

ISOMETRIC VIEW

DOUBLE-SIDED, NCHRP 350 TL-2 ROUGH STONE MASONRY GUARDWALL



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### INTENDED USE

The double-sided, Rough Stone Masonry Guardwall system is intended for applications where an aesthetically-pleasing barrier is desired. The barrier system was configured with a reinforced concrete, inner core wall and support foundation system which requires a minimum 28-day concrete compression strength of 3,500 psi (24.13 MPa). The Rough Stone Masonry Guardwall system's inner core wall was rigidly attached to a support slab or foundation using vertical steel reinforcing bars. A 6-in. [152] thick aggregate base was placed under the concrete support slab or foundation. The Rough Stone Masonry Guardwall system should be constructed with a 22-in. [559] top mounting height, which provides a 2-in. [51] downside construction tolerance as well as allows for future pavement overlays placed adjacent to the barrier system if 2 in. [51] thick or less. The single-sided, Rough Stone Masonry Guardwall system has been successfully crash tested according to the Test Level 2 (TL-2) guidelines provided in NCHRP Report No. 350 and has been accepted for use by the Federal Highway Administration. The double-sided, Rough Stone Masonry Guardwall system has been accepted for use by the Federal Highway Administration based on the crashworthiness of the single-sided version of the barrier system.

### INTERIOR SECTION COMPONENTS

Unit Length = 144" [3658]

DESIGNATOR	COMPONENT	QUANTITY PER UNIT	
-	See Bill of Bars	-	
a4	Dovetail Anchor Slot 21" [533] Long (5 front, 5 back)	10	
a5	Dovetail Anchor Slot 11" [279] Long*(1 front, 1 back)	2	
a6	Dovetail Anchor Tie (24 on sides and 6 on top)		30
a7	5x3x½" [127x76x13] Interior Angle	2	
a10	¾" [19] Ø by 6" [152] Long Wedge-Bolt Screw Anchor	10	
a11	Z-Clips (12 on sides and 6 on top)	18	
a12	Heavy-Weight, Tapcon Masonry Anchors		18
b1	Aggregate Base	-	
b2	Concrete Corewall Base	-	
b3	Concrete Corewall Top	-	
c1	Rough Stone Masonry Façade (Rubble Masonry)	-	
c2	Mortar Bed-PROMIX Stone Veneer Mortar	-	

\*Use a5 in lieu of a4 when a weep hole intersects an anchor slot.

## DOUBLE-SIDED, NCHRP 350 TL-2 ROUGH STONE MASONRY GUARDWALL



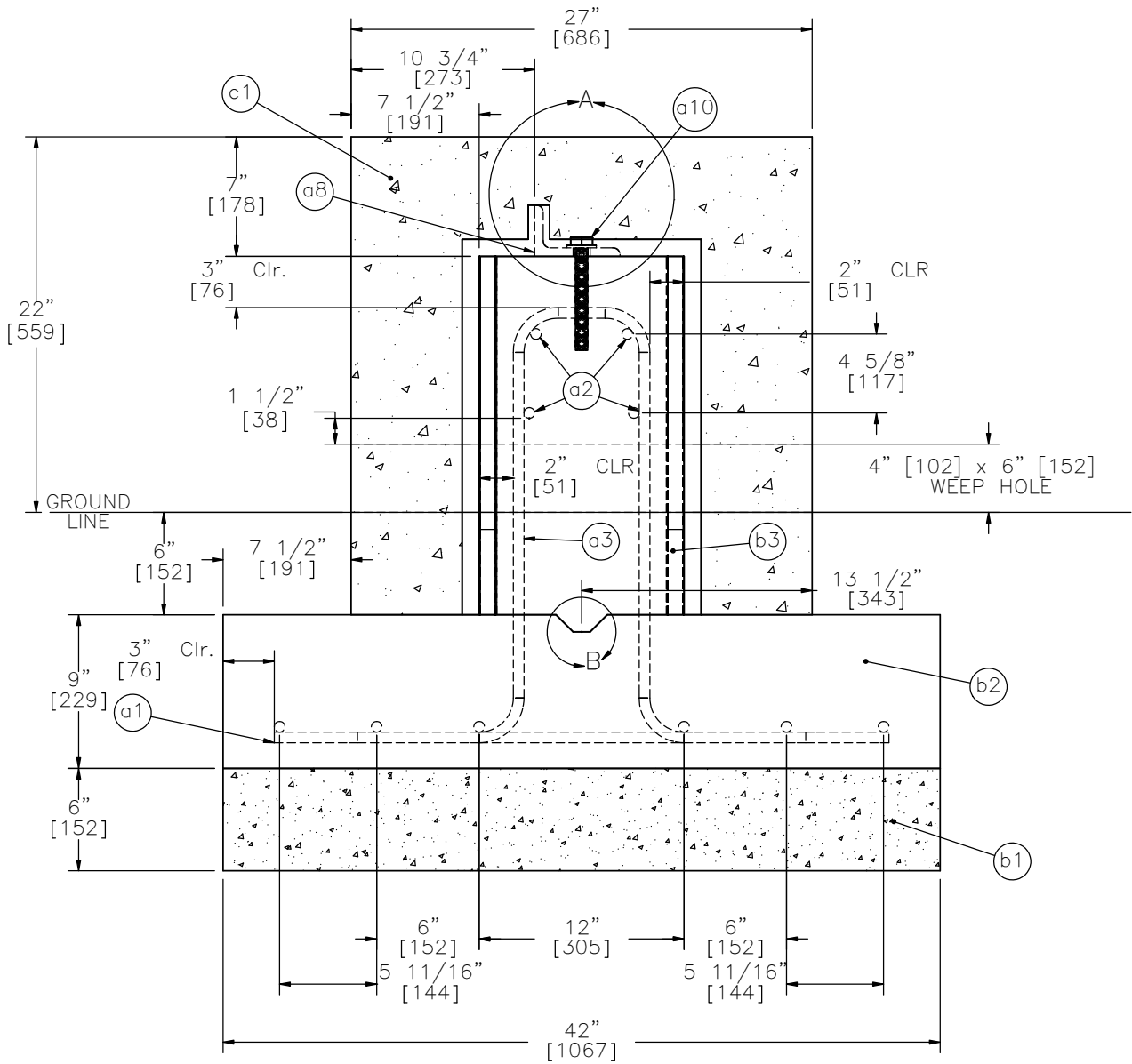
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PROFILE VIEW

