CONNECTICUT RIVER FLOOD CONTROL PROJECT

HOLYOKE DIKE

SOUTH END AND SPRINGDALE SECTIONS

HOLYOKE, MASS.

ITEMS HI. 3 & 4

ANALYSIS OF DESIGN

APPENDIX F

WAR DEPARTMENT CORPS OF ENGINEERS U. S. ARMY
U. S. ENGINEER OFFICE PROVIDENCE, R.I.

OCTOBER, 1945

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A. Springdale Pumping Station

SPRINGDALE PUMPING STATION

ESTIMATED WEIGHT OF MECHANICAL EQUIPMENT

Electric Motor	4200#
Concrete base for motor	1200#
Switchboard	2500#
Furnace	800#
Pump and base elbow (empty)	8500#
Pump and base elbow (full of water)	9500#
Suction pipe and valve (empty)	2100#
Suction pipe and valve (full of water)	4000#
Discharge pipe and valves (empty)	3000#
Discharge pipe and valves (full of water)	5100#
Thrust on pump	4000#
Sluice gate stand with load	7000#
Crane (4 ton) max. wheel load	5000#
cc truck wheels 3'-6"	
use 30# ASCE rail	

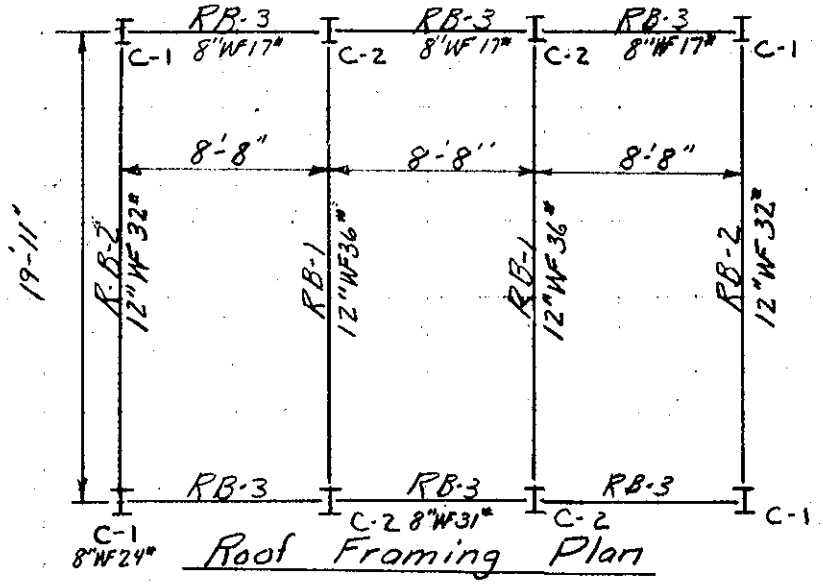
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station

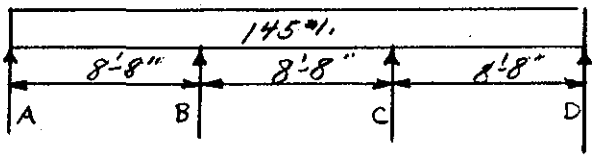
Computation Roof Slab

Computed by H.E.W. **Checked by** C.J.H. **Date** 14-April-45



The roof will be designed for a Live Load of 40 #/□'
plus a 4" cinder concrete fill plus the dead load of slab

L.L	=	40 #/□'
Roofing	=	5
4" Con. fill	=	35
5" Conc. slab	=	63
		143 #/□'



Shears

AB @ A = .4 x 145 x 8.67 = 500#

AB @ B = .6 x 145 x 8.67 = 750#

BC @ B = .5 x 145 x 8.67 = 630#

Moments

AB -M @ A = 0

+M = .08 x 143 x 8.67² = 870'#

-M @ B = .1 x 143 x 8.67² = 1.090'#

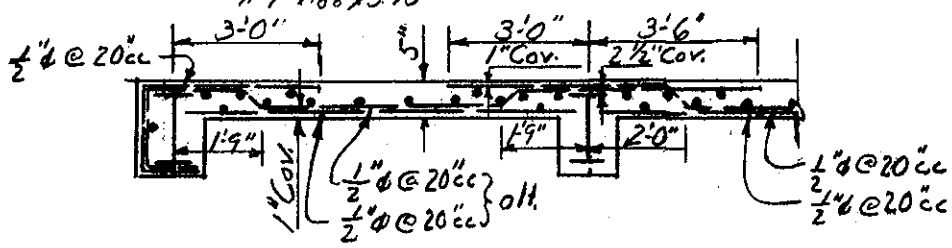
BC +M = .025 x 143 x 8.67² = 270'#

$$\text{reqd } d = \sqrt{\frac{1090}{147}} = 2.7'' < 3.75'' \text{ OK}$$

$$v = \frac{750}{12 \times .88 \times 3.75} = 19 \text{ \#/□''}$$

$$-A_s = \frac{1090 \times 12}{18000 \times .88 \times 3.75} = .22 \text{ □''}$$ Use ½"φ @ 10"cc Top & Bot

$$u_o = \frac{750}{1.9 \times .88 \times 3.75} = 120 \text{ \#/□''}$$



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station
Computation Roof Beams
Computed by H. E. W. **Checked by** **Date** 14 April 45

Roof Beam RB-1
Length 19'-11"

Reaction = 1380 #/'
12" Bm + fpfg = 160
1540 #/'

$M = \frac{1}{8} \times 1540 \times 19.92^2 = 76,390$ '#

$R = 1540 \times 19.92 \times .5 = 15340$ #

$S = \frac{76,390 \times 12}{20,000} = 45.8$ "³ 12" WF 36 #

$\Delta = \frac{5 \times 1540 \times 19.92^4 \times 12^3}{384 \times 30,000,000 \times 280.8} = .65"$ OK $\frac{1}{360} \times 19.92 \times 12 = .66"$

Roof Beam RB-2
Length 19'-11"

Max possible slab reaction = 143 x 3.92 = 560
Wt. 12" bm + fpfg = 225 #/'
Parapet 1 x 2.58 x 120 = 310
1 x 1.29 x 150 = 190
1285 #/'

$M = \frac{1}{8} \times 1285 \times 19.92^2 = 63,740$ '#

$R = 1285 \times 19.92 \times .5 = 12,800$ #

$S = \frac{63,740 \times 12}{20,000} = 38.2$ "³ Use 12" WF 32 #

$\Delta = \frac{5 \times 1285 \times 19.92^4 \times 12^3}{384 \times 30,000,000 \; 246.8} = .61 < \frac{1}{360}$ span

Roof Beam RB-3
Length = 8'-8"

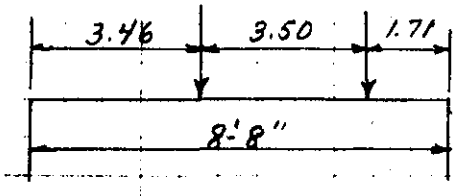
Wt. of parapet = 500 #/'
" 8" bm + fpfg = 140
640 #/'

$M = \frac{1}{8} \times 640 \times 8.67^2 = 6010$ '#

$R = 640 \times 8.67 \times .5 = 2770$ #

$S = \frac{6010 \times 12}{20,000} = 3.6$ "³ Use 8" WF x 17 #

Crane Beams



Crane Capacity = 8000 #
Wheel load = 3'-6"
Max. wheel load = 5000 #

L.L. Mom = $\frac{5000}{2 \times 8.67}(8.67 - 1.75)^2 = 13,810$ '#

25% Impact 3450
D.L. M = $\frac{1}{8} \times 35 \times 8.67^2 = 330$ '#
17590 '#

Subject Springdale Pumping Station
Computation Crane Beam
Computed by H.E.W. **Checked by** **Date** 16-April-45

Crane Beam (cont.)

Horiz. Thrust = 20% Crane Capacity = $\frac{1}{5} \times 8000 \times \frac{1}{4}$ = 400#/wheel

Lat. L.L. M = $\frac{400}{5000} \times 13{,}810$ = 1100'#

Try 10" WF 21# Beam L = 8'-8" b = 5.75" S_{xx} = 21.5 S_{yy} = 3.4

$\frac{l}{b} = \frac{104}{5.750} = 18.1$ Allowable fs = 19,040 #/□"

Actual Stress

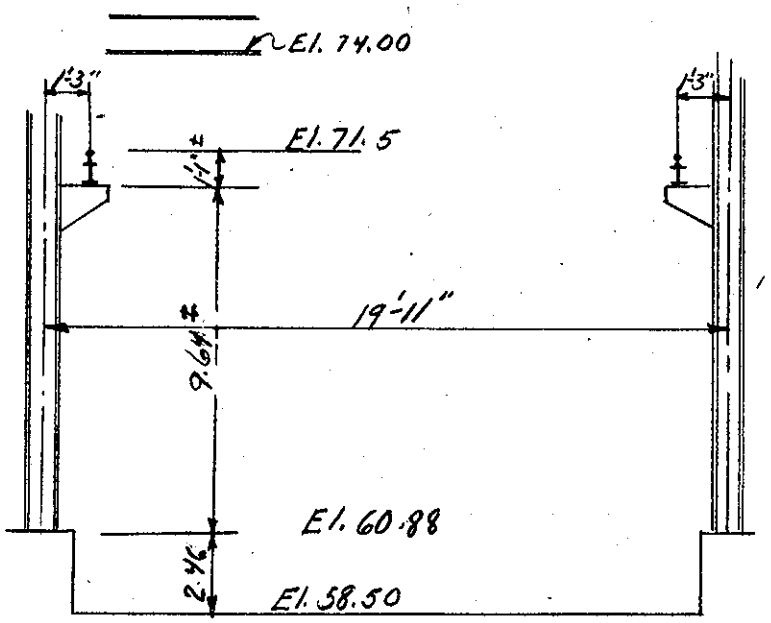
fs from Vert. M = $\frac{17590 \times 12}{21.5}$ = 9800 #/□"

fs from Horiz M = $\frac{1100 \times 12}{3.4 \times .5}$ = 7760 #/□"

16560 < 19,040

Use 10" WF 21# Beam

Columns



The roof slab will be considered as a horizontal frame taking the horizontal thrust into the side walls

Columns will be consided supported by the roof slab and the top of curb

Assume wind load at 20#/□'

All columns are designed for $\frac{l}{r} \leq 120$

Allowable f = $17000 - 0.485 \frac{l^2}{r^2}$

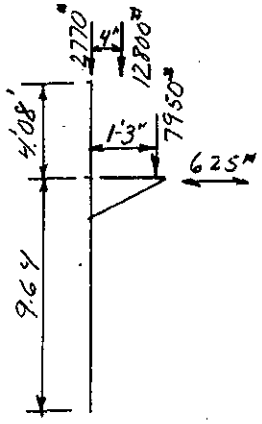
Assume crane stop at 1'-6" from ℄ end columns

WAR DEPARTMENT

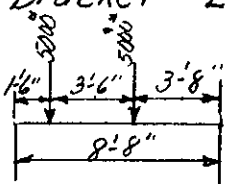
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station
Computation Columns
Computed by H.E.W. **Checked by** **Date** 16-April-45

End column C-1



Bracket Load



$R_L = 10{,}000 \times \frac{5.42}{8.67} = 6250^{\#}$

25% Impact $= 1560$

D.L. Rail & Beam $= 140$

$7950^{\#}$

Horiz Thrust of Crane

$H = \frac{5.42 \times 800}{8.67} = 500^{\#}$

Impact $= 125$

$625^{\#}$

Moment at Bracket

$M = 12800 \times .33 + \frac{7950 \times 1.25 \times 10.0}{14.08} + \frac{625 \times 4.08 \times 10}{14.08} = 13130'^{\#}$

Try 8" WF 24# col. $A_g = 7.06$ $S = 20.8''^3$ $r = 1.61$ $\frac{l}{r} = 102.0$

Allow. $f_s = 11{,}950$ #/□"

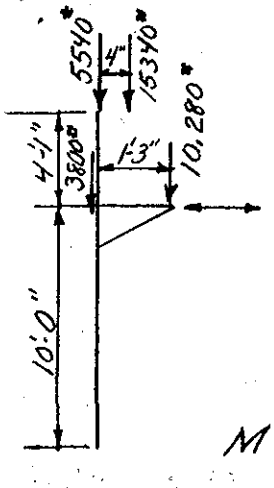
Actual $f_s = \frac{P}{A} = \frac{23520}{7.06} = 3330$

$\frac{M}{S} = \frac{13130 \times 12}{20.8} = 7580$

10910 #/□" < 11950 #/□" OK

Use 8" WF 24# col

Column C-2



Bracket Load

$5000 \times \left(1 + \frac{5.17}{8.67}\right) = 8000^{\#}$

25% Impact 2000

D.L. Bm + Rail 280

$10280^{\#}$

Horiz Thrust

$400 \times \left(1 + \frac{5.17}{8.67}\right) = 640^{\#}$

Impact $= 160$

$800^{\#}$

M due to wind $= \frac{1}{8} \times 20 \times 8.67 \times 14.08^2 = 4300'^{\#}$ (not critical)

Moment at Bracket

$M = 15340 \times .33 + \frac{10{,}280 \times 1.25 \times 10.0}{14.08} + \frac{800 \times 4.08 \times 10}{14.08} = 16{,}560'^{\#}$

Load on Lintel (approx) $= 5 \times 8.67 \times .5 \times 150 \times 1.17 = 3800^{\#}$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station
Computation Columns
Computed by H. E. W. **Checked by** **Date** 16-April-45

Column C-2 (cont.)

Try 8" WF 31# col $A_g = 9.12$ $S = 27.4$ $r = 2.01$ $\frac{l}{r} = \frac{164.6}{2.01} = 82$

Allowable $f_s = 13,740$ #/□"

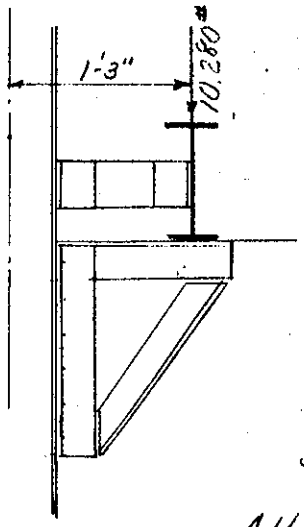
Actual $f_s = \frac{P}{A} = \frac{34960}{9.12} = 38.30$ #/□"

$\frac{M}{S} = \frac{16560 \times 12}{27.4} = 7250$

$11,080$ #/□" < 13,740 #/□" OK

Use 8" WF 31# columns

Crane Bracket



Let S = rivet stress

Try 12 rivets spaced 3" cc

$4 \times 7.5\,S = 30S$

$4 \times \frac{4.5^2}{7.5} S = 10.8S$

$4 \times \frac{1.5^2}{7.5} S = 1.2S$

$42.0S$

Moment $= 11 \times 10,280 = 113,080$ "#

$42S = 113,080$ $S = 2690$#

Vert. Shear by eq. rivet

$\frac{10280}{12} = 857$#

Stress on extreme rivet $= \sqrt{2690^2 + 857^2} = 2820$#

Allow. tensile stress on 3/4" rivet: $.442 \times 15000 = 6630$#

Use 12 - 3/4"ϕ rivets

Size of Angle

Assume 4" x 3½" x 3/4" L

Moment = 2820 x 1.75 = 4940 "#

$f = \frac{4940}{3 \times .75^2} = 17,600$ #/□" OK

Use 4" x 3½" x 3/4" L

Plate Thickness

$3/4 \times t \times 20,000 = 2820$

$t = .19$" Use 3/8" Plate

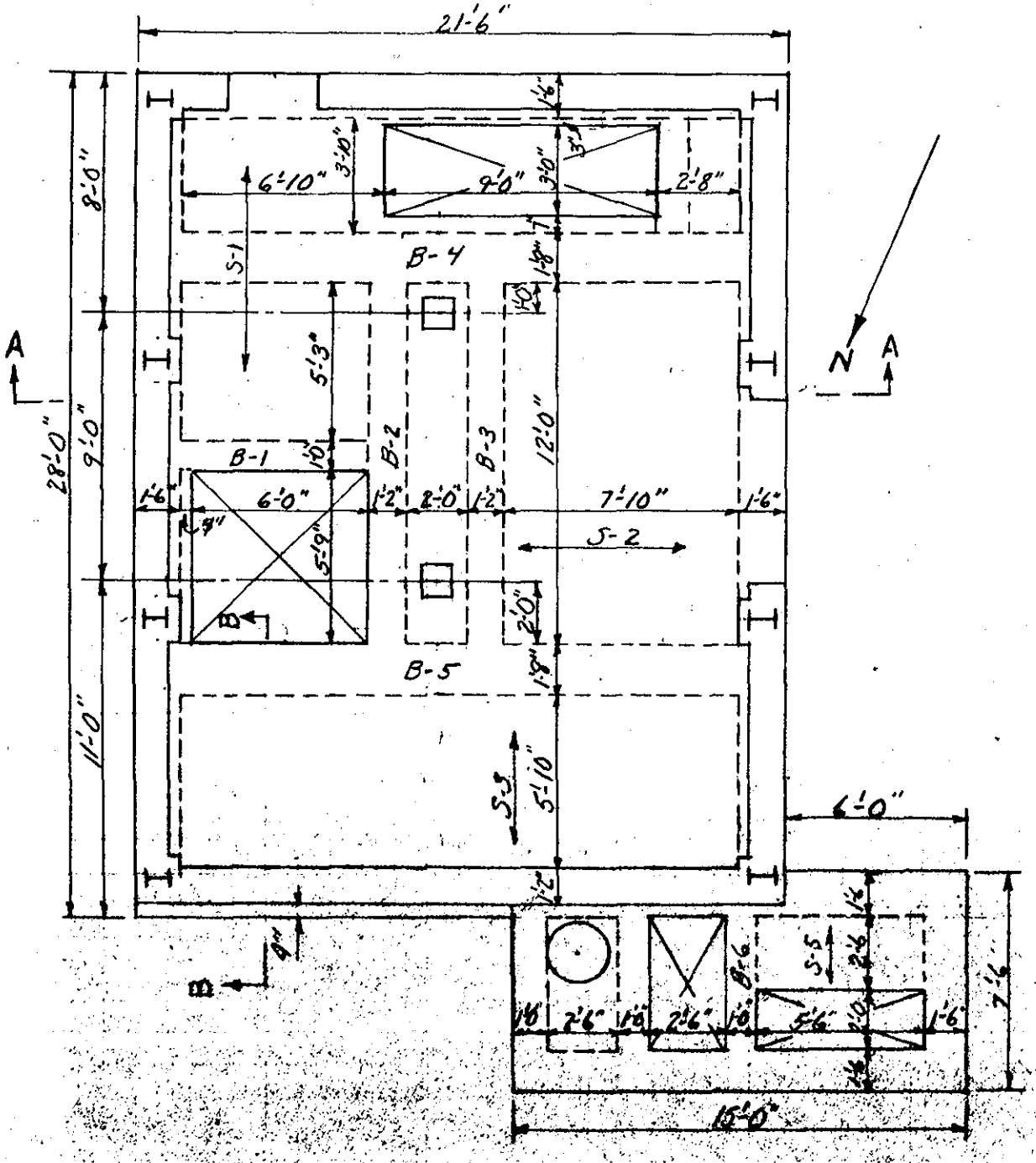
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station

Computation Motor Room Floor

Computed by H. E. W. **Checked by** **Date** 16-April 45



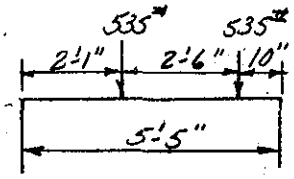
Motor Room Floor Plan

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station
Computation Motor Room Floor Slabs
Computed by H.E.W. **Checked by** _____ **Date** 17-April-45

Determination of Live Load for Design of Floor Slabs



Load at outer edge of motor = $\frac{4200}{\pi \times 2.5} = 535$ #/'

$M = \frac{535}{10.83}(5.42 - 1.25)^2 = 860$ '#

Equiv. uniform $w = \frac{860 \times 8}{5.42^2} = 235$ #/□'

Design floor slabs for a uniform Live Load of 250 #/□'
" " beams " " " " " of 200 #/□'

Slab S-1

Uniform L.L. = 250 #/□'
D.L. 8" Slab 100
350 #/□'

	350 #/'			
	A 6'-7"	B	5'-5"	C
Simple Sup.		.45	.55	Fixed
	+1.26	-1.26	+0.86	-0.86
	-7.26	+0.18	+0.22	0.00
	+0.09	-0.63	0.00	+0.11
	-0.09	+0.28	+0.35	0.00
	+0.14	-0.04	0.00	+0.17
	-0.14	+0.02	+0.02	0.00
-M	0.00	-1.45	+1.45	-0.58
V	0.93	1.37	1.11	0.79
x_0	→ 2.66'		2.26' ←	
+M	1.24'k		0.31'k	

Fixed End Moments

$M^F_{AB} = \frac{1}{12} \times 350 \times 6.58^2 = 1.26$ 'k

$M^F_{BC} = \frac{1}{12} \times 350 \times 5.42^2 = 0.86$ 'k

req'd $d = \sqrt{\frac{1450}{147}} = 3.1" < 6.0"$ OK

$v = \frac{1370}{12 \times .88 \times 6.0} = 22$ #/□"

$-A_s = \frac{1450 \times 12}{18000 \times .88 \times 6.0} = .18$ □" Use $\frac{5}{8}$"φ @ 1'-0"cc

$u_0 = \frac{1370}{1.96 \times .88 \times 6.0} = 132$ #/□"

$+A_s$ Use $\frac{5}{8}$"φ @ 1'-0"cc

Slab S-2

	350 #/'			
	A 3'-2"	B	9'-2"	C
Simple Sup.		.74	.26	Fixed
	+0.29	-0.29	+2.45	-2.45
	-0.29	-1.60	-0.56	0.00
	-0.80	-0.15	0.00	-0.28
	+0.80	+0.11	+0.04	0.00
	+0.05	+0.40	+0.00	+0.02
	-0.05	-0.30	-0.10	0.00
-M	0.00	-1.83	+1.83	-2.71
V	-0.20	+1.13	+1.51	+1.70
x_0			4.86 ←	
+M	0		1.42'k	

Fixed End Moments

$M^F_{AB} = \frac{1}{12} \times 350 \times 3.17^2 = 0.29$ 'k

$M^F_{BC} = \frac{1}{12} \times 350 \times 9.17^2 = 2.45$ 'k

req'd $d = \sqrt{\frac{2710}{147}} = 4.3" < 6.6$

$v = \frac{1700}{12 \times .88 \times 6.6} = 24$ #/□"

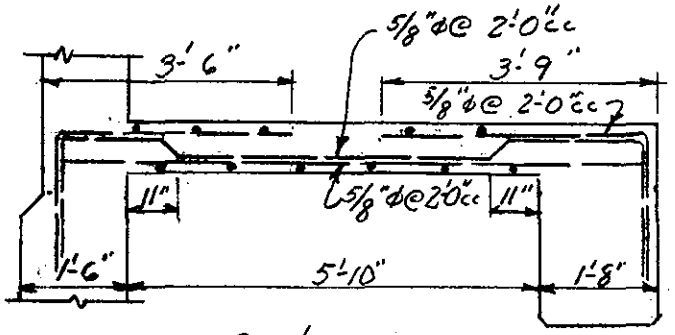
$-A_s = \frac{2710 \times 12}{18000 \times .88 \times 6.6} = .31$ □" Use $\frac{5}{8}$"φ @ 1'-0"cc

$u_0 = \frac{1700}{1.96 \times .88 \times 6.6} = 149$ #/□"

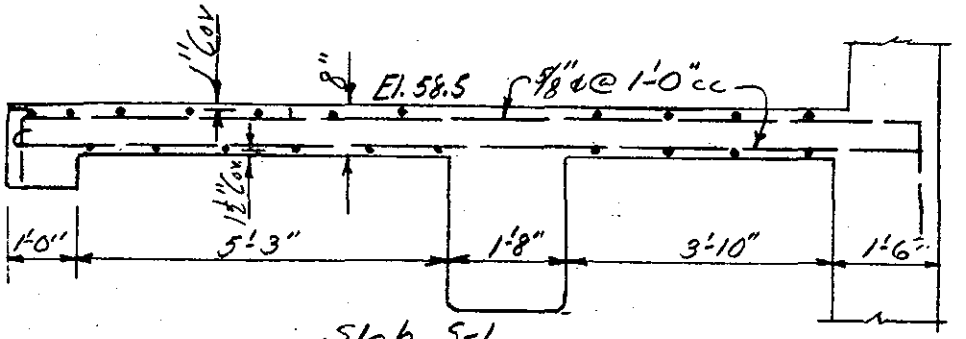
Use $\frac{5}{8}$"φ @ 1'-0"cc

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

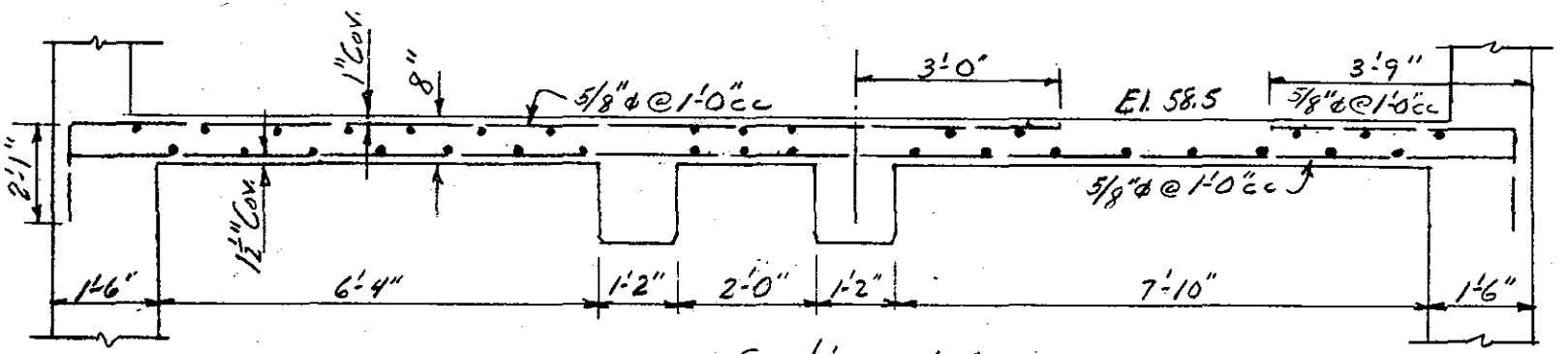
Subject Springdale Pumping Station
Computation Motor Room Floor Slabs
Computed by H.E.W. **Checked by** **Date** 19-April-45



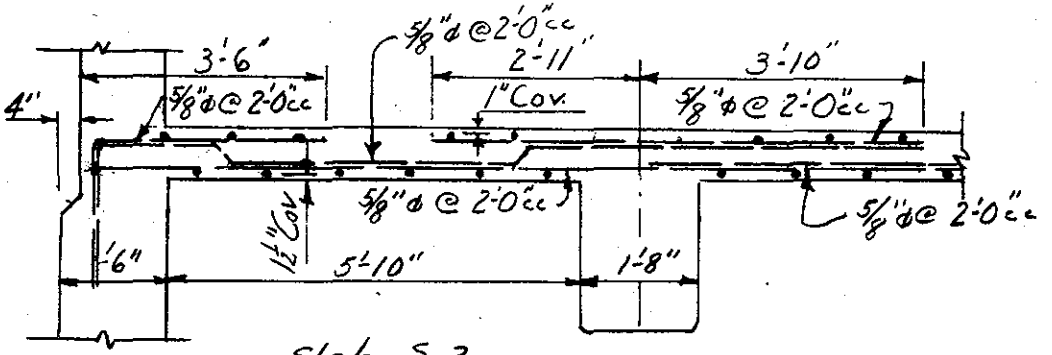
Section B-B



Slab S-1



Section A-A



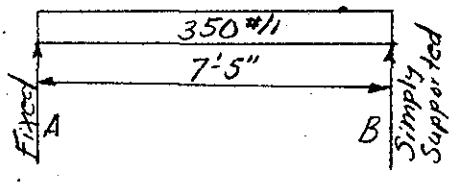
Slab S-3

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station
Computation Motor Room Floor Slabs
Computed by H. E. W. **Checked by** **Date** 17-April-45

Slab S-3



$-M_B = 0 \quad -M_A = \frac{350 \times 7.42^2}{8} = 2.41'^K$

$+M = \frac{9}{128} \times 350 \times 7.42^2 = 1.35'^K$

$V_B = 3/8 \times 350 \times 7.42 = 0.97^K$

$V_A = 5/8 \times 350 \times 7.42 = 1.62^K$

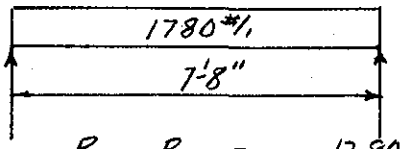
$-A_s = \frac{2410 \times 12}{18000 \times .88 \times 6.0} = .30^{\square''}$ Use 5/8"ϕ @ 1'-0" cc Top and Bot

$u_o = \frac{1620}{1.96 \times .88 \times 6.0} = 156\ \#/\square''$

Make all steel in floor slab 5/8"ϕ @ 1'-0" cc Top and Bot
Make steel running East & West the outside steel

Floor Beams

Beam B-1



D.

D.L. slab =	100 × 3.62	=	360
D.L. Cover =	15 × 2.87	=	45
D.L 12"×14" bm =	75 × 1	=	75
L.L =	200 × 6.50	=	1300
			1780#/'

$R_L = R_R = 1780 \times 7.67 \times .5 = 6830^{\#}$

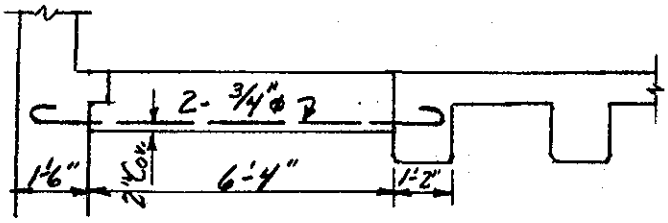
$M = \frac{1}{8} \times 1780 \times 7.67^2 = 13{,}090'^{\#}$

req'd $d = \sqrt{\frac{13090}{123}} = 10.3'' < 11.5''$ Make beam 12"×14"

$v = \frac{6830}{12 \times .88 \times 11.5} = 56\ \#/\square''$

$A_s = \frac{13090 \times 12}{18000 \times .88 \times 11.5} = .86^{\square''}$ Use 2-3/4"ϕ bars

$u_o = \frac{6830}{4.71 \times .88 \times 11.5} = 143\ \#/\square''$



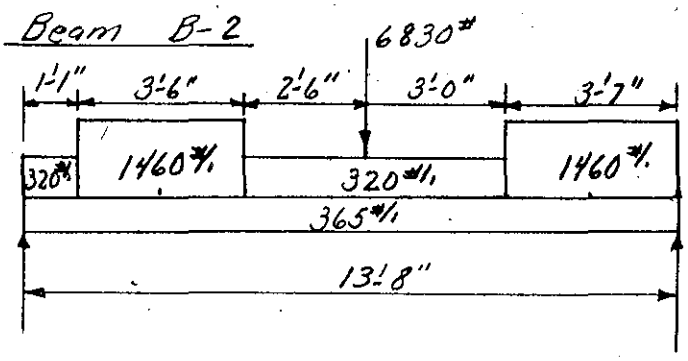
Beam B-1
12"×14"

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station
Computation Motor Room Floor Beams
Computed by H. E. W. **Checked by** _____ **Date** 17-April-45

Beam B-2



D.L. Slab = 1.58 x 100 = 160#/'
D.L. 14"x22" bm = 1.17 x 1.17 x 150 = 205
365#/'

D.L. Motor Base 1.75 x 1 x 150 = 260#/'
D.L. Motor $\frac{4200}{2 \times 3.5}$ = 600

Impact 600
1460#/'

L.L = 1.58 x 200 = 320#/'

R_L = 365 x 13.67 x .5 = 2490#
320 x 1.08 x .960 = 330
1460 x 3.5 x .793 = 4050
320 x 5.5 x .463 = 810
1460 x 3.58 x .131 = 680
6830 x .481 3290
11650#

R_R = 365 x 13.67 x .5 = 2490#
320 x 1.08 x .040 = 10
1460 x 3.5 x .207 = 1060
320 x 5.5 x .537 = 950
1460 x 3.58 x .869 = 4540
6830 x .519 = 3540
12590#

x_0 = 6.58' from R_R

$M = 12590 \times 6.58 - 365 \times \frac{6.58^2}{2} - 1460 \times 3.58 \times 4.77 - 320 \times \frac{3^2}{2} = 48,570$ '#

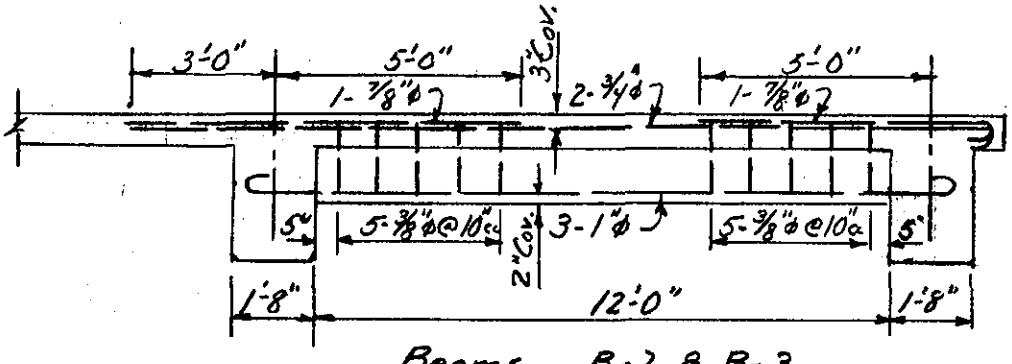
req'd $d = \sqrt{\frac{48570 \times 12}{123 \times 14}} = 18.4" < 19.5"$ OK

Make beam 14"x22"

$v = \frac{12,590}{14 \times .88 \times 19.5} = 52$ #/□" OK

$A_s = \frac{48570 \times 12}{18000 \times .88 \times 19.5} = 1.89$ □" Use 3-1"φ

$u_0 = \frac{12590}{9.42 \times .88 \times 19.5} = 78$ #/□"



Beams B-2 & B-3
14" x 22"

WAR DEPARTMENT

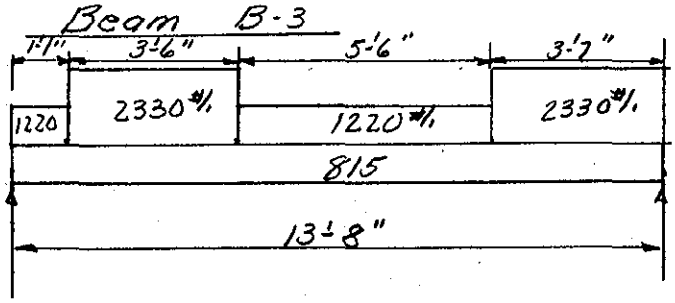
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station

Computation Motor Room Floor Beams

Computed by H. E. W. **Checked by** _____ **Date** 18-April-45

Beam B-3



D.L. Slab = 6.08 × 100 = 610

D.L. 14"×22" bm = 205

815#/'

L.L = 200 × 6.08 = 1220#/'

Motor, Motor Base, Impact = 1460

L.L = 4.33 × 200 = 870

2330#/'

R_L:

815 × 13.67 × .5 =	5570
1220 × 1.08 × .960	1260
2330 × 3.5 × .793	6470
1220 × 5.5 × .463	3110
2330 × 3.58 × .131	1090
	17,500

R_R:

815 × 13.67 × .5 =	5570#
1220 × 1.08 × 0.40 =	50
2330 × 3.5 × .207 =	1690
1220 × 3.5 × .537 =	3600
2330 × 3.58 × .869 =	7250
	18160#

x_0 = 6.97' from R_R

$$M = 18160 \times 6.97 - 815 \times \frac{6.97^2}{2} - 2330 \times 3.58 \times 5.18 - 1220 \times \frac{3.39^2}{2} = 56{,}560'^{\#}$$

req'd $d = \sqrt{\frac{56560 \times 12}{123 \times 14}} = 19.8 > 19.5"$ OK as beam will have Tee beam action.

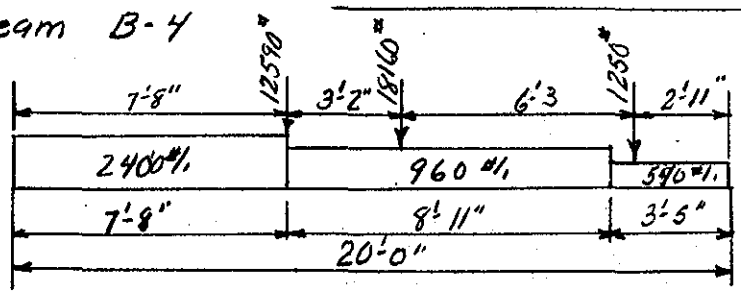
$v = \frac{18160}{14 \times .88 \times 19.5} = 75\#/\square''$ OK

Use 14"×22" Beam

$A_s = \frac{56{,}560 \times 12}{18000 \times .88 \times 19.5} = 2.19\ \square''$ **Use 3-1"⌀**

$u_0 = \frac{18160}{9.42 \times .88 \times 19.5} = 112\#/\square''$ **Make Beam same as B-2**

Beam B-4



D.L. Slab = 6.21 × 100 = 620#/'

D.L. 20"×34" bm = 1.67 × 2.17 × 150 = 540

L.L = 6.21 × 200 = 1240

2400#/'

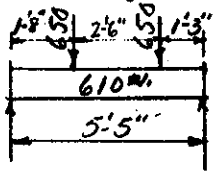
D.L. Slab 1.42 × 100 = 140#/'

D.L. bm = 540

L.L 1.42 × 200 = 280

960#/'

Stairway Header Beam



Load per ft. on bm

D.L. Slab: 100 × 1.83 = 180#/'

L.L = 200 × 1.83 = 370

D.L. 12"×12" = 50 × 1 = 50

610

R_L = 610 × 5.42 × .5 = 1650

$1300 \times \frac{2.5}{5.42} = 600$

1250#

Use 12"×12" beam with 2-5/8"⌀ bars

Stairway conc. = 1.25 × 80 × 6.5 = 650#

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station
Computation Motor Room Floor Beams
Computed by H.E.W. **Checked by** **Date** 18-April-45

Beam B-4

R_L =			R_R =		
2400 × 7.67 × .808	=	14870	2400 × 7.67 × .192	=	3530
960 × 8.92 × .393	=	3370	960 × 8.92 × .607	=	5200
540 × 3.42 × .086	=	160	540 × 3.42 × .914	=	1690
12590 × .616	=	7760	12590 × .384	=	4830
18160 × .458	=	8320	18160 × .542	=	9840
1250 × .146	=	180	1250 × .854	=	1070
		34660#			26160#

x_0 = 10.83 from R_L

$M = 34660 \times 10.83 - 2400 \times 7.67 \times 7.00 - 12590 \times 3.17 - 960 \times \frac{3.12^2}{2} = 201{,}780$ '#

reqd $d = \sqrt{\frac{201{,}780 \times 12}{123 \times 20}} = 31.4'' < 31.5''$ OK

$v = \frac{34660}{20 \times .88 \times 31.5} = 62$ #/□"

$A_s = \frac{201{,}780 \times 12}{18000 \times .88 \times 31.5} = 4.85$ □" Use 5-1"□ bars

Try Bending up 2-1"□ bars

$M = 3 \times 31.5 \times .88 \times \frac{18000}{12} = 124{,}740$ '#

Left side

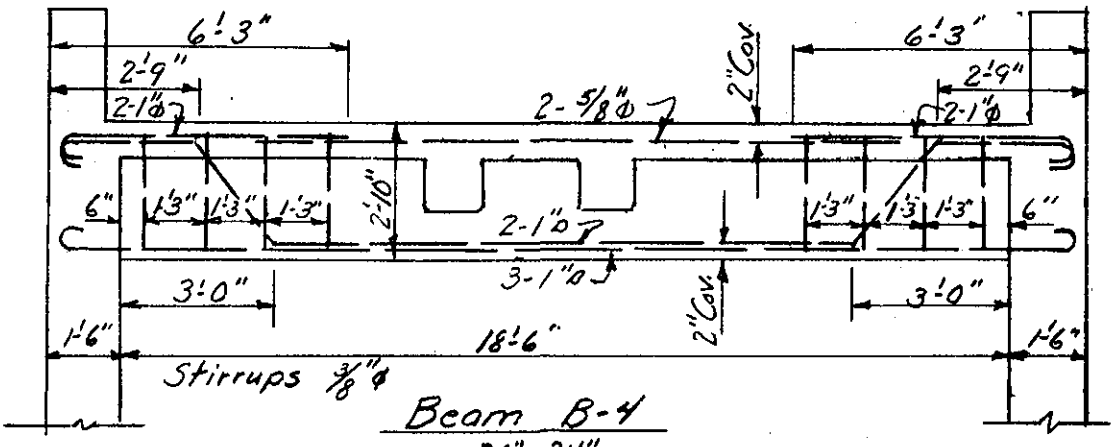
$34660x - 2400\frac{x^2}{2} = 124{,}740$ x = 4.2' from R_L

Right side

$26160x - 540 \times 3.42(x - 1.71) - 1250(x - 2.92) - 960\frac{(x - 3.42)^2}{2} = 124740$

x 5.2'

$u_0 = \frac{34660}{12 \times .88 \times 31.5} = 104$ #/□"



Beam B-4
20" × 34"

WAR DEPARTMENT

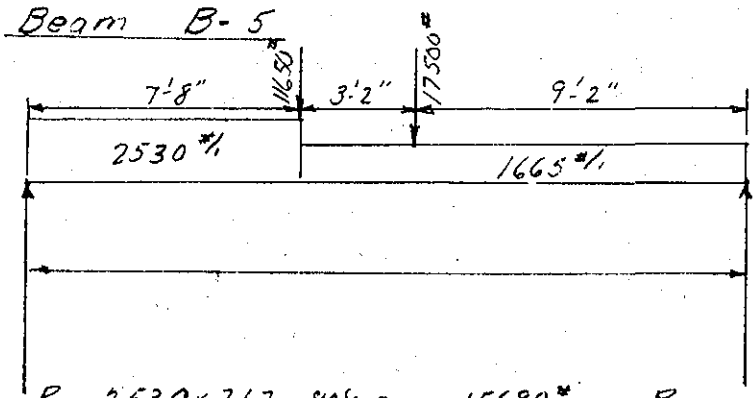
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station

Computation Motor Room Floor Beams

Computed by H. E. W. **Checked by** _____ **Date** 18-April-45

Beam B-5



D.L. slab = 4.59×100 = 460
D.L. cover = 15×2.87 = 40
L.L = 7.46×200 = 1490
D.L. 20×34" bm = 540
2530 #/'

D.L. slab = 3.75×100 = 375
D.L. Bm 540
L.L = 3.75×200 = 750
1665 #/'

R_L = 2530×7.67×.808 = 15680#
1665×12.33×.308 = 6320
11650×.616 = 7180
17500×.458 = 8020
37200

R_R = 2530×7.67×.192 = 3730#
1665×12.33×.692 = 14210
11650×.384 = 4470
17500×.542 = 9490
31900

x_0 = 9.17' from R.R

$M = 31900 \times 9.17 - 1665 \times \frac{9.17^2}{2} = 222520$ '#

req'd d: $\sqrt{\frac{222,520 \times 12}{123 \times 20}} = 32.1" > 31.5"$ OK as Beam will act as a Tee Beam

$v = \frac{37,200}{20 \times .88 \times 31.5} = 67$ #/□"

$A_s = \frac{222,520 \times 12}{18000 \times .88 \times 31.5} = 5.12$ □" Use 3-1"□ and 2-1⅛"□

Try bending up 2-1⅛"□ bars

$M = 3 \times 31.5 \times .88 \times \frac{18000}{12} = 124,740$ '#

Left side

$37,200x - 2530\frac{x^2}{2} = 124,740$ $x = 3.9'$ from R_L

Right side

$31,900x - 2530\frac{x^2}{2} = 124,740$ x 4.8' from R_R

$u_0 = \frac{37,200}{12 \times .88 \times 31.5} = 111$ #/□"

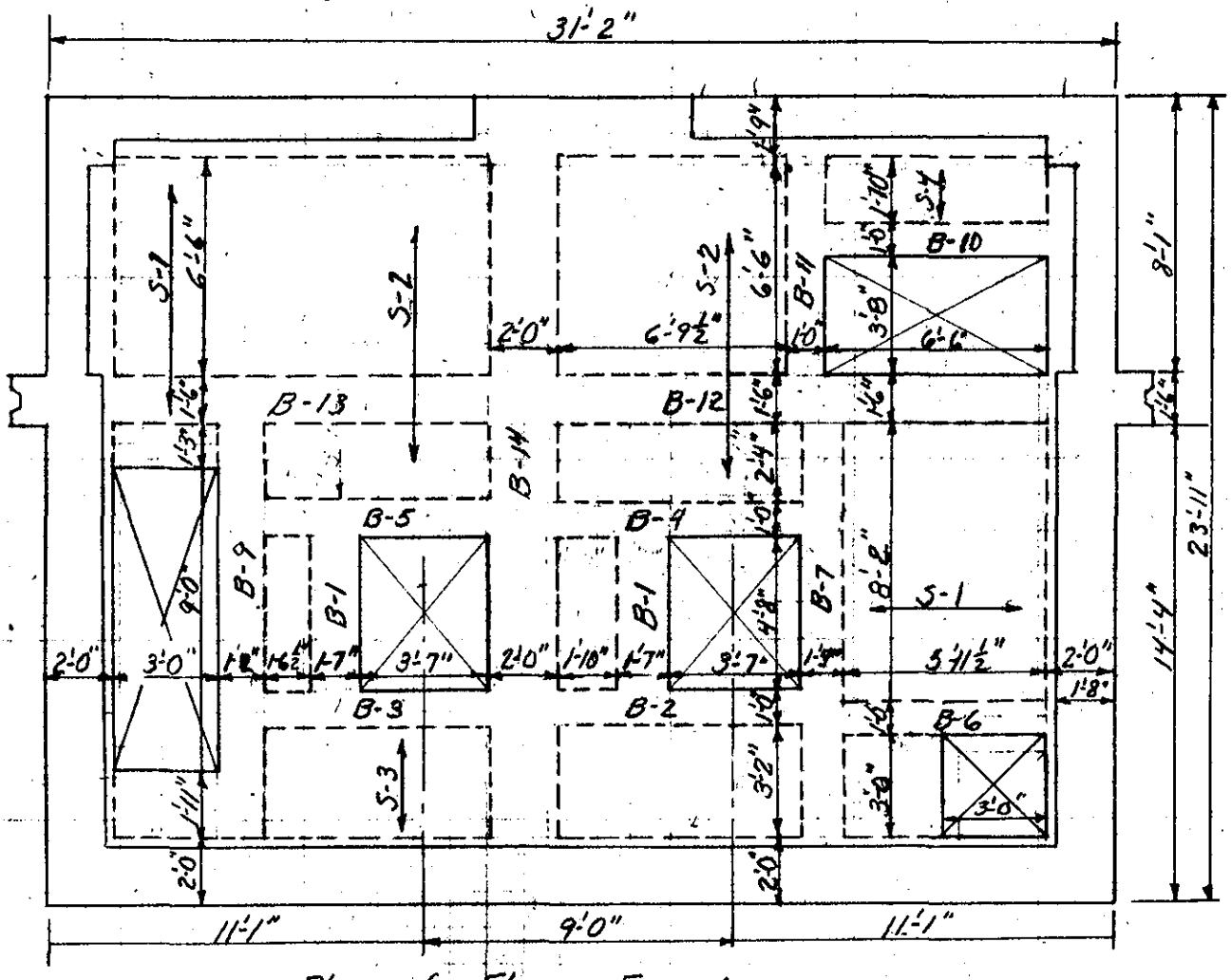
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5

Computation Motor Room Floor Slab

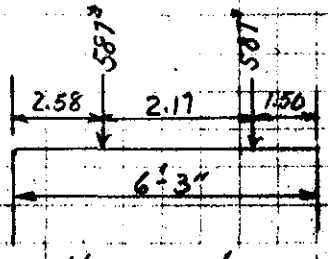
Computed by H.E.W. **Checked by** **Date** 6- June -45



Plan of Floor Framing

Equivalent uniform Floor Load

Load of Motor distributed along circumferance (Use circle thru anchor bolts) = $\frac{4000}{\pi\, 2.17}$ = 587 #/'



$M = \frac{587}{12.5}\left(6.25 - \frac{2.17}{2}\right)^2 = 1255$ '#

Equiv. unif. w. = $\frac{1255 \times 8}{6.25^2} = 257$ #/□'

Use a Live Load of 250 #/□' for slabs

Use a Live Load of 200 #/□' plus concentrated equipment load for beams

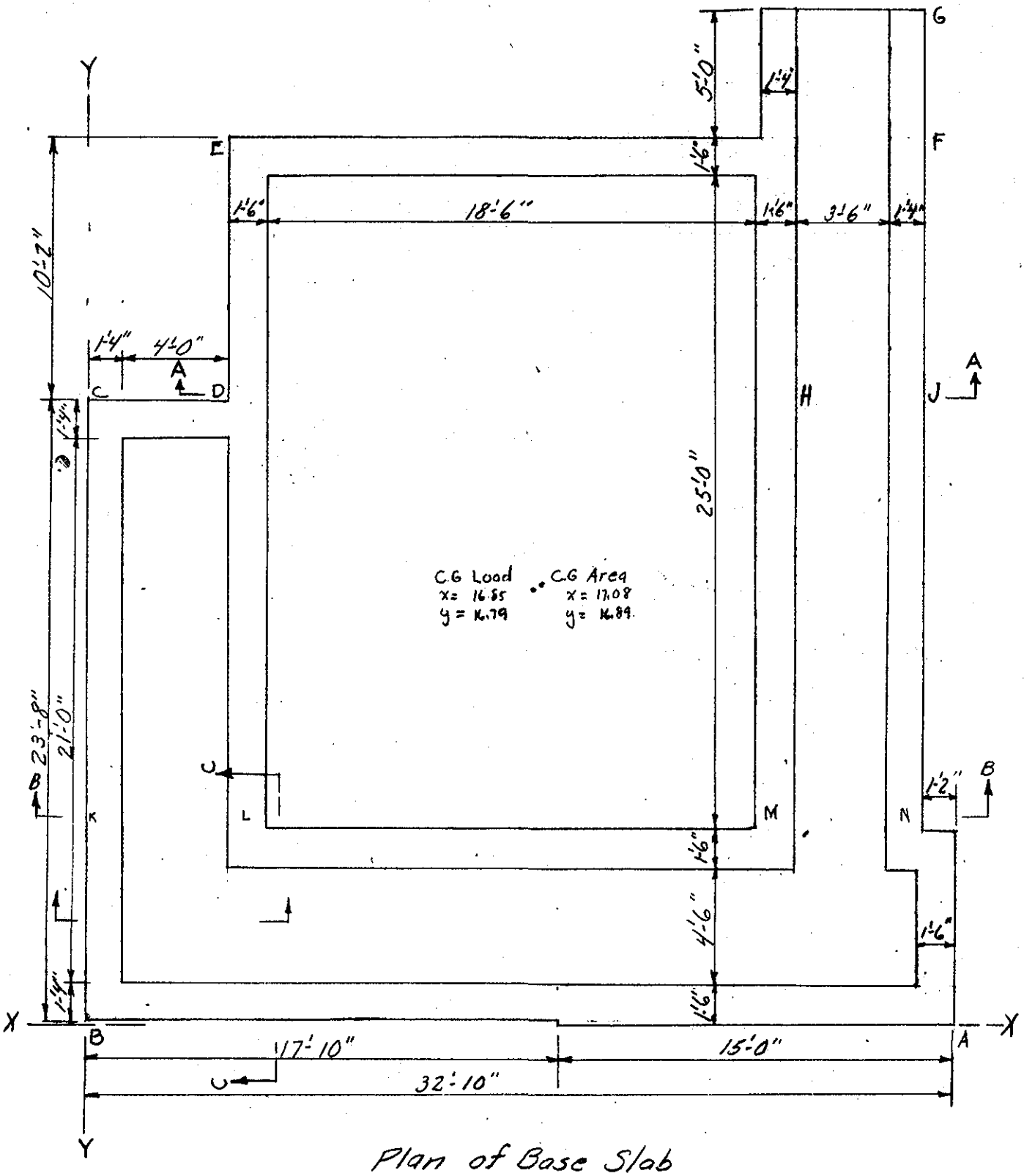
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station

Computation Bearing Pressure

Computed by H.E.W. **Checked by** **Date** 19-April-45



Plan of Base Slab

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page

Subject Springdale Pumping Station

Computation Bearing Pressure

Computed by H.E.W. **Checked by** **Date** 19 April 45

Description	Dimensions and Unit Weights	Weight (Kips)	Arm "Y"	Moment abt. X-X	Arm X	Moment abt. Y-Y
Roofing	19.17 × 25.17 × 5	2.4	20.17	48.7	16.08	38.8
Cind. Conc.	19.17 × 25.17 × 35	16.9	20.17	340.6	16.08	271.6
Conc. Rf Slab	19.17 × 25.17 × .42 × 150	30.4	20.17	613.1	16.08	488.8
Parapet	27.50 × 2 × 1.08 × 2.61 × 120	18.6	20.17	375.2	16.08	299.2
"	19.17 × 2 × 1.08 × 2.61 × 120	13.0	20.17	261.6	16.08	208.5
Coping	1 × 1 × 27.50 × 2 × 150	8.3	20.17	166.4	16.08	132.7
"	1 × 1 × 19.17 × 2 × 150	5.8	20.17	116.0	16.08	92.5
Roof Bm RB-1	19.17 × 165 × 2	6.3	20.17	127.6	16.08	101.7
" " RB-2	19.17 × 2 × 160	6.1	20.17	123.7	16.08	98.6
" " RB-3	26.83 × 2 × 140	7.5	20.17	151.5	16.08	120.8
Crane Beam	25.33 × 2 × 35	1.8	20.17	35.8	16.08	28.5
Crane		8.0	20.17	161.4	16.08	128.6
End columns	4 × 24 × 14.58	1.4	20.17	28.2	16.08	22.5
C-2	4 × 31 × 14.58	1.8	20.17	36.5	16.08	29.1
Brick Walls	13.33 × 27.53 × 2 × 120	88.1	20.17	1776.5	16.08	1416.2
	13.33 × 19.17 × 2 × 120	61.3	20.17	1237.0	16.08	986.2
Br. Pilasters	2.5 × .33 × 13.33 × 4 × 120	5.3	20.17	106.5	16.08	84.9
" "	.33 × .33 × 13.33 × 4 × 120	0.7	20.17	14.1	16.08	11.2
Br. Chimney	18.5 × 450	8.3	8.0	66.6	9.83	81.8
Conc. Curbing	1.17 × 27.67 × 2.37 × 150	11.5	20.17	232.1	16.08	185.1
" "	1.17 × 19.08 × 2.37 × 150	7.9	20.17	160.1	16.08	127.6
Floor Slab	21.5 × 27.67 × 100	59.5	20.17	1200.0	16.08	956.6
Minus Openings	6 × 5.75 × 85	− 2.9	17.87	− 52.4	10.17	− 29.8
	9 × 3 × 100	− 2.7	30.75	− 83.0	18.16	− 49.0
	1 × 1 × 100 × 2	− 0.2	21.5	− 4.3	15.33	− 3.1
Fl Bms B-4, B-5	1.67 × 2.17 × 18.5 × 150 × 2	20.1	21.0	422.4	16.08	323.4
B2 + B3	1.17 × 1.17 × 12 × 150 × 2	4.9	21.0	103.5	15.33	75.5
B-1	.5 × 1 × 150 × 6.33	0.5	21.25	10.1	10.00	4.7
Chimney Base	2.37 × 2.5 × 1.75 × 150	1.6	8.0	12.4	9.83	15.3
Raking Ch Roof	15.0 × 6.33 × 100	9.5	3.16	30.0	25.33	240.5
* Gt Haunch	2.5 × 2.5 × .5 × 6.5 × 150	3.0	4.75	14.5	28.08	85.6
" "	.33 × 2.5 × 5.5 × 150	0.7	4.75	3.3	28.58	19.6
Bm B-6	.33 × 1 × 4.5 × 150	0.2	3.75	0.8	25.33	5.7
Minus Openings	5.5 × 2 × 85	− 0.9	2.50	− 2.3	28.58	− 26.7
" "	2.5 × 4.5 × 85	− 1.0	3.75	− 3.5	23.58	− 22.5
	3.14 × 85	− 0.3	4.75	− 1.3	19.83	− 5.3
*Raking Ch. Roof	6 × 1.17 × 100	0.7	6.92	4.9	29.83	20.9
Pump. St Walls	28 × 1.5 × 15.08 × 150 × 2	190.0	20.0	3800.0	16.08	3055.2
	21.5 × 1.5 × 15.08 × 150 × 2	145.9	20.0	2918.0	16.08	2346.1
Suct Cond. Roof	5.33 × 23.67 × 1.33 × 150	25.2	12.0	302.8	2.67	67.4
Suct. Cond. Walls	5 × 5.33 × 1.33 × 150	5.3	23.17	123.5	2.67	14.2
" " "	21.0 × 1.33 × 5 × 150	21.0	12.0	252.0	0.67	14.0
		791.5		15230.6		12,063.2

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page

Subject Springdale Pumping Station

Computation Bearing Pressure

Computed by H.E.W. **Checked by** **Date** 20-April-45

Description	Dimensions and Unit Weights	Weight (Kips)	Arm "Y"	Moment abt. X-X	Arm X	Moment abt. Y-Y
Suct. Cond Roof	12.5 x 1.33 x 5.83 x 150	14.6	3.08	44.9	12.08	176.1
" " Wall	17.83 x 5 x 1.33 x 150	17.8	0.83	14.8	8.91	158.6
Raking Ch. Wall	1.5 x 15 x 14.33 x 150	48.4	0.75	36.3	25.33	1225.1
" " "	4.5 x 9.33 x 1.0 x 150	6.3	3.75	23.6	18.33	115.4
" " "	4.5 x 1.5 x 14.33 x 150	14.5	3.75	54.4	32.08	465.2
" " "	6 x 1.5 x 14.33 x 150	19.3	6.75	130.6	29.83	577.1
Disch. Cond. Rf.	31.5 x 4.83 x 1.33 x 150	30.4	23.25	707.5	29.25	890.0
" " Wall	27.83 x 1.33 x 7.5 x 150	41.7	21.41	893.8	31.00	1294.1
" " "	4.83 x 1.33 x 4 x 150	3.9	34.67	134.0	27.92	107.9
" " "	3.5 x 1.33 x 3.67 x 150	2.6	37.16	95.5	31.00	79.6
	3.5 x 5 x 1.33 x 150	3.5	36.50	127.8	26.16	91.6
	1.33 x 1.33 x 3.67 x 150	1.0	37.16	36.3	26.16	25.5
Tr. Rack Apron	1 x 4.5 x 4 x 150	2.7	3.75	10.1	22.0	59.4
Base Slab	21.5 x 28.00 x 3.25 x 150	286.7	20.00	5733.0	16.08	4609.3
" "	23.67 x 5.33 x 4.0 x 150	75.7	12.00	908.4	2.67	202.1
" "	27.33 x 5.83 x 4.0 x 150	95.6	3.08	294.4	19.00	1816.4
" "	15 x .17 x 4 x 150	1.5	0.08	0.1	25.33	38.8
" "	6 x 1.33 x 4 x 150	4.8	6.67	32.0	29.83	143.2
" "	4.83 x 31.5 x 4 x 150	91.3	23.25	2122.4	29.25	2670.1
" "	1.33 x 5 x 4 x 150	4.0	36.5	146.0	26.16	104.6
Minus gate opening	3.5 x 3.5 x 1.5 x 150	− 2.8	6.75	− 18.6	28.58	− 78.8
" " pocket	.75 x 4.5 x 6 x 150	− 3.0	3.75	− 11.4	28.33	− 86.1
Trash Rack Seat	2.75 x 4.5 x 2 x 150	3.7	3.75	13.9	39.33	146.0
Elec. Motors.	2 x 4200	8.4	21.5	180.6	15.33	128.8
Elec. Motor Base	3.5^2 x 1 x 150 x 2	3.7	21.5	79.0	15.33	56.3
Switch board		2.5	11.75	29.4	21.83	54.6
Furnace		0.8	10.00	8.0	11.67	9.3
Pump + Elbow.	2 x 8500	17.0	21.5	365.5	15.33	260.6
Suct pipe + Valve	2 x 2100	4.2	18.0	75.6	9.0	37.8
Disc. Pipe + Valve	2 x 3000	6.0	23.5	141.0	22.0	132.0
Sl. Gate + Stand		3.5	5.25	18.4	28.58	100.0
Trash Rack	4.5 x 8.5 x 30	1.1	3.75	4.3	22.5	25.8
Stairway	2.5 x 15.83 x 30	1.2	36.75	36.5	14.75	17.5
"	2.5 x 2.5 x 30	0.2	28.0	5.3	8.58	1.6
Ea. on Suct. Cond.	5.33 x 23.67 x 8.00 x 100	100.9	12.0	1211.1	2.67	269.5
	5.33 x 23.67 x 5.17 x 25	16.3	12.0	195.7	2.67	43.5
	12.5 x 5.83 x 8.00 x 100	58.3	3.08	179.6	11.58	675.1
	12.5 x 5.83 x 5.17 x 25	9.4	3.08	29.0	11.58	109.1
Disc. Cond. Ea.	27.83 x 4.83 x 5.5 x 100	73.9	21.42	1583.6	29.25	2162.5
	27.83 x 4.83 x 2.67 x 25	9.0	2.42	21.7	29.25	262.4
" " "	3.67 x 6.17 x 9.5 x 100	21.5	37.17	799.6	28.59	615.0
	3.67 x 6.17 x 6.67 x 25	3.8	37.17	140.3	28.59	108.0
		1105.9		16,634.0		19,900.6

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page

Subject Springdale Pumping Station

Computation Bearing Pressure

Computed by H. E. W. **Checked by** **Date** 21 - April - 45

Description	Dimensions and Unit Weights	Weight (kips)	Arm "Y"	Moment abt. X-X	Arm X	Moment abt. Y-Y
	Total First Page	791.5		15 230.6		12 063.2
	Total Second Page	1105.9		16 634.0		19900.6
	Grand Total	1897.4		31 864.6		31963.8

$$Y\,arm = \frac{31.864.6}{1897.4} = 16.79$$

$$X\,arm = \frac{31.963.8}{1897.4} = 16.85$$

Description	Dimensions	Area	Arm Y	Moment abt. X-X	Arm X	Moment abt Y-Y
	5.33 x 23.67	126.2	12.0	1513.9	2.67	336.9
	33.83 x 26.33	890.7	17.08	15213.9	18.50	16478.8
	15 x .17	2.6	0.08	0.2	25.33	64.6
	1.17 x 7.5	8.8	3.75	32.9	37.58	329.8
	5 x 6.17	30.9	36.5	1126.0	28.59	882.0
		1059.2		17886.9		18092.1

$$Y\,arm = \frac{17886.9}{1059.2} = 16.89 \qquad e = 0.10'$$

$$X\,arm = \frac{18092.1}{1059.2} = 17.08 \qquad e = 0.23'$$

Moment of Inertia of base area about axis thru C.G of load area and parallel to Y axis

$$\tfrac{1}{12} \times 23.67 \times 5.33^3 + 126.2 \times 14.18^2 = 25,670$$
$$\tfrac{1}{12} \times 33.83 \times 26.33^3 + 890.7 \times 1.65^2 = 53\,880$$
$$\tfrac{1}{12} \times .17 \times 15^3 + 2.6 \times 8.48^2 = 230$$
$$\tfrac{1}{12} \times 7.5 \times 1.17^3 + 8.8 \times 20.73^2 = 3\,780$$
$$\tfrac{1}{12} \times 5 \times 6.17^3 + 30.9 \times 11.74^2 = 4360$$
$$87,920\ ^{14}$$

Moment of Inertia of base area about axis thru C.G of load and parallel to X axis

$$\tfrac{1}{12} \times 5.33 \times 23.67^3 + 126.2 \times 4.79^2 = 8790$$
$$\tfrac{1}{12} \times 26.33 \times 33.83^3 + 890.7 \times 0.29^2 = 85020$$
$$\tfrac{1}{12} \times 15 \times .17^3 + 2.6 \times 16.71^2 = 730$$
$$\tfrac{1}{12} \times 1.17 \times 7.5^3 + 8.8 \times 13.04^2 = 1540$$
$$\tfrac{1}{12} \times 6.17 \times 5^3 + 30.9 \times 19.71^2 = 12070$$
$$108150\ ^{14}$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page

Subject Springdale Pumping Station

Computation Bearing Pressure

Computed by H.E.W. **Checked by** **Date** 21 April 45

Bearing Pressures

Point A = $\frac{1897400}{1059.2}$ (1790) − $\frac{1897400 \times 0.23 \times 15.98}{87,920}$ (80) + $\frac{1897400 \times 0.10 \times 16.79}{108,150}$ (30) = 1740 #/□'

Point B = 1790 + $\frac{1897400 \times 0.23 \times 16.85}{87920}$ (83) + 30 = 1900 #/□'

Point C = 1790 + 80 − $\frac{1897400 \times .10 \times 7.04}{108150}$ (10) = 1860 #/□'

Point D = 1790 + $\frac{1897400 \times 0.23 \times 11.52}{87920}$ (60) − 10 = 1840 #/□'

Point E = 1790 + 60 − $\frac{1897400 \times .10 \times 17.21}{108150}$ (30) = 1820 #/□'

Point F = 1790 − $\frac{1897400 \times 0.23 \times 14.81}{87920}$ − 30 = 1690 #/□'

Point G = 1790 − 70 − $\frac{1897400 \times .12 \times 22.21}{108150}$ (50) = 1670 #/□'

Point H = 1790 − $\frac{1897400 \times 0.23 \times 9.98}{87920}$ (50) − 10 = 1730 #/□'

Point J = 1790 − 70 − 10 = 1710 #/□'

Point K = 1790 + $\frac{1897400 \times .23 \times 16.18}{87920}$ + $\frac{1897400 \times .10 \times 9.29}{108.150}$ (10) = 1885

Point L = 1790 + $\frac{1897400 \times .23 \times 10.77}{87920}$ + 15 = 1860

*

Bearing Pressure when water in Station is at El 53.0

Description	Dimensions and Unit Weights	Weight (Kips)	Arm "Y"	Moment abt. "X-X"	Arm X	Moment abt. Y-Y
Water Suct. Cond.	4 x 21 x 5 x 62.5	26.3	12.0	315.0	3.33	87.4
" " "	26 x 4.5 x 5 x 62.5	36.6	3.75	137.1	18.33	670.2
" " "	12.5 x 4.5 x 4.5 x 62.5	15.8	3.75	59.3	25.08	396.8
" Disc. Cond.	3.5 x 3.5 x 33.0 x 62.5	25.3	22.5	568.5	28.58	722.1
	4 x 3.5 x 26.5 x 62.5	23.2	21.75	481.1	28.58	662.7
Water in Pump & Elb	2 x 1000	2.0	21.5	43.0	15.33	30.7
" " Suct pipe	2 x 1900	3.8	18.0	68.4	9.0	34.2
" " Disc pipe	2 x 2100	4.2	23.5	98.7	22.0	92.4
Previous Total		1897.4		31864.6		31963.8
		2034.6		33,635.7		34660.3

Y arm = $\frac{33635.7}{2034.6}$ = 16.53 ecc = 0.36'

X arm = $\frac{34,660.3}{2034.6}$ = 17.03 ecc = 0.05'

* Point M = 1790 − $\frac{1897400 \times .23 \times 9.23}{87920}$ + 15 = 1760

Point N = 1790 − $\frac{1897400 \times .23 \times 14.15}{87920}$ + 15 = 1735

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station

Computation Bearing Pressures

Computed by H. E. W. **Checked by** _____ **Date** 21-April-45

Bearing Pressures when Sta. contains water

Point A $= \frac{2034,600}{1059.2} - \frac{2034600 \times .05 \times 15.80}{87920} + \frac{2034600 \times 0.36 \times 16.53}{108150} = 2010$ #/□'

Point B $= 1920 + \frac{2034600 \times 0.05 \times 17.03}{87,920} + 110 = 2050$ #/□'

Point C $= 1920 + 20 - \frac{2034600 \times 0.36 \times 7.04}{108150} = 1890$ #/□'

Point D $= 1920 + \frac{2034600 \times 0.05 \times 11.70}{87920} - 50 = 1880$ #/□'

Point E $= 1920 + 10 - \frac{2034600 \times 0.36 \times 12.47}{108150} = 1810$ #/□'

Point F $= 1920 - \frac{2034600 \times 0.05 \times 14.63}{87920} - 120 = 1780$ #/□'

Point G $= 1920 - 20 - \frac{2034600 \times 0.36 \times 22.47}{108150} = 1750$ #/□'

Point H $= 1920 - \frac{2034600 \times 0.05 \times 9.8}{87920} - 80 = 1860$ #/□'

Point J $= 1920 - 20 - 50 = 1850$ #/□'

Point K $= 1920 + \frac{2034600 \times .05 \times 16.36}{87920} + \frac{2034600 \times .036 \times 9.63}{108150} = 2000$ #/□'

Point L $= 1920 + \frac{2034600 \times .05 \times 11.61}{87920} + 60 = 1990$ #/□'

Point M $= 1920 - \frac{2034600 \times .05 \times 9.05}{87920} + 60 = 1970$ #/□'

Point N $= 1920 - \frac{2034600 \times .05 \times 13.97}{87920} + 60 = 1960$ #/□'

Uplift on base $= 15.5 \times 62.5 = 970$ #/□'

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

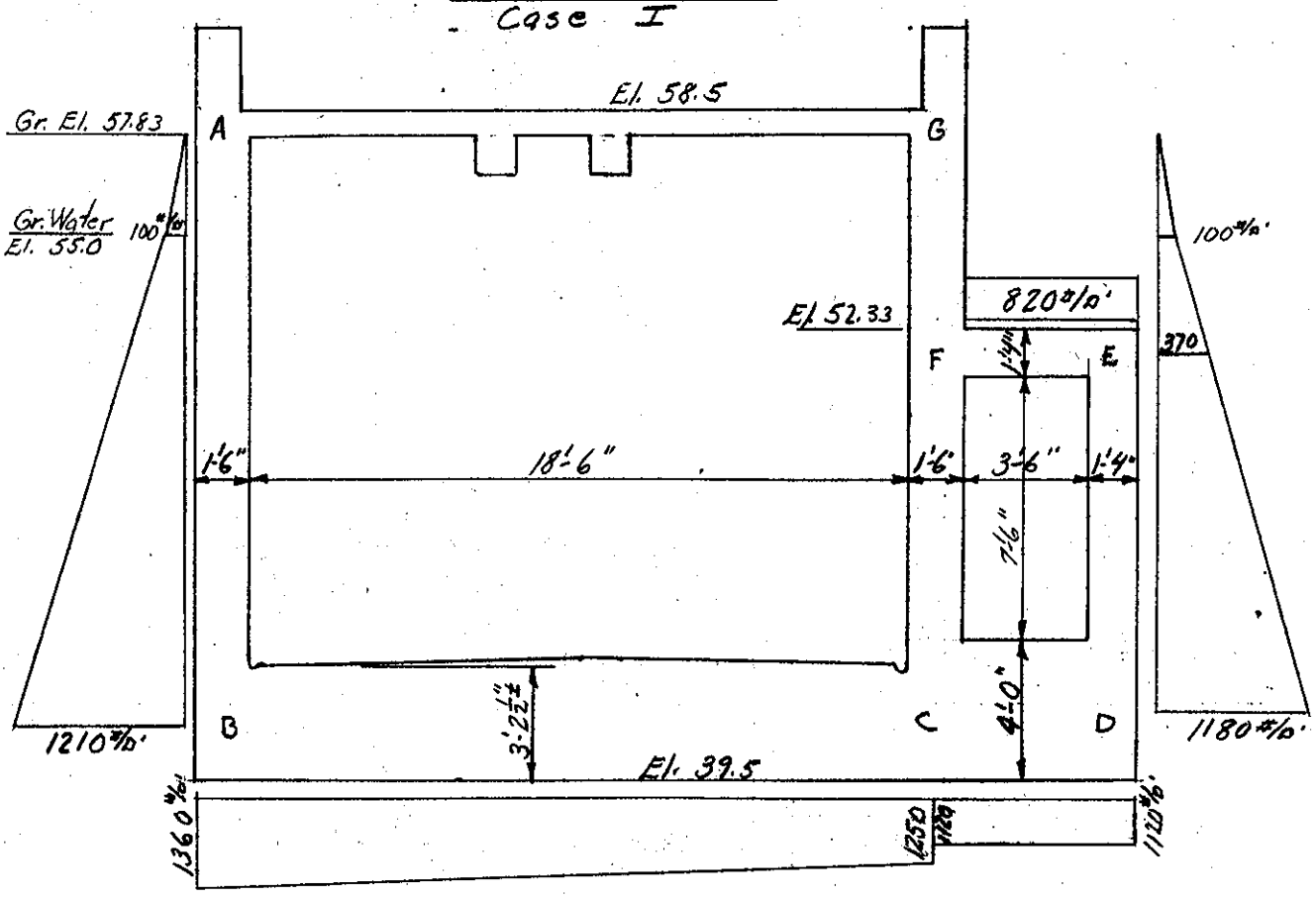
Subject Springdale Pumping Station

Computation Transverse Section A-A

Computed by H. E. W. **Checked by** **Date** 21-April-45

The transverse sections will be analized for two Cases. Case I with conduit empty and ground water at El. 55.0
Case II - Conduit full with river El. at 69.8 and ground water at El. 55.0, and water in station at El. 53.0

Section A-A
Case I



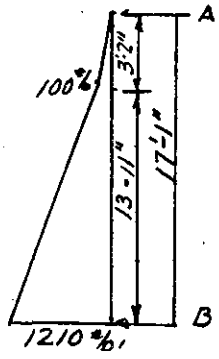
Horiz Thrust at El. 55.0 = 2.83x35 = 100#/□'
" " " El 51.67 = 100+3.33x80 = 370#/□'
" " " El. 41.10 = 100+13.9x80 = 1210#/□'
" " " El. 41.50 = 100+13.5x80 = 1180#/□'
Load on cond roof = 5.5x100 + 2.67x25 + 1.33x150 = 820#/□'
Base Pressure at B = 1840 - 3.21x150 = 1360#/□'
" " " C = 1730 - 3.21x150 = 1250#/□'
" " " C = 1730 - 4x150 = 1130#/□'
" " " D = 1710 - 4x150 = 1110#/□'

Subject Springdale Pumping Station
Computation Transverse Section A-A
Computed by H.E.W. **Checked by** **Date** 23-April-45

Case I

Fixed End Moments

Member AB



$$M^F_{AB} = .186\frac{(10-15\times .186+6\times .186^2)}{15}\times 100\times\frac{3.17}{2}\times 17.08$$

$$+\frac{.816^2(4-3\times .816)}{12}\times 100\times 13.92\times 17.08+\frac{.816^2(5-3\times .816)}{30}\times 1110\times\frac{13.92}{2}\times 17.08 = 9.78^{'k}$$

$$M^F_{BA} = \frac{.186^2(5-4\times .186)}{10}\times 100\times\frac{3.17}{2}\times 17.08+.816\frac{(6-8\times .816+3\times .816^2)}{12}\times 100\times 13.92\times 17.08$$

$$+\frac{.816(10-10\times .816+3\times .816^2)}{30}\times 1110\times\frac{13.92}{2}\times 17.08 = 16.19^{'k}$$

Member BC

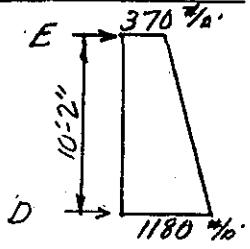
$$M^F_{BC} = \frac{1}{12}\times 1250\times 20^2+\frac{1}{10}\times 110\times\frac{20^2}{2} = 43.87^{'k}$$

$$M^F_{CB} = \frac{1}{12}\times 1250\times 20^2+\frac{1}{15}\times 110\times\frac{20^2}{2} = 43.14^{'k}$$

Member CD

$$M^F_{CD} = M^F_{DC} = \frac{1}{12}\times 1120\times 4.92^2 = 2.26^{'k}$$

Member DE



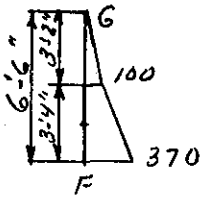
$$M^F_{ED} = \frac{1}{12}\times 370\times 10.17^2+\frac{1}{15}\times 810\times\frac{10.17^2}{2} = 5.98^{'k}$$

$$M^F_{DE} = \frac{1}{12}\times 370\times 10.17^2+\frac{1}{10}\times 810\times\frac{10.17^2}{2} = 7.38^{'k}$$

Member FE

$$M^F_{FE} = M^F_{EF} = \frac{1}{12}\times 820\times 4.92^2 = 1.65^{'k}$$

Member FG



$$M^F_{GF} = \frac{.488(10-15\times .488+6\times .488^2)}{15}100\times\frac{3.17}{2}\times 6.5+\frac{.512^2(4-3\times .512)}{12}\times 100\times 3.33\times 6.5$$

$$+\frac{.512^2(5-3\times .512)}{30}\times 270\times\frac{3.33}{2}\times 6.5 = 0.35^{'k}$$

$$M^F_{FG} = \frac{.488^2(5-4\times .488)}{10}100\times 3.17\times\frac{6.5}{2}+.512\frac{(6-8\times .512+3\times .512^2)}{12}\times 100\times 3.33\times 6.5$$

$$+\frac{.512(10-10\times .512+3\times .512^2)}{30}\times 270\times\frac{3.32}{2}\times 6.5 = 0.74^{'k}$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station

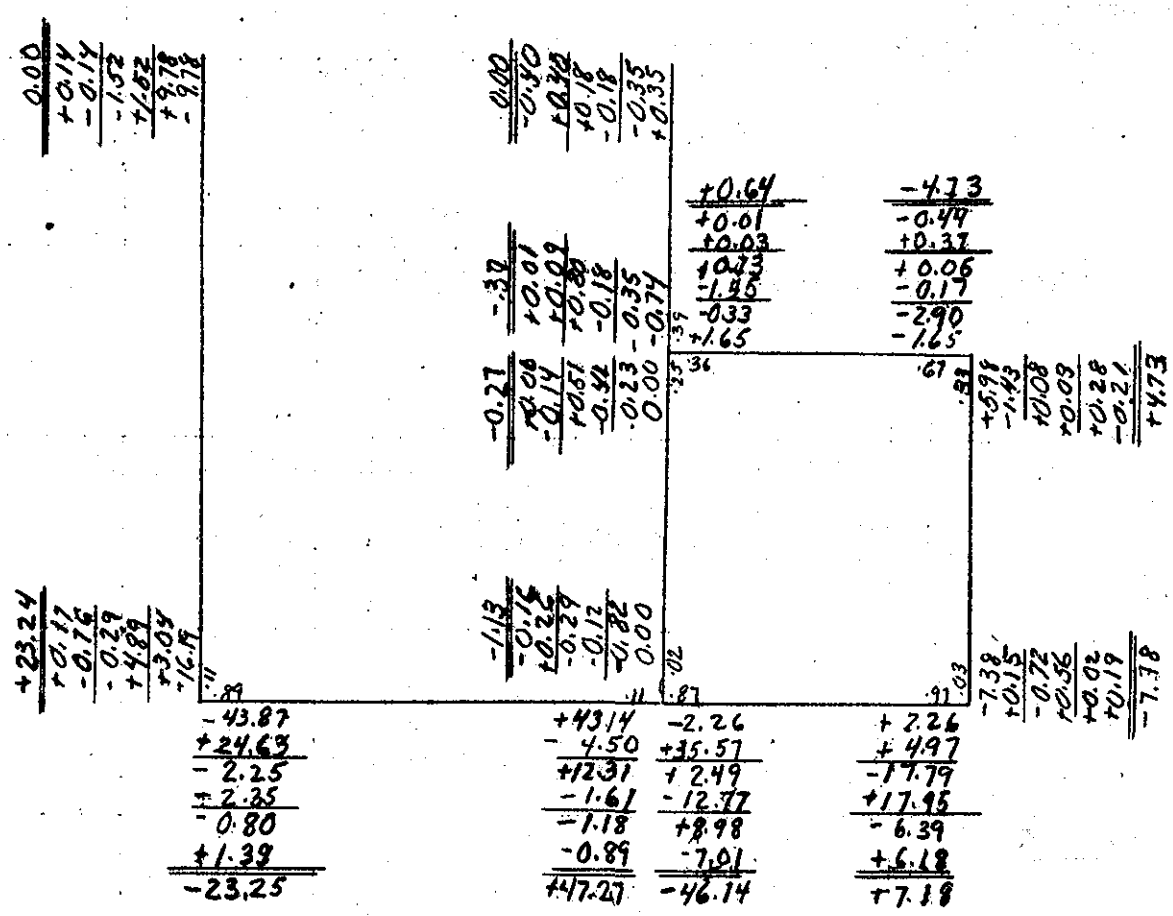
Computation Section A-A

Computed by H.E.W **Checked by** _____ **Date** 23-April-45

Case I (cont.)

Stiffness

Member	d	d^3	L	d^3/L	K
AB	18	5832	205	28.4	1.0
BC	38.5	57067	240	237.8	8.4
CD	48	110592	59	1874.4	66.0
DE	16	4096	122	33.6	1.2
EF	16	4096	59	69.4	2.4
FG	18	5832	78	74.8	2.6
FC	18	5832	122	47.8	1.7



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station
Computation Section A-A
Computed by H. E. W. **Checked by** **Date** 24-April-45

End Reactions and Center Moments

Member AB

$$H_A = 100\times3.17\times\frac{14.98+.5}{17.08} + 100\times13.92\times\frac{6.96}{17.08} + 1110\times13.92\times.5\times\frac{4.64}{17.08} - \frac{23240}{17.08} = 1450^{\#}$$

$$H_B = 100\times3.17\times.5\times\frac{2.11}{17.08} + 100\times13.92\times\frac{10.12}{17.08} + 1110\times13.92\times.5\times\frac{12.44}{17.08} + \frac{23240}{17.08} = 7830^{\#}$$

$x_0 = 7.65'$ from A

$$M = 1450\times7.65 - 100\times3.12\times.5\times5.54 - 100\times\frac{4.48^2}{2} - 358\times\frac{4.48^2}{6} = 8030'^{\#}$$

Member BC

$$V_B = 1250\times20\times.5 + 110\times20\times.5\times.67 - \frac{22860}{20} = 12,040^{\#}$$

$$V_C = 1250\times20\times.5 + 110\times20\times.5\times.33 + \frac{22860}{20} = 14,060^{\#}$$

$x_0 = 11.0'$ from C

$$M = 14060\times11 - 1250\times\frac{11.0^2}{2} - 60\times\frac{11.0^2}{6} - 46,920 = 30900'^{\#}$$

Member CD

$$V_C = 1120\times4.92\times.5 + \frac{38960}{4.92} = 10,670^{\#}$$

$$V_D = 1120\times4.92\times.5 - \frac{38960}{4.92} = -5160^{\#}$$

No Pos. M

Member DE

$$H_D = 370\times10.17\times.5 + 810\times10.17\times.5\times.67 + \frac{2450}{10.17} = 4870^{\#}$$

$$H_E = 370\times10.17\times.5 + 810\times10.17\times.5\times.33 - \frac{2450}{10.17} = 3010^{\#}$$

$x_0 = 5.2'$ from E

$$M = 3010\times5.2 - 370\times\frac{5.2^2}{2} - 416\times\frac{5.2^2}{6} - 4260 = 4520'^{\#}$$

Member EF

$$V_E = 820\times4.92\times.5 + \frac{4090}{4.92} = 2850^{\#}$$

$$V_F = 820\times4.92\times.5 - \frac{4090}{4.92} = 1190^{\#}$$

$x_0 = 3.48'$ from E

$$M = 2850\times3.48 - 820\times\frac{3.48^2}{2} - 4730 = 220'^{\#}$$

Member FG

$$H_G = 100\times3.17\times.5\times\frac{4.39}{6.5} + 100\times3.33\times\frac{1.67}{6.5} + 270\times3.33\times.5\times\frac{1.11}{6.5} - \frac{370}{6.5} = 200^{\#}$$

$$H_F = 100\times3.17\times.5\times\frac{2.11}{6.5} + 100\times3.33\times\frac{4.83}{6.5} + 270\times3.33\times.5\times\frac{5.39}{6.5} + \frac{370}{6.5} = 740^{\#}$$

$x_0 = 3.4'$ from G

$$M = 200\times3.4 - 100\times3.17\times.5\times1.31 - 100\times\frac{.25^2}{2} - 20\times\frac{.25^2}{6} = 500'^{\#}$$

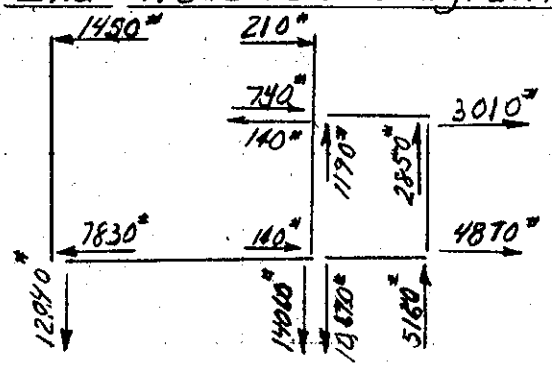
Subject Springdale Pumping Station
Computation Section A-A
Computed by H.E.W. **Checked by** **Date** 24-April-45

Case I (cont.) End React. + Center Mom. cont.

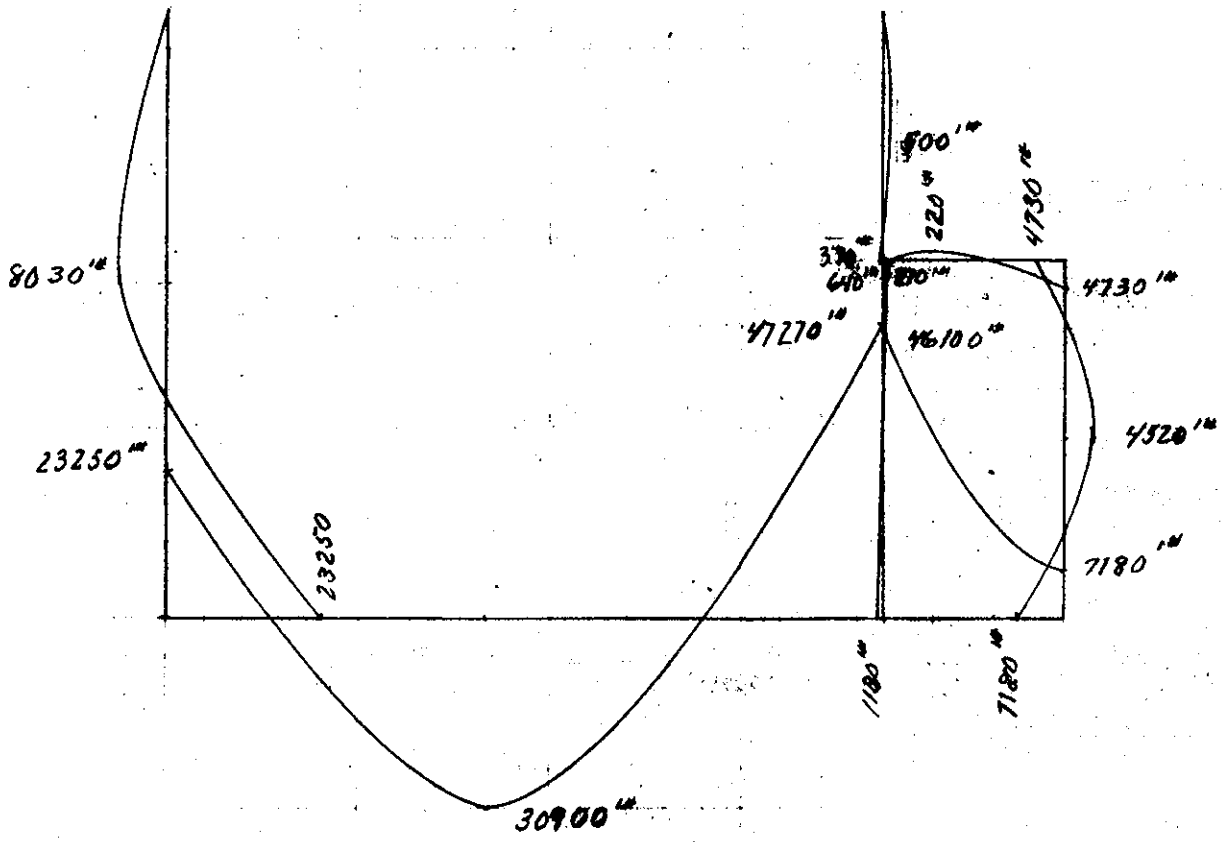
Member CF

$H_C = \frac{1400}{10.17} = 140^{\#} \rightarrow \qquad H_F = 140^{\#} \leftarrow$

End Reaction Diagram



Moment Diagram



WAR DEPARTMENT

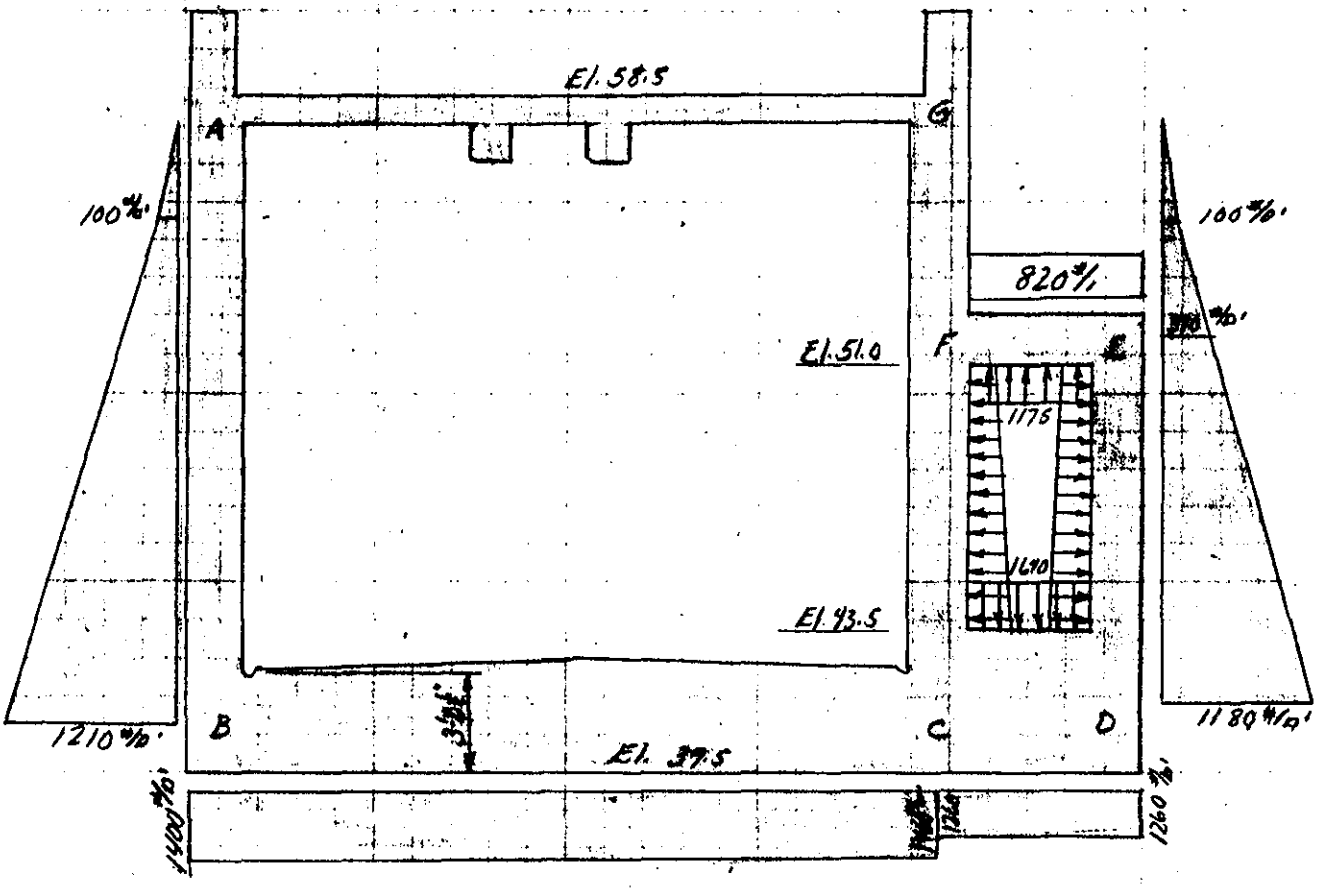
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station

Computation Section A-A

Computed by H.E.W. **Checked by** _____ **Date** 24 April 45

Case II



Base Pressure at B = 1880 - 3.21 x 150 = 1400#/□'

" " " C = 1860 - 3.21 x 150 = 1380#/□'

" " " C = 1860 - 4 x 150 = 1260#/□'

" " " D = 1850 - 4 x 150 = 1250#/□'

Internal Cond. Pressure at El. 51.0 = 18.8 x 62.5 = 1175#/□'

" " " " " 43.5 = 26.3 x 62.5 1640#/□'

For Member BC use a uniform base pres. of 1400#/□'

" " CD " " " " " " 1260#/□'

Subject Springdale Pumping Station
Computation Transverse Section A-A
Computed by H. E. W. **Checked by** **Date** 9-May-45

Case II (cont.)
Fixed End Moments

Member AB

$M^F_{AB} = 9.78^{'k}$ $M^F_{BA} = 16.19^{'k}$ (see Case I)

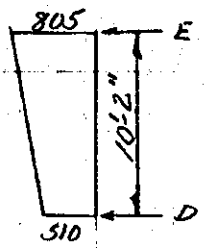
Member BC

$M^F_{BC} = M^F_{CD} = \frac{1}{12} \times 1400 \times 20^2 = 46.67^{'k}$

Member CD

$M^F_{CD} = M^F_{DC} = \frac{1}{12} \times 380 \times 4.92^2 = 0.77^{'k}$

Member DE



$M^F_{DE} = \frac{1}{12} \times 510 \times 10.17^2 + \frac{1}{15} \times 295 \times \frac{10.17^2}{2} = 5.42^{'k}$

$M^F_{ED} = \frac{1}{12} \times 510 \times 10.17^2 + \frac{1}{10} \times 295 \times \frac{10.17^2}{2} = 5.92^{'k}$

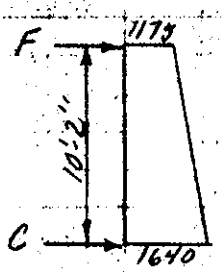
Member FE

$M^F_{FE} = M^F_{EF} = \frac{1}{12} \times 355 \times 4.92^2 = 0.72^{'k}$

Member FG

$M^F_{FG} = 0.74^{'k}$ $M^F_{GF} = 0.35^{'k}$

Member FC



$M^F_{FC} = \frac{1}{12} \times 1175 \times 10.17^2 + \frac{1}{15} \times 465 \times \frac{10.17^2}{2} = 11.73^{'k}$

$M^F_{CF} = \frac{1}{12} \times 1175 \times 10.17^2 + \frac{1}{10} \times 465 \times \frac{10.17^2}{2} = 12.53^{'k}$

WAR DEPARTMENT

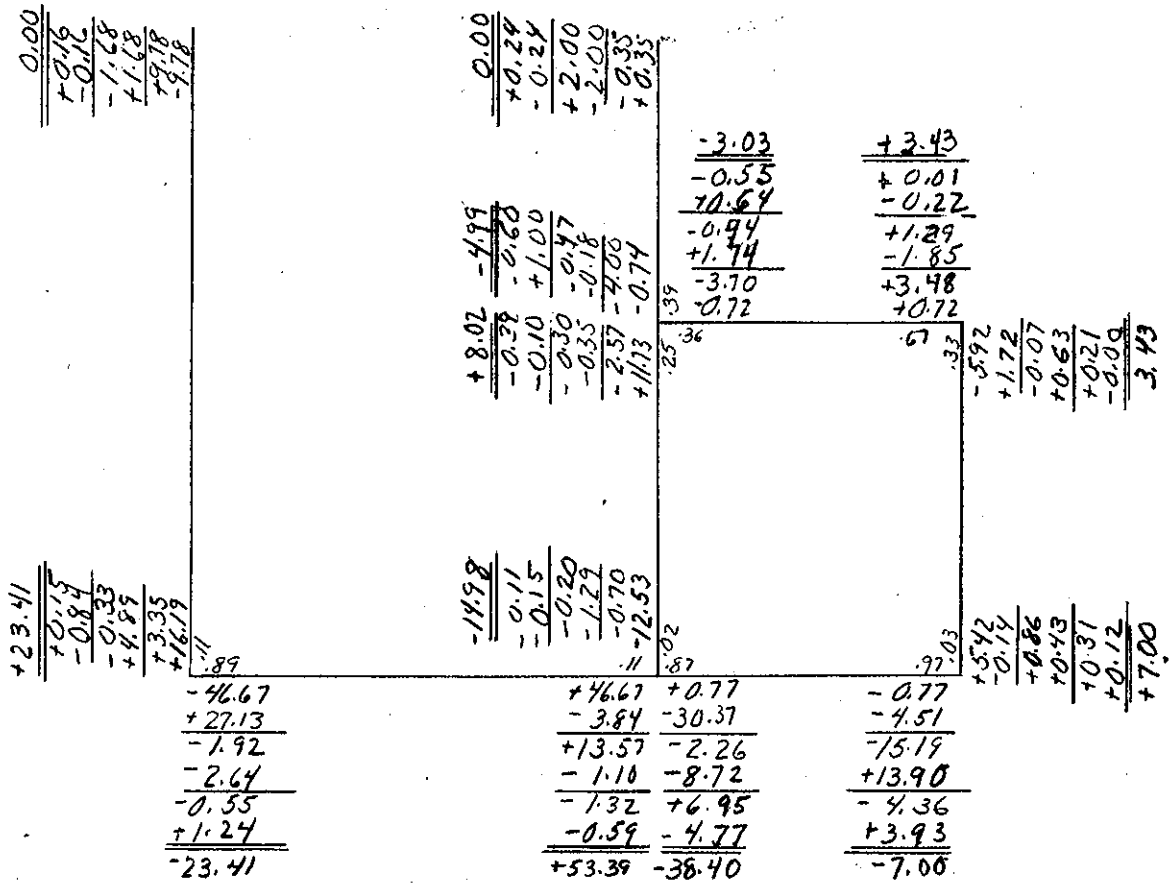
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station

Computation Transverse Section A-A

Computed by H. E. W. **Checked by** **Date** 10-May-45

Case II (cont.)



End Reactions and Center Moments

Member AB

$$H_A = 100 \times 3.17 \times \frac{14.98}{17.08} \times .5 + 100 \times 13.92 \times \frac{6.96}{17.08} + 1110 \times 13.92 \times .5 \times \frac{4.64}{17.08} - \frac{23,410}{17.08} = 1440^{\#}$$

$$H_B = 100 \times 3.17 \times .5 \times \frac{2.11}{17.08} + 100 \times 13.92 \times \frac{10.12}{17.08} + 1110 \times 13.92 \times .5 \times \frac{12.44}{17.08} + \frac{23410}{17.08} = 7840^{\#}$$

$x_0 = 7.65'$ from A

$$M = 1440 \times 7.65 - 100 \times 3.12 \times .5 \times 5.54 - 100 \times \frac{4.48^2}{2} - 358 \times \frac{4.48^2}{6} = 7960'^{\#}$$

Member BC

$$V_A = 1400 \times 20 \times .5 - \frac{29,980}{20} = 12500^{\#}$$

$$V_C = 1400 \times 20 \times .5 + \frac{29,980}{20} = 15500^{\#}$$

$x_0 = 8.68'$ from B

$$M = 12500 \times 8.68 - 1440 \times \frac{8.68^2}{2} - 23,410 = 30,840'^{\#}$$

Subject Springdale Pumping Station
Computation Transverse Section A-A
Computed by H.E.W. **Checked by** **Date** 10-May-45

Case II cont.
End Reactions + Center Moments (cont.)

Member CD

$V_C = 380 \times 4.92 \times .5 - \frac{45400}{4.92} = 8290^{\#} \downarrow$

$V_D = 380 \times 4.92 \times .5 + \frac{45400}{4.92} = 10160^{\#} \uparrow$

No Center Mom.

Member DE

$H_D = 510 \times 10.17 \times .5 + 295 \times 10.17 \times .5 \times .33 + \frac{3570}{10.17} = 3440^{\#}$

$H_E = 510 \times 10.17 \times .5 + 295 \times 10.17 \times .5 \times .67 - \frac{3570}{10.17} = 3240^{\#}$

$x_0 = 5.4'$ from D

$M = 3440 \times 5.4 - 510 \times \frac{5.4^2}{2} - 151 \times \frac{5.4^2}{6} - 7000 = 3380'^{\#}$

Member EF

$V_E = 355 \times 4.92 \times .5 - \frac{400}{4.92} = 800^{\#}$

$V_F = 355 \times 4.92 \times .5 + \frac{530}{4.92} = 950^{\#}$

$x_0 = 2.25'$ from E

$M = 800 \times 2.25 - 3430 - 355 \times \frac{2.25^2}{2} = -2530'^{\#}$

Member FG

$H_F = 100 \times 3.17 \times .5 \times \frac{4.39}{6.5} + 100 \times 3.33 \times \frac{1.67}{6.5} + 270 \times 3.33 \times .5 \times \frac{1.11}{6.5} - \frac{4990}{6.5} = 500^{\#} \leftarrow$

$H_G = 100 \times 3.17 \times .5 \times \frac{2.11}{6.5} + 100 \times 3.33 \times \frac{4.83}{6.5} + 270 \times 3.33 \times .5 \times \frac{5.39}{6.5} + \frac{4990}{6.5} = 1400^{\#} \rightarrow$

No Center Mom.

Member FC

$H_F = 1175 \times 10.17 \times .5 + 465 \times 10.17 \times .5 \times .33 - \frac{6960}{10.17} = 6070^{\#}$

$H_C = 1175 \times 10.17 \times .5 + 465 \times 10.17 \times .5 \times .67 + \frac{6840}{10.17} = 8240^{\#}$

$x_0 = 4.7'$ from F

$M = 6070 \times 4.7 - 1175 \times \frac{4.7^2}{2} - 215 \times \frac{4.7^2}{6} - 8040 = 6720'^{\#}$

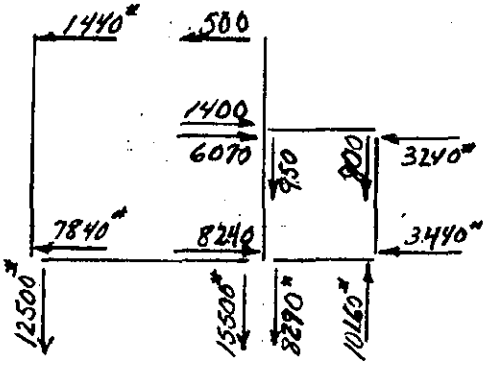
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

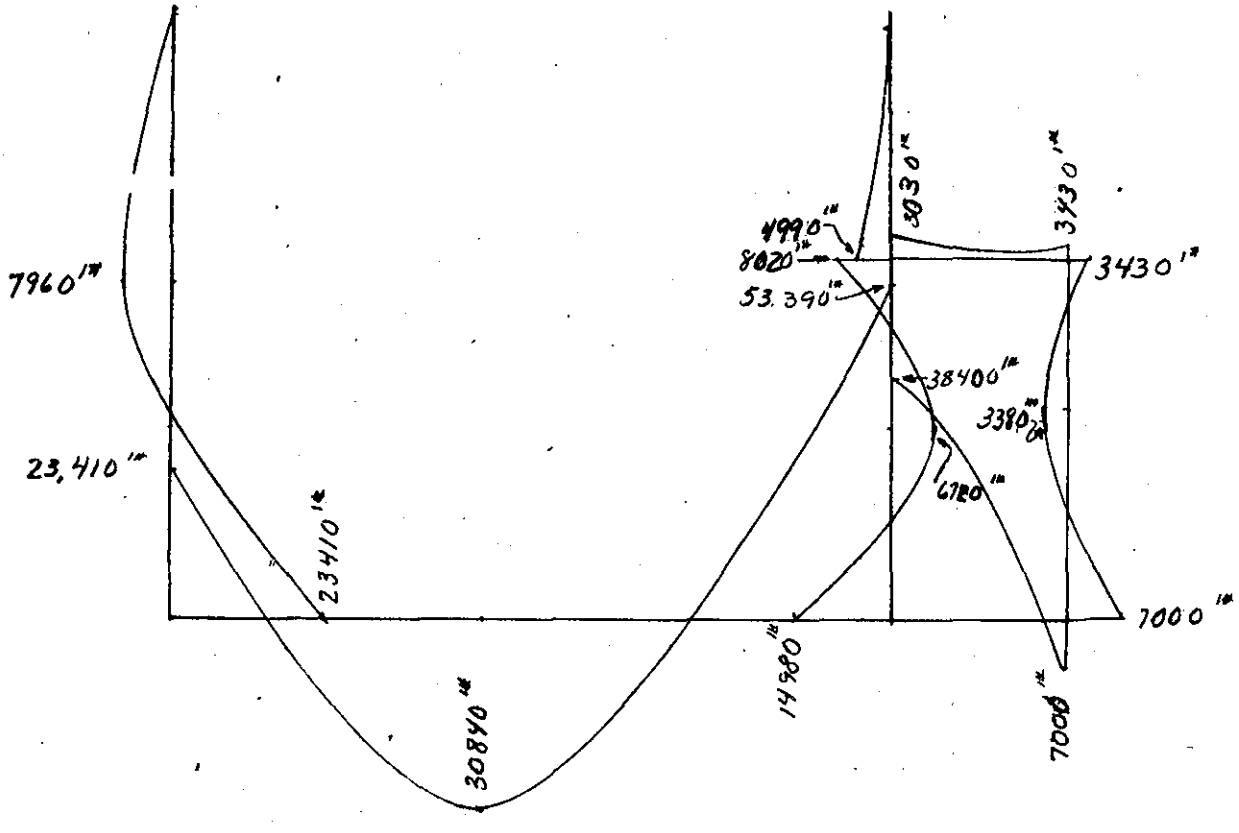
Subject Springdale Pumping Station
Computation Transverse Section A-A
Computed by H.E.W. **Checked by** **Date** 10-May-45

Case II cont.

End Reaction Diagram



Moment Diagram



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

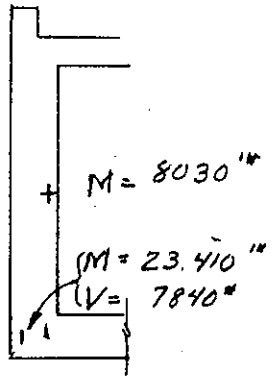
Subject Springdale Pumping Station

Computation Transverse Section A-A

Computed by H.E.W. **Checked by** **Date** 10-May-45

Design of Members

Wall AB



req'd $d = \sqrt{\frac{23.410}{147}} = 12.65'' < 14.5''$ OK

$v = \frac{7840}{12 \times .88 \times 14.5} = 51\ \#/\square''$

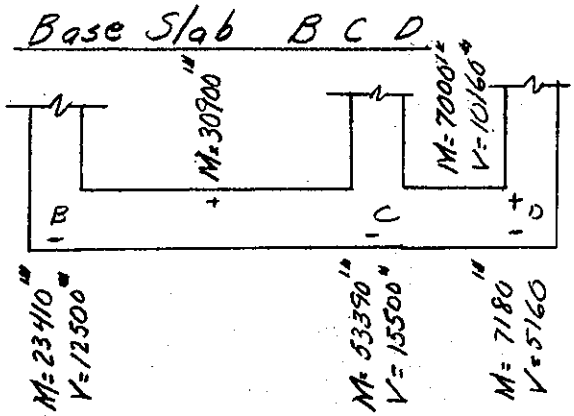
$-As$ at base $= \frac{23.410 \times 12}{18000 \times .88 \times 14.5} = 1.22\ \square''$

Use 7/8"⌀ @ 6"cc

$u_0 = \frac{7840}{5.5 \times .88 \times 14.5} = 112\ \#/\square''$

$+As = \frac{8030 \times 12}{18000 \times .88 \times 14.5} = .42\ \square''$ Use 3/4"⌀ @ 1'-0"cc

Base Slab B C D



req'd $d = \sqrt{\frac{53390}{147}} = 19.0'' < 30''$ OK

Change bot. of base slab El. to El. 40.0

then d for +As long span = 22.5"
d for −As " " = 26.5"
d for −As shortspan = 37.5"
d for +As " " = 38.5

$v = \frac{15500}{12 \times .88 \times 26.5} = 55\ \#/\square''$

$-As$ at B $= \frac{23410 \times 12}{18000 \times .88 \times 26.5} = .67\ \square''$ Use 7/8"⌀ @ 6"cc from wall

$u_0 = \frac{12500}{5.5 \times .88 \times 26.5} = 98\ \#/\square''$

$+As = \frac{30.900 \times 12}{18000 \times .88 \times 22.5} = 1.04\ \square''$ Use 1"⌀ @ 9"cc

$-As$ at C $= \frac{53,390 \times 12}{18000 \times .88 \times 26.5} = 1.53\ \square''$ Use 1"⌀ @ 6"cc

$u_0 = \frac{15,500}{6.3 \times .88 \times 26.5} = 105\ \#/\square''$

$+As$ at D $= \frac{7000 \times 12}{18000 \times .88 \times 38.5} = .14\ \square''$ Use 7/8"⌀ @ 1'-0"cc

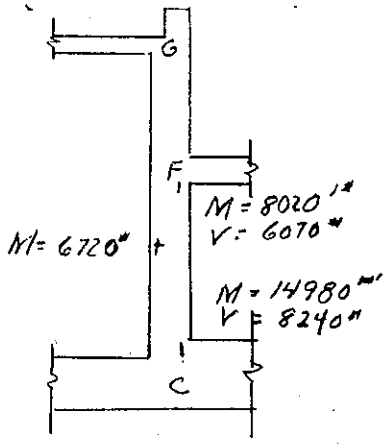
$-As$ at D − Use 3/4"⌀ @ 1'-0"cc

$u_0 = \frac{10,160}{2.4 \times .88 \times 38.5} = 125\ \#/\square''$

Subject Springdale Pumping Station
Computation Transverse Section A-A
Computed by H.E.W. **Checked by** **Date** 11-May-45

Design of Members (cont.)

Wall C F G



req'd $d = \sqrt{\frac{14980}{147}} = 10.1'' < 14.5''$

$v = \frac{8240}{12 \times .88 \times 14.5} = 54\ \#/\square''$

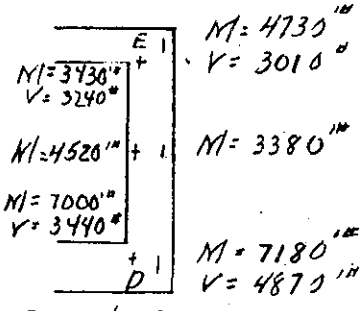
$-As \text{ at } C = \frac{14980 \times 12}{18000 \times .88 \times 14.5} = .78\ \square''$ Use 3/4" ⌀ @ 6" cc

$u_0 = \frac{8240}{4.7 \times .88 \times 14.5} = 137\ \#/\square''$

$-As \text{ at } F = \frac{8020 \times 12}{18000 \times .88 \times 14.5} = .42\ \square''$ Use 3/4" ⌀ @ 1'-0" cc

$+As$ Use 3/4" ⌀ @ 1'-0" cc

Cond. Wall F E



req'd $d = \sqrt{\frac{7180}{147}} = 7.0'' < 12.5''$ OK

$v = \frac{4870}{12 \times .88 \times 12.5} = 37\ \#/\square''$

$-As \text{ at } D = \frac{7180 \times 12}{18000 \times .88 \times 12.5} = .44\ \square''$ Use 3/4" ⌀ @ 1'-0" cc

$u_0 = \frac{4870}{2.4 \times .88 \times 12.5} = 185\ \#/\square''$

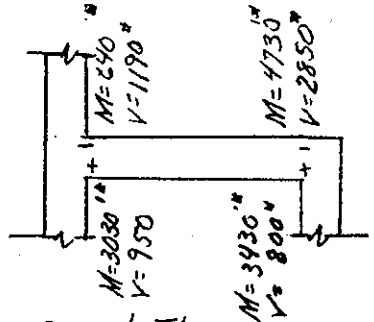
$-As \text{ at } E$ Use 3/4" ⌀ @ 1'-0" cc

Direct Tension = +10,160#

$M_s = 7180 - \frac{4.5}{12} \times 10160 = 3380'\#$

$+As = \frac{12 M_s}{f_s jd} + \frac{N}{f_s} = \frac{12 \times 3380}{18000 \times .88 \times 12.5} + \frac{10160}{18000} = .77\ \square''$ Use 3/4" ⌀ 6" cc

Cond. Roof E F



Direct Thrust = 7470# max

$-As = \frac{4730 \times 12}{18000 \times .88 \times 12.5} = .29\ \square''$ Use 3/4" ⌀ @ 1'-0" cc

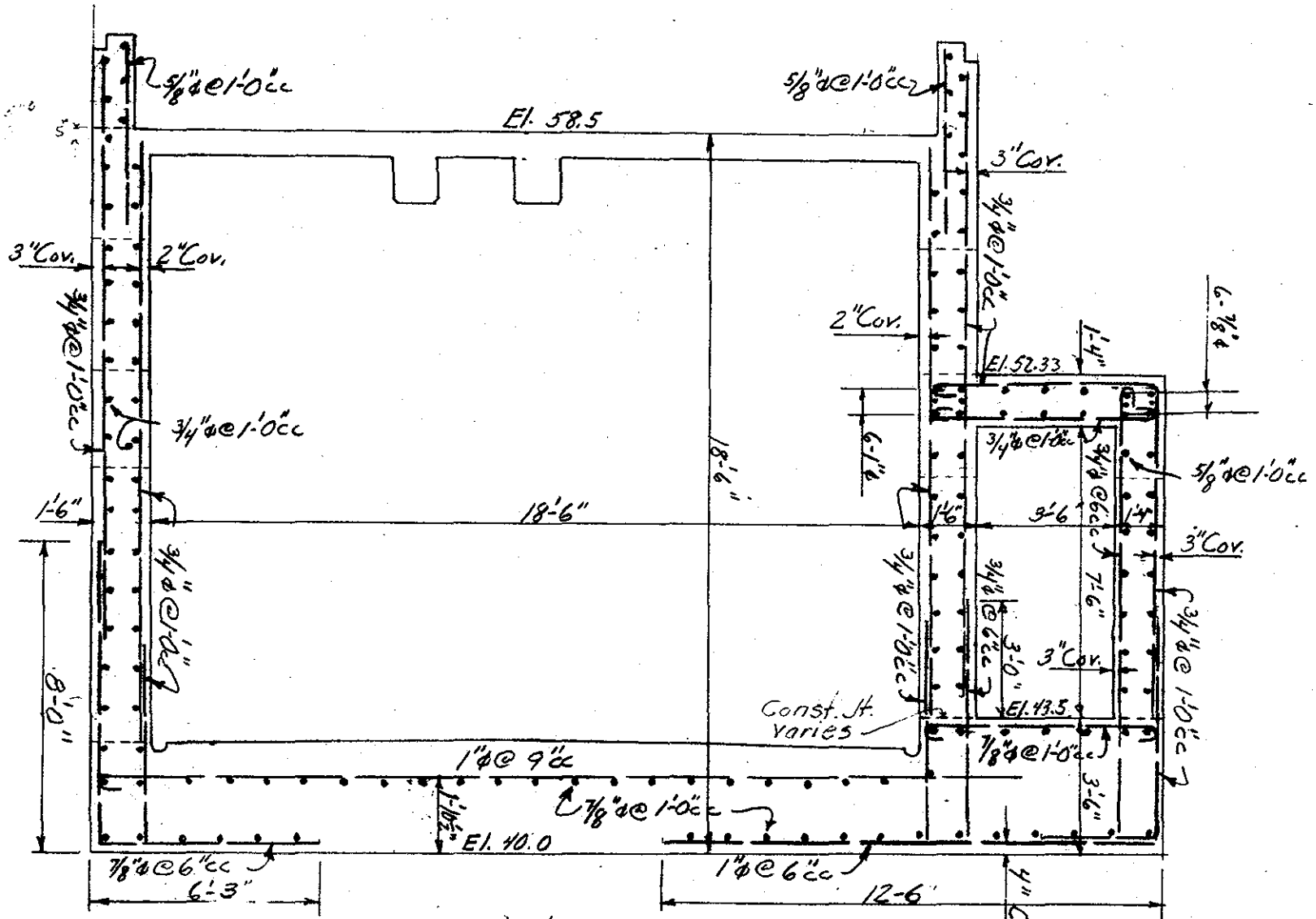
$u_0 = \frac{2850}{2.4 \times .88 \times 12.5} = 108\ \#/\square''$

$M_s = M - \frac{d''}{12} \times N = 3430 - \frac{4.5}{12} \times 7470 = 630'\#$

$+As = \frac{12 \times 630}{18000 \times .88 \times 12.5} + \frac{7470}{18000} = .44\ \square''$ Use 3/4" ⌀ @ 1'-0" cc

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station
Computation Transverse Section A-A
Computed by H.E.W. **Checked by** _____ **Date** 11 May 45

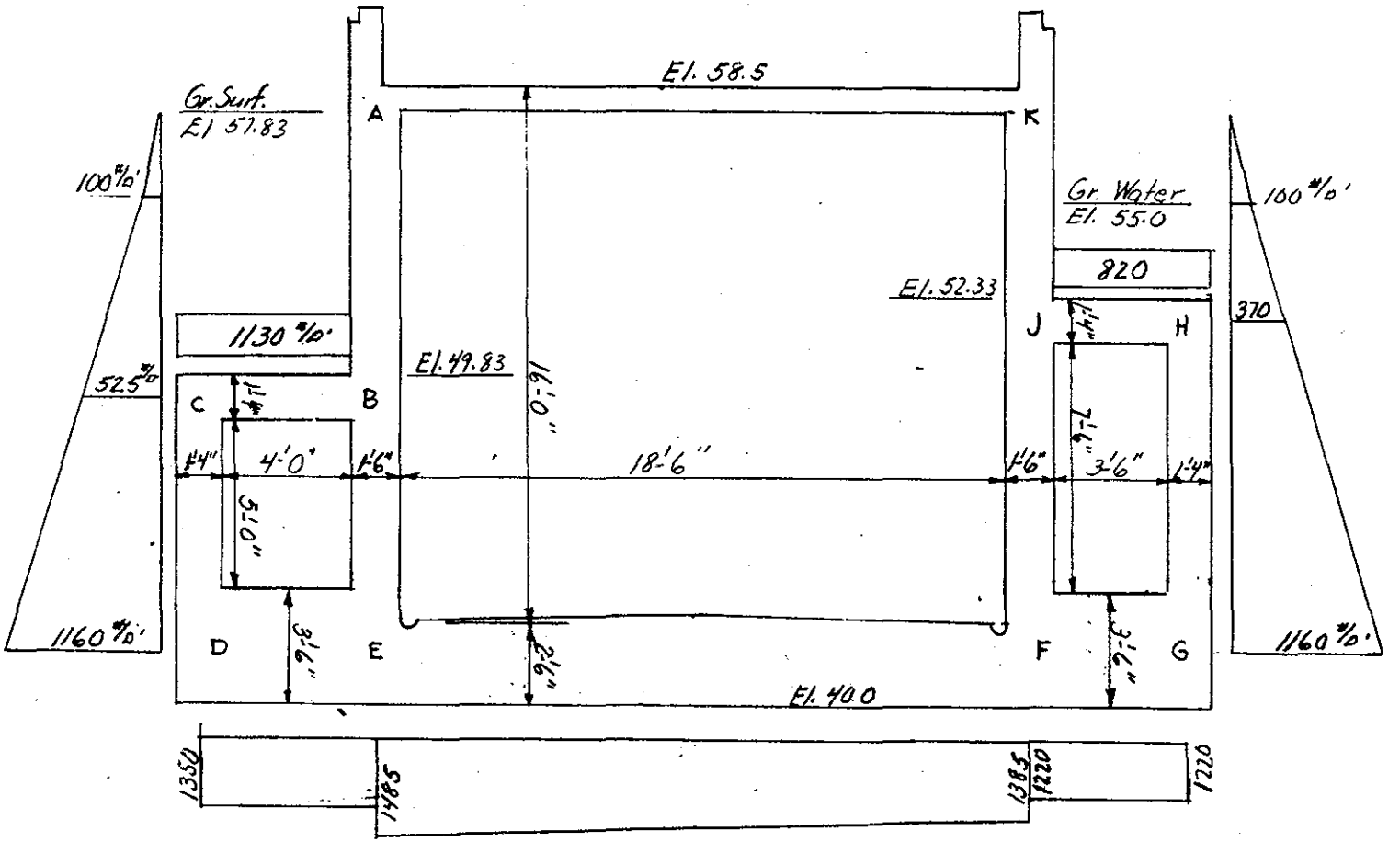


Section A-A

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station
Computation Transverse Section B-B
Computed by H.C.W. **Checked by** **Date** 15 May - 45

Section B-B
Case I



WAR DEPARTMENT

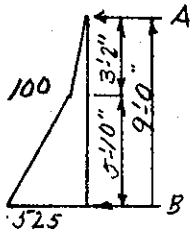
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station
Computation Transverse Section B-B
Computed by H.E.W. **Checked by** **Date** 15-May-45

Horiz. Thrust at El. 41.75 = 100 + 13.25 x 80 = 1160 #/o'
" " " El. 49.17 = 100 + 5.83 x 80 = 525 #/o'
Load on Intake Cond. Roof = 100x8 + 5.17x25 + 1.33x150 = 1130 #/o'
Base Pres at D = 1885 - 3.5x150 = 1360 } use ave 1350 #/o'
" " " E = 1860 - 3.5x150 = 1335
" " " E = 1860 - 2.5x150 = 1485
" " " F = 1760 - 2.5x150 = 1385
" " " F = 1760 - 3.5x150 = 1235 } Use ave of 1220 #/o'
" " " G = 1735 - 3.5x150 = 1210

Fixed End Moments

Member AB



$$M^F_{AB} = \frac{.352\,(10-15\times.352+6\times.352^2)}{15}\times\frac{100\times3.17}{2}\times9 + \frac{.648^2(4-3\times.648)}{12}\times100\times5.83\times9$$

$$+\frac{.648^2(5-3\times.648)}{36}\times\frac{425\times5.83}{2}\times9 = 1.04'^k$$

$$M^F_{BA} = \frac{.352^2(5-4\times.352)}{10}\times\frac{100\times3.17}{2}\times9 + \frac{.648(6-8\times.648+3\times.648^2)}{12}\times100\times5.83\times9$$

$$+\frac{.648(10-10\times.648+3\times.648^2)}{30}\times\frac{425\times5.83\times9}{2} = 1.80'^k$$

Member BC

$$M^F_{BC} = M^F_{CB} = \frac{1}{12}\times1130\times5.42^2 = 2.77'^k$$

Member CD

$$M^F_{CD} = \frac{1}{12}\times525\times7.42^2 + \frac{1}{15}\times635\times\frac{7.42^2}{2} = 3.58'^k$$

$$M^F_{DC} = \frac{1}{12}\times525\times7.42^2 + \frac{1}{10}+635\times\frac{7.42^2}{2} = 4.16'^k$$

Member DE

$$M^F_{DE} = \frac{1}{12}\times1350\times5.42^2 = 3.30'^k$$

Member EF

$$M^F_{EF} = \frac{1}{12}\times1385\times20^2 + \frac{1}{10}\times100\times\frac{20^2}{2} = 48.17'^k$$

$$M^F_{FE} = \frac{1}{12}\times1385\times20^2 + \frac{1}{15}\times100\times\frac{20^2}{2} = 47.50'^k$$

Member FG

$$M^F_{FG} = M^F_{GF} = \frac{1}{12}\times1220\times4.92^2 = 2.46'^k$$

Member GH

$$M^F_{GH} = \frac{1}{12}\times370\times9.92^2 + \frac{1}{10}\times790\times\frac{9.92^2}{2} = 6.92'^k$$

$$M^F_{HG} = \frac{1}{12}\times370\times9.92^2 + \frac{1}{15}\times790\times\frac{9.92^2}{2} = 5.62'^k$$

Members HJ + JK see Sect. A-A

WAR DEPARTMENT

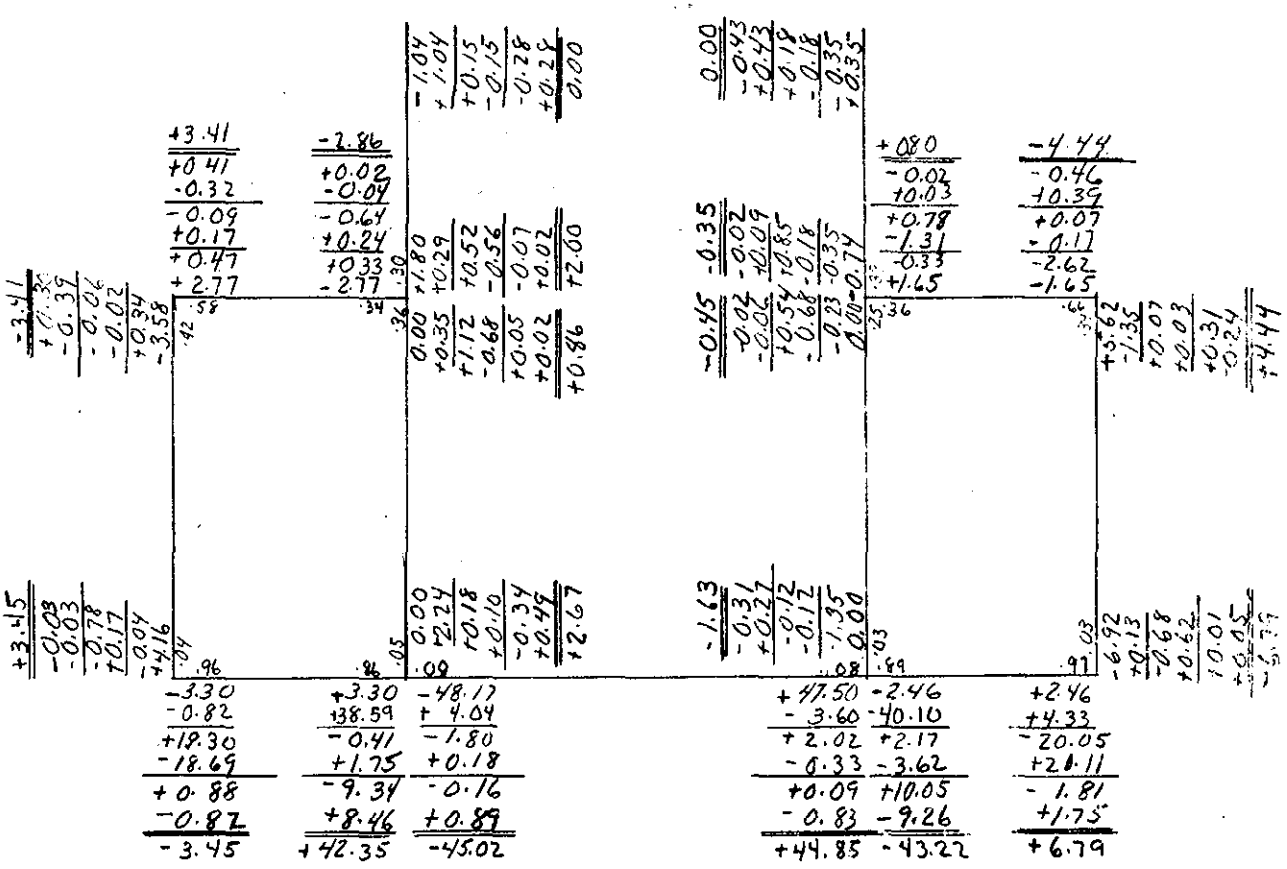
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station
Computation Transverse Section B-B
Computed by H.E.W. **Checked by** **Date** 17-May-45

Case I (cont.)

Stiffness

Member	d	d^3	L	d^3/L	K
AB	18	5832	108	54.00	1.57
BC	16	4096	65	63.02	1.83
CD	16	4096	89	46.02	1.34
DE	42	74088	65	1139.82	33.12
EB	18	5832	89	65.53	1.90
EF	30	27000	240	112.50	3.27
FG	42	74088	59	1255.73	36.48
GH	16	4096	119	34.42	1.00
HJ	16	4096	59	69.42	2.02
JK	18	5832	78	74.77	2.17
JF	18	5832	119	49.01	1.42



Subject Springdale Pumping Station

Computation Transverse Section B-B

Computed by H. E. W. **Checked by** **Date** 18-May-45

Case I End Reactions & Pos Moments cont.

