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FOUNDATIONS & ABUTMENTS

Bearing pressures are analysed for the pier footings, and for the abutments together with stability.

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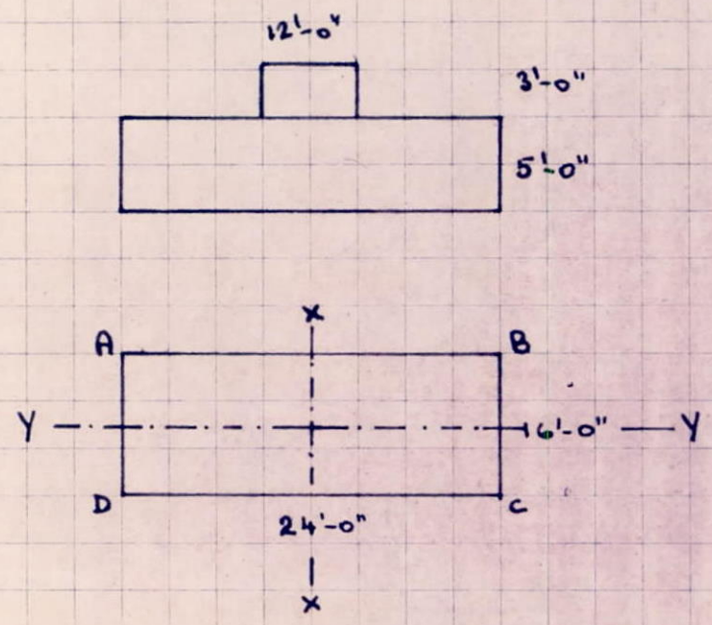
Design of Foundations

Consider foundation for Unit 6



Vertical loads on base:

(a) wt. of Unit 3 = 71, 600 lb — 71, 600 lb
½ wt of Unit 2 = 9, 713 lb — 9, 713 lb
½ wt. of Unit 4 = 10, 351 lb — 10, 351 lb

(b) Superload @ 166 lb/ft run
= 166 × (16.25 + 15.25 + 68.75)
= 16,641 lb — 16, 641 lb.

(c) Column
Vol. = $\frac{20}{2}$ (1.5 × 4.25 + 3.0 × 6.0) = 24.375 × 10
Wt = 24.375 × 1500 = — 37, 000 lb.

(d) footing. Wt = 5 × 16 × 24 × 150 = 288,000]
and. 12 × 3 × 16 × 150 = 86,400] — 374, 400 lb.

Total. (day) 519,700 lb

Section properties of base:

Area = 16×24 = 384 ft^2

$I_{xx} = 16 \times \frac{24^3}{12}$ = 18,432 ft^4

$Z_{xx} = \frac{18,432}{12}$ = 1536 ft^3

$I_{yy} = \frac{24 \times 16^3}{12}$ = 8192 ft^4

$Z_{yy} = \frac{8192}{8}$ = 1024 ft^3

Moments on base (see column design)

M_x = 8,440,580 lb.in.

M_y = 2,350,000 lb.in

Stresses under corner of Base

$$\sigma = \frac{P}{A} \pm \frac{M_x}{Z_{xx}} \pm \frac{M_y}{Z_{yy}}$$

$$= \frac{519,700}{384} \pm \frac{8,440,580}{1536 \times 12} \pm \frac{2,350,000}{1024 \times 12}$$

$$= 1353 \pm 458 \pm 192$$

$$= + 2003 \text{ lb/ft}^2 \text{ or } + 703 \text{ lb/ft}^2$$

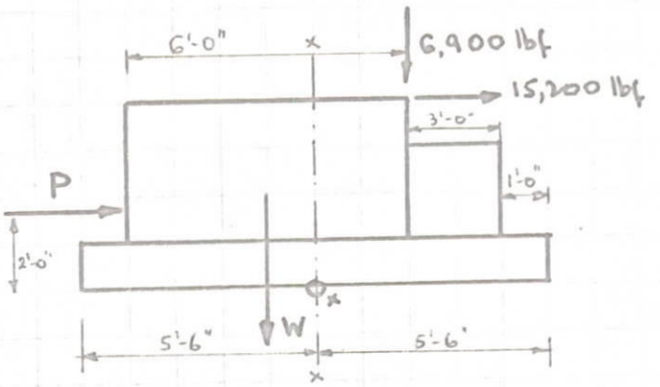
OR $\sigma_{max} = 0.9 \text{ t/ft}^2$ — O.K

