



Single Reinforced Concrete Box Culvert Standards

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		Standard Design Single Reinforced Concrete Box Culverts July, 2020	
		Index of Sheets	RCB G1-20



Single Reinforced Concrete Box Culvert Standards

General Notes:

- 1. The RCB culvert sections are designed for HL-93 live load and earth fills of varying heights.
- 2. Vertical earth pressure, EV=0.120 kcf.
Horizontal earth pressure, EHmax = 0.060 kcf max, EHmin = 0.030 kcf.
- 3. The RCB culvert sections are designed for Class 1 exposure conditions except:
Class 2 exposure condition is utilized for the slab design in 0' fill instances.
- 4. All slab and floor reinforcing steel is to be supported at intervals of not more than 3'-0" in either direction as outlined in the Standard Specifications.
- 5. The clear distance from face of concrete to near edge or end of reinforcing bar to be 2" unless otherwise noted.
- 6. Except for dowel bars 5r1 in slab, longitudinal reinforcing is not to extend thru the construction joints.
- 7. Floor of barrel is to be finished smooth. Sides of footing are to be formed to insure correct line and grade.
- 8. The permissible construction joint at the top of the walls may be lowered at the Contractor's option with Engineer's approval.
- 9. The reinforcement supplied for this structure shall be Grade 60 reinforcement in accordance with the Standard Specifications. The design stresses are based on ASTM A706 Grade 60 reinforcement.
- 10. The vertical bars in the walls may be spliced above the footing at the Contractor's option as follows:

Bar Size Number	4	5	6	7	8	9
Minimum Splice Length	20"	24"	29"	34"	38"	47"

This splice, if used, will be at the Contractor's expense.

- 11. Reinforcing bar clearances will be as follows:
Edge clearances: 2" except
Top of floor 2¼" to near transverse reinforcing bar
Bottom of floor 3½" to near transverse reinforcing bar
End clearances:
Vertical top 2"
Vertical bottom 3" or 3½" if overall height of the culvert is not to a full inch
Transverse 2"
12. All construction joints shall be formed with a beveled keyway except at bell joints.
- 13. All beveled keyways shall be centered.
- 14. Keyway size shall be 2"x4" except as follows:
Keyway between the floor and wall shall be 2"x6" when the wall is greater than 10 inches wide.
- 15. Keyway dimensions shown on the plans are based on nominal dimensions unless stated otherwise. In addition, the bevel used on the keyway shall be limited to a maximum of 10 degrees from vertical.
- 16. If 0' of fill is specified, details for paving notch and reference to epoxy coating of slab reinforcing steel, if applicable, shall be included in the final plans.
- 17. All dimensions are in feet and inches unless otherwise noted or shown.
- 18. See current Standard Specifications regarding concrete form removal.
- 19. These culvert standards label all reinforcing steel with English notation (5a1 is ⅝ inch diameter bar). English reinforcing steel received in the field may display the following "bar designation". The "bar designation" is the stamped impression on the reinforcing bars, and is equivalent to the bar diameter in millimeters.

English Size	4	5	6	7	8	9
Bar Designation	13	16	19	22	25	29

- 20. In the event the slab thickness at the barrel end section exceeds 18 inches, the culvert parapet shall extend a minimum of 6 inches above the top of the culvert slab. Refer to the Culvert Design Manual for instructions. These details are to be included in the design plans to address these situations.

Specifications:


Design:
AASHTO LRFD Bridge Design Specifications, 8th Ed., Series of 2017.


Construction:
Iowa Department of Transportation Standard Specifications for Highway and Bridge Construction, current series, plus applicable General Supplemental Specifications, Developmental Specifications, Supplemental Specifications and Special Provisions

Design Stresses:

Design stresses for the following materials are in accordance with the AASHTO LRFD Bridge Design Specifications, 8th Ed., Series of 2017:
Reinforcing steel in accordance with AASHTO LRFD Section 5, Grade 60.
Concrete in accordance with AASHTO LRFD Section 5, f'c = 4.0 ksi.

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APPROVED BY BRIDGE ENGINEER



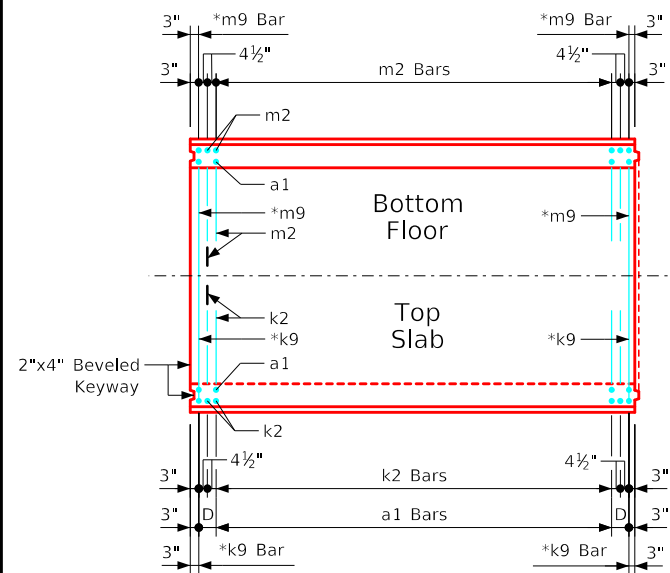
Standard Design
Single Reinforced Concrete Box Culverts
July, 2020

General Notes & Specifications

RCB G2-20

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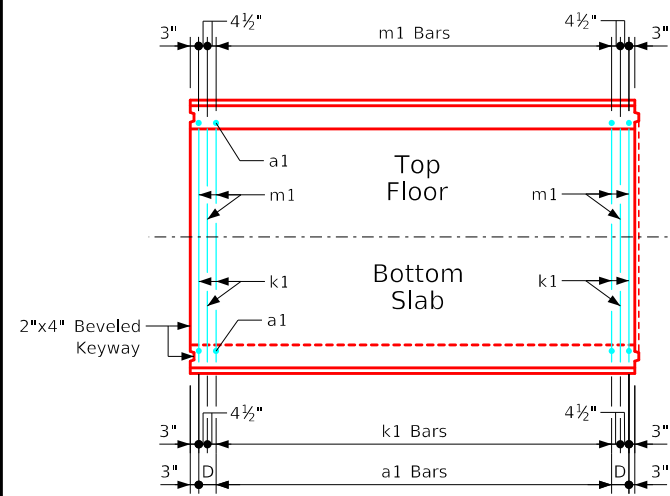


Note:
Typical for lengths of 38', 35', 32', 29', and 26'. These lengths are shown as typical because all transverse and vertical reinforcing steel spacing repeats in 3'-0" intervals.

* The k9 and m9 bars are to be placed in the top slab and bottom floor unless the horizontal legs of the k2 and m2 bars touch or lap. The culvert barrel detail standards identify when the k9 and m9 bars are omitted.

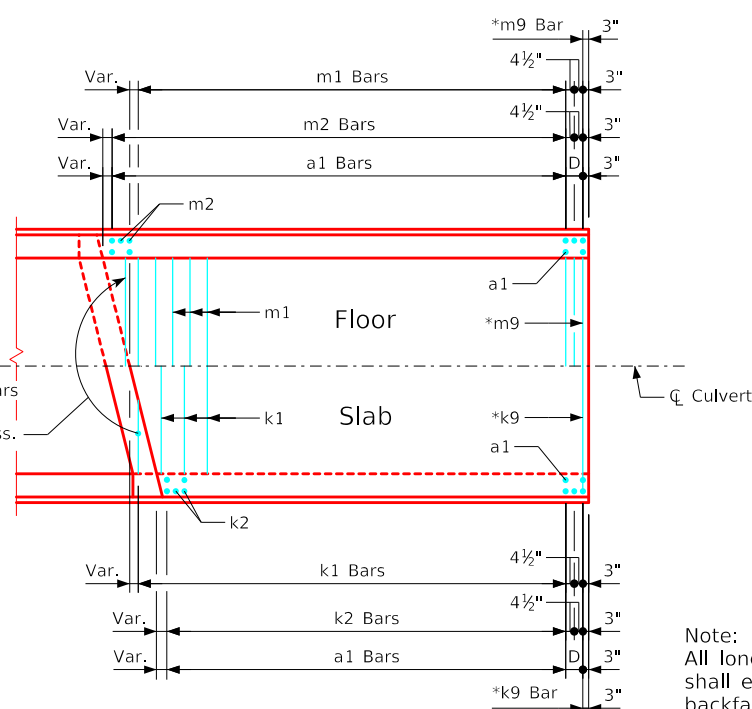
Cut & relocate bars as required. The k1 bars all fills & k2 bars zero fill only. The m1 bars to extend into headwall apron. Discard cut lengths of 2'-0" or less.

Standard Section Plan View
(Keyway is to be omitted when bell joints are used)

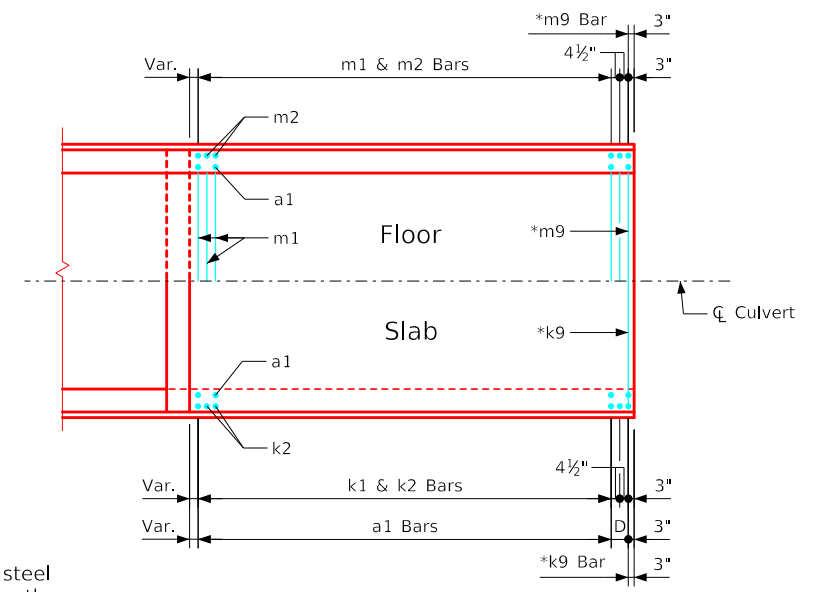


Note:
Typical for lengths of 38', 35', 32', 29', and 26'. These lengths are shown as typical because all transverse and vertical reinforcing steel spacing repeats in 3'-0" intervals.

Standard Section Plan View
(Keyway is to be omitted when bell joints are used)



Typical Skew



0° Skew

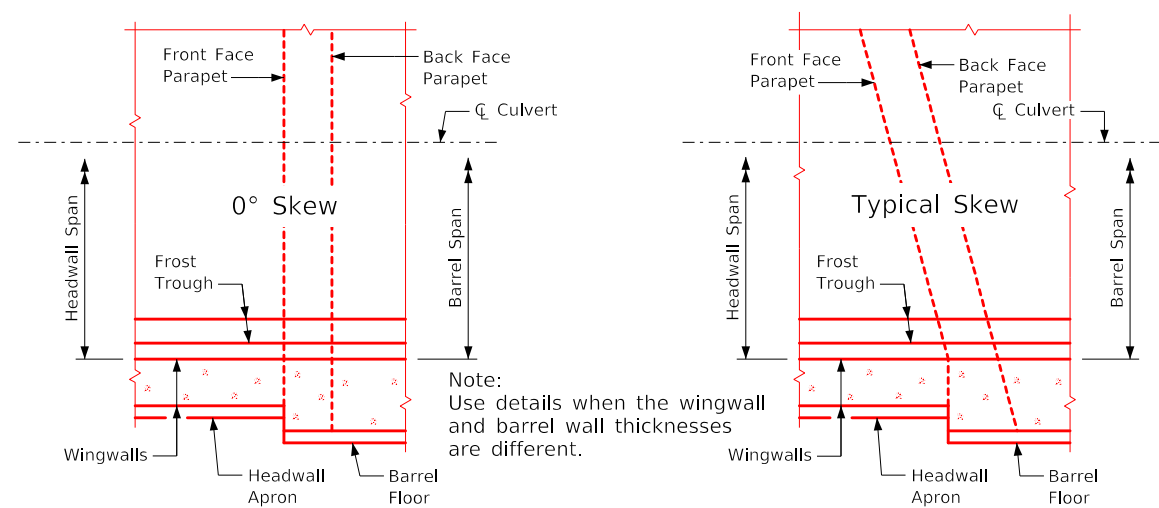
End Section Plan Views
(Keyways not shown)

Note:
End section details shown are for a 15° skew barrel. Use for skews of 30° & 45° by increasing the number of transverse reinforcing bars required to be cut and relocated.

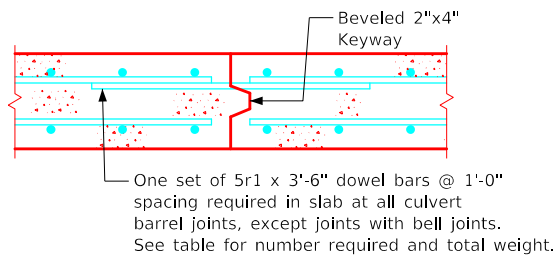
5r1 Bars - One Const. Jt.

Span	No.	Weight (LB)
3'-0"	4	15
4'-0"	5	18
5'-0"	6	22
6'-0"	7	26
8'-0"	9	33
10'-0"	11	40
12'-0"	13	47
14'-0"	15	55
16'-0"	17	62



Note:
Dimensions listed on this sheet to be used in conjunction with dimensions and quantities for barrel section sheets.



Transition Wall Details



Top Slab Construction Joint Detail

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		Standard Design Single Reinforced Concrete Box Culverts July, 2020	
		Typical Culvert Barrel Details	RCB G3-20

Dimensions							Bar List																												Quantities														
							a1			b1			e1			e2			f1			f2			k1			k2					k9		m1			m2					m9		Concrete (CY/FT)				Steel (LB/FT)
Fill	S	H	A	B	C	D	Size	Sp.	L	Size	Sp.	No.	Size	Sp.	No.	Size	Sp.	No.	Size	Sp.	No.	Size	Sp.	L	Size	Sp.	L	H	V	Size	L	Size	Sp.	L	Size	Sp.	L	H	V	Size	L	Slab	Floor	Walls	Total				
0	14	6	14	14	9	9	4	9	8'-3	4	6	24	5	12	13	4	16	6	4	12	15	4	13	8	6	6	15'-2	6	9	7'-4	3'-4	4'-0	6	15'-2	7	9	15'-8	6	9	10'-7	4'-0	6'-7	6	15'-8	0.702	0.728	0.313	1.743	231.66
1	14	6	13.5	14	9	9	4	9	8'-2	4	6	24	5	12	13	4	17	6	4	12	15	4	13	8	6	6	15'-2	6	9	7'-5	3'-5	4'-0	6	15'-2	7	9	15'-8	6	9	10'-5	3'-10	6'-7	6	15'-8	0.678	0.728	0.313	1.719	231.13
2	14	6	9	10.5	9	9	4	12	7'-6	4	6	24	6	12	13	4	13	8	4	12	15	4	14	8	7	6	15'-2	6	6	8'-0	4'-0	4'-0	6	15'-2	7	6	15'-8	6	6	10'-5	4'-1	6'-4	6	15'-8	0.463	0.555	0.313	1.331	308.26
3-5	14	6	8.5	10.5	9	9	4	12	7'-6	4	6	24	4	12	13	4	13	8	4	12	15	4	13	8	7	6	15'-2	6	6	7'-10	3'-11	3'-11	6	15'-2	7	6	15'-8	6	6	10'-3	3'-11	6'-4	6	15'-8	0.439	0.555	0.313	1.307	295.53
6-8	14	6	9.5	12.5	9	9	4	12	7'-9	4	6	24	4	12	13	4	18	6	4	12	15	4	16	6	7	6	15'-2	6	6	7'-2	3'-7	3'-7	6	15'-2	7	6	15'-8	6	6	9'-9	3'-3	6'-6	6	15'-8	0.487	0.654	0.313	1.454	286.13
9-10	14	6	10	12.5	9	9	4	12	7'-9	4	6	24	4	12	13	4	12	8	4	12	15	4	15	6	8	6	15'-2	6	6	7'-4	3'-8	3'-8	6	15'-2	8	6	15'-8	6	6	9'-8	3'-2	6'-6	6	15'-8	0.511	0.654	0.313	1.478	327.05
11-13	14	6	11.5	14	9	9	4	12	8'-0	4	6	24	4	12	13	4	14	6	4	12	15	4	13	6	8	6	15'-2	6	6	6'-9	2'-11	3'-10	6	15'-2	8	6	15'-8	6	6	9'-4	2'-9	6'-7	6	15'-8	0.583	0.728	0.313	1.624	320.50
14-16	14	6	12.5	15	9.5	9	4	12	8'-2	4	6	24	4	12	13	4	13	6	4	12	15	4	12	6	8	6	15'-3	6	6	6'-9	2'-10	3'-11	6	15'-3	8	6	15'-9	6	6	9'-5	2'-9	6'-8	6	15'-9	0.635	0.782	0.330	1.747	322.13

Bent Bar Detail

The diagram shows a bent bar with a horizontal leg of length H and a vertical leg of height D . A dashed circle at the corner indicates a fillet with a radius of $D = 4\frac{1}{2}''$. The dimensions H and D are measured from the centerline of the bar. A note specifies that all dimensions are out to out.

