F-C. 14/32-144

VOLUME II

CONNECTICUT RIVER FLOOD CONTROL PROJECT

LOCAL PROTECTION WORKS
HARTFORD, CONNECTICUT

ANALYSIS OF DESIGN
FOR
PARK RIVER CONDUIT

FISCAL YEAR 1939 SECTION, ITEM Ht-6

May 31, 1940

Corps of Engineers, U. S. Army

U. S. Engineer Office, Providence, R. I.

Metcalf & Eddy
Engineers
Boston, Massachusetts

THIS FILE HAS BEEN WITHDRAWN
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NEW ENGLAND DIVISION, C. OF E.
PLEASE RETURN PROMPTLY

CONDUIT INLET - WING WALLS

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PROJECT U.S. Engineers - Hartford
SUBJECT Park River Conduit
DESIGN Dike Walls at Inlet

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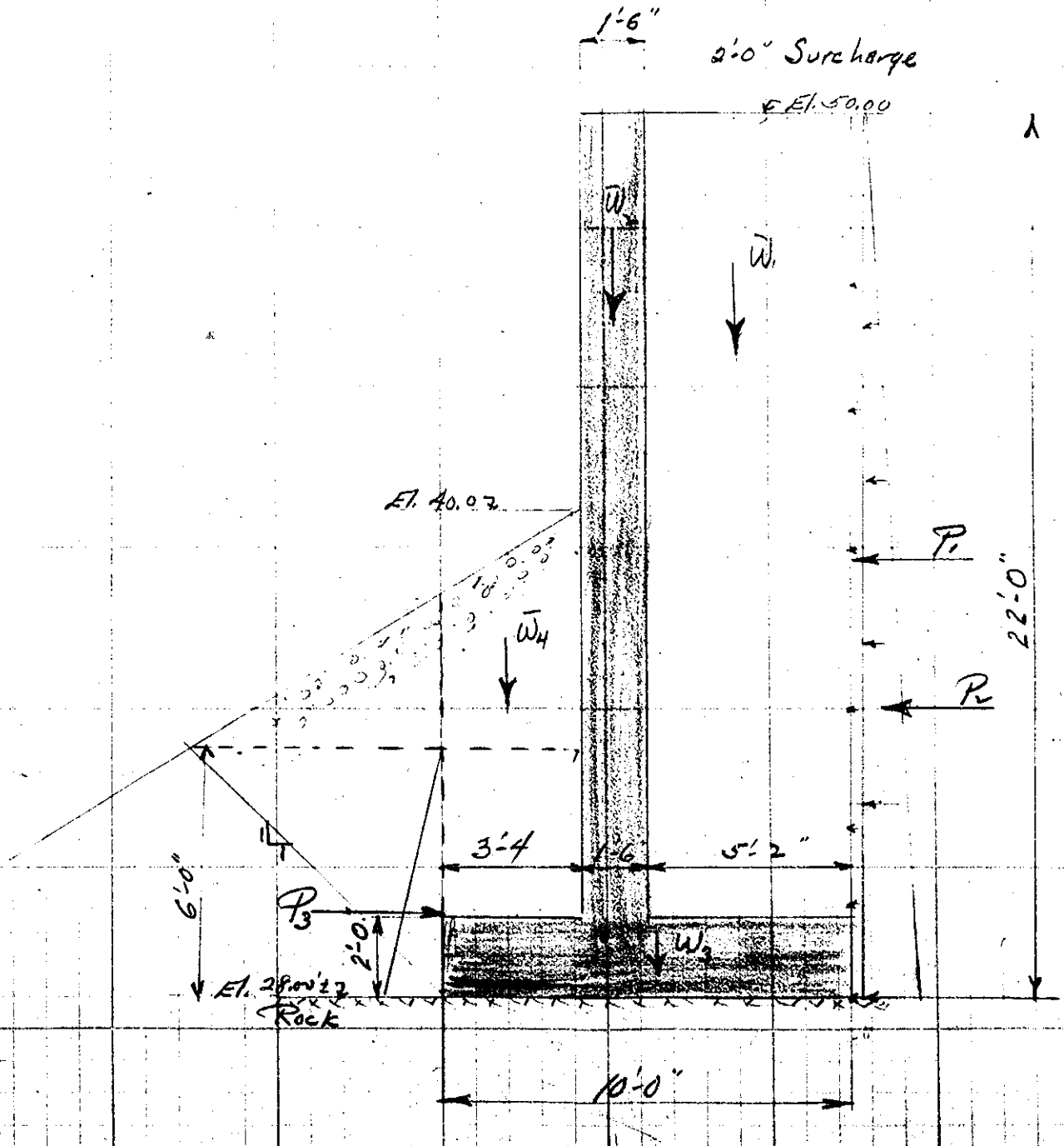
Type III
El. Top of Footing should be 34.0
El. Top of Rock = 28'± and sloping upward
Shafly ∴ Assume El bottom of Footing = 28.00



Scale 1/4" = 1'-0"

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Park River Conduit
Dike Walls at Inlet

2/
4/27/4
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Type III

		Force	Arm	Moment	Moment
$P_1 = (35)(2)(22) =$		1540#	11	16900	
$P_2 = \frac{(35)(22)^2}{2} =$		8450	7.33	62000	
$P_3 = \frac{(35)(6)^2}{2} =$	630		(2)		1260
$W_1 = (22)(5.17)(100) =$	11400		7.42		84500
$W_2 = (1.5)(20)(150) =$	4500		4.08		18400
$W_3 = (2)(10)(150) =$	3000		5.0		15000
$- W_4 = (8)(3.33)(100) =$	2660		1.67		4450
	21560			78900	123610
					- 78900
					44710

Position of Resultant Force $= \frac{44710}{21560} = 2.08$

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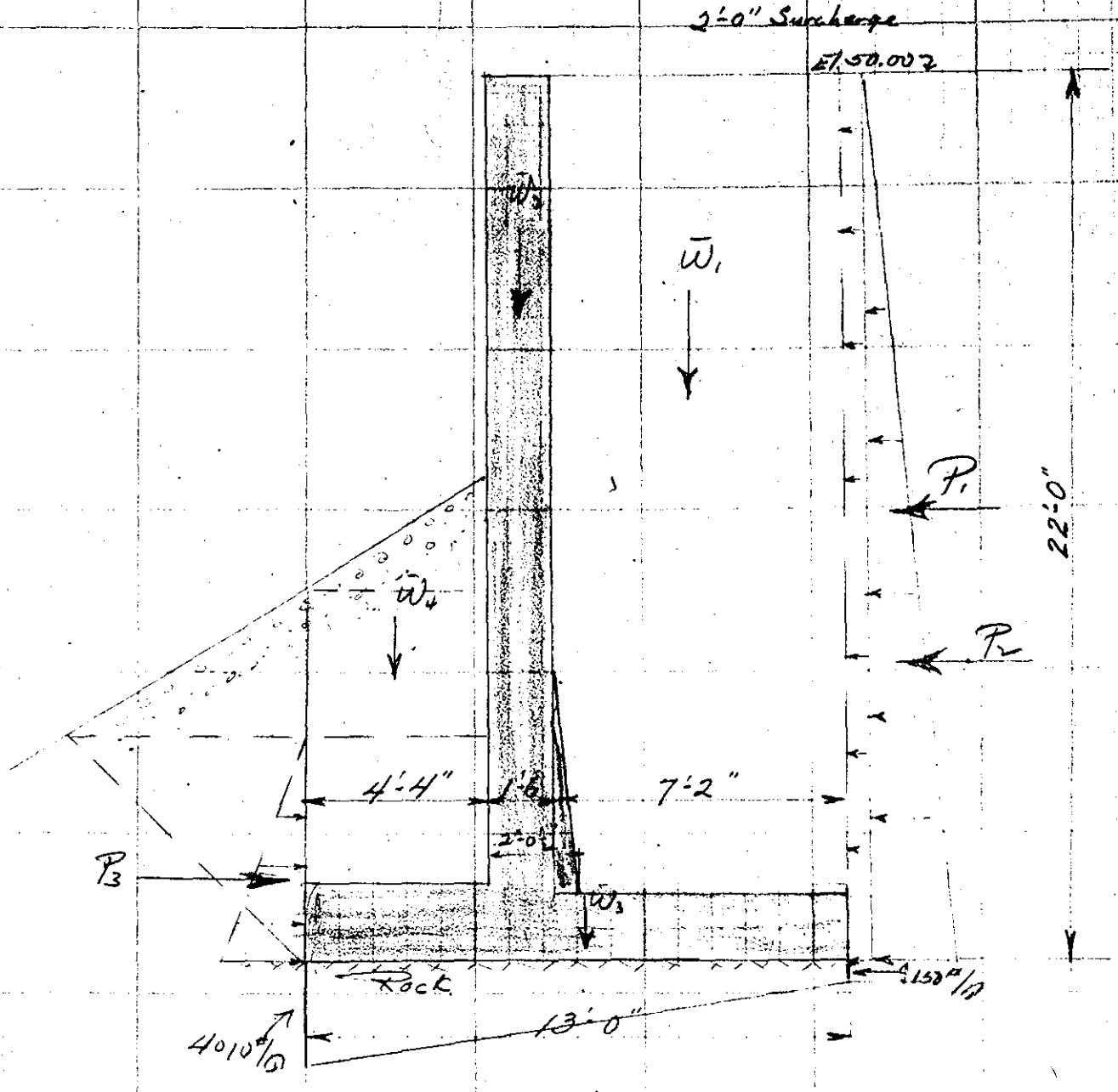
FINAL DESIGN

Type IV



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FINAL DESIGN — Type III

	Force	Arm	↺ Moment	Moment ↻
$P_1 = (35)(2)(22)$	1540	11	16900	
$P_2 = \frac{(35)(22)^2}{2}$	8450	7.33	62000	
	9990			
$P_3 = \frac{(35)(6)^2}{2}$	630	2.		1260.
$W_1 = (7.16)(22)(100) =$	15,800	9.42		149,000
$W_2 = (1.5)(20)(150) =$	4500	5.08		22 800
$W_3 = (1.5)(13)(150) =$	2920	6.50		18 900
$W_4 = (8.75)(4.33)(100) =$	3800	2.17		8 200
	27020		78,900	200 160
				− 78 900
				121 260

Position of Resultant Force $= \frac{121,260}{27020} = 4.5'$ o.k.

$$f = \frac{27020}{13} \pm \frac{(27020)(2)(6.5)}{\left(\frac{1}{12}\right)(13)^3}$$

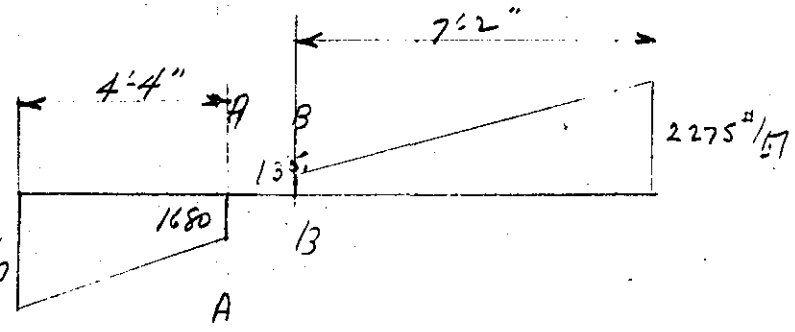
$f = 2080 \pm 1930$

$f_i = 4010$ #/□'

$f_c = 150$ #/□'

825↓
225↓
1050↓

4010↑
1050↓
2960↑



2200
225
2425↓
150↑
2275↓

2275↓
2140↑
135↓

2730↑
1050↓
1680↑

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DETAIL Dike Walls at Inlet

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FINAL DESIGN - Footing Type III

Section A

$1680(4.33) = 7260 \times 2.17 = 15{,}700$

$\left(\frac{1280}{2}\right) 4.33 = 2760 \times 2.9 = 8000$

$10020^{\#} \qquad 23700^{\#}$

$d_s = \frac{10{,}020}{(12)(0.875)(50)} = 19.1 + 3.5 = 22.6$ Say 2'-0"

$d_m = \sqrt{\frac{23{,}700}{147.7}} = \sqrt{160} = 12.6"$

A_s bottom $= \frac{(23{,}700)(12)}{(18000)(0.875)(20.5)} = 0.885 \square$

1" ⌀ - 5 c/c used

3/4" ⌀ 5" c/c

(1.06 = A_s, 5.7 = Σo)

$\Sigma o = \frac{10{,}020}{(125)(0.875)(20.5)} = 4.5"$

Sec B.

$(135)(7.17) = 970 \times 3.58 = 3460$

$\left(\frac{2140}{2}\right) 7.17 = 7700 \times 4.78 = 36800$

$8670^{\#} \qquad 40260^{\#}$

$d_m = \sqrt{\frac{40{,}260}{147.7}} = \sqrt{273} = 16.5$

$d_s = \frac{8670}{(12)(0.875)(50)} = 16.5$

3.5

$20.0"$

1'-8"

A_s top $= \frac{(40260)(12)}{(18000)(0.875)(16.5)} = 1.86 \square$ (1" ⌀ 5" c/c)

$A_s = 1.90$

$\Sigma o = 7.5$

$\Sigma o = \frac{8670}{(125)(0.875)(16.5)} = 4.8"$

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FINAL DESIGN

Type III

Design of Stem

	Shear		Moment
$(35)(2)(20) =$	1400#	10.0 =	14000
$\frac{(35)(20)^2}{2} =$	7000	6.67 =	46600
	8400#		60,600
$-\frac{(35)(4)^2}{2} =$	280	-1.33 =	400
	8120		60,200

$d_m = \sqrt{\frac{60600}{1477}} = \sqrt{410} = 20.2 + 3.5 = 23.7$

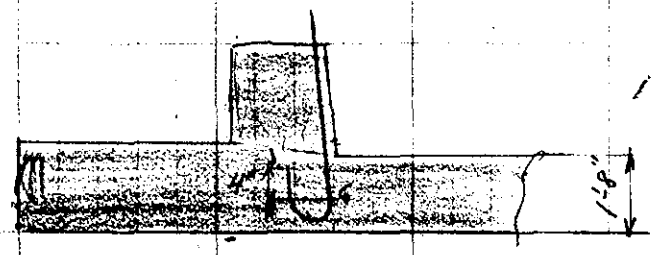
depth = 2'-0" at base of Stem.

$d_s = \frac{8400}{(12)(0.875)(50)} = .16"$

$A_s = \frac{(60,600)(12)}{(18000)(0.875)(20.5)} = 2.26$ □"

1" □ - 5" c/c ($A_s = 2.40$ □" $S_o = 9.6$")

$I_o = \frac{8120}{(125)(0.875)(20.5)} = 3.64"$



$SH = 4d = 4"$

$f_{s_H} = \frac{4(125)(4)}{1} = 2000$ #/□"

$HG = \frac{7\pi}{2} = 11"$

$f_{s_G} = 2000 + (4)(125)(11) = 7500$ #/□"

Distance left for development = 16.5 - 3 = 13.5"

$f = 7500 + \frac{(4)(125)(13.5)}{1} = 14,250$ #/□" Insufficient distance for full development

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DETAIL Dike Walls at Inlet

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Final Design — Type III

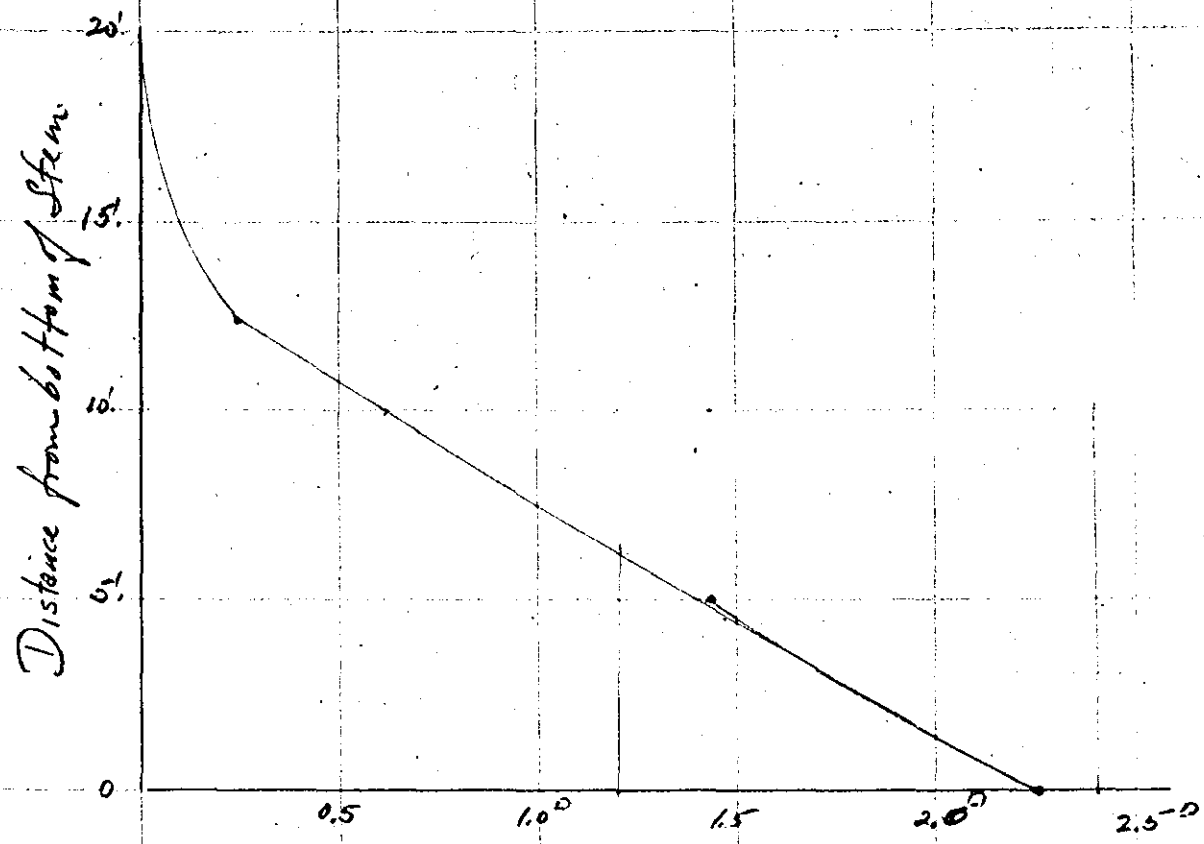
Area of web Steel

Moment at base of Stem at flood period:

$\frac{(62.5)(12)^2}{2} = 7200^{\#} \rightarrow$

$(7200)(4) = 28,800^{'\#}$

Net M = 60,200 (See Sheet 25)
− 28800
31,400'# Case I (Empty) worse conditions



Area

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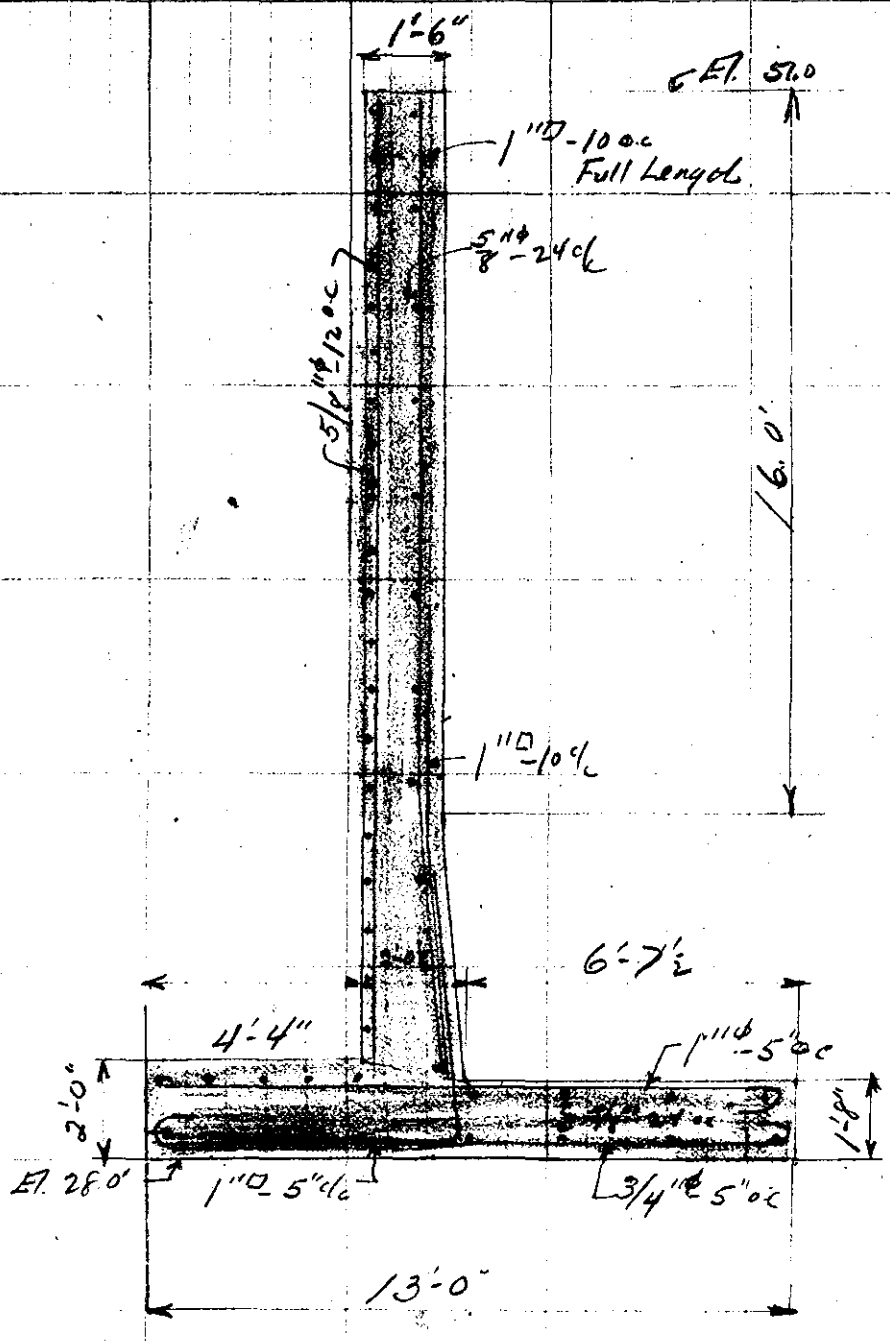
Type III

1-10,%



Scale ¼" = 1'-0"

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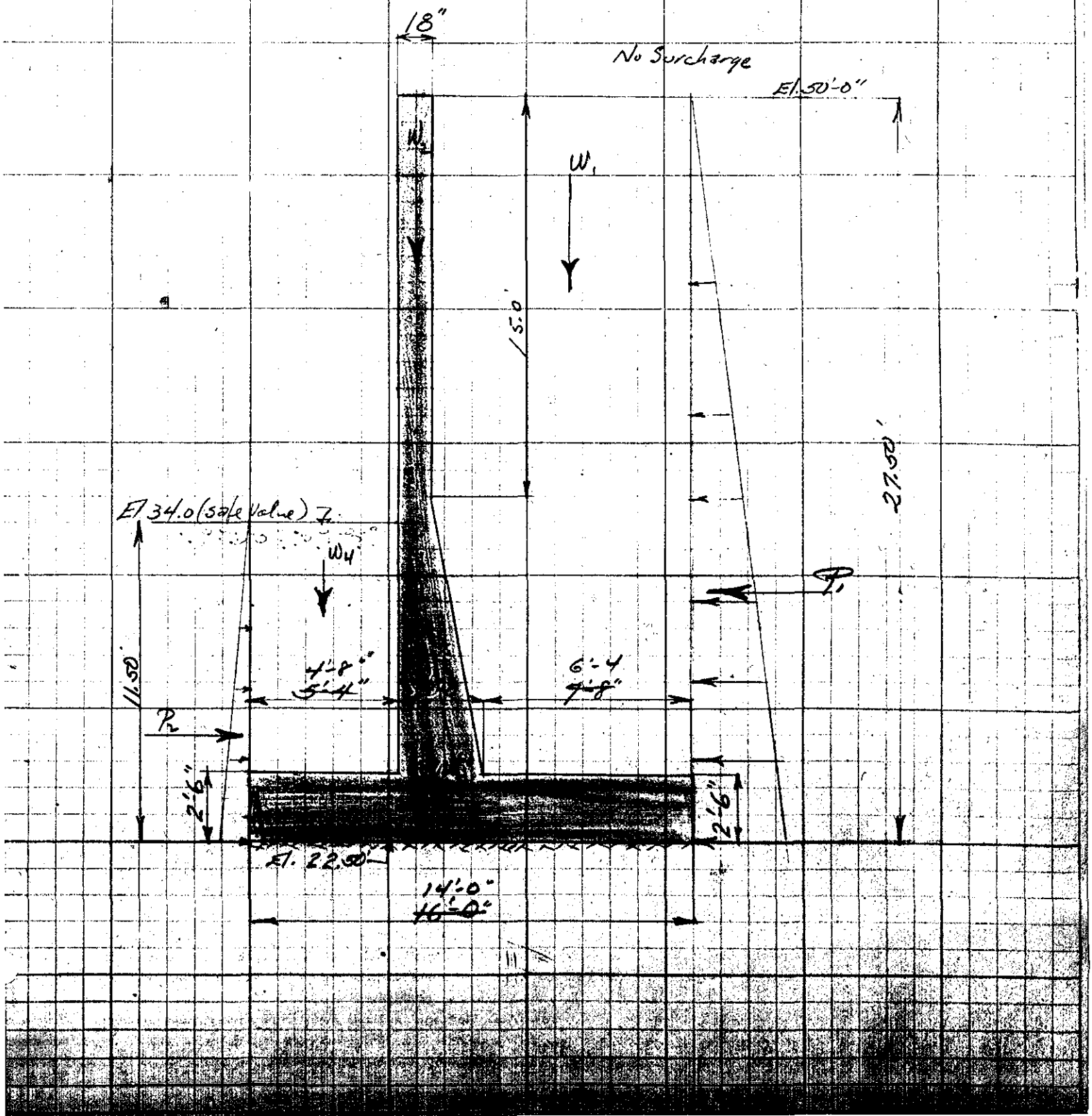
Type V

El. of Rock = 22.5' (bottom of footing.



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Park River Pressure Conduit
Dike Walls at Inlet

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FINAL DESIGN Type V

		Force	Arm	Moment	Moment
$P_1 = \frac{(35)(27.50)^2}{2} =$	13,200		9.17	121,000	
$P_2 = \frac{(35)(11.50)^2}{2} =$	2320		3.83		9000
$W_1 \begin{cases} (9.17)(25)(100) = \\ \frac{(10)(1.5)}{2} 50 = \end{cases}$		23,000 375	11.42 7.33		262,000 2700
$W_2 = (1.5)(25)(150) =$		5650	6.08		34,200
$W_3 = (2.5)(16)(150) =$		6000	8.0		48,000
$W_4 = (9.0)(5.33)(100) =$		4800	2.67		12,800
		39,825			368,700 - 121,000 247,700

Position of Resultant Force $= \frac{247,700}{39,825} = 6.2'$

For Width = 14'-0"

		Force	Arm	Moment	Moment
$P_1 =$	13,200		9.17	121,000	
$P_2 =$	- 2320		3.83		9000
	10880				
$W_1 = \begin{cases} (7.83)(25)(100) = \\ \frac{(10)(1.5)}{2} 50 \end{cases}$		19600 375	10.08 6.67		196,000 2500
$W_2 =$		5650	5.42		30,600
$W_3 = (14)(2.5)(150) =$		5250	7.0		36,800
$W_4 = (4.67)(9)(100) =$		4200	2.33		9800
		35,075			284,700 - 121,000 163,700

Position of Resultant Force $= \frac{163,700}{35,075} = 4.67'$ o.k.

$f = \left(\frac{35,075}{14}\right) 2 = 5,010$ #/□'

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SUBJECT Park River Press. Conduit
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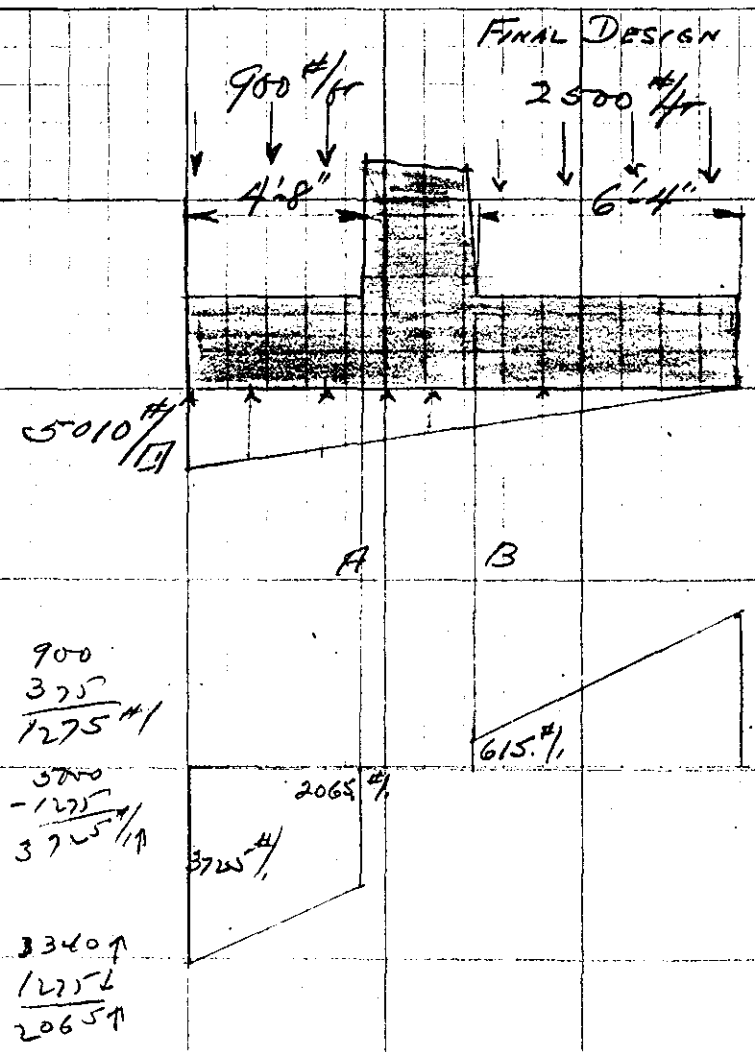
FINAL DESIGN

Type V



Sec. A

$(2065)(4.67) = 9675 \times 2.33 = 22600$

$\left(\frac{1660}{2}\right) 4.67 = 3875 \times 3.11 = 12000$

$13,550^{\#}$ $\quad$ $34,600$

$d_s = \frac{13,550}{(12)(0.875)(50)} = 26.''$

$d_m = \sqrt{\frac{34,600}{147.7}} = \sqrt{234} = 15.3$

depth = 30" ok $\quad d = 26.5''$

Sec. B

$(615)6.33 = 3900 \times 3.17 = 12,300$

$\left(\frac{2260}{2}\right) 6.33 = 7140 \times 4.22 = 30,200$

$11,040^{\#}$ $\quad$ $42,500^{\#}$

$d_s = \frac{11,040}{(12)(0.875)(50)} = 21''$

$d_m = \sqrt{\frac{42,500}{147.7}} = 17''$

Use same depth = 30"
d = 26.5"

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FINAL DESIGN Type V

Stem

$\frac{(35)(25)^2}{2} = 10,900 \times 8.33 = 90,500$

$\frac{(35)(9)^2}{2} = -\frac{1420}{9480} \times 4.5 = -\frac{6320}{84,130}$

$d_m = \sqrt{\frac{84,130}{147.7}} = \sqrt{570} = 23.8$

$+ 3.5$

27.3

Use depth = 2'-4"

$d = 24.5$

$v = \frac{9480}{(12)(0.875)(24.5)} = 37$ #/□"

FINAL DESIGN

Type V

Design of Steel Footing

Section A (See Sheet 30)

$$A_s = \frac{(34{,}600)(12)}{(18000)(0.867)(26.5)} = 1.0 \square$$

$-1''\phi - 9'' - c/c$ (1.05 □, 4.2)

$$S_o = \frac{13{,}550}{(125)(0.875)(26.5)} = 4.7''$$

Section B

$$A_s = \frac{(42{,}500)(12)}{(18000)(0.875)(26.5)} = 1.22 \square$$

$7/8''\phi - 4\frac{1}{2}''$ c/c (1.60 & 7.3) span increased from 6'-4" to 7'-0"

$$S_o = \frac{11{,}040}{(125)(0.875)(26.5)} = 3.82''$$

Base of Stem

$$A_s = \frac{(84{,}130)(12)}{(18000)(0.875)(24.5)} = 2.62 \square$$

$1''\square - 4\frac{1}{2}''$ c/c (2.67 = A_s, S_o = 1.1)

$$S_o = \frac{9480}{(125)(0.875)(24.5)} = 3.54''$$

[redacted] $1''\square$ 4½ c/c

check for development at rate of 125#/□

$H_s = 4d = 4''$

$f_{H_s} = \frac{(4)(4)(125)}{1} = 2000$ #/□

$H_s = \frac{[illegible]}{[illegible]} = 11''$ [illegible] $= \frac{2000 + (11)(4)(125)}{1} = 7500$ #/□

[illegible] $= \frac{[illegible] + (23.5)(4)(125)}{[illegible]} = 10{,}250$ #/□ [illegible]

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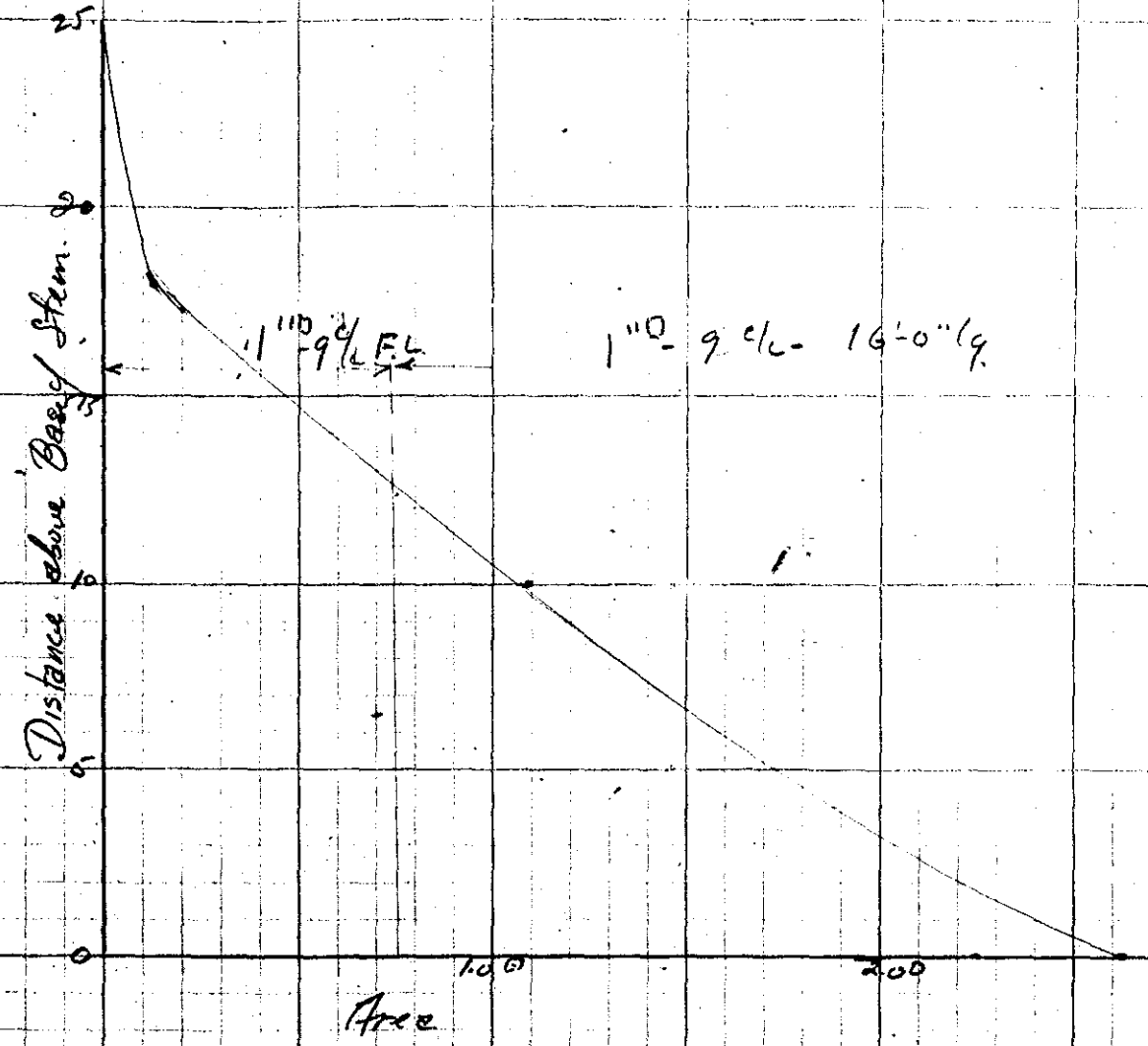
FINAL DESIGN Type V



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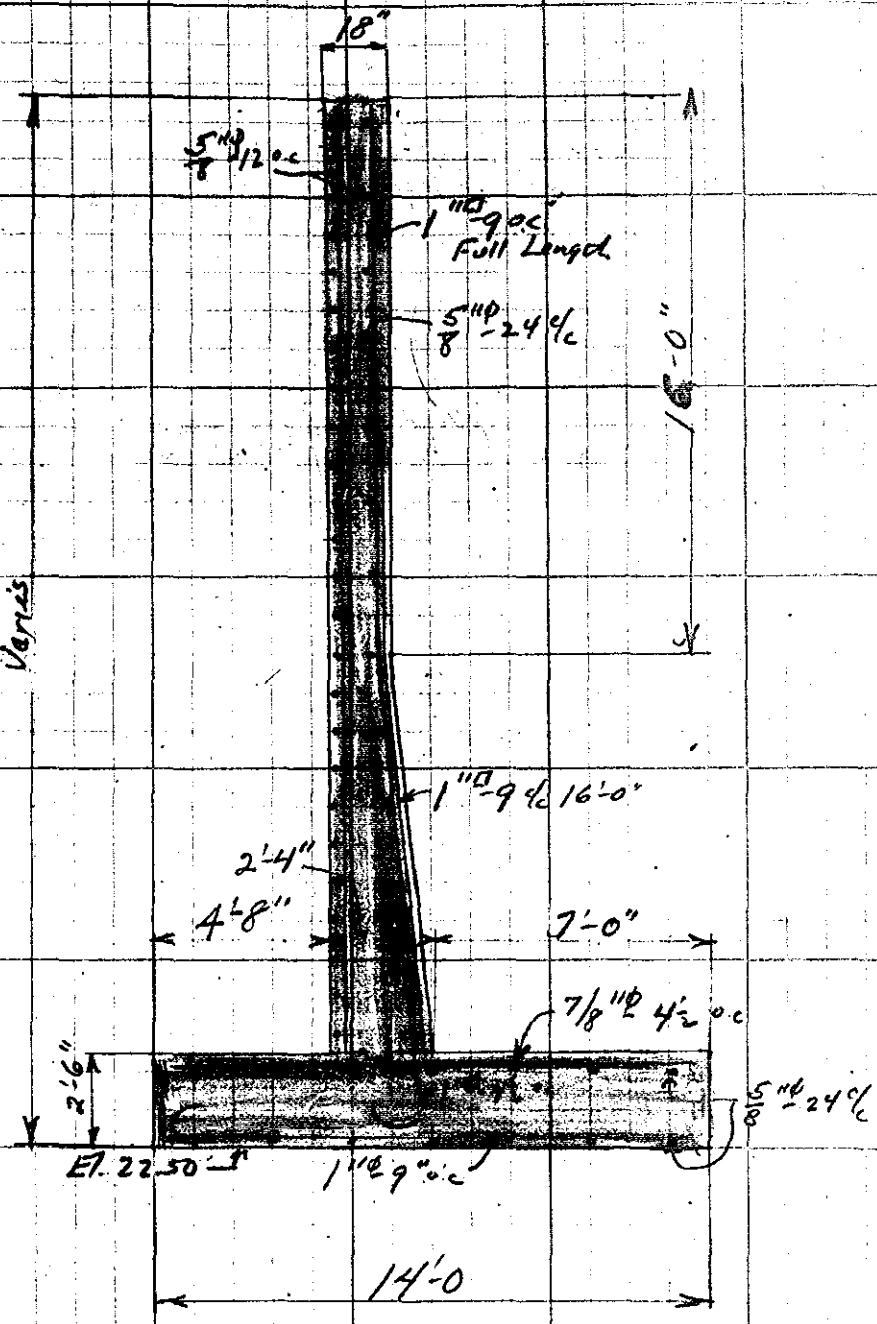
FINAL DESIGN

Type "V"



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Park River Pressure Conduit
Dike Walls at Inlet

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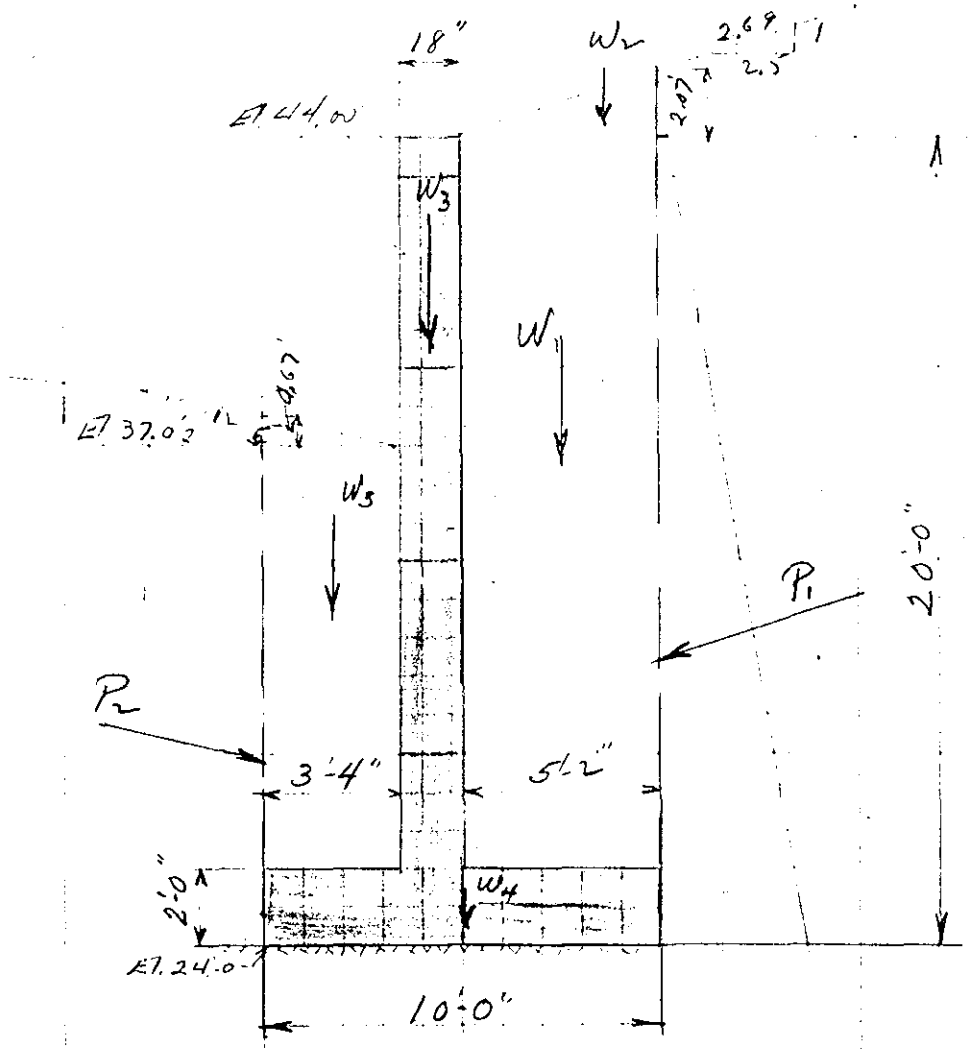
Type VI

El. of Rock - 24 [illegible] Say 24 [illegible] (El. Bottom [illegible])



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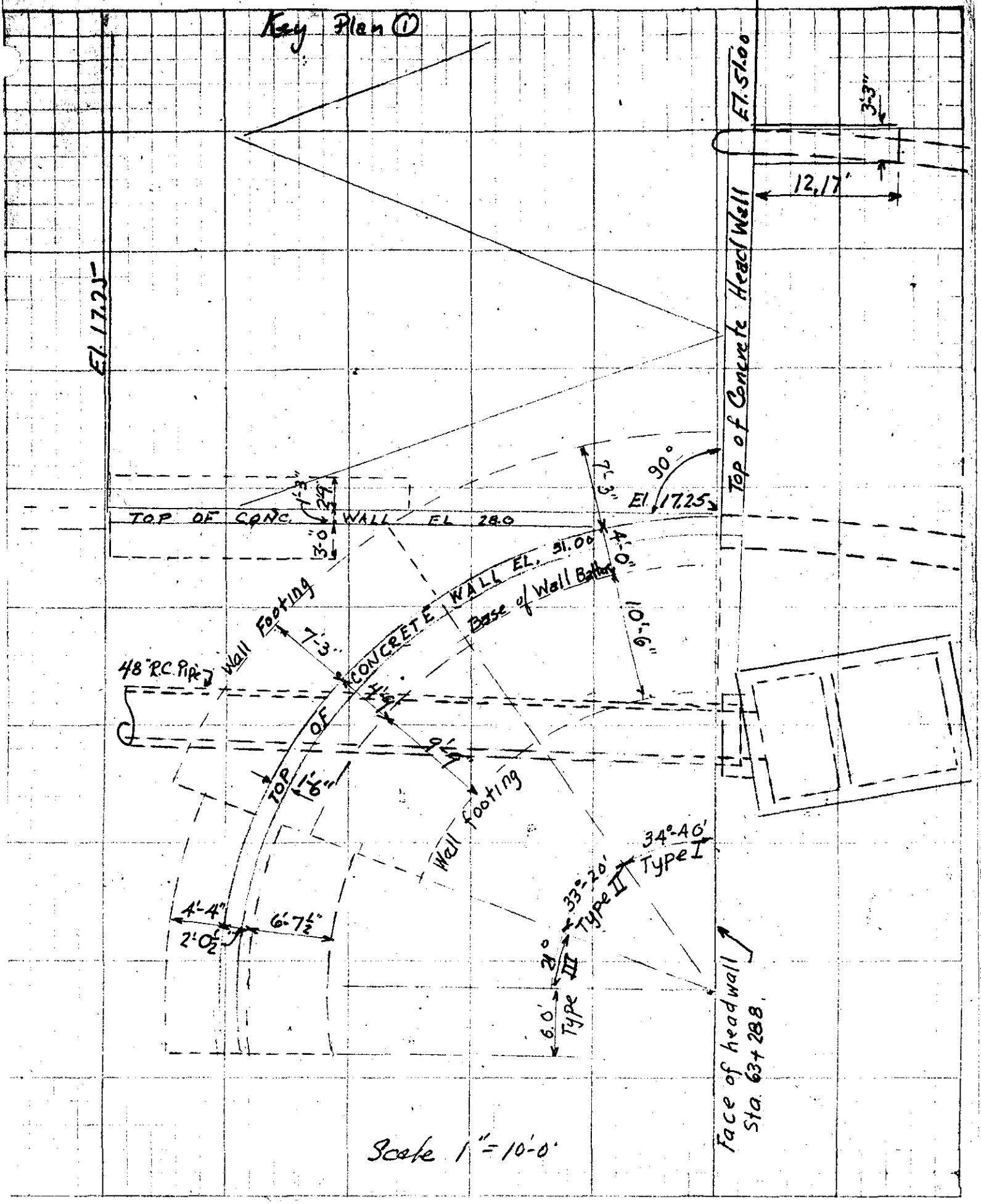

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Key Plan (2)

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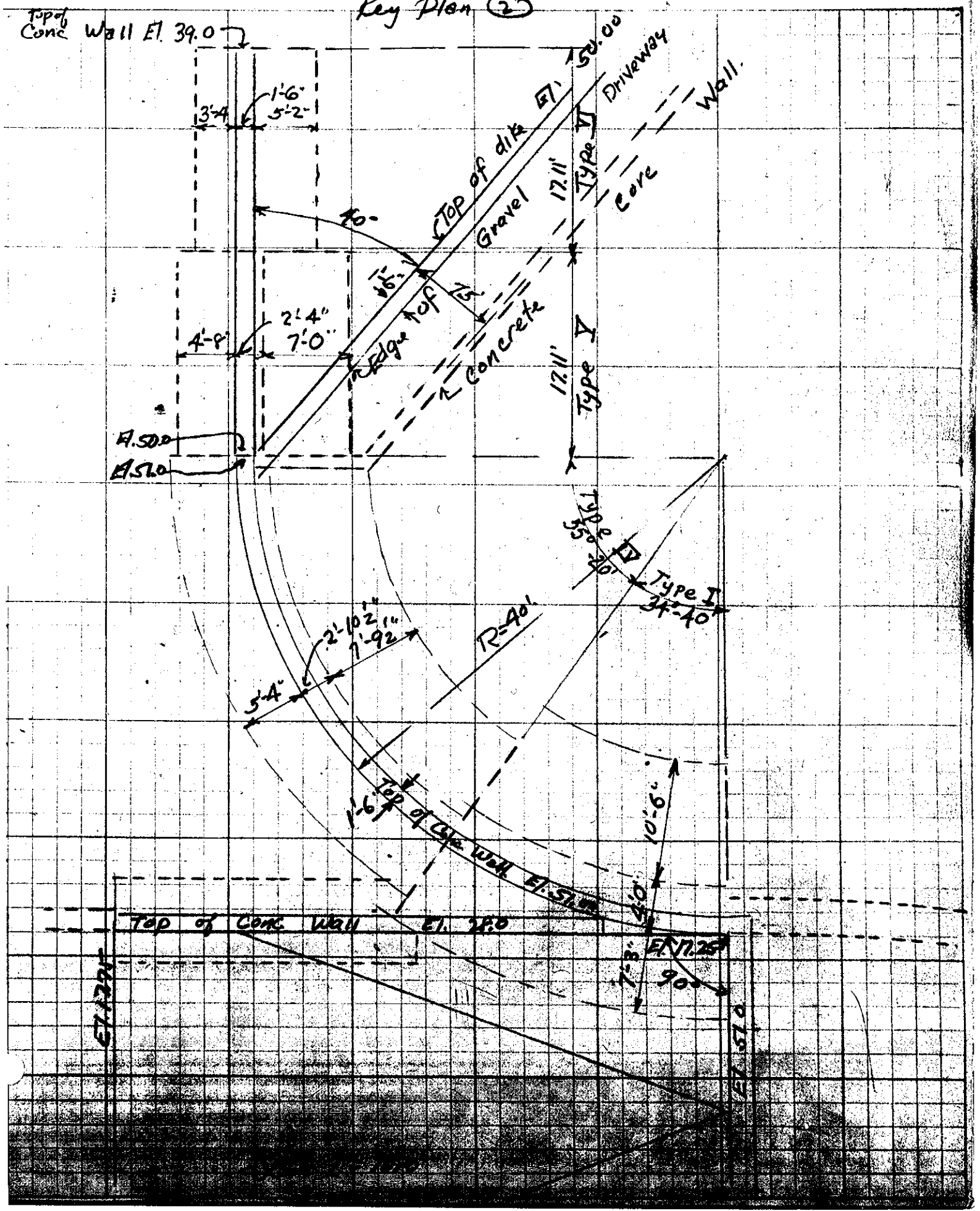

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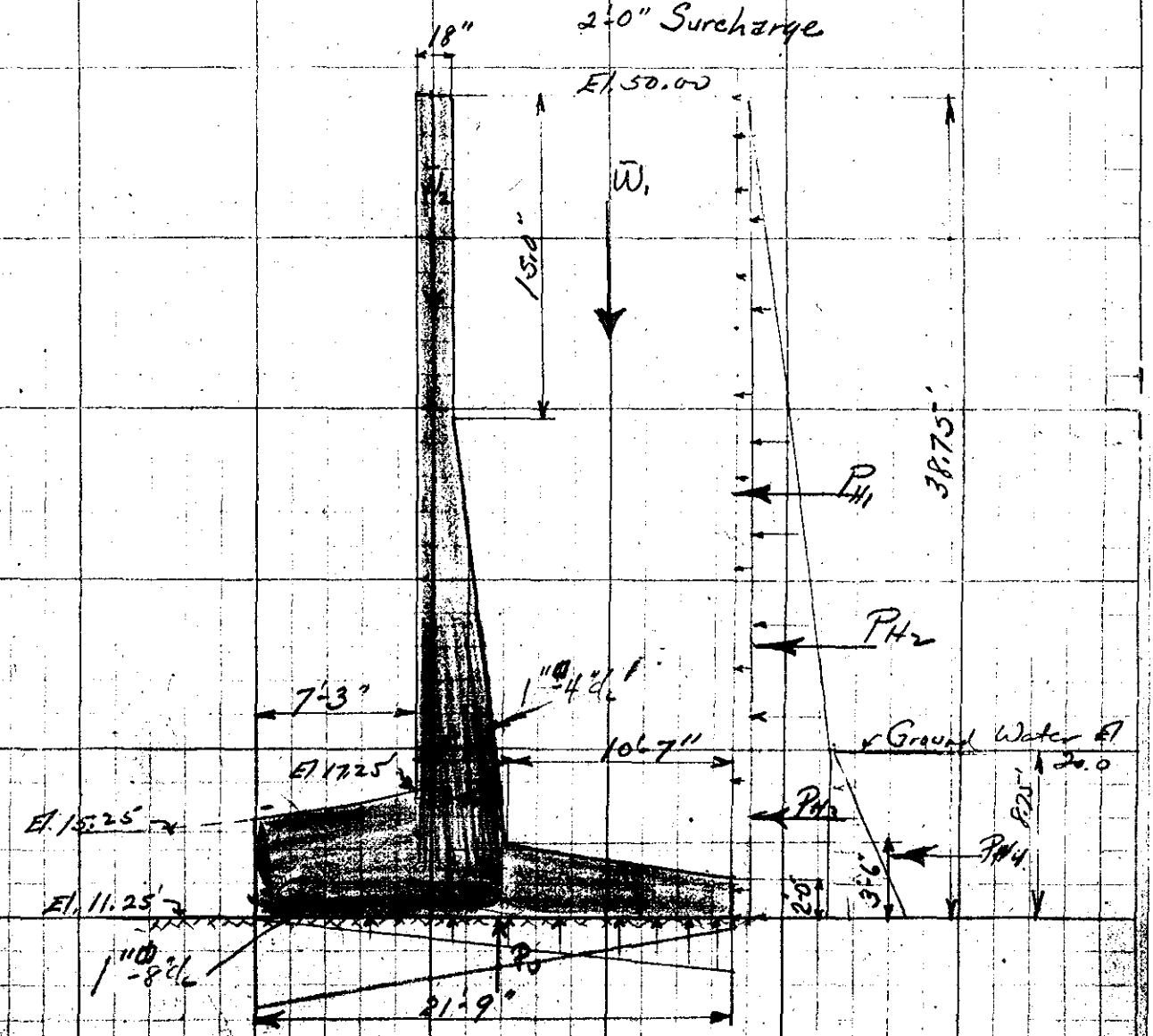
FINAL DESIGN

Type I

Case I - Channel Dry



Scale ½" = 1'-0"

FINAL DESIGN

Type I

Case I - Channel Dry

		Force	Arm	(Moment	Moment)
$P_{H_1} = (35)(2)\ 38.75 =$		2720	19.38	52500	
$P_{H_2} = \frac{(35)(30)^2}{2} =$		15700	18.75	294,000	
$P_{H_3} = (35)(30)\ 8.75 =$		9200	4.38	40,400	
$P_{H_4} = (80)(8.75)^2/2 =$		3060	2.92	9000	
$\bar{W}_1$ $(13)(37.25)$	= 48500		15.25		739,000
$\frac{(20.25)(2.42)}{2}150$	= 3700		9.56		35200
$\frac{(10.58)(1.5)}{2}100$	= 800		18.23		14400
$\bar{W}_2 = (1.5)(38.75)150$	= 8700		8.00		69,500
$\bar{W}_3$ $(4.0)(7.25)150$	= 4350		3.62		15700
$\frac{(2.0)(7.25)}{2}150$	= 1090		4.83		5250
$(3.5)(2.42)150$	= 1270		9.96		12600
$(2.0)(10.58)(150)$	= 3160		16.46		52,000
$\frac{(1.5)(10.58)}{2}150$	= 1190		14.70		17,500
	72,760			395,900	Σ961 150
					-Σ395,900
					Σ565,250

Position of Resultant Force = $\frac{565,250}{72,760}$ = 7.75 (without Uplift)

Ground Water El. 20.00
El. bottom of Wall = 11.25
8.75'

$(8.75)(62.5) = 530\ \#/\square' \div 2 = 275\ \#/\square'$

$P_u = \frac{(275)(21.75)}{2} = 2980\ \#$

M(due to uplift) = $(2980)(2/3 \times 21.75) = 43,200'\#$ ↺

Position of Resultant Force = $\frac{(565,250 - 43,200)}{(72,760 - 2980)} = \frac{522,050}{69,780} = 7.5$ u.k.

With Uplift

$f = \frac{69,780}{(21.75)(1)} \pm \frac{69,780 \times (3.375)(10.875)}{\frac{1}{12} \times (21.75)^3}$

$f = 3210 \pm 2980$

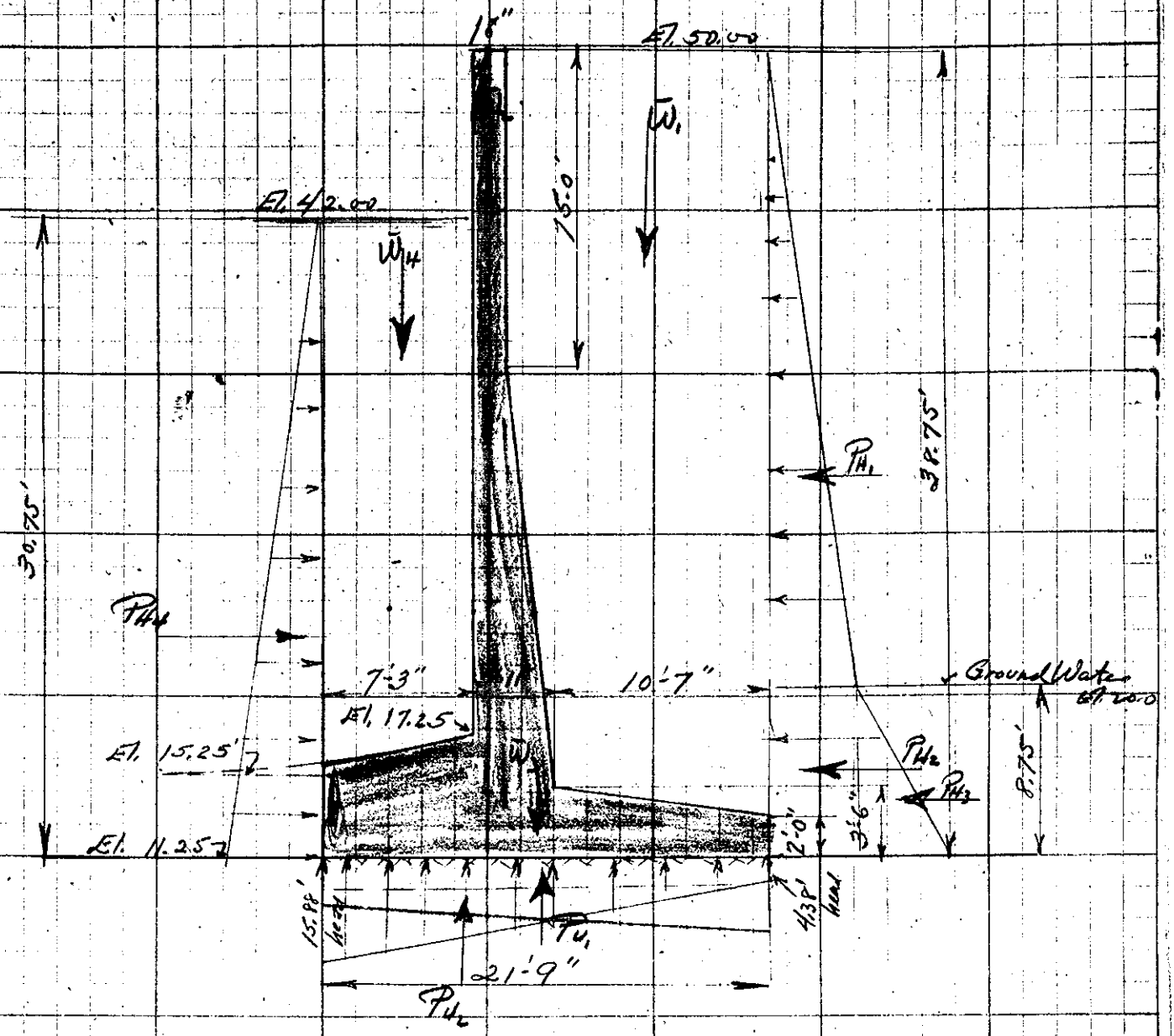
$f_1 = 6190\ \#/\square'$ C

$f_2 = 230\ \#/\square'$ C

Final Design

Type I

Case II - Channel Full.



