CONNECTICUT RIVER FLOOD CONTROL PROJECT

HARTFORD, CONN.

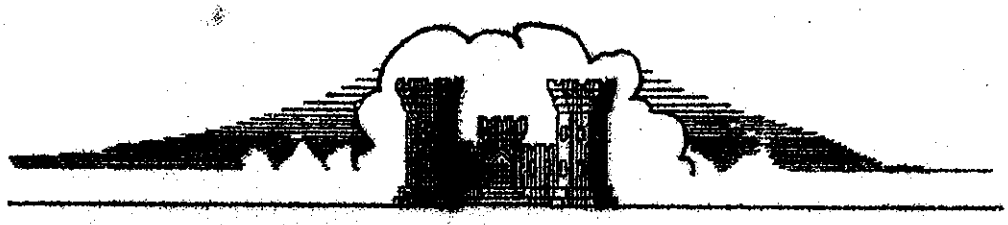
CONNECTICUT RIVER CONNECTICUT

ANALYSIS OF DESIGN FOR LOCAL PROTECTION WORKS

ITEM H1.5-7b – CONTRACT

RIVERFRONT, MORGAN ST. TO STA. 96+73

APPENDIX A



MAY 1940

CORPS OF ENGINEERS, U. S. ARMY

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

HARTFORD - HT.5 & 7b

MEMORIAL BRIDGE TO CLARK DIKE

1940

APPENDIX "A" - STRUCTURAL DESIGN

HARTFORD - HT.5 & 7b

APPENDIX "A" STRUCTURAL DESIGN

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STRUCTURAL DESIGN

A. GENERAL INFORMATION

1. Location, head and loading. - The reinforced concrete flood walls will extend between the following stations: Morgan Street and Memorial Bridge (Station 0+17.75) to Station 22+08± (200'± south of Grove Street) at junction with an earth dike; from dike at Park River Conduit (Station 35+54±) to Station 42+87± (present Park River) and beginning of dike; end of dike (Station 79+86±) to Station 92+34± at the beginning of the Clark Dike. Stop-log structure No. 1 is at Station 85+39± and stop-log structure No. 2 is at Station 87+58±.

The structures and walls are designed to resist a principal load coming from the assumed head of water taken to the top of the walls which is greater than the design flood stage. The walls vary in height from 16 to 36 feet.

2. Type of walls. - The "T" type cantilever wall and the counterfort walls used throughout this project were so selected to meet the existing conditions at the various sites. Some of the determining features were economy of construction, limiting space and existing structures.

3. Stop-log structures. - The concrete stop-log structures were designed to resist a load coming from a head of water, equivalent to that used in the design of the walls. The structures were investigated for stability for two conditions of loading; one with the river at flood stage and one with the river down.

4. Architecture. - The structures and walls will be of

modern design in keeping with the architectural treatment used on similar projects elsewhere on the Connecticut River. This design will give a pleasing appearance without undue emphasis being placed on purely decorative features.

B. GENERAL DESIGN DATA

1. General. - The structural design of the structures has been executed in accordance with standard practice. The specifications which follow cover the conditions affecting the design of the reinforced concrete and structural steel.

2. Unit weights. - The following unit weights for material were assumed in the design of the structure:

Water	62.5# per cubic foot
Dry earth	100 # " " "
Saturated earth	125 # " " "
Concrete	150 # " " "

3. Earth pressures. - In computing active earth pressures, equivalent fluid pressures computed by the use of Rankine's formula were used. They are as follows:

Equivalent liquid pressure of dry earth = 35 pounds per cubic foot.

Equivalent liquid pressure for saturated earth = 80 pounds per cubic foot.

In computing passive resistances, Rankine's formula was used with the coefficient of internal friction = 35 degrees.

4. Hydrostatic uplift.

a. Riverside of sheet piling.

Full head due to headwater.

b. Landside of sheet piling.

(1) At landward toe, full head due to tailwater.

(2) At sheet piling, full head due to tailwater plus one-half the difference between headwater and tailwater.

(3) At intermediate points, the uplift was assumed to vary uniformly with the distance from the toe.

5. Overturning. - In general, the resultant of all external loads, including hydrostatic uplift and excluding base pressure, does not fall within the middle third under every condition but under no condition is the allowable bearing value of the soil exceeded. For walls with bearing piles, the resultant falls within the rear pile, except at the Dutch Point Station. In every case the pile specified is of sufficient strength to carry the maximum loading.

6. Sliding. - In general, the total horizontal forces due to external loads shall not exceed the resistance available from friction and passive resistance. The coefficient of friction used is 0.45. For walls with bearing piles, the horizontal forces due to external loads shall not exceed the resistance available from passive pressure and shear on the piles. At the Dutch Point Station most of the wall bases were poured against the existing power house base to aid in preventing sliding.

7. Bearing. - The total bearing pressure, equal to the sum of hydrostatic pressure plus the remaining effective base pressure, shall in no case exceed the maximum allowable soil pressure, or pile loading.

8. Frost cover. - All footing bases shall lie at least 4

feet beneath the ground surface to avoid heaving by frost action.

9. Path of percolation. - Except where the steel sheet piling is either driven to rock or extended a minimum distance of 3 feet into an underlying stratum of impervious clay, the minimum path of percolation shall be four times the head of water.

10. Structural steel. - The design of structural steel was carried out in accordance with the Standard Specifications for Steel Construction for Buildings of the American Institute of Steel Construction.

11. Reinforced concrete. - In general, all reinforced concrete was designed in accordance with the "Joint Committee on Standard Specifications for Concrete and Reinforced Concrete" issued in January 1937, and with the "Joint Code of the American Concrete Institute and the Reinforcing Steel Institute for the Design of Concrete and Reinforced Concrete" issued in 1928.

a. Allowable working stress. - The allowable working stress in concrete used in the design is based on a compressive strength of 3,000 pounds per square inch in 28 days.

b. Flexure (f_c). - Lbs. per sq. in.

Extreme fibre stress in compression 800

c. Shear (v). -

Beams with no web reinforcement and without special anchorage 60

Beams with no web reinforcement but with special anchorage of longitudinal steel 90

	Lbs. per sq. in.
Beams with properly designed web reinforcement but without special anchorage of longitudinal steel	180
Beams with properly designed web reinforcement and with special anchorage of longitudinal steel	270

d. Bond (u).

In beams, slabs, and one way footings	150
Where special anchorage is provided	300

The above stresses are for deformed bars.

e. Bearing (f_c). -

Where a concrete member has an area at least twice the area in bearing	500

f. Axial compression (f_c). -

Columns with lateral ties	450

g. Steel stresses. -

Tension	18000
Web reinforcement	16000

h. Protective concrete covering. -

Type of members	Minimum cover in inches
Members poured directly against the ground	4
Members exposed to earth or water but poured against forms	3

For secondary steel, such as temperature and spacer steel, the above minimum cover may be decreased by the diameter of the temperature or spacer steel rods.

C. BASIC ASSUMPTIONS FOR DESIGN

1. Flood walls. - a. Cantilever walls. - The stem and base were designed for loads from hydrostatic pressure to the top of the wall and also for earth pressures due to anticipated fill on the landside face.

b. Counterforted walls. - 1. Stem and base. - The stem and base slabs were designed as continuous beams supported at the counterforts. The extension of the base slab on the opposite side of the stem from the counterforts was designed as a cantilever beam.

2. Counterforts. - The counterforts were designed with consideration for anticipated loadings. In general, they will act as compression buttresses at flood stages and as tension counterforts at normal river stages.

3. Conduits. - The conduits were designed for bursting pressures with the river at maximum flood stage where this condition exists, and for earth loading of the fill over the conduits with water level at normal river stage. The gate chamber was designed for thrusts resulting from river flow at maximum flood stage and for lateral earth pressures.

4. Stop-log structures. - The structures have an opening spanned by wooden stop-logs. These logs are held in place by grooves in the abutments. The base is designed to take up stresses transmitted to it by the abutments which act as counterfort sections.

D. COMPUTATIONS

HARTFORD - HT-5

WAR DEPARTMENT

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Subject: Hartford - Conn. (H-75)

Computation: Flood Wall Sta. 0+00 28' Stem Construction

Computed by: D.H.M. Checked by: [illegible] Date: 2/12/40

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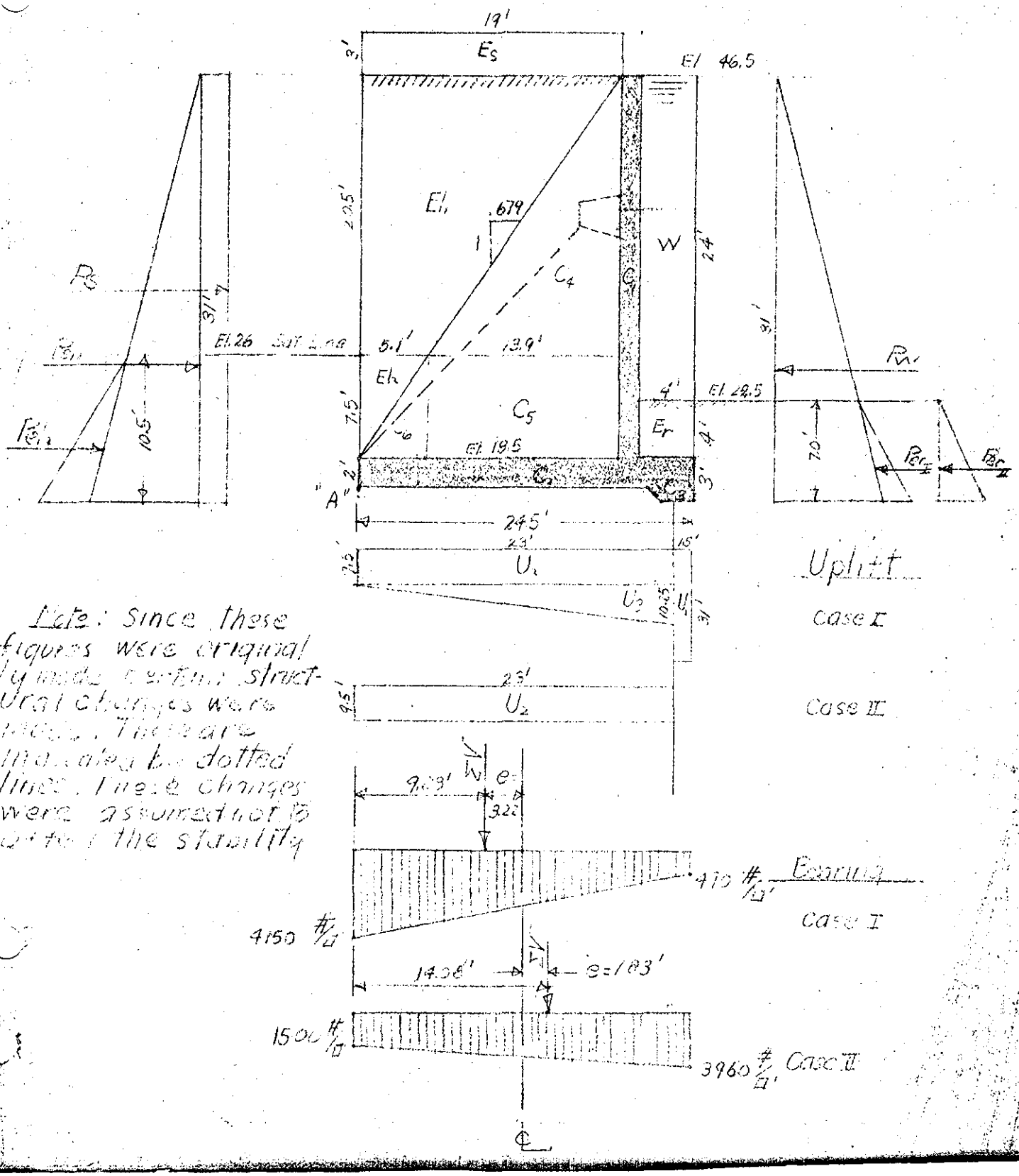

Note: Since these figures were originally made certain structural changes were made. These are indicated by dotted lines. These changes were assumed not to affect the stability

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Object: Hartford Conn. (H-T5)

Computation: Flood Wall Sta. 0+00 28' Stem Cant Wall

Computed by: R.H.M. Checked by: W.H.F. Date: 2/12/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case I - River Up — Case II River Down

Forces Acting		↓	↑	→	←	Arm	Moments about "A" ↻	Moments about "A" ↺
C_1	$1.5 \times 2.8 \times 150$	6300				19.75	124430	
C_2	$2.0 \times 24.5 \times 150$	7350				12.25	90040	
C_3	$1.0 \times 3.0 \times 150$	450				23.0	10350	
C_4	$20.5 \times 13.9 \times \frac{1}{2} \times 50 \times \frac{2}{10}$	1420				14.37	20410	
C_5	$7.5 \times 13.9 \times 25 \times \frac{2}{10}$	520				12.05	6270	
C_6	$7.5 \times 5.1 \times \frac{1}{2} \times 25 \times \frac{2}{10}$	100				3.40	340	
E_s	$3 \times 19 \times 100$	5700				9.5	54150 **	
E_1	$20.5 \times 19 \times 100$	38950				9.5	370,030	
E_2	$7.5 \times 19 \times 125$	17810				9.5	169,200	
W_w	$24 \times 4 \times 62.5$	6000				22.5	135,000 *	
E_p	$4 \times 4 \times 125$	2000				22.5	45000	
U_1	$1.5 \times 31 \times 62.5$		2910			23.75		69110 *
U_2	$23 \times 9.5 \times 62.5$		13660			11.5		157,070
U_3	$23 \times 10.25 \times \frac{1}{2} \times 62.5$		7370			15.33		112,900 *
P_{e1}	$31^2 \times \frac{1}{2} \times 35$			16820		9.33	156930	
P_{e1}	$10.5^2 \times \frac{1}{2} \times 45$			2480		2.5	6200	
P_s	$3 \times 35 \times 31$			3260		14.5	47270 **	
P_w	$31^2 \times \frac{1}{2} \times 62.5$				30030	9.33		280180 *
P_{e_I}	$7^2 \times \frac{1}{2} \times 17.5$				430	1.33		570 *
$P_{e_{II}}$	$7^2 \times \frac{1}{2} \times 35$				860	1.33		1140 **
Case I		80900	23740	19300	30460		1134200	619730
		$\Sigma V = 56960$ #↓		$\Sigma H = 11160$ #←			$\Sigma M = 514270$ #↻	
Case II		80600	13660	22560	860		1,100,620	158230
		$\Sigma V = 66940$ #↓		$\Sigma H = 21700$ #→			$\Sigma M = 942390$ #↻	

Case I $\frac{\Sigma M}{\Sigma V} = \frac{514270}{56960} = 9.03$ $\frac{1}{3}$ Base = 8.17' OK $e = 12.25 - 9.03 = 3.22'$

$B.P. = \frac{56960}{24.5}\left(1 \pm \frac{6 \times 3.22}{24.5}\right) = 2320$ $\begin{cases} 1.79 = 4150 \text{ \#/□'} & \text{P.B.L.} \\ 0.21 = 490 \text{ \#/□'} & \text{P.B.R.} \end{cases}$

$0.45 \times 56960 = 25630 > 11160 (\Sigma H)$ ∴ OK against sliding

Case II $\frac{\Sigma M}{\Sigma V} = \frac{942390}{66940} = 14.08'$ $\frac{2}{3}$ Base = 16.34' OK $e = 14.08 - 12.25 = 1.83'$

$B.P. = \frac{66940}{24.5}\left(1 \pm \frac{6 \times 1.83}{24.5}\right) = 2730$ $\begin{cases} 1.45 = 3960 \text{ \#/□'} & \text{P.B.R.} \\ 0.55 = 1500 \text{ \#/□'} & \text{P.B.L.} \end{cases}$

$0.45 \times 66940 = 30120 > 21700 (\Sigma H)$ ∴ OK against sliding

WAR DEPARTMENT

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

Subject: Hartford - Conn (Ht-5) - Floor Wall at 3rd Floor

Computation: Design of Riverside Base Slab

Computed by: R.H.M. Checked by: Date: 2/21/40

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Top Steel - Case I

↓	W	4 x 24 x 62.5	= 6000	x 2.0	=	12000	'# ↓
↓	E_r	4 x 4 x 125	= 2000	x 2.0	=	4000	"
↓	C_2	4 x 2 x 150	= 1200	x 2.0	=	2400	"
↓	C_3	1 x 3 x 150	= 450	x 2.5	=	1130	"
↑	U_1	1.5 x 31 x 62.5	= 2910	x 3.25	=	9460	'# ↑
↑	U_2	2.5 x 18.64 x 62.5	= 2910	x 1.25	=	3640	"
↑	U_3	Neglect					
↑	b_1	4 x 410	= 1960	x 2.0	=	3920	"
↑	b_2	4 x ½ x 598	= 1200	x 1.33	=	1600	"

ΣV = 670 # ΣM = 910 '# ↑

$$d_{(required)} = \sqrt{\frac{910}{123}} = 2^{+}" \quad \text{ok. Use } 18 - 3.5 = 14.5"$$

$$A_s = \frac{12 \times 910}{18000 \times .884 \times 14.5} = \frac{10920}{231000} = .05 \square" \quad \text{Use } \tfrac{5}{8}" \phi \text{ @ } 12" \text{ c.c.}$$

Bottom Steel - Case II

↓	E_r	4 x 4 x 100	= 1600	x 2.0	=	3200	'# ↓
↓	C_2	4 x 2 x 150	= 1200	x 2.0	=	2400	"
↓	C_3	1 x 3 x 150	= 450	x 2.5	=	1130	"
↑	U_2	2.5 x 9.5 x 62.5	= 1480	x 1.25	=	1850	'# ↑
↑	b_1	4 x 3560	= 14240	x 2.0	=	28480	"
↑	b_2	4 x ½ x 400	= 800	x 2.66	=	2130	"

ΣV = 13270 # ΣM = 25730 '# ↑

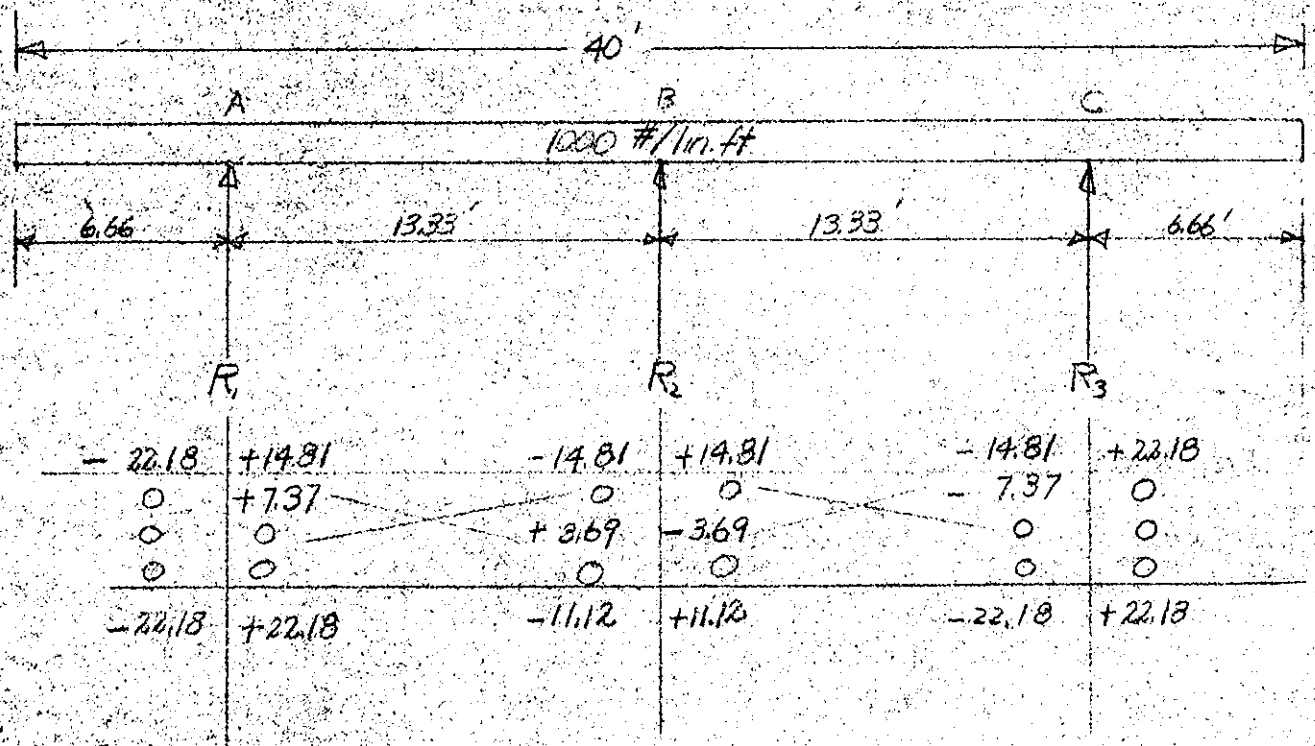
$$d = \sqrt{\frac{25730}{123}} = \sqrt{209} = 14.5"$$

$$A_s = \frac{12 \times 25730}{18000 \times .884 \times 16.5} = \frac{308760}{262350} = 1.18 \square" \quad \text{Use } 1\tfrac{1}{8}" \square \text{ @ } 12"$$

$$v = \frac{13270}{12 \times .884 \times 16.5} = \frac{13270}{175} = 76 \ \#/\square" \quad \text{hook bars}$$

Subject: Hartford Conn. (HI-5)
Computation: Design of Longitudinal Steel for all counterfort walls
Computed by: Checked by: Date:

U.S. GOVERNMENT PRINTING OFFICE 3—10528



To find reactions

$$R_3 = R_1 = \frac{20{,}000 \times 10 - 11120}{13.33} = \frac{188880}{13.33} = 14170 \text{ \#} \uparrow$$

$$R_2 = \frac{93330 \times 16.66 - 14170 \times 26.66 - 22180}{13.33} = \frac{155330}{13.33} = 11650 \text{ \#} \uparrow$$

$$\Sigma V = 0 = 40{,}000 - 14170 \times 2 - 11650 = 0 \quad \text{O.K.}$$

To find mid-span moments

$$M_{(\text{Middle } AB)} = 14170 \times 6.66 - 13330 \times 6.66 = 94370 - 88780$$
$$= 5590 \text{ \#}$$

WAR DEPARTMENT

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

Object: Hartford - Conn (Ht-5)

Computation: Design of longitudinal steel, Counterfort Walls

Computed by: R.H.M. Checked by: Date:

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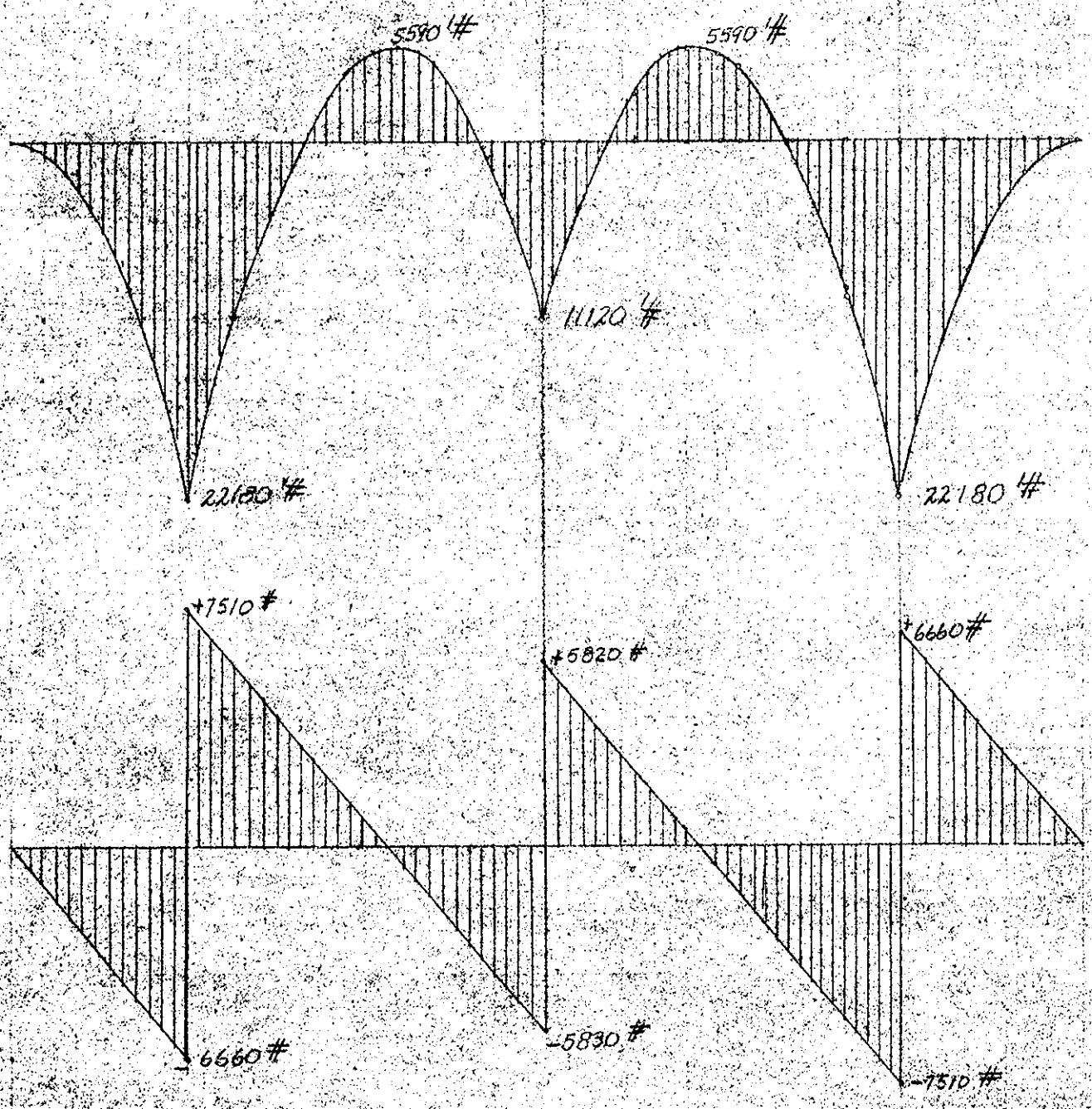
Moment diagram Shear Diagram



Subject: Hartford - Conn. (Ht-5)
Computation: Design of longitudinal Steel Counterfort Walls
Computed by: R.H.M. Checked by: Date:

U. S. GOVERNMENT PRINTING OFFICE 3—10523

$$\frac{M_B}{M_A} = \frac{11120}{22180} = .50 \qquad \frac{M_{(Mid\ pt\ AB)}}{M_A} = \frac{5570}{22180} = .25$$

Max. Shear = 7510 # for every 1000 # of uniform load

WAR DEPARTMENT

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Subject: Hartford - Conn (Ht-5)

Computation: Flood Wall Sta 0+00 28' Cft

Computed by: RHM Checked by: Date:

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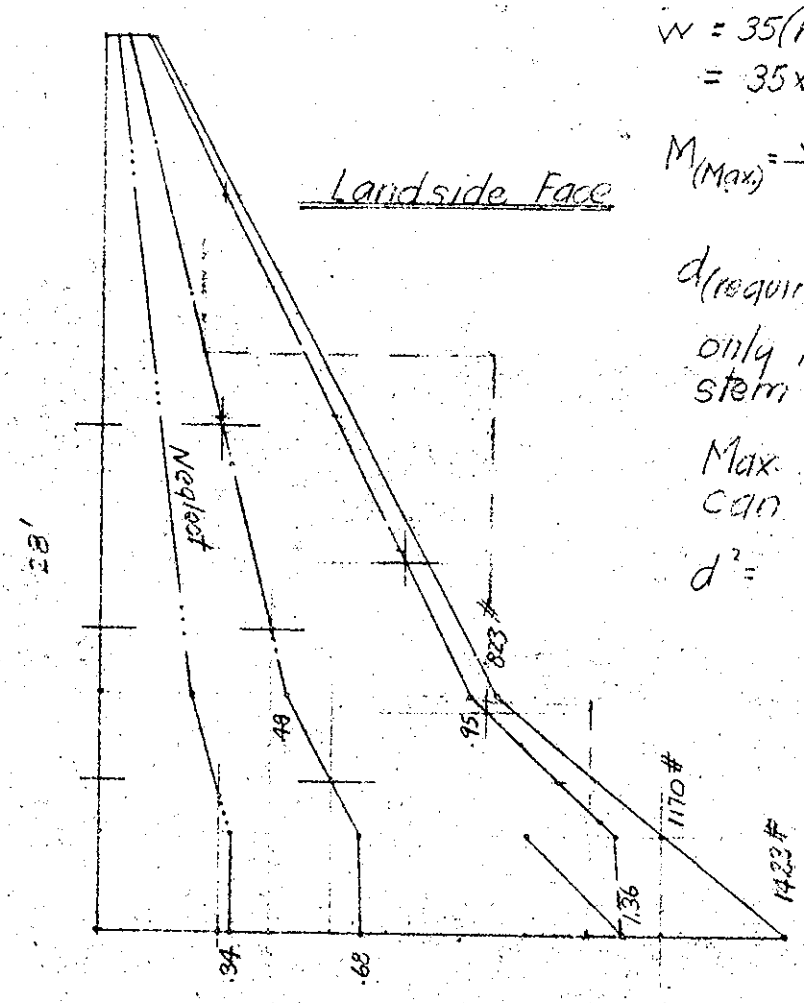
Loading Diagram - Areas of Steel - Case II



$w = 35(h+3)$ to El. 26

$= 35 \times 23.5 + 80(h-20.5)$ below El. 26

$M_{(Max)} = \frac{wl^2}{2} = 22.18\,w = 22.18 \times 1423 = 31560'\#$

$d_{(required)} = \sqrt{\frac{31560}{123}} = 16''$

only 14.5" provided. Thicken stem by 3" 17.5" then provided

Max. load which 18" stem (d=14.5") can take. —

$d^2 = \frac{M}{123}$, $M = 123d^2 = 22.18w$

$22.18w = 123 \times 210.25$

$w = \frac{25860}{22.18} = 1170\#$

Add 3" at point 4' above base

$A_s = \frac{M}{f_s \cdot j \cdot d} = \frac{22.18 \times 12 \times w}{18000 \times .884 \times d} = \frac{w}{59.74d}$

Use 5/8"φ @ 12" c.c for 13 bars
" 3/4"φ @ 12" c.c " 6 "
" 7/8"φ @ 12" c.c " 4 "
" 1"φ @ 12" c.c " 5 "

run these bars for 40 feet.

Double steel at ends - make these 11'-6" long - starting 5' down

Max Shear: $\frac{1423}{1000} \times 7510 = 10690\#$

$V = \frac{10690}{12 \times .884 \times 17.5} = 57\#/\square''$ OK $U = \frac{10690}{6.28 \times .884 \times 17.5} = 110\#/\square''$ OK.

WAR DEPARTMENT

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

Object: Hartford - Conn (HT-5)

Computation: Flood Wall Sta 0+00

Computed by ..... Checked by ..... Date .....

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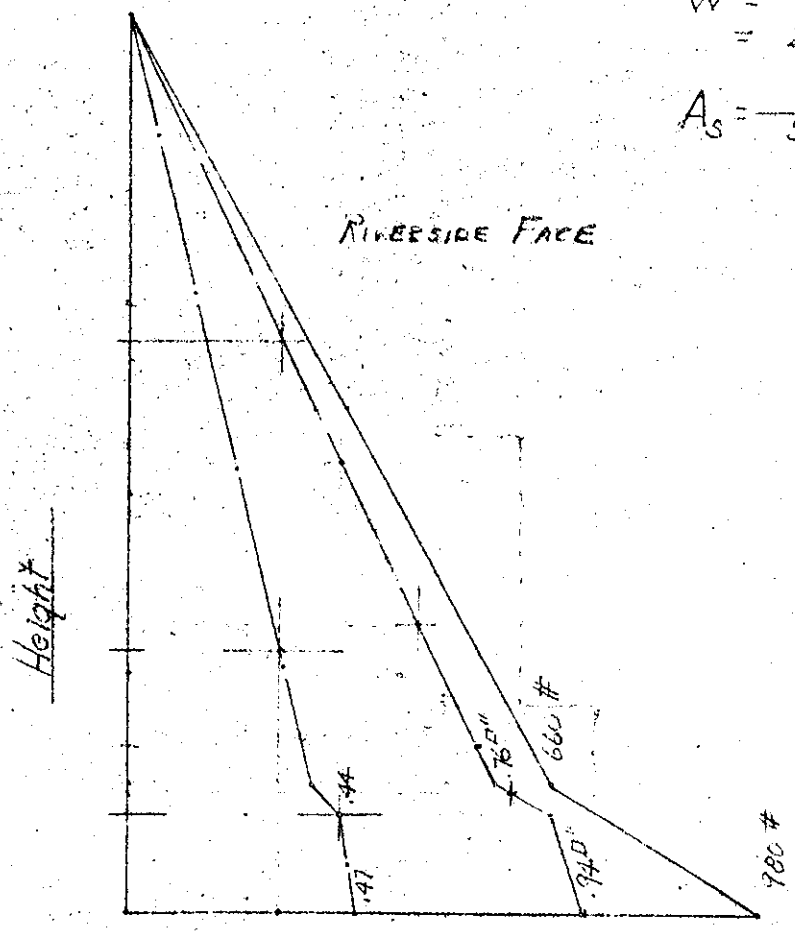
Loading Diagram - Areas of Steel Case I

$W = 27.5h$ to El. 26

$= 27.5h + (h - 20.5)\,80$ below El. 26

$A_s = \dfrac{W}{59.74\,d}$



Loads and Areas of Steel

Use $\frac{5}{8}$"φ @ 12" o.c for 20 bars
" $\frac{3}{4}$"φ @ 12" o.c " 5 "
" $\frac{7}{8}$"φ @ 12" o.c " 3 "
} Run the bars for 40'

Double steel at ends - make these 11'-6" long starting 10' down.

Shear and bend off

WAR DEPARTMENT

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

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Object: Hartford - Conn (Ht-5)

Computation: Flood wall Sta 0+00

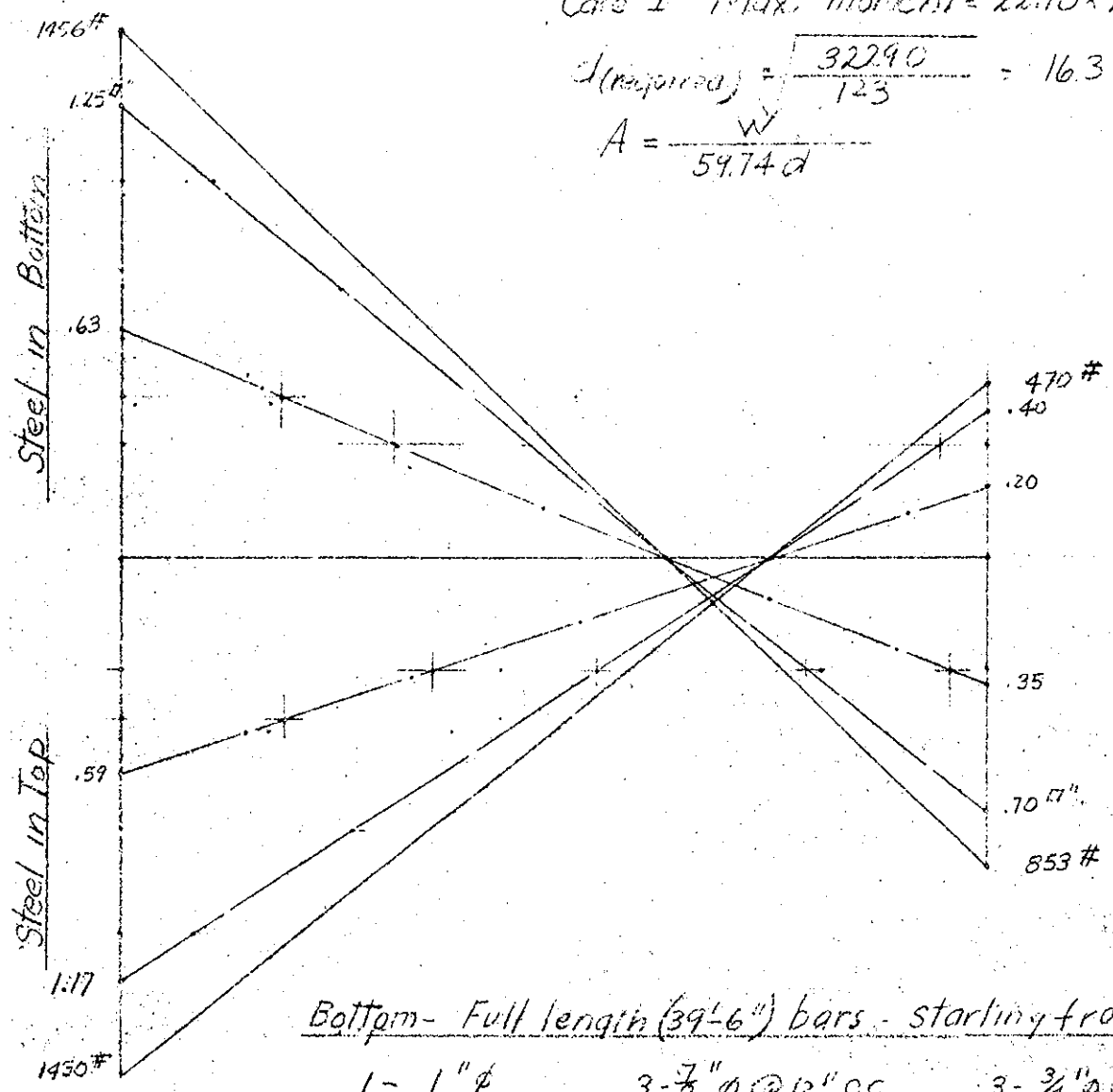
Computed by: R.H.M. Checked by: Date:

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case I Max. moment = 22.18 × 1456 = 32,290 #

$d_{(required)} = \sqrt{\frac{32290}{123}} = 16.3'$ Use 19.5"

$A = \frac{W}{59.74\,d}$



Bottom - Full length (39'-6") bars - starting from L.S.

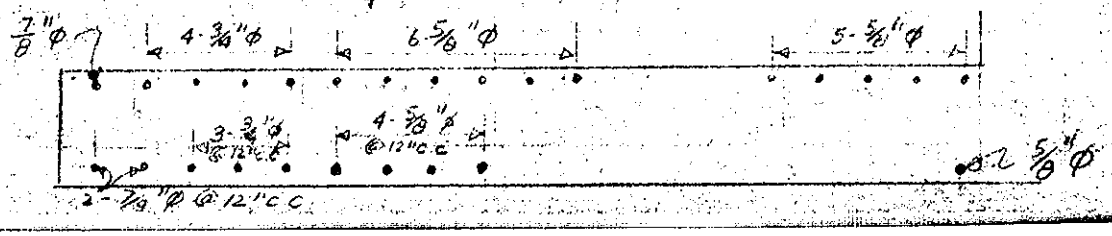
1 - 1"φ , 3 - 7/8"φ @ 12" c.c , 3 - 3/4"φ @ 12" c.c.

5/8"φ @ 12" c.c. rest of way - End steel shown below

Top - Full length (39'-6") bars starting from L.S.

4 - 7/8"φ @ 12" c.c. 4 - 3/4"φ @ 12" c.c 10 - 5/8"φ @ 12" c.c

1 - 3/4"φ @ 12" c.c - End steel shown below



WAR DEPARTMENT

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

Project: Hartford - Conn (Ht-5)

Computation: Flood Wall Sta 0+00

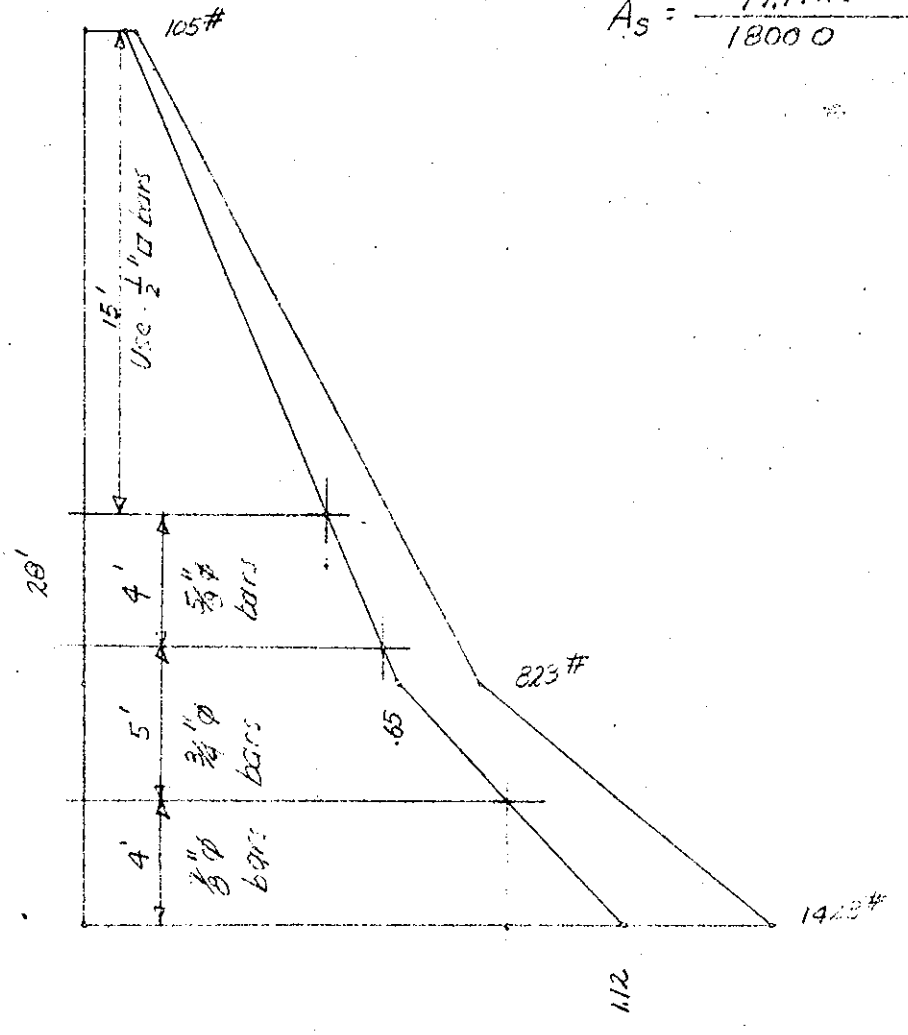
Computed by ..... Checked by ..... Date .....

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Bonding Steel in stem

Case II governs at end counterforts

$$A_s = \frac{14.17 \times W}{18000} = \frac{W}{1270}$$



WAR DEPARTMENT

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

Subject: Hartford - Conn - (HT-5)

Computation: Flood Wall - Sta 0+00

Computed by: ..... Checked by: ..... Date: .....

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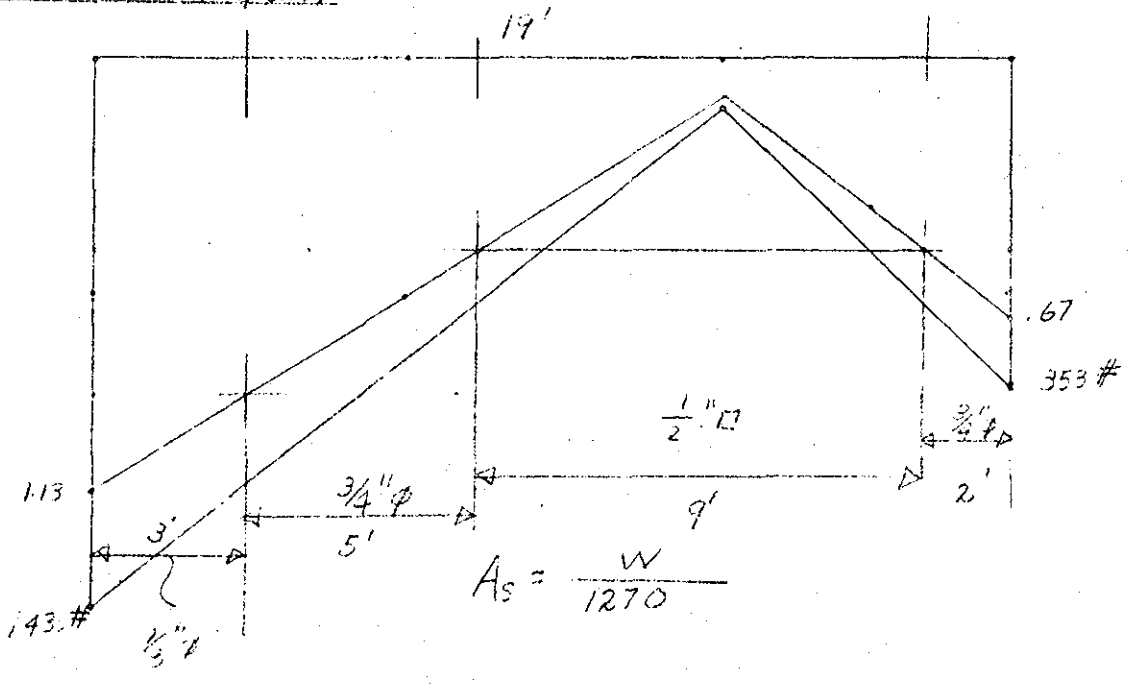
Bonding Steel in Base Cases I & II governs

Loading Diagram



$$A_s = \frac{W}{1270}$$

WAR DEPARTMENT

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

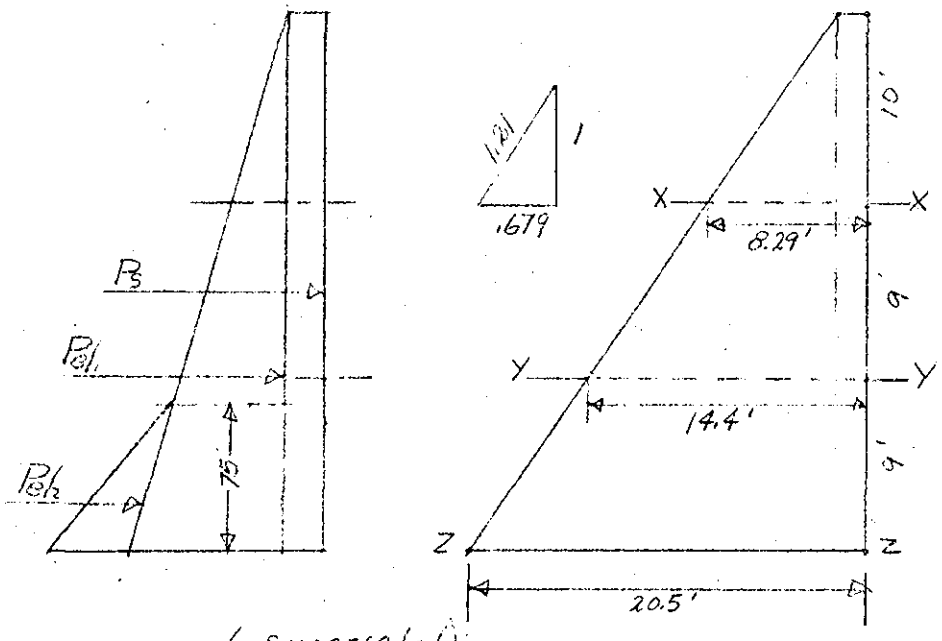
Subject: Hartford Conn (Ht-5)

Computation: Flood Wall Sta 0+00

Computed by: R.H.M. Checked by: Date: 2/29/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Counterfort Steel Case II governs



At section X---X (superseded)

P_s: $3 \times 35 \times 10 = 1050 \times 5 = 5250$ '#

P_{e1}: $10^2 \times \frac{1}{2} \times 35 = 1750 \times 3.33 = 5830$ "

2800 #→ 11,080 '# (For one ft. of wall)

39680 #→ 157000 '# (" 14.17' " ")

$$A_s = \frac{1.21 \times 12 \times 157000}{18000 \times .884 \times 96} = \frac{2,279,600}{1,526,400} = 1.50 \square''$$ Use 2-1" □ bars

At section Y---Y (superseded steel at bottom governs)

P_s: $3 \times 35 \times 19 = 2000 \times 9.5 = 19000$ '#

P_{e1}: $19^2 \times \frac{1}{2} \times 35 = 6320 \times 6.33 = 40000$ "

8320 #→ 59000 '# (For one ft of wall)

117890 #→ 836030 '# (" 14.17' " ")

$$A_s = \frac{1.21 \times 12 \times 836030}{18000 \times .884 \times 169} = \frac{12,139,200}{2,687,100} = 4.52 \square''$$ use 5-1" □ bars

* At section Z---Z

P_s: $3 \times 35 \times 28 = 2940 \times 14 = 41160$ '#

P_{e1}: $28^2 \times \frac{1}{2} \times 35 = 13720 \times 9.33 = 128010$ "

P_{e2}: $7.5^2 \times \frac{1}{2} \times 45 = 1270 \times 2.5 = 3180$ "

17990 #→ 172350 '# (For one ft. of wall)

254100 #→ 2,442,200 '# (" 14.17' " ")

$$A_s = \frac{1.21 \times 12 \times 2,442,200}{18000 \times .884 \times 142.5} = \frac{35,460,700}{3,847,800} = 9.22 \square''$$ Use 10-1 1/8" □

12.95

Project Hartford - Conn (Ht-5)
Computation Flood Wall Sta 0+00
Computed by R.H.M. Checked by ..... Date .....

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Design of counterfort steel

Shear in counterforts

Sec. X--X $V = \frac{39680}{24 \times .884 \times 96} = 19.5$ #/□" O.K.

" Y--Y $V = \frac{117,890}{24 \times .884 \times 169} = 33$ #/□" "

" Z---Z $V = \frac{254100}{24 \times .884 \times 242} = \cancel{49}$ #/□" "
197.5 61.6 #/□

Bond in counterforts

Sec X--X $U = \frac{39680}{8 \times .884 \times 96} = 58$ #/□" O.K.

" Y--Y $U = \frac{117,890}{20 \times .884 \times 169} = 39$ #/□" "

" Z--Z $U = \frac{254100}{40 \times .884 \times 242} = \cancel{30}$ 36.1 #/□" "

Vertical Steel in Stem (Case I)

Pw - Pel, : $28^2 \times \frac{1}{2} \times 27.5 = 10780 \times 9.33 = 100,580$ '#
Per : $4^2 \times \frac{1}{2} \times 52.5 = 420 \times 1.33 = 560$ "
11200 # ← 101,140 '#
(For one ft)

$M = 14.17 \times 101,140 = 1,433,200$ '# (for 14.17' of wall)

$A_s = \frac{12 \times 1,433,200}{18000 \times .884 \times 237} = \frac{17,198400}{3,768,300} = 4.56$ □" .50 □' provided per foot of stem ($\frac{1}{2}$" □ bars) if $\frac{4.56}{.5} = 9.12$' of stem acts out of 14.17' of wall. This is reasonable since weight of stem has been neglected

$f_c = \frac{2 M \times 12}{k j b d^2} = \frac{2 \times 17,198400}{.348 \times .884 \times 24 \times 237^2} = \frac{34,396,800}{414,700} = 83$ #/□" O.K.

WAR DEPARTMENT

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

Object: Hartford NE 5

Computation: Wall Stem 28' Base 15' to 19' Sta. 0+00 to 0+43±

Computed by: F.L.A. Checked by: Date: 3/11/40

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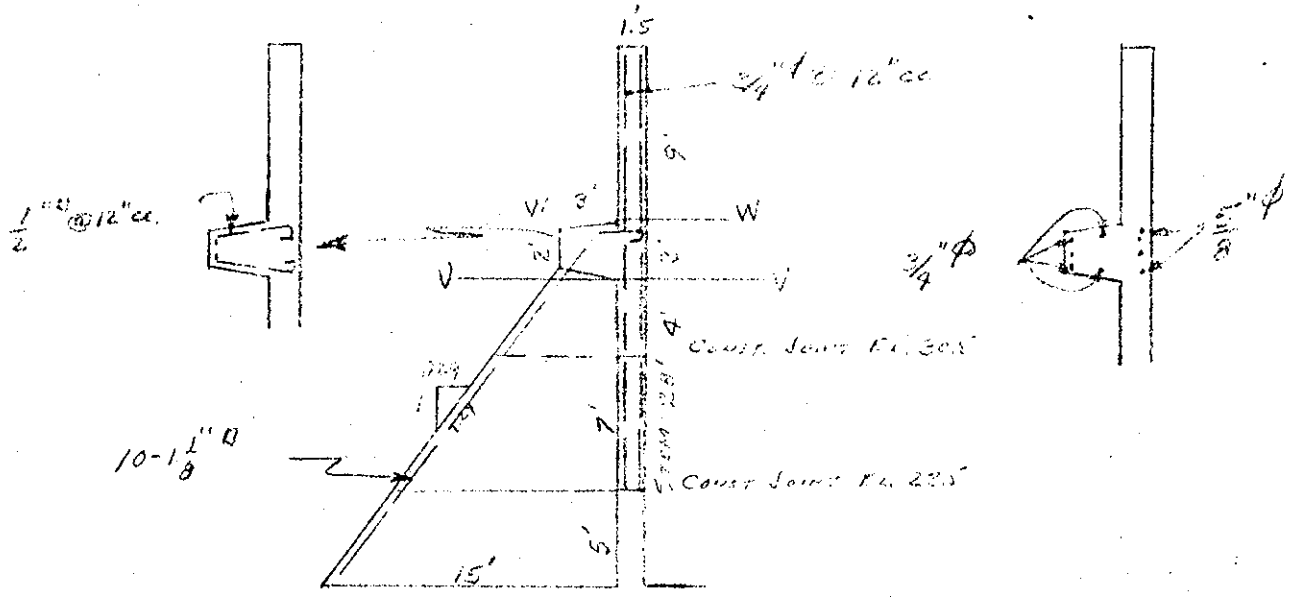

Bonding Stem & Base Steel Same
As For Regular Counterfort Computed For Sta. 0+00.

Design of Cantilever Stem Above Beam
Case I River Up & No Surcharge — Riverside Face
Moments About W-W

Forces Acting		→	←	Arm	Moments ↷	Moments ↶
PW	$\frac{1}{2} \times 62.5 \times \bar{y}^2$		2540	3.0		7600
PEL	$\frac{1}{2} \times 35 \times \bar{y}^2$	1420		3.0	4260	
		ΣV = 1120 ←			ΣM = 3340 ↶	

$$d_{W-W}(\text{Req'd}) = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{3340 \times 12}{123 \times 12}} = 5.21'' \quad d = 14.5''$$

$$A_{s\,W-W}(\text{Req'd}) = \frac{M}{f_s j d} = \frac{3340 \times 12}{18000 \times .884 \times 14.5} = 0.15\ \square''$$

Use 3/4"φ @ 12" cc. and Run To Field Joint El. 23.5

WAR DEPARTMENT

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

Page 21

Project: Hartford Hts

Computation: Wall Stem 28' Base 15' To 19' Sta. 0+00 To 0+43±

Computed by: P.L.A. Checked by: Date: 3/11/40

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Case II River Down & Surcharge Landside Face

Design of Cantilever Stem Above Beam Cont'd

Moments About W-W

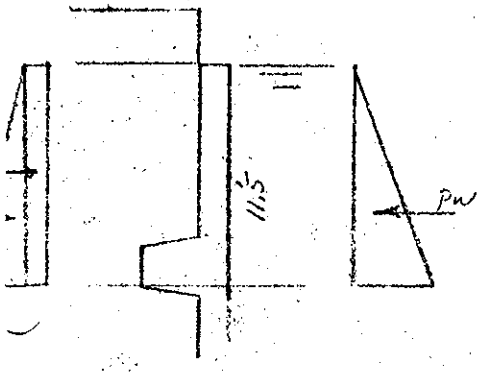
Forces Acting		→	←	Arm	Moments ↻	↺
PEL	$\frac{1}{2} \times 35 \times \overline{9}^2$	1420		3.0	4260	
PS	$35 \times 9 \times 3$	945		4.5	4250	
		$\Sigma V = 2365 \rightarrow$			$\Sigma M = 8510$	

$$d_{V-V}\ \text{Req'd} = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{8510 \times 12}{123 \times 12}} = 8.34'' \qquad d = 14.5''$$

$$A_{s_{V-V}} = \frac{M}{f_s j d} = \frac{8510 \times 12}{18000 \times .884 \times 14.5} = 0.45\ \square''$$

Use $\frac{3}{4}''\phi$ @ 12" and Run to Field Joint El. 23.5'

Design of Beam at Elev. 35.0'



Forces

River Up

$PW = \frac{1}{2} \times 62.5 \times \overline{11.5}^2 = 4130^{\#} \leftarrow$

$PEL = \frac{1}{2} \times 35 \times \overline{11.5}^2 = 2320^{\#} \rightarrow$

$\Sigma V = 1810^{\#} \leftarrow$

River Down

$PEL = \frac{1}{2} \times 35 \times \overline{11.5}^2 = 2320^{\#} \rightarrow$

$PS = 3 \times 35 \times 11.5 = 1150^{\#} \rightarrow$

$\Sigma V = 3470^{\#} \rightarrow$

WAR DEPARTMENT

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

bject HES HARTFORD

mputation WALL STEM 28' BASE 15' TO 19' STA. 0+00 TO 0+43±

mputed by PLK Checked by Date 3/12/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

RIVER UP RIVERSIDE FACE

$$M = \frac{wl^2}{10} = \frac{1810 \times \overline{13.33}^2}{10} = 32200'\#$$

$$A_s \text{ REQ'D} = \frac{32200 \times 12}{18000 \times .884 \times 50.5} = 0.49^{\square''}$$

USE 3-$\frac{5}{8}$ ϕ RUN ALL WAY THROUGH. GIVEN AREA = 0.93 □"

RIVER DOWN LANDSIDE

$$M = \frac{3470 \times \overline{13.33}^2}{10} = 61600'\#$$

$$A_s \text{ REQ'D} = \frac{61600 \times 12}{18000 \times .884 \times 50.5} = 0.93^{\square''}$$

USE 3-$\frac{3}{4}$ ϕ RUN ALL WAY THROUGH GIVEN AREA = 1.32 □"

SHEAR @ ELEV. 35.0

RIVER UP

$$V = \frac{1810 \times 14.17}{24 \times .884 \times 50.5} = 24^{\#/\square''}$$

RIVER DOWN

$$V = \frac{3470 \times 14.17}{24 \times .884 \times 50.5} = 46^{\#/\square''}$$

BENDING STEEL FOR BEAM

$$A_s \text{ REQ'D} = \frac{3470 \times 14.17}{18000} = 2.75^{\square''}$$

USE $\frac{1}{2}$"□ @ 12" cc. GIVEN A_s = 3.00 □"

WAR DEPARTMENT

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

Page 23

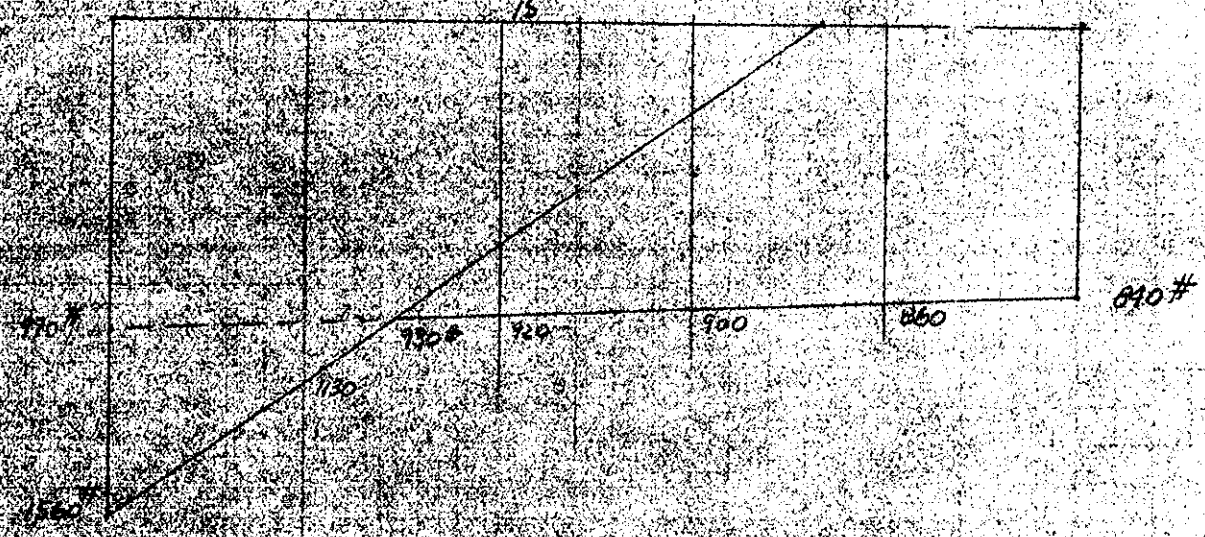
Project: Hartford - Conn (H-5)

Computation: Longitudinal Base Steel Sect. @ 0+00 +

Computed by: R.H.M. Checked by: Date:

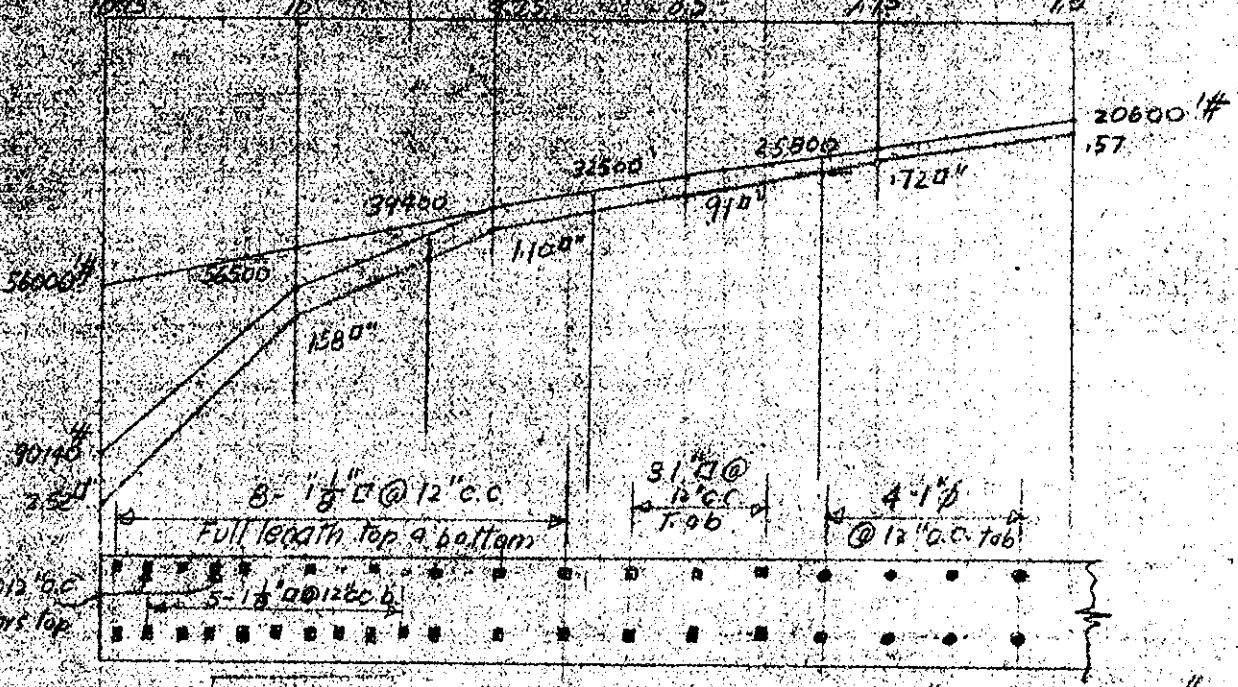
U.S. GOVERNMENT PRINTING OFFICE 3—10528

Loading Diagram



Moment diagram (for varying cantilever) $M = \frac{wl^2}{2}$

Length of cantilever



$d(\text{Max}) = \sqrt{\frac{90140}{123}} = \sqrt{733} = 27'' + 4.5 = 31.5''$ call it 33"

add 9" on top of land side base south of second counterfort.

WAR DEPARTMENT

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

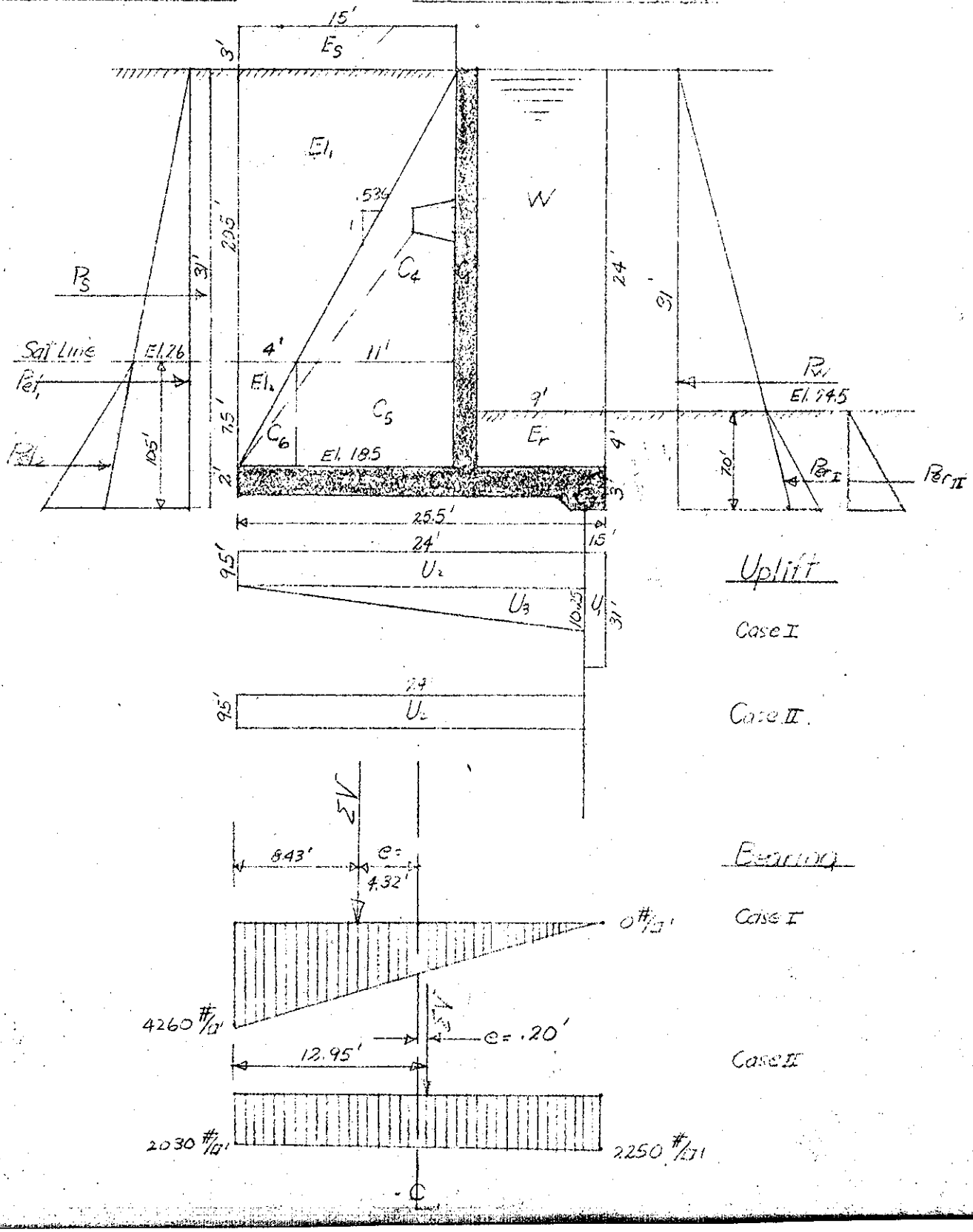
Object: Hartford Conn. (H-15)

Computation: Flood and retaining wall -- Sta 0+43

Computed by: R.H.M. Checked by: Date: 2/13/40

U. S. GOVERNMENT PRINTING OFFICE 8—10528

Case I - River Up Case II - River Down



WAR DEPARTMENT

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

Object: Hartford - Conn. - (H-15)

Computation: Flood and retaining wall - Sta 0+43

Computed by: R.H.M. Checked by: Date: 2/13/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Case I - River Up | Case II - River Down

Forces Acting		↓	↑	→	←	Arm	Moments ft (↻)	Moments ft (↺)
C_1	1.5×28×150	6300				15.75	99230	
C_2	2×25.5×150	7650				12.15	97540	
C_3	1.0×3.0×150	450				2.40	10800	
C_4	11×2.05×½×50×2/10	113.0				11.33	12800	
C_5	11×7.5×.25×2/10	41.0				9.5	3900	
C_6	4×7.5×.25×½×2/10	80				2.66	210	
E_s	15×3×100	4500				7.5	33750 **	
E_{l_1}	15×20.5×100	30750				7.5	230630	
E_{l_2}	15×7.5×125	14060				7.5	105450	
W	9×24×62.5	13500				21.0	283500 *	
E_{r_I}	9×4×125	4500				21.0	94500 *	
$E_{r_{II}}$	9×4×100	3600				21.0	75600 **	
U_1	1.5×31×62.5		2910			24.75		72020 *
U_2	24×9.5×62.5		14250			12.0		171000
U_3	24×½×10.25×62.5		7690			16.0		123040 *
P_{el_1}	31²×½×35			16820		9.33	156930	
P_{el_2}	10.5²×½×45			2490		2.50	6200	
P_s	3×35×31			3260		14.5	47270 **	
P_w	31²×½×62.5				30030	9.33		280190 *
P_{er_I}	7²×½×17.5				430	1.33		570 *
$P_{er_{II}}$	7²×½×35				860	1.33		1140 **
Case I		78830	24850	19300	30460		1,101,670	646810
		ΣV = 53980 #↓		ΣH = 11160 #→			ΣM = 454880 ft#↻	
Case II		68930	14250	22560	860		880310	172140
		ΣV = 54680 #↓		ΣH = 21700 #→			ΣM = 708170 ft#↻	

Case I: $\frac{\Sigma M}{\Sigma V} = \frac{454880}{53980} = 8.43'$; $\frac{1}{3}$ Base = 8.50' ok e = 12.75 - 8.43 = 4.32'

$B.P. = \frac{53980}{3 \times 8.43}\left(\frac{2}{0}\right) = 2130 \begin{cases} 2 = 4260 \text{ \#/□'} & \text{P.B.L.} \\ 0 = 0 \text{ \#/□'} & \text{P.B.R.} \end{cases}$

0.45×53980 = 24290 > 11160 ok against sliding

Case II: $\frac{\Sigma M}{\Sigma V} = \frac{708170}{54680} = 12.95'$; $\frac{2}{3}$ Base = 17' ok e = 12.95 - 12.75 = .2'

$B.P. = \frac{54680}{25.5}\left(1 \pm \frac{6 \times .2}{25.5}\right) = 2140 \begin{cases} 1.05 = 2250 \text{ \#/□'} & \text{P.B.R.} \\ .95 = 2030 \text{ \#/□'} & \text{P.B.L.} \end{cases}$

0.45×54680 = 24610 > 21700 ∴ ok against sliding

WAR DEPARTMENT

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

Project: Hartford - Conn. - (Ht-5)

Computation: Flood and retaining wall Sta 0 + 43

Computed by: R.H.M. Checked by: Date: 3/1/40

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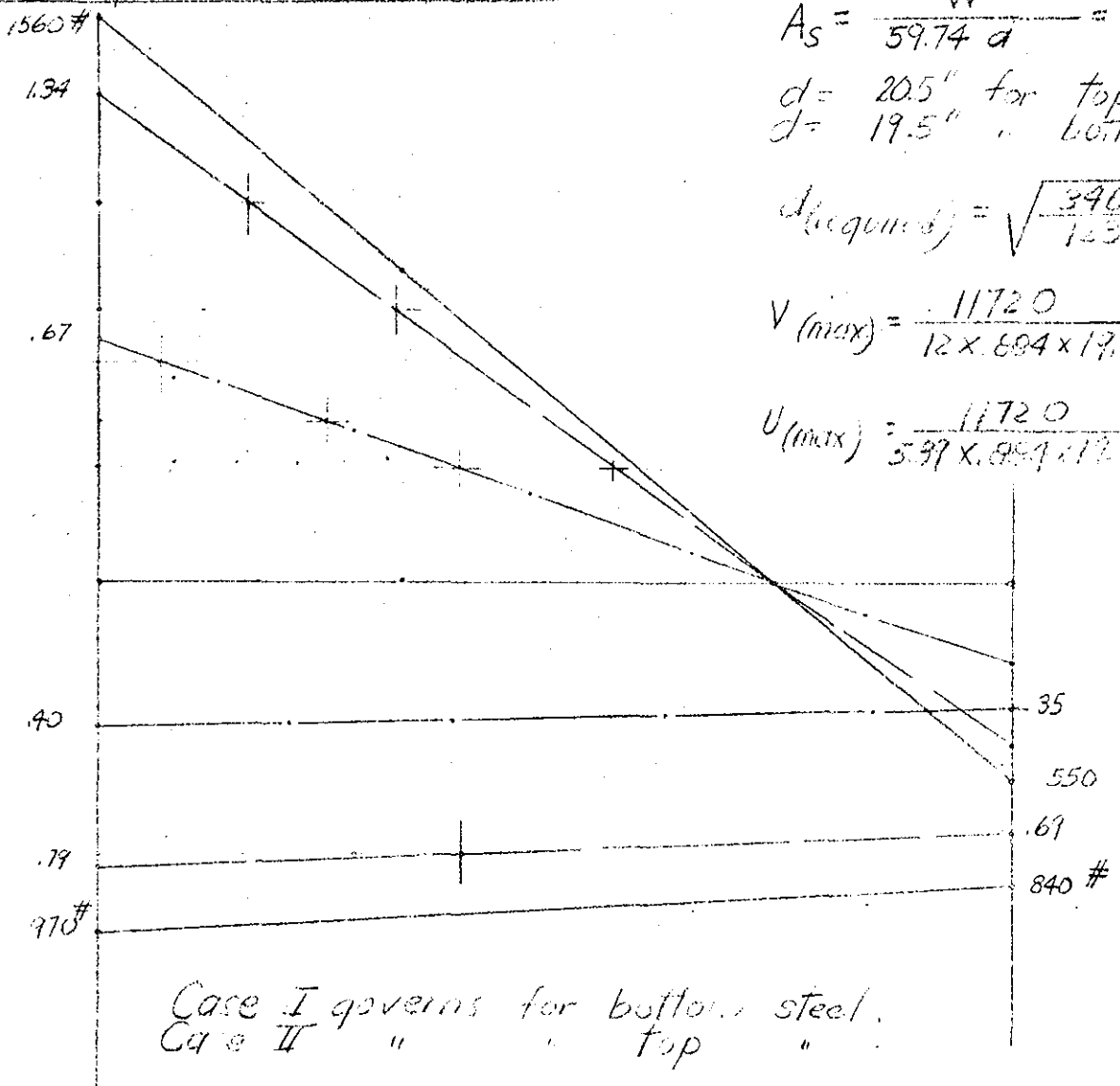
Longitudinal Stem Steel - same as in section 0+00

Bonding Steel in Stem - same as in section 0+00

Longitudinal Base Steel



$A_s = \frac{W}{59.74\,d} =$

$d = 20.5''$ for top steel.
$d = 19.5''$ " bottom "

$d_{(required)} = \sqrt{\frac{34600}{125}} = 16.8''$ ok.

$V_{(max)} = \frac{1172\,0}{12 \times .884 \times 19.5} = 57\ \#/\square''$

$U_{(max)} = \frac{1172\,0}{5.97 \times .884 \times 19.5} = 115\ \#/\square''$

Case I governs for bottom steel.
Case II " " top "

Top: Use $\frac{3}{4}''\phi$ @ 12" full length (34'-6") throughout.
" $\frac{3}{4}''\phi$ @ 12" at ends (11'-6") for 6 bars then $\frac{5}{8}''\phi$

Bottom

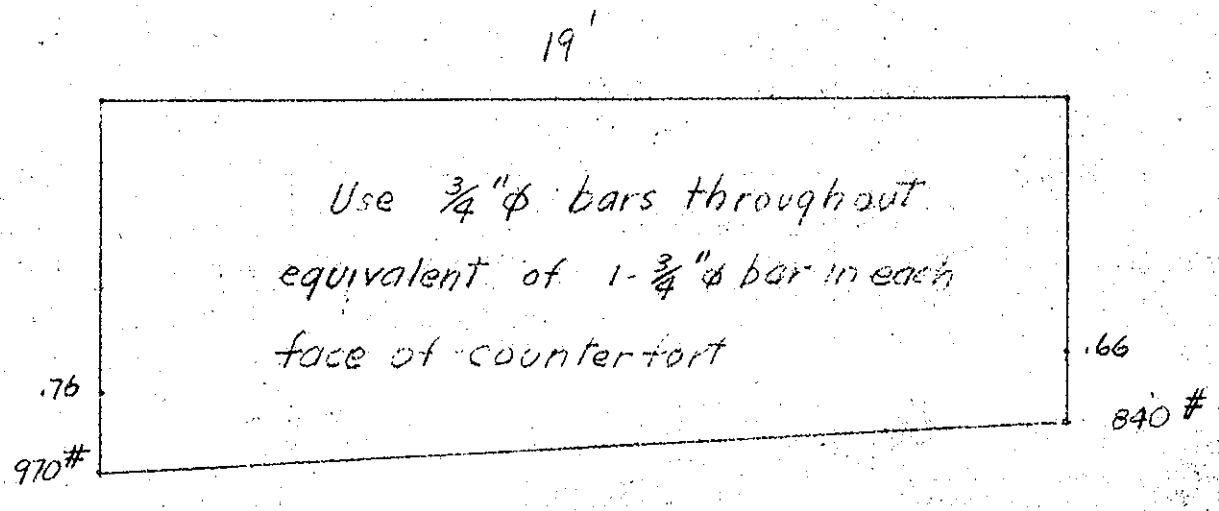
Starting from end of base
2 - 1"ϕ, 2 - $\frac{7}{8}''\phi$ 3 - $\frac{3}{4}''\phi$, $\frac{5}{8}''\phi$ rest of way (full length)

End bars - 2 - $\frac{7}{8}''\phi$, 3 - $\frac{3}{4}''\phi$ 4 - $\frac{5}{8}''\phi$

Project: Hartford - Conn (Ht-5)
Computation: Flood and retaining wall Sta 0+43
Computed by: Checked by: Date:

U. S. GOVERNMENT PRINTING OFFICE 3—10528

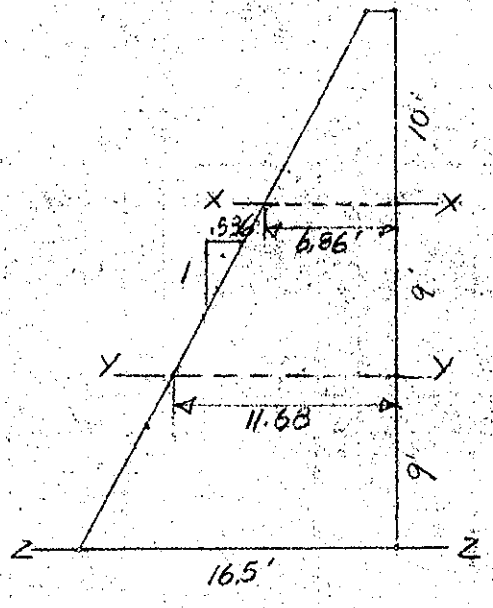
Bonding Steel in Base Case II Governs



$$A_s = \frac{14.17\,W}{18000} = \frac{W}{1270}$$

Design of counterfort steel

For loads & moments see page 18 for wall at 0+00



Project Hartford - Conn (Ht-5)
Computation Flood and retaining wall Sta 0+43
Computed by R.H.M. Checked by Date 3/1/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of counterfort steel (see pg 18 - 0+00)

At sect. x---x

$$A_s = \frac{2,279,600}{18000 \times .884 \times 78} = \frac{2,279,600}{1,240,200} = 1.84 \square''$$

Use 2 - 1"□ bars

$$V = \frac{39680}{24 \times .884 \times 78} = \frac{39680}{1650} = 24 \#/\square''$$

$$\Sigma_o = \frac{39680}{120 \times .884 \times 78} = \frac{39680}{8270} = 4.80'' \text{ ok } 8'' \text{ provided}$$

At sect Y---Y

$$A_s = \frac{12,139,200}{18000 \times .884 \times 136} = \frac{12,139,200}{2,162,400} = 5.61 \square''$$

Use 4 - $1\frac{1}{4}$"□ bars

$$V = \frac{117890}{24 \times .884 \times 136} = \frac{117890}{2886} = 41 \#/\square''$$

$$\Sigma_o = \frac{117890}{120 \times .884 \times 136} = \frac{117890}{14420} = 8.16'' \text{ OK } 20'' \text{ provided}$$

At Sect. z---z

$$A_s = \frac{35,460,700}{18000 \times .884 \times 194} = \frac{35460,700}{3,084,600} = 11.5 \square''$$

Use 3 $1\frac{1}{4}$"□ bars

$$V = \frac{254,100}{24 \times .884 \times 194} = \frac{254,100}{4117} = 62 \#/\square'' \text{ ok}$$

$$\Sigma_o = \frac{254100}{120 \times .884 \times 194} = \frac{254100}{20560} = 12.36'' \text{ ok. } 40'' \text{ provided}$$

Vertical steel in stem

$$A_s = \frac{17,198,400}{18000 \times .884 \times 189} = \frac{17,198400}{3,005,100} = 5.72 \square'' \quad .50 \square''$$

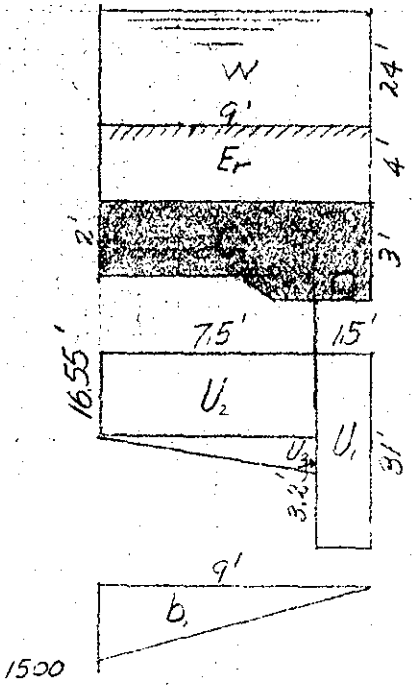
provided per foot of stem ($\frac{1}{2}$"□ bars) if $\frac{5.72}{.5}$ = 11.5' of stem acts out of 14.17 of wall. This is reasonable.

$$f_c = \frac{2M \times 12}{k j b d^2} = \frac{34,396,800}{.348 \times .884 \times 24 \times 189^2} = \frac{34396800}{263,730} = 130 \#/\square'' \text{ OK}$$

Subject: Hartford - Conn. (Ht-5)
Computation: Flood and retaining wall - Sta 0+43
Computed by: R.H.M. Checked by: Date: 2/13/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Riverside Base Slab



Top Steel

W	9 × 24 × 62.5 =	13500 × 4.5	= 60750 #/□
E_r	9 × 4 × 12.5 =	4500 × 4.5	= 20250 "
C_2	9 × 2 × 150 =	2700 × 4.5	= 12150 "
C_3	1 × 3 × 150 =	450 × 7.5	= 3380 "
U_1	1.5 × 3.1 × 62.5 =	2910 × 8.25	= 24,010 #/□
U_2	7.5 × 16.55 × 62.5 =	7760 × 3.75	= 29,100 "
U_3	7.5 × 3.2 × ½ × 62.5 =	750 × 5.0	= 3,750 "
b_1	9 × ½ × 1500 =	6750 × 3.0	= 20,250 "

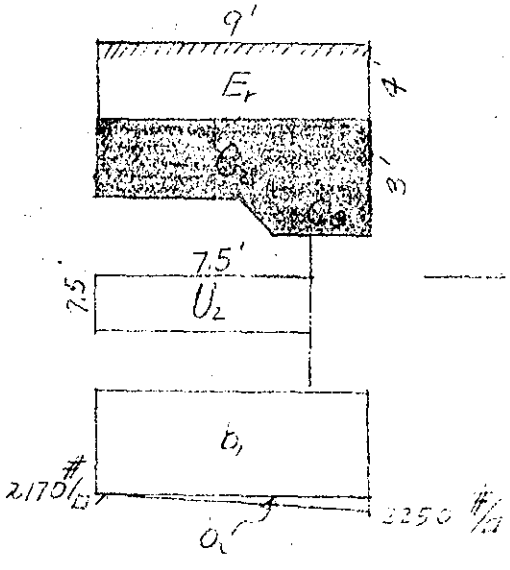
$\Sigma V = 2980$ ↓ $\Sigma M = 19420$ '#/□

$$A_s = \frac{12 \times 19420}{18000 \times .884 \times 26.5} = \frac{233,040}{421,350} = .55 \square''$$

Use $\frac{7}{8}''\phi$ @ 12" c.c.

Shear and bond ok by inspection.

Bottom Steel



E_r	9 × 4 × 100 =	3600 × 4.5	= 16200 #/□
C_2	9 × 2 × 150 =	2100 × 4.5	= 12150 "
C_3	1 × 3 × 150 =	450 × 7.5	= 3380 "
U_2	7.5 × 9.5 × 62.5 =	4450 × 3.75	= 16670 #/□
b_1	9 × 2170 =	19530 × 4.5	= 87870 "
b_2	9 × ½ × 800 =	360 × 6.0	= 2160 "

$\Sigma V = 17510$ #, $\Sigma M = 75010$ '#/□

$$d_{(\text{required})} = \sqrt{\frac{75010}{123}} = \sqrt{623} = 25''$$

Use 30 − 4.5 = 25.5" add 6" [illegible]

$$A_s = \frac{12 \times 75010}{18000 \times .884 \times 25.5} = \frac{900120}{405,450} = 2.22 \square''$$

Use $1\frac{1}{8}''\square$ @ 6" c.c.

$$V = \frac{17510}{12 \times .884 \times 25.5} = \frac{17510}{268} = 66 \text{ #/□'}$$ Use special anchorage

$$\Sigma_o = \frac{17590}{15 \times .884 \times 25.5} = \frac{17590}{3391} = 5.2''$$ ok 9" pro[illegible]

28% of steel needed at mid-section

WAR DEPARTMENT

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

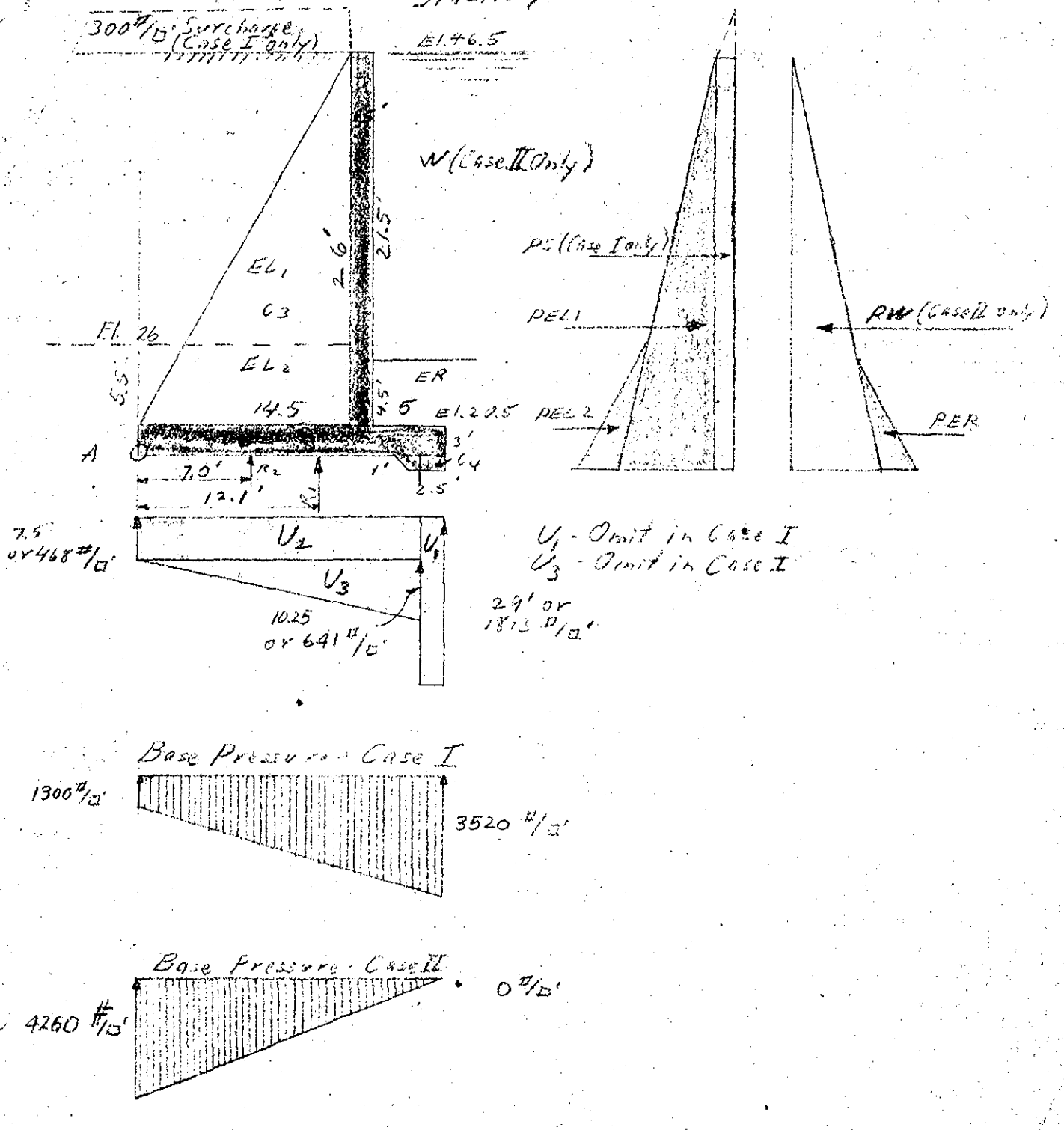
Subject Ht 5 Hartford

Computation Flood Retaining Wall 26' Stem 21' Base Sta. Inc.

Computed by RW Checked by R.H.M. Date 2-19-40

Stability

U. S. GOVERNMENT PRINTING OFFICE 3—10528



WAR DEPARTMENT

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

bject Ht 5 Hartford

omputation Flood Retaining Wall Sta 1+00 26' Stem, 21' Base

omputed by RW Checked by RHM Date 2-16-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case I - Water Down, 3' Surcharge

Forces Acting		↓	↑	→	←	Arm	Moments about A ↷	↶
C_1	26 x 1.5 x 150	5850				15.24	89200	
C_2	2 x 21 x 150	6300				10.50	66200	
C_3	14.5 x 26 x 25 $\frac{1}{2}$ x $\frac{2}{10}$	940				9.7	9120	
C_4	3 x 1 x 150	450				19.5	8780	
EL1	20.5 x 14.5 x 100	29700				7.25	215500	
EL2	5.5 x 14.5 x 125	10,000				7.25	72500	
S	3 x 100 x 14.5	4250				7.25	31600	
ER	4.5 x 5 x 100	2250				18.5	41700	
U_2	7.5 x 19.5 x 62.5		9150			9.75		89200
PEL1	29^2 x $\frac{1}{2}$ x 35			14700		8.67	127500	
PEL2	8.5^2 x $\frac{1}{2}$ x 45			1620		1.83	2960	
PS	3 x 35 x 29			3040		13.5	41100	
PER	7.5^2 x $\frac{1}{2}$ x 35				980	1.5		1470
FR	0.45 x 54,250				24400			
		59840	9150	19360	25380		706,160	90670
		ΣV = 50690 #↓		ΣH = 0			ΣM = 615,490 #↓	

Position of Resultant

$$\frac{\Sigma M}{\Sigma V} = \frac{615490}{50690} = 12.1$$

$\frac{2}{3}$ base = 14'

$e = 12.1 - 10.5 = 1.60'$

Base Pressure

$$\frac{50690}{21} \times \left(1 \pm \frac{6 \times 1.6}{21}\right) = 2410 \begin{cases} 1.46 \\ 0.54 \end{cases} = \begin{cases} 3520 \ \#/\square' & \text{River Side} \\ 1300 \ \#/\square' & \text{Land Side} \end{cases}$$

WAR DEPARTMENT

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

Subject: Ht 5 Hartford

Computation: Flood-Retaining Wall Sta. 14+00± 26' Stem 21' Base

Computed by: R.W. Checked by: R.H.M. Date: 2-19-40

U.S. GOVERNMENT PRINTING OFFICE 3—10623

Stability Case II. Water Up, No Surcharge

Forces Acting		↓	↑	→	←	Arm	Moments about A	
C_1	$26 \times 1.5 \times 150$	5850				15.25	89200	
C_2	$2 \times 21 \times 150$	6300				10.50	66200	
C_3	$14.5 \times 26 \times 25 \times \frac{1}{2} \times \frac{2}{21}$	940				9.7	9120	
C_4	$3 \times 1 \times 150$	450				19.5	8780	
EL1	$20.5 \times 14.5 \times 100$	29700				7.25	215500	
EL2	$5.5 \times 14.5 \times 125$	10,000				7.25	72500	
W	$21.5 \times 5 \times 62.5$	6720				18.5	124200	
ER	$4.5 \times 5 \times 125$	2820				18.5	52200	
U_1	$29 \times 1.5 \times 62.5$		2720			20.25		55100
U_2	$7.5 \times 19.5 \times 62.5$		9150			9.75		89200
U_3	$10.25 \times 19.5 \times \frac{1}{2} \times 62.5$		6250			13		81300
PEL1	$29^2 \times \frac{1}{2} \times 35$			14700		8.67	127500	
PEL2	$8.5^2 \times \frac{1}{2} \times 45$			1620		1.83	2960	
PER	$7.5^2 \times \frac{1}{2} \times 17.5$				490	1.5		740
PW	$29^2 \times \frac{1}{2} \times 62.5$				26300	8.67		228000
FR	0.45×44660			(20100)		—		
		62780	18120	26790	26790		768160	454,340
		$\Sigma V = 44660$ #/'		$\Sigma H = 0$			$\Sigma M = 313,820$	

Position of Resultant

$$\frac{\Sigma M}{\Sigma V} = \frac{313820}{44660} = 7.0 \quad \text{OK}$$

$\frac{1}{3}$ base = 7.00

$e = 10.5 - 7.0 = 3.5'$

Base Pressure

$$B.P. = \frac{44660}{21}\begin{pmatrix}2\\0\end{pmatrix} = 2130 \begin{cases} 2 = 4260 \ \#/\square' & \text{Landside} \\ 0 = 0 \ \#/\square' & \text{Riverside} \end{cases}$$

WAR DEPARTMENT

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

Subject: Hartford - Conn (Ht-5)

Computation: Flood-retaining wall Sta 1+00

Computed by: R.H.M. Checked by: Date: 3/6/40

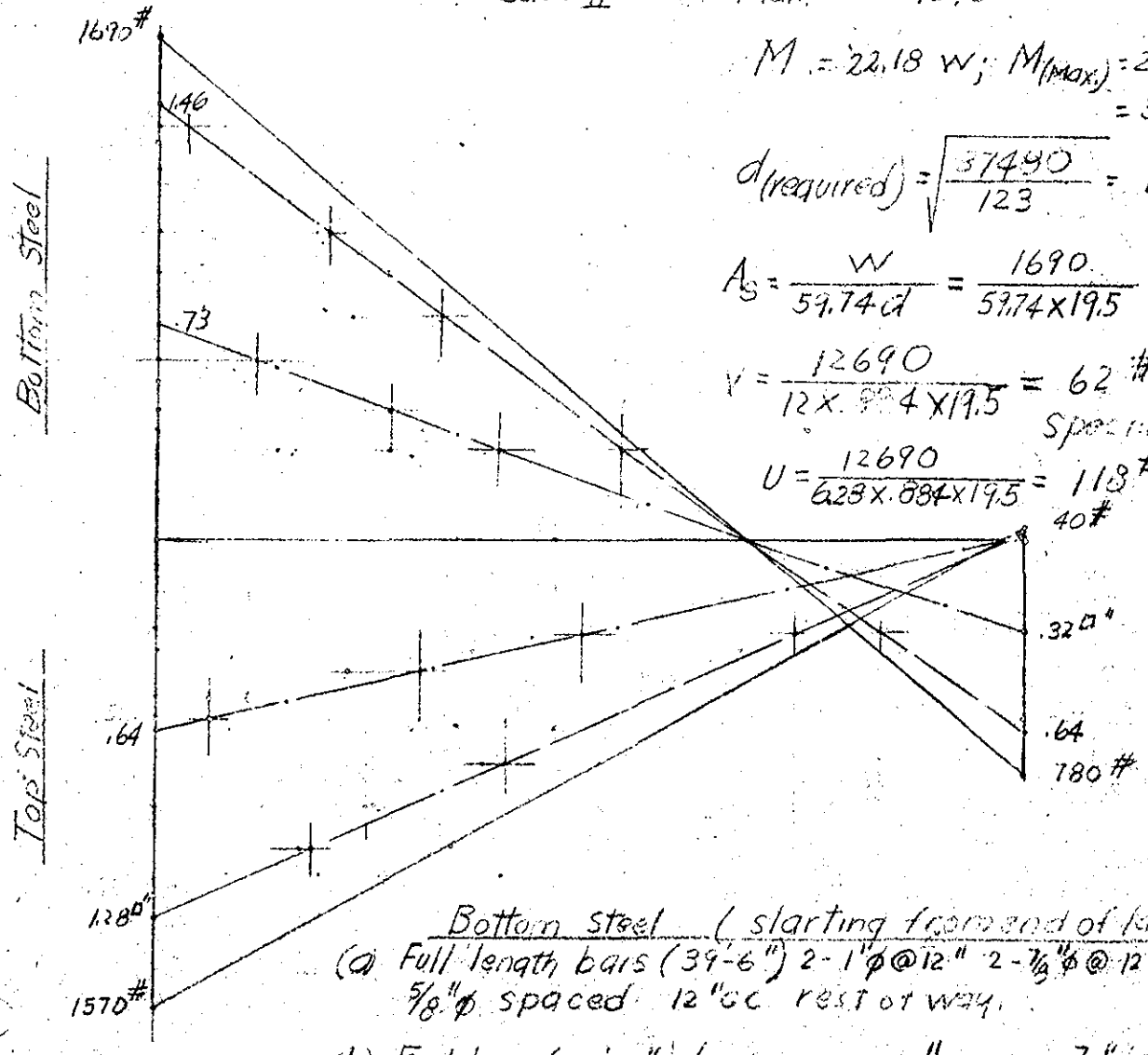
U. S. GOVERNMENT PRINTING OFFICE 3—10528

Longitudinal stem and bending steel - same as in sect. 0+00 at same elevation

Longitudinal Base Steel

Loading diagram

Case II - Max. w = 1690



$M = 22.18\,w$; $M_{(max)} = 22.18 \times 1690 = 37480$ '#

$d_{(required)} = \sqrt{\frac{37490}{123}} = 17.5''$ OK.

$A_s = \frac{w}{59.74\,d} = \frac{1690}{59.74 \times 19.5} = \frac{1690}{1160} = 1.46\,\square$ max.

$v = \frac{12690}{12 \times .884 \times 19.5} = 62$ #/□" Use special anchorage

$u = \frac{12690}{6.28 \times .884 \times 19.5} = 118$ #/□" OK

Bottom Steel (starting from end of full length bars)

(a) Full length bars (39'-6") 2-1"φ @ 12" 2-7/8"φ @ 12", 2-3/4"φ @ 12" 5/8"φ spaced 12" c.c. rest of way.

(b) End bars (11'-6") long - 1-1"φ, 2-7/8"φ's, 2-3/4"φ's 3-5/8"φ's

Top Steel

(a) Full length bars - 1-1"φ, 4-7/8"φ's, 3-3/4"φ's, 5/8"φ's to stem.

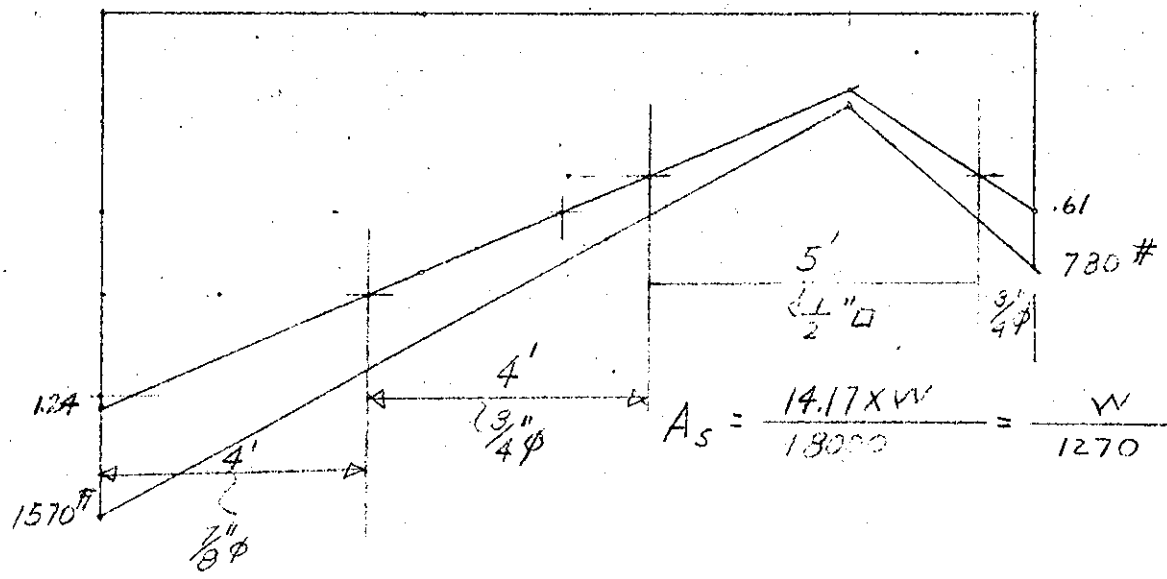
(b) End bars - 3-7/8"φ's, 3-3/4"φ's, 5-5/8"φ's

Subject Hartford (Ht-5)
Computation Flood and retaining walls 26' stem, 21' base Sta. 1+00
Computed by R.H.M. Checked by Date 3/1/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Bonding Steel in Base

Loading Diagram



$$A_s = \frac{14.17 \times W}{18000} = \frac{W}{1270}$$

WAR DEPARTMENT

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

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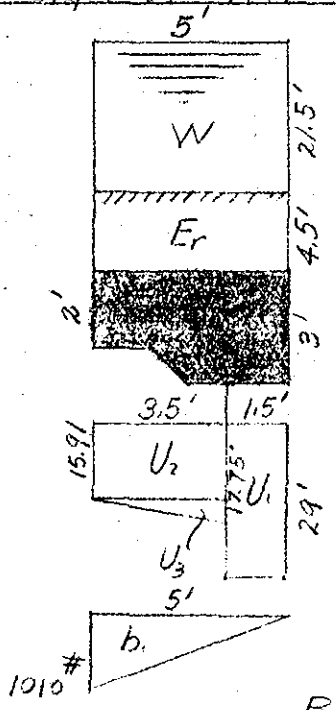
Subject: Hartford - (Ht-5) Conn

Computation: Flood Retaining Wall 26' Stem 21' Base Sta. 1+00

Computed by: R.H.M. Checked by: Date: 3/7/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Riverside Base Slab — Top Steel - Case II

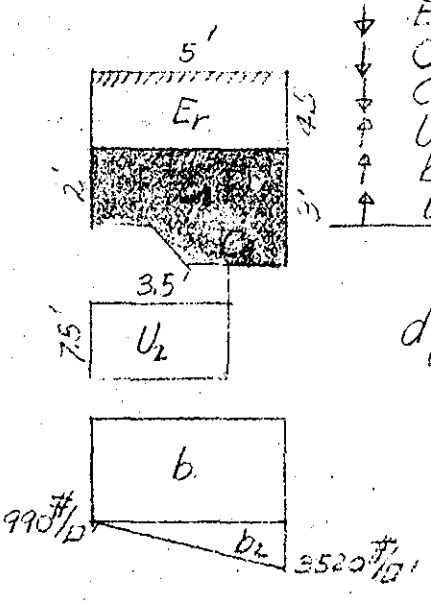


W:	5 x 21.5 x 62.5	=	6720	x 2.5	= 16800	#↓
E_r:	5 x 4.5 x 125	=	2810	x 2.5	= 7030	"
C_2:	5 x 2 x 150	=	1500	x 2.5	= 3750	"
C_4:	1 x 3 x 150	=	450	x 3.5	= 1580	"
U_1:	1.5 x 29 x 62.5	=	2720	x 4.25	= 11560	#↑
U_2:	3.5 x 15.91 x 62.5	=	3490	x 1.75	= 6090	"
U_3:	3.5 x 1.84 x ½ x 62.5	=	200	x 2.33	= 470	"
b_1:	5 x ½ x 1010	=	2530	x 1.67	= 4230	"
			2550 #↓		6810	#↑

$$A_s = \frac{12 \times 6810}{18000 \times .884 \times 20.5} = \frac{81,720}{326000} = .25 \square''$$

Use ⅝"ϕ @ 12" c.c.

Bottom Steel — Case I



E_r:	5 x 4.5 x 100	=	2250	x 2.5	= 5630	#↑
C_2:	5 x 2 x 150	=	1500	x 2.5	= 3750	"
C_4:	1 x 3 x 150	=	450	x 3.5	= 1580	"
U_2:	3.5 x 7.5 x 62.5	=	1640	x 1.75	= 2870	#↓
b_1:	5 x 2990	=	14950	x 2.5	= 37390	"
b_2:	5 x ½ x 530	=	1330	x 3.33	= 4430	"
			13720 #↑		33720	#↓

$$d_{(required)} = \sqrt{\frac{33720}{123}} = 16.6'' \quad \text{Use } 24 - 4.5 = 19.5''$$

$$A_s = \frac{12 \times 33720}{18000 \times .884 \times 19.5} = \frac{404,640}{310100} = 1.30 \square''$$

Use 1"ϕ @ 6" c.c.

$$v = \frac{13720}{12 \times .884 \times 19.5} = 66 \ \#/\square' \qquad u = \frac{13720}{6.28 \times .884 \times 19.5} = 127 \ \#/\square'' \text{ ok.}$$

Use special anchorage

WAR DEPARTMENT

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

Subject: Hartford (Ht-5) Conn.

Computation: Flood-Retaining Wall 26' stem - 21' Base - Sta 1+00

Computed by: R.H.M. Checked by: Date: 3/7/40

U. S. GOVERNMENT PRINTING OFFICE 2—10528

Counterfort Steel

Use same steel as in section sta. 0+43

WAR DEPARTMENT

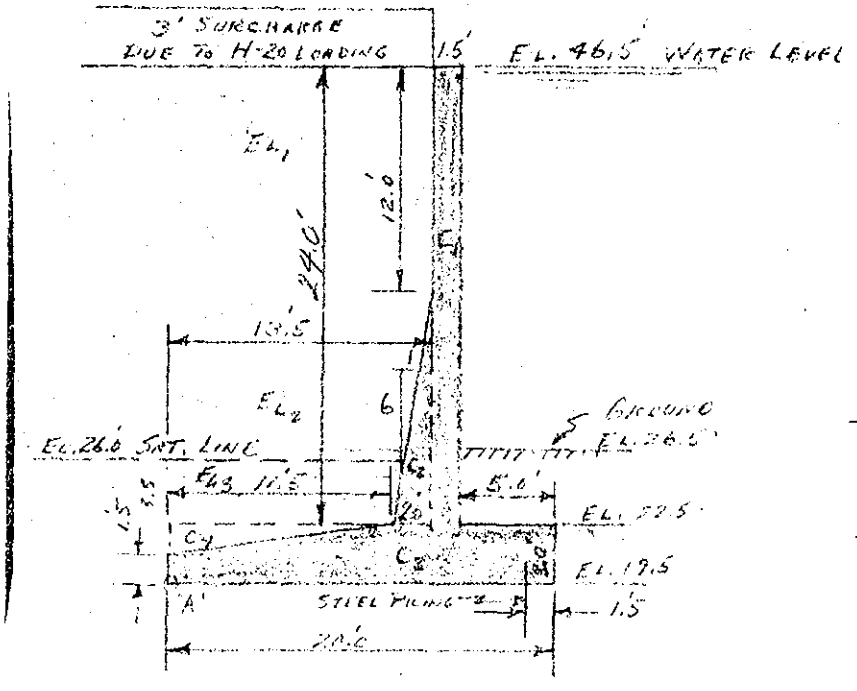
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

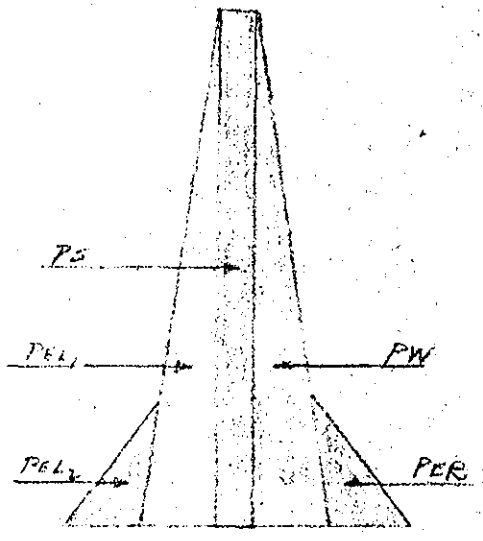
Subject: H&S HARTFORD

Computation: RETAINING WALL 24' STEM BASE = 20' STA. 1+50 ±

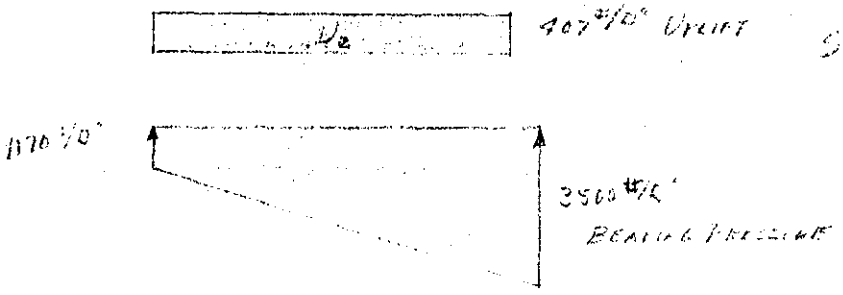
Computed by: P.L.A. Checked by: JSM Date: 2/15/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528



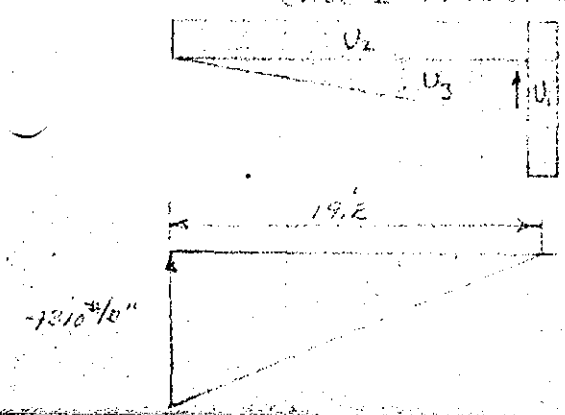


CASE II RIVER DOWN & SURCHARGE



KEY ADDED AFTER STABILITY COMPUTATIONS

CASE I RIVER UP & NO SURCHARGE



WAR DEPARTMENT

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

Subject: HCS Hartford

Computation: RETAINING WALL 24' STEM 20' BASE STABILITY

Computed by: F.L.K. Checked by: JSM Date: 2/14/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

CASE I - STABILITY, WATER UP AND NO SURCHARGE

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT "A" ↻	MOMENTS ABOUT "A" ↺
C_1	24'×1.5'×150'	5400'				14.25'	76,900'	
C_2	12'×2'×½×150'	1800'				12.83'	23,100'	
C_3	3'×20'×150'	9000'				10.00	90,000.	
C_4	11.5'×1.5'×½×25'		220'			3.83		842
EL_1	13.5'×12.0'×100'	16200'				6.75	109,000'	
EL_2	8.5'(12.5+12.2)/2 100'	10,900'				6.46	70,400	
EL_3	3.5'(12.2+11.6)/2 125'	5190'				5.90	30,600'	
ER	5'×4'×125'	2500'				17.50	43,700'	
W	28'×5'×62.5'	6250'				17.50	109,300'	
U_1	27'×1.5'×62.5'		2540'			19.25		48,900'
U_2	18.5'×6.5'×62.5'		7510			9.25'		69,500'
U_3	10.25'×½×18.5'×62.5'		5930'			12.33		73,100'
FEL_1	½×35×27²			12750		9.00	115,000	
FEL_2	½×45×6.5²			950'		2.2'	2090	
FER	½×17.5×7²				430'	2.33		1000'
FW	½×62.5×27²				22,800'	9.00		205,000'
		57,230'	16,200'	13,700'	23,230		679,090	398,342
		ΣV = 41030#		ΣH =	9530		ΣM = 271,748	

SLIDING 41030 × 0.45 = 18,465 > 9530 e = 10.0 − 6.6 = 3.4

POSITION OF RESULTANT = $\frac{\Sigma M}{\Sigma V} = \frac{271,718}{41030} = 6.6$ ½ OF BASE = 6.7

BASE PRESSURE = $\frac{41030}{20}\left(1 \pm \frac{6 \times 3.4}{20}\right) = 4260^{\#}$ / $-164^{\#}$

BASE PRESSURE $\frac{41030}{19.8}(2) = 4210^{\#}$

WAR DEPARTMENT

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

Subject: Ht5 Hartford

Computation: Retaining Wall — Sta. 1450 I.

Computed by: F.L.A. Checked by: [illegible] Date: 2/15/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Case II River Down, Backfill To Top of Wall & Surcharge

Forces Acting		↓	↑	→	←	Arm	Moments About "A" ↻	↺
C_1	24 X 1.5 X 150	5400				14.25	76,900	
C_2	12 X 2 X ½ X 150	1800				12.83	23,100	
C_3	3 X 20 X 150	9000				10.00	90,000	
C_4	11.5 X 1.5 X ½ X 25		720			3.83		843
S	3 X 100 X 13.5	4050				6.75	27,400	
EL_1	13.5 X 12.0 X 100	16,200				6.75	109,000	
EL_2	$8.5 \times \left(\frac{12.5+12.2}{2}\right) \times 100$	10,900				6.46	70,400	
EL_3	$3.5 \times \left(\frac{12.2+11.5}{2}\right) \times 125$	5180				5.90	30,600	
ER	5 X 4 X 100	2000				17.50	35,000	
U_2	18.5 X 6.5 X 62.5		7510			9.25		69,500
PS	3 X 35 X 27			2830		13.50	30,200	
PEL_1	½ X 35 X 27^2			12,750		9.00	115,000	
PEL_2	½ X 45 X 6.5^2			950		[illegible]	2090	
PER	½ X 35 X 7^2				860	2.33		2000
		54520	7720	16530	860		617,670	72343
		ΣV = 46,800		ΣH = 15,670			ΣM = 545,347	

Sliding 46,800 X .45 = 21,100 > 15,670

Position of Resultant = $\frac{\Sigma M}{\Sigma V} = \frac{545,347}{46,800} = 11.65$ ⅔ base = 13.3, e = 11.65 − 10.0 = 1.65

Base Pressure = $\frac{46,800}{20}\left(1 \pm \frac{6 \times 1.65}{20}\right) =$ 3800 #/□" / 1170 #/□"

WAR DEPARTMENT

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

bject H.L.S. HARTFORD

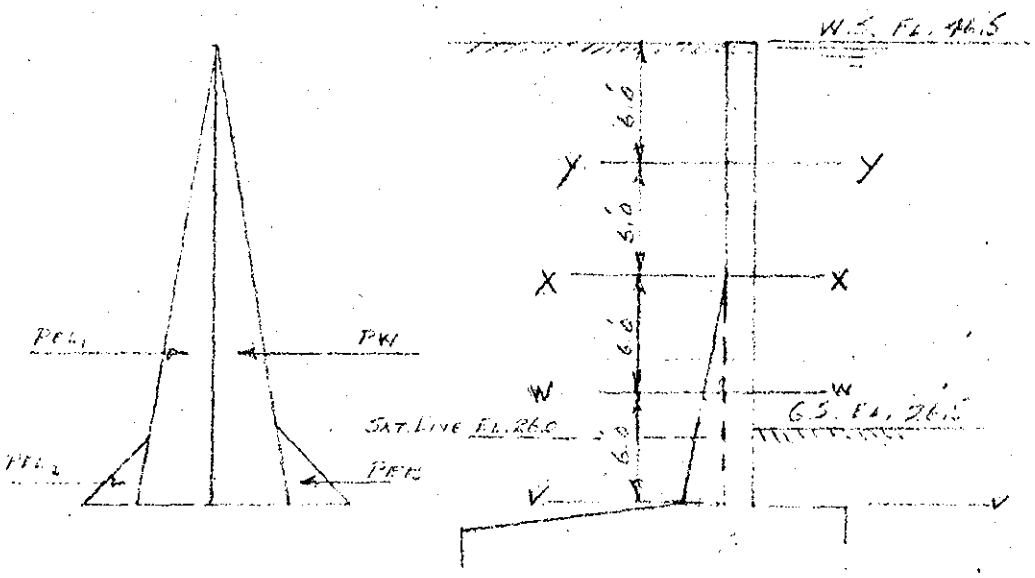
omputation RETAINING WALL 24' STEM BASE = 20' STA. 1+00 I

omputed by PLA Checked by JSM Date 2/16/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

STEEL IN STEM. RIVERSIDE FACE

CASE I RIVER UP AND NO SURCHARGE



FOR MOMENTS ABOUT V-V

FORCES ACTING		→	←	ARM	MOMENTS ↶	MOMENTS ↷
PEL1	½ x 24² x 35	10,100		8.0	80,800	
PEL2	½ x 3.5² x 45	275		1.2	330	
PER	½ x 4² x 17.5		140	1.33		186
PW	½ x 24² x 62.5		18,000	8.00		144,000
		10,375	18,140		81,130	144,186
		ΣV = 7765 ←			ΣM = 63,656 ↶	

FOR MOMENTS ABOUT W-W

PEL1	½ x 18² x 35	5670		6.0	34000	
PW	½ x 18² x 62.5		10300	6.0		61800
		5670	10300		34000	61800
		ΣV = 4630 ←			ΣM = 27800 ↶	

FOR MOMENTS ABOUT X-X

PEL1	½ x 12² x 35	2520		4.0	10,080	
PW	½ x 12² x 62.5		9500	4.0		18,000
		2520	9500		10,080	18,000
		ΣV = 1980 ←			ΣM = 7920 ↶	

WAR DEPARTMENT

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

Subject [illegible]

Computation [illegible] Span for Base 20' [illegible]

Computed by FLA **Checked by** [illegible] **Date** [illegible]

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in Stem Cantilever Bridge Pier
Case I Dam Up and No Tailwater

For Moments about Y-Y

Forces Acting		→	←	Arm	Moments ↻	↺
HL	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]
HW	[illegible]		[illegible]	[illegible]		[illegible]
		[illegible]	[illegible]		[illegible]	[illegible]
		ΣV = [illegible]			ΣM = [illegible]	[illegible]

$d_{V-V} = \sqrt{\frac{M}{bc}} = \sqrt{\frac{[illegible] \times 12}{12 \times 12}} = 22.6$ Actual d = 42.0 − 3.5 = 38.5

$A_{s\,V-V} = \frac{M}{f_s j d} = \frac{[illegible]}{16000 \times .874 \times 38.5} = 1.22^{\square''}$ Reqd

Unit Shear $_{V-V} = \frac{V}{bjd} = \frac{[illegible]}{12 \times .874 \times 38.5}$ 19.0 #/□" < 60 #/□" reqd

Unit Stresses $_{V-V} = \frac{V}{\Sigma_o jd} = \frac{[illegible]}{[illegible] \times .874 \times 38.5} = 41.6$ #/□" < 150 #/□"

Use 7/8" ϕ @ 6" cc

$d_{W-W} = \sqrt{\frac{[illegible] \times 12}{12 \times 12}} = 15.1$ Actual d = 30.0 − 3.5 = 26.5

$A_{s\,W-W} = \frac{27800 \times 12}{16000 \times .874 \times 26.5} = 0.79^{\square''}$ Use 3/4" ϕ @ 6" cc

Unit Shear $_{W-W} = \frac{V}{bjd} = \frac{4630}{12 \times .874 \times 26.5}$ 16.5 #/□" < 60 #/□"

Unit Stresses $_{W-W} = \frac{4630}{[illegible] \times .874 \times 26.5} = 42.0$ #/□" < 150 #/□"

WAR DEPARTMENT

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

Subject: HLS HARTFORD

Computation: RETAINING WALL STEM 29' BASE 20' STA. 1+50 ±

Computed by: P.L.A. Checked by: JRM Date: 2/16/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL IN STEM CONT'D RIVERSIDE FACE

CASE I RIVER UP AND NO SURCHARGE

$$d_{x-x} = \sqrt{\frac{7920 \times 12}{123 \times 12}} = 8.03'' \quad \text{ACTUAL } d = 18.0 - 3.5 = 14.5''$$

$$A_{s_{x-x}} = \frac{7920 \times 12}{18000 \times .884 \times 14.5} = 0.41 \ \square''$$

$$\text{UNIT SHEAR}_{x-x} = \frac{1980}{12 \times .884 \times 14.5} = 12.9 \ \#/\square'' < 60 \ \#/\square''$$

$$\text{BOND STRESS}_{x-x} = \frac{1980}{2.36 \times .884 \times 14.5} = 65.4 \ \#/\square'' < 150 \ \#/\square''$$

USE $\frac{3}{4}''\phi$ @ 12" c.c.

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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Subject: HL5 HARTFORD
Computation: RETAINING WALL STEM 24' BASE 20' STA. 1+50±
Computed by: P.L.A. Checked by: JMW Date: 2/17/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL IN STEM CONT'D RIVERSIDE FACE
CASE I RIVER UP AND NO SURCHARGE

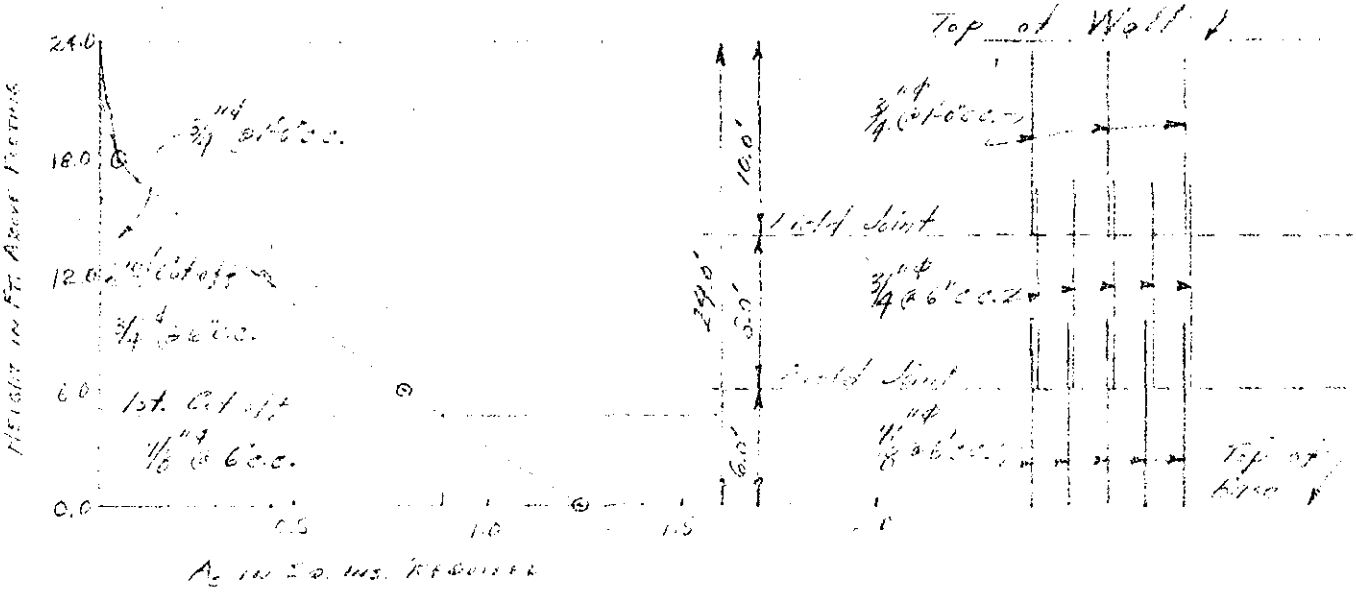
$$d_{y-y} = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{990 \times 12}{123 \times 12}} = 2.84'' \quad \text{Actual } d = 18.0 - 3.5 = 14.5''$$

$$A_{s_{y-y}} = \frac{M}{f_s j d} = \frac{990 \times 12}{18000 \times .884 \times 14.5} = .051 \ \square''$$

$$\text{Unit Shear}_{y-y} = \frac{495}{12 \times .884 \times 14.5} = 3.2 \ \#/\square' < 60 \ \#/\square''$$

$$\text{Bond Stresses}_{y-y} = \frac{495}{2.36 \times .884 \times 14.5} = 16.3 \ \#/\square' < 150 \ \#/\square''$$

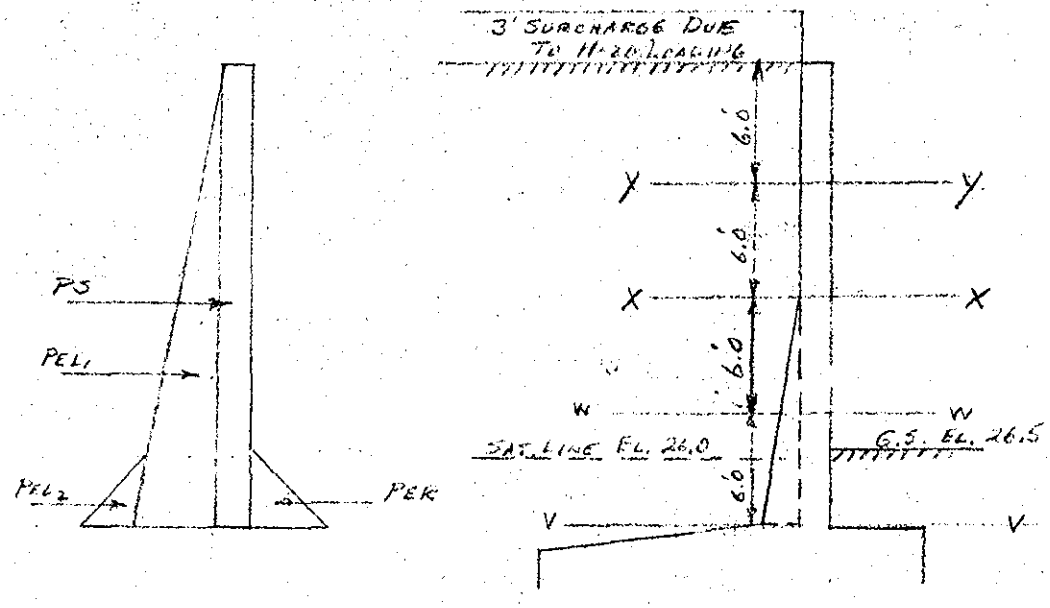
USE 3/4"φ @ 12" cc



Subject: Ht 5 Hartford
Computation: Retaining Wall Stem 24 Base 20' Sta. 1450±
Computed by: P.L.A. Checked by: JSM Date: 2/17/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in Stem Cont'd Landside Face
Case II River Down and Surcharge



For Moments About V-V

Forces Acting		→	←	Arm	Moments ↻	Moments ↺
PEL1	½ x 24² x 35	10,100		8.0	80,800	
PEL2	½ x 3.5² x 45	275		1.2	330	
PS	3 x 35 x 24	2520		12.0	30,300	
PER	½ x 4² x 35		280	1.33		370
		12895	280		111,430	370
		ΣV = 12615 →			ΣM = 111,060 ↻	

For Moments About W-W

PEL2	½ x 18² x 35	5670		6.0	34,000	
PS	3 x 35 x 18	1890		9.0	17,000	
PER	—					
		7560	0		51,000	0
		ΣV = 7560 →			ΣM = 51,000 ↻	

WAR DEPARTMENT

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

Subject: Hts Hartford

Computation: Retaining Wall Stem 24' Base 20' Sta. 1+50±

Computed by: F.L.A. Checked by: JSMC Date: 2/17/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in Stem Cont'd Landside Face
Case II River Down and Surcharge

For Moments About Y-X

Forces Acting		→	←	Arm	Moments	
Pel.	1/2 x 12 x 35	2520		4.0	10080	
Ps	3 x 35 x 12	1260		6.0	7560	
		3780	0		17640	0
		ΣV = 3780 →			ΣM = 17640	

For Moments About Y-Y

Pel.	1/2 x 12 x 35	630		2.0	1260	
Ps	3 x 35 x 6	630		3.0	1890	
		1260	0		3150	0
		ΣV = 1260 →			ΣM = 3150	

$d_{v-v} = \sqrt{\frac{M}{kb}} = \sqrt{\frac{111,060 \times 12}{1.23 \times 12}} = 30''$ Actual d = 42" − 3" = 38.5"

$A_{s_{v-v}} = \frac{M}{f_s j d} = \frac{111,060 \times 12}{18000 \times .884 \times 38.5} = 2.18$ □"

Shear $v_{v-v} = \frac{V}{b_1 d} = \frac{12.15}{12 \times .884 \times 38.5} = [illegible]$ #/□" < [illegible] #/□"

Bond Stresses $v_{v-v} = \frac{V}{\Sigma_o j d} = \frac{12600}{25 \times .884 \times 38.5} = 43.7$ #/□" < 120 #/□"

Use 1 1/2" and 1" □ 12" o.c. and stagger $f_s = 2.27$ □"

$d_{w-w} = \frac{[illegible] \times 12}{\sqrt{1.23 \times 12}} = 10.9$ [illegible]

$A_{s_{w-w}} = \frac{[illegible] \times 12}{18000 \times .884 \times 38.5} = 1.4[illegible]$ □"

Subject HLS HARTFORD
Computation RETAINING WALL STEM 24' BASE 20' STA. 14+50±
Computed by P.L.A. Checked by JSM Date 2/19/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL IN STEM CONT'D LANDSIDE FACE
CASE II RIVER DOWN AND SURCHARGE

$$\text{SHEAR}_{W-W} = \frac{V}{bjd} = \frac{7560}{12 \times .884 \times 26.5} = 26.9\ \#/\square' < 60\ \#/\square'$$

$$\text{BOND STRESSES}_{W-W} = \frac{V}{\Sigma_0 jd} = \frac{7560}{8541.884 \times 26.5} = 38\ \#/\square'' < 150\ \#/\square''$$

USE $1\frac{1}{8}''\square$ & $1''\square$ 1'-0" cc STAGGERED

$$d_{X-X} = \sqrt{\frac{17640 \times 12}{1.2 \times 12}} = 12'' \qquad \text{ACTUAL } d = 18.0 - 3.5 = 14.5''$$

$$A_{s_{X-X}} = \frac{17640 \times 12}{18000 \times .884 \times 14.5} = 0.92\ \square''$$

$$\text{UNIT SHEAR}_{X-X} = \frac{3780}{12 \times .884 \times 14.5} = 24.6\ \#/\square' < 60\ \#/\square'$$

$$\text{BOND STRESSES}_{X-X} = \frac{3780}{6341.884 \times 14.5} = 77.1\ \#/\square'' < 150\ \#/\square''$$

USE $1''\square$ @ 6" cc

$$d_{Y-Y} = \sqrt{\frac{7560 \times 12}{1.2 \times 12}} = 5.1'' \qquad \text{ACTUAL } d = 18.0 - 3.5 = 14.5''$$

$$A_{s_{Y-Y}} = \frac{2150 \times 12}{18000 \times .884 \times 14.5} = 0.16\ \square''$$

WAR DEPARTMENT

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

Subject: HC 5 Hartford

Computation: Retaining Wall Stem 24' Base 20' Sta. 1+50±

Computed by: [illegible] Checked by: JSM Date: 2/19/40

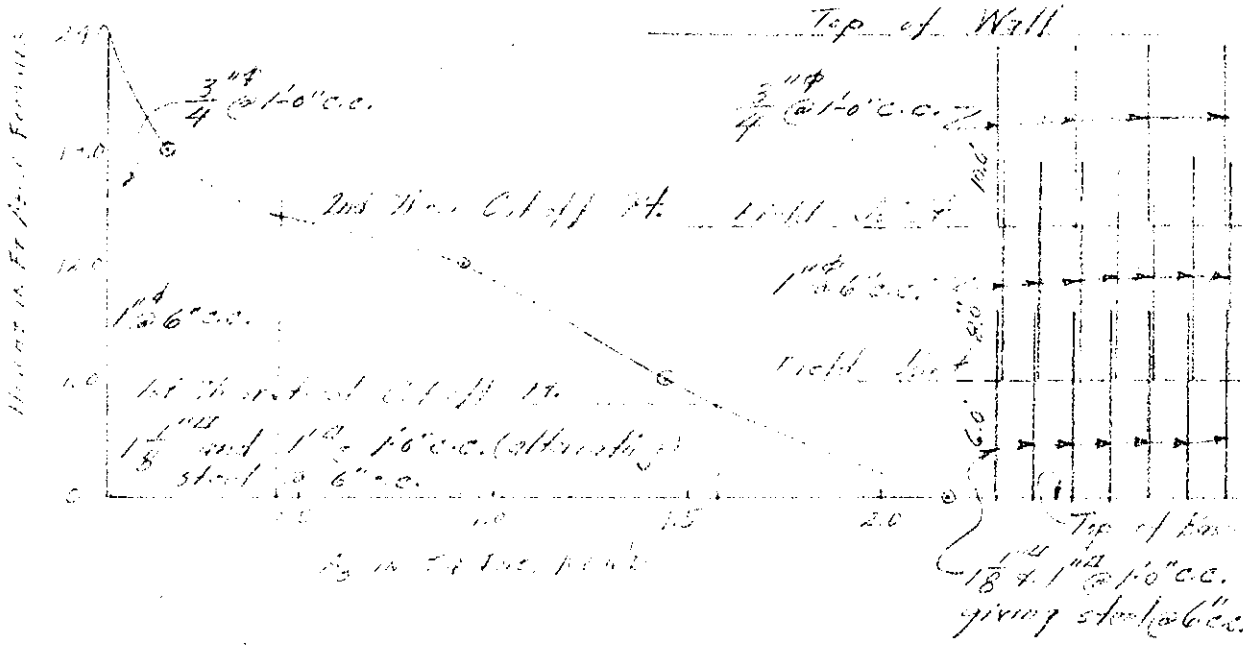
U. S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in Stem Cont'd Landside Face
Case II River Down and Surcharge

$$\text{Unit Shear}_{y-y} = \frac{V}{bjd} = \frac{1260}{12 \times .884 \times 14.5} = 8.2^{\#}/\square'' < 60^{\#}/\square''$$

$$\text{Bond Stress}_{y-y} = \frac{V}{\Sigma_o jd} = \frac{1260}{126 \times .884 \times 14.5} = 41.7^{\#}/\square'' < 150^{\#}/\square''$$

Use $\frac{3}{4}$" @ 12" c.c.



WAR DEPARTMENT

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

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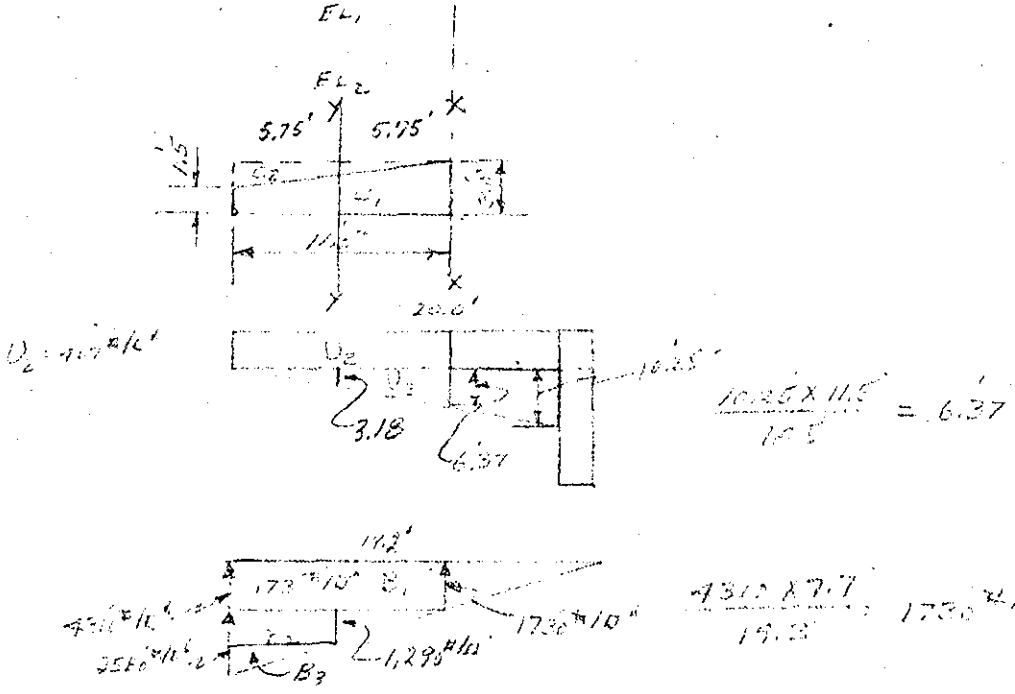
Subject: Ht 5 Hartford

Computation: Retaining Wall Stem 24' Base 20' Sta 1450 I

Computed by: P.L.A. Checked by: JSM Date: 2/19/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Steel in Base, Landside Bottom Steel
Case I River Up and No Surcharge



For Moments About Y-Y

Forces Acting		↓	↑	Arm	Moments ↷	↶
EL1	11.5 x 24.5 x 100	23,600		5.75		135,400
EL2	11.5 x 3.5 x 125	5040		5.75		29,000
C1	11.5 x 3.0 x 150	5180		5.75		29,800
C2	½ x 1.5 x 11.5 x 25		216	7.67	1660	
U2	407 x 11.5		4680	5.75	26,900	
U3	½ x 6.37 x 11.5 x 67.5		2290	3.82	8760	
P1	1730 x 11.5		19,900	5.75	114,000	
P2	½ x 2580 x 11.5		14,800	7.67	114,000	
		33880	41986		265,600	[illegible]
		ΣV = 8088 ↑			ΣM = 71,420 ↷	

WAR DEPARTMENT

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

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Subject: HCS HARTFORD

Computation: RETAINING WALL STEM 24' BASE 20' STA. 14+53.8

Computed by: F.L.A. Checked by: JSM Date: 2/19/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL IN BASE CONTR. LANDSIDE BOTTOM STEEL
CASE I RIVER UP AND NO SURCHARGE

FOR MOMENTS ABOUT Y-Y

Forces Acting		↓	↑	Arm	Moments ↺	Moments ↻
EL_1	5.75×2.25×160	11,800		2.88		34,000
FL_2	5.75×2.25×125	2520		2.88		7250
C_1	5.75×2.0×150	2590		2.88		7460
C_2	5.75×0.75×25		108	2.88	311	
C_3	½×0.75×5.75×25		54	2.83	267	
U_2	5.75×4.17		2396	2.88	6750	
U_3	½×2.0×5.75×62.5		574	1.92	1100	
EL_1	17.96×5.75		9750	2.88	28,700	
FL_2	17.96×5.75		7420	2.88	21,400	
C_3	½×12.0×5.75		1320	3.83	17300	
		16,910	21164		72,168	46,710
		ΣV = 4254 ↑			ΣM = 24058 ↺	

$$f_{x-x} = \frac{M}{Vbt} = \frac{72,420 \times 12}{12 \times 12} = 24.0 \text{ (horizontal shear} = 45 \pm 31.5)$$

$$f_{x-x} = \frac{M}{tjd} = \frac{72,420 \times 12}{18000 \times .899 \times 21.5} = 1.71''$$

$$\text{Stirrup}_{x-x} = \frac{V}{tjd} = \frac{4254}{12 \times .899 \times 21.5} = 24.2 \text{ \#/12" } \angle 60 \text{ \#/12"}$$

$$\text{Bond Stresses}_{x-x} = \frac{V}{\Sigma o j d} = \frac{2266}{7.14 \times .899 \times 21.5} = 40.7 \text{ \#/12" } \angle 150 \text{ \#/12"}$$

Use 1"⊕ and 1"□ 12" c.c. and staggered, giving steel @ 6" c.c.