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## END SECTION COMPONENTS

Unit Length = 56 5/16" [1430]

DESIGNATOR	COMPONENT	QUANTITY PER UNIT
-	See Bill of Bars	-
a4	Dovetail Anchor Slot 21" [533] Long	4
a6	Dovetail Anchor Tie (4 on each side and 3 on top)	11
a8	5x3x1/2" [127x76x13] Upstream End Angle	1
a10	3/4" [19] Ø by 6" [152] Long Wedge-Bolt Screw Anchor	4
a11	Z-Clips (3 on each side and 3 on top)	9
a12	Heavy-Weight, Tapcon Masonry Anchors	9
b1	Aggregate Base	-
b2	Concrete Corewall Base	-
b3	Concrete Corewall Top	-
c1	Rough Stone Masonry Façade (Rubble Masonry)	-
c2	Mortar Bed-PROMIX Stone Veneer Mortar	-

### ACCEPTANCE

FHWA Acceptance Letter B-202, April 16, 2010

### REFERENCES

Johnson, E.A., Faller, R.K., Reid, J.D., Sicking, D.L., Bielenberg, R.W., Lechtenberg, K.A., and Rosenbaugh, S.K., *Analysis, Design, and Dynamic Evaluation of a TL-2 Rough Stone Masonry Guardwall*, Final Report to the Federal Highway Administration, Central Federal Lands Highway Division, Transportation Research Report No. TRP-03-217-09, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, May 6, 2009.

Reid, J.D. and Faller, R.K., *A New TL-2 Rough Stone Masonry Guardwall*, Paper No. 10-0087, Transportation Research Record No. 2195, Journal of the Transportation Research Board, Washington, D.C., 2010.

### CONTACT INFORMATION

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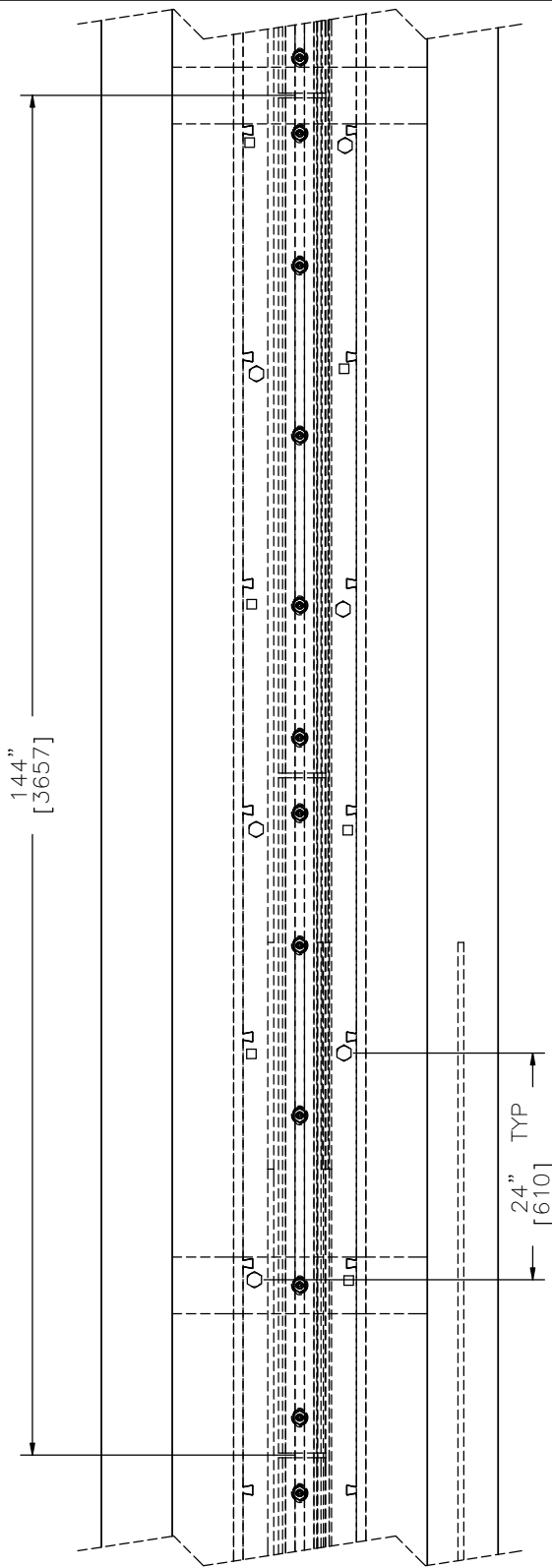
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INTERIOR SECTION  
TOP VIEW  
Z-CLIPS AND DOVETAIL ANCHOR SUGGESTED LOCATIONS