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FINAL DESIGN Type I

Case II - Channel Full

	Force	Arm	(Moment	Moment)
$P_{H1} = \frac{(35)(30)^2}{2} =$	15700	18.75	294,000	
$P_{H2} = (35)(30)\ 8.75 =$	9200	4.38	40,400	
$P_{H3} = \frac{(80 \times 8.75)^2}{2} =$	3060	2.92	9000	
$P_{H4} = \frac{(62.5)(30.75)^2}{2}$	29,550	10.25		303,000
W_1 (See Sheet 2) = 50,400# (Note 2'-0" Surcharge Not included)				749,000
W_2 (See Sheet 2) = 8700		8.0		69,500
W_3 (See Sheet 2) 11,060				103,050
W_4 $\begin{cases} (24.75)(7.25)\ 62.5 = 11200 \\ \frac{(2)(7.25)}{2}\ 62.5 = 450 \end{cases}$		3.62 2.42		40,500 1090
$P_{U1} = (4.38)(62.5)(21.75) = 5940$		10.88	64,200	
$P_{U2} = \frac{(15.88 - 4.38)\ 62.5}{2} \times 21.75 = 7800$		7.25	56600	
			464,200	1,266,140
$\Sigma V = 68070$				− 464,200
				801,940

Position of Resultant Force = $\frac{801,940}{68070} = 11.75$

$$f_c = \frac{68070}{(24.75)} \pm \frac{(68,070)(0.875)(10.875)}{(\frac{1}{12})(21.75)^3}$$

[illegible]

f_c = 2230 #/□" [illegible] 403 #/□"

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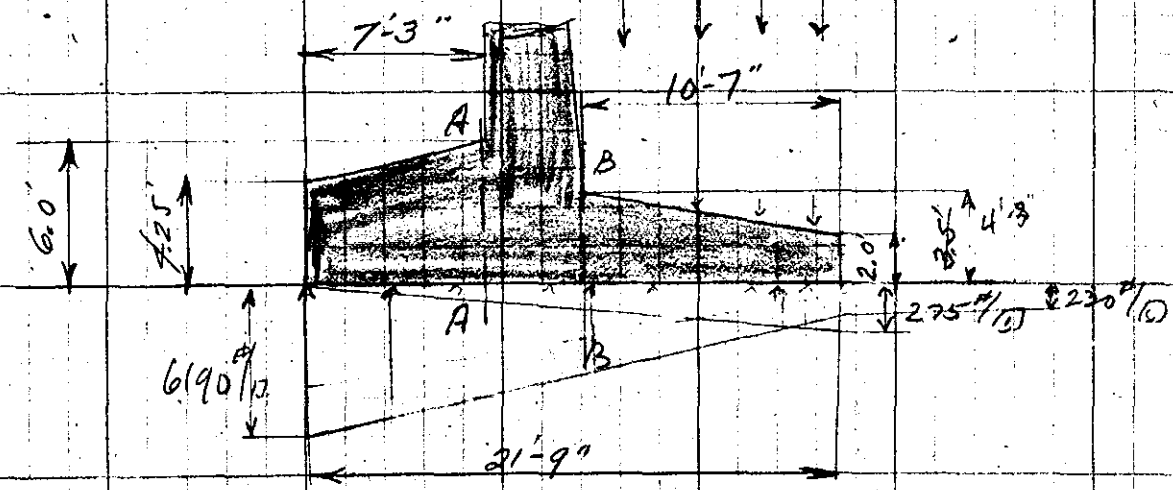
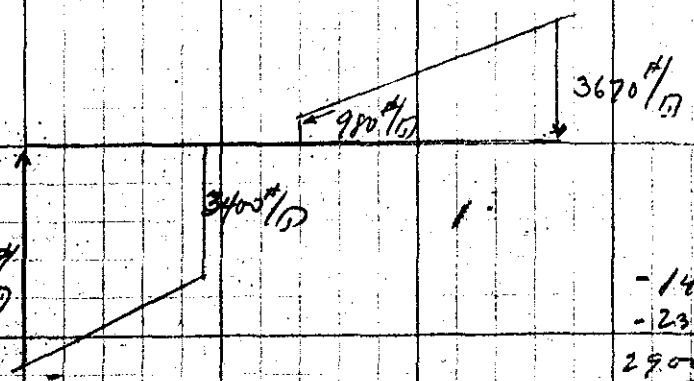
Case I - Channel Dry Type I
FINAL DESIGN



3725
150
300 Concrete
4175 ↓
505 ↑
3670 ↓

6190 ↑
640 ↓
5550 ↑



3725
525 Conc.
4250 ↓
3270 ↑
980 ↓

90 ↑
230 ↑
3980 ↑
4300 ↑
900 ↓
3400 ↑

-140 ↑
-230 ↑
2900 ↑
3270 ↑

Section "A"

(3400) 7.25 = 24600 × 3.63 = 89,500
(2150/2) 7.25 = 7800 × 4.83 = 37,600
32400# 127,100 "

$d_m = \sqrt{\frac{(127,100)}{147.7}} = \sqrt{865} = 29.4"$

$d_s = \frac{(32,400)}{(12)(0.875)(50)} = 61.6"$

Section B

(980) 10.58 = 10350 × 5.29 = 54,500
(2690/2) 10.58 = 14200 × 7.05 = 100,000
24550 154,500

$d_m = \sqrt{\frac{154,500}{147.7}} = \sqrt{1050} = 32.4$

$d_s = \frac{24,550}{(12)(0.875)(50)} = 46.8"$

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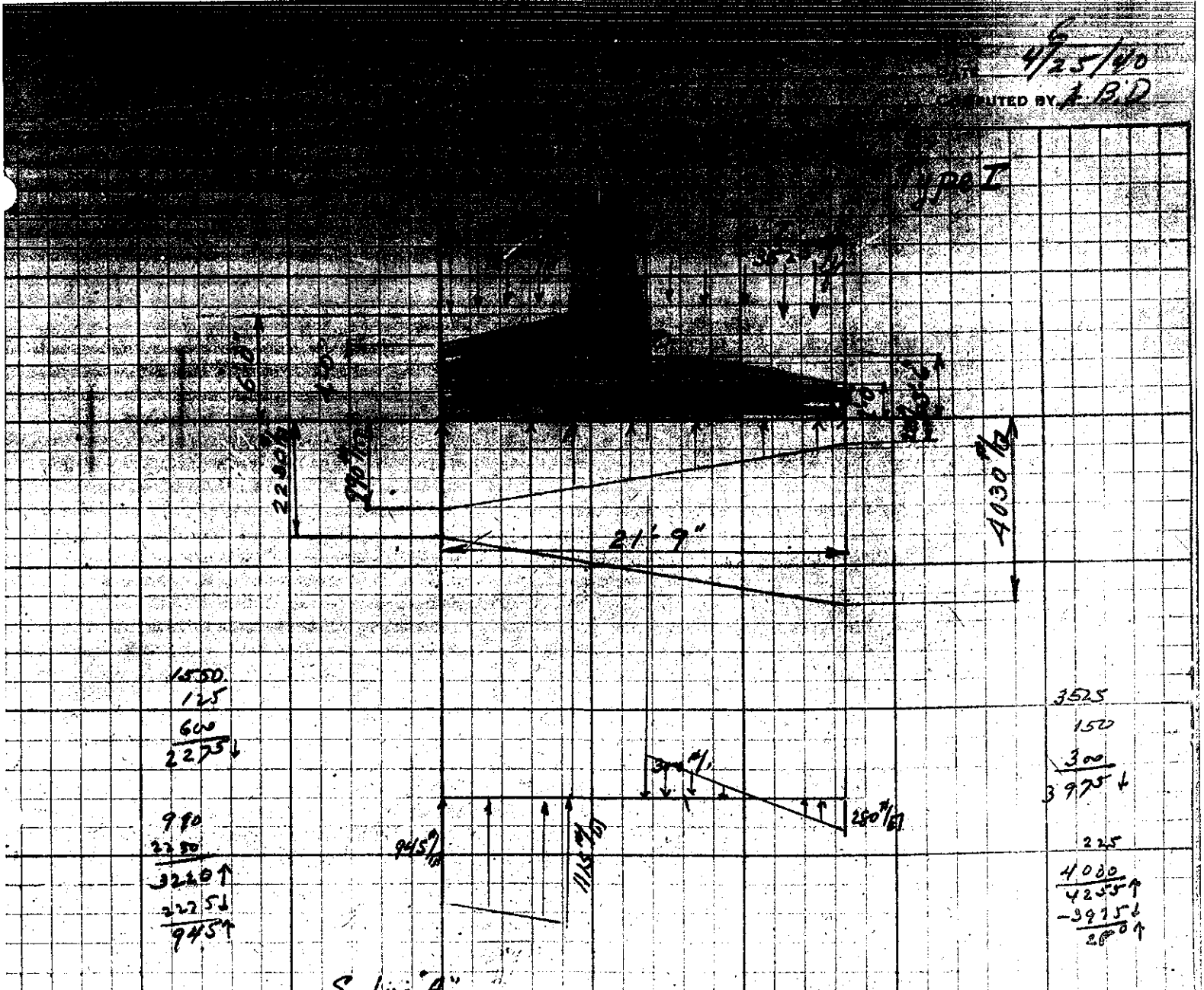

1550
125
600
2275 ↓

990
2250
3240 ↑
2275 ↓
945 ↑

3525
150
300
3975 ↓

225
4000
4225 ↑
-3975 ↓
250 ↑

Section "A"

(945)(7.25) = 6850 × 3.6 ~ = 24,800

$\left(\frac{170}{2}\right)$ 7.25 = 615 × 2.42 = 1500

7465 — 26300

1550
900
2450 ↓

225
510
2230
600
3565 ↑
2450 ↓
1115 ↑

3525
525
4050 ↓

225
370
2230
930
3755 ↑

4050 ↓
3755 ↑
300 ↓

[illegible] - Hartford
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FINAL DESIGN

Case I - Channel Dry

Type I

Stem

Lever & Moment at base of Stem (See Sheet 1)

$(35)(30)(32.25) = 2290 \times 16.38 = 37,400$

$\frac{(35)(30)^2}{2} = 15800 \times 12.75 = 201,500$

$(35)(30)2.75 = 2880 \times 1.38 = 4000$

$\frac{(80)(2.75)^2}{2} = 300 \times 0.92 = 300$

$21,270 \qquad 6\,243,200$

$d_m = \sqrt{\frac{243,200}{147.7}} = \sqrt{1645} = 40.5''$

$d_s = \frac{21,270}{(12)(0.875)(50)} = 41.5''$

Case II - Channel Full

Stem

$\frac{(35)(30)^2}{2} = 15800 \times 12.75 = 201,500$

$(35)(30)(2.75) = 2880 \times 1.38 = 4000$

$\frac{80(2.75)^2}{2} = 300 \times 0.92 = 300$

$18,980 \qquad 6\,205,800$

$-\frac{(62.5)(24.75)^2}{2} = \frac{19,100}{-120} \times 8.25 = 156,000$

$6\,49,800$

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FINAL DESIGN

Type I

From Sheet (7) Stem d_s = 41.5"
+ 3.5
45.0"

3'-9" at base

El. 35.0 (15.0 from top)

$(35)(2)(15) = 1050 \times 7.5 = 7850$
$\frac{(35)(15)^2}{2} = 3940 \times 5.0 = 19700$
$4990 \qquad 27550$

$d_m = \sqrt{\frac{27550}{1472}} = \sqrt{186} = 13.7"$

$d_s = \frac{4990}{(12)(0.875)(50)} = 9.6"$

El 26.12 (23.88 from top)

$(35)(2)(23.88) = 1670 \times 11.94 = 20000$
$\frac{(35)(23.88)^2}{2} = 10000 \times 7.96 = 79600$
$11760 \qquad 99600$

$d_m = \sqrt{\frac{99600}{1472}} = \sqrt{675} = 26"$ req'd
28" supplied [illegible]

[illegible]

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FINAL DESIGN
Stem.

Type I

Case I worse condition than Case II

M (at base) = 243,200 '#' (See Sheet 7)
Shear (" ") = 21,270 # (See Sheet 7)
depth at base = 3'-9" } See Sheet 8
& d = 41.5" }

$$A_s = \frac{243,200 \times 12}{(18000)(0.875)(41.5)} = 4.47 \text{ □"}$$

$$s_o = \frac{21,270^{\#}}{(125)(0.875)(41.5)} = 4.7"$$

1¼" □ 4" o.c.

El. 26.12

M = 99,600 '#' (See Sheet 8)
S = 11,760 # (See Sheet 8)
d_s = 28.

$$A_s = \frac{(99600)(12)}{(18000)(0.875)(28)} = 2.72 \text{ □"}$$

$$s_o = \frac{11,760}{(125)(0.875)(28)} = 3.84"$$

POINT 5'-0" ABOVE BASE 3.28

1¼ - 8" = 2.34
1" - 8" = 1.50
3.84

Point 10'-0" Above Base = 2.46

El 35.0

M = 27,550 '#' (See Sheet 8)
S = 4990 # (See Sheet 8)
d_s = 14.5

$$A_s = \frac{(27,550)(12)}{(18000)(0.875)(14.5)} = 1.44 \text{ □"}$$

1" □ - 8" = 1.5 o.k

$$s_o = \frac{4990}{(125)(0.875)(14.5)} = 3.15"$$

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Final Moment Type I
Footing (Toe)

Sec A (Channel Side) - See Sheet (5)

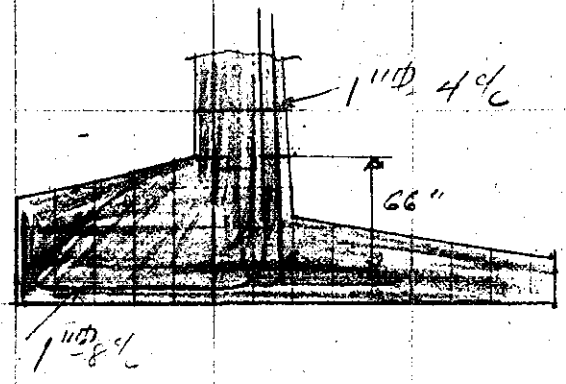
M = 127,100 '#
S = 33,400 #
} See Sheet (5)

Use depth = 6'0" (as shown - Sheet (1)) to prevent increase of moment at base of stem

$A_s = \frac{(127,100)(12)}{(18000)(0.875)(68.5)} = 1.42$ □"

1 "□ - 8 c/c (1.50 □" w/ 6)

$\Sigma o = \frac{32,400}{(6)(0.875)(68.5)} = 71$ #/□"



To develop bond stress of 100 #/□" - 45"d anchorage necessary = 45"
Anchorage supplied = 66"
+ 11" (half of Perimeter Dia = 6d.
4" (extension past hook = 4d)
81"

∴ bond = $\left(\frac{45}{81}\right)$ d = 55d or 55 #/□"

f_s (at J) = $\frac{(4)(4)(55)}{1}$ = 880 #/□"

f_s at G = 880 + $\frac{(4)(11)(55)}{1}$ = 3300 #/□"

f_s at joint = 3300 + $\frac{(4)(66)(55)}{1}$ = 18000 #/□"

Compressive Stress in Concrete due to hook = $\frac{(3300)(1)}{(3)1}$ = f_c = 1100 #/□" o.k.

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FINAL DESIGN Type I

Footing (Heel)

$M = 154,500$ "#
$S = 24,550$ #
$d_s = 46.8$
$\quad 3.5$
$\quad 50.3$ depth = 51" = 4'-3"

$A_s = \frac{(154,500)(12)}{(18000)(0.875)(47.5)} = 2.48$ □"

1"φ 4" c/c (3.00 #, $\Sigma_0 = 12$

$\Sigma_0 = \frac{24,550}{(125)(0.875)(47.5)} = 4.7$"

$u = \frac{(125)(4.7)}{12} = 49$ #/□"

Moment 5'-3½ from End (℄)

980 x 5.29 =	5180	x 2.64 =	13700
1345 x 5.29 =	7100	x 2.64 =	18700
$\left(\frac{1345}{2}\right)$ 5.29 =	3500	x 3.53 =	12500
	15820		44900

$d_m = \sqrt{\frac{44900}{147.7}} = 17.4$

$d_s = \frac{15820}{(12)(0.875)(50)} = 30$" 34" Supplied O.K.

f_s (for 1"φ = 4" c/c) $= \frac{(44900)(12)}{(3)(0.875)(34)} = 6000$ #/□"

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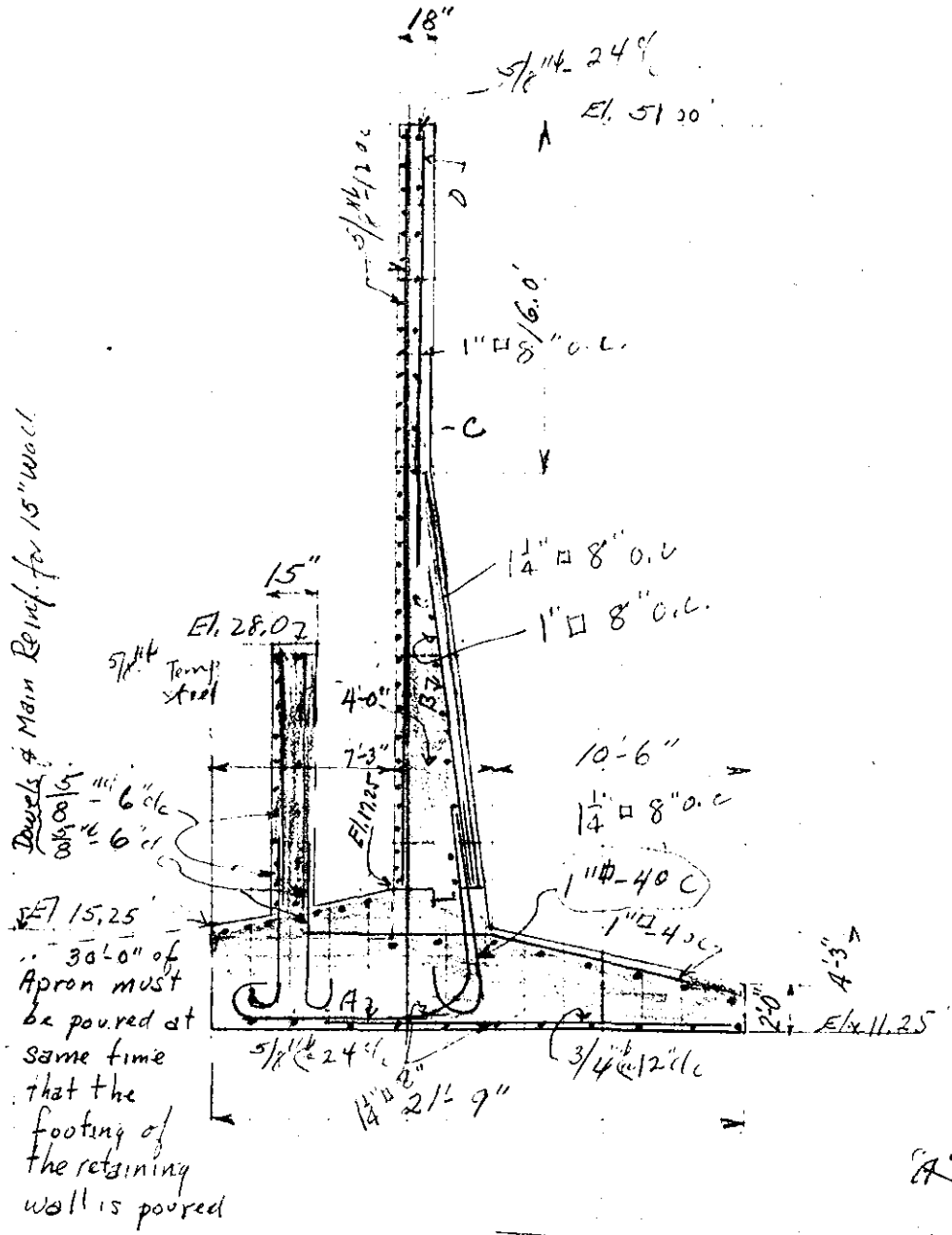
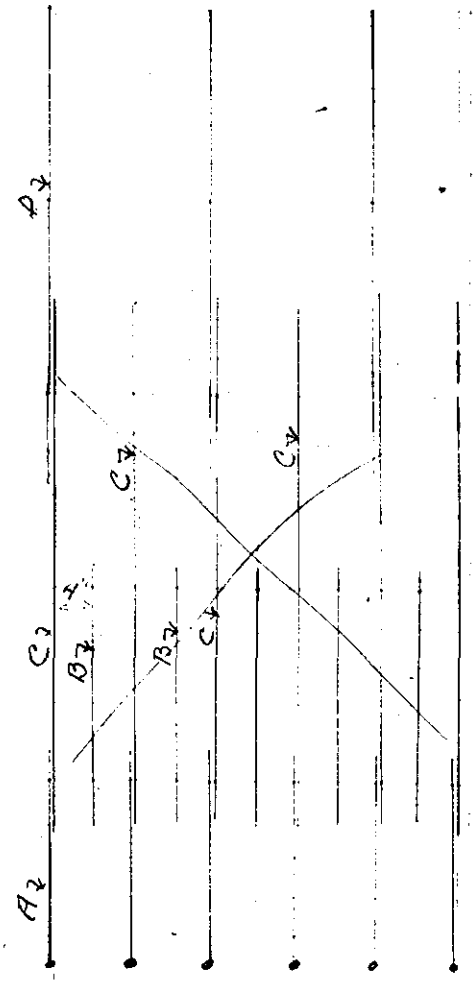
4.B.D

1-7.8

Frame Design

Type I





Type I
Scale 1/8" = 1'-0"

~~A - 1"□ 8" o.c. - steel placed in front of Stem Steel.~~
~~B - 1 1/4"□ - 8" o.c. - 10'-9"~~
~~C - 1"□ 8" o.c. - 21'-6"~~
~~D - 1"□ - 16 o.c. - 18'-6"~~

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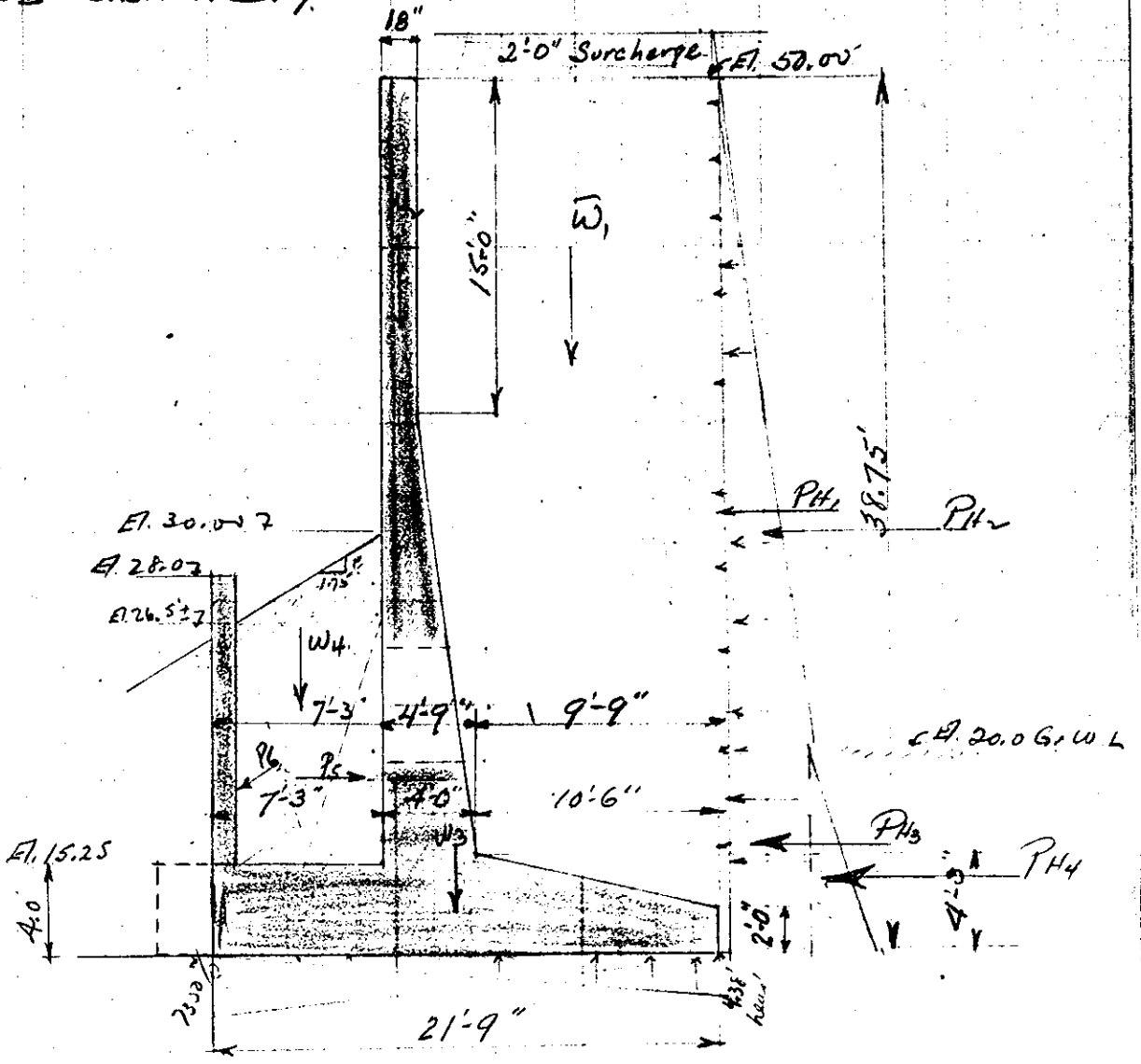
Type II

FINAL DESIGN.
Case I - Channel Dry.



Increase of thickness of stem due to opening

$$t^3 = \left(\frac{10.7}{6.7}\right)(48)^3 = 57''$$

$$\Delta t = 57 - 48 = 9''$$

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FINAL Moment
Design of Wall on Channel Side — Type II
Case I (Channel Dry)

$P_6 = \frac{(35)(11.25)^2}{2} = 2220^{\#}$

$P_{H6} = (2220)\frac{1.75}{2.02} = 1920^{\#}$

$M = (1920)\left(\frac{11.25}{3}\right) = 7200'^{\#}$

$d_m = \sqrt{\frac{7200}{147.7}} = \sqrt{48.6} = 7''$

$d_s = \frac{1920}{(12)(0.875)(50)} = 3.7''$

With Water Press. at El. 28.0 on one side

$P = \frac{(62)(12.75)^2}{2} - 1920 = 5130 - 1920 = 3210^{\#}$

$M = (5130)(4.25) - 7200'^{\#}$
$= 21800 - 7200$
$= 14600'^{\#}$

$d_m = \sqrt{\frac{14600}{147.7}} = \sqrt{99.2} = 10''$

Use 15" Wall

A_s channel Side $= \frac{(14600)(12)}{(18000)(0.87)(11.5)} = 0.97^{\square''}$ 5/8"φ (4 c/c) (0.93 / 20 = 5.9)

$u = \frac{3210}{(5.9)(0.87)(11.5)} = 54^{\#}/\square''$

A_s earth side $= \frac{(7200)(12)}{(18000)(0.87)(11.5)} = 0.48^{\square''}$ 1"φ - 8 c/c (0.47 / 20 = 2.9)

$u = \frac{1920}{(2.9)(0.87)(11.5)} = 66^{\#}/\square''$

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Type II

FINAL Design
Case I worse than case II (See Sheet 5 + 6)

For Soil Press. { From Sheet (2) M (without earth on channel side) = 522,050 ↻
" " " V (" " " " ") = 69,780#

Resisting Active press = $\frac{(35)(11.25)^2}{2}$ = 2220#

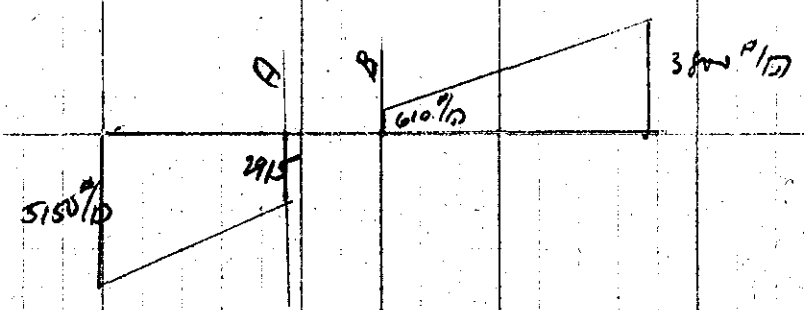
Earth press. on 15" Wall practically neutralizes the effect of soil pressure due to 2220# force

$\bar{W}_4$ (See Sheet 14) = 10,180#

Resultant Soil Press. practically at middle third

$f = \frac{2(79960)}{21.75}$ = 7350#/□ (Same condition exists where resisting acting moment is considered 2220(7.75) added

7350 ↑
2200
5150 ↑



3875
300
4175 ↓
-275
3800

3650
640
4290 ↓
120
4170 ↓
3560
610 ↓

4900
90
4990 ↑

600
1475
2075 ↓

4990
2075
2915 ↑

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FINAL DESIGN

Type II

Section A (Sheet 16)

$(2915)\ 7.25 = 21100 \times 3.62 = 76500$
$\left(\frac{2235}{2}\right) 7.25 = 8100 \times 4.83 = 39200$
$29200 \qquad 115700$

$d_s = \frac{29200}{(12)(0.875)(50)} = 55.5$
$+3.5$
59.0

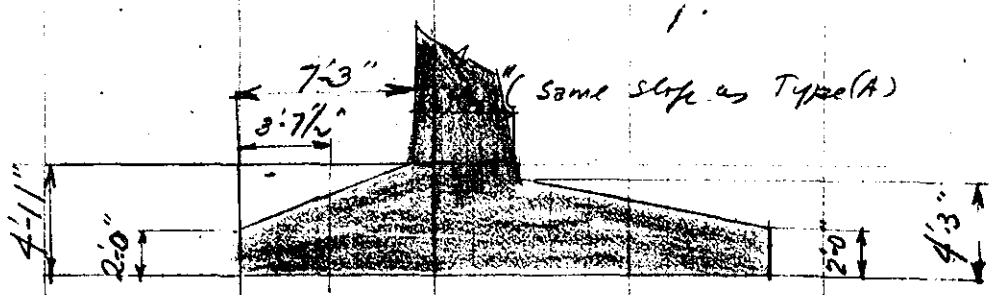
Depth = 4'-11"

$A_s = \frac{(115,700)(12)}{(18000)(0.875)(55.5)} = 1.58$ □"

1" □ 8" o.c. o.k.

For Heel Use Same as sketch shown on sheet (13)

To keep resultant soil pressure in middle third, use sloping footing for toe where 15" wall does not rest on Retaining Wall footing.



Moment at Section 3'-7½" from End
Using Loading Diagram of Sheet (16)

$(2915)(3.62) = 10550 \times 1.81 = 19100$
$(1120)(3.62) = 4050 \times 1.81 = 7350$
$\frac{(1120)\ 3.62}{2} = 2030 \times 2.42 = 4900$
$16630 \qquad 31350$

$d_s = \frac{16630}{(12)(0.875)(50)} = 31.8"$ $\qquad d_m = \sqrt{\frac{31,350}{147.7}} = 14.5"$

d (applied) = 38.0" o.k.

$A_s = \frac{31,350}{(1500)(0.87)(38)} = 0.63$ □"

1" □ – 8" o.c. o.k.

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FINAL DESIGN

Type II

Stem

21,270# (See Sheet 7) (Shear without resisting Earth press.)
2220# (See Sheet 16) Resisting Earth Press)
19 050#

1300
20350#

(35)(2)(1.08)
(35)(20)(1.08)
(80)(1.08)

Depth of footing at toe = 4'-11"
∴ Critical Section 1.08' below Type A

See Sheet 7 — Sheet 16

$M = 243,200 + 21,270(1.08) + 1200(1.08)(0.54) - 2220(3.75)$
$= 243,200 + 23,000 + 700 - 8300$
$= 258,600$ '#

$d_m = \sqrt{\frac{(258,600)(}{1477}} = \sqrt{1718} = 41.8$

43.2 Supplied O.K.

$A_s = \frac{(258,600)(12)}{(18000)(0.875)(43.2)} = 4.5$ □ Use same steel as shown on Sheet 13

$v = \frac{19050}{(12)(0.875)(43.2)} = 42.$ #/□

$u = \frac{19,050}{(18)(0.875)(43.2)} = 28$ #/□

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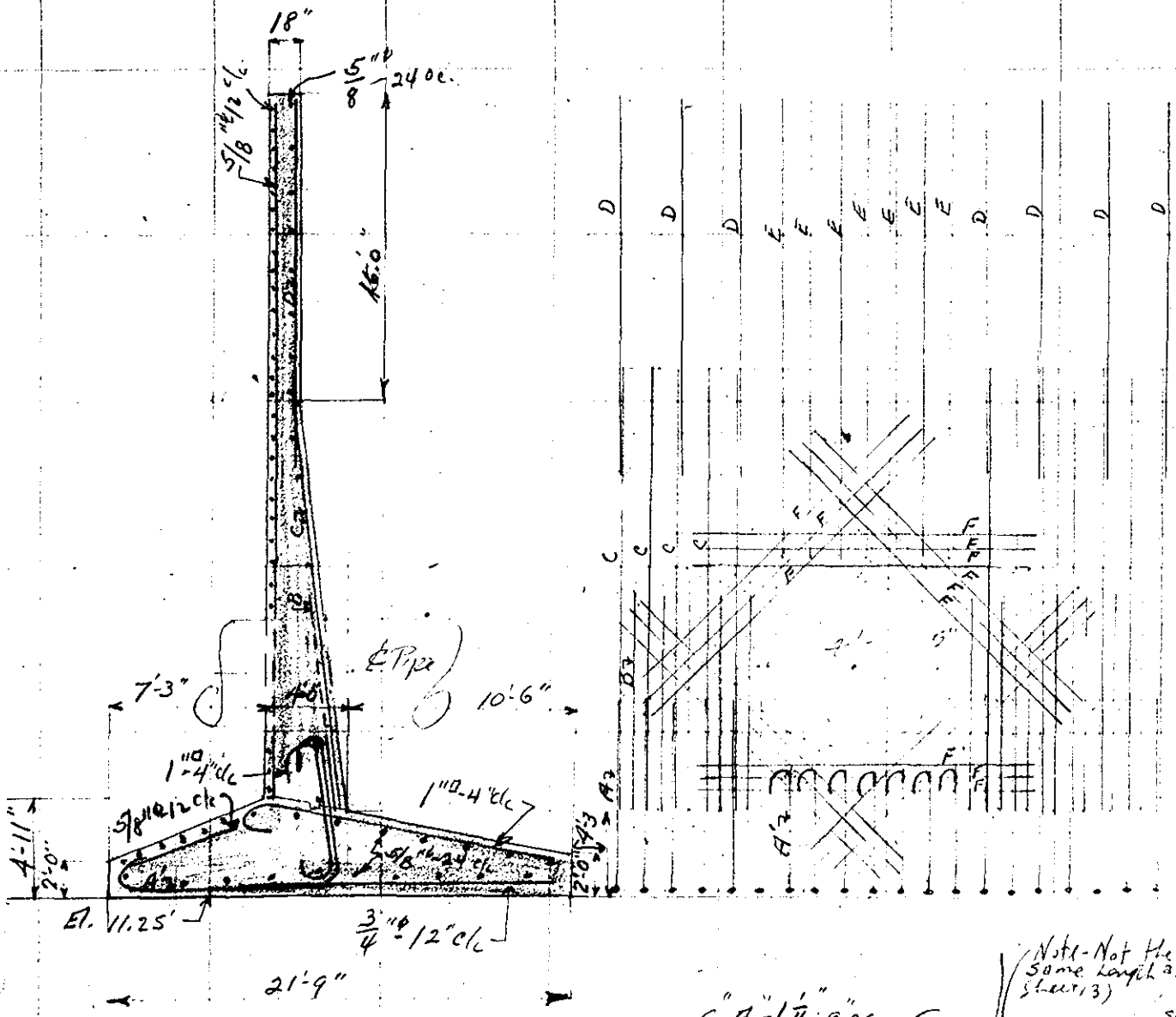
FINAL DESIGN

Type II (This type to be used where 15" wall does not rest on toe of retaining wall)

1.78



For Earth Side only

"A" - 1 1/4" 8" oc (Note - Not the same length as sheet 3) - steel placed in front of stem steel)
A' - 1"□ 8" oc (steel placed in front of stem steel)
B1 - 1/4"□ - 8" oc - 11'-9"
C - 1/4"□ - 8" oc - 22'-6"
D - 1"□ - 16" oc - 18'-6"
E - 1"□ - 8" oc
F - 1"□ - 4 oc

FINAL DESIGN

Type VI

Case I (Channel Dry)

	Force	Arm	(Moment	Moment)
$P_1 = \frac{(35)(22.07)^2}{2} = 8{,}500^{\#}$				
$P_{1H} = (8500)\frac{2.5}{2.69} = 7900^{\#}$		7.36	58000	
$P_{1V} = (8500)\frac{1}{2.69} =$	3160#	10.0		31,600
$P_2 = \frac{(35)(13.67)^2}{2} = 3270^{\#}$				
$P_{2H} = (3270)\frac{5}{5.1} = 3200$		4.42		14100
$P_{2V} = (3270)\frac{1}{5.1} =$	640	0		
$W_1 = (5.17)(18)(100) =$	9320	7.42		69000
$W_2 = \frac{(5.17)(2.07)}{2}100 =$	530	8.28		4400
$W_3 = (1.5)(18)(150) =$	4050	4.08		16500
$W_4 = (10)(2.0)(150)$	3000	5.0		15000
$W_5 = (3.33)(11)(100) =$	3650	11.67		6100
	24,350			156700
				− 58000
				98700

Position of Resultant Force $= \frac{98{,}700}{24{,}350} = 4.05$

Case II (Channel Full)
Worse condition Water Level at 42.00
Saturated Soil at El. 37.00

Pressure against channel side $= \frac{(62.5)(5)^2}{2} = 780^{\#} \times 14.67 = 11{,}400^{\#}$
$\frac{(80)(13)^2}{2} =$ $= 6800^{\#} \times 4.42 = 30{,}000$
$7580 \rightarrow$ 41,400
$7900 \leftarrow$ 84,600
$\Sigma P_{I+II} = 320 \leftarrow$ 126,000

Position of Resultant Force $= \frac{126{,}000}{26{,}900} = 4.7$ ft

FINAL DESIGN

Type VII

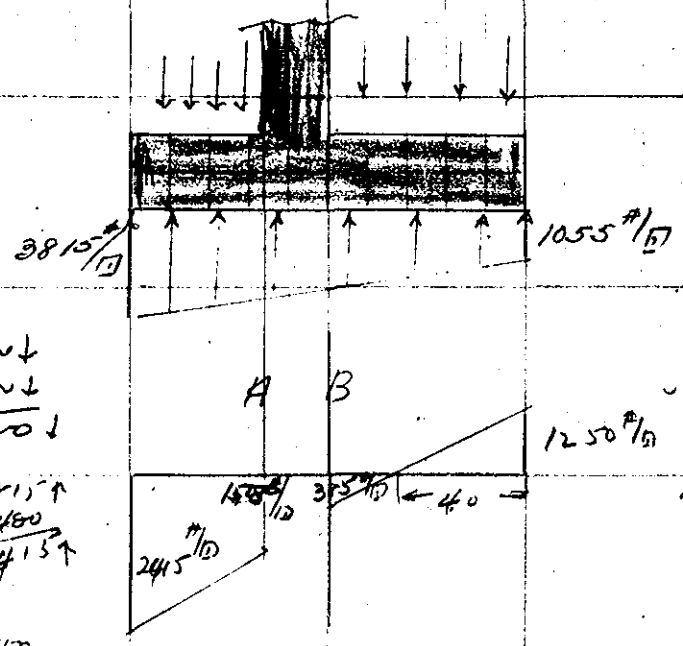
Case I

$$f = \frac{24,350}{10} \pm \frac{(24350)(0.95)(5)}{(\frac{1}{12})(10)^3}$$

$f = 2435 \pm 1380$

$f_{c_1} = 3815$ #/□'

$f_{c_2} = 1055$ #/□'



1400 ↓
300 ↓
1700 ↓

3815 ↑
− 1400
2415 ↑

1850
1055
2905 ↑
1400
1505 ↑

1800 ↓
207 ↓
300 ↓
2307 ↓
1055 ↑
1252 ↓

1800
300
2100

1055
1430
2485 ↑
210
385 ↑

Case II

$$f = \frac{26,900}{10} \pm \frac{(26,900)(0.3)(5)}{(\frac{1}{12})(10)^3}$$

$f = 2690 \pm 485$

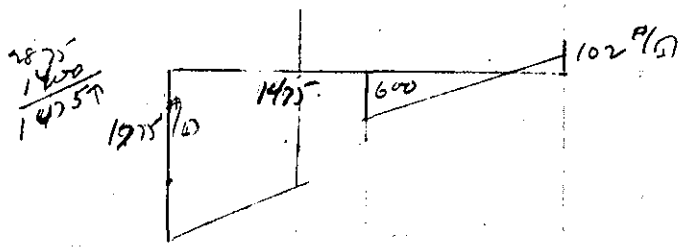
$f_{c_1} = 3175$

$f_{c_2} = 2205$ #/□'

3175 ↑
1400
1775 ↑

2307 ↓
2205 ↑
102 ↓

2700 ↑
2100 ↓
600 ↑



2875
1400
1475 ↑

FINAL DESIGN
Footing Design

Type VI

Section "A"

$(1505)\,3.33 = 5000 \times 1.67 = 8400^{\#}$

$\frac{(910)}{2}\,3.33 = 1610 \times 2.2 = 3360^{\#}$

$6610 \qquad 11{,}760^{\#}$

$V = \frac{6610}{(12)(0.875)(20.5)} = 31\ \#/\square''$

$R = \frac{(11{,}760)}{(20.5)^2} = 28$

$A_{s\,bottom} = \frac{(11760)(12)}{(18000)(0.94)(20.5)} = .41\ \square''$ $\quad 3/8^{\#}$ $= 1.47$ $(0.6\ 2.8)$

$\tau_0 = \frac{6610}{(12.5)(0.94)(20.5)} = 2.75''$

Section B

$(1250)\,\frac{4}{2} = 2500^{\#}$ Max Lean

Max M $= 2500(3.84) = 9600$
$- (225)(0.39) = 90$
$9510^{\#}$

$A_{s\,top} = \frac{(9510)(12)}{(18000)(0.95)(20.5)} = 0.326\ \square$

$\tau_0 = \frac{2275}{(12.5)(0.95)(20.5)} = 0.93''$

$3/4^{\#}$ $1/2$ c/c
$(0.44\ 1.4)$

Stem

$P_1 = \frac{(35)(18)^2}{2} = 5850^{\#}$

$P_{H_1} = \frac{(5850)(2.5)}{2.69} = 5300^{\#} \times 6 = 31{,}600$

$P_2 = \frac{(35)(11.0)^2}{2} = 2120^{\#}$

$P_{H_2} = (2120)\,\frac{5}{5.1} = 2060^{\#} \times 3.7 = 7800$
$23{,}800$

Shear $= 5300$
$- 2060$
$3240^{\#}$

$R = \frac{23{,}800}{(14.5)^2} = 113$

$A_s = \frac{(23800)(12)}{(18000)(0.88)(14.5)} = 1.24\ \square$ — $1^{\#}$ 6" c/c $(1.58\ 6.3)$

$\tau_0 = \frac{3240}{(12.5)(0.88)(14.5)} = 2.03''$

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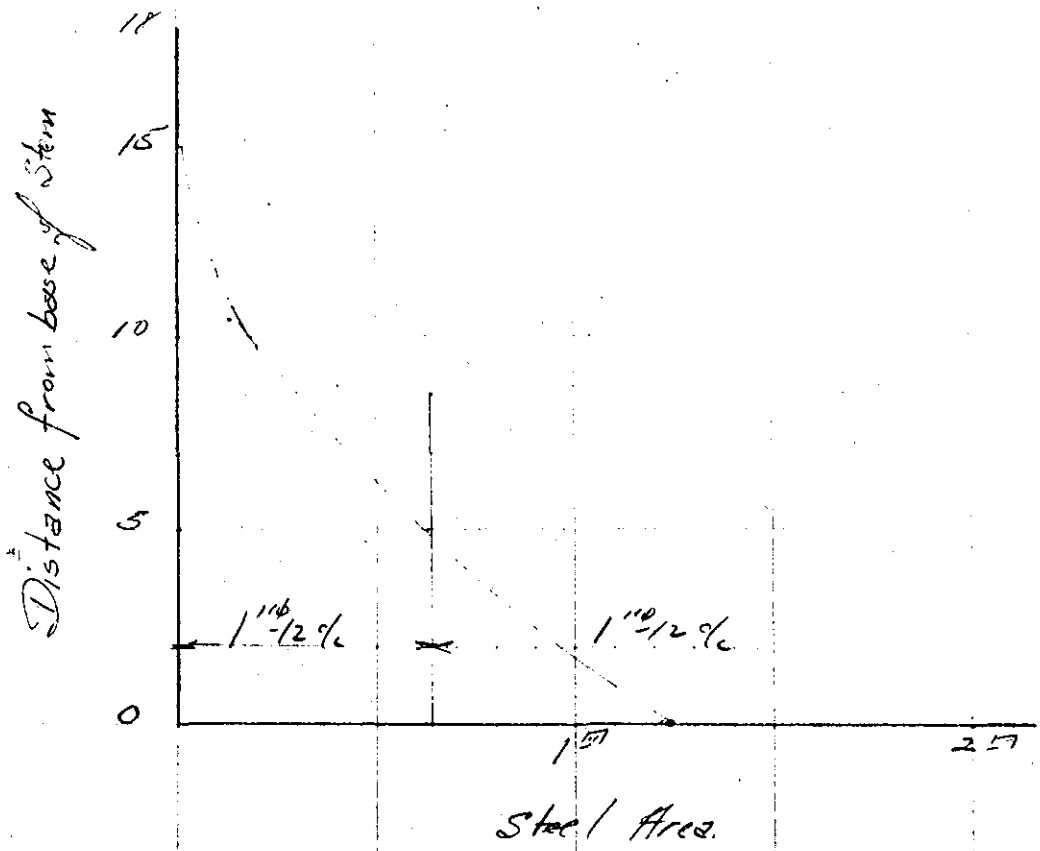
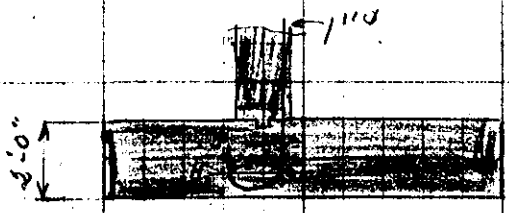
FINAL DESIGN

Type VI





$JH = 4d = 4''$

$f_H = \frac{(4)(4)(125)}{1} = 2000\#/\square''$

$HG = \frac{9\pi}{2} = 14.1''$ $\quad f_G = 2000 + \frac{(14.1)(4)(125)}{1} = 9050\#/\square''$

$f(\text{at joint}) = 9050 + \frac{(14.5)(4)(125)}{1} = 17300\#$ O.K. $\quad$ $m(\text{about}) = 130\#/\square''$

Compressive Stress in Concrete $= \frac{(2\pi)(9050)\left(\frac{130}{125}\right)}{(4)\,1} = f_c = 1830\#/\square''$ OK

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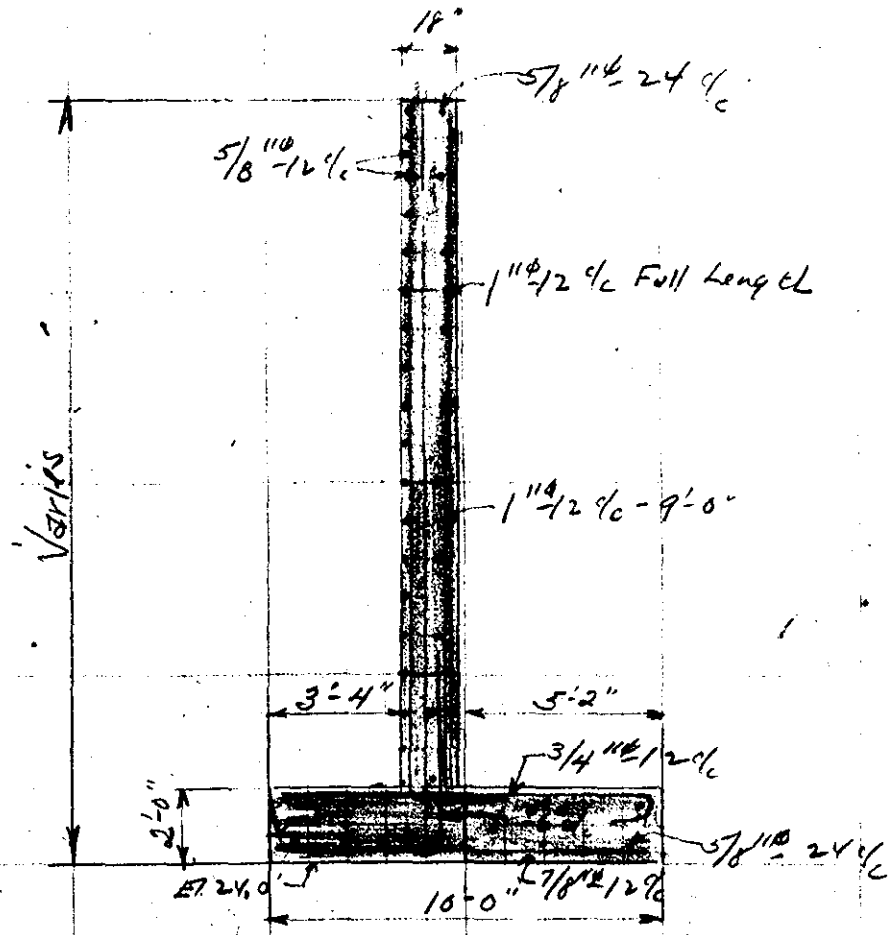
Type VI FINAL DESIGN



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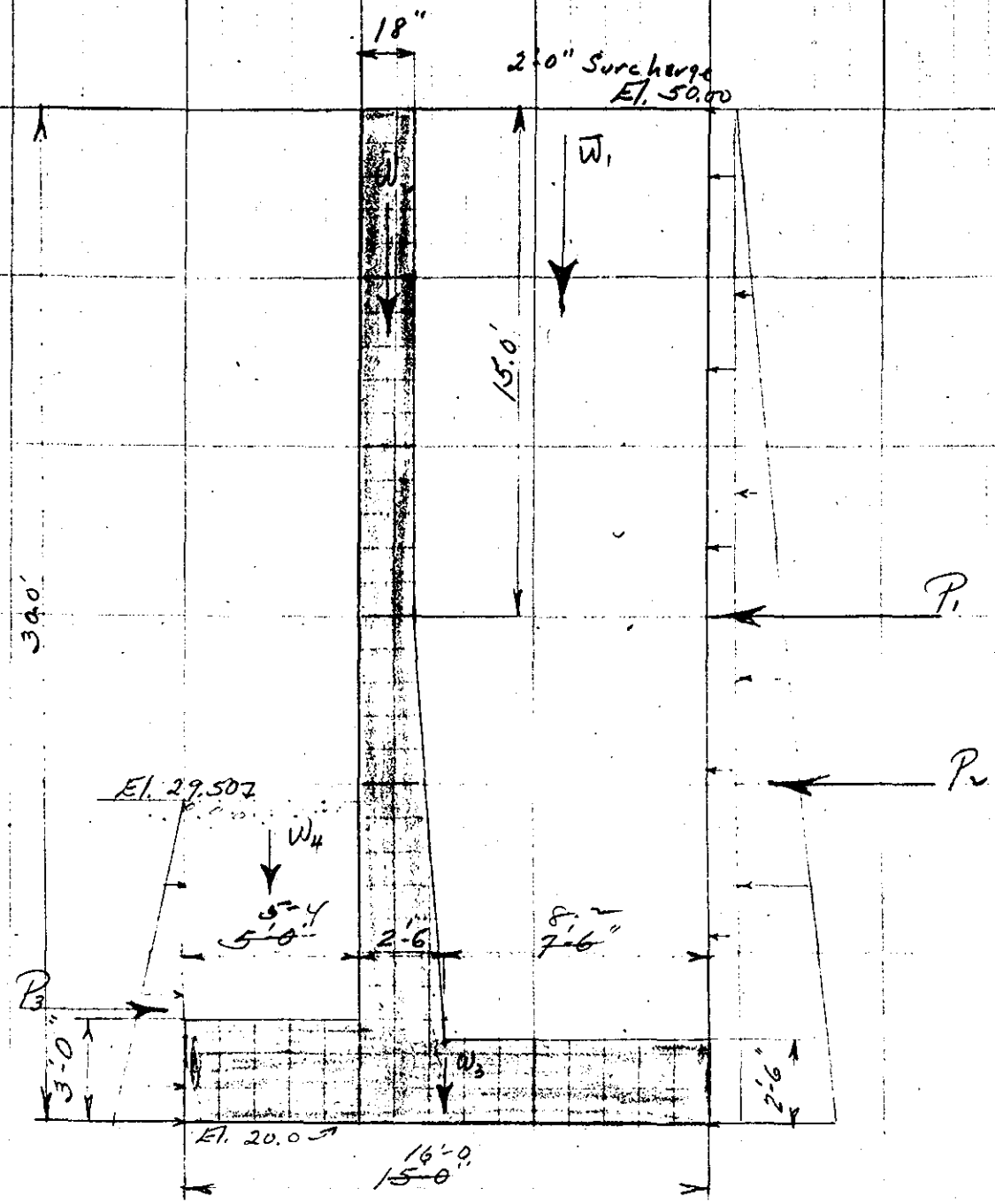
Type "IV"

Elev. of Rock = 20.0 (Elev. of bottom of footing)



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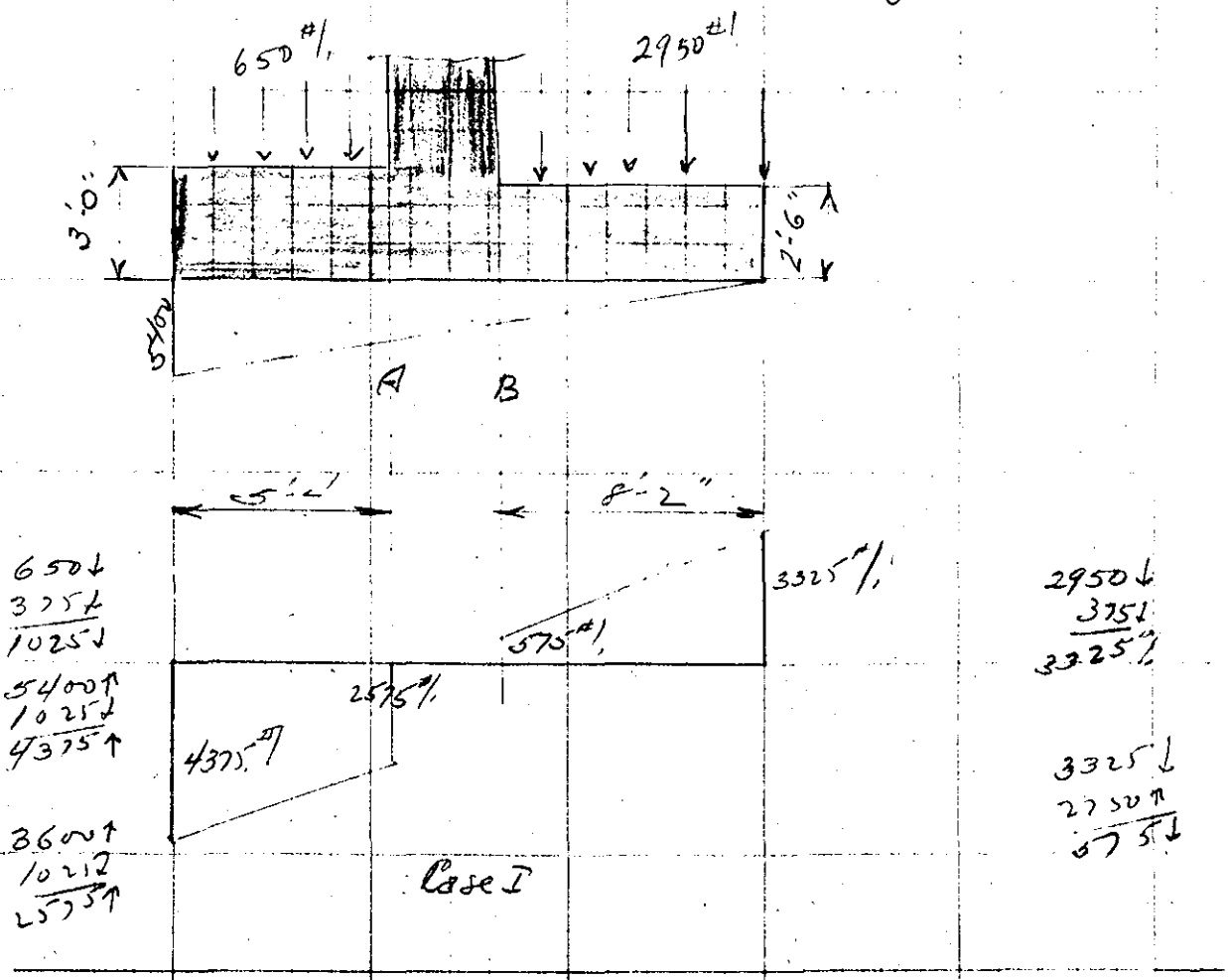
FINAL DESIGN

Type IV



FINAL DESIGN

Case II (Channel Full) Type IV

		Force	Arm	Moment	Moment
P_1 = (See Sheet 43)		2100	15	31,500	
P_2 = " " "		15700	10	157,000	
$P_{3_1} = \frac{(62.5)(12.50)^2}{2} =$	4900		13.67		67000
$P_{3_2} = \frac{(80)(9.5)^2}{2} =$	3600		3.17		11400
W_1 = (See Sheet 43)		27310			312,200
W_2 = " " "		6068			36800
W_3 = " " "		6570			50150
$W_4 = (62.5)(12.5)(5.33)$		4150	2.67		11100
$W_4 = (130)(6.25)(5.33)$		4300	2.67		11500
		48398		188,500	500150
					-188500
					311650

Position of Resultant Press = $\frac{311,650}{48,398} = 6.45'$

$$f = \frac{48398}{16} \pm \frac{(48398)(1.55)(8)}{\left(\frac{1}{12}\right)(16)^3}$$

$f = 3050 \pm 1770$

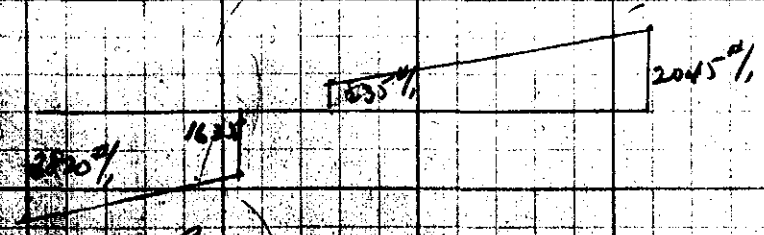
$f_1 = 4820$ #/□'

$f_2 = 1280$ #/□'

7807
8607
3751
2005↓

4825↑
2005↓
2820↑

2640
2005↓
[illegible]



Case II

Point (Sheet 44)
[illegible] Conduit

2950
375
3325↓
-1280
2045↓

3325↓
-3090↑
235↓

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Final Design

Footing

Type IV

Section "A"

$(2575)5.33 = 13700 \times 2.67 = 36600$

$\frac{(1800)}{2}5.33 = \frac{4800}{18500} \times 3.55 = \frac{17000}{53600}$

$d_s = \frac{18500}{(12)(0.875)(50)} = 35.4''$
$+3.5$
$38.9''$ say $3'-3''$

$R = \frac{53600}{(35.5)^2} = 42$

$A_{s\,bottom} = \frac{(53600)(12)}{(18000)(0.927)(35.5)} = 1.09^{\square''}$ — $1''\square$ 11 c/c $\left(\begin{matrix}1.09\\4.4\end{matrix}\right)$

$\Sigma_o = \frac{18500}{(125)(0.927)(35.5)} = 4.5''$

Section B

$(575)(8.17) = 4700 \times 4.08 = 19200$

$\left(\frac{2750}{2}\right)8.17 = \frac{11250}{15950} \times 5.45 = \frac{66500}{85700}$

$d_s = \frac{15950}{(12)(0.875)(50)} = 30.4$
$+3.5$
33.9 say $2'-10''$

$R = \frac{85700}{(30.5)^2} = 92$

$A_{s\,tot} = \frac{(85700)(12)}{(18000)(.895)(30.5)} = 2.09^{\square''}$ — $1''\square$ $-5\frac{1}{2}$ c/c $\left(\begin{matrix}2.18\\8.7\end{matrix}\right)$

$\Sigma_o = \frac{15950}{(125)(0.895)(30.5)} = 4.7''$

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FINAL DESIGN Type IV

Stem

$P_1 = (35)(2)(28.75) = 2010 \times 13.38 = 26,800$

$P_2 = \frac{(35)(26.75)^2}{2} = 12500 \times 8.92 = 111,000$

$14510 \qquad 137,800$

$P_3 = \frac{(35)(6.25)^2}{2} = -688 \times 2.08 = -1430$

$13,830 \qquad 136,370$

$d_s = \frac{13,830}{(12)(0.875)(50)} = 26.5''$

$d_m = \sqrt{\frac{136,370}{1427}} = 30.4 + 3.5 = 33.9$ Say 2'-10"

$A_s = \frac{(136,370)(12)}{(18000)(0.875)(30.5)} = 3.42 \square'' \quad -1\frac{1}{4}'' \square - 5\frac{1}{2}\ c/c \left(\frac{3.40}{10.9}\right)$

$I_0 = \frac{13,830}{(125)(0.875)(35.5)} = 4.15''$

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Pile Wall at Inlet

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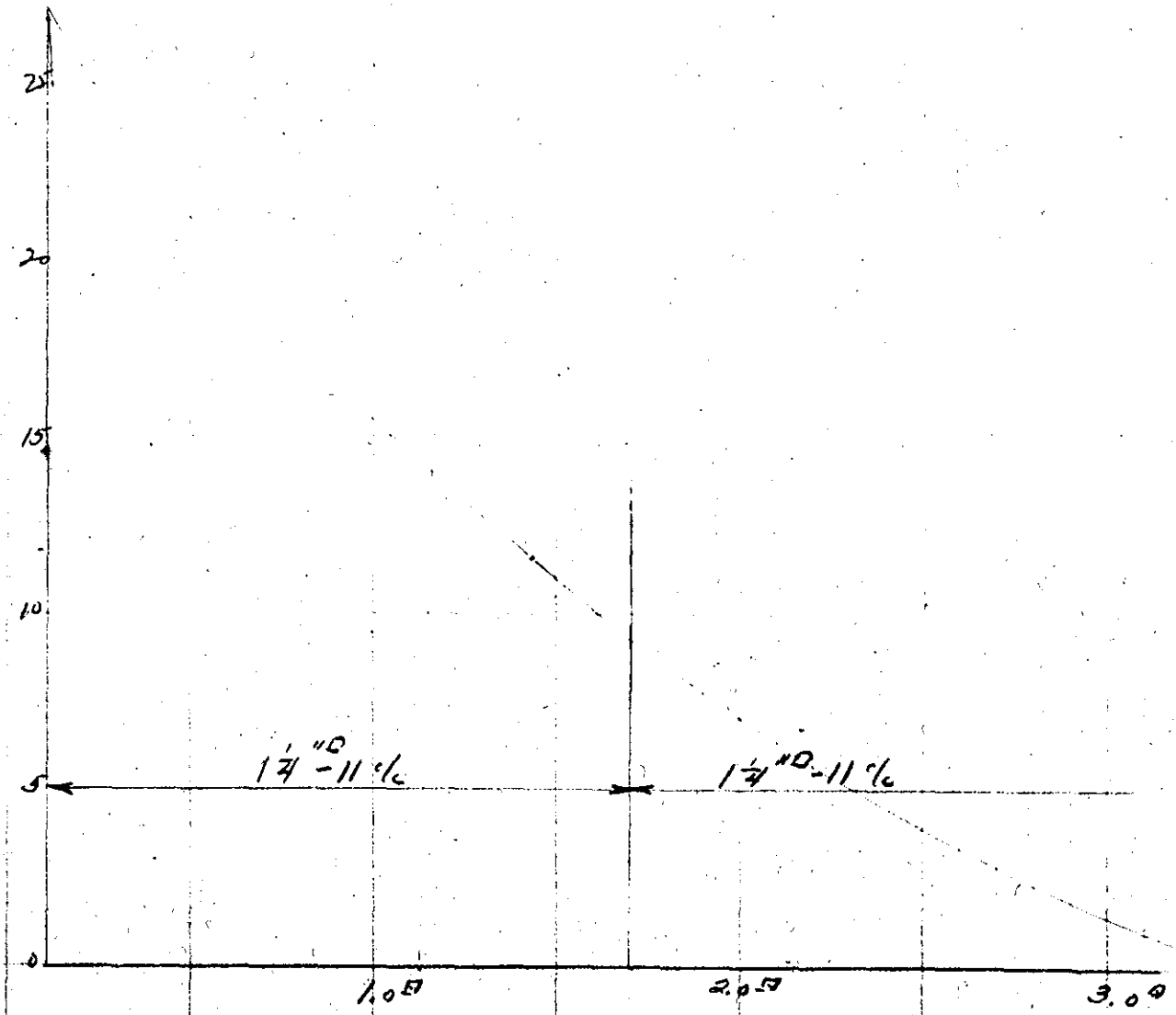

Area of Steel

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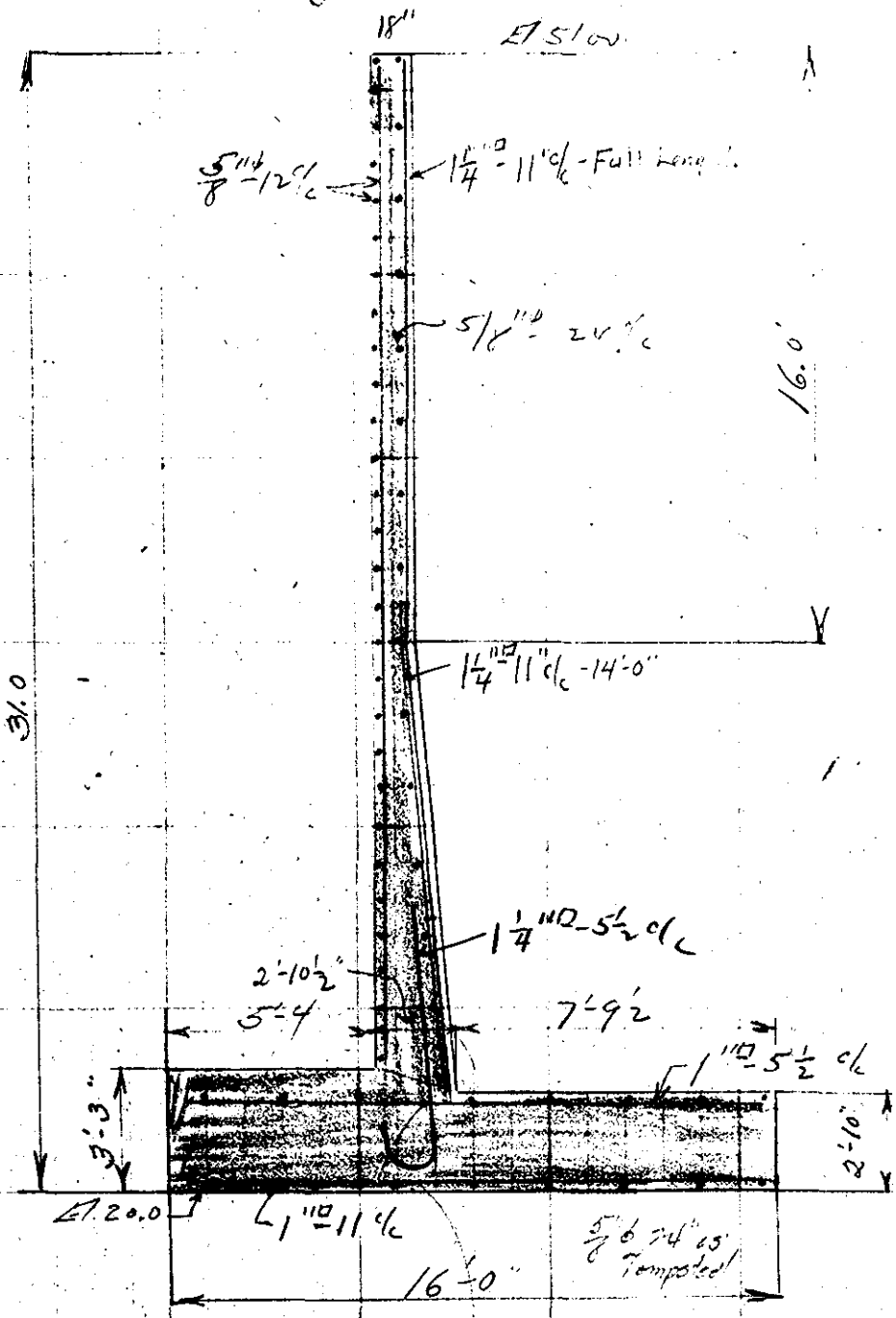
4/3/4
A B D

FINAL DESIGN

1-8-88

Type IV



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FINAL DESIGN

Design of wall and counterforts on inlet section.