WAR DEPARTMENT

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

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Subject: HCS Hartford

Computation: Retaining Wall Stem 24' Base 20' Str. [illegible]

Computed by: P.L.A. Checked by: JWM Date: 2/19/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in Base Cont'd Landside Bottom Steel
Case I River Up and No Surcharge

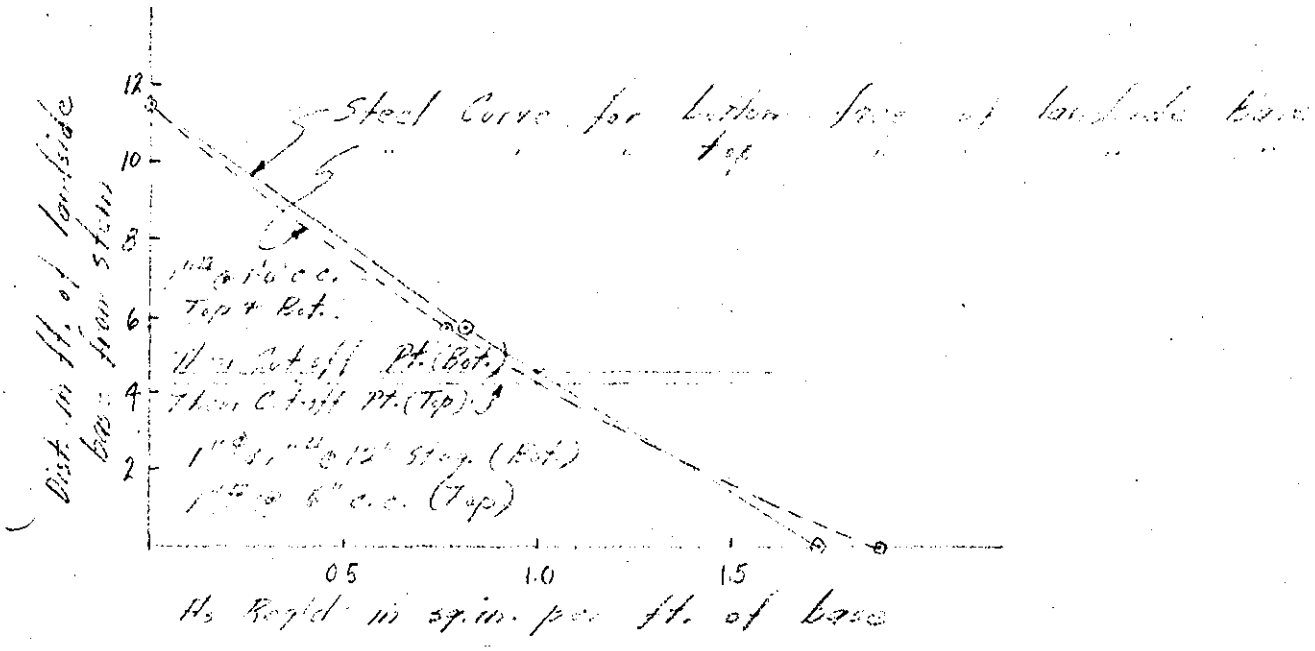
$$d_{y\text{-}y} = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{24058 \times 12}{123 \times 12}} = 14.0'' \quad \text{Actual } d = 27.0 - 4.5 = 22.5''$$

$$A_{s_{y\text{-}y}} = \frac{M}{f_s j d} = \frac{24058 \times 12}{18000 \times .884 \times 22.5} = 0.81 \square''$$

$$\text{Unit Shear}_{y\text{-}y} = \frac{V}{b j d} = \frac{7254}{12 \times .884 \times 22.5} = 30.5 \ \#/\square'' < 60 \ \#/\square''$$

$$\text{Bond Stress}_{y\text{-}y} = \frac{V}{\Sigma_o j d} = \frac{7254}{4.0 \times .884 \times 22.5} = 87.3 \ \#/\square'' < 150 \ \#/\square''$$

Use 1" □ 12" cc



WAR DEPARTMENT

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

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bject HM.5 HARTFORD

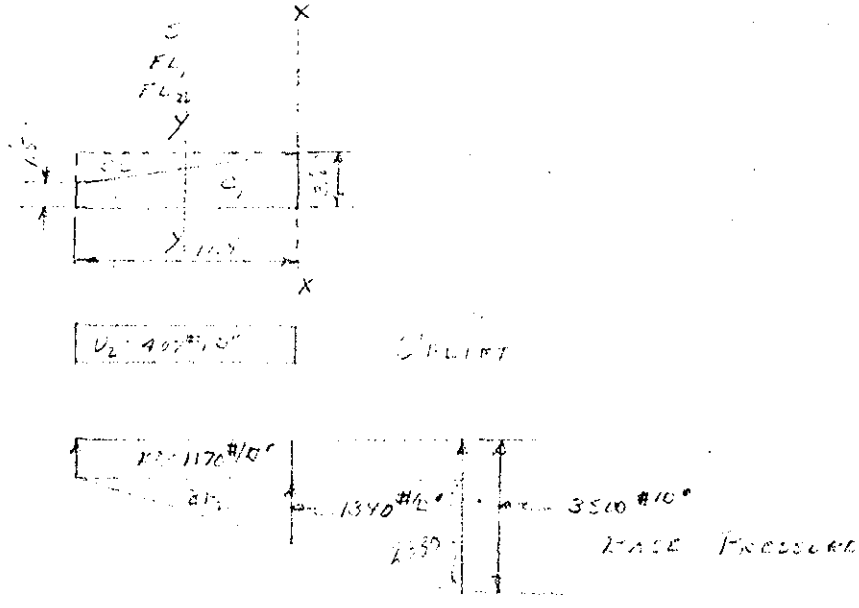
mputation RETAINING WALL STEM 24 BASE 20' STR. 1950 I

mputed by P.L.A. Checked by JSM Date 2/19/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL IN BASE CONT'D LANDSIDE TOP STEEL

CASE II RIVER DOWN AND SURCHARGE



FOR MOMENTS ABOUT A X

FORCES ACTING		↓	↑	ARM	MOMENTS ↷	MOMENTS ↶
S	3 x 11.5 x 100	3450		5.75		19,800
FL_1	11.5 x 20.5 x 100	23600		5.75		135,400
FL_2	11.5 x 3.5 x 125	5040		5.75		29,000
C_1	11.5 x 3.0 x 150	5180		5.75		29,800
C_2	½ x 1.5 x 11.5 x 2.5		216	7.67	1660	
U_2	407 x 11.5		4680	5.75	26,900	
BP_1	1170 x 11.5		13500	5.75	77,600	
BP_2	½ x 1340 x 11.5		7700	3.83	29,500	
		37270	26,096		135,660	214,000
		ΣV: 11174 ↓			ΣM: 78,340 ↶	

WAR DEPARTMENT

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

Subject: HLS Hartford

Computation: Retaining Wall Stem 24' Base 20' Sta. 1750 ±

Computed by: P.L.A. Checked by: JM Date: 2/19/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in Base Cont'd Landside Top Steel
Case II River Down and Surcharge

For Moments About Y-Y

Forces Acting		↓	↑	Arm	Moments ↺	Moments ↻
S	[illegible] x 5.75 x 100	1730		2.88		4990
FL_1	5.75 x 20.5 x 100	11,800		2.88		34000
FL_2	5.75 x 3.5 x 125	2520		2.88		7250
C_1	5.75 x 30 x 150	2590		2.88		7460
C_2	5.75 x 0.75 x 25		108	2.88	311	
C_3	½ x 0.75 x 5.75 x 25		54	3.83	207	
U_2	407 x 5.75		2340	2.88	6750	
BP_1	1170 x 5.75		6730	2.88	19400	
BP_2	½ x 670 x 5.75		1925	1.92	3700	
		18640	11157		30,368	53690
		ΣV =	7483 ↓		ΣM = 23322 ↺	

$$d_{x-x} = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{78340 \times 12}{123 \times 12}} = 25.2 \quad \text{Actual } d = 36.0 - 4.5 = 31.5''$$

$$A_{s_{x-x}} = \frac{M}{f_s j d} = \frac{78340 \times 12}{18000 \times .884 \times 31.5} = 1.88 \ \square''$$

$$\text{Unit Shear}_{x-x} = \frac{V}{b j d} = \frac{11174}{12 \times .884 \times 31.5} = 33.4 \ \#/\square'' < [illegible] \ \#/\square''$$

$$\text{Bond Stress} = \frac{V}{\Sigma u} = \frac{11174}{8.0 \times .884 \times 31.5} = 50 \ \#/\square'' < 150 \ \#/\square''$$

Use 1" □ @ 6" c.c.

$$d_{y-y} = \sqrt{\frac{23322 \times 12}{123 \times 12}} = 13.8 \quad \text{Actual } d = 27.0 - 4.5 = 22.5''$$

$$A_{s_{y-y}} = \frac{31342 \times 12}{18000 \times .884 \times 22.5} = 0.78 \ \square''$$

$$\text{Unit Shear}_{y-y} = \frac{7483}{12 \times .884 \times 22.5} = 31.3 \ \#/\square'' < 60.0 \ \#/\square''$$

$$\text{Bond Stress} = \frac{7483}{4.00 \times .884 \times 22.5} = 94 \ \#/\square'' < 150 \ \#/\square'' \quad \text{Use } 1'' \square \ 12'' \text{ cc}$$

WAR DEPARTMENT

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

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Subject HCS Hartford

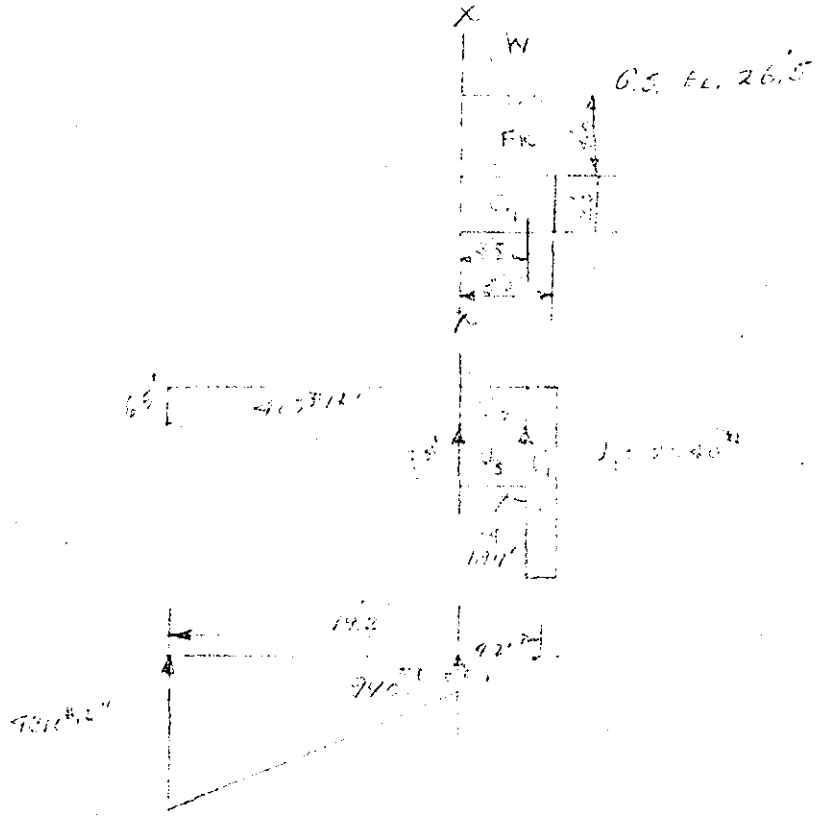
Computation Retaining Wall Stem 24' Base 20' Sta. 1+50 ±

Computed by R.L.A. Checked by JEM Date 2/17/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in Base Contr. Riverside Top Steel

Case I River Up and No Surcharge



For Moments About X-X

Forces Acting		↓	↑	Arm	Moments ↺	Moments ↻
W	[illegible] x 62.5	[illegible]		2.5	15,600	
Ek	[illegible] x [illegible]	[illegible]		2.5	6250	
U_1	5x3 x 150	2250		2.5	5630	
U_1	[illegible]		2540	4.25		10,800
U_2	[illegible] x 35		1430	1.75		2500
U_3	[illegible] x 35 x 62.5		1820	1.75		3190
U_4	[illegible]		[illegible]	2.33		495
P_{e_1}	[illegible] 940 x 4.2		1990	1.4		2780
		11000	7975		27480	19755
		Sum 3022 ↓			SM = 7725 ↻	

Subject: HLS Hartford

Computation: Retaining Wall Stem 24' Base 20' Sta [illegible]

Computed by: F.L.A. Checked by: JSM Date: 2/20/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Steel in Base Cont'd Riverside Top Steel

Case I River Up and No Surcharge

$$d_{x-x} = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{7725 \times 12}{123 \times 12}} = 7.9 \quad \text{Actual } d = 36 - 4.5 = 31.5$$

$$A_{s_{x-x}} = \frac{M}{f_s j d} = \frac{7725 \times 12}{18000 \times .884 \times 31.5} = 0.17 \square''$$

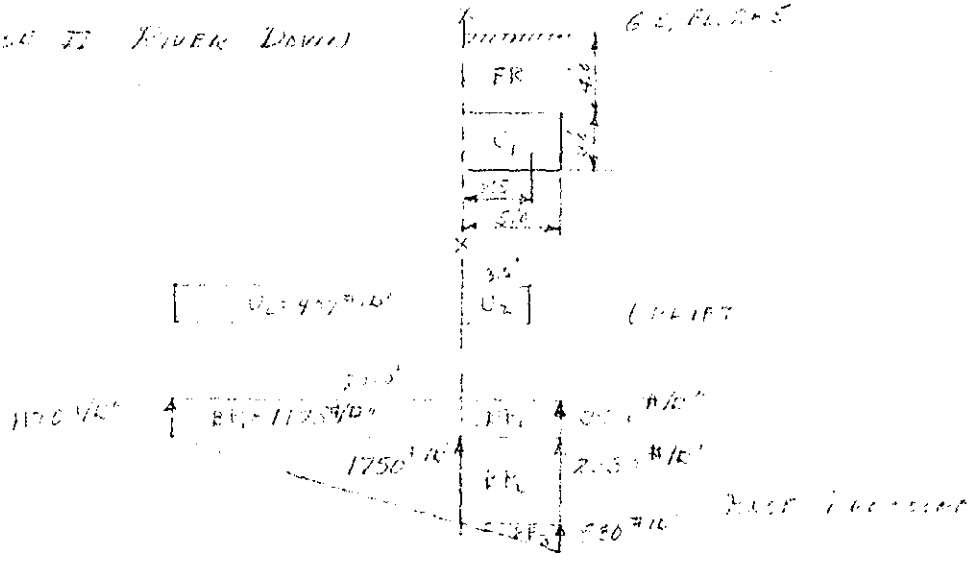
$$\text{Unit Shear}_{x-x} = \frac{V}{bjd} = \frac{3022}{[illegible] \times .884 \times 31.5} = 9.1^{\#/\square'} < 60^{\#/\square''}$$

$$\text{Bond Stress}_{x-x} = \frac{V}{\Sigma_o j d} = \frac{3022}{1.96 \times .884 \times 31.5} = 55.5^{\#/\square'} < 150^{\#/\square''}$$

Use $\frac{5}{8}$" ϕ 12" cc

Steel in Base Riverside Bottom Steel

Case II River Down



Subject: HES HARTFORD
Computation: RETAINING WALL STEM 24' BASE 20' STA. 1450±
Computed by: P.L.A. Checked by: JSM Date: 2/20/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL IN BASE CONT'D RIVERSIDE BOTTOM STEEL

CASE II RIVER DOWN

FOR MOMENTS ABOUT X-X

FORCES ACTING		↓	↑	ARM	MOMENTS ↺	MOMENTS ↻
FK	5 X 4 X 100	2000		2.5	5000	
C_1	5 X 3 X 150	2250		2.5	5630	
U_2	407 X 3.5		1430	1.75		2500
BP_1	1170 X 5.0		5850	2.5		14620
BP_2	1750 X 5.0		8750	2.5		21900
BP_3	1/2 X 580 X 5.0		1450	3.33		4830
		4250	17480		[illegible]	43850
		ΣD 13230 ↑			ΣM 33220 ↻	

$$d_{x-x} = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{33220 \times 12}{123 \times 12}} = 16.4'' \quad \text{Actual } d = 36.0 - 4.5 = 31.5''$$

$$A_{s_{x-x}} = \frac{M}{f_s j d} = \frac{33220 \times 12}{18000 \times .884 \times 31.5} = 0.80 \ \square''$$

$$\text{UNIT SHEAR}_{x-x} = \frac{V}{b j d} = \frac{13230}{12 \times .884 \times 31.5} = 39.6^{\#/\square''} < 40^{\#/\square''}$$

$$\text{BOND STRESS}_{x-x} = \frac{V}{\Sigma_o j d} = \frac{13230}{4.0 \times .884 \times 31.5} = 119^{\#/\square''} < 150^{\#/\square''}$$

USE 1" □ @ 12 cc

WAR DEPARTMENT

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

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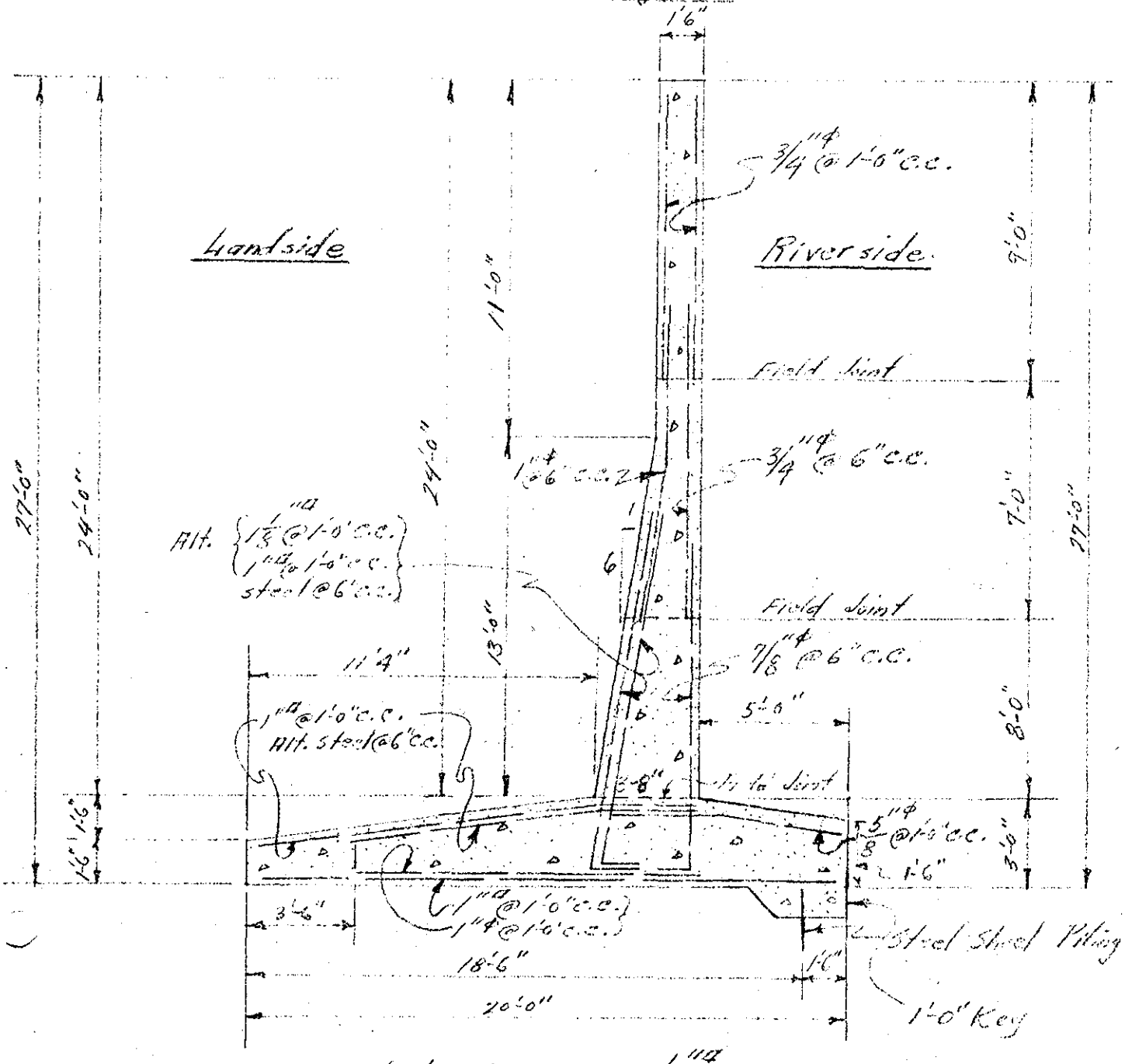
Subject Hartford, Conn. Flood Wall, Ht-5

Computation 24'-0" Wall @ Sta. 1+50 ±

Computed by R.L.A. Checked by JJM Date 2/24/40

U. S. GOVERNMENT PRINTING OFFICE 3—10328

Final Section as Designed



All longitudinal Steel: 1/2"□ @ 1'-0" c.c.

WAR DEPARTMENT

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

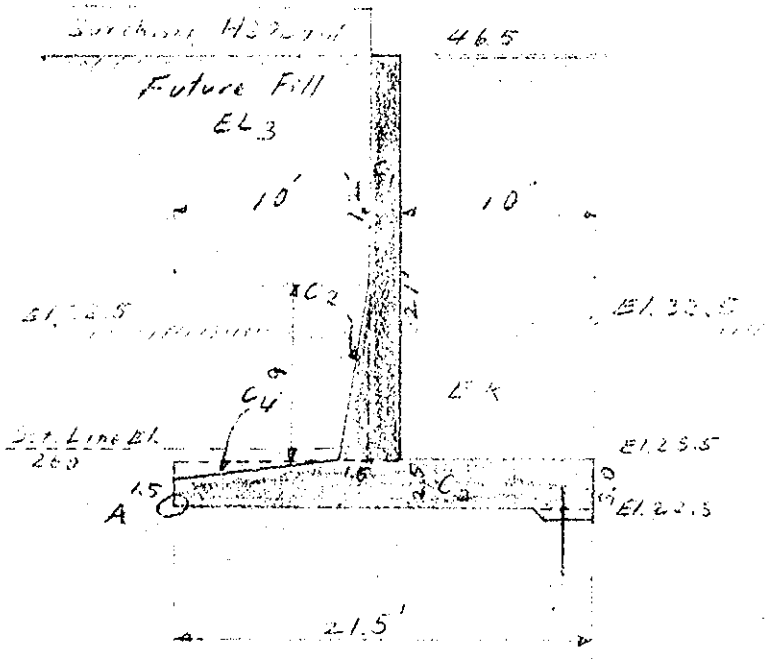
bject Ht 5 Hartford [illegible]

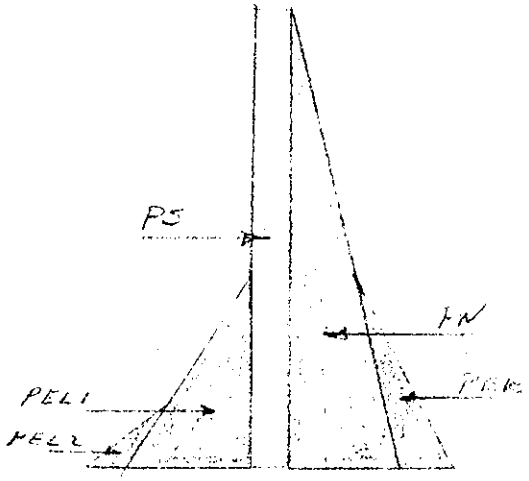
omputation Retaining wall 21' Stem, 21'-6" Base

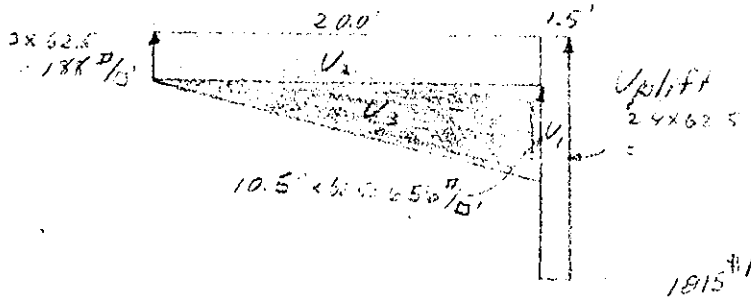
omputed by RW Checked by [illegible] Date 2 [illegible]

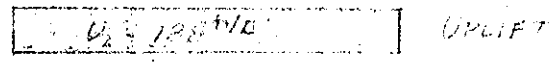
U. S. GOVERNMENT PRINTING OFFICE 3—10528

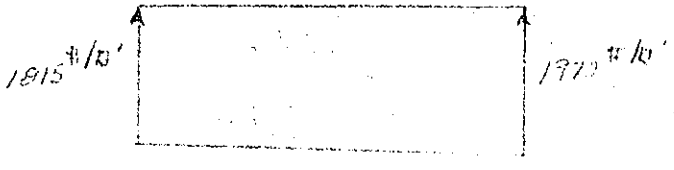
Stability



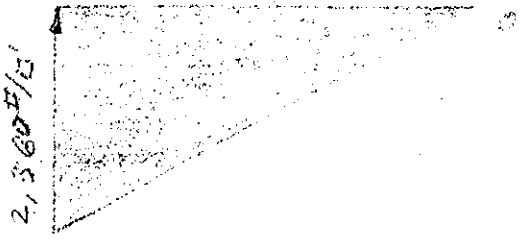








BASE PRESSURES



CASE II RIVER UP

CASE I
RIVER DOWN AND SURCHARGE

WAR DEPARTMENT

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

Subject: Ht 5 Hartford

Computation: Retaining Flood Wall 21 [illegible] Sta 1+63 to 3+63±

Computed by: KW Checked by: [illegible] Date: 2-16-60

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability Case I (Water Down, Full Back fill)

Forces Acting		↓	↑	→	←		Moments about A	
C_1	1.5 × 21 × 150	4720				10.50	49 600	
C_2	9 × 1.5 × ½ × 150	1010				9.5	9 600	
C_3	21.5 × 2.5 × 150	8070				10.75	86 700	
C_4	8.5 × 1 × ½ × 25		110			2.8		310
C_5	0.5 × 2.75 × 150	210				20.1	4 220	
EL1	$\left(\frac{9.7+8.6}{2}\right)$ × 6.5 × 100	5950				4.6	27 400	
EL2	.5 × 8.5 × 125	530				4.3	2 280	
EL3	10 × 14 × 100	14 000				5	70 000	
ER	10 × 7 × 100	7000				16.5	115 600	
V_2	3 × 20 × 62.5		3750			10		37 500
PEL1	24^2 × 35 × ½			10100		7.5	75 700	
PEL2	3.5^2 × 45 × ½			280		0.7	200	
PS	3 × 35 × 24			2520		11.5	29 [illegible]	
PER	10^2 × ½ × 35				1750	2.83		4950
S	3 × 10 × 100	3000				5	15 000	
FR	0.45 × 40630				18300	—		
		44,490	3860	12900	20050		485,300	42760
		ΣV = 40630		ΣH = 0			ΣM 442,540	

Position of Resultant

$$\frac{\Sigma M}{\Sigma V} = \frac{442540}{40630} = 10.9'$$

$\frac{2}{3}$ base = 14.33'

e = 10.9 − 10.25 = 0.15'

Base Pressure

$$\frac{40630}{21.5}\left(1 \pm \frac{6 \times .15}{21.5}\right) = 1890 \begin{cases} 1.04 \\ 0.96 \end{cases}$$

1970 #/□' [illegible]

1815 #/□' [illegible]

WAR DEPARTMENT

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

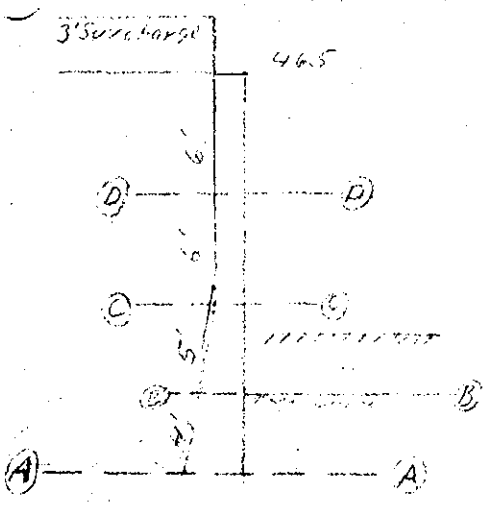
Subject Hl 5 Hartford

Computation Retaining Wall, 21' Span, 41.6' Bay — Sta 21+00 - 22+00 ℄

Computed by [illegible] Checked by [illegible] Date 2-14-[illegible]

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stem in Span — Case I — With Down Pressure in Top
Land Side



Section A-A d = 21.2"

Forces		→	←	Moments	
PS	3×33×21	2210		×10.5 =	23200
PEL1	21²×.5×.35	77[illegible]		×7 =	53900
PEL2	.5²×½×.45	5		×0.2	
PER	7²×½×.35		300	×1.33 =	370
		1915	300		
Σ =		1615		ΣM =	76,730

d required = $\sqrt{\frac{76\,730}{129}}$ = 24.6" 33" provided

$A_s = \frac{76730 \times 12}{18000 \times .884 \times 33}$ = 1.76 □"

1" □ & 1" ϕ @ 12" c.c. Lower 6" Square

Section B-B Depth 17'

Forces		→	Moments	
PS	3×33×17	1683	×8.5 =	15140
PEL1	17²×½×.35	505	×5.66 =	2860
		6830	ΣM =	43,740
PER	3²×½×.35	[illegible]	×1.[illegible]	[illegible]

$A_s = \frac{43740 \times 12}{18000 \times .884 \times 25}$ = 1.32 □"

1" ϕ & 7/8" ϕ @ 12" c.c. Alternate (or 1⅛" ϕ @ 12" c.c.)

Section C-C Depth 12'

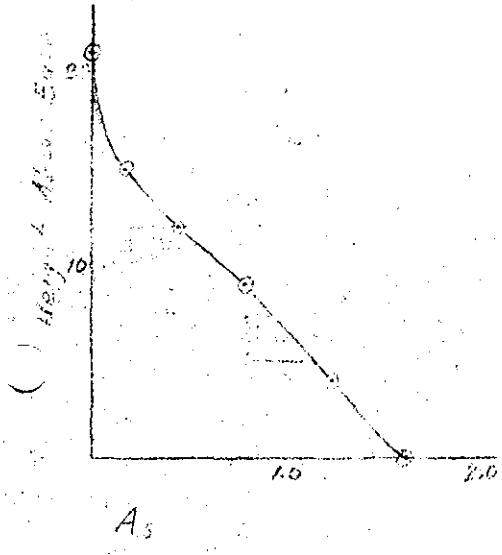
		→		
PS	3×33×12	1200	×6 =	7560
PEL	12²×.35×½	250	×4 =	1080
		1450		17640

$A_s = \frac{17640 \times 12}{18000 \times .884 \times 15}$ = .87 □"

3/4" ϕ & 7/8" ϕ @ 12" c.c. Alternate (or 1" ϕ @ 12" c.c.)

Section D-D Depth 6'

PS	3×33×6	600	×3 =	1800
PEL	6²×.35×½	50	×2 =	1250
				3150



$A_s = \frac{3150 \times 12}{18000 \times .884 \times 15}$ = .157 □"

WAR DEPARTMENT

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

Subject: H.T.E. Hoff Land

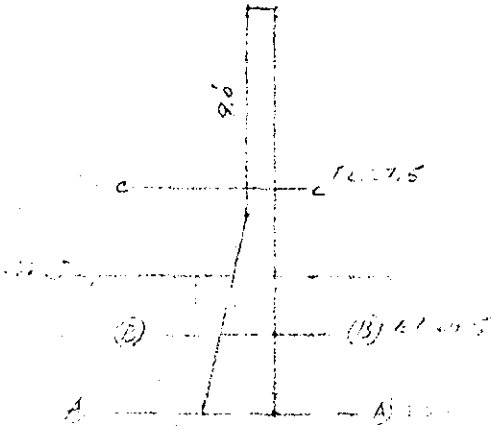
Computation: [illegible]

Computed by: R.W. Checked by: Date: [illegible]

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Reinforcing Steel

Steel to Stem, River side,
Case II is critical case - Water up, backfill to El 32.5



Section A-A El. 25.5 Depth 21'

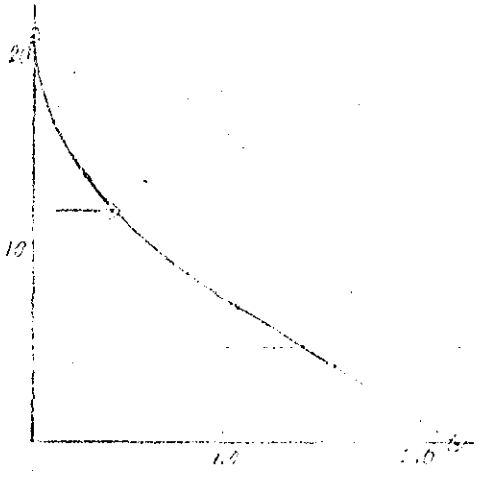
Forces		→	←	Moments	
PSL	$70^2 \times 35 \times \frac{1}{2}$	860		×2.5 =	2300
PAL	$0.5^2 \times 45 \times \frac{1}{2}$	5		×0.2 =	
PSR	$7^2 \times 17.5 \times \frac{1}{2}$		430	×2.33 =	1000
PW	$21^2 \times \frac{1}{2} \times 62.5$		3800	×7 =	96600
		865	4230		
		ΣH = 13260	←	ΣM =	95,600

$$A_s = \frac{95,450 \times 12}{18,000 \times .884 \times 33} = 2.16 \text{ □"}$$

Use 1" ⌀ @ 1½" ⌀ @ 12" c.c. $A_s = 2.26$ □"

Section B-B El. 23.5 Depth 17'

Forces		→	←	Moments	
PSL	$3^2 \times 35 \times \frac{1}{2}$	157		×1 =	160
PW	$17^2 \times 62.5 \times \frac{1}{2}$		9000	×5.66 =	51,000
PSR	$3^2 \times 17.5 \times \frac{1}{2}$		80	×1 =	80
				ΣM =	50,920 ft-lb



$$A_s = \frac{50,920 \times 12}{18,000 \times .884 \times 25} = 1.54 \text{ □"}$$

Use 1" ⌀ @ 6" c.c.

Moments About C-C

PW	$1 \times 62.5 \times 9.0^2$		2500	×3.00 =	7600 ft-lb

$$A_s = \frac{7600 \times 12}{18000 \times .884 \times 14.5} = 0.40 \text{ □"}$$

Use ¾" ⌀ @ 12" c.c.

WAR DEPARTMENT

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

Subject: Ht 5 Hartford

Computation: 21' Stem, 21' 6" Base Stg 3450 ±

Computed by: KW Checked by: [illegible] Date: 2-16-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability Case II (Water Up Backfill to El 32.5)

Forces		↓	↑	→	←	Arm	Moments about 'A'	
C_1	1.5 × 21 × 150	4720				10.50	49600	
C_2	9 × 1.5 × ½ × 150	1010				9.5	9600	
C_3	21.5 × 2.5 × 150	8070				10.75	86700	
C_4	[illegible] × 1 × ½ × [illegible]		110			2.8		310
C_5	0.5 × 2.75 × 150	210				20.1	4220	
EL1	(17 + 8.6)/2 × 6.5 × 100	5950				4.6	27400	
EL2	.5 × 8.5 × 125	530				4.3	2280	
ER	10 × 7 × 125	8750				16.5	144500	
W	10 × 14 × 62.5	8750				16.5	144500	
U_1	24 × 1.5 × 62.5		2250			20.75		46700
U_2	3 × 20 × 62.5		3750			10		37500
U_3	10.5 × 20 × ½ × 62.5		6560			13.3		87500
PEL1	15² × 35 × ½			1750		2.8	4950	
PEL2	5.5² × [illegible] × ½			280		0.7	200	
PW	24² × ½ × 62.5				18,000	7.5		135,000
PER	10² × ½ × 17.5				875	2.8		2490
FK	0.45 × 25,320			11,400		—		
PK				5445		2.8	15750	
		37990	12670	18875	18875		489700	309500
		ΣV = 25320		ΣH = 0			ΣM 180200	

Position of Resultant

$\frac{\Sigma M}{\Sigma V} = \frac{180200}{25320} = 7.14$

$\frac{1}{3}$ base = 7.17'

$E = 10.75 - 7.14 = 3.61'$

Base Pressure

$\frac{25320}{71.4} = 1180 (2) = 2360$ #□'

0 #/□'

WAR DEPARTMENT

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

Subject Ht 5

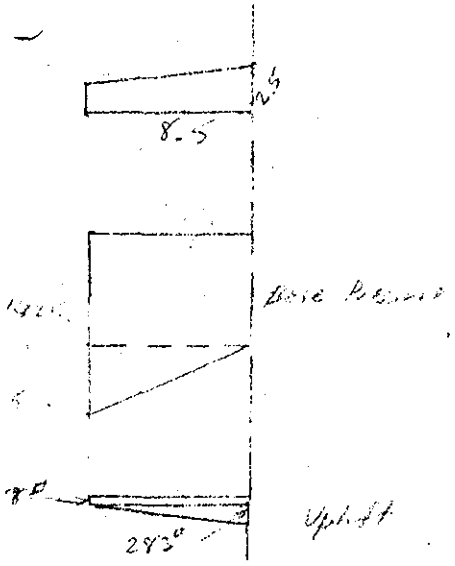
Computation Wall 21' Stem 21'-6" Base Sta 1+63 to 3+63±

Computed by R.W. Checked by JAC Date 3-8-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in Base, Land Side River Up

BACKFILL TO EL. 32.5



EL	8.5 × 7 × 100	5950		4.25 = 25,300 ↓
C_1	2.5 × 8.5 × 150	3190		4.25 = 13,560 ↓
C_2	1.0 × 8.5 × ½ × 25		106	5.7 = 600 ↓
U_2	181 × 8.5		1600	4.25 = 6800 ↓
U_3	283 × ½ × 8.5		1200	2.8 = 3350 ↓
BP_1	14.25 × 8.5		12100	4.25 = 51400 ↓
BP_2	935 × ½ × 8.5		3970	5.7 = 22700 ↓
				46,000

ΣM = 36,000 '# ↓

46,000 1.31

$A_s = \frac{36,000 \times 12}{18,000 \times .884 \times 26.5} = 1.03$ □" bottom

Use 7/8" ϕ @ 3/4" ϕ @ 12" St. × 6"

1" ϕ

Land Side, River Down with Surcharge

		↓	↑	
EL		5950		× 4.25 = 25,300 ↓
EL 3	14 × 8.5 × 100	11900		4.25 = 50,700 ↓
S	200 × 8.5	2550		4.25 = 10,850 ↓
C_1		3190		× 4.25 = 13,560 ↓
C_2			106	5.7 = 600 ↓
U_2			1600	× 4.25 = 6800 ↓
BP_1	1875 × 8		15,450	× 4.25 = 65,700 ↓
BP_2	50 × ½ × 8.5		210	5.7 = 1200 ↓

ΣM = 26,110 ↓

$A_s = \frac{26,110 \times 12}{18,000 \times .884 \times 26.5} = .75$ □" Top Steel

Use: 1" ϕ @ 12" c.c. St. × 6"

WAR DEPARTMENT

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

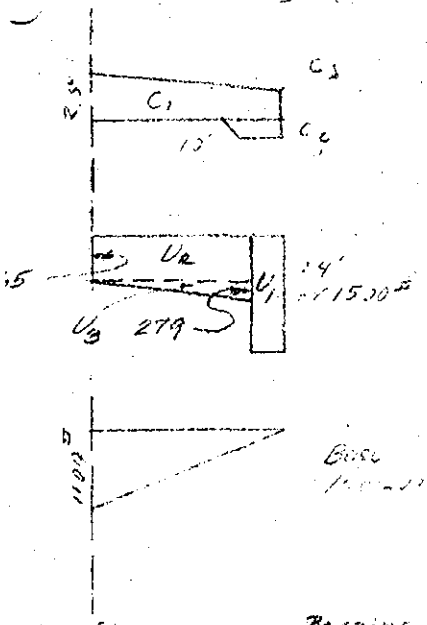
Subject: H+5 Hartford — Sta. 1+63 to 3+63±

Computation: 21' Stem 21'6" Base

Computed by: RW — Checked by: JAC — Date: 3-8-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in Base, River Side — River Up



W	14 x 10 x 62.5	8750		x 5 =	43,750
E	7 x 10 x 125	8750		x 5 =	43,750
C_1	2.5 x 10 x 150	3750		x 5 =	18,760
C_2	1 x 3 x 150	450		x 8.6 =	3,870
C_3	1 x 10 x 25		250	x 6.67 =	1,670
U_1	1500 x 1.5		2250	x 9.25 =	20,800
U_2	565 x 8.5		4800	x 4.25 =	20,400
U_3	½ x 279 x 8.5		1185	x 5.7 =	6,750
BP	1100 x ½ x 10		3500	x 3.33 =	18,350
				ΣM	42,160 ft

d required $= \sqrt{\frac{42,160}{123}} = 18\frac{1}{2}$" O.K. 26.5" provided

$A_s = \frac{42,160 \times 12}{18000 \times .884 \times 26.5} = 1.20$ □"

Use 1"φ @ 7/8"φ @ 12" c.c. Leaving 6" Spacing

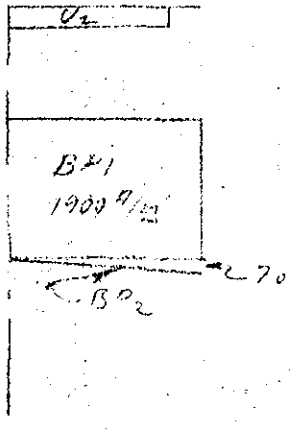
Top Steel

Uplift: $\frac{656}{20} = 32.8$/ft × 8.5 = 279

656 + 188 = 848 − 279 = 565

Bearing: $\frac{2860}{21.5} = 110$ × 10 = 1100

Steel in Base River Side — River Down



	Forces			Moments	
E	7 x 10 x 100	7000		x 5 =	35,000
C_1		3750		x 5 =	43,750
C_2		450		x 8.6 =	3,870
C_3	1 x 10 x 50		500	x 6.67 =	3,330
U_2	188 x 8.5		1600	x 4.25 =	6,800
BP_1	1900 x 10		19000	x 5 =	95,000
BP_2	70 x ½ x 10		350	x 6.67 =	2,330
				ΣM =	24,840

$A_s = \frac{24,840 \times 12}{18,000 \times .884 \times 26.5} = 0.71$ □"

Use 3/4"φ @ 12" c.c. } Alt.
5/8"φ @ 12" c.c. }

Bottom Steel

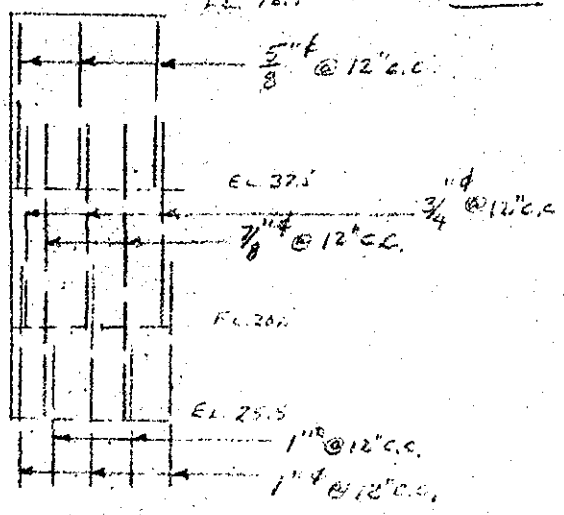
$A_s = 0.75$ □"

Subject: HARTFORD HTS
Computation: CANTILEVER WALL STEM 21' BASE 21.5' STA. 1+63± TO 3+63±
Computed by: PLA Checked by: ____ Date: 3/12/40

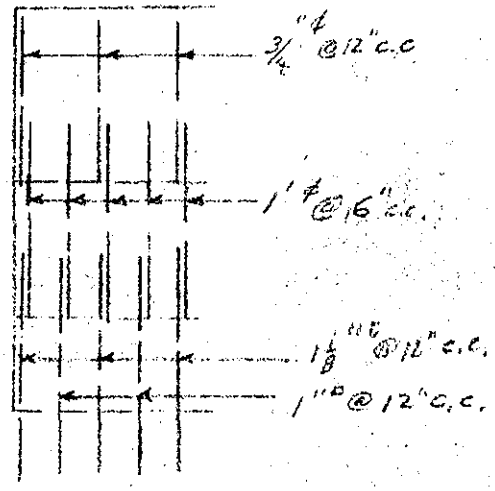
U.S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL REINF.
ARRANGEMENT OF STEEL

STEM

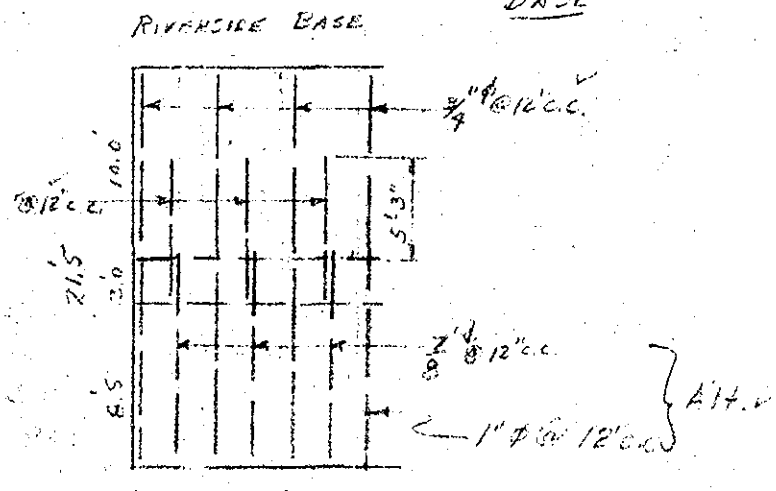


LANDSIDE FACE



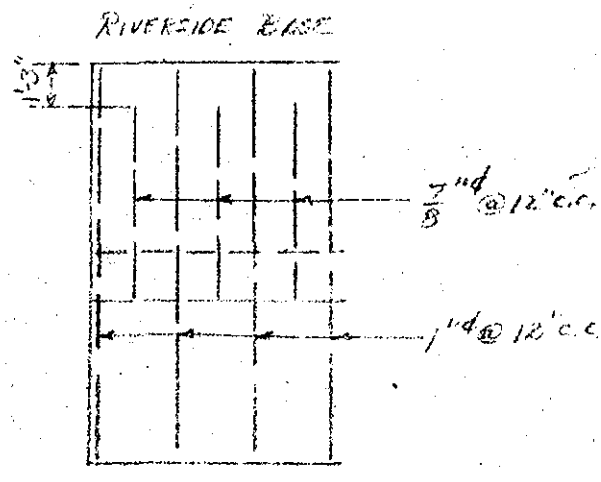
RIVERSIDE FACE

BASE



LANDSIDE BASE

BOTTOM STEEL



LANDSIDE BASE

TOP STEEL

WAR DEPARTMENT

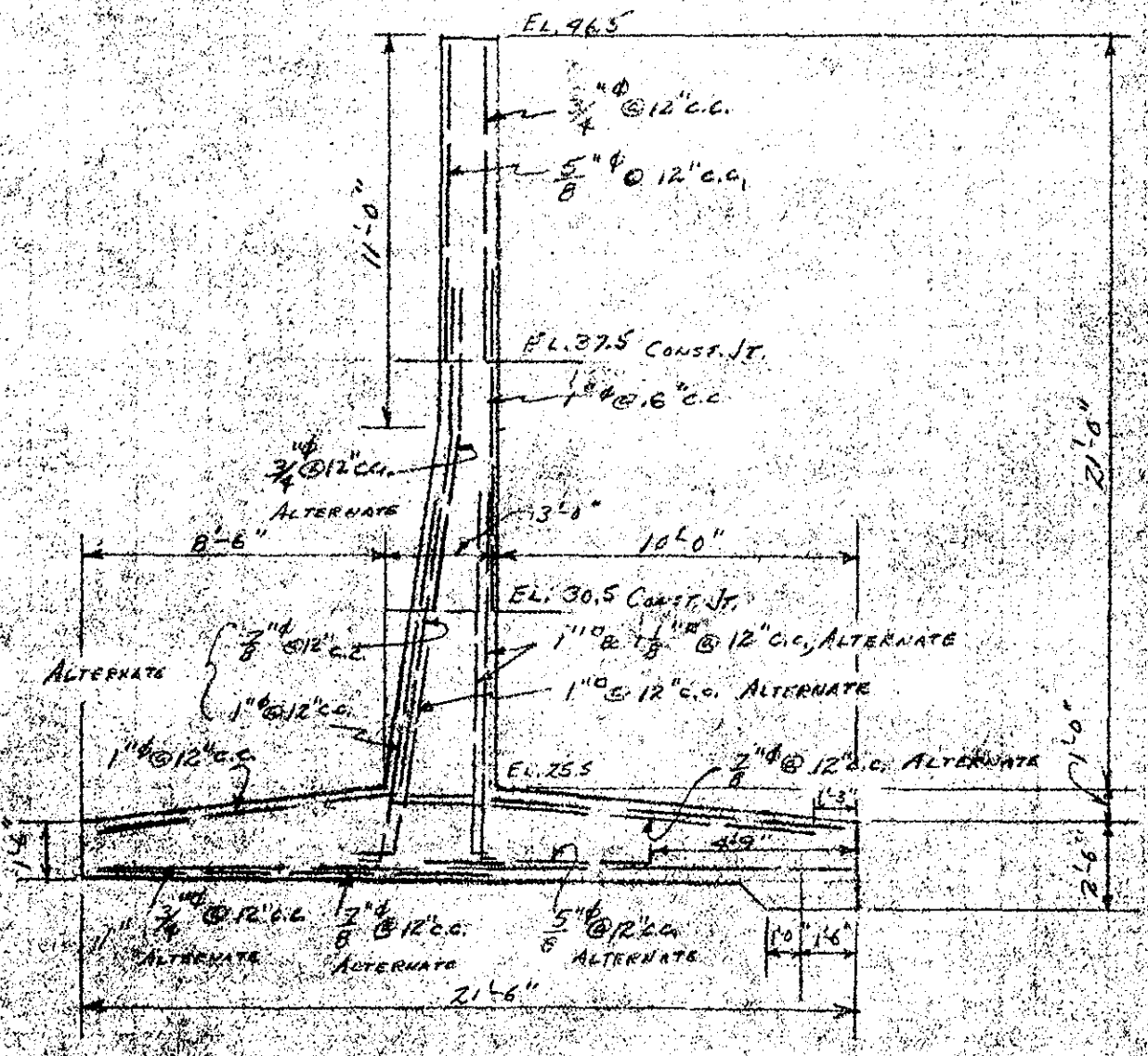
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: HARTFORD HES

Computation: CANTILEVER WALL STEM 21' BASE 21.5' STA. 1+63± TO 3+63±

Computed by: P.L.A. Checked by: Date: 3/16/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



TEMPERATURE STEEL TO BE PLACED LONGITUDINALLY @ 12" c.c.

WAR DEPARTMENT

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

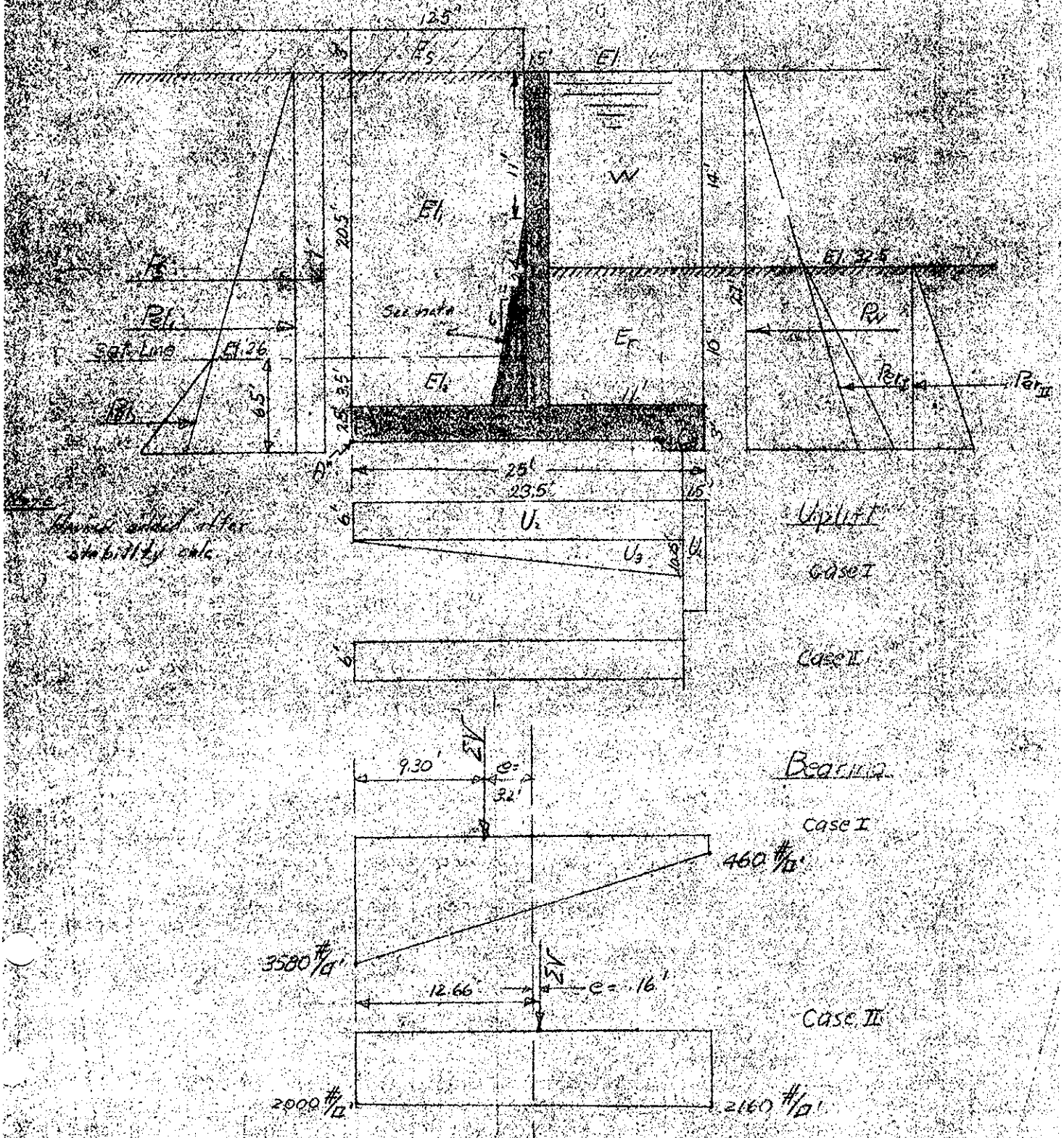
Page 66

Project Hartford - Conn (H+S)

Computation Flood and retaining wall - 24' stem, 25' base Sta 31+80±

Computed by R.H.M. Checked by W.H.F. Date 2/15/40

U. S. GOVERNMENT PRINTING OFFICE 3—10538



WAR DEPARTMENT

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

Object: Hartford - Conn (Ht-5) 3+62 - 4+02

Computation: Flood and retaining wall - 24' stem - 25' base

Computed by: R.H.M. Checked by: W.H.F. Date: 2/15/40

U. S. GOVERNMENT PRINTING OFFICE 3—10538

Case I (*) River Up Case II (**) River Down

Forces Acting		↓	↑	→	←	Arm	Moments about "A" ↻	Moments about "A" ↺
C_1	.15×24×150	5400				13.25	71550	
C_2	2.5×25×150	9380				12.5	117250	
C_3	.5×2.75×150	210				23.62	4960	
E_s	3×100×12.5	3750				6.25	23440**	
E_1	20.5×100×12.5	25630				6.25	160,190	
E_2	3.5×125×12.5	5470				6.25	34190	
W	14×62.5×11	9630				19.5	187790 *	
E_{rI}	10×125×11	13750				19.5	268130 *	
E_{rII}	10×100×11	11000				19.5	214500**	
U_1	27×62.5×1.5		2530			24.25		61350*
U_2	6×62.5×23.5		8810			11.75		103520
U_3	10.25×62.5×23.5×½		7530			15.66		117920*
P_s	3×35×27			2840		13.0	36920**	
P_{e1}	27²×½×35			12760		8.5	108460	
P_{e2}	6.5²×½×45			950		1.67	1590	
P_w	27²×½×62.5				22780	8.5		193630*
P_{rI}	13²×½×17.5				1480	3.83		5670*
P_{rII}	13²×½×35				2960	3.83		11340**
Case I		69470	18870	13710	24260		954110	483360
		ΣV = 50600 #↓		ΣH = 10550 #←			ΣM = 470,750 '#↻	
Case II		60840	8810	16570	2960		773310	114860
		ΣV = 52030 #↓		ΣH = 13610 #→			ΣM = 658450 '#↻	

Case I: $\frac{\Sigma M}{\Sigma V} = \frac{470750}{50600} = 9.30'$ $\frac{1}{3}$ Base = 8.33' ok e = 12.5 - 9.3 = 3.2'

$BP = \frac{50600}{25}\left(1 \pm \frac{6\times 3.2}{25}\right) = 2020 \begin{cases} 1.77 = 3580 \ \#/\square' & \text{P.B.L.} \\ 0.23 = 460 \ \#/\square' & \text{P.B.R.} \end{cases}$

0.45 × 50600 = 22700# > 10550# ok against sliding

Case II: $\frac{\Sigma M}{\Sigma V} = \frac{658450}{52030} = 12.66'$ $\frac{1}{3}$ Base = 16.66' ok e = 12.66 - 12.50 = .16'

$BP = \frac{52030}{25}\left(1 \pm \frac{6\times .16}{25}\right) = 2080 \begin{cases} 1.04 = 2160 \ \#/\square' & \text{P.B.R.} \\ .96 = 2000 \ \#/\square' & \text{P.B.L.} \end{cases}$

0.45 × 52030 = 23410# > 13610# ok against sliding

Project: Hartford - Conn (Ht-5)
Computation: Flood and retaining wall 24' stem - 25' base
Computed by: R.H.M. Checked by: W.H.F. Date: 2/15/40

U. S. GOVERNMENT PRINTING OFFICE 3—10526

Case III - Landside Earth Fill at El 32.5

P_{e1} becomes $13^2 \times \frac{1}{2} \times 35 = 2960 \times 3.83 = 11340$ '#

Change in ΣM due to smaller P_{e1} = 108460 - 11340 = 97120 '#

" " " " " " E_1 = 12.5 X 14 X 100 = 17500 X 6.25 = 109380 '#

" " ΣV " " " " = 17500 #

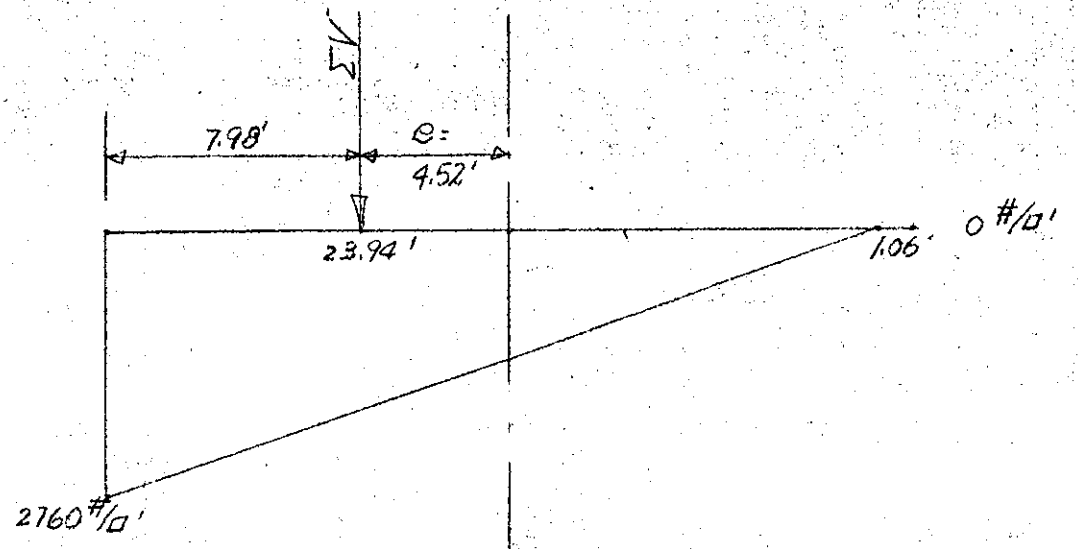
ΣM = 470,750 (From Case I) - 97120 - 109380 = 264250 '#

ΣV = 50600 (" ") - 17500 = 33100 #

$\frac{\Sigma M}{\Sigma V} = \frac{264250}{33100} = 7.98'$ $\frac{1}{3}$ Base = 8.33' .35' outside but ok

e = 12.5 - 7.98' = 4.52'

$B.P. = \frac{33100}{3 \times 7.98} \begin{pmatrix} 2 \\ 0 \end{pmatrix} = 1380 \begin{cases} 2.0 = 2760 \ \#/\square' & \text{P.B.L} \\ 0 = 0 \ \#/\square' & \text{P.B.R} \end{cases}$



WAR DEPARTMENT

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

bject Hartford, Conn. — Ht 5 — Flood and Retaining Wall

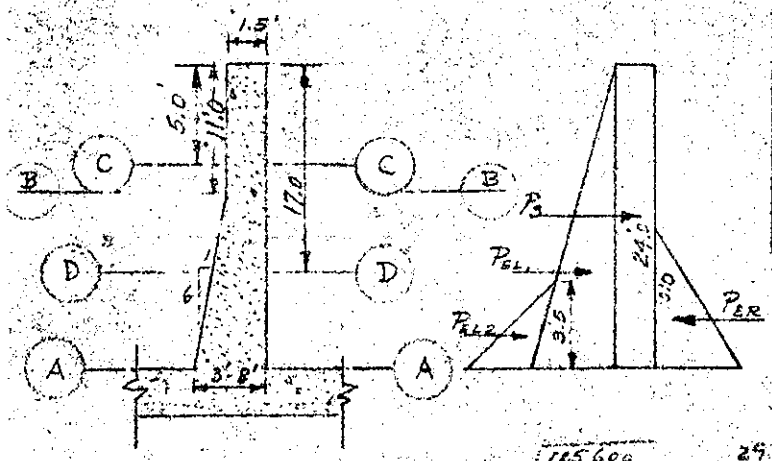
omputation Steel in Stem at Sta. 3+80 ± ..... 24' Stem, 25 Base

omputed by J.A.C. Checked by PLA Date 3/4/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Case II - River Down

Stem



Section A-A

Forces Acting	→	←	Arm	Moment
$P_S = 3 \times 35 \times 24$	2,520		12.0	+ 30,300
$P_{EL_1} = 24^2 \times \frac{1}{2} \times 35$	10,100		8.0	+ 80,800
$P_{EL_2} = 3.5^2 \times \frac{1}{2} \times 45$	~~2,760~~ 230		1.17	+ ~~3,230~~ 330
$P_{ER} = 10.0^2 \times \frac{1}{2} \times 35$		1,750	3.33	- 5,830
	V = ~~13,620~~ 12900 #			M = ~~108,500~~ 105600 '#

3" cover

$d = 44 - 3.5 = 40.5''$

$d_m = \sqrt{\frac{\cancel{108,500}\ 125600}{123}} = \sqrt{882} = \cancel{29.7}\ 29.2''$

Call it 30"

$A_s = \frac{12 \times \cancel{108,500}\ 105600}{18,000 \times .884 \times 40.5} = \cancel{2.03}\ 1.97\ \square''$

$\Sigma_o = \frac{\cancel{13,630}\ 12900}{150 \times .884 \times 40.5} = \cancel{2.54}\ 2.40''$

$v = \frac{\cancel{13,630}\ 12900}{12 \times .884 \times 40.5} = \cancel{32}\ 30\ \#/\square''$

Allowable Stresses

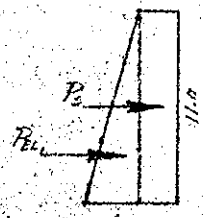
$f_s = 18,000$

$f_c = 800$

$u = 150$

$v = 60$

$K = 123$



Section B-B (Top of Haunch)

Forces Acting	→	←	Arm	Moment
$P_S = 3 \times 35 \times 11.0$	1,160		5.5	6,380
$P_{EL_1} = 11^2 \times \frac{1}{2} \times 35$	2,120		3.67	7,780
	V = 3,280 #			M = 14,160 '#

$d = 18 - 3.5 = 14.5''$

$A_s = \frac{12 \times 14,160}{18,000 \times .884 \times 14.5} = 0.74\ \square''$

$\Sigma_o = \frac{3,280}{150 \times .884 \times 14.5} = 1.71''$

$v = \frac{3,280}{12 \times .884 \times 14.5} = 21\ \#/\square''$

Section C-C

Forces Acting	→	←	Arm	Moment
$P_S = 3 \times 35 \times 5$	525		2.5	1,310
$P_{EL} = 5.0^2 \times \frac{1}{2} \times 35$	438		1.67	730
	V = 963 #			M = 2,040 '#

$A_s = \frac{12 \times 2,040}{18,000 \times .884 \times 14.5} = .11\ \square''$

$\Sigma_o = \frac{963}{150 \times .884 \times 14.5} = .50''$

$v = \frac{963}{12 \times .884 \times 14.5} = 6.3\ \#/\square''$

WAR DEPARTMENT

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

Object: HARTFORD CONN - HT 5 - FLOOD AND RETAINING WALL

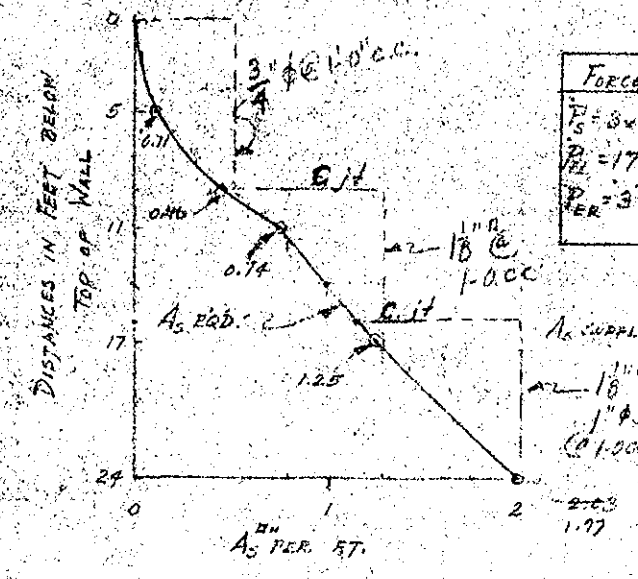
Computation: STEEL IN STEM AT STA. 3+80 + - - - - 24' STEM, 25' BASE

Computed by: T.A.C. Checked by: PLR Date: 8/4/40

U. S. GOVERNMENT PRINTING OFFICE 2—10698

CASE II - RIVER DOWN — STEM

A_s DIAGRAM



SECTION D-D

FORCES ACTING	—	—	ARM	MOMENTS
$P_S = 8 \times 35 \times 17$	1,785		8.5	+ 15,200
$P_{FL} = 17^2 \times \frac{1}{2} \times 35$	5,060		5.67	+ 28,700
$P_{ER} = 3^2 \times \frac{1}{2} \times 35$		158	1.0	- 158
	V = 6,687 #			M = 43,742 '#

$d = 30 - 3.5 = 26.5''$

$$A_s = \frac{43{,}742 \times 12}{18{,}000 \times .874 \times 26.5} = 1.25 \text{ □''}$$

$$E_c = \frac{6{,}687}{150 \times .884 \times 26.5} = 1.90''$$

$$v = \frac{6{,}687}{12 \times .884 \times 26.5} = 24 \text{ \#/□''}$$

WAR DEPARTMENT

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

Subject: Hartford, Conn. – Ht. 5 – Flood and Retaining Wall

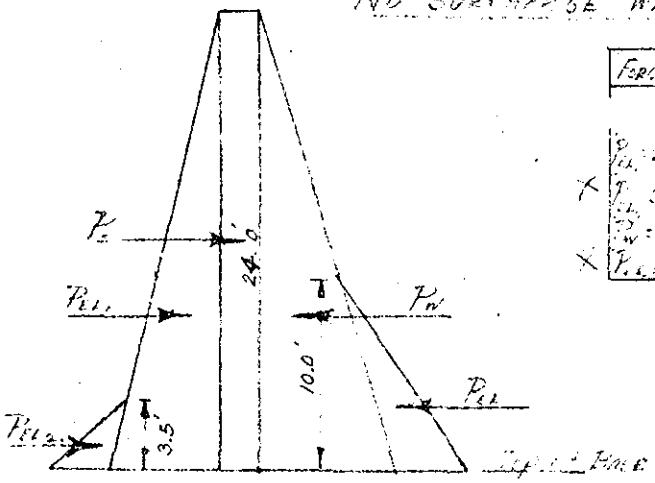
Computation: Still in Stem at Sta. 34+80 – 24' Stem, 25' Base

Computed by: J.A.C. Checked by: PLA Date: 3/4/46

U. S. GOVERNMENT PRINTING OFFICE 3—10328

Case I – River Up

No surcharge with River Up Section A'-A'



Forces Acting	→	←	Arm	Moment ↷	Moment ↶
P_{EL}: 24'×½×3.5	10,100		8.0	80,800	
P_{EL}: 3.5'×½×.45	2,760 (200)		1.17	3,240 (230)	
P_W: 24'×½×62.5		18,000	8.0		144,000
P_{EL}: 3.5'×½×.175	375	8,750	3.33	2920	29,150
	V: 8495 (12,750) # →			M: 65790 (49,120) '#	

d = 46.5"

$A_s = \frac{65800}{18,000 \times .884 \times 46.5} = 1.66^{\square''}$ (1.23)

$E_o = \frac{+3,440 \times 8500}{150 \times .884 \times 46.5} = 2.58''$ (1.58)

$v = \frac{+3,440 \times 8500}{12 \times .884 \times 46.5} = 32$ #/□" (19.8)

2.62 □" (Case III governs)

2.62

Section E'-E'

$A_s = \frac{12 \times 6,100}{18,000 \times .884 \times 14.5} = 6.32^{\square''}$

Forces Acting	→	←	Arm	Moment ↷	Moment ↶
P_{EL}: 11'×½×.35	2,120		3.67	7,780	
P_W: 11'×½×62.5		3,780	3.67		13,900
	V: 1660 →			M: 6,120 '# ↷	

Section D'-D'

$A_s = \frac{12 \times 22,700}{18,000 \times .884 \times 26.5} = 6.65^{\square''}$

$E_o = \frac{4070 \times 4,193}{150 \times .884 \times 26.5} = 1.80''$ (1.16)

$v = \frac{4070 \times 4,193}{12 \times .884 \times 26.5} = 15$ #/□" (11)

Forces Acting	→	←	Arm	Moment ↷	Moment ↶
P_{EL}: 17'×½×.35	5,060		5.67	28,700	
P_W: 17'×½×62.5		9,050	5.67		51,300
P_{EL}: 3'×½×.175		80 (803)	1.0		80 (803)
	V: 4070 (4,193) # →			M: 22,890 (22,803) '# ↷	

d = 26.5"

WAR DEPARTMENT

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

Subject: Hartford, Conn. - Ht. 5 - Flood and Retaining Wall

Computation: Steel in Stem at Sta. 3+80 ± ... 24' Stem, 25' Base

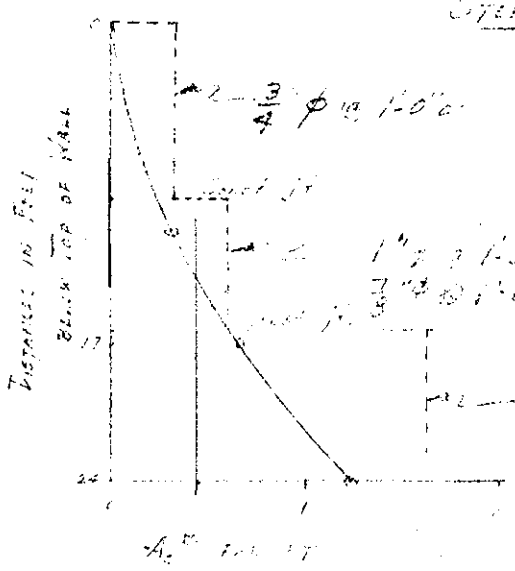
Computed by: J.A.C. Checked by: PLA Date: 3/4/46

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case I - River Up

Stem

Steel in Riverside Face



$\frac{3}{4}$" φ @ 1'-0" c.c.

1" φ @ 1'-0" c.c. } Alt
$\frac{7}{8}$" φ @ 1'-0" c.c. }

$1\frac{1}{4}$" φ @ 1'-0" c.c. } Alt. A_s = 1.00 OK
$1\frac{1}{8}$" φ @ 1'-0" c.c. }

The steel as shown is req'd because governing case is where landside backfill is to Elev. 32.5.

WAR DEPARTMENT

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

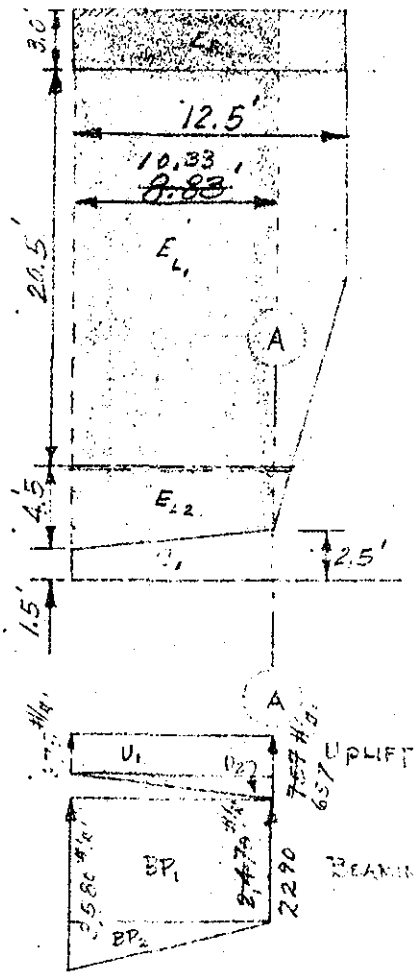
bject: Hartford, Conn. - Ht. 5 - Flood and Retaining Wall

omputation: Steel in Heel Slab at Sta 3+80+ - - - - 24' Stem, 25' Base

omputed by: J.A.C. Checked by: [illegible] Date: 3/4/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case I - River Up. Heel Slab

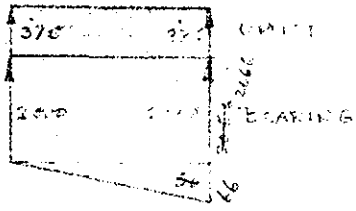


3580
-460
3,120 ÷ 25 = 125 #/□'

10.33
~~8.83~~ × 125 = 1290
~~1,110~~

3,580 - 1290 = ~~2,470~~ 7290

Case II



Case I - Section A-A

Forces Acting	↓	↑	Arm	Moment ↷	Moment ↶
$E_S = 3 \times 100 \times$ ~~8.83~~ 10.33	3100 ~~2,650~~		~~4.41~~	5.17	16000 ~~11,700~~
$E_{L_1} = 20.5 \times$ ~~8.83~~ 10.33 $\times 100$	21200 ~~18,100~~		~~4.41~~	5.17	110000 ~~79,900~~
$E_{L_2} = \frac{1}{2}(3.5+4.5)$ ~~8.83~~ 10.33 (125)	5160 ~~4,415~~		~~4.60~~	5.4	27900 ~~20,300~~
$C_1 = \frac{1}{2}(1.5+2.5)$ ~~8.83~~ 10.33 (150)	3100 ~~2,650~~		~~4.16~~	4.7	14600 ~~11,000~~
$BP_1 =$ ~~2470~~ 2290 $\times$ ~~8.83~~ 10.33 $\times 1$		23700 ~~21,800~~	5.17 ~~4.41~~	123000 ~~96,000~~	
$BP_2 = \frac{1}{2} \times$ ~~1110~~ 1290 $\times$ ~~8.83~~ 10.33 $\times 1$		6660 ~~4,700~~	6.89 ~~5.89~~	~~28,900~~	46000
$U_1 = 375 \times$ ~~8.83~~ 10.33 $\times 1$		3880 ~~3,310~~	5.17 ~~4.41~~	~~14,600~~	20100
$U_2 = \frac{1}{2} \times$ ~~8.83~~ 10.33 $\times$ ~~342~~ 282 $\times 1$		1460 ~~1,740~~	5.44 ~~4.94~~	~~5,120~~	5020
	V = ~~3,935~~ 3140 # ↑			M = ~~21,720~~ 25620 '# ↷	

4 3" cover

$d = 30 - \frac{4.5}{\cancel{3.5}} = 25.5''$

$A_s = \frac{12 \times \cancel{21,720}\ 25620}{18,000 \times .884 \times 25.5} = \cancel{0.62}\ 0.76$ □"

~~Use 7/8" φ @ 1'-0" cc~~

$\Sigma_0 = \frac{\cancel{3,935}\ 3140}{150 \times .884 \times 25.5} = \cancel{1.12}\ 0.93''$

Bott. Face

$v = \frac{\cancel{3,935}\ 3140}{12 \times .884 \times 25.5} = \cancel{14}\ 12$ #/□"

Case II - Section A-A

Forces Acting	↓	↑	Arm	Moment ↷	Moment ↶
E_S	3100 ~~2,650~~		~~4.41~~		16000 ~~11,700~~
E_{L_1}	21200 ~~18,100~~		~~4.41~~	5.17	110000 ~~79,900~~
E_{L_2}	5160 ~~4,415~~		~~4.60~~	5.4	27,900 ~~20,300~~
C_1	3100 ~~2,650~~		~~4.16~~	4.7	14600 ~~11,000~~
$BP_1 = 2000 \times$ ~~8.83~~ 10.33		20660 ~~17,660~~	5.17 ~~4.41~~	107000 ~~78,000~~	
$BP_2 = \frac{1}{2} \times$ ~~32~~ 66 $\times$ ~~8.83~~ 10.33		340 ~~248~~	5.44 ~~4.94~~	1170 ~~720~~	
$U_1 = 375 \times$ ~~8.83~~ 10.33		3880 ~~3,310~~	5.17 ~~4.41~~	20100 ~~14,600~~	
	V = ~~6,597~~ 7680 # ↓			M = ~~29,570~~ 40230 '# ↶	

3" cover

$A_s = \frac{12 \times \cancel{29,570}\ 40230}{18,000 \times .884 \times 26.5} = \cancel{0.84}\ 1.15$ □"

~~Use 1" φ @ 1'-0" cc~~

$\Sigma_0 = \frac{\cancel{6,597}\ 7680}{150 \times .884 \times 26.5} = \cancel{1.88}\ 2.18''$

Top Face

$v = \frac{\cancel{6,597}\ 7680}{12 \times .884 \times 26.5} = \cancel{24}\ 27$ #/□"

WAR DEPARTMENT

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

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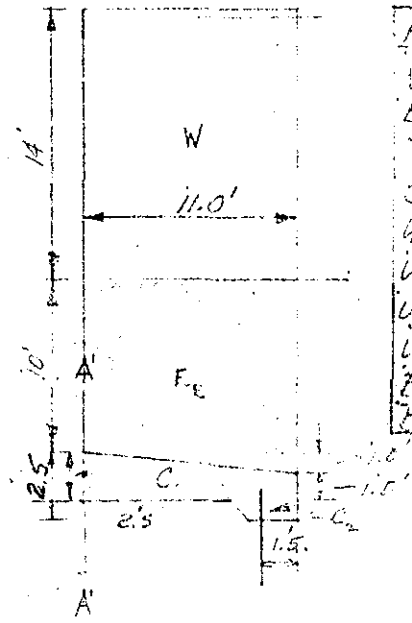
Subject: Hartford, Conn. - H.E.E. - Floor and Retaining Wall

Computation: Steel in Top Slab at Sta 3+86.2 - 24' Steel 25' Base

Computed by: J.A.C. Checked by: H.K. Date: 3/5/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



Case I - Retaining Wall

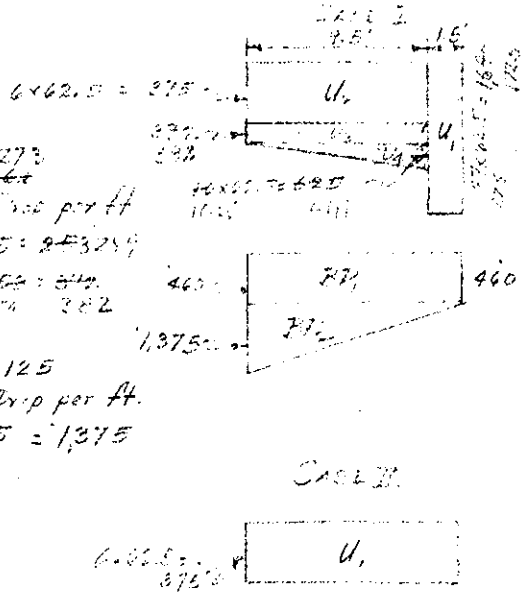
Force Factors					
W = 11×14×62.5	9,050		5.5		53,000
F_c = ½(26+11)11×125	14450		5.63		81,400
C_1 = ½(26-2.5)11×150	3,300		5.03		16,500
C_2 = ½(2.5+1.5)2×150	207		9.5		1,970
U_1 = 37×62.5×15		2,530	11.5		
U_2 = 6×62.5×9.5		3,500	4.75		16,900
U_3 = 37×9.5		2,550	4.75		12,200
U_4 = ½×25×9.5		1,200	6.33		7,650
P_1 = 400×11		5,500	5.5		24,200
P_2 = ½×1375×11		7,550	8.17		62,000
		4220	5.67		32,110
	V = 4,157			M = 37,775	

$d = 30 - \frac{2.5}{2} - 2.5 = 26.5$ (Thickness to 31.5 see below)

$A_s = \frac{12 \times 37,775 - 32,110}{12{,}000 \times .884 \times 31.5}$ = 1.08 in² Use 1 1/8" @ 1'-0" c.c. Top Face

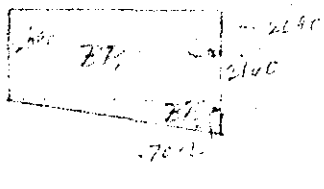
$S_o = \frac{4,157 - 4220}{150 \times .884 \times 31.5}$ = 1.01 in

$v = \frac{4220 - 4,157}{12 \times .884 \times 31.5}$ = 12.3 #/in²



Case II - Tower Loads

Force Factors					
F_c = ½(26+11)11×125	11,550		5.57		65000
C_1 =	3,300		5.03		16,500
C_2 =	207		9.5		1,970
U_1 =		3,560	4.75		16,900
P_1 = 2.06×11		23,100	5.5		126,500
P_2 = ½×70×11		1,375	7.33		10,100
		11645			60450
	V = 11,717			M = 62,250	



$\frac{P_1}{2.6}$ = 6.4 Trip per ft

6.4×11 = 70

$A_s = \frac{12 \times 62{,}250 - 60450}{12{,}000 \times .884 \times 31.5}$ = 1.46 in² Use 1" & 1/2" staggered @ 6" c.c. Bottom Face

$S_o = \frac{11645 - 11717}{150 \times .884 \times 26.5}$ = 2.8 in

$v = \frac{11645 - 11717}{12 \times .884 \times 31.5}$ = 34.8 #/in²

Subject: HARTFORD, CONN. — HT. 5
Computation: STEEL IN TOE SLAB AT STA. 3+92 — 24' STEEL — 25' PLACE
Computed by: J.A.C. Checked by: H.A. Date: 3/12/40

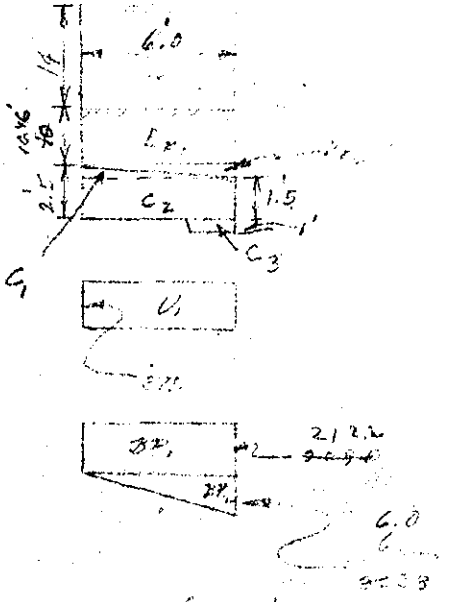
U. S. GOVERNMENT PRINTING OFFICE 3—10523

TOE SLAB

SECTION 6'-0" FROM RIVERSIDE EDGE OF FOOTING

CASE II — RIVER DOWN

Dry fill



FORCE ARTICLE	↓	↑	ARM	↻	↺
C_3 3×1×150	450		4.5	2030	
E_D: 6×~~11~~ 10.46×100	6,~~244~~ 6200		3.0	18,~~840~~ 840	
E_B: ½×6×.54×100	162		4.0	648	
C_1: ½×6×.54×150	243		2.0	486	
C_2 6×1.5×150	1,350		3.0	4,050	
U_1 375×6		2,250			6,750
BP_1: ~~2640~~ 2122×6		12,~~840~~ 12,730			27,~~660~~ 660
BP_2: ½×~~38~~ 28×6	115	168	4.0	22.54	460 ~~432~~
	~~4755~~ 8455	~~14,448~~ 15,898		~~53,184~~ 53,184	~~44,502~~ 45410
	V = ~~7,143~~ 7,610 ↑			M = ~~21,618~~ 19356 ↻	

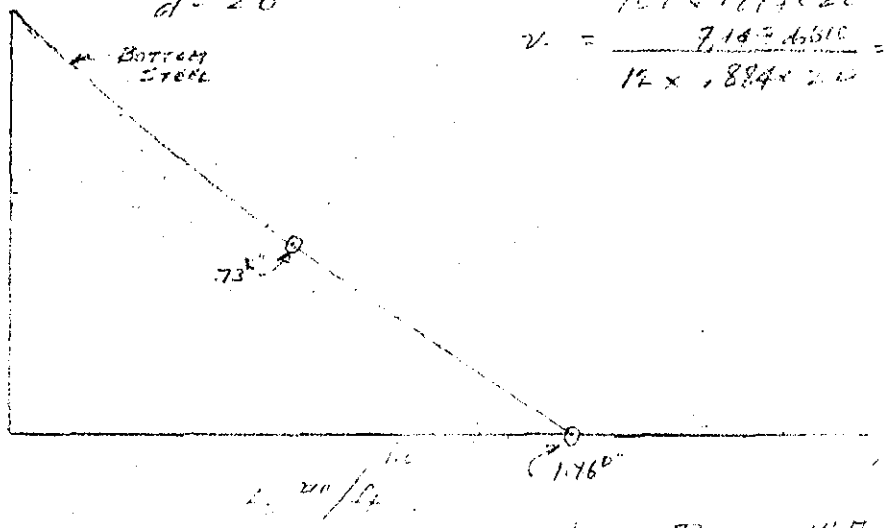
$$A_s = \frac{12 \times \cancel{21,618}\ 19356}{18,000 \times .884 \times 20} = \cancel{0.72}\ 0.64 \text{ in}^2 \qquad d = 25.5 - 4.5 = 20.0$$

EACH INTERVAL
P. 36 SEE PREVIOUS SHEET

Total depth = 30 − 6.5 = 23.5"
d = 20

$$E_b = \frac{7,143\ 6610}{16 \times .884 \times 20} = \cancel{2.5}\ 2.3 \text{"}$$

$$v = \frac{7,143\ 6610}{12 \times .884 \times 20} = \cancel{31}\ 34 \text{ #/in}^2$$



LET BOTH 1" □ & 1" Φ RUN OUT FULL LENGTH FROM STEEL

WAR DEPARTMENT

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

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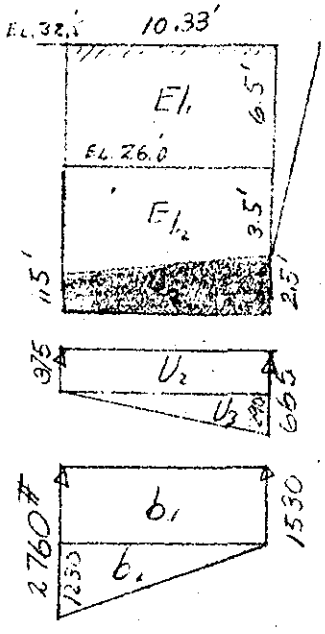
Project: Hartford - Conn (HT-5)

Computation: Flood and retaining wall 24' Stem 25' base

Computed by: R.H.M. Checked by: PLA Date: 3/14/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Landside Base Steel - Case III River Up



El_1: 10.33 × 6.5 × 100 = 6710 × 5.17 = 34690 '#

El_2: 10.33 × 4.5 × 125 = 5810 × 5.17 = 30040 "

C_2: 10.33 × 1 × ½ × 25 = 130 × ~~6.88~~ = 450 ~~890~~ "

10.33 × 1.5 × 150 = 2320 × 5.17 = 11990 "

U_2: 375 × 10.33 = 3870 × 5.17 = 20010 '#

U_3: 290 × ½ × 10.33 = 1500 × 3.44 = 5160 "

b_1: 1530 × 10.33 = 15800 × 5.17 = 81690 "

b_2: 1230 × ½ × 10.33 = 6350 × 6.88 = 43370 "

$\Sigma V = 12550$ ↑ $\Sigma M = \cancel{72620}$ 73060 '#

$$d_{(required)} = \sqrt{\frac{\cancel{72620}\ 73060}{123}} = \sqrt{590} = 24.5''$$

OK. Use 30 - 4.5 = 25.5"

$$A_s = \frac{12 \times \cancel{72620}\ 73060}{18000 \times .884 \times 25.5} = \frac{871{,}440}{405450} = 2.15\ \square''$$

Bottom Steel Staggered — $\left\{ \begin{array}{l} 1''\square \text{ @ } 12'' \text{ c.c} \\ 1\frac{1}{8}''\square \text{ @ } 12'' \text{ c.c} \end{array} \right\} = 2.27\ \square''$

Riverside Base Steel Case III River Up

From Case I (all forces except base pressure)

$\Sigma V = \cancel{16770}$ 16830 # ↓ $\Sigma M = \cancel{85{,}670}$ 86910 '#

B.P. ↑ : 9.94 × 1150 × ½ = 5720 × 3.31 = 18930 '#

$\Sigma V = \cancel{11050}$ 11110 # ↓ $\Sigma M = \cancel{66740}$ 67980 '#

$$A_s = \frac{12 \times \cancel{66740}\ 67980}{18000 \times .884 \times 26.5} = \frac{\cancel{800880}\ 816000}{421{,}350} = \cancel{1.90}\ 1.93\ \square''$$ Top Steel

Use 1"□ @ 6" c.c

WAR DEPARTMENT

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

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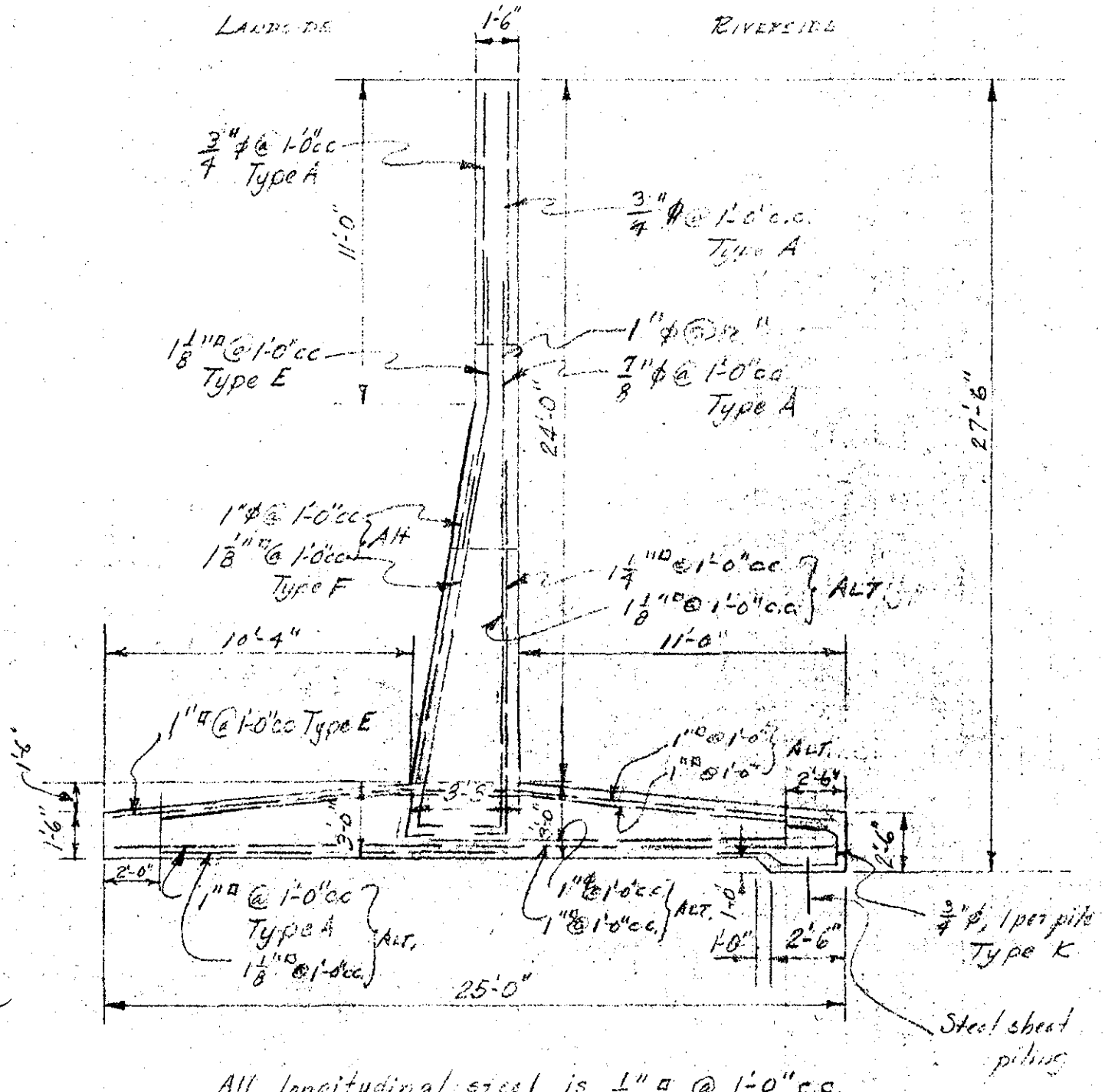
Subject: HARTFORD, CONN. - HT. 5 - FLOOD AND RETAINING WALL

Computation: SECTION SHOWING STEEL AT STA. 3+60 I

Computed by: J.A.C. Checked by: K.A. Date: 3/6/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

FINAL SECTION AS DESIGNED AND DETAILED



All longitudinal steel is 1/2" □ @ 1'-0" c.c.

WAR DEPARTMENT

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

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Project Hartford - Conn (H+5)

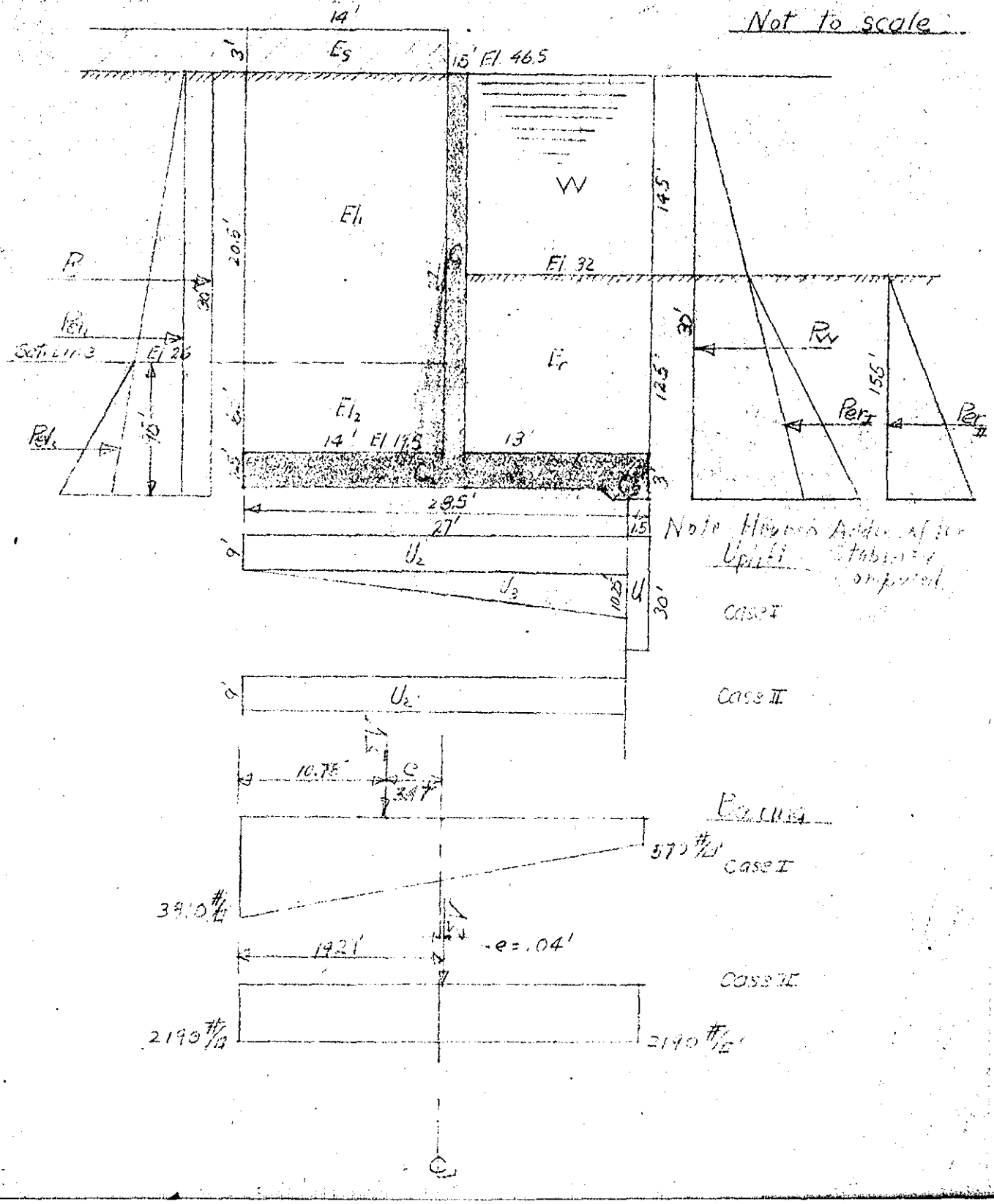
Computation Flood and retaining wall 26.5 stem : 23.5' base Sta 4+10±

Computed by R.H.M. Checked by W.H.F. Date 2/13/40

U. S. GOVERNMENT PRINTING OFFICE 8—10528

Case I - River Up Case II - River Down

Not to scale



WAR DEPARTMENT

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

Object: Hartford - Conn (Ht-5)

Computation: Flood and retaining wall - 2.65 stem 28.5' base Sta 4+10 ±

Computed by: R.H.M. Checked by: W.H.F. Date: 2/13/40

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Case I (*) River Up Case II (**) River Down.

Forces Acting		↓	↑	→	←	Arm	Moments about "A" ↷	↶
C_1	1.5×27×150	6080				14.75	89680	
C_2	2.5×28.5×150	10690				14.25	152330	
C_3	.5×2.75×150	210				27.12	5700	
E_s	3×14×100	4200				1.0	29400**	
El_1	20.5×14×100	28700				7.0	200900	
El_2	6.5×14×125	11380				7.0	79660	
W	14.5×13×62.5	11780				22	259160*	
Er_I	12.5×13×125	20310				22	446820*	
Er_{II}	12.5×13×100	16250				22	357500**	
U_1	1.5×30×62.5		2810			27.75		77980*
U_2	27×9×62.5		15190			13.5		205070
U_3	27×10.25×½×62.5		8650			18.0		155700*
P_s	3×35×30			3150		14.5	45680**	
Pel_1	30²×½×35			15750		9.5	149630	
Pel_2	9.5²×½×45			2030		2.67	5420	
P_w	30²×½×62.5				28130	9.5		267240*
Per_I	15.5²×½×17.5				2100	4.67		9810*
Per_{II}	15.5²×½×35				4200	4.67		19610**
Case I		89150	26650	17780	30230		1,389,300	715800
		ΣV = 62500 # ↓		ΣH = 12450 # ←			ΣM = 673500 '# ↷	
Case II		77510	15190	20930	4200		1,115,270	224680
		ΣV = 62320 # ↓		ΣH = 16730 # ↷			ΣM = 891220 '# ↷	

Case I: $\frac{\Sigma M}{\Sigma V} = \frac{673500}{62500} = 10.78'$ $\frac{1}{3}$ Base = 9.50' OK e = 14.25 - 10.78 = 3.47

$B.P. = \frac{62500}{28.5}\left(1 \pm \frac{6 \times 3.47}{28.5}\right) = 2190$ { 1.74 = 3810 #/□' P.B.L. ; 0.26 = 570 #/□' P.B.R.

0.45 × 62500 = 28130 # > 12450 OK against sliding.

Case II: $\frac{\Sigma M}{\Sigma V} = \frac{891220}{62320} = 14.29'$ $\frac{2}{3}$ Base = 19' OK e = 14.29 - 14.25 = .04

$B.P. = \frac{62320}{28.5} = 2190$ #/□' Distributed over whole of base.

0.45 × 62320 = 28040 # > 16730 # OK against sliding

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Project: Hartford - Conn (Ht-5)
Computation: Flood and retaining wall - 26.5 stem : 28.5' base Sta. 4+10±
Computed by: Checked by: W H E Date:

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case III - Landside earth fill at El. 32

Pel_1 becomes $= 15.5^2 \times \frac{1}{2} \times 35 = 4200 \times 4.67 = 19610$ '#↻

Change in ΣM due to smaller $Pel_1 = 149630 - 19610 = 130020$ '#↻

" " " " " " $El_1 = 14.5 \times 14 \times 100 = 20300 \times 7$

" " ΣV " " " " $= 20300$ #↑ $= 142100$ '#↻

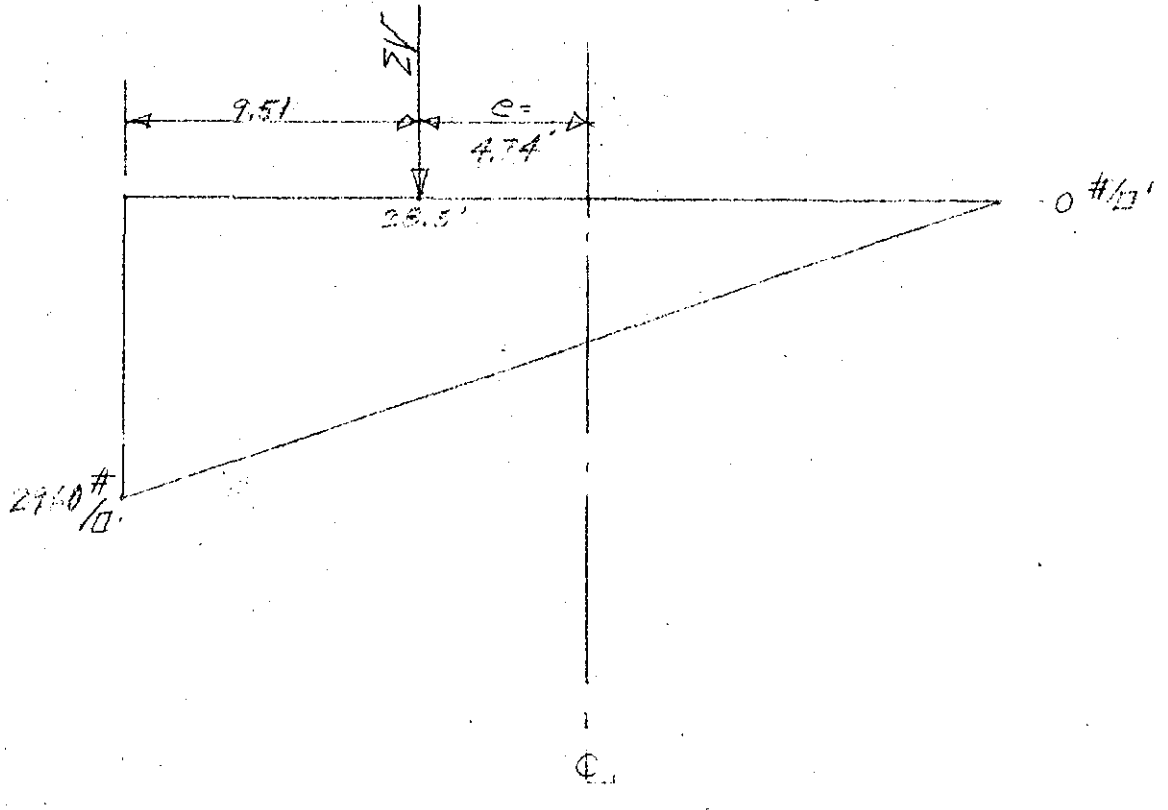
$\Sigma M = 673500$ (From Case I) $- 130020 - 142100 = 401{,}380$ '#↻

$\Sigma V = 62500$ (" ") $- 20300 = 42200$ #↓

$\frac{\Sigma M}{\Sigma V} = \frac{401380}{42200} = 9.51'$ $\frac{1}{3}$ Base $= 9.50$ O.K.

$e = 14.25 - 9.51 = 4.74'$

$B.P. = \frac{42200}{28.5}\left(1 \pm \frac{6 \times 4.74}{28.5}\right) = 1480 \begin{cases} 2.0 = 2960 \text{ \#/□' P.B.L.} \\ 0 = 0 \text{ \#/□ P.B.R.} \end{cases}$



WAR DEPARTMENT

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

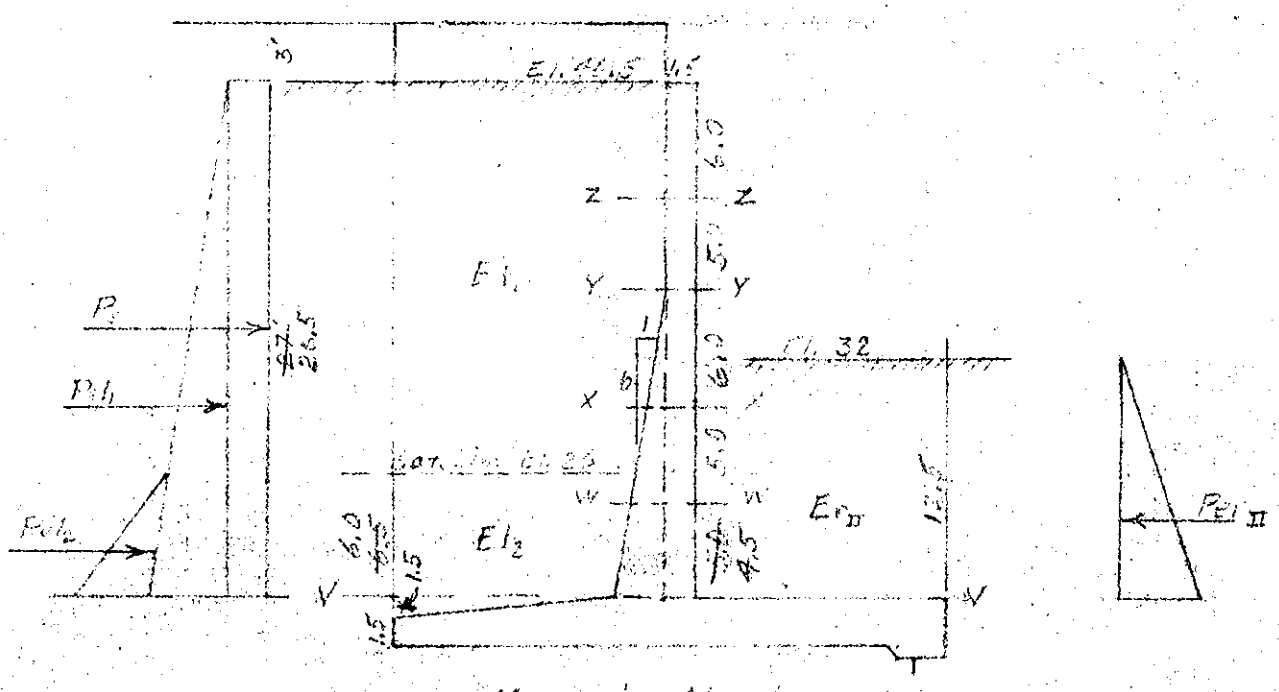
bject Hartford Conn Ht. Sta 4+10±

omputation Design of Stem 26.5' Wall

omputed by W.A.F. Checked by Date

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case II - River Down



Moments About V-V

Forces Acting		→	←	Arm	↷	↶
Ps	3 × 27 × 35	2835		9.0	25520	
Pel1	27² × ½ × 35	12760		9.0	114840	
Pel2	6.5² × ½ × 45	950		2.17	2060	
Per II	12.5² × ½ × 35		2730	4.17		11380
		16550	2730		142420	11380
		ΣV = 13,820 →			ΣM = 131,040 ↷	

Moments About W-W

Ps	3 × 22 × 35	2310		7.33	16[illegible]0	
Pel1	22² × ½ × 35	8470		7.35	62090	
Pel2	1.5² × ½ × 45	50		.50	25	
Per II	7.5² × ½ × 35		980	2.50		2450
		10830	980		79050	2450
		ΣV = 9850 →			ΣM = 76600 ↷	

Moments About X-X

Ps	3 × 17 × 35	17[illegible]		5.67	10120	
Pel1	17² × ½ × 35	5060		5.67	28690	
Per II	2.5² × ½ × 35		110	.83		90
		6850	110		38810	90
		ΣV = 6740 →			ΣM = 38720 ↷	

Project: Hartford Conn. Alt. 5 Sta. 4+103

Computation: Design of Stem 26.5' Wall

Computed by: W.H.F. Checked by: Date:

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case II continued

Moments About Y—Y

Forces Acting		→	←	Arm	↷	↶
P_1	3 × 11 × 35	1160		3.67	4260	
P_{c1}	11² × ½ × 35	2120		3.67	7780	
		ΣY = 3280 →			ΣM = 12040 ↷	

Moments About Z—Z

P_1	3 × 6 × 35	630		2.0	1260	
P_{c1}	6² × ½ × 35	630		2.0	1260	
		ΣV = 1260 →			ΣM = 2520 ↷	

At Y-Y:

$d = \frac{27-11}{6} + 1.5 = 4.17' = 50''$

$d' = \sqrt{\frac{131040}{123}} = 32.6 + 3.5 = 36.1 < 50''$ o.k.

$A_s = \frac{131040 \times 12}{18000 \times .884 \times 46.5} = 2.12\ \square''$

Unit Shear $= \frac{13820}{12 \times .884 \times 50} = 26\ \#/\square'' < 60$ o.k.

Bond $= \frac{13820}{(444.5) \times .884 \times 46.5} = 40\ \#/\square''$

Use 1 □ alt 1½ □ spaced 6" c.c.

At W-W:

$d = \frac{27-11}{6} + 1.5 = 3.33' = 40''$

$d' = \sqrt{\frac{76600}{123}} = 25.0 + 3.5 = 28.5'' < 40''$ o.k.

$A_s = \frac{76600 \times 12}{18000 \times .884 \times 36.5} = 1.58\ \square''$

Shear $= \frac{9850}{12 \times .884 \times 40} = 23\ \#/\square'' < 60$ o.k.

Bond $= \frac{9850}{2(3.14) \times .884 \times 36.5} = 48\ \#/\square''$

Use 1 □ spaced 6" c.c. ($A_s = 1.57$ o.k.)

At X-X:

$d = \frac{17-11}{6} + 1.5 = 2.5' = 30''$

$d' = \sqrt{\frac{38720}{123}} = 17.7'' + 3.5 = 21.2'' < 30''$ o.k.

$A_s = \frac{38720 \times 12}{18000 \times .884 \times 26.5} = 1.10\ \square''$

Shear $= \frac{6740}{12 \times .884 \times 30} = 21\ \#/\square'' < 60$ o.k.

Bond $= \frac{6740}{2(2.749) \times .884 \times 26.5} = 52\ \#/\square''$

Use ⅞ □ spaced 6" c.c.

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Project Hartford Conn Ht-5 Sta. 4+10±
Computation Design of Stem 26.5 Wall
Computed by W.H.F. Checked by ..... Date .....

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Case II continued

At Y-Y
$d = 18''$

$d' = \sqrt{\frac{12040}{123}} = 9.9'' + 3.5 = 13.4'' < 18''$ ok.

$A_s = \frac{12040 \times 12}{18000 \times .884 \times 14.5} = .63 \square''$

$Shear = \frac{3280}{12 \times .884 \times 18} = 17^{\#}/\square'' < 60$ ok.

$Bond = \frac{3280}{(1.57+2.36) \times .884 \times 14.5} = 65^{\#}/\square''$

Use ½" ϕ alt. ¾" ϕ spaced 6" o.c.

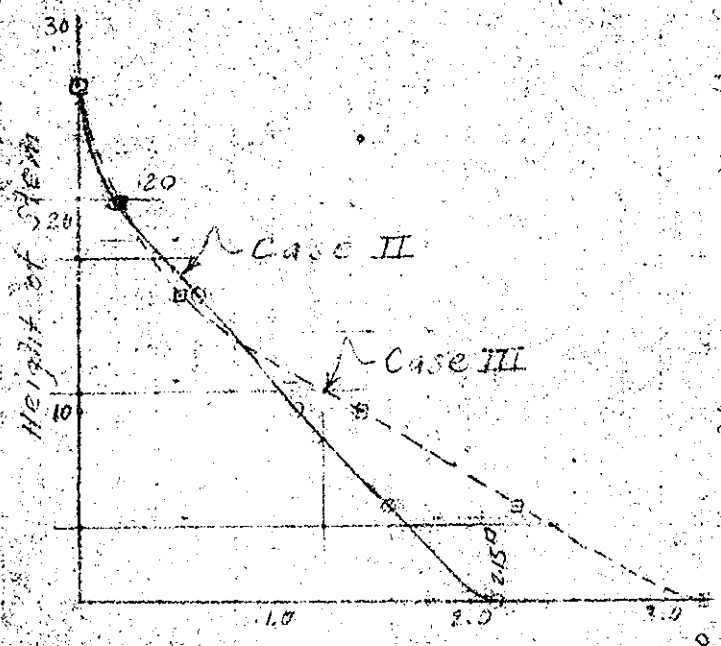
At Z-Z
$d = 18''$

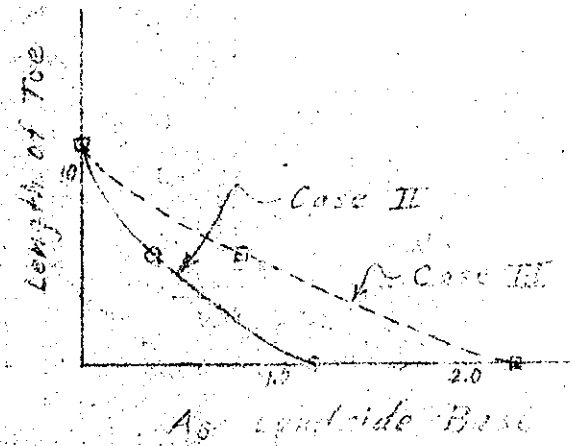
$A_s = \frac{2320 \times 12}{18000 \times .884 \times 14.5} = 0.19$

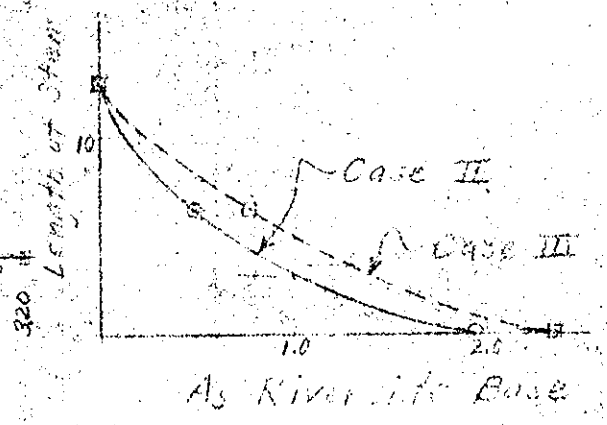
$Shear = \frac{1260}{12 \times .884 \times 18} = 7^{\#}/\square'' < 60$ ok.

$Bond = \frac{1260}{1.57 \times .884 \times 14.5} = 62^{\#}/\square''$

Use ½" ϕ spaced 1' o.c.



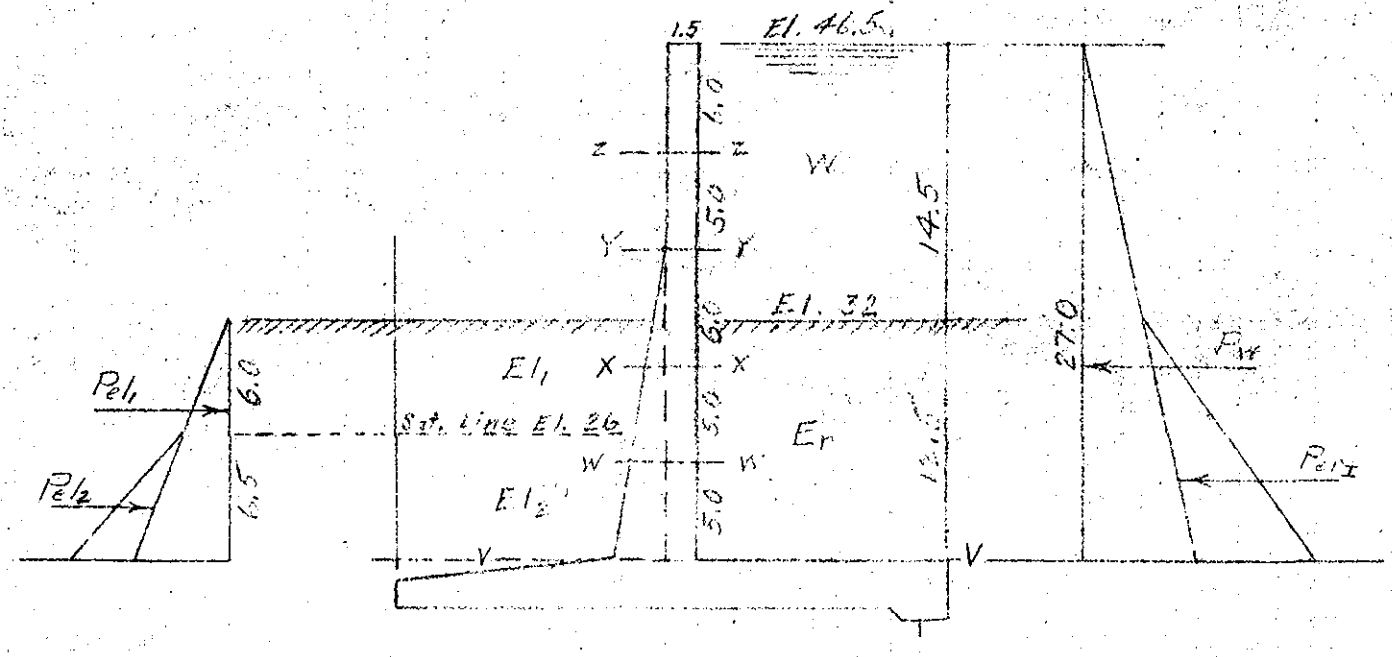




Project Hartford Conn. Ht. 5 Sta. 4+10±
Computation Design of Stem 26.5' Wall
Computed by WHF Checked by ..... Date .....

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case III Landside Earth Fill at El. 32



Moments About V – V

Forces Acting		→	←	Arm	↻	↺
Pel_1	$12.5^2 \times \frac{1}{2} \times 35$	2750		4.17	11380	
Pel_2	$6.5^2 \times \frac{1}{2} \times 45$	950		2.17	2060	
P_W	$27^2 \times \frac{1}{2} \times 62.5$		22780	9.0		205020
Per_I	$12.5^2 \times \frac{1}{2} \times 17.5$		1370	4.17		5720
		3680	24150		13440	210740
		ΣV = 20470 ←			ΣM = 197300 ↺	

Moments About W – W

Pel_1	$7.5^2 \times \frac{1}{2} \times 35$	980		2.5	2450	
Pel_2	$1.5^2 \times \frac{1}{2} \times 45$	50		.5	25	
P_W	$22^2 \times \frac{1}{2} \times 62.5$		15125	7.33		110870
Per_I	$7.5^2 \times \frac{1}{2} \times 17.5$		440	2.5		1225
		1030	15620		2480	112100
		ΣV = 14590 ←			ΣM 109620 ↺	

Moments About X – X

Pel_1	$2.5^2 \times \frac{1}{2} \times 35$	110		0.83	90	
P_W	$17^2 \times \frac{1}{2} \times 62.5$		9030	5.67		51200
Per_I	$2.5^2 \times \frac{1}{2} \times 17.5$		55	0.83		45
		110	9090		90	51250
		ΣV = 8980 ←			ΣM = 51160 ↺	

WAR DEPARTMENT

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

Project [illegible] Sta. 4+10[illegible]

Computation Design of Stem 26.5 Wall

Computed by W.H.F. Checked by _____ Date _____

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case III continued

Moments About Y-Y

Forces Acting		→	←	[illegible]	↻	↺
Pv	11[illegible] × 62.5		3780	3.67		13880
		ΣV = 3780			S.M. = 10100	

Moments About Z-Z

Pv	6[illegible] × [illegible]		[illegible]	[illegible]		4500
		ΣV = [illegible]			[illegible]	

At V-V:

d = 50"

$d = \sqrt{\frac{[illegible]}{12[illegible]}} = 40 + [illegible] = 43.5 < 50$

$A = \frac{[illegible] \times [illegible]}{[illegible] \times [illegible] \times 46.5} = 3.[illegible]$

$[illegible] = \frac{[illegible]}{12 \times [illegible] \times 50} = 40 < [illegible]$

$[illegible] = \frac{[illegible]}{2([illegible]) \times .684 \times 46.5} = 50$ #/□"

Use 1¼" □ spaced 6" c.c. (A = 3.[illegible])

At W-W:

d = 40"

$d = \sqrt{\frac{[illegible]}{12[illegible]}} = 29.[illegible] + [illegible] = 33.[illegible] < 4[illegible]$

$A = \frac{109620 \times [illegible]}{[illegible] \times [illegible] \times [illegible]} = 2.26$ □"

$[illegible] = \frac{145[illegible]}{12 \times .884 \times 40} = 34$ #/□" < 10 [illegible]

$[illegible] = \frac{[illegible]}{[illegible] \times [illegible] \times 36.5} = 53$ #/□"

[illegible] alt. 1½" □ [illegible] 6" c.c.

At X-X:

d = 30"

$d = \sqrt{\frac{[illegible]}{12[illegible]}} = 20.[illegible] + 3.[illegible] = 23.7 < [illegible]$

$A = \frac{[illegible] \times 12}{[illegible] \times .889 \times [illegible]} = [illegible]$

$[illegible] = \frac{[illegible]}{12 \times [illegible] \times 30} = 28$ #/□" < [illegible]

$[illegible] = \frac{[illegible]}{2([illegible]) \times .884 \times 26.5} = 61$ #/□"

[illegible]

WAR DEPARTMENT

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

Project Hartford Conn Ht. 5 Sta. 4+10±

Computation Design of Stem 26.5' Wall

Computed by WHF Checked by ..... Date .....

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case III continued

At Y-Y:

$d = 18''$

$d' = \sqrt{\frac{10100}{123}} = 9.1'' + 3.5 = 12.6'' < 18$ o.k.

$A_s = \frac{10100 \times 12}{18000 \times .884 \times 14.5} = .53 \square''$

$Shear = \frac{3780}{12 \times .884 \times 18} = 20\ \#/\square'' < 60$ o.k.

$Bond = \frac{3780}{2.75 \times .884 \times 14.5} = 107\ \#/\square''$

Use 7/8" φ spaced 1' o.c.

At Z-Z:

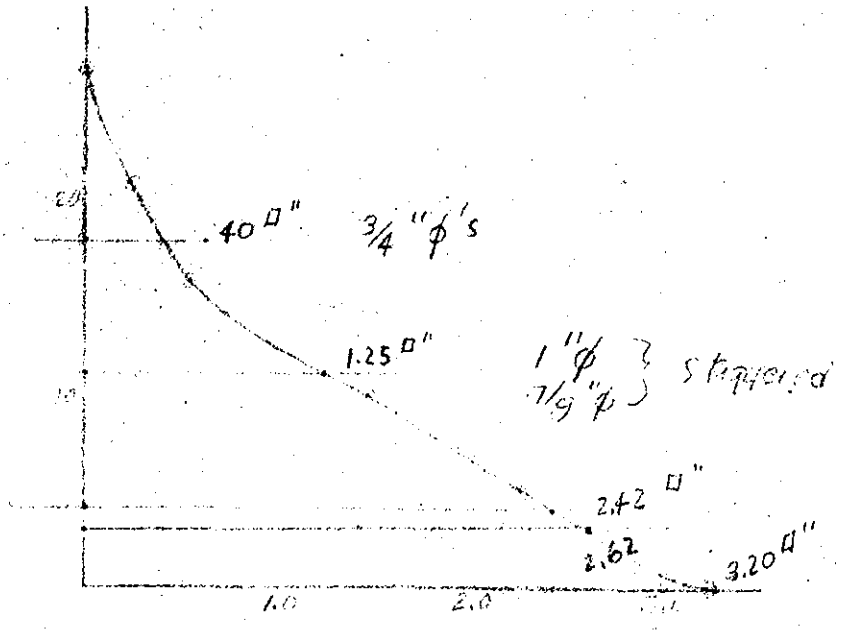
$d = 18$

$A_s = \frac{4500 \times 12}{18000 \times .884 \times 14.5} = .23 \square''$

$Shear = \frac{2250}{12 \times .884 \times 18} = 12\ \#/\square'' < 60$ o.k.

$Bond = \frac{2250}{1.92 \times .884 \times 14.5} = 87\ \#/\square''$

Use 5/8 φ spaced 1' o.c.



1 1/8" □ @ 6"
1" φ @ 6"
in double rows

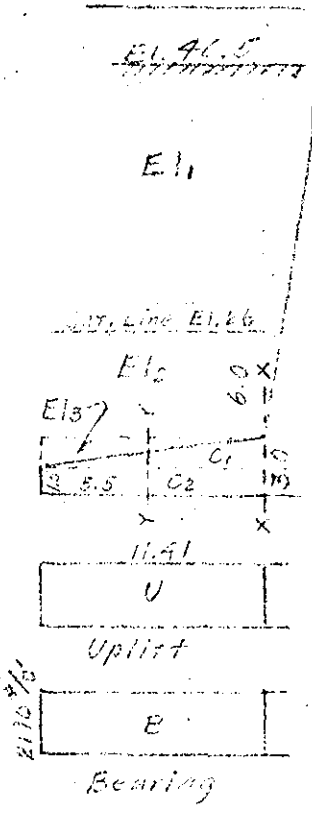
Subject: Hartford Flood Wall — Sta. 2 + 10.4

Computation: Design of Landside Base 2.25' Wall

Computed by: W.H.F. Checked by: Date:

U. S. GOVERNMENT PRINTING OFFICE 3—10628

Case II River Down



Moments About X – X

Forces Acting		V	H	Arm	M	M
E_3	3 × 11.42 × 100	3420		5.7	19470	
E_1	20.5 × 11.41 × 100	23410		5.7	133420	
E_2	6 × 11.41 × 125	8550		5.7	48700	
E_4	1.5 × ½ × 11.41 × 125	1070		7.0	8190	
C_1	1.5 × ½ × 11.41 × 150	1280		3.5	4480	
C_2	1.5 × 11.41 × 150	2570		5.7	14650	
U	9 × 11.41 × 62.5		6420	5.7		36570
B	10.6 × 2.110		22410	5.7		127700
		40290	31410		229270	164270
		ΣV = 5880	↓		ΣM = 50240	↺

d = 36"

$d = \sqrt{\frac{50240}{123}} = 20.2 + 4.5 = 24.7"$ (36" ok)

$A_s = \frac{50240}{12000 \times 31.5} = 1.33$ □"

Bond = $\frac{8500}{550 \times .299 \times 31.5} = 57$ #/□"

Shear = $\frac{8500}{10.6 \times 36} = 23$ #/□"

Use ¾ ϕ spaced 6 c.c.

Moments About Y – Y (5.5' from End)

Forces Acting		V	H	Arm	M	M
E_3	3 × 5.5 × 100	1650		2.75	4540	
E_1	20.5 × 5.5 × 100	11280		2.75	31020	
E_2	6.78 × 5.5 × 125	4650		2.75	12800	
C	2.22 × 5.5 × 150	1830		2.75	5030	
U	9 × 5.5 × 62.5		3020	2.75		8300
B	5.5 × 2.110		12050	2.75		33140
		19410	15070		53410	41440
		ΣV = 4340	↓		ΣM = 11970	↺

d = 3.0 – .75 = 2.25' = 27"

$d = \sqrt{\frac{11970}{123}} = 1.5 + 4.5 = 14.3 < 27"$ ok

$A_s = \frac{11970}{12000 \times 31.5} = .39$ □"

Bond = $\frac{11970}{550 \times .299 \times 31.5} = 13$ #/□"

Shear = $\frac{4340}{10.6 \times 27} = 15$ #/□" < 60 ok

Use ½" ϕ spaced 6 c.c.

Subject Hartford Conn. Hd. 5 Sta. 4+10±

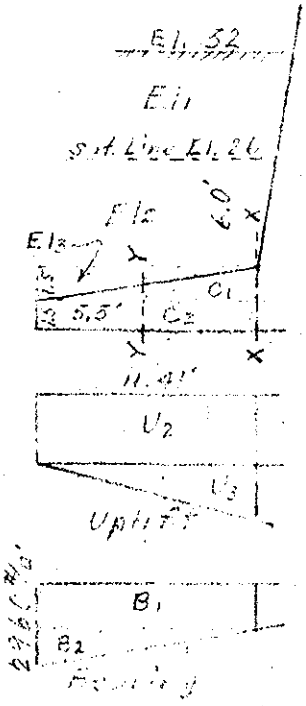
Computation Design of Loadable Base, 26.5' Wall

Computed by W.J.F. **Checked by** ..... **Date** .....

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Case III Loadable End in Fill at El. 32

Water El. 42.5



$U_3 = 20.5 \times \frac{1}{2} \times 12.5 = 642$ $\quad Y = \frac{11.41}{27} \times 642 = 271$

$B_1 = \frac{17.29}{26.5} \times 2760 = 1770$ $\quad B_2 = 2760 - 1770 = 1170$

Moments About X-X

Forces Acting		↓	↑	Arm	↻	↺
El_1	$6 \times 11.42 \times 100$	6850		5.7	39050	
El_2	$6 \times 11.41 \times 125$	8560		5.7	48790	
El_3	$.5 \times \frac{1}{2} \times 11.41 \times 125$	1070		7.61	8140	
C_1	$.5 \times 2 \times 11.41 \times 0.79$	1280		3.8	4860	
C_2	$.5 \times 11.41 \times 150$	2570		5.7	14650	
U_2	$9 \times 11.41 \times 62.5$		6420	5.7		36590
U_3	$\frac{1}{2} \times 11.41 \times 271$		1550	3.8		5890
B_1	11.41×1770		20200	5.7		115140
B_2	$\frac{1}{2} \times 11.41 \times 1170$		6670	7.61		51670
		22330	34960		115490	209290
		$\Sigma V = 14630$ ↑			$\Sigma M = 93800$ ↻	

At X-X: $\quad d = 36''$

$d = \sqrt{\frac{93800}{123}} = 27.6 + 4.5 = 32.1 < 36''$ o.k. $\quad Bond = \frac{14630}{(4.0+4.50) \times .854 \times 31.5} = 62\ \#/\square''$

$A_s = \frac{93800 \times 12}{18000 \times .854 \times 31.5} = 2.24\ \square''$ $\quad$ Use 1" ϕ at 1 1/8" o.c. spaced 6" o.c.

Unit Shear $= \frac{14630}{12 \times .854 \times 36} = 38\ \#/\square'' < 60$ o.k.

Moments About Y-Y (5.5' from End)

$Y = \frac{5.5}{27} \times 642 = 130$

$B_1 = \frac{23}{26.5} \times 2760 = 2390$

$B_2 = 2760 - 2390 = 370$

$d = 3.0 - .78 = 2.22' = 27''$

		↓	↑	Arm	↻	↺
El_1	$6 \times 5.5 \times 100$	3300		2.75	9080	
El_2	$6.18 \times 5.5 \times 125$	4660		2.75	12820	
C	$2.22 \times 5.5 \times 150$	1830		2.75	5030	
U_2	$7 \times 5.5 \times 62.5$		3090	2.75		8500
U_3	$\frac{1}{2} \times 5.5 \times 130$		360	1.83		660
B_1	5.5×2390		13150	2.75		36160
B_2	$\frac{1}{2} \times 5.5 \times 570$		1570	3.67		5760
		9790	18170		26930	51080
		$\Sigma V = 8380$ ↑			$\Sigma M = 24150$ ↻	

$d = \sqrt{\frac{24150}{123}} = 14.0 + 4.5 = 18.5 < 27$ o.k.

$A_s = \frac{24150}{18000 \times 22.5} = .81\ \square''$ $\quad Bond = \frac{8380}{3.14 \times .854 \times 22.5} = 130\ \#/\square''$

$Shear = \frac{8380}{10.6 \times 27} = 29\ \#/\square'' < 60$ o.k. $\quad$ Use 1" ϕ spaced 1' o.c. (Area = .785 o.k.)

WAR DEPARTMENT

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

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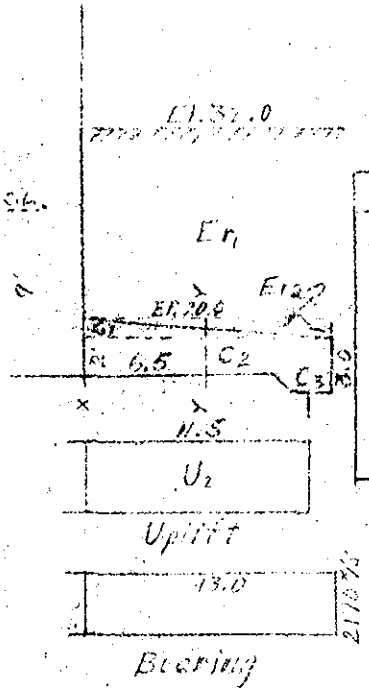
Project: Hartford Conn. Ht-5 Sta. 4+10 2

Computation: Design of Riverside Bar, 26.5' Wall

Computed by: W.H.F. Checked by: Date:

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Case II River Down



Moments About X - X

Forces Acting		↓	↑	Arm	↻	↺
Er	12 × 13 × 100	15600		6.5	101400	
Er2	½ × 1 × 13 × 100	650		8.67	5640	
C1	½ × 1 × 13 × 150	980		4.33	4240	
C2	2 × 13 × 150	3900		6.5	25350	
C3	1 × 3 × 150	450		11.5	5180	
U2	9 × 11.5 × 62.5		6470	5.75		37200
B	13 × 2190		28470	6.5		185060
		21580	34940		141810	222260
		ΣV = 13360 ↑			ΣM = 80450 ↺	

$d = 36''$

$d = \sqrt{\frac{80450}{123}} = 25.6 + 4.5 = 30.1 < 36$ ok.

$A_s = \frac{80450}{1325 \times 31.5} = 1.93$ □". Bond $= \frac{13360}{8 \times .884 \times 31.5} = 51$ #/□"

Shear $= \frac{13360}{10.6 \times 36} = 35$ #/□" < 60 ok. Use 1 □ spaced 5" o.c.

Moments About Y - Y

Er	12.25 × 6.5 × 100	8290		3.25	26940	
C2	2.25 × 6.5 × 150	2190		3.25	7120	
C3	1 × 3 × 150	450		5	2250	
U2	9 × 5 × 62.5		2810	2.5		7030
B	6.5 × 2190		14240	3.25		46280
		10930	17050		36310	53310
		ΣV = 6120 ↑			ΣM = 17000 ↺	

$d = 30''$

$d = \sqrt{\frac{17000}{123}} = 11.8 + 4.5 = 16.3 < 30$ ok.

$A_s = \frac{17000}{1325 \times 25.5} = 0.50$ Bond $= \frac{6120}{2.55 \times .884 \times 25.5} = 107$ #/□"

Shear $= \frac{6120}{10.6 \times 30} = 19 < 60$ o.k. Use ¾" φ alt. ⅞" φ spaced 1' o.c.

WAR DEPARTMENT

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

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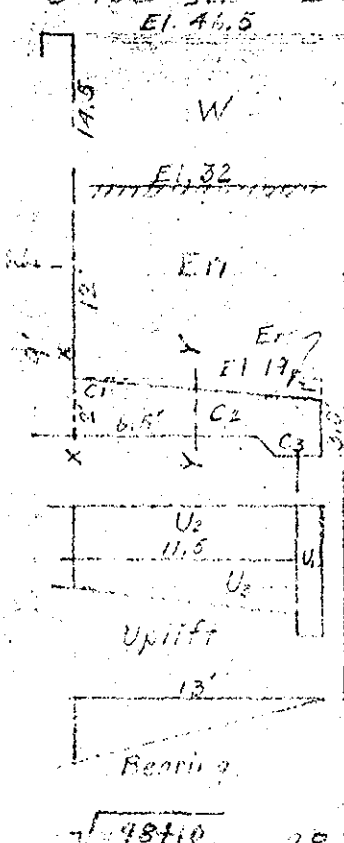
Project: Hartford Conn. Ht-5 Sta. 4±10

Computation: Design of Riverside Base 26.5' Wall

Computed by: W.H.F. Checked by: Date:

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case III Landside Earth Fill at El. 32



$U_3 = 20.5 \times \frac{1}{2} \times 62.5 = 642$ $\quad Y = \frac{15.5}{27} \times 642 = 368$

$B = \frac{13}{28.5} \times 2960 = 1350$ $\quad Y = 642 - 368 = 274$

Moments About X-X

Forces Acting		↓	↑	Arm	↻	↺
W	14.5 × 13 × 62.5	11780		6.5	76570	
En	12 × 13 × 125	19500		6.5	126750	
En2	½ × 1 × 13 × 125	810		8.67	7020	
C1	½ × 1 × 13 × 150	980		4.33	4240	
C2	2 × 13 × 150	3900		6.5	25350	
C3	1 × 3 × 150	450		11.5	5180	
U1	30.5 × 1.5 × 62.5		2860	12.25		35040
U2	9 × 11.5 × 62.5		6470	5.75		37200
U3	11.5 × 368		4230	5.75		24320
U3	½ × 11.5 × 274		1580	7.67		12120
B	½ × 13 × 1350		8780	4.33		38020
		37420	23920		245110	146700
		ΣV = 13500 ↓			ΣM = 98410 ↻	

$d = 31''$

$\sqrt{\frac{98410}{123}} = 28.3 + 4.5 = 32.8'' < 36''$ o.k. $\quad$ Bond $= \frac{13500}{9 \times .884 \times 31.5} = 54\ \#/\square''$

$A_s = \frac{98410}{1325 \times 31.5} = 2.36\ \square''$ $\quad$ Shear $= \frac{13500}{10.6 \times 36} = 35\ \#/\square'' < 60$ o.k. $\quad$ Use 1⅛" ϕ spaced 6" c.c.

$Y = \frac{20.5}{27} \times 642 = 488$

$Y = 642 - 488 = 154$

$B = \frac{6.5}{28.5} \times 2960 = 675$

W	14.5 × 6.5 × 62.5	5890		3.25	19190	
En	12.5 × 6.5 × 125	10150		3.25	33000	
C2	2.5 × 6.5 × 150	2440		3.25	7930	
C3	1 × 3 × 150	450		5	2300	
U1	30.5 × 1.5 × 62.5		2860	5.75		16450
U2	9 × 5 × 62.5		2810	2.5		7020
U3	5 × 488		2440	2.5		6100
U3	½ × 5 × 154		390	3.33		1300
B	½ × 6.5 × 675		2190	2.17		4750
		18930	10190		62420	35620
		ΣV = 8240 ↓			ΣM = 26800 ↻	

$d = 30''$

$d' = \sqrt{\frac{26800}{123}} = 14.8 + 4.5 = 19.3'' < 30$ o.k.

$A_s = \frac{26800}{1325 \times 25.5} = 0.79\ \square''$ $\quad$ Bond $= \frac{8240}{3.14 \times .884 \times 25.5} = 116\ \#/\square''$

Shear $= \frac{8240}{10.6 \times 30} = 26\ \#/\square'' < 60$ o.k. $\quad$ Use 1" ϕ spaced 6" c.c.

