STRUCTURAL CALCULATIONS

FOR

CENTER AVE RD.
Fort Collins, CO

prepared by

THE SEAR-BROWN GROUP

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THE SEAR-BROWN GROUP

Project: CENTER AVE RD. Project No. 120-030

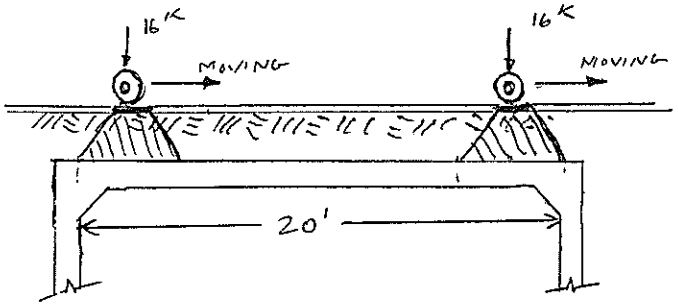
By: MIR Checked: _____

Date: 9-23-97 Sheet ONE of 10

LARIMER NO. 2
BOX CULVERT:

HS20 LOADING, COVER DEPTH ≈ 2'-0"

DEPTH = 5'-0" WIDTH = 20'-0" $U = 1.3[DL + 1.67(LL+I)]$



$W_{DL} = 120 \times 2 = 240^{PSF}$

LOAD ON CULVERT w/ 2'-0" COVER

$A_{LL} = \{0.83 + 1.75(2)\}\{5.67 + 1.75(2)\} = 39.71\ ft^2$

$W_{LL} = 32^K / 39.71\ ft^2 = 806^{PSF}$ WIDTH OF LOAD = 0.83 + 1.75(2) = 4.33'

EQUIVALEN $P_{LL} = 806 \times 4.3 = 3.5^K$

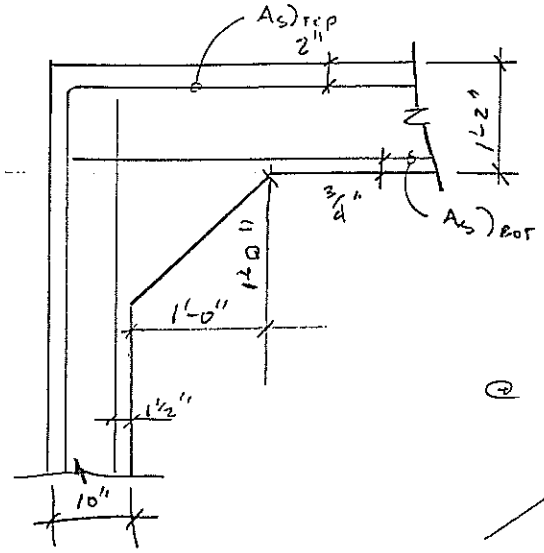
$M_{NEG})_{MAX} = 8.94^{K-Ft} + 10.33^{K-Ft}$ $V_{MAX} = 7.5^K$

$M_{POS})_{AVE} = 5.17^{K-Ft} + 1.58^{K-Ft}$

$M_{NEG})_{LL} = 32.83^{K-Ft}$

$M_{POS})_{AVE} = 10.15^{K-Ft}$ $V_{LL} = 14.1^K$

SLAB STEEL:



d = 14" - 2" = 12" @ MID

d = 31" - 2" = 29" @ ENDS

@ ENDS

$A_S)_{TOP} = 32.83/4.29 = 0.36\ in^2/ft$

$A_S)_{MIN} = 0.0018 \times 12 \times 29 = 0.63\ in^2/ft$

$= (200/60000) \times 12 \times 29 = 1.16\ in^2/ft$

GOVS → $= 1.33 \times 0.32 = 0.43\ in^2/ft$

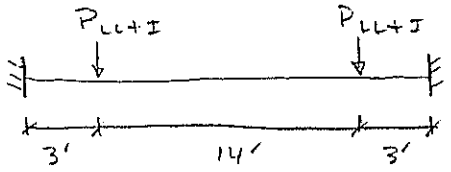
@ MID

$A_S)_{BOT} = 10.15/4 \times 12 = 0.13\ in^2/ft$ ← GOVS

$A_S)_{MIN} = 0.0018 \times 12 \times 14 = 0.3\ in^2/ft$

$= 200/60000 \times 12 \times 14 = 0.56$

1 ARMFR No.2 ROOF CURRENT (CONT)



$$M_{max-neg-LL} = \frac{(3.507)(17)(3)^2}{20^2} + \frac{(3.507)(17)^2(3)}{20^2} = 8.94 \text{ k'}$$

$$M_{max-pos-LL} = \frac{(2)(3.507)(17)^2(3)^2}{20^3} + \frac{(3.507)(3)^2}{20^3}[(3)(17)+3](3) - \frac{(3.507)(17)(3)^2}{20^2}$$