Member HG

$H_G = 370 \times 9.92 \times .5 + 790 \times \frac{9.92}{2} \times .67 + \frac{2350}{9.92} = 4700^{\#}$

$H_H = 370 \times 9.92 \times .5 + 790 \times \frac{9.92}{2} \times .33 - \frac{2350}{9.92} = 2890^{\#}$

$x_0 = 5.0'$ from H_H

$M = 2890 \times 5 - 370 \times \frac{5^2}{2} - 400 \times \frac{5^2}{6} - 4440 = 3720^{\#}$

Member JH

$V_H = 820 \times 4.92 \times .5 + \frac{3640}{4.92} = 2760$

$V_J = 820 \times 4.92 \times .5 - \frac{3640}{4.92} = 1280$

$x_0 = \frac{2760}{820} = 3.37'$ from H

$M = 2760 \times 3.37 - 820 \times \frac{3.37^2}{2} - 4440 = 200'^{\#}$

Member JK

$H_K = 100 \times 3.17 \times .5 \times \frac{4.39}{6.5} + 100 \times 3.33 \times \frac{1.67}{6.5} + 270 \times 3.33 \times .5 \times \frac{1.11}{6.5} - \frac{350}{6.5} = 220^{\#}$

$H_J = 100 \times 3.17 \times .5 \times \frac{2.11}{6.5} + 100 \times 3.33 \times \frac{4.83}{6.5} + 270 \times 3.33 \times .5 \times \frac{5.39}{6.5} + \frac{350}{6.5} \quad 730^{\#}$

$x_0 = 3.7'$ from

$M = 220 \times 4.7 - 100 \times 3.17 \times .5 \times 1.59 - 100 \times \frac{.53^2}{2} - 42 \times \frac{.53^2}{6} = 860'^{\#}$

Member JF

$H_J = \frac{2080}{9.92} = 210^{\#} \leftarrow \qquad H_F \quad 210^{\#} \rightarrow$

Member BE

$H_B = \frac{3530}{7.42} = 480^{\#} \rightarrow \qquad H_E \quad 480^{\#} \leftarrow$

Subject Springdale Pumping Station
Computation Transverse Section B-B
Computed by H.E.W. **Checked by** ______ **Date** 19-May-45

Case I (cont.)
Joint Deflection of Joints B & C

Assume Joints C & B will deflect inward .01 inches

Member AB

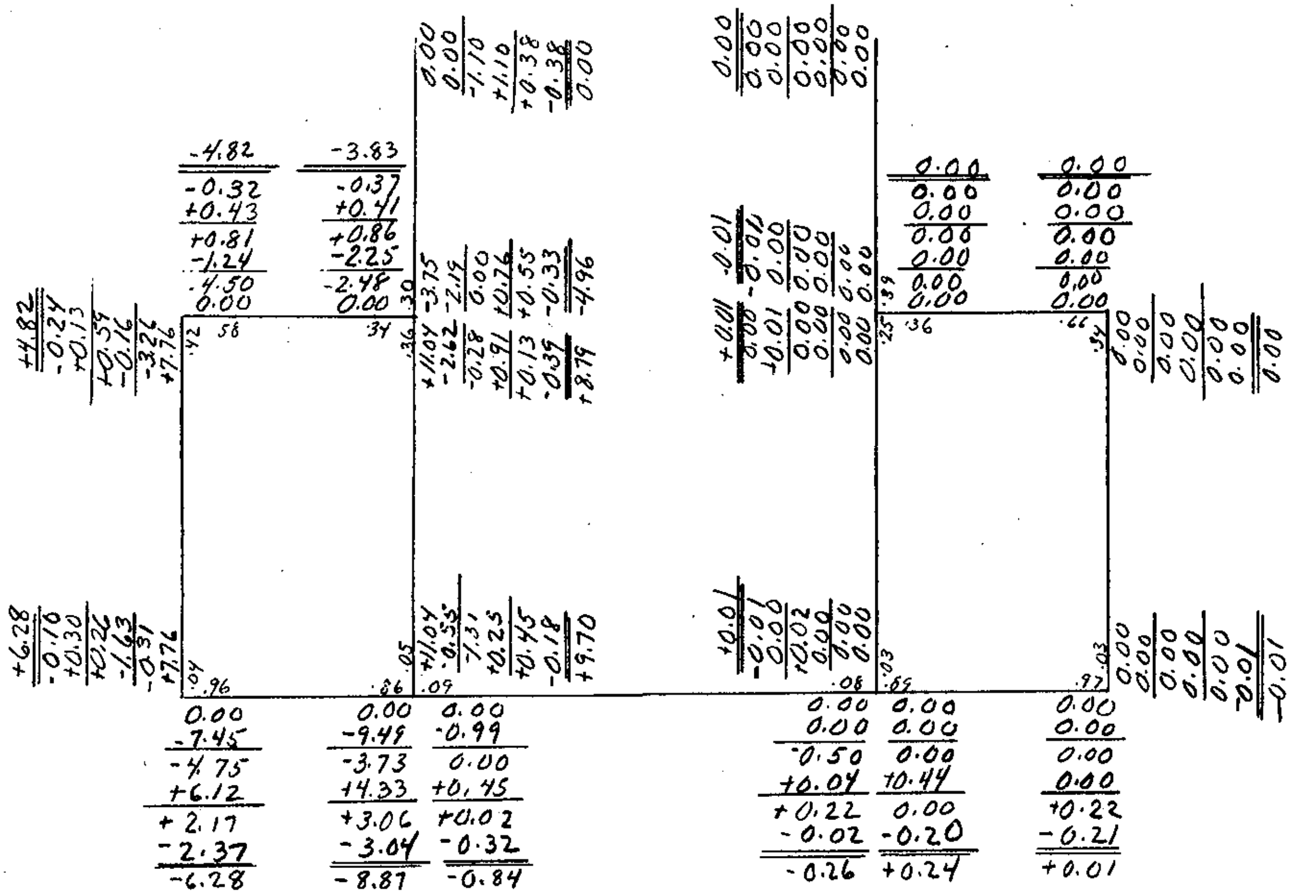
$$M = \frac{3 \times 3{,}000{,}000 \times 5832 \times .01}{108 \times 108 \times 12 \times 1000} = 3.75^{'K}$$

Member BE

$$M = \frac{6 \times 3{,}000{,}000 \times 5832 \times .01}{89 \times 89 \times 12 \times 1000} = 11.04^{'K}$$

Member CD

$$M = \frac{6 \times 3{,}000{,}000 \times 4096 \times .01}{89 \times 89 \times 12 \times 1000} = 7.76^{'K}$$



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station
Computation Transverse Section B-B
Computed by H.E.W. **Checked by** **Date** 21-May-45

Case I Joint Defl. cont.

Member AB

$H_B = \frac{4960}{9.0} = 552$

Member BE

$H_B = \frac{18490}{7.42} = 2493$

Mom. Mult. $= \frac{3810}{4540} = .839$

Member CD

$H_C = \frac{11100}{7.42} = \frac{1496}{4540\#}$

Moment due to joint deflection will be combined with original moments to produce a maximum, only where it increases the moment or causes a reversal.

Maximum Moments at Joints

Member	Dist. Mom.	Defl. Moment	Max. Mom.
AB @ A	0.00	0.00 x .839 = 0	0
@ B	+2.00	-4.96 x .839 = -4.16	+2.00 + -2.96
BC @ B	-2.86	-3.83 x .839 = -3.21	-6.07
@ C	+3.41	-4.82 x .839 = -4.04	+3.41 + -0.63
CD @ C	-3.41	+4.82 x .839 = +4.04	-3.41 + +0.63
@ D	+3.45	+6.28 x .839 = +5.27	+ 8.72
DE @ D	-3.45	-6.28 x .839 = -5.27	- 8.72
@ E	+42.35	-8.87 x .839 = -7.44	+42.35
EF @ E	-45.02	-0.84 x .839 = -0.70	- 45.72
@ F	+44.85	-0.26 x .839 = -0.22	+ 44.85
FG @ F	-43.22	+0.24 x .839 = +0.20	- 43.22
@ G	+6.79	+0.01 x .839 = 0	+ 6.79
GH @ G	-6.79	-0.01 x .839 = 0	- 6.79
@ H	+4.44	0.00 x .839 = 0	+4.44
HJ @ H	-4.44	0.00 x .839 = 0	- 4.44
@ J	+0.80	0.00 x .839 = 0	+0.80
JK @ J	-0.35	-0.01 .839 = 0	-0.35
@ K	0.00	0.00 x .839 = 0	0.00
JF @ J	-0.45	+0.01 x .839 = 0	-0.45
@ F	-1.63	+0.01 x .839 = 0	-1.63
BE @ B	+0.86	+8.79 x .839 = +7.37	+ 8.23
@ E	+2.67	+9.70 x .839 = +8.14	+10.81

Subject Springdale Pumping Station
Computation Transverse Section B-B
Computed by H.E.W. **Checked by** **Date** 21-May-45

Case I - (cont.)
End Reactions due to Joint Deflection

Member AB

$H_A = \frac{4160}{9} = 460^{\#} \leftarrow \qquad H_B = 460^{\#} \rightarrow$

Member BC

$V_B = \frac{7250}{5.42} = 1340^{\#} \uparrow \qquad V_C = 1340^{\#} \downarrow$

Member CD

$H_C = \frac{9310}{7.42} = 1250^{\#} \rightarrow \qquad H_D = 1250^{\#} \leftarrow$

Member DE

$V_D = \frac{12710}{5.42} = 2350^{\#} \downarrow \qquad V_E \; 2350^{\#} \uparrow$

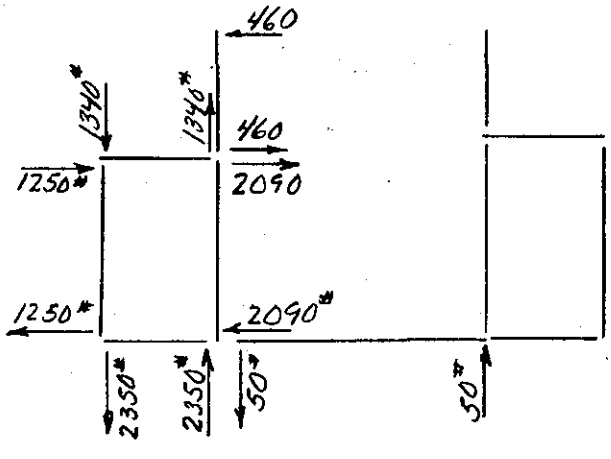
Member EF

$V_E \; \frac{920}{20} = 50^{\#} \downarrow \qquad V_F = 50^{\#} \uparrow$

Member BE

$H_B = \frac{15510}{7.42} = 2090^{\#} \rightarrow \qquad H_E = 2090^{\#} \leftarrow$

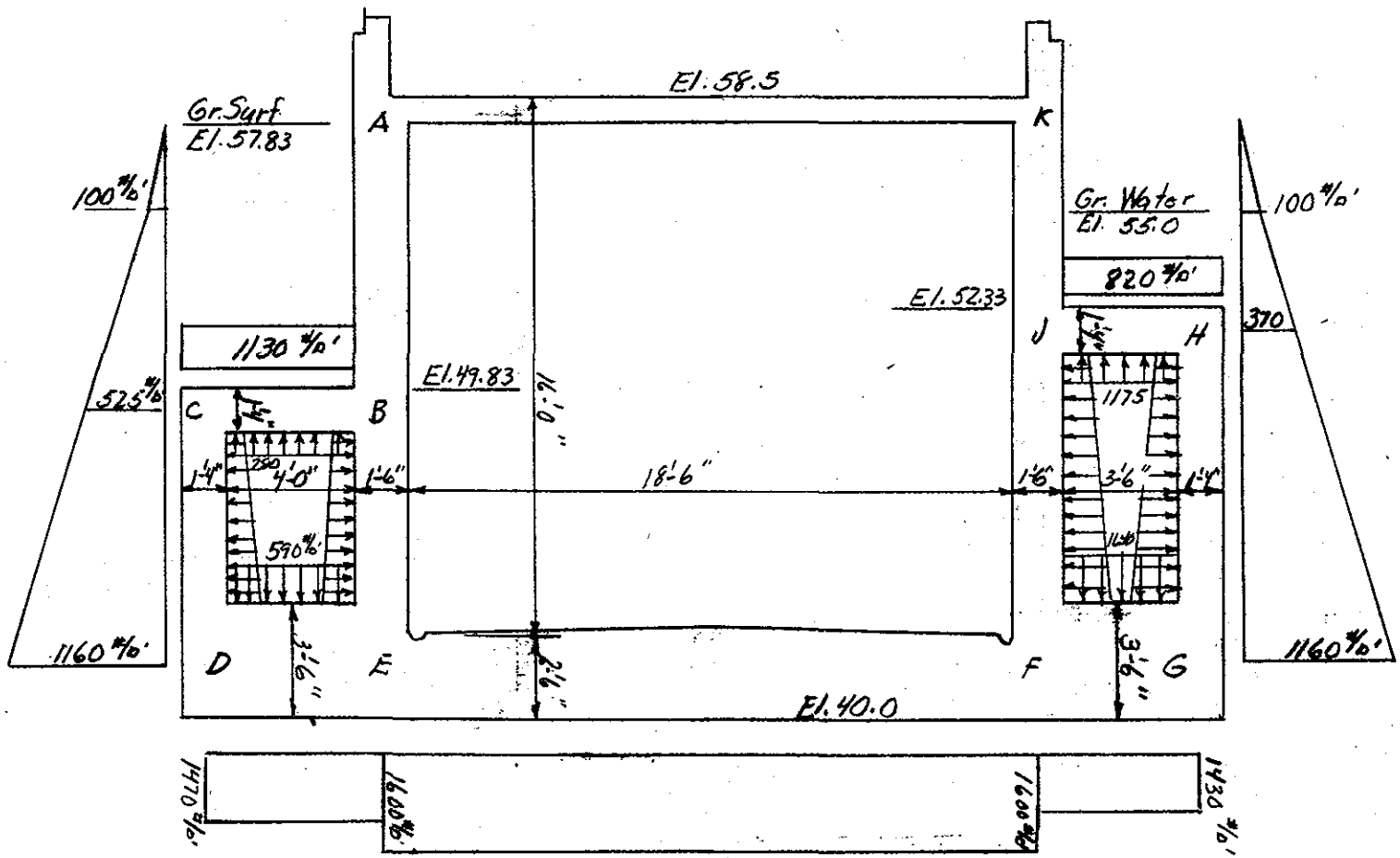
End Reaction Diagram for Joint Defl.



WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Springdale Pumping Station
Computation: Transverse Section B-B
Computed by: H.E.W. Checked by: Date: 22-May-45

Section B-B
Case II



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station
Computation Transverse Section B-B
Computed by H.E.W **Checked by** **Date** 22 May-45

Case II

Base Pressure at D = 2000 - 3.5 x 150 = 1470 #/□' } use 1470 #/□'
" " at E = 1990 - 3.5 x 150 = 1460 #/□'
" " " E = 1990 - 2.5 x 150 = 1616 #/□' } use 1600 #/□'
" " " F = 1970 - 2.5 x 150 = 1590 #/□'
" " " F = 1970 - 3.5 x 150 = 1430 #/□' } use 1430 #/□'
" " " G = 1960 - 3.5 x 150 = 1420 #/□'

Intake Cond Water Pressure at El 48.5 = 4.5 x 62.5 = 280 #/□'
" " " " " El. 43.5 = 9.5 x 62.5 = 590 #/□'

Fixed End Moments

Member AB

$M^F_{AB} = 1.04^{'k}$ $M^F_{BA} = 1.80^{'k}$ (See Case I)

Member BC

$M^F_{BC} = M^F_{CB} = \frac{1}{12} \times 850 \times 5.42^2 = 2.08^{'k}$

Member BE

$M^F_{BE} = \frac{1}{12} \times 280 \times 7.42^2 + \frac{1}{15} \times 310 \times \frac{7.42^2}{2} = 1.85^{'k}$

$M^F_{EB} = \frac{1}{12} \times 280 \times 7.42^2 + \frac{1}{10} \times 310 \times \frac{7.42^2}{2} = 2.13^{'k}$

Member CD

$M^F_{CD} = 3.58 - 1.85 = 1.73^{'k}$

$M^F_{DC} = 4.16 - 2.13 = 2.03^{'k}$

Member DE

$M^F_{DE} = M^F_{ED} = \frac{1}{12} \times 880 \times 5.42^2 = 2.15^{'k}$

Member EF

$M^F_{EF} = M^F_{FE} = \frac{1}{12} \times 1600 \times 20^2 = 53.33^{'k}$

Member FG

$M^F_{FG} = M^F_{GF} = \frac{1}{12} \times 210 \times 4.92^2 = 0.42^{'k}$

Member FJ

$M^F_{JF} = \frac{1}{12} \times 1175 \times 9.92^2 + \frac{1}{15} \times 465 \times \frac{9.92^2}{2} = 11.16^{'k}$

$M^F_{FJ} = \frac{1}{12} \times 1175 \times 9.92^2 + \frac{1}{10} \times 465 \times \frac{9.92^2}{2} = 11.92^{'k}$

Member HG

$M^F_{GH} = -6.92 + 11.92 = 5.00^{'k}$ $M^F_{HG} = -5.62 + 11.16 = 5.54^{'k}$

Member HJ

$M^F_{HJ} = M^F_{JH} = 0.72^{'k}$ (see Sect. A-A)

Member JK

$M^F_{JK} = 0.74$ $M^F_{KJ} = 0.35$ (See Sect. A-A)

WAR DEPARTMENT

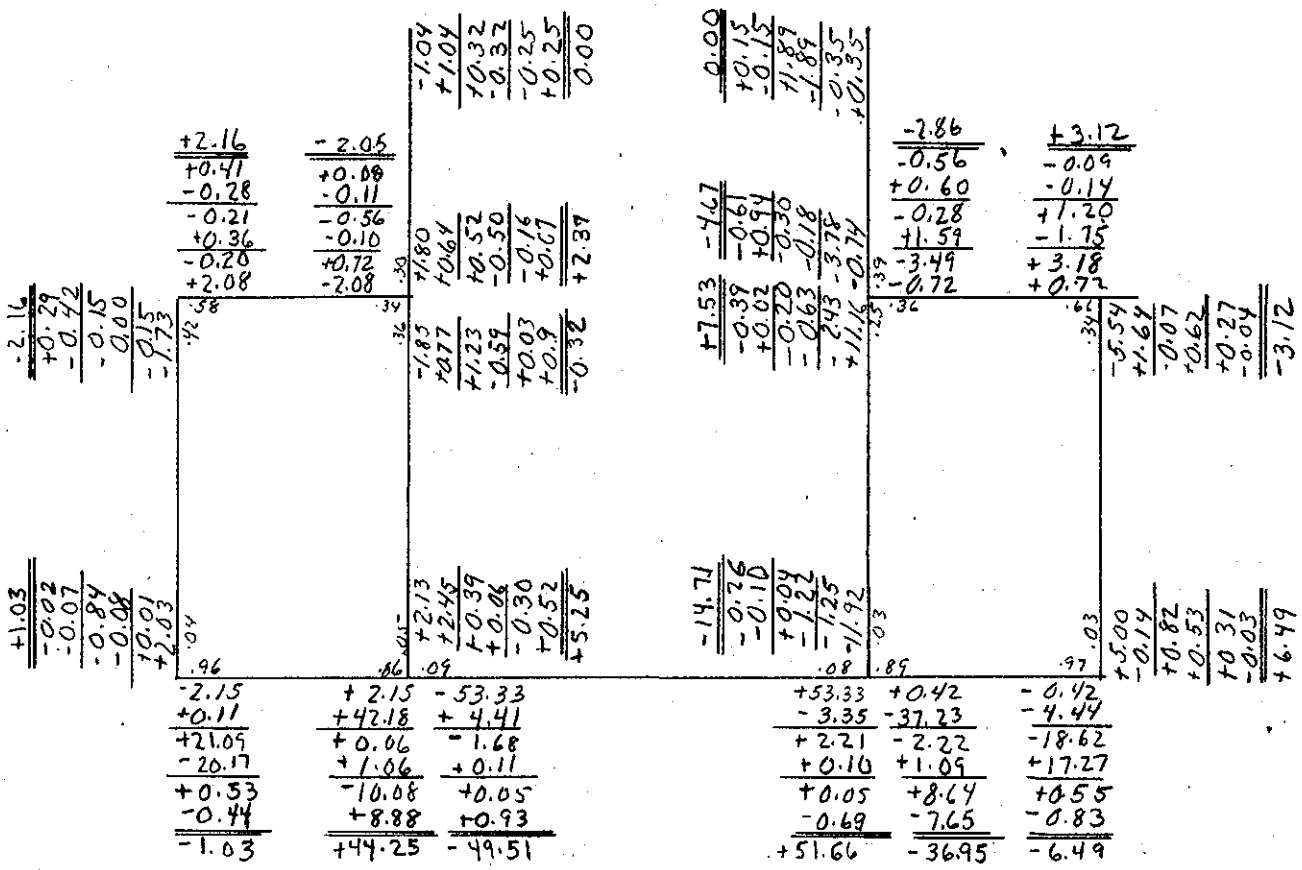
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station

Computation Transverse Section B-B

Computed by H. E. W. **Checked by** **Date** 22-May-45

Case II (cont.)



End Reactions and Center Moments

Member AB

$$H_A = 100 \times 3.17 \times .5 \times \frac{6.89}{9.0} + 100 \times 5.83 \times \frac{2.92}{9} + 425 \times \frac{5.83}{2} \times \frac{1.94}{9} - \frac{2370}{9} = 320^{\#}$$

$$H_B = 100 \times 3.17 \times .5 \times \frac{2.11}{9} + 100 \times 5.83 \times \frac{6.08}{9} + 425 \times \frac{5.83}{2} \times \frac{7.06}{9} + \frac{2370}{9} = 1620^{\#}$$

$x_0 = 4.40'$ from A

$$M = 320 \times 4.4 - 100 \times 3.17 \times .5 \times 2.29 - 100 \times \frac{1.23^2}{2} - 98 \times \frac{1.23^2}{6} = 940'^{\#}$$

Member BC

$$V_B = 850 \times 5.42 \times .5 - \frac{110}{5.42} = 2280^{\#}$$

$$V_C = 850 \times 5.42 \times .5 + \frac{110}{5.42} = 2320^{\#}$$

$x_0 = 2.68'$ from B

$$M = 2280 \times 2.68 - 850 \times \frac{2.68^2}{2} - 2,050 = 10'^{\#}$$

Case II - End Reactions and Center Moments (cont.)

Member CD

$H_C = 245 \times 7.42 \times .5 + 325 \times 7.42 \times .5 \times .33 + \frac{1130}{7.42} = 1460^{\#}$

$H_D = 245 \times 7.42 \times .5 + 325 \times 7.42 \times .5 \times .67 - \frac{1130}{7.42} = 1570^{\#}$

$x_0 = 4.3'$ from C

$M = 1460 \times 4.3 - 245 \times \frac{4.3^2}{2} - 188 \times \frac{4.3^2}{6} - 2160 = 270'^{\#}$

Member BE

$H_B = 280 \times 7.42 \times .5 + 310 \times 7.42 \times .5 \times .33 - \frac{4930}{7.42} = 760^{\#}$

$H_E = 280 \times 7.42 \times .5 + 310 \times 7.42 \times .5 \times .67 + \frac{4930}{7.42} = 2470^{\#}$

$x_0 = 2.3'$ from B

$M = 760 \times 2.3 - 320 - 280 \times \frac{2.3^2}{2} - 100 \times \frac{2.3^2}{6} = 600'^{\#}$

Member DE

$V_D = 880 \times 5.42 \times .5 - \frac{43220}{5.42} = -5590^{\#}$

$V_E = 880 \times 5.42 \times .5 + \frac{43220}{5.42} = 10360^{\#}$

No center Moment

Member EF

$V_E = 1600 \times 20 \times .5 - \frac{2150}{20} = 15890^{\#}$

$V_F = 1600 \times 20 \times .5 + \frac{2150}{20} = 16110^{\#}$

$x_0 = 9.93'$ from E

$M = 15890 \times 9.93 - 49,510 - 1600 \times \frac{9.93^2}{2} = 29350'^{\#}$

Member FG

$V_F = 210 \times 4.92 \times .5 + \frac{43440}{4.92} = 9350^{\#} \downarrow$

$V_G = 210 \times 4.92 \times .5 - \frac{43,440}{4.92} = 8310^{\#} \uparrow$

No Center Moment

Member GH

$H_G = 480 \times 9.92 \times .5 + 325 \times 9.92 \times .5 \times .33 + \frac{3370}{9.92} = 3250^{\#}$

$H_H = 480 \times 9.92 \times .5 + 325 \times 9.92 \times .5 \times .67 - \frac{3370}{9.92} = 3120^{\#}$

$x_0 = 5.6'$ from G

$M = 3250 \times 5.6 - 6490 - 480 \times \frac{5.6^2}{2} - 184 \times \frac{5.6^2}{6} = 3220'^{\#}$

Case II End Reactions and Center Moments (cont.)

Member JH.

$V_H = 355 \times 4.92 \times .5 + \frac{260}{4.92} = 930^{\#}$

$V_J = 355 \times 4.92 \times .5 - \frac{260}{4.92} = 820^{\#}$

$x_0 = 2.62'$ from H

$M = 930 \times 2.62 - 3120 - 355 \times \frac{2.62^2}{2} = -1900'^{\#}$

Member KJ

$H_J = 100 \times 3.17 \times .5 \times \frac{2.11}{6.5} + 100 \times 3.33 \times \frac{4.83}{6.5} + 270 \times 3.33 \times .5 \times \frac{5.39}{6.5} + \frac{4670}{6.5} = 1390^{\#}$

$H_K = 100 \times 3.17 \times .5 \times \frac{4.39}{6.5} + 100 \times 3.33 \times \frac{1.67}{6.5} + 270 \times 3.33 \times .5 \times \frac{1.11}{6.5} - \frac{4670}{6.5} = 450^{\#} \leftarrow$

No Center Mom.

Member JF

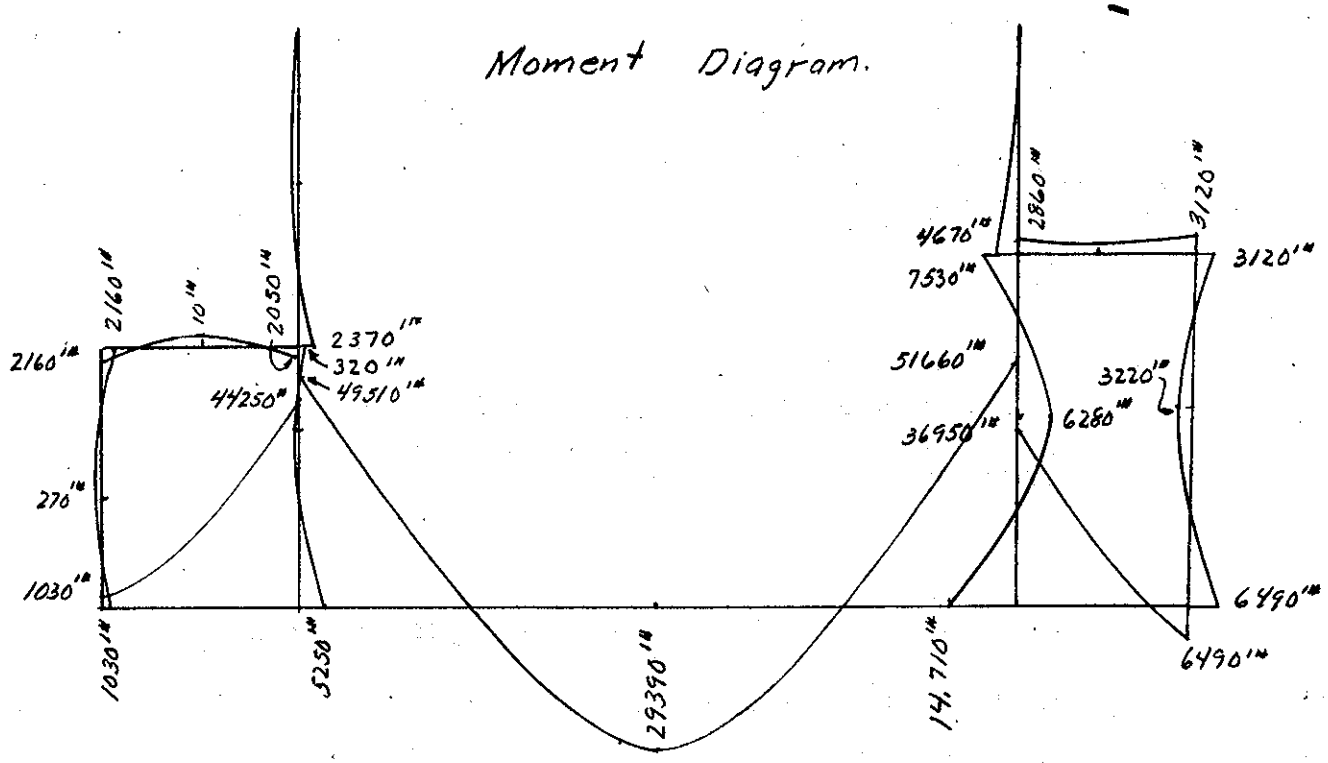
$H_J = 1175 \times 9.92 \times .5 + 465 \times 9.92 \times .5 \times .33 - \frac{7180}{9.92} = 5870^{\#}$

$H_F = 1175 \times 9.92 \times .5 + 465 \times 9.92 \times .5 \times .67 + \frac{7180}{9.92} = 8100^{\#}$

$x_0 = 4.5'$ from J

$M = 5870 \times 4.5 - 7530 - 1175 \times \frac{4.5^2}{2} - 211 \times \frac{4.5^2}{6} = 6280'^{\#}$

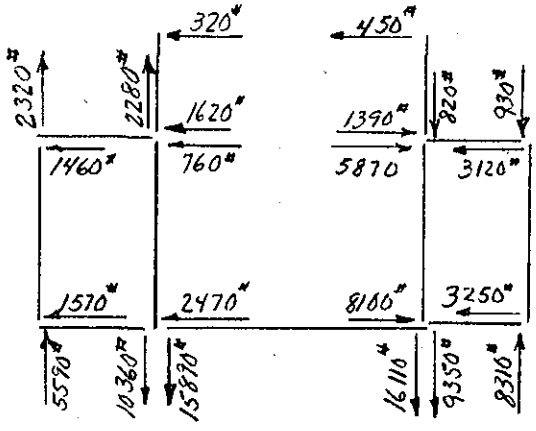
Moment Diagram.



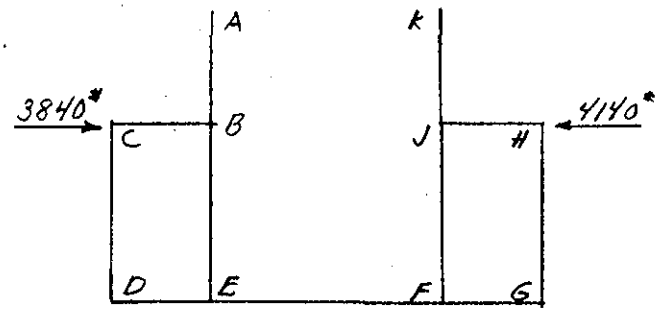
Subject Springdale Pumping Station
Computation Transverse Section B-B
Computed by H.E.W. **Checked by** **Date** 23-May-45

Case II (cont.)

Reaction Diagram



Forces Producing Joint Deflection



For deflection of Joints C + B use Case I values
Deflection of Joints J + H will be taken care of by beam action in roof J H

Maximum Moments at Joints

Member	Dist. Mom.	Defl. Moment	Max. Mom.
AB @ A	0	0	0
@ B	+2.37	-4.16	+2.37 + - 1.79
BC @ B	-2.05	-3.21	- 5.26
@ C	+2.16	-4.04	+2.16 + -1.88
CD @ C	-2.16	+4.04	-2.16 +1.88
@ D	+1.03	+5.27	+ 6.30
DE @ D	-1.03	-5.27	- 6.30
@ E	+44.25	-7.44	+44.25
EF @ E	-49.51	-0.70	- 50.21
@ F	+51.66	-0.22	+ 51.66
FG @ F	-36.95	+0.20	- 36.95
@ G	-6.49	0	-6.49
GH @ G	+6.49	0	+6.49
@ H	-3.12	0	-3.12
HJ @ H	+3.12	0	+3.12
@ J	-2.86	0	-2.86
JK @ J	-4.67	0	-4.67
@ K	0	0	0
JF @ J	+7.53	0	+7.53
@ F	-14.71	0	-14.71
BE @ B	-0.32	+7.37	+ 7.05 - 0.32
@ E	+5.25	+8.14	+13.39

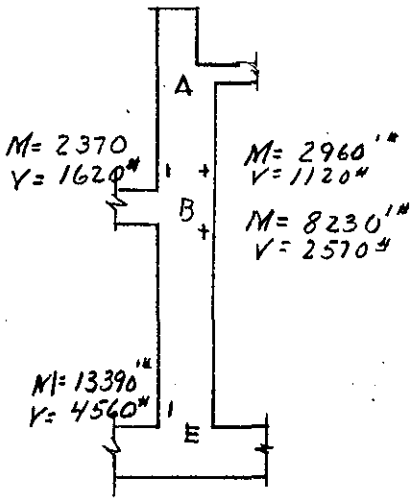
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station
Computation Transverse Section B-B
Computed by H.E.W. **Checked by** **Date** 23-May-45

Design of Members

Wall A,B,E



req'd $d = \sqrt{\frac{13390}{147}} = 9.5'' < 14.5''$

$v = \frac{4560}{12 \times .88 \times 14.5} = 30\ \#/\square''$

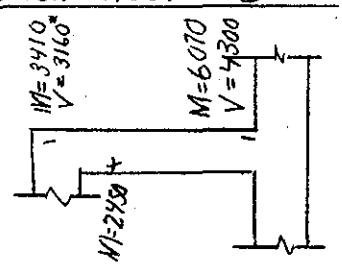
$-A_s$ @ E $= \frac{13{,}390 \times 12}{18000 \times .88 \times 14.5} = .70\ \square''$ Use 1"⌀ @ 12"cc

$u_0 = \frac{4560}{3.1 \times .88 \times 14.5} = 115\ \#/\square''$ OK

$-A_s$ @ B $= \frac{2370 \times 12}{18000 \times .88 \times 14.5} = .12\ \square''$ Use 3/4"⌀ @ 12"cc

$+A_s = \frac{8230 \times 12}{18000 \times .88 \times 14.5} = .43\ \square''$ Use 3/4"⌀ @ 12"cc

Cond. Roof BC



Max +M when M@C = 1880'# + V = 980#
x_0 = 1.15' from C

$M = 980 \times 1.15 + 1880 - 850 \times \frac{1.15^2}{2} = 2450'\#$

req'd $d = \sqrt{\frac{6070}{147}} = 6.4'' < 12.5''$

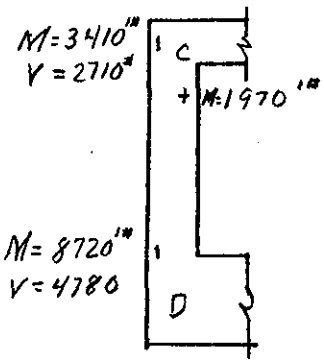
$v = \frac{4300}{12 \times .88 \times 12.5} = 33\ \#/\square''$

$-A_s = \frac{6070 \times 12}{18000 \times .88 \times 12.5} = .37\ \square''$ Use 3/4"⌀ @ 12"cc

$u_0 = \frac{4300}{2.4 \times .88 \times 12.5} = 163\ \#/\square''$

$+A_s = \frac{2450 \times 12}{18000 \times .88\ 12.5} = .15\ \square''$ Use 5/8"⌀ @ 1'-0"cc

Wall CD



Max +M when M@C = 1880'# + V = 210#
x_0 = 0.8 from C

$M = 210 \times 0.8 + 1880 - 245 \times \frac{.8^2}{2} - 35 \times \frac{.8^2}{6} = 1970'\#$

req'd $d = \sqrt{\frac{8720}{147}} = 7.7'' < 12.5''$ OK

$-A_s = \frac{8720 \times 12}{18000 \times .88 \times 12.5} = .53\ \square''$ Use 7/8"⌀ @ 1'-0"cc

$u_0 = \frac{4780}{2.8 \times .88 \times 12.5} = 155\ \#/\square''$

$-A_s = \frac{3410 \times 12}{18000 \times .88 \times 12.5} = .21\ \square''$ Use 5/8"⌀ @ 1'-0"cc

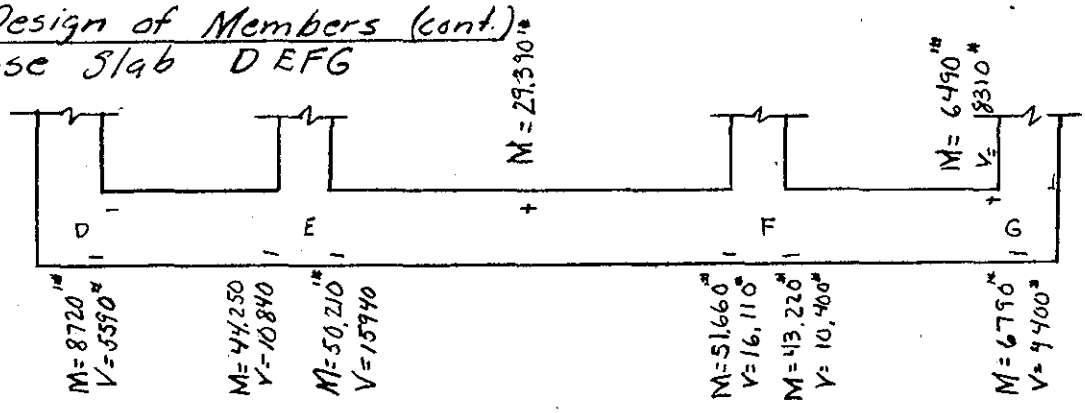
$u_0 = \frac{2710}{1.96 \times .88 \times 12.6} = 125\ \#/\square''$ OK

$+A_s$ Use 5/8"⌀ @ 1'-0"cc

Subject Springdale Pumping Station
Computation Transverse Section B-B
Computed by H.E.W **Checked by** **Date** 24 May-45

Design of Members (cont.)

Base Slab DEFG



req'd $d = \sqrt{\frac{51,660}{147}} = 18.7" < 23.0"$

$v = \frac{16110}{12 \times .88 \times 23.0} = 66$ #/□"

Use d = 23.0" for -As in EF
" d = 22.5" for +As in EF
Use d = 37.5" " -As in DE+FG
Use d = 38.5" for +As in DE+FG

$-As @ E = \frac{50210 \times 12}{18000 \times .88 \times 23} = 1.38$ □" Use 1"ϕ @ 6"cc

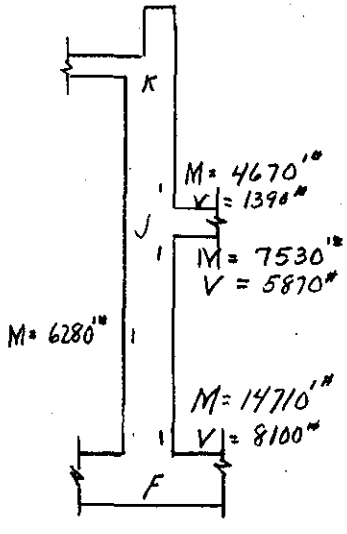
$u_0 = \frac{15940}{63 \times .88 \times 23} = 125$ #/□"

$-As @ F = \frac{51,660 \times 12}{18,000 \times .88 \times .23} = 1.42$ □" Use 1"ϕ @ 6"cc

$+As = \frac{29390 \times 12}{18000 \times .88 \times 22.5} = .99$ □" Use 1"ϕ @ 9"cc.

$+As = \frac{6490 \times 12}{18000 \times .88 \times 38.5} = .13$ □" Use 7/8"ϕ @ 12"cc for temp. reasons

Wall F J K



req'd $d = \sqrt{\frac{14710}{147}} = 10" < 14.5"$

$v = \frac{8100}{12 \times .88 \times 14.5} = 53$ #/□"

$-As @ F = \frac{14710 \times 12}{18000 \times .88 \times 14.5} = .77$ □" Use 1"ϕ @ 12"cc

$u_0 = \frac{8100}{4.7 \times .88 \times 14.5} = 135$ #/□"

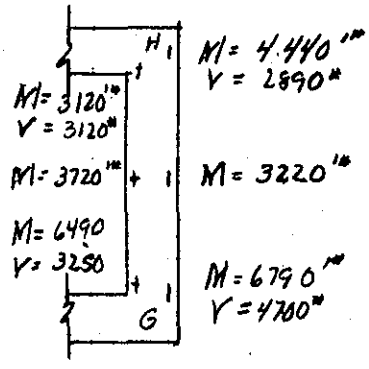
$-As @ J = \frac{7530 \times 12}{18000 \times .88 \times 14.5} = .39$ □" Use 3/4"ϕ @ 1'-0"cc

$u_0 = \frac{5870}{2.4 \times .88 \times 14.5} = 192$ #/□" OK special anchorage provided

$+As = \frac{6280 \times 12}{18000 \times .88 \times 15.5} = .31$ □" Use 3/4"ϕ @ 1'-0"cc

Subject Springdale Pumping Station
Computation Transverse Section B-B
Computed by H.E.W. **Checked by** **Date** 24-May-45

Design of Section (cont.)
Cond. Wall GH



Direct Tension = 8310#

$$\text{req'd } d = \sqrt{\frac{6790}{147}} = 6.8'' < 12.5''$$

$$v = \frac{4700}{12 \times .88 \times 12.5} = 36\ \#/\square''$$

$$-A_s \text{ @ } G = \frac{6790 \times 12}{18000 \times .88 \times 12.5} = .41\ \square'' \quad \text{Use } 3/4''\phi \text{ @ } 1'\text{-}0''_{cc}$$

$$u_o = \frac{4700}{2.4 \times .88 \times 12.5} = 178\ \#/\square''$$

$$-A_s \text{ @ } H = \frac{4440 \times 12}{18000 \times .88 \times 12.5} = .27\ \square'' \quad \text{Use } 3/4''\phi \text{ @ } 1'\text{-}0''_{cc}$$

$$M_s = M - \frac{d''}{12} N = 6490 - \frac{4.5}{12} \times 8310 = 3370'\#$$

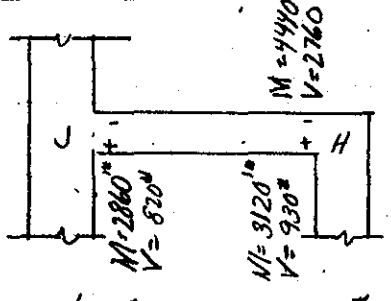
$$+A_s = \frac{12 M_s}{f_s j d} + \frac{N}{f_s} = \frac{12 \times 3370}{18000 \times .88 \times 12.5} + \frac{8310}{18000} = .66\ \square''$$

Use $3/4''\phi$ @ $8''_{cc}$

$$M_s = 3220 - \frac{4.5}{12} \times 8310 = 110'\#$$

$$A_s = \frac{12 \times 110}{18000 \times .88 \times 12.5} + \frac{8310}{18000} = .46\ \square'' \quad 3/4''\phi \text{ @ } 1'\text{-}0''_{cc} \text{ OK}$$

Cond. Roof HJ



Direct Tension = 7260#

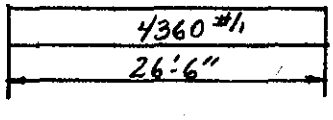
$$-A_s = \frac{4440 \times 12}{18000 \times .88 \times 12.5} = .27\ \square'' \quad \text{Use } 3/4''\phi \text{ @ } 1'\text{-}0''_{cc}$$

$$u_o = \frac{2760}{2.4 \times .88 \times 12.5} = 105\ \#/\square''$$

$$M_s = 3120 - \frac{4.5}{12} \times 7260 = 400'\#$$

$$+A_s = \frac{400 \times 12}{18000 \times .88 \times 12.5} + \frac{7260}{18000} = .42\ \square'' \quad \text{Use } 3/4''\phi \text{ @ } 1'\text{-}0''_{cc}$$

Horiz. Beam in Cond. Roof



$$V = 4360 \times \frac{26.5}{2} = 56680\#$$

$$M = \frac{1}{8} \times 4360 \times 26.5^2 = 382{,}730'\#$$

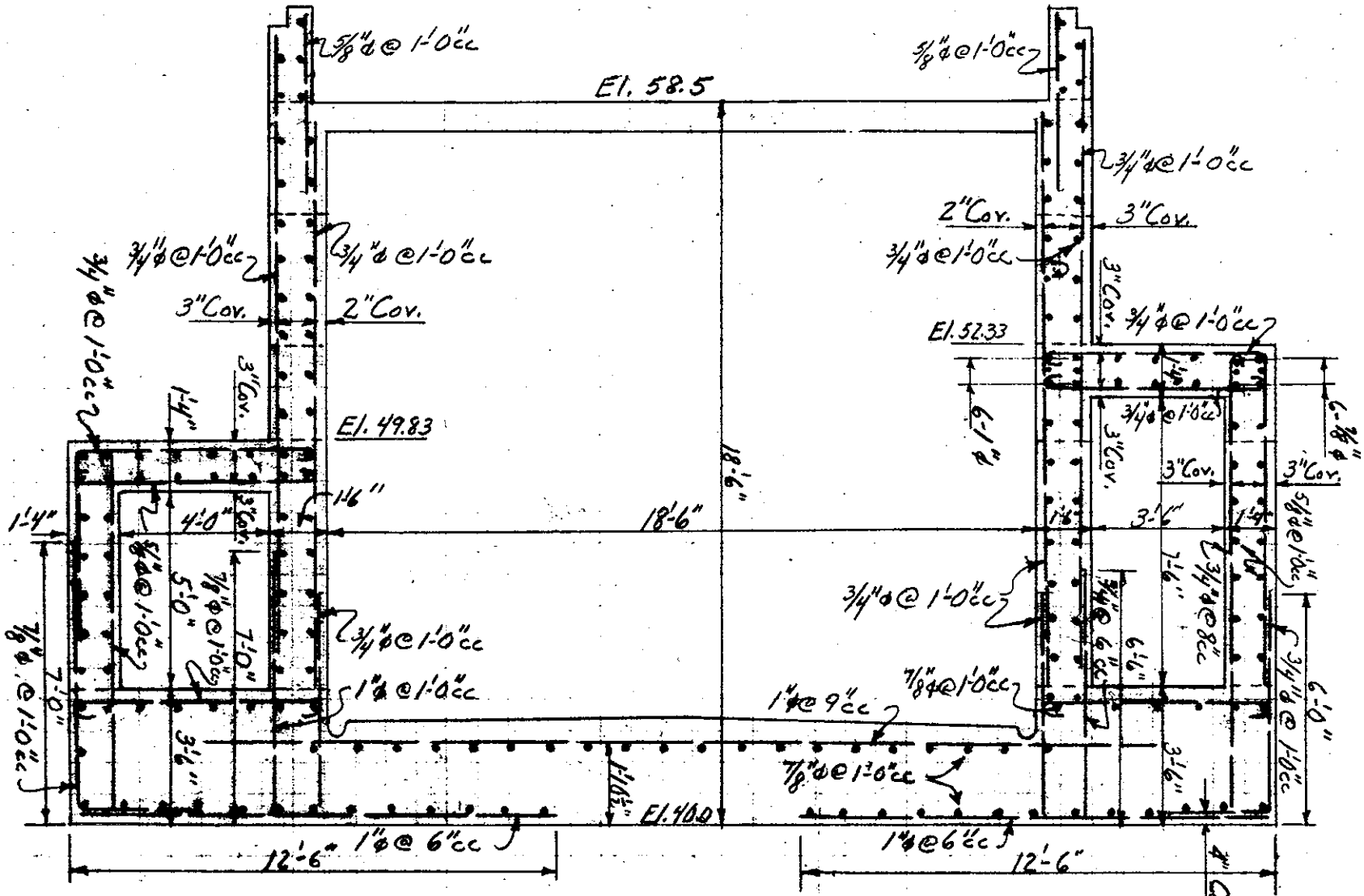
$$\text{req'd } d = \sqrt{\frac{382730}{123}} = 55.7'' < 67$$

$$v = \frac{56680}{16 \times .88 \times 67.0} = 60\ \#/\square''$$

$$A_s = \frac{382{,}730 \times 12}{18000 \times .88 \times 67.0} = 4.33\ \square'' \quad \text{Use } 6\text{-}1''\phi$$

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Springdale Pumping Station
Computation: Transverse Section B-B
Computed by: H.E.W. Checked by: Date: 25 May-45

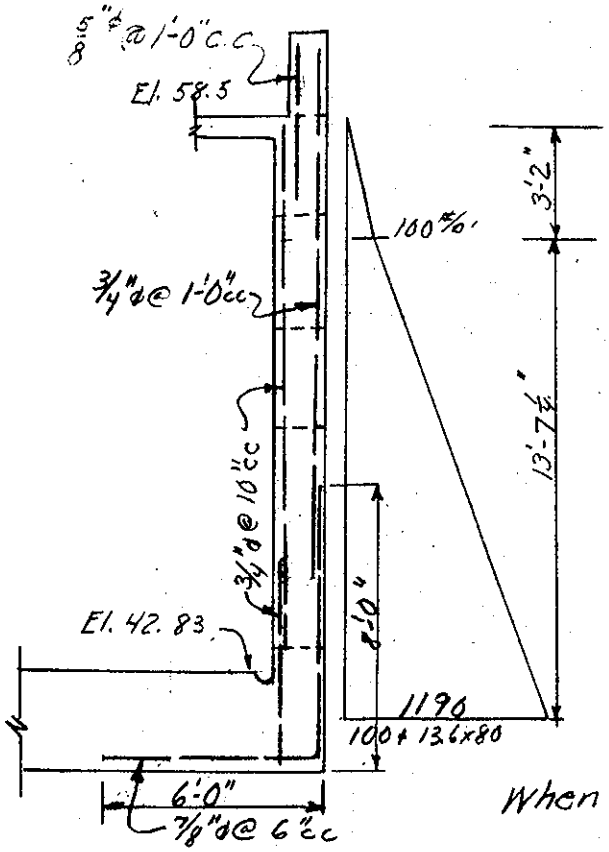


Section B-B

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station
Computation South End Wall
Computed by H. E. W. **Checked by** **Date** 24-May-45



For max. neg. mom. at the base, the wall will be considered fixed at the base.

For pos. mom. use a value 75 % of neg. mom. determined above for the neg. mom. at the base.

F.E.M. - Use same values as in Section A-A Member AB

Max. neg. Mat base = 16.19 + 4.89 = 21.08'^K

End React. not including Mom. effect

$$V_{Top} = 100 \times \frac{3.17}{2} \times \frac{14.66}{16.77} + 100 \times 13.6 \times \frac{6.8}{16.77} + 1090 \times \frac{13.6}{2} \times \frac{4.53}{16.77}$$

$$= 2690^{\#}$$

$$V_{Bot} = 100 \times \frac{3.17}{2} \times \frac{2.11}{16.77} + 100 \times 13.6 \times \frac{9.97}{16.77} + 1090 \times \frac{13.6}{2} \times \frac{12.24}{16.77}$$

$$= 6240^{\#}$$

When - Mat bot = 21.08 Vat bot = $6240 + \frac{26080}{16.77} = 7500^{\#}$

When - Mat bot = .75x 21.08 = 15.81

V at top = $2690 - \frac{15810}{16.77} = 1750^{\#}$ Vat bot = $6240 + \frac{15810}{16.77} = 7180^{\#}$

x_0 = 5.15' from Top

$$+M = 1750 \times 8.32 - 3.17 \times 100 \times .5 \times 6.21 - 100 \times \frac{5.15^2}{2} - 412 \times \frac{5.15^2}{6} = 10430'^{\#}$$

$$\text{reqd } d = \sqrt{\frac{21{,}080}{147}} = 12.0'' < 14.5$$

$$v = \frac{7500}{12 \times .88 \times 14.5} = 49\ \#/\square''$$

$$-A_s = \frac{21{,}080 \times 12}{18000 \times .88 \times 14.5} = 1.10\ \square'' \quad \text{Use } 7/8''\phi @ 6''cc$$

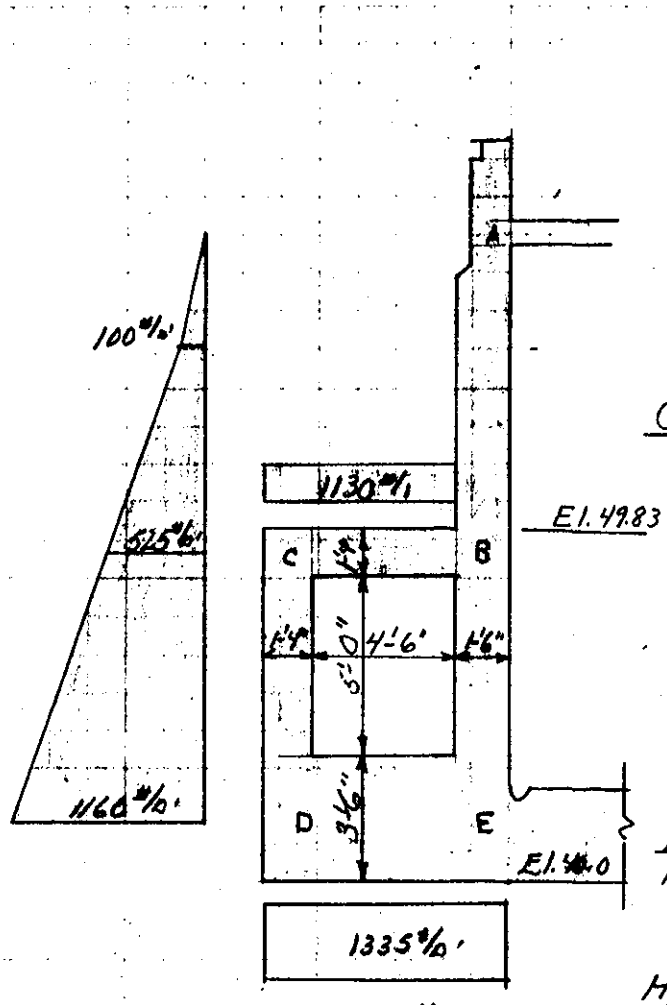
$$u_0 = \frac{7500}{5.5 \times .88 \times 14.5} = 107\ \#/\square''$$

$$+A_s = \frac{10430 \times 12}{18000 \times .88 \times 15.5} = .51\ \square'' \quad \text{Use } 3/4''\phi @ 10''cc$$

Subject Springdale Pumping Station

Computation Section C-C Thru North Wall

Computed by H. E. W. **Checked by** _____ **Date** 26-May-45



Ave bear P = 1860#/□'

net " P = 1860 - 3.5x150 = 1335#/□'

Section C-C will be analized for two conditions of loading

Case I Conduit empty and ground water at El. 55.0

Case II Conduit with head of water to El. 53.0 and ground water at El. 55.0

Case I

F. E. M – Members AB & CD will be the same as Section B-B Case I

Member DE

$M^F_{DE} = M^F_{ED} = \frac{1}{12} \times 1335 \times 5.92^2 = 3.90$ 'K

Member CB

$M^F_{BC} = M^F_{CB} = \frac{1}{12} \times 1130 \times 5.92^2 = 3.30$

End React. and Center Moments

Member AB

$H_A = 100 \times 3.17 \times .5 \times \frac{6.89}{9.0} + 100 \times 5.83 \times \frac{2.92}{9.0} + 425 \times \frac{5.83}{2} \times \frac{1.94}{9.0} - \frac{2570}{9} = 300^{\#}$

$H_B = 100 \times 3.17 \times .5 \times \frac{2.11}{9} + 100 \times 5.83 \times \frac{6.08}{9.0} + 425 \times \frac{5.83}{2} \times \frac{7.06}{9.0} + \frac{2570}{9} = 1640^{\#}$

$x_0 = 4.17'$ from A

$M = 300 \times 4.17 - 100 \times 3.17 \times .5 \times 2.11 - 100 \times \frac{1.0^2}{2} - 80 \times \frac{1.0^2}{6} = 860$ '#

Member BC

$V_B = 1130 \times .5 \times 5.92 - \frac{650}{5.92} = 3240^{\#}$

$V_C = 1130 \times .5 \times 5.92 + \frac{650}{5.92} = 3450^{\#}$

$x_0 = 2.87'$ from B

$M = 3240 \times 2.87 - 2880 - 1130 \times \frac{2.87^2}{2} = 1770$ '#

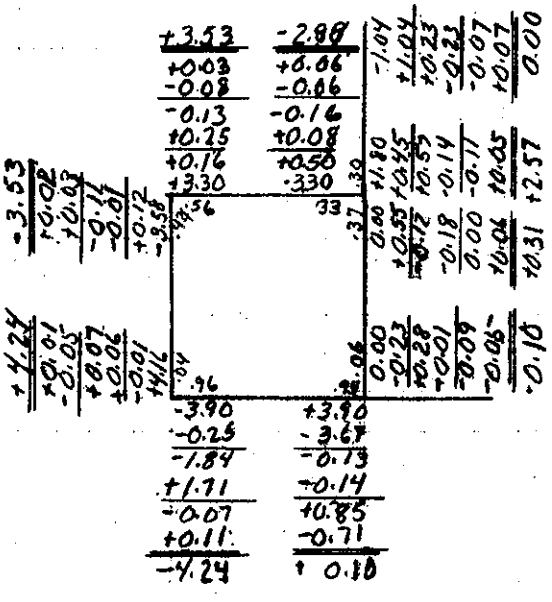
Member CD

$H_C = 525 \times 7.42 \times .5 + 635 \times 7.42 \times .5 \times .33 - \frac{710}{7.42} = 2630^{\#}$

$H_D = 525 \times 7.42 \times .5 + 635 \times 7.42 \times .5 \times .67 + \frac{710}{7.42} = 3620^{\#}$

$x_0 = 3.85'$ from C

$M = 2630 \times 3.85 - 3530 - 525 \times \frac{3.85^2}{2} - 308 \times \frac{3.85^2}{6} = 1950$ '#



Subject Springdale Pumping Station
Computation Section C-C Thru North Wall
Computed by H.E.W. **Checked by** **Date** 28-May-45

Case I (cont.)

Member DE

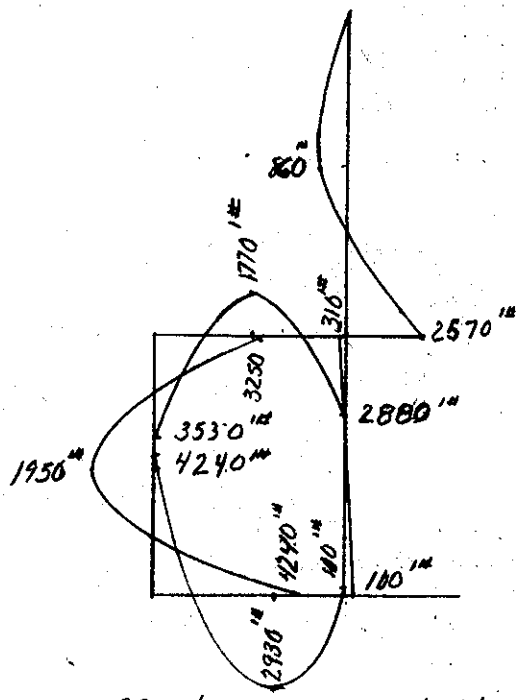
$V_D = 1335 \times 5.92 \times .5 + \frac{4140}{5.92} = 4630^{\#}$

$V_E = 1335 \times 5.92 \times .5 - \frac{4140}{5.92} = 3250^{\#}$

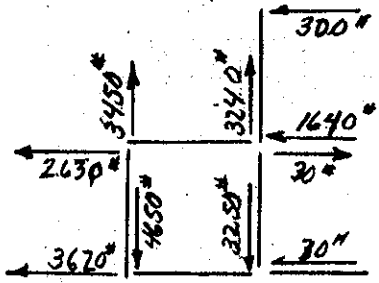
$x_0 = 3.48'$ from D

$M = 4630 \times 3.48 - 4240 - 1335 \times \frac{3.48^2}{2} = 3860^{'\#}$

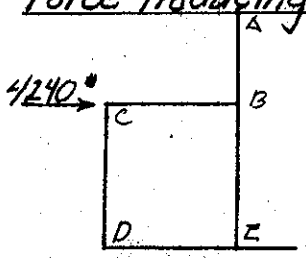
Moment Diagram



Shear Diagram



Force Producing Joint Deflection



The effect of the deflection of joints B & C will be relatively the same as Section B-B. It is considered that the values determined for .01" defl. in Sect. B-B can be used with a mom. multiplier based on 4240#.

Mom. mult. $= \frac{4240}{4540} = .934$

Subject Springdale Pumping Station
Computation Section C-C Thru North Wall
Computed by H.E.W. **Checked by** **Date** 28-May-45

Case I (cont.)

Maximum Moments at Joints

Member	Dist. Mom.	Defl. Mom.		Max. Mom.
AB @ A	0.00	0	0	0
@ B	+2.57	-4.96 x .934 =	-4.63	+2.57 - 2.06
BC @ B	-2.88	-3.83 x .934 =	-3.58	6.46
@ C	+3.53	-4.82 x .934 =	-4.50	+3.53 + -0.98
CD @ C	-3.53	+4.82 x .934 =	+4.50	-3.53 + +0.98
@ D	+4.24	+6.28 x .934 =	+5.87	+10.11
DE @ D	-4.24	-6.28 x .934 =	-5.87	-10.11
@ E	+0.10	-8.87 x .934 =	-8.28	+0.10 - 8.18
BE @ B	+0.31	+8.79 x .934 =	+8.21	+8.52
@ E	-0.10	+9.70 x .934 =	+9.06	+8.96 - 0.10

End Reactions due to Joint Deflection

Member AB

$H_A = \frac{4630}{9} = 510^{\#} \leftarrow$ $H_B = 510^{\#} \rightarrow$

Member BC

$V_B = \frac{8080}{5.92} = 1360^{\#} \uparrow$ $V_C = 1360^{\#} \downarrow$

Member CD

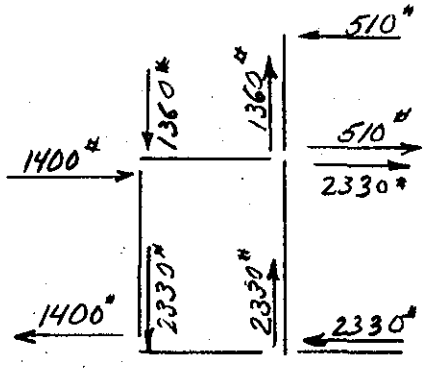
$H_C = \frac{10370}{7.42} = 1400^{\#} \rightarrow$ $H_D = 1400^{\#} \leftarrow$

Member DE

$V_D = \frac{14150}{5.92} = 2390^{\#} \downarrow$ $V_E = 2390^{\#} \uparrow$

Member BE.

$H_B = \frac{17270}{7.42} = 2,330 \rightarrow$ $H_E = 2330^{\#} \leftarrow$



WAR DEPARTMENT

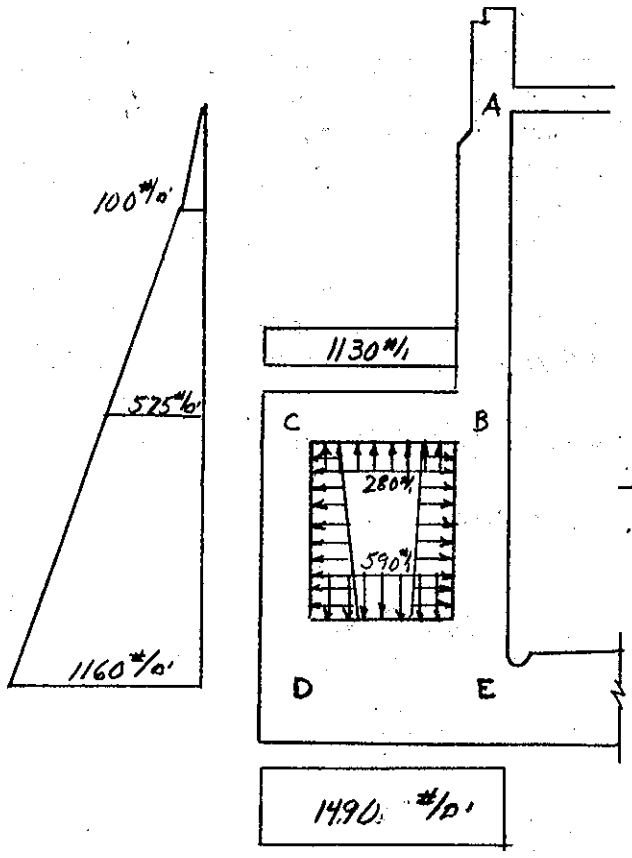
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station

Computation Section C-C Thru North Wall

Computed by _____ **Checked by** _____ **Date** 28-May-45

Case II Conduit with head of water to El 53.0



Bear. Pressure

Use Ave Bear. P = 2020#/□'

not " P = 2015 - 3.5x150 - 590 = 900 #/□'

F.E.M - Members AB, CD & BE will be the same as Section B-B - Case - II

Member DE

$M^F_{DE} = M^F_{ED} = \frac{1}{12} \times 900 \times 5.92^2 = 2.63$ '#

Member BC

$M^F_{BC} = M^F_{CB} = \frac{1}{12} \times 850 \times 5.92^2 = 2.48$

End Reactions + Center Moments

Member AB

$H_A = 100 \times 3.17 \times .5 \times \frac{6.89}{9.0} + 100 \times 5.83 \times \frac{2.92}{9.0} + 425 \times \frac{5.83}{2} \times \frac{1.54}{9.0} - \frac{2790}{9} = 260^{\#}$

$H_B = 100 \times 3.17 \times .5 \times \frac{2.11}{9} + 100 \times 5.83 \times \frac{6.08}{9.0} + 425 \times \frac{5.83}{2} \times \frac{7.06}{9} + \frac{2790}{9} = 1680^{\#}$

$x_0 = 4.0'$ from A

$M = 260 \times 4.0 - 100 \times .5 \times 3.17 \times 1.89 - 67 \times \frac{.83^2}{6} - 100 \times \frac{.83^2}{2} = 700$ '#

Member BC

$V_B = 850 \times 5.92 \times .5 - \frac{260}{5.92} = 2470^{\#}$

$V_C = 850 \times .592 \times .5 + \frac{260}{5.92} = 2560^{\#}$

$x_0 = 2.91'$ from B

$M = 2470 \times 2.91 - 1940 - 850 \times \frac{2.91^2}{2} = 1820$ '#

Member CD

$H_C = 245 \times 7.42 \times .5 + 325 \times 7.42 \times .5 \times .33 \times \frac{30}{7.42} = 1310^{\#}$

$H_D = 245 \times 7.42 \times .5 + 325 \times 7.42 \times .5 \times .67 \times \frac{30}{7.42} = 1720^{\#}$

$x_0 = 3.95'$ from C

$M = 1310 \times 3.95 - 2200 - 245 \times \frac{3.95^2}{2} - 173 \times \frac{3.95^2}{6} = -280$

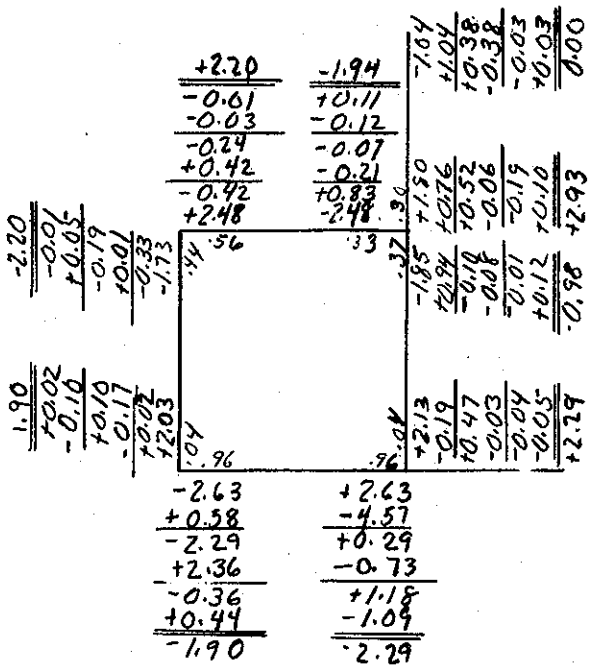
Member DE

$V_D = 900 \times 5.92 \times .5 + \frac{4190}{5.92} = 3500^{\#}$

$V_E = 900 \times 5.92 \times .5 - \frac{4190}{5.92} = 1830^{\#}$

$x_0 = 3.89'$ from D

$M = 3500 \times 3.89 - 1900 - 900 \times \frac{3.89^2}{2} = 4910$ '#



Subject Springdale Pumping Station
Computation Section C-C Thru North Wall
Computed by H.E.W **Checked by** **Date** 28 May - 45

Case II

Member BE

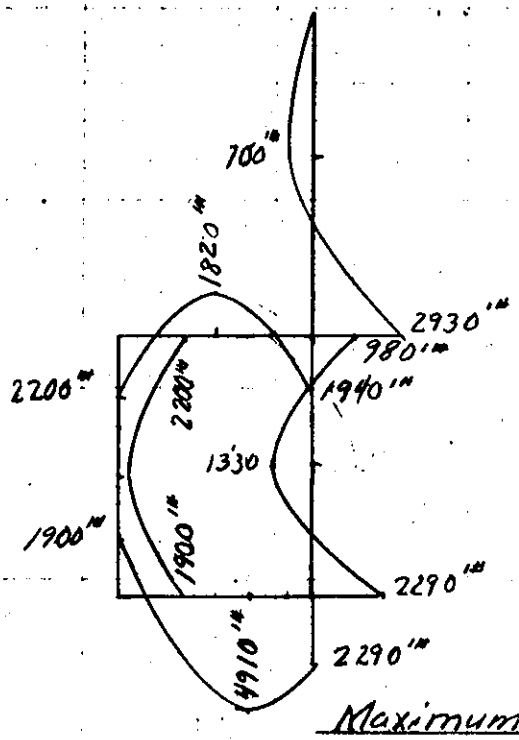
$H_B = 280 \times 7.42 \times .5 + 310 \times 7.42 \times .5 \times .33 - \frac{970}{7.42} = 1240^{\#}$

$H_E = 280 \times 7.42 \times .5 + 310 \times 7.42 \times .5 \times .67 + \frac{970}{7.42} = 1990^{\#}$

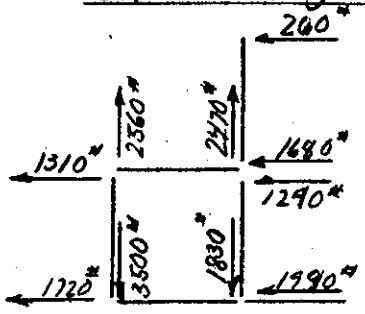
$x_0 = 3.5'$ from B

$M = 1240 \times 3.5 - 980 - 280 \times \frac{3.5^2}{2} - 150 \times \frac{3.5^2}{6} = 1330'^{\#}$

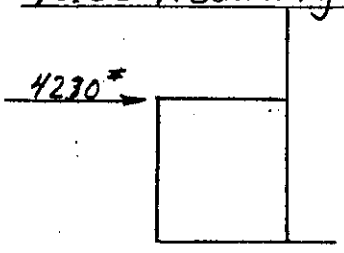
Moment Diagram.



Shear Diagram



Force Producing Joint Deflection



Mom. Mult. $= \frac{4230}{4540} = .932$

Maximum Moments at Joints

Member	Dist. Mom.	Defl. Mom.	Max. Mom.
AB @ A	0	0	0
@ B	+2.93	-4.96 x .932 = -4.62	+2.93 - 1.69
BC @ B	-1.94	-3.83 x .932 = -3.57	- 5.51
@ C	+2.20	-4.82 x .932 = -4.49	+2.20 - 2.29
CD @ C	-2.20	+4.82 x .932 = +4.49	- 2.20 + 2.29
@ D	+1.90	+6.28 x .932 = +5.85	+ 7.75
DE @ D	-1.90	-6.28 x .932 = -5.85	- 7.75
@ E	- 2.29	- 8.87 x .932 = - 8.27	- 10.56
BE @ B	+0.98	+8.19 x .932 = +8.19	-0.98 + 7.21
E	+2.29	+9.70 x .932 = +9.04	+11.33

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station

Computation Section C-C Thru. North Wall

Computed by H.E.W. **Checked by** _____ **Date** 29-May-45

Case II (cont.)

End Reactions due to Joint Deflection

Member AB

$H_A = \frac{4620}{9} = 510^{\#} \leftarrow$ $\qquad H_B = 510^{\#} \rightarrow$

Member BC

$V_B = \frac{8060}{5.92} = 1360^{\#} \uparrow$ $\qquad V_C = 1360^{\#} \downarrow$

Member CD

$H_C = \frac{10340}{7.42} = 1390^{\#} \rightarrow$ $\qquad H_D = 1390^{\#} \leftarrow$

Member DE

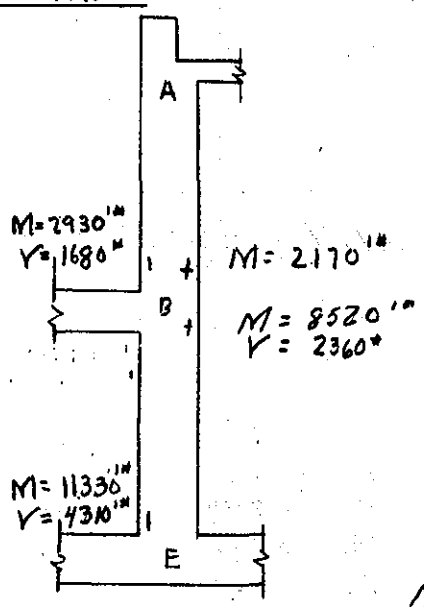
$V_C = \frac{14120}{5.92} = 2390^{\#} \downarrow$ $\qquad V_E = 2390 \uparrow$

Member BE

$H_B = \frac{17230}{7.42} = 2320^{\#} \rightarrow$ $\qquad H_E = 2320^{\#} \leftarrow$

Design of Members

Wall ABE



req'd $d = \sqrt{\frac{11330}{147}} = 8.8'' < 14.5''$

$v = \frac{4310}{12 \times .88 \times 14.5} = 28\ \#/\square''$

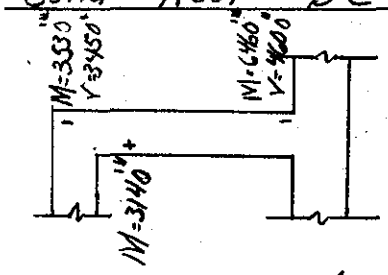
$-A_s @ E = \frac{11330 \times 12}{18000 \times .88 \times 14.5} = .59\ \square''$ Use $\frac{7}{8}''\phi$ @ $1\frac{1}{2}''$ cc

$u_o = \frac{4310}{2.75 \times .88 \times 14.5} = 123\ \#/\square''$

$-A_s @ B = \frac{2930 \times 12}{18000 \times .88 \times 14.5} = .15\ \square''$ Use $\frac{3}{4}''\phi$ @ 12"

$+A_s = \frac{8520 \times 12}{18000 \times .88 \times 15.5} = .42\ \square''$ Use $\frac{3}{4}''\phi$ @ 12" c

Cond. Roof BC



Max +M when M @ C = -2290 × V = 1200#

$x_o = 1.41'$ from C

$+M = 1200 \times 1.41 + 2290 - 850 \times \frac{1.41^2}{2} = 3140'^{\#}$

$v = \frac{4600}{12 \times .88 \times 12.5} = 35\ \#/\square'$

$-A_s = \frac{6460 \times 12}{18000 \times .88 \times 12.5} = .39\ \square''$ Use $\frac{3}{4}''\phi$ @ 12" cc

$u_o = \frac{4600}{2.4 \times .88 \times 12.5} = 175\ \#/\square''$

$+A_s = \frac{3140 \times 12}{18000 \times .88 \times 12.5} = .19\ \square''$ Use $\frac{5}{8}''\phi$ @ 12" cc

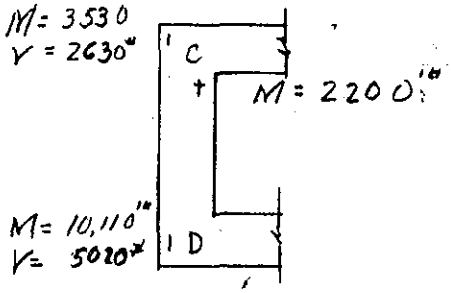
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station
Computation Section C-C Thru. North Wall
Computed by H.E.W **Checked by** **Date** 19-May-45

Design of Members (cont.)

Wall CD



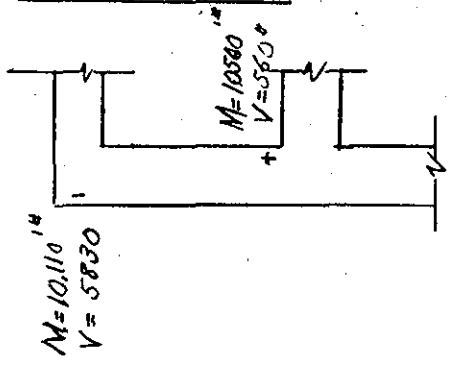
req'd $d = \sqrt{\frac{10,110}{147}} = 8.3' < 12.5''$ OK

$-A_s = \frac{10110 \times 12}{18000 \times .88 \times 12.5} = .61^{\square''}$ Use 7/8"φ @ 1'-0"cc

$u_o = \frac{5020}{2.8 \times .88 \times 12.5} = 162$ #/□"

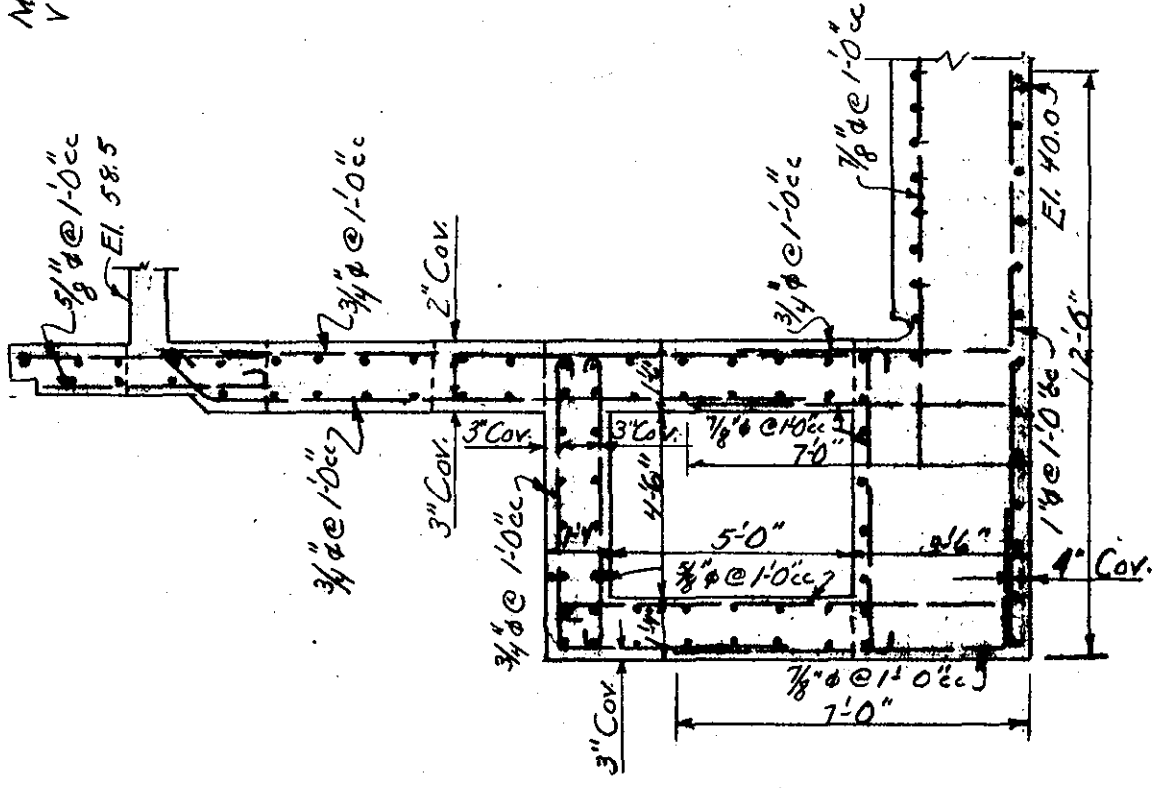
$+A_s = \frac{2200 \times 12}{18000 \times .88 \times 12.5} = .13^{\square''}$ Use 5/8"φ @ 1'-0"cc

Base DE



$-A_s = \frac{10,110 \times 12}{18000 \times .88 \times 37.5} = .21^{\square''}$ Use 1"φ @ 1'-0"cc

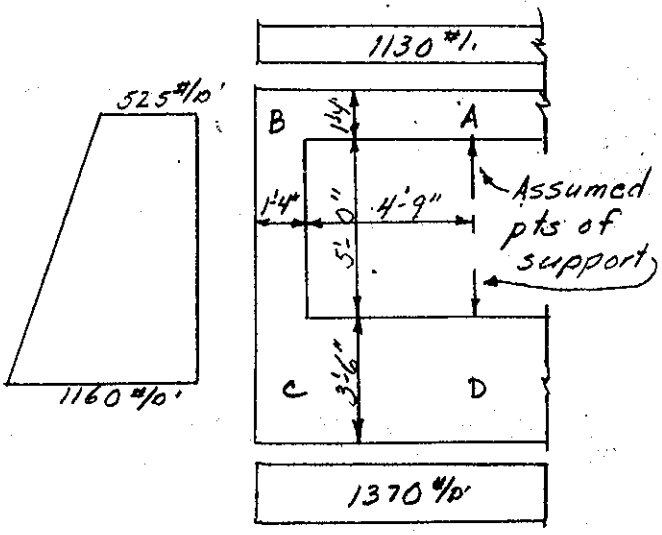
$+A_s$ Use 7/8"φ @ 1'-0"cc



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station
Computation Section D-D Thru Conduit
Computed by H.E.W. **Checked by** **Date** 30-May-45



Wall and roof loading will be the same as in Section B-B

Base Pressure

Ave base P (Case I) = 1900 #/'

Wt. base slab = 3.5x150 = 530

1370 #/'

F.E.M. Members AB & BC will be the same as Sect B-B

Member CD

$M^F_{CD} = M^F_{DC} = \frac{1}{12} \times 1370 \times 5.42^2 = 3.35'^k$

End Reactions & Center Moments

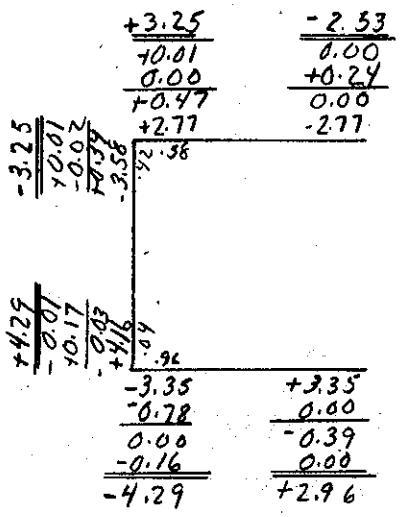
Member AB

$V_A = 1130 \times 5.42 \times .5 - \frac{720}{5.42} = 2930^\#$

$V_B = 1130 \times 5.42 \times .5 + \frac{720}{5.42} = 3200^\#$

$x_0 = 2.59'$ from A

$M = 2930 \times 2.59 - 2530 - 1130 \times \frac{2.59^2}{2} = 1270'^\#$



Member BC

$H_B = 525 \times 7.42 \times .5 + 635 \times 7.42 \times .5 \times .33 - \frac{1040}{7.42} = 2590^\#$

$H_C = 525 \times 7.42 \times .5 + 635 \times 7.42 \times .5 \times .67 + \frac{1040}{7.42} = 3670^\#$

$x_0 = 3.8'$ from B

$M = 2590 \times 3.8 - 3250 - 525 \times \frac{3.8^2}{2} - 304 \times \frac{3.8^2}{6} = 2070'^\#$

Member CD

$V_C = 1370 \times 5.42 \times .5 + \frac{1330}{5.42} = 3960^\#$

$V_D = 1370 \times 5.42 \times .5 - \frac{1330}{5.42} = 3470^\#$

$x_0 = 2.89'$ from C

$M = 3960 \times 2.89 - 4290 - 1370 \times \frac{2.89^2}{2} = 1430'^\#$

Design of Members

Roof AB

$v = \frac{3200}{12 \times .88 \times 12.5} = 24\ \#/\square''$

$-As = \frac{3250 \times 12}{18000 \times .88 \times 12.5} = .20\ \square''$ Use 3/4"ϕ @ 1'-0"cc

$u_0 = \frac{3200}{2.4 \times .88 \times 12.5} = 121\ \#/\square''$

+As Use 5/8"ϕ @ 12"cc

Wall BC

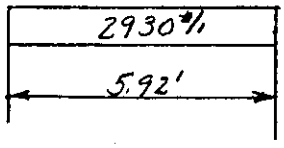
$-As = \frac{4290 \times 12}{18000 \times .88 \times 12.5} = .26\ \square''$ Use 7/8"ϕ @ 1'-0"cc

+As - Use 5/8"ϕ @ 1'-0"cc

Base CD

Use 7/8"ϕ @ 1'-0"cc Top & Bot.

Beam at Pt. A



$V = 2930 \times 5.92 \times .5 = 8670\#$

$M = \frac{1}{10} \times 2930 \times 5.92^2 = 10,270'\#$

Assume beam 18" wide

reqd $d = \sqrt{\frac{10270 \times 12}{18 \times 123}} = 7.5'' < 12$

$v = \frac{8670}{18 \times .88 \times 12} = 46\ \#/\square''$

$As = \frac{10,270 \times 12}{18000 \times .88 \times 12} = .65\ \square''$ 2- 5/8"ϕ bars in bot and 2- 3/4"ϕ bars in top OK

Beam Action at Pt. D

Normal steel in base will be sufficient to take the load

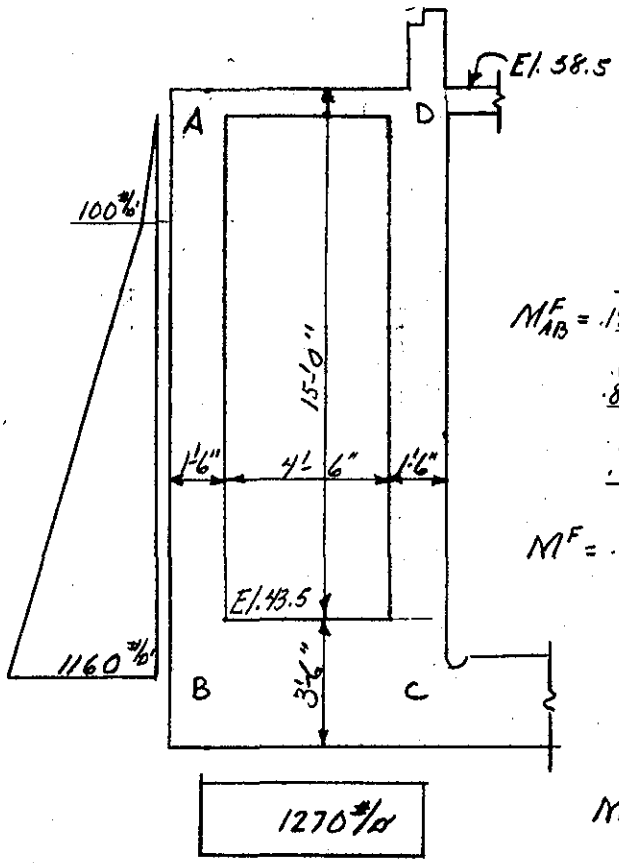
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station

Computation Section E-E Thru Conduit

Computed by H. E. W **Checked by** **Date** 31-May-45



Case I Chamber empty & ground water at El. 55.0

Base Pressure - Use an average base pressure of 1800 #/□' net pressure = 1270 #/□'

Fixed End Moments

$$M^F_{AB} = \frac{.193(10-15\times\overset{7.329}{.193}+6\times.193^2)}{15}\times\frac{100\times\overset{2.603}{3.17}}{2}\times 16.42 = 0.24$$

$$\frac{\overset{.650}{.806^2}(4-\overset{1.552}{3\times.806})}{12}\times 100\times\overset{21.757}{13.25}\times 16.42 = 1.86$$

$$\frac{\overset{.650}{.806^2}(5-\overset{2.582}{3\times.806})}{30}\times 1060\times\frac{\overset{115.309}{13.25}}{2}\times 16.42 = \frac{6.45}{8.55^{'K}}$$

$$M^F = \frac{\overset{.0372}{.193^2}(5-\overset{4.223}{4\times.193})}{10}\times 100\times\frac{\overset{2.603}{3.17}}{2}\times 16.42 = 0.04$$

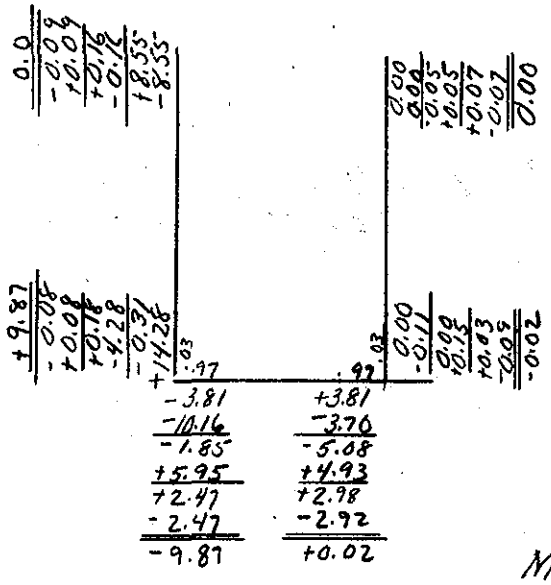
$$\frac{.806(6-8\times\overset{1.501}{.806}+3\times.806^2)}{12}\times 100\times\overset{21.757}{13.25}\times 16.42 = 2.19$$

$$\frac{.806(10-10\times\overset{3.89}{.806}+3\times.806^2)}{30}\times 1060\times\frac{\overset{115.309}{13.25}}{2}\times 16.42 = \frac{12.05}{14.28^{'K}}$$

$$M^F_{BC} = M^F_{CB} = \frac{1}{12}\times 1270\times 6^2 = 3.81^{'K}$$

Stiffness

Member	d	d^3	L	$\frac{d^3}{L}$	K
AB	18	5832	197	29.60	1.00
BC	42	74088	72	1029.00	34.76
CD	18	5832	197	29.60	1.00



End Reactions & Center Mom.

Member AB

$$H_A = 100\times\frac{3.17}{2}\times\frac{14.31}{16.42} + 100\times 13.25\times\frac{6.63}{16.42} + 1060\times\frac{13.25}{2}\times\frac{4.41}{16.42}$$

$$= \frac{9870}{16.42} = 1960^{\#}$$

$$H_B = 100\times\frac{3.17}{2}\times\frac{2.11}{16.42} + 100\times 13.25\times\frac{9.79}{16.42} + 1060\times\frac{13.25}{2}\times\frac{12.01}{16.42}$$

$$+\frac{9870}{16.42} = 6550^{\#}$$

$x_0 = 8.75'$ from A

$$M = 1960\times 8.75 - 100\times\frac{3.17}{2}\times 6.64 - 100\times\frac{5.58^2}{2} - 447\times\frac{5.58^2}{6}$$

$$= 12{,}220^{'\#}$$

Subject Springdale Pumping Station
Computation Section E-E Thru Conduit.
Computed by H.E.W. **Checked by** **Date** 1-June-45

Case I cont.

Member BC

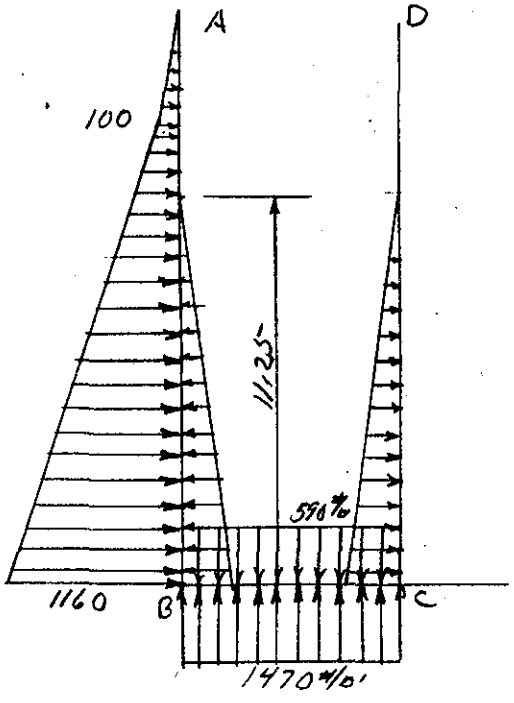
$V_B = 1270 \times 6 \times .5 + \frac{9850}{6} = 5450^{\#}$

$V_C = 1270 \times 6 \times .5 - \frac{9850}{6} = 2170^{\#}$

$x_0 = 4.29'$ from B

$M = 5450 \times 4.29 - 9870 - 1270 \times \frac{4.29^2}{2} = 1820^{'\#}$

Case II



Base Pressure Use a base pressure of 2000#/□'

Bear. pres. less wt. of base

2000 - 530 = 1470#/□'

Water pres. at El. 43.5 = 9.5×62.5 = 590#/□'

F.E.M.

Member DC

$M^F_{DC} = \frac{.685(5-3\times.685)}{30} \times 590 \times \frac{11.25}{2} \times 16.42 = 2.51^{'k}$ (2.945, 54.494)

$M^F_{CD} = \frac{.685(10-10\times.685+3\times.685^2)}{30} \times 590 \times \frac{11.25}{2} \times 16.42 = 5.67^{'k}$ (4.558, 54.494)

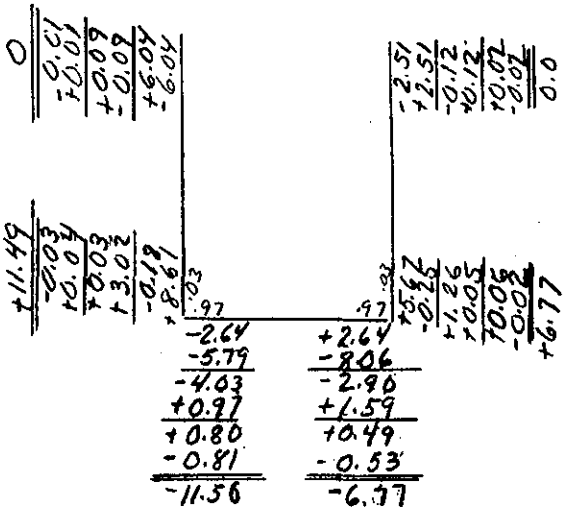
Member AB

$M^F_{AB} = 8.55 - 2.51 = 6.04^{'k}$

$M^F_{BA} = 14.28 - 5.67 = 8.61^{'k}$

Member BC

$M^F_{BC} = M^F_{CB} = \frac{1}{12} \times 880 \times 6^2 = 2.64^{'k}$



End Reactions & Center Moments

Member AB

$H_A = 100 \times \frac{3.17}{2} \times \frac{14.31}{16.42} + 100 \times 13.25 \times \frac{6.63}{16.42} + 1060 \times \frac{13.25}{2} \times \frac{4.41}{16.42}$

$- 590 \times \frac{11.25}{2} \times \frac{3.75}{16.42} - \frac{11490}{16.42} = 1100^{\#}$

$H_B = 100 \times \frac{3.17}{2} \times \frac{2.11}{16.42} + 100 \times 13.25 \times \frac{9.79}{16.42} + 1060 \times \frac{13.25}{2} \times \frac{12.01}{16.42}$

$+ \frac{11490}{16.42} - 590 \times \frac{11.25}{2} \times \frac{12.67}{16.42} = 4090^{\#}$

$x_0 = 7.17'$ from A

$M = 1100 \times 7.17 - 100 \times \frac{3.17}{2} \times 5.06 - 100 \times \frac{4^2}{2} - 320 \times \frac{4^2}{6}$

$- 105 \times \frac{2^2}{6} = 5360^{\#}$

Subject Springdale Pumping Station
Computation Section E-E Thru Conduit
Computed by H.E.W. **Checked by** **Date** 1-June-45

Case II (cont.)

Member BC

$V_B = 880 \times 6 \times .5 + \frac{18270}{6} = 5690^{\#} \downarrow$

$V_C = 880 \times 6 \times .5 - \frac{18270}{6} = 410^{\#} \uparrow$

No Center Mom

Member CD

$H_D = 590 \times \frac{11.25}{2} \times \frac{3.75}{16.42} - \frac{6770}{16.42} = 350^{\#}$

$H_C = 590 \times \frac{11.25}{2} \times \frac{12.67}{16.42} + \frac{6770}{16.42} = 2970^{\#}$

$x_0 = 8.81'$ from D

$M = 350 \times 8.81 - 191 \times \frac{3.64^2}{6} = 2660'^{\#}$

Design of Members

Wall AB

req'd $d = \sqrt{\frac{12220}{123}} = 10'' < 14.5''$ ok

$v = \frac{6550}{12 \times .88 \times 14.5} = 43^{\#}/\square''$

$-A_s$ @ B $= \frac{11,490 \times 12}{18000 \times .88 \times 14.5} = .60$ Use $\frac{7}{8}''\phi$ @ 1'-0" cc

$u_0 = \frac{6550}{2.75 \times .88 \times 14.5} = 187^{\#}/\square''$

$+A_s = \frac{12220 \times 12}{18000 \times .88 \times 14.5} = .64^{\square''}$ Use $\frac{3}{4}''\phi$ @ 8" cc

Base BC

$+A_s = \frac{6770 \times 12}{18000 \times .88 \times 38.5} = .13^{\square''}$ Use $\frac{7}{8}''\phi$ @ 1'-0" cc

$-A_s = \frac{11,500 \times 12}{18000 \times .88 \times 37.5} = .23^{\square''}$ Use 1"ϕ @ 1'-0" cc

Wall CD

$-A_s = \frac{6770 \times 12}{18000 \times .88 \times 14.5} = .35^{\square''}$ Use $\frac{3}{4}''\phi$ @ 1'-0" cc

$+A_s$ Use $\frac{3}{4}''\phi$ @ 1'-0" cc

$u_0 = \frac{2970}{2.36 \times .88 \times 14.5} = 100^{\#}/\square''$

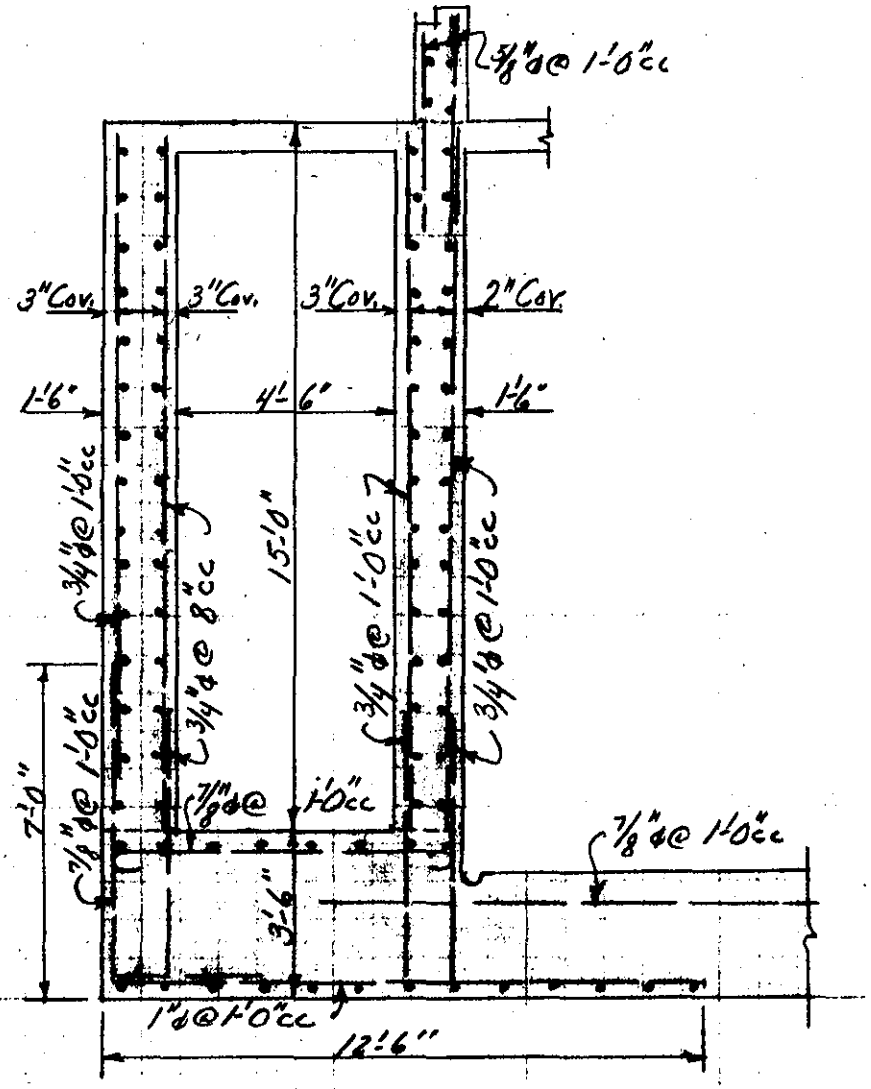
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station

Computation Section E-E Thru Conduit

Computed by H.E.W. **Checked by** **Date** 1-June-45



Section E-E

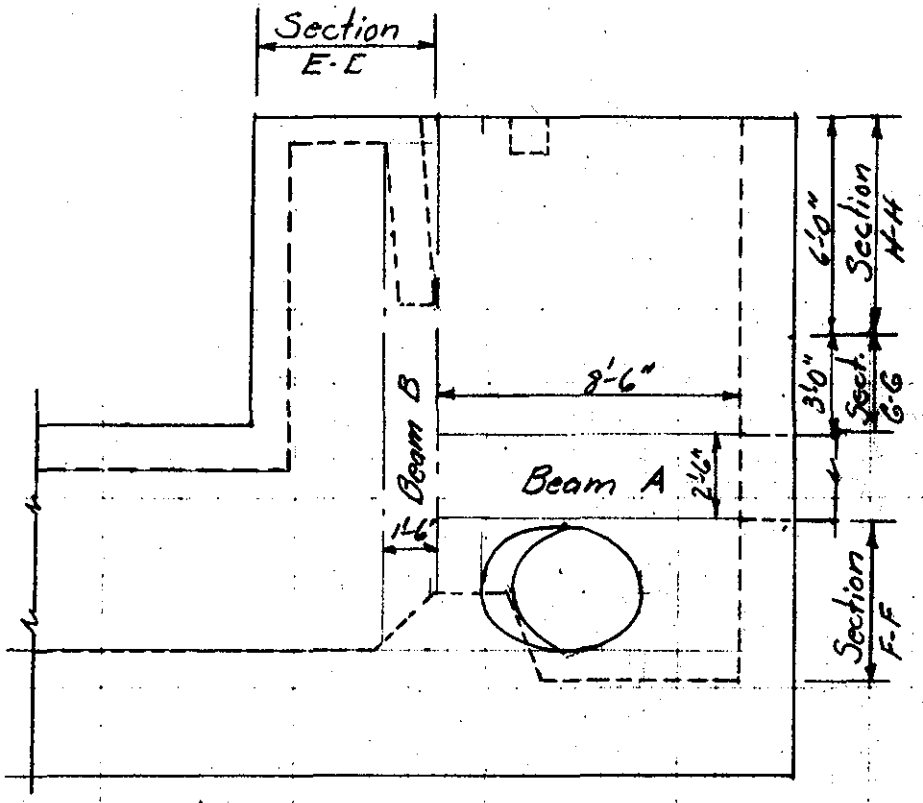
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station

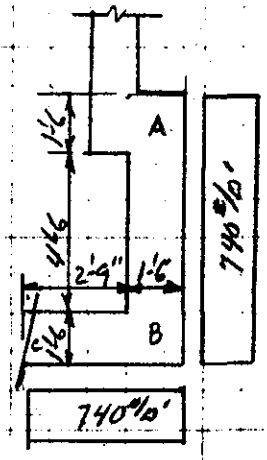
Computation North Wall of Screening Chamber

Computed by H.E.W. **Checked by** _____ **Date** 1- June-45



Elevation of Screening Chamber Wall Showing Design Sections

Section F-F at El. 45.0



Horiz. Thrust @ El. 45.0

$100 + 8 \times 80 = 740$ #/o'

Mom at cor. C $= \frac{3.5^2 \times 7.40}{2} = 4530$ '#

For Member AB assume fixity at A and Mom at B = 4530 '#

F.E.M for AB: $\frac{1}{12} \times 740 \times 6^2 = 2120$ '#

Then Mom at A $= 2120 - \frac{4530-2120}{2} = 920$ '#

$H_B = 740 \times 6 \times .5 + \frac{3610}{6} = 2820$ #

$x_0 = 3.81'$

$+M = 2820 \times 3.81 - 4530 - 740 \times \frac{3.81^2}{2} = 850$ '#

Subject Springdale Pumping Station
Computation North Wall of Screening Chamber
Computed by H.E.W. **Checked by** _____ **Date** 1-June-45

Section F-F (cont.)

$-As$ at $B = \frac{4530 \times 12}{18000 \times .88 \times 14} = .25''$ Use 3/4"ϕ @ 1'-0" cc

Horizontal Beam A

Center of Beam at El. 48.5

Horiz Thrust at El. 48.5 = 100 + 6.5×80 = 620 #/□'

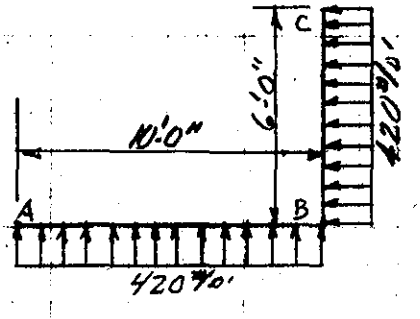
Span = 10'-0" load = 2.5×620 = 1550 #/'

$V = 1550 \times 10 \times .5 = 7750^{\#}$ $M = \frac{1}{10} \times 1550 \times 10^2 = 15500'^{\#}$

$v = \frac{7750}{30 \times .88 \times 14} = 21$ #/□'

$As = \frac{15500 \times 12}{18000 \times .88 \times 14} = .84''$ Use 3/4"ϕ @ 1'-0" cc both faces

Horizontal Section G-G



Horiz Thrust at El. 51.0

100 + 4×80 = 420 #/□'

F.E.M

$\frac{1}{12} \times 420 \times 10^{-2} = 3500'^{\#}$

$\frac{1}{12} \times 420 \times 6^2 = 1260'^{\#}$

$V_A = 420 \times 10 \times .5 + \frac{1260}{10} = 2220^{\#}$

$V_B = 420 \times 10 \times .5 - \frac{1260}{10} = 1980^{\#}$

$x_0 = 5.29'$ from A

$M = 2220 \times 5.29 - 3910 - 420 \times \frac{5.29^2}{2} = 1950'^{\#}$

$H_B = 420 \times 6 \times .5 + \frac{2110}{6} = 1610^{\#}$

$H_C = 420 \times 6 \times .5 - \frac{2110}{6} = 910^{\#}$

$x_0 = 3.83'$ from B

$M = 1610 \times 3.83 - 2670 - 420 \times \frac{3.83^2}{2} = 420'^{\#}$

Assume both ends fixed

		+1.26
		0.00
		-0.70
		0.00
		+0.56
	+.67	
		-1.26
		-1.41
		0.00
		0.00
		-2.67
-3.50	+3.50	
0.00	-0.83	
-0.41	0.00	
0.00	0.00	
-3.91	+2.67	

Moments and shears are small 3/4"ϕ @ 1'-0" cc will be OK

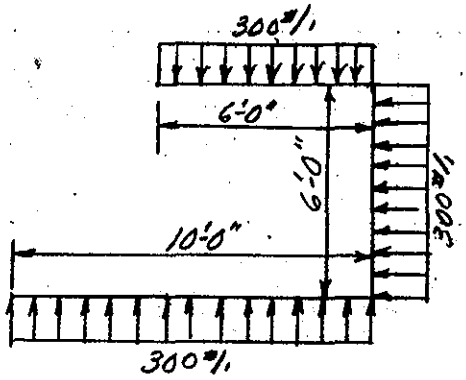
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station
Computation North Wall of Screening Chamber
Computed by H.E.N. **Checked by** _____ **Date** 2-June-43

Section H-H

Horiz. Thrust at El 52.5 = 100 x 2.5 x 80 = 300 #/□'



F. E. M

$\frac{1}{12} \times 300 \times 6^2 = 900'^{\#}$

$\frac{1}{12} \times 300 \times 10^2 = 2{,}500'^{\#}$

Member AB

$V_A = 300 \times 10 \times .5 + \frac{890}{10} = 1590^{\#}$

$V_B = 300 \times 10 \times .5 - \frac{890}{10} = 1410^{\#}$

$x_0 = 5.3'$ from A

$M = 1590 \times 5.3 - 2800 - 300 \times \frac{5.3^2}{2} = 1420'^{\#}$

Member BC

$H_B = 300 \times 6 \times .5 + \frac{1260}{6} = 1110^{\#}$

$H_C = 300 \times 6 \times .5 - \frac{1260}{6} = 690^{\#}$

$x_0 = 3.7'$ from B

$M = 1110 \times 3.7 - 1910 - 300 \times \frac{3.7^2}{2} = 150'^{\#}$

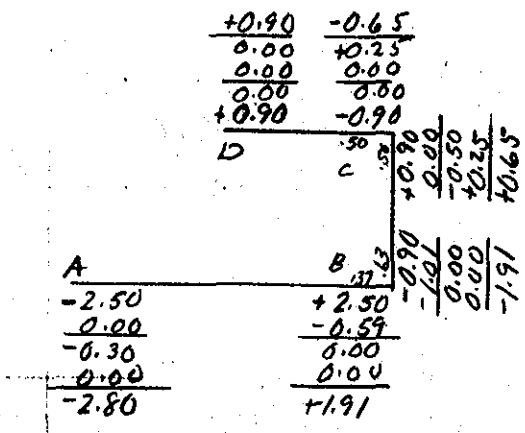
Member CD

$V_C = 300 \times 6 \times .5 - \frac{250}{6} = 860^{\#}$

$V_D = 300 \times 6 \times .5 + \frac{250}{6} = 940^{\#}$

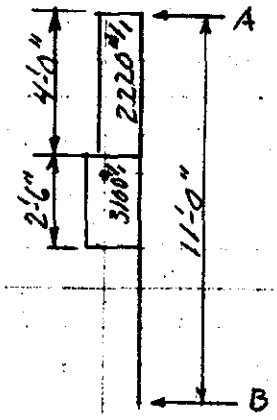
$x_0 = 2.87'$ from D

$M = 860 \times 2.87 - 650 - 300 \times \frac{2.87^2}{2} = 580'^{\#}$



Moments & Shears are small use 3/4" ø @ 1'-0" cc both faces

Vertical Beam B



$H_A = 2220 \times 4 \times \frac{9}{11} + 3100 \times 2.5 \times \frac{5.75}{11} = 11320^{\#}$

$x_0 = 4.79'$ from A

$M = 11320 \times 4.79 - 2220 \times 4 \times 2.79 - 3100 \times \frac{.79^2}{2}$
$= 28{,}480'^{\#}$

reqd $d = \sqrt{\frac{28480 \times 12}{.18 \times 12.3}} = 12.4" < 14.5"$ OK

$v = \frac{11320}{18 \times .88 \times 14.5} = 49\ \#/\square''$

$A_s = \frac{28480 \times 12}{18000 \times .88 \times 14.5} = 1.48\ \square''$

4- 3/4" ø @ 8" cc OK

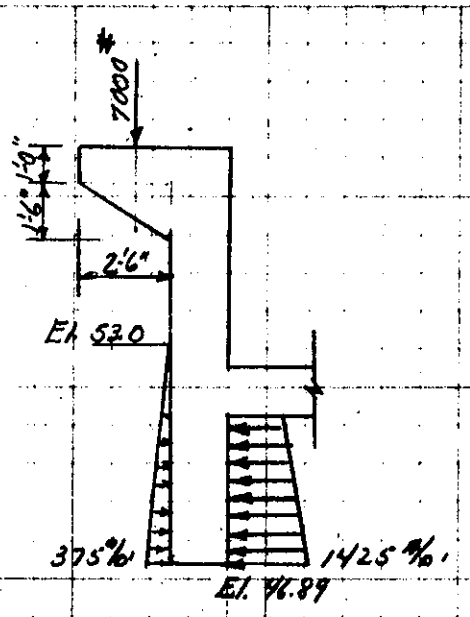
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station

Computation Gate Haunch Wall

Computed by H.E.W. **Checked by** _____ **Date** 2-June-45



Horiz. Thrust @ El. 47.

$(69.8-47)(62.5) = 1425$ #/□'

$(53-47)(62.5) = 375$ #/□'

Wall will span horizontally

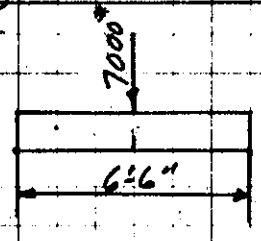
span = 4.92'

$V = 1050 \times 4.92 \times .5 = 2580$ #

$M = \frac{1}{10} \times 1050 \times 4.92^2 = 2540$ '#

$A_s = \frac{2540 \times 12}{18000 \times .88 \times 14} = .14$ □" use 3/4"φ @ 1'-0" cc

Design of Haunch (Beam Action)



D.L. Haunch = $1 \times 2.5 \times 150 = 375$ #/'

$1.5 \times 2.5 \times .5 \times 150 = 280$

655 #/'

$R_L = 655 \times 6.5 \times .5 + 7000 \times .5 = 5630$ #

$M = 5630 \times 3.25 - 655 \times \frac{3.25^2}{2} = 14840$ '#

req'd $d = \sqrt{\frac{14840 \times 12}{30 \times 12.3}} = 6.9" < 16"$ OK

$A_s = \frac{14840 \times 12}{18000 \times .88 \times 16} = .70$ □" 2- 3/4"φ OK

or 3- 5/8"φ OK

(Cantilever Action)

Assume load spread over an area 2'-6" sq = 1120 #/□'

Moments about face of wall

$1120 \times 2.5 \times 1.25 + 1 \times 2.5 \times 150 \times 1.25 + 1.5 \times 2.5 \times 150 \times .5 \times .83 = 4200$ '#

$A_s = \frac{4200 \times 12}{18000 \times .88 \times 14.5} = .22$ □' 3/4"φ @ 1'-0" cc OK

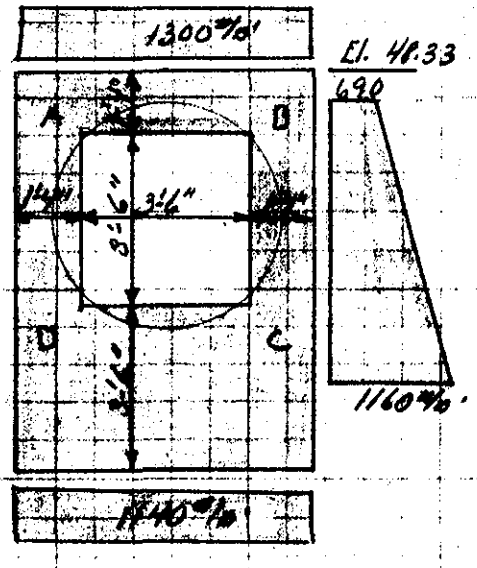
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station

Computation 5'-0" Conduit Section beyond Pumping Station

Computed by H.E.W. **Checked by** _____ **Date** 2-June-45



Case I - Conduit Empty

Roof load = 2.67x100 + 6.67x125 + 1.33x150
= 1300#/lf

Horiz. thrust at El. 47.67 = 100 + 7.33x80
= 690 #/lf

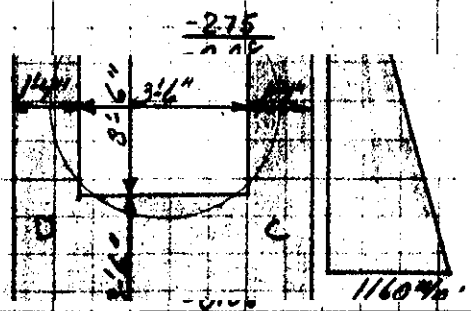
Base Pressure = 1670 - 3.5x150 = 1140

The roof and walls will be designed as a U section fixed at the base slab. The base slab will be designed as a cantilever from the building

F.E.M

Member AB

$M^F_{AB} = M^F_{BA} = \frac{1}{12} \times 1300 \times 4.83^2 = 2.53'^K$



= 690 #/lf

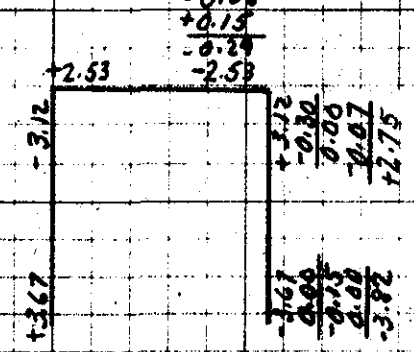
Base Pressure = 1670 - 3.5x150 = 1140

The roof and walls will be designed as a U section fixed at the base slab. The base

Member BC

$M^F_{BC} = \frac{1}{12} \times 690 \times 5.92^2 + \frac{1}{15} \times 470 \times \frac{5.92^2}{2} = 3.12$

$M^F_{CB} = \frac{1}{12} \times 690 \times 5.92^2 + \frac{1}{10} \times 470 \times \frac{5.92^2}{2} = 3.67$



Member AB

$V_A = V_B = 1300 \times 4.83 \times .5 = 3140^{\#}$

$M = \frac{1}{8} \times 1300 \times 4.83^2 - 2750 = 1040^{\#}$

Member BC

$H_B = 690 \times 5.92 \times .5 + 470 \times 5.92 \times .5 \times .33 - \frac{1070}{5.92} = 2320^{\#}$

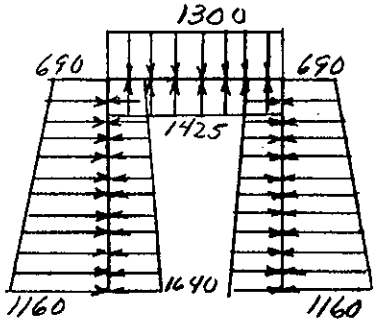
$H_C = 690 \times 5.92 \times .5 + 470 \times 5.92 \times .5 \times .67 + \frac{1070}{5.92} = 3160^{\#}$

$x_0 = 2.85'$ from B

$M = 2320 \times 2.85 + 2750 - 690 \times \frac{2.85^2}{2} - 227 \times \frac{2.85^3}{6} = 770'^{\#}$

Subject Springdale Pumping Station
Computation 5'-0" Conduit Section Beyond Pumping Station
Computed by H.E.W. **Checked by** **Date** 4- June- 45

Case II Cond Full with River El. 69.8



Int. Pres. at El. 47.0 = 22.8 x 62.5 = 1425 #/□'
" " " El. 43.5 = 26.3 x 62.5 1640 #/□'

F.E.M

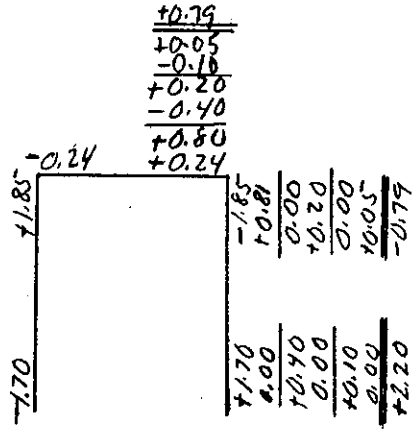
Member AB

$M^F = \frac{1}{12} \times 125 \times 4.83^2 = 0.24$ 'K

Member BC

$M^F_{BC} = \frac{1}{12} \times 480 \times 5.92^2 + 255 \times \frac{1}{10} \times \frac{5.92^2}{2} = 1.85$ 'K

$M^F_{CB} = \frac{1}{12} \times 480 \times 5.92^2 + 255 \times \frac{1}{15} \times \frac{5.92^2}{2} = 1.70$ 'K



Member AB

$V_A = V_B = 125 \times 4.83 \times .5 = 300$ #

$M = \frac{1}{8} \times 125 \times 4.83^2 - 790 = -430$ '#

Member BC

$H_B = 480 \times 5.92 \times .5 + 255 \times 5.92 \times .5 \times .67 - \frac{1410}{5.92} = 1690$ #

$H_C = 480 \times 5.92 \times .5 + 255 \times 5.92 \times .5 \times .33 + \frac{1410}{5.92} = 1910$ #

$x_0 = 3.45'$ from C

$M = 1910 \times 3.45 - 2200 - 480 \times \frac{3.45^2}{2} - 149 \times \frac{3.45^2}{6} = 1240$ '#

Design of Members

Roof AB

$-A_s = \frac{2750 \times 12}{18000 \times .88 \times 12.5} = .11$ □" 5/8"ϕ @ 1'-0" cc

$M_s = 790 - \frac{4.5}{12} \times 1690 = 160$ '#

$A_s = \frac{12 \times 160}{18000 \times .88 \times 12.5} + \frac{1690}{18000} = .10$ □" 5/8"ϕ @ 1'-0" cc

Wall BC

Direct Tension is negligable

$-A_s = \frac{3820 \times 12}{18000 \times .88 \times 12.5} = .23$ □"

Use 5/8"ϕ @ 1'-0" cc both faces

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Springdale Pumping Station

Computation 5'-0" Conduit Section Beyond Pumping Station

Computed by H. E. W. **Checked by** _____ **Date** 2-June-45

Base Slab - (Cantilever Section from Station)

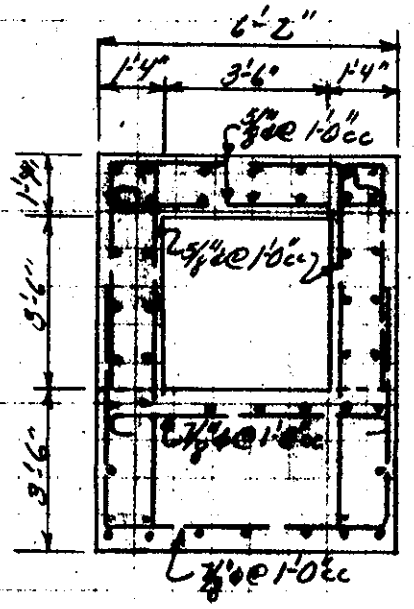
Downward Loads =	1300 x 6.17	=	8020
	1.33 x 3.5 x 2 x 150	=	1400
	3.5 x 3.5 x 62.5	=	720
	3.5 x 6.17 x 150	=	3240
			13430
Upward Load	1750 x 6.17	=	10800
	Net Load	=	2630 # down

$M = 2630 \times \frac{6^2}{2} = 47,340'^{\#}$

$V = 2630 \times 6 = 15780^{\#}$

$A_s = \frac{47,340 \times 12}{18000 \times .88 \times 36} = 1.00^{\square''}$ 7/8" ⌀ @ 1'-0" cc OK

$u_o = \frac{15780}{2.75 \times 6.17 \times .88 \times 36} = 30^{\#}/\square''$



Section Thru Conduit

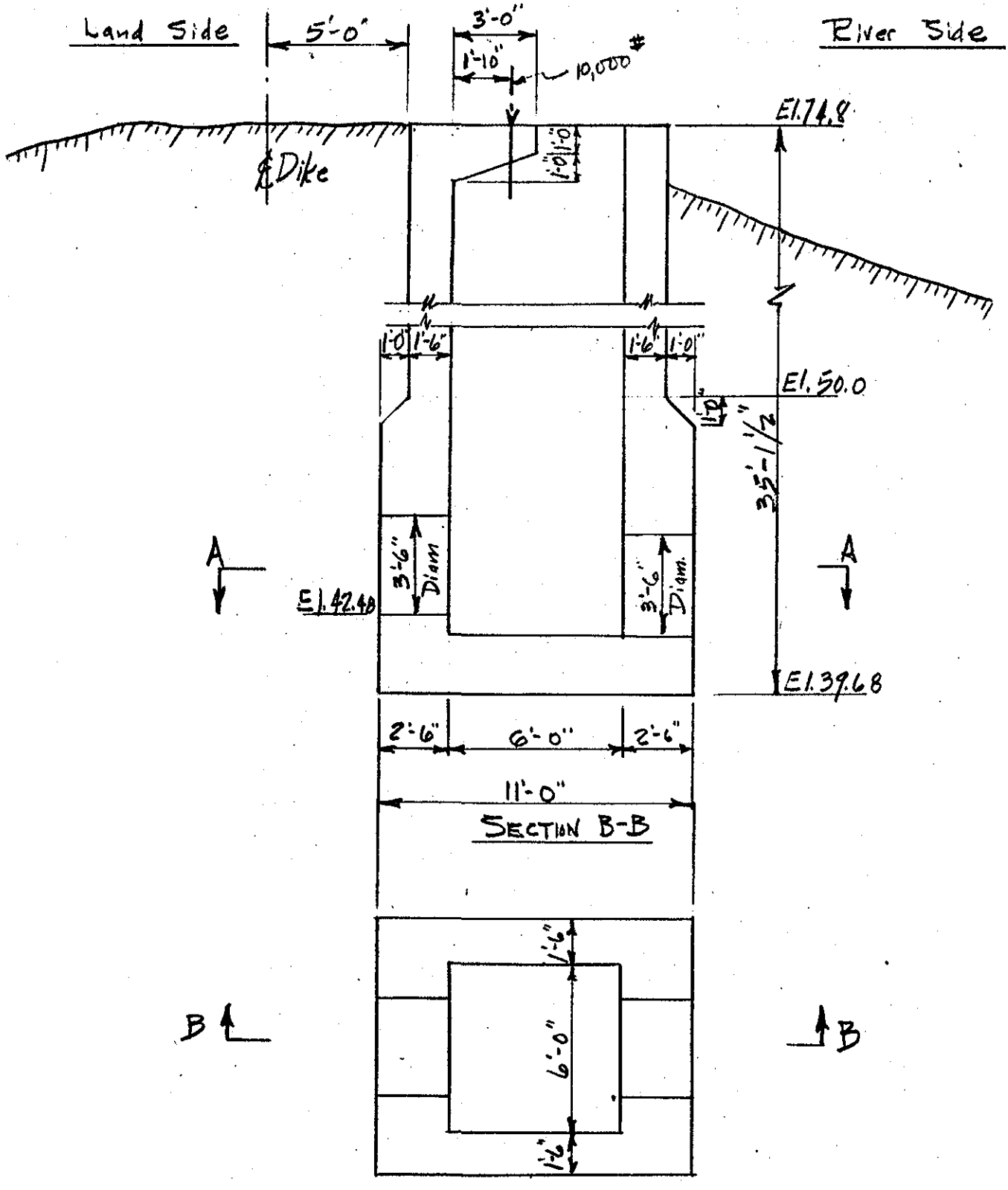
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject SPRINGDALE PUMPING STATION

Computation GATE STRUCTURE

Computed by H.L.F. **Checked by** _____ **Date** 12 Sept. 1945



F 74a

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject SPRINGDALE PUMPING STATION

Computation GATE STRUCTURE

Computed by [illegible] **Checked by** _____ **Date** 1 Sept. 1945

Design Base

Wt. Walls	$1.5 \times 30 \times 33.12 \times 150$	=	224,000
	$1.0 \times 18 \times 8 \times 150$	=	21,600
Earth	$1.0 \times 18 \times 25 \times 100$	=	45,000
			290,600 #

$$\text{Bearing} = \frac{290{,}600}{11 \times 9} = 3{,}000 \ \#/\square$$

$$M = \frac{3{,}000 \times 7.5^2}{8} = 21{,}100. \ '\#$$

$$V = 3{,}000 \times 7.5/2 = 11{,}250. \ \#$$

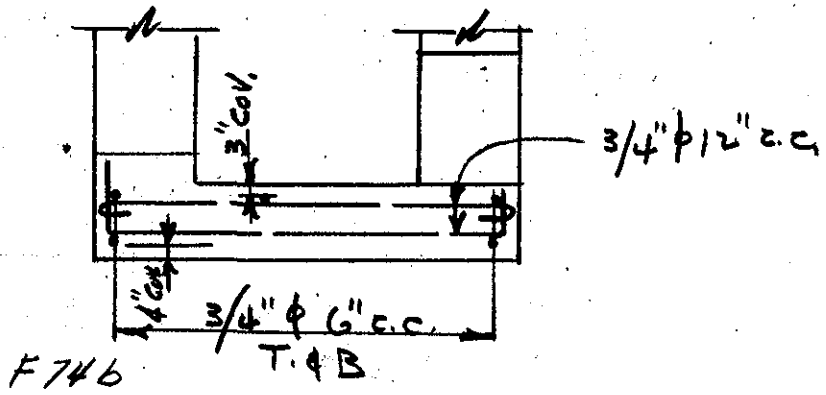
$$A_s = \frac{21{,}100 \times 12}{18{,}000 \times .88 \times 19.5} = 0.82 \ \square'$$

$3/4''\phi$ @ $6'' = .88 \ \square'$

$\Sigma_o = 4.72''$

$$v = \frac{11{,}250}{12 \times .88 \times 19.5} = 55 \ \#/\square'$$

$$u = \frac{11{,}250}{4.72 \times .88 \times 19.5} = 139. \ \#/\square' \quad \text{Spec. Anch.}$$



F746

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject SPRINGDALE PUMPING STATION

Computation GATE STRUCTURE

Computed by H.L.F. **Checked by** _____ **Date** 12 Sept. 1945

Design shaft

74.8
43

Load @ El. 43.0 = 31.8 x 35 = 1,120. #/□'

Hor. beam span = 8'-6" t = 1'-6" d = 14.5"

$$M = \frac{1{,}120 \times 8.5^2}{8} = 10{,}100.'\#$$

$$V = 1{,}120 \times 8.5/2 = 4{,}750.\#$$

$$A_s = \frac{10{,}100 \times 12}{18{,}000 \times .88 \times 14.5} = 0.53 \ \square''$$

~~5/8" φ @ 6" = .62~~
~~ε_0 = 3.92~~

$$v = \frac{4{,}750}{12 \times .88 \times 14.5} = 31.\#/\square''$$

7/8" φ @ 12" = .60
ε_0 = 2.75

u = 2.75 = 102. #/□''

Vert. beam @ 3'-6" opening

Span = 4.5' b = 2'-6" t = 2'-9" d = 29.5"

$$M = \frac{4{,}750 \times 4.5^2}{12} = 8{,}050.'\#$$

$$V = 4{,}750 \times 4.5/2 = 10{,}700.\#$$

$$A_s = \frac{8{,}050 \times 12}{18{,}000 \times .88 \times 29.5} = .21 \ \square''$$

2-3/4" φ = .88
ε_1 = 4.72

$$v = \frac{10{,}700}{24 \times .88 \times 29.5} = 17.2 \ \#/\square''$$

u = 4.72 = 87. #/□''

F 74c

Subject: SPRINGDALE PUMPING STATION
Computation: GATE STRUCTURE
Computed by: H.L.F. Checked by: Date: 12 Sept. 1945

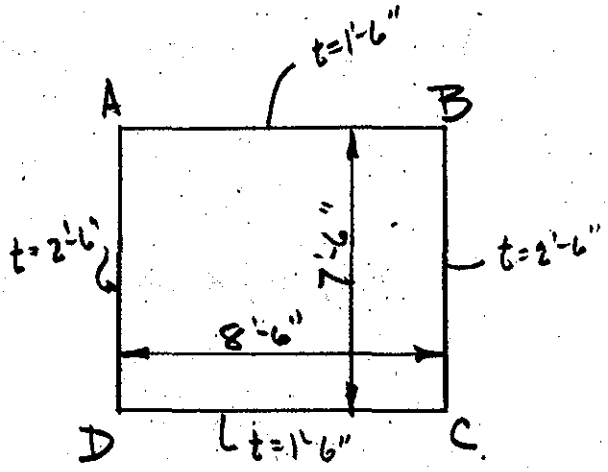
Shaft @ El. 46.0

Load = 28.8 × 35 = 1,010. #/□

A-B t^3 = 3.37
B-C t^3 = 15.62

$K_{A-B} = \frac{3.37}{8.5} = .396$

$K_{B-C} = \frac{15.62}{7.5} = 2.085$



Distribution factors

$AB = \frac{.396}{2.481} = 0.16$

$BC = \frac{2.085}{2.481} = 0.84$

Fixed End Moments

$A-B = \frac{1,010 \times 8.5^2}{12} = 6,100.'\#$

$B-C = \frac{1,010 \times 7.5^2}{12} = 4,750'\#$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject SPRINGDALE PUMPING STATION

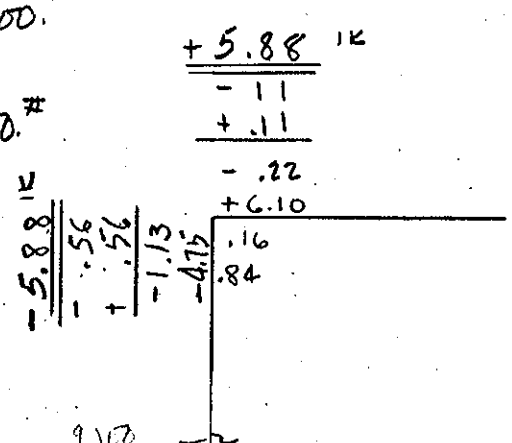
Computation GATE STRUCTURE

Computed by H.L.F. **Checked by** _____ **Date** 12 Sept. 1945

Moment Distribution

$V_{A-B} = 1{,}010 \times 8.5/2 = 4{,}300.^{\#}$

$V_{B-C} = 1{,}010 \times 7.5/2 = 3{,}800.^{\#}$



$+M_{A-B} = \overset{18{,}300}{4{,}300 \times 4.25} - \overset{9{,}100}{1{,}010 \times \frac{4.25^2}{2}} - 5{,}880 = 3{,}320.^{\prime\#}$

$+M_{B-C} = \overset{14{,}250}{3{,}800 \times 3.75} - \overset{7{,}100}{1{,}010 \times \frac{3.75^2}{2}} - 5{,}880 = 1{,}270.^{\prime\#}$

A-B $-A_s = \dfrac{5{,}880 \times 12}{18{,}000 \times .88 \times 14.5} = 0.31 \square$ 3/4"φ @12"

$A_s = 0.44 \square$

$v = \dfrac{4{,}300}{12 \times .88 \times 14.5} = 28.^{\#}/\square$

$u = 2.36 = 142.^{\#}/\square$ Spec. Anch.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject SPRINGDALE PUMPING STATION

Computation GATE STRUCTURE

Computed by H.L.F. **Checked by** **Date** 13 Sept. 1945

Shaft @ El. 50.0

Load = 24.8 x 35 = 870. #/□

Span = 7.5' t = 1'-6" d = 14.5"

$$M = 870 \times \frac{7.5^2}{12} = 4{,}080.\ '\#$$

$$V = 870 \times 7.5/2 = 3{,}260.\ \#$$

$$A_s = \frac{4{,}080 \times 12}{18{,}000 \times .88 \times 14.5} = 0.21\ \square$$

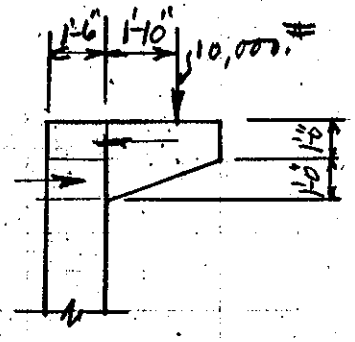
5/8"ϕ @ 12" = .31

Σ_o = 1.96

$$v = \frac{3{,}260}{12 \times .88 \times 14.5} = 21.\ \#/\square$$

u = 1.96 = 130. #/□

Haunch



Assume load spread over 3' width

$$M = 10{,}000 \times 1.83 = 18{,}300\ '\#$$

$$A_s = \frac{18{,}300 \times 12}{18{,}000 \times .88 \times 20.5} = .68\ \square$$

3 - 5/8"ϕ = .93 □

Σ_o = 5.88"

$$v = \frac{10{,}000}{36 \times .88 \times 20.5} = 16.\ \#/\square$$

u = 5.88 = 94. #/□

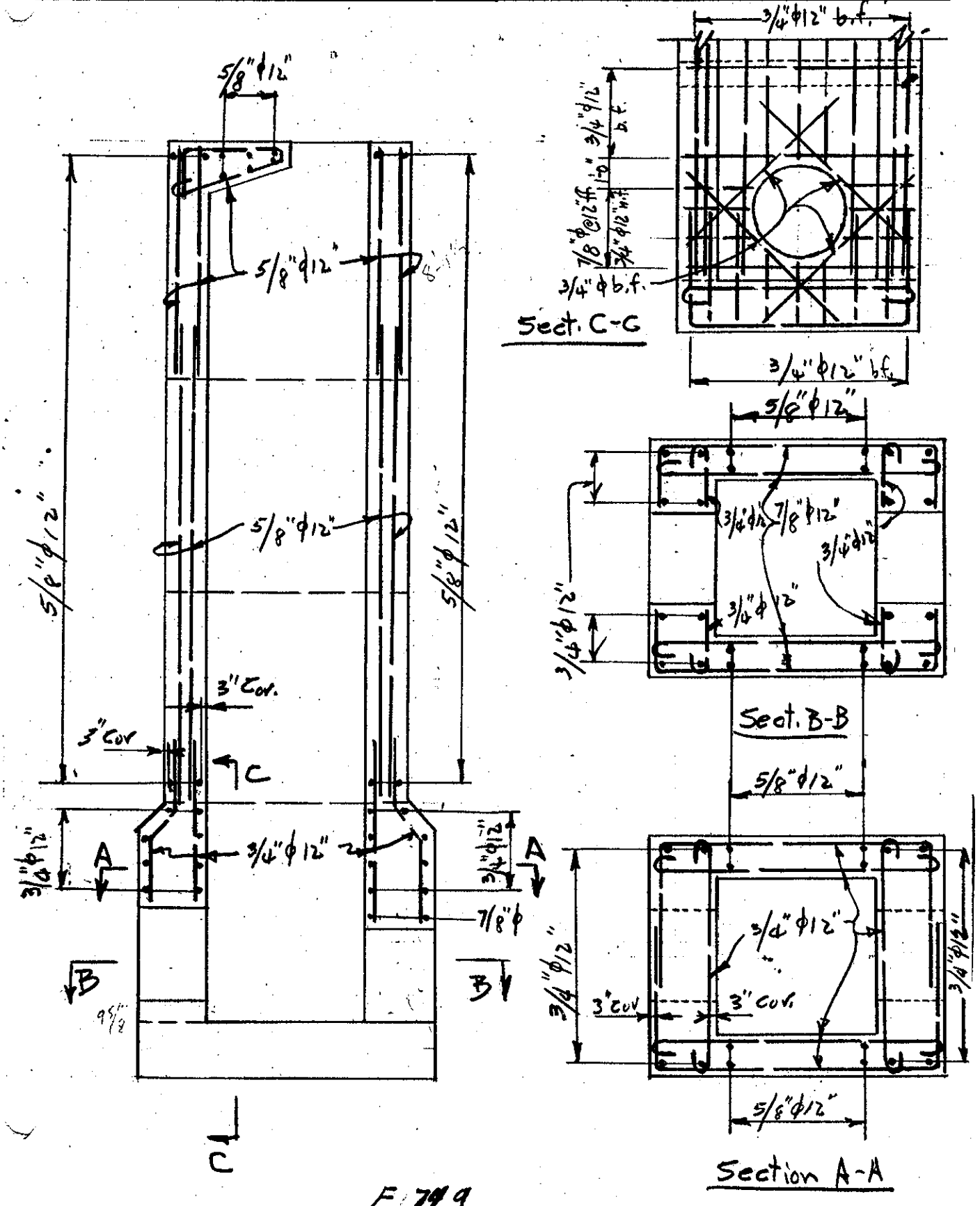
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject SPRINGDALE PUMPING STATION

Computation GATE STRUCTURE

Computed by H.L.F. **Checked by** **Date** 13 Sept. 1945



F 79

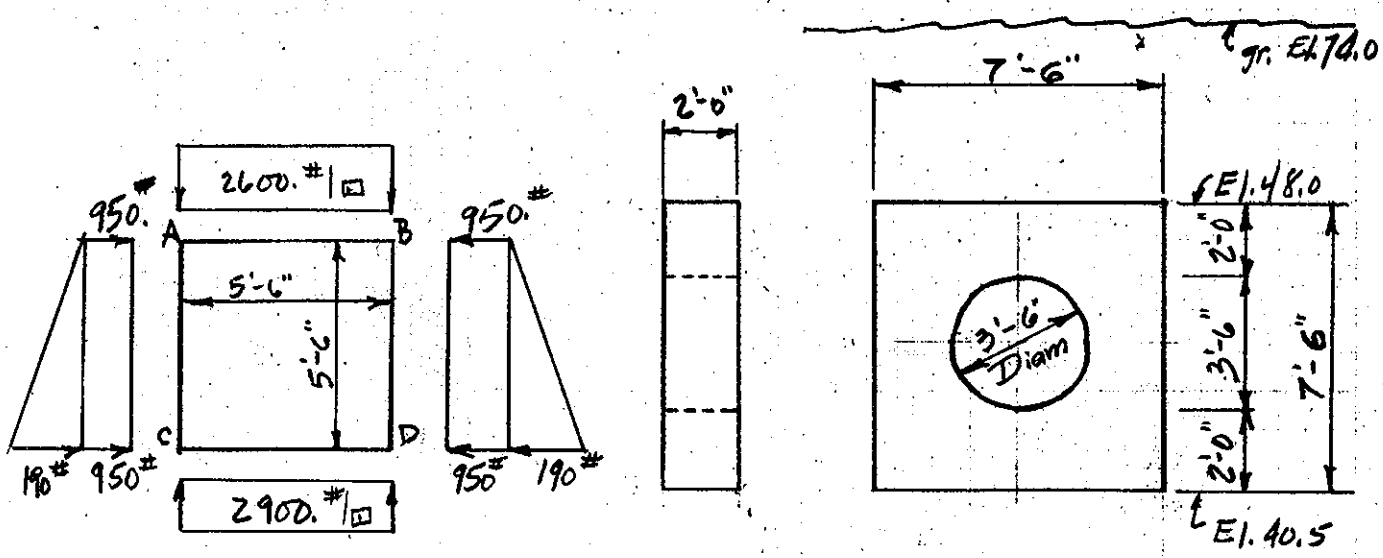
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject SPRINGDALE PUMPING STATION

Computation Seep Ring -

Computed by H.L.F. **Checked by** _____ **Date** 13 Sept. 1945



Base Pressure

$$26 \times 100 = 2600$$
$$2 \times 150 = 300$$
$$2900 \ \#/\square$$

F.E.M

$$AB = BA = 2{,}600 \times \frac{5.5^2}{12} = 6{,}560.'\#$$

$$CD = DC = 2{,}900 \times \frac{5.5^2}{12} = 7{,}330.'\#$$

$$AC = BD = 950 \times \frac{5.5^2}{12} + \frac{1}{15} \times \overset{190}{190} \times \frac{5.5^2}{2} = 2{,}590'\#$$

$$CA = DB = 2{,}400 + \frac{1}{10} \times \overset{290}{190} \times \cancel{\frac{5.5^2}{2}} = 2{,}690'\#$$

F 74b

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject SPRINGDALE PUMPING STATION

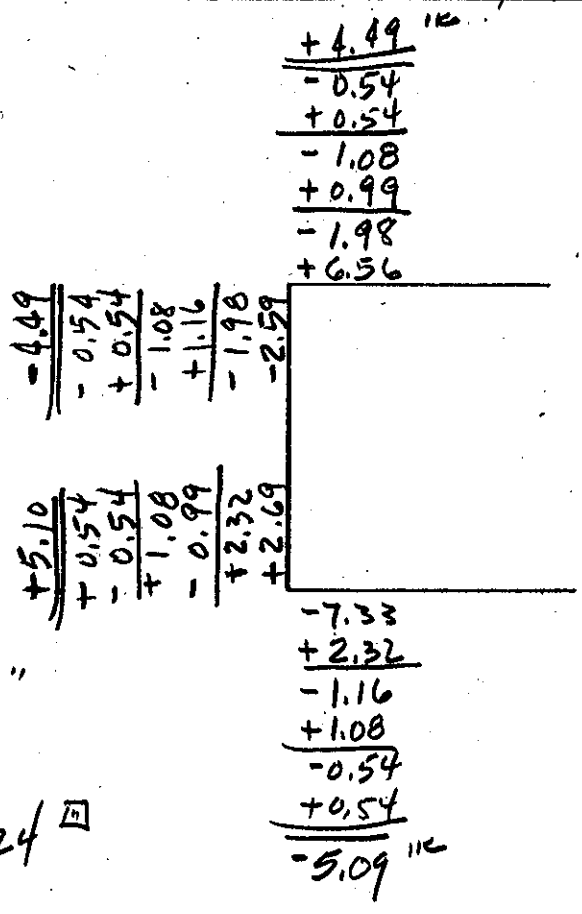
Computation Seep Ring

Computed by H.L.F. **Checked by** _____ **Date** 13 Sept. 1945

Moment Distribution

$V_{C-D} = 2,900 \times 2.75 = 8,000.^{\#}$

$+M_{C+D} = 2900 \times \frac{5.5^2}{8} - 5,090 = 5,910.'^{\#}$ (11,000)



$b = 12''$ $t = 1'-10''$ $d = 18.5''$

$$A_s = \frac{5,910 \times 12}{18,000 \times .88 \times 18.5} = 0.24 \ \square''$$

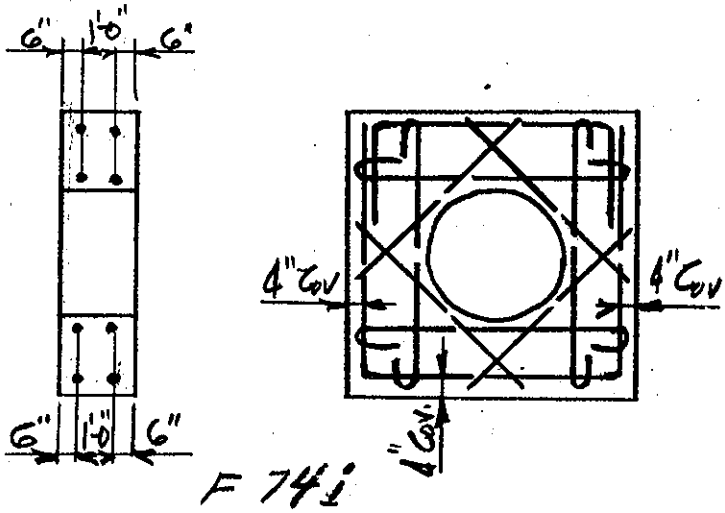
$$v = \frac{8000}{12 \times .88 \times 18.5} = 41. \ ^{\#}/\square''$$

$u = 2.36$ $= 208 \ ^{\#}/\square''$

$1-3/4''\phi = .44$

$\Sigma_0 = 2.36$

Spec. Anch.