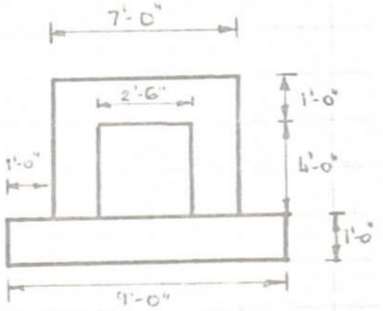
$\sigma_{min} = 0.3 \text{ t/ft}^2$ — O.K.

Max. allowable footing pressure recommended by soils survey is 2 tons/ft^2

Stability of Abutments

Abutments founded on clayey gravel. $\gamma = 120$ lb/ft³
Max. bearing pressure = 2 T/ft²





Earth Pressure, $P = 28\ h^2$ (Approx. Wedge theory)

Then $P = 28 \times 36 = 1008$ lbf.

W =	9 × 11 × 1 × 150	= 14,850
	6 × 7 × 5 × 150	= 31,500
	3 × 4 × 2·5 × 150	= 4,500
		50,800 lbf.

T.M.A. x-x. $M_x = 31,500 \times 1.5 - 1008 \times 2 - 15,200 \times 6 - 6,900 \times 1.5 - 4,500 \times 3$

$M_x = -69,816$ lb.ft.

Properties of Base :- $A = 11 \times 9 = 99$ ft² ; $Z_x = \frac{9 \times 11^2}{6} = 181.5$ ft³

Stress under toe, $\sigma_T = \frac{M_x}{Z_x} + \frac{V}{A}$ where V = 6,900 + 50,800 = 57,700 lbf.

$\sigma_T = \frac{69,816}{181.5} + \frac{57,700}{99} = 385 + 583$ lb/ft²

$\sigma_T = \underline{+ 0.43}$ T/ft² O.K.

Stress under heel, $\sigma_H = 583 - 385 = \underline{+0.09}$ T/ft² O.K.

Sliding ($\epsilon = 0.4$), V = 57,700 + 120 × 6 × 9 = 63,100 lbf.

factor of Safety = 1·5,

Allowable horizontal force, $H = \frac{0.4 \times 63,100}{1.5} = \underline{16,800}$ lbf.

We have 15,200 + 1008 = 16,208 lbf. This structure is adequate in sliding.

MISCELLANEOUS

Various factors are considered for the design of railings

Methods of lifting & transportation of the cantilever units are proposed and analysed.

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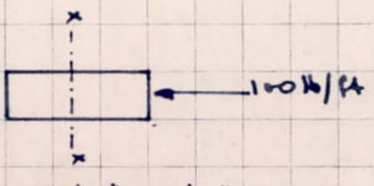
Railing Design

Loading: 100 lb/ft run @ 3'-0" high

(a) Horizontal hand rail



R.H.S. $3\frac{1}{2}" \times \frac{1}{2}" \times 10$ G. in m.s.

$Z_{xx} = 0.969$

B.M. can be written

$M = k\, w\, l^2$ where l = 6'-0" (Avg)

w = 100 lb/ft run

k = End fixity factor.