El. of Invert = 15.25' ∴ 15.25
+ 19.50
3.08
37.83 El. of Top of Slab

El. Top of Wall = 51.00
− 37.83
13.17

2'-0" (Surcharge)

$w_{max} = (35)(15.17) = 530$ #/' $M_d = (530)\left(\frac{30}{8}\right)^2 = 59{,}500$ '#

$d = \sqrt{\frac{59{,}500}{147.7}} = 20''$
+ 3.5
23.5'

Use 24" Section Case I

Shear $= \left(\frac{5}{8}\right)(530)(30) = 10{,}000$ #

$v = \frac{10{,}000}{(12)(0.875)(20.5)} = 46$ #/□"

$A_{s\,negative} = \frac{(59{,}500)(12)}{(18000)(0.875)(20.5)} = 2.21$ □" − 1 ''□ − 5"c/c (2.40 / 9.6)

$\Sigma o = \frac{10{,}000}{(125)(0.875)(20.5)} = 4.5''$

$M_{positive} = (.07)(530)(30)^2 = 33{,}400$ '#

$A_{s\,positive} = \frac{(33{,}400)(12)}{(18000)(0.875)(20.5)} = 1.24$ □" − 1 ''□ − 10"c/c (1.20 / 4.8)

Case II − El. Top of Water = 42.00
El. Top of Slab = 37.83
4.17'

w(Water) = (62.5)(4.17) = 250 #/□" →
Due to Earth = 530 #/□" ←
280 #/□" ←

Final Design — Design of Headwall & Counterforts

Distance 7'-0" from Top

$w = (35)(7) = 245\#/\square'$

$M_{\mathbb{C}} = \frac{(245)(30)^2}{8} = 27{,}500''\#$

$A_{s\,negative} = \frac{(27{,}500)(12)}{(18000)(0.875)(20.5)} = 1.02\square'' \quad -1''\square - 12\ c/c$

$I_0 = \frac{4650}{(125)(0.875)(20.5)} = 2.1''$

$A_{s\,positive} = \frac{(1.24)(245)}{530} = 0.57\square'' \quad -1''\square - 24\ c/c$

$M_{cantilever} = (2)(35)(13.17) = 920. \quad \times 6.58 = 6050$

$\frac{(35)(13.17)^2}{2} = 3000 \quad \times 4.4 = 13300$

$3920'' \qquad 19350''\#$

$A_s = \frac{(19{,}350)(12)}{(18000)(0.875)(20.5)} = 0.72 \quad -1''\square - 12\ c/c \ (0.79)$ 3.1

$I_0 = \frac{3920}{(125)(0.875)(20.5)} = 1.75''$

$A_{s\,corner} = \left[\frac{(530)(30)^2}{12}\right]\frac{12}{(18000)(0.875)(14.5)} = 2.08\square'' \quad -1''\square - 6\ c/c$

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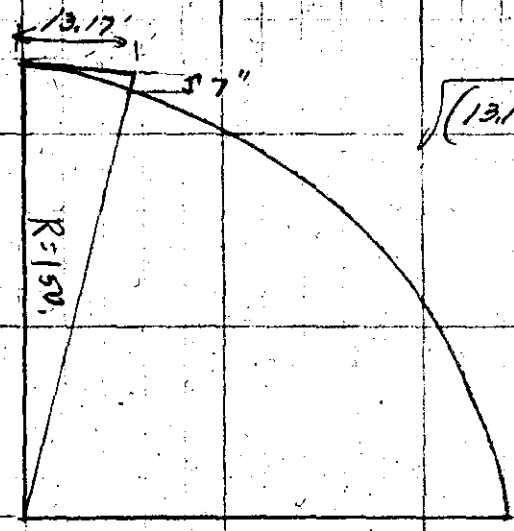
FINAL DESIGN

Design of Headwall & Counterforts



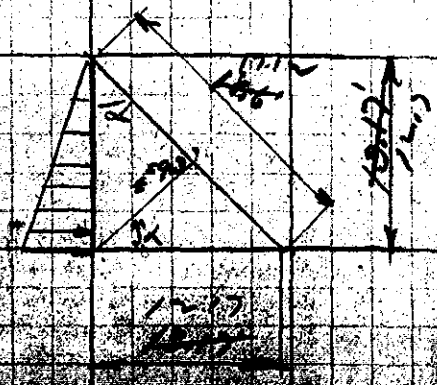
$\sqrt{(13.17)^2+(150)^2} = 150.57'$

∴ Make Width of Counterforts =

$$\begin{array}{r} 24 \\ +7 \\ +7 \\ \hline 38'' \end{array} = 3'\text{-}2''$$

Force on Counterforts $= \left(\frac{530}{2}\right)(13.17)64 = 223{,}000^{\#}$

$M = (223{,}000)\frac{(13.17)}{8} = 980{,}000^{\text{in}}$



$\cos\alpha = \frac{z}{13.17} = \frac{13.17}{14.6}$

$z = 9.3$

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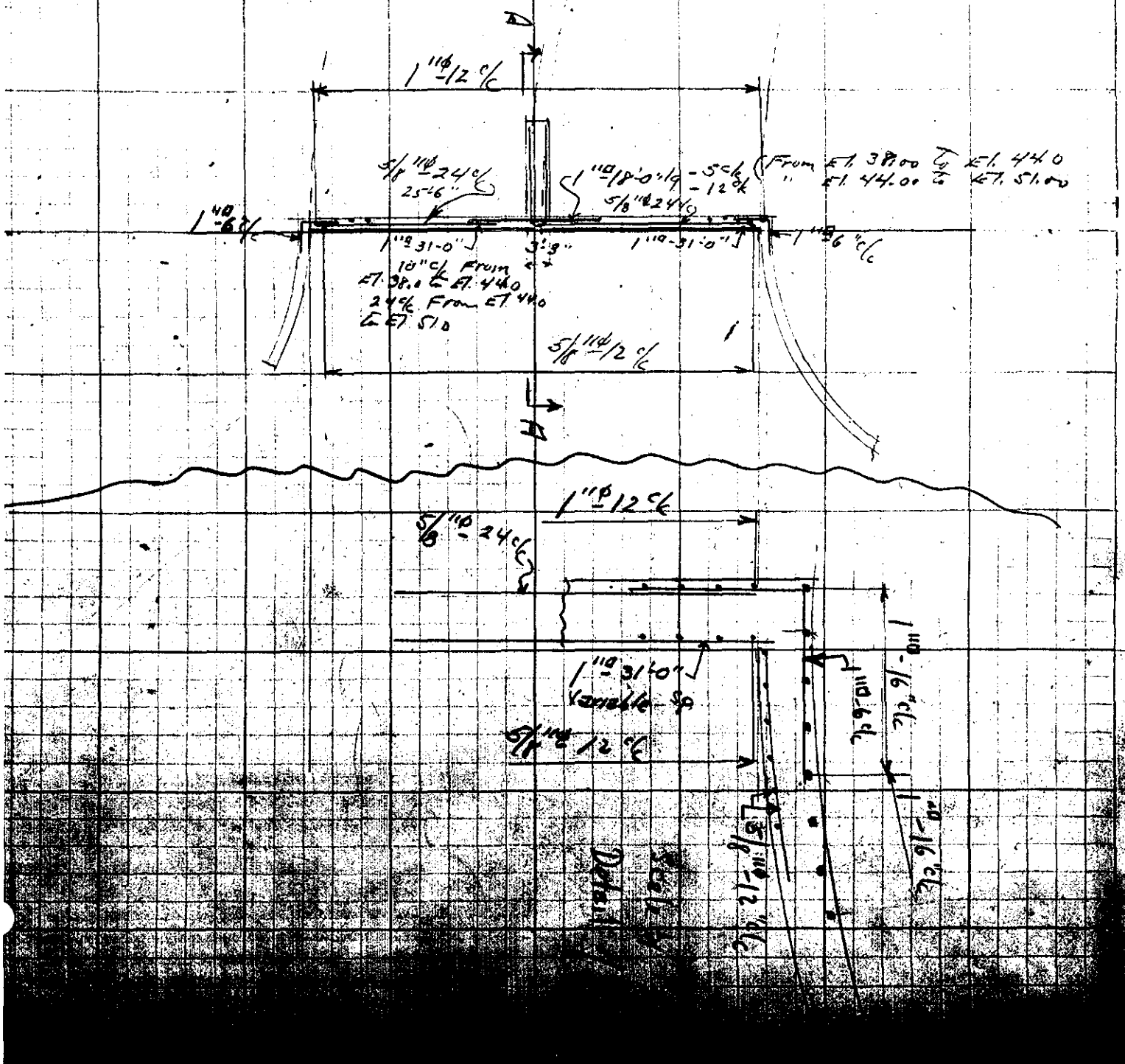
FINAL DESIGN
Design of Headwall + Counterforts



SURCHARGE $2 \times 35 = 70^{\#}$
$35 \times 13.17 = 461^{\#}$
$531^{\#}/\square'$

w_1 = HOR. LOAD
w_2 = VER. LOAD

EQUAL DEF. @ ℄ $\frac{30^4 w_1}{384} = \frac{13^5 w_2}{30}$

$2110\, w_1 = 12400\, w_2$

$w_1 = 5.87\, w_2$

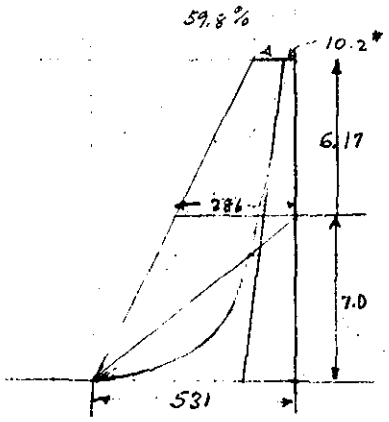
$w_1 + w_2 = W$

$5.87 w_2 + w_2 = W$

$w_2 = \frac{W}{6.87}$

$w_1 + \frac{1}{5.87} w_1 = W$

$w_1 = \frac{5.87}{6.87} W$



$w_2 = 14.55\%$
$w_1 = 85.45\%$

$14.55 \times 70 = 10.2$
$85.45 \times 70 = 59.8$

$14.55 \times 531 = 77^{\#}$
$85.45 \times 531 = 454$

HOR. REIN. $70 + \overset{216}{6.17 \times 35} = 286^{\#}$

$-M = 286 \times \frac{30^2}{8} = 32{,}200^{'\#}$

$-A_s = \frac{32{,}200 \times 12}{.88 \times 20.5 \times 18{,}000} = 1.19$ $\quad$ 1"□ 9.9" o.c. $\quad$ USE 1"□ 10" o.c.

$+M = 32{,}200 \times .8 = 25{,}800$

$+A_s = .95\ \square''$ $\quad$ 1"φ 10" o.c.

VERTICAL REIN

$M = 531 \times \frac{7^2}{6} = 4{,}340$ $\quad$ SAY $6{,}000^{'\#}$

$A_s = \frac{6{,}000 \times 12}{.88 \times 20.5 \times 18{,}000} = .222\ \square''$ $\quad$ 3/4"φ 24" o.c.

$M = 531 \times \frac{13.17^2}{6} = 15{,}300^{'\#}$

AVERAGE $= 19{,}640 \times 1/2 = 9{,}870$ $\quad$ APPROX SAFE $M = 10{,}000^{'\#}$

$A_s = \frac{10{,}000 \times 12}{.88 \times 20.5 \times 18{,}000} = .370\ \square''$ $\quad$ 3/4"φ 1'-2"

USE 3/4"φ 1'-0" o.c.

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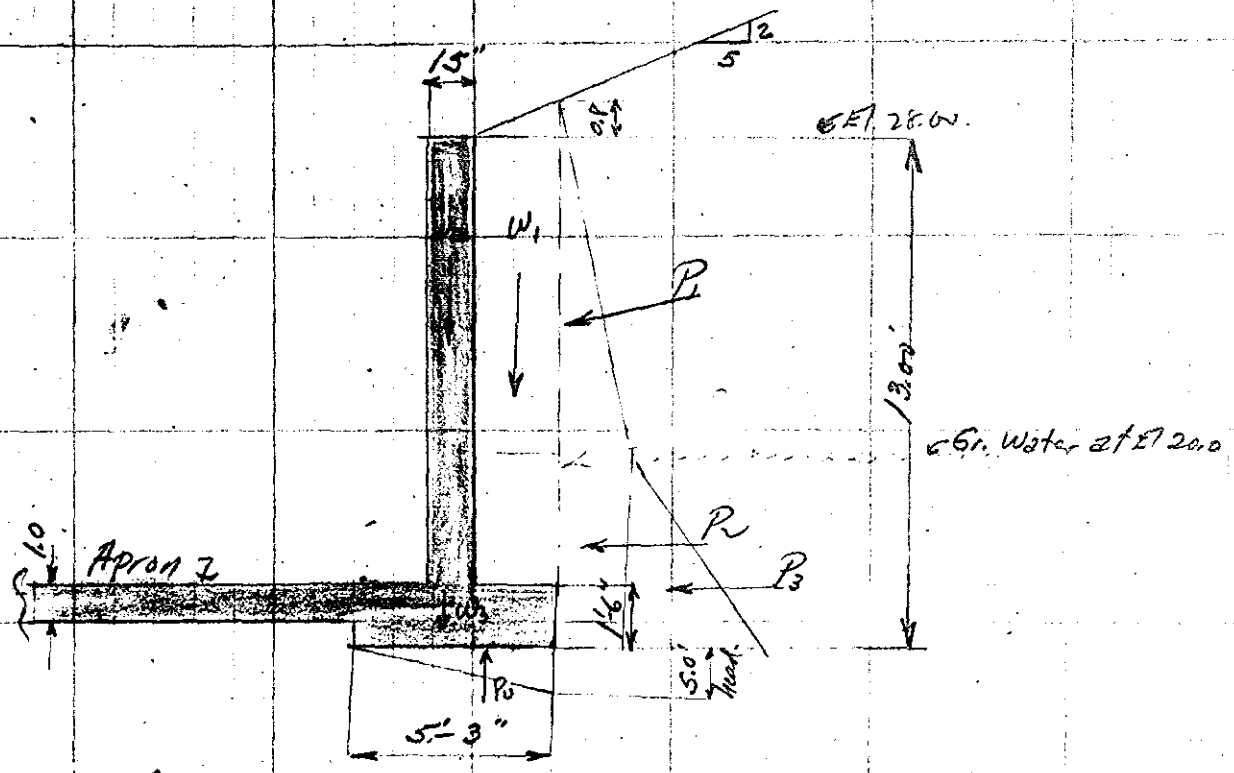
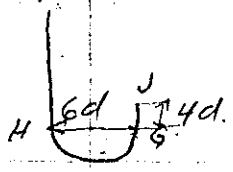
FINAL DESIGN River Wall

Footing for Wall on Apron.

Elev. of bottom of Apron at Section of Design = 15.50
Elev. of Top of Wall = 28.00



Depth of Footing to depend upon req'd length to develop 5/8" at 125 #/□" bond stress



$4d = (4)(5/8) = 2.5"$

$f_G = \frac{(4)(125)(2.5)}{0.625} = 2000$ #/□"

$GH = \frac{7\pi}{2}(5/8) = 6.85"$

$f_H = 2000 + \frac{(4)(125)(6.85)}{0.625} = 7500$ #/□"

f_c (in concrete) $= \frac{(0.31)\,7500}{(3)(0.625)^2} = 1980$ #/□"

$10500 = \frac{(4)(125)(L)}{0.625}$

$\frac{(10,500)(0.625)}{500} = L = 13.1"$

∴ Depth of footing = 13.1
3d = 1.88
Cover 3 = 3.0
17.98

make depth = 18"

FINAL DESIGN — River Wall

Footing for Wall on Apron

		Force	Arm	↺ Moment	Moment ↻
$P_1 = \frac{(35)(8.8)}{2} = 1350$					
$P_{H_1} = (1350)\frac{2.5}{27} =$	1250#		7.93	9900	
$P_{V_1} = (1350)(\frac{1}{27}) =$		500.#	5.25		2625
$P_2 = (35)(8.8)(5) =$	1540		2.5	3850	
$P_3 = (80)\frac{(5)^2}{2} =$	1000		1.67	1670	
$P_U = (62.5)\frac{(5)}{2}(5.25) = 820$			3.5	2870	
$W_1 = (11.9)(2)(100) =$		2380	4.25		10,100
$W_2 = (1.25)(11.5)(150) =$		2160	2.62		5650
$W_3 = (1.5)(5.25)(150) =$		1180	2.62		3100
		6220		18290	21475
		− 500			−18,290
		5440			3185

Footing made 7'-0" Wide

		Force	Arm	↺ Moment	Moment ↻
$P_{H_1} =$	1250		7.93	9900	
$P_{V_1} =$		500	7.0		3500
$P_2 =$	1540		2.5	3850	
$P_3 =$	1000		1.67	1670	
$P_U = (62.5)\frac{(5)}{2}(7) = 1090$			4.67	5700	
$W_1 \begin{cases} (6.4)(3.0)(100) = \\ (3.5)(3.0)(150) = \end{cases}$		2520 1320	5.5 5.5		13900 7350
$W_2 =$		2160	3.37		7250
$W_3 = (1.5)(7)(150) =$		1575	3.5		5500
		8130		20520	37700
		− 1090			−20520
		7040			17180

Position of Resultant Force = $\frac{17180}{7040} = 2.44$

$f = \frac{7040}{7} \pm \frac{(7040)(4.06)3.5}{(\frac{1}{12})(7)^3}$

$f = 1006 \pm 915$

$f = 1920$ #/□

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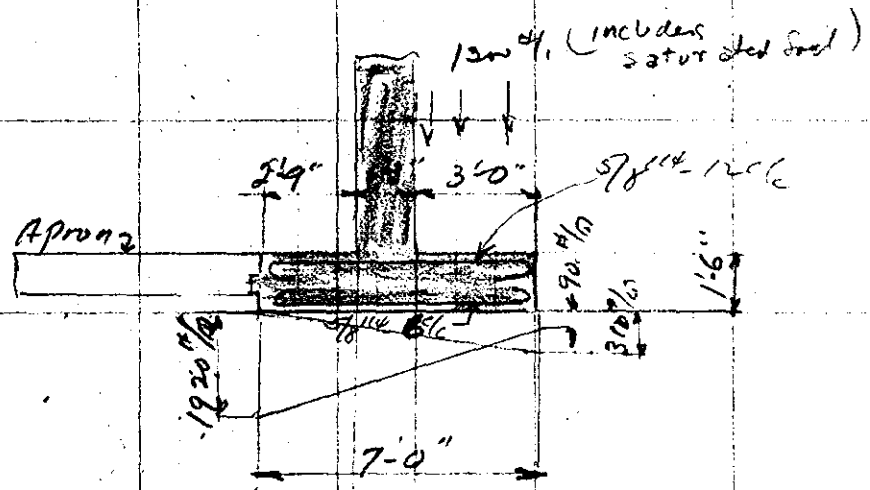
FINAL DESIGN

River Wall

Footing for wall on apron

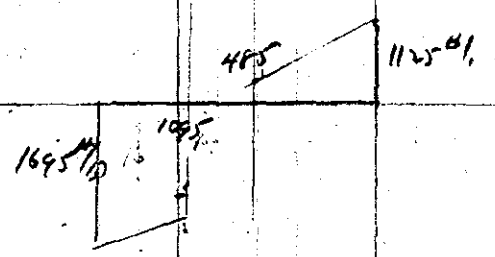


1300 ↓
225 ↓
1525 ↓
400 ↑
1125 ↓

A B

1525 ↓

1920 ↑
225 ↓
1695 ↑



90 ↑
380 ↑
175
1045 ↑

1525 ↓
1045 ↑
480 ↓

120 ↑
90 ↑
1110
1320 ↑
225 ↓
1095 ↓

Sec. A

(1095)(2.75) = 3000 × 1.37 = 4100
(600/2)(2.75) = 825 × 1.83 = 1560
3825 # 5610

Sec. B

(485)(3) = 1455 × 1.5 = 2180
(640/2)3 = 960 × 2.0 = 1920
2415 # 4100

$v = \frac{3825}{(12)(0.875)(14.5)} = 25$ $R = \frac{5610}{(14.5)^2} = 27$

$As_{bottom} = \frac{(5610)(12)}{(18000)(0.95)(14.5)} = .272$

5/8" ⌀ - 12 c/c (0.31 sq. in.)

$u = \frac{(3825)}{(2)(0.95)(14.5)} = 139$

$As_{Tot} = \frac{(4100)(12)}{(18000)(0.95)(14.5)} = .198$

5/8" ⌀ - 12 c/c (As = 0.31 sq. in.)

$u = \frac{(2415)}{(2)(0.95)(14.5)} = 88$ #/□'

Form 115 10M-11-39

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PROJECT U.S. Engineers - Hartford
SUBJECT Park River Pressure Conduit
DETAIL Dike Wall at Inlet

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FINAL DESIGN River Wall

Stem of wall that rests on apron.

$P_1 = \frac{(35)(8)^2}{2} = 1120^{\#}$

$P_{H1} = (1120)\left(\frac{2.5}{2.7}\right) = 1040^{\#} \times 6.17 = 6400$

$P_2 = (35)(8)(3.5) = 980 \times 1.75 = 1710$

$P_3 = \frac{(80)(3.5)^2}{2} = \frac{490}{2510} \times 1.2 = \frac{590}{8700}$

$V = \frac{2510}{(12)(0.875)(11.5)} = 25$

$R = \frac{8700}{(11.5)^2} = 66$

$A_s = \frac{(8700)(12)}{(18000)(0.91)(11.5)} = .55$

$\frac{5/8^{\text{ins}} - 6'' \text{ c/c}}{\text{Earth Side}} \quad \frac{(0.62)}{3.9}$

$u = \frac{2510}{(3.9)(0.91)(11.5)} = 61^{\#}/\square'$

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River Wall

Case II

Assuming worse Case Water on one side up to El. 28 (condition as water is rising; assuming no increase of Ground water level.)

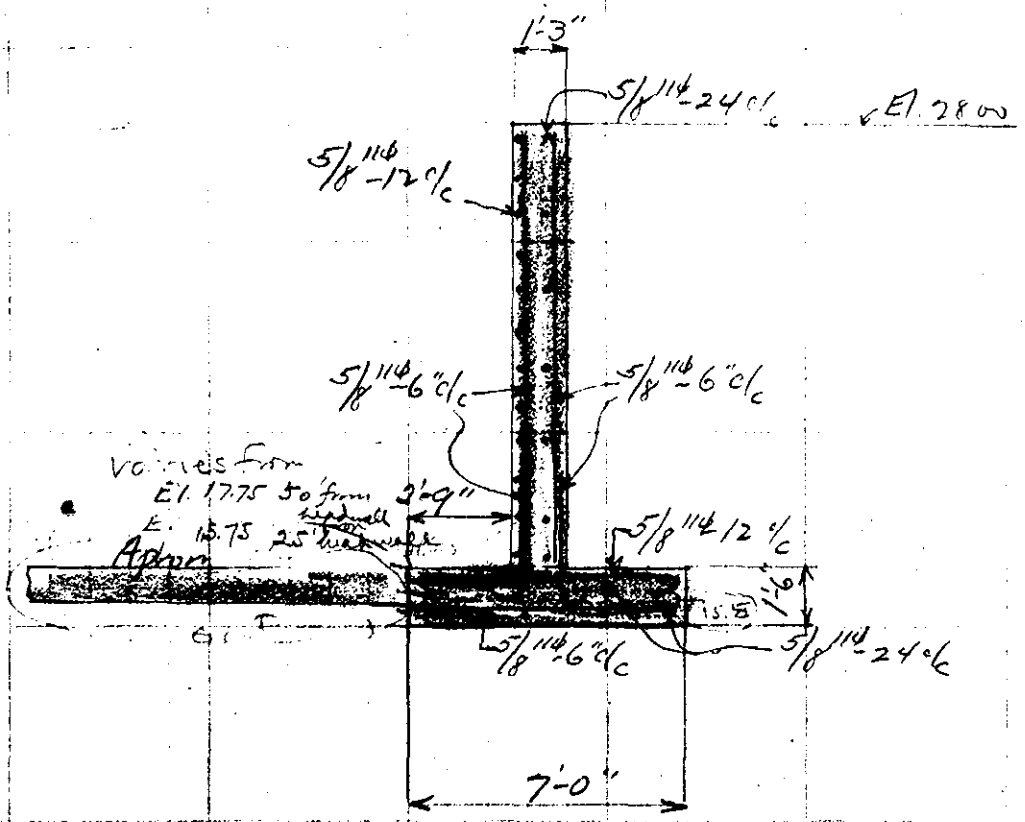
$P_w = \frac{62.5(11.5)^2}{2} = 4150^{\#}$

$M = (4150)\frac{(11.5)}{3} = 15,700^{\#}$

Case I $M = \frac{8700}{7200^{\#}}$

5/8" ϕ - 6" c/c o.c. channel side.

FINAL DESIGN. River Wall

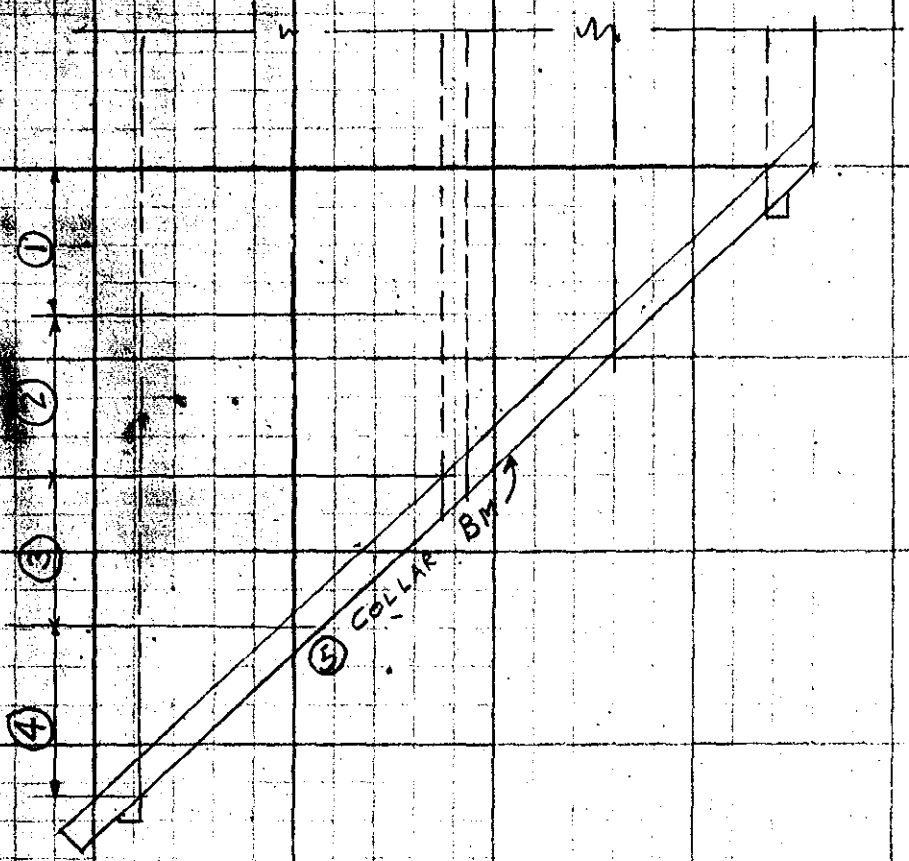


CONDUIT OUTLET

U.S. ENGINEERS - HARTFORD
PARK RIVER - PRESSURE CONDUIT
OUTLET

PAGE K1
DATE APRIL 1940
COMPUTED BY S.W.O.

CORRELATION MARKS NOTED THUS ①



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SUBJECT PARK RIVER - PRESSURE CONDUIT
DETAIL OUTLET.

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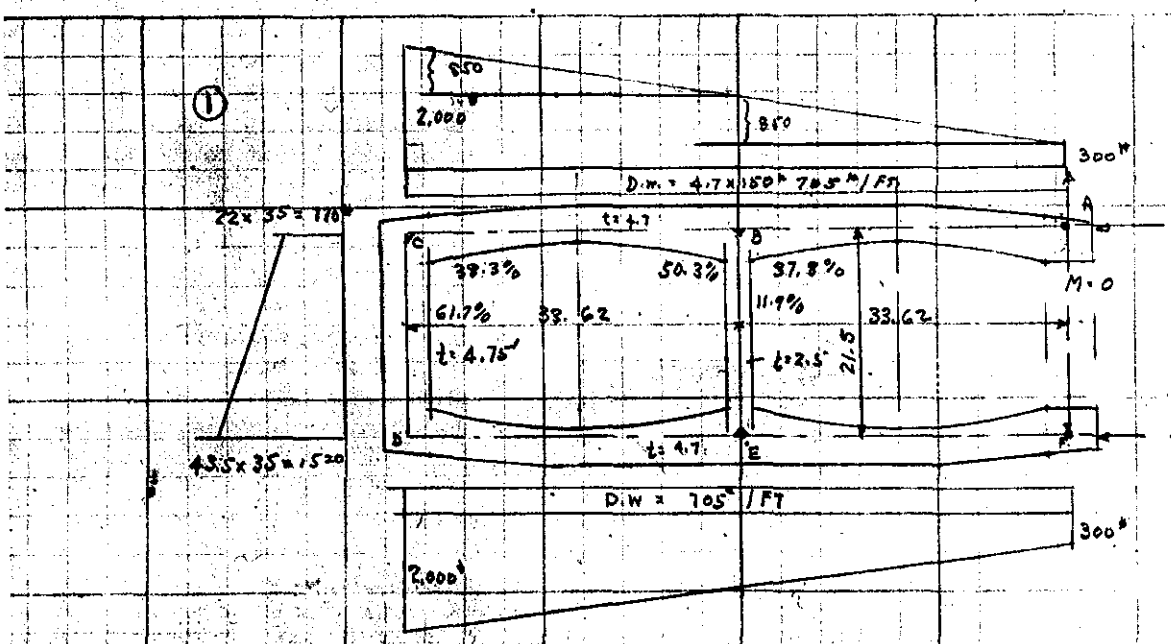

15.5 + 4.75 = 20.25
19.5 + 3.67 = 23.17
15.5 + 5.67 = 21.17
64.59
Av. = 21.53
Av. $t = \frac{14.09}{3} = 4.70$ FT.

F. E. M. in ft. Kips.

AB @ A $1.005 \frac{33.62^2}{12} + \frac{1}{30} .850\ 33.62^2$
94.7 + 32.0 = 126.7

@ B $1.005 \frac{33.62^2}{12} + \frac{1}{20} .850\ 33.62^2$
94.7 + 48.0 = 142.7

BC @ B $1.855 \frac{33.62^2}{12} + \frac{1}{30} .850\ 33.62^2$
174.5 + 32.0 = 206.5

@ C 174.5 + 48.0 = 222.5

CD @ C $.770 \frac{21.5^2}{12} + \frac{1}{30} .750\ 21.5^2$
29.7 + 11.6 = 41.3

@ D 29.7 + $\frac{1}{20}$ .750 21.5^2
29.7 + 17.3 = 47.0

DE @ D 222.5
@ E 206.5

EF @ E 142.7
@ A 126.7

STIFFNESS

$\frac{1}{33.62} \times .75 = 42.8\%$
$\frac{1}{33.62} \times 1.0 = 57.2\%$

$\frac{4.7^3}{33.62} = 3.09$ 38.3%
$\frac{4.75^3}{21.5} = 4.98$ 61.7%
8.07

$.75 \frac{4.7^3}{33.62} = 2.32$ 37.8 %
$\frac{4.7^3}{33.62} = 3.09$ 50.3 %
$\frac{2.5^3}{21.5} = .73$ 11.9 %
6.14

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DETAIL Outlet

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(1)

+125.5	-0.4	D	+2.0	-216.9	+216.6	+1.5	D		
+125.9	-3.8	C	-3.2	-218.9	+215.1	0	C		
+129.7	-6.4	D	-7.5	-215.7	+215.1	-5.7	D		
+136.1	-6.2	C	+13.4	-208.2	+220.8	0	C		
+142.3	-26.8	D	-12.4	-221.6	+220.8	-9.3	D		
+169.1	+16.1	C	-34.8	-209.2	+230.1	+63.3	C		
+153.0	-69.5	D	+32.1	-174.4	+166.8	+24.1	D	+126.7	0
+222.5		F		-206.5	+142.7		F		-126.7
ΣM	Δ		Δ	ΣM	ΣM	Δ		Δ	ΣM

C 38.3% 50.3% B A

-125.5	-125.0	-129.7	-119.4	-142.3	-99.1	-153.3	-41.3	ΣM	
-0.5	+4.7	-10.3	+22.9	-43.2	+54.2	-112.0	-	Δ	
D	C	D	C	D	C	D	F		
+5.2	-5.2	+9.3	-21.6	+45.8	-56.0	+108.3		Δ	
+132.8	+127.6	+132.8	+123.5	+145.1	+99.3	+155.3	+47.0	ΣM	

61.7%

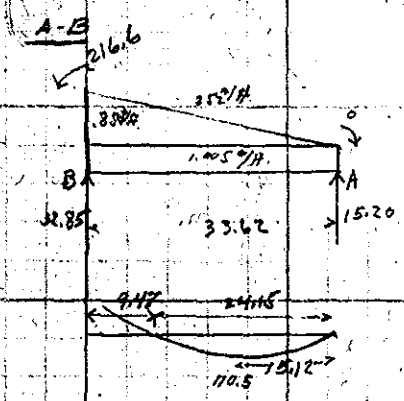
37.8% 11.9%

ΣM	0	+7.6	+3.8	+0.8	+2.4	+0.6	-0.2	+0.3	
Δ		+7.6	-3.8	-3.8	+1.6	-1.8	-0.8	+0.5	
	F	D	C	D	C	D	C	D	
Δ		-7.6	+3.8	+3.1	-1.5	-1.5	-0.9	-0.2	
ΣM	0	-7.6	-3.8	-0.7	-2.2	-3.7	-4.6	-4.8	

D 38.3% 50.3% E F

37.8% 11.9%

ΣM	Δ		Δ	ΣM	ΣM	Δ		Δ	ΣM
-222.5		F		+206.5	-142.7		F		+126.7
-157.3	+67.2	D	-32.1	+174.4	-166.8	-24.1	D	-126.7	0
-173.4	-16.1	C	+33.6	+208.0	-230.1	-63.3	C		
-145.0	+28.4	D	+13.0	+221.0	-220.3	+9.8	D		
-138.5	+6.5	C	+14.2	+235.2	-220.3	0	C		
-132.8	+5.7	D	-6.4	+228.8	-225.1	-4.8	D		
-136.0	-3.2	C	+2.9	+231.7	-225.1	0	C		
-132.8	+3.2	D	-1.0	+230.7	-225.9	-0.8	D		



$$W = \begin{cases} 1.005 \times 33.62 \times \frac{1}{2} = \\ .850 \times \frac{33.62^2}{2} \times \frac{1}{3} = \end{cases}$$

R_A		R_B
16.9		16.9
4.75	$\times \frac{2}{3} =$	9.5
21.65		26.4
- 6.45		+ 6.45
15.20		32.85

$$\text{Mom. diff} = \frac{216.6}{33.62}$$

$$x = \frac{15.20}{1.005} = 15.12 \qquad \frac{15.12}{33.62} \times .850 = 0.38$$

$$+M = +15.20 \times 15.12 - 1.005 \times \frac{15.12^2}{2} - \frac{.38 \times 15.12^2}{6} - 0$$

$$230.0 - 115.0 - 14.5 = 110.5$$

Pt. inflection.

$$15.20\,x - 1.005\frac{x^2}{2} - .0252\frac{x^3}{2 \times 3} = 0$$

$$x^2 + 119.5x - 3620 = 0$$

$$(x + 59.75)^2 = 3620 + 3570 = 7190$$

$$x = 83.9 - 59.75 = 24.15$$

(1) sh @ Pt of inflection $= 15.20 - 24.15 \times 1.005 - \frac{24.15}{33.65} \times .850 \times \frac{24.15}{2}$

$= 15.20 - 24.30 - 7.35 = -16.45$

@ B

$d = 5'8" - 3\frac{1}{2}" = 5'4\frac{1}{2}"$

$-A_s = \frac{216.6 \times 12}{.88 \times 64.5" \times 18000} = 2.54 \square"$ { 1" ⌀ – 4.7" oc. ; 1⅛ □ – 6" oc ; 1¼ □ – 7.4" oc.

Bond $\frac{32.85}{.88 \times 64.5 \times 125} = 4.63$ { 1" ⌀ – 10" oc. ; 1¼ □ – 13" oc. Use 1¼ □ – 7" oc outside

$+A_s = \frac{110.5 \times 12}{.88 \times 41.5 \times 18000} = 2.00$ { 1¼ □ – 9" oc ; 1⅛ ⌀ – 9½" oc.

Bond at Pt of Inflection

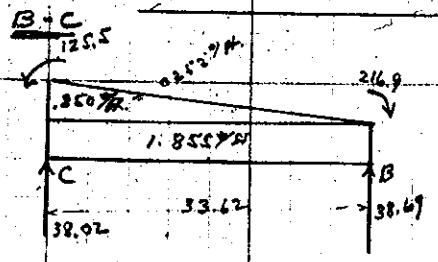
$d = 49 - 3.5 = 45.5$

$\frac{16,450}{.88 \times 45.5 \times 125} = 3.28$ { 1⅛ ⌀ – 16" oc ; 1¼ ⌀ – 18" oc. Use 1¼ □ – 9" oc inside

@ A.

Bond $\frac{15200}{.88 \times 61.5 \times 125} = 2.25$ 1¼ ⌀ – 26" oc inside

B-C

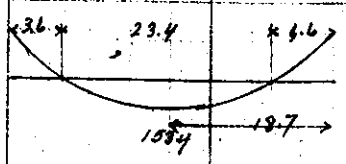


$W = 1.855 \times 33.62 \times \frac{1}{2}$

$.850 \times \frac{33.62}{2} \times \frac{1}{3}$

Mom. Diff $\frac{91.4}{33.62}$

R_b		R_c
31.2		31.2
4.77	× ⅔	9.54
35.97		40.74
2.72		2.72
38.69		38.02



x zero sh. $38.69 = 1.855x + .0252\frac{x^2}{2}$

$x^2 + 147x = 3070$

$(x + 73.5)^2 = 3070 + 5420 = 8490$

$x = 92.2 - 73.5 = 18.7$

$+M = 38.69 \times 18.7 - 1.855 \times \frac{18.7^2}{2} - \frac{18.7}{33.62} \times .850 \frac{18.7^2}{2 \times 3} - 216.9$

$724 - 325.0 - 28.7 - 216.9 = 153.4$

Pt. of inflection

$38.69x - \frac{1.855 \times x^2}{2} - .0252\frac{x^3}{6} - 216.9 = 0$

$x^3 + 220.5x^2 - 9210x = -51700$

try 6.0

$216 + 7940 - 55260 = -47104$ NG

try 6.5

$274 + 9300 - 59,900 = -50,326$ Use 6.6

try 28.5

$23,100 + 179,000 - 262,500 = -60,700$ NG

try 30.0

$27,000 + 198,500 - 276,300 = -50,800$ Use 30.0

(1) Sh at 6.6 #/pt.

$$38.69 - 6.6 \times 1.855 - \frac{.850 \times 6.6}{33.62} \times \frac{6.6}{2}$$

$$38.69 - 12.23 - 0.55 = 25.9$$

Sh. at 30.0 pt.

$$38.69 - 1.855 \times 30 - \frac{.850 \times 30}{33.62} \times \frac{30}{2}$$

$$38.69 - 55.65 - 11.4 = -28.4$$

at B

$$-A_s = \frac{216{,}900 \times 12}{.88 \times 64.5 \times 18000} = 2.56 \square'' \quad - 1\tfrac{1}{4}\square - 7''\text{ oc}$$

$$\text{Bond} \quad \frac{38{,}690}{.88 \times 64.5 \times 125} = 5.46 \square'' \quad 1\tfrac{1}{4}''\square - 11''\text{ oc}$$

use 1¼"-7" oc outside

at C

$$-A_s = \frac{125{,}500 \times 12}{.88 \times 61.5 \times 18{,}000} = 1.55 \square'' \quad \begin{cases} 1\tfrac{1}{4}\square - 12''\text{ oc} \\ 1\tfrac{1}{8}'' - 9.8''\text{ oc} \\ 1''\square - 7.7''\text{ oc} \end{cases}$$

$$\text{Bond} - \frac{38{,}020}{.88 \times 61.5 \times 125} = 5.63 \square'' \quad \begin{cases} 1\tfrac{1}{8}'' - 9.6''\text{ oc} \\ 1''\square - 8\tfrac{1}{2}''\text{ oc} \end{cases}$$

use 1¼"-10" oc outside

Center

d = 3'-9" - 3½" = 41.5"

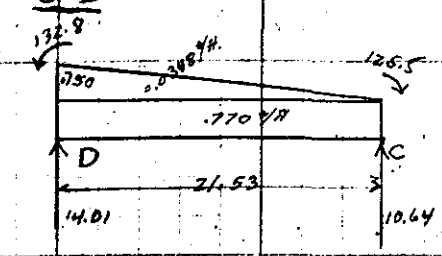
$$+A_s = \frac{153{,}400 \times 12}{.88 \times 41.5 \times 18000} = 2.80 \square'' \quad \begin{cases} 1\tfrac{1}{4}''\square\ 6.7''\text{ oc} \\ 1''\square\ 4.3''\text{ oc} \\ 1\tfrac{1}{8}\square - 5.4''\text{ oc} \end{cases}$$

$$\text{Bond Pt. infl} = \frac{28{,}400}{.88 \times 52.5 \times 125} = 4.92 \square'' \quad 1''\square - 9''\text{ ok}$$

d = 56 3.5 = 52.5

use 1⅛"□ 5" oc inside

C-D

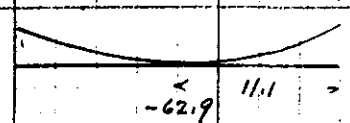


$$W = .770 \times 21.53 \times \tfrac{1}{2}$$

$$.750 \times \frac{21.53}{2} \times \tfrac{1}{3}$$

$$\text{Mom. diff} \quad \frac{7.3}{21.53}$$

Rc	Rd
8.29	8.29
2.69	×⅔ 5.38
10.88	13.67
.34	.34
10.64	14.01



x zero Sh.

$$10.64 = .770 \times x + \frac{.0348\,x^2}{2}$$

$$x^2 + 44.2x = 612$$

$$(x + 22.1)^2 = 612 + 488 = 1100$$

$$x = 33.2 - 22.1 = 11.1$$

$$+M = 10.64 \times 11.1 - .770 \times \frac{11.1^2}{2} - \frac{11.1}{21.53} \cdot .750 \times \frac{11.1^2}{2 \cdot 3} - 125.5$$

$$118.0 - 47.4 - 7.95 - 125.5 = -62.9$$

Pt. of inflection

$$10.64x - \frac{.770x^2}{2} - \frac{.0348\,x^3}{6} - 125.5$$

$$x^3 + 57.8x^2 - 1835x = -21{,}600$$

try 21 $\quad 9{,}200 + 25{,}500 - 38600 = -3900$ None

(1) H.C.

$d = 65" - 3.5 = 61.5$ $\quad -A_s = \dfrac{125{,}500 \times 12}{.88 \times 61.5 \times 18000} = 1.55 \square''$ $\quad \begin{cases} 1\tfrac{1}{8}"\square \ 9.8 \text{ oc.} \\ 1"\square \ 7.8 \text{ oc.} \end{cases}$

Bond $\dfrac{10640}{.88 \times 61.5 \times 125} = 1.58''$ $\quad \{ 1"\square \ 30" \text{ oc.}$ $\quad$ use $1\tfrac{1}{8}"\square$ - 9" oc. outside

At D $\quad -A_s = \dfrac{132.800}{125{,}500} \times 1.55 = 1.64 \square''$ $\quad 1\tfrac{1}{8}" - 9.3" \text{ oc}$

Bond $\dfrac{14.01}{10.64} \times 1.58 = 2.08''$ $\quad 1\tfrac{1}{8}" - 26" \text{ oc.}$ $\quad$ use $1\tfrac{1}{8}\square$ - 9" oc outside

At Center $\quad -A_s = \dfrac{62{,}900 \times 12}{.88 \times 53.5 \times 18000} = 0.89 \square''$ $\quad 1\tfrac{1}{8}\square - 17.1" \text{ oc.}$ $\quad 1\tfrac{1}{4}\square - 21.0" \text{ oc.}$ $\quad$ use $1\tfrac{1}{8}\square - 13\tfrac{1}{2}" \text{ oc.}$

$d = 57" - 3.5 = 53.5$

At C

N. from roof = 38.02 Compr. is (-)

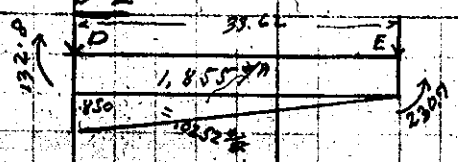
$e = \dfrac{M12}{N} = \dfrac{125.5 \times 12}{38.2} = 39.4$

$e' = e - \dfrac{t}{2} + d = 39.4 - \dfrac{65}{2} + 61.5 = 68.4$ $\quad bd = 12 \times 61.5 = 738.0$ $\quad bd^2 = 12 \times 61.5^2 = 45{,}400$

$\dfrac{Ne'}{bd^2} = \dfrac{38.02 \times 68.4}{45{,}400} = 56.2$ $\quad f_c = .480$ $\quad k = .245$

$A_s = \dfrac{-38.02 + .5 \times .480 \times .245 \times 738}{18{,}000} = 0.30 \square''$ $\quad -1\tfrac{1}{8}"\square - 9" \text{ oc}$ outside ok as above

D-E



W (same as for B.C.)

Mom diff $\dfrac{97.9}{33.62}$

Re	Rd
35.97	40.74
2.91	2.91
38.88	37.83

$x - Sh = 0$ $\quad 38.88 = 1.855x + \dfrac{.0252x^2}{2}$

$x^2 + 147x = 3090$

$(x + 73.5)^2 = 3090 + 5420 = 8510$

$x = 92.4 - 73.5 = 18.9$

$tM = 38.88 \times 18.9 - 1.855 \times \dfrac{18.9^2}{2} - \dfrac{18.9}{33.62} \times .850 \times \dfrac{18.9^2}{2 \times 3} - 230.7$

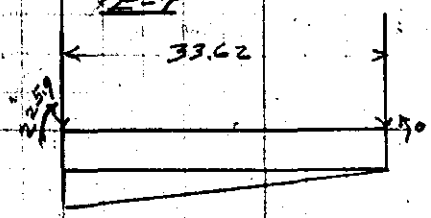
$737 - 332.5 - 28.7 - 230.7 = 145.1$

At D $\quad -A_s = \dfrac{132{,}800 \times 12}{.88 \times 61.5 \times 18000} = 1.64 \square''$ $\quad 1\tfrac{1}{8}"\square - 9" \text{ oc ok}$

At E $\quad -A_s = \dfrac{230{,}700 \times 12}{.88 \times 64.5 \times 18{,}000} = 2.72 \square''$ $\quad 1\tfrac{1}{4}"\square - 6.9" \text{ oc}$ $\quad 1\tfrac{1}{4}"\square - 7" \text{ oc ok}$

Same design as for B-C ok

(1)
E-F



Same design as for A-B OK

Midwall $A_s = \frac{48 \times 12}{.88 \times 26.5 \times 18.0} = 0.140''$

Previous design

Form 115 10M-11-39

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DETAIL OUTLET

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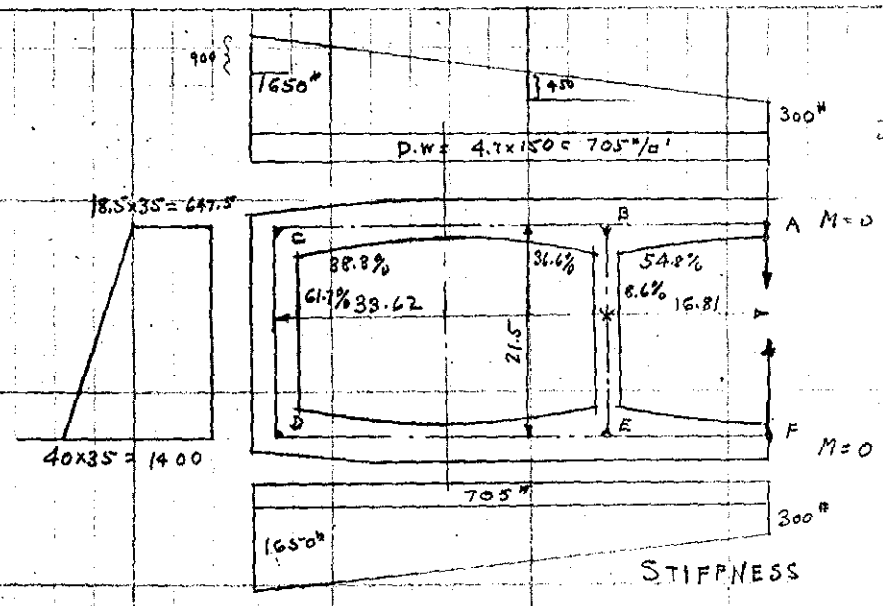
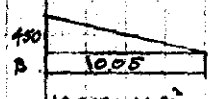
(2)



$\frac{1350}{50.48} \times 16.81 = 450$

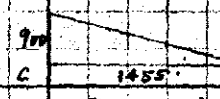
F.E.M.



$\frac{1005 \times 16.81^2}{12} = 23.7 \quad 23.7$

$\frac{450 \times 16.81^2}{20} = 6.4 \quad 4.2$

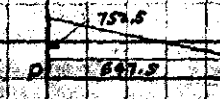
30.1 27.9



$\frac{1455 \times 33.62^2}{12} = 137.5 \quad 137.5$

$\frac{900 \times 33.62^2}{20} = 50.8 \quad 33.9$

188.3 171.4



$\frac{647.5 \times 21.5^2}{12} = 25.0 \quad 25.0$

$\frac{752.5 \times 21.5^2}{20} = 17.4 \quad 11.6$

42.4 36.6 AVERAGE = 39.5

STIFFNESS

$.75 \times \frac{4.7^3}{16.81} = 4.63 \quad 54.8\%$

$\frac{4.7^3}{33.62} = 3.09 \quad 36.6\%$

$\frac{2.5^3}{21} = .73 \quad 8.6\%$

8.45 100.0

(2)

M = 150,000 M = 141,500

M = 120,000"

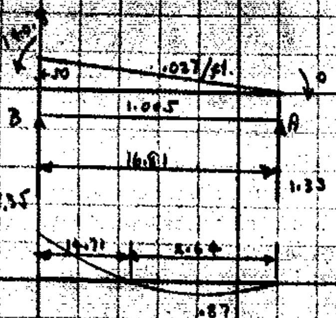
+123.6	-4.9	D	+5.6	-149.0	+140.8	+8.0	D			
+139.5	+3.8	C	-13.7	-164.4	+132.8		C			
+129.7	-17.4	D	+7.5	-140.7	+132.8	+1.3	D			
+157.1	+25.8	C	-28.5	-148.2	+121.5	+13.9	C			
+[illegible]37.3	-57.0	D	+51.7	-119.7	+107.6	+77.5	D	+27.1	0	
[illegible]183		F		-171.40	+30.10		F		-27.90	M = 0
ΣM	Δ	C	Δ	ΣM	ΣM	Δ		Δ	ΣM	A

D	C	D	C	D	F
-16.0	+22.1	-44.8	+45.9	-91.8	Δ
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	ΣM

38.3% 61.7%

36.6% 54.8% B 8.6%

F	D	C	D	C	D	
Δ	+12.1	-6.0	+1.8	-.9	+1.2	M = 8,500
ΣM 0	+12.1	+6.1	+7.90	+7.0	+8.2	



W = 1.005 × 16.81 = 16.90 × 1/2 = 8.45 | 8.45

.450/2 × 16.81 = 3.78 × 1/3 = 1.26 | 2/3 | 2.52

9.71 | 10.97

Mom. Diff. $\frac{140.8}{16.81}$ = 8.38 | 8.38

1.33 R_A | 19.35 R_B

$x = \frac{1.33}{1.005} = 1.32'$ close enough.

+M. $1.33(1.32)' - 1.005\frac{1.32^2}{2} - .027\frac{(1.32^3)}{6}$

$1.76 - .875 - .011 = 0.87$

PT. infl. = 1.32 × 2 = <u>2.64</u> approx.

@ B. $-A_s$. $\frac{140.8\,00 \times 12}{.88 \times 64.5 \times 18000} = 1.66$ 1 1/4" ϕ 11.3" o.c.

Bond $\frac{19350}{.88 \times 64.5 \times 12} = 2.73$ Use 1 1/4" ϕ - 10" o.c. Outside.

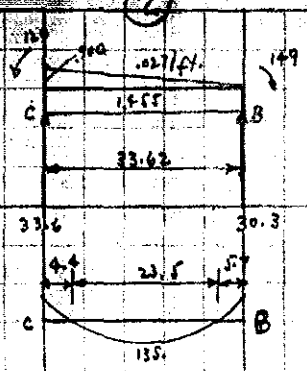
<u>Contin.</u> 1/2" ϕ/12" o.c. inside face.

SH @ infl. - Very small.

$+A_s = \frac{870 \times 12}{.88 \times 18000 \times 41.5} = .016$

1/2" ϕ - 12" o.c. OK.

(2)



$W = 1.455 \times 33.62 = 48.9 \quad \times \frac{1}{2} = 24.45 \qquad 24.45$

$.900 \times \frac{33.62}{2} = 15.0 \quad \times \frac{1}{3} = 5. \qquad \% \quad 10$

$29.45 \qquad 34.45$

Mom. Diff. $\frac{29}{33.62} = .87 \qquad .87$

$30.32 \qquad 33.58$

Zero SH. $30.3 = 1.455x + \frac{.027x^2}{2}$

$x^2 + 108x = 2240$

$(x + 54)^2 = 2240 + 2920 = 5160$

$x + 54 = 71.8 \qquad x = 17.8$

$+M = 30.3(17.8) - 149 - 1.455\frac{17.8^2}{2} - \frac{17.8}{33.6}.900\frac{17.8^2}{6}$

$= 539 - 149 - 230 - 25.1 = 135$

Pts of infl.

$30.3x - 1.455\frac{x^2}{2} - \frac{.027x^3}{6} - 149 = 0$

$x^3 + 162x^2 + 33100 = 6740x$

Try	5.2	37480+	= 35000	
	5.7	38400+	= 38400	ok (5.7)
Try	27.6	178,100	= 186,000	
	28.0	182,000	189,000	
	29.	193.5	195,000	ok. (29.2)

@ B $\quad -A_s = \frac{149000 \times 12}{.88 \times 64.5 \times 18000} = 1.75 \qquad 1\frac{1}{4}''\phi - 10''oc$

Bond. $\frac{30300}{.88 \times 64.5 \times 125} = 4.27 \qquad$ use $1\frac{1}{4}''\phi - 10''oc$ Outside

@ C $\quad -A. \frac{120000 \times 12}{.88 \times 61.5 \times 18000} = 1.48$

Bond $\frac{33300}{.88 \times 61.5 \times 125} = 4.92 \qquad 1\frac{1}{4}''\phi - 12''oc \qquad 1\frac{1}{4}''\phi - 12''oc.$ Outside.

Center, $\frac{135000 \times 12}{.88 \times 41.5 \times 18000} = 2.46$

$3'-9 - 5\frac{1}{2} = 3'-5\frac{1}{2}$

$1\frac{1}{4}''\phi - 7.6''oc$ ✓

$1\frac{1}{8}''\phi - 6''o.c.$

$1''\phi - 4.9$ o.c

use $1\frac{1}{8}''\phi - 6''oc$ Inside.

$1''\phi - 5''oc$ Inside

SH @ inflection. $33.6 - 2.3(4.4)$

$33.6 - 10 = 23.6$

rm 115 10M-11-39
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PROJECT U. S. Engineers - Hartford.
SUBJECT Park River - Pressure Conduit
DETAIL Outlet.
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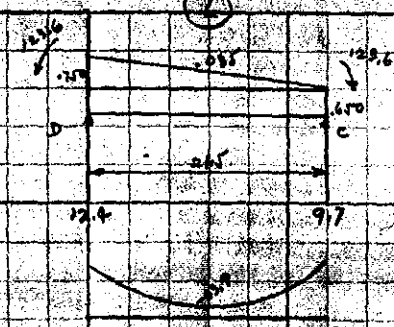


$W = .650 \times 21.5 = 14.0 \quad \times \frac{1}{2} = 7.0 \qquad 7.0$

$.750 \quad \frac{21.5}{2} = 8.06 \quad \times \frac{1}{3} = 2.7 \qquad \frac{2}{3} \quad 5.4$

$9.7 \qquad 12.4$

Zero SH: $9.7 = .65x + .035\frac{x^2}{2}$

$x^2 + 37.1x = +555$

$(x + 18.55)^2 = 555 + 344 = 899$

$x = 30 - 18.55 = 11.45$

$+M = 9.7(11.45) - 123.6 - .650\,\frac{11.45^2}{2} - \frac{11.45}{21.5}\,.750\,\frac{11.45^2}{6}$

$= 111. - 123.6 - 42.6 - 8.7 = -63.9$

@ C
or D

$-A_s \quad \frac{123{,}600 \times 12}{.88 \times 60.5 \times 18000} = 1.55$

1¼ ϕ - 12" o.c.
1⅛" ϕ - 9.8" o.c.
1" ϕ - 6" o.c.

Bond. $\frac{12\,400}{.88 \times 60.5 \times 125} = 1.86$

Use 1¼" ϕ - 12" o.c. Outside

Center

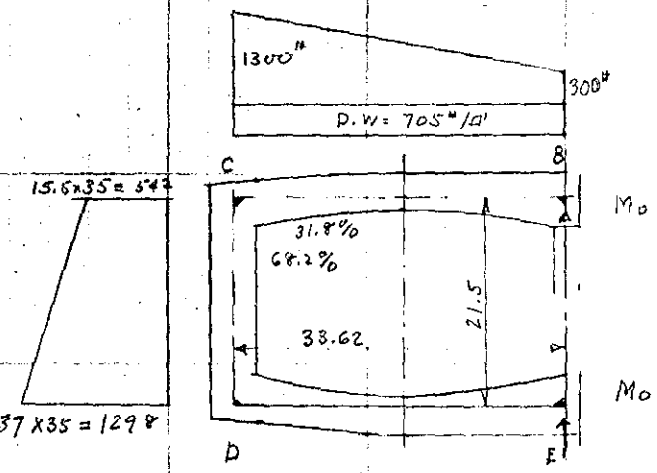
$A_s \quad \frac{63\,900 \times 12}{.88 \times 53.5 \times 18000} = .91$

Use 1" ϕ - 12" o.c.

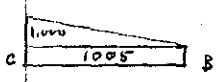
BOTTOM SLABS as TOP SLABS.

Mid wall 1" ϕ - 18" o.c. both faces. see p. 5.

(3)



F. E. M.



$$\frac{1005 \times 33.62^2}{12} = 95.0 \qquad 95.0$$

$$\frac{1,000 \times 33.62^2}{20} = 56.6 \qquad 37.8$$

$$151.6 \qquad 132.8$$

C-D

Approx F.E.M. = $\frac{1840 \times 21.5^2}{12 \times 2} = 35.5$

STIFFNESS

$$.75 \times \frac{4.7^3}{33.62} = 2.32 \qquad 31.8\%$$

$$\frac{4.75^3}{21.5} = 4.98 \qquad 68.2\%$$

$$7.30$$

M = 132,000

132.0	-3.9				
+135.9	-11.5	D			
+147.4	0	C			
+147.4	-33.7	D			
+181.1	+66.4	C			
+114.7	-38.9	D	+132.8	0	
+151.6		F		-132.8	M = 0
ΣM	Δ		Δ	ΣM	

31.8%
68.2%

								-135.9
								-111.2
								-147.4
								-75.1
								-114.7
							-35.5	ΣM
	+12.3	-24.7	+36.2	-72.3	+39.6	-79.2		Δ
		D	C	D	C	D	F	

Form 115 10M-11-39

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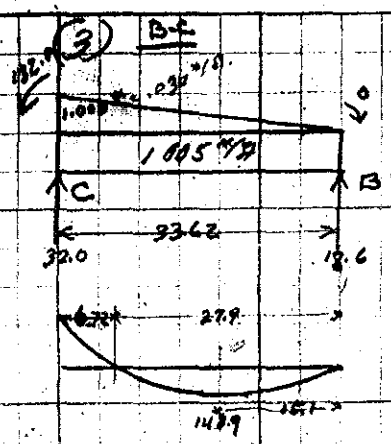
(3) B-C



$W = 1.005 \times \frac{33.62}{2}$

$1 \times \frac{33.62}{2} \times 1/3$

Mom diff $= \frac{13^2}{33.62}$

B		C
16.9		16.9
5.6	2/3 =	11.2
22.5		28.1
3.9		3.9
18.6		32.0

Zero Sh. $= 18.6 = 1.005x + \frac{.030x^2}{2}$

$x^2 + 67.0x = 1240$

$(x+33.5)^2 = 1240 + 1125 = 2365$

$x = 48.6 - 33.5 = 15.1$

$+M = 18.6 \times 15.1 - \frac{1.005 \times 15.1^2}{2} - 1.005 \times \frac{15.1}{33.62} \times \frac{15.1^2}{2 \times 3}$

$= 281 - 114.5 - 17.1 = 148.9$

Pt of Infl. $18.6x - 1.005\frac{x^2}{2} - .030\frac{x^3}{6} = 0$

$x^2 + 105x = 3720$

$(x+52.5)^2 = 3720 + 2760 = 6480$

$x = 80.4 - 52.5 = 27.9$

Sh at Pt. Infl

$18.6 - 1.005 \times 27.9 - \frac{1.0 \times 27.9^2}{33.6 \times 2}$

$18.6 - 28.1 - 11.5 = -21.0$

At B

Bond $= \frac{18600}{.88 \times 64.5 \times 125} = 2.62''$ 7/8" ϕ - 12" oc inside

At C

$-A_s = \frac{132.0 \times 12}{.88 \times 61.5 \times 18.0} = 1.63\ \square''$ 1 1/4" ϕ - 12" oc outside

Bond $= \frac{32.0}{18.6} \times 2.62 = 4.51\ \square''$ - ok

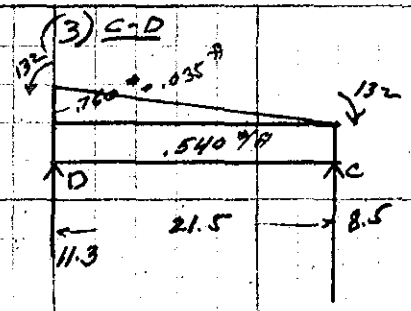
Center

$A_s = \frac{148.9 \times 12}{.88 \times 41.5 \times 18.0} = 2.72\ \square''$ 1 1/4" ϕ - 6.9" oc

or 1 1/8" ϕ - 5.6" oc

Use 1 1/8" ϕ - 5" oc inside

(3) C-D



$W = .540 \times \frac{21.5}{2}$

$.760 \times \frac{21.5}{2} \times 1/3$

C		D
5.8		5.8
2.7	$\times 2/3$	5.5
8.5		11.3

Zero Sh: $8.5 = .540x + \frac{.035x^2}{2}$

$x^2 + 30.8x = 485$

$(x + 15.4)^2 = 485 + 237 = 722$

$x = 26.9 - 15.4 = 11.5$

$+M = 8.5 \times 11.5 - 132 - .540 \times \frac{11.5^2}{2} - \frac{11.5}{21.5} \times .760 \times \frac{11.5^2}{6}$

$98.0 - 132.0 - 35.7 - 9.0 = -78.6$

At C

$-A_s = \frac{132.0 \times 12}{.88 \times 61.5 \times 18.0} = 1.63$

1 1/4 ⌀ - 11" oc.
1 1/8 ⌀ - 9"
1" ⌀ - 7" oc

Bond. $\frac{8.5}{.88 \times 61.5 \times 12.5} = 1.25''$ " " -

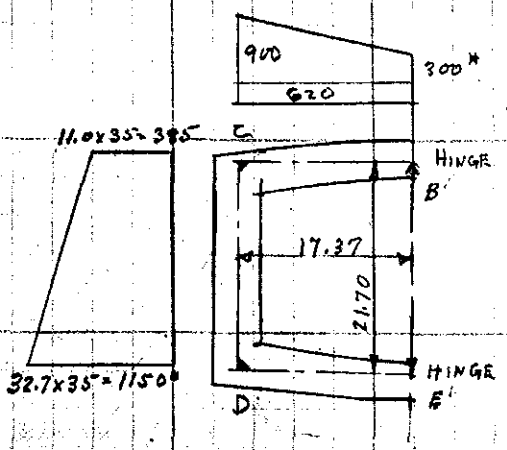
use 1 1/8" ⌀ - 9" oc outside

Center $+A_s$. $\frac{-78.6 \times 12}{.88 \times 53.5 \times 18.0} = 1.11''$

1" ⌀ - 8.6 oc.
1" ⌀ - 10.8

use 1" ⌀ - 9" oc. outside

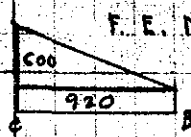
(4)



$$Av.\ t = \frac{4.75+3.67}{2} = 4.21$$

$$Av.(h) = \frac{23.17+20.25}{2} = 21.7$$

F. E. M.



$$\frac{920 \times 17.37^2}{12} = 23.1 \qquad 23.1$$

$$\frac{600 \times 17.37^2}{20} = 9.0 \qquad 6.0$$

$$32.1 \qquad 29.1$$

C-D.

$$\text{Approx. F.E.M.} = \frac{1535 \times 21.7^2}{12 \times 2} = 30.2$$

STIFFNESS.