Note:
All dimensions are out to out.
 D = pin diameter.



1. Dimensions listed on this sheet to be used in conjunction with Sheet RCB G3-20.
2. The k2 and m2 bars horizontal legs may lap in low fill situations.
3. Fill, dimensions "S" and "H" are in feet.
4. Dimensions "A", "B", "C", "D", and "Sp." listed in the bar list are in inches.
5. Dimensions "L", "H", "V" are in feet and inches.



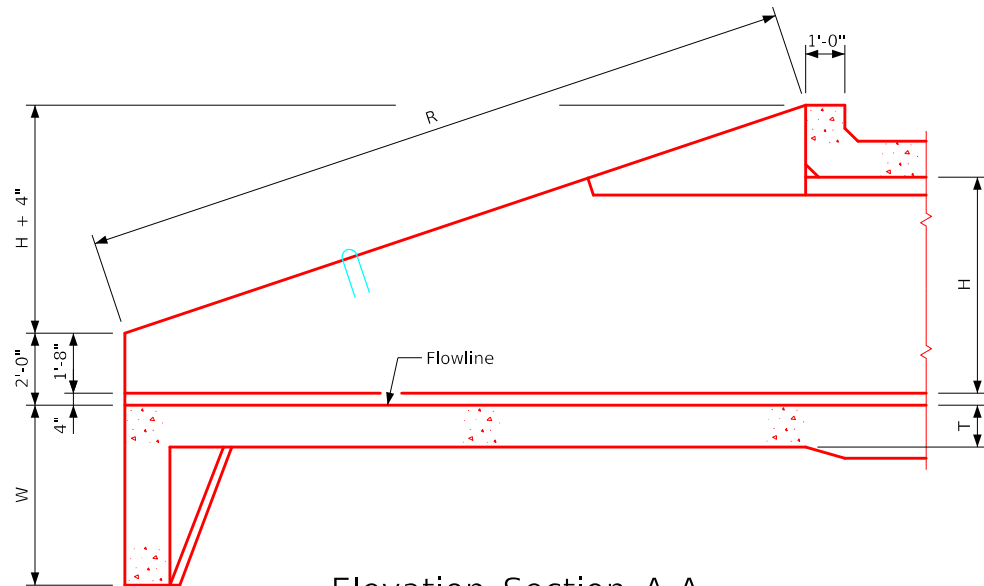
Standard Design Single Reinforced Concrete Box Culverts

July, 2020

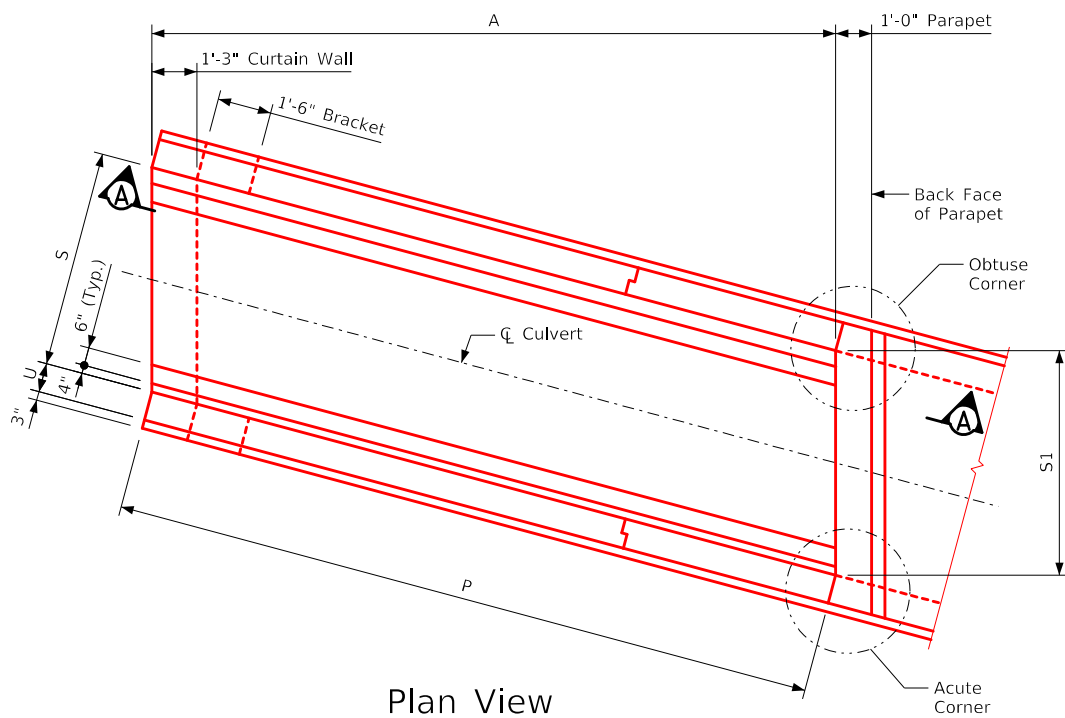
Culvert Barrel Details

14' x 6' Barrel Sections

RCB 14-6-20



Elevation Section A-A





Plan View

Dimension Table																								
S x H	16' x 14'	16' x 13'	16' x 12'	16' x 11'	16' x 10'	16' x 9'	16' x 8'	16' x 7'	16' x 6'	16' x 5'	16' x 4'	14' x 14'	14' x 13'	14' x 12'	14' x 11'	14' x 10'	14' x 9'	14' x 8'	14' x 7'	14' x 6'	14' x 5'	14' x 4'	S x H	
Headwall Dimensions	A	43'-0	40'-0	37'-0	34'-0	31'-0	28'-0	25'-0	22'-0	19'-0	16'-0	13'-0	43'-0	40'-0	37'-0	34'-0	31'-0	28'-0	25'-0	22'-0	19'-0	16'-0	13'-0	A
	H	14'-0	13'-0	12'-0	11'-0	10'-0	9'-0	8'-0	7'-0	6'-0	5'-0	4'-0	14'-0	13'-0	12'-0	11'-0	10'-0	9'-0	8'-0	7'-0	6'-0	5'-0	4'-0	H
	P	44'-6¼	41'-4⅞	38'-3¾	35'-2¾	32'-1½	28'-11⅝	25'-10⅝	22'-9¾	19'-8	16'-6¾	13'-5½	44'-6¼	41'-4⅞	38'-3¾	35'-2¾	32'-1½	28'-11⅝	25'-10⅝	22'-9¾	19'-8	16'-6¾	13'-5½	P
	R	46'-9¼	43'-6	40'-2⅞	36'-11¾	33'-8⅝	30'-5½	27'-2¼	23'-11⅜	20'-8	17'-4⅞	14'-1½	46'-9¼	43'-6	40'-2⅞	36'-11¾	33'-8⅝	30'-5½	27'-2¼	23'-11⅜	20'-8	17'-4⅞	14'-1½	R
	S	16'-0	16'-0	16'-0	16'-0	16'-0	16'-0	16'-0	16'-0	16'-0	16'-0	16'-0	14'-0	14'-0	14'-0	14'-0	14'-0	14'-0	14'-0	14'-0	14'-0	14'-0	14'-0	S
	S1	16'-6¾	16'-6¾	16'-6¾	16'-6¾	16'-6¾	16'-6¾	16'-6¾	16'-6¾	16'-6¾	16'-6¾	16'-6¾	14'-5⅝	14'-5⅝	14'-5⅝	14'-5⅝	14'-5⅝	14'-5⅝	14'-5⅝	14'-5⅝	14'-5⅝	14'-5⅝	14'-5⅝	S1
	T	1'-4	1'-4	1'-4	1'-4	1'-4	1'-4	1'-4	1'-4	1'-4	1'-4	1'-4	1'-3	1'-3	1'-3	1'-3	1'-3	1'-3	1'-3	1'-3	1'-3	1'-3	1'-3	T
	U	1'-1	1'-1	1'-0	1'-0	10	10	10	9	9	9	9	1'-1	1'-1	1'-0	1'-0	10	10	10	9	9	9	9	U
	W	5'-6	5'-3	5'-0	4'-9	4'-6	4'-3	4'-0	3'-9	3'-6	3'-6	3'-6	5'-6	5'-3	5'-0	4'-9	4'-6	4'-3	4'-0	3'-9	3'-6	3'-6	3'-6	W
Bar Spacing	B	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	9	9	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	9	9	B	
	C	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	9	9	9	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	9	9	9	1'-0	1'-0	C	
	D	6	6	6	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	6	6	6	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	D	
	E	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	9	9	9	E	

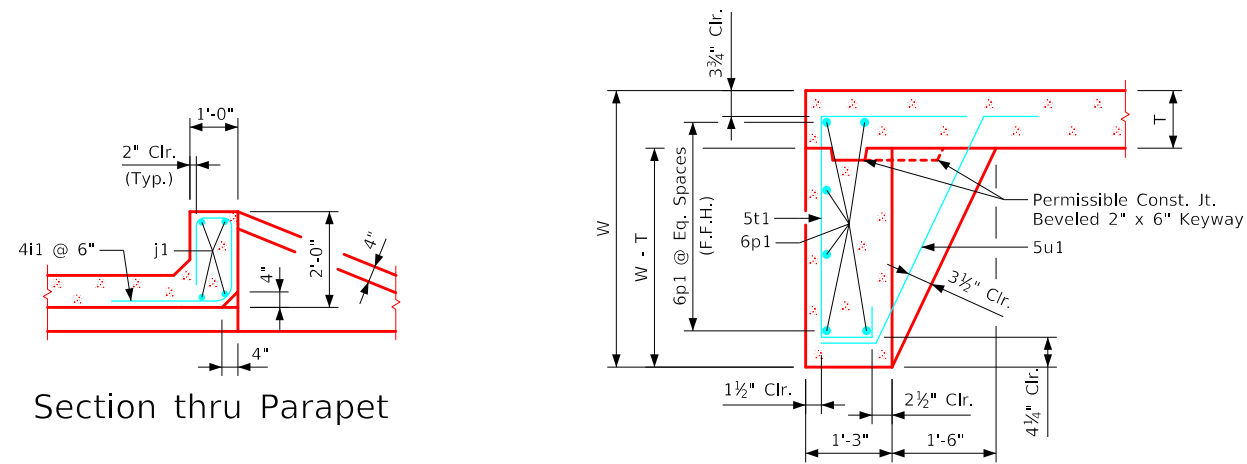
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Notes:

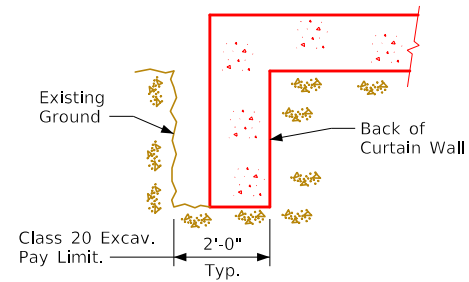
1. See Sheet RCB G2-20 for General Notes, Specifications, and Design Stresses.
2. See Sheets PWH 15-2-20 thru 15-4-20 for location of certain dimensions tabulated.
3. Dimensions are in feet and inches unless otherwise noted.

LATEST REVISION DATE	 APPROVED BY BRIDGE ENGINEER		
		Standard Design - Single Reinforced Concrete Box Culverts Parallel Wing Headwalls July, 2020	
		Dimension Table 15° Skew	PWH 15-1-20

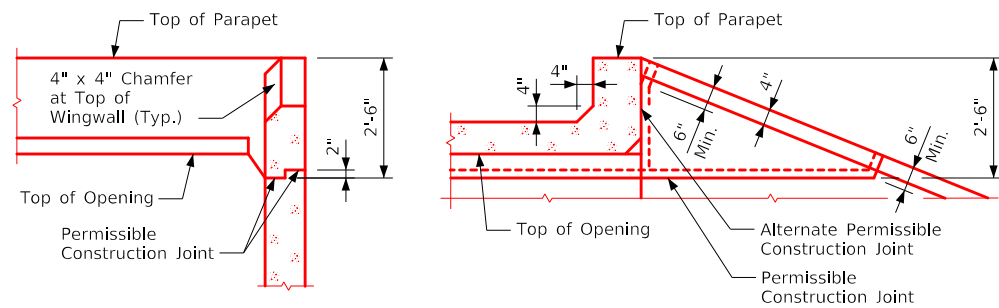
ENGLISHLRFDSDIGNEDSINGLECULVERTS.DGN - PWH 15-2-20 - THIS SHEET ISSUED 07-2020.



