口型 1~12 迄

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~~JIJI~~ SHOWA BLDG, TOKYO

新宿停車場 D E F 型/鐵構框

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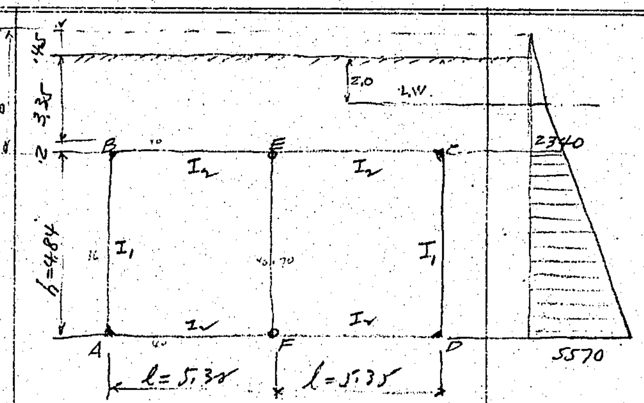
CALCULATIONS FOR 東京地下鉄道株式会社

鉄筋混凝土 口型ノ穴隧道 計算書



Dead load on roof slab.

Earth above L.W.	2.0 @ 1600 =	3200	
" below "	1.35 @ 2000 =	2700	
			5900
weight of slab	0.40 @ 2400 =		960
			6860
Live load on roof slab.			700
			w = 7560 kg/m²

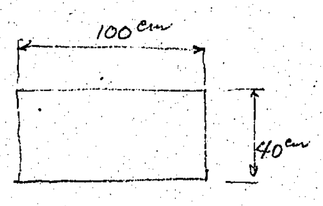
Horizontal pressure on side wall for the angle of repose of $\varphi = 30°$.
Surcharge for live load say $700 \div 1600 = 0.45^m$

Pressure intensity at C.
$\frac{1}{3} \times 1600 \times 4.0 = 2130$
$\frac{1}{3} \times 400 \times 1.55 = 210$
$q_1 = 2340$ kg/m²

Pressure intensity at D.
$\frac{1}{3} \times 2000 \times 4.84 = 3230$
2340
$q_2 = 5570$ kg/m²

4710
800
5510 ✓

Assumed section of slab and wall.
slab.



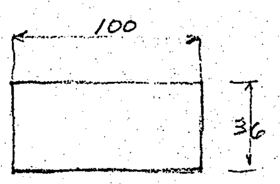
sectional area $A_2 = 100 \times 40 = 4{,}000$ cm²
moment of inertia $\frac{100 \times 40^3}{12} = 533{,}000$ cm⁴
add for reinforcement 67000
$I_2 = 600000$ cm⁴

$19 \times 15^2 \times 14 = 60{,}000$

64 000.0

$20 \times 13^2 \times 14 = 47000$

Side wall

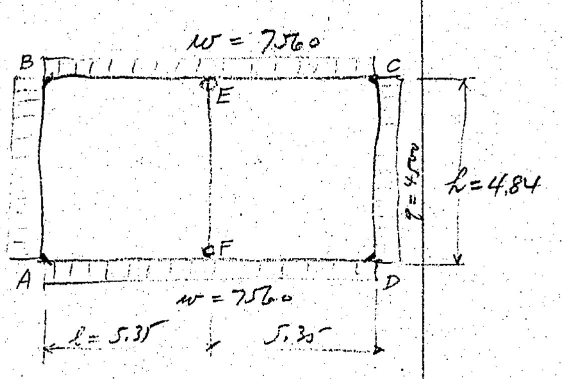


sectional area $A_1 = 100 \times 36 = 3600$ cm²
m. of inertia $= \frac{100 \times 36^3}{12} = 389000$ cm⁴
add for reinforcements 51000
$I_1 = 440000$ cm⁴

(163頁)

Approx. Stresses.

$$C_{AB} = \frac{q a^2}{12 h^2}(3a^2 - 8ah + 6h^2) + \frac{P a b^2}{h^2} \quad \text{in which} \quad P = 0,\ a = h,\ b = 0$$



$$= \frac{q h^2}{12}$$

$$C_{BA} = \frac{q h^2}{12}$$

$$C = \frac{w l^2}{12}$$

$$\alpha = \frac{I_2}{I_1}\frac{h}{l} = \frac{600{,}000}{440{,}000} \times \frac{4.84}{5.35} = 1.234$$

$$C_{AB} = C_{BA} = \frac{4500 \times 4.84^2}{12} = 8800 \text{ kgm}$$

$$C = \frac{7560 \times 5.35^2}{12} = 18{,}000 \text{ "}$$

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CALCULATIONS FOR

鉄筋混凝土 口型ボックス隧道

$\alpha = 1.234$ $\quad 11\alpha = 13.57$

$\alpha(13+4\alpha) = 22.12$

$2(6+\alpha) = 14.47$ } $2(6+\alpha)(1+2\alpha) = 14.47 \times 3.47 = 50.20$

$1+2\alpha = 3.47$

$\alpha(5-\alpha) = 4.64$

$\alpha(7+3\alpha) = 13.20$

$2(6+19\alpha+3\alpha^2) = 34.01 \times 2 = 68.02$

$$M_A = -\frac{22.12 \times 8800 + 14.47 \times 18000 + 13.57 \times 8800}{50.20} = -\frac{194700 + 260300 + 119300}{50.20} = -11450 \text{ kgm}$$

$$M_B = -\frac{13.57 \times 8800 + 22.12 \times 8800 + 1447 \times 18000}{50.20} = -11450 \text{ "}$$

$$M_E = +\frac{4.64 \times 8800 + 13.20 \times 8800 - 34.01 \times 18000}{50.20} = +\frac{40800 + 116200 - 612000}{50.20} = -9070 \text{ kgm}$$

$$M_F = -\frac{34.01 \times 18000 - 4.64 \times 8800 - 13.20 \times 8800}{50.20} = -9070 \text{ "}$$

3rd shears

$$S_{BE} = \frac{wl}{2} + \frac{M_E - M_B}{l} = \frac{7560 \times 5.35}{2} + \frac{-9070 + 11450}{5.35} = 20200 + 450 = +20650 \text{ kg}$$

$$S_{EB} = -\frac{wl}{2} - \frac{M_B - M_E}{l} = -20200 + 450 = -19750 \text{ "}$$

$$S_{BA} = -\frac{qh}{2} = -\frac{4500 \times 4.84}{2} = -11900 \text{ "}$$

S_{AB} $\quad = +11900$ "

R_A $\quad = 20650 + 7560 \times 0.2 = 22170$ kg

R_E $\quad = 19750 \times 2 = 39500$ "

max. positive moment on slab.

point of Zero shear $\quad \frac{20650}{7560} = 2.73$ m from B.

max. (+) moment $M_T = 20650 \times 2.73 - 7560 \times 2.73^2 \div 2 - M_A$

$= 56400 - 28150 - 11450$

$M_T = +16800$ kgm.

$\frac{wl^2}{8} = \frac{7560 \times 5.35^2}{8} = +27100$ kgm.

max. positive moment on side wall.

$\frac{4500 \times 4.84^2}{8} = 13200$

$M_A = -11450$

$M_S = +1750$ kgm at mid-height.

loads on one center column. spacing 2.50 m c/c.

$2.5 R_E = 2.5 \times 39500 = 98700$ kg on one column.

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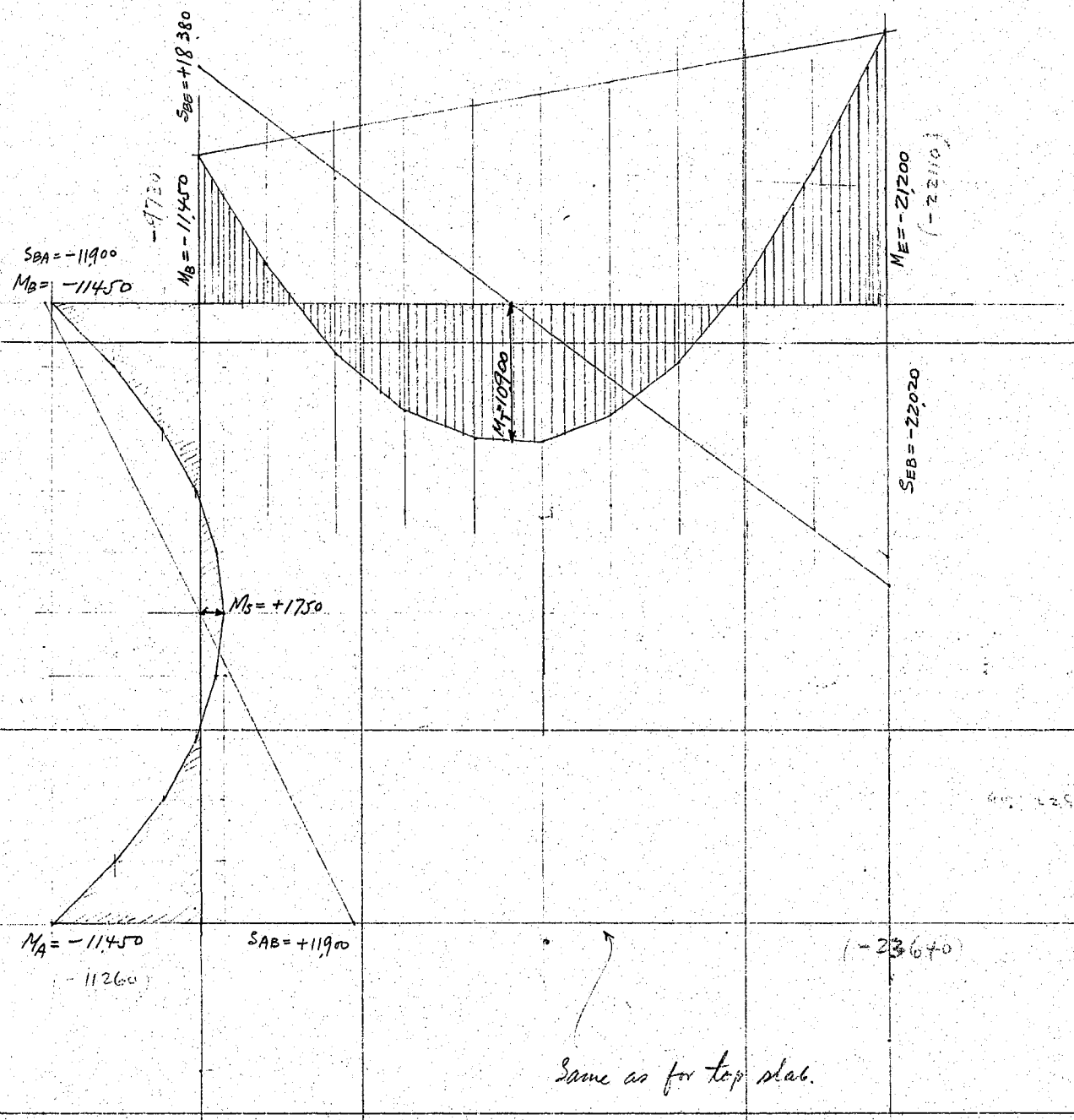
CALCULATIONS FOR