All bars = 3/4" ϕ

Cover = 3" except where noted

F 74i

B. Holyoke Pumping Station NO. 5

HOLYOKE PUMPING STATION #5

WEIGHT OF MECHANICAL EQUIPMENT

30" Propeller Pump with motor	11,500#
30" Discharge pipe and valves full of water	8,500#
Thrust on pump	6,000#
Switchboard	2,500#
Sluice gate and frame	5,500#
Max. load on sluice gate floorstand	12,000#
Heater	600#
4-Ton Crane	
Max. wheel load	5,000#
c-c crane rail 3'-6"	
Use 30# rail	
Wt. of sump pump with motor	1,000#

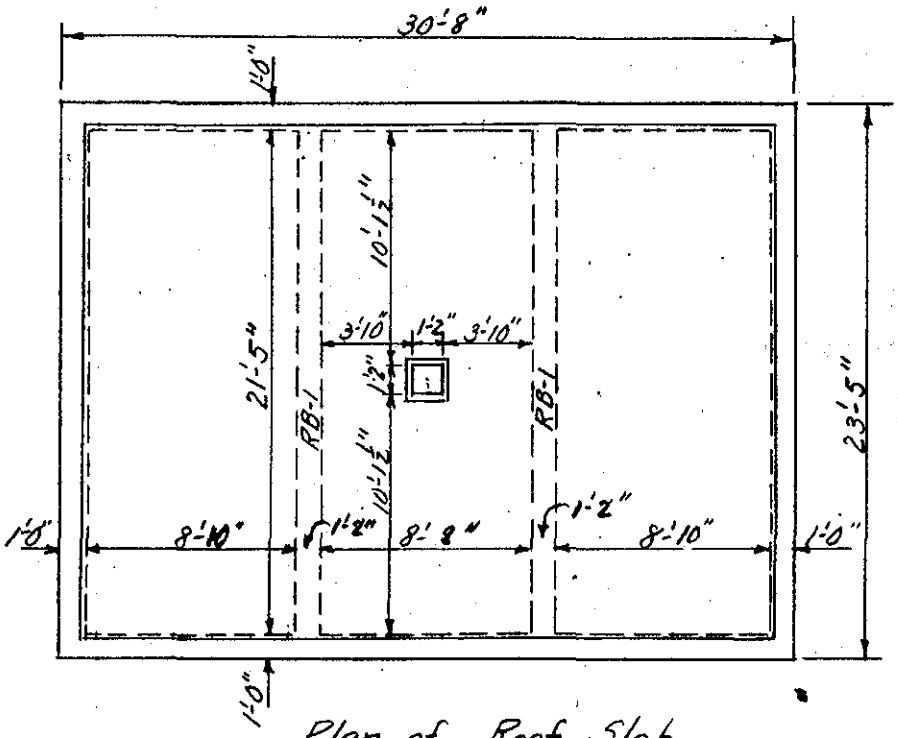
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5

Computation Roof Slab

Computed by H.E.W. **Checked by** **Date** 5-June-45



Plan of Roof Slab

Roof will be designed for a Live Load of 40#/□'

D.L. 5" Slab =	5/12 x 150	=	65
D.L. comp. roofing		=	5
Live Load		=	40
			110#/□'

	110#/□'					
	9'-11"		9'-10"		9'-11"	
		.50	.50	.50	.50	
	+.90	-0.90	+0.83	-0.83	+0.90	-0.90
	-.90	+0.03	+0.04	-0.04	-0.03	+0.90
	+0.01	-0.45	-0.02	+0.02	+0.45	-0.01
	-0.01	+0.24	+0.23	-0.23	-0.24	+0.01
-M	0.00	-1.08	+1.08	-1.08	+1.08	0.00
V	0.44	0.65	0.54	0.54	0.65	0.44
x_0	→ 4.0'		→ 4.91 ←		4.0' ←	
+M	0.88'K		0.24'K		0.88'K	

F. E. M

$M^F = \frac{1}{12} \times 110 \times 9.92^2 = .90'^K$

$M^F = \frac{1}{12} \times 110 \times 9.83^2 = .89'^K$

reqd d = $\sqrt{\frac{1080}{147}} = 2.71" < 3.25"$

$-A_s = \frac{1080 \times 12}{18000 \times .88 \times 3.25} = .25^{\square"}$

Use ½"ϕ @ 9" c c

$u_0 = \frac{650}{2.1 \times .88 \times 3.25} = 108\ \#/\square"$

$v = \frac{650}{12 \times .88 \times 3.25} = 19\ \#/\square"$

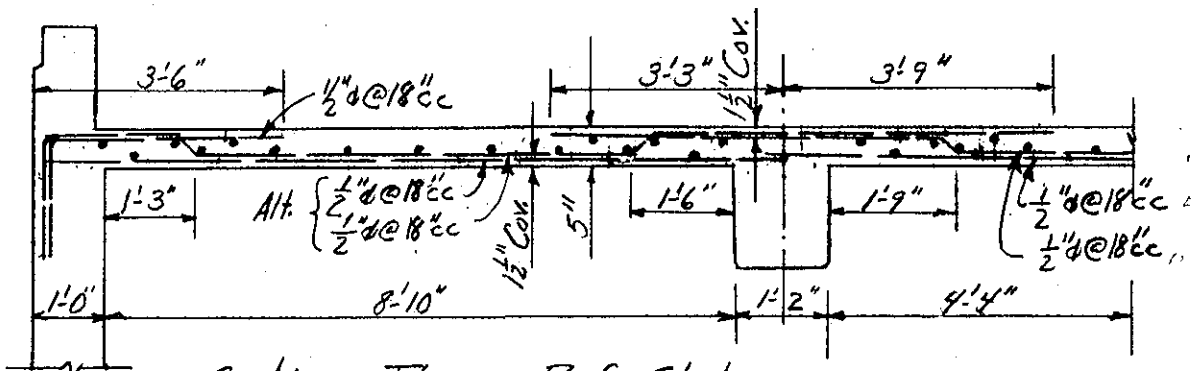
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

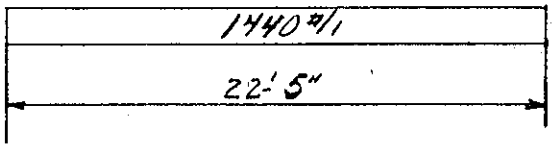
Computation Roof Slab

Computed by H.E.W. **Checked by** **Date** 5-June-45



Section Thru Roof Slab

Roof Beam RB-1



React from slab = 1190

Assume 14"x22" bm = 1.17x1.42x150 = 250

1440#

$R_L = R_R = 1440 \times 22.42 \times .5 = 16140^{\#}$

$M = \frac{1}{8} \times 1440 \times 22.42^2 = 90{,}480'^{\#}$

Beam will act as a Tee Beam $b = 67"$ $\frac{t}{d} = \frac{5}{19.5} = .256$

$k = .348$ $K = 116$

req'd $d = \sqrt{\frac{90480 \times 12}{67 \times 116}} = 11.8" < 19.5"$ OK

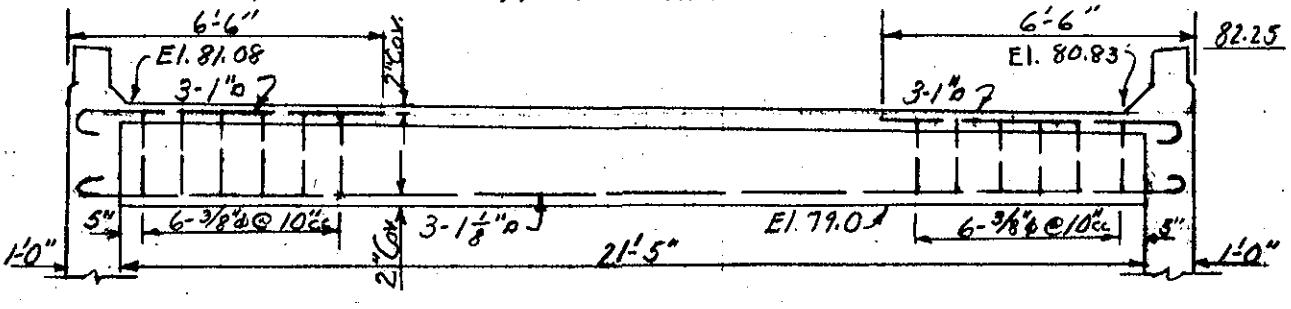
$v = \frac{16140}{14 \times .88 \times 19.5} = 67\ \#/\square''$

$A_s = \frac{90480 \times 12}{18000 \times .88 \times 19.5} = 3.51\ \square''$ Use 3-1⅛"ϕ bars

$u_o = \frac{16140}{13.5 \times .88 \times 19.5} = 70\ \#/\square''$

RB-1

14"x 1'-10" min.



WAR DEPARTMENT

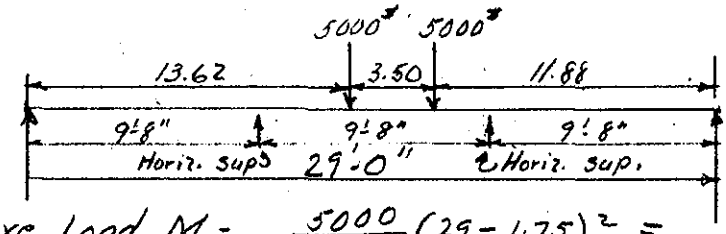
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Crane Beam

Computed by H.E.W. **Checked by** _____ **Date** 14 June 45

Crane capacity 4 Tons
Wheel spacing 3'-6"
Max. wheel load 5000#



Live Load $M = \frac{5000}{2 \times 29}(29 - 1.75)^2 = 64{,}010$

25% Impact = 16000

D.L. Mom $= \frac{1}{8} \times 60 \times 29^2 =$ 6300

86310 '#

Horiz Thrust = 20% Crane Cap $= \frac{1}{5} \times 8000 \times \frac{1}{4} = 400$ #/wheel

Lat. Mom $= \frac{400}{2 \times 9.67}(9.67 - 1.75)^2 = 1300$ '#

Try 12" WF x 50# $b = 8.077$ $S_{xx} = 64.7$ $S_{yy} = 14.0$

$\frac{l}{b} = \frac{116}{8.077} = 14.36$ — the allow. $f_s = 20{,}000$ #/□"

Actual stress

Vert $M = \frac{86310 \times 12}{64.7} = 16010$ #/□"

Horiz $M = \frac{1300 \times 12}{14 \times .5} = 2230$ #/□"

18240 #/□" < 20,000 #/□" OK

Use 12" WF x 50#

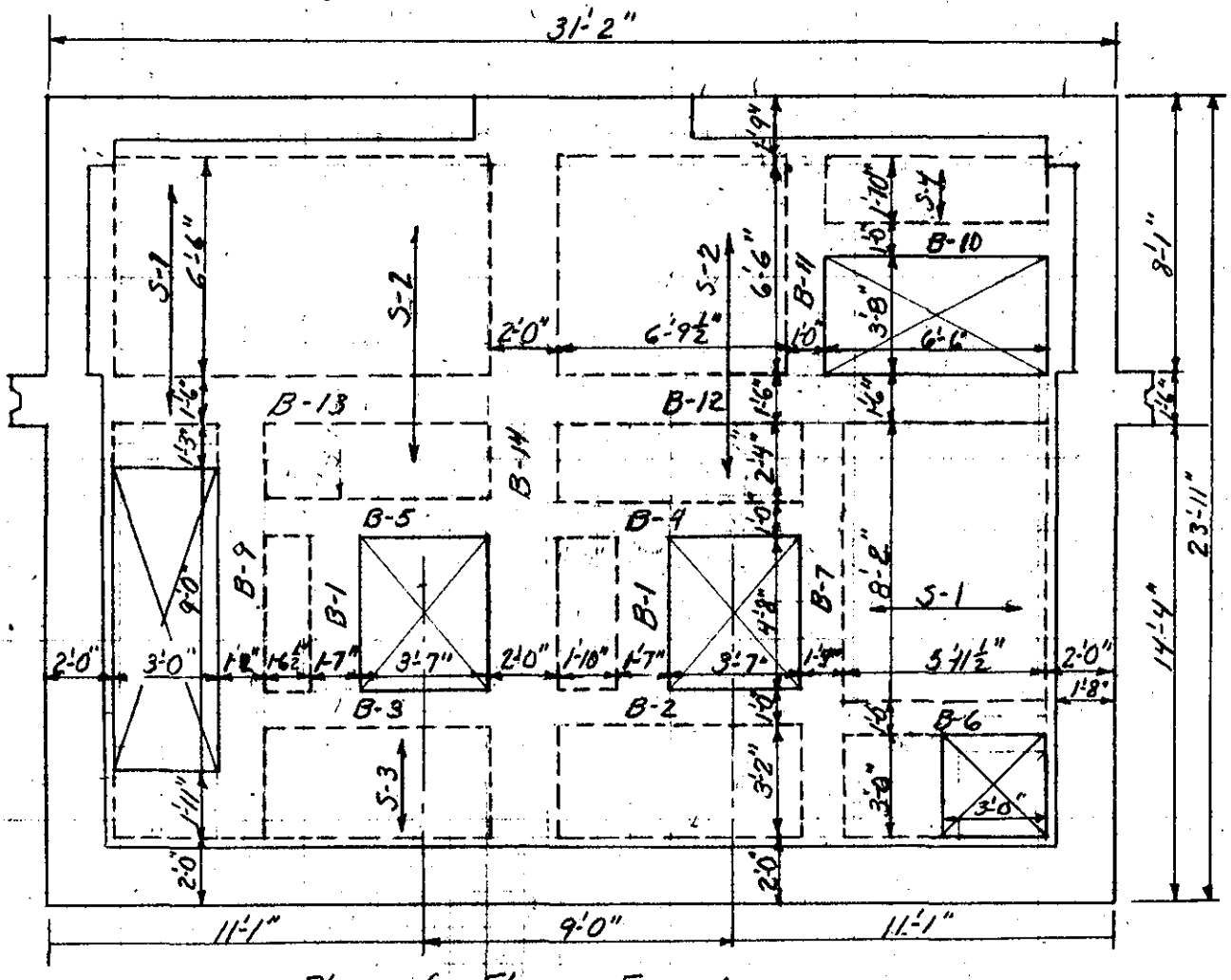
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5

Computation Motor Room Floor Slab

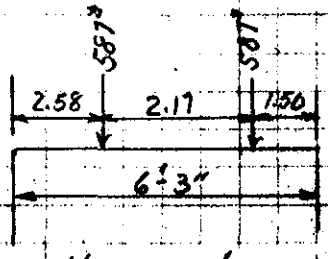
Computed by H.E.W. **Checked by** **Date** 6- June -45



Plan of Floor Framing

Equivalent uniform Floor Load

Load of Motor distributed along circumferance (Use circle thru anchor bolts) = $\frac{4000}{\pi\, 2.17}$ = 587 #/'



$M = \frac{587}{12.5}\left(6.25 - \frac{2.17}{2}\right)^2 = 1255$ '#

Equiv. unif. w. = $\frac{1255 \times 8}{6.25^2} = 257$ #/□'

Use a Live Load of 250 #/□' for slabs

Use a Live Load of 200 #/□' plus concentrated equipment load for beams

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Motor Room Floor Slab

Computed by H.E.W. **Checked by** _____ **Date** 7 June-45

Slab S-1

Uniform L.L. = 250 #/□'
D.L. 10" slab 125
375 #/□'

375 #/□'			
2'-0"	8'-1½"		Fixed
-0.75	+2.06	2.06	
	-1.31	0.00	
	0.00	-0.61	
		0.00	
	0.75	2.67	-M
	1.29	1.76	V
	4.69'	←	x_0
	1.46'k		+M

F.E.M

$M^F = \frac{1}{12} \times 375 \times 8.12^2 = 2060$ '#

$M^F = 2 \times 3.75 \times 1 = 750$ '#

req'd $d = \sqrt{\frac{2670}{147}} = 4.3" < 8.7"$ OK

(10" slab used to take thrust from walls)

$v = \frac{1760}{12 \times .88 \times 8.7} = 19$ #/□'

$-A_s = \frac{2670 \times 12}{18000 \times .88 \times 8.7} = .23$ □" Use 5/8"φ @ 12"cc

+As Use 5/8"φ @ 1'-0"cc

$u_0 = \frac{1760}{1.76 \times .88 \times 8.7} = 117$ #/□'

Slab S-2

F.E.M

$M^F = \frac{1}{12} \times 3.75 \times 3.58^2 = 0.40$ 'k

375 #/□'				
3'-7"		8'-1½"		
.70		.30		
+0.40	-0.40	+2.06	-2.06	
-0.40	-1.16	-0.50	0.00	
-0.58	-0.20	0.00	-0.25	
+0.58	+0.14	+0.06	0.00	
+0.07	+0.29	0.00	+0.03	
-0.07	-0.28	-0.09	0.00	
0	-1.53	+1.53	-2.28	-M
0.24	1.18	1.43	1.62	V
→0.64		4.32	←	x_0
0.010'k		1.22'k		+M

$-A_s = \frac{2280 \times 12}{18000 \times .88 \times 8.7} = .20$ □" Use 5/8"φ @ 12"cc

$u_0 = \frac{1620}{1.76 \times .88 \times 8.7} = 108$ #/□"

+As Use 5/8"φ @ 1'-0"cc

Slab S-3

375 #/□'
4'-9"

A B

FEM - $M^F = \frac{1}{12} \times 375 \times 4.67^2 = 680$ 'k

$-M$ at $A = 680 + \frac{680}{2} = 1020$ '#

$-M$ at $B = 0$

$V_A = 375 \times \frac{4.67}{2} + \frac{1020}{4.67} = 1090$ # $x_0 = 2.91$ $+M = 1090 \times 2.91 - 1090 - 375 \times \frac{2.91^2}{2} = 490$ '#

Use 5/8"φ @ 1'-0"cc Top & Bot

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Motor Room Floor Slab

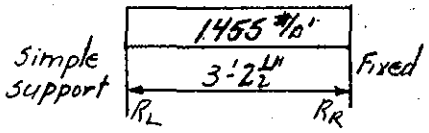
Computed by H.E.W. **Checked by** _____ **Date** 7-June-45

Slab S-4

D.L. 8" Slab = 125 #/□'

Assume Gate ld. spread over 3' wide strip = $\frac{12000}{9}$ = 1330

1455 #/□'



F.E.M. = $\frac{1}{12} \times 1455 \times 3.21^2 = 1.25^{'k}$

$-M$ at R_R: $1.25 + \frac{1.25}{2} = 1.87^{'k}$ $-M$ at $R_L = 0$

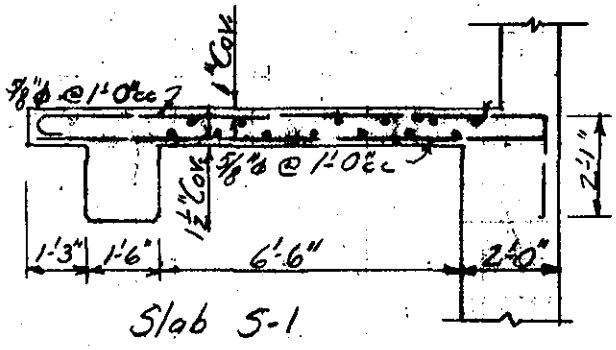
$R_R = 1455 \times \frac{3.21}{2} + \frac{1870}{3.21} = 2920^{\#}$ $R_L = 1455 \times \frac{3.21}{2} - \frac{1870}{3.21} = 1750^{\#}$

$+M = 1750 \times 1.20 - 1455 \times \frac{1.20^2}{2} = 1050^{'\#}$

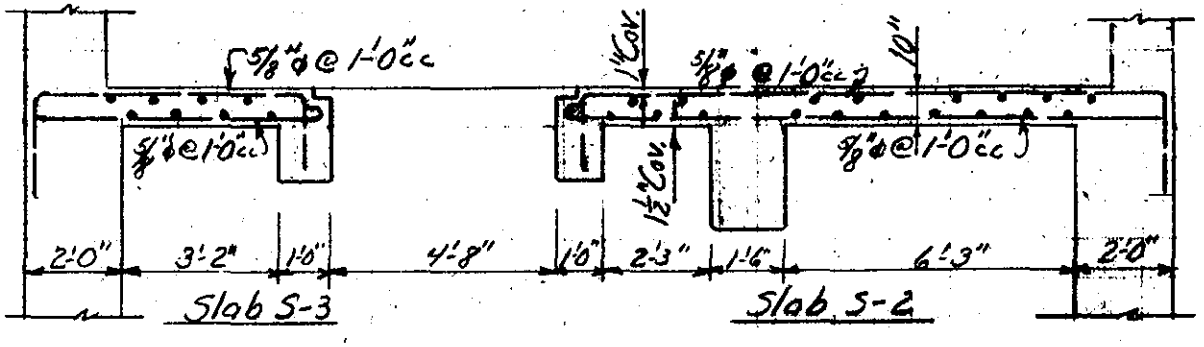
$v = \frac{2920}{12 \times .88 \times 8.7} = 32$ #/□"

5/8"ϕ @ 1'-0"cc Top + Bot. OK. for mom.

$u_0 = \frac{2920}{1.96 \times .88 \times 8.7} = 195$ #/□" high Use 5/8"ϕ @ 6"cc for 3 ft. Strip



Slab S-1



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

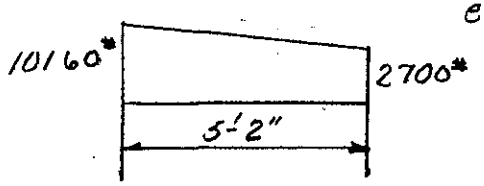
Subject Holyoke Pumping Station No. 5
Computation Motor Room Floor Slab
Computed by H.E.W. **Checked by** **Date** 7-June-45

Load Dist. on Motor Support Plates

Wt. 30" Propeller Pump with Motor = 11500#
Impact at 100% = = 11,500#
Thrust on Pump = 6000#
Wt of Disc. pipe and valves with water: $\frac{8500}{2}$ = 4250#
Total load on plate 33 250#

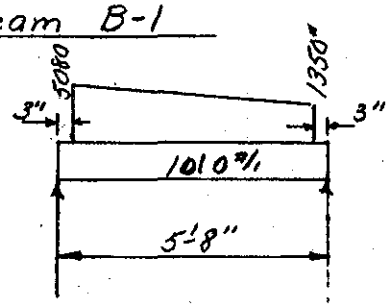
Dist. of load on plate

eccentricity of load = .50'



$$\frac{33250}{5.17}\left(1 \pm \frac{6 \times .50}{5.17}\right) = \begin{matrix}10160\# \\ 2700\#\end{matrix}$$

Beam B-1



Beam will be made 19" wide to take 4" pipe sleeve

D.L. 10" Slab = 125 × 2.50 = 310#
L.L. = 200 × 2.50 = 500
D.L. 19" × 20" bm = 1.58 × .83 × 150 = 200
1010#/'

R_L = 1010 × 5.67 × .5 = 2860
1350 × 5.17 × .5 = 3490
3730 × 5.17 × .5 × .653 = 6300
12650#

R_R = 1010 × 5.67 × .5 = 2860
1350 × 5.17 × .5 = 3490
3730 × 5.17 × .5 × .347 = 3350
9700#

x_0 3.03' from R_R

$$M = 9700 \times 3.03 - 1010 \times \frac{3.03^2}{2} - 1350 \times \frac{2.78^2}{2} - 2010 \times \frac{2.78^2}{6} = 16{,}950'\#$$

$$\text{req'd } d = \sqrt{\frac{16{,}950 \times 12}{14.5 \times 123}} = 10.7" < 14.5"$$

Note. Top 3" of beam is taken up by frame and must be neglected

$$v = \frac{12650}{14.5 \times .88 \times 14.5} = 68\#/\square''$$

OK Use 19" × 20" bm.

$$A_s = \frac{16950 \times 12}{18000 \times .88 \times 14.5} = .89\square''$$

Use 4-5/8"ϕ

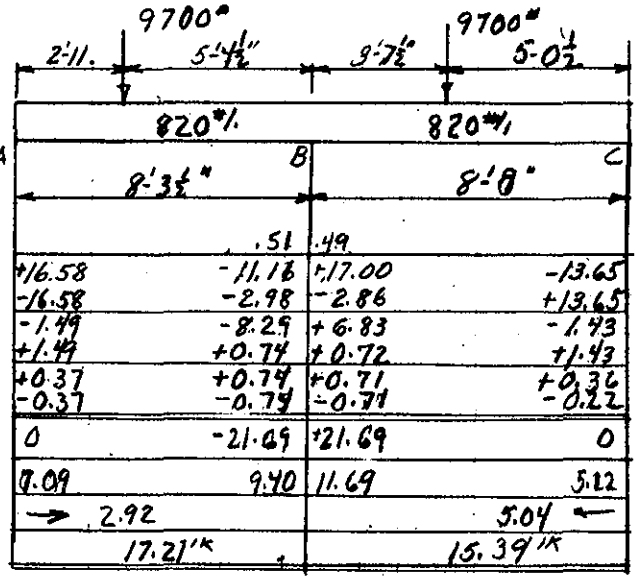
$$u_0 = \frac{12650}{7.86 \times .88 \times 14.5} = 126\#/\square''$$

Subject Holyoke Pumping Station No 5

Computation Motor Room Floor Beams

Computed by H.E.W. **Checked by** **Date** 8 June 45

Beam B-2 & Beam B-3



		.51	.49	
	+16.58	-11.16	+17.00	-13.65
	-16.58	-2.98	-2.86	+13.65
	-1.49	-8.29	+6.83	-1.43
	+1.49	+0.74	+0.72	+1.43
	+0.37	+0.74	+0.71	+0.36
	-0.37	-0.74	-0.71	-0.22
-M	0	-21.69	+21.69	0
V	7.09	9.40	11.69	5.22
x_0	→ 2.92		5.04 ←	
+M	17.21'k		15.39'k	

D.L. 10" slab = 2.08×125 = 260

L.L 2.08×200 = 420

D.L. 12×21" bm = 1×.92×150 = 140

820#

F.E.M

Member AB

$M^F_{AB} = \frac{1}{12}\times 820\times 8.29^2 + \frac{9700\times 5.37^2\times 2.92}{8.29^2} = 16.58'^k$

$M^F_{BA} = \frac{1}{12}\times 820\times 8.29^2 + \frac{9700\times 2.92^2\times 5.37}{8.29^2} = 11.16'^k$

Member BC

$M^F_{BC} = \frac{1}{12}\times 820\times 8.67^2 + \frac{9700\times 5.04^2\times 3.62}{8.67^2} = 17.00$

$M^F_{CB} = \frac{1}{12}\times 820\times 8.67^2 + \frac{9700\times 3.62^2\times 5.04}{8.67^2} = 13.65$

req'd d = $\sqrt{\frac{21690}{147}}$ = 12.1" < 15.5" OK

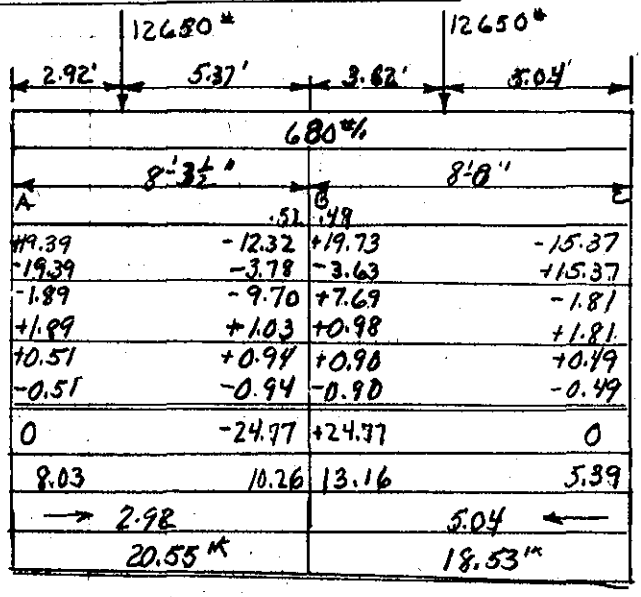
$v = \frac{11690}{12\times .88\times 15.5} = 71\ \#/\square''$ OK

$-A_s = \frac{21,690\times 12}{18000\times .88\times 15.5} = 1.08\ \square''$ Use 3-3/4"φ

$u_0 = \frac{11690}{7.07\times .88\times 15.5} = 121\ \#/\square''$

$+A_s$ Use 3 - 3/4"φ

Beam B-4 & Beam B-5



		.51	.49	
	+19.39	-12.32	+19.73	-15.37
	-19.39	-3.78	-3.63	+15.37
	-1.89	-9.70	+7.69	-1.81
	+1.89	+1.03	+0.98	+1.81
	+0.51	+0.94	+0.90	+0.49
	-0.51	-0.94	-0.90	-0.49
-M	0	-24.97	+24.97	0
V	8.03	10.26	13.16	5.39
x_0	→ 2.98		5.04 ←	
+M	20.55'k		18.53'k	

D.L. 8" slab = 1.67×125 = 210 #/'

L.L = 1.67×200 = 330

D.L. 12"×21" bm = 140

680 #/'

F.E.M

$M^F_{AB} = \frac{1}{12}\times 680\times 8.29^2 + \frac{12650\times 5.37^2\times 2.92}{8.29^2} = 19.39'^k$

$M^F_{BA} = \frac{1}{12}\times 680\times 8.29^2 + \frac{12650\times 2.92^2\times 5.37}{8.29^2} = 12.32'^k$

$M^F_{BC} = \frac{1}{12}\times 680\times 8.67^2 + \frac{12650\times 5.04^2\times 3.62}{8.67^2} = 19.73'^k$

$M^F_{CB} = \frac{1}{12}\times 680\times 8.67^2 + \frac{12650\times 3.62^2\times 5.04}{8.67^2} = 15.37'^k$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Motor Room Beams

Computed by H.E.W. **Checked by** _____ **Date** 8 June 45

Beams B-3 + B-4 (cont.)

reqd $d = \sqrt{\frac{24770}{147}} = 13.0" < 15.5"$ OK

$v = \frac{13160}{12 \times .88 \times 15.5} = 80$ #/□" Use Stirrups

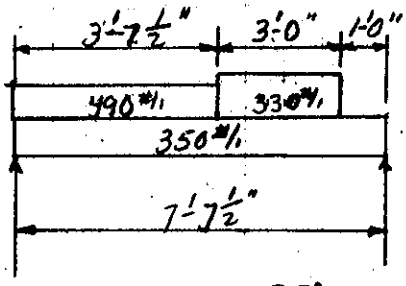
$-A_s = \frac{24770 \times 12}{18000 \times .88 \times 15.5} = 1.21$ □" Use 3-3/4"φ

$u_o = \frac{13160}{7.07 \times .88 \times 15.5} = 136$ #/□"

$+A_s$ Use 3-3/4"φ

Stirrup spacing = 3/8"φ @ 4", 9" 9" 9"

Beam B-6



D.L. 12"x 12" Bm = 1x1x150 = 150
L.L = 1x200 = 200
350#/'

D.L. 10" Slab = 1.50 x 125 = 190#/'
L.L = 1.50 x 200 = 300#/'
490#/'

Wt. Sump pump = 1000#
Impact @ 100% = 1000
2000#

load per ft. = $\frac{2000}{2 \times 3}$ = 330#/'

$R_L = 350 \times 7.62 \times .5 + 330 \times 3.0 \times \frac{2.50}{7.62} + 490 \times 3.62 \times \frac{5.88}{7.62} = 3010$#

$R_R = 350 \times 7.62 \times .5 + 330 \times 3.0 \times \frac{5.12}{7.62} + 490 \times 3.62 \times \frac{1.88}{7.62} = 2480$#

$x_o = 3.58'$ from R_L

$M = 3010 \times 3.58 - 840 \times \frac{3.58^2}{2} = 5390'$#

reqd $d = \sqrt{\frac{5390}{123}} = 6.6' < 9.5"$ OK

$v = \frac{3010}{12 \times .88 \times 9.5} = 30$ #/□"

$A_s = \frac{5390 \times 12}{18000 \times .88 \times 9.5} = .43$ □" Use 2-5/8"φ

$u_o = \frac{3010}{3.93 \times .88 \times 9.5} = 92$ #/□"

WAR DEPARTMENT

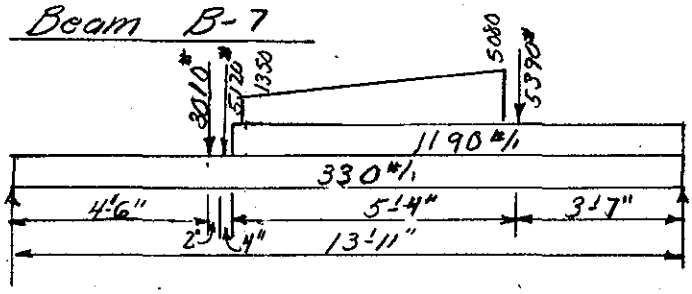
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5

Computation Motor Room Beams

Computed by H.E.W. **Checked by** **Date** 9-June-45

Beam B-7



D.L. 16"x30" bm = 1.33x1.67x150 = 330

D.L. 10" slab = 3.65x125 = 460#

L.L = 3.65x200 = 730

1190

R_L = 330x13.92x.5 = 2300
1190x8.92x.320 = 3400
1350x5.17x.467 = 3260
3730x5.17x.5x.405 = 3910
5390x.257 = 1390
5120x.665 = 3400
3010x.677 = 2040
19,700#

R_R = 330x13.92x.5 = 2300
1190x8.92x.680 = 7220
1350x5.17x.533 = 3720
3730x5.17x.5x.595 = 5740
5390x.743 = 4000
5120x.335 = 1720
3010x.323 = 970
25670

x_0 = 7.77' from R_L

$$M = 19700\times7.77 - 330\times\frac{7.77^2}{2} - 1190\times\frac{2.77^2}{2} - 1350\times\frac{2.52^2}{2} - 1820\times\frac{2.52^2}{6}$$

$$- 3010\times3.27 - 5120\times3.10 = 106,620'^{\#}$$

$$\text{req'd } d = \sqrt{\frac{106620\times12}{16\times123}} = 25.4" > 24.5"$$ OK as beam will have some Tee Beam action

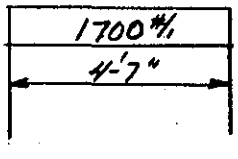
$$v = \frac{25670}{16\times.88\times27.5} = 66\#/\square''$$ OK Use 16"x30" beam

$$A_s = \frac{106620\times12}{18000\times.88\times24.5} = 3.30\square''$$ Use 2-1"⌀ + 2-1"□

$$u_0 = \frac{25670}{14.28\times.88\times27.5} = 75\#/\square''$$

Stairway Landing

D.L. 1'-11"x1'-10" bm = 1.92x1.83x150 = 530#/'
L.L = 1.92x200 = 380#/'
910#/'



Approx. Stairway load = 105x7.5 = 790#/'

React = 1700x4.58x.5 = 3890#

React. ld per ft. = $\frac{3890}{1.92}$ = 2030#

$$M = \frac{1}{8}\times1700\times4.58^2 = 4460'^{\#}$$

Use 3-5/8"⌀ Top + Bot.

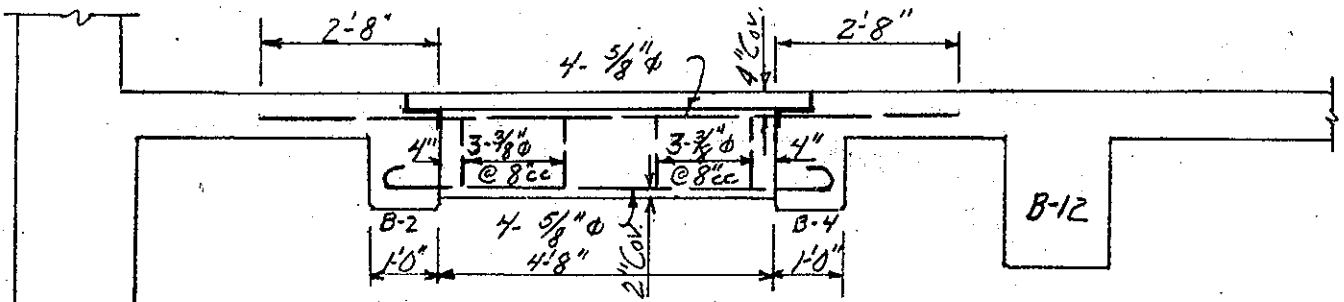
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

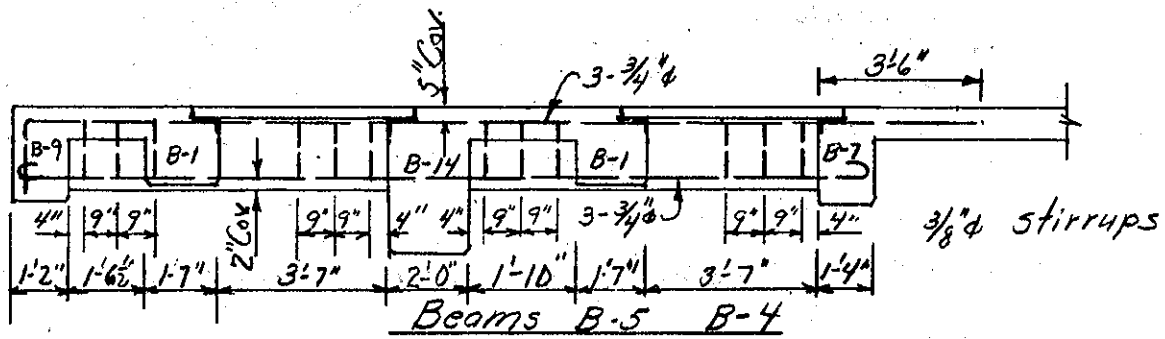
Subject Holyoke Pumping Station No 5

Computation Motor Room Floor Beams

Computed by H.E.W. **Checked by** **Date** 9-June-45

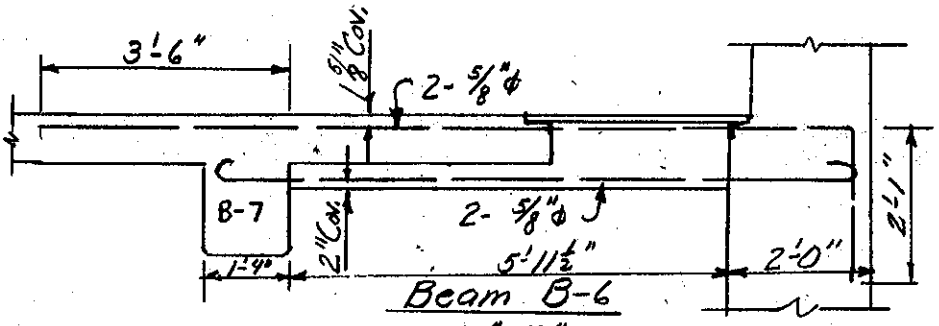


Beam B-1
19"x 20"

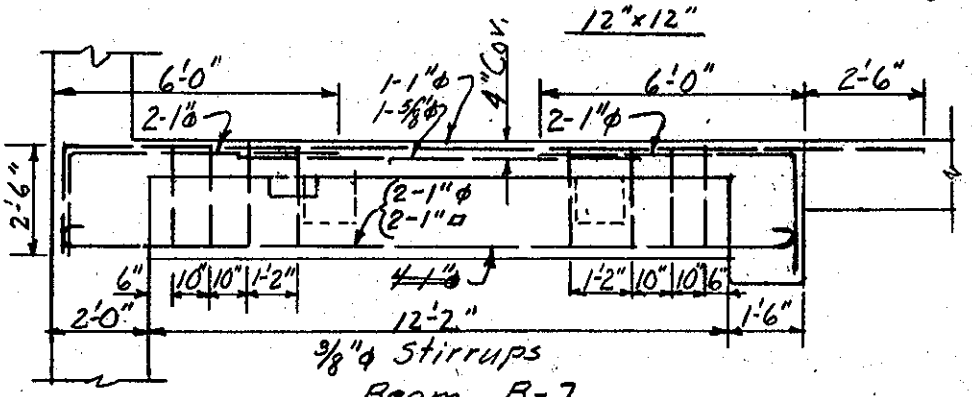


3/8"φ stirrups

Beams B-5 B-4
Beams B-3 B-2
12"x 21"



Beam B-6
12"x12"



3/8"φ Stirrups

Beam B-7
16"x 30"

WAR DEPARTMENT

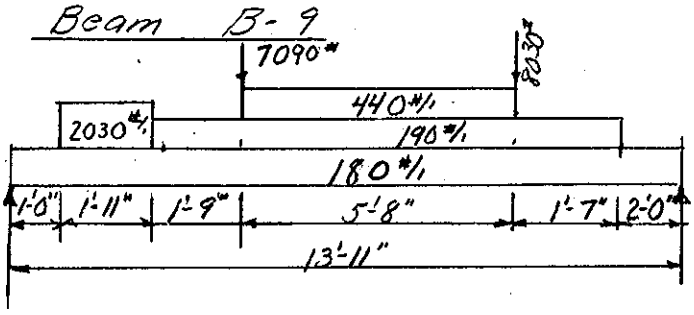
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Motor Room Floor Beams

Computed by H. E. W. **Checked by** _____ **Date** 11-June-45

Beam B-9



D.L. 14"x22" beam = 1.17 x 1.0 x 150 = 180#/'

7" width of beam adjacent to stairway

D.L = 0.58 x 125 = 70

L.L = 0.58 x 200 = 120

190#/'

D.L. 10" Slab = 1.35 x 125 = 170

L.L = 1.35 x 200 = 270

440#/'

R_L =	180 x 13.92 x .5	= 1250#	R_R =	180 x 13.92 x .5	= 1250#
	190 x 9 x .467	= 800		190 x 9 x .533	= 910
	440 x 5.67 x .461	= 1150		440 x 5.67 x .539	= 1340
	2030 x 1.92 x .859	= 3350		2030 x 1.92 x .141	= 550
	7090 x .665	= 4710		7090 x .335	= 2380
	8030 x .246	= 1980		8030 x .753	= 6050
		13240#			12480#

x_0 = 7.91' from R_R

$$M = 12480 \times 7.91 - 180 \times \frac{7.91^2}{2} - 190 \times \frac{5.91^2}{2} - 440 \times \frac{4.33^2}{2} - 8030 \times 4.33 = 50870'^{\#}$$

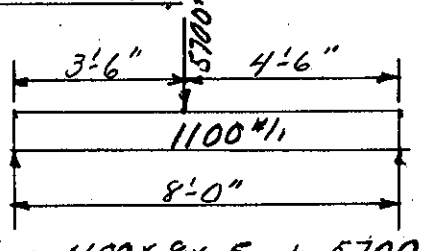
$$\text{req'd } d = \sqrt{\frac{50870 \times 12}{14 \times .123}} = 18.8'' < 19.5'' \text{ OK}$$

$$v = \frac{13240}{14 \times .88 \times 19.5} = 55\ \#/\square''$$

$$A_s = \frac{50870 \times 12}{18000 \times .88 \times 19.5} = 1.98\ \square'' \text{ Use } 3\text{-}1''\phi$$

$$u_0 = \frac{13240}{9.42 \times .88 \times 19.5} = 82\ \#/\square'' \text{ OK}$$

Beam B-10



D.L. 10" Slab = 125 x 1.92 = 240

L.L = 200 x 3.75 = 750

D.L. 12"x16" bm = 1 x 0.50 x 150 = 80

D.L. Cov. Pl. = 15 x 1.83 = 30

1100#/'

Gate conc. = $12000 \times \frac{.87}{1.83}$ = 5700#

$$R_L = 1100 \times 8 \times .5 + 5700 \times \frac{4.5}{8.0} = 7610^{\#}$$

$$R_R = 1100 \times 8 \times .5 + 5700 \times \frac{3.5}{8} = 6890^{\#}$$

x_0 = 3.5' from R_L

$$M = 7610 \times 3.5 - 1100 \times \frac{3.5^2}{2} = 19900'^{\#}$$

$$\text{req'd } d = \sqrt{\frac{19900}{123}} = 12.7'' > 13.5''$$

Subject Holyoke Pumping Station No 5
Computation Motor Room Floor Beams
Computed by H.E.W. **Checked by** **Date** 11-June-45

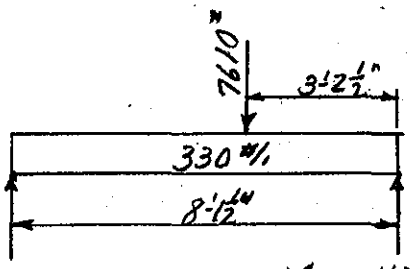
Beam B-10 (cont.)

$v = \frac{7610}{12 \times .88 \times 13.5} = 53$ #/□"

$A_s = \frac{19900 \times 12}{18000 \times .88 \times 13.5} = 1.12$ □" Use 2-7/8"φ

$u_0 = \frac{7610}{5.5 \times .88 \times 13.5} = 117$ #/□" OK.

Beam B-11



D.L. 12"x18" bm = 1x1.5x150 = 230#
L.L = .5x200 = 100
(L.L on ½ bm. width in B-10) 330 #/'

$R_L = 330 \times 8.12 \times .5 + 7610 \times \frac{3.21}{8.12} = 4350$#

$R_R = 330 \times 8.12 \times .5 + 7610 \times \frac{4.91}{8.12} = 5940$#

$M = 4350 \times 4.91 - 330 \times \frac{4.91^2}{2} = 17,380$ '#

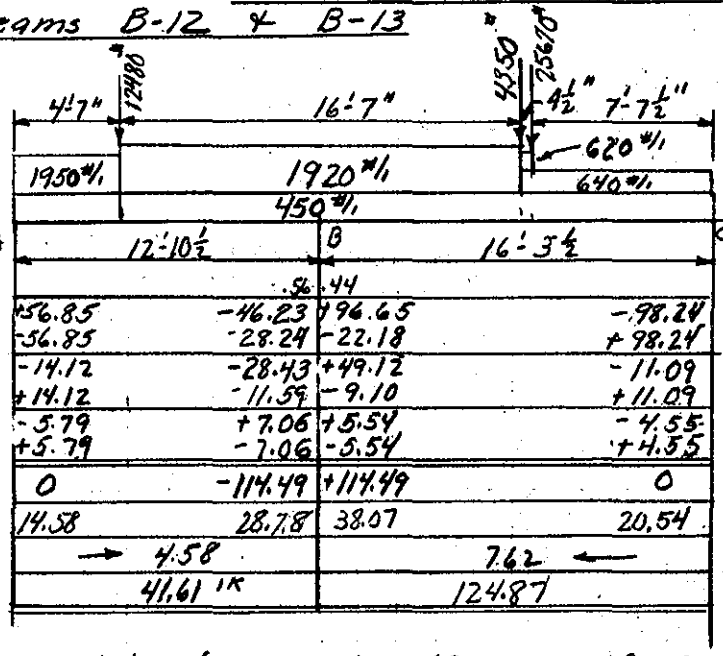
req'd $d = \sqrt{\frac{17380}{123}} = 12.1" < 15.5"$ OK

$v = \frac{5940}{12 \times .88 \times 15.5} = 36$ #/□" OK

$A_s = \frac{17380 \times 12}{18000 \times .88 \times 15.5} = .85$ □" Use 2-7/8"φ

$u_0 = \frac{5940}{5.5 \times .88 \times 15.5} = 79$ #/□"

Beams B-12 & B-13



Assume bm 18"x 34" = 1.5x2.0x150 = 450 #/'
D.L. 10" Slab = 6.0x125 = 750 #/'
L.L = 6.0x200 = 1200
1950 #/'

D.L. 10" Slab = 5.92x125 = 740
L.L = 5.92x200 = 1180
1920 #/'

D.L. Cov. Pl = 1.83x15 = 30
L.L = 2.58x200 = 520
D.L. 10" Slab = .75x125 = 90
640 #/'

D.L. 10" Slab = 1.92x125 = 290
L.L = 1.92x200 = 380
620 #/'

(For F.E.M see next page)

Note. (In member AB use uniform w = 2400 #/')

Subject Holyoke Pumping Station No 5
Computation Motor Room Floor Beams
Computed by H.E.W. **Checked by** **Date** 12-June-45

Beam B-12 + B-13 (cont.)

Fixed End Moments

Member AB

$$M^F_{AB} = \frac{1}{12}\times 2400\times 12.87^2 + \frac{12480\times 4.58\times 8.29^2}{12.87^2} = 56.85^{'K}$$

$$M^F_{BA} = \frac{1}{12}\times 2020\times 12.87^2 + \frac{12480\times 4.58^2\times 8.29}{12.87^2} = 46.23^{'K}$$

Member BC

$$M^F_{BC} = \frac{1}{12}\times 1090\times 16.29^2 + \frac{.509(\overset{2.005}{6-8\times .509+3\times .509^2})}{12}\times \overset{172.856}{1280\times 8.29}\times 16.29 + \frac{4350\times 8^2\times 8.29}{16.29^2}$$

$$+ \frac{25{,}670\times 7.62^2\times 8.67}{16.29^2} + \frac{620\times .37\times 7.80^2\times 8.49}{16.29^2} = 96.65$$

$$M^F_{CB} = \frac{1}{12}\times 1090\times 16.29^2 + \frac{\overset{.259}{.509^2}(\overset{2.473}{4-3\times .509})}{12}\times \overset{172.856}{1280\times 8.29}\times 16.29 + \frac{4350\times 8.29^2\times 8}{16.29^2}$$

$$+ \frac{25670\times 8.67^2\times 7.62}{16.29^2} + \frac{620\times .37\times 8.49^2\times 7.80}{16.29^2} = 98.24$$

Member AB

$$V_A = 2400\times 12.87\times .5 - \frac{114{,}490}{12.87} + 12480\times\frac{8.29}{12.87} = 14{,}580^{\#}$$

$$V_B = 2400\times 12.87\times .5 + \frac{114{,}490}{12.87} + 12480\times\frac{4.58}{12.87} = 28\,780^{\#}$$

$x_0 = 4.58'$ from A

$$+M = 14580\times 4.58 - 2400\times\frac{4.58^2}{2} = 31{,}610^{'\#}$$

Member BC

$$V_B = 1090\times 16.29\times .5 + 1280\times 8.29\times\frac{12.14}{16.29} + 4350\times\frac{8}{16.29} + 620\times .37\times\frac{7.82}{16.29} + 25670\times\frac{7.62}{16.29}$$

$$+ \frac{114{,}490}{16.29} = 38070$$

$$V_C = 1090\times 16.29\times .5 + 1280\times 8.29\times\frac{4.14}{16.29} + 4350\times\frac{8.29}{16.29} + 620\times .37\times\frac{8.47}{16.29} + 25670\times\frac{8.67}{16.29}$$

$$- \frac{114490}{16.29} = 20540^{\#}$$

$x_0 = 7.62'$ from C

$$M = 20540\times 7.62 - 1090\times\frac{7.62^2}{2} = 124{,}870^{'\#}$$

Use 18"x34" beam

$$\text{req'd } d = \sqrt{\frac{124870\times 12}{18\times 123}} = 26.0" < 31.5" \text{ OK}$$

$$v = \frac{38070}{18\times .88\times 31.5} = 77^{\#}/\square'$$ Use 3/8" Stirrups spaced 5,"12"12"16,16

$$-A_s = \frac{114{,}490\times 12}{18000\times .88\times 31.5} = 2.75^{\square''}$$ Use 4-1"⌀

$$u_0 = \frac{38070}{12.57\times .88\times 31.5} = 109^{\#}/\square'' \text{ OK}$$

Subject Holyoke Pumping Station No 5
Computation Motor Room Floor Beams
Computed by H. E. W. **Checked by** _____ **Date** 12-June-45

Beams B-12 + B-13 (cont.)

$+A_s$ B-12 = $\frac{124,870 \times 12}{18000 \times .88 \times 31.5}$ = 3.00□" Use 4-1"⌀

$+A_s$ B-13 = $\frac{41610 \times 12}{18000 \times .88 \times 31.5}$ = 1.00□" Use 3-3/4"⌀

Bending Points

Beam B-13 – Steel cannot be bent economically

Beam B-12
Left side – Point of inflection

$38070x = 2370\frac{x^2}{2} + 114490$ $x = 3.4'$

Point of bending for 2-1"⌀
$M = \frac{1.57 \times 18000 \times .88 \times 31.5}{12} = 65280$

$114490 + 38070x = 2370\frac{x^2}{2} + 65280$ $x = 1.66$

Assume bot bars are bent 4'-3" from support. Then moment at that point = $38070 \times 4.25 - 114490 - 2370 \times \frac{4.25^2}{2} = 25900$'#

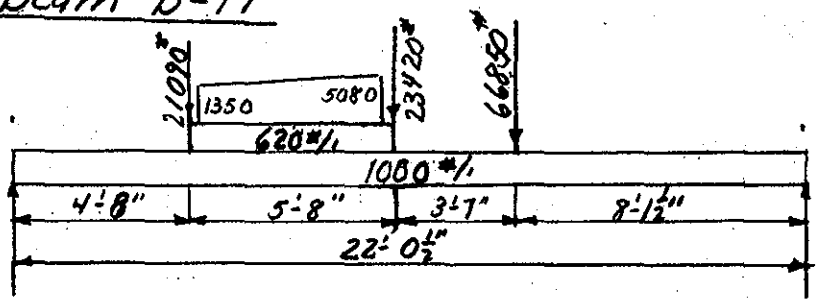
reqd A_s = $\frac{25900 \times 12}{18000 \times .88 \times 31.5}$ = .62□" 2-1"⌀ will be OK

Right side

Pt. of bending for 2-1"⌀ bars in bot

$20540x = 1090\frac{x^2}{2} + 65,280$ $x = 3.50'$

Beam B-14



Assume bm. 24"x50"
2.0 x 3.33 x 150 = 1000#/'

D.L. 10" slab = 1.92 x 125 = 240
L.L. = 1.92 x 200 = 380
620#/'

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5

Computation Motor Room Floor Beams

Computed by H. E. W. **Checked by** _____ **Date** 13-June-45

Beam B-14

R_L =			R_R =		
1000 x 22.04 x .5	=	11020	1000 x 22.04 x .5	=	11020
620 x 5.67 x .660	=	2320	620 x 5.67 x .340	=	1200
1350 x 5.17 x .660	=	4610	1350 x 5.17 x .340	=	2370
3730 x 5.17 x .5 x .620	=	5980	3730 x 5.17 x .5 x .380	=	3660
21,090 x .788	=	16620	21,090 x .212	=	4470
23920 x .538	=	12440	23420 x .469	=	10980
66850 x .368	=	24600	66850 x .632	=	42250
		77590#			75950#

x_a = 9.1' from R_R

$M = 75950 \times 9.1 - 1000 \times \frac{9.1^2}{2} - 66850 \times .98 = 584{,}230$ '#

req'd $d = \sqrt{\frac{584230 \times 12}{24 \times 123}} = 48.6'' > 47.5$ No Tee Beam Action

Tee Beam Action $\frac{t}{d} = \frac{8}{47.5} = .168$ $k = .348$ $b = 35''$ $K = 94$

req'd $d = \sqrt{\frac{584230 \ 12}{35 \times 94}} = 46.0 < 47.5''$ O.K

$v = \frac{77590}{24 \times .88 \times 47.5} = 77$ #/□" OK $\frac{1}{2}''$ ø stirrups at 7", 18" 18" 18"

$A_s = \frac{584230 \times 12}{18000 \times .88 \times 47.5} = 9.31$ □" Use 6-1¼" □ $A_s = 9.37$

Try bending up 2-bars

Mom. for 4 bars $= \frac{6.25 \times 18000 \times .88 \times 47.5}{12} = 391{,}900$ '#

Left Side

$77{,}590\,x = 1000\frac{x^2}{2} + 391{,}900 + 21090(x-4.62) - 620\frac{(x-4.62)^2}{2} - 1350\frac{(x-4.92)^2}{2} - 720\frac{(x-4.92)^3}{6}$ $x = 5'-6''$

Right side

$75{,}950\,x = 1000\frac{x^2}{2} + 391{,}900$ $x = 5.5'$

$w_o = \frac{77590}{20 \times .88 \times 47.5} = 93$ #/□"

Mom at 12.1' from R_R = $75950 \times 12.1 - 1000 \times \frac{12.1^2}{2} - 66850 \times 4 = 578{,}400$ '#

$f_s = \frac{578{,}400 \times 12}{9.37 \times .88 \times 44.5} = 18{,}800$ #/□" OK

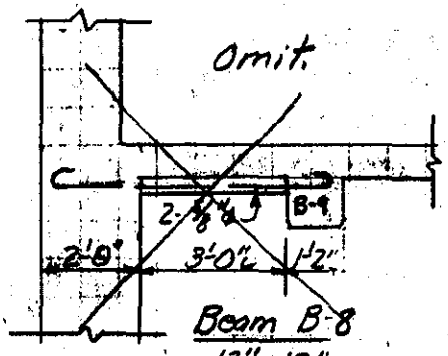
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

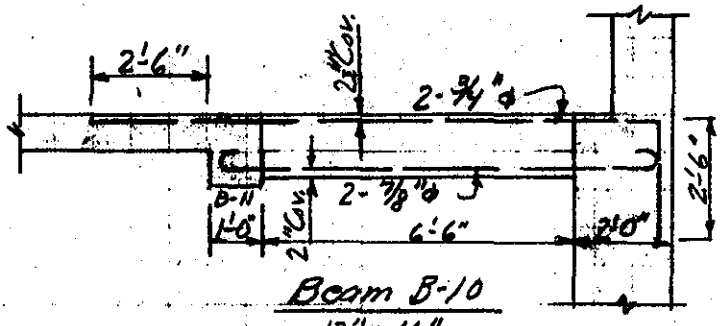
Subject Holyoke Pumping Station No 5

Computation Motor Room Floor Beams

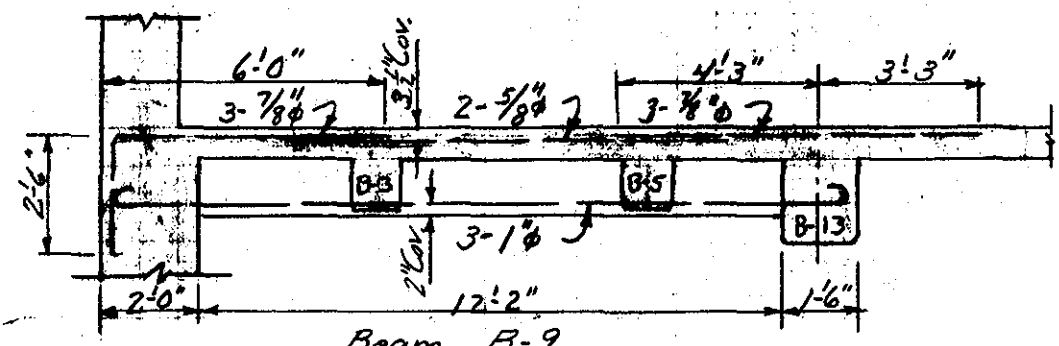
Computed by H.E.W. **Checked by** _____ **Date** 12-June-45



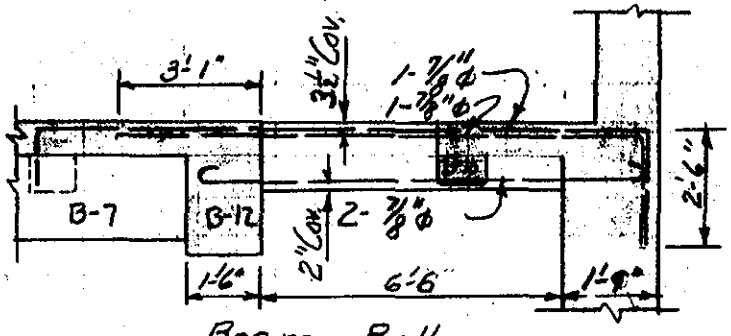
Beam B-8
12"x 12"



Beam B-10
12"x 16"



Beam B-9
14"x 22"



Beam B-11
12"x 18"

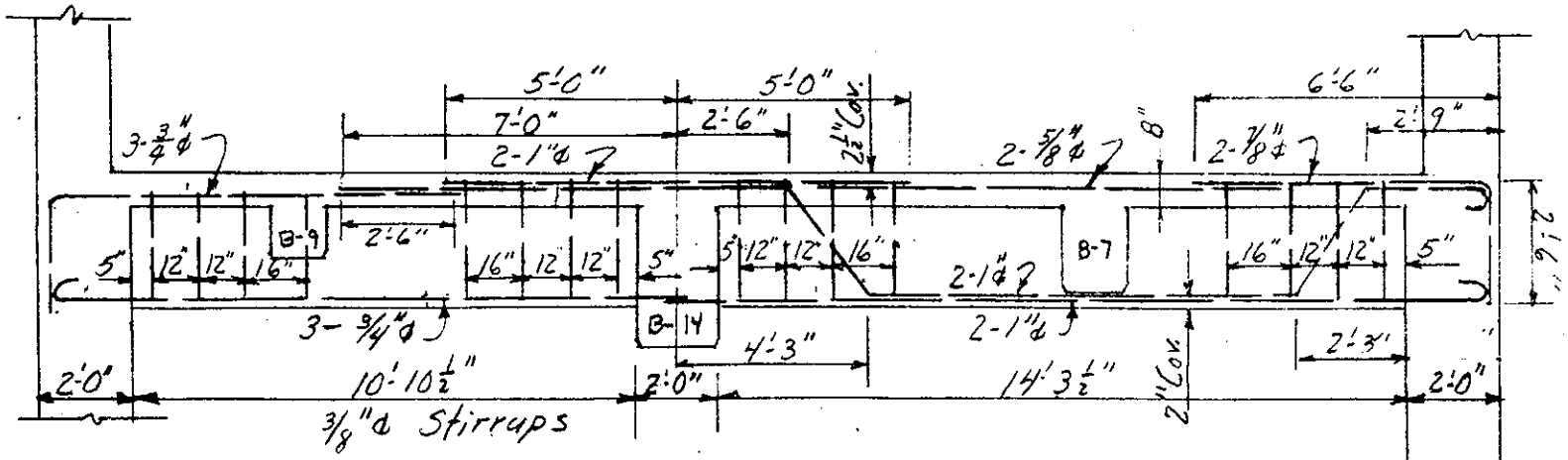
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Hydro Pumping Station No 5

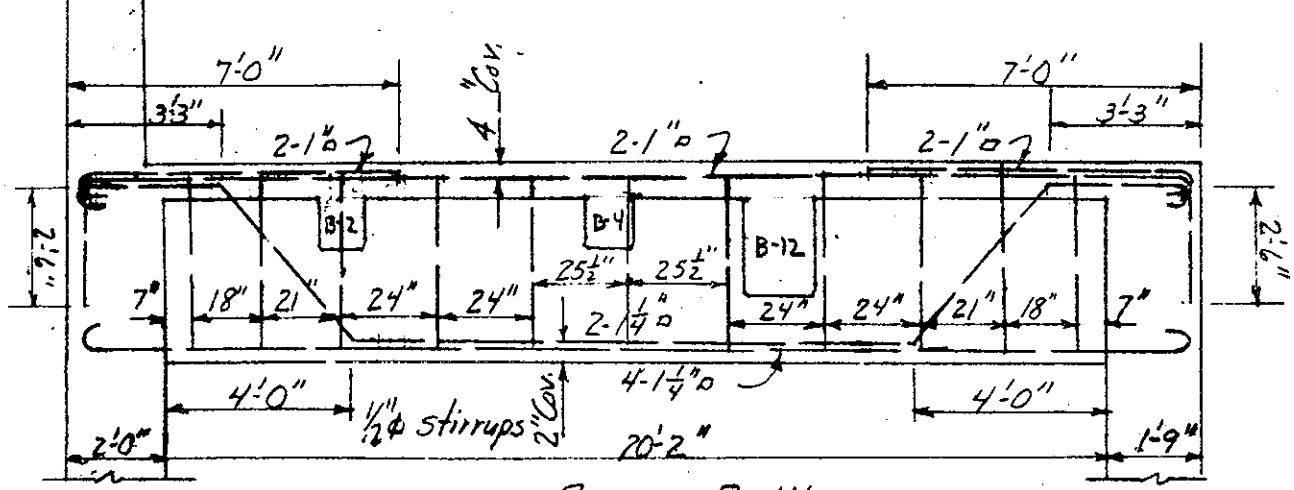
Computation Motor Room Floor Beams

Computed by H.E.H. **Checked by** **Date** 14-June-45



Beam B-13
18"x 34"

Beam B-12
18"x34"



Beam B-14
24"x 50"

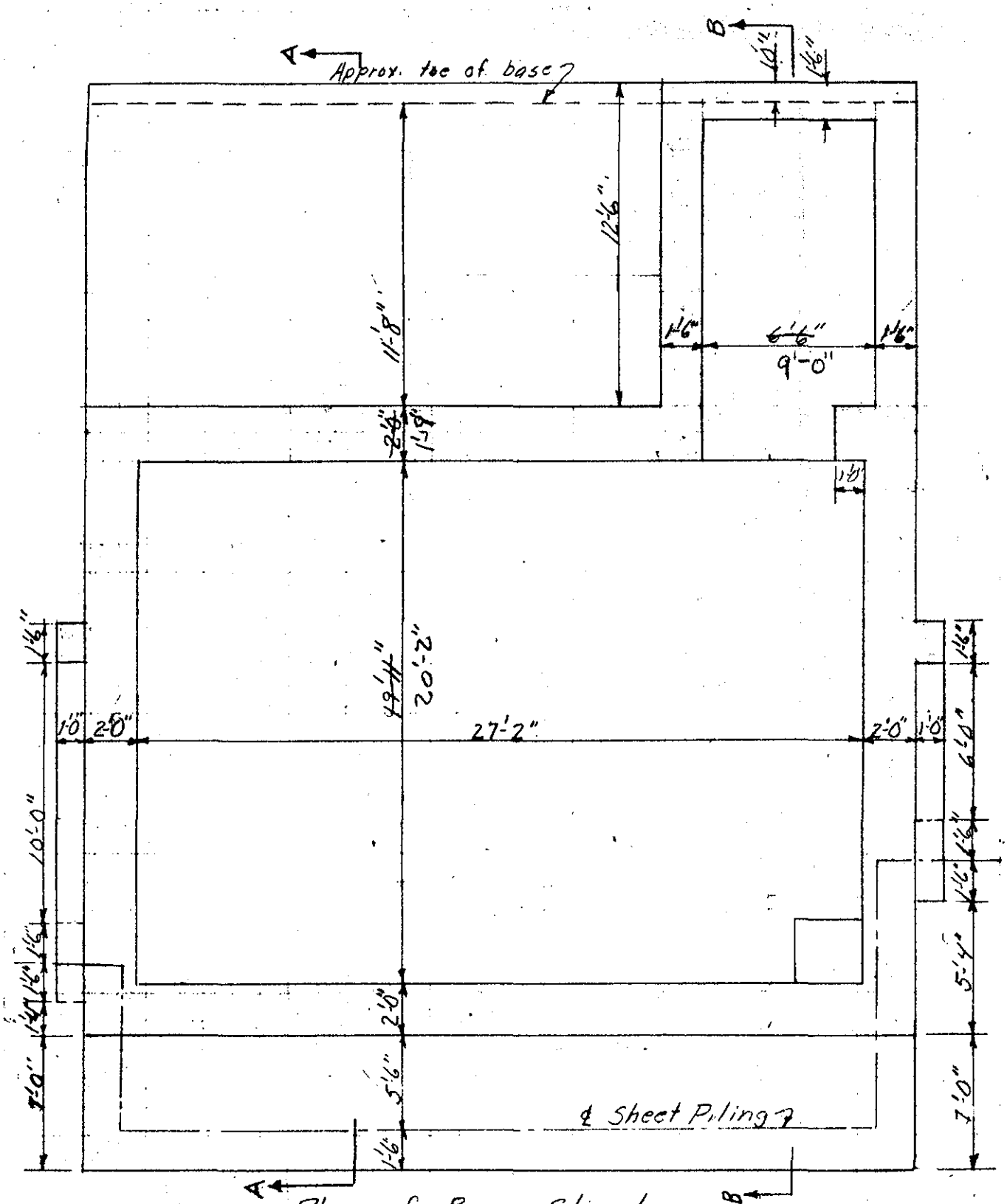
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Stability

Computed by H.E.W. **Checked by** H.L.F. **Date** 14-June-45



Plan of Base Structure

WAR DEPARTMENT

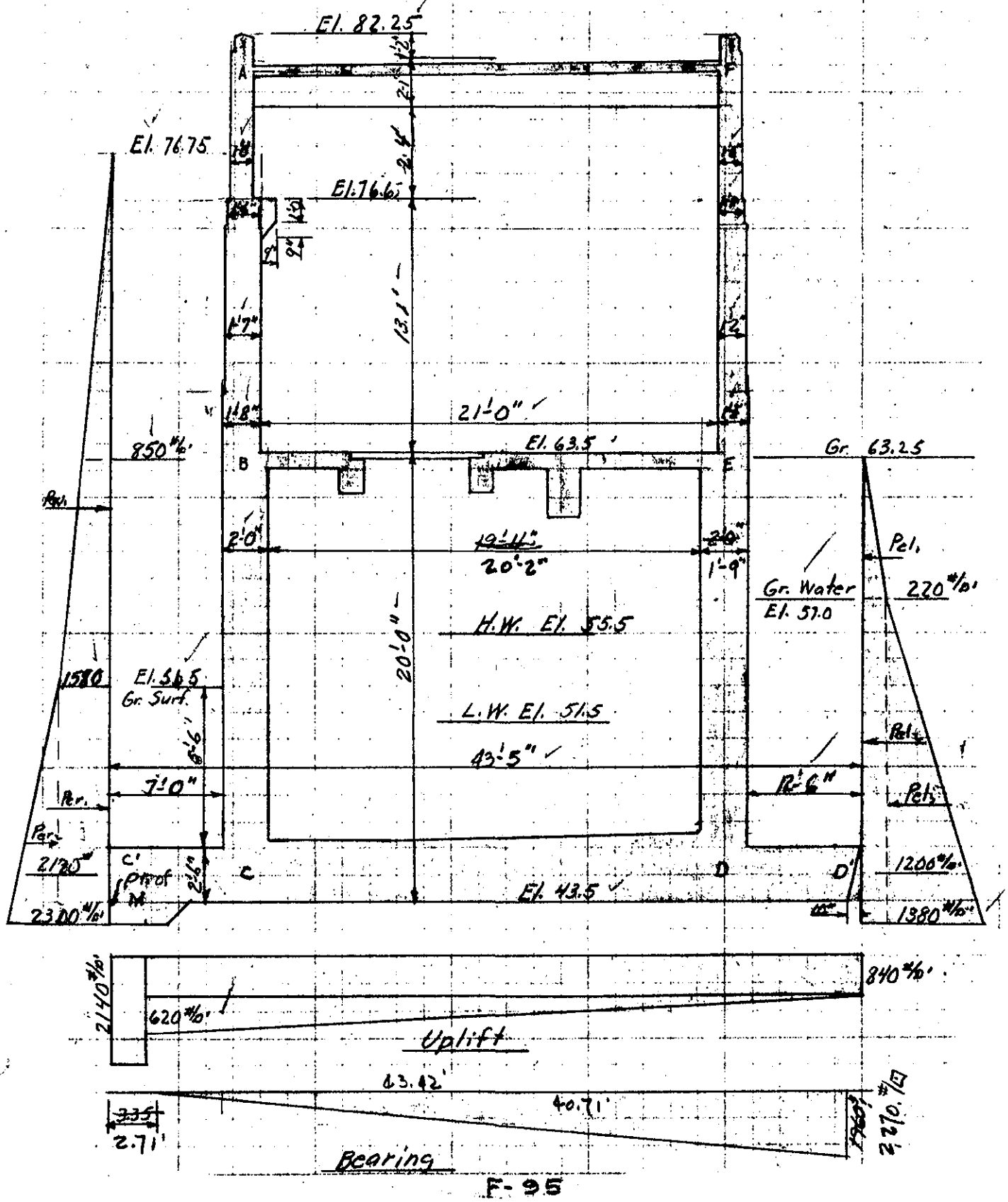
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Stability

Computed by H.E.W. **Checked by** H.L.F. **Date** 15-June-45

Section A-A Case I River up



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Stability

Computed by H.E.W. **Checked by** **Date** 15-June-45

Case I

Horizontal Loading Values

Riverside

El. 63.17 = (76.75 - 63.17) 62.5 = 850 #/□'

El 52.0 = (76.75 - 52.5) 62.5 = 1580 #/□'

El. 44.75 = 1580 + (52.5 - 44.75) 80 = 2120 #/□'

El. 42.5 = 1580 + (52.5 - 42.5) 80 = 2300 #/□'

Landside

El. 57.0 = (63.25 - 57.0) 35 = 220 #/□'

El. 44.75 = 220 + (57.0 - 44.75) 80 = 1200 #/□'

El. 42.5 = 220 + (57.0 - 42.5) 80 = 1380 #/□'

Uplift Loading Values

Riverside steel sheet piling

(76.75 - 42.5) 62.5 = 2140 #/□'

Landside due to tailwater

(57.0 - 43.5) 62.5 = 840 #/□'

Landside steel sheet piling

(76.75 - 57.0) x .5 x 62.5 = 620 #/□'

Assumptions for stability analysis

Axis of moments will be taken at the riverside edge of the base slab. The eccentricity of loading will be determined transversely only as it is considered that the eccentricity longitudinally will be small enough to be neglected. Full headwater uplift will be used at riverside of sheet piling. Uplift on landside will vary from tailwater head at lanside toe to 50% of the difference in tailwater and river head at the landside of the sheet piling.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5

Computation Stability

Computed by H.E.W. **Checked by** H.L.F. **Date** 15 June 45

Case I

Forces Acting		↓	↑	→	←	Arm	Moments ↻	Moments ↺
Rf Slab	70 x 30.67 x 23.5	50.5				18.96	957.5	
curb	165 x 30.67 x 2	10.1				18.96	191.5	
"	165 x 21.84 x 2	7.2				18.96	136.5	
Rf. bm	2x1.53 x 1.17 x 21.5 x 150	11.5				18.96	218.0	
Walls	1 x 5.78 x 30.67 x 2 x 150	53.2				18.96	1008.7	
(above	1 x 5.78 x 21.42 x 2 x 150	37.1				18.96	703.4	
Motor	11.25 x 3.10 x 1.58 x 150	82.6				7.87	650.1	
Room	11.25 x ~~13.17~~ 14.35 x 2x1.58x150	~~78.2~~	76.			~~14.33~~ 15.80	~~1006.0~~	1,200.
Floor)	11.25 x ~~7.83~~ 6.75 x 1.17 x 2 x 150	~~30.9~~	26.6			~~23.83~~ 24.30	~~736.3~~	702.
	11.25 x 31 x 1.17 x 150	61.2				30.25	1851.3	
Pilasters	11.25 x 1 x 1 x 2 x 150	3.4				29.16	99.1	
Crane sup	150 x 27.83	4.2				9.17	38.5	
Crane bm	50 x 28.67	1.4				8.83	12.4	
Crane rail	20 x 28.67	0.6				18.96	11.4	
Crane		3.0				18.96	56.9	
Fl. Slab	31.17 x 23.92 x ~~100~~ 125	~~94.6~~	93.2			18.96	~~1411.4~~	1769.
Less opnigs	9 x 3 x ~~100~~ 125	- ~~2.7~~	-3.4			~~16.77~~ 15.09	- ~~43.9~~	-51.
	3.58 x 4.67 x 2 x ~~100~~ 125	- ~~3.3~~	-3.8			15.5	- ~~51.2~~	-58.4
	~~2.5~~ 3.8 x ~~2.5~~ 3.8 x ~~100~~ 125	- ~~0.6~~	-1.1			10.25	- ~~6.2~~	-11.8
" "	6.5 x 3.67 x ~~100~~ 125	- ~~2.4~~	-3.0			24.5	- ~~58.8~~	-73.
Bm B-1	4.67 x 1.5 x .83 x 150 x 2	1.7				15.5	26.4	
B2 - B-5	1 x 14.08 x ~~1.08~~ 0.92 x 150 x 2	4.6				15.5	71.3	
B-6	5.96 x 1 x .33 x 150	0.3				12.0	3.6	
B-7	1.33 x 1.83 x 12.17 x 150	4.5				15.08	~~67.9~~	61.0
B-8	.33 x 1.0 x 3 x 150	0.1				11.17	1.1	
B-9	12.17 x 1.17 x 1.17 x 150	2.5				15.08	~~37.7~~	32.2
B-10	1 x ~~6.5~~ 23 x 6.5 x 150	~~0.7~~	.3			26.84	~~18.8~~	8.6
B-11	1 x 6.25 x ~~1.67~~ 1.67 x 150	~~0.8~~	.6			25.79	~~20.6~~	16.4
B-12 - B-13	1.5 x 2.~~17~~ 00 x 25.5 x 150	~~12.5~~	11.5			21.92	~~274.0~~	252.
B-14	19.92 x 3.~~5~~ 32 x 2 x 150	~~20.9~~	20.0			~~18.76~~ 19.08	~~396.3~~	380.
(Basement	19.~~33~~ 17 x 31.17 x ~~2~~ 1 x 150 x 3.75	~~160.4~~	336.			~~15.76~~ 19.08	~~3428.0~~	6,410.
walls)	19.~~33~~ 17 x 19.92 x ~~1~~ 4 x 150	~~115.5~~	229.			~~18.42~~ 19.08	~~2190.0~~	4,370.
Base Slab	~~19.92~~ 38.17 x 27.17 x 2.75 x 150	~~273.3~~	226.			~~18.76~~ 19.08	~~4235.8~~	4,310.
" "	~~7.5~~ 13.6 x 12.5 x 3.75 x 150	~~66.8~~	84.5			37.17	~~2483.0~~	3,130.
" "	12.5 x ~~27.67~~ 19.17 x 2.5 x 150	~~101.6~~	89.3			37.17	~~3775.7~~	3,320.
" "	7 x 31.17 x 2.5 x 150	81.8				3.5	286.4	
Int. Cha.	12.83 x 1.5 x 16 x 2 x 150	92.4				37.34	3450.2	
	4 x 1 x 9.5 x 150	5.7				44.25	252.2	
	3 x 12 x .5 x 9.5 x 150	25.7	56.4			44.75	1150.1	2,299
	1.83 x 5.67 x 6.5 x 150	10.1				42.83	432.6	
	2.5 x 2.5 x 6.5 x 150	6.1				41.08	250.6	
		~~1951.1~~					~~31782.4~~	
		1,752.0					37,840.3	

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Stability

Computed by H.E.W. **Checked by** H.L.F. **Date** 15- June- 45

Case I

	Forces Acting		↓	↑	→	←	Arm	Moments ↷	Moments ↶
1	Int. Ch.	12.83 × ~~6.5~~ 9.0 × 100	~~8.3~~	11.5			37.34	~~309.9~~	431.
2		6.5 × ~~6.5~~ × 100	~~4.2~~	omit			~~35.17~~	~~147.7~~	omit
3	Less op.	2.25 × ~~6.5~~ 9.0 × 100	− ~~1.5~~	−2.0			36.04	− ~~54.1~~	−73.
4		3.14 × 100	− 0.3				32.17	− 9.7	
5	W.W. con.	1.5 × 16.5 × 150	3.7				22.08	81.7	
6		1.5 × 9 × 150	2.0				16.83	33.7	
7		14.25 × 3 × 150	6.4				13.83	88.5	
8		1.5 × 22 × 150	5.0	29.4			22.08	110.4	510.7
9		13 × 1.5 × 150	2.9				14.83	43.0	
10		8.75 × 3 × 150	3.9				9.83	38.3	
11	Sh. pl'g key	2.5 × 1 × 31.17 × 150	11.7				1.25	14.6	
12		1 × 1.5 × 26.17 × 150	2.0				2.83	5.6	
13		2.5 × 1 × 8.83 × 150	3.3				6.91	22.9	
14		1 × 1.5 × 8.83 × 150	0.7				6.91	4.6	
15		2.5 × 1 × 12.83 × 150	4.8				8.91	42.9	
16		1 × 1.5 × 12.83 × 150	1.0				8.91	8.9	
17	Ld. on R.S.	7 × 30.75 × 31.17 × 62.5	419.3				3.5	1467.7	
18	Ext.	7 × 5.5 × 31.17 × 62.5	75.0				3.5	262.5	
19		5 × 8 × 7 × .5 × 62.5 × 2	17.5				3.5	61.3	
20	Ld. on L.S	17.25 × 12.5 × ~~27.67~~ 19.17 × 100	~~467.3~~	411.			37.17	~~17368.0~~	15,260.
21	Ext.	12.5 × ~~27.67~~ 19.17 × 11 × 2.5	~~74.5~~	66.			37.12	~~2768.8~~	2,450.
22	Ld on W.W	18.5 × 62.5 × 9 × 1	10.4				16.83	175.0	
23	base	9 × 62.5 × 1 × 2.5	1.4				16.83	23.6	
24		24 × 62.5 × 13 × 1	19.5				14.83	289.2	
25		13 × 1 × 62.5 × 2.5	2.0				14.83	29.7	
26	Uplift	2140 × 1.5 × 31.17		100.1			0.75		76.0
27		2140 × 8.33 × 1.5		26.2			5.66		151.1
28		2140 × 12.33 × 1.5		39.6			7.66		303.2
29		840 × 41.92 × 28.17		991.9			22.46		22279.1
30		29.59 × 840 × 1.5		37.3			28.63		1067.4
31		33.59 × 840 × 1.5		42.3			26.63		1127.1
32									
33		620 × 41.92 × 28.17 × .5		366.1			15.47		5663.1
34		620 × 29.59 × 1.5 × .5		13.8			23.69		326.0
35		620 × 33.59 × 1.5 × .5		15.6			20.93		326.9
36		2140 × 1.5 × 1		3.2			13.08		41.9
37		21 × 62.5 × .5 × ~~7.5~~ 9.5 × .5 × 1		~~2.5~~	3.2		~~17.83~~ 19.5		62.7 ~~41.6~~
38		2140 × 1.5 × 1		3.2			9.08		29.1
39		5.75 × 62.5 × 1 × ~~11.5~~ 14.0		~~4.1~~	5.0		~~17.08~~ 18		90.5 ~~70.0~~
40		~~9.75~~ 13.75 × 62.5 × 1 × ~~11.5~~ 14.0 × .5		~~3.4~~	5.6		15.16		82. ~~51.5~~
41	Prop. Pump	11,500 × 2	23.0				16.0	368.0	
			~~1168.0~~	1649.8				~~23702.7~~	~~31,557.8~~
			1,107.3	1653.6				21,345.5	31,626.1

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Stability

Computed by H.E.W. **Checked by** H.L.F. **Date** 16 June 45

Case I

	Forces Acting	↓	↑	→	←	Arm	Moments →	Moments ←
Disc. pipes	8.500 x 2	17.0				11.0	187.0	
Sw'b'd	2500	2.5				26.0	65.0	
Heater		0.6				19.0	11.4	
Conc. Stwy	200 x 3 x 17.25	10.4				20.25	210.6	
	3 x 3 x 200	1.8				27.0	48.6	
Pel_1	220 x 6.25 x .5 x 33.17				22.8	15.58		355.3
Pel_2	220 x 14.5 x 33.17				105.8	6.25		661.3
Pel_3	1160 x 14.5 x .5 x 33.17				279.0	3.83 ~~2.83~~		1,070. ~~789.5~~
Pw_1	1580 x 25.25 x .5 x 15.17			302.6		16.42	4968.8	
Per_1	1580 x 9.0 x 15.17			215.7		3.50	755.0	
Per_2	720 x 9.0 x .5 x 15.17			49.2		2.00	98.3	
Pw_2	1420 x 22.75 x .5 x 18			290.7		18.08	5256.7	
Per_3	1420 x 11.5 x 18			293.9		4.75	1396.2	
Per_4	920 x 11.5 x .5 · 18.0	179.5		95.2		2.83	269.5	
Water in Sta.	27.17 x ~~1792~~ 20.17 x 5.25 x 62.5	~~177.6~~				19.08 ~~18.96~~	3,430.	
Water in ch	~~6.5~~ 9.91 x 4.25 x 62.5	~~19.0~~	26.3		407.6	36.42	960.	
Sluicegate		5.5			645.0	29.	160.	
fr.	0.45 x ~~1199.1~~ 1433.3				~~539.6~~			
					947.2			
passive resist req'd					1052.6 ~~300.7~~			
Less Opg. N. Wall	107 x 150	− 16.0			194.7	30.5	− 490.	
		227.6					17,327.1	2,086.6
Total this page		~~228.9~~		1247.3	1247.2		~~13267.1~~	~~1806.1~~
Total first page	1,752.0	~~1451.1~~				37,840.3	~~31782.4~~	626.1
Total second page	1,107.3	~~1168.0~~	16 ~~48.9~~ 53.6			21,345.5	~~23702.7~~	31 ~~557.0~~
Grand Total	3,086.9	~~2848.0~~	16 ~~48.9~~ 53.6			76,512.9	~~68752.2~~	33 ~~363.1~~ 712.7
		~~1199.1~~ 1,433.3					~~35389.1~~ 42,800.2	

Pos. of result = $\frac{\cancel{35389.1}\ 42,800.2}{\cancel{1199.1}\ 1,433.3}$ = 29.~~51~~ 85' middle third at 28.~~41~~ 95'

Bear Pres. $\frac{\cancel{1199100}\ 1,433,300}{13.57\ \cancel{13.08} \times 3 \times 31.17 \times .5}$ = ~~1960~~ 2,270. #/□'

Max. allow pas. resist = $\frac{1}{2} \times 100 \times 19.75^2 \tan^2(45° + \frac{\phi}{2}) \times 31.17$ = 1497.9 K (1.5697)

Factor of safety against sliding = $\frac{1497.9 + \cancel{539.6}\ 645.}{1247.3}$ = 1.~~63~~ 72

WAR DEPARTMENT

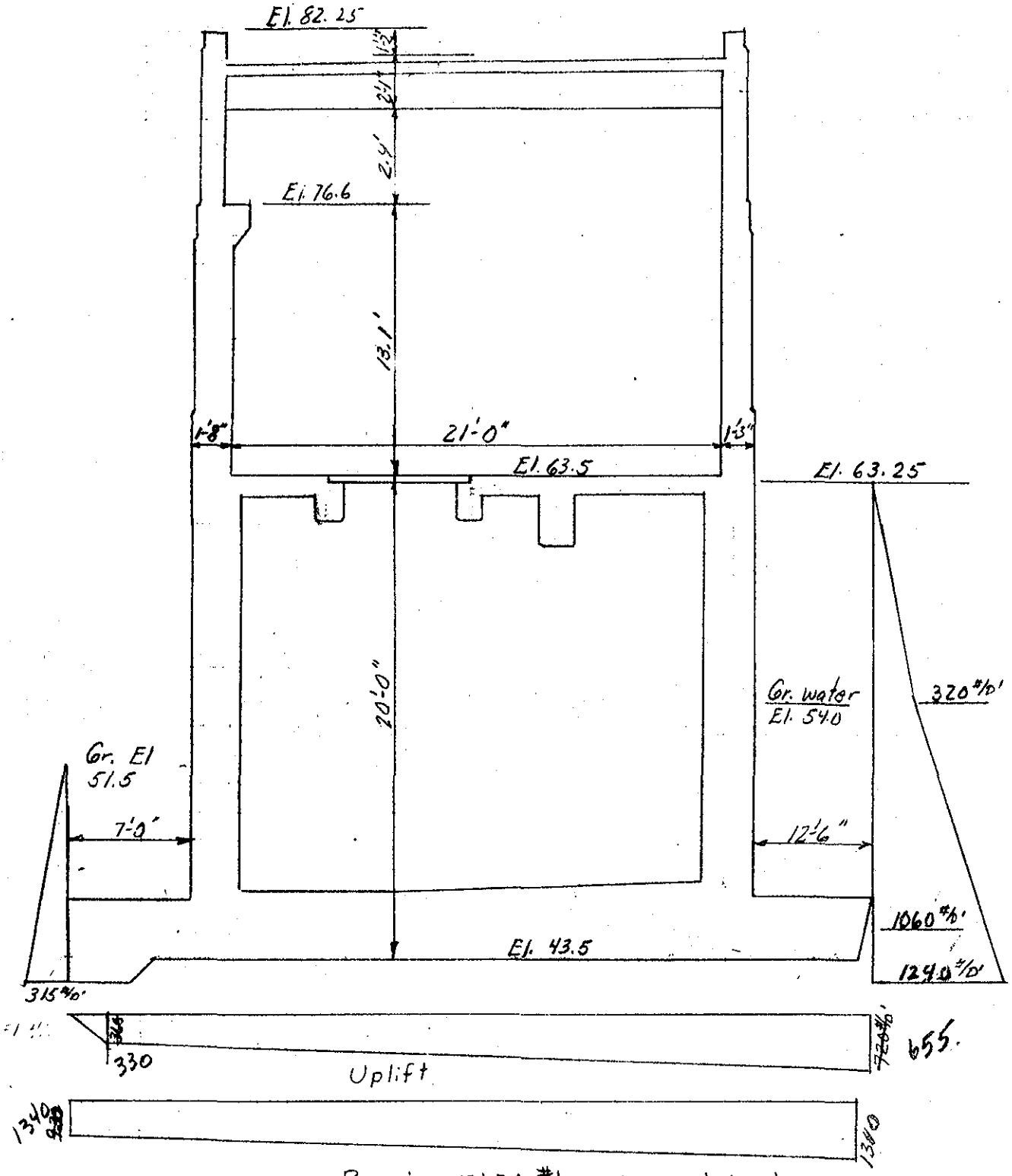
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Stability

Computed by H.E.W. **Checked by** H.L.F. **Date** 20-June-45

Sect. A-A. Case II - River down and ground water at El. 54.0



Bearing = 1,340#/□ over whole base.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Stability

Computed by H.E.W. **Checked by** H.L.F. **Date** 20-June-45

Case II Horizontal Loading Values

Riveside

El. 42.5 = 9 x 35 = 315 #/□'

Landside

El. 54.0 = 9.25 x 35 = 320 #/□'

El. 44.75 = 320 + 9.25 x 80 = 1060 #/□'

El. 42.5 = 320 + 11.5 x 80 = 1240 #/□'

Uplift Loading Values

Landside due to tailwater = (54 - 43.5) 62.5 = ~~720~~ 655 #/□'

Landside of sht. piling = ~~360~~ 330. #/□'

Forces Acting		↓	↑	→	←	Arm.	Moments ↷	Moments ↶
	Total page	~~1451.1~~	1,752.0				~~31,782.4~~	37,840.3
Total	lines 1-16 page	~~58.1~~	62.1				~~888.9~~	958.5
Ld. on R.S.	7 x .55 x 31.17 x 100	120.0				3.5	420.0	
Ext.	5 x 8 x 7 x .5 x 100 x 2	28.0				3.5	98.0	
Ld. on L.S.	17.25 x 12.5 x ~~21.67~~ 19.17 x 100	~~467.3~~	411.			37.17	~~17,368.0~~	15,260.
Ext.	12.5 x ~~21.67~~ 19.17 x 8 x 25	~~52.7~~	48			37.17	~~1957.7~~	1,780.
Ld. on W.W.	9 x 1 x 2.5 x 100	2.3				16.83	38.7	
base	13 x 1 x 100 x 2.5	3.3				14.83	48.9	
Uplift.	~~360~~ 330 x 42 x 31.17		~~471.3~~	432.		22.5		~~10,604.0~~ 9720.
	~~360~~ 325 x 42 x .5 x 31.17		~~235.6~~	212.		29.5		~~6951.5~~ 6,270.
	~~360~~ 330 x 1.5 x 31.17 x .5		~~8.4~~	7.7		1.0		7.7 ~~8.4~~
Pel₁	320 x 9.25 x .5 x 33.17				49.1	13.58		666.8
Pel₂	320 x 11.5 x 33.17				122.1	4.75		580.0
Pel₃	920 x 11.5 x .5 x 33.17				175.5	2.83		496.6
Per₁	315 x 9 x .5 x 33.17			47.0		2.0	94.0	
Prop. Pump	11,500 x 2	23.0				16.0	368.0	
Disc. pipes	6000 x 2	12.0				11.0	132.0	
Sw'bd	2500	2.5				26.0	65.0	
Heater		0.6				19.0	11.4	
Conc Stwy		12.2					259.2	
fr.				299.7				
Sluicegate		5.5					160.	
Less op's N Wall		-16.	651.7				-490	17,741.1
	Total 2,466.5	~~2233.1~~	~~715.3~~	346.7	346.7	57,044.	~~53,532.2~~	~~49,309.3~~
	1,814.8	~~1517.8~~		0	0		~~34,222.9~~ 39,303.	

Pos. of result = ~~34222900~~ / ~~1517800~~ = ~~22.55~~ 21.65 e = ~~1.22~~ = .06

Bear P = ~~1517800 / 42.67 x 31.17 (1 ± 6 x 1.22 / 42.67)~~ = ~~1140 (1.172 / 0.828)~~ = ~~1340~~ #/□' ~~1910~~ #/□' 1,340 #/□ over all of base.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

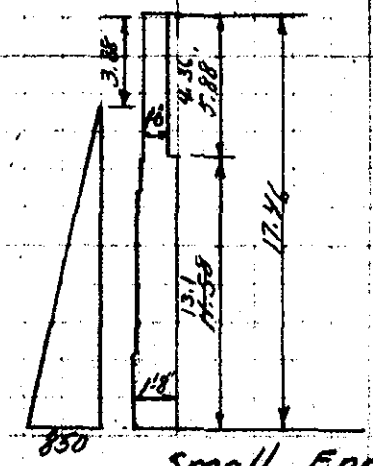
Computation Transverse Section - A-A

Computed by H.E.W. **Checked by** _____ **Date** 19-June-45

Fixed End Moments Case I

Member AB

$a = \frac{\cancel{11.58}\ 13.1}{17.46} = \cancel{.663}\ .750$ $\quad \frac{\min d}{\max d} = \frac{12}{20} = .60$



Haunched end

$K = \cancel{11}\ 11.5 \times \frac{12^3}{17.46 \times 12} = \cancel{90.72}\ 94.85$

Carry over $c = \cancel{0.37}\ .35$

Uniform ld f.em. coef. $= \cancel{.120}\ .118$

coef for triang. ld $= \frac{.777(10 - 10 \times .777 + 3 \times .777^2)}{30} = 0.105$ (.604)

f.em. coef. $= \frac{\cancel{.120}\ .118 \times .105}{.0833} = \cancel{.151}\ .149$

f.e.m $= .151 \times \frac{850 \times 13.58}{2} \times 17.46 = \cancel{15.22}\ 15.01$ 'k

Small End

$K = \frac{\cancel{4.80}\ 4.90 \times 12^3}{17.46 \times 12} = \cancel{39.59}\ 40.4$ $\quad$ Carry over $c = \cancel{0.85}\ .82$

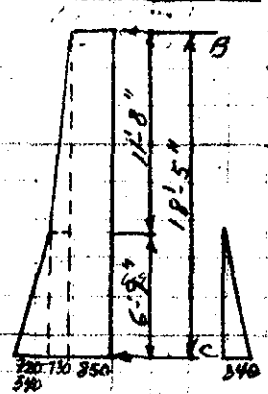
Uniform ld f.e.m. coef $= .064$

coef. for triangular load (constand I) $= \frac{.777^2(5 - 3 \times .777)}{30} = .054$ (.604)

f.em coef Δ load (variable I) $= \frac{.064 \times .054}{.0833} = .041$

f.em $= .041 \times \frac{850 \times 13.58}{2} \times 17.46 = 4.13$ 'k

Member BC



$M^F_{BC} = \frac{1}{12} \times 850 \times 18.42^2 + \frac{.633(10 - 15 \times .633 + 6 \times .633^2)}{15} \times 730 \times \frac{11.67}{2} \times 18.42$ (2.904, 78.461)

$+ \frac{.366^2(4 - 3 \times .366)}{12} \times 730 \times 6.75 \times 18.42 + \frac{.366^2(5 - 3 \times .366)}{30} \times 720 \times \frac{6.75}{2} \times 18.42$ (.134, 2.902, 90.765, .134, 3.902, 540, 44.761)

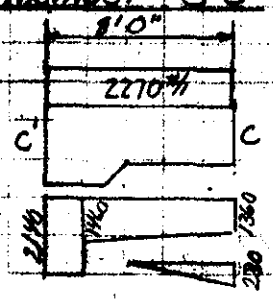
$- \frac{.366^2(5 - 3 \times .366)}{30} \times 340 \times \frac{6.75}{2} \times 18.42 = \cancel{37.03}\ 36.84$ (.401)

$M^F_{CB} = \frac{1}{12} \times 850 \times 18.42^2 + \frac{.633^2(5 - 4 \times .633)}{10} \times 730 \times \frac{11.67}{2} \times 18.42 +$ (2.468)

$\frac{.366(6 - 8 \times .366 + 3 \times .366^2)}{12} \times 730 \times 6.75 \times 18.42 + \frac{.366(10 - 10 \times .366 + 3 \times .366^2)}{30} \times 720 \times \frac{6.75}{2} \times 18.42$ (3.474, 90.765, 6.742, 540, 44.761)

$- \frac{.366(10 - 10 \times .366 + 3 \times .366^2)}{30} \times 340 \times \frac{6.75}{2} \times 18.42 = \cancel{43.36}\ 42.44$ (21.137)

Member CC'



Mom at C $= 2270 \times 8 \times 4 + 2.5 \times 150 \times 8 \times 4 + 1 \times 2.5 \times 150 \times 6.75$
$+ 1 \times 1 \times .5 \times 150 \times 5.17 - 2140 \times 1.5 \times 7.25 - 1360 \times 6.5 \times 3.25$
$- 100 \times 6.5 \times .5 \times 4.33 - 230 \times 4.65 \times .5 \times 1.55 = 33.32$ 'k

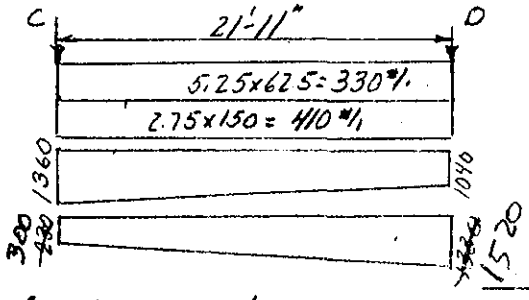
Subject Holyoke Pumping Station No 5

Computation Section A-A

Computed by H.E.W. **Checked by** H.L.F. **Date** 19-June-45

F.E.M (cont.) Case I

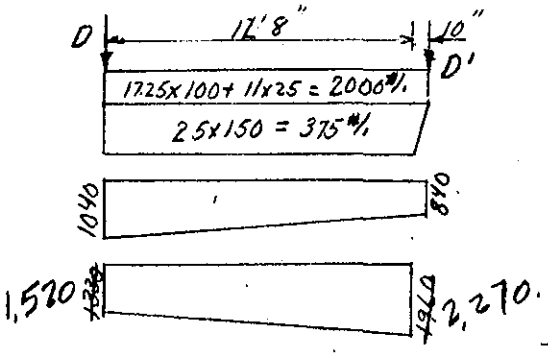
Member CD



$$M^F_{CD} = \frac{1}{12}\times 1590\times 21.92^2 - \frac{1}{12}\times 740\times 21.92^2 + \frac{1}{15}\times 780\times\frac{21.92^2}{2} = \cancel{46.52^{1K}}\ 51.20$$

$$M^F_{DC} = \frac{1}{12}\times 1590\times 21.92^2 - \frac{1}{12}\times 740\times 21.92^2 + \frac{1}{10}\times 780\times\frac{21.92^2}{2} = \cancel{52.77^{1K}}\ 58.40.$$

Member DD'

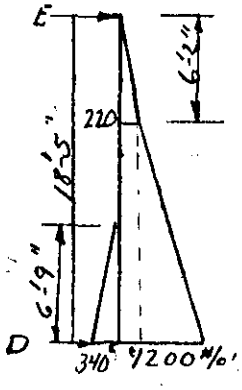


$$Mat\ D = 840\times 13.5\times 6.75 + 200\times 13.5\times .5\times 4.5 + 1330\times 12.67\times 6.33 + 630\times 12.67\times .5\times 8.45 - 2375\times 13.5\times 6.75 = \cancel{6.59^{1K}}$$

Span = 13.37'

49.3 1K

Member DE



$$M^F_{DE} = \frac{.335^2(5-4\times .335)}{10}\times 220\times\frac{6.17}{2}\times 18.42 + \frac{.665\times(6-8\times .665+3\times .665^2)}{12}\times 220\times 12.25\times$$

$$+\frac{.665(10-10\times .665+3\times .665^2)}{30}\times 980\times\frac{12.25}{2}\times 18.42 -$$

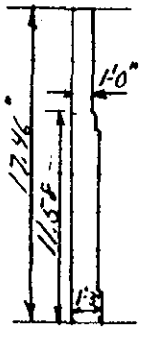
$$\frac{.366(10-10\times .366+3\times .366^2)}{30}\times 340\times\frac{6.75}{2}\times 18.42 = 15.75^{1K}$$

$$M^F_{ED} = .335\frac{(10-15\times .335+6\times .335^2)}{15}\times 220\times\frac{6.17}{2}\times 18.42 + .665^2\frac{(4-3\times .665)}{12}\times 220\times 12.25\times$$

$$+ .665^2\frac{(5-3\times .665)}{30}\times 980\times\frac{12.25}{2}\times 18.42 - .366^2\frac{(5-3\times .366)}{30}\times 340\times\frac{6.75}{2}\times 18.42 = 10.06^{1K}/'$$

Member EF

$a = .663$ $\quad \frac{min.\ d}{max\ d} = \frac{12}{15} = .80$



Haunched end

$$K = 6.3\times\frac{12^3}{17.46\times 12} = 51.96 \qquad C = 0.44$$

Small end

$$K = 4.29\times\frac{12^3}{17.46\times 12} = 35.38 \qquad C = 0.65$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

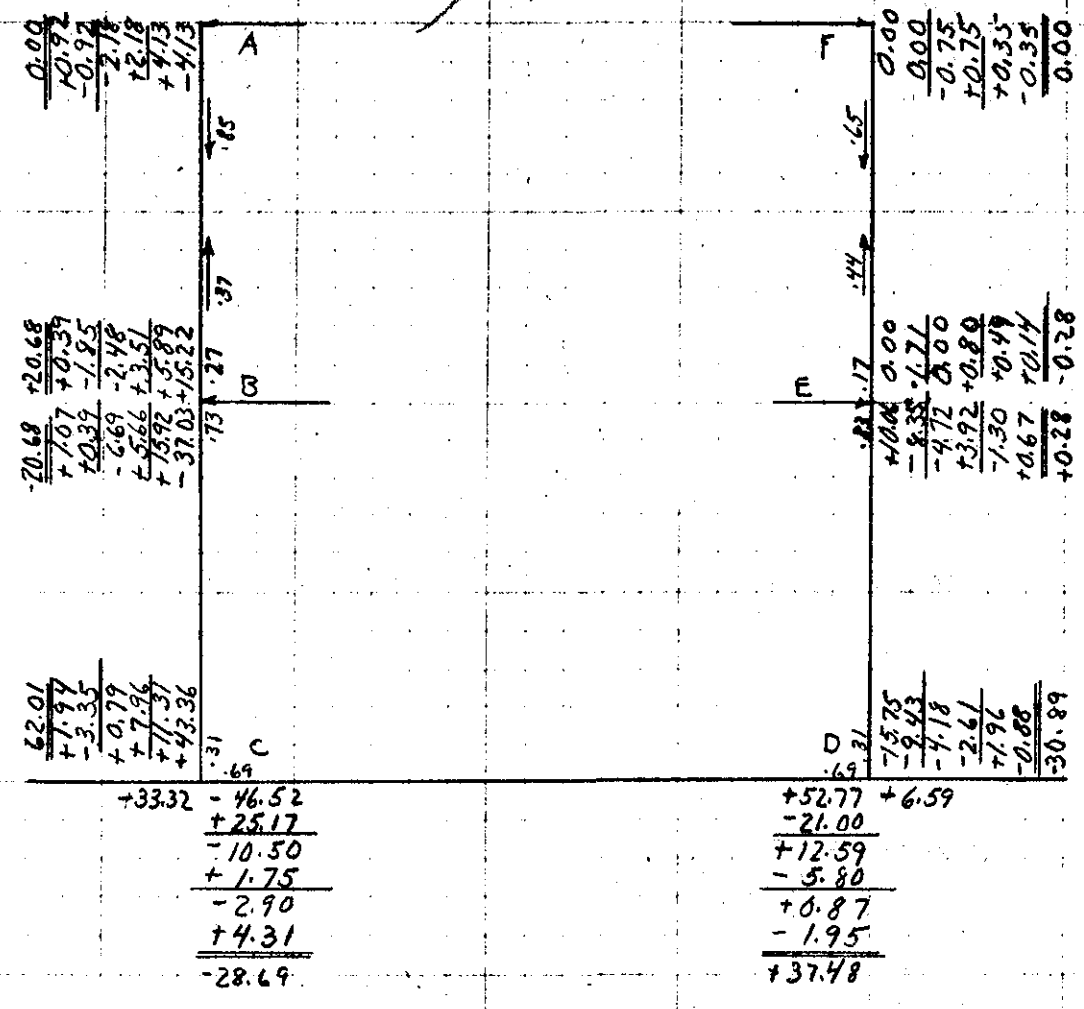
Computation Section A-A

Computed by H. E. W. **Checked by** _____ **Date** 19-June-45

Stiffness Case I

Member	d	d^3	L	d^3/L	K	
AB e.B.				90.72	90.72	1.75
BC	24	13824	221	62.55x4	250.20	4.82
CD	33	35937	263	136.65 x4	546.60	10.52
DE	24	13824	221	62.55x4	250.20	4.82
EF e.E				51.96	51.96	1.00

VOID



reqd d @ D $\sqrt{\frac{30,890}{147}} = 14.6''$ reduce the 24" wall at the back side to 21"

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5

Computation Section A-A

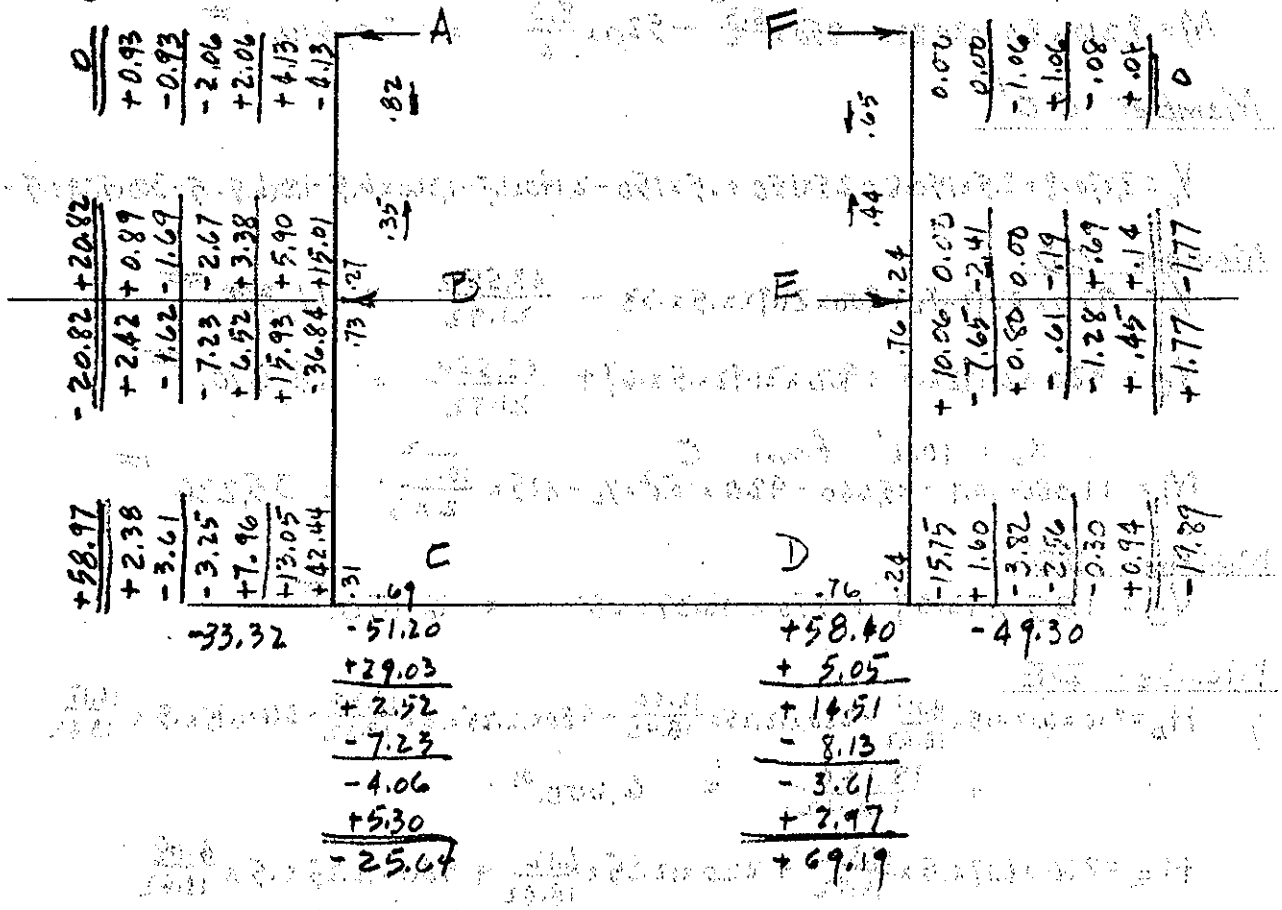
Computed by H.L.F. **Checked by** _____ **Date** _____

Case I

Revised figures due to change in wall thickness

Stiffness

Member	d	d^3	L	$\frac{d^3}{L} \times 4$	K	
AB @ B					94.85	1.82
BC	24	13,824	221.	62.55 × 4	250.20	4.82
CD	33	35,937	264.5	135.87 × 4	543.48	10.46
DE	21	9,261	221.	41.90 × 4	167.60	3.23
EF @ E					51.96	1.00



End Reactions & Center Moments

Member A-B

$$H_A = 850 \times 13.58 \times .5 \times \frac{4.53}{17.46} - \frac{20,820}{17.46} = 320^{\#}$$

$$H_B = 850 \times 13.58 \times .5 \times \frac{12.93}{17.46} + \frac{20,820}{17.46} = 5,460^{\#} \qquad x_0 = 7.08'$$

$$M = 320 \times 7.08 - \frac{3.72^2 \times 62.5}{2} \times 1.07 = 1,930'^{\#}$$

Subject Holyoke Pumping Station No. 5
Computation Section A-A
Computed by H.L.F. **Checked by** **Date**

Case I. End Reactions and Center Moments (Cont'd)

Member BC

$$H_B = 850\times18.42\times.5 + 730\times11.67\times.5\times\frac{10.64}{18.42} + 730\times6.75\times\frac{3.38}{18.42} + 200\times6.75\times.5\times\frac{2.25}{18.42} - \frac{38,150}{18.42} = 9,210.^{\#}$$

$$H_C = 850\times18.42\times.5 + 730\times11.67\times.5\times\frac{7.78}{18.42} + 730\times6.75\times\frac{15.04}{18.42} + 200\times6.75\times.5\times\frac{16.17}{18.42} + \frac{38,150}{18.42} = 16,320.^{\#}$$

$x_0 = 8.3'$ from B

$$M = 9,210\times8.3 - 20,820 - 850\times\frac{\overline{8.3}^2}{2} - 520\times\frac{\overline{8.3}^2}{6} = 20,410.'^{\#}$$

Member CC'

$$V_C = 2,270\times8 + 2.5\times150\times8 + 2.5\times150 + .5\times150 - 2,140\times1.5 - 1,360\times6.5 - 100\times6.5\times.5 - 300\times5.29\times.5 = 8,460.^{\#}$$

Member CD

$$V_C = 920\times21.92\times\tfrac{1}{2} + 900\times21.92\times.5\times.33 - \frac{43,550}{21.92} = 11,380.^{\#}$$

$$V_D = 920\times21.92\times.5 + 900\times21.92\times.5\times.67 + \frac{43,550}{21.92} = 18,670.^{\#}$$

$x_0 = 10.1'$ from C

$$M = 11,380\times10.1 - 25,640 - 920\times\overline{10.1}^2\times\tfrac{1}{2} - 425\times\frac{\overline{10.1}^2}{2\times3} = 35,230.'^{\#}$$

Member DD'

$$V_D = 185\times13.37 + 550\times13.37\times.5 = 6,150.^{\#}$$

Member DE

$$H_D = 220\times6.17\times.5\times\frac{4.11}{18.42} + 220\times12.25\times\frac{12.30}{18.42} + 980\times12.25\times.5\times\frac{14.34}{18.42} - 340\times6.75\times.5\times\frac{16.17}{18.42} + \frac{18,120}{18.42} = 6,600.^{\#}$$

$$H_E = 220\times6.17\times.5\times\frac{14.31}{18.42} + 220\times12.25\times\frac{6.12}{18.42} + 980\times12.25\times.5\times\frac{4.06}{18.42} - 340\times6.75\times.5\times\frac{2.25}{18.42} - \frac{18,120}{18.42} = 1,640.^{\#}$$

$x_0 = 9.07'$ from E

$$M = 1640\times9.07 - 1,770 - 220\times\frac{6.17}{2}\times4.96 - 220\times\overline{2.9}^2/2 - 230\times\frac{\overline{2.9}^2}{6} = 8,200.'^{\#}$$

Member EF

$$H_E = \frac{1770}{17.46} = 100.^{\#} \rightarrow \qquad H_F = 100.^{\#} \leftarrow$$

WAR DEPARTMENT

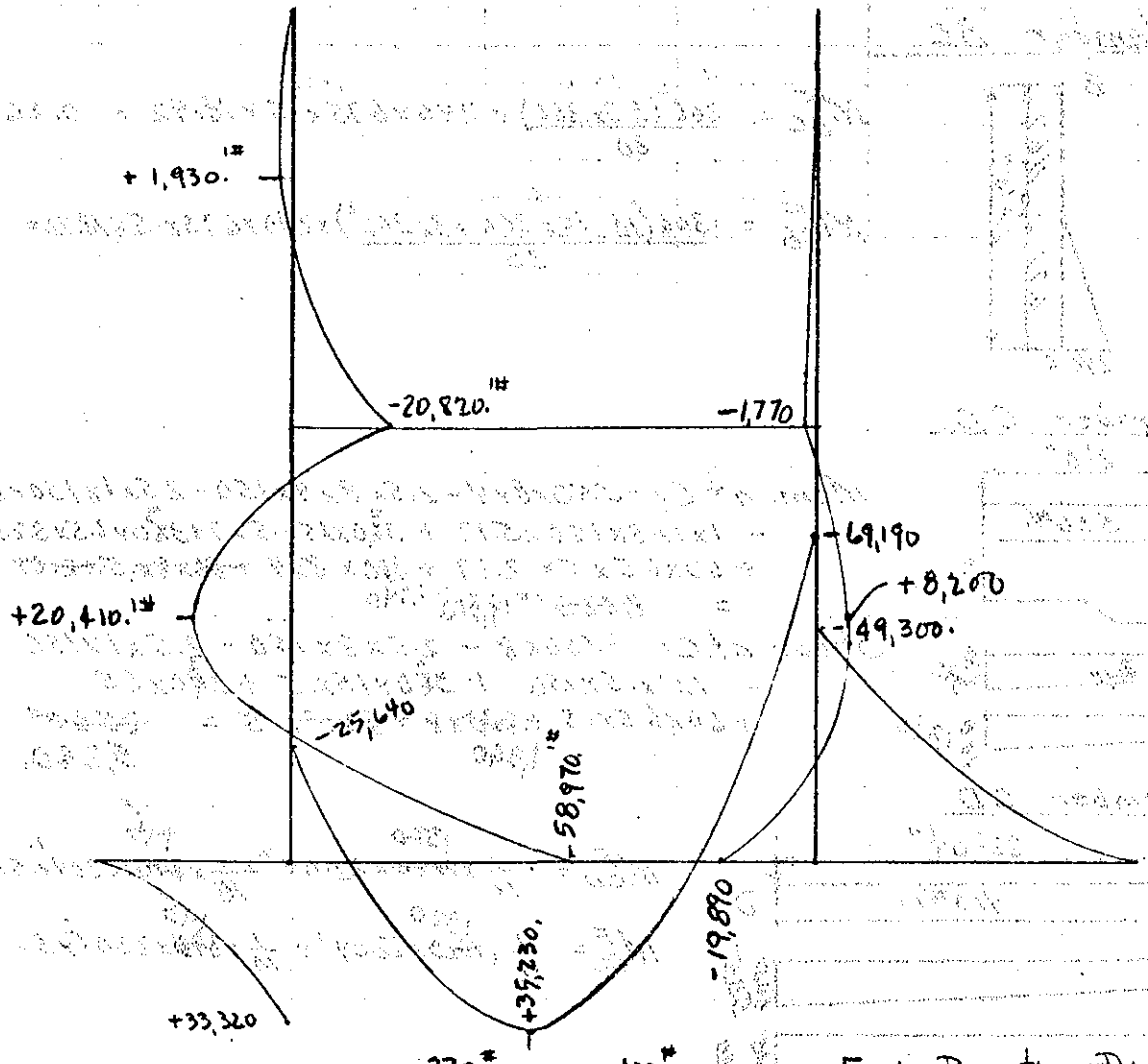
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5

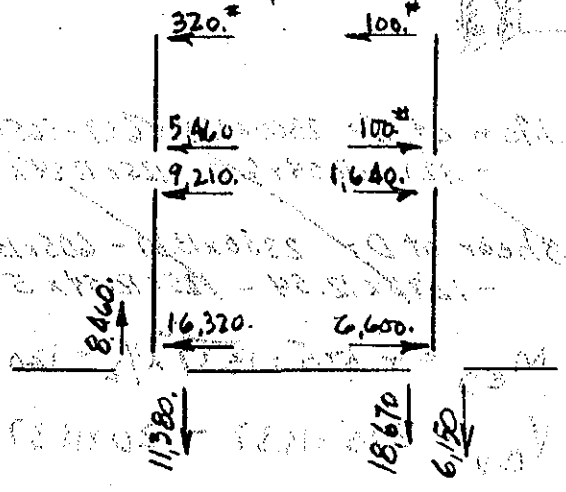
Computation Section A-A

Computed by H.L.F. **Checked by** **Date**

Case I - Moment Diagram



End Reaction Diagram



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Section A-A

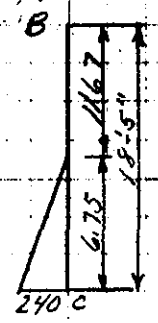
Computed by H.E.W **Checked by** H.L.F. **Date** 21-June-45

Case II Fixed End Moments

Member AB

$M^F_{AB} = 0 \qquad M^F_{BA} = 0$

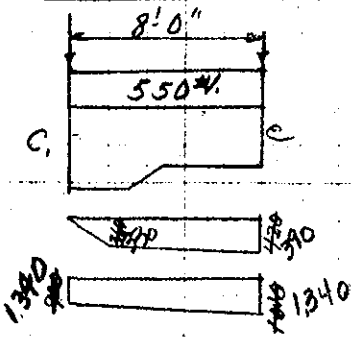
Member BC



$$M^F_{BC} = \frac{.366^2(5-3\times.366)}{30}\times 240\times 6.75\times .5\times 18.42 = 0.26^{'k}$$

$$M^F_{CB} = \frac{.366(10-10\times.366+3\times.366^2)}{30}\times 240\times 6.75\times .5\times 18.42 = 1.23^{'k}$$

Member CC'



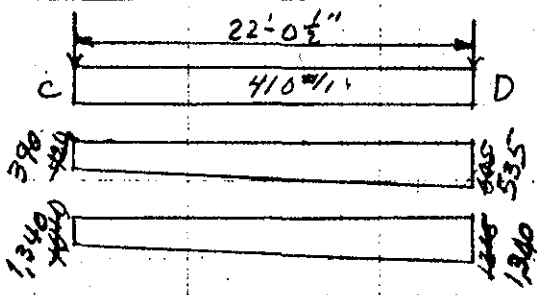
Mom. at C = $-550\times 8\times 4 - 2.5\times 8\times 4\times 150 - 2.5\times 1\times 150\times 6.75 - 1\times 1\times .5\times 150\times 5.17 + 330\times 1.5\times .5\times 7 + 330\times 6.5\times 3.25 + 60\times 6.5\times .5\times 2.17 + \cancel{930}\times 8\times 4 \cancel{+ 80\times 8\times .5\times 2.67}$

$= \cancel{8,020}^{'\#}$ 19,500 1,340

Shear at C = $-550\times 8 - 2.5\times 8\times 150 - 2.5\times 1\times 150 - 1\times 1\times .5\times 150 + 330\times 1.5\times .5 + 330\times 6.5 + 60\times 6.5\times .5 + \cancel{930}\times 8 \cancel{+ 80\times 8\times .5} = \cancel{2560}$ 5,340.