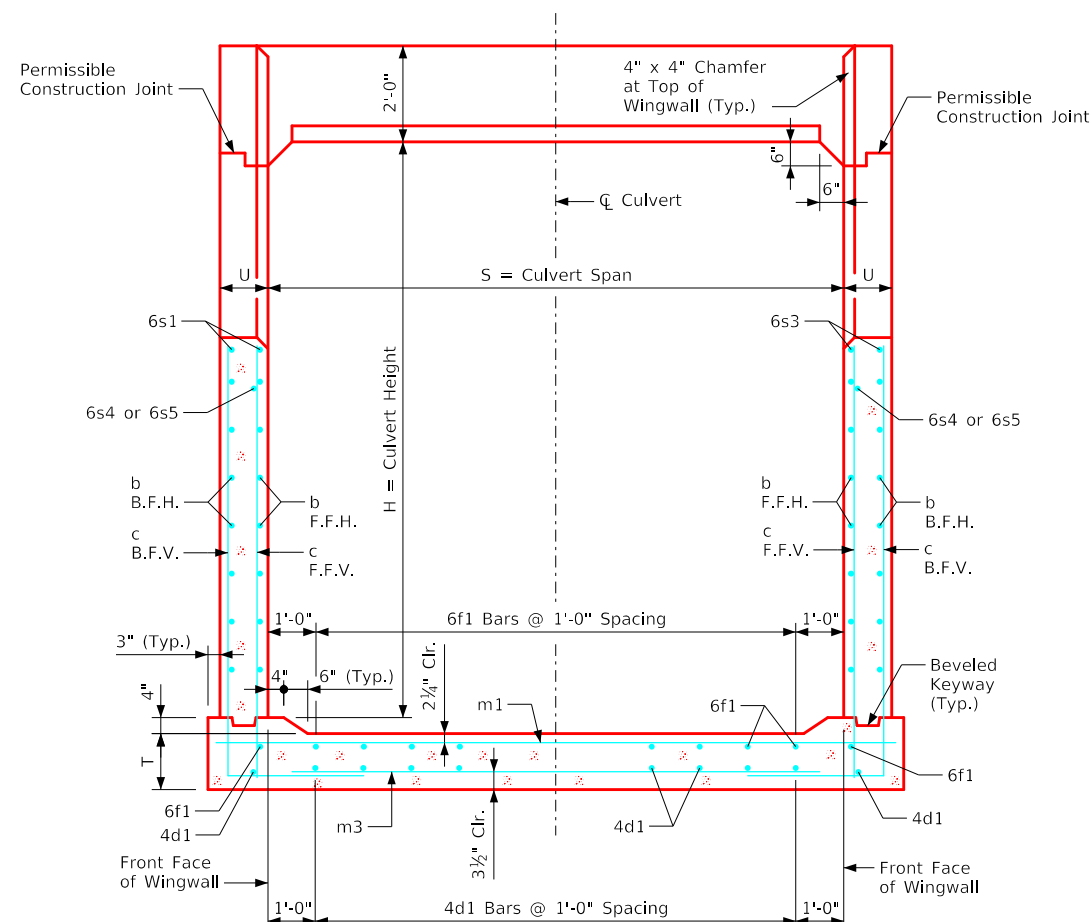
Section thru Curtain Wall



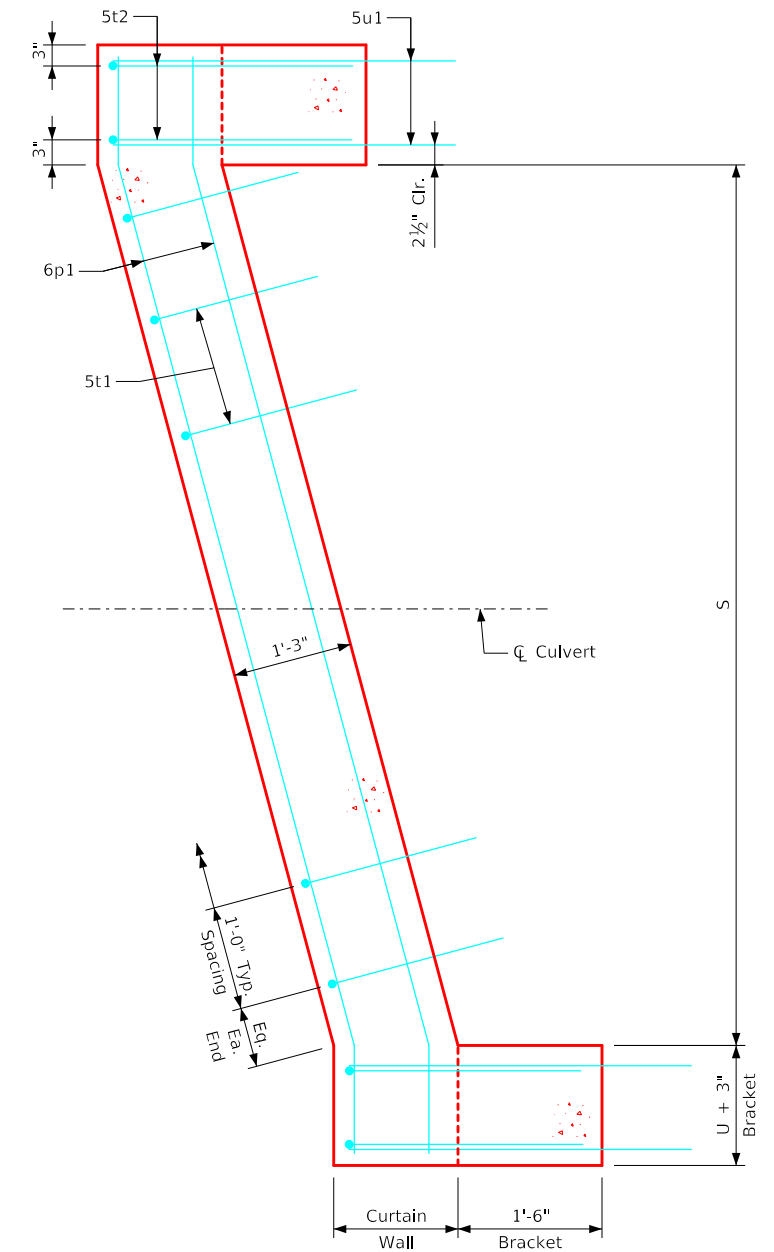
Curtain Wall
Class 20 Excavation



Top of Wingwall Details





Typical Cross Section - thru Headwall

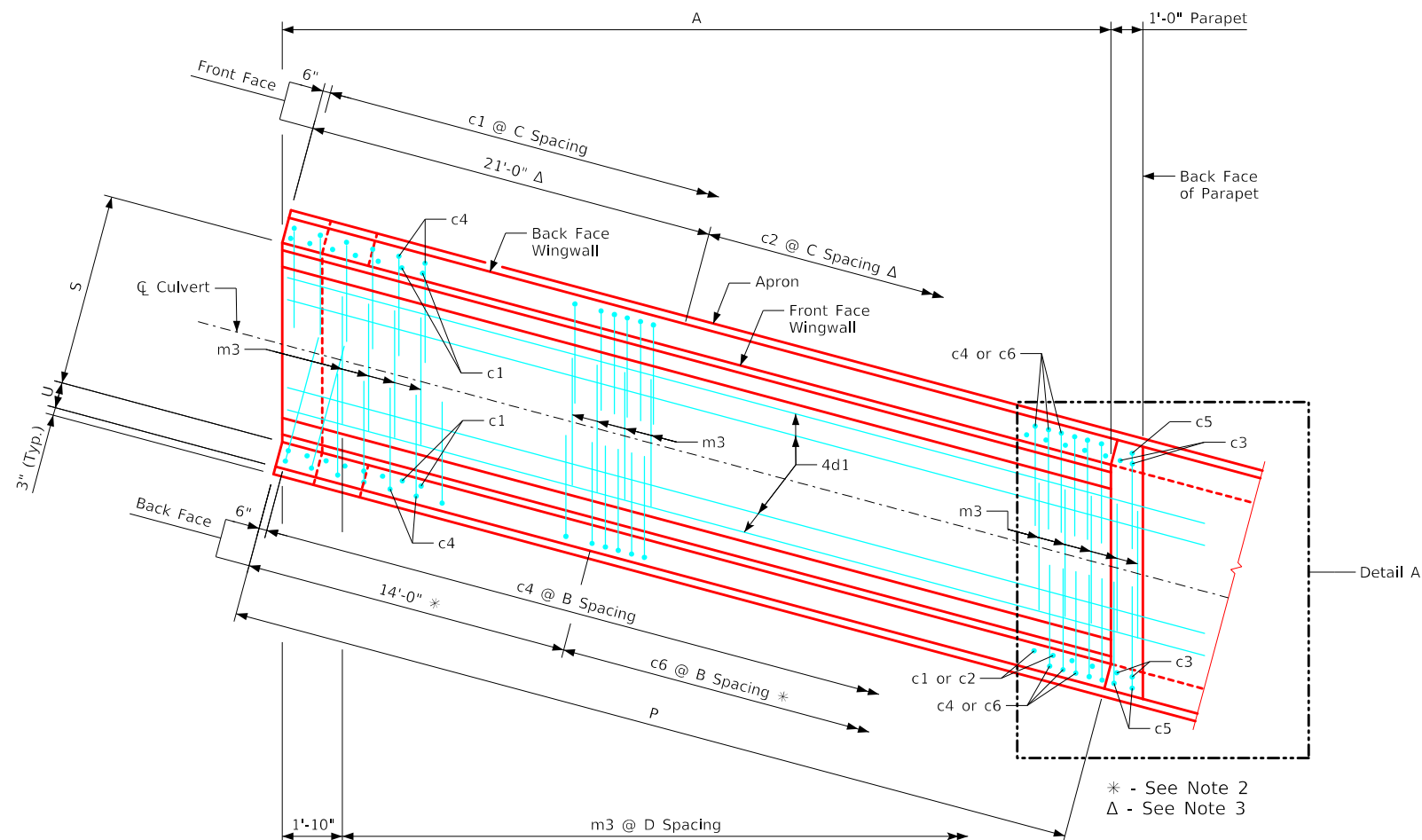


Curtain Wall Detail - Plan View
(Apron is not shown)

Notes:

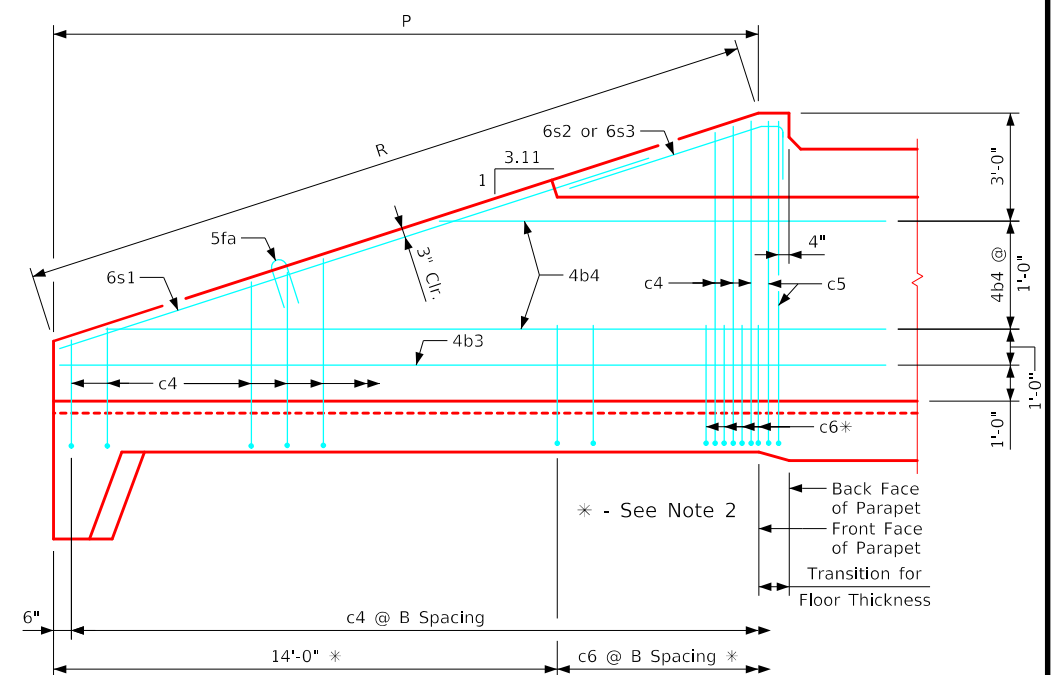
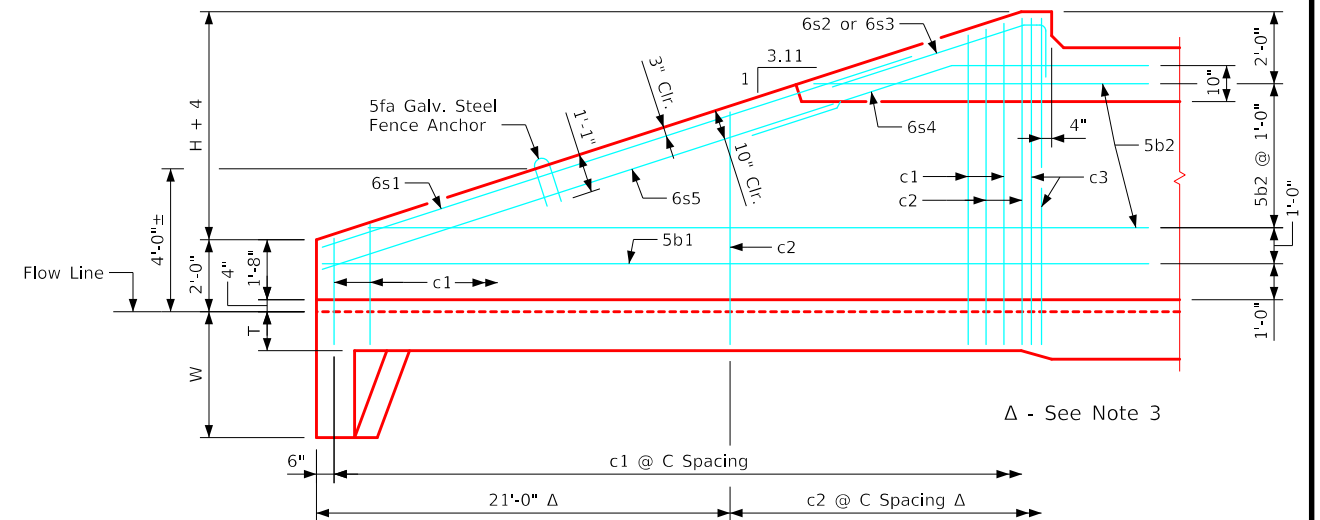
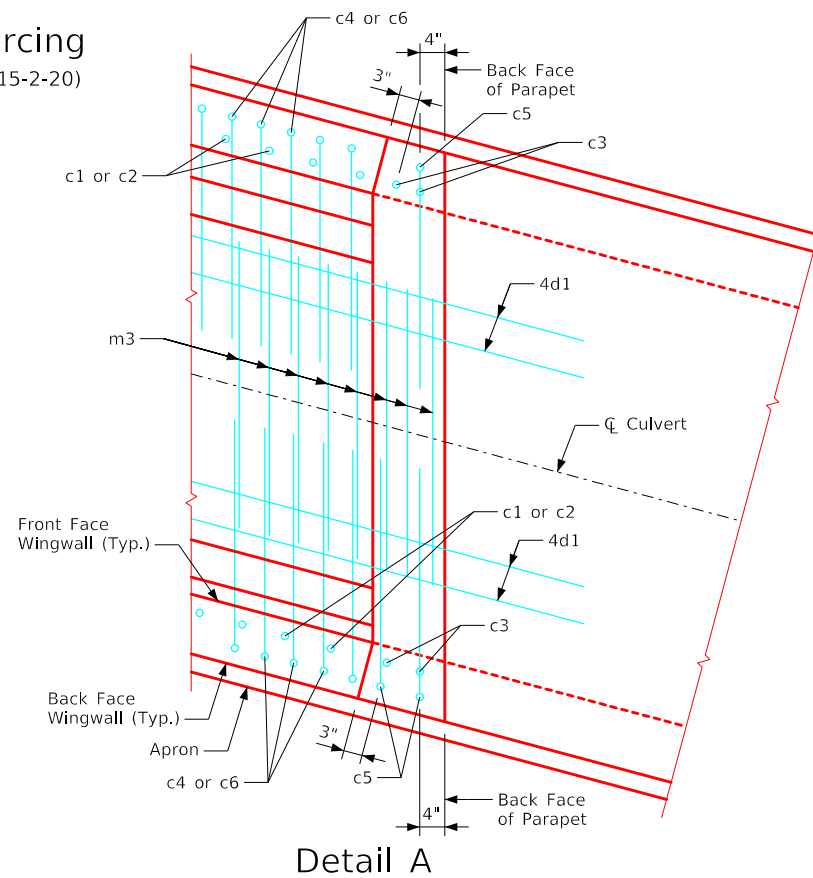
1. See Sheet RCB G2-20 for General Notes, Specifications, and Design Stresses.
2. For dimension table see Sheet PWH 15-1-20.



LATEST REVISION DATE	 APPROVED BY BRIDGE ENGINEER		
		Standard Design - Single Reinforced Concrete Box Culverts	
		Parallel Wing Headwalls	
		July, 2020	
		Cross Section Details 15° Skew	PWH 15-2-20



Notes:



1. Bar spacings and positions shown are similar for all sizes of headwalls in this standard.
2. Not applicable for 3' thru 5' height headwalls.
3. Not applicable for 3' thru 8' height headwalls.
4. For headwall dimensions and bar spacing see Sheet PWH 15-1-20.
5. Apron m3 bars are to be centered on ϕ culvert.
6. B.F.V. (c5) and F.F.V. (c3) bars are approximately 4" from the back of parapet for all headwalls.



LATEST REVISION DATE			
		Standard Design - Single Reinforced Concrete Box Culverts	
		Parallel Wing Headwalls	
		July, 2020	
		Wingwall Elevations & Bottom Apron Reinforcing 15° Skew	PWH 15-3-20



1. Bar spacings and positions shown are similar for all sizes of headwalls in this standard.
2. For headwall dimensions and bar spacing see Sheet PWH 15-1-20.
3. Top transverse apron bars are referenced approximately 4" from the back of the parapet for all headwalls.