(from tables $k_{max} = 0.119$)

Then $M = 0.119 \times 100 \times (6)^2 \times 12$

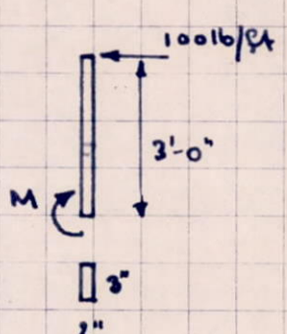
$= 5141$ lb.ins

Stresses, $\sigma = \pm \frac{5141}{0.969} = \pm$ 5,300 p.s.i. — O.K.

(b) Standard.

R.H.S. 3"x2"x 6G

$Z_{yy} = 0.993$



$M = 100 \times 6 \times 3 \times 12 = 21,600$ lb.in

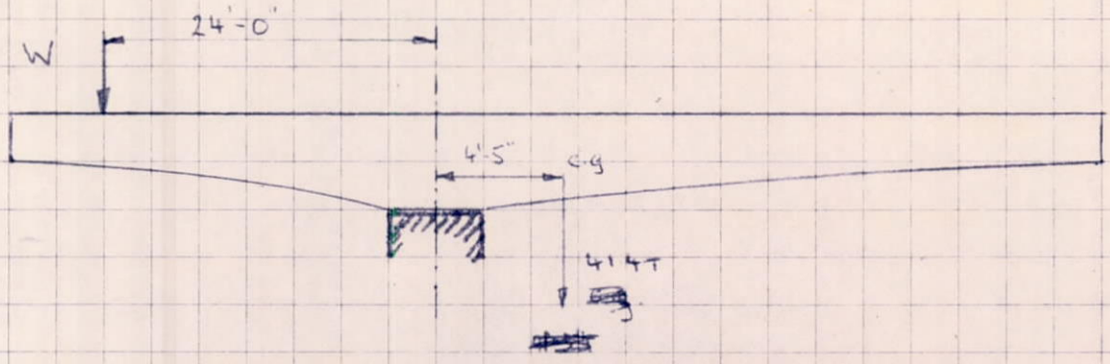
Stresses, $\sigma = \pm \frac{21,600}{0.993} = \pm$ 21,800 p.s.i — O.K.

[check: $\sigma \star S_x f_y = 1.2 \times (16.0 \times 2240) = 43,000$ p.s.i.]

TRASPORTATION & LIFTING OF UNITS 1-5

A. Transport

Unit 1



T.M.A. @

$W \times 24'0" = 41.4 \times 4.42$

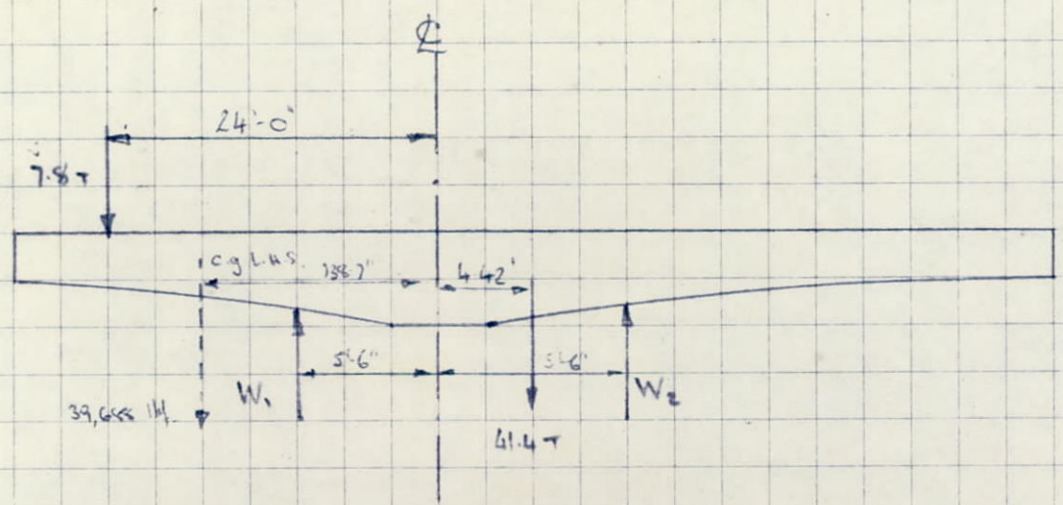
$W = 7.6\,T$

4 for Unit 5 $\quad W = \frac{43 \times 3.27}{26}$

$W = 5.45\,T$

4 for Unit 3 ~~$W = 37.5 \times 0.75$~~ beam is stable - no ballast needed.