$$= 1.58 \text{ k'}$$

$$M_{max-neg-DL} = \frac{1}{12}(0.31)(20')^2 = 10.33 \text{ k'}$$

$$M_{max-pos-DL} = \frac{1}{24}(0.31)(20')^2 = 5.17 \text{ k'}$$

$$M_{u-NEG} = (1.3)(10.33) + (2.17)(8.94) = 32.83 \text{ k'}$$

$$M_{u-pos} = (1.3)(5.17) + (2.17)(1.58) = 10.15 \text{ k'}$$

V_u (@ 13") = 10.3 k M_{u-neg} (@ 12") = 23 k'

$$A_{s\,REQ-NEG} = \frac{(32.83)}{(4)(23")} = 0.357 \text{ in}^2/\text{ft} \quad \text{OR} \quad \frac{(23)}{(4)(13)} = 0.442 \text{ in}^2/\text{ft}$$

#6 @ 10"

$$A_{s\,REQ-pos} = \frac{(10.15)}{(4)(13")} = 0.195 \text{ in}^2/\text{ft}$$

#5 @ 12" o.c.

$$\phi V_c = (0.85)(2)\sqrt{4000}(12")(13")\frac{1}{1000} = 16.8 \text{ k} > 10.3 \text{ k} \rightarrow \text{provide min steel}$$

$$\frac{A_v}{s} = \frac{(50)(12")}{60{,}000} = 0.01 \text{ in}^2/\text{in} = 0.12 \text{ in}^2/\text{ft} \rightarrow$$

#4 @ 12"

BOX CULVERT (CONT.)

LOAD ON CULVERT WALLS

APPROACHING LIVE:

FROM ASTM $W_{LL} = 700/H_{cover} = 350^{PLF}$ (ALONG CULVERT HEIGHT)

SOIL LATERAL LOAD:

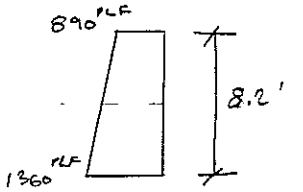
@ TOP OF CULVERT $50 \times 2 = 100^{PLF}$

@ BOTTOM OF CULVERT $50 \times (2 + 5 + 1 + 1.2) = 460^{PLF}$

SUMMATION OF LOADING

$U_{TOP} = 1.3[100 + 1.67(350)] = 890^{PLF}$

$U_{BOT} = 1.3[460 + 1.67(350)] = 1360^{PLF}$



AVE EQ WT = 1125^{PLF}

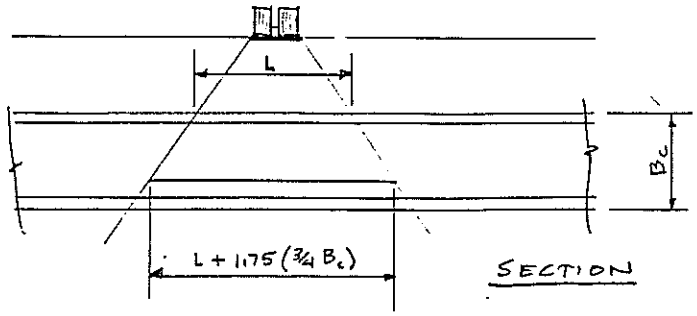
$M = \frac{1125 \times 8^2}{8} = 9^{K\text{-}ft/ft}$

$A_s = 9/(4 \times 8) = 0.28\ in^2/ft$

$A_{s)MIN} = 0.0012 \times 10 \times 12 = 0.14\ in^2$

$= 200/60000 \times 12 \times 8 = 0.32\ in^2/ft$ ← GOV'S

LIVE LOAD DISTRIBUTION ON BOTTOM SLAB:



SECTION

SINCE THE CULVERT IS LIKE A BEAM ON CONT. SUPPORTS THIS ASSUMPTION MAY BE MADE

CASE 1

$L = 1.67 + 1.75(2) = 5.17'$

$A_{LL} = 5.17 + [1.75 + (3/4 \times 7.2)] \times 21.67' = 267\ ft^2$

$q_{LL} = 16000/267 = 60^{PSF}$

CASE 2

$L = 5.67 + 1.75(2) = 9.17$

$A_{LL} = 9.17 + [1.75 + (3/4 \times 7.2)] \times 21.67 = 354\ ft^2$

$q_{LL} = 32000/1354 = 91^{PSF}$ ← GOV'S

BOTTOM SLAB (CONT.)

$q_{DL)_{SOIL}} = 120 \times 2 = 240^{PSF}$

$q_{DL)_{CULVERT}} = 150 \times [(21.67 \times 7.2) - (20 \times 5)] / 21.67 = 390^{PSF}$

$q_{TOTAL} = 390 + 240 + 91 = 721^{PSF}$

$q_u = 1.3[(390+240) + 1.67(91)] = 971^{PSF}$

@ ENDS

$M_u = 971 \times 20^2/12 = 32.4^{K\cdot Ft/Ft}$ $\quad A_s = 32.4/(4 \times 11) = 0.73^{in^2/Ft}$

@ MIDDLE

$M_u = 971 \times 20^2/16 = 24.3^{K\cdot Ft/Ft}$ $\quad A_s = 24.3/(4 \times 13) = 0.47^{in^2/Ft}$

DISTRIBUTION STEEL FOR TOP/BOT SLAB

$A_s = \frac{1}{\sqrt{S}} \times A_s)_{MAIN} = \frac{1}{\sqrt{20}} \times 0.93 = 0.21^{in^2/Ft}$

HORIZONTAL WALL REINF.