WAR DEPARTMENT

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

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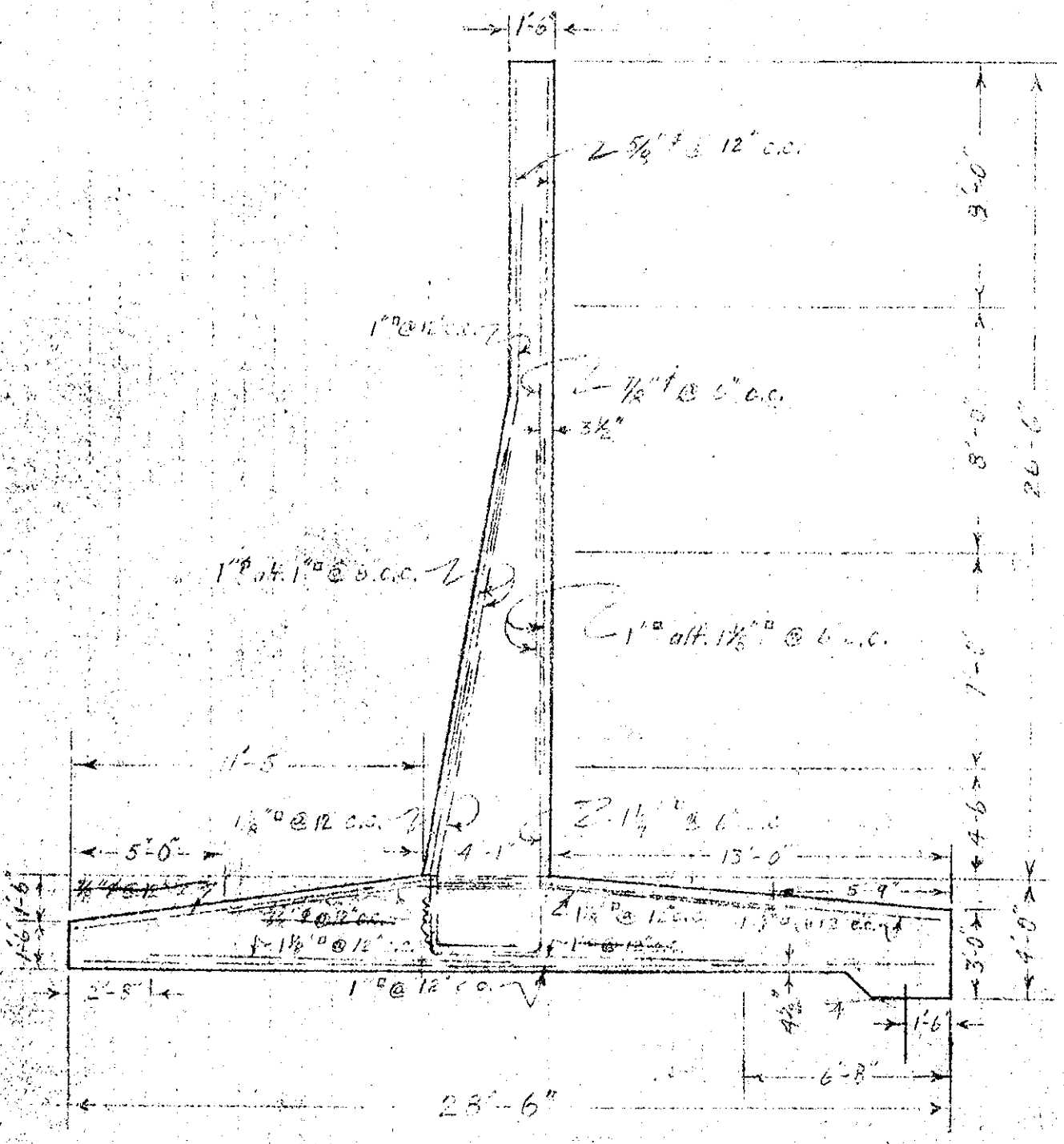
Project Hartford Conn Ht-5

Computation Steel Reinforcement 26.5' Seam [illegible]

Computed by W.H.E. Checked by _____ Date 3/5/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



Temperature Steel: Use ½"φ @ 12" c.c. hor.

Base Steel O.K.

WAR DEPARTMENT

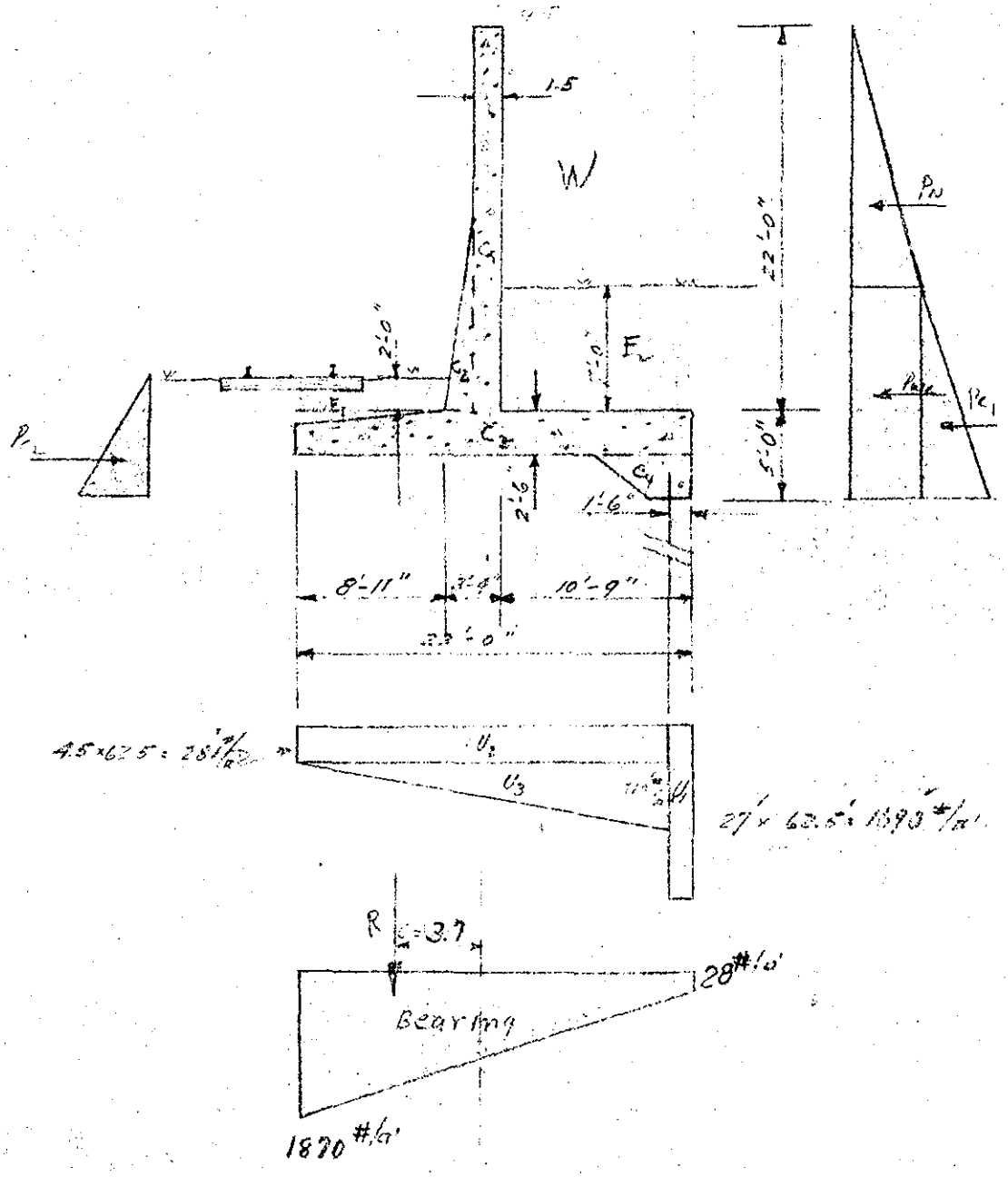
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Hartford Ht. 5 Sta. 5+12 to 7+92 ±

Computation: Wall @ Sta. 6+00 Stem 22' Base 23'

Computed by: Rustett Checked by: J. H. L. Date: Feb. 18, 1940

U. S. GOVERNMENT PRINTING OFFICE 2—10528



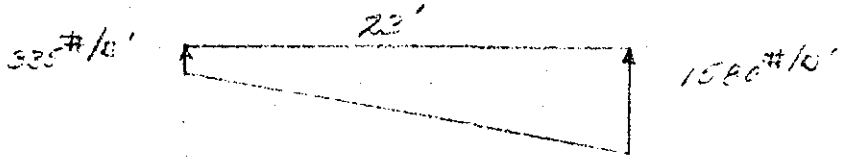
Subject: HARTFORD HCS
Computation: WALL STEM 22' BASE 23' STA. 6+00 TO 7+00
Computed by: P.L.A. Checked by: Date: 3/5/40

U.S. GOVERNMENT PRINTING OFFICE 3—10628

CASE # RIVER DOWN

$U_2 = 281$ #/□'

UPLIFT



BEARING

WAR DEPARTMENT

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

Subject: Hartford, Conn. Ht. 5 — Sta. 5+12± to 7+12±

Computation: Wall @ Sta. 6+00

Computed by: ____ Checked by: J. H. S. Date: Feb. 18, 1940.

U. S. GOVERNMENT PRINTING OFFICE 3—10628

CASE I RIVER UP

Forces Acting	↓	↑	→	←	Arm	Moments About "A" →	Moments About "A" ←
C_1 22' x 15' x 150'	4950'				11.50'	56,900'	
C_2 11' x 1.8' x ½ x 150'	1485'				10.15	15,100'	
C_3 23' x 2.5' x 150'	8610'				11.50'	99,400'	
C_4 2.5' x 3.5' x 150'	1400'				21.13'	29,700'	
E_1 8.9' x 2' x 125'	2230'				9.45'	19,300	
E_2 10.75' x 7' x 125'	9400'				17.62'	[illegible]	
P_W 15' x ½ x 62.5'				[illegible]	14.5'		103,300'
P_{WC} 15' x 42.5' x 12'				11,300'	3.5'		39,580'
P_{e_1} 12' x ½ x 83'				5760'	1.5'		8,600'
[illegible]	[illegible]				[illegible]	[illegible]	
P_{a_2} 7' x ½ x 40'			1960'		6.17'		500'
U_1 [illegible] x 15'		25,30'			22.35'		56,300'
U_2 2.81' x 21.5'		[illegible]			15.35'		65,100'
U_3 7.10' x ½ x 21.5'		7620'			14.35'		109,300'
Friction .45 x 21,980			9900				
Passive Resistance			12230		5.17		2,780
	38,180'	[illegible]	4090	[illegible]		554,650	38[illegible],080
	ΣV = 21,980'		ΣH = [illegible]			ΣM = 171,570	

Location of resultant $= \frac{\Sigma M}{\Sigma V} = 7.8$ O.K. in middle third

$e = 11.5 - 7.8 = 3.7$

$$\text{Bearing} = \frac{21,980}{23}\left[1 \pm \frac{6 \times 3.7}{23}\right]$$

$$= 957 \begin{bmatrix} 1.97 \\ .03 \end{bmatrix} = \begin{matrix} 1870 \\ 28 \end{matrix}$$

WAR DEPARTMENT

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

Ject: HARTFORD HTS

omputation: WALL STEM 22' BASE 23' STA. 6+00± TO 7+00±

omputed by: P.L.A. Checked by: Date: 3/4/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

CASE II RIVER LOW

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT "A" ↷	MOMENTS ABOUT "A" ↶
C_1		4950					56,900	
C_2		1490					15,100	
C_3		8610					99,000	
C_4		1400					29,700	
E_1		2230					9950	
E_2		9400					166,000	
Pe_1				1960			300	
Pe_2	$V_2 \times .35 \times T_2^2$				2520	1.5		3780
U_2			6050					65100
FK	22030 X .45			9900				
		28180	6050	11860	2520		376,950	68,880
		ΣV: 22,030		ΣH = 0			ΣM = 308,150	

$\frac{2}{3}$ BASE $= \frac{23 \times 2}{3} = 15.3'$

POSITION OF RESULTANT $= \frac{\Sigma M}{\Sigma V} = \frac{308,000}{22,000} = 14.0'$ $\quad e = 14.0 - 11.5 = 2.5'$

BEARING $= \frac{\Sigma V}{A}\left(1 \pm \frac{6e}{d}\right) = \frac{22000}{23}\left(1 \pm \frac{6 \times 2.5}{23}\right) = 956 \begin{cases} 1.65 = 1580 \ \#/\square' \\ .35 = 335 \ \#/\square' \end{cases}$

Note: Use Same Steel as in Sections (9), (10) & (11)

WAR DEPARTMENT

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

Subject: HARTFORD, CONN. - H.T.5 - FLOOD AND RETAINING WALL

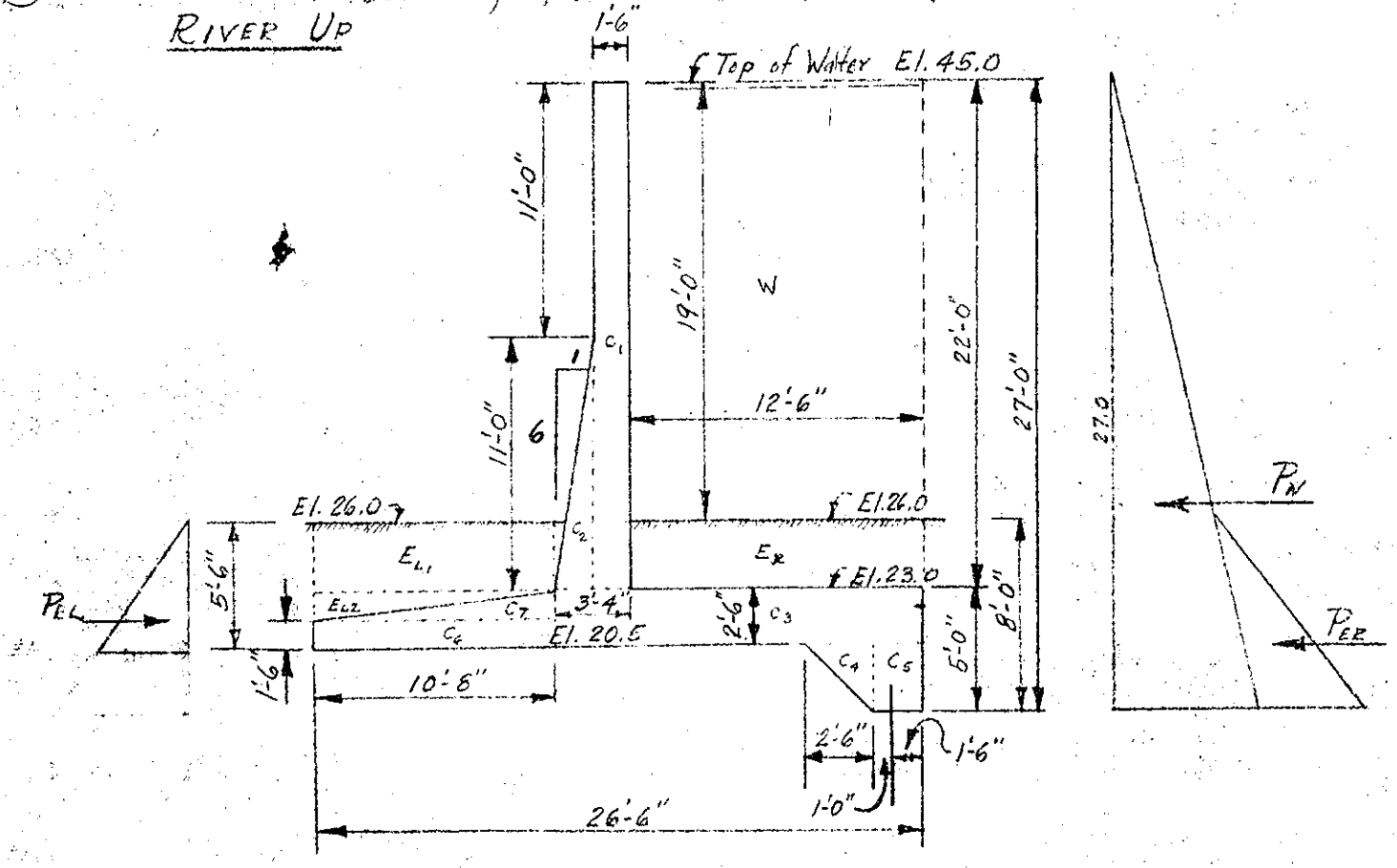
Computation: STABILITY - 22' STEM; 26'-6' BASE

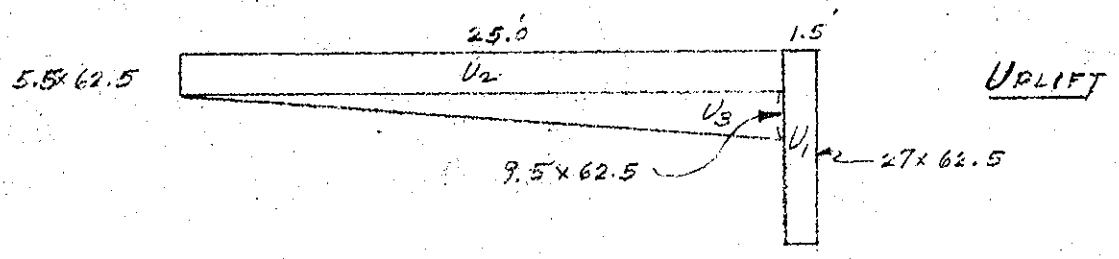
Computed by: J.A.C. Checked by: Date: 3/7/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

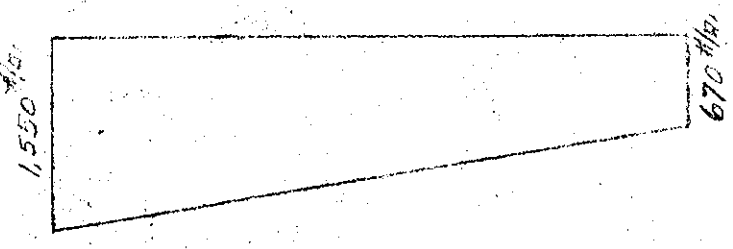
Note: These Computations Cover from Sta. 7+92± to Sta. 10+32±

RIVER UP





UPLIFT



BEARING

WAR DEPARTMENT

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

Subject: Hartford Conn Ht 5

Computation: Stability 22' Stem 26'-6" Base

Computed by: J.A.C. Checked by: W. S. Date: 3/7/40

U.S. GOVERNMENT PRINTING OFFICE 3—10538

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT A ↷	↶
W	19 × 12.5 × 62.5	14850				20.25	301000	
Er	3.0 × 12.5 × 125	4690				20.25	95000	
El1	3.0 × 10.67 × 125	4000				5.34	21360	
El2	½ × 1.0 × 10.67 × 125	670				3.56	2390	
C1	22 × 1.5 × 150	4950				13.25	65600	
C2	½ × 11.0 × 1.83 × 150	1510				11.81	18000	
C3	2.5 × 15.83 × 150	5950				18.59	110800	
C4	½ × 2.5 × 2.5 × 150	470				23.17	10900	
C5	2.5 × 2.5 × 150	940				25.25	23500	
C6	1.5 × 10.67 × 150	2400				5.34	12830	
C7	½ × 1.0 × 10.67 × 150	1200				7.11	8530	
Pw	½ × 27² × 62.5				22800	6.50		148200
Per	½ × 8² × 17.5				560	0.17		95
Pel	½ × 8² × 80			2560		1.83	4680	
U1	27 × 1.5 × 62.5		2530			25.75		65100
U2	5.5 × 2.5 × 62.5		8660			12.5		107500
U3	½ × 9.5 × 2.5 × 62.5		7420			16.67		123500
Fr	0.45 × 23080			10,400				
Pr	Passive Resistance			10400		0.17		2480
		41,630	18,550	23,360	23,360		674,570	446,875
		ΣV = 23,080 ↓		ΣH = 0			ΣM = 227,715 ↷	

Position of Resultant $\Big\} = \dfrac{\Sigma M}{\Sigma V} = \dfrac{227715}{23080} = 9.85'$ 1.35 inside middle 3rd

$e = 13.25 - 9.85 = 3.40'$

$$B.P. = \frac{23080}{26.5}\left[1 \pm \frac{6 \times 3.4}{26.5}\right] = 872\left[1 \begin{matrix} +.77 \\ -.77 \end{matrix}\right] = \begin{matrix} 1550 \ \#/\square' \\ 670 \ \#/\square' \end{matrix}$$

Subject: HARTFORD, CONN. – HT. 5
Computation: 22' STEM – 26'-6" BASE
Computed by: J.A.C. Checked by: W.H.F. Date: 3/7/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF STEEL IN STEM – RIVER UP

	→	←	Arm	Mom ↷	Mom ↶
$P_W = \frac{1}{2} \times 22^2 \times 62.5$		15,150	7.33		111,000
$P_{EX} = \frac{1}{2} \times 3^2 \times 17.5$		79	1.00		79*
$P_{EL} = \frac{1}{2} \times 3^2 \times 80$	360		1.00	360*	

*Neglect $V = 15,150^{\#}$, $M = 111,000'\#$

$$A_s = \frac{12 \times 111,000}{18,000 \times .884 \times 36.5} = 2.29^{\square''}$$

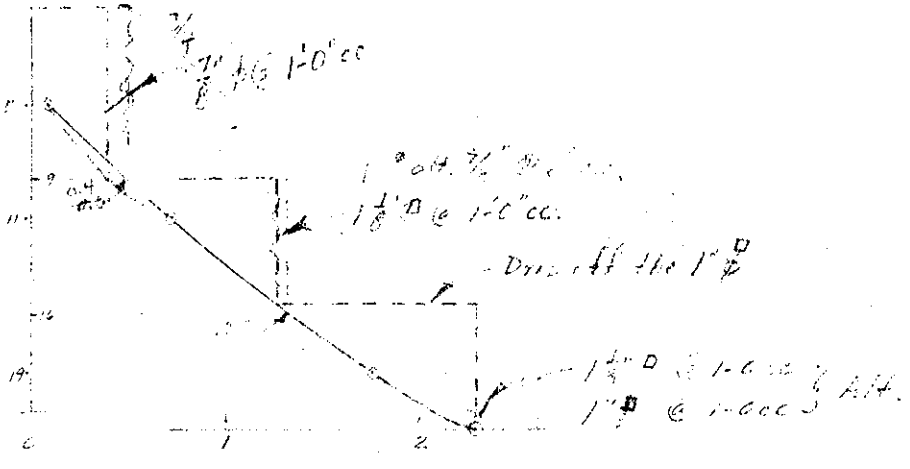
$$\Sigma_o = \frac{15,150}{15 \times .884 \times 36.5} = 3.13''$$

$$v = \frac{15,150}{12 \times .884 \times 36.5} = 39^{\#/\square''}$$

Use $1\frac{1}{8}''\square$ & $1''\square$ staggered @ 6" c.c. in Riverside face. A_s supplied $1.00 + 1.27 = 2.27^{\square''}/ft$

A_s DIAGRAM – RIVERSIDE FACE

At top of base only



Subject: Hartford Conn. - Mt. C
Computation: 22' Stem - 26'-6" Base
Computed by: J.A.C. Checked by: M.A.E. Date: 3/11/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF STEEL IN STEM - RIVER UP

SECTION AT 19'-0" BELOW TOP OF WALL

$P_w = \frac{1}{2} \times 19^2 \times 62.5 = 11,300 \times 6.33 = 71,500'^{\#}$

$V = 11,300^{\#}$
$M = 71,500'^{\#}$

Total depth = 2'-10"
$d = 30.5"$

$A_s = \frac{12 \times 71,500}{18,000 \times .884 \times 30.5} = 1.77^{\square''}$

$\Sigma_o = \frac{11,300}{150 \times .884 \times 30.5} = 2.8"$

$v = \frac{11,300}{12 \times .884 \times 30.5} = 35^{\#/\square''}$

SECTION AT 11'-0" BELOW TOP OF WALL

$P_w = \frac{1}{2} \times 11^2 \times 62.5 = 3,780 \times 3.67 = 13,900'^{\#}$

Total depth = 1'-6"
$d = 14.5"$

$V = 3,780^{\#}$
$M = 13,900'^{\#}$

$A_s = \frac{12 \times 13,900}{18,000 \times .884 \times 14.5} = 0.73^{\square''}$

$\Sigma_o = \frac{3,780}{150 \times .884 \times 14.5} = 1.97"$

$v = \frac{3,780}{12 \times .884 \times 14.5} = 25^{\#/\square''}$

SECTION AT 5'-0" BELOW TOP OF WALL

$P_w = \frac{1}{2} \times 5^2 \times 62.5 = 780 \times 1.67 = 1,300'^{\#}$

$V = 780^{\#}$
$M = 1,300'^{\#}$

$A_s = \frac{12 \times 1,300}{18,000 \times .884 \times 14.5} = 0.07^{\square''}$

$\Sigma_o =$

$v =$

Subject: HARTFORD, CONN. – H.T.5
Computation: 22' STEM – 26'-6" BASE
Computed by: T.A.C. Checked by: W.H.F. Date: 3/7/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF STEEL IN TOE SLAB – RIVER UP

	Forces Acting	↓	↑	Arm	Mom ↷	Mom ↶
6.5 × 62.5 = 344	W	14,850		6.25	92,800	
9.5 × 62.5 = 594	I_R	4,690		6.25	29,300	
938	C_1 = 2.5 × 12.5 × 150	4,700		6.25	29,400	
	C_2 = ½ × 2.5 × 2.5 × 150	470		9.17	4,300	
23.8 × 11.0 = 262	C_3 = 2.5 × 2.5 × 150	940		11.25	10,600	
676	U_1 =		2,530	11.75		29,700
	U_2 = 676 × 11		7,440	5.5		41,000
	U_3 = ½ × 252 × 11		1,390	7.33		10,200
33.2 × 12.5 = 415	BP_1 = 670 × 12.5		8,380	6.25		52,400
	BP_2 = ½ × 415 × 12.5		2,600	4.17		10,850
		V = 3,310 ↓			M = 22,250 ↷	

$d = 30 - 3.5 = 26.5''$

$$A_s = \frac{12 \times 22{,}250}{18{,}000 \times .884 \times 26.5} = 0.64^{\square''}$$

$$\Sigma_o = \frac{3{,}310}{150 \times .884 \times 26.5} = 0.95''$$

$$v = \frac{3{,}310}{12 \times .884 \times 26.5} = 12^{\#/\square''}$$

USE $\frac{7}{8}''\phi$ @ 12" c.c.

IN TOP FACE ($A_s = 0.60^{\square''}$)

WAR DEPARTMENT

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

Project: HARTFORD CONN - HT. 5

Computation: 22' STEM - 26-6 BASE

Computed by: J.A.C. Checked by: W.H.F. Date: 3/7/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF STEEL IN HEEL SLAB - RIVER UP

Land Side

$\frac{9.5 \times 62.5}{25.0} = 23.8$

$10.67 \times 23.8 = 253$

$1550 - 670 = 880$

$\frac{880}{26.5} = 33.2$ Trap/ft

$10.67 \times 33.2 = 354$

$1550 - 354 = 1196$

FORCES ACTING	↓	↑	ARM	MOMENT ↷	MOMENT ↶
E_{L1} =	4,000		5.34		21,360
E_{L2} =	670		7.11		4,760
C_1 =	1,200		3.56		4,270
C_2 =	2,400		5.34		12,850
$U_1 = 5.5 \times 62.5 \times 10.67$		3,670	5.34	19,600	
$U_2 = 253 \times \frac{1}{2} \times 10.67$		1,350	3.56	4,800	
$BP_1 = 1196 \times 10.67$		12,750	5.34	68,000	
$BP_2 = \frac{1}{2} \times 354 \times 10.67$		1,890	7.11	13,450	
	$V = 11,390^{\#}$ ↑			$M = 62,610$ ↷	

$d = 30 - 3.5 = 26.5''$

$A_s = \frac{12 \times 62,610}{18,100 \times .884 \times 26.5} = 1.78^{\square''}$

$I_s = \frac{11,390}{150 \times .884 \times 26.5} = 3.25^{\square''}$

$v = \frac{11,390}{12 \times .884 \times 26.5} = 41^{\#/\square''}$

USE 1"□ & 1"φ staggered @ 6" cc IN BOTTOM FACE {A_s supplied: $1.79^{\square}$

USE $\frac{5}{8}$" φ @ 1'-0" c.c. IN TOP FACE

WAR DEPARTMENT

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

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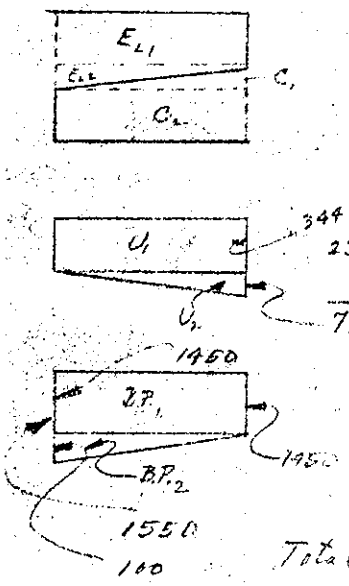
Project: Hartford, Conn. — Ht. 5

Computation: 21'-0" Stem — 25'-6" Base

Computed by: T.A.C. Checked by: W H F Date: 3/11/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Steel in Heel Slab — River Up



23.8 per ft
×3
71.4 (3'-0")

33.2 per ft
3
99.6 = 100 (3'-0")

Section 3'-0" from Heel

	↓	↑	Arm	↷	↶
E_{L1} = 3×3×125	1125		1.5		1,690
E_{L2} = ½×3×0.28×125	56		2.0		112
C_1 = ½×3×0.28×150	63		1.0		63
C_2 = 3×1.5×150	675		1.5		1,010
U_1 = 344×3		1032	1.5	1,550	
U_2 = ½×3×71		106	1.0	106	
BP_1 = 1450×3		4350	1.5	6,520	
BP_2 = ½×100×3		150	2.0	300	
	1,919	5638		8,476	2,875
		−1,919		−2,875	
		V = 3,719# ↑		M 5,601'# ↷	

Total depth = 1.6 + 3 = 1.9
d = 17.5
16.5

$A_s = \frac{12 \times 5,601}{18000 \times .884 \times 17.5} = 0.24$ □"

$\Sigma_o = \frac{3,719}{150 \times .884 \times 17.5} = 1.60$"

$v = \frac{3,719}{12 \times .884 \times 17.5} = 20$ #/□"

Section 6'-0" from Heel

	↓	↑		↷	↶
E_{L1} = 6×3×125	2250		3.0		6,750
E_{L2} = ½×6×0.56×125	210		4.0		840
C_1 = ½×6×0.56×150	252		2.0		504
C_2 = 6×1.5×150	1350		3.0		4,050
U_1 = 344×6		2064	3.0	6,192	
U_2 = ½×6×143		429	2.0	858	
BP_1 = 1350×6		8100	3.0	24,300	
BP_2 = ½×6×200		600	4.0	2400	
	4,062	11,193		33,750	12,144
		−4,062		−12,144	
		V = 7,131#		M = 21,606'#	

23.8
×6
142.8

33.2
6
199.2

1550
d = 200
1350

$A_s = \frac{12 \times 21,606}{18,000 \times .884 \times 21.5} = 0.76$ □"

WAR DEPARTMENT
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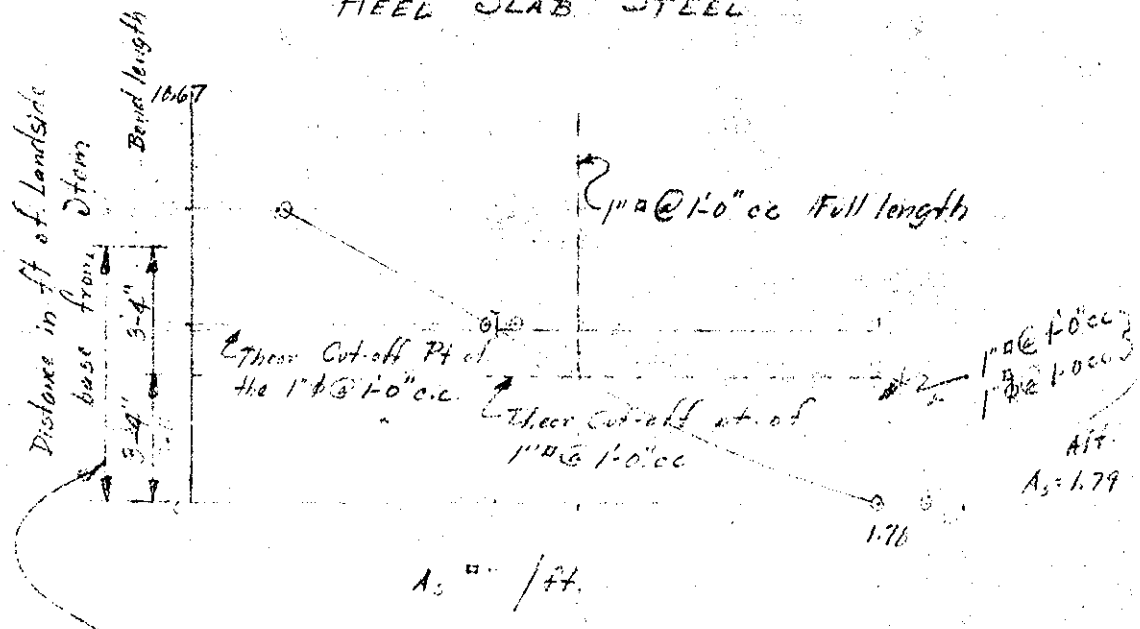
Subject
Computation
Computed by -IAC Checked by W HF Date 3/12/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

HEEL SLAB STEEL



Tot Length beyond section at bott. of haunch = 6'-8"

BOTTOM FACE STEEL
- LET 1"□ @ 1'-0" cc RUN FULL LENGTH
- CUT 1"□ @ 1'-0" cc 6'-8" (7'-3") FROM BOTT OF HAUNCH.

WAR DEPARTMENT

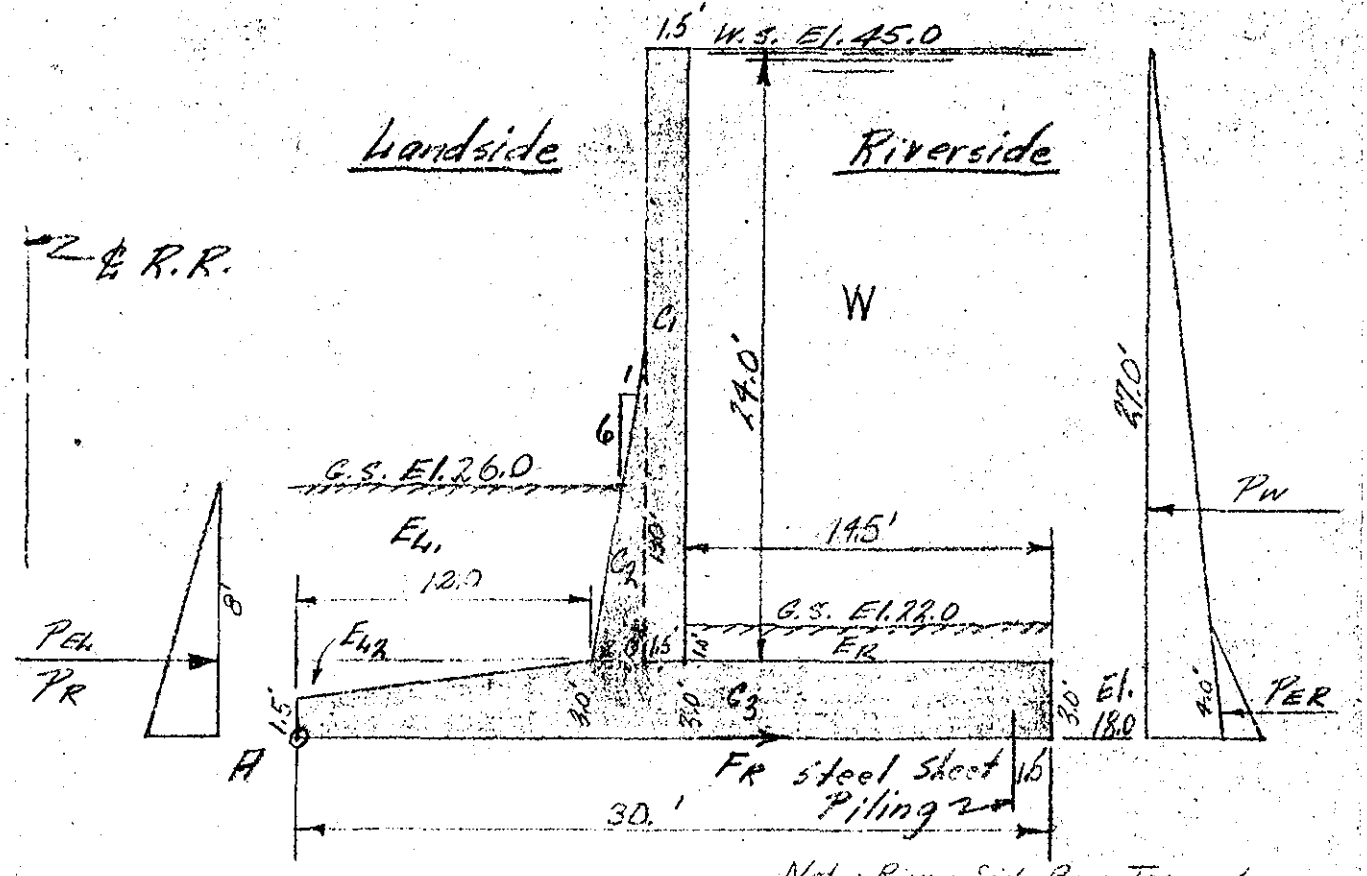
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Object: Hartford Dike - Ht-5

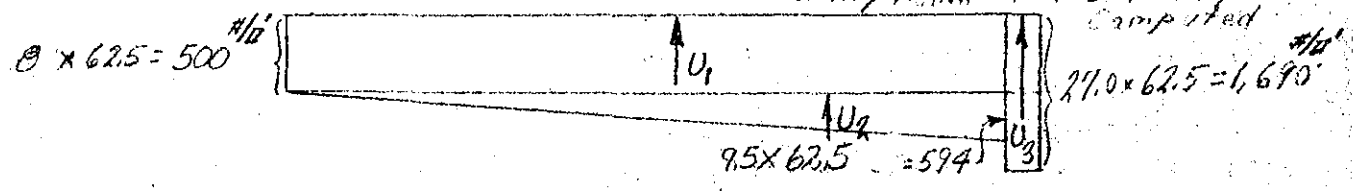
Computation: Flood Wall - Typical Section - Sta. 10+00 to Sta. 11+00

Computed by: JSM Checked by: R.W. Date: 1/24/40

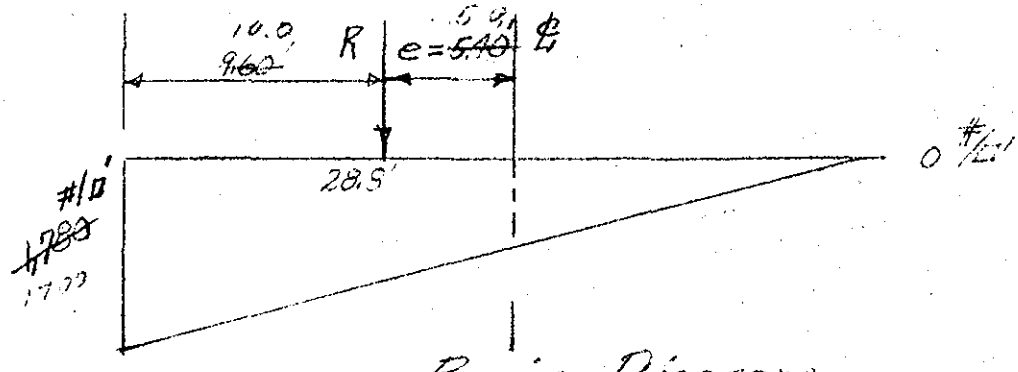
U. S. GOVERNMENT PRINTING OFFICE 3—10528



Note: River Side Base Tapered and Key Added after Stability Computed



Uplift Diagram



Bearing Diagram

WAR DEPARTMENT

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

Subject: Hartford Dike - HT-5

Computation: Flood Wall - Typical Section - Sta. 10+00 to Sta. 11+00

Computed by: JSM Checked by: RW Date: 1/24/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

24'-0" Wall - 31'-0" Base

Forces Acting		↓	↑	→	←	Arm	Moments about A ↻	Moments about A ↺
C_1	1.5 × 24 × 150	5,400				14.75	79650	
C_2	1/2 × 2 × 13 × 150	1,950				13.33	25990	
C_3	3 × 30 × 150	13,500				15.00	202500	
W	14.5 × 23 × 62.5	20840				22.75	474110	
E_R	1 × 14.5 × 125	1,810				22.75	41180	
E_{H_1}	12.0 × 5 × 125	7500				6.00	45000	
E_{H_2}	1/2 × 1.5 × 12.0 × 125		230			4.00		920
P_W	1/2 × 62.5 × 27²				22,800	9.00		205,200
P_{ER}	1/2 × (80 - 62.5) × 4²				140	1.33		190
P_{EH}	1/2 × 80 × 8²			2560		2.67	6840	
U_1	500 × 28.5		14250			14.25		203060
U_2	1/2 × 59.7 × 28.5		8460			19.00	161,000	170,540
U_3	1,670 × 1.5		2,535			29.25		74,250
F_R	0.45 × 25,525			11,490		0.00	—	—
P_R	22,940 - 14050			8,890		2.67	23,740	64,620
		51000	25475	22,940	22,940		899010	654260
		ΣV = 25525		ΣH = 0			ΣM = ~~244750~~ 254,390 #	

$$\frac{\Sigma M}{\Sigma V} = \frac{\cancel{244750}\ 254,390}{25525} = \cancel{9.60}\ 10.0'$$

Middle 3rd } = 10.0' ~~.4' outside~~ OK. On Third Point

Max. Passive Resistance } $= \frac{125 \times (8+1)^2}{2} \times 3.44 = 17400$ #/'

Max. Net Allowable Pas. Res. = 17,400 - 2560 = 14840 #/'

(Max. Allowable Pas. Res.) 14840 #/' > (Max. Used Pas. Res) 8890 #/' : OK.

$$\text{Eccentricity} = \frac{30.0}{2} - \cancel{9.60}\ 10.0 = \cancel{5.40}\ 5.0'$$

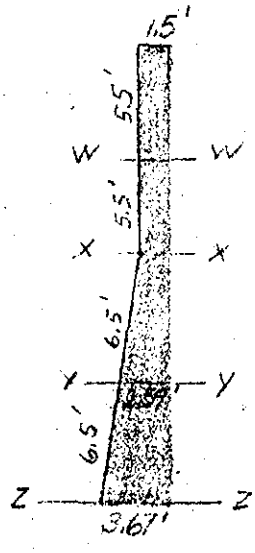
$$\text{Bearing} = \frac{25525}{3 \times \cancel{9.60}\ 3 \times 10}\begin{pmatrix}2\\0\end{pmatrix} = \cancel{886}\ 850 \begin{cases} 2 = \cancel{1780}\ 1700\ \#/\square' \\ 0 = 0\ \#/\square' \end{cases}$$

Note: Corrections made will have no material effect on Steel Design.

Subject: Hartford - H-T5
Computation: Flood Wall - Typical Section - Sta. 10+00 to Sta. 11+00
Computed by: R.H.M. Checked by: R.W. Date: 2/9/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Stem Steel



$M_{(w-w)} = 5.5^2 \times \frac{1}{2} \times 62.5 = 945 \times 1.83 = 1730$ #

$M_{(x-x)} = 11^2 \times \frac{1}{2} \times 62.5 = 3780 \times 3.67 = 13870$ #

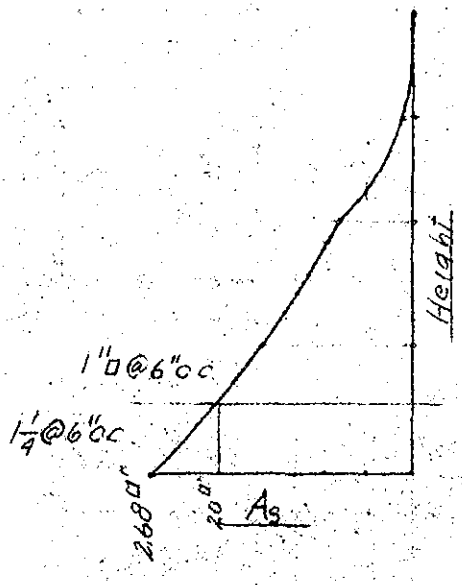
$M_{(y-y)} = 17.5^2 \times \frac{1}{2} \times 62.5 = 9570 \times 5.83 = 55790$ #

$M_{(z-z)} = 24^2 \times \frac{1}{2} \times 62.5 = 18000 \times 8.0 = 144{,}000$ #

$A_{s(w-w)} = \frac{12 \times 1730}{18000 \times .884 \times 14.5} = \frac{20760}{231000} = .09 \square''$

$A_{s(x-x)} = \frac{12 \times 13870}{18000 \times .884 \times 14.5} = \frac{166440}{231000} = .72 \square''$

$V_{(x-x)} = \frac{3780}{12 \times .884 \times 14.5} = \frac{3780}{154} = 25 \ \#/\square''$ O.K.



$A_{s(y-y)} = \frac{12 \times 55790}{18000 \times .884 \times 27.5} = \frac{669480}{437250} = 1.53 \square''$

$V_{(y-y)} = \frac{9570}{12 \times .884 \times 27.5} = \frac{9570}{292} = 33 \ \#/\square''$

$A_{s(z-z)} = \frac{12 \times 144000}{18000 \times .884 \times 40.5} = \frac{1728000}{643950} = 2.68 \square''$

$V_{(z-z)} = \frac{18000}{12 \times .884 \times 40.5} = \frac{18000}{429} = 42 \ \#/\square''$ O.K.

$d_{(required)x-x} = \sqrt{\frac{13870}{123}} = 10.7''$ O.K.

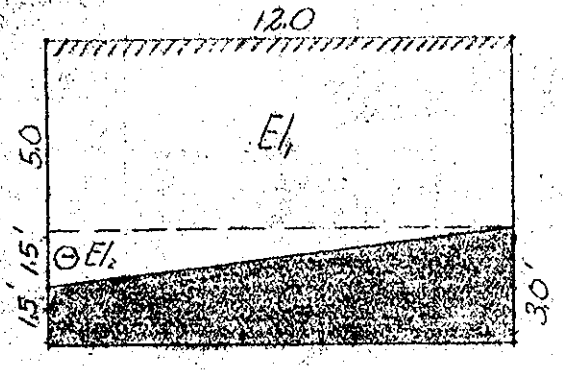
$d_{(required)y-y} = \sqrt{\frac{55790}{123}} = 21.3''$ O.K.

$d_{(required)z-z} = \sqrt{\frac{144000}{123}} = 34.3''$ O.K.

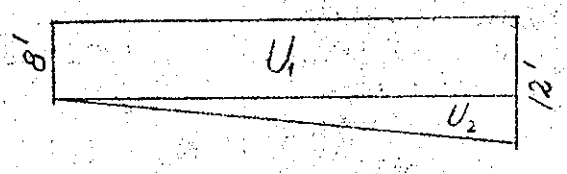
Object: Hartford - (H-T5)
Computation: Flood Wall - Typical Section Sta 10+00 to Sta 11+00
Computed by: R.H.M. Checked by: RW Date: 2/9/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

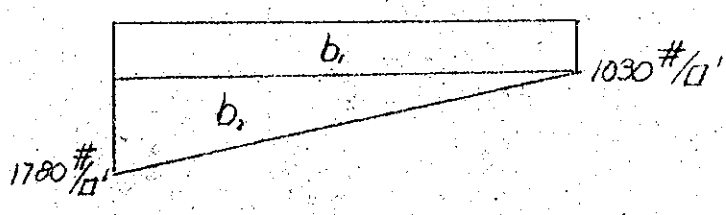
Design of Landside Base Slab



Loads Down



Uplift



Bearing

↓	El_1 :	12 × 5 × 125	= 7500	× 6	=	45000	1#↺
↓	C_3 :	12 × 3 × 150	= 5400	× 6	=	32400	"
↑	El_2 :	12 × 1.5 × ½ × 25	= 230	× 8	=	1840	1#↺
↑	U_1 :	12 × 8 × 62.5	= ~~4500~~ 6000	× 6	=	~~27000~~	" 36,000
↑	U_2 :	12 × 4 × ½ × 62.5	= 1500	× 4	=	6000	"
↑	b_1 :	12 × 1030	= 12,360	× 6	=	74160	"
↑	b_2 :	12 × ½ × 750	= 4500	× 8	=	36000	"

$\Sigma V = 11690$ #↑ $\Sigma M = 76600$ 1#↺

$$d_{(required)} = \sqrt{\frac{67600}{123}} = \sqrt{250} = 23.5'' \text{ ok } 36 - 4.5 = 31.5'' \text{ provided}$$

$$A_s = \frac{12 \times 67600}{18000 \times .884 \times 31.5} = \frac{\cancel{811,200}}{501,000} = \cancel{1.62}\ 1.84\ \square'' \quad \text{Use } 1''\square @ 1'\ 0''\ \text{o.c.}$$

1"p ~~7/8~~"φ @ 1'0" o.c.

$$V = \frac{10190}{12 \times .884 \times 31.5} = 31\ \#/\square'' \text{ O.K.} \qquad \Sigma_o = \frac{10190}{150 \times .884 \times 31.5} = 2.44'' \text{ O.K.}$$

6.15" provided

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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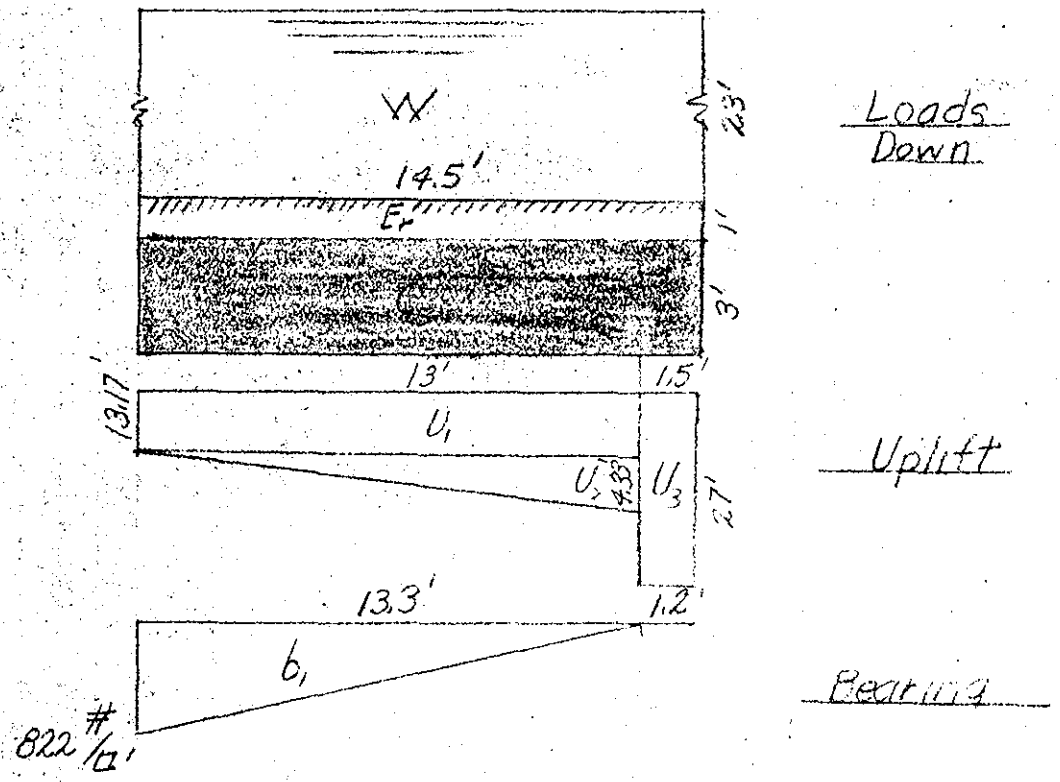
bject Hartford - H-75
mputation Flood Wall - Typical Section Sta 10+00 to Sta 11+00
mputed by R.H.M. Checked by RW Date 2/9/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Riverside Base Slab



↓ W	: 14.5 × 23 × 62.5	= 20840	× 7.25	=	151090	'# ↓
↓ E_r	: 14.5 × 1 × 125	= 1810	× 7.25	=	13120	"
↓ C_3	: 14.5 × 3 × 150	= 6530	× 7.25	=	47340	"
↑ U_1	: 13 × 13.17 × 62.5	= 10700	× 6.50	=	69550	'# ↑
↑ U_2	: 13 × 4.33 × ½ × 62.5	= 1760	× 8.66	=	15240	"
↑ U_3	: 1.5 × 27 × 62.5	= 2540	× 13.75	=	34930	"
↑ b_1	: 13.3 × ½ × 822	= 5470	× 4.43	=	24230	"
	$\Sigma V = 8710$		#↓ $\Sigma M =$		61600	'# ↓

d (ok. see page ④)

$$A_s = \frac{12 \times 67600}{18000 \times .884 \times 32.5} = \frac{811200}{517{,}000} = 1.57 \square''$$ Use 1"φ@6"

Shear and Bond ok by inspection

WAR DEPARTMENT

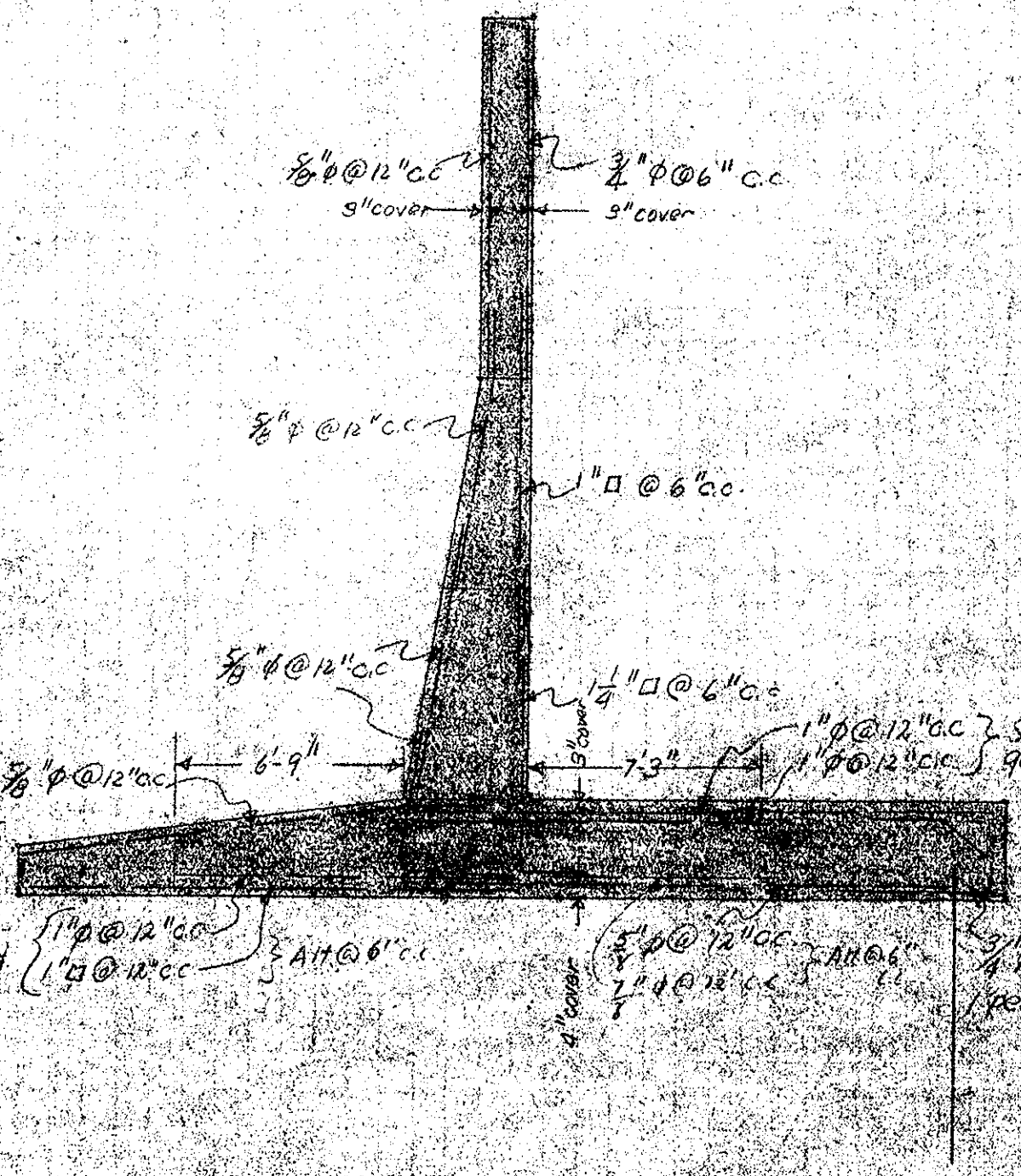
U. S. ENGINEER OFFICE, PROVIDENCE, R. I. Sta. 10+31.19 to 10+71.19 Page 109

Subject: Hartford - H-75

Computation: Flood Wall - Typical Section Sta. 10+00 to Sta 11+00

Computed by: R.H.M. Checked by: RW Date: 2/9/40

U.S. GOVERNMENT PRINTING OFFICE 3—10523



WAR DEPARTMENT

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

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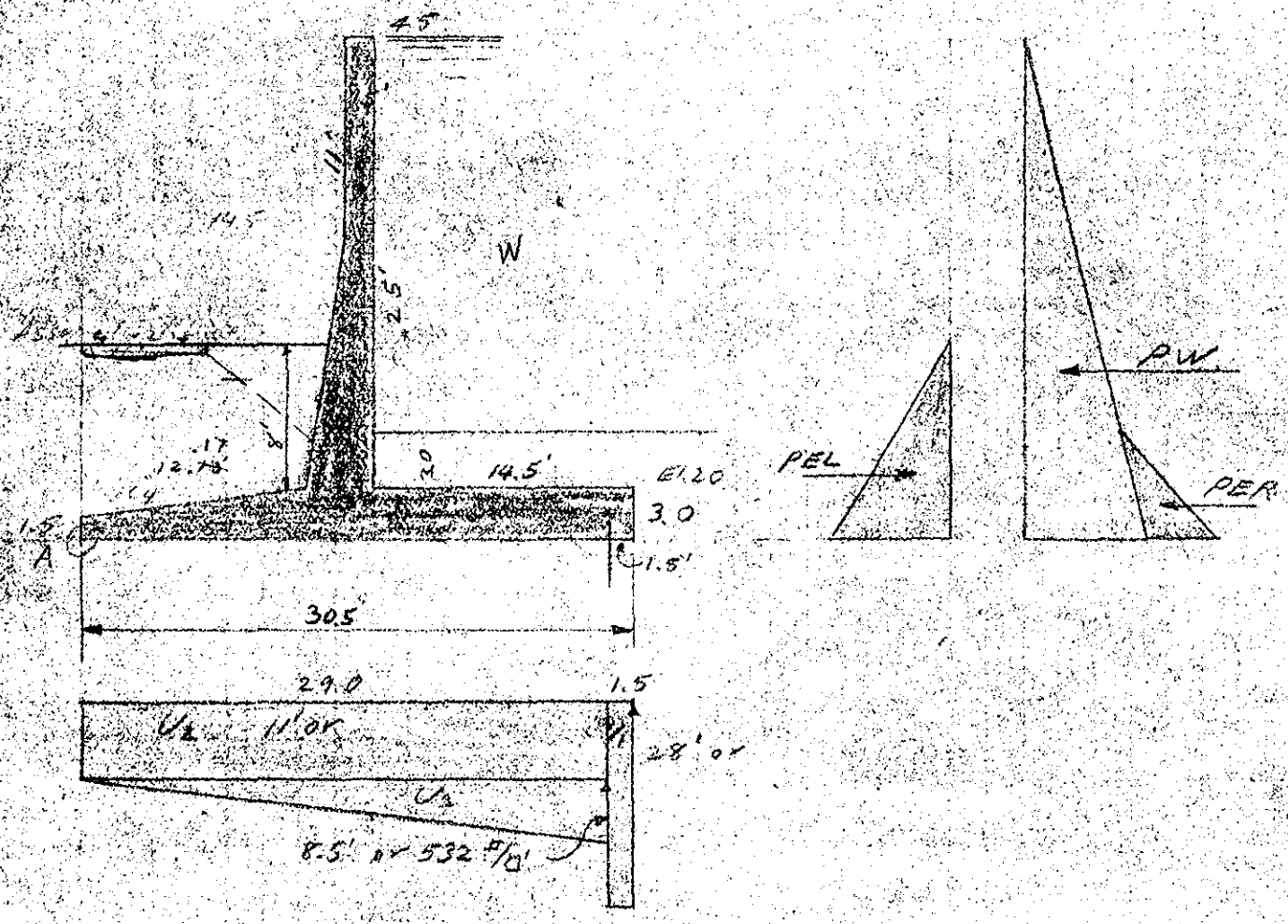
Subject: H15 Hartford — 10+72± to 11+52±

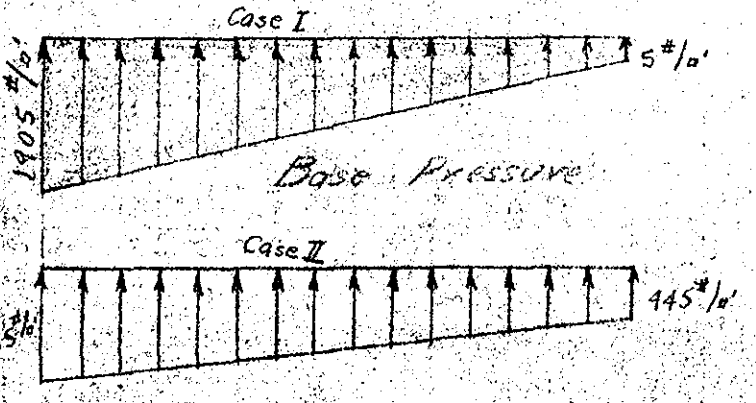
Computation: 25' Stem, 30.5' Base — Sta. 11+00

Computed by: KW — Checked by: E.H.V. — Date: 2-20-40

U. S. GOVERNMENT PRINTING OFFICE 8—10528

Stability





WAR DEPARTMENT

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

Subject Ht.S HARTFORD

Computation 25'-0" WALL

Computed by R.W. & E.H.V. Checked by E.H.V. Date 2-20-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STABILITY

CASE I River up
Sat. earth behind wall

FORCES ACTING	↓	↑	→	←	ARM	MOMENTS ABOUT A ↻	MOMENTS ABOUT A ↺
$C_1 = 1.5 \times 25 \times 150$	5,630				15.25	85,800	
$C_2 = 14 \times 2.33 \times \frac{1}{2} \times 150$	2,445				13.73	33600	
$C_3 = 30.5 \times 3 \times 150$	13,720				15.25	209500	
$C_4 = -1.5 \times 12.13 \times \frac{1}{2} \times 25$		228			4.04		920
$E_L = \left(\frac{13.5+12.1}{2}\right) \times 8 \times 125$	12,800				6.3	80600	
$E_R = 3 \times 14.5 \times 125$	5,440				23.25	126,400	
$W = 22 \times 14.5 \times 62.5$	19,950				23.25	464,000	
$U_1 = 28 \times 1.5 \times 62.5$		2625			29.75		78,100
$U_2 = 11 \times 29 \times 62.5$		19920			14.5		288500
$U_3 = 8.5 \times 29 \times \frac{1}{2} \times 62.5$		7700			19.33		149,000
$P_{EL} = 11^2 \times \frac{1}{2} \times 12.5$			7570		3.66	27650	
$P_{ER} = 6^2 \times \frac{1}{2} \times 17.5$				315	2.0		630
$P_W = 29^2 \times \frac{1}{2} \times 62.5$				24500	9.33		229000
$F_R = .45 \times 29112$			13100		0		
$P_R =$			4145		3.66	15180	
	59,985	30,873	24815	24815		1,042,730	746,150
	$\Sigma V = 29,112$ #		$\Sigma H = 0$			$\Sigma M = 296,580$ '#	

POSITION OF RESULTANT

$\frac{1}{3}$ base = 10.17

$$\frac{\Sigma M}{\Sigma V} = \frac{296,580}{29112} = 10.19'$$ inside middle third o.k.

$e = 15.25 - 10.19 = 5.06'$

BASE PRESSURE

$$\frac{29112}{30.5}\left(1 \pm \frac{6 \times 5.06}{30.5}\right) = .954 \begin{cases} 1.995 = 1905\ \#/\square' \text{ landside} \\ .005 = 4.8\ \#/\square' \text{ riverside} \end{cases}$$

Subject: HARTFORD - Ht. 5
Computation: 25'-0" Wall (cont.)
Computed by: E.H.V. Checked by: Date: 2-28-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

CASE II — River down. Sat. earth behind wall.

FORCES ACTING	↓	↑	→	←	ARM	MOMENTS ABOUT A ↻	MOMENTS ABOUT A ↺
C_1	5630				15.25	85,800	
C_2	2445				13.73	33,600	
C_3	13720				15.25	209,500	
C_4		228			4.04		920
E_L	12800				6.3	80,600	
E_R	5440				23.25	126,400	
U_2		19920			14.5		288,500
P_{EL}			7570		3.66	27,650	
$P_{ER} = 6^2 \times \frac{1}{2} \times 80$				1440	2.0		2880
$F_R = .45 \times 39,887$ max				6130	0		
	40,035	20148	7570	7570		563,550	292,300
	$\Sigma V = 19,887$ #		$\Sigma H = 0$			$\Sigma M = 271,250$ '#	

RESULTANT

$$\frac{\Sigma M}{\Sigma V} = \frac{271,250}{19,887} = 13.65' \text{ O.K.}$$

Middle $\frac{1}{3}$ = 10.17

$e = 15.25 - 13.65 = 1.6'$

BEARING

$$\frac{19,887}{30.5}\left(1 \pm \frac{6 \times 1.6}{30.5}\right) = 650 \begin{cases} 1.315 = 855\#/\square' \text{ land.} \\ .685 = 445\#/\square' \text{ river.} \end{cases}$$

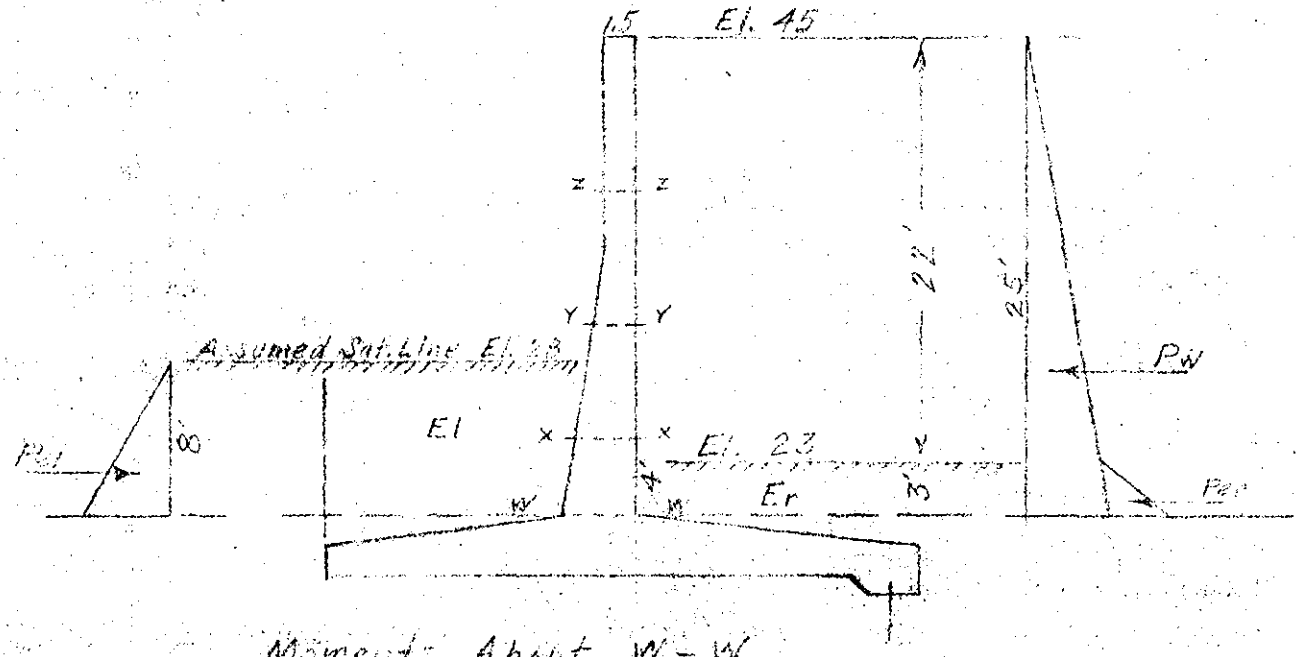
Subject: Hartford Conn. Ht 5 — Sta. 10+72± to 11+52±

Computation: Design of Stem

Computed by: W. G. F. — Checked by: K. N. — Date: 3/7/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case I River Up



Moments About W-W

Forces Acting		→	←	Arm	↷	↶
Pel	$8^2 \times \frac{1}{2} \times 125$	4000		2.67	10680	
Pw	$25^2 \times \frac{1}{2} \times 62.5$		19530	8.33		162680
Per	$3^2 \times \frac{1}{2} \times 17.5$		80	1.0		80
		4000	19610		10680	162760
$d = 3.83' = 46''$		$\Sigma V = 15610$ ←			$\Sigma M = 152080$ ↶	

$d = \sqrt{\frac{152080}{123}} = 35.2 + 3.5 = 38.7'' < 46''$ o.k. Bond $= \frac{15610}{(4.5+5) \times .884 \times 42.5} = 44\ \#/\square''$

$A_s = \frac{152080}{1325 \times 42.5} = 2.70\ \square''$ Use $1\frac{1}{8}''\square$ alt $1\frac{1}{4}''\square$ @ 6" c.c.

Unit Shear $= \frac{15610}{10.6 \times 46} = 32\ \#/\square'' < 60$ o.k.

Moments About X-X

Pel	$4^2 \times \frac{1}{2} \times 125$	1000		1.33	1330	
Pw	$21^2 \times \frac{1}{2} \times 62.5$		13780	7.0		96460
$d = \frac{14-4}{6} + 1.5 = 3.17'' = 38''$		$\Sigma V = 12780$ ←			$\Sigma M = 95130$ ↶	

$A_s = \frac{95130}{1325 \times 34.5} = 2.08$

Use $1\frac{1}{8}''\square$ alt. $1''\phi$ @ 6" c.c. ($A = 2.05$ o.k.)

Subject: Hartford Conn. Ht-5 Sta. 10+72± to 11+52±
Computation: Design of Stem
Computed by: W.H.F. Checked by: RW Date: 3/11/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Case I River Up (Continued)

Moments About Y-Y

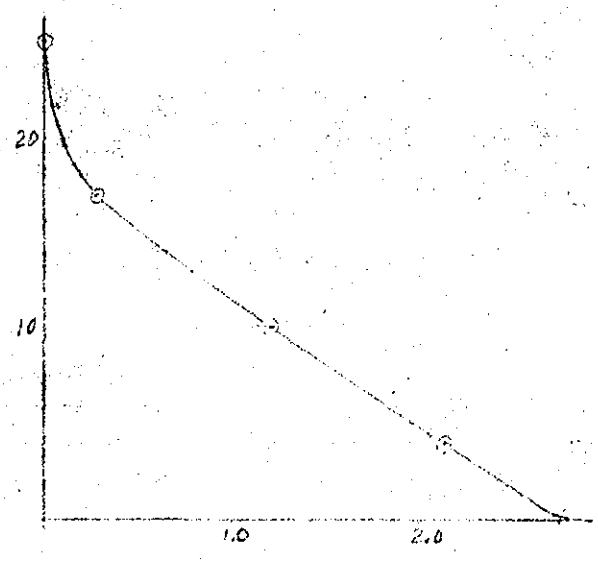
Forces Acting		→	←	Arm	↷	↶
Pw	$15^2 \times \frac{1}{2} \times 62.5$	0	7030	5.0	0	35150

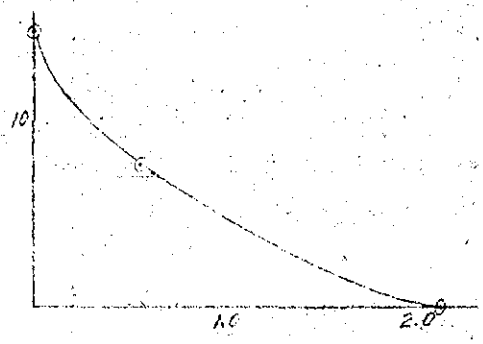
$d = \frac{14-10}{6} + 1.5 = 2.17' = 26''$ $A_s = \frac{35150}{1325 \times 22.5} = 1.18\ \square''$

Use $\frac{7}{8}''\phi$ @ 6" c.c.

			←			↶
Pw	$8^2 \times \frac{1}{2} \times 62.5$		2000	2.67		5340

$d = 1.5' = 18''$ $A_s = \frac{5340}{1325 \times 14.5} = .28\ \square''$ Use $\frac{5}{8}''\phi$ @ 12" c.c.





A_s Riverside Base

WAR DEPARTMENT

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

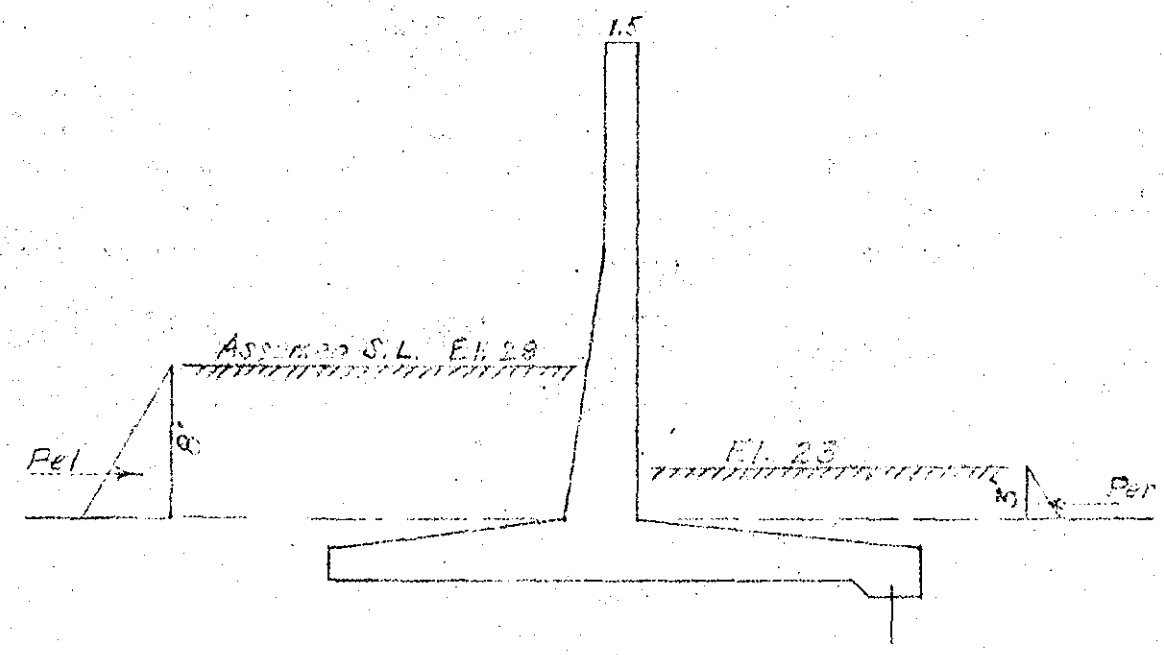
Subject: Hartford Conn. Ht-5 Stn. 10+72± to 11+52±

Computation: Design of Stem

Computed by: Checked by: RW Date: 3/9/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case II River Down



Forces Acting		→	←	Arm	↷	↶
Pel	8 × ½ × 100#	400		2.67	1070	
Per	3 × ½ × 100#		150	1.0		150
		ΣV = 250	→		ΣM = 920	↷

$A_s = \frac{920}{1525 \times 42.5} = .02^{\square''}$ Use temperature steel e.s.

WAR DEPARTMENT

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

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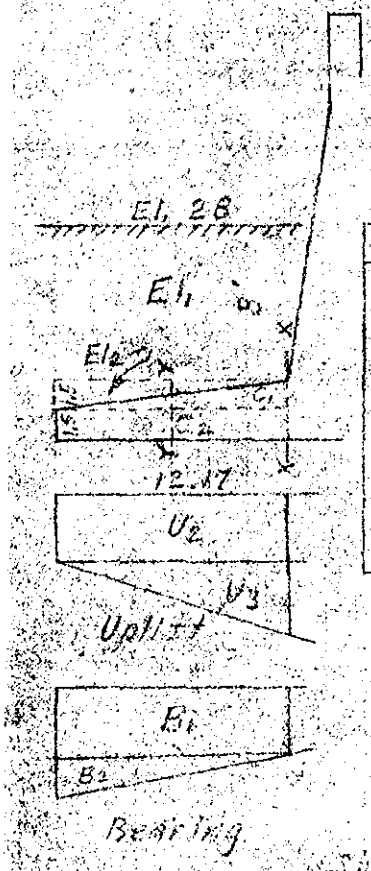
bject Hartford Conn. Ht-5 Sta. 10+72± to 11+52±

mputation Design of Landside Base

mputed by Checked by R.W. Date 3/8/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case I River Up



$U_3 = 17 \times \frac{1}{2} \times 62.5 = 531$ $\quad Y = \frac{12.17}{29} \times 531 = 223$

$B_1 = \frac{18.33}{30.5} \times (1095-5) + 5 = 660$ $\quad B_2 = 1095 - 660 = 435$

Moments About X-X

Forces Acting		↓	↑	Arw	↻	↺
El1	8 × 12.17 × 125	12170		6.08	74000	
El2	1.5 × ½ × 12.17 × 125	1140		8.11	9250	
C1	1.5 × ½ × 12.17 × 150	1370		4.06	5560	
C2	1.5 × 12.17 × 150	2740		6.08	16660	
U2	11 × 12.17 × 62.5		8370	6.08		50920
U3	½ × 12.17 × 223		1380	4.06		5600
B1	12.17 × ~~660~~ 1145		~~8030~~ 13950	6.08		84800
B2	½ × 12.17 × ~~435~~ 760		~~2650~~ 4620	8.11		37500
		17420	20430		105470	178820
		ΣV = 3010 ↑			ΣM = 73,350 ↺	

$d = 3 = 36''$

$d = \sqrt{\frac{\cancel{21360}\ 73,350}{123}} = 13.2 + 4.5 = 17.7 < 36$ o.k.

$A_s = \frac{73,350}{1325 \times 31.5} = 1.76\ \square''$ $\quad$ Bond $= \frac{3010}{\left(\frac{2.75+2.25}{2}\right) \times .884 \times 31.5} = 42\ \#/\square''$

Shear $= \frac{3010}{10.6 \times 36} = 8\ \#/\square'' < 60$ o.k.

Use 1" □ alt. 1" φ @ 12" c.c.

$Y = \frac{6}{29} \times 531 = 110$

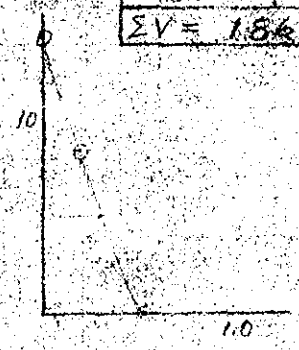
$B_1 = \frac{24.5}{30.5} \times (1095-5) + 5 = 881$

$B_2 = 1095 - 876 = 214$

$d = \frac{1.5 \times 6}{12.17} + 1.5 = 2.24 = 27''$

$A_s = \frac{5890}{1325 \times 22.5} = .19\ \square''$

El	9.33 × 6 × 125	6850		3.0	20550	
C	1.87 × 6 × 150	1680		3.0	5040	
U2	11 × 6 × 62.5		4130	3.0		12390
U3	½ × 6 × 110		330	2.0		660
B1	6 × 881		5290	3.0		15870
B2	½ × 6 × 214		640	4.0		2560
		8530	10390		25590	31480
		ΣV = 1860 ↑			ΣM = 5890 ↺	



WAR DEPARTMENT

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

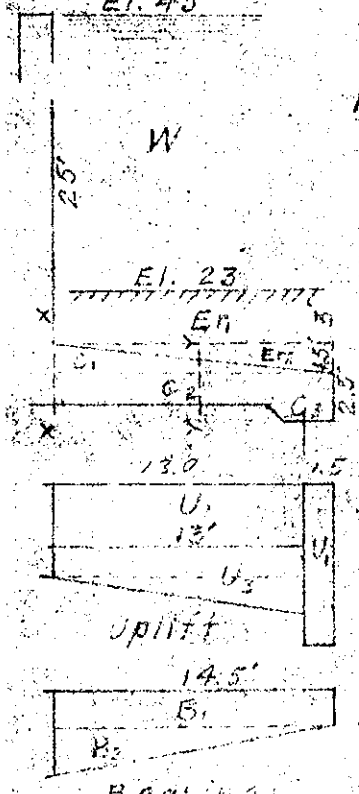
bject Hartford Conn Ht-5 Sta. 10+72± to 11+52±

omputation Design of Riverside Base

omputed by W. H. F. Checked by RW Date 3/8/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case I River Up



$U_3 = (45-28) \times \frac{1}{2} \times 62.5 = 531$ $\quad Y = \frac{16}{29} \times 531 = 293$

$B_2 = \frac{14.5}{30.5} \times (1095-3) = 518$ $\quad Y = 531 - 293 = 238$

Moments About X-X

Forces Acting		↓	↑	Arm	↷	↶
W	22 × 14.5 × 62.5	19940		7.25	144570	
E_{r1}	3 × 14.5 × 125	5440		7.25	39440	
E_{r2}	1.5 × ½ × 14.5 × 125	1360		9.67	13150	
C_1	1.5 × ½ × 14.5 × 150	1630		4.83	7870	
C_2	1.5 × 14.5 × 150	3260		7.25	23640	
C_3	1 × 3 × 150	450		13.0	5850	
U_1	29 × 1.5 × 62.5		2720	13.75		37400
U_2	11 × 13 × 62.5		8940	6.5		58110
U_3	13 × 293		3810	6.5		24770
U_3	½ × 13 × ~~543~~ 239		1550	~~4.33~~ 8.66		13420
B_1	14.5 × 5		70	7.25		510
B_2	½ × 14.5 × ~~518~~ 900		6530	4.83		31500
		32080	23620		234520	165710
		ΣV = 8,460	↓		ΣM = 68,810	↷

$d = 3' = 36''$

$d' = \sqrt{\frac{87340}{123}} = 26.6 + 4.5 = 31.1'' < 36''$ o.k. $\quad$ Bond $= \frac{10880}{(4.0+4.5) \times 584 \times 31.5} = 46$ #/□"

$A_s = \frac{\cancel{87340}\ 68810}{1325 \times 31.5} = \cancel{2.07}\ 1.65$ □"

~~Use 1"φ alt. 1⅛"φ @ 6" c.c.~~

Use 1" □ alt. 1" φ @ 6" c.c. (A = 2.05 □" o.k.)

Shear $= \frac{10880}{10.6 \times 36} = 28$ #/□" < 60 o.k.

Moments About Y-Y (7' from End)

$Y = \frac{23.5}{29} \times 531 = 430$

$Y = 531 - 430 = 101$

$B_2 = \frac{7}{30.5} \times 1090 = 250$

$d = 27$

$A_s = \frac{16040}{1325 \times 22.5} = .54$ □"

Use 5/8"φ @ 6" c.c.

W	22 × 7 × 62.5	9630		3.5	33710	
E_1	4.13 × 7 × 100	2890		3.5	10120	
C_2	1.87 × 7 × 150	1960		3.5	6860	
C_3	1 × 3 × 150	450		5.5	2480	
U_1	29 × 1.5 × 62.5		2720	6.25		17010
U_2	11 × 5.5 × 62.5		3780	2.75		10400
U_3	5.5 × 430		2370	2.75		6520
U_3	½ × 5.5 × 101		280	3.67		1030
B_1	7 × 5		40	3.5		140
B_2	½ × 7 × 250		870	2.33		2030
		14930	10060		53170	37130
		ΣV = 4870	↓		ΣM = 16040	↷

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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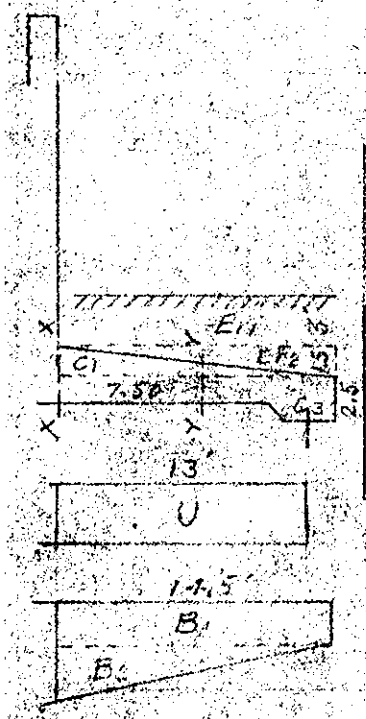
bject Hartford Conn. Ht-5 Sta. 10+72± to 11+52±
omputation Design of Riverside Base
omputed by Checked by RW Date 3/9/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case II River Down Saturated Earth Behind Wall



$B_2 = \frac{14.5}{30.5} \times (885 - 445) = 209$

Moments About X-X

Forces Acting		↓	↑	Arm	↷	↶
E_{r1}	3 × 14.5 × 100	4350		7.25	31540	
E_{r2}	1.5 × ½ × 14.5 × 100	1090		9.67	10540	
C_1	1.5 × ½ × 14.5 × 150	1630		4.83	7870	
C_2	1.5 × 14.5 × 150	3260		7.25	23640	
C_3	1 × 3 × 150	450		13.0	5850	
U	11 × 13 × 62.5		8940	6.5		58110
B_1	14.5 × 445		6450	7.25		46760
B_2	½ × 14.5 × 209		1520	4.83		7340
		10780	16910		79440	112210
		ΣV = 6130 ↓↑			ΣM = 32770 ↶	

$d = 36''$

$d = \sqrt{\frac{32770}{123}} = 16.3 + 4.5 = 20.8''$

$A_s = \frac{32770}{1325 \times 31.5} = .78 \square''$ Bond $= \frac{6130}{3.14 \times 884 \times 31.5} = 70\ \#/\square''$

Shear $= \frac{6130}{10.6 \times 31.5} = 18\ \#/\square''$

Use 1" ϕ @ 12" c.c.
or ⅞" ϕ and ⅝" ϕ All @ 6"

Moments About Y-Y (7' from End)

$B_2 = \frac{7}{30.5} \times 440 = 101$

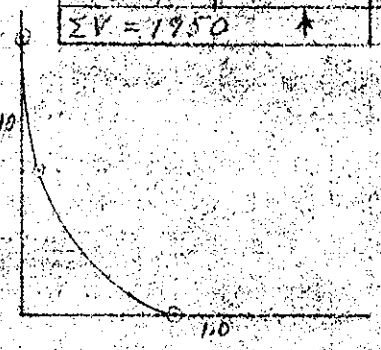
E_{r1}	4.13 × 7.0 × 100	2890		3.5	10120	
C_2	1.87 × 7.0 × 150	1960		3.5	6860	
C_3	1 × 3.0 × 150	450		5.5	2430	
U	11 × 5.5 × 62.5		3780	2.75		10400
B_1	7.0 × 445		3120	3.5		10920
B_2	½ × 7.0 × 101		350	2.33		820
		5300	7230		19460	22140
		ΣV = 1950 ↑			ΣM = 2680	

$d = \frac{1.5 \times 7}{14.5} + 1.5 = 2.22'$
$= 27''$

$d = \sqrt{\frac{2680}{123}} = 4.7 + 4.5 = 9.2$

$A_s = \frac{2680}{1325 \times 22.5} = .09 \square''$

Temperature steel o.k.



WAR DEPARTMENT

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

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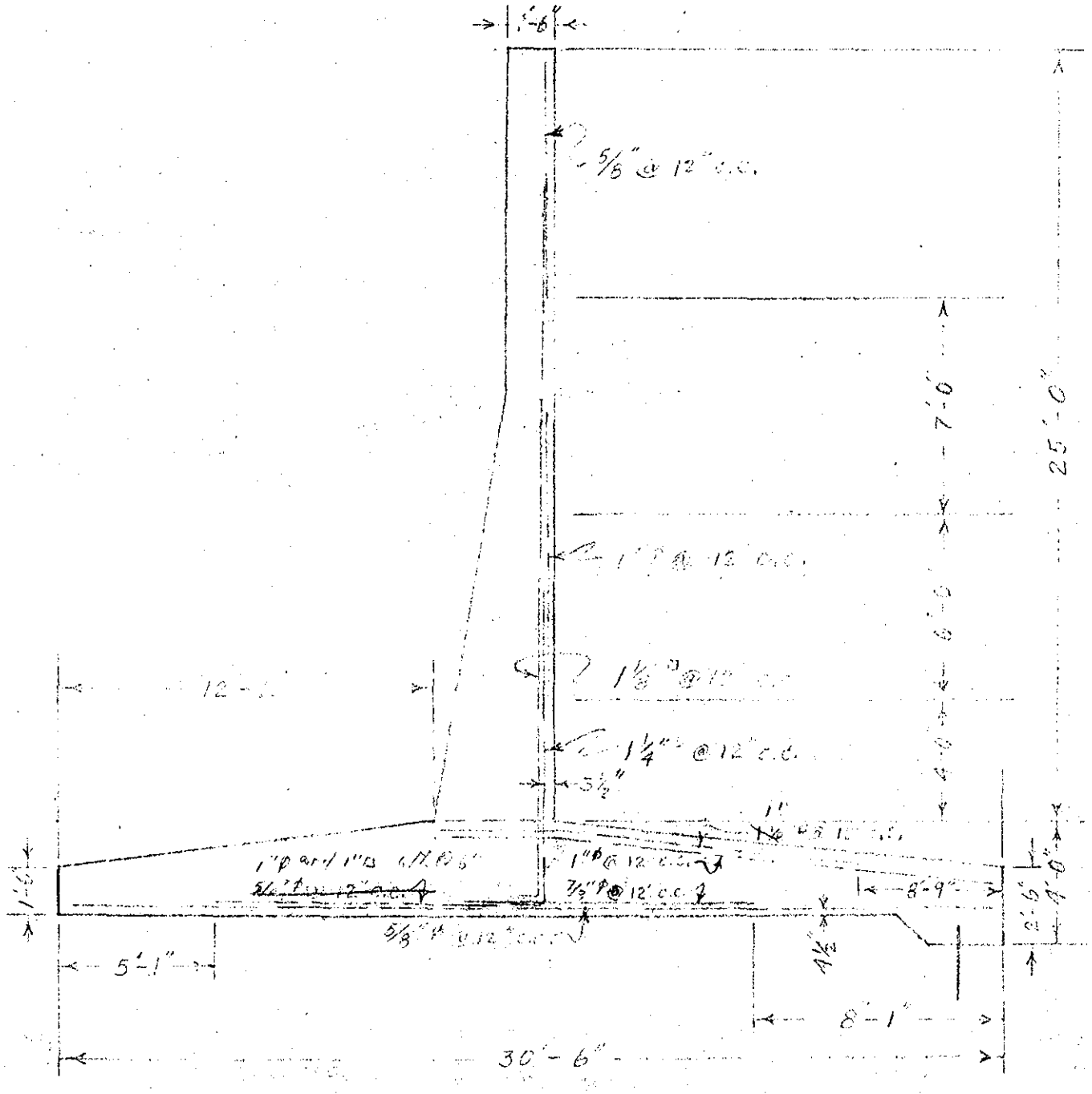
Subject: Hartford Conn Ht-5 Sta 10+78± to 11+52±

Computation: Steel Reinforcement

Computed by: W.K.F. Checked by: RW Date: 3/3/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



WAR DEPARTMENT

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

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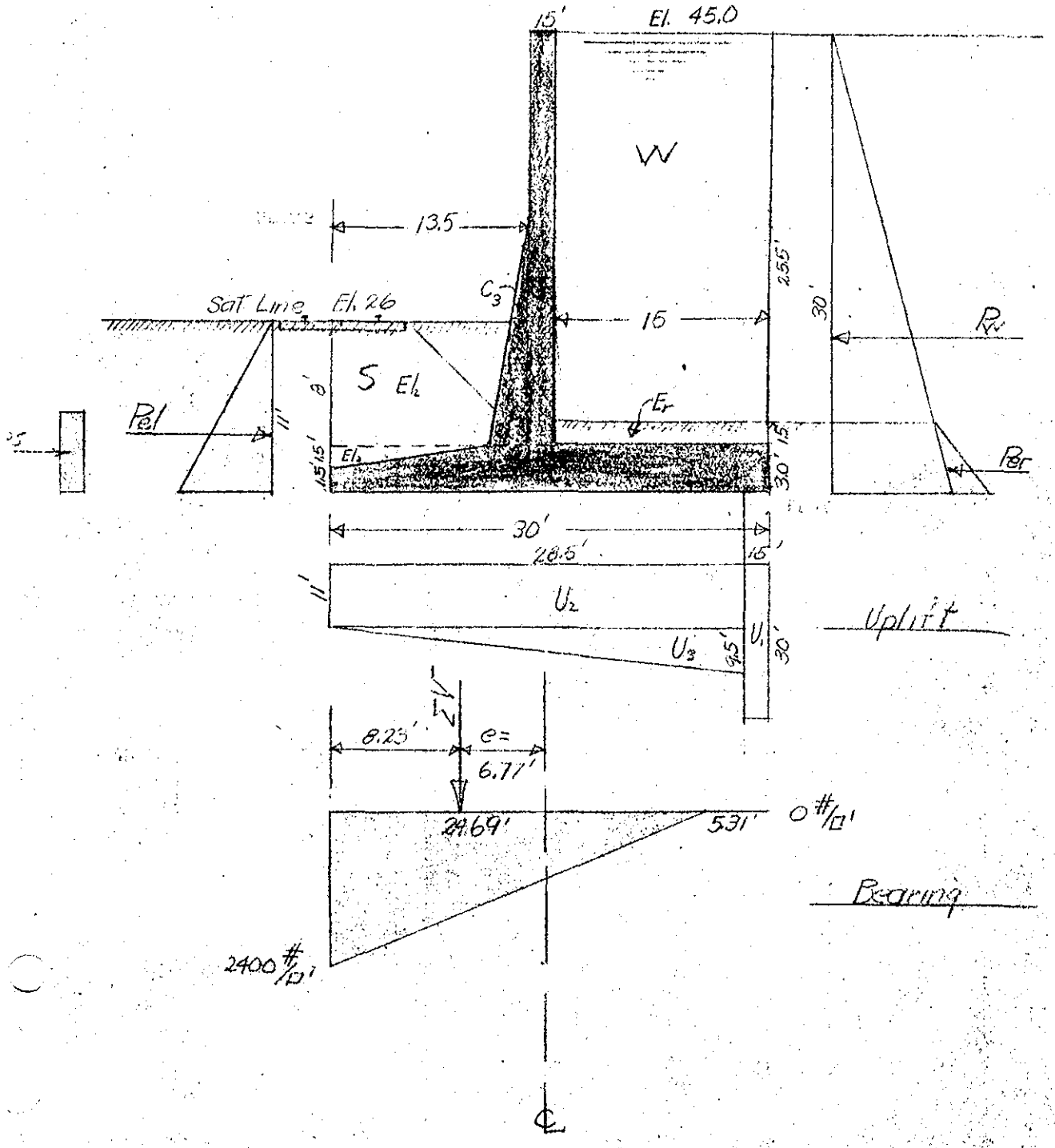
Subject Hartford - Conn (H-15) Sta 11+52 ± - 12+32 ±

Computation Stability of cantilever wall with 27' Stem

Computed by R.H.M. **Checked by** I.A.A. **Date** 2/28/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



WAR DEPARTMENT

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

Subject: Hartford-Conn. (H-15) Sta. 11+52± - 12+32±

Computation: Stability of Cantilever Wall with 27' Stem

Computed by: R.H.M. Checked by: P.L.A. Date: 2/28/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

CASE I RIVER UP

Forces Acting		↓	↑	←	→	Arm	Moments about "A" ↻	↺
C_1	1.5 x 27 x 150	6080				14.25	86640	
C_2	3.0 x 30 x 150	13500				15.00	202500	
C_3	1.2 x 7 x ½ x 150	630				13.10	8250	
C_4	1.3 x 8 x ½ x 25	130				11.86	1540	
C_5	1.2 x 8 x 25	240				12.90	3100	
W	15 x 25.5 x 62.5	23910				22.5	538000	
E_r	15 x 1.5 x 125	2810				22.5	63230	
E_{l_1}	13.5 x 8 x 125	13500				6.75	91130	
E_{l_2}	11.0 x 1.5 x ½ x 25		210			3.67		770
U_1	30 x 1.5 x 62.5		2810			29.25		82190
U_2	11 x 28.5 x 62.5		19590			14.25		279160
U_3	9.5 x ½ x 28.5 x 62.5		8460			19.0		160740
P_w	30^2 x ½ x 62.5			28130		10.00		281,300
P_{er}	4.5^2 x ½ x 17.5			180		1.50		270
P_{el}	11^2 x ½ x 40				4340	3.67	17760	
Fr.	0.45 x 29730				13380			
P.R.					10090	3.67	37030	
		60800	31070	28310	28310		1,049,180	804430
		ΣV = 29730 #↓		ΣH = 0			ΣM = 244750 #↻	

$$\frac{\Sigma M}{\Sigma V} = \frac{244750}{29730} = 8.23 \qquad \frac{1}{3}\text{ Base} = 10' \qquad 1.77' \text{ outside}$$

$$B.P. = \frac{29730}{3 \times 8.23} \begin{cases} 2 \\ 0 \end{cases} = 1200 \begin{cases} 2 = 2400 \ \#/\square' \\ 0 = 0 \ \#/\square' \end{cases}$$

$$e = 15 - 8.23 = 6.77'$$

WAR DEPARTMENT

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

bject Hartford Hts

Computation Cantilever Wall Stem 27' Base 30' Sta. 11+52± to 12+32±

Computed by FLA Checked by RW Date 2/29/40

U.S. GOVERNMENT PRINTING OFFICE 3—10523

Case II River Down

Forces Acting		↓	↑	→	←	Arm	Moments About "A" ↷	↶
C_1	1.5 x 27 x 150	6080				14.25	86640	
C_2	3.0 x 30 x 150	13500				15.00	202500	
C_3	1.2 x 7 x ½ x 150	630				13.10	8250	
C_4	1.3 x 8 x ½ x 25	130				11.86	1540	
C_5	1.2 x 8 x 25	240				12.90	3100	
ER	15 x 1.5 x 100	2250				22.5	50600	
EL_1	13.5 x 8.0 x 125	13500				6.75	91130	
EL_2	11.0 x 1.5 x ½ x 25		210			3.67		770
U_2	11.0 x 28.5 x 62.5		19590			14.25		279160
PER	½ x 35 x $\overline{4.5}^2$				354	1.50		500
PEL	½ x 80 x $\overline{11}^2$			4840		3.67	17760	
FR	17090 x 0.45				7700			
		36330	19800	4840	8054		461520	280,430
		ΣV = 16530 ↓		ΣH = 0			181,090 ↷	

Position of Resultant $= \frac{\Sigma M}{\Sigma V} = \frac{181,090}{16530} = 10.9$ ⅓ Base = 10.0'

$e = 15.0' - 10.9 = 4.1$

Base Pressure $= \frac{\Sigma V}{A}\left(1 \pm \frac{6e}{d}\right) = \frac{16530}{30}\left(1 \pm \frac{6 \times 4.1}{30}\right) = 1006$ #/□' 100 #/□'

28.5'

$U_2 = 686$ #/□'

Uplift

Base Pressure

Case II

WAR DEPARTMENT

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

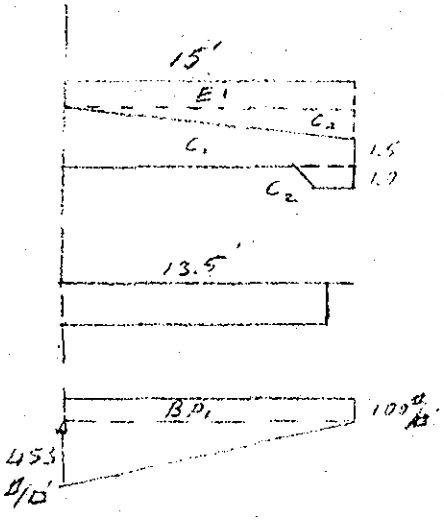
Subject: Ht 5 Hartford Sta 11+52.1 - 12+32±

Computation: 27' Wall

Computed by: RW Checked by: Date: 3-5-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

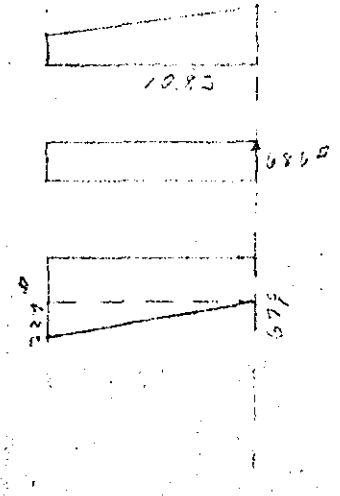
Steel in Base, River Side, River Down Bottom



		↓	↑			
E_1	1.5 × 15 × 100	2250		× 7.5	16 900	↷
C_1		6750		× 7.5	50 700	↷
C_2		450		× 13.6	6 120	↷
C_3			280	× 10	2800	↶
BP_1	100 × 15		1500	× 7.5	11 260	↶
BP_2	453 × 15 × ½		3400	× 5	17 000	↶
U_2	686 × 13.5		9250	× 6.75	62 500	↶
				ΣM =	19 840'#	↶

$A_s = \frac{19840 \times 12}{18{,}000 \times .884 \times 31.5} = .475 \square''$ or 7/8 ϕ @ 12' o.c. bottom

Steel in Base, Low Side, River Low



	Forces				
E_1		10830		× 5.41	58 700
C_1		4850		× 5.41	26 400
C_2			200	× 7.2	1 440
U_1			7420	× 5.41	40 200
BP_1	679 × 10.83		7350	× 5.41	39 800
BP_2	327 × 10.83 × ½		1720	× 7.2	12 400
				ΣM =	6 760'#

$A_s = \frac{6760 \times 12}{18{,}000 \times .884 \times 31.5} = .21 \square''$

WAR DEPARTMENT

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

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Subject Ht 5 Hartford 11+52 I - 12+32 I

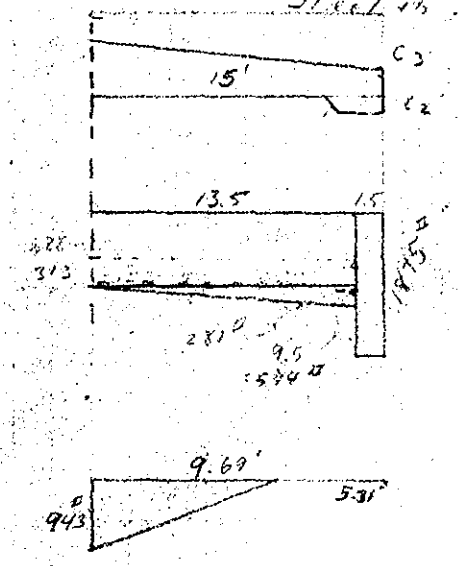
Computation 27' Cantilever Wall 30' Base

Computed by R.W. Checked by ..... Date 3-2-40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in Base, River Side

Case I River Up Saturated backfill



		↓	↑		
E1	1.5 x 15 x 125	2800		x 7.5	21,000
C1	3 x 15 x 150	6750		x 7.5	50,100
C2	1 x 3 x 150	450		x 13.6	6120
C3	1.5 x 15 x ½ x 25		280	x 10	2800
W	25.5 x 15 x 62.5	23,900		x 7.5	179400
BP	943 x 9.69 x ½		4570	x 3.23	14,750
U1	30 x 15 x 62.5		2815	x 14.25	40,200
U2	(688 + 313) x 13.5		13,500	x 6.75	91,000
U3	281 x ½ x 13.5		1890	x 4.5	8500

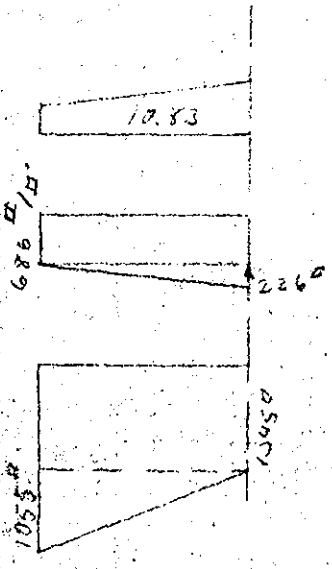
ΣM = 99,970 '#

Depth Required $\sqrt{\frac{99970}{123}}$ = 28.5" O.K. 33" Provided

$A_s = \frac{99970 \times 12}{18,000 \times 884 \times 33} = 2.27$ □" Top

Steel in Base, Land Side

Case I, River Up, No Surcharge



		↓	↑		
E1	8 x 10.83 x 125	10830		x 5.41	58,700
C1	3 x 10.83 x 150	4880		x 5.41	26,400
C2	1.5 x 10.83 x ½ x 25		202	x 7.2	1460
U1	686 x 10.83		7430	x 5.41	40200
BP1	1345 x 10.83		14570	5.41	78800
BP2	1055 x 10.83 x ½		5700	x 7.2	41200
U2	226 x 10.83 x ½		1230	x 3.6	4430

ΣM 80,790 '#

[illegible]

$A_s = \frac{80,790 \times 12}{18,000 \times .884 \times 31.5} = 1.94$ □" 1"□ @ 6"

Bottom

WAR DEPARTMENT

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

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Subject Ht 5 Hartford Sta 11+52 - 12+32

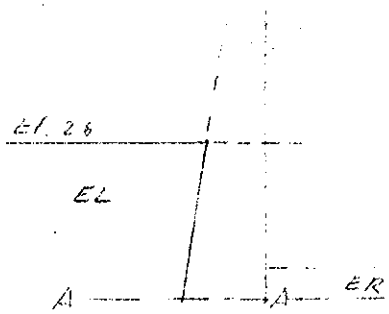
Computation 27' Wall 30' Base

Computed by R W Checked by Date 3-[illegible]-40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Stem Steel; land side

Section A-A



$M(PEL) = 8^2 \times 80 \times \frac{1}{2} = 2040 \times 2.67 = 6,830$ '#

$M(PS) = 3 \times 202 = 606 \times 1.5 = 909$ '#

$\Sigma M = 7,739$ #

$A_s = \frac{7739 \times 12}{18000 \times .884 \times 47} = .124$ □"

WAR DEPARTMENT

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

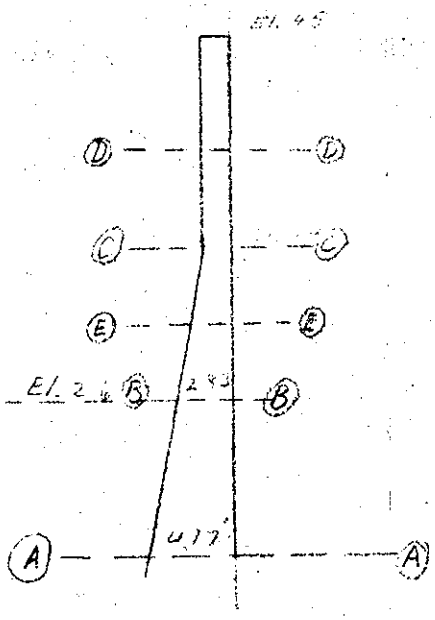
Subject: H+5 Hartford

Computation: 27' Wall with 30' Base — Sta. 11+52 - 12+32 ±

Computed by: RW — Checked by: ..... — Date: 3-5-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stem Steel, River Side



Section A-A, Depth 27'

Forces		→	←	Moments	
PEL	$8^2 \times 35 \times \frac{1}{2}$	1120		×2.67 =	2990
PW	$27^2 \times \frac{1}{2} \times 62.5$		22 700	×9 =	204 500
PER	$1.5^2 \times \frac{1}{2} \times 17.5$		20	×0.5 =	10
		ΣH:		ΣM:	201 520

d required $= \sqrt{\frac{201520}{123}} = 40.5''$ O.K.

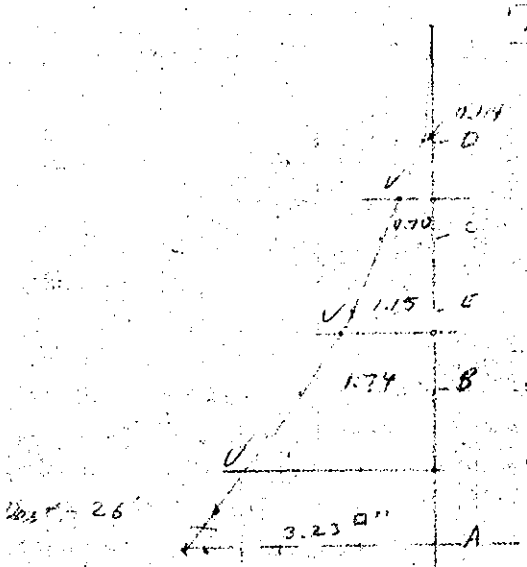
50 - 3 = 47" Provided

$A_s = \frac{201\,520 \times 12}{.884 \times 18\,000 \times 47} = 3.23\ \square''$

$1\frac{1}{8}$ @ 6" + $\frac{3}{4}$" ϕ @ 6'

Section B-B, depth 19' - Typical all Cantilever Flood Wa

PW	$19^2 \times \frac{1}{2} \times 62.5$ =		11300	×6.33 =	71500 '#



$A_s = \frac{71500 \times 12}{18000 \times .884 \times 31} = 1.74\ \square''$

$1\frac{1}{4}$ □ and 2" □

Section C-C depth 11'

PW = $11^2 \times \frac{1}{2} \times 62.5$ = 3780 # ×3.67 = 13,900 '#

$A_s = \frac{13900 \times 12}{18,000 \times .884 \times 15} = 0.70\ \square''$

Section DD Depth 6'

PW = $6^2 \times \frac{1}{2} \times 62.5$ = 1126 # × 2 = 2250 '#

$A_s = \frac{2250 \times 12}{18,000 \times .884 \times 15} = .114\ \square''$ Temp. Steel

Section EE Depth 15'

M = 35,000 '#

$A_s = \frac{35,000 \times 12}{18,000 \times .884 \times 23} = 1.15\ \square''$

WAR DEPARTMENT

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

bject Hartford HLS

omputation Cantilever Wall Stem 27' Base 30' Sta 11+52 To 12+32 ±

omputed by PEA Checked by RW Date 2/29/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case III

Stability River Up and Railroad Surcharge

Forces Acting		↓	↑	→	←	Arm	Moments About "A" ↷	↶
		60800	31070	28310	4840		1,012,150	804430
S		6000				5.2	31200	
PS	202 x 5.0			1010		2.5	2530	
FR	0.45 x 35730				16100			
PR					8360	3.67	30800	
		66800	31070	29320	29320		1,076,680	804,430
		ΣV = 35730 ↓		ΣH = 0			ΣM = 272250 ↷	

1/3 Base = 10.0'

Position of Resultant = $\frac{\Sigma M}{\Sigma V} = \frac{272250}{35730} = 7.62$

Base Pressure = $\frac{\Sigma V}{A}\left(1 \pm \frac{6e}{d}\right) = \frac{35730}{22.9}(2) = 3120$ #/□' 0 #/□'

Dwyer

Case IV

River Down and Railroad Surcharge

Forces Acting		↓	↑	→	←	Arm	Moments About "A" ↷	↶
		36330	19800	4840	354		461520	280430
S		6000				5.2	31200	
PS	210 x 5.0			1010		2.5	2530	
FR	23096 x .45				10400			
		42530	19800	5850	10754		495050	280430
		ΣV = 22530		ΣH = 0			ΣM = 214620	

1/3 Base = 10.0

Position of Resultant = $\frac{\Sigma M}{\Sigma V} = \frac{214620}{22530} = 9.53'$

Base Pressure = $\frac{\Sigma V}{A}\left(1 \pm \frac{6e}{d}\right) = \frac{22530}{28.6}(2) = 1580$ #/□' 0 #/□'

Dwyer

WAR DEPARTMENT

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

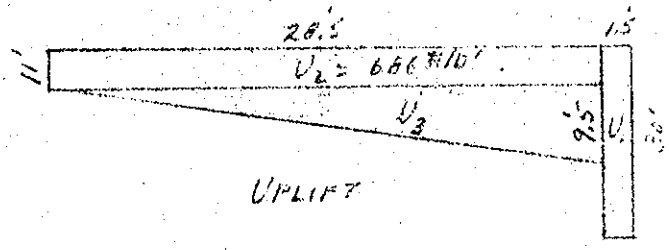
Subject: HARTFORD HES

Computation: CANTILEVER WALL STEM 2.1' BASE 20' STA. 11452 + TO 12432 ±

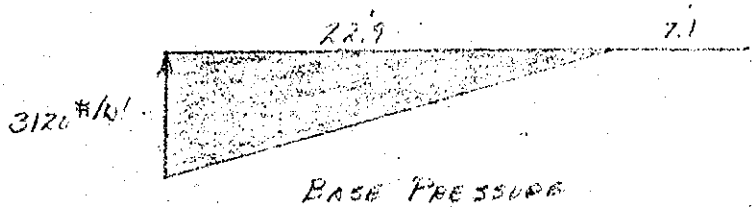
Computed by: P.L.A. Checked by: R.N. Date: 2/27/40

U. S. GOVERNMENT PRINTING OFFICE 3—10628

STABILITY

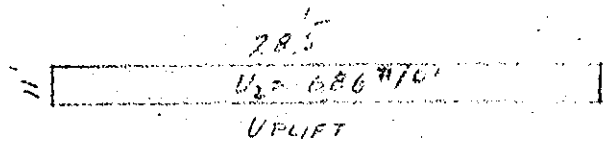


UPLIFT

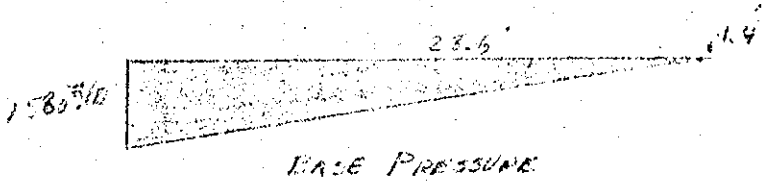


BASE PRESSURE

CASE III RIVER UP & RAILROAD SURCHARGE



UPLIFT



BASE PRESSURE

CASE IV RIVER DOWN AND RAILROAD SURCHARGE

WAR DEPARTMENT

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

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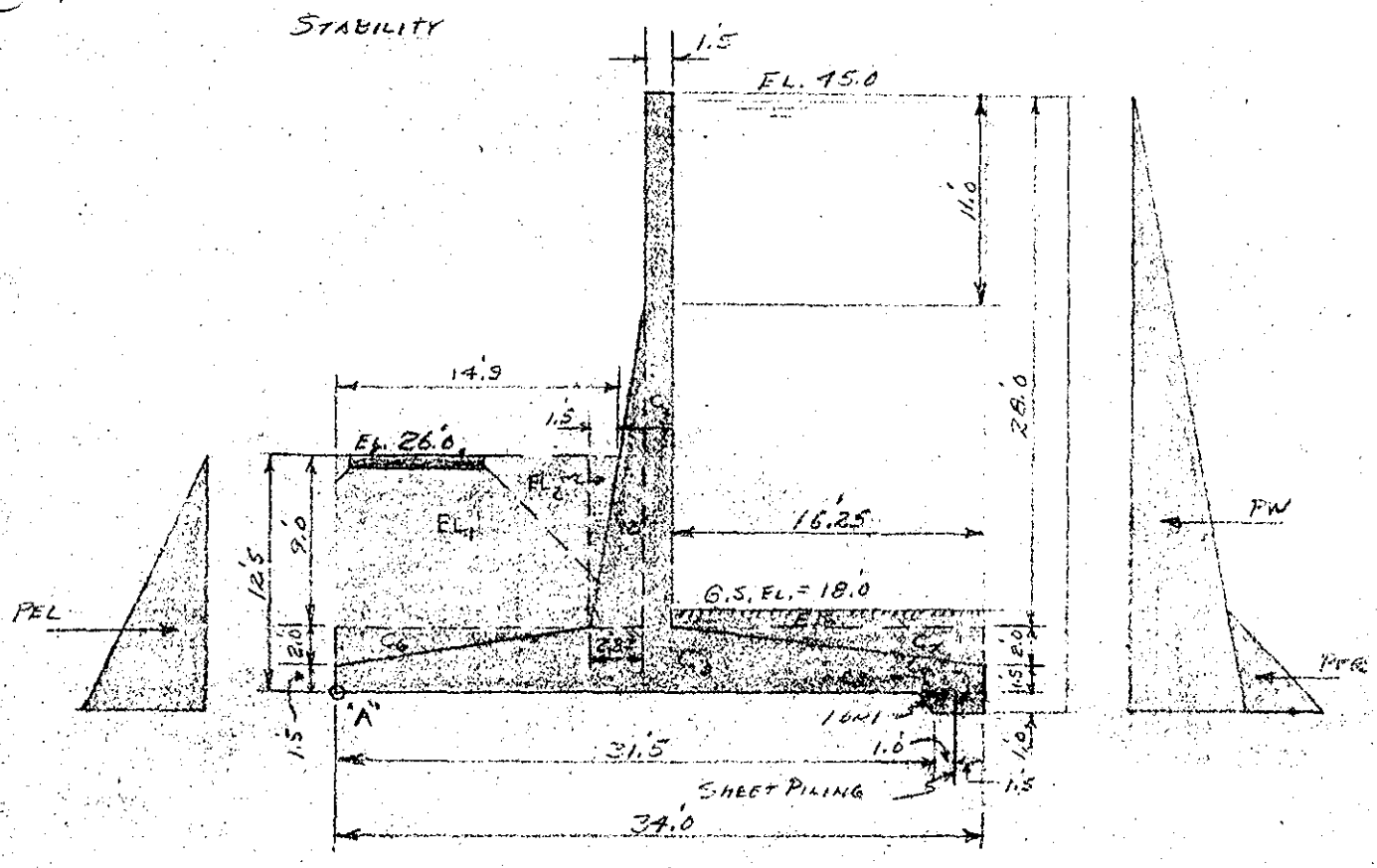
Subject: HLS HARTFORD

Computation: RETAINING WALL STEM 28' BASE 34' STA. 13+00 ±

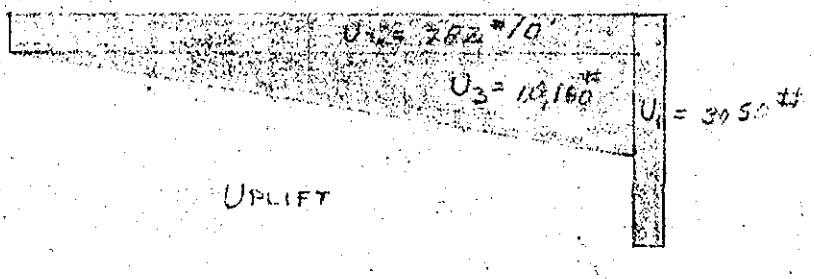
Computed by: F.L.A. Checked by: J.A.C. Date: 2/21/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

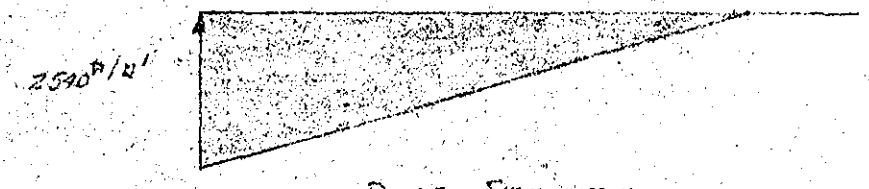
STABILITY



CASE I: RIVER UP



UPLIFT



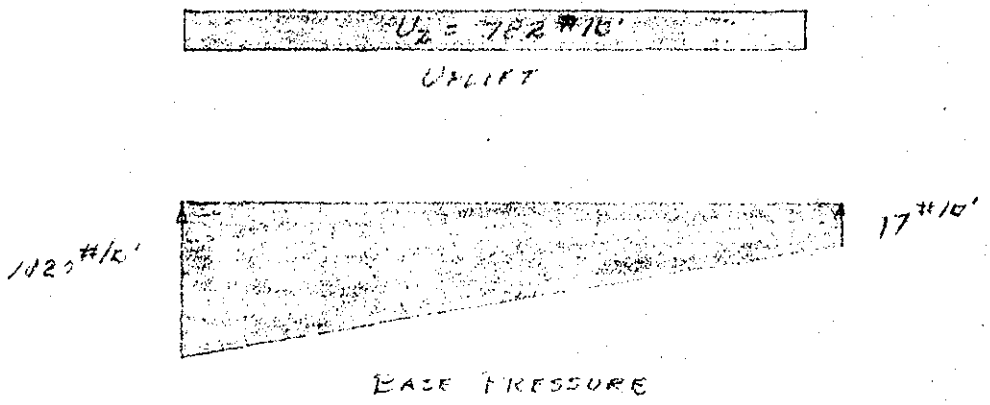
BASE PRESSURE

Subject HCS HARTFORD
Computation RETAINING WALL STEM 28' BASE 34' STA. 13+00 ±
Computed by P.L.A. Checked by T.A.C. Date 2/21/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

STABILITY CONT'D

CASE II RIVER DOWN



Subject: H.L.S. HARTFORD
Computation: RETAINING WALL STEM 28' BASE 34' STA. 131+00±
Computed by: P.L.A. Checked by: J.A.C. Date: 2/21/40

U. S. GOVERNMENT PRINTING OFFICE 3—10526

STABILITY CONT'D

CASE I RIVER UP

Forces Acting		↓	↑	→	←	Arm	Moments About "A" ↻	Moments About "A" ↺
C_1	28 X 1.5 X 150	6300				17.0	107000	
C_2	½ X 2.83 X 17 X 150	3610				15.3	55 200	
C_3	34 X 3.5 X 150	17900				17.0	304 000	
C_4	2.5 X 1.0 X 150	375				32.8	12 300	
C_5	½ X 1.0 X 1.0 X 150	75				31.2	2340	
C_6	½ X 2.0 X 13.42 X 25		336			4.47		1500
C_7	½ X 2.0 X 16.25 X 25		407			28.6		11600
EL_1	9 X 13.42 X 125	15100				6.7	101,000	
EL_2	½ X 1.5 X 9.0 X 125	844				13.9	11,700	
ER	1 X 16.25 X 125	2030				25.9	52,500	
W	16.25 X 27 X 62.5	27400				25.9	710,000	
U_1	1.5 X 32.5 X 62.5		3050			33.3		101400
U_2	12.5 X 32.5 X 62.5		25400			16.3		414 000
U_3	½ X 10.0 X 32.5 X 62.5		10160			21.7		220,000
PEL	½ X 80 X $\overline{13.5}^2$			7290		3.5	25,500	
PER	½ X 17.5 X $\overline{5.5}^2$				265	0.83		220
PW	½ X 62.5 X $\overline{22.5}^2$				33000	9.83		324000
FR	0.45 X 34281			15500				
Passive Resistance				10475				
		73634	39353	33265	33265		1,381,540	1,072,720
		ΣV = 34281 ↓		ΣH = 0			ΣM = 308,820 ↻	

$e = 17.0 - 9.0 = 8.0$

Position of Resultant $= \frac{\Sigma M}{\Sigma V} = \frac{308,820}{34281} = 9.0$ Middle Third $= 11.3'$

$$p = \frac{\Sigma V}{A}\left(1 \pm \frac{6e}{d}\right) = \frac{34281}{27.0}(1 \pm 1) = 2540 \text{ \#/□'}, \; 0 \text{ \#/□'}$$

Subject: HC 5 HARTFORD
Computation: RETAINING WALL STEM 28' BASE 34' STA. 13+00±
Computed by: P.L.A. Checked by: J.A.C. Date: 2/21/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STABILITY CONT'D

CASE II, RIVER DOWN

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT 'A' ↷	MOMENTS ABOUT 'A' ↶
C_1	28 X 1.5 X 150	6300				17.0	107000	
C_2	½ X 2.83 X 17 X 150	3610				15.3	55200	
C_3	34 X 3.5 X 150	17900				17.0	304000	
C_4	2.5 X 1.0 X 150	375				32.8	12300	
C_5	½ X 1.0 X 1.0 X 150	75				31.2	2340	
C_6	½ X 2.0 X 13.42 X 25		336			4.47		1500
C_7	½ X 2.0 X 16.25 X 50		813			28.6		23200
EL_1	9 X 13.42 X 125	15100				6.7	101000	
EL_2	½ X 1.5 X 9.0 X 125	844				13.9	11700	
ER	1 X 16.25 X 100	1625				25.9	42100	
PEL	½ X 80 X $\overline{13.5}^2$			7290		3.5	25500	
PER	½ X 35 X $\overline{3.5}^2$				530	0.83		440
U_2	12.5 X 32.5 X 62.5		25400			16.3		414000
FR	0.45 X 19280				8660			
		45829	26549	7290	8190		661,140	439,140
		ΣV = 19280 ↓		Σ H = 0			ΣM = 222,000 ↶	

MIDDLE THIRD = $\frac{34.0}{3}$ = 11.3'

POSITION OF RESULTANT = $\frac{\Sigma M}{\Sigma V} = \frac{222,000}{19280} = 11.5$ $e = 17.0 - 11.5 = 5.5'$

$$p = \frac{\Sigma V}{A}\left(1 \pm \frac{6e}{d}\right) = \frac{19280}{34}\left(1 \pm \frac{6 \times 5.5}{34}\right) = \begin{matrix} 1120 \ \#/\square' \\ 17 \ \#/\square' \end{matrix}$$

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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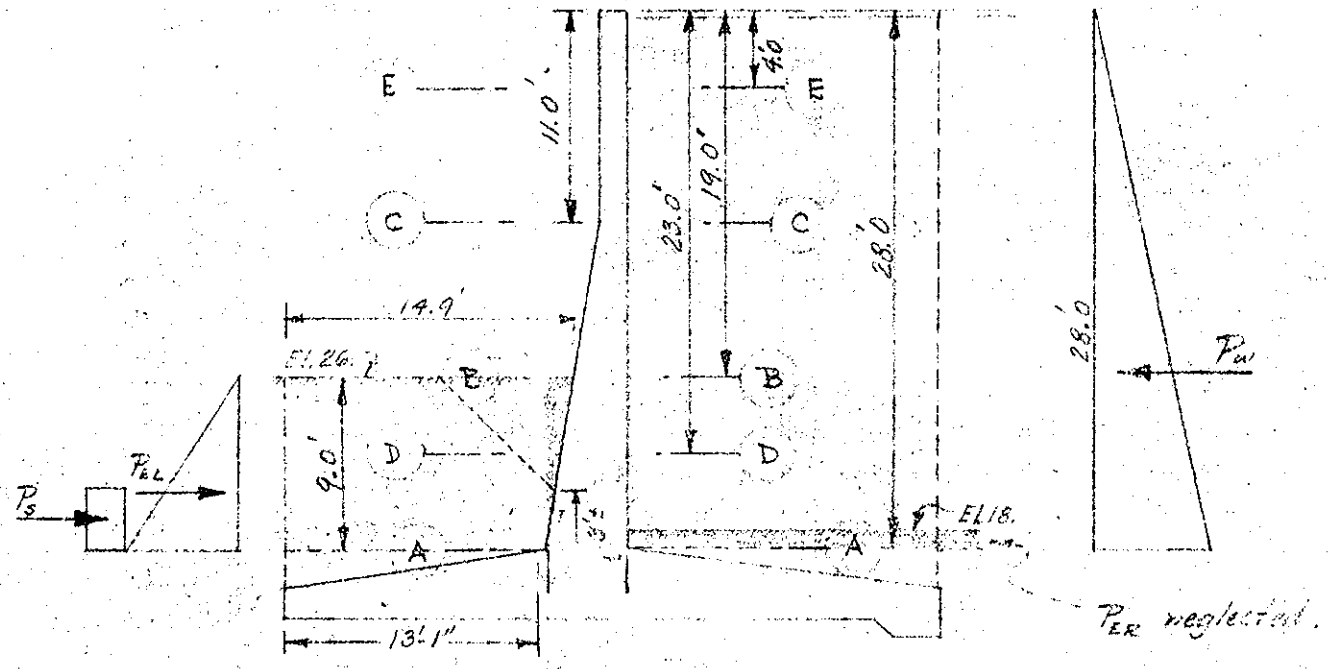
Subject: Hartford, Conn - Ht. 5 - Flood and Retaining Wall
Computation: 28' Stem — 34' Base Sta. 13+00 ±
Computed by: J.A.C. Checked by: K.M. Date: 3/6/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Steel in Stem - Case I - River Up



P_s assumed as 120 #/□' acting over 3' of stem

Section A-A

Forces Acting	→	←	Arm	Moment ↷	Moment ↶
$P_W = \frac{1}{2} \times \overline{28}^2 \times 62.5$		24,500	9.33		228,500
$P_{EL} = \frac{1}{2} \times \overline{9}^2 \times 80$	3,240		3.00	9,720	
$P_S = 3 \times 120$	360		1.5	540	
	V = 20,900 # ←			M = 218,240 # ↶	

$d = 56 - 3.5 = 52.5''$

$A_s = \frac{12 \times 218,240}{18,000 \times .884 \times 47.5} = \cancel{3.36}\ 3.48$ □"

$\Sigma_o = \frac{20,900}{150 \times .884 \times 48.5} = 3.00''$

$v = \frac{20,900}{12 \times .884 \times 48.5} = 38$ #/□"

Use $1\frac{1}{4}$"□ @ 6" c.c. Vert. in Riverside Face

These will extend only part way up the stem.

Use $\frac{1}{2}$"□ @ 1'-0" Hor.

WAR DEPARTMENT

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

Subject: HARTFORD, CONN. - HT. 5 - FLOOD AND RETAINING WALL

Computation: 28' STEM - 34' BASE — STA. 12+32 - 13+12 ±

Computed by: T.A.C. Checked by: R.W. Date: 3/7/42

U. S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF STEEL IN STEM - CASE I - RIVER UP

SECTION D-D

FORCES ACTING	→	←	ARM	MOMENT ↷	MOMENT ↶
$P_W = \frac{1}{2} \times 23^2 \times 62.5$		16,550	7.67		127,000
$P_{EL} = \frac{1}{2} \times 4^2 \times 80$	640		1.33	850	
	V = 15,910 # ←			M = 126,150 '# ↶	

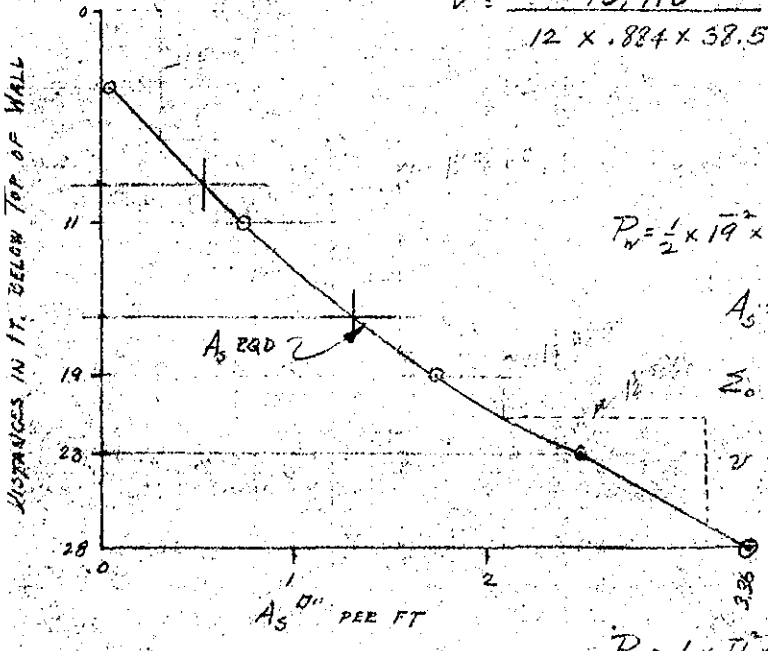
$d = 42 - 3.5 = 38.5''$

$A_s = \frac{12 \times 126{,}150}{18{,}000 \times .884 \times 38.5} = 2.47$ □''

$\Sigma_0 = \frac{15{,}910}{150 \times .884 \times 38.5} = 3.12''$

$v = \frac{15{,}910}{12 \times .884 \times 38.5} = 89$ #/□''

A_s DIAGRAM



SECTION B-B

$P_W = \frac{1}{2} \times 19^2 \times 62.5 = 11{,}300^{\#} \times 6.33' = 71{,}500'^{\#}$

$A_s = \frac{12 \times 71{,}500}{18{,}000 \times .884 \times 31.5} = 1.72$ □''

$\Sigma_0 = \frac{11{,}300}{150 \times .884 \times 31.5} = 2.7''$

$v = \frac{11{,}300}{12 \times .884 \times 31.5} = 34$ #/□''

SECTION C-C

$P_W = \frac{1}{2} \times 11^2 \times 62.5 = 3{,}780^{\#} \times 3.67' = 13{,}900'^{\#}$

$A_s = \frac{12 \times 13{,}900}{18{,}000 \times .884 \times 14.5} = 0.73$ □''

$\Sigma_0 = \frac{3{,}780}{150 \times .884 \times 14.5} = 1.97''$

$v = \frac{3{,}780}{12 \times .884 \times 14.5} = 25$ #/□''

SECTION E-E

$P_W = \frac{1}{2} \times 4^2 \times 62.5 = 500^{\#} \times 1.33 = 665'^{\#}$

$A_s = \frac{12 \times 665}{18{,}000 \times .884 \times 14.5} = .035$ □''

Note: Use 3/4" ϕ @ 6" 4.5" in back of 1 1/8" ϕ @ 6" at Bottom

Subject: HARTFORD, CONN. – HT. 5 – FLOOD AND RETAINING WALL
Computation: 28' STEM – 34' BASE STA. 12+32 TO 13+12 ±
Computed by: T.A.C. Checked by: R.W. Date: 3/6/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

DESIGN OF STEEL IN STEM – CASE II – RIVER DOWN

SECTION A-A

$P_{EL} = 3{,}240 \times 3.00 = 9{,}720'^{\#}$

$P_S = 360 \times 1.5 = 540$

$V = 3{,}600^{\#}$ $M = 10{,}260'^{\#}$

$A_S = \dfrac{12 \times 10{,}260}{18{,}000 \times .884 \times 52.5} = 0.15^{\square''}$

$Z_0 = \dfrac{3{,}600}{150 \times .884 \times 52.5} = 0.52''$

$v = \dfrac{3{,}600}{12 \times .884 \times 52.5} = 6.5^{\#/\square''}$

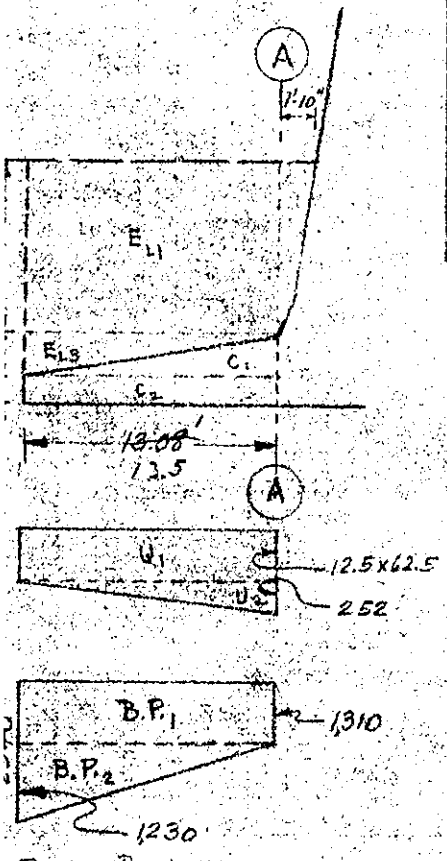
USE MIN. TEMP. STEEL IN LANDSIDE FACE OF STEM

[$\frac{5}{8}''\phi$ @ 1'-0" c.c. VERT.
$\frac{1}{2}''\square$ @ 1'-0" c.c. HOR.]

Subject: HARTFORD, CONN. — HT. 5 — FLOOD AND RETAINING WALL
Computation: 28' STEM — 34' BASE Sta. 12 + 32 ± to 13 + 12 ±
Computed by: T.A.C. Checked by: RW Date: 3/7/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF STEEL IN HEEL SLAB — CASE I — RIVER UP
Land Side



Forces Acting	↓	↑	Arm	Moment ↷	Moment ↶
$E_{L1} = 9.0 \times 13.08 \times 125$	14,700		6.54		96,000
$E_{L3} = \frac{1}{2} \times 2 \times 13.08 \times 125$	1,640		8.72		14,300
$C_1 = \frac{1}{2} \times 13.08 \times 2.0 \times 150$	1,965		4.36		8,560
$C_2 = 13.08 \times 1.5 \times 150$	2,940		6.54		19,250
$U_1 = 12.5 \times 62.5 \times 13.08$		10,250	6.54	67,000	
$U_2 = \frac{1}{2} \times 252 \times 13.08$		1,650	4.36	7,200	
$B.P._1 = 1,310 \times 13.08$		17,150	6.54	112,000	
$B.P._2 = \frac{1}{2} \times 1230 \times 13.08$		8,050	8.72	70,200	
	V = 15,855# ↑			M = 118,290 ↷	

$$d_{REQ'D} = \sqrt{\frac{118,290}{123}} = \sqrt{961} = 31''$$

$$d_{SUPPLIED} = 42 - 3.5 = 38.5''$$

$$A_s = \frac{12 \times 118,290}{18,100 \times .884 \times 38.5} = 2.32^{\square''}$$

$$\Sigma_o = \frac{15,855}{150 \times .884 \times 38.5} = 3.11''$$

$$v = \frac{15,855}{12 \times .884 \times 38.5} = 39^{\#/\square''}$$

USE $1\frac{1}{8}''\square$ @ 6" c.c. HOR.
IN BOTTOM FACE OF SLAB

USE $\frac{1}{2}''\square$ @ 1'-0" c.c. HOR.
IN TOP FACE OF SLAB

Bearing Pressure

$\frac{2540}{27} = 94^{\#/\square'}$ Drop per ft

$13.08 \times 94 = 1,230$ Drop in 13.08 ft

$2540 - 1230 = 1,310$

Uplift

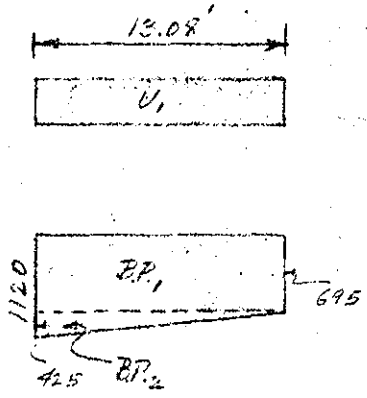
$\frac{10 \times 62.5}{32.5} = 19.25$ Drop per ft

$13.08 \times 19.25 = 252^{\#/\square''}$ Incr. in 13.08 ft.