1,340

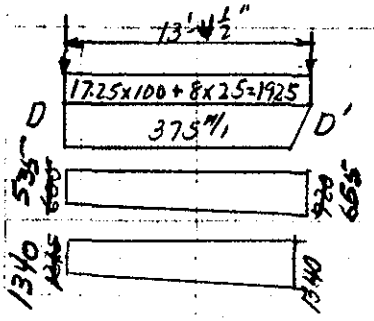
Member CD



$$M^F_{CD} = \frac{1}{12}\times \cancel{1020}\,1320\times 22.04^2 + \frac{1}{18}\times \cancel{390}\,145\times 22.04^2\times .5 = \cancel{47.60}\ 55.95$$

$$M^F_{DC} = \frac{1}{12}\times \cancel{1020}\,1320\times 22.04^2 + \frac{1}{10}\times \cancel{390}\,145\times 22.04^2\times .5 = \cancel{56.76}\ 57.13$$

Member DD'



~~Mom at D = $2300\times 13.37\times 6.69 - 605\times 13.37\times 6.69 - 115\times \frac{13.37}{2}\times 8.91 - 1215\times 12.54\times 6.27 - 125\times 12.54\times .5\times 8.36 = 42,150^{'\#}$~~

~~Shear at D = $2300\times 13.37 - 605\times 13.37 - 115\times 13.37\times .5 - 1215\times 12.54 - 125\times 12.54\times .5 = 5810^{\#}$~~

$$M_{@D} = +425\times 13.37^2\times \tfrac{1}{2} - 120\times 13.37\times \tfrac{1}{2}\times 8.93 = 30.7^{'k}$$

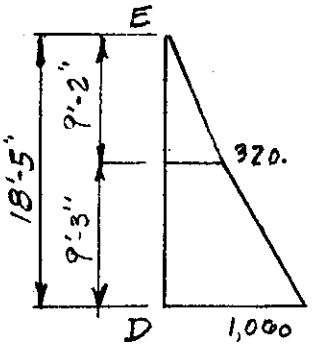
$$V_{@D} = 425\times 13.37 - 120\times 13.37\times \tfrac{1}{2} = 4,880.^{\#}\downarrow$$

Subject Holyoke Pumping Sta. No. 5

Computation Section A-A

Computed by H.L.F. **Checked by** _____ **Date** _____

Case II F.E.M. (cont'd.)

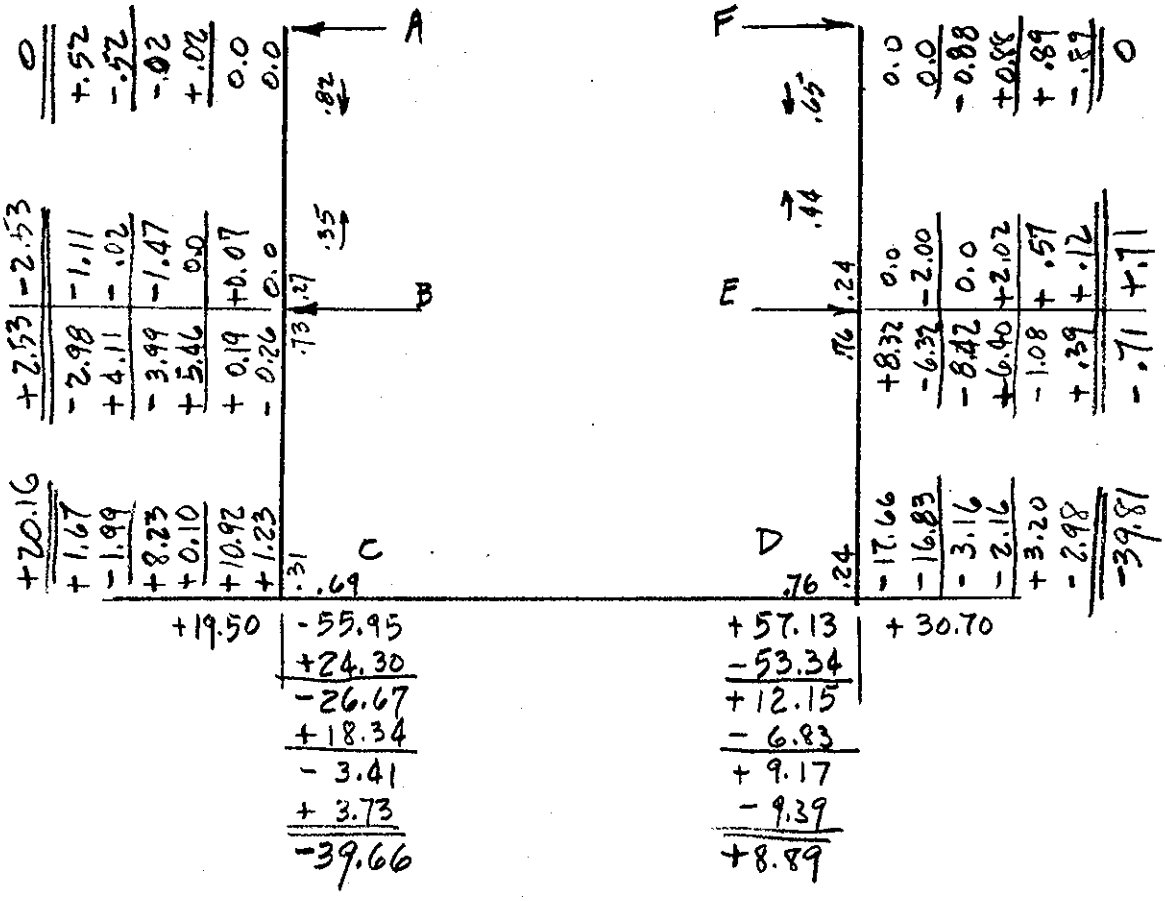


$$M^F_{DE} = \frac{.498^2(5-4\times.498)}{10}\times 320\times\frac{9.17}{2}\times 18.42 + \frac{.502(6-8\times.502+3\times.502)}{12}$$

$$\times 320\times 9.25\times 18.42 + \frac{.502(10-10\times.502+3\times.502^2)}{30}\times 740\times\frac{9.25}{2}\times 18.42 = 17.66^{1K}$$

$$M^F_{ED} = \frac{.498(10-15\times.498+6\times.498^2)}{15}\times 320\times\frac{9.17}{2}\times 18.42 + \frac{.502^2(4-3\times.502)}{12}\times 320\times 9.25\times 18.42$$

$$+ \frac{.502^2(5-3\times.502)}{30}\times 740\times\frac{9.25}{2}\times 18.42 = 8.32^{1K}$$



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5

Computation Transverse Section A-A

Computed by H.L.F. **Checked by** _____ **Date** _____

Case II End Reactions and Center Moments

Member AB

$$H_A = \frac{2,530}{17.46} = 150.^{\#} \leftarrow \qquad H_B = 150.^{\#} \rightarrow$$

Member BC

$$H_B = 240 \times 6.75 \times .5 \times \frac{2.25}{18.42} - \frac{22,690}{18.42} = 1,130. \rightarrow$$

$$H_C = 240 \times 6.75 \times .5 \times \frac{16.17}{18.42} + \frac{22,690}{18.42} = 1,330. \leftarrow$$

No center M

Member CD

$$V_C = 1320 \times 22.04 \times .5 + 145 \times 22.04 \times .5 \times 1/3 + \frac{30,770}{22.04} = 16,590.^{\#}$$

$$V_D = 1320 \times 22.04 \times .5 + 145 \times 22.04 \times .5 \times 2/3 - \frac{30,770}{22.04} = 14,070.^{\#}$$

$x_0 = 12.2'$ from C

$$M = 16,590 \times 12.2 - 39,660 - 1320 \times \frac{12.2^2}{2} - 80 \times \frac{12.2^2}{6} = 62,160.'^{\#}$$

Member DE

$$H_D = 320 \times 9.17 \times .5 \times \frac{6.12}{18.42} + 320 \times 9.25 \times \frac{13.79}{18.42} + 740 \times \frac{9.25}{2} \times \frac{15.34}{18.42} + \frac{40,520}{18.42} = 7,750.^{\#} \rightarrow$$

$$H_E = 320 \times 9.17 \times .5 \times \frac{12.30}{18.42} + 320 \times 9.25 \times \frac{4.63}{18.42} + 740 \times \frac{9.25}{2} \times \frac{3.08}{18.42} - \frac{40,520}{18.42} = 90.^{\#} \rightarrow$$

$x_0 = 2.36$ from E

$$M = 90 \times 2.36 + 710 - 80 \times \frac{2.36^2}{6} = 850.'^{\#}$$

Member EF

$$H_E = \frac{710}{17.46} = 40.^{\#} \leftarrow \qquad H_F = 40.^{\#} \rightarrow$$

WAR DEPARTMENT

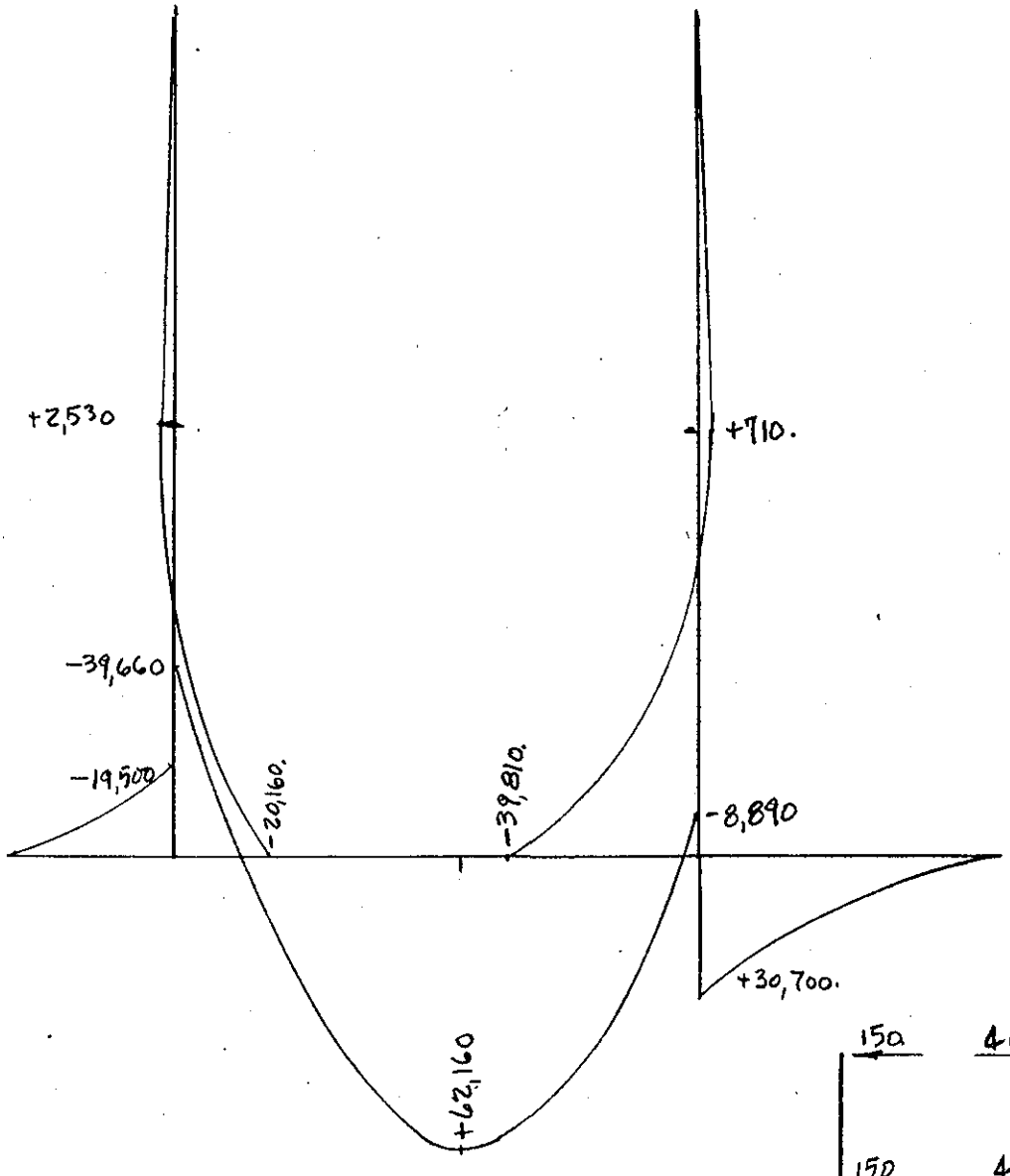
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5

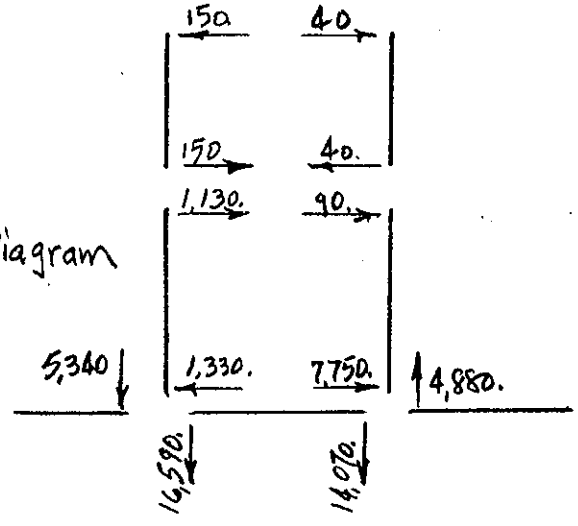
Computation Transverse Section A-A

Computed by H.L.F **Checked by** **Date**

Case II Moment Diagram



End Reaction Diagram



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Transverse Section A-A

Computed by H.E.W **Checked by** H.L.F. **Date** 22-June-45

Design of Section

Riverside Wall

req'd d at C = $\sqrt{\frac{\cancel{62,470}\ 58,970}{147}}$ = $\cancel{20.6}$ 20.0" > 20.5" OK ✓

$v = \frac{\cancel{17050}\ 16,320}{12 \times .88 \times 20.5}$ = $\cancel{78}$ 75 #/□" OK

req'd d at B = $\sqrt{\frac{20,640}{147}}$ = 11.8" < 16.5" OK ✓

$v = \frac{5460}{12 \times .88 \times 16.5}$ = 31 #/□" ✓

-As at C = $\frac{\cancel{62,470}\ 58,970 \times 12}{18000 \times .88 \times 20.5}$ = 2.3 □" Use $1\frac{1}{8}$"□ @ 12"cc ✓ 1"□ @ 12"cc ✓

$u_o = \frac{17050}{8.3 \times .88 \times 20.5}$ = 111 #/□" OK ✓

-As at B = $\frac{20,640 \times 12}{18000 \times .88 \times 16.5}$ = .95 □" Use 1"□ @ 1'-0"cc ✓

$u_o = \frac{5460}{4 \times .88 \times 16.5}$ = 94 #/□" OK ✓

+As = $\frac{\cancel{19500}\ 20,410 \times 12}{18000 \times .88 \times 20.5}$ = $\cancel{.72}$ .75 □" Use 1"□ @ 12"cc ✓

+As = $\frac{\cancel{2280}\ 1930 \times 12}{18000 \times .88 \times 8.5}$ = .20 □" Use 5/8"□ @ 12"cc ✓

Base Slab

req'd d at ℄ D = $\sqrt{\frac{\cancel{33,320}\ 69,190}{147}}$ = $\cancel{15.1}$ 21.7" < 26.5" ✓

req'd d at center = $\sqrt{\frac{\cancel{60,140}\ 62,160}{123}}$ = 22.1" < 26.5" ✓

$v = \frac{\cancel{15300}\ 18,670}{12 \times .88 \times 25.5}$ = $\cancel{57}$ 69 #/□" OK

-As at C = $\frac{\cancel{30,220}\ 39,660 \times 12}{18,000 \times .88 \times 25.5}$ = $\cancel{.90}$ 1.18 □" Use $\cancel{1"□}$ 1 1/8"□ @ 1'-0"cc

$u_o = \frac{\cancel{14070}\ 16,590}{\cancel{4}\ 4.5 \times .88 \times 25.5}$ = $\cancel{156}$ 165 #/□"

-As at D = $\frac{\cancel{28,200}\ 69,190 \times 12}{18000 \times .88 \times 25.5}$ = $\cancel{.84}$ 2.04 □" Use 1"□ @ $\cancel{1'-0"cc}$ 6" c.c

+ $u_o = \frac{\cancel{15300}\ 18,670}{\cancel{4}\ 8 \times .88 \times 25.5}$ = $\cancel{170}$ 104 #/□"

+As at C = $\frac{33320 \times 12}{18000 \times .88 \times 26.5}$ = .95 □" Use 1"□ @ 1'-0"cc ✓

+As at center = $\frac{\cancel{60,140}\ 62,160 \times 12}{18000 \times .88 \times 26.5}$ = $\cancel{1.72}$ 1.77 □" Use 1"□ @ 1'-0"cc 1"□ @ 1'-0"cc

+As at D = $\frac{\cancel{42,100}\ 30,700 \times 12}{18000 \times .88 \times 26.5}$ = $\cancel{1.20}$ .88 □" Use 1"□ @ 1'-0"cc ~~1"□ @ 1'-0"cc~~

Design of Section (cont.)

Landside Wall

req'd d at D = $\sqrt{\frac{\overset{39,810}{41350}}{147}}$ = 16.7" < 17.5" ✓

$V = \frac{7730}{12 \times .88 \times 17.5}$ = 42 #/□" ✓

$-As$ at D = $\frac{41350 \times 12}{18000 \times .88 \times 17.5}$ = .179 □" Use 1"□ @ 12"cc } alt. ✓
Use 1"□ @ 12"cc }

$u_o = \frac{7730}{7.1 \times .88 \times 17.5}$ = 71 #/□" OK

$+As = \frac{\overset{8,200}{\cancel{5270}} \times 12}{18000 \times .88 \times 17.5}$ = $\overset{.36}{\cancel{.23}}$ □" Use 3/4"□ @ 1'-0"cc ✓

Pt. where 1"□ bars can be cut.

Max M for 1"□ = $\frac{18000 \times .88 \times 17.5 \times .79}{12}$ = 18250 '#

Mom 5' from base -
$7730 \times 5 - 41,350 - 660 \times \frac{5^2}{2} - 400 \times \frac{5}{2} \times 3.33 = 14280$

Mom. 4' from base
$7730 \times 4 - 41350 - 740 \times \frac{4^2}{2} + 320 \times \frac{4}{2} \times 2.67 = 17,060$ '#

Mom. 3.75 from base
$7730 \times 3.75 - 41350 - 760 \times \frac{3.75^2}{2} - 300 \times \frac{3.75}{2} \times 2.5 = 19,110$ '#

Cut bars 9'-0" from bot. of base ✓

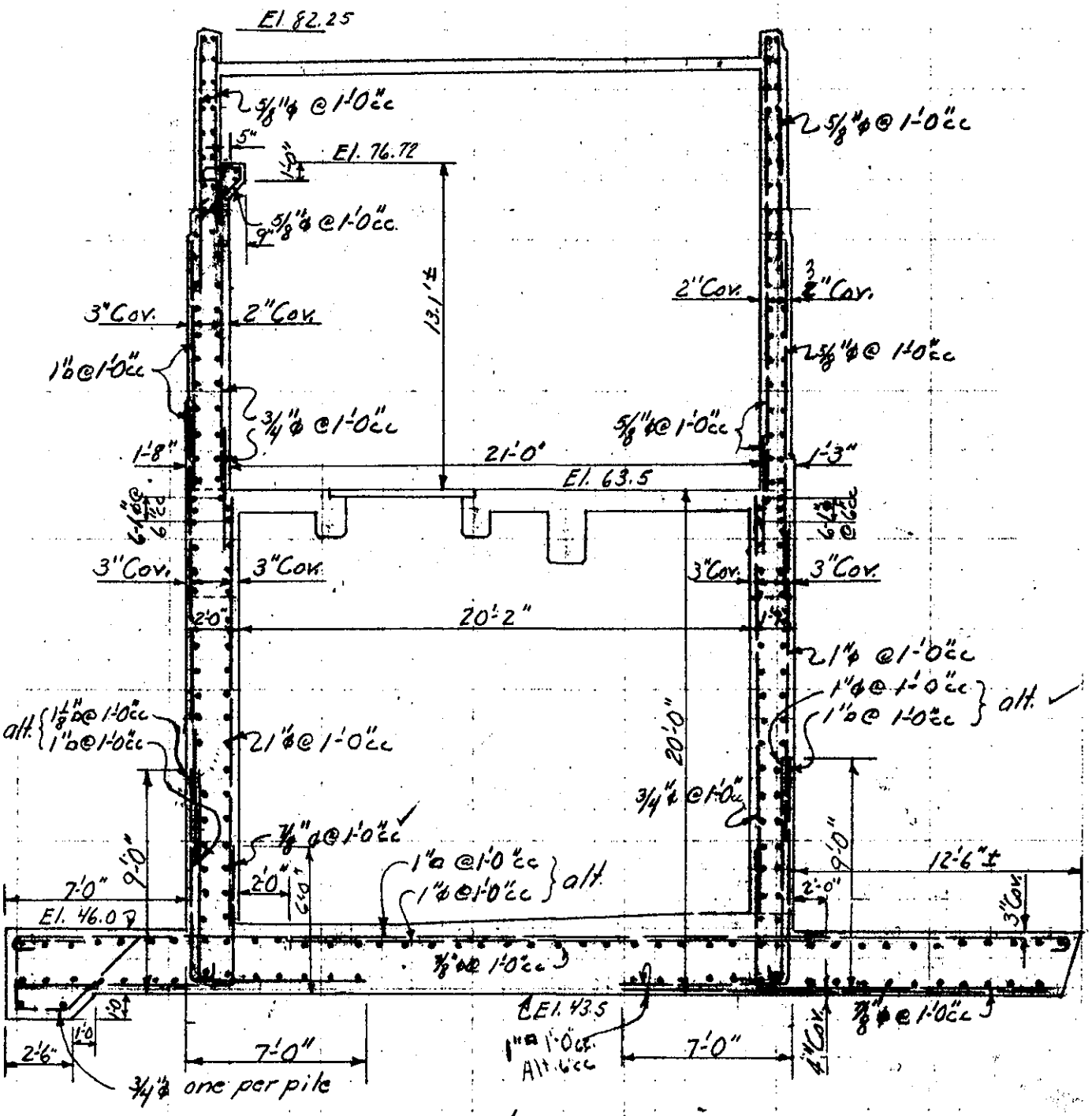
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Transverse Section A-A

Computed by H.E.W. **Checked by** H.L.F. **Date** 25-June-45



Section A-A

WAR DEPARTMENT

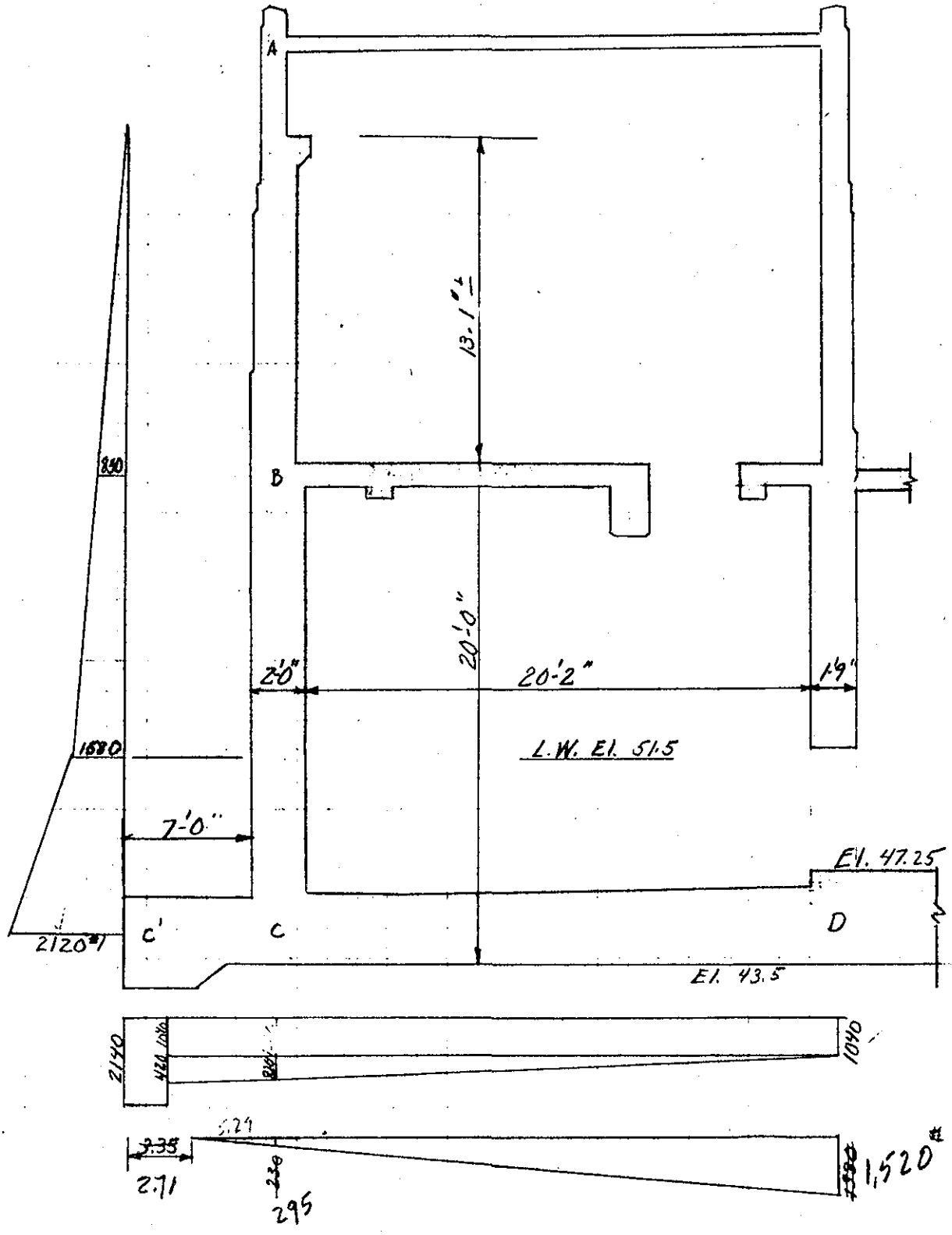
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Transverse Section B-B

Computed by H.E.W. **Checked by** H.L.F. **Date** 25 June - 45

Section B-B Case I River up

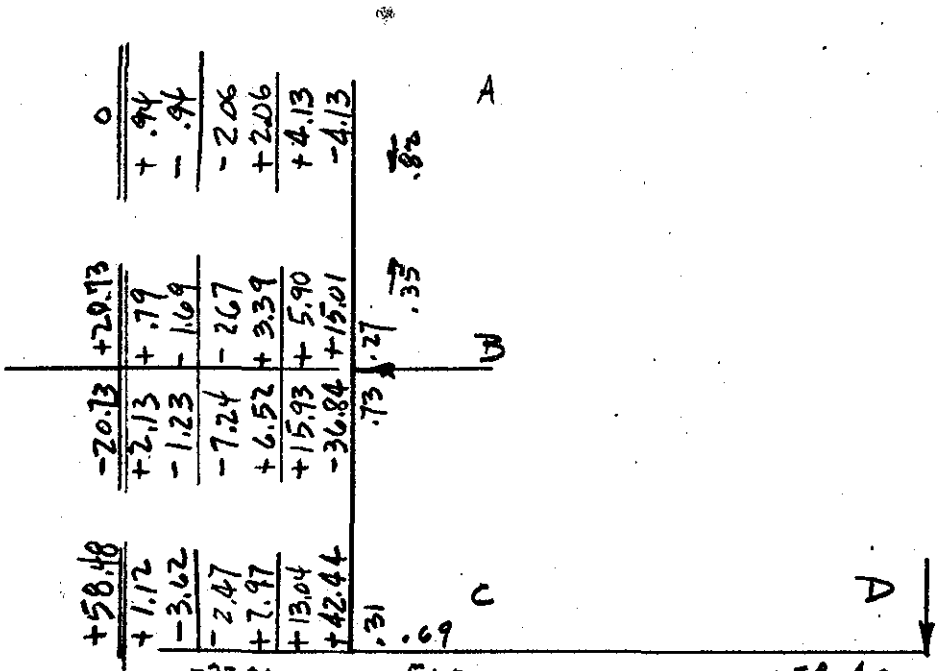


WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5
Computation Transverse Section B-B
Computed by H.L.F. **Checked by** _____ **Date** _____

Case I (Cont'd)
F.E.M. Use same f.e.m. as in Sect. A-A



-33.32	-51.20	+58.40
	+29.04	0.0
	0.0	+14.52
	- 5.50	0.0
	0.0	-2.75
	+ 2.50	0.0
	-25.16	+70.17

End Reactions & Center Moments

Member AB

$$H_A = 850 \times 13.58 \times .5 \times 4.53/17.46 - \frac{20,730}{17.46} = 240.^{\#}$$

$$H_B = 850 \times 13.58 \times .5 \times \frac{12.93}{17.46} + \frac{20,730}{17.46} = 6,540.^{\#}$$

$x_0 = 6.66$

$$M = 240 \times 6.66 - 2.77^2 \times \frac{62.5}{2} \times .92 = 1,380.^{\#}$$

Member BC

$$H_B = 850 \times 18.42 \times .5 + 730 \times 11.67 \times .5 \times \frac{10.64}{18.42} + 730 \times 6.75 \times \frac{3.38}{18.42} + 200 \times 6.75 \times .5 \times \frac{2.25}{18.42} - 37,750/18.42 = 9,250.^{\#}$$

$$H_C = 850 \times 18.42 \times .5 + 730 \times 11.67 \times .5 \times \frac{7.78}{18.42} + 730 \times 6.75 \times \frac{15.08}{18.42} + 200 \times 6.75 \times .5 \times \frac{16.17}{18.42} + 37,750/18.42 = 16,310.^{\#}$$

$x_0 = 8.4'$ from B

$$M = 9,390 \times 8.4 - 850 \times \frac{8.4^2}{2} - \underset{F=116}{525} \times \frac{8.4^2}{6} - 20,730 = 20,790.^{1\#}$$

Subject Holyoke Pumping Station No. 5

Computation Transverse Section B-B

Computed by H.L.F. **Checked by** _____ **Date** _____

Case I (cont'd)

Member CC'

$V_C = 8,460.^{\#}$ (See Sect. AA)

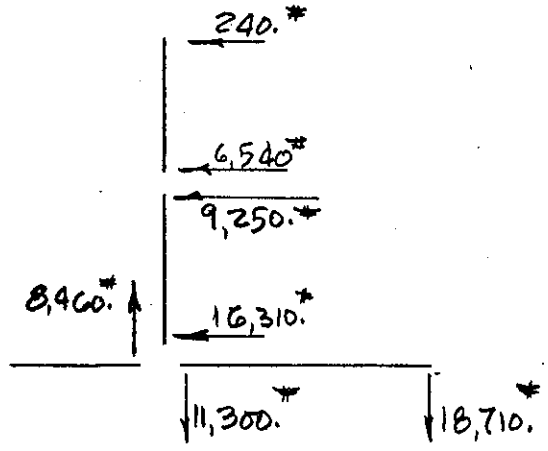
Member CD

$V_C = 920 \times 21.92 \times 1/2 + 900 \times 21.92 \times .5 \times .33 - \frac{45,010}{21.92} = 11,300.^{\#}$

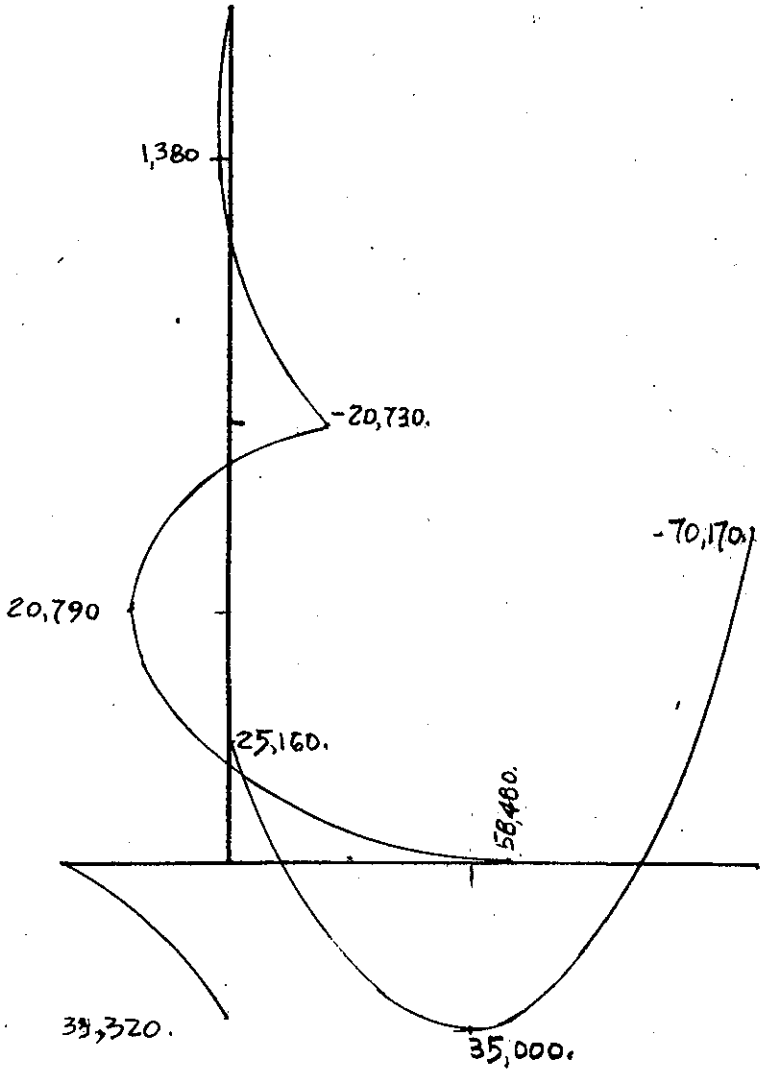
$V_D = 920 \times 21.92 \times 1/2 + 900 \times 21.92 \times .5 \times .67 + \frac{45,010}{21.92} = 18,710.^{\#}$

$t_0 = 10.0'$ from e

$M = 11,300 \times 10 - 25,160 - 920 \times \frac{10^2}{2} - 410 \times \frac{10^{-2}}{6} = 35,000.^{\#}$



End Reaction Diagram



Moment Diagram.

F- 117

WAR DEPARTMENT

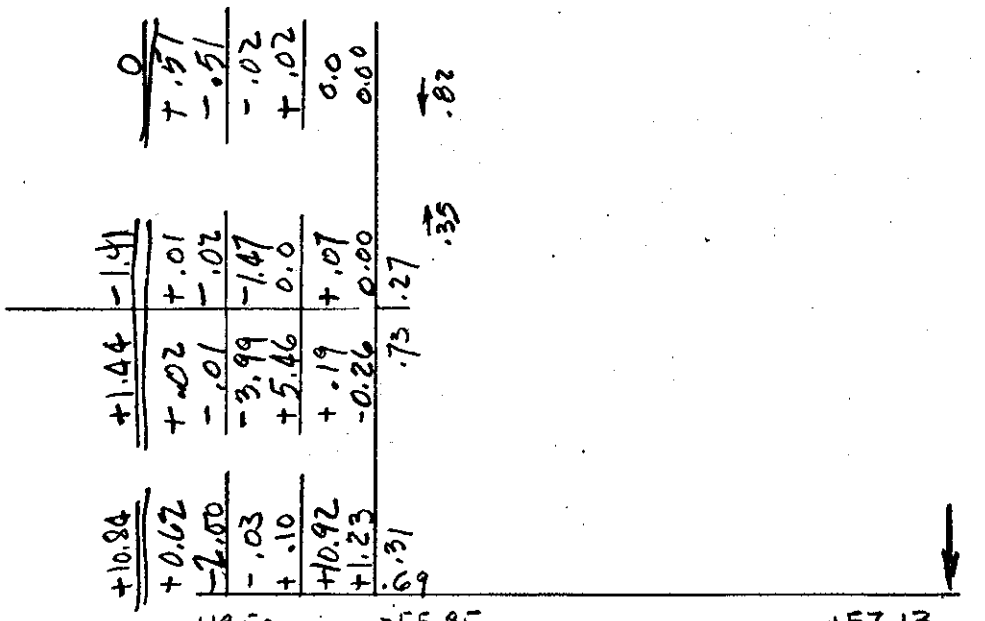
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5

Computation Transverse Section B-B

Computed by H.L.F. **Checked by** _____ **Date** _____

Case II F.E.M. will be the same as Sect. A-A Case II



End Reactions and Center Moments

Member AB

$H_A = 1{,}440 / 17.46 = 82.^{\#} \leftarrow$ $\qquad H_B = 82.^{\#} \rightarrow$

Member BC

$H_B = 240 \times 6.75 \times .5 \times \frac{2.25}{18.42} - \frac{12{,}280}{18.42} = 570. \rightarrow$

$H_C = 240 \times 6.75 \times .5 \times \frac{16.17}{18.42} + \frac{12{,}280}{18.42} = 1{,}380. \leftarrow$

No Center moment

Member CD

$V_C = 1320 \times 22.04 \times .5 + 145 \times 22.04 \times .5 \times 1/3 + \frac{38{,}900}{22.04} = 13{,}320.^{\#}$

$V_D = 1320 \times 22.04 \times .5 + 145 \times 22.04 \times .5 \times 2/3 + \frac{38{,}900}{22.04} = 17{,}370.^{\#}$

$x_0 = 9.8'$ from C

$M = 13{,}320 \times 9.8 - 30{,}340 - 1{,}320 \times \frac{9.8^2}{2} - 65 \times \frac{9.8^2}{6} = 35{,}320.^{\prime\#}$

WAR DEPARTMENT

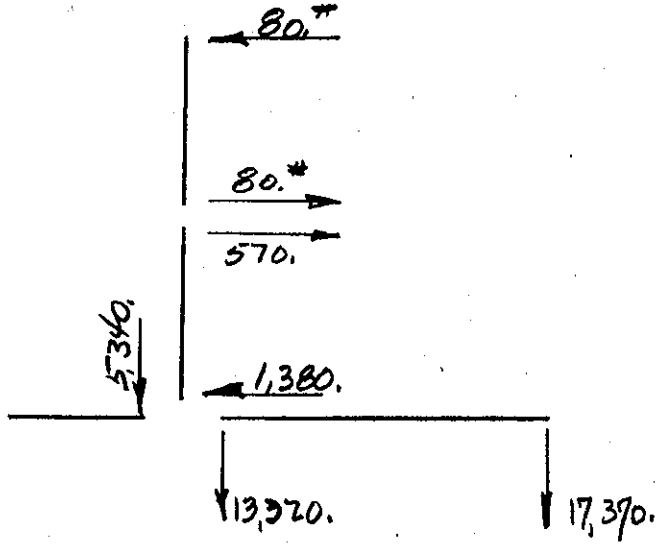
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5

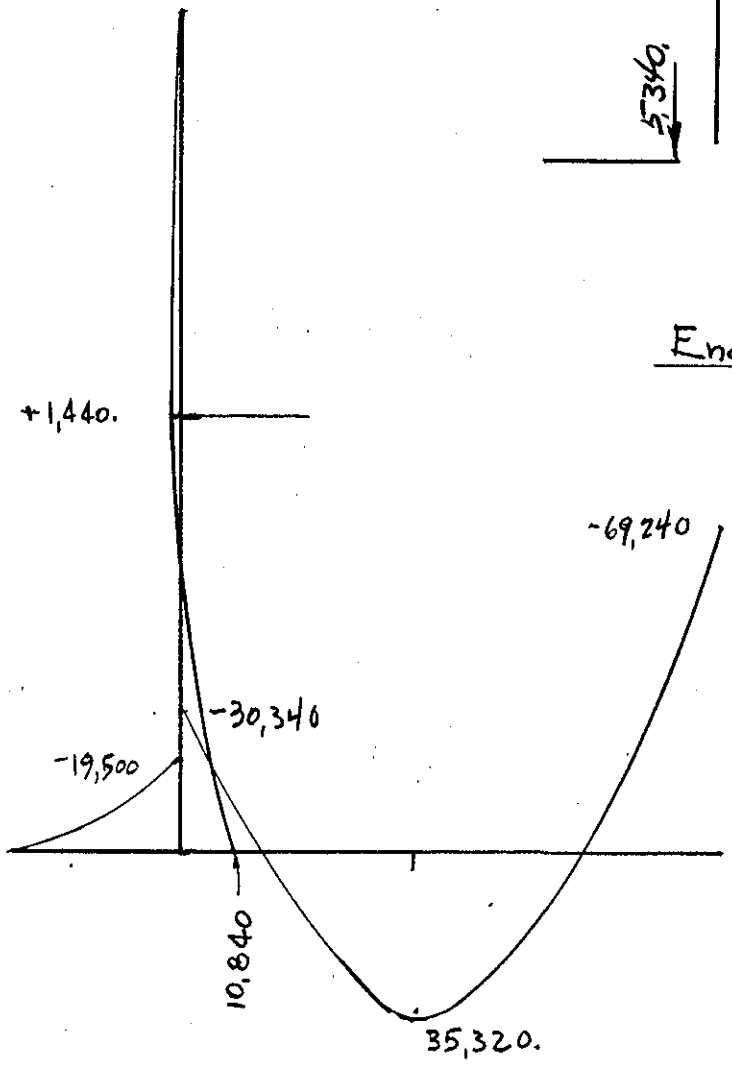
Computation Transverse Section B-B

Computed by H.L.F **Checked by** **Date**

Case II



End Reaction Diagram.



Moment Diagram

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5

Computation Transverse Section B-B

Computed by H. E. W. **Checked by** H. L. F. **Date** 26 June 45

Design of Section.

Riverside Wall Use same steel as in Section A-A ✓

Base Slab

$v = \frac{\cancel{16,920}\ 18,710}{12 \times .88 \times 25.5} = \cancel{63}\ 70.\ \#/\square''$

$-A_s$ at C $= \frac{\cancel{24560}\ 30,340 \times 12}{18000 \times .88 \times 25.5} = \cancel{.73}\ .90\ \square''$ Use 1" ⌀ @ 1'-0" c.c. ✓

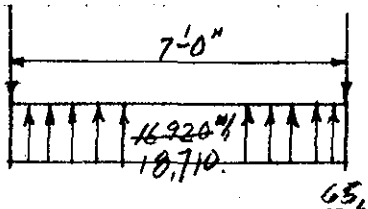
$-A_s$ at D $= \frac{\cancel{64710}\ 70,170 \times 12}{18000 \times .88 \times 25.5} = \cancel{1.92}\ 2.08\ \square''$ Use 1" ⌀ @ 6" c.c. ✓

$u_0 = \frac{\cancel{16920}\ 18,710}{8 \times .88 \times 25.5} = \cancel{94}\ 104\ \#/\square''$

$u_0 = \frac{\cancel{16620}\ 13,320}{4 \times .88 \times 25.5} = \cancel{118}\ 148\ \#/\square''$

$+A_s$ at Center $= \frac{\cancel{32620}\ 35,320 \times 12}{18000 \times .88 \times 26.5} = \cancel{.92}\ 1.01\ \square''$ Use 1" ⌀ @ 1'-0" c.c. ✓

Beam Action at D



$V = \cancel{16920}\ 18,710 \times 7 \times .5 = \cancel{57220}\ 65,600\ \#$

$M = \frac{1}{10} \times \cancel{16920}\ 18,710 \times 7^2 = \cancel{82910}\ 91,700\ '\#$

req'd $d = \sqrt{\frac{\cancel{82910}\ 91,700 \times 12}{21 \times 123}} = \cancel{19.6}\ 20.6'' < 40.5''$ ✓

$v = \frac{\cancel{59220}\ 65,600}{21 \times .88 \times 40.5} = \cancel{79}\ 88\ \#/\square''$

$A_s = \frac{\cancel{82910}\ 91,700 \times 12}{18000 \times .88 \times 40.5} = \cancel{1.55}\ 1.72\ \square''$ Use 4-7/8" ⌀ Top + bot. ✓

$u_0 = \frac{\cancel{59220}\ 65,600}{11.0 \times .88 \times 40.5} = \cancel{151}\ 167\ \#/\square''$

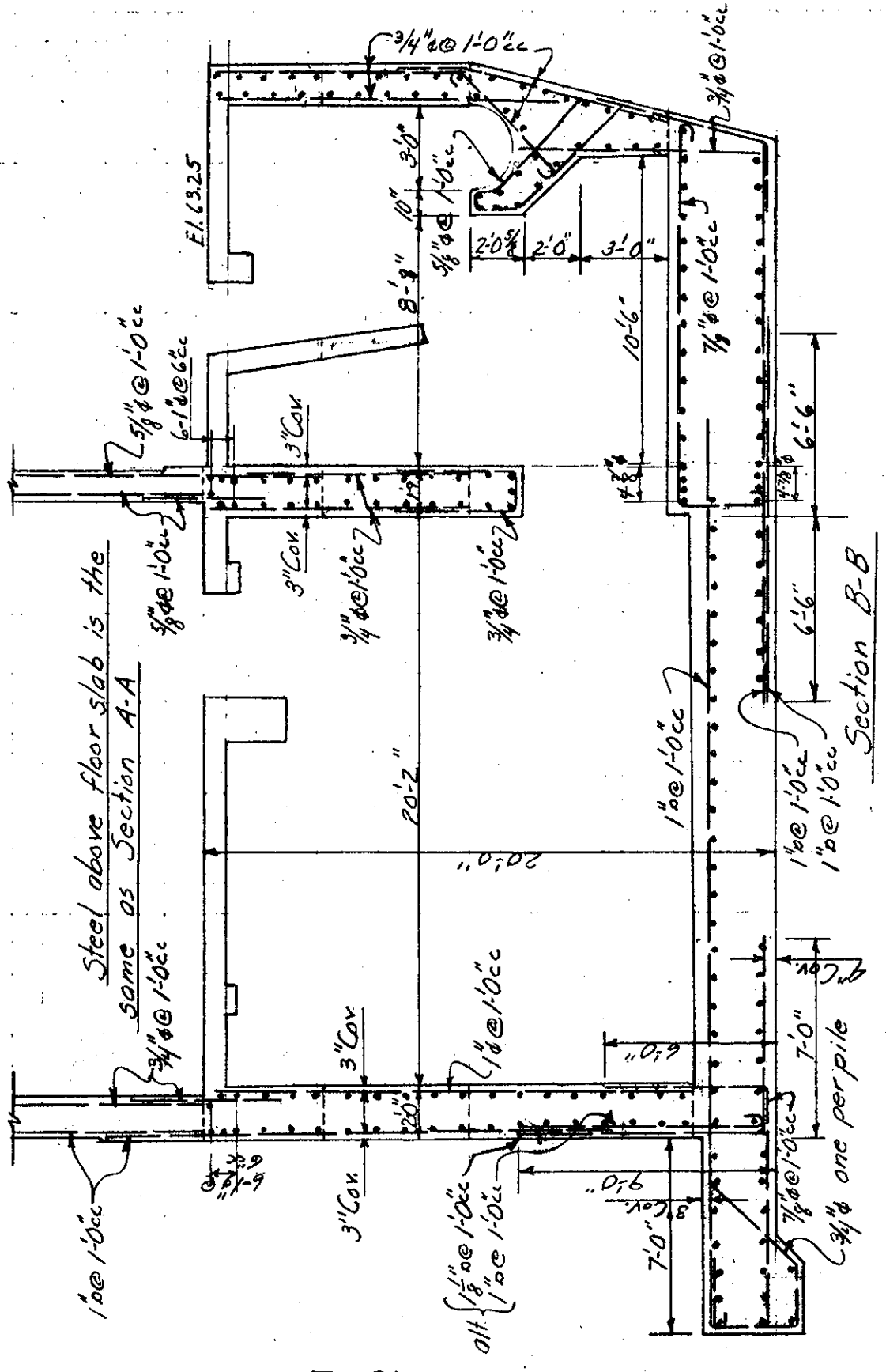
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5

Computation Transverse Section B-B

Computed by H. E. W. **Checked by** **Date** 26-June-45



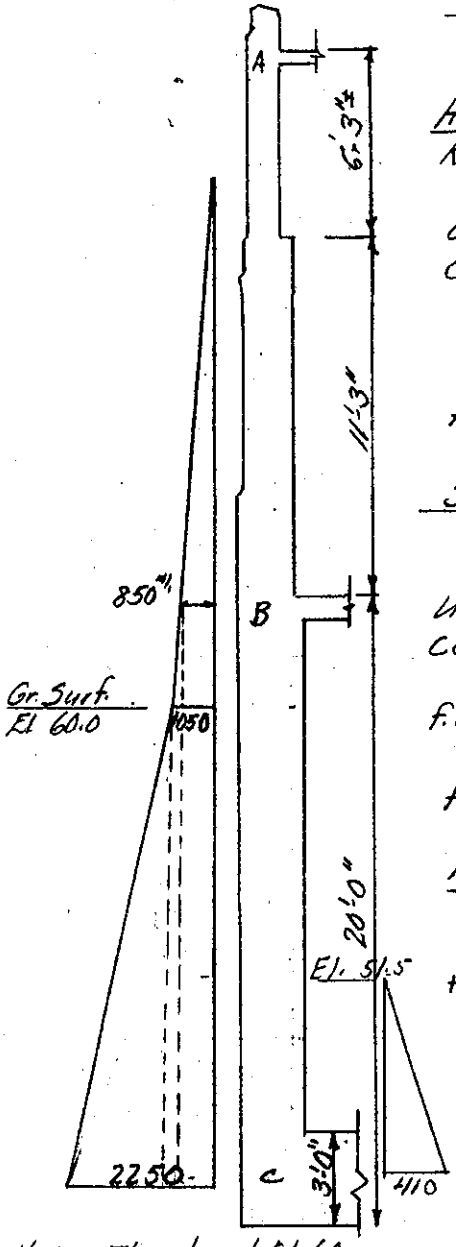
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5

Computation End Walls Riverside of Floodwall

Computed by H.E.W. **Checked by** **Date** 27-June-45



Horiz Thrust at El. 60.
62.5 x 16.75 =
Horiz. thrust at El. 45
1045 + 80 x 15 = 2250
6.5 x 62.5 = 410

Fixed End Moments

Member AB

$a = \frac{11.58}{17.62} = .657$ $\quad \frac{\text{min } d}{\text{max } d} = .60$

Haunched End

$K = 11 \times \frac{12^3}{17.62 \times 12} = 89.90$ $\quad c = 0.37$

Uniform ld f.e.m coef. = .120

coef for triang. ld $= \frac{.771(10 - 10 \times .771 + 3 \times .771^2)}{30} = 0.105$

f.e.m. coef $= \frac{.120 \times .105}{.0833} = .151$

f.e.m $= .151 \times \frac{850 \times 13.58}{2} \times 17.62 = 15.36^{1K}$

Small End

$K = 4.85 \times \frac{12^3}{17.62 \times 12} = 39.64$ $\quad c = 0.85$

Uniform ld f.e.m coef = .0.64

coef. for triang. ld $= \frac{.771^2(5 - 3 \times .771)}{30} = .053$

f.e.m. coef for triang. ld $= \frac{.064 \times .053}{.0833} = .041$

f.e.m. $= .041 \times \frac{850 \times 13.58}{2} \times 17.62 = 4.17^{1K}$

Member BC

$$M^F_{BC} = \frac{1}{12} \times 850 \times 18.17^2 + \frac{.174(10 - 15 \times .174 + 6 \times .174^2)}{15} \times 200 \times \frac{3.17}{2} \times 18.17$$

$$+ \frac{.826^2(4 - 3 \times .826)}{12} \times 200 \times 15 \times 18.17 + \frac{.826^2(5 - 3 \times .826)}{30} \times 1200 \times \frac{15}{2} \times 18.17$$

$$- \frac{.358^2(5 - 3 \times .358)}{30} \times 410 \times \frac{6.5}{2} \times 18.17 = 37.59^{1K}$$

$$M^F_{CB} = \frac{1}{12} \times 850 \times 18.17^2 + \frac{.174^2(5 - 4 \times .174)}{10} \times 200 \times \frac{3.17}{2} \times 18.17$$

$$+ \frac{.826(6 - 8 \times .826 + 3 \times .826^2)}{12} \times 200 \times 15 \times 18.17 + \frac{.826(10 - 10 \times .826 + 3 \times .826^2)}{30} \times 1200 \times \frac{15}{2} \times 18.17$$

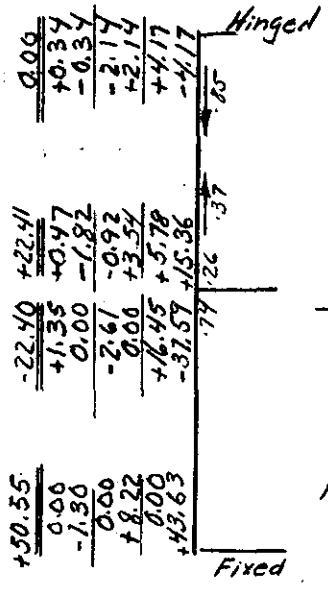
$$- \frac{.358(10 - 10 \times .358 + 3 \times .358^2)}{30} \times 410 \times \frac{6.5}{2} \times 18.17 = 43.63^{1K}$$

Stiffness $= \frac{13824}{218} \times 4 = 253.65$

Subject Holyoke Pumping Station No 5

Computation End Walls - Riverside of Flood Wall

Computed by H.E.W. **Checked by** **Date** 27 June 45



Member AB

$$H_A = 850 \times \frac{13.58}{2} \times \frac{4.53}{17.62} - \frac{22410}{17.62} = 210^{\#}$$

$$H_B = 850 \times \frac{13.58}{2} \times \frac{13.09}{17.62} + \frac{22410}{17.62} = 5560^{\#}$$

$$x_0 = 6.63' \text{ from } A$$

$$M = 210 \times 6.63 - 162 \times \frac{2.59^2}{6} = 1210^{'\#}$$

Member BC

$$H_B = 850 \times 18.17 \times .5 + 200 \times \frac{3.17}{2} \times \frac{16.06}{18.17} + 200 \times 15 \times \frac{7.5}{18.17}$$
$$+ 1200 \times \frac{15}{2} \times \frac{5}{18.17} - 410 \times \frac{6.5}{2} \times \frac{2.17}{18.17} - \frac{28150}{18.17} = 10{,}170^{\#}$$

$$H_C = 850 \times 18.17 \times .5 + 200 \times \frac{3.17}{2} \times \frac{2.11}{18.17} + 200 \times 15 \times \frac{10.67}{18.17}$$
$$+ 1200 \times \frac{15}{2} \times \frac{13.17}{18.17} - 410 \times \frac{6.5}{2} \times \frac{16.0}{18.17} + \frac{28150}{18.17} = 17590^{\#}$$

$$x_0 = 8.87' \text{ from } B$$

$$M = 10170 \times 8.87 - 22{,}400 - 850 \times \frac{8.87^2}{2} - 200 \times \frac{3.17}{2} \times 6.76 - 200 \times \frac{5.7^2}{2} - 456 \times \frac{5.7^2}{6}$$
$$= 26{,}510^{'\#}$$

Design of Wall

req'd d at C = $\sqrt{\frac{50550}{147}} = 18.5'' < 20.5''$ OK

req'd d at B = $\sqrt{\frac{22{,}410}{147}} = 12.4'' < 16.5''$ OK

v at C = $\frac{17590}{12 \times .88 \times 20.5} = 81\ \#/\square''$ OK

$-As$ at C = $\frac{50{,}550 \times 12}{18000 \times .88 \times 20.5} = 1.87\ \square''$ Use 1"⌀ @ 6" cc

$u_0 = \frac{17590}{8 \times .88 \times 20.5} = 122\ \#/\square''$ OK

$-As$ at B = $\frac{22{,}410 \times 12}{18000 \times .88 \times 16.5} = 1.03\ \square''$ Use 1"⌀ @ 1'-0" cc.

$u_0 = \frac{10170}{4 \times .88 \times 20.5} = 141\ \#/\square''$ OK

$+As = \frac{26510 \times 12}{18000 \times .88 \times 20.5} = .98\ \square''$ Use 7/8"⌀ @ 6" cc

WAR DEPARTMENT

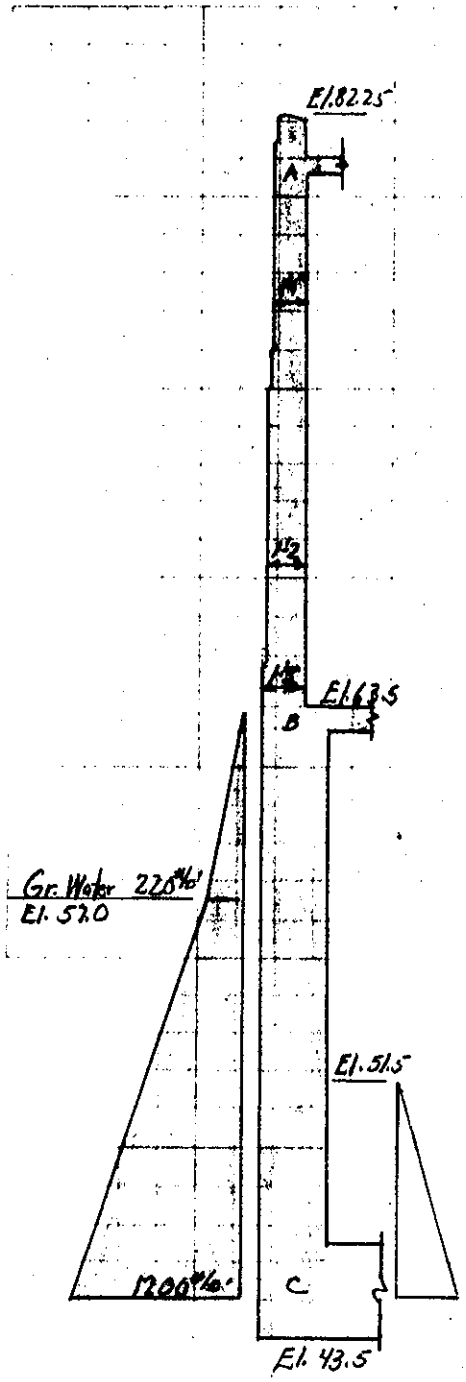
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

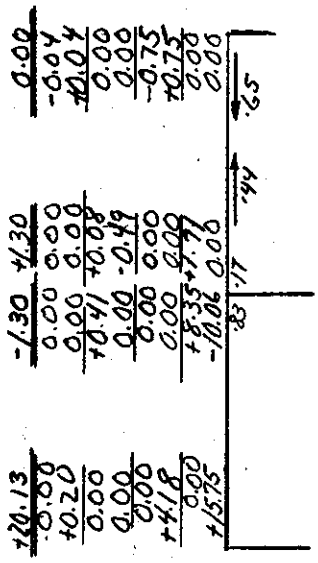
Subject Holyoke Pumping Station No. 5

Computation End Walls - Landside of Floodwall

Computed by H.E.W. **Checked by** _____ **Date** 27- June- 45

The f.e.m will be the same as for wall D.E.F Section A-A. Case I





Member BC

$$H_C = 220\times6.17\times.5\times\frac{4.11}{18.42} + 220\times12.25\times\frac{12.30}{18.42} + 980\times12.25\times.5\times\frac{14.34}{18.42}$$

$$-340\times6.75\times.5\times\frac{16.17}{18.42} + \frac{18,830}{18.42} = 6640^{\#}$$

$$H_B = 220\times6.17\times.5\times\frac{14.31}{18.42} + 220\times12.25\times\frac{6.12}{18.42} + 980\times12.25\times.5\times\frac{4.08}{18.42}$$

$$-340\times6.75\times.5\times\frac{2.75}{18.42} - \frac{18830}{18.42} = 1590^{\#}$$

$x_0 = 8.92'$ from B

$$M = 1590\times8.92 - 1300 - 220\times6.17\times.5\times4.81 - 220\times\frac{2.75^2}{2}$$

$$-220\times\frac{2.75^2}{6} = 8510^{'\#}$$

$$V = \frac{6640}{12\times.88\times20.5} = 31^{\#}/\square'$$

$$-As \text{ at } C = \frac{20130\times12}{18000\times.88\times20.5} = .75^{\square''} \text{ Use } 1''\phi \text{ @ } 1'\text{-}0''\text{ cc}$$

$$u_0 = \frac{6640}{3.14\times.88\times20.5} = 117^{\#}/\square'$$

$$+As = \frac{8510\times12}{18000\times.88\times20.5} = .31^{\square''} \text{ Use } 3/4''\phi \text{ @ } 1'\text{-}0''\text{ cc}$$

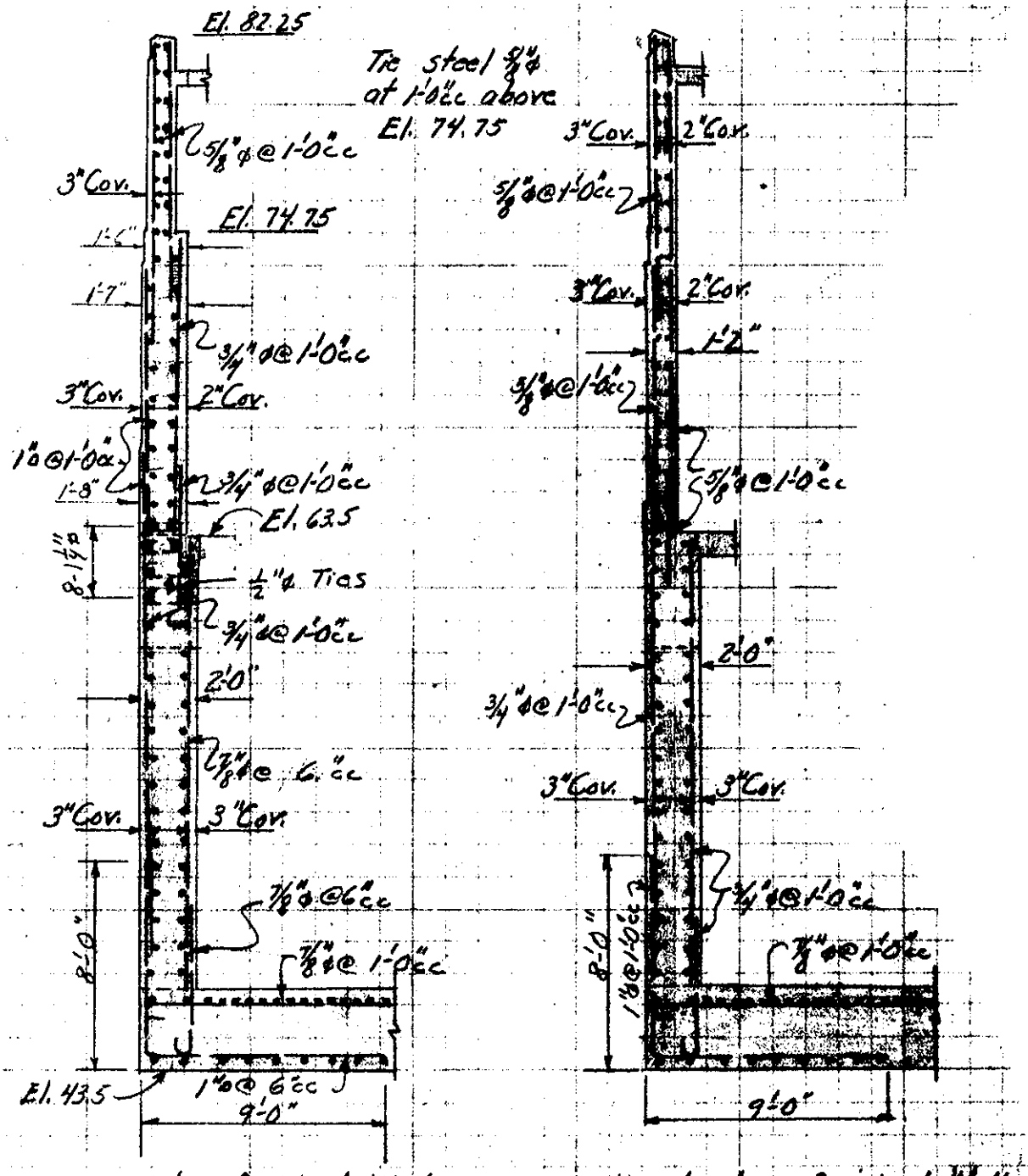
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5

Computation End Walls

Computed by H.E.W. **Checked by** _____ **Date** 27-June-45



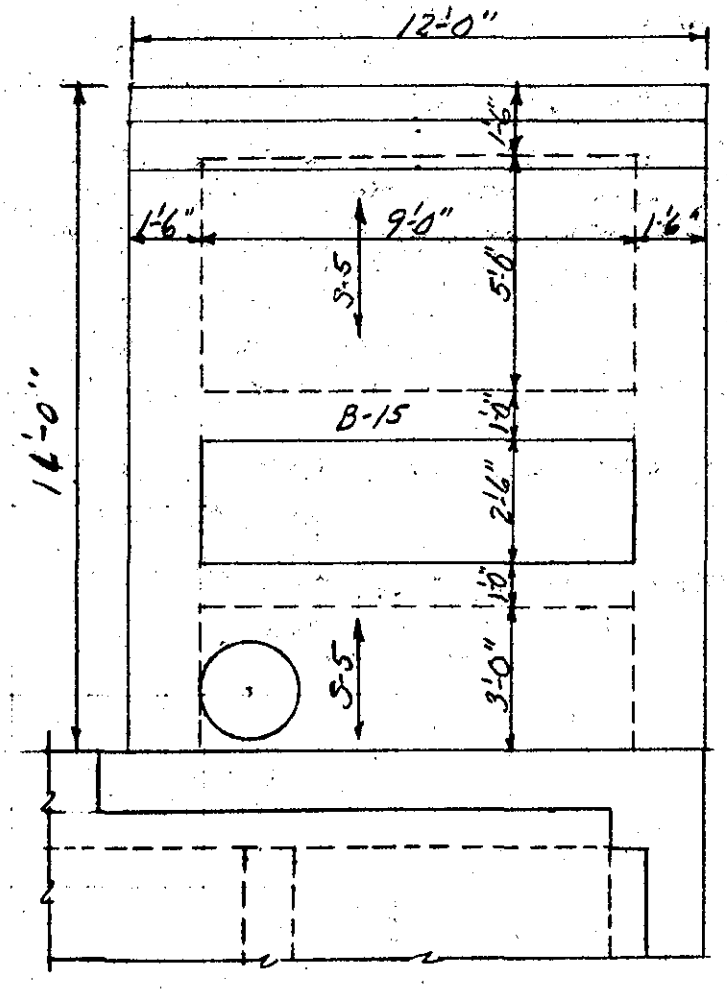
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5

Computation Intake Chamber

Computed by H. E. W. **Checked by** H. L. F. **Date** 28 June 45



Plan of Intake Chamber Roof

Roof slab will be designed for a Live Load of 300#.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5

Computation Intake Chamber

Computed by H.E.W. **Checked by** **Date** 28-June-45

Slab S-1

span = 6'-3"

L.L = 300#

D.L 8" slab = 100

400 #/□'

$M = \frac{1}{8} \times 400 \times 6.25^2 = 1950''^{\#}$

$V = 400 \times 6.25 \times .5 = 1250^{\#}$

req'd $d = \sqrt{\frac{1950}{123}} = 4.0'' < 6.25''$

$v = \frac{1250}{12 \times .88 \times 6.25} = 19\ \#/\square'$

$A_s = \frac{1950 \times 12}{18000 \times .88 \times 6.25} = .24\ \square''$ Use 5/8"φ @ 1'-0" c.c. Top + Bot.

$u_o = \frac{1250}{1.96 \times .88 \times 6.25} = 116\ \#/\square'$

Beam B-15

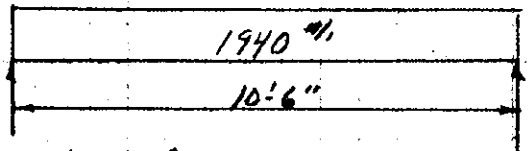
D.L. 8" slab = 2.5 x 100 = 250 #/'

D.L. cover pl. = 1.25 x 30 = 40

D.L. 12" x 18" bm = 1 x 1.50 x 150 = 220

L.L = 300 x 4.75 = 1430

1940 #/'



$V_L = V_R = 1940 \times 10.5 \times .5 = 10{,}190^{\#}$

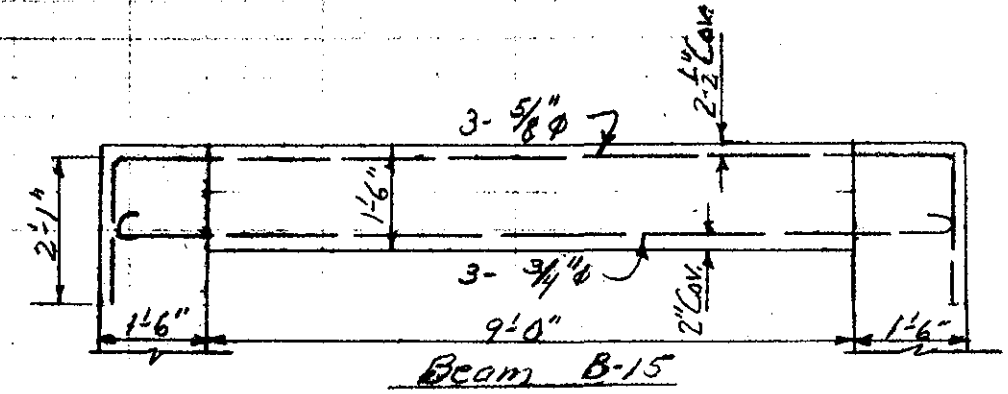
$M = \frac{1}{8} \times 1940 \times 10.5^2 = 26{,}740''^{\#}$

req'd $d = \sqrt{\frac{26740}{123}} = 14.8'' < 15.5''$ OK

$v = \frac{10190}{12 \times .88 \times 15.5} = 62\ \#/\square'$ OK

$A_s = \frac{26740 \times 12}{18000 \times .88 \times 15.5} = 1.31\ \square''$ Use 3 - 3/4"φ

$u_o = \frac{10190}{7.07 \times .88 \times 15.5} = 105\ \#/\square''$



Beam B-15

12" x 18"

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

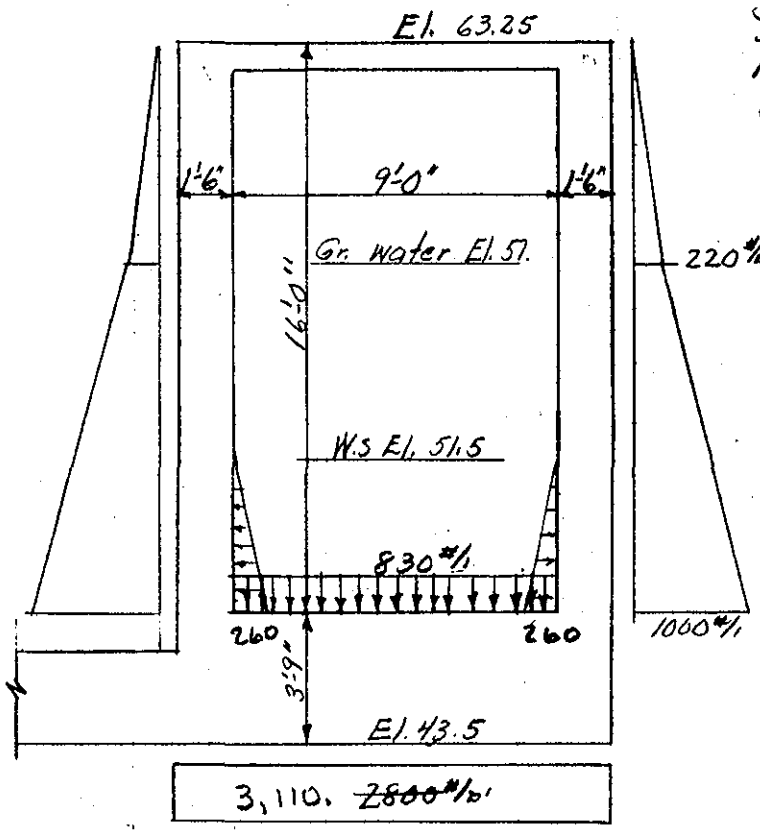
Subject Holyoke Pumping Station No 5

Computation Intake Chamber

Computed by H.E.W. **Checked by** H.L.F. **Date** 29-June-43

Substructure

Case I with River up will govern the design. The section will be analized horizontally. Frame will be considered hinged at A and fixed at D



Vertical Section at Outer End

Horiz. Thrust at El. 47.25

220 + 9.75×80 = 1000 #/'

4.25 × 62.5 = 260 #/'

Base Pressures

Downward Load

Water = 4.25×62.5 = 265

Conc = 3.75×150 = 565

830

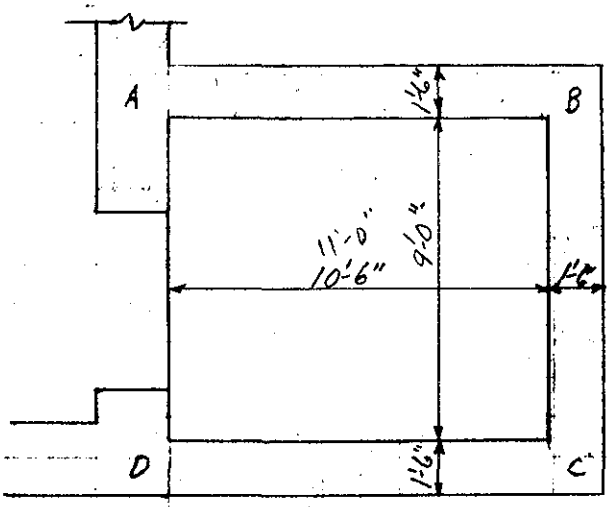
Upward Load

Uplift = 840 #/'

Bearing = ~~1960~~ 2,270

~~2800~~ #/'

3,110.



Horiz. Sect. at Top of Base Slab

F.E.M.

Member AB & CD

$M^F = \frac{1}{12} \times 740 \times 12.25^2 = 9.25^{'K}$

Member BC

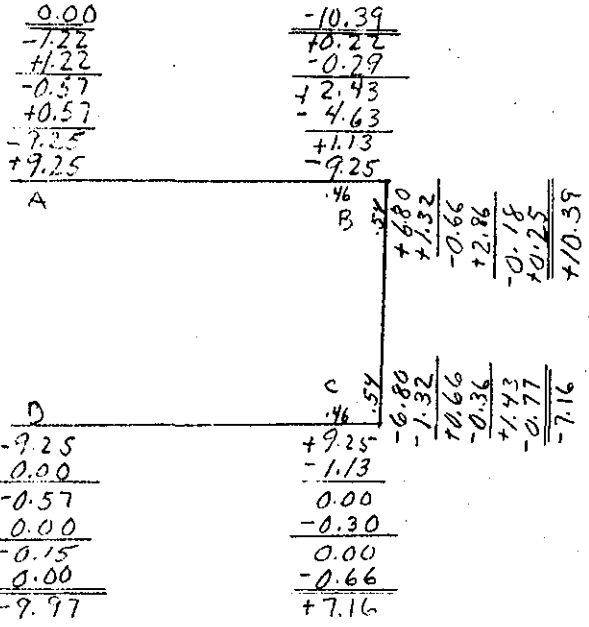
$M^F = \frac{1}{12} \times 740 \times 10.5^2 = 6.80^{'K}$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Hayoke Pumping Station No 5
Computation Intake Chamber
Computed by H.E.W. **Checked by** **Date** 29 June 45

Horiz. Sect at Top of Base Slab cont



Member AB

$H_A = 740 \times 12.25 \times .5 - \frac{10.370}{12.25} = 3690^{\#}$

$H_B = 740 \times 12.25 \times .5 + \frac{10390}{12.25} = 5380^{\#}$

$x_0 = 4.99'$ from A

$M = 3690 \times 4.99 - 740 \times \frac{4.99^2}{2} = 9200'^{\#}$

Member BC

$H_B = 740 \times 10.5 \times .5 + \frac{3230}{10.5} = 4190^{\#}$

$H_C = 740 \times 10.5 \times .5 - \frac{3230}{10.5} = 3580^{\#}$

$x_0 = 5.66'$

$M = 4190 \times 5.66 - 10390 - 740 \times \frac{5.66^2}{2} = 1470'^{\#}$

Member CD

$H_C = 740 \times 12.25 \times .5 - \frac{2810}{12.25} = 4300^{\#}$

$H_D = 740 \times 12.25 \times .5 + \frac{2810}{12.25} = 4860^{\#}$

$X_0 = 5.81'$ from C

$M = 4300 \times 5.81 - 7160 - 740 \times \frac{5.81^2}{2} = 5330'^{\#}$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Intake Chamber

Computed by H.E.W. **Checked by** H.L.F. **Date** 29- June - 45

Horiz. Sect. at Top of Base Slab (cont.)

Design of Section

$$\text{Req'd } d = \sqrt{\frac{10390}{147}} = 8.4'' < 14.5'' \text{ OK}$$

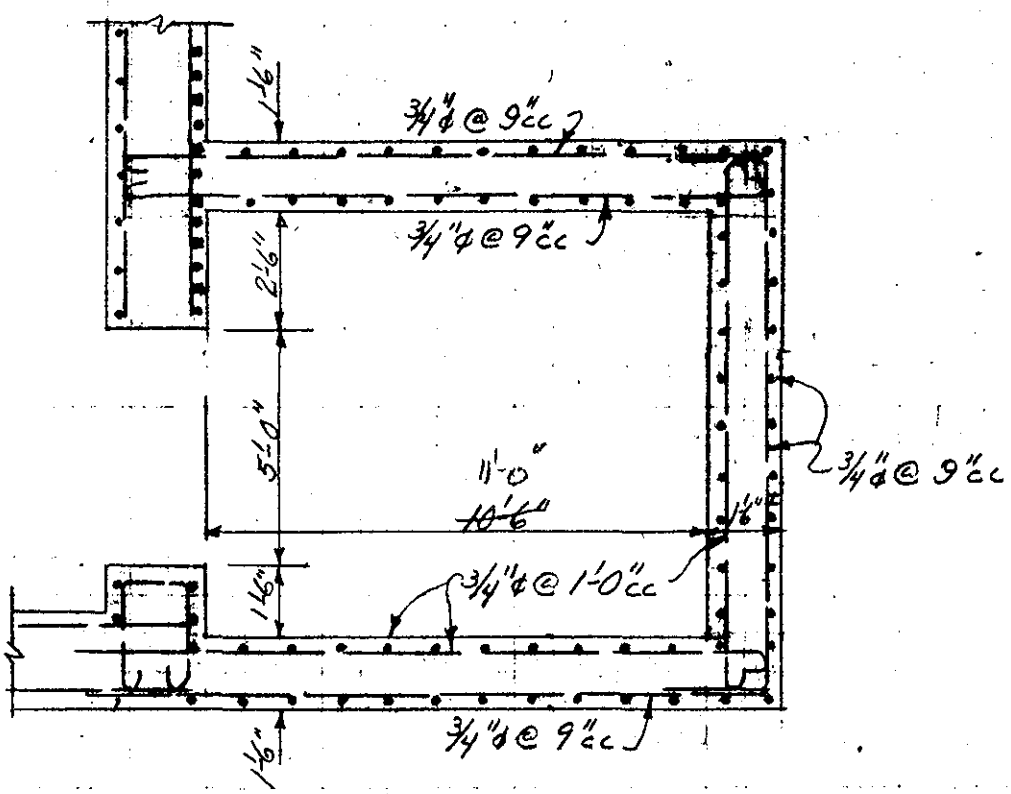
$$v = \frac{5380}{12 \times .88 \times 14.5} = 35\#/\square''$$

$$-A_s \text{ at } B = \frac{10390 \times 12}{18000 \times .88 \times 14.0} = .58^{\square''} \text{ Use } 3/4''\phi \text{ @ } 9''cc$$

$$-A_s \text{ at } D = \frac{9970 \times 12}{18000 \times .88 \times 14.0} = .55^{\square''} \text{ Use } 3/4''\phi \text{ @ } 9''cc$$

$$u_0 = \frac{5380}{3.1 \times .88 \times 14.0} = 141\#/\square''$$

$$+A_s = \frac{9200 \times 12}{18000 \times .88 \times 14.0} = .50^{\square''} \text{ Use } 3/4''\phi \text{ @ } 10''cc.$$



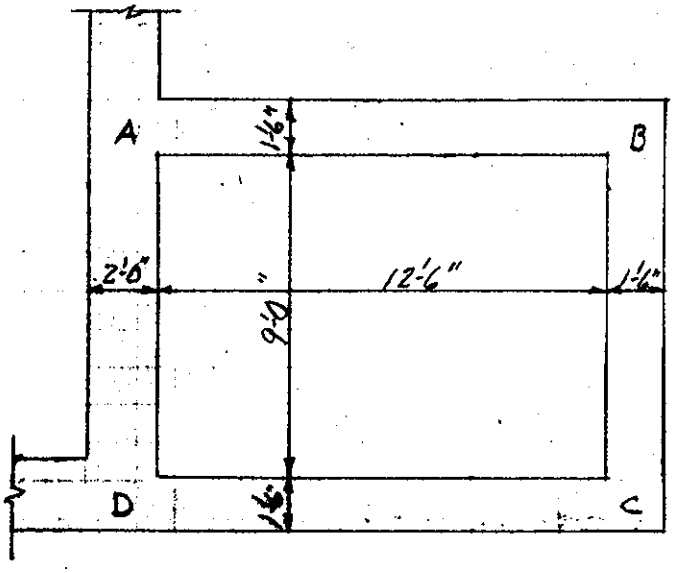
Horiz. Section at El 47.25 - Typical for steel from El. 47.25 to 52.25

Subject Holyoke Pumping Station No. 5

Computation Intake Chamber

Computed by H.E.W. **Checked by** **Date** 29-June-45

Horizontal Sect. at El. 55.0



Horiz Thrust at El. 55.0

$220 + 2 \times 80 = 380^{\#}/$

F.E.M

Member AB + CD

$M_A^F = M_B^F = \frac{1}{12} \times 380 \times 14.25^2 = 6.43'^k$

Member BC

$M_E = M_B^F = \frac{1}{12} \times 380 \times 10.5^2 = 3.49'^k$

0.00	-6.72
-0.88	+0.24
+0.88	-0.32
-0.63	+1.75
+0.63	-3.22
-6.43	+1.26
+6.43	-6.43

.43 .57 +3.49 +1.68 -0.84 +2.31 -0.24 +0.32 +6.72

.43 .57 -3.49 -1.68 +0.84 -0.48 +1.15 -0.66 -3.75

-6.43	+6.43
0.00	-1.26
-0.63	0.00
0.00	-0.36
-0.18	0.00
0.00	-0.49
-7.24	+4.75

Member AB

$H_A = 380 \times 14.25 \times .5 - \frac{6720}{14.25} = 2240^{\#}$

$H_B = 380 \times 14.25 \times .5 + \frac{6720}{14.25} = 3180^{\#}$

$x_0 = 5.89'$ from A

$M = 2240 \times 5.89 - 380 \times \frac{5.89^2}{2} = 6600'^{\#}$

Member BC

$H_B = 380 \times 10.5 \times .5 + \frac{2970}{10.5} = 2280^{\#}$

$H_C = 380 \times 10.5 \times .5 - \frac{2970}{10.5} = 1710^{\#}$

$x_0 = 6.0'$

$M = 2280 \times 6 - 6720 - 380 \times \frac{6^2}{2} = 120'^{\#}$

Member CD

$H_C = 380 \times 14.25 \times .5 - \frac{2490}{14.25} = 2530^{\#}$

$H_D = 380 \times 14.25 \times .5 + \frac{2490}{14.25} = 2890^{\#}$

$x_4 = 6.66'$ from C

$M = 2530 \times 6.66 - 4750 - 380 \times \frac{6.66^2}{2} = 3670'^{\#}$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Intake Chamber

Computed by H.E.W. **Checked by** H.L.F. **Date** 20-June-45

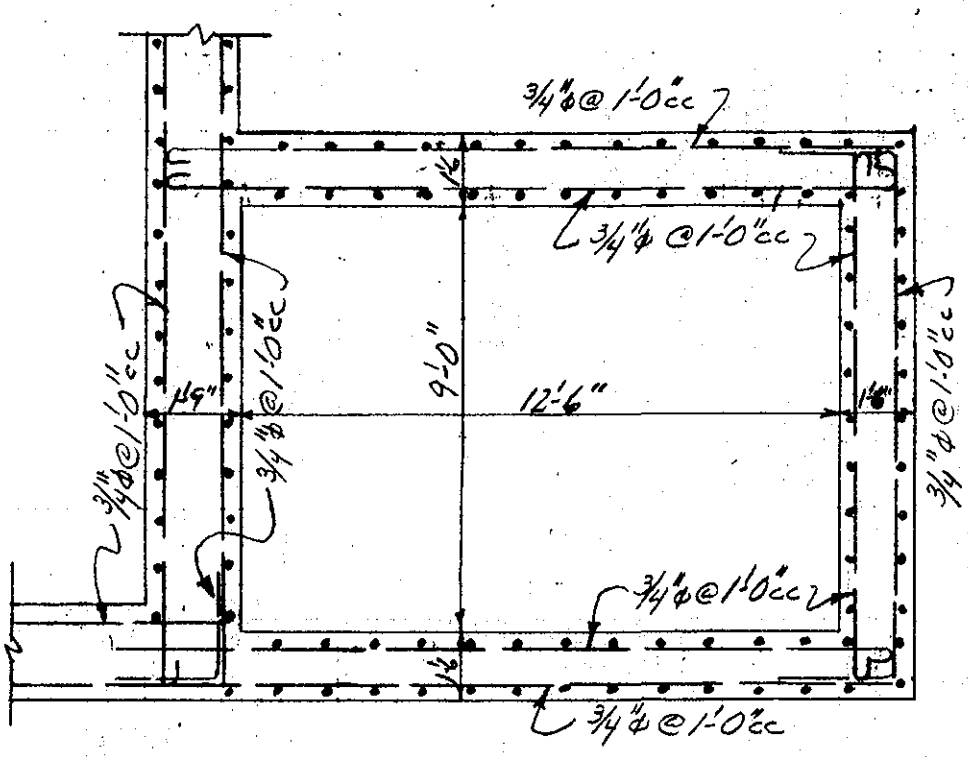
Horiz. Section at El. 55.0 (cont.)

Design of Section

$-A_s$ at D = $\frac{7240 \times 12}{18000 \times .88 \times 14.0}$ = .39 □" Use 3/4"φ @ 1'-0"cc

Use 3/4"φ @ 1'-0"cc both faces all around

$u_o = \frac{3180}{2.34 \times 88 \times 14.0}$ = 110 #/□'



Typical Steel from El. 52.25 to top

Steel in base slab

Net load upward = ~~1970~~ 2280 #/□' Span = 10.5'

$M = \frac{1}{10} \times$ ~~1970~~ 2280 $\times 10.5^2 =$ ~~21,720~~ 25,150 '# $V =$ ~~1970~~ 2,280 $\times 10.5 \times .5 =$ ~~10,340~~ 12,000 #

$-A_s = \frac{\cancel{21,720} \; 25,150 \times 12}{18000 \times .88 \times 24.5}$ = ~~.67~~ .78 □" Use

$-A_s = \frac{\cancel{21,720} \; 25,150 \times 12}{18000 \times .88 \times 39.5}$ = ~~.42~~ .48 □" Use 7/8"φ @ 1'-0"c.c.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

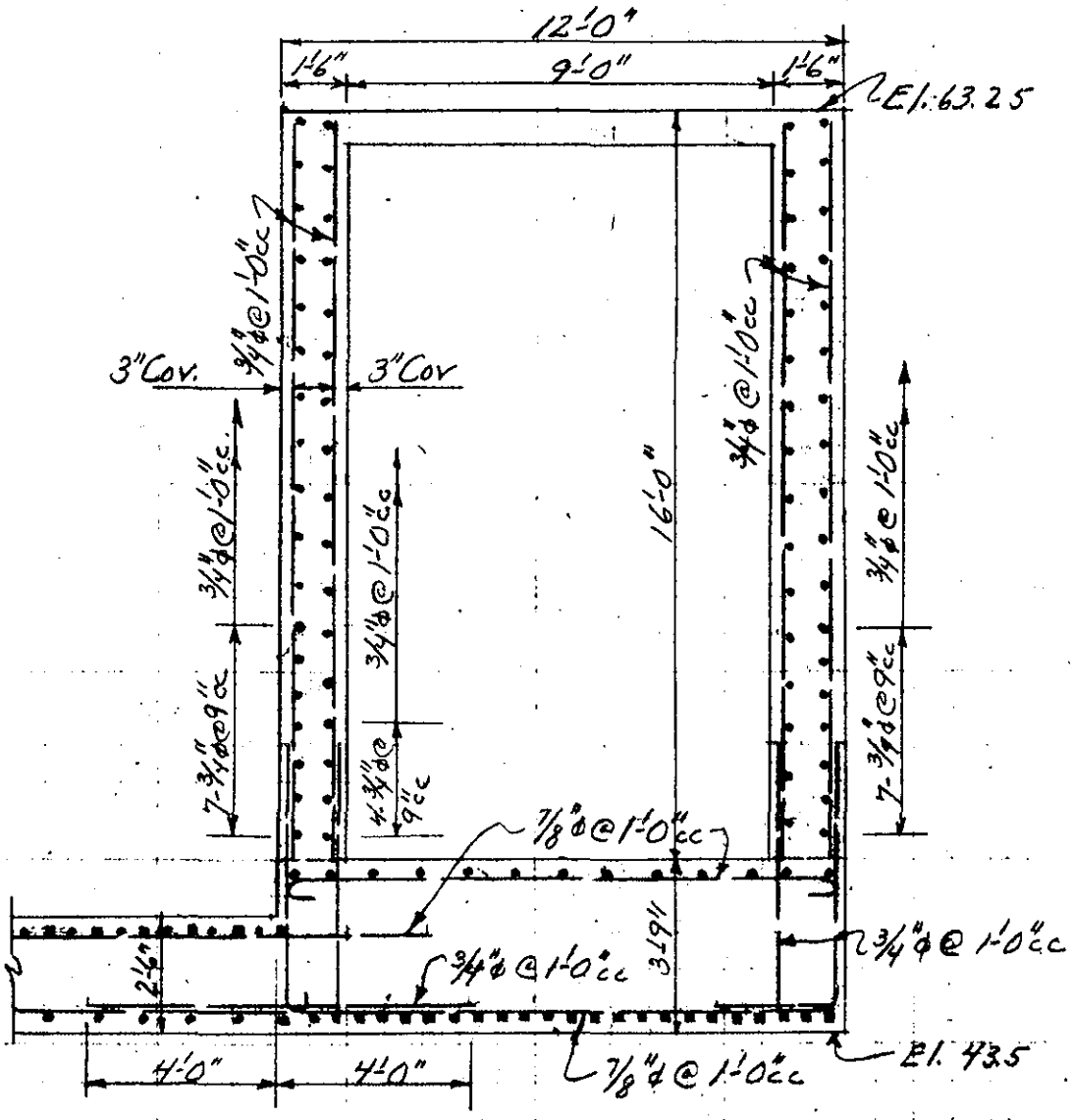
Computation Intake Chamber

Computed by H.E.W. **Checked by** H.L.F. **Date** 30 June-45

Base Slab (cont.)

+As — Use 7/8"φ @ 1'-0"cc ✓

$$u_0 = \frac{\cancel{10340}\ 12{,}000}{275 \times .88 \times 39.5} = \cancel{108}\ 125\ \#/\square''$$



Vert. Section Thru Intake Chamber ✓

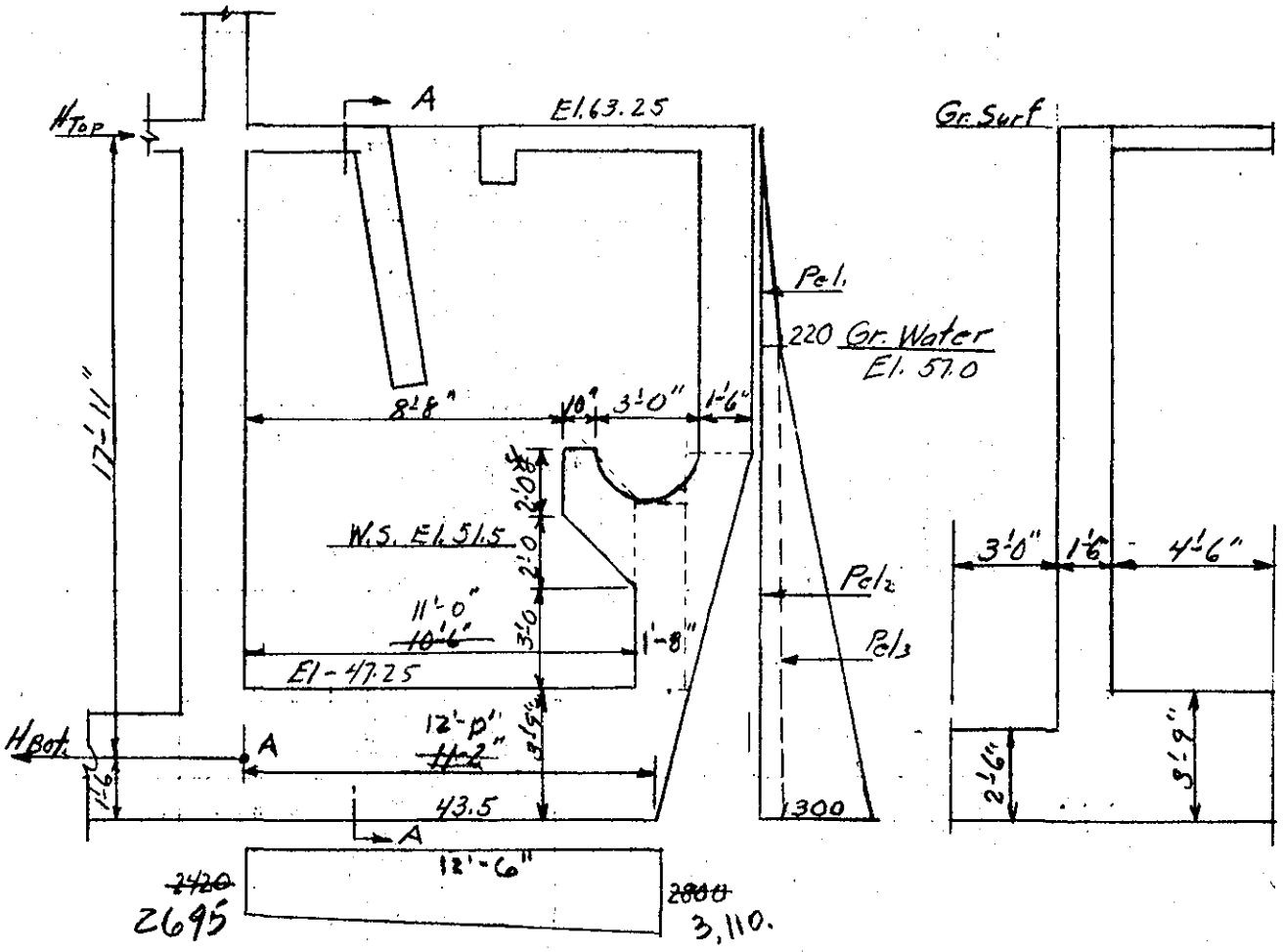
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation West Wall of Intake Chamber - Buttress Action

Computed by H.E.W. **Checked by** H.L.F. **Date** 30 June - 45



The west wall will act as a buttress taking up the net upward load on the base slab. The wall will be investigated for the moment about the face of the pumping station wall and the two horiz reactions shown on diagram will be determined. The motor room floor will be designed to resist the horiz. thrust at the top.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation West Wall of Intake Chamber Buttress Action

Computed by H.E.W. **Checked by** H.L.F. **Date** 30-June-45

Moments about Face of Pumping Station Wall

	Forces Acting	↓	↑	→	←	Arm	Moments ↷	Moments ↶
Roof Slab	14x6x100	8.4				7	58.8	
Less op.	2.5x4.5x100	-1.1				5.25	-5.9	
Bm	1x.83x4.5x150	0.6				7.0	3.9	
Tr Rck Apron	1x 7x4.5x150	4.7				4.0	18.9	
W. Wall	~~12~~ 12.67 x1.5x 15.17x150	~~11.0~~ 13.2				6.33	274. ~~245.8~~	
	~~2~~ 1.33 x8.12x1.5 x150	~~5.5~~ 24				13.33	32.4 ~~71.3~~	
	5x~~2~~ 1.33 x1.5x 7.05x150	1.1 ~~1.6~~				~~12.66~~ 13.11	13.8 ~~20.1~~	
End Wall	2x7.05x.5x4.5x150	4.8				12.66	60.2	
	1.5x8.12x4.5x150	8.2				13.0	106.9	
	1.5x5.55x4.5x150	5.6				11.25	63.2	
Weir	3x2.5x4.5x150	5.1				9.5	48.1	
Base Sl.	3.75x6 x~~12.25~~ 12.5x150	42.2 ~~39.7~~				~~5.75~~ 6.25	264 ~~226.3~~	
"	2.5x 3x~~11.58~~ 12.9 x150	13.2				~~5.75~~ 6.0	81. ~~75.4~~	
Eq	3x12.5x 17.25 x100	~~62.1~~	64.7			~~5.75~~ 6.25	404. ~~359.6~~	
	3x12.5x 11 x.25	~~4.9~~	10.3			~~3.75~~ 4.25	64.5 ~~57.3~~	
Water	4.25x ~~10.3~~ 11.0 x4.5x62.5	~~12.6~~	13.2			~~5.25~~ 5.50	72.4 ~~69.9~~	1,890. ~~1359.9~~
Uplift	~~2.720~~ 2.695 x ~~1.77~~ 1.75 x9		~~243.3~~	303.		~~6.25~~ 6.25		
Bearing	~~380~~ x ~~1.49~~ x9x.5		~~19.1~~			~~7.45~~ 8.3		194. ~~142.3~~
	415 12.5	226.9	23.4				1560.2	2084.
	Total	~~221.1~~	~~262.4~~	326.4			~~1475.8~~	~~1502.2~~
			~~41.3~~	99.5				~~26.4~~ 523.8

As in bot. of slab = $\frac{523{,}800 \text{ (~~26,100~~)} \times 12}{18000 \times .88 \times 228} = 1.74$ (~~1.09~~") 3 4-7/8 sufficient

Moments about Pt. A

	Forces Acting	↓	↑	→	←	Arm	M ↷	↶
	Total above		~~41.3~~ 99.5					523.8 ~~26.4~~
P_{c1}	220x6.25x.5x6				4.1	14.08		58.1
P_{c2}	220x 13.5x6				17.8	4.75		84.6
P_{c3}	1060x13.5x.5x6				43.7	3.00		131.2
							797.7 ~~300.3~~	
			~~41.3~~ 99.5		65.6		797.7 ~~300.3~~	

$H_{top} = \frac{797{,}700 \text{ (~~300,300~~)}}{17.92} = \text{~~16,760~~}^{\#}$ 44,500 #

WAR DEPARTMENT

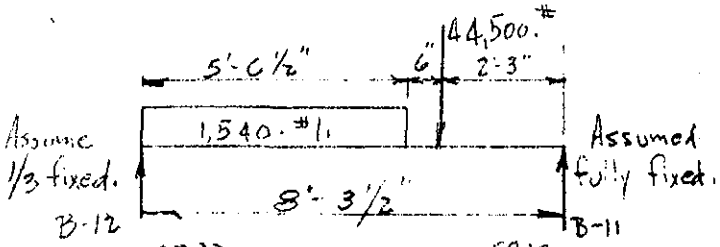
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 5

Computation West Wall at Intake Chamber Buttress Action

Computed by H.L.F. **Checked by** _____ **Date** _____

Beam Action at Top of Wall



B-12	B-11
+27.32	-58.39
-9.10	0
0	-4.55
0	0
+18.22	62.94

F.E.M

$$B\text{-}12 = \frac{.67(6-8\times.67+3\times.67^2)}{12}1540\times5.54\times8.29 + .73(1-.73)^2\,44{,}500\times8.29 = 27{,}320.^{\prime\#}$$

$$B\text{-}11 = \frac{.67^2(4-3\times.67)}{12}1540\times5.54\times8.29 + .73^2(1-.73)\,44{,}500\times8.29 = 58{,}390^{\prime\#}$$

$$V_{B\text{-}12} = 44{,}500\times\frac{2.25}{8.29} + 1540\times5.54\times\frac{5.52}{8.29} - \frac{44{,}720}{8.29} = 12{,}470^{\#}$$

$$V_{B\text{-}11} = 44{,}500\times\frac{6.04}{8.29} + 1540\times5.54\times\frac{2.77}{8.29} + \frac{44{,}720}{8.29} = 40{,}650^{\#}$$

$$+M_{@2.25'} = -40{,}650\times2.25 + 62{,}940 = 28{,}560.^{\prime\#}$$

$b = 24"$ $d = 17"$

$$\text{req'd } d = \sqrt{\frac{62{,}940\times12}{24\times147}} = 214 = 14.6"$$

$$v = \frac{40{,}650}{24\times.88\times17} = 113.\ ^{\#}/\square$$

$$A_s = \frac{62{,}940\times12}{18{,}000\times.88\times17} = 2.80\ \square$$

$$u = \frac{40{,}650}{14.52\times.88\times17} = 1.87.\ ^{\#}/\square$$

4-1¼" ϕ = 3.16 ; 1-⅝" ϕ = .31 □ ; 3.47 □

E_0 1.96 ; 12.56 ; 14.52"

Direct Thrust on Beam B-11

Thrust = 40,650.# $M = 17{,}380.^{\prime\#}$

$$M_s = 17{,}380 + \frac{6.5}{12}\times40{,}650 = 39{,}380.^{\prime\#}$$

$$\text{req'd } \sqrt{\frac{39{,}380}{123}} = 17.9" > 15.5"$$

Use comp steel.

$$A_s = \frac{12\times39{,}380}{18{,}000\times.88\times15.5} - \frac{40{,}650}{18{,}000} = .34\ \square$$

$$A_s' = \frac{12\times39{,}380 - 123\times12\times15.5^2}{\frac{11}{12}\times\frac{.348-\frac{2.5}{15.5}}{1-.348}\left(1-\frac{2.5}{15.5}\right)18{,}000\times15.5} = \frac{118{,}020}{.917\times.287\times.839\times18{,}000\times15.5} = 1.91\ \square$$

3-⅞" ϕ = 1.8

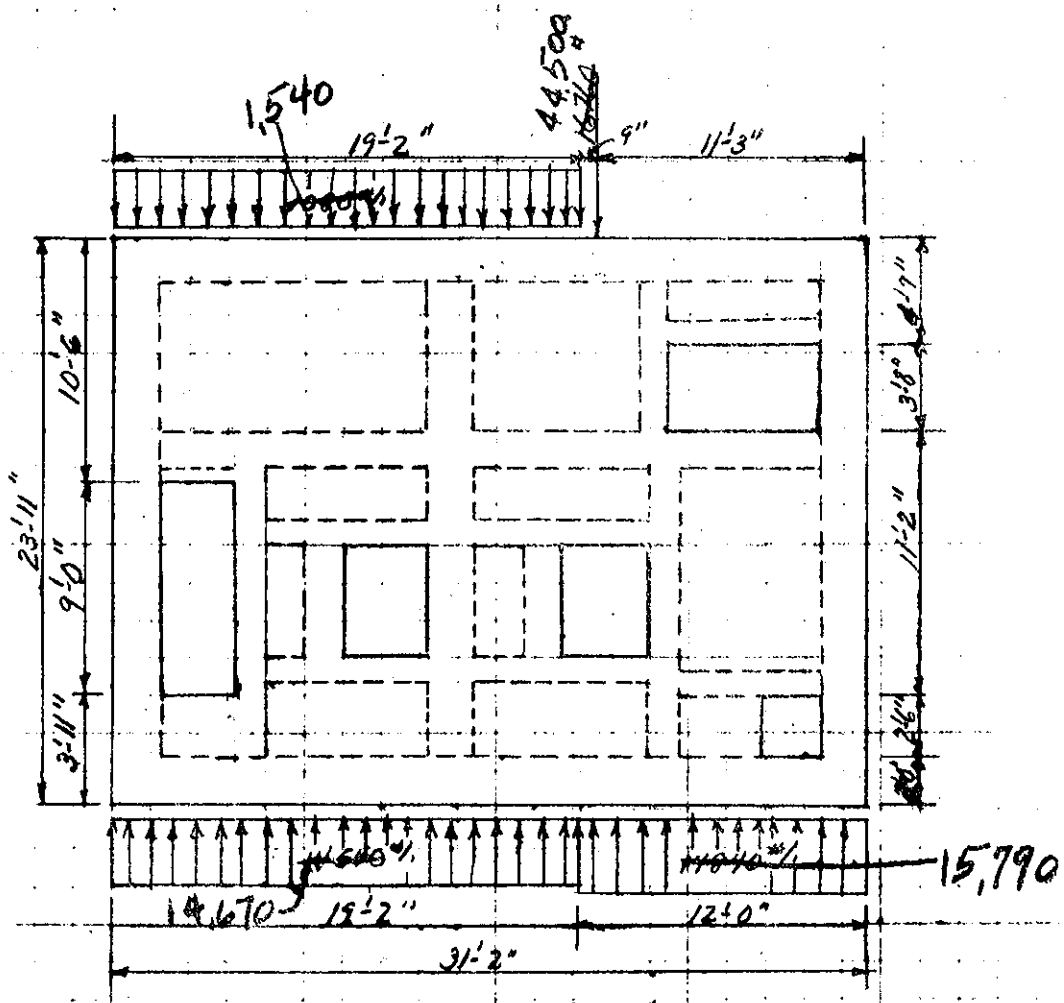
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Horiz Thrust at Motor Room Floor

Computed by H. E. W. **Checked by** H. L. F. **Date** 2-July-45



Plan of Loading at Motor Room Floor

It is assumed that the floor will act as a deep girder transferring the load to the end walls.

V_L = 14,540 (670) × 18.17 × .689 = 182,000 (183,000)
14,640 (15,790) × 11 × .189 = 27,930 (27,900)
− 1080 (1540) × 18.17 × .689 = − 13,520 (13,500)
− 16,760 (44,500) × .351 = − 5880 (15,600)
181,000 ~~195,560~~#

V_R = 14,540 (670) × 18.17 × .311 = 82,760 (82,900)
14,640 (15,790) × 11 × .811 = 141,310
− 1080 (1540) × 18.17 × .311 = − 6700 (8,700)
− 16,760 (44,500) × .649 = − 10,880 (28,900)
~~206,490~~#
186,400

x_0 = ~~14.53~~ 13.8' from V_L

M = ~~195,560~~ 181,000 × ~~14.53~~ 13.8 − 13,460 (130) × ~~14.53~~ 13.8 / 2 = ~~1,420,650~~ 1,250,000 '#

reqd $d = \sqrt{\frac{\cancel{1,420,650}\ 1,250,000 \times 12}{10 \times 123}}$ = ~~117.8~~ 111" < 284"

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5
Computation Horiz. Thrust at Motor Room Floor
Computed by H.E.W. **Checked by** H.L.F. **Date** 3 July 45

v at left $= \dfrac{\cancel{195560}\ 181{,}000}{10 \times .88 \times 176} = \cancel{126}\ 117$ #/□"

req'd spacing for steel acting as stirrups

$\dfrac{1}{s} = \dfrac{66 \times 10}{16000 \times .62}$ - $s = 15$" OK as floor slab steel is 5/8"φ spaced 12"cc ✓

v at right $= \dfrac{206490}{10 \times .88 \times 210} = 111$ #/□" ok ✓

$A_s = \dfrac{\cancel{1{,}420{,}650}\ 1{,}250{,}000 \times 12}{18000 \times .88 \times 275} = \cancel{3.90}\ 3.45$ □" Use - 6-1"φ @ 6"cc ✓

$u_o = \dfrac{\cancel{206490}\ 186{,}400}{18.84 \times .88 \times 210} = 59$ #/□" ok

Cantilever Action of End Walls

Moments about top of base slab

$M = \cancel{195560}\ 181{,}000 \times 17.17 = \cancel{3{,}357{,}770}\ 3{,}110{,}000$ ''

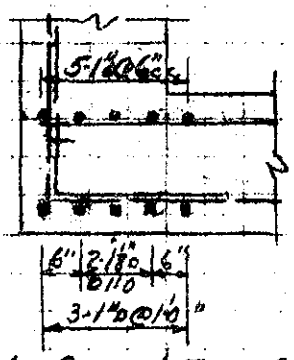
req'd $= \sqrt{\dfrac{3357770 \times 12}{24 \times 147}} = 107" < 287"$ ✓

$A_s = \dfrac{\cancel{3357770}\ 3110000 \times 12}{18000 \times .88 \times 275} = \cancel{9.2}\ 8.6$ □" Use 3-1"□ = 3.0; 2-1 1/8"□ 2.53; 5-1"φ 3.93; 9.46 □" ✓

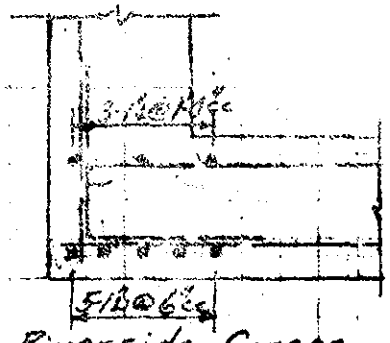
$u_o = \dfrac{195560}{36.71 \times .88 \times 275} = 22$ #/□"

Moment at 14' $= \cancel{195560}\ 181{,}000 \times 14 = \cancel{2{,}737840}\ 2{,}540{,}000$ ''

$A_s = \dfrac{\cancel{2737840}\ 2{,}540{,}000 \times 12}{18000 \times .88 \times 275} = \cancel{7.5}\ 7.0$ □" Use 5-1"□ 3-1"φ ✓



Riverside Cor at Top of Base Slab



Riverside Corner
El. 52.5 to 63.25

WAR DEPARTMENT

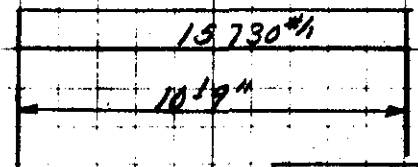
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Horiz. Thrust at Motor Room Floor

Computed by H.E.W. **Checked by** _____ **Date** 3-July-45

Horiz. Thrust at Stairway opening



$M = \frac{1}{10} \times 15730 \times 10.75^2 = 181.780''^{\#}$

$V = 15730 \times 10.75 \times .5 = 84550$

Assume effective $b = 36''$

req'd $d = \sqrt{\frac{181.780 \times 12}{36 \times .923}} = 22.2 > 19.6''$ Use comp. reinf & $f_c = 900$

$K = \frac{1}{2} \times 147 \quad F = 1.15$

$c = \frac{18000}{12000} \times \frac{N}{12} \times \frac{\left(1 - \frac{4.4}{19.6}\right)\left(.348 - \frac{4.4}{19.6}\right)}{1 - .348} = .203$

$A'_s = \frac{181.78 - 147 \times 1.15}{.203 \times 19.6} = 3.2^{\square''}$

$A_s = \frac{181.780 \times 12}{18000 \times .88 \times 19.6} = 7.0$ Use 4-1¼ + 2-¾"φ eq. face $= 7.13^{\square''}$

$u_o = \frac{84550}{24.71 \times .88 \times 19.6} = 198^{\#/\square''}$ OK

$V = \frac{84550}{36 \times .88 \times 19.6} = 136^{\#/\square''}$ Stirrups req'd

Use ½"φ stirrups with 4 legs

V by conc. $= 90 \times 36 \times .88 \times 19.6 = 55.880^{\#}$

point where stirrups not req'd $= \frac{28670}{15,730} = 1.82'$

stirrup spacing at 3"-9"-12"-12"
10½

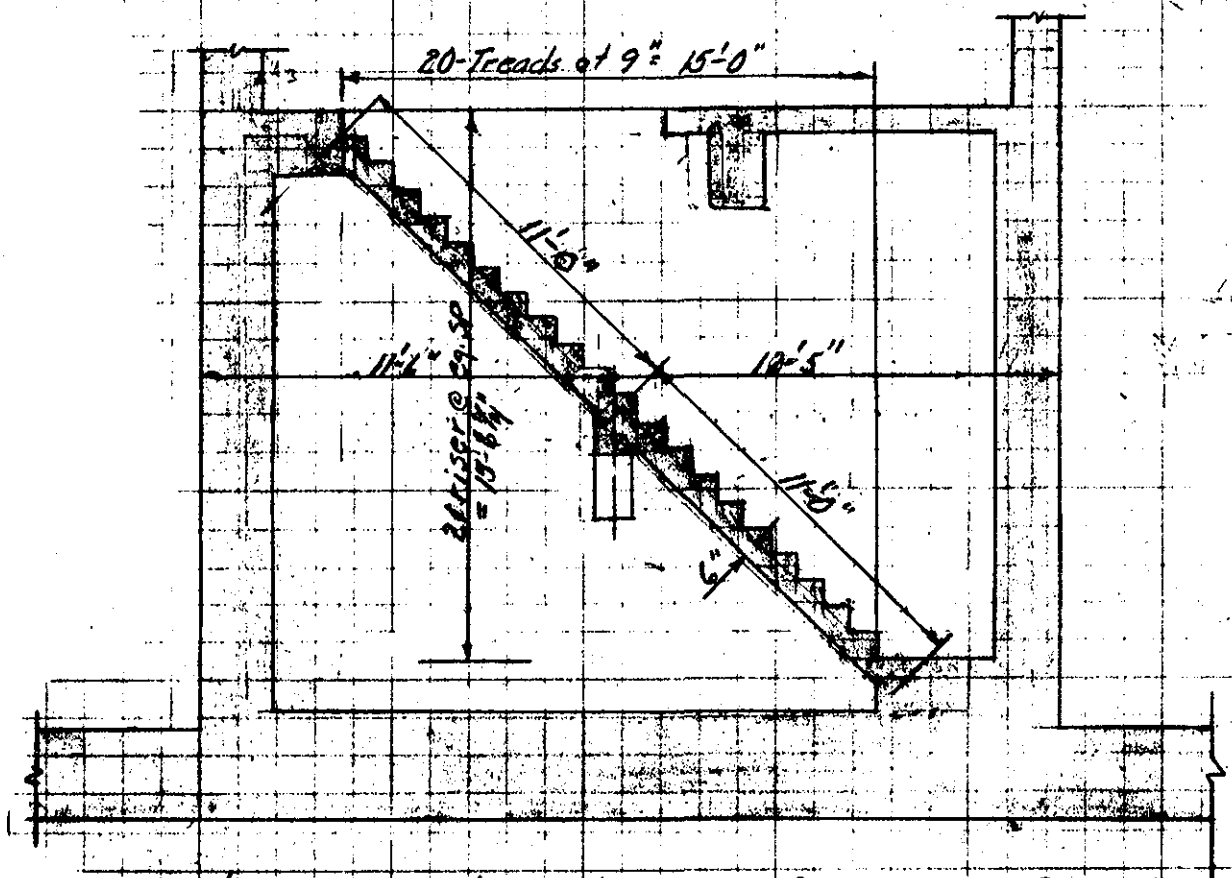
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 5

Computation Concrete Stairway

Computed by H. E. W. **Checked by** _____ **Date** 6-July-45



Stairway will be designed for a L.L. of 50#/□' Horiz proj.

L.L. for slope dist = $\frac{50}{1.414 \text{ (approx.)}}$ = 35 #/□'

D.L. Stairs - 6" slab = 75 #/□'

Treads = .75 x .5 x 150 = 45

185 #/□'

Stairway will be considered fixed at ends

Neg. M at supports = $\frac{1}{12} \times 155 \times 11^2$ = 1560 '#

Pos. M at center = $\frac{1}{24} \times 155 \times 11^2$ = 780 '#

req'd d = $\sqrt{\frac{1560}{147}}$ = 3.25" < 4.75

$v = \frac{155 \times 11 \times .5}{12 \times .88 \times 4.75}$ = 17 #/□"

$A_s = \frac{1560 \times 12}{18000 \times .88 \times 4.75}$ = .25□" Use 3/8"ø @ 1'-0" cc Top + Bot.

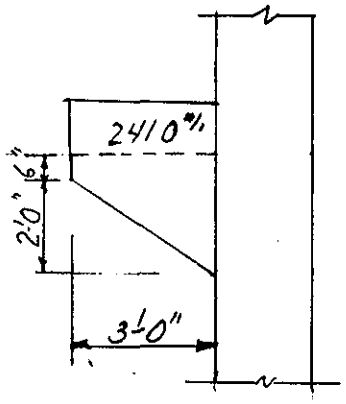
$u_0 = \frac{155 \times 11 \times .5}{1.96 \times .88 \times 4.75}$ = 40.4 #/□"

Subject Holyoke Pumping Station No 5

Computation Concrete Stairway

Computed by H.E.W. **Checked by** **Date** 6 July - 45

Stairway Bracket



Stairway React = 1705 x 1.414 = 2410 #/'

$V = 2410 \times 3 + .5 \times 1 \times 3 \times 150 + 2 \times 3 \times 1 \times .5 \times 150 + 1 \times 1 \times .5 \times 3 \times 150 = 8120^{\#}$

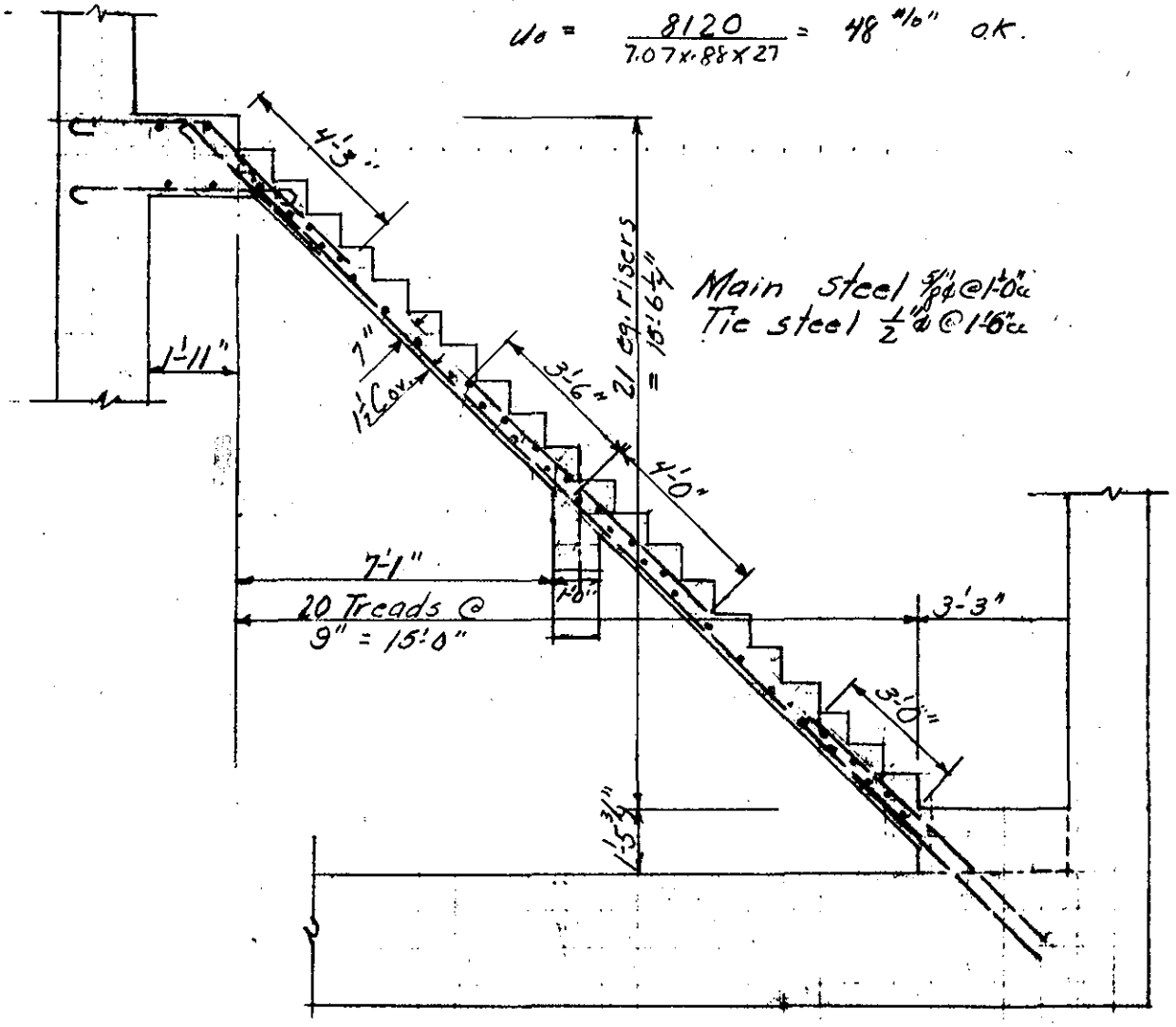
$M = 2410 \times 3 \times 1.5 + .5 \times 1 \times 3 \times 150 \times 1.5 + 2 \times 3 \times 1 \times .5 \times 150 \times 1 + 1 \times 1 \times .5 \times 3 \times 150 \times 1.5 = 11970'^{\#}$

$\text{req'd } d = \sqrt{\frac{11970}{147}} = 9'0" < 27"$

$v = \frac{8120}{12 \times .88 \times 27} = 29^{\#}/\square"$

$A_s = \frac{11970 \times 12}{18000 \times .88 \times 27} = .34\square"$ Use 3 - 3/4" ϕ

$u_o = \frac{8120}{7.07 \times .88 \times 27} = 48^{\#}/\square"$ o.k.