LATEST REVISION DATE	 APPROVED BY BRIDGE ENGINEER		
		Standard Design - Single Reinforced Concrete Box Culverts	
		Parallel Wing Headwalls July, 2020	
		Parapet Reinforcing & Top Apron Reinforcing 15° Skew	PWH 15-4-20

Bill of Reinforcing for One Headwall 15° Skew Span x Culvert Height																																										
Location		Shape	14' x 14'				14' x 13'				14' x 12'				14' x 11'				14' x 10'				14' x 9'				14' x 8'				14' x 7'											
			Bar	No.	Length	Wt.	Bar	No.	Length	Wt.	Bar	No.	Length	Wt.	Bar	No.	Length	Wt.	Bar	No.	Length	Wt.	Bar	No.	Length	Wt.	Bar	No.	Length	Wt.	Bar	No.	Length	Wt.								
Fence Anchor (Galv.)			5fa	2	2'-10	6	5fa	2	2'-10	6	5fa	2	2'-10	6	5fa	2	2'-10	6	5fa	2	2'-10	6	5fa	2	2'-10	6	5fa	2	2'-10	6	5fa	2	2'-10	6								
Wingwall, F.F.H.			5b1	2	47'-10	105	5b1	2	44'-9	98	5b1	2	41'-7	92	5b1	2	38'-6	80	5b1	2	35'-5	74	5b1	2	32'-4	67	5b1	2	29'-2	61	5b1	2	26'-1	54								
Wingwall, F.F.H.			5b2	26 Var.	2 Each 9'-2 to 46'-5	769	5b2	24 Var.	2 Each 9'-2 to 43'-4	667	5b2	22 Var.	2 Each 9'-2 to 40'-2	571	5b2	20 Var.	2 Each 9'-2 to 37'-1	482	5b2	18 Var.	2 Each 9'-2 to 34'-0	405	5b2	16 Var.	2 Each 9'-2 to 30'-11	334	5b2	14 Var.	2 Each 9'-2 to 27'-9	270	5b2	12 Var.	2 Each 9'-2 to 24'-8	212								
Wingwall, B.F.H.			4b3	2	48'-0	67	4b3	2	44'-11	63	4b3	2	41'-9	59	4b3	2	38'-8	52	4b3	2	35'-6	47	4b3	2	32'-5	43	4b3	2	29'-3	39	4b3	2	26'-2	35								
Wingwall, B.F.H.			4b4	24 Var.	2 Each 12'-5 to 46'-7	483	4b4	22 Var.	2 Each 12'-5 to 43'-6	417	4b4	20 Var.	2 Each 12'-5 to 40'-4	356	4b4	18 Var.	2 Each 12'-5 to 37'-3	299	4b4	16 Var.	2 Each 12'-4 to 34'-1	248	4b4	14 Var.	2 Each 12'-4 to 31'-0	203	4b4	12 Var.	2 Each 12'-4 to 27'-11	161	4b4	10 Var.	2 Each 12'-4 to 24'-9	124								
Wingwall, F.F.V.			5c1	90 Var.	2 Each 2'-9 to 16'-11	923	5c1	82 Var.	2 Each 2'-9 to 15'-8	788	5c1	76 Var.	2 Each 2'-9 to 14'-8	690	5c1	70 Var.	2 Each 2'-9 to 13'-8	599	4c1	64 Var.	2 Each 2'-9 to 12'-9	331	4c1	58 Var.	2 Each 2'-9 to 11'-9	281	4c1	68 Var.	2 Each 2'-9 to 10'-9	307	4c1	60 Var.	2 Each 2'-9 to 9'-9	251								
Wingwall, F.F.V.			5c2	48 Var.	2 Each 9'-4 to 16'-9	653	5c2	42 Var.	2 Each 9'-4 to 15'-10	551	5c2	36 Var.	2 Each 9'-4 to 14'-10	454	5c2	30 Var.	2 Each 9'-4 to 13'-10	362	4c2	24 Var.	2 Each 9'-4 to 12'-11	178	4c2	16 Var.	2 Each 9'-4 to 11'-7	112	c2	--	--	--	c2	--	--	--								
Wingwall, F.F.V. (O)			5c3	2	17'-2	36	5c3	2	16'-2	34	5c3	2	15'-2	32	5c3	2	14'-2	30	4c3	2	13'-2	18	4c3	2	12'-2	16	4c3	2	11'-2	15	4c3	2	10'-2	14								
Wingwall, F.F.V. (A)			5c3	2	17'-2	36	5c3	2	16'-2	34	5c3	2	15'-2	32	5c3	2	14'-2	30	4c3	2	13'-2	18	4c3	2	12'-2	16	4c3	2	11'-2	15	4c3	2	10'-2	14								
Wingwall, B.F.V.			6c4	90 Var.	2 Each 6'-5 to 20'-7	1825	6c4	82 Var.	2 Each 6'-5 to 19'-4	1586	6c4	76 Var.	2 Each 6'-5 to 18'-4	1413	5c4	70 Var.	2 Each 6'-5 to 17'-5	870	5c4	64 Var.	2 Each 6'-5 to 16'-5	762	5c4	58 Var.	2 Each 6'-5 to 15'-6	663	5c4	52 Var.	2 Each 6'-5 to 14'-6	567	5c4	46 Var.	2 Each 6'-5 to 13'-6	478								
Wingwall, B.F.V. (O)			6c5	1	20'-8	31	6c5	1	19'-8	30	6c5	1	18'-8	28	5c5	1	17'-8	18	5c5	1	16'-8	17	5c5	1	15'-8	16	5c5	1	14'-8	15	5c5	1	13'-8	14								
Wingwall, B.F.V. (A)			6c5	2	20'-8	62	6c5	2	19'-8	59	6c5	2	18'-8	56	5c5	2	17'-8	37	5c5	2	16'-8	35	5c5	2	15'-8	33	5c5	2	14'-8	31	5c5	2	13'-8	29								
Wingwall, B.F.V.			7c6	62	9'-6	1204	6c6	56	8'-6	715	6c6	50	8'-6	638	5c6	44	8'-6	390	5c6	38	8'-6	337	5c6	30	8'-6	266	5c6	24	8'-6	213	5c6	18	8'-6	160								
Apron, Longit., Bott.			4d1	15	47'-9	503	4d1	15	44'-8	472	4d1	15	41'-7	441	4d1	15	38'-5	385	4d1	15	35'-4	354	4d1	15	32'-3	323	4d1	15	29'-2	292	4d1	15	26'-0	261								
Apron, Longit., Top			6f1	15	47'-9	1130	6f1	15	44'-8	1061	6f1	15	41'-7	991	6f1	15	38'-5	866	6f1	15	35'-4	796	6f1	15	32'-3	727	6f1	15	29'-2	657	6f1	15	26'-0	586								
Parapet, Vertical			4i1	29	6'-7	128	4i1	29	6'-7	128	4i1	29	6'-7	128	4i1	29	6'-7	128	4i1	29	6'-7	128	4i1	29	6'-7	128	4i1	29	6'-7	128	4i1	29	6'-7	128								
Parapet, Horiz.			9j1	4	16'-4	222	9j1	4	16'-4	222	9j1	4	16'-2	220	9j1	4	16'-2	220	9j1	4	15'-10	215	9j1	4	15'-10	215	9j1	4	15'-10	215	9j1	4	15'-8	213								
Apron, Trans., Top			5m1	87	16'-4	1482	5m1	80	16'-4	1363	5m1	74	16'-2	1248	5m1	68	16'-2	1147	5m1	62	15'-10	1024	5m1	56	15'-10	925	5m1	49	15'-10	809	5m1	43	15'-8	703								
Apron, Trans., Top			5m2	7 Var.	2'-9 to 13'-11	61	5m2	8 Var.	2'-3 to 15'-4	73	5m2	7 Var.	3'-8 to 14'-11	68	5m2	7 Var.	3'-4 to 14'-6	65	5m2	7 Var.	2'-9 to 13'-11	61	5m2	7 Var.	2'-4 to 13'-7	58	5m2	8 Var.	2'-0 to 15'-0	71	5m2	7 Var.	3'-4 to 14'-7	65								
Apron, Trans., Bott.			6m3	85	14'-1	1798	6m3	79	14'-1	1671	5m3	73	13'-2	1002	6m3	34	13'-11	711	6m3	31	13'-7	632	5m3	28	12'-10	375	5m3	25	12'-10	335	5m3	22	12'-8	291								
Curtain, Horiz.			6p1	7	16'-9	176	6p1	7	16'-9	176	6p1	6	16'-7	149	6p1	6	16'-7	149	6p1	6	16'-3	146	6p1	6	16'-3	146	6p1	6	16'-3	146	6p1	5	16'-1	121								
Wing Slope, Both F.			6s1	4	43'-3	274	6s1	4	39'-11	240	6s1	4	36'-8	220	6s1	4	33'-5	201	6s1	4	30'-2	181	6s1	4	26'-11	162	6s1	4	23'-8	142	6s1	4	20'-5	123								
Wing Slope, Both F. (O)			6s2	2	7'-9	23	6s2	2	7'-9	23	6s2	2	7'-9	23	6s2	2	7'-9	23	6s2	2	7'-10	24	6s2	2	7'-10	24	6s2	2	7'-10	24	6s2	2	7'-10	24								
Wing Slope, Both F. (A)			6s3	2	8'-0	24	6s3	2	8'-0	24	6s3	2	8'-0	24	6s3	2	8'-0	24	6s3	2	8'-0	24	6s3	2	8'-0	24	6s3	2	8'-0	24	6s3	2	8'-0	24								
Wing Slope, F.F.			6s4	2	11'-8	35	6s4	2	11'-8	35	6s4	2	11'-8	35	6s4	2	11'-8	35	6s4	2	11'-8	35	6s4	2	11'-8	35	6s4	2	11'-8	35	6s4	2	11'-8	35								
Wing Slope, F.F.			6s5	2	40'-9	130	6s5	2	37'-6	113	6s5	2	34'-2	103	6s5	2	30'-11	93	6s5	2	27'-8	83	6s5	2	24'-5	73	6s5	2	21'-2	64	6s5	2	17'-11	54								
Curtain, Vert.			5t1	15	8'-5	132	5t1	15	8'-2	128	5t1	15	7'-11	124	5t1	15	7'-8	120	5t1	15	7'-5	116	5t1	15	7'-2	112	5t1	15	6'-11	108	5t1	15	6'-8	104								
Curtain, Vert. Ends			5t2	4	8'-5	35	5t2	4	8'-2	34	5t2	4	7'-11	33	5t2	4	7'-8	32	5t2	4	7'-5	31	5t2	4	7'-2	30	5t2	4	6'-11	29	5t2	4	6'-8	28								
Bracket, Vert.			5u1	4	7'-1	30	5u1	4	6'-10	29	5u1	4	6'-8	28	5u1	4	6'-5	27	5u1	4	6'-2	26	5u1	4	6'-0	25	5u1	4	5'-9	24	5u1	4	5'-7	23								
Estimated Quantities One Headwall	Reinf. Steel		12,383 LB				10,840 LB				9264 LB				7481 LB				6352 LB				5438 LB				4803 LB				4174 LB											
	Concrete	Parapet Δ	2.0	74.7 CY				2.0	68.1 CY				2.0	59.4 CY				2.0	53.4 CY				1.8	44.1 CY				1.8	39.2 CY				1.8	34.5 CY				1.7	28.8 CY			
		Wingwalls	31.7					27.8					22.3					19.1					13.4					11.2					9.1					6.5				
		Apron *	41.0					38.3					35.1					32.3					28.9					26.2					23.6					20.6				

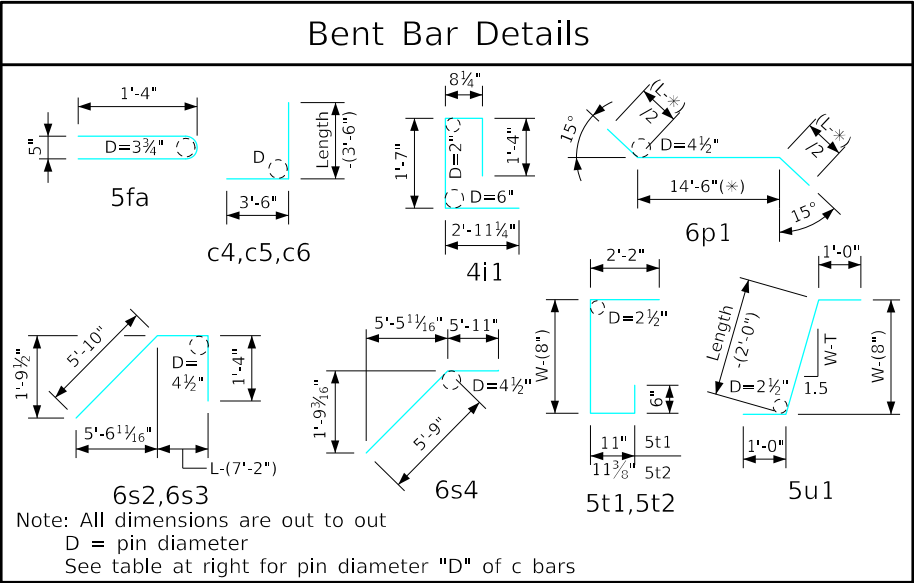
Δ Includes top of wingwall quantities.
* Assumes apron and floor are equal thickness, adjust concrete quantities for transition where apron and floor thickness are not equal.

(A) - Indicates bar located at acute corner.
(O) - Indicates bar located at obtuse corner.
Refer to Sheet PWH 15-1-20 for acute and obtuse corner locations.

Note: Weight of bars over 40'-0" long include an allowance of 2'-5" for lap.

Headwall Notes:

- This headwall is based on a 3:1 slope normal to centerline of roadway.
- The sides of the apron are to be formed to ensure correct line and grade.
- All apron reinforcing steel is to be supported by bar chairs at intervals of not more than 3'-0" in either direction as outlined in the Standard Specifications.
- Clear distance from face of concrete to near reinforcing bar is to be 2" unless otherwise noted or shown. Clearance to the bottom ends of vertical bars shall be 3 inches.
- Concrete quantities are estimated from back of parapet.
- Horizontal tails of bars "b" & "s" estimated to extend 2'-5" beyond back of parapet (into end of barrel). Longitudinal bars "4d1" and "6f1" estimated to project into end section of barrel a minimum of 2'-5" beyond back of parapet. The "length" column reflects total number of feet necessary to meet these requirements.
- Dimensions are in feet and inches unless otherwise noted.

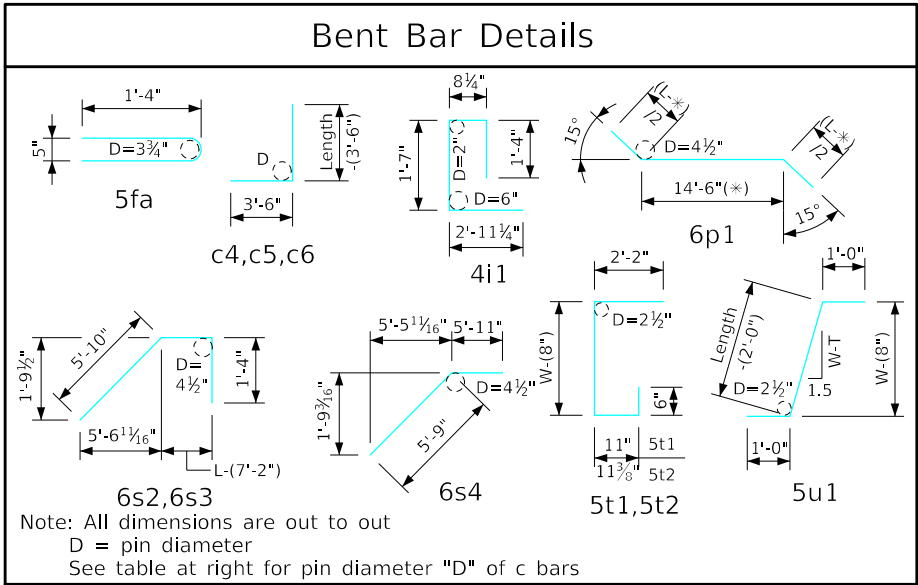


c Bar Pin Diameter	
Bar Size	D
5	3¾"
6	4½"
7	5½"

LATEST REVISION DATE

APPROVED BY BRIDGE ENGINEER

Standard Design - Single Reinforced Concrete Box Culverts
Parallel Wing Headwalls
July, 2020
Quantity Tabulation
14'-0" Span
15° Skew
PWH 15-6-20
SHEET 1 OF 2



Headwall Notes:

1. This headwall is based on a 3:1 slope normal to centerline of roadway.

2. The sides of the apron are to be formed to ensure correct line and grade.






























3. All apron reinforcing steel is to be supported by bar chairs at intervals of not more than 3'-0" in either direction as outlined in the Standard Specifications.