○ Z-CLIPS LOCATIONS

□ TYPE 106 DOVETAIL ANCHOR LOCATIONS

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DETAIL A NOTES:

- (1) THE CAPSTONES PLACED ON THE TOP OF THE BARRIER SHALL BE KERFED TO ALL FOR THEIR PLACEMENT OVER THE STEEL ANGLE. THE KERF WIDTH SHALL BE APPROXIMATELY 1" TO 1 1/2" [25 TO 38] WIDE. THE MAXIMUM KERF DEPTH SHALL BE 2 1/2" [64] ALTHOUGH THINNER KERF DEPTHS ARE ALLOWED AS LONG AS ALL OTHER GEOMETRIES ARE MET.
- (2) THE TOP MORTAR BED THICKNESS SHALL RANGE BETWEEN 1/2" AND 2" [13 AND 52] FOR RUBBLE STONE MASONRY. THE TOP CAPSTONE THICKNESS SHALL RANGE BETWEEN 5 TO 6 1/2 in. [127 TO 165].
- (3) MORTAR SHALL FILL THE VOID REGION SURROUNDING THE ANGLE'S VERTICAL LEG WHEN THE CAPSTONES ARE SET IN PLACE.
- (4) THE FIRST 36' TO 38' [11.0 TO 11.6 m] OF BARRIER SHALL BE CONSTRUCTED WITH CAPSTONES COVERING THE ENTIRE WIDTH OF 24 in. [610], THUS REVEALING A MORTAR JOINT ON THE FRONT FACE.
- (5) THE REMAINING BARRIER LENGTH SHALL BE CONSTRUCTED USING ALTERNATING FACE AND TOP STONES TO MEET UP AT THE TOP-FRONT CORNER OF THE BARRIER.
- (6) FOR TOP CAPSTONE THICKNESSES GREATER THAN 5 7/8" [149], IT WILL BE NECESSARY TO CHISEL THE BOTTOM OF THE STONE TO FORM A DISH TO ALLOW ITS PLACEMENT OVER THE HEADS OF THE WEDGE-BOLT SCREW ANCHORS.
- (7) TWO TYPES OF STEEL ANCHORS WERE USED TO PROVIDE VERTICAL ATTACHMENT OF THE STONE MASONRY TO THE TOP OF THE INNER CORE WALL. TYPE 106 CORRUGATED DOVETAIL ANCHOR TIES (16 GAUGE [1.5] BY 5 1/2" [140] LONG) WERE WEDGED UNDER THE TOP-MOUNTING ANGLES AND BENT UPWARD TO ENGAGE THE MORTAR. THE TYPE 106 TIES WERE SPACED APPROXIMATELY ON 2' [610] CENTERS, ALTERNATING SIDES OF THE STEEL ANGLES. STAINLESS STEEL (SS 304) Z-CLIPS WERE ALSO USED TO ANCHOR THE STONE MASONRY USING 1/4" [6.4] DIAMETER BY 2 3/4" [70] LONG, HEAVY-WEIGHT STAINLESS STEEL TAPCON MASONRY ANCHORS. THE Z-CLIPS WERE SPACED APPROXIMATELY ON 2' [610] CENTERS, ALTERNATING SIDES OF THE STEEL ANGLES, AND USED TO ENGAGE A RECESS CUT IN THE STONE.
- (8) DOVETAIL ANCHOR TIES SHALL BE MILL GALVANIZED STEEL ASTM A653 OR HOT DIP GALVANIZED ASTM A153.