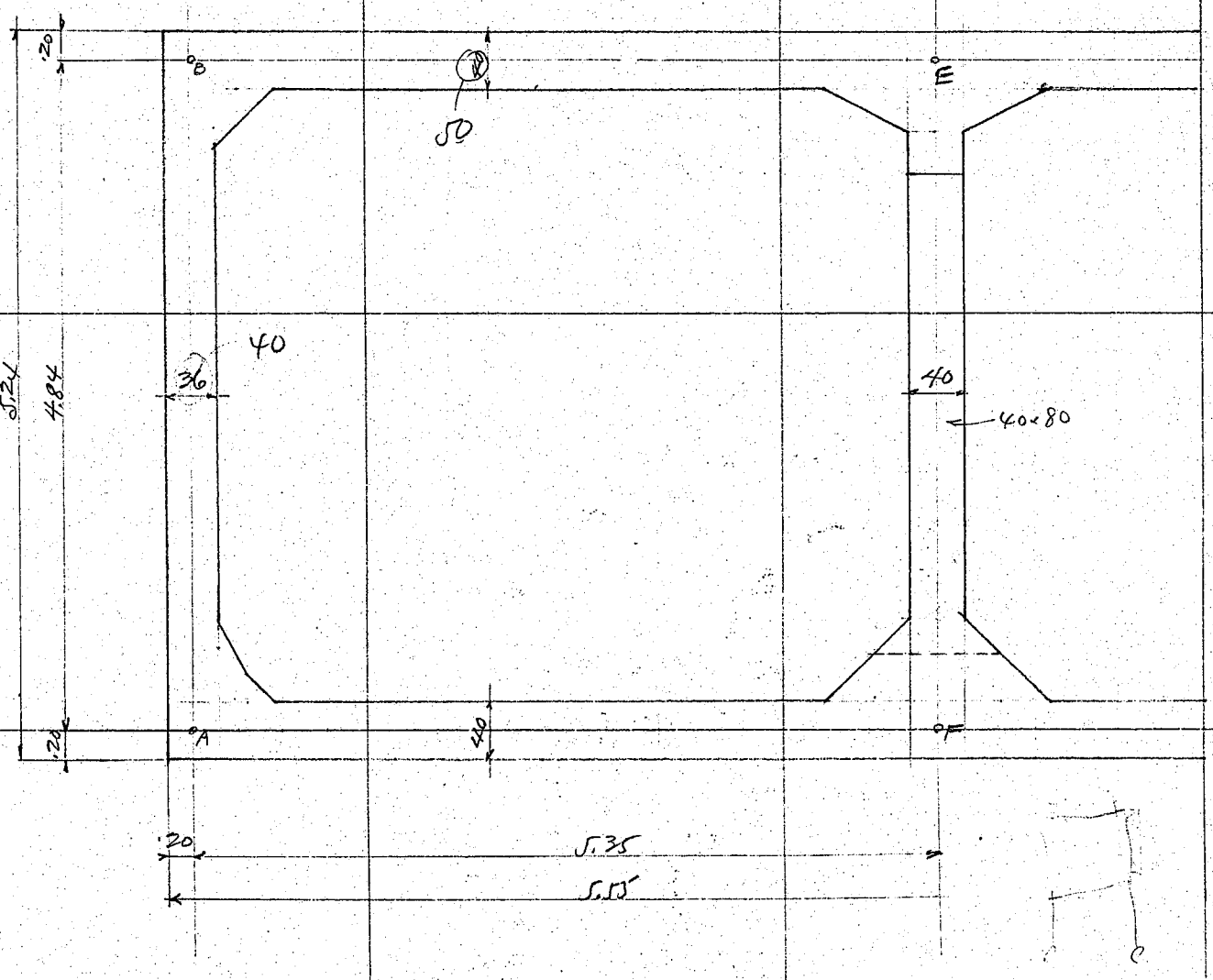
口型ノ大隧道.

Moment and shear diagram.



1	1080	5.30
2	4330	2.100
3	9750	.4750
4	17350	8210

Same as for top slab.



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CALCULATIONS FOR

口型ノ大隧道.

Unit stresses.

Top slab.

		moment.	Thrust	Shear.
	M_B	−11,450 kgm′	9,000 kg,	S_{BE} = ~~20650~~ kg 18380; S_{EB} = ~~19750~~ , 22,020
	M_T	+ ~~16800~~ 10,900 .	9,000 ″ ,	0.
wall,	M_A	−11,450 ′ .	11,800 ″ ,	S_{AF} = ~~20650~~ 18380; S_{FA} = ~~19750~~ 22020

2340
5570
7910 ÷ 2 = 3960 .432

3960 × 5,24 = 20,800 kg

Hor top. 20800 × .432 = 9,000
H on bott 20800 × .568 = 11,800
20800

Pos moment.

Ecc. $e = \frac{-11450}{9000} = 1.27^m$, $e = \frac{-11450}{11800} = 0.97m$. $e' = 1.12$

$e' = 1.42$

$b = 100^{cm}$, $d = 35cm$ $e/d = \frac{127}{35} = 3.63$ $\frac{97}{35} = 2.77$

$\frac{Ne'}{bd^2} = \frac{9000 \times 142}{100 \times 35^2} = 10.4$ $\frac{11800 \times 112}{100 \times 35^2} = 10.8$

.003 × 100 × 35 = 10.5

Horizontal thrust is very small, so the slab reinf. may be determined by bending.!

~~Effective depth reqd. for bending m, d = $\sqrt{\frac{16800 \times 100}{100 \times 7.13}}$ = 48.5cm~~ (10900) 39.1

Use 45cm eff depth with an insulation of 5 cm. Total depth = 50cm.

Steel area reqd. for B.M. = $\frac{\text{~~16800~~ } 10900 \times 100}{1200 \times \frac{7}{8} \times \frac{\text{~~50~~ }}{45}}$ = ~~33.0~~ 23.1 cm2 $p = \frac{\text{~~38~~ } 28.35}{\text{~~5000~~ } 4500}$ = .00~~76~~ 63 $\frac{22}{3000}$

Use 10 − ~~22~~ 19φ bars = ~~38.01~~ 28.35 j = ~~.875~~ .883 k = ~~.376~~ .350

$f_s = \frac{\text{~~16800~~ } 10900 \times 100}{\text{~~38.01~~ } 28.35 \times .875 \times \text{~~50~~ } 45}$ = ~~1010~~ 976 kg/cm²

$f_c = \frac{\text{~~1010~~ } 976 \times \text{~~.375~~ } .35}{15(1 - \text{~~.375~~ } .35)}$ = ~~40.4~~ 35.0
.650

Direct stress = $\frac{11800}{\text{~~5000~~ } 4500}$ = ~~2.4~~ 2.6

~~42.8~~ 37.6 kg/cm².

Side wall Section assumed ~~50~~ 40.0 × 100.0 eff. depth d = ~~45~~ 35 cm
neg. moment say − ~~10000~~ 6000 kgm
load 22,170 kg

Ecc. $e = \frac{\text{~~10000~~ } 6000}{22170}$ = ~~0.451~~ 0.271 e' = ~~.45~~ .27 + ~~.225~~ .15 = ~~.675~~ .42 m e'/d = ~~.675~~ .42 / ~~.45~~ .35 = ~~1.50~~ 1.20

$\frac{Ne'}{bd^2} = \frac{22170 \times \text{~~67.5~~ } 42}{100 \times \text{~~45^2~~ } 35^2}$ = ~~7.39~~ 7.60 × 14.22 = ~~115.~~ 108

p. reqd = ~~0.35~~ 0.60 % = .00~~35~~ 60

A_s = ~~4500~~ 3500 × 0.00~~35~~ 60 = ~~15.75~~ 21.00 cm²

Use 10 − 19φ bars = 28.35 $\rho = \frac{28.35}{\text{~~4500~~ } 3500}$ = 0.00~~63~~ 81   12000 9500 / 6.00 5.75

f_c = ~~40.4~~ 33.1 kg/cm² f_s = ~~6700~~ 3870 kg/cm²

Center column. $f_c = \frac{110,000}{40 \times 80}$ = 34.4 kg/cm²

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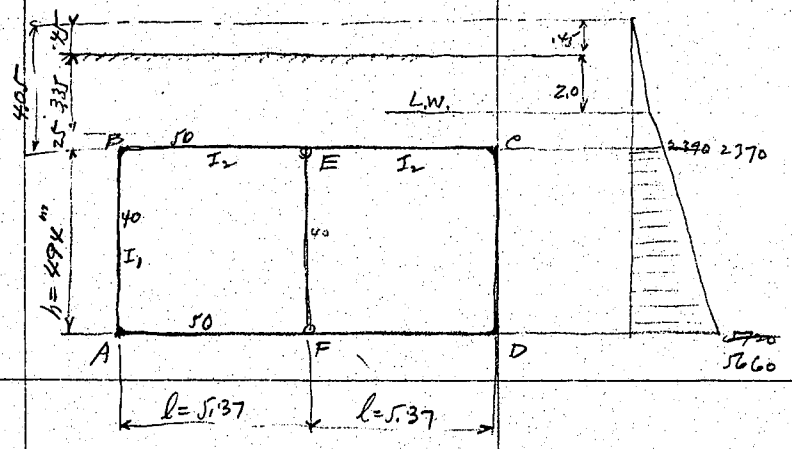
CALCULATIONS FOR
口型水路断面
設計例



Dead load on Top Slab.