$A_s = 0.002 \times 12 \times 10.5 = 0.25^{in^2/Ft}$

DEVELOPMENT LENGTHS

#6 BARS $\quad l_d = 38 d_b \times 1.2$ (EPOXY COATED) $= 34''$

USE $36''$

#5 BARS $\quad l_d = 38 \times 5/8 \times 1.2 = 29''$

USE $30''$

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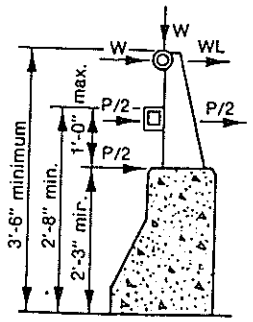
Project: CENTER AVE ROAD Project No. 120-030

By: M.R. Checked: _____

Date: 6-30-98 Sheet 4 of 10

GUARDRAILS & HEADWALLS



$P = 10^{K}$

$W = 50^{PLF}$

$M_{@\ SIDEWALK} = 5(3.65)/5' = 3.65^{K\text{-}Ft/Ft}$

$M_{@\ TOP\ OF\ CULVERT} = 5(9.5)/5 = 9.5^{K\text{-}Ft/Ft}$

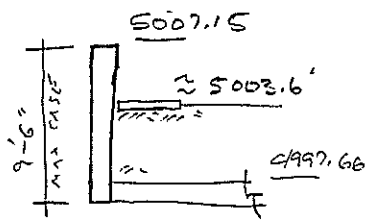
$I = \frac{50}{1+125} = 1.9$

$M_u = 1.3[2.2(1.3 \times 3.65)]^{K\text{-}Ft/Ft} = 13.6^{K\text{-}Ft/Ft}$

$M_u = 1.3[2.2(1.3 \times 9.5)]^{K\text{-}Ft/Ft} = 35^{K\text{-}Ft/Ft}$

$A_s)_{REQ\ @\ SIDE} = 13.6/4\times4 = 0.85\ in^2/Ft$

$A_s)_{REQ\ @\ CULVERT} = 35/4\times9 = 0.972\ in^2/Ft$



W/ PIER REINFORCING (4) #6 IN TENSION FACE + #5 @ 3" O.C.

$A_s = 4.86\ in^2$ $A_s)_{REQ} = 0.972 \times 5 = 4.86\ in^2$

O.K.

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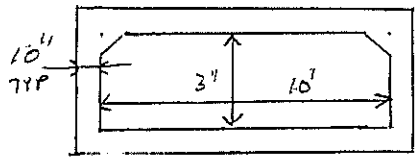
Project: CENTRE AVE FLUME Project No. 120-030

By: M.R. Checked: _____

Date: 10-28-98 Sheet 5 of 10

BOX CULVERT:

SHERWOOD & ARTHUR

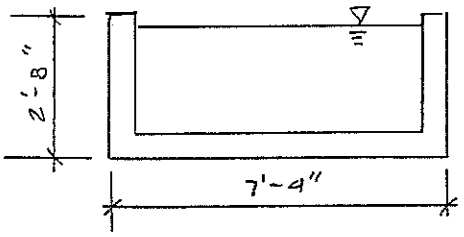


SECTION

REFER TO SPREADSHEET FOR CALCS

OPEN CHANNEL DESIGN:

SPAN ≅ 30'



SECTION

$W_{DL})_{WATER} = 62.4 \times 6 \times 2 = 750^{PLF}$

$W_{DL})_{CONC} = (0.150 \times 0.67)(2 \times 2.67 + 6) = 1140^{PLF}$

ASSUME WATER DL GOVS OVER ANY POTENTIAL LL

$M = \frac{1890 \times 30^2}{10} = 170^{K\text{-}ft}$

$M_u = 1.4 \times 170 = 238^{K\text{-}ft}$

$A_s = 7 \times 0.31 = 2.17\ in^2$

$d = 2.667 - 0.125 = 29"$

$a = \frac{2.17 \times 60}{0.85 \times 3 \times 16} = 3.9"$

$\phi M_n = 0.9\left(2.17 \times 60\right)\left[29 - \frac{3.9}{2}\right]/12$

$= 267^{K\text{-}ft} > 238^{K\text{-}ft}$ O.K.