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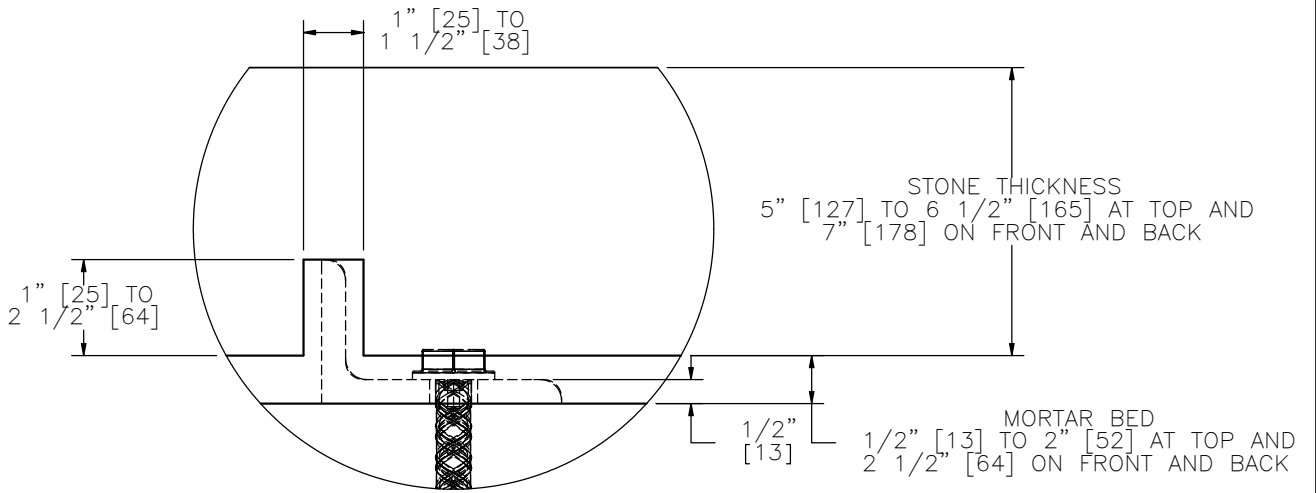
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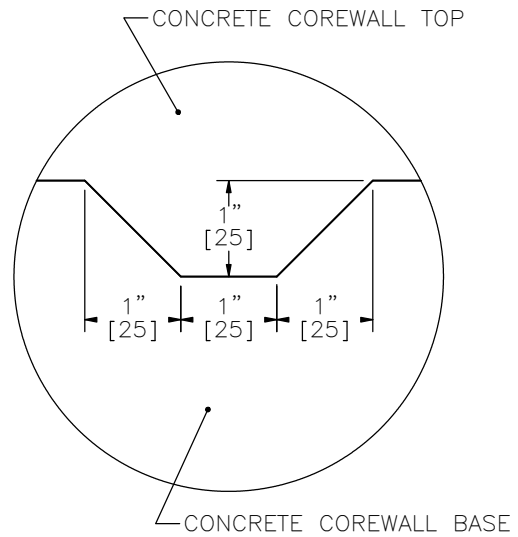
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DETAIL A



DETAIL B

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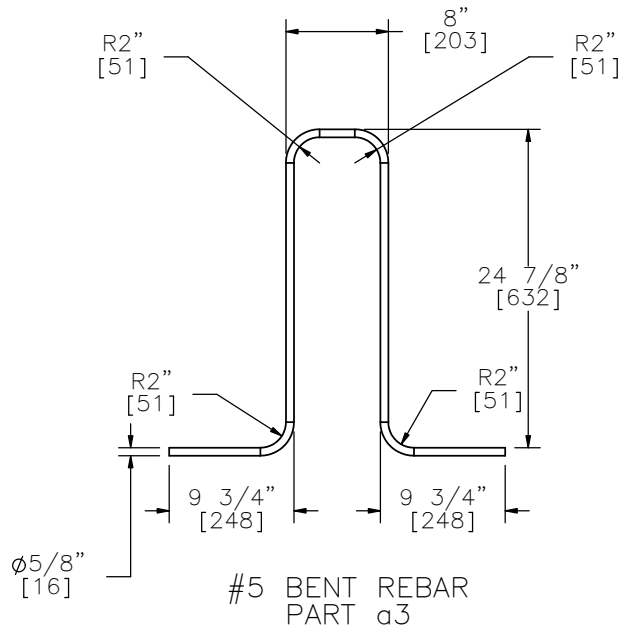
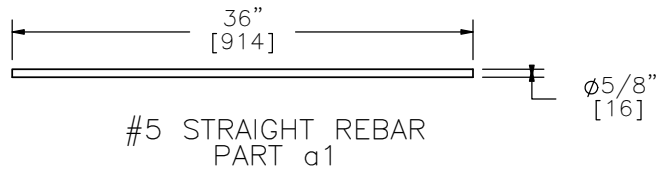
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INTERNAL SECTION BILL OF BARS

ITEM NO.	DESCRIPTION	MATERIAL SPECIFICATIONS	QTY. PER UNIT
a1	#5 STRAIGHT REBAR, 36" [914] LONG	GRADE 60	8
a2	#5 STRAIGHT REBAR, 240" [6096] LONG	GRADE 60	10
a3	#5 BENT REBAR	GRADE 60	8

END SECTION BILL OF BARS

ITEM NO.	DESCRIPTION	MATERIAL SPECIFICATIONS	QTY. PER UNIT
a1	#5 STRAIGHT REBAR, 36" [914] LONG	GRADE 60	6
a2	#5 STRAIGHT REBAR, 240" [6096] LONG	GRADE 60	10
a3	#5 BENT REBAR	GRADE 60	6