Earth above L.W.	2.0 @1600 =	3200
" below "	1.35 @2000 =	2700
		5900
Weight of Slab	0.50 @2400 =	1200
		7100
Live load on slab		700
	W =	7800

Hor. pressure on side wall

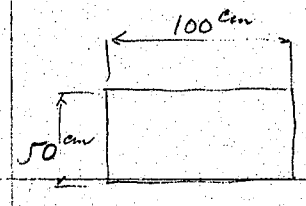
Angle of repose $\phi = 30°$ assumed.

Exchange of L.L. into $\frac{700}{1600} = 0.45$ m of earth.

Pressure intensity at C	1/3 ×1600 × 4.05 =	2,160
	1/3 × 400 × 1.60 =	210
	q_1 =	2,370 kg/m²
" " at D.	1/3 × 2000 × 4.94 =	3290
	q_2 =	5660 kg/m²

Assumed section of slab and wall.

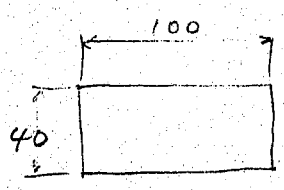
Slab.



Sectional area $A_2 = 100 \times 50 = 5000$ cm²

Moment of inertia $(I_2) = \frac{100 \times 50^3}{12} = 1,042,000$ cm⁴

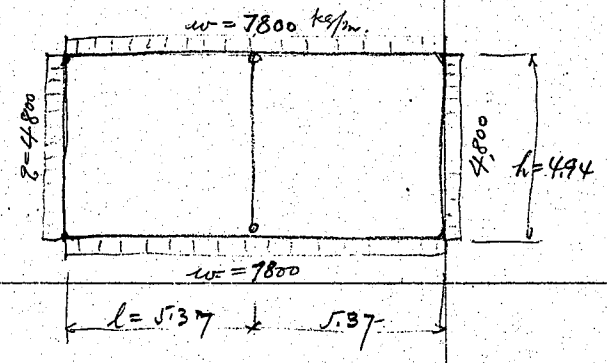
Side wall.



$A_1 = 100 \times 40 = 4,000$ cm²

$I_1 = \frac{100 \times 40^3}{12} = 533,000$ cm⁴

Approx. Stress.



$C_{AB} = C_{BA} = \frac{wh^2}{12} = \frac{4800 \times 4.94^2}{12} = 9760$ ~~10420~~ kgm

$C = \frac{wl^2}{12} = \frac{7800 \times 5.37^2}{12} = 18750$ ~~19600~~ s

$\alpha = \frac{I_2}{I_1}\frac{h}{l} = \frac{1042000}{533000} \times \frac{4.94}{5.37} = 1.80$

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CALCULATIONS FOR
ヒ型，大

Constants used in calculation

$\alpha = 1.80$, $11\alpha = 19.8$

$\alpha(13+4\alpha) = 36.36$
$2(6+\alpha) = 15.60$
$1+2\alpha = 4.60$
$2(6+\alpha)(1+2\alpha) = 71.80$

$\alpha(5-\alpha) = 5.76$
$\alpha(7+3\alpha) = 22.32$
$2(6+19\alpha+3\alpha^2) = 99.84$

$C_{AB} = C_{BA} = \frac{9h^2}{12} = 9760$

$C = \frac{wl^2}{12} = 18750$

$$M_A = M_B = -\frac{36.36\times 9760 + 15.60\times 18750 + 19.80\times 9760}{71.80} = -\frac{355000 + 292200 + 193300}{71.80} = -11700 \text{ kgm}$$

(840,500)

$$M_E = M_F = +\frac{5.76\times 9760 + 22.32\times 9760 - 99.84\times 18750}{71.80} = +\frac{56200 + 218000 - 1872000}{71.80} = -22300 \text{ kgm}$$

(−1597,800)

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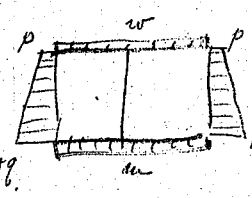
CALCULATIONS FOR

口型 1/3

Solution of condition equation by the successible trials.
Condition equations

No. of eqn.	Θ_A	Θ_B	R	
1	5.546	1	−5.319	$C_{AB} - C_{AD} = -7230$ ①
2	1	5.546	−5.319	$C_{BC} - C_{BA} = 13930$ ②
3	1.773	1.773	−7.092	0 ③



−8130 −729
+3188
−2292 −9006

$C_{AB} = \frac{5660 \times 4.94^2}{12} = 11,520$

$C_{BA} = \frac{2370 \times 4.94^2}{12} = 4820$

$C_{AD} = \frac{7800 \times 5.37^2}{12} = 18750$

$C_{BC} = \text{〃} = 18750$

① $\Theta_A = \frac{-7230}{1,227} = -5890$

$\Theta_B = \frac{13930}{1227} = +11,355$

$R = 0$

② $\Theta_A = \frac{1}{5.546}(-7230 - 11,355) = -3,350$

$\Theta_B = \frac{1}{5.546}(13930 + 3350) = +3,115$

$R = -\frac{1}{7092}(3350 \times 1.773 - 3115 \times 1.773) = -59$

③ $\Theta_A = \frac{1}{5.546}(-7230 - 3115 - 5.319 \times 59) = -1922$

$\Theta_B = \frac{1}{5.546}(13930 + 1922 - 5.319 \times 59) = +2800$

$R = \frac{1}{7092}\{1.773 \times (2800 - 1922)\} = +220$

④ $\Theta_A = \frac{1}{5.546}(-7230 - 2800 + 5.319 \times 220) = -1597$

$\Theta_B = \frac{1}{5.546}(13930 + 1597 + 5.319 \times 220) = +3010$

$R = \frac{1}{7092}\{1.773(3010 - 1597)\} = +354$

⑤ $\Theta_A = \frac{1}{5.546}(-7230 - 3010 + 354 \times 5.319) = -1506$

$\Theta_B = \frac{1}{5.546}(13930 + 1506 + 354 \times 5.319) = +3120$

$R = \frac{1}{7092}\{1.773(3120 - 1506)\} = +404$

	Θ_A	Θ_B	R	
1	5.546	1	−5.319	= −7230
2	1	5.546	−5.319	= 13930
3	1.773	1.773	−7.092	= 0
①	−5890	+11355	0	
②	−3350	+3115	−59	
③	−1922	+2800	+220	
④	−1597	+3010	+354	
⑤	−1506	+3120	+404	
⑥	−1478	+3165	+422	
⑦	−1469	+3179	+428	
⑧	−1467	+3185	+430	
⑨	−1465	+3188	+431	
⑩	−1464.5	+3188.0	+431.0	

⑥ $\Theta_A = \frac{1}{5.546}\{(-7230 - 3120 + 404 \times 5.319)\} = -1478$

$\Theta_B = \frac{1}{5.546}(13930 + 1478 + 5.319 \times 404) = +3165$

$R = \frac{1}{7092}\{(1.773(3165 - 1478)\} = +422$

⑦ $\Theta_A = \frac{1}{5.546}(-7230 - 3165 + 422 \times 5.319) = -1469$

$\Theta_B = \frac{1}{5.546}(13930 + 1469 + 5.319 \times 422) = +3179$

$R = \frac{1}{7092}\{(1.773(3179 - 1469)\} = +428$

⑧ $\Theta_A = \frac{1}{5.546}(-7230 - 3179 + 428 \times 5.319) = -1467$

$\Theta_B = \frac{1}{5.546}(13930 + 1467 + 5.319 \times 428) = +3185$

$R = \frac{1}{7092}\{(1.773(3185 - 1467)\} = +430$

⑨ $\Theta_A = \frac{1}{5.546}(-7230 - 3185 + 430 \times 5.319) = -1465$

$\Theta_B = \frac{1}{5.546}(13930 + 1465 + 430 \times 5.319) = +3188$

$R = \frac{1}{7092}\{(1.773(3188 - 1465)\} = +431$

⑩ $\Theta_A = \frac{1}{5.546}(-7230 - 3188 + 431 \times 5.319) = -1464.5$

$\Theta_B = \frac{1}{5.546}(13930 + 1464.5 + 431 \times 5.319) = +3188.0$

$R = \frac{1}{7092}\{(1.773(3188 - 1464.5)\} = +431.0$

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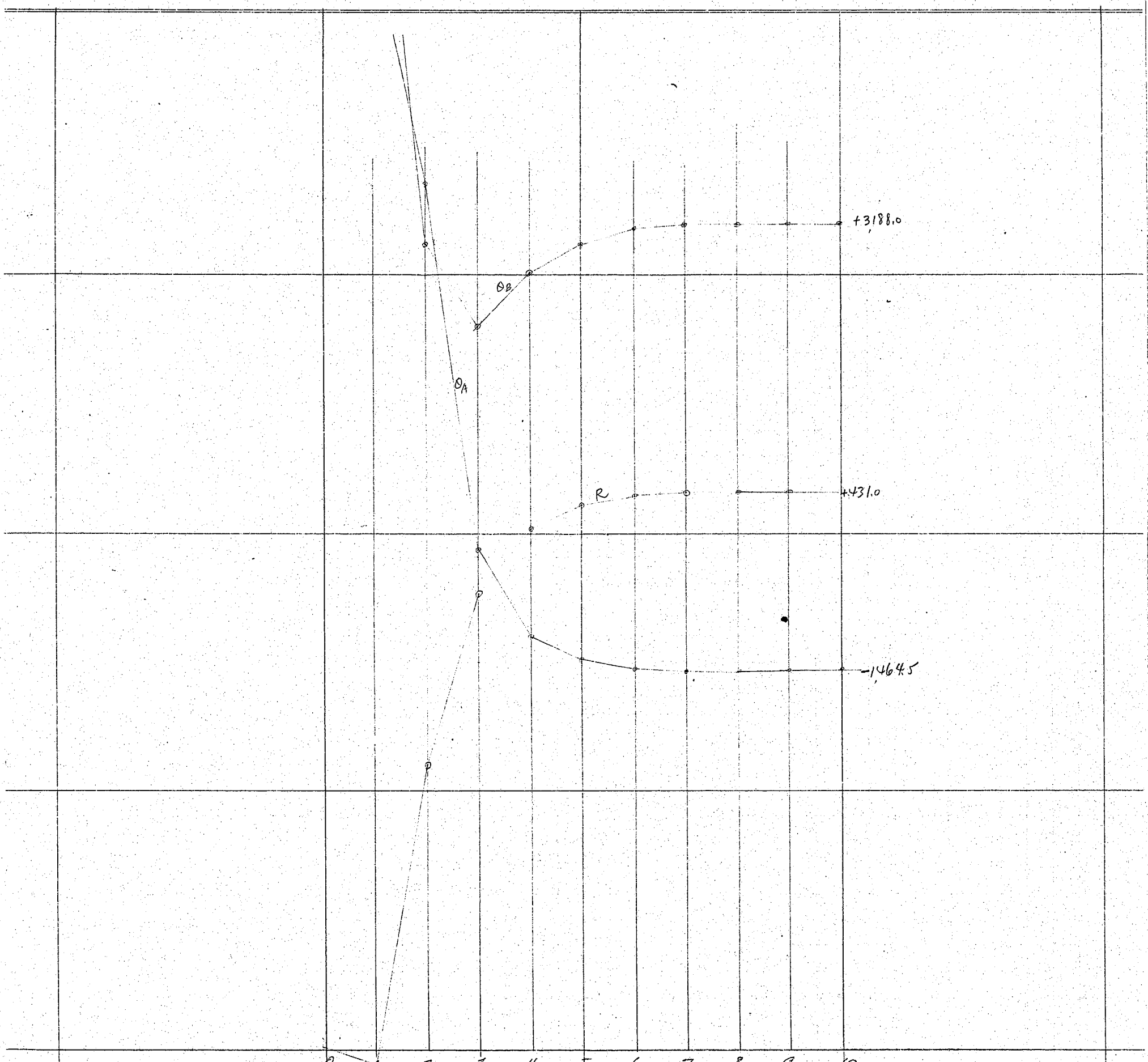
CALCULATIONS FOR