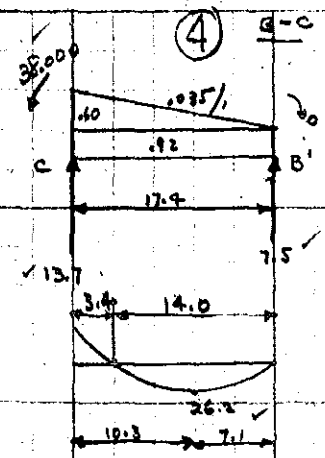
$$\frac{.75 \times 4.21^3}{17.37} = 3.21 \qquad 39.4\%$$

$$\frac{4.75^3}{21.70} = 4.94 \qquad 60.6\%$$

$$8.15 \qquad 100.0$$

+38.1	-1.8	D			
+39.9	0	C			
+39.9	-5.9	D			
+45.8	+14.5	C			
[illegible]	-0.8	D	+29.1	0	
				29.1	
				29.1	0.0

(4) B-C



			B	C
$W = .92 \times 17.4 = 16.0$	$\times \frac{1}{2}$		8.0	8.0
$.60 \times \frac{17.4}{2} = 5.2$	$\times \frac{1}{3}$		1.7	3.5
21.2			9.7	11.5
Mom. Diff $\frac{38}{17.4} = 2.2$			2.2	2.2
			7.5	13.7

Zero SH. $7.5 = .92x + \frac{.035x^2}{2}$

$x^2 + 52.5x = 428$

$(x + 26.3)^2 = 428 + 691. = 1119$

$x + 26.3 = 33.4$

$x = 7.1$

+M. $7.5(7.1) - .92\frac{7.1^2}{2} - \frac{7.1}{17.4} \cdot .6 \frac{7.1^2}{6}$

$53.2 - 24.4 - 2.1 = \underline{27.9}$

PT infl. $7.5x = .92\frac{x^2}{2} + \frac{.035x^3}{6}$

$x^2 + 77.0x = 1285.$

$(x + 39.5)^2 = 1285 + 1560 = 2845$

$x + 39.5 = 53.5$

$\underline{x} = \underline{14.0}$

@ C. $-A_s$. $\frac{38000 \times 12}{.88 \times 61.5 \times 18000} = .48$ 3/4 - 10" o c
7/8 - 15" o c

Bond $\frac{13700}{.88 \times 61.5 \times 125} = 2.02$ Use. 7/8 φ - 15" o.c.

Center 48-3.5 $\frac{29.900 \times 12}{.88 \times 44.5\ 18000} = .48$ 3/4" - 11" o c
3/4" φ - 12" o.c. OK Use.

Hartford

Pressure Conduit

Outlet

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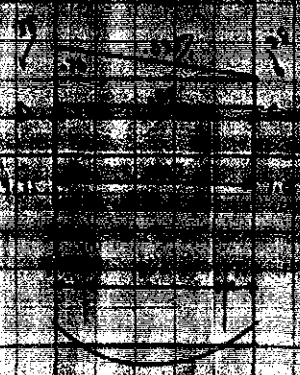


$W = .39 \times 21.7 = 8.5 \quad \times \frac{1}{2} \quad 4.25 \quad 4.25$

$.76 \times \frac{21.7}{2} = 8.25 \quad \times \frac{1}{3} \quad 2.75 \quad \frac{2}{3} \quad 5.5$

$17.75 \quad 7.00 \quad 9.75$

Use SH $7.0 = .39x + .035\frac{x^2}{2}$

$x^2 + 21.3x = 400.$

$(x + 10.6)^2 = 400 + 113. = 513$

$x + 10.6 = 22.7$

$x = 12.1.$

+M $7.0(12.1) - 38 - .39\frac{12.1^2}{2} - \frac{12.1}{21.7} .76 \frac{12.1^2}{6}$

$84.7 - 38 - 28.6 - 10.4 = +7.7$

Pts. Infl.

$7.0x - .39\frac{x^2}{2} - .035\frac{x^3}{6} - 38 = 0.$

$1160x = 32.5x^2 + x^3 + 6340$

Try $x = 7$. $8120 = 8270.$ OK Use $x = 7.$

Try $x = 14$ $16250 = 15350$

15 $17400 = 17030$ OK Use $x = 15$

SH @ 7 $7.0 - .39 \times 7 - 1 \; .035\frac{7^2}{2}$

$7 - 2.7 - .9 = 3.4$

SH @ 15 $7.0 - .39(15) - .035\frac{15^2}{2}$

$7.0 - 5.85 - 3.95 = -2.8$

@ C.

$-A_s = .48$

Bond < 2.02 } $7/8$" ϕ - 15" o.c Outside.

@ D. $-A_s = .48$ } Use $7/8$ ϕ - 15" o.c Outside.

Center $A_s = \frac{7,700 \times 12}{.88 \times 53.5 \times 18000} = .11$ $1/2$" ϕ - 22" o.c.

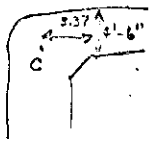
Section	A.	center.	B.	center	C	center	D.
①	Bond 2.59 in.	+ 2.55 in. 1¼"φ - 7" o.c	- 1.58 out. 1¼φ - 12" oc	+ 3.29 in. 1¼"φ - 5" o.c	- 1.87 out 1⅛φ - 8" o.c.	- 1.22 out 1⅛φ - 12" o.c.	
②		+.02	- 1.75 1¼ - 10" o.c	+ 2.46 1¼"φ - 7" o.c	- 1.55 1⅛φ - 9" oc	- .91 1"φ - 12" oc.	
③				+ 2.32 1¼"φ - 8" o.c.	- 1.63 1⅛φ - 8" o.c.	- .61 ⅞φ - 12" oc	
④					+.45 - .48 ¾φ - 11" o.c.	+ .11 ½φ - 12" oc. ¾"φ - 24" o.c.	

Investigation for stirrups.

@ point c. p. 3.
beyond haunch.

$SH = 41.24 - 1.86 \times 3.37 - .8(3.37)$
$= 41.24 - 6.27 - 2.7 = 32.3$

$SH. \frac{32,300}{.88 \times 12 \times 50} = 61.5$ #/□ use stirrups.



Laminat in sh. is about 25,000.

.036 × 6 = .216 .850 .126 .63 .85 .63 1.48 2 .74

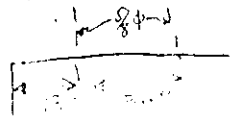
SH @ pt 6' in = 41.24 - 6(1.855) - 6(.74)
= 41.24 - 11.1 - 4.43 = 25.71

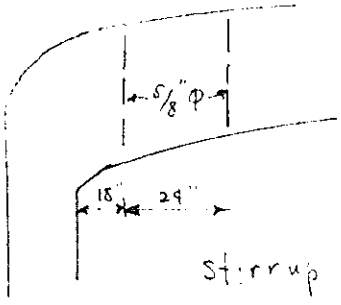
$SH. \frac{25710}{.88 \times 12 \times 47} = 52$ #/□ use 7'.
51-4

Total SH/ft. 1.5 × 7 × 12 = 165# approx only.
width.

Use ⅝ [ ] - 2. on left side.

spacing.





Stirrup spacing left side only.

No other [illegible]

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DETAIL Outlet.

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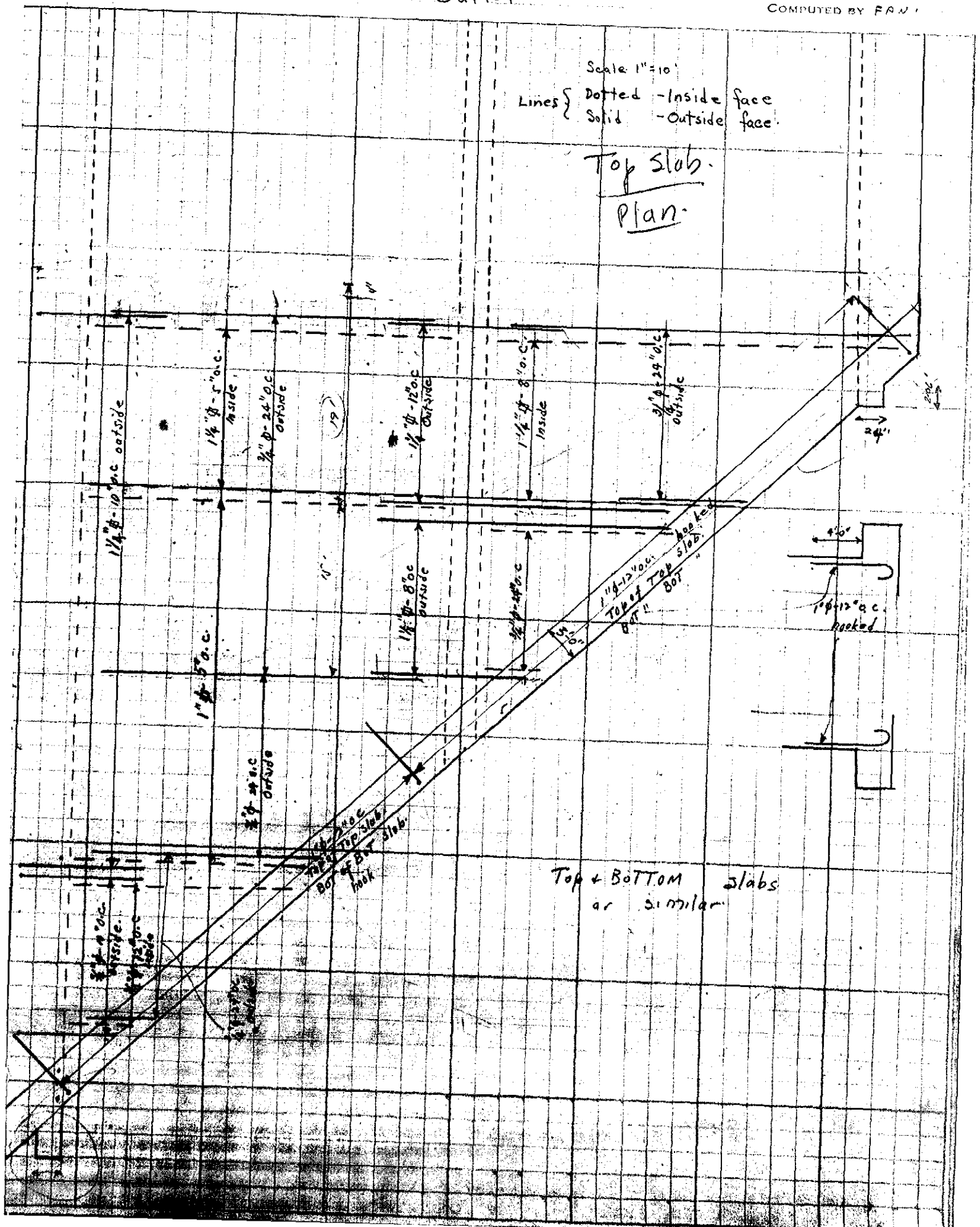
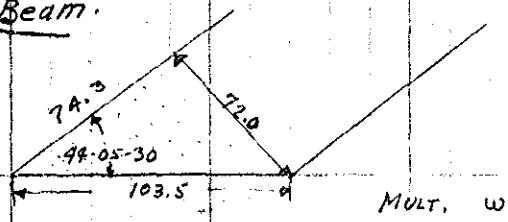


Collar Beam.

(5)



LGTH = 72.0 sin 44-05-30

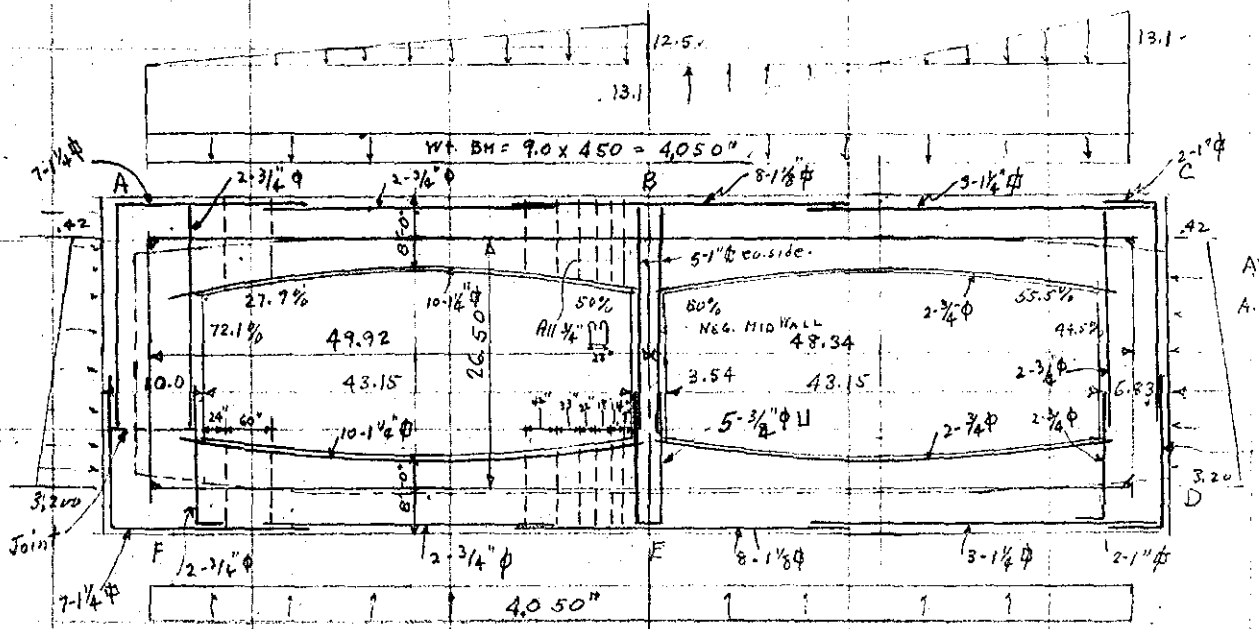
72.0 × .69576 = 103.5

72.0 ÷ tan 44-05-30

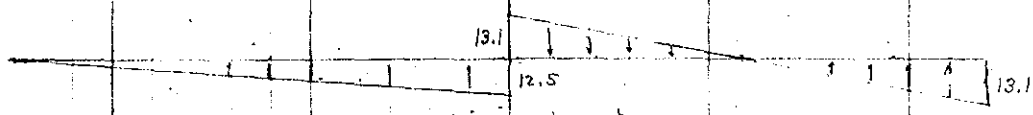
72.0 ÷ .96879 = 74.3

MULT. $\omega = \frac{74.3}{103.5} = .718$ ✓

4.75 ÷ .69576 = 6.83 30 ÷ .69576 = 43.15 2.5 ÷ .69576 = 3.54



Scale 1" = 20'
All laps 45φ
3½" to ℄ steel.



Section thru ℄

LOADS = 18.2 × .718 = 13.1 ✓ 17.4 × .718 = 12.5 ✓

SIDE PRESS = 3 × 35 × 4 = 420 ✓ Bot = 420 + 26.5 × 35 × 3 = 3,200#

F.E.M.

AT (C)

$-\frac{23}{60 \times 16}$ 13.1 × 48.34² = − 784

$+\frac{7}{60 \times 16}$ 13.1 × 48.34² = + 223

− 511

− 4.05 × $\frac{48.34^2}{12}$ = − 790

− 1300.0

AT (B)c

+ 734

− 223

+ 511

− 790

− 279.0

AB

4.05 × $\frac{49.92^2}{12}$ = − 842 − 842

12.5 × $\frac{49.92^2}{20}$ = − 1560 − 1040

− 2402₁₂ − 1882₄

STIFFNESS

$\frac{6.83^3}{26.50}$ = 12.05 44.5 %

$\frac{9.0^3}{48.34}$ = 15.08 55.5 %

27.13

$\frac{9.0^3}{49.92}$ = 14.6 27.9 %

$\frac{10.0^3}{26.5}$ = 37.8 72.1

52.4

F.E.M. VER. WALLS. (Approx.)

$M = \frac{1.810 \times 26.5^2}{2 \times 12} = -53.0$

ΣM	Δ		Δ	ΣM	ΣM	Δ		Δ	ΣM
+1670	-184	F	+405	-1487	+1487	+114	D	-12	-292
+1786	-5	C	-174	-1592	+1383	-35	C	-5	-280
+799	-367	D	-10	-1418	+1418	-9	D	-69	-275
+2166	+401	C	-328	-1408	+1427	+307	C	+401	-206
+1765	-657	D	+802	-1080	+1080	+801	D	+693	-607
+2402		F		-1882	+279		F		-1300

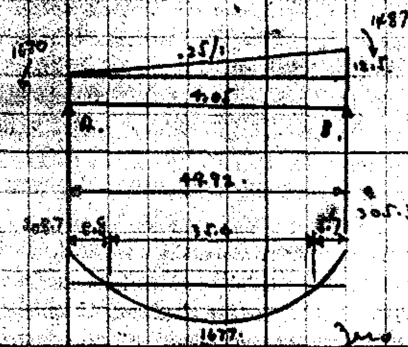
A 27.9%   72.1%   50% B 50%   55.5% C 44.5%

1670 K

292 K

	Δ	ΣM
D	-321	-1670
C	+440	-1189
D	-900	-1777
C	+846	-899
D	-1693	-1126
F		-53

	ΣM	Δ
F	+53	
D	+607	+554
C	+330	-277
D	+275	-55
C	+302	+267
D	+292	-10



$W = 4.05 \times 49.92 = 202 \times \frac{1}{2}$ 101   101

$12.5 \quad \frac{49.92}{2} = 312 \times \frac{1}{3}$ 104 $\frac{2}{3}$ 208

514   205   309

Mom Diff $\frac{183}{49.92} =$ 3.7 / 208.7   3.7 / 305.3

Zero SH. $208.7 = 4.05\,x + .25\,\frac{x^2}{2}$

$1670 = 32.4\,x + x^2$

$(x + 16.2)^2 = 1670 + 263 = 1933$

$x = 44. - 16.2 = 27.8'$

$+M = 208.7(27.8) - 4.05\,\frac{27.8^2}{2} - \frac{27.8}{49.9}\,12.5\,\frac{27.8^2}{6} - 1670$

$5810 - 1565 - 898 - 1670 = 1677$ K

PTS of inflection

$208.7x - 1670 - 4.05\,\frac{x^2}{2} - .25\,\frac{x^3}{6} = 0$

$5000x - 40{,}100 - 48.7\,x^2 - x^3 = 0.$

$x^3 + 48.7x^2 + 40100 = 5000x$

Try 8.8   44,550 = 44,000 .   OK   Use 8.8

Try. 42.   172,000 = 210,000

Try. 45.2   231. = 226,000

44.5   223.6 = 222,000   Use 44.2

SH @ 8.8. $208.7 - 8.8(4.05) - .25\,\frac{8.8^2}{2}$

$208.7 - 35.6 - 9.7 = 163.4$

SH @ 44.2 $208.7 - 44.2(4.05) - .25\,\frac{44.2^2}{2}$

$208.7 - 179 - 244 = 214.3.$

@ A. (5) 120-4 $-A_s = \frac{1670,000 \times 12}{.88 \times 18000 \times 116} = 10.9''$ Use 7-1¼" ϕ - 2 rows. outside.

Bond. $\frac{208700}{.88 \times 116 \times 125} = 16.4$ OK.

@ B $-A_s = \frac{148 \times 7.}{1670.} 10.9 = 9.7$ Use 8-1⅛" ϕ - 2 rows. Outside.

Bond $\frac{305.3}{208.7} 16.4 = 24.0$

Center. $+A_s = \frac{1667000 \times 12}{.88 \times 18000 \times 89} = 14.2$ Use 10-1¼" ϕ - 2 rows. Inside.

7'-9" = 93.4 = 89"

Bond OK. length 40'-0".

49.2
8.8
35.4

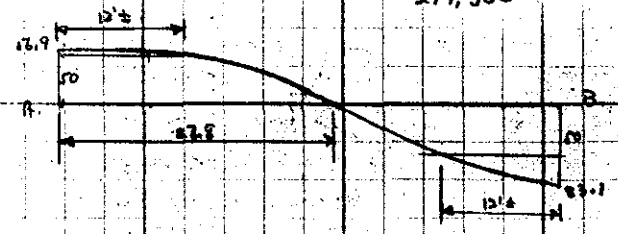
@ pt. of inflection $\frac{214,300}{.88 \times 125 \times 104} = 18.8$

SH @ ends. $v = \frac{208700}{36 \times .88 \times 116} = 56.9$ #/□ Use stirrups

$v = \frac{305300.}{208,700} = 83.1$ #/□

@ pts of infl. $\frac{214300}{36 \times .88 \times 104} = 70.6$ #/□

$\frac{163400}{214,300} 70.6 = 53.8$ #/□

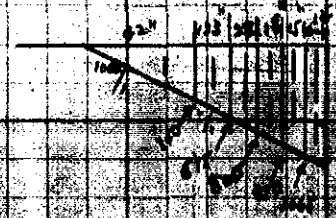


Total SH @ B to be taken by stirrups.

$\frac{120}{2} \times 33.1 \times 36 = 71500$ #

¾" stirrups. $\frac{71500}{.88 \times 18000} = 15850$ Use 6. [illegible]

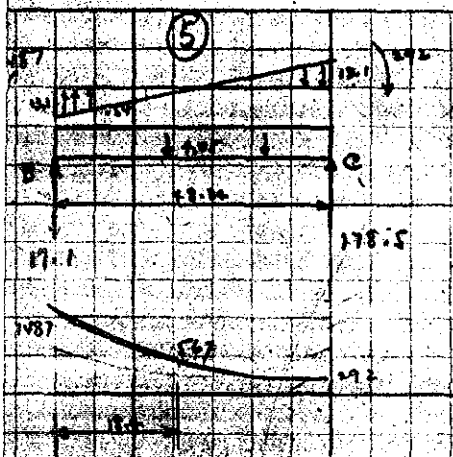
End spacing. $x = \frac{15850}{30 \times 36} = 15''$ ±



Spacing as shown.

@ A. Other end. Total SH = 6.9 × 120 × [illegible] = [illegible] Use [illegible]

(5)



			@ B	@ C
$w = 48.34 \times 4.05$	$= 195.5 \times \frac{1}{2}$		97.8	97.8
$13.1 \times \frac{48.34}{4}$	$= 158.0$	$\times \frac{1}{6}$	26.3	$\times \frac{5}{6}$ 131.7
			124.1	229.5
	$= 158.0$		131.7	26.3
			− 7.6	203.2
Mom. Diff. $\frac{1195}{48.34}$	$= 24.7$		24.7	24.7
			+ 17.1	178.5

Zero Sh. $17.1 + 4.05x = .54\frac{x^2}{2}$

$x^2 - 15x = 63.3$

$(x - 7.5)^2 = 56.2 + 63.3 = 119.5$

$x = 10.9 + 7.5 = 18.4$ $\qquad 18.4 \times .54 = 9.94$

$+M = 17.1(18.4) + 4 \times \frac{18.4^2}{2} + 9.1\frac{18.4^2}{6} - 4.05\left(\frac{18.4}{2}\right)^2 - 1487.$

$314 + 678 + 513 - 685 - 1487 = -567.$

@ B $\quad A_s = \frac{1470000 \times 12}{.88 \times 116 \times 18000} = 9.72$ $\qquad$ 8-1-1/8" ⌀ - 2 rows, outside.

Bond. ok.

$v = \frac{17100}{.88 \times 36 \times 125} = 43$ #/□" $\qquad$ No stirrups.

@ C $\quad A_s = \frac{24}{1487} \times 9.72 = 1.91$ $\qquad$ 2-1" ⌀

Bond $\frac{178500}{.88 \times 116 \times 125} = 14.0$ $\qquad$ Use 3-1 1/4" ⌀. Outside.

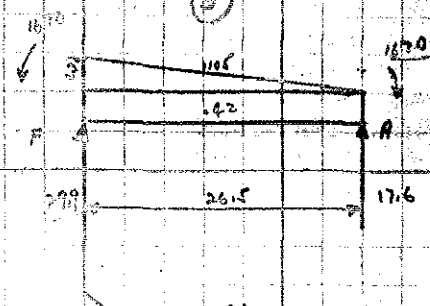
$v = \frac{178500}{.88 \times 36 \times 116} = 48.7$ $\qquad$ No stirrups.

$A_s = \frac{[illegible]}{[illegible]} = 14.7$ $\qquad$ use 3-1 1/4" ⌀. at C Outside.

Bond $u = 70000$ #

ETCALF & EDDY
ENGINEERS
BOSTON, MASS.

(b)



$w = .42 \times 26.5 = 10.7 \times \frac{1}{2} = 5.35$ A

$2.78 \times \frac{26.5}{2} = 36.8 \times \frac{1}{3} = 12.25$ $\frac{2}{3}$ F 24.5

47.5 17.6

Zero S.H. $17.6x = .42(x) + .105\frac{x^2}{2}$

$x^2 + 80x = 335$

$(x+4)^2 = 335 + 16 = 351$

$x = 18.8 - 4 = 14.8$

$d(M) = \sqrt{\frac{1670000}{167.7 \times 3}} = 6.2$

$+M$ $17.6(14.8) - .42\frac{14.8^2}{2} - \frac{14.8^3}{6}.105 - 1670$

$251 - 46 - 56.8 - 1670 = -1521.8$

@ F. $A_s = \frac{1670000 \times 12}{.88 \times 96 \times 18000} = 10.9$

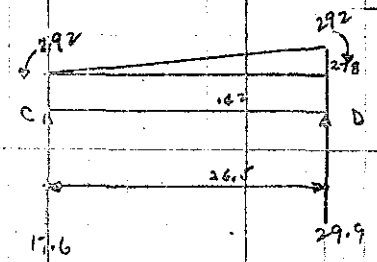
96 - 4 = 92

Use 7 - 1¼" ⊕.

Bond OK.

v OK.

Use these bars whole length.



$w = .42 \times 26.5 = 10.7$ as above

$2.78 \times \frac{26.5}{2} = 36.8$ C = 17.6 D = 29.9

47.5

@ C. $\frac{292000 \times 12}{.88 \times 116 \times 18000} = 1.91$ Use 2-1" ⊕ Full length

+ both Corners. Outside.

Bond $\frac{29.900}{.88 \times 116 \times 125} = 2.34$. OK.

Mid wall Steel

Reaction 305.3 + 17.1 = 322.4 K

w = 3.5' - .5 = 3.0'. stress = $\frac{322,400}{2.5' \times 9.5 \times 144} = 358$ #/□ OK.

3 - .5 = 2.5

Use 1% steel.

2.5 × 2.5 × 144 × .01 = 9 □ in.

9.5 ea. side. Use 5-1" ⊕ ea side

(5)

Piles at Outlet Collar Beam.

Additional Soil load due to BOT. SLAB COLLAR BEAM.

9 × 150 = 1350 #/□ per ft. length.

Side walls. 103.5 − 86.3 = 17.2 width.

$\frac{17.2 \times 15.5 \times 150}{103.5} = 385$ #/□

1735 #/□ additional soil load.

Inside water to springing line of Top arch slabs.

Vol. 30 × 15.5 = 465.
$\frac{2}{30}$ = .067 2 × 30 × .669 = 40
505. c.f / barrel.

wgt. per s.f. $\frac{505 \times 2 \times 62.5}{103.5 \times}$ = 610 #/□

Total Additional Load. 1735 + 610 = 2,345 K/□

Uplift water @ +2.0.

Invert − 3.18.
Base Beam. − 11.18
13.18 × 62.5 = .825

Net. 1.520 Downward } @ F
1.350

From p. 19. $\frac{4050}{3}$

@ E. & D. $\frac{13,100}{3}$ 4.370

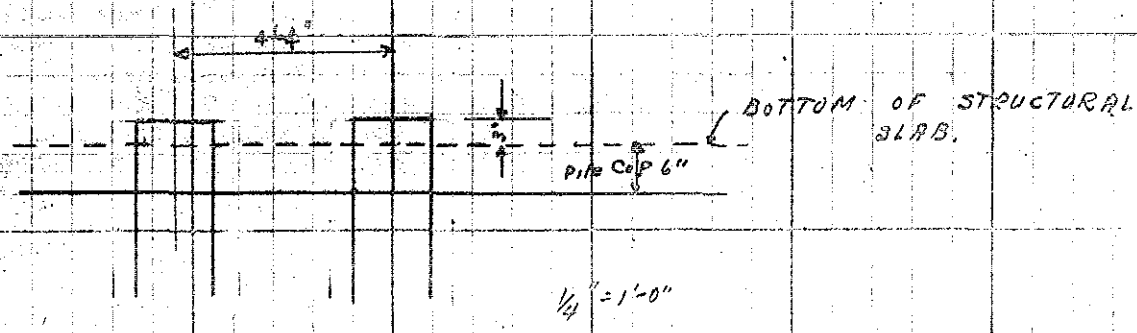
7,240 K/□

Load on Pile. 50 Tons.

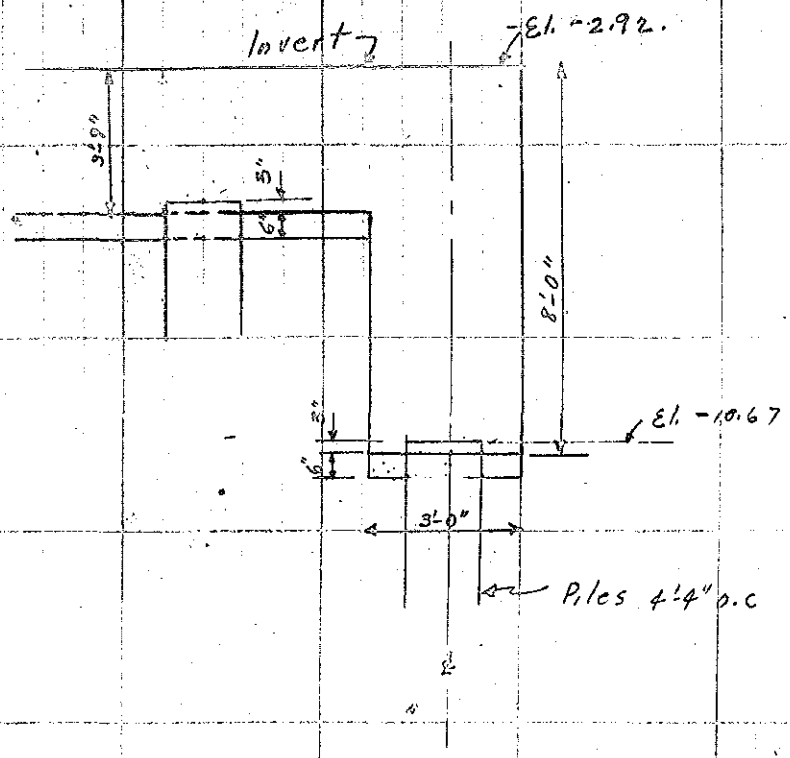
@ E.&D. spacing $\sqrt{\frac{100}{7.24}} = \sqrt{13.8}$ = 3.72 ft. both ways.

[illegible] = 5.9 ft. both ways

[illegible] = 4.62 = 4'-7½" use spacing



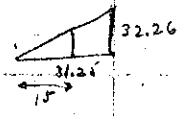
1/4" = 1'-0"



Invert Section @ Outlet along ℄ South barrel

1/4" = 1'-0"

El. Invert @ ℄ South Barrel.



$\frac{15}{31.25}$ 32.26 = 15.48 15.48 + 19 = 34.48.

S = .007 34.48 × .007 = .24 Inv = −3.16 + .24 = −2.92

CONDUIT OUTLET - WING WALLS AND APRON

Form 115 10M-11-39

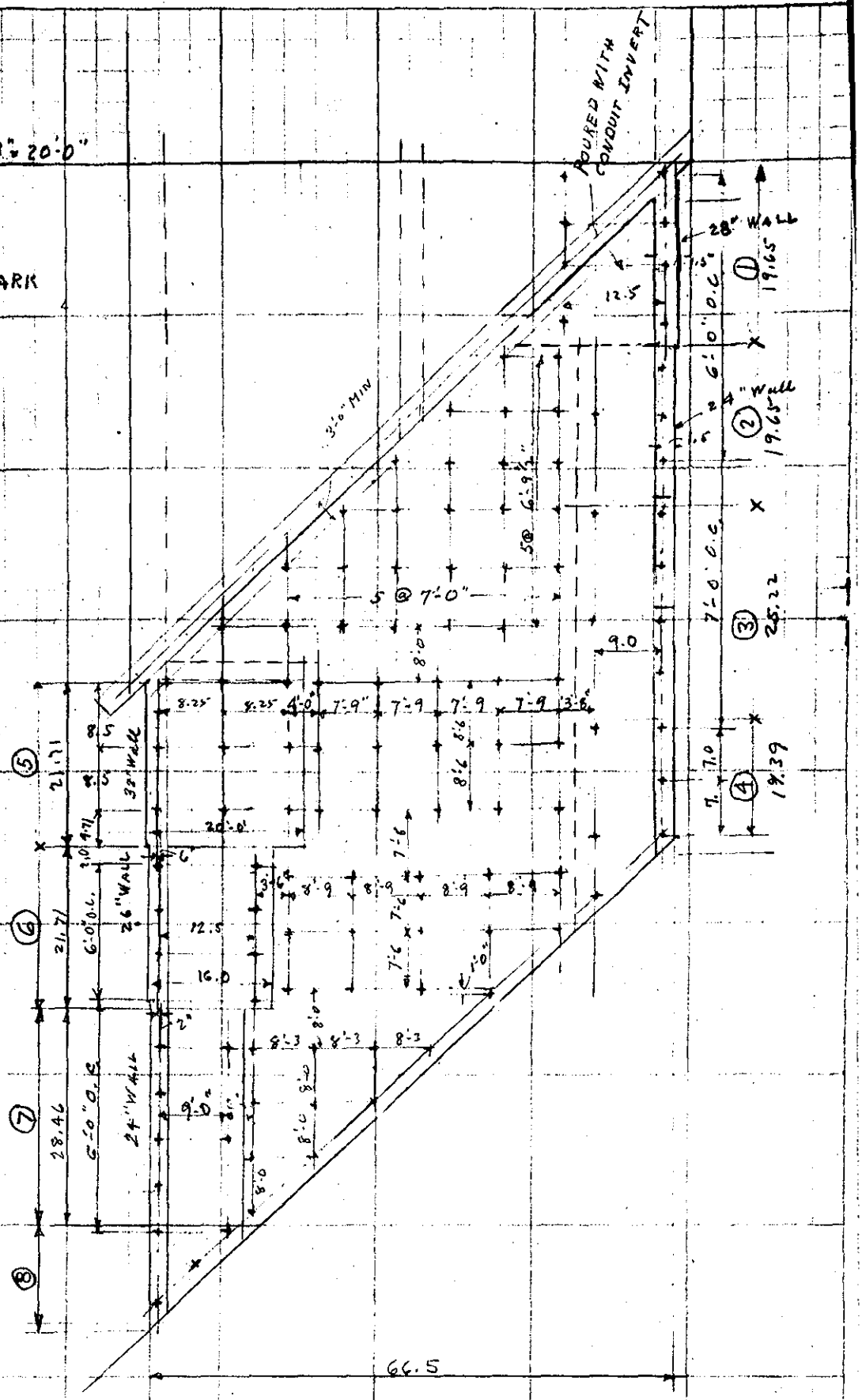
METCALF & EDDY
ENGINEERS
BOSTON, MASS.

PROJECT U. S. ENGINEERS - HARTFORD
SUBJECT PARK RIVER - PRESSURE CONDUIT
DETAIL OUTLET

PAGE K1
DATE APRIL 1940
COMPUTED BY S.W.O.

SCALE 1" = 20'-0"

COMPUTATION MARK NOTED THUS 1



① NORTH WALL

SLOPING DOWN BACK FILL SLOPE = 15° = δ

KETCHUM HAND BOOK PAGE 383 $N = \frac{1}{2} w h^2 \frac{\cos^2\phi}{\left(1+\sqrt{\frac{\sin\phi \sin(\phi+\delta)}{\cos\delta}}\right)^2}$

$\cos^2 35° = .819^2 = .671$ $\cos 15° = .966$

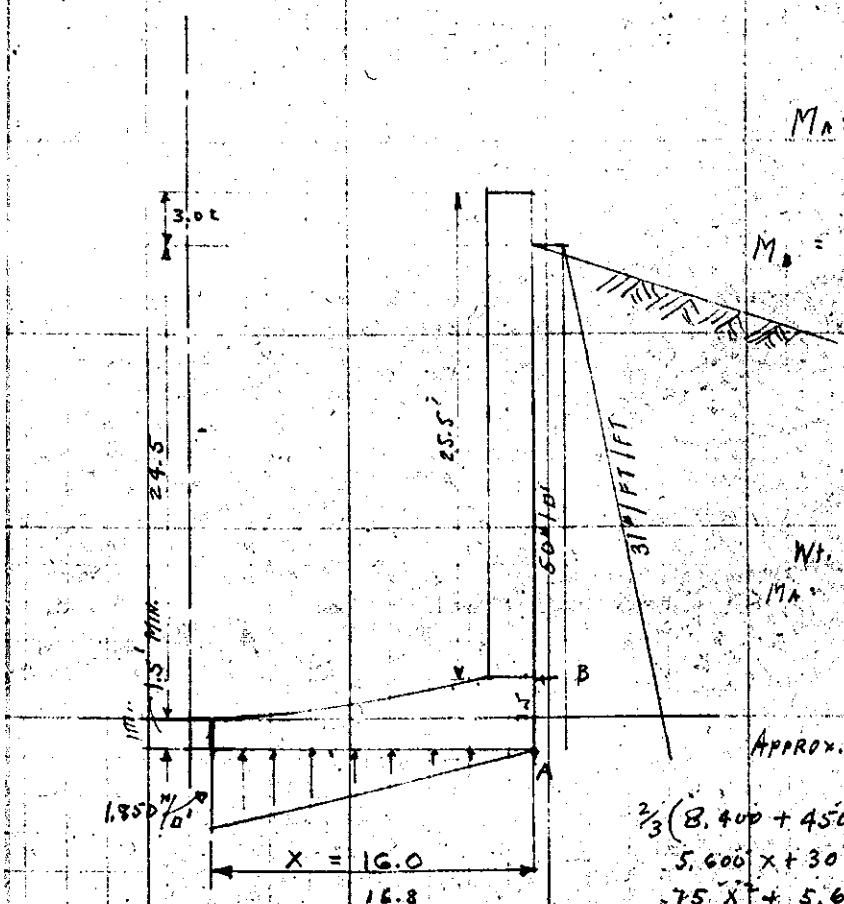
$\sin 35° = .574$

$\sin 50° = .766$

$\sqrt{\frac{\sin\phi \sin(\phi+\delta)}{\cos\delta}} = \sqrt{\frac{.574 \times .766}{.966}} = \sqrt{.455} = .675$ $(1+.675)^2 = 2.8$

$C = \frac{.671}{2.8} = .240$ LEVEL $C = .271$ $w = 35^{\#}/\square''$

$w = \frac{.24}{.271} \times 35 = \underline{31}^{\#}$ 200# SURCHARGE SAY 50#/FT.



MOM. ABT (A)

$M_A = 31 \times \frac{26^3}{6} + 50 \times \frac{26^2}{2} = 90,600 + 16,900 = \underline{107,500}$ 1#

MOM. ABT. (B)

$M_B = 31 \times \frac{22.5^3}{6} + 50 \times \frac{22.5^2}{2} = 58,800 + 12,700 = 71,500$ 1#

APPROX. $d = \sqrt{\frac{71,500}{147.7}} = 22 + 3.5 = 25.5'$

TRY. 26" WALL

$SH = 31 \times \frac{22.5^2}{2} + 50 \times 22.5 = 7,850 + 1130 = 8980^{\#}$

$d\,(SH) = \frac{8,980}{.88 \times 12 \times 50} = 17.0''$

WT. WALL = $2.17 \times 150 \times 25.5' = 8,400$

$M_A = 8,400 \times 1.08 = \cancel{2600}$ 9000

TOTAL $M_A = \cancel{110,100}$ 116,500 107,500

APPROX. MAT = 450 X $M_A = 450 \frac{X^2}{2}$

$\frac{2}{3}(8,400 + 450X)X = \cancel{110,100}$ 116,500 $+ 225X^2$

$5,600X + 300X^2 = \cancel{110,100}$ 116,500 $+ 225X^2$

$75X^2 + 5,600X = \cancel{110,100}$ 116,500

$X^2 + 74.6X + 37.8^2 = \cancel{1466}$ 1550 $+ 1430 = \cancel{28960}$ 2980

$X + 37.8 = \cancel{53.8}$ 54.6

$X = \cancel{16.0}$ 16.8

TOTAL LGTH. = 16.00 MAT = 400 × 16 = 6,400 8,400 14,800

PRESS / □FT = $\frac{14,800}{16.0} \times 2.0 = 1,850^{\#}$

No revision required since base becomes part of conduit invert at this point.

F.T.A.

(1) $N. = 25.5 \times 2.17 \times 150 = 8400$

$$e = \frac{71500 \times 12}{8400} = 102$$

$$e' = 102 - 13 + 22.5 = 111.5$$

$$\frac{Ne'}{bd^2} = \frac{8400 \times 111.5}{12 \times 22.5^2} = 154 \qquad fc. \ 920\#/\square$$

Use 28" base & Taper to 24" Top.

$$e' = 102 - 14 + 24.5 = 112.5$$

$$\frac{Ne'}{bd^2} = \frac{8400 \times 112.5}{12 \times 24.5^2} = 131. \qquad fc = 840.$$

@ B. $- A_s = \dfrac{71500 \times 12}{.88 \times 24.5 \times 18000} = 2.21$

Bond $\dfrac{8980}{.88 \times 125 \times 24.5} = 3.34$

$\Big\}$ 1 1/8 ⊕ - 6" o.c.

Note - Old p. 2 superceded.
In some cases, following computations are base on side wall thickness of 26".

METCALF & EDDY
ENGINEERS
BOSTON, MASS.

PROJECT U.S. Engineers - Hartford SHEET NO. 3
SUBJECT Park River - Pressure Conduit DATE Apr. 30-1940
DETAIL Outlet COMPUTED BY F.A.N.

① M. @ Point 3' above B.

$$31 \frac{19.5^3}{6} + 50 \frac{19.5^2}{2} = 38,300 + 9520 = 47,820.$$

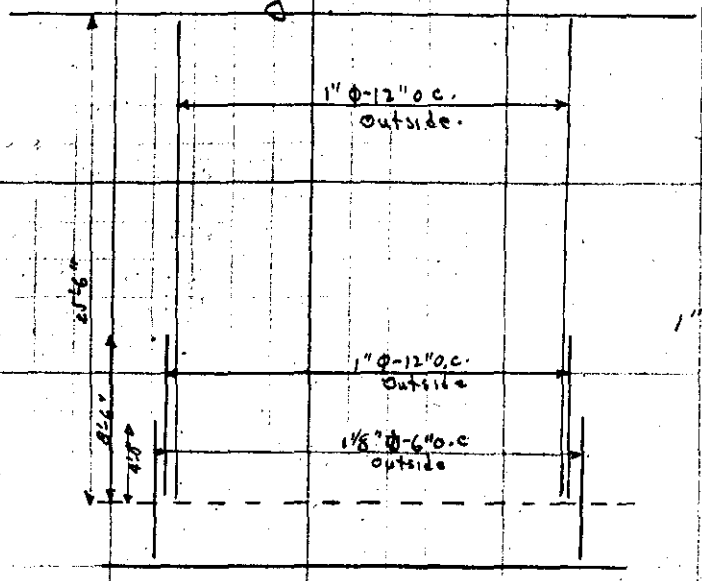
$$A_s = \frac{47,820}{71,500} \times 2.21 = 1.48. \qquad \underline{1" \phi - 6" o.c.}$$

M. @ Point 7' above B.

$$31 \times \frac{15.5^3}{6} + 50 \frac{15.5^2}{2} = 19,250 + 6000 = 25,250 \text{ '\#}$$

$$A_s = \frac{25,250}{71,500} \times 2.21 = .78.$$

Carry Rods to 8.5' above B. then use 1" ϕ-12" o.c.



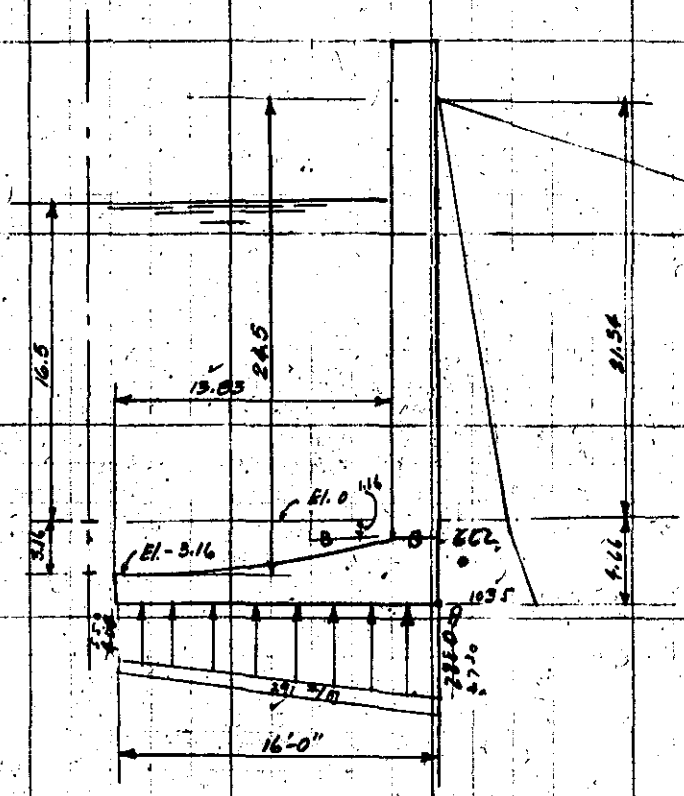
1" = 10'-0"

Spacers - Horiz. 3/4" ϕ - 24" o.c.

Use 5/8" ϕ-12" o.c. horiz. } inside
5/8" ϕ - 24" o.c. vert } face.

Elev. of wall

① North Wall Continued.



$31 \times \frac{21.34^2}{2} = 7060$ #

M. @ (B.)

$7060 \times 8.27 = 58,400$

$662 \times \frac{1.16^2}{2} = 445$

$80 \times 1.16 \times 1/6 = 15$

58,860

Water. $62.5 \times 17.66^3 \times \frac{1}{6} = 57,500$

1,360 No steel inside.

Mom. @ A.

Earth. $7060 \times 11.77 = 83,100$

$662 \times 4.66^2 \times 1/2 = 7200$

$80 \times 4.66^3 \times 1/6 = 1350$

Wall $8400 \times 1.08 = 9000$

Water $62.5 \times 13.83 \times 18.66 \times 9.08 = 146,500$

MAT $6400 \times 8. = 51,200$

~~291,800~~ 278,350

WATER $= 62.5 \times \frac{19.65}{2} = 12,100$ #

water $12,100 \times 8.05 = 97,500$

$62.5 \times 4.66 \times 16^2 \times 1/2 = 27300$

134,800

MA. = ~~157,020~~ 163,550

Weights. $62.5 \times 13.83 \times 18.66 = 16120$

$62.5 \times 4.66 \times 16 = -4660$

11,460

WALL 8400

MAT 6400

26,260 = ΣV.

~~157,020~~ 163,550 / 26,260 = ~~5.98~~ 6.23

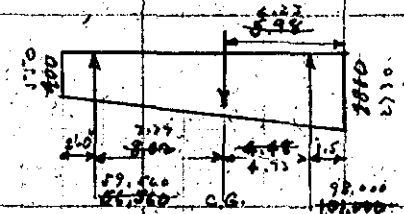
Ecc. = 8.0 - ~~5.98~~ 6.23 = ~~2.02~~ 1.77

M℄ = 26260 × ~~2.02~~ 1.77 = ~~53,000~~ 46,500 1M

Upward $= 62.5 \times 4.66 = 291$ #/□

$f = \frac{26260}{16.0} \pm \frac{\cancel{53,000} \times 6}{16^2} = 1640 \pm \cancel{1040}\ 1090$

$= \cancel{2680}\ 2730$ or $\cancel{600}\ 550$

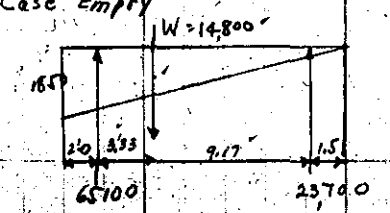


Total Pile Load. = 26,260 #/ft Use 2 piles

$S = \frac{2 \times 100,000}{26260} = 7.6'$ Try piles 6'-0" o.c.

Ld = 26,260 × 6.0 = 157,560

Case Empty



Max L.D. 157,560 $\frac{2.33}{12.5}$ = ~~101,000~~ 78,000 # Use 6'-0" spacing

L.D. 14,800 × 6.0 = 88,800

Pile Load 88,800 $\frac{9.17}{12.50}$ = 65,100

23,700

Form 115 10M-11-39

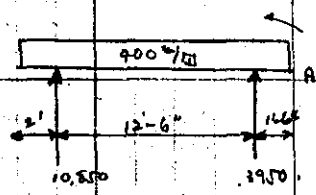
METCALF & EDDY
ENGINEERS
BOSTON, MASS.

PROJECT U. S. Engineers - Hartford
SUBJECT Park River - Pressure Conduit
DETAIL Outlet

PAGE 5
DATE 5/4/40
COMPUTED BY FAN.

① Dry Case

Base.



Pile Load = 10 850 × 6 = 65,100

Circum. Pile = 50"

Punching SH $d = \frac{65,100}{.88 \times 50 \times 150} = 9.85$

3.5

13.35

18" slab min. OK.

M @ face wall. $10,850 \times 12 - 400 \frac{14^2}{2} = 130,300 - 39200 = 91,100.$

SH = 10 850 − 400(14) = 5250

$A_s = \frac{91100 \times 2}{.88 \times 38.5 \times 18000} = 1.79$ 1" ⌀ - 6" o.c. outside.

$d\ (M) = \sqrt{\frac{91100}{147.7}} = \sqrt{617} = 24.9$ OK.

Bond is O.K.

at point edge of pile near D.

SH = 10 850 − 2.75 (400) = 9750

Bond $\frac{9750}{.88 \times 125 \times 17.5} = 5.07$ 7/8" ⌀ - 6" o.c.

d = 21 - 3.5

Mom. Practically zero here. Use on BOT face.

@ Point 4'-6 from A.

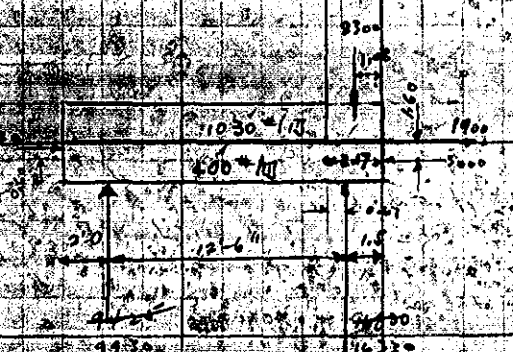
$10850\ (9.5) - 400 \frac{11.5^2}{2} = 103,000 - 26,400 = 76600$ "

SH = 10850 − 400 (11.5) = 6250 #

$A_s = \frac{76600 \times 12}{.88 \times 18000 \times 33} = 1.82$ 1" ⌀ - 6" o.c.

Bond OK.

① Wet Case



Water Load - 16.5
62.5 × 16.5 = 1031

M @ Face wall

$\cancel{9425}$ 9930 × 11.83 = $\cancel{111,500}$ 117,300
− 1430 $\frac{13.83^2}{2}$ − 136,500
− $\cancel{25000}$ 19,200

Wall design shows No Steel required on inside face of wall.
∴ No Neg. M. can occur in base.
Steel O.K. as per dry case

$\frac{59560}{6}$ = 9930

$\frac{98000}{6}$ = 16330

$A_s = \frac{\cancel{25000}\ 19200 \times 12}{.88 \times 38.5 \times 18000} = \cancel{.492}\ .378$

S.H. $\cancel{9425}$ 9930 − 1430 (13.83) = $\cancel{9425}$ 9930 − 19800 = $\cancel{10,375}$ 9870

Bond $\frac{\cancel{10375}\ 9870}{.88 \times 125 \times 38.5} = \cancel{2.45}\ 2.33$

OK as per dry case.

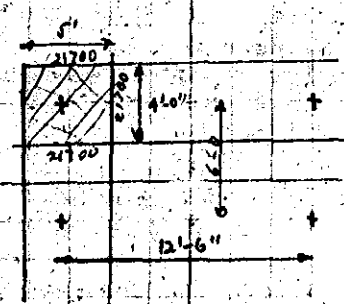
Point zero SH in base

$\cancel{9425}$ 9930 = 1430 x or x = $\cancel{6.57}$ 6.95

+M $\cancel{9425}$ 9930 ($\cancel{4.57}$ 4.95) − 1431 $\frac{\cancel{6.57^2}\ 6.95}{2}$ = $\cancel{43,100}$ 49100 − $\cancel{30,900}$ 34500 = $\cancel{12200}$ 14,600 #

Steel Ok as per dry case.

Transverse steel



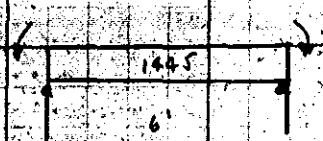
10850 × 6 =

Pile Load = 65100 #

(SH) Load per side shaded area = $\frac{65100}{3}$ = 21700

Load on beam.

$\frac{21700 \times 2}{6 \times 5}$ = 1445 #/□'



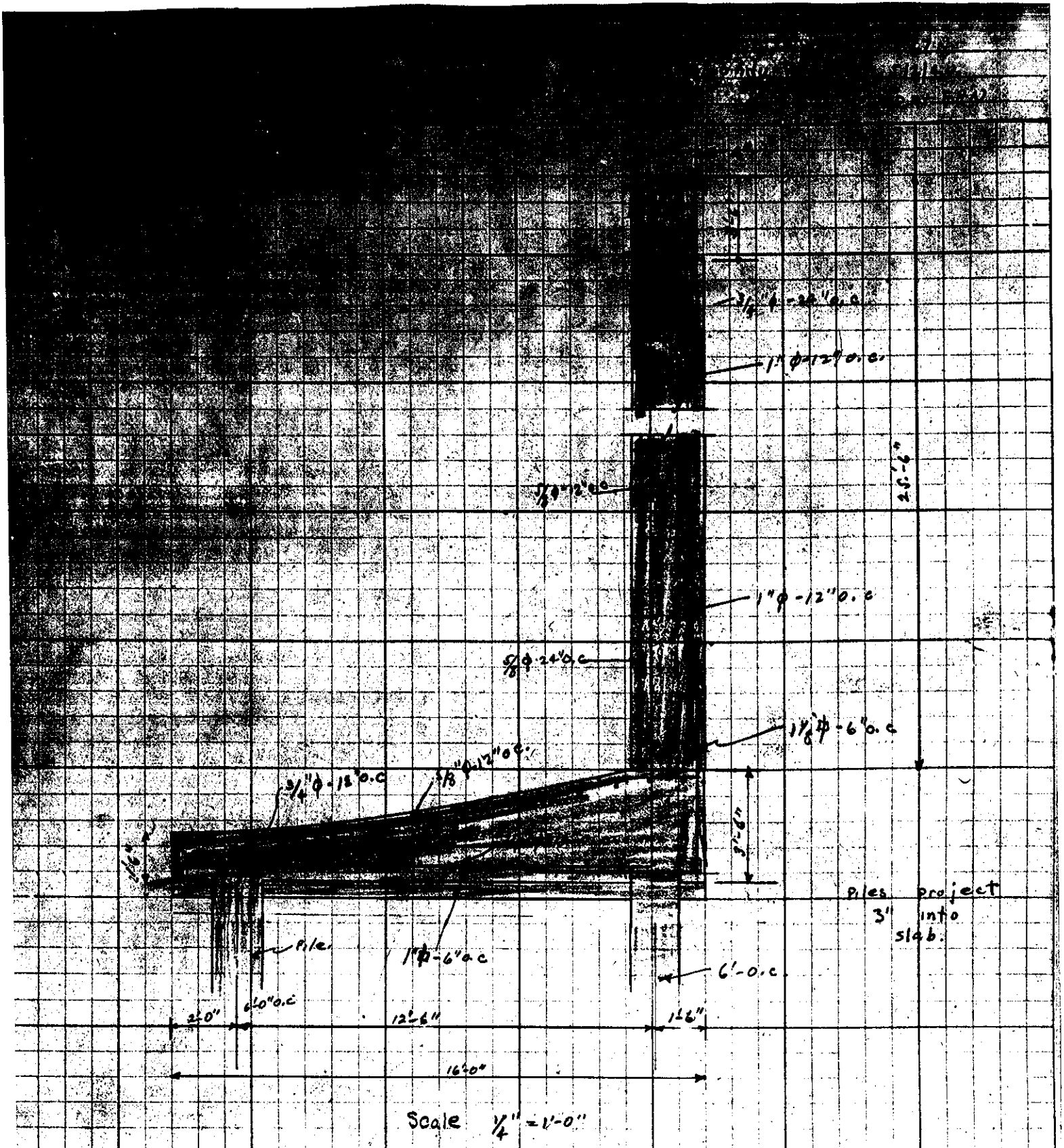
M = 1445 $\frac{6^2}{12}$ = 4335 '#

SH = 1445 × 2.5 = 3610 To edge piles.

$A_s = \frac{4335 \times 12}{.88 \times 18000 \times 14.5}$ = .226

Bond $\frac{3610}{.88 \times 125 \times 14.5}$ = 2.27

3/4" ϕ - 12" o.c. both faces

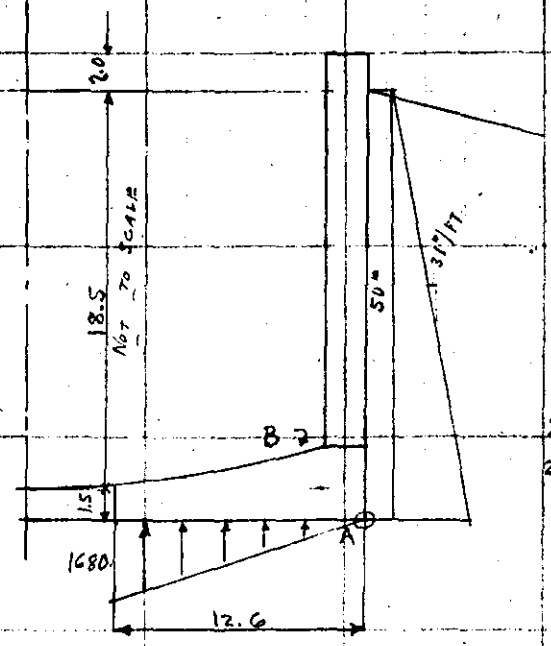


Scale 1/4" = 1'-0"

Typical Section (1)

(2) NORTH WALL

MINIMUM WALL THICKNESS = 24"



MOM. @ B.

$50 \times 16.5^2 \times \frac{1}{2} + 31 \times 16.5^3 \times \frac{1}{6} = 6{,}800 + 23{,}200 = 30{,}000$ '#

$SH = 50 \times 16.5 + 31 \times 16.5^2 \times \frac{1}{2} = 825 + 4230 = 5055$ #

$d(M) = \sqrt{\frac{30{,}000}{147.7}} = 14.3$ " $d(SH) = \frac{5055}{.88 \times 12 \times 50} = 9.6$

— USE 24" WALL —

Wt. WALL = $150 \times 2 \times 18.5 = 5550$ #

MAT = 400x.

MOM. @ A

$50 \times 20^2 \times \frac{1}{2} + 31 \times 20^3 \times \frac{1}{6} = 10{,}000 + 41{,}300 = 51{,}300$

$5{,}550 \times 1.0 = 5600$

$M = 56{,}900$

$\frac{2}{3} x (400x + 5{,}550) = 56{,}900 + 400 \frac{x^2}{2}$

$267 x^2 + 3{,}700 x = 56{,}900 + 200 x^2$

$67 x^2 + 3{,}700 x = 56{,}900$

$x^2 + 55.2x + 27.6^2 = 850 + 762 = 1612$

$x + 27.6 = 40.2$

$x = 12.6$

TOTAL Wt. = $5{,}550 + 12.6 \times 400 = 10{,}590$ #.

EARTH PRESSURE = $2 \times \frac{10{,}590}{12.6} = 1680$ #

Side wall

@ B. — $A_s = \frac{30{,}000 \times 12}{.88 \times 20.5 \times 18000} = 1.11$ □ 7/8 φ — 6" O.C.

Bond $\frac{5055}{.88 \times 20.5 \times 125} = 2.24$

Mom. @ face wall on base

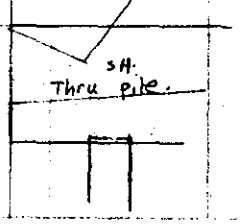
from p.10. pile load 8030.

$M = 8030 (9.1 + .5) - 400 \frac{10.5^2}{2} = 69{,}000 - 22050 = 46{,}950$

$SH = 8030 - 400 \times 10.5 = 8030 - 4200 = 3830$ #

$A_s = \frac{46{,}950 \times 12}{.88 \times 18000 \times 38.5} = .923$ 7/8 φ - 6" O.C. OK.

d @ point Max SH. in base $\frac{6930}{.88 \times 12 \times 50} = 13.1$ 3.5 16.6 18" OK.



$8030 - 400(2.75) = 6930$

② M at point 3'-0" above B

18.5
2
16.5
3
13.5

$50 \times \frac{13.5^2}{2} + 31 \frac{13.5^3}{6} = 4550 + 12700 = 17,250$ '#

$A_s = \frac{17250}{30000} 1.11 = .64$

Carry corner bars up to point 4'-6" above B. and use $A_s = .60$" beyond that point.

@ Point 7' above B.

$50 \times \frac{9.5^2}{2} + 31 \frac{9.5^3}{6} = 2250 + 4440 = 6690$ '#

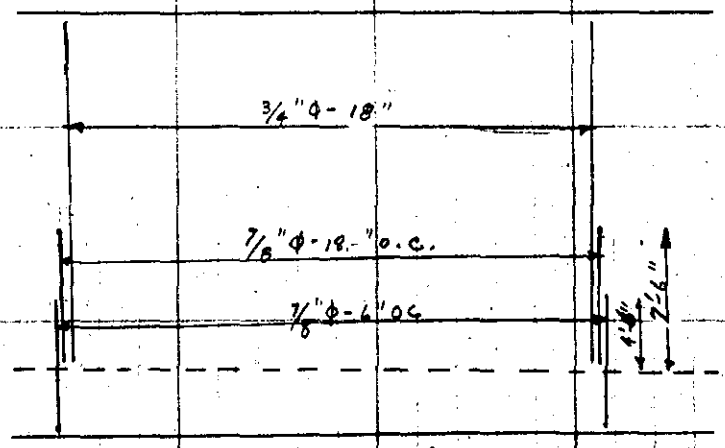
$A_s = \frac{6690}{30} 1.11 = .25$ Try 7.5' and 3/4 φ-24" oc.

@ 6' above B M = 2760 + 5800 8560 $A_s = \frac{8560}{30} 1.11 = .32$

Use 3/4 φ-18" oc 6-6" above B.