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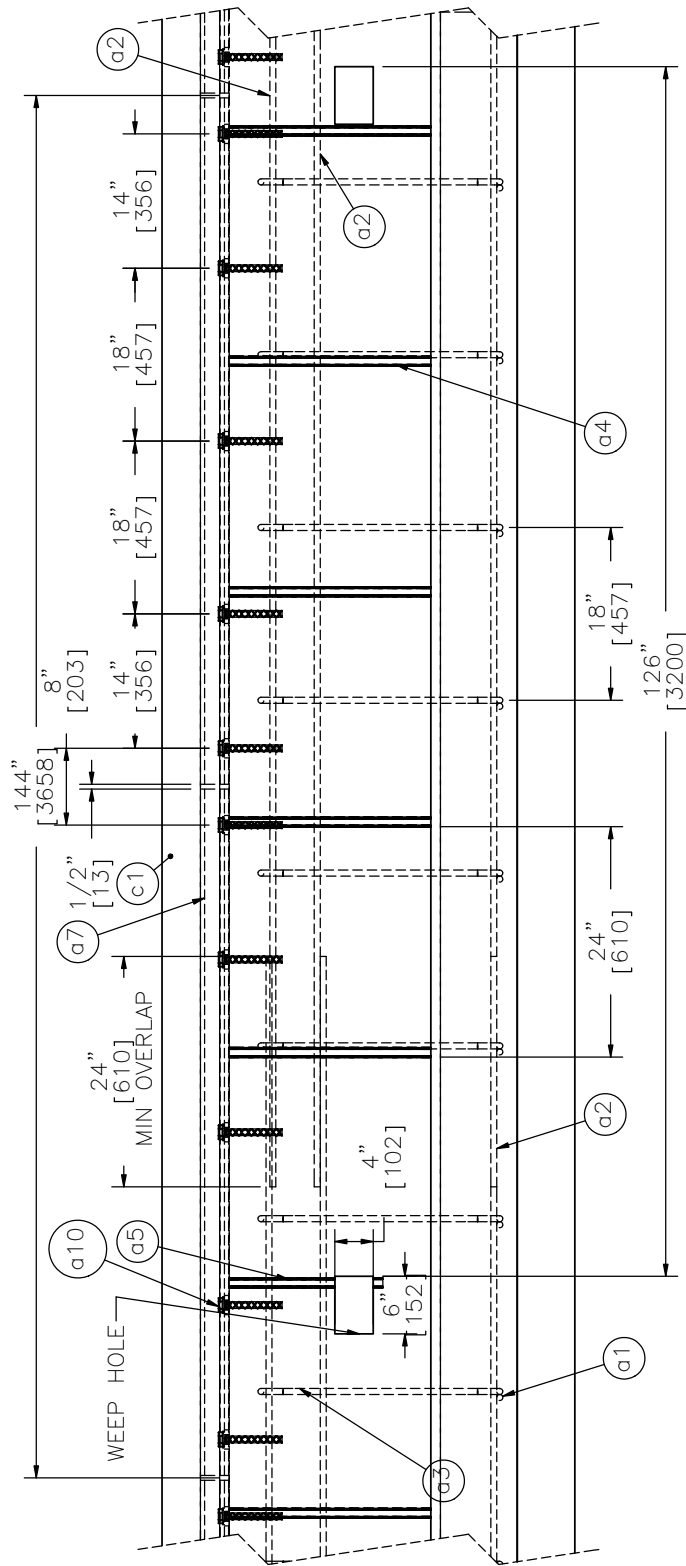
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INTERIOR SECTION  
PROFILE VIEW

- NOTES:
- (1) THE OPEN CHANNELS IN THE DOVETAIL ANCHOR SLOTS ARE 1"x1"x5/8" [25x25x16] AND ARE FOAM FILLED TO PROTECT THE SLOT DURING CONCRETE FORMING AND PLACEMENT.
  - (2) TWO TYPE 106 DOVETAIL ANCHOR TIES SHALL BE PLACED IN EACH DOVETAIL ANCHOR SLOT TO ATTACH THE RUBBLE STONE MASONRY TO THE FRONT AND BACK FACES OF THE INNER CORE WALL.
  - (3) BEND AT LEAST 25 PERCENT OF DOVETAIL ANCHOR TIES AT A SHORT RIGHT ANGLE TO ENGAGE A RECESS CUT IN THE STONE. EXTEND THE ANCHORS TO WITHIN 3" [76] OF THE EXPOSED FACE OF THE STONE WORK.
  - (4) STAINLESS STEEL (SS 304) Z-CLIPS WERE ALSO USED TO ANCHOR THE STONE MASONRY USING 1/4" [6.4] DIAMETER BY 2 3/4" [70] LONG, HEAVY-WEIGHT, STAINLESS STEEL TAPCON MASONRY ANCHORS TO THE FRONT AND BACK FACES OF THE GUARDWALL. THE Z-CLIPS WERE SPACED APPROXIMATELY ON 2' [610] CENTERS AND USED TO ENGAGE A RECESS CUT IN THE STONE.

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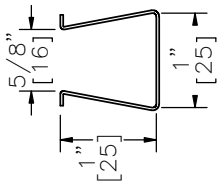
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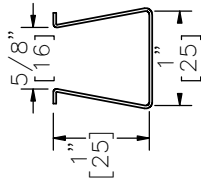
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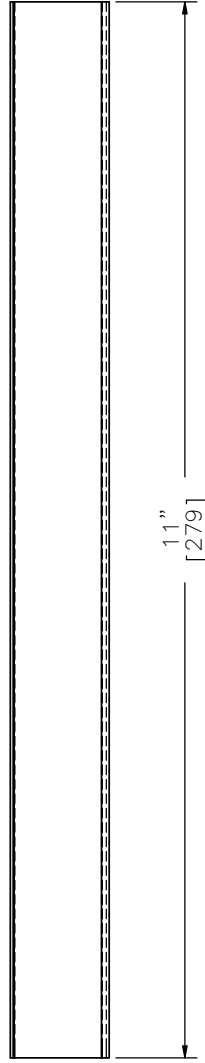
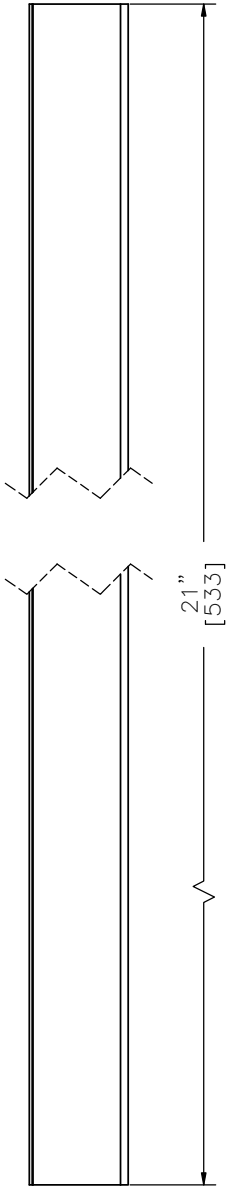
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DOVETAIL ANCHOR SLOT  
22-GAUGE [0.8]  
PART a4



