the foundation is on either rock fill or solid rock.



ELEVATION



SECTION A-A



TYPICAL GUARDWALL CROSS SECTION

Design Speed (Km/h)	Shy line offset (meters)	Flare rate inside shy line (a:b)	Flare rate outside shy line (a:b)
100	2.5	26:1	13:1
80	2.0	21:1	11:1
60	1.5	17:1	9:1
50 or less	1.0	13:1	7:1

U.S. DEPARTMENT OF TRANSPORTATION  
FEDERAL HIGHWAY ADMINISTRATION  
FEDERAL LANDS HIGHWAY

METRIC STANDARD

**STONE MASONRY GUARDWALL  
TERMINAL SECTIONS  
TYPE SAT AND TYPE BT**

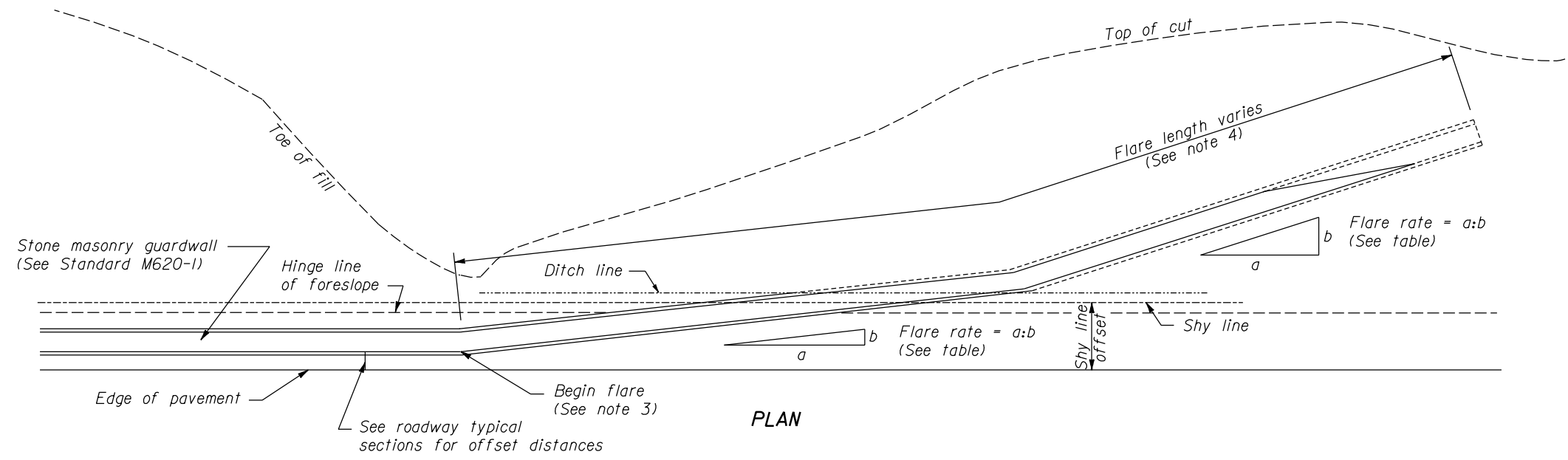
STANDARD APPROVED FOR USE 3/1996  
REVISED: 6/1997

STANDARD  
M620-2

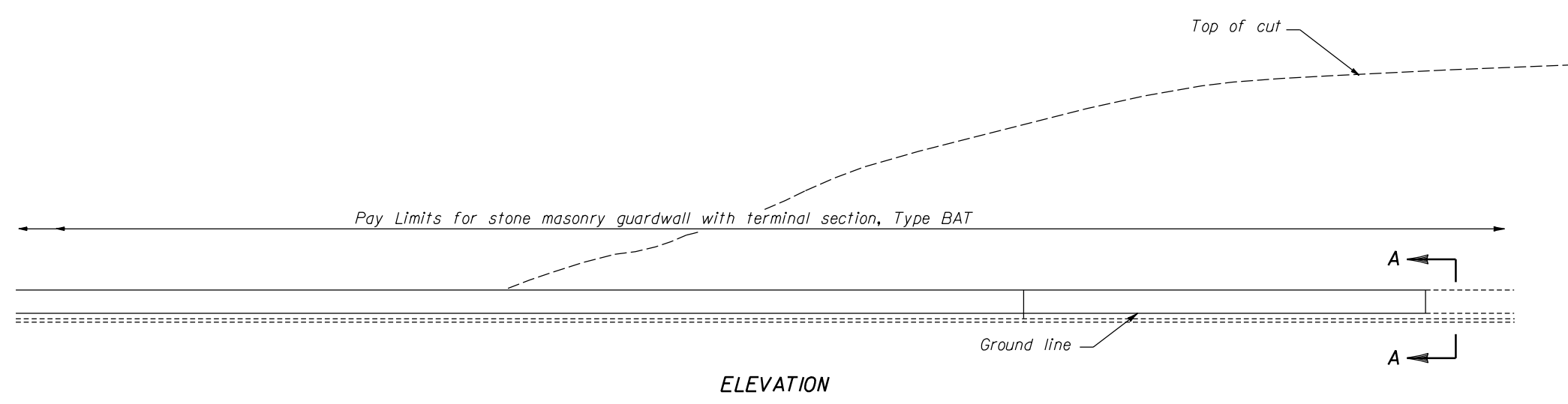