DEFLECTION:

$W = 1890^{PLF}$

$\bar{Y}_{BOT} = \frac{(7.3333)(0.6667)(0.333) + 2(2)(1.667)(0.67)}{(7.333)(0.667) + (2)(2)(0.6667)}$

$= 9.65"$ FROM BOT

$I_g = \frac{1}{12}(7.333)(0.6667)^3 + (7.333 \times 0.6667)(6.804 - 0.333)^2 + 2\left[\frac{1}{12}(0.6667)(2)^3 + (2 \times 0.6667)(1.667 - 0.8)^2\right]$

$= 56012\ in^4$

$M_{cr} = \frac{7.5\sqrt{3000} \times 56012}{22135} = 86^{K\text{-}ft} < 170^{K\text{-}ft}$ SECTION IS CRACKED

OPEN CHANNEL (CONT.)

DEFLECTION (CONT)

$\rho = \frac{2.17}{16 \times 29} = 0.00468$ $\quad n = 9.29$

$\rho n = 0.0434$ $\quad K = \sqrt{2(0.0434) + (0.0434)^2} - 0.0434$

$C = 0.25 \times 29 = 7.38''$ $\quad = 0.25$

$\bar{Y}_{cr} = \frac{9.29(2.17)(3) + (7.38 \times 16)(28.3)}{(9.29)(2.17) + (7.38 \times 16)} = 24.6''$ (EST.)

$I = 2\left[\frac{1}{12} \times 8 \times \overline{7.38}^3 + (7.38 \times 8)(28.3 - 24.6)^2\right] + (9.29 \times 2.17)(24.6 - 3)^2$

$= 9775 \text{ in}^4$

$I_e = \left(\frac{86}{170}\right)^3 56012 + \left[1 - \left(\frac{86}{170}\right)^3\right] 9775 = 15761 \text{ in}^4$

$\Delta \approx \frac{5(1890/12)(30 \times 12)^4}{384 \times 57000\sqrt{3000} \times 15761} = 0.7''$

$\Delta_a = \frac{30 \times 12}{240} = 1.5$ $\quad$ O.K.

ARTHUR & SHERWOOD

Box Culvert Design (traffic perpendicular to length)

qa(psf)=	1500
Wconc.(pcf)=	150
Wsoil (pcf)=	120
EFPsoil(psf/ft)=	45
Hcover(ft)=	8
Hculvert(ft)=	4.6667
Wculvert(ft)=	11.8867
Ttop(in)=	10
Tbot(in)=	10
Twall(in)=	10
f'c(psi)=	3000
Fy(psi)=	60000
S (ft) =	10.833

Load Type = 1 (0=no traffic,1=HS20,2=ALT)
P(kip) = 16 HS20 Load Type Selected
All (ft^2) = 370.39

Impact = 1

Loading on top of culvert (per foot of width):

wdl (plf) = 1085
wll (plf) = 130

Moment on top of culvert middle (per foot of width):

Mdl (lb-ft)= 5306
Mll (lb-ft) = 951

Mu (lb-ft) 8989

Moment on top of culvert ends (per foot of width):

Mdl (lb-ft) = 10611
Mll (lb-ft) = 1267

Mu (lb-ft) = 16583

Required area of top slab steel (assume 2" top cover, 3/4" bottom):

GOV.S > Astop(in^2)= 0.55 Asmin(in^2)= 0.30
Asbot(in^2)= 0.26 Asmin(in^2)= 0.34 < GOV.S
Aslongit(in^2)= 0.17 Astemp(in^2)= 0.22 < GOV.S

Check Shear in top of culvert (per foot of width):

Vdl (lb) = 5877
Vll (lb) = 702

Vu (lb) = 9185

Vc (lb) = 11174 f'c and thickness O.K.

Loading on culvert walls (per foot of width):

wsoil top (plf) = 360
wsoil bot (plf) = 885
wll horiz (plf) = 88

wequ (plf) = 3025
Mequ (lb-ft) = 8235

Asreq(in^2)= 0.26 Asmin(in^2)= 0.32 < GOV.S

Check soil bearing pressure (per foot of width):

Pdlculvert(plf)= 3667
wdlsoil (plf) = 960
Pll (lb) = 29740
wll (plf) = 99

Ptotal (lb) = 16020

qtotal (psf) = 1373 Soil bearing pressure O.K.
qu (psf) = 1874

Moment on bottom of culvert ends (per foot of width):

Mu (lb-ft) = 18328

Moment on bottom of culvert middle (per foot of width):

Mu (lb-ft) = 9164

Required area of bottom slab steel (assume 2" top cover, 3" bottom):

Astop(in^2)= 0.27 Asmin(in^2)= 0.34 < GOV.S Astemp(in^2)= 0.22
Asbot(in^2)= 0.61 < GOV.S Asmin(in^2)= 0.30