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CALCULATIONS FOR

D型 1/3

Moments.

$M_{AD} = 1.773(-2\times1464.5 - 3\times431.0) + 18750 = -7490 + 18750 = ⊙ +11260$ kgm

$M_{AB} = (-2\times1464.5 + 3188.) - 11520 = -11261$

$M_{BA} = (2\times3188 - 1464.5) + 4820 = ⊙ +9732$

$M_{BC} = 1.773(2\times3188 - 3\times431.0) - 18750 = -9730$

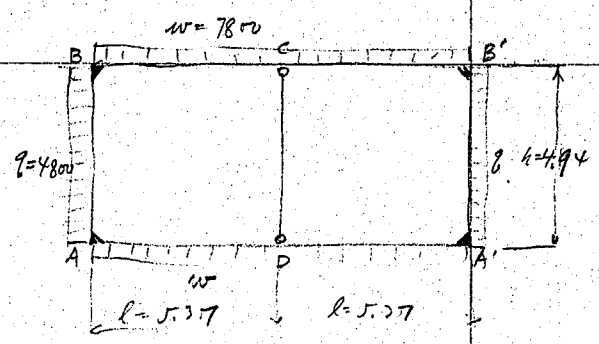
} $M_A = -11260$ kgm 4.8%

} $M_B = -9730$ kgm 4%

$M_{DA} = 1.773(-1464.5 - 3\times431) - 18750 = -23640$ ⊙ $M_D = -23640$ kgm 4.8%

$M_{CB} = 1.773(3188 - 3\times431) + 18750 = ⊙ +22110$ ⊙ $M_C = -22110$ kgm 4.3%

check.



$C_{AB} = C_{BA} = \frac{4800\times4.94^2}{12} = 9760$

$C_{AD} = C_{BC} = \frac{7800\times5.37^2}{12} = 18750$

$\alpha = \frac{1042.0\text{cm}}{532.0\text{cm}} < \frac{4.94}{5.37} = 1.80$

$C_{AB} - C_{AD} = -8990$

$C_{DC} - C_{BA} = ⊕8990$

$2(1+\alpha) = 5.60$

$3\alpha = 5.40$

$4\alpha = 7.20$

Eq'n.

	θ_A	θ_B	R		
1	5.60	1	−5.40	=	−8990
2	1	5.60	−5.40	=	⊕8990
3	1.80	1.80	−7.20	=	0
①	−7490	−7490	0		
②	−2945	+2132	+203		
③	−1792	+2132	+83		
④	−1905	+2025	+30		
⑤	−1939	+1980	+10.25		
⑥	−1950	+1963	+3.25		
⑦	−1954	+1959	+1.25		
⑧	−1953	+1955	+0.50		
⑨	−1955	+1955	+0.00		

11.39

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CALCULATIONS FOR
口型ﾗﾒﾝ.

1955
1955
7910

① $\theta_A = -8990 + 1.20 = -7490$
$\theta_B = -8990 + 1.20 = +7490$
$R = 0$

$M_{AD} = 1.80(-3910) + 18750 = +11720$ kgm
$M_{AB} = (-3910 + 1955) - 9760 = -11715$ } 0

② $\theta_A = \frac{1}{5.6}(-8990 - 7490) = -2945$
$\theta_B = \frac{1}{5.6}(8990 + 2945) = +2132$
$R = \frac{1}{7.2}\{1.8(-2945 + 2132)\} = +203$

$M_{BA} = 3910 - 1955 + 9760 = +11715$
$M_{BC} = 1.8(3910) - 18750 = -11720$ } 0

③ $\theta_A = \frac{1}{5.6}(-8990 - 2132 + 203 \times \frac{1096}{5.4}) = -1792$
$\theta_B = \frac{1}{5.6}(8990 + 1792 + 1096) = +2120$
$R = \frac{1}{7.2}\{1.8(2120 - 1792)\} = +83$

$M_{DA} = 1.8(-1955) - 18750 = -22265$
$M_{CB} = 1.8(1955) + 18750 = +22265$ } 0 ✓

④ $\theta_A = \frac{1}{5.6}(-8990 - 2120 + 83 \times \frac{447}{5.4}) = -1905$
$\theta_B = \frac{1}{5.6}(+8990 + 1905 + 447) = +2025$
$R = \frac{1}{7.2}\{1.8(2025 - 1905)\} = +30$

⑤ $\theta_A = \frac{1}{5.6}(-8990 - 2025 + 30 \times \frac{162}{5.4}) = -1939$
$\theta_B = \frac{1}{5.6}(8990 + 1939 + 162) = +1980$
$R = \frac{1}{7.2}\{1.8(1980 - 1939)\} = +10.25$

⑥ $\theta_A = \frac{1}{5.6}(-8990 - 1980 + 10.25 \times \frac{55}{5.4}) = -1950$
$\theta_B = \frac{1}{5.6}(8990 + 1950 + 55) = +1963$
$R = \frac{1}{7.2}\{1.8(1963 - 1950)\} = +3.25$

⑦ $\theta_A = \frac{1}{5.6}(-8990 - 1963 + 3.25 \times \frac{18}{5.4}) = -1954$
$\theta_B = \frac{1}{5.6}(8990 + 1954 + 18) = +1959$
$R = \frac{1}{7.2}\{1.8(1959 - 1954)\} = +1.125$

⑧ $\theta_A = \frac{1}{5.6}(-8990 - 1959 + 1.125 \times \frac{7}{1.25}) = -1953$
$\theta_B = \frac{1}{5.6}(8990 + 1953 + 7) = +1955$
$R = \frac{1}{7.2}\{1.8(2)\} = +0.50$

⑨ $\theta_A = \frac{1}{5.6}(-8990 - 1955 + \frac{0}{0.5}) = -1955$
$\theta_B = \frac{1}{5.6}(8990 + 1955 + 0) = +1955$
$R = 0$

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CALCULATIONS FOR

口型ノ六

Seismic stresses.

$$k = \frac{k_h}{1-k_v} = \frac{0.200}{1-0.05} = 0.211$$

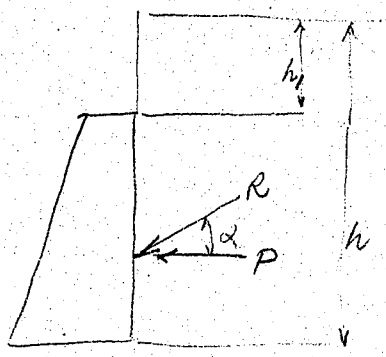
$$\tan^{-1} k = \tan^{-1} 0.211 = 12°\,00'$$

$$\varphi' = \varphi - \tan^{-1} k = 30°00' - 12°00' = 18°\,00' \qquad \sin\varphi' = 0.3090$$

$$C = \frac{1-\sin\varphi'}{1+\sin\varphi'} = \frac{1-.3090}{1+.3090} = \frac{.691}{1.309} = 0.528$$

$(1-k_v)\,C = .528 \times .95 = .501$

118%



$$R = \frac{1}{2}(1-k_v)\,w\,(h^2-h_1^2)\,C$$

$$C = \frac{\left[\left\{\cos\theta - \sqrt{\cos^2\theta - \cos^2\varphi}\right\}^2 + 4\sin^2\theta\right]^{\frac{1}{2}}}{\cos\theta\left\{\cos\theta + \sqrt{\cos^2\theta - \cos^2\varphi}\right\}}$$

where φ = angle of repose of earth = 30°-00'

$$\theta = \tan^{-1} k = \tan^{-1} 0.211 = 12°-00'$$

$$C = \frac{\left[\left\{.978 - \sqrt{.957 - .75}\right\}^2 + 4\times.0433\right]^{\frac{1}{2}}}{.978\left\{.978 + \sqrt{.957-.75}\right\}} = \frac{.669}{1.412} = .474$$

$$C_1 = (1-k_v)\,C = 0.95 \times .474 = 0.450$$

$$\sin\alpha = \frac{1}{C}\sin\theta\,(\cos\theta + k\sin\theta) = \frac{1}{.474}\cdot 208\,(.978 + .211\times.208) = 0.448$$

(1.022 ✓)

$$\alpha = 26°-40', \quad \cos\alpha = 0.894$$

$$P = R\cos\alpha$$

$$C' = C\cos\alpha = 0.474 \times .894 = 0.425$$

$$C_2 = (1-k_v)\,C' = .95 \times .425 = 0.403$$

$$P = \frac{1}{2} C_2\, w\,(h^2 - h_1^2) = \frac{1}{2} \times 0.403\, w\,(h^2 - h_1^2)$$