C. HOLYOKE PUMPING STATION NO. 6

HOLYOKE PUMPING STATION #6

WEIGHT OF MECHANICAL EQUIPMENT

30" Propeller Pump with motor	11,500#
30" Discharge Pipe and valves full of water	8,500#
Thrust on pump	6,000#
16" Pump and base elbow full of water	6,000#
16" Suction pipe and valve full of water	3,500#
16" Discharge pipe and valves full of water	3,600#
Motor for 16" pump	1,800#
Concrete base for motor	1,200#
Thrust on pump	2,000#
6' x 6' sluice gate and frame	7,000#
Maximum load on 6'x6' sluice gate floorstand	18,000#
5'x5' sluice gate and frame	4,400#
Maximum load on 5'x5' sluice gate floorstand	10,000#
Switchboard	4,000#
Heater	1,000#
4-Ton Crane	
Maximum wheel load	5,100#
c-c crane wheels 3'-6"	
Use 30# rail	
Sump pump with motor	1000#

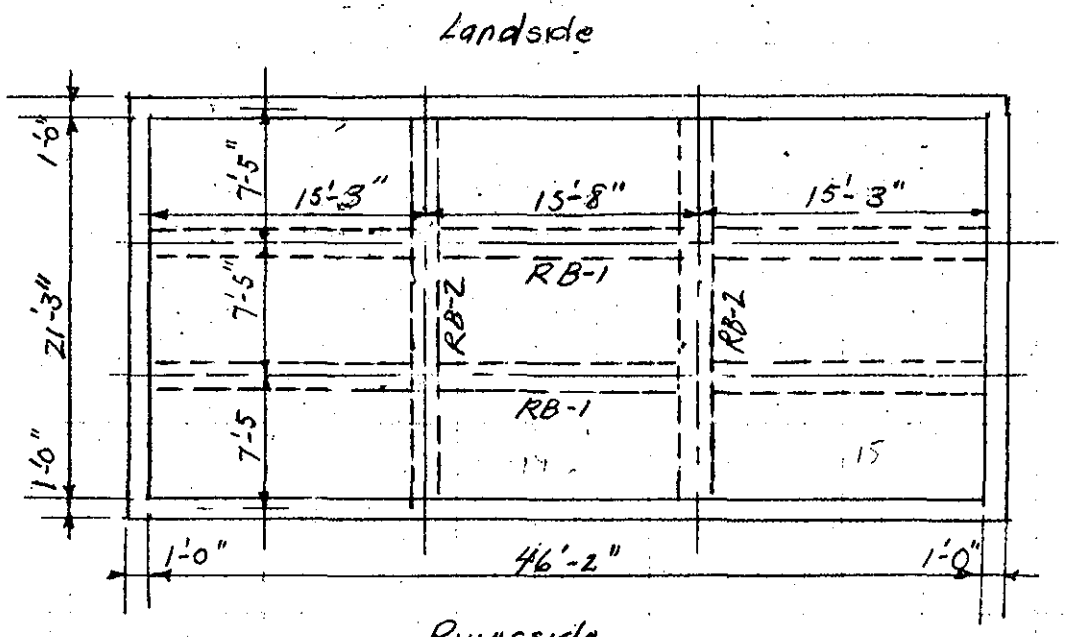
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation ROOF SLAB

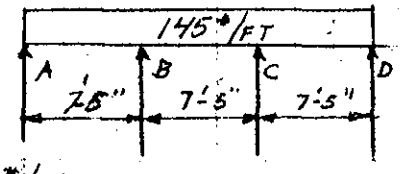
Computed by A.L.K. **Checked by** **Date** 22 JUNE 1945



Plan of Roof Slab

The roof will be designed for a live load of 40 #/□' plus acinder concrete fill plus dead load of slab

Live load = 40
Roofing = 5
4" cinder fill = 35
5" conc. slab = 63
143 #/□' Say 145 #/□'



$+M_{AB} = \frac{16}{200} \times 145 \times 7.42^2 = .64^{1K}$ $\quad -M_{B\&C} = \frac{20}{200} \times 145 \times 7.42^2 = .80^{1K}$

$V_A = \frac{4}{10} \times 145 \times 7.42 = 430^{\#}$ $\quad V_{BA} = \frac{6}{10} \times 145 \times 7.42 = 646^{\#}$

$V_{BC} = \frac{5}{10} \times 145 \times 7.42 = 536^{\#}$ $\quad +M_{BC} = \frac{5}{200} \times 145 \times 7.42^2 = .199^{1K}$

$R_B = \frac{11}{10} \times 145 \times 7.42 = 1180^{\#}$ $\quad R_C = 1180^{\#}$

$Req'd = \sqrt{\frac{800}{147}} = 2.33" < 3.19"$ $\quad v = \frac{646}{12 \times .88 \times 3.19} = 19.2 \#/□"$

$A_s = \frac{800 \times 12}{18000 \times .88 \times 3.19} = .19 □"$ use $\frac{1}{2}$" ϕ @ 10" $\quad u = \frac{646}{1.9 \times .88 \times 3.19} = 122 \#/□"$

F143

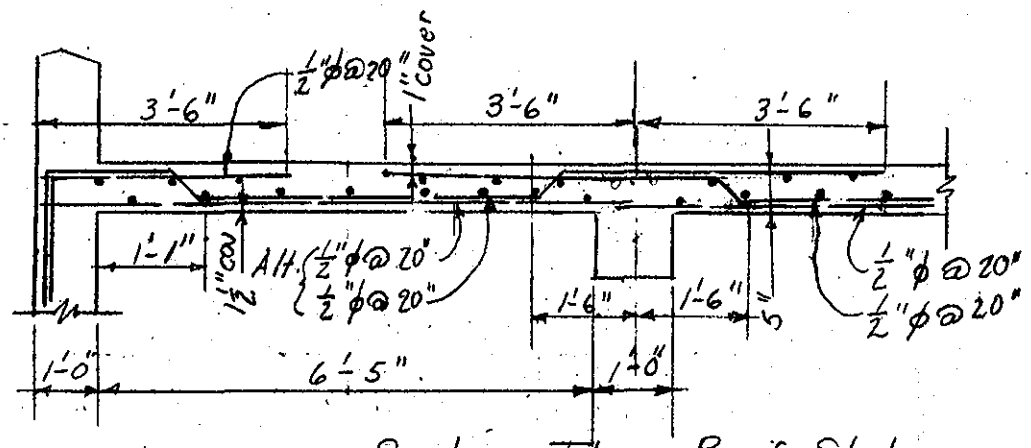
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation ROOF SLAB

Computed by A.L.K. **Checked by** _____ **Date** 22 JUNE 1945



Section Thru Roof Slab

Roof Beam RB-1 Assume 12" x 20" deep

Reaction from slab = 1180 #/FT.
Beam 12"x20" = 1x1.25x150 = 190 #/FT.
1370 #/FT

$M^F_{AB} = \frac{1}{12} \times 1370 \times 15.75^2 = 28.4'^K$

$M^F_{BC} = \frac{1}{12} \times 1370 \times 15.67^2 = 28.0'^K$

	1370 #/FT					
	0 15'-9" .5		5 15'-8" .5		.5 15'-9" 0	
	A	B		C		D
	+28.4	-28.4	+28.0	-28.0	+28.4	-28.4
	-28.4	+0.2	+0.2	-0.2	-0.2	+28.4
	+0.1	-14.2	-0.1	+0.1	+14.2	-0.1
	-0.1	+7.15	+7.15	-7.15	-7.15	+0.1
	+3.58	-0.05	-3.58	+3.58	+0.05	-3.58
	-3.58	+1.82	+1.81	+1.81	+1.82	+3.58
-M	0	-33.48	+33.48	-33.48	+33.48	0
V	8680#	12920#	10750#	10750#	12920#	8680#
x_0	→ 6.34'		→ 7.84'		6.34 ←	
+M	27500'#		8920'#		27500'#	

$d_{req'd\ -M} = \sqrt{\frac{33480 \times 12}{12 \times 147}} = 15.1" < 18.0"$

$v = \frac{12920}{12 \times .88 \times 18.0} = 68\ \#/\square'$

$d_{req'd\ +M} = \sqrt{\frac{27500}{123}} = 14.9" < 17.5"$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation ROOF SLAB

Computed by A.L.K. **Checked by** **Date** 22 June 1945

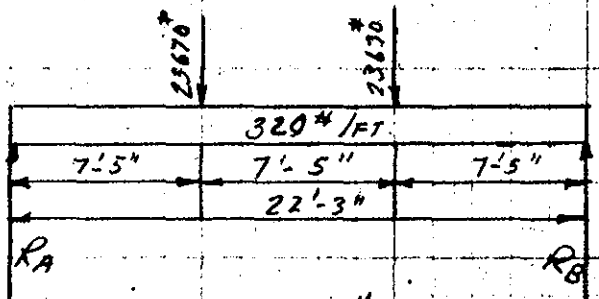
$$-A_s = \frac{33400 \times 12}{18000 \times .88 \times 18.0} = 1.41 \square'' \quad \text{use } 2\text{-}1''\phi \text{ top}$$

$$+A_s = \frac{27500 \times 12}{18000 \times .88 \times 17.5} = 1.19 \square'' \quad \text{use } 3\text{-}3/4''\phi \text{ bott}$$

$$u = \frac{12920}{6.2 \times .88 \times 18} = 132\ \#/\square''$$

RB-2 Reactions from RB-1 = 23830 #

assume 16"X24" deep Beam D.L. 1.33X1.58X150 = 315 #/FT 304 320 #/FT.



$$R_A = R_B = 23670 + 320 \times 11.12 = 27240\ \#$$

$$+M = 27240 \times 11.12 - 23670 \times 3.71 - 320 \times \frac{11.12^2}{2} = 196600\ '\#$$

$$d\ req'd = \sqrt{\frac{196600 \times 12}{16 \times 123}} = 34.6'' > 21.5''$$

Beam will act as a tee beam $b = 67''$ $\frac{t}{d} = \frac{5}{21.5} = .233$

$$K = \frac{800}{2} \times .233 \left(2 - .233 - \frac{.233}{.348} + \frac{2}{3} \times \frac{1}{.348} \times .233^2\right) = 113.5$$

$$d\ req'd = \sqrt{\frac{196600 \times 12}{113.5 \times 67}} = 17.6'' < 19.75''$$ with two layers of steel

$$V = \frac{27240}{16 \times .88 \times 19.75} = 98.2\ \#/\square''$$ use stirrups

$$A_s = \frac{196600 \times 12}{18000 \times .88 \times 19.75} = 7.35 \square''$$ use 8-1"□ bars 2 layers, bott

$$u = \frac{27240}{16 \times .88 \times 19.75} = 198\ \#/\square''$$

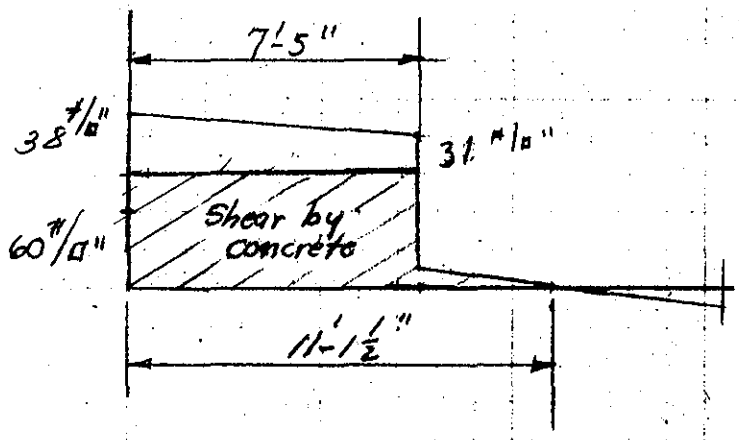
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation ROOF SLAB

Computed by A.L.K. **Checked by** _____ **Date** 23 June 1945



Shear Diagram

Use ½"ϕ stirrups = 6400 #/stirrup

$S_0 = \frac{A_s f_v}{b(v-60)} = \frac{6400}{16(38)} = 10.5''$ $\quad S_1 = \frac{6400}{16(38 - 7.95 \times \frac{10.5}{12})} = 17.8''$

3.45

31.05

$\frac{dV}{dx} = \frac{7}{7.42} + 7 = 7.95$ #/□"/FT

$S_2 = \frac{6400}{16(31.8 - 7.95 \times \frac{17.8}{12})} = 17.8''$

No. Stirrups $= \frac{(\frac{10650 + 8600}{2})\, 7.42 \times 12}{6400 \times .88 \times 19.75} = 7.4$ stirrups

Make spacing 5", 10", 10", 10", 10", 10", 10", 10" At both ends of beam

Bending Pt for upper Layer

$M = 4 \times 18000 \times .88 \times \frac{19.75}{12} = 104000''^{\#}$

$27{,}390\,X - 320\,\frac{X^2}{2} = 104000 \qquad X = 4\text{ ft.}$

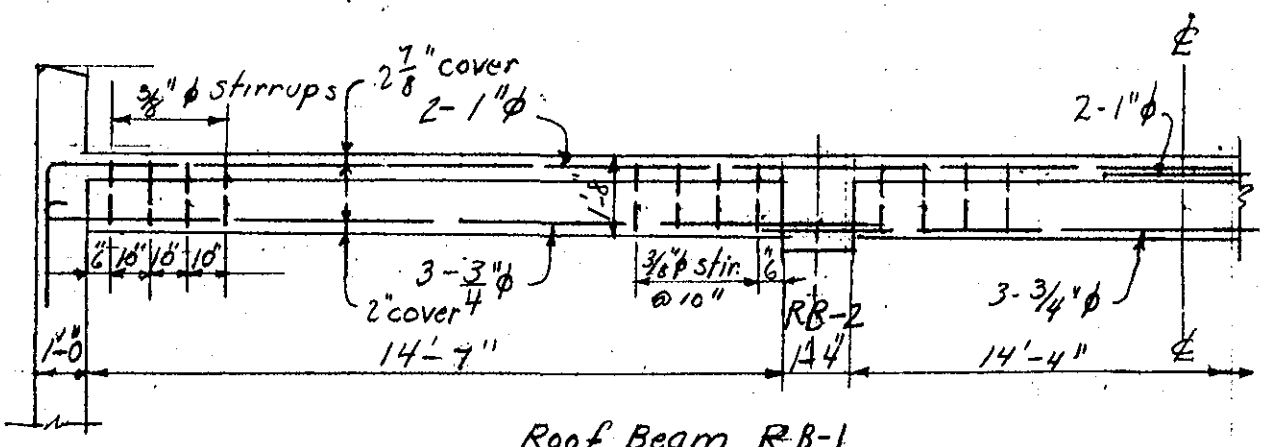
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

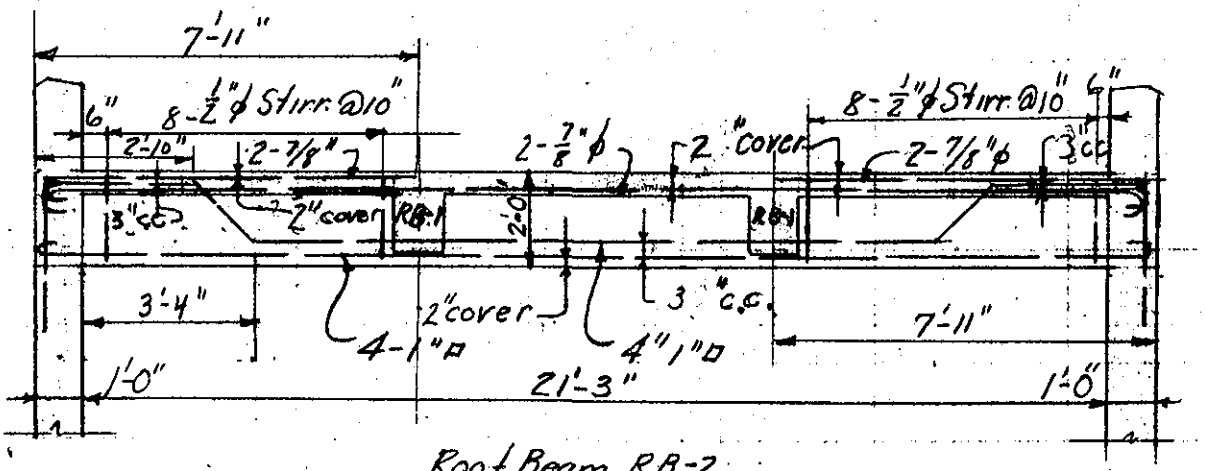
Subject HOLYOKE PUMPING STATION No. 6

Computation ROOF SLAB

Computed by A.L.K. **Checked by** **Date** 22 JUNE 1945



Roof Beam RB-1
12" wide x 20" deep



Roof Beam RB-2
16" wide x 24" deep

WAR DEPARTMENT

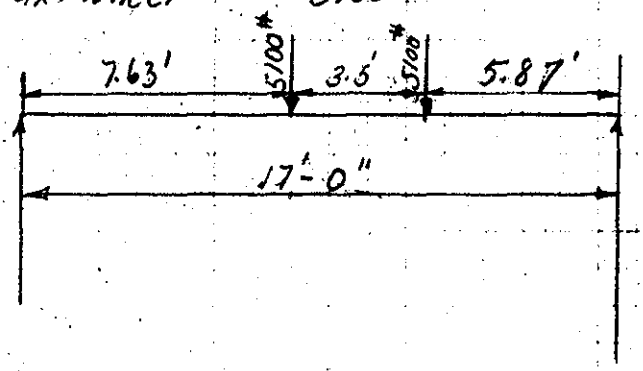
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation CRANE BEAMS

Computed by A.L.K. **Checked by** **Date** 27 June 1945

Crane capacity 4 Tons
Wheel spacing 3'-6"
Max. wheel 5100#



$$L.L.M = \frac{5100}{2 \times 17.0}\left(17.0 - \frac{3.5}{2}\right)^2 = 35000'\#$$

25% Impact 8750 '#

$$D.L.M = \frac{1}{8} \times 40 \times (17.0)^2 = 1445'\#$$

45195 '#

Horiz. Thrust = 20% Crane capacity $= \frac{1}{5} \times 8000 \times \frac{1}{4} = 400\#/\text{wheel}$

$$\text{Lateral Mom.} = \frac{400}{5100} \times 35000 = 2740'\#$$

Try 10" WF 37# $L = 15.83'$ $b = 7.98"$ $S_{xx} = 39.9$ $S_{yy} = 10.6$

then allow $f_s = \dfrac{22500}{1 + \dfrac{204^2}{1800 \times 7.98^2}} = 16{,}400\#/\square''$

Actual stress

for Vert. M $= \dfrac{45200 \times 12}{39.9} = 13650$

for Horiz. M $= \dfrac{2740 \times 12}{10.6 \times 5} = 6200$

13850 #/□" > 16,400 #/□"

Try 10" WF 45# bm. $S_{xx} = 49.1$ $S_{yy} = 13.3$

actual $f_s = \dfrac{45200 \times 12}{49.1} = 11000$

$f_s = \dfrac{2740 \times 12}{13.3 \times 5} = 4950$

15950 #/□" < 16500 #/□" OK.

F148

WAR DEPARTMENT

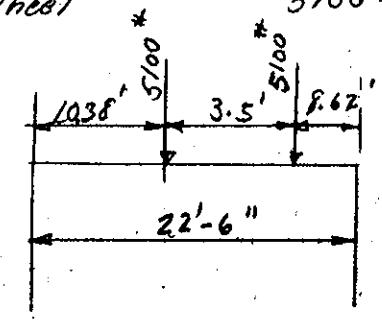
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation CRANE BEAMS

Computed by A. L. K. **Checked by** _____ **Date** 9 JULY 1945

CRANE capacity 4 tons
Wheel spacing 3'-6"
Max wheel 5100#



$LLM = \frac{5100}{2 \times 22.5}(22.5 - 1.75)^2 = 48900''\#$

$= 12225\#$

25% Imp =

$DLM. \frac{1}{8} \times 49 \times 22.5^2 = 3100$

$64225'\#$

Horiz. Thrust = 20% Crane capacity $\frac{1}{5} \times 8000 \times \frac{1}{4} = 400\#/\text{wheel}$

Lateral Mom = $\frac{400}{2 \times 13}(13.0 - 1.75)^2 = 1950'\#$

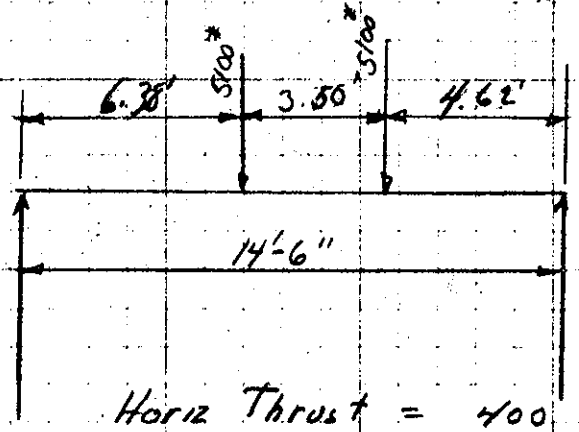
Try 10" WF 49# L = 270" b = 10" Sxx = 54.6 Syy = 18.6

then allow. $f_s = 16010\#/\square'$

Actual Vert. stress = $64230 \times 12 \div 54.6 = 14100$

" Horiz " = $1950 \times 12 \div 18.6 \times .5 = 2520$

$16620\#/\square''$ ok as the Max. Vertical stress and max. Lateral stress do not occur at same pt.



$LLM = \frac{5100}{2 \times 14.5}(14.5 - 1.75)^2 = 28500'\#$

25% impact 7125

$DLM = \frac{1}{8} \times 37 \times 14.5^2 = 980$

$36610'\#$

Horiz Thrust = 400#/wheel

Lateral M = $\frac{400}{5100} \times 36610 = 2950'\#$

Try 10" WF 37# L = 174" b = 7.978" Sxx = 39.9 Syy = 1'

then allow $f_s = \frac{22500}{1 + \frac{174^2}{1800 \times 7.98^2}} = 17800\#/\square''$

F149

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No 6

Computation CRANE BEAMS

Computed by A.L.K. **Checked by** _____ **Date** 9 July 1945

Actual stress for Vert M = $\frac{36610 \times 12}{39.9}$ = 11000 #/□"

for Horiz. M = $\frac{2950 \times 12}{.5 \times 10.6}$ = 6680

17680 #/□"

Total f_s actual = 17680 #/□ < 17800 #/□ allow. OK.

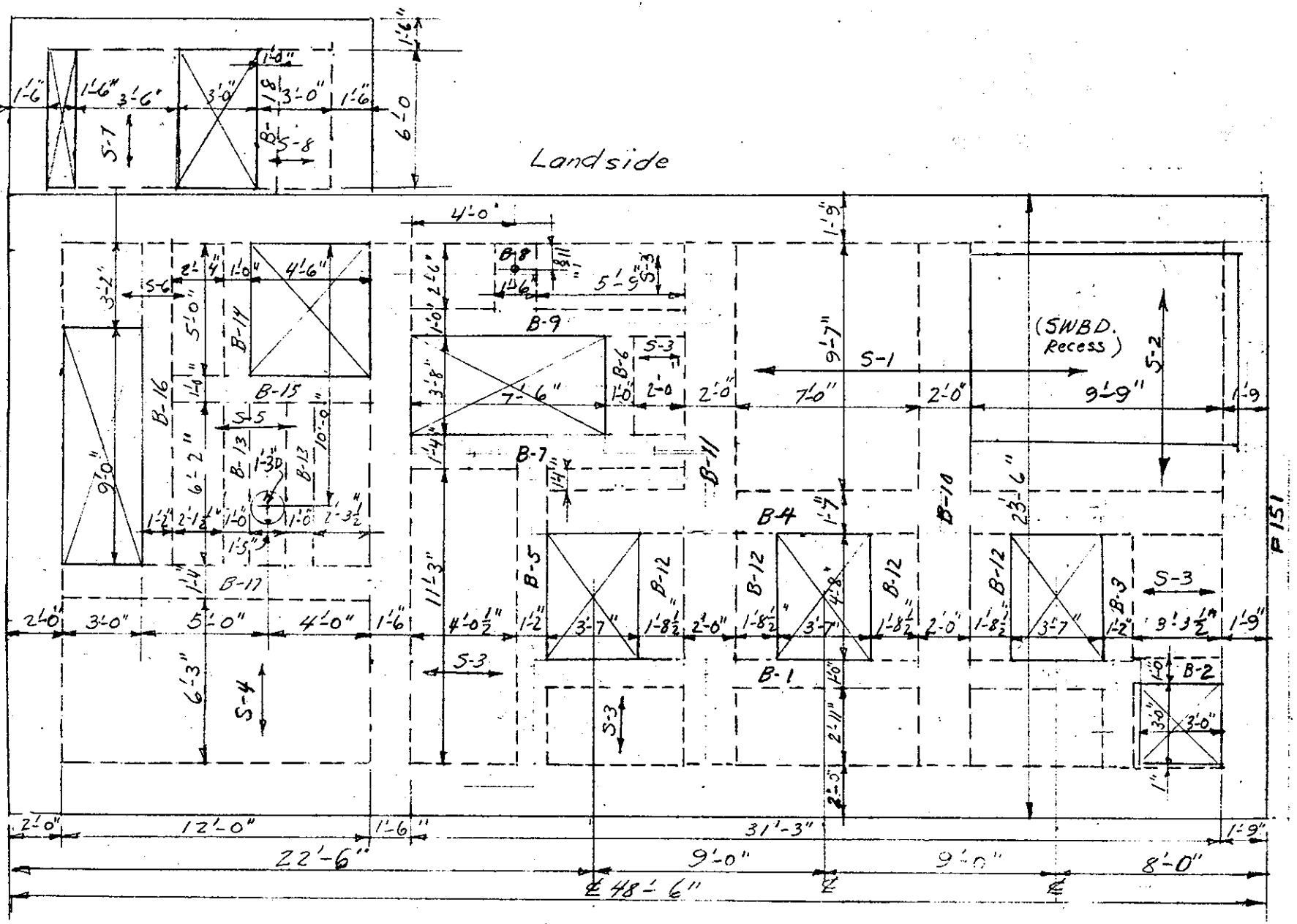
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: HOLYOKE PUMPING STATION NO. 6

Computation: MOTOR ROOM FLOOR SLAB

Computed by: A.L.L. Checked by: Date: JULY 26, 1945



Riverside

PLAN O- Motor Room Floor

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

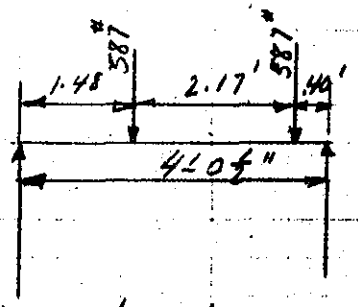
Subject HOLYOKE PUMPING STATION No. 6

Computation MOTOR ROOM FLOOR SLAB

Computed by A.L.K. **Checked by** _____ **Date** JULY 26, 1945

Equivalent uniform live load

Load of motor distributed along circumference (Use circle thru anchor bolts) $= \frac{4000}{\pi \times 2.17} = 587\,\#/FT$



$$M = \frac{587}{8.08}\left(4.04 - \frac{2.17}{2}\right)^2 = 635'\#$$

$$w = \frac{635 \times 8}{4.04^2} = 315\,\#/\square'$$

Use a live load of 300 #/□' for slabs

Use a live load of 250 #/□' plus concentrated equipment loads for beams.

Uniform L.L. + D.L. 8" slab = 400 #/□'

Slab S-1

		d^3/L
AB	$\frac{512}{42}$	12.2
BC	$\frac{512}{108} = 4.74$	
CD	$\frac{1000}{139.5} = 7.17$	

$M^F_{AB\,BA} = \frac{1}{12} \times 400 \times 3.5^2 = .41$ 'k.

$M^F_{BC\,CB} = \frac{1}{12} \times 400 \times 9^2 = 2.72$ 'k

$M^F_{CD\,DC} = \frac{1}{12} \times 200 \times 11.62^2 = 2.26$ 'k

Span BC is designed as a two way slab DL+LL = 200 #/FT

	400 #/FT		200 #/FT		
	0 .72	.28 .40	.60	1	fixed
	A 3'-6"	B 9'-0" C	11'-7 1/2"	D	
	+.41 -.41	+2.72 -2.72	+2.26	-2.26	
	-.41 -1.66	-.65 +.18	+.28	0	
	-.83 -.22	+.09 -.33	0	+.14	
	+.83 +.09	+.04 +.14	+.19	0	
	+.05 +.42	+.07 +.02	0	+.10	
	-.05 -.35	-.14 -.01	-.01	0	
+M	0 -2.13	+2.13 -2.72	+2.72	-2.02	
V	100# 1300#	1730# 1870#	1230#	1100#	
X_0	→ .25'	→ 4.32'	→ 6.15'		
+M	13'#	1590'#	1560'#		

Member AB d req'd −M $= \sqrt{\frac{2720}{147}} = 4.3'' < 6.7$ −M

~~FTSZ~~ +M $= \sqrt{\frac{1590}{123}} = 3.6'' < 6.19$ +M

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION NO. 6

Computation MOTOR ROOM FLOOR SLAB

Computed by A.L.K. **Checked by** _____ **Date** JULY 27, 1945

Slab S-1 cont'd

$$v = \frac{1870}{12 \times .88 \times 6.7} = 264\#/\square''$$

$$-A_s = \frac{2720}{18000 \times .88 \times 6.7} = .308\ \square''$$ Use $\frac{5}{8}''\phi$ @ 1'-0" top & bott.

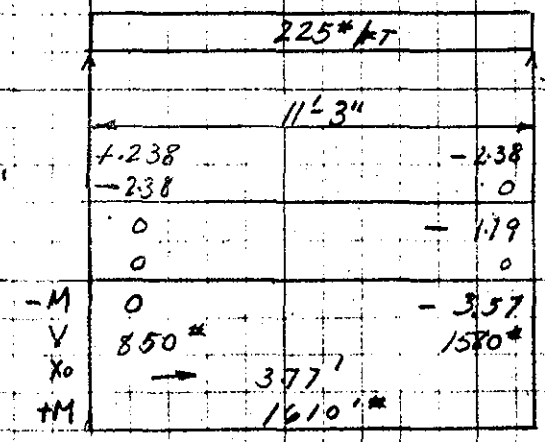
$$u = \frac{1870}{2 \times .88 \times 6.7} = 158\#/\square''$$

Slab S-2

10" slab

Short span of two way slab D.L. + L.L. = 225 #/FT

Slab will be designed as 8" slab because switchboard requires 2" Recess for mounting.



$$FEM = \frac{1}{12} \times 225 \times 11.25^2 = 2.38'^k$$

$$d_{req'd} = \sqrt{\frac{3570}{147}} = 5.4'' < 6''\ -M$$
$$6.19''\ +M$$

$$V = \frac{1580}{12 \times .88 \times 6} = 250\#/\square''$$

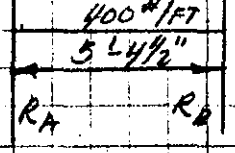
$$-A_s = \frac{3570 \times 12}{18000 \times .88 \times 6} = .45\ \square''$$ Use $\frac{5}{8}''\phi$ @ 6" c.c. top

$$+A_s = \frac{1610 \times 12}{18000 \times .88 \times 6.19} = .197\ \square''$$ $$u = \frac{1580}{3.9 \times .88 \times 6} = 77\#/\square''$$

use $\frac{5}{8}''\phi$ @ 1'-0 bott.

Slab S-3 8" slab

D.L. + L.L. = 400 #/FT



$$M = \frac{400 \times 5.37^2}{8} = 1440'\#$$

$$R_A = R_B = 400 \times 5.37 \times .5 = 1075\#$$

$$d_{req'd} = \sqrt{\frac{1440}{123}} = 3.42'' < 6.2''$$

$$V = \frac{1075}{12 \times .88 \times 6.2} = 16.4\#/\square''$$

$$A_s = \frac{1440 \times 12}{18000 \times .88 \times 6.2} = .176\ \square''$$ Use $\frac{5}{8}''\phi$ @ 1'-0" top and bott.

$$u = \frac{1075}{2 \times .88 \times 6.2} = 99\#/\square''$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation MOTOR ROOM FLOOR SLAB

Computed by A.L.K **Checked by** **Date** JULY 27, 1945

Slab S-4

fixed	400#/ft.	
	7'-5"	
	+1.83	−1.83
	0	+1.83
	+.92	0
	0	0
−M	+2.75	0
V	1850#	1110#
x_0	2.77'	
+M	1550'#	

F.E.M

$M^F = \frac{1}{12} \times 400 \times 7.42^2 = 1.83'^k$

$d_{req'd} \sqrt{\frac{2750}{147}} = 4.32'' < 6.06''$

$-A_s = \frac{2750 \times 12}{18000 \times .88 \times 6.06} = .35 \square''$

Use $\frac{5}{8}''\phi$ @ 6" top

$u = \frac{1850}{39 \times .88 \times 6.06} = 189\#/\square''$

$+A_s = \frac{1550 \times 12}{18000 \times .88 \times 5.6} = .21 \square''$

Use $\frac{5}{8}''\phi$ @ 12.0" bott.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation MOTOR ROOM FLOOR SLAB

Computed by A.L.K. **Checked by** _____ **Date** 28 JULY 1945

Slab S-5

$M^F_{AB} = \frac{1}{12} \times 400 \times 3.20^2 = .34^{'K}$

$M^F_{BC} = \frac{1}{12} \times 400 \times 2.42^2 = .20^{'K}$

$M^F_{CD} = \frac{1}{12} \times 400 \times 3.54^2 = .42^{'K}$

	A		B		C		D
	400#/FT						
	3'-2½"			2'-5"		3'-6½"	
	0	.43	.57	.59	.41		0
	+.34	-.34	+.20	-.20	+.42		-.42
	-.34	+.06	+.08	-.13	-.09		+.42
	+.03	-.17	-.07	+.04	+.21		-.05
	-.03	+.10	+.14	-.15	-.10		+.05
	+.05	-.02	-.08	+.07	+.03		-.05
	-.05	+.04	+.06	-.06	-.04		+.05
−M	0	-.33	+.33	-.43	+.43		0
V	537#	743#	362#	526#	830#		586#
X_0	→ 1.34'		1.32' ←		1.46' ←		
+M	360'#		No Pos		426'#		

$d\ req'd = \sqrt{\frac{430}{147}} = 1.72'' < 6.7''$

$v = \frac{830}{12 \times .88 \times 6.7} = 11.8\ \#/\square''$

$-A_s = \frac{430 \times 12}{18000 \times .88 \times 6.7} = .048\ \square''$ use $\frac{5}{8}''\phi$ @ 1'-0" top & bott

$u = \frac{830}{2.0 \times .88 \times 6.7} = 71\ \#/\square''$

Slab S-6

$M^F = \frac{1}{12} \times 400 \times 4.58^2 = .70^{'K}$

$M^F = \frac{1}{12} \times 400 \times 3.42^2 = .39^{'K}$

fixed

	A		B		C
	400#/□'				
	4'-7"		.43 .57	3'-5"	0
	+.70	-.70	+.39	-.39	
	0	+.13	+.18	+.39	
	+.07	0	+.20	+.09	
	0	-.09	-.11	-.09	
	-.05	0	-.05	-.06	
	0	+.02	+.03	+.06	
−M	+.72	-.64	+.64	0	
V	1073#	759#	870#	497#	
X_0	→ 2.68'		1.24' ←		
+M	600'#		308'#		

$d\ req'd = \sqrt{\frac{640}{147}} = 2.09'' < 6.7''$

$v = \frac{1073}{12 \times .88 \times 6.7} = 15.2\ \#/\square''$

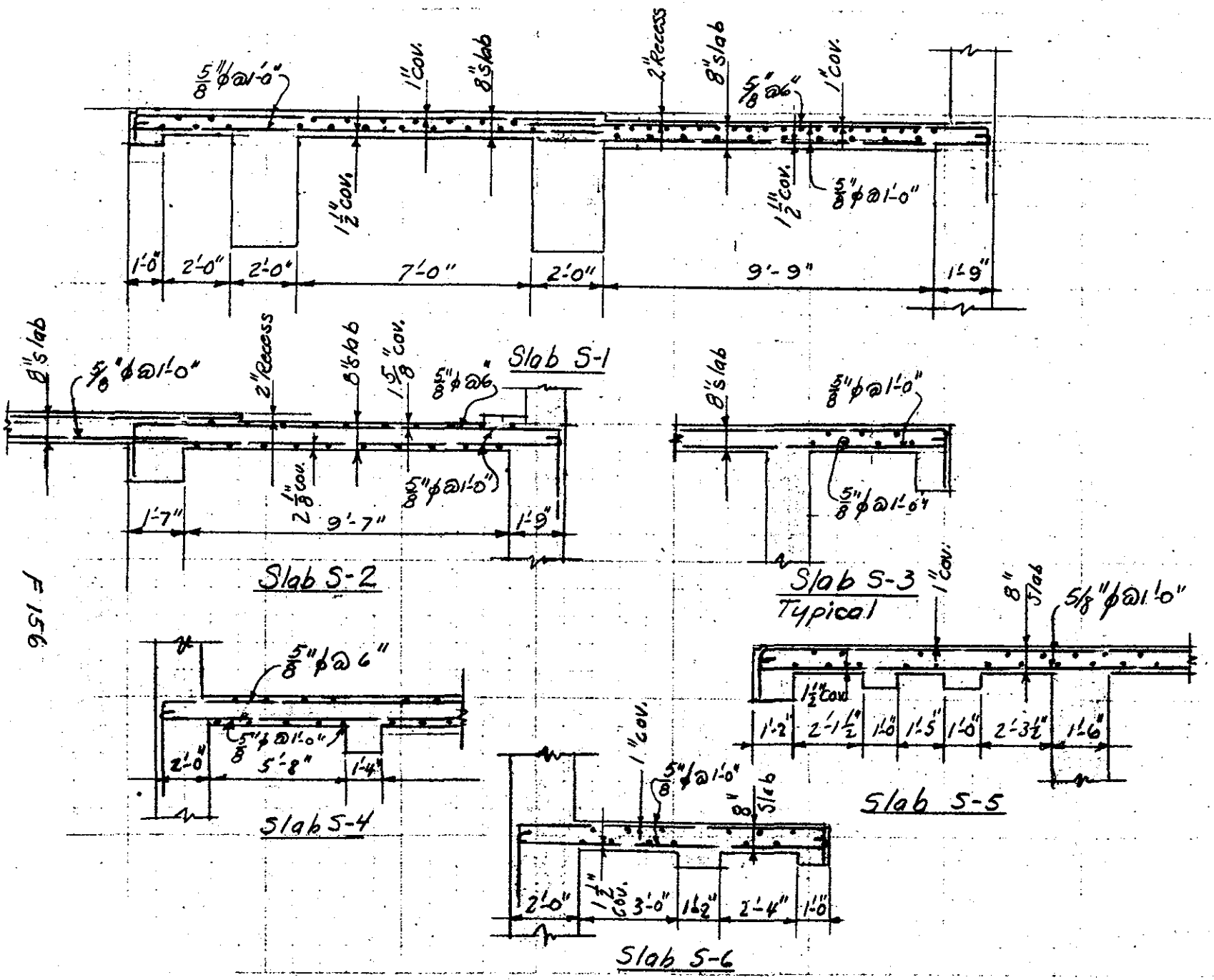
$-A_s = \frac{640 \times 12}{18000 \times .88 \times 6.7} = .073\ \square''$ use $\frac{5}{8}''\phi$ @ 1'-0" top & bot #.

$u = \frac{1073}{2.0 \times .88 \times 6.7} = 91\ \#/\square''$

F 155

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6
Computation MOTOR ROOM FLOOR SLAB
Computed by A.L.K. **Checked by** _____ **Date** JULY 24, 1945



F 156

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation MOTOR ROOM FLOOR BEAMS

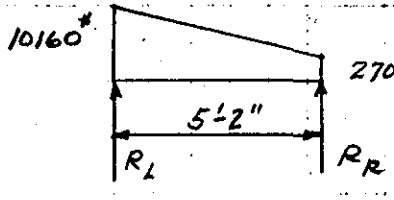
Computed by A.L.K. **Checked by** _____ **Date** 28 JULY 1945

Load Distribution on Motor support plates

Wt 30" Proppelor Pump with motor	11500 #
Impact at 100%	11500 #
Thrust on pump	6000 #
Wt. of Disch. pipe and valves with water $\frac{8500}{2}$ =	4250 #
	33250 #

ecc. of load = .60'

$$p = \frac{33250}{5.17}\left(1 \pm \frac{6(.5)}{5.17}\right) = \begin{matrix} 10160 \# \\ 2700 \# \end{matrix}$$



$R_L = 2700 \times 5.17 \times .5 + 7460 \times 5.17 \times .5 \times .67 = 19850$ #

$R_R = 2700 \times 5.17 \times .5 + 7460 \times 5.17 \times .5 \times .33 = 13400$ #

Beams B-1 and B-2

Note: top 3" of beam is taken up by frame and must be neglected in calculations.

Loads on B-1 from 30" Pumps = $\frac{13400}{4.08}$ = 3280 #/FT

D.L. 8" slab	100 × 2.46 =	246 #/FT
L.L	250 × 2.20 =	550 "
DL B-1 12"×24" bm	.133 × 150 =	200 "
		996 #/FT Say 1000 #/FT

DL of cover & fr.	.15 × 1.5 = 25
DL. 12"×14" bm	= 175
LL. 1 × 250	= 250
	450 #/FT

Load on B-2 from Sump pump & motor = 1000

Impact 100% = 1000

2000 #

Dist Load = $\frac{2000}{4 \times 3}$ = 170 #/FT

total unif. Ld on B-2 = 620 #/FT

WAR DEPARTMENT

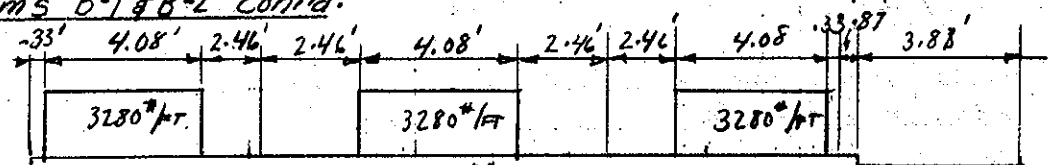
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation MOTOR ROOM FLOOR BEAMS

Computed by A.L.K. **Checked by** _____ **Date** 28 JULY 1945

Beams B-1 & B-2 cont'd.



	A	B		C		D		E
	+14.87	-10.90	+20.75	-20.75	+10.90	-14.87	+1.28	-1.19
	-14.87	-5.62	-4.23	+4.23	+5.62	+10.60	+2.99	+1.19
	-2.81	-7.44	+2.12	-2.12	+5.30	+2.81	+.60	+1.5
	+2.81	+3.02	+2.30	-1.37	-1.81	-2.66	-.75	-1.5
	+1.51	+1.47	-.69	+1.15	-1.33	-.91	-.75	-.38
	-1.51	-.41	-.31	+.08	+.10	+1.30	+.36	+38
-M	0	-19.94	+19.94	-18.78	+18.78	-3.73	+3.73	0
V	9340#	11000#	11330#	11070#	10260#	9950#	2560#	720#
x_0	→ 2.44'		→ 4.52'		→ 4.3'		1.16 ←	
+M	12500'#		14200'#		10620'#		435'#	

Stiff. factors	Mem	d	d^3	L	d^3/L	
"	AB	24	13820	82.5	168	3.5
"	BC	24	13820	108	128	2.7
"	CD	24	13820	82.5	168	3.5
"	DE	14	2744	57	48	1

$$M^F_{AB} = 1000 \times \frac{6.87^2}{12} + \frac{.642}{12}(6 - 8 \times .642 + 3 \times .642^2) \times 3280 \times 4.42 \times 6.87 - \frac{.048}{12}(6 - 8 \times .048 + 3 \times .048^2)$$

2.10 5.623

$$\times 3280 \times .33 \times 6.87 = 14.87'^K$$

$$M^F_{BA} = 1000 \times \frac{6.87^2}{12} + \frac{.642^2}{12}(4 - 3 \times .642) \times 3280 \times 4.42 \times 6.87 - \frac{.048^2}{12}(4 - 3 \times .048)$$

2.074 3.86

$$\times 3280 \times .33 \times 6.87 = 10.90'^K$$

1.397

$$M^F_{BC} = M^F_{CB} = \frac{1}{12} \times 1000 \times 9^2 + \frac{1 + 2 \times .273 - 2 \times .273^2}{12}(3280 \times 4.08 \times 9) = 20.75'^K$$

$$M^F_{CD} = M^F_{BA} = 10.9'^K$$

$$M^F_{DC} = M^F_{AB} = 14.87'^K$$

4.636

$$M^F_{DE} = \frac{1}{12} \times 620 \times 4.75^2 + \frac{.183}{12}(6 - 8 \times .183 \times 3 \times .183^2)\, 380 \times .87 \times 4.75 = 1.28'^K$$

3.45

$$M^F_{ED} = \frac{1}{12} \times 620 \times 4.75^2 + \frac{.183^2}{12}(4 - 3 \times .183)\, 380 \times .87 \times 4.75 = 1.19'^K$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation MOTOR ROOM FLOOR BEAMS

Computed by A.L.K. **Checked by** _____ **Date** 30 JULY 1945

Shears and Moments

Member AB

$$V_A = 1000 \times \frac{6.87}{2} + 3280 \times 4.08 \times \frac{4.50}{6.87} - \frac{19940}{6.87} = 9340^{\#}$$

$$V_B = 1000 \times \frac{6.87}{2} + 3280 \times 4.08 \times \frac{2.37}{6.87} + \frac{19940}{6.87} = 11000^{\#}$$

$$x_0 = 2.44'$$

$$+M = 9340 \times 2.44 - 1000 \times \frac{2.44^2}{2} - 3280 \times \frac{2.11^2}{2} = 12500'^{\#}$$

Member BC

$$V_B = 1000 \times \frac{9}{2} + 3280 \times \frac{4.08}{2} + \frac{1160}{9} = 11{,}330^{\#}$$

$$V_C = 1000 \times \frac{9}{2} \times 3280 \times \frac{4.08}{2} - \frac{1160}{9} = 11{,}070^{\#}$$

$$x_0 = 4.52'$$

$$+M = 11330 \times 4.52 - 1000 \times \frac{4.5^2}{2} - 3280 \times \frac{2.06^2}{2} - 19940 = 14200'^{\#}$$

Member CD

$$V_C = 1000 \times \frac{6.87}{2} + 3280 \times \frac{2.37}{6.87} \times 4.08 + \frac{15050}{6.87} = 10260^{\#}$$

$$V_D = 1000 \times \frac{6.87}{2} + 3280 \times \frac{4.5}{6.87} \times 4.08 - \frac{15050}{6.87} = 9950^{\#}$$

$$x_0 = 4.3'$$

$$+M = 10260 \times 4.3 - 1000 \times \frac{4.3^2}{2} - 3280 \times \frac{1.84^2}{2} - 18780 = 10620'^{\#}$$

Beam B-2

Member DE

$$V_D = 620 \times \frac{4.75}{2} + 380 \times .87 \times \frac{4.32}{4.75} + \frac{3730}{4.75} = 2560^{\#}$$

$$V_E = 620 \times \frac{4.75}{2} + 380 \times .87 \times \frac{.43}{4.75} - \frac{3730}{4.75} = 720^{\#}$$

$$x_0 = 1.16'$$

$$+M = 720 \times 1.16 - 620 \times \frac{1.16^2}{2} = 435'^{\#}$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION NO 6

Computation MOTOR ROOM FLOOR BEAMS

Computed by A.L.K. **Checked by** **Date** 30 JULY 1945

Beams B-1 & B-2 cont'd.

Design of members

Member AB

$d_{req'd\ -A_s} = \sqrt{\frac{19940}{147}} = 11.7'' <$ make beam 20" deep $d = 15.5''$

$d_{req'd\ +A_s} = \sqrt{\frac{12500}{123}} = 10.1'' < 14.5''$

$v = \frac{11000}{12 \times .88 \times 15.5} = 67\ \#/\square''$ use stirrups 3-3/8"φ U's @ 1'-0" @ 4", 6, 8.

$-A_s = \frac{19940 \times 12}{18000 \times .88 \times 15.5} = .98\ \square''$ use 3-3/4"φ top

$+A_s = \frac{12500 \times 12}{18000 \times .88 \times 14.5} = .65\ \square''$ use 3-3/4"φ both.

$u = \frac{11000}{7.2 \times .88 \times 15.5} = 112\ \#/\square''$

Member BC

$d_{req'd\ +A_s} = \sqrt{\frac{14200}{123}} = 10.7'' < 14.5''$

$-A_s = .98\ \square''$ use 3-3/4"φ top

$+A_s = \frac{14200 \times 12}{18000 \times .88 \times 14.5} = .75\ \square''$ use 3-3/4"φ both.

$v = \frac{11330}{12 \times .88 \times 15.5} = 69.5\ \#/\square''$ OK as shear reduces at face use 3-3/8"φ U's @ 1'-0" @ 4", 6", 8".

$u = \frac{11330}{7.2 \times .88 \times 15.5} = 115\ \#/\square''$

Member CD

$-A_s =$ use 3-3/4"φ top

$+A_s =$ use 3-3/4"φ both

Member DE

$d_{req'd} \sqrt{\frac{3730}{147}} = 5.02'' < 7\frac{1}{2}''$

F-160

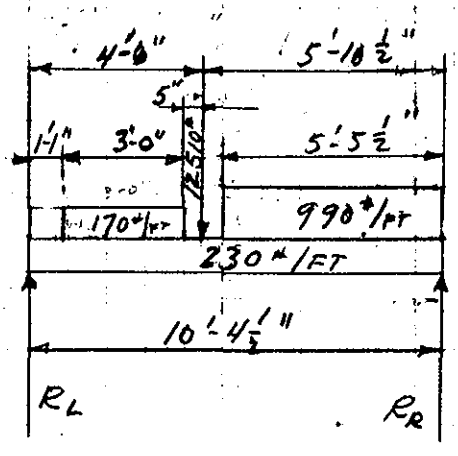
Beams B-1 & B-2 cont'd.

$$V = \frac{2560}{12 \times .88 \times 7.5} = 32.4\#/\square''$$

$$A_s = \frac{3730 \times 12}{18000 \times .88 \times 7.5} = .38\ \square''$$ use 2-3/4" ϕ top & bott.

$$u = \frac{2560}{4.8 \times .88 \times 7.5} = 81\ \#/\square''$$

Beam B-3



DL. 8" slab = 100 × 2.81 = 280
LL. = 250 × 2.81 = 704
990#/FT.

D.L. 14"×27" BM = 1.16 × 1.16 × 150 = 230 #/FT

Load of sump pump + Impact = 170#/FT

Reaction from B_1 & B_2

$$R_L = 230 \times 10.37 \times .5 = 1090$$
$$= 170 \times 3 \times \frac{7.79}{10.37} = 380$$
$$= 990 \times 5.46 \times \frac{2.73}{10.37} = 1240$$
$$= 12510 \times \frac{5.87}{10.37} = 7080$$
$$9790\#$$

$$R_R = 230 \times 10.37 \times .5 = 1090$$
$$= 170 \times 3 \times \frac{2.58}{10.37} = 130$$
$$= 990 \times 5.46 \times \frac{7.64}{10.37} = 3980$$
$$= 12510 \times \frac{4.5}{10.37} = 5430$$
$$10630\#$$

$X_0 = 4.5$ ft. from R_L

$$+M = 9790 \times 4.5 - 290 \times \frac{4.5^2}{2} - 170 \times 3 \times 1.92 = 39980'\#$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation MOTOR ROOM FLOOR BEAMS

Computed by A.L.K. **Checked by** _____ **Date** 31 JULY 1945

Beam B-3 cont'd.

$$d\ req'd = \sqrt{\frac{39980 \times 12}{14 \times 123}} = 16.7'' < 16.5''$$

$$v = \frac{10670}{14 \times .88 \times 16.5} = 52.5\ \#/\square''$$

$$A_s = \frac{39980 \times 12}{18000 \times .88 \times 16.5} = 1.83\ \square''$$ use $\begin{cases} 3-\frac{7}{8}''\phi \text{ bot} \\ 3-\frac{3}{4}''\phi \text{ top} \end{cases}$

$$u = \frac{10670}{7.2 \times .88 \times 16.5} = 102\ \#/\square''$$

Beam B-4

D.L. 8" slab .79 x 100 = 79
L.L. .79 x 250 = 196
280 #/FT.

D.L. 8" slab 4.79 x 65 = 310
L.L. 4.79 x 125 = 600
910 #/FT

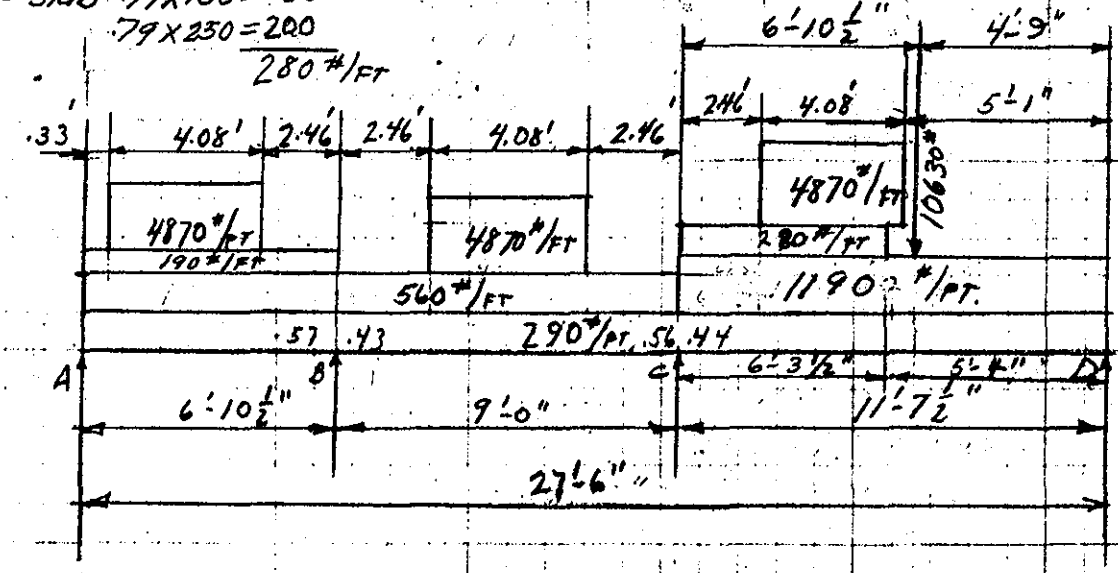
Loads on B-4 from 30" Pumps $\frac{19850}{4.08} = 4870\ \#/FT$

D.L. 8" slab 1.58 x 100 = 160
L.L. 1.58 x 2.50 = 400
560 #/FT

D.L. of 19" x 24" BM 1.58 x 1.33 x 150 = 290 #/FT

D.L. 8" slab .54 x 100 = 54
L.L. .54 x 250 = 135
190 #/FT.

D.L. 8" slab .79 x 100 = 80
L.L. .79 x 250 = 200
280 #/FT



Beam B-4 cont'd.

Stiffness factors Member

" " AB $\frac{1}{6.87} = .146$

" " BC $\frac{1}{9} = .111$

" " CD $\frac{1}{11.62} = .086$

$$M^F_{AB} = \frac{1}{12} \times 1040 \times 6.87^2 + \frac{.642}{12}\left(6 - 8 \times .642 + 3 \times .642^2\right) 4870 \times 4.42 \times 6.87$$

$$- \frac{.048}{12}\left(6 - 8 \times .048 + 3 \times .048^2\right) \times 4870 \times .33 \times 6.87 = 20.45^{k}$$

$$M^F_{BA} = \frac{1}{12} \times 1040 \times 6.87^2 + \frac{.642^2}{12}\left(4 - 3 \times .642\right) 4870 \times 4.42 \times 6.87$$

$$- \frac{.048^2}{12}\left(4 - 3 \times .048\right) \times 4870 \times .33 \times 6.87 = \cancel{13.79}\ 14.54^{k}$$

$$M^F_{\substack{BC \\ CB}} = \frac{1}{12} \times 850 \times 9^2 + \frac{1.42 \times 2.73 - 2 \times 2.73^2}{12}\left(4870 \times 4.08 \times 9\right) = 26.56^{k}$$

$$M^F_{CD} = \frac{1}{12} \times 1480 \times 11.62^2 + \frac{.54}{12}\left(6 - 8 \times .54 + 3 \times .54^2\right)\left(280 \times 6.29 \times 11.62\right)$$

$$+ \frac{10630 \times 6.87 \times 4.75^2}{11.62^2} + \frac{.562}{12}\left(6 - 8 \times .562 + 3 \times .562^2\right) 4870 \times 6.54 \times 11.62$$

$$- \frac{.212}{12}\left(6 - 8 \times .212 + 3 \times .212^2\right) 4870 \times 2.46 \times 11.62 = \cancel{72.3}\ 62.67^{k}$$

$$M^F_{DC} = \frac{1}{12} \times 1480 \times 11.62^2 + \frac{.54^2}{12}\left(4 - 3 \times .54\right)\left(280 \times 6.29 \times 11.62\right)$$

$$+ \frac{10630 \times 4.75 \times 6.87^2}{11.62^2} + \frac{.562^2}{12}\left(4 - 3 \times .562\right) 4870 \times 6.54 \times 11.62$$

$$- \frac{.212^2}{12}\left(4 - 3 \times .212\right) \times 4870 \times 2.46 \times 11.62 = \cancel{57.7}\ 56.28^{k}$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION NO. 6

Computation MOTOR ROOM FLOOR BEAMS.

Computed by ALK **Checked by** _____ **Date** 31 JULY 1945

Beam B-4 cont'd.

	0	.57 .43		.56 .44		0
	A	B		C		D
	+20.45	-14.54	+26.56	-26.56	+62.67	-56.28
	-20.45	-6.85	-5.17	-20.23	-15.89	+56.28
	-3.43	-10.23	-10.11	-2.59	+28.14	-7.95
	+3.43	+11.59	+8.74	-14.31	-11.24	+7.95
	+5.80	+1.71	-7.15	+4.37	+3.97	-5.62
	-5.80	+3.10	+2.34	-4.68	-3.67	+5.62
	1 +1.55	-2.90	-2.34	+1.17	+2.81	-1.84
	-1.55	+2.99	+2.25	-2.23	-1.75	+1.84
-M	0	-15.11	+15.11	-65.04	+65.04	0
V	14380#	12630#	8230#	19320#	31980#	17470#
	21380'#		6110'#		31980'#	

$$V_A = 1040 \times 6.87 \times .5 + 4870 \times 4.08 \times \frac{4.5}{6.87} - \frac{15110}{6.87} = 14380^{\#}$$

$$V_B = 1040 \times 6.87 \times .5 + 4870 \times 4.08 \times \frac{2.37}{6.87} + \frac{15100}{6.87} = 12630^{\#}$$

$X_0 = 2.71'$ from V_A

$$+M = 14380 \times 2.71 - 1040 \times \frac{2.71^2}{2} - 4870 \times \frac{2.38^2}{2} = 21380'^{\#}$$

$$V_B = 850 \times 9 \times .5 + 4870 \times 4.08 \times .5 - \frac{49930}{9} = 8230^{\#}$$

$$V_C = 850 \times 9 \times .5 + 4870 \times 4.08 \times .5 + \frac{49930}{9} = 19320^{\#}$$

$X_0 = 3.53'$ from V_B

$$+M = 8230 \times 3.53 - 850 \times \frac{3.53^2}{2} - 4870 \times \frac{1.07^2}{2} - 15{,}110 = 6110'^{\#}$$

$$V_C = 1480 \times 11.62 \times .5 + 280 \times 6.29 \times \frac{8.47}{11.62} + 4870 \times 4.08 \times \frac{7.12}{11.62}$$
$$+ 10630 \times \frac{4.75}{11.62} + \frac{65040}{11.62} = 31980^{\#}$$

$$V_D = 1480 \times 11.62 \times .5 + 280 \times 6.29 \times \frac{3.15}{11.62} + 4870 \times 4.08 \times \frac{4.50}{11.62}$$
$$+ 10630 \times \frac{6.87}{11.62} - \frac{65040}{11.62} = 17470^{\#}$$

$X_0 = 4.75'$ from V_D

$$+M = 17470 \times 4.75 - \frac{1480 \times 4.75^2}{2} = 66{,}300'^{\#}$$

Beam B-4 cont'd. Design of Members

Mem. CD

$d\ req'd - M = \sqrt{\frac{65040 \times 12}{19 \times 144}} = 16.7'' < 18.5''$ neglect top 3" of Beam.

$d\ req'd + M = \sqrt{\frac{66300 \times 12}{19 \times 123}} = 18'' < 18.5''$

$v = \frac{31980}{19 \times .88 \times 18.5} = 103\ \#/\square''$ use stirrups

$-A_s = \frac{65040 \times 12}{18000 \times .88 \times 18.5} = 2.66\ \square''$ use 4-1"ϕ top

$u = \frac{31980}{12.57 \times .88 \times 18.5} = 156\ \#/\square''$

$+A_s = \frac{66300 \times 12}{18000 \times .88 \times 18.5} = 2.72\ \square''$ use 4-1"ϕ bot.

Mem. AB

$-A_s = \frac{15110 \times 12}{18000 \times .88 \times 18.5} = .62\ \square''$ use 2-1"ϕ top

$u = \frac{14830}{6.28 \times .88 \times 18.5} = 145\ \#/\square''$

$+A_s = \frac{21380 \times 12}{18000 \times .88 \times 18.5} = .87\ \square''$ use 2-1"ϕ bott.

$v = \frac{14830}{19 \times .88 \times 18.5} = 48\ \#/\square''$

Mem BC

$+A_s = 2\text{-}1''\phi$

$-A_s = 2\text{-}1''\phi$

$v = \frac{19320}{19 \times .88 \times 18.5} = 62.5\ \#/\square$ use stirrups

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

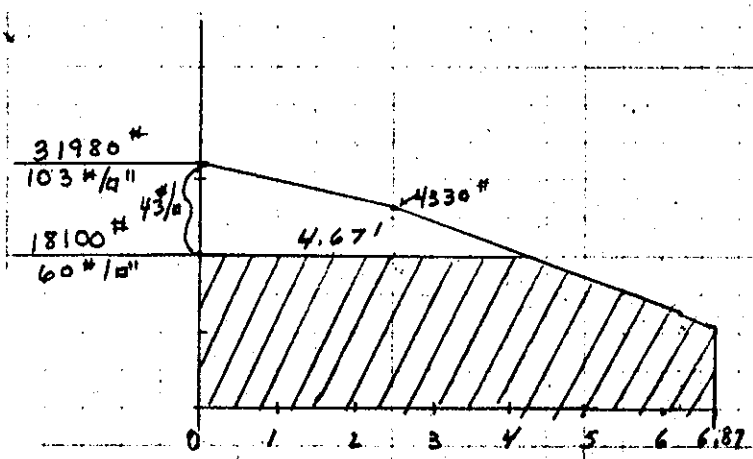
Subject HOLYOKE PUMPING STATION No. 6.

Computation MOTOR ROOM FLOOR BEAMS.

Computed by A.L.K. **Checked by** _____ **Date** 3 Aug. 1945

Beam B-4 cont'd.

Stirrup req'd. use $\frac{1}{2}$" ϕ Stirr. = 6400 #/Stirr.



$$S_0 = \frac{6400}{19 \times 43} = 7.85''$$

$$S_1 = \frac{6400}{19\left(43 - \frac{1760 \times \frac{7.85}{12}}{19 \times .88 \times 18.5}\right)} = 8.55''$$

3.72

39.3

$$S_2 = \frac{6400}{19\left(39.3 - \frac{1760 \times 8.55}{12 \times 19 \times .88 \times 18.5}\right)} = 9.65''$$

34.96

$$S_3 = \frac{6400}{19\left(34.98 - \frac{1760 \times 9.65}{12 \times 19 \times .88 \times 18.5}\right)} = 11''$$

30.43 × 4.55

Total shear $= \frac{1}{2} \times 4330 \times 2.46 + 9550 \times 2.46 + 9550 \times 2.21 \times \frac{1}{2} =$

$= 40300$ #

No Stirr req'd $= \frac{40300 \times 12}{6400 \times .88 \times 18.5} = 4.65 = 5$ stirrups $\frac{1}{2}$" ϕ

Space @ 2", 6, 8, 9, 10 from C and 3-$\frac{1}{2}$" ϕ Ustirr. @ D. Same Spacing

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WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

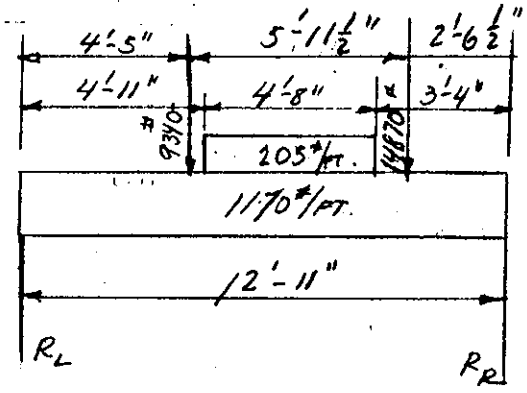
Computation MOTOR ROOM FLOOR BEAMS.

Computed by A.L.K **Checked by** **Date** 31 JULY 1945

Beam B-4 Cont'd

Use 3-$\frac{1}{2}$"ϕ a each end of the other members of the beam spaced @ 4", 8", 10"

Beam B-5



D.L. 14"x26" BM. 1.16x130x150 = 260
D.L. 8" slab 2.60x100 = 260
LL 2.60x250 = 650
1170 #/ft.

D.L. 8" slab .58x100 = 58
LL .58x250 = 145
205 #/ft.

Reaction from B-4 = 14870 #
" " B-1 = 9340 #

R_L = 1170x12.92x.5 = 7550
= 205x4.67x $\frac{5.67}{12.92}$ = 420
= 9340x $\frac{8.5}{12.92}$ = 6120
= 14870x $\frac{2.54}{12.92}$ = 2920
17010 #

R_R = 1170x12.92x.5 = 7550
= 205x4.67x $\frac{6.25}{12.92}$ = 460
= 9340x $\frac{4.42}{12.92}$ = 3180
= 14870x $\frac{10.37}{12.92}$ = 11900
23,090 #

X_0 = 6.31 ft.

$+M = 17010 \times 6.31 - 1170 \times \frac{6.31^2}{2} - 9340 \times 1.89 - 205 \times \frac{1.39^2}{2} =$

$+M = 65,950$ '#

d req'd = $\sqrt{\frac{65950 \times 12}{14 \times 123}}$ = 21.5" < 20.5" neglecting 3" for frame recess
OK
As there will be T beam action

$v = \frac{23090}{14 \times 88 \times 20.5}$ = 91.5 #/□"

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION NO 6

Computation MOTOR ROOM FLOOR BEAMS

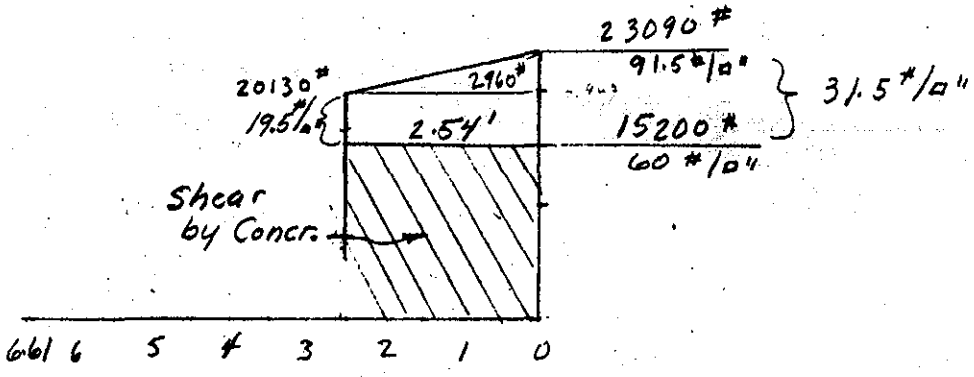
Computed by A.L.K. **Checked by** _____ **Date** 1 Aug. 1945

Beam B-5 cont'd.

$$+A_s = \frac{65950 \times 12}{18000 \times .88 \times 20.5} = 2.43 \square'' \quad \text{use } 4\text{-}\tfrac{7}{8}''\phi$$

$$-A_s = 1.80 \square'' \quad \text{use } 3\text{-}\tfrac{7}{8}''\phi$$

$$u = \frac{23090}{10.4 \times .88 \times 20.5} = 123\ \#/\square''$$



Shear Diagram

$$S_o = \frac{A_s f v}{b(v-60)} = \frac{.112 \times 2 \times 16000}{14 \times 31.5} = 8.2'' \qquad S_1 = \frac{3520}{14\left(31.5 - \frac{8.2}{12} \times 24.22\right)} = 16.7''$$

$$\frac{dV}{dx} = \frac{12}{2.54} + 19.5 = 24.22\ \#/\square''/ft$$

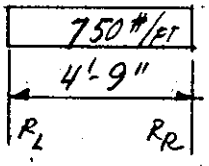
$$\text{No of } \tfrac{3}{8}''\phi \text{ Stirr req'd} = \frac{\left(\frac{4930 + 7890}{2}\right) 2.54 \times 12}{3520 \times .88 \times 17.5} = 3.6 = 4 \text{ Stirrups } \tfrac{3}{8}''\phi$$

space @ 4", 8", 10", 12" both ends of span.

Subject Holyoke Pumping Station No. 6
Computation Motor Room Floor Beams
Computed by A.L.K. **Checked by** **Date** 1 Aug 1945

Beam B-6

D.L. 8" slab 2 X 100 = 200
LL 2 X 250 = 500
DL 12"X12" BM 1X.33X150 = 50
750#/FT.



$M = 750 \times \frac{4.75^2}{8} = 2110$ '#

$R_L = R_R = 750 \times 4.75 \times .5 = 1780$ #

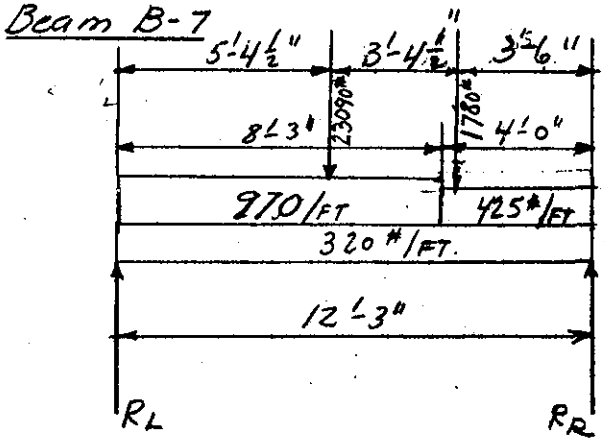
d req'd $= \sqrt{\frac{2110}{123}} = 4.12'' < 9.5''$

$v = \frac{1780}{12 \times .88 \times 9.5} = 17.8$ #/□"

$A_s = \frac{2110 \times 12}{18000 \times .88 \times 9.5} = .168$ □" Use 2-$\frac{5}{8}$"φ top & bott.

$u = \frac{1780}{4 \times .88 \times 9.5} = 53.5$ #/□"

Beam B-7



DL 8" slab .67X100 = 68
LL .67 X 250 = 167
235 #/FT

DL 8" slab 1.21X100 = 121
LL 1.21X250 = 304
425 #/FT

DL 16"X27" BM = 1.33X1.58X150 = 320 #/FT

DL cover & Frame 15X1.83 = 275
LL 250X1.83 = 460
735 #/FT

DL+LL = 735+235 = 970 #/FT.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation MOTOR ROOM FLOOR BEAMS.

Computed by A.L.K. **Checked by** _____ **Date** 1 Aug 1945

Beam B-7 cont'd

$R_L = 320 \times 12.25 \times .5 = 1960$

$= 970 \times 8.25 \times \frac{8.12}{12.25} = 5310$

$= 425 \times 4 \times \frac{2}{12.25} = 280$

$= 1780 \times \frac{3.5}{12.25} = 510$

$= 23090 \times \frac{6.87}{12.25} = 12900$

$20960\#$

$R_L = 320 \times 12.25 \times .5 = 1960$

$= 970 \times 8.25 \times \frac{4.13}{12.25} = 2690$

$= 425 \times 4 \times \frac{10.25}{12.25} = 1420$

$= 1780 \times \frac{8.75}{12.25} = 1270$

$= 23090 \times \frac{5.38}{12.25} = 10100$

$17440\#$

$X_0 = 5.37$ ft. from R_L

$+M = 20960 \times 5.37 - 1290 \times \frac{5.37^2}{2} = 93,400$

$d\ req'd = \sqrt{\frac{93400 \times 12}{16 \times 123}} = 23.8'' < 24.5''$

$v = \frac{20960}{16 \times .88 \times 24.5} = 60.6\ \#/\square''$

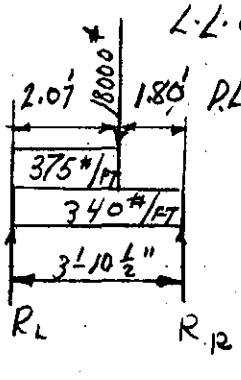
$+A_s = \frac{93400 \times 12}{18000 \times .88 \times 24.5} = 2.8\ \square''$ use 4-1" ϕ bott
3-1" ϕ top

$u = \frac{20960}{9.3 \times .88 \times 24.5} = 104\ \#/\square''$

Beam 8-8

max gate load = 18000#

L.L. on BM = 250 × 1.5 = 375 #/FT



D.L. of 18" x 18" BM = 1.5 × 1.5 × 150 = 340 #/FT

$R_L = 340 \times 3.87 \times .5 = 660$

$= 375 \times 2.07 \times .73 = 570$

$= 18000 \times \frac{1.80}{3.87} = 8350$

$9580\#$

$R_L = 340 \times 3.87 \times .5 = 660$

$= 375 \times 2.07 \times .27 = 210$

$= 18000 \times \frac{2.07}{3.87} = 9650$

$10,520\#$

$X_0 = 1.8'$ from R_R

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WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION NO.6

Computation MOTOR ROOM FLOOR BEAMS

Computed by A.L.K. **Checked by** **Date** 2 Aug. 1945

Beam B-8

$$M = 10520 \times 1.8 - 340 \times \frac{1.8^2}{2} = 18450'^{\#}$$

$b = 18 - 5 = 13''$ for 5" sleeve

$$d'req'd = \sqrt{\frac{18450 \times 12}{123 \times 13}} = 11.7'' < 15.5''$$

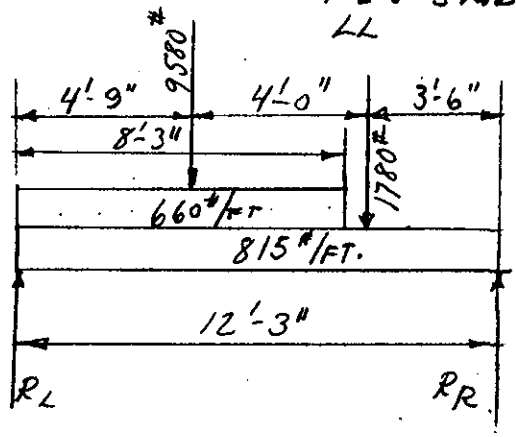
$$v = \frac{10520}{13 \times .88 \times 15.5} =$$

$$A_s = \frac{18450 \times 12}{18000 \times .88 \times 15.5} = .905 \square'' \text{ use } 4\text{-}5/8'' \phi \begin{cases} \text{top} \\ \text{both} \end{cases}$$

$$u = \frac{10520}{7.85 \times .88 \times 15.5} = 98^{\#}/\square''$$

Beam B-9

DL. 12"x24" Bm = 1x1.33x150 = 200
DL. 8" slab 1.75 x 100 = 175
LL 1.75 x 250 = 440
815 #/FT.



DL. 8" slab .5 x 100 = 50
LL 2.33 x 250 = 582
DL. cov. & fr. 1.83x15 = 28
660 #/FT.

$$R_L = 815 \times 12.25 \times .5 = 5000$$
$$= 660 \times 8.25 \times \frac{8.12}{12.25} = 3620$$
$$= 9580 \times \frac{7.5}{12.25} = 5850$$
$$= 1780 \times \frac{3.5}{12.25} = 510$$
$$14980^{\#}$$

$$R_R = 815 \times 12.25 \times .5 = 5000$$
$$= 660 \times 8.25 \times \frac{4.13}{12.25} = 1830$$
$$= 9580 \times \frac{4.75}{12.25} = 3700$$
$$= 1780 \times \frac{8.75}{12.25} = 1270$$
$$11800$$

$X_0 = 4.75$ ft from R_L.

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WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation MOTOR ROOM FLOOR BEAMS

Computed by A.L.K. **Checked by** _____ **Date** 2 Aug 1945

Beam B-9 cont'd

$$M = 14980 \times 4.75 - 1475 \times \frac{4.75^2}{2} = 54350'\#$$

$$d \text{ req'd} = \sqrt{\frac{54350}{123}} = 21'' < 21.5''$$

$$v = \frac{14980}{12 \times .88 \times 21.5} = 66\ \#/\square'' \quad \text{Use } 3\text{-}\tfrac{3}{8}''\phi \text{ stirr @ } 1'\text{-}0'' \text{ at each end.}$$

$$A_s = \frac{54350 \times 12}{18000 \times .88 \times 21.5} = 1.92\ \square'' \quad \text{use } \begin{cases} 3\text{-}1''\phi \text{ bott} \\ 2\text{-}1''\phi \text{ top} \end{cases}$$

$$u = \frac{14980}{6.28 \times .88 \times 21.5} = 126\ \#/\square''$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No.6

Computation MOTOR ROOM FLOOR BEAMS

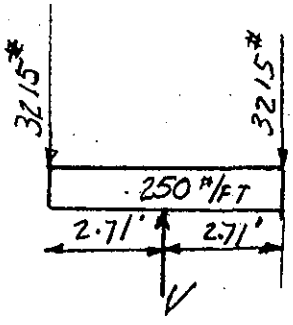
Computed by A.L.K. **Checked by** _____ **Date** 4 Aug 1945

Beam B-12

Beam B-12 will be designed both as a cantilever and a simple supported beam

Avg. Load on cant. from 30" Pump $\frac{5080+1350}{2} = 3215^{\#}$

D.L. of Bm = $1.0 \times 1.67 \times 150 = 250$ #/□'



$M = 3215 \times 2.71 + 250 \times \frac{2.71^2}{2} = 9620$ '#

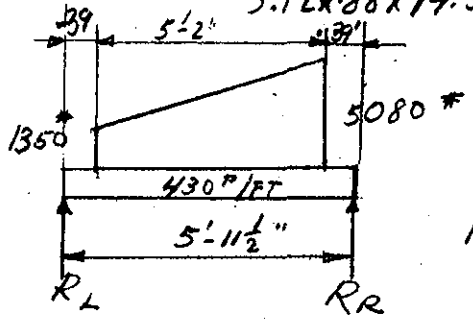
$V = 250 \times 2.71 + 3215 = 3895$ #

$d_{req'd} = \sqrt{\frac{9620}{147}} = 8.1'' < 14.5''$ top 3" neglected.

$v = \frac{3895}{12 \times .88 \times 14.5} = 25.3$ #/□"

$A_s = \frac{9620 \times 12}{18000 \times .88 \times 14.5} = .50$ □" use 5/8"φ @ 6" top, 5/8"φ @ 1'-0" bott.

$u = \frac{3895}{3.92 \times .88 \times 14.5} = 78$ #/□"



D.L. of 20½" x 20" BM =

$= 1.71 \times 1.67 \times 150 = 430$ #/FT

$R_L = 430 \times 5.96 \times .5 + 1350 \times 5.16 \times .5 + 3730 \times 5.16 \times .5 \times .36 = 8240$ #

$R_R = 430 \times 5.96 \times .5 + 1350 \times 5.16 \times .5 + 3730 \times 5.16 \times .5 \times .64 = 10810$ #

$X_0 = 3.21'$

$+M = 8240 \times 3.21 - 430 \times \frac{3.21^2}{2} - 1350 \times \frac{2.82^2}{2} - \frac{3730}{5.16}\left(\frac{2.82}{2}\right)^2 \times 2.27 =$

$+M = 12290$ '#

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U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation MOTOR ROOM FLOOR BEAMS.

Computed by A.L.K. **Checked by** _____ **Date** 4 Aug 1945

$$d\ req'd = \sqrt{\frac{12290 \times 12}{20.5 \times 123}} = 7.65'' < 14.5''$$ top 3" neglected.

$$v = \frac{10810}{20.5 \times .88 \times 14.5} = 41.2\ \#/\square''$$

$$+ A_s = \frac{12290 \times 12}{18000 \times .88 \times 14.5} = .64\ \square''$$ use 2-3/4" ϕ bot, 2-3/4" ϕ top

$$u = \frac{10810}{4.71 \times .88 \times 14.5} = 180\ \#/\square''$$

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6
Computation MOTOR ROOM FLOOR BEAMS
Computed by A.L.K. **Checked by** _____ **Date** 4 JULY 1945

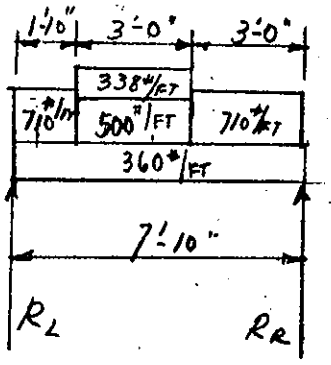
Beam B-13

Concrete Base for Motor 1200
Motor for 16" Pump 1800
Assume load on 3'-0" x 3'-0" Area = 3000 #

Load = $\frac{3000}{2 \times 3}$ = 500 #/FT/Beam.

D.L. 8" slab 2.85 X 100 = 285
D.L. 12" x 14" Bm. 1 x .5 x 150 = 75
360 #/FT

LL 2.85 X 250 = 710 #/FT
L.L. 1.35 X 250 = 338 #/FT



R_L = 860 X 7.83 X .5 = 3370
= 210 X 7.83 X .5 = 820
= 128 X 3 X .576 220
4410 #

R_R = 860 X 7.83 X .5 = 3370
= 210 X 7.83 X .5 = 820
= 128 X 3 X .424 = 165
4360 #

X_0 = 3.9' from R_L

$M = 4410 \times 3.9 - 1060 \times \frac{3.9^2}{2} - 128 \frac{(2.07)^2}{2} = 8880$ '#

$d_{req'd} = \sqrt{\frac{8880}{123}} = 8.5" < 11.5"$ make beam 12" x 12"
thend = 9.5"

$v = \frac{4410}{12 \times .88 \times .9.5} = 44.0$ #/□"

$A_s = \frac{8880 \times 12}{18000 \times .88 \times .9.5} = .72$ □" use { 2 - 3/4" ϕ bott
2 - 3/4" ϕ top

$u = \frac{4410}{4.71 \times .88 \times .9.5} = 112$ #/□"

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

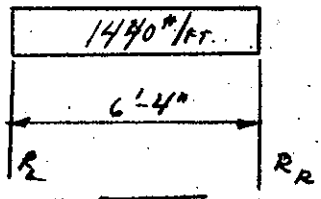
Subject HOLYOKE PUMPING STATION NO. 6

Computation MOTOR ROOM FLOOR BEAMS

Computed by A.L.K. **Checked by** _____ **Date** 4 JULY 1945

Beam B-14

D.L. 8" Slab = 2.16 × 100 = 216
D.L. 12"×12" BM = .33 × 1 × 150 = 50
D.L. cover & frame = 2.25 × 30 = 68
L.L. = 4.42 × 250 = 1100
1434 #/FT.



$R_L = R_R = 1440 \times \frac{6.33}{2} = 4540$ #

$M = 1440 \times \frac{6.33^2}{8} = 7200$ '#

$d = \sqrt{\frac{7200}{123}} = 7.65" < 9.12"$

$v = \frac{4540}{12 \times .88 \times 9.12} = 47$ #/□"

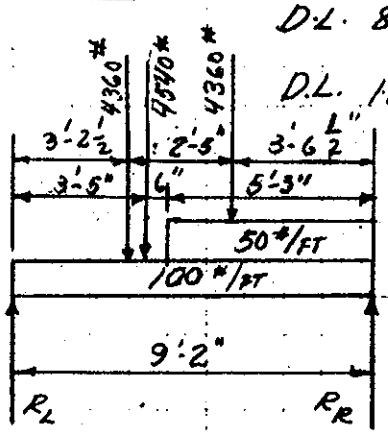
$A_s = \frac{7200 \times 12}{18000 \times .88 \times 9.12} = .60$ □" Use 2-3/4"φ bott & top

$u = \frac{4540}{4.71 \times .88 \times 9.12} = 121$ #/□"

Beam B-15

D.L. 8" Slab .5 × 100 = 50 #/FT.

D.L. 12"×16" Beam 1 × .67 × 150 = 100 #/FT.



R_L	R_R
= 100 × 9.16 × .5 = 460	= 100 × 9.16 × .5 = 460
= 50 × 5.25 × .286 = 75	= 50 × 5.25 × .714 = 188
= 4360 × .386 = 1680	= 4360 × .614 = 2680
= 4540 × .628 = 2850	= 4540 × .372 = 1690
= 4360 × .65 = 2830	= 4360 × .35 = 1530
7895 #	6550 #

$X_0 = 3.42'$ from R_L

$M = 7895 \times 3.42 - 100 \times \frac{3.42^2}{2} - 4360 \times 2.0 = 25540$ '#

d req'd $= \sqrt{\frac{25540}{123}} = 14.4" > 13.5"$ OK as there will be T beam action

F176

Beam B-15 cont'd

$$v = \frac{7895}{12 \times .88 \times 13.5} = 55\ \#/\square''$$

$$A_s = \frac{25540 \times 12}{18000 \times .88 \times 13.5} = 1.43\ \square''$$ use $\begin{cases} 3-\frac{7}{8}''\phi \text{ bottom} \\ 3-\frac{3}{4}''\phi \text{ top} \end{cases}$

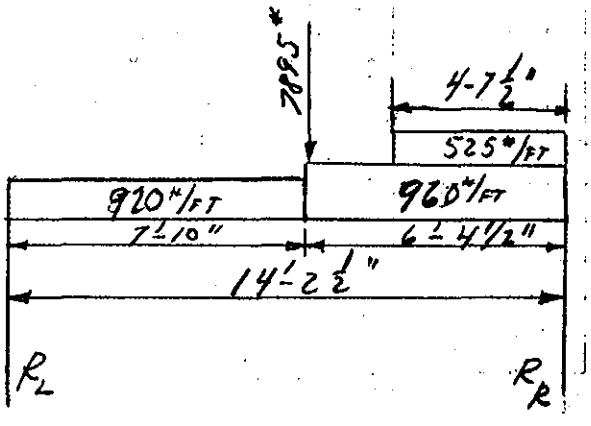
$$u = \frac{7895}{7.08 \times .88 \times 13.5} = 93.5\ \#/\square''$$

Beam B-16

DL 8" SLAB = 2.22 X 100 = 222
DL 14"X18" BM = 1.16 X .83 X 150 = 145
LL = 2.22 X 250 = 555
920 #/FT.

DL 8" SLAB = 2.33 X 100 = 235
LL = 2.33 X 250 = 580
DL 14"X18" Bm = 1.16 X .67 X 150 = 145
960 #/FT

DL 8" Slab = 1.5 X 100 = 150
LL = 1.5 X 250 = 375
525 #/FT.



R_L = 920 X 14.20 X .5 = 6520
= 40 X 6.37 X .22 = 56
= 525 X 4.62 X .163 = 396
= 7895 X .45 = 3540
10510 #

R_R = 920 X 14.20 X .5 = 6520
= 40 X 6.37 X .78 = 199
= 525 X 4.62 X .837 = 2040
= 7895 X .55 = 4350
13110 #

X_o = 7.83' from R_L.

$$M = 10510 \times 7.83 - 920 \times \frac{7.83^2}{2} = 54{,}200'\#$$

$$d\ req'd = \sqrt{\frac{54{,}200 \times 12}{14 \times 123}} = 19.4'' > 15.5''$$

there will be Tee Beam action

Subject: HOLYOKE PUMPING STATION No. 6
Computation: MOTOR ROOM FLOOR BEAMS
Computed by: A.L.K. Checked by: Date: 4 JULY

BEAM B-16 cont'd.

$$v = \frac{13110}{14 \times .88 \times 15.5} = 69\ \#/\square''$$ Use stirrups

$$A_s = \frac{54200 \times 12}{18000 \times .88 \times 15.5} = 2.65\ \square''$$ Use 3-1"□" bottom, 3-½"φ top.

$$u = \frac{13110}{9.3 \times .88 \times 15.5} = 104\ \#/\square''$$

Beam will act as a Tee Beam

$$b = 26.75'' \quad \frac{t}{d} = \frac{8}{15.5} = .515$$

$$K = \frac{800}{2} \times .515 \left(2 - .515 - \frac{.515}{.348} + \frac{2}{3} \times \frac{1}{.348} \times .515^2\right) = 106$$

$$d\ req'd = \sqrt{\frac{54200 \times 12}{26.75 \times 106}} = 15.2'' < 15.5''\ OK$$

Use ¾"φ stirrup @ 4", 10", 10".

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6
Computation MOTOR ROOM FLOOR BEAMS
Computed by A.L.K. **Checked by** _____ **Date** 5 JULY 1945

Beam B-17

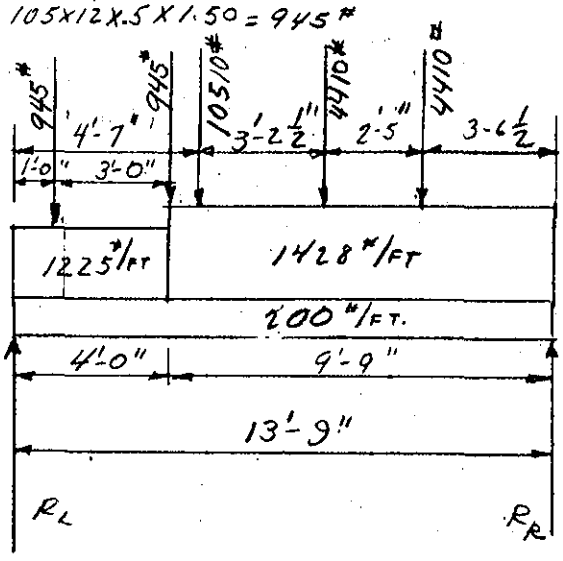
Stairway Reactions (Approx.)

D.L. 8" slab 3.5 x 100 = 350
L.L. 3.5 x 250 = 875
1225 #/FT.

D.L. 8" slab 4.08 x 100 = 408
L.L. 4.08 x 250 = 1020
1428 #/FT.

Assume wt. stairway = 30 #/□' horiz. proj.
LL = 75 #/□' " "
105 #/□'
Reaction 105 x 12 x .5 x 1.50 = 945 #

D.L. 16"x20" Bm = 1.33 x 1.0 x 150 = 200 #/FT.



R_L = 1425 x 13.75 x .5 = 9800
= 203 x 9.75 x .356 = 705
= 4410 x .264 = 1160
= 4410 x .434 = 1910
= 10510 x .667 = 7000
= 945 x .71 = 670
= 945 x .925 = 875
22120 #.

x_0 = 7.29' from R_R

R_R = 1428 x 13.75 x .5 = 9800
= 203 x 9.75 x .644 = 1280
= 4410 x .736 = 3250
= 4410 x .566 = 2500
= 10510 x .333 = 3500
= 945 x .29 = 275
= 945 x .073 = 70
20680 #

$$M = 20680 \times 7.29 - 1610 \times \frac{7.29^2}{2} - 4410 \times 3.75 - 4410 \times 1.33 = 85{,}500'\#$$

$$d\ req'd = \sqrt{\frac{85500 \times 12}{16 \times 123}} = 22.8'' > 17.5''$$

there will be Tee Beam action

$$v = \frac{22120}{16 \times .88 \times 17.5} = 90\ \#/\square''$$ Use stirrups

$$A_s = \frac{85500 \times 12}{18000 \times .88 \times 17.5} = 3.7\ \square''$$ Use 4-1"□ bottom, 3-1"φ top

$$u = \frac{22120}{9.42 \times .88 \times 17.5} = 152\ \#/\square''$$

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WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation MOTOR ROOM FLOOR BEAMS

Computed by A.L.K. **Checked by** **Date** 5 JULY 1945

Beam B-17 cont'd

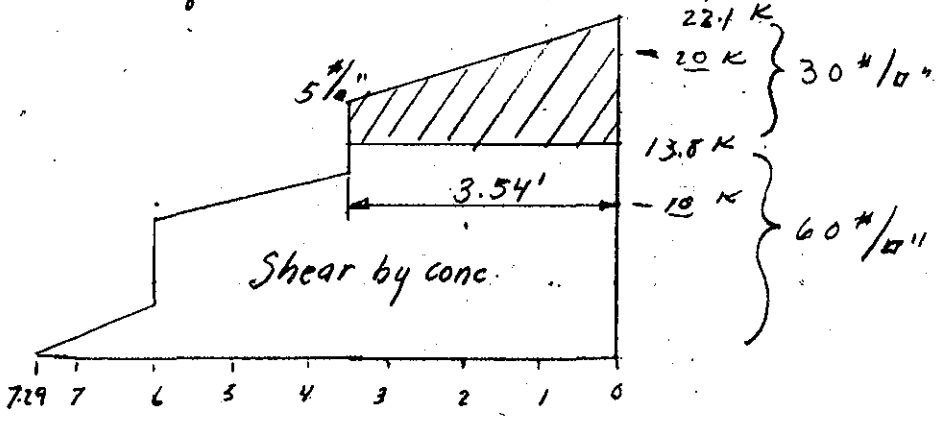
Beam will act as a Tee Beam.

$b = 42.2''$ $\frac{t}{d} = \frac{8}{17.5} = .468$

$$K = \frac{800}{2} \times .468 \left(2 - .468 - \frac{.468}{.348} + \frac{2}{3} \times \frac{1}{.348} \times .468^2\right) = 113$$

$$d_{req'd} = \sqrt{\frac{85500 \times 12}{42.2 \times 113}} = 14.7'' < 17.5'' \text{ OK}$$

Use $\frac{3}{8}''\phi$ Stirrups $= 3520\#/\text{stirrup}$



Shear diagram

$$S_0 = \frac{A_s f v}{b(v-60)} = \frac{3520}{16(30)} = 7.32'' \qquad S_1 = \frac{3520}{16\left(30 - \frac{7.32}{12} \times 12.08\right)} = 9.75''$$

7.45

$$\frac{dV}{dx} = \frac{25}{3.54} + 5 = 12.08\#/\square''/FT$$

$$S_2 = \frac{3520}{16\left(22.5 - \frac{9.75}{12} \times 12.08\right)} = 17.4''$$

126

$$\text{No stirr req'd} = \frac{\left(\frac{8320 + 1230}{2}\right) \times 3.54 \times 12}{3520 \times .88 \times 17.5} = 3.76 = 4 \text{ stirr}$$

9780

Space @ 4", 8, 10", 10" at both ends

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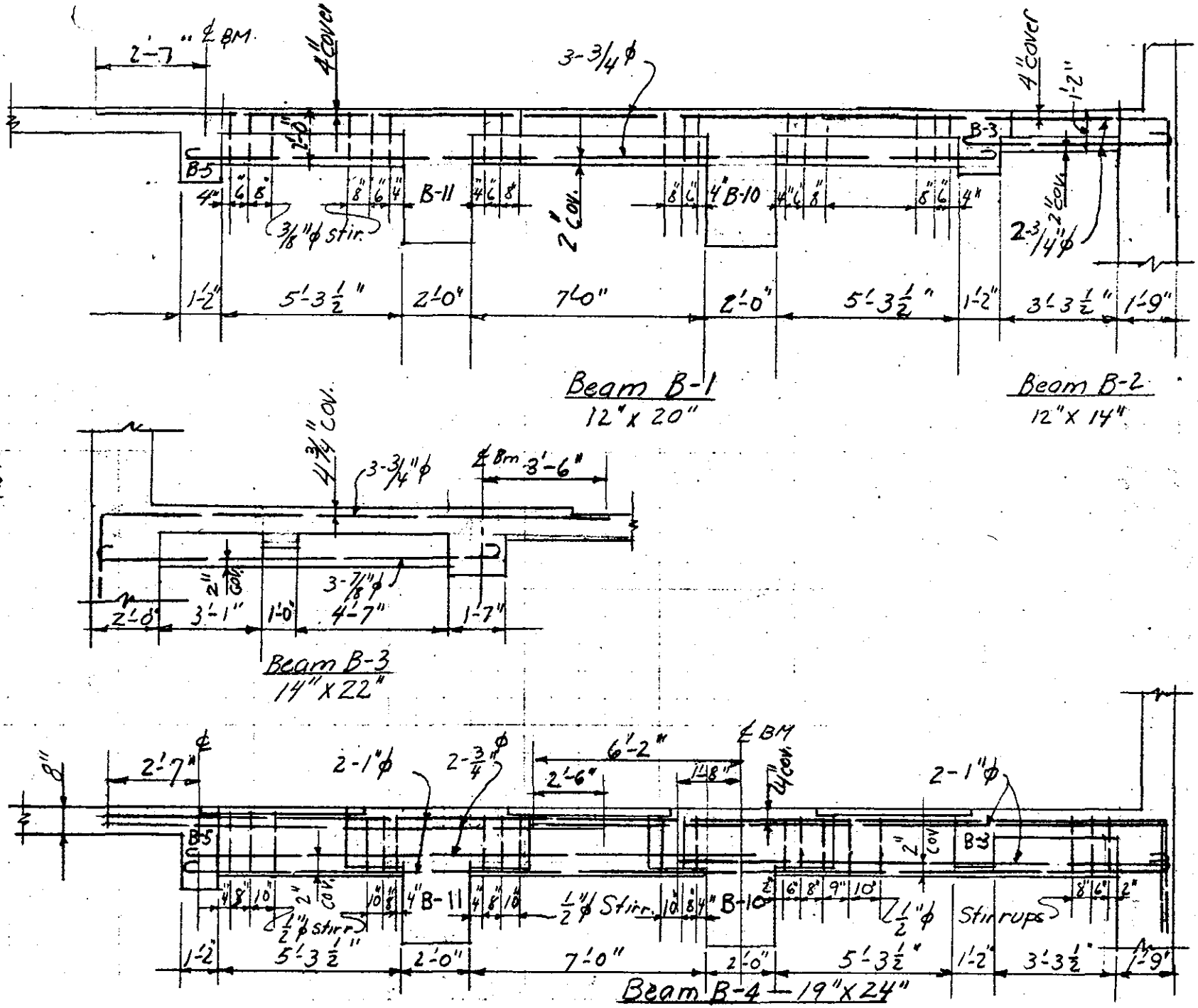
WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 6
Computation Motor Room Floor Beams
Computed by A.L.K. **Checked by** **Date** 6 Aug 1945



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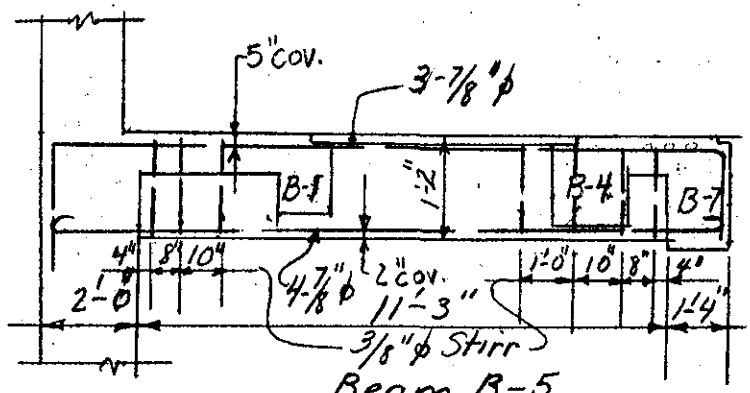
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

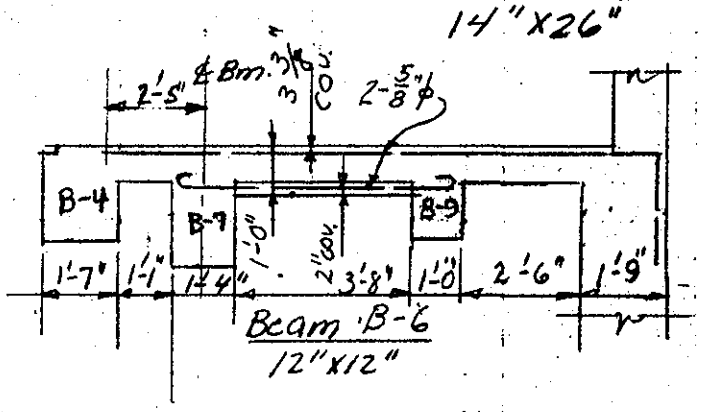
Subject HOLYOKE PUMPING STATION NO 6.

Computation MOTOR ROOM FLOOR BEAMS.

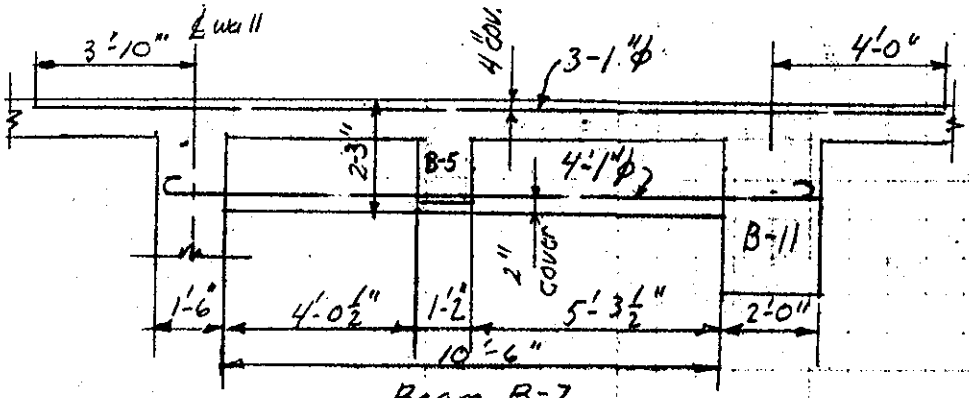
Computed by A.L.K **Checked by** **Date** 6 Aug 1945



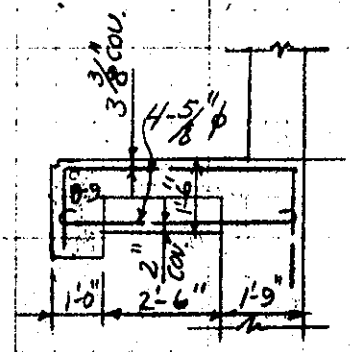
Beam B-5
14" x 26"



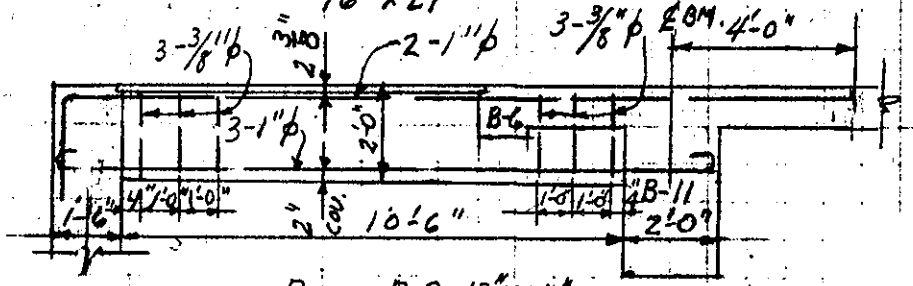
Beam B-6
12" x 12"



Beam B-7
16" x 27"



Beam B-8
18" x 18"



Beam B-9 12" x 24"

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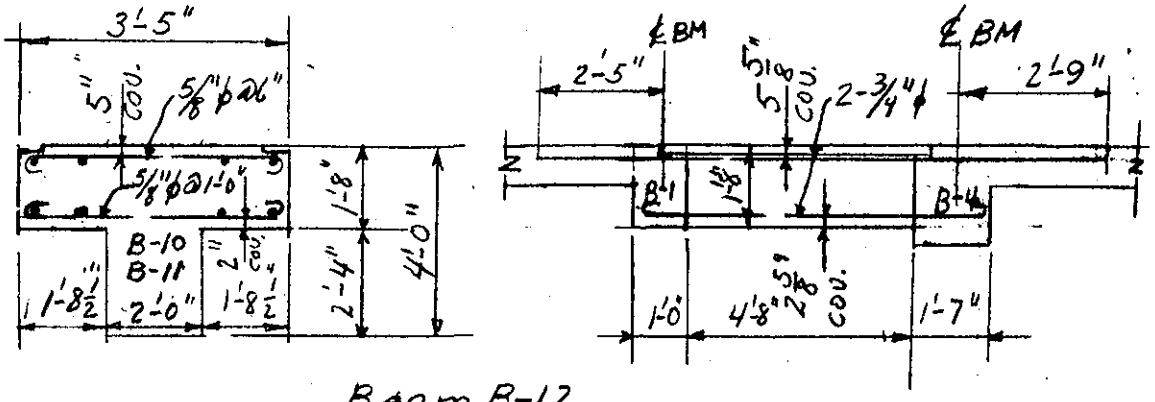
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

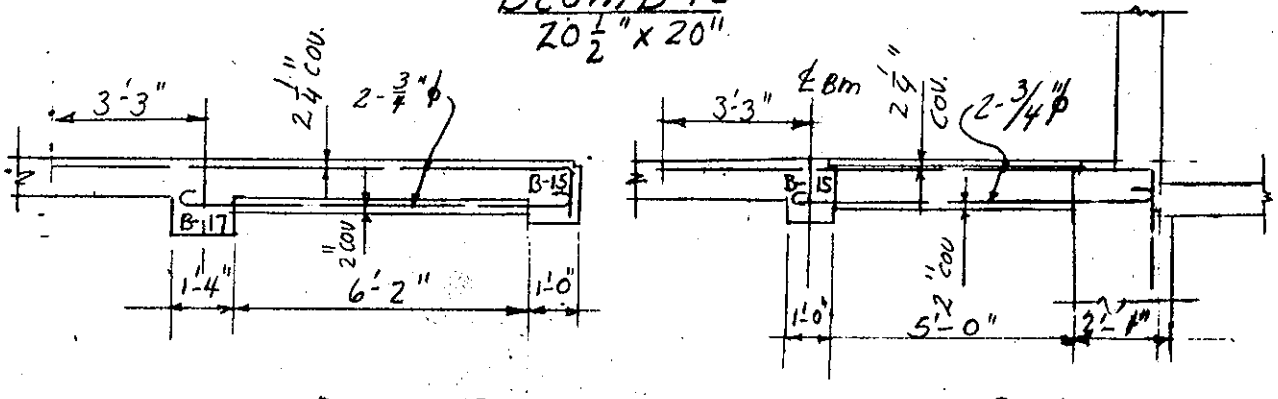
Subject HOLYOKE PUMPING STATION NO 6

Computation MOTOR ROOM FLOOR BEAMS

Computed by A.L.K. **Checked by** **Date** 6 AUG 1945

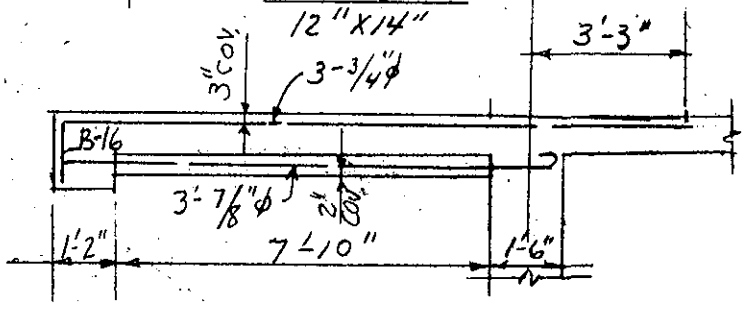


Beam B-12
20 1/2" x 20"

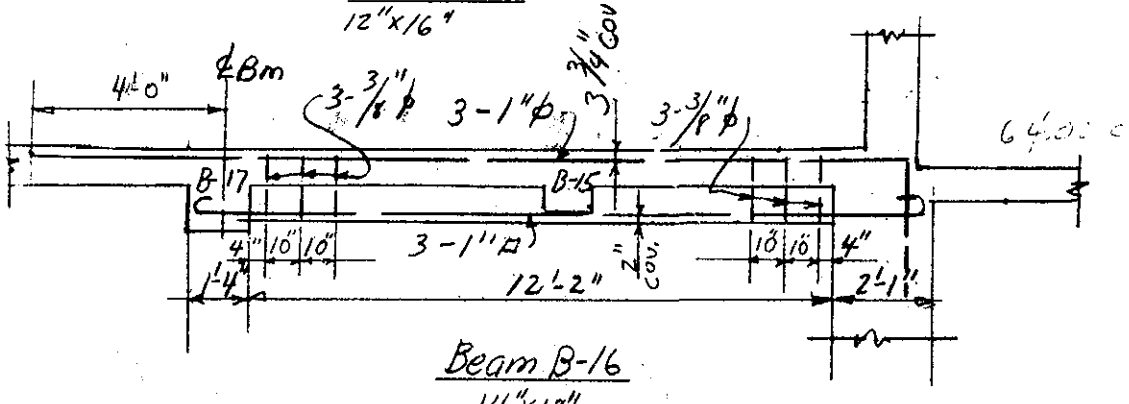


Beam B-13
12" X 14"

Beam B-14
12" X 12"



Beam B-15
12" x 16"



Beam B-16
14" X 18"

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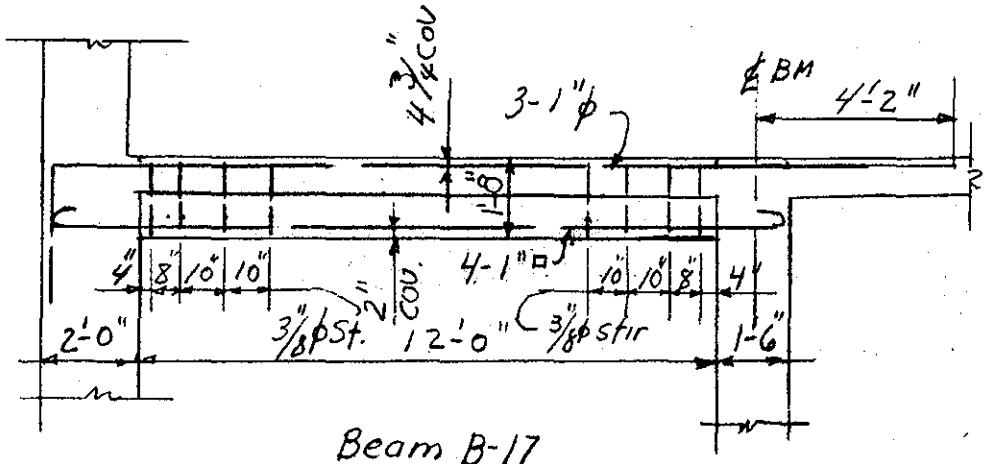
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation MOTOR ROOM FLOOR BEAMS

Computed by A.L.K. **Checked by** **Date** 7 Aug. 1945



Beam B-17
16" X 20"

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation TRASH RACK FLOOR SLAB

Computed by A.L.K. **Checked by** **Date** 4 Aug 1945

Slab S-7

Assume 12 Ton TRUCK LOAD with one wheel concentration

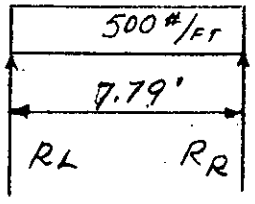
$.4 \times 24000 = 9600^{\#}$

Distr. $= E = .6\,S + 2.5 = .6 \times 6 + 2.5 = 6.0$ ft

L.L. $\frac{9600}{6'} = 400^{\#}/\square'$ equiv live load

D.L. $= 8''$ slab $= 1 \times 100 = 100^{\#}/\square'$

Uniform D.L. + L.L. $= 500^{\#}/\square'$



$M = \frac{1}{8} \times 500 \times 7.79^2 = 3780'^{\#}$

d req'd $= \sqrt{\frac{3780}{123}} = 5.55'' < 6.19''$

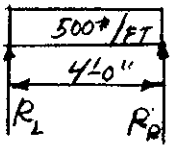
$R_L = R_L = 500 \times \frac{7.79}{2} = 1950^{\#}$

$v = \frac{1950}{12 \times .88 \times 6.19} = 29.8^{\#}/\square''$

$A_s = \frac{3780 \times 12}{18000 \times .88 \times 6.19} = .465\ \square''$ use $5/8''\phi$ @ 6" top & bott

$u = \frac{1950}{3.91 \times .88 \times 6.19} = 92.5^{\#}/\square''$

Slab S-8



$M = 500 \times \frac{4^2}{8} = 1000'^{\#}$

$R_L = R_R = 500 \times \frac{4}{2} = 1000^{\#}$

$A_s = \frac{1000 \times 12}{18000 \times .88 \times 6.19} = .122\ \square''$ use $5/8''\phi$ @ 1'-0" top & bott

$u = \frac{1000}{1.96 \times .88 \times 6.19} = 92.1^{\#}/\square''$

WAR DEPARTMENT

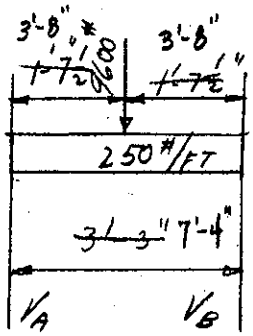
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation TRASH RACK FLOOR SLAB

Computed by A.L.K. **Checked by** H.L.F. **Date** 4 Aug 1945

Beam B-18



D.L. 8" slab 2 X 100 = 200

D.L. 12" x ~~12~~ 15" beam = 50

250 #/FT

$M = 250 \times \frac{7.33^2}{8} + 9600 \times \frac{7.33}{4} = 19{,}220$ #

$d = \sqrt{\frac{19{,}220}{123}} = 12.5 = 12\frac{1}{2}$ "

$V_A = V_B = 250 \times \frac{7.33}{2} + 4800 = 5710$ #

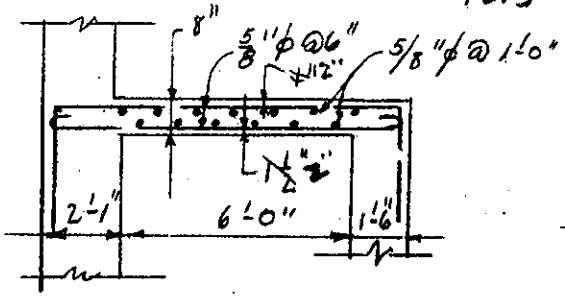
$v = \frac{5710}{12 \times .88 \times 12.5} = 43$ #/□"

$+A_s = \frac{19{,}220 \times 12}{18000 \times .88 \times 12.5} = 1.17$

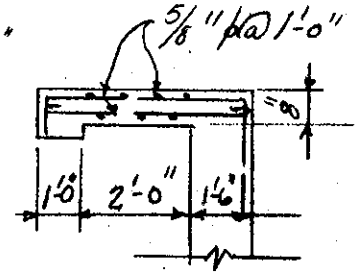
use 3 - 3/4 "φ bott = 1.32

2 - 3/4 "φ top

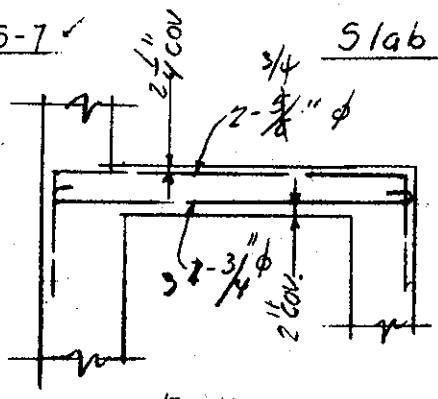
$u = \frac{5710}{4.72 \times .88 \times 12.5} = 120$ #/□"



Slab S-7



Slab S-8



Beam B-18 12"x15"

F186

WAR DEPARTMENT

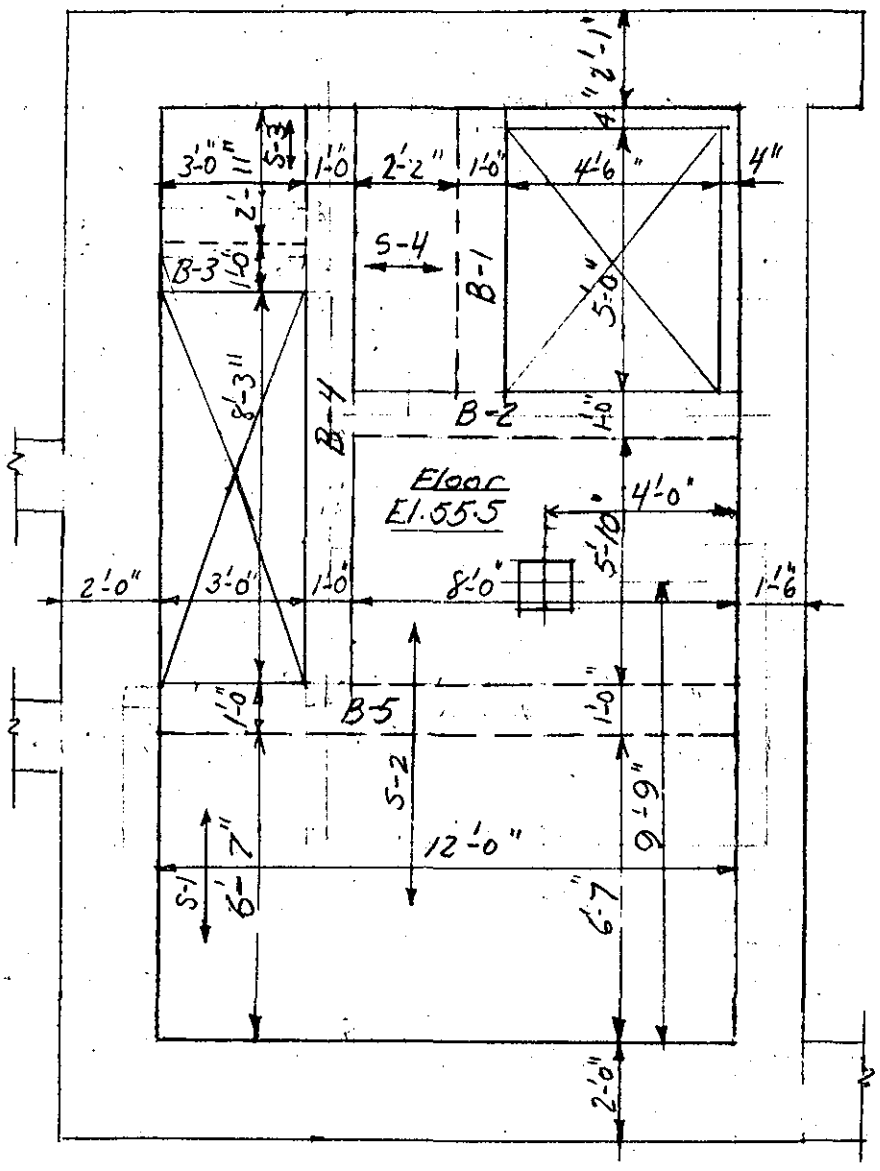
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 6

Computation Heater Room Floor Slab

Computed by A.L.K. **Checked by** _____ **Date** 6 July 1945

Landside



Heater Room floor Plan
El. 55.5

The heater room floor slab and beams will be designed for a live load of 100 #/□'

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

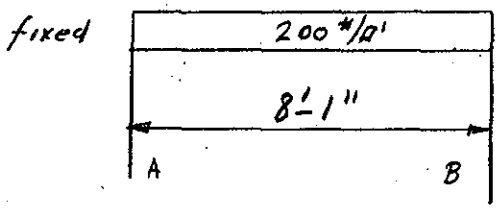
Computation HEATER ROOM FLOOR SLAB

Computed by A.L.K. **Checked by** _____ **Date** 6 JULY 1945

Slab S-1

D.L. 8" slab = 100
LL = 100
200 #/□'

$M^F = \frac{1}{12} \times 200 \times 8.08^2 = 1.09$ 'k



$M_A = 1.63$ 'k

$d_{req'd} = \sqrt{\frac{1,630}{147}} = 3.33" < 6.7"$
$-M$

$V_A = 200 \times \frac{8.08}{2} + \frac{1630}{8.08} = 1010$ #
$V_B = 200 \times \frac{8.08}{2} - \frac{1630}{8.08} = 610$ #

$X_o = 3.03'$ from B.

$+M = 610 \times 3.03 - 200 \times \frac{3.03^2}{2} = 930$ '#

$v = \frac{1010}{12 \times .88 \times 6.7} = 14.2$ #/□"

$-A_s = \frac{1630 \times 12}{18000 \times .88 \times 6.7} = .184$ □" $\frac{5}{8}$"ϕ @ 1'-0" top & bott.

$u = \frac{1010}{2 \times .88 \times 6.7} = 65$ #/□"

Slab S-2

$M^F_{AB} = \frac{1}{12} \times 200 \times 8.08^2 = 1.09$ 'k

$M^F_{BC} = \frac{1}{12} \times 200 \times 6.83^2 = .785$ 'k

fixed

	200 #/FT			
	A 1	.46 B	.54	0 C
	8'-1"		6'-10"	
	+1.09	−1.09	+.79	−.79
	0	+.14	+.16	+.79
	+.07	0	+.40	+.08
	0	−.18	−.22	−.08
	−.09	0	−.04	−.11
	0	+.01	+.03	+.11
−M	+1.07	−1.12	+1.12	0
V	800#	815#	820#	545#
X_o	→ 4.0'		2.72' ←	
+M	530'#		740'#	

$d_{req'd} = \sqrt{\frac{1120}{147}} = 2.78" < 6.7"$

$v = \frac{820}{12 \times .88 \times 6.7} = 11.6$ #/□"

$A_s = \frac{1120 \times 12}{18000 \times .88 \times 6.7} = .126$ □" use $\frac{5}{8}$"ϕ @ 1'-0"

$u = \frac{820}{2 \times .88 \times 6.7} = 70$ #/□"

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No 6

Computation HEATER ROOM FLOOR SLABS

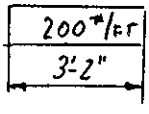
Computed by A.L.K. **Checked by** _____ **Date** 6 JULY 1945

SLAB S-3

Reinforcing steel $\frac{5}{8}$"ϕ @ 1'-0" top & bott.

Same as S-1

SLAB S-4



$$M = 200 \times \frac{3.16^2}{2} = 1000'\#$$

$$d \text{ req'd} = \sqrt{\frac{1000}{123}} = 2.86" < 5.56"$$

$$v = \frac{630}{12 \times .88 \times 5.56} = 10.8\#/\square"$$

$$A_s = \frac{1000 \times 12}{18000 \times .88 \times 5.56} = .136 \square" \quad \text{use } \frac{5}{8}"\phi @ 1'-0" \text{ top \& bott.}$$

$$u = \frac{630}{2 \times .88 \times 5.56} = 64\#/\square"$$

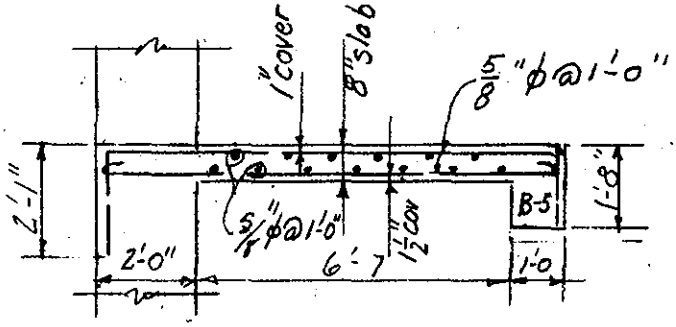
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

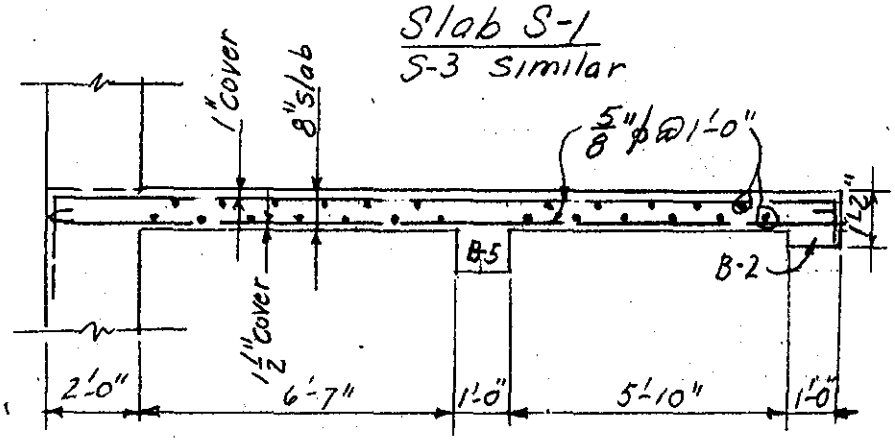
Subject HOLYOKE PUMPING STATION NO. 6

Computation HEATER ROOM FLOOR SLAB

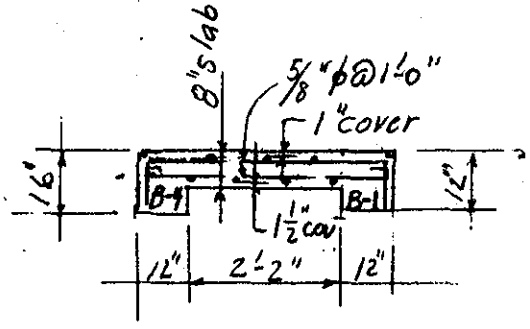
Computed by A.L.K. **Checked by** _____ **Date** 6 JULY 1945



Slab S-1
S-3 similar



Slab S-2



Slab S-4

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

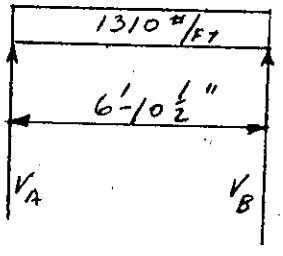
Subject HOLYOKE PUMPING STATION No. 6

Computation HEATER ROOM FLOOR BEAMS

Computed by A.L.K. **Checked by** _____ **Date** JULY 1945

BEAM B-1

Dead Load 8" slab = 2.08 X 100 = 210 #/FT
D.L. cover & frame = 15 X 2.25 = 35
L.L. = 4.33 X 100 = 435
D.L. 12" x 12" Bm = 1 X .33 X 150 = 50
730 #/FT.



$M = 730 \times \frac{6.87^2}{8} = 4300$ '#

$V_A = V_B = 730 \times 6.87 \times .5 = 2510$ #

$v = \frac{2510}{12 \times .88 \times 9.5} = 25.0$ #/□"

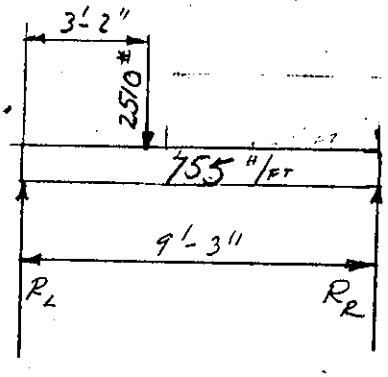
d req'd $= \sqrt{\frac{4300}{123}} = 5.92" < 9.5"$

$A_s = \frac{4300 \times 12}{18000 \times .88 \times 9.5} = .615$ □"

Use 2 - 3/4" ϕ top & bot.

$u = \frac{2510}{4.8 \times .88 \times 9.5} = 62.5$ #/□"

Beam B-2



D.L. 8" slab 3.42 X 100 = 370
L.L. 3.42 X 100 = 340
D.L. 12" X 14" = 1 X .5 X 150 = 75
755 #/FT

$R_L = 755 \times 9.25 \times .5 = 3500$ $R_R = 955 \times 9.25 \times .5 = 3500$

$x_0 = 3.5'$ from R_L $= 2510 \times .657 = 1650$ $= 2510 \times .343 = 860$
5150 # 4360 #

$M = 5150 \times 3.5 - 755 \times \frac{3.5^2}{2} = 2510 \times .34 = 12500$ '#

d req'd $= \sqrt{\frac{12500}{123}} = 10.1 < 11.5"$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 6

Computation Heater Room Floor Beams

Computed by A.L.K. **Checked by** **Date** 7 July 1945

Beam B-2 Cont'd.

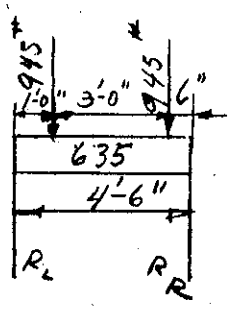
$$v = \frac{5150}{12 \times .88 \times 11.5} = 42.5\ \#/\square''$$

$$A_s = \frac{12500 \times 12}{18000 \times .88 \times 11.5} = .825\square''$$ Use 2-$\frac{3}{4}$"ϕ top & bott.

$$u = \frac{5150}{4.71 \times .88 \times 11.5} = 108\ \#/\square''$$

Beam B-3

D.L. 8" Slab 242×100 = 242
L.L. 242×100 = 242
D.L. 12"×12" Bm = 150
634 #/FT.



$R_L = 635 \times 4.5 \times .5 + 945 \times .11 + 945 \times .78 = 2280\ \#$

$R_R = 635 \times 4.5 \times .5 + 945 \times .89 + 945 \times .22 = 2478\ \#$

$X_0 = 1.96'$ from R_L

$M = 2270 \times 1.96 - 945 \times 1.96 - 635 \times \frac{1.96^2}{2} = 2320\ \#$

d req'd $\sqrt{\frac{2320}{123}} = 4.35'' < 9.5''$

$$v = \frac{2480}{12 \times .88 \times 9.5} = 29.8\ \#/\square''$$

$$A_s = \frac{2320 \times 12}{18000 \times .88 \times 9.5} = .184\square''$$ Use 2-$\frac{5}{8}$"ϕ top & bott.

$$u = \frac{2480}{3.92 \times .88 \times 9.5} = 76\ \#/\square''$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation HEATER ROOM FLOOR BEAMS

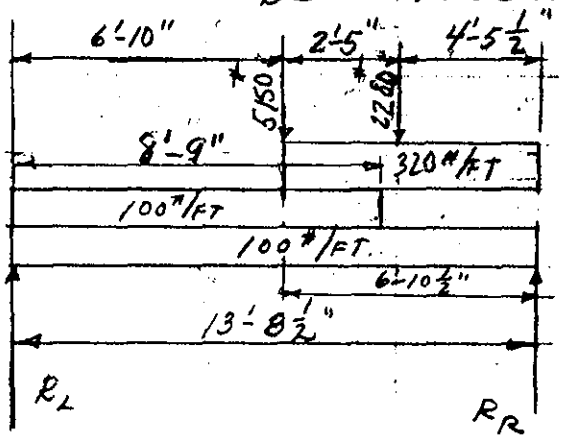
Computed by A.L.K. **Checked by** _____ **Date** JULY 1945

Beam B-4

D.L. 8" slab 1.58 X 100 = 160
L.L. 1.58 X 100 = 160
320 #/FT

D.L. 8" slab .5 X 100 = 50
L.L. .5 X 100 = 50
100 #/FT.

D.L. 12"X16" Bm. 1X.67X150 = 100 #/FT



R_L = 100 X 13.71 X .5 = 686
= 100 X 8.75 X .68 = 595
= 320 X 6.87 X .25 = 550
= 2280 X .325 = 740
= 5150 X .502 = 2580
5150 #

R_R = 100 X 13.71 X .5 = 686
= 100 X 8.75 X .32 = 280
= 320 X 6.87 X .75 = 1650
= 2280 X .675 = 1540
= 5150 X .498 = 2570
6720 #

X_0 = 6.83' from R_L

$M = 5150 \times 6.83 - 200 \times \frac{6.83^2}{2} = 30550$ '#

$d_{req'd} = \sqrt{\frac{30550}{123}} = 15.75" > 13.5"$ there will be Tee beam action.

$v = \frac{6720}{12 \times .88 \times 13.5} = 47.0$ #/□"

$A_s = \frac{30550 \times 12}{18000 \times .88 \times 13.5} = 1.72$ □" use 3 - 7/8"φ both
3 = 7/8"φ top

$u = \frac{6720}{8.25 \times .88 \times 13.5} = 70.0$ #/□"

$b = 25"$ $\frac{t}{d} = \frac{8}{13.5} = .592$

$K = \frac{800}{2} \times .592 \left(2 - .592 - \frac{.592}{.348} + \frac{2}{3} \times \frac{1}{.348} \times .592^2\right) = 91.0$

F193

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation HEATER ROOM FLOOR BEAMS

Computed by A.L.K. **Checked by** _____ **Date** 7 JULY 1945

Beam B-4 cont'd.

$$d\ req'd = \sqrt{\frac{30550 \times 12}{25 \times 91}} = 12.7'' < 13.5''$$

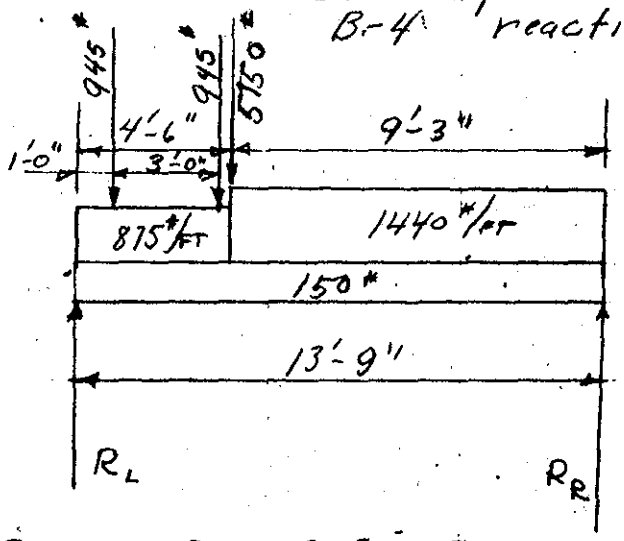
Beam B-5

D.L. 8" slab $7.20 \times 100 = 720$
LL $7.20 \times 100 = 720$
1440 #/FT

D.L. 8" slab $4.37 \times 100 = 437$
LL $4.37 \times 100 = 437$
875 #/FT

D.L. 12 X 20" Bm. $1 \times 1 \times 150 = 150$ #/FT.

Stairway reactions 945# (approx.)
B-4 reaction 5150#



$R_R = 1025 \times 13.75 \times .5 = 7050$
$= 565 \times 9.25 \times .665 = 3490$
$= 5150 \times .328 = 1690$
$= 945 \times .29 = 274$
$= 945 \times .072 = 70$
12574 #

$R_L = 1025 \times 13.75 \times .5 = 7050$
$= 565 \times 9.25 \times .335 = 1750$
$= 5150 \times .672 = 3470$
$= 945 \times .71 = 670$
$= 945 \times .928 = 875$
13815 #

$X_0 = 7.90'$ from R_R.

$$M = 12690 \times 7.90 - 1590 \times \frac{7.90^2}{2} = 50{,}500'\#$$

$$d\ req'd\ \sqrt{\frac{50500}{123}} = 20.3'' > 17.5''$$ There will be Tee beam action.

F19.4

Subject HOLYOKE PUMPING STATION No. 6

Computation HEATER ROOM FLOOR BEAMS

Computed by A.L.K **Checked by** **Date** 7 JULY 1945

$$v = \frac{13820}{12 \times .88 \times 17.5} = 74.6 \ \#/\square''$$ Use stirrups

Tee Beam action

$$b = 25.5'' \qquad \frac{t}{d} = \frac{8}{17.5} = .458$$

$$K = \frac{800}{2} \times .458 \left(2 - .458 - \frac{.458}{.348} + \frac{2}{3} \times \frac{1}{.348} \times .458^2\right) = 97$$

$$d \text{ req'd } \sqrt{\frac{50500 \times 12}{25.5 \times 97}} = 15.7'' < 17.5''$$

Use 4-3/8" ϕ Stirr. @ 4", 8", 10", 10" @ both ends

$$A_s = \frac{50500 \times 12}{18000 \times .88 \times 17.5} = 2.20 \square''$$ Use 3-1" ϕ bott.
3-7/8" ϕ top

$$u = \frac{13820}{8.25 \times .88 \times 17.5} = 109 \ \#/\square''$$

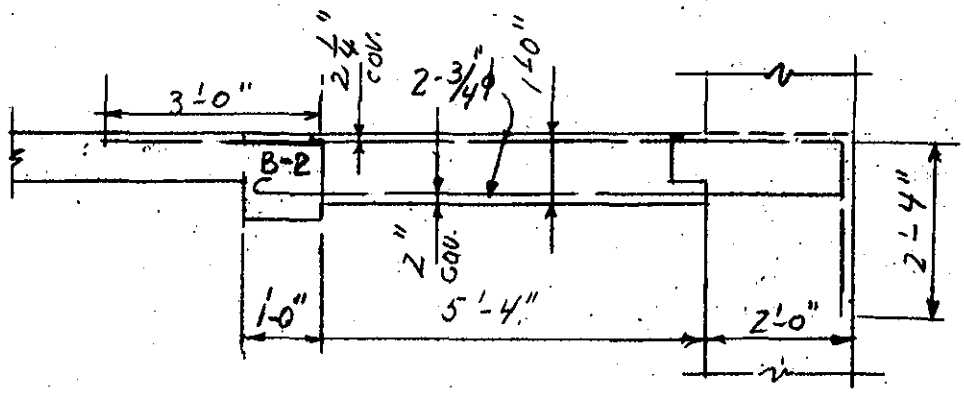
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

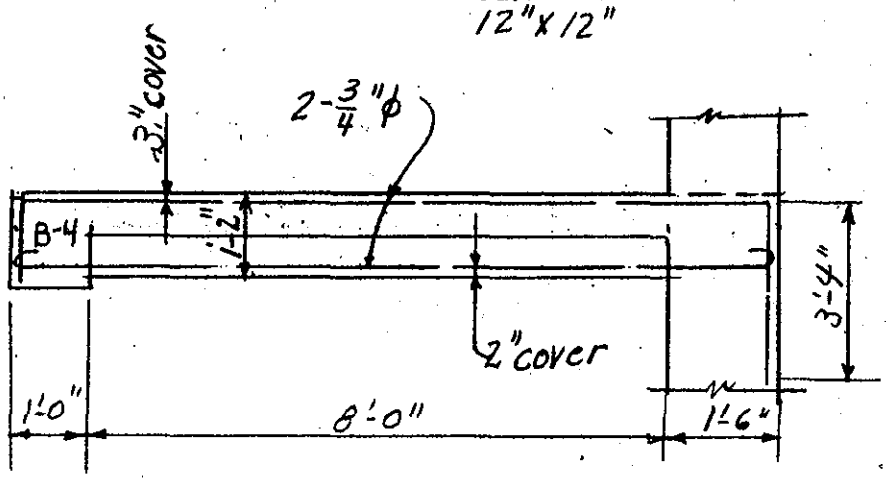
Subject HOLYOKE PUMPING STATION No. 6

Computation HEATER ROOM FLOOR BEAMS.