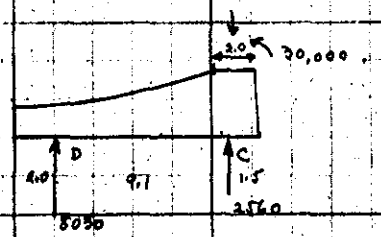
Scale 1"=10'-0"

Bars shown are on Outside



Spacers Horiz 3/4" φ-24" o.c.

Outside face.



SH. @ D. 8030 - 400 x 2.75 = 8030 - 1100 = 6930

Bond. $\frac{6930}{.88 \times 20.5 \times 125} = 3.07$ 3/4" φ-9" o.c.

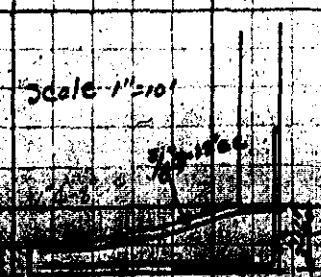
Inside Face. { M is practically zero on top side

At point 3' from face wall toward D.

M = 8030 5.6 - 400 $\frac{7.6^2}{2}$ = 44900 - 11500 = 33,400

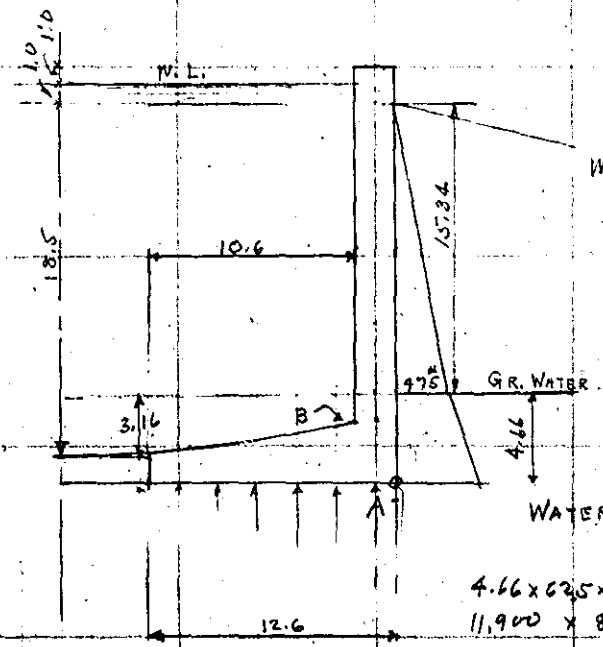
$A_s = \frac{33400 \times 12}{.88 \times 18000 \times 26.5} = 0.96$

Scale 1"=10'



Extend corner bars out to point 3'-3" from face of wall and use 7/8 φ - 6" o.c. in base.

(2) NORTH WALL (FLOODED)



31 × 15.34 = 475# 80 × 4.66 = 373

475 × 15.34 × ½ = 3640

MOM'S. @ B.

3,640 × 6.27	=	22,800
475 × 1.16² × ½	=	320
80 × 1.16³ × ⅙	=	20
		23,140
WATER = 62.5 × 17.5³ × ⅙	=	-55,800
M_B	=	-32,660' INSIDE STEEL

Wall

MOM'S @ A 19.5² × 62.5 × ½ = 11,900#

3,640 × 9.77	=	35600
475 × 4.66² × ½	=	5160
80# × 4.66³ × ⅙	=	1350
WALL	=	5,600
MAT 5040 × 6.3	=	31,800
WATER = 10.6 × 18.5 × 62.5 × 7.3	=	89,500
		169 010
4.66 × 62.5 × 12.6² × ½ =	23,100	
11,900 × 8.0	95,200	118,300
	M_A =	50,710

VERTICAL LOAD.

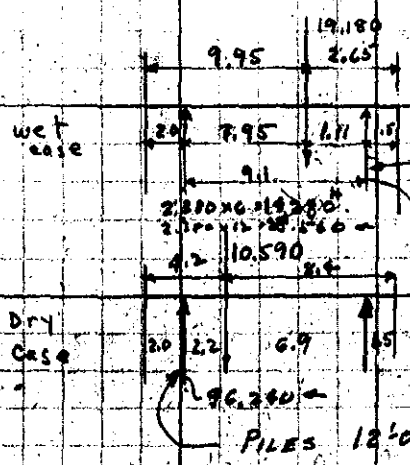
WALL	=	5,550
MAT	=	5040
WATER 10.6 × 18.5 × 62.5	=	12,260
		22850
UPWARD = 4.66 × 12.6 × 62.5	=	-3670
		19,180#

C. G. = 50,710 ÷ 19,180 = 2.65

19,180 × 7.95 / 9.10 = 16,800# 19,180 − 16,800 = 2380

S = 100,000 ÷ 16,800 = 5.95

19,180 − 16,800 = 2380



6.0 O.C. = 6 × 16,800 = 100,800#

SPACE 6'-0" O.C.

10,590 × 6.9 / 9.1 = 8,030 × 12 = 96,360

Dry case

Pile loads / ft.

	Left	Right
wet case	2380	16,800
Dry Case	8030	2560
Pile spacing	12'-0"	6'-0"

Vertical wall.

Wet case.

@ B. $M_1 = -32660$

$+A_s \quad \frac{32.66}{30} 1.11 = 1.21$

S.H. @ B. $3640 + 80 \frac{1.17^2}{2} - \frac{17.5^2}{2} \times 62.5 = 3695 - 9560 = -5865$

Bond $\frac{5865}{.88 \times 20.5 \times 125} = 2.6$

Try $7/8\phi$ - 6" o.c. Inside.

@ Base along face of wall

S.H. $= 2380 - 400(10.6) - 62.5(13.84)10.6 = 2380 - 4240 - 9090 = 10950$

$M_1 = 2380.(8.6) - 400 \frac{10.6^2}{2} - 62.5 \times 13.84 \times \frac{10.6^2}{2}$

$20,400 - 22,400 - 48,500 = -50,500$

$A_s \quad \frac{50500 \times 12}{.88 \times 38.5 \times 18000} = .99$ Bond $\frac{10950}{.88 \times 38.5 \times 125} = 2.59$ $\frac{7}{8}\phi$ 6" o.c. Inside

M @ Point 3' above B.

$+31 \frac{13.5^3}{6} - 62.5 \frac{4.5^3}{6} = 12,700 - 31700 = 19,000$ '#

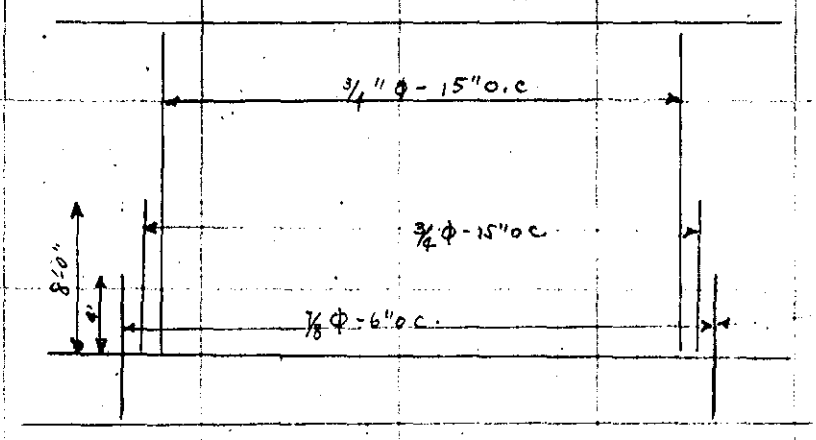
$A_s = \frac{19}{30} 1.11 = .703$ $3/4\phi$ - 7.5" o.c

M @ Point. 7' above B.

$31 \frac{9.5^3}{6} - 62.5 \frac{10.5^3}{6} = 4430 - 12,100 = 7,670$ '#

$A_s = \frac{7.67}{30} 1.11 = .284$ $3/4\phi$ - 18" o.c.

Inside face

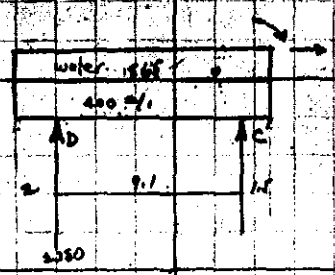


Spacers.
3/4" φ - 24" o.c.

Inside face

(2)

Base



water $62.5(18.5 - 4.66) = 865$ (13.84)

PT zero SH. $\frac{2380}{1265} = 1.88$ in pile. D.

SH. @ D. $2380 - 1265(2.75) = -1100$ (2480)

Use same steel as per dry case over pile p.9.

M @ PT. 3' to left of face of wall.

$M = 2380(5.6) - 1265 \frac{7.6^2}{2} =$

$13,330 - 36,500 = -23,170$ '#

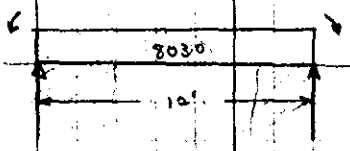
$A_s = \frac{23170 \times 12}{.88 \times 18000 \times 28.5} = .615$ Carry 7/8 φ - 12" oc Inside.

$SH = 2380 - 1265(7.6) = 2380 - 9600 = 7220$ #

Bond $\frac{7220}{.88 \times 28.5 \times 125} = 2.31$

Transverse Beam Action

Design for Dry Case only.

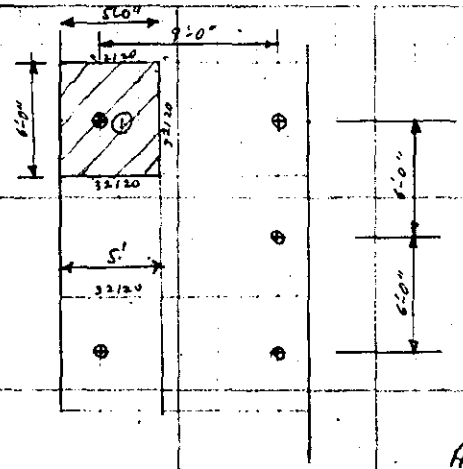


$M = \frac{8030 \cdot 12^2}{12} = 96400$ '#

Assume strip 5'-0" wide $M = 19,300$ "

$d\ (M)\ \sqrt{\frac{19300}{147.7}} = 11.5$ OK

(2)



Pile 1 carries 8030 x 12 = 96 360 #
or SH. per side = 32 120

or on a foot strip,
SH. = $\frac{32160}{5}$ = 6430 #

d (SH) = $\frac{6430}{.88 \times 12 \times 50}$ = 12.2

Area pile head = $.67^2 \pi$ = 1.4 s. ft.

Aver. Load on square ① = $\frac{96360}{5 \times 6}$ = 3212. #/□

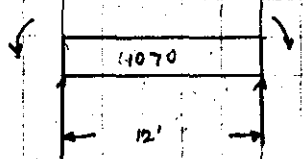
Load on pile head = 3212 x 1.4 = 4490. #

Net shear on pile 96 360 - 4500 = 91,860 #

Circum pile using 16" D. = πD = 50"

Punching SH. $\frac{91860}{.88 \times 50 \times 150}$ = 14.0 18" slab is ok.

Load per □ ft. = $\frac{64240}{5 \times 12}$ = $\frac{5350}{5}$ = 1070

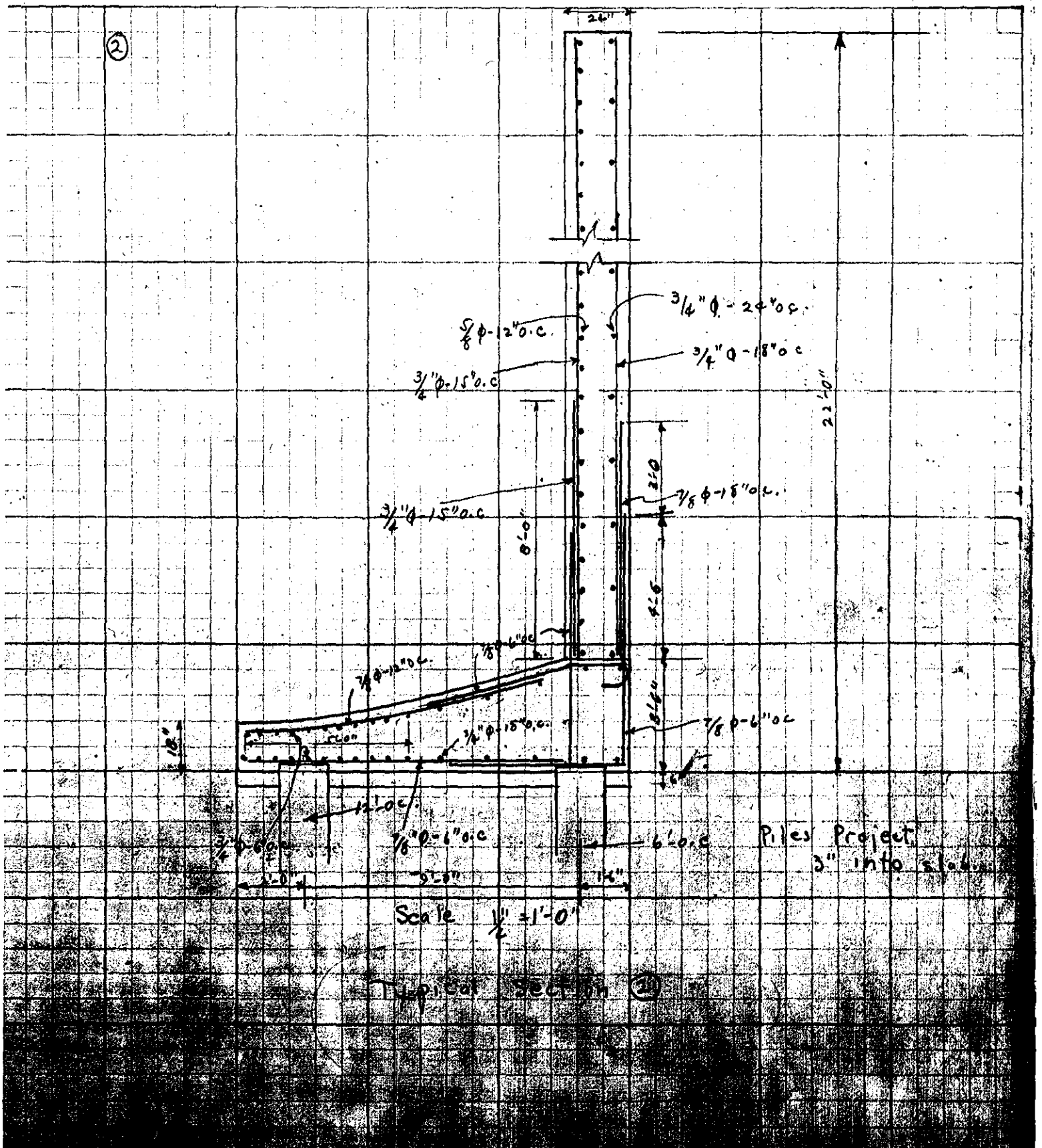


Max M = 1070 $\frac{12^2}{12}$ = 12,840 '#

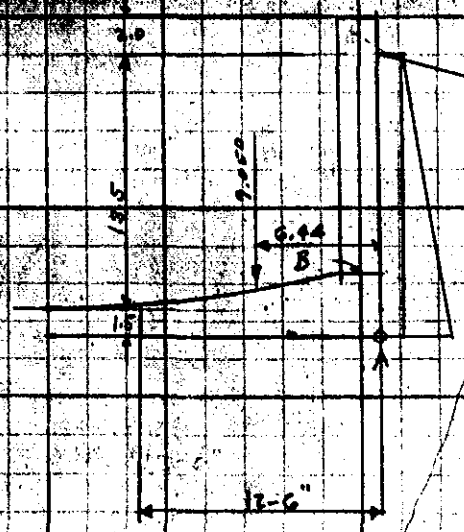
A_s = $\frac{12840 \times 12}{.88 \times 14.5 \times 18000}$ = .67

Bond. $\frac{6430}{.88 \times 14.5 \times 1.25}$ = 4.02

Use 3/4" φ - 6" oc in 5'-0 strip.
Top & BOT.


2
24"
3/4" ϕ - 24" o.c.
5/8 ϕ - 12" o.c.
3/4" ϕ - 18" o.c
3/4" ϕ - 15" o.c
22'-0"
3'-0
7/8 ϕ - 18" o.c.
3/4" ϕ - 15" o.c
8'-0
4'-6
7/8 ϕ - 6" o.c
7/8 ϕ - 12" o.c.
7/8 ϕ - 6" o.c
3/4" ϕ - 18" o.c.
7/8 ϕ - 6" o.c
12'-0 c.c.
3/4 ϕ - 6" o.c
7/8" ϕ - 6" o.c
6'-0 c.c
Piles Project 3" into slab
3'-0"
3'-8"
1'-4"
Scale 1/2" = 1'-0"
Typical Section 2

NORTH WALL



Mom @ B

$50 \times 11.5^2 \times \frac{1}{2} + 31 \times 11.5^3 \times \frac{1}{6} = 3,300 + 7,860 = 11,160'^{\#}$

$SH = 50 \times 11.5 + 31 \times 11.5^2 \times \frac{1}{2} = 580 + 2050 = 2630^{\#}$

Mom @ A WALL = $13.5 \times 300 = 4050'^{\#}$

$50 \times 15.0^2 \times \frac{1}{2} + 31 \times 15.0^3 \times \frac{1}{6} = 5630 + 17,450 = 23,080'^{\#}$

WALL = $1.0 \times 4050 = 4050$

27,130

MAT = $450\,\frac{x^2}{2}$

TOTAL LOAD = $450x + 4,050$

$\frac{2}{3}x(450x + 4,050) = 27,130 + 225x^2$

$300x^2 + 2700x = 27,130 + 225x^2$

$75x^2 + 2700x = 27,130$

$x^2 + 36x + 18^2 = 362 + 324 = 686$

$x + 18 = 26.2$

$x = 8.2$ USE 12.5 FT. PILES 9'-0" O.C.

MAT Use 400#/FT

MOM @ A = $27,130 + \overset{31,200}{400 \times 12.5^2 \times \frac{1}{2}} = 58,330'^{\#}$

VER. LOAD = $4050 + \overset{5000}{400 \times 12.5} = 9,050$ C.G = $58,330 \div 9,050 = 6.44$

@ B $d(M) = \sqrt{\frac{11160}{147.7}} = 8.7$ $d.SH = \frac{2630}{.88 \times 12 \times 50} = .5$

Use 24" wall.

$-A_s = \frac{11,160 \times 12}{.88 \times 18000 \times 20.5} = .41$ Use 3/4"ϕ-12" o.c.

Bond ok.

Mom. at face of wall on base.
See p. 17 for pile load.

$4980\,(8.5) - 400\,\frac{10.5^2}{2}$

$42,300 - 22050 = 20,250'^{\#}$

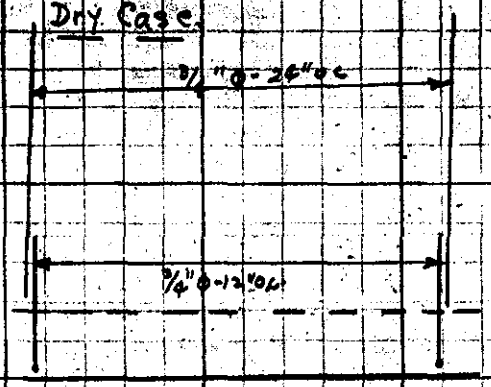
$A_s = \frac{20,250 \times 12}{.88 \times 18000 \times 38.5} = .40$ 3/4"ϕ-12" o.c. OK.

M. @ point 3 ft. above B.

$50\,\frac{8.5^2}{2} + 31\,\frac{8.5^3}{6} = 1800 + 3170 = 4970.$

$A_s = \frac{4970}{20250}\,.40 = .10$ Use 5/8"ϕ 24" o.c. both ways.

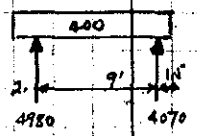
(3) Dry Case.



Outside face

Base.

Point 3' in from face wall



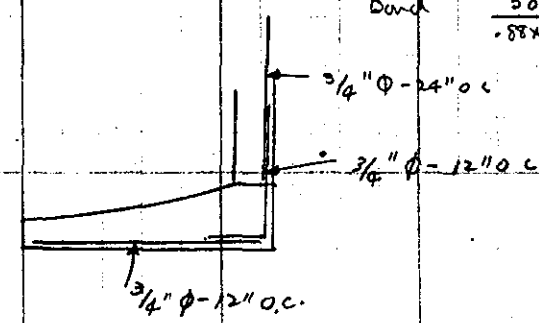
$4980(5.5) - 400\,\frac{7.5^2}{2}$

$27400 - 11500 = 15,900$ #

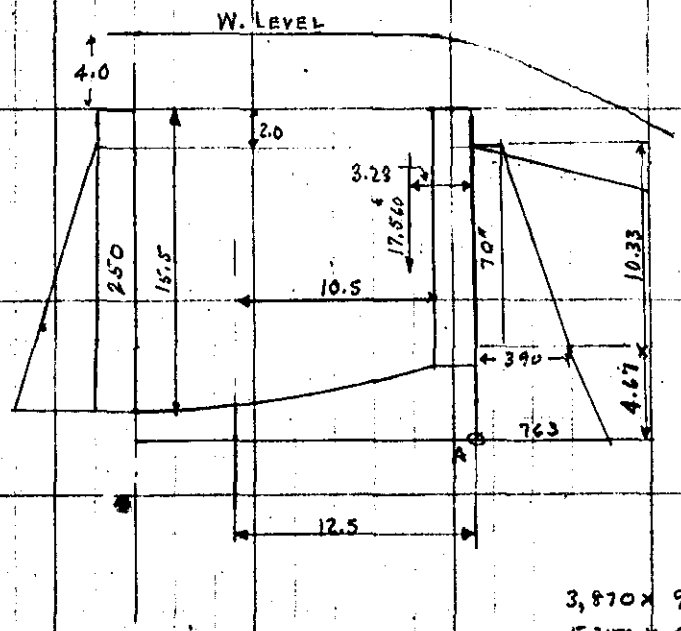
$A_s = \frac{15900 \times 12}{.88 \times 15000 \times 28.5} = .42$ 3/4" Φ-12" o.c. Use entire face.

Sh. @ pile $4980 - 2.75(400) = 3880$ #

Bond $\frac{3880}{.88 \times 14.5 \times 125} = 2.44$. Use 3/4" Φ-12" o.c.



③ NORTH WALL FLOODED



ASSUME 4 FT WATER ON GROUND = 4 × 62.5 × .271 = 70#/□

31 × 10.33 = 320 80 × 4.67 = 373#

70 × 10.33 = 722#

320 × 10.33 × ½ = 1650#

250 × 15.5 = 3870#

62.5 × 15.5² × ½ = 5700#

18.5 × 10.5 × 62.5 = 12,150#

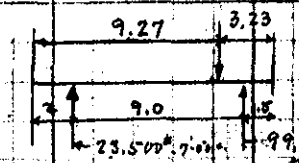
MOM. (A)

WATER SURCHARGE	722 × 9.84	=	7,100
EARTH	1650 × 8.11	=	13,400
EARTH	390 × 4.67² × ½	=	4250
EARTH + WATER	80# × 4.67³ × 1/6	=	1360
WALL	1 × 4050	=	4050
WATER =	12,150 × 7.25	=	88,100
MAT =	5,000 × 6.25	=	31,300
			149,560
3,870 × 9.25 =	35,800		
5,700 × 6.00 =	34,200		
62.5 × 4.67 × 12.5² × ½ =	22,800		92,800
		M_A =	56,760

VERT. LOADS.

WALL = 4050
MAT = 5,000
WATER = 12,150
21,200 + 4.67 × 62.5 × 12.5 = 17,560 (3,640)

ECC = 56,760 ÷ 17,560 = 3.23



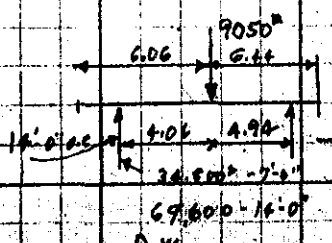
FLOOD CONDITION

21,200 × 7.82/9.00 = 18,400 S = 100,000 ÷ 18,400 = 5.42 FT O.C.

21,200 − 18,400 = 2,800

PILE LD = 7.27/9.0 × 17,560 = 14,200#/' (17,560) S = 100,000/14,200 = 7 FT O.C.

3,360 × 7.0 = 23,500#



9,050 × 4.94/9.0 = 4,980#/' 34,800# ON PILE

— USE 7'-0" O.C.

Pile loads per Foot

	Left.	Right.	Total.
Dry Case	4980	4070	9050
Wet Case	3360	14,200	17,560
Pile Spacing	1460	740	

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(3) Wet Case Vertical Wall.

M @ B.

$722 \times 6.34 = 4680$
$1650 \times 4.61 = 7600$
$390 \times \frac{1.17^2}{2} = 255$
$80 \times 1.17^3 \, 1/6 = 20$
$12,555$

12555

Inside water.

3370 $62.5 \times 4 \times 13.5^2 \times 1/2 = 21900$
5700 $62.5 \times 11.5^3 \times 1/6 = 15850$
-37750

$-37,750$

$-25,195$ Inside steel

$SH = 722 + 1650 + \overset{456}{390(1.17)} + \overset{55}{\left(80 \frac{1.17^2}{2}\right)} - \overset{3370}{62.5 \times 4 \times 13.5} - \overset{4130}{62.5 \cdot \frac{11.5^2}{2}}$
$= 2880 - 7500 = -4620.$

$-A_s = \frac{25,195 \times 12}{.88 \times 18000 \times 20.5} = .81.$ $3/4\,\phi$ - 6" o.c. Inside.

Bond. $\frac{4620}{.88 \times 125 \times 20.5} = 2.05$ Inside face
Carry up. 4'-0 ft.

M. @ Point. 3' above B.

$70 \times 8.5^2 \times 1/2 = 2520$
$31 \times 8.5^3 \times 1/6 = 3170$
5690

$4 \times 62.5 \times 12.5^2 \times 1/2 = 13800$
$62.5 \times 18.5^3 \times 1/6 = 6400$
$20,200$ Net. $20200 - 5690 = 14,510$

$A_s = \frac{14510}{25,195} \cdot 181 = .46$ $3/4\,\phi$ - 11½" o.c. Inside
Extend [illegible] 6" [illegible]
[illegible]

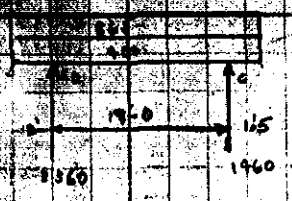
M @ Point 6' above B.

$70 \times 5.5^2 \times 1/2 = 1060$
$3 \times 5.5^3 \times 1/6 = 861$
1820

$4 \times 62.5 \times$ [illegible]

Left Cant. Bent

water load. $(18.5 - 4.67)\ 62.5 = 865^{\#}/\square$



M. @ Face wall.

$3360\,(8.5) - 1265\,\frac{10.5^2}{2} =$

$28{,}500 - 69{,}800 = -41{,}300$

SH. $= 3360 - 1265 = 9{,}290$ #

$A_s = \frac{41{,}300}{.88 \times 18000 \times 38.5} = .68$ } $7/8\,\phi$-10.5" o.c. / 1"ϕ - 14" o.c

Bond $\frac{9290}{.88 \times 38.5 \times 125} = 2.19.$

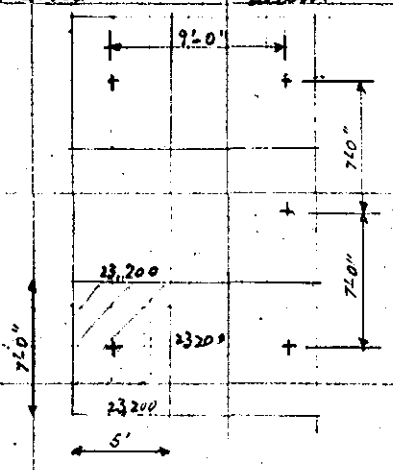
@ Point 2 ft in from face.

M. $= 3360\,(6.5) - 1265\,\frac{8.5^2}{2} = 21{,}800 - 45600 = 23{,}800$ #

$A_s = \frac{23\,800 \times 12}{.88 \times 18000 \times 32.5} = .56.$ $7/8\,\phi$-12" o.c.

Use 1"ϕ - 14" oc + limit

Transverse beam.



Area Pile head 1.4 s.f.

shaded Pile Carries. 69,600

SH. Per side = 23,200

Per ft. $\frac{23{,}200}{5} = 4{,}800$

Aver load on shaded area $= \frac{69600}{35} = 1990$ #/□

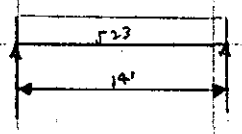
Load on Pile head $= 1990 \times 1.4 = 2780$ #

Net. SH on Pile $= 69600 - 2780 = 66820$

Punching SH $= \frac{66820}{.88 \times 50 \times 140} = 10.1$ OK.

(50 = circumference)

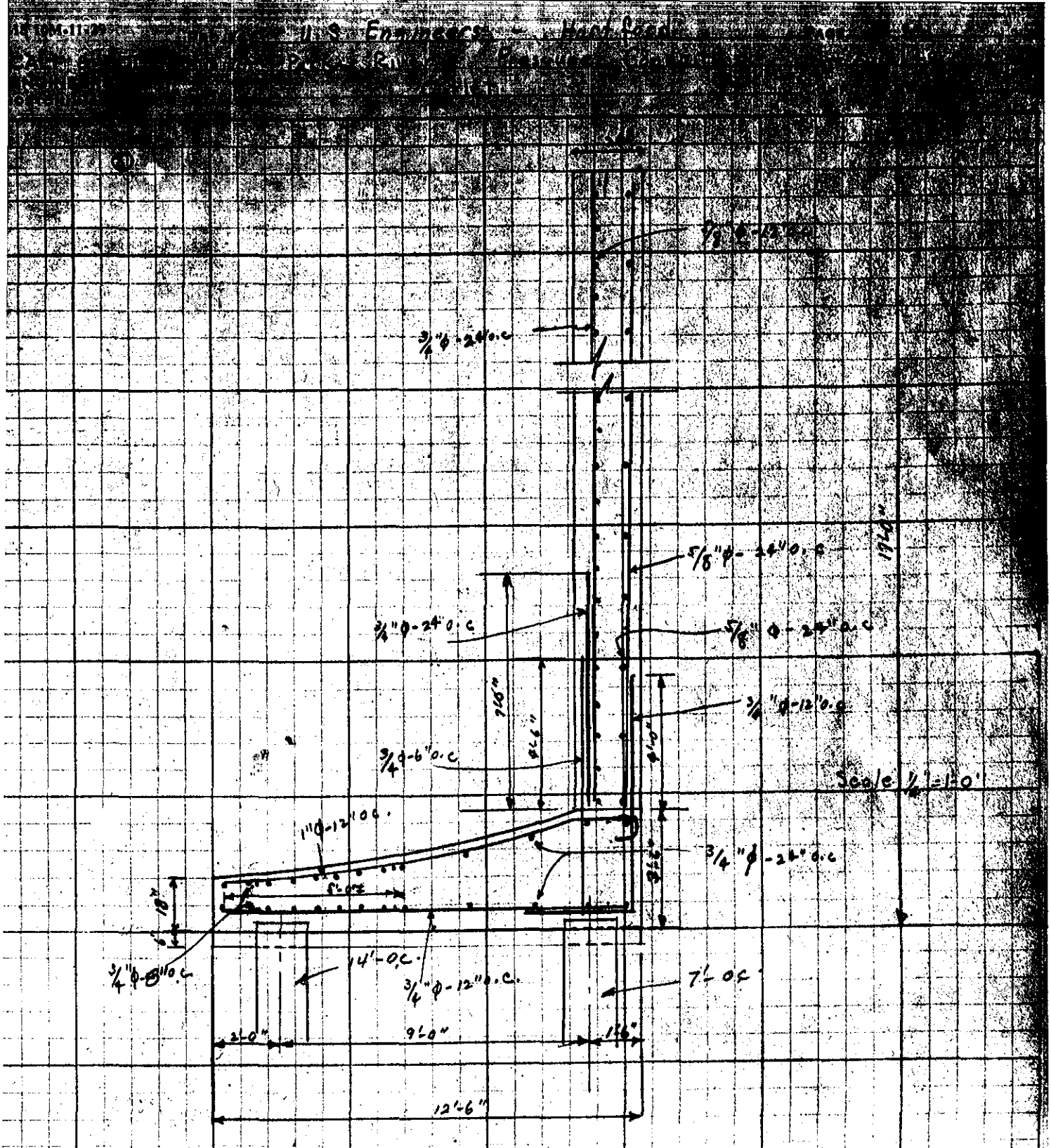
Load per ft $= \frac{23{,}200 \times 2}{5 \times 12} = 774$ #/□



Max M $= 774 \times \frac{14^2}{12} = 12{,}600$ '#

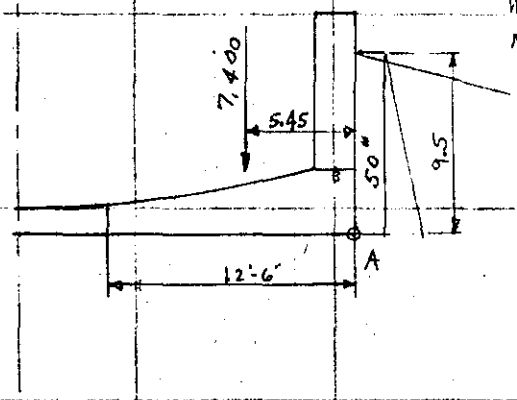
$A_s = \frac{12600 \times 12}{.88 \times 14.5 \times 18000} = .658$ } 3/4"ϕ-8 o.c. Top + Bot.

Bond $\frac{774 \times 7}{.88 \times 14.5 \times 125} = 3.40.$



Typical Section (5)

(4) Dry Case.



MAT = 400 x 12.5 = 5,000#

MOM @ A

50 x 9.5² x 1/2 = 2260
31 x 9.5³ x 1/6 = 4430
WALL 2400 x 1.0 = 2400
MAT 5,000 x 6.25 = 31,300

M_A = 40,390

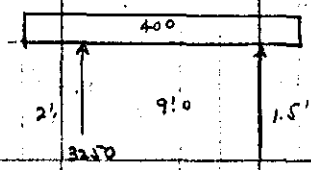
C. G = 40,390 ÷ 7,400 = 5.45 FT.

M_B = 50 x 6² x 1/2 = 900
31 x 6³ x 1/6 = 1120
1020 #

SH. B = 50 x 6 + 31 x 6² x 1/2 = 300 + 560 = 860 #

$A_s = \frac{900 \times 12}{.88 \times 18000 \times 20.5} = .033$ 1/2" φ - 12" OC OK.

Bond $\frac{860}{.88 \times 125 \times 20.5} = .38$

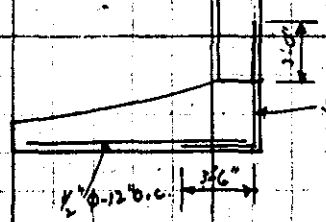


M @ face wall.

3250 (10.5) − 400 $\frac{10.5^2}{2}$
34100 − 22000 = 12,100 #

SH = 3250 − 10.5 x 400 = −950.

$A_s = \frac{12100 \times 12}{.88 \times 18000 \times 38.5} = .24$ Use 5/8" φ - 12" o.c. Outside



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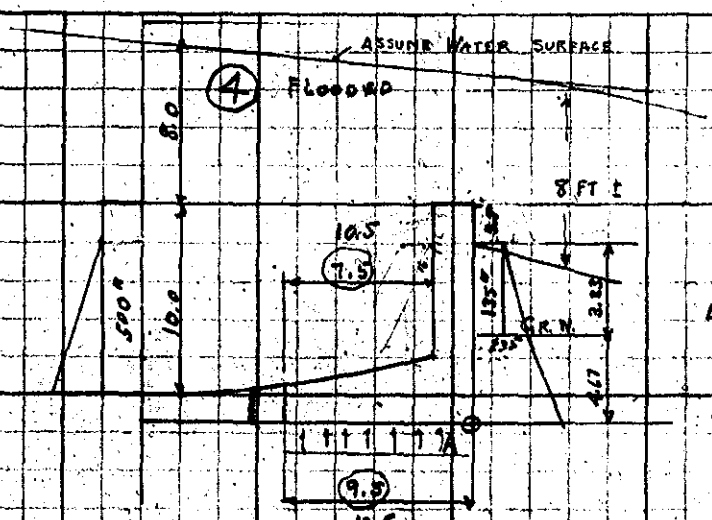


ASSUME 8 FT WATER ON GROUND

8 × 62.5 × .271 = 135#

31 × 3.33 = 103#

8 × 62.5 = 500

LOADS.

135 × 3.33 = 450

EARTH 103 × 3.33 × ½ = 170#

500 × 10 = 5,000

62.5 × 8² × ½ = 2,000#

WATER = 7.5 × 16 × 62.5 = 7,500#

Wall = 300 × 8 = 2400

MAT = 450 × 9.5 = 4300

Conc. = 6700

WATER = 7,500

TOTAL = 14,200

MOM. AT (A)

450 × 6.34 = 2850

170 × 5.78 = 980

235 × 4.67² × ½ = 2560

80# × 4.67³ × ⅙ = 1360

Wall = 2,400 × 1.0 = 2400

MAT = 4,300 × 4.75 = 20400

WATER = 7,500 × 5.75 = 43200

73750

4.67 × 62.5 = 292# × 9.5 = 2780#

5000 × 6.5 = 32,500

2,000 × 4.83 = 9,660

292 × 9.5² × ½ = 13,200

55360

18390

NET LOAD = 14,200 − 2,780# = 11,420#

C.G. = 18,390 / 11,420 = 1.61

TRY 12.5 FT. MAT

INCREASE MAT = 3 × 450 + 4300 = 5,600#

INCREASE MOM. = 1350 × 10.0 = 13,500

[illegible]

			M
[illegible]	[illegible]	[illegible]	1275
[illegible]	[illegible]	[illegible]	390
[illegible]	[illegible]	1.17/2	160
[illegible]	[illegible]	1.17/3	20
[illegible]	[illegible]		1845

Left: [illegible] = [illegible] 4.4/2 — 16000
[illegible] 4.5/3 — 950
4685 — 16950

Net 3685# — 15,100

@ B. $A_s = \frac{15100 \times 12}{.88 \times 18000 \times 20.5} = .559$

Bond $= \frac{3685}{.88 \times 125 \times 20.5} = 1.63$

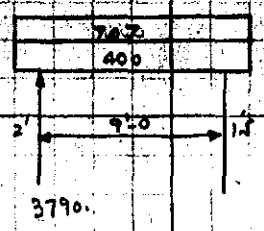
7/8" φ-12" o.c. Inside.

Bond

d = 16 − 4.67 → uplift = 11.33

Aver. water load. 62.5 × 11.33 = 707 p.22

Pile load $\frac{53000}{14} = 3790$



@ face wall. − $3790(8.5) - 1110 \frac{10.5^2}{2}$

$= 32,200 - 61200 = 29,000$ #

$A_s = \frac{29000 \times 12}{.88 \times 18000 \times 38.5} = .571$ 7/8 φ-12" o.c. Inside.

$\Delta H = 3790 - 1110 \times 10.5 = 3790 - 11650 = 7860$ #

Bond $\frac{7860}{.88 \times 125 \times 38.5} = 1.85$

@ Point 2 FT above. B

135 × 2.5 =	337	1.25	=	422
31 × 2.5² × 1/2 =	97	2.5 × 1/6	=	40
	435			460
500 × 6 =	3000	3	=	9000
62.5 × 2.5² × 1/2 =	195	2.5/3	=	162
	3195			9160
Net	2760			8700

[illegible] Use 5/8 φ - 12" o.c. inside to top.

Long Steel.

As per previous cases (see p. 9)

Max Pile Load on Left side = 53,000.

Pile load Carried on section 5x7 $\frac{53000}{35} = 1510$ #/□

Load on Pile head $1510 \times 1.4 = 2120$ #

$53000 - 2100 = 50900$

$\frac{50900}{.88 \times 50 \times 150} = 7.73$ O.K.

SH per side $= \frac{53000}{3} = 17,670$ #

Load per ft. $= \frac{17670 \times 2}{5 \times 12} = 590$ #/□

Max M. $590 \frac{14^2}{12} = 9640$ '#

$A_s = \frac{9640 \times 12}{.88 \times 18000 \times 14.5} = .505$

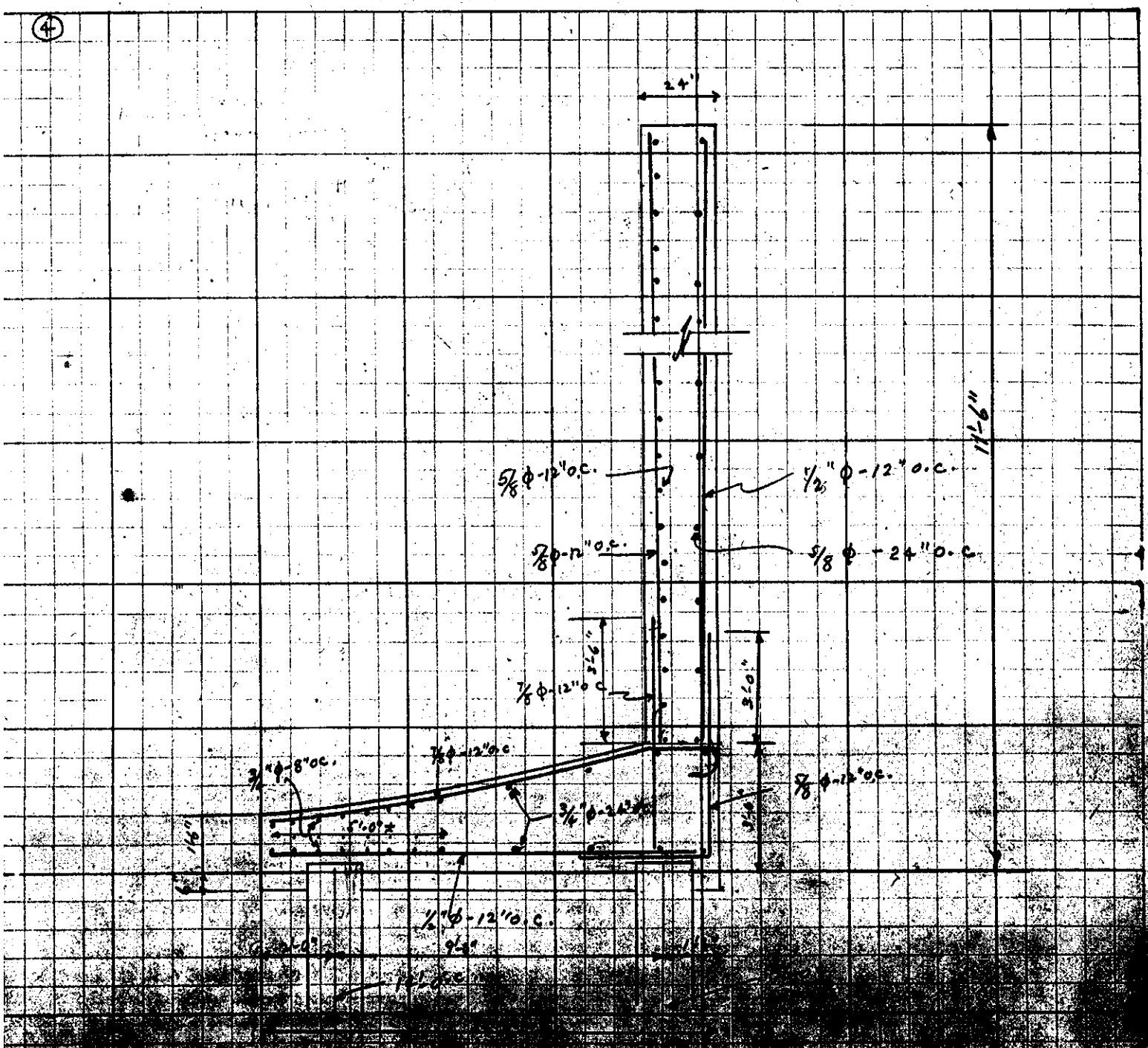
SH $= 590 \times 7 = 4130$

Bond $\frac{4130}{.88 \times 125 \times 14.5} = 2.59$

3/4" φ - 10'4" o.c.

Use 8" as previous section (3)

(4)


24"
11'-6"
5/8 φ-12" o.c.
1/2" φ-12" o.c.
5/8 φ-12" o.c.
5/8 φ-24" o.c.
5'-6"
3'-0"
7/8 φ-12" o.c.
7/8 φ-12" o.c.
3/4" φ-8" o.c.
5/8 φ-12" o.c.
3/4" φ-24" o.c.
5'-0"±
1'-6"
1/2" φ-12" o.c.
9'-9"

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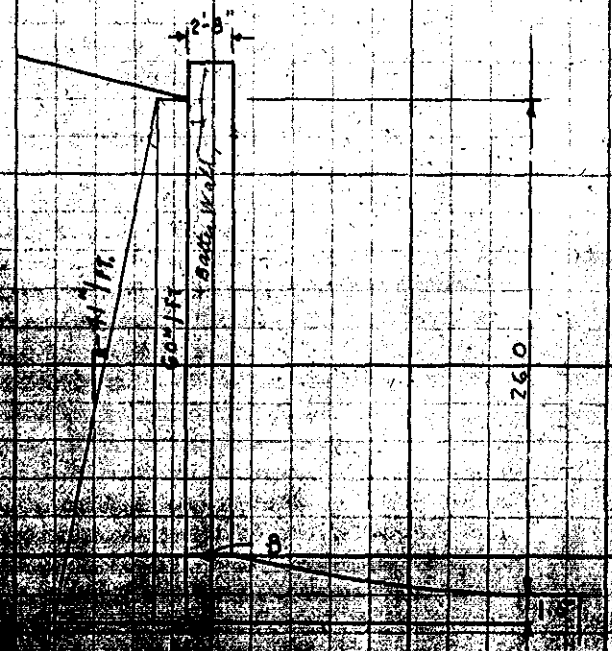
(5) SOUTH WALL. KETCHUM HAND BOOK PAGE 382

δ = SLOPE OF FILL = 15° SLOPES UP. $N = \frac{1}{2} w h^2 \dfrac{\cos^2\phi}{\left(1+\sqrt{\dfrac{\sin\phi \sin(\phi-\delta)}{\cos\delta}}\right)^2}$

$\sin(35-15) = \sin 20° = .342$

$\sqrt{\dfrac{\sin\phi \sin 20°}{\cos 15°}} = \sqrt{\dfrac{.574 \times .342}{.966}} = \sqrt{.203} = .451$ $\quad (1+.451)^2 = 2.11$

$C = \dfrac{.671}{2.11} = .318$ $\quad \dfrac{.318}{.271} \times 35^{\#} = 41^{\#}$ SURFACE LD USE 60#/FT.



MOM. @ B

$60^{\#} \times 24^2 \times \frac{1}{2} = 17{,}300$
$41^{\#} \times 24^3 \times \frac{1}{6} = 94{,}600$
$111{,}900$

SHEAR
1440
11800
13,240#

$d = \sqrt{\dfrac{111{,}900}{147.7}} = 27.5 + 3.5 = 31"$
$d(SH) = \dfrac{13{,}240}{.88 \times 600} = 25.0 + 3.5 = 28.5$
} Use 32" WALL

Wt. WALL $N = 2.67 \times 150 \times 26.0 = 10{,}400^{\#}$

$e = 12 \times 111{,}900 \div 10{,}400 = 129"$

$e' = 129 - 16 + 28.5 = 141.5$

$\dfrac{Ne'}{bd^2} = \dfrac{10{,}400 \times 141.5}{12 \times 28.5 \times 28.5} = 150.5$ $\quad f_c = 910^{\#}/\square"$ O.K.

TAPER WALL TO 24" @ TOP.

MOM. @ A

$60^{\#} \times 27.5^2 \times \frac{1}{2} = 22{,}700$
$41^{\#} \times 27.5^3 \times \frac{1}{6} = 142{,}400$
$165{,}100'^{\#}$

WALL $10{,}400 \times 1.33 = 13{,}800$

$M_a = 178{,}900 + 450 \frac{x^2}{2}$

LOADS

[illegible] + 10,400

[illegible] 2130 = 4510

[illegible] 20-0 [illegible] MAT [illegible]

[illegible]

[illegible] 1" φ - 6" o.c.

[illegible] 57700

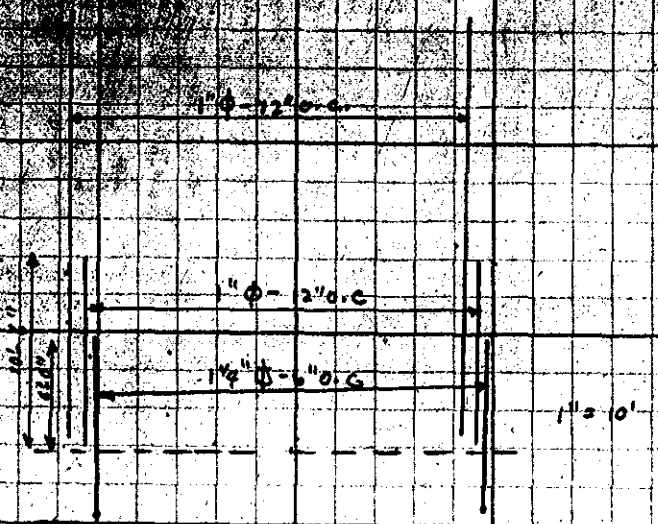
[illegible] 57700 × 12 / 88 × 18000 × 27.5 = 1.59 1" φ - 6" o.c.

[illegible] × 14½ × ½ = 5880

[illegible] × 14½ × ½ = 18750

24630

A_s = 24630 × 12 / 88 × 18000 × 27 = .69 Use 1" φ - 12" oc at point slightly below 10'.



Dry Case
Outside face

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Max Pile load = 11,700 per ft.

Max Pile load = 11,700 × 18.5 = 99,500#

P. SH. 150#/□ Cir. Pile = 50 in.

d(req d) $\frac{99500}{.88 \times 50 \times 150} = 15.1$

Cir. Top = π 4.5 × 12 = 170"

over cir. = 110 in.

area surface = 110 × 18 √2 = 4590 □

? SH. 4590 × 50 = ample OK.

15.5 + 3.5 = 19" Use 20" slab.

over wgt 400#/ft.

@ Face of side wall.

M. 11700 (15.33) + 6700 (7.08) − 400 (17.33²) × ½

= 179,000 + 47,400 − 60,000 = 166,400

d (M) = $\sqrt{\frac{166400}{147.7}}$ = 33.5
3.5
37.0 d = 40.5 OK.

SH. = 18400 − 17.33 (400) = 18400 − 6930 = 11,470

$A_s = \frac{166400 \times 12}{.88 \times 18000 \times 40.5} = 3.11$ Use 1¼" Φ − 6" o.c.

@ Point 3' to right of face of wall.

M = 11700 (12.33) + 6700 (4.08) − 400 (14.33²) ½

144,300 + 27,300 − 41200 = 130,400

SH. = 18400 − 14.33 (400) = 18400 − 5730 = 12,670

36 − 3.5" = 32.5 $A_s = \frac{130,400 \times 12}{.88 \times 18000 \times 32.5} = 3.03$ Bond $\frac{12670}{.88 \times 125 \times 32.5} = 3.54$

1¼" Φ 6" o.c.

@ Middle Pile.

M = 11700 (8.25) − 400 (10.25²) ½

96,500 − 21000 = 75,500

$M = \frac{75500 \times 12}{.88 \times 18000 \times 25.5} = 2.25$ 1⅛" Φ − 6" o.c.

29" − 3.5

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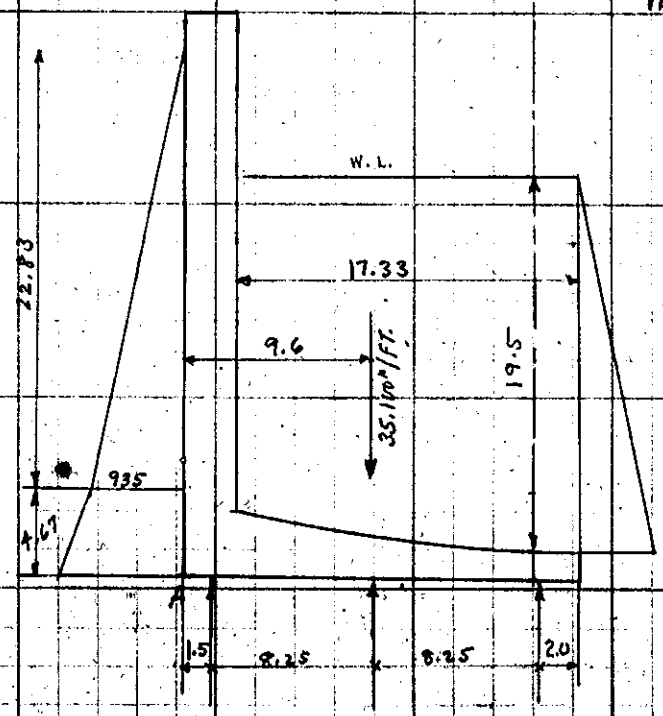


UPLIFT = 4.67 × 62.5 × 20 = 5,900#
Wt MAT = 10,000# Wt. WALL = 10,400#
EARTH = 41# × 22.83² × ½ = 10,700#
HOR - WATER = 62.5 × 19.5² × ½ = 11,900#
VER " : 62.5 × 19.0 × 17.23 = 20,600#

MOM. @ A

EARTH = 10,700 × 12.28 = 131,000
935 × 4.7² × ½ = 10,200
80# × 4.67³ × ⅙ = 1400
WALL = 10,400 × 1.33 = 13,800
MAT = 10,000 × 10 = 100,000
WATER = 20,600 × 11.34 = 234,000
490,400

HOR. 11,900 × 8.0 = 95200
Up. 5,900 × 10 = 59,000 154,200
M_A = 336,200

VER. LOADS.
20,400
20,600
41,000
5,900
35,100

ECC. = $\frac{336,200}{35,100}$ = 9.6 FT.

CENTRE OF GRAVITY @ ℄ PILES. LD / PILE = 35,100 ÷ 3 = 11,700#
SPACING = 100,000 ÷ 11,700 = 8'-6" LONGITUDINAL.

Side wall - M @ B 935 × 22.83 × ½ × 8.78 = 93,800
935 × 1.17² × ½ = 640
80 × 1.17³ × ⅙ = 20
94,460

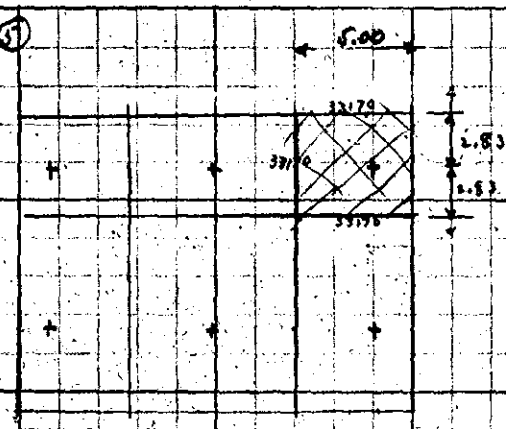
Water 62.5 × 17.5³ × ⅙ = 55,500
38,660

No inside steel req'd. on wall.

over water = 18.5 - 4.67 = 13.83
gr. 13.83 × 62.5 = 865#

M @ D

(5)



Load per pile shaded area = 11700 x 8.5 = 99500

Load per side = $\frac{99500}{3}$ = 33170

SH = $\frac{33170}{5}$ = 6640

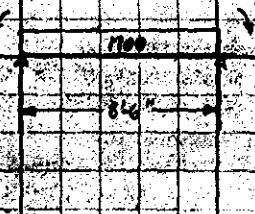
dSH = $\frac{6640}{.88 \times 18 \times 50}$ = 12.6 OK ✓

Aver load on square = $\frac{99500}{5 \times 5.67}$ = 3500

Load on pile head 3500 x 1.4 = 4900

Net SH. pile = 99500 - 4900 = 94600

Pile shear = $\frac{94600}{.88 \times 50 \times 100}$ = 14.3 20" OK.



Load per ft = $\frac{33170 \times 2}{10 \times 5}$ = say 1100 #/ft

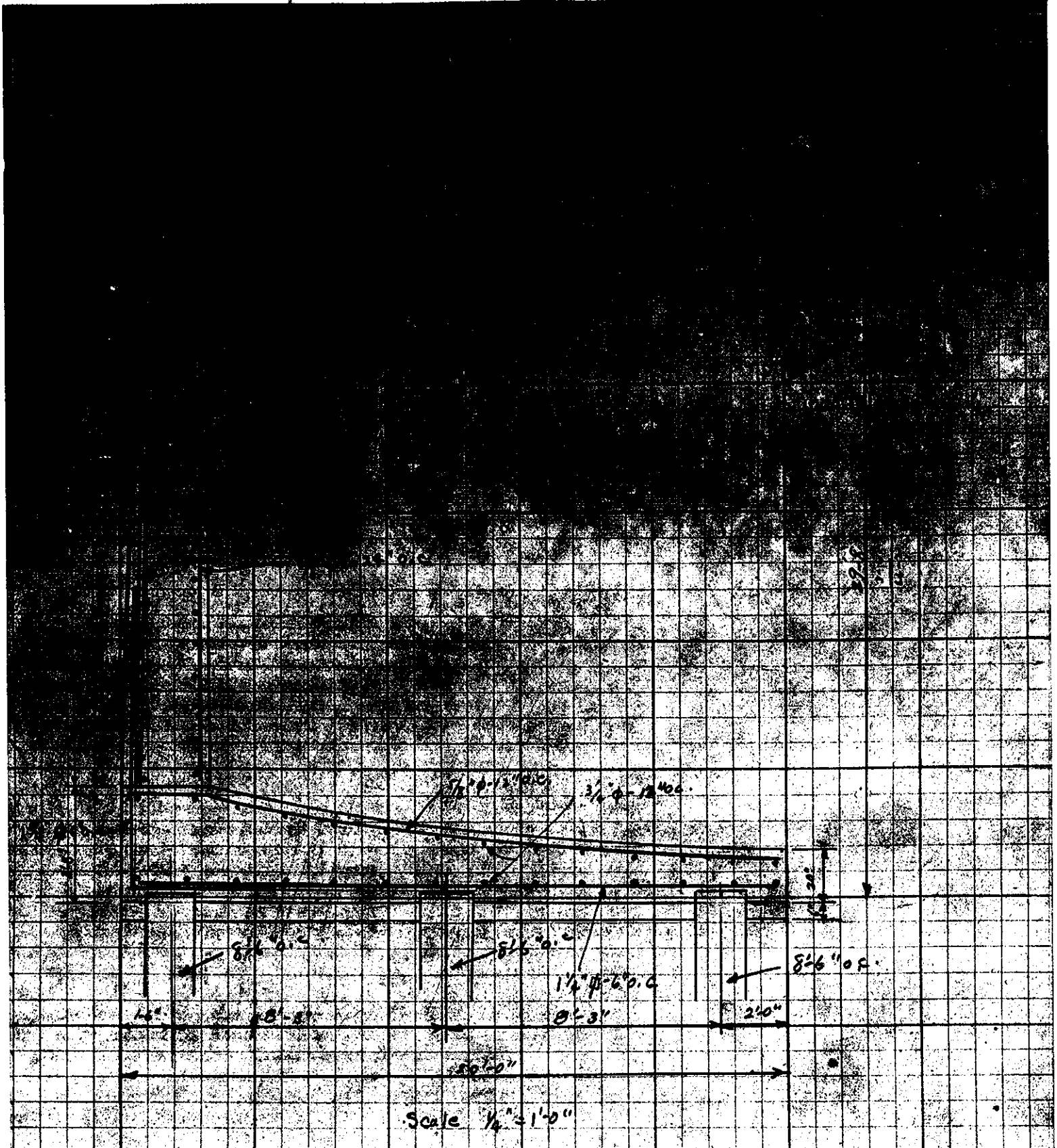
Max. M = 1100 $\frac{8.5^2}{12}$ = 6620

A_s = $\frac{6620 \times 12}{.88 \times 18000 \times 16.5}$ = .314

SH = 100 x 4.25 = 4670 - 4.94

Bond = $\frac{4670}{.88 \times 1.5 \times 16.5}$ = 2.57

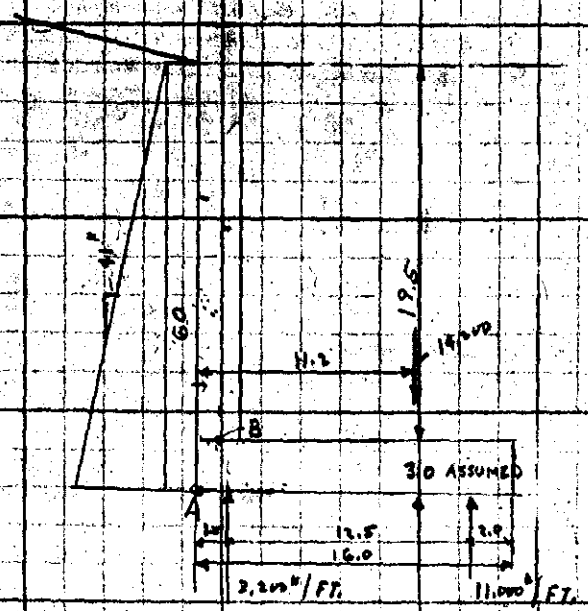
Use 3/4" ϕ 12" o.c. both ways



Scale ¼" = 1'-0"

Typical Section (5)

(6)



MOM @ B

$60 \times 19.5^2 \times \frac{1}{2} = 11,400$

$41 \times 19.5^3 \times \frac{1}{6} = 50,700$

$M_B = 62,100$ '#

SH: $60 \times 19.5 + 41 \times 19.5^2 \times \frac{1}{2} = 1170 + 7780 = 8950$ #

$d(M) = \sqrt{\frac{62,100}{147.7}} = 20.5$ $\quad d(SH) = \frac{8,950}{.88 \times 600} = 17''$

$t = 20.5 + 3.5 = 24''$

To allow Wght of Wall Use 26" t

Wt. Wall = $2.17 \times 150 \times 21.5 = 7,000$ #

$M_{AT} = 450\,x$

MOM. @ A

$60 \times 22.5^2 \times \frac{1}{2} = 15,200$ '#

$41 \times 22.5^3 \times \frac{1}{6} = 78,000$

Wall = $7,000 \times 1.17 = 8,200$

$M_A = 101,400 + 450\,\frac{x^2}{2}$

$\frac{2}{3}x(450x + 7,000) = 101,400 + 225x^2$

$300x^2 + 4670x = 101,400 + 225x^2$

$75x^2 + 4670x = 101,400$

$x^2 + 62.2x + 31.1^2 = 1350 + 970 = 2320$

$x + 31.1 = 48.2$

$x = 17.1$

TRY $x = 16.0$ FT

$M_A = 101,400 + \overset{57,600}{225} \times 256 = 159,000$ '#

VER. LD = $7,000 + 7,200 = 14,200$ #

C.G = $159,000 \div 14,200 = 11.2$ FT $\quad$ PILE LD = $\frac{9.7}{12.5} \times 14,200 = 11,000$ #/FT.

INVESTIGATION STRESS IN WALL INCLD. WT. OF WALL.

$e = \frac{62,100 \times 12}{7,000} = 106.4$ $\quad e' = 106.4 - 13 + 22.5 = 115.9$

$\frac{Ne'}{bd^2} = \frac{7,000 \times 115.9}{12 \times 22.5 \times 22.5} = 133.5$ $\quad f_c = 850$ #/□"

Pile spacing 6'-0" o.c. see Wet Case.

Side wall

@B $\quad -A_s = \frac{62100 \times 12}{.88 \times 22.5 \times 18000} = 2.09$ $\quad$ 1 1/8" □ -7.3" o.c.

Bond $\quad \frac{8950}{.88 \times 125 \times 50} = 1.63$

3' above B.

$60 \times 16.5^2 \times \frac{1}{2} = 8150.$

$41 \times 16.5^3 \times \frac{1}{6} = 30600$

38,750 '#

$-A_s = \frac{38750}{62100}\ 2.09 = 1.31.$ $\quad$ 7/8 φ - 6" o.c. Extend corner bars 6"

7' above B.

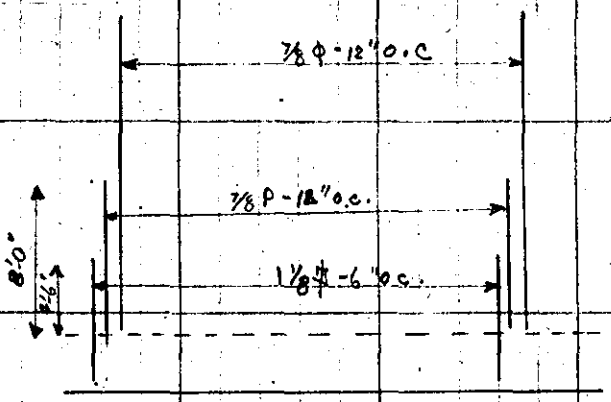
$60 \quad 12.5^2 \times \frac{1}{2} = 4690$

$41 \times 12.5^3 \times \frac{1}{6} = 13350$

18,040

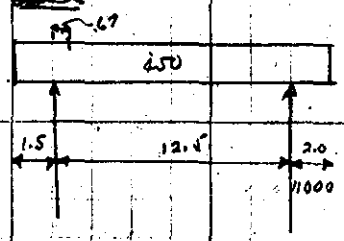
$A_s \quad \frac{18040}{62100}\ 2.09 = .60$ $\quad$ 7/8 φ - 12" o.c.