DOVETAIL ANCHOR SLOT  
22-GAUGE [0.8]  
PART a5



NOTES:

- (1) THE FINISH FOR THE DOVETAIL ANCHOR SLOTS SHALL BE MILL GALVANIZED STEEL ASTM A653, HOT DIP GALVANIZED STEEL ASTM A153, OR CLASS B2 DEPENDING UPON THE MATERIAL SELECTED.
- (2) TWO DOVETAIL ANCHOR TIES SHALL BE USED WITH EACH DOVETAIL ANCHOR SLOT IN ORDER TO ATTACH THE RUBBLE STONE MASONRY TO THE FRONT AND BACK FACES OF THE INNER CONCRETE CORE WALL. TYPE 106 (16 GAUGE [1.5] BY 5 1/2" [140] LONG) DOVETAIL CORRUGATED ANCHORS SHALL BE MILL GALVANIZED STEEL ASTM A653 OR HOT DIP GALVANIZED STEEL ASTM A153.
- (3) BEND AT LEAST 25 PERCENT OF ANCHOR TIES AT A SHORT RIGHT ANGLE TO ENGAGE A RECESS CUT IN THE STONE. EXTEND THE ANCHORS TO WITHIN 3" [76] OF THE EXPOSED FACE OF THE STONE WORK.

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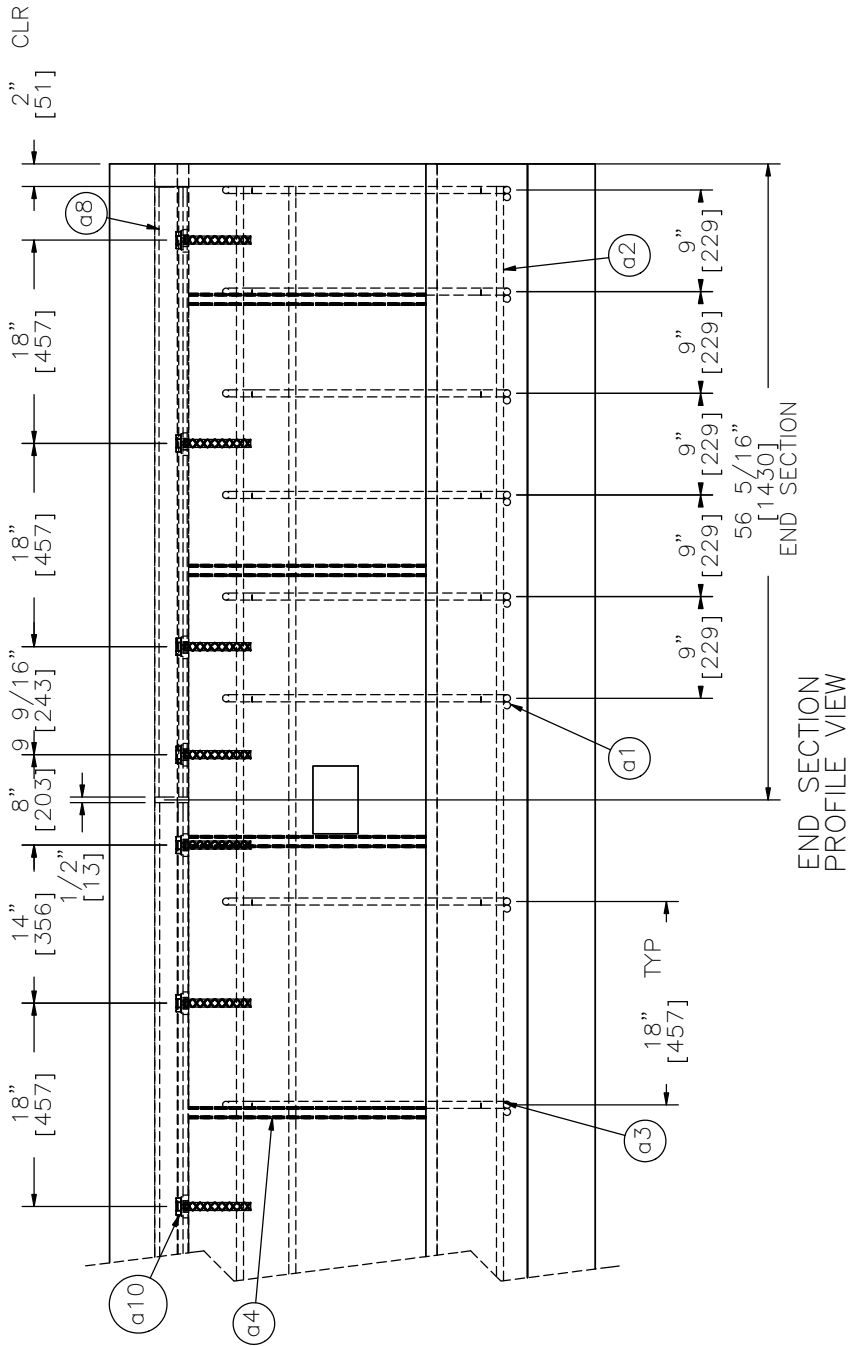
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- NOTES:
- (1) THE OPEN CHANNELS IN THE DOVETAIL ANCHOR SLOTS ARE 1"x1"x5/8" [25x25x16] AND ARE FOAM FILLED TO PROTECT THE SLOT DURING CONCRETE FORMING AND PLACEMENT.
  - (2) TWO TYPE 106 DOVETAIL ANCHOR TIES SHALL BE PLACED IN EACH DOVETAIL ANCHOR SLOT TO ATTACH THE RUBBLE STONE MASONRY TO THE FRONT FACE OF THE INNER CORE WALL.
  - (3) BEND AT LEAST 25 PERCENT OF DOVETAIL ANCHOR TIES AT A SHORT RIGHT ANGLE TO ENGAGE A RECESS CUT IN THE STONE. EXTEND THE ANCHORS TO WITHIN 3" [76] OF THE EXPOSED FACE OF THE STONE WORK.
  - (4) STAINLESS STEEL (SS 304) Z-CLIPS WERE ALSO USED TO ANCHOR THE STONE MASONRY USING 1/4" [6.4] DIAMETER BY 2 3/4" [70] LONG, HEAVY-WEIGHT, STAINLESS STEEL TAPCON MASONRY ANCHORS TO THE FRONT AND BACK FACES OF THE GUARDWALL. THE Z-CLIPS WERE SPACED APPROXIMATELY ON 2' [610] CENTERS AND USED TO ENGAGE A RECESS CUT IN THE STONE.