Subject: HARTFORD, CONN. - HT 5 - FLOOD AND RETAINING WALL
Computation: 28' STEM - 34' BASE STA. 12 +32± to 13 +12±
Computed by: T.A.C. Checked by: R.W. Date: 3/7/40

U. S. GOVERNMENT PRINTING OFFICE 3—10633

DESIGN OF STEEL IN HEEL SLAB - CASE II - RIVER DOWN



FORCES ACTING	↓	↑	ARM	MOMENT ↷	MOMENT ↶
E_{L1} =	14,700		6.54		96,100
E_{L3} =	1,640		8.72		14,300
C_1 =	1,965		4.36		8,560
C_2 =	2,940		6.54		19,250
U_1 =		10,250	6.54	67,000	
$B.P_1$ = 695 × 13.08		9,100	6.54	59,500	
$B.P_2$ = ½ × 425 × 13.08		2,780	8.72	24,300	
	V = 885# ↑			M = 12,690 '# ↷	

1120 - 17 = 1103

1103 / 34 = 32.5 Drop per ft

32.5 × 13.08 = 425 Total Drop

1120 - 425 = 695

NO CALCULATION NECESSARY - CASE I LIMITS THE STEEL DESIGN

WAR DEPARTMENT

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

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Subject: HARTFORD, CONN. - HT. 5 - FLOOD AND RETAINING WALL

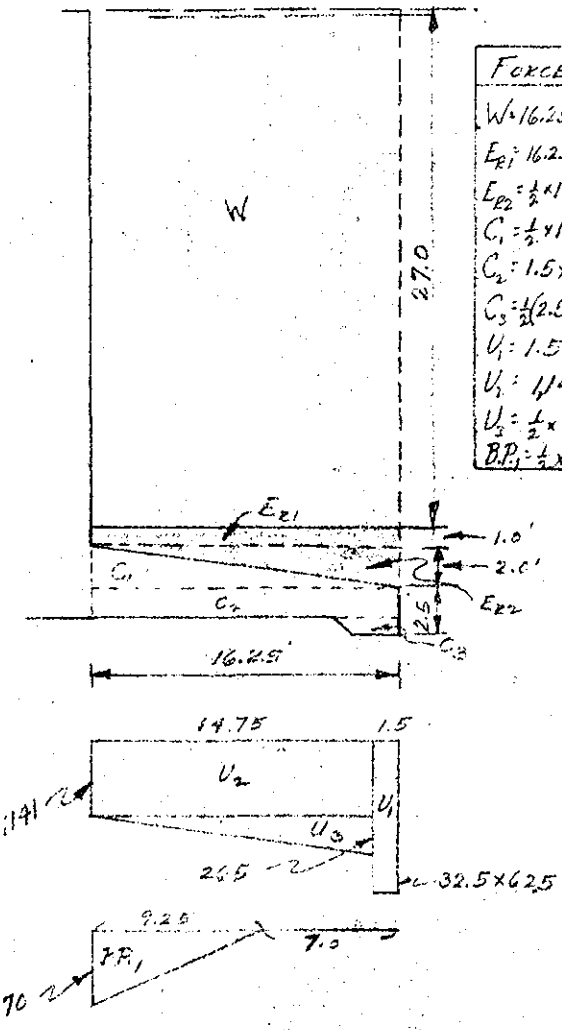
Computation: 28' STEM - 34' BASE STA. 12+32[illegible] to 13+[illegible]

Computed by: J.A.C. Checked by: R.W. Date: 3/7/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF STEEL IN TOE SLAB - CASE I - RIVER UP

River Side



FORCES ACTING	↓	↑	ARM	MOMENT ↷	MOMENT ↶
$W = 16.25 \times 27 \times 62.5$	27,400		8.13	223,000	
$E_{R1} = 16.25 \times 1 \times 125$	2,030		8.13	16,500	
$E_{R2} = \frac{1}{2} \times 16.25 \times 2 \times 125$	2,030		10.83	22,000	
$C_1 = \frac{1}{2} \times 16.25 \times 2 \times 150$	2,440		5.42	13,250	
$C_2 = 1.5 \times 16.25 \times 150$	3,660		8.13	29,800	
$C_3 = \frac{1}{2}(2.5+3.5) \times 1 \times 150$	450		14.75	6,650	
$U_1 = 1.5 \times 32.5 \times 62.5$		3,050	15.5		47,250
$U_2 = 1,141 \times 14.75$		16,800	7.38		124,000
$U_3 = \frac{1}{2} \times 265 \times 14.75$		1,950	8.13		15,850
$BP_1 = \frac{1}{2} \times 870 \times 14.75$		6,410	3.08		19,750
	V = 9,800 ↓			M = 104,350 ↷	

$$d_{RQD} = \sqrt{\frac{104,350}{123}} = \sqrt{848} = 29''$$

$$d_{SUPPLIED} = 38.5''$$

$$A_s = \frac{12 \times 104,350}{18,000 \times .884 \times 38.5} = 2.05^{\square''}$$

$$\Sigma_o = \frac{9,800}{150 \times .884 \times 38.5} = 1.93''$$

$$v = \frac{9,800}{12 \times .884 \times 38.5} = 24^{\#/\square''}$$

Uplift

$19.25 \times 13.75 = 265^{\#/\square'}$

Total Drop in 13.75'

$12.5 \times 62.5 = 781^{\#/\square'}$

$10.0 \times 62.5 = 625^{\#/\square'}$

$1,406^{\#/\square'}$

Int. on Landside of Sheet pile

$1,406 - 265 = 1,141$

Bearing

$94 \times 9.25 = 870^{\#/\square'}$

Total Incr.

USE 1" □ @ 6" C.C.

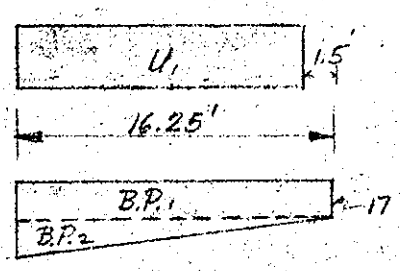
IN TOP FACE OF SLAB

Subject: HARTFORD, CONN — HT 5 — FLOOD AND RETAINING WALL
Computation: 28' STEM — 34' BASE STA 12+32± TO 13±12±
Computed by: T.A.C. Checked by: R.W. Date: 3/7/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF STEEL IN TOE SLAB - CASE II - RIVER DOWN

River Side



Forces Acting	↓	↑	Arm	Moment ↷	Moment ↶
$E_{P1} = 16.25 \times 1 \times 100$	1,625		8.13	13,200	
$E_{P2} = \frac{1}{2} \times 16.25 \times 2 \times 100$	1,625		10.83	17,600	
$C_1 =$	2,440		5.42	13,250	
$C_2 =$	3,660		8.13	29,800	
$C_3 =$	450		14.75	6,650	
$U_1 = 12.5 \times 52.5 \times 14.75$		11,550	7.38		85,300
$B.P._1 = 17 \times 16.25$		276	8.13		2,240
$B.P._2 = \frac{1}{2} \times 528 \times 16.25$		4,290	5.42		23,300
	V = 7,316 ↑			M = 30,340 '# ↶	

$32.5 \times 16.25 = 528$

$d = 42 - 3.5 = 38.5$

$$A_s = \frac{12 \times 30{,}340}{18{,}000 \times .884 \times 38.5} = 0.60 \square''$$

$$S_o = \frac{7{,}316}{150 \times .884 \times 38.5} = 1.44''$$

$$v = \frac{7{,}316}{12 \times .884 \times 38.5} = 18\ \#/\square''$$

USE $\frac{7}{8}''$ φ @ 1'-0" c.c

IN BOTTOM FACE OF SLAB

WAR DEPARTMENT

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

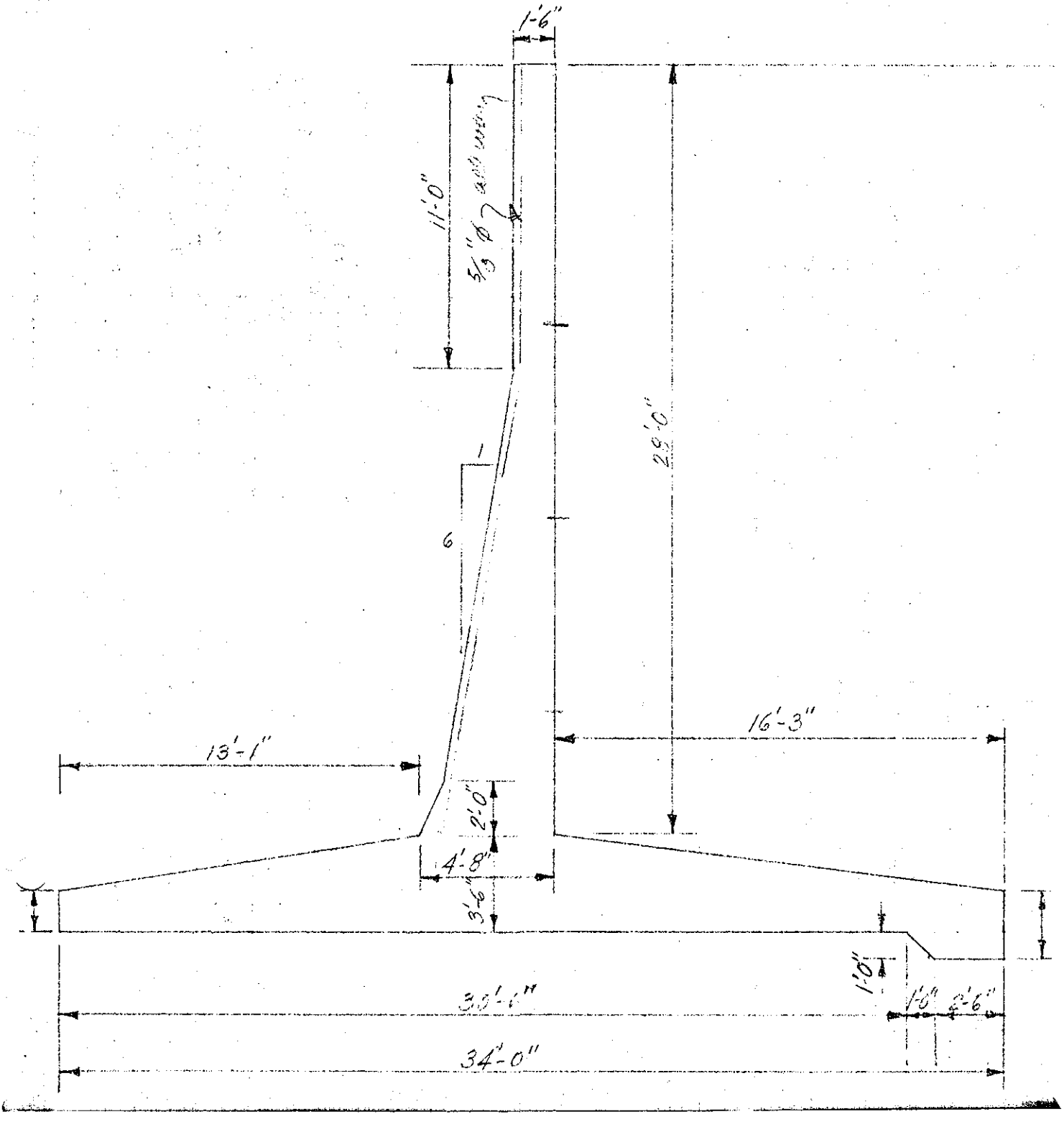
Subject: HARTFORD, CONN. – HT. 5 – FLOOD AND RETAINING WALL

Computation: 28' STEM – 34' BASE STA. 12 +32 ± TO 13 +12 ±

Computed by: T.A.C. Checked by: ____ Date: 3/7/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

SCALE: 1" = 5'



WAR DEPARTMENT

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

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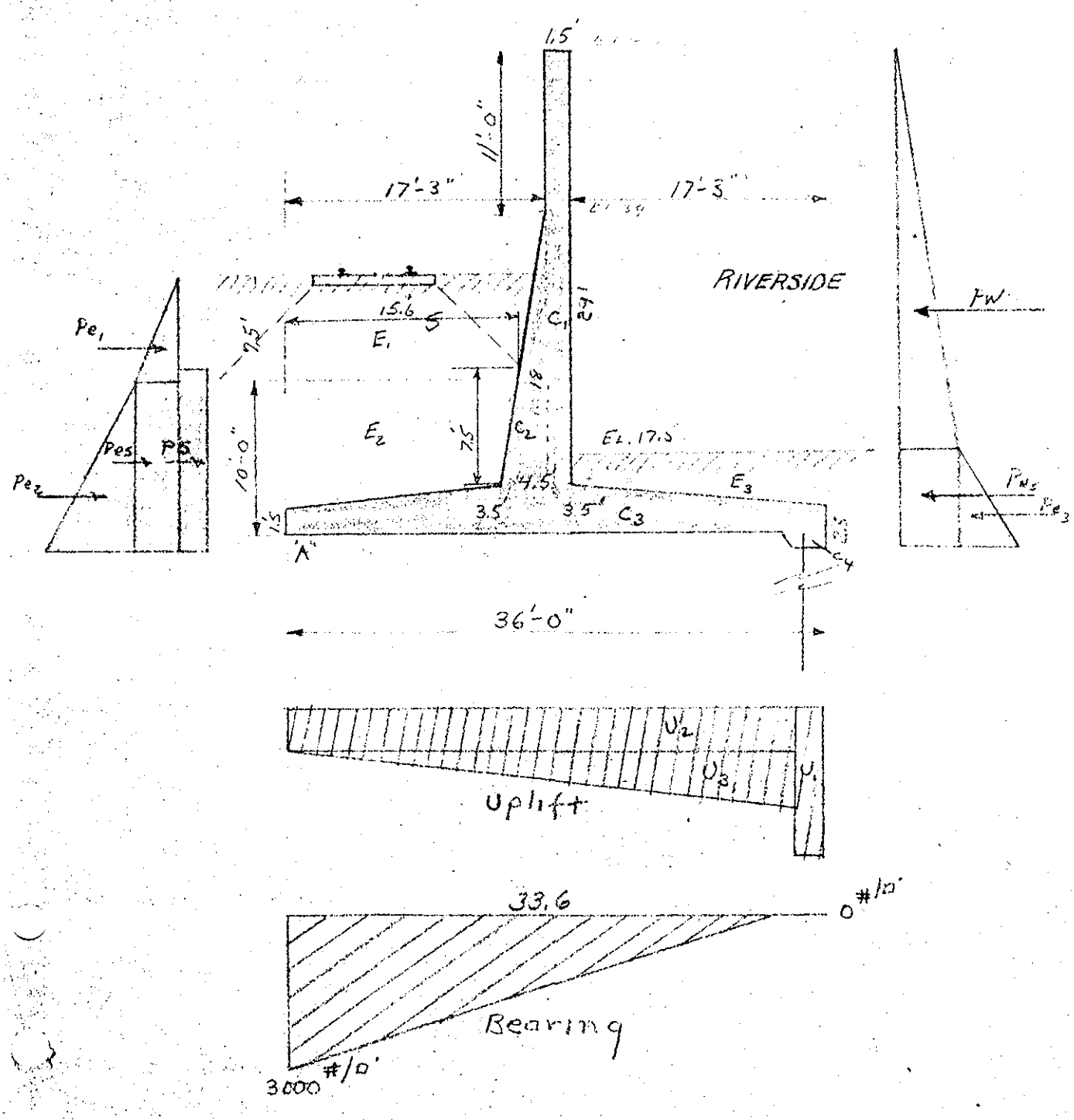
Subject: Hartford H+S — Sta. 13+12± to 15+12±

Computation: Wall at Sta 14+00 and Sta 15+00 — 29' Stem

Computed by: M. S. Jr. Checked by: J. H. L. Date: 2/19/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



WAR DEPARTMENT

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

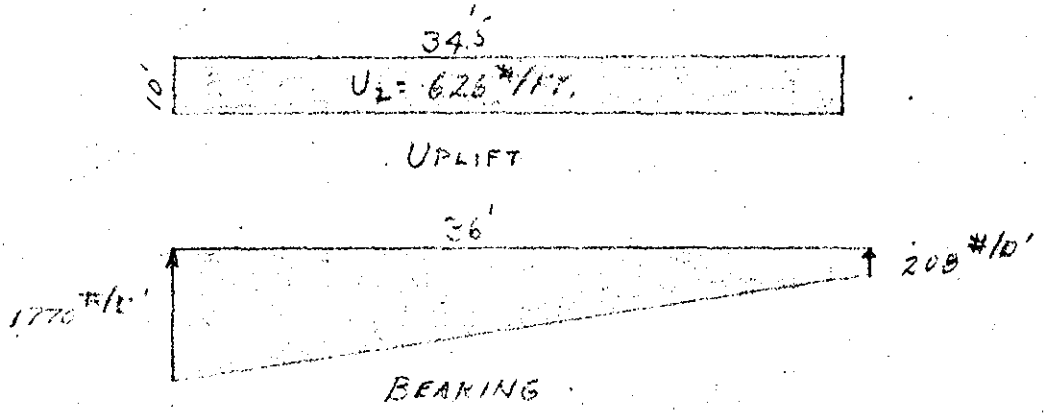
Subject: HARTFORD HES

Computation: WALL STEM 29' BASE 36' STA. 14+00± TO 15+00±

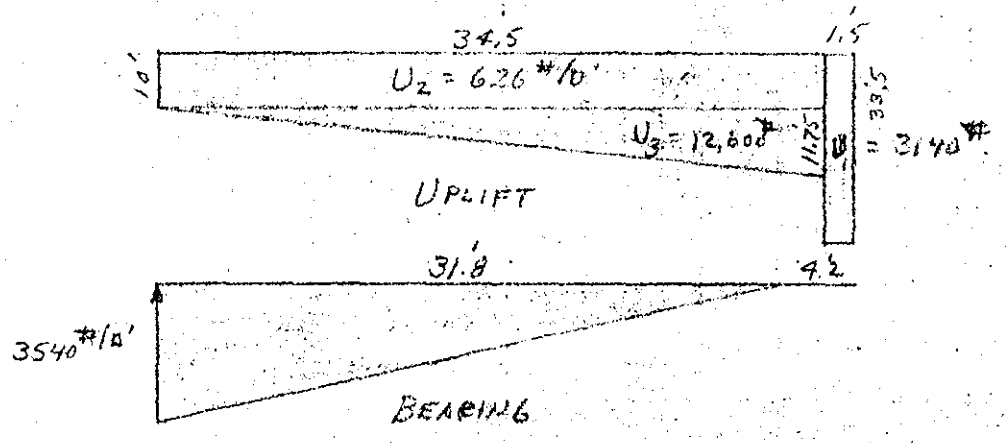
Computed by: P.L.A. Checked by: KW Date: 3/4/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

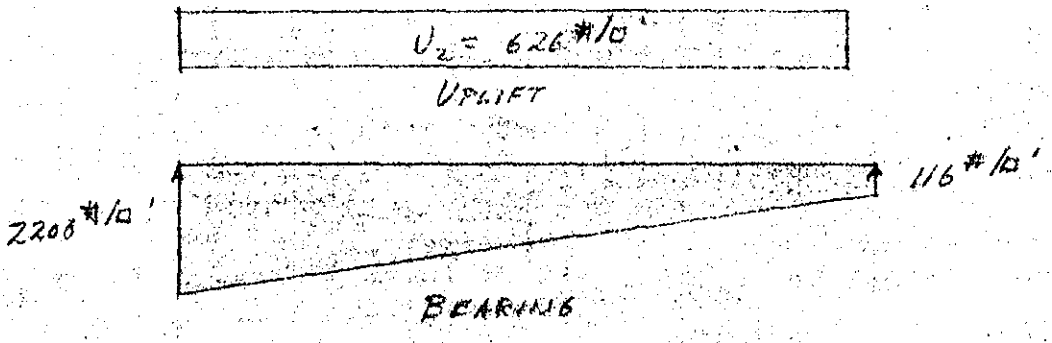
CASE II RIVER DOWN



CASE III RIVER UP & RAILROAD SURCHARGE



CASE IV RIVER DOWN & SURCHARGE



WAR DEPARTMENT

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

bject Hartford Ht. 5

omputation Wall at Sta 14+00 and Sta 15+00 2.9' Stem

omputed by M. S. J. Checked by J. N. J. Date 2/23/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case I River Up

	FORCES ACTING	↓	↑	→	←	ARM	MOMENTS AT "A"	
C_1	29'x1.5'x150'	6510'				18.0'	117,000'	
C_2	3'x18'x½'x150'	4050'				16.25'	65,800'	
C_3	3.5'x36'x150'	18,900'				18.0'	340,000'	
C_4	1'x3'x150'	450'				34.5'	15,500'	
E_1	7.5'x17'x100'	12,700'				8.5'	108,000'	
E_2	6.5'x14.75'x125'	12,000'				7.4'	88,500'	
E_3	1.5'x17.25'x125'	3,240'				27.38'	88,600'	
W	27.5'x17.25'x62.5'	29,600'				27.38'	810,000'	
P_w	27.5'²x½'x62.5'				23600'	14.17'		334,000'
P_{ws}	27.5'x62.5'x6'				10300'	2.0'		20,600'
Pe_3	6'²x½'x80'				1440'	1.0'		1,440'
Pe_1	7.5'²x½'x35'			982'		12.5'	12,300'	
Pe_s	7.5'x35'x11'			2890'		4.5'	13,000'	
Pe_2	11'²x½'x80'			4850'		2.67'	12,900'	
U_1	33.5'x62.5'x1.5'		3140'			35.25'		111,000'
U_2	10'x62.5'x34.5'		21600'			17.25'		372,000'
U_3	735'x½'x34.5'		12600			23.0		293,000'
		87,450'	37,340'					
		ΣV = 50,110						
	Friction .45x50,410			22,600				
	Passive Pressure			4,018		5.1	20,090	
				35,340	35,340		1,691,700'	1,131,040
	TOTALS →	ΣV = 50,110'		ΣH = 0			ΣM = 560,650	

$\frac{\Sigma M}{\Sigma V} = 11.2'$ 0.8' outside middle third O.K.

$$\text{Bearing} = \frac{50,410}{3 \times 11.2} \times \begin{matrix} 2 = 3000 \ \#/\square' \\ 0 = 0 \ \#/\square' \end{matrix}$$

WAR DEPARTMENT

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

Project: HARTFORD NES

Computation: WALL STEM 29' BASE 36' STA. 14+00± TO 15+00±

Computed by: PLA Checked by: R.H. Date: 3/4/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STABILITY CONT'D CASE II RIVER DOWN

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT "A" ↷	↶
C_1		6510					117,000	
C_2		4050					65,800	
C_3		18900					340,000	
C_4		450					15,500	
E_1		12700					108,000	
E_2		12000					88,500	
E_3	1.5 X 17.25 X 100	2590				27.38	71,000	
Pa_3	½ X 35 X 6²				630	1.0		630
Pe_1				982			12,300	
Pe_5				2890			13,000	
Pe_2				4850			12,900	
U_2			21600					372,000
FR	0.45 X 35600				16000			
		57200	21600	8722	16,630		844,000	372,630
		ΣV = 35,600 ↓		ΣH = 0			ΣM = 471,370 ↶	

$$\text{Position of Resultant} = \frac{\Sigma M}{\Sigma V} = \frac{471,000}{35,600} = 13.25'$$

⅓ BASE = 12.0'

1.25' INSIDE MIDDLE 3RD

$e = 18.0 - 13.25 = 4.75'$

$$\text{BASE PRESSURE} = \frac{\Sigma V}{A}\left(1 \pm \frac{6e}{d}\right) = \frac{35600}{36}\left(1 \pm \frac{6 \times 4.75}{36}\right) = \begin{matrix} 1770 \ \#/\square' \\ 208 \ \#/\square' \end{matrix}$$

Project HARTFORD HC 5
Computation WALL STEM 29' BASE 36' STA. 14+00 ℄ TO 15+00 ℄
Computed by P.L.A. Checked by KW Date 3/4/40

U. S. GOVERNMENT PRINTING OFFICE 8—10528

STABILITY

CASE III RIVER UP & RAILROAD SURCHARGE
E-60 LOADING 6000#/FT. OF TRACK

NOTE CASES III & IV NOT USED

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT "A" ↻	MOMENTS ABOUT "A" ↺
CARRIED FORWARD		87450	37340	8722	35340		1,671,610	1,131,040
S		6000				7.8	46,800	
PS	39'×.35 X 11.0			1480		5.5	8,150	
FR	.45 X 56100			25300				
		93450	37340	35502	35340		1,726,560	1,131,040
		ΣV = 56110 ↓		ΣH = 0			ΣM = 595,520 ↻	

½ BASE = 12.0'
OUTSIDE MIDDLE 3rd = 2.4'

$$\text{POSITION OF RESULTANT} = \frac{\Sigma M}{\Sigma V} = \frac{596,000}{56100} = 10.6'$$

$$\text{BEARING} = \frac{\Sigma V}{A}\left(1 \pm \frac{6e}{d}\right) = \frac{56100}{31.8} = 1766 \begin{cases} 2 \\ 0 \end{cases} = \begin{matrix} 3540\ \#/\square' \\ 0\ \#/\square' \end{matrix}$$

CASE IV RIVER DOWN & RAILROAD SURCHARGE

CARRIED FORWARD		57,200	21,600	8722	630		844,000	372,630
S		6000				7.8	46,800	
PS				1480		5.5	8150	
FR	0.45 X 41,600				18,800			
		63,200	21600	10,202	19430		898,950	372,630
		ΣV = 41600 ↓		ΣH = 0			ΣM = 526,320 ↻	

$$\text{POSITION OF RESULTANT} = \frac{\Sigma M}{\Sigma V} = \frac{526,000}{41,600} = 12.6'$$

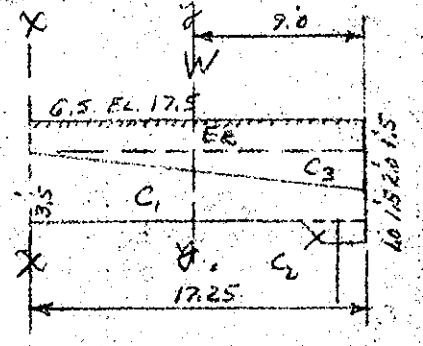
0.6' INSIDE MIDDLE 3RD.
$e = 18.0 - 12.6 = 5.4'$

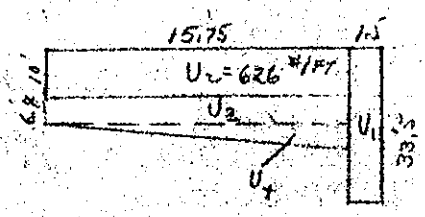
$$\text{BEARING} = \frac{41,600}{36}\left(1 \pm \frac{6 \times 5.4}{36}\right) = 1160 \begin{cases} 1.90 \\ 0.10 \end{cases} = \begin{matrix} 2200\ \#/\square' \\ 116\ \#/\square' \end{matrix}$$

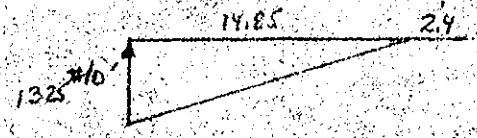
Subject HARTFORD Ht 5
Computation CANTILEVER WALL STEM 29' BASE 36' STA. 14100± TO 15+00±
Computed by P.L.A. Checked by R.N. Date 3/5/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

CASE I RIVER UP RIVERSIDE BASE TOP STEEL







FOR MOMENTS ABOUT X-X

FORCES ACTING		↓	↑	ARM	MOMENTS ↻	MOMENTS ↺
C_1	3.5 X 17.25 X 150	9050		8.63	78100	
C_2	3.0 X 1.0 X 150	450		15.75	7090	
C_3	½ X 2.0 X 17.25 X 25		430	11.5		4950
W	27.5 X 17.25 X 62.5	29600		8.63	256,000	
ER	1.5 X 17.25 X 125	3240		8.63	28,000	
U_1	33.5 X 1.5 X 62.5		3140	16.5		51800
U_2	626 X 15.75		9860	7.88		77800
U_3	6.4 X 15.75 X 62.5		6300	7.88		49600
U_4	½ X 5.35 X 15.75 X 62.5		2640	10.5		27,700
E.P.	½ X 1325 X 14.85		9840	4.95		48600
		42340	32210		369,190	260,450
		$\Sigma V = 10,130 \downarrow$			$\Sigma M = 108,740$ ↻	

$$d_{X-X} = \sqrt{\frac{M}{Rb}} = \sqrt{\frac{108,740 \times 12}{123 \times 12}} = 29.8'' \quad \text{ACTUAL } d = 42.0 - 4.5 = 37.5''$$

$$A_{s_{X-X}} = \frac{M}{f_s j d} = \frac{108,740 \times 12}{18000 \times .884 \times 37.5} = 2.18 \text{ □''}$$

Subject: HARTFORD H&S
Computation: CANTILEVER WALL STEM 29' BASE 36' STA. 14+00 TO 15+00 ±
Computed by: P.L.A. Checked by: Date: 3/6/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

CASE I RIVER UP.

STEEL REINF. CONT'D RIVERSIDE BASE TOP STEEL

$$\text{SHEAR}_{x-x} = \frac{\Sigma V}{bjd} = \frac{10130}{12 \times .884 \times 37.5} = 25.5^{\#/\square''} < 60^{\#/\square''}$$

$$\text{BOND}_{x-x} = \frac{\Sigma V}{\Sigma_0 jd} = \frac{10130}{8.5 \times .884 \times 37.5} = 36.1^{\#/\square''} < 150^{\#/\square''}$$

USE $1''\square$ & $1\frac{1}{8}''\square$ @ 12" c.c. LEAVING A SPACING OF 6"

FOR MOMENTS ABOUT y-y

FORCES ACTING		↓	↑	ARM	MOMENTS ↷	MOMENTS ↶
C_1	2.5 X 9.0 X 150	3380		4.5	15200	
C_2	3.0 X 1.0 X 150	450		7.5	3380	
C_3	½ X 1.0 X 9.0 X 25		113	6.0		680
W	27.5 X 9.0 X 62.5	15450		4.5	69500	
ER	2.5 X 9.0 X 125	2810		4.5	12650	
U_1			3140	8.25		25900
U_2	19.2 X 7.5 X 62.5		9000	3.75		33750
U_3	½ X 2.6 X 7.5 X 62.5		610	5.0		3050
EP	½ X 5.0 X 6.6		1950	2.2		4290
		22090	14813		100,730	67660
		ΣV = 7277 ↓			ΣM = 33,070 ↷	

$$d_{y-y} = \sqrt{\frac{M}{Rb}} = \sqrt{\frac{33,070 \times 12}{122 \times 12}} = 16.4 \quad \text{Actual } d = 30.0 - 4.5 = 25.5''$$

$$A_{s\,y-y} = \frac{M}{f_s jd} = \frac{33070 \times 12}{18000 \times .884 \times 25.5} = 0.98^{\square''}$$

$$\text{SHEAR}_{y-y} = \frac{\Sigma V}{bjd} = \frac{7280}{12 \times .884 \times 25.5} = 26.8^{\#/\square''} < 60^{\#/\square''}$$

$$\text{BOND}_{y-y} = \frac{\Sigma V}{\Sigma_0 jd} = \frac{7280}{4.0 \times .884 \times 25.5} = 80.8^{\#/\square''} < 150^{\#/\square''}$$

USE $1''\square$ @ 12" c.c.

WAR DEPARTMENT

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

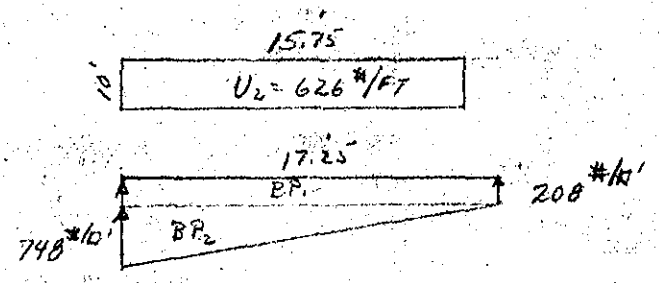
Subject: HARTFORD HTS

Computation: CANTILEVER WALL STEM 29' BASE 36' STA. 14400± TO 15400±

Computed by: P.L.A. Checked by: R.W. Date: 3/5/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

CASE II RIVER DOWN RIVERSIDE BASE BOTTOM STEEL



FOR MOMENTS ABOUT X-X

FORCES ACTING		↓	↑	ARM	MOMENTS ↻	MOMENTS ↺
C_1		9050			78100	
C_2		450			7090	
C_3	½ x 2.0 x 17.25 x 50		860	11.5		9820
ER	1.5 x 17.25 x 100	2580		8.63	22,300	
U_2	626 x 15.75		9860	7.88		77800
BP_1	208 x 17.25		3590	8.63		31000
BP_2	½ x 748 x 17.25		6440	5.75		37000
		12080	20750		107490	155,620
		ΣV = 8670↑			ΣM = 48130 ↺	

$$d_{x-x} = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{48130 \times 12}{773 \times 12}} = 19.8 \quad \text{Actual } d = 42.0 - 4.5 = 37.5$$

$$A_{s\,x-x} = \frac{M}{f_s j d} = \frac{48130 \times 12}{18000 \times .884 \times 37.5} = 0.97 \text{ □"}$$

$$\text{SHEAR}_{x-x} = \frac{\Sigma V}{b j d} = \frac{8670}{12 \times .884 \times 37.5} = 21.7 \text{ \#/□"} < 60 \text{ \#/□"}$$

$$\text{BOND}_{x-x} = \frac{\Sigma V}{\Sigma o j d} = \frac{8670}{4.0 \times .884 \times 37.5} = 65.4 \text{ \#/□"} < 150 \text{ \#/□"}$$

USE 7/8" □ @ 12" c.c.

Note: Considering Railroad Surcharge gives no increase in this steel. RW.

WAR DEPARTMENT

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

Subject: HARTFORD HTS

Computation: CANTILEVER WALL STEM 29' BASE 36' STA. 14+00± TO 15+00±

Computed by: P.L.A. Checked by: Date: 3/6/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

CASE II RIVER DOWN RIVERSIDE BASE BOTTOM STEEL

FOR MOMENTS 3.25' FROM STEM

FORCES ACTING		↓	↑	ARM	MOMENTS ↻	MOMENTS ↺
C_1	3.12 X 14 X 150	6550		7.0	45800	
C_2		450		12.5	5620	
C_3	½ X 1.62 X 14 X 150		570	9.3		5130
EW	1.88 X 14 X 100	2630		7.0	18400	
U_2	626 X 12.5		7830	6.25		49000
EP_1	208 X 14		2900	7.0		20400
EP_2	½ X 608 X 14		4250	4.7		20000
		9630	15550		69820	94530
		ΣV = 5920 ↑			ΣM = 24710 ↺	

$$d = \sqrt{\frac{M}{Rb}} = \sqrt{\frac{24710 \times 12}{123 \times 12}} = 14.2'' \qquad d = 37.4 - 4.5 = 32.9''$$

$$A_s = \frac{24710 \times 12}{18000 \times .884 \times 32.9} = 0.57^{\square''}$$

$$\text{SHEAR} = \frac{5920}{12 \times .884 \times 32.9} = 17.0^{\#/\square''} < 60^{\#/\square''}$$

$$\text{BOND} = \frac{\Sigma V}{\Sigma_s j d} = \frac{5920}{2.75 \times .884 \times 32.9} = 74.2^{\#/\square''} < 150^{\#/\square''}$$

Use 7/8" ϕ @ 12" c.c.

Subject: HARTFORD HES
Computation: CANTILEVER WALL STEM 29' BASE 36' STA. 14+00± TO 15+00±
Computed by: PLA Checked by: Date: 3/6/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

CASE II RIVER DOWN
STEEL REINF. CONT'D RIVERSIDE BASE BOTTOM STEEL

FOR MOMENTS ABOUT y-y

FORCES ACTING		↓	↑	ARM	MOMENTS ↻	MOMENTS ↺
C_1	2.54 X 9.0 X 150	3420		4.5	15400	
C_2		450		7.5	3380	
C_3	½ X 1.04 X 9.0 X 50		234	6.0		1400
ER	2.46 X 9.0 X 100	2220		4.5	10000	
U_2	626 X 7.5		4700	3.75		17600
BP_1	208 X 9.0		1870	4.5		8410
BP_2	½ X 390 X 9.0		1750	3.0		5250
		6090	8554		28780	32660
		ΣV = 2464 ↑			ΣM = 3880 ↺	

$$d_{y-y} = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{3880 \times 12}{123 \times 12}} = 5.62'' \quad \text{ACTUAL } d = 26.0$$

$$A_{s_{y-y}} = \frac{M}{f_s j d} = \frac{3880 \times 12}{18000 \times .884 \times 26} = 0.11 \text{ □''}$$

$$\text{SHEAR}_{y-y} = \frac{\Sigma V}{b j d} = \frac{2464}{12 \times .884 \times 25.5} = 9.1 \text{ \#/□''} < 60 \text{ \#/□''}$$

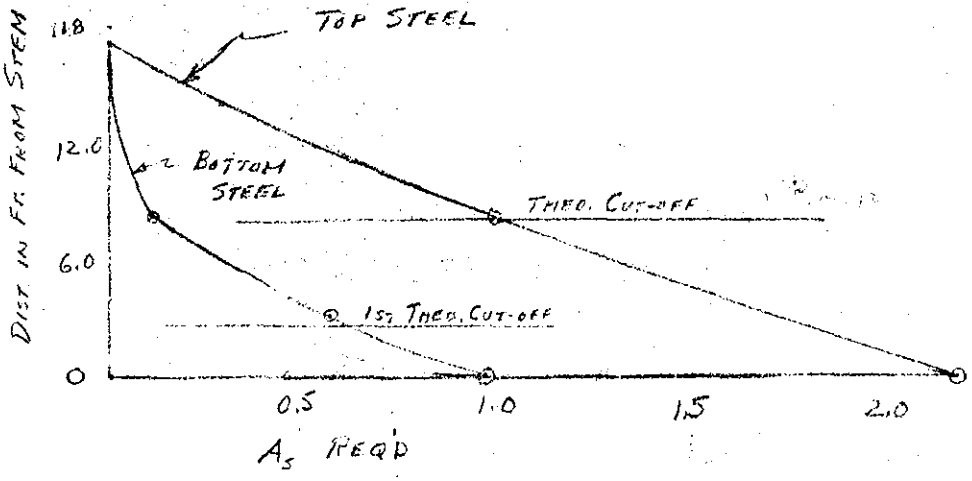
$$\text{BOND}_{y-y} = \frac{\Sigma V}{\Sigma_0 j d} = \frac{2464}{2.75 \times .884 \times 25.5} = 39.8 \text{ \#/□''} < 150 \text{ \#/□''}$$

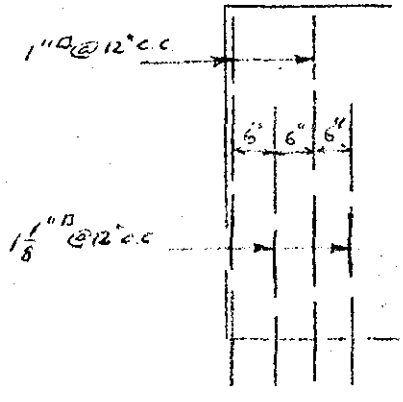
USE 7/8"φ @ 12" c.c.

Subject HARTFORD HES
Computation CANTILEVER WALL STEM 29' BASE 36' STA 14+00± TO 15+00±
Computed by PLA Checked by R.V. Date 3/6/40

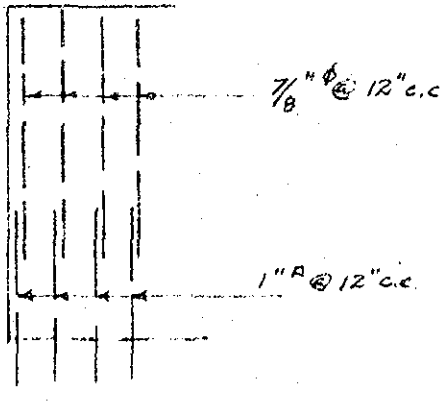
U. S. GOVERNMENT PRINTING OFFICE 3—10523

CASE I RIVER UP
STEEL REINF. CONT'D RIVERSIDE BASE TOP & BOTTOM STEEL





RIVERSIDE BASE
TOP STEEL

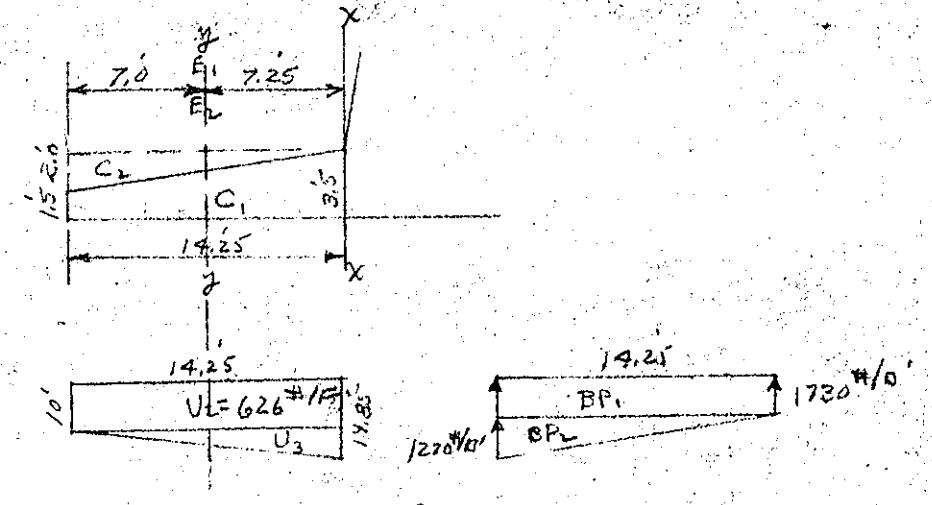


RIVERSIDE BASE
BOTTOM STEEL

Subject: HARTFORD HTS
Computation: CANTILEVER WALL STEM 29' BASE 36' STA. 14+00± TO 15+00±
Computed by: F.L.A. Checked by: R.W. Date: 3/5/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

CASE I RIVER UP LANDSIDE BASE BOTTOM STEEL



FOR MOMENTS ABOUT X-X

FORCES ACTING		↓	↑	ARM	MOMENTS ↻	MOMENTS ↺
C_1	3.5 X 14.25 X 150	7500		7.13		53500
C_2	½ X 2.0 X 14.25 X 25		356	9.5	3380	
E_1	7.5 X 14.25 X 100	10700		7.13		76300
E_2	6.5 X 14.25 X 125	11600		7.13		82600
U_2	14.25 X 626		8930	7.13	63600	
U_3	½ X 4.75 X 14.25 X 625		2160	4.75	10300	
BP₁	1730 X 14.25		24600	7.13	175500	
BP₂	½ X 1270 X 14.25		9050	9.5	86000	
		29800	45096		338,780	212,400
		ΣV = 15296 ↑			ΣM = 126380 ↻	

$$d_{x-x} = \sqrt{\frac{M}{kb}} = \sqrt{\frac{126400 \times 12}{123 \times 12}} = 32.0'' \quad \text{ACTUAL } d = 42.0 - 4.5 = 37.5''$$

$$A_{s_{x-x}} = \frac{M}{f_s j d} = \frac{126400 \times 12}{18000 \times .884 \times 37.5} = 2.54 \text{ □''}$$

$$\text{SHEAR}_{x-x} = \frac{15300}{12 \times .884 \times 37.5} = 38.4 \text{ \#/□''} < 60 \text{ \#/□''}$$

$$\text{BOND}_{x-x} = \frac{15300}{9.0 \times .884 \times 37.5} = 51.3 \text{ \#/□''} < 100 \text{ \#/□''}$$

USE $1\frac{1}{8}$" □ @ 6" cc

Project: HARTFORD HTS
Computation: CANTILEVER WALL STEM 29' BASE 36' STA. 14700± TO 15100±
Computed by: P.L.A. Checked by: KW Date: 3/7/40

U. S. GOVERNMENT PRINTING OFFICE 3—10623

CASE 2 RIVER UP LANDSIDE BASE BOTTOM STEEL
FOR MOMENTS ABOUT Y-Y

FORCES ACTING		↓	↑	ARM	MOMENTS ↷	MOMENTS ↶
C_1	2.48 X 7 X 150	2600		3.5		9100
C_2	½ X .98 X 7 X 25		90	4.7	420	
F_1	7.5 X 7.0 X 100	5250		3.5		18400
E_2	7.5 L X 7.0² X 125	6580		3.5		23000
U_2	626 X 7.0		4380	3.5	15300	
U_3	½ X 2.38 X 7 X 62.5		520	2.3	1200	
BP_1	2380 X 7.0		16700	3.5	58400	
BP_2	½ X 620 X 7.0		2170	4.7	10200	
		14430	23860		85520	50500
		ΣV = 9430 ↑			ΣM = 35020 ↷	

$$d_{YY} = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{35000 \times 12}{123 \times 12}} = 16.9'' \quad \text{ACTUAL } d = 29.8 - 4.5 = 25.3''$$

$$A_{s_{YY}} = \frac{M}{f_s j d} = \frac{35000 \times 12}{18000 \times .884 \times 25.3} = 1.05 \ \square''$$

$$\text{SHEAR}_{Y-Y} = \frac{\Sigma V}{b j d} = \frac{9430}{12 \times .884 \times 25.3} = 35^{\#/\square''} < 60^{\#/\square''}$$

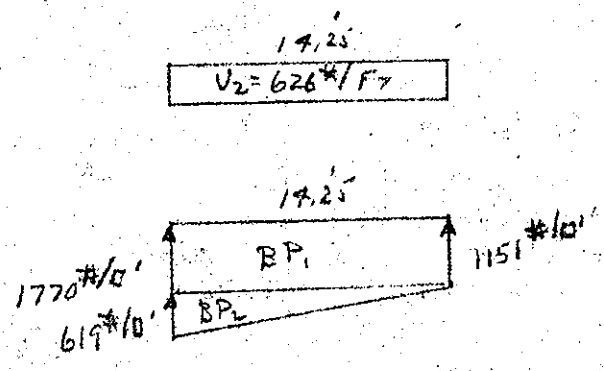
$$\text{BOND}_{Y-Y} = \frac{\Sigma V}{\Sigma_o j d} = \frac{9430}{4.0 \times .884 \times 25.3} = 105^{\#/\square''} < 150^{\#/\square''}$$

USE 1"□ @ 12" CC.

Subject: HARTFORD HTS
Computation: CANTILEVER WALL STEM 29' BASE 36' STA. 14+00± TO 15+00±
Computed by: PLA Checked by: RW Date: 3/5/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

CASE II RIVER DOWN LANDSIDE BASE BOTTOM STEEL



FOR MOMENTS ABOUT X-X

FORCES ACTING		↓	↑	ARM	MOMENTS ↻	MOMENTS ↺
C_1		7500				53500
C_2			356		3380	
E_1		10700				76300
E_2		11600				82600
V_2			8930		63600	
BP_1	1151 X 14.25		16400	7.13	117000	
BP_2	½ X 619 X 14.25		4910	9.5	41900	
		29800	30096		225,880	212,400
		ΣV = 296 ↑			ΣM = 13,480 ↻	

$$d_{X-X} = \sqrt{\frac{M}{RO}} = \sqrt{\frac{13480 \times 12}{123 \times 12}} = 10.''9 \quad \text{ACTUAL } d = 42.0 - 4.5 = 37.5''$$

$$A_{S_{X-X}} = \frac{M}{f_s j d} = \frac{13480 \times 12}{18000 \times .884 \times 37.5} = 0.27 \square''$$

$$\text{SHEAR}_{X-X} = \frac{\Sigma V}{b j d} = \frac{296}{12 \times .884 \times 37.5} = 0.75\ \#/\square'' < 60\ \#/\square''$$

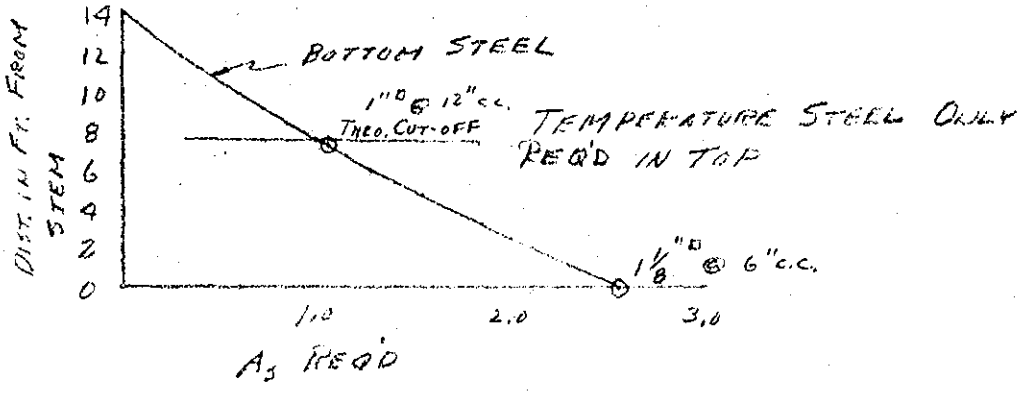
$$\text{BOND}_{X-X} = \frac{296}{X \times .884 \times 37.5} = \quad < 150\ \#/\square''$$

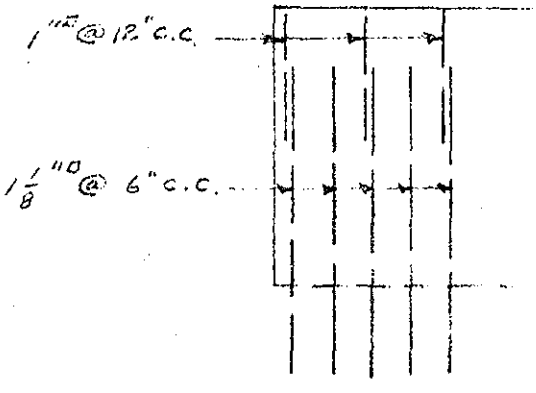
THIS CASE DOES NOT GOVERN

Subject HTS HARTFORD
Computation CANTILEVER WALL STEM 29' BASE 36' STA. 14+00± TO 15+00±
Computed by PLA Checked by KW Date 3/7/40

U.S. GOVERNMENT PRINTING OFFICE 3—10520

LANDSIDE BASE



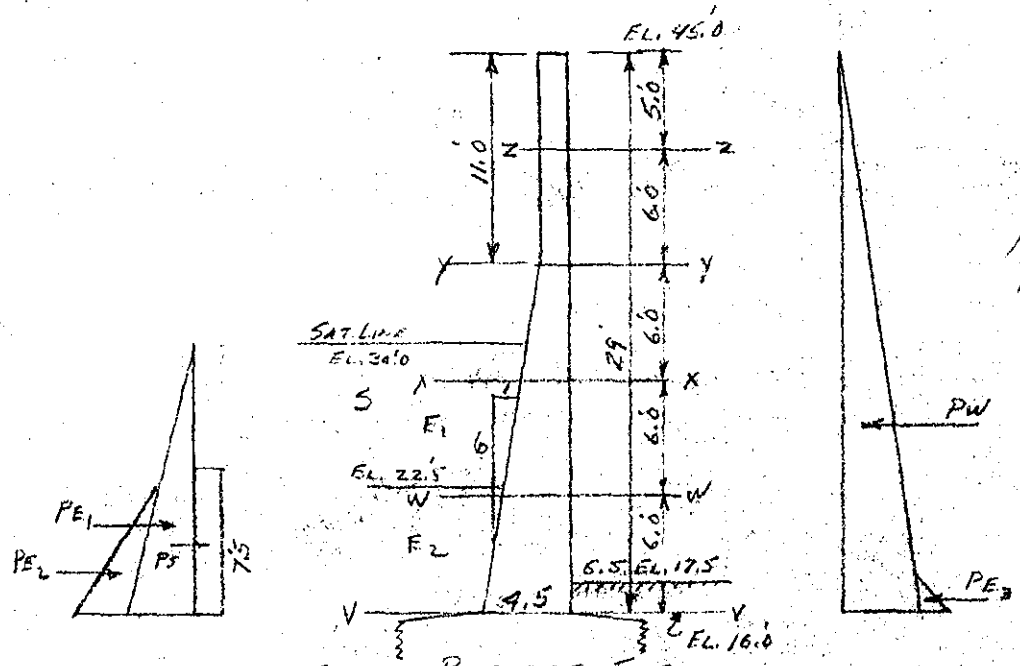


FOOTING
LANDSIDE BOTTOM STEEL

bject HES HARTFORD
mputation CANTILEVER WALL STEM 29' BASE 36' STA. 14+00± TO 15+00±
mputed by P.L.A. Checked by KW Date 3/7/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL REINF. CONT'D.
CASE I RIVER UP & NO SURCHARGE



Note:
Incorrect Backfill
El. Taken.
Does not affect
design

STEEL IN STEM RIVERSIDE FACE

FOR MOMENTS ABOUT V-V

FORCES ACTING		→	←	ARM	MOMENTS ↷	MOMENTS ↶
PE_1	$\frac{1}{2} \times 35 \times \overline{14}^2$ 10^2	3430		~~4.7~~ 3.33	13300 ~~16200~~	
PE_2	$\frac{1}{2} \times 45 \times \overline{6.5}^2$	950		2.17	2060	
PW	$\frac{1}{2} \times 62.5 \times \overline{29}^2$		26300	9.7		255,000
PE_3	$\frac{1}{2} \times 17.5 \times \overline{1.5}^2$		20	0.5		10
		4380	26320		18260	255010
		ΣV = 21940 ←			ΣM = 236,750 ↶	

240,700

FOR MOMENTS ABOUT W-W

PE_1	$\frac{1}{2} \times 35 \times \overline{8.0}^2$	1120		2.7	3020	
PW	$\frac{1}{2} \times 62.5 \times \overline{23}^2$		16500	7.7		127000
		1120	16500		3020	127000
		ΣV = 15380 ←			ΣM = 123980	

FOR MOMENTS ABOUT X-X

PE_1	$\frac{1}{2} \times 35 \times \overline{2.0}^2$	70		0.7	49	
PW	$\frac{1}{2} \times 62.5 \times \overline{17}^2$		9040	5.7		51,500
		70	9040		49	51500
		ΣV = 8970 ←			ΣM = 51451 ↶	

bject HARTFORD HES
omputation CANTILEVER WALL STEM 29' BASE 36' STA. 14100± TO 15700±
omputed by P.L.A. Checked by RW Date 3/7/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL REINF. CONT'D STEEL IN STEM
CASE I RIVER UP & NO SURCHARGE
STEEL IN RIVERSIDE FACE

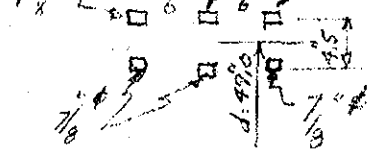
FOR MOMENTS ABOUT Y-Y

FORCES ACTING		→	←	ARM	MOMENTS ↷	MOMENTS ↶
PW	$\frac{1}{2} \times 62.5 \times \overline{11.0}^2$		3780	3.7		14000
		0	3780		0	14000
		ΣV = 3780 ←			ΣM = 14000 ↶	

FOR MOMENTS ABOUT Z-Z

PW	$\frac{1}{2} \times 62.5 \times \overline{5.0}^2$		780	1.7		1330
		0	780		0	1330
		ΣV = 780 ←			ΣM = 1330 ↶	

$$d_{V-V} = \sqrt{\frac{M}{Rb}} = \sqrt{\frac{237000 \times 12}{123 \times 12}} = 43.8'' \quad \text{Actual } d = 54.0 - 5.0 = 49.0''$$



$$A_{s_{V-V}} = \frac{M}{f_s j d} = \frac{\overset{243,720}{237000} \times 12}{18000 \times .884 \times 49.0} = \overset{3.72}{3.66}\ \square''$$

$$\text{Shear}_{V-V} = \frac{\Sigma V}{b j d} = \frac{21900}{12 \times .884 \times 49.0} = 42.1\ \#/\square'' < 60\ \#/\square''$$

$$\text{Bond}_{V-V} = \frac{\Sigma V}{\Sigma_o j d} = \frac{21900}{14.5 \times .884 \times 49.0} = 35\ \#/\square'' < 150\ \#/\square''$$

USE $1\frac{1}{8}''\square$ SPACED 6" c.c. & $\frac{7}{8}''\phi$ $4\frac{1}{2}''$ BACK OF FIRST ROW & SPACED 6" c.c. ACTUAL $A_s = 3.73\ \square''$

$$d_{W-W} = \sqrt{\frac{124000 \times 12}{123 \times 12}} = 31.8'' \quad \text{Actual } d = 42.0 - 3.5 = 38.5''$$

$$A_{s_{W-W}} = \frac{124000 \times 12}{18000 \times .884 \times 38.5} = 2.47\ \square''$$

Subject: HARTFORD HTS
Computation: CANTILEVER WALL STEM 29' BASE 36' STA. 14400± TO 15400±
Computed by: PLA Checked by: RH Date: 3/7/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL REINF. CONT'D STEEL IN STEM RIVERSIDE FACE
CASE I RIVER UP & NO SURCHARGE

$$SHEAR_{W-W} = \frac{\Sigma V}{bjd} = \frac{15380}{12 \times .884 \times 38.5} = 37.5 \#/\square'' < 60 \#/\square''$$

$$BOND_{W-W} = \frac{\Sigma V}{\Sigma_o jd} = \frac{15380}{9.0 \times .884 \times 38.5} = 50.1 \#/\square'' < 150 \#/\square''$$

USE $1\frac{1}{8}''\phi$ @ 6" c.c. $A_s = 2.53 \square''$

$$d_{X-X} = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{51500 \times 12}{123 \times 12}} = 20.4'' \quad \text{ACTUAL } d = 30.0 - 3.5 = 26.5''$$

$$A_{s_{X-X}} = \frac{M}{f_s jd} = \frac{51500 \times 12}{18000 \times .884 \times 26.5} = 1.47 \square''$$

$$SHEAR_{X-Y} = \frac{8970}{12 \times .884 \times 26.5} = 31.8 \#/\square'' < 60 \#/\square''$$

$$BOND_{X-Y} = \frac{8970}{6.2 \times .884 \times 26.5} = 60.9 \#/\square'' < 150 \#/\square''$$

USE $1''\phi$ @ 6" c.c. $A_s = 1.57 \square''$

$$d_{Y-Y} = \sqrt{\frac{14000 \times 12}{123 \times 12}} = 10.7'' \quad \text{ACTUAL } d = 18.0 - 3.5 = 14.5''$$

$$A_{s_{Y-Y}} = \frac{14000 \times 12}{18000 \times .884 \times 14.5} = 0.73 \square''$$

$$SHEAR_{Y-Y} = \frac{3780}{12 \times .884 \times 14.5} = 24.5 \#/\square'' < 60 \#/\square''$$

$$BOND_{Y-Y} = \frac{3780}{3.14 \times .884 \times 14.5} = 94 \#/\square'' < 150 \#/\square''$$

USE $1''\phi$ @ 12" c.c.

Subject HARTFORD HTS
Computation CANTILEVER WALL STEM 29' BASE 36' STA. 14+00± TO 15+00±
Computed by FLA Checked by Date 3/7/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

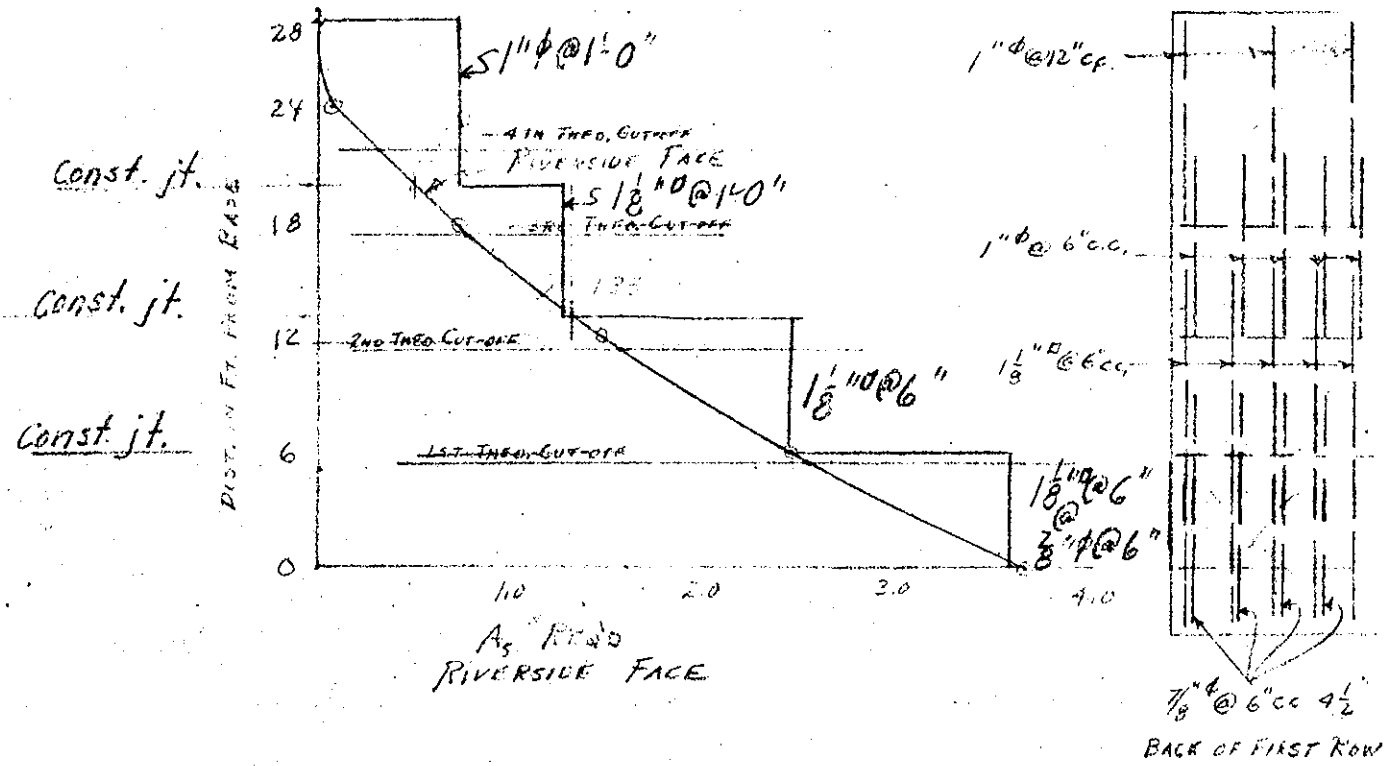
STEEL REINF. CONT'D STEEL IN STEM RIVERSIDE FACE
CASE I RIVER UP & NO SURCHARGE

$$d_{2-2} = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{1330 \times 12}{123 \times 12}} = 3.3'' \quad \text{ACTUAL } d = 14.5''$$

$$A_{s_{2-2}} = \frac{M}{f_s j d} = \frac{1330 \times 12}{18000 \times .884 \times 14.5} = .07 \text{ □}''$$

$$\text{SHEAR}_{2-2} = \frac{EV}{bjd} = \frac{780}{12 \times .884 \times 14.5} = 5.1 \text{ \#/□}' < 60 \text{ \#/□}''$$

USE 1" ϕ @ 12" cc



RIVERSIDE FACE
OF STEM

Subject HARTFORD Ht 5
Computation CANTILEVER WALL STEM 29' BASE 36' STA. 14+00± TO 15+00±
Computed by P.L.A. Checked by RW Date 3/7/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL REINF. CONT'D
STEEL IN STEM LANDSIDE FACE

CASE II RIVER DOWN & RAILROAD SURCHARGE

FORCES ACTING		→	←	ARM	MOMENTS ↻	MOMENTS ↺
P_S	385 x 3.5 x 7.5	1010		3.75	3780	
P_{E_1}		3430			16200	
P_{E_2}		950			2060	
P_{E_3}			20			10
		5390	20		22040	10
		ΣV = 5370 →			ΣM = 22030 ↻	

$$d_{W\text{-}W} = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{22000 \times 12}{123 \times 12}} = 13.4 \qquad \text{ACTUAL } d = 54.0 - 3.5 = 50.5$$

$$A_{s_{W\text{-}W}} = \frac{M}{f_s j d} = \frac{22000 \times 12}{18000 \times .884 \times 50.5} = 0.33 \ \square''$$

$$\text{SHEAR}_{W\text{-}W} = \frac{\Sigma V}{b j d} = \frac{5370}{12 \times .884 \times 50.5} = 9.8 \ \#/\square'' < 60 \ \#/\square''$$

$$\text{BOND}_{W\text{-}W} = \frac{\Sigma V}{\Sigma_o j d} = \frac{5370}{1.96 \times .884 \times 50.5} = 61.4 \ \#/\square'' < 150 \ \#/\square''$$

USE $\frac{5}{8}''\phi$ SPACED 12" C.C.

WAR DEPARTMENT

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

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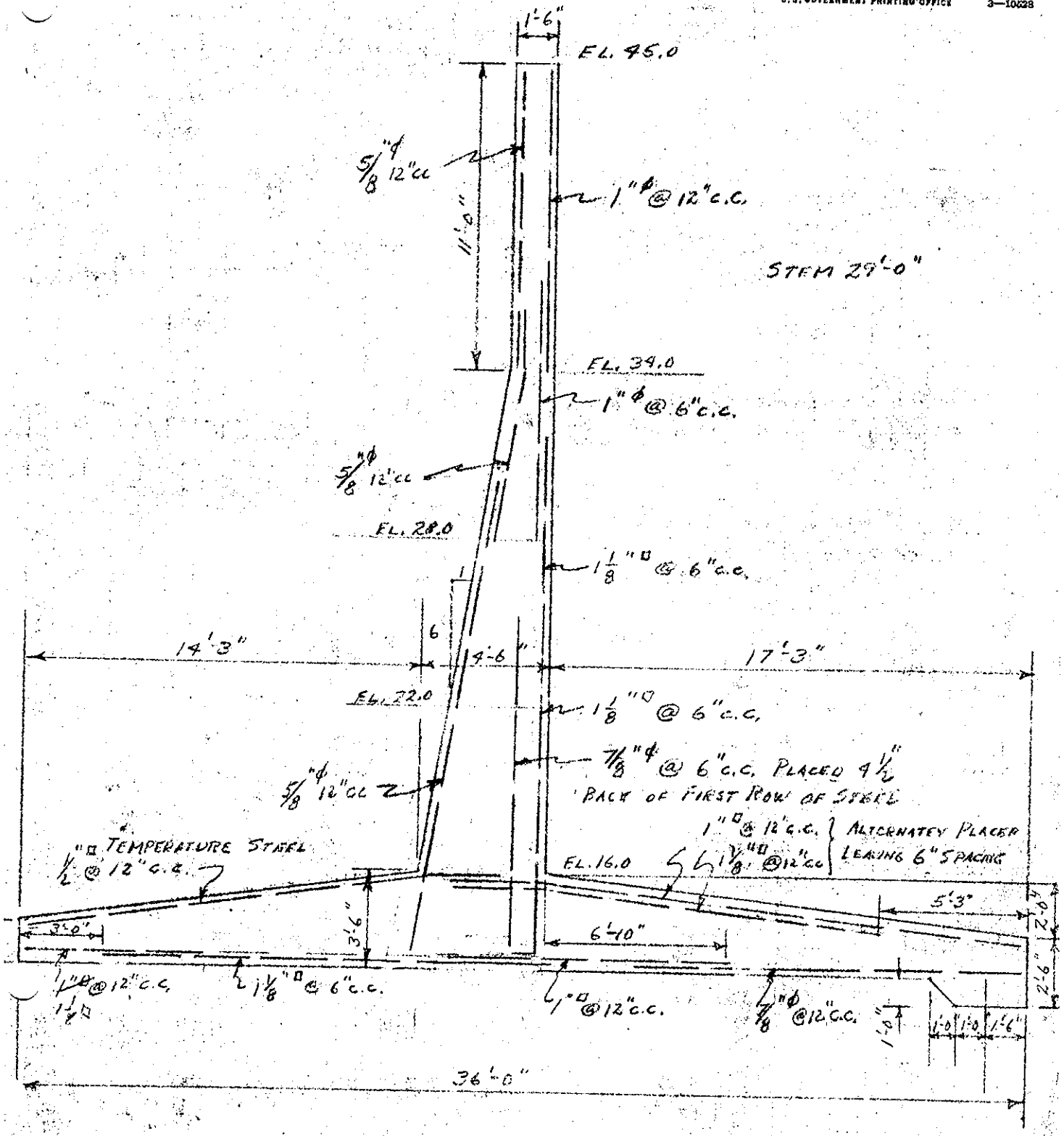
Subject HARTFORD HES 13+12 1 to 15+12 2

Computation CANTILEVER WALL STEM 29' BASE 36' STA. 14+00± TO 15+00±

Computed by PLA Checked by Date 3/7/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



WAR DEPARTMENT

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

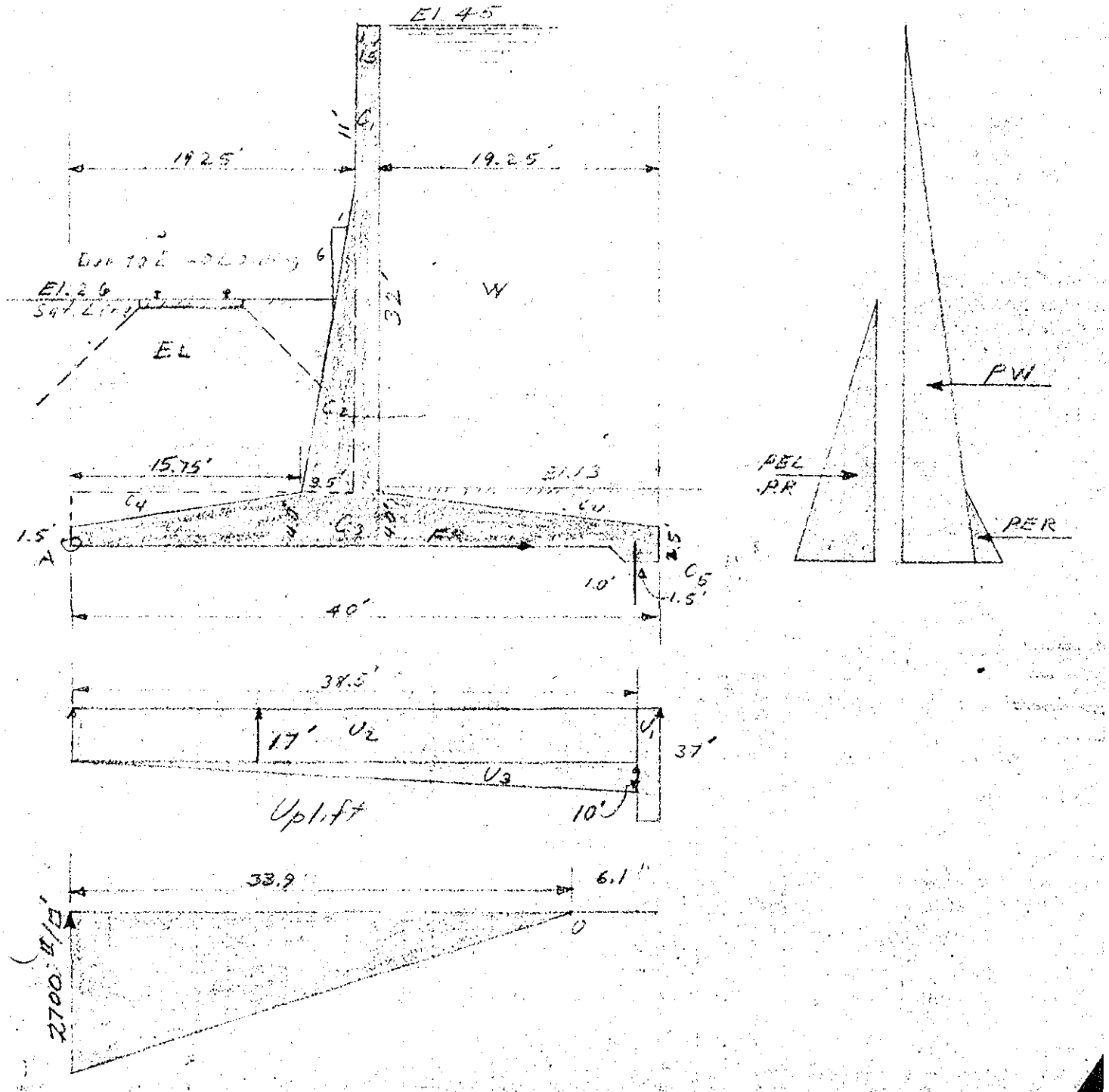
Object Ht 5 Hartford

Computation 32' Cantilever Wall, Base 40' Sta 15+12 to 15+92 ±

Computed by RW Checked by [illegible] Date 2-27-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability



WAR DEPARTMENT

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

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Subject: Ht 5 [illegible]

Computation: 32' [illegible] 15+32

Computed by: R.W. Checked by: [illegible] Date: 2-28-4

U.S. GOVERNMENT PRINTING OFFICE 3—10523

Stability, [illegible] II [illegible], Tr[illegible]

Forces Acting		↓	↑	→	←	Arm	Moment Lb	Ft
C_1		7200				20	144 000	
C_2		5510				18.1	99 800	
C_3		24000				20	400 000	
C_4			1095			21		23 000
C_5		450				38.4	17 380	
EL		27300				8.4	229 300	
ER								
V_2			40 [illegible]			19.25		785 000
PEL				12 [illegible]		5	[illegible]	
PER	$V_2 \times 3 \times 2$				440	[illegible]		300
S	6000	6000				8	48 000	
PL	122 × 11			1340		5.5	7370	
PR	4 × 28560				12,900			
		70460	41[illegible]	5 1424	13 340		1,090,350	808,300
		ΣV 28 [illegible]		Σ[illegible] *900# →			ΣM 282,050	

* Use Passive Resistance

Position of Resultant

$\frac{\Sigma M}{\Sigma V} = \frac{282,000}{28560} = 9.86'$ $\frac{1}{3}$ b [illegible] 12.33

[illegible] $\frac{28560}{3 \times 9.86} \times \begin{cases} 2 \\ 0 \end{cases}$ 1935 0 #/□' Land Side

Correction applied for condition of No Track [illegible]

$\Sigma V = 28560 - 6000 = 22,560$

$\Sigma M = 282,000 - 48,000 - 7370 = 226,630$

$\frac{\Sigma M}{\Sigma V} = \frac{226,630}{22560} = 10.04'$

Base Pressure

$\frac{22560}{3 \times 10.04} \begin{cases} 2 \\ 0 \end{cases}$

Land Side 1500 #/□'

River Side 0 #/□'

WAR DEPARTMENT

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

Project Ht 5

Computation 32' Cantilever Wall 40' Base Sta. 15+12± to 15+92±

Computed by [illegible] Checked by PLA Date 2-27-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability - Case I, River up to El. 45

Forces Acting		↓	↑	→	←	Arm	Moments about A	
C_1	32 × 1.5 × 150	7200				20	144 000	
C_2	31 × 3.5 × ½ × 150	5500				18.1	99 800	
C_3	4 × 40 × 150	24000				20	480 000	
C_4	2.5 × 35 × ½ × 25		1095			21		23 000
C_5	3 × 1 × 150	450				38.4	17 380	
EL	$13 \times \left(\frac{1575+1729}{2}\right) \times 125$	27300				8.4	229,300	
EX								
W	19.25 × 32 × 62.5	38500				30.4	1,170 000	
U_1	37 × 1.5 × 62.5		3470			39.25		136 200
U_2	38.5 × 17 × 62.5		40800			19.25		785 000
U_3	38.5 × 10 × ½ × 62.5		72030			25.7		304 000
PEL	$18^2 \times \frac{1}{2} \times 80$			12900		5	64 500	
PER	$5^2 \times \frac{1}{2} \times 175$				220	0.67		150
PW	$37^2 \times \frac{1}{2} \times 62.5$				42000	11.33		485000
P.R	0.45 × 45 570			20,520		—		
P.R.				9,600		5	48,000	
		102,960	57,395	43020	43,020		2,252,980	1,738,350
		ΣV = 45,570		ΣH =	0		ΣM = 514 630	

Position of Resultant

$\frac{\Sigma M}{\Sigma V} = \frac{514630}{45570} = 11.3'$ $\frac{1}{3}$ base = 13.33'

e = 20.0 − 11.3 = 8.7

Base Pressure

$\frac{45,570}{3 \times 11.3} \begin{cases} 2 \\ 0 \end{cases} = \begin{matrix} 2700 \ \#/\square' & \text{Land Side} \\ 0 \ \#/\square' & \text{River Side} \end{matrix}$

Correction for Track Loaded

ΣV = 45,570
+ 6,000
51,570

ΣM = 514,630
+ 48,000
+ 7370
510,000

$\frac{\Sigma M}{\Sigma V} = \frac{570,000}{51,570} = 11.0'$

Base Pressure

$\frac{51,570}{3 \times 11.0} \begin{cases} 2 \\ 0 \end{cases} = \begin{matrix} 3130 \ \#/\square' & \text{Land Side} \\ 0 \ \#/\square' & \end{matrix}$

WAR DEPARTMENT

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

Object: HLS Hartford

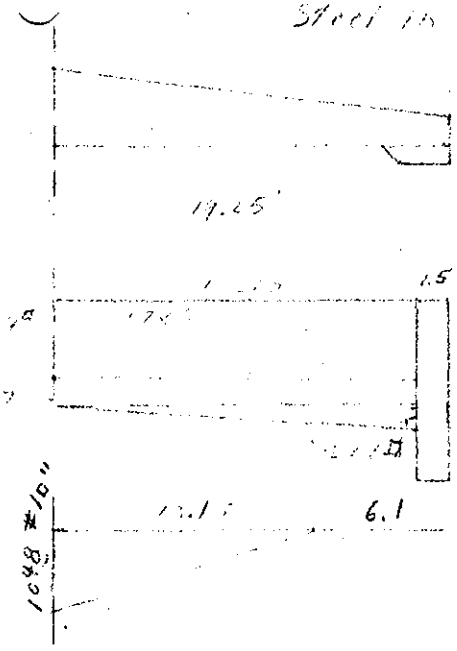
Computation: 32' Cantilever Wall — Sta. 15712 to 15732

Computed by: RW Checked by: P.L.A Date: 3-6-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in Base - River Side River Up

TOP STEEL

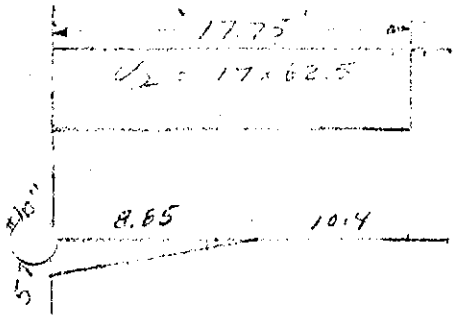


Forces		↓	↑	Moments
W	32 × 19.25 × 62.5	38600		× 9.62 = 371,000
C_1	4 × 19.25 × 150	11550		× 9.62 = 111,000
C_2	3 × 1 × 150	450		× 17.75 = 8,000
E_1	2.5 × 1 × 19.25 × 25		600	× 12.83 = 7700
U_1	3 × 1.5 × 62.5		3470	× 18.5 = 64,300
U_2	[illegible] × 17.75		24900	× 8.9 = 222,000
U_3	[illegible] × ½ × 17.75		2560	× 11.5 = 30,200
BP	1048 × ½ × 13.1		6870	× 4.4 = 30,200
				Σ M = 135,500 ft-lb

$d_{required} = \sqrt{\frac{135500}{123}} = 31.6''$

$A_s = \frac{35600 \times 12}{17500 \times 7/8 \times 31.6} = 2.36 \square''$

Steel in Base River Side, River Down BOTTOM STEEL



Forces		↓	↑	Moments
C_1		11550		× 9.62 = 111,000
C_2		450		× 17.75 = 8,000
E_1	2.5 × 1 × 17.75 × 50		1200	× 12.83 = 15400
U_2	17 × 62.5 × 17.75		18900	× 8.9 = 168200
BP	577 × 8.85 × ½		2550	× 2.95 = 7520
				Σ M = 73,120 ft-lb

$A_s = \frac{73120 \times 12}{17500 \times 7/8 \times 42.5} = 1.27 \square''$

WAR DEPARTMENT

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

Subject: Pier 5

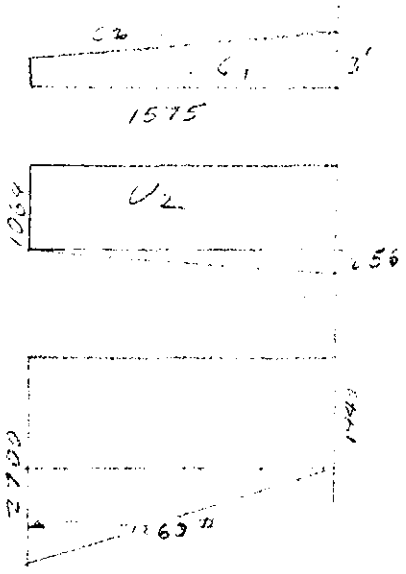
Computation: 32' Span 40' Bay Cantilever Wall Str. 15 to 15+95

Computed by: [illegible] Checked by: P.A.K. Date: 3-7-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in Base, Land Side, River Up

BOTTOM STEEL



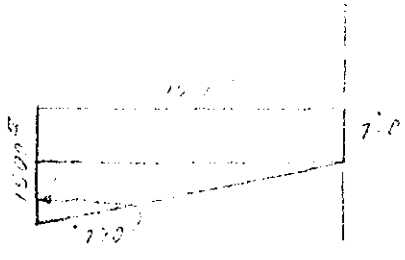
Parts			Moments	
EL 132 15.75 x 1.25	2900		x 7.9	22,900
C1 4 x 15.75 x 1.50	9450		x 7.9	74,600
C2 [illegible]		490	x 10.5	5,150
U1 [illegible] x 15.75		78	x 7.9	132
U2 256 x 15.75 x ½		2020	x 5.25	10,600
[illegible]		227	x 7.9	1,790
[illegible] x ½		1910	x 10.5	20,040
			Σ M = 153,850 '#	

d required = $\sqrt{153,850}$ = 39.5"

$A_s = \frac{153,850 \times 12}{16,000 \times 39.5 \times 43.5}$ = 2.77 □"

River Down

Parts			Moments	
[illegible]			x 7.9	[illegible]
C1 4 x 15.75 x 1.50	9450		x 7.9	74,600
C2 [illegible]		490	x 10.5	5,150
U1 [illegible]		6280	x 7.9	132,500
U2 [illegible] x 15.75		[illegible]	x 7.9	87,500
[illegible]		2220	x 10.5	23,300
			Σ M = [illegible]	

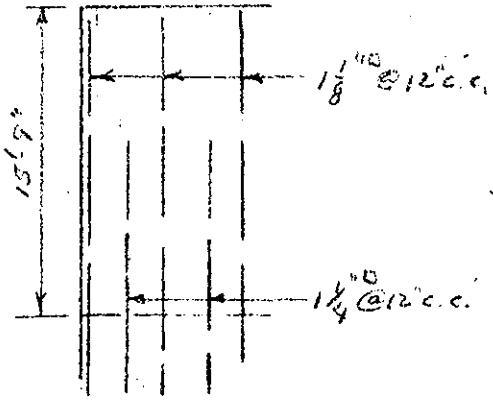


$\frac{[illegible] \times 12}{16,000 \times 39.5 \times 43.5}$

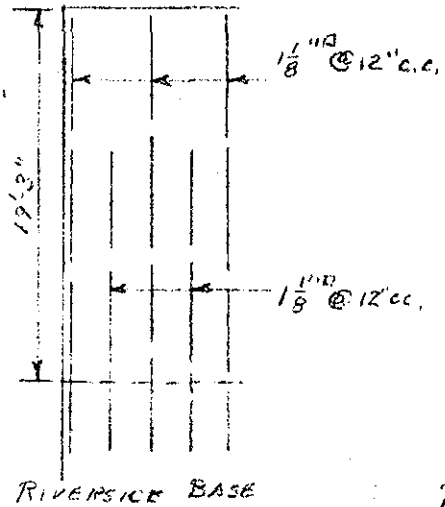
As same steel as River Side, Land Side, Time steel in top only.

Project: HARTFORD HES
Computation: CANTILEVER WALL STEM 32' BASE 40' STA. 15+12± TO 15+92±
Computed by: P.L.A. Checked by: Date: 3/11/40

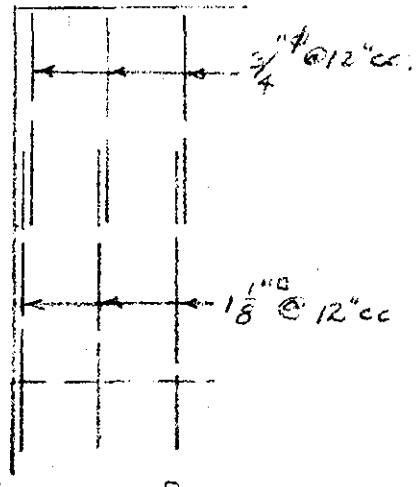
U. S. GOVERNMENT PRINTING OFFICE 3—10523



LANDSIDE BASE
BOTTOM STEEL
PLAN



RIVERSIDE BASE
TOP STEEL
PLAN



RIVERSIDE BASE
BOTTOM STEEL
PLAN

WAR DEPARTMENT

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

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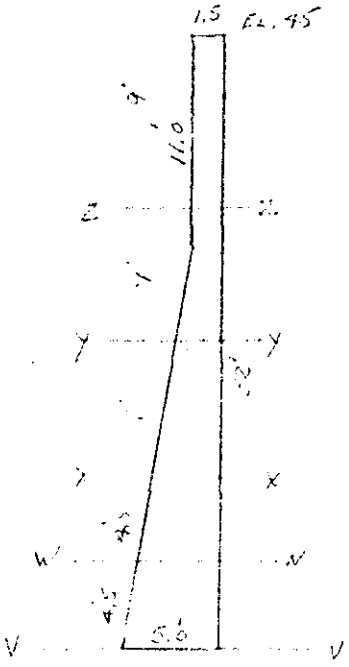
bject

Computation 32' Stem 40' Base Cantilever Wall Sta. 15+[illegible] ± 1-15+[illegible]

Computed by RW Checked by J.A.C. Date 3-7-[illegible]

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in Stem, River Side



MOMENTS ABOUT V-V

	Forces	←	→	Moments
PW	[illegible]	[illegible]		x 10.67 = [illegible]
PEL	[illegible] x ½ x 80		[illegible]	x 4.[illegible] = [illegible]
				ΣM = [illegible]

$$A_{s_{V-V}} = \frac{311,800 \times 12}{18,000 \times .884 \times 54.5} = 4.34 \square''$$

Bottom of Stem -

1⅛" □ @ 6" O.C.

and 1" □ @ 6" O.C. & ½" Back of 1st Row

give area of 4.54 □".

MOMENTS ABOUT W-W

		←	→	
PW	½ x 62.5 x 27.5²	23600		x 9.17 = 216000
PEL	½ x 80 x 8.5²		2900	x 2.83 = 8180
				ΣM = 207820
		ΣV = 20700		

$$A_{s_{W-W}} = \frac{208000 \times 12}{18000 \times .884 \times 45.4} = 3.48 \square''$$

WAR DEPARTMENT

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

Project HARTFORD HES

Computation CANTILEVER WALL STEM 32' BASE 40' STA. 15+12± TO 15+92±

Computed by P.L.A. Checked by J.A.C. Date 3/9/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL IN STEM CONT'D RIVERSIDE FACE

CASE I RIVER UP & NO SURCHARGE

MOMENTS ABOUT X-Y

FORCES ACTING		→	←	ARM	MOMENTS ↷	MOMENTS ↶
PW	$\frac{1}{2} \times 62.5 \times \overline{23}^2$		16500	7.67		127000
PEL	$\frac{1}{2} \times 80 \times \overline{4}^2$	640		1.33	850	
		ΣV = 198600			ΣM = 126150 ↷	

$$A_{s_{X-Y}} = \frac{126{,}160 \times 12}{18000 \times .884 \times 38.5} = 2.48^{\square''}$$

MOMENTS ABOUT Y-Y

PW	$\frac{1}{2} \times 62.5 \times \overline{16}^2$		8000	5.33		42600
		ΣV = 8000 ←			ΣM = 42600 ↶	

$$A_{s_{Y-Y}} = \frac{42600 \times 12}{18000 \times .884 \times 24.5} = 1.32^{\square''}$$

WAR DEPARTMENT

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

Project HARTFORD HES

Computation CANTILEVER WALL STEM 32' BASE 40' STA. 15712 TO 15792

Computed by P.L.A. Checked by J.A.C. Date 3/9/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

STEEL IN STEM CONC. RIVERSIDE FACE

CASE I RIVER UP & NO SURCHARGE

MOMENTS ABOUT Z-Z

FORCES ACTING		→	←	ARM	↻ MOMENTS	↺
FW	$\frac{1}{2} \times 62.5 \times \bar{9}^2$		2520	3.0		7590
		ΣV = 2520 →			ΣM = 7590 ↺	

$$A_{z-z} = \frac{7590 \times 12}{18000 \times .884 \times 14.5} = 0.40 \square''$$

LANDSIDE FACE OF STEM

CASE II RIVER DOWN & RAILROAD SURCHARGE

MOMENTS ABOUT V-V

PEL	$\frac{1}{2} \times 80 \times 13^2$	6760		4.33	29300	
PS	12 X 7	850		3.5	2990	
		7610			32280	
		ΣV = 7610 →			ΣM = 32280 ↺	

$$A_{v-v} = \frac{32300 \times 12}{18000 \times .884 \times 56.5} = 0.44 \square''$$

Project HARTFORD HT. 5
Computation CANTILEVER WALL STEM 32' BASE 40' STA. 15+12± TO 15+92±
Computed by P.L.A. Checked by J.A.C. Date 3/9/40

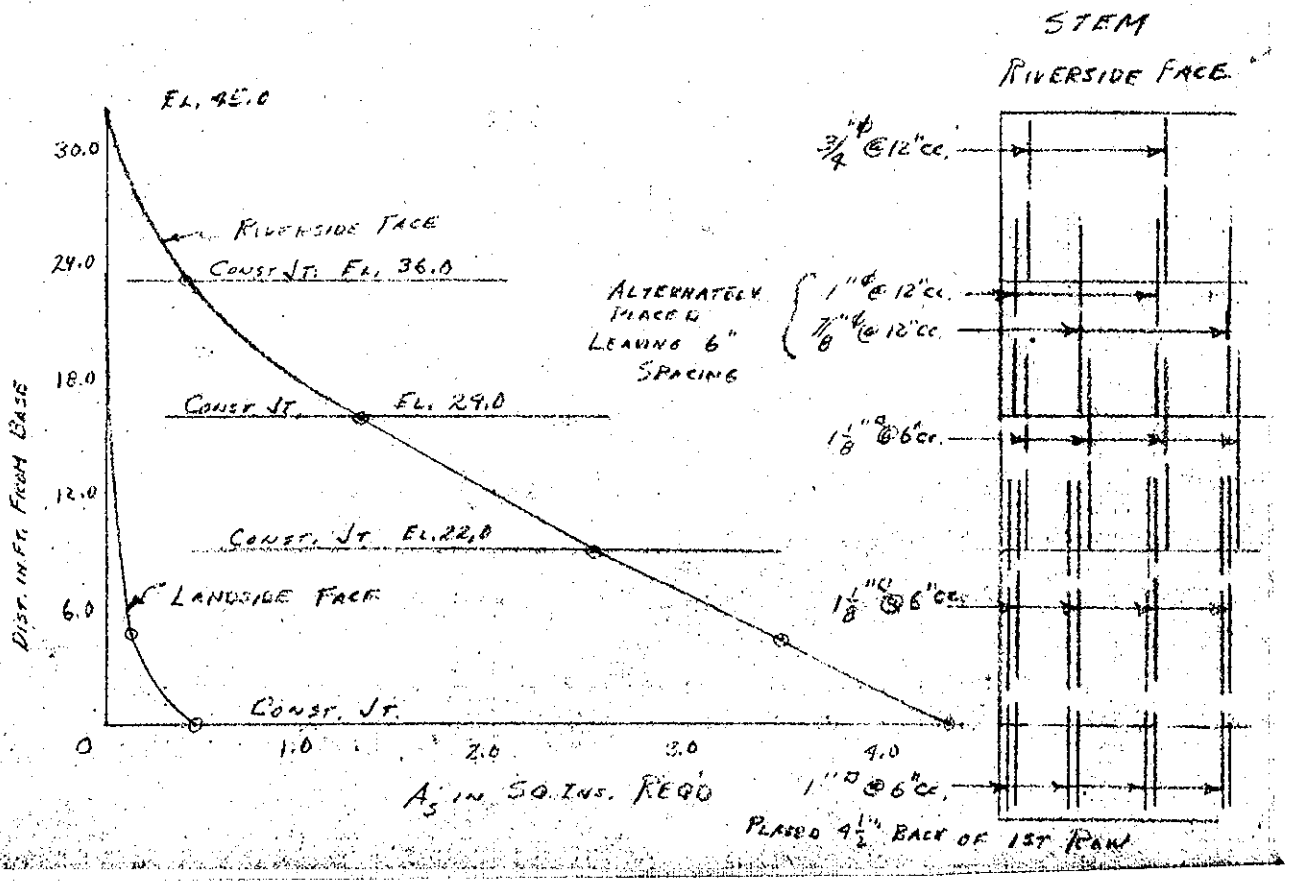
U. S. GOVERNMENT PRINTING OFFICE 3—10538

STEEL IN STEM CONT'D LANDSIDE FACE
CASE II RIVER DOWN & RAILROAD SURCHARGE

MOMENTS ABOUT W-W

FORCES ACTING		→	←	ARM	↷ MOMENTS ↶	
PEL	½ X 80 X 8.5	2900		2.83	8180	
PS	122 X 2.5	305		0.83	250	
		3205			8430	
		ΣV = 3200 →			ΣM = 8430 ↷	

$$A_{s_{W-W}} = \frac{8430 \times 12}{18000 \times .884 \times 47.5} = 0.13 \square''$$



WAR DEPARTMENT

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

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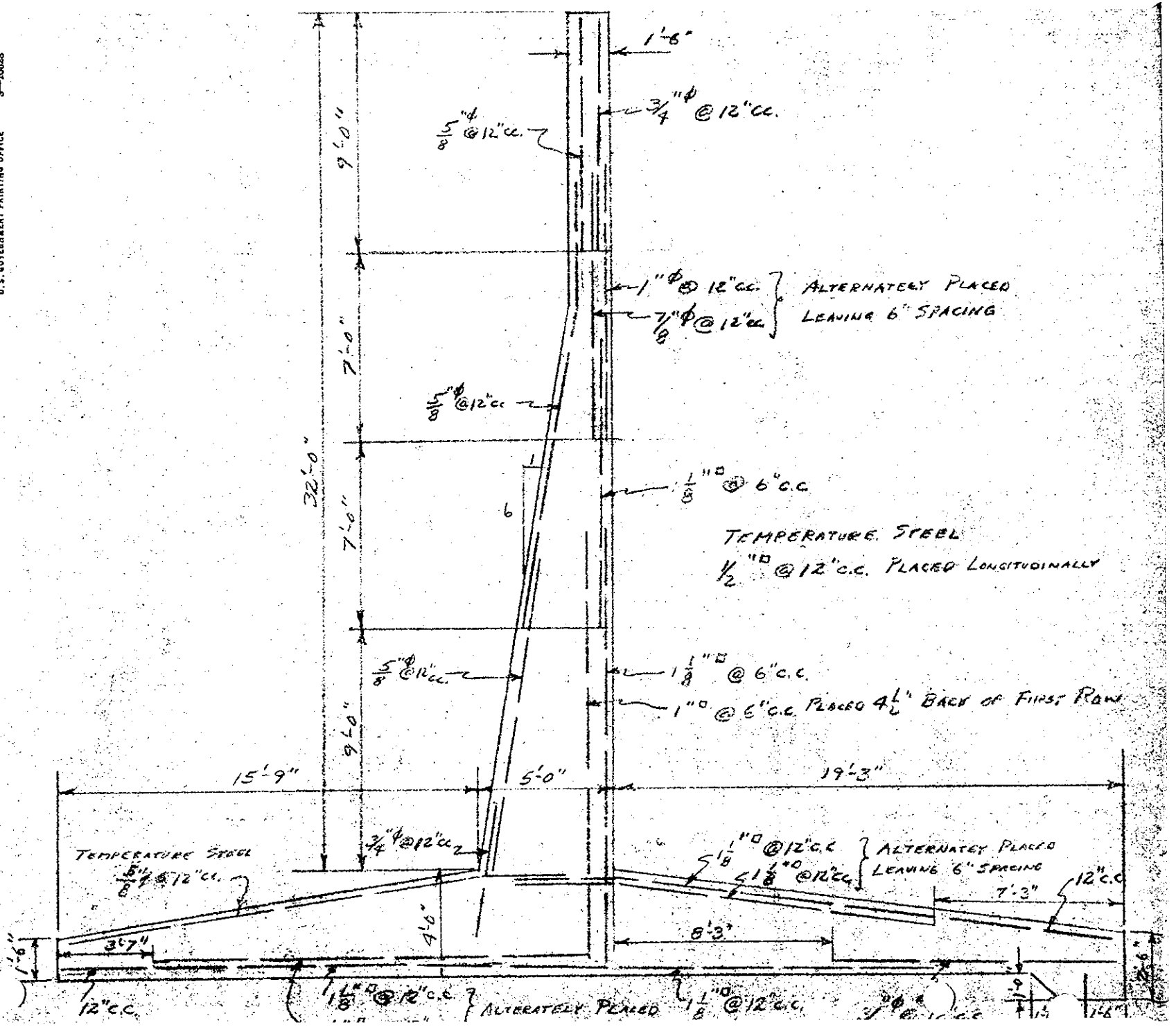
Subject HARTFORD HES

Computation CANTILEVER WALL STEM 32' BASE 40' STA. 15+12± TO 15+92±

Computed by P.L.A. Checked by T.A.C. Date 3/11/40



U.S. GOVERNMENT PRINTING OFFICE 3—10528

WAR DEPARTMENT

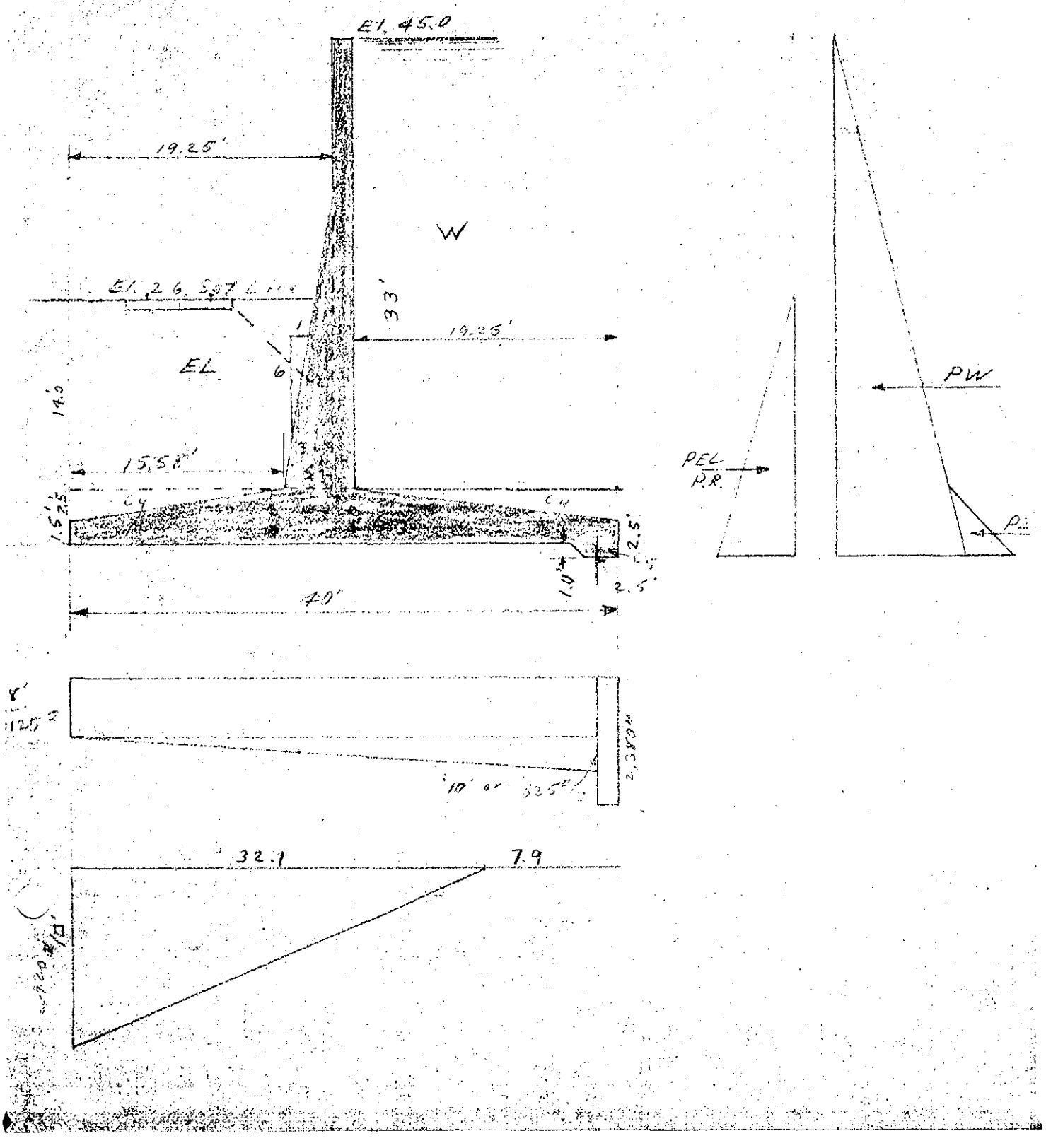
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject H+5 Hartford

Computation 33' Wall, 40' Base Sta. 15+92 - 16+32 I

Computed by RW Checked by [illegible] Date 3-7-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



WAR DEPARTMENT

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

Subject Ht 5 Hartford

Computation 33' Wall 40' Base Sta 15+42 - 16+32 ±

Computed by RW Checked by PLA Date 3-7-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability Case I River Up

Forces		↓	↑	→	←	Arm	Moments about A ↻	↺
C_1	33 × 1.5 × 150	7400				20	148,000	
C_2	22 × 3.67 × ½ × 150	6050				18.0	108,000	
C_3	4 × 40 × 150	24000				20	480,000	
C_4	2.5 × 34.8 × ½ × 25	—	1084			21		22750
C_5	3 × 1 × 150	450				38.4	17380	
EL	$14 \times \left(\frac{15.6+17.9}{2}\right) \times 125$	29300				8.4	246,000	
W	33 × 19.25 × 62.5	39700				30.4	1204,000	
U_1	38 × 1.5 × 62.5		3570			39.25		140,000
U_2	32.5 × 18 × 62.5		43300			19.25		835,000
U_3	38.5 × 10 × ½ × 62.5		12030			25.7		309,000
PEL	$19^2 \times \frac{1}{2} \times 80$			14400		5.33	76,700	
PER	$5^2 \times \frac{1}{2} \times 17.5$				220	0.67		150
PW	$38^2 \times \frac{1}{2} \times 62.5$				45200	11.67		526000
FR	0.45 × 46,920			21100		—		
PR				9920		5.33	53,000	
		106,900	59,980	45420	45420		2,334,080	1,832,900
		ΣV = 46920		ΣH = 0			ΣM = 501,180	

Position of Resultant

$$\frac{\Sigma M}{\Sigma V} = \frac{501\,180}{46920} = 10.7$$

$\frac{1}{3}$ Base = 13.33

2.63' outside middle Third

e = 20 - 10.7 = 9.3'

Base Pressure

$$\frac{46920}{10.7 \times 3} \times \begin{cases} 2 \\ 0 \end{cases} = \begin{matrix} 2920 \text{ \#/□'} \\ 0 \text{ \#/□'} \end{matrix}$$

WAR DEPARTMENT

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

Subject: HARTFORD HTS

Computation: 33' Wall 40' Base Sta 15+32± to 16+32±

Computed by: RW Checked by: [illegible] Date: 3-1-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability, Case II River, Down, Surcharge

Forces Acting		↓	↑	→	←	Arm	Moments about A ↺	↻
C_1		7400					148 000	
C_2		6050					109 000	
C_3		24000					480 000	
C_4			1084					22750
C_5		450					17 380	
EL		29300					246,000	
ES		6000				8.0	48 000	
U_2			43300					835000
PEL				14400			76 700	
PS	131 × 13			~~2730~~ 1700		6.5	~~17~~ 750 11,100	
PER	5' × ½ × 35				440	0.67		300
FP	0.45 × 28820				13000			
PR					2660 ~~3690~~	0.67	1,136,180	1780 ~~2460~~
		73200	44380	16100 ~~14130~~	~~14130~~ 15100		~~1142,830~~	865,510
		ΣV = 28820		ΣH = [illegible]			ΣM = ~~282,320~~	[illegible]

ΣM = [illegible]

Position of Resultant

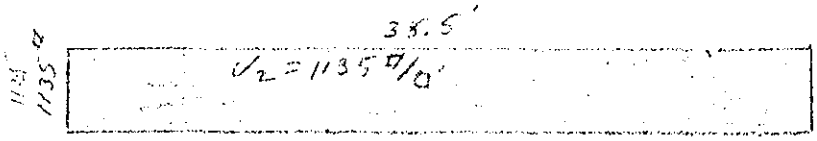
$\frac{282,320}{28820} = \cancel{9.8'}$ 9.6

$\frac{1}{2}$ base = 13.33

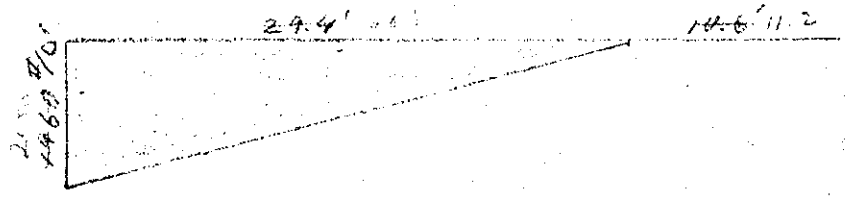
e = 20 − ~~9.8~~ = ~~10.2~~ 10.6

Base Pressure =

$\frac{28820}{3 \times 9.8} = \frac{28820}{29.4} \begin{cases} 2 \\ 0 \end{cases} = \begin{cases} \cancel{1960} \\ 0 \end{cases}$ #/□' Land Side



Uplift



Base Pressure

WAR DEPARTMENT

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

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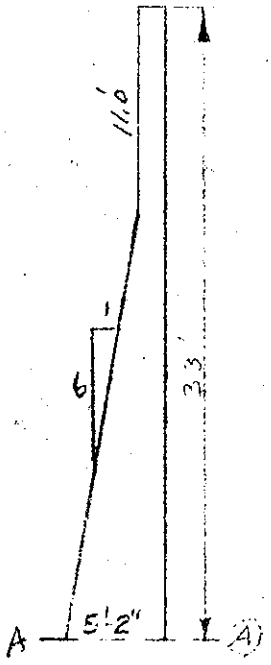
Subject H+5 Hartford

Computation 33 [illegible] Base Cantilever [illegible] Sta. 15+92± to 16+32±

Computed by [illegible] Checked by P.L.A. Date [illegible]

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Steel [illegible] River Side River Up



	Forces	←	→ Moments
PW	33² × ½ × 62.5	34000	× 11 = 374,000
PLS	[illegible] × ½ × 60		7840 × 4.67 = 36600
			ΣM = 337,400'#
		ΣM	

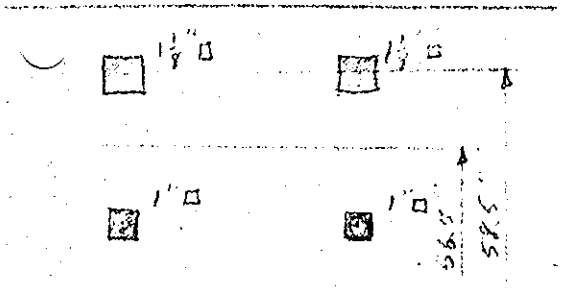
$$d \text{ required} = \sqrt{\frac{337,400}{12.3}} = 52.3''$$

60 − 3.5 = 56.5" provide.

$$A_{s_{AA}} = \frac{M}{f_s j d} = \frac{337400 \times 12}{18000 \times .884 \times 56.5} = 4.51^{\square''}$$

$$SHEAR_{AA} = \frac{26160}{1.2 \times .884 \times 56.5} = 43.6^{\#/\square''} < 60^{\#/\square''}$$

USE $1\frac{1}{8}''\square$ @ 6" c.c. AND $4\frac{1}{2}''$ BACK OF FIRST ROW USE $1''\square$ @ 6" c.c.



WAR DEPARTMENT

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

Subject H-5 Hartford Sta. 15+92 ± to 16+32 ±

Computation 33' Wall

Computed by RW Checked by PLA Date 3-8-40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Steel in Stem, Landside RIVER DOWN & SURCHARGE

PEL = $14^2 \times \frac{1}{2} \times 80$ 7850 × 4.67 = 36,600

PS = 21.2×9 1890 × 45 = 8,500

ΣM = 45,100

Depth provided = 58.5"

$$A_s = \frac{45,100 \times 12}{18000 \times .884 \times 58.5} = .582 \square''$$

Use $\frac{7}{8}$" ⌀ @ 12" o.c.

WAR DEPARTMENT

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

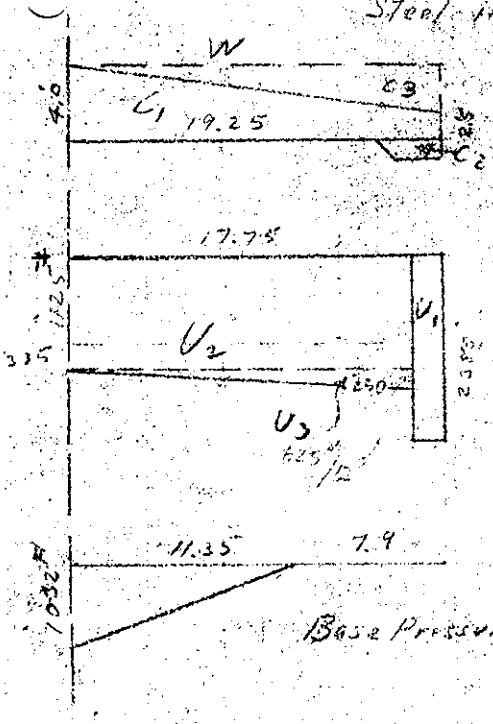
Subject: H-5 Hartford Sta. 15+32 to 16+32

Computation: 33' Cantilever Wall, 40' Base

Computed by: RW Checked by: PLA Date: 3-9-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in River Side Base River Up



TOP STEEL

	Forces	↓	↑	Moments	
W	33 × 19.25 × 625	39700		× 9.62	382,000
C_1	4 × 19.25 × 150	11560		× 9.62	111 500
C_2	3 × 1 × 150	450		× 17.75	8000
C_3	2.5 × 19.25 × ½ × 20		600	× 12.83	7700
U_1	2380 × 1.5		3570	× 18.5	66,000
U_2	1460 × 17.75		25900	× 8.9	230000
U_3	290 × ½ × 17.75		2570	× 11.83	30400
BP_1	1032 × 11.35 × ½		5860	× 2.8	16300
		51710	38560		
		ΣV = 13210		ΣM = 144500	

d required $= \sqrt{\frac{144500}{123}} = 34Z$"

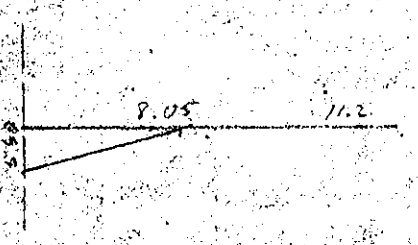
48 − 4.5 = 43.5" provided

$A_s = \frac{144500 \times 12}{18000 \times .884 \times 43.5} = 2.51$ □"

Use 1⅛ □ @ 6"

$V = \frac{13210}{12 \times .884 \times 43.5} = 28.5$ #/□"

River Down Bottom Steel



C_1		11560		× 9.62	111 500
C_2		450		17.75	8000
C_3	2.5 × 19.25 × ½ × 50		1200	× 12.83	15400
U_2	7125 × 17.75		20000	8.9	178 000
BP_1	560 × 8.05 × ½		2250	2.68	6050
		12010	23450		
		ΣV = 11450		ΣM = 79750	

$A_s = \frac{80000 \times 12}{18000 \times .884 \times 43.5} = 1.39$ □"

Use 1" ϕ @ 12" o.c.

and ⅞ ϕ @ 12" o.c. staggered

WAR DEPARTMENT

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Subject Ht 5

Computation [illegible] 40' Lane St 15+92 – 16+32 [illegible]

Computed by [illegible] Checked by PLA Date [illegible]

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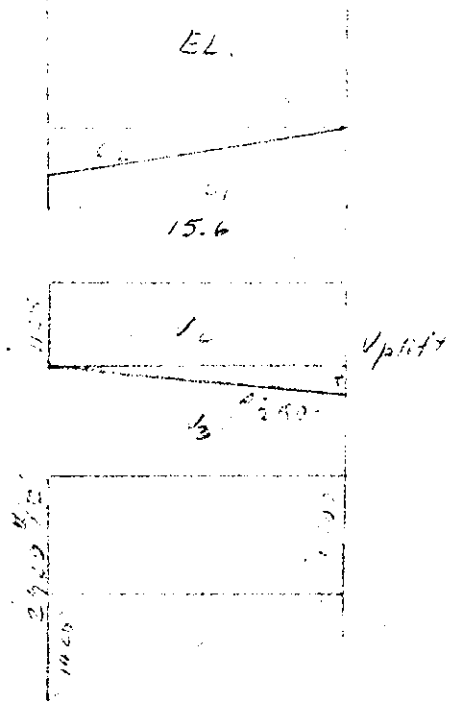
Steel [illegible] Bay, [illegible]

River [illegible]



E_1	[illegible] × 15.6 × [illegible]	27300		[illegible]	213,000
C_1	4 × 15.6 × 150	[illegible]		[illegible]	[illegible]
C_2	2.5 × [illegible] × ½ × 25	—	490	[illegible]	5,[illegible]
[illegible]	1125 × [illegible]		17560	7.8	[illegible]
[illegible]	250 × ½ × 15.[illegible]		[illegible]	5.2	[illegible]
[illegible]	1500 × 15.6		[illegible]		[illegible]
[illegible]	[illegible]		11,[illegible]	[illegible]	[illegible]
		36700	59480		
		ΣV = 17780			[illegible]

$$A_s = \frac{159,900 \times 12}{[illegible] \times [illegible] \times 43.5} = 2.17 \square''$$

Use 1½" □ @ 12" [illegible]
and 1⅛" □ [illegible]
Staggered

Tab - Use ⅝" ϕ @ 12" [illegible]

[illegible] Temperature Steel Reqd

WAR DEPARTMENT

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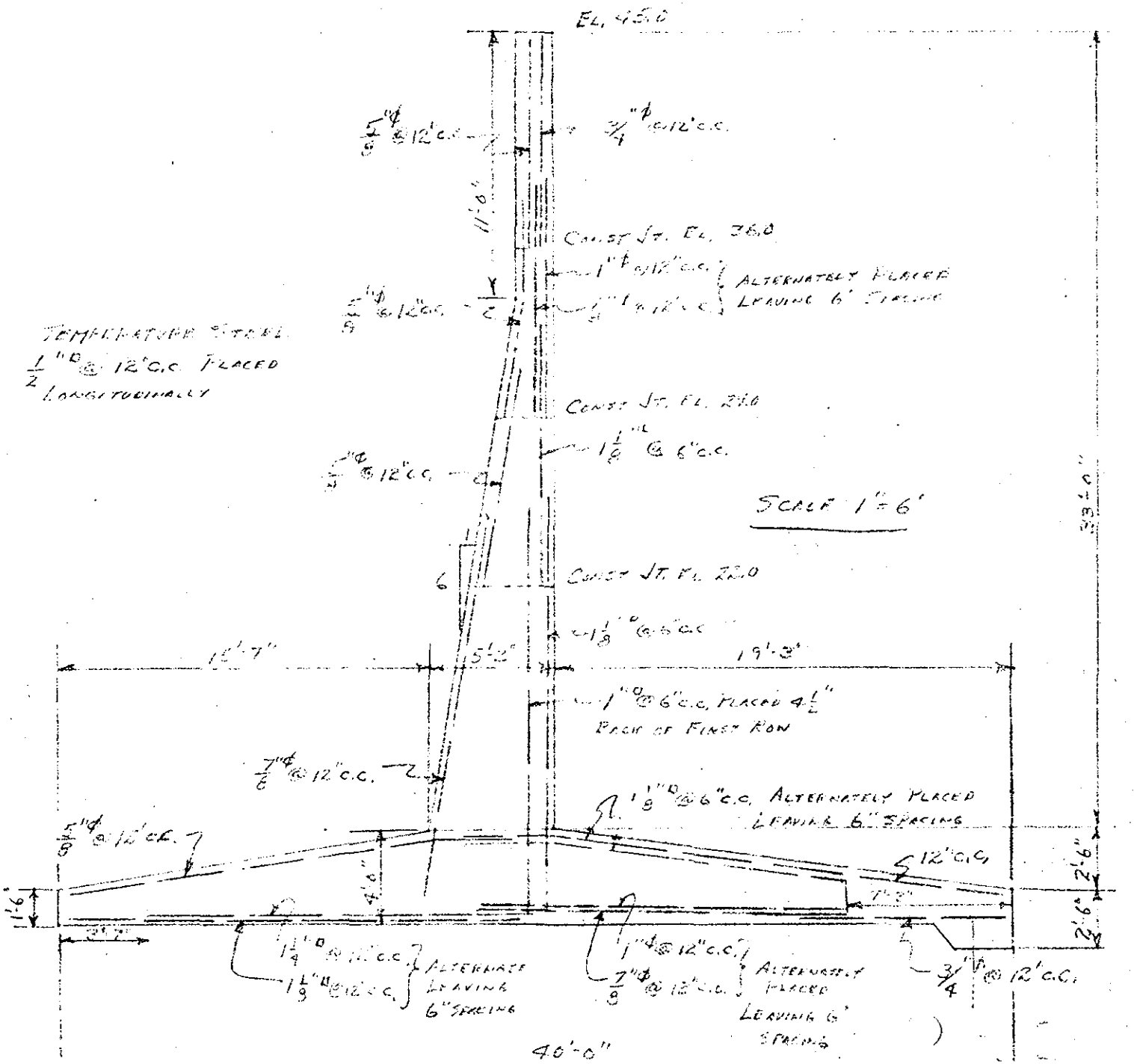
Project HARTFORD H65

Computation CANTILEVER WALL STEM 33' BASE 40' STA. 1549+ TO 1673+

Computed by P.L.A. Checked by ..... Date 3/13/40



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WAR DEPARTMENT

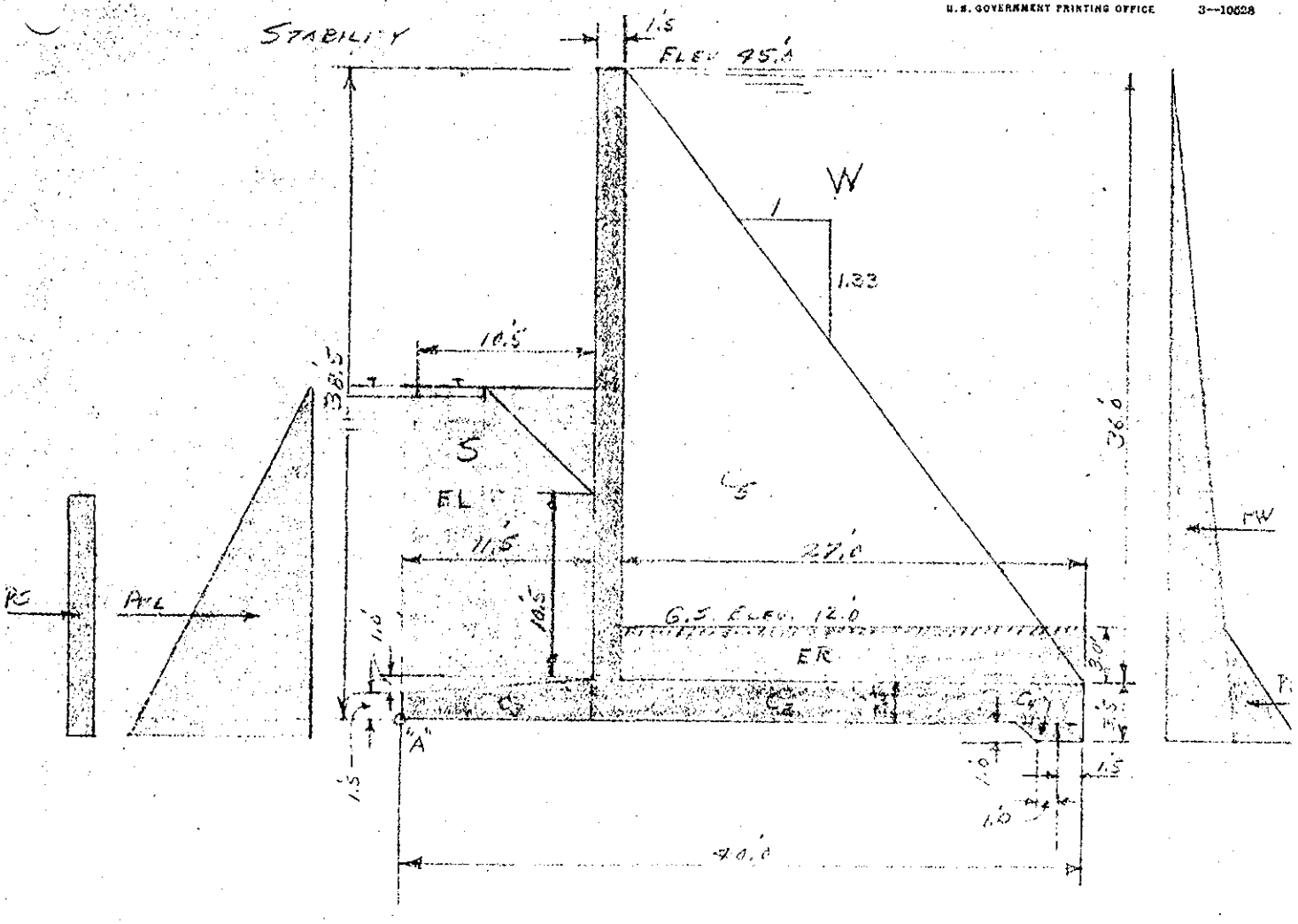
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

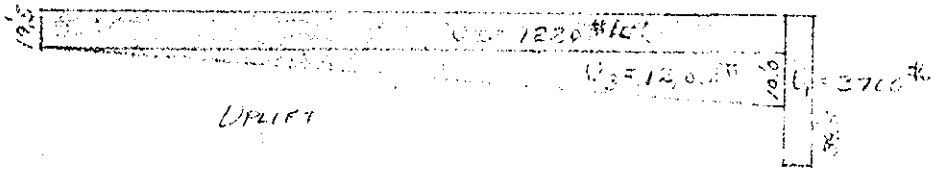
Subject: HARTFORD HLS

Computation: COUNTERFORT WALL STEM 26' BASE 40' STA 16+32 ± : 17+12

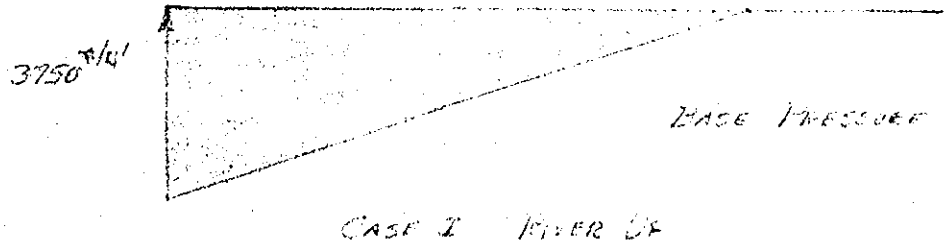
Computed by: P.L.A. Checked by: J.A.C. Date: 2/23/40

U. S. GOVERNMENT PRINTING OFFICE 3—10628





UPLIFT



BASE PRESSURE

CASE I RIVER SIDE

WAR DEPARTMENT
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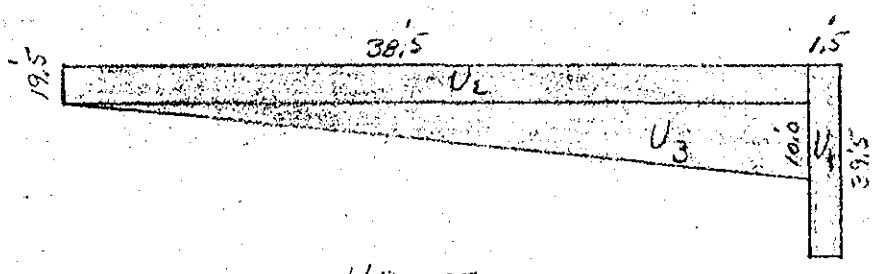
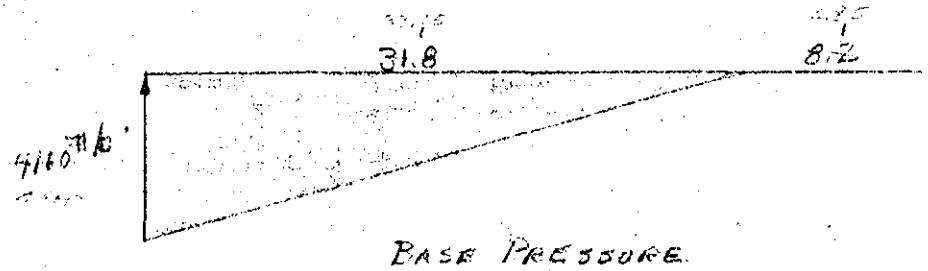
Object HARTFORD Ht 5 Sta. 16+32± - 17+12±
Computation COUNTERFORT WALL STEM 36' BASE 40'
Computed by PLA Checked by J.A.C. Date 2/29/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STABILITY

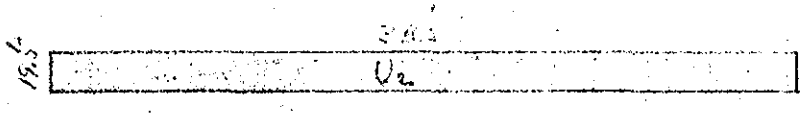


UPLIFT

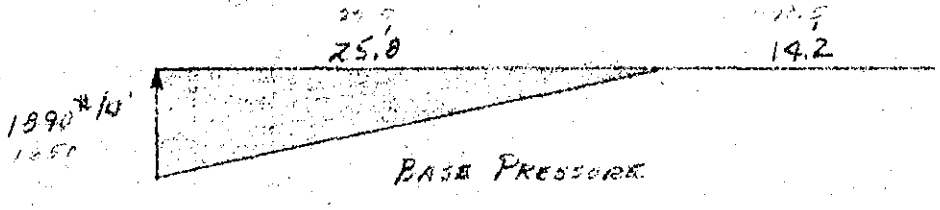


BASE PRESSURE

CASE III RIVER UP & RAILROAD SURCHARGE



UPLIFT



BASE PRESSURE

CASE IV RIVER DOWN & RAILROAD SURCHARGE

WAR DEPARTMENT

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

Subject: HARTFORD HES — STA. 16+32 ± - 17+12 ±

Computation: COUNTERFORT WALL STEM 36' BASE 40'

Computed by: H.L.A. Checked by: J.A.C. Date: 2/26/40

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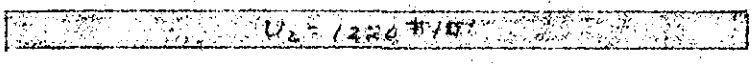
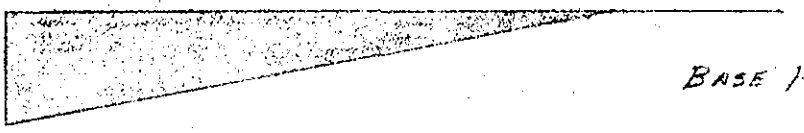
STABILITY CONT'D



UPLIFT

1300 #/□'



BASE PRESSURE

CASE II RIVER DOWN

CASE I RIVER UP

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT 'A' ↷	MOMENTS ABOUT 'A' ↶
C_1	36 x 1.5 x 150	8100				12.25	99 300	
C_2	28.5 x 2.5 x 150	10700				25.75	276 000	
C_3	½(1.5+2.5) x 1.5 x 150	2450				6.24	21 500	
C_4	½(2.5+3.0) x 1.0 x 150	450				38.5	17 300	
C_5	½ x 3/13 x 27.0 x 36.0 x 150	11200				22.0	247 000	
EL	½(17+18) x 1.5 x 125	2200				5.7	143,500	
EK	3 x 27 x 125	10100				26.5	268 000	
W	27 x 33 x 62.5	55700				26.5	1,475,000	
U_1	39.5 x 1.5 x 62.5		3700			39.3		146 000
U_2	19.5 x 38.5 x 62.5		46900			19.3		905 000
U_3	½ 16.0 x 38.5 x 62.5		12000			25.7		309 000
PEL	½ x 80 x 29.5²			16600		5.83	98,000	
PEK	½ x 17.5 x 6.5²				370	1.17		433
PW	½ x 62.5 x 39.5²				48600	12.17		592,000
PR	0.45 x 62300			28000				
PR				4170				
		124900	62600	48970	48970		2,645,600	1,952,433
		ΣV = 62300 ↓		ΣH = 0			ΣM = 693,167 ↷	

$$\text{POSITION OF RESULTANT} = \frac{\Sigma M}{\Sigma V} = \frac{693{,}167}{62300} = 11.10 \qquad \tfrac{1}{3}\ \text{BASE} = \frac{40}{3} = 13.33$$

$$\text{BASE PRESSURE} = \frac{\Sigma V}{A}\left(1 \pm \frac{6e}{a}\right) = \frac{62300}{33.3}(2) = 3750\ \#/\square'$$

$$0\ \#/\square'$$

Subject: HARTFORD HTS — STA. 16+32.1 - 17+12.1
Computation: COUNTERFORT WALL STEM 36' BASE 40'
Computed by: P.L.A. Checked by: J.A.C. Date: 2/26/40

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STABILITY CONT'D
CASE II RIVER DOWN

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT "A" ↻	MOMENTS ABOUT "A" ↺
C_1	36 X 1.5 X 150	8100				12.75	99300	
C_2	28.5 X 2.5 X 150	10700				25.75	276 000	
C_3	½(1.5+2.5) 11.5 X 150	3450				6.24	21500	
C_4	½(2.5+3.5) 1.0 X 150	450				38.5	17300	
C_5	½ X 2/13 X 27 X 36 X 150	11200				22.0	247000	
EL	½(17+18) 11.5 X 125	25200				5.7	143,500	
ER	3 X 27 X 100	8100				26.5	215000	
U_2	19.5 X 38.5 X 62.5		46900			19.3		905000
PEL	½ X 80 X $\overline{20.5}^2$			16800		5.83	98,000	
PER	½ X 25 X $\overline{6.5}^2$				740	1.17		865
FR	0.45 X 20300				9150			
PR					6710			
		67200	46900	16800	16800		1,117,600	905,965
		ΣV = 20300		ΣH = 0			ΣM = 211,735 ↻	

MIDDLE THIRD = $\frac{40}{3}$ = 13.33'

POSITION OF RESULTANT = $\frac{\Sigma M}{\Sigma V} = \frac{211,735}{20300} = 10.4'$

BASE PRESSURE = $\frac{\Sigma V}{A}\left(1 \pm \frac{6e}{d}\right) = \frac{20300}{31.2}(2) =$ 1300 #/□' , 0 #/□'

WAR DEPARTMENT

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

Subject: HARTFORD HE-5 — STA 16+22± TO 17+12±

Computation: COUNTERFORT WALL STEM 36' BASE 40'

Computed by: PLA — Checked by: J.A.C. — Date: 2/29/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STABILITY

CASE III RIVER UP & RAILROAD SURCHARGE ASSUMED AS 4000#/FT. OF TRACK.

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT "A" ↻	MOMENTS ABOUT "A" ↺
		124900	62600	16800	48970		2,683,800	1,752,433
S		4000				5.75	23000	
PS	348X.35X14			1705		7.0	11900	
PR	.45X 66300			29900				
PR				565		5.83	3300	
		128900	62600	48970	48970		2,683,800	1,752,433
		ΣV: 66300↓		ΣH: 0			ΣM: 731,367	

POSITION OF RESULTANT $= \frac{\Sigma M}{\Sigma V} = \frac{731,000}{66300} = 11.05'$ ½ BASE = 20.33

BASE PRESSURE: $\frac{\Sigma V}{A}\left(1 \pm \frac{6e}{d}\right) = \frac{66300}{33.15}(2) = 4000\ \#/\square'$, $0\ \#/\square'$

CASE IV RIVER DOWN & SURCHARGE ASSUMED AS 4000#/FT. OF TRACK

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT "A" ↻	MOMENTS ABOUT "A" ↺
		67400	46900	16800	790		1,117,600	905,865
S		4000				5.75	23000	
PS	348X.35X14			1705		7.0	11900	
PR	.45X24300				11000			
PR					6765	1.17		7800
		71200	46900	18505	18565		1,152,000	913,665
		ΣV: 24300		ΣH: 0			ΣM: 238,835	

POSITION OF RESULTANT $= \frac{\Sigma M}{\Sigma V} = \frac{239,000}{24300} = 9.83'$ ½ BASE = 14.75'

BASE PRESSURE: $\frac{\Sigma V}{A}\left(1 \pm \frac{6e}{d}\right) = \frac{24300}{29.5}(2) = 1650\ \#/\square'$, $0\ \#/\square'$

Subject: Hartford (Ht. 5) Conn.
Computation: Wall at Sta. 17+00±
Computed by: R.H.M. Checked by: Date: 3/7/40

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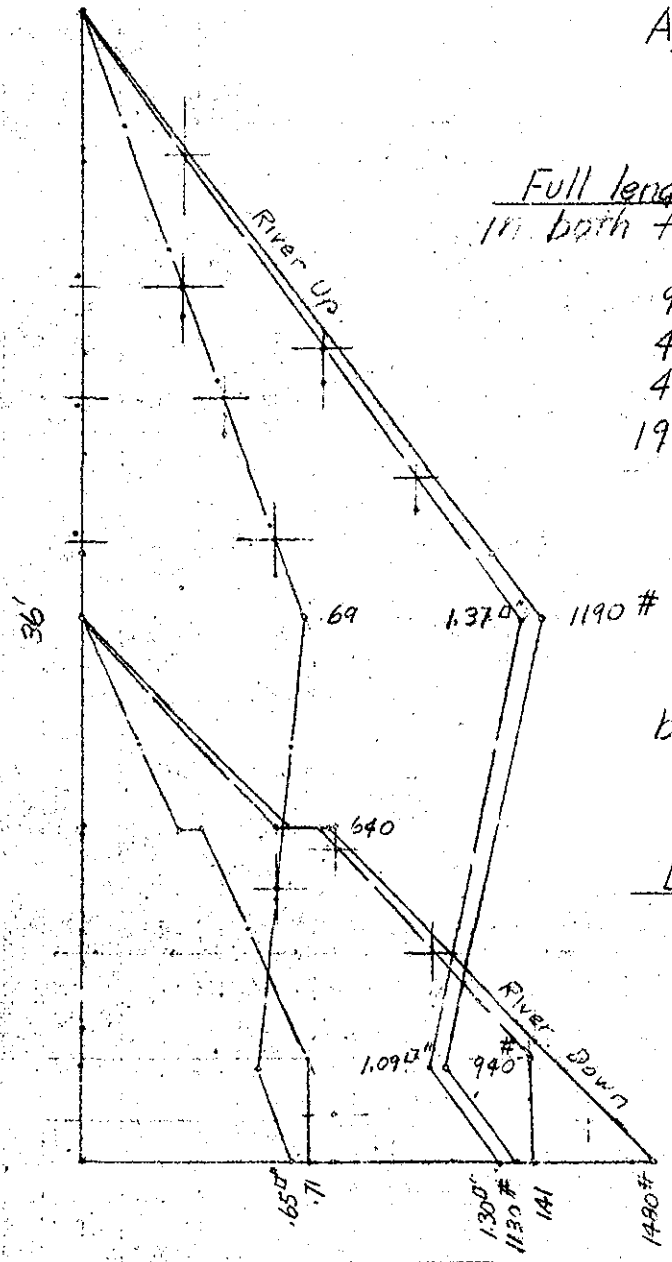
Design of Stem Steel. Case I governs in riverside face

Loading Diagram



$$A_s = \frac{W}{59.74\,d} = \frac{W}{866}$$

Full length (39'-6") bars to be same in both faces of stem as follows.

9 - 5/8"ø @ 12" c.c.
4 - 3/4"ø " "
4 - 7/8"ø " "
19 - 1"ø " "

End bars (11'-6")

Riverside face

Start between 5th & 6th long bar: 6 - 5/8"ø @ 12"
4 - 3/4"ø "
22 - 7/8"ø " "

Landside face

Start between 26th & 27th long bar:
4 - 5/8"ø @ 12"
3 - 7/8"ø " "
4 - 1"ø " "

$$d_{(required)} = \sqrt{\frac{32\,930}{123}} = \sqrt{267} = 16.5'' \quad \text{Use} - 17.5''$$

$$v = \frac{11.110}{12 \times .884 \times 17.5} = \frac{11.110}{186} = 60\ \#/\square''$$

Thicken stem 3" 4' above base

WAR DEPARTMENT

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Project: Hartford (HI-5) Conn

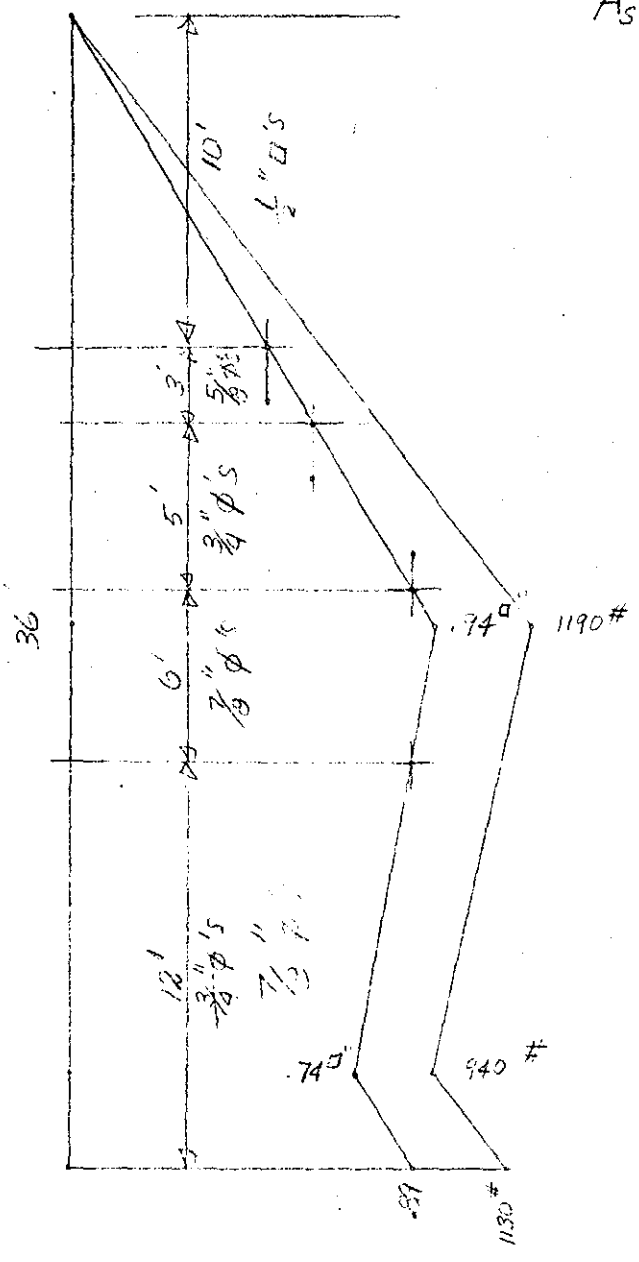
Computation: Wall at Sta 17+00 S

Computed by: R.H.M. Checked by: Date: 3/7/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Bonding Steel in Stem

$$A_s = \frac{W}{1270}$$



Subject: Hartford (Ht-5) Conn. Sta. 16+32 ± to 17+12 ±
Computation: Counterfort wall Stem 36'
Computed by: R.H.M. Checked by: Date: 3/8/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Longitudinal Base Steel Loading Diagram

$A_s = \frac{W}{59.74d}$ $d_{(required)} = \sqrt{\frac{25290}{123}} = 14.3$

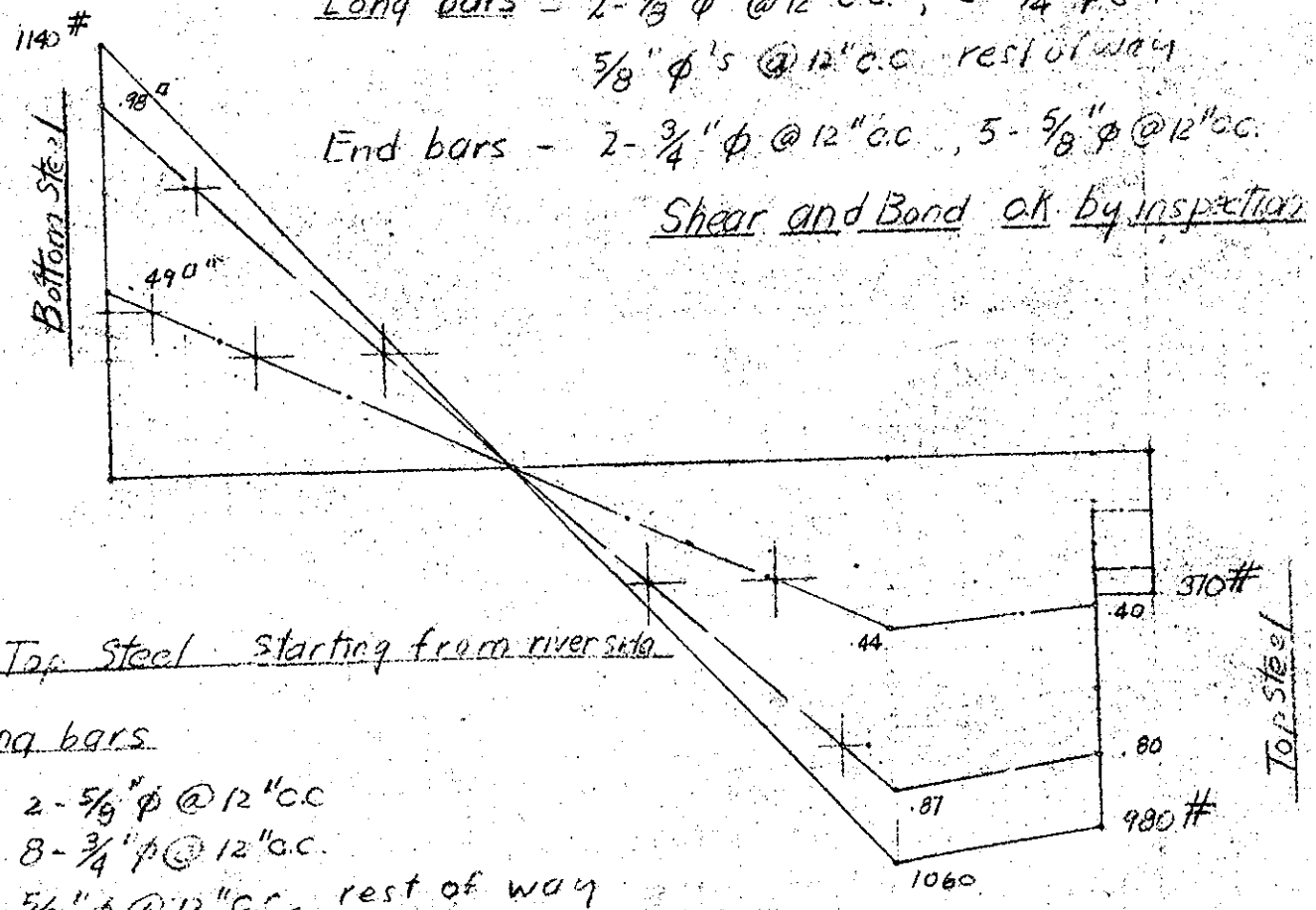
Use 24 - 4.5 = 19.5" bot.
24 - 3.5 = 20.5" Top

Bottom steel - starting from stem

Long bars - 2 - 7/8" φ @ 12" c.c., 3 - 3/4" φ @ 12" o.c.
5/8" φ's @ 12" c.c. rest of way

End bars - 2 - 3/4" φ @ 12" c.c., 5 - 5/8" φ @ 12" o.c.