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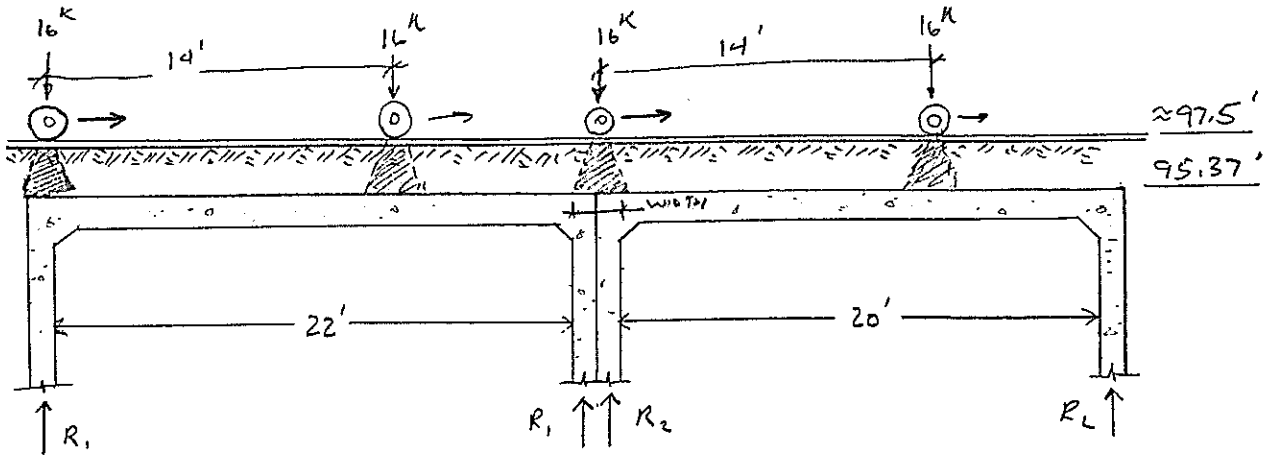
Project: CENTER AVE RD Project No. 120-030

By: M.R. Checked:

Date: 2-18-99 Sheet 7A of 10

SPRING CREEK (3) SIDED BRIDGES

LL DO NOT ACT CONCURRENT



$W_{SOIL} = 120^{PCF} \times 2.13' = 256^{PSF}$

$W_{22' BRIDGE} = 33.6^{K}$

$W_{20' BRIDGE} = 26.4^{K}$

$W_{LL} = 32^{K}/42.83 = 750^{PSF}$

$A_{LL} = (0.83' + 1.75 \times 2.13)(5.67 + 1.75 \times 2.13)$

$= 42.83\ Ft^2$

WIDTH OF LOAD $= 0.83 + 1.75 \times 2.13 = 4.6'$

$P_{LL} = 750 \times 4.6 = 3450^{\#}$

DEAD LOAD REACTIONS:

$R_1 = 33.6/2 \times 5 + .256 \times 23.67/2 = 6.4^{KLF}$

$R_2 = 26.4/2 \times 5 + .256 \times 21.67/2 = 5.4^{KLF}$

LIVE LOAD REACTIONS:

$R_1 = 3.45^{K} + 3.45^{K} \times \frac{8}{22} = 4.7^{KLF} \times 1.2 = 5.64^{KLF}$ (IMPACT)

$R_2 = 3.45^{K} + 3.45 \times \frac{6}{20} = 4.5^{KLF} \times 1.2 = 5.4^{KLF}$

TOTAL @ END

$R_{20'} = 5.4 + 5.4 = 10.8^{KLF}$

$R_{22'} = 5.64 + 6.4 = 12^{KLF}$

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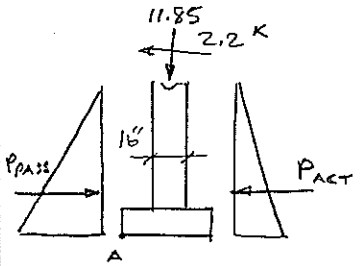
Project: CENTRE AVE RD Project No. 120-030

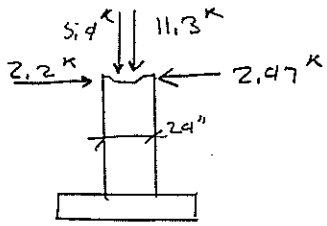
By: M. R. Checked: _____

Date: 2-18-99 Sheet 7B of 10

FOUNDATIONS :



@ END



@ MIDDLE

$P_{ACT} = \frac{1}{2} \times 40 \times 6^2 = 720^{\#}$

$P_{PASS} = \frac{1}{2} \times 150 \times 6^2 = 2700^{\#}$

FOOTING @ END $q_a = 2500^{PSF}$ (ASSUMED)

$11.85^{K} / 2.5^{KSF} = 4'-9"$

FOOTING IN MIDDLE

$(5.4^{K} + 5.0^{K} + 6.3^{K}) / 2.5^{KSF} = 6'-9"$

WALL @ END

$+\circlearrowleft \Sigma M_A = (720 \times 6/3) + (2.2 \times 6) - (2700 \times 6/3) - (11.85 \times 4.75/2) = -18.9^{K\text{-ft}}$

NO NET OTM

BY INSPECTION NO OTM IN MIDDLE

FOOTING STEEL @ END

$q_u = (6.46 \times 2.17) + (1.3 \times 5.4) / 4.75 = 4400^{PSF}$

$M_u = 4.4 \times 1.17^2/2 = 6.4^{K\text{-ft/ft}}$ $A_s)_{req} = \frac{6.4}{4 \times 8} = 0.20^{in^2/ft}$ USE #4 @ 12" O.C.