4. Clear distance from face of concrete to near reinforcing bar is to be 2" unless otherwise noted or shown. Clearance to the bottom ends of vertical bars shall be 3 inches.

5. Concrete quantities are estimated from back of parapet.

6. Horizontal tails of bars "b" & "s" estimated to extend 2'-5" beyond back of parapet (into end of barrel). Longitudinal bars "4d1" and "6f1" estimated to project into end section of barrel a minimum of 2'-5" beyond back of parapet. The "length" column reflects total number of feet necessary to meet these requirements.

7. Dimensions are in feet and inches unless otherwise noted.

Bill of Reinforcing for One Headwall 15° Skew Span x Culvert Height														
Location		Shape	14' x 6'				14' x 5'				14' x 4'			
			Bar	No.	Length	Wt.	Bar	No.	Length	Wt.	Bar	No.	Length	Wt.
Fence Anchor (Galv.)			5fa	2	2'-10	6	5fa	2	2'-10	6	5fa	2	2'-10	6
Wingwall, F.F.H.			5b1	2	23'-0	48	5b1	2	19'-10	41	5b1	2	16'-9	35
Wingwall, F.F.H.			5b2	10 Var.	2 Each 9'-2 to 21'-7	160	5b2	8 Var.	2 Each 9'-2 to 18'-5	115	5b2	6 Var.	2 Each 9'-2 to 15'-4	77
Wingwall, B.F.H.			4b3	2	23'-1	31	4b3	2	19'-11	27	4b3	2	16'-10	22
Wingwall, B.F.H.			4b4	8 Var.	2 Each 12'-4 to 21'-8	91	4b4	6 Var.	2 Each 12'-4 to 18'-6	62	4b4	4 Var.	2 Each 12'-4 to 15'-5	37
Wingwall, F.F.V.			4c1	52 Var.	2 Each 2'-9 to 8'-10	201	4c1	34 Var.	2 Each 2'-9 to 7'-11	121	4c1	26 Var.	2 Each 2'-9 to 6'-7	81
Wingwall, F.F.V.			c2	--	--	--	c2	--	--	--	c2	--	--	--
Wingwall, F.F.V. (O)			4c3	2	9'-2	12	4c3	2	8'-2	11	4c3	2	7'-2	10
Wingwall, F.F.V. (A)			4c3	2	9'-2	12	4c3	2	8'-2	11	4c3	2	7'-2	10
Wingwall, B.F.V.			5c4	40 Var.	2 Each 6'-5 to 12'-7	396	5c4	44 Var.	2 Each 6'-5 to 11'-6	411	5c4	36 Var.	2 Each 6'-5 to 10'-7	319
Wingwall, B.F.V. (O)			5c5	1	12'-8	13	5c5	1	11'-8	12	5c5	1	10'-8	11
Wingwall, B.F.V. (A)			5c5	2	12'-8	26	5c5	2	11'-8	24	5c5	2	10'-8	22
Wingwall, B.F.V.			5c6	12	8'-6	106	c6	--	--	--	c6	--	--	--
Apron, Longit., Bott.			4d1	15	22'-11	230	4d1	15	19'-10	199	4d1	15	16'-8	167
Apron, Longit., Top			6f1	15	22'-11	516	6f1	15	19'-10	447	6f1	15	16'-8	376
Parapet, Vertical			4i1	29	6'-7	128	4i1	29	6'-7	128	4i1	29	6'-7	128
Parapet, Horiz.			9j1	4	15'-8	213	9j1	4	15'-8	213	9j1	4	15'-8	213
Apron, Trans., Top			5m1	25	15'-8	409	5m1	21	15'-8	343	5m1	17	15'-8	278
Apron, Trans., Top			5m2	5 Var.	2'-0 to 13'-2	40	5m2	4 Var.	4'-5 to 12'-10	36	5m2	4 Var.	4'-0 to 12'-5	34
Apron, Trans., Bott.			4m3	19	11'-10	150	4m3	16	11'-10	126	4m3	13	11'-10	103
Curtain, Horiz.			6p1	5	16'-1	121	6p1	5	16'-1	121	6p1	5	16'-1	121
Wing Slope, Both F.			6s1	4	17'-1	103	6s1	4	13'-10	83	6s1	4	10'-7	64
Wing Slope, Both F. (O)			6s2	2	7'-10	24	6s2	2	7'-10	24	6s2	2	7'-10	24
Wing Slope, Both F. (A)			6s3	2	8'-0	24	6s3	2	8'-0	24	6s3	2	8'-0	24
Wing Slope, F.F.			6s4	2	11'-8	35	6s4	2	11'-8	35	6s4	2	11'-8	35
Wing Slope, F.F.			6s5	2	14'-8	44	6s5	2	11'-4	34	6s5	2	8'-1	24
Curtain, Vert.			5t1	15	6'-5	100	5t1	15	6'-5	100	5t1	15	6'-5	100
Curtain, Vert. Ends			5t2	4	6'-5	27	5t2	4	6'-5	27	5t2	4	6'-5	27
Bracket, Vert.			5u1	4	5'-4	22	5u1	4	5'-4	22	5u1	4	5'-4	22
Estimated Quantities One Headwall	Reinf. Steel		3288 LB				2803 LB				2370 LB			
	Concrete	Parapet Δ	1.7	24.7 CY		1.7	21.0 CY		1.7	17.4 CY				
		Wingwalls	5.0			3.7			2.5					
		Apron *	18.0			15.6			13.2					

Δ Includes top of wingwall quantities.
* Assumes apron and floor are equal thickness, adjust concrete quantities for transition where apron and floor thickness are not equal.

(A) - Indicates bar located at acute corner.
(O) - Indicates bar located at obtuse corner.
Refer to Sheet PWH 15-1-20 for acute and obtuse corner locations.

Note: Weight of bars over 40'-0" long include an allowance of 2'-5" for lap.

LATEST REVISION DATE

APPROVED BY BRIDGE ENGINEER

Standard Design - Single Reinforced Concrete Box Culverts

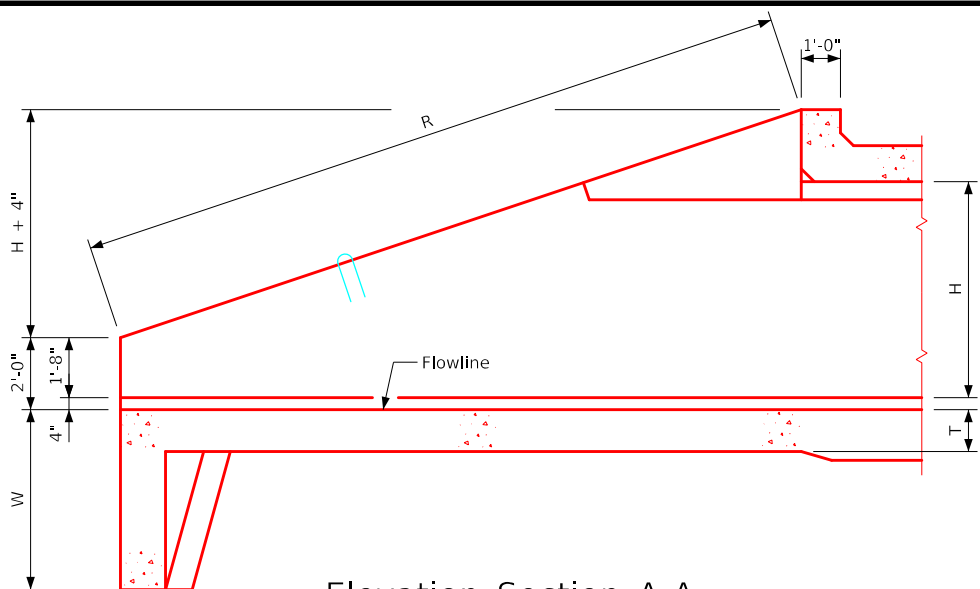
Parallel Wing Headwalls

July, 2020

Quantity Tabulation
14'-0" Span
15° Skew

PWH 15-6-20
SHEET 2 OF 2

ENGLISHLRFDSignedSingleCulverts.DGN - PWH 45-1-20 - THIS SHEET ISSUED 07-2020.

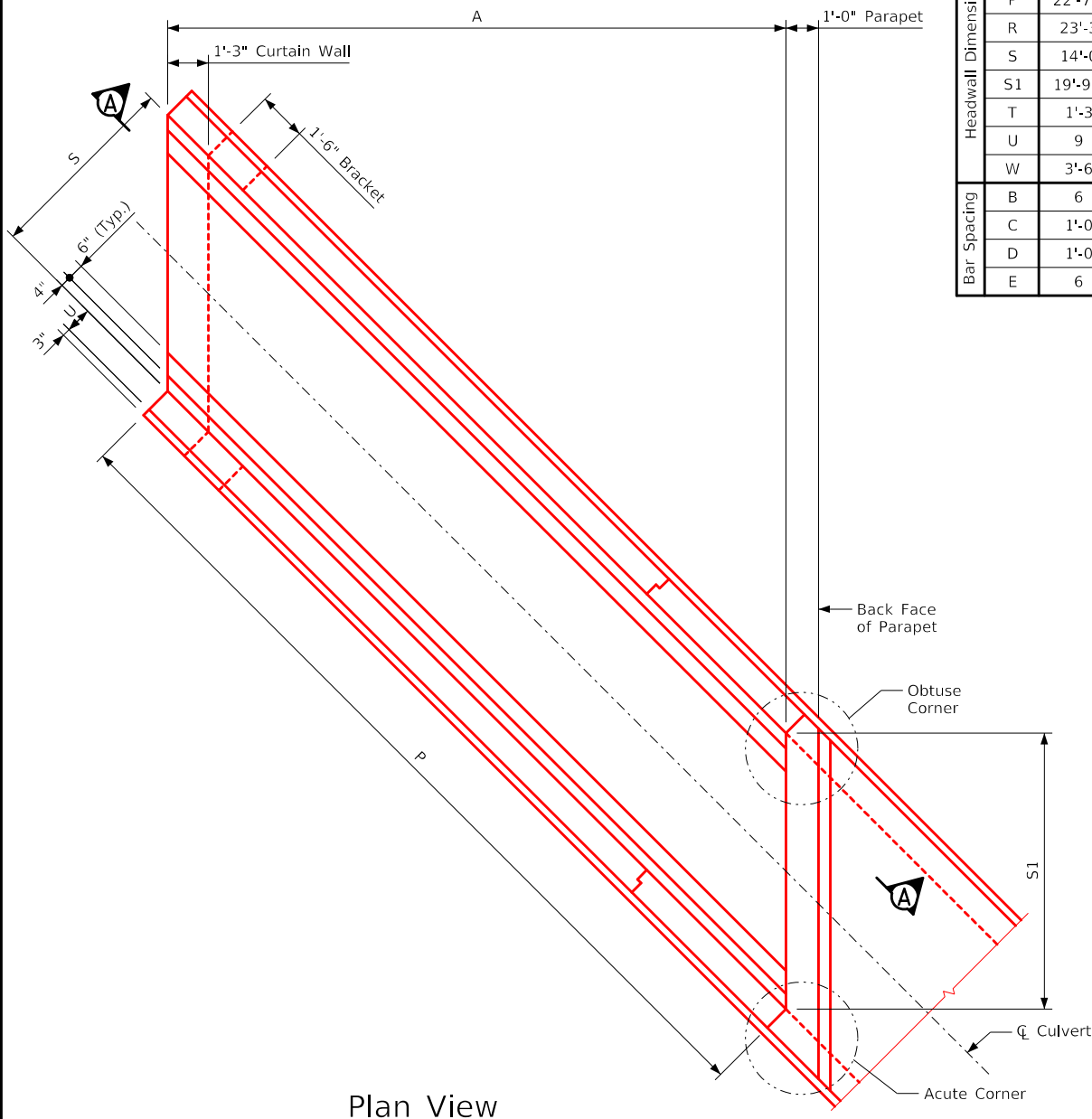


Elevation Section A-A

		Dimension Table																						
		S x H	16' x 14'	16' x 13'	16' x 12'	16' x 11'	16' x 10'	16' x 9'	16' x 8'	16' x 7'	16' x 6'	16' x 5'	16' x 4'	14' x 14'	14' x 13'	14' x 12'	14' x 11'	14' x 10'	14' x 9'	14' x 8'	14' x 7'	14' x 6'	S x H	
Headwall Dimensions	A	43'-0	40'-0	37'-0	34'-0	31'-0	28'-0	25'-0	22'-0	19'-0	16'-0	13'-0	43'-0	40'-0	37'-0	34'-0	31'-0	28'-0	25'-0	22'-0	19'-0		A	
	H	14'-0	13'-0	12'-0	11'-0	10'-0	9'-0	8'-0	7'-0	6'-0	5'-0	4'-0	14'-0	13'-0	12'-0	11'-0	10'-0	9'-0	8'-0	7'-0	6'-0		H	
	P	60'-9¾	56'-6⅞	52'-3⅞	48'-1	43'-10⅞	39'-7⅞	35'-4¼	31'-1⅜	26'-10½	22'-7½	18'-4⅞	60'-9¾	56'-6⅞	52'-3⅞	48'-1	43'-10⅞	39'-7⅞	35'-4¼	31'-1⅜	26'-10½		P	
	R	62'-5¾	58'-1⅜	53'-9⅞	49'-4¾	45'-0½	40'-8¼	36'-3⅞	31'-11⅞	27'-7¼	23'-3	18'-10⅞	62'-5¾	58'-1⅜	53'-9⅞	49'-4¾	45'-0½	40'-8¼	36'-3⅞	31'-11⅞	27'-7¼		R	
	S	16'-0	16'-0	16'-0	16'-0	16'-0	16'-0	16'-0	16'-0	16'-0	16'-0	16'-0	14'-0	14'-0	14'-0	14'-0	14'-0	14'-0	14'-0	14'-0	14'-0		S	
	S1	22'-7½	22'-7½	22'-7½	22'-7½	22'-7½	22'-7½	22'-7½	22'-7½	22'-7½	22'-7½	22'-7½	22'-7½	19'-9⅞	19'-9⅞	19'-9⅞	19'-9⅞	19'-9⅞	19'-9⅞	19'-9⅞	19'-9⅞		S1	
	T	1'-4	1'-4	1'-4	1'-4	1'-4	1'-4	1'-4	1'-4	1'-4	1'-4	1'-4	1'-4	1'-3	1'-3	1'-3	1'-3	1'-3	1'-3	1'-3	1'-3		T	
	U	1'-1	1'-1	1'-0	1'-0	10	10	10	9	9	9	9	9	1'-1	1'-1	1'-0	1'-0	10	10	10	9	9		U
	W	5'-6	5'-3	5'-0	4'-9	4'-6	4'-3	4'-0	3'-9	3'-6	3'-6	3'-6	5'-6	5'-3	5'-0	4'-9	4'-6	4'-3	4'-0	3'-9	3'-6		W	
Bar Spacing	B	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	6	6	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0		B	
	C	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	9	9	9	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	9	9	9		C	
	D	6	6	6	6	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	6	6	6	6	1'-0	1'-0	1'-0	1'-0	1'-0		D	
	E	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6		E	