Shear and Bond ok by inspection



Top Steel starting from river side

Long bars

2 - 5/8" φ @ 12" c.c.
8 - 3/4" φ @ 12" o.c.
5/8" φ @ 12" c.c. rest of way

End bars

8 - 3/4" φ @ 12" c.c.

5 - 5/8" φ @ 12" c.c.

Note Change depth of riverside base slab from 30" to 24"

WAR DEPARTMENT

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Subject: Hartford (Ht-5) Conn. Sta. 15+32 to 17+12

Computation: Counterfort wall Slen. 36'

Computed by: R.H.M. Checked by: Date: 3/8/90

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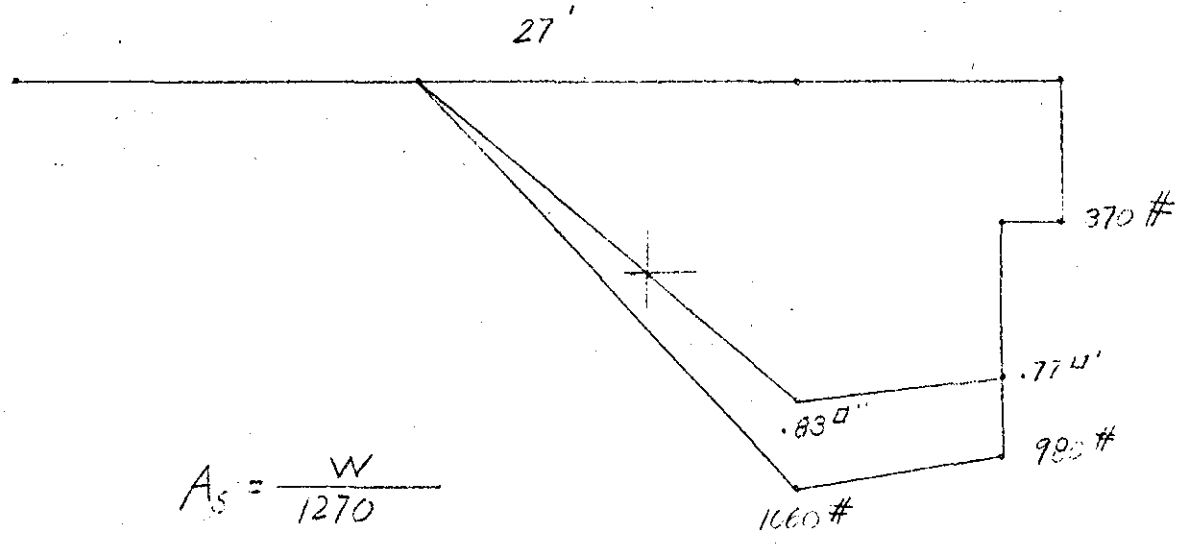
Bending Steel in Base Loading diagram



$$A_s = \frac{W}{1270}$$

Starting at riverside end of base

$\frac{3}{4}$" ⌀'s for 12', then $\frac{1}{2}$" ⌀'s

WAR DEPARTMENT

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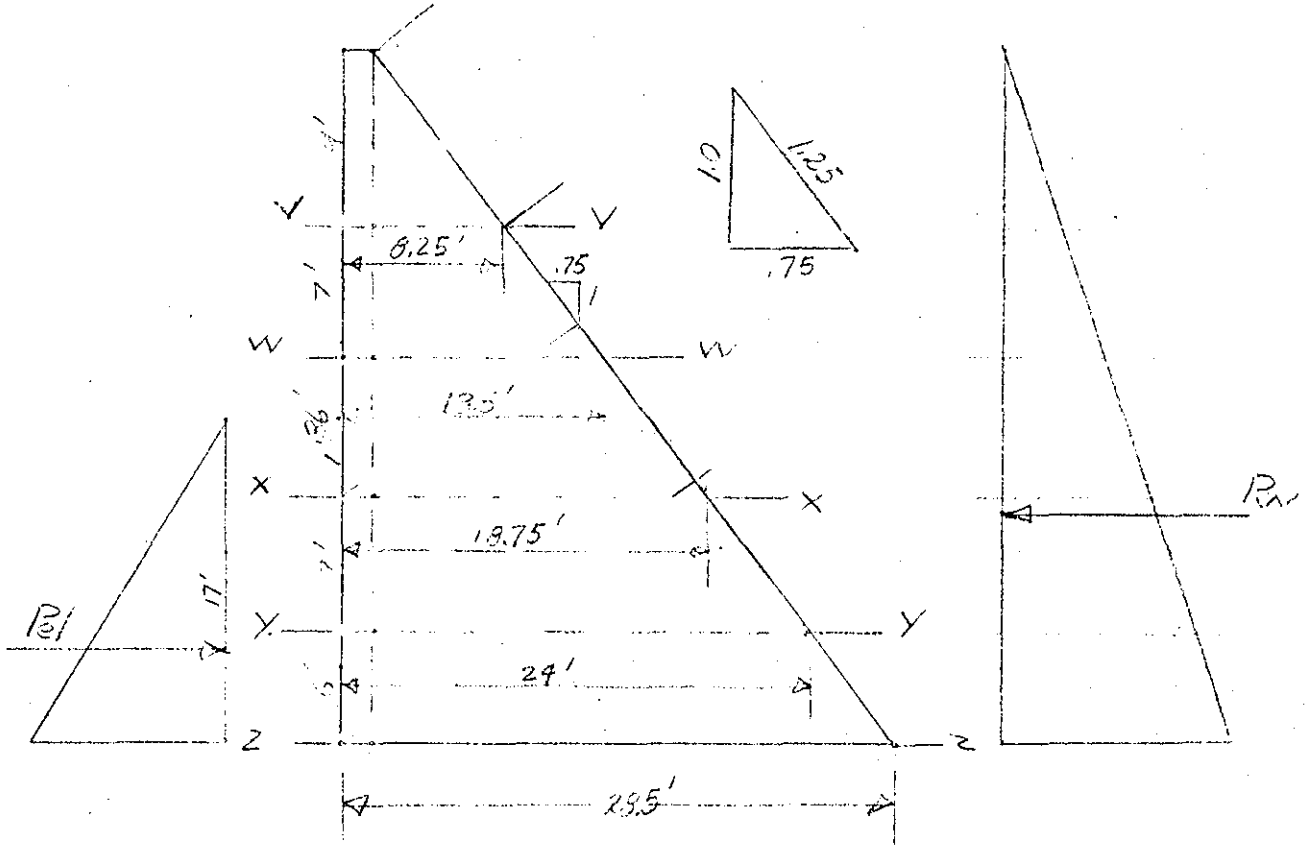
Subject: Hartford Conn (Ht. 5) [illegible]

Computation: Counterfort wall Steel '36'

Computed by: R.H.M. Checked by: Date: 3/[illegible]

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Counterfort Steel



At Section V--V

P_w: $9^2 \times \frac{1}{2} \times 62.5 = 2530 \times 3 = 7590$ '# for 1' of wall

35710 # 107,600 '# " 14.17 " "

$$A_s = \frac{1.25 \times 12 \times 107,600}{18000 \times .854 \times 95} = \frac{1,614,000}{1,510,500} = 1.01 \square''$$

Use 2-1" □ bars

At Section W--W

P_w: $16^2 \times \frac{1}{2} \times 62.5 = 8000 \times 5.33 = 42640$ '# for 1' of wall.

113,360 604,210 '# " 14.11' " "

$$A_s = \frac{1.25 \times 12 \times 604,210}{18000 \times .864 \times 158} = \frac{9,063,000}{2,512,200} = 3.61 \square''$$ Use 4-1" □ bars

At Section X--X

P_w: $23^2 \times \frac{1}{2} \times 62.5 = 16,530 \times 7.67 = 126,790$ '# for 1' of wa

234,230 1,796,600 # " 14.11' " "

$$A_s = \frac{1.25 \times 12 \times 1,796,600}{18000 \times .854 \times 221} = \frac{26,949,000}{3,515,900} = 7.67 \square''$$

Use 5-1" □ bars

Subject Hartford, Conn (Ht-5) Sta 16+32± to 17+12±
Computation Counterfort wall Stem 36'
Computed by R.H.M. Checked by Date 3/8/40

U. S. GOVERNMENT PRINTING OFFICE 2—10528

Design of Counterfort Steel (continued)

At section Y--Y

P_W : $30^2 \times \frac{1}{2} \times 62.5 = 28130 \times 10 = 281300$ '#
P_{el} : $11^2 \times \frac{1}{2} \times 80 = 4840 \times 3.67 = 17760$ '#
23290 263540 '# For 1' of wall.
330,000 # 3,734,360 '# " 14.17' " ".

$$A_s = \frac{1.25 \times 12 \times 3{,}734{,}360}{18000 \times .884 \times 284} = \frac{56{,}015{,}400}{4{,}515{,}600} = 12.40 \square''$$

Use 10 $1\frac{1}{8}''\square$ bars

At section 2--2

P_W : $36^2 \times \frac{1}{2} \times 62.5 = 40{,}500 \times 12 = 486{,}000$ '#
P_{el} : $17^2 \times \frac{1}{2} \times 80 = 11{,}560 \times 5.67 = 65{,}550$ '#
28940 420,450 '# For 1' of wall
410100 # 5,957,780 '# " 14.17' " "

$$A_s = \frac{1.25 \times 12 \times 5{,}957{,}780}{18000 \times .884 \times 338} = \frac{89{,}366{,}700}{5{,}374{,}200} = 16.63 \square''$$

Use 10 - $1\frac{1}{4}''\square$ bars

Shear and Bond

Y--Y $V = \frac{35710}{24 \times .884 \times 95} = 18 \#/\square''$ $\Sigma_0 = \frac{35710}{150 \times .884 \times 95} = 2.83''$

W--W $V = \frac{113{,}360}{24 \times .884 \times 158} = 34 \#/\square''$ $\Sigma_0 = \frac{113360}{150 \times .884 \times 158} = 5.40''$

X--X $V = \frac{234230}{24 \times .884 \times 221} = 50 \#/\square''$ $\Sigma_0 = \frac{234230}{150 \times .884 \times 221} = 7.97''$

Y--Y $V = \frac{330{,}000}{24 \times .884 \times 284} = 55 \#/\square''$ $\Sigma_0 = \frac{330{,}000}{150 \times .884 \times 284} = 8.75''$

Z--Z $V = \frac{410100}{24 \times .884 \times 338} = 57 \#/\square''$ $\Sigma_0 = \frac{410100}{150 \times .884 \times 338} = 9.12''$

WAR DEPARTMENT

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

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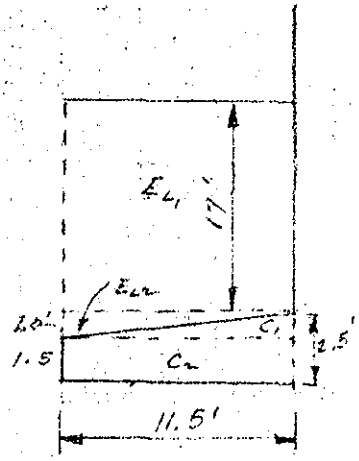
Subject: Hartford - (Ht-5) - Conn Sta. 16+32 ± to 17+12 ±

Computation: 36' Stem - 40' Base - - -

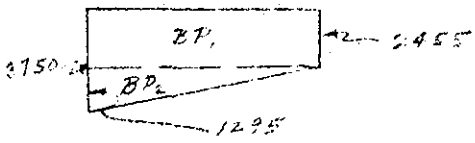
Computed by: J.A.C. Checked by: Date: 3/8/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Steel in Heel Slab - Case I - River Up



Forces Acting	↓	↑	Arm	Mom. ↷	Mom. ↶
E_{L_1} 11.5×17.0×125	24,500		5.75	140,880	
E_{L_2} ½×11.5×1.0×125	720		7.67	5,520	
C_1 ½×11.5×1.0×150	865		3.83	3310	
C_2 11.5×1.5×150	2,590		5.75	14890	
U_1 1220×11.5		14,050	5.75		80790
U_2 ½×186×11.5		1070	3.83		4100
BP_1 2455×11.5		28230	5.75		162320
BP_2 ½×1295×11.5		7450	7.67		57140
	$\Sigma V = 22130$ # ↑			$\Sigma M = 139750$ #/ft	



$$d_{(required)} = \sqrt{\frac{139750}{123}} = \sqrt{1136} = 34''$$

Use 39 - 4.5 = 34.5"

$$A_s = \frac{12 \times 139{,}750}{18000 \times .884 \times 34.5} = \frac{1{,}677{,}000}{548550} = 3.06 \square''$$

Use $1\frac{1}{4}''\square$ @ 6" c.c.

$$V = \frac{22130}{12 \times .884 \times 34.5} = \frac{22130}{366} = 60 \#/\square''$$

OK.

$$U = \frac{22130}{10 \times .884 \times 34.5} = \frac{22130}{305} = 73 \#/\square''$$

Uplift

$\frac{10 \times 62.5}{38.5} = 16.2$

$11.5 \times 16.2 = 186$

Bearing

$\frac{3750}{33.3} = 112.5$

$11.5 \times 112.5 = 1295$

$3750 - 1295 = 2455$

WAR DEPARTMENT

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

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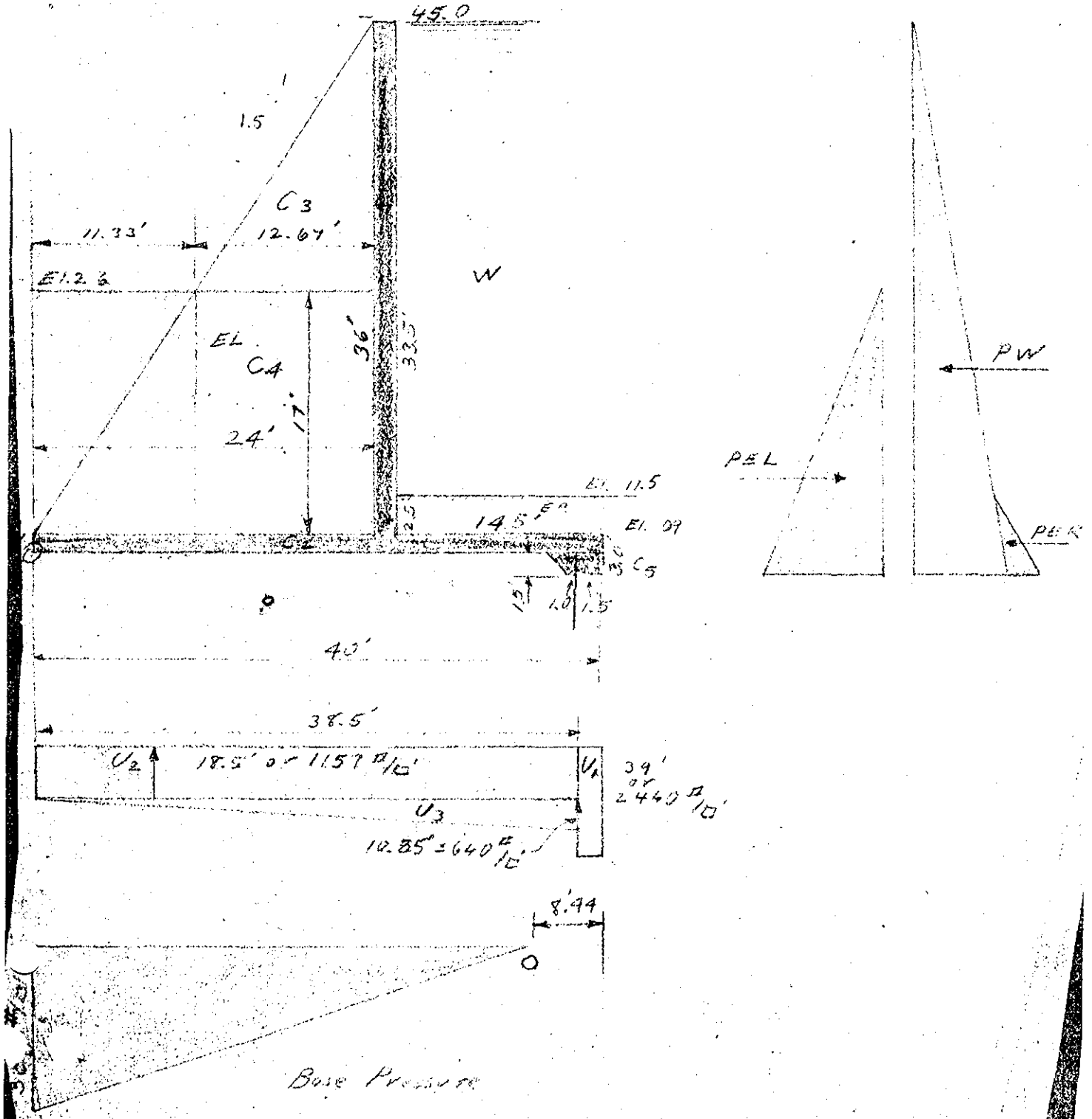
Subject Ht 5 Hartford Sta 17+12 18+72 ±

Calculation 36' Wall Counterforted, 40' Base

Computed by RW Checked by E.H.V. Date 2-26-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability, Case I, Water to Top of Wall



WAR DEPARTMENT

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

Subject: Ht 5 Hartford Sta. 17+12± - 18+72±

Computation: 36' Counterfort Wall 40' Base

Computed by: RW Checked by: E.H.V. Date: 2-26-40

U. S. GOVERNMENT PRINTING OFFICE 3—10628

STABILITY CASE I WATER UP

Forces Acting		↓	↑	→	←	Arm	Moments about "A" ↺	↻
C_1	$1.5 \times 36 \times 150$	8100				24.75	200 700	
C_2	$1.5 \times 40 \times 150$	9000				20	180 000	
C_3	$19 \times 12.67 \times \frac{1}{2} \times \frac{2}{13.33} \times 150$	2700				19.8	53 500	
C_4	$\left(\frac{12.67+24}{2}\right) \times 17 \times \frac{2}{13.33} \times 25$	1170				14.3	16 720	
C_5	$3 \times 1 \times 150$	450				38.5	17 330	
EL	$17 \times 24 \times 125$	51000				12	612 000	
ER	$2.5 \times 14.5 \times 125$	4530				32.75	148 400	
W	$33.5 \times 14.5 \times 62.5$	30 400				32.75	995 000	
U_1	$39 \times 62.5 \times 1.5$		3660			39.25		143 800
U_2	$18.5 \times 38.5 \times 62.5$		44 500			19.25		857 000
U_3	$10.25 \times 38.5 \times \frac{1}{2} \times 62.5$		12340			25.7		317 000
PEL	$20^2 \times \frac{1}{2} \times 80$			16000		5.2	83 200	
PER	$5.5^2 \times \frac{1}{2} \times 17.5$				270	0.33		90
PW	$34^2 \times \frac{1}{2} \times 62.5$				47500	11.5		547 000
FR	$0.45 \times 46,850$			21700		—		
PR				10070		5.2	52 400	
		107350	60500	47770	47770		2,359,250	1,864,890
		ΣV = 46850		ΣH = 0			ΣM = 494,360 '#	

Position of Resultant

$$\frac{\Sigma M}{\Sigma V} = \frac{494360}{46850} = 10.52'$$

$\frac{1}{3}$ base = 13.33'

$e = 20 - 10.52 = 9.48'$

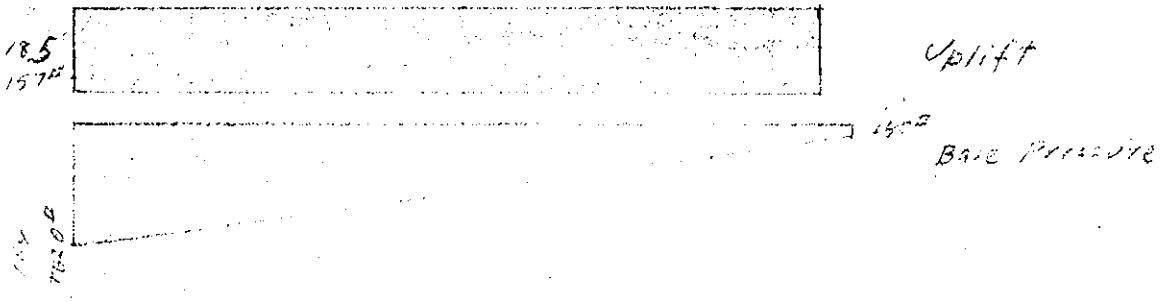
Base Pressure

$$\frac{48,150}{3 \times 10.52}\left\{\begin{matrix} 2 \\ 0 \end{matrix}\right. = 3050 \text{ \#/□'}$$ at landside toe to 0 31.56 toward riverside

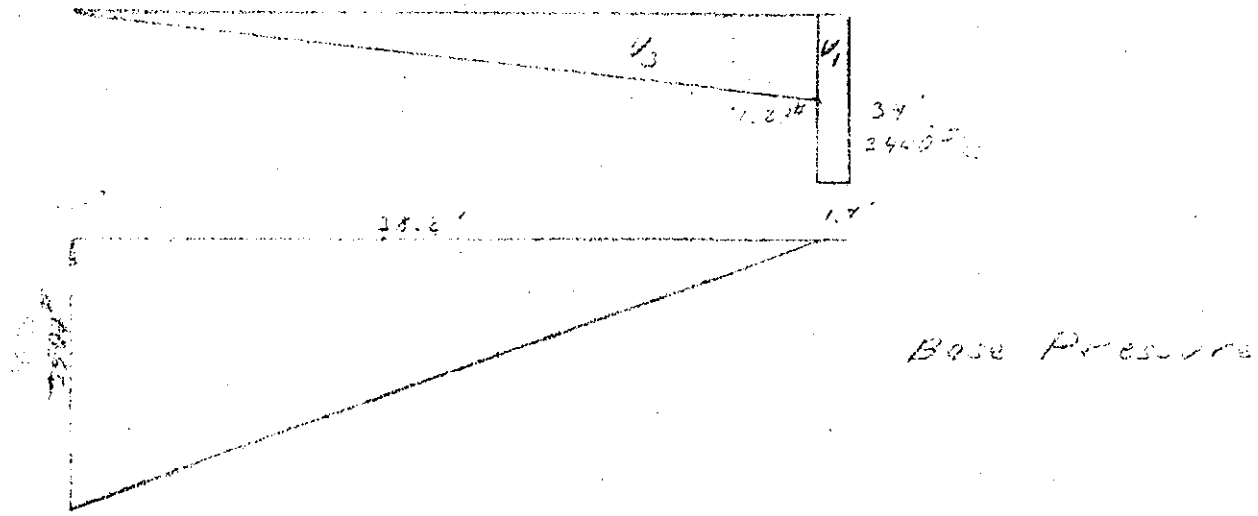
Subject Ht 5 Hartford
Computation Sta. 17+12 ± to 18+72 ±
Computed by [illegible] Checked by [illegible] Date [illegible]

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case II River Down, Sat. Backfill



Case III River Up, Dry Backfill (Unlikely)



Case IV River Down, Dry Backfill

No Uplift

WAR DEPARTMENT

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

Subject: Ht 5 Hartford

Computation: 36' Wall Counterfortel 40' Base Sta. 17+12± to 18+72±

Computed by: RW Checked by: [illegible] Date: 2-29-40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Case II River Down [illegible]

Forces Acting		↓	↑	→	←	Arm	Moments about "A"	
C_1		8100				24.75	200 700	
C_2	2×40×150	12000				20	240 000	
C_3		2700				19.8	53 500	
C_4		1170				14.3	16 720	
C_5		450				38.5	17 330	
EL		51000				12	612 000	
ER	7.5×14.5×100	4530				32.75	148 400	
U_2			44 500			19.25	[illegible]	857 000
PL				16 000		5.2	83 200	
PR	5.5²×½×35				530	0.33		180
FR	[illegible] 35 450	[illegible]			15 400	[illegible]		
	[illegible]	79 150	[illegible]	16 000	16 490	11 000	[illegible]	857 180
		ΣV = 35 450		ΣH = [illegible]			ΣM 514,670	

Position of Resultant [illegible]

$\frac{\Sigma M}{\Sigma V} = \frac{514,670}{35,450} = 14.5$ $\frac{1}{3}$ base = 13.33'

e = 20 − 14.5 = 5.5' [illegible]

Base Pressure

$\frac{35450}{40}\left(1 \pm \frac{6 \times 5.5}{40}\right) = 880 \begin{cases} 1.83 \\ 0.17 \end{cases} = \begin{matrix} 1620 \text{ \#/□'} \text{ Land Side} \\ 150 \text{ \#/□'} \text{ River Side} \end{matrix}$

CASE IV River Down, Dry Bi[illegible]

[illegible]		79 850	[illegible]	[illegible]			[illegible]	
EL	17 [illegible]		10 200			12		[illegible]
[illegible]	[illegible]				[illegible]			[illegible]
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]				[illegible]			
		ΣV 69 750 ↓					ΣM [illegible]	

Position [illegible]

$\frac{\Sigma M}{\Sigma V} = \frac{1,[illegible],170}{61750} = 17.25'$ $\frac{1}{3}$ base = 13.33 e = 20 − 17.25 = 2.75'

Base Pressure

$\frac{69750}{40} \times \left(1 \pm \frac{6 \times 2.75}{40}\right) = 1750 \begin{cases} 1.44 \\ 0.59 \end{cases}$ 2470 #/□ Land; 1035 #/□' River

Subject: Hartford, Conn. – Ht. 5
Computation: 36' Stem — Sta. 17+12 ± to 18+72 ±
Computed by: J.A.C. Checked by: Date: 3/8/40

U.S. GOVERNMENT PRINTING OFFICE 3—10523

DESIGN OF STEEL IN TOE SLAB

SUMMARY OF MOMENTS FOR 4 CONDITIONS OF LOADING

CASE NO.	DEPTH RQD.	MOMENT	A_s RQD	A_s SUPPLIED
I. River Up; Sat. Backf.	27"	88,470'# →	—	
* II. River Down; " "	23½"	67,320 ←		
* III. River Up; Dry Backf.	30½"	113,460 →		
IV. River Down; " "	22½"	60,670 ←	—	

* LIMITING CASES FOR DESIGN

d supplied = 36 − 3.5 = 32.5"

$$A_s = \frac{12 \times 67{,}320}{18{,}000 \times .884 \times 32.5} = 1.56^{\square''}$$

2 − 1"φ bot. = 1.58 □"

$$A_s = \frac{12 \times 113{,}460}{18{,}000 \times .884 \times 32.5} = 2.63^{\square''}$$

1⅛"φ @ 1'-0" and 1¼"φ @ 1'-0" alternated

WAR DEPARTMENT

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

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Subject: Hartford, Conn (Ht-5) Sta 17+12 ± to 18+72 ±

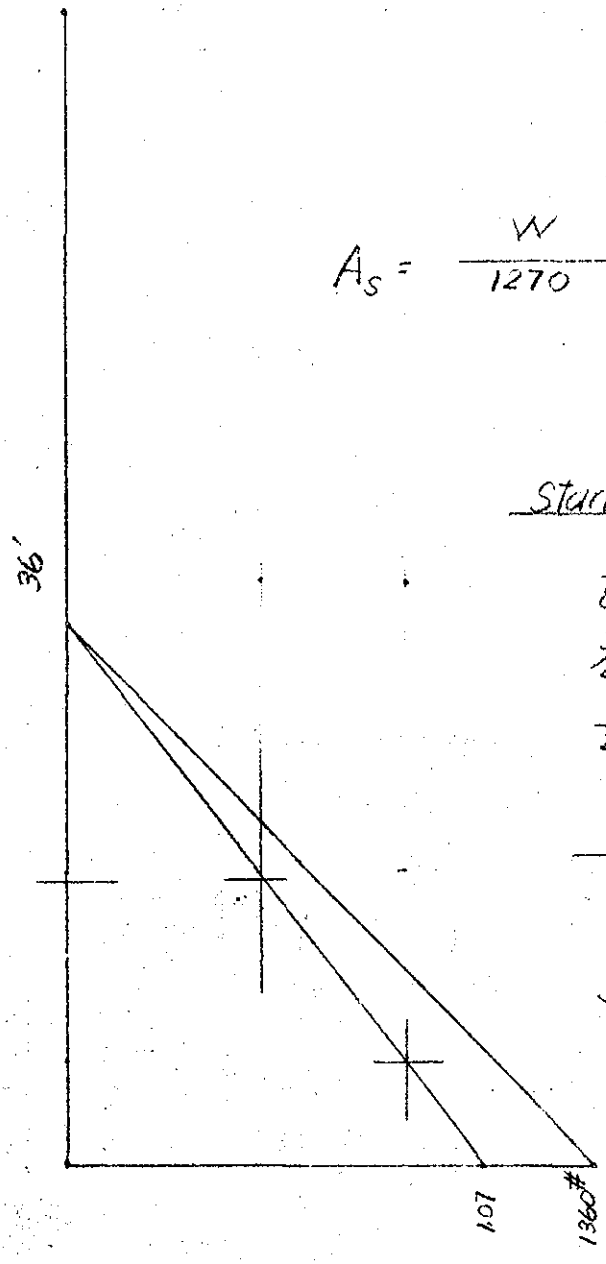
Computation: Counterfort Wall Stem 36'

Computed by: R.H.M. Checked by: Date: 9/8/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Longitudinal Steel in Stem Same as sect. @ 17+00 ±

Bonding Steel in Stem Loading Diagram



$$A_s = \frac{W}{1270}$$

Starting at base (moving up)

$\frac{7}{8}$"ϕ's for 3'

$\frac{3}{4}$"ϕ's for 6'

$\frac{1}{2}$"$\square$'s for rest of way.

From Top

$\frac{1}{2}$"$\square$'s for 27'

$\frac{3}{4}$"ϕ's for 6'

$\frac{7}{8}$"ϕ's for 3'

Subject Hartford (Ht-5) Conn
Computation 36' Counterforted wall Sta. 17+12 ± to 18+72 ±
Computed by R.H.M. Checked by Date 3/12/40

U. S. GOVERNMENT PRINTING OFFICE 3—10628

Longitudinal Base Steel

$$A_s = \frac{W}{59.74\,d}$$

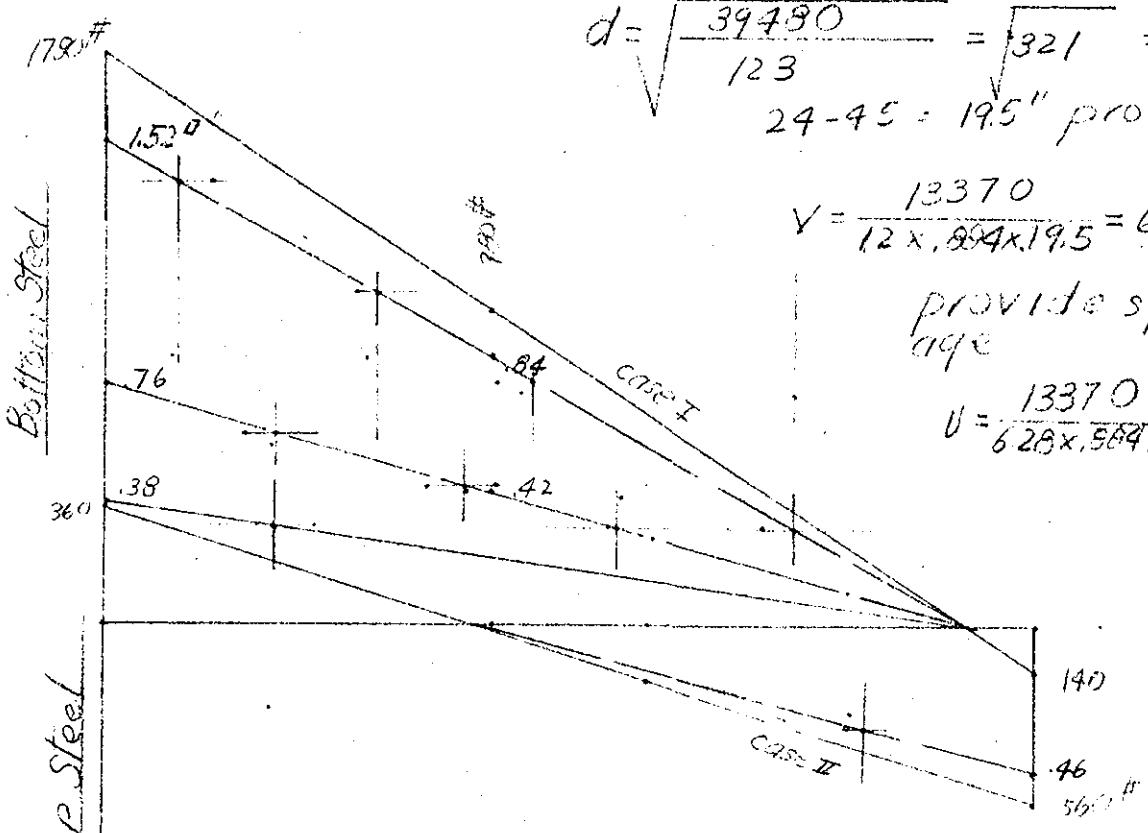
$$d = \sqrt{\frac{39480}{123}} = \sqrt{321} = 18'' \text{ OK.}$$

24-45 = 19.5" provided

$$V = \frac{13370}{12 \times .884 \times 19.5} = 65\ \#/\square''$$

provide special anchorage

$$U = \frac{13370}{6.28 \times .584 \times 19.5} = 124\ \#/\square''$$



Top Steel Use 5-3/4"φ's, 15 5/8"φ's, 4-3/4"φ's all long bars No short bars

Bottom Steel

Long Bars Use 5-1"φ's, 5-7/8"φ's, 4-3/4"φ's, 5/8"φ's rest of way

Short bars - 2-1"φ's 5-7/8"φ's, 4-3/4"φ's, 7-5/8"φ's

Bonding Steel in Base $A_{s(Max)} = \frac{560}{1270} = .44\ \square''$

Use 1/2"□ bars throughout

WAR DEPARTMENT

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

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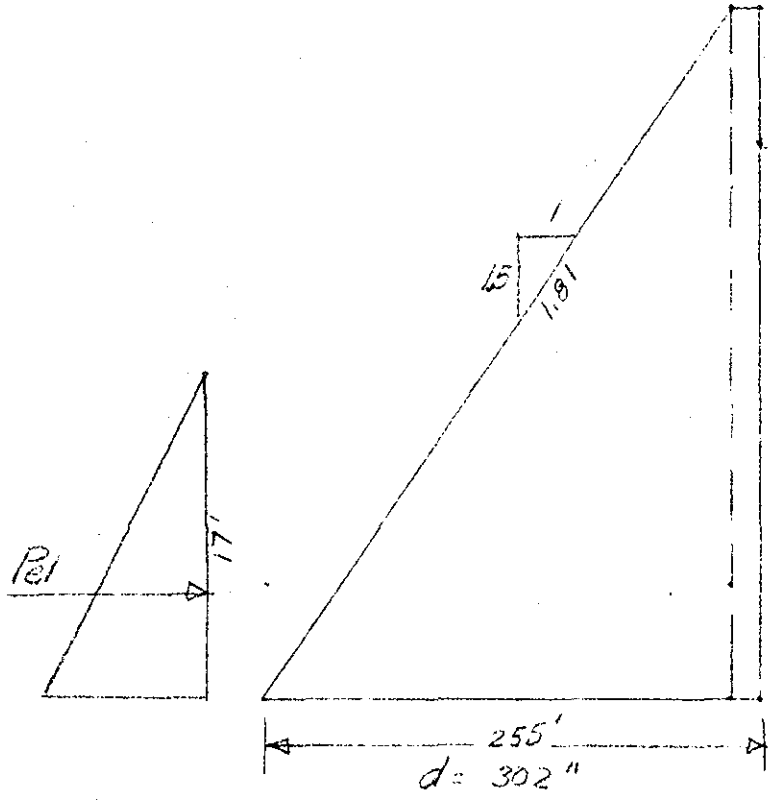
Project Hartford - Conn (Ht-5)

Computation 36' wall Counterforted 40' Base Sta 17+12 to 18+72

Computed by R.H.M. Checked by ..... Date 3/12/40

U. S. GOVERNMENT PRINTING OFFICE 3--10528

Counterfort Steel



Pel: $17^2 \times \frac{1}{2} \times 80 = 11560 \times 5.67 = 65,550$ '# For 1' of wall

$163,810 = 928,840$ For 14.17' " "

$$A_s = \frac{1.21 \times 12 \times 928,840}{18000 \times .884 \times 302} = \frac{13,486,800}{4,801,800} = 2.81 \square''$$

Use, 2-1 $\frac{1}{4}$" □'s

WAR DEPARTMENT

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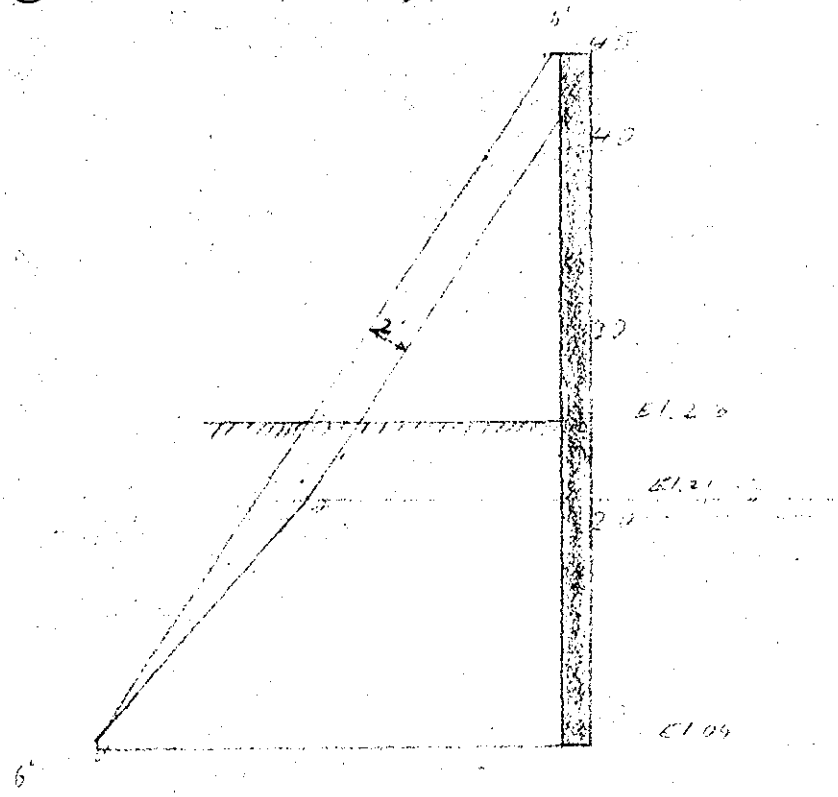
Subject #45

Computation 36' Counterfort Wall Sta. 17+12 ± to 18+72 ±

Computed by ..... Checked by ..... Date 3-22-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Counterfort cut in 2' for clearance



WAR DEPARTMENT

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

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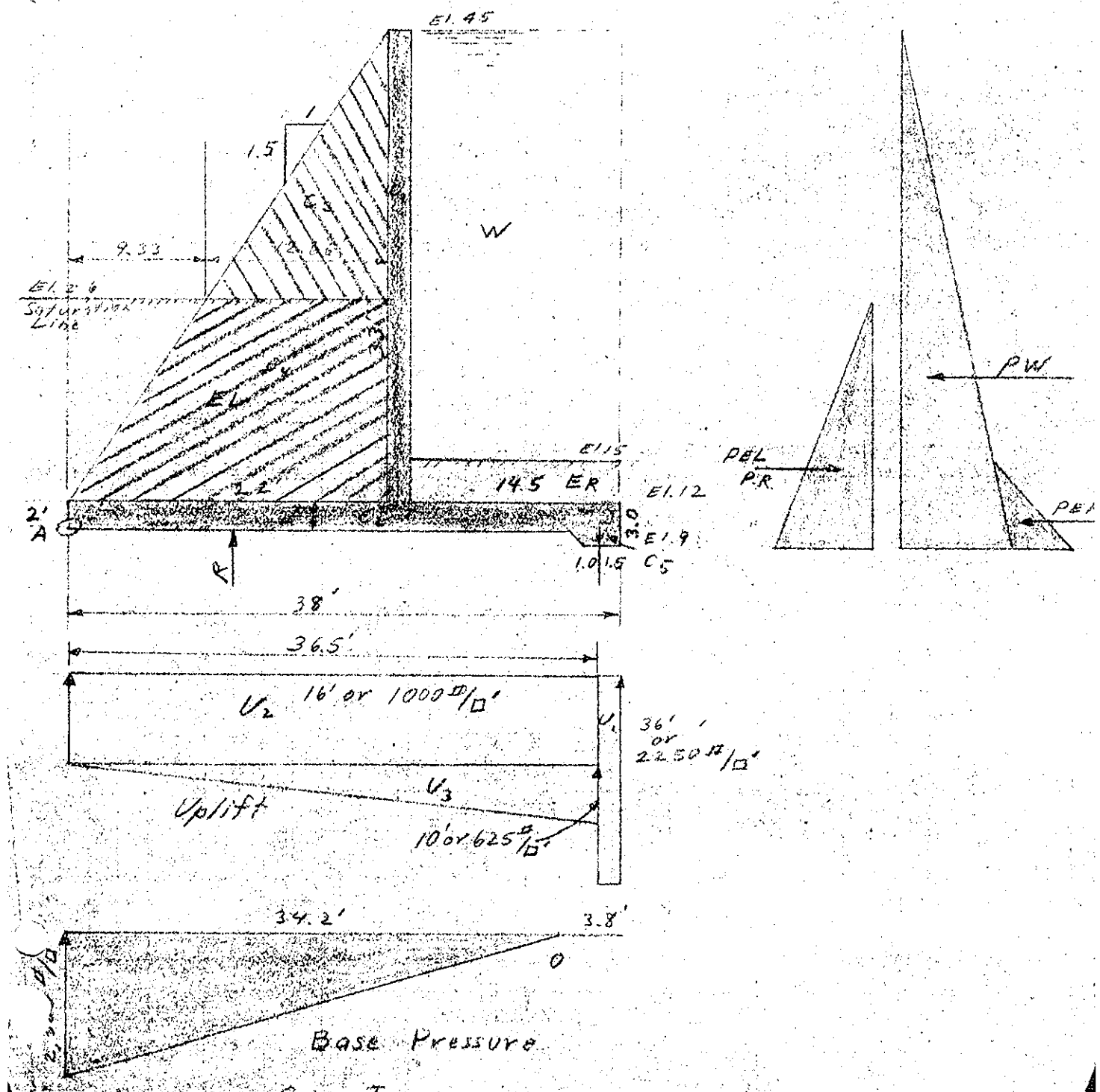
Subject H+5 Hartford 18+72± to 19+12±

Computation Counterfort Wall, 33' Stem Sta. 19+00

Computed by RW Checked by PLK Date 2-26-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



WAR DEPARTMENT

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

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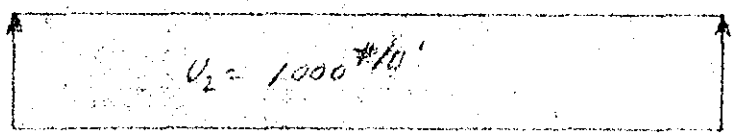
Project Hartford Ht 5

Computation Flood Wall Stem 33' Base 38' Sta 18+72± to Sta 19+12 ±

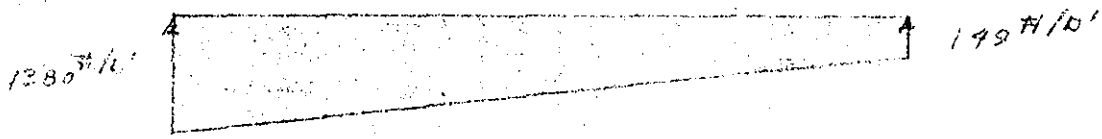
Computed by FLA Checked by Date 2/28/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

STABILITY



UPLIFT



BASE PRESSURE

CASE II

WAR DEPARTMENT

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

Subject H+5 Hartford Sta. 18+72 ± to 19+12 ±

Computation Flood Well 33' Stem 38' Base

Computed by RW Checked by PLA Date 2-26-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability Case I, River Up

Forces Acting		↓	↑	→	←	Arm	Moments about A ↻	↺
C_1	1.5×33×150	7420				22.95	169 000	
C_2	2×38×150	11 400				19	217 000	
C_3	$12.66 \times 19 \times \frac{1}{2} \times \frac{2}{13.33} \times 150$	2710				17.8	48 250	
C_4	$\left(\frac{12.66+22}{2}\right) \times 14 \times \frac{2}{13.33} \times 25$	910				13.2	12 000	
C_5	3×1×150	450				36.5	16 500	
EL	14×22×125	38500				11	423 000	
ER	3×14.5×125	5440				30.75	167 500	
W	30×14.5×62.5	27200				30.75	837 000	
U_1	36×1.5×62.5		3380			37.25		126 000
U_2	16×36.5×62.5		36 600			18.25		668 000
U_3	$10 \times 36.5 \times \frac{1}{2} \times 62.5$		11 420			24.33		278 000
PEL	$17^2 \times \frac{1}{2} \times$ ~~124~~ 80			11 600		4.66	54 100	
PER	$6^2 \times \frac{1}{2} \times 17.5$				320	1.0		320
PW	$36^2 \times \frac{1}{2} \times 62.5$				40500	11		446 000
FR	0.45×42630			19200				
PR				12900		4.66	60 200	
		94,530	51,400	43700	43700		2,164,455	1518,320
		ΣV = 42,630 ↓		ΣH = 0			ΣM = 486,130	

Position of Resultant

$\frac{\Sigma M}{\Sigma V} = \frac{486,130}{42,630} = 11.4'$

$\frac{1}{3}$ base = 12.67'

e = 19 − 11.4 = 7.6

Base Pressure

$\frac{42630}{3 \times 11.4} \begin{cases} 2 \\ 0 \end{cases} = 1250 \begin{cases} 2 \\ 0 \end{cases}$

2,500 #/□' Land Side

0 #/□' River Side

WAR DEPARTMENT

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

Project: 11t 5 Hartford

Computation: Flood Wall Stem 33' Base 38' Sta. 19+72± to Sta. 19+12±

Computed by: F.L.A. Checked by: [illegible] Date: 2/28/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability

Case II River Down

Forces Acting		↓	↑	→	←	Arm	Moments About "A" ↷	↶
C_1	1.5 x 33.0 x 150	7920				22.75	167,000	
C_2	2.0 x 33.0 x 150	11400				17.0	217,000	
C_3	$\frac{1}{2} \times \frac{2}{133} \times 12.66 \times 19.0 \times 150$	2710				17.8	48,250	
C_4	$\left(\frac{12.66 + 24.0}{2}\right) 19 \times \frac{2}{133} \times 150$	910				13.2	12,000	
C_5	3.0 x 1.0 x 150	450				36.5	16,400	
EL	14.0 x 22.0 x 125	38500				11.0	423,0	
FR	3 x 14.5 x 100	4350				30.75	134000	
[illegible]	16 x 36.5 x 62.5		36600			18.25		668,000
IEL	$\frac{1}{2} \times 80 \times 17^2$			11600		4.66	54200	
IER	$\frac{1}{2} \times 35 \times 6^2$				630	1.0		630
FR	6.45 x 29140				13100			
		65740	36600	11600	13730		1,073,850	668,630
		ΣV = 29140 ↓		ΣH = 0			ΣM = 405,220 ↷	

Position of Resultant: $\frac{\Sigma M}{\Sigma V} = \frac{405,000}{29100} = 13.9$

Middle Third: 12.67

$e = 19.0 - 13.9 = 5.1$

Base Pressures: $\frac{\Sigma V}{A}\left(1 \pm \frac{6e}{d}\right) = \frac{29100}{38}\left(1 \pm \frac{6 \times 5.1}{38}\right) = 1380$ #/□' 149 #/□'

WAR DEPARTMENT

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

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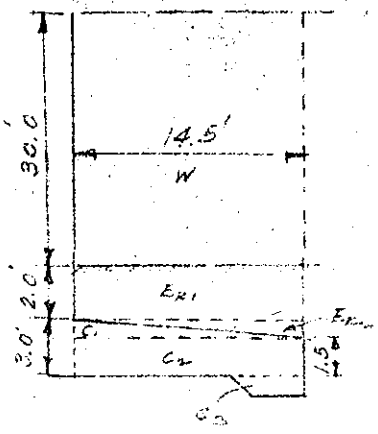
Subject

Computation 33' STEM - Sta 18+72± to 19+12±

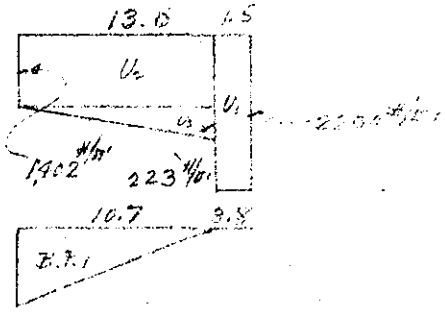
Computed by J.A.C. Checked by Date 3/8/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF STEEL IN TOE SLAB - CASE I - RIVER UP



FORCES ACTING	↓	↑	ARM	MOM. ↷	MOM. ↶
W 30 × 14.5 × 62.5	27,200		7.25	197,500	
E_{R1} 2 × 14.5 × 125	3,630		7.25	26,300	
E_{R2} ½ × 1.5 × 14.5 × 125	1,360		9.67	13,150	
C_1 ½ × 1.5 × 14.5 × 150	1,630		4.83	7,870	
C_2 1.5 × 14.5 × 150	3,260		7.25	23,700	
C_3 ½(2.5+3.5) × 1.0 × 150	450		13.0	5,850	
U_1 2250 × 1.5		3,380	13.75		47,500
U_2 1402 × 13.0		18,200	6.5		118,300
U_3 ½ × 223 × 13.0		1,450	8.67		12,550
B.P. = ½ × 780 × 10.7		4,170	3.57		14,900
	V = 10,330# ↓			M = 81,120'# ↷	



$d = 36 - 3.5 = 32.5$

$d_{REQ} = \sqrt{\frac{81,120}{123}} = \sqrt{660} = 26''$

$A_s = \frac{12 \times 81,120}{18,000 \times .884 \times 32.5} = 1.89^{\square''}$ 1" □ @ 6" top

$Z_c = \frac{10,330}{150 \times .884 \times 32.5} = 2.00''$

$v = \frac{10,330}{12 \times .884 \times 32.5} = 30\ \#/\square''$

Uplift

$\frac{625}{36.5} = 17.1$ Drop per ft.

$13.0 \times 17.1 = 223$ Drop in 13 ft.

$1625 - 223 = 1,402$

Bearing

$\frac{2500}{34.2} = 73.1$

$10.7 \times 73.1 = 780$

WAR DEPARTMENT

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

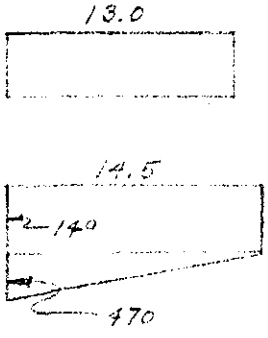
ject H+5

nputation 33' STEM — Sta 18+72 ± to Sta 19+12

omputed by J.A.C. Checked by Date 3/8/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF STEEL IN TOE SLAB - CASE II - RIVER DOWN



FORCES ACTING	↓	↑	ARM	MOM →	MOM ↶
E_{R1} 2×14.5×100	2,900		7.25	21,000	
E_{R2} ½×1.5×14.5×100	1,090		9.67	10,550	
C_1	1,630		4.83	7,870	
C_2	3,260		7.25	23,700	
C_3	450		13.0	5,850	
U_1 1000×13.0		13,000	6.5		84,500
B.P.$_1$ 149×14.5		2,160	7.25		15,650
B.P.$_2$ ½×470×14.5		3,410	4.83		16,500
	V = 9,240# ↓			M = 47,680'# ↶	

1380 - 149 = 1,231

$\frac{1231}{38} = 32.4$

32.4 × 14.5 = 470

d = 32.5"

$A_s = \frac{12 \times 47,680}{18,000 \times .884 \times 32.5} = 1.11$ #" 7/8 @ 6" C.C.

$\Sigma_o = \frac{9,240}{150 \times .884 \times 32.5} = 2.14$"

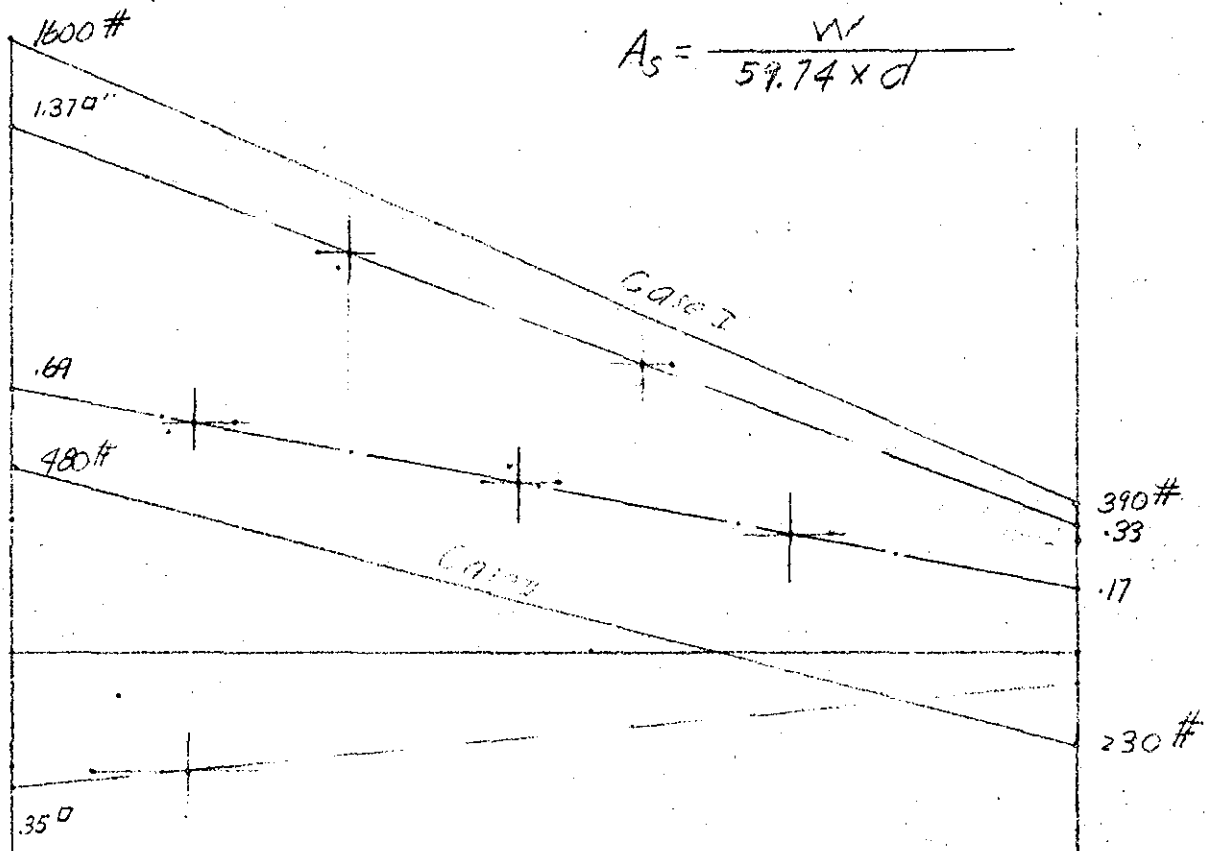
$\sigma = \frac{9,240}{12 \times .884 \times 32.5} = 27$ #/□"

Project Hartford Conn (HI-5) Sta. 18+72± to 19+12±
Computation 33 Stem
Computed by R Checked by Date 3-12-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Longitudinal Base Steel

$$A_s = \frac{W}{59.74 \times d}$$



Top Steel

Long bars only – 4 - 3/4"φ's rest 5/8"φ's

Bottom Steel

Long bars - 4 - 1"φ's, 7 - 7/8"φ's, 6 - 3/4"φ's then 5/8"φ's
Short bars - 7 - 7/8"φ's, 6 - 3/4"φ's, then 5/8"φ's

Bonding Steel in Base

1/2"□'s throughout (by inspection)

WAR DEPARTMENT

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

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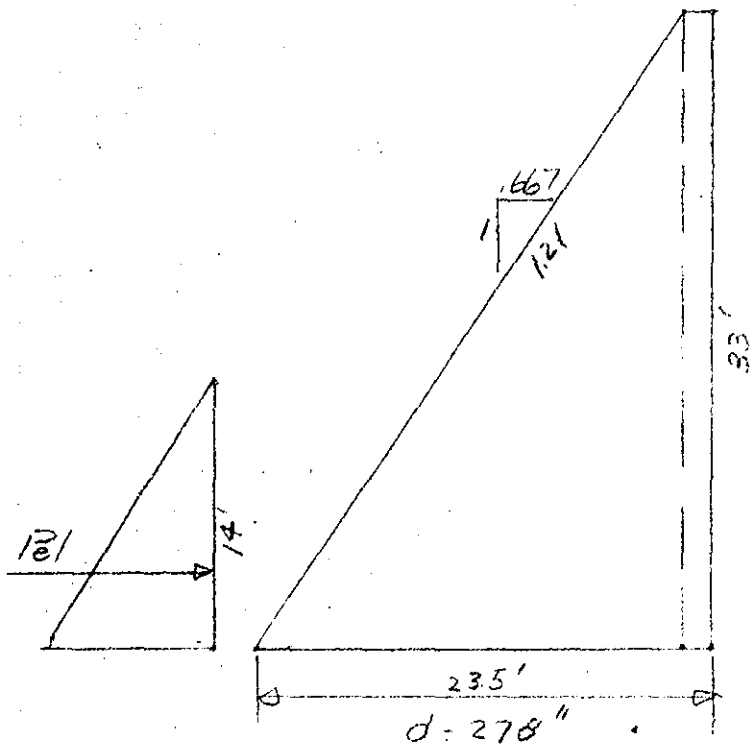
Project Hartford Conn (Ht-5) Sta 18+72 ± to 19+12 ±

Computation Counterfort wall 33 Stem

Computed by R.H. Checked by Date 3/12/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Counterfort Steel



Pel : $14^2 \times \frac{1}{2} \times 80 = 7840 \times 4.67 = 36610$ '# For 1' of wall

111,090 # = 518760 '# " 14.17' " "

$$A_s = \frac{1.21 \times 12 \times 518760}{18000 \times .884 \times 278} = \frac{7,532,400}{4,420,200} = 1.71 \square''$$

Use 2 - 1" □ bars

Longitudinal Stem Steel - see sec. @ 17+00 ±

Bonding steel in stem - see sec @ 18+00 ±

WAR DEPARTMENT

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

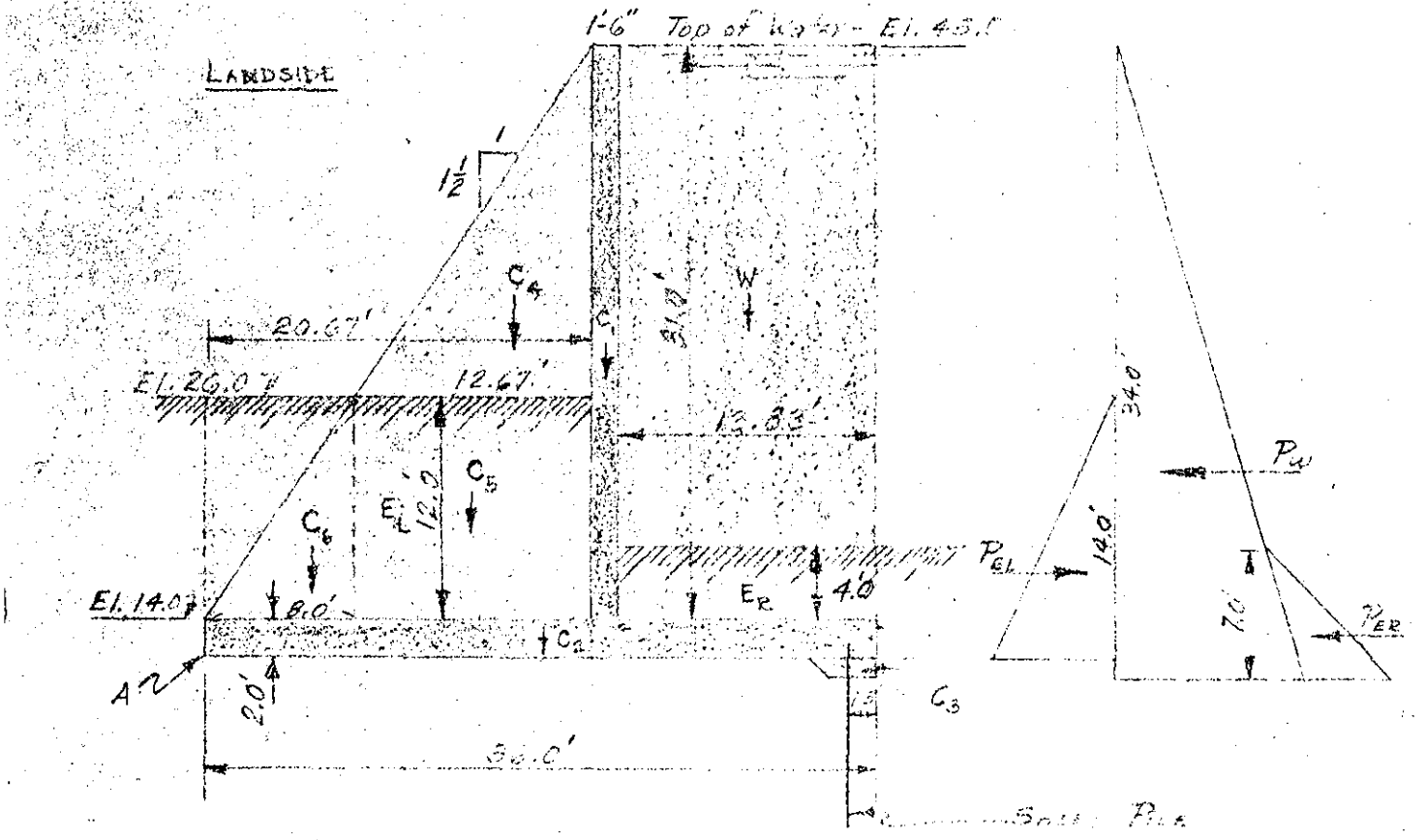
Project: HARTFORD FLOOD WALL - H&S - 31'-0" STEEL

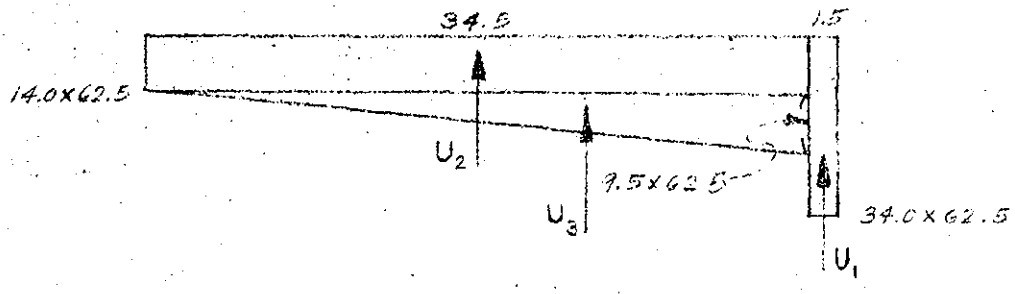
Computation: STABILITY FOR FULL HEAD OF WATER - STA. 19+12 ± 20+32

Computed by: J.A.C. Checked by: PLA Date: 2/27/40

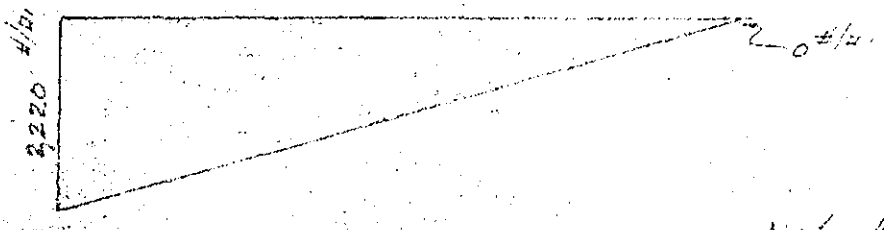
U.S. GOVERNMENT PRINTING OFFICE 3—10528

CASE I - WATER UP, 12' OF SATURATED EARTH ON LANDSIDE





UPLIFT



BEARING

Note: Base Thickness River Side Increased to 3'-0"

WAR DEPARTMENT

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

Project: Hartford Flood Wall - H.5 31'-0" Stem

Computation: Sta. 19+12 ± to 20+32 ±

Computed by: J.A.C. Checked by: P.L.A. Date: 2/27/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case I (Cont'd)

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT A ↻	MOMENTS ABOUT A ↺
C_1	1.5 × 31.0 × 150	6,980				21.42	149,500	
C_2	2.0 × 36.0 × 150	10,800				18.0	194,500	
C_3	3.0 × 1.0 × 150	450				34.5	15,500	
C_4	2/15 × 19.0 × 12.67 × ½ × 150	2,410				16.45	39,600	
C_5	2/15 × 12.0 × 12.67 × 25	507				14.33	7,250	
C_6	2/15 × 8.0 × 12.0 × ½ × 25	160				5.33	855	
E_L	20.67 × 12.0 × 125	31,000				10.33	320,000	
E_R	13.83 × 4.0 × 125	6,915				29.09	201,000	
W	27.0 × 13.83 × 62.5	23,350				29.09	680,000	
P_w	½ × 34.0 × 34.0 × 62.5				36,100	10.33		373,000
P_{E_L}	½ × 14.0 × 14.0 × 80			7,250		4.67	36,700	
P_{E_R}	½ × 7.0 × 7.0 × 17.5				430	1.33		570
U_1	34.0 × 1.5 × 62.5		3,190			35.25		112,500
U_2	14.0 × 34.5 × 62.5		30,200			17.25		521,000
U_3	½ × 9.5 × 62.5 × 34.5		10,250			23.00		235,500
F_R	.45 ΣV = .45 × 38,932			17,500		0		
F_P	Passive Resistance			11,180		4.67	52,200	
		52,572	43,640	36,530	36,530		1,687,105	1,243,070
		ΣV = 38,932		ΣH = 0			ΣM = 454,035	

Position of Resultant $= \frac{\Sigma M}{\Sigma V} = \frac{454,035}{38,932} = 11.65'$ from A .35' outside mid 3rd.

$e = 18.0 - 11.65 = 6.35'$

$x = 3 \times 11.65' = 35.0'$

Bearing $= \frac{2\Sigma V}{b} = \frac{2 \times 38,932}{35.0'} = 2,220$ #/□'

0 #/□'

WAR DEPARTMENT

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

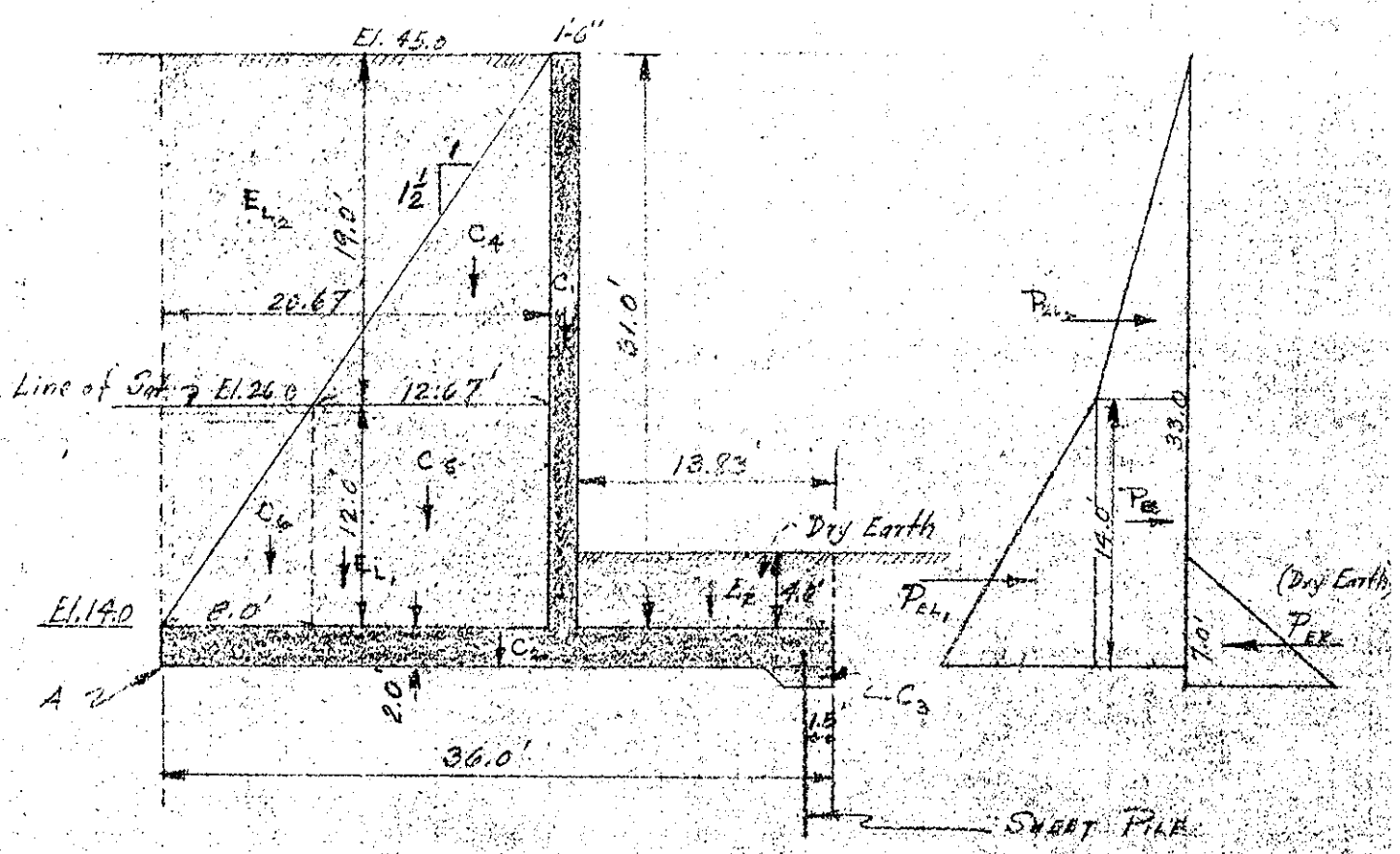
ect: HARTFORD FLOOD WALL - HI. 5 STA. 19+12 ± TO 20+32 ±

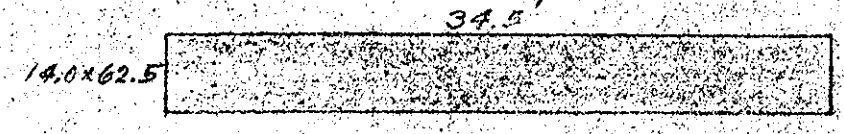
omputation: 31'-0" STEM

omputed by: T.A.C. Checked by: P.L.H. Date: 2/26/40

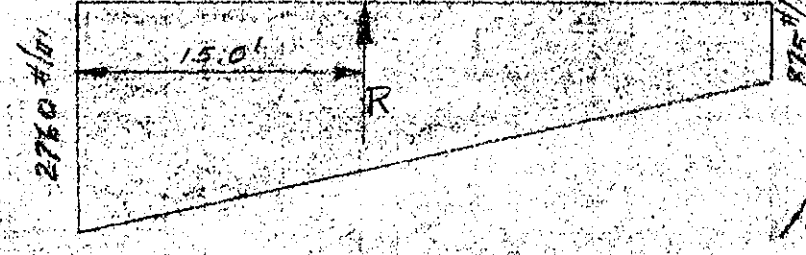
U. S. GOVERNMENT PRINTING OFFICE 3—10528

CASE II – RIVER DOWN, FUTURE EARTH FILL TO TOP OF WALL





UPLIFT



BEARING

Note: Base Thickness, River Side increased to 3'-0"

Subject: Hartford Flood Wall
Computation: 31'-0" Stem Sta. 19+12 to 20+34
Computed by: T.A.C. Checked by: PLS Date: 2/29/40

U. S. GOVERNMENT PRINTING OFFICE 3—10328

Case II (Cont'd)

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT A ↻	MOMENTS ABOUT A ↺
C_1		6,980					149,500	
C_2		10,800					194,500	
C_3		450					15,500	
C_4	$\frac{2}{15} \times 19.0 \times 12.67 \times \frac{1}{2} \times 50$	803				16.45	13,200	
C_5		507					7,250	
C_6		160					855	
E_R	$4.0 \times 13.83 \times 100$	5,530				29.09	161,000	
E_{L1}		31,000					320,000	
E_{L2}	$19.0 \times 20.67 \times 100$	39,400				13.33	467,000	
P_{ER}	$7.0 \times 7.0 \times 35 \times \frac{1}{2}$				850	1.33		1,140
P_{EL2}	$19.0 \times 19.0 \times 35 \times \frac{1}{2}$			6,320		20.33	128,000	
P_{EL1}	$14.0 \times 14.0 \times \frac{1}{2} \times 80$			7,840		4.67	36,600	
P_{ES}	$19.0 \times 35 \times 14.0$			9,310		7.0	65,200	
U_1	$14.0 \times 62.5 \times 34.5$		30,200			17.25		521,000
F_T					23,620			
		95,430	30,200	23,470	23,470		1,498,605	522,140
		$\Sigma V = 65,430$		$\Sigma H = 0$			$\Sigma M = 976,465$	

Position of Resultant $= \frac{\Sigma M}{\Sigma V} = \frac{976,465}{65,430} = 14.9'$ 2.9' within mid 3rd

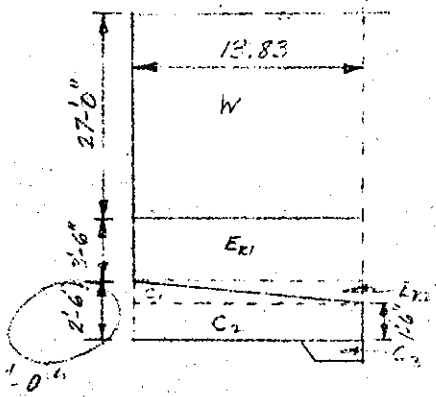
$e = 3.1$

Bearing $\frac{65,430}{36}\left[1 \pm \frac{6 \times 3.1}{36}\right] = 1820\left[\begin{matrix}1 + .52 \\ 1 - .52\end{matrix}\right] = \begin{matrix}2760 \text{ \#/□'} \\ 875 \text{ \#/□'}\end{matrix}$

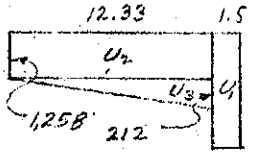
Project: Hartford, Conn. - Ht. 5 -
Computation: 31'-0" Stem - Sta. 19+12 to 20+32
Computed by: T.A.C. Checked by: Date: 3/8/40

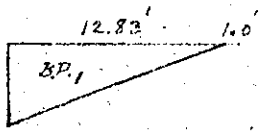
U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Steel in Toe Slab - Case I - River Up



Forces Acting	↓	↑	Arm	Moment ↷	Moment ↶
W	23,350		6.92	161,500	
E_{R1} = 13.83 × 3.5 × 125	6,050		6.92	41,800	
E_{R2} = ½ × 13.83 × 1.0 × 125	86.5		9.22	7,980	
C_1 = ½ × 13.83 × 1.0 × 150	1,035		4.61	4,770	
C_2 = 13.83 × 1.5 × 150	3,110		6.92	21,500	
C_3 = ½(2.5+3.5) × 1 × 150	450		12.33	5,550	
U_1 =		3,190	13.08		41,800
U_2 = 1,258 × 12.33		15,500	6.17		95,500
U_3 = ½ × 212 × 12.33		1,310	8.22		10,760
BP_1 = ½ × 815 × 12.83		5,230	4.11		21,500
	V =	# ↑		M = 73,540 # ↷	





$d = 30 - 3.5 = 26.5''$

$d_{req} = \sqrt{\frac{73,540}{12.2}} = \sqrt{597} = 24.5''$

$A_s = \frac{12 \times 73,540}{18,000 \times .884 \times 32.5} = 1.71 \square''$

Use 1" □ @ 6" in Top

Uplift

14.0 × 62.5 = 875
9.5 × 62.5 = 595
1470

$\frac{9.5 \times 62.5}{34.5} = 17.20$ Drop per ft.

12.33 × 17.20 = 212
Drop in 12.33 ft.

1470 − 212 = 1,258

Bearing

$\frac{2,220}{35.0} = 63.5$
Drop per ft

12.83 × 63.5 = 815
Drop in 12.83 ft

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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ect Hartford, Conn. - Ht. 5
omputation 31'-0" Stem — Sta. 19+12 ± to 20+32 ±
omputed by J.A.C. Checked by R.W. Date 3/8/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

River Side

Design of Steel in Toe Slab - Case II - River Down

Bearing
2760
-875
1885

$\frac{1885}{36.0} = 52.4$ Incr per ft

$13.83 \times 52.4 = 725$ Tot. Incr in 13.83'

Forces Acting	↓	↑	Arm	Mom. ↷	Mom. ↶
$E_{R_1} = 13.83 \times 3.5 \times 100$	4,840		6.92	33,500	
$E_{P_2} = \frac{1}{2} \times 13.83 \times 1.0 \times 100$	690		9.22	6,360	
C_1	1,035		4.61	4,770	
C_2	3,110		6.92	21,500	
C_3	450		12.33	5,550	
$U_1 = 14.0 \times 62.5 \times 12.33$		10,800	6.17		66,600
$B.P._1 = 875 \times 13.83$		12,100	6.92		83,900
$B.P._2 = \frac{1}{2} \times 725 \times 13.83$		5,010	4.61		23,100
	V = 17,785 ↑			M = 101,920 '# ↷	

$d = 26.5''$

$d_{EQD} = \sqrt{\frac{101,920}{123}} = \sqrt{830} = 29''$

∴ d supplied is not sufficient
Make overall depth at stem = 3'-0" New d = 31.5"

$E_{R_1} = 13.83 \times 3.0 \times 100$	4,150		6.92	28,500	
$E_{P_2} = \frac{1}{2} \times 13.83 \times 1.5 \times 100$	1,035		9.22	9,550	
$C_1 = \frac{1}{2} \times 13.83 \times 1.5 \times 150$	1,560		4.61	7,200	
C_2	3,110		6.92	21,500	
C_3	450		12.33	5,550	
U_1		10,800	6.17		66,600
$B.P._1$		12,100	6.92		83,900
$B.P._2$		5,010	4.61		23,100
	V = 17,605# ↑			M = 101,300 '# ↷	

$d = 36 - 3.5 = 32.5'$

$A_s = \frac{12 \times 101,300}{18,000 \times .884 \times 31.5} = 2.43$ □"

$\Sigma_o = \frac{17,605}{150 \times .884 \times 32.5} = 4.07''$

$w = \frac{17,605}{12 \times .884 \times 32.5} = 51$ #/in

Use $1\frac{1}{8}$" □ @ 5" in bottom

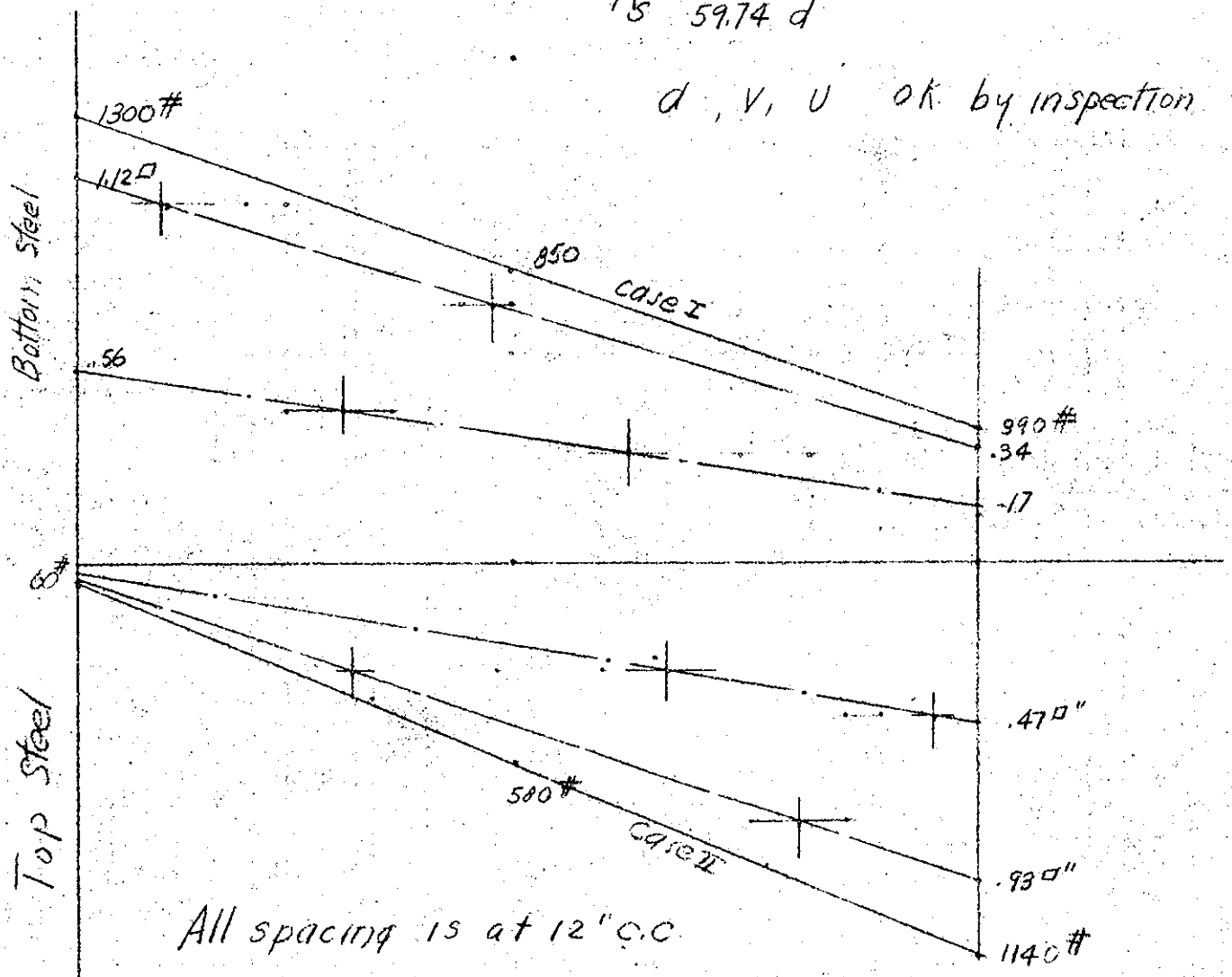
Project: Hartford - Conn (Ht-5)
Computation: Counterfort Wall 31' stem Sta 19+12± to 20+32
Computed by: R.H.M. Checked by: Date: 3/11/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Longitudinal Base Steel

$$A_s = \frac{W}{59.74\ d}$$

d, V, U OK by inspection



All spacing is at 12" c.c

Bottom Steel Starting from left

Long bars - 7 - 7/8" φ's, 7 - 3/4" φ's, 5/8" φ's rest of way.

Short bars - 2 - 7/8" φ's, 8 - 3/4" φ's, 5/8" φ's " " "

Top Steel

Long bars - 14 - 5/8" φ's, 6 - 3/4" φ's, 1 - 7/8" φ's

Short bars - 10 - 5/8" φ's, 4 - 3/4" φ's, (Come in from landing 6'-9" and then start placing these bars)

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

Page No. 1

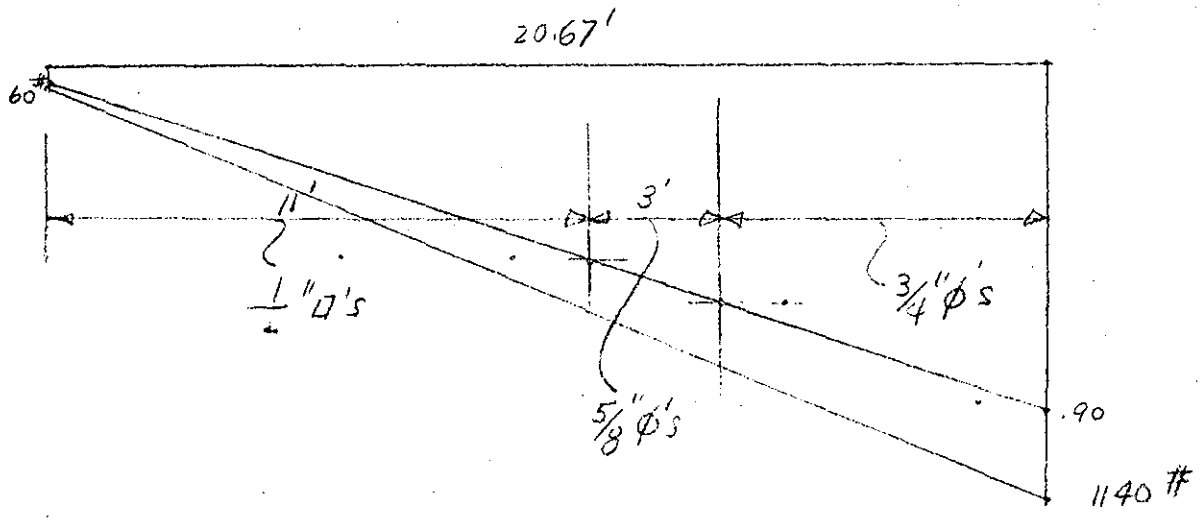
Project: Hartford - Conn (HH-5)

Computation: Counterfort wall 31' stem Sta. 19+12± to 20+32

Computed by: RHM Checked by: Date: 3/11/90

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Bonding Steel in Base



$$A_s = \frac{W}{1270}$$

Subject Hartford - Conn (Ht-5)
Computation 31'-0" Stem Sta 19+12 to 20+32
Computed by R.H.M. Checked by Date 3/12/40

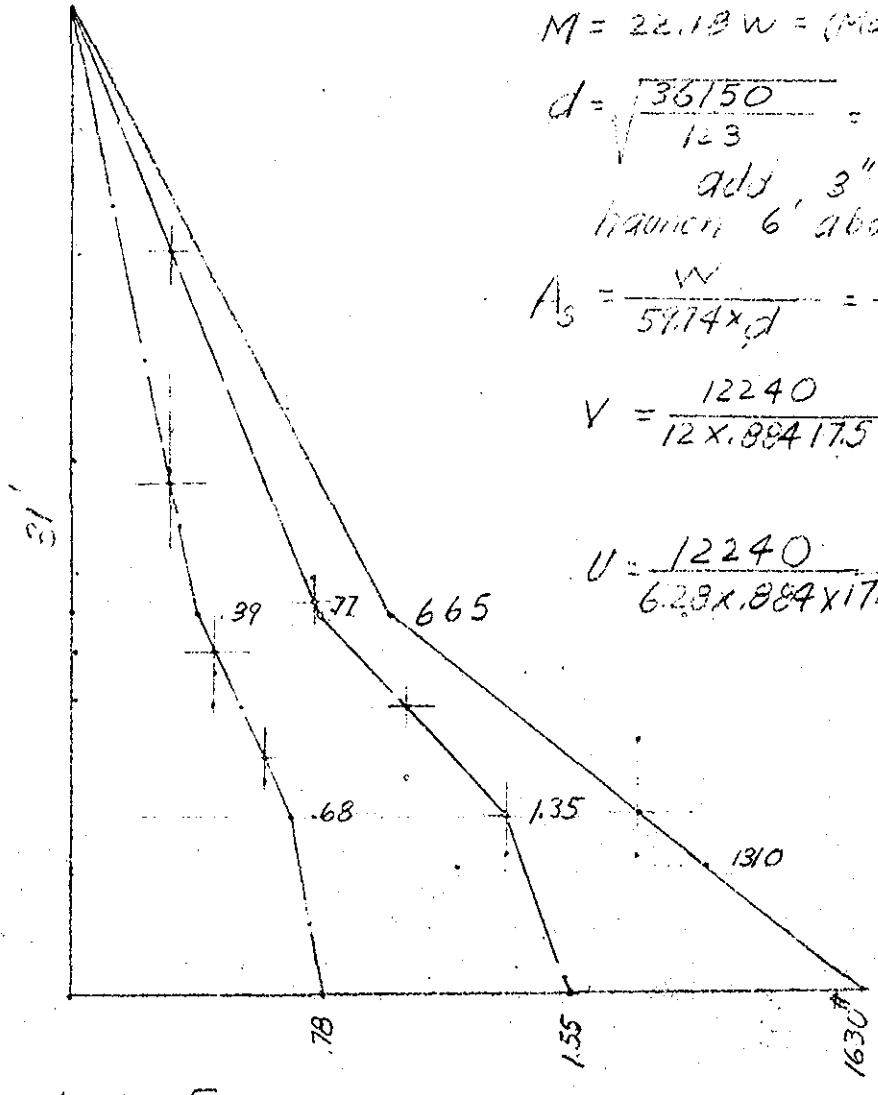
U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stem Steel

Steel in Riverside Face - see sec @ sta 17+00

Steel in landside face Case II Governs

Loading diagram



$M = 22.18\,w = (Max) = 36150$ 1#

$d = \sqrt{\frac{36150}{123}} = \sqrt{294} = 17.5''$

add 3" haunch start haunch 6' above base

$A_s = \frac{W}{59.74 \times d} = \frac{W}{866}$

$V = \frac{12240}{12 \times .884\,17.5} = 66$ #/□" Use special anchorage

$U = \frac{12240}{6.28 \times .884 \times 17.5} = 126$ #/□"

Landside Face

Long bars 15 - 5/8"φ's, 6 - 3/4"φ's, 3 - 7/8"φ's, 1"φ's
Short bars - 7'-9" then 11 - 5/8"φ's, 4 - 3/4"φ's, 4 - 7/8"φ's, 1"φ's

WAR DEPARTMENT

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

Subject: Hartford Conn (HT-5)

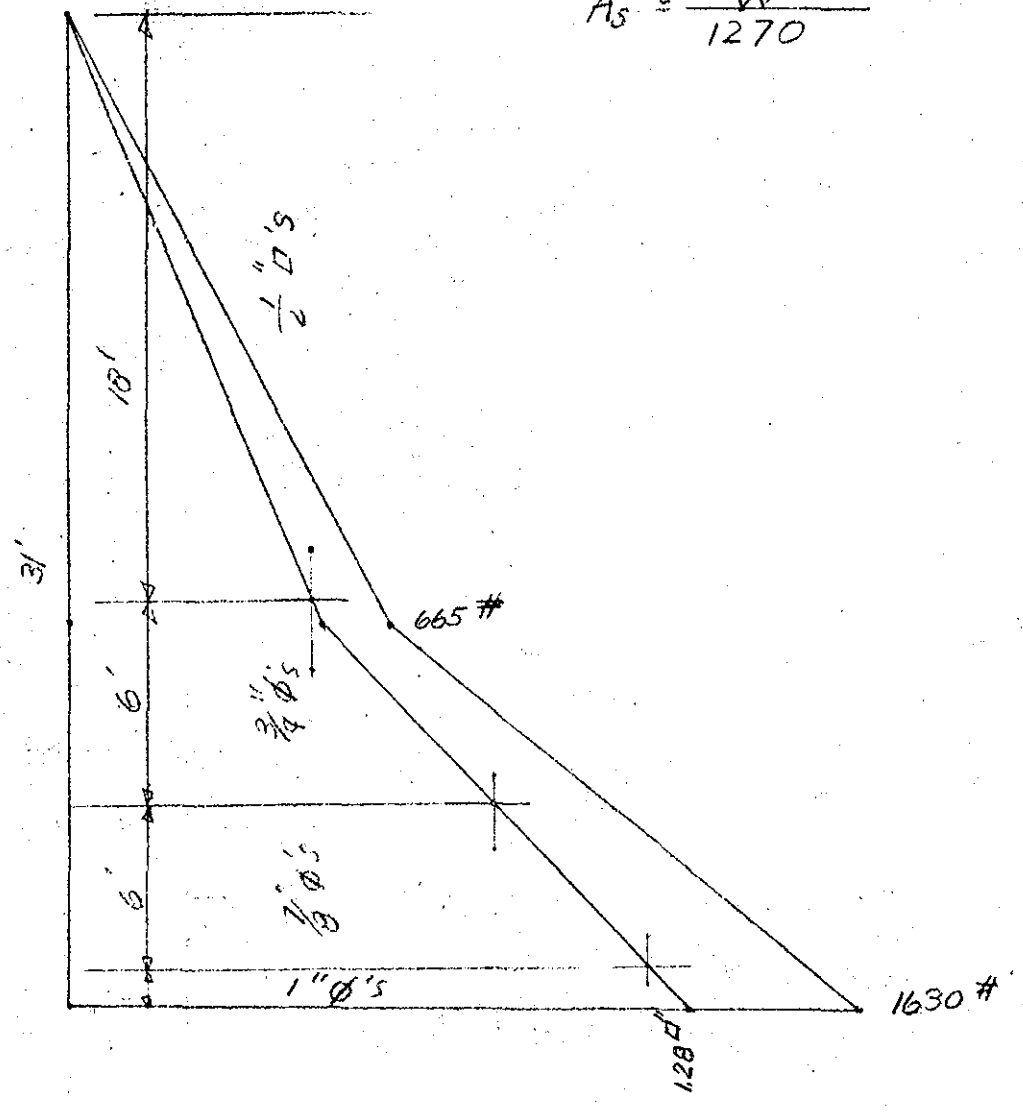
Computation: 3'-0" Stem — Sta 19+12± to 20+32

Computed by: R.H.M. Checked by: Date: 3/12/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Bonding Steel in Stem

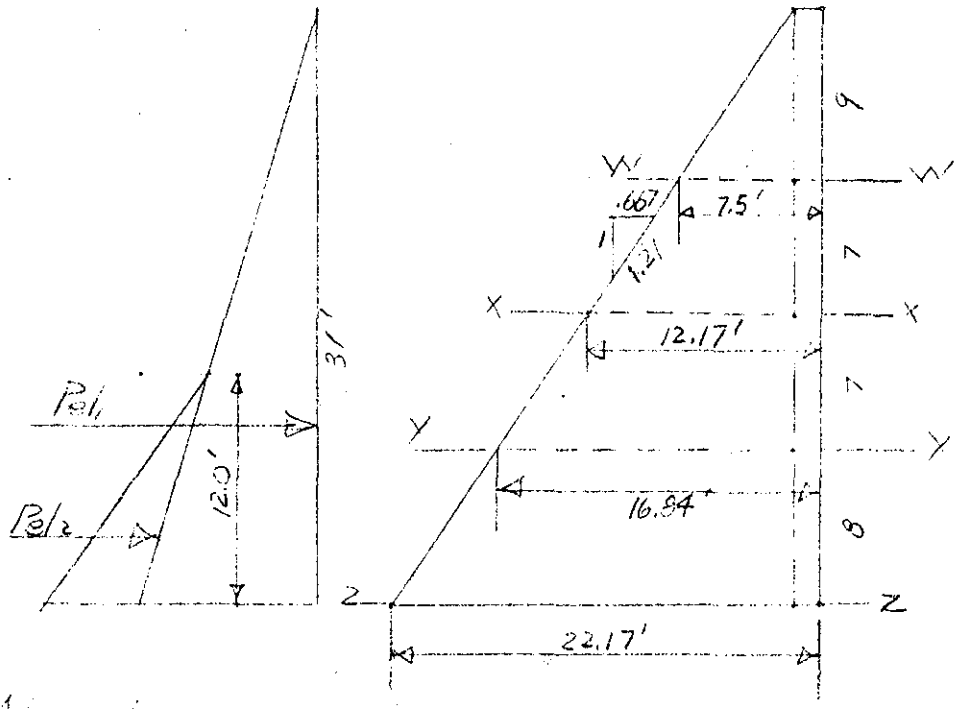
$$A_s = \frac{W}{1270}$$



Project: Hartford (Ht-5) Conn.
Computation: 31' Counterforted Wall Sta 19+12 to 20+32
Computed by: R.H.M. Checked by: Date: 3/12/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Counterfort Steel



At sect W-W

Pel_1: $9^2 \times \frac{1}{2} \times 35 = 1420 \times 3.0 = 4260$ '# For 1' of wall.
20120 # 60360 '# " 14.17' " "

$$A_s = \frac{1.21 \times 12 \times 60360}{18000 \times .884 \times 86} = \frac{876430}{1,367,400} = .64 \square''$$

2 - 1" □ bars

At sect X-X

Pel_1: $16^2 \times \frac{1}{2} \times 35 = 4480 \times 5.28 = 23880$ '# For 1'
63490 # 338580 '# " 14.17'

$$A_s = \frac{1.21 \times 12 \times 338580}{18000 \times .884 \times 142} = \frac{4,913,300}{2,251,900} = 2.18 \square''$$

3 - 1" □ bars

At sect Y-Y

Pel_1: $23^2 \times \frac{1}{2} \times 35 = 9260 \times 7.67 = 71020$ '#
Pel_2: $4^2 \times \frac{1}{2} \times 45 = 360 \times 1.33 = 480$ '#
9620 # 71500 '# For 1'
136,320 # 1,013,160 '# " 14.17'

$$A_s = \frac{1.21 \times 12 \times 1,013,160}{18000 \times .884 \times 198} = \frac{14,711,100}{3,148,200} = 4.67 \square''$$

Use 5-1" □ bars

Project Hartford (Ht-5) Conn
Computation 31 Counterfort Wall Sta 19+12± to 20+32
Computed by R.H.M. Checked by Date 3/12/40

U. S. GOVERNMENT PRINTING OFFICE 3—10526

Counterfort Steel (continued)

At Sect 2---2

Pel_1 : $31^2 \times \frac{1}{2} \times 35 = 16820 \times 10.33 = 173,750$ '#
Pel_2 : $12^2 \times \frac{1}{2} \times 45 = 3240 \times 4.0 = 12,960$ '#

20060 186,710 '# For 1'
284,250 # 2,645,700 '# " 14.17'

$$A_s = \frac{1.21 \times 12 \times 2,645,700}{18000 \times .884 \times 262} = \frac{38,415,600}{4,165,800} = 9.22 \square''$$

Use 10 1" □ bars

Shear & Bond

W---W

$$V = \frac{20120}{24 \times .884 \times 86} = 11 \#/\square'' \qquad U = \frac{20120}{8 \times .884 \times 86} = 35 \#/\square''$$

X---X

$$V = \frac{63480}{24 \times .884 \times 142} = 21 \#/\square'' \qquad U = \frac{63480}{12 \times .884 \times 142} = 42 \#/\square''$$

Y---Y

$$V = \frac{136320}{24 \times .884 \times 198} = 32 \#/\square'' \qquad U = \frac{136320}{20 \times .884 \times 198} = 39 \#/\square''$$

Z---Z

$$V = \frac{284,250}{24 \times .884 \times 262} = 51 \#/\square'' \qquad U = \frac{284250}{40 \times .884 \times 262} = 31 \#/\square''$$

WAR DEPARTMENT

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

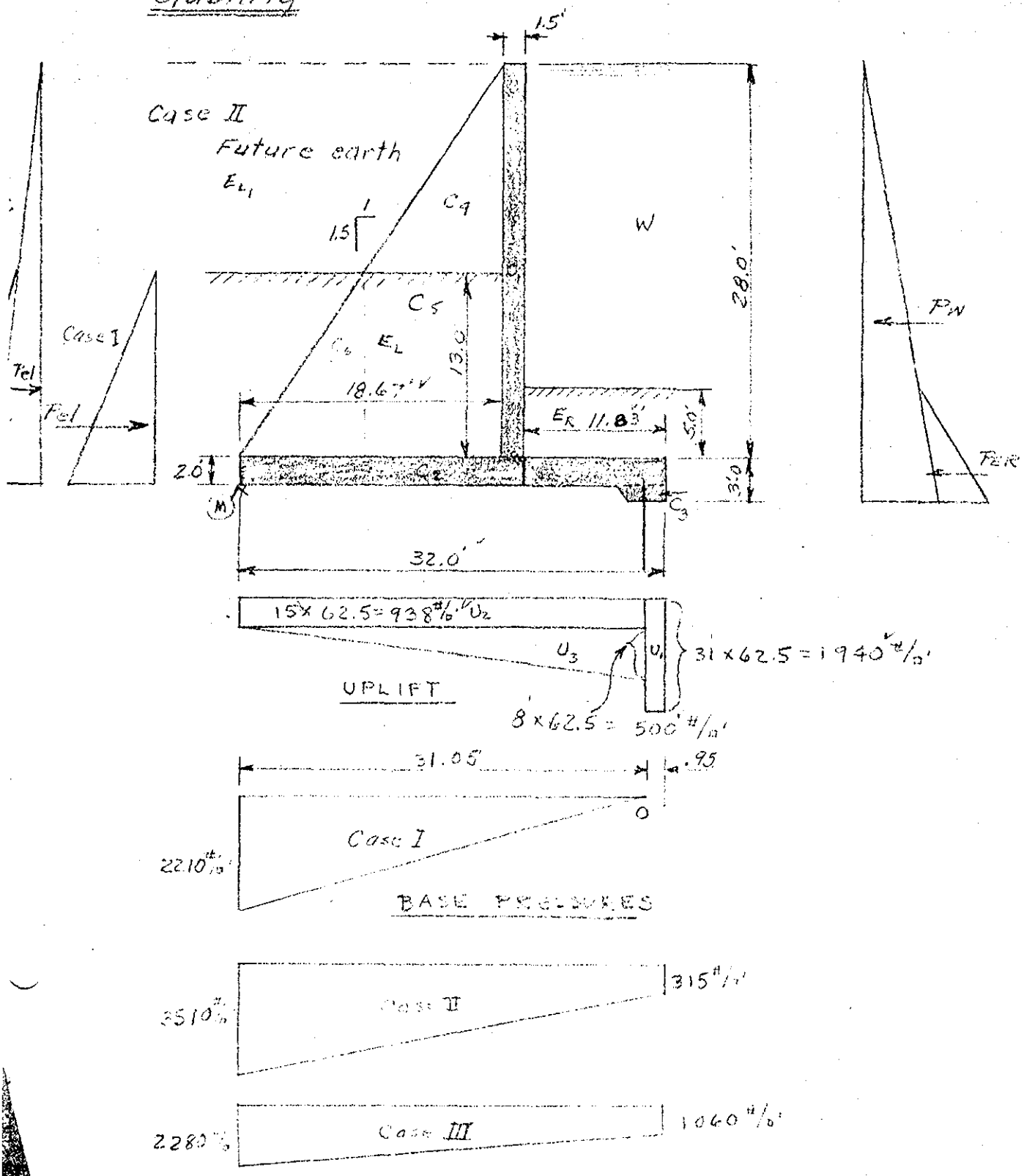
ct HARTFORD - Ht. 5 STA. 20+32 - 2[illegible]+72

mputation 28'-0" WALL, COUNTERFORTED, 32' BASE

mputed by E.H.V. Checked by J.H.L. Date Feb. 26, 1940

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability



Project HARTFORD – Ht.5
Computation 28'-0" WALL (cont.) Sta. 20+32 to 20+72
Computed by E.H.V. Checked by J.H.L. Date 2-26-40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

STABILITY – CASE I water up – 13.0 earth above land base – sat.

Forces Acting	↓	↑	→	←	ARM	MOMENT ↓	MOMENT ↑
$C_1 = 1.5 \times 28 \times 150$	6300				19.42	122,300	
$C_2 = 2 \times 32 \times 150$	9600				16.0	153,600	
$C_3 = 3 \times 1 \times 150$	450				30.5	13,730	
$C_4 = \frac{1}{2} \times 15 \times 10 \times \frac{2}{13.33} \times 150$	1,690				15.34	25,900	
$C_5 = 10 \times 13 \times \frac{2}{13.33} \times 25$	487				13.67	6,660	
$C_6 = 8.67 \times 13 \times \frac{1}{2} \times \frac{2}{13.33} \times 25$	214				5.78	1,240	
$E_L = 18.67 \times 13 \times 125$	30,350				9.33	282,500	
$E_R = 11.83 \times 5 \times 125$	7400				26.09	193,000	
$W = 23 \times 11.83 \times 62.5$	17,000				26.09	444,500	
$U_1 = 31 \times 62.5 \times 1.5$		2910			31.25		90,800
$U_2 = 15 \times 62.5 \times 30.5$		28600			15.25		436,000
$U_3 = 8 \times 62.5 \times 30.5 \times \frac{1}{2}$		7620			20.3		155,000
$P_{el} = 15^2 \times \frac{1}{2} \times 80$			9000		5.0	45,000	
$P_{eR} = 8^2 \times \frac{1}{2} \times 17.5$				560	1.7		952
$P_W = 31^2 \times \frac{1}{2} \times 62.5$				30,000	9.33		280,000
$F_R = .45 \times 34,361$			15450				
P_R			6110		5.0	30,550	
	73,491	39,130		30,560		1,318,980	962,752
	ΣV = 34,361		ΣH = 0			ΣM = 356,228 ′#	

Position of Resultant

$$\frac{\Sigma M}{\Sigma V} = \frac{356,228}{34361} = 10.35' \qquad e = 16 - 10.35 = 5.65'$$

Base Pressure

$$\frac{34,361}{3 \times 10.35} \left\{ \begin{matrix} 2 \\ 0 \end{matrix} \right. = 2210 \ \#/\square' \text{ land. to } 0$$

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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Project HARTFORD - Ht. 5 Sta. 20+32 ± to 20+72 ±
Computation 28'-0" WALL (cont.) - Landside earth to top of wall - (future fill)
Computed by E.H.V. Checked by J.H.L. Date 2-27-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case II Future earth fill behind wall to top

FORCES Acting	↓	↑	→	←	Arm	Moment ↻	Moment ↺
C_1	6300'				19.42	122 300'	
C_2	9600'				16.0	153 600'	
C_3	450'				30.5	13 730'	
$C_4 = \frac{1}{2}' \times 15' \times 10' \times \frac{2}{13.33} \times 50'$	562'				15.34	8620'	
C_5	487'				13.67	6660'	
C_6	214'				5.78	1240'	
E_L	30350'				9.33'	282,500'	
$E_{L_1} = 18.67' \times 15' \times 100'$	28,000'				9.33'	261,000'	
E_R	7400'				26.0'	193,000'	
W	17000'				26.07	444,500'	
U_1		2910'			31.25		90,800'
U_2		28600'			15.25		436,000'
U_3		7620'			20.3		155,000'
$P_{el} = 30^2' \times \frac{1}{2}' \times 35'$			15750'		10.0'	157,500'	
$P_{el_1} = 15^2' \times \frac{1}{2} \times 45'$			5060'		5.0	25,300'	
P_W				30,000'	9.33		280,000'
P_{eR}				560'	1.7		952'
P_R =			9750'				
	100363'	39,130'	30 560'	30 560'		1669,950'	962,752'
	ΣV = 61,233'		ΣH = 0'			ΣM = 707,198' #	

POSITION OF RESULTANT

$$\frac{\Sigma M}{\Sigma V} = 11.55' \quad \text{O.K.} \qquad e = 16 - 11.55 = 4.45$$

Base Pressure

$$\frac{61,233}{32}\left(1 \pm \frac{6 \times 4.45}{32}\right) = 1910 \begin{cases} 1.835 = 3510\ \#/\text{ft lan} \\ .165 = 315\ \#/\text{ft lan} \end{cases}$$

Subject HARTFORD - Ht. 5
Computation 28'-0" Wall - (cont.) - Sta. 20+32 to 20+72
Computed by E.H.V. Checked by J.H.L. Date 2-27-40

U. S. GOVERNMENT PRINTING OFFICE 3—10828

CASE III Future earth fill to top of wall
Earth sat. 13.0 above top of base
River down.

FORCES ACTING	↓	↑	→	←	ARM	MOMENT ↓	MOMENT ↑
C_1	6300				19.42	122,300	
C_2	9600				16.0	153,600	
C_3	450				30.5	13,730	
C_4	562				15.34	8620	
C_5	487				13.67	6660	
C_6	214				5.78	1240	
E_L	30350				9.33	282,500	
E_{L_1}	28000				9.33	261,000	
E_R 11.83×5×100	5920				26.07	154,000	
U_2		28600			15.25		436,000
$Pel = 31^2 \times \frac{1}{2} \times 35$			16850		9.33	157200	
$Pel_1 = 16^2 \times \frac{1}{2} \times 45$			5750		4.33	24,900	
$Per = 8^2 \times \frac{1}{2} \times 35'$				1120	1.67		1,870
$F_R = .45 \times 53,363$ max.				21480	—		
	81,883	28600	22600	22600		1,185,750	437,870
	ΣV = 53,283		ΣH = 0			ΣM = 747,880'#	

POSITION OF RESULTANT

$$\frac{\Sigma M}{\Sigma V} = \frac{747,880}{53,283} = 14.05' \text{ ok.}$$

middle $\frac{1}{3}$ = 10.67'

e = 16 − 14.05 = 1.95

BEARING PRESSURE

$$\frac{53,283}{32}\left(1 \pm \frac{6 \times 1.95}{32}\right) = 1665 \begin{cases} 1.365 = 2280\#/\square' \text{ landside} \\ .635 = 1060\#/\square' \text{ riverside} \end{cases}$$

WAR DEPARTMENT

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

Project: Hartford - Conn (HT-5)

Computation: 28'-0" wall Counterfort wall Sta 20+32 - 22+72

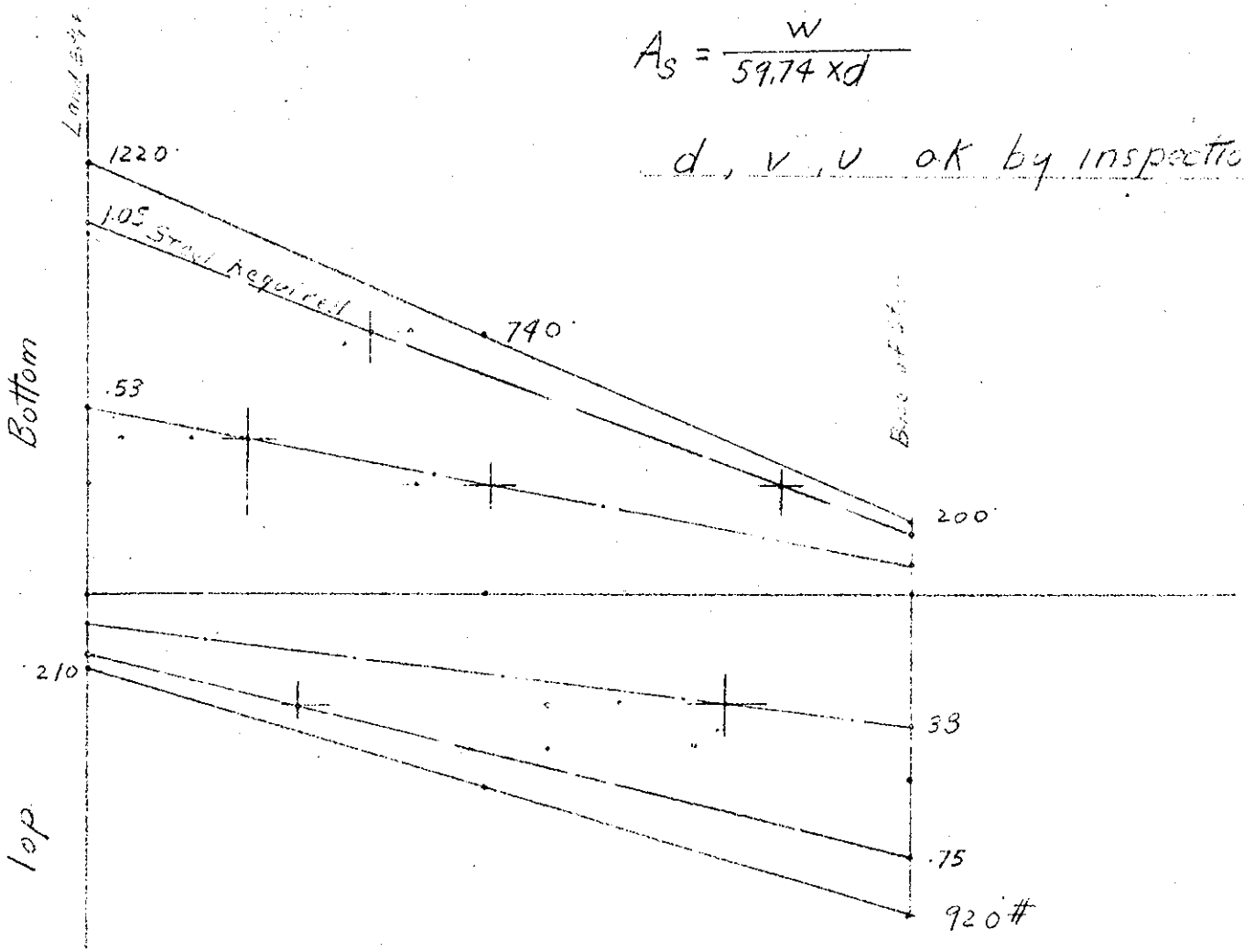
Computed by: K.H.M. Checked by: Date: 3/11/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Longitudinal Base Steel

$$A_s = \frac{W}{59.74 \times d}$$

d, v, u ok by inspection



Bottom Steel

Long bars - 4 - 7/8"φ's 6 - 3/4"φ's, 5/8"φ's rest of way

Short bars - 6 3/4"φ's 10 - 5/8"φ's

Top Steel

Long bars - 15 - 5/8"φ's 4 - 3/4"φ's

Short bars 10 - 5/8"φ's 4 - 3/4"φ's (come in from land side end of base 4'-9" then start place these bars)

WAR DEPARTMENT

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

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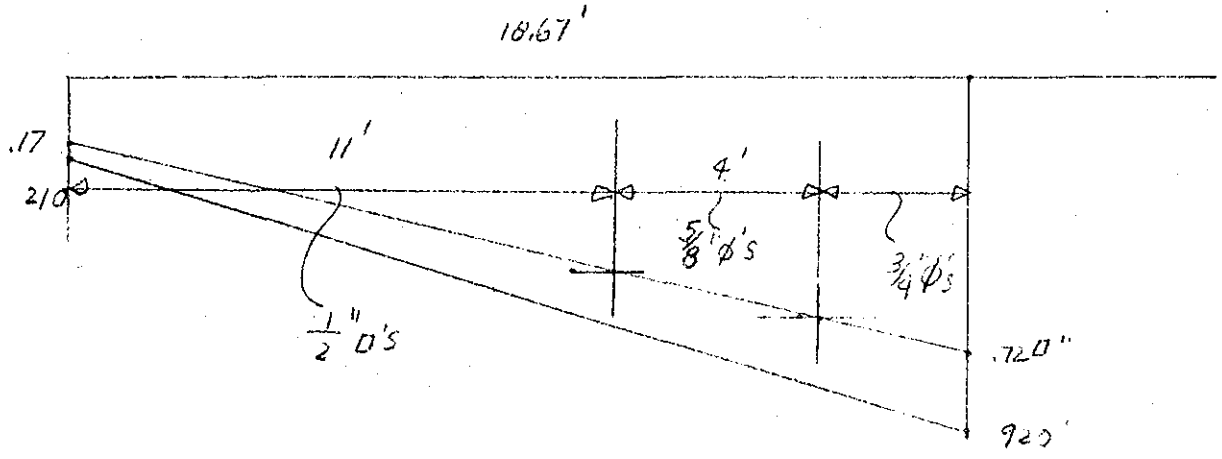
Project: Hartford Conn (HT-5)

Computation: 28'-0" Wall Counterfort wall Sta 20+32 - 20+72

Computed by: R.H.M. Checked by: Date: 3/11/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Base Bonding Steel



$$A_s = \frac{W}{1270}$$

Subject: Hartford Conn (Ht-5)
Computation: 28' wall counterfort wall Sta. 20+32 - 20+72
Computed by: R.H.M. Checked by: Date: 3/11/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stem Steel (longitudinal)

Steel in Riverside Face same as in wall @ Sta. 17+00±

Landside Face. see wall @ Sta 19+80±

Counterfort Steel see wall @ Sta 19+80±

Bonding Steel in Stem see wall @ Sta 19+80±

WAR DEPARTMENT

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

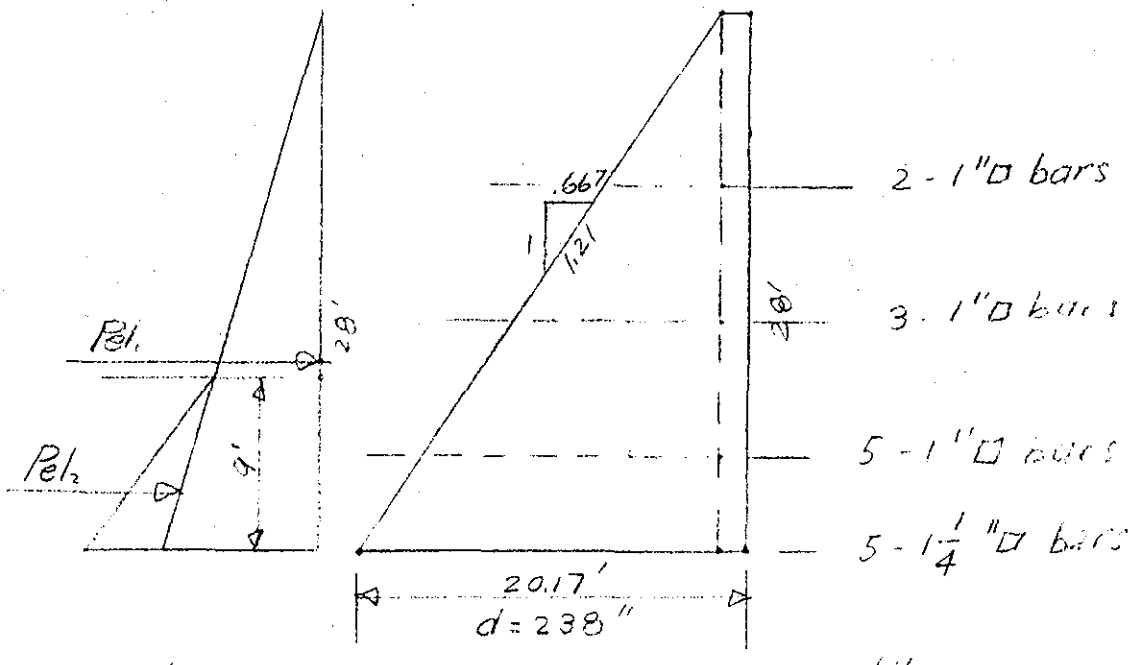
Project: Hartford - HT-5

Computation: 28'-0" Wall 32' Base Sta 20+32 - 20+72'

Computed by: R.H.M. Checked by: Date: 3/12/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Counterfort Steel



Pel. : 28' × ½ × 35 = 13720 × 9.33 = 128000 '#

Pel. : 9' × ½ × 45 = 1820 × 3.00 = 5430 '#

15540 133,430 '# For 1'

220200 # 1,890700 '# = 14.17'

$$A_s = \frac{1.21 \times 12 \times 1,890,700}{18000 \times .884 \times 238} = \frac{27,453,000}{3,784,200} = 7.25 \square''$$

Use 5 - 1 1/4"□ bars

For counterfort steel at other elevations see wall @ Sta 19+80

WAR DEPARTMENT

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

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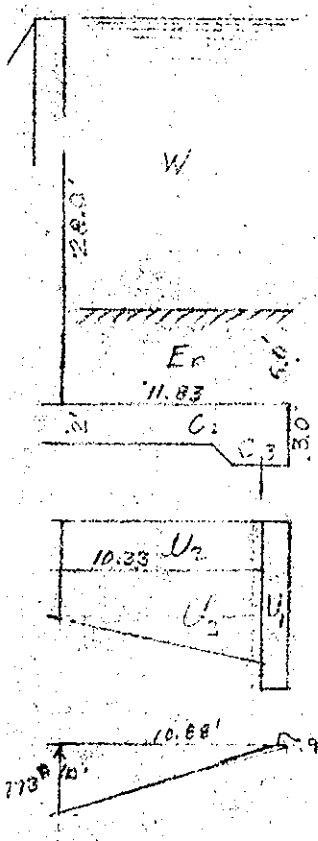
Project Hartford Cone Ht 5 Sta. 29+32 to 26+72

Computation Riverside Base 28' Wall

Computed by W H F Checked by [illegible] Date 3/11/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Case I River Up



$U_2 = 16 \times \frac{1}{2} \times 62.5 = 500$

$B = \frac{10.88}{31.05} \times 2210 = 773$

$Y = \frac{20.17}{30.5} \times 500 = 330$

$Y = 500 - 330 = 170$

Forces Acting				Arm	↷	↶
W	23×11.83×62.5	17000		5.92	100600	
Er	5×11.83×125	7400		5.92	43800	
C2	2×11.83×150	3550		5.92	21000	
C3	1×3×150	450		10.33	4650	
U1	31×1.5×62.5		2910	11.08		32200
U2	15×10.33×62.5		9680	5.17		50000
U3	10.33×330		3420	5.17		17700
U3	½×10.33×170		880	6.87		6050
B	½×10.88×773		4200	3.94		16600
		28400	21090		170050	122550
		ΣV = 7310 ↓			ΣM = 47500	↷

d = 30"

$A_s = \frac{47500}{127.5 \times 26.5} = 1.36$ □"

d Req'd = $\sqrt{\frac{47500}{127}} = 19.6$"

Actual d = 26.5 Base Increased to 2.5. See Following Sheet

WAR DEPARTMENT

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

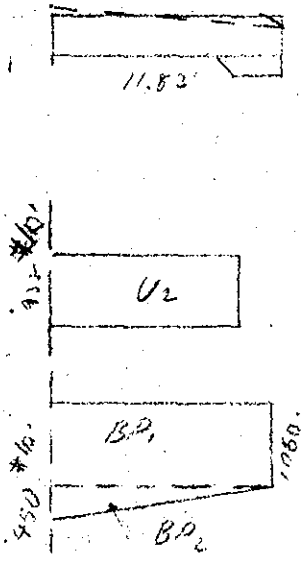
ect H+5

omputation 28' Counterfort Wall Sta. 20+32 ± to 20+72

omputed by RW Checked by Date 3-12-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Base Steel, Case III, River Down, Full Backfill



		↓	↑	Moments
E	.5 × 100 × 11.83	.5920		× 5.91 = .35,000
C1	.2 × 11.83 × 150	.3550		× 5.91 = .21,000
C2				
C3	.3 × 1 × 150	.450		× 10.4 = .4,680
U2	.938 × 10.33		.9700	× 5.17 = .50,200
BP1	.1060 × 11.83		.12550	× 5.91 = .74,200
BP2	.450 × 1/2 × 11.83		.2660	× 3.96 = .10,540
				ΣM = .74,260

d needed $= \sqrt{\frac{74,260}{123}} = 24.6''$

So Need Total Thickness of 30", $d = 25.5''$

$A_s = \frac{74,260 \times 12}{18,000 \times .874 \times 25.5} = 2.20$ □"

Use 1" □ and 1 1/8" □ Alternating, 6" Spacing A_s 2.26□"

Total Thickness .30"

WAR DEPARTMENT

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

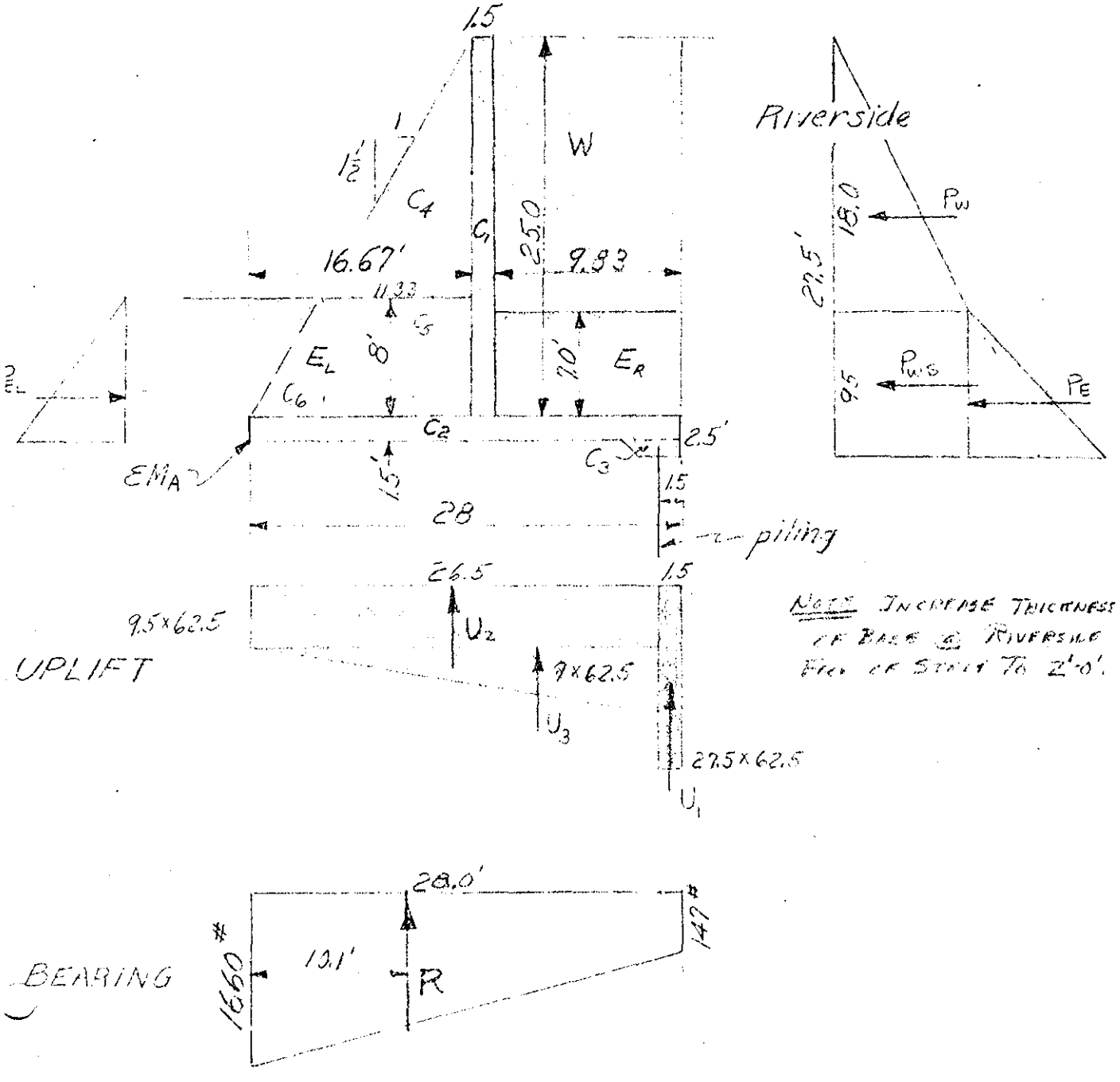
Project Hartford

Station 25'-0" flood wall

Computed by J.H.L. Checked by Date

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Case I - Water up, 8' of saturated earth on landside



Subject Hartford Ht 5

Computation 25'-0" Flood Wall Sta 20+72± to 21+12

Computed by JHL Checked by JAC Date 3-11-40

Stability - Case I

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT A ↷	↶
C_1	1.5×25×150	5630				17.42	98,000	
C_2	28×1.5×150	6300				14.0	88,200	
C_3	3×1×150	450				26.5	11,900	
C_4	2/15×17×11.33×150×½	1925				12.9	24,850	
C_5	2/15×11.33×8×25	302				11.0	3320	
C_6	2/15×½×8×5.34×25	71				3.56	350	
ER	9.83×7.0×125	8600				23.09	198,000	
EL	16.67×8×125	16,700				8.33	139,000	
W	18×9.83×62.5	11,050				23.09	255,000	
P_W	½×18×18×62.5				10,100	14.5		146,500
P_{WS}	18×62.5×9.5				10,700	3.75		40,100
P_E	½×9.5×80×9.5				3610	2.17		7,830
P_{EL}	½×9.5×80×9.5			3610		3.17	11,450	
U_1	1.5×27.5×62.5		2580			27.25		70,300
U_2	9.5×62.5×26.5		15700			13.25		208,000
U_3	½×9×62.5×26.5		7450			17.67		131,500
Fr	.45×25,298			11400		.0		
P.R.	Passive Resistance			9400		3.17	29,800	
		51,028	25,730	24,410	24,410		859,870	604,230
		ΣV = 25,298		ΣH = 0			ΣM = 255,640	

Position of Resultant $\Big\} = \dfrac{\Sigma M}{\Sigma V} = \dfrac{255,640}{25,298} = 10.1$

$\dfrac{28}{3} = 9.33$

.77' inside middle third

Bearing $e = 14 - 10.1 = 3.9$

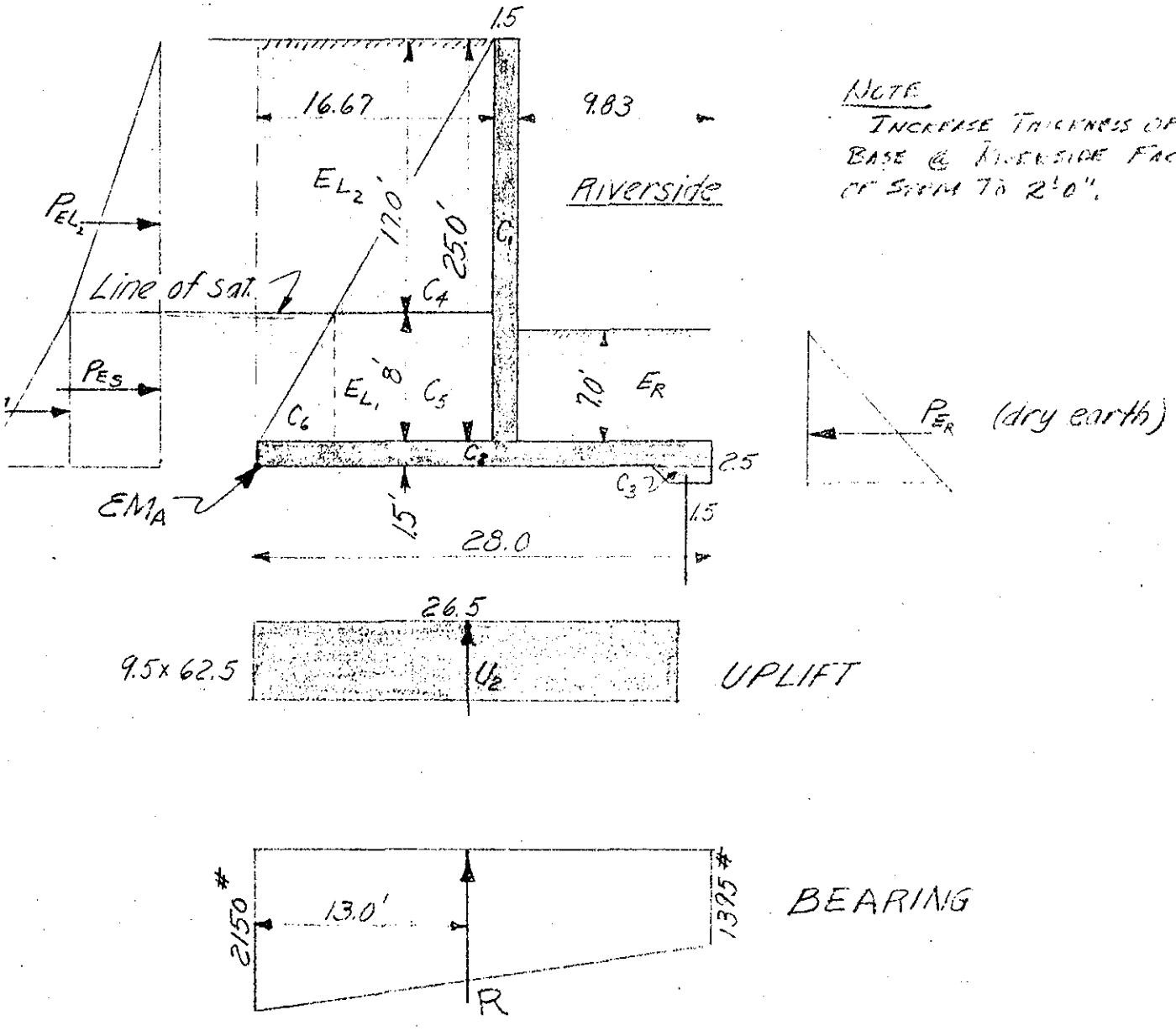
$\dfrac{25,298}{28}\left[1 \pm \dfrac{6 \times 3.9}{28}\right] = 904\left[\dfrac{1+.837}{1-.837}\right] = 1660\ \#/\square'$

$147\ \#/\square'$

Project Hartford
Computation 25'-0" flood wall Sta. 20+72± to 21+12±
Computed by J.H.L. Checked by J.A.C. Date 3-11-42

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case II - River down, future earth fill to top of wall



NOTE
INCREASE THICKNESS OF BASE @ RIVERSIDE FACE OF SLAB TO 2'-0".