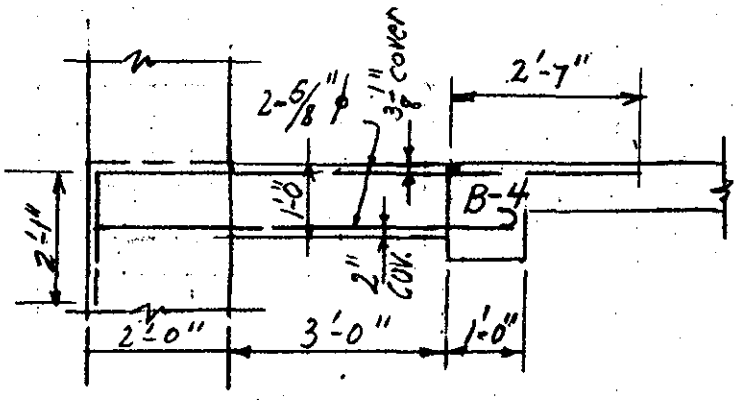
Computed by A.L.K. **Checked by** **Date** 7 JULY 1945



Beam B-1
12" x 12"



Beam B-2
12" x 14"



Beam B-3
12" x 12"

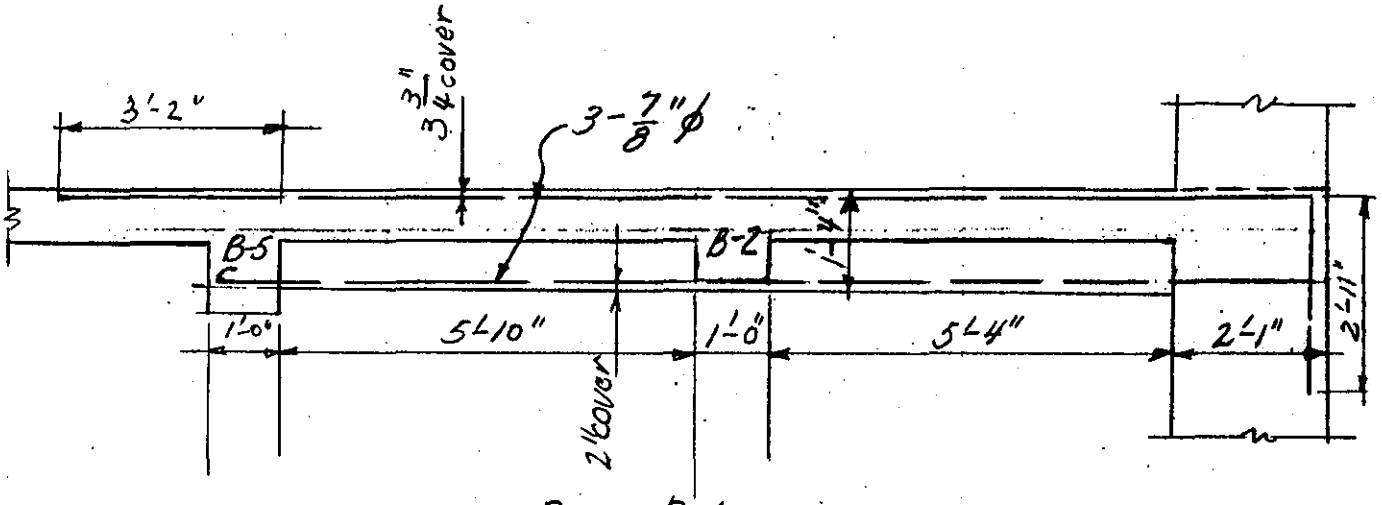
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION NO. 6

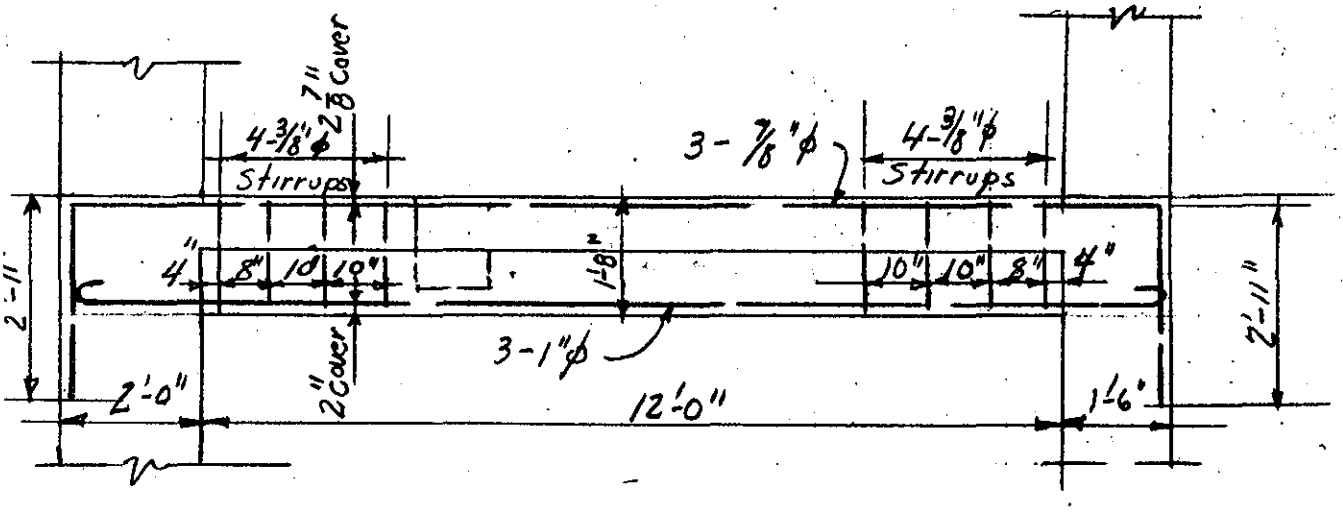
Computation HEATER ROOM FLOOR BEAMS

Computed by A.L.K. **Checked by** **Date** 2 Aug 1945



Beam B-4

12"x16"



Beam B-5

12"x20"

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION NO. 6

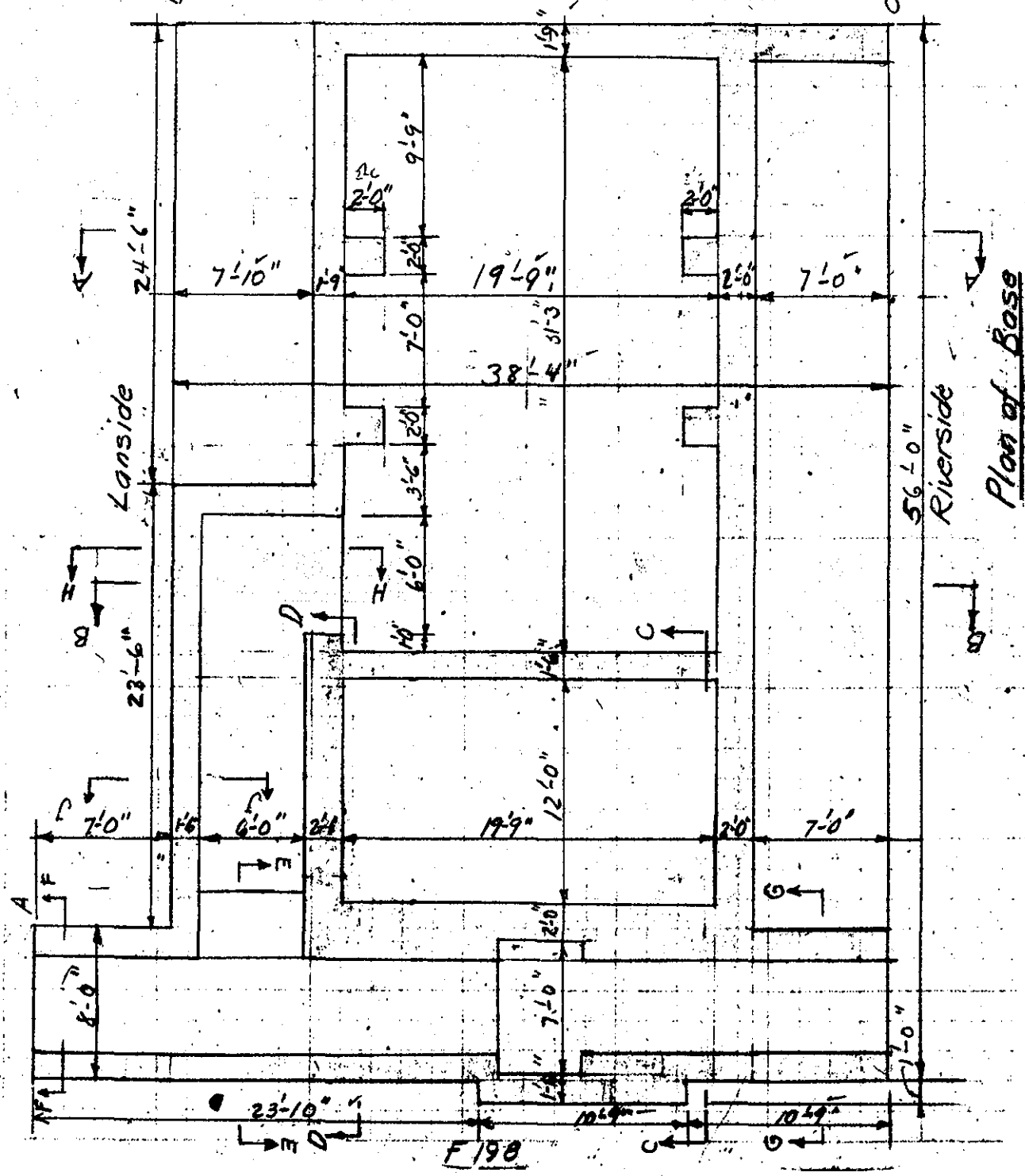
Computation STABILITY

Computed by A.L.K. **Checked by** _____ **Date** 18 JULY 1945

AREA = 56 × 38.33 + 10.75 × 1 + 7 × 8 = 2206.8 □'

C. of G = 18.6' FT from Landside edge of base

$$I_{cg} = 48 \times \frac{18.6^3}{3} + 56 \times \frac{19.73^3}{3} + 8 \times \frac{25.6^3}{3} + 1 \times \frac{1.77^3}{3} + 1 \times \frac{8.98^3}{3} = \cancel{290,740}\ 291,300$$



WAR DEPARTMENT

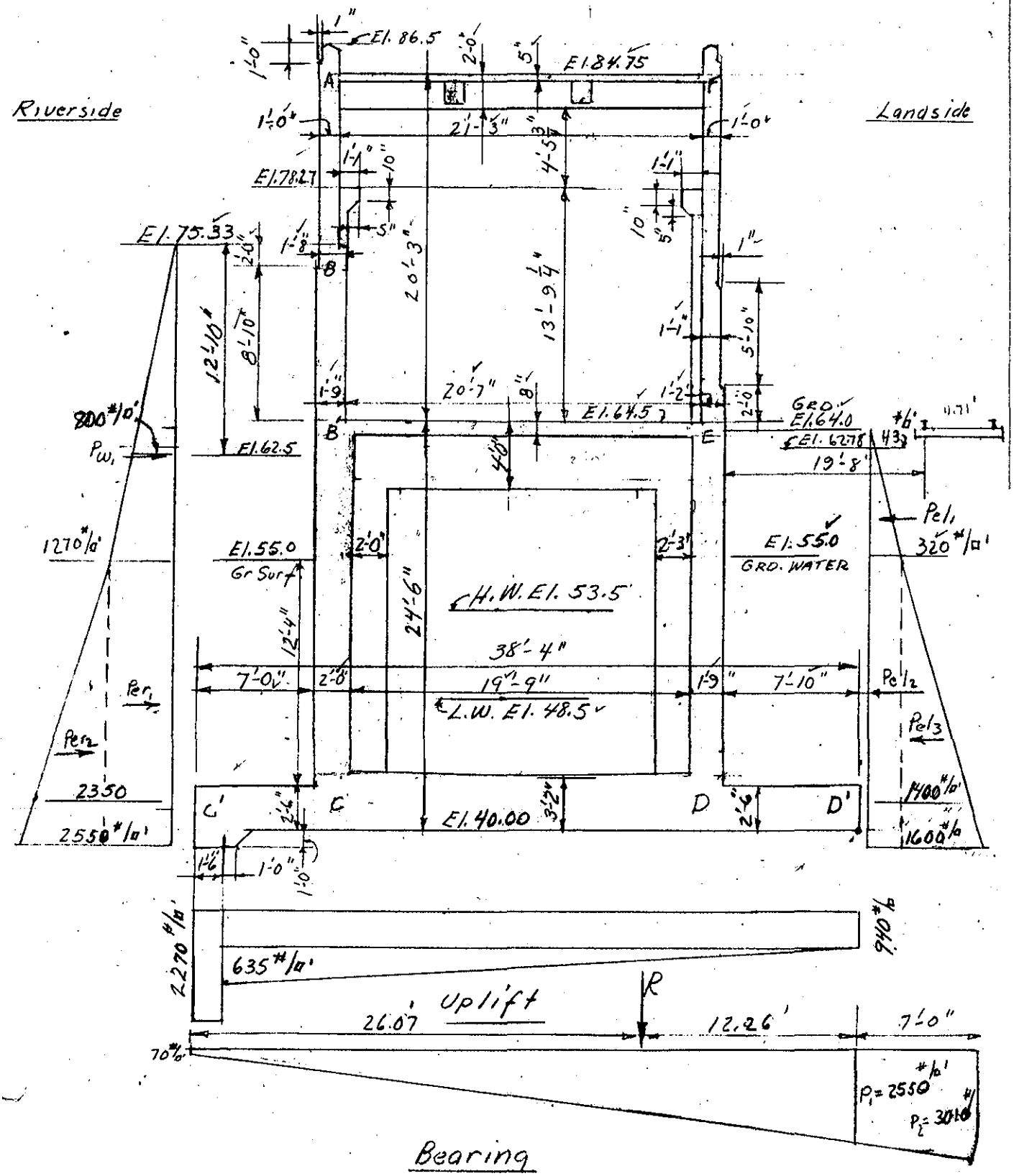
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation STABILITY

Computed by A.L.K. **Checked by** [illegible] **Date** 10 JULY 1945

Section A-A - CASE I River up



Bearing

F199

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation Stability

Computed by A.L.K. **Checked by** KEM **Date** 10 JULY 1945

Horizontal loading values

Riverside

El. 62.5 = (75.33 − 62.5) 62.5 = 800 #/□'

El. 55.0 = (75.33 − 55.0) 62.5 = 1270 #/□'

El 41.50 = 1270 + (55.0 − 41.50) 80 = 2350 #/□'

El. 39.0 = 1270 + (55.0 − 39.0) 80 = 2550 #/□'

Landside

El. 55.0 = (64 − 55) 35 = 320 #/□'

El. 41.50 = 320 + (55 − 41.50) 80 = 1410 #/□'

El. 39.0 = 320 + (55 − 39.0) 80 = 1600 #/□'

Uplift loading Values

Riverside steel sheet piling

(75.33 − 39.00) 62.5 = 2270 #/□'

Landside due to tailwater

(55 − 40.00) 62.5 = 940 #/□'

Landside steel sheet piling

(75.33 − 55.0) × .5 × 62.5 = 635 #/□'

Assumptions for stability analysis

Axis of moments will be taken at the landside edge of the base slab. The eccentricity of loading will be determined transversely only as it is considered that eccentricity longitudinally will be small enough to be neglected.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION NO. 6

Computation STABILITY

Computed by A.L.K. **Checked by** NSN **Date** 10 JULY 1945

Case I

Forces Acting		↓	↑	→	←	Arm	Moments ↷	Moments ↶
Roof slab	21.25'x46.16'x95	93.2				19.62		1828.3
curb	250x 21.25'x2'	10.6				19.62		208.5
"	250x48.16'x 2'	24.1				19.62		472.4
Rf bms	1'x1.25'x 46.16'x2'x150	17.3				19.62		339.6
"	1.33'x1.58'x19.25x2'x150	12.2				19.62		238.7
(Walls	10.83'x1.75'x48.33'x150	137.4				30.46		4185.1
above	9.42'x1.0'x48.16'x 150	68.1				30.75		2092.5
Motor	10.83'x1.75'x7.25'x150	20.6				25.96		535.0
Room	1.0'x 8'x9.42'x150	11.3				26.33		297.6
floor)	1.08'x 20.25'x13.25'x150	43.5				15.75		684.6
	3.08'x.67'x11.42x150	3.5				28.79		101.3
	2.54'x.67'x11.42x150	2.9				29.83		86.5
Landside wall	1.08'x.20.25x48.17'x150	158.0				8.46		1336.9
end wall	1.08'x20.25'x21.00x150	68.9				19.00		1308.9
CHIMNEY	4.39'x22.5'x150	14.8				28.37		420.3
Pilasters	3.0x.5'x13.77x150	3.1				9.25		28.6
Less Door Op	6.73'x12.67'x1.08'x150	-13.8				8.46		-116.9
Door + Gl. Blks	850	.9				8.46		7.2
Pilasters	2.94'x3.0x.67'x150	.9				29.92		26.4
Brackets	3'x 1'x.42 x 150	.2				29.38		5.5
"	.75'x 2.94'x1.08'x150x2	.7				29.92		21.4
Crane Bms	42'x50	2.1				29.77		62.4
" "	46'x50	2.3				9.54		21.9
Crane rails	42'x 10	0.4				29.71		12.5
" "	46'x 1.0	0.5				9.54		4.7
Floor Slab	19.75'x 44.75'x100	88.4				19.46		1719.9
Less openg	9'x3'x100	-2.7				17.25		-46.6
" "	4.5'x5'x100	-2.2				12.08		-27.2
" "	7.5'x3.67'x100	-2.8				14.92		-41.1
" "	3.58x4.67'x100x3	-5.0				23.08		-115.8
" "	3'x3'x 100	-.9				27.92		-25.1
Swbd slab	2.5'x 9.75'x9.58	2.3				14.37		33.6
Bm B-1	1'x1.0 x 18.58'x150	2.8				25.97		72.2
Bm B-2	1'x.33 x 3 x 150	0.2				25.87		3.9
Bm B-3	1.17'x1.33'x8.58'x150	2.0				25.03		50.3
Bm B-4	1.58'x1'x 23.04'x 150	5.5				19.95		108.9
Bm B-5	1.17'x1.33'x 11.25'x150	2.6				24.70		65.0
Bm B-6	1'x.33'x3.67 x150	0.2				14.91		2.7
Bm B-7	1.33'x1.58'x10.5'x150	3.3				17.42		57.8
Bm B-8	1.5'x .83'x 2.5'x 150	0.5				10.83		5.1
Bm B-9	1'x 1.33'x 10.5'x 150	2.1				12.58		26.4
		780.0						16099.0

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WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation STABILITY

Computed by A.L.K. **Checked by** H.E.W. **Date** 11 JULY 1945

CASE I

Forces Acting		↓ Kips	↑ Kips	→ Kips	← Kips	Arm	Moments ↻	Moments ↺
B-10, B-11, B-12, B-13	19.75'x2x3.33'x2x150	39.5				19.46'		767.9
	1.71'x3.58'x1x150x4	3.7				23.08		84.8
	2x6.75'x75'	1.0				18.96'		19.2
B-14	5'x50'	.3				12.08'		3.0
B-15	7.83'x100'	.8				15.08'		11.8'
B-16	12.17'x145'	1.8				15.66'		27.6
B-17	12'x 200'	2.4				19.45'		46.7
(BASEMENT	2x 24.5' x33'x150'	242.6				30.33'		7356.5
WALLS)	2'x24.5'x15.5'x150'	113.9				30.33'		3455.3
"	2'x19.75'x 24.5'x150'	145.2				19.46'		2824.9
"	1.75'x24.50'x19.75'x150	127.0				19.46'		2471.8
"	1.5'x19.75'x24.50'x150	108.9				19.46'		2118.6
"	1.75'x24.50'x26'x150'	167.2				8.71'		1456.4
"	1.75'x24.50'x22.5'x150'	144.7				8.71'		1260.4
Less open'g	6'x6'x1.75'x150'	-9.4				8.71'		-82.3
add. wall cond	2.50'x7.5'x.33'x150'	.9				7.67'		7.2
" " cond	14.0'x19.75'x.33'x150'	13.8				7.67'		106.0
" " gr. cond	1'x11.5'x108.3'x150'	18.7				12.91'		241.2
" " "	1'x7.75'x14.5'x150	16.9				31.08'		523.9
" " "	.5'x7'x11.35'x150'	6.0				34.83'		207.5
Grav. Con. rf	6.5'x14.5'x1.5'x150	21.2				31.08'		659.1
" " wall	6.25'x14.5'x1.5'x150	20.4				31.08'		633.7
" " rf.	6.5'x23.83'x1.5'x150	34.8				4.91'		171.1
" " wall	10.0'x23.83'x1.5'x150	53.6				4.91'		263.3
Gate tower	29.03'x1.5'x7.5'x150	49.0				17.58'		861.2
walls	4'x1.5'x29.73'x150	26.8				20.33'		544.0
"	29.73'x8.5'x1.5'x150	56.9				23.08'		1312.3
Less open'gs	5'x5'x1.5'x150	-5.6				17.58'		-98.9
" "	6'x5'x1.5'x150	-6.8				23.08'		-155.8
(trash rack	6'x15'x7.83'x150'	10.6				3.91		41.3
chamber	8.5'x6'x1.5'x150	11.5				.75'		8.6'
walls	19.08'x13.5'x1.5'x150	53.7				.75'		40.2
"	1.5'x13.08'x6.0'x150	15.7				4.50'		70.6
" SILL	3.5'x2'x6'x150	6.3				4.50'		28.8
"	1.5'x9.75'x6.0'x150	13.2				4.50'		59.2
"	11.5'x1.5'x7'x150'	18.1				-3.50'		-63.4'
" rf. slab	10.0'x1.5'x7.83'x150'	17.6				3.91'		68.9
" " "	14'x7.5'x100'	10.5				3.75'		39.4
less open'gs	3.0'x6'x100'	-1.8				4.5'		-8.1'
" "	1'x6'x100'	-.6				4.5'		-2.7'
Plat.	5.75'x6'x100	3.4				4.5'		15.5'
		1554.4						27396.4

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WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation STABILITY

Computed by A.L.K. **Checked by** K.E.H. **Date** 12 JULY 1945

CASE I

FORCES ACTING		↓	↑	→	←	Arm	Moments ↻	Moments ↺
Base slab	31.25 X 19.75 X 3.75 X 150	300.0				19.46		5838.0
" "	19.75 X 12.00 X 4.25 X 150	151.9				19.46		2940.2
" "	7.83 X 24.0 X 4.25 X 150	119.8				8.92		469.6
" "	7 X 8 X 4.5 X 150	37.8				-3.50		-132.3
" "	18.33 X 7.5 X 4.5 X 150	92.8				9.17		850.9
" "	7.5 X 20 X 3.6 X 150	81.0				29.33		2375.7
	1 X 3.6 X 7 X 150	3.8				20.33		76.8
gate haunch	2 X 7 X 150 X 1.5	3.2				19.33		60.9
Foot'g proj. R.	2.5 X 7 X 48.0 X 150	126.0				34.83		4388.6
Foot'g " Land	7.83 X 2.5 X 24.5 X 150	71.9				3.92		282.0
Sheet piling	1.5 X 1 X 56 X 150	21.0				37.08		778.7
key	1 X 1 X 5 X 53.5 X 150	4.0				35.50		142.4
"	2.5 X 1 X 8.75 X 150	3.3				31.56		103.6
"	1 X 1 X 8.75 X 150	1.3				31.56		41.4
Sheet pl'g wall	2 X 3.75 X 9.58 X 25	1.8				25.70		46.2
	1 X 3.75 X 11.75 X 150	6.6				25.70		169.9
Crane		3.0				19.46		58.4
(Heater Rm	12 X 19.75 X 100	23.7				19.46		461.2
Floor slab)	5 X 4.5 X 100	-2.3				12.42		-28.0
Beams B-1	50 X 5.33	.3				12.25		3.3
" B-2	75 X 8	.6				15.42		9.3
" B-3	50 X 3	.2				12.00		1.7
" B-4	100 X 12.16	1.2				15.66		19.0
" B-5	150 X 12	1.8				22.25		40.2
less open'g	8.25 X 3 X 100	-2.5				17.55		-43.5
Conc. Stwy	200 X 3 X 11	6.6				23.83		157.3
" "	200 X 3 X 5	3.0				27.83		83.5
Metal Stwy	8.25 X 3 X 30 X 2	1.5				17.57		26.1
Butt. conc.	2 X 2 X 17.17 X 150 X 4	41.2				19.46		801.9
CHIM. Basement	4.39 X 8.33 X 150	5.5				28.37		155.6
30" Prop Pumps	11500 X 3	34.5				22.58		778.0
Disc Pipes	8500 X 3	25.5				29.31		747.2
16" Pump	6000	6.0				19.58		117.5
base (conc)	1200	1.2				19.58		23.5
16" suc. pipe	3500	3.5				13.00		45.5
Motor	1800	1.8				19.58		35.2
Disc pipe	3600	3.6				21.00		75.6
Sw'bd	4000	4.0				13.33		53.3
Heater	1000	1.0				26.33		26.3
Toilet eq'p	300	.3				10.0		3.0
Sump Pump	1000	1.0				27.75		27.8
		1191.6						22112.4

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 6

Computation Stability

Computed by A.L.K. **Checked by** X.E.H. **Date** 13 July 1945

Case I

Forces Acting		↓	↑	→	←	Arm	Moments ↻	Moments ↙
Ld. on R.S.	7×32.83×48.0×62.5	689.4				34.83		24012.8
Ext.)	7×12.50×48.0×62.5	262.5				34.83		9142.9
Ld on R.S.	8.0×7×24.08×62.5	84.3				34.83		2935.5
(cond.)	8.0×7×12×62.5	42.0				34.83		1462.9
"	8.5×7.5×12.5×62.5	50.7				27.58		1382.4
"	8.5×7.5×24.08×62.5	96.9				27.58		2646.1
6"×6' Sl. Gate		7.0				10.51		73.6
4"×5" Sl. Gate		4.4				26.25		115.5
Conc. End Wall	7×2×11.83×25	4.1				34.83		144.2
Ld on L.S.	24.5×7.83×21.5×100	412.4				3.92		1616.8
Ext.)	24.5×7.83×12.50×25	59.9				3.92		235.0
Ld on L.S. cond	10×7.83×12.25×100	95.9				3.92		376.0
" " " "	10×7.83×3.25×25	6.4				3.92		24.9
" " " "	8×7×8.21×100	46.0				3.50		−161.0
" " " "	16.83×7.5×8.21×100	103.6				8.42		872.6
Uplift.	7×8×940		52.6			−3.5	−184.2	
	2270×1.5×56		190.7			37.58	7165.8	
	2270×10.75×1.5		36.6			31.46	1151.6	
	940×36.83×54.5		1886.8			18.42	34754.9	
	635×36.83×.5×54.5		637.3			24.54	15639.3	
	600×9.25×1		5.6			21.45	119.0	
	940×9.25×1		8.7			21.45	186.5	
	635×26.08×.5×1.5		12.4			17.39	216.0	
Wat. in R.S. Con.	6.25×5×16×62.5	31.2				30.33		947.8
Water gate Ch.	4×7×31.73×62.5	55.5				20.33		1128.9
Water Gr. Cond	25.33×5×4×62.5	31.7				5.67		179.5
Water trk. ch.	3.5×6×2.25×62.5	3.0				4.5		13.3
" " " "	20.0×6×4.25×62.5	31.9				4.5		143.4
Water in sta.	19.75×31.25×5×62.5	199.4				19.46		3880.9
Uplift	940×1.5×26.08		36.8			13.04	479.5	
Pe1	320×9×.5×57				82.1	18.00		1477.4
Pe2	320×16.0×57				291.8	7.00		2042.9
Pe3	1280×16.0×.5×57				583.7	4.33		2527.3
less Open'g	960×3²×π (arc)				−27.2	7.00		−190.0
Pw1	1270×20.33×.5×48.5			626.1		21.78	13636.7	
Per1	1270×16.00×48.5			985.5		7.00	6898.6	
Per2	1280×16.00×.5×48.5			496.6		4.33	2150.5	
Pw2	720×.5×11.5×8.5			35.2		27.66	973.4	
Per3	720×24.83×8.5			152.0		11.41	1733.9	
Per4	1830×24.83×.5×8.5			193.1		7.28	1405.9	
Less open'g	300 ×8.0×9.25			−22.2		6.72	−149.2	
		2316.6	2867.5	2466.3	930.4		86178.2	57031.2

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WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation Stability

Computed by A.L.K. **Checked by** H.E.W. **Date** 14 July 1945

CASE I

Forces Acting		↓	↑	→	←	Arm	Moments ↻	↺
fr	.45 X 2975.1				1338.8			
passive	resist req'd				197.1			
Total	this page				1400.9			
"	first page	780.0						16099.6
"	second page	1554.4						27396.7
"	third page	1191.6						22112.4
"	fourth page	2316.6	2867.5	2466.3	930.9		86178.2	37031.6
		5842.6	2867.5	2466.3	2318.7		86178.2	122640.3
Grand Total		2975.1						36462.1

Pos. of result. = $\frac{36462.1}{2975.1}$ = 12.26' middle 3d = 12.77'

Max allow pass. resist. = $\frac{1}{2} \times 100 \times 2\ 5.0^2 \tan^2(45° + \frac{\phi}{2}) \times 57$ = 4388# (1.5697)

Factor of safety against sliding = $\frac{4388 + 1338.8}{2466.3}$ = 2.32

For C.G. area & Mom. Inertia of base see base plan.

Bear. P at Lanside Base = $\frac{2975100}{2200} + \frac{2975100 \times 6.34 \times 18.6}{291,300}$ = 2550 #/□'

Bear. P at Riverside of Base = $1350 - \frac{2975100 \times 6.34 \times 19.74}{291,300}$ = 70 #/□'

Bear P at End of Cond. Ext = $1350 + \frac{2975100 \times 6.34 \times 25.6}{291,300}$ = 3010 #/□'

WAR DEPARTMENT

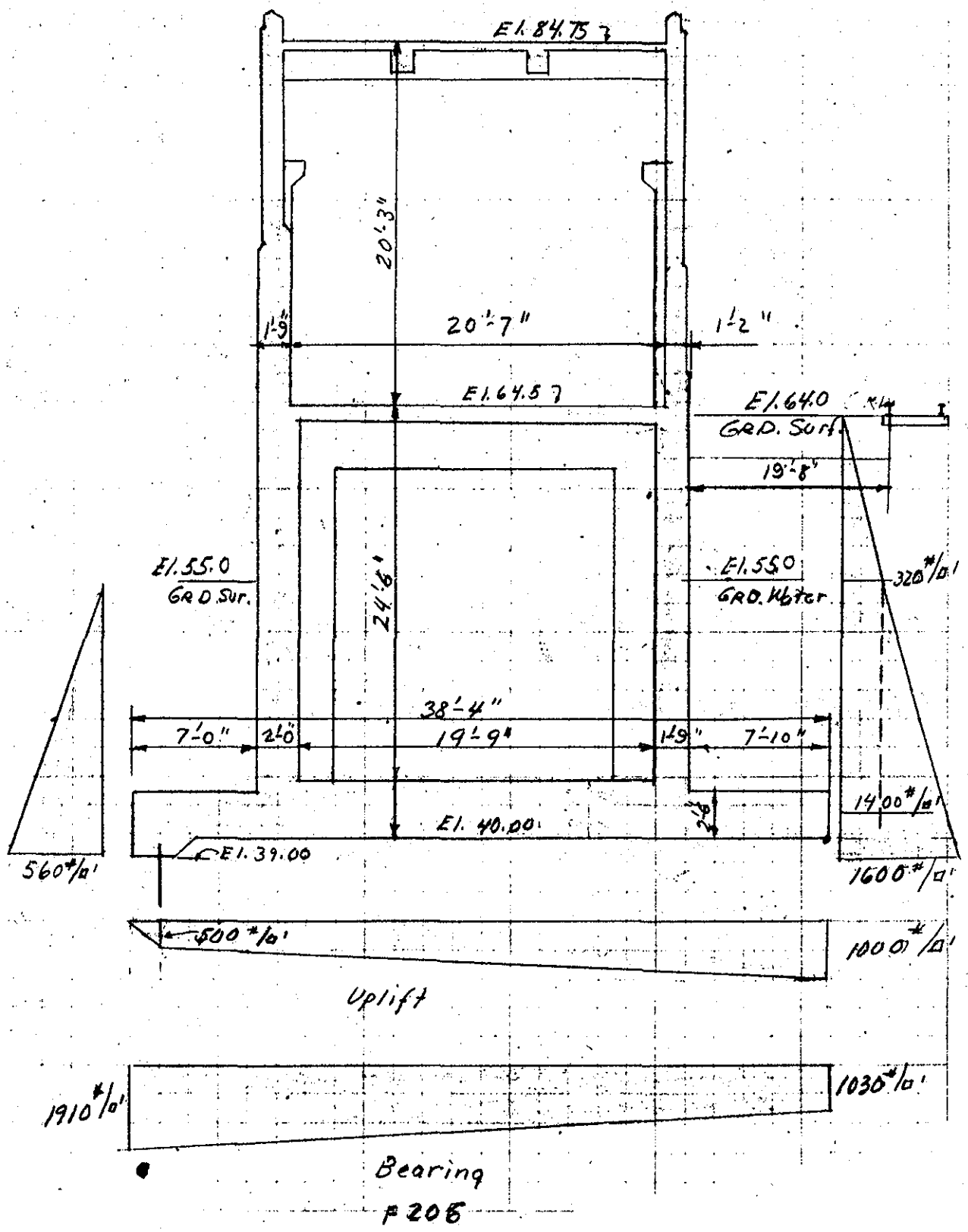
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation STABILITY

Computed by A.L.K. **Checked by** J.E.M. **Date** 18 JULY 1945

Section A-A CASE II River down and Ground water at El. 55.0



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation STABILITY

Computed by A.L.K. **Checked by** Y.C.H. **Date** 18 JULY 1945

CASE II HORIZ. LOADING VALUES.

RIVERSIDE

El. 39.00 = 16.00 x 35 = 560 #/□'

LANDSIDE

El. 55.0 = 9 X 3.5 = 320 #/□'

El. 41.50 = 320 + 13.50 x 80 = 1400 #/□'

El. 39.16 = 320 16.00 x 80 = 1600 #/□'

UPLIFT LOADING VALUES

Landside due to tailwater = 16.00 x 62.5 = 1000 #/□'

Landside of sht piling = 500 #/□'

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ↻	MOMENTS ↺
Total	First Page	780.0						16,099.6
"	Second Page	1554.4						27396.7
"	Third Page	1191.6						22112.4
Ld. on R. Stx.	7 x 12.50 x 48.0 x 100	420.0				34.83		14628.6
Ld on R.S. Con.	8 x 7 x x 12 x 100	67.2				34.83		2340.6
" " " "	8.5 x 7.5 x 12.58 x 100	80.2				27.58		2211.8
Conc. End W.	2 x 7.0 x 1 x 50	0.7				34.83		24.4
Ld on L.S. Stx	+ Conduits	724.2	(See Case I)					2964.3
Sl. Gates		11.4	(see Case I)					189.1
Uplift	500 x 1.5 x 5 x 56		21.0			37.33	783.9	
"	500 x 1.5 x 5 x 10.75		4.0			31.46	126.8	
"	500 x 36.83 x 54.5		1003.6			18.41	18476.6	
"	500 x 36.83 x 54.5 x 5		501.8			12.27	6157.1	
"	600 x 9.25 x 1		5.6			21.45	119.0	
"	1000 x 7 x 8		56.0			-3.5	-196.0	
"	500 x 26.08 x 1.5		19.6			13.04	256.1	
"	500 x 26.08 x .5 x 1.5		9.8			8.69	85.2	
Pe_1 to Pe_3	less opening				930.4			5857.8
Per_1	560 x 16.0 x .5 x 48.5			217.3		5.33	1158.1	
Per_2	35 x 24.83 x .5 x 8.5			91.7		8.28	759.3	
Per_3 deduct	18.16 x 35 x 8.0 x 9.25			-47.0		5.67	-266.7	
friction	3208.3 x .45			668.4				
		4829.7	1621.4	930.9	930.4		27459.4	93825.1
	Total	3208.3		0	0			66365.7

Pos. of Result. = $\frac{66365.7}{3208.3}$ = 20.69 e = 2.09'

CASE II

Soil Pressures

$$Pt\ A = \frac{3208.300}{2200} - \frac{3208300 \times 2.09 \times 25.6}{291,300} = 870\ \#/\square'$$

$$Pt\ B = 1460 - \frac{3208300 \times 2.09 \times 18.6}{291,300} = 1030\ \#/\square'$$

$$Pt\ C = 1460 + \frac{3208300 \times 2.09 \times 19.74}{291,300} = 1910\ \#/\square'$$

Design of Transverse Sections in Pump Room

Two transverse bents will be used to stiffen the wet sump walls. The base slab will be designed transversely, spaning between the pump room walls The wet sump walls will be considered as spaning between the bents and end walls of the wet sump. The portion of the wall above the motor room floor to surcharge elevation will be considered as cantilevered from the motor room floor

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Transverse Bent A-A

Computed by H.E.W **Checked by** _____ **Date** 1-Aug-45

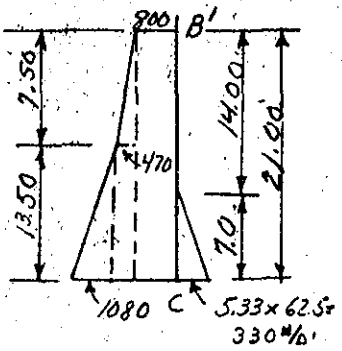
Fixed End Moments

Cantilever Wall BB' (Moments about center of bent)

$$M = 12.83 \times 800 \times .5 \times 2 \times \frac{12.83}{3} = 43{,}900^{'\#}$$

$$\text{React} = 12.83 \times 800 \times .5 \times 2 = 10260^{\#}$$

Wall B'C



Loading per ft.

Bent will be loaded with 10'-4½" of wall

For 1' strip

$$M^F_{B'C} = \frac{1}{12} \times 800 \times 21^2 + .357\frac{(10 - 15 \times .357 + 6 \times .357^2)}{15} \times 470 \times \frac{7.5}{2} \times 21$$

$$+ \frac{.643^2(4 - 3 \times .643)}{12} \times 470 \times 13.5 \times 21 + \frac{.643^2(5 - 3 \times .643)}{30} \times 1080 \times \frac{13.5}{2} \times 21$$

$$- \frac{.333^2(5 - 3 \times .333)}{30} \times 330 \times \frac{7}{2} \times 21 = 49.78^{'k}$$

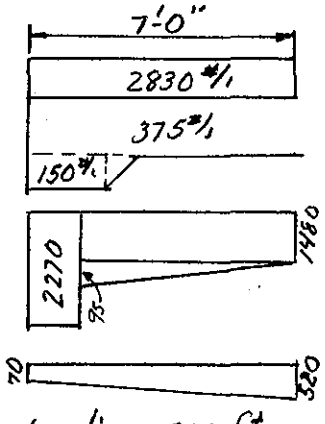
$$M^F_{CB} = \frac{1}{12} \times 800 \times 21^2 + .357^2\frac{(5 - 4 \times .357)}{10} \times 470 \times \frac{7.5}{2} \times 21$$

$$+ .643\frac{(6 - 8 \times .643 + 3 \times .643^2)}{12} \times 470 \times 13.5 \times 21 + .643\frac{(10 - 10 \times .643 + 3 \times .643^2)}{30} \times 1080 \times \frac{13.5}{2} \times 21$$

$$- .333\frac{(10 - 10 \times .333 + 3 \times .333^2)}{30} \times 330 \times \frac{7}{2} \times 21 = 59.99^{'k}$$

Tot. F.E.M @ B' = $49.78 \times 10.37 = 516.22^{'k}$ @ C = $59.94 \times 10.37 = 621.58^{'k}$

Cantilever C'C



Loading per ft.

Shear at face of wall (2'-0" width)

$$2830 \times 7 \times 2 + 375 \times 7 \times 2 + 150 \times 2 \times 2.5 + 1 \times 1 \times 150 \times .5 \times 2$$
$$- 2270 \times 1.5 \times 2 - 1480 \times 5.5 \times 2 - 95 \times 5.5 \times .5 \times 2$$
$$- 70 \times 7 \times 2 - 450 \times 7 \times .5 \times 2 = 18030^{\#}$$

Mom. at face of wall (2'-0" width)

$$2830 \times 7 \times 2 \times 3.5 + 375 \times 7 \times 2 \times 3.5 + 150 \times 2.5 \times 2 \times 5.75 + 1 \times 1 \times 150 \times 1 \times 4.17$$
$$- 2270 \times 1.5 \times 2 \times 6.25 - 1480 \times 5.5 \times 2 \times 2.75 - 95 \times 5.5 \times .5 \times 2 \times 3.67$$
$$- 70 \times 7 \times 2 \times 3.5 - 450 \times 7 \times .5 \times 2 \times 2.33 = 61{,}960^{'\#}$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

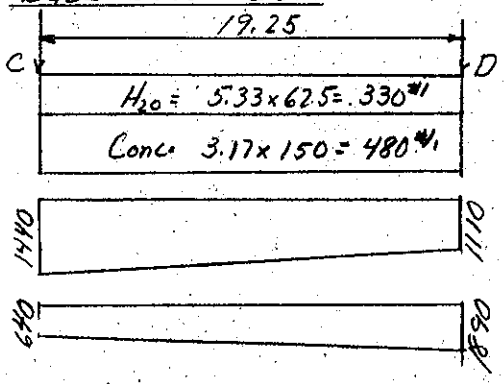
Subject Holyoke Pumping Station No 6

Computation Transverse Bent A-A

Computed by H.E.W **Checked by** **Date** 2-Aug-45

Case I F.E.M. (cont.)

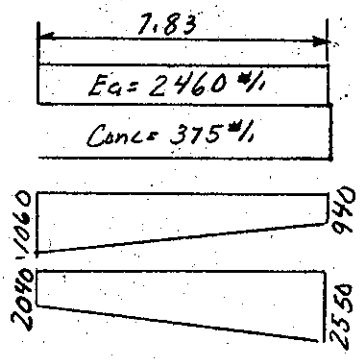
Base Slab CD



$$M^F_{CD} = 2\times\frac{1}{12}\times 1270\times 19.25^2 + \frac{1}{15}\times 920\times\frac{19.25^2}{2}\times 2 = 101.17^{'k}$$

$$M^F_{DC} = 2\times\frac{1}{12}\times 1270\times 19.25^2 + \frac{1}{10}\times 920\times\frac{19.25^2}{2}\times 2 = 112.53^{'k}$$

Cantilever D'D



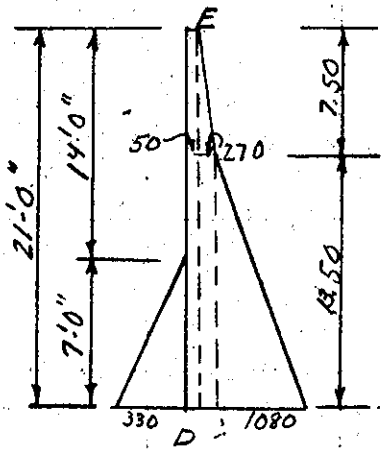
Shear at face of wall

$$2835\times 7.83\times 2 - 2\times 940\times 7.83 - 120\times 7.83\times .5\times 2 - 2040\times 7.83\times 2 - 510\times 7.83\times .5\times 2 = -7200^{\#}$$

Mom at face of wall

$$2835\times 7.83\times 2\times 3.91 - 2\times 940\times 7.83\times 3.91 - 120\times 7.83\times 2.61 - 2040\times 7.83\times 2\times 3.91 - 510\times 7.83\times 5.22 = 32,170^{'\#}$$

Wall ED



Moments for 1' strip

$$M^F_{ED} = .357\left(10-15\times .357+6\times .357^2\right)\times 270\times\frac{7.5}{2}\times 21 + .643^2\left(4-3\times .643\right)\times 320\times 13.5\times 21 + .643^2\left(5-3\times .643\right)\times 1080\times\frac{13.5}{2}\times 21 - .333^2\left(5-3\times .333\right)\times 330\times\frac{7}{2}\times 21 + \frac{1}{12}\times 50\times 21^2 = 16.15^{'k}$$

$$M^F_{DE} = .357^2\left(5-4\times .357\right)\times 270\times\frac{7.5}{2}\times 21 + .643\left(6-8\times .643+3\times .643^2\right)\times 270\times 13.5\times 21 + .643\left(10-10\times .643+3\times .643^2\right)\times 1080\times\frac{13.5}{2}\times 21 - .333\left(10-10\times .333+3\times .333^2\right)\times 330\times\frac{7}{2}\times 21 + \frac{1}{12}\times 50\times 21^2 = 25.30^{'k}$$

Total F.E.M @ E = 16.15x10.37 = 167.48$^{'k}$ @ D = 25.30x10.37 = 262.36$^{'k}$

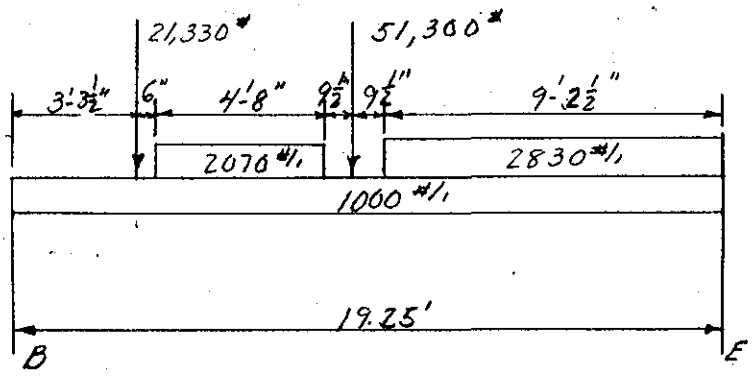
Subject Holyoke Pumping Station No. 6

Computation Transverse Bent A-A

Computed by K.E.K. **Checked by** **Date**

Case I. F.E.M (cont.)

Beam B-10 (With full live load + dead load)



D.L. 24"x48" Bm: $2 \times 3.33 \times 150 = 1000$ #/'

D.L. 20" B-12	$= 1 \times 150 \times 1.71 \times 2$	=	510 #/'
" 8" slab	$= 2 \times 100$	=	200 #/'
L.L =	250×5.42	=	1360 #/'
			2070 #/'
D.L. 8" slab	$= 5.5 \times 100$	=	550 #/'
L.L on 8" slab	$= 5.5 \times 250$	=	1380
D.L. 10" slab	$= 4.87 \times 60$	=	290
L.L. 10" slab	$= 4.87 \times 125$	=	610
			2830 #/'

$$M^F_{BE} = \frac{1}{12} \times 1000 \times 19.25^2 + \frac{\overset{.228}{.478}^2(\overset{2.566}{4-3\times.478})}{12} \times 2830 \times \overset{501.737}{9.21} \times 19.25 + \frac{51300 \times 10.00^2 \times 9.25}{19.25^2}$$

$$+ \frac{.439(\overset{3.066}{6-8\times.439+3\times.439^2})}{12} \times 2070 \times \overset{337.11}{8.46} \times 19.25 - \frac{.197(\overset{4.54}{6-8\times.197+3\times.197^2})}{12} \times 2070 \times \overset{131.10}{3.79} \times 19.25$$

$$+ \frac{21{,}330 \times 15.96^2 \times 3.29}{19.25^2} = 258.19 \text{ 'K}$$

$$M^F_{EB} = \frac{1}{12} \times 1000 \times 19.25^2 + .478\frac{(\overset{2.86}{6-8\times.478+3\times.478^2})}{12} \times 2830 \times \overset{501.737}{9.21} \times 19.25 + \frac{51300 \times 10.00 \times 9.25^2}{19.25^2}$$

$$+ \frac{\overset{.191}{.439}^2(\overset{2.663}{4-3\times.439})}{12} \times 2070 \times \overset{337.4}{8.46} \times 19.25 - \frac{\overset{.039}{.197}^2(\overset{2.539}{4-3\times.197})}{12} \times 2070 \times \overset{131.10}{3.79} \times 19.25$$

$$+ \frac{21{,}330 \times 15.96 \times 3.29^2}{19.25^2} = 229.72 \text{ 'K}$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Transverse Bent A-A

Computed by H.E.W. **Checked by** **Date** 3-Aug-45

Case I F.E.M Beam B-10

F.E.M for dead load on B-10 will be determined approx.

D.L. React. on B-10 from B-1

$450 \times 7.94 = 3570^{\#}$ $\quad 1000 \times 7.94 = 7940$

Pump ld. (approx.) $\frac{15000}{33250} \times 3280 \times 2.04 = 3020$ $\quad 3280 \times 2.04 = 6690$

$\frac{15000}{33250} \times 3280 \times 4.08 \times \frac{2.37}{6.87} = 2080$ $\quad 3280 \times 4.08 \times \frac{2.37}{6.87} = 4620$

$8670^{\#}$ $\quad 19250$

D.L. React on B-10 $= \frac{8670}{19250} \times 21,330 = 9600^{\#}$

D.L React. on B-3 from B-1 + B-2

$450 \times 4.31 = 1940$ $\quad 1000 \times 4.31 = 4310$

$\frac{15000}{33250} \times 3280 \times 4.08 \times \frac{4.50}{6.87} = 3950$ $\quad 3280 \times 4.08 \times \frac{4.50}{6.87} = 8760$

$\frac{1.94}{4.75} \times 290 \times 3.88 = 460$ $\quad \frac{1.94}{4.75} \times 620 \times 3.88 = 980$

6350 $\quad 14050$

D.L. React. on B-3 $= \frac{6350}{14050} \times 12510 = 5650^{\#}$

D.L React on B-4 from B-3

$230 \times 5.21 = 1200$

$5650 \times \frac{4.5}{10.37} = 2450$

$280 \times 5.46 \times \frac{7.64}{10.37} = 1130$

$\frac{290}{620} \times 170 \times 3 \times \frac{2.58}{10.37} = 60$

$4840^{\#}$

D.L. React on B-10 from B-4.

$290 \times 10.31 = 2990$ $\quad 290 \times 10.31 = 2990$

$160 \times 4.5 = 720$ $\quad 560 \times 4.5 = 2520$

$\frac{15000}{33250} \times 4870 \times 2.04 = 4480$ $\quad 4870 \times 2.04 = 9930$

$390 \times 5.81 = 2270$ $\quad 1190 \times 5.81 = 6910$

$80 \times 6.29 \times \frac{8.58}{11.62} = 370$ $\quad 280 \times 6.29 \times \frac{8.58}{11.62} = 1300$

$\frac{15000}{33250} \times 4870 \times 4.08 \times \frac{7.12}{11.62}$ $\quad 5490$ $\quad 4870 \times 4.08 \times \frac{7.12}{11.62} = 12170$

$4840 \times \frac{4.75}{11.62}$ $\quad 1980$ $\quad 10630 \times \frac{4.75}{11.62}$ $\quad 4350$

$18300^{\#}$ $\quad 40170$

D.L. React on B-10 $= \frac{18300}{40170} \times 51300^{\#} = 23370^{\#}$

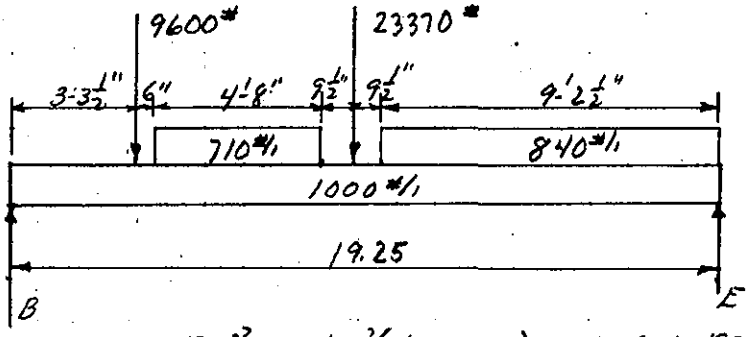
F 212

Subject Holyoke Pumping Station No 6

Computation Transverse Bent A-A

Computed by H. E. W. **Checked by** _____ **Date** 3-Aug-45

Case I F.E.M B-10 dead load (cont.)



$$M^F_{BE} = \frac{1}{12}\times 1000\times 19.25^2 + .478^2\frac{(4-3\times .478)}{12}\times 840\times 9.21\times 19.25 + \frac{23370\times 10.00^2\times 9.25}{19.25^2}$$

$$+ .439\frac{(6-8\times .439+3\times .439^2)}{12}\times 710\times 8.46\times 19.25 - .197\frac{(6-8\times .197+3\times .197^2)}{12}\times 710\times 3.79\times 19.25$$

$$+ \frac{9600\times 15.96^2\times 3.29}{19.25^2} = 127.30^{\text{'K}}$$

$$M^F_{EB} = \frac{1}{12}\times 1000\times 19.62^2 + .478\frac{(6-8\times .478+3\times .478^2)}{12}\times 840\times 9.21\times 19.25 + \frac{23370\times 10.00\times 9.25^2}{19.25^2}$$

$$+ .439\frac{(6-8\times .439+3\times .439^2)}{12}\times 710\times 8.46\times 19.25 - .197\frac{(6-8\times .197+3\times .197^2)}{12}\times 710\times 3.79\times 19.25$$

$$+ \frac{9600\times 16.96\times 3.29^2}{19.25^2} = 110.84$$

Stiffness of Members

Member	d	d^3	L	d^3/L	K
B'C	4.25	76.77	21.0	3.66	2.06
CD	3.25	34.33	19.25	1.78	1.0
DE	4.25	76.77	21.0	3.66	2.06
EB'	4	64	19.25	3.32	1.86

WAR DEPARTMENT

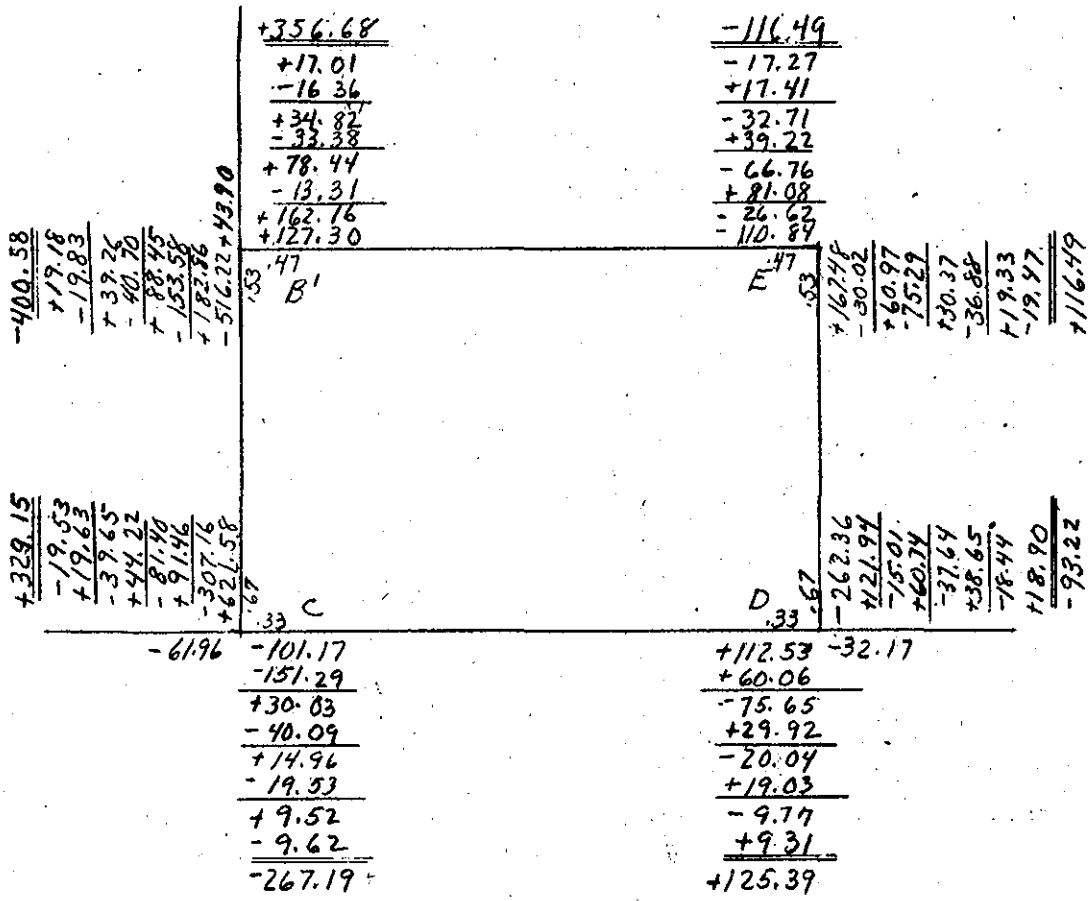
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Transverse Bent A-A

Computed by H.E.W. **Checked by** **Date** 3-Aug-45

Case I (cont.)
Dist with Dead Load only on B-10



End Reactions + Center Moments

Member B'C

$$H_{B'} = \left[800\times21\times.5 + 470\times7.5\times.5\times\frac{16.0}{21} + 470\times13.5\times\frac{6.75}{21} + 1080\times\frac{13.5}{2}\times\frac{4.5}{21} - 330\times\frac{7}{2}\times\frac{2.33}{21}\right]10.37 + \frac{71,430}{21} = 140,450^{\#}$$

$$H_C = \left[800\times21\times.5 + 470\times7.5\times.5\times\frac{5.0}{21} + 470\times13.5\times\frac{14.25}{21} + 1080\times\frac{13.5}{2}\times\frac{16.5}{21} - 330\times\frac{7}{2}\times\frac{18.67}{21}\right]10.37 - \frac{71,430}{21} = 181,470^{\#}$$

$x_0 = 11.5'$ from B'

$$M = 140450\times11.5 - \left[800\times\frac{11.50^2}{2} + 470\times7.5\times.5\times6.5 + 470\times\frac{.4^2}{2} + 320\times\frac{4.0^2}{6}\right]10.37 - 400580 = 499,390'^{\#}$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Transverse Bent AA

Computed by H.E.W. **Checked by** **Date** 4 Aug - 45

Case I End Reactions & Center Moments

Base Slab CD

$$V_C = 1270 \times 2 \times 19.25 \times .5 + 920 \times 2 \times 19.25 \times .5 \times .33 + \frac{141,800}{19.25} = 37660^{\#}$$

$$V_D = 1270 \times 2 \times 19.25 \times .5 + 920 \times 2 \times 19.25 \times .5 \times .67 - \frac{141,800}{19.25} = 28950^{\#}$$

$x_0 = 12.0'$ from C

$$M = 37,660 \times 12 - 1270 \times \frac{12^2}{2} \times 2 - 1138 \times \frac{12^2}{6} - 267190 = -22240'^{\#}$$

Wall ED

$$H_E = \left[50 \times 21 \times .5 + 270 \times 750 \times .5 \times \frac{16.0}{21} + 270 \times 13.5 \times \frac{6.75}{21} + 1080 \times \frac{13.5}{2} \times \frac{4.5}{21} - 330 \times \frac{7}{2} \times \frac{2.33}{21}\right] \times 10.37 + \frac{23270}{21} = 41570^{\#}$$

$$H_D = \left[50 \times 21 \times .5 + 270 \times 750 \times .5 \times \frac{5.6}{21} + 270 \times 13.5 \times \frac{14.25}{21} + 1080 \times \frac{13.5}{2} \times \frac{16.5}{21} - 330 \times \frac{7}{2} \times \frac{18.67}{21}\right] \times 10.37 - \frac{23270}{21} = 81,230^{\#}$$

$x_0 = 12.6'$ from E

$$M = 41570 \times 12.6 - \left[50 \times \frac{12.6^2}{2} + 270 \times \frac{7.5}{2} \times 7.6 + 270 \times \frac{5.1^2}{2} + 408 \times \frac{5.1^2}{6}\right] 10.37 - 116,490 = 231,580'^{\#}$$

Beam B-10 (not critical when loaded with dead ld. only

WAR DEPARTMENT

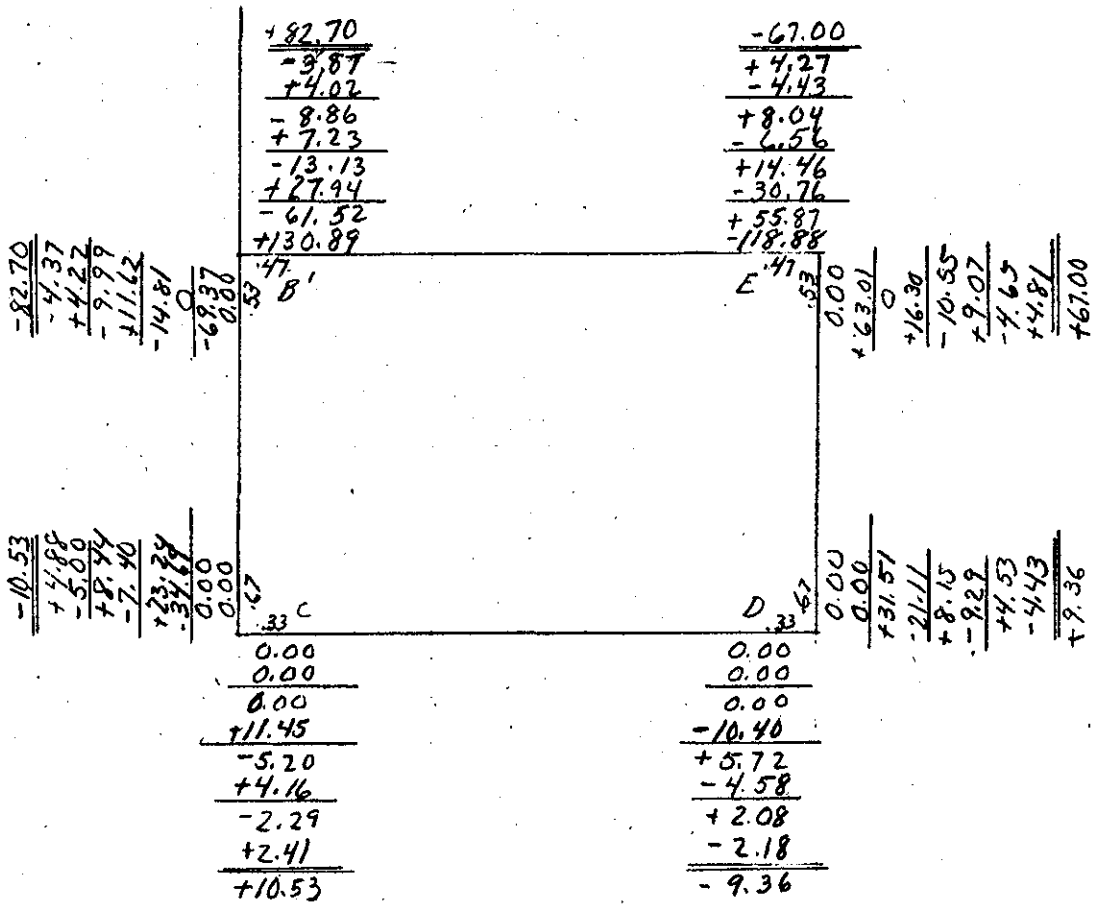
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Transverse Bent A-A

Computed by H.E.W. **Checked by** **Date** 4-Aug-45

Case I - Moments for Live Load on B-10



End Reactions + Center Mom. (add above mom. to previous mom.)

Member B'C

$$H_{B'} = 140,450 + \frac{93230}{21} = 144,890^{\#}$$

$$H_C = 181,470 - \frac{93230}{21} = 177030^{\#}$$

Member CD

$$V_C = 37,660 - \frac{1170}{19.25} = 37590^{\#}$$

$$V_D = 28,950 + \frac{1170}{19.25} = 29,020^{\#}$$

$$M = 37590 \times 12 - 1270 \times \frac{12^2}{2} \times 2 - 1138 \times \frac{12^2}{6} - 256660 = -15770^{'\#}$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Transverse Bent A-A

Computed by H. E. W. **Checked by** **Date** 6-Aug-45

Case I - Additional Moments when Floor has full Live Load

Member DE

$H_E = 41\,570 + \frac{76360}{21} = 45210^{\#}$

$H_D = 81230 - \frac{76360}{21} = 77590^{\#}$

Cent. Mom. less than for D.L. only.

Beam 8-10

$V_B = 1000 \times 19.25 \times .5 + 2070 \times 4.67 \times \frac{13.12}{19.25} + 2830 \times 9.21 \times \frac{4.60}{19.25} + 21,330 \times \frac{15.96}{19.25}$

$+ 51,300 \times \frac{10.0}{19.25} + \frac{265890}{19.25} = 80,590^{\#}$

$V_E = 1000 \times 19.25 \times .5 + 2070 \times 4.67 \times \frac{6.13}{19.25} + 2830 \times 9.21 \times \frac{14.65}{19.25} + 21,330 \times \frac{3.29}{19.62}$

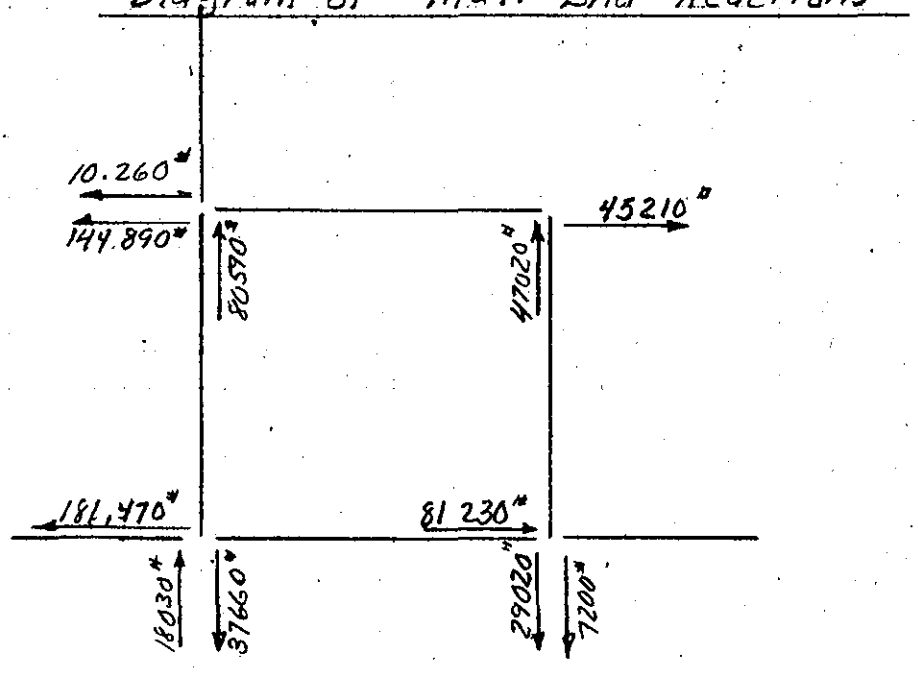
$+ 51,300 \times \frac{9.25}{19.25} - \frac{265890}{19.25} = 47020^{\#}$

$x_0 = 10.$ ' from E

$M = 47020 \times 10.0 - 1000 \times \frac{10.0^2}{2} - 2830 \times 9.21 \times 5.39 - 483,490$

$= 95\,220^{'\#}$

Diagram of Max. End Reactions



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

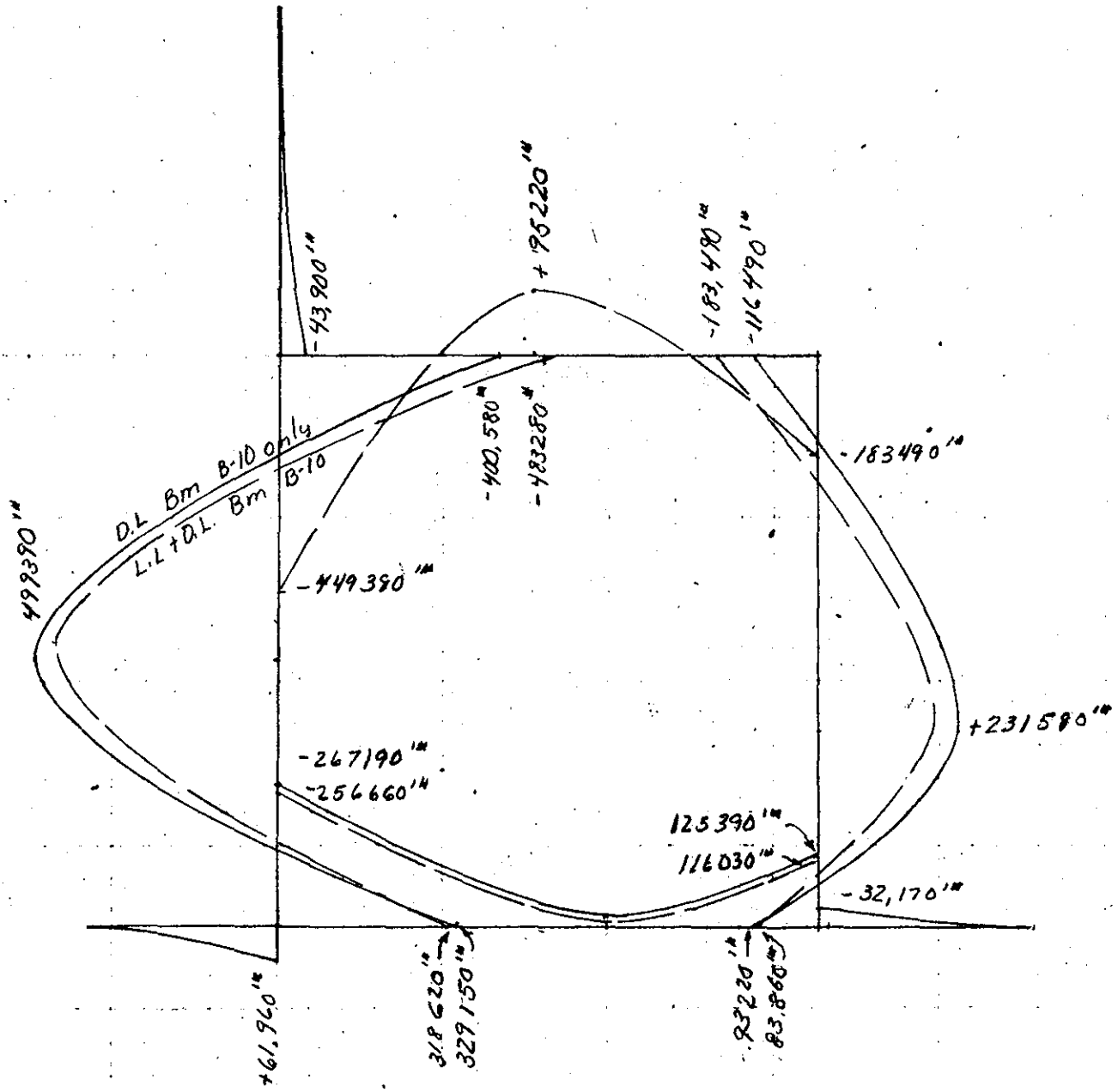
Subject Holyoke Pumping Station No 6

Computation Transverse Bent A-A

Computed by H. E. W. **Checked by** _____ **Date** 6-Aug-45

Case I-(cont.)

Moment Diagrams



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

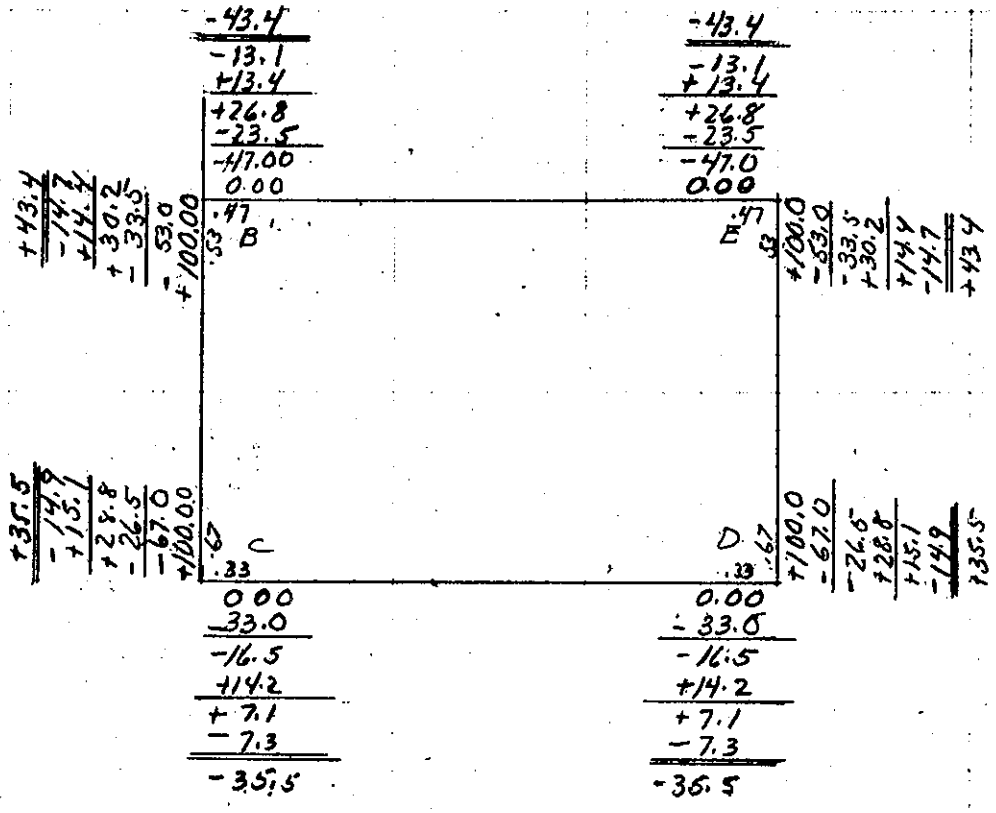
Computation Transverse Bent A-A

Computed by H.E.W. **Checked by** _____ **Date** 6 Aug - 45

Side Thrust at El. 62.5

Total side thrust at El. 62.5 = 144890 + 10,260 - 95210 + 4551 x 8.37 + 1.83 x 750 x 10.37 - 50 x 1.5 x .5 x 10.37 = 162,650#

The thrust at Beam B'E will cause the structure to deflect inward at Joints B' & E. As members B'C & ED have the same stiffness, the f.e.m. induced into these members will be the same. A trial moment of 100'# will be used for distribution.



Member B'C

$H_B = \frac{78\,900}{21} = 3757$

Member E D

$H_E = \frac{78,900}{21} = \frac{3757}{7514''}$

Mom. Mult. $= \frac{162\,650}{7514} = 21.65$

F 219.

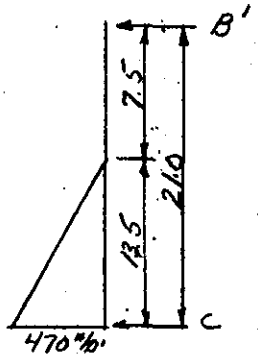
Side Thrust at El. 62.5 cont.

Member	Trial M	Mult.	Mom	React
B'C @ B'	+43.4	21.65	+939610 '#	81340# →
@ C	+35.5	"	+768580	81340# ←
CD @ C	-35.5	"	-768580	79850# ↓
@ D	-35.5	"	-768580	79850# ↑
DE @ D	+35.5	"	+76858	81340# ←
@ E	+43.4	"	+939610	81340# →
EB' @ E	-43.4	"	-939610 '#	97620# ↑
@ B'	-43.4	"	-939610 '#	97620# ↓

Case II - Water down - Gr. water at El. 55.0 on landside

F.E.M

Wall B'C



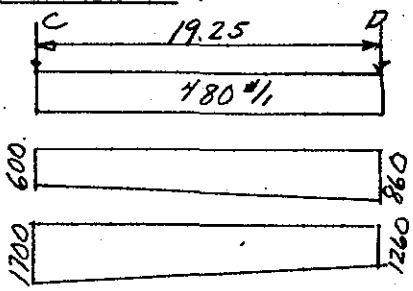
$$M^F_{B'C} = \frac{\overset{.413^2}{.643}\overset{3.071}{(5-3\times.643)}}{30}\times 470\times\frac{\overset{66.62}{13.5}}{2}\times 21 = 2.82'^K$$

$$M^F_{CB'} = \frac{.643(10-\overset{4.81}{10\times.643}+3\times.643^2)}{30}\times 470\times\frac{\overset{66.62}{13.5}}{2}\times 21 = 6.87'^K$$

Total F.E.M @ B' = 2.82 × 10.37 = 29.24'^K

" " " C = 6.87 × 10.37 = 71.24'^K

Base CD



$$M^F_{CD} = 2\times\frac{1}{12}\times 1640\times 19.25^2 + 2\times\frac{1}{10}\times 180\times 19.25^2 = 114.63$$

$$M^F_{DC} = 2\times\frac{1}{12}\times 1640\times 19.25^2 + 2\times\frac{1}{15}\times 180\times 19.25^2 = 110.18$$

Wall DE

$$M^F_{ED} = 167.48 + \left(.333^2\frac{(5-3\times.333)}{30} + 330\times\frac{7}{2}\times 21\right)10.37 = 171.20$$

$$M^F_{DE} = 262.36 + \left[.333\frac{(10-10\times.333+3\times.333^2)}{30}\times 330\times\frac{7}{2}\times 21\right]10.37 = 281.90$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

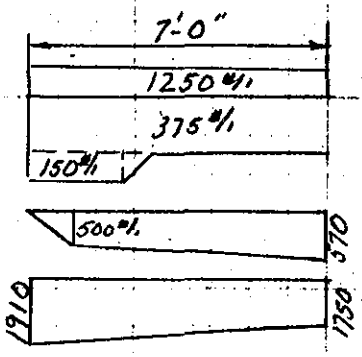
Subject Holyoke Pumping Station No. 6

Computation Transverse Bent A-A

Computed by H.E.W **Checked by** **Date** 9-Aug-45

Case II. F.E.M. (cont.)

Cantilever C'C



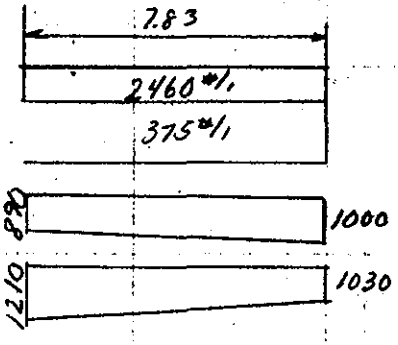
Shear at face of wall 2'-0" width

2x500x1.5x.5 + 2x500x5.5 + 70x5.5x.5x2 + 1750x7x2 + 160x7x2x.5 + 1625x7 - 150x2.5x2 + 150x1x.5x2 = 8600#

Mom. at face of wall 2'-0" width

2x500x1.5x.5x6 + 2x500x5.5x2.75 + 70x5.5x.5x2x1.83 + 1750x7x2x3.5 + 160x7x2x.5x4.67 - 1625x7x3.5x2 - 150x2.5x2x5.75 - 150x1x.5x2x4.17 = 26,750'#

Cantilever DD'



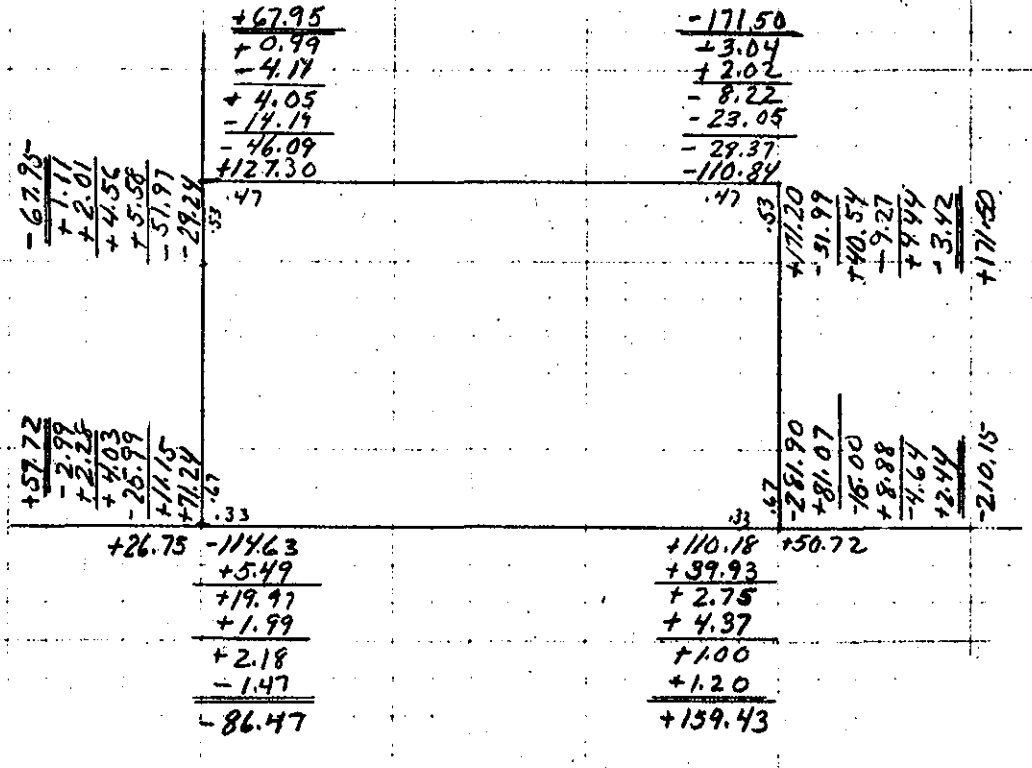
Shear at face of wall

805x7.83x2 + 70x7.83x.5x2 = 13150#

Mom. at face of wall

805x7.83x2x3.91 + 70x7.83x.5x2x2.61 = 50,720'#

Dist. with D.L. on Bm. B-10



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 6

Computation Transverse Bent A-A

Computed by H.E.W. **Checked by** _____ **Date** 9-Aug.-45

End Reactions + Center Moments

Member B'C

$H_{B'} = 2\times470\times13.5\times.5\times\frac{4.5}{21} + \frac{8230}{21} = 1780^{\#}$

$H_C = 2\times470\times13.5\times.5\times\frac{16.5}{21} - \frac{8230}{21} = 4570^{\#}$

$x_0 = 14.6'$ from B'

$M = 1780\times14.6 - 67950 - 470\times\frac{7.1^2}{6} = -46,140'^{\#}$

Member CD

$V_C = 1640\times19.25\times.5\times2 + 2\times180\times19.25\times.5\times.67 - \frac{54970}{19.25} = 30160^{\#}$

$V_D = 1640\times19.25\times.5\times2 + 2\times180\times19.25\times.5\times.33 + \frac{54970}{19.25} = 36450^{\#}$

$x_0 = 10.5$ from D

$M = 36450\times10.5 - 159430 - 1640\times\frac{10.5^2}{2}\times2 - 98\times\frac{10.5^2}{6}\times2 = 39890'^{\#}$

Member DE

$H_E = \left[50\times21\times.5 + 270\times7.5\times.5\times\frac{16.0}{21} + 270\times13.5\times\frac{6.75}{21} + 1080\times\frac{13.5}{2}\times\frac{4.5}{21}\right]\times10.37 - \frac{38650}{21} = 36,720$

$H_D = \left[50\times21\times.5 + 270\times7.5\times.5\times\frac{5.0}{21} + 270\times13.5\times\frac{14.25}{21} + 1080\times\frac{13.5}{2}\times\frac{16.5}{21}\right]\times10.37 + \frac{38650}{21} = 82940^{\#}$

$x_0 = 13.55'$ from E

$M = 36720\times13.55 - 171,500 - \left[50\times\frac{13.55^2}{2} + 270\times\frac{7.5}{2}\times8.55 + 270\times\frac{6.05^2}{2} + 484\times\frac{6.05^2}{6}\right]\times10.37 = 106,830'^{\#}$

Values for B-10 not critical

End Reactions + Center Moments with full L.L. on B-10

Member B'C

$H_{B'} = 1780 + \frac{93230}{21} = 5720^{\#}$

$H_C = 4570 - \frac{93230}{21} = 130^{\#}$

V_0 + M

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6
Computation Transverse Bent A-A
Computed by H. E. W. **Checked by** **Date** 10-Aug-45

Case II - End React. & Center Mom. with full L.L. on B-10 cont.

Member CD

$V_C = 30160 - \frac{1170}{19.25} = 30,090$

$V_D = 36450 + \frac{1170}{19.25} = 36520$

$M = 36520 \times 10.5 - 150070 - 1640 \times \frac{10.5^2}{2} \times 2 - 99 \times \frac{10.5^3}{6} \times 2 = 64750'^{\#}$

Member DE

$H_E = 36,720 + \frac{76360}{21} = 40,360^{\#}$

$H_D = 82940 - \frac{76360}{21} = 79300^{\#}$

Center Mom less than for D.L only on B-10

Beam B-10

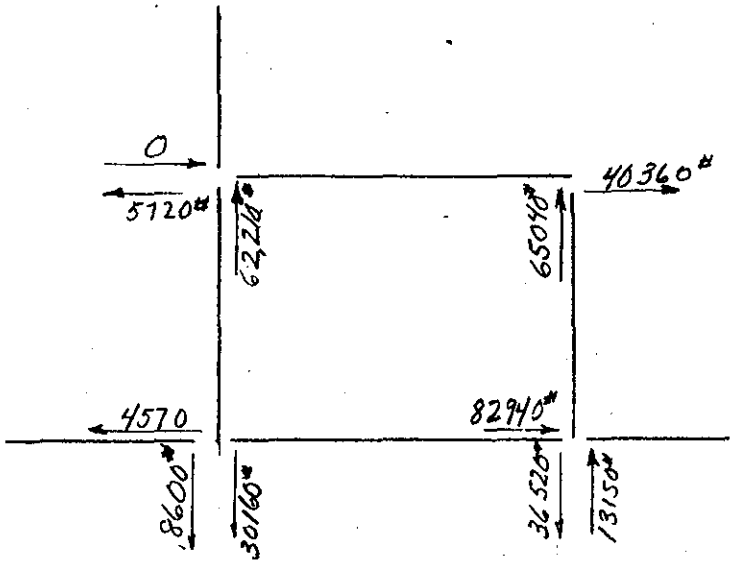
$V_B' = 80,590 - \frac{265,890}{19.25} - \frac{87850}{19.25} = 62210^{\#}$

$V_E = 47020 + \frac{265890}{19.25} + \frac{87850}{19.25} = 65400^{\#}$

$x_0 = 10'$ from V_E

$M = 65400 \times 10 - 1000 \times \frac{10^2}{2} - 2830 \times 9.21 \times 5.39 - 238500 = 225010'^{\#}$

Diagram of Max End Reactions



F223.

WAR DEPARTMENT

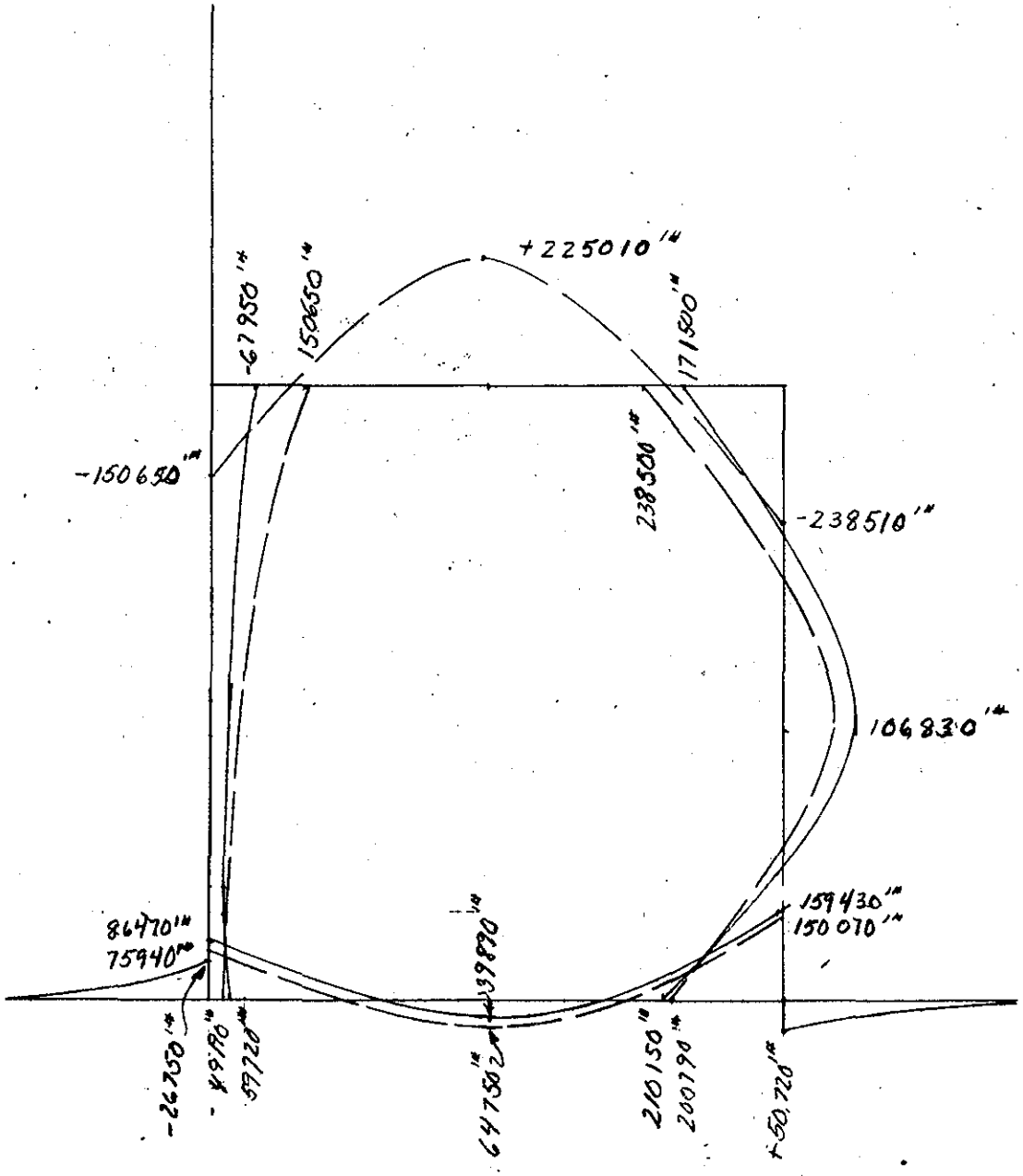
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Transverse Bent A-A

Computed by H.E.W. **Checked by** **Date** 16-Aug.-45

Moment Diagram



F 224

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6
Computation Transverse Bent A-A
Computed by H.E.W **Checked by** **Date** 10-Aug-45

Case II Side Thrust at El. 62.5

Side Thrust = $40360 - 5720 + 50 \times 1.5 \times .5 \times 10.37 = 35030^{\#}$

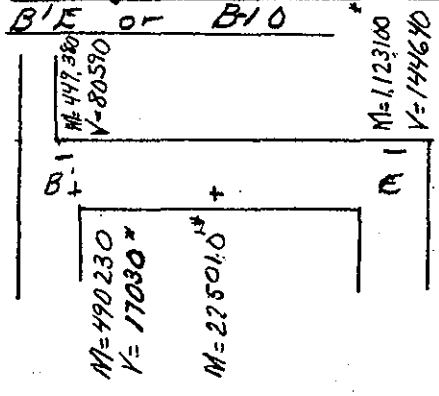
As the thrust is in the oposite direction than Case I, the trial moments will be of opposite sign

Mom. mult. = $\frac{35030}{7514} = 4.662$

Memb.	Trial M	Mult	Mom.	React.
B'C @ B'	-43.4	4.662	-202330 '#	17520# ←
@ C	-35.5	"	-165500 '#	17520# →
CD @ C	+35.5	"	+165500 '#	17190# ↑
@ D	+35.5	"	+165500 '#	17190# ↓
DE @ D	-35.5	"	-165500 '#	17520# →
@ E	-43.4	"	-202330 '#	17520# ←
EB' @ E	+43.4	"	+202330 '#	21,020# ↓
@ B'	+43.4	"	+202330 '#	21,020# ↑

Design of Bent Members

B'E or B-10



Values of M & V at face of support at E
(see Cont. in Conc. Bldg Frames by P.C.A)

$V = 144640 - 3830 \times 2.12 = 136520^{\#}$

$M = -\frac{1}{3}\left(\frac{144640 + 136520}{2}\right) \times 4.25 + 1,123,100 = 923940'^{\#}$

req'd $d = \sqrt{\frac{923940 \times 12}{24 \times 147}} = 55.9'' > 45.5''$

Use comp. steel

$v = \frac{136520}{24 \times .88 \times 45.5} = 142\ ^{\#}/_{\square''}$ Stirrups req'd at E

$v = \frac{(80590 - 1000 \times 2.12)}{24 \times .88 \times 45.5} = 82\ ^{\#}/_{\square''}$ Stirrups not req'd

$+A_s = \frac{490,230 \times 12}{18000 \times .88 \times 45.5} = 8.16\ \square''$ Use $3\text{-}1\frac{1}{8}''\square + 3\text{-}1\frac{1}{4}''\square$ single layer $A_s = 8.49\ \square''$

$-A_s = \frac{923,940 \times 12}{18000 \times .88 \times 43.0} = 16.3\ \square''$ Use $6\text{-}1\frac{1}{8}''\square + 6\text{-}1\frac{1}{4}''\square$ two layers $A_s = 16.98\ \square''$

$u_o = \frac{136,520}{520 \times .88 \times 43.0} = 64\ ^{\#}/_{\square''}$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6.
Computation Transverse Bent A-A
Computed by H.E.W **Checked by** **Date** 14 Aug-45

Design of Bent Members (cont.)

B-10 (cont.)

Comp. Steel at E (Use Reinf. Conc. Design Handbook by PCA)

Assume $A_s' = 9.37$ $A_s = 16.98$ $d = 43.0''$ $d' = 2.5''$ $d'' = 19.0''$

$M = 923.94^{'k}$ $N = 126.94^{k}$

$e = \frac{12M}{N} + d'' = \frac{12 \times 923.94}{126.94} + 19.0 = 106.34$ $\frac{e}{d} = \frac{106.34}{43} = 2.47$

Using $j = .87$ then $i = 1.54$

$m = \frac{n A_s i}{bd} + \frac{(n-1)A_s'}{bd} = \frac{12 \times 16.98 \times 1.54}{24 \times 43} + \frac{11 \times 9.37}{24 \times 43} = .404$

$q = \frac{n(A_s)i}{bd} + \frac{(n-1)A_s'}{bd} \times \frac{d'}{d} = .304 + .100 \times \frac{2.5}{43} = .310$

$K = 0.48$ $\frac{1}{K} \times \frac{(n-1)A_s'}{bd} = \frac{1}{.48} \times \frac{11 \times 9.37}{24 \times 43} = .208$

$\frac{1}{K} \times \frac{d'}{d} = \frac{1}{.48} \times \frac{2.5}{43} = .121$ then $Z = .28$ & true $j = .87$

then $i = 1.54$

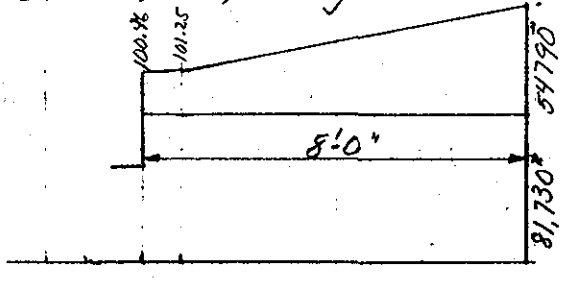
$f_s = \frac{N \times 1000}{j A_s i} \times \frac{e}{d} = \frac{126940}{.87 \times 16.98 \times 1.54} \times 2.56 = 14{,}250$ #/□"

$f_c = \frac{f_s}{n} \times \frac{K}{1-K} = \frac{14250}{12} \times \frac{.48}{.52} = 1090$ OK as values are extreme & bm is protected from the weather

Use 6- $1\frac{1}{4}$"□ in bot

Use 6- $1\frac{1}{4}$"□ & 6-$1\frac{1}{4}$"□ in cor at E

Stirrup spacing at E



Shear by conc. = $90 \times 24 \times .88 \times 43 = 81{,}730^{\#}$

No of Stirrups $\frac{(54790 - 18730) \times 96}{2 \times .62 \times 16000 \times .88 \times 43.0} = 10$

5/8"□ 2 legs

Spacing = $\frac{.62 \times 16000 \times .88 \times 43}{54790} = 6.85$

Spacing @ 3", 6", 6", 6", 9", 9", 9", 9", 9" 12", 12" 12".

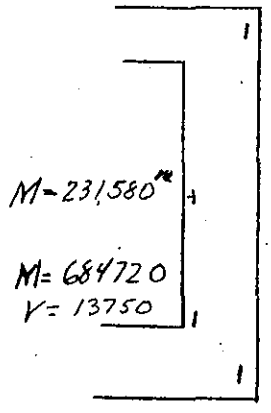
$-A_s$ @ B' = $\frac{449.380 \times 12}{18000 \times .88 \times 45.5} = 7.5$ □" Use 5- $1\frac{1}{4}$"□

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6
Computation Transverse Bent A-A
Computed by H.E.W. **Checked by** **Date** 10-Aug-45

Design of Bent Members (cont.)
Landside Wall



Values of M & V at face of sup. at E

$V = 126550 - [50\times2 + 70\times2\times.5]10.37 = 124,790$

$M = -\frac{1}{3}\left(\frac{126550+124790}{2}\right)\times 4 + 1,123,100 = 955,540'^{\#}$

req'd $d = \sqrt{\frac{955540\times12}{24\times147}} = 57" > 47.5"$

Use comp. steel

$v = \frac{124790}{24\times.88\times45} = 131\ \#/\square''$ Use stirrups

$v = \frac{82940}{24\times.88\times47.5} = 80\ \#/\square''$ Stirrups not req'd

$+A_s = \frac{684720\times12}{18000\times.88\times45.0} = 11.5\ \square''$ Use $10-1\frac{1}{8}''\square$ 2 rows

$-A_s = \frac{955540\times12}{18000\times.88\times45} = 16.0\ \square''$ Try $6-1\frac{1}{4}''\square + 6-1\frac{1}{8}''\square$ two layers

$-A_s = \frac{210150\times12}{18000\times.88\times47.5} = 3.34$ Use $6-1''\square$ one layer

$u_0 = \frac{124790}{57.0\times.88\times45.0} = 56\ \#/\square''$

$u_0 = \frac{82940}{18.85\times.88\times47.5} = 105\ \#/\square''$ OK

Comp. steel at E

$A_s = 16.98$, $A_s' = 12.66$ $d = 45.0$ $d' = 6.0$ $d'' = 19.5$

$M = 955540'^{\#}$ $N = 144,640^{\#}$

$e = \frac{12\times955.540}{144.640} + 19.5 = 98.78$ $\frac{e}{d} = \frac{98.78}{45} = 2.195$

Using $j = .88$ $i = 1.67$

$m = \frac{12\times16.98\times1.67}{24\times45.0} + \frac{11\times12.66}{24\times45.0} = .444$

$q = .315 + .129\times\frac{6.0}{45} = .332$

$K = 0.484$ $\frac{1}{K}\times\frac{(n-1)(A_s')}{bd} = \frac{1}{.484}\times.129 = .267$

$\frac{1}{K}\times\frac{d'}{d} = \frac{1}{.484}\times\frac{6.0}{45} = .276$ then $z = .32$ then $j = 0.84$

$i = 1.62$

Subject Holyoke Pumping Station
Computation Transverse Bent A-A
Computed by H.E.W. **Checked by** _____ **Date** 13-Aug-45

Design of Bent Members Landside Wall (cont.)

$$f_s = \frac{144.640 \times 2.195}{.84 \times 16.98 \times 1.62} = 13700 \text{ \#/□''}$$

$$f_c = \frac{13700}{12} \times \frac{.484}{.516} = 1070 \text{ \#/□''} \quad OK$$

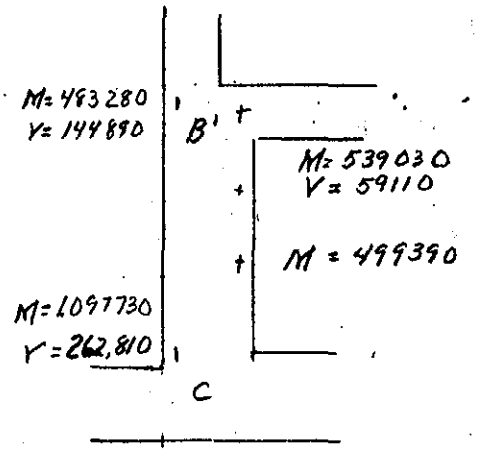
Use 10-1 1/8"□ on inside — Use 6-1 1/4"□ + 6-1 1/8"□ outside

Stirrup spacing at E
Shear by conc = 90 x 24 x .85 x 45 = 82.620#

Use 5/8"□ Stirrups 4 legs $sp = \frac{.123 \times 16000 \times .85 \times 45}{42170} = 18''$ cc

Use a 12" spacing

Riverside Wall



Max pos M = 59110 x 5.8 + 539030 − [800 x 5.8²/2 + 362 x 5.8²/6] 10.
x_0 = 5.8'
= 721,240 '#

Values of M & V at top of base slab

V = 262,810 − [2280 x 1.67 − 290 x 1.67] 10.37 = 228340

$M = -\frac{1}{3}\left(\frac{262810 + 228340}{2}\right) \times 3.33 + 1097730 = 825,140$ '#

req'd d = $\sqrt{\frac{825140 \times 12}{24 \times 147}}$ = 52.8" > 47.5" Use comp. st

req'd d = $\sqrt{\frac{721,240 \times 12}{24 \times 123}}$ = 53.9 > 47.5" Use Comp. St.

$v = \frac{228340}{24 \times .88 \times .45} = 239$ #/□" Stirrups req'd

$v = \frac{144890}{24 \times .88 \times 45} = 151$ #/□" Stirrups req'd

$+A_s = \frac{721,240 \times 12}{18000 \times .88 \times 45} = 12.1$ □" Use 10-1 1/8"□ two layers

$-A_s = \frac{825,140 \times 12}{18000 \times .88 \times 45} = 13.8$ □" Use 5-1 1/8"□ + 5-1 1/4"□ two layers

$-A_s = \frac{483,280 \times 12}{18000 \times .88 \times 47.5} = 7.2$ □" Use 5-1 1/4"□

Design of Bent Members Riverside Wall (cont.)

$u_0 = \frac{228340}{47.5 \times .88 \times 45} = 121$ #/□"

$u_0 = \frac{144890}{25 \times .88 \times 47.5} = 138$ #/□"

Comp. steel at C

$A_s = 14.15$ $A_s' = 12.66$ $d = 45$ $d' = 6$ $M = 825{,}140$ '#

$m = \frac{nA_s}{bd} + \frac{(n-1)A_s'}{bd} = \frac{12 \times 14.15}{24 \times 45} + \frac{11 \times 12.66}{24 \times 45} = .286$

$q = \frac{nA_s}{bd} + \frac{(n-1)(A_s')}{bd} \times \frac{d'}{d} = .157 + .129 \times \frac{6}{45} = .174$

$K = .39$

$\frac{1}{K} \times \frac{(n-1)A_s'}{bd} = \frac{1}{.39} \times .129 = .331$ $\frac{1}{K} \times \frac{d'}{d} = \frac{1}{.39} \times \frac{6}{45} = .342$

$Z = 0.34$ $j = .865$

$f_s = \frac{825{,}140 \times 12}{.865 \times 45 \times 14.15} = 17{,}900$ #/□"

$f_c = \frac{17{,}900}{12} \times \frac{0.39}{0.61} = 950$ #/□" OK

Stirrup spacing.

Shear by conc = $90 \times 24 \times .865 \times 45 = 84080$ #

Use 5/8" ϕ stirrups 4 legs

Spacing 1st stir. = $\frac{1.23 \times 16000 \times .865 \times 45}{144260} = 5.34$"

sp. stirrups up from base at 2½", 6", 6, 6, 6, 6, 9" 9", 9", 12"—

sp stirrups down from top 6" 12" 12" —

WAR DEPARTMENT

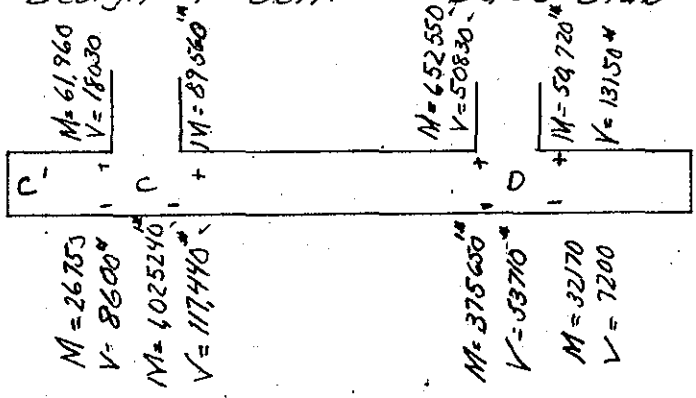
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Transverse Bent A-A

Computed by H.E.W. **Checked by** _____ **Date** 14-Aug-45

Design of Bent Base Slab



Reduced Values of Shear & Mom. at face of Bent

End C

$V = 117,440 - \left(1270 \times 2.12 + \frac{930 \times 2.12^2}{19.25} \times 2\right) = 111,840^{\#}$

$M = 1,025,240 - \frac{1}{3} \times \frac{117440 + 111840}{2} \times 4.25 = 962830^{\prime\#}$

It will be assumed that the effective $b = 36''$

reqd $d = \sqrt{\frac{962830 \times 12}{36 \times 147}} = 46.6 > 35.5$ comp. steel reqd

reqd $d = \sqrt{\frac{652550 \times 12}{36 \times 147}} = 38.4 > 34.5$ " " "

$v = \frac{111,840}{36 \times .88 \times 35.5} = 99^{\#}/\square''$ Use stirrups

Cantilever CC

$-A_s = \frac{26750 \times 12}{18000 \times .88 \times 25.5} = .80^{\square''}$ Use $\frac{7}{8}''\phi$ @ 12" cc

$u_o = \frac{8600}{5.5 \times .88 \times 25.5} = 70^{\#}/\square''$

$+A_s = \frac{61,960 \times 12}{18000 \times .88 \times 26.5} = 1.77^{\square''}$ Use $\frac{7}{8}''\phi$ 6" cc

$u_o = \frac{18030}{11.00 \times .88 \times 26.5} = 70^{\#}/\square''$

Base CD

$-A_s$ at C $= \frac{962830 \times 12}{18000 \times .88 \times 33} = 22.0^{\square''}$ Use $14 - 1\frac{1}{4}''\square$

$u_o = \frac{111840}{70 \times .88 \times 38} = 55^{\#}/\square''$ OK

F 230

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Transverse Bent A-A

Computed by H. E. W. **Checked by** **Date** 17-Aug-45

Design of Bent Base Slab (cont.)

$+A_s = \frac{652\,550 \times 12}{18000 \times .88 \times 320} = 15.5$ □" Use 7-1¼"□ 6-1"□

$+A_s = \frac{89,560 \times 12}{18000 \times .88 \times 32} = 2.12$ Try 7-1¼"□ as comp. steel

Comp. steel at C

$A_s = 21.78$ $A_s' = 10.94$ $d = 33$ $d' = 5.5'$ $M = 962\,830$ '#

$m = \frac{12 \times 21.78}{36 \times 33} + \frac{11 \times 10.94}{36 \times 33} = .321$

$q = .220 + .101 \times \frac{5.5}{33} = .237$

then $k = 0.44$

$\frac{1}{.44} \times .101 = .230$ $\frac{1}{.44} \times \frac{5.5}{33} = .378$ $z = .34$ & $j = .85$

$f_s = \frac{962\,830 \times 12}{.85 \times 33 \times 21.78} = 18,900$ #/□" OK

$f_c = \frac{18900}{12} \times \frac{.44}{56} = 1240$ #/□" OK as more than 3' of base will act

$-A_s$ at $D = \frac{375,650 \times 12}{18000 \times .88 \times 33} = 8.62$ Use 7-1¼"□ one layer

Comp. steel at D

$A_s = 16.94$ $A_s' = 11.94$ $d = 30.5"$ $d' = 4.5"$ $M = 652,550$ '#

$m = \frac{12 \times 16.94}{36 \times 30.5} + \frac{11 \times 11.94}{36 \times 30.5} = .305$ then $k = .401$

$q = .185 + .120 \times \frac{4.5}{30.5}$ $.203$

$\frac{1}{.401} \times .120 = .299$ $\frac{1}{.401} \times \frac{4.5}{30.5} = .368$ $z = .35$ & $j = .86$

$f_s = \frac{652\,550 \times 12}{.86 \times 30.5 \times 16.94} = 17,600$ #/□"

$f_c = \frac{17600}{12} \times \frac{.401}{599} = 980$ #/□" OK

Cantilever DD'

$+A_s$ Use 6-1"□

$-A_s$ Use 7-1⅛"□

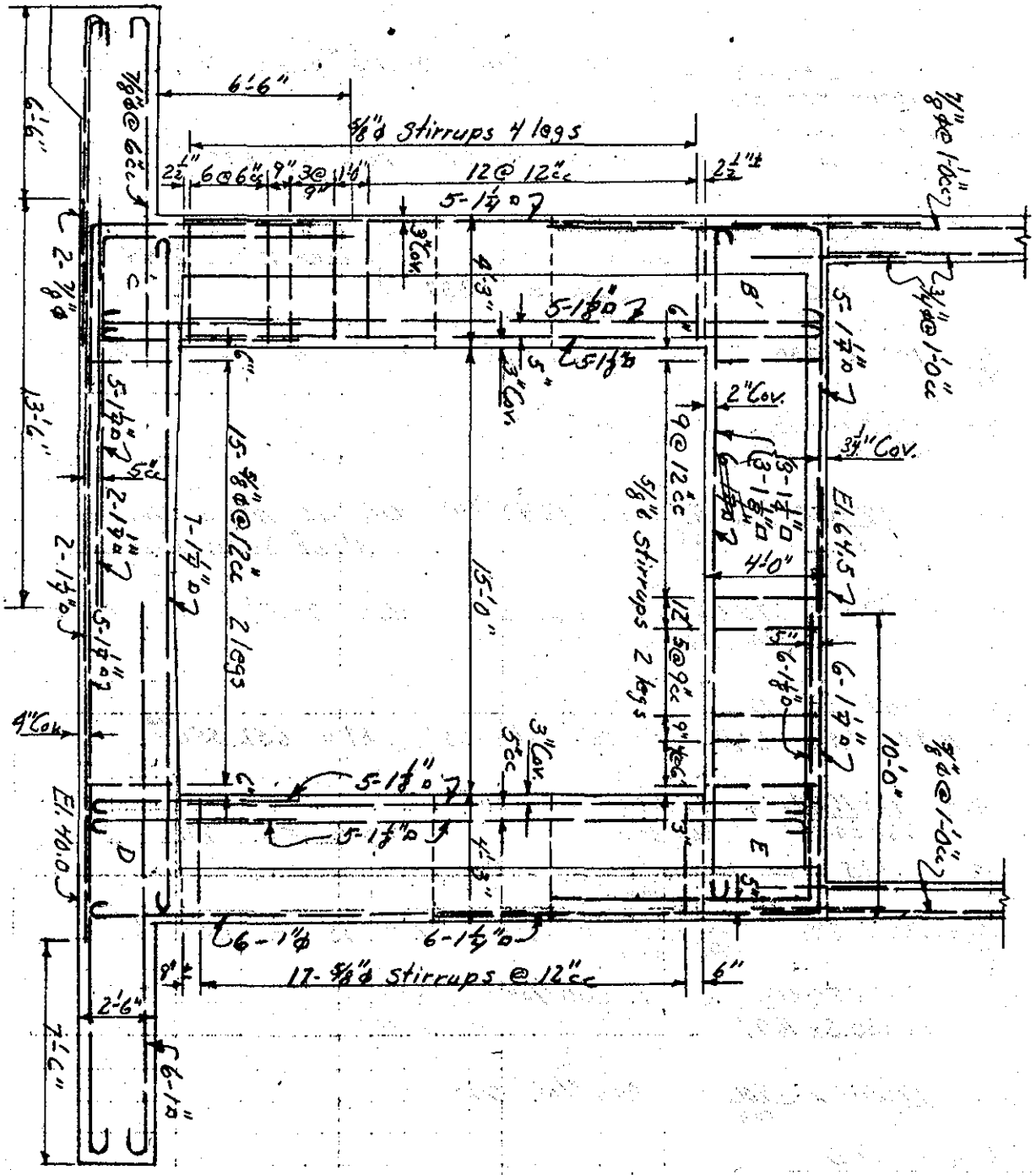
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6.

Computation Transverse Bent A-A

Computed by H.E.W **Checked by** **Date** 20-Aug-45



F 232

WAR DEPARTMENT

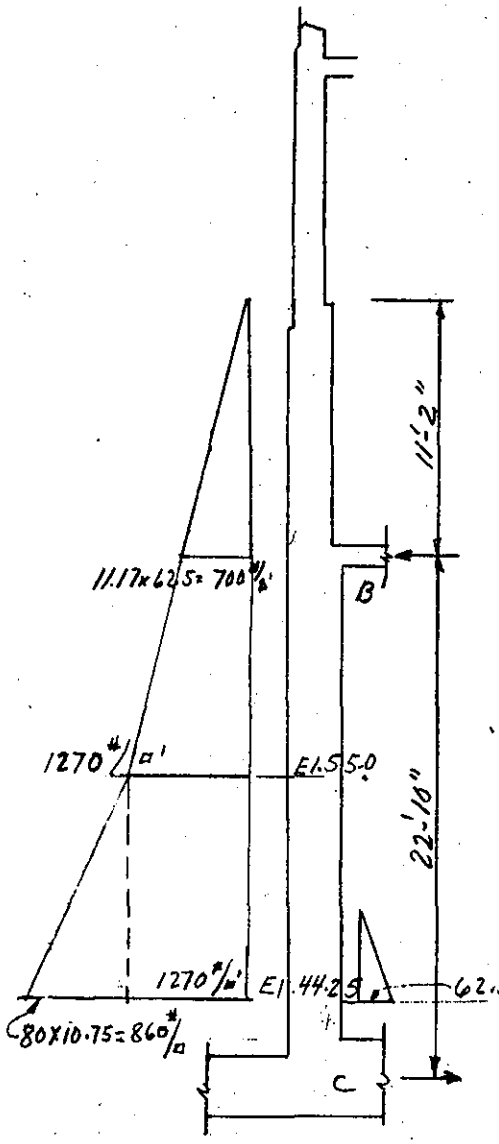
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Riverside Wall

Computed by H.E.W **Checked by** **Date** 6-Aug-45

The portion of the wall above the motor room floor between bents will be designed as cantilevered about the motor room floor



$$H_{B_1} = \frac{700 \times 11.17 \times .5 \times 26.55}{22.83} = 4550^{\#}$$

$$H_C = \frac{700 \times 11.17 \times .5 \times 3.72}{22.83} = 640^{\#}$$

$$\text{Mom at } B = 700 \times 11.17 \times .5 \times 3.72 = 14{,}550^{\#}$$

$$\text{req'd } d = \sqrt{\frac{14550}{147}} = 10'' < 17.5'' \text{ OK}$$

$$v = \frac{4550}{12 \times .88 \times 17.5} = 25\ \#/\square''$$

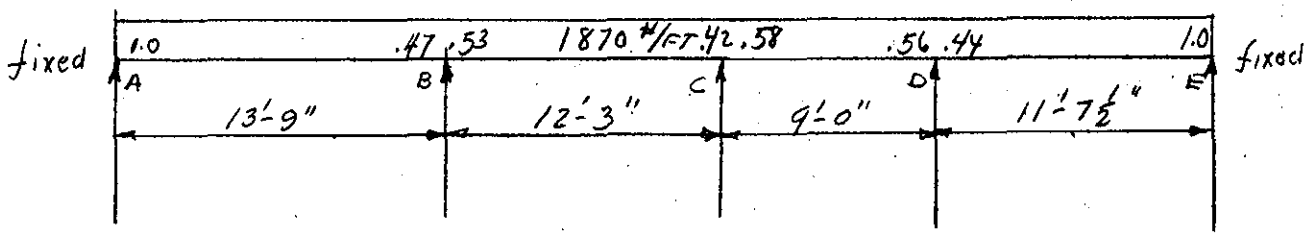
$$A_s = \frac{14550 \times 12}{18000 \times .88 \times 17.5} = .63\ \square'' \quad \text{Use } 7/8''\phi \text{ @ } 1'\text{-}0''\text{cc}$$

$$u_0 = \frac{4550}{2.8 \times .88 \times 17.5} = 106\ \#/\square'$$

The portion below motor room floor will be designed horizontally spanning between the bents and end walls of the pump room.

$$\text{Press @ El.44.25} = 1270 + 860 - 265 = 1865\ \#/\square'$$

Say 1870 #/□'



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 6.

Computation Riverside Wall

Computed by A.L.K. **Checked by** **Date** 7 Aug. 1945

F.E.M.

$M^F_{AB\,BA} = \frac{1}{12} \times 1870 \times 13.75^2 = 29.6^{'k}$ $\quad M^F_{BC\,CB} = \frac{1}{12} \times 1870 \times 12.25^2 = 23.6^{'k}$

$M^F_{CD\,DC} = \frac{1}{12} \times 1870 \times 9^2 = 16.8^{'k}$ $\quad M^F_{DE\,ED} = \frac{1}{12} \times 1870 \times 11.62^2 = 21.1^{'k}$

	A	B		C		D		E
10		.47	.53		.42	.58	.56	.44	1.0
	+29.6	-29.6	+23.6	-23.6	+16.8	-16.8	+21.1	-21.1
	0	+2.8	+3.2	+2.9	+3.9	-2.4	-1.9	0
	+1.4	0	+1.5	+1.6	-1.2	+2.0	0	+1.0
	0	-0.7	-0.8	-0.1	-0.3	-1.1	-0.9	0
-M	+31.0	-27.5	+27.5	-19.2	+19.2	-18.3	+18.3	-22.1
V	13100#	12600#	12180#	10820#	8500#	8300#	10570#	11230#
X_0	→ 7.0'		→ 6.5'		→ 4.55'		→ 5.65'	
+M	14700'#		12100'#		150'#		11500'#	

Mem AB

$\therefore d_{req'd\,-M} = \sqrt{\frac{31000}{147}} = 14.5'' < 20.5''$

$v = \frac{13100}{12 \times .88 \times 20.5} = 60.6\ \#/\square''$

$d_{req'd\,+M} = \sqrt{\frac{14700}{123}} = 10.9'' < 20.5''$

$-A_s = \frac{31000 \times 12}{18000 \times .88 \times 20.5} = 1.14\ \square''$ use 7/8" ϕ @ 6" in Mem's AB & BC from top of slab to El. 59.6

$+A_s = \frac{14700 \times 12}{18000 \times .88 \times 20.5} = .542\ \square''$ use 7/8" ϕ @ 1'-0" in Mem's AB & BC

$u = \frac{13100}{5.5 \times .88 \times 20.5} = 133\ \#/\square''$

Mem. DE

$-A_s = \frac{22100 \times 12}{18000 \times .88 \times 20.5} = .814\ \square''$ use 3/4" ϕ @ 6" in Mem's CD & DE

$u = \frac{11230}{4.71 \times .88 \times 20.5} = 132\ \#/\square''$

$+A_s = \frac{11500 \times 12}{18000 \times .88 \times 20.5} = .426\ \square''$ 3/4" ϕ @ 1'-0" in Mem CD & DE

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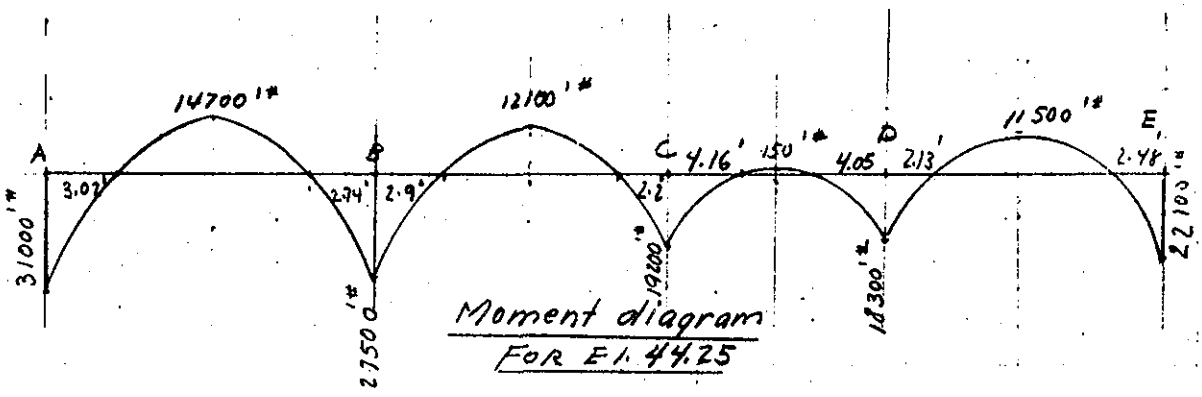
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

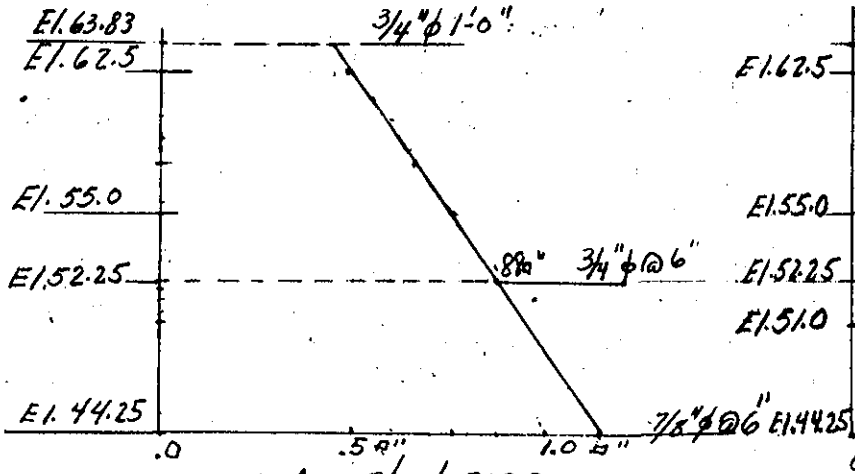
Subject Holyoke Pumping Station No. 6

Computation Riverside Wall

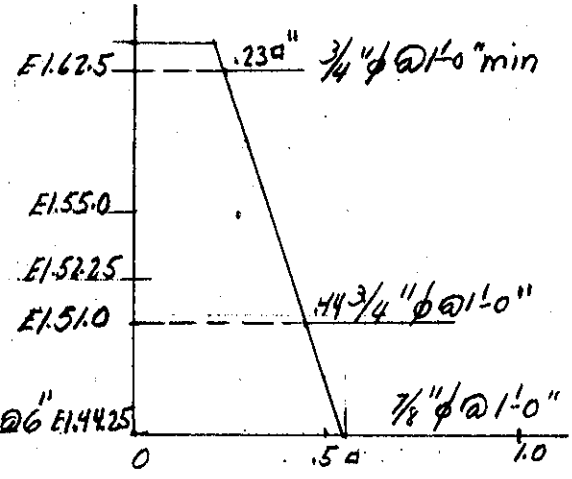
Computed by A.K. **Checked by** _____ **Date** 9 Aug. 1945



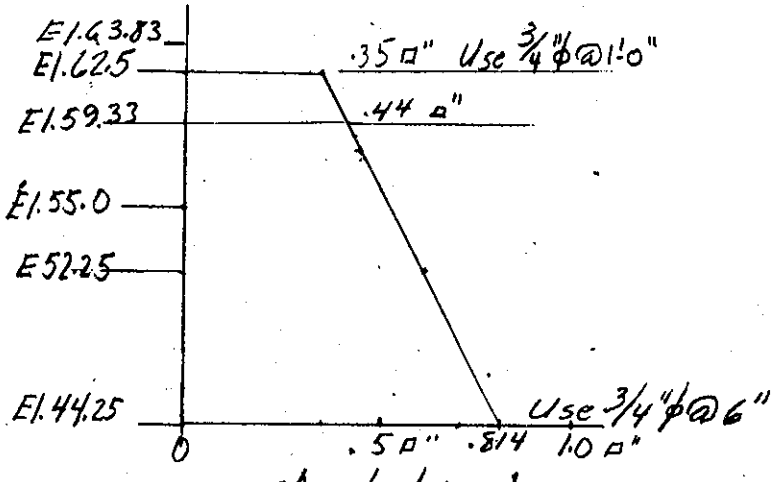
Moment diagram
For El. 44.25



−As steel req'd
For Joint A



+As steel req'd.
For Mem. AB



−As steel req'd
For Joint E

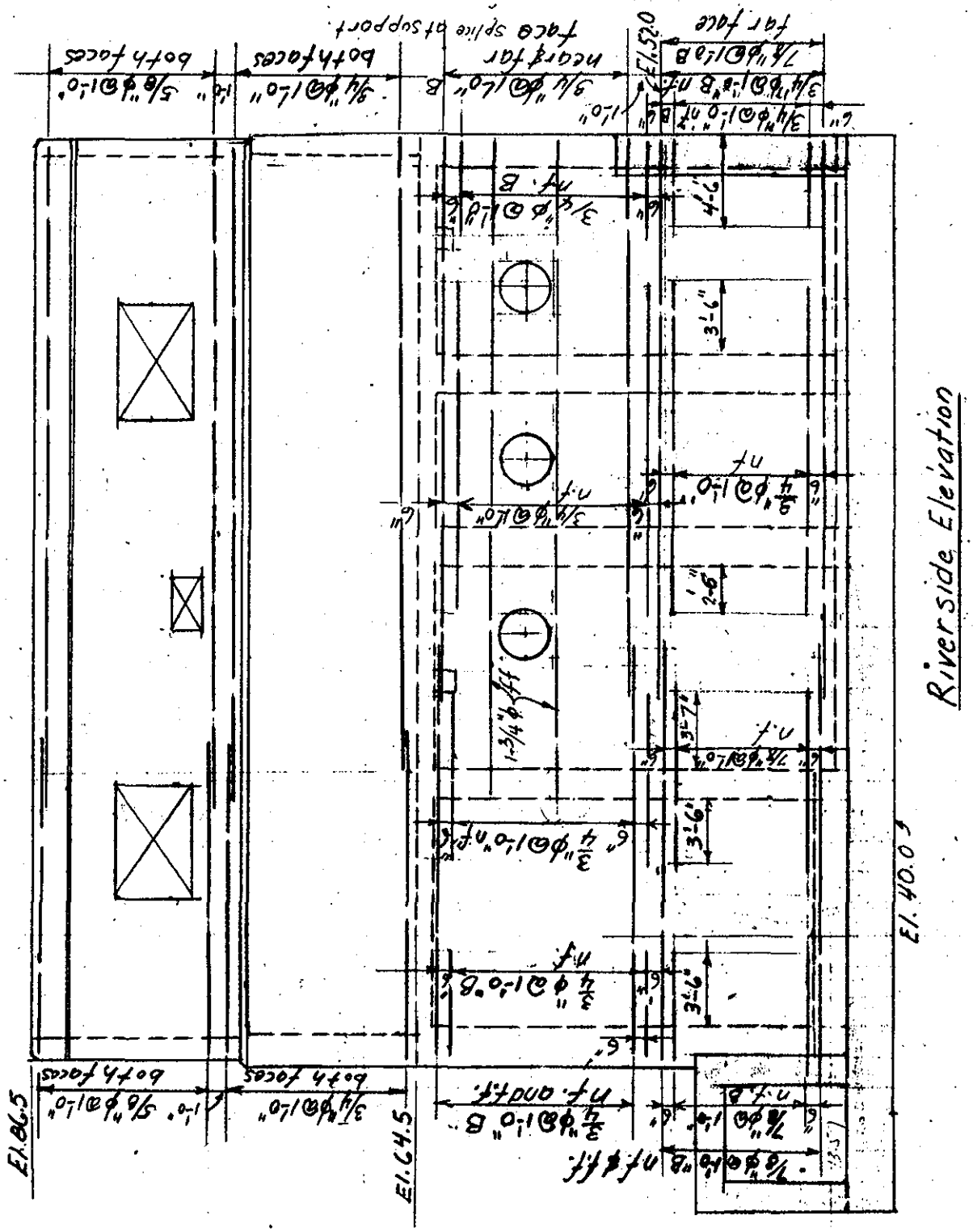
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation Riverside Wall

Computed by A.L.K. **Checked by** _____ **Date** 9 Aug 1945



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation North Landside Wall

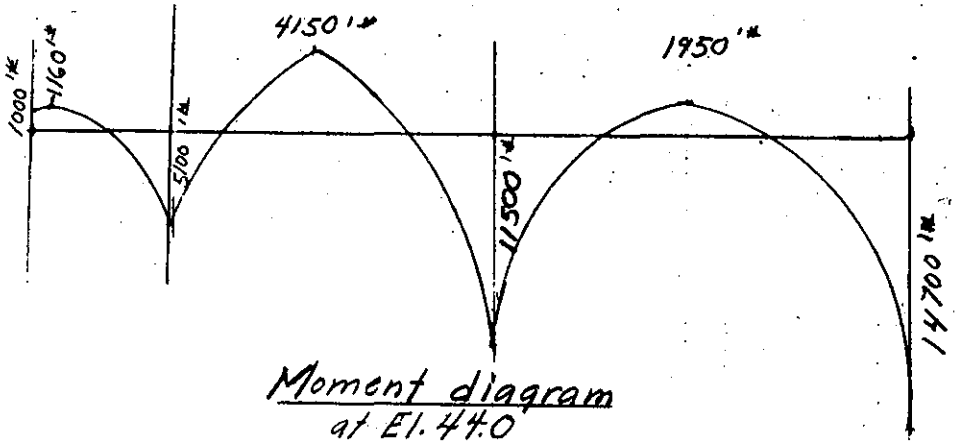
Computed by A.L.K. **Checked by** _____ **Date** 20 Aug 1945

Pressure at El. 44.0 = 320 + 80 × 11 = 1200 #/ft.

$F.E.M. = M^F_{\substack{AB\\BA}} = \frac{1}{12} \times 1200 \times 3.75^2 = 1.4'^k$; $M^F_{\substack{BC\\CB}} = \frac{1}{12} \times 1200 \times 9^2 = 8.1'^k$

$M^F_{\substack{CD\\DE}} = \frac{1}{12} \times 1200 \times 11.62^2 = 13.5'^k$

fixed	1	.71	.29	1200#/ft.	.56	.44	1	fixed
	A	B		C			D	
	3'-9"		9'-0"		11'-7½"			
	+1.4	-1.4	+8.1	-8.1	+13.5	-13.5		
	0	-4.8	-1.9	-3.0	-2.4	0		
	-2.4	0	-1.5	-1.0	0	-1.2		
	0	+1.1	+0.4	+.6	+.4	0		
−M	-1.0	-5.1	+5.1	-11.5	+11.5	-14.7		
V	625#	3875#	4690#	6110#	5600	7260#		
X_0	→ .52'		→ 3.91'		→ 4.67'			
+M	1160'#		4150'#		1950'#			



Moment diagram at El. 44.0

Joint D.