Dimension Table																							
S x H		14' x 5'	14' x 4'	12' x 12'	12' x 11'	12' x 10'	12' x 9'	12' x 8'	12' x 7'	12' x 6'	12' x 5'	12' x 4'	10' x 12'	10' x 11'	10' x 10'	10' x 9'	10' x 8'	10' x 7'	10' x 6'	10' x 5'	10' x 4'	S x H	
Headwall Dimensions	A	16'-0	13'-0	37'-0	34'-0	31'-0	28'-0	25'-0	22'-0	19'-0	16'-0	13'-0	37'-0	34'-0	31'-0	28'-0	25'-0	22'-0	19'-0	16'-0	13'-0	A	
	H	5'-0	4'-0	12'-0	11'-0	10'-0	9'-0	8'-0	7'-0	6'-0	5'-0	4'-0	12'-0	11'-0	10'-0	9'-0	8'-0	7'-0	6'-0	5'-0	4'-0	H	
	P	22'-7½	18'-4⅝	52'-3⅝	48'-1	43'-10⅞	39'-7⅞	35'-4¼	31'-1⅜	26'-10½	22'-7½	18'-4⅝	52'-3⅝	48'-1	43'-10⅞	39'-7⅞	35'-4¼	31'-1⅜	26'-10½	22'-7½	18'-4⅝	P	
	R	23'-3	18'-10⅞	53'-9⅞	49'-4¾	45'-0½	40'-8¼	36'-3⅞	31'-11⅞	27'-7¼	23'-3	18'-10⅞	53'-9⅞	49'-4¾	45'-0½	40'-8¼	36'-3⅞	31'-11⅞	27'-7¼	23'-3	18'-10⅞	R	
	S	14'-0	14'-0	12'-0	12'-0	12'-0	12'-0	12'-0	12'-0	12'-0	12'-0	12'-0	10'-0	10'-0	10'-0	10'-0	10'-0	10'-0	10'-0	10'-0	10'-0	S	
	S1	19'-9⅞	19'-9⅞	16'-11⅞	16'-11⅞	16'-11⅞	16'-11⅞	16'-11⅞	16'-11⅞	16'-11⅞	16'-11⅞	16'-11⅞	14'-1¾	14'-1¾	14'-1¾	14'-1¾	14'-1¾	14'-1¾	14'-1¾	14'-1¾	14'-1¾	14'-1¾	S1
	T	1'-3	1'-3	1'-2	1'-2	1'-2	1'-2	1'-2	1'-2	1'-2	1'-2	1'-2	1'-1	1'-1	1'-1	1'-1	1'-1	1'-1	1'-1	1'-1	1'-1	1'-1	T
	U	9	9	1'-0	1'-0	10	10	10	9	9	9	9	1'-0	1'-0	10	10	10	9	9	9	9	9	U
	W	3'-6	3'-6	5'-0	4'-9	4'-6	4'-3	4'-0	3'-9	3'-6	3'-6	3'-6	5'-0	4'-9	4'-6	4'-3	4'-0	3'-9	3'-6	3'-6	3'-6	3'-6	W
Bar Spacing	B	6	6	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	9	9	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	9	9	B	
	C	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	9	9	9	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	9	9	9	1'-0	1'-0	C	
	D	1'-0	1'-0	6	6	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	6	6	6	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	D	
	E	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	E	

		Dimension Table																	
S x H		8' x 10'	8' x 9'	8' x 8'	8' x 7'	8' x 6'	8' x 5'	8' x 4'	6' x 8'	6' x 7'	6' x 6'	6' x 5'	6' x 4'	6' x 3'	5' x 6'	5' x 5'	5' x 4'	5' x 3'	S x H
Headwall Dimensions	A	31'-0	28'-0	25'-0	22'-0	19'-0	16'-0	13'-0	25'-0	22'-0	19'-0	16'-0	13'-0	10'-0	19'-0	16'-0	13'-0	10'-0	A
	H	10'-0	9'-0	8'-0	7'-0	6'-0	5'-0	4'-0	8'-0	7'-0	6'-0	5'-0	4'-0	3'-0	6'-0	5'-0	4'-0	3'-0	H
	P	43'-10½	39'-7½	35'-4¼	31'-1¾	26'-10½	22'-7½	18'-4¾	35'-4¼	31'-1¾	26'-10½	22'-7½	18'-4¾	14'-1¾	26'-10½	22'-7½	18'-4¾	14'-1¾	P
	R	45'-0½	40'-8¼	36'-3¾	31'-11¾	27'-7¼	23'-3	18'-10¾	36'-3¾	31'-11¾	27'-7¼	23'-3	18'-10¾	14'-6¾	27'-7¼	23'-3	18'-10¾	14'-6¾	R
	S	8'-0	8'-0	8'-0	8'-0	8'-0	8'-0	8'-0	6'-0	6'-0	6'-0	6'-0	6'-0	6'-0	5'-0	5'-0	5'-0	5'-0	S
	S1	11'-3¾	11'-3¾	11'-3¾	11'-3¾	11'-3¾	11'-3¾	11'-3¾	8'-5¾	8'-5¾	8'-5¾	8'-5¾	8'-5¾	8'-5¾	7'-0¾	7'-0¾	7'-0¾	7'-0¾	S1
	T	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	T
	U	10	10	10	9	9	9	9	10	9	9	9	9	9	9	9	9	9	U
	W	4'-6	4'-3	4'-0	3'-9	3'-6	3'-6	3'-6	4'-0	3'-9	3'-6	3'-6	3'-6	3'-6	3'-6	3'-6	3'-6	3'-6	W
Bar Spacing	B	1'-0	1'-0	1'-0	1'-0	1'-0	9	9	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	B
	C	1'-0	1'-0	9	9	9	1'-0	1'-0	9	9	9	1'-0	1'-0	1'-0	9	1'-0	1'-0	1'-0	C
	D	6	6	1'-0	1'-0	1'-0	1'-0	1'-0	6	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	D
	E	6	6	6	6	6	9	9	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	1'-0	E



Plan View

Notes:

1. See Sheet RCB G2-20 for General Notes, Specifications, and Design Stresses.
2. See Sheets PWH 45-2-20 thru 45-4-20 for location of certain dimensions tabulated.
3. Dimensions are in feet and inches unless otherwise noted.

LATEST REVISION DATE

APPROVED BY BRIDGE ENGINEER



Standard Design - Single Reinforced Concrete Box Culverts

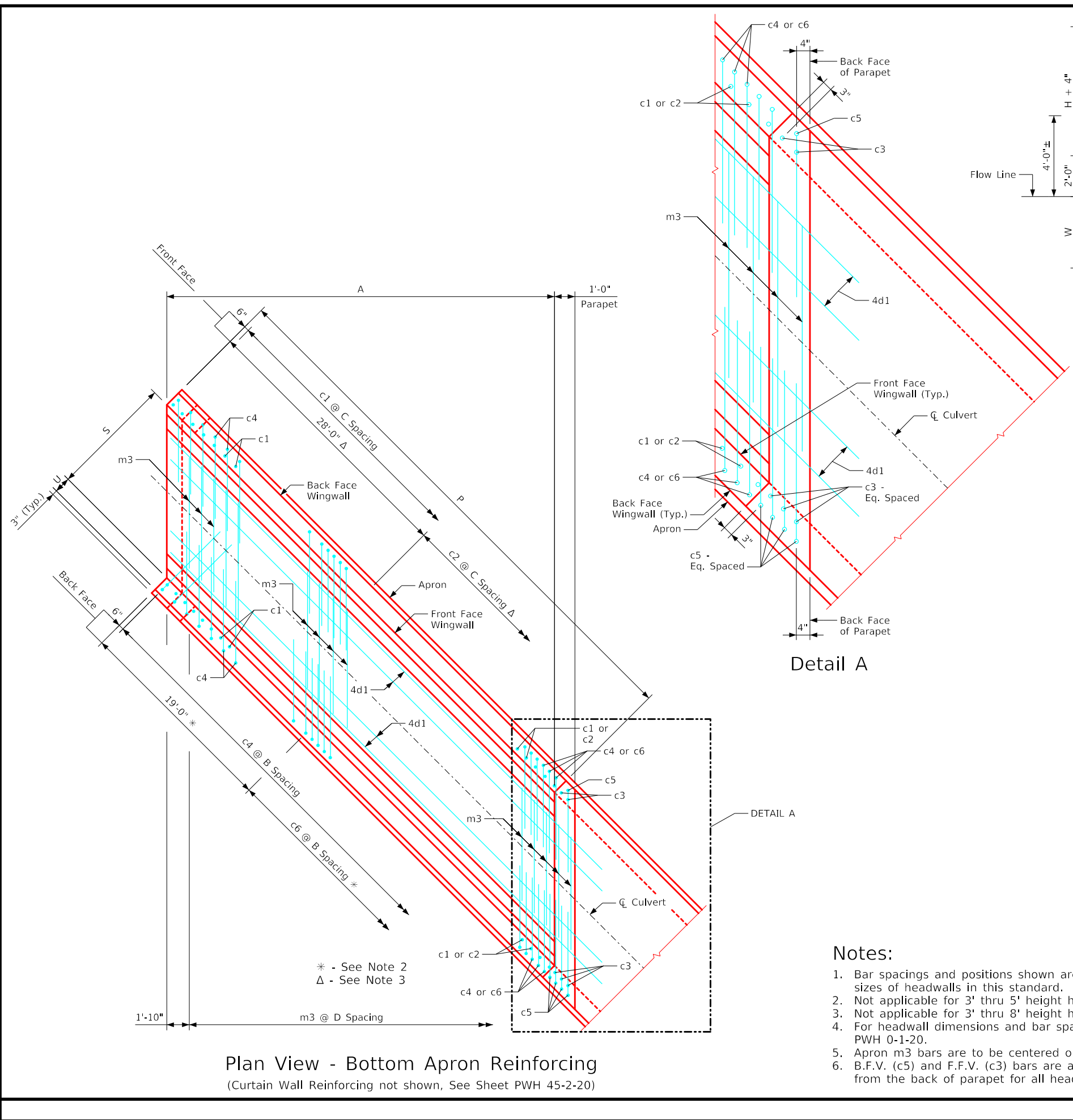
Parallel Wing Headwalls

July, 2020

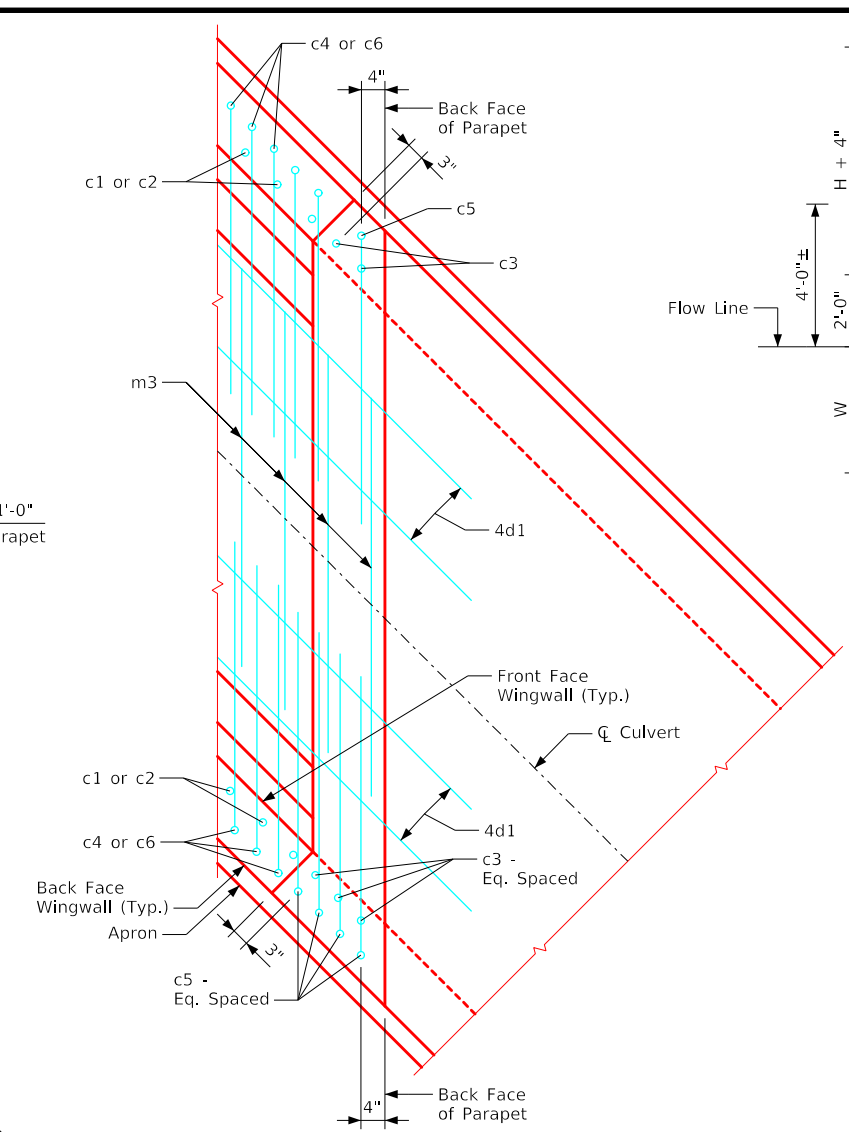
Dimension Table
45° Skew

PWH 45-1-20

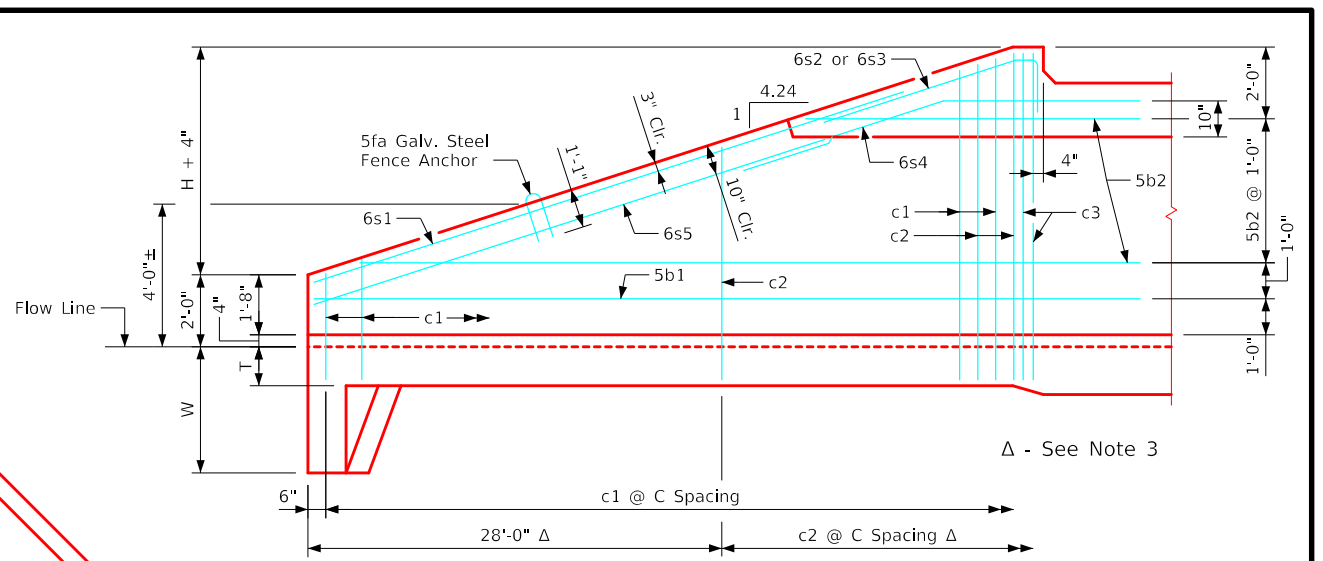
ENGLISHLRFDSSIGNEDSINGLECULVERTS.DGN - PWH 45-3-20 - THIS SHEET ISSUED 07-2020.