Subject Ht 5 Hartford

Computation 25'-0" Flood Wall Sta 20+72 ± to 21+12 ±

Computed by J.H.L. Checked by J.A.S. Date 3-11-40

Stability Case II

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT A ↻	MOMENTS ABOUT A ↺
C_1		5,630					98,000	
C_2		6,300					88,200	
C_3		450					11,900	
C_4	$2/15 \times 17 \times 11.33 \times 50 \times \frac{1}{2}$	643				12.9	8,300	
C_5		302					3320	
C_6		71					350	
E_R	$9.83 \times 7 \times 100$	6880				23.09	159,000	
E_{L_1}		16,700					139,000	
E_{L_2}	$-16.67 \times 17 \times 100$	28400				8.33	236,000	
P_{EL_2}	$17.0 \times 35 \times 17 \times \frac{1}{2}$			5060		15.17	76800	
P_{ES}	$17 \times 35 \times 9.5$			5660		4.75	26,900	
P_{EL_1}	$9.5 \times 80 \times 9.5 \times \frac{1}{2}$			3610		3.17	11,450	
P_{ER}	$9.5 \times 35 \times 9.5 \times \frac{1}{2}$				1580	2.17		3,400
V_2	$9.5 \times 62.5 \times 26.5$		15700			13.25		208,000
Fr.	Friction				12750			
		65,376	15,700	14,330	14,330			
		$\Sigma V = 49,676$		$\Sigma H = 0$			$\Sigma M = 647,820$ '#	

Position of Resultant $= \frac{\Sigma M}{\Sigma V} = \frac{647,820}{49,676} = 13.0$ (within middle third)

$e = 14 - 13 = 1$

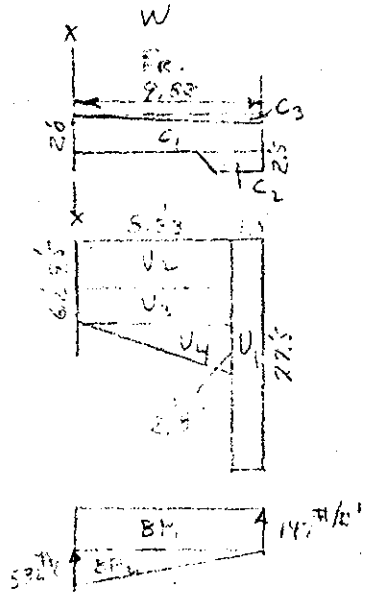
Bearing $\frac{49,676}{28}\left[1 \pm \frac{6}{28}\right] = 1775\left[\begin{matrix}1 + .214 \\ 1 - .214\end{matrix}\right] = \begin{matrix}2150 \text{ \#/□'} \\ 1395 \text{ \#/□'}\end{matrix}$

Resultant

Subject: HTS HARTFORD
Computation: WALL STEM 25' BASE 28' STA. 20+72± TO 21+12±
Computed by: PLA Checked by: Date: 3/12/40

U. S. GOVERNMENT PRINTING OFFICE 3—10538

STEEL REINF. CASE I RIVER UP RIVERSIDE BASE TOP STEEL



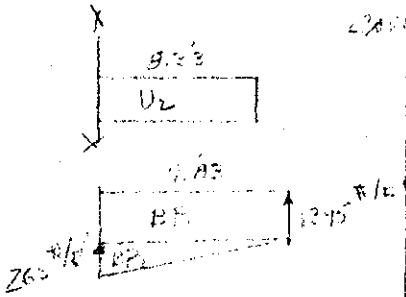
MOMENTS ABOUT X X

FORCES ACTING		↓ ↑	ARM	MOMENTS	
W	9.83 X 18 X 62.5	11100 ↓	4.92	54500	
FR	6.5 X 9.83 X 125	8000 ↓	4.92	39,400	
C1	2.0 X 9.83 X 150	2950 ↓	4.92	14500	
C2	3 X 1 X 150	450 ↓	8.33	3750	
U1	1.5 X 27.5 X 62.5	2580 ↑	9.08		23400
U2	9.5 X 8.33 X 62.5	4950 ↑	4.17		20600
U3	6.2 X 8.33 X 62.5	3230 ↑	4.17		13500
U4	½ X 2.8 X 8.33 X 62.5	730 ↑	5.55		4050
BP1	147 X 9.83	1450 ↑	4.92		7130
BP2	½ X 532 X 9.83	2600 ↑	3.28		[illegible]
C3		120 ↑			790
		ΣV = 6820 ↓			ΣM = 34080

$$d(\text{REQ'D}) = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{34100 \times 12}{123 \times 12}} = 16.7'' \quad d = 20.5''$$

$$A_{s_{X-X}} = \frac{M}{f_s j d} = \frac{34100 \times 12}{18000 \times .884 \times 20.5} = 1.26 \square'' \quad \text{USE } 1\tfrac{1}{8}''\square \text{ @ } 12'' \text{ C.C.}$$

CASE II RIVER DOWN RIVERSIDE BASE BOTTOM STEEL



MOMENTS ABOUT X X

FORCES ACTING		↓ ↑	ARM	MOMENTS	
FR	6.5 X 9.83 X 100	6400 ↓	4.92	31500	
C1	2.0 X 9.83 X 150	2950 ↓	4.92	14500	
C2		450 ↓		[illegible]	
U2		2580 ↑			23400
BP1	1345 X 9.83	13200 ↑	4.97		67500
BP2	½ X 2.8 X 9.83	1300 ↑	3.28		4050
C3	½ X ½ X 9.83 X 50	120 ↑	6.55		790
		ΣV = 9[illegible] ↑			ΣM = 45910

$$d(\text{REQ'D}) = \sqrt{\frac{45400 \times 12}{123 \times 12}} = 19.2'' \quad d = 20.5''$$

$$A_{s_{X-X}} = \frac{45400 \times 12}{18000 \times .884 \times 20.5} = 1.68 \square''$$

USE 1"⌀ & 1"□ @ 12" CC. ALTERNATELY PLACED LEAVING 6" SPACING

Project Hartford - Conn (Ht-5)
Computation 25'-0" Flood wall Sta 20+72± to 21+12±
Computed by R.H.M. Checked by Date 3/12/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

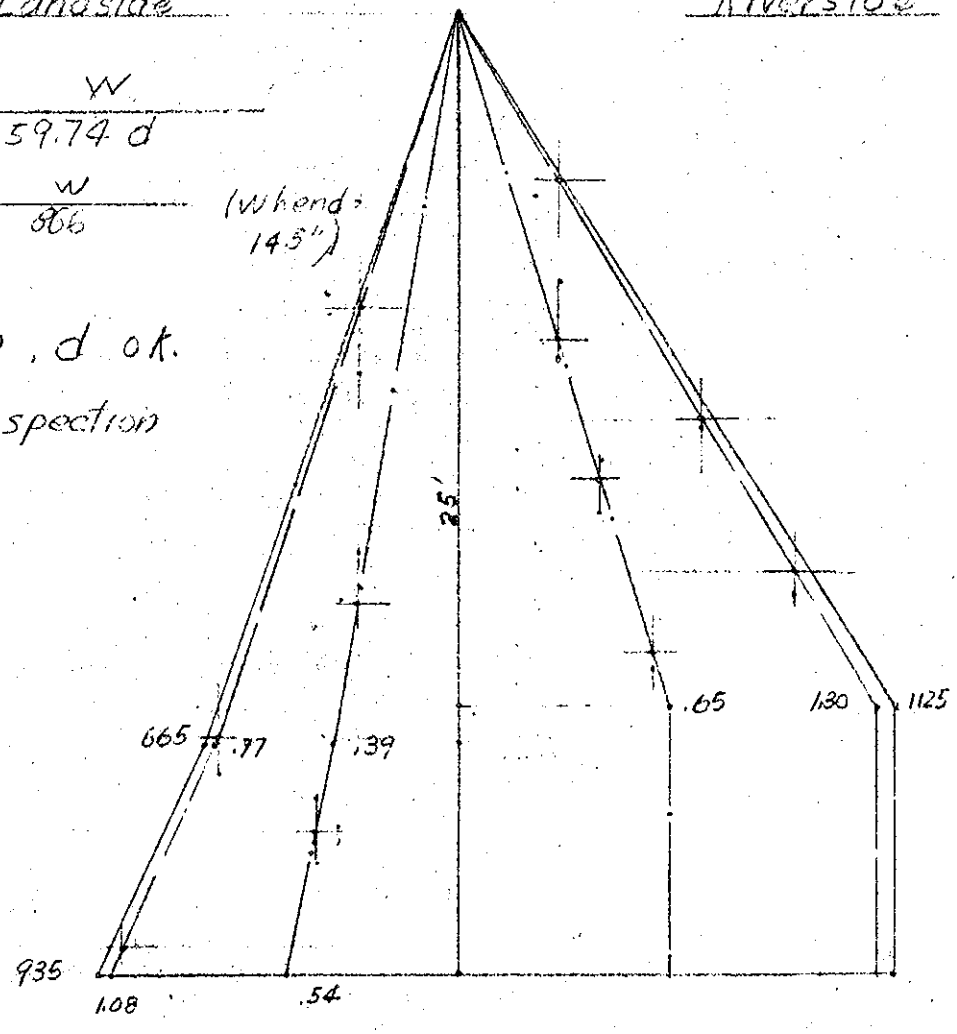
Longitudinal Stem Steel

Landside Riverside

$A_s = \frac{W}{59.74\,d}$

$= \frac{W}{866}$ (When d = 14.5")

v, u, d ok.
by inspection



Landside Face (Reading down)

Long bars 16 - 5/8"φ's 6 - 3/4"φ's, 3 - 7/8"φ's

Short bars Come down 7'-9" then 12 - 5/8"φ, 5 - 3/4"φ's
1 - 7/8"φ's

Riverside Face

Long bars - 9 - 5/8"φ's, 3 - 3/4"φ's, 5 - 7/8"φ's, 8 - 1"φ's

Short bars come down 4'-9" then 6 - 5/8"φ's 4 - 3/4"φ's
11 - 7/8"φ's

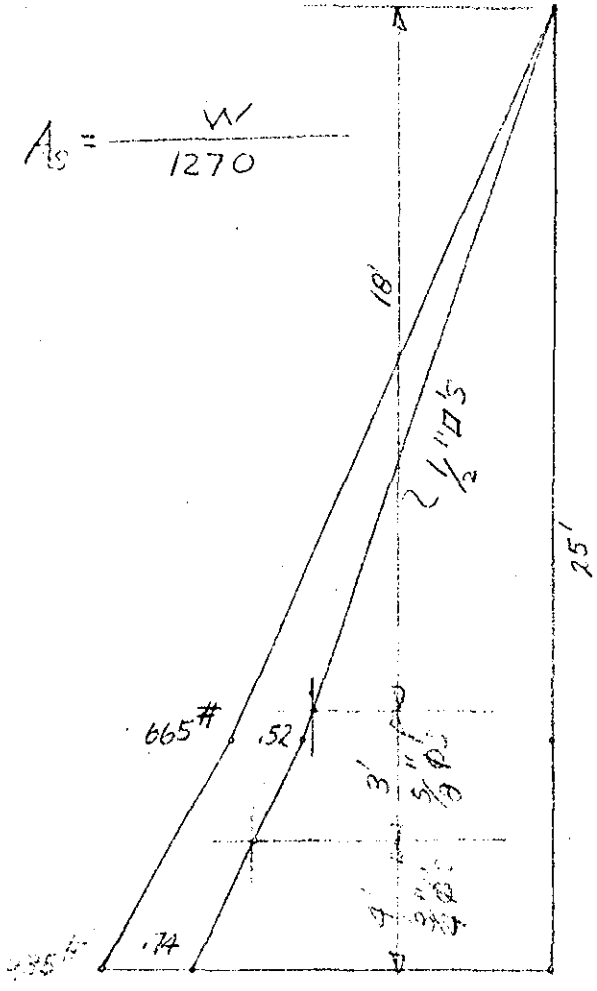
Subject: Hartford-Conn (Ht-5)
Computation: 25'-0" Hood wall — Sta 20+72± to 21+12±
Computed by: R.H.M. Checked by: Date: 3/12/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Bonding Steel in Stem

Loading Diagram

$$A_s = \frac{W}{1270}$$



Subject: Hartford - Conn (Ht-5)
Computation: 25'-0" Flood Wall — Sta 20+72± to 21+12±
Computed by: R.H.M. Checked by: Date: 3/13/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

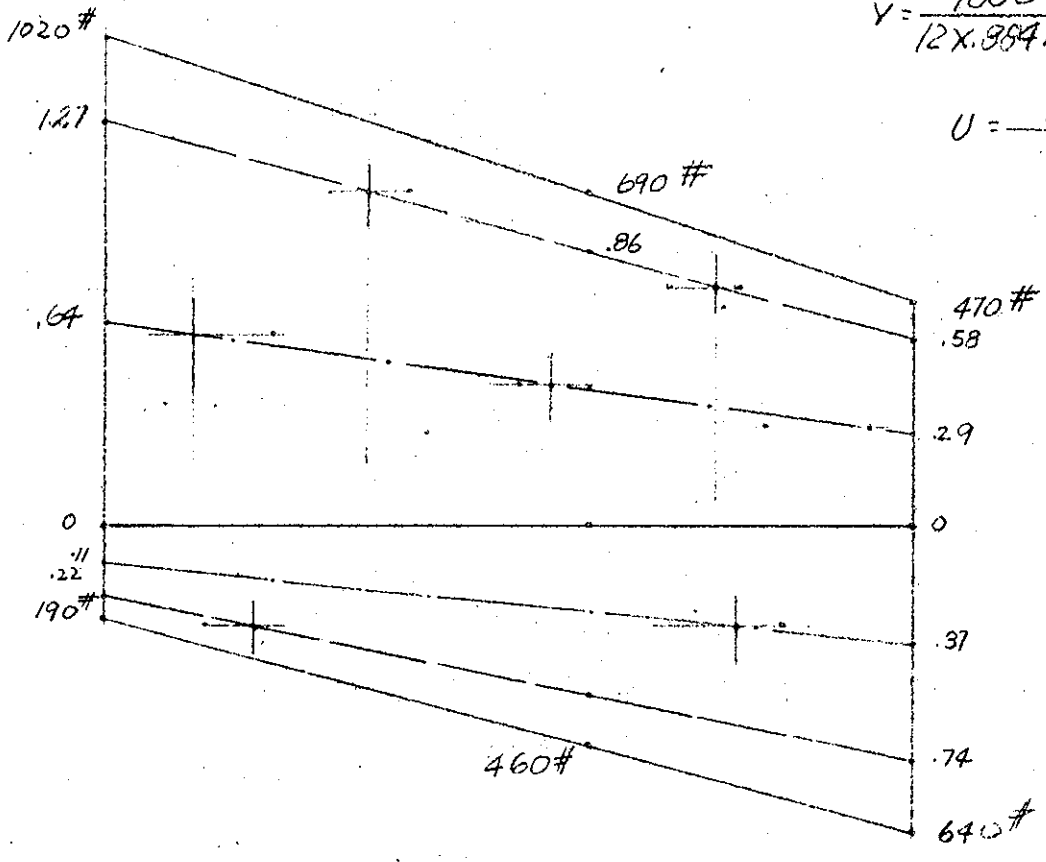
Longitudinal Base Steel

$$A_s = \frac{W}{59.74\,d}$$

$$d = \sqrt{\frac{22620}{123}} = 13.5'' \text{ OK}$$

$$V = \frac{7660}{12 \times .884 \times 13.5} = 54\ \#/\square''$$

$$U = \frac{7660}{.884 \times 135} =$$



Bottom Steel

Long bars - 2 - 1"φ's - 8 - 7/8"φ's - 7 - 3/4"φ's

Short bars - 6 - 7/8"φ's 6 3/4"φ's 4 5/8"φ's

Top Steel

Long bars 13 - 5/8"φ's 4 - 3/4"φ's

Short bars Come in 2'-9" then 5/8"φ's rest of way.

Bonding Steel in base

$$A_{s\,(Max)} = \frac{640}{1270} = .50\ \square''$$ Use 1/2"□ bars throughout

WAR DEPARTMENT

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

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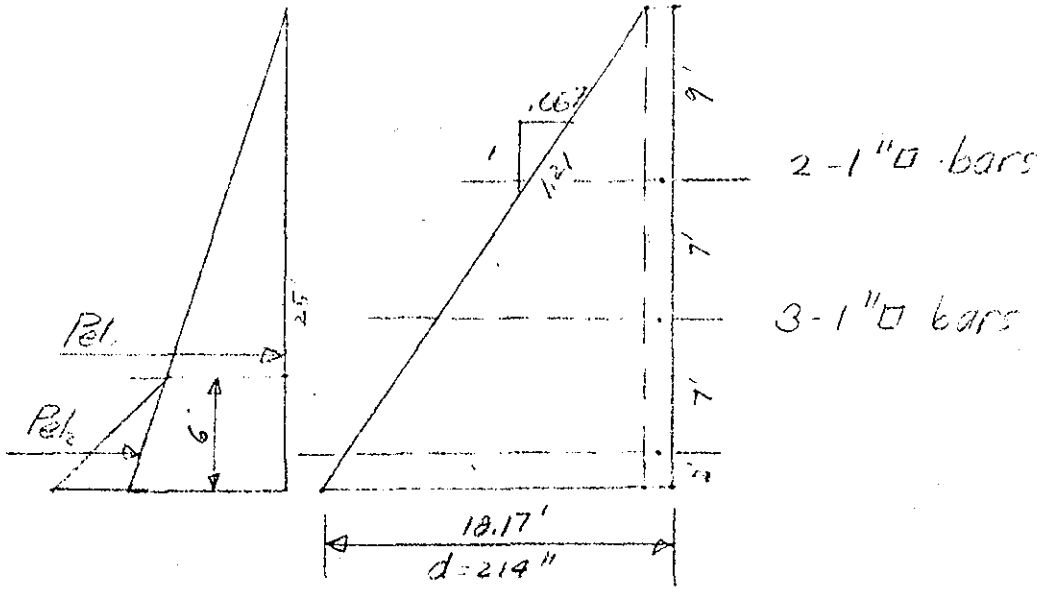
Subject Hartford - Conn (H4.5)

Computation 25'-0" Flood Wall STA 20+72± to 21+12±

Computed by R.H.M. Checked by Date 3/13/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528



Pel_1 : $25^2 \times \frac{1}{2} \times 35 = 10940 \times 8.33 = 91130$ '#

Pel_2 : $6^2 \times \frac{1}{2} \times 45 = 810 \times 2.00 = 1640$ '#

11,750 # 92770 '#, For 1' of wall

166500 # 1,314,600 '# " 14.17 " "

$$A_s = \frac{1.21 \times 12 \times 1,314,600}{18000 \times .884 \times 2.14} = \frac{19,088,000}{3,402,600} = 5.61 \square''$$

Use 4 - $1\frac{1}{4}$"□ bars

WAR DEPARTMENT

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

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Subject Hartford

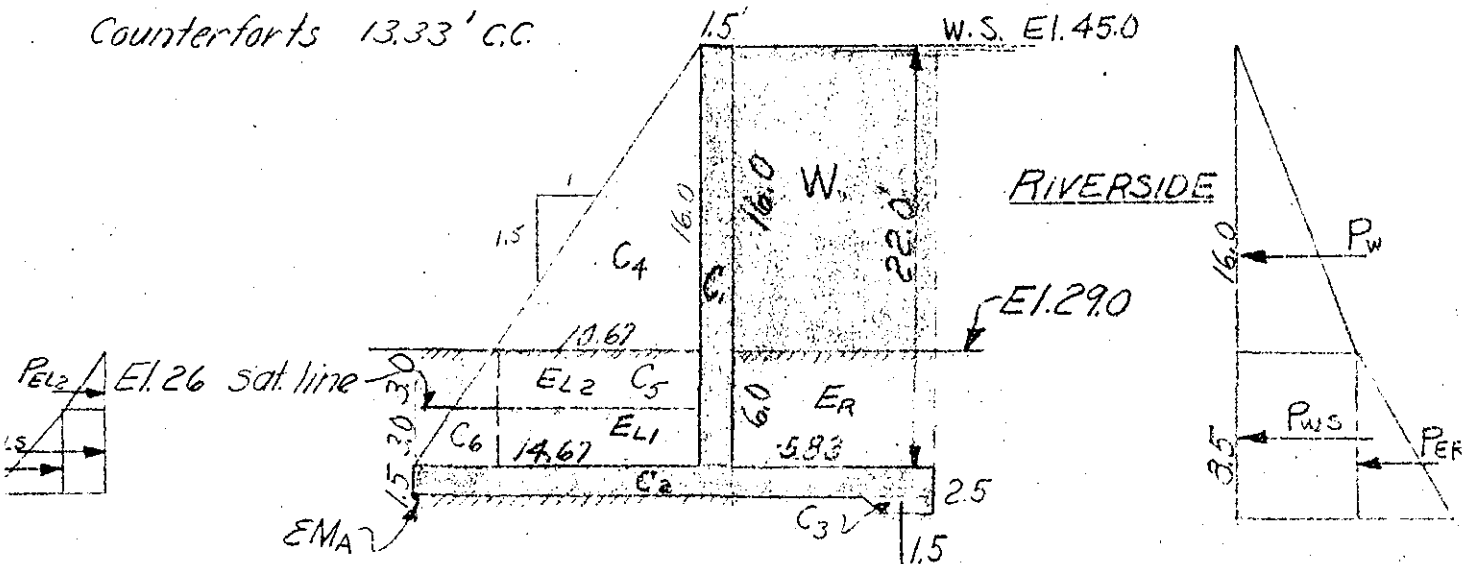
Computation 22'-0" wall section STA 21+12± TO 21+52±

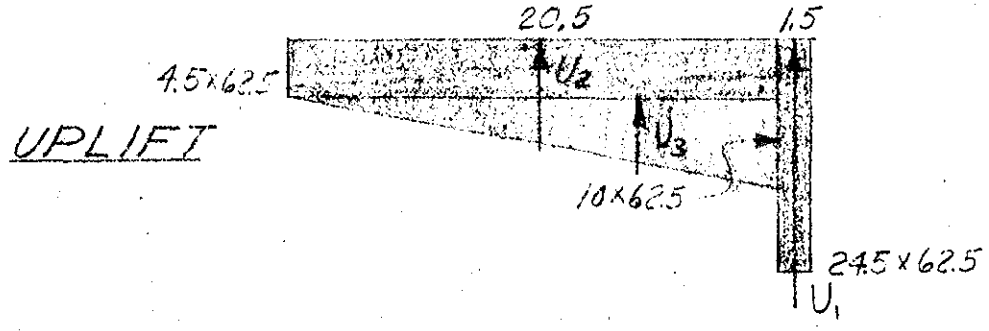
Computed by J.H.L. Checked by [illegible] Date 3/4/41

U. S. GOVERNMENT PRINTING OFFICE 3—10528

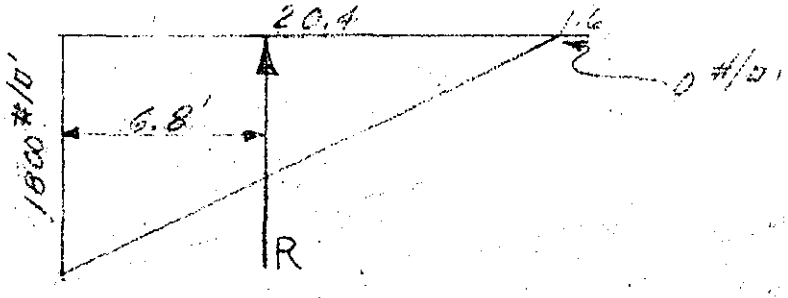
Case I - Water up

Counterforts 13.33' c.c.





UPLIFT



BEARING

WAR DEPARTMENT

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

Subject: Hartford

Computation: 22'-0" wall section — Sta. 21+12± to 21+52±

Computed by: J.H.L. Checked by: F.L.A. Date: 3/4/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case I - Stability Water Up

	Forces acting	↓	↑	→	←	Arm	Moments about "A" ↻	↺
C_1	22×1.5×150	4950				15.42	76,300	
C_2	22.0×1.5×150	4950				11.0	54,500	
C_3	3×1×150	450				20.5	9,220	
C_4	$\frac{2}{13.33}\times\frac{1}{2}\times10.67\times16\times150$	1920				11.11	21,300	
C_5	$\frac{2}{13.33}\times6\times10.67\times37.5$	360				9.33	3,360	
C_6	$\frac{2}{13.33}\times\frac{1}{2}\times4\times6\times33.3$	60				2.67	160	
E_{L1}	14.67×3×125	5510				7.33	40,400	
E_{L2}	14.67×3×100	4400				7.33	32,300	
E_R	5.83×6.0×125	4380				19.1	83,600	
W	16×5.93×62.5	5880				19.1	111,500	
U_1	24.5×62.5×1.5		2290			23.25		53,300
U_2	4.5×62.5×20.5		5760			10.25		59,000
U_3	$\frac{1}{2}$×10×62.5×20.5		6400			13.7		87,600
P_W	$16\times62.5\times\frac{1}{2}\times16$				8000	12.83		102,500
P_{WS}	16×62.5×8.5				8500	3.25		27,600
P_{ER}	$\frac{1}{2}\times8.5\times80\times8.5$				2890	1.83		5,290
P_{EL2}	$\frac{1}{2}\times3\times35\times3$			160		5.5	870	
P_{ELS}	3×35×4.5			470		2.25	1,080	
P_{EL1}	$\frac{1}{2}\times4.5\times80\times4.5$			810		1.5	1,210	
F_r	.45×18,360			8,250				
P_r	Passive resist			9,700		2.5	24,300	
		38,810	14,450	19,390	19,390		460,100	335,290
		ΣV = 18,360		ΣH = 0			ΣM =	124,810

Position of Result $= \frac{124,810}{18,360} = 6.8'$

$\frac{22.0}{3} = 7.33'$

is .53' outside middle third

$b' = 3\times6.8 = 20.4$

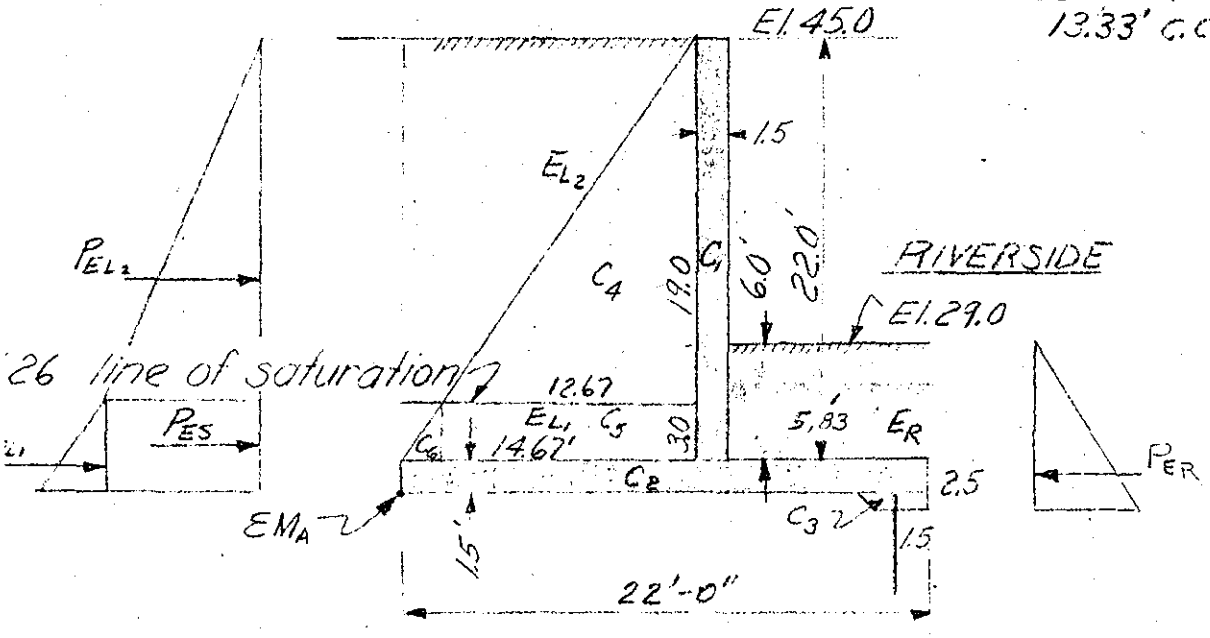
$e = 11.00 - 6.8 = 4.2$

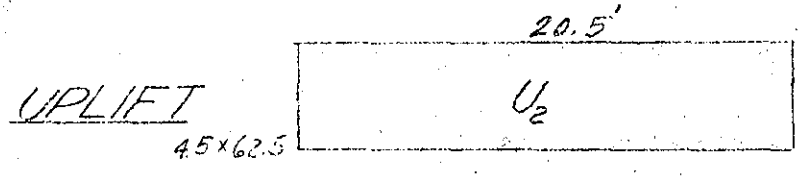
Bearing $\frac{18,360}{20.4}\left[1 \pm 1\right] = 1800$ #/□' , 0 #/□'

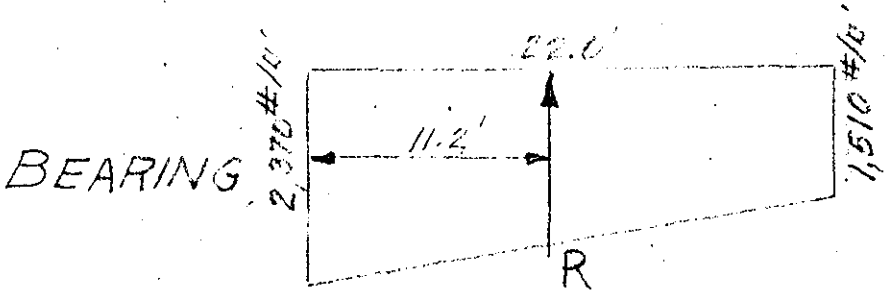
Project Hartford
Computation 22'-0" wall section STA. 21412 ± To 21452 ±
Computed by J.H.L. Checked by H.L.A. Date 3/4/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case II - Water down, future earth fill to top of wall. Counterforts are 13.33' c.c.







WAR DEPARTMENT

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

Project Hartford

Computation 22'-0" wall section Sta 21+12± to 21+52±

Computed by J.H.L. Checked by PLA Date 2/4/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case II - Stability River Down

Forces acting		↓	↑	→	←	Arm	Moments about "A" ↻	↺
C_1	22×1.5×150	4,950				15.42	76,300	
C_2	22.0×1.5×150	4,950				11.0	54,500	
C_3	3×1×150	450				20.5	9,220	
C_4	$\frac{1}{2}\times\frac{2}{13.33}\times 19\times 12.67\times 50$	900				10.45	9,450	
C_5	$\frac{2}{13.33}\times 3\times 12.67\times 25$	143				8.33	1,190	
C_6	$\frac{1}{2}\times\frac{2}{13.33}\times 2\times 3\times 25$	11				1.33	15	
E_{L1}	14.67×3×125	5,510				7.33	40,400	
E_{L2}	14.67×19×100	27,900				7.33	204,500	
E_R	6×5.83×100	3,500				19.1	66,900	
P_{EL2}	$19\times 35\times\frac{1}{2}\times 19$			6,330		10.83	68,500	
P_{ES}	19×35×4.5			2990		2.25	6,740	
P_{EL1}	$4.5\times 80\times\frac{1}{2}\times 4.5$			810		1.5	1,210	
P_{ER}	$8.5\times 35\times\frac{1}{2}\times 8.5$				1,260	1.83	?	2,300
U_2	4.5×62.5×20.5		5,760			10.25		59,100
F_r	friction resist.				8,870			
		48,314	5,760	10,130	10,130		538,925	61,400
		ΣV = 42,554		ΣH = 0			ΣM = 477,525	

Position of resultant $\frac{477,525}{42,554} = 11.2'$ is in middle third

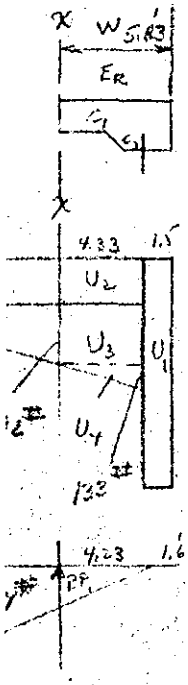
"e" = 12.0 - 11.2 = 0.8'

Bearing $\frac{42,554}{22.0}\left[1 \pm \frac{6\times 0.8}{22.0}\right] = 1,940\left[1 \pm .22\right] = \begin{matrix} 2,370 \\ 1,510 \end{matrix}$ #/□'

Project: HARTFORD HES
Computation: COUNTERFORT WALL STEM 22' BASE 22' STA. 21+12± TO 21+52±
Computed by: P.L.A. Checked by: R.W. Date: 3/12/40

U. S. GOVERNMENT PRINTING OFFICE 3—10628

STEEL REINF. RIVERSIDE BASE TOP STEEL
CASE I RIVER UP



MOMENTS ABOUT X-X

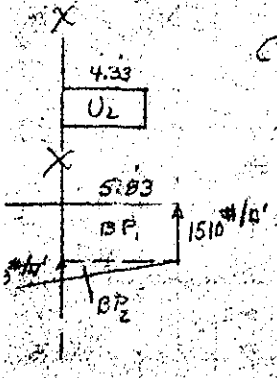
FORCES ACTING		↓ ↑	ARM	↷ MOMENTS ↶	
W	62.5 X 5.83 X 16	5830 ↓	2.92	17100	
ER	6 X 5.83 X 125	4370 ↓	2.92	12800	
C_1	1.5 X 5.83 X 150	1310 ↓	2.92	3820	
C_2	3 X 1 X 150	450 ↓	4.33	1950	
U_1	1.5 X 62.5 X 24.5	2300 ↑	5.08		11700
U_2	9.5 X 4.33 X 62.5	1220 ↑	2.17		2650
U_3	492 X 4.33	2130 ↑	2.17		4620
U_4	½ X 133 X 4.33	290 ↑	2.89		840
BP	½ X 374 X 4.23	790 ↑	1.41		1120
	ΣV =	5280 ↓		ΣM = 14740 ↷	

$$d(\text{REQD}) = \sqrt{\frac{M}{Rb}} = \sqrt{\frac{14740 \times 12}{123 \times 12}} = 11.0'' \quad d = 14.5''$$

$$A_{s_{X-X}} = \frac{M}{f_s j d} = \frac{14740 \times 12}{18000 \times .884 \times 14.5} = 0.77 \square''$$

USE 1" ϕ @ 12" cc. Top

CASE II RIVER BOTTOM STEEL RIVERSIDE BASE



MOMENTS ABOUT X-X

FORCES ACTING		↓ ↑	ARM	↷ MOMENTS ↶	
ER	6 X 5.83 X 100	3500 ↓	2.92	10200	
C_1		1310 ↓		3820	
C_2		450 ↓		1950	
U_2		1220 ↑			2650
BP_1	1510 X 5.83	8800 ↑	2.92		25700
BP_2	½ X 228 X 5.83	665 ↑	1.94		1290
	ΣV =	5425 ↑		ΣM = 13670 ↶	

$$d\ \text{REQD} = \sqrt{\frac{13670 \times 12}{123 \times 12}} = 10.6'' \quad d = \cancel{14.5''}\ 13.5$$

$$A_{s_{X-X}} = \frac{13670 \times 12}{18000 \times .884 \times \cancel{14.5}\ 13.5} = 0.71 \square''$$

USE 1" ϕ @ 12" c.c. Bottom

WAR DEPARTMENT

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

Project: Hartford-Conn (Ht-5)

Computation: 22'-0" wall Section Sta 21+12 ± to 21+52 ±

Computed by: R.H.M. Checked by: Date: 3/13/40

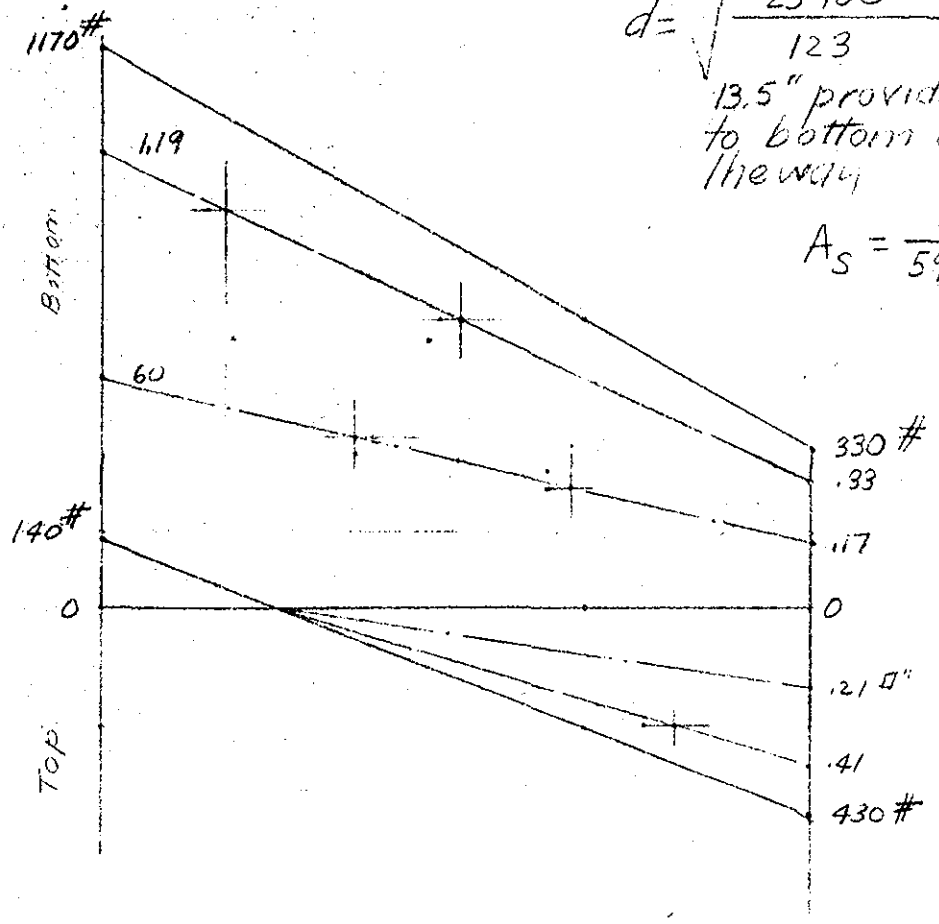
U. S. GOVERNMENT PRINTING OFFICE 3—10628

Longitudinal Base Steel

$$d = \sqrt{\frac{25950}{123}} = 14.5'' \text{ only}$$

13.5" provided add 3" to bottom of base all the way

$$A_s = \frac{M}{59.74 \times d}$$



Top Steel

Long bars only : 12 - 5/8" ϕ's , 3 - 3/4" ϕ's

Bottom Steel

Long bars 6 - 7/8" ϕ's 4 - 3/4" ϕ's - 5 - 5/8" ϕ's

Short bars 3 - 7/8" ϕ's - 4 - 3/4" ϕ's 7 - 5/8" ϕ's

Bonding steel in base :

$$A_{s(Max)} = \frac{430}{1270} = .34 \ \square'$$ Use 1/2" □ bars throughout

WAR DEPARTMENT

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

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Project: Hartford - Conn (Ht-5)

Computation: 22'-0" Wall Section Sta 21+12± to 21+52±

Computed by: R.H.M. Checked by: Date: 3/13/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

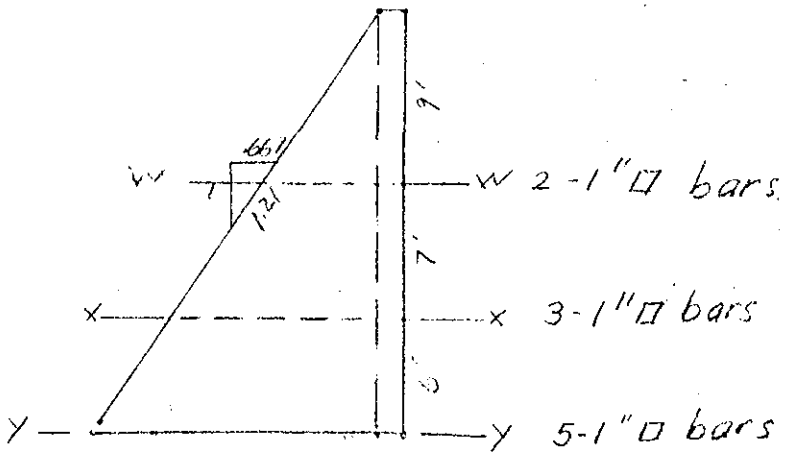
Longitudinal Stem Steel

See Section @ Sta 21+00±

Bonding Steel in Stem

See Section @ Sta 21+00±

Counterfort Steel



WAR DEPARTMENT

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

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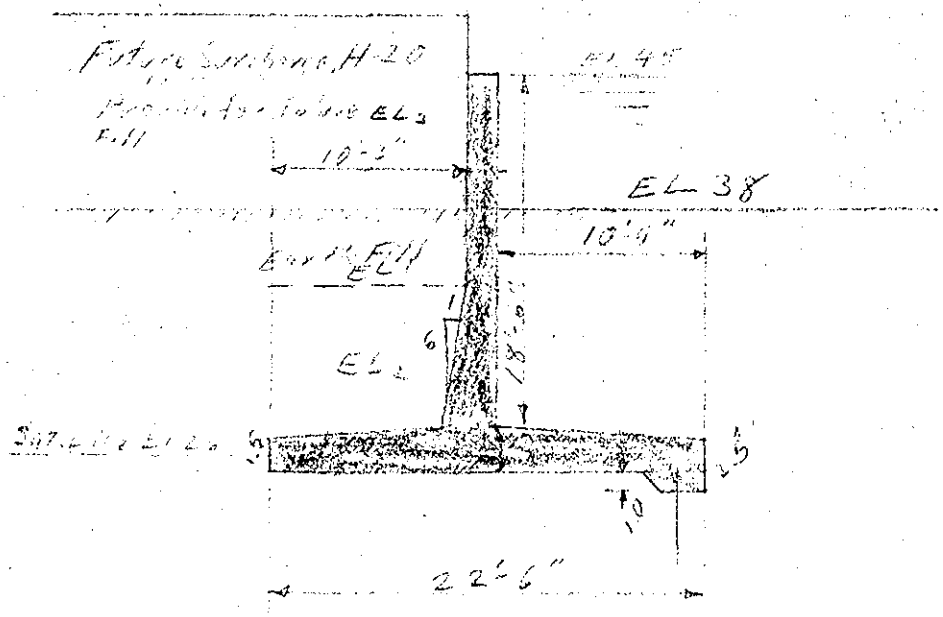
Project HR5 Hartford Sta. 21+52 to 21+76.19 ±

Computation [illegible]

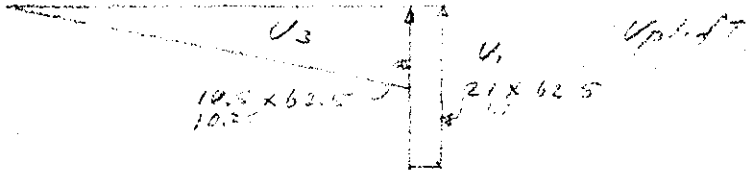
Computed by RW Checked by W.H.E. Date 3-11-40

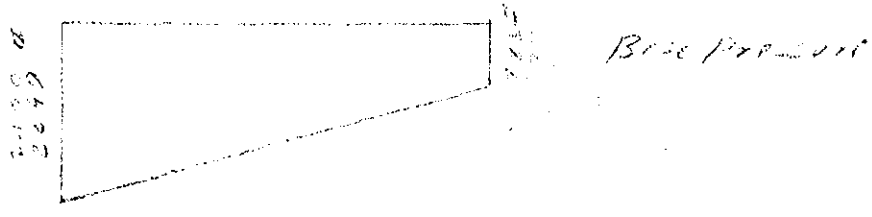
U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability



Note - Assume Tailwater El at Bottom of Base





WAR DEPARTMENT

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

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Project H-5

Computation 18'-8" Wall 21432 - 21476.9 ℄

Computed by R.W. Checked by W.H.E. Date Jan 11-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability, River Up

		↓	↑	→	←	Arm	Moments	
C_1	18 x 1.5 x 150	4050				11.0	44500	
C_2	7.5 x 1.25 x ½ x 150	700				9.80	6870	
C_3	22.5 x 2 x 150	6740				11.25	75800	
C_4	3 x 1 x 150	450				21.0	9450	
EL_1	4 x 10.25 x 100	4100				5.12	21000	
EL_2	7.5 x (10.25-9) x 100	7220				4.81	34700	
ER	11.5 x 10.75 x 125	15450				17.12	264,500	
W	7 x 62.5 x 18.75	4700				17.12	80,470	
PER	14.5² x ½ x 17.5				1840	3.83		7050
PEW	21.5² x ½ x 62.5				14400	6.17		88,900
PEL	14.5² x ½ x 35			3680		9.83	14,100	
U_1	21.5 x 1.5 x 62.5		2020			21.75		43,930
U_2	10.25 x 21 x ½ x 62.5		6730			14		97220
FR	0.45 x 34,490			15500				
		43410	8750		16240		551,390	234,100
		Σ V = 34,660		ΣH = 0			ΣM = 317,290	

Position of Resultant

$\frac{324,770}{34,490} = 9.15'$

$\frac{1}{3}$ base = 7.5'

e = 11.25 - 9.15 = 2.10'

Base Pressure

$\frac{34,660}{22.5}\left(1 \pm \frac{6 \times 2.10}{22.5}\right) = 1535 \begin{cases} 1.56 \\ 0.44 \end{cases} = \begin{matrix} 2300 \text{ #/□'} & \text{Land} \\ 677 \text{ #/□'} & \text{River} \end{matrix}$

WAR DEPARTMENT

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

Subject Sta. 21+52± to 21+76.19

Computation 18'-6" Cantilever Wall

Computed by RW Checked by W.H.F. Date 3-12-40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Case II River Down, Full Backfill, Surcharge

Forces		↓	↑	→	←	Arm	Moments ↻	↺
C_1		4050					44500	
C_2		700					6870	
C_3		6740					75850	
C_4		450					9450	
EL_1		9100					21[illegible]	
EL_2		7[illegible]				[illegible]	34700	
EL3	7×10.25×100	7180				5.12	[illegible]	
ES	3×100×10.25	3080				5.12	[illegible]	
ER	11.5×10.75×100	[illegible]				17.12	[illegible]	
PER	[illegible] × ½ × 35				[illegible]	3.[illegible]		[illegible]
PEL	21.5² × ½ × 35			8100		[illegible]	[illegible]	
PS	3×35×21.5			[illegible]		[illegible]	[illegible]	
FR	0.45×45,[illegible]				20,600			
		45870					[illegible]	
		ΣV = 45,870		ΣH =	0		ΣM = 514,830	↻

Position of Resultant

$\frac{514830}{45,870} = 11.23$

$\frac{2}{3}$ [illegible] 15'

e = [illegible] − 11.25 = 0'

Base Pressure = $\frac{45870}{[illegible]}$ = 2740 #/□' Uniform [illegible]

WAR DEPARTMENT

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

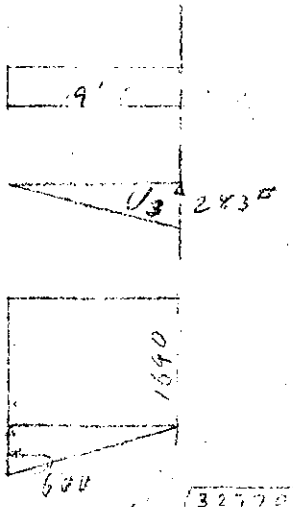
Project H45

Computation 16 - 8" Wall 21+52 - 21+76.19

Computed by R.W. Checked by W.H.F. Date 3-12-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in Base, Land S Case I River Up



		↓	↑		
E	11.5 x 9 x 100	10360		x 4.5	46 700
C	9 x 2 x 150	2700		x 4.5	12 150
U_3	275 x ½ x 9		1240	x 3	3720
BP_1	1711 9		15400	x 4.5	69 300
BP_2	689 x 9 x ½		3100	x 6	18,600
		13060	19740		
		Σ = 6680# ↑		Σ M = 32,770 ⁱ#	

$$A_s = \frac{32,770 \times 12}{18,600 \times .884 \times 19.5} = 1.27 \ \square''$$

$d = \sqrt{\frac{32770}{123}} = 16.3 + 4.0 = 20.8''$ Use $\frac{7}{8}''\phi$ alt $1''\phi$ @ 6" c.c. or $1\frac{1}{8}''\square$ @ 1.0' c.c. Bottom

Case II River Down and Scarcity

S	300 x 9	2700		x 4.5	12150
E	18.5 x 9 x 100	16670		x 4.5	75000
C	9 x 2 x 150	2700		x 4.5	12 150
B.P.	2040 x 9		13400	x 4.5	82,800
		22,070	13400		
		Σ = 3670 ↓		Σ M =	16,500 ⁱ#

$$A_s = \frac{16,500 \times 12}{18,700 \times .884 \times 20.5} = .61 \ \square''$$

Use $\frac{7}{8}''\phi$ @ 12" Top

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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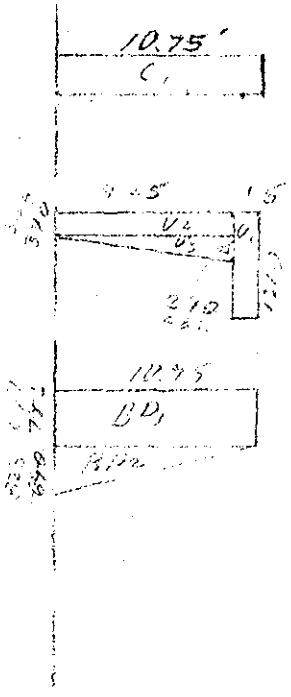
Project HH 5
Computation 18' C Wall 21450-21475 [illegible]
Computed by RW Checked by W H E Date 3-12-40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Steel, River Side Base River Up



		↓	↑		
C_1	2 x [illegible] x 150	3230		x 5.37	17350
E	11.5 x 10.75 x [illegible]	[illegible]		x 5.37	82800
W	[illegible] x 63.5	4700		x 5.37	25200
C_2	[illegible]	450		x 9.25	4170
V_1	[illegible]		1910	x 100	14700
V_2	370 x 9.25		3420	x 4.62	15800
V_3	290 x ½ x 9.25		1340	x 6.16	[illegible]
BD_1	78.2 x 10.75		8420	x 5.37	45200
BD_2	680 x ½ x 10.75		3710	x 3.55	13300
		23830 - 18460			
		ΣV = 5140		Σ [illegible]	

$d' = \sqrt{31500} = 16 + 3.5 = 17.5''$

$A_s = \frac{[illegible] \times 12}{[illegible] \times 205} = 1.16$ □'

Use ¾" ϕ and ⅞" ϕ, = tagged [illegible] @ 6' Toe Base

Steel River Side Base, River Down

C_1		3230		x 5.37	17350
E	11.5 x 10.75 x 100	12[illegible]		x 5.37	66300
C_2		450		x 9.25	4170
B.P.	2040 x 10.75		21900	x 5.37	117500
		[illegible]	[illegible]	Σ [illegible]	14,[illegible]

$A_s = \frac{[illegible] \times 12}{18,000 \times .884 \times 19.5} = .558$ □'

Use ¾" ϕ @ 6" c.c.

Bottom

WAR DEPARTMENT

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

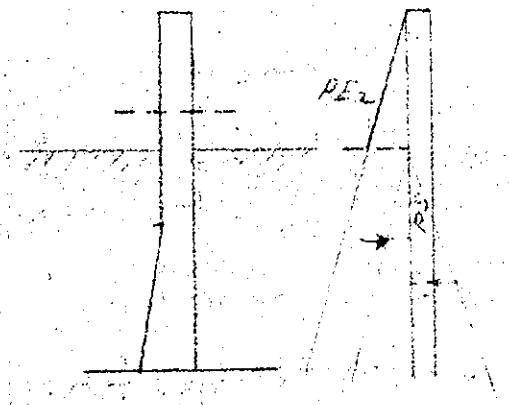
Project HT5

Computation 18' 6" Wall 21+52 to 21+76

Computed by RW Checked by W H F Date 3-18-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Land Face Stem Steel River Down



At 5' Depth

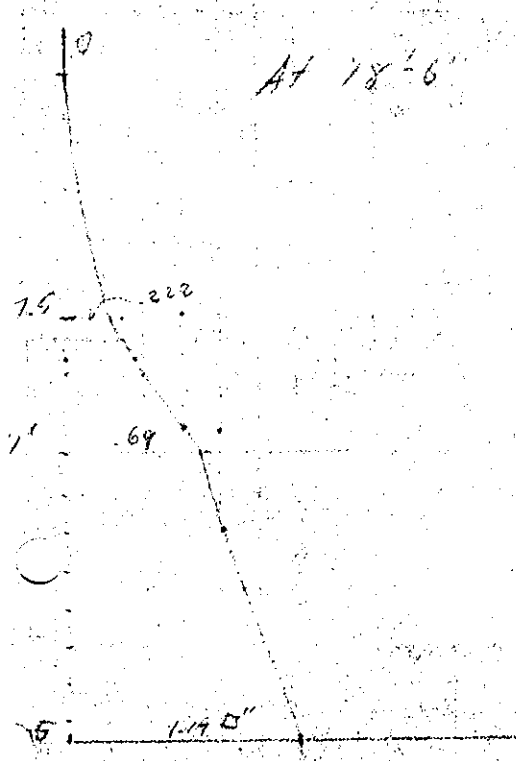
		→	←	
PS =	3×35×5	525	2.5	1310
PEL	5²×¼×35	438	1.67	730

V = 963# M = 2,040'#

Steel on Land Side

PS
PEL
PER

At 18'-6"



→ PS =	3×35×18.5 =	1940#	× 9.25	17950
→ PEL =	18.5²×½×35 =	6000	× 6.2	37,200
← PER	11.5²×½×35 =	2310	× 3.8	8780
			ΣM	46,370'#

$A_s = \frac{46370 \times 12}{18,000 \times .884 \times 29.5} = 1.19$ □"

Use 1" ϕ and ¾" ϕ alt @ 6"

At Depth 7.5'

PS =	3×35×7.5	= 787	× 3.75	2950
PEL =	7.5²×½×35	= 785	× 7.5	1440
			ΣM:	4440

$A_s = \frac{4440 \times 12}{18,000 \times .884 \times 45} = .222$ □" (5410, 29, 14.5)

Use ⅝" ϕ @ 12"

At Depth 11'

→ PS =	105×11	= 1155	× 5.5	6350
→ PEL =	11²×35×½	= 2120	× 3.67	7870
← PER	4²×35×½	280	× 1.33	370

ΣM = 13,780

$A_s = \frac{13780 \times 12}{18,000 \times .884 \times 45} = .69$ □" (14.5)

Use 1" ϕ

WAR DEPARTMENT

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

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bject HT5

mputation 18'-6" wall — sta. 21+5[illegible] to sta. 21+76

mputed by R.W. Checked by [illegible] Date [illegible]

U. S. GOVERNMENT PRINTING OFFICE 3—10528

[illegible] Run Up

A-A

[illegible] 1160 × [illegible] = [illegible]

[illegible] 1320 × [illegible] = [illegible]

ΣM = 32,[illegible]

$A_s = \frac{[illegible] \times 12}{[illegible] \times 27.5} = 1.59$ □"

Depth 15'

[illegible]	15 × ½ × 62.5	[illegible] × 5	35300
[illegible]	8 × ½ × 17.5	560 × 2.67 = [illegible]	1400
		ΣM =	33,710 ~~33,810~~

$A_s = \frac{[illegible] \times 12}{[illegible] \times 23} = .11$ □"

Depth 11'

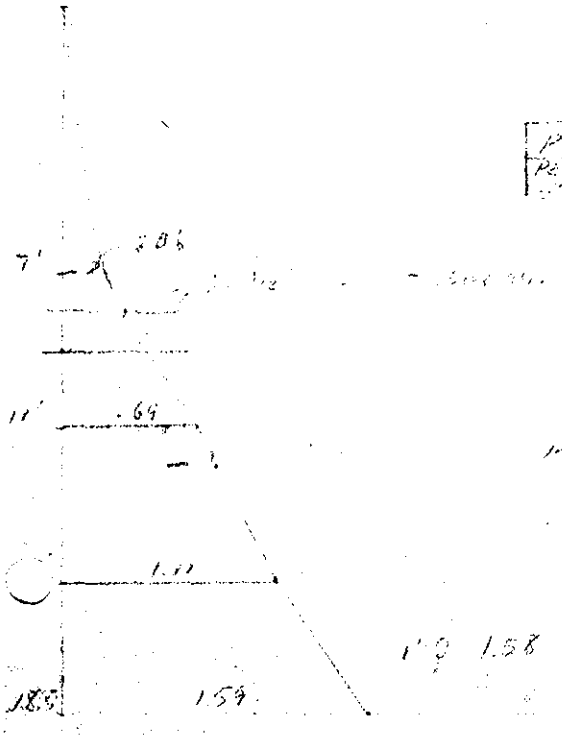
[illegible]	11 × ½ × 62.5	3770	× 3.67 = [illegible]
[illegible]	4 × ½ × [illegible]	140	× [illegible] = [illegible]
			ΣM = 2,664

$A_s = \frac{[illegible] \times 12}{[illegible] \times 14.5} = .69$ □"

Depth 7'

[illegible] = 7 × ½ × 62.5 1500 × 2.33 = 3,570

$A_s = \frac{[illegible] \times 12}{[illegible] \times 14.5} = .19$ □"



WAR DEPARTMENT

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

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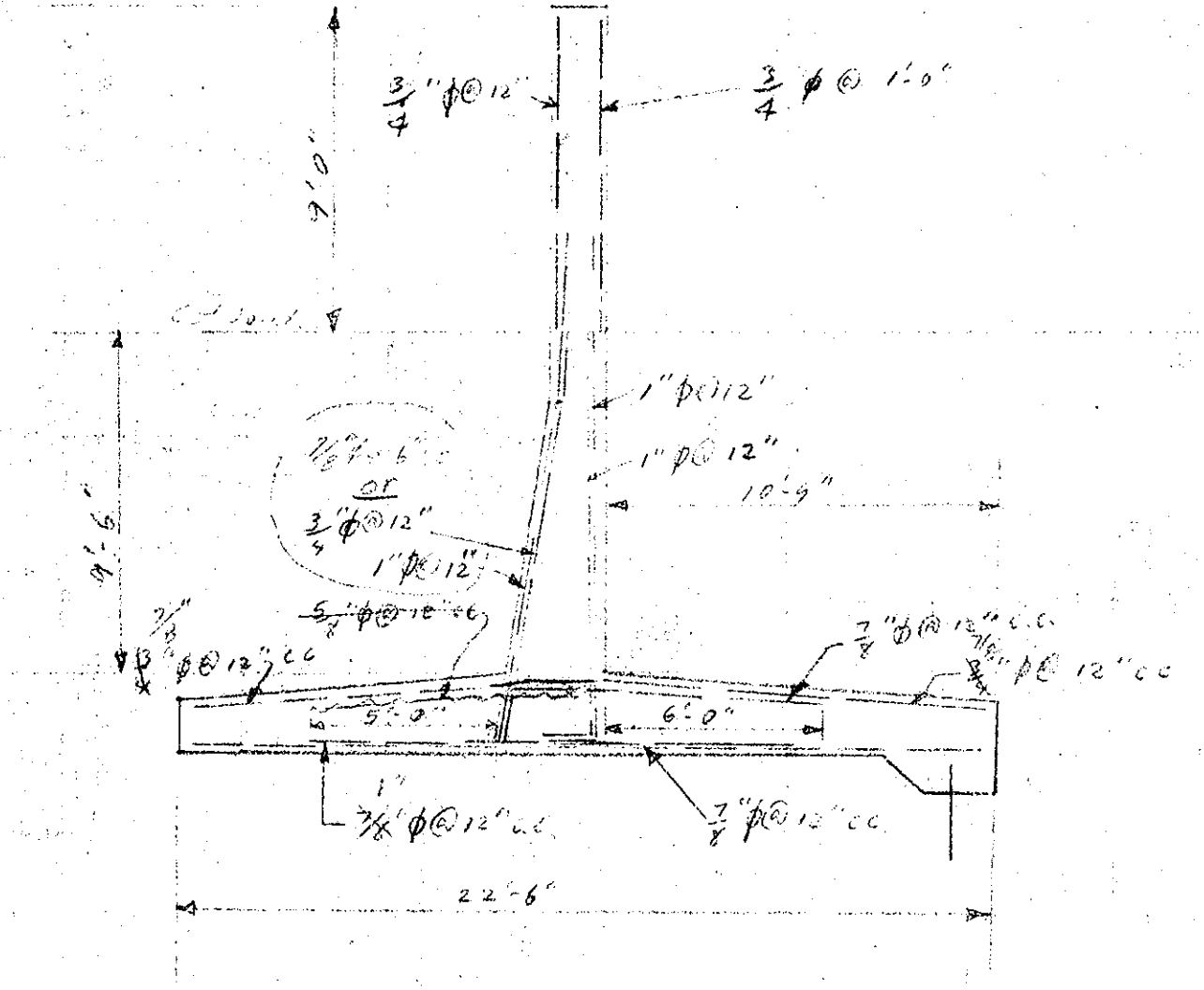
Subject HT5

Computation 18'-6" wall sta. 21+52 to sta 21+76

Computed by R.W. Checked by W. E. S. Date 3-12-40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Steel Diagram



WAR DEPARTMENT

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

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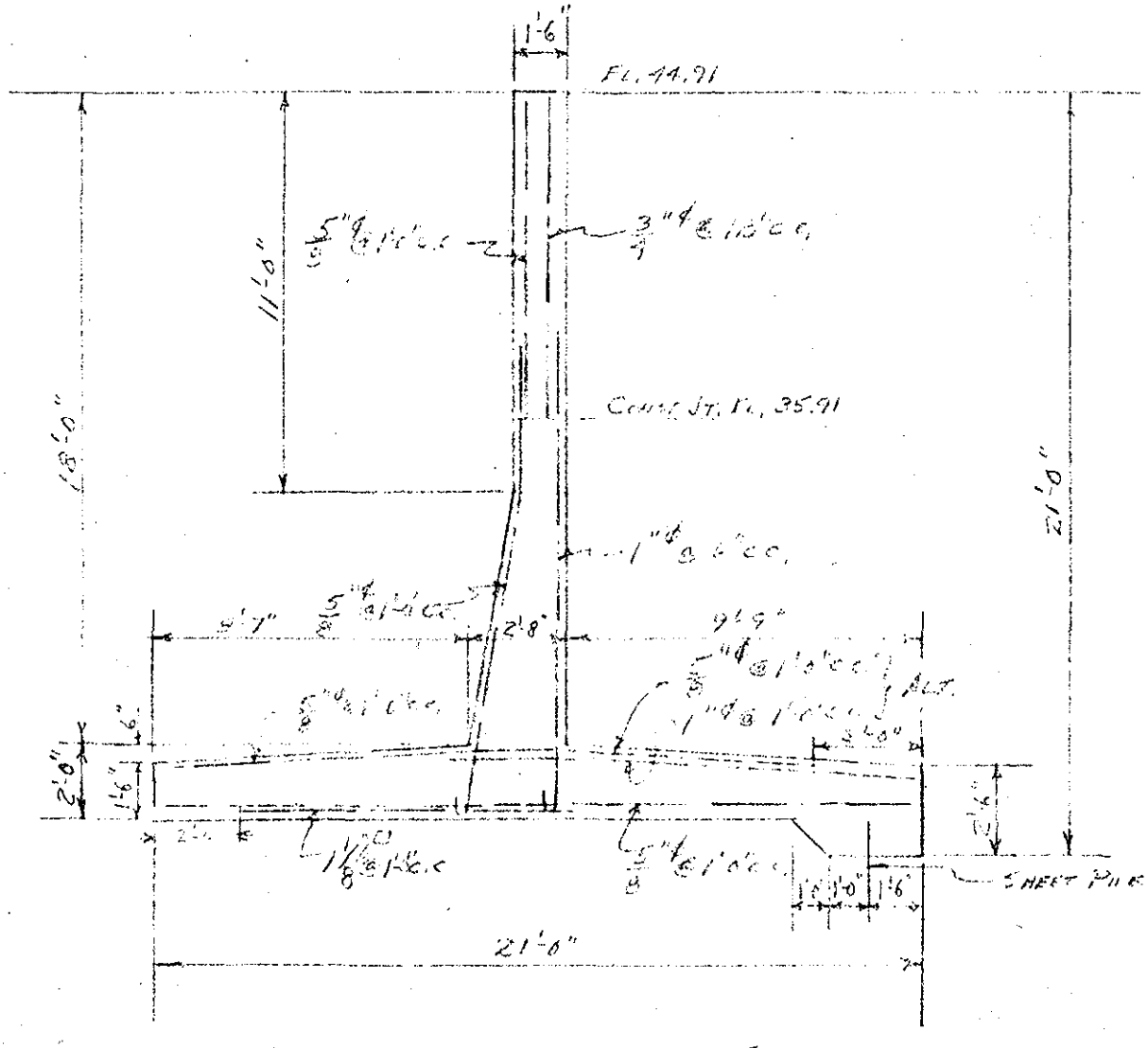
Subject Hartford HES

Computation Cantilever Wall Stem 18' Base 21' Sta 36+01.31 To 38+41.31

Computed by P.L.A. Checked by ..... Date 3/18/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Wall as Designed



All Longitudinal Temperature Steel
To Be ½"ϕ @ 1'-0" c.c.

WAR DEPARTMENT

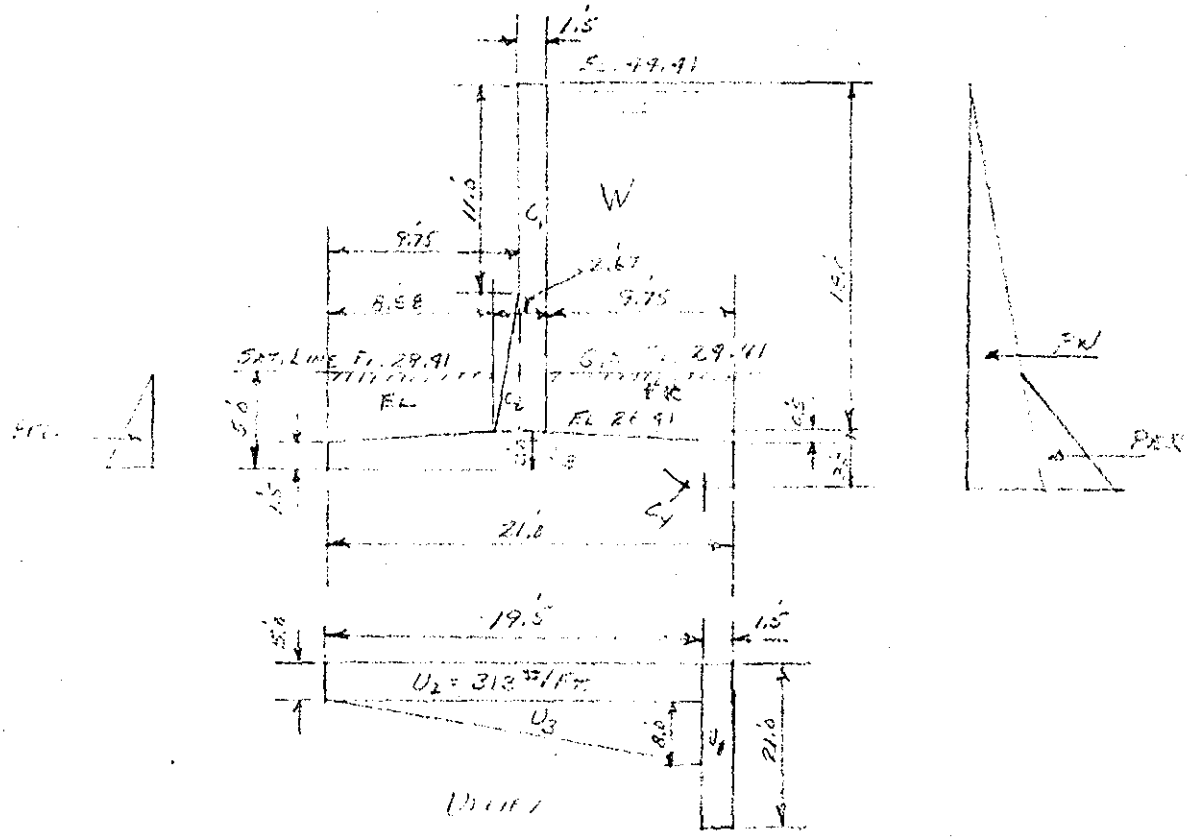
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

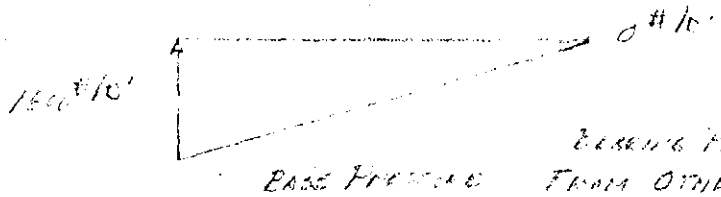
Object: HARTFORD HC 5

Computation: CANTILEVER WALL STEM 18' BASE 21' STA. 36+01.31 TO 28+41.31

Computed by: F. L. A. Checked by: R.W. Date: 2/18/40

U.S. GOVERNMENT PRINTING OFFICE 2—10528





BASE PRESSURE

BEARING PRESSURE OBTAINED FROM OTHER SIMILAR WALLS

bject HARTFORD HTS

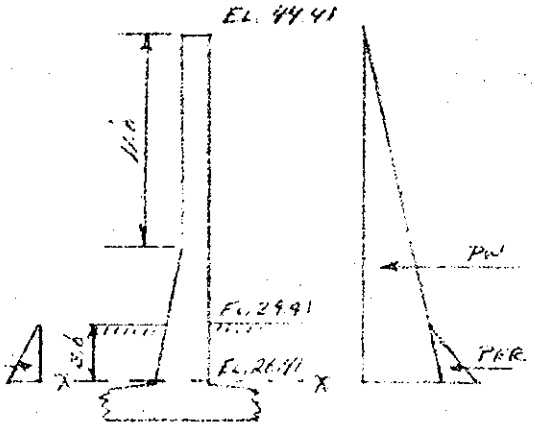
omputation CANTILEVER WALL STEM 18' BASE 21' STA. 36+01.31 TO 38+41.31

omputed by P.L.A. Checked by W.H.E. Date 3/18/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL REINF. STEM

RIVERSIDE FACE. CASE I RIVER UP BACKFILL TO EL. 29.41



MOMENTS ABOUT X-X

FORCES ACTING		→	←	ARM	MOMENTS ↷	MOMENTS ↶
PEL	$\frac{1}{2} \times 80 \times \overline{3.0}^2$	360		1.0	360	
PW	$\frac{1}{2} \times 62.5 \times \overline{18.0}^2$		10100	6.0		60600
PER	$\frac{1}{2} \times 17.5 \times \overline{3.0}^2$		80	1.0		80
		360	1018		360	60680
		ΣV = 9820 ←			ΣM = 60320 ↶	

$$d_{X-X}(\text{REQ'D}) = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{60320 \times 12}{123 \times 12}} = 22.2''$$

ACTUAL $d = 32.0 - 3.5 = 28.5''$

$$A_{s_{X-X}} = \frac{M}{f_s jd} = \frac{60320 \times 12}{18000 \times .884 \times 28.5} = 1.60 \square''$$

$$\text{SHEAR}_{X-X} = \frac{V}{bjd} = \frac{9820}{12 \times .884 \times 28.5} = 32.5 \#/\square'' < 60 \#/\square''$$

USE 1"φ @ 6" c.c. $A_s = 1.57 \square''$ $f_s = 18350 \#/\square''$

$$\text{BOND} = \frac{V}{\Sigma_0 jd} = \frac{9820}{6.3 \times .884 \times 28.5} = 61.8 \#/\square'' < 150 \#/\square''$$

LANDSIDE FACE

USE $\frac{5}{8}$"φ @ 1'-0" c.c.

WAR DEPARTMENT

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

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bject Hartford HL 5

omputation Cantilever Wall Stem 18' Base 21' Sta 36+01.31 To 38+41.31

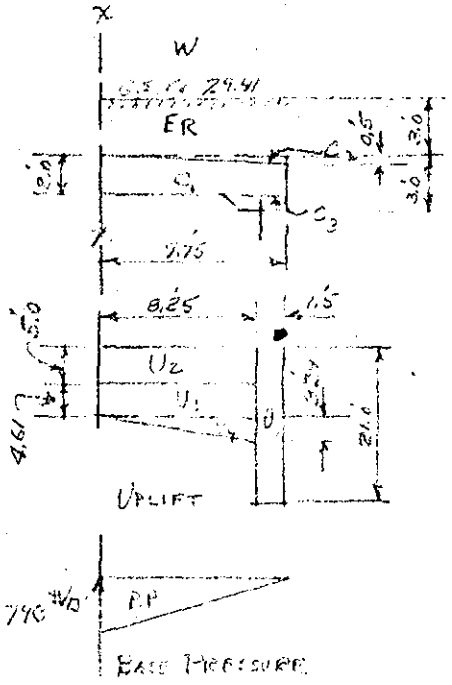
omputed by P.L.A. Checked by [illegible] Date 3/19/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Steel Reinf. Cont'd

Case I River Up & Backfill To El. 29.41

Riverside Base Top Steel



Moments About X-X

Forces Acting		↓	↑	Arm	Moments CA	Moments FC
W	15x9.75x62.5	9140		4.88	44500	
ER	3x9.75x125	3660		4.88	17900	
C_1	2x9.75x150	2920		4.88	14300	
C_2	½x.5x9.75x45		60	6.50		390
C_3	3x1x150	450		8.25	3710	
U_2	5x62.5x8.25		2590	4.13		10700
U_3	4.61x62.5x5.25		[illegible]	4.13		[illegible]
U_1	21x1.5x62.5		1970	9.0		17700
U_4	½x3.29x8.25x62.5		875	5.5		4810
ER	½x[illegible]		3620	3.25		11[illegible]
		16170	11485		80310	[illegible]
		ΣV = 4685 ↓			ΣM = 25080 ↑	

$$d_{x-x}\ (\text{Ref Q'D}) = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{25100 \times 12}{173 \times 12}} = 14.3$$

Actual d = 20.5"

$$A_{s_{x-x}}\ (\text{Ref Q'D}) = \frac{M}{f_s j d} = \frac{25100 \times 12}{18000 \times .884 \times 20.5} = 0.93^{\square''}$$

$$\text{Shear}_{x-x} = \frac{\Sigma V}{b j d} = \frac{4690}{12 \times .884 \times 20.5} = 21.6^{\#/\square'} < 60^{\#/\square'}$$

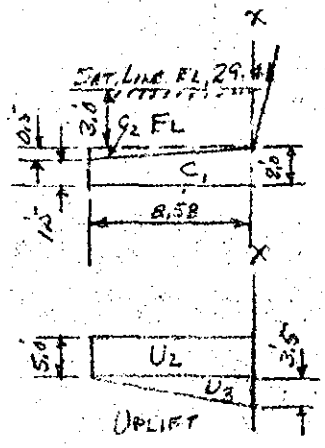
$$\text{Bond}_{x-x} = \frac{\Sigma V}{\Sigma_o j d} = \frac{4690}{5.11 \times .884 \times 20.5} = 50.6^{\#/\square'} < 150^{\#/\square''}$$

Use $\frac{5}{8}$"φ @ 1"φ @ 1'-0" c.c. Alt. $A_s = 1.10^{\square''}$

Project: HARTFORD HES
Computation: CANTILEVER WALL STEM 18' BASE 21' STA. 36+01.31 TO 38+41.31
Computed by: P.L.A. Checked by: W.H.F. Date: 3/18/40

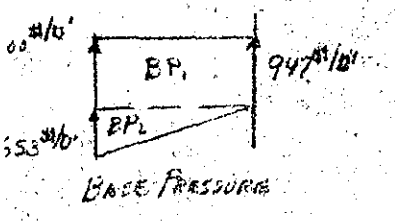
U. S. GOVERNMENT PRINTING OFFICE 3—10528

STEEL REINF. CONT'D
CASE I RIVER UP BACKFILL TO EL. 29.4
LANDSIDE BASE BOTTOM STEEL



MOMENTS ABOUT X-X

FORCES ACTING		↓	↑	ARM	MOMENTS ↻	MOMENTS ↺
EL	3 X 8.58 X 125	3220		4.29		13800
C_1	2 X 8.58 X 150	2570		4.29		11000
C_2	½ X 0.5 X 8.58 X 25		54	5.72	310	
U_2	5 X 62.5 X 8.58		2680	4.29	11500	
U_3	½ X 3.5 X 8.58 X 62.5		940	2.86	2680	
BP_1	947 X 8.58		8130	4.29	34900	
BP_2	½ X 653 X 8.58		2800	5.72	16000	
		5790	14604		65390	24800
		ΣV = 8814 ↑			ΣM = 40590 ↻	



BASE PRESSURE IN OTHER SIMILAR WALLS USED

$$d_{X-X}\ (\text{REQ'D}) = \sqrt{\frac{40600 \times 12}{123 \times 12}} = 18.2''$$

ACTUAL $d = 24.0 - 4.5 = 19.5''$

$$A_{s\ X-X}\ (\text{REQ'D}) = \frac{40600 \times 12}{18000 \times .884 \times 19.5} = 1.58\ \square''$$

$$\text{SHEAR}_{X-X} = \frac{8810}{12 \times .884 \times 19.5} = 42.5\ \#/\square'' < 60\ \#/\square''$$

$$\text{BOND}_{X-X} = \frac{8810}{6.3 \times .884 \times 19.5} = 81.2\ \#/\square'' < 150\ \#/\square''$$

USE 1" ϕ @ 6" c.c. $A_s = 1.57\ \square''$ $f_s = 18{,}100\ \#/\square''$

WAR DEPARTMENT

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

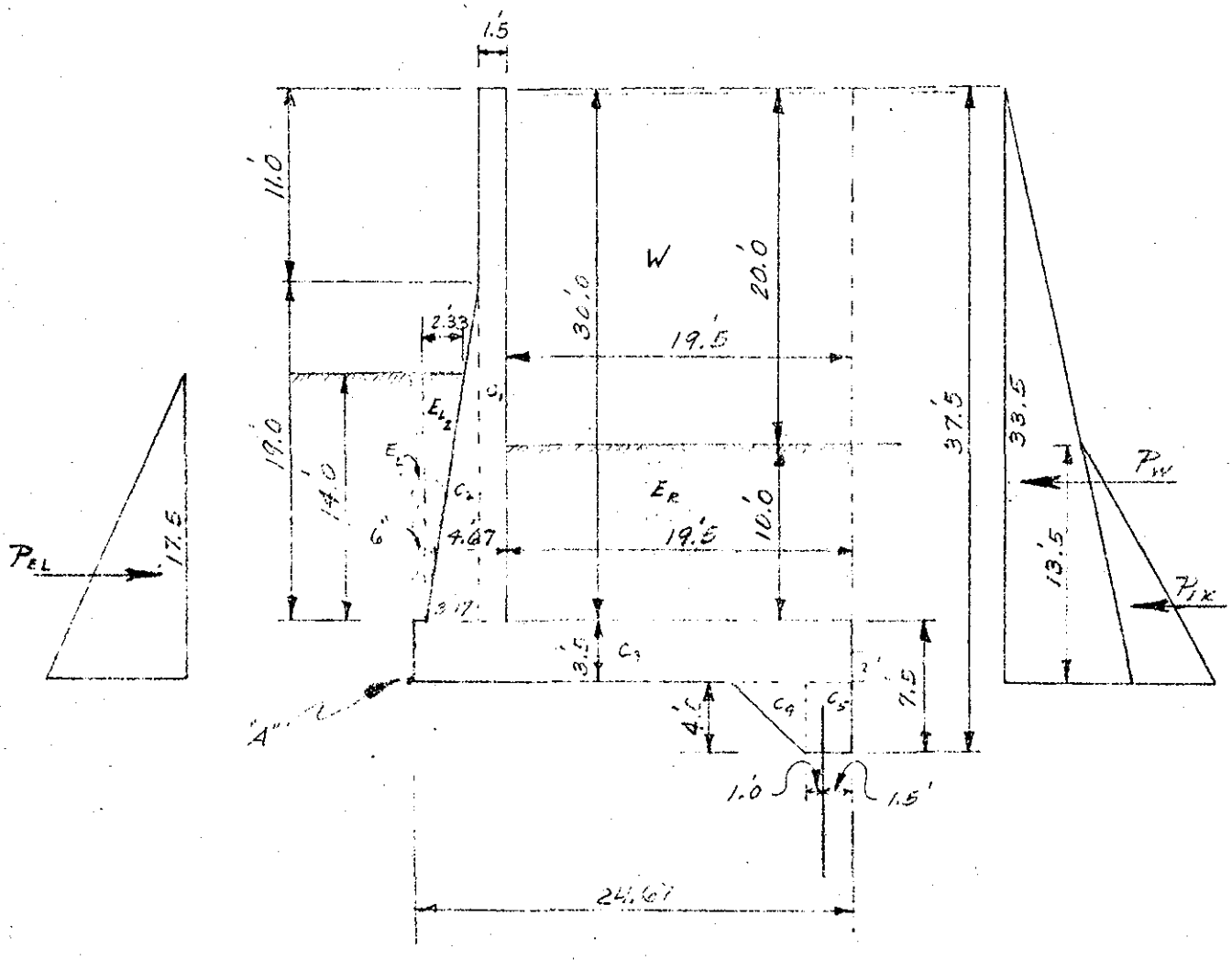
Subject: Hartford, Conn. - Ht. 5

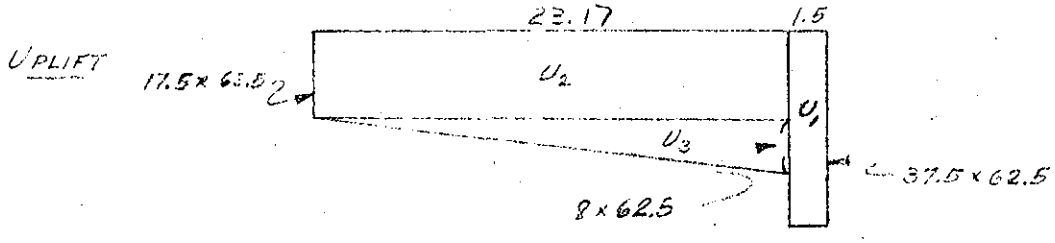
Computation: Wall Thru Dutch Point Plant (Sta 39+00 ±), 30' wall

Computed by: T.A.C. Checked by: Date: 3/14/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STABILITY - RIVER UP - CASE I





WAR DEPARTMENT

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

Object: Hartford, Conn. - Ht. 5

Computation: 30' wall - thru Dutch Point Station

Computed by: J. A. C. Checked by: Date: 3/14/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability - River Up - Case I

Forces Acting		↓	↑	→	←	Arm	Moments About "A" →	Moments About "A" ↶
W	20.0 × 19.5 × 62.5	24,400				14.92	364,000	
E_R	10.0 × 19.5 × 125	24,400				14.92	364,000	
E_{L1}	14.0 × 0.5 × 125	875				0.25	220	
E_{L2}	½ × 14.0 × 2.33 × 125	2,040				1.25	2,550	
C_1	30.0 × 1.5 × 150	6,750				4.42	29,800	
C_2	½ × 19.0 × 3.17 × 150	4,510				2.50	11,300	
C_3	24.67 × 3.5 × 150	13,000				12.33	160,000	
C_4	½ × 4.0 × 4.0 × 150	1,200				20.84	25,000	
C_5	4.0 × 2.5 × 150	1,500				23.42	35,200	
P_W	½ × $\overline{33.5}^2$ × 62.5				35,100	11.17		392,000
P_{ER}	½ × $\overline{13.5}^2$ × 17.5				1,595	4.5		6,950
P_{EL}	½ × $\overline{17.5}^2$ × 17.5			2,680		5.83	15,650	
U_1	37.5 × 62.5 × 1.5		3,510			23.92		84,000
U_2	17.5 × 62.5 × 23.17		25,400			11.55		294,000
U_3	½ × 8 × 62.5 × 23.17		5,770			15.40		89,000
	Shear on piles			9,000				
P_r	Passive pressure			25,015		3.16	79,000	
		78,675	34,680	36,695	36,695		1,086,720	865,950
		$\Sigma V = 43{,}995^{\#}$ ↓		$\Sigma H =$			$\Sigma M = 220{,}770'^{\#}$ ↶	

Position of Resultant $\Big\} = \dfrac{\Sigma M}{\Sigma V} = \dfrac{220{,}770}{43{,}995} = 5.17'$ from "A"

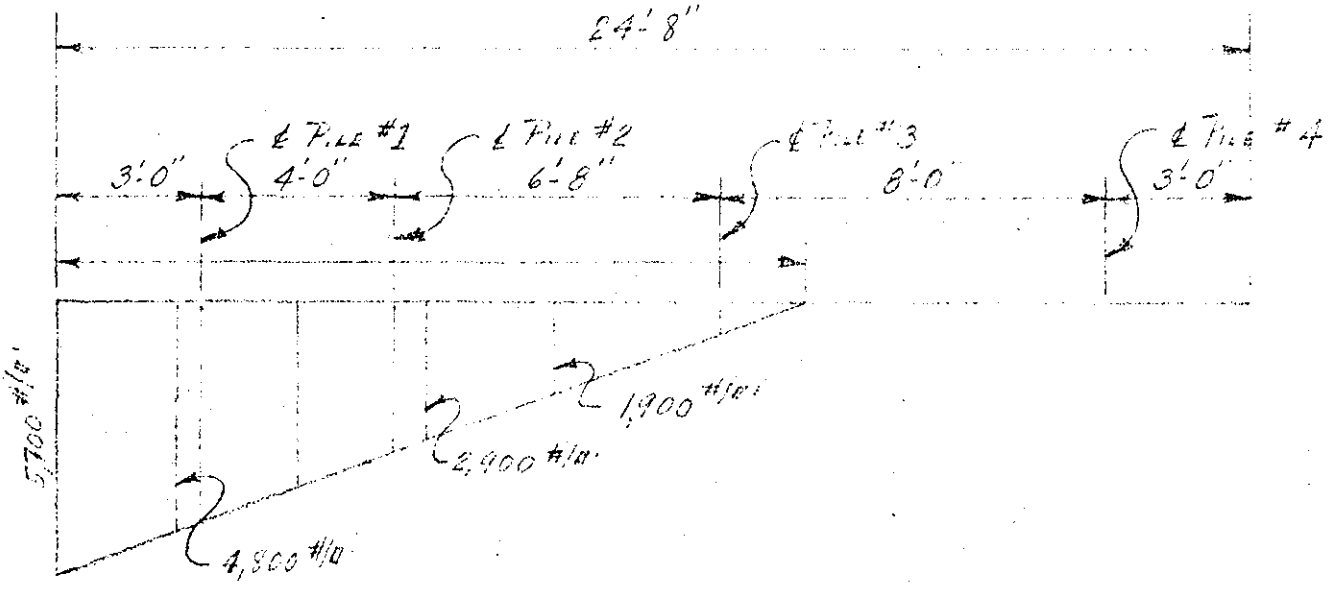
or 6.0' outside middle third

Bearing $\dfrac{\Sigma V}{b}(1+1) = \dfrac{43{,}995}{15.5} \times 2 = 5{,}700\ \#/\square'$ to $0\ \#/\square'$ — Footing on piles

Object: Hartford, Conn - H.T.5
Computation: 30' wall - Bro. Dutch Point Station
Computed by: T.A.C. Checked by: Date: 3/16/40

U. S. GOVERNMENT PRINTING OFFICE 3—10526

LOAD ON PILES - RIVER UP - CASE I



LOAD ON PILE #1 = 4,800 × 5 × 4.0 = 96,000# = 48 TONS

LOAD ON PILE #2 = 2,900 × 5.33 × 4.0 = 62,000# = 31 TONS

LOAD ON PILE #3 = $\frac{1}{2}$ × 1,900 × 5.3 × 4.0 = 20,000# 10 TONS

MAX. ALLOWABLE LOAD PER PILE = 65 TONS

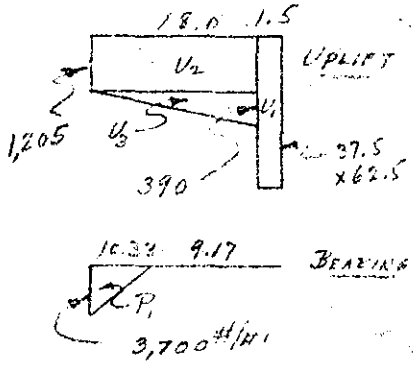
Subject: HARTFORD, CONN. - HT. 5
Computation: 30' WALL
Computed by: T.A.C. Checked by: Date: 3/15/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF STEEL IN TOE SLAB

CASE I - RIVER UP

SECTION AT RIVERSIDE FACE OF STEM



FORCES ACTING	↓	↑	ARM	MOMENTS ↻	MOMENTS ↺
W	24,400		9.25	226,000	
E_R	24,400		9.25	226,000	
C_1	10,350		9.25	95,700	
C_2	1,200		15.67	18,800	
C_3	1,500		18.25	27,400	
U_1 =		3,510	18.75		65,800
U_2 = 1,205 × 18		21,700	9.0		195,300
U_3 = ½ × 390 × 18.0		3,510	12.0		42,200
T_1 = ½ × 3,700 × 10.33		19,100	3.44		65,700
	61,850	47,820		593,900	369,000
	ΣV = 14,030 # ↓			ΣM = 224,900 #-△	

Uplift

8 × 62.5 = 21.6
23.17 Drop/ft.

18 × 21.6 = 390 #/□'
Total Drop

8 × 62.5 = 500
17.5 × 62.5 = 1,095
1,595
− 390
1,205

Bearing

5200 / 15.5 = 368 Drop/ft
368 × 10.33 = 3,700 #/□'

d = 50.5"

$d_{200} = \sqrt{\frac{224,900}{123}} = \sqrt{1830} = 43"$

Change total depth at stem from 3'-6" to 4'-6" - This makes new d = 50.5"
Subtract 5" for piles making d = 45.5
Using same moment as figured above:
and d = 45.5

$A_s = \frac{12 \times 224,900}{18,000 \times .884 \times 45.5} = 3.73 \square''$

$Z_s = \frac{14,030}{150 \times .884 \times 45.5} = 2.33"$

$v = \frac{14,030}{12 \times .884 \times 45.5} = 29$ #/□"

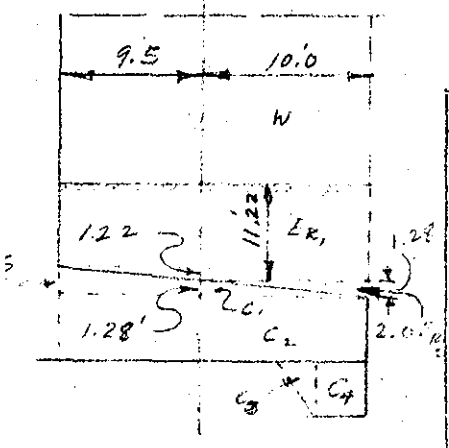
Object: Hartford, Conn. - H. 5
Computation: 30' wall
Computed by: T.A.C. Checked by: Date: 3/15/40

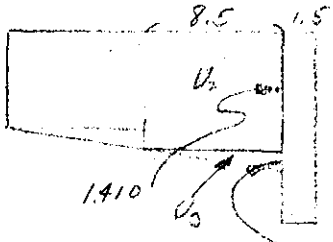
U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Steel in Toe Slab

Case I - River Up

Base tapers from 4'-6" at stem to 2'-0" at toe or at the rate of 1.54" per ft.





21.6 × 8.5 = 185 #/□'

1595 − 185 = 1,410 #/□'

Section at 9'-6" from Riverside Face of Stem

Forces Acting	↓	↑	Arm	Moments ↻	Moments ↺
W = 20 × 10 × 62.5	12,500		5.0	62,500	
E_{R_1} = 11.22 × 10 × 125	14,000		5.0	70,000	
E_{R_2} = ½ × 10 × 1.28 × 125	800		6.67	5,340	
C_1 = ½ × 10 × 1.28 × 150	960		3.33	3,200	
C_2 = 10 × 2 × 150	3,000		5.0	15,000	
C_3 =	1,200		6.17	7,400	
C_4	1,500		8.75	13,100	
U_1		3,510	9.25		32,400
U_2 = 1.410 × 8.5		12,000	4.25		51,000
U_3 = ½ × 185 × 8.5		790	5.67		4,480
	33,960	16,300		176,540	87,880
	ΣV = 17,660 ↓			ΣM = 88,660 ↻	

Total depth = 2.0 + 1.28 = 3.28 = 3'-3"
d = 39 − 3.5 = 35.5"
Subtract 5" for piles, making d = 30.5"

$A_s = \frac{12 \times 88,660}{18,000 \times .884 \times 30.5} = 2.20^{\square''}$

WAR DEPARTMENT

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

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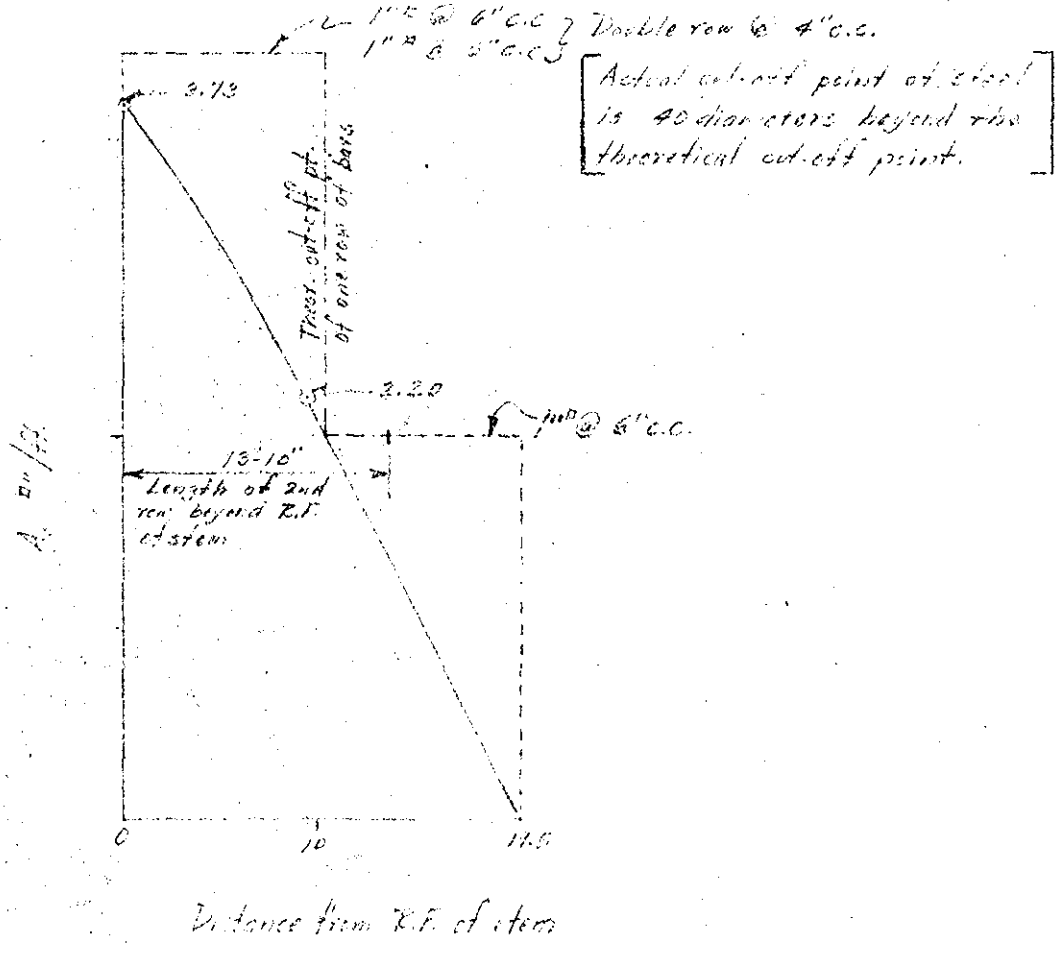
Subject: Hartford, Conn. - H.T.5

Computation: 30' wall - Thru Dutch Point Station

Computed by: T.A.C. Checked by: Date: 3/19/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

A_s DIAGRAM FOR STEEL IN BASE



WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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Subject: Hartford, Conn. – Ht. 5
Computation: 30' wall
Computed by: J.A.C. Checked by: Date: 3/14/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STABILITY – RIVER DOWN – CASE II

DRY BACKFILL – LAND AND RIVER SIDES

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT "A" →	MOMENTS ABOUT "A" ←
E_R	10.0 × 19.5 × 100	19,500				14.92	291,000	
E_{L1}	14.0 × 0.5 × 100	700				0.25	175	
E_{L2}	½ × 14.0 × 2.33 × 100	1,630				1.27	2,070	
C_1		6,750				4.42	29,900	
C_2		4,510				2.61	11,750	
C_3		13,000				12.33	160,000	
C_4		1,200				20.84	25,000	
C_5		1,500				23.42	35,200	
P_{ER}	½ × $\overline{13.5}^2$ × 35				3,190	4.5		14,350
P_{EL}	½ × $\overline{17.5}^2$ × 35			5,360		5.83	31,300	
	Shear on piles				2,170			
		48,790		5,360	5,360		586,395	14,350
		ΣV = 48,790# ↓		ΣH = 0			ΣM = 572,045'# ↷	

Position of Resultant } $= \frac{\Sigma M}{\Sigma V} = \frac{572,045}{48,790} = 11.7'$ from "A"

or 3.48' inside middle third

$e = 12.33 - 11.7 = 0.63$

Bearing. $\frac{\Sigma V}{b}\left[1 \pm \frac{6e}{b}\right]$

$= \frac{48,790}{24.67}\left[1 \pm \frac{6 \times 0.63}{24.67}\right] = 1,980\left[1 \begin{matrix} + \\ - \end{matrix} \begin{matrix} .15 \\ .15 \end{matrix}\right] = \begin{matrix} 2,250 \text{ \#/□'} \\ 1,700 \text{ \#/□'} \end{matrix}$ HEEL PR. / TOE PR.

WAR DEPARTMENT

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

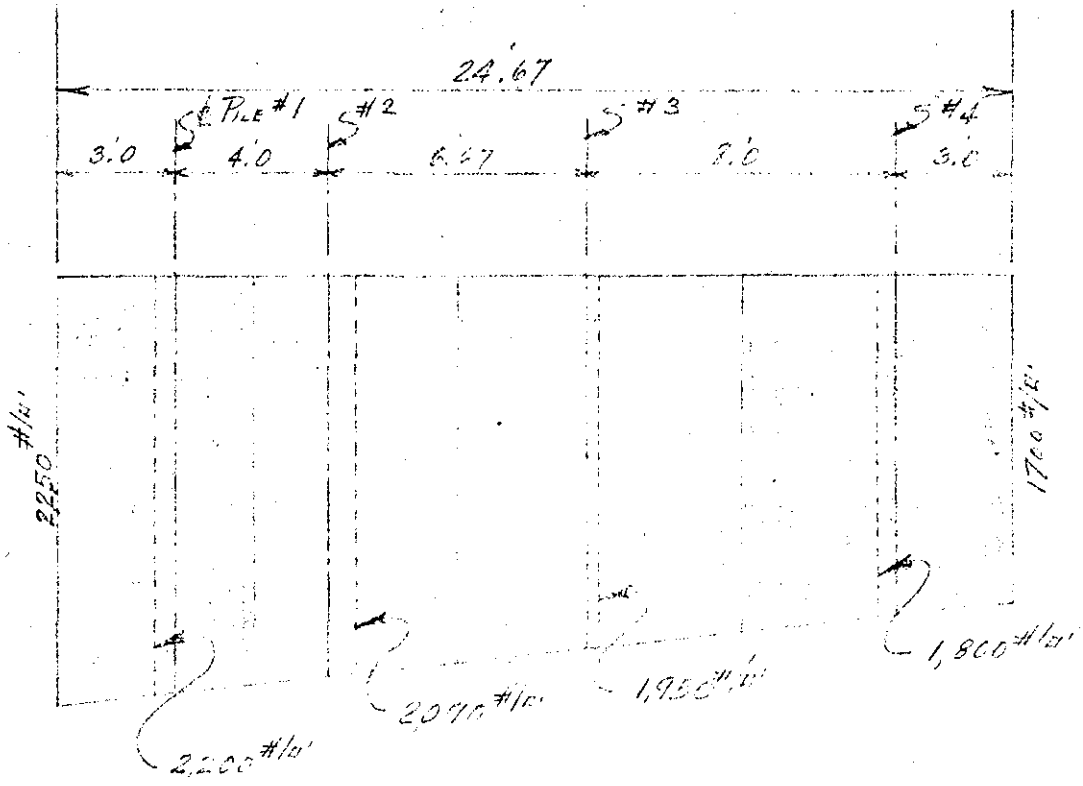
Subject: HARTFORD, CONN. - HT. 5

Computation: 30' WALL

Computed by: G.T.A.C. Checked by: Date: 3/16/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

LOAD ON PILES - RIVER DOWN - CASE II



LOAD ON PILE #1 = 2,200 × 5 × 4 = 44,000 #

#2 = 2,090 × 6.33 × 4 = 47,651 #

#3 = 1,950 × 7.33 × 4 = [illegible] #

#4 = 1,800 × 7 × 4 = 50,400 #

PILE SPACING = 4'-0" LONG.

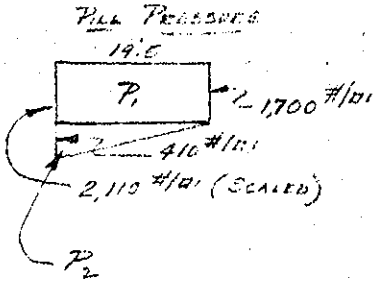
MAX. ALLOW. LOAD = 65 TONS

Subject: HARTFORD, CONN. – HT. 5
Computation: 30' WALL
Computed by: T.A.C. Checked by: Date: 3/14/40

U. S. GOVERNMENT PRINTING OFFICE 8—10628

DESIGN OF STEEL IN TOE SLAB

CASE II – RIVER DOWN



SECTION AT RIVERSIDE FACE OF STEM.

FORCES ACTING	↓	↑	ARM	↶	↷
E_R =	19,500		9.25	180,500	
C_1 = 19.5×3.5×150	10,350		9.25	95,700	
C_2 =	1,200		15.67	18,800	
C_3 =	1,500		18.25	27,400	
P_1 = 1,700 × 19.5		33,200	9.25		307,000
P_2 = ½ × 410 × 19.5		3,800	6.5		24,700
	32,550	37,000		322,400	331,700
	ΣV = 4,450 # ↑			ΣM = 9,300 '# ↶	

$d = 45.5''$ (Revised)

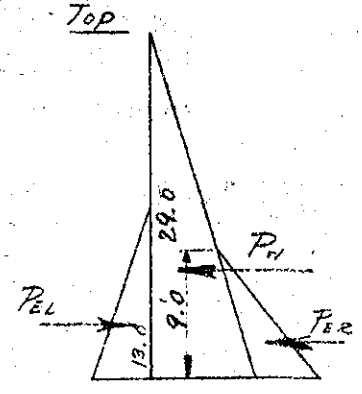
$$A_s = \frac{12 \times 9{,}300}{18{,}000 \times .884 \times 45.5} = 0.16 \ \square''$$

Subject: Hartford, Conn. – Hr. 5
Computation: 20' wall
Computed by: J.A.C. Checked by: Date: 3/15/40

U. S. GOVERNMENT PRINTING OFFICE 3—10628

Design of Steel in Stem

Case I - River Up



Section at Top of Base

Forces Acting	→	↓	Arm	↺	↻
$P_W = \frac{1}{2} \times 29.0^2 \times 62.5$		26,300	9.67		254,000
$P_{ER} = \frac{1}{2} \times 9^2 \times 17.5$		720	3.0		2,160
$P_{EL} = \frac{1}{2} \times 13^2 \times 80$	6,760		4.33	29,300	
	6,760	27,020		29,300	256,160
	ΣV = 20,260 # →			ΣM 226,860 '# ↻	

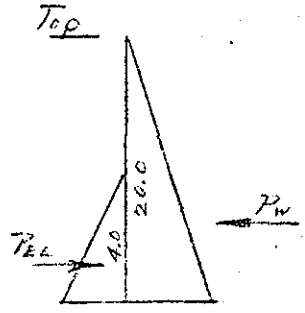
Total thick at 29.0' ↓ = 4'-6"
d = 54 - 3.5 = 50.5

$d_{REQ} = \sqrt{\frac{228,000}{100}} \sqrt{1860}$
= 43"

$A_s = \frac{12 \times 226,860}{18,000 \times .884 \times 50.5} = 3.40 \square''$

$Z_0 = \frac{20,260}{150 \times .884 \times 50.5} = 3.02''$

$v = \frac{20,260}{12 \times .884 \times 50.5} = 38$ #/□"



Section at 20'-0" Below Top of Wall

Forces Acting	→	↓	Arm	↺	↻
$P_W = \frac{1}{2} \times 20^2 \times 62.5$		12,500	6.67		83,500
$P_{EL} = \frac{1}{2} \times 4^2 \times 80$	640		1.33	850	
	ΣV = 11,860 →			ΣM = 82,650 '# ↻	

Total thick. at 20.0' ↓ = 3'-0"
d = 36 - 3.5 = 32.5"

$A_s = \frac{12 \times 82,650}{18,000 \times .884 \times 32.5} = 1.93 \square''$

Subject: Hartford Conn. - Ht. 5
Computation: 30' wall - Thru Dutch Point Station
Computed by: J.A.C. Checked by: Date: 3/15/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Steel in Stem

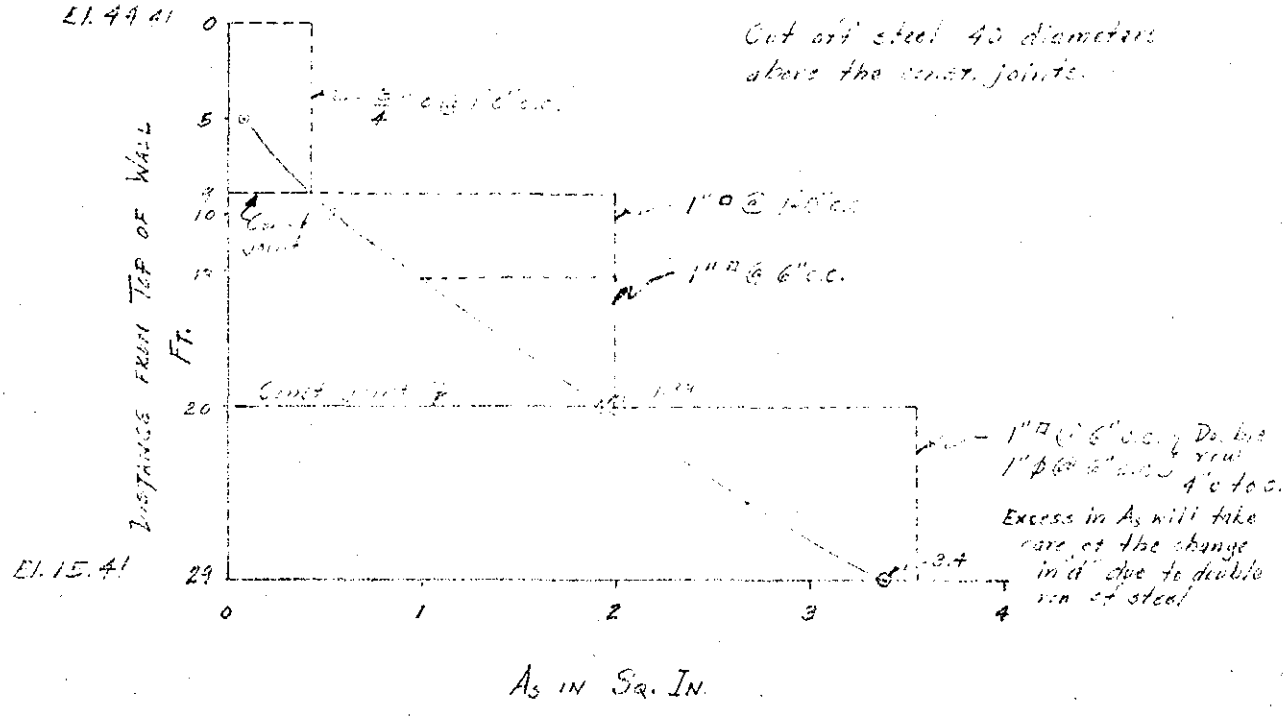
Case II - Rule Down

Section at Top of Base

Forces Acting	→	←	Arm	↷	↶
$P_{EL} = \frac{1}{2} \times 15^2 \times 70$	6,760		4.33	29,300	
$P_{EK} = \frac{1}{2} \times 9^2 \times 35$		1,420	3.00		4,260
	$\Sigma V = 5,340^{\#} \rightarrow$			$\Sigma M = 25,040$ ↷	

$$A_s = \frac{12 \times 25,040}{18,000 \times .884 \times 50.5} = 0.37 \text{ □"}$$

A_s Diagram for Stem - Case I



WAR DEPARTMENT

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

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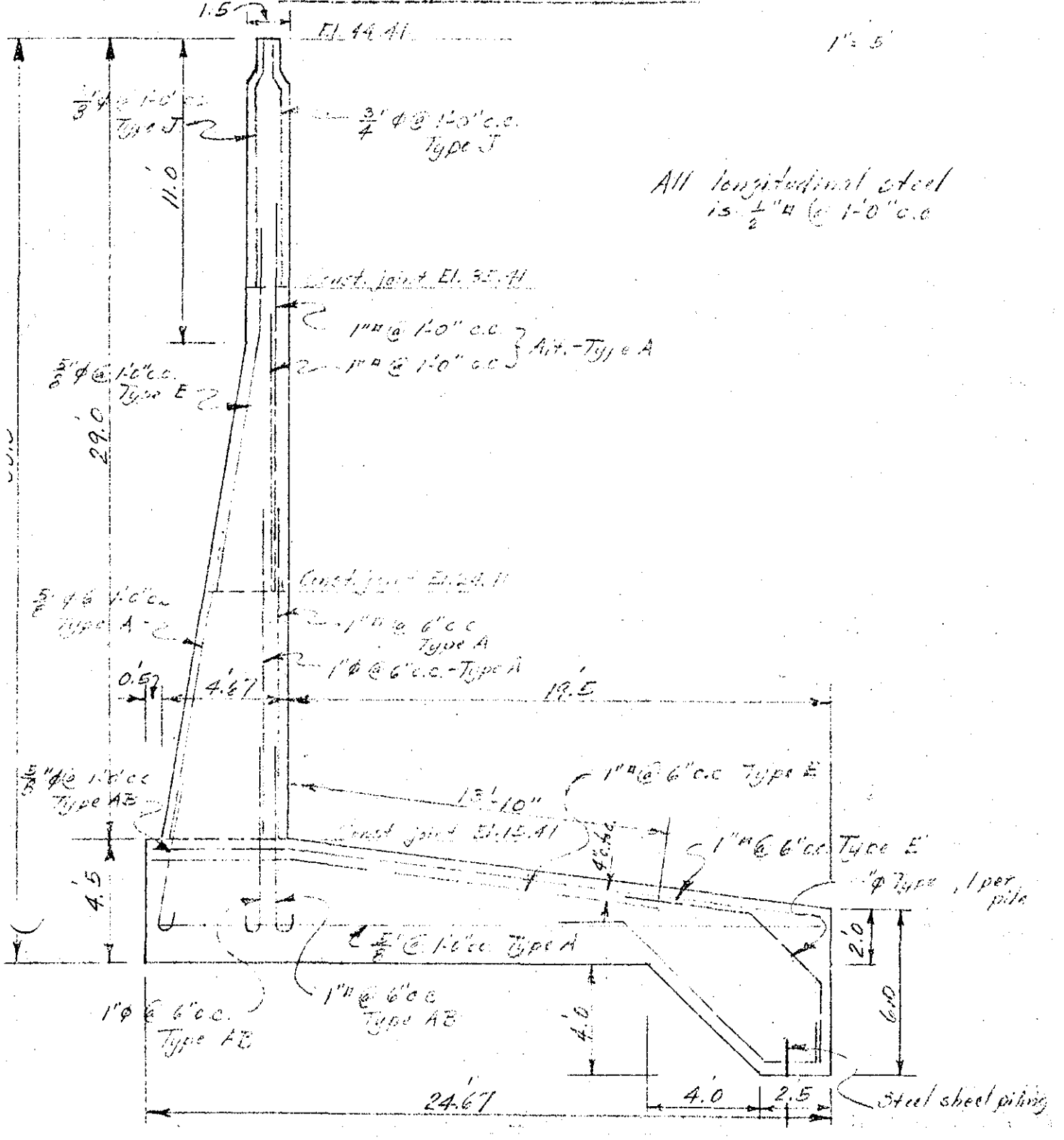
Subject: Hartford, Conn. - Ht. 5

Computation: 30' wall - thru Dutch Point Station

Computed by: J.A.C. Checked by: Date: 3/18/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

FINAL SECTION AS DESIGNED



WAR DEPARTMENT

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

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Subject: Hartford Flood wall (Sta 39+22±)

Computation: Wall Thru Dutch Paint Plant (31'-6" or 32'-0" stem)

Computed by: W.C.O. Checked by: Date: 3/20/40

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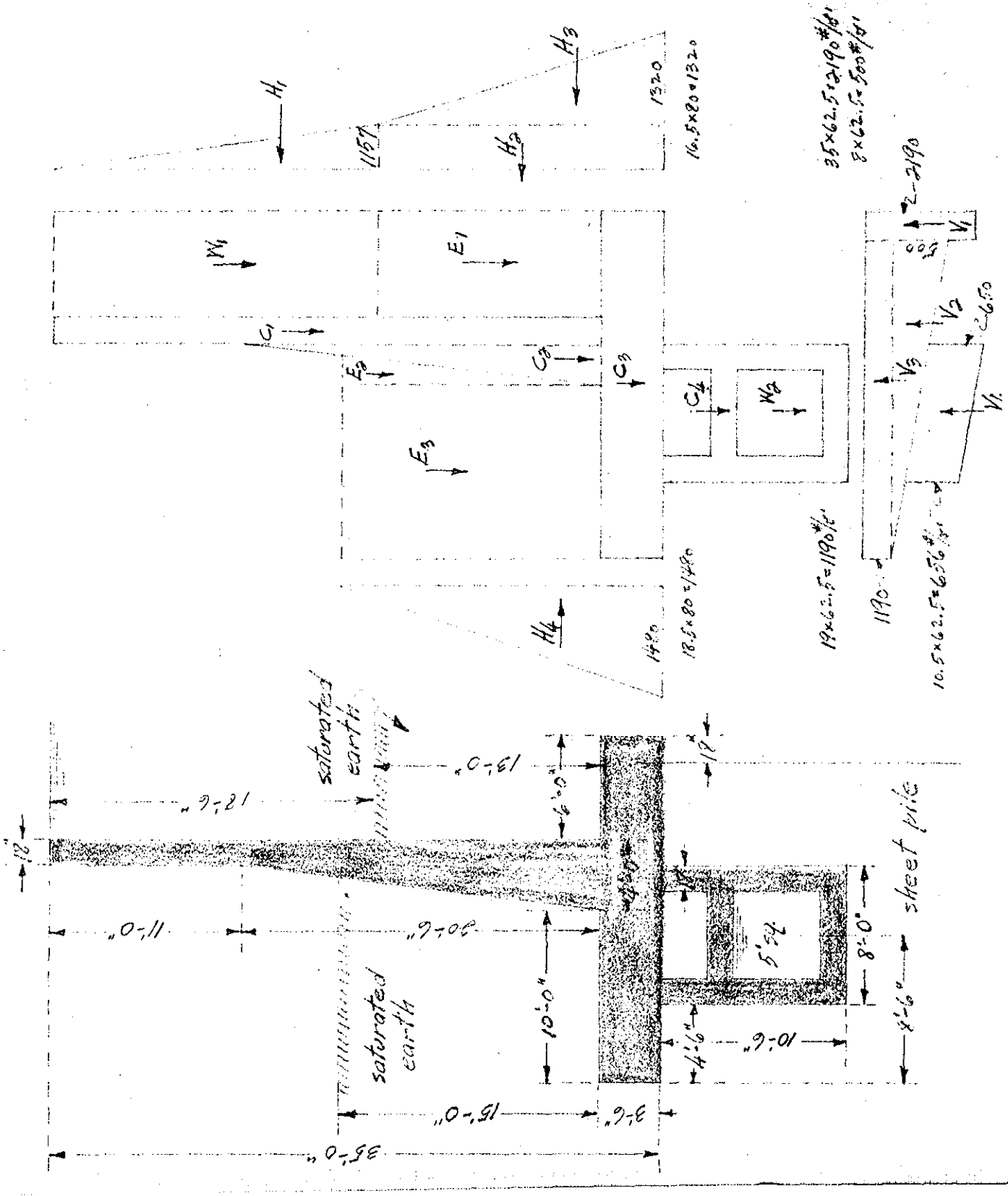


Subject: Hartford Flood Wall
Computation: Stability Case I River Up
Computed by: W.C.O. Checked by: Date:

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Overturning moments

load	× arm	= moment
t_1: 1157 × 18.5 × 1/2 =	10800 × 22.67 =	245000
t_2: 1157 × 16.5 =	19230 × 8.25 =	158700
t_3: 1320 × 16.5 × 1/2 =	10900 × 5.5 =	60000
f_1: 2190 × 1.5 =	3210 × 19.25 =	63400
f_2: 500 × 18.5 × 1/2 =	4630 × 12.33 =	57100
f_3: 1190 × 18.5 =	22000 × 9.25 =	203500
f_4: 650 × 8 =	5200 × 8.5 =	44200
	ΣV = 35040# ↓	ΣM = 832,000'# ↻

Stabilizing moments

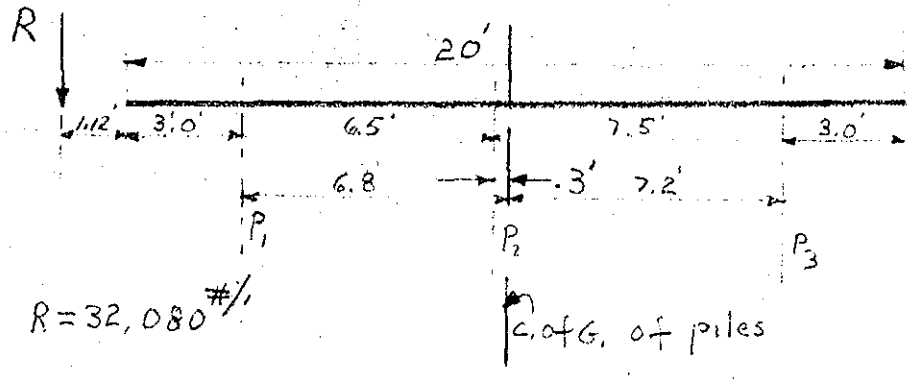
load	× arm	= moment
w_1: 1480 × 18.5 × 1/2 =	13700 × 6.17 =	84500
w_2: 150 × 1.5 × 31.5 =	7100 × 13.25 =	94000
w_2: 150 × 20.5 × 2.5 × 1/2 =	3840 × 11.67 =	44800
w_3: 150 × 20 × 3.5 =	10500 × 10 =	105000
w_4: 150 × 1.5 × 31 =	7000 × 8.5 =	59500
w_5: 125 × 6 × 13 =	9750 × 17 =	165800
w_6: 125 × 15 × 1.83 × 1/2 =	1720 × 10.58 =	18200
w_7: 125 × 15 × 10 =	18750 × 5 =	93700
w_8: 62.5 × 18.5 × 6 =	6900 × 17 =	117300
w_9: 62.5 × 5 × 5 =	1560 × 8.5 =	13300
	ΣV = 67120# ↓	ΣM = 796,100'# ↻

$$e = \frac{832000 - 796100}{67120 - 35040} = \frac{35900}{32080} = -1.12'$$

Subject: Hartford, Conn. HTS
Computation: Wall thru Dutch Point Plant
Computed by: W. S. Jr. Checked by: Date: 3/18/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Pile Loadings (Case I)



Direct load per pile $= \frac{32,080}{3} = 10,700^{\#}$

Loads due to moment

Let $P_3 = y$; $P_1 = \frac{6.8}{7.2} y$; $P_2 = \frac{.3}{7.2} y$;

Moment $= 32,080 \times 10.82' = 348,000'^{\#}$

$$y(7.2) + \frac{6.8}{7.2} y(6.8) + \frac{.3}{7.2} y(.3) = 348,000'^{\#}$$

$$7.2y + 6.4y + .0125y = 348,000'^{\#}$$

$$13.612y = 348,000'^{\#}$$

$$y = 25,500^{\#}$$

$P_3 = 25,500^{\#} \downarrow$; $P_1 = 24,100^{\#} \uparrow$; $P_2 = 1,060^{\#} \uparrow$

Resultant Loading

$P_1 = 10,700^{\#} + 24,100^{\#} = 34,800^{\#} \uparrow$
$P_2 = 10,700^{\#} + 1,060^{\#} = 11,760^{\#} \uparrow$
$P_3 = 10,700^{\#} - 25,500^{\#} = 14,800^{\#} \downarrow$

Assume 3'-6" spacing of piles

$P_1 = 34,800 \times 3.5 = 122,000^{\#} = 61$ Tons
$P_2 = 11,760 \times 3.5 = 41,100^{\#} = 20.5$ Tons
$P_3 = 14,800 \times 3.5 = 52,000^{\#} = 26$ Tons (withdrawal)

WAR DEPARTMENT

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

Subject: Hartford, Conn. H+S

Computation: Wall Thru Dutch Point Plant

Computed by: W. S. Jr. Checked by: Date: 3/18/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

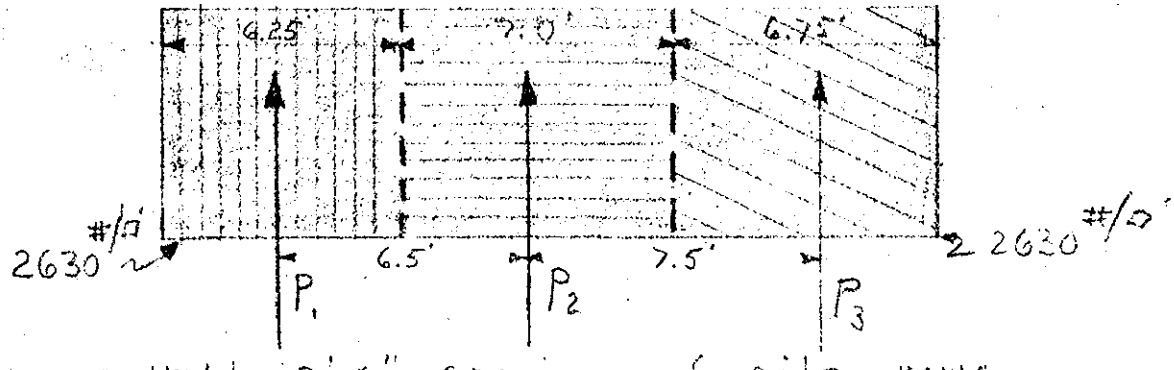
Case II

Stability and Pile Loading, River Down

Forces	↓	↑	→	←	Arm	Moment at "A"	
C_1	7100					94000	
C_2 See	3840					44800	
C_3 Case I	10500					105000	
C_4	7000					59500	
E_1 100 × 6 × 13	7800				17.0	133000	
E_2 100 × 15 × 1.83/2	1370				10.5	14400	
E_3 100 × 15 × 10	15,000				5	75000	
Pe_l, Pe_r neglect							
$\Sigma V =$	52,610				$\Sigma M =$	525,700	

$\frac{\Sigma M}{\Sigma V} = 9.99'$ o.k. in center of base

Bearing $= \frac{52,610}{20} = 2630$ #/□' uniform



With 3'-6" spacing of pile rows

$P_1 = 6.25 \times 2630 \times 3.5 = 57,500^{\#} = 28.7$ Tons

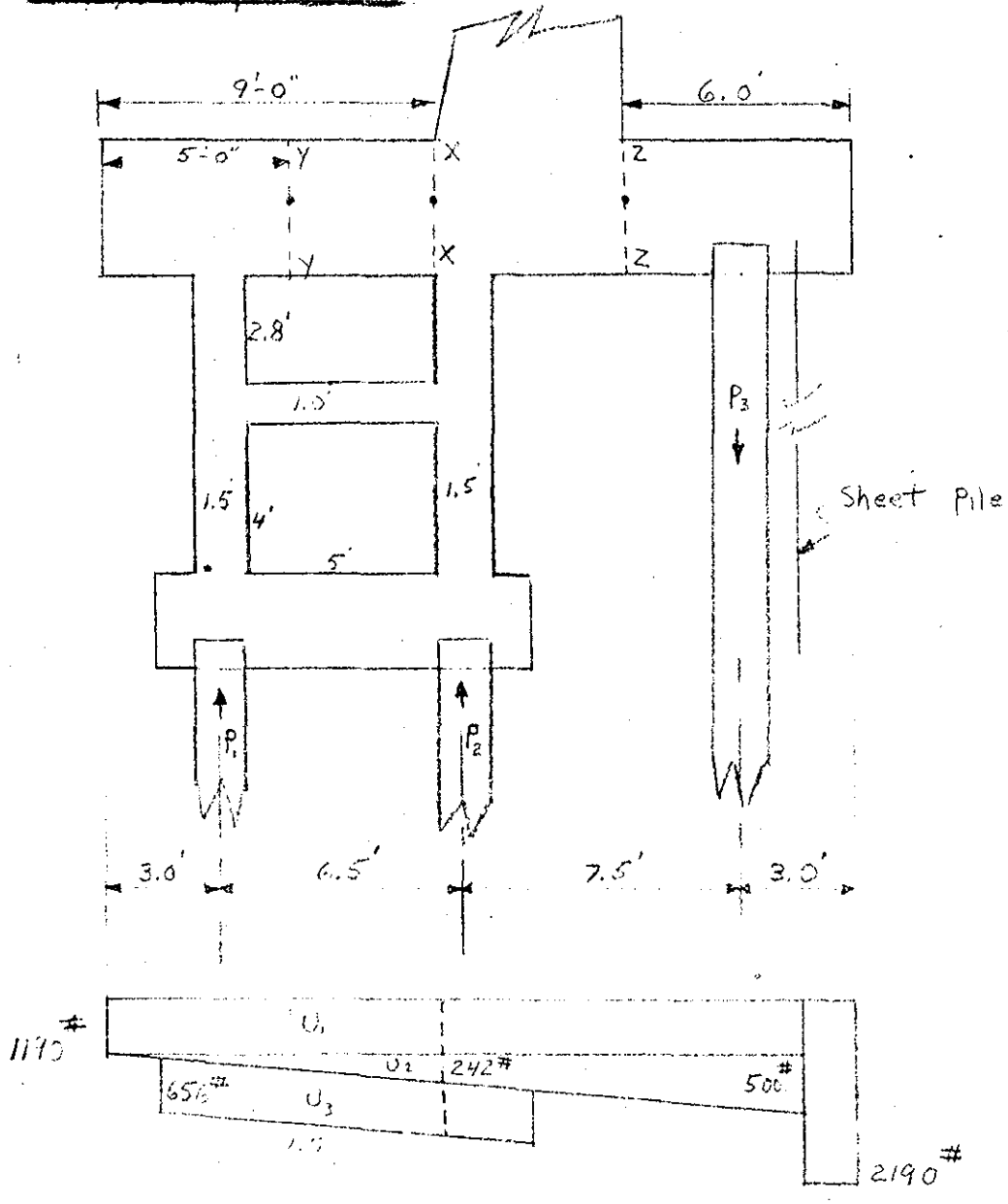
$P_2 = 7.0 \times 2630 \times 3.5 = 64,300^{\#} = 32$ Tons

$P_3 = 6.75 \times 2630 \times 3.5 = 62,000^{\#} = 31$ Tons

ct Hartford, Conn. Ht 5
utation Wall Thru Dutch Paint Plant
uted by M.S.P. Checked by Date 3/19/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Base



Subject: Hartford, Conn. Ht. 5
Computation: Wall Thru Dutch Point Plant
Computed by: M. S. Jr. Checked by: Date: 3/18/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Base (Use 4'-0" for base thickness)

Moments at X-X

$U_1 = 1190 \times 9 = 10{,}700^{\#}$ $\times$ 4.5 = 48,100'#
$U_2 = 242 \times 9 \times \frac{1}{2} = 1{,}090^{\#}$ $\times$ 6.0 = 6,540'#
$U_3 = 656 \times 7.5 = 4{,}910^{\#}$ $\times$ 3.75 = 18,400'#

$P_1 = 34{,}800^{\#}$ $\times$ 6.0 = 209,000'#

$\uparrow V = 51{,}500^{\#}$ $\circlearrowleft M = 282{,}040'^{\#}$

$E_1 = 9 \times 15 \times 125 = 16{,}900^{\#}$ $\times$ 4.5 = 76,000#
$C_1 = 9 \times 3.5 \times 150 = 4{,}720^{\#}$ $\times$ 4.5 = 21,200#

$\downarrow V = 21{,}620^{\#}$ $\circlearrowright M = 97{,}200'^{\#}$

$\Sigma V = 29{,}880^{\#} \uparrow$ $\Sigma M = 184{,}840'^{\#} \circlearrowleft$

$d_{required} = \sqrt{\frac{184{,}840 \times 12}{123 \times 12}} = 39''$ $d_{provided}$ 44.5" O.K.

$\text{Shear} = \frac{29{,}880}{12 \times .884 \times 44.5} = 63^{\#/\square''}$ O.K.

$A_s = \frac{184{,}840 \times 12}{18000 \times .884 \times 44.5} = 3.14^{\square''}$ Use $1\frac{1}{4}''\square$ @6" c.c.

$\text{Bond} = \frac{29{,}880}{10 \times .884 \times 44.5} = 74^{\#/\square''}$ O.K.

Moments at Y-Y

$U_1 = 1190 \times 5 = 5950$ $\times$ 2.5 = 14,900'#
$U_2 = 135 \times \frac{1}{2} \times 5 = 338$ $\times$ 3.33 = 1,120'#
$U_3 = 656 \times 3.5 = 2300$ $\times$ 1.75 = 4,020'#

$P_1 = 34{,}800$ $\times$ 2.0 = 69,600'#

$\uparrow V = 43{,}388$ $\circlearrowleft M = 89{,}640'^{\#}$

$E_1 = 5 \times 15 \times 125 = 9400^{\#}$ $\times$ 2.5 = 23,500'#
$C_1 = 3.5 \times 5 \times 150 = 2620^{\#}$ $\times$ 2.5 = 6,530'#

$\downarrow V = 12{,}020^{\#}$ $\circlearrowright M = 30{,}030$

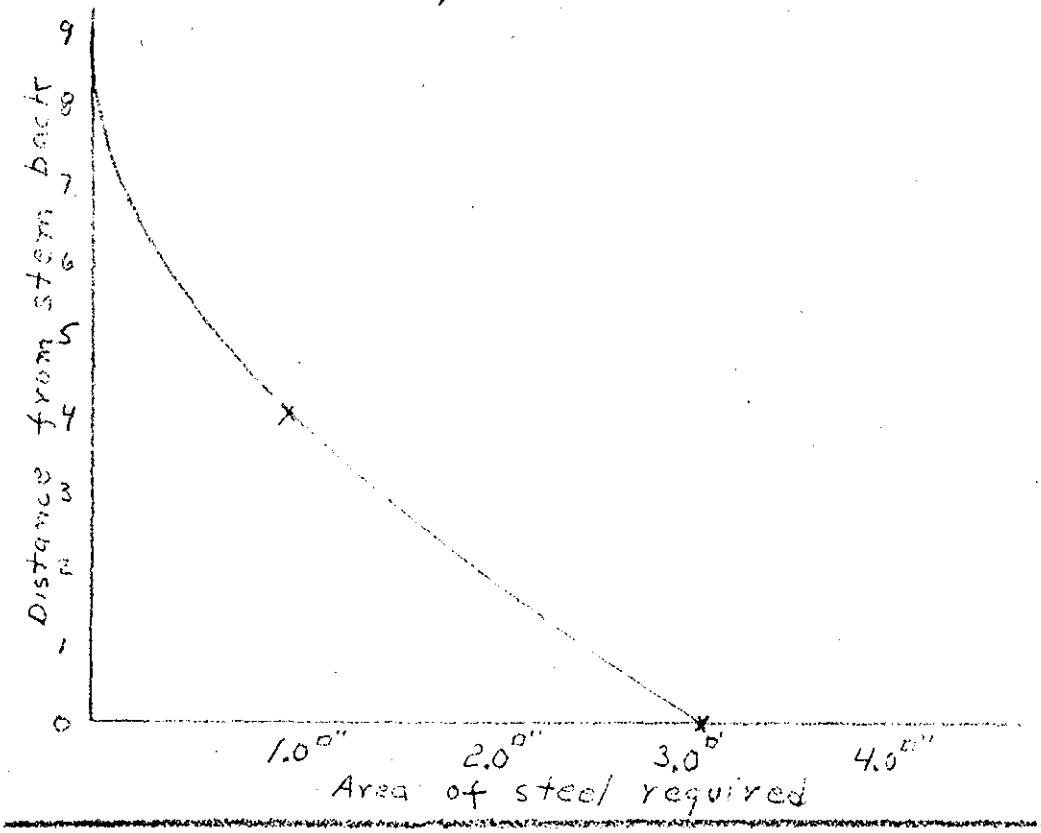
$\Sigma V = 31{,}368^{\#}$ $\Sigma M = 59{,}610'^{\#}$

$A_s = 1.0^{\square''}$

Project Hartford, Conn. H+5
Computation Wall Thru Dutch Point Plant
Computed by ..... Checked by ..... Date .....

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Curve of steel in L.S. base.



Moment at Z-Z (River Up)

$U_1 = 1550 \times 4.5 = 6970^{\#} \times 2.25 = 15{,}700'^{\#}$
$U_2 = 2190 \times 1.5 = 3170^{\#} \times 5.25 = 16{,}650'^{\#}$
$U_3 = 240 \times \frac{1}{2} \times 4.5 = 540^{\#} \times 3.0 = 1{,}620'^{\#}$
$\uparrow 10{,}680^{\#}$ $\circlearrowleft 33{,}970'^{\#}$

$E_1 = 6 \times 13 \times 125 = 9{,}750 \times 3.0 = 29{,}200'^{\#}$
$C_1 = 3.5 \times 6 \times 150 = 3{,}150 \times 3.0 = 9{,}500'^{\#}$
$P_3 = = 14{,}800 \times 3.0 = 44{,}500'^{\#}$
$\downarrow 27{,}700^{\#}$ $\circlearrowright 83{,}200'^{\#}$
$\Sigma V = 17{,}020^{\#} \downarrow$ $\Sigma M = 49{,}230'^{\#} \circlearrowright$

Shear O.K.

$$A_s = \frac{49{,}230 \times 12}{18000 \times .884 \times 45} = .840\,\square''$$

Subject: Hartford Conn. H+S
Computation: Wall Thru Dutch Point Plant
Computed by: M. S. J. Checked by: Date: 3/20/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Moment at Z-Z (River Down)

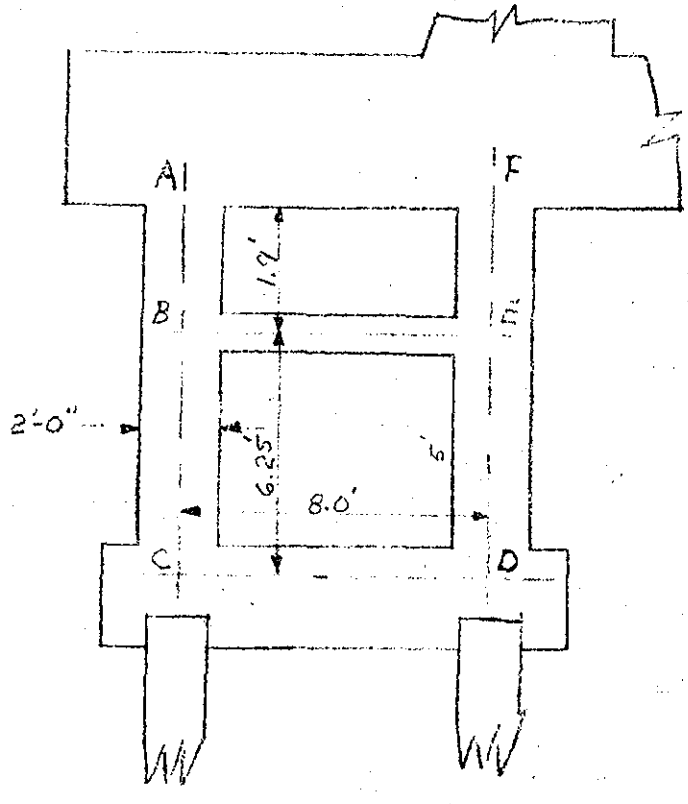
$E_1 = 6 \times 13 \times 100 = 7800^{\#} \times 3 = 23,400'^{\#}$
$C_1 = 3.5 \times 6 \times 150 = 3150^{\#} \times 3 = 9,500$
$10,950^{\#} \downarrow \quad 32,900'^{\#}$

$P_3 = \quad = 17,700^{\#} \uparrow \times 3 = 53,100'^{\#}$

$\Sigma V = 6,850^{\#} \uparrow \quad \Sigma M = 20,200'^{\#}$

$A_s = \dfrac{20,200 \times 12}{18000 \times .884 \times 33} = .46$ Use $\frac{7}{8}$" ϕ @ 1'-0" c.c. in top

Moments on Conduit



Case I
Sat. earth to El. 18.
River Down.

Case II
River to El. 44
Sat earth to El. 18

Project: Hartford, Conn. H+5
Computation: Wall Thru Dutch Point Plant
Computed by: M. S. Jr. Checked by: Date: 3/20/40

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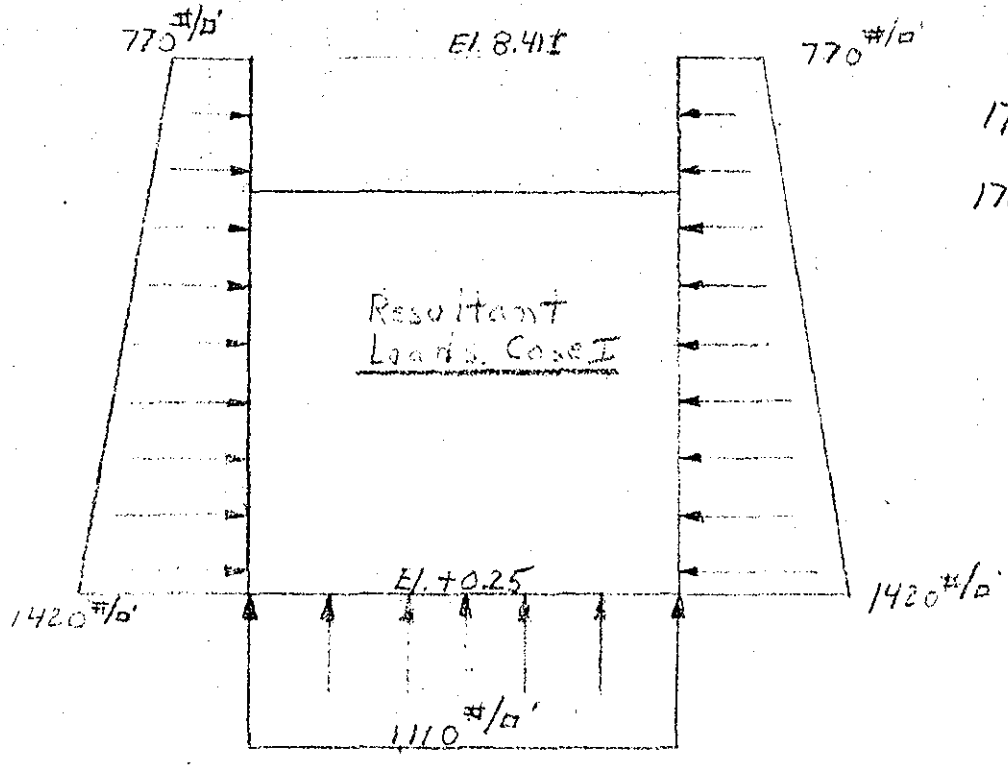
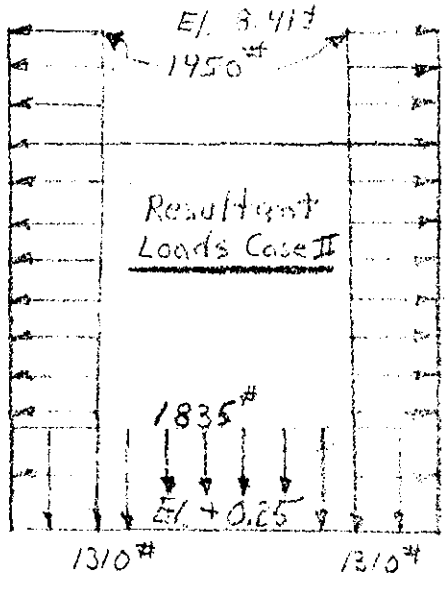
Conduit Design



9.6 x 80 = 770 #/□'
17.75 x 80 = 1420 #/□'
17.75 x 62.5 = 1110 #/□'



35.59 x 62.5 = 2220#
43.75 x 62.5 = 2730#

← 2220 ← 2730
→ 770 → 1420
← 1450# ← 1310#

43 x 62.5 = 2680#
2.5 x 150 = 375#
3055# ↓
19.5 x 62.5 = 1220# ↑
1835# ↓

By inspection, Case II will govern.

Project: Hartford Conn Ht 5
Computation: Wall Thru Dutch Point Plant 32'-0" Stem
Computed by: M. S. P. Checked by: Date:

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Conduit Design (neglect diaphram BE)

Wall AC or FD
Assume 1400# uniform load/ft.

$+M = \frac{1400 \times 8.15^2}{8} = 11,600'^{\#}$

$-M = \frac{1400 \times 8.15^2}{12} = 7,750'^{\#}$

Slab CD

$+M = \frac{1835 \times 8^2}{8} = 14,700'^{\#}$

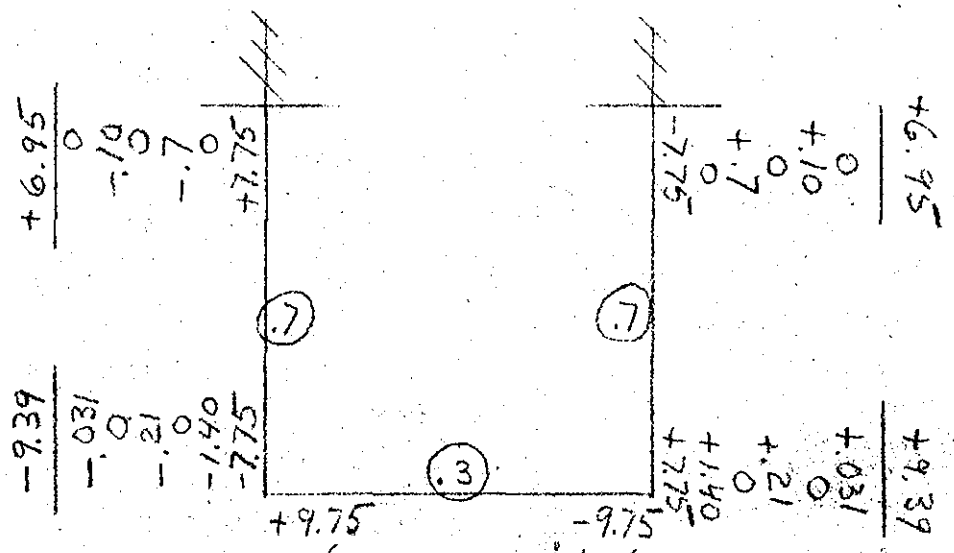
$-M = \frac{1835 \times 8^2}{12} = 9,750'^{\#}$

Relative Stiffness Factors

AC or $FD = \frac{2^3}{8.15} = .98$

$CD = \frac{1.5^3}{8} = .42$

$\frac{.42}{1.40} = .3$ $\frac{.98}{1.40} = .7$



+9.75	-9.75
-.6	+.6
+.3	-.3
-.09	+.09
+.045	-.045
-.014	+.014
+9.39	-9.39

Project Hartford, Conn. Ht 5
Computation Wall Thru Dutch Point 32'-0" Stem
Computed by M. S. Jr. Checked by Date

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Conduit Design

Max. moment in CD = 9,390'#

$A_s = \frac{9390 \times 12}{18000 \times .884 \times 20.5} = .36^{\square''}$ use 5/8" ϕ @ 1'-0" c.c.

Max Moment in AC or DF = 9,390'#

$A_s = \frac{9390 \times 12}{18000 \times .884 \times 20.5} = .344^{\square''}$ use 5/8" ϕ @ 1'-0" c.c.
(Diaphram will lower moment)

Max Moment in diaphram BE.

$38 \times 62.5 = 2380^{\#} - 150^{\#} = 2230^{\#/\square'}$

$mom = \frac{2230 \times 6^2}{12} = 6700'^{\#}$

$A_s = \frac{6700 \times 12}{18000 \times .884 \times 9} = .56^{\square''}$ use 7/8" ϕ @ 1'-6" c.c.

Bends and shears O.K.

Direct stress in walls above piles is O.K., see last page on wall at sta. 40+50.