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20 NOV 2000 f:\standrow\metric\m62002.dgn

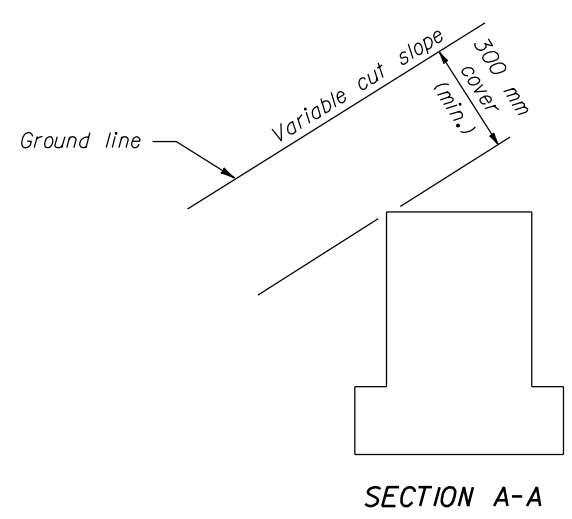




- NOTE:**
1. Dimensions not labeled are in millimeters.
  2. See guardrail standards for concrete, masonry, and base details.
  3. Begin cut flares at the transition point between fill and cut as directed.
  4. Extend flare into cut until a minimum 300 mm cover is obtained over the guardwall end.



**APPROACH AND DEPARTURE FLARE  
BACK SLOPE ANCHORED TERMINAL (BAT)**



GUARDRAIL FLARE RATE TABLE			
Design Speed (Km/h)	Shy line offset (meters)	Flare rate inside shy line (a:b)	Flare rate outside shy line (a:b)
100	2.5	26:1	13:1
80	2.0	21:1	11:1
60	1.5	17:1	9:1
50 or less	1.0	13:1	7:1