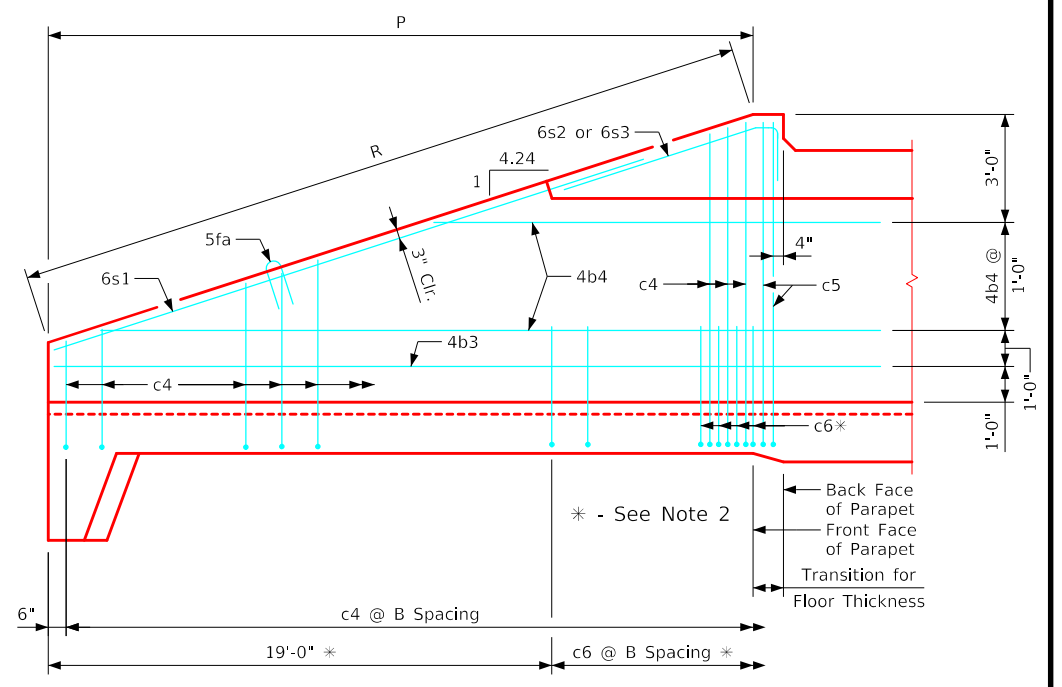
Plan View - Bottom Apron Reinforcing
(Curtain Wall Reinforcing not shown, See Sheet PWH 45-2-20)



Detail A





Typical View - Front Face Wingwall Reinforcing



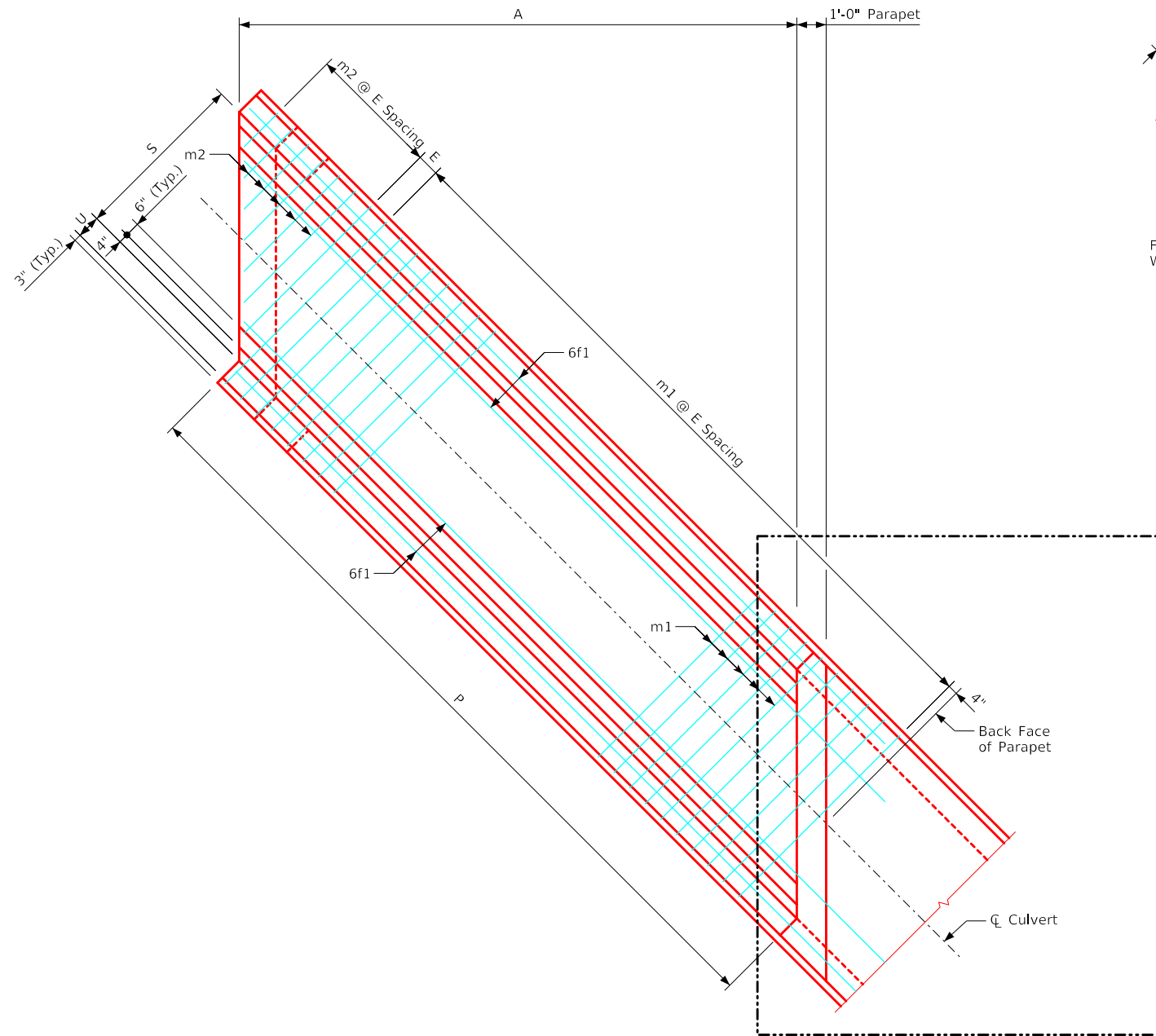
Typical View - Back Face Wingwall Reinforcing

Notes:

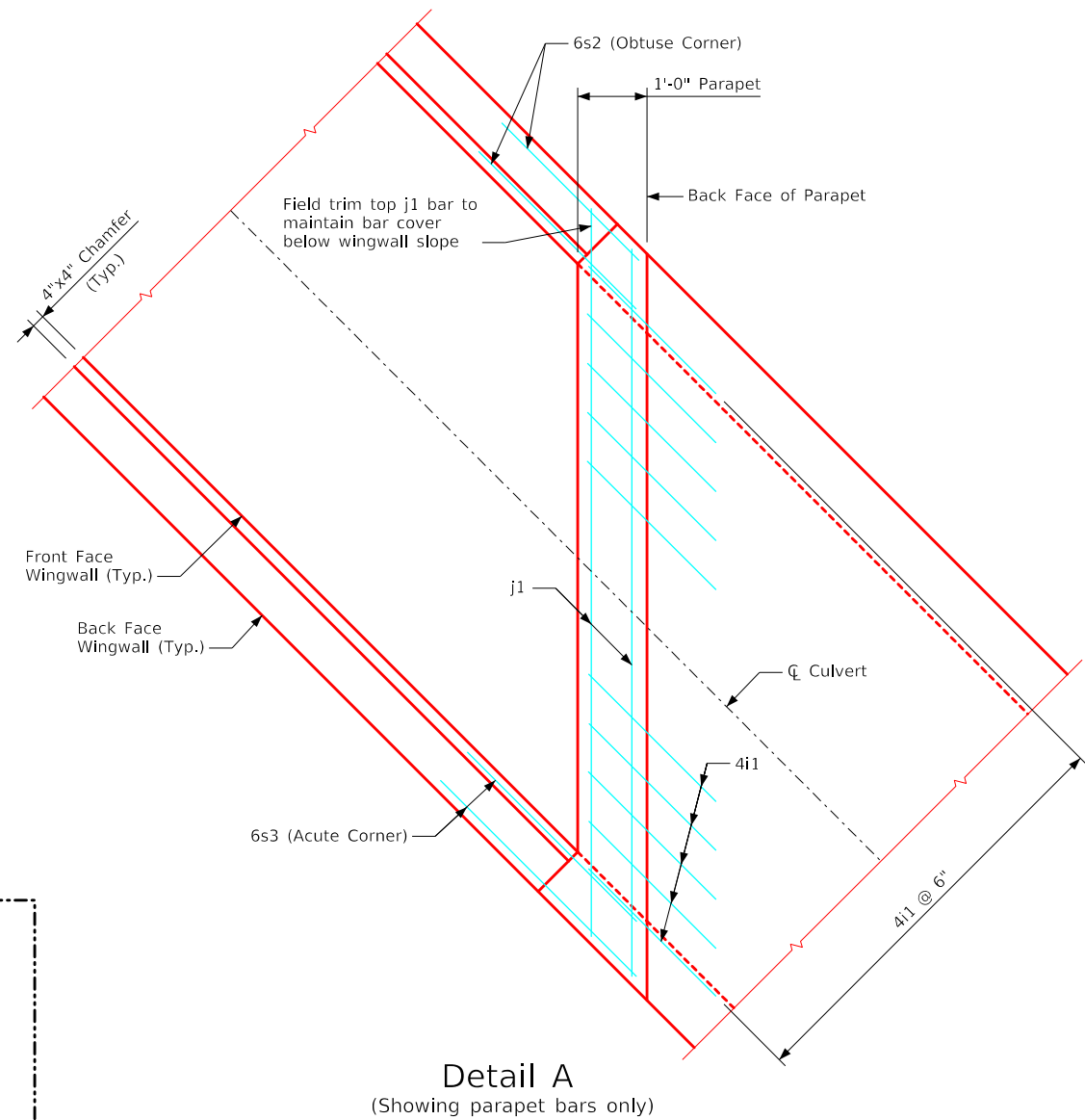
1. Bar spacings and positions shown are similar for all sizes of headwalls in this standard.
2. Not applicable for 3' thru 5' height headwalls.
3. Not applicable for 3' thru 8' height headwalls.
4. For headwall dimensions and bar spacing see Sheet PWH 0-1-20.
5. Apron m3 bars are to be centered on ϕ culvert.
6. B.F.V. (c5) and F.F.V. (c3) bars are approximately 4" from the back of parapet for all headwalls.

LATEST REVISION DATE			
		Standard Design - Single Reinforced Concrete Box Culverts	
		Parallel Wing Headwalls	
		July, 2020	
		Wingwall Elevations & Bottom Apron Reinforcing	PWH 45-3-20
		45° Skew	

ENGLISHLRFDSSIGNEDSINGLECULVERTS.DGN - PWH 45-4-20 - THIS SHEET ISSUED 07-2020.





Plan View - Top Apron Reinforcing
(Wall Reinforcing not shown for clarity)



Detail A
(Showing parapet bars only)






























Notes:

1. Bar spacings and positions shown are similar for all sizes of headwalls in this standard.
2. For headwall dimensions and bar spacing see Sheet PWH 45-1-20.
3. Top transverse apron bars are referenced approximately 4" from the back of the parapet for all headwalls.

LATEST REVISION DATE	 APPROVED BY BRIDGE ENGINEER		
		Standard Design - Single Reinforced Concrete Box Culverts	
		Parallel Wing Headwalls	
		July, 2020	
		Parapet Reinforcing & Top Apron Reinforcing 45° Skew	PWH 45-4-20

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Bill of Reinforcing for One Headwall 45° Skew Span x Culvert Height

Location		Shape	14' x 14'				14' x 13'				14' x 12'				14' x 11'				14' x 10'				14' x 9'				14' x 8'				14' x 7'											
Fence Anchor (Galv.)			Bar 5fa	No. 2	Length 2'-10	Wt. 6	Bar 5fa	No. 2	Length 2'-10	Wt. 6	Bar 5fa	No. 2	Length 2'-10	Wt. 6	Bar 5fa	No. 2	Length 2'-10	Wt. 6	Bar 5fa	No. 2	Length 2'-10	Wt. 6	Bar 5fa	No. 2	Length 2'-10	Wt. 6	Bar 5fa	No. 2	Length 2'-10	Wt. 6	Bar 5fa	No. 2	Length 2'-10	Wt. 6								
Wingwall, F.F.H.			5b1	2	64'-8	140	5b1	2	60'-5	131	5b1	2	56'-2	122	5b1	2	51'-11	113	5b1	2	47'-8	104	5b1	2	43'-5	96	5b1	2	39'-2	82	5b1	2	34'-11	73								
Wingwall, F.F.H.			5b2	26 Var.	2 Each 11'-9 to 62'-8	1039	5b2	24 Var.	2 Each 11'-9 to 58'-5	903	5b2	22 Var.	2 Each 11'-9 to 54'-2	776	5b2	20 Var.	2 Each 11'-9 to 49'-11	658	5b2	18 Var.	2 Each 11'-9 to 45'-9	550	5b2	16 Var.	2 Each 11'-9 to 41'-6	449	5b2	14 Var.	2 Each 11'-9 to 37'-3	358	5b2	12 Var.	2 Each 11'-9 to 33'-0	280								
Wingwall, B.F.H.			4b3	2	65'-3	90	4b3	2	61'-1	85	4b3	2	56'-9	79	4b3	2	52'-6	73	4b3	2	48'-1	67	4b3	2	43'-10	62	4b3	2	39'-7	53	4b3	2	35'-3	47								
Wingwall, B.F.H.			4b4	24 Var.	2 Each 16'-8 to 63'-4	661	4b4	22 Var.	2 Each 16'-8 to 59'-1	573	4b4	20 Var.	2 Each 16'-7 to 54'-9	489	4b4	18 Var.	2 Each 16'-7 to 50'-6	413	4b4	16 Var.	2 Each 16'-5 to 46'-1	340	4b4	14 Var.	2 Each 16'-5 to 41'-10	276	4b4	12 Var.	2 Each 16'-5 to 37'-7	216	4b4	10 Var.	2 Each 16'-4 to 33'-3	166								
Wingwall, F.F.V.			5c1	122 Var.	2 Each 2'-9 to 16'-10	1246	5c1	114 Var.	2 Each 2'-9 to 15'-11	1110	5c1	104 Var.	2 Each 2'-9 to 14'-9	949	5c1	96 Var.	2 Each 2'-9 to 13'-10	830	4c1	88 Var.	2 Each 2'-9 to 12'-10	458	4c1	80 Var.	2 Each 2'-9 to 11'-11	392	4c1	94 Var.	2 Each 2'-9 to 10'-10	426	4c1	82 Var.	2 Each 2'-9 to 9'-10	345								
Wingwall, F.F.V.			5c2	66 Var.	2 Each 9'-2 to 16'-9	892	5c2	58 Var.	2 Each 9'-2 to 15'-10	756	5c2	50 Var.	2 Each 9'-2 to 14'-10	626	5c2	42 Var.	2 Each 9'-2 to 13'-11	506	4c2	32 Var.	2 Each 9'-2 to 12'-9	234	4c2	24 Var.	2 Each 9'-2 to 11'-10	168	c2	--	--	--	c2	--	--	--								
Wingwall, F.F.V. (O)			5c3	2	17'-2	36	5c3	2	16'-2	34	5c3	2	15'-2	32	5c3	2	14'-2	30	4c3	2	13'-2	18	4c3	2	12'-2	16	4c3	2	11'-2	15	4c3	2	10'-2	14								
Wingwall, F.F.V. (A)			5c3	3	17'-2	54	5c3	3	16'-2	51	5c3	3	15'-2	47	5c3	3	14'-2	44	4c3	3	13'-2	26	4c3	3	12'-2	24	4c3	3	11'-2	22	4c3	3	10'-2	20								
Wingwall, B.F.V.			7c4	122 Var.	2 Each 6'-11 to 21'-1	3491	7c4	114 Var.	2 Each 6'-11 to 20'-1	3146	7c4	104 Var.	2 Each 6'-11 to 18'-11	2746	7c4	96 Var.	2 Each 6'-11 to 18'-0	2445	7c4	88 Var.	2 Each 6'-11 to 17'-0	2151	7c4	80 Var.	2 Each 6'-11 to 16'-1	1880	6c4	70 Var.	2 Each 6'-11 to 14'-11	1148	6c4	62 Var.	2 Each 6'-11 to 14'-0	974								
Wingwall, B.F.V. (O)			7c5	1	21'-2	43	7c5	1	20'-2	41	7c5	1	19'-2	39	7c5	1	18'-2	37	7c5	1	17'-2	35	7c5	1	16'-2	33	6c5	1	15'-2	23	6c5	1	14'-2	21								
Wingwall, B.F.V. (A)			7c5	4	21'-2	173	7c5	4	20'-2	165	7c5	4	19'-2	157	7c5	4	18'-2	149	7c5	4	17'-2	140	7c5	4	16'-2	132	6c5	4	15'-2	91	6c5	4	14'-2	85								
Wingwall, B.F.V.			8c6	84	9'-6	2131	7c6	76	9'-0	1398	7c6	68	9'-0	1251	7c6	60	9'-0	1104	7c6	50	9'-0	920	7c6	42	9'-0	773	6c6	34	9'-0	460	6c6	26	9'-0	351								
Apron, Longit., Bott.			4d1	15	64'-5	670	4d1	15	60'-2	627	4d1	15	55'-11	585	4d1	15	51'-8	542	4d1	15	47'-6	500	4d1	15	43'-3	458	4d1	15	39'-0	391	4d1	15	34'-9	348								
Apron, Longit., Top			6f1	15	64'-5	1506	6f1	15	60'-2	1410	6f1	15	55'-11	1314	6f1	15	51'-8	1218	6f1	15	47'-6	1125	6f1	15	43'-3	1029	6f1	15	39'-0	879	6f1	15	34'-9	783								
Parapet, Vertical			4i1	29	7'-10	152	4i1	29	7'-10	152	4i1	29	7'-10	152	4i1	29	7'-10	152	4i1	29	7'-10	152	4i1	29	7'-10	152	4i1	29	7'-10	152	4i1	29	7'-10	152								
Parapet, Horiz.			10j1	4	22'-4	384	10j1	4	22'-4	384	10j1	4	22'-1	380	10j1	4	22'-1	380	10j1	4	21'-8	373	10j1	4	21'-8	373	10j1	4	21'-8	373	10j1	4	21'-5	369								
Apron, Trans., Top			7m1	110	16'-4	3672	7m1	101	16'-4	3372	7m1	93	16'-2	3073	7m1	84	16'-2	2776	7m1	76	15'-10	2460	7m1	67	15'-10	2168	7m1	59	15'-10	1909	6m1	50	15'-8	1177								
Apron, Trans., Top			7m2	26 Var.	2'-3 to 14'-9	452	7m2	26 Var.	2'-7 to 15'-1	469	7m2	26 Var.	2'-3 to 14'-9	452	7m2	26 Var.	2'-6 to 15'-0	465	7m2	26 Var.	2'-1 to 14'-7	443	7m2	26 Var.	2'-4 to 14'-10	456	7m2	26 Var.	2'-1 to 14'-7	443	6m2	26 Var.	2'-3 to 14'-9	332								
Apron, Trans., Bott.			7m3	85	19'-11	3460	6m3	79	19'-1	2264	6m3	73	18'-11	2074	6m3	67	18'-11	1904	6m3	31	18'-5	858	5m3	28	17'-11	523	5m3	25	17'-8	461	5m3	22	17'-5	400								
Curtain, Horiz.			6p1	7	22'-1	232	6p1	7	22'-1	232	6p1	6	21'-11	198	6p1	6	21'-11	198	6p1	6	21'-7	195	6p1	6	21'-7	195	6p1	6	21'-7	195	6p1	5	21'-5	161								
Wing Slope, Both F.			6s1	4	57'-0	357	6s1	4	52'-8	331	6s1	4	48'-4	305	6s1	4	43'-11	278	6s1	4	39'-7	238	6s1	4	35'-3	212	6s1	4	30'-10	185	6s1	4	26'-6	159								
Wing Slope, Both F. (O)			6s2	2	9'-4	28	6s2	2	9'-4	28	6s2	2	9'-5	28	6s2	2	9'-5	28	6s2	2	9'-7	29	6s2	2	9'-7	29	6s2	2	9'-7	29	6s2	2	9'-8	29								
Wing Slope, Both F. (A)			6s3	2	10'-5	31	6s3	2	10'-5	31	6s3	2	10'-5	31	6s3	2	10'-5	31	6s3	2	10'-5	31	6s3	2	10'-5	31	6s3	2	10'-5	31	6s3	2	10'-5	31								
Wing Slope, F.F.			6s4	2	14'-1	42	6s4	2	14'-1	42	6s4	2	14'-1	42	6s4	2	14'-1	42	6s4	2	14'-1	42	6s4	2	14'-1	42	6s4	2	14'-1	42	6s4	2	14'-1	42								
Wing Slope, F.F.			6s5	2	54'-7	171	6s5	2	50'-2	158	6s5	2	45'-10	145	6s5	2	41'-6	132	6s5	2	37'-2	112	6s5	2	32'-9	98	6s5	2	28'-5	85	6s5	2	24'-1	72								
Curtain, Vert.			5t1	20	8'-5	176	5t1	20	8'-2	170	5t1	20	7'-11	165	5t1	20	7'-8	160	5t1	20	7'-5	155	5t1	20	7'-2	149	5t1	20	6'-11	144	5t1	20	6'-8	139								
Curtain, Vert. Ends			5t2	4	8'-10	37	5t2	4	8'-7	36	5t2	4	8'-4	35	5t2	4	8'-1	34	5t2	4	7'-10	33	5t2	4	7'-7	32	5t2	4	7'-4	31	5t2	4	7'-1	30								
Bracket, Vert.			5u1	4	7'-1	30	5u1	4	6'-10	29	5u1	4	6'-8	28	5u1	4	6'-5	27	5u1	4	6'-2	26	5u1	4	6'-0	25	5u1	4	5'-9	24	5u1	4	5'-7	23								
Estimated Quantities One Headwall	Reinf. Steel		21,402 LB				18,134 LB				16,326 LB				14,775 LB				11,821 LB				10,279 LB				8274 LB				6629 LB											
	Concrete	Parapet Δ	2.8	102.1 CY				2.8	92.9 CY				2.7	80.9 CY				2.7	72.9 CY				2.5	60.3 CY				2.5	53.5 CY				2.5	47.1 CY				2.4	39.4 CY			
		Wingwalls	43.4					38.0					30.4					26.1					18.4					15.3					12.5					8.9				
		Apron *	55.9					52.1					47.8					44.1					39.4					35.7					28.1									