B. Jacking and Lifting



Unit 1

T.M.A. W_1

$$7.8 \times 19.5 = 41.4 \times 9.92 + W_2 \times 11.0$$

$$W_2 = 23.5 \text{ T}$$

Vert. Eq'bm. $W_1 = 7.8 + 41.4 - 23.5 = 25.7$ T

B.M. @ ℄

$$M = (7.8 \times 240 - 25.7 \times 5.5) 2240 \times 12 + 39,688 \times 138.7$$

$$= +6,738,000 \text{ lb. in.}$$

D.L. Stresses

$$\sigma_{top} = \frac{6,738,000}{14660.612} = +460 \text{ p.s.i.}$$

$$\sigma_{bot} = \frac{6,738,000}{14033.92} = +480$$

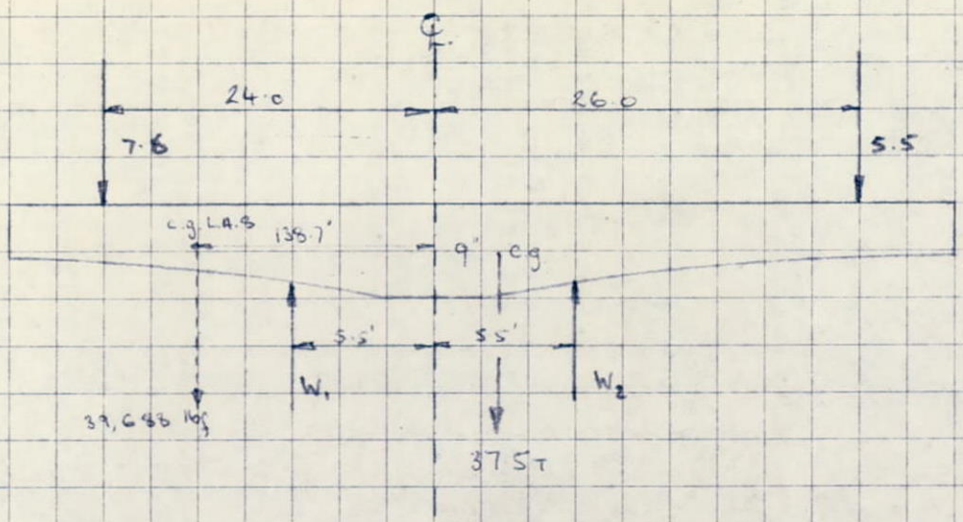
Prestress + Dead Load

$$\sigma_{top} = -460 + 775 + 431 = \underline{+746}$$

$$\sigma_{bot} = +480 - 810 + 431 = \underline{+101}$$

O.K.

Unit 3



T.M.A. W_1

$$(7\,6 \times 13\,5) - (37\,5 \times 6\,25) = 5\,5 \times 31\,5 + W_2 \times 11\,0$$

$$W_2 = 24.28\,T$$

Vert. Eq'b'lm.

$$W_1 = 7\,6 + 5\,5 + 37\,5 - 24.28 = 26.32\,T.$$

B.M. at ℄ (consdr L.H.S)

$$M = (7.6 \times 24.0 - 26.32 \times 5.5)\,2240 \times 12 + 39,685 \times 130.7$$

$$= 6,516,488 \text{ lb.in.}$$

check $\sigma_{bot} = \dfrac{6,516,488^{464}}{14,033.92} - 810 + 431 = +85.3$ p.s.i.

By inspection σ_{top} of Unit 3, and σ_{bot} and σ_{top} ℄ of Unit 5 are safe.

Continued