$V_u = 4.4 \times 1.7 = 7.5^{K}$ $\phi V_c = 0.85 \times 2\sqrt{3500} \times 144 = 14.5^{K}$ O.K.

FOOTING STEEL IN MIDDLE

$q_u = (6.3 \times 2.17) + (10.4 \times 1.3) / 6.75 = 4000^{PSF}$

$M_u = 4 \times 2.4^2/2 = 11.52^{K\text{-ft/ft}}$ $A_s)_{req} = \frac{11.52}{4 \times 8} = 0.36^{in^2/ft}$

$V_u = 4 \times 2.4 = 9.6^{K} < 14.5$ O.K. USE #5 @ 10" O.C.

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Project: CENTER AVE RETAINING WALL DESIGN Project No. 120-030

By: OL Checked: _____

Date: 12-3-98 Sheet 8 of 10

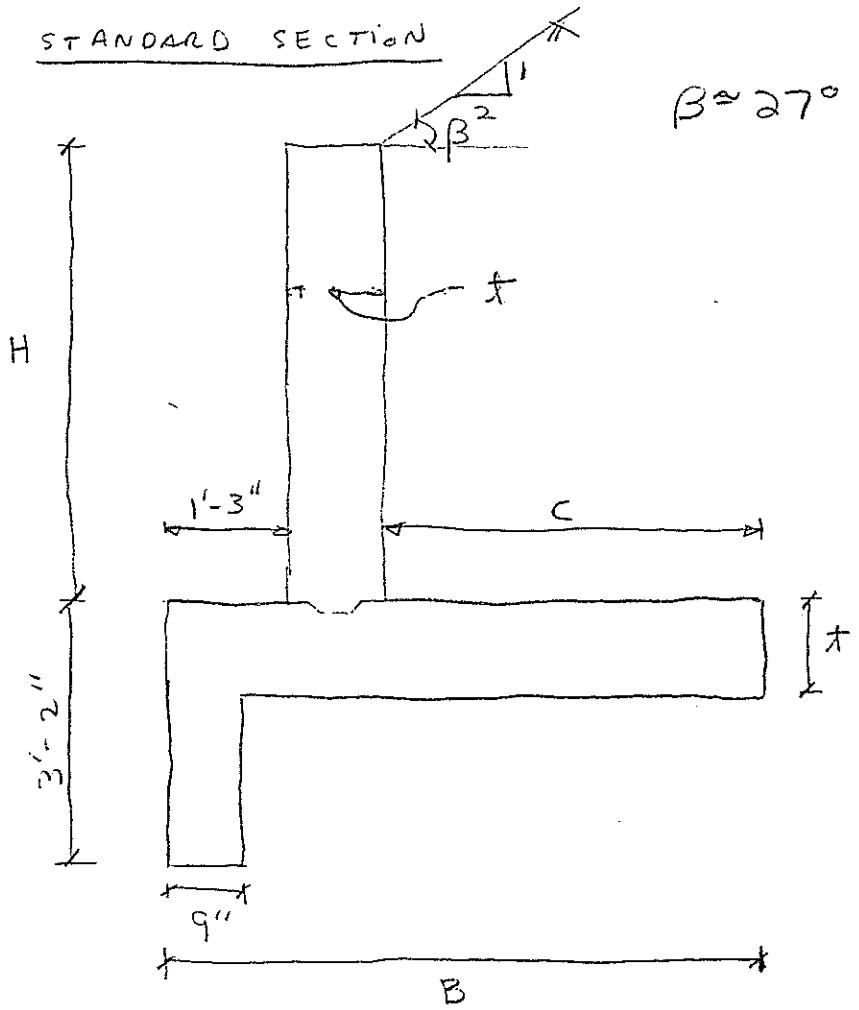
Wall Heights

LARIMER No. 2 → 6'-2" = 6.17'

ARTHUR → (4997.90' - 4997.73') + 3.833' = 4'-0" = 4.00'

SHERWOOD → (5000.00' - 4995.18') + 3.833' = 8.65'

STANDARD SECTION



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Project: CENTER AVE Retaining Wall Design Project No. 120-030

By: OL Checked: _____

Date: 12-3-98 Sheet 9 of 10

LARIMER No. 2

B = 4'-6"

t = 1'-0"

ARTHUR

t = 12"

B = ~~3'-8"~~ 4'-0"

SHERWOOD

t = 12"

B = 6'-8"