Δ Includes top of wingwall quantities.

* Assumes apron and floor are equal thickness, adjust concrete quantities for transition where apron and floor thickness are not equal.

(A) - Indicates bar located at acute corner.
(O) - Indicates bar located at obtuse corner.
Refer to Sheet PWH 45-1-20 for acute and obtuse corner locations.

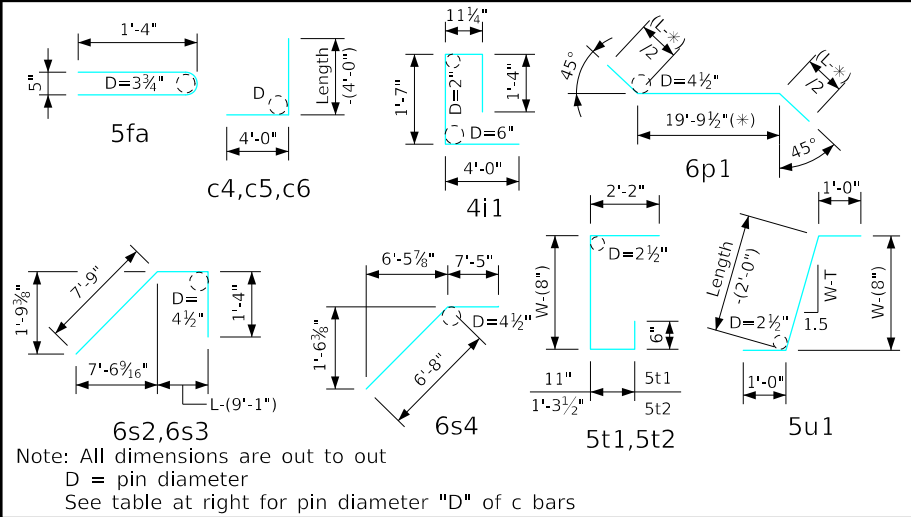
Note: Weight of bars over 40'-0" long include an allowance of 2'-5" for lap.

Headwall Notes:

- This headwall is based on a 3:1 slope normal to centerline of roadway.
- The sides of the apron are to be formed to ensure correct line and grade.
- All apron reinforcing steel is to be supported by bar chairs at intervals of not more than 3'-0" in either direction as outlined in the Standard Specifications.
- Clear distance from face of concrete to near reinforcing bar is to be 2" unless otherwise noted or shown. Clearance to the bottom ends of vertical bars shall be 3 inches.
- Concrete quantities are estimated from back of parapet.
- Horizontal tails of bars "b" & "s" estimated to extend 2'-5" beyond back of parapet (into end of barrel). Longitudinal bars "4d1" and "6f1" estimated to project into end section of barrel a minimum of 2'-5" beyond back of parapet. The "length" column reflects total number of feet necessary to meet these requirements.
- Dimensions are in feet and inches unless otherwise noted.

c Bar Pin Diameter	
Bar Size	D
6	4½"
7	5½"
8	6"

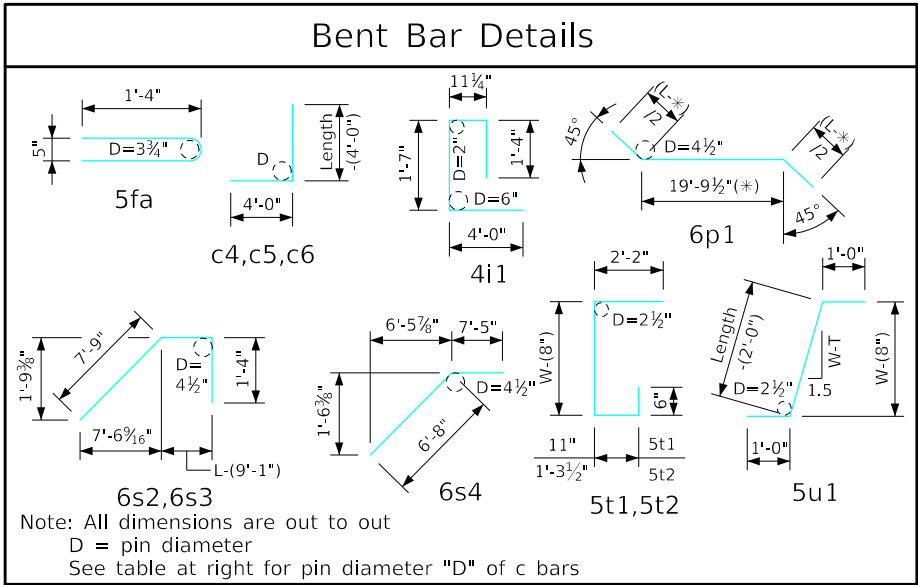
Bent Bar Details



Standard Design - Single Reinforced Concrete Box Culverts

Parallel Wing Headwalls

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Headwall Notes:

1. This headwall is based on a 3:1 slope normal to centerline of roadway.

2. The sides of the apron are to be formed to ensure correct line and grade.






























3. All apron reinforcing steel is to be supported by bar chairs at intervals of not more than 3'-0" in either direction as outlined in the Standard Specifications.

4. Clear distance from face of concrete to near reinforcing bar is to be 2" unless otherwise noted or shown. Clearance to the bottom ends of vertical bars shall be 3 inches.

5. Concrete quantities are estimated from back of parapet.

6. Horizontal tails of bars "b" & "s" estimated to extend 2'-5" beyond back of parapet (into end of barrel). Longitudinal bars "4d1" and "6f1" estimated to project into end section of barrel a minimum of 2'-5" beyond back of parapet. The "length" column reflects total number of feet necessary to meet these requirements.

7. Dimensions are in feet and inches unless otherwise noted.

Bill of Reinforcing for One Headwall 45° Skew Span x Culvert Height														
Location		Shape	14' x 6'				14' x 5'				14' x 4'			
			Bar	No.	Length	Wt.	Bar	No.	Length	Wt.	Bar	No.	Length	Wt.
Fence Anchor (Galv.)			5fa	2	2'-10	6	5fa	2	2'-10	6	5fa	2	2'-10	6
Wingwall, F.F.H.			5b1	2	30'-9	64	5b1	2	26'-6	55	5b1	2	22'-3	46
Wingwall, F.F.H.			5b2	10 Var.	2 Each 11'-9 to 28'-9	211	5b2	8 Var.	2 Each 11'-9 to 24'-6	151	5b2	6 Var.	2 Each 11'-9 to 20'-3	100
Wingwall, B.F.H.			4b3	2	31'-0	41	4b3	2	26'-9	36	4b3	2	22'-6	30
Wingwall, B.F.H.			4b4	8 Var.	2 Each 16'-4 to 29'-1	121	4b4	6 Var.	2 Each 16'-4 to 24'-10	82	4b4	4 Var.	2 Each 16'-4 to 20'-7	49
Wingwall, F.F.V.			4c1	72 Var.	2 Each 2'-9 to 8'-11	281	4c1	46 Var.	2 Each 2'-9 to 7'-11	164	4c1	36 Var.	2 Each 2'-9 to 6'-9	114
Wingwall, F.F.V.			c2	--	--	--	c2	--	--	--	c2	--	--	--
Wingwall, F.F.V. (O)			4c3	2	9'-2	12	4c3	2	8'-2	11	4c3	2	7'-2	10
Wingwall, F.F.V. (A)			4c3	3	9'-2	18	4c3	3	8'-2	16	4c3	3	7'-2	14
Wingwall, B.F.V.			6c4	54 Var.	2 Each 6'-11 to 13'-0	808	6c4	90 Var.	2 Each 6'-11 to 12'-1	1284	6c4	72 Var.	2 Each 6'-11 to 11'-0	969
Wingwall, B.F.V. (O)			6c5	1	13'-2	20	6c5	1	12'-2	18	6c5	1	11'-2	17
Wingwall, B.F.V. (A)			6c5	4	13'-2	79	6c5	4	12'-2	73	6c5	4	11'-2	67
Wingwall, B.F.V.			6c6	16	9'-0	216	c6	--	--	--	c6	--	--	--
Apron, Longit., Bott.			4d1	15	30'-6	306	4d1	15	26'-3	263	4d1	15	22'-0	220
Apron, Longit., Top			6f1	15	30'-6	687	6f1	15	26'-3	591	6f1	15	22'-0	496
Parapet, Vertical			4i1	29	7'-10	152	4i1	29	7'-10	152	4i1	29	7'-10	152
Parapet, Horiz.			10j1	4	21'-5	369	10j1	4	21'-5	369	10j1	4	21'-5	369
Apron, Trans., Top			6m1	42	15'-8	988	6m1	33	15'-8	777	6m1	25	15'-8	588
Apron, Trans., Top			6m2	26 Var.	2'-0 to 14'-6	322	6m2	26 Var.	2'-3 to 14'-9	332	6m2	26 Var.	2'-0 to 14'-6	322
Apron, Trans., Bott.			5m3	19	17'-5	345	5m3	16	17'-5	291	5m3	13	17'-5	236
Curtain, Horiz.			6p1	5	21'-5	161	6p1	5	21'-5	161	6p1	5	21'-5	161
Wing Slope, Both F.			6s1	4	22'-2	133	6s1	4	17'-9	107	6s1	4	13'-5	81
Wing Slope, Both F. (O)			6s2	2	9'-8	29	6s2	2	9'-8	29	6s2	2	9'-8	29
Wing Slope, Both F. (A)			6s3	2	10'-5	31	6s3	2	10'-5	31	6s3	2	10'-5	31
Wing Slope, F.F.			6s4	2	14'-1	42	6s4	2	14'-1	42	6s4	2	14'-1	42
Wing Slope, F.F.			6s5	2	19'-8	59	6s5	2	15'-4	46	6s5	2	11'-0	33
Curtain, Vert.			5t1	20	6'-5	134	5t1	20	6'-5	134	5t1	20	6'-5	134
Curtain, Vert. Ends			5t2	4	6'-10	29	5t2	4	6'-10	29	5t2	4	6'-10	29
Bracket, Vert.			5u1	4	5'-4	22	5u1	4	5'-4	22	5u1	4	5'-4	22
Estimated Quantities One Headwall	Reinf. Steel		5686 LB				5272 LB				4367 LB			
	Concrete	Parapet Δ	2.4	33.7 CY		2.4	28.6 CY		2.4	23.7 CY		2.4		
		Wingwalls	6.8			5.0			3.4					
		Apron *	24.5			21.2			17.9					

Δ Includes top of wingwall quantities.
* Assumes apron and floor are equal thickness, adjust concrete quantities for transition where apron and floor thickness are not equal.

(A) - Indicates bar located at acute corner.
(O) - Indicates bar located at obtuse corner.
Refer to Sheet PWH 45-1-20 for acute and obtuse corner locations.

Note: Weight of bars over 40'-0" long include an allowance of 2'-5" for lap.

LATEST REVISION DATE

APPROVED BY BRIDGE ENGINEER

Standard Design - Single Reinforced Concrete Box Culverts

Parallel Wing Headwalls

July, 2020

Quantity Tabulation
14'-0" Span
45° Skew

PWH 45-6-20
SHEET 2 OF 2