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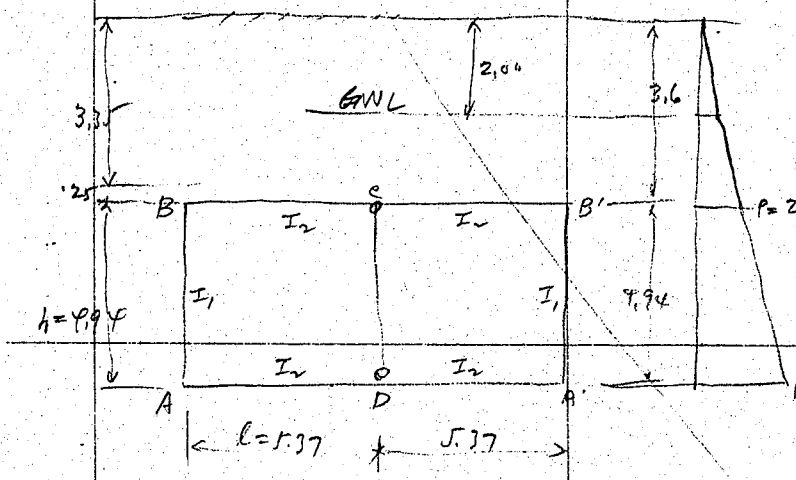
CALCULATIONS FOR

ロ型ノ六

Loads on tunnel during earthquake.



vertical load on slab = 7100 ks/m²

Seismic load. 0.95 × 7100 = 6750 ∴ = W

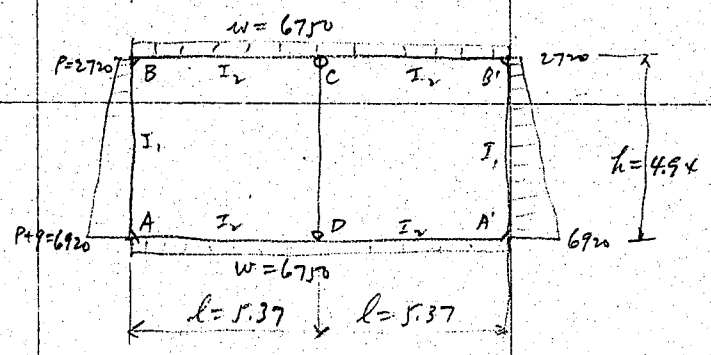
Side pressure for k = 2.11 C = 0.425

Pressure intensity at B'.

0.425 × 1600 × 3.60 = 2450
0.425 × 400 × 1.60 = 270
2720 = P

at A'

0.425 × 2000 × 4.94 = 4200 = q
6920 = p+q



$C_{AB} = \frac{6920 \times 4.94^2}{12} = 14100 \times \frac{1}{2} = 8831$

$C_{BA} = \frac{2720 \times 4.94^2}{12} = 5520 \times \int = 7491$

$C_{AD} = \frac{6750 \times 5.37^2}{12} = 16220 \times$

$C_{BC} = \quad " \quad = 16220 \times$

$C_{AB} - C_{AD} = -2120$

$C_{BC} - C_{BA} = 10700$

Condition eqn.

no. of eq'n	Q_A	Q_B	R	C
1	5.546	1	-5.319	-2120
2	1	5.546	-5.319	+10700
3	1.773	1.773	-7.092	0
(1)	-1730	8720	0	
(2)	-1955	2282	82	
(3)	-715	2135	355	
(4)	-427	2345	480	
(5)	-345	2450	527	
(6)	-319	2490	545	
(7)	-308	2508	550	
(8)	-307	2510	551	
(9)	-306.5	2511.0	551.5	
(10)	-306.	2512.	552.	

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CALCULATIONS FOR

口型，六

Solution of condition eqns.

① θ_A $\frac{1}{1.227} \times (-2120) = -1730$

θ_B $\frac{1}{1.227} \times 10700 = 8720$

$R = 0$

② $\theta_A = \frac{1}{5.546}(-2120-8720) = -1955$

$\theta_B = \frac{1}{5.546}(10700+1955) = +2282$

$R = \frac{1}{7.092}\{1.773(2282-1955)\}$ (327) $= +82$

③ $\theta_A = \frac{1}{5.546}(-2120-2282+82\times 5.319)$ (435) $= -715$

$\theta_B = \frac{1}{5.546}(+10700+715+435) = +2135$

$R = \frac{1}{7.092}\{1.773(2135-715)\} = +355$

④ $\theta_A = \frac{1}{5.546}(-2120-2135+355\times 5.319)$ (1888) $= -427$

$\theta_B = \frac{1}{5.546}(10700+427+1888) = +2345$

$R = \frac{1}{7.092}\{1.773(2345-427)\} = +480$

⑤ $\theta_A = \frac{1}{5.546}(-2120-2345+480\times 5.319)$ (2550) $= -345$

$\theta_B = \frac{1}{5.546}(+10700+345+2550) = +2450$

$R = \frac{1}{7.092}\{1.773(2450-345)\} = +527$

⑥ $\theta_A = \frac{1}{5.546}(-2120-2450+527\times 5.319)$ (2800) $= -319$

$\theta_B = \frac{1}{5.546}(10700+319+2800) = +2490$

$R = \frac{1}{7.092}\{1.773(2490-319)\} = +545$

⑦ $\theta_A = \frac{1}{5.546}(-2120-2490+545\times 5.319)$ (2900) $= -308$

$\theta_B = \frac{1}{5.546}(10700+308+2900) = +2508$

$R = \frac{1}{7.092}\{1.773(2508-308)\} = +550$

⑧ $\theta_A = \frac{1}{5.546}(-2120-2508+550\times 5.319)$ (2925) $= -307$

$\theta_B = \frac{1}{5.546}(10700+307+2925) = +2510$

$R = \frac{1}{7.092}\{1.773(2510-307)\} = +551$

⑨ $\theta_A = \frac{1}{5.546}(-2120-2510+551\times 5.319)$ (2930) $= -306.5$

$\theta_B = \frac{1}{5.546}(10700+306.5+2930) = +2511.0$

$R = \frac{1}{7.092}\{1.773(2511-306.5)\} = +551.5$

⑩ use

$\theta_A = -306$

$\theta_B = +2512$

$R = +552$

} 採用

$M_{AD} = 1.773(-2\times 306 - 552\times 3) + 16220 = -4020 + 16220 = +12200$ (612, 1656)

$M_{AB} = (-2\times 306 + 2512) - 14100 = +1900 - 14100 = -12200$

} $M_A = -12200$ kgm

$M_{BA} = (+2\times 2512 - 306) + 5520 = 4718 + 5520 = +10238$ (5024)

$M_{BC} = 1.773(2\times 2512 - 552\times 3) - 16220 = 5970 - 16220 = -10250$

} $M_B = -10250$ "

$M_{DA} = 1.773(-306 - 552\times 3) - 16220 = 3480 - 16220 = -12740$

$M_{CB} = 1.773(2512 - 552\times 3) + 16220 = 1518 + 16220 = +17738$

$M_D = -12740$ "

$M_C = -17740$ "

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CALCULATIONS FOR

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Seismic moments condition equations.

no. of eqn.	θ_A	θ_B	R		
1	5.546	1	−5.319	=	+430
2	1	5.546	−5.319	=	+10,190
3	1.773	1.773	−7.092	=	0

check

+1620	+2439	− 3630	=	+ 429 --- 430
+292	+13530	− 3630	=	+ 10192 --- 10190
+518	+4325	− 4842	=	+ 1 --- 0

①	+ 350	+8300	0
②	−1420	+1773	+ 88
③	− 157.5	+1950	+448
④	+ 156	+2242	+599
⑤	+ 248	+2365	+ 653
⑥	+ 277	+ 2412	+ 672
⑦	+ 287	+2430	+ 680
⑧	+ 291	+ 2438	+ 682
⑨	+ 292	+ 2439	+ 683
⑩	+ 292	+ 2439	+ 683

① $\theta_A = \frac{1}{1.227} \times 430 = +350$

$\theta_B = \frac{1}{1.227} \times 10,190 = +8300$

$R = 0$

② $\theta_A = \frac{1}{5.546}(430 - 8300) = -1,420$

$\theta_B = \frac{1}{5.546}(10,190 - 350) = +1,773$

$R = \frac{1}{7.092}\{1.773(1773 - 1420)\} = +88$

③ $\theta_A = \frac{1}{5.546}(430 - 1773 + \overset{469}{5.319 \times 88}) = -157.5$

$\theta_B = \frac{1}{5.546}(10190 + 157.5 + 469) = +1950.$

$R = \frac{1}{7.092}\{1.773(1950 - 157.5)\} = +448$

④ $\theta_A = \frac{1}{5.546}(430 - 1950 + \overset{2385}{5.319 \times 448}) = +156$

$\theta_B = \frac{1}{5.546}(10,190 - 156 + \overset{2385}{5.319 \times 448}) = +2242$

$R = \frac{1}{7.092}\{1.773(2242 + 156)\} = +599$

⑤ $\theta_A = \frac{1}{5.546}(430 - 2242 + \overset{3185}{599 \times 5.319}) = +248$

$\theta_B = \frac{1}{5.546}(10190 - 248 + 3185) = +2365$

$R = \frac{1}{7.092}\{1.773(248 + 2365)\} = +653$

⑥ $\theta_A = \frac{1}{5.546}(430 - 2365 + \overset{3470}{5.319 \times 653}) = +277$

$\theta_B = \frac{1}{5.546}(10190 - 277 + 3470) = +2412$

$R = \frac{1}{7.092}\{1.773(277 + 2412)\} = +672$

⑦ $\theta_A = \frac{1}{5.546}(430 - 2412 + \overset{3575}{5.319 \times 672}) = +287$

$\theta_B = \frac{1}{5.546}(10190 - 287 + 3575) = +2430$

$R = \frac{1}{7.092}\{1.773(287 + 2430)\} = +680$

⑧ $\theta_A = \frac{1}{5.546}(430 - 2430 + \overset{3615}{5.319 \times 680}) = +291$

$\theta_B = \frac{1}{5.546}(10190 - 291 + 3615) = +2438$

$R = \frac{1}{7.092}\{1.773(291 + 2438)\} = +682$

⑨ $\theta_A = \frac{1}{5.546}(430 - 2438 + \overset{3630}{5.319 \times 682}) = +292$

$\theta_B = \frac{1}{5.546}(10190 - 292 + 3630) = +2439$

$R = \frac{1}{7.092}\{1.773(292 + 2439)\} = +683$

⑩ $\theta_A = \frac{1}{5.546}(430 - 2439 + \overset{3630}{5.319 \times 683}) = +292$

$\theta_B = \frac{1}{5.546}(10190 - 292 + 3630) = +2439$

$R = \frac{1}{7.092}\{1.773(292 + 2439) = +683$

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CALCULATIONS FOR

D 型 / 九.