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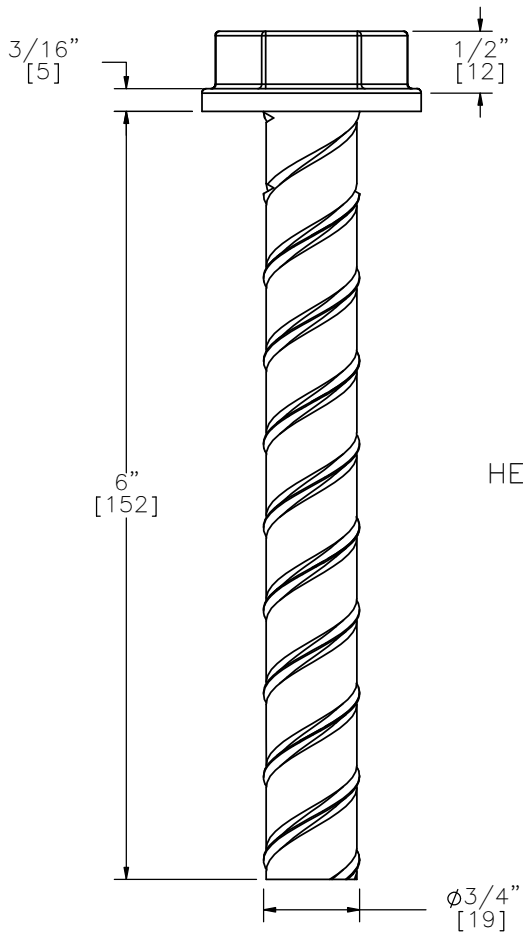
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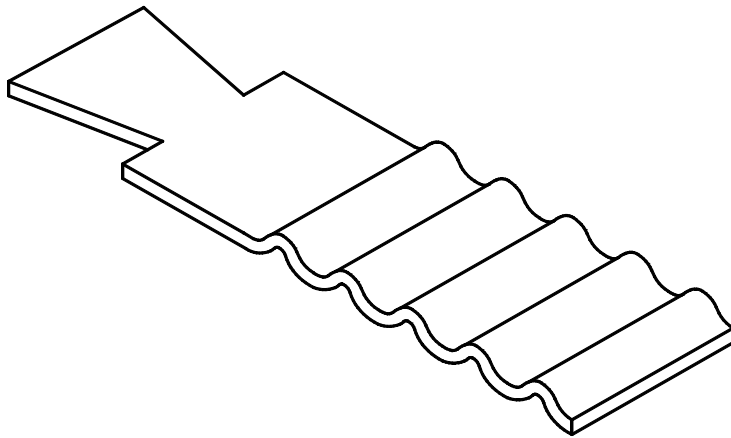
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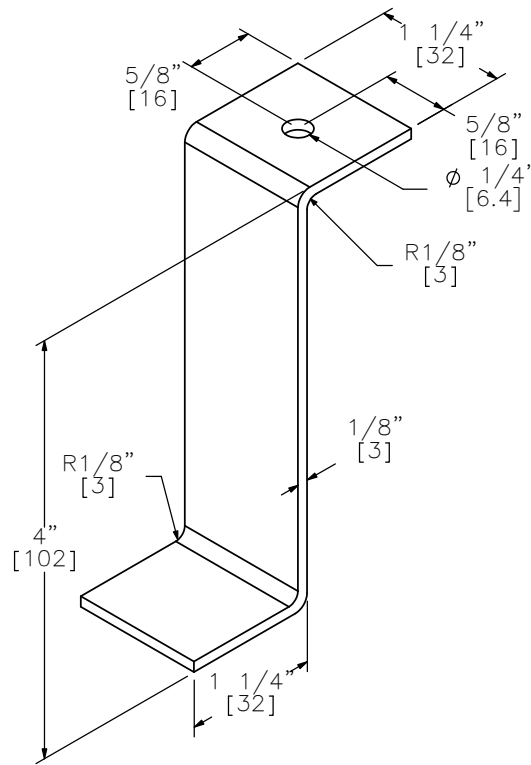
$\phi 3/4$ " [19] x 6" [152] LONG  
 WEDGE-BOLT SCREW ANCHOR  
 PART a10