CANTILEVER RETAINING WALLS—Backfill Slope, $\phi = 33°40'$

CONCRETE DIMENSIONS $D = A$

Height h_w (ft.)	Base (ft.)	B (ft.)	A (ft.)	C (ft.)	Base Pressure at Toe (psf)	Base Pressure at Heel (psf)	Resist. Moment M_r (ft.-kips)	Overturn. Moment M_o (ft.-kips)	S.F. $\frac{M_r}{M_o}$	Concrete (cu. ft. per lin. ft.)
LOW WALLS										
3	2'-6"	0'-7"	1'-0"	0'-11"	985	311	2.807	1.133	2.477	5.50
4	3'-2"	0'-9"	1'-0"	1'-5"	1253	341	5.667	2.427	2.335	7.17
5	3'-10"	1'-0"	1'-0"	1'-10"	1456	399	9.856	4.343	2.269	8.83
6	4'-6"	1'-3"	1'-0"	2'-3"	1655	460	15.780	7.087	2.227	10.50
7	5'-3"	1'-6"	1'-0"	2'-9"	1829	550	24.425	10.972	2.226	12.25
8	5'-11"	1'-9"	1'-0"	3'-2"	2027	611	34.811	15.839	2.198	13.92
9	6'-8"	2'-0"	1'-0"	3'-8"	2200	700	48.954	22.250	2.200	15.67
10	7'-5"	2'-3"	1'-0"	4'-2"	2374	790	66.485	30.194	2.202	17.42
HIGH WALLS										
10	7'-5"	2'-3"	1'-4"	3'-10"	2737	651	71.048	33.993	2.090	19.89
11	8'-1"	2'-6"	1'-5"	4'-2"	3018	677	92.015	44.444	2.070	23.04
12	8'-10"	2'-9"	1'-6"	4'-7"	3268	741	119.164	57.447	2.074	26.55
13	9'-6"	3'-0"	1'-6"	4'-11"	3546	771	148.659	72.139	2.061	30.16
14	10'-3"	3'-3"	1'-7"	5'-5"	3796	835	185.555	89.867	2.065	34.13
15	11'-0"	3'-6"	1'-8"	5'-10"	4045	898	228.098	110.284	2.068	38.33
16	11'-10"	3'-10"	1'-9"	6'-3"	4211	1015	279.125	133.582	2.090	42.90
17	12'-7"	4'-1"	1'-10"	6'-8"	4461	1078	334.476	159.948	2.091	47.57
18	13'-4"	4'-4"	1'-10"	7'-2"	4711	1141	396.699	189.574	2.093	52.48
19	14'-2"	4'-8"	1'-11"	7'-7"	4869	1261	470.028	222.650	2.111	57.79
20	15'-0"	5'-0"	2'-0"	8'-0"	5040	1374	551.374	259.365	2.126	63.33