Condition equations. (等時).

No. of eqn.	θ_A	θ_B	R	
1	5.674	1	-5.511	= -5930
2	1	5.674	-5.511	= +12,630
3	1.837	1.837	-7.348	= 0

① $\theta_A = \frac{1}{5.674}(-5930 - 3188 + 431 \times 5.511) = -1189$ (2376)

$\theta_B = \frac{1}{5.674}(12630 + 1189 + 2376) = +2,855$

$R = \frac{1}{7.348}\{1.837(2855 - 1189)\} = +417$ (0.250)

② $\theta_A = \frac{1}{5.674}(-5930 - 2855 + 5.511 \times 417) = -1143$ (2300)

$\theta_B = \text{〃}\ (12630 + 1143 + 2300) = +2832$

$R = 0.250\ (2832 - 1143) = +422$

③ $\theta_A = \frac{1}{5.674}(-5930 - 2832 + 5.511 \times 422) = -1133$ (2328)

$\theta_B = \text{〃}\ (12630 + 1133 + 2328) = +2835$

$R = 0.250\ (2835 - 1133) = +426$

④ $\theta_A = \frac{1}{5.674}(-5930 - 2835 + 5.511 \times 426) = -1130$ (2350)

$\theta_B = \text{〃}\ (12630 + 1130 + 2350) = +2840$

$R = 0.25\ (2840 - 1130) = +428$

⑤ $\theta_A = \frac{1}{5.674}(-5930 - 2840 + 5.511 \times 428) = -1130$ (2360)

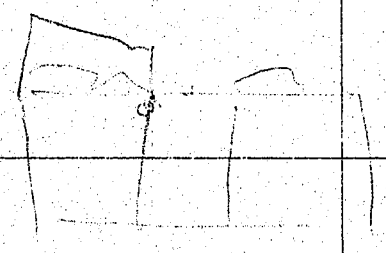
$\theta_B = \text{〃}\ (12630 + 1130 + 2360) = +2840$

$R = 0.25\ (2840 - 1130) = +427.5$

① $-6410 + 2840 - 2360 = -5930$ ✓

② $-1130 + 16120 - 2360 = +12630$ ✓

③ $-2075 + 5215 - 3140 = 0$ ✓



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CALCULATIONS FOR

D 形 1 九 -

(地震時)

Condition equation.

No. of eqn.	θ_A	θ_B	R		
1	5.674	1	-5.511	=	+ 1620
2	1	5.674	-5.511	=	+ 9000
3	1.837	1.837	-7.348	=	0

① $\theta_A = \frac{1}{5.674}(1620 - 2439 + 683 \times 5.511) = +520$ (3761)

$\theta_B = 〃 \ (9000 - 520 + 3765) = +2160$

$R = \frac{1.837}{7.348}(520 + 2160) = +670$

② $\theta_A = \frac{1}{5.674}(1620 - 2160 + 670 \times 5.511) = +556$ (3692)

$\theta_B = 〃 \ (9000 - 556 + 3692) = +2140$

$R = \frac{1.837}{7.348}(556 + 2140) = +675$

③ $\theta_A = \frac{1}{5.674}(1620 - 2120 + 680 \times 5.511) = +573$ (3750)

$\theta_B = 〃 \ (9000 - 573 + 3750) = +2148$

$R = \frac{1.837}{7.348}(573 + 2148) = +680$

④ $\theta_A = \frac{1}{5.674}(1620 - 2148 + 680 \times 5.511) = +568$ (3750)

$\theta_B = 〃 \ (9000 - 568 + 3750) = +2148$

$R = \frac{1.837}{7.348}(568 + 2148) = 679$

⑤ $\theta_A = \frac{1}{5.674}(1620 - 2148 + 679 \times 5.511) = 567$ (3742)

$\theta_B = 〃 \ (9000 - 567 + 3742) = 2146$

$R = \frac{1.837}{7.348}(567 + 2146) = 678$

1	+ 3220	+ 2146	- 3735	=	1631	
2	+ 567	+ 12180	- 3735	=	9012	
3	1041	+ 3940	- 4980	=	1	

⑥ $\theta_A = \frac{1}{5.674}(1620 - 2146 + 678 \times 5.511) =$ 566 (3737)

$\theta_B = 〃 \ (9000 - 566 + 3737) =$ 2145

$R = \frac{1.837}{7.348}(566 + 2145) =$ 678

+ 3212	+ 2145	- 3736	=	1621	✓
+ 566	+ 12175	- 3736	=	9005	-
+ 1040	+ 3938	- 4980	=	-2	✓

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CALCULATIONS FOR

口形，六.

Trials.

No. of eqns	θ_A	θ_B	R		
1	5.704	1	-5.556	=	-3370
2	1	5.704	-5.556	=	+9820
3	1.852	1.852	-7.408	=	0

① $\theta_A = \frac{1}{5.704}(-3370 - 3188 + 5.556^{2395} \times 431) = -730$

$\theta_B = \text{〃}\ (9820 + 730 + 2395) = +2270$

$R = \frac{1.852}{7.408}(2270 - 730) = +385$

② $\theta_A = \frac{1}{5.704}(-3370 - 2270 + 5.556^{2140} \times 385) = -614$

$\theta_B = \text{〃}\ (9820 + 614 + 2140) = +2210$

$R = \frac{1.852}{7.408}(2210 - 614) = +399$

③ $\theta_A = \frac{1}{5.704}(-3370 - 2210 + 5.556^{2215} \times 399) = -590$

$\theta_B = \text{〃}\ (9820 + 590 + 2215) = +2213$

$R = \frac{1.852}{7.408}(2213 - 590) = +406$

④ $\theta_A = \frac{1}{5.704}(-3370 - 2213 + 5.556^{2255} \times 406) = -583$

$\theta_B = \text{〃}\ (9820 + 583 + 2255) = +2220$

$R = \frac{1.852}{7.408}(2220 - 583) = +409$

⑤ $\theta_A = \frac{1}{5.704}(-3370 - 2220 + 5.556^{2271} \times 409) = -582$

$\theta_B = \text{〃}\ (9820 + 582 + 2271) = +2220$

$R = \frac{1.852}{7.408}(2220 - 582) = +409.$

① $-3320 + 2220 - 2270 = 3370$ ✓

② $-582 + 13670 - 2270 = 9818$ ✓

③ $-1078 + 4110 - 3030 = 2$ ✓

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CALCULATIONS FOR

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地震時.

Equ. no.	θ_A	θ_B	R		
1	5.704	1	−5.556	=	+3690
2	1	5.704	−5.556	=	+6230
3	1.852	1.852	−7.408	=	0

① ~~$\theta_A = \frac{1}{5.704}(3690 - 2145 + 5.556 \times 678) = + 930$~~ (3765)

$\theta_B = 〃 (6230 - 930 + 3675) = + 1573$

$R = \frac{1.852}{7.408}(930 + 1573) = + 626$

② $\theta_A = \frac{1}{5.704}(3690 - 1573 + 5.556 \times 626) = + 980$ (3475)

$\theta_B = 〃 (6230 - 980 + 3475) = + 1530$

$R = \frac{1.852}{7.408}(980 + 1530) = + 628$

③ $\theta_A = \frac{1}{5.704}(3690 - 1530 + 5.556 \times 628) = + 990$ (3488)

$\theta_B = 〃 (6230 - 990 + 3488) = + 1529$

$R = \frac{1.852}{7.408}(990 + 1529) = + 629$

④ $\theta_A = \frac{1}{5.704}(3690 - 1529 + 5.556 \times 629) = + 991$ (3495)

$\theta_B = 〃 (6230 - 991 + 3495) = + 1531$

$R = \frac{1.852}{7.408}(991 + 1531) = 630$

⑤ $\theta_A = \frac{1}{5.704}(3690 - 1531 + 5.556 \times 630) = + 992$ (3500)

$\theta_B = 〃 (6230 - 992 + 3500) = + 1531$

$R = \frac{1.852}{7.408}(992 + 1531) = + 630$

			error
5660 + 1531 − 3500	=	3691	+1
992 + 8740 − 3500	=	6232	+2
1837 + 2834 − 4665	=	−6	−6

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SHOWA

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CALCULATIONS FOR

口形ノ三.

Condition equation

no. of eqns.	θ_A	θ_B	R	
1	5.704	1	-5.556	= -2010
2	1	5.704	-5.556	= +8460
3	1.852	1.852	-7.408	= 0

① $\theta_A = \frac{1}{5.704}(-2010 - 2220 + 5.556 \times 409) = -343$ (2275)

$\theta_B = 〃 (8460 + 343 + 2275) = +1943$

$R = \frac{1.852}{7.408}(1943 - 343) = +400$

② $\theta_A = \frac{1}{5.704}(-2010 - 1943 + 5.556 \times 400) = -303$ (2224)

$\theta_B = 〃 (8460 + 303 + 2224) = +1925$

$R = \frac{1.852}{7.408}(1925 - 303) = +405$

③ $\theta_A = \frac{1}{5.704}(-2010 - 1925 + 5.556 \times 405) = -295$ (2251)

$\theta_B = 〃 (8460 + 295 + 2251) = +1930$

$R = \frac{1.852}{7.408}(1930 - 295) = +408.5$

④ $\theta_A = \frac{1}{5.704}(-2010 - 1930 + 5.556 \times 408.5) = -292.6$ (2270)

$\theta_B = 〃 (8460 + 292.6 + 2270) = 1932$

$R = \frac{1.852}{7.408}(1932 - 292.6) = 409.5$

⑤ $\theta_A = \frac{1}{5.704}(-2010 - 1932 + 5.556 \times 409.5) = -292$ (2275)

$\theta_B = 〃 (8460 + 292 + 2275) = +1934$

$R = \frac{1.852}{7.408}(1934 - 292) = +410.5$

⑥ $\theta_A = \frac{1}{5.704}(-2010 - 1934 + 5.556 \times 410.5) = -291.5$ (2280)

$\theta_B = 〃 (8460 + 291.5 + 2280) = +1934$

$R = \frac{1.852}{7.408}(1934 - 291.5) = +410.$

Error

$-1663 + 1934 - 2278 = -2007$ ✓ $+3$

$-291.5 + 11030 - 2278 = +8460.5$, $+0.5$

$-520. + 3580 - 3037 = +3.$ $+3.$

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CALCULATIONS FOR

口 開 / 三

地震時.