$d\ req'd = \sqrt{\frac{14700}{147}} = 10'' < 17.0''$

$v = \frac{7260}{12 \times .88 \times 17.0} = 40.5\ \#/\square''$

$-A_s = \frac{14700 \times 12}{18000 \times .88 \times 17.0} = .656\ \square''$ use 3/4" ϕ @ 8"

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WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 6

Computation North Landside Wall

Computed by A.L.K. **Checked by** _____ **Date** 20 Aug 1945

$$u = \frac{7260}{3.5 \times .88 \times 17.0} = 139 \ \#/\square''$$

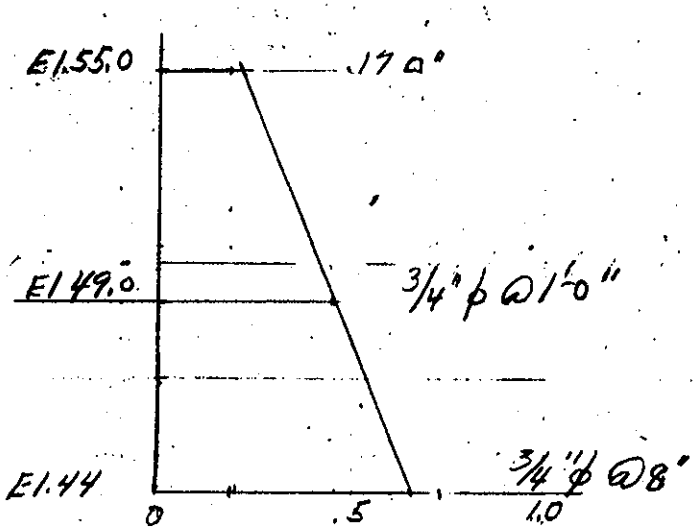
Pf. at which $-A_s = 3/4''\phi$ @ 1'-0". Joint D.

$$-M = \frac{18000 \times .88 \times 17.0 \times .44}{12} = 9900 \ '\#$$

$$\frac{9900}{14700} = \frac{P}{1200} \qquad P = 805 \ \#/\square'$$

At El. 49.0 $\quad p = 320 + 80 \times 6 = 800 \ \#/\square'$

At El. 55.0 $\quad p = 320 \ \#/\square' \qquad \frac{A_s}{.66} = \frac{320}{1200} \qquad -A_s = .170 \ \square''$



$-A_s$ Steel Req'd For Joint D

Joints B at El. 44.0

at Jt. B $\quad -A_s = \frac{5100 \times 12}{18000 \times .88 \times 17.0} = .23 \ \square''$

$$u = \frac{4690}{2[illegible] \times .88 \times 17.0} = 131 \ \#/\square''$$

at Jt C $\quad -A_s = \frac{11500 \times 12}{18000 \times .88 \times 17.0} = .51 \ \square''$ use 3/4" φ @ 8"

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WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation North Landside Wall

Computed by A.L.K. **Checked by** _____ **Date** 20 Aug 1945

Horiz. Section at El. 52.0

Pres. at El. 52.0 = 320 + 3×80 = 560 #/□' for members BC, CD & DE

pres @ El. 52.0 = 1.5×62.5 = 94 #/□' for member AB

$M^F_{AB,BA} = \frac{1}{12} \times 94 \times 13.75^2 = 1.48$ 'K. $M^F_{BC,CB} = \frac{1}{12} \times 560 \times 12.25^2 = 7.00$ 'K.

$M^F_{CD,DC} = \frac{1}{12} \times 560 \times 9^2 = 3.78$ 'K. $M^F_{DE,ED} = \frac{1}{12} \times 560 \times 11.62^2 = 6.30$ 'K.

	94 #/FT.		560 #/FT.						
fixed	1.0	.60	.40	.42	.58	.56	.44	1.0	fixed
	A	B		C		D		E	
	13'-9"		12'-3"		9'-0"		11'-7½"		
	+1.48	−1.48	+7.00	−7.00	+3.78	−3.78	+6.30	−6.30	
	0	−3.32	−2.20	+1.35	+1.87	−1.41	−1.11	0	
	−1.66	0	+.68	−1.10	−.72	+.94	0	−.56	
	0	−.41	−.27	+.17	+1.05	−.53	−.41	0	
	−.22	0	+.39	−.14	−.27	+.53	0	−.22	
	0	−.23	−.16	+.17	+.24	−.29	−.24	0	
−M	−.40	−5.44	+5.44	−5.95	+5.95	−4.54	+4.54	−7.08	
V	220#	1070#	3260#	3340#	2680#	2370#	3030#	3470#	
x_0	→ 2.34'		→ 5.82'		→ 4.78'		→ 5.4'		
+M	660'#		4000'#		440'#		3660'#		

$d_{req'd} \sqrt{\frac{7080}{147}} = 6.94'' < 16.88''$

$v = \frac{3470}{12 \times .88 \times 16.88} = 19.5$ #/□"

$-A_s = \frac{7080 \times 12}{18000 \times .88 \times 16.88} = .318$ □" use 3/4" φ @ 1'-0" both faces

$u = \frac{3470}{24 \times .88 \times 16.88} = 97.5$ #/□"

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No 6

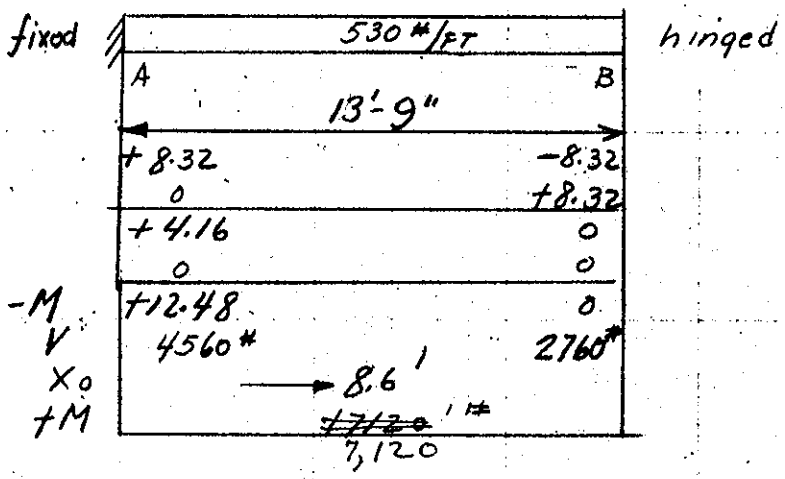
Computation North Landside Wall

Computed by A.L.K. **Checked by** _____ **Date** 23 Aug 1945

Horiz. Section of wall at El. 45.0

$p = 8.5 \times 62.5 = 530\ \#/\square'$

$M^F_{AB,BA} = \frac{1}{12} \times 530 \times 13.75^2 = 8.32^{1K}$



d reqd $\sqrt{\frac{7120}{123}} = \cancel{11.8}\ 7.6'' > 20.88''$

$v = \frac{4560}{12 \times .88 \times 20.88} = 20.7\ \#/\square''$

$+A_s = \frac{17,120 \times 12}{18000 \times .88 \times 20.88} = \cancel{.220}\ .26''$ use $\cancel{\frac{1}{2}}\ \frac{3}{4}''\phi$ @ 1'-0"

$-A_s = \frac{12480 \times 12}{18000 \times .88 \times 20.88} = .45\ \square''$ use $\frac{3}{4}''\phi$ @ 1'-0"

$u = \frac{4560}{2.4 \times .88 \times 20.88} = 103\ \#/\square''$

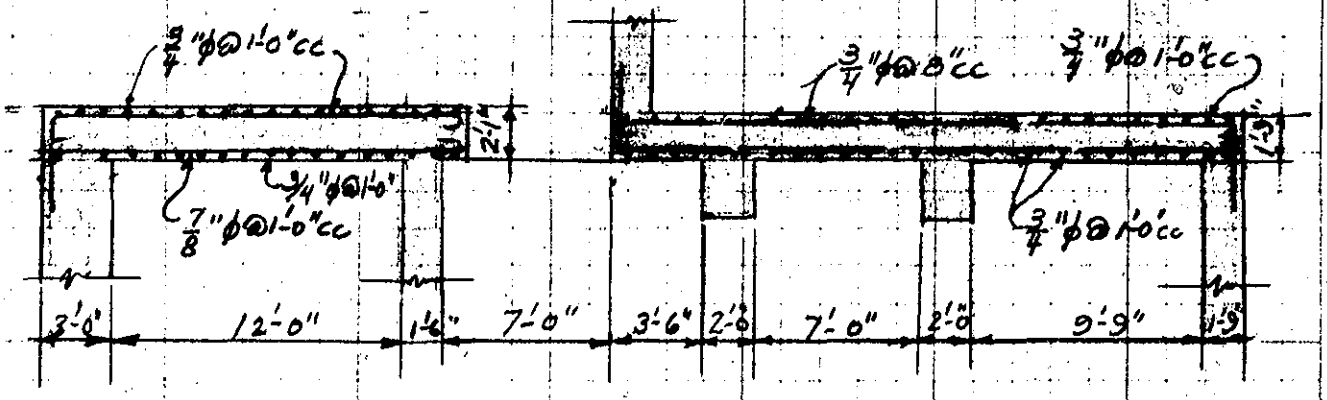
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

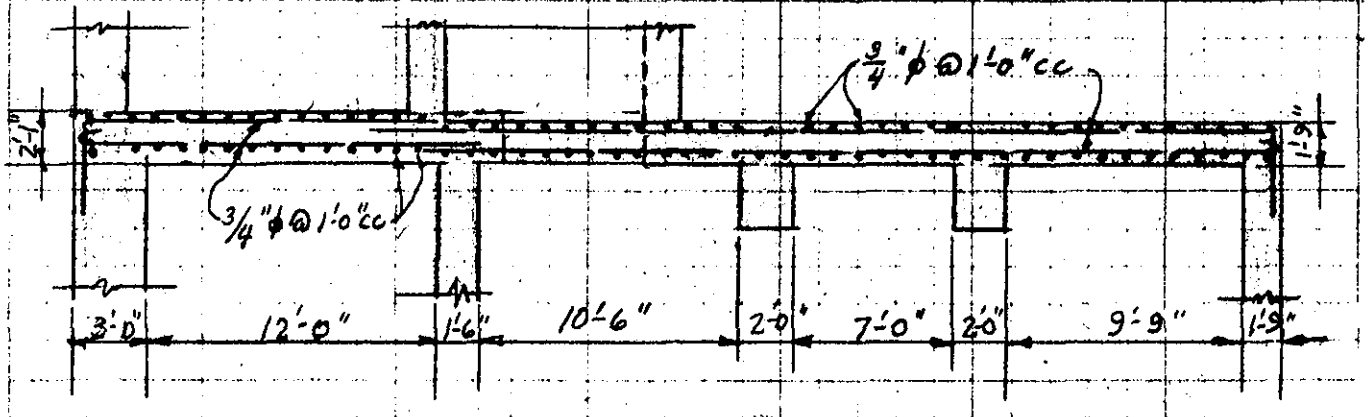
Subject HOLYOKE PUMPING STATION No. 6

Computation North Landside Wall

Computed by A.L.K. **Checked by** _____ **Date** 23 Aug 1945



Horiz. Section of landside wall for reinf. from El. 44.25 to El. 51.75



Horiz. Section of landside wall for reinf. from El. 51.75 to El. 64.5

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

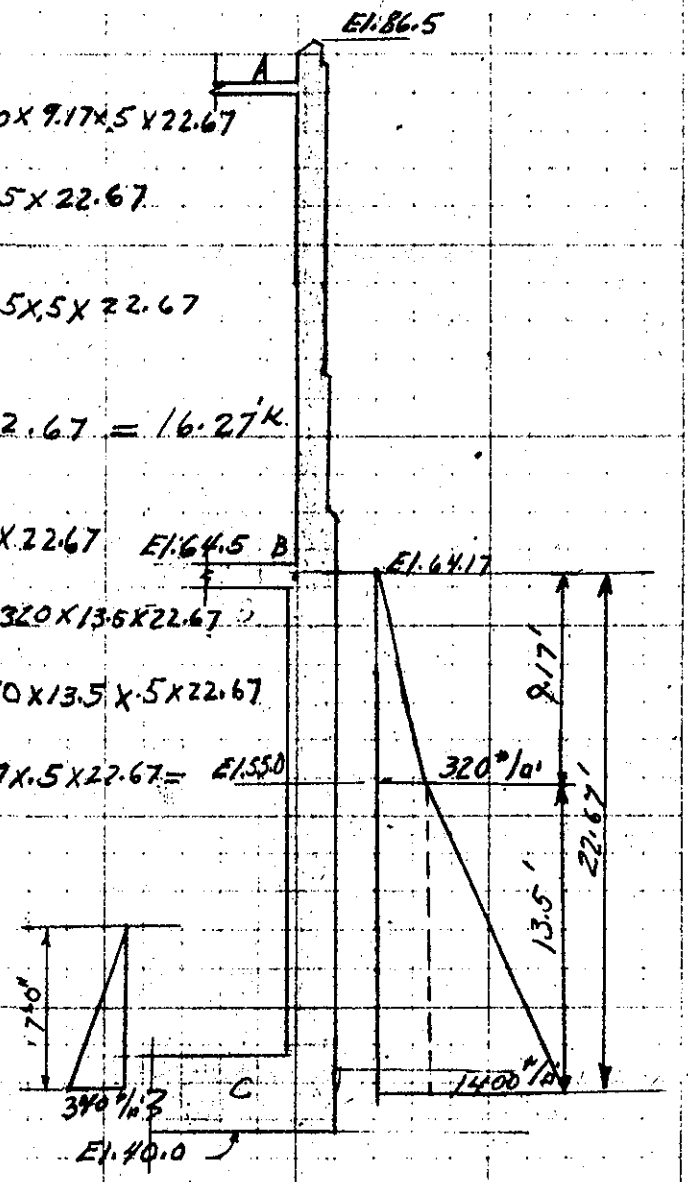
Subject HOLYOKE PUMPING STATION No. 6

Computation East End Wall

Computed by A.L.K. **Checked by** _____ **Date** 29 Aug 1945

Wall will be designed vertically; hinged at roof, continuous at motor room floor and fixed at base.

Fixed End Moments



$$M^F_{BD} = \frac{.405(10-15\times.405+6\times.405^2)}{15}\times 320\times 9.17\times.5\times 22.67 \quad (4.91)$$

$$+\frac{.597^2(4-3\times.597)}{12}\times 320\times 13.5\times 22.67 \quad (2.21)$$

$$+\frac{.597^2(5-3\times.597)}{30}\times 1080\times 13.5\times.5\times 22.67 \quad (3.21)$$

$$-\frac{.31^2(5-3\times.31)}{30}\times 340\times 7\times.5\times 22.67 = 16.27'^K \quad (4.07)$$

$$M^F_{DB} = \frac{.405^2(5-4\times.405)}{10}\times 320\times 9.17\times.5\times 22.67 \quad (3.38)$$

$$+\frac{.597(6-8\times.597+3\times.597^2)}{12}\times 320\times 13.5\times 22.67 \quad (2.3)$$

$$+\frac{.597(10-10\times.597+3\times.597^2)}{30}\times 1080\times 13.5\times.5\times 22.67 \quad (5.1)$$

$$-\frac{.31(10-10\times.31+3\times.31^2)}{30}\times 340\times 7\times.5\times 22.67 = \quad (7.19)$$

$$= 27.74'^K$$

Mem.	d^3/L
AB	$\frac{21^3}{22.67} = 410$
BC	$\frac{14^3}{20.37} = 135$

		0.00	0.00	0.00	0.00	Hinged
		0.00	0.00	-2.04	+2.04	0
	+3.31	+.26	-1.02	0.00	0.00	
	-3.31	+.76	0.00	0.00	+4.07	.25
		0.00	0.00	+12.20	0.00	
+33.84		0.00	0.00	-16.27		.75
		0.00	0.00	0		
			+6.[illegible]	+27.74		
						1.0
						Fixed

Member AB

$$H_A = H_B = \frac{3310}{20.37} = 160\#$$

$$H_B = 320\times 9.17\times.5\times\frac{16.52}{22.67} + 320\times 13.5\times\frac{6.75}{22.67}$$

$$+ 1080\times 13.5\times.5\times\frac{4.36}{22.67} - \frac{30530}{22.67}$$

$$- 340\times 7.5\times.5\times\frac{2.67}{22.67} = 2,270\#$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation East. End Wall

Computed by A.L.K. **Checked by** _____ **Date** 29 Aug 1945

$$H_c = 320 \times 9.17 \times .5 \times \frac{6.15}{22.67} + 320 \times 13.5 \times \frac{15.92}{22.67} + 1080 \times 13.5 \times .5 \times \frac{18.31}{22.67}$$

$$+ \frac{30530}{22.67} - 340 \times 7.5 \times .5 \times \frac{20.00}{22.67} = 9590.^{\#}$$

$X_0 = 11.17'$ from B

$$+M = 2270 \times 11.17 - 320 \times \frac{9.17}{2} \times 5.05 - 320 \times \frac{2^2}{2} - \frac{80 \times 2^3}{6} - 3310 =$$

$+M = 13830'^{\#}$

$$d_{req'd\ -M} \sqrt{\frac{33840}{147}} = 15.2'' < 17.5''$$

$$v = \frac{9590}{12 \times .88 \times 17.5} = 52^{\#}/\square''$$

at C $\quad -A_s = \dfrac{33840 \times 12}{18000 \times .88 \times 17.5} = 1.46\ \square''$ use $1''\phi$ @ 6"

$+A_s = \dfrac{13830 \times 12}{18000 \times .88 \times 17.5} = .60\ \square''$ use $\frac{7}{8}''\phi$ @ 1'-0"

$$u = \frac{9590}{6.3 \times .88 \times 17.5} = 98.5^{\#}/\square''$$

at B $\quad -A_s = \dfrac{3310 \times 12}{18000 \times .88 \times 10.5} = .24\ \square''$ Use $\frac{5}{8}''\phi$ @ 1'-0"

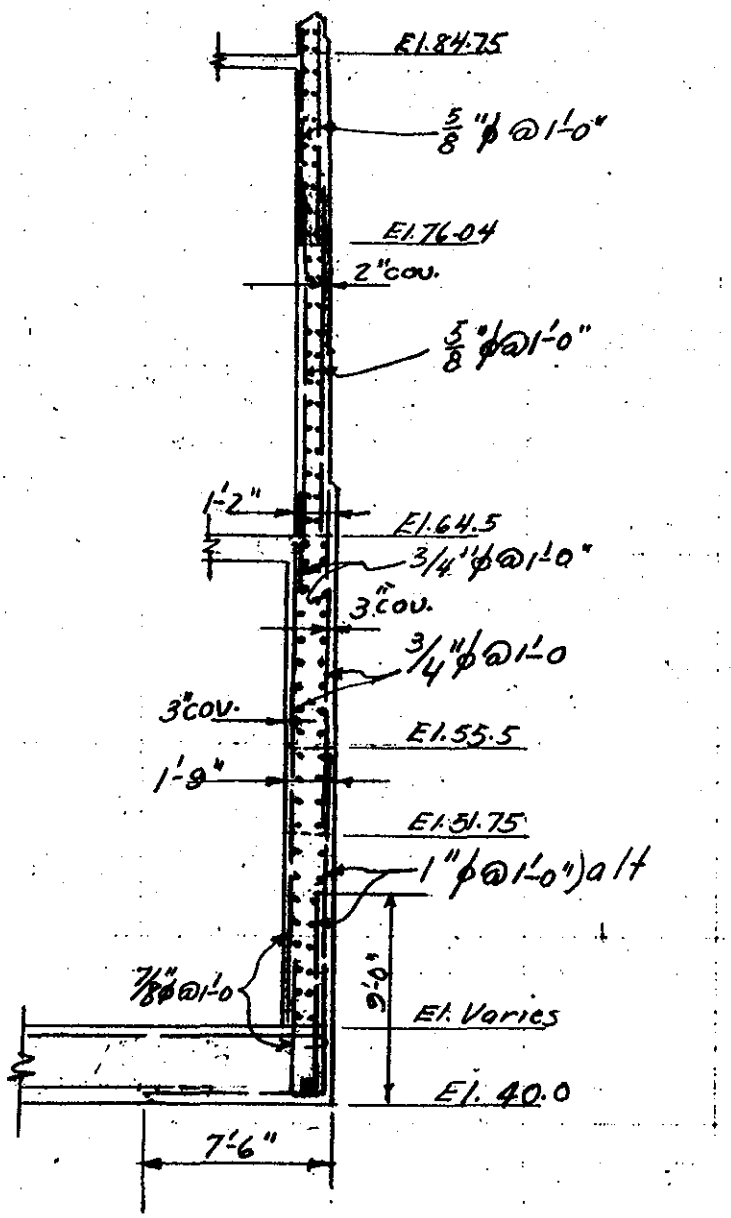
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation East End Wall

Computed by A.L.K. **Checked by** _____ **Date** 31 Aug 1945



F 244

WAR DEPARTMENT

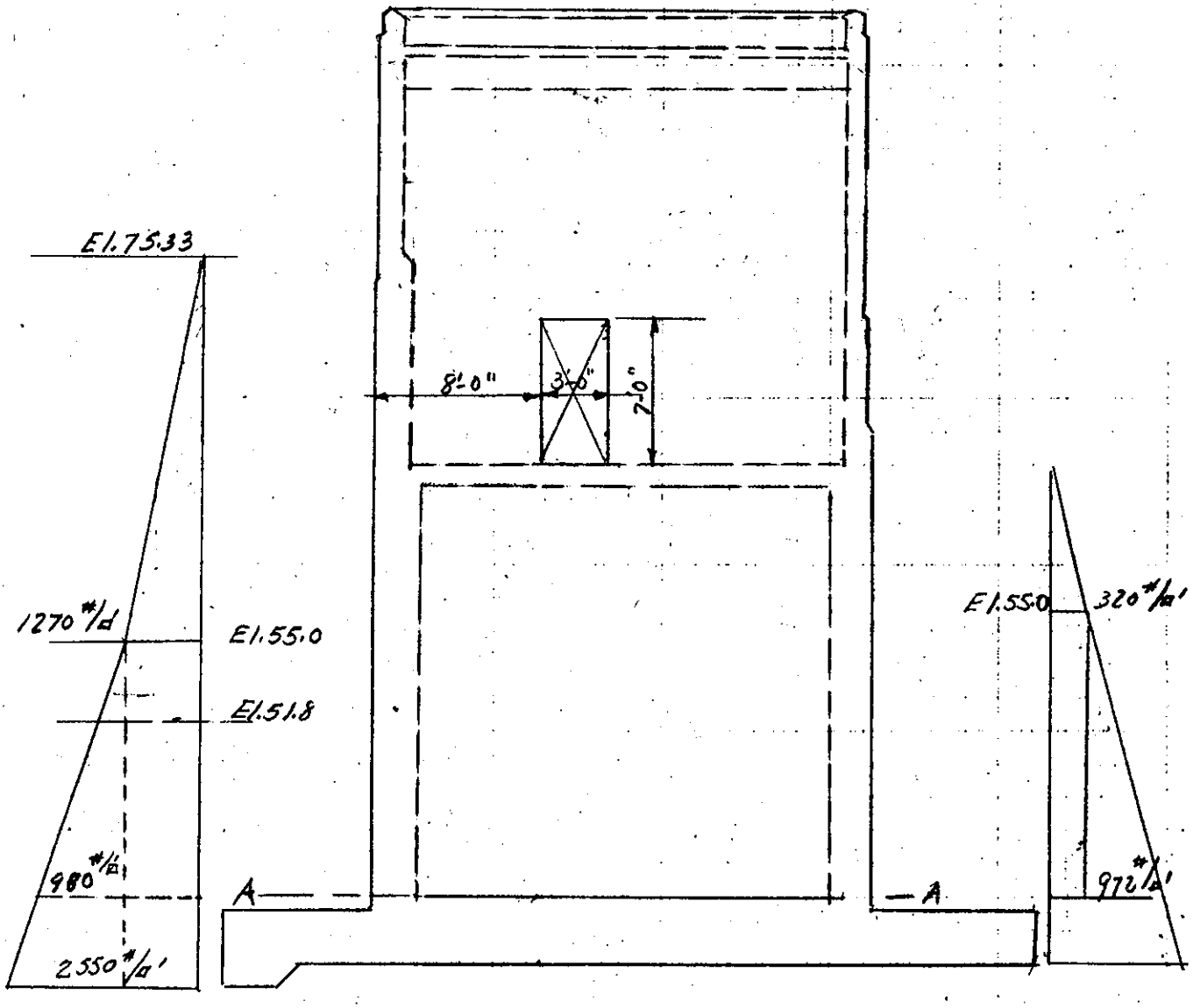
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 6

Computation East End Wall.

Computed by A.L.K. **Checked by** _____ **Date** 4 Sept 1945

Wall will be designed as cantilevered about base.



Moments about A-A

$$M_{A-A} = 1270 \times 20.33 \times .5 \times 18.94 + 1270 \times \frac{12.17^2}{2} + 980 \times 12.17 \times .5 \times 4.06$$

$$- 320 \times 9.5 \times 15.17 - 320 \times \frac{12.17^2}{2}$$

$$- 972 \times 12.17 \times .5 \times 4.06 = 292{,}800 \text{ '\#}$$

$$\text{Total } M_{A-A} = 6.62 \times 292800 = 1{,}940{,}000 \text{ '\#}$$

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Subject HOLYOKE PUMPING STATION NO. 6
Computation East End Wall
Computed by A.L.K. **Checked by** **Date** 4 Sept 1945

$d = 271.0''$

d req'd $\sqrt{\frac{1,940,000 \times 12}{147 \times 21}} = 87.0'' < 271.0''$

$A_s = \frac{1,940,000 \times 12}{18000 \times .88 \times 271} = 5.43 \square''$ use 6-1" □

$V_{\#/FT} = 1270 \times 20.33 \times .5 + 980 \times 12.17 \times .5 + 1270 \times 12.17 - 320 \times 9 \times .5 - \left(\frac{320 + 1292}{2}\right) 12.17 =$

$V_{\#/FT} = 23,020$ #/FT.

Total $V = 6.62 \times 23,020 = 152500$#

$u = \frac{152500}{24 \times .88 \times 271} = 26.6$ #/□".

at El. 51.8 $M = 1270 \times \frac{20.33}{2} \times 10 + 1270 \times \frac{3.21^2}{2} + 80 \times \frac{3.21^3}{6} = 135,980$ '#

Total $M = 135980 \times 6.62 = 896,000$ '#

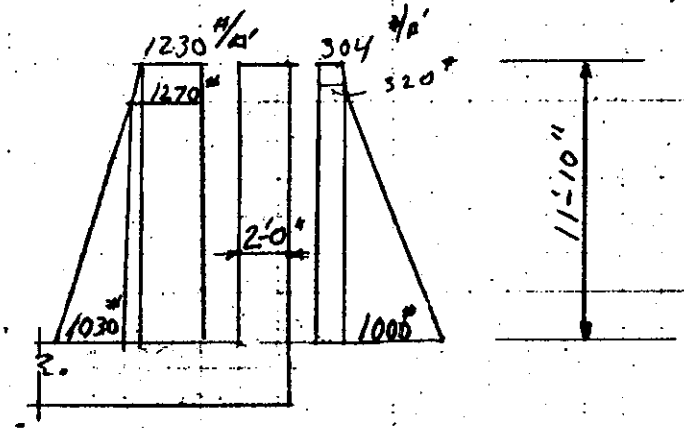
$A_s = \frac{896,000 \times 12}{18000 \times .88 \times 271} = 2.51 \square''$ use 6-7/8" ϕ

At El. 64.5 $M = 62.5 \times \frac{10.83^3}{6} \times 6.62 = 88000$ '#

$A_s = \frac{88000 \times 12}{18000 \times .88 \times 271} = .245 \square''$ use 4-7/8" ϕ

Subject Holyoke Pumping Station No. 6
Computation Sheet Piling Cutoff Wall
Computed by A.L.K. **Checked by** **Date** 5 Sept 1945

Design wall Horizontally



Net press $2300 - 1320 = 980$ #/□'

$M = \frac{980 \times 5.5^2}{2} = 14900$ '#

d req'd $\sqrt{\frac{14900}{147}} = 10.1" < 20.5"$

$v = \frac{980 \times 5.5}{12 \times .88 \times 20.5} = 248$ #/□"

$A_s = \frac{14900 \times 12}{18000 \times .88 \times 20.5} = .55$ □" Use 7/8"φ @ 1'-0"

3/4"φ Vert. @ 1'-0"

$u = \frac{5400}{2.8 \times .88 \times 20.5} = 107$ #/□"

WAR DEPARTMENT

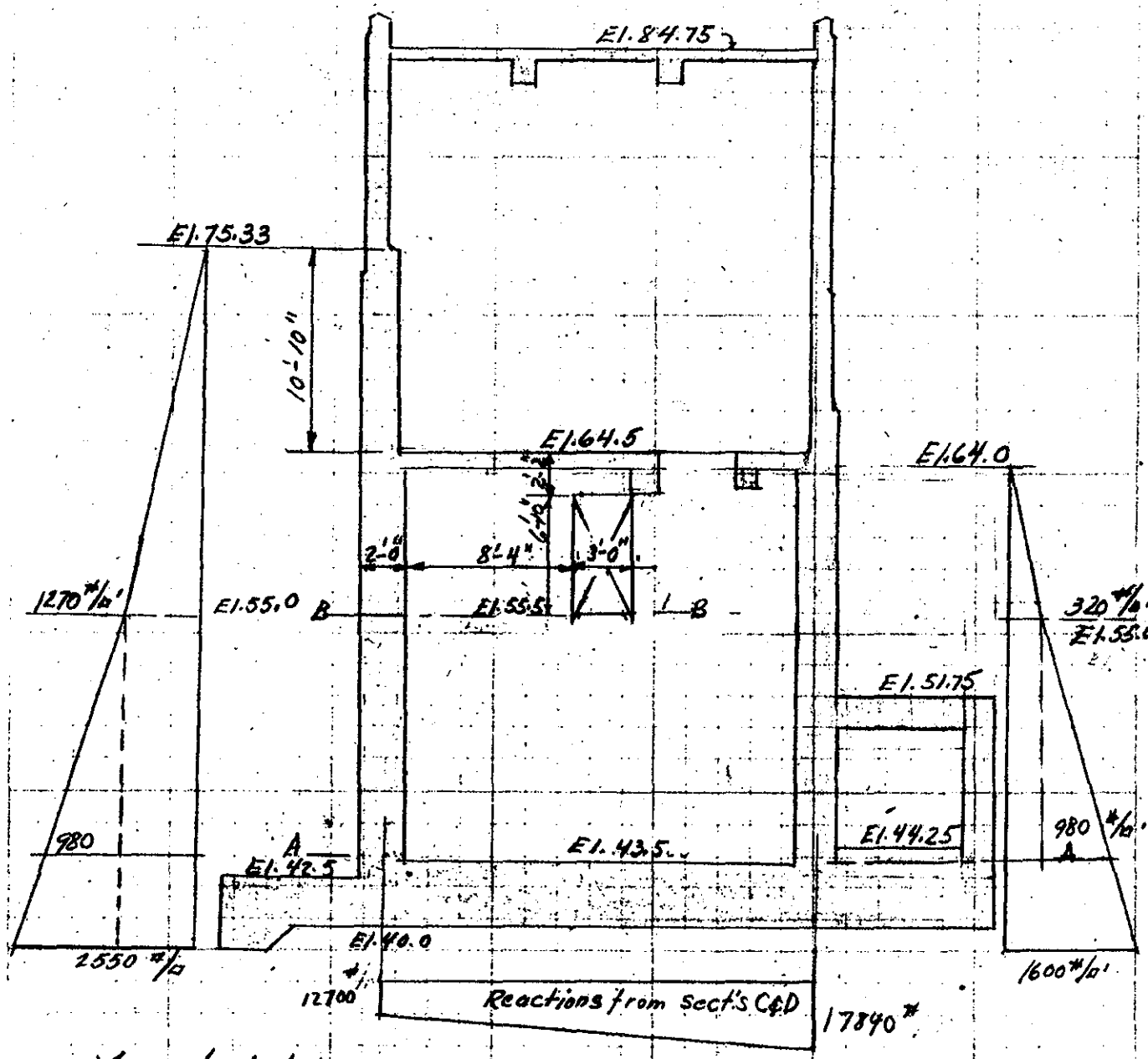
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION NO. 6

Computation Dividing wall

Computed by A.L.K. **Checked by** **Date** 5 Sept 1945

Dividing wall will be designed to withstand lateral pressure
. Loaded section equals 12'-9"



Moments A-A

$$M_{A-A} = 1270 \times 20.33 \times .5 \times 18.27 + 1270 \times \frac{11.5^2}{2} + 980 \times \frac{11.5}{2} \times 3.8$$

$$- 320 \times 9 \times .5 \times 14.5 - 320 \times \frac{11.5^2}{2} - 980 \times 11.5 \times .5 \times 3.8 = 276{,}900'\#$$

Total $M_{A-A} = 12.75 \times 276{,}900 = 3{,}520{,}000'\#$

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WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 6

Computation Dividing Wall

Computed by A.L.K. **Checked by** **Date** 5 Sept 1945

$d = 271.0''$

$d_{req'd} = \sqrt{\frac{3,520,000 \times 12}{147 \times 18}} = 126.5'' < 271''$

$V = 1270 \times 20.33 \times .5 + 1270 \times 11.5 + 980 \times 11.5 \times .5$
$\#/FT \quad - 320 \times 9 \times .5 - 320 \times 11.5 - 980 \times 11.5 \times .5 = 22,380^{\#}$

Total $V = 12.75 \times 22380 = 284000^{\#}$

$A_s = \frac{3520,000 \times 12}{18000 \times .88 \times 271} = 9.85 \square''$ use $\underline{8-1\frac{1}{8}''\square}$

$u = \frac{284000}{36 \times .88 \times 271} = 33\ \#/\square''$

at El. 55.5 river $p = 62.5 \times 19.83 = 1240\ \#/\square'$
landside $p = 35 \times 8.5 = 300\ \#/\square'$

$M_{B-B} = 1240 \times 19.83 \times .5 \times 6.61 = 81500'^{\#}$

Total Mom. $= 81500 \times 12.75 = 1,040,000'^{\#}$

$d_{req'd} = \sqrt{\frac{1,040,000 \times 12}{18 \times 147}} = 68.7'' < 109''$

$A_s = \frac{1,040,000 \times 12}{18000 \times .88 \times 109} = 7.24 \square''$ use $\underline{8-1''\square}$

$V = 1240 \times 19.83 \times .5 \times 12.75 = 157000^{\#}$

$v = \frac{157000}{18 \times .88 \times 109} = 91\ \#/\square$

$u = \frac{157000}{32 \times .88 \times 109} = 51.2\ \#/\square''$

WAR DEPARTMENT

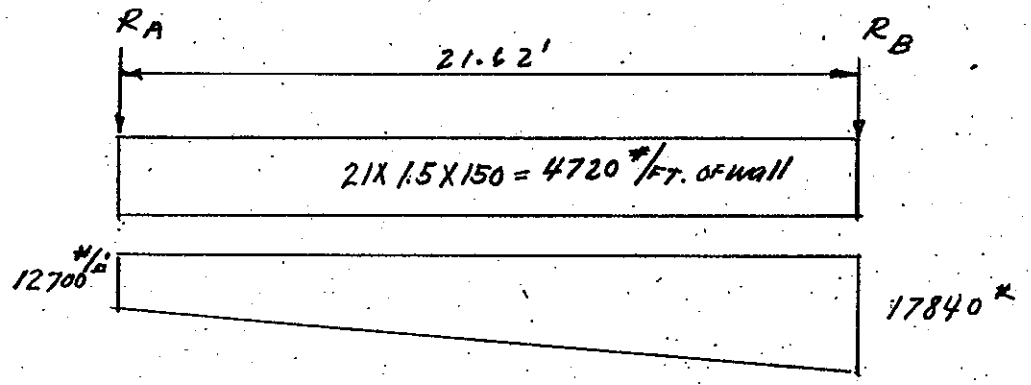
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 6

Computation Dividing Wall

Computed by A.L.K. **Checked by** **Date** 6 Sept., 1945

Wall below El. 55.5 will be designed as a vertical beam supported by landside and riverside walls.



$R_A = 7980 \times 21.62 \times .5 + 5140 \times 21.62 \times .5 \times .33 = 104700$ #

$R_B = 7980 \times 21.62 \times .5 + 5140 \times 21.62 \times .5 \times .67 = 123200$ #

$X_0 = 12.05'$ from R_A

$+M = 104700 \times 12.05 - 7980 \times \frac{12.05^2}{2} - \frac{5140}{21.62} \times \frac{12.05^3}{6} = 612700$ '#

$d \text{ req'd} = \sqrt{\frac{612700 \times 12}{.123 \times 18}} = 57.6'' < 182.5''$

$v = \frac{123700}{18 \times .88 \times 182.5} = 427$ #/□"

$A_s = \frac{612700 \times 12}{18000 \times .88 \times 182.5} = 2.55$ □" Use 3-1"φ

$u = \frac{123700}{9.42 \times .88 \times 182.5} = 82$ #/□"

WAR DEPARTMENT

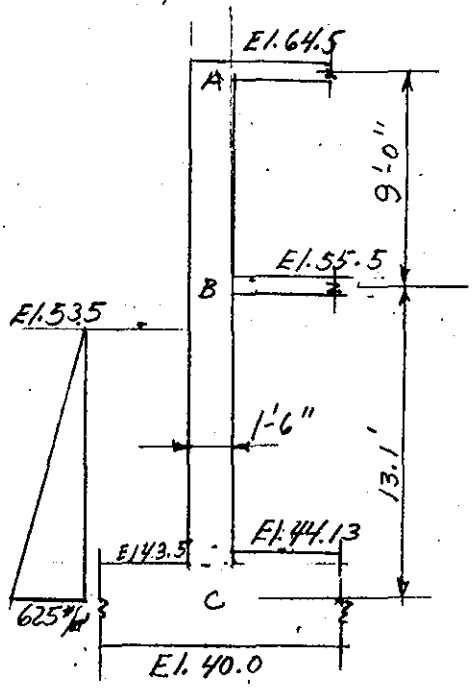
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Dividing Wall.

Computed by A.L.K. **Checked by** _____ **Date** 6 Sept 1945

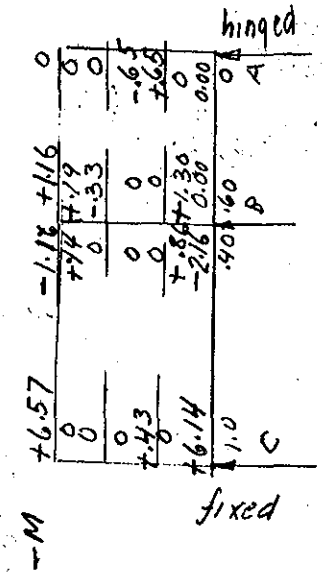
Wall will be designed vertically to resist hydrostatic head.



pres @ El. 43.5 = 62.5 X 10 = 625 #/□'

Fixed End Moment $M^F_{BC} = \frac{.764^2(5-3\times .764)}{30} \times 625\times 10\times .5\times 13.1 = 2.16'^{k}$ (2.71)

$M^F_{CB} = \frac{.764(10-10\times .764+6\times .764^2)}{30} \times 625\times 10\times .5\times 13.1 = 6.14'^{k}$ (5.86)



$H_A = H_B = \frac{1160}{9} = 128.\#$

$H_B = 625\times 10\times .5\times \frac{3.33}{13.1} - \frac{5410}{13.1} = 380\#$

$H_C = 625\times 10\times .5\times \frac{9.77}{13.1} + \frac{5410}{13.1} = 2750\#$

Reaction at B = 510#

$d_{req'd} = \sqrt{\frac{6570}{147}} = 6.7" < 14.5"$

at C $-A_s = \frac{6570\times 12}{18000\times .88\times 14.5} = .344\ \square''$ use 3/4"φ @ 1'-0" both faces

$v = \frac{2750}{12\times .88\times 14.5} = 17.9\ \#/\square$

$u = \frac{2750}{2.4\times .88\times 14.5} = 90\ \#/\square''$

For reinforcement details see sheets No. ~~282~~ 283 and No. ~~286~~ 289

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WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

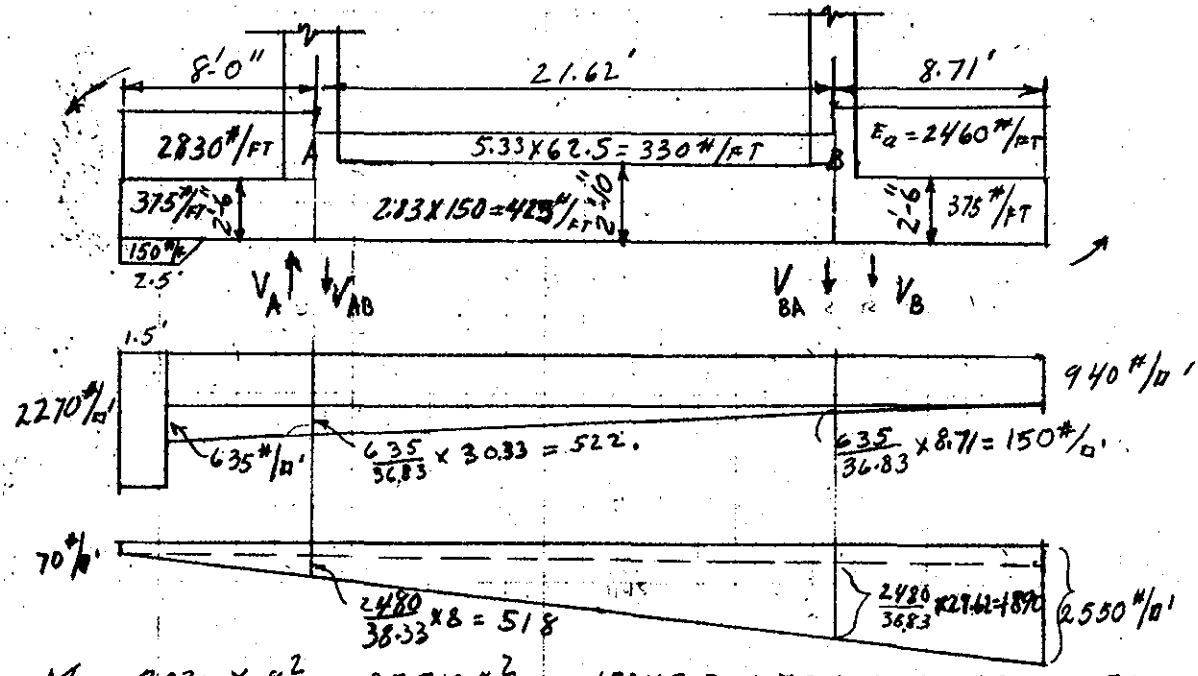
Subject HOLYOKE PUMPING STATION No. 6

Computation Base slab at section A-A

Computed by A.L.K. **Checked by** _____ **Date** 9 Aug 1945

CASE I

Base slab between bents will be designed as simply supported at vertical walls.



$$M_A = 2830 \times \frac{8^2}{2} + 375 \times \frac{8^2}{2} + 150 \times 2.5 \times 6.75 + 1 \times 1 \times 150 \times .5 \times 5.17$$
$$- 2270 \times 1.5 \times 7.25 + \left(\frac{635}{36.83} \times 30.33 + 940\right) \frac{6.5^2}{2} - 113 \times \frac{6.5}{2} \times 4.34$$
$$- 70 \times \frac{8^2}{2} - \frac{2480}{38.33} \times \frac{8^2}{2} \times 2.66 = 40{,}230'\#$$

$$V_A = 2830 \times 8 + 375 \times 8 + 150 \times 2.5 + 1 \times 1 \times .5 \times 150 - 2270 \times 1.5$$
$$- \left(\frac{635}{36.83} \times 30.33 + 940\right) 6.5 - 113 \times \frac{6.5}{2} - 70 \times 8 - \frac{2480}{38.33} \times \frac{8^2}{2} = 10160\#$$

$$M_B = 215 \times \frac{8.71^2}{2} + 440 \times \frac{8.71}{2} \times 5.81 = 19280'\#$$

$$V_B = 215 \times 8.71 + 440 \times \frac{8.71}{2} = 3790\#$$

$$V_{AB} = 1295 \times \frac{21.62}{2} + 1000 \times 21.62 \times .5 \times .33 - \frac{59510}{21.62} = 14860\#$$

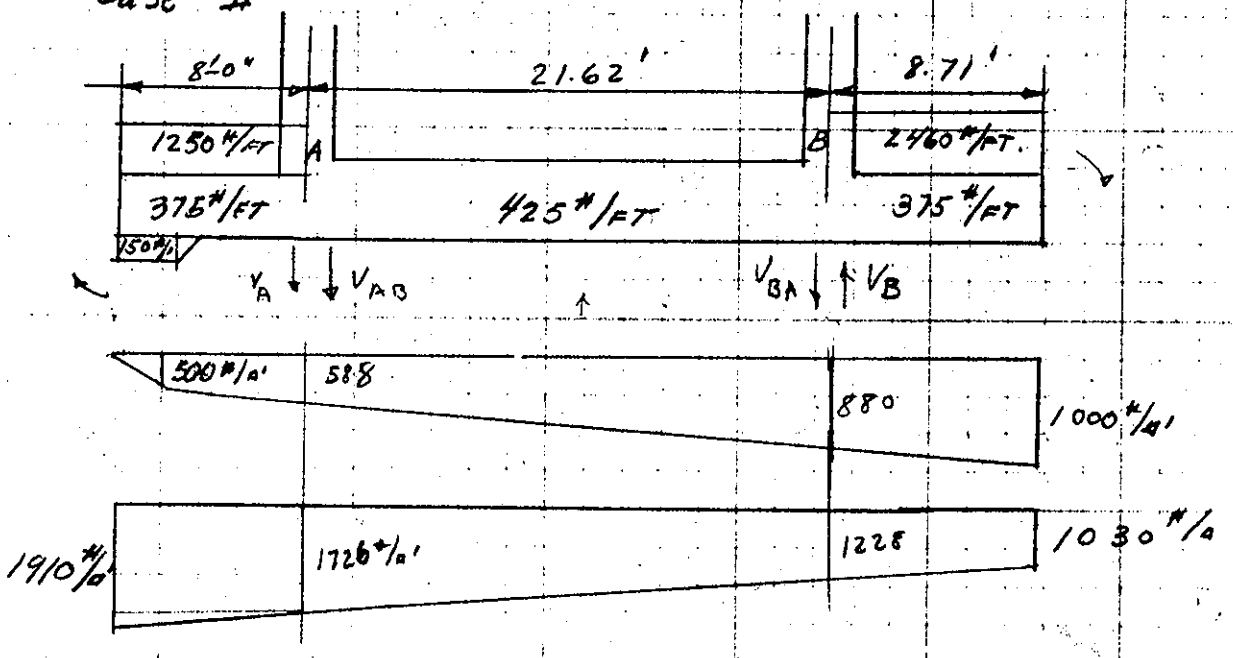
$$V_{BA} = 1295 \times \frac{21.62}{2} + 1000 \times 21.62 \times .5 \times .67 + \frac{59510}{21.62} = 23970\#$$

x_0 = 9.80 ft from R_A

$$+M = 14860 \times 9.80 + 40230 - 1295 \times \frac{9.80^2}{2} - \frac{1000}{21.62} \times \frac{9.80^3}{6} = 116{,}070'\#$$

Subject Holyoke Pumping Station No. 6
Computation Base Slab at section A-A
Computed by A.L.K. **Checked by** _____ **Date** 10 Aug 1945

Case II



$$M_A = 1250\times\frac{8^2}{2} + 375\times\frac{8^2}{2} + 150\times 2.5\times 6.75 + 75\times 5.17$$
$$- 500\times 1.5\times .5\times 7.0 - 500\times\frac{6.5^2}{2} - \frac{500}{36.83}\times\frac{6.5^2}{2}\times 2.16$$
$$- \left(\frac{880}{38.33}\times 30.33 + 1030\right)\frac{8^2}{2} - 190\times\frac{8^2}{3} = 17900\,'\#$$

$$V_A = 1250\times 8 + 375\times 8 + 150\times 2.5 + 75 - 500\times\frac{1.5}{2} + 500\times 6.5$$
$$- \frac{500}{36.83}\times\frac{6.5^2}{2} - \left(\frac{1910+1726}{2}\right)8 = 5000\#$$

$$M_B = 727\times\frac{8.71^2}{2} + 7.8\times\frac{8.71}{2}\times 5.81 = 29580\,'\#$$

$$V_B = \left(\frac{727+805}{2}\right)8.71 = 6660\#$$

$$V_{AB} = 1683\times 21.62\times .5 + 206\times 21.62\times .5\times .67 + \frac{47480}{21.62} = 21930$$

$$V_{BA} = 1683\times 21.62\times .5 + 206\times 21.62\times .5\times .33 - \frac{47480}{21.62} = 16810\#$$

$$x_0 = 9.7'\text{ ft. from } R_B$$

$$+M_{AB} = 16810\times 9.7 + 29580 - 1683\times\frac{9.70^2}{2} - \frac{206\times 9.70^3}{21.62\times 6} = 111{,}730\,'\#$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION NO 6

Computation Base slab at section A-A

Computed by A.L.K. **Checked by** _____ **Date** 10 Aug 1945

Design of Base slab contd.

Case I $d_{req'd\ -M_A} = \sqrt{\frac{40230}{147}} = 16.6'' < 26.5''$

$v = \frac{10160}{12 \times .88 \times 26.5} = 36.4\#/\square''$ $\quad v = \frac{23970}{12 \times .88 \times 33.5} = 66.0\#/\square''$

$A_s = \frac{40230 \times 12}{18000 \times .88 \times 26.5} = 1.15\square''$ use $\frac{7}{8}''\phi$ @ 6" top left end

$u = \frac{10160}{3.5 \times .88 \times 26.5} = 79.5\#/\square''$

$d_{req'd\ -M_B} = \sqrt{\frac{19280}{147}} = 11.4'' < 25.5''$

$-A_s = \frac{19280 \times 12}{18000 \times .88 \times 25.5} = .575\square''$ Use $\frac{3}{4}''\phi$ @ 1'-0" } alt. $\frac{7}{8}''\phi$ @ 1'-0" } bott right end.

for $\frac{7}{8}''\phi$ @ 1'-0" $u_{BA} = \frac{23970}{2.8 \times .88 \times 33.5} = 290\#/\square''$ $\quad u_{BA} = \frac{23970}{5.11 \times .88 \times 33.5} = 157\#/\square''$

$d_{req'd\ +M} = \sqrt{\frac{116070}{123}} = 30.8'' < 30.5''$ ok base on min. depth of slab.

$+A_s = \frac{116070 \times 12}{18000 \times .88 \times 30.5} = 2.88 \times \frac{8.37}{7.37} = 3.27\square''$ use $1\frac{1}{4}''\square$ @ 6" top cent.

Case II

$d_{req'd\ -M} = \sqrt{\frac{29380}{147}} = 14.15'' < 26.5''$

$d_{req'd\ -M} = \sqrt{\frac{17900}{123}} = 12'' < 25.5''$

$v = \frac{21930}{12 \times .88 \times 29.5} = 70.4\#/\square''$

at B $-A_s = \frac{29580 \times 12}{18000 \times .88 \times 26.5} = .843\square''$ $\frac{7}{8}''\phi$ @ 8" top right

at A $-A_s = \frac{17900 \times 12}{18000 \times .88 \times 25.5} = .532\square''$

$u = \frac{21930}{2.8 \times .88 \times 29.5} = 300\#/\square''$ $\quad u = \frac{21930}{5.11 \times .88 \times 29.5} = 165\#/\square''$ use alt. $\frac{3}{4}''\phi$ @ 1'-0" $\frac{7}{8}''\phi$ @ 1'-0" bott. left

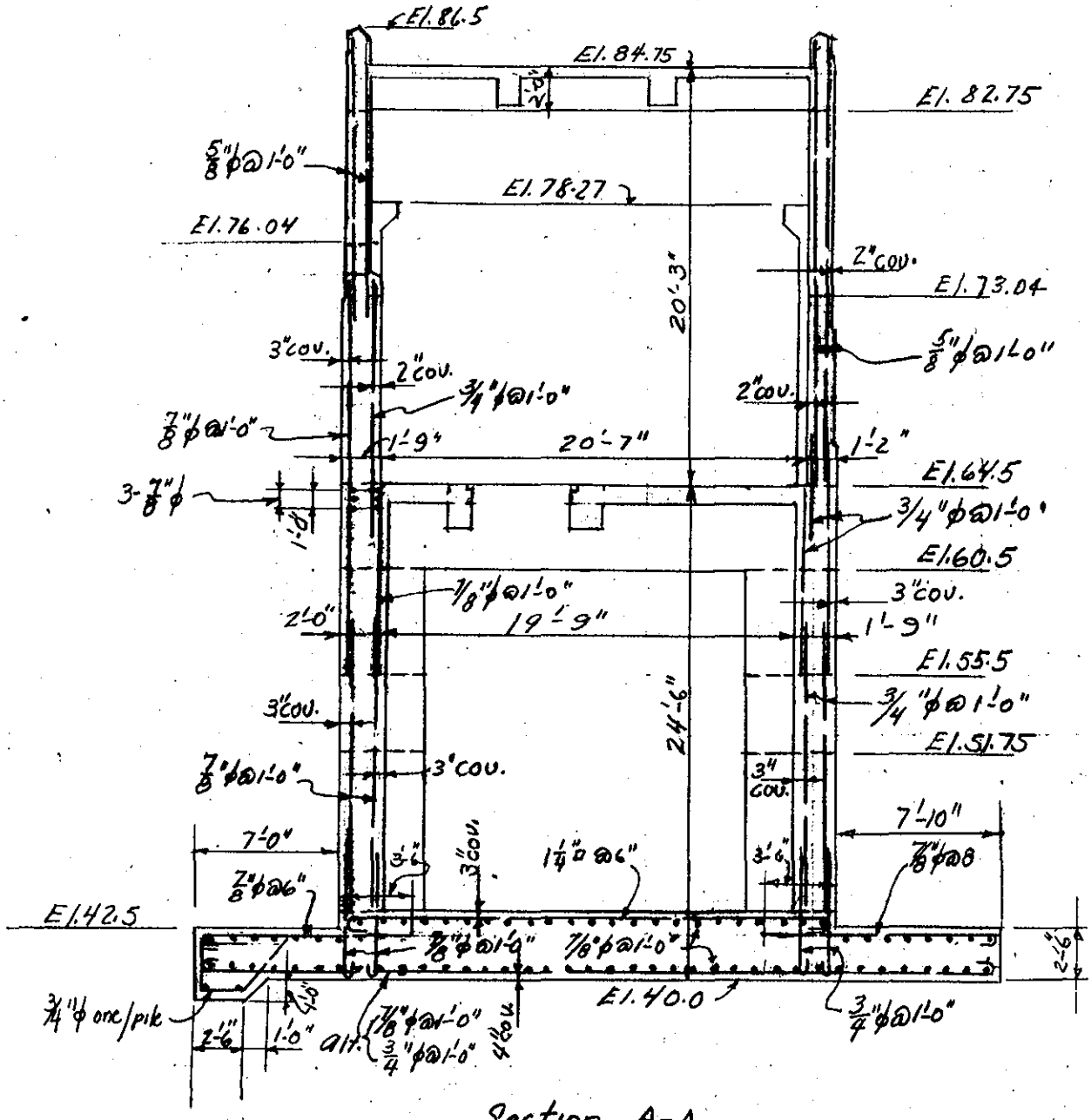
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation Base slab at section A-A

Computed by A.L.K. **Checked by** **Date** 21 Aug 1945



Section A-A

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

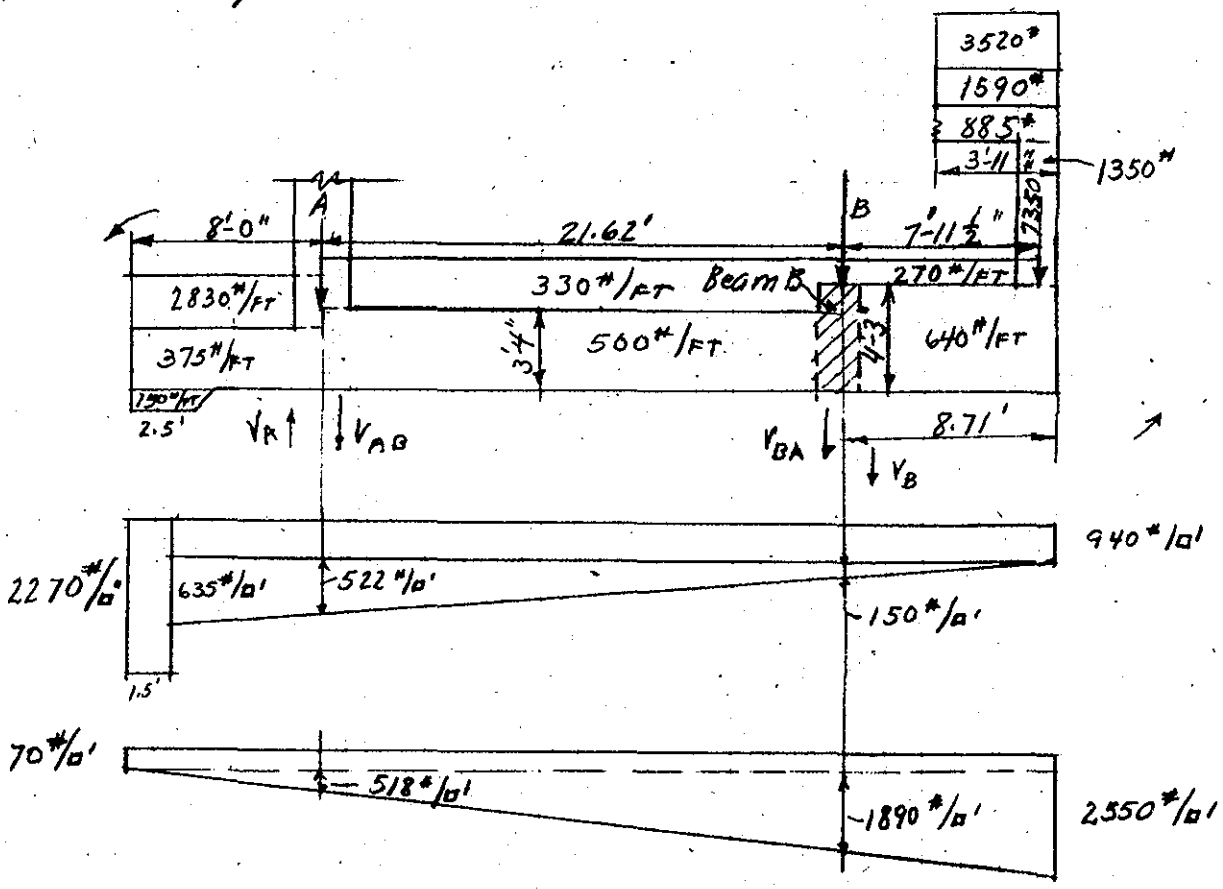
Subject HOLYOKE PUMPING STATION No. 6

Computation Base slab at section B-B.

Computed by A. L. K. **Checked by** _____ **Date** 24 Aug 1945

Case I

Base slab will designed supported by wall at A and by a beam at B.



$M_A = 40{,}230$ '# $V_A = 10160$ #

$$M_B = 7350 \times 7.96 + 270 \times \frac{7.96^2}{2} + 640 \times \frac{8.71^2}{2} - 2980 \times \frac{8.71^2}{2} - 440 \times \frac{8.71^2}{3} = 32750'\#$$

$$V_B = 7350 + 270 \times 7.96 + 640 \times 8.71 - \left(\frac{3050 + 3490}{2}\right) 8.71 = 13440\#$$

$$V_{AB} = 1220 \times \frac{21.62}{2} + 1000 \times \frac{21.62}{2} \times \frac{1}{3} - \frac{72980}{21.62} = 13{,}440\#$$

$$V_{BA} = 1220 \times \frac{21.62}{2} + 1000 \times \frac{21.62}{2} \times \frac{2}{3} + \frac{72980}{21.62} = 23{,}890\#$$

$x_0 = 9.35'$ from R_A

$$+M = 13320 \times 9.35 + 40230 - 1200 \times \frac{9.35^2}{2} - \frac{1000}{21.62} \times \frac{9.35^3}{6} = 106310'\#$$

WAR DEPARTMENT

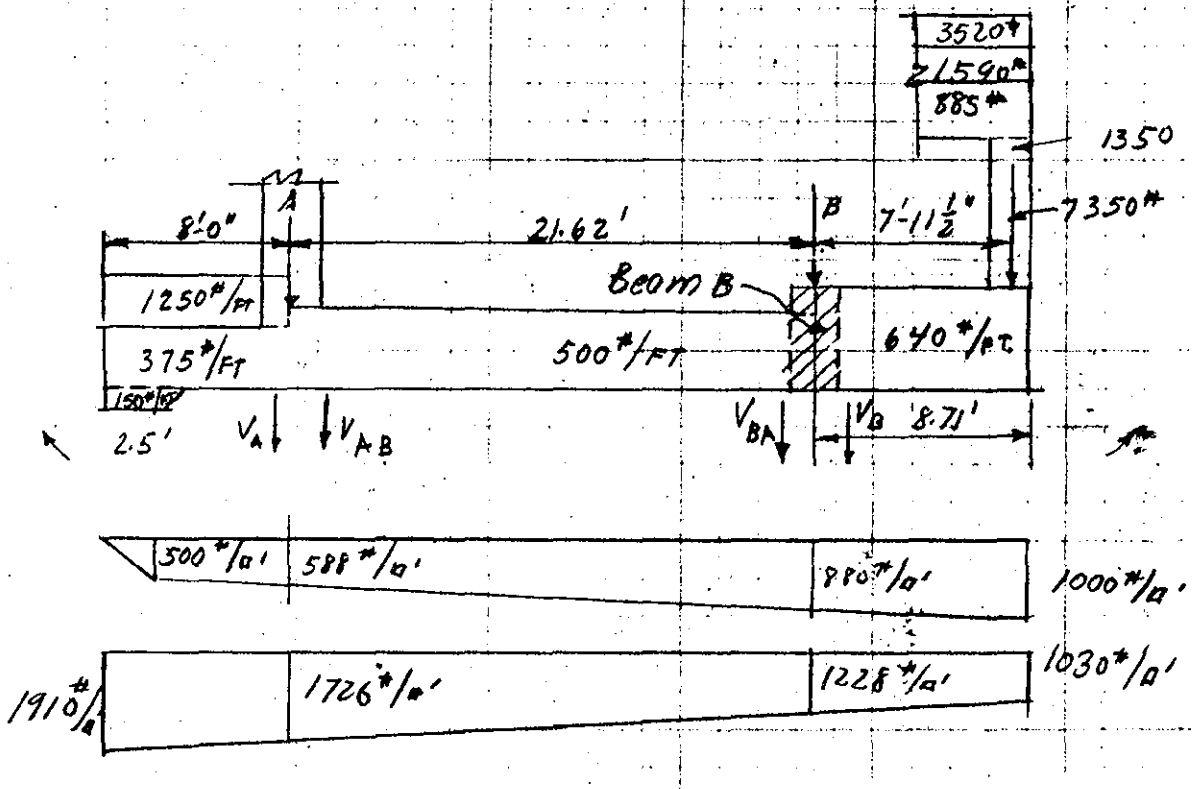
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION NO. 6

Computation Base Slab at Section B-B

Computed by A.L.K. **Checked by** **Date** 27 Aug 1945

Case II



$M_A = 17900$ '# $V_A = 5000$ #

$M_B = 7350 \times 7.96 + 640 \times \frac{8.71^2}{2} - 2030 \times \frac{8.71^2}{2} - 80 \times \frac{8.71^2}{6} =$

$M_B = 33{,}210$ '#

$V_B = 7350 + 640 \times 8.71 - 2030 \times 8.71 + 80 \times \frac{8.71}{2} = 5130$ #

$V_{AB} = 1608 \times \frac{21.62}{2} + 206 \times \frac{21.62}{2} \times \frac{2}{3} - \frac{15310}{21.62} = 18{,}180$ #

$V_{BA} = 1608 \times \frac{21.62}{2} + 206 \times \frac{21.62}{2} \times \frac{1}{3} + \frac{15310}{21.62} = 18{,}850$ #

$x_0 = 11.3'$ from R_B

$+M_{AB} = 18850 \times 11.3 - 1608 \times \frac{11.3^2}{2} - \frac{206}{21.62} \times \frac{11.3^3}{6} - 33210 =$

$+M_{AB} = 74510$ '#

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation Base slab at section B-B

Computed by A.L.K. **Checked by** _____ **Date** 28 Aug 1945

at A $A_s = \frac{7}{8}$"ϕ @ 6" top left end alt $\left\{\begin{array}{l}\frac{7}{8}\text{"}\phi \text{ @ } 1'\text{-}0\text{" bott left end} \\ \frac{3}{4}\text{"}\phi \text{ @ } 1'\text{-}0\text{"}\end{array}\right.$

at B $A_s = \dfrac{33210 \times 12}{18000 \times .88 \times 46.5} = .54 \square''$

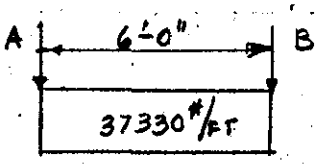
at B $A_s = \dfrac{33210 \times 12}{18000 \times .88 \times 36.5} = .69 \square''$ use $\left\{\begin{array}{l}\frac{7}{8}\text{"} \\ \frac{3}{4}\text{"}\phi \text{ @ } 1'\text{-}0\text{"} \\ \frac{7}{8}\text{"}\phi \text{ @ } 1'\text{-}0\text{"}\end{array}\right.$ alt. bott right.

$u = \dfrac{23890}{5.11 \times .88 \times 36.5} = 145\#/\square''$

$+A_s = \dfrac{106310 \times 12}{18000 \times .88 \times 36.5} = 2.2 \square''$ use $1\frac{1}{4}$"$\square$ @ 8" cc top mem. AB

Beam at B

Reaction at B $= 23890 + 13440 = 37{,}330\#/FT$



$V_A = V_B = 37330 \times \frac{6}{2} = 111{,}990\#$

$M = 37330 \times \frac{6^2}{10} = 134{,}000'\#$

$d\ req'd = \sqrt{\dfrac{134000 \times 12}{21 \times 123}} = 25'' < 47.5''$ 45.75

$v = \dfrac{111990}{21 \times .88 \times 47.5} = 127\#/\square''$ 45.75 Use stirrups

$A_s = \dfrac{134000 \times 12}{18000 \times .88 \times 47.5} = 2.14 \square''$

$u = \dfrac{111990}{9.52 \times .88 \times 46.5} = 285\#/\square''$ for 3-1"ϕ

$u = \dfrac{111990}{16 \times .88 \times 46.5} = 170\#/\square''$ for 4-1"$\square$ top & bott 45.75

$S = \dfrac{.62 \times 16000}{21 \times 37} = 12.8''$

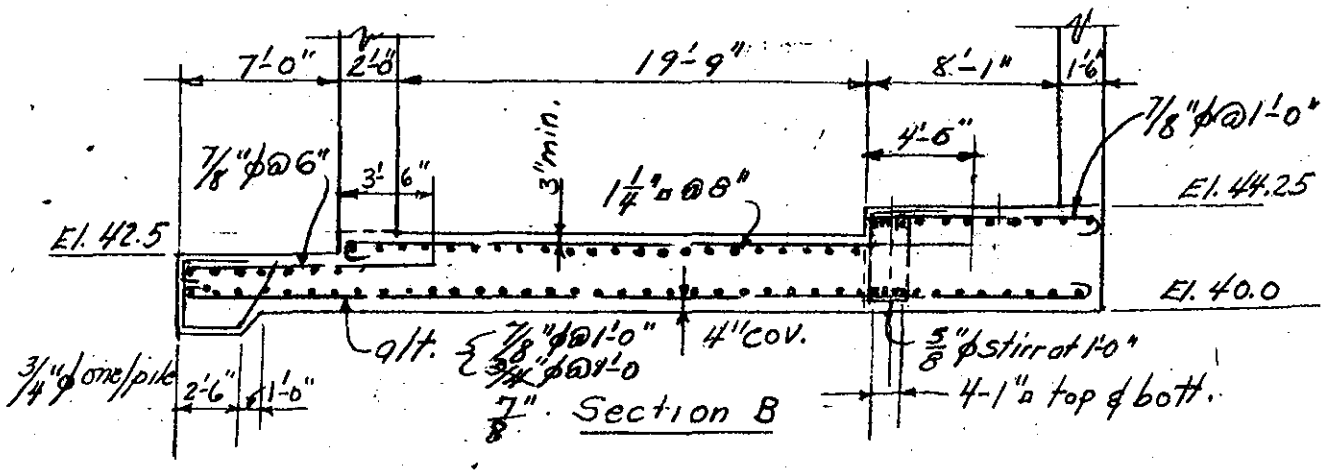
Use $\frac{5}{8}$"ϕ Stirrups @ 1'-0"

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation Base slab at Section B-B

Computed by A.L.K. **Checked by** **Date** 28 Aug 1945



WAR DEPARTMENT

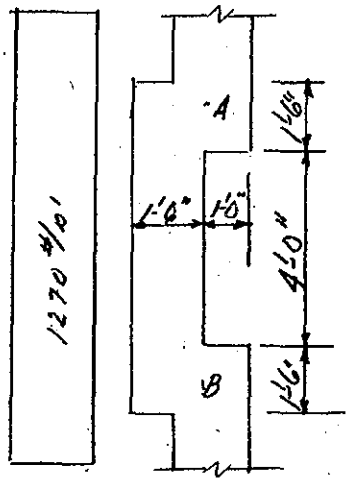
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Gravity Flow Gate Chamber

Computed by H. E. W. **Checked by** _____ **Date** 28 Aug - 45

Section of Gate Chamber from El. 43.6 to El. 49.9



Assume Gr. Water Head at 55.5

Horiz. Thrust at El 43.6 . 320+11.9x80 = 1270 #/□'

Horiz " " El 49.9 = 320+5.6x80 = 770 #/□'

$V_A = V_B = 1270 \times 5.5 \times .5 = 3490^{\#}$ at El. 43.6

$V_A = V_B = 770 \times 5.5 \times .5 = 2120^{\#}$ at El. 49.9

$M = \frac{1}{10} \times 1270 \times 5.5^2 = 3840^{'\#}$

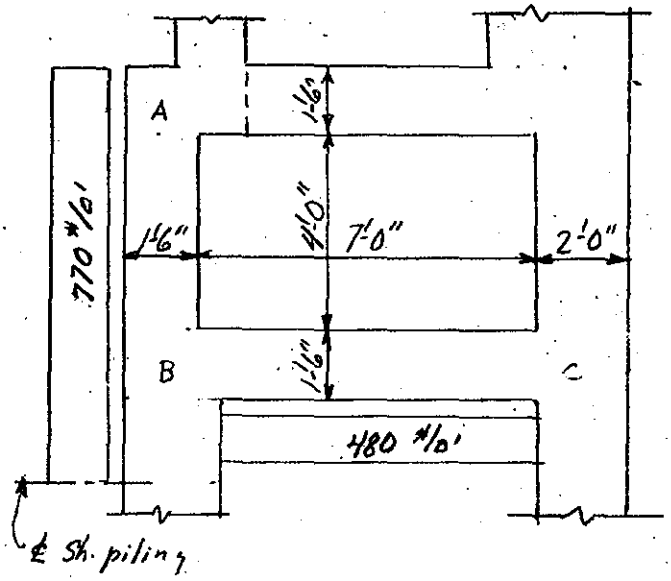
req'd $d = \sqrt{\frac{3840}{123}} = 5.6'' < 14.0''$ OK

$v = \frac{3490}{12 \times .88 \times 14} = 24\ \#/□''$

$A_s = \frac{3840 \times 12}{18000 \times .88 \times 14} = .21\ □''$ Use $\frac{3}{8}''\phi$ @ 1'-0"

$u_0 = \frac{3490}{1.96 \times .88 \times 14} < 1.45\ \#/□''$

Section of Gate Chamber from El. 49.9 to El. 55.79



Horiz. Thrust against wall AB

El. 49.9 = 770#

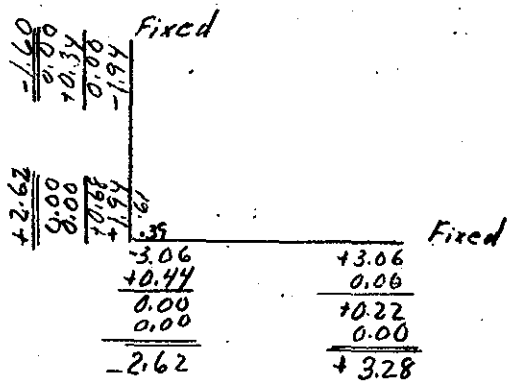
El. 55.79 = 8.21 x 35 = 290

Horiz Thrust against wall BC

El. 49.9 = 13.73 x 35 = 480 #/□'

El 55.79 = 8.04 x 35 = 280 #/□'

Section will be designed at El. 49.9



F. E. M

Memb. AB $M^F = \frac{1}{12} \times 770 \times 5.5^2 = 1.94'^{K}$

Memb. BC $M^F = \frac{1}{12} \times 480 \times 8.75^2 = 3.06'^{K}$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Gravity Flow Gate Chamber

Computed by H. E. W. **Checked by** _____ **Date** 29-Aug-45

Member AB

$H_A = 770 \times 5.5 \times .5 - \frac{1020}{5.5} = 1930^{\#}$

$H_B = 770 \times 5.5 \times .5 + \frac{1020}{5.5} = 2300^{\#}$

$x_0 = 2.5'$ from A

$M = 2.5 \times 1930 - 1600 - 770 \times \frac{2.5^2}{2} = 820^{'\#}$

Member BC

$H_B = 480 \times 8.75 \times .5 - \frac{660}{8.75} = 2020^{\#}$

$H_C = 480 \times 8.75 \times .5 + \frac{660}{8.75} = 2180^{\#}$

$x_0 = 4.21'$ from B

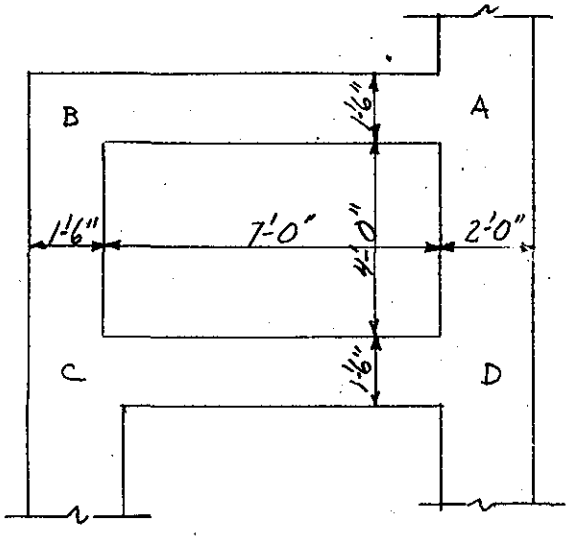
$M = 2020 \times 4.21 - 2620 - 480 \times \frac{4.21^2}{2} = 1630^{'\#}$

$A_s = \frac{3280 \times 12}{18000 \times .88 \times 14} = .18^{\square''}$ Use $5/8''\phi$ @ 1'-0" cc

$u_0 = \frac{2300}{1.96 \times .88 \times 14} = 95^{\#/\square''}$

Use 5/8"ϕ @ 1'-0"cc both faces

Horizontal Section at El. 55.79 Case II River down.

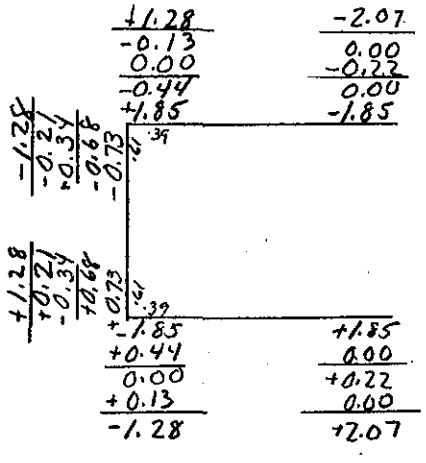


Horiz. Thrust at El. 55.79 = $290^{\#/\square'}$

F. E. M.

$M^F = \frac{1}{12} \times 290 \times 5.5^2 = 0.73^{'K}$

$M^F = \frac{1}{12} \times 290 \times 8.75^2 = 1.85^{'K}$



Moments + Shears are small
5/8"ϕ @ 1'-0"cc both faces ok

$H_B = H_C = 290 \times 5.5 \times .5 = 800^{\#}$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Gravity Flow Gate Chamber

Computed by H. E. W. **Checked by** _____ **Date** 29-Aug-45

Horiz. Section at El. 55.79 Case I

Riverside - Horiz. thrust (net) = $8.21 \times (80-62.5) = 140$ #/o'

Landside Horiz. thrust = $19.54 \times 62.5 - 290 = 930$ #/o'

F.E.M. Member AB

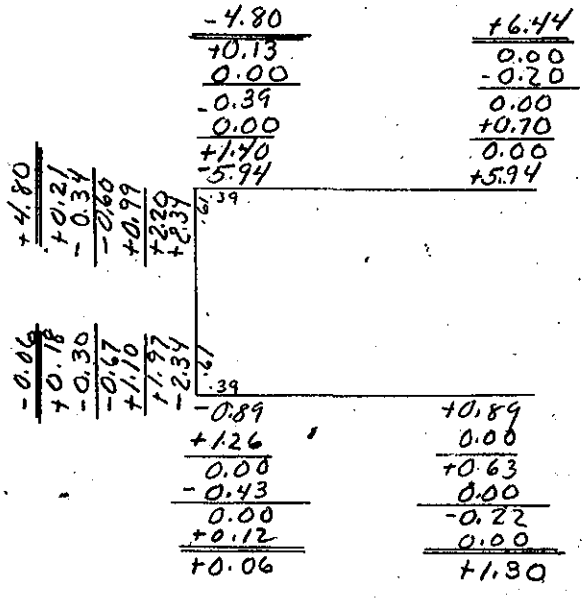
$M^F = \frac{1}{12} \times 930 \times 8.75^2 = 5.94$ 'k

Member BC

$M^F = \frac{1}{12} \times 930 \times 5.5^2 = 2.34$ 'k

Member CD

$M^F = \frac{1}{12} \times 140 \times 8.75^2 = 0.89$ 'k



Member AB

$H_A = 930 \times 8.75 \times .5 + \frac{1640}{8.75} = 4260$#

$H_B = 930 \times 8.75 \times .5 - \frac{1640}{8.75} = 3860$#

$x_0 = 4.58'$ from A

$M = 4260 \times 4.58 - 6440 - 930 \times \frac{4.58^2}{2}$

$= 3320$ '#

Member BC

$H_B = 930 \times 5.5 \times .5 + \frac{4740}{8.75} = 3100$#

$H_C = 930 \times 5.5 \times .5 - \frac{4740}{8.75} = 2020$#

$x_0 = 3.33'$ from B

$M = 3100 \times 3.33 - 4800 - 930 \times \frac{3.33^2}{2} = 370$ '#

Member CD - not critical

req'd $d = \sqrt{\frac{6440}{147}} = 6.6" < 14.0"$ OK

$V = \frac{4260}{12 \times .88 \times 14} = 29$ #/o" OK

$A_s = \frac{6440 \times 12}{18000 \times .88 \times 14} = .35$ □" Use 5/8 φ @ 1'-0" cc as M will be less at face of support.

$u_0 = \frac{4260}{1.96 \times .88 \times 14} = 176$ #/□"

Use 5/8" φ @ 1'-0" cc both faces

WAR DEPARTMENT

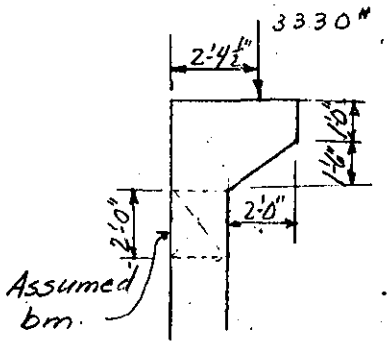
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Gravity Flow Gate Chamber

Computed by H. E. W **Checked by** _____ **Date** 28 Aug - 45

Gate Hounch



Sluice Gate load = 10,000#
assume ld distributed over 3' width
load per ft = 3330#

Mom. about ℄ wall

$3330 \times 1.62 + 1 \times \frac{2.75^2}{2} \times 150 \times 1 + 2 \times 1.5 \times .5 \times 150 \times 1.42 = 6280'^{\#}$

Shear at face of wall

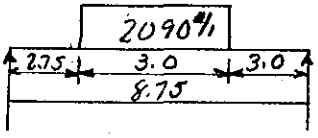
$3330 + 1 \times 2.75 \times 150 + 2 \times 1.5 \times .5 \times 150 = 3970^{\#}$

$v = \frac{3970}{12 \times .88 \times 26} = 14\ \#/\square''$

$A_s = \frac{6280 \times 12}{18000 \times .88 \times 26} = .18\ \square''$ $\frac{5}{8}''\phi$ @ 1'-0" cc OK

$u_0 = \frac{3970}{1.96 \times .88 \times 26} = 89\ \#/\square''$

Thrust on assumed bm $= \frac{6280}{3} = 2090^{\#}$



$V_L = 2090 \times 3 \times \frac{4.5}{8.75} = 3220^{\#}$

$M = 3220 \times 4.29 - 2090 \times \frac{1.54^2}{2} = 11{,}340'^{\#}$

reqd $d = \sqrt{\frac{11{,}340 \times 12}{36 \times 123}} = 5.5'' < 14''$ OK

$A_s = \frac{11340 \times 12}{18000 \times .88 \times 14} = .61\ \square''$ 3 - $\frac{5}{8}''\phi$ OK

$u_0 = \frac{3220}{5.89 \times .88 \times 14} = 45\ \#/\square''$ OK

Wall above Gate

Horiz. thrust at center of gate $= (75.33 - 46.8)62.5 = 1780\ \#/\square'$

Assuming load spread equally around edges the thrust at top of gate will be $1780 \times \frac{5}{4} = 2230\ \#/'$

Horiz. thrust from water at El. 49.8 $= 25.53 \times 62.5 = 1590\ \#/'$

Total load = 3820 #/' span = 6'

$M = \frac{1}{10} \times 3820 \times 6^2 = 13750^{\#}$ shear $= 2.5 \times 3820 = 9550^{\#}$

$v = \frac{9550}{12 \times .88 \times 14} = 64\ \#/\square''$ OK

$A_s = \frac{13750 \times 12}{18000 \times .88 \times 14} = .74\ \square''$ Use 3 - $\frac{5}{8}''\phi$ both faces

$u_0 = \frac{9550}{5.89 \times .88 \times 14} = 131\ \#/\square''$ OK

WAR DEPARTMENT

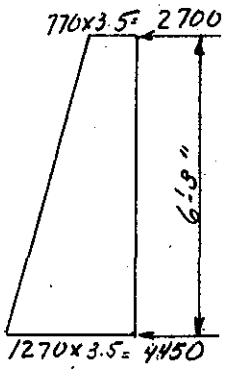
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Gravity Flow Gate Chamber

Computed by H.E.W. **Checked by** **Date** 30-Aug.-45

Vert. Bm. in Outside Wall



$H_{bot} = 2700 \times 6.25 \times .5 + 1750 \times 6.25 \times .5 \times .67 = 12{,}100^{\#}$

$H_{Top} = 2700 \times 6.25 \times .5 + 1750 \times 6.25 \times .5 \times .33 = 10{,}240^{\#}$

$M^{Top} = \frac{1}{12} \times 2700 \times 6.25^2 + \frac{1}{15} \times 1750 \times \frac{6.25^2}{2} = 11{,}070^{'\#}$

$M_{bot} = \frac{1}{12} \times 2700 \times 6.25^2 + \frac{1}{10} \times 1750 \times \frac{6.25^2}{2} = 12{,}210^{'\#}$

$x_0 = 3.25'$ from top

$M = 10240 \times 3.25 - 11{,}070 - 2700 \times \frac{3.25^2}{2} - 910 \times \frac{3.25^2}{6}$

$= 6350^{'\#}$

reqd $d = \sqrt{\frac{12{,}210}{147}} = 9.1'' < 25.5''$

$v = \frac{12{,}100}{18 \times .88 \times 25.5} = 30^{\#}/\square''$

$A_s = \frac{12{,}210 \times 12}{18000 \times .88 \times 25.5} = .36^{\square''}$ Try 2-5/8"ϕ

$u_0 = \frac{12{,}100}{3.93 \times .88 \times 25.5} = 137^{\#}/\square''$ OK

2-5/8"ϕ both faces

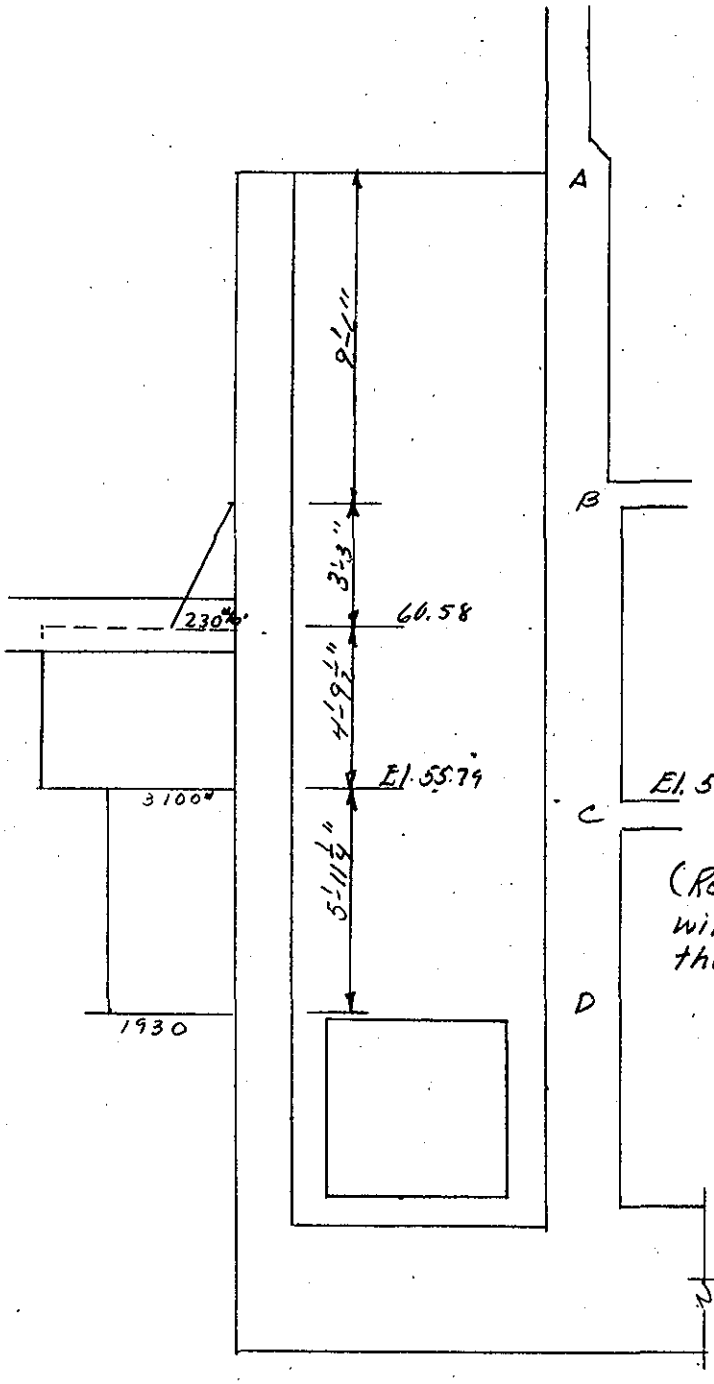
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Gravity Flow Gate Chamber

Computed by H.E.W. **Checked by** _____ **Date** 5-Sept.-45



Horiz. Thrust at El. 60.58

$3.25 \times 2 \times 35 = 230$ #/□'

F.E.M.

Member BC

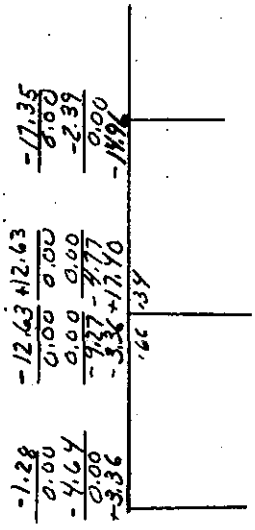
$$M^F_{BC} = \frac{.4(10-15\times.4^4+6\times.4^2)}{15}\times 230\times\frac{3.59}{2}\times 9 + \frac{.6^2(4-3\times.6)}{12}\times 3100\times 5.41\times 9 = 14.96^{1K}$$

$$M^F_{CB} = \frac{.4^2(5-4\times.4)}{10}\times 230\times\frac{3.59}{2}\times 9 + \frac{.6(6-8\times.6+3\times.6^2)}{12}\times 3100\times 5.41\times 9 = 17.40^{1K}$$

Member CD

$$M^F_{CD} = M^F_{DC} = \frac{1}{12}\times 1930\times 4.57^2 = 3.36^{1K}$$

(Regular steel will be ok for these moments)



Reactions

Member BC

$$H_B = 230\times\frac{3.59}{2}\times\frac{6.57}{9} + 3100\times 5.41\times\frac{2.70}{9} - \frac{4720}{9} = 4810^{\#}$$

$$H_C = 230\times 3.59\times\frac{2.43}{9} + 3100\times 5.41\times\frac{6.3}{9} + \frac{4720}{9} = 12{,}380^{\#}$$

Member CD

$$H_C = 1930\times 4.57\times .5 + \frac{13{,}910}{4.57} = 7450^{\#}$$

$$H_D = 1930\times 4.57\times .5 - \frac{13{,}910}{4.57} = 1370^{\#}$$

F 265

WAR DEPARTMENT

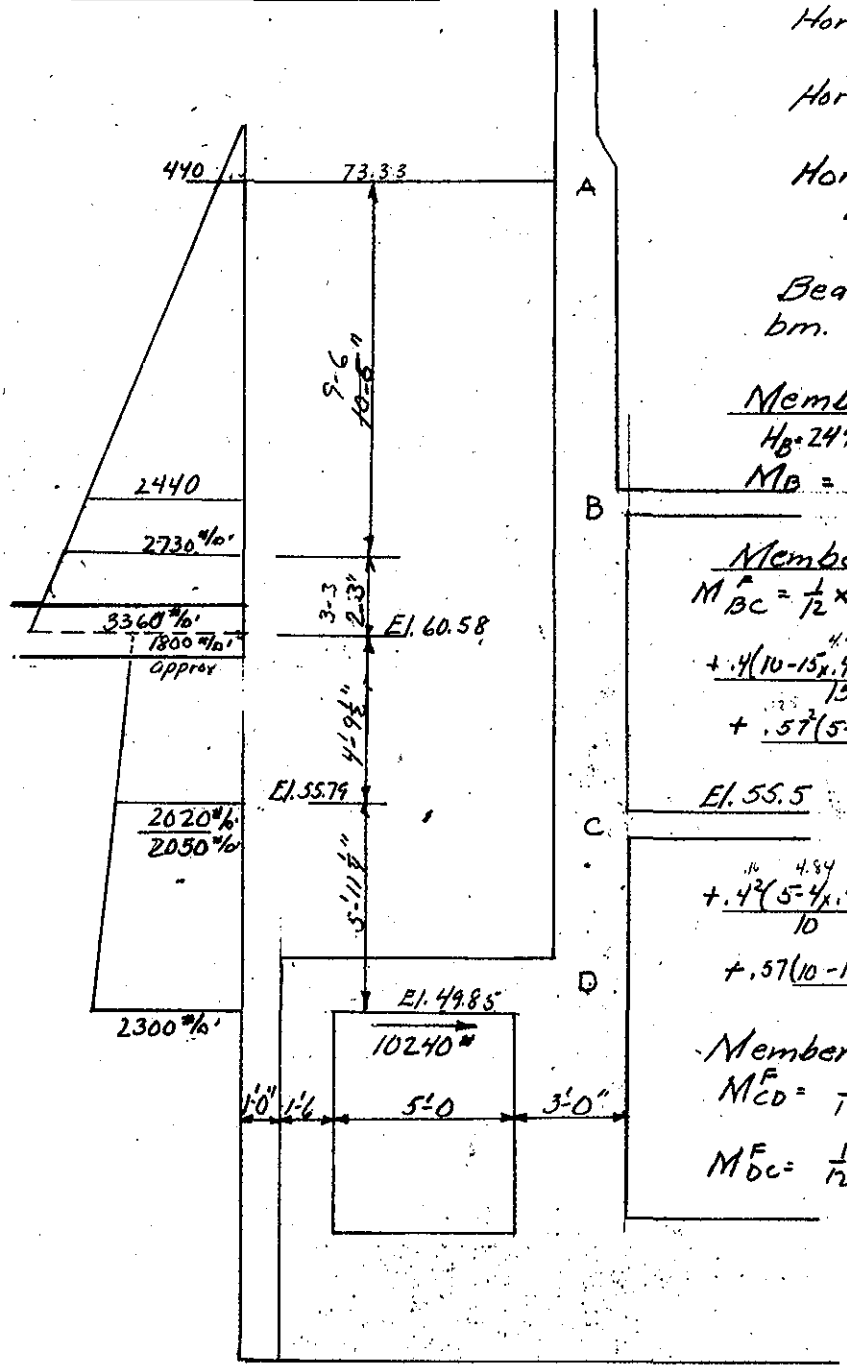
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Gravity Flow Gate Chamber

Computed by H.E.N. **Checked by** _____ **Date** 31- Aug- 45

Riverside Wall



Horiz. Thrust at El. 73.33

$2 \times 62.5 \times 3.5 = 440$ #/lo'

Horiz Thrust at El. 63.83

$12.5 \times 62.5 \times 3.5 = 2730$ #/lo'

Horiz Thrust at El 60.58

$2730 + \overset{3.25}{2.25} \times 80 \times 3.5 = \overset{3440}{\cancel{3360}}$ #/lo'

(neglect error)

Beam ABCD. - consider bm. fixed at point D

Member AB

$H_B = 2440 \times 11.16 \times .5 = 13,620$#

$M_B = 2440 \times 11.16 \times .5 \times 3.72' = 50,650$ '#

Member BC

$$M^F_{BC} = \frac{1}{12} \times 1800 \times 9^2 + \frac{.4(\overset{3.28}{6} - 8 \times .4 + 3 \times .4^2)}{12} \times 640 \times \overset{20.673}{3.59} \times 9$$

$$+ \frac{.4(\overset{4.96}{10} - 15 \times .4 + 6 \times .4^2)}{15} \times 920 \times \overset{14.663}{\frac{3.59}{2}} \times 9$$

$$+ \frac{.57^2(\overset{3.29}{5} - 3 \times .57)}{30} \times 250 \times \overset{5.76}{\frac{5.12}{2}} \times 9 = 16.59$$

El. 55.5

$$M^F_{CB} = \frac{1}{12} \times 1800 \times 9^2 + \frac{.4(\overset{3.88}{4} - 3 \times .4)}{12} \times 640 \times \overset{20.673}{3.59} \times 9$$

$$+ \frac{.4^2(\overset{4.84}{5} - 4 \times .4)}{10} \times 920 \times \overset{14.863}{\frac{3.69}{2}} \times 9$$

$$+ \frac{.57(\overset{5.275}{10} - 10 \times .57 + 3 \times .57^2)}{30} \times 250 \times \overset{5.76}{\frac{5.12}{2}} \times 9 = 14.95$$

Member CD

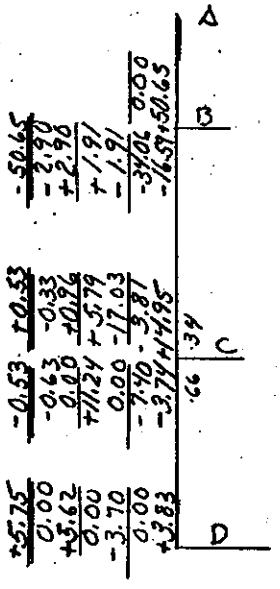
$$M^F_{CD} = \frac{1}{12} \times 2050 \times 4.57^2 + \frac{1}{15} \times 250 \times \frac{4.57^2}{2} = 3.74'^{\#}$$

$$M^F_{DC} = \frac{1}{12} \times 2050 \times 4.57^2 + \frac{1}{10} \times 250 \times \frac{4.57^2}{2} = 3.83'^{\#}$$

Subject Holyoke Pumping Station No 6

Computation Gravity Flow Gate Tower

Computed by H.E.W. **Checked by** **Date** 31-Aug. 45



Member BC

$H_B = 1800\times 9\times .5 + 640\times 3.59\times \frac{7.20}{9.0} + 920\times 3.59\times .5\times \frac{6.61}{9}$
$+ 250\times 5.12\times .5\times \frac{1.71}{9} + \frac{50.120}{9} = 16,840^{\#}$

$H_C = 1800\times 9\times .5 + 640\times 3.59\times \frac{1.80}{9} + 920\times 3.59\times .6\times \frac{2.39}{9}$
$+ 250\times 5.12\times .5\times \frac{7.39}{9} - \frac{50120}{9} = 3960^{\#}$

$x_0 = 2'$ from H_B

$M = 3960\times 2 - 530 - 1950\times \frac{2^2}{2} - 100\times \frac{2}{2}\times 1.33$
$= 3360^{'\#}$

Member CD

$H_C = 2050\times 4.57\times .5 + 250\times 4.57\times .5\times .33 - \frac{5220}{4.57}$
$= 4500^{\#}$

$H_D = 2050\times 4.57\times .5 + 250\times 4.57\times .5\times .67 + \frac{5220}{4.57}$
$= 5070^{\#}$

$x_0 = 2.0'$ from C

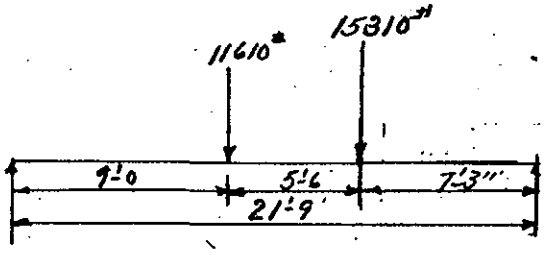
$M = 4500\times 2 - 530 - 2050\times \frac{2^2}{2} - 109\times \frac{2^2}{6} = 3300^{'\#}$

$v = \frac{16840}{18\times .88\times 122.5} = 9^{\#}/\square''$

$-A_s = \frac{50650\times 12}{18000\times .88\times 122.5} = .31^{\square''}$ 2-5/8"ϕ bars OK

$u_0 = \frac{16840}{3.93\times .88\times 122.5} = 40^{\#}/\square''$ OK

Horiz Beam in wall at D



$R_L = 15310\times \frac{7.25}{21.75} + 11610\times \frac{12.75}{21.75} = 11,910$

$R_R = 15310\times \frac{14.50}{21.75} + 11610\times \frac{9}{21.75} = 15,010^{\#}$

$M = 15010\times 7.25 = 108,820^{'\#}$

reqd $b = \frac{108,820\times 12}{123\times 20^2} = 2.65'$ OK

$v = \frac{15010}{24\times .88\times 20} = 24^{\#}/\square''$

$A_s = \frac{108,820\times 12}{18000\times .88\times 20} = 1.12^{\square''}$ Use 5-1"ϕ

$u_0 = \frac{15010}{20.00\times .88\times 20} = 43^{\#}/\square''$

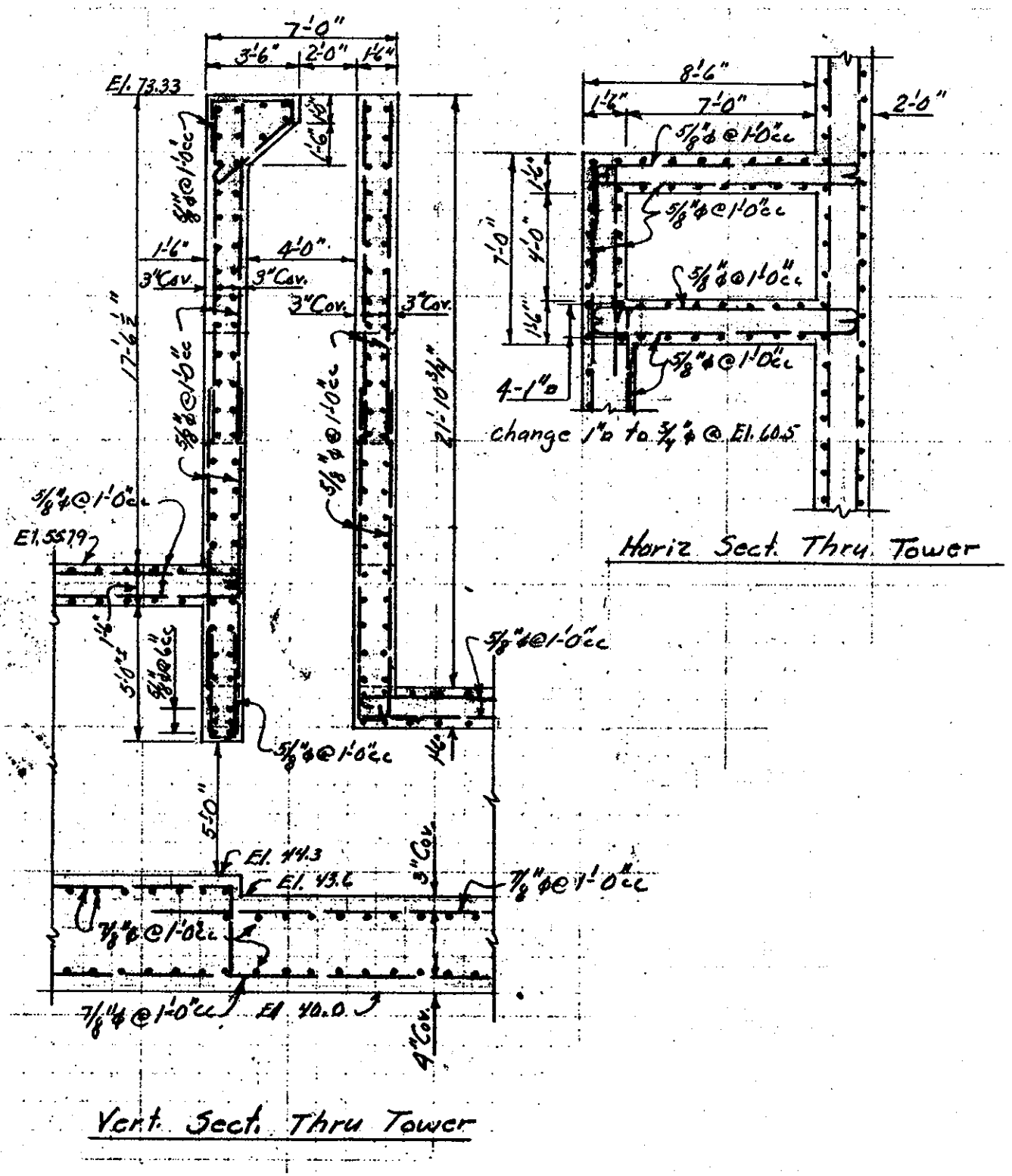
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Gravity Flow Gate Chamber

Computed by H.E.W. **Checked by** **Date** 6- Sept. 45



WAR DEPARTMENT

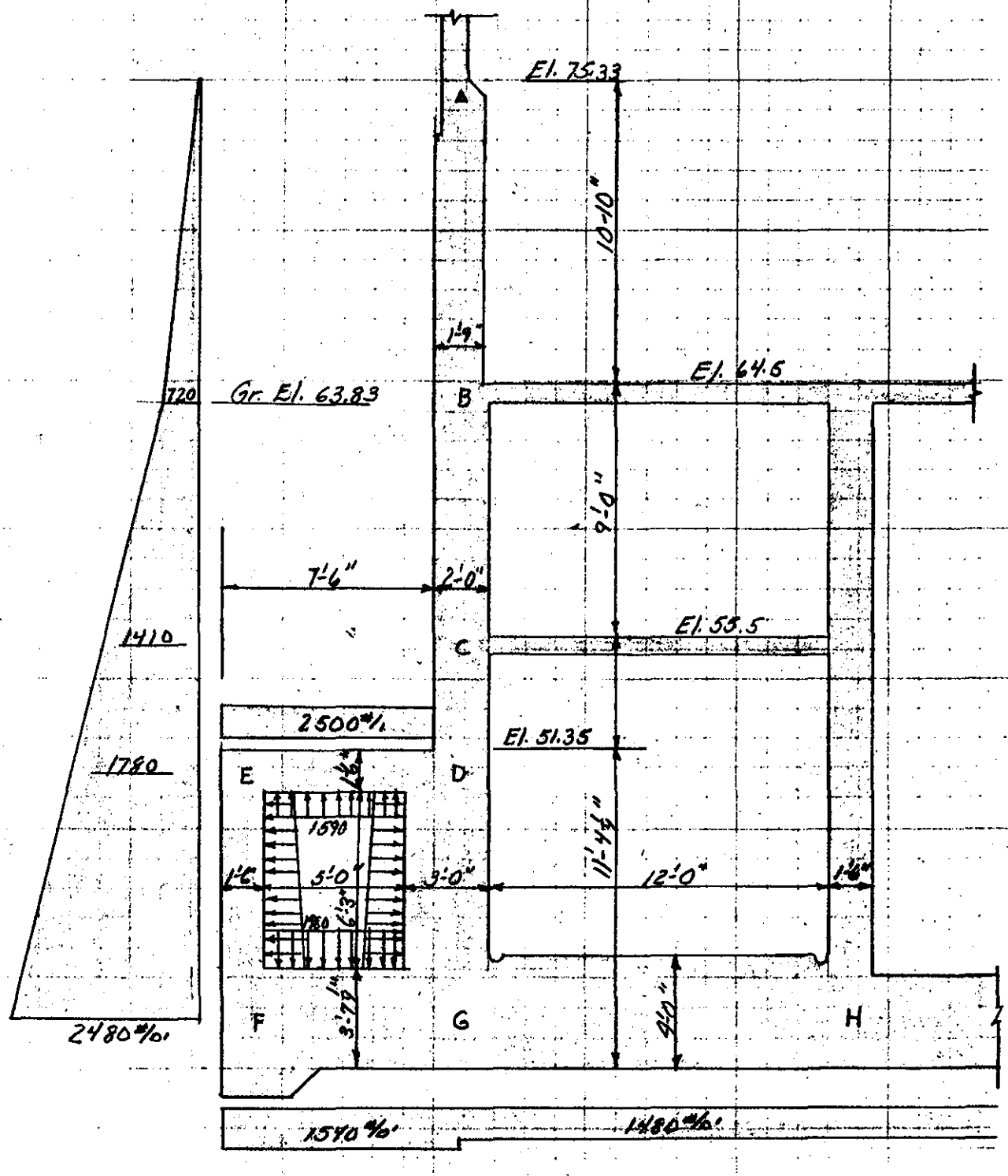
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Section C-C thru Gravity Flow Conduit

Computed by H. E. W. **Checked by** _____ **Date** 23-Aug.-45

Case I River at surcharge elevation



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WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6
Computation Section C-C thru Gravity Flow Conduit
Computed by H.E.W. **Checked by** _____ **Date** 23-Aug.-45

Case I

Horiz. Thrust at El. 63.83 = 11.5 × 62.5 = 720 #/l'
" " " El. 55.17 = 720 + 80 × 8.66 = 1410 #/l'
" " " El. 50.6 = 720 + 80 × 13.23 = 1780 #/l'
" " at El. 41.8 = 720 + 80 × 22.03 = 2480 #/l'
Water Pres. at cond. roof = 25.48 × 62.5 = 1590 #/l'
" " " cond base = 1590 + 6.25 × 62.5 = 1980 #/l'
Wt. on cond roof = 720 + 12.48 × 125 + 150 × 1.5 = 2500#
Base Pressure + 1440 + 640 + 150 × 3.6 = 1540 #/l'
" " 1440 + 640 − 150 × 4 = 1480 #/l'

Basis of design – Wall AB will be considered as a cantilever. The base slab will be considered fixed at H

Fixed End Moments

Member AB

$H_B = 720 \times 11.17 \times .5 = 4020^{\#}$ $M = 4020 \times \frac{11.17}{3} = 14.99^{1K}$

Member BC

$M^F_{BC} = \frac{1}{12} \times 720 \times 9^2 + \frac{1}{15} \times 690 \times \frac{9^2}{2} = 6.72^{1K}$

$M^F_{CB} = \frac{1}{12} \times 720 \times 9^2 + \frac{1}{10} \times 690 \times \frac{9^2}{2} = 7.65^{1K}$

Member CD

$M^F_{CD} = \frac{1}{12} \times 1410 \times 4.57^2 + \frac{1}{15} \times 370 \times \frac{4.57^2}{2} = 2.71^{1K}$

$M^F_{DC} = \frac{1}{12} \times 1410 \times 4.57^2 + \frac{1}{10} \times 370 \times \frac{4.57^2}{2} = 2.89^{1K}$

Member ED

$M^F_{ED} = M^F_{DE} = \frac{1}{12} \times 910 \times 7.25^2 = 3.99^{1K}$

Member EF

$M^F_{EF} = \frac{1}{12} \times 1780 \times 8.8^2 + \frac{1}{15} \times 700 \times \frac{8.8^2}{2} - \frac{1}{12} \times 1590 \times 8.8^2 - \frac{1}{15} \times 390 \times 8.8^2 = 2.03^{1K}$ (13.34)

$M^F_{FE} = \frac{1}{12} \times 1780 \times 8.8^2 + \frac{1}{10} \times 700 \times \frac{8.8^2}{2} - \frac{1}{12} \times 1590 \times 8.8^2 - \frac{1}{10} \times 390 \times 8.8^2 = 2.43^{1K}$ (14.20)

Member FG

$M^F_{FG} = M^F_{GF} = \frac{1}{12} \times 440 \times 7.25^2 = 1.93^{1K}$

Member GH

$M^F_{GH} = M^F_{HG} = \frac{1}{12} \times 1480 \times 14.25^2 = 25.04^{1K}$

Member GD

$M^F_{GD} = \frac{1}{12} \times 1590 \times 8.8^2 + \frac{1}{10} \times 390 \times \frac{8.8^2}{2} = 11.77^{1K}$

$M^F_{DG} = \frac{1}{12} \times 1590 \times 8.8^2 + \frac{1}{15} \times 390 \times \frac{8.8^2}{2} = 11.27^{1K}$

Subject Holyoke Pumping Station No 6

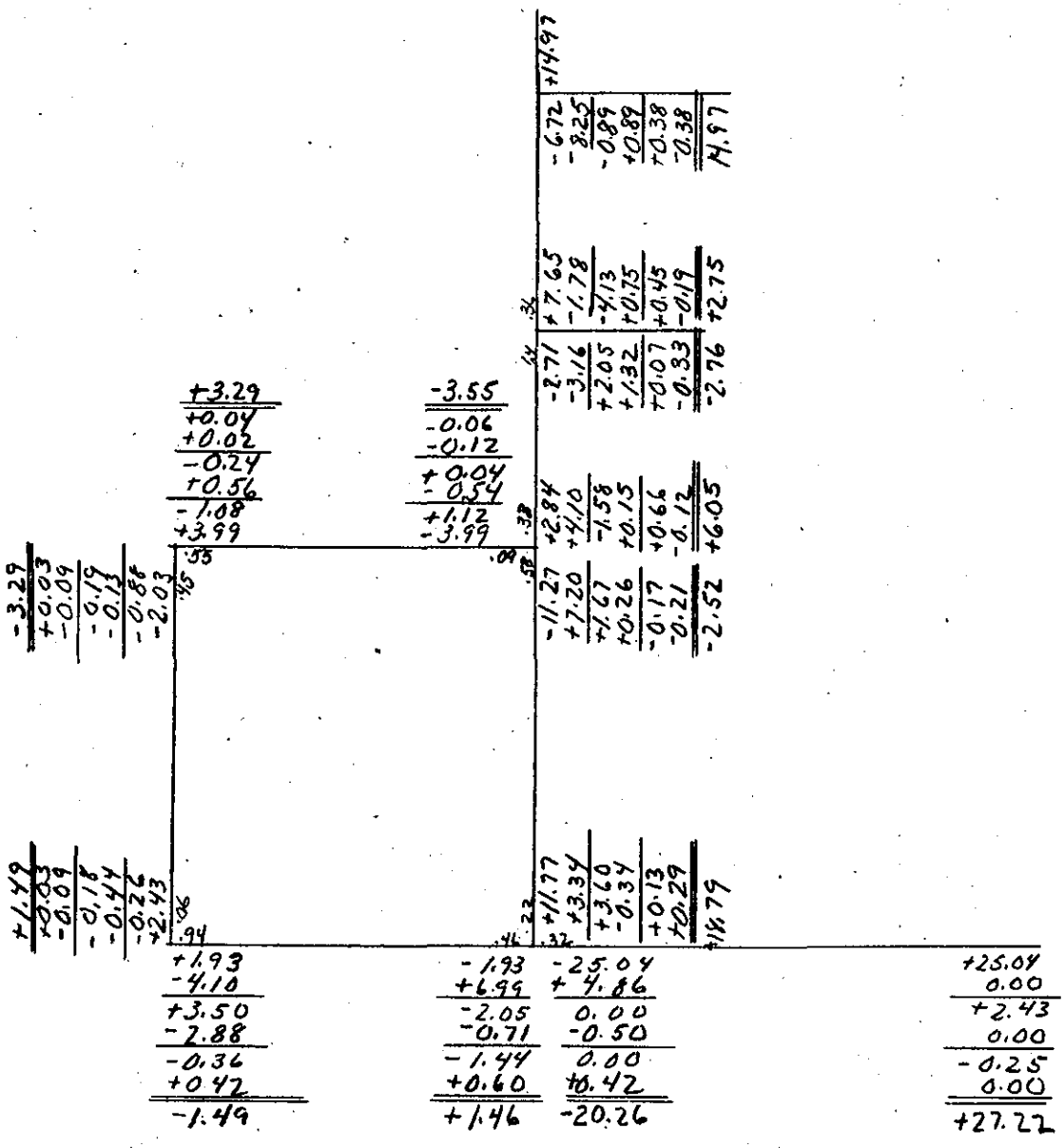
Computation Section C-C thru Gravity Flow Conduit

Computed by H.E.W. **Checked by** _____ **Date** 24-Aug-43

Case I (cont.)

Stiffness

Member	d	d^3	L	d^3/L	K
BC	24	13824	108	128.0	2.32
CD	24	13824	55.25	250.2	4.53
DE	18	5832	87	67.0	1.21
EF	18	5832	105.6	55.2	1.00
FG	43.25	80,902	87	929.9	16.85
GH	48	110592	171.0	646.7	11.72
GD'	36	46656	105.6	441.2	7.99



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Section C-C thru Gravity Flow Conduit

Computed by H.E.W. **Checked by** _____ **Date** 24-Aug-45

Case I (cont.)

End Reactions and Center Moments

Member BC

$H_B = 720 \times 9 \times .5 + \frac{1}{2} \times 690 \times 9 \times .33 + \frac{12,220}{9} = 5620^{\#}$

$H_C = 720 \times 9 \times .5 + \frac{1}{2} \times 690 \times 9 \times .67 - \frac{12,220}{9} = 3960^{\#}$

$x_0 = 5.9'$ from B

$M = 5620 \times 5.9 - 14,970 - 720 \times \frac{5.9^2}{2} - 472 \times \frac{5.9^2}{6} = 2,920^{'\#}$

Member CD

$H_C = 1410 \times 4.57 \times .5 + 370 \times 4.57 \times .5 \times .33 - \frac{3290}{4.57} = 2780^{\#}$

$H_D = 1410 \times 4.57 \times .5 + 370 \times 4.57 \times .5 \times .67 + \frac{3290}{4.57} = 4510^{\#}$

$x_0 = 1.88'$ from C

$M = 2780 \times 1.88 - 2760 - 1410 \times \frac{1.88^2}{2} - 150 \times \frac{1.88^2}{6} = -110^{'\#}$

Member DE

$V_D = 910 \times 7.25 \times .5 + \frac{260}{7.25} = 3340^{\#}$

$V_E = 910 \times 7.25 \times .5 - \frac{260}{7.25} = 3260^{\#}$

$x_0 = 3.67$

$M = 3340 \times 3.67 - 3550 - 910 \times \frac{3.67^2}{2} = 2580^{'\#}$

Member EF

$H_E = 190 \times 8.8 \times .5 + 310 \times 8.8 \times .5 \times .33 + \frac{1800}{8.8} = 1490^{\#}$

$H_F = 190 \times 8.8 \times .5 + 310 \times 8.8 \times .5 \times .67 - \frac{1800}{8.8} = 1550^{\#}$

$x_0 = 5.15'$ from E

$M = 1490 \times 5.15 - 3290 - 190 \times \frac{5.15^2}{2} - 180 \times \frac{5.15^2}{6} = 1070^{'\#}$

Member FG

$V_F = 440 \times 7.25 \times .5 - \frac{30}{7.25} = 1590^{\#}$

$V_G = 440 \times 7.25 \times .5 + \frac{30}{7.25} = 1600^{\#}$

$x_0 = 3.61'$ from F

$M = 1590 \times 3.61 + 1490 - 440 \times \frac{3.61^2}{2} = 3960^{'\#}$

Member GH

$V_G = 1480 \times 14.25 \times .5 - \frac{6960}{14.25} = 10060^{\#}$

$V_H = 1480 \times 14.25 \times .5 + \frac{6960}{14.25} = 11030^{\#}$

$x_0 = 7.06$

F272 $M = 10060 \times 7.06 - 20,260 - 1480 \times \frac{7.06^2}{2} = 13,880^{'\#}$

Subject Holyoke Pumping Station No 6

Computation Section C-C thru Gravity Flow Conduit

Computed by H.E.W. **Checked by** _____ **Date** 24 Aug - 45

Case I cont

End Reactions and Center Moments

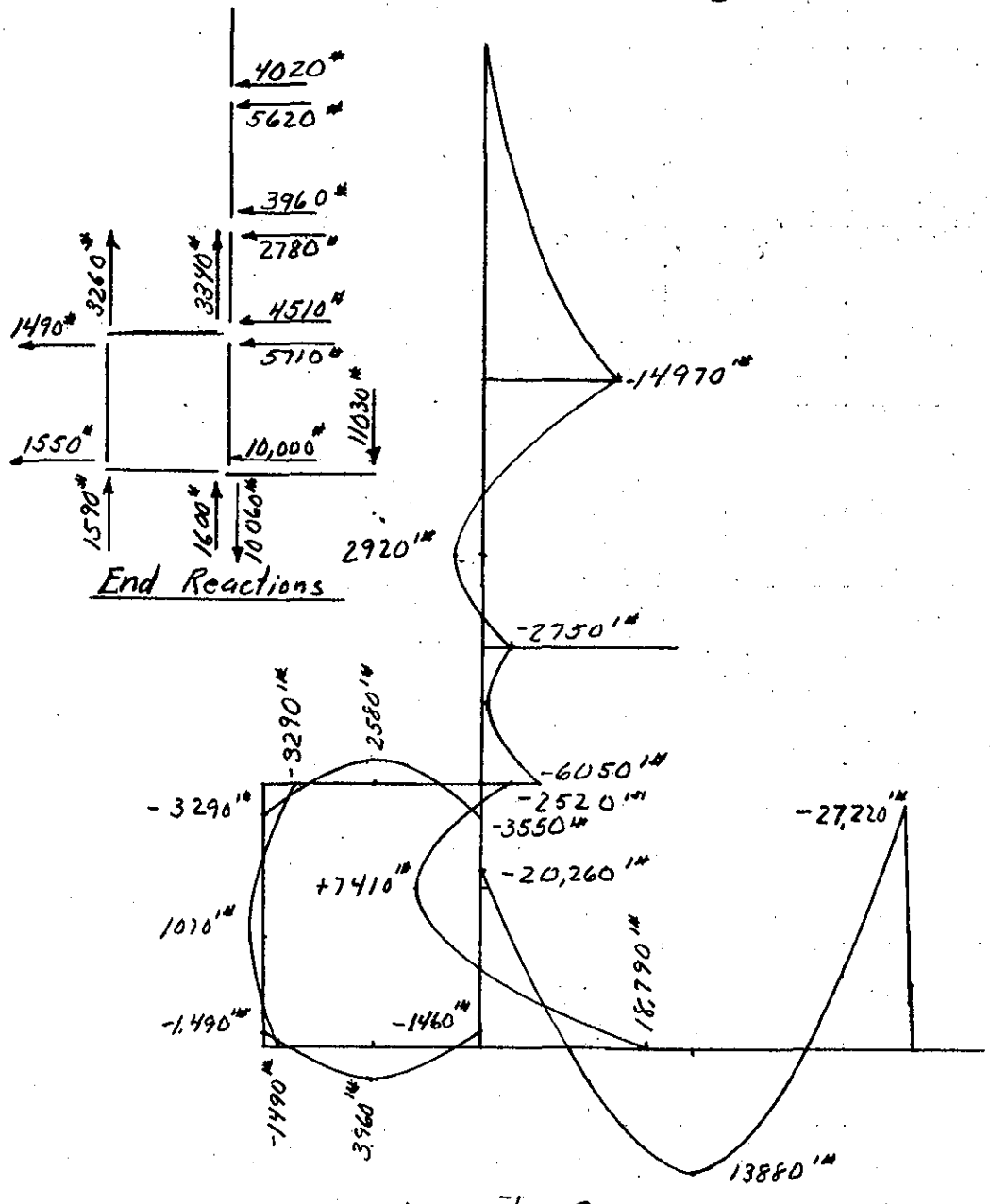
Member 6D

$$H_D = 1590 \times 8.8 \times .5 + 390 \times 8.8 \times .5 \times .33 - \frac{16,270}{8.8} = 5710^{\#}$$

$$H_G = 1590 \times 8.8 \times .5 + 390 \times 8.8 \times .5 \times .67 + \frac{16,270}{8.8} = 10,000^{\#}$$

$$x_0 = 3.35' \text{ from } D$$

$$M = 5710 \times 3.35 - 2,520 - 1590 \times \frac{3.35^2}{2} - 148 \times \frac{3.35^2}{6} = 7410'^{\#}$$



Moment Curve

WAR DEPARTMENT

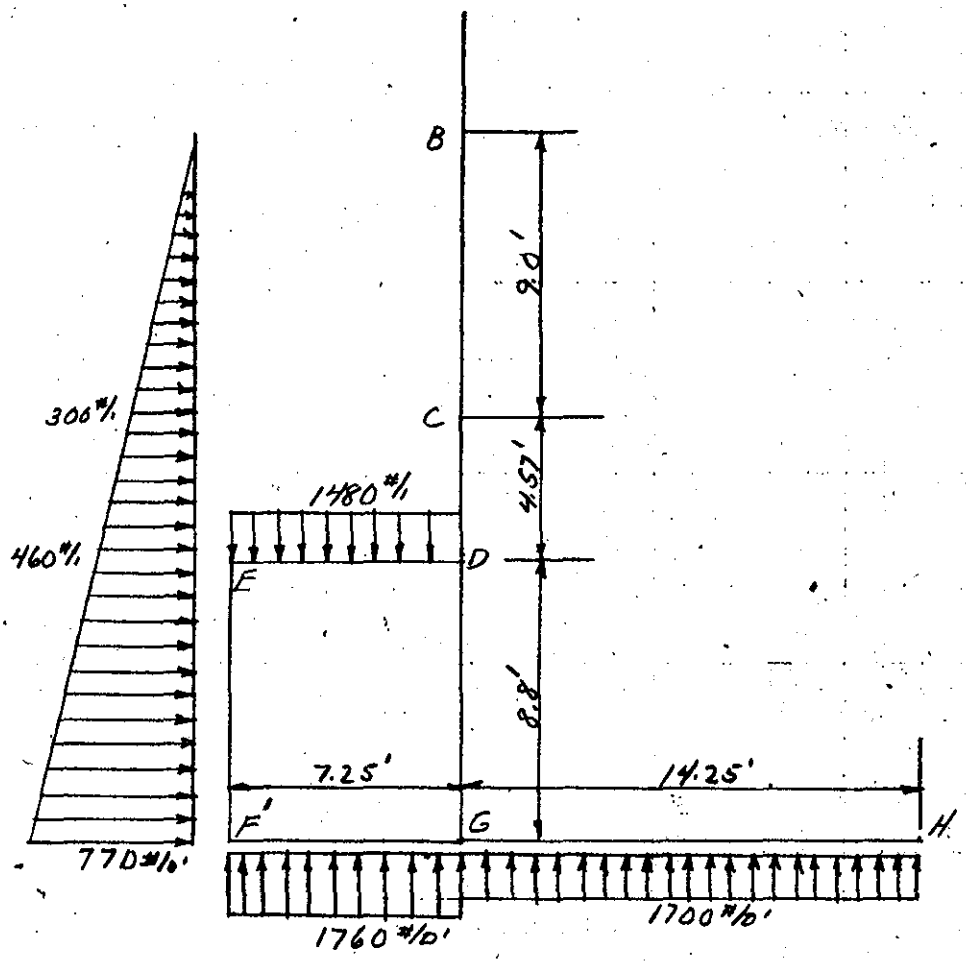
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Section C-C thru Gravity Flow Conduit

Computed by H.E.W **Checked by** _____ **Date** 24-Aug-45

Case II River down



Horiz Pres at El. 41.8 = 35 x 22.03 = 770 #/□'

" " " El. 50.6 = 35 x 13.23 = 460 #/□'

" " " El. 55.17 = 35 x 8.66 = 300 #/□'

Wt. on cond. roof = 12.48 x 100 + 1.5 x 150 = 1480 #/□'

Base Pressure = 2300 - 150 x 3.6 = 1760 #/□'

" " = 2300 - 150 x 4 = 1700 #/□

Case II (cont.)

F. E. M. Member BC

$M^F_{BC} = \frac{1}{15} \times 300 \times \frac{9^2}{2} = .81^{'K}$

$M^F_{CB} = \frac{1}{10} \times 300 \times \frac{9^2}{2} = 1.215^{'K}$

Member CD

$M^F_{CD} = \frac{1}{12} \times 300 \times 4.57^2 + \frac{1}{15} \times 160 \times \frac{4.57^2}{2} = .63^{'K}$

$M^F_{DC} = \frac{1}{12} \times 300 \times 4.57^2 + \frac{1}{10} \times 160 \times \frac{4.57^2}{2} = .69^{'K}$

Member DE

$M^F_{DE} = M^F_{ED} = \frac{1}{12} \times 1480 \times 7.25^2 = 6.48^{'K}$

Member EF

$M^F_{EF} = \frac{1}{12} \times 460 \times 8.8^2 + \frac{1}{15} \times 310 \times \frac{8.8^2}{2} = 3.77^{'K}$

$M^F_{FE} = \frac{1}{12} \times 460 \times 8.8^2 + \frac{1}{10} \times 310 \times \frac{8.8^2}{2} = 4.17^{'K}$

Member FG

$M^F_{FG} = M^F_{GF} = \frac{1}{12} \times 1760 \times 7.25^2 = 7.71^{'K}$

Member GH

$M^F_{GH} = M^F_{HG} = \frac{1}{12} \times 1700 \times 14.25^2 = 28.77^{'K}$

WAR DEPARTMENT

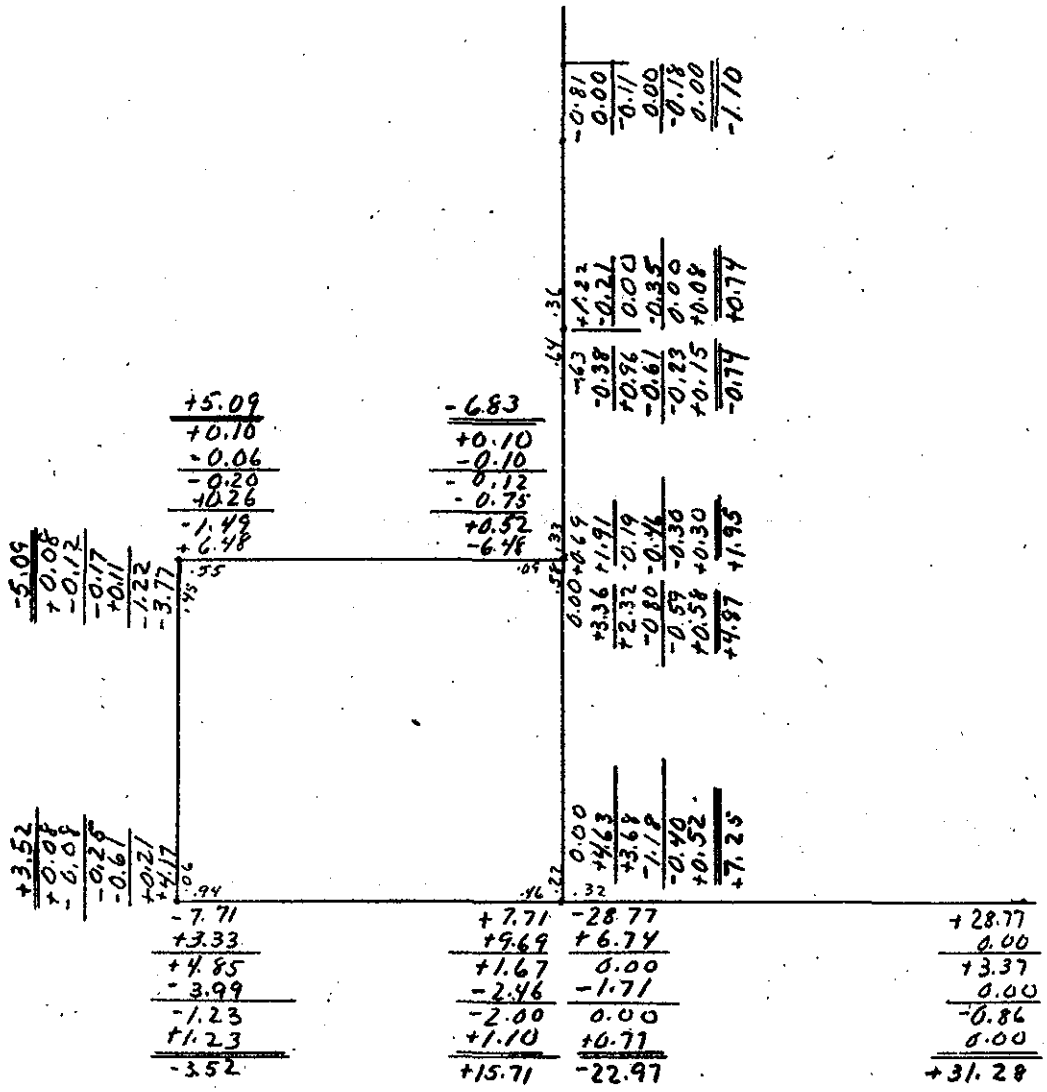
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Section C-C thru Gravity Flow Conduit

Computed by H.E.W. **Checked by** **Date** 27-Aug-45

Case II (cont.)