(6) Dry Case (Sidewall.)



Scale 1" = 10'
Dry Case
Outside Wall.

Base



M @ Face wall

11000 x 11.83 = 130,000
450 13.83² x ½ = 43000
87,000 #

d (M) = $\sqrt{\frac{87000}{147.7}}$ = 24.3
8.5
27.8

30" slab ok.
Use 33" see p. 35.

SH = 11,000 - 450 (13.83) = 4780
6220

d (SH) $\frac{4780}{.88 \times 12 \times 50}$ = 9.05"

As = $\frac{87000 \times 12}{.88 \times 18000 \times 29.5}$ = 2.23 1 1/8" ϕ - 6" o.c. ok
see p. 32.

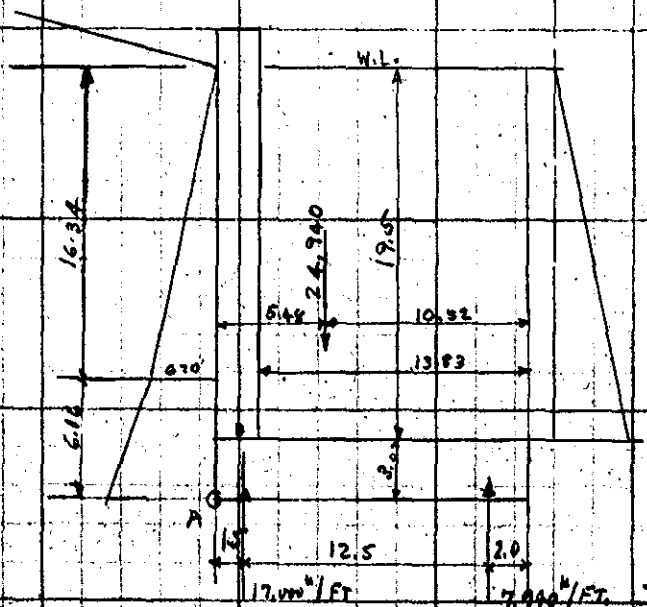
@ PT. 3 ft. in from face.

M = 11000 (8.83) - 450 (10.33²) x ½ =
97,200 - 26400 = 70,800

As = $\frac{70800}{87000}$ 2.23 = 1.82 1" ϕ - 6" o.c.

Extend corner bar only 3'-6" in from face.

(6)



EARTH = 41 × 16.34² × ½ = 5,480#
WATER = 62.5 × 19.5² × ½ = 11,900#
UP. " = 62.5 × 6.16 × 16 = 6,160#
DOWN " = 62.5 × 19.5 × 13.83 = 16,900#

MOM. @ A

EARTH =	5,480 × 11.61 =	63,700
	670 × 6.16² × ½ =	12,750
	80# × 6.16³ × ⅙ =	3,100
WALL =	7,000 × 1.17 =	8,200
MAT =	7,200 × 8.0 =	57,600
WATER =	16,900 × 9.08 =	153,800
11,900 × 9.5 =	113,000	299,150
6,160 × 8.0 =	49,300	162,300

VER. LDS. M_A = 136,850'#

14,200 Wall & Mat
16,900 WATER
31,100
− 6,160 WATER
24,940

C. G. = 136,850 / 24,940 = 5.48

PILE LD = 24,940 × 8.52 / 12.5 = 17,000#

Σ = 100,000 ÷ 17,000 = 5.92 FT O.C.

SPACE PILES 6.0 O.C.

Side Wall

M @ B.	SH	Arm	Mom.
670 × 16.34 × ½ =	5470	16.34 × ⅓ + 3.16	47,000
670 × 3.16 =	2120	3.16 × ½	3,350
80# × 3.16² × ½ =	400	3.16 × ⅓	420
	7970		50,770
Water Wall × 19.5 × ½ =	11,900	19.5 × ⅓	77,300
	3,910		26,530

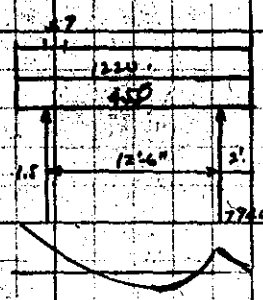
C.B. = 26,530'# / 3,910# = 6.78 ; 1.893 ; ¾" ϕ - 6" O.C. OK.

$\left.\begin{array}{l} .41 \times 12.50^3 \times 1/6 \\ .625 \times 12.50^3 \times 1/6 \end{array}\right\} = 7000$ #

$\frac{7000}{26,530} \cdot .893 = .235$ Use 5/8 φ - 12" o.c. Vert.

Inside face.

Base



Water load $62.5 \times 19.5 = 1220$

Base $3 \times 150 = 450$ Try.

SH - Face Wall. $7900 - 1670\,(13.83) = 15,200$ #
23,100

$d(SH) = \frac{15200}{.88 \times 12 \times 50} = 28.8$
3.5
32.3

33" slab o.k.
Use.

M @ Face wall.
$7940\,(11.83) - 1670\,(13.83^2) \times 1/2$
$= 94000 - 159,700 = -65,700$ '#

$d(M) = \sqrt{\frac{65,700}{147.7}} = 21.2$

Use same loads - as above - on safe side.

@ Face wall. Bond $\frac{15200}{.88 \times 29.5 \times 12.5} = 4.69$

$- A_s = \frac{65700 \times 12}{.88 \times 18000 \times 29.5} = 1.69$

1" φ. 7.1" o.c. use 6" o.c. Inside. (Top)

@ Point. 3' in from face.

$7900\,(8.83) - 1670\,(10.83)^2 \times 1/2$
$= 69,700 - 98,100 = 28,400$

$A_s = \frac{28400}{65,700}\,1.69 = .73$ 3/4" φ - 6" o.c. (Top side)

PT. zero SH. $7940 = 1670\,x$ $x = 4.75$

M. @ Point. $7940 \times 2.75 - 1670\,(4.75)^2 \times 1/2 =$
$21800 - 18800 = +3800$

$A_s = \frac{3800}{65700}\,1.69 = .10$

Net Case

Pt. infl. approx. 9.5' from end.

SH = 7940 - 1670 (9.5) = 7,910.

15850

Bond. $\frac{7910}{.88 \times 29.5 \times 125}$ = 2.44

See below

ok.

$7940(x) = 1670 \frac{(x+2)^2}{2}$

$\frac{7900x}{1835} = x^2+4x+4$ or $9.46x = x^2+4x+4$

$x^2 - 5.46x = -4$

$(x - 2.73)^2 = -4 + 7.47$

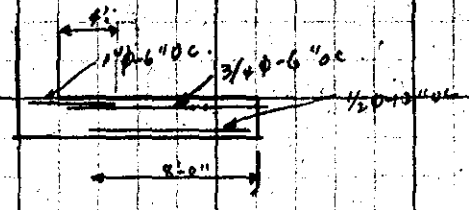
$x = 7.86 \pm 2.73$

Try 4.59 say 4.60

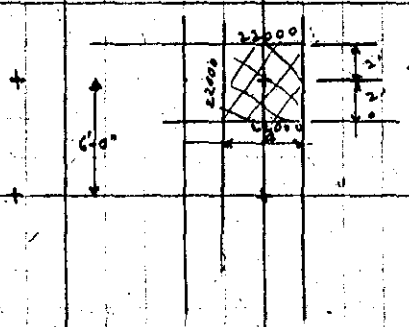
SH = 7940 - 1670 (4.6) = 3060# 11000

Bond $\frac{3060}{7910}$ 2.44 = .94

½ Φ-12" o.c. BOT face



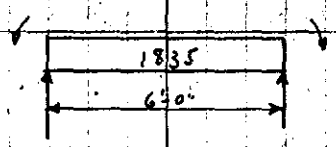
Transverse



Assume strip 4' wide.
Punching SH ok.

Load per pile 11000 × 6 = 66000.
" " side = 22000

Beam Load $\frac{44000}{4 \times 6}$ = 1835 #/□'



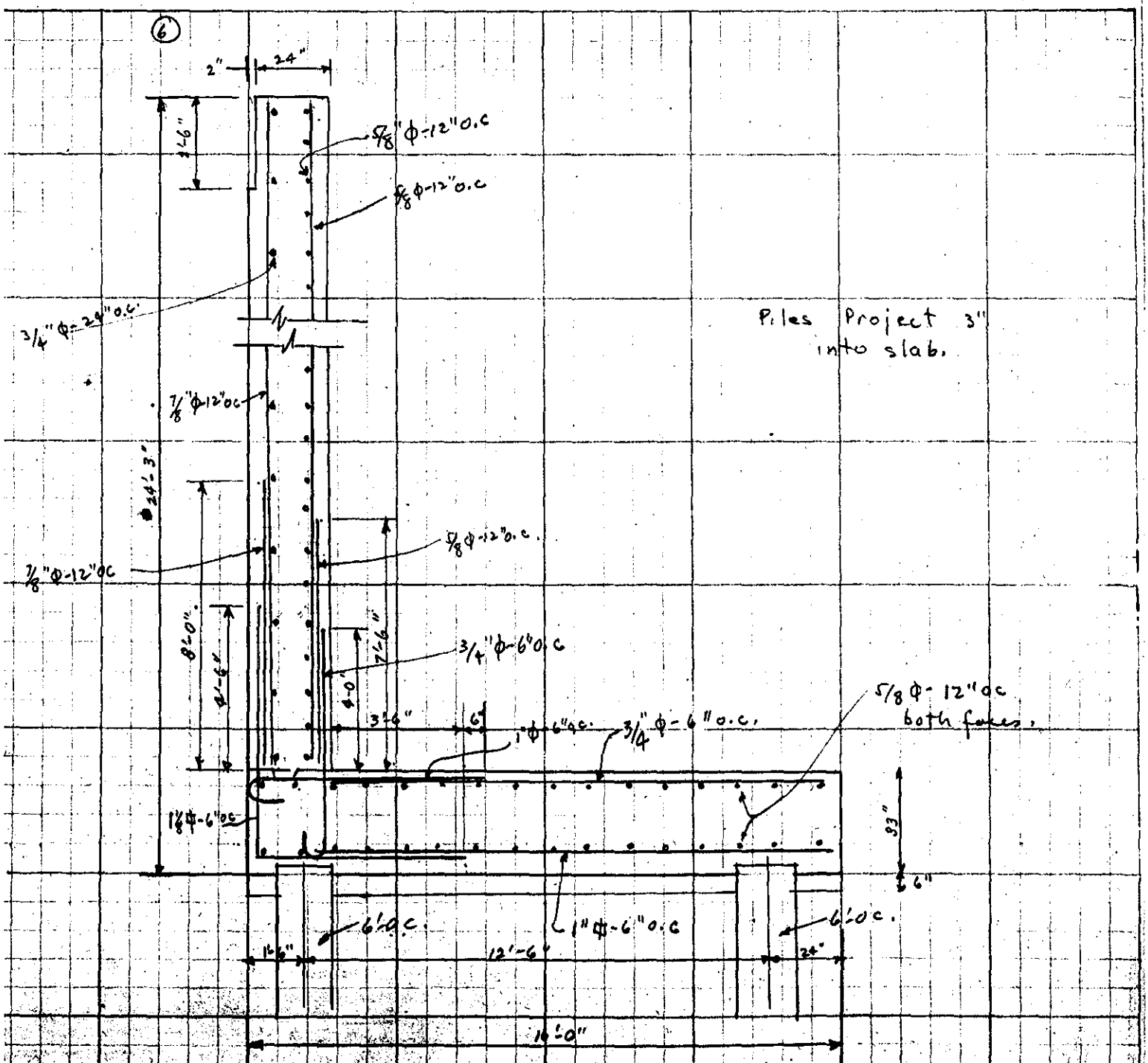
SH = 1835 × 3 = 5505#

Mom = 1835 $\frac{6^2}{12}$ = 5505 '#

$A_s = \frac{5505 \times 12}{.88 \times 18000 \times 29.5}$ = .14

Bond $\frac{5505}{.88 \times 125 \times 29.5}$ = 1.70

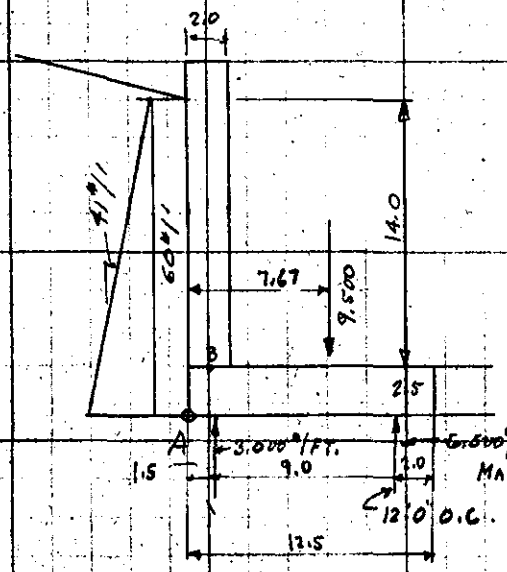
⅝ Φ-12" oc use Top & BOT



Typical Section 6

Scale 1/4" = 1'-0"

(7)



MAT 375 X = 4,700#
WALL: 300 x 16 = 4800#

MOM. @ A

$60 \times 16.5^2 \times 1/2 = 8150'^{\#}$
$41 \times 16.5^3 \times 1/6 = 30700'^{\#}$

$38850 + 375 \frac{X^2}{2}$

LOAD = 4800 + 375X

ADD MOM. FROM WALL

$\frac{2}{3} \times (375X + 4800) = 38,850 + 186X^2$

$250X^2 + 3200X = 38,850 + 186X^2$

$64X^2 + 3200X = 38,850$

$X^2 + 50X + 25^2 = 605 + 625 = 1230$

$X + 25 = 35$

$X = 10$ FT.

TRY 12.5 FT. WIDTH.

$M_A = 4,800 + 38,850 + 375 \times 12.5^2 \times 1/2 = 72,850'^{\#}$ (24,200)

LOAD = 4,800 + 375 × 12.5 = 9,500# (4,700) C.G. = $\frac{72,850}{9,500} = 7.67$

PILE LOAD = $\frac{6.17}{9.0} \times 9,500 = 6,500$

SPACING = 100,000 ÷ 6,500 = 16.9 FT. ON CENTRE
Use 12'-0" O.C.

MOM. @ B.

$60 \times 14^2 \times 1/2 = 5890$
$41 \times 14^3 \times 1/6 = 18750$
24,640

$A_s = \frac{24640 \times 12}{.85 \times 18000 \times 20.5} = .912$ 3/4" φ - 5.9" Use 6" o.c.

$S.H. = 60 \times 14 + 41 \times \frac{14^2}{2}$
$840 + 4020 = 4860$

Bond $\frac{4860}{.85 \times 12.5 \times 20.5} = 2.15$ OK.

[illegible]

$M = 60 \times 11^2 \times 1/2 = 3630$
$41 \times 11^3 \times 1/6 = 7080$
10710'#

[illegible]

[illegible]

[illegible] load [illegible]

[illegible] 6500 - [illegible] (10.5)

6500 - 3940 = 2560 #

Nom. face wall 6500 (8.5) - 375 $\frac{10.5^2}{2}$

55,200 - 20700 = 34,500 #

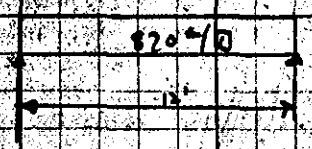
$d(M) \quad \sqrt{\frac{34500}{147.7}} = \frac{15.3}{3.5}$ 19" say 20"

Punching SH 6500 × 12 = 78000 #

Pile circum. 50"

$d = \frac{78000}{.88 \times 50 \times 150} = 11.8$

Transverse loading across piles.



$\frac{78000}{3} = 26,000$

Load on Beam = 52000 #

or $\frac{52000}{5 \times 12} = 868$

$M = 870 \; \frac{12^2}{12} = 10400$ '#

SH = 870 × 5.5 = 4790 #

20" Slab

SH. @ Face wall - wet. case. see p. 42 say net water load 15'

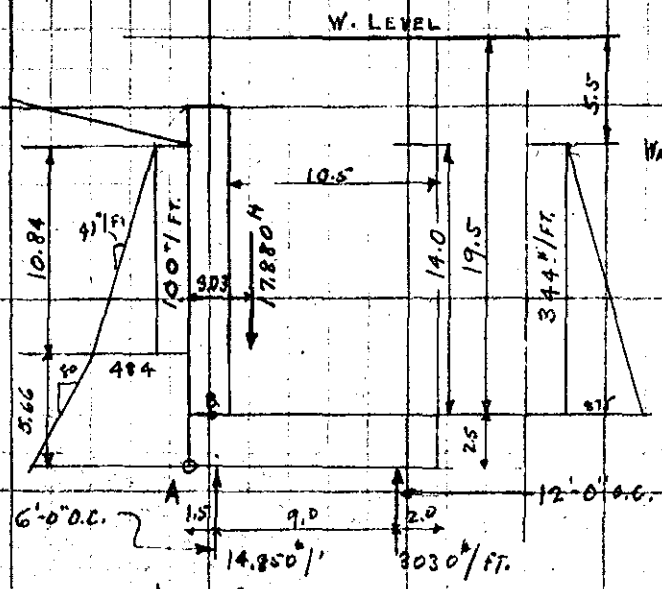
$3030 - \overbrace{150 \times 2.5}^{375} (10.5) - \overbrace{62.5 \times 15}^{940} \times 10.5 = 3030 - 3950 - 9850 = 10750$

$d = \frac{10750}{.88 \times 12 \times 50} = 20.4$ 24" req'd.

(M) Face = 3030 (8.5) - 1315 $(10.5)^2 \times \frac{1}{2}$ = 25,700 - 72500 = 46,800 '#

$d(M) = \sqrt{\frac{46800}{147.7}} = 17.8$ Use 30" slab to avoid Moving C.G.

(7)



WATER = 62.5 × 5.5 = 344#
SURCHARGE 62.5 × .271 × 41/35 = 20#/□' × 5 = 100#
WALL = 4,800
100# × 10.84 = 1084
41# × 10.84² × ½ = 2410
WATER { 344 × 14.0 = 4820
62.5 × 14² × ½ = 6130
10.5 × 19.5 × 62.5 = 12,800
UP = 5.66 × 62.5 = 354#

MOM @ A.

1084 × 11.08 =	12,000
2410 × 9.27 =	22,300
484 × 5.66² × ½ =	7770
80 × 5.66³ × ⅙ =	2420
WALL = 4,800 × 1.0 =	4800
MAT. = 4,700 × 6.25 =	29,400
WATER = 12,800 × 7.25 =	92,800
	171490

LOADS

WALL = 4,800	4,820 × 9.5 =	45,800	
MAT = 4,700	6,130 × 7.17 =	44,000	
WATER = 12,800	354 × 12.5² × ½ =	27,600	117,400
22,300			M_A = 54090
UP = -4420			
17880			

ECC. = $\frac{54,090}{17,880}$ = 3.03 FT.

PILE LOAD $\frac{7.47}{9.00}$ × 17,880 = 17,880 / 14,850 / 3030

S = $\frac{100,000}{14,850}$ = 6.75 FT
Use 6'-0" O.C.

Side wall

@ B. M 344 14² × ½ + 875 × 14² × ⅙ − 100 (14²)½ − 384 $\frac{10.84}{2}$ 6.77 − 384 3.16² × ½ − 253 × $\frac{3.16^2}{6}$
= 33,700 + 28,600 − 9800 − 14,100 − 1920 − 420
= 62,300 − 26,240 = 36,060 '#

SH. = 344 (14) + 875 × 14/2 − 100 × 14 − 384 $\frac{10.84}{2}$ − 384 × 3.16 − 253 $\frac{3.16}{2}$
= 4820 + 6120 − 1400 − 2080 − 1210 − 400 = 5090.#

d (M) $\sqrt{\frac{36060}{147.7}}$ = 15.6

d (SH) $\frac{5090}{.88 \times 12 \times 50}$ = 9.7

+A = $\frac{36060 \times 12}{.88 \times 18000 \times 20.5}$ = 1.33.
Bond = $\frac{5090}{.88 \times 125 \times 20.5}$ = 2.26
} 1" φ - 7.1" o.c. Inside.

@ Point 3' above B.
M = 344 × 13² × ½ + 62.5 × 11³ × ⅙ − 100 11² × ½ − 384 $\frac{10.84}{2}$ 3.78 − 490 (.17²) × ½ (approx.)
20,800 + 13870 − 6050 − 7870 − 7 = 34670 − 13930 = 20,740 '#
A_s = $\frac{20740}{36060}$ 1.33 = .76 1" φ - 12" o.c.
or ¾" φ - 6.95" o.c.

(7) Wet case

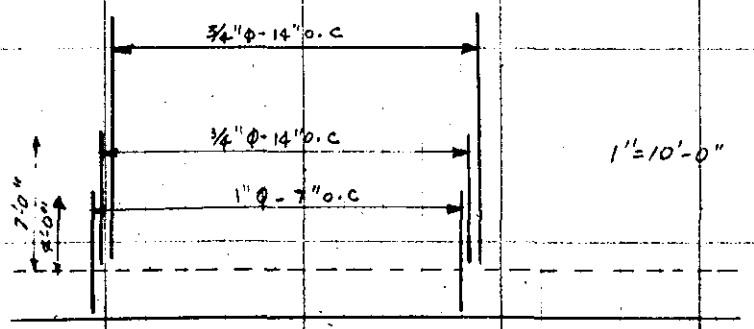
Point 6' above B.

$244 \times 8^2 \times 1/2 + 62.5 \times 8^3 \times 1/6 - 41 \times 8^3 \times 1/6$

$7800 + 5330 - 3500 = 9630.$ '#

$A_s = \frac{9630}{36060} 1.33 = .36$ $\quad 3/4"\phi - 14.7"$ o.c.

Bond OK.

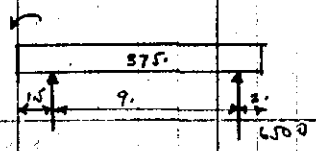


1"=10'-0" (Probably use 6" spacing.)

Inside Face.

Design of Base.

Dry Case



M. Face wall.

$6500(8.5) - 3.75 \frac{10.5^2}{2}$

$55,250 - 20700 = 34,550$ '#

$SH = 6500 - 375(10.5) = 2560.$ #
3940

$A_s = \frac{34550 \times 12}{.88 \times 18000 \times 26.5} = .987$ use $7/8"\phi - 7.3"$ o.c. at Corner. Outside.

@ PT. 2 ft. from face.

$6500 \times 6.5 - 3.75 \frac{8.5^2}{2}$

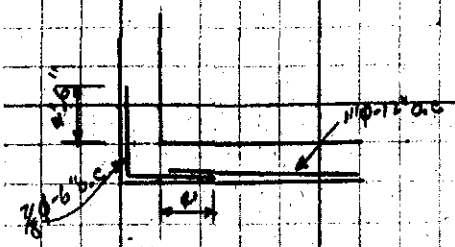
$42250 - 13,540 = 28,710$ '#

3' from face

$6500(5.5) - 3.75 \frac{7.5^2}{2}$

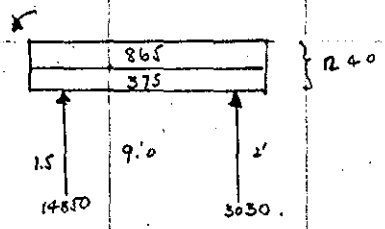
$35,700 - 10500 = 25,200$

$A_s = \frac{25200}{34550} .99 = .722$ $\quad 1"\phi - 12"$ o.c. use. Outside face.



(7) Base Design (cont.)
Wet Case.

$\frac{19.5 - 5.66}{13.84}$ $62.5 \times 13.83 = 865.$



(M) face wall.

$3030 \times 8.5 - 1240\ 10.5^2 \times 1/2$

$25{,}700 - 68{,}400 = -42{,}700$ '#

S.H. $1240(10.5) - 3030 = 13030 - 3030 = 10{,}000$

d(S.H.) $\frac{10{,}000}{.88 \times 12 \times 50} = 19''$ OK.

Pt. zero S.H. $3030 = 1240x$ or $x = 2.46$.

$+M = 3030(4.6) - 1240 \times 2.46^2 \times 1/2 =$
$1390 - 3750 = -2360.$ '#

There is no +M.

@ Face wall, $+A_s = \frac{42700 \times 12}{.88 \times 15000 \times 26.5} = 1.22$ 7/8 φ-6" o.c. O.K. Inside.

Bond $\frac{10000}{.88 \times 125 \times 26.5} = 3.43.$ OK

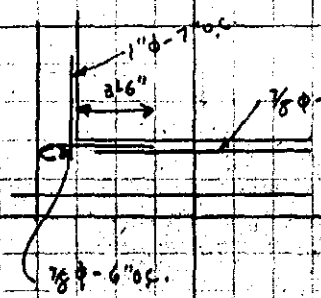
Point 3' in from face.

$M = 3030(5.5) - 1240\ 7.5^2 \times 1/2 =$
$16670 - 34900 = 18{,}230$ '#

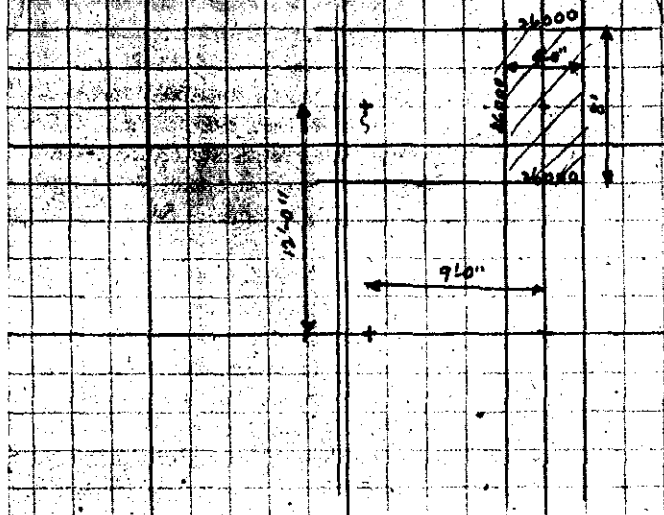
$A_s = \frac{18230}{42700} 1.22 = .52$

@ 2.5' in from face

$M = 3030(6) - 1240\ 8^2\ 1/2$
$18{,}180 - 39{,}700 \quad 21{,}520 \quad A_s = .615$ 7/8 φ-12" o.c. Inside



Transverse Steel.

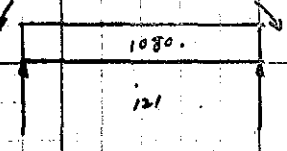


Max Pile Load. 78000

$\frac{78000}{3} = 26000$

Using 4' strip

$\frac{52000}{4 \times 12} = 1083$



$M = \frac{1080 \cdot 12^2}{12} = 12,950$ '#

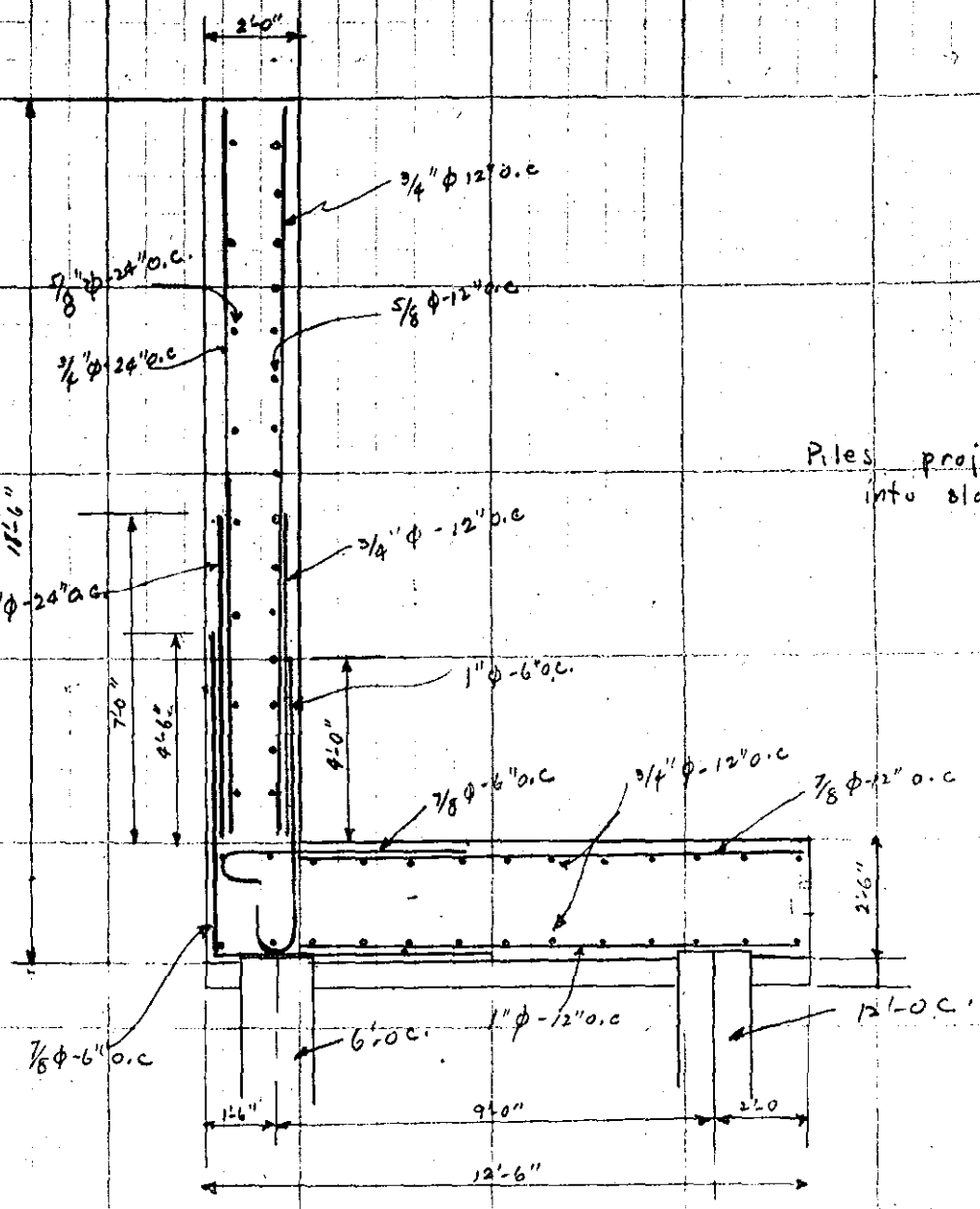
$A_s = \frac{12,950 \times 12}{.88 \times 18000 \times 26.5} = .37$

$SH = 1080 \times 5.25 = 5670$ #

Bond $\frac{5670}{.88 \times 125 \times 26.5} = 1.95.$

Use 3/4" ϕ - 12" o c both faces.

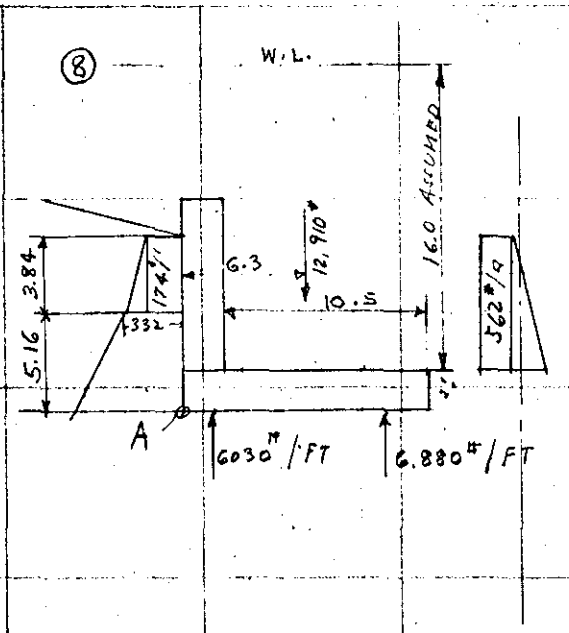
(7) Final Design.



Scale 1/4" = 1'-0"

Typical Section (7)

(8)



SURCHARGE = 8'-0" $62.5 \times 8 \times .271 \times \frac{41}{35} = 174^{\#}/\square'$

$9 \times 62.5 = 562^{\#}/\square'$

$174^{\#} \times 3.84 = 670$

$41^{\#} \times 3.84^2 \times \frac{1}{2} = 300^{\#}$

$562 \times 7.0 = 3930$

$62.5 \times 7.0^2 \times \frac{1}{2} = 1530$

UP $5.16 \times 62.5^{\#} = 323$

WATER $= 10.5 \times 16 \times 62.5 = 10{,}500^{\#}$

MOM. @ A.

$670 \times 7.08 =$	4750
$300 \times 6.44 =$	1930
$332 \times 5.16^2 \times \frac{1}{2} =$	4420
$80 \times 5.16^3 \times \frac{1}{6} =$	1830
WALL $= 2700 \times 1 =$	2700
MAT. $= 3750 \times 6.25 =$	23400
WATER $= 10{,}500 \times 7.25 =$	76,000
	115030

$3930 \times 5.5 =$	21,700
$1530 \times 4.33 =$	6620
UP — $323 \times 12.5^2 \times \frac{1}{2} =$	25,300
	53620
	81410

WALL = 2,700
MAT = 3750
WATER = 10,500
16950
$323 \times 12.5 =$ 4040.
12910

ECC. = 81,410 ÷ 12,910 = 6.3 FT.

PILE LD $= \frac{4.2}{9.0} \times 12{,}910 =$ 6030#
12,910
6,880

12FT SPACING O.K.

M. A. $= -(562 - 174)\,7^2 \times \frac{1}{2} - 62.5 \times 7^3 \times \frac{1}{6} + 41\,\frac{3.84^2}{2}\,4.44 + 80 \times 3.16^3 \times \frac{1}{6} + 158\,\frac{3.16^2}{2}$ (388)

$= -9510 - 3670 + 1340 + 420 + 790$

$= -13180 + 2550 = -10{,}630$ '#

$A_s = \frac{10{,}630 \times 12}{.88 \times 18000 \times 20.5} = .393$ 3/4" ϕ - 13" o.c. Inside

SH. $= 388 \times 7 + 62.5 \times 7^2 \times \frac{1}{2} - 41\,\frac{3.84^2}{2} - 158 \times 3.16 - 80\,\frac{3.16^2}{2}$

$= 2710 + 1530 - 300 - 500 - 400$

$= 3040$ #

Bond $\frac{3040}{.88 \times 125 \times 20.5} = 1.34$ o.k. above.

M @ Point 3.16 above B.

$M = -388 \times 3.84^2 \times \frac{1}{2} - 62.5\,3.84^3 \times \frac{1}{6} + 41\,3.84^3 \times \frac{1}{6}$

$= -2660 - 570 + 390 = -3060$

$A_s = \frac{3060}{10630} \cdot .393 = .11$ 1/2" ϕ - 12" o.c. Inside.

(6) Base Slab.

Dry Case.

24" base slab used to keep structure massive as desired

M @ face wall $2650\,(8.5) - 300\,(10.5^2)\,\tfrac{1}{2}$

$= 22500 - 16{,}530 = 5970$ '#

$A_s = \dfrac{5970 \times 12}{.88 \times 18000 \times 20.5} = .221$ ½" φ - 10.8" o.c. Outside

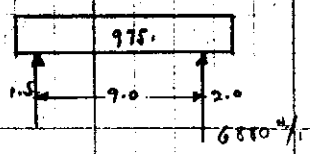
Bond OK.

Wet Case.

Loads. water 16 + 5.16 = 10.83 × 62.5 = 676.

D.L. 300

976. #/□



@ Face wall

$M = 6880\ 8.5 - 975\ 10.5^2 \times \tfrac{1}{2}$

$58500 - 53{,}800 = 4{,}700$ '#

A_s ½" φ - 12" o.c. OK. Outside Corner

Point zero > H. $\dfrac{6880}{975} = 7.06'$

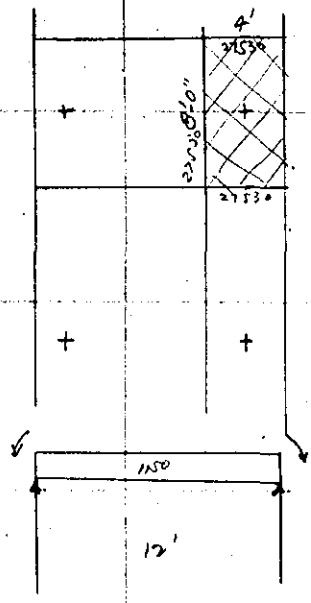
+M $6880\ 7.06 - 975\ 7.06^2 \times \tfrac{1}{2}$

$48600 - 24{,}300 = +24300.$

$A_s = \dfrac{24300}{5970}\ .22 = .90$ Use ¾" φ - 12" o.c Outside.

Longitudinal steel.

Wet case.



Pile load = 6880 × 12 = 82,600 #

$\dfrac{82600}{3} = 27{,}530$ #

Load on Beam. = 55,060 # $\dfrac{55060}{4 \times 12} = 1150.$ #/□

$M = 1150 \times \dfrac{12^2}{12} = 13800$ '#

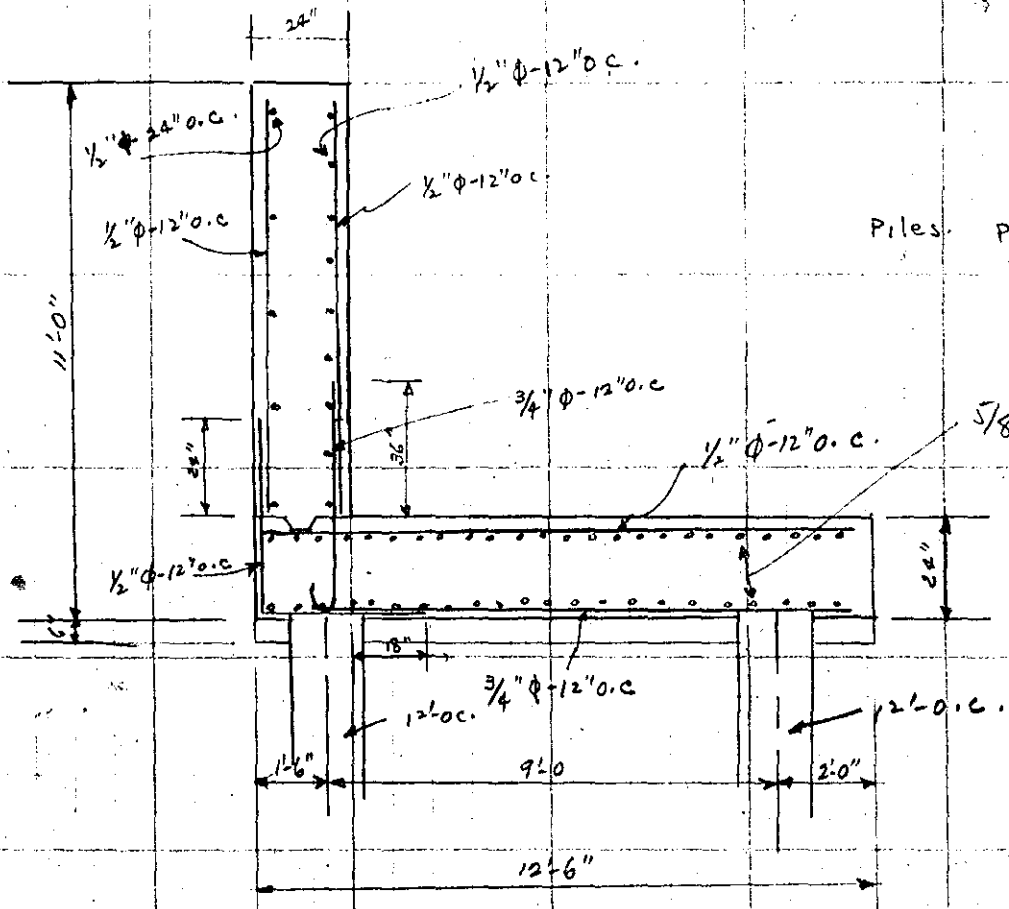
$SH = 5.25 \times 1150 = 6040$

$A_s = \dfrac{13800 \times 12}{.88 \times 18000 \times 20.5} = .51$ } ¾" φ - 10.3

Bond $\dfrac{6040}{.88 \times 125 \times 20.5} = 2.68.$ } or ⅝ φ - 7" o.c

Use ⅝ φ - 6" o.c.

(8) Final Design.



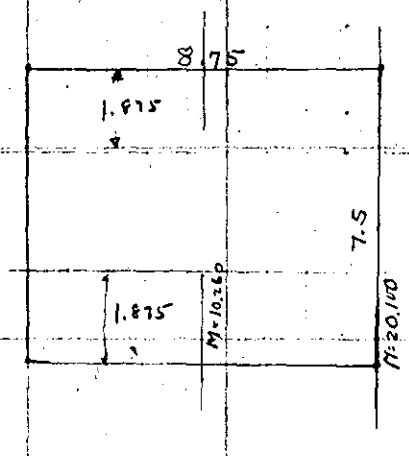
Scale 1/4" = 1'-0"

Typical Section (8)

PILES FOR OUTLET PAVING SLAB

WATER = 19.5 × 62.5 = 1220#
CONC. = 2 × 150 = 300
1520# / □ FT

AREA = 100,000# / 1520 = 65.7 □ FT. 8.15 FT ON CENTRE



$+M = \frac{1520 \times 7.5 \times 8.75^2}{25} = 35{,}000'^{\#} \times .55 = 19{,}250$

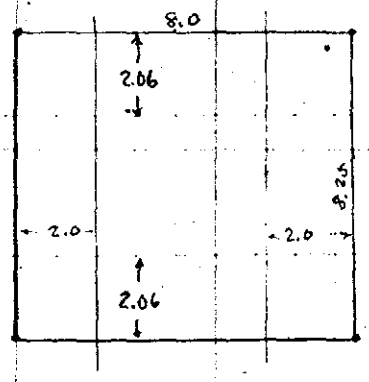
$-M = \frac{1520 \times 7.5 \times 8.75^2}{15} = 58{,}000'^{\#} \times .65 = 37{,}700$

+M/FT = 19,250 ÷ 1.875 = 10,260 (MAX) } LONG
-M " = 37,700 ÷ 1.875 = 20,100 (MAX) } RODS.

$+M = \frac{1520 \times 8.75 \times 7.5^2}{25} = 29{,}900 \times .55 = 16{,}500$

$-M = \frac{1520 \times 8.75 \times 7.5^2}{15} = 50{,}000 \times .65 = 32{,}500$

+M/FT = 16,500 ÷ 2.2 = 7,500 } SHORT
-M " = 32,500 ÷ 2.2 = 14,800 } RODS.



$+M = \frac{1520 \times 8.25 \times 8.0^2}{25} = 32{,}100 \times .55 = 17{,}600$

$-M = \frac{1520 \times 8.25 \times 8.0^2}{15} = 53{,}500 \times .65 = 34{,}800$

+M/FT = 17,600 ÷ 2.06 = 8,550'# } SHORT
-M/FT = 34,800 ÷ 2.06 = 16,900# } RODS.

$+M = \frac{1520 \times 8.0 \times 8.25^2}{25} = 33{,}100'^{\#} \times .55 = 18{,}200$

$-M = \frac{1520 \times 8.0 \times 8.25^2}{15} = 55{,}200'^{\#} \times .65 = 35{,}800$

+M/FT = 18,200 ÷ 2.0 = 9,100 } LONG
-M/FT = 35,800 ÷ 2.0 = 17,900 } RODS

FOR DESIGN

Use +M = 10,260
-M = 20,100

$d = \sqrt{\frac{20{,}100}{147.7}} = 11.7$ d USED = 18 - 4.5 = 13.5
18" SLAB O.K.

TOP STEEL $A_s = \frac{20{,}100 \times 12}{.88 \times 13.5 \times 18{,}000} = 1.13$ □" 1" □ 12" O.C. TOP.

BOT STEEL $A_s = \frac{10{,}260 \times 12}{.88 \times 13.5 \times 18{,}000} = .576$ □" 7/8" ϕ 12" O.C. BOT.

Both Ways.

SEWER SIPHON - INLET CHAMBER

Form 115 10M-11-39

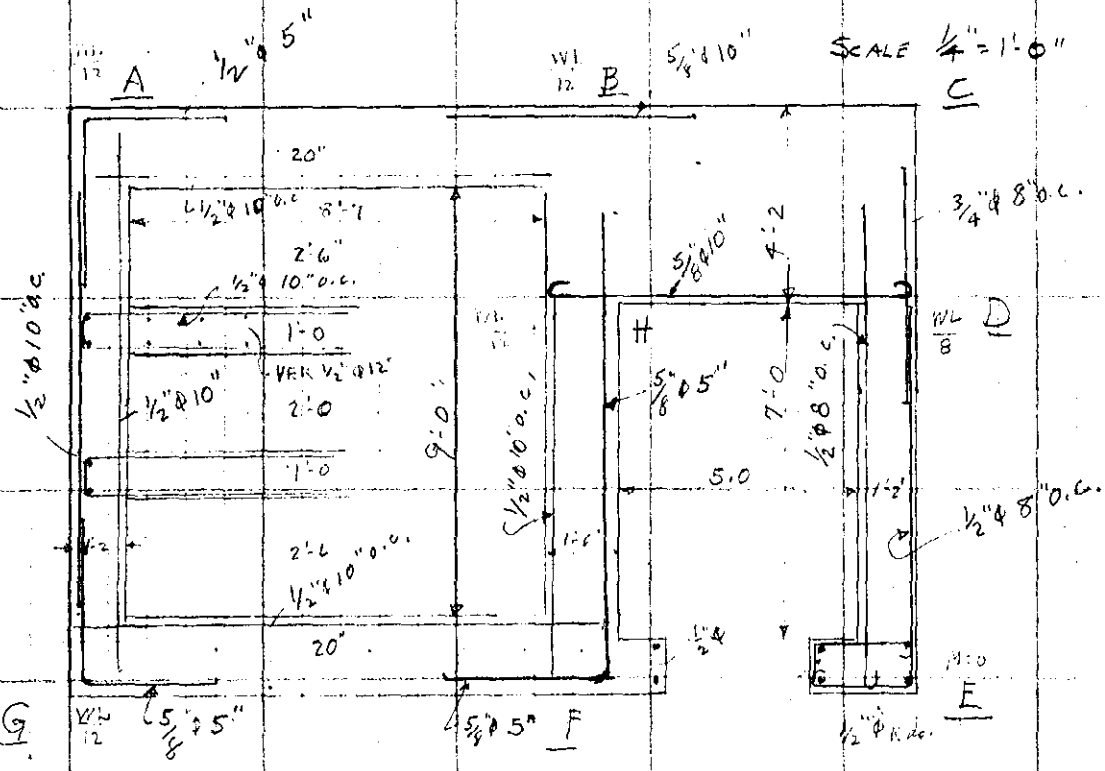
METCALF & EDDY
ENGINEERS
BOSTON, MASS.

PROJECT: U. S. ENGINEERS HARTFORD
SUBJECT: PARK RIVER - PRESSURE CONDUIT
DETAIL: SIPHON INLET CHAMBER.

PAGE 1
DATE APRIL 13, 1940
COMPUTED BY S. W. O.

SECTION AT EL. 24.20

SCALE 1/4" = 1'-0"



PRESSURE = $(50 - 24.2)\,35 + 100^{\#} \times .27 = 904 + 27 = \underline{931^{\#}}$ / LF.

AB $L = 8.58$ $\quad -M = 931 \times \frac{8.58^2}{12} = 5{,}720^{'\#}$ $\quad SH = \frac{8.58}{2} \times 931 = 4{,}000^{\#}$ $\quad V = \frac{4{,}000}{.88 \times 12 \times 16.5} = \underline{23^{\#}/\square''}$

$A_s = \frac{5{,}720 \times 12}{.88 \times 16.5 \times 18{,}000} = .2620\ \square''$ $\quad$ BOND $= \frac{4{,}000}{.88 \times 16.5 \times 125} = 2.2$

1/2"φ 9" O.C. $\quad$ 5/8"φ 10" O.C. SEE A-G

+ MOM. @ ℄ = 1/2 OF CORNER MOMS. USE 1/2"φ 10" O.C.

DE $L = 7.58$ $\quad -M = 931 \times \frac{7.58^2}{8} = \underline{6{,}700^{'\#}}$ $\quad SH = 931 \times 5/8 \times 7.58 = 4420^{\#}$

$+M = \frac{9}{128} \times 931 \times 7.58^2 = 3{,}780^{'\#}$ $\quad SH = 931 \times 3/8 \times 7.58 = 2650^{\#}$

$V = 4{,}420 \div .88 \times 10.5 \times 12 = 40^{\#}/\square''$

$-A_s = \frac{6{,}700 \times 12}{.88 \times 10.5 \times 18{,}000} = .483\ \square''$ $\quad$ BOND $= \frac{4{,}420}{.88 \times 10.5 \times 125} = 3.83''$

3/4"φ 10.9" O.C. $\quad$ 3/4"φ 8"

USE 3/4"φ 8" O.C.

$+A_s = \frac{3{,}780 \times 12}{.88 \times 10.5 \times 18{,}000} = .272\ \square''$ $\quad$ BOND $= \frac{2650}{4420} \times 3.83 = 2.30\ \square''$

USE 1/2"φ 8" O.C.

VERTICAL BM. $SH = 1.5 \times 2650^{\#} = 4{,}000^{\#}$ $\quad M = \frac{8{,}000 \times 3}{8} = 3{,}000^{'\#}$

$A_s = \frac{3{,}000 \times 12}{.88 \times 24 \times 18{,}000} = 0.95$ USE 2-1/2" φ Rds.

Form 113 10M-11-39

METCALF & EDDY
ENGINEERS
BOSTON, MASS.

PROJECT U. S. ENGINEERS - HARTFORD
SUBJECT PARK RIVER - PRESSURE CONDUIT
DETAIL SIPHON INLET CHAMBER

PAGE 2
DATE APRIL 15, 1940
COMPUTED BY S.W.O.

G. F. H.

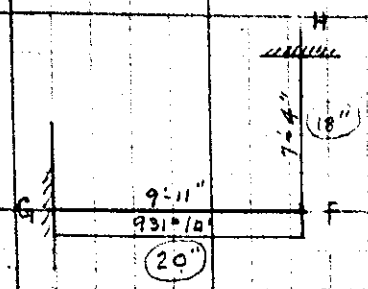
$\frac{I}{L} = \frac{1.5^3}{7.33} = .461$

" $= \frac{1.67^3}{9.92} = .469$

$.930$

$U_s = 50\%$

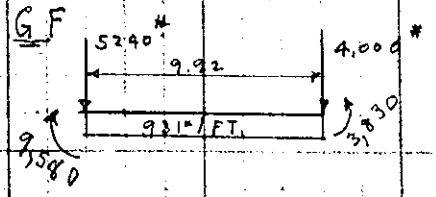
F. E. M.
$931 \times \frac{9.92^2}{12} = 7,650'^{\#}$



ΣM	Δ		Δ	ΣM
0		F		0
		D	0	0
		C	-1.92	-1.92
		D		
ΣM	Δ		Δ	ΣM
0		F		0
-3.83	-3.83	D	0	-3.83
		C	-1.92	-1.92
		D		

ΣM	Δ		Δ	ΣM
-7.67		F		+7.65
-7.67	0	D	-3.82	+3.83
-9.58	-1.91	C	0	+3.83
		D		

GF



$W = 931 \times 9.92 = 9,240^{\#}$

$R_R = 4,620 - \frac{5,750}{9.22} = 4,000$

$R_R = 4,620 + 620 = 5240$

ZERO SH. $= 4,000 \div 931 = 4.3$ $\quad +M = 4,000 \times 4.3 \times \frac{1}{2} - 3,830 = 4,770'^{\#}$

$L' = \sqrt{\frac{8 \times 4,770}{931}} = 6.4$ FT. $\quad +SH = 3.2 \times 931 = 2,980^{\#}$

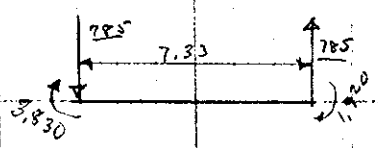
$-A_{s_L} = \frac{9,580 \times 12}{.88 \times 16.5 \times 18,000} = .44$ □" $\quad$ BOND $= \frac{5,240}{.88 \times 16.5 \times 125} = 2.89$ $\quad V = \frac{5240}{.88 \times 12 \times 16.5} = 29.7^{\#}/\square'$

5/8" φ 8" O.C. $\quad$ Use 3/4" φ 10" See A-G.

$+A_s = \frac{4770}{9580} \times .44 = .219$ $\quad$ BOND $= \frac{2,980}{5,240} \times 2.89 = 1.65$

1/2" φ 10"

BOND RIGHT $= \frac{4,000}{5,240} \times 2.89 = 2.21$ $\quad$ 5/8" φ 10" O.C. Corner Bar.



$R = 5,750 \div 7.33 = 785$

$-A_s = \frac{12 \times 3830}{.88 \times 14.5 \times 18,000} = .20$ $\quad$ 5/8" φ 18" OR 1/2" φ 12" USE 1/2" φ 10"

A G

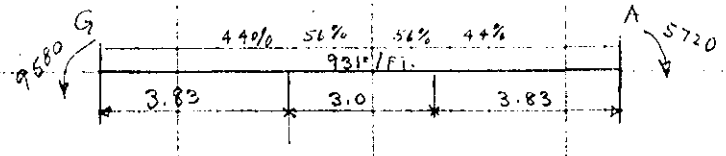
$\frac{1}{3.83} = .261$ 44%

$\frac{1}{3.0} = .333$ 56%

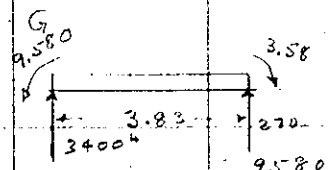
$.594$

$931 \times \frac{3.83^2}{12} = 1140$

$931 \times \frac{3.0^2}{12} = 700$



ΣM	Δ		Δ	ΣM	ΣM	Δ		Δ	ΣM	ΣM	Δ		Δ	ΣM
				44%	56%				56%	44%				
-9.58		F		-1.14	+.70		F		-.70	+1.14		F		+5.72
-9.58	0	D	+.19	-.95	+.95	+.25	D	-.25	-.95	+.95	-.19	D	0	+5.72
		C	-4.79	-5.74	+.83	-.12	C	+.12	-.83	+3.81	+2.86	C		
		D	+2.16	-3.58	+3.58	+2.75	D	-1.68	-2.51	+2.50	-1.31	D		



$W = 931 \times 3.83 = 3670$

$R = 3670 \times \frac{1}{2} - \frac{6.0}{3.83} =$

$= 1835 - 1570 = 270$

$d = \sqrt{\frac{9580}{147.7}} = 8.05''$ O.K.

$A_s = \frac{9580 \times 12}{.88 \times 10.5 \times 18{,}000} = .691$

$3/4''\phi$ 7.64" o.c.

$BOND = \frac{3400}{.88 \times 10.5 \times 125} = 2.94$

$5/8''\phi$ 5" o.c.

$A_s = \frac{3.58}{9.58} \times .691 = .258$ Use $1/2''\phi$ 10"

A_T (A)

$A_s = \frac{5{,}720 \times 12}{.88 \times 10.5 \times 18{,}000} = .4120''$ $1/2''\phi$ 5" o.c.

BURSTING WATER PRESSURE = $(48 - 24.20)\,62.5 = 1{,}490^{\#}/\square'$ (23.8)

BM. D-E. NET PRESS. = 1490 - 931 = 559 #/□FT.

$-M = 559 \times \frac{7.58^2}{8} = 4020^{\#}$ SH = 559 × 5/8 × 7.58 = 2650

$-A_s = \frac{4020 \times 12}{.88 \times 10.5 \times 18{,}000} = .29\ \square''$ BOND = $\frac{2650}{.81 \times 10.5 \times 125} = 2.79$

1/2"φ 8" o.c. 1/2"φ 8" o.c. USE 1/2"φ 8" o.c.

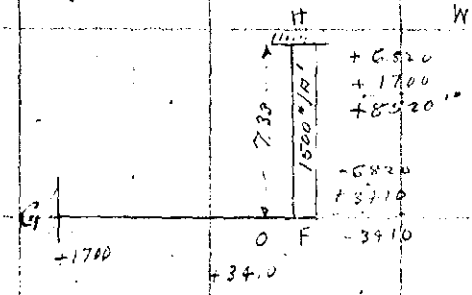
$+M = \frac{7}{128} \times 559 \times 7.58^2 = 2260$ SH = 2650 × 1/5 × 3 = 1590

$A_s = \frac{2260 \times 12}{.88 \times 10.5 \times 18{,}000} = 1.63\ \square''$ BOND = $\frac{1590}{2650} \times 2.79 = 1.38$

1/2"φ 14" o.c. 1/2"φ 13 1/4" o.c.

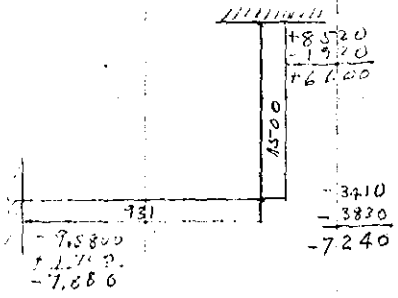
IF FULL ACTIVE PRESSURE IS NOT ACTING (As) IS ABOUT SAME AS FOR EARTH PRESS. ALONE 559 + 400 = 959 USE 1/2"φ 8" o.c.

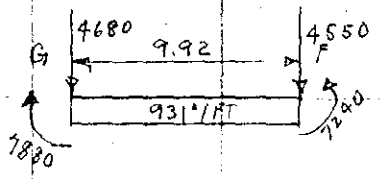
G.F & H



W = 1500 × 7.33 = 11,000# M = 11,000 × 7.33/12 = 6,820'#

COMBINE WITH MOM. ON PAGE 2



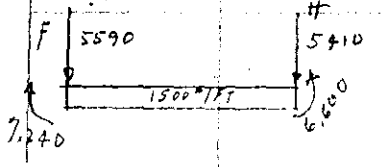


W = 9,240#

R_L = 4620 + 640 ÷ 9.92 = 4680 (65)

R_R = 4620 - 70 = 4550

$x = \frac{4550}{931} = 4.9$ $+M = 4550 \times 4.9 \times 1/2 - 7{,}240 = 3{,}900^{\#}$ (11,100) 1/2"φ 10" o.c. O.K.



W = 11,000#

R_R = 5,500 - 640 ÷ 7.33 = 5410 (90)

5500 + 90 = 5590#

$V = \frac{5410}{.36 \times 12 \times 14.5} = 35.3\#/\square''$

$x = 5410 \div 1500 = 3.6$ $M = 5410 \times 3.6 \times 1/2 - 6{,}600 = 3150'^{\#}$ (9750)

$L = \sqrt{\frac{8 \times 3150}{1500}} = 4.1$ SH = 2.05 × 1500 = 3080#

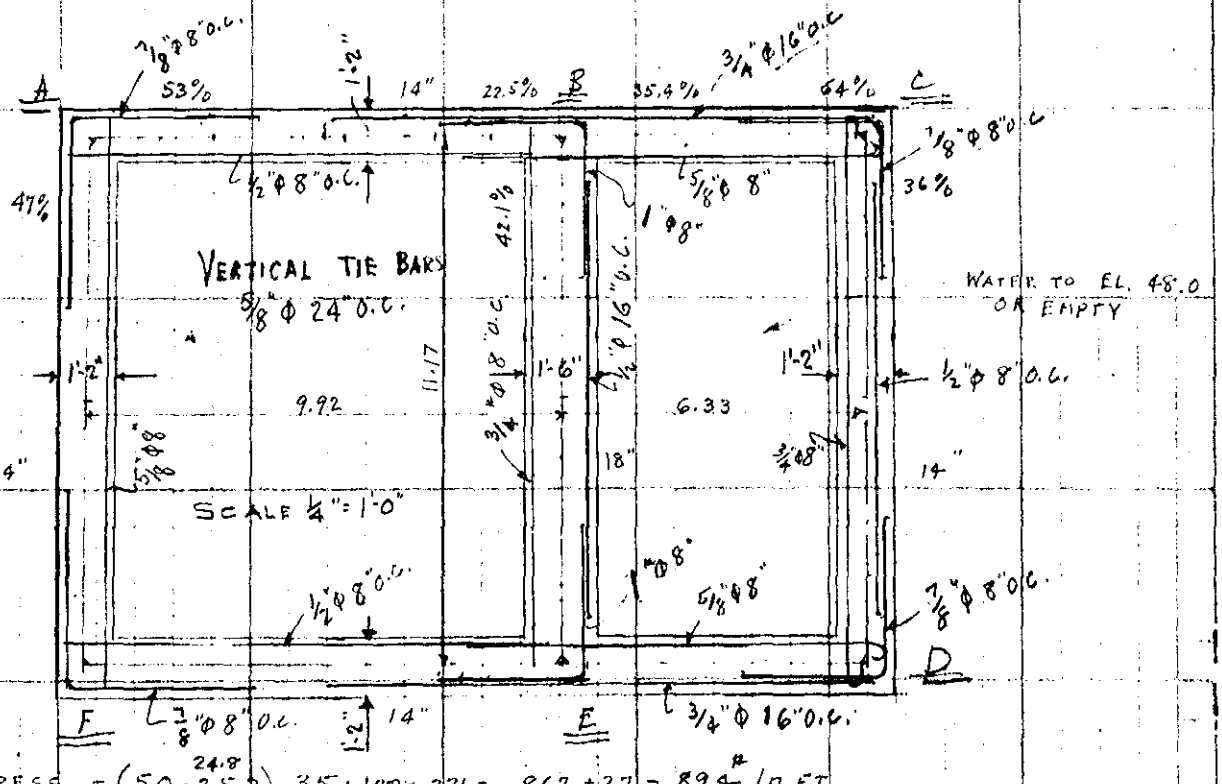
$+$ BOND = $\frac{3080}{.88 \times 14.5 \times 125} = 1.93$ 1/2"φ 10" o.c.

$-A_s = \frac{7{,}240 \times 12}{.88 \times 14.5 \times 18{,}000} = .378\ \square''$ BOND = $\frac{5{,}590}{.88 \times 14.5 \times 125} = 3.5$

USE 5/8"φ @ 5" BOTH ENDS.

TIE @ H = $\frac{5410}{18{,}000} = .30$ USE 5/8"φ 10" o.c.

SECTION AT EL. 25.20 TO 33.50



PRESS. = (50 − 25.2) 35 + 100 × .271 = 867 + 27 = 894# /□ FT.

F.E.M.

$894^{\#} \times \frac{11.17^2}{12} = 9{,}300'^{\#}$

$894 \times \frac{9.92^2}{12} = 7{,}320'^{\#}$

$894 \times \frac{6.33^2}{12} = 2{,}980'^{\#}$

STIFFNESS FACTORS

$\frac{1.17^2}{9.92} = .161$ — 22.5%

$\frac{1.17^3}{6.33} = .253$ 35.4%

$\frac{1.5^3}{11.17} = .302$ 42.1%

.716 100.0

$\frac{1}{11.17} = .0895$ 47%

$\frac{1}{9.92} = .1010$ 53%

.1905

$1/6.33 = .1595$ 64%

$1/11.17 = .0895$ 36%

.2490

BURSTING PRESS. = (48 − 25.2) 62.5# = 1428# /□'

F.E.M.

$1428 \times \frac{11.17^2}{12} = 14{,}900'^{\#}$

$1428 \times \frac{6.33^2}{12} = 4770$

Form 115 10M-11-39

METCALF & EDDY
ENGINEERS
BOSTON, MASS.

PROJECT U. S. ENGINEERS - HARTFORD
SUBJECT PARK RIVER - PRESSURE CONDUIT
DETAIL SIPHON INLET CHAMBER

PAGE 6
DATE APRIL 17, 1940
COMPUTED BY S.W.O.