Condition equations.

no. of eqns.	θ_A	θ_B	R		
1	5.890	1	-5.835	=	4940
2	1	5.890	-5.835	=	5280
3	1.945	1.945	-7.780	=	0
	(+992)	(+531)	(+630)		

① $\theta_A = \frac{1}{5.890}\left(4940 - 1531 + \overset{3675}{5.835 \times 630}\right) = +1203$

$\theta_B = \frac{1}{5.890}\left(5280 - 1203 + 3675\right) = +1317$

$R = \frac{1.945}{7.780}\left(1203 + 1317\right) = +630$

② $\theta_A = \frac{1}{5.890}\left(4940 - 1317 + 3675\right) = +1239$

$\theta_B = \frac{1}{5.890}\left(5280 - 1239 + 3675\right) = +1310$

$R = \frac{1.945}{7.780}\left(1239 + 1310\right) = +637$

③ $\theta_A = \frac{1}{5.890}\left(4940 - 1310 + \overset{3720}{5.835 \times 637}\right) = +1248$

$\theta_B = \frac{1}{5.890}\left(5280 - 1248 + 3720\right) = +1316$

$R = \frac{1.945}{7.780}\left(1248 + 1316\right) = +641$

④ $\theta_A = \frac{1}{5.890}\left(4940 - 1316 + \overset{3740}{5.835 \times 641}\right) = +1251$

$\theta_B = \frac{1}{5.890}\left(5280 - 1251 + 3740\right) = +1319$

$R = \frac{1.945}{7.780}\left(1251 + 1319\right) = +643$

⑤ $\theta_A = \frac{1}{5.890}\left(4940 - 1319 + \overset{3750}{5.835 \times 643}\right) = +1252$

$\theta_B = \frac{1}{5.890}\left(5280 - 1252 + 3750\right) = +1320$

$R = \frac{1.945}{7.780}\left(1252 + 1320\right) = +643$

					error
7375	+ 1320	- 3750	= +4945		+5
1252	+ 7775	- 3750	= +5277		-3
2435	+ 3567	- 5800	= + 2		+2

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CALCULATIONS FOR

ロ型ノ三

荷重 (釘西ノ分)

Condition eqns.

no. of eqn.	θ_A	θ_B	R		
1	5.890	1	−5.835	=	−2,010
2	1	5.890	−5.835	=	+8,460
3	1.945	1.945	−7.780	=	0
	(−292)	(1934)	(410)		

① $\theta_A = \frac{1}{5.890}(-2010 - 1934 + \overset{2394}{5.835 \times 410}) = -263$

$\theta_B = \text{〃} (8460 + 263 + 2394) = +1918$

$R = \frac{1.945}{7.780}(-263 + 1918) = +414$

② $\theta_A = \frac{1}{5.890}(-2010 - 1918 + \overset{2418}{414 \times 5.835}) = -256$

$\theta_B = \text{〃} (8460 + 256 + 2418) = +1890$

$R = \frac{1.945}{7.780}(-256 + 1890) = +408$

③ $\theta_A = \frac{1}{5.890}(-2010 - 1890 + \overset{2385}{5.835 \times 408}) = -257$

$\theta_B = \text{〃} (8460 + 257 + 2385) = +1885$

$R = \frac{1.945}{7.780}(-257 + 1885) = +407$

④ $\theta_A = \frac{1}{5.890}(-2010 - 1885 + \overset{2375}{5.835 \times 407}) = -258$

$\theta_B = \text{〃} (8460 + 258 + 2375) = +1883$

$R = \frac{1.945}{7.780}(-258 + 1883) = +406$

⑤ $\theta_A = \frac{1}{5.890}(-2010 - 1883 + \overset{2370}{5.835 \times 406}) = -258.5$

$\theta_B = \text{〃} (8460 + 258.5 + 2370) = +1882$

$R = \frac{1.945}{7.780}(-258.5 + 1883) = +406$

				error
−1523	1882	−2370	−2011	1
−259	11,080	−2370	+8471	+11
−503	3,667	−3160	−0	−0

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CALCULATIONS FOR

12 形 / 三 .

常時 moment. (設計の為)

$M_{AD} = 1.945(-2\times259 - 3\times406) + 13140 = -3375 + 13140 = +9765$ } 9770 9780 -10

$M_{AB} \quad (-2\times259 + 1882) - 11130 = 1365 - 11130 = -9765$

$M_{BA} = (2\times1882 - 259) + 4680 = 3505 + 4680 = +8185$ } 8190 8260 -70

$M_{BC} = 1.945(2\times1882 - 3\times406) - 13140 = 4950 - 13140 = -8190$

$M_{DA} = 1.945(-259 - 3\times406) - 13140 = -2870 - 13140 = -16010$ 16010 15960 +50

$M_{CB} = 1.945(1882 - 3\times406) + 13140 = 1291 + 13140 = +14431$ 14430 14440 -10

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CALCULATIONS FOR

円形・大

	Q_A	Q_B	R		
1	5,704	1	−5,556	=	+3690
2	1	5,704	−5,556	=	+6530
3	1,852	1,852	−7,408	=	0

992 1531 630

① $Q_A = \frac{1}{5,704}(3690 - 1531 + 5,556 \times 630)$ (3550) $= +992$

$Q_B = \text{〃}\ (6530 - 992 + 3550) = +1583$

$R = \frac{1,852}{7,408}(992 + 1583) = +676$

② $Q_A = \frac{1}{5,704}(3690 - 1583 + 5,556 \times 676)$ (3755) $= +1028$

$Q_B = \text{〃}\ (6530 - 1028 + 3755) = +1622$

$R = \frac{1,852}{7,408}(1028 + 1622) = +662$

③ $Q_A = \frac{1}{5,704}(3690 - 1622 + 5,556 \times 662)$ (3675) $= +1007$

$Q_B = \text{〃}\ (6530 - 1007 + 3675) = +1612$

$R = \frac{1,852}{7,408}(1007 + 1612) = +655$

④ $Q_A = \frac{1}{5,704}(3690 - 1612 + 5,556 \times 655)$ (3635) $= +1001$

$Q_B = \text{〃}\ (6530 - 1001 + 3635) = +1606$

$R = \frac{1,852}{7,408}(1001 + 1606) = +652$

⑤ $Q_A = \frac{1}{5,704}(3690 - 1606 + 5,556 \times 652)$ (3620) $= +1,000$

$Q_B = \text{〃}\ (6530 - 1000 + 3620) = +1603$

$R = \frac{1,852}{7,408}(2603) = +650$

⑥ $Q_A = \frac{1}{5,704}(3690 - 1603 + 650 \times 5,556)$ (3612) $= +999$

$Q_B = \text{〃}\ (6530 - 999 + 3612) = +1603$

$R = \frac{1,852}{7,408}(999 + 1603) = +651$

					error
5700	+ 1603	− 3615	= 3688		−2
999	+ 9150	− 3615	= 6534		+4
1849	+ 2968	− 4820	= −3		−3

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MADE BY K. I DATE 10-5-21 FILE NO

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CALCULATIONS FOR

日型ノ天

地震時 (荷重ケ)

moment.

$M_{AD} = 1.852(2\times999 - 3\times651) + 13180 = 80 + 13180 = +13{,}260$ (1998) (1953)

$M_{AB} = (2\times999 + 1603) - 16870 = 3601 - 16870 = -13269$

$M_{BA} = (2\times1603 + 999) + 6650 = 4205 + 6650 = +10855$ (3206)

$M_{BC} = 1852(2\times1603 - 3\times651) - 13180 = 2320 - 13180 = -10{,}860$

$M_{DA} = 1852(999 - 3\times651) - 13180 = -1766 - 13180 = -14{,}946$

$M_{CB} = 1852(1603 - 3\times651) + 13180 = -648 + 13180 = +12{,}532$

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CALCULATIONS FOR 東京〜〜〜合社
鉄筋混凝土〜〜.

三型

中二階. Floor slab span length = 4.00 m.
Dead Load. Concrete slab say 25 cm @ 24.00 = 600
Live load 600
1200

800
720
1320 1400

$\frac{1}{8} \times 1400 \times 16 = 2800$ kgm
$d = .362\sqrt{\frac{2800 \times 100}{100}} = 19.2$

Moment say $\frac{1}{8} \times 1200 \times 4^2 = 2400$ kgm.
shear $\frac{1}{2} \times 1200 \times 4 = 2400$ kg

Eff. depth req'd $= 0.362\sqrt{\frac{2400 \times 100}{100}} = 17.8$

steel req'd $= \frac{2400 \times 100}{1200 \times \frac{7}{8} \times d} = \frac{229}{d}$

~~d = 20, As = 11.45 cm²~~
d = 22, As = 10.40

10-12φ = 11.30 cm²/m strip. (22+3 = 25 cm slab)

shear $= \frac{2400}{100 \times \frac{7}{8} \times 22} = 1.25$

bond $= \frac{2400}{3.77 \times 10 \times \frac{7}{8} \times 22} = 3.3$

Top slab. span length = 4.00 m

Dead Load. slab 40 cm (35) @ 24.0 = 960
water proofing conc say 15 @ 22.0 = 330
earth filling say 0.47 @ 1600 = 752
mis @ 58
2100 kg/m²

80%
50%

Live Load 800
impact ½ × 800 = 400
1200
3300 kg/m²

moment $\frac{1}{8} \times 3300 \times 4^2 = 6600$ kgm
shear $\frac{1}{2} \times 3300 \times 4 = 6600$ kg.

eff. depth $0.362\sqrt{\frac{6600 \times 100}{100}} = 29.4$ cm use 31 cm. (31+4 = 35 cm slab.)

steel area req'd $= \frac{6600 \times 100}{1200 \times \frac{7}{8} \times 31} = 20.3$ cm² shear $= \frac{6600}{100 \times \frac{7}{8} \times 31} = 2.43$

use 10-16φ = 20.11 cm² bond $= \frac{6600}{10 \times 5.03 \times \frac{7}{8} \times 31} =$ ~~4.7~~ 4.9

Bottom slab. span length = 4.0 m.