End Reactions & Center Moments

Member BC

$H_B = 300 \times 9 \times .5 \times .33 + \frac{360}{9} = 490^{\#}$

$H_C = 300 \times 9 \times .5 \times .67 - \frac{360}{9} = 860^{\#}$

$x_0 = 5.3'$ from B

$M = 490 \times 5.3 - 1100 - 185 \times \frac{5.3^2}{6} = 630'^{\#}$

Member CD

$H_C = 300 \times 4.57 \times .5 + 160 \times 4.57 \times .5 \times .33 - \frac{1210}{4.57} = 540^{\#}$

$H_D = 300 \times 4.57 \times .5 + 160 \times 4.57 \times .5 \times .67 + \frac{1210}{4.57} = 1190^{\#}$

$x_0 = 1.65'$ from C

$M = 540 \times 1.65 - 740 - 460 \times \frac{1.65^2}{2} - 58 \times \frac{1.65^2}{6} = -500'^{\#}$ no + M

Subject Holyoke Pumping Station No 6
Computation Section C-C thru Gravity Flow Conduit
Computed by H.E.W **Checked by** **Date** 27. Aug. 44

Case II End React. & Center Moments (cont)

Member DE

$V_D = 1480 \times 7.25 \times .5 + \frac{1740}{7.25} = 5610^{\#}$

$V_E = 1480 \times 7.25 \times .5 - \frac{1740}{7.25} = 5130^{\#}$

$x_0 = 3.8'$ from D

$M = 5610 \times 3.8 - 6830 - 1480 \times \frac{3.8^2}{2} = 3800'^{\#}$

Member EF

$H_E = 460 \times 8.8 \times .5 + 310 \times 8.8 \times .5 \times .33 - \frac{1570}{8.8} = 2300^{\#}$

$H_F = 460 \times 8.8 \times .5 + 310 \times 8.8 \times .5 \times .67 + \frac{1570}{8.8} = 3120^{\#}$

$x_0 = 4.25'$ from E

$M = 2300 \times 4.25 - 5090 - 460 \times \frac{4.25^2}{2} - 149 \times \frac{4.25^2}{6} = 80'^{\#}$

Member FG

$V_F = 1760 \times 7.25 \times .5 - \frac{12190}{7.25} = 4700^{\#}$

$V_G = 1760 \times 7.25 \times .5 + \frac{12190}{7.25} \quad 8060^{\#}$

$x_0 = 2.67'$ from F

$M = 4700 \times 2.67 - 3520 - 1760 \times \frac{2.67^2}{2} = 2760'^{\#}$

Member GH

$V_G = 1700 \times 14.25 \times .5 - \frac{8310}{14.25} = 11530^{\#}$

$V_H = 1700 \times 14.25 \times .5 + \frac{8310}{14.25} = 12700^{\#}$

$x_0 = 6.78'$ from G

$M = 11530 \times 6.78 - 22970 - 1700 \times \frac{6.78^2}{2} = 16130'^{\#}$

Member GD

$H_G = \frac{12120}{8.8} = 1380^{\#} \leftarrow$

$H_D = 1380^{\#} \rightarrow$

WAR DEPARTMENT

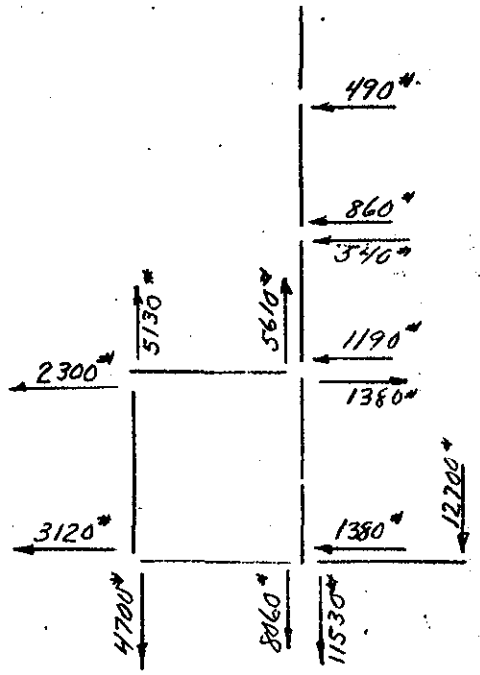
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

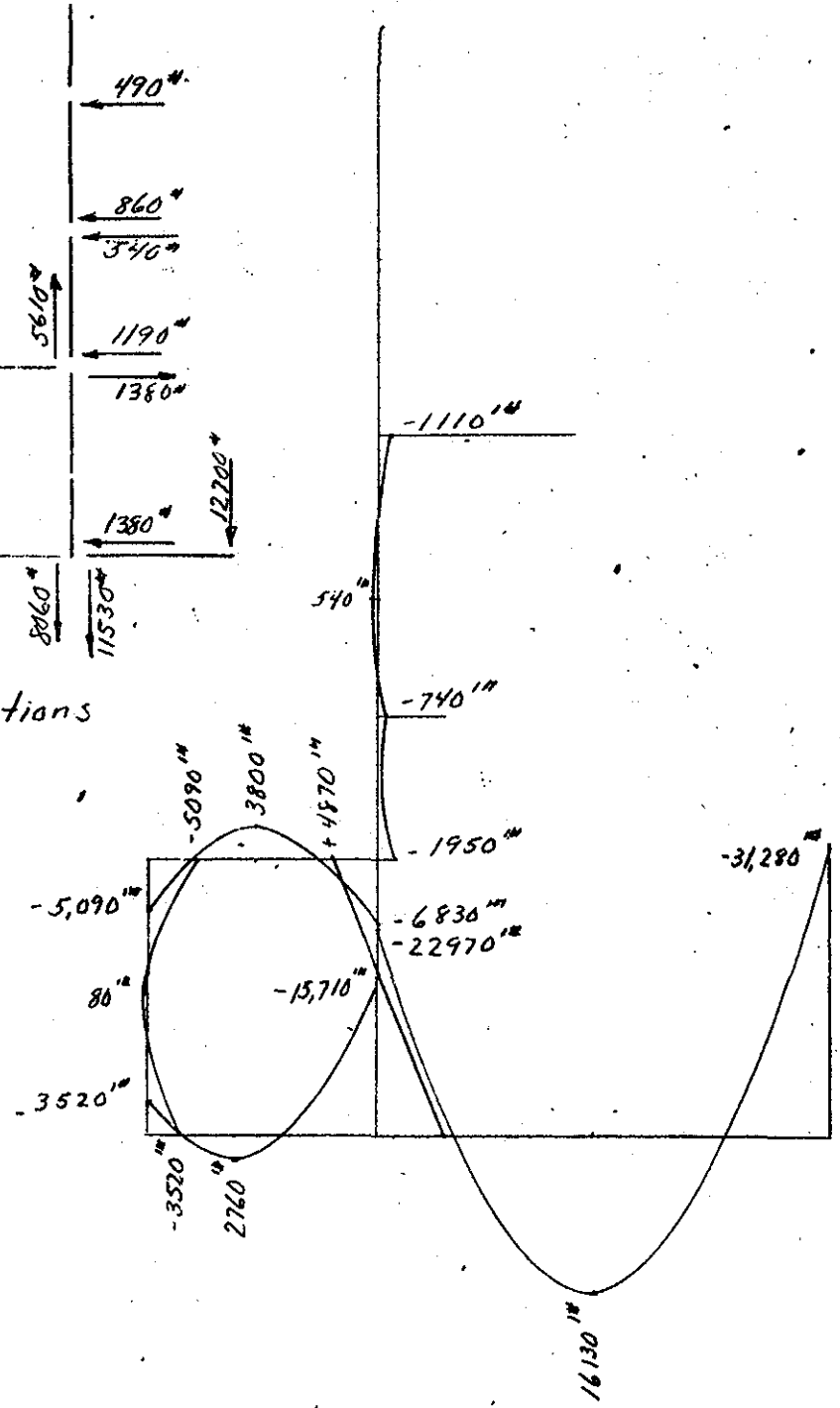
Computation Section C-C thru Gravity Flow Conduit

Computed by H.E.W. **Checked by** _____ **Date** 27 Aug - 45

Case II cont.



End Reactions



Moment Curve

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Section C-C thru Gravity Flow Conduit

Computed by H.E.W. **Checked by** _____ **Date** 1-Sept-45

Case I Joint Defl. at D

Assume Joint D deflects inward .01 inches

Member CD

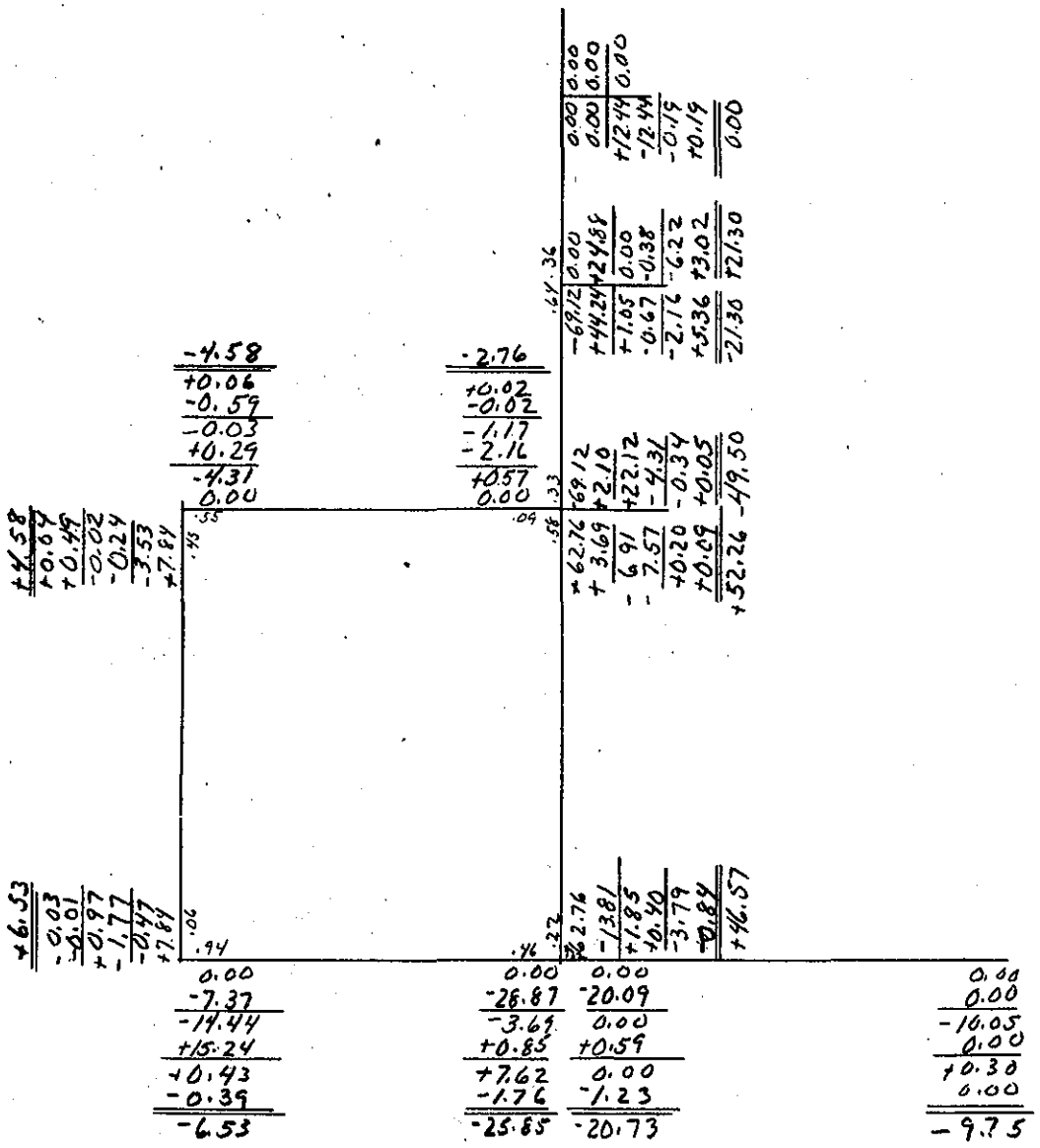
$$M = \frac{6 \times 3{,}000{,}000 \times 13{,}824 \times .01}{55 \times 55 \times 12 \times 1000} = 69.12^{'K}$$

Member DG

$$M = \frac{6 \times 3{,}000{,}000 \times 46656 \times .01}{105.6 \times 105.6 \times 12 \times 1000} = 62.76^{'K}$$

Member EF

$$M = \frac{6 \times 3{,}000{,}000 \times .5832 \times .01}{105.6 \times 105.6 \times 12 \times 1000} = 7.84^{'K}$$



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Section C-C thru Gravity Conduit

Computed by H.E.W. **Checked by** _____ **Date** 4 Sept. - 45

Case I Joint Defl. (cont.)

Member CD

$H_D = \frac{70800}{457} = 15.490$

Member GD

$H_D = \frac{98830}{8.8} = 11,230$

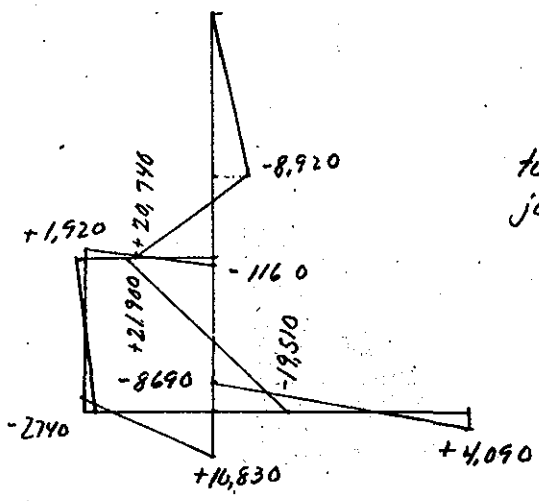
Mom. Mult = $\frac{11710}{27980} = .419$

Member EF

$H_E = \frac{11,110}{8.8} = \frac{1260}{27,980^{\#}}$

Memb.	Trial M	Mult.	Mom.	Shear	
BC @ B	0	.419	0	990#	→
@ C	+21.30	"	+8.92	990#	←
CD @ C	-21.30	"	-8.92	6490#	←
@ D	-49.50	"	-20.74	6490#	→
DE @ D	-2.76	"	-1.16	420#	↑
@ E	-4.58	"	-1.92	420#	↓
EF @ E	+4.58	"	+1.92	530	→
@ F	+6.53	"	+2.74	530#	←
FG @ F	-6.53	"	-2.74	1870#	↓
@ G	-25.85	"	-10.83	1870#	↑
GH @ G	-20.73	"	-8.69	900#	↓
@ H	-9.75	"	-4.09	900#	↑
GD @ G	+46.57	"	+19.51	4710#	←
@ D	+52.26	"	+21.90	4710#	→

Reaction at DE = 4710 + 6490 + 530 = 11730# OK



It will not be necessary to compute the values of joint defl. for case II
Values will be $\frac{2110}{11710} = .18$ of Case I

F 280

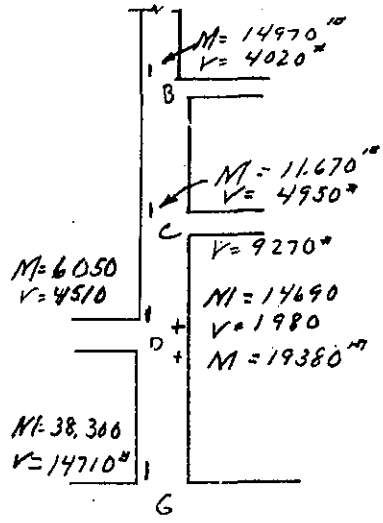
Subject Holyoke Pumping Station No 6

Computation Section C-C thru Gravity Flow Conduit

Computed by H.E.W. **Checked by** _____ **Date** 4-Sept.-45

Design of Members

Wall ABCDG



$$\text{req'd } d = \sqrt{\frac{14970}{147}} = 10.1'' < 17.5'' \text{ OK}$$

$$\text{req'd } d = \sqrt{\frac{38300}{147}} \quad 16.1'' < 32.5''$$

$$v = \frac{14710}{12 \times .88 \times 32.5} = 43\ \#/\square''\ \text{OK}$$

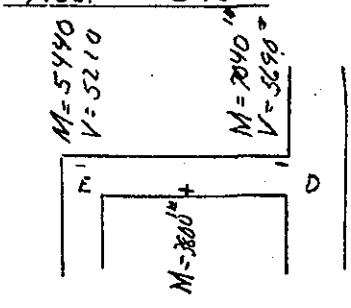
$$-A_s \text{ @ } B = \frac{14970 \times 12}{18000 \times .88 \times 17.5} = .64\ \square''/' \text{ Use } \tfrac{7}{8}''\phi \text{ @ } 1'\text{-}0''\text{cc}$$

$$-A_s \text{ @ } G = \frac{38300 \times 12}{18000 \times .88 \times 32.5} = .89\ \square''/' \text{ Use } 1''\phi \text{ @ } 1'\text{-}0''\text{cc}$$

$$+A_s \text{ @ } D = \frac{14690 \times 12}{18000 \times .88 \times 21.5} = .52\ \square''/' \text{ Use } \tfrac{7}{8}''\phi \text{ @ } 1'\text{-}0''\text{cc}$$

$$u_o = \frac{14710}{4 \times .88 \times 32.5} = 129\ \#/\square''$$

Roof DE



$$M \text{ @ } E = 5090 + .18 \times 1920 = 5440'^{\#}$$

$$V = 5130 + .420 \times 18 = 5210\#$$

$$M \text{ @ } D = 6830 + .18 \times 1160 = 7040'^{\#}$$

$$V = 5610 + .420 \times 18 = 5690\#$$

$$\text{req'd } d = \sqrt{\frac{7040}{147}} = 6.9'' < 14.5'' \text{ OK}$$

$$v = \frac{5690}{12 \times .88 \times 14.5} = 37\ \#/\square''$$

$$-A_s = \frac{7040 \times 12}{18000 \times .88 \times 14.5} = .37\ \square''/' \text{ Use } \tfrac{3}{4}''\phi \text{ @ } 1'\text{-}0''\text{cc}$$

$$u_o = \frac{5690}{2.36 \times .88 \times 14.5} = 189\ \#/\square'' \text{ OK}$$

$$+A_s = \frac{3800 \times 12}{18000 \times .88 \times 14.5} = .20\ \square''/' \text{ Use } \tfrac{5}{8}''\phi \text{ @ } 1'\text{-}0''\text{cc}$$

Wall EF

$$\text{Mom at Base} = 3520 + .18 \times 2740 = 4010$$

$$V = 3120 + .18 \times 530 = 3220\#$$

$$-A_s \text{ @ } E = \frac{5440 \times 12}{18000 \times .88 \times 14.5} = .28\ \square''/' \text{ Use } \tfrac{5}{8}''\phi \text{ @ } 1'\text{-}0''\text{cc}$$

$$u_o = \frac{3220}{1.94 \times .88 \times 14.5} = 130\ \#/\square'' \text{ OK}$$

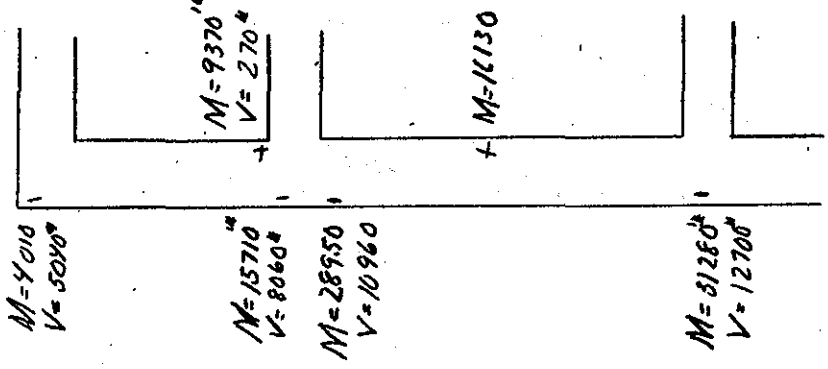
Subject Holyoke Pumping Station No 6

Computation Section C-C thru Gravity Flow Conduit

Computed by H. E. W. **Checked by** _____ **Date** 4-Sept. 45

Design of Members (cont.)

Base Slab



$$\text{reqd } d = \sqrt{\frac{31280}{147}} = 14.6 < 43.5''$$

$$V = \frac{12700}{12 \times .88 \times 43.5} = 28\#/\square''$$

$$-A_s = \frac{31,280 \times 12}{18000 \times .88 \times 43.5} = .550'' \text{ Use } 7/8''\phi \text{ @ } 1'\text{-}0''\text{ cc}$$

$$u_0 = \frac{12700}{2.75 \times .88 \times 43.5} = 121.\#/\square''$$

$+A_s$ Use $7/8''\phi$ @ 1'-0" cc

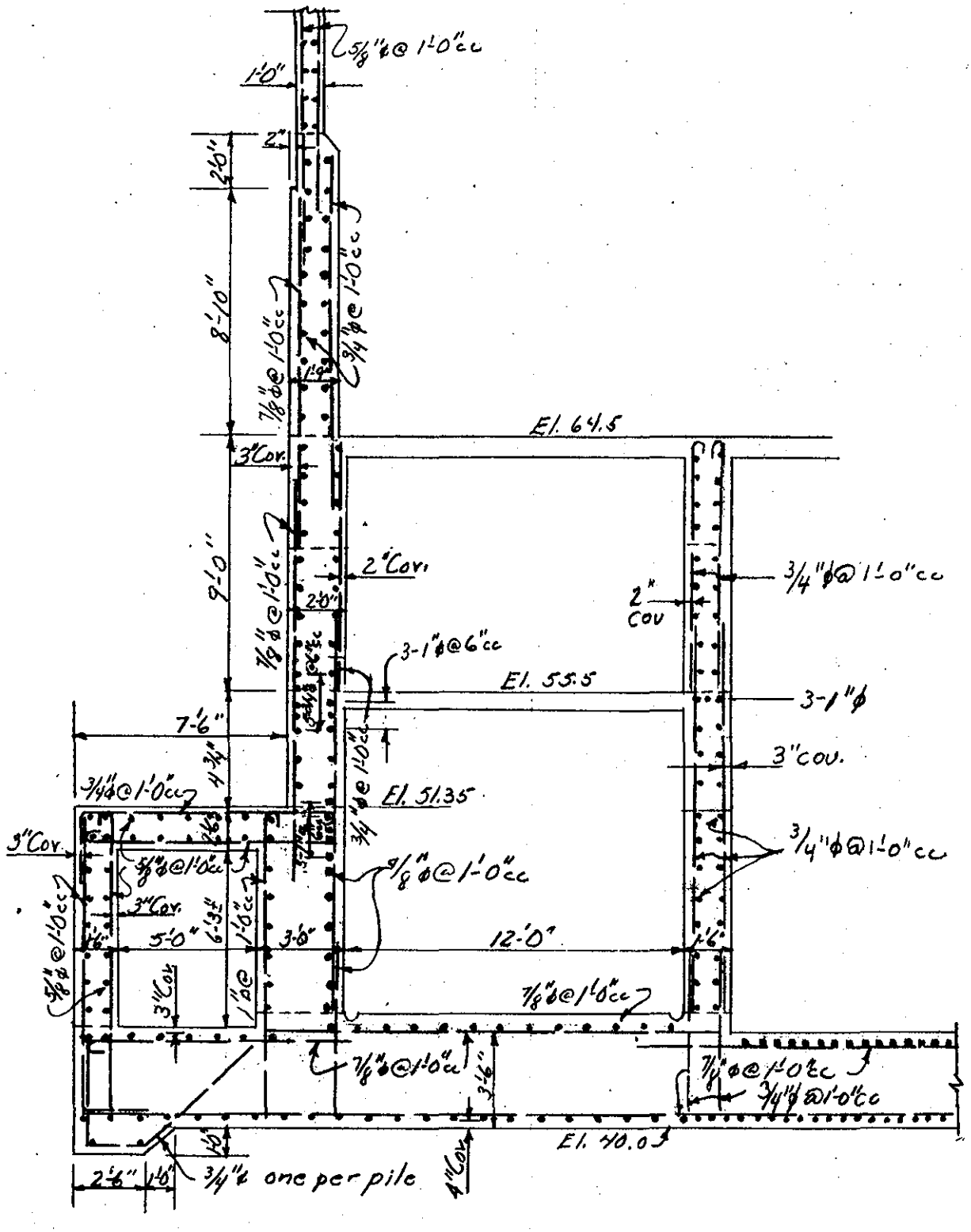
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station

Computation Section C-C thru Gravity Flow Conduit

Computed by H. E. W. **Checked by** **Date** 27 Aug. 45



F283

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

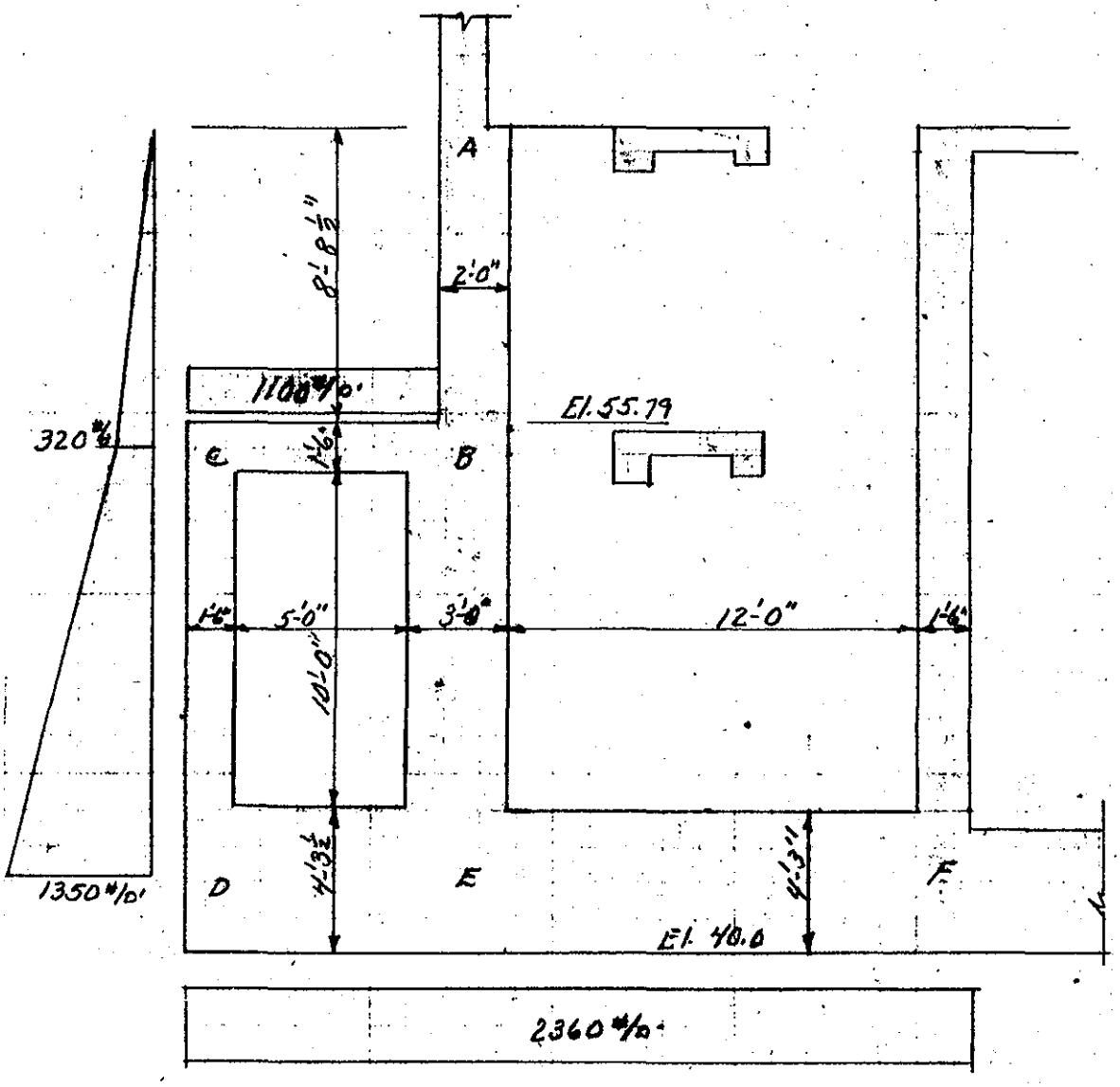
Subject Holyoke Pumping Station No 6

Computation Section D-D thru Gravity Flow Conduit

Computed by H.E.W. **Checked by** _____ **Date** Aug 21

Section will be designed for Case I loading but neglecting water in the conduit.

It will be considered that the wall is fixed at point A and the base slab at point F



Horiz. Thrust at El. 42.15 = 320 + 12.85×80 = 1350#/□'

Roof load = 8.71×100 + 1.5×150 = 1100#/□'

Net Base P = 1110 + 1890 − 4.25×150 = 2360#/□'

F284

Subject Holyoke Pumping Station No 6
Computation Section D-D thru Gravity Flow Conduit
Computed by H.E.W. **Checked by** **Date** Aug. 22

Fixed End Moments

Member AB

$M^F_{AB} = \frac{1}{15} \times 320 \times \frac{9.12^2}{2} = 0.89^{'K}$

$M^F_{BA} = \frac{1}{10} \times 320 \times \frac{9.12^2}{2} = 1.33^{'K}$

Member BC

$M^F_{BC} = M^F_{CB} = \frac{1}{12} \times 1180 \times 7.25^2 = 4.82^{'K}$

Member CD

$M^F_{CD} = \frac{1}{12} \times 320 \times 12.90^2 + \frac{1}{15} \times 1030 \times \frac{12.90^2}{2} = 10.15^{'K}$

$M^F_{DC} = \frac{1}{12} \times 320 \times 12.90^2 + \frac{1}{10} \times 1030 \times \frac{12.90^2}{2} = 13.01^{'K}$

Member DE

$M^F_{DE} = M^F_{ED} = \frac{1}{12} \times 2360 \times 7.25^2 = 10.34^{'K}$

Member EF

$M^F_{EF} = M^F_{FE} = \frac{1}{12} \times 2360 \times 14.25^2 = 39.94^{'K}$

Stiffness Factors

Member	d	d^3	L	d^3/L	K
AB	24"	13824	109.4	126.4	3.35
BC	18"	5832	87	67.0	1.78
CD	18"	5832	154.8	37.7	1.00
DE	51.5"	136591	87	1570.0	41.64
EF	51"	132651	171.0	775.7	20.58
BE	36"	46656	154.8	301.4	7.99

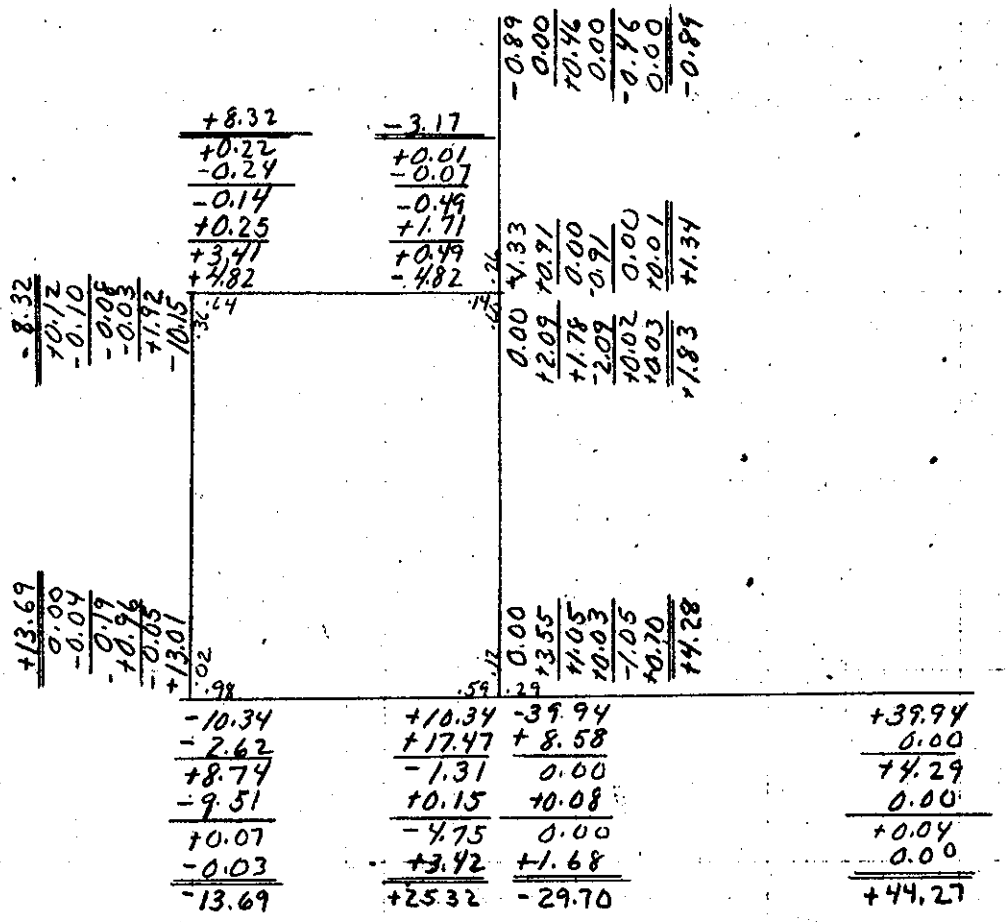
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Section D-D thru Gravity Flow Conduit

Computed by H.E.W. **Checked by** _____ **Date** Aug 22, 1945



End Reactions & Center Moments

Member AB

$H_A = 320 \times 9.12 \times .5 \times .33 - \frac{450}{9.12} = 430^{\#}$

$H_B = 320 \times 9.12 \times .5 \times .67 + \frac{450}{9.12} = 1030^{\#}$

$x_0 = 4.95'$ from A

$M = 430 \times 4.95 - 890 - 173 \times \frac{4.95^2}{6} = 520'^{\#}$

Member BC

$V_B = 1100 \times 7.25 \times .5 - \frac{5150}{7.25} = 3280^{\#}$

$V_C = 1100 \times 7.25 \times .5 + \frac{5150}{7.25} = 4700^{\#}$

$x_0 = 2.98'$ from B

$M = 3280 \times 2.98 - 3170 - 1100 \times \frac{2.98^2}{2} = 1720'^{\#}$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6
Computation Section D-D thru Gravity Flow Conduit
Computed by H.E.W. **Checked by** **Date** Aug 22, 1945

End React. & Center Moments (cont.)

Member CD

$H_C = 320 \times 12.90 \times .5 + 1030 \times 12.90 \times .5 \times .33 - \frac{5370}{12.90} = 3840^{\#}$

$H_D = 320 \times 12.90 \times .5 + 1030 \times 12.90 \times .5 \times .67 + \frac{5370}{12.90} = 7930^{\#}$

$x_0 = 6.6'$ from C

$M = 3840 \times 6.6 - 8320 - 320 \times \frac{6.6^2}{2} - 528 \times \frac{6.6^2}{6} = 6220'^{\#}$

Member DE

$V_D = 2360 \times 7.25 \times .5 - \frac{11630}{7.25} = 6950^{\#}$

$V_E = 2360 \times 7.25 \times .5 + \frac{11630}{7.25} = 10160^{\#}$

$x_0 = 2.94'$ from D

$M = 6950 \times 2.94 - 13690 - 2360 \times \frac{2.94^2}{2} = 3460'^{\#}$

Member EF

$V_E = 2360 \times 14.25 \times .5 - \frac{14570}{14.25} = 15790^{\#}$

$V_F = 2360 \times 14.25 \times .5 + \frac{14570}{14.25} = 17840^{\#}$

$x_0 = 6.69$

$M = 15790 \times 6.69 - 29,700 - 2360 \times \frac{6.69^2}{2} = 23,120'^{\#}$

Member BE

$H_B = \frac{6110}{12.90} = 470^{\#} \rightarrow \quad H_E = 470^{\#} \leftarrow$

Design of Members

Wall ABE

Moments and shears are small use 3/4" ϕ @ 1'-0" cc as minimum steel

Roof CB

req'd t. $\sqrt{\frac{8320}{147}} = 7.5" < 14.5"$ OK

$v = \frac{4700}{12 \times .88 \times 14.5} = 31^{\#}/\square"$

$-A_s$ at C $= \frac{8320 \times 12}{18000 \times .88 \times 14.5} = .43^{\square"}$ Use 3/4" ϕ @ 12" cc

$v_0 = \frac{4700}{236 \times .88 \times 14.5} = 156^{\#}/\square"$ OK

$+A_s = \frac{1720 \times 12}{18000 \times .88 \times 14.5} = .19^{\square"}$ Use 5/8" ϕ @ 1'-0" cc

Design of Members (cont.)

Conduit Wall CD

req'd $d = \sqrt{\frac{13690}{147}} = 9.65'' < 14.5''$

$v = \frac{7930}{12 \times .88 \times 14.5} = 52$ #/□" OK

-As at C Use 3/4"ϕ @ 1'-0" cc

-As at D: $\frac{13690 \times 12}{18000 \times .88 \times 14.5} = .72$ □" Use 3/4"ϕ @ 6" cc

$u_o = \frac{7930}{4.71 \times .88 \times 14.5} = 132$ #/□" OK

+As $= \frac{6220 \times 12}{18000 \times .88 \times 14.5} = .33$ □" Use 3/4"ϕ @ 1'-0" cc

Base Slab DEF

req'd $d = \sqrt{\frac{44270}{147}} = 17.3'' < 46.5''$ OK

$v = \frac{17840}{12 \times .88 \times 46.5} = 36$ #/□" OK

-As at F $= \frac{44270 \times 12}{18000 \times .88 \times 46.5} = .72$ □" Use 7/8"ϕ @ 12" cc } alt. 3/4"ϕ @ 12" cc

$u_o = \frac{17840}{5.2 \times .88 \times 46.5} = 84$ #/□" OK

-As at E $= \frac{29700 \times 12}{18000 \times .88 \times 46.5} = .49$ □" Use 7/8"ϕ @ 12" cc

$u_o = \frac{15790}{2.75 \times .88 \times 46.5} = 140$ #/□" OK

+As $= \frac{23120 \times 12}{18000 \times .88 \times 42} = .42$ □" Use 7/8"ϕ @ 12" cc

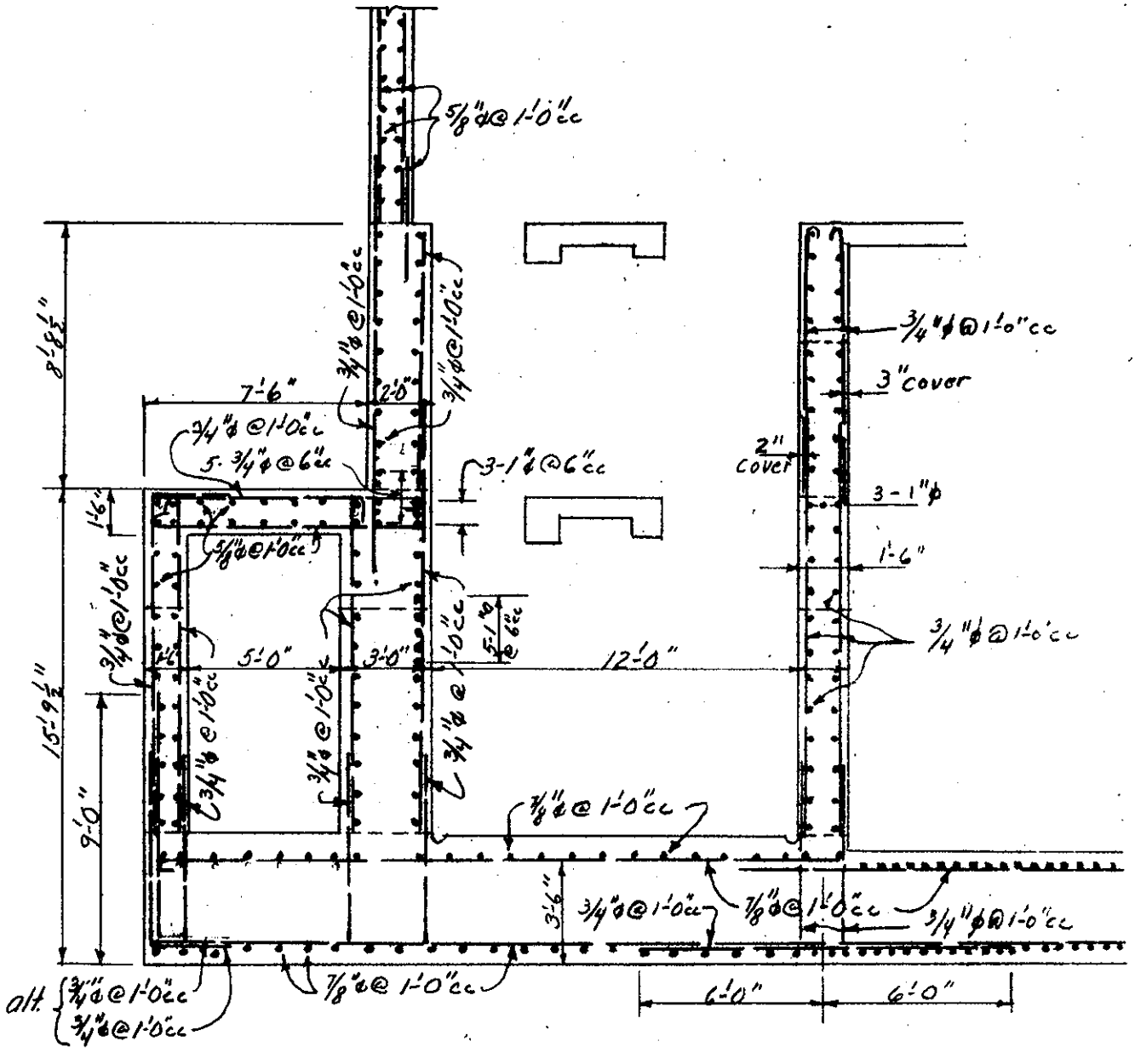
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Section D-D thru Gravity Flow Conduit

Computed by H.E.W. **Checked by** _____ **Date** Aug. 23



F289

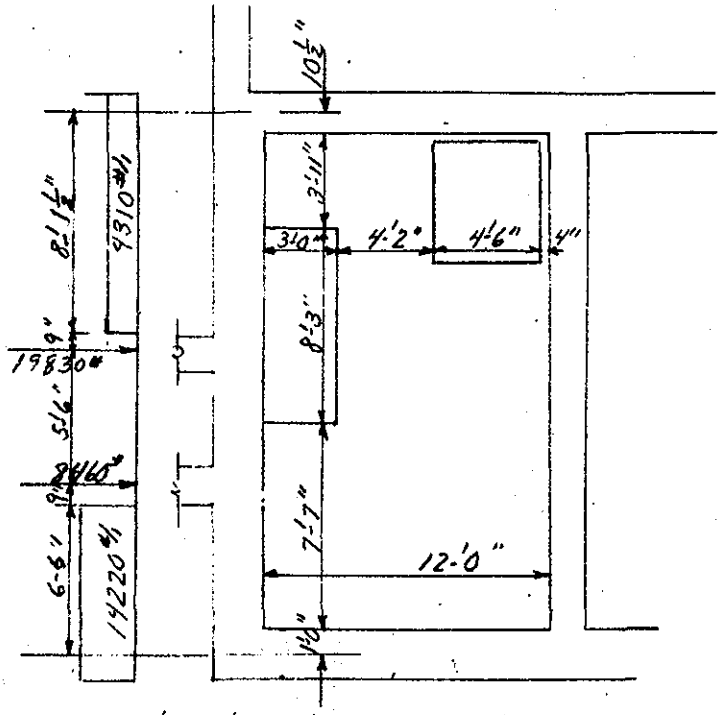
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Horiz. Thrust on Boiler Rm. Floor from End Wall

Computed by H.E.W. **Checked by** **Date** 5-Sept.-45



Thrust at Stairway Opening

$H_R = 4310 \times 3.33 \times \frac{6.58}{8.25} + 19830 \times \frac{4.17}{8.25} = 21,470^{\#}$

$H_L = 4310 \times 3.33 \times \frac{1.67}{8.25} + 19830 \times \frac{4.08}{8.25} = 12710^{\#}$

$\therefore M = 12710 \times 4.17 = 53,000^{'\#}$

Assume 12" width then reqd $d = \sqrt{\frac{53000}{123}} = 20.7"$ OK

$v = \frac{21,470}{12 \times .88 \times 20} = 102\ \#/\square''$ OK as more than 12" will act

$A_s = \frac{53000 \times 12}{18000 \times .88 \times 20} = 2.0^{\square''}$ Use 3-1"ϕ @ 6" c c

$u_o = \frac{21,470}{9.42 \times .88 \times 20} = 130\ \#/\square''$

North Side

Face of North Wall

$V = 4310 \times 3.92 + 21,470 = 38370^{\#}$

$M = 21,470 \times 3.92 + 4310 \times \frac{3.92^2}{2} = 117,280^{'\#}$

reqd $d = \sqrt{\frac{117280 \times 12}{8 \times 147}} = 315" < 106"$ OK

$v = \frac{38370}{8 \times .88 \times 106} = 52\ \#/\square''$

$A_s = \frac{117,280 \times 12}{18000 \times .88 \times 106} = .83^{\square''}$ 2-3/4"ϕ

F 290

Subject Holyoke Pumping Station No 6

Computation Horiz Thrust on Boiler Rm Floor from End Wall

Computed by H.E.W. **Checked by** **Date** 5-Sept-45

$$u_o = \frac{38370}{4.71 \times .88 \times 106} = 87\ \#/\square''$$

South End

Face of So. Wall

$$V = 12{,}710 + 8460 + 14{,}220 \times 5.5 = 99{,}380^{\#}$$

$$M = 12710 \times 7.58 + 8460 \times 6.25 + 14220 \times \frac{6.5^2}{2} = 449620'^{\#}$$

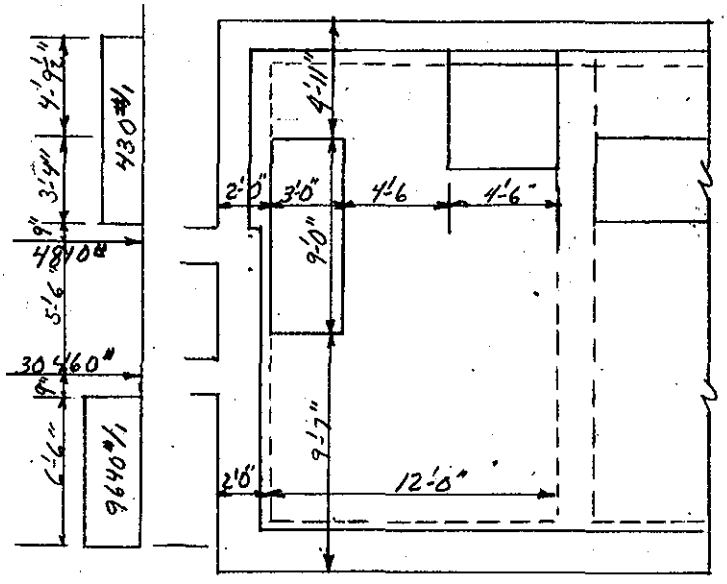
$$\text{reqd } d = \sqrt{\frac{449620 \times 12}{8 \times 147}} = 67.8'' < 182.5$$

$$v = \frac{99380}{8 \times .88 \times 182.5} = 77\ \#/\square''\ \text{OK}$$

$$A_s = \frac{449{,}620 \times 12}{18000 \times .88 \times 182.5} = 1.87\ \square''\ \text{Use } 5\text{-}\tfrac{3}{4}''\phi\ @\ 6''\text{cc}$$

$$u_o = \frac{99380}{11.78 \times .88 \times 182.5} = 52\ \#/\square''\ \text{OK}$$

Horiz Thrust at Motor Room Floor from End Wall



The Motor Room Floor will resist the horiz. loading shown. At the stairway opening the end wall must be designed as a beam to take the load.

$$H_R = 430 \times 3.33 \times \frac{6.58}{8.25} + 4810 \times \frac{4.17}{8.25} = 3570^{\#}$$

$$H_L = 430 \times 3.33 \times \frac{1.67}{8.25} + 4810 \times \frac{4.08}{8.25} = 2670^{\#}$$

$$M = 2670 \times 4.17 = 11{,}130'^{\#}$$

$$A_s = \frac{11{,}130 \times 12}{18000 \times .88 \times 20} = .42\ \square''\quad \tfrac{3}{4}''\phi\ @\ 1'\text{-}0''\text{cc OK}$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

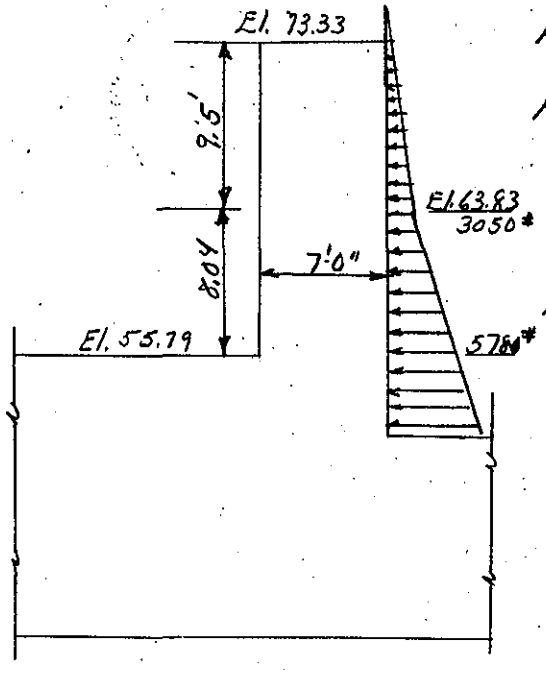
Subject Holyoke Pumping Station No 6

Computation Thrust on West Wall and Gravity Flow Gate Chamber

Computed by H.E.W. **Checked by** _____ **Date** 6 - Sept. 45

The West wall will resist the thrust on the South wall for a distance half way to the dividing wall and for half the width of Gate Chamber. This dist is approx. the same width as for the dividing wall and the same steel will be furnished.

End wall of Gravity Flow Gate Chamber.



Horiz. Thrust at El. 63.83

$11.5 \times 62.5 \times 4.25 = 3050^{\#}$

Horiz Thrust at El. 55.79

$3050 + 8.04 \times 80 \times 4.25 = 5780^{\#}$

Mom. at El. 55.79

$M = 3050 \times \frac{11.5}{2} \times 11.87 + 3050 \times \frac{8.04^2}{2} + 2730 \times \frac{8.04}{2} \times 2.68$

$= 336\,160'^{\#}$

$V = 3050 \times \frac{11.5}{2} + 3050 \times 8.04 + 2730 \times \frac{8.04}{2} = 63{,}040^{\#}$

reqd $d = \sqrt{\frac{336160 \times 12}{18 \times 147}} = 39'' < 75.$ "

$v = \frac{63040}{18 \times .88 \times 75} = 54^{\#}/\square''$ OK

$A_s = \frac{336160 \times 12}{18000 \times .88 \times 75} = 3.40^{\square''}$ Use 4- 1" ⌀

$u_0 = \frac{63040}{16 \times .88 \times 75} = 60^{\#}/\square''$

Mom at El. 60.5

$M = 3050 \times \frac{11.5}{2} \times 7.16 + 3050 \times \frac{3.33^2}{2} + 1130 \times \frac{3.33^2}{6} = 149{,}570$ ·

$A_s = \frac{149570 \times 12}{18000 \times .88 \times 75} = 1.51^{\square''}$ Use 4- 3/4" ⌀

WAR DEPARTMENT

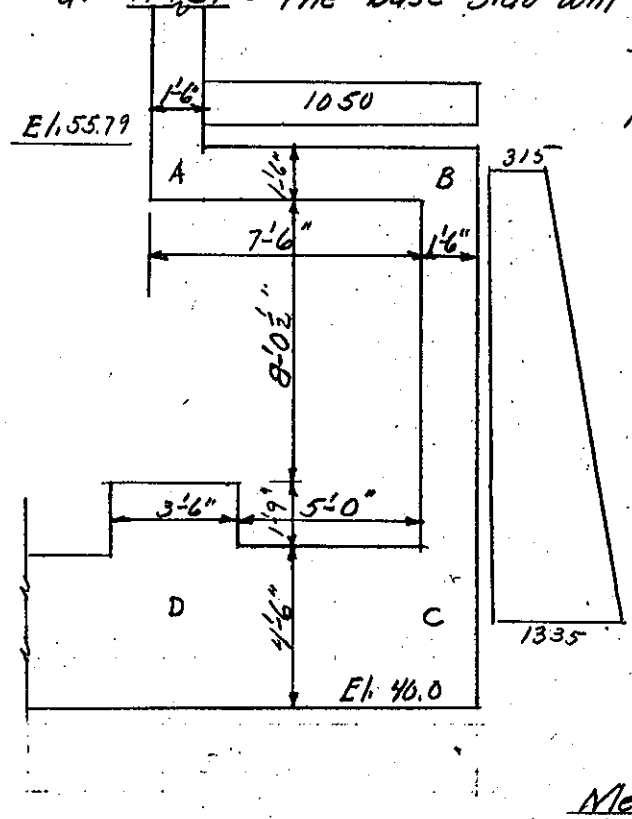
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Section E-E Thru Gravity Flow Conduit

Computed by H. E. W. **Checked by** _____ **Date** 10-Sept.-45

Section will be designed for Case I loading but neglecting water in the conduit - Consider ABC as fixed at A & C. - The base slab will be considered cantilevered at D



Vert. load on conduit roof

$8.21 \times 100 + 1.5 \times 150 = 1050$ #/'

Horiz. thrust at El. 55.05 =

$9 \times 35 = 315$#

Horiz thrust at El. 42.25

$315 + 12.75 \times 80 = 1335$ #/'

Base Pressure

$940 + 2550 = 3490$ #/'

F. E. M. Member AB

$M^F = \frac{1}{12} \times 1050 \times 7.5^2 = 4.92$ 'K

Member BC

$M^F_{BC} = \frac{1}{12} \times 315 \times 12.79^2 + \frac{1}{15} \times 1020 \times \frac{12.79^2}{2}$

$= 9.85$ 'K

$M^F_{CB} = \frac{1}{12} \times 315 \times 12.79^2 + \frac{1}{10} \times 1020 \times \frac{12.79^2}{2}$

$= 12.63$ 'K

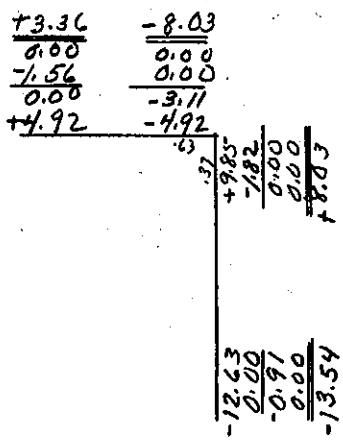
Member AB

$V_A = 1050 \times 7.5 \times .5 - \frac{4670}{7.5} = 3320$#

$V_B = 1050 \times 7.5 \times .5 + \frac{4670}{7.5} = 4560$#

$x_0 = 3.16$ ' from A

$M = 3320 \times 3.16 - 3360 - 1050 \times \frac{3.16^2}{2} = 1890$ '#



Member BC

$H_B = 315 \times 12.79 \times .5 + 1020 \times 12.79 \times .5 \times .33 - \frac{5510}{12.79}$

$= 3740$#

$H_C = 315 \times 12.79 \times .5 + 1020 \times 12.79 \times .5 \times .67 + \frac{5510}{12.79}$

$= 6820$#

$x_0 = 6.5$ ' from B

$M = 3740 \times 6.5 - 8030 - 315 \times \frac{6.5^2}{2} - 520 \times \frac{6.5^2}{6}$

$= 5960$ '#

Design of Members

req'd $d = \sqrt{\frac{13540}{147}} = 9.6 < 14.5$"

$v = \frac{6820}{12 \times .88 \times 14.5} = 45$ #/□"

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Section E-E Thru Gravity Flow Conduit

Computed by H.E.W. **Checked by** **Date** 10-Sept. 45

Design of Members

$-A_s = \frac{13540 \times 12}{18000 \times .88 \times 14.5} = .71^{\square''}$ Use $\frac{3}{4}''\phi$ @ 6" cc

$u_o = \frac{6820}{4.71 \times .88 \times 14.5} = 113\ \#/\square''$

$-A_s = \frac{8030 \times 12}{18000 \times .88 \times 14.5} = .42^{\square''}$ Use $\frac{3}{4}''\phi$ @ 1'-0" cc

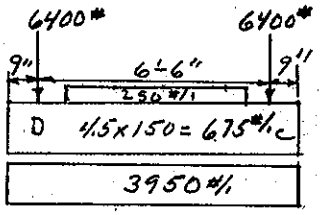
$u_o = \frac{4560}{2.36 \times .88 \times 14.5} = 152\ \#/\square''$

$+A_s = \frac{5960 \times 12}{18000 \times .88 \times 14.5} = .31^{\square''}$ Use $\frac{3}{4}''\phi$ @ 1'-0" cc

Design of Base Slab

Case I Loading

Moments about D at Sewer Connection



Roof Ld 1050 x 4 = 4200#

Wall ld = 1.5 x 150 x 9.79 = 2200#

6400#

Wt. water = 4 x 62.5 = 250#

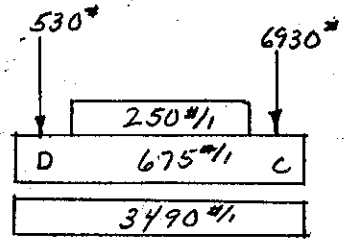
Reaction at D (not including 6400# at D)

3950 x 8 - 6400 - 675 x 8 - 250 x 5 = 18,550#

M at face of wall

3950 x 6.5 x 3.25 - 675 x 6.5 x 3.25 - 250 x 5 x 2.5 - 6400 x 5.75 = 29,250'#

Moments about D at face of Pump Sta.



Roof ld. 1050 x 4.5 = 4730

Wall ld = 2200

6930#

Wall ld = 1.5 x 1.75 x 150 = 390#

2.25 x 62.5 = 140

530#

Reaction at D (not including 530# at D)

3490 x 8 - 6930 - 675 x 8 - 250 x 5 = 14340

M at face of Wall

3490 x 6.5 x 3.25 - 675 x 6.5 x 3.25 - 250 x 5 x 2.5 - 6930 x 5.75 = 16,490'#

A_s in base $= \frac{29,250 \times 12}{18000 \times .88 \times 49.5} = .45^{\square''}$ $\frac{7}{8}''\phi$ @ 1'-0" cc

$u_o = \frac{18550}{2.75 \times .88 \times 49.5} = 155\ \#/\square''$

F294

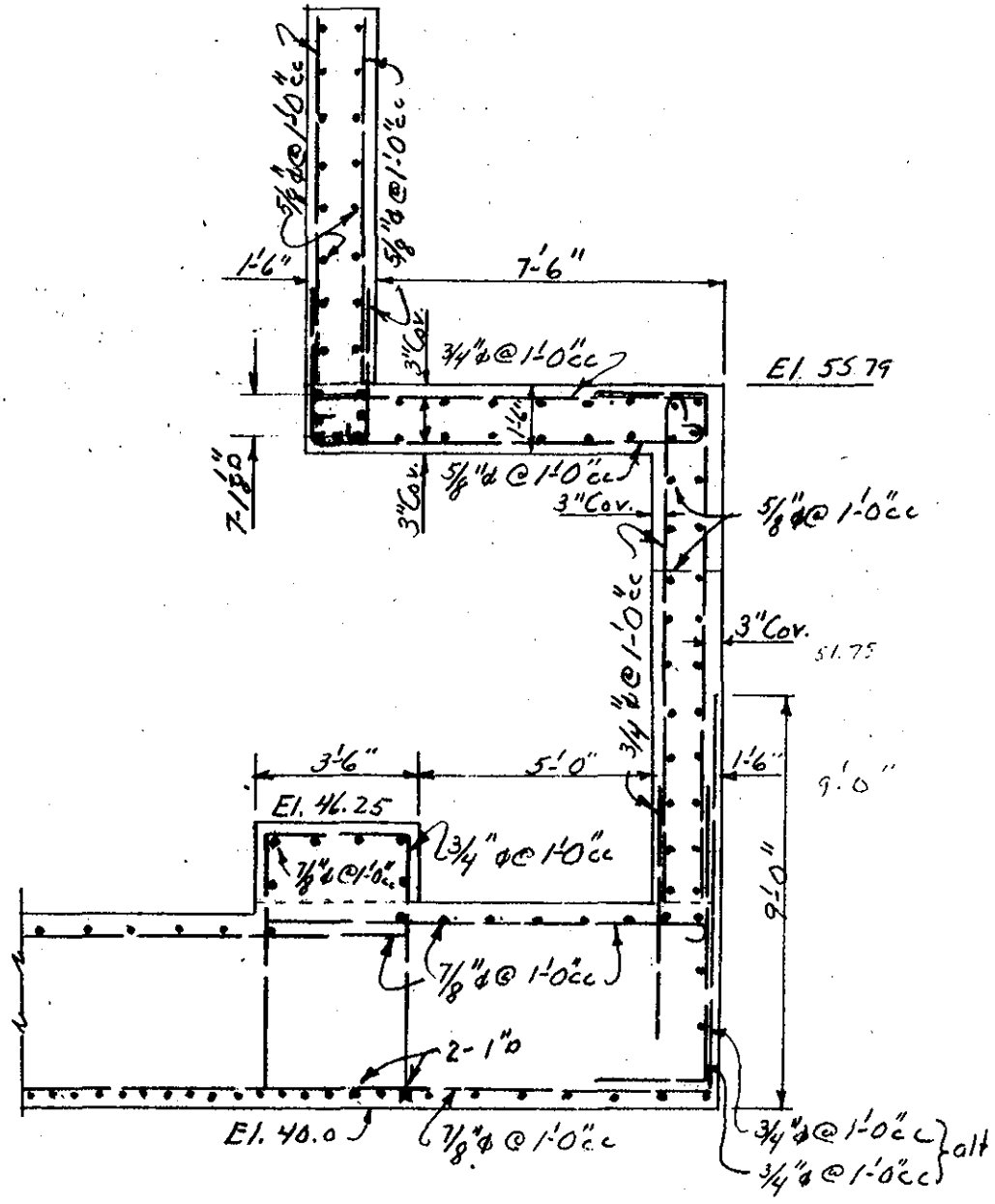
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Section E-E Thru Gravity Flow Conduit

Computed by H. E. W. **Checked by** **Date** 12-Sept. 45



Section EE

F295

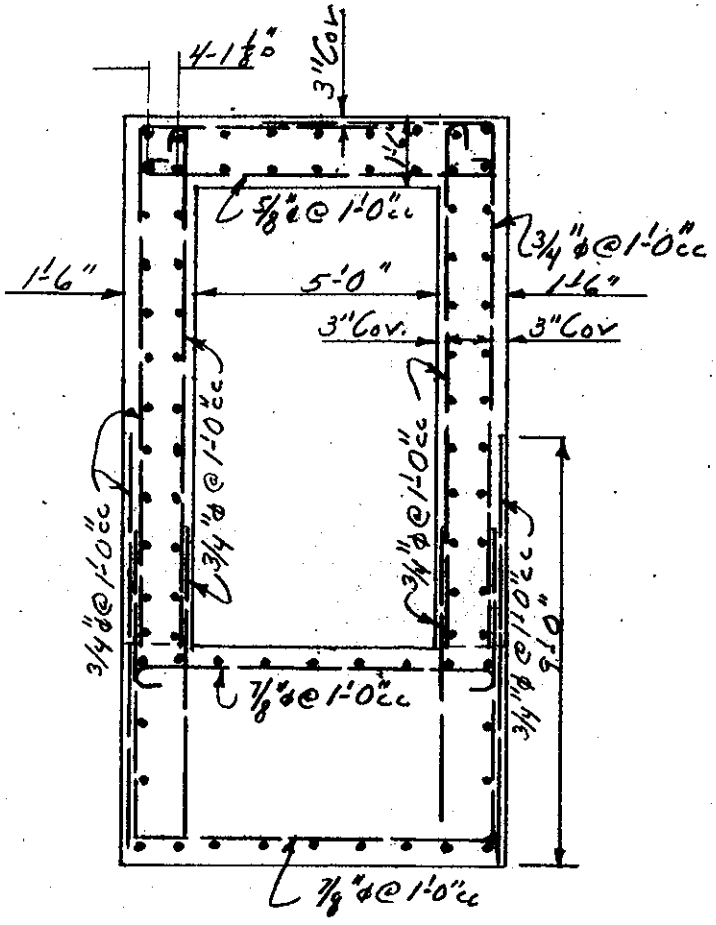
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Section F-F thru Gravity Flow Conduit at Intake

Computed by H. E. W. **Checked by** **Date** 12-Sept 45



Section F

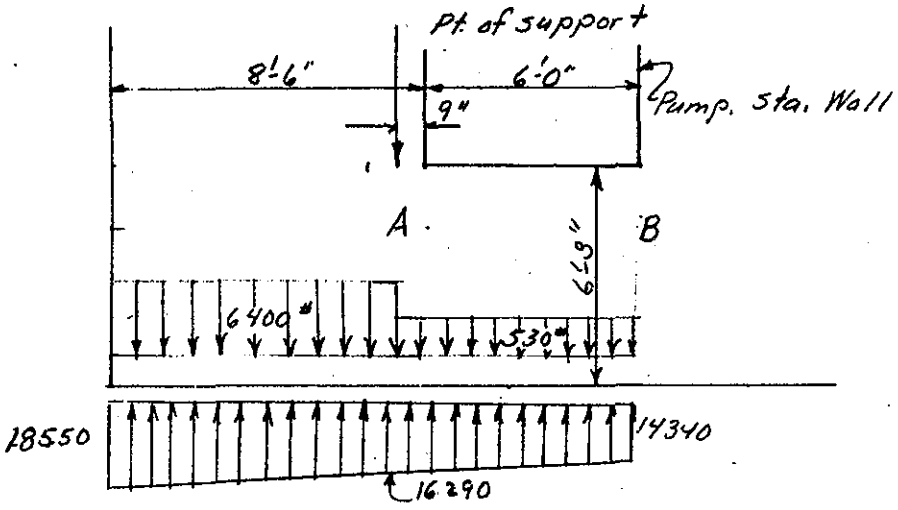
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation East Wall of Gravity Flow Conduit at Intake

Computed by H. E. W. **Checked by** _____ **Date** 11 Sept. 45



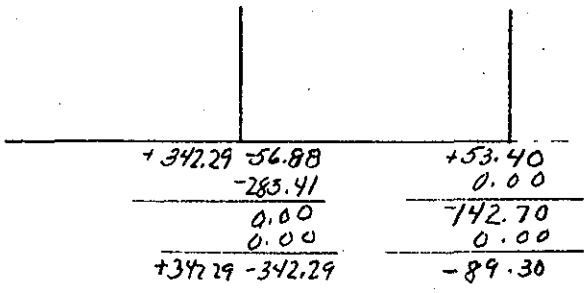
Shear at Pt A = $16290 \times 7.75 + 2260 \times 7.75 \times .5 - 6400 \times 7.75 = 85{,}410$

$M_{lom} = 16290 \times \frac{7.75^2}{2} + 2260 \times 7.75 \times .5 \times 5.17 - 6400 \times \frac{7.75^2}{2} = 342{,}290^{\#}$

Member AB

$M_A^F = \frac{1}{12} \times 13{,}810 \times 6.75^2 + \frac{1}{10} \times 1950 \times \frac{6.75^2}{2} = 56.880$

$M_B^F = \frac{1}{12} \times 13810 \times 6.75^2 + \frac{1}{15} \times 1950 \times \frac{6.75^2}{2} = 53400$



Member AB

$V_A = 14340 \times \frac{6.75}{2} + 1950 \times \frac{6.75}{2} \times .67 + \frac{431{,}590}{6.75} - 530 \times \frac{6.75}{2} = 118{,}540^{\#}$

$V_B = 14340 \times \frac{6.75}{2} + 1950 \times \frac{6.75}{2} \times .33 - \frac{431{,}590}{6.75} - 530 \times \frac{6.75}{2} = -15160$

req'd d at A = $\sqrt{\frac{342{,}290 \times 12}{42 \times 147}} = 25.8''$ OK

$v = \frac{118{,}540}{42 \times .88 \times 70.5} = 46^{\#}/\square''$

$-A_s = \frac{342{,}290 \times 12}{18000 \times .88 \times 70.5} = 3.7^{\square''}$ Use 2- 7/8"φ @ 2-1□"

$+A_s$ @ B = $\frac{89{,}300 \times 12}{18000 \times .88 \times 70.5} = 96^{\square''}$ Use 4- 7/8"φ

$u_o = \frac{118{,}540}{13.5 \times 88 \times 70.5} = 142^{\#}/\square''$

Subject Holyoke Pumping Station No 6
Computation East Wall of Gravity Flow Conduit at Intake
Computed by H.E.W. **Checked by** **Date** 11 Sept 45

The upward thrust at A will be 118,540 + 85410 = 203,950#
This thrust will be assumed taken by the wall of the raking chamber acting as a cantilever from the pump. sta.

$$M = 203{,}950 \times 6.75 - 9.71 \times 225 \times \frac{6.75^2}{2} = 1{,}326{,}890'^{\#}$$

$$\text{req'd } d = \sqrt{\frac{1{,}326{,}890 \times 12}{18 \times 147}} = 77'' < 108'' \text{ OK}$$

$$A_s = \frac{1{,}326{,}890 \times 12}{18000 \times .88 \times 108} = 9.3^{\square''} \quad \text{Use } 7\text{-}1\tfrac{1}{8}\square''$$

$$u_o = \frac{203950 - 9.71 \times 225 \times 6.75}{26 \times .88 \times 108} = 76\ \#/\square''$$

From the raking chamber to pipe opening the wall will be designed horizontally

Horiz thrust at El. 44.25 = 320 + 10.75 × 80 = 1180 #/□'
" " " El. 50.50 = 320 + 4.75 × 80 = 700 #/□'

At El. 44.25

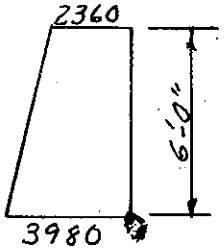
$$M = \frac{1}{10} \times 1180 \times 6.75^2 = 5{,}380'^{\#} \qquad V = 1180 \times \frac{6.75}{2} = 3980^{\#}$$

$$A_s = \frac{5380 \times 12}{18000 \times .88 \times 14} = .29^{\square''} \quad \text{Use } 5/8''\phi \text{ @ } 1'\text{-}0''\text{cc}$$

$$u_o = \frac{3980}{1.96 \times .88 \times 14} = 165\ \#/\square''$$

Reaction at El. 49.50 = $700 \times \frac{6.75}{2}$ = 2360

Vertical Beam at pipe opening



Consider Beam fixed top & bot

$$M^F_{Top} = \frac{1}{12} \times 2360 \times 6^2 + \frac{1}{15} \times 1620 \times \frac{6^2}{2} = 9{,}030'^{\#}$$

$$M^F_{Bot} = \frac{1}{12} \times 2360 \times 6^2 + \frac{1}{10} \times 1620 \times \frac{6^2}{2} = 10{,}000'^{\#}$$

$$\text{req'd } d = \sqrt{\frac{10{,}000 \times 12}{24 \times 147}} = 5.8'' < 14.5''$$

$$A_s = \frac{10{,}000 \times 12}{18000 \times .88 \times 14.5} = .52^{\square''} \quad 5/8''\phi \text{ @ } 12''\text{cc will be OK}$$

WAR DEPARTMENT

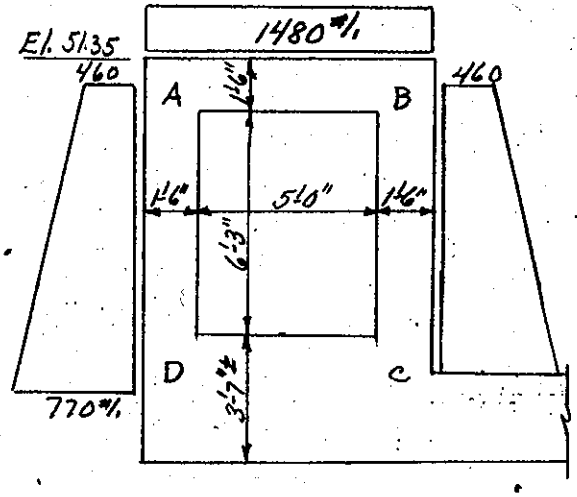
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Gravity Flow Conduit at Section G-G

Computed by H.E.W. **Checked by** _____ **Date** 7-Sept. 45

Conduit walls and roof will be loaded to a maximum when the River is down. Ground will be assumed dry and walls AD + BC fixed at the base. Gr. El. at 63.83



Roof load = 12.48 x 100 + 1.5 x 150 = 1480#/'
Horiz. Thrust at El. 50.60 = 13.23 x 35 = 460#/'
Horiz. Thrust at El. 41.8 = 22.03 x 35 = 770#/'

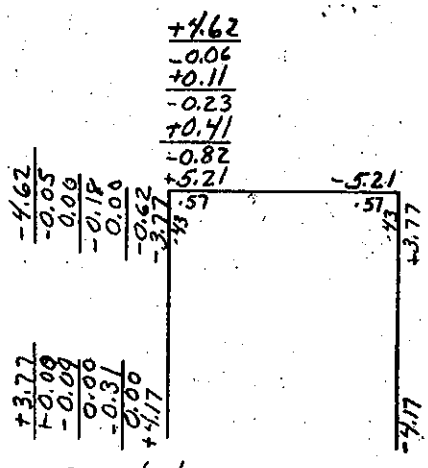
F.E.M. - Member AB

$M^F_{AB} = M^F_{BA} = \frac{1}{12} \times 1480 \times 6.5^2 = 5.21'^k$

Member AD

$M^F_{AD} = \frac{1}{12} \times 460 \times 8.8^2 + \frac{1}{15} \times 310 \times \frac{8.8^2}{2} = 3.77'^k$

$M^F_{DA} = \frac{1}{12} \times 460 \times 8.8^2 + \frac{1}{10} \times 310 \times \frac{8.8^2}{2} = 4.17'^k$



Member AB

$V_A = V_B = 1480 \times 6.5 \times .5 = 4810^\#$

$M = \frac{1}{8} \times 1480 \times 6.5^2 - 4620 = 3200'^\#$

Member AD

$H_A = 460 \times 8.8 \times .5 + 310 \times 8.8 \times .5 \times .33 + \frac{850}{8.8} = 2570^\#$

$H_D = 460 \times 8.8 \times .5 + 310 \times 8.8 \times .5 \times .67 - \frac{850}{8.8} = 2840^\#$

$x_0 = 5.4'$

$M = 2570 \times 5.4 - 460 \times \frac{5.4^2}{2} - 189 \times \frac{5.4^2}{6} - 4620 = 1630'^\#$

Roof slab

reqd $d = \sqrt{\frac{4620}{147}} = 5.6" < 14.5"$ ok

$v = \frac{4810}{12 \times .88 \times 14.5} = 31\#/\square"$ ok

$-A_s = \frac{4620 \times 12}{18000 \times .88 \times 14.5} = .24\square"$ Use 5/8"ø @ 1'-0" cc

$+A_s$ Use 5/8"ø @ 1'-0" cc

$u_0 = \frac{4810}{1.96 \times .88 \times 14.5} = 192\#/\square"$

Wall steel

Use 5/8"ø @ 1'-0" cc both faces

F299

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

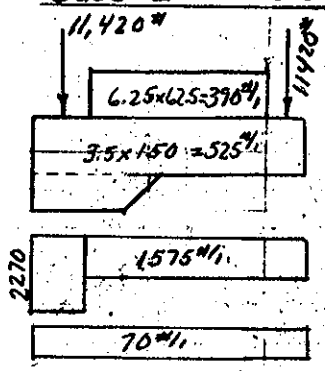
Computation Gravity Flow Conduit at Section G-G

Computed by H.E.W. **Checked by** _____ **Date** 7-Sept. 45

Base Slab

The base slab will be designed as a cantilever about East wall of the conduit and the wall than designed as a cantilever from the pumping station

Case I Loading



Load on cond roof = 11.5 x 62.5 x 8 = 5750#

12.48 x 125 x 8 = 12480#

1.5 x 150 x 8 = 1800

2 | 20030

load on ea. wall = 10,015

Wt. of wall = 1.5 x 6.25 x 150 = 1405

11,420#

React at ℄ of wall

11,420 + 390x5 + 525x8 + 150x2.5 + 150x.5 − 2270x1.5 − 1575x6.5 − 70x8 = 3820#

Mom about face of wall

11,420 x 5.75 + 390x5x2.5 + 525x6.5x3.25 + 150x2.5x5.25 + 75x3.67 − 2270x1.5x5.75 − 1575x5x2.5 − 70x6.5x3.25 = 43,130'#

Shear at face of pump sta. wall

[11420 + 3820]x7 = 106,680#

Mom at face of pump. sta. wall

106680x3.5 = 373,380'#

Design of Base Slab for Case I

req'd $d = \sqrt{\frac{43,130}{147}} = 17.1'' < 38.5''$

$A_s = \frac{43130 \times 12}{18000 \times .88 \times 38.5} = .85^{\square''}$ Use 3/4"φ @ ~~10"~~ 6" Top of slab

$u_o = \frac{3820}{471 \times .88 \times 38.5} = 24\#/\square''$ ok

Cantilever Action of Wall

req'd $d = \sqrt{\frac{373,380 \times 12}{18 \times 147}} = 41'' < 131''$

$A_s = \frac{373,380 \times 12}{18000 \times .88 \times 129} = 2.18^{\square''}$ Use 4-7/8"φ

$u_o = \frac{106,680}{11.0 \times .88 \times 129} = 85\#/\square''$

WAR DEPARTMENT

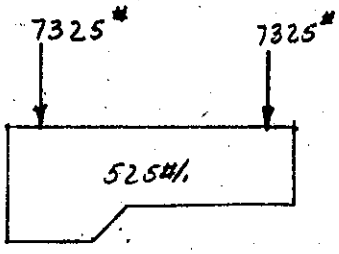
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No 6

Computation Gravity Flow Conduit at Section G – G

Computed by H.E.W. **Checked by** _____ **Date** 7-Sept-45

Base Slab (cont.)
Case II Loading



Uplift + Bearing = 2400#/'

Roof Load = 1480×8 = 11840
½ Ld on ea. wall = 5920#
Wt. of wall = 1405
7325

React @ ℄ East Wall

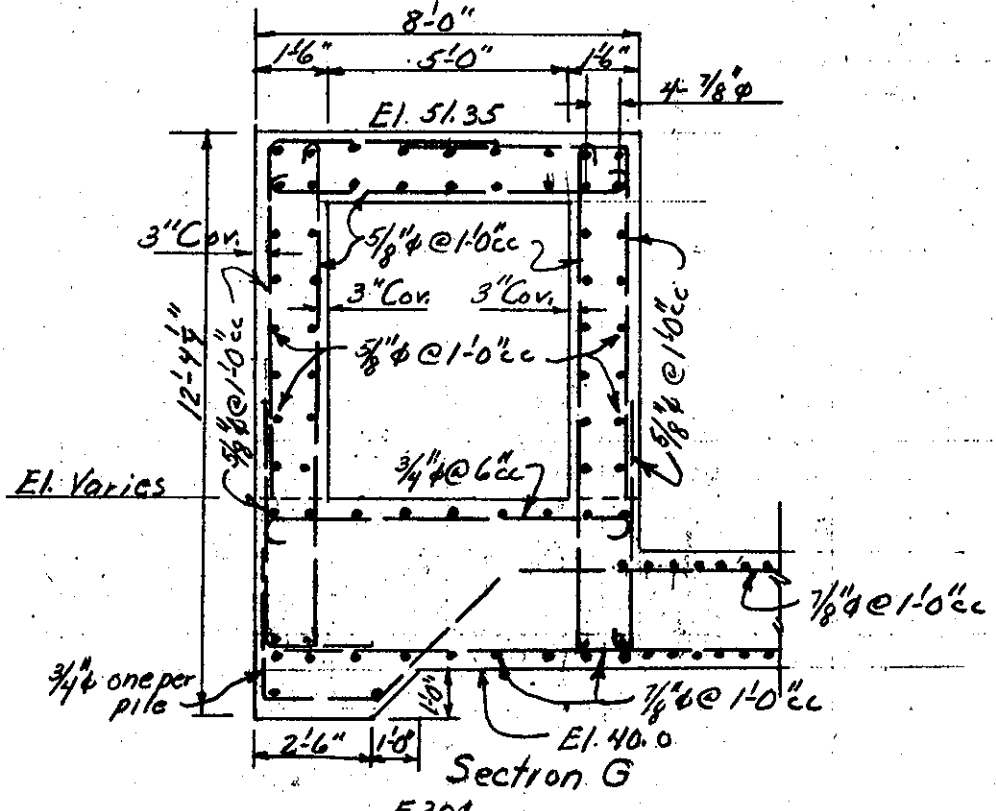
2400×8 − 7325 − 525×8 − 150×2.5 − 75 = 7220#

Mom @ Face of East Wall
2400×6.5×3.25 − 7325×5.75 − 525×6.5×3.25 + 150×2.5×5.25 − 75×3.67 = −4760

Shear at Face of Pump Sta. wall
[7325 + 7220] × 7 = 101,820#

Mom. at Face of Pump Sta. Wall.
M = 101,820 × 3.5 = 356,370 '#

Base slab
Use 7/8"φ @ 1'-0" cc in bot
Cantilever Action of East Wall
Mom. & shear approx same as Case I – use same steel



Section G

F301

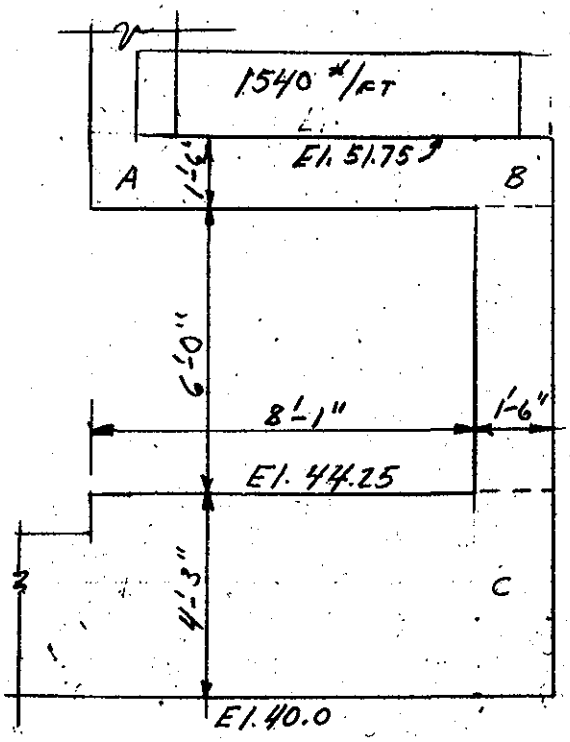
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation Intake conduit at Section H-H

Computed by A.L.K. **Checked by** _____ **Date** 6 Sept 1945



The portion of intake chamber shown will be designed as fixed at A and B.

Ea load down = 9×100 + 3.25×125 = 1318 #/□'

Conc " " = 1.5×150 = 225

1535# per ft

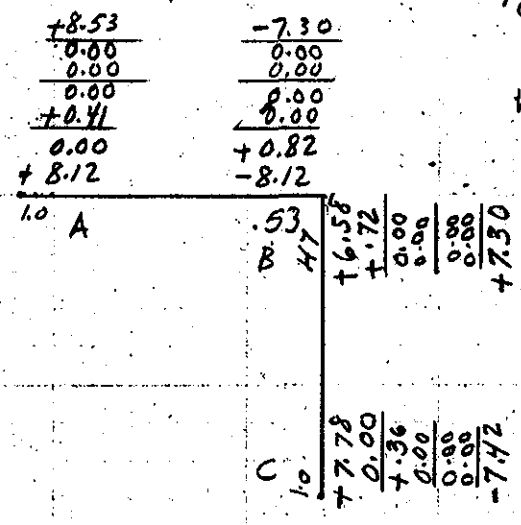
FEM.

$M^F_{AB} = M^F_{BA} = \frac{1}{12} \times 1540 \times 7.96^2 = 8.12'^k$

$M^F_{BC} = \frac{1}{12} \times 640 \times 8.87^2 + \frac{1}{30} \times 910 \times 8.87^2 =$

$M^F_B = 6.58'^k$

$M^F_{CB} = \frac{1}{12} \times 640 \times 8.87^2 + \frac{1}{20} \times 910 \times 8.87^2 = 7.78'^k$



$V_A = 1540 \times 7.96 \times .5 + \frac{1230}{7.96} = 6290^{\#}$

$V_B = 1540 \times 7.96 \times .5 - \frac{1230}{7.96} = 5990^{\#}$

$V_B = 640 \times 8.87 \times .5 - \frac{120}{8.87} + 910 \times 8.87 \times .5 \times .33 = 4160^{\#}$

$V_C = 640 \times 8.87 \times .5 + \frac{120}{8.87} + 910 \times 8.87 \times .5 \times .67 = 5540^{\#}$

Member AB

$X_0 = 4.08'$ from A

$+M = 6290 \times 4.08 - 1540 \times \frac{4.08^2}{2} - 8530 = 4270^{\#}$

$d_{req'd} = \sqrt{\frac{8530}{147}} = 7.63'' < 14.5''$

$v = \frac{6290}{12 \times .88 \times 14.5} = 41.2\ \#/\square''$

$-A_s = \frac{8530 \times 12}{18000 \times .88 \times 14.5} = .444\ \square''$ $\quad +A_s = \frac{4270 \times 12}{18000 \times .88 \times 14.5} = .223\ \square''$

F:302

Subject HOLYOKE PUMPING STATION No. 6

Computation Intake conduit at Section H-H

Computed by A.L.K. **Checked by** **Date** 6 Sept 1945

for 3/4" ϕ @ 1'-0" $u = \frac{6290}{2.4 \times .88 \times 14.5} = 205$ #/□" OK as there will be a reduction of shear at face

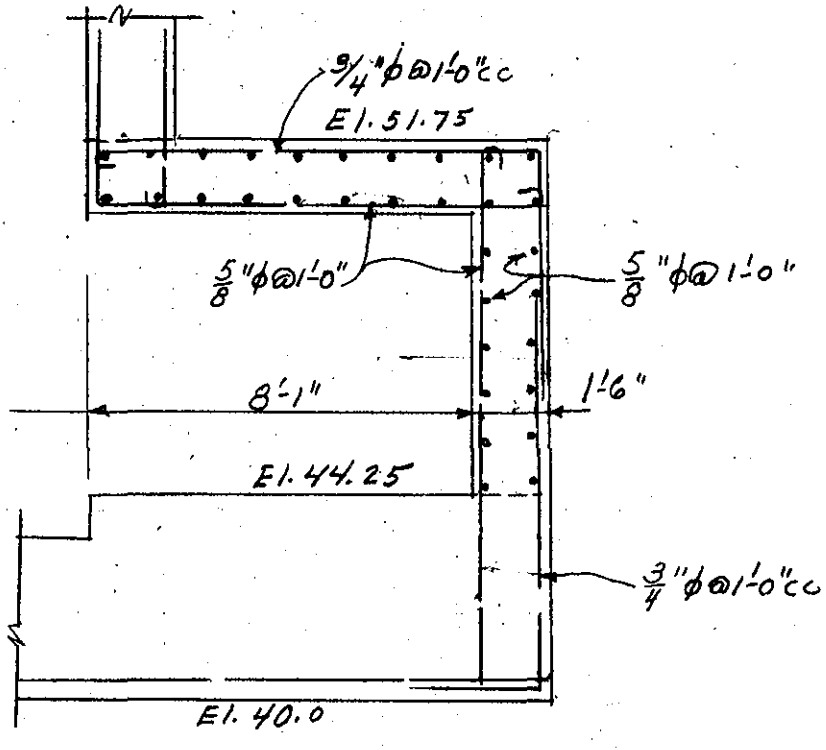
Member BC

$X_0 = 4.7'$ from C

$$+M = 4160 \times 4.7 - 640 \times \frac{4.7^2}{2} - \frac{910}{8.87} \times \frac{4.7^3}{6} - 7300 = 3430'^{\#}$$

$$-A_s = \frac{7420 \times 12}{18000 \times .88 \times 14.5} = .388 \square''$$

$$u = \frac{5540}{2.4 \times .88 \times 14.5} = 181 \ \#/\square''$$



Section H

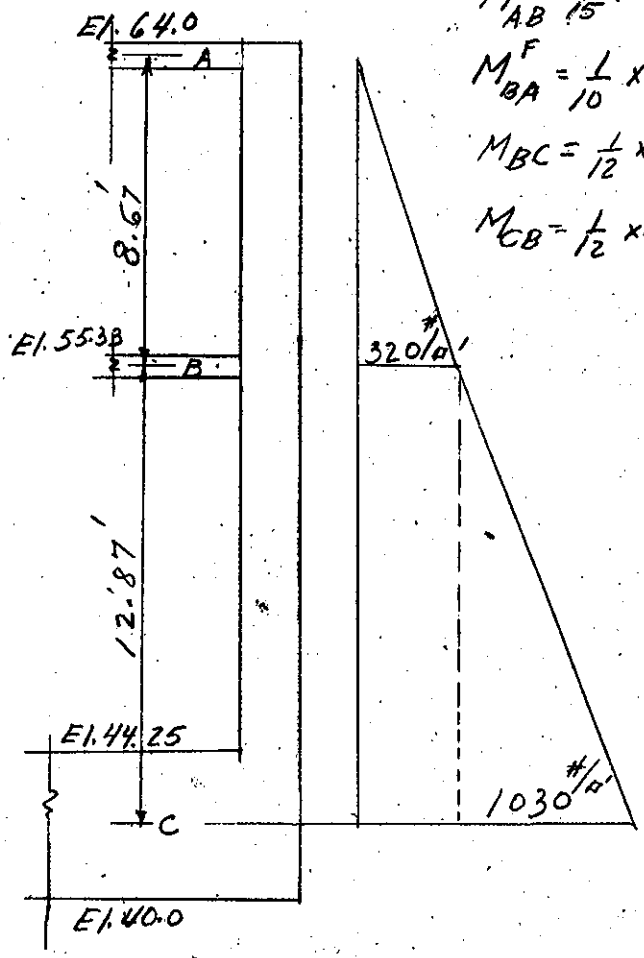
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Station No. 6

Computation Trash Rack Wall at Section J-J

Computed by A.L.K. **Checked by** _____ **Date** 7 Sept 1945.

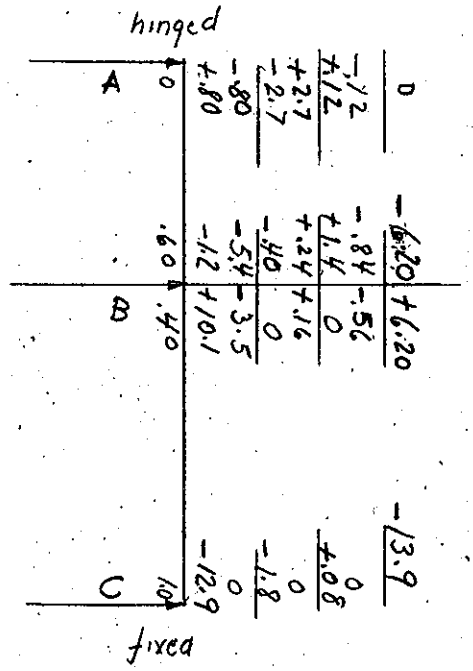


$$M^F_{AB} = \frac{1}{15} \times 320 \times \frac{8.67^2}{2} = .80^{'k}$$

$$M^F_{BA} = \frac{1}{10} \times 320 \times \frac{8.67^2}{2} = 1.2^{'k}$$

$$M_{BC} = \frac{1}{12} \times 320 \times 12.87^2 + \frac{1}{30} \times 1030 \times 12.87^2 = 10.1^{'k}$$

$$M_{CB} = \frac{1}{12} \times 320 \times 12.87^2 + \frac{1}{20} \times 1030 \times 12.87^2 = 12.92^{'k}$$



$$V_A = 320 \times 8.67 \times .5 \times .33 - \frac{6200}{8.67} = -250^{\#}$$

$$V_B = 320 \times 8.67 \times .5 \times .67 + \frac{6200}{8.67} = 1750^{\#}$$

$X_0 = 3.68'$ from A

$$V_B = 320 \times 12.87 \times .5 + 1030 \times 12.87 \times .5 \times .33 - \frac{7700}{12.87} = 3670^{\#}$$

$$V_C = 320 \times 12.87 \times .5 + 1030 \times 12.87 \times .5 \times .67 + \frac{7700}{12.87} = 7080^{\#}$$

$X_0 = 6.3'$

Member BC $+M = 3670 \times 6.3 - 320 \times \frac{6.3^2}{2} - \frac{1030}{12.87} \times \frac{6.3^3}{6} - 6200 = 7210^{'\#}$

$-A_s = \frac{6200 \times 12}{18000 \times .88 \times 14.5} = .324$ □" use 3/4"ϕ @ 1'-0"

F304

Subject HOLYOKE PUMPING STATION No. 6

Computation Trash Rack Wall at Section "J-J"

Computed by A.L.K. **Checked by** _____ **Date** 7 Sept 1945

$$d_{req'd} = \sqrt{\frac{13900}{147}} = 9.74'' < 14.5''$$

$$v = \frac{7080}{12 \times .88 \times 14.5} = 46.2\ \#/\square''$$

$$-A_s = \frac{13900 \times 12}{18000 \times .88 \times 14.5} = .73\ \square'' \quad \text{use } 1''\phi @ 1'\text{-}0''$$

$$u = \frac{7080}{3.14 \times .88 \times 14.5} = 176\ \#/\square''$$

$$+A_s = \frac{7210 \times 12}{18000 \times .88 \times 14.5} = .377\ \square'' \quad 3/4''\phi @ 1'\text{-}0''$$

pt of inflection M_0 at 3.1 ft from C

<u>change to 3/4" φ @ 1'-0" at E 1.48.53</u>

Beam at B in wall at opening in floor slab will be designed to take reaction at B

$$M = 5420 \times \frac{5^2}{10} = 13500'\#$$

$$V_A = V_B = 5420 \times \frac{5}{2} = 13500\#$$

$$v = \frac{13500}{12 \times .88 \times 14.0} = 91.2\ \#/\square'' \text{ OK as } b \text{ is greater than } 12'' \qquad A_s = \frac{13500 \times 12}{18000 \times .88 \times 14.0} = .735\ \square''$$

<u>use 3-7/8" φ</u>

$$u = \frac{135000}{8.25 \times .88 \times 14} = 133\ \#/\square''$$

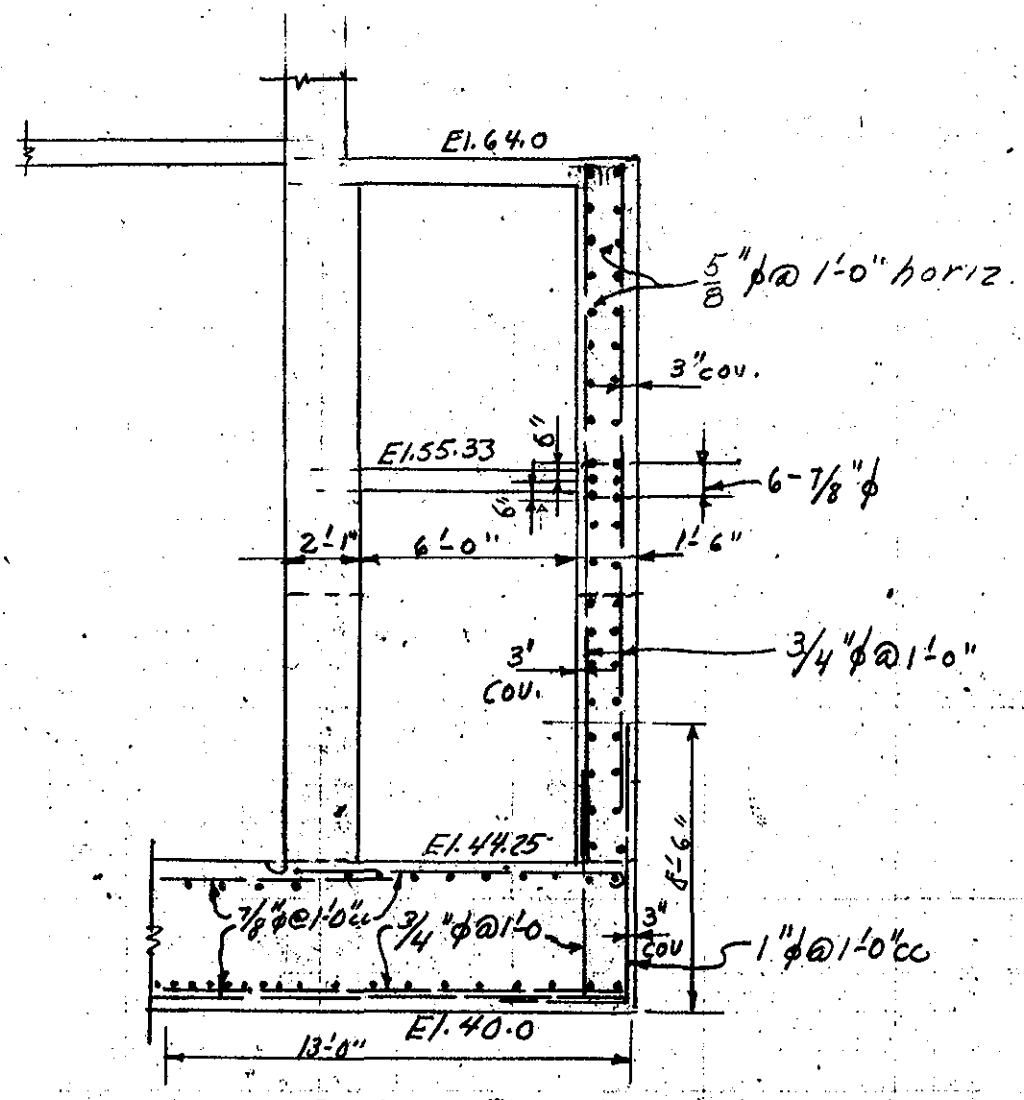
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION NO. 6

Computation Trash Rack Wall at Section J-J

Computed by A.L.K. **Checked by** **Date** 7 Sept 1945



Section J

F 3.06

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

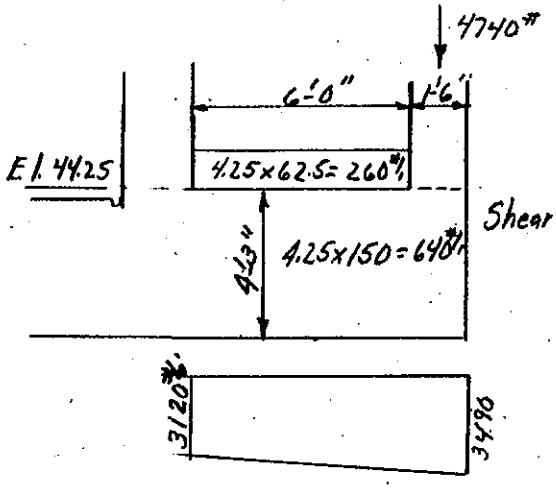
Subject Holyoke Pumping Station No 6

Computation Trash Rack Chamber Base Slab

Computed by H. E. W. **Checked by** _____ **Date** 12-Sept-45

Case I Loading -

Assume base slab cantilevered



Wt. of chamb. roof = 3x100 = 300#

" " " wall 1.5x150x19.75 = 4440

4740#

Shear + Moments about face of Sta. Wall

$V = 3120\times7.5 + 370\times\frac{7.5}{2} - 640\times7.5 - 260\times6 - 4740 = 13690^{\#}$

$M = 3120\times\frac{7.5^2}{2} + 370\times\frac{7.5}{2}\times5 - 640\times\frac{7.5^2}{2} - 260\times\frac{6^2}{2} - 4740\times6.75 = 40{,}010''^{\#}$

$\text{reqd } d = \sqrt{\frac{40{,}010}{147}} = 16.5'' < 46.5$

$A_s = \frac{40{,}010\times12}{18000\times.88\times46.5} = .66^{\square''}$ Use 7/8"ϕ @ 3/4"ϕ staggered @ 6" cc

$u_o = \frac{13690}{5.11\times.88\times46.5} = 65^{\#}/o''$ - OK

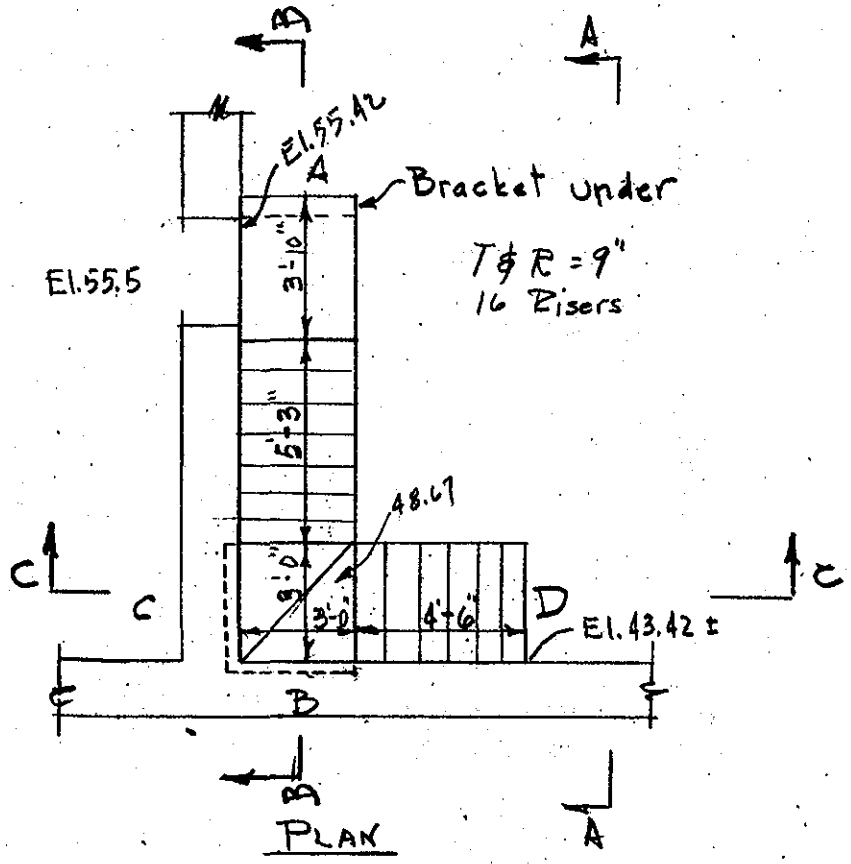
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

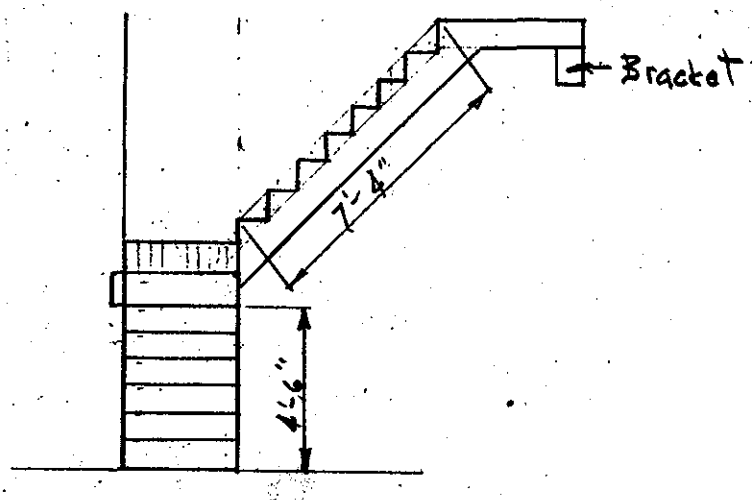
Subject Holyoke Pumping Sta. No. 6

Computation Concrete Stairway

Computed by H.L.F. **Checked by** **Date** 12 Sept. 1945



PLAN



SECTION A-A

F308

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Holyoke Pumping Sta. No. 6

Computation Concrete Stairway

Computed by H.L.F. **Checked by** _____ **Date** 12 Sept. 1945

A-B

L.L. = 75#/□ on horizontal projection

L.L = 75 x 12.08 = 905.

D.L = .75 x .75 x 1/2 x 9 x 150 = 380

.67 x 14 x 150 = 1,410

2,695 # = 2,695 / 12.08 = 223 #/'

$M = 223 \times \frac{12.08^2}{8} = 4,050.'\#$

8" slab.
d = 6"

$A_s = \frac{4,050 \times 12}{18,000 \times .88 \times 6} = 0.51$ □"

5/8" ϕ @ 6" = .62

Σ_0 = 3.92"

$v = \frac{223 \times 6.04}{12 \times .88 \times 6} = 21.$ #/□ ok

C-D

Use same steel as A-B

Bracket

Load / ft. = 223 (1,350) x 6.04 + 150 = 1,500.#

$M = 1,500 \times \frac{3^2}{2} = 6,750.'\#$

V = 1,500 x 3 = 4,500 #

Say Bracket = 12" x 24 d = 20".

$A_s = \frac{6,750 \times 12}{18,000 \times .88 \times 20} = 0.26$

Use: 2-3/4" ϕ = .88

Σ_0 = 4.72"

$v = \frac{4,500}{12 \times .88 \times 20} = 22.$ #/□

$u = \frac{4500}{472 \times .88 \times 20} = 57$ #/□"

F 308

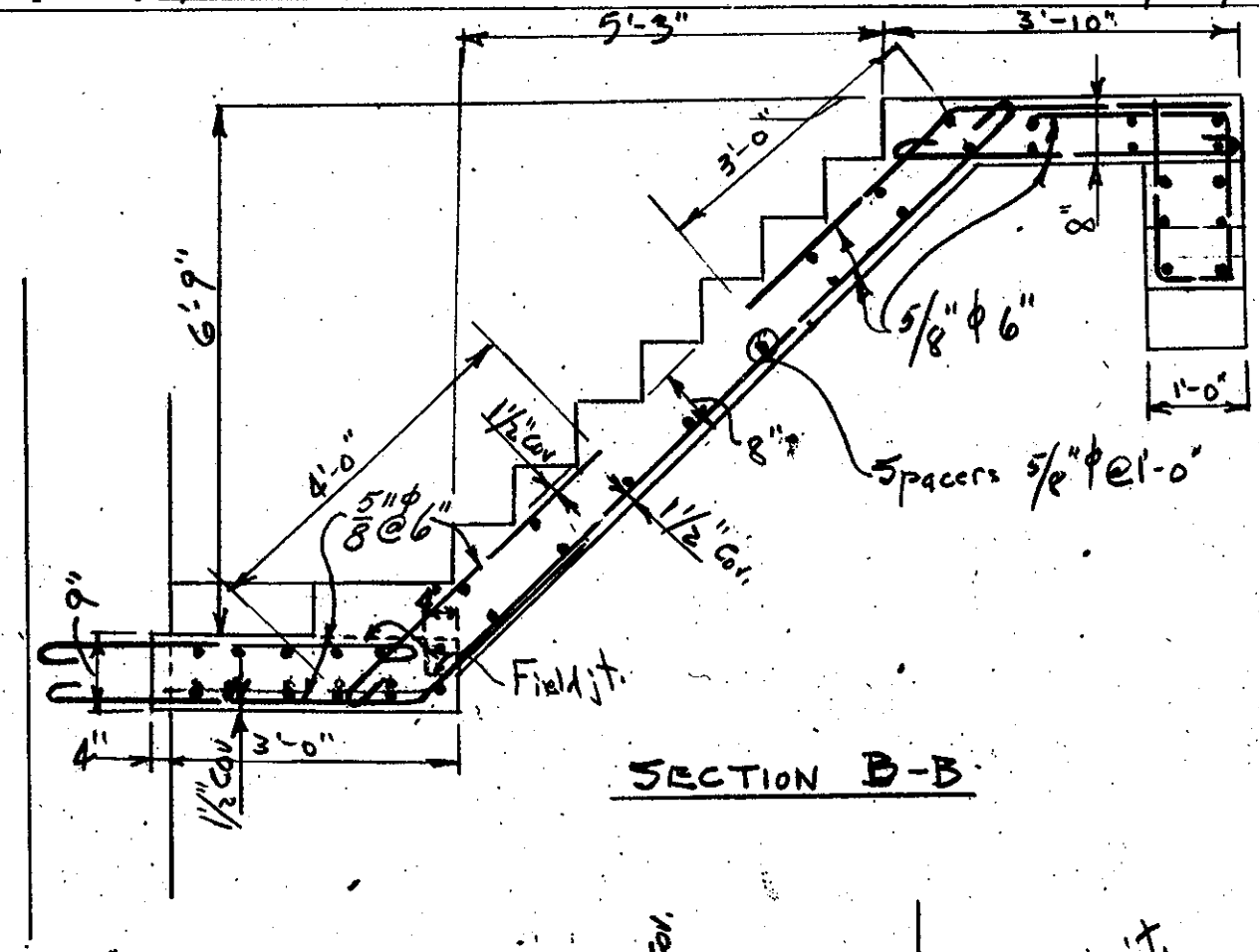
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

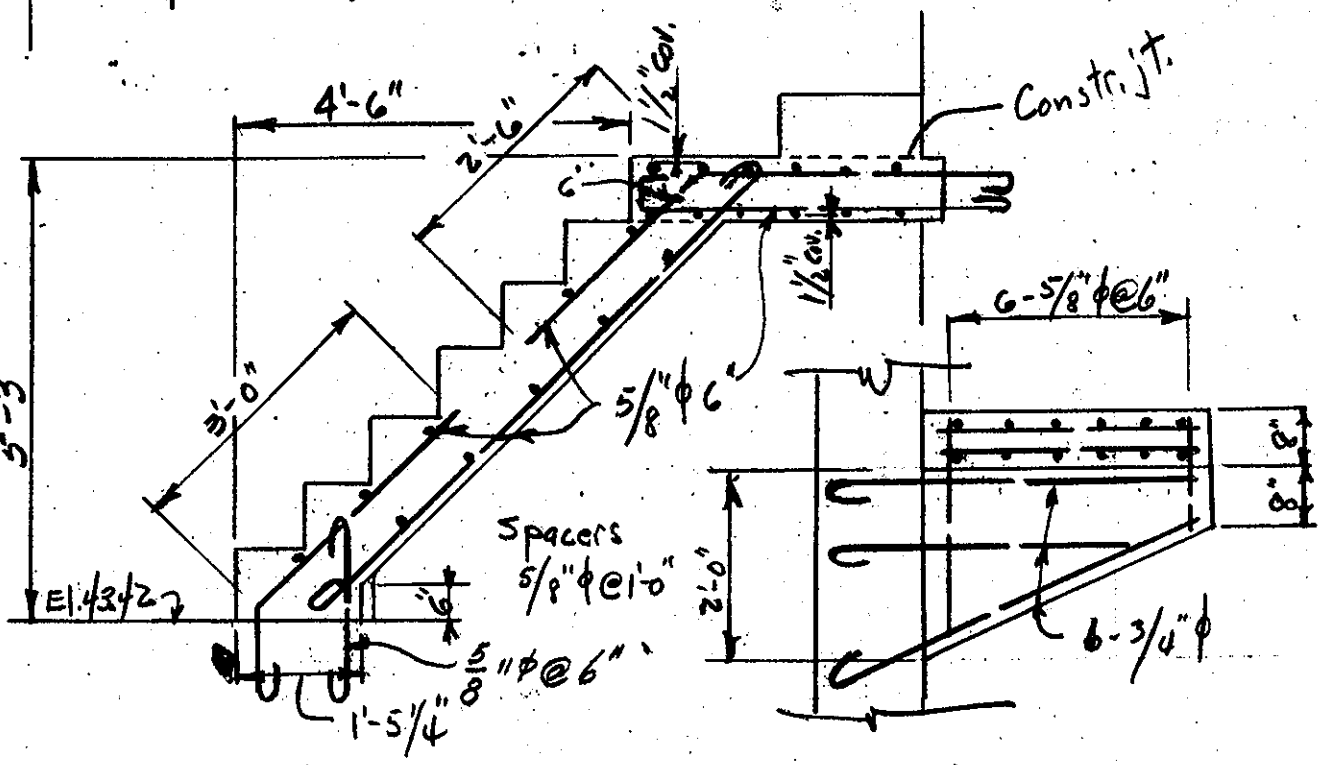
Subject Holyoke Pumping Sta. No. 6

Computation Concrete Stairway

Computed by H.L.F. **Checked by** _____ **Date** 12 Sept. 1945



SECTION B-B



SECTION C-C

El. Haunch

F 3/10

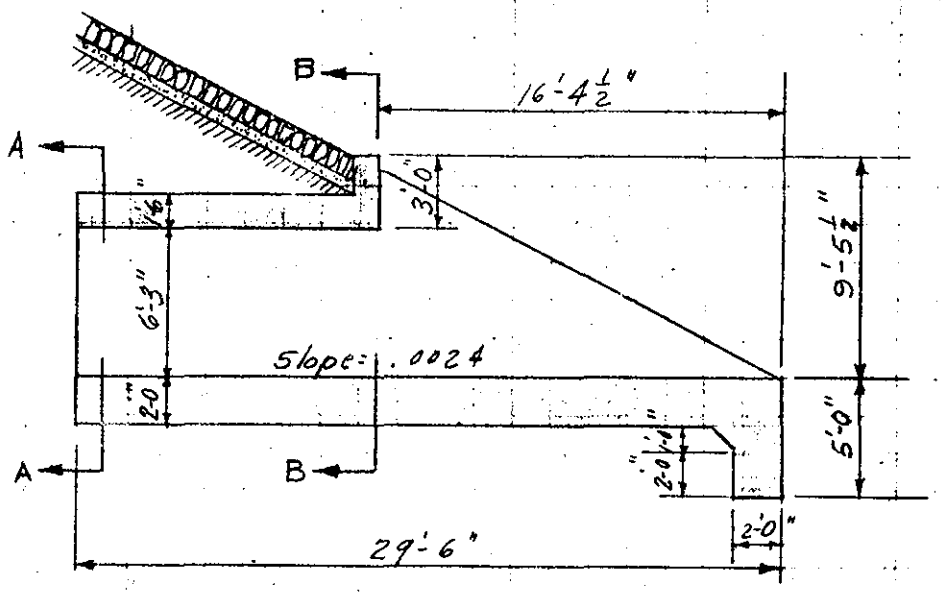
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

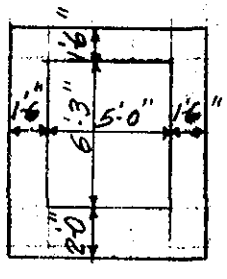
Subject HOLYOKE PUMPING STATION NO. 6

Computation OUTLET CONDUIT-

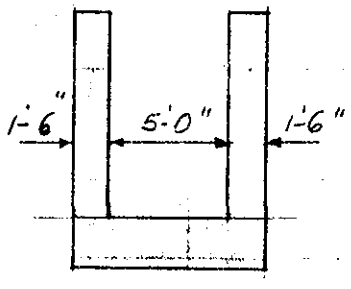
Computed by E. J. H. **Checked by** _____ **Date** 11 SEPT. 1945



SECTION ON ℄ OF CONDUIT



SECTION A-A



SECTION B-B

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

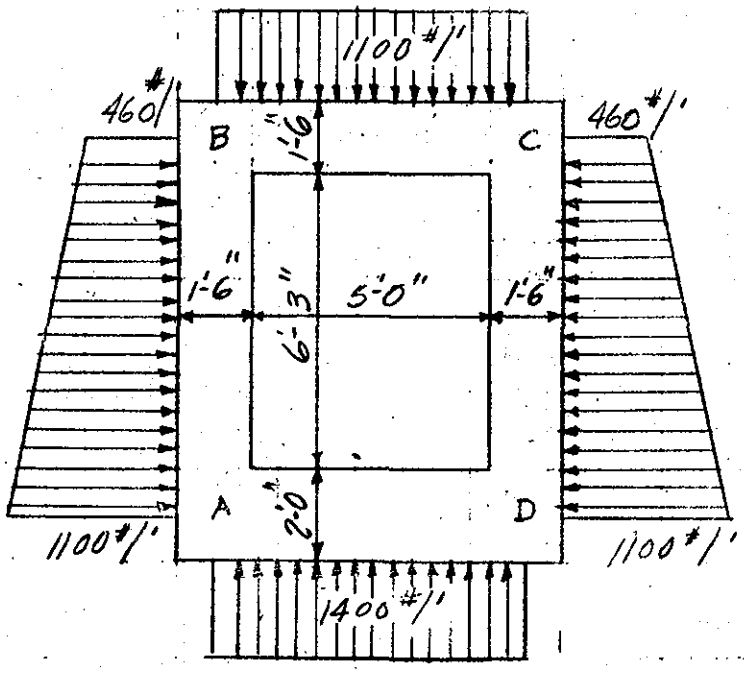
Subject HOLYOKE PUMPING STATION NO. 6

Computation OUTLET CONDUIT

Computed by E.J.H **Checked by** **Date** 1 SEPT. 1945

SECTION A-A (one ft. section)

For worst condition assume conduit empty with saturated earth all around. Assume bearing pressure equal to weight of earth on top of conduit plus weight of conduit itself.



Load on roof =

Earth = 7 x 125 = 875 #/in. Ft.
Concrete = 1.5 x 150 = 225
1100 #/in. Ft.

Load on sidewall =

Earth 5.75 x 80 460 # at top
(8.0 x 80) + 460 1100 # at bottom

Load on bottom slab =

Weight of earth = 7 x 8 x 125 = 7000 #
Weight of concrete = 1.5 x 6.25 x 150 x 2 = 2820
1.5 x 8.0 x 150 = 1800
2 x 8.0 x 150 2400
8. 14020 #

Bearing pressure = 1750 #/in. Ft.
Less wt. of slab 2 x 150 = 300
1400 #/in. Ft.

F 312

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: HOLYOKE PUMPING STATION NO. 6

Computation: OUTLET CONDUIT

Computed by: E. J. H. Checked by: Date: 11 SEPT. 1945

FIXED END MOMENTS

$AB \,\&\, DC = \frac{wl^2}{12} + \frac{wl^2}{20} \qquad \frac{\overset{2450}{460 \times 8.0^2}}{12} + \frac{\overset{2040}{640 \times 8.0^2}}{20} = 4500^{\#}$

$BA \,\&\, CD = \frac{wl^2}{12} + \frac{wl^2}{30} = \frac{\overset{2450}{460 \times 8.0^2}}{12} + \frac{\overset{1360}{640 \times 8.0^2}}{30} = 3800^{\#}$

$BC = \frac{wl^2}{12} = \frac{1100 \times 6.5^2}{12} = 3860^{\#}$

$AD = \frac{wl^2}{12} = \frac{1400 \times 6.5^2}{12} = 4900^{\#}$

$\frac{I}{L}$ Relations $\quad I = \frac{bh^3}{12} \quad \frac{b}{12}$ is a constant

$AB \,\&\, CD = \frac{1.5^3}{8.0} = .42 = 1.00$

$BC = \frac{1.5^3}{6.5} = .52 \quad 1.24$

$AD = \frac{2.0^3}{6.5} = 1.23 \quad 2.92$

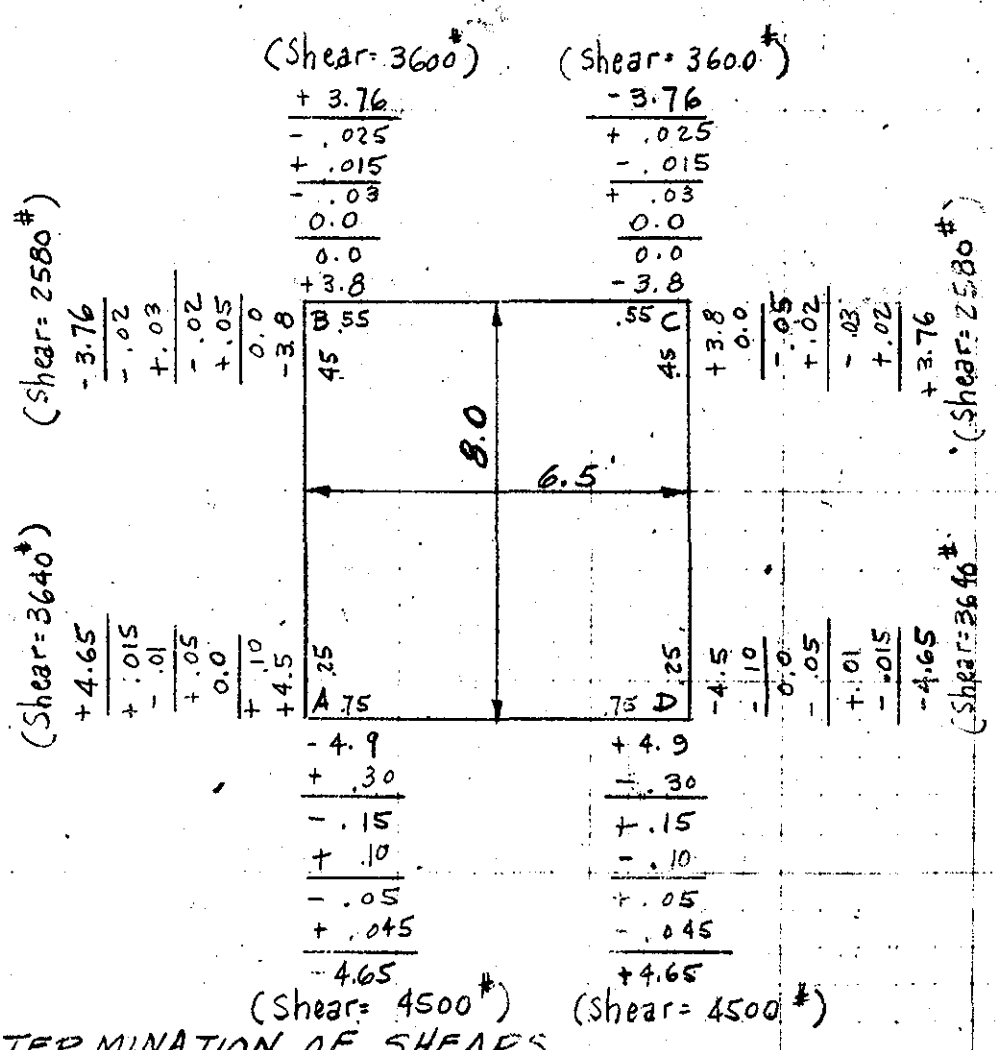
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation OUTLET CONDUIT

Computed by E. J. H. **Checked by** _____ **Date** 11 SEPT. 1945



DETERMINATION OF SHEARS

$$AB = \left[(460 \times 8.0 \times 4.0) + (640 \times \tfrac{8}{2} \times 5.33) + 4650 - 3760\right] \div 8 = 3640^{\#}$$

$$BA = \left[(460 \times 8.0 \times 4.0) + (640 \times \tfrac{8}{2} \times 2.67) + 3760 - 4650\right] \div 8 = 2580^{\#}$$

$$BC = 1100 \times 3.25 = 3600^{\#}$$

$$AD = 1400 \times 3.25 = 4500^{\#}$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION No. 6

Computation OUTLET CONDUIT

Computed by E.J.H. **Checked by** **Date** 12 SEPT. 1945

DESIGN OF MEMBERS

AB & CD $= d = \sqrt{\frac{4650}{147}} = 5.6 \quad d = 14.5$

$$As = \frac{4650 \times 12}{.88 \times 18000 \times 14.5} = .25 \quad \text{Use } \tfrac{5}{8}\text{"}\phi \text{ @ } 12\text{"}$$

$$w = \frac{3640}{.88 \times 1.96 \times 14.5} = 145 \text{ \#/□"}$$

$$v = \frac{3640}{.88 \times 12 \times 14.5} = 25 \text{ \#/□"}$$

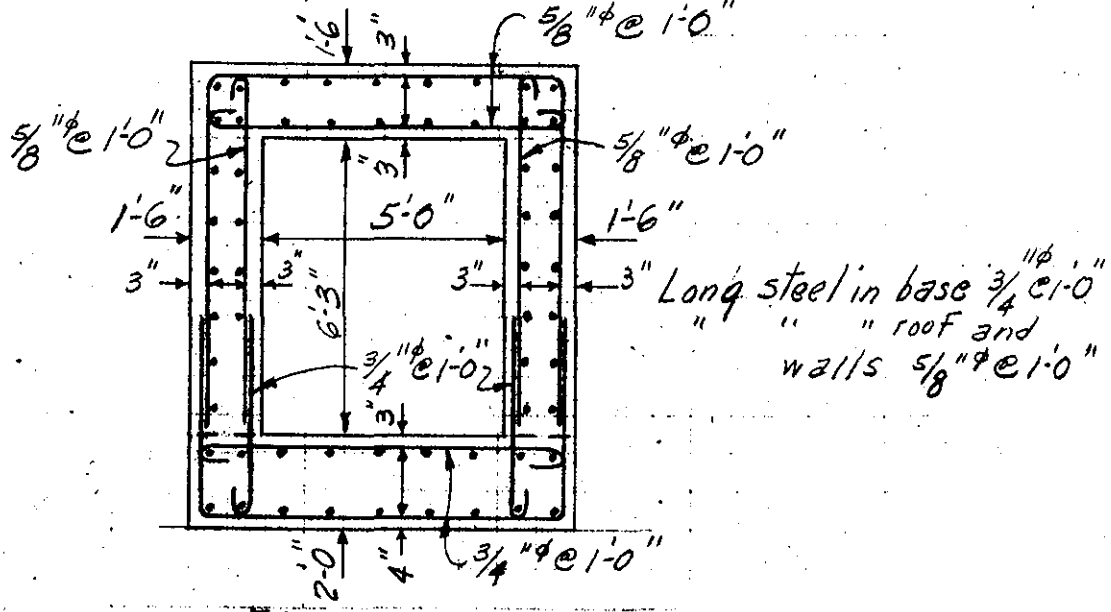
BC Use $\tfrac{5}{8}$"ϕ @ 12"

AD $d = 20.5$

$$\text{Temp steel required} = \frac{12 \times 24 \times .0025}{2} = .36 \quad \text{Use } \tfrac{3}{4}\text{"}\phi \text{ @ } 12\text{"}$$

$$w = \frac{4500}{.88 \times 2.36 \times 20.5} = 115 \text{ \#/□"}$$

$$v = \frac{4500}{.88 \times 12 \times 20.5} = 20 \text{ \#/□"}$$



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WAR DEPARTMENT

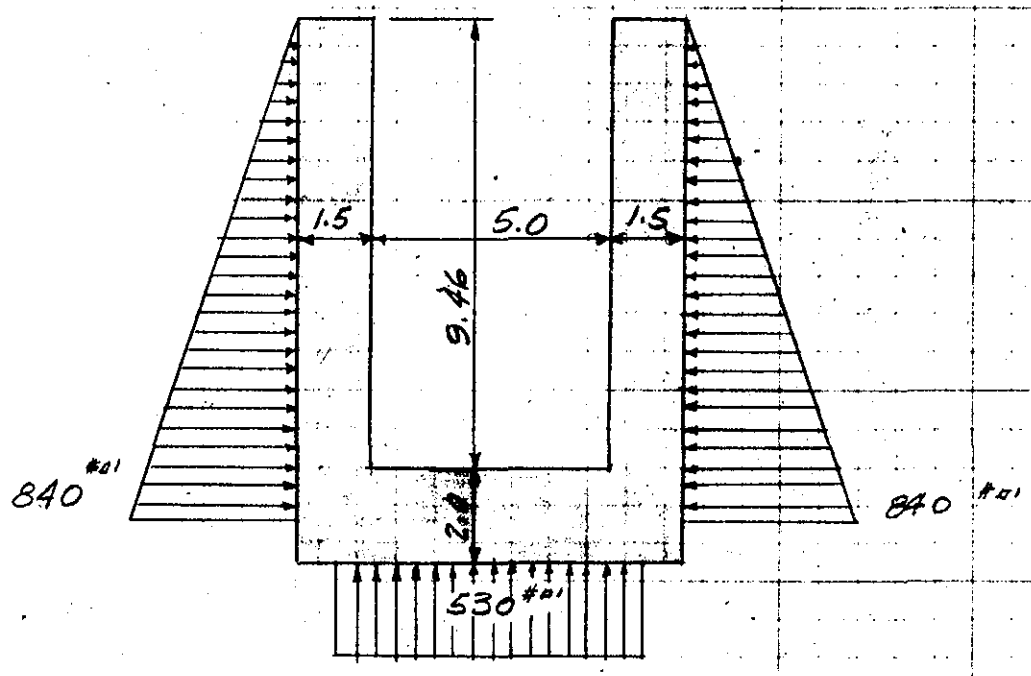
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject HOLYOKE PUMPING STATION NO 6

Computation OUTLET CONDUIT-

Computed by E. J. H. **Checked by** _____ **Date** 12 SEPT. 1945

SECTION B-B



Load on sidewall = 10.46 x 80 = 840

Load on base =

9.46 x 1.5 x 2 x 150 = 4250

8.0 x 2 x 150 = 2400

8 | 6650

830

Less 2 x 150 = 300

530 #/'

Max Moment on sidewall = $\frac{840 \times 10.46}{2} \times 3.49 = 15350$ '#

$d = \sqrt{\frac{15350}{147}} = 10.3$ d = 14.5

$AS = \frac{15350 \times 12}{.88 \times 18000 \times 14.5} = .80$ Use 3/4" ⌀ @ 6"

Moment midway between section B-B and end

Height of wall = 4'-6"

Load = 5.5 x 80 = 440 #/'

$M = \frac{440 \times 5.5}{2} \times 1.8 = 2180$ '#

$A_s = \frac{2180 \times 12}{.88 \times 18000 \times 14.5} = .11$ use 7/8" ⌀ @ 12"

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WAR DEPARTMENT

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Computation OUTLET CONDUIT

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MOMENT $\frac{1}{3}$ the way out.

Height = 6'-0"

Load = 7 x 80 = 560 #/'

$M = \frac{560 \times 7.0}{2} \times 2.33 = 4600$ '#

$As = \frac{4600 \times 12}{.88 \times 18000 \times 14.5} = .24$ 5/8" ϕ @ 1'-0"

MOMENT 3'-0" from Section B-B =

Height = 7'-0"

Load = 8 x 80 = 640

$M = \frac{640 \times 8}{2} \times 2.67 = 6750$ '#

$As = \frac{6750 \times 12}{.88 \times 18000 \times 14.5} = .35$ Use 3/4" ϕ @ 12"

$Max\ w = \frac{4400}{.88 \times 4.72 \times 14.5} = 75$ #/□"

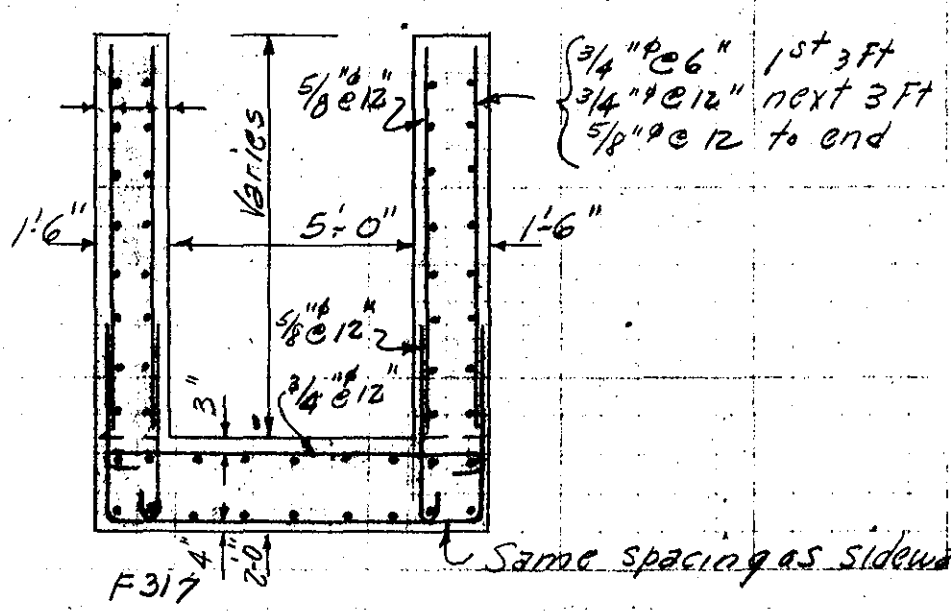
$Max\ v = \frac{4400}{.88 \times 14.5 \times 12} = 30$ #/□"

In outside face of sidewall use 3/4" ϕ @ 6" for 3 ft. then 3/4" ϕ @ 12" for 3 ft. then 5/8" ϕ @ 12 rest of way.

Moment on bottom slab

$= \frac{1}{8} \times 530 \times 6.5^2 - 15,350 = 12,550$ '# negative

Use same steel as for sidewalls



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