M = 5,000 M = 3,100

+8.97	-.15	D	+.25	-5.03	+3.13	+.40	P	-.49	-7.55
+9.12	+.27	C	0	-5.28	+2.73	-.61	C	+.42	-7.06
+8.85	-.01	D	+.54	-5.28	+3.34	+.85	D	-1.22	-7.48
+8.86	+.49	C	+.52	-5.82	+2.49	-2.02	C	+.77	-6.26
+8.37	+1.05	D	+.98	-6.34	+4.51	+1.63	D	-4.05	-7.03
+7.32		P		-7.32	+2.98		F		-2.98
ΣM	Δ		Δ	ΣM	ΣM	Δ		Δ	ΣM

M = 9,000 1#

M = 7,600 1#

-8.97	-8.44	-8.85	-8.53	-8.37	-9.30	ΣM
-.18	+.01	-.02	-.46	+.93		Δ
D	C	D	C	D	F	

53% 22.5% 35% 42.1% 47%

ΣM	0	+1.83	+.92	+1.94	+1.43	+1.90
Δ		+1.83	-.92	+1.02	-.51	+.47
	F	D	C	D	C	D

M = 1,900

64% 36%

ΣM	+9.30	+7.03	+8.16	+7.48	+7.82	+7.55
Δ		-2.27	+1.13	-.68	+.34	-.27
	F	D	C	D	C	D

BOTH SIDES EMPTY

M = 3,800 1# 6740 1#

-.68	+.47	D	-.58	-3.77	-6.77	-.91	P	+1.02	+11.84
-1.15	-.61	C	+.30	-3.19	-5.86	+1.15	C	-.95	+10.82
-.54	+.60	D	-1.21	-3.49	-7.01	-1.90	D	+2.31	+11.77
-1.14	-1.14	C	0	-2.28	-5.11	+3.24	C	-1.79	+9.46
0		D	-2.28	-2.28	-8.35	-3.58	D	+6.48	+11.25
0		F		0	-4.77		F		+4.77
ΣM	Δ		Δ	ΣM					

M = 600 1#

M = 11,900 1#

+.68	+.27	+.54	0	0	0	ΣM
+.41	-.27	+.54				Δ
D	C	D	C	D	F	

+14.90	+10.63	+12.76	+16.50	+11.63	+10.54	
	-4.27	+2.13	-2.26	+1.13	-1.09	
	F	D	C	D	C	D

M = 10,540

ΣM	-14.90	-11.25	-13.07	-11.77	-12.42	-11.84
Δ		+3.65	-1.82	+1.30	-.65	+.58
	F	D	C	D	C	D

RIGHT SIDE FLOODED

Form 115 10M-11-39

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ENGINEERS
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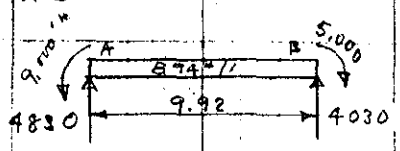
PROJECT U. S. ENGINEERS - HARTFORD
SUBJECT PARK RIVER - PRESSURE CONDUIT
DETAIL SIPHON INLET CHAMBER

PAGE 7
DATE APRIL, 17, 1940
COMPUTED BY S. W. O.

BOTH CHAMBERS EMPTY

Mom value Wall = $147.7 \frac{12}{12} 10.5^2 = 16,300^{1\#}$

AB



$W = 894 \times 9.92 = 8860^{\#} \times \frac{1}{2} = 4430$

MOM. DIFF = 4,000 ÷ 9.92 = 400

4030 OR 4830

$V = \frac{4,830}{.88 \times 12 \times 10.5} = 43.6^{\#/\square}$

$X = 4030 \div 894 = 4.5$

$+M = 4.5 \times 4030 \times \frac{1}{2} - 5,000 = 4070^{1\#}$ (9070)

$L' = \sqrt{\frac{8 \times 4070}{894}} = 6.05$

$S_H = 3.02 \times 894 = 2700^{\#}$

$-A_s = \frac{9,000 \times 12}{.88 \times 10.5 \times 18,000} = .648 \square''$

3/4"φ 8" o.c.

$BOND = \frac{4830}{.88 \times 10.5 \times 125} = 4.18$ inches.

3/4"φ 7" o.c.

USE 3/4"φ 8" o.c. USE 7/8"φ 8" o.c.

$+A_s = \frac{4.07}{9.00} \times .648 = .293$

1/2"φ 8" o.c.

$BOND = \frac{2.7}{4.83} \times 4.18 = 2.34$

1/2"φ 7.9" o.c.

USE 1/2"φ 8" o.c.

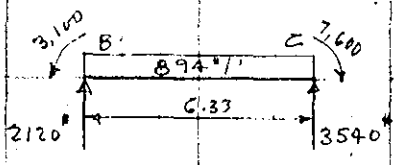
$-A_s = \frac{5.00}{9.00} \times .643 = .357$

5/8"φ 10" o.c.

$BOND = \frac{4.03}{4.83} \times 4.18 = 3.50$

5/8"φ 6.7" o.c. 3/4"φ 8" o.c.

BC



$W = 894 \times 6.33 = 5660 \times \frac{1}{2} = 2830$

$4,500 \div 6.33 = 710$

2120 & 3540

$X = 3540 \div 894 = 3.96$

$M = 3540 \times 3.96 \times \frac{1}{2} - 7,600 = -600$ No + Mom. (7,000)

$-A_s = \frac{7,600 \times 12}{.88 \times 10.5 \times 18,000} = .55 \square''$

3/4"φ 9 1/2" 5/8"φ 6 1/2"

$BOND = \frac{3.54}{4.83} \times 4.18 = 3.06$

3/4"φ 9.25" 5/8"φ 7.7

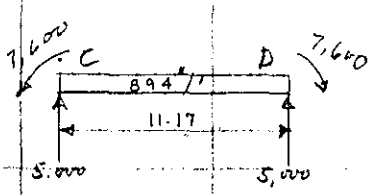
USE 3/4"φ 8" o.c.

$-A_s = \frac{3.1}{7.6} \times .55 = .224$

$BOND = \frac{2.12}{4.83} \times 4.18 = 1.83$

USE 3/4"φ 16" o.c. 3/4"φ 15.5"

CD



$W = 894 \times 11.17 = 10,000^{\#}$

$+M = \frac{10,000 \times 11.17}{8} - 7,600 = 6,400^{1\#}$ (14,000)

$L' = \sqrt{\frac{6,400 \times 8}{894}} = 7.57$

$S = 894 \times 7.57 \times \frac{1}{2} = 3,380$

$+A_s = \frac{6.4}{7.6} \times .55 = .463 \square''$

5/8"φ 7.8" o.c. S = 18,000

$BOND = \frac{3.38}{4.83} \times 4.18 = 2.93$

5/8"φ 8" o.c.

USE 3/4"φ 8" o.c.

$-BOND = \frac{5,000 - 894 \times .58}{.88 \times 10.5 \times 125} = 3.82$ (4,480 520)

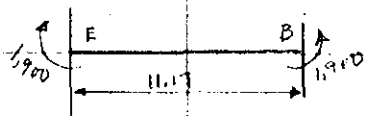
3/4"φ 7.4" 8" o.c. BOND = 135#/□

USE 7/8"φ 8" o.c.

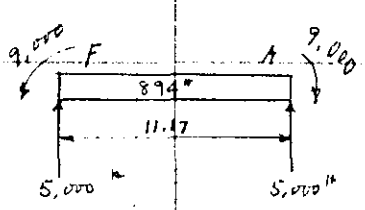
BE

$d = 18 - 3.5 = 14.5''$

$A_s = \frac{12 \times 1{,}900}{.88 \times 14.5 \times 18{,}000} = .10\ \square''$ $\frac{1}{2}''\phi$ 24" O.C.



A.E.



$W = 894 \times 11.17 = 10{,}000^{\#}$

$+M = \frac{10{,}000 \times 11.17}{8} - 9{,}000 = 5{,}000^{\prime\#}$ (14,000) $L' = \sqrt{\frac{5{,}000 \times 8}{894}} = 6.7$

$SH = 894 \times 3.35 = 3{,}000^{\#}$

$+A_s = \frac{5{,}000}{9{,}000} \times .643 = .357\ \square''$ $BOND = \frac{3.0}{4.83} \times 4.18 = 2.60$

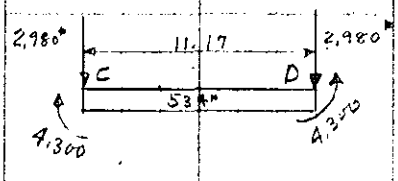
$5/8''\phi$ 10" O.C. $5/8''\phi$ 9"

$BOND = \frac{5{,}000}{.88 \times 10.5 \times 125} = 4.33$ $7/8''\phi$ 8" O.C. ← SEE C-D. USE $5/8''\phi$ 8" O.C.

CHAMBER FLOODED.

CD

NET PRESSURE = 1428 − 894 = 534# NET M = 11,900 − 7,600 = 4,300'#



$W = 534 \times 11.17 = 5960^{\#}$ $R = 2980^{\#}$

$+M = \frac{5960 \times 11.17}{8} - 4{,}300 = 8{,}300 - 4{,}300 = 4{,}000^{\prime\#}$

$L' = \sqrt{\frac{4{,}000 \times 8}{534}} = 7.75$ $SH = 7.75 \times \frac{1}{2} \times 534 = 2070^{\#}$

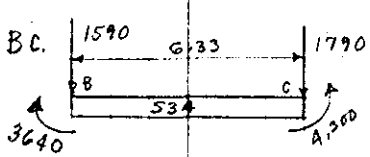
$-A_s = \frac{4{,}300 \times 12}{.88 \times 10.5 \times 18{,}000} = .31\ \square$ $BOND = \frac{2980}{.88 \times 10.5 \times 125} = 2.58''$

EXTEND $3/4''\phi$ 8" O.C. & HOOK ENDS.

$+A_s = \frac{4.0}{4.3} \times .31 = .288$ $BOND = \frac{2.07}{2.98} \times 2.58 = 1.79$

$\frac{1}{2}''\phi$ 8" O.C.

BC.



NET MOM. = −6740 + 3,100 = −3640'#

$W = 534 \times 6.33 = 3380^{\#}$ 1690

$4{,}300 - 3640 = 660 \div 6.33 = 100$

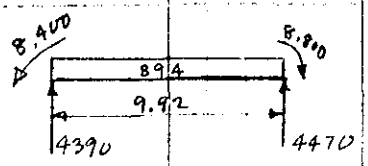
1790#

NOT NECESSARY TO COMPUTE (+M)

$-A_s = .31\ \square''$ $BOND = \frac{1.79}{2.98} \times 2.58 = 1.55$

Use $5/8''\phi$ 8" O.C. EXCESSIVE

AB



MOM = 3,800 + 5,000 = 8,800 9,000 − 600 = 8,400'#

W = 8,860 4430

400 ÷ 9.92 = 40

4390

$X = \frac{4470}{894} = 5.0$

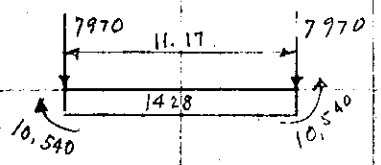
$M = 4470 \times 5.0 \times \frac{1}{2} - 8{,}800 = 2{,}400^{\prime\#}$ (11,200)

$L' = \sqrt{\frac{2400 \times 8}{894}} = 4.65$

$+A_s = \frac{8.8}{5.0} \times .357 = .628$ $BOND = \frac{4.47}{4.83}\ 4.18 = 3.88$

$3/4''\phi$ 8" O.C. $3/4''\phi$ 7.3" O.C. Bond @ 8" = 137#/□ O.K.

BE



$W = 1428 \times 11.17 = 15{,}940^{\#}$

$+M = \dfrac{\overset{22{,}200}{15{,}940 \times 11.17}}{8} - 10{,}540 = 11{,}660$

$d = \sqrt{\dfrac{11{,}660}{147.7}} = 8.90''$

$L' = \sqrt{\dfrac{11{,}660 \times 8}{1428}} = 8.10$

$SH = 4.05 \times 1428 = 5{,}780^{\#}$

NET $SH = 7{,}970 - \overset{930}{1428 \times .58} = 7{,}040^{\#}$

$Y = \dfrac{7040}{.88 \times 12 \times 14.5} = 46\ \square''$

17" WALL OK USE 18"

$+A_s = \dfrac{11{,}660 \times 12}{.88 \times 14.5 \times 18{,}000} = .61\ \square''$

3/4"φ 8.7" o.c.

$BOND = \dfrac{5780}{.88 \times 14.5 \times 125} = 3.62$ inches

3/4"φ 7.8" o.c.

Use 3/4"φ 8" o.c.

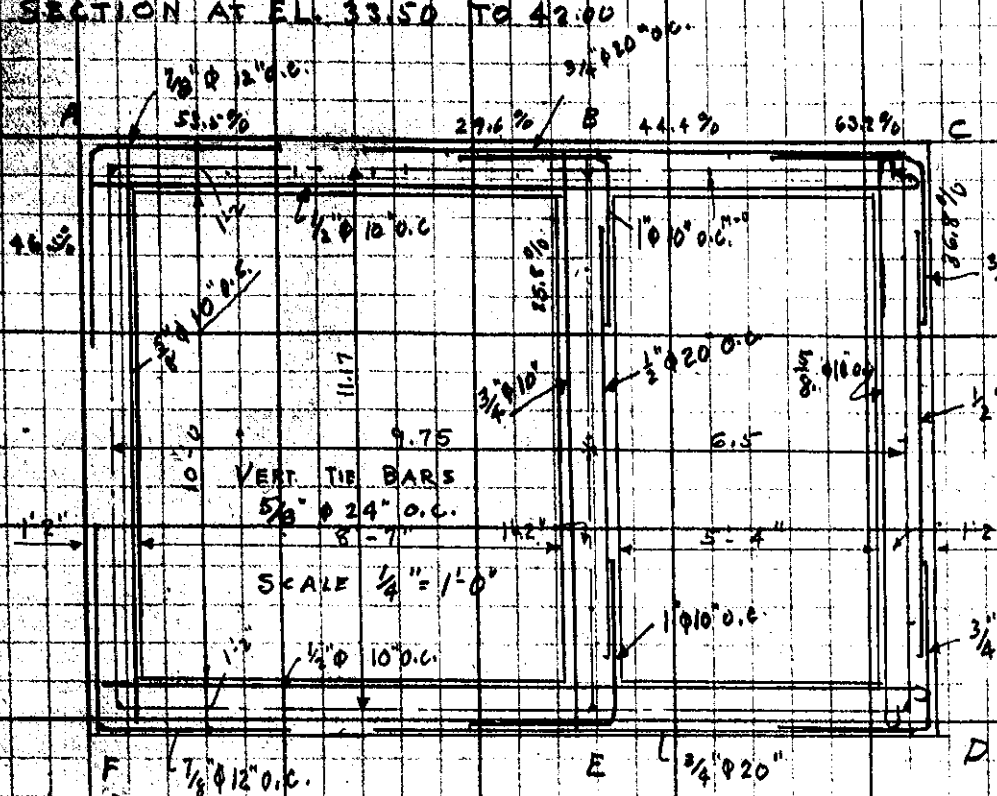
$-A_s = \dfrac{10{,}540 \times 12}{.88 \times 14.5 \times 18{,}000} = .55\ \square''$

$Bond = \dfrac{7040}{.88 \times 14.5 \times 125} = 4.4$ inches.

1"φ 8" o.c. 7/8"φ 7.5" o.c.

Use 1"φ 8" o.c.

SECTION AT EL. 33.50 TO 42.00



$$\text{PRESS} = (50.0 - \overset{16.5}{33.5})\,35^{\#} + 27 = 578 + 27 = 605^{\#}/\square'$$

F. E. M

$$605 \times \frac{9.75^2}{12} = 4{,}800'^{\#}$$

$$\text{"} \times \frac{11.17^2}{12} = 6{,}300'^{\#}$$

$$\text{"} \times \frac{6.5^2}{12} = 2130'^{\#}$$

STIFFNESS FACTORS.

$$\frac{1}{11.17} = .0894 = 46.5\%$$

$$\frac{1}{9.75} = \frac{1026}{1920} = 53.5\%$$

$$\frac{1}{9.75} = .1026 \qquad 29.7\%$$

$$\frac{1}{11.17} = .0894 \qquad 25.8\%$$

$$\frac{1}{6.5} = \frac{.1540}{.3460} \qquad 44.5\%$$

$$\frac{1}{6.5} = .1540 \qquad 63.2\%$$

$$\frac{1}{11.17} = \frac{.0894}{.2434} \qquad 36.8\%$$

BURSTING

$$\text{PRESS} = (48 - \overset{14.5}{33.5})\,62.5^{\#} = 906^{\#}/\square'$$

$$906 \times \frac{11.17^2}{12} = 9420'^{\#}$$

$$906 \times \frac{6.5^2}{12} = 3{,}200'^{\#}$$

Form 113 10M-11-39

METCALF & EDDY
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PROJECT U. S. ENGINEERS – HARTFORD
SUBJECT PARK RIVER – PRESSURE CONDUIT
DETAIL SIPHON INLET CHAMBER

PAGE 11
DATE APRIL 19, 1940
COMPUTED BY S. W. O.

M = 6,100 '#

M = -3,050 +2380

+6.05	-.11	P	+.18	-3.07	+2.40	+.27	D	-.33	-5.07
+6.16	+.19	C	-.02	-3.25	+2.13	-.43	C	+.28	-4.74
+5.97	-.03	D	+.38	-3.23	+2.56	+.56	D	-.86	-5.02
+6.00	+.40	C	+.40	-3.61	+2.00	-1.32	C	+.60	-4.16
+5.60	+.80	D	+0.79	-4.01	+3.32	+1.19	D	-2.63	-4.76
+4.80		F		-4.80	+2.13		F		-2.13
ΣM	Δ		Δ	ΣM	ΣM	Δ		Δ	ΣM

M = 5,100 '#

D	-.09	6.05	C	+.01	-5.96	D	-.02	-5.97	C	-.35	-5.95	D	+.70	-5.60	F		-6.30	Δ	ΣM	46.5%	53.5%		29.7%	44.5%	25.8%	Δ	ΣM	F	+.69	+.69	D	+.69	+.34	C	-.35	+.33	D	+.67	+.51	C	-.16	+.16	D	+.67	M = 670	63.2%	36.8%	Δ	ΣM	F	+.30	+.76	D	-1.54	+5.53	C	+.77	+5.02	D	-.51	+5.27	C	+.25	+5.07	D	-.26

BOTH SIDES EMPTY

M 550 '#

M = 2,900 M = 5,000

-.51	+.33	D	-.42	-2.84	-5.06	-.62	D	+.69	+7.41
-.84	-.41	C	+.25	-2.42	-4.44	+.80	C	-.62	+6.72
-.43	+.49	D	-.82	-2.67	-5.24	-1.24	D	+1.59	+7.34
-0.92	-0.92	C	0	-1.85	-4.00	+1.97	C	-1.38	+5.75
0	0	D	-1.85	-1.85	-5.97	-2.77	D	+3.93	+7.13
0		F		0	-3.20		F		+3.20
ΣM	Δ		Δ	ΣM	ΣM	Δ		Δ	ΣM

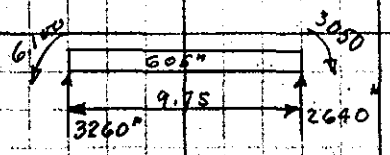
M = 7,450

D	+.29	+.51	C	-.22	+.22	D	+.43	+.43	C	0	0	D		0	F		0	Δ	ΣM							Δ	ΣM	F	+9.42	+9.42	D	-1.60	+7.82	C	+.80	+8.62	D	-.71	+7.91	C	+.35	8.26	D	-.36	+7.90	M = 7,900	Δ	ΣM	F	-9.42	-9.42	D	+2.29	-7.13	C	-1.14	-8.27	D	+.93	-7.34	C	-.47	-7.81	D	+.40	-7.41

RIGHT SIDE FLOODED

BOTH CHAMBERS EMPTY

AB



$W = 605 \times 9.75 = 5900$ 2950
$3050 \div 9.75 =$ 310
2640 & 3260

$X = \frac{2640}{605} = 4.36$

$+M = 4.36 \times 2640 \times \frac{1}{2} - 3050 = 2700''^{\#}$ $L' = \sqrt{\frac{2700 \times 8}{605}} = 5.97$

SHEAR $= 5.97 \times 605 \times \frac{1}{2} = 1.800''^{\#}$

$-A_s = \frac{6,100 \times 12}{.88 \times 10.5 \times 18,000} = .44 \square''$ BOND $= \frac{3,260}{.88 \times 10.5 \times 125} = 2.82$ $\frac{3.50}{.58 \times 605}$ $\frac{2910}{3260} \times 2.82 = 2.52$

USE — 3/4" ϕ 10" O.C. FOR BOND.

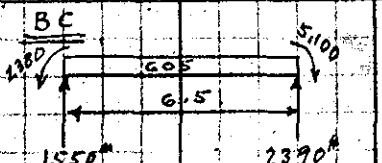
$+A_s = \frac{2700 \times 12}{.88 \times 10.5 \times 18,000} = .1950''$ BOND $= \frac{1.800}{3260} \times 2.82 = 1.56$

1/2" ϕ 10" O.C.

$-A_s = \frac{3.05}{6.10} \times .44 = .22 \square''$ BOND $= \frac{2.6}{3.26} \times 2.82 = 2.2$

3/4" ϕ 10" O.C.

BC



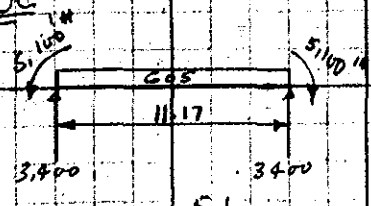
$W = 605 \times 6.5 = 3940$ 1970
$5,100 - 2380 = 2720 \div 6.5 =$ 420
1550" 2390

$X = 2,390 \div 605 = 3.95$

$+M = 3.95 \times 2390 \times \frac{1}{2} - 5,100 = -400''^{\#}$ NO (+M)

(−) REIN. SEE AB & DC

DC



$W = 605 \times 11.17 = 6,750$
9,420

$+M = \frac{6,750 \times 11.17}{8} - 5,100 = 4320''^{\#}$ $L' = \sqrt{\frac{8 \times 4320}{605}} = 7.57$

SH $= 3.78 \times 605 = 2,290''^{\#}$

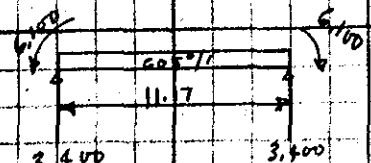
$-A = \frac{5.1}{6.1} \times .44 = .3680 \square''$ BOND $= \frac{3.4}{3.26} \times 2.82 = 2.94$

USE 3/4" ϕ 10" O.C.

$+A_s = \frac{4.32}{6.10} \times .44 = .312$ BOND $= \frac{2.29}{3.26} \times 2.82 = 1.98$

USE 5/8" ϕ 10" O.C. BOND.

AF



$+M = 9,420 - 6,100 = 3,320$ $L' = \sqrt{\frac{8 \times 3320}{605}} = 6.64$ FT

SH $= 3.32 \times 605 = 2010''^{\#}$

$+A_s = \frac{3.32}{6.10} \times .44 = .24 \square''$ BOND $= \frac{2.01}{3.26} \times 2.82 = 1.74$

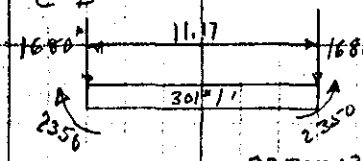
1/2" ϕ 9.8 O.C. 1/2" ϕ 10" O.C.

USE 5/8" ϕ 10" O.C.

BURSTING

NET PRESS. 906 − 605 = 301# 1□" NET MOM = 7,450 − 5,100 = 2,350'#

CD



W = 301 × 11.17 = 3360#

+M 301 × $\frac{11.17^2}{8}$ − 2350 = 4680 − 2350 = 2330'#

L' = $\sqrt{\frac{8 \times 2330}{301}}$ = 7.9' SH = 7.9 × 301 × ½ = 1190#

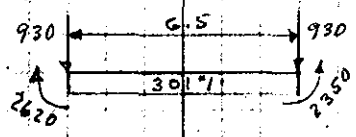
− As = $\frac{2350 \times 12}{.88 \times 10.5 \times 18{,}000}$ = .17 □" BOND = $\frac{1680}{.88 \times 10.5 \times 125}$ = 1.45

Use 5/8"ϕ HOOKED ENDS.

+ As = $\frac{2.33}{2.35}$ × .17 = .17 BOND = $\frac{1190}{1680}$ × 1.45 = 1.03

Use ½"ϕ 10" O.C.

BC.

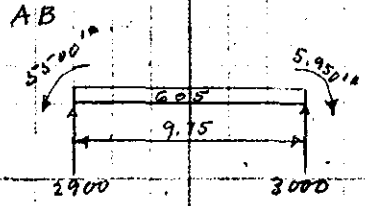


NET M = 5,000 − 2380 = 2,620'#

W = 301 × 6.5 = 1960#

− As = $\frac{2.62}{2.35}$ × .17 = .19 ½"ϕ 10" O.C. O.K.

AB



M = 2,900 + 3,050 = 5,950'" 6,100 − 600 = 5,500'#

W = 5900 2950
450 ÷ 9.75 = 45
R = 2900 & 3,000

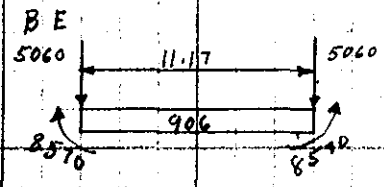
x = 3,000 ÷ 605 = 4.96

+M = 4.96 × ½ × 3,000 − 5950 = 1510 L' = $\sqrt{\frac{1510 \times 8}{605}}$ = 4.5 FT.

− As = $\frac{5.95}{2.35}$ × .17 = .43 □" BOND = $\frac{3.0}{1.68}$ × 1.45 = 2.58

3/4" ϕ 10" O.C

BE



M = 7,900 + 670 = 8570

W = 906 × 11.17 = 10,120# V = $\frac{5060}{.88 \times 12 \times 10.5}$ = 45.7#/□"

+M = $\frac{10{,}120 \times 11.17}{8}$ − 8570 = 5530 L' = $\sqrt{\frac{8 \times 5530}{906}}$ = 7.0

SH = 3.5 × 906 = 3,180#

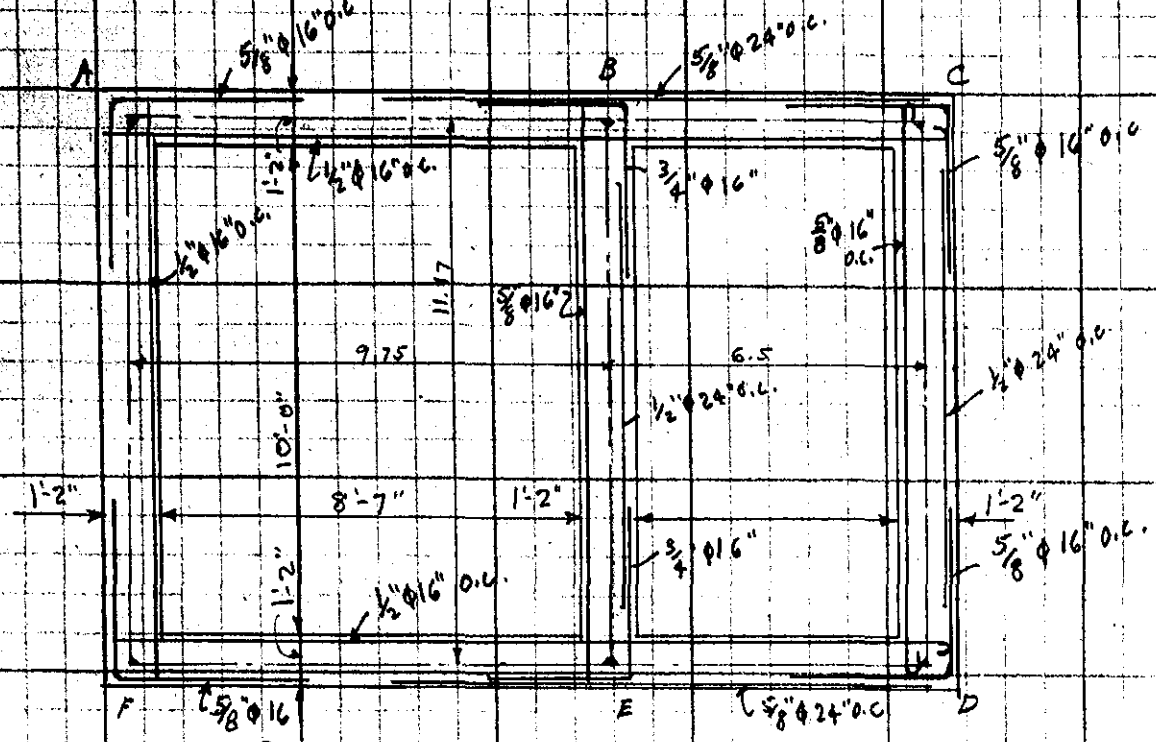
− As = $\frac{5.06}{2.35}$ × .17 = .366 □" BOND = $\frac{5{,}060}{.88 \times 10.5 \times 125}$ = 4.38

1"ϕ 10" BOND = 130#/□" O.K.

+ As = $\frac{5.53}{2.35}$ × .17 = .40 □" BOND = $\frac{3{,}18}{5.06}$ × 4.38 = 2.75

3/4"ϕ 10" O.C.

SECTION AT EL 42.0 TO EL 50.00



PRESS = (50 - 42.0) 35 + 27 = 280 + 27 = 307# /□'

MULTIPLIER = $\frac{307}{605}$ = .507 × REIN OF SEC. 33.50

WATER PRESS = 62.5 (48 - 42) = 375.0# /□'

MULTIPIER = $\frac{375}{906}$ = $\frac{6}{14.5}$ = .414

SEE SECTION @ EL 33.50

AB

$-A_s = .44 \times .507 = .223$ BOND $= 2.82 \times .507 = 1.43$
5/8" φ 16"

$+A_s = .195 \times .507 = .099$ BOND $= 1.56 \times .507 = .079$
1/2" φ 24" USE 1/2" φ 16"

$-A_s = .22 \times .507 = .112$ BOND $= 2.28 \times .507 = 1.16$
1/2" φ 16" O.C.

DC.

$-A_s = .368 \times .507 = .187$ BOND $= 2.94 \times .507 = 1.49$
5/8" φ 16" O.C. BOND.

$+A_s = .312 \times .507 = .158$ BOND $= 1.98 \times .507 = 1.01$
USE 5/8" φ 16" O.C.

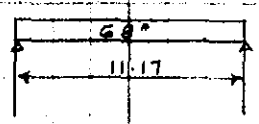
AF.

$+A_s = .24 \times .507 = .122$ BOND $= 1.74 \times .507 = .88$
USE 1/2" φ 16" O.C.

BURSTING

C-D.

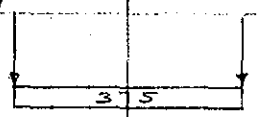
NET PRESSURE = 375 - 307 = 68#/□



MOM'S. = $\overset{2580}{.507 \times 5.100} - \overset{3090}{.414 \times 7.450} = 510'^{\#}$

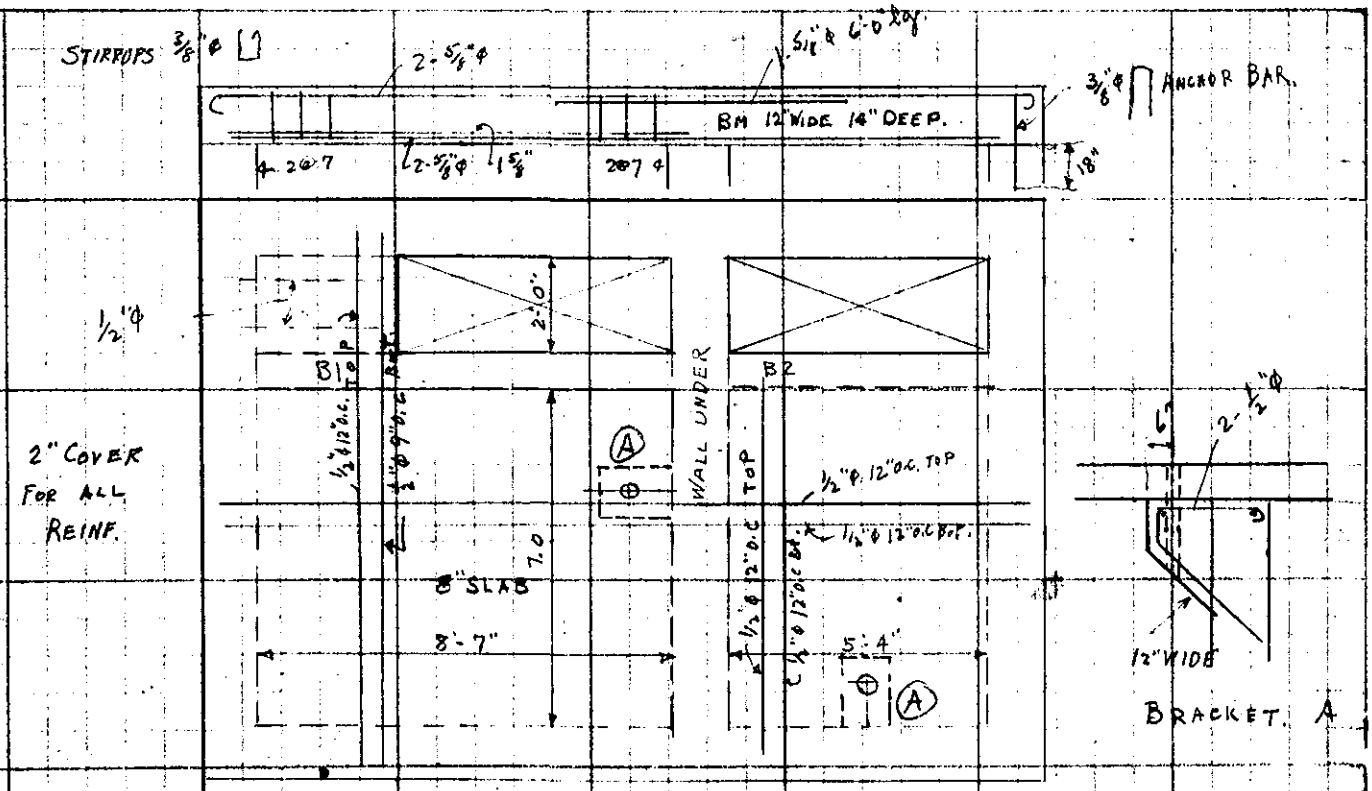
AS MOMS ARE SMALL USE 1/2" φ 24" O.C. +M.

B.E.



$-A_s = .414 \times .366 = .152$ BOND $= 4.38 \times .414 = 1.81$
3/4" φ 15.5" USE 3/4" φ 16"

$+A_s = .40 \times .414 = .166$ BOND $= 2.75 \times .414 = 1.14$
5/8" φ 16"



48" SLUICE GATE

PRESS = 62.5 x 25.80 x 2² x π = 20,300#
FRICTION RESIST. = 5,100#
Weight = 2,000#
TOTAL = 7,100#

36" SLUICE GATE

PRESS = 62.5 x 23.90 x 1.5² x π = 10,500
FRICTION RESIST. = 2600
GATE = 1500
TOTAL = 4,100#

DESIGN SLAB FOR 200# L.L.

APPROX LOAD DISTRIBUTION

8.88 / 7.0 - .5 = 1.225 - .5 = .725 SHORTWAY
.275 LONG WAY.

7.0 / 5.33 - .5 = 1.31 - .5 = .81 SHORT WAY
.19 LONG "

~~ASSUME WHEEL LOAD DISTRIBUTES 3.5 FT. AT WALL~~
~~" " " 6.0 " AT ℄ SPAN.~~ } FOR 8" SLAB

~~SH / FT = 16,000 ÷ 3.5 = 4560#~~
~~SLAB = 73" x 3.5 = 260#~~
~~4820~~

~~d = 4820 / .88 x 50 x 12 = 9.1" + 1.5 = 10.6"~~

~~TRY 10" SLAB.~~

~~e = .75 + 1.9 + .83 = 7.60 ÷ 1.25 = 3.75" SAY 4.0"~~

~~SH = 4300 d = 4300 / .88 x 60 = 8.15 + 1.5 = 9.65"~~

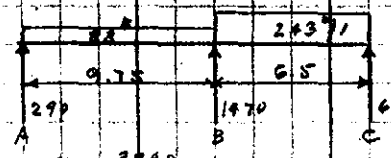
~~USE 10" SLAB~~

~~e = .75 + 1.0 + 1 + 2 = 5.75 + 1.25 = 7'-0" ON ℄. USE 6'-0"~~

~~BOND EITHER WAY = 4,300 / .88 x 6.5 x π x 5/8 = 4.6 = 5/8"φ 5" O.C.~~

LONG. TRY. 8" SLAB L.L. = 200 300 × .275 = 83# 300 × .81 = 243
SLAB = 100 300 × .725 = 217 300 × .19 = 57
300#

2 × 16.25 $M_B = \frac{83 \times 9.75^2}{4} + \frac{243 \times 6.5^2}{4} = 19{,}800 + 16{,}700 = 36{,}000$



$M_B = 36{,}000 \div 32.5 = 1140$ '#

$W = 83 \times 9.75 = 810$# $W = 243 \times 6.5 = 1580$#

3940

$83 \times 9.75^2 \times \frac{1}{2} - 1140 = 2800$ $R_A = \frac{2800}{9.75} = 290$#
$243 \times 6.5^2 \times \frac{1}{2} - 1140 = 4110$ $R_C = \frac{4110}{6.5} = 630$ } 920 + 2390 = 1470
$290 \div 83 = 3.5$ $+M = 290 \times 3.5 \times \frac{1}{2} = 510$ '#
$630 \div 243 = 2.6$ $+M = 630 \times 2.6 \times \frac{1}{2} = 820$ '# $d = 8 - 2.5 = 5.5$

$A_s = \frac{1140 \times 12}{.88 \times 5.5 \times 18{,}000} = .156 = \frac{1}{2}$"φ 12" o.c. o.k. $.002 \times 96 = .192 = \frac{1}{2}$"φ 12" o.c.

Use ½" φ 12" o.c. TOP & BOT. STR.

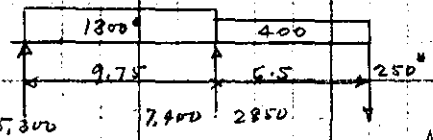
SHORT WAY

$M = \frac{217 \times 8^2}{8} = 1740$ '# $A_s = \frac{1740 \times 12}{.88 \times 5.5 \times 18{,}000} = .24$ Use ½"φ 9" o.c.

5'-4" BAY Use ½"φ 12" o.c.

B1 & B2

$217 \times 5.5 = 1200$ $55 \times 5.5 = 300$
BM = 100 BM = 100
1300# 400



$M_B \times 32.5 = \frac{1300 \times 9.75^2}{4} + \frac{400 \times 6.5^2}{4} = 300{,}000 + 27{,}500$

$1300 \times \frac{9.75^2}{2} = 61{,}800$ $M_B = \frac{327{,}500}{32.5} = 10{,}100$ '#
10,100
51,700 ÷ 9.75 = 5,300 12,700 = W
7,400

$d(SH) = \frac{7{,}400}{.88 \times 12 \times 50} = 14$"

$400 \times \frac{6.5^2}{2} = 8{,}500$ 10,100 2600 = W $d(M) = \sqrt{\frac{10{,}800}{147.7}} = 8.5$
− 1,600 ÷ 6.5 = 250
2850 = SH Use d = 11.5 t = 14" b = 12"

X = 5,300 ÷ 1300 = 4.07
+M = 5,300 × 4.07 × ½ = 10,800 '# SH value = 12 × .88 × 11.5 × 50# = 6060#

$A_s = \frac{10{,}800 \times 12}{.88 \times 11.5 \times 18{,}000} = .710$" Bond = $\frac{7{,}400}{.88 \times 11.5 \times 125} = 5.85$

2 - ¾"φ Rds. Bond = 155
3 - ⅝"φ Rds = 90 Bond o.k. Use 3 - ⅝"φ Rds.

STIRRUPS = $\frac{2}{3} \times \frac{7{,}400}{.88 \times 11.5} = 490$ ⅜" U = $\frac{3530}{490} = 7$" 4 & 2 @ 7" EACH END.

BRACKET LD = 7,100# AREA SHF $\frac{7{,}100}{.88 \times 50} = 161$ 12 × 14 o.k.

SEWER SIPHON - OUTLET CHAMBER

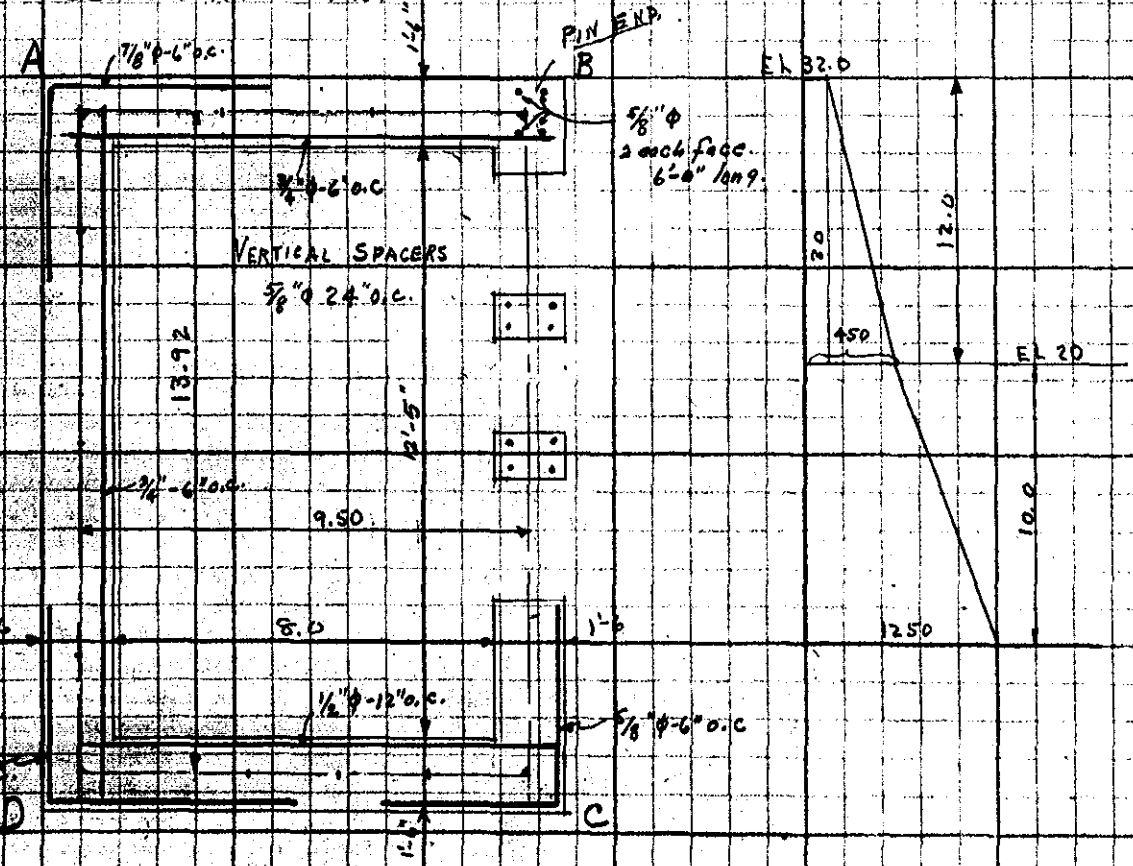
Form 115 10M-11-39

METCALF & EDDY
ENGINEERS
BOSTON, MASS.

PROJECT U. S. ENGINEERS - HARTFORD
SUBJECT PARK RIVER - PRESSURE CONDUIT
DETAIL SIPHON OUTLET CHAMBER

PAGE 1
DATE APRIL 23, 1940
COMPUTED BY S.W.O.

SECTION AT ELEV. 10.



PRESS = 30 + 12 × 2.5 + 10 × 8.0 = 126.0

$\frac{1}{9.5}$ = .1053 .594 PIN END $\frac{.75}{9.5}$ = .0790 .524

$\frac{1}{13.92}$ = .0718 .406 $\frac{1}{13.92}$ = .0718 .476

.1771 .1508

F.E.M. = $1250 \times \frac{13.92^2}{12}$ = 20,200 '# $1250 \times \frac{9.50^2}{12}$ = 9,400 '#

CANTILEVER M = 1250 × 3.5² × ½ = 7,600 '#

Mem. 18" Slab = 147.7 × 18.5² = 31,000 '# $M = Rbd^2$

Form 115 10M-11-39

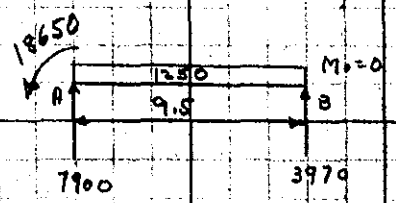
METCALF & EDDY
ENGINEERS
BOSTON, MASS.

PROJECT: U.S. ENGINEERS - HARTFORD — PAGE 2
SUBJECT: PARK RIVER - PRESSURE CONDUIT — DATE: APRIL 23, 1940
DETAIL: SIPHON OUTLET CHAMBER — COMPUTED BY: [illegible]

M = 18,650 ft

							+18.62		P			
							+18.44	+.18	C			
							+18.44	-1.31	D			
							+19.75	+4.70	C			
							+15.05	+5.65	D	+.84	0	Pin
							+9.40		F		-9.40	
						A	ΣM	Δ		Δ	ΣM	B
-18.62	-18.78	-18.44	-17.25	-15.05	-20.20	ΣM		52.4%				
+.16	-.34	-1.19	-2.20	+5.15		Δ	47.6%					
D	C	D	C	D	F							
-.41	-.60	-0.68	+2.57	-4.40		Δ						
+16.68	+17.09	+17.69	+18.37	+15.80	+20.20	ΣM	40.6%	59.4%				-7.60
						D						C
							-9.40		F		+9.40	
							-15.80	-6.40	D	-1.8	+7.60	M = 7,600 ft
							-16.70	-.90	C	-3.20		
							-17.69	-.99	D	+3.20	+7.60	
							-16.09	+1.60	C	-.50		
							-16.68	-.59	D			

M = 16,650 ft



$M_o = 0$

W = 1250 × 9.5 = 11,870 × ½ = 5935
Mom Diff. = 18650 ÷ 9.5 = 1965
3970 or 7900

$X = \frac{3970}{1250} = 3.17$

$+M = 3970 \times 3.17 \times \frac{1}{2} = 6,300$ ft

$L = \sqrt{\frac{16,300 \times 8}{1250}} = 6.35$

SH = 1250 × 3.18 = 4980 #

$-A_s = \frac{18650 \times 12}{.88 \times 14.5 \times 18000} = .975$ □"

1"φ - 9" o.c.

Bond. $\frac{7900}{.88 \times 14.5 \times 125} = 4.95$

1" φ 7.6" o.c

Use ⅞" φ - 6" o.c.

$+A_s$. $\frac{6300}{18650} \times .975 = .329$

⅝" φ - 11" o.c.

Bond. $\frac{4980}{7900}$ 4.95 = 3.12

¾" φ - 8" o.c.

Use ¾" φ - 8" o.c.

At Pin support SH = 3970

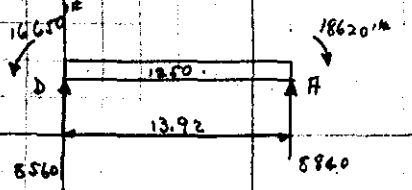
Bond = $\frac{3970}{7900}$ 4.95 = 2.49 ¾" φ - 8" o.c. OK

Form 115 10M-11-39

METCALF & EDDY
ENGINEERS
BOSTON, MASS.

PROJECT. U.S. Engineers - Hartford.
SUBJECT Park River - Pressure Conduit
DETAIL Siphon Outlet Chamber

PAGE 3
DATE April 24 1940
COMPUTED BY F.A.N.



W = 1250 × 13.92 = 17,400 × ½ = 8700
Mom Diff 1970 ÷ 13.92 = 140
8560 or 8840

x = 8840 ÷ 1250 = 7.07

+M = 8840 (7.07)½ − 18620 = 12,580 '# L = $\sqrt{\frac{12580 \times 8}{1250}}$ = 8.97

SH = 1250 × 4.49 = 5620#

− As $\frac{16650 \times 12}{.88 \times 14.5 \times 18000}$ = .870
¾" φ - 6" o.c.

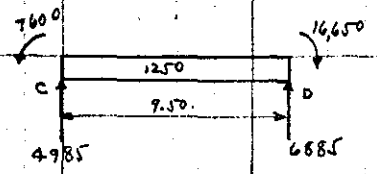
Bond = $\frac{8560}{.88 \times 14.5 \times 125}$ = 5.37
⅞" φ - 6" o.c.

+ M $\frac{12,580}{16650}$ .870 = .657
¾" φ - 8" o.c.

Bond $\frac{5620}{8560}$ 5.37 = 3.53
¾" φ - 8" o.c

− M $\frac{18620}{16650}$ .870 = .974
1" φ - 10" o.c.
⅞ φ - 6" o.c

Bond $\frac{8840}{8560}$ 5.37 = 5.55
⅞ φ - 6" o.c.



W = 1250 × 9.50 = 11870 × ½ = 5935
Mom. Diff. 9,050 ÷ 9.50 = 950
6885 or 4985

x = 6885 ÷ 1250 = 5.50

M = 6885 × 5.50 ½ − 16650 = 2,250 '#

L = $\sqrt{\frac{2250 \times 8}{1250}}$ = 3.8'

SH = 1250 × 1.9 = 2380.#

− As $\frac{7600 \times 12}{.88 \times 14.5 \times 18000}$ = .397
¾" φ - 12" o.c.

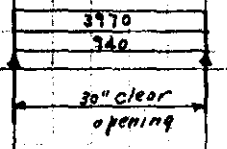
Bond $\frac{4985}{.88 \times 14.5 \times 125}$ = 3.12
¾" φ - 9" o.c.
Use ⅝ φ - 6" o.c.

+ As $\frac{2250}{7600}$ .397 = .118
½" φ - 20" o.c.

Bond $\frac{2380}{.4985}$ 3.12 = 1.49
½" φ - 12" o.c.
Use ½" φ - 12" o.c.

− As Use as above ⅞" φ - 6" o.c. at D.

At Pin end B.



Reaction 3970.

Additional Soil Ld. $\frac{940}{4910}$ = 1250 x .75

Shear. 4910 x 1.25 = 6140 #

Bond. $\frac{6140}{.88 \times 14.5 \times 1.25}$ = 3.85

Use 2 - 5/8" ϕ each face.

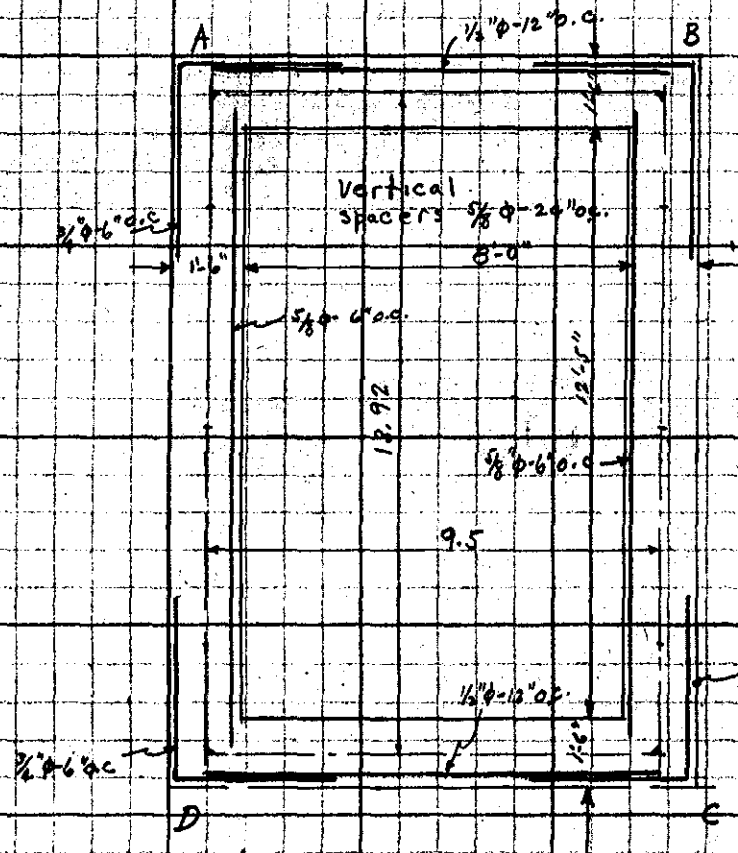
Form 115 10M-11-39

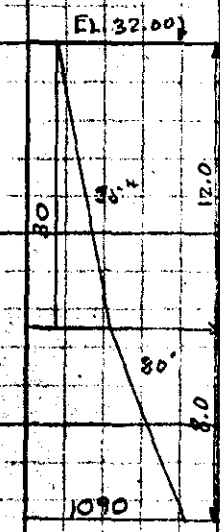
METCALF & EDDY
ENGINEERS
BOSTON, MASS.

PROJECT U. S. ENGINEERS - HARTFORD
SUBJECT PARK RIVER - PRESSURE CONDUIT
DETAIL SIPHON OUTLET CHAMBER

PAGE 5
DATE APRIL 24, 1940
COMPUTED BY S.W.O.

SECTION AT EL. 12.00





35 x 12 = 420 + 30 = 450
8 x 80 = 640
1090

$\frac{I}{L} = \frac{1}{9.5} = .1054$ 59.4%

" $= \frac{1}{13.92} = .0718$ 40.6

.1772

F. E. M.

$1090 \times \frac{9.5^2}{12} = 8200$ '#

$1090 \times \frac{13.92^2}{12} = 17,600$ '#

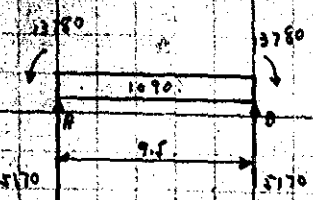
Max M = Rbd² = 147.7 x 12.5² = 31100 '#

METCALF & EDDY ENGINEERS BOSTON, MASS.

PROJECT U. S. ENGINEER - HARTFORD
SUBJECT PARK RIVER - PRESSURE CONDUIT
DETAIL SIPHON OUTLET CHAMBER

PAGE 16
DATE APRIL 2[illegible], 1940
COMPUTED BY [illegible]

										D
										C
								+13.78	+ 2.79	D
								+10.99	-2.79	C
							M = 13,780 ‘#	+13.78	+ 5.58	D
								+8.20		F
								ΣM	Δ	
						-13.78			59.4%	
						-15.69				
						-13.78				
						-17.60	ΣM			
					Δ			40.6%		
		D	+ 1.91							
		C	- 1.91							
		D	+3.82							
		F								



$W = 1090 \times 9.5 = 10340^{\#} \times \frac{1}{2} = 5170^{\#}$

$x = 4.75$

$+M = 5170 \times 4.75 \times \frac{1}{2} - 13780 = -1,480^{\prime\#}$ (12300)

$-A_s$ ends $= \frac{13780 \times 12}{.88 \times 14.5 \times 18000} = .72$ Bond $\frac{5170}{.88 \times 14.5 \times 125} = 3.24''$

$\frac{3}{4}''\phi$ - 7.3" o.c. $\frac{3}{4}''\phi$ - 8.7" o.c. or $\frac{7}{8}\phi$ - 10" o.c

Use $\frac{3}{4}''\phi$ - 6" o.c.

Center A_s $\frac{1480}{13780} \cdot .72 = .08$ $\frac{1}{2}''\phi$ - 12" o.c

Point where A_s req'd = .20 ($\frac{1}{2}''\phi$)

$M = -.20 \times .88 \times \frac{14.5}{12} \times 18000 = -3820^{\prime\#}$ or $\frac{.20}{72} \times 13780 = -3820$

$-3820 = 5170x - 1090\frac{x^2}{2} - 13780$ or $9960 = 5170x - 545x^2$

$-18.3 = x^2 - 9.48x$

or $x^2 - 9.48x + 22.4 = 4.1$

$(x - 4.74) = \pm 2.03$ or $x = 6.77$ or 2.71

Point for Bond $\Sigma o = 1.57$ $1.57 \times .88 \times 14.5 \times 125 = 2500$

$5170 - 1090x = 2500$

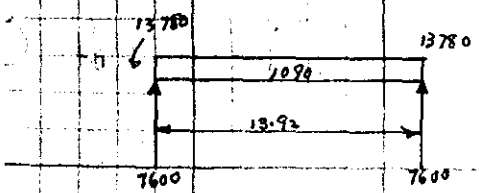
$x = 2.45$

Form 115 10M-11-39

METCALF & EDDY
ENGINEERS
BOSTON, MASS

PROJECT U.S. Engineers - Hartford
SUBJECT Park River - Pressure Conduit
DETAIL Siphon Outlet Chamber

PAGE 7.
DATE April 24-1940
COMPUTED BY FAN.



$W = 1090 \times 13.92 = 15200 \times \frac{1}{2} = 7600^{\#}$

$x = 6.96$

$+M = 7600 \times \overset{25400}{6.96 \times \frac{1}{2}} - 13780 = 11{,}620^{\#}$

$L = \sqrt{\frac{8 \times 11620}{1090}} = \sqrt{85.3} = 9.23$

$SH = 4.62 \times 1090 = 5030.$

$-A_s = .72$ p.6.

$\text{Bond} = \frac{7600}{.88 \times 14.5 \times 125} = 4.76.$

$\frac{3}{4}''\phi - 6''$ o.c. ok.

$+A_s \quad \frac{11620}{13780} \cdot .72 = .608$

$\frac{7}{8}\phi - 12''$ o.c.
or $\frac{5}{8}\phi - 6''$ o.c.

$\text{Bond} \quad \frac{5030}{7600} \cdot 4.76 = 3.15$

$\frac{5}{8}\phi - 6''$ o.c. ok.

All four Corners Similar.

Form 115 10M-11-39

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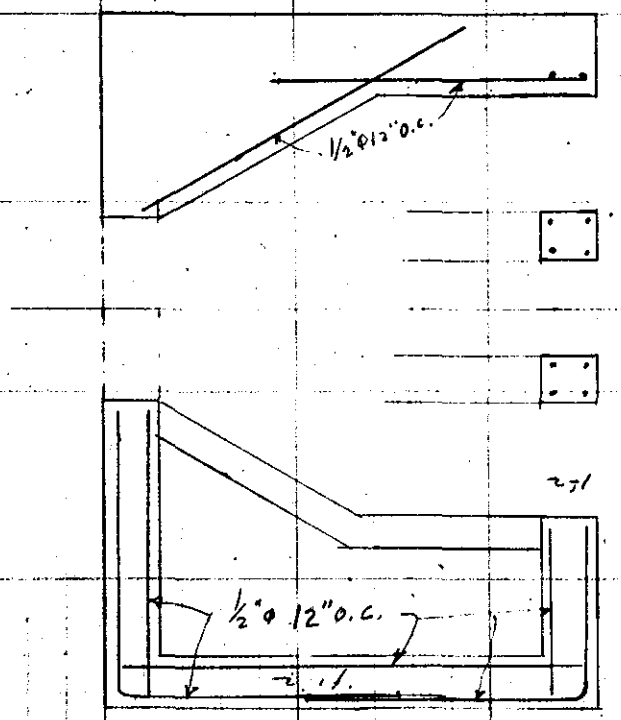
PROJECT: U. S. ENGINEERS - HARTFORD
SUBJECT: PARK RIVER - PRESSURE CONDUIT
DETAIL: SIPHON OUTLET CHAMBER

PAGE 8
DATE APRIL 24, 1940
COMPUTED BY S.W.O

SECTION EL. 21.25 NO GROUND WATER.



PRESS. = 30 + (32 - 21.25) 85# = 406#/□'

$M = 406 \times \frac{9^2}{8} = 4{,}100$

$A_s = \frac{4{,}100 \times 12}{.88 \times 16.5 \times 18{,}000} = .188$

$M = 406 \times \frac{9.17^2}{12} = 2850$ '#

$A_s = \frac{2850 \times 12}{.88 \times 10.5 \times 18{,}000} = .205$

$S_H = 4 \times 406 = 1624$

$BOND = \frac{1624}{.88 \times 10.5 \times 125} = 1.4$

1/2" φ 12" o.c. OK.

Vertical spacers 1/2" φ-24" o.c.

Form 115 10M-11-39

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SUBJECT Park River - Pressure Conduit
DETAIL Siphon Outlet Chamber

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DATE April 24-1940
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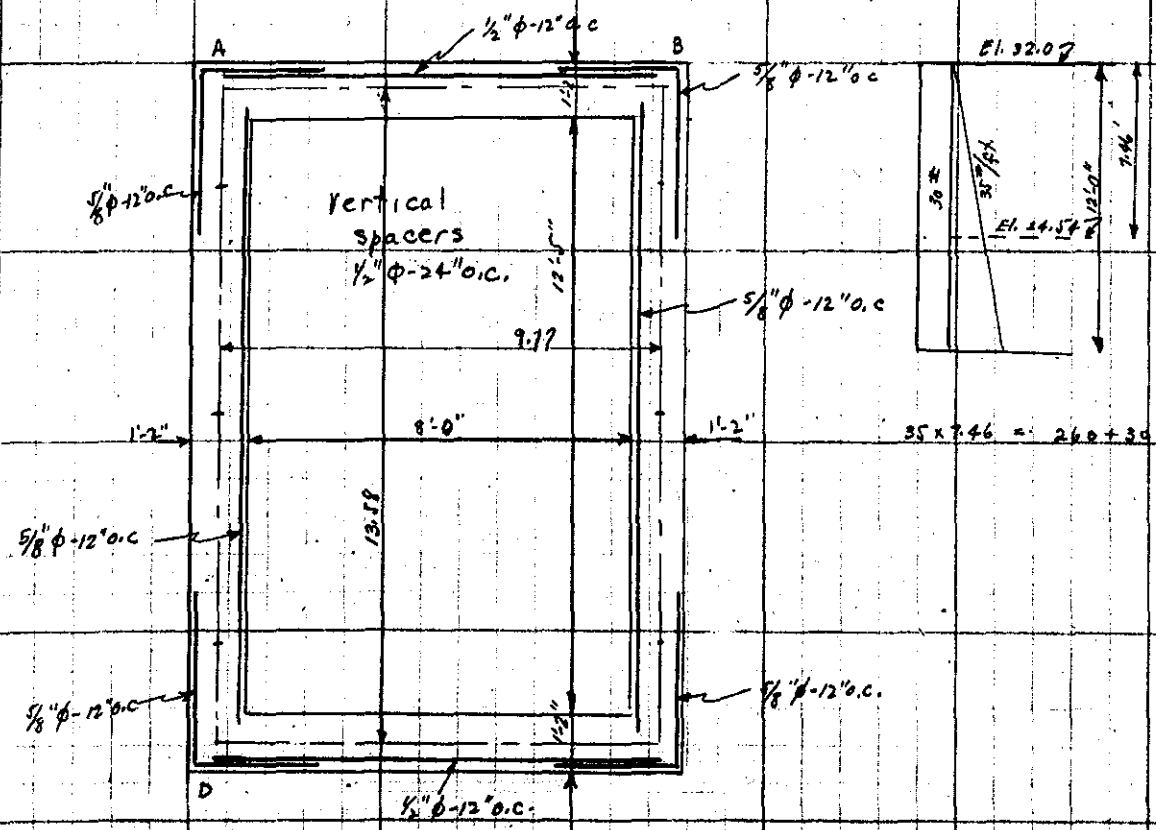
Section @ El. 24.54



35 x 7.46 = 260 + 30 = 290 #/□'

$\frac{I}{L} = \frac{1}{9.17} = .1090$ 59.7 %

" $= \frac{1}{13.58}$ .0736 40.3 %

.1826

F.E.M = $290 \frac{9.17^2}{12} = 2030$ '#

$290 \frac{13.58^2}{12} = 4469$ '#

M = 3470 '#

+3.47	+0.72	D	
+2.75	-0.73	C	
+3.48	+1.45	D	
+2.03		F	
ΣM	Δ		
	59.7%		

	-3.47				
	-3.96				
	-3.47				
	-4.46				
ΣM					
Δ	40.3%				
D	+0.49	C	-0.49	D	+0.98
F					

Form 115 10M-11-39

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SUBJECT Park River - Pressure Conduit
DETAIL Siphon Outlet Chamber

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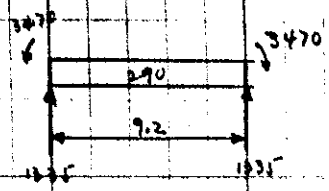


$w = 290 \times 9.2 = 2670 \times \frac{1}{2} = 1335$

$x = 4.6$

$+M = 1335 \times 4.6 \times \frac{1}{2} - 3470 = -400.$ (3070)

$-A$ ends. $= \frac{3470 \times 12}{.88 \times 10.5 \times 18000} = .251$ Bond $\frac{1335}{.88 \times 10.5 \times 125} = 1.16.$

$\frac{1}{2}\phi$ - 9" o.c.

Center A_s use $\frac{1}{2}$"ϕ - 12" o.c.

Point where A_s req'd = .20.

$M = -.20 \times .88 \times \frac{10.5}{12} \times 18000 = -2770$ '#

$-2770 = 1335x - 290\frac{x^2}{2} - 3470$ or $700 = 1335x - 145x^2$

$x^2 - 9.22x = -4.82$

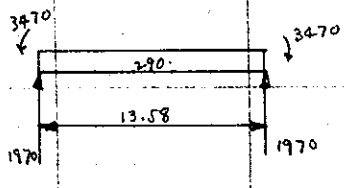
$(x - 4.61)^2 = 16.43$ $21.25 - 4.82 = 16.43$

$x = 4.61 \pm 4.05$ 8.66 or $.56$

SH. $\frac{1}{2}$"ϕ-12"oc Bond = 1.57

$SH = \frac{1.57}{1.16} 1335 = 1810.$

Use $\frac{5}{8}$"ϕ - 12" oc corners.
$\frac{1}{2}$"ϕ - 12"oc center.