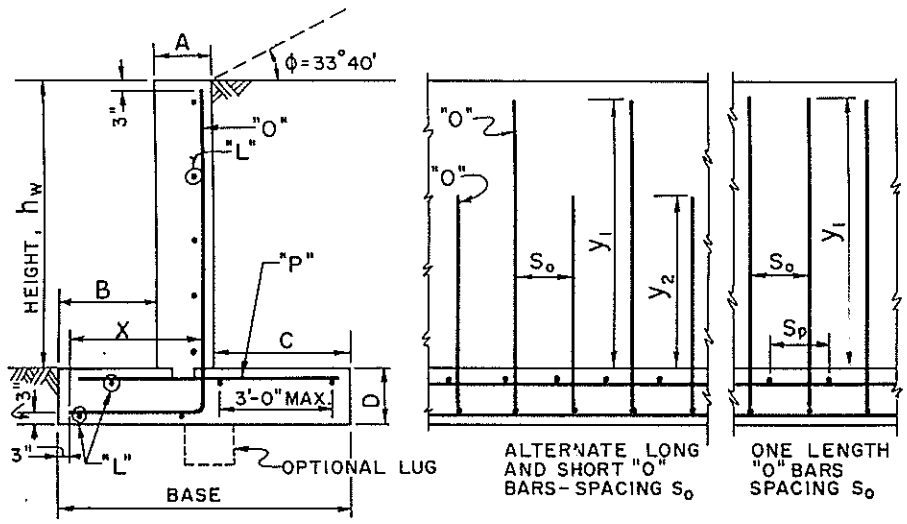

FIG. 14-1 BAR DETAILS AND NOTATION- LOW WALLS

STRUCTURAL REINFORCEMENT

f'_c = 3,000 psi
f_y = 60,000 psi

Case 2 Sloping (33°-40')' Backfill

Height h_w (ft.)	O-BARS Size-Spacing	O-BARS X	O-BARS Y_1	O-BARS Y_2	M-BARS Size-Spacing	M-BARS Y_1	P-BARS Size-Length-Spacing	L-BARS Size-Spacing	Total Steel (lbs./L.F.)	Stem Steel at Base ($in.^2$/L.F.)
LOW WALLS—Dowels only—No Splices										
3	#3 @ 18	1'-1		—	—	—	#3 x 2'-0 @ 18	#4 @ 8	8.6	0.012
4	#3 @ 18	1'-3		—	—	—	#3 x 2'-8 @ 18	#4 @ 8	10.0	0.030
5	#3 @ 18	1'-6	(h_w	—	—	—	#3 x 3'-4 @ 18	#4 @ 8	11.8	0.058
6	#3 @ 13	1'-9	less	—	—	—	#3 x 4'-0 @ 18	#4 @ 8	14.3	0.100
7	#3 @ 8	2'-0	top	2'-4	—	—	#3 x 4'-9 @ 14	#4 @ 8	16.9	0.161
8	#4 @ 9½	2'-3	cover)	2'-7	—	—	#3 x 5'-0 @ 8	#4 @ 8	21.0	0.242
9	#4 @ 6½	2'-6		2'-9	—	—	#4 x 5'-0 @ 11	#4 @ 8	26.9	0.348
10	#5 @ 7½	2'-9		3'-3	—	—	#5 x 5'-0 @ 12	#4 @ 8	36.0	0.484
HIGH WALLS—Class B Tension Lap Splices										
10	#4 @ 6	3'-1	3'-0	1'-3	#3 @ 7	4'-7	#4 x 5'-0 @ 10	#5 @ 11	31.9	0.379
11	#5 @ 7½	3'-5	3'-6	1'-8	#4 @ 9	5'-6	#5 x 5'-5 @ 12	#5 @ 11	41.9	0.479
12	#6 @ 9	3'-9	3'-10	2'-0	#4 @ 8	5'-11	#6 x 6'-2 @ 15	#5 @ 11	49.8	0.592
13	#6 @ 7	4'-0	4'-2	2'-1	#5 @ 9	6'-8	#6 x 6'-6 @ 12	#5 @ 11	63.5	0.720
14	#7 @ 8	4'-4	4'-10	2'-10	#5 @ 8½	7'-1	#7 x 7'-7 @ 13	#5 @ 11	79.2	0.861
15	#7 @ 7	4'-8	5'-0	2'-9	#6 @ 9	7'-9	#7 x 8'-0 @ 11	#5 @ 11	98.6	1.017
16	#8 @ 8	5'-1	5'-10	3'-9	#6 @ 9	8'-2	#8 x 9'-3 @ 12	#5 @ 10	119.3	1.188
17	#9 @ 8½	5'-5	6'-8	4'-8	#7 @ 9	9'-2	#9 x 10'-7 @ 14½	#5 @ 10	149.3	1.375
18	#9 @ 7½	5'-8	6'-11	4'-9	#7 @ 9	9'-7	#9 x 11'-0 @ 12½	#5 @ 10	172.2	1.577
19	#9 @ 6½	6'-1	7'-2	4'-9	#8 @ 9	10'-8	#9 x 11'-5 @ 11	#5 @ 10	207.7	1.796
20	#9 @ 5½	6'-6	7'-4	4'-8	#8 @ 9	11'-1	#9 x 11'-10 @ 8½	#5 @ 10	241.8	2.032

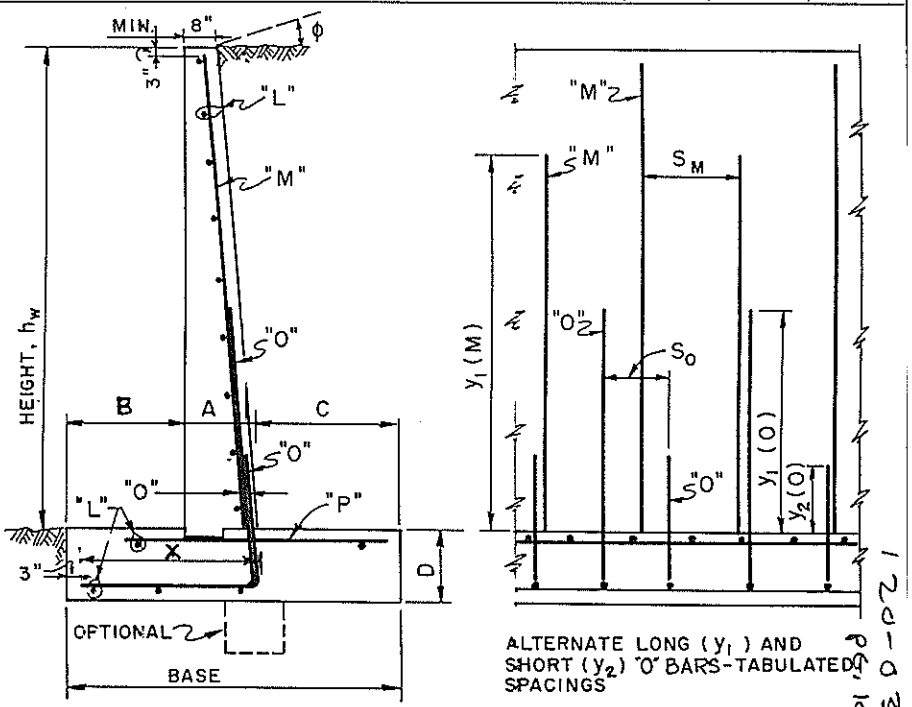

FIG. 14-2 BAR DETAILS AND NOTATION - HIGH WALLS

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