WAR DEPARTMENT

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

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Subject Hartford, Conn. Ht-5

Computation Wall Thru Dutch Point Plant Sta 40+45±

Computed by M. S. Jr. Checked by Date 3/13/40

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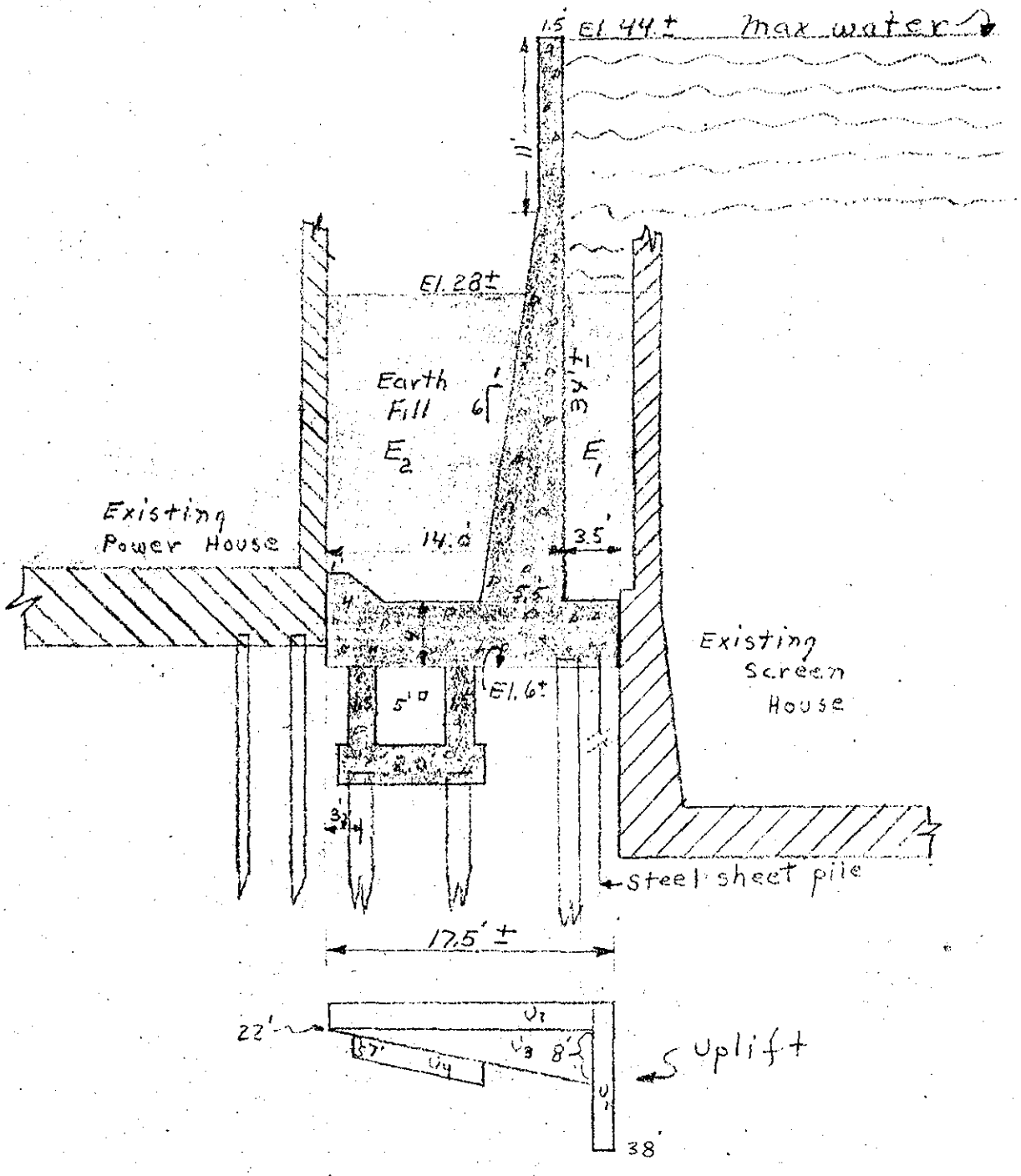


WAR DEPARTMENT

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

Project: Hartford Conn. H+5

Computation: Wall Thru Dutch Point Plant

Computed by: ..... Checked by: ..... Date: .....

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case I

Stability, River Up.

Forces	↓	↑	→	←	Arm	Moment at "A"	
C_1 150 x 34.5 x 1.5	7760				13.25	103,000	
C_2 150 x 24.5 x 4 x 1/2	7350				11.2	82,300	
C_3 150 x 17.5 x 3.5	9200				8.75	80,500	
C_4 (150 x 1.5 x 5) 2	2250				6.3	14,200	
C_5 150 x 2 x 8	2400				6.3	15,100	
E_1 3.5 x 18 x 125	7900				15.75	124,500	
E_2 10.5 x 18 x 125	23600				5.25	124,500	
W_1 3.5 x 16 x 62.5	3500				15.75	55,000	
W_2 5 x 5 x 62.5	1560				6.3	9,800	
P_w 38² x 1/2 x 62.5				45,000	12.7		571,000
Pe_1 22² x 1/2 x 17.5				4,220	7.3		30,800
Pe_2 22² x 1/2 x 80			19,300		7.3	141,000	
U_1 38 x 62.5 x 1.5		3560			16.75		59,500
U_2 22 x 62.5 x 16		22000			8.0		176,000
U_3 8 x 62.5 x 1/2 x 16		4000			10.7		42,800
U_4 7 x 62.5 x 8		3500			6.3		22,000
T = 49,220 − 19,300			29,920		5.0	150,000	
	65,520	33,060				897,900	902,100
	ΣV = 32,460#					ΣM = 2,200 1#	

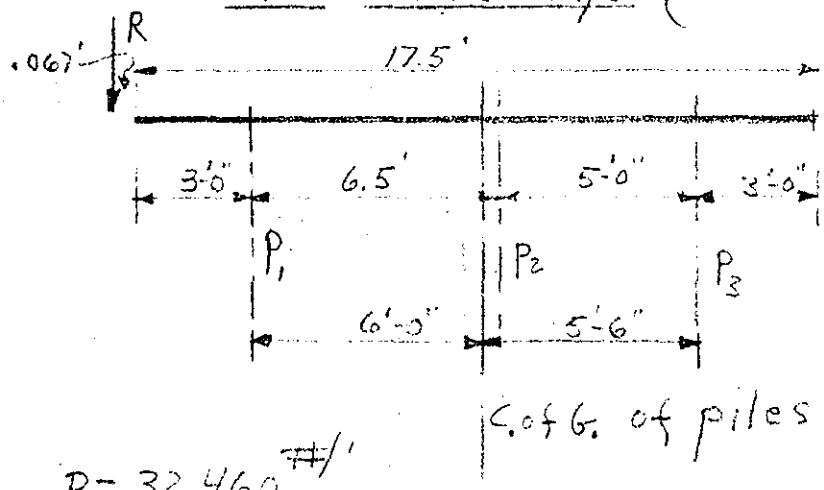
$\frac{\Sigma M}{\Sigma V} = .067'$ outside base, but O.K.

(see next page.)

Object Hartford, Conn. HTS
Computation Wall thru Dutch Point Plant
Computed by W. S. Jr. Checked by Date 3/14/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Pile Loadings (Case I)



$R = 32,460$ #/'

$\frac{32,460}{3} = 10,850$ # direct load per pile

Assume $P_2 = x$

$$P_1 = \frac{6.0}{5.5}x$$

$$P_2 = \frac{.5}{5.5}x$$

moment on pile group $= 32460^{\#} \times 9.067'$
$= 294,000'^{\#}$

$$x(5.5) + \frac{6.0}{5.5}x(6.0) + \frac{.5}{5.5}x(.5) = 294,000'^{\#}$$

$$5.5x + 6.54x + .0454x = 294,000'^{\#}$$

$$12.085x = 294,000'^{\#}$$

$$x = 24,300^{\#} = P_3 \downarrow$$

Loads from moment

$$P_1 = \frac{6}{5.5}(24,300) = 26,600^{\#} \uparrow$$

$$P_2 = \frac{.5}{5.5}(24,300) = 2,200^{\#} \downarrow$$

$$P_3 = 24,300^{\#} \downarrow$$

Subject Hartford Conn. H+S
Computation Wall Thru Dutch Point Plant
Computed by W. S. J. Checked by Date 3/14/40

U. S. GOVERNMENT PRINTING OFFICE 2—10533

Pile Loadings (Case-I)

Resultant loading from direct stress and bending.

$P_1 = 10{,}850 + 26{,}600 = 37{,}450$ #/ft. of wall ↑
$P_2 = 10{,}850 - 2{,}200 = 8{,}650$ #/ft. of wall ↑
$P_3 = 10{,}850 - 24{,}300 = 13{,}450$ #/ft. of wall ↓

Assume 3'-6" spacing of rear piles, "P_1".

$37{,}450 \times 3.5 = 130{,}000$# or 65 Tons on P_1

Assume 3'-6" spacing of middle piles, "P_2".

$8650 \times 3.5 = 30{,}000$# or 15 Tons on P_2

Assume 3'-6" spacing of front piles, "P_3".

$13{,}450 \times 3.5 = 47{,}000$# or 23.5 Tons withdrawl value on P_3.

Dead Wt. of $P_3 = \frac{256}{144} \times 150 \times 50 = 13{,}400$#

$47{,}000 - 13{,}400 = 33{,}600$ or 16.8 Tons withdrawl value. O.K.

Note: If the above pile loads are obtained, wall will be safe.

Punch Shear

Assume 18" square pile.

$18 \times 4 \times 30 = 2160$ □"

$\frac{130{,}000}{2160} = 60$ #/□" O.K.

Subject: Hartford, Conn. H+5
Computation: Wall Thru Dutch Point Plant
Computed by: M. S. Jr. Checked by: Date:

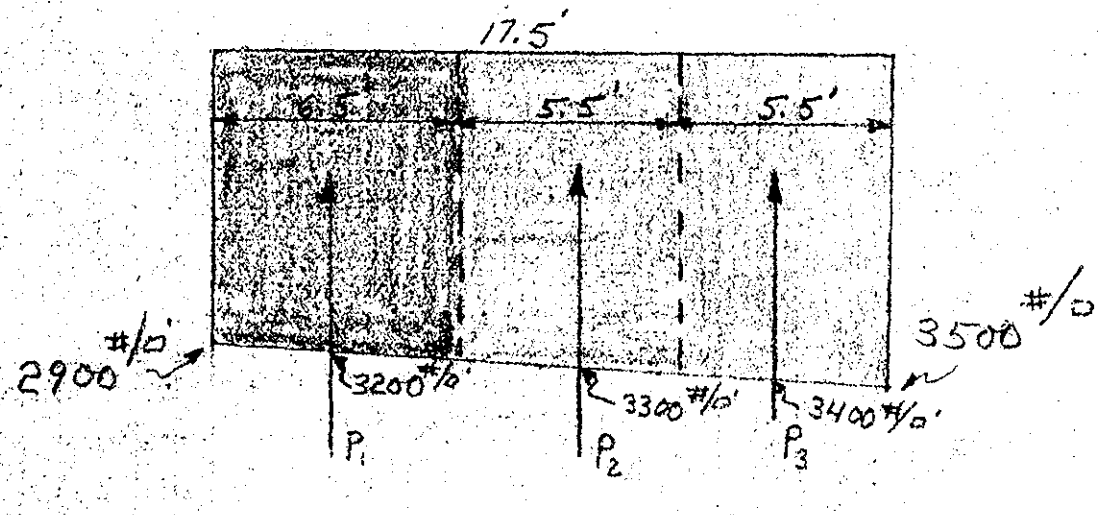
U.S. GOVERNMENT PRINTING OFFICE 3—10528

Case II
Stability, and Pile Loading, River Down

Forces	↓	↑	→	←	Arm	Moment at "A"
C_1	7760					103,000
C_2 See	7350					82,300
C_3 Case	9200					80,500
C_4 I	2250					14,200
C_5	2400					15,100
E_1 3.5 X 18 X 100	6300				15.75	99,000
E_2 10.5 X 18 X 100	18900				5.25	99,000
P_{e1}, P_{e2} Balances						
	54,160					493,100

$$\frac{\Sigma M}{\Sigma V} = 9.10' \quad \text{O.K.} \quad e = .35$$

$$\text{Bearing} = \frac{54160}{17.5}\left(1 \pm \frac{6 \times .35}{17.5}\right) = \begin{matrix} 3500 \ \#/\square' \\ 2900 \ \#/\square \end{matrix}$$



Subject: Hartford Conn. H+5
Computation: Wall Thru Dutch Point Plant
Computed by: W. S. J. Checked by: Date: 3/14/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

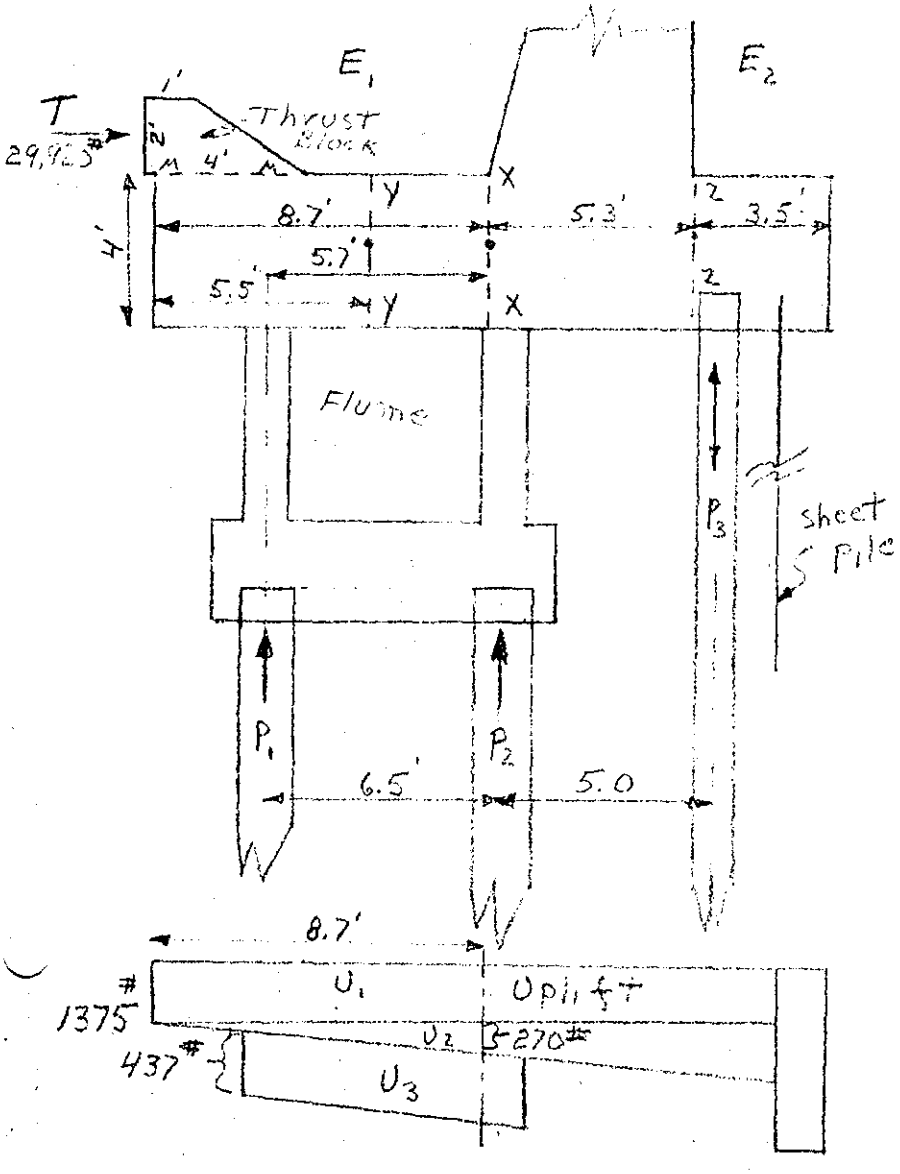
Pile Loadings (Case II)

$P_1 = 3200 \times 6.5 \times 3.5 = 73{,}000^{\#} = 36.5$ Tons

$P_2 = 3300 \times 5.5 \times 3.5 = 63{,}500^{\#} = 32$ Tons

$P_3 = 3400 \times 5.5 \times 3.5 = 65{,}000^{\#} = 32.5$ Tons O.K.

Design of Base



t Hartford, Conn. HT5
utation Wall Thru Dutch Point Plant
uted by N. S. Jr. Checked by Date 3/15/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Base

Moments at x-x

$U_1 = 1375 \times 8.7 = 12,000 \times 4.35 = 52,200'\#$
$U_2' = 270 \times \frac{1}{2} \times 8.7 = 1,175 \times 5.80 = 6,800'\#$
$U_3 = 437 \times 6.45 = 2,820 \times 3.22 = 9,060'\#$
$P_1 = \quad = 37,450 \times 5.7 = 214,000'\#$
$T = 29,920 \rightarrow \quad \times 2.5 = 74,600'\#$
$\uparrow V = 53,445\#$ $\circlearrowleft M = 356,660'\#$

$E_1 = 18 \times 8.7 \times 125 = 19,600 \times 4.35 = 85,100'\#$
$C_1 = 8.7 \times 4 \times 150 = 5,200 \times 4.35 = 22,700'\#$
$C_2 = 2 \times 3 \times 150 = 900 \times 7.2 = 6,500'\#$
$\downarrow V = 25,700\#$ $\circlearrowright M = 114,300'\#$

$\Sigma V = 27,745\# \uparrow$ $\Sigma M = 242,360'\# \circlearrowleft$

$d_{required} = \sqrt{\frac{242,360 \times 12}{123 \times 12}} = 44.5'' + 3.5''\text{ cover} = 48''$ O.K.

$\text{Shear} = \frac{27,745}{12 \times .884 \times 44.5} = 60\#/\square''$ O.K.

$A_s = \frac{242,360 \times 12}{18000 \times .884 \times 44.5} = 4.1\ \square''$

Use 2 rows of steel, 4" between rows.
"d" to c. of g. of rows becomes 42.5" ±

$A_s = 4.1 \times \frac{44.5}{42.5} = 4.3\ \square''$ Use $1\frac{1}{8}''\square$ @ 6" c.c. and 1"□ @ 6" c.c.

Bond

$u = \frac{27,745}{17 \times .884 \times 42.5} = 46\#/\square''$ O.K.

Project: Hartford Conn. H+5
Computation: Wall Thru Dutch Point Plant
Computed by: M. & J. Checked by: Date: 3/15/40

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Design of Base

Moment at Y-Y

$U_1 = 1375 \times 5.5 = 7560 \quad \times 2.75 = 20800'\#$
$U_2 = 170 \times \frac{1}{2} \times 5.5 = 467 \quad \times 3.66 = 1710'\#$
$U_3 = 437 \times 3 = 1300 \quad \times 1.5 = 1950'\#$

$P_1 = \quad = 37450 \quad \times 2.5 = 93600'\#$
$T = 29,920 \quad \times 2.5 = 74600'\#$

$\uparrow V = 46,777 \quad \circlearrowleft M = 192,660$

$E_1 = 18 \times 5.5 \times 125 = 12400 \quad \times 2.75 = 34,100$
$C_1 = 5.5 \times 4 \times 150 = 3300 \quad \times 2.75 = 9,100$
$C_2 = 2 \times 3 \times 150 = 900 \quad \times 4.0 = 3,600$

$\downarrow V = 16,600 \quad \circlearrowleft M = 46,800$

$\Sigma V = 30,177\# \uparrow \quad \Sigma M = 145,860'\# \circlearrowleft$

"d" is O.K.

$$\text{Shear} = \frac{30,177}{12 \times .884'' \times 44.5} = 65^{\#/\square''} \text{ O.K.}$$

$$A_s = \frac{145,860 \times 12}{18000 \times .884 \times 44.5} = 2.47^{\square''} \qquad \text{Use } 1\tfrac{1}{8}''\square \text{ @ } 6''\text{ cc}$$

Bond

$$u = \frac{30,177}{9 \times .884 \times 42.5} = 90^{\#/\square''} \text{ O.K.}$$

Moment at 2-2

$E_2 = 18 \times 3.5 \times 125 = 7700 \quad \times 1.75 = 13,800'\#$
$W = 3.5 \times 16 \times 62.5 = 3500 \quad \times 1.75 = 6,120'\#$
$C = 4 \times 3.5 \times 150 = 2100 \quad \times 1.75 = 3,680'\#$
$P_3 \downarrow = (\text{withdrawl}) = 13450\# \quad \times .5 = 6,720'\#$

$\downarrow V = 26,950 \quad \circlearrowleft M = 30,320'\#$

$U_1 = 1.5 \times 62.5 \times 38 = 3560 \quad \times 2.75 = 9,790'\#$
$U_2 = 30 \times 62.5 \times 2 = 3750 \quad \times 1 = 3,750'\#$
$\uparrow V = 7,310\# \quad \circlearrowleft M = 13,540'\#$

(over)

Subject Hartford, Conn. Ht 5
Computation Wall Thru Dutch Paint Plant
Computed by W. S. Checked by Date 3/15/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Moment at Z-Z

$\Sigma V = 19,640^{\#}\downarrow$ $\Sigma M = 16,780'^{\#}$

Shear O.K. Temp. steel O.K.

Moment at X-X (River Down, Case II)

$E = 18 \times 8.7 \times 100 = 15700^{\#} \times 4.35 = 68,000'^{\#}$
$C_1 = 8.7 \times 4 \times 150 = 5200^{\#} \times 4.35 = 22,700'^{\#}$
$C_2 = 2 \times 3 \times 150 = 900^{\#} \times 7.2 = 6,500'^{\#}$
$\downarrow V = 21,800^{\#}$ $\circlearrowleft M = 97,200'^{\#}$

$P_1 = 20,800^{\#} \times 5.7 = 118,500'^{\#}$

$\Sigma V = 1,000^{\#}\downarrow$ $\Sigma M = 21,300'^{\#}$

Steel required for Case I governs.

Moment at Z-Z (Case II)

$E_1 = 3.5 \times 18 \times 100 = 6300^{\#} \times 1.75 = 11,000'^{\#}$
$C = 3.5 \times 4 \times 150 = 2100^{\#} \times 1.75 = 3,670'^{\#}$
$V = 8,400^{\#}$ $M = 14,670'^{\#}$

$P_3 = 21,700^{\#} \times .5 = 10,900'^{\#}$

$\Sigma V = 13,300^{\#}$ $\Sigma M = 13,770'^{\#}$

Temp steel O.K.

Stress in Base due to Direct Thrust

$T = 29,920^{\#/'}$ Assume load taken by concrete above neutral axis.

$.35 \times 44.5 = 15.7''$

$\frac{29,920}{15.7 \times 12} = 157^{\#/\square''}$ O.K. { We are using a low conc. stress (800#/□

Project Hartford, Conn.
Computation Wall Thru Dutch Paint Plant
Computed by W. S. Jr. Checked by Date 3/21/40

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Design of Thrust Block (See page 289

Thrust = 29,920 #/'

Bearing on concrete = $\frac{29,920}{24 \times 12}$ = 104 #/□" O.K.

Shear along M-M = $\frac{29,920}{48 \times 12}$ = 52 #/□" O.K.

Moment on M-M

$29,920 \times 1 = 29,920$ '#

$A_s = \frac{29,920 \times 12}{18000 \times .884 \times 45} = .5$ □"

WAR DEPARTMENT

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

Project: HARTFORD, CONN. - HT. 5

Computation: 35' STEM

Computed by: T.A.C. Checked by: Date: 3/19/40

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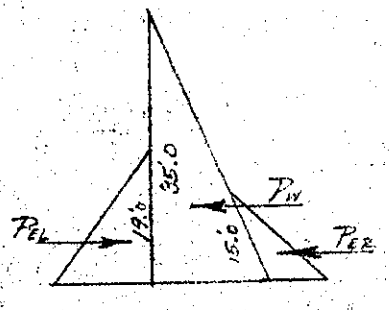
STEEL IN STEM - RIVER UP

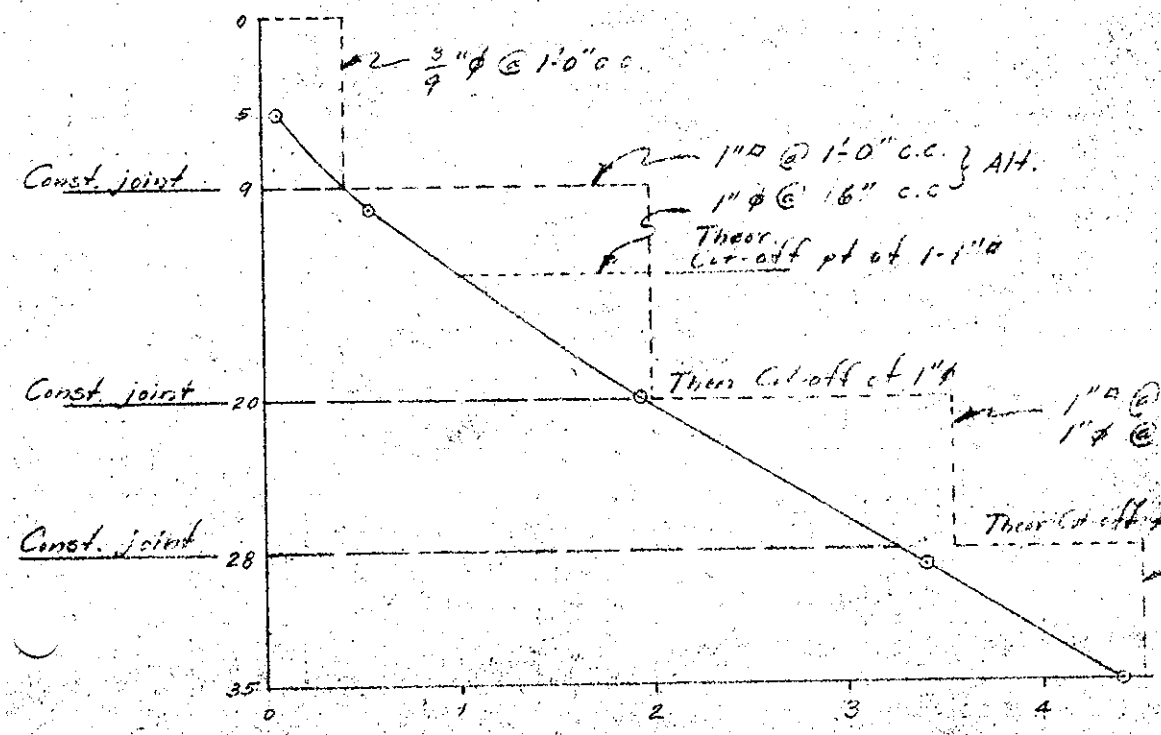


	→	←	Arm	↻	↺
$P_{IN} = \frac{1}{2} \times \overline{35}^2 \times 62.5$		38,300	11.67		447,000
$P_{ER} = \frac{1}{2} \times \overline{15}^2 \times 17.5$		1,970	5.0		9,850
$P_{EL} = \frac{1}{2} \times \overline{19}^2 \times 80$	14,440		6.33	91,400	
	14,440	40,270		91,400	456,850
		−14,440			−91,400
$\Sigma V =$		25,830#		$\Sigma M =$	365,450

$$d_{REQ} = \sqrt{\frac{365,450}{12}} = \sqrt{2970} = 54.5''$$

$$A_S = \frac{12 \times 365,450}{18,000 \times .884 \times 62.5} = 4.41 \square''$$

Steel Curve drawn similar to 32'-0" wall



WAR DEPARTMENT

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

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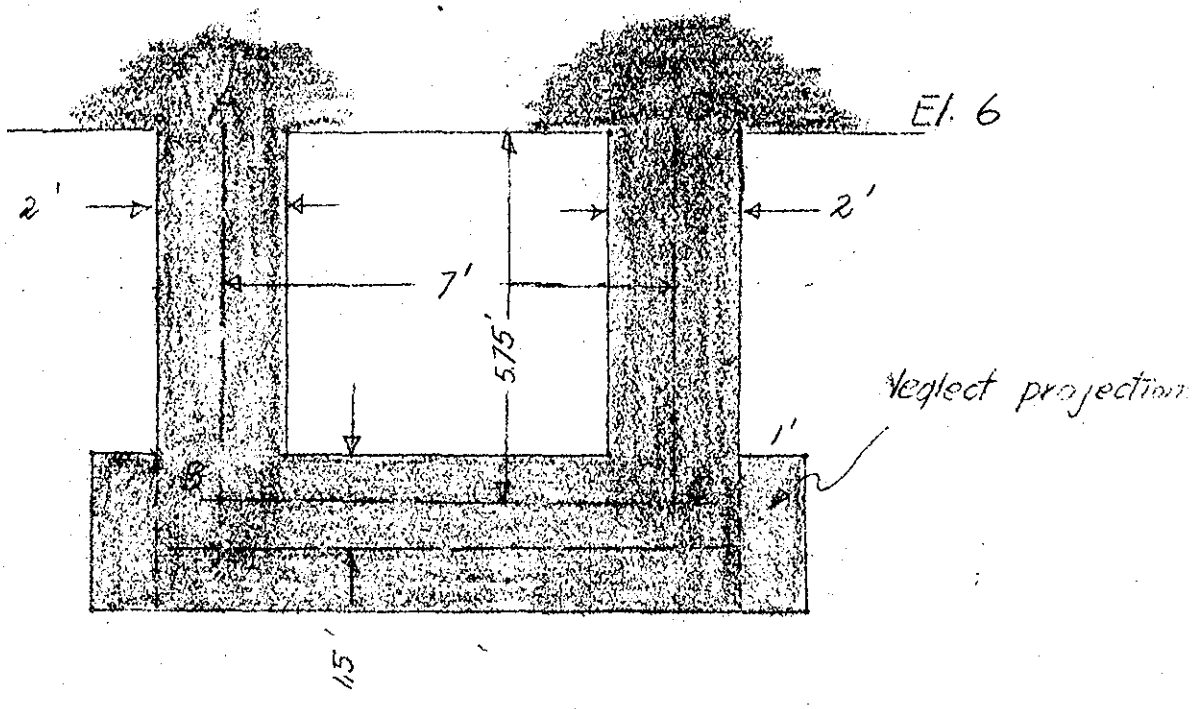
Subject: Hartford - Conn Ht-5

Computation: Wall thru Dutch Point Pkwy

Computed by: R.H.M. Checked by: Date:

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Conduit

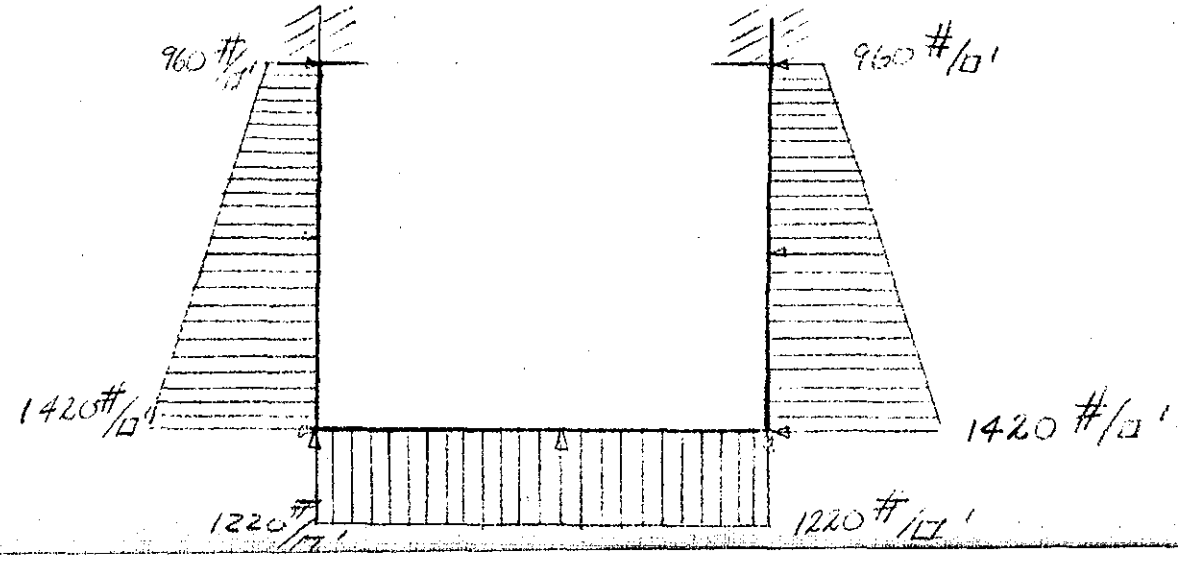


Relative Stiffness Factors

$$BA, CD = \frac{2^3}{5.75} = 1.39$$

$$BC = \frac{1.5^3}{7} = .48$$

Loading diagram Case I Saturated earth to El. 18



Project: Hartford - Conn (Ht-5)
Computation: Weir thru Dutch Point Plant
Computed by ..... Checked by ..... Date .....

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Design of Conduit

Slab AB, DC

$$+M = \frac{5.75^2}{16}(2 \times 960 + 460) = 4930 \text{ '\#}$$

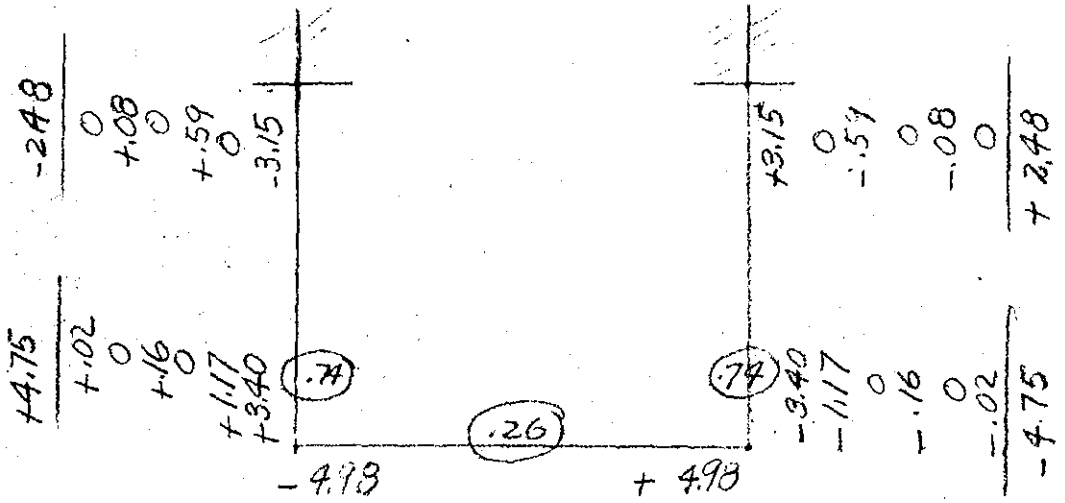
$$-M_A = -M_B = \frac{960 \times 5.75^2}{12} + \frac{230 \times 5.75^2}{15} = 3150 \text{ '\#}$$

$$-M_B = -M_C = \frac{960 \times 5.75^2}{12} + \frac{230 \times 5.75^2}{10} = 3400 \text{ '\#}$$

Slab BC

$$+M = \frac{1220 \times 7^2}{8} = 7480 \text{ '\#}$$

$$-M = \frac{1220 \times 7^2}{12} = 4980 \text{ '\#}$$



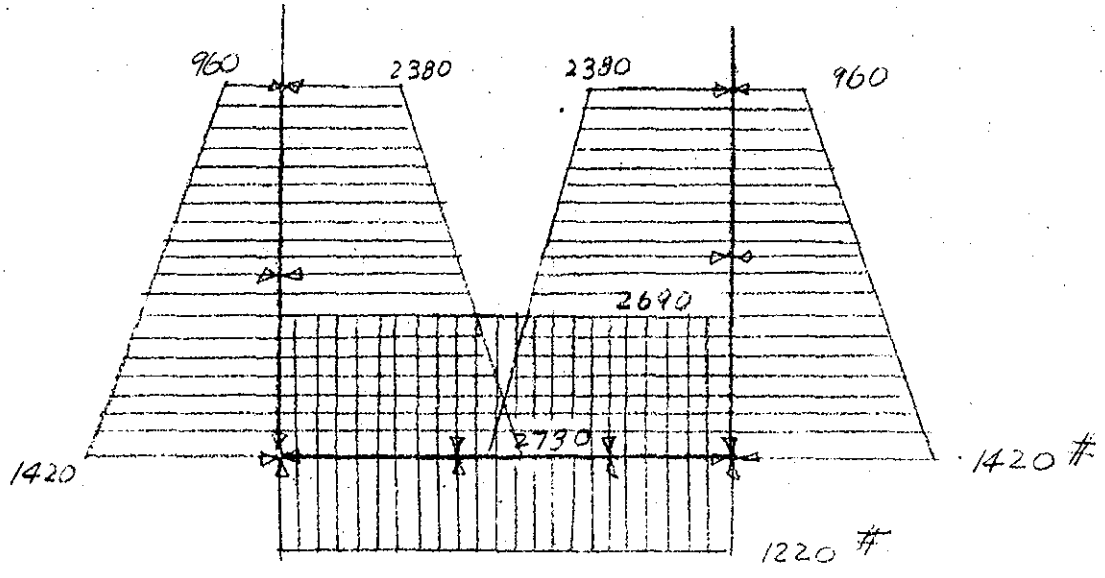
-4.98	+4.98
+.41	-.41
-.21	+.21
+.05	-.05
-.03	+.03
+.01	-.01
-4.75	+4.75

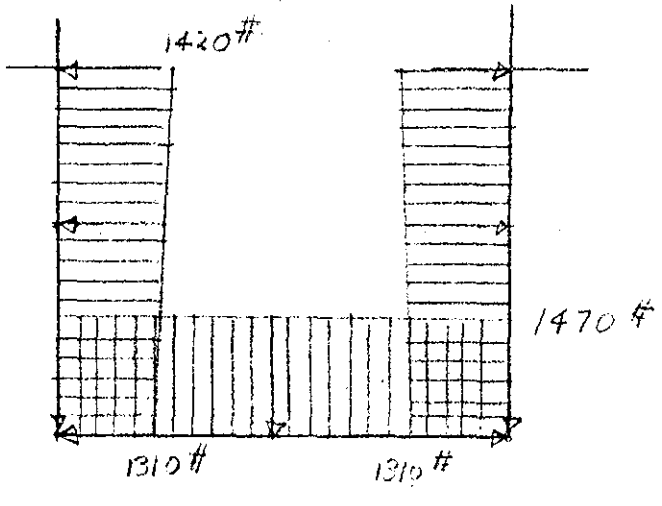
Project Hartford-Conn Ht-5
Computation Wall thru Dutch Point Plant
Computed by ..... Checked by ..... Date .....

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Conduit

Loading diagram Case II Sat earth to El. 18
River at El. 44





Assume 1420 #/□ is uniform over side walls

Ject Hartford (Hts)
Computation Wall thru Dutch Point Plant
Computed by ..... Checked by ..... Date .....

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Conduit

Slab AB, DC

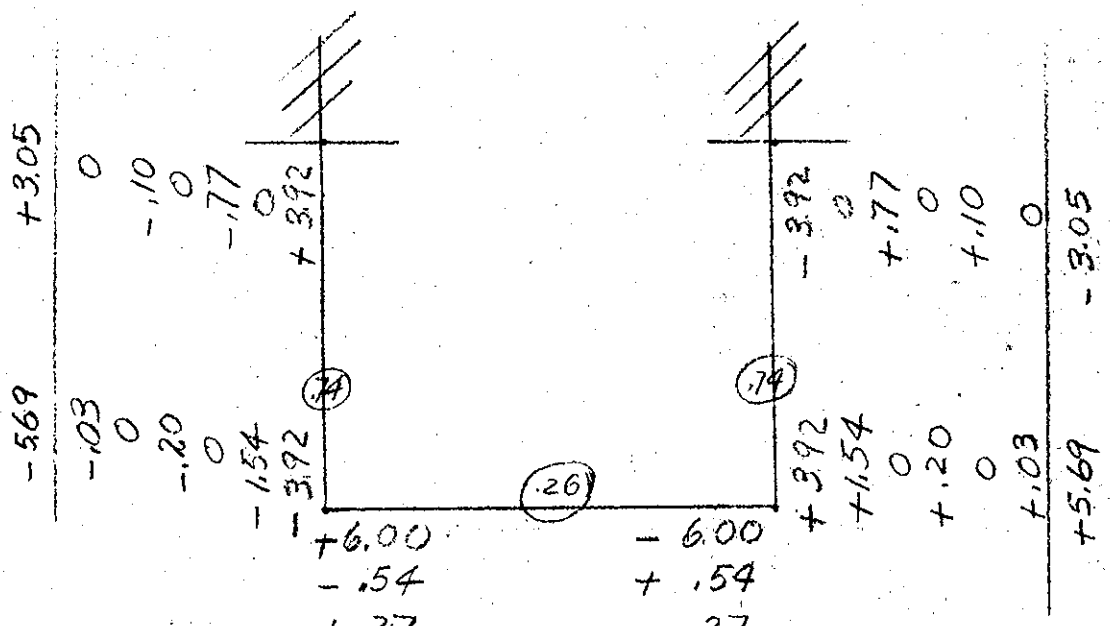
$$+M = \frac{1420 \times 5.75^2}{8} = 5860 \text{ '\#}$$

$$-M = \frac{1420 \times 5.75^2}{12} = 3920 \text{ '\#}$$

Slab BC

$$+M = \frac{1470 \times 7^2}{8} = 9010 \text{ '\#}$$

$$-M = \frac{1470 \times 7^2}{12} = 6000 \text{ '\#}$$



+6.00	−6.00
−.54	+.54
+.27	−.27
−.07	+.07
+.04	−.04
−.01	+.01
+5.69	−5.69

ect Hartford Conn Ht 5
putation Wall Thru Dutch Point Plant Sta 40+45±
puted by W. S. Jr. Checked by Date 3/21/40

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Design of Conduit

Max Moment = 5,690'# in base slab.

$d = 13.5''$

$A_s = \frac{5,690 \times 12}{18000 \times .884 \times 13.5} = .316^{\square''}$ $\frac{5}{8}''\phi$ @ 1'-0"

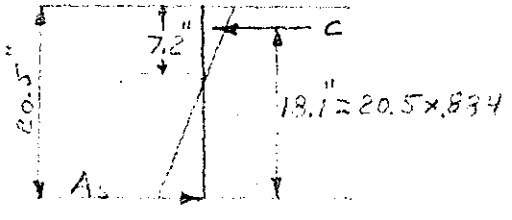
Use $\frac{5}{8}''\phi$ @ 1'-0" c.c. in entire conduit, except longitudinal temp steel which will be $\frac{1}{2}''\square$ @ 1'-0" c.c.

Shear and bond OK.

Concrete Stress in Conduit Wall over P_1

Stress due to moment

$d = 20.5''$ $K = .35$ $Kd = 7.2''$



Max Moment = 5,690'# = 68,100"#

$\frac{68,100}{18.1} = 3760^{\#} = C$

$\frac{3760}{7.2 \times 12} = 44^{\#/\square''} \times 2 = 88^{\#/\square''}$

max f_c due to bending

Stress due to P_1

$P_1 = 130,000^{\#}$ $\frac{130,000}{3.5} = 37,450^{\#/ft}$

Assume load taken by 7.2" above axis.

$\frac{37,450}{7.2 \times 12} = 430^{\#/\square''}$ direct load $430 + 88 = 518^{\#/\square''} = f_c$ O.K.

WAR DEPARTMENT

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

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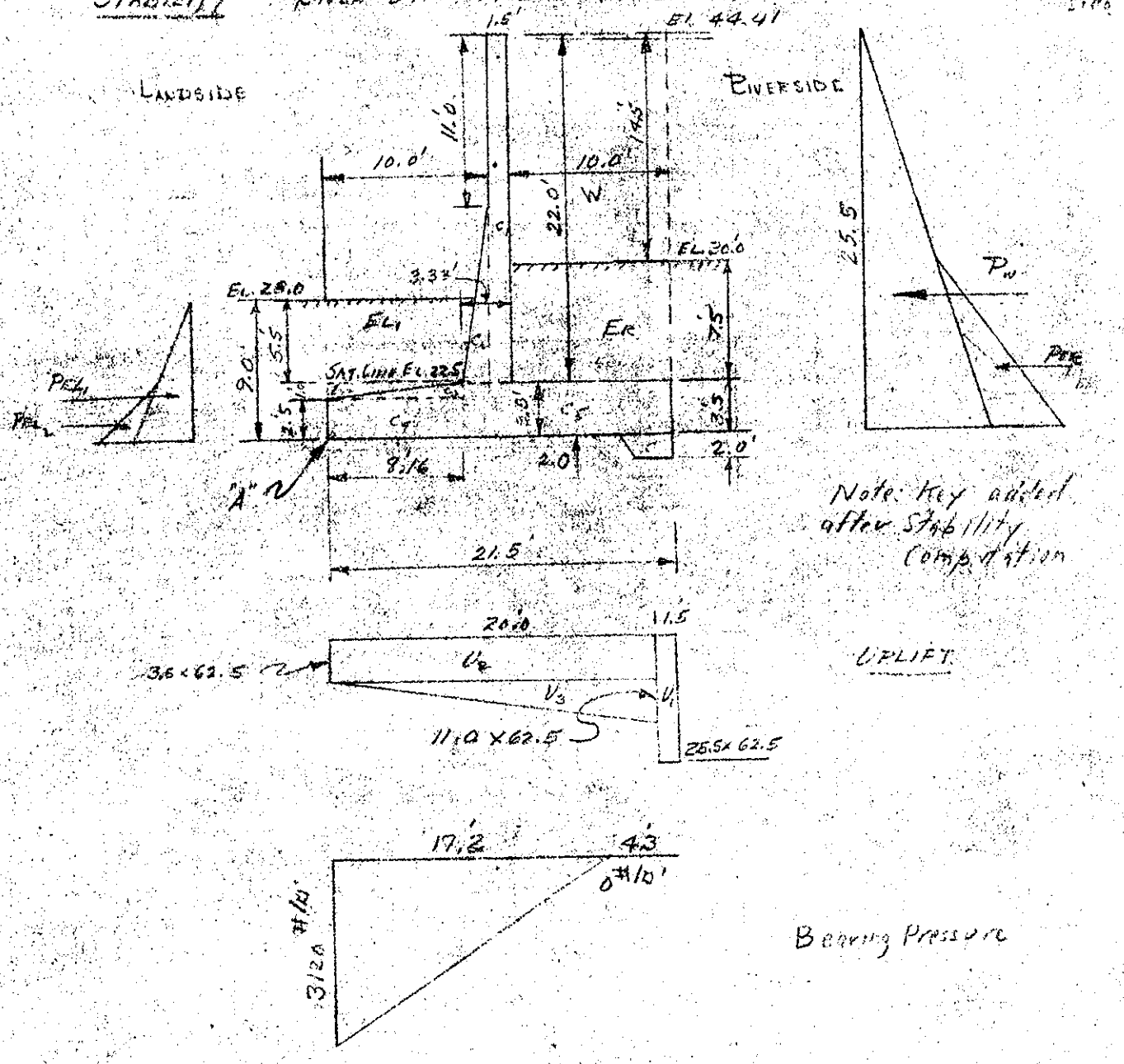
Subject Ht 5 Hartford Sta 41+00± to 42+07

Computation 22' Wall on Piles South of Dutch Point Plant

Computed by PLA Checked by R. W. Date 3/13/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

STABILITY - RIVER UP - FILL UP TO El. 28 on land side, El. 30 on river side



WAR DEPARTMENT

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

Subject: Ht 5 Hartford

Computation: 22' Wall

Computed by: PLA Checked by: RW Date: 3/13/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STABILITY CASE I RIVER UP

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT 'A' ↷	↶
W	10 × 14.5 × 62.5	9050				16.5	149500	
E_{L1}	8.16 × 5.5 × 100	4490				4.08	18,300	
E_{L2}	½ × 8.16 × 1.0 × 125	510				2.72	1,390	
E_{R1}	10.0 × 7.5 × 125	9,360				16.5	154500	
C_1	1.5 × 22 × 150	4,950				10.75	53,200	
C_2	½ × 1.8.3 × 11 × 150	1,510				9.39	14,200	
C_3	½ × 8.16 × 1.0 × 150	610				5.44	3,320	
C_4	8.16 × 2.5 × 150	3,060				4.08	12,500	
C_5	13.34 × 3.5 × 150	7,000				14.83	104,000	
P_W	½ × $\overline{25.5}^2$ × 62.5				20,200	8.5		172,500
P_{ER}	½ × $\overline{11}^2$ × 17.5				1060	3.67		3880
P_{EL1}	½ × 9² × 35			1420		3.0	4260	
P_{EL2}	½ × 45 × $\overline{3.5}^2$			276		1.17	320	
U_1	25.5 × 62.5 × 1.5		2390			20.75		49500
U_2	3.5 × 62.5 × 20.0		4370			10.0		43700
U_3	½ × 11.0 × 62.5 × 20.		6880			13.33		91600
LR	LATERAL R OF PILES			19664				
		40,540	13640	21360	21360		515490	361,180
		ΣV = 26900 ↓		ΣH = 0			ΣM = 154310 ↷	

Position of Resultant = $\frac{\Sigma M}{\Sigma V}$ = $\frac{154300}{26900}$ = 5.74' ⅓ BASE = $\frac{21.5}{3}$ = 7.17'

[illegible] = $\frac{26900}{2 \times 5.74} \times \begin{cases} 2 \\ 0 \end{cases}$ = $\frac{26900}{17.22} \times \begin{cases} 2 \\ 0 \end{cases}$ = 3120 #/□' Land; 0 #/□' River

WAR DEPARTMENT

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

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Subject Ht 5

Computation 22' Wall on Piles South of Dutch Point Plant

Computed by PLA Checked by R.W. Date 4-18-40

U. S. GOVERNMENT PRINTING OFFICE 2—10523

Stability Case II River Down

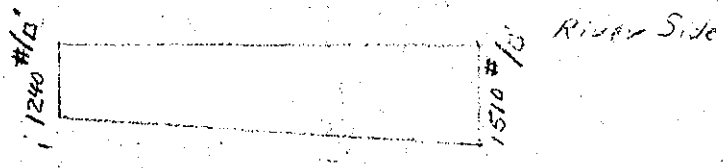
Forces Acting		↓	↑	→	←	Arm	Moments about A ↻	↺
EL1	8.16 × 5.5 × 100	4500				4.09	18400	
EL2	½ × 8.6 × 1 × 100	410				2.72	1120	
ER	10 × 7.5 × 100	7500				16.5	124000	
C1		4950				10.75	53200	
C2		1510				9.34	14200	
C3		610				5.44	3320	
C4		3060				4.08	12500	
C5		7000				14.83	104000	
PEL	½ × 35 × 9.0²			1420		3.0	4260	
PER	½ × 35 × 11²				2120	3.67		7800
		29540		1420	2120		335000	7800
		ΣV = 29540 ↓		ΣH = 0			ΣM = 327200 ↻	

Position of Resultant

$$\frac{\Sigma M}{\Sigma V} = \frac{327000}{29500} = 11.1' \qquad \frac{2}{3}\text{ base} = 14.33'$$

$$e = 11.1 - 10.75 = 0.35'$$

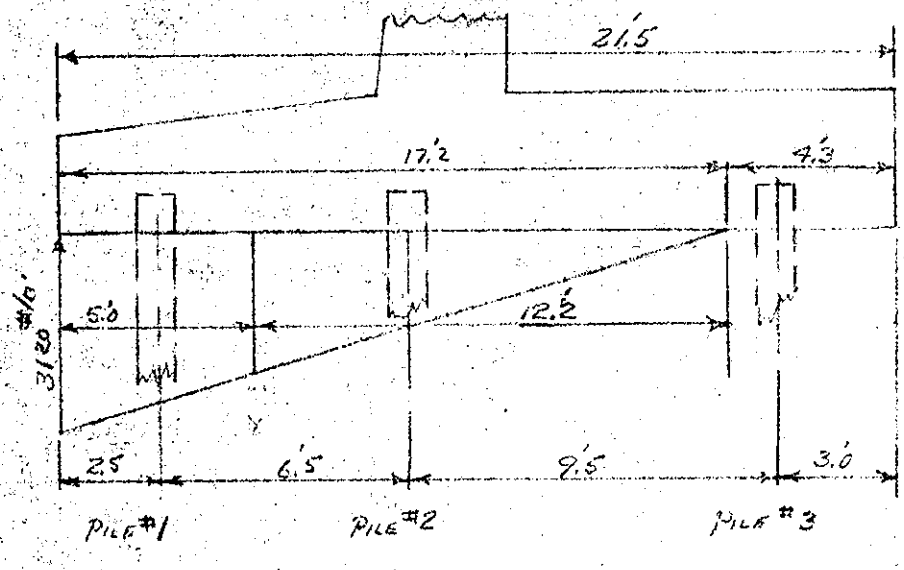
Base Pressure $\frac{29500}{21.5} \times \left(1 \pm \frac{6 \times 0.35}{21.5}\right) = 1370 \begin{cases} 1510 \ \#/\square' \\ 1240 \ \#/\square' \end{cases}$ River



Subject HLS HARTFORD
Computation WALL ON PILES SOUTH OF DUTCH PT. PLANT
Computed by PLA Checked by R.W. Date 3/20/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

BASE PRESSURE & PILE LOADING
CASE I RIVER UP



LOADING ON PILE #1

$5.0 \times \left(\frac{3120 + 2210}{2}\right) = 13320^{\#}$ PER LIN. FT. OF WALL

ALLOWABLE LOAD ON PILE = $60000^{\#}$

PILE SPACING ALONG WALL = $\frac{60000}{13320} = 4.5'$ USE $4.0'$

PILE #2

$12.2 \times \frac{2210}{2} = 13500^{\#}$ PER LIN. FT OF WALL

PILE SPACING ALONG WALL = $\frac{60000}{13500} = 4.45'$ USE $4.0'$

PILE #3 ZERO

Subject HT 5 Sta. 41+00 - 42+07
Computation 22' Wall on Piles
Computed by RW Checked by Date 3-25-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Lateral Stability

Unbalanced Force = 19,664 # per foot
= 4 × 19,664 # = 78,700 # in 4'

Shearing value of piles =
3 × 12 × 12 × 60 = 25,900 # for 4'

Leaves unbalanced force of
78,700
− 25,900
52,800 # for 4'

Passive Resistance possible to develop
$= \frac{w h^2}{2} (2.46)$

w = 100 # / cu. ft
h, (counting 18' of sheet pile) = 28 − 18 = 10'

Passive resistance = $\frac{100 \times 10^2}{2} \times 2.46$

= 12,300 # per ft.
× 4 = 49,200 # for 4'

49,200 < 52,800
So - Need Key

With 2' Key, h = 12'
PR = $\frac{100 \times 144}{2} \times 2.46$ = 17,700 # per lin. ft

× 4 = 70,800 # for 4'

70,800 > 52,800 #

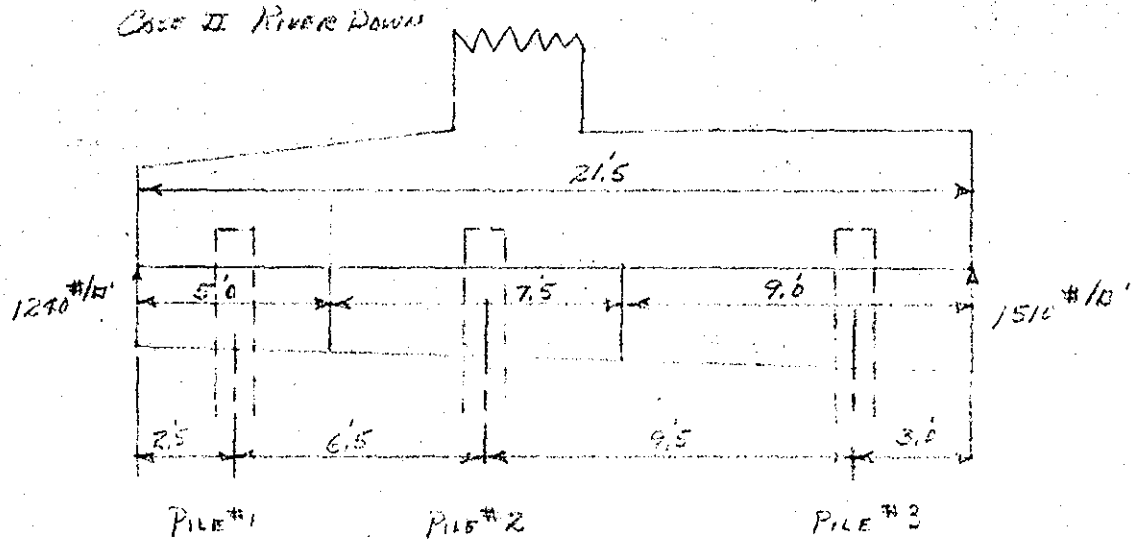
So 2' Key will be sufficient throughout length of wall.

Subject HTS HARTFORD
Computation WALL ON PILES SOUTH OF DUTCH POINT PLANT
Computed by PLA Checked by RW Date 3/20/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

BASE PRESSURE & PILE LOADING

CASE II RIVER DOWN



LOADING ON PILE #3

$$9.0 \times \left(\frac{1510 + 1377}{2}\right) = 13100^{\#} \text{ PER LIN. FT. OF WALL}$$

PILE SPACING ALONG WALL $\frac{60000}{13100} = 4.58$ USE 4.0'

PILE #2

$$7.5 \times \left(\frac{1377 + 1357}{2}\right) = 10100^{\#} \text{ PER LIN. FT. OF WALL}$$

CASE I GOVERNS USE 4.0 SPACING

PILE #1

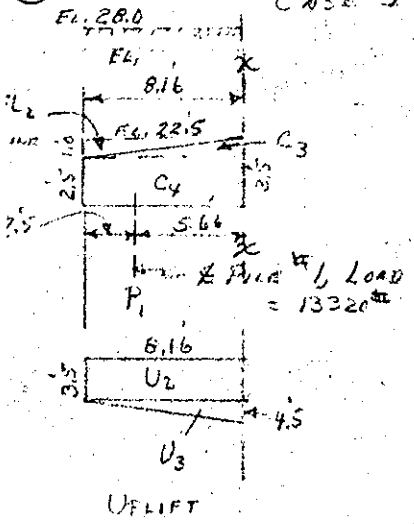
$$5.0 \times \left(\frac{1363 + 1240}{2}\right) = 6360^{\#} \text{ PER LIN. FT. OF WALL}$$

CASE I GOVERNS USE 4.0 SPACING

Subject: Hartford Hts
Computation: Wall on Piles South of Dutch Pt. Plant
Computed by: F.L.A. Checked by: R.W. Date: 3/20/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Design of Base Landside Bottom Steel
Case I River Up

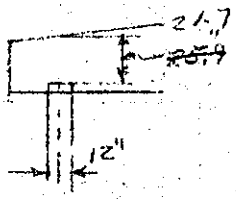


Uplift

Moments About X-X

Forces Acting		↓	↑	Arm	Moments ↷	Moments ↶
EL_1		4490				18300
EL_2		510		5.44		7780
C_3		610		2.72		1660
C_4		3060		4.08		12500
U_2	3.5×8.16×62.5		1790	4.08	7300	
U_3	½×4.5×8.16×62.5		1150	2.72	3130	
P_1			13320	5.66	75500	
		8670	16260		85930	35240
		ΣV = 7590 ↑			ΣM = 50690 ↷	

Piles Spaced 4'-0" o.c. Along Wall. Use 12" Piles



$$\text{Punching Shear} = \frac{13320 \times 4}{21.7 \times 12 \times 4} = 42.9^{\#/\square''} \text{ O.K.}$$

Actual $d = 30.0 - 4.5 = 25.5''$

$$d_{X-Y}(\text{Req'd}) = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{50700 \times 12}{123 \times 12}} = 20.3''$$

$$A_{s_{X-X}}(\text{Req'd}) = \frac{M}{f_s j d} = \frac{50700 \times 12}{18000 \times .884 \times 25.5} = 1.51^{\square''}$$

$$\text{Shear}_{X-X} = \frac{V}{bjd} = \frac{7590}{12 \times .884 \times 25.5} = 28.0^{\#/\square''} < 60^{\#/\square''}$$

Use 1"φ @ 6" o.c.

$$\text{Bond}_{X-X} = \frac{V}{\Sigma_0 jd} = \frac{7590}{6.3 \times .884 \times 25.5} = 53.3^{\#/\square''} < 150^{\#/\square''}$$

WAR DEPARTMENT

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

Subject: HARTFORD HLS

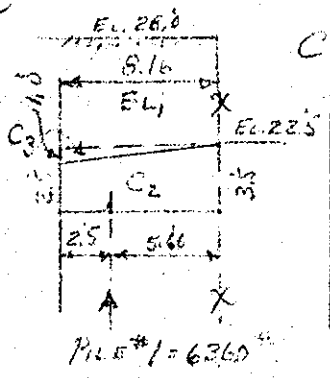
Computation: WALL ON PILES SOUTH OF DUTCH PT. PLANT STA 122 BASE 21.5

Computed by: P.L.A. Checked by: R.W. Date: 3/20/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF BASE CONT'D LANDSIDE BOTTOM STEEL

CASE II RIVER DOWN NO UPLIFT



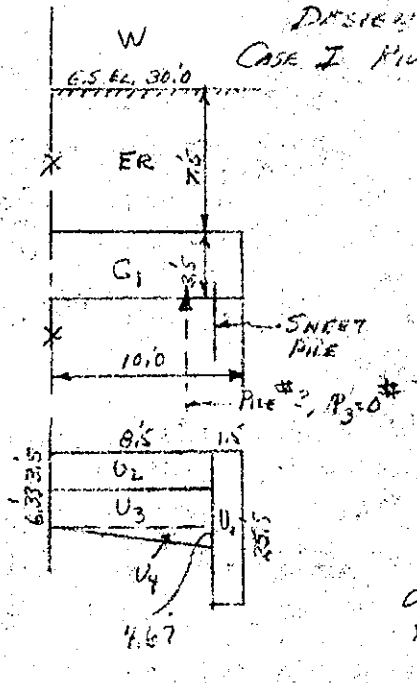
MOMENTS ABOUT X-X

FORCES ACTING		↓	↑	ARM	MOMENTS ↻	MOMENTS ↺
EL1	8.16x5.5x100	4500		4.08		18400
C2	3.5x8.16x150	4290		4.08		17500
C3	½ x1.0x8.16x50		204	5.44	1110	
P1			6360	5.66	36000	
		8790	6564		37110	35900
		ΣV = 2226 ↓			ΣM = 1210 ↻	

CASE I GOVERNS USE 1"⌀ @ 6" C.C.

DESIGN OF BASE RIVERSIDE TOP STEEL

CASE I RIVER UP



FOR MOMENTS ABOUT X-X

FORCES ACTING		↓	↑	ARM	MOMENTS ↻	MOMENTS ↺
W	14.5x10x62.5	9050		5.0	45300	
ER	7.5x10x125	9380		5.0	46900	
C1	3.5x10x150	5250		5.0	26200	
U1	25.5x1.5x62.5		2390	9.25		22100
U2	3.5x8.5x62.5		1860	4.25		7900
U3	6.33x8.5x62.5		3360	4.25		14300
U4	½x4.67x8.5x62.5		1240	5.67		7050
		23680	8850		118400	51250
		ΣV = 14830 ↓			ΣM = 67050 ↻	

$$d_{X-X}(\text{REQ'D}) = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{67050 \times 12}{123 \times 12}} = 23.4'' \quad \text{ACTUAL } d = 30.0 - 3.5 = 26.5''$$

$$A_{s\,X-X} = \frac{M}{f_s j d} = \frac{67050 \times 12}{18000 \times .884 \times 26.5} = 1.92^{\square''}$$

$$\text{SHEAR}_{X-X} = \frac{\Sigma V}{b j d} = \frac{14830}{12 \times .884 \times 26.5} = 52.6^{\#/\square''} < 60^{\#/\square''}$$

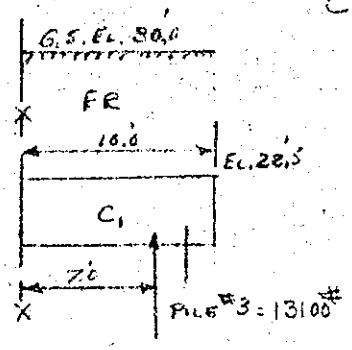
$$\text{BOND}_{X-X} = \frac{\Sigma V}{\Sigma_0 j d} = \frac{14830}{8.0 \times .884 \times 26.5} = 79.3^{\#/\square''} < 150^{\#/\square''}$$

USE 1"⌀ @ 6" C.C.

Subject: HARTFORD HTS
Computation: CANTILEVER WALL ON PILES SOUTH OF DUTCH PT. PLANT
Computed by: P.L.A. Checked by: R.W. Date: 3/21/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF BASE CONT'D RIVERSIDE BOTTOM STEEL
CASE II RIVER DOWN & NO UPLIFT



MOMENTS ABOUT X-X

FORCES ACTING		↓	↑	ARM	MOMENTS ↻	MOMENTS ↺
FR	7.5 X 10 X 100	7500		5.0	37500	
C_1	3.5 X 10 X 150	5250		5.0	26200	
P_3			13100	7.0		91700
		12750	13100		63700	91700
		ΣV = 350 ↑			ΣM = 28000 ↻	

$$A_{s_{X-X}} = \frac{M}{f_s j d} = \frac{28000 \times 12}{18000 \times .889 \times 25.5} = 0.83 \square''$$

USE $\frac{3}{4}''\square$ @ 8" C.C.

CONSIDER BASE AS A BEAM FROM PILE TO PILE ALONG THE WALL. PILES SPACED AT 4'0.
MAXIMUM BEARING = 3120#/□'

$$M = \frac{wl^2}{10} = \frac{3120 \times 4^2}{10} = 5000'\#$$

$$R = \frac{wl}{2} = \frac{3120 \times 4}{2} = 6240\#$$

$$A_s = \frac{M}{f_s j d} = \frac{5000 \times 12}{18000 \times .889 \times 25.5} = 0.15 \square''$$

USE $\frac{1}{2}''\square$ @ 1'-0" C.C. FOR FULL WIDTH.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. Page 309

Subject: HTS HARTFORD

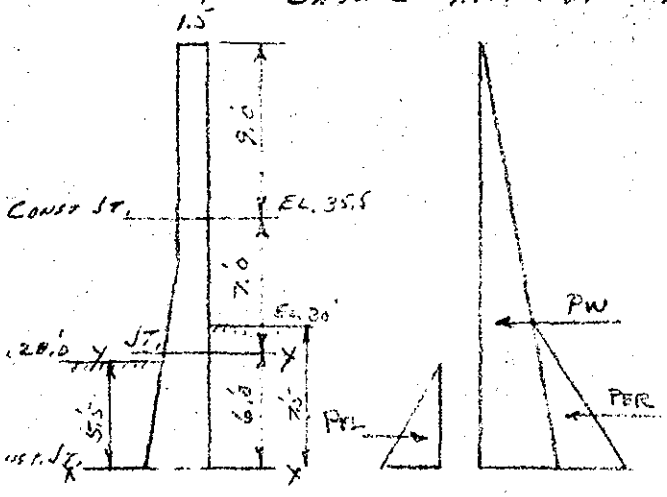
Computation: CANTILEVER WALL ON PILES SOUTH OF DUTCH PT. PLANT.

Computed by: PLA Checked by: R. W. Date: 3/21/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

DESIGN OF STEM

CASE I RIVER UP RIVERSIDE FACE



MOMENTS ABOUT X-X

FORCES ACTING		→	←	ARM	MOMENTS ↷	MOMENTS ↶
PW	$\frac{1}{2} \times 62.5 \times \overline{22}^2$		15100	7.33		111000
PER	$\frac{1}{2} \times 17.5 \times \overline{7.5}^2$		490	2.5		1230
PEL	$\frac{1}{2} \times \cancel{80}\ 35 \times \overline{5.5}^2$	590 ~~1210~~		1.83	1080 ~~2220~~	
		1210	15590		2220	112230
		ΣV = 14380 ←			ΣM = 111,150 ↶	

$$d_{X-X}\ \text{REQ'D} = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{110000 \times 12}{123 \times 12}} = 29.8''$$

ACTUAL $d = 40.0 - 3.5 = 36.5''$

$$A_{s_{X-Y}}(\text{REQ'D}) = \frac{M}{f_s j d} = \frac{\cancel{110000}\ 111{,}150 \times 12}{18000 \times .884 \times 36.5} = \cancel{2.28}\ 2.30\ \square''$$

$$\text{SHEAR}_{X-X} = \frac{\Sigma V}{bjd} = \frac{14380}{12 \times .884 \times 36.5} = 37.0\ \#/\square'' < 60\ \#/\square''$$

$$\text{BOND}_{X-X} = \frac{\Sigma V}{\Sigma_o j d} = \frac{14380}{8.5 \times .884 \times 36.5} = 52.4\ \#/\square'' < 60\ \#/\square''$$

USE $1''\square$ & $1\frac{1}{8}''\square$ @ 1'-0" C.C. ALT. $f_s = \cancel{18{,}050}\ 18{,}250\ \#/\square''$

FOR MOMENTS ABOUT Y-Y

FORCES ACTING		→	←	ARM	MOMENTS ↷	MOMENTS ↶
PW	$\frac{1}{2} \times 62.5 \times \overline{16}^2$		8000	5.33		42600
PER	$\frac{1}{2} \times 17.5 \times \overline{1.5}^2$		20	0.5		10
		ΣV = 8020 ←			ΣM = 42610 ↶	

$$A_{s_{Y-Y}}\ \text{REQ'D} = \frac{42600 \times 12}{18000 \times .884 \times 24.5} = 1.32\ \square''$$

USE $\frac{7}{8}''\phi$ & $1''\phi$ @ 1'-0" C.C. ALT.

IN TOP LIFT USE $\frac{3}{4}''\phi$ @ 12" C.C.

WAR DEPARTMENT

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

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Subject: HARTFORD HCS — Sta 41+00 to 42+07

Computation: CANTILEVER WALL ON PILES SOUTH OF DUTCH PT. PLANT

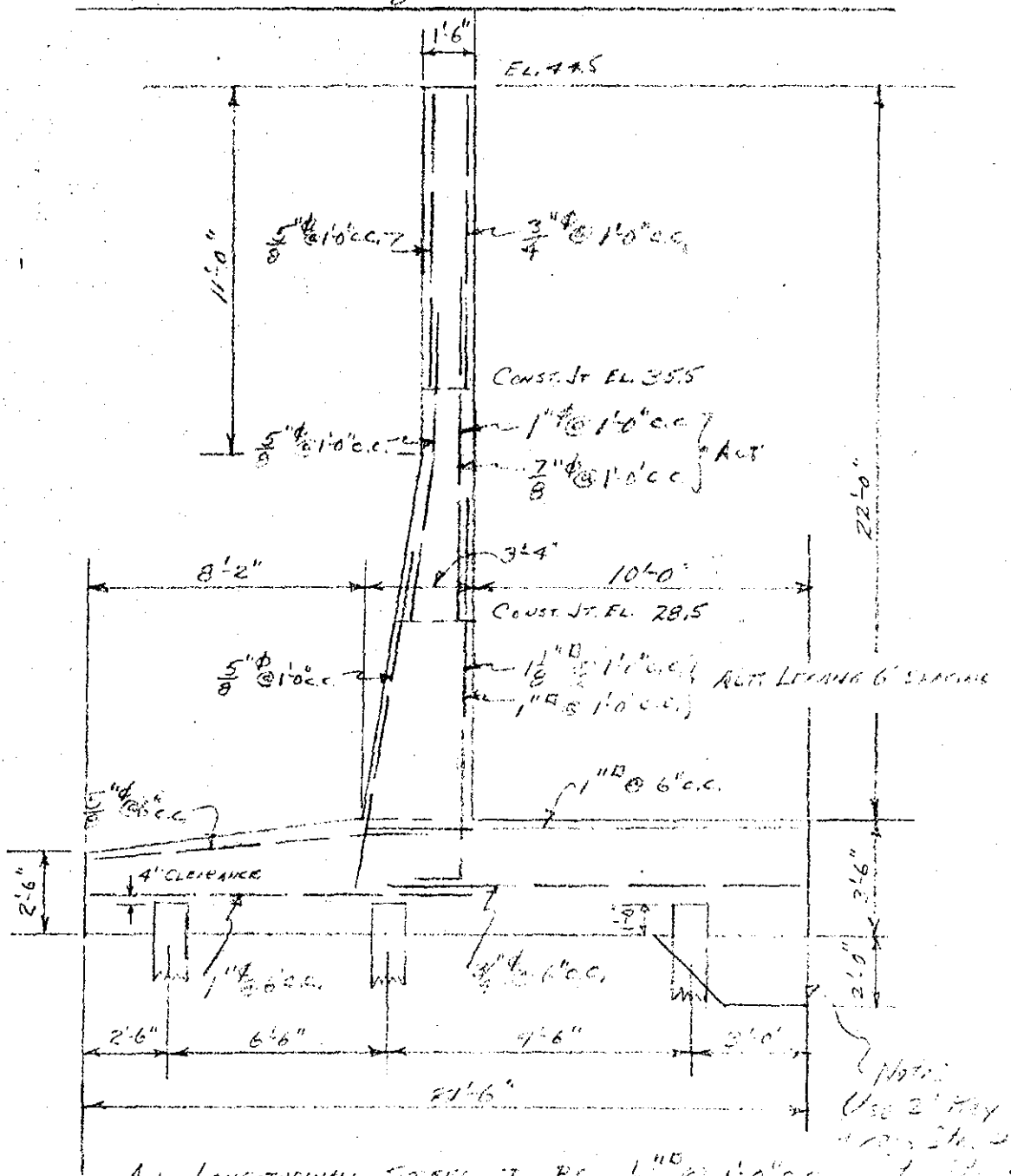
Computed by: P.L.A. Checked by: R.W. Date: 3/21/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

DESIGN OF STEM CONT'D

CASE II RIVER DOWN LANDSIDE FACE

BY INSPECTION – USE $\frac{5}{8}$"ϕ @ 12" c.c.



ALL LONGITUDINAL STEEL TO BE $\frac{1}{2}$"□ @ 1'-0" c.c.

WAR DEPARTMENT

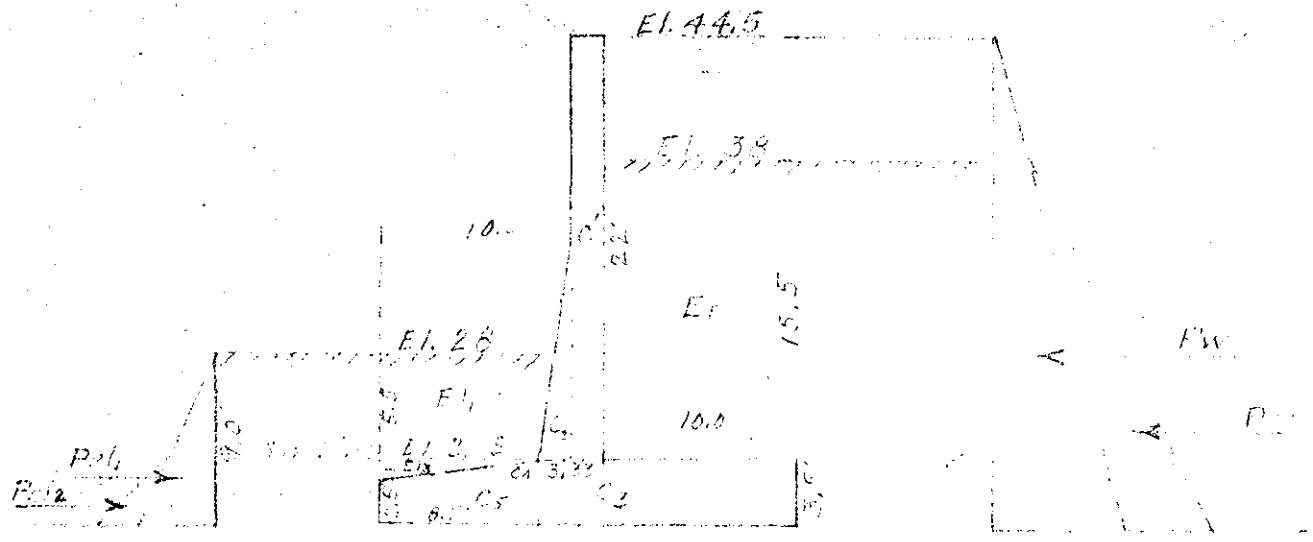
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

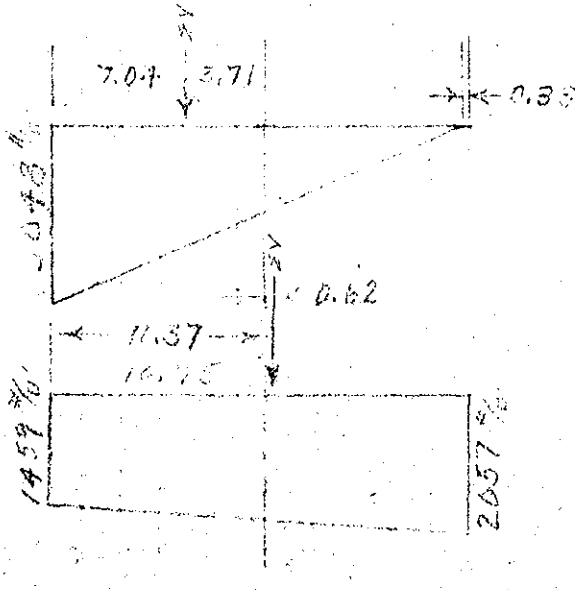
Subject Hartford Conn Ht-5 Sta 41+81

Computation 22' Wall on Piles South of Dutch Point

Computed by W.H.F. Checked by Date 3/[illegible]

U.S. GOVERNMENT PRINTING OFFICE 3—10528





Case I
River Up

Case II
River Down

WAR DEPARTMENT

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

Subject: Hartford Conn Ht-5

Computation: 22' Wall on Piles

Computed by: W H F Checked by: F L A Date: 3/20/[illegible]

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Stability Case I [illegible]

Forces Acting		↓	↑	→	←	Arm	Moments About A →	Moments About A ←
C_1	22 × 1.5 × 150	4950				10.75	53200	
C_2	11 × 1.83 × ½ × 150	1510				9.39	14200	
C_3	13.33 × 3.5 × 150	7000				14.84	104000	
C_4	8.17 × 1 × ½ × 150	610				5.45	3320	
C_5	8.17 × 2.5 × 150	3060				4.08	12490	
W	6.5 × 10 × 62.5	4060				16.5	67000	
E_r	15.5 × 10 × 125	19380				16.5	319800	
E_l	8.63 × 5.5 × 150	4750				4.32	20500	
E_h	—							
F_h	8.17 × 1 × ½ × 125	510				2.12	1390	
U_1	25.5 × 1.5 × 62.5		2390			20.75		49600
U_2	3.5 × 20 × 62.5		4380			10.0		43800
U_3	½ × 11 × 20 × 62.5		6880			13.33		91700
P_{eh}	9² × ½ × 35			1420		3.0	4260	
P_{eh}	3.5² × ½ × 45			276		1.17	323	
P_{w}	25.5² × ½ × 62.5				20320	8.5		172700
P_{er}	19² × ½ × 17.5				3160	6.33		120000
L.R.	See Sheet #10							
		45830	13650	1700	23480		600483	377800
		ΣV = 32180 ↓					ΣM = 222683 ↷	

Position of Resultant: $\frac{\Sigma M}{\Sigma V} = \frac{222683}{32180} = 7.04'$ ⅓ Base = 7.17'

$e = 10.75 - 7.04 = 3.71$ L.S.

Allowable = 3.58

$$\text{Bearing} = \frac{32180}{3 \times 7.04}\left(1 \pm \frac{6 \times 3.71}{21.5}\right)$$

$$= 1524 \times \begin{cases} 2.0 \\ 0.0 \end{cases} = 3048 \text{ \#/□' L.S.}$$

WAR DEPARTMENT

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

Subject: Hartford Conn. Ht-5

Computation: 22' Wall on Piles

Computed by: W. H. F. Checked by: PLA Date: 3/[illegible]/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability Case II River Down

Forces Acting		↓	↑	→	←	Arm	Moments About A ↷	↶
C_1		4150				10.75	53 200	
C_2		1510				9.[illegible]	14 190	
C_3		7000				14.84	104 000	
C_4		610				5.95	3 [illegible]	
C_5		3060				4.08	12 4[illegible]	
E_r	15.5 × 10 × 100	15500				16.5	255 750	
E_l	8.63 × 5.5 × 100	4750				4.[illegible]	20 500	
E_{l2}	8.17 × 1 × ½ × 100	410				2.[illegible]	1 1[illegible]0	
P_{el}	9² × ½ × 35			1420		3.0	4 260	
P_{er}	19² × ½ × 35				6320	6.33		40000
		37780					468 820	40 000
		ΣV = 37780 ↓					ΣM = 428 820 ↷	

Position of Resultant: $\frac{\Sigma M}{\Sigma V} = \frac{428820}{37780} = 11.35$ K.B. = 7.[illegible]

$e = 11.35 - 10.75 = 0.60$

$$\text{Bearing} = \frac{37780}{21.5}\left(1 \pm \frac{6 \times 0.60}{21.5}\right)$$

$$= 1758 \times \begin{cases} 1.17 = 2057 \text{ \#/□'} \\ .83 = 1459 \text{ \#/□'} \end{cases}$$

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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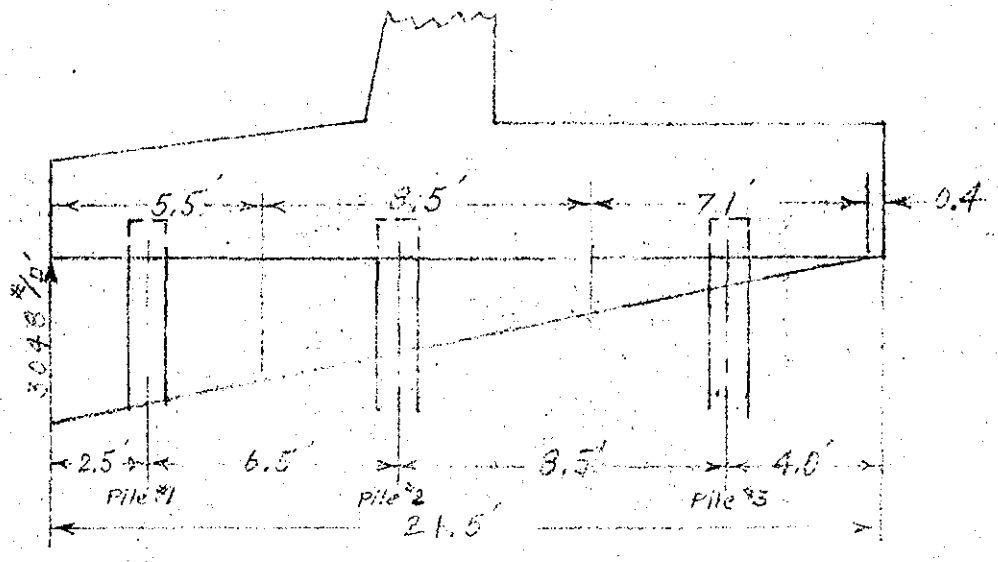
Subject Hartford Conn Ht-5
Computation Wall on Piles South of Dutch Point
Computed by W. H. E. Checked by Date 3/21/40

U. S. GOVERNMENT PRINTING OFFICE 3—10593

Base Pressure + Pile Loading

Case I River Up



Allowable Loading on Pile = 60000#

Loading on Pile #1

$\frac{2255+3048}{2} \times 5.5 = 14580$ $14580 \times 4 = 58,320$ *

Pile Spacing along Wall $\frac{60000}{14580} = 4.11$ Use 4'

Loading on Pile #2

$\frac{1026+2255}{2} \times 8.5 = 13940$ $13940 \times 4 = 55760$ *

Pile spacing along wall $\frac{60000}{13940} = 4.3$ Use 4'

Loading on Pile #3

$\frac{0+1026}{2} \times 7.1 = 3645$ $3645 \times 4 = 14580$ *

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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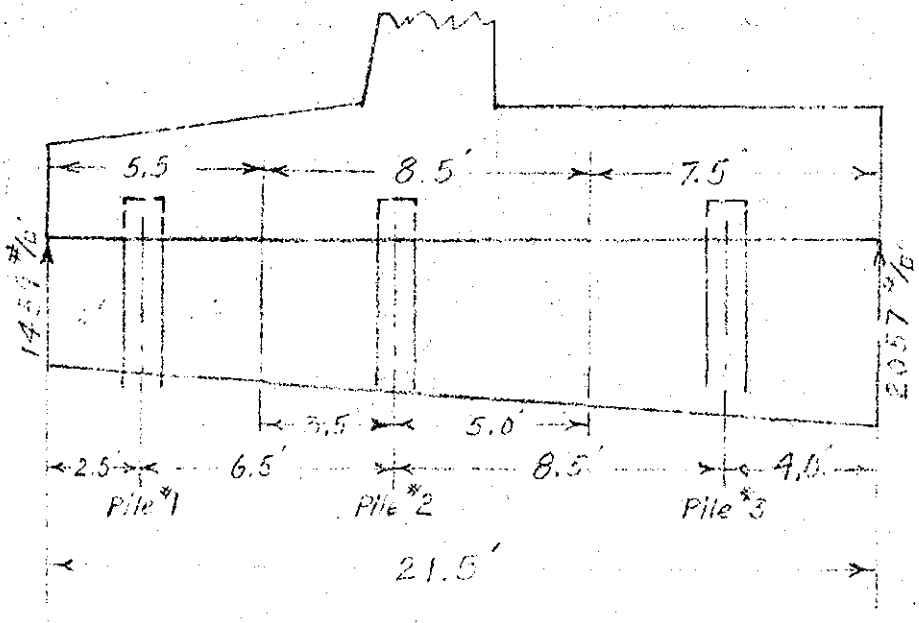
Subject Hertford Conn Ht-5
Computation Wall on Piles South of Dutch Point
Computed by W H F Checked by Date 3/21/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Base Pressure & Pile Loading

Case II River Down



Allowable Loading on Pile = 60,000#

Loading on Pile #3

$\frac{2057+1944}{2} \times 7.5 = 14640$ 14640 × 4 = 58,560#

Pile Spacing along [illegible] $\frac{[illegible]}{14640} = 4.0$ [illegible]

Loading on Pile #2

$\frac{1843+1600}{2} \times 8.5 = 14700$ [illegible] × 4 = [illegible]#

Pile Spacing along [illegible] $\frac{[illegible]}{14700} = 4.0$ [illegible]

Loading on Pile #1

$\frac{1512+1450}{2} \times 5.5 = 8450$ 8450 × 4 = 33,800#

WAR DEPARTMENT

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

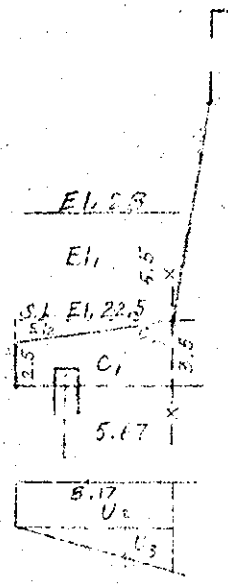
Subject: Hurricane Gate H4-5 South of Fresh Pond

Computation: Reinforcement in Lower Lift Pier 22 Wall on Pier

Computed by: W. H. F. Checked by: Date: 3/22/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case I River Up



U_3 $22 \times \frac{1}{2} \times 62.5 = 687$ $Y = \frac{8.17}{20} \times 687 = 280$

Forces Acting		Y	↑	Arm	↻	↺
C_1	$2.5 \times 8.17 \times 150$	3060		4.09	12 510	
C_2	$1 \times \frac{1}{2} \times 8.17 \times 150$	610		2.72	1 660	
El_1	$5.5 \times 8.17 \times 100$	4490		4.09	18 360	
El_2	$1 \times \frac{1}{2} \times 8.17 \times 125$	510		5.45	2 780	
U_2	$2.5 \times 8.17 \times 62.5$		1 790	4.09		7 330
U_3	$\frac{1}{2} \times 8.17 \times 280$		1 140	2.72		3 120
P_1			14 500	5.67		82 670
		8 670	17 510		35 310	93 120
$d = 2.5 = 30$		$\Sigma V = 8840$ ↑			$\Sigma M = 57800$ ↻	

$d' = \sqrt{\frac{57800}{132.5}} = 21.7 + 4.5 = 26.2''$ Bond $= \frac{8840}{7.14 \times 4 \times 26.5} = 53$ #/□"

$A_s = \frac{57800}{1325 \times 26.5} = 1.65$ □" Use 1" Bars 1" @ 6" c.c.

Unit Shear $= \frac{6840}{10.6 \times 26.5} = 31$ #/□"

WAR DEPARTMENT

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

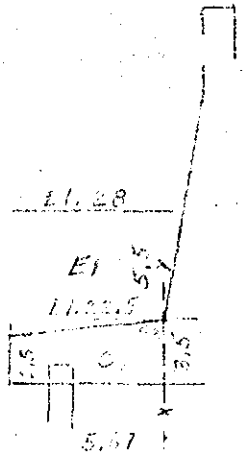
Subject Hartford Conn Ht-5 South of Dutch Point

Computation Reinforcement in Landside Base

Computed by W H F Checked by ..... Date 3/22/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Case II River Down



Forces Acting		↓	↑	Arm	↻	↺
C_1	2.5 × 8.17 × 150	3000		4.09	20520	
C_1	1 × ½ × 8.17 × 50	200		2.72	540	
El	6.5 × 8.17 × 100	5310		4.09	21720	
P_1			8450	5.67		47910
		8570	8450		42780	47910
		ΣV = 120 ↓			ΣM = 5130 ↺	

V = [illegible]

WAR DEPARTMENT

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

Page 318

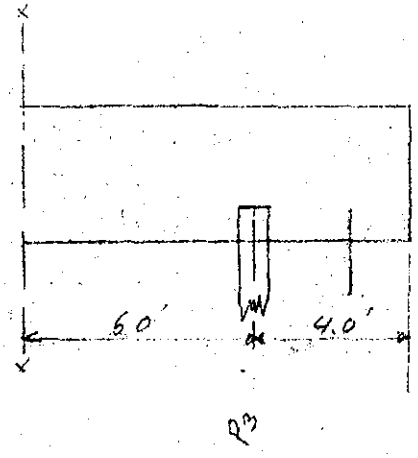
ubject

omputation

omputed by R.W. Checked by W.H.F. Date 3-22-40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in River Side Base



Case I, River Up Section x-x

C —		5250	x 5	26200
W —	6.5 x 10 x 62.5 =	4070	x 5	20350
ER —	15.5 x 10 x 125 =	19400	x 5	97000
P_3 —	3,645 =	3,645	x 6	21870
U_1 —	=	2390	x 9.25	22100
U_2 —	=	1860	x 4.25	7900
U_3 —	=	3360	x 4.25	14300
U_4 —	=	1240	x 5.67	7050
		ΣV = 16,235 + ΣM		70,330 '#

$$A_s = \frac{70,330 \times 12}{18,000 \times .884 \times 26.5} = 2.0 \square''$$

Use 1' □ @ 6" o.c. Top

Case II River Down

Section x-x	C		↓ 5250 x 5	26200
	ER	15.5 x 10 x 100	↓ 15500 x 5	77500
	P_3		↑ 14640 x 6	88,000
			ΣM =	15,700 '#

$$A_s = \frac{15,700 \times 12}{18,000 \times .884 \times 26.5} = .45 \square''$$ Top

Moment, Beam action between P_2 and P_3

C = 3.5 x 150 = 525

ER = 15.5 x 100 = 1550

2075 #/ft

$$M = \frac{wl^2}{8} = \frac{2075 \times 8.5^2}{8} = 18740 \#$$

$$A_s = \frac{18740 \times 12}{18,000 \times .884 \times 26.5} = .534 \square''$$

Use 7/8" ϕ @ 1'-0" Bottom

WAR DEPARTMENT

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

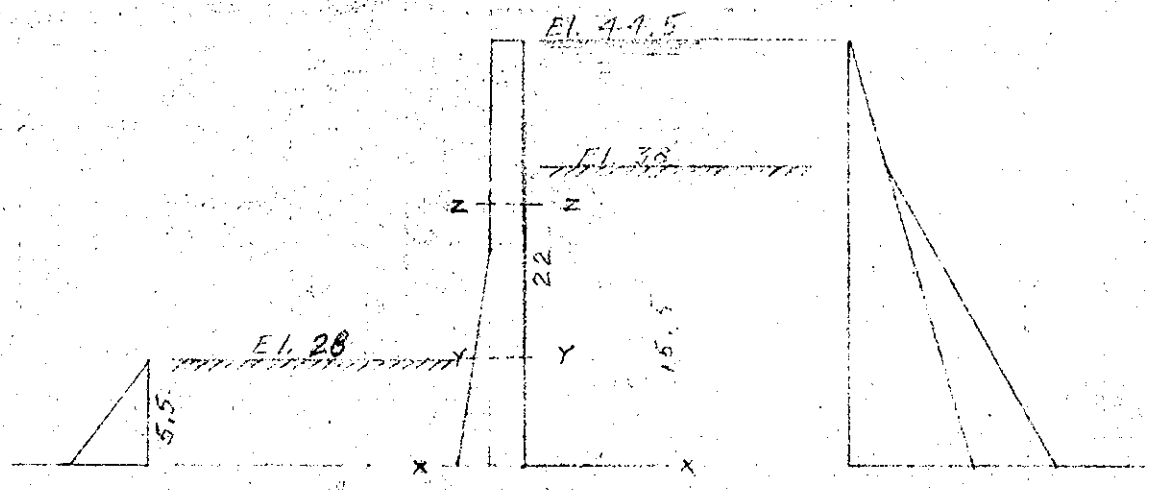
Subject Hartford Dam Ht-5 South of Rock Road

Computation Stem Reinforcement

Computed by W. H. F. **Checked by** **Date** 3/23/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case I River Up



Moments about X-X

	Forces Acting	→	←	Arm	↷	↶
	P_w	$22^2 \times \frac{1}{2} \times 62.5$	15 125	7.33		110 900
	P_{ar}	$15.5^2 \times \frac{1}{2} \times 17.5$	2 100	5.17		10 830
$d = 3.33 \div .40$	P_{el}	$5.5^2 \times \frac{1}{2} \times 35$	530	1.83	970	
			530	17 230	970	121 530
			$\Sigma V = 16700$ ←		$\Sigma M = 120\,560$ ↶	

$d' = \sqrt{\frac{120\,560}{123}} = 31.3 + 3.5 = 34.8''$

$A_s = \frac{120\,560}{1325 \times 36.5} = 2.49\ \square''$ Use $1\frac{1}{8}''\square$ @ 6" c.c.

Unit Shear $= \frac{16\,700}{10.5 \times 36.5} = 43\ \#/\square''$ Bond $= \frac{16\,700}{9.0 \times .884 \times 36.5} = 57.5\ \#/\square''$

Moments about Y-Y

	P_w	$16.5^2 \times \frac{1}{2} \times 62.5$	8520 × 5.5	46 850
$d = 2.42 \div .27$	P_{el}	$10^2 \times \frac{1}{2} \times 17.5$	875 × 3.33	2 920
$d = 25.5$			$\Sigma V = 9400$ ←	$\Sigma M = 49\,770$ ↶

$A_s = \frac{49\,770}{1325 \times 25.5} = 1.47\ \square''$

Use 1"⌀ @ 6" c.c.

	P_w	$8.5^2 \times \frac{1}{2} \times 62.5$	2260 × 2.83	6 400
$d = 1.5 \div .13$	P_{el}	$2 \times \frac{1}{2} \times 62.5$	60 × .67	40
$d = 14.5$			$\Sigma V = 2320$ ←	$\Sigma M = 6440$ ↶

$A_s = \frac{6440}{1325 \times 14.5} = .34\ \square''$ Use $\frac{5}{8}''$ alt. $\frac{3}{4}''$ @ 6" c.c.

Subject Hartford Temp H1-5 Sta. 41+81±
Computation
Computed by W. H. K. Checked by Date 3/25/40

U. S. GOVERNMENT PRINTING OFFICE 3—10538

Unbalanced Horizontal Force

Horizontal Force for 4' of wall = 21700 × 4 = 86800#

Max. Shear Resistance of Piles = 3 × 12² × 60
= 144 × 180 = 25900#

Horizontal Force still unbalanced = 86800 − 25900 = 60900#

Max. Available Passive Resistance

$P.R. = \frac{wH^2}{2} \times 2.46$

$= \frac{100 \times 10^2}{2} \times 2.46 = 5000 \times 2.46 = 12300$
×4
49200 < 60900

∴ Key Required

Using 2 Key

$P.R. = 2 \times 100 \times 12^2 \times 2.46 = 70800 > 60900$ ok

WAR DEPARTMENT

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

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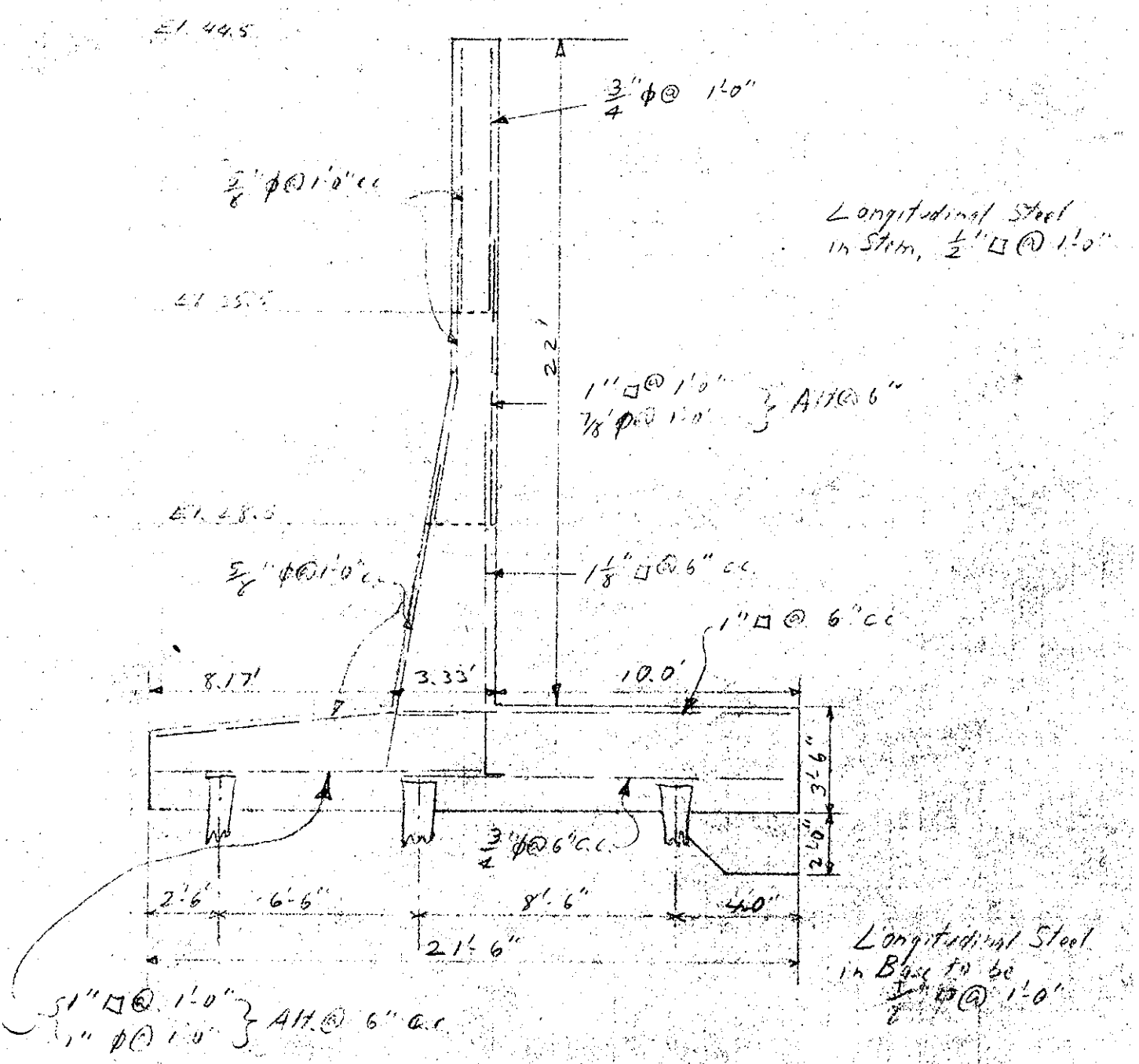
Subject Ht 5 — Sta. 41+00 - Sta. 41+81

Computation 22' wall on piles

Computed by RW — Checked by ..... — Date 3-23-42

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Typical Section Sta. 41+00 ± to Sta. 41+81 ±



WAR DEPARTMENT

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

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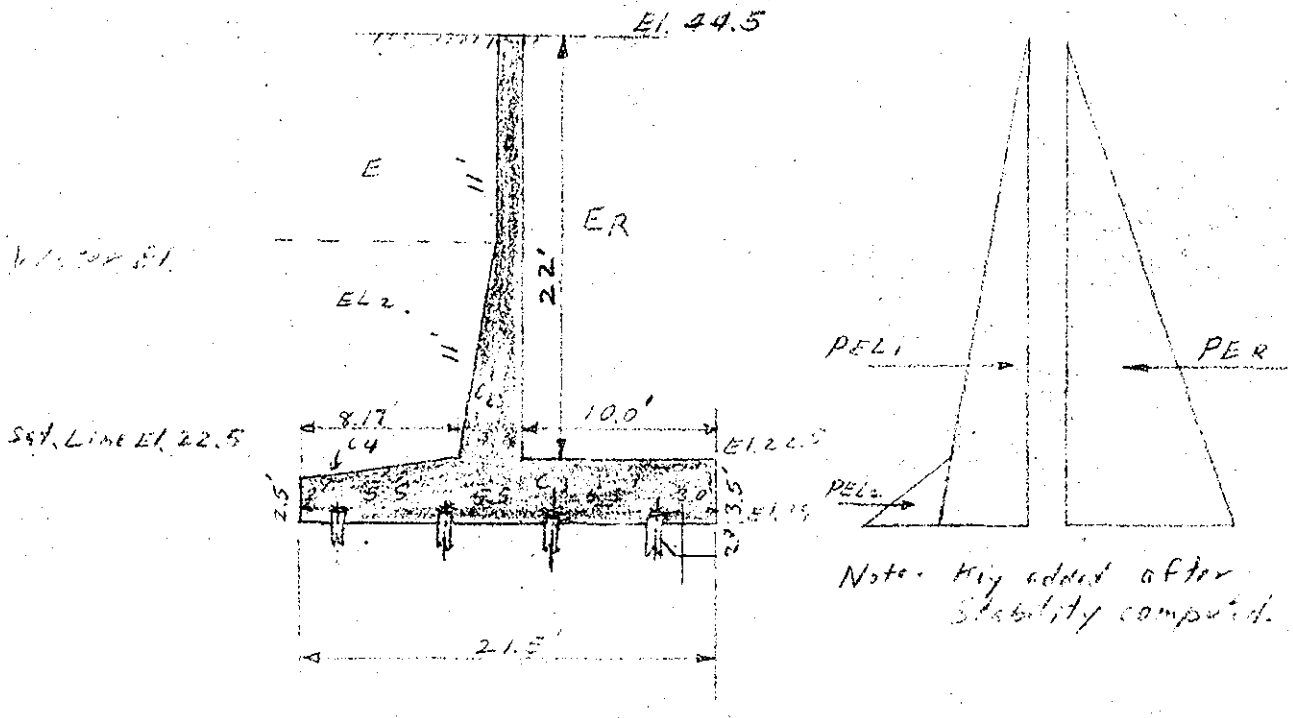
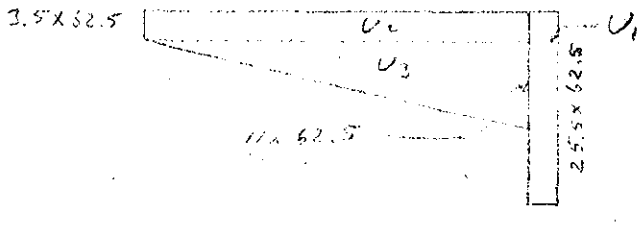
Subject Ht 5 Hartford

Computation 22' Wall on Piles Sta 42 + 47

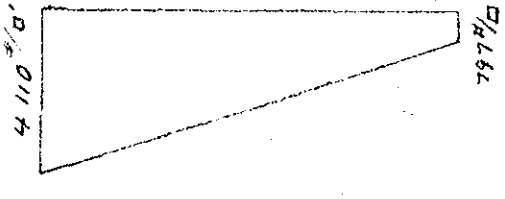
Computed by RW Checked by Date 3-20-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

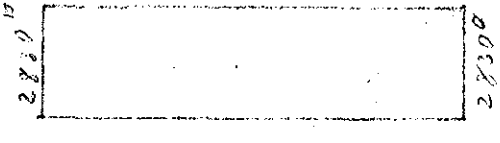




Uplift



Bearing Case I



Bearing, Case II

WAR DEPARTMENT

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

Subject: Ht 5 Hartford

Computation: 22' wall on piles — Sta 42+47

Computed by: R.W. — Checked by: — Date: 3-20-40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Stability - Portion Imbedded in Dike Case I River Up
Ground El. 44.5 Both Sides

	Forces	↓	↑	→	←	Arm	Moments about "A"	
EL_2	$\frac{8.17+10}{2} \times 11 \times 100$	10100				4.6	46,400	
EL_3	$10 \times 11 \times 100$	11000				5	55,000	
ER	$10 \times 22 \times 125$	27500				16.5	454000	
C_1		4950				10.75	53200	
C_2		1510				9.39	14200	
C_3	$3.5 \times 21.5 \times 150$	11300				10.75	121500	
C_4	$-8.17 \times \frac{1}{2} \times 1 \times 25$		100			2.72		270
PER	$25.5^2 \times \frac{1}{2} \times 80$				26000	8.5		221000
PEL_1	$25.5^2 \times \frac{1}{2} \times 35$			11400		8.5	97000	
PEL_2	$3.5^2 \times \frac{1}{2} \times 45$			275		1.17	310	
U_1	$25.5 \times 1.5 \times 62.5$		2390			20.75		49700
U_2	$3.5 \times 20 \times 62.5$		4380			10		43800
U_3	$11 \times 20 \times \frac{1}{2} \times 62.5$		6870			13.33		91500
L.R.	Lateral Resistance of Piles			14,325		—		
		66,360	13740	26000	26000		841,610	406,270
		ΣV. 52620		ΣH. 0			ΣM. 435,340	

Position of Resultant

$$\frac{\Sigma M}{\Sigma V} = \frac{435,340}{52620} = 8.28' \qquad \frac{1}{3}\text{ Base} = 7.17'$$

$$e = 10.75 - 8.28 = 2.47'$$

Base Pressure

$$\frac{52620}{21.5}\left(1 \pm \frac{6 \times 2.42}{21.5}\right) = 2450 \begin{cases} 1.675 = 4,110 \text{ #/□'} & \text{Land} \\ 0.325 = 797 \text{ #/□'} & \text{River} \end{cases}$$

WAR DEPARTMENT

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

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Subject Ht 5 Hartford

Computation 22' Wall on Piles

Computed by RW Checked by _____ Date 3-20-40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Stability - River Down

		↓	↑	→	←	Arm	Moments about A	
EL2		10100					46 400	
EL3		11000					55 000	
ER	10x22x100	22000				16.5	363 000	
C1		4950					53 200	
C2		1510					14 200	
C3		11300					121 500	
C4			100					270
PER	Cancel out							
PEL								
FR								
		60,860	100				653 300	270
		ΣV = 60,760		ΣH = 0			ΣM = 653,030	

Position of Resultant

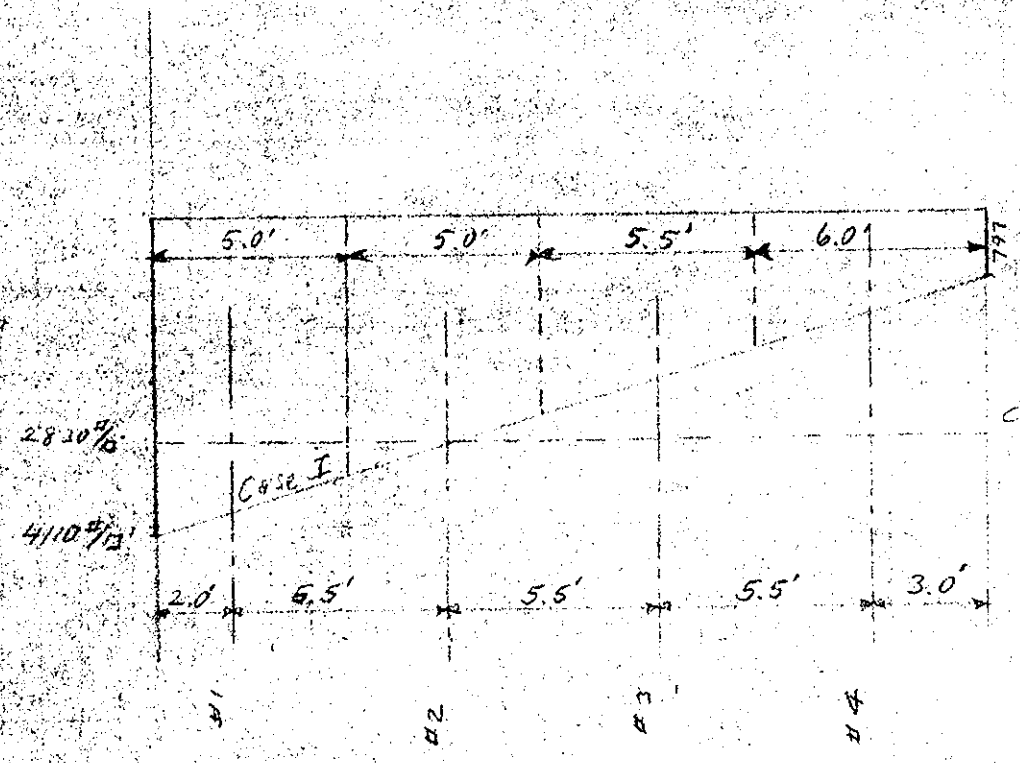
$\frac{\Sigma M}{\Sigma V} = \frac{653030}{60,760} = 10.75'$ In Center

$B.P. = \frac{60760}{21.5} = 2830$ #/□' Uniform.

Subject: H 5
Computation: 22' Wall on Piles
Computed by: R. W. Checked by: Date: 3-20-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Pile Spacing



Loading Pile #1 = $\frac{4110 + 3350}{2} \times 5 = 18,650^{\#}$ per lin. ft.

Controlling Case

With 4' Spacing, Load is $4 \times 18,650 = 74,700^{\#}$ per pile

Pile #2 = $\frac{3350 + 2650}{2} \times 5 = 15,000^{\#}$ per lin. ft.

$\times 4 = 60,000^{\#}$ per pile #2

Pile #3 = $\frac{2650 + 1750}{2} \times 5.5 = 12,100^{\#}$ per lin. ft.

$\times 4 = 48,400^{\#}$ per pile #3

Pile #4 = $\frac{1750 + 797}{2} \times 6 = 7,650^{\#}$

$\times 4 = 30,600^{\#}$ per Pile #4

WAR DEPARTMENT

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

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Subject Ht 5

Computation 22' Wall on Piles

Computed by RW Checked by _____ Date 3-20-40

U. S. GOVERNMENT PRINTING OFFICE 3—10538

Pile Loading Case II

#1 5 × 2830 = 14150 # per lin ft

× 4 = 56700 # per Pile

#2 5 × 2830 = 14,150 # per [illegible]

× 4 = 56,700 # per Pile

#3 5½ × 2830 = 15,5[illegible]5 # per lin

× 4 = 62,300 # per Pile

#4 6 × 2830 [illegible] # per lin ft

× 4 = 68,000 # per pile — Controlling case

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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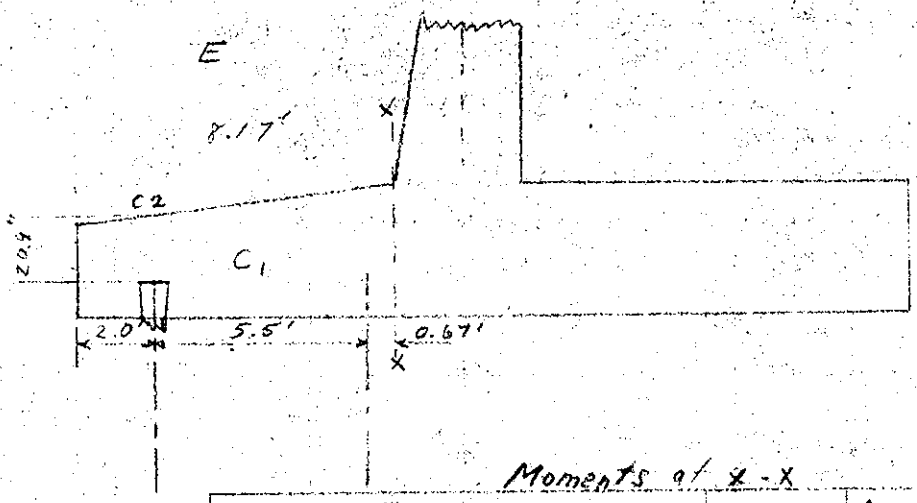
Subject Ht 5
Computation 22' Wall on Piles
Computed by R W Checked by Date 3-20-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design - Base Steel, Land Side Case I



Moments at X-X

	Forces		Arm	Moment	
E	22 X 8.17 X 100	18,000 ↓	4.08	73 500	↺
C_1	8.17 X 3.5 X 150	4,290 ↓	4.08	17 550	↺
C_2	8.17 X ½ X 1 X 25	100 ↑	5.44	540	↻
P_1	18,650	18,650 ↑	6.17	115 000	↻
P_2	15,000	15,000 ↑	0.67	10 000	↻
U_2	3.5 X 62.5 X 8.17	1790 ↑	4.08	7300	↻
U_1	281 X 8.17 X ½	1150 ↑	2.72	3130	↻
		ΣV = 14,600# ↑		ΣM = 44,920 '#	↻

$A_s = \frac{44920 \times 12}{18,000 \times .884 \times 26.5} = 1.28$ □"

Use 1¼" ⌀ @ 1'-0"

Land Side, Case II

E		18,000		73500	↺
C_1		4290		17550	↺
C_2		100		540	↺
P_1		14150	6.17	87500	↻
P_2		14150	0.67	9500	↻
	ΣV	5,900# ↑		ΣM = 5,410 '#	↻

d reqd - O.K. by inspection

Punching Shear $\frac{18,650 \times 4}{20.9 \times 12 \times 4} = 74.4$ #/□"

Shear $\frac{V}{bjd} = \frac{14,600}{12 \times .884 \times 26.5} = 52$ #/□" O.K.

WAR DEPARTMENT

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

Subject Hl # 5

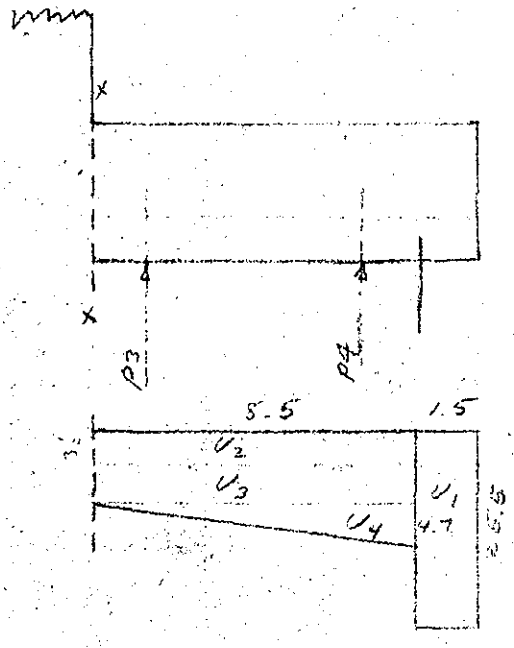
Computation 22' Wall on Piles

Computed by R.W. Checked by ..... Date 3-20-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in Base River Side Case I

Section X-X



Forces			Moments	
E	10×22×125	27500	× 5 =	137,500
C	3.5×10×150	5250	× 5 =	26,300
P_3	12,100 #	12100	× 1.5 =	18120
P_4	7,650	7650	× 7 =	53500
U_1	25.5×1.5×62.5	2390	× 9.25 =	22100
U_2	3.5×62.5×8.5	5220	× 4.25 =	22200
U_3	6.3×8.5×62.5			
U_4	4.7×8.5×62.5	1250	× 5.7 =	7120
		4,100 ↑	ΣM =	40,760 '# ↷

$$A_s = \frac{40,760 \times 12}{18,000 \times .884 \times 26.5} = 1.16 \ \square''$$

Use $\frac{7}{8}$" ϕ @ 6"

Case II

Forces				
E	10×22×100	22,000	× 5 =	110,000
C		5250	× 5 =	26300
P_3		15,565	× 1.5 =	23320
P_4		16980	× 7 =	119,000
			ΣM =	6,020 '# ↗

$$A_s = \frac{6020 \times 12}{18000 \times .884 \times 26.5} = .17 \ \square''$$

Temp. Steel

Top $3 \times 2725 \times \frac{3}{2} = 12,250$ '# Above Pile #4

Pile 3-Pile 4 $\frac{2725 \times 5.5^2}{8} = 10,300$ '#

$$A_s = \frac{10,300 \times 12}{18,000 \times .884 \times 26.5} = .29 \ \square''$$

Temp. Steel

Subject Ht 5
Computation 22' Wall on Piles
Computed by R.W. Checked by Date 3-21-40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Longitudinal Steel and Stem Steel

Longitudinal Steel -
Consider as simple beam between piles

B.P. = 3800 #/□'

$l = 4'$

$M = \frac{wl^2}{8} = \frac{3800 \times 16}{8} = 7600$ '#

$A_s = \frac{7600 \times 12}{18,000 \times .884 \times 26.5} = .216$ □"

Use 5/8" ϕ @ 1'-0"

Stem Steel

M Sect. x-x
PER = $80 \times 22^2 \times \frac{1}{2}$ = 19400 × 7.33 = 142,000
PEL = $35 \times 22^2 \times \frac{1}{2}$ = 8470 × 7.33 = 62,000
ΣV = 10,900# ← ΣM = 80,000 '#

M Sect. y-y $45 \times 16^2 \times \frac{1}{2}$
$45 \times 16^2 \times \frac{1}{2}$ = 5770 × 5.33 = 30,700 '#

M Sect. z-z
$45 \times 11^2 \times \frac{1}{2}$ = 2720 × 3.67 = 10,000 '#

M Sect. a-a
$45 \times 6^2 \times \frac{1}{2}$ = 810 × 2 = 1620 '#

M Sect. b-b
$45 \times 9^2 \times \frac{1}{2}$ = 1820 × 3 = 5,460

Stem steel Case of Fill R El. 38 River Side, El. 22 Land side
PW = $22^2 \times \frac{1}{2} \times 62.5$ = 15,100 × 7.33 = 111,000
PER = $15.5^2 \times \frac{1}{2} \times 17.5$ = 2,100 × 5.2 = 10,400
PER = $5.5^2 \times \frac{1}{2} \times 35$ = 590 × 1.83 = 1080
ΣM = 120,820

$A_s = \frac{120,820 \times 12}{18000 \times .884 \times 36.5} = 2.49$ □"

Use 1 1/8" □ @ 6"

Subject H 1 5
Computation 24' Wall on Piles
Computed by K W Checked by Date 3-21-43

U.S. GOVERNMENT PRINTING OFFICE 2—10623

Stem Steel

A_s x-x : $\frac{80,000 \times 12}{18,000 \times .884 \times 36.5} = 1.65 \square''$

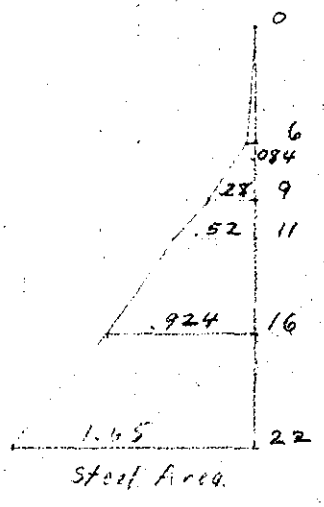
$\frac{12}{18,000 \times .884} = .000754$

A_s y-y : $\frac{30,000 \times .000754}{24.5} = .924 \square''$ depth 16'

A_s z-z : $\frac{10,000 \times .000754}{14.5} = .52$

A_s a-a : $\frac{1620 \times .000754}{14.5} = .084$

A_s b-b : $\frac{5460 \times .000754}{14.5} = .284$



Subject Ht. 5
Computation 22' Wall on Piles. Sta 42+47
Computed by R.W. Checked by Date 3-23-40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Lateral Stability Sta. 42+47

Unbalanced force for 4' of wall = 14,320 X 4 = 57,280

Max. Shearing Resistance of piles = 4 X 12 X 12 X 60
= 34600 # for 4 piles

Lateral Force still unbalanced 57,280
- 34,600
22,680 # for 4'

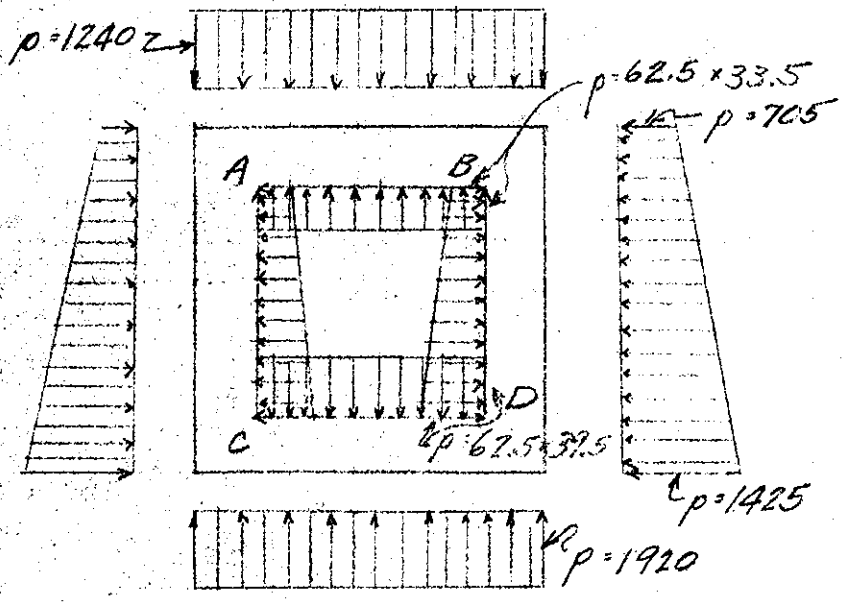
Passive Resistance (1' of Sheet Pile included)
$= \frac{wh^2}{2}(2.6)$
$= \frac{100 \times 17.7^2}{2} \times 2.6 = 23,000$ # per foot
$\times 4 = 92,000$ # > 57,280

∴ O.K. for Horizontal Stability at 42+47

Project: HARTFORD HES
Computation: Keeney Lane Sta. Outlet
Computed by: RSM Checked by: Date: 3/5/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

CASE II River up, conduit full. Internal pressure with water to El. 41.5 in river. Section inside dike
Fill to El. 20.0
Line of saturation El. 17.0±



$M_{AB} = 850 \times \overline{7.5}^2/12 = 3980'\#$

$M_{CD} = 550 \times \overline{7.5}^2/12 = 2580'\#$

M_{AC} at A $1105 \times \overline{7.5}^2/12 = 5180$
$220 \times \overline{7.5}^2/20 = 1030$ $6210'\#$

M_{AC} at C $1105 \times \overline{7.5}^2/12 = 5180$
$220 \times \overline{7.5}^2/30 = 690$ $5770'\#$

WAR DEPARTMENT

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

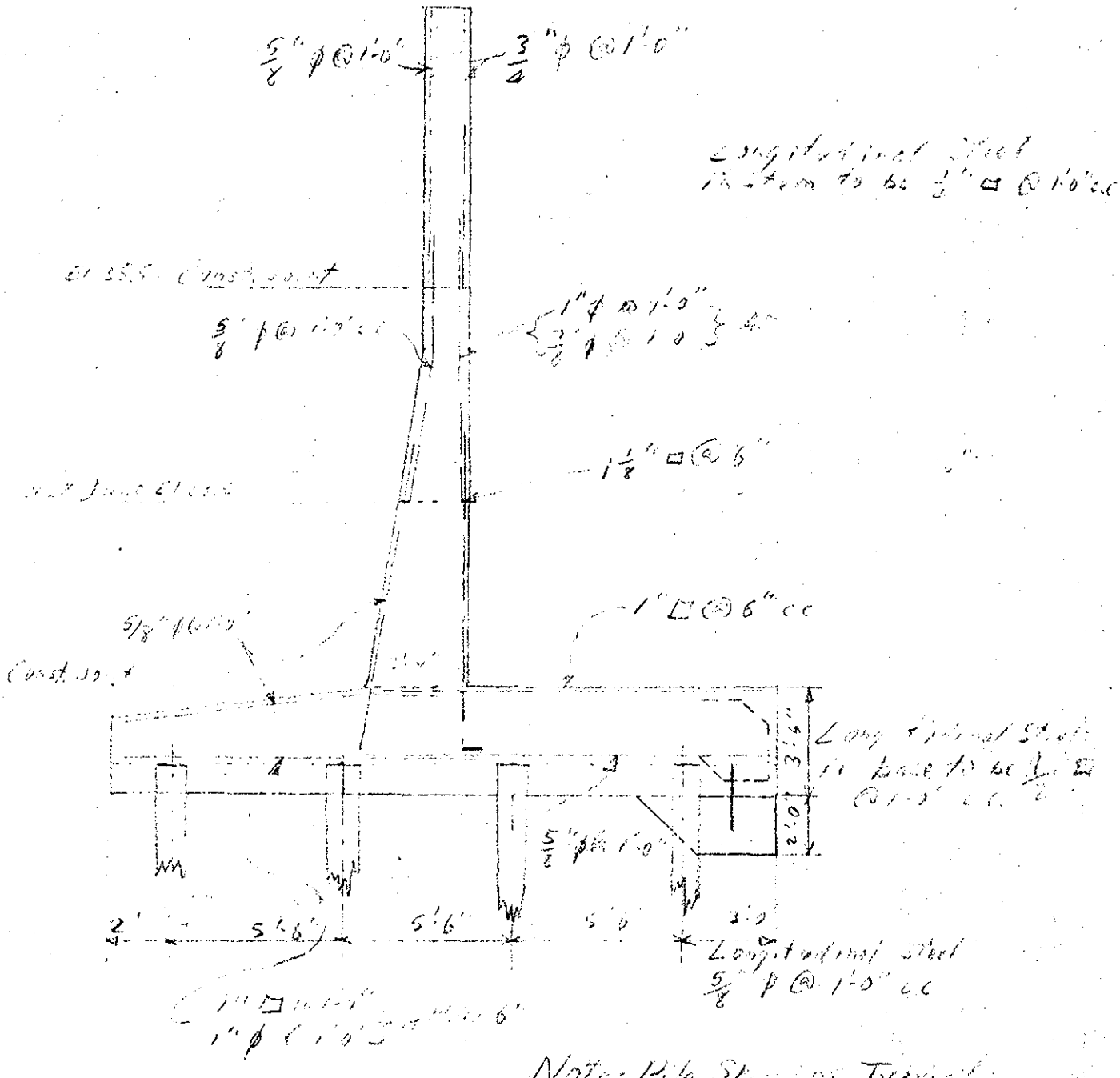
Subject Ht 5

Computation 22' wall on piles Sta 41+51 to Sta. 42+47

Computed by RW Checked by Date 3-21-40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Steel Diagram



Note - Pile Spacing Typical Sta. 41+71 to Sta. 42+07

Steel Spacing Typical Sta. 41+51 to Sta. 42+47

WAR DEPARTMENT

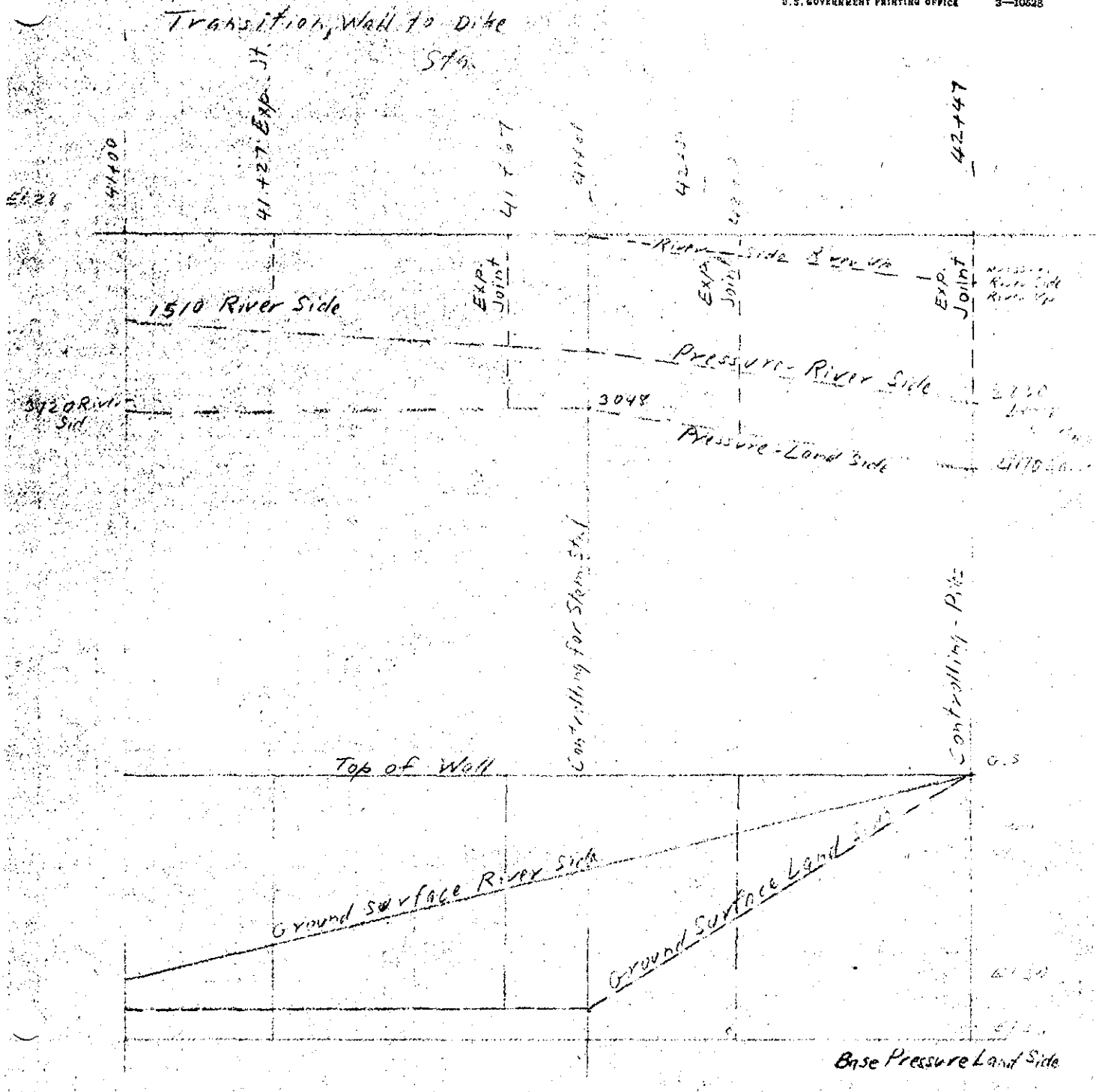
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Ht 5 Hartford

Computation Transition - Wall to Dike

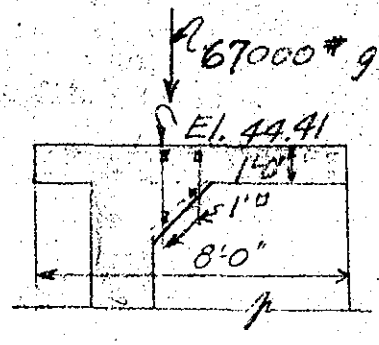
Computed by R.W. Checked by Date

U. S. GOVERNMENT PRINTING OFFICE 3—10528

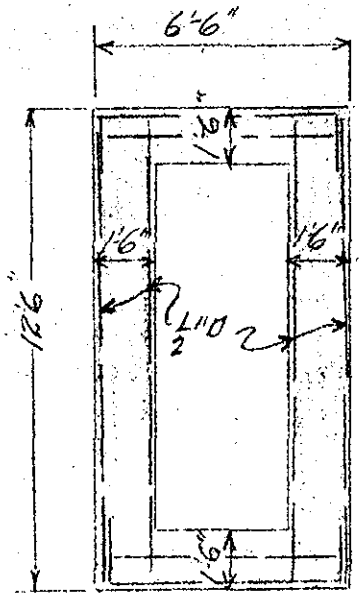


Project: HARTFORD HES
Computation: Keeney Lane sewer gate chamber
Computed by: PSM Checked by: R.W. Date: 3-13-40

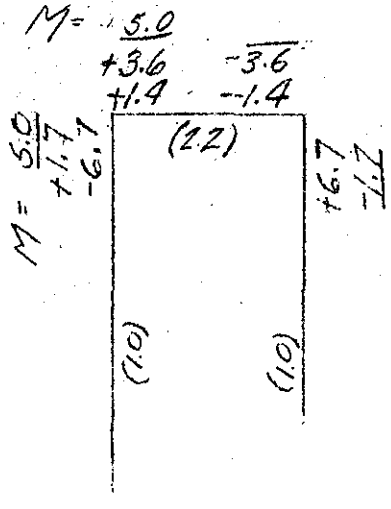
U. S. GOVERNMENT PRINTING OFFICE 3—10528



Base 8'6" x 14'6" square



Design of box
Earth Loading 19 x 35 = 665 #/□'



$v = 665 \times 9.5/2 \times 12 \times .884 \times 14.5 = 21$ #/□"

$A_s = 5{,}000 \times 12/18000 \times .884 \times 14.5 = .26$ □" Use $\frac{5}{8}$"φ @ 1'-3"

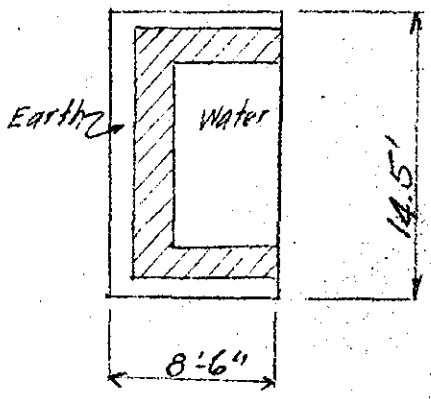
Design of platform
Load acting on haunch as beam
$M = 450 \times 9.5^2/10 = 4050$ '#
$67000 \times 9.5/8 = 79450$
80000 '#
$A_s = 74000 \times 12/18000 \times .884 \times 24 = 2.64$ □"
$v = 67000/2 \times 18 \times .884 \times 24 = 88$ #/□", anchor negative steel.
Load acting on haunch as cantilever.
$A_s = 67000 \times 8/24 \times 18000 = 1.24$ □", spread over 5'. Use $\frac{1}{2}$" @ 1'-0

Project: HARTFORD HES
Computation: Keeney Lane sewer gate chamber
Computed by: RSM Checked by: R.W. Date: 3-19-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

STABILITY

Assume 2' differential water loading due to flow in river. Loading applied to 15' of chamber projecting above dike.



M water, acting at El. 37.0

Loading $15 \times 2 \times 62.5 \times 6.5 =$ 12,150 #

$M = 12150 \times 38 =$ 462,000 '#

M Vertical loading

↓ Water $5.5 \times 9.5 \times 43.41 \times 62.5 =$ 141,000 #

↓ Conc. $1.5 \times 43.41 \times 22.5 \times 150 =$ 220,000 #

↓ $8.5 \times 14.5 \times 2 \times 150 =$ 37,000

↓ Earth $33 \times 28.41 \times 125 =$ 117,000

↑ Uplift $62.5 \times 8.5 \times 14.5 \times \frac{45.41}{2} =$ 175,000

Net ↓ load. 340,000 #

$M = 340,000 \times 7.25 =$ 2,462,000 '#

Net M = 2,000,000 '#

Position of resultant = 2000000/340000 = 5.9'

$e = 1.35'$

$$b = \frac{340,000}{123}\left(1 \pm \frac{6 \times 1.35}{14.5}\right) = 4300\ \#/\square' \text{ to } 1200\ \#/\square'$$

Design of base

↓ water (net) $62.5 \times 43.41/2 =$ 1350

↓ Conc. $150 \times 2 =$ 300

1650

↑ Bearing 3700 to 1800 #/□'

Net 2050 to 150 #/□'

$M = 150 \times 9.5^2/12 =$ 1120 '#

$1900 \times 9.5^2/20 =$ 8550

9670 '#

$A_s = 9670 \times 12/18000 \times .884 \times 19.5 =$ .37 □"

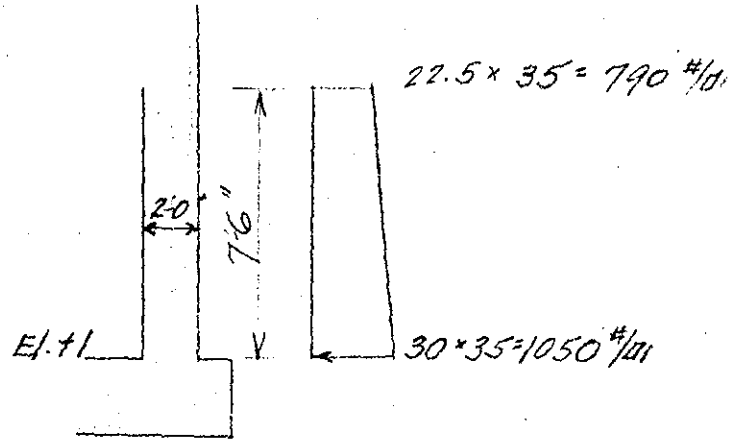
Use $\frac{3}{4}$"ϕ @ 1'-0", longitudinal, $\frac{1}{2}$"□ @ 1'-0", transverse.

$$v = \frac{(150 \times 9.5/2) + (1900 \times 9.5/3)}{12 \times .884 \times 19.5} = 33\ \#/\square''$$

Subject: HARTFORD HE.5
Computation: Keeney Lane sewer gate chamber
Computed by: RSM Checked by: RW Date: 3-13-40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

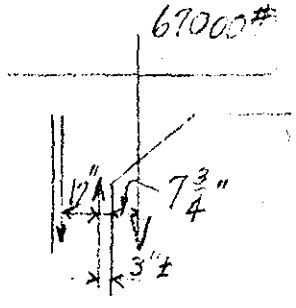
Sidewalls at conduit
Design for earth loading



$M = 790 \times 9^2/12 = 5320$ '#
$260 \times 9^2/20 = 1050$
6370 '#

$A_s = 6370 \times 12 / 18000 \times .884 \times 20.5 = .24$ □" Use ½" ⌀ @ 10"

Investigation of rear wall for gate loading.

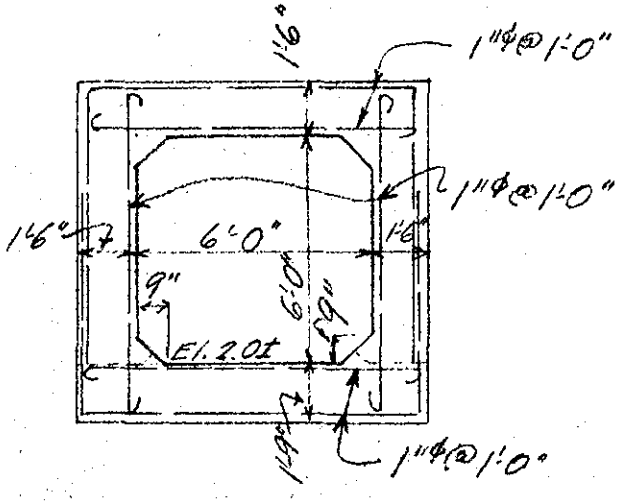


$L = 67000 \times 10.75/12 = 60000$#

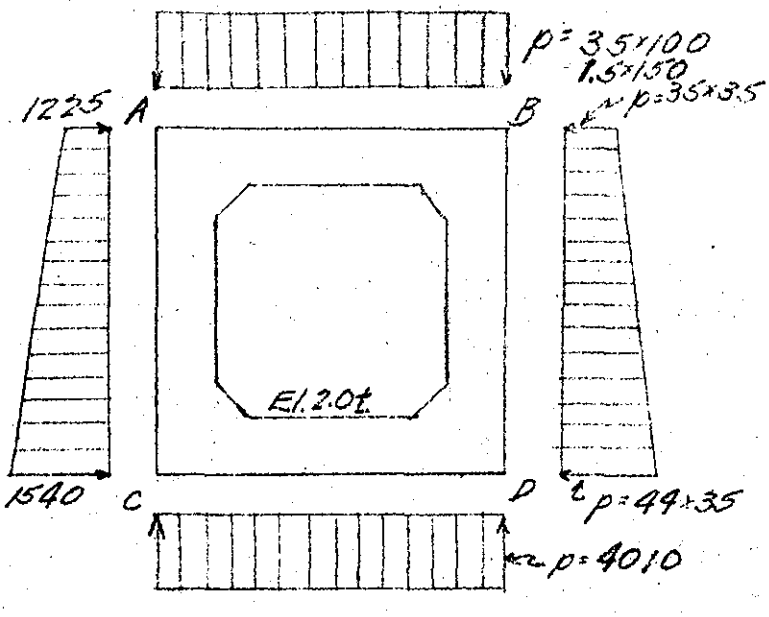
$A_s = 60000/18000 = 3.33$ □", distributed over 5'. Use ½" ⌀ @ 6" in rear wall

Project: HARTFORD Ht. 5
Computation: Keeney Lane Sta. Outlet
Computed by: RSM Checked by: Date: 3/5/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



CASE I. Conduit empty. Section at ℄ of earth dike.
Earth dry. Dike, top El. 44.5±



$-M_{AB} = 3730 \times \overline{7.5}^2/12 = 17{,}400'^{\#}$

$-M_{CD} = 4010 \times \overline{7.5}^2/12 = 18{,}800'^{\#}$

$-M_{AC}$ at A

$= 1260 \times \overline{7.5}^2/12 = 5900'^{\#}$

$260 \times \overline{7.5}^2/30 = 500$

$6400'^{\#}$

$-M_{AC}$ at C

$= 1260 \times \overline{7.5}^2/12 = 5900'^{\#}$

$260 \times \overline{7.5}^2/20 = 800$

$6{,}700'^{\#}$

WAR DEPARTMENT

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

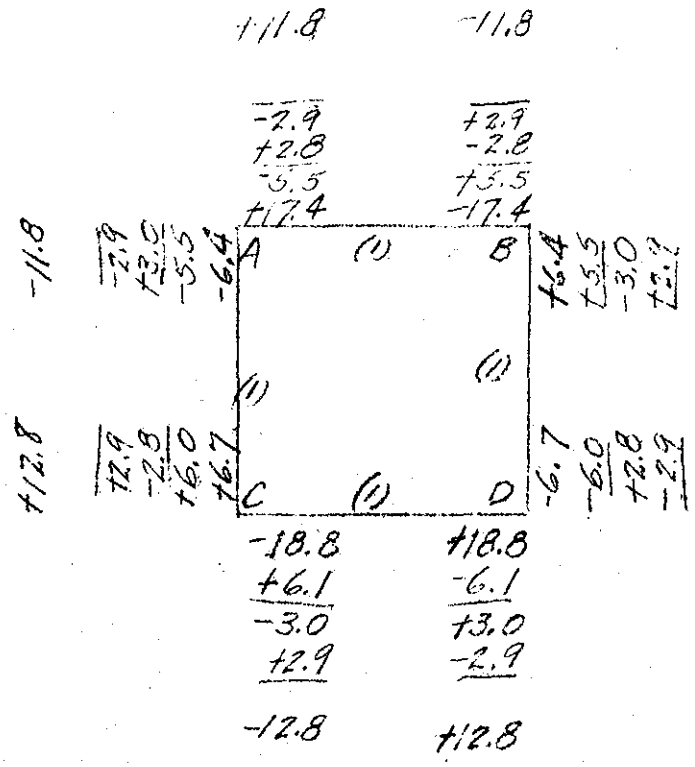
Project: HARTFORD H.C.S.