HECKMANN TYPE 106 DOVETAIL CORRUGATED ANCHOR  
 5 1/2" [140] LONG, 16 GAUGE [1.5]  
 PART a6



$\phi 1/4$ " [6] x 2-3/4" [70]  
 HWH TAPCON  
 PART a12



304 STAINLESS STEEL Z-CLIP  
 PART a11

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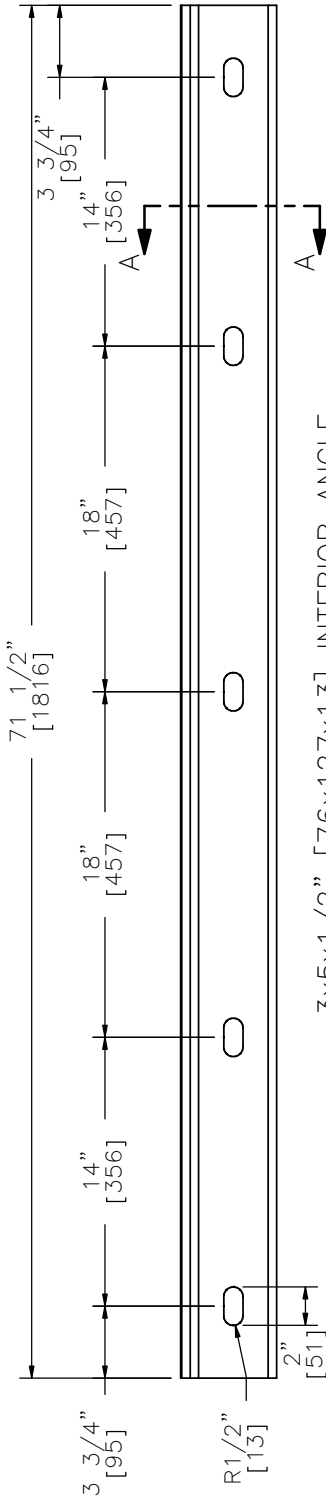
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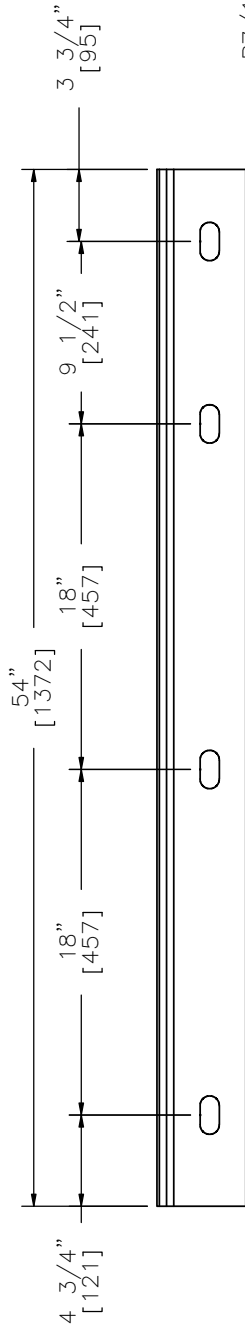
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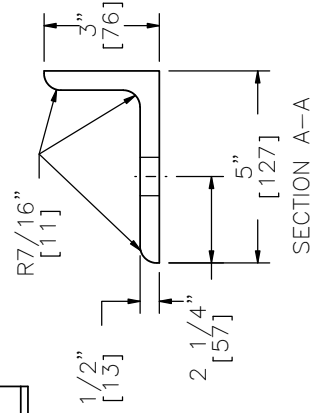
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3x5x1 1/2" [76x127x13] INTERIOR ANGLE  
PART a7



3x5x1 1/2" [76x127x13] END ANGLE  
PART a8



SECTION A-A

DOUBLE-SIDED, NCHRP 350 TL-2 ROUGH STONE MASONRY GUARDWALL



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NOTES: (1) ANGLES ARE USED TO PROVIDE LATERAL SHEAR RESISTANCE FOR HTE RUBBLE STONE MASONRY PLACED ON TOP OF THE INNER CORE WALL.

(2) SPACING BETWEEN ALL ANGLES IS APPROXIMATELY 1/2" [13].

(3) INTERIOR STEEL ANGLES ARE ATTACHED WITH WEDGE-BOLT SCREW ANCHORS. INTERIOR ANCHORS ARE CENTERED BETWEEN STIRRUPS. END ANCHORS ON INTERIOR ANGLES ARE PLACED BETWEEN STIRRUPS, BUT NOT CENTERED SINCE AN ANCHOR FROM THE ADJACENT ANGLE MUST ALSO BE PLACED WITHIN THE SAME STIRRUP SPAN.