$w = 290 \times 13.58 = 3940 \times \frac{1}{2} = 1970$

$x = 6.79'$

$+M = 1970 \times 6.79 \times \frac{1}{2} - 3470 = 6700 - 3470 = 3230$ '#

$L = \sqrt{\frac{8 \times 3230}{290}} = 9.43.$

$SH = 4.72 \times 290 = 1340.$ #

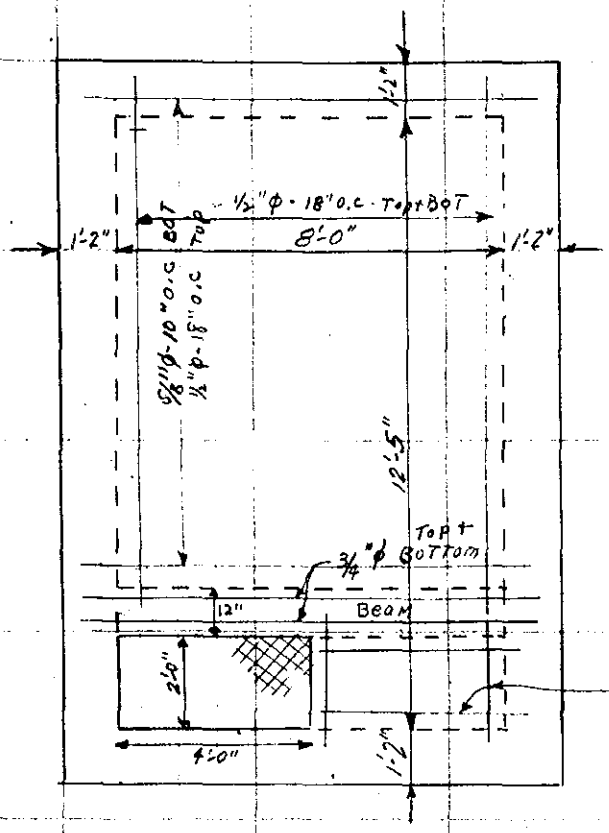
$-A_s$ .25 as above Bond $\frac{1970}{.88 \times 10.5 \times 125} = 1.71$

$\frac{5}{8}\phi$ - 12" oc OK. Corners.

$+A_s$. $\frac{3230}{3470} .25 = .23$ Bond $\frac{1340}{1970}$ 1.71 = 1.16

$\frac{1}{2}$"ϕ - 10" o.c Use $\frac{5}{8}\phi$ 12" o.c.

Top Slab.



Load Distr. $\frac{10.5}{8} - .5 = 1.31 - .5 = .81$ short
.19 long

Roof L.L. = 200 #/□
Dead L. = 100 — 8" slab.
300 #/□

240 #/□ shortway
60 #/□ longway.

short span.

SH. = 240 × 4 = 960 #

M = 240 $\frac{9.17^2}{8}$ = 2520 '#

d (SH) $\frac{960}{.88 \times 12 \times 50}$ = 1.8

d(M) = $\sqrt{\frac{2520}{147.7}}$ = 4.12

8" slab O.K.

Short span.

As = $\frac{2520 \times 12}{.88 \times 5.5 \times 18000}$ = .347

Bond $\frac{960}{.88 \times 5.5 \times 125}$ = 1.59

Use 5/8 φ - 10" o.c. Underside.

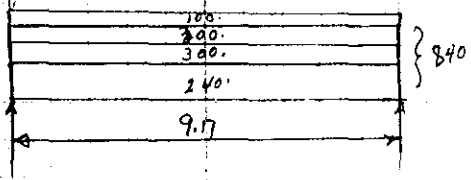
Long span.

M = $\frac{60 \times 11^2}{8}$ = 907 '# As = .13

SH = 60 × 5 = 300 #/□

Use ½"φ - 18" oc. Underside

Beam at Cover Plate



Loads. from short span. 240 #/□
Reaction from long " 300 #/□
Reaction " short span 300. 300×1.
Additional D. wgt Beam say 100. [ ]8" 12"
940 #/□

Beam.

$SH = 940 \times 4 = 3760$ #

$d(SH) = \frac{3760}{.88 \times 12 \times 50} = 7.13$ "

$M = 940 \frac{9.17^2}{8} = 9870$ '#

$d(M) = \sqrt{\frac{9870}{147.7}} = 6.7$ " Use 12" beam d = 9.5

Reduction in weight. Additional dead wgt. becomes 50#

240
300
300
50
890 #/□

$SH = 890 \times 4 = 3560$ #

Bond. $\frac{3560}{.88 \times 9.5 \times 125} = 3.41$

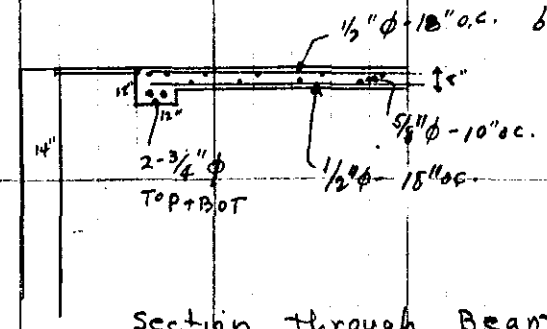
$M = \frac{890}{940} 9870 = 9350$ '#

$A_s. \frac{9350 \times 12}{.88 \times 9.5 \times 18000} = .747$

Use 2-3/4" ϕ. hookends. Top + BOT.
no stirrups.

Short slab beside opening. Use ½" ϕ-12" oc each way

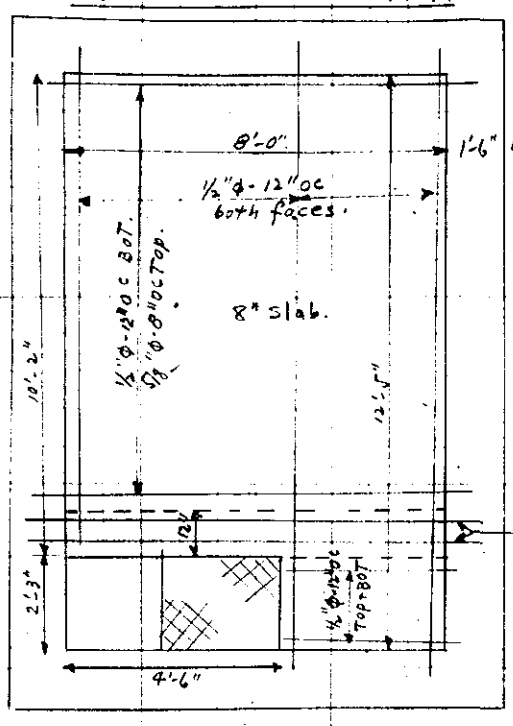
Use ½" ϕ-12" o.c. both ways top of slab.



2½" to ℄ steel.

Section through Beam.

Slab at Elev. 19.99.



Loads.

Concrete built up sections. say 150#

Water. 62.5 × 3.5 = 220

370#/□

Use 400#/□

D.W. of slab. 100# 8"

500#/□

Load Distribution

$\frac{10.17}{8} - .5 = 1.27 - .5 = .77$ short span

.23 long span.

Loads. 500 × .77 = 385#/□ short span

115#/□ long span

Short span

shear. 4 × 385 = 1540#

$d_{(SH)} = \frac{1540}{.88 \times 12 \times 50} = 2.91$

$-M = 385 \frac{9.17^2}{12} = 2700'^{\#}$

$+M = \frac{2700}{8} \times 12 = 3600 - 2700 = 900'^{\#}$

$d_{(M)} = \sqrt{\frac{2700}{147.7}} = 4.28''$ Use 8" slab. d = 5.5"

Bond $= \frac{1540}{.88 \times 5.5 \times 125} = 2.55$ ⅝ φ - 8" o.c.

USE ⅝"φ Top & Bot
Hook Top Rods

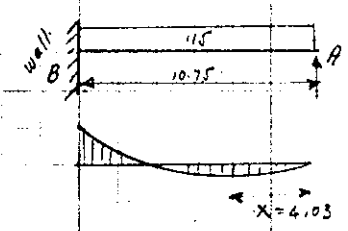
Top $-A_s = \frac{2700}{.88 \times 5.5 \times 18000} = .31$ ⅝ φ - 12" o.c. Use ⅝ φ - 8" o.c. Top.

Bot $+A_s = \frac{900}{2700} .31 = .10$ ½" φ - 26" o.c.

$L = \sqrt{\frac{900 \times 8}{400}} = 4.3$ SH = 385 × 2.15 = 828#

Bond $\frac{830}{1540} 2.55 = 1.38$ Use ½" φ - 12" o.c. Bottom.

Long span



x = ⅜ 10.75 = 4.03

Kleinlogel

$M_B = -115 \frac{10.75^2}{8} = 1660'^{\#}$ $A_B = \frac{1660}{2700} .31 = .19$

$M_x = +\frac{9}{128} 115 \times 10.75^2 = 935'^{\#}$

$V_A = 3/8 \; 115 \times 10.75 = 465$
$V_B = 5/8 \; 115 \times 10.75 = 775$ } $w = 10.75 \times 115 = 1235$

Max Bond. $\frac{775}{.88 \times 5.5 \times 125} = 1.28.$ Use ½"φ-12"oc both faces.

Loads at Slab beam.

From Long slab.	465
" 8'-0" span.	385
From short span 2'-3"	375
Extra Beam wgt.	50.
	1275. #/□'

$1.25 \times 200 + 1.25 \times 100$
$250 \quad 125 = 375$

SH. = $4 \times 1275 = 5090$ # $\quad d_{SH} = \frac{5090}{.88 \times 12 \times 50} = 9.6$ close enough. No stirrups.

− Mom = $1275 \; \frac{9.17^2}{12} = 8930$ '#
+ Mom = $1275 \; \frac{9.17^2}{8} - 8930$ '# $= 13400 - 8930 = 4470$ '#

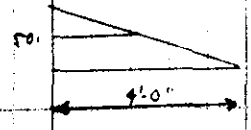
$d(M) = \sqrt{\frac{8930}{147.7}} = 7.8$ Use 12" beam. d = 9.5.

Top steel. $A_s = \frac{8930 \times 12}{.88 \times 9.5 \times 18000} = .712$
Bond. $\frac{5090}{.88 \times 9.5 \times 125} = 4.87$ } Use 2 - ¾ φ. Top & Bot

Bot steel.
$L = \sqrt{\frac{4470 \times 8}{1275}} = 5.3.$
SH = $2.65 \times 1275 = 3,380.$

$A_s = \frac{4470}{8930} \; .712 = .356$
Bond $\frac{3380}{5090} \; 4.87 = 3.23$ } Use 2 - ⅝ φ. BOT.

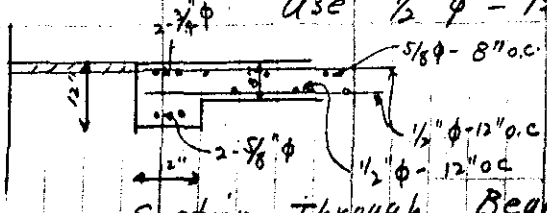
Beam Stirrups.



$v = \frac{5090}{.88 \times 12 \times 9.5} = 51.$ Ok. close enough. None req'd.

In small slab near over plate

Use ½"φ - 12"oc both ways Top & BOT.

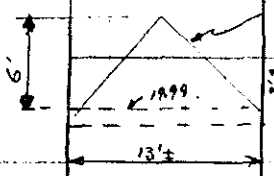


2½" to ℄ steel

Section Through Beam.

Slab at El. 19.99

Corner steel in side wall.



From side wall load. (450#/□)

aver. M. say $450 \times 3 \times 3/2 = 2025'^{\#}$

$-M$ from slab load. p.13 $= -2700$

$$-A_s = \frac{-2700 \times 12}{.88 \times 10.5 \times 18000} = .195$$

Elev. of Sidewall.

$450 \times 3 = 1350$ Bond. $\frac{1350}{.88 \times 10.5 \times 12} = 1.17$

$\frac{5}{8}\phi$ - 18" o.c. all around. 6'-0" long.

BOTTOM SLAB AT EL. 7.50

Cover on Rods. 4" to ℄ on bottom
3" to ℄ on top.

Foundation is rock. Use hydrostatic uplift
62#/□ below El. 20.0

Assume bot. of slab at 6.25 15" thick.

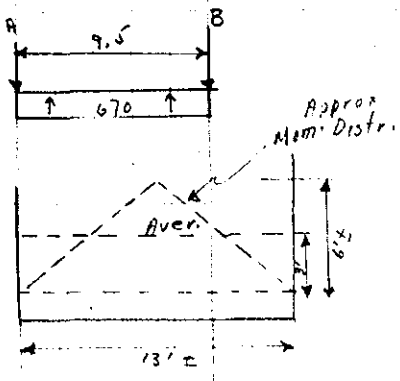
$\frac{20 - 6.25}{13.75} \times 62.5 = 860$ #/□

D. wgt. slab = 190 1.25×150
Net. 670 #/□

Load. Distr.

$\frac{12.4}{8} - .5 = 1.55 - .5 = 1.05$

Use full load short span only.



Elev. of Side wall

Assuming fixed ends.

corner $-M = 670 \frac{9.5^2}{12} = 5030$ '#

Investigation of M at Sidewall
Side wall load 1090 #/□

M @ Base assuming
3' Cantilever. $1090 \times 3 \times \frac{3}{2} = 4900$ '#

Use Corner Mom. of 5030 '#

$+M = 670 \frac{9.5^2}{8} - 5030 = 7060 - 5030 = 2030$ '#

End SHEAR = 4 × 670 = 2680 #

$L = \sqrt{\frac{2030 \times 8}{675}} = 4.9.$

SH = 2.45 × 670 = 1640 #

Using 15" Slab.

$-A_s = \frac{5030 \times 12}{.88 \times 11 \times 18000} = .27.$

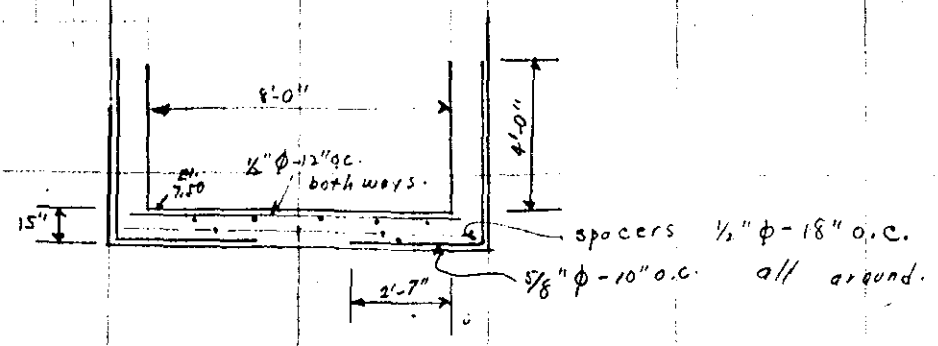
Bond. $\frac{2680}{.88 \times 11 \times 125} = 2.21$

} 5/8"φ - 10" o.c. outside all around.

$+A_s = \frac{2030}{5030} .27 = .11$

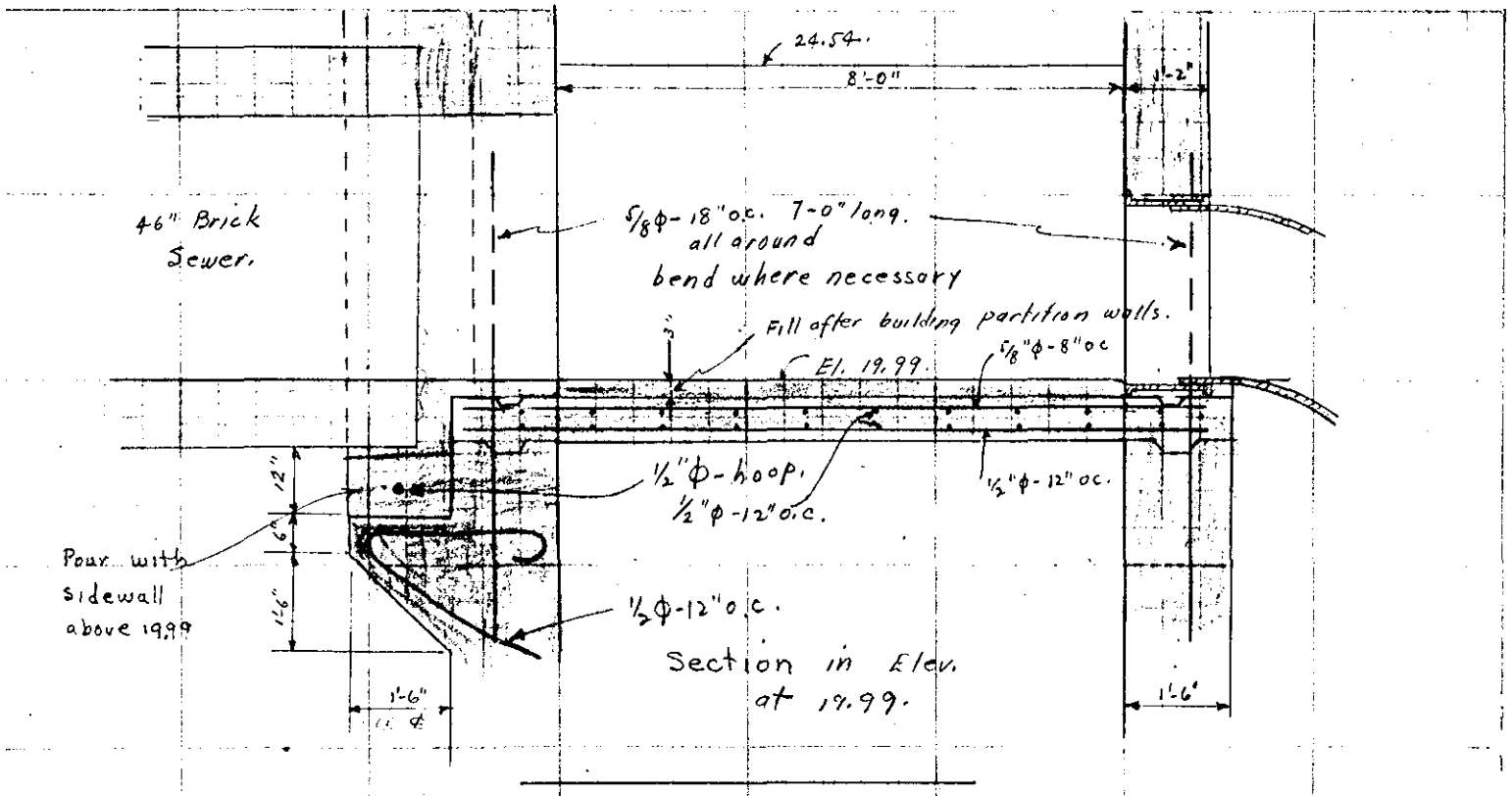
Bond $\frac{1640}{2680} \times 2.21 = 1.35$

} 1/2"φ - 12" o.c inside face.

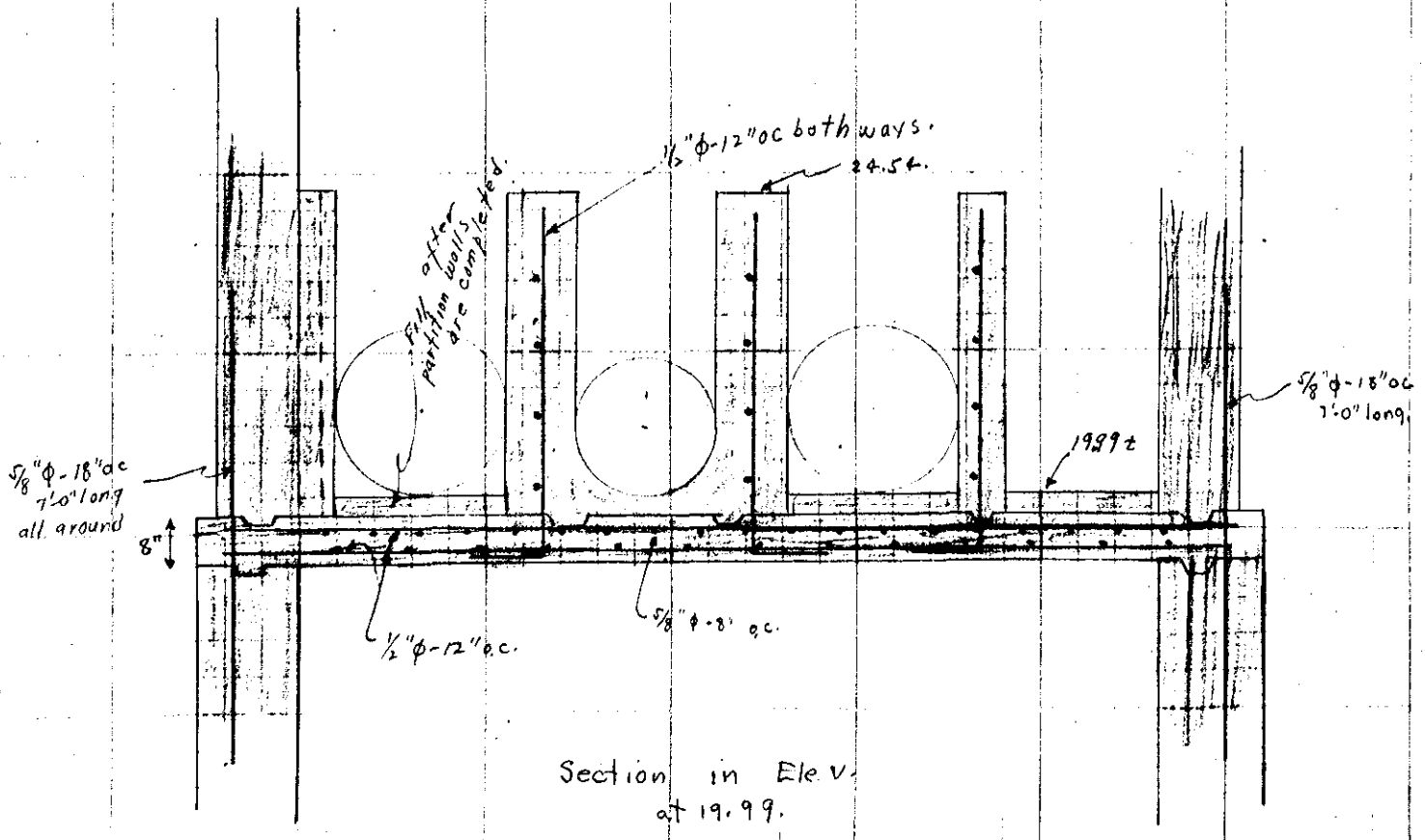


Cover on bars.

Top of slab 3" to ℄ steel.
BOT of slab. 4" " " "



Section in Elev. at 19.99.



Section in Elev. at 19.99.

SIDE DRAIN GATE CHAMBER

Form 115 10M-11-39

METCALF & EDDY
ENGINEERS
BOSTON, MASS.

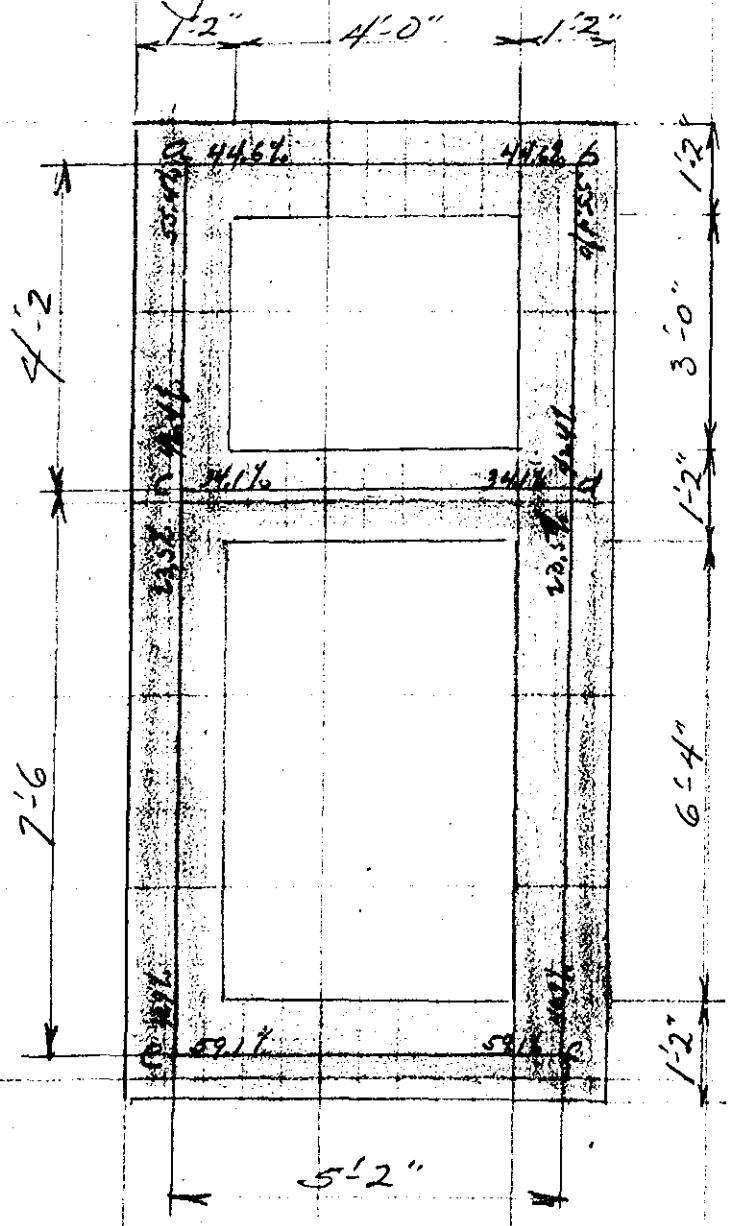
PROJECT U.S. Engineers - Hartford
SUBJECT Park River Pressure Conduit
DETAIL Gate Chamber - Side Drains
FINAL DESIGN

PAGE 1
DATE 5/4/40
COMPUTED BY A.B.D.

Sta 14+30 ±

Future El = 32.0
Section of Analysis: 7.5
24.5 ft

Intensity of press. = (35)(24.5) = 860 #/ft



$M_{ab} = M_{ba} = M_{cd} = M_{dc} = M_{ef} = M_{fe} = \frac{(860)(5.17)^2}{16} = 1440''$

$M_{ac} = M_{bd} = (860)\frac{(4.17)^2}{12} = 1250''$

$M_{ce} = M_{df} = (860)\frac{(7.5)^2}{12} = 4030''$

% Distribution of Distributed Moment

$K_{ab} = 1.45$

$K_{ac} = \frac{1.80}{3.25}$

$\frac{1.45}{3.25} = 44.6\%$

$K_{cd} = 1.45$

$K_{ca} = 1.80$

$K_{ce} = \frac{1.00}{4.25}$

$\frac{1.45}{4.25} = 34.1\%$

$\frac{1.80}{4.25} = 42.4\%$

$K_{ef} = 1.45$

$K_{ec} = \frac{1.00}{2.45}$

$\frac{1.45}{2.45} = 59.1\%$

$K_{ab} = K_{cd} = K_{ef} = \frac{\left(\frac{1}{12}\right)(12)(14)^3}{(5.17)(12)} = \frac{2740}{62} = 44.2$ $\quad K = 1.455$

$K_{ac} = K_{bd} = \frac{2740}{50} = 54.8$ $\quad K = 1.8$

$K_{ce} = K_{df} = \frac{2740}{90} = 30.4$ $\quad K = 1$

Form 113 10M-11-30

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ENGINEERS
BOSTON, MASS.

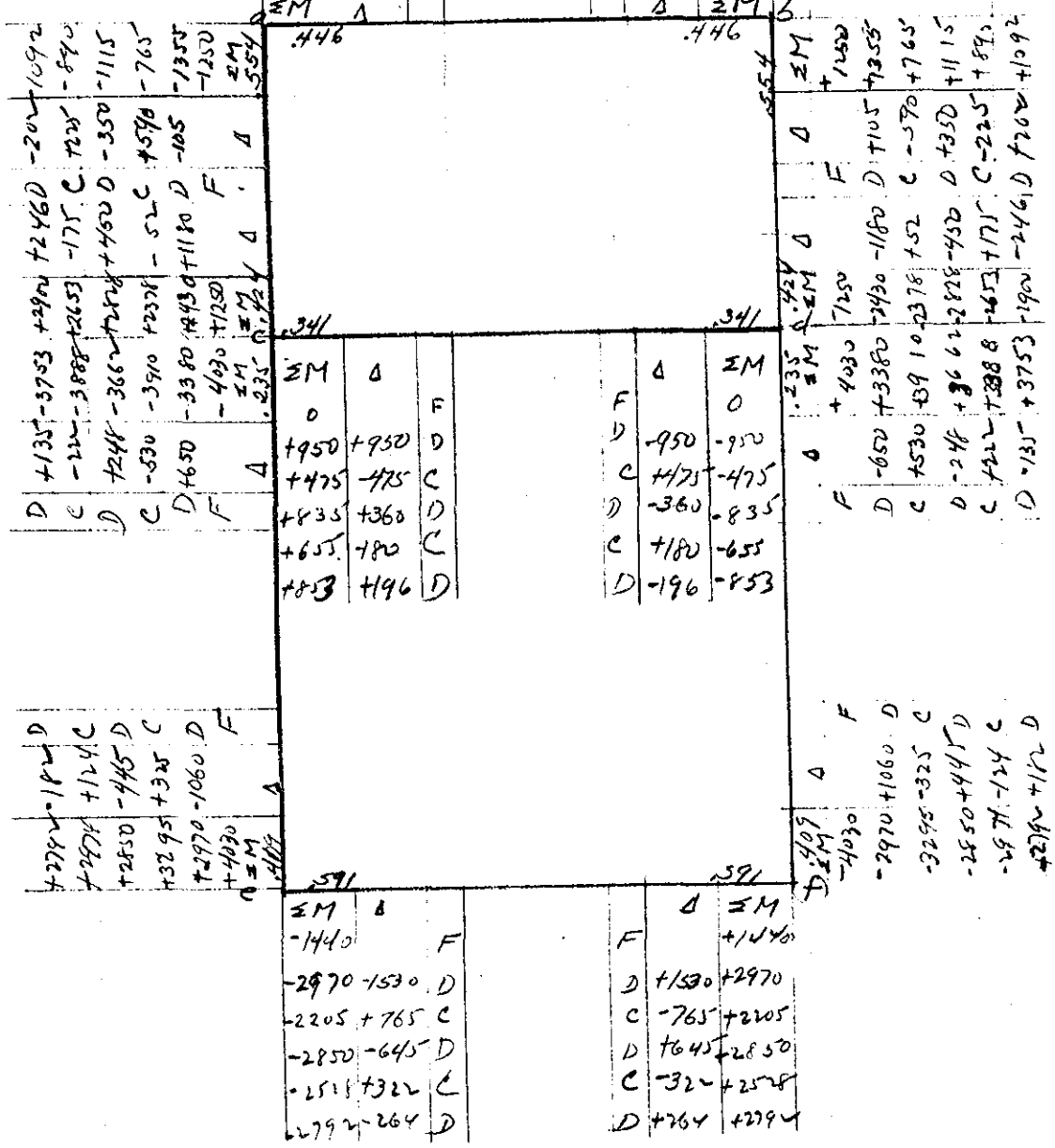
PROJECT U.S. Engineers - Hartford
SUBJECT Park River Pressure Conduit
DETAIL Gate Chamber - Side Drain
FINAL DESIGN

PAGE 3
DATE 5/6/40
COMPUTED BY A. B. D.

Sta. 14+30 ±

+1092	-164	D
+1256	+141	C
+1115	-282	D
+1397	+42	C
+1355	-85	D
+1440		F
ΣM	Δ	

D	+164	-1092
C	-141	-1256
D	+282	-1115
C	-42	-1397
D	+85	-1355
F		-1440
	Δ	ΣM



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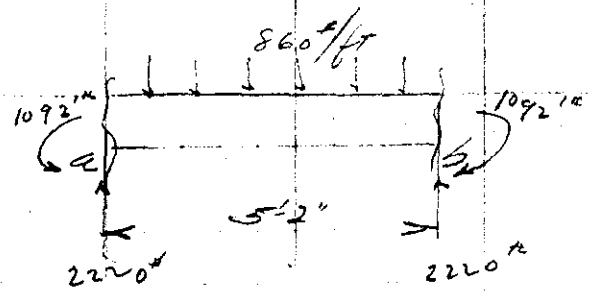
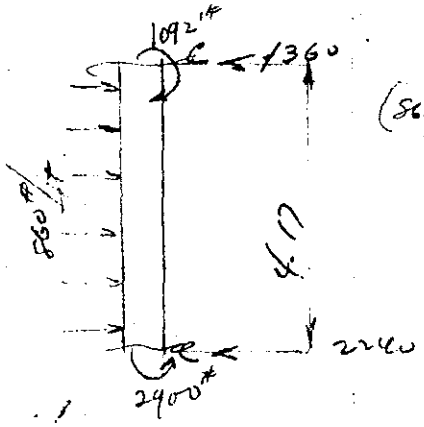
Sta. 14+30 ±



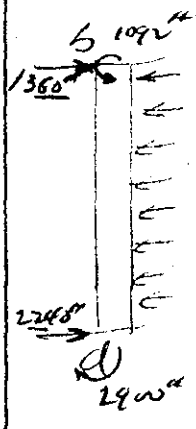


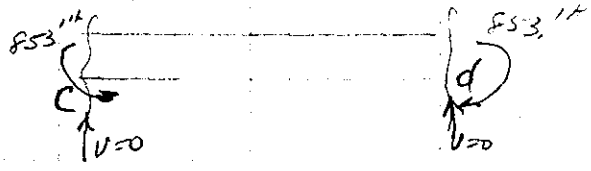
$(860)(4.17)^2 + 2900 - 1092 = 4.17\,H_c$

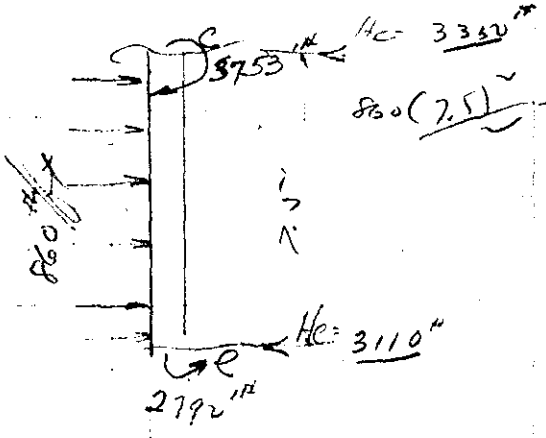
$2240^{\#}\ H_c$

$1092 + (860)(4.17)^2 - 2900 - 4.17\,H_c = 0$

$1360 = H_c$





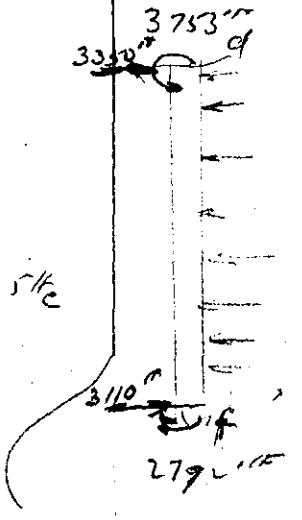


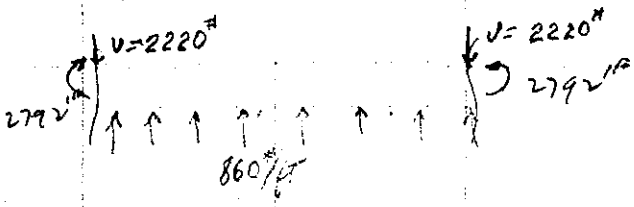
$860(7.5)^2 + 2792 - 3753 - 7.5\,H_c = 0$

$3110^{\#} = H_c$

$(860)(7.5)^2 + 3753 - 2792 = 7.5\,H_c$

$3350^{\#} = H_c$





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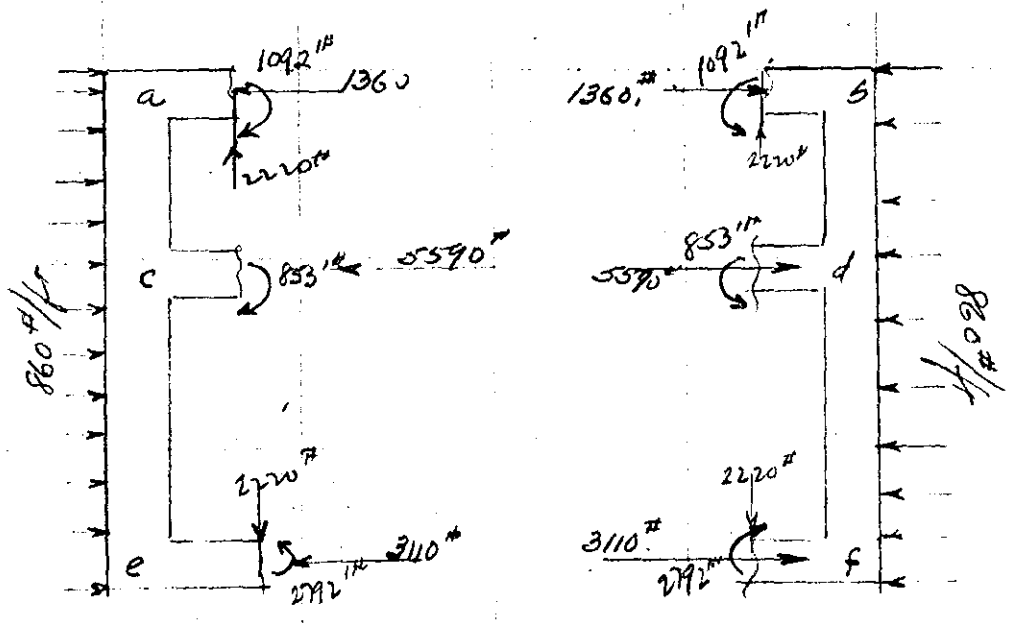

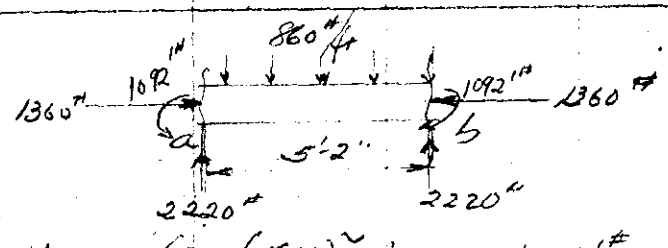

$M_{p\,max} = \frac{(860)(5.17)^2}{8} - 1092 = 1790'^{\#}$

$R = \frac{(1790)(}{(10.5)^2} = 16.$

$v = \frac{2220}{(12)(0.95)(10.5)} = 18.\ \#/\square''$

$A_{s\,tot} = \frac{(1092)(12)}{(18000)(0.95)(10.5)} = .073$

$\Sigma o = \frac{(2220)}{(125)(0.95)(10.5)} = 1.78''$

$p = \frac{3.5}{(12)(10.5)} = .276\%$

3/4"ϕ 15 c/c (0.35□ $\Sigma o = 1.9$)

$A_{s\,bottom} = \frac{(1790)(12)}{(18000)(0.95)(10.5)} = 1.2''$

Use 3/4"ϕ 15 c/c

$\frac{(1092)12}{1360} = 9.65 = e$

$e' = 9.65 - 7 + 10.5 = 13.15$

$K = \frac{(1360)(13.15)}{(12)(10.5)^2} = 131$

$f_s = 18000$

$f_c = 150$

$\frac{e'}{d} = \frac{13.15}{10.5} = 1.25$

$p = .005\%$

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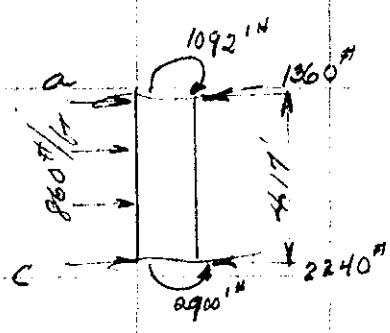
Sta. 14+30 ±



Point of Zero Shear $= \frac{1360}{860} = 1.58$ ft from (a)

$M_p = -1092 + 1360(1.58) - 860\frac{(1.5)^2}{2}$

$M_p = 113'^{\#}$

$R = \frac{2900}{(10.5)} \sim = 26.$

3/4" ϕ – 15" c/c (Outside)

$f_s = \frac{(2900)(12)}{(0.35)(0.94)(10.5)^2} = 10,000$ #/□"

$u = \frac{(2240)}{(1.9)(0.94)(10.5)} = 119.$ #/□"

$p = .276\%$

$e = \frac{(2900)(12)}{2220} = 15.7'$

$e' = 15.7 - 7 + 10.5 = 19.2'$

$k = \frac{(2220)(19.2)}{(12)(10.5)^2} = 3.2$

$f_s = 18000$

$f_c = 350$

$\frac{e'}{d} = \frac{19.2}{10.5} = 1.82$

$j = .16$

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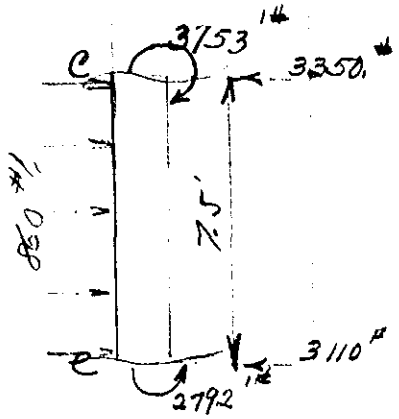


Position of Zero Shear $= \frac{3350}{7.5} = 4.46'$ from (e)

$M_p = -3753 + 3350(4.46) - 860\frac{(4.46)^2}{2}$

$M_p = -3753 + 14910 - 8550$

$M_p = +2610'^{\#}$

$\Sigma_o = \frac{(3350)}{(125)(0.93)(10.5)} = 2.76''$

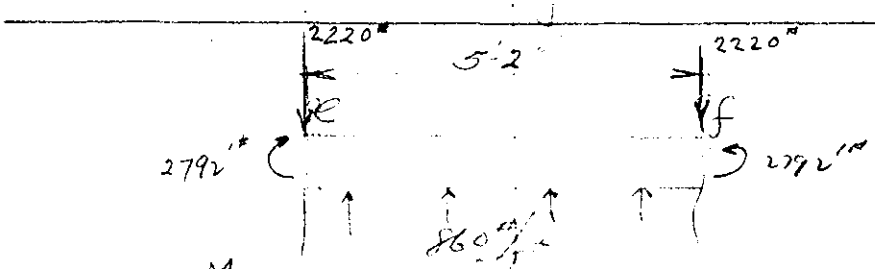
$\frac{3}{4}''\phi$ 10 c/c (outside) $= \begin{pmatrix} .53 \\ 2.8 \end{pmatrix}$

$f_s = \frac{(3753)(12)}{(0.53)(0.93)(10.5)} = 8800\ \#/\square''$

$R = \frac{3753}{(10.5)^2} = 34.$

$A_{s(inside)} = \frac{(2610)(12)}{(18000)(0.93)(10.5)} = .177^{\square''}$

$\frac{3}{4}''\phi$ - 15 c/c [illegible] $\begin{pmatrix} 0.35 \\ 1.9 \end{pmatrix}$



$M_{inside} = \frac{(860)(5.17)^2}{8} - 2792 = 90'^{\#}$

$A_{s\,outside} = \frac{(2792)(12)}{(18000)(0.93)(10.5)} = .19^{\square''}$

$\Sigma_o = \frac{(2220)}{(125)(0.93)(10.5)} = 1.8''$

$\frac{3}{4}''\phi$ - 15 c/c $\begin{pmatrix} 0.35 \\ \Sigma_o = 1.9 \end{pmatrix}$
(outside)

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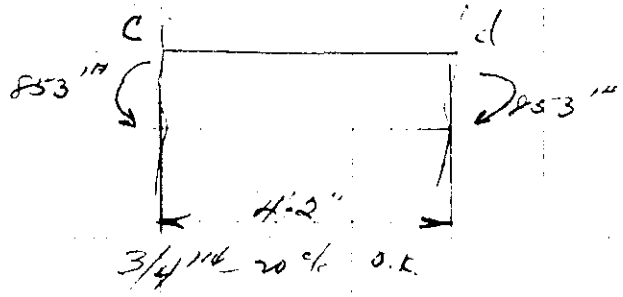

With Water on one side

$w = (62.5)(12.5) = 780$ #/ft

$S = (780)(2) = 1560$ #

$M = (780)\left(\frac{16}{12}\right) = 1040$ '#

for 3/4" ϕ 20 c/c

$f = \frac{(1040)(12)}{(0.264)(0.94)(10.5)} = 4400$ #/□"

$v = \frac{(1560)}{(1.44)(0.94)(10.5)} = 100$ #/□"

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U.S. Engineers - Hartford
Park River Pressure Conduit
Gate Chamber - [illegible]
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Design of Concrete Bracket

Cross Sectional Area of Gate Chamber

$(6.33)(12.83) = 81.00$
$-[(4)(3) + (4)(6.33)] = -37.32$
43.68 ft

$\therefore (43.68)(150) = 6550^{\#}$/Vertical foot

$(6550)(14.87) = 97500^{\#}$

D.W. Barrel + M.H. $= (81)(11.5)(100) = 93,000^{\#}$

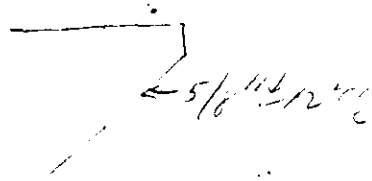
$97,500$
$+ 93,000$
$190,500^{\#} \div 2 = 95,250^{\#}$ to Bracket
$95,250^{\#}$ to Piles

$\frac{95,250}{12.83} = 7410^{\#}$

$d_s = \frac{7410}{(12)(0.88)(50)} = 14''$

Make depth = 18"

22" depth Used



Stress in bar $= \left[\frac{(7050)(0.38)}{1.33}\right]_{0.31} = 10,000$ #/□"

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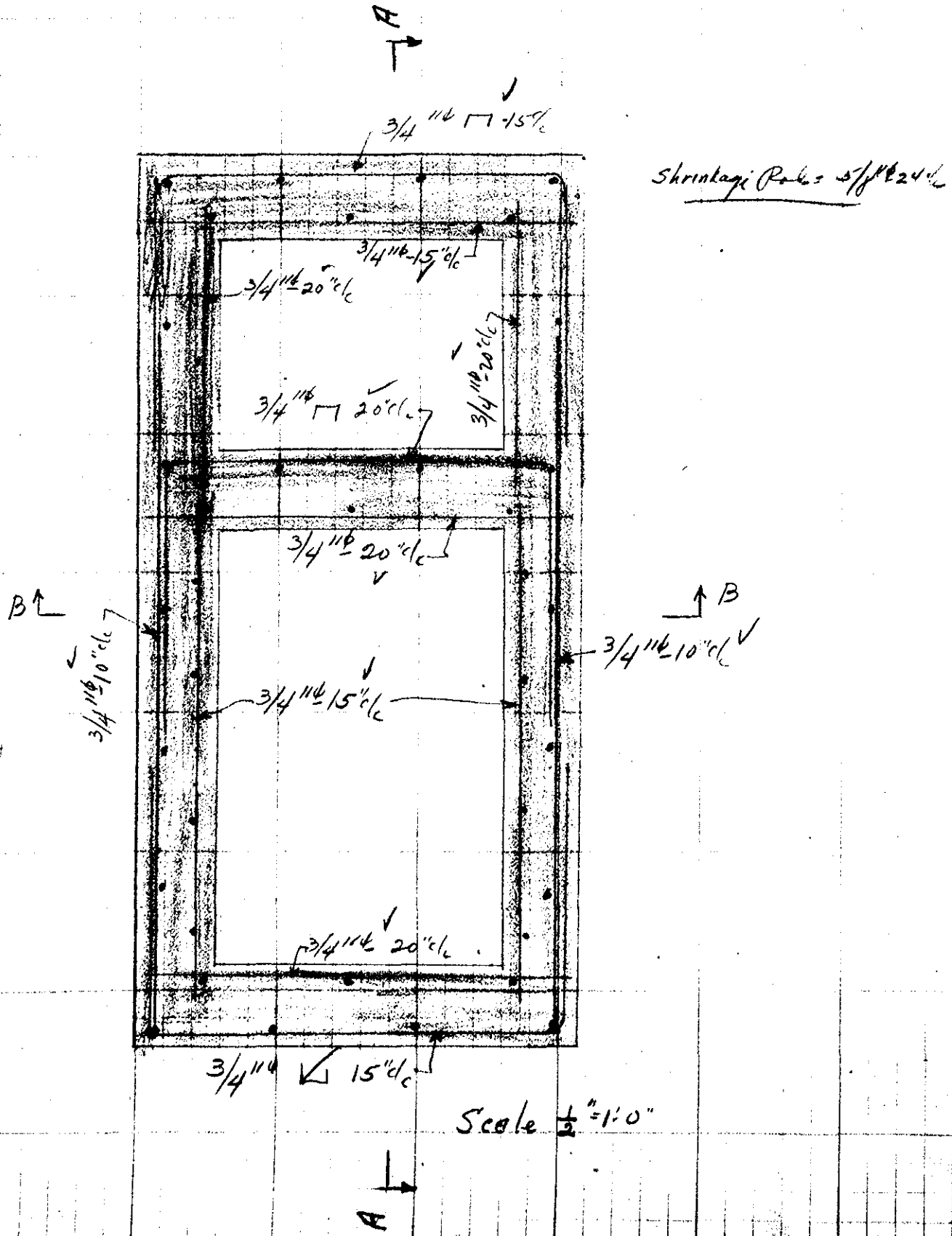
Sta. 14+30



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Beams to support wet wall concrete

Wall (ab) (See Sheet 1) - Weight = (1.17)(6.33)(12.7)(150) = 14100#

$d_s = \frac{7050}{(14)(0.88)(50)} = 11.5$
$+ 3.5$
$15.0''$

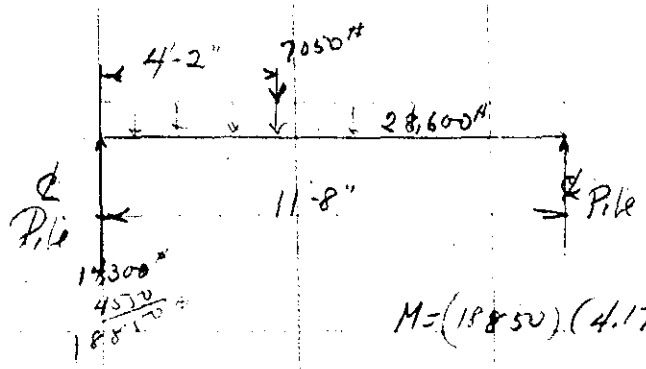
$M = \frac{(14100)(5.17)}{8} = 9120''^{\#}$

$A_s = \frac{(9120)(12)}{(18000)(0.88)(11.5)} = 0.6$

2-3/4"φ (0.88, 4.8)

Beam to Support Wall (bf) during pouring

(1.17)(12.83)(12.7)(150) = 28600#
Due to Wall (cd) = 14100 ÷ 2 = 7050#



$M = (18850)(4.17) - \left(\frac{28600}{11.67}\right)\frac{(4.17)^2}{2}$

$M = 78500 - 21,400$
$M = 57,100''^{\#}$

$d_m = \sqrt{\frac{(57,100)}{147.7}} = \sqrt{388} = 19.7$
$+ 3.5$
23.2

Use 24" depth

$v = \frac{18,850}{(14)(0.88)(20.5)} = 75\#/\square''$. OK for Temporary Load (beam rests on Temporary Load)

$A_s = \frac{(57,100)(12)}{(18000)(0.88)(20.5)} = 2.1''$

3-1"φ (2.37 □", 9.3")

$u = \frac{18,850}{(9.3)(0.88)(20.5)} = 112.\#/\square''$

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Design of Top Slab

Earth Fill
(11.5)(100) = 1150 #/ft

(80)(11.5) = 920 #/ft
(LL) 16,000 / (π) 4 = 1270 #/ft
2190 #/ft
D.W. Slab = 150 #/ft
2340 #/ft

Shear = (2340)(2) = 4680 #

$d_s = \frac{(4680)}{(12)(0.88)(50)} = 8.8$

12" Slab o.k.

Σo Top $= \frac{4680}{(125)(0.88)(8.5)} = 5"$

Corner rods 3/4" ϕ - 6" o/c
Top

Σo bottom bars $= \frac{(2340)}{(125)(0.88)(8.5} = 2.5"$ 3/4" ϕ - 12" o/c

BY S.W.O. MANHOLE AT HUDSON ST. EL. = 32.5
18.4
14.1 FT OF EARTH

14.1 × 100 = 1410 #
TRUCK LD. = 1270 #
2680 #
SLAB - 150
2830 #/□'

SH = 2830 × 2 = 5,660 # $V = \frac{5660}{.88 \times 12 \times 8.5} = 63.3$ #/□"

ASSUME SLAB TO ARCH ALLOW V = 150 #/□"

$M = \frac{2,830 \times 5.0^2}{8} = 8850$ 'k

$A_s = \frac{8850 \times 12}{.88 \times 8.5 \times 18,000} = .79$ □" Use 3/4"ϕ 6" o.c.
AND Hook ENDS.

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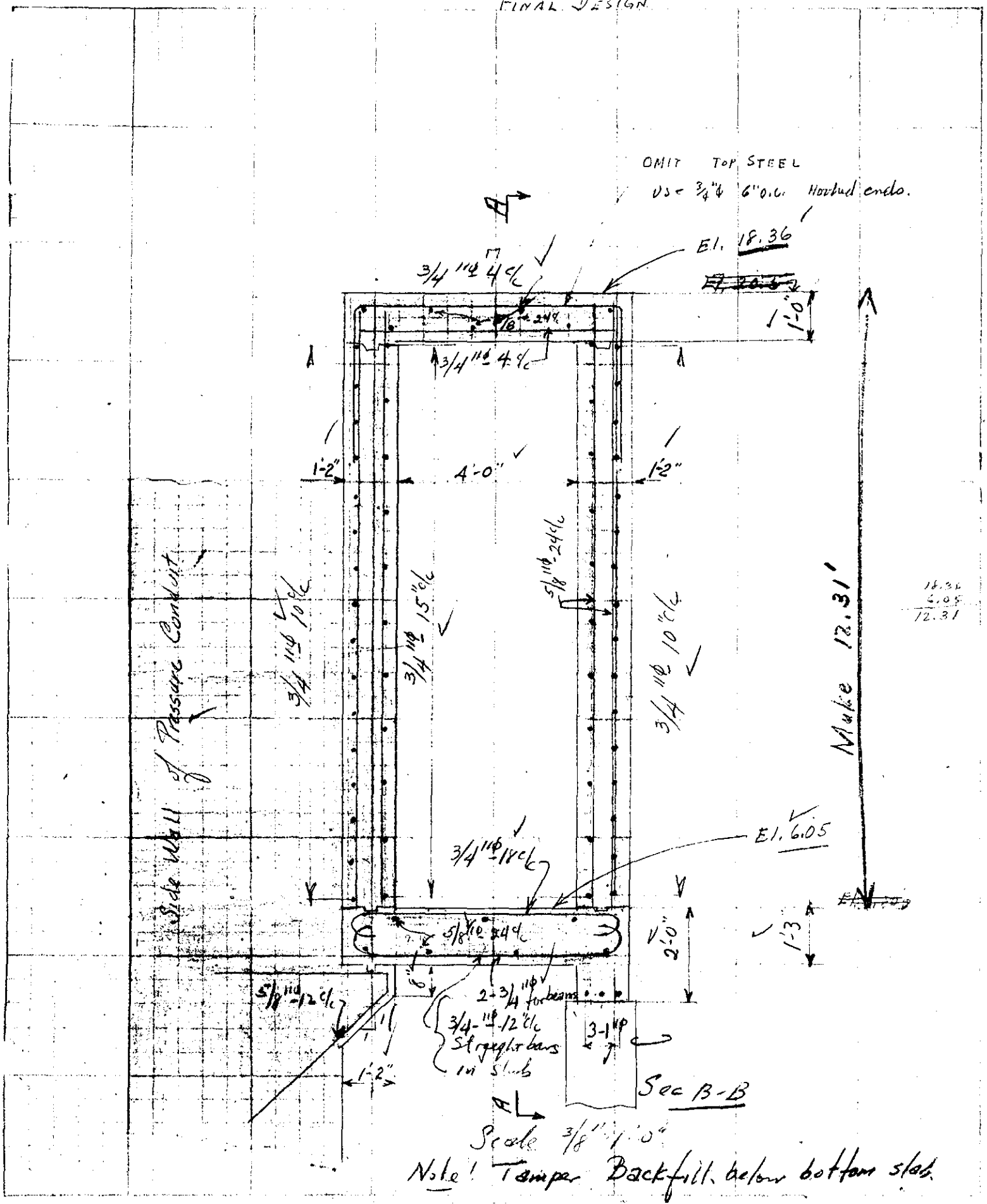

Note! Tamper Backfill below bottom slab.

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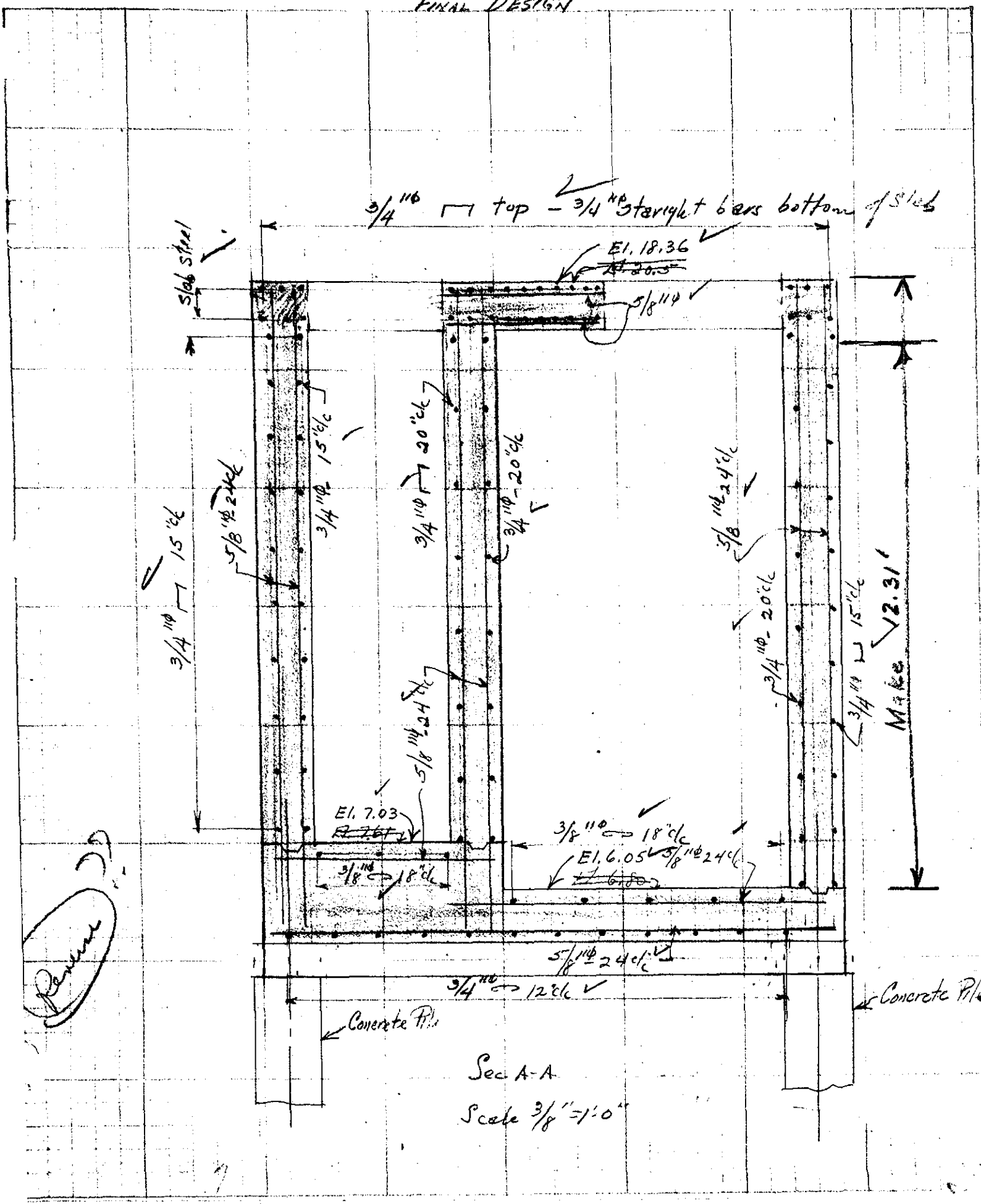

Sec A-A

Scale 3/8" = 1'-0"

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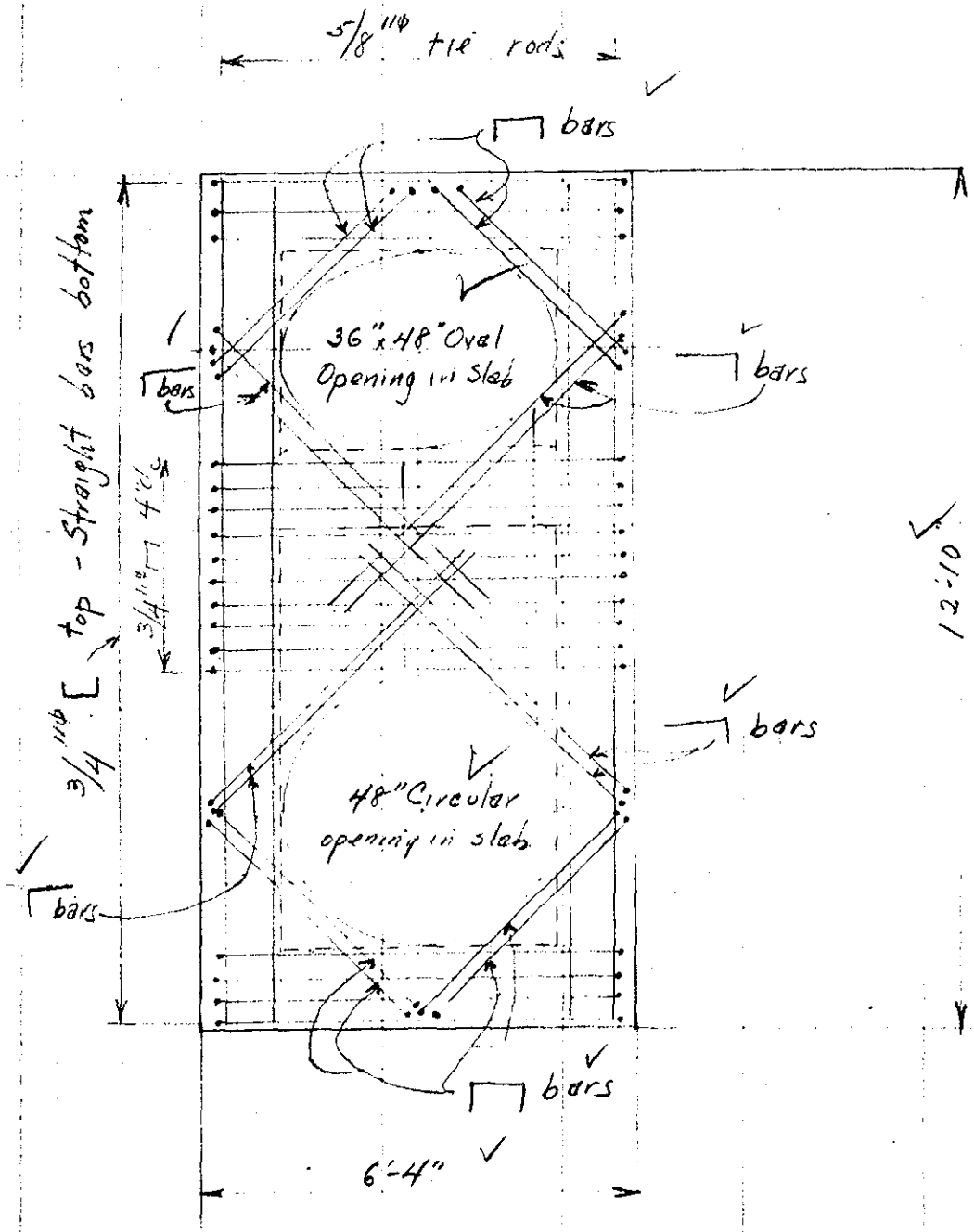

Scale 3/8" = 1'-0"