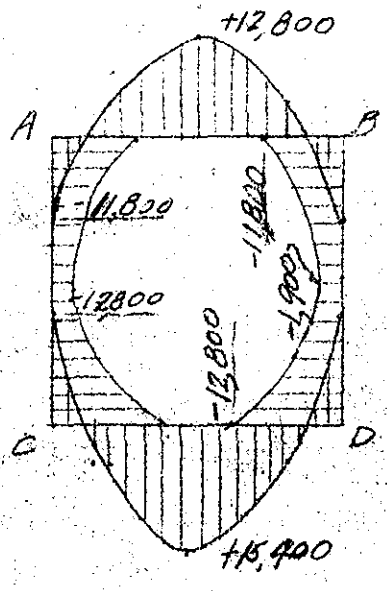
Computation: Keeney Lane Sta. Outlet

Computed by: RSM Checked by: ____ Date: 3/5/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

CASE I





Shear

AB 3×3500 = 10,500#

CD 3×4010 = 12030#

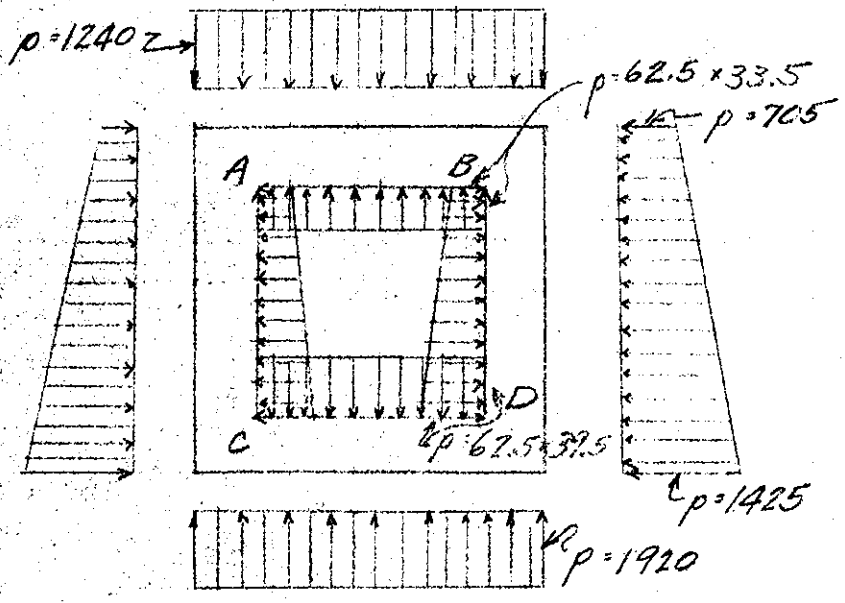
AC

1260×3 =	3780
$\frac{3.5\times7.5\times7.5}{2}\times\frac{2}{3}$ =	650
$\frac{12800-11,800}{7.5}$	130
Total	4460#

Project: HARTFORD HES
Computation: Keeney Lane Sta. Outlet
Computed by: RSM Checked by: Date: 3/5/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

CASE II River up, conduit full. Internal pressure with water to El. 41.5 in river. Section inside dike
Fill to El. 20.0
Line of saturation El. 17.0±



$M_{AB} = 850 \times \overline{7.5}^2/12 = 3980'\#$

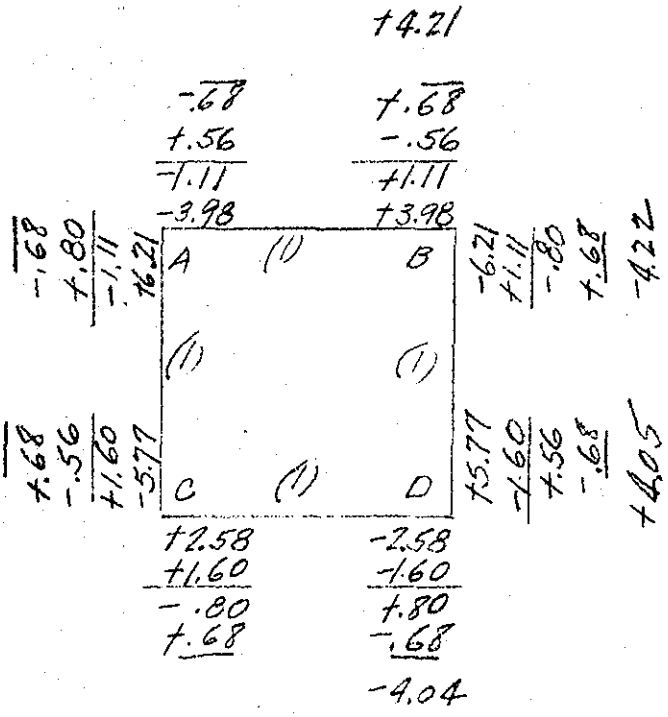
$M_{CD} = 550 \times \overline{7.5}^2/12 = 2580'\#$

M_{AC} at A $1105 \times \overline{7.5}^2/12 = 5180$
$220 \times \overline{7.5}^2/20 = 1030$ $6210'\#$

M_{AC} at C $1105 \times \overline{7.5}^2/12 = 5180$
$220 \times \overline{7.5}^2/30 = 690$ $5770'\#$

Subject: HARTFORD HES
Computation: Keeney Lane Sta. Outlet
Computed by: RSM Checked by: Date: 3/5/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



Moments are negligible.

Shear

AB $(2090-1240)\times\frac{6}{2} = 2550^{\#}$

CD $(2470-1920)\times\frac{6}{2} = 1650^{\#}$

AC $(2470-1305)\times 3 \quad 3495$

$\frac{40\times 6}{2}\times\frac{2}{3} = +\ 80$

$3575^{\#}$

Subject: HARTFORD HE 5
Computation: Keeney Lane Sta. Outlet
Computed by: RSM Checked by: Date: 3-5-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Steel

AB $-A_s = \frac{11800 \times 12}{18000 \times \frac{7}{8} \times 14.5} = .62 \square''$

$+A_s = \frac{12800 \times 12}{18000 \times \frac{7}{8} \times 14.5} = .67 \square''$

CD $-A_s = \frac{12800 \times 12}{18000 \times \frac{7}{8} \times 16.5} = .55 \square''$

$+A_s = \frac{15400 \times 12}{18000 \times \frac{7}{8} \times 16.5} = .72 \square''$

Shear

AB $10500/12 \times \frac{7}{8} \times 23.5 = 43$ #/□" at base of haunch.

$7900/12 \times \frac{7}{8} \times 14.5 = 52$ #/□" at beginning of haunch

CD $9360/12 \times \frac{7}{8} \times 16.5 = 54$ #/□" at " " " .

$12030/12 \times \frac{7}{8} \times 25.5 = 42$ #/□" at base " " .

WAR DEPARTMENT

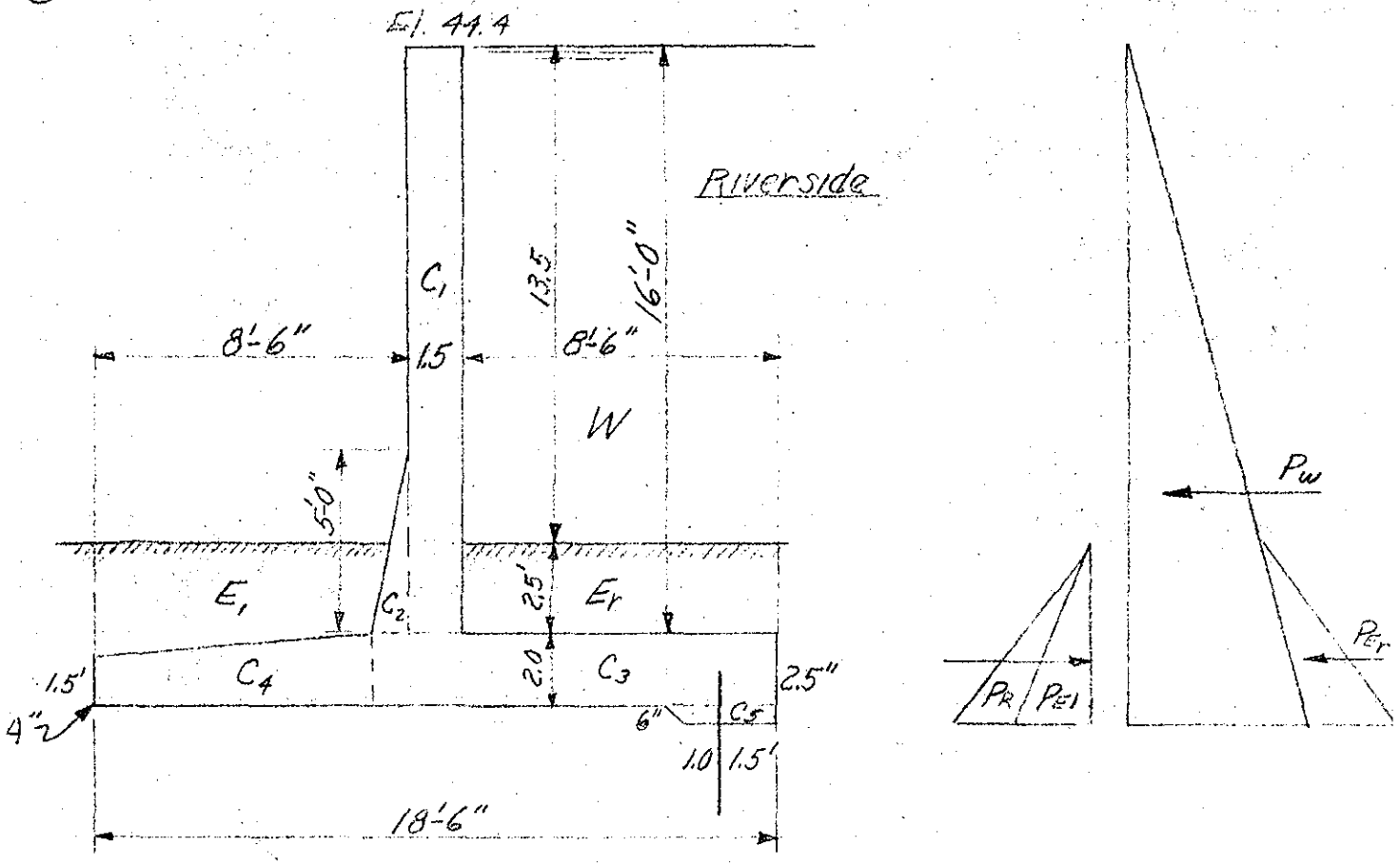
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

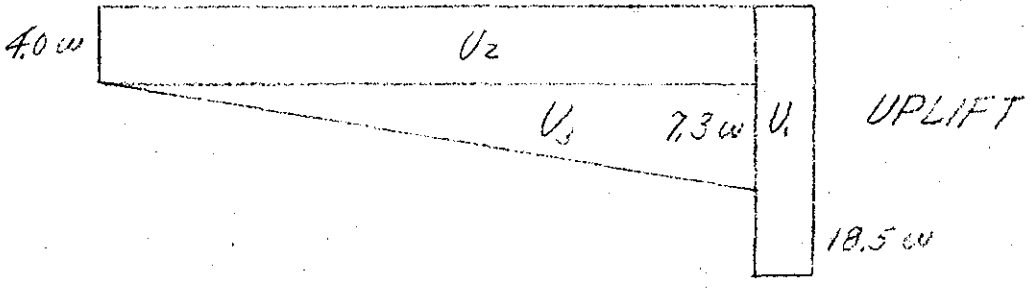
Subject: Hartford Ht. 7b

Computation: 16'-0" wall

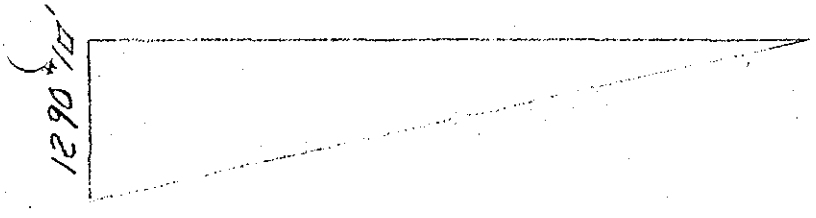
Computed by: R.W. Checked by: Date: 1-3-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528





UPLIFT



BEARING

WAR DEPARTMENT

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

Subject: Hartford Ht. 76

Computation: Stability

Computed by: R. W. Checked by: Date:

U. S. GOVERNMENT PRINTING OFFICE 3—10528

	Forces	↓	↑	←	→	Arm	Moments @ "A" ↻	↺
C_1	1.5 x 16 x 150	3600				9.25	33,300	
C_2	1 x 5 x ½ x 150	370				8.17	3020	
C_3	11.0 x 2 x 150	3300				13.0	42,900	
C_4	7.5 x 1.75 x 150	1970				3.8	7500	
C_5	0.5 x 2.75 x 150	210				17.1	3,590	
W	13.5 x 8.5 x 62.5	7170				14.25	102,200	
E_r	2.5 x 8.5 x 125	2660				14.25	37,900	
E_1	7.7 x 2.75 x 125	2650				3.6	9,550	
U_1	18.5 x 1.5 x 62.5		1740			17.75		30,900
U_2	4.0 x 17 x 62.5		4250			8.5		36,100
U_3	7.3 x ½ x 17 x 62.5		3880			11.3		43,800
P_W	18.5^2 x ½ x 62.5			10680		5.7		60,800
P_{Er}	5^2 x ½ x 17.5			220		1.3		290
P_{E1}	5^2 x ½ x 80				1000	1.3	1300	
FR	.45 x 12,060				5430	—		
PR					4470	1.3	5800	
		21,930	9,870	10,900	10,900		247,060	171,890
		ΣV = 12,060		ΣH = 0			ΣM = 75,170	

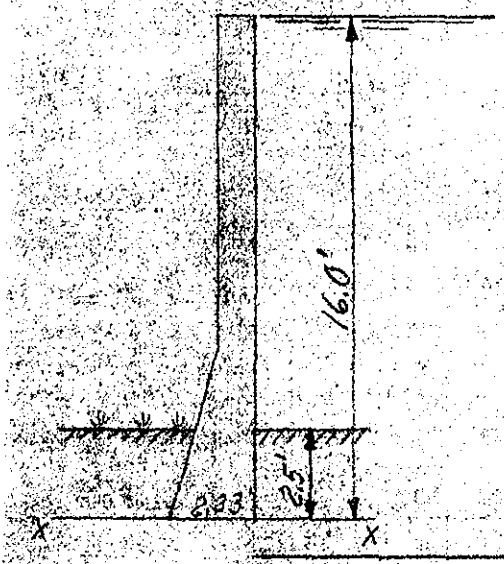
Position of resultant $\frac{\Sigma M}{\Sigma V} = \frac{75170}{12060} = 6.23'$ $\frac{18.5}{3} = 6.17'$

$e = 9.25 - 6.23 = 3.02$

$\frac{12060}{18.5} = 652$ $652\left(1 \pm \frac{6 \times 3.02}{18.5}\right) = 1290\#$, $13\#$

Subject Hartford Ht. 7b
Computation Steel in stem and base
Computed by J.H.L. Checked by Date

U. S. GOVERNMENT PRINTING OFFICE 3—10528



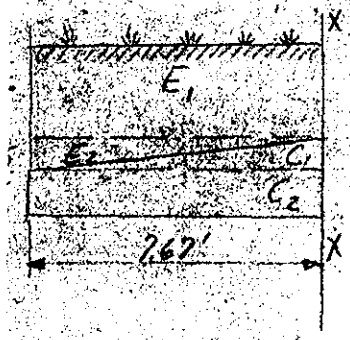
Steel in stem

	Force ←	Force →	Arm	ΣM @ X-X ↷	ΣM @ X-X ↶
P_W $\frac{1}{2}\times16^2\times62.5$	8000		5.33	42,600	
P_{ER} $\frac{1}{2}\times2.5^2\times17.5$	55		.83	46	
P_{EL} $\frac{1}{2}\times2.5^2\times.80$		250	.83		207

ΣH = 7800 ΣM = 42,450 ↷

Steel Area $\frac{42450\times12}{18000\times.884\times24.5} = 1.31$ □"

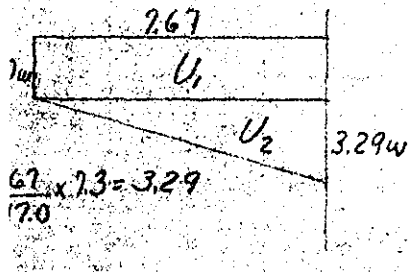
riverside face



Steel in landside base

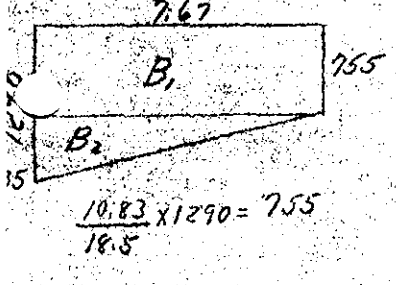
	Force ↓	Force ↑	Arm	ΣM @ X-X ↶	ΣM @ X-X ↷
E_1 $7.67\times2.5\times125$	2400		3.83	9200	
E_2 $\frac{1}{2}\times7.67\times.5\times125$	240		5.12	1230	
C_1 $\frac{1}{2}\times7.67\times.5\times150$	290		2.56	740	
C_2 $1.5\times7.67\times150$	1730		3.83	6630	
U_1 $7.67\times4\times62.5$		1920	3.83		7,350
U_2 $\frac{1}{2}\times3.29\times7.67\times62.5$		790	2.56		2,020
B_1 755×7.67		5780	3.83		22,100
B_2 $\frac{1}{2}\times535\times7.67$		2050	5.12		10,500

ΣV = 5,880 ↑ ΣM = 24,170 ↶



Steel A $\frac{24,170\times12}{18000\times.884\times19.5} = .935$ □"

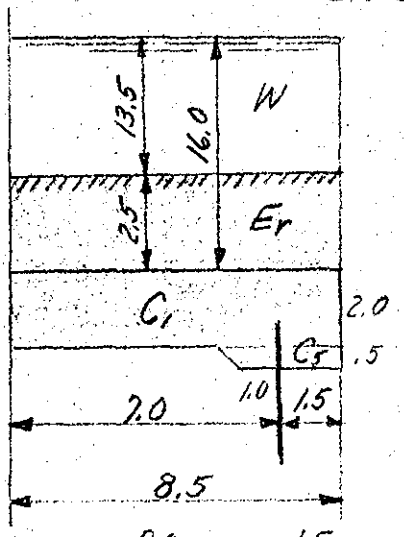
in bottom



Subject: Hartford Ht. 7b
Computation: Steel
Computed by: J.H.L. Checked by: Date:

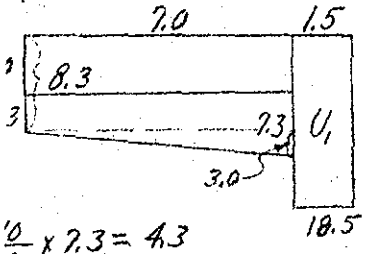
U. S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in riverside base

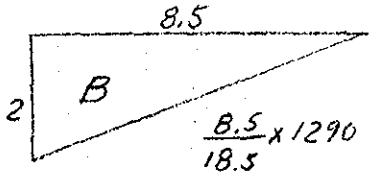


Force	↓	↑	Arm	EM @ X-X ↻	EM @ X-X ↺
W	7170		4.25	30,500	
E_r	2660		4.25	11,300	
C_1 8.5×2×150	2550		4.25	10,800	
C_5	210		7.0	1500	
U_1		1740	7.75		13,500
U_2 8.3×7.0×62.5		3630	3.5		12,700
U_3 $\frac{1}{2}$×3×7×62.5		660	4.67		3,100
B $\frac{1}{2}$×8.5×592		2520	2.83		7,100

$\Sigma V = 4040$ ↓ $\Sigma M = 17,700$ ↻



$\frac{10}{7} \times 7.3 = 4.3$



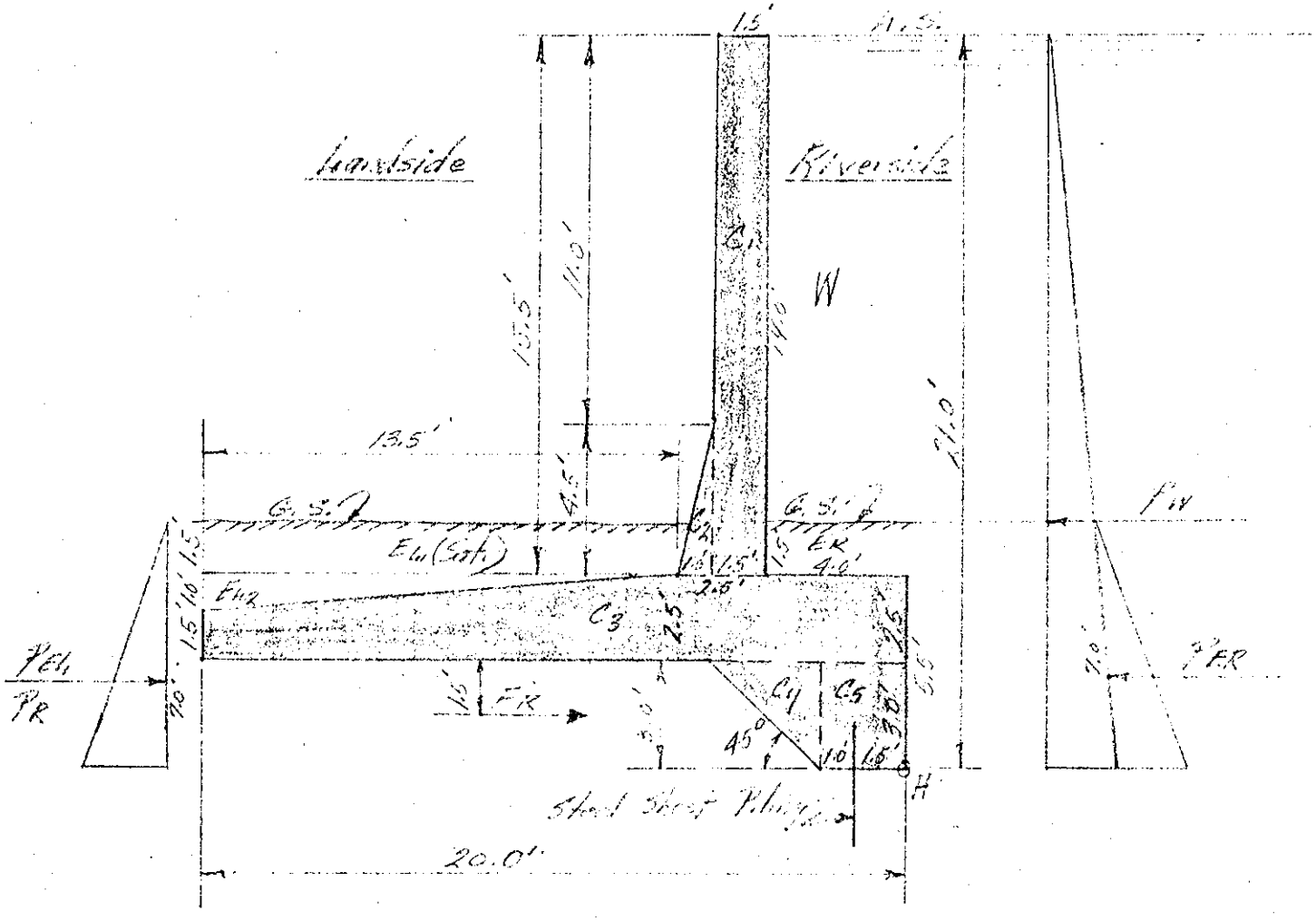
$$\text{Steel Area} = \frac{17,700 \times 12}{18000 \times .864 \times 19.5} = .685 \text{ □"}$$

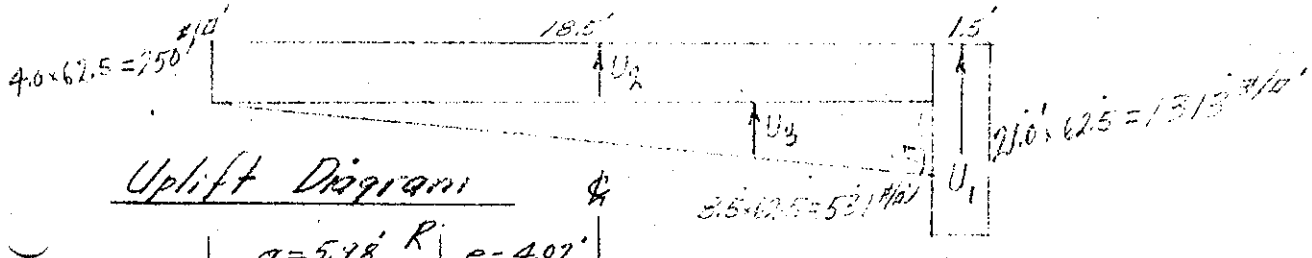
in top

Subject: Hartford, Conn. Ht. 7b
Computation: Flood Wall @ Sta. 85+30± to 87+30±
Computed by: JSM Checked by: Date: 2/27/40

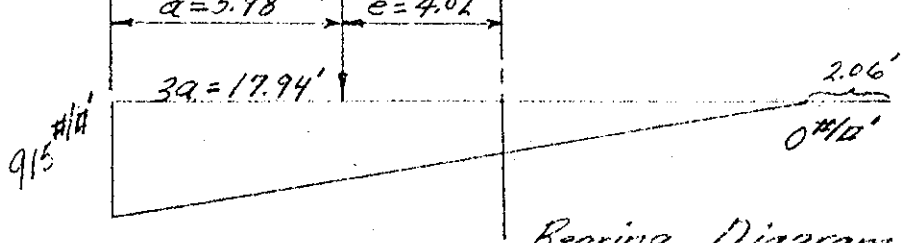
U. S. GOVERNMENT PRINTING OFFICE 3—10528

15'-6" Flood Wall





Uplift Diagram



Bearing Diagram

WAR DEPARTMENT

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

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Subject: Hartford Cap. Ht. - Ib

Computation: Head Wall @ Sta. 65+00 to Sta. 87+30±

Computed by: JMC Checked by: ____ Date: 2/29/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability - Governing Case - Water to top of Head wall

Forces Acting		↓	↑	→	←	Arm	Moments ↺	Moments ↻
C_1	1.5 × 15.5 × 150	3,180				4.75	16,500	
C_2	1/2 × 1 × 4.5 × 150	330				5.83	1,925	
C_3	2.5 × 20 × 150	7,500				10.00	75,000	
C_4	1/2 × 3 × 3 × 150	675				2.00	1,350	
C_5	2.5 × 3 × 150	1,125				1.25	1,407	
W	4 × 14 × 62.5	3,500				2.00	7,000	
E_R	1.5 × 4 × 125	750				2.00	1,500	
E_{H1}	12.5 × 1.5 × 125	2,550				12.5	32,550	
E_{H2}	1/2 × 1 × 12.5 × 25		161			15.00		2,420
U_1	2 × 62.5 × 1.5		1,170			2.75		1,480
U_2	4 × 12.5 × 62.5		4,630			10.75		49,800
U_3	1/2 × 5.5 × 12.5 × 62.5		4,170			7.00		29,700
P_W	4 × 62.5 × 21.64				13,500	1.00	13,500	
P_{ER}	1/2 × (62 − 62.5) × 7.5				422	2.00	844	
P_{EH}	1/2 × 8.0 × 7.5			1,160		2.75		4,570
P_R	14,828 − 5,000			6,568		2.00		20,600
FR	0.45 × 8,209			3,700		1.00		3,700
		19,518	1,009	11,428	14,922		236,844	111,765
		ΣV = 20,527		ΣH = 0			ΣM = 124,079	

Position of Resultant: $\frac{\Sigma M}{\Sigma V} = \frac{124,079}{8,527} = 14.62'$ Std. Pt. = 13.33'

Max. Vert. of Resultant: $\frac{\Sigma V}{b}\left(1 + \frac{6e}{b}\right) = \frac{20,527}{20}\left(1 + \frac{6 \times 1.29}{20}\right) = 1026.3 \times 1.39 = 1,427^{\#}$

Min. Vert. of Resultant: $= 1,026.3 - 426.3 = 600^{\#}$ / $= 1,026.3 - 426.3 = 600^{\#}$

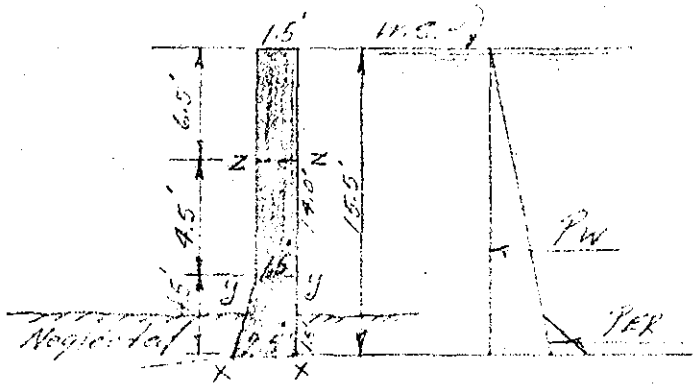
Overturning Moment $= 14.62 - 13.33 = 1.29'$

Resultant $= \frac{3\Sigma V}{3 \times a} = \frac{2 \times 8209}{3(20 - 14.62)} = \frac{16,418}{16.14} = 1,017^{\#}$ or $0^{\#}$

Subject: Hartford, Conn. Ht. - 7b
Computation: Flood Wall @ Sta. 85+30 to Sta. 87+30
Computed by: JAM Checked by: Date: 2/28/40

U. S. GOVERNMENT PRINTING OFFICE 3—10538

Design of Stem (Riverside Face)



	Forces Acting	←	Arm	Moment about x-x
P_W	$\frac{1}{2} \times 62.5 \times 15.5^2$	7,500	5.17	38,800
P_{ER}	$\frac{1}{2} \times 8 \times 62.5 \times 1.5$	20	6.50	130
		7,520	ΣM =	38,810
	Forces Acting	←	Arm	Moment about x-x
P_W	$\frac{1}{2} \times 62.5 \times 11.0^2$	3,780	3.67	13,900
	Forces Acting	←	Arm	Moment about x-x
P_W	$\frac{1}{2} \times 62.5 \times 6.5^2$	1,320	2.17	2,860

$$d_{x-x} = \sqrt{\frac{38,810 \times 12}{12 \times 12}} = \sqrt{3,235} = 17.7'' \text{ use. Actual } d = 27 - 3.5 = 23.5''$$

$$M_{x-x} = \frac{38,810 \times 12}{12,000 \times 12 \times 23.5} = 1.25 \text{ ok/ft} \quad \text{Use } \left\{ \begin{array}{l} 1'' \times 6'' \text{ Bent} \\ \text{Bars. } d_b = 1.35'' \end{array} \right\}$$

$$\text{Shear } v = \frac{7,520}{12 \times 12 \times 23.5} = 31.0 \text{ psi} < 60 \text{ psi} \quad \therefore \text{ O.K.}$$

$$\text{Bond } u = \frac{7,520}{6.28 \times 0.66 \times 23.5} = 58.0 \text{ psi} < 100 \text{ psi} \quad \therefore \text{ O.K.}$$

WAR DEPARTMENT

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Subject Hartford, Conn. HT-76

Computation Flood Wall @ Sta. 85+30 to Sta. 87+30

Computed by [illegible] Checked by ..... Date 2/28/40

U. S. GOVERNMENT PRINTING OFFICE 3—10328

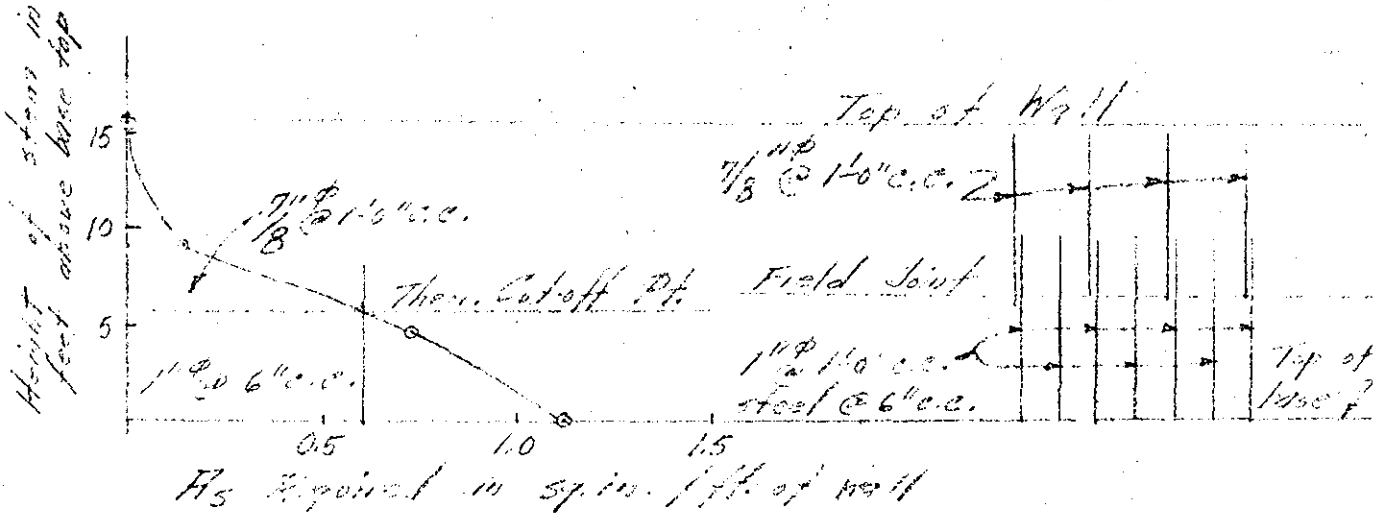
Design of Stem (Cont'd)

$$d_{g-g} = \sqrt{\frac{13,900 \times 12}{128 \times 12}} = \sqrt{113} = 10.6'' \text{ ok. Actual } d = 18 - 3.5 = 14.5''$$

$$A_s = \frac{13,900 \times 12}{18000 \times 0.88 \times 14.5} = 0.13 \text{ □"/'}$$

Unit Shear + Unit Bond Stresses are Ok. by Inspection

$$A_{s\,2-2} = \frac{2,860 \times 12}{18000 \times 0.88 \times 14.5} = 0.15 \text{ □"/'}$$



A_s required in sq. in. / ft. of wall

For landside face of stem } Use Min. Stress Steel: 7/8" ⌀ @ 1'-6" c.c.

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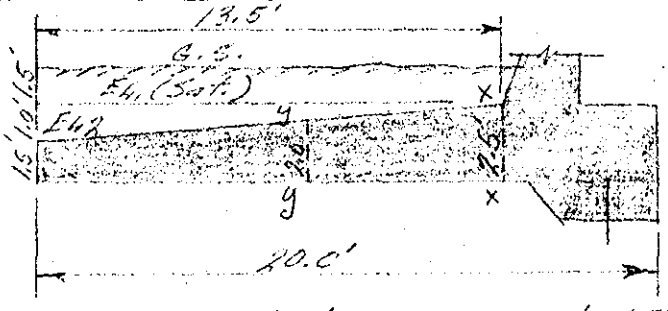
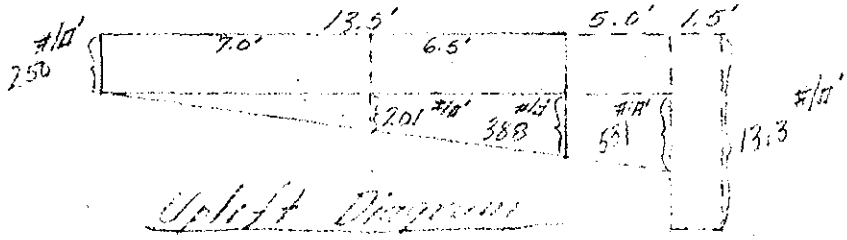
Subject Hartford, Conn. Ht-76
Computation Flood Wall @ Sta. 85+30 to Sta. 87+30
Computed by JRM Checked by ..... Date 3/1/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Landside Base Slab - Water to top of wall

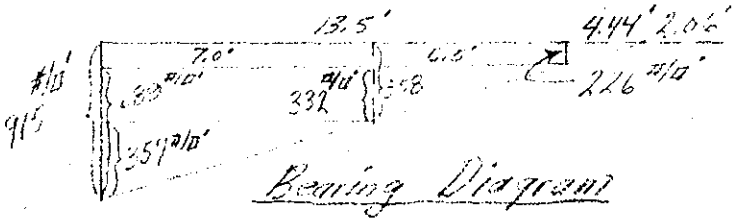




Uplift Diagram

$\frac{531 \times 13.5}{18.5} = 388$ #/□'

$\frac{531 \times 7.0}{18.5} = 201$ #/□'



Bearing Diagram

$\frac{915 \times 4.44}{17.94} = 226$ #/□'

$\frac{689 \times 6.5}{13.5} = 332$ #/□'

Forces Acting		↓	↑	Arm	Moments about x-x ↙	↖
E_{L1}	1.5×13.5×125	2,530		6.75	17,100	
E_{L2}	1/2×1.0×13.5×125		844	4.00		7,576
C	2.5×13.5×150	5,050		6.75	34,100	
U_1	250×13.5		3,375	6.75		22,800
U_2	1/2×[illegible]×13.5		2,615	4.50		11,770
b_1	226×13.5		3,050	6.75		20,600
b_2	1/2×689×13.5		4,640	7.00		41,760
		7,580	14,524		51,200	104,546
		ΣV = 6,944 ↑			[illegible]	
Moment about y-y						
E_{L1}	2×7×125	1,750		3.50	6,125	
C	2×7×150	2,100		3.50	7,350	
U_1	250×7		1750	3.50		6,125
U_2	[illegible]×7		754	2.33		1,640
b_1	358×7		2506	3.50		13,760
b_2	1/2×357×7		1250	4.67		5,830
		3,850	7,610		13,475	27,295
		ΣV = 3,760 ↑			ΣM = 13,820	

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Subject Hartford, Conn. Ht. 76
Computation Flood Wall @ Sta. 85+30 to Sta. 87+30
Computed by JSM Checked by Date 3/5/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Landside Base Slab (Cont'd)

$$d_{x-x} = \sqrt{\frac{53,346 \times 12}{123 \times 12}} = \sqrt{433} = 20.8'' \text{ O.K.} \quad d_{x-x} \text{ used} = 25.5''$$

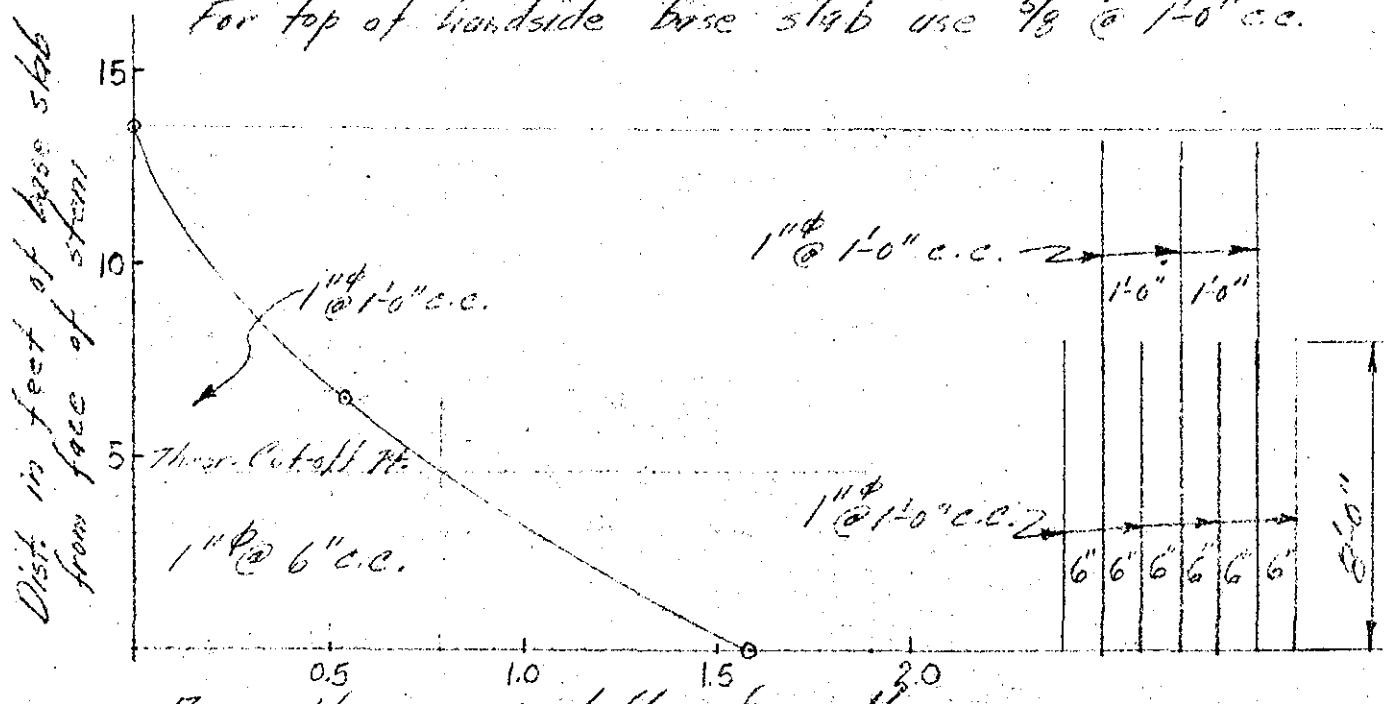
$$As_{x-x} = \frac{53,346 \times 12}{18,000 \times 0.88 \times 25.5} = 1.59 \square'' \quad \text{Use: } \left\{ \begin{array}{l} 1''\phi @ 6'' \text{ c.c.} \\ \text{giving } As = 1.58 \square'' \\ \text{bottom} \end{array} \right\}$$

$$\left.\begin{array}{l}\text{Unit Shear} \\ \text{Stress}\end{array}\right\} r = \frac{6,944}{12 \times 0.88 \times 25.5} = 25.8 \#/\square'' < 60 \#/\square'' \therefore \text{O.K.}$$

$$\left.\begin{array}{l}\text{Unit Bond} \\ \text{Stress}\end{array}\right\} u = \frac{6,944}{6.28 \times 0.88 \times 25.5} = 49.3 \#/\square'' < 150 \#/\square'' \therefore \text{O.K.}$$

$$As_{y-y} = \frac{13,820 \times 12}{18,000 \times 0.88 \times 19.5} = 0.54 \square''$$

For top of landside base slab use 5/8"φ @ 1'-0" c.c.



For Riverside base slab, top & bottom, use min. stress steel of 5/8"φ @ 1'-0" c.c.

WAR DEPARTMENT

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

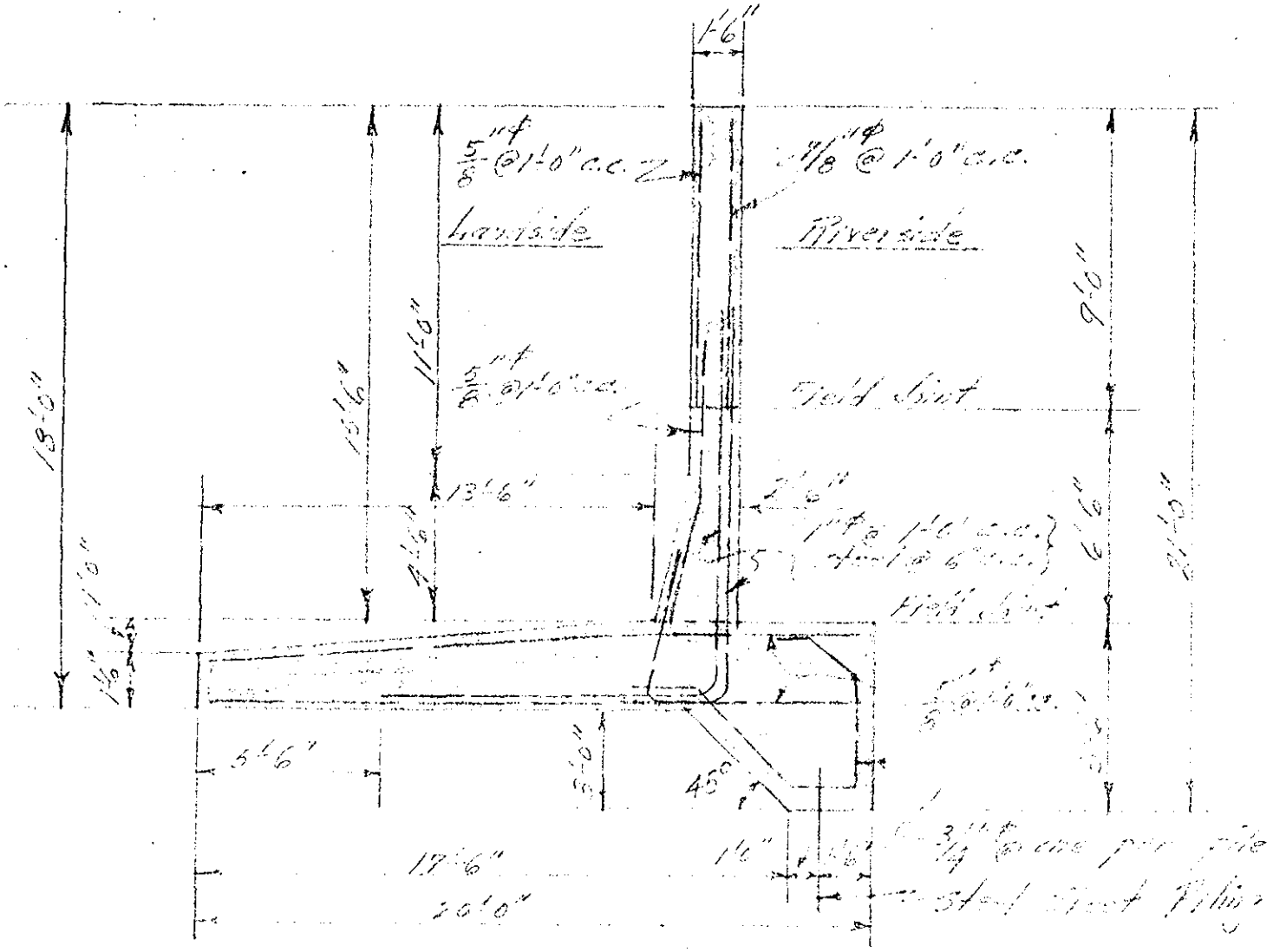
Subject: Hartford Coop. HT 76

Computation: Flood Wall @ Sta. 85+30 to Sta. 87+30

Computed by: JSMc Checked by: ____ Date: 3/5/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Final Section as Designed



All Longitudinal steel: 1/2" ⌀ @ 1'-0" c.c.

Note: The min. cover for main reinforcement shall be 3" except where concrete is poured against earth in which case it shall be 4"

WAR DEPARTMENT

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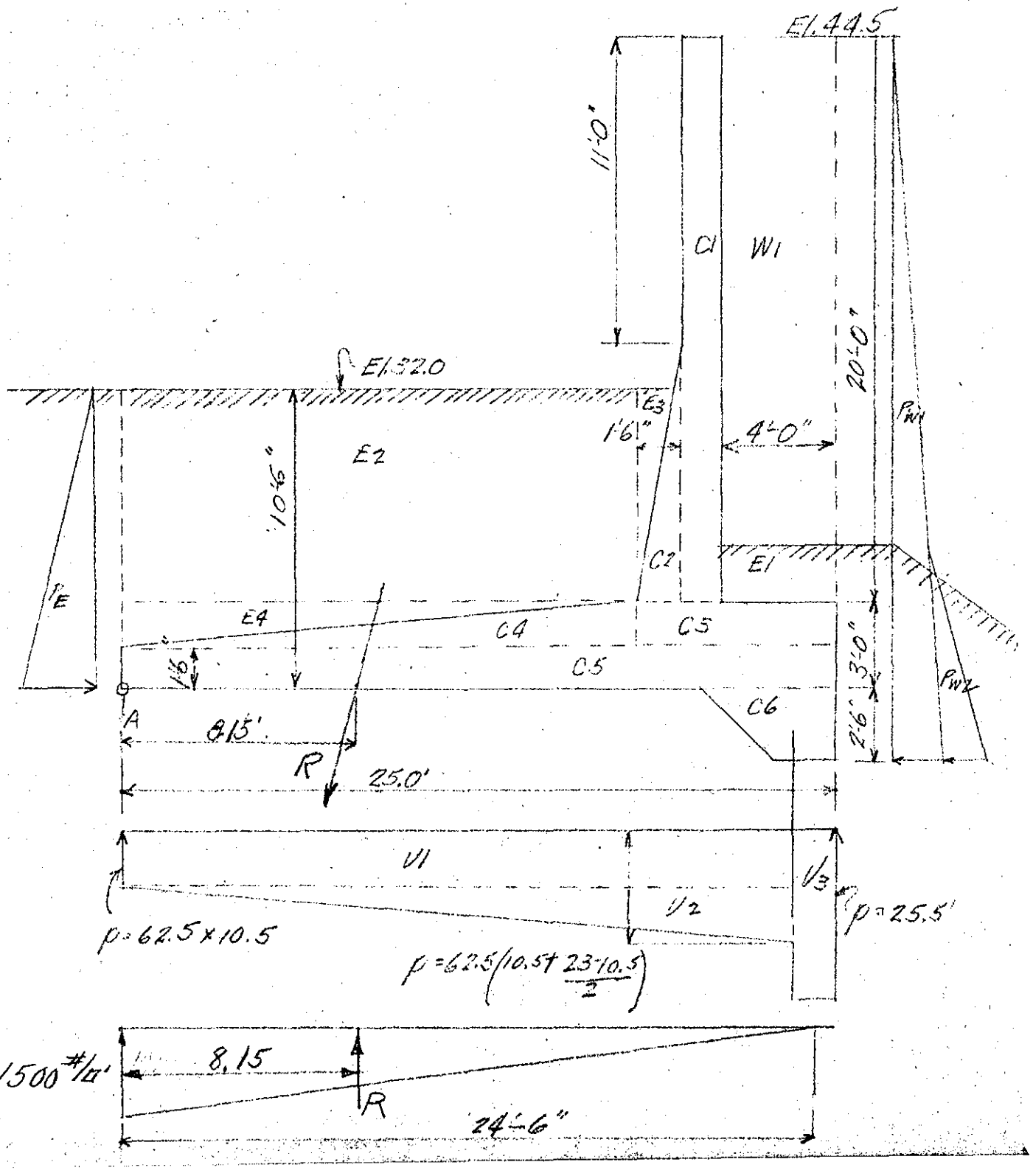
Object: HARTFORD Ht 76

Computation: 20' wall

Computed by: RSM Checked by: J.H.L. Date: 3-6-40

U.S. GOVERNMENT PRINTING OFFICE 3—10528



WAR DEPARTMENT

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

Object: HARTFORD Ht 76

Computation: 20' wall

Computed by: RSM Checked by: J. H. L. Date: 3-6-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

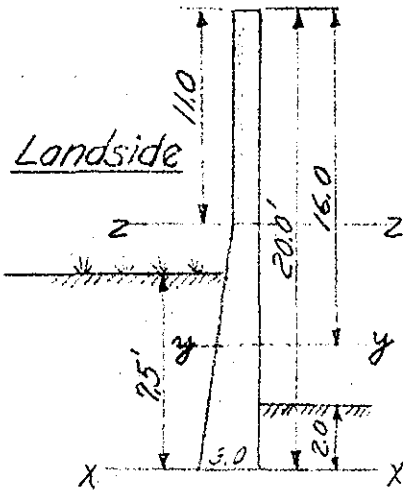
		Force ↓	Force ↑	Force →	Force ←	Arm	Moment abt "A" → 'kips	Moment abt "A" ←
C1	150'×1.5'×20'	4,500'				20.2'	91'	
C2	150'×1.5'×9/2'	1,010'				19.0	19	
C3	150'×1.5'×7'	1,570'				21.5'	34	
C4	150×1.5'×18/2'	2,020'				12.0'	24'	
C5	150'×1.5'×25'	5630'				12.5'	70'	
C6	150'×2.5'×3.8'	1,420'				23.1'	33	
W1	62.5'×4'×18'	4500'				23.0'	103'	
E1	125'×4'×2'	1,000'				23.0'	23'	
E2	125'×18'×7.5'	16,900'				9.0'	152'	
E3	125×1.2×7.5/2'	560'				18.4'	10'	
E4	125×1.5×18/2'	1,690'				6.0'	10'	
U1	62.5×10.5×23.5		15,400			11.8'		182
U2	62.5×6.25×23.5/2		4590			15.7'		72
U3	62.5×25.5×1.5'		2,390'			24.3'		58'
P_{W1}	62.5×25.5²/2'				20,350'	6.0'		122'
P_{W2}	17.5×7.5²/2'				490'	0'		
P_E	80×10.5²/2'			4,400'		3.5'	15'	
		40800'	22,380	4,400	20,840		584	434
Σ		18,420				Σ	150	

Position of resultant $\frac{150,000}{18,420} = 8.15'$

$b = \frac{18420 \times 2}{3 \times 8.15} = 1500$ #/□' to 0

Subject: Hartford Ht. 7b
Computation: Steel in Stem 20' wall
Computed by: J.H.L. Checked by: Date:

U. S. GOVERNMENT PRINTING OFFICE 3—10528



Force	←	→	Arm	EM @ x-x ↺	↻
P_W $\frac{1}{2}\times 20^2\times 62.5$	12,500		6.67	83,400	
P_{ER} $\frac{1}{2}\times 2^2\times 17.5$	35		.67	23	
P_{EL} $\frac{1}{2}\times 7.5^2\times 80$		2250	2.5		5620

$\Sigma V = 10,300$ $\Sigma M = 77,800$ '#

$$\text{Unit shear} = \frac{10,300}{.884\times 12\times 31.5} = 30.8^{\#} \text{ O.K.}$$

$$\text{Steel } A_{x-x} = \frac{77,800\times 12}{18000\times .884\times 32.5} = 1.80 \text{ □"}$$
riverside face

Force	←	→	Arm	EM @ y-y ↺	↻
P_W $\frac{1}{2}\times 16^2\times 62.5$	8000		5.33	42,600	
P_{EL} $\frac{1}{2}\times 3.5^2\times 80$		490	1.17		580

$\Sigma M = 42,000$ '#

$$\text{Steel } A_{y-y} = \frac{42,000\times 12}{18000\times .884\times 25} = 1.27 \text{ □"}$$
riverside face

EM @ z-z

$$P_W \quad \frac{1}{2}\times 11^2\times 62.5\times \frac{11}{3} = 13,850 \text{ '#}$$

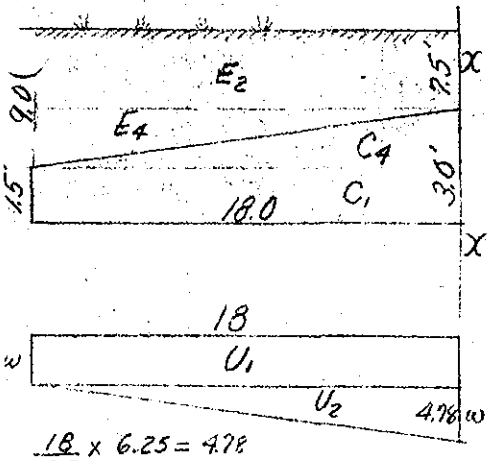
$$\text{Steel } A_{z-z} = \frac{13,850\times 12}{18000\times .884\times 14.5} = .72 \text{ □"}$$
riverside face

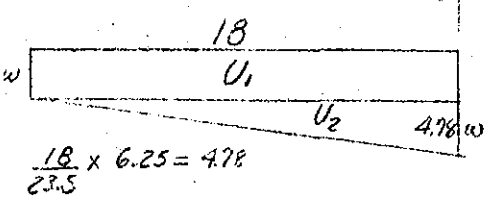
$$P_{EL} \quad \frac{1}{2}\times 7.5^2\times 80\times 2.5 = 5620 \text{ '#}$$

$$\text{Steel } A_{x-x} = \frac{5620\times 12}{18000\times .884\times 32.5} = .0131 \text{ □"}$$
landside face

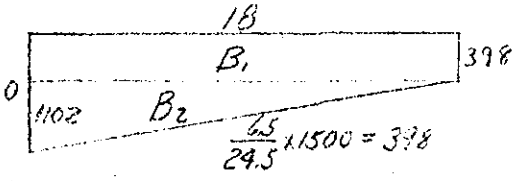
Subject: Hartford Ht. 26
Computation: 20' wall
Computed by: J.H.L. Checked by: Date:

U.S. GOVERNMENT PRINTING OFFICE 3—10628





$\frac{18}{23.5} \times 6.25 = 4.78$



$\frac{6.5}{24.5} \times 1500 = 398$

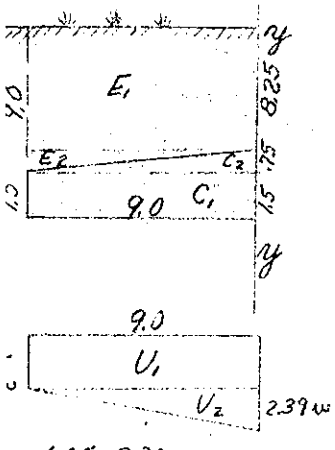
Steel in landside base

Force	↓	↑	Arm	EM @ x-x ↶	↷
C_1 18×1.5×150	4050		9.0	36,400	
C_4	2020		6.0	12,100	
E_2	16,900		9.0	152,000	
E_4	1,690		12.0	20,300	
U_1 10.5×62.5×18		11,800	9.0		106,00
U_2 $\frac{1}{2}$×4.78×62.5×18		2,690	6.0		16,10
B_1 398×18		7,170	9.0		64,50
B_2 $\frac{1}{2}$×1102×18		9,920	12.0		119,00

$\Sigma V = 6920$ ↑ $\Sigma M = 84,800$ ↶

Unit shear $= \frac{6920}{.884 \times 12 \times 31.5} = 21\#$ O.K.

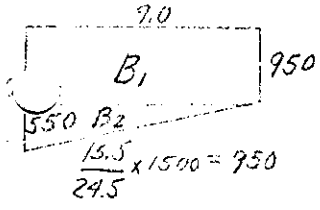
Steel required $A_{x-x} = \frac{84,800 \times 12}{18000 \times .884 \times 31.5} = 2.03$ □" in bottom



$\times 6.25 = 2.39$

Force	↓	↑	Arm	↶	↷
E_1 8.25×9×125	9270		4.5	41,700	
E_2 $\frac{1}{2}$×.75×9×125	420		3.0	1300	
C_1 1.5×9.0×150	2020		4.5	9100	
C_2 $\frac{1}{2}$×.75×9×150	510		6.0	3100	
U_1 10.5×62.5×9		5910	4.5		26,600
U_2 $\frac{1}{2}$×2.39×62.5×9		700	6.0		4,200
B_1 950×9		8550	4.5		38,500
B_2 $\frac{1}{2}$×550×9		2470	3.0		7,400

$\Sigma V = 5,410$ $\Sigma M = 21,500$ ↶



$\frac{15.5}{24.5} \times 1500 = 950$

Steel required $A_{y-y} = \frac{21,500 \times 12}{.884 \times 12 \times 22.5} = .722$ □"

Steel in Riverside base

By inspection temperature steel will be sufficient

WAR DEPARTMENT

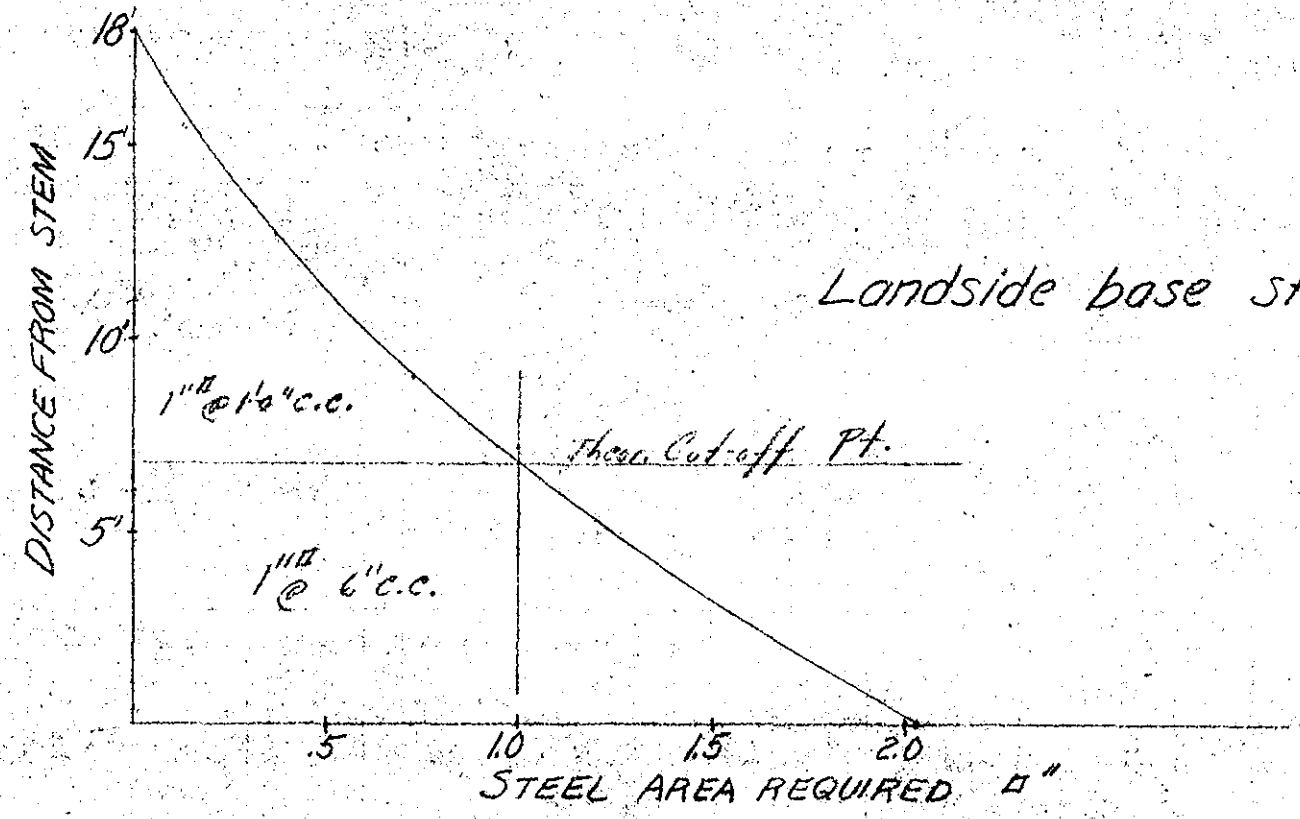
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

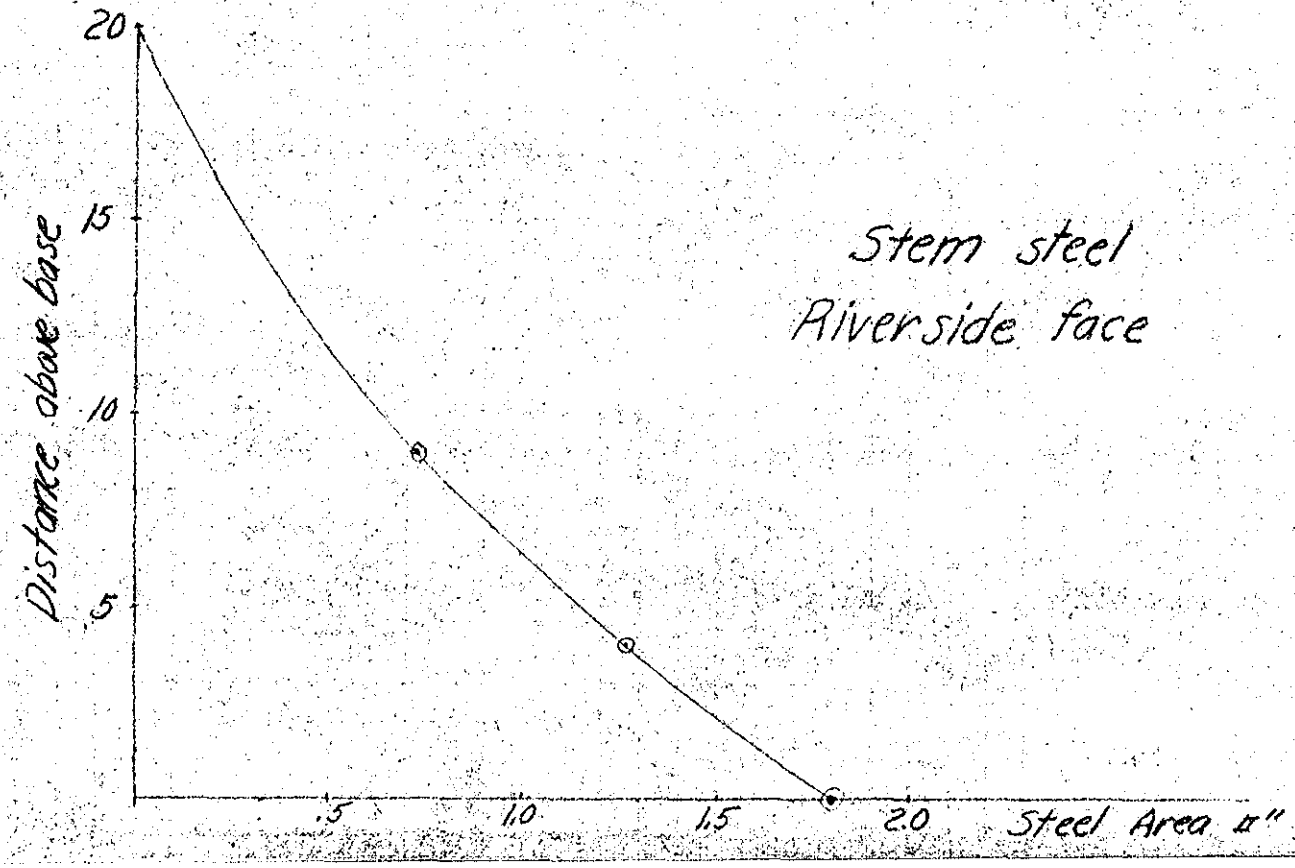
Project: Hartford Ht. 7b

Computation: 20' wall

Computed by: J.H.L. Checked by: Date:

U. S. GOVERNMENT PRINTING OFFICE 3—10528





WAR DEPARTMENT

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

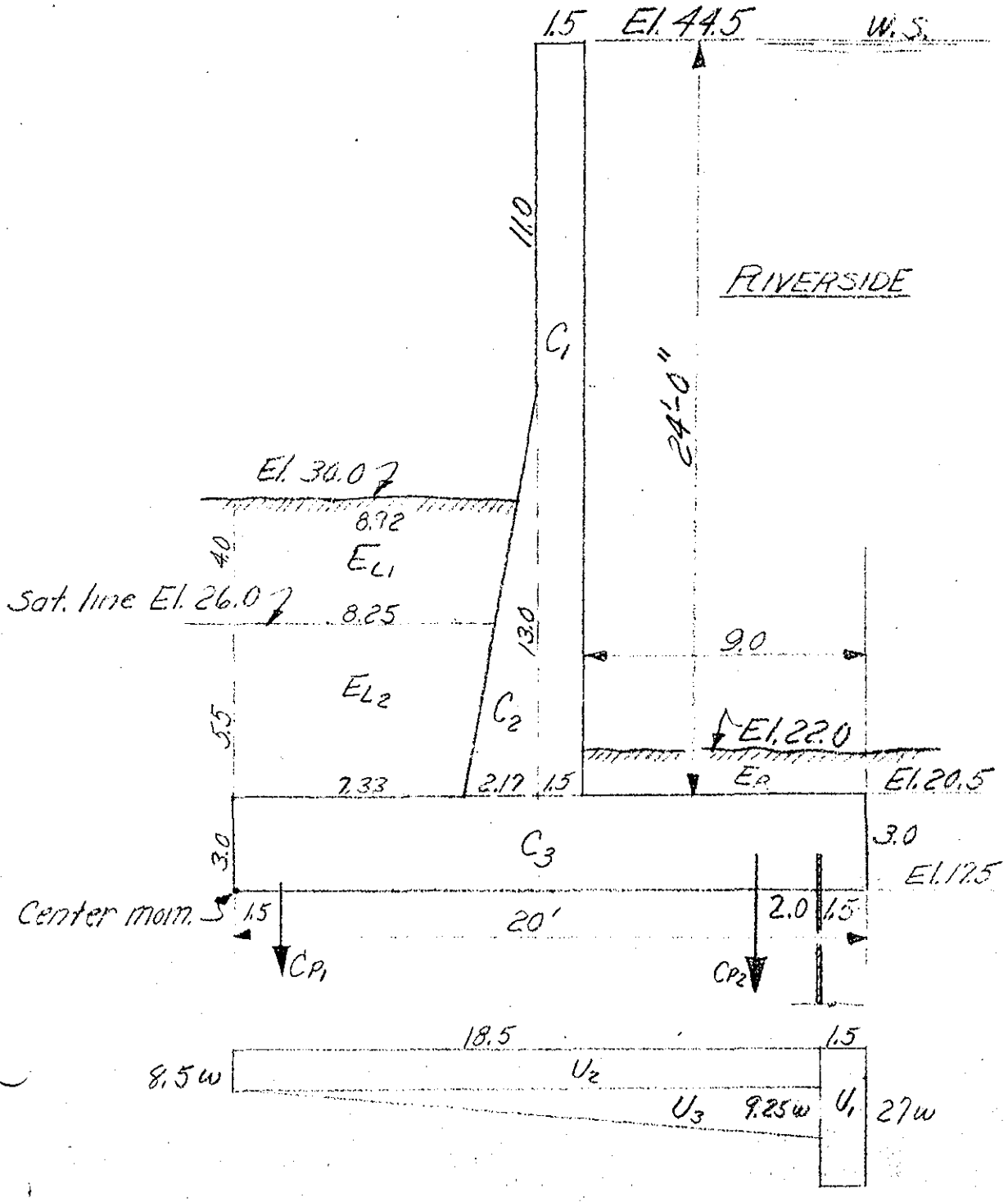
Page 359

Subject Hartford Ht. 7b

Computation 24'-0" floodwall on piles

Computed by J.H.L. Checked by ..... Date 3/6/40

U.S. GOVERNMENT PRINTING OFFICE 8—10528



WAR DEPARTMENT

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

Subject: Hartford Ht 7b

Computation: 24'-0" wall

Computed by: J.H.L. Checked by: Date: 3/6/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case I - Stability

Forces		↓	↑	→	←	Arm	Moments ↻	Moments ↺
C_1	$1.5 \times 24 \times 150$	5400				10.25	55,300	
C_2	$\frac{1}{2} \times 2.17 \times 13 \times 150$	2110				8.78	18,500	
C_3	$3 \times 20 \times 150$	9000				10.0	90,000	
E_R	$1.5 \times 9 \times 125$	1690				15.5	26,200	
E_{L1}	$4 \times 8.58 \times 100$	3430				4.29	14,700	
W	$22.5 \times 9 \times 62.5$	12,650				15.5	196,000	
E_{L2}	$5.5 \times 2.79 \times 125$	5350				3.9	20,800	
P_W	$27.0^2 \times \frac{1}{2} \times 62.5$				22,800	9.0		205,000
P_{ER}	$4.5^2 \times \frac{1}{2} \times 17.5$				180	1.5		300
P_{EL}	$12.5^2 \times \frac{1}{2} \times 35$			2730		4.17	11,400	
P_{EW}	$8.5^2 \times \frac{1}{2} \times 45$			1630		2.83	4,600	
U_1	$27 \times 62.5 \times 1.5$		2530			19.25		48,700
U_2	$8.5 \times 62.5 \times 18.5$		9850			9.25		91,100
U_3	$\frac{1}{2} \times 9.25 \times 62.5 \times 18.5$		5350			12.33		66,000
C_{P1}	$\frac{256}{144} \times 30 \times \frac{150}{3}$	1600				1.5	2400	
C_{P2}		1600				16.5	26,400	
		$\Sigma V =$ 25,100		$\Sigma H = 18,620$			$\Sigma M = 55,200$	

$$\frac{\Sigma M}{\Sigma V} = \frac{55,200}{25,100} = 2.2' \text{ o.k. inside rear pile}$$

Unbalanced lateral load will be taken care of by concrete piles, existing sheet piling, and by passive resistance of the backfill.

WAR DEPARTMENT

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

Subject Hartford Ht. 76

Computation 24'-0 wall

Computed by J.H.L. Checked by Date

U. S. GOVERNMENT PRINTING OFFICE 3—10528

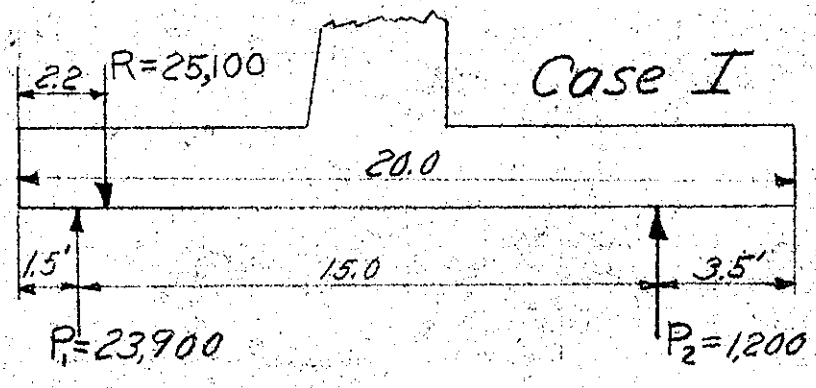
Case II – water down Stability

	Force	↓	↑	→	←	Arm	Moments ↻	Moments ↺
C_1		5400					55,300	
C_2		2110					18,500	
C_3		9000					90,000	
E_R	1.5 × 9 × 100	1350				15.5	20,900	
E_{L1}		3430					14,700	
E_{L2}		5350					20,800	
P_{ER}	$4.5^2 \times \frac{1}{2} \times 35$				355	1.5		530
P_{EL}				2730			11,400	
P_{EW}				1630			4,600	
U_2			9850					91,100
C_{P1}		1600					2400	
C_{P2}		1600					26,400	
		19,990					173,370	

Position of Resultant $= \frac{\Sigma M}{\Sigma V} = \frac{173,370}{19,990} = 8.7'$

Subject Hartford Ht. 2b
Computation Pile spacing 24' wall
Computed by J.H.L. Checked by Date

U. S. GOVERNMENT PRINTING OFFICE 3—10528

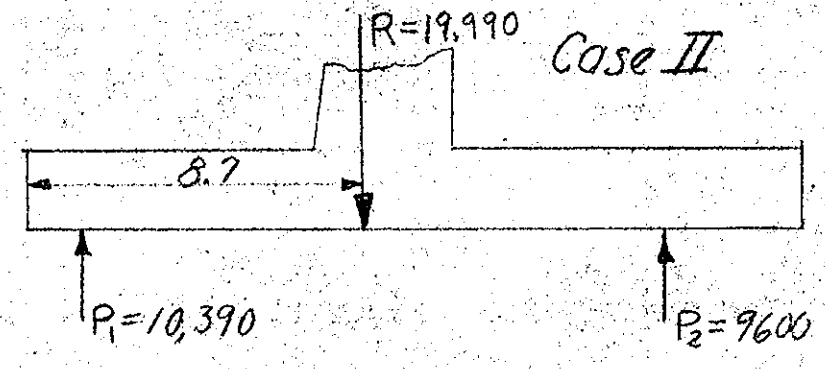


Pile loading

$15 P_1 = 14.3 \times 25{,}100$

$P_1 = 23{,}900\#$ $\quad P_2 = 1{,}200\#$ per foot of wall

Allowable load per pile assumed at 50 tons
piles spaced at 4'-0" c.c.
$4 \times 23{,}900 = 95{,}000\#$ per pile



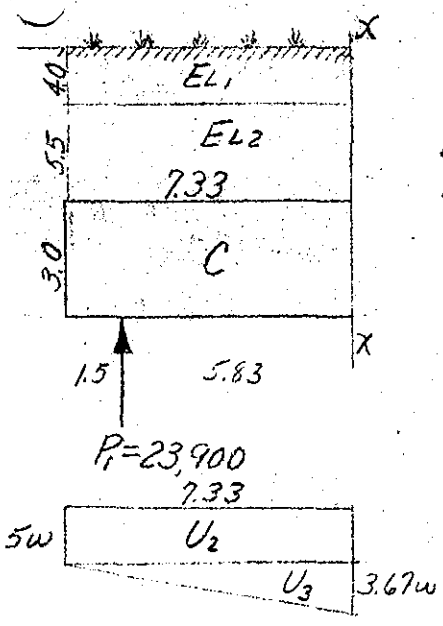
By inspection pile loading for this case is O.K.

$15 P_2 = 7.2 \times 19{,}990$

$P_2 = 9{,}600$

Project Hartford H.T.P.
Computation Steel in base 24' wall
Computed by J.H.L. Checked by Date

U. S. GOVERNMENT PRINTING OFFICE 3—10523



$\frac{33}{1.5} \times 9.25 = 3.67$

Landside base Case I

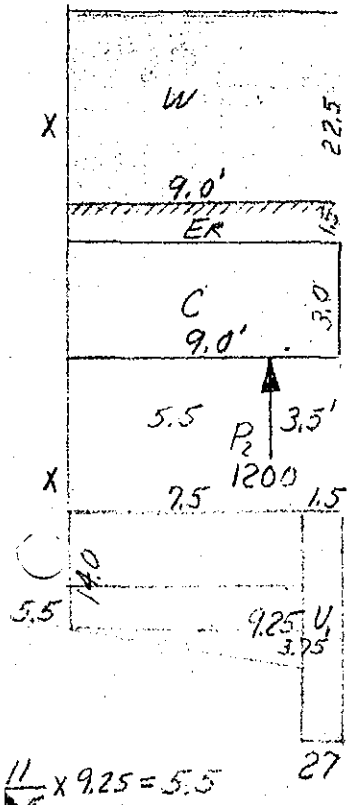
Force	↓	↑	Arm	EM @ X-X ↶	↷
E_{L1} 4×7.33×100 =	2,930		3.67	10,750	
E_{L2} 5.5×7.33×125 =	5,050		3.67	18,500	
C 3×7.33×150 =	3,300		3.67	12,100	
U_2 8.5×62.5×7.33 =		3,890	3.67		14,300
U_3 $\frac{1}{2}$×3.67×62.5×7.33 =		840	2.44		2,050
P_1		23,700	5.83		139,500

EV = 17,350 ↑ EM = 114,500 ↶

Unit shear $\frac{17350}{.884 \times 12 \times 31.5} = 52^{\#}$ O.K.

Depth needed $\sqrt{\frac{114,500}{123}} = 30.5''$ O.K.

Steel $A_{x-x} = \frac{114,500 \times 12}{18000 \times .884 \times 31.5} = 2.74 \square''$ in bottom



$\frac{11}{5} \times 9.25 = 5.5$

Case I Riverside base

Force	↓	↑	Arm	EM @ X-X ↷	↶
W	12,650		4.5	57,000	
E_R	1690		4.5	7,600	
C 9×3×150	4050		4.5	18,200	
U_1		2530	8.25		20,900
U_2 14×62.5×7.5		6550	3.75		24,500
U_3 $\frac{1}{2}$×3.75×62.5×7.5		880	5.0		4,400
P_2		1200	5.5		6,600

EV = 7,230 ↓ EM = 26,400 ↶

Steel $A_{x-x} = \frac{26,400 \times 12}{.884 \times 12 \times 31.5} = .632 \square''$ in top

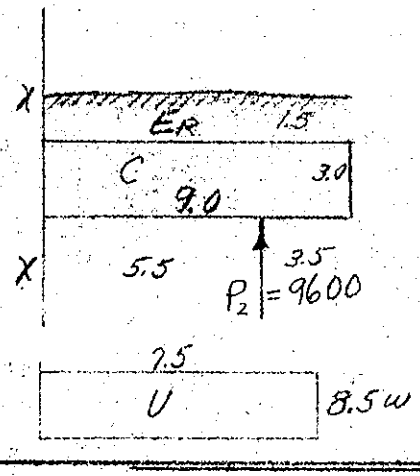
Project Hartford Ht. 7b
Computation Steel in base 24' wall
Computed by J.H.L. Checked by Date

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case II Landside base

By inspection Case II will required less steel in the bottom of the base.

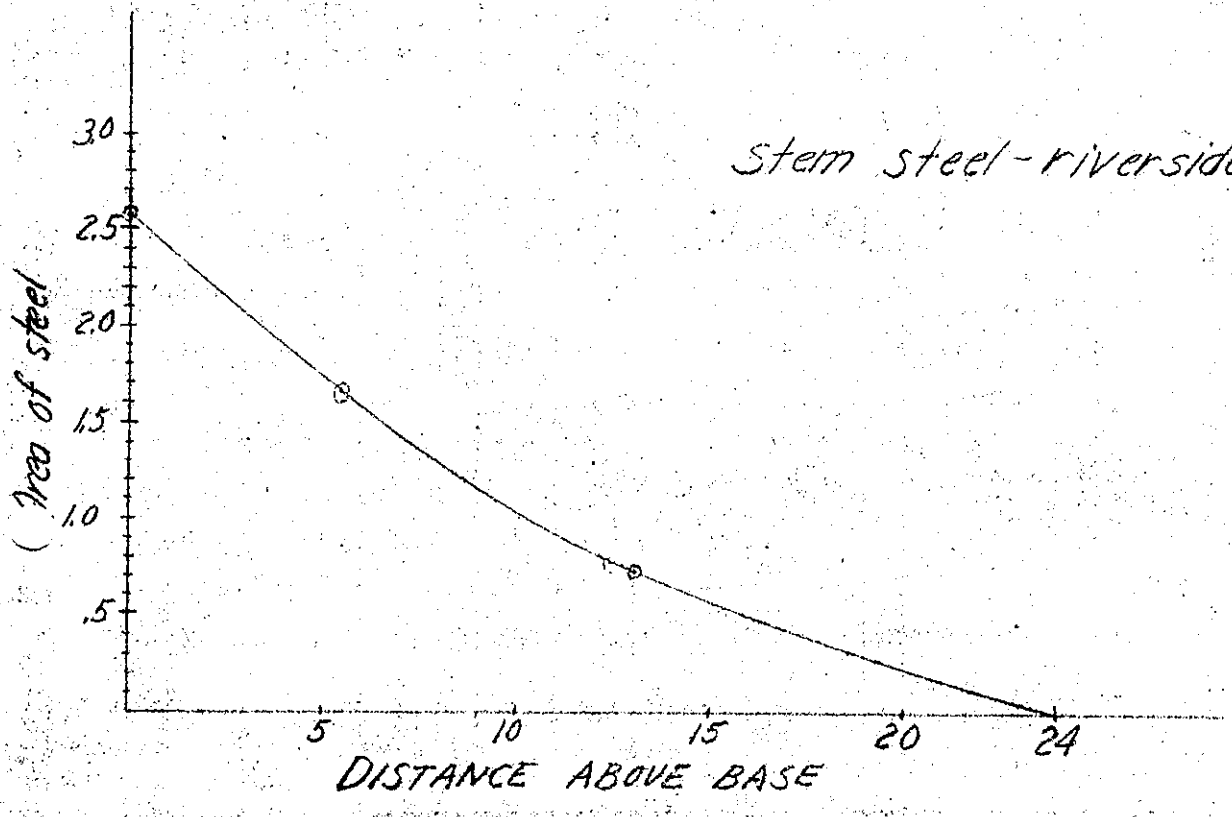
Case II Riverside base



	Force	↓	↑	Arm	↻	↺
E_R	1.5×9×100	1350		4.5	6080	
C	3×9×150	4050		4.5	18,200	
P_2			9600	5.5		52,800
U	8.5×62.5×7.5		3,980	3.75		14,90

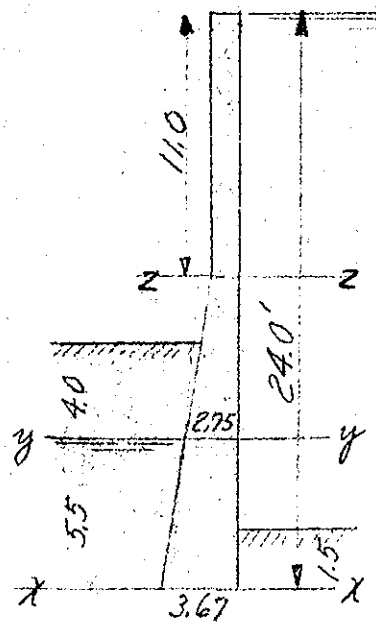
$\Sigma V = 8,180$ $\Sigma M = 43,420$;

Steel $A_{x-x} = \dfrac{43,420 \times 12}{18000 \times .884 \times 31.5} = 1.04$ □" in bottom



Project Hartford Ht. 76
Computation Steel in stem 24' wall
Computed by J.H.L. Checked by Date

U.S. GOVERNMENT PRINTING OFFICE 3—10528



Force	←	→	Arm	EM @ X-X ↶	↷
P_W $\frac{1}{2}\times 24^2\times 62.5$	18000		8.0	144,000	
P_{ER} $\frac{1}{2}\times 1.5^2\times 17.5$	20		.5	10	
P_{EL} $\frac{1}{2}\times 9.5^2\times 35$		1580	3.17		5000
P_{WL} $\frac{1}{2}\times 5.5^2\times 45$		680	1.83		1240
	$\Sigma H = 15,760$			$\Sigma M = 137,760$	

Unit shear

$$\frac{15,760}{.884\times 12\times 40.5} = 36.7\#\ \text{O.K.}$$

Depth of concrete

$$\sqrt{\frac{137,760}{123}} = 33.5''\ \text{O.K.}$$

Steel $A_{x-x} = \frac{137,760\times 12}{18,000\times .884\times 40.5} = 2.56\ \square''$ riverside face

Force	←	→	Arm	EM @ y-y ↶	↷
P_W $\frac{1}{2}\times 18.5^2\times 62.5$	10,700		6.17	66,000	
P_{EL} $\frac{1}{2}\times 4^2\times 35$		280	1.33		400

$\Sigma M = 65,600$

Steel $A_{y-y} = \frac{65,600\times 12}{18,000\times .884\times 29.5} = 1.67\ \square''$ riverside face

$$\Sigma M_{z-z} = \frac{1}{2}\times 11^2\times 62.5\times \frac{11}{3} = 13,900'\#\ \curvearrowleft$$

Steel $A_{z-z} = \frac{13,900\times 12}{18,000\times .884\times 14.5} = .725\ \square''$ riverside face

Case II

$$\Sigma M_{x-x} = 5000 + 1240 = 6240'\#\ \curvearrowright$$

Steel $A_{x-x} = \frac{6240\times 12}{18,000\times .884\times 40.5} = .116\ \square''$ landside face

WAR DEPARTMENT

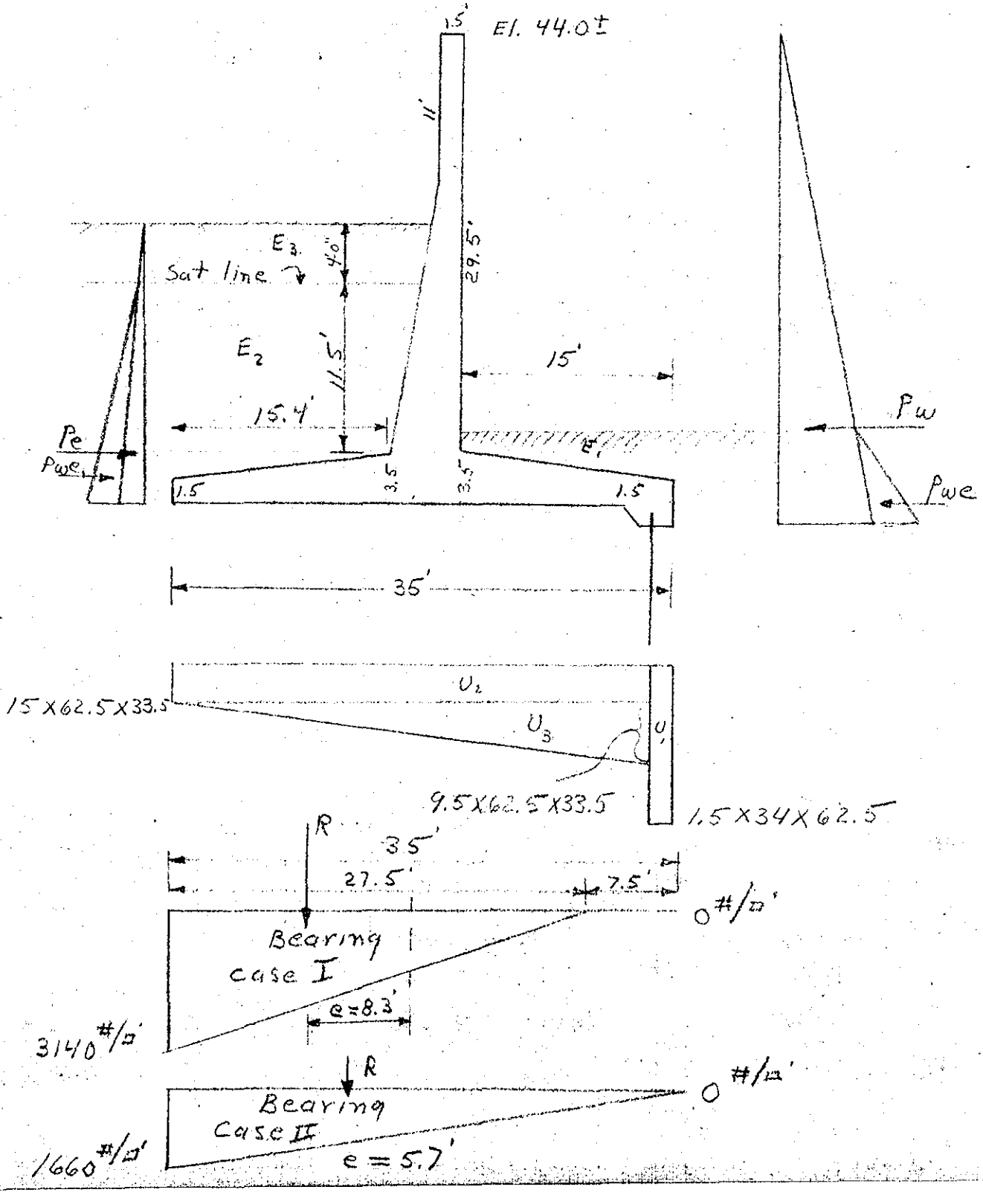
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Hartford, Conn. Ht 7b

Computation: Wall 29'-6" (overall height)

Computed by: W. S. Checked by: Date: 3/7/45

U. S. GOVERNMENT PRINTING OFFICE 3—10528



WAR DEPARTMENT

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

Subject: Hartford Conn. H76

Computation: Wall 29' 6"

Computed by: M. S. J. Checked by: Date: 3/2/42

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Case I River Up

Forces	↓	↑	→	←	Arm	Moment - "A"	
C_1 29.5 x 1.5 x 150	6650				19.25	128,000	
C_2 18.5 x 3.1 x ½ x 150	4300				17.5	75,000	
C_3 35 x 2.5 x 150	13100				17.5	229,000	
C_4 1 x 3 x 150	450				33.5	15,000	
W 28.5 x 15 x 62.5	26700				27.5	734,000	
E_1 2 x 15 x 125	3750				27.5	103,000	
E_2 17.0 x 12.5 x 125	26600				8.5	226,000	
E_3 16 x 4 x 100	6400				8.0	51,200	
P_w 34² x ½ x 62.5				36200	10.3		372,000
P_{we} 5.5² x ½ x 17.5				265	.83		220
P_e 20² x ½ x 35			7000		5.6	39,200	
P_{we} 16² x ½ x 45			5750		4.3	24,700	
U_1 1.5 x 34 x 62.5		3190			34.25		109,000
U_2 15 x 62.5 x 33.5		31400			16.75		526,000
U_3 9.5 x 62.5 x 33.5 x ½		10000			22.4		220,000
	87950	44590				1,625,100	1,227,220
	ΣV = 43,360					ΣM = 397,880	

$$\frac{\Sigma M}{\Sigma V} = 9.17' \quad \text{O. K.} \qquad \frac{35}{3} = 11.6'$$

$$\text{Bearing} = \frac{43,360}{3 \times 9.17} \times \begin{matrix} 2 \\ 0 \end{matrix} = \begin{matrix} 3140 \text{ \#/□'} \\ 0 \text{ \#/□'} \end{matrix}$$

WAR DEPARTMENT

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

bject Hartford Conn Ht 7b

Computation Wall 29'-6"

Computed by W. S. J. Checked by Date 3/7/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Case II River Down

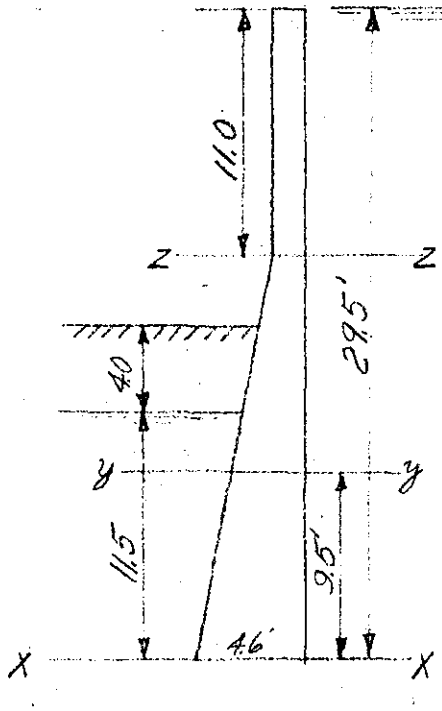
Forces	↓	↑	→	←	Arm	Moment A
C_1	6650					128,000
C_2 See	4300					75,000
C_3 Case	13100					229,000
C_4 I	450					15,000
E_1 2X15 X100	3000				27.5	82,500
E_2	26600					226,000
E_3	6400					51,200
Pe			7000			39,200
Pwe			5750			24,700
U_2		31400				-526,000
	60,500	31400				
	$\Sigma V = 29,100$					$\Sigma M = 344,600$

$$\frac{\Sigma M}{\Sigma V} = 11.8' \quad \text{O.K.}$$

$$\text{Bearing} = \frac{29100}{35} \times \begin{matrix} 2 = 1660 \ \#/\square' \\ 0 = 0 \ \#/\square' \end{matrix}$$

Subject Hartford Ht-72
Computation Steel in stem 29.5' wall
Computed by J.H.L. Checked by Date

U.S. GOVERNMENT PRINTING OFFICE 3—10528



Force		→	←	Arm	EM @ X-X ↷	↶
P_{EL}	$\frac{1}{2}\times15.5^2\times35$	4200		5.17	21,700	
P_{WL}	$\frac{1}{2}\times11.5^2\times45$	2970		3.83	11,400	
P_W	$\frac{1}{2}\times29.5^2\times62.5$		27,200	9.83		267,0

$\Sigma H = 20,030 \leftarrow$ $\Sigma M = 234,0$

Unit shear $\frac{20,030}{.884\times12\times52} = 36.3^{\#}$ O.K.

Depth of concrete $\sqrt{\frac{234,000}{123}} = 43.6''$ O.K.

Steel $A_{x-x} = \frac{234,000\times12}{18000\times.884\times52} = 3.4\ \square''$ riverside face

Force		→	←	Arm	EM @ Y-Y ↷	↶
P_{EL}	$\frac{1}{2}\times6^2\times35$	630		2.0	1260	
P_{WL}	$\frac{1}{2}\times2^2\times45$	90		.67	60	
P_W	$\frac{1}{2}\times20^2\times62.5$		12,500	6.67		83,4

$\Sigma M = 82,100$

Steel $A_{y-y} = \frac{82,100\times12}{18000\times.884\times32.5} = 1.9\ \square''$ riverside face

Steel $A_{z-z} = .725\ \square''$ riverside face

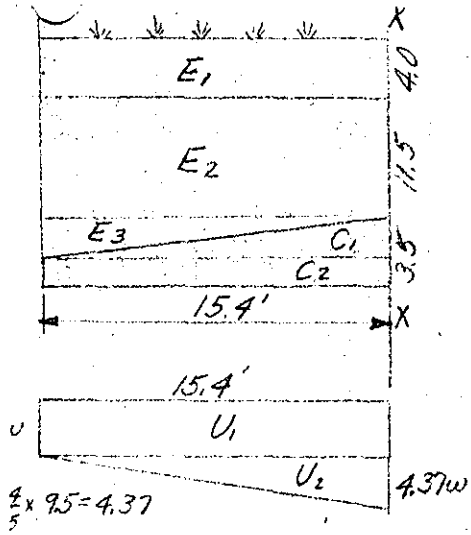
Case II

$\Sigma M_{x-x} = 21,700 + 11,400 = 33,100'^{\#}$ ↷

Steel $A_{x-x} = \frac{33,100\times12}{18000\times.884\times52} = .48\ \square''$ in landside fa

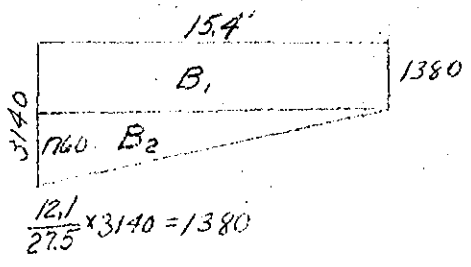
Subject: Hartford H.7b
Computation: Steel in landside base - Case I 29.5' wall
Computed by: J.H.L. Checked by: Date:

U. S. GOVERNMENT PRINTING OFFICE 3—10528



Force	↓	↑	Arm	EM @ X-X ↶	↷
E_1 15.4 x 4 x 100	6170		7.7	47,500	
E_2 15.4 x 11.5 x 125	22,100		7.7	170,000	
E_3 ½ x 2 x 15.4 x 125	1,920		10.27	19,700	
C_1 ½ x 2 x 15.4 x 150	2,310		5.13	11,900	
C_2 1.5 x 15.4 x 150	3460		7.7	26,600	
U_1 15 x 62.5 x 15.4		14,450	7.7		111,000
U_2 ½ x 4.37 x 15.4 x 150		5,050	5.13		25,900
B_1 1380 x 15.4		21,200	7.7		163,000
B_2 ½ x 1760 x 15.4		13,550	10.27		139,000

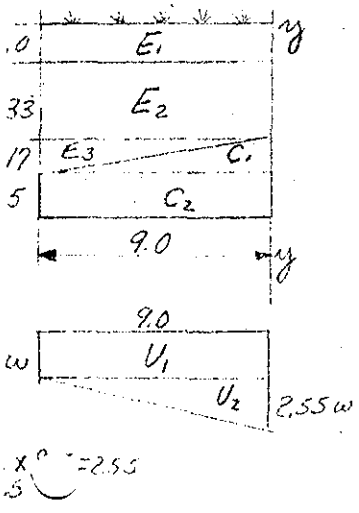
$\Sigma V = 18,290$ $\Sigma M = 163,200$



Unit shear $\frac{18,290}{.884 \times 12 \times 37.5} = 46^{\#}$ O.K.

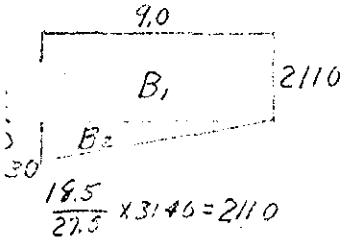
Depth of conc. $\sqrt{\frac{163,200}{123}} = 36.3''$ O.K.

Steel $A_{x-x} = \frac{163,200 \times 12}{18000 \times .884 \times 37.5} = 3.29 \square''$ in bottom



Force	↓	↑	Arm	EM @ Y-Y ↶	↷
E_1 9 x 4 x 100	3600		4.5	16,200	
E_2 9 x 12.33 x 125	13,850		4.5	62,300	
E_3 ½ x 9 x 1.17 x 125	660		6.0	4,000	
C_1 ½ x 9 x 1.17 x 150	790		3.0	2,400	
C_2 9 x 1.5 x 150	2030		4.5	9,100	
U_1 15 x 62.5 x 9		8430	4.5		37,900
U_2 ½ x 2.55 x 62.5 x 9		720	3.0		2,200
B_1 2110 x 9		19,000	4.5		85,500
B_2 ½ x 1030 x 9		4,530	6.0		27,200

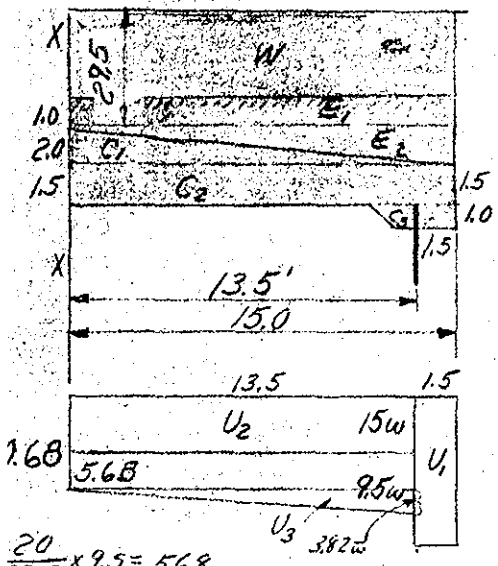
$\Sigma V = 11,750$ ↑ $\Sigma M = 58,800$ ↶



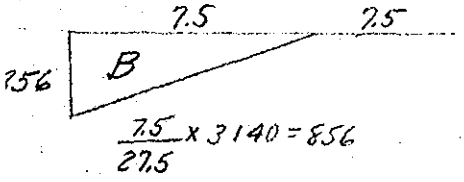
Steel $A_{y-y} = \frac{58,800 \times 12}{18000 \times .884 \times 27.5} = 1.61 \square''$ in bottom

Object Hartford Ht. 7b
Computation Steel in Riverside base - Case I 29.5' wall
Computed by J.H.L. Checked by Date

U. S. GOVERNMENT PRINTING OFFICE 3—10528



$\frac{20}{33.5} \times 9.5 = 5.68$



$\frac{7.5}{27.5} \times 3140 = 856$

Force	↓	↑	Arm	ΣM @ X-X ↻	↺
W 28.5×62.5×15	26,700		7.5	200,000	
E_1 1×15×125	1,870		7.5	14,000	
E_2 $\frac{1}{2}$×2×15×125	1870		10.0	18,700	
C_1 $\frac{1}{2}$×2×15×150	2250		5.0	11,300	
C_2 1.5×15×150	3370		7.5	25,300	
C_3 3×1×150	450		13.5	6,100	
U_1		3190	14.25		45,500
U_2 20.68×62.5×13.5		17,500	6.75		118,000
U_3 $\frac{1}{2}$×13.5×3.82×62.5		1,610	9.0		14,500
B $\frac{1}{2}$×856×7.5		3,200	2.5		8,000

ΣV = 11,010 ΣM = 89,400

Steel $A_{x-x} = \frac{89,400 \times 12}{18000 \times .884 \times 37.5} = 1.80$ □" in top

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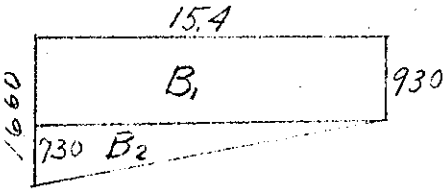
Project Hartford Ht 7b

Computation Base steel - Case II 29.5 ft. wall

Computed by J.H.L. Checked by Date

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Steel in landside base - Case II



$\frac{19.6}{35} \times 1660 = 930$

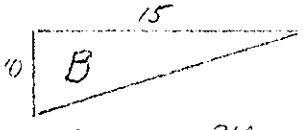
Force	↓	↑	Arm	EM @ x-x ↙	↖
E_1 Same as Case I	6170			47,500	
E_2 " " "	22,100			170,000	
E_3 " " "	1920			19,700	
C_1 " " "	2310			11,900	
C_2 " " "	3460			26,600	
U_1 " " "		14450			111,000
B_1 930 × 15.4		14,330	7.7		110,500
B_2 $\frac{1}{2}$ × 730 × 15.4		5,620	10.27		57,700

EM = 3,500

Temp. steel only needed in top.

Case I obviously is the worst condition for steel in bottom of the landside base

Steel in riverside base - Case II



$\frac{15}{35} \times 1660 = 710$

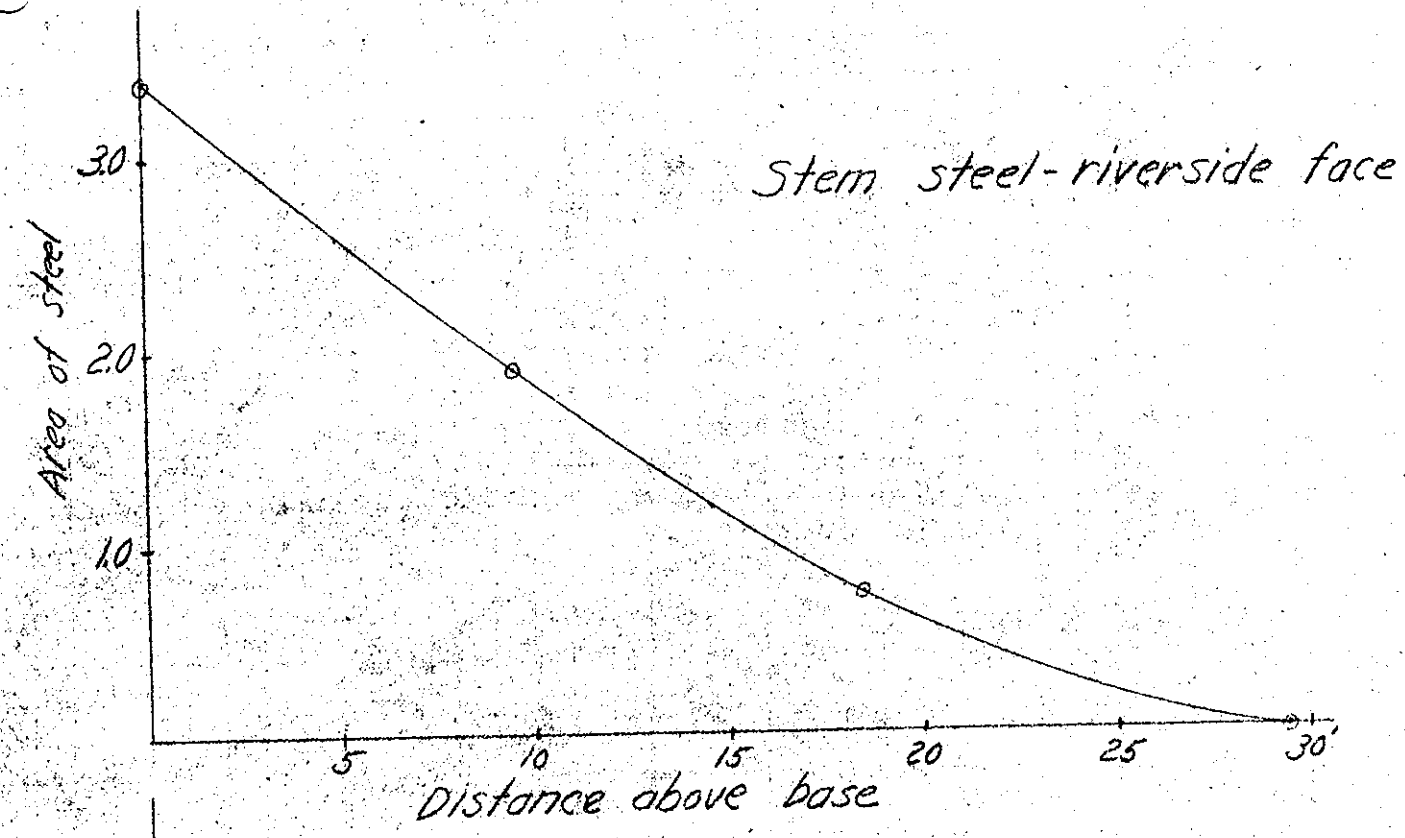
Force	↓	↑	Arm	EM @ x-x ↙	↖
E_1 1 × 15 × 100	1500		7.5	11,250	
E_2 $\frac{1}{2}$ × 2 × 15 × 100	1500		10.0	15,000	
C_1 Same as case I	2250			11,300	
C_2 " " "	3370			25,300	
C_3 " " "	450			6100	
U_2 " " "		3190			45,500
B $\frac{1}{2}$ × 15 × 710		5330	5.0		26,700

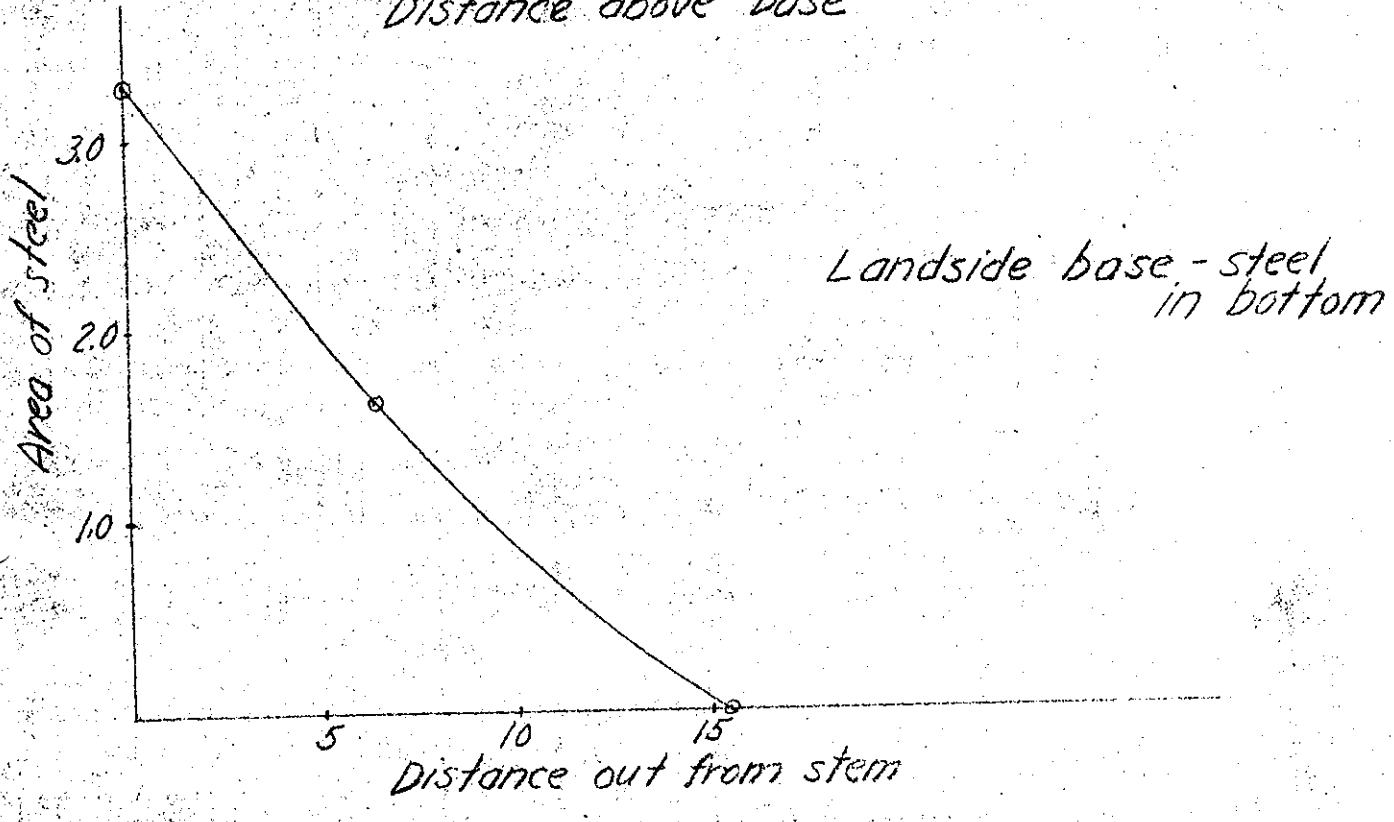
EM = 3250

Temperature steel only is needed in bottom.

Project Hartford Ht. 7b
Computation Steel cut-off curves 29.5' wall
Computed by J.H.L. Checked by Date

U. S. GOVERNMENT PRINTING OFFICE 3—10628





WAR DEPARTMENT

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bject Hartford, Conn. H.T.L.

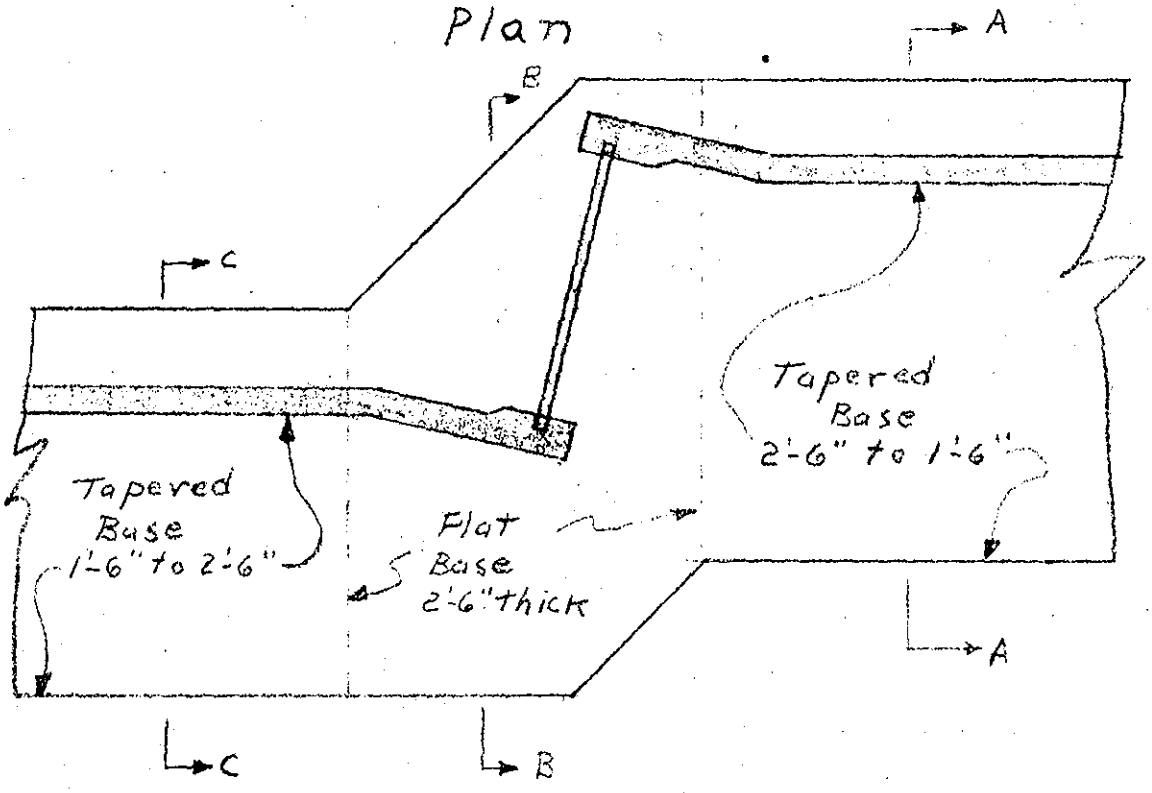
mputation Stop Log Structure

mputed by M. S. J. Checked by Date 3/12/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

In H. E. L. Yard

Plan



Section C-C is typical wall, see page

WAR DEPARTMENT

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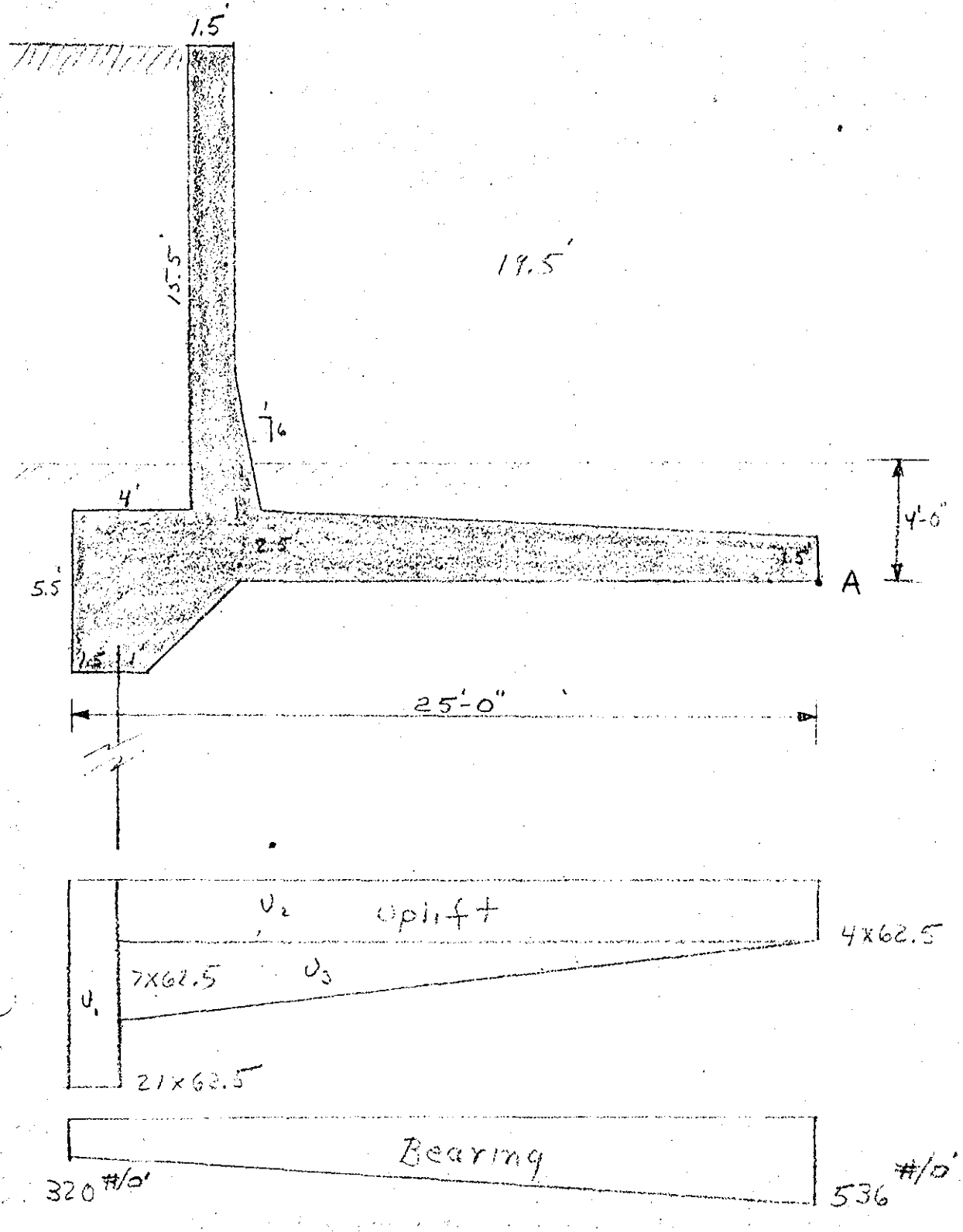
Project Hartford, Conn. Ht 7b

Computation Stop Log Structure

Computed by W. S. Jr. Checked by Date 3/12/40

U. S. GOVERNMENT PRINTING OFFICE 3—10538

Section A-A



WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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Project Hartford, Conn.
Computation Stop Log Structure
Computed by W. S. Jr. Checked by Date 3/12/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability at A-A

Forces	↓	↑	→	←	Arm	Moment at A	
C_1 1.5×15.5×150	3500				20.25	71,000	
C_2 2.5×25×150	9400				12.5	117,500	
C_3 3×4×150	1800				23.0	41,400	
E_1 4×2×125	1000				23.0	23,000	
E_2 2×19.5×125	4870				9.75	47,500	
E_e 1×½×19.5×25		244			6.5		1590
W 4×13.5×62.5	3380				23.0	77600	
P_w 21²×½×62.5				13800	4.0		55,000
P_{eR} 7.5²×½×17.5				490	-.5	245	
P_{eL} 7.5²×½×80			2250		-.5		1125
U_1 21×62.5×1.5		1970			24.25		47900
U_2 4×62.5×23.5		5880			11.75		69100
U_3 7×62.5×½×23.5		5150			15.7		80800
	23950	13244				378,245	255,515
	ΣV = 10,706					ΣM = 122,730	

$$\frac{\Sigma M}{\Sigma V} = 11.46' \quad \text{O.K.} \quad e = \frac{25}{2} - 11.46 = 1.04'$$

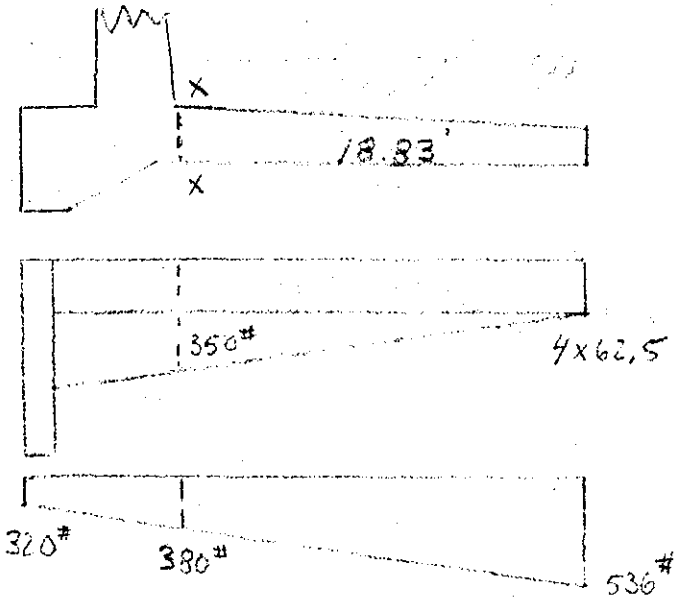
$$\text{Bearing} = \frac{10,706}{25}\left(1 \pm \frac{6 \times 1.04}{25}\right) = 536 \ \#/\square' = 320 \ \#/\square'$$

Project: Hartford, Conn. H-76
Computation: Stop Log Structure
Computed by: M. S. J. Checked by: Date: 3/12/40

U. S. GOVERNMENT PRINTING OFFICE 3—10628

Steel in stem is same as typical wall section.

Steel in Base



Moment at x-x

$E_1 = 2.5 \times 18.83 \times 125 = 5900 \times 9.41 = 55,600^{\#}$
$C_1 = 2 \times 18.83 \times 150 = 5650 \times 9.41 = 53,200$
$11,550 \quad 108,800^{\#}$

$U_1 = 4 \times 62.5 \times 18.83 = 4700 \times 9.41 = 44,100$
$U_2 = 350 \times \frac{1}{2} \times 18.83 = 3300 \times 6.27 = 20,700$
$B_1 = 380 \times 18.83 = 7150 \times 9.41 = 67,200$
$B_2 = 156 \times \frac{1}{2} \times 18.83 = 1470 \times 12.5 = 18,400$
$16,620 \quad 150,400^{\#}$

$\Sigma V = 5070^{\#} \quad \Sigma M = 41,600^{\#}$

Shear O.K. "d" is o.k.

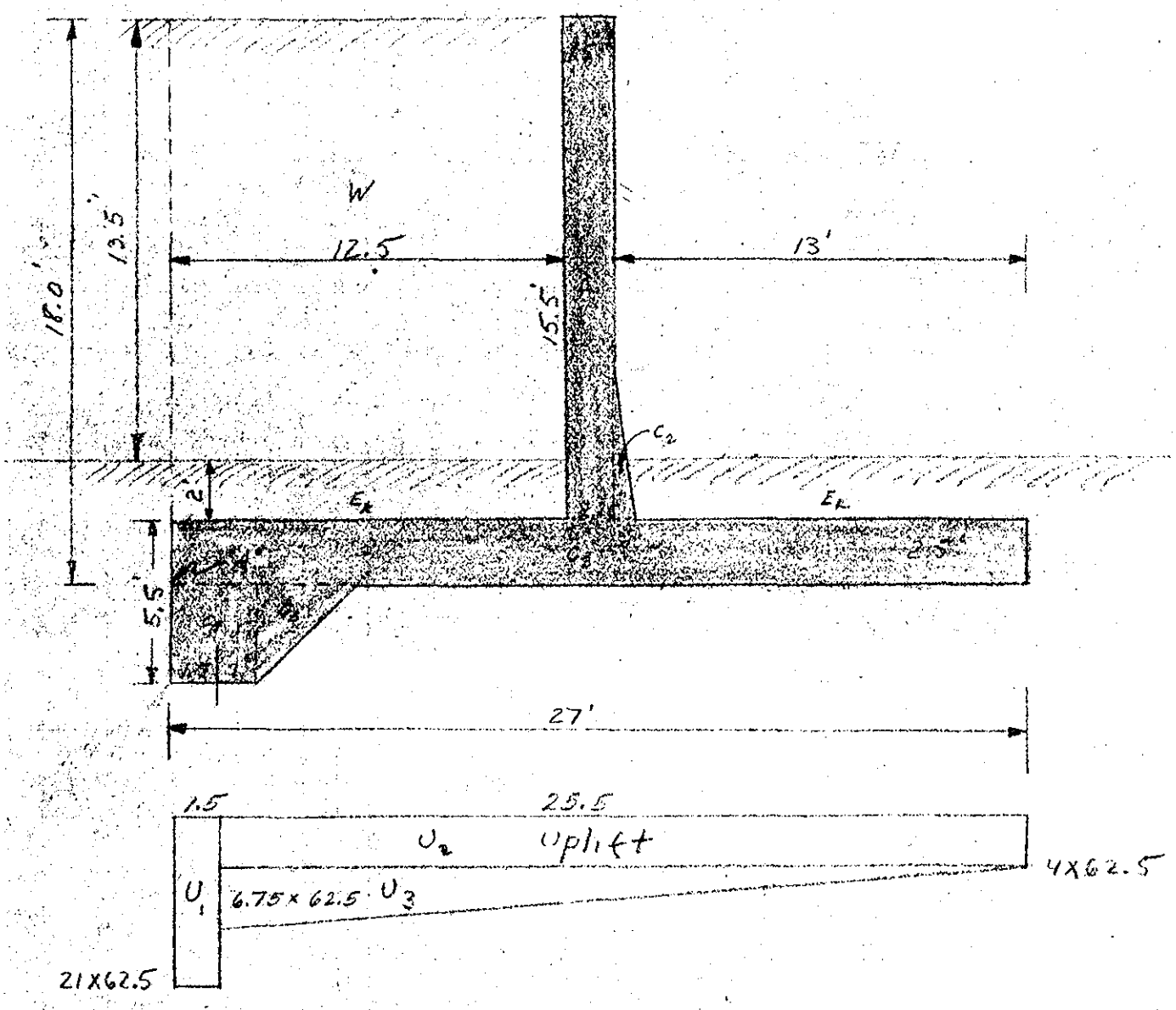
$$A_s = \frac{41600 \times 12}{18000 \times .884 \times 25.5} = 1.23^{\square''}$$

This steel is slightly lower than typical wall steel, so it will be O.K. to run typical steel right thru.

Subject Hartford, Conn. Ht 7b
Computation Stop Log Structure
Computed by M. S. Checked by Date 3/12/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Section B-B



WAR DEPARTMENT

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

Subject: Hartford, Conn. H.7b

Computation: Stop Log Structure

Computed by: H.A.C. Checked by: Date: 3/13/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stability at B-B

Forces Acting		↓	↑	→	←	Arm	Moments About 'A' ↷	Moments About 'A' ↶
W	13.5 × 12.5 × 62.5	10,550				6.25	66,000	
E_2	2.0 × 12.5 × 125	3,125				6.25	19,500	
E_1	2.0 × 13.0 × 125	3,250				20.5	66,500	
C_1	15.5 × 1.5 × 150	3,490				13.25	46,300	
C_2	$\frac{1}{2}$ × 4.5 × 0.75 × 150	253				14.25	3,600	
C_3	27.0 × 2.5 × 150	10,130				13.5	137,000	
C_4	3.0 × 2.5 × 150	1,125				1.25	1,400	
C_5	$\frac{1}{2}$ × 3.0 × 2.5 × 150	561				1.83	1,030	
P_W	$\frac{1}{2}$ × $\overline{18}^2$ × 62.5			10,150		6.0	60,900	
P_{EL}	$\frac{1}{2}$ × $\overline{4.5}^2$ × 17.5			178		1.5	270	
P_{ER}	$\frac{1}{2}$ × $\overline{4.5}^2$ × 17.5				178	1.5		270 } 0
U_1	21 × 62.5 × 1.5		1,970			0.75		1,480
U_2	4 × 62.5 × 25.5		6,370			14.25		91,000
U_3	$\frac{1}{2}$ × 6.75 × 62.5 × 25.5		5,370			10.0		53,700
Frict.	0.45 × 18,774				8,450			
P_r					1,700	1.5		2,550
		32,484	13,710	10,328	10,328		402,230	148,730
		ΣV = 18,774 ↓		ΣH = 0			ΣM = 253,500 '# ↷	

Position of Resultant } $\frac{\Sigma M}{\Sigma V} = \frac{253,500}{18,774} = 13.5'$

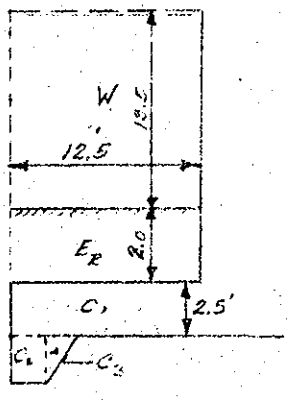
Bearing $= \frac{\Sigma V}{b} = \frac{18,774}{27} = 695$ #/□'

Subject: Hartford, Conn — Ht. 76
Computation: Stop-Log Steel
Computed by: T.A.C. Checked by: Date: 3/19/40

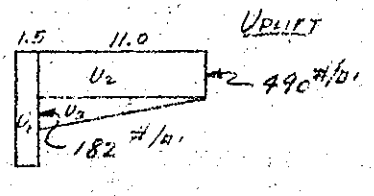
U. S. GOVERNMENT PRINTING OFFICE 3—10528

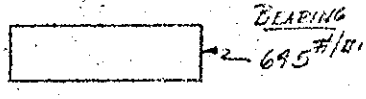
Design of Steel in Toe Slab

Section at Riverside Face of Stem



Forces Acting	↓	↑		Moments about "A" ↷	Moments about "A" ↶
W	10,550		6.25		66,000
E_R	3,125		6.25		19,500
C_1 = 12.5 × 2.5 × 150	4,690		6.25		29,300
C_2	1,125		11.25		12,650
C_3	561		9.17		5,150
U_1		1,970	11.75	23,200	
U_2 = 490 × 11		5,390	5.5	29,600	
U_3 = ½ × 182 × 11		1,000	7.33	7,330	
B.P. = 695 × 12.5		8,700	6.25	54,400	
	20,051	17,060		114,530	132,600
	ΣV = 2,991# ↓			ΣM = 18,070 #↶	





$$d_{REQ} = \sqrt{\frac{18,070}{123}} = \sqrt{147} = 12.1''$$

26.5" Supply

$$A_s = \frac{12 \times 18,070}{18,000 \times .884 \times 26.5} = 0.52 \text{ \#''}$$

$$\Sigma_o = \frac{2,991}{150 \times .884 \times 26.5} = 0.85''$$

$$v = \frac{2,991}{12 \times .884 \times 26.5} = 11 \text{ \#/in''}$$

Uplift:

$\frac{6.75 \times 62.5}{25.5} = 16.55$ #/in Drop/ft.

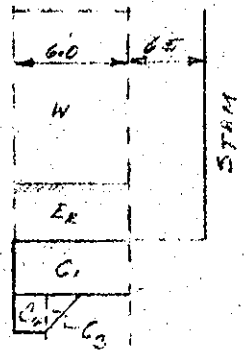
$11.0 \times 16.55 = 182$ #/in Tot. Drop

$6.75 \times 62.5 = 422$
$4.0 \times 62.5 = 250$
672 #/in'
− 182
490 #/in'

Subject: Hartford, Conn – Ht. 76.
Computation: Stop Log Steel
Computed by: T.A.C. Checked by: Date: 3/14/40

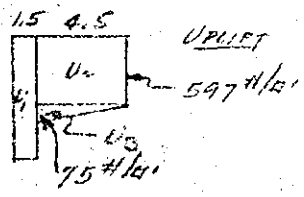
U.S. GOVERNMENT PRINTING OFFICE 3—10528

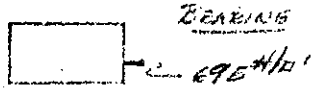
Design of Steel in Toe Slab



Section 6'-6" from Riverside Face of Stem

Forces Acting	↓	↑	Arm	↺ Moments	↻ Moments
W = 6.0 × 13.5 × 62.5	5,060		3.0		15,180
E_R = 2.0 × 6.0 × 125	1,500		3.0		4,500
C_1 = 2.5 × 6.0 × 150	2,250		3.0		6,750
C_2 =	1,125		4.75		5,350
C_3 =	561		2.17		1,220
U_1 =		1,970	5.25	10,350	
U_2 = 4.5 × 597		2,690	2.25	6,050	
U_3 = ½ × 75 × 4.5		170	3.0	510	
B.P. = 695 × 6		4,170	3.0	12,510	
	10,496	9,000		29,420	33,000
	ΣV = 1,496 # ↓			ΣM = 3,580 ↺	



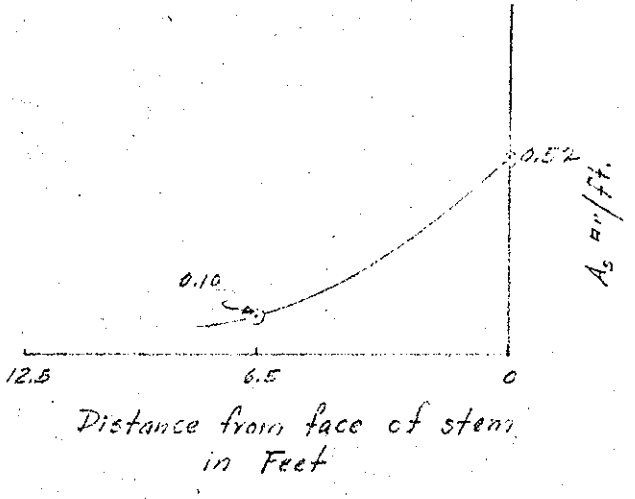


$$A_s = \frac{12 \times 3{,}580}{18{,}000 \times .884 \times 26.5} = 0.10 \text{ □''}$$

Uplift

16.55 × 4.5 : 75 #/□' Tot. Drop

672 − 75 : 597 #/□'

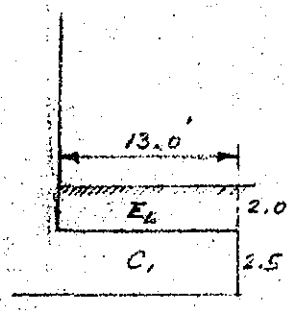


Subject: Hartford, Conn. — Ht. 76
Computation: Stop Log Steel
Computed by: T.A.C. Checked by: Date: 3/14/40

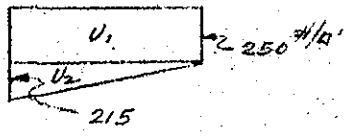
U. S. GOVERNMENT PRINTING OFFICE 3—10528

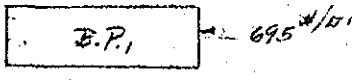
Design of Steel in Heel Slab

Section at Landside Face of Stem



Forces Acting	↓	↑	Arm	↷	↶
E_L	3,250		6.5	21,100	
$C_1 = 13.0 \times 2.5 \times 150$	4,875		6.5	31,700	
$U_1 = 250 \times 13$		3,250	6.5		21,100
$U_2 = \frac{1}{2} \times 215 \times 13$		1,400	4.33		6,050
$B.P. = 695 \times 13$		9,050	6.5		58,800
	8,125	13,700		52,800	85,950
	$\Sigma V = 5,575$ # ↑			$\Sigma M = 23,150$ ↷	





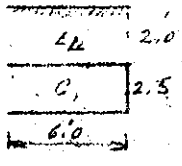
$16.55 \times 13 = 215$ #/□' (uplift)

$$A_s = \frac{12 \times 23,150}{18,000 \times .884 \times 26.5} = 0.66 \text{ □''}$$

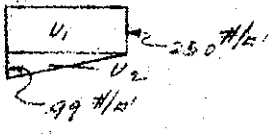
$$\Sigma_0 = \frac{5,575}{150 \times .884 \times 26.5} = 1.59''$$

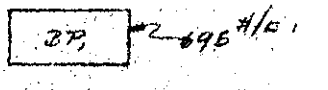
$$v = \frac{5,575}{12 \times .884 \times 26.5} = 20 \text{ #/□''}$$

Section at 7'-0" from Landside Face of Stem



Forces Acting	↓	↑	Arm	↷	↶
$E_L = 6 \times 2 \times 125$	1,500		3.0	4,500	
$C_1 = 6 \times 2.5 \times 150$	2,250		3.0	6,750	
$U_1 = 250 \times 6$		1,500	3.0		4,500
$U_2 = \frac{1}{2} \times 99 \times 6$		297	2.0		594
$BP_1 = 695 \times 6$		4,170	3.0		12,510
	3,750	5,967		11,250	17,604
	$\Sigma V = 2,217$ # ↑			$\Sigma M = 6,354$ # ↷	





$16.55 \times 6 = 99$ #/□'

$$A_s = \frac{12 \times 6,354}{18,000 \times .884 \times 26.5} = 0.18 \text{ □''}$$

Subject: Hartford, Conn. – Ht. 7b
Computation: Stop Log Steel
Computed by: T.A.C. Checked by: Date: 3/14/40

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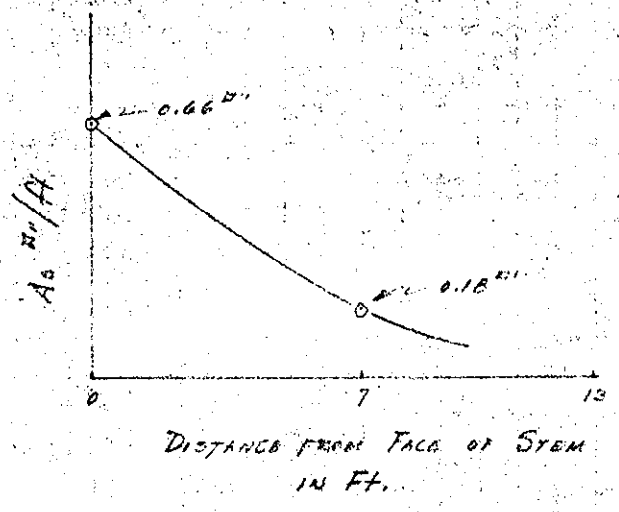
Steel in Heel Slab



Scale 1:50