U.S. DEPARTMENT OF TRANSPORTATION  
FEDERAL HIGHWAY ADMINISTRATION  
FEDERAL LANDS HIGHWAY

**METRIC STANDARD**

**STONE MASONRY GUARDWALL  
TERMINAL SECTION, TYPE BAT**

STANDARD APPROVED FOR USE 3/1996

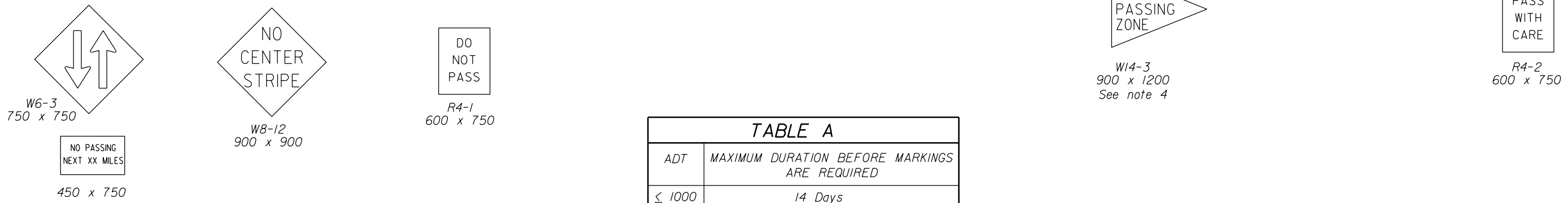
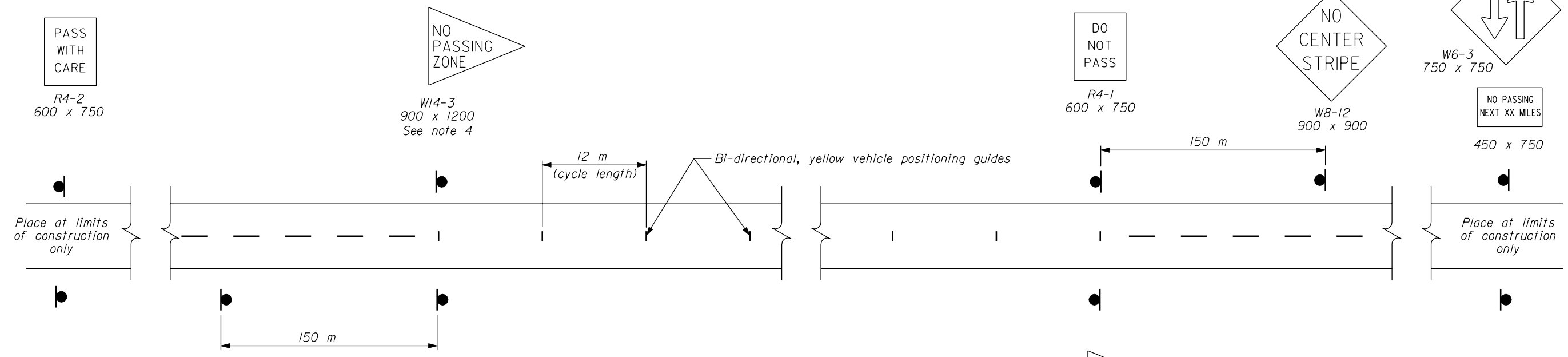
STANDARD  
M620-3

NO SCALE

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**NOTE:**

1. For periods as noted in Table A, pavement may be unmarked if appropriate vehicle positioning guides are provided.
2. Typical spacing between Vehicle Position Guides is 12 m as shown. In areas of severe curvature the spacing is 6 m. Areas of severe curvature are shown in the plans or provided in the Vehicle Positioning Guide Schedule.
3. Vehicle positioning guides shall meet the requirements of Section 718.21(b).
4. When ADT > 1000 and special hazards are present, supplement the R4-1 sign at the beginning of each no passing zone with a W14-3 sign mounted on the left of the roadside.
5. W14-3 and R4-1 shall be repeated at 1 km intervals minimum.



ADT	MAXIMUM DURATION BEFORE MARKINGS ARE REQUIRED
≤ 1000	14 Days
> 1000	3 Days

NO SCALE

U.S. DEPARTMENT OF TRANSPORTATION  
 FEDERAL HIGHWAY ADMINISTRATION  
 FEDERAL LANDS HIGHWAY

**METRIC STANDARD**

**VEHICLE POSITIONING GUIDES FOR TEMPORARY USE WITH UNMARKED PAVEMENTS**

STANDARD APPROVED FOR USE 6/1998

REVISOR: STANDARD M635-1