D.L. = 2100 + 600 = 2700
L.L. = 1200 + 600 = 1800
4500 kg/m²

m = $\frac{1}{8} \times 4500 \times 4.0^2 = 9000$ kgm
shear = $\frac{1}{2} \times 4500 \times 4.0 = 9000$ kg
eff. d. = $.362\sqrt{\frac{9000 \times 100}{100}} = 34.4$ cm use 90 cm

Steel 72 66.10
#210
Fill 17
100

Steel req'd. = $\frac{9000 \times 100}{1200 \times \frac{7}{8} \times 90} = 9.52$ cm²
use 5-16φ = 10.06 cm²

Side wall. span length = 4.0 m
Earth pressure on wall.
Surcharge for live load $\frac{1200}{1600}$ = 0.75 m of earth
earth filling = 8.75
9.50 m.

Σ = ½ @ 1600 × 9.50 = 5,060
1/3 @ 400 × 6.75 = 900
5,960 kg/m²

moment = 1/8 × 5960 × 4² = 11,920 kgm shear 11920 kg

Eff. depth reqd = $0.362\sqrt{11920}$ = 39.5 cm. use 40 cm. 40+5 = 45

Steel reqd = $\frac{11920 \times 100}{1200 \times \frac{7}{8} \times 40}$ = 28.4 cm²

use 10-19φ = 28.35 cm²

shear = $\frac{11920}{100 \times \frac{7}{8} \times 40}$ = 3.4 kg/cm²

unit bond = $\frac{11920}{59.7 \times \frac{7}{8} \times 40}$ = 5.7 kg/cm².

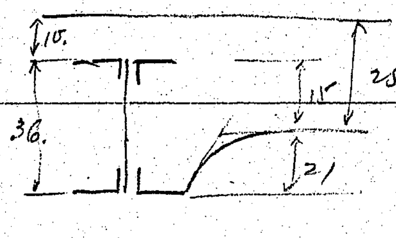
中 = 下段 hor. strut. Span length = 6.2 m.

load in beam 4.0 @ 1200 = 4800
wt of beam say 180
concrete fillets .15×.15×1.5 @ 24.00 = 80
40
5,100 kg/lin m.

29×1.6 = 46.4 cm²
40 @ 28.35 = 114.3
160.7
details 30% = 50.
210 @ .785 = 165 kg/m

M = 1/8 × 5100 × 6.2² = 24,500 kgm
Shear = ½ × 5100 × 6.2 = 15,800 kg.

Try web 350 × 16 = 56.0 cm² 1/8 web = 7.0 cm²
flg. stress = $\frac{24500}{.312}$ = 78,500 kg
flg area = 78,500 ÷ 1200 = 65.5
−7.0
58.5 cm² net



use 2 L 150×100×15 = 70.50 − 7.5 = 63.0 cm² net ✓

M_F = −13,100 kgm
+ ... + 13,000 kgm
flg stress = $\frac{13000}{.31}$ = 58100 kg

... unit stress 58100 ÷ 63.00 = 922 58100 ÷ 7050 = −825
direct stress 37700 ÷ 183 = −206 −206
716 1031

Top beam. span length = 6.20 m.
load on beam.

D.L.	4.0 @ 2,100	= 8,400	4Ls @ 22.4 = 90.0
	wt. of beam say	= 300	1Pl. 90.0
	fillets .46 × .3 = .138; .15 × .15 = .022; .160 @ 2400 =	400	2Pls @ 26 = 52.0
		9100 kg/m	232.0
L.L.	4.0 @ 1200	= 4800 "	detail 30% = 68.0
		13900 "	300.0

M. = 1/12 × 13900 × 6.20² = 44,500 kgm.

Shear = 1/2 × 13900 × 6.2 = 43,100 kg

Try web. 600 × (16) = 96 (14, 72) 1/8 web = 12.0 cm² (9.0)

flg. stress = 44500 / 0.59 = 75400 kg

flg. area = 75400 / 1200 = 62.8 cm²
12
50.8 cm² net
(53.8)

3800
2100
6000 × 4 = 24000
700
4800
29500

Use 2Ls 150 × 100 × 12 = 57.12 − 12 = 45.12
1Pl. 330 × 10 = 33.00 − 5 = 28.00
90.12 73.12
9.0
87.12

90.12
9
99.12

90.12
72.0
252.12 gr

30000 × 5.33² / 12 = 71,000

86 cm²
−14
72.0 cm²

78.72 net

35000 × 5.33² / 15 = 66500

Bottom beam. span length = 6.20 m.
load on beam.
say 5100 + 13900 = 19000 kg/m.

M = 1/15 × 19000 × 6.20² = 48,700 kgm
Shear = 1/2 × 19000 × 6.2 = 59,000 kg

78.72
12.2
91.0 × 1200 × 0.6 = 65,500

Try web 600 × (16) = 96.00 (12, 72) 1/8 web = 12.0 (9.0)

flg stress = 48700 / 0.59 = 82,600

flg area = 82600 ÷ 1200 = 68.80
9.00
56.80 cm² net.
(59.8)

Same section as for top beam.

Shear. = 59000 / 72 = 820 kg/cm²

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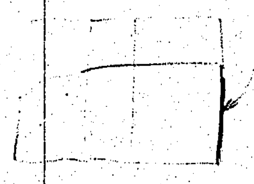
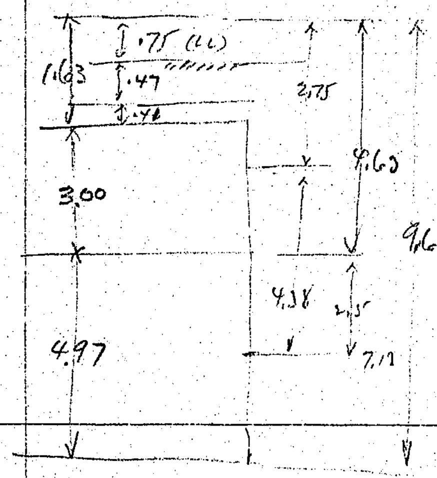
CALCULATIONS FOR

Side beam.
lower member.





Earth pressure. 1/3 × 1600 × 7.13 = 3800
1/3 × 400 × 4.38 = 581
4380
4400 kg/m²

4400 × 4 = 17600 kg/m.

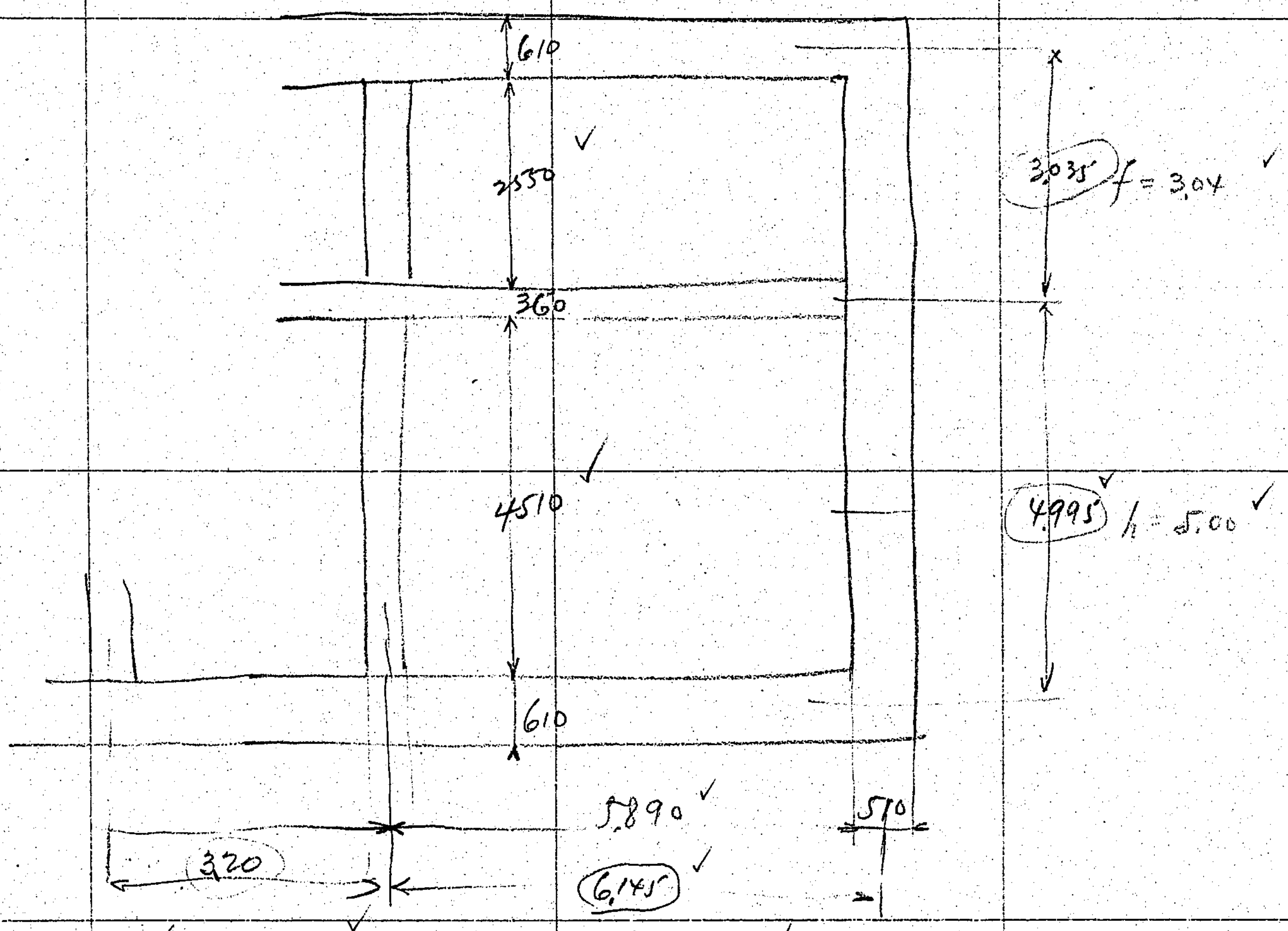
$M = \frac{17600 \times 5^2}{12} = 36700$ kgm.

Try web 500 × 12 = 60.0 1/8 web = 7.5

flg. stress = $\frac{36700}{.48}$ = 76500

flg area = 76500 ÷ 1200 = 63.7
7.5
56.2 cm² net

Use 2Ls 150 × 100 × 12 = 57.12 − 12 = 45.12
1 pl 380 × 10 = 33.00 − 5 = 28.00
73.12 net ✓



l_2 = 3.20 ✓ l_1 = 6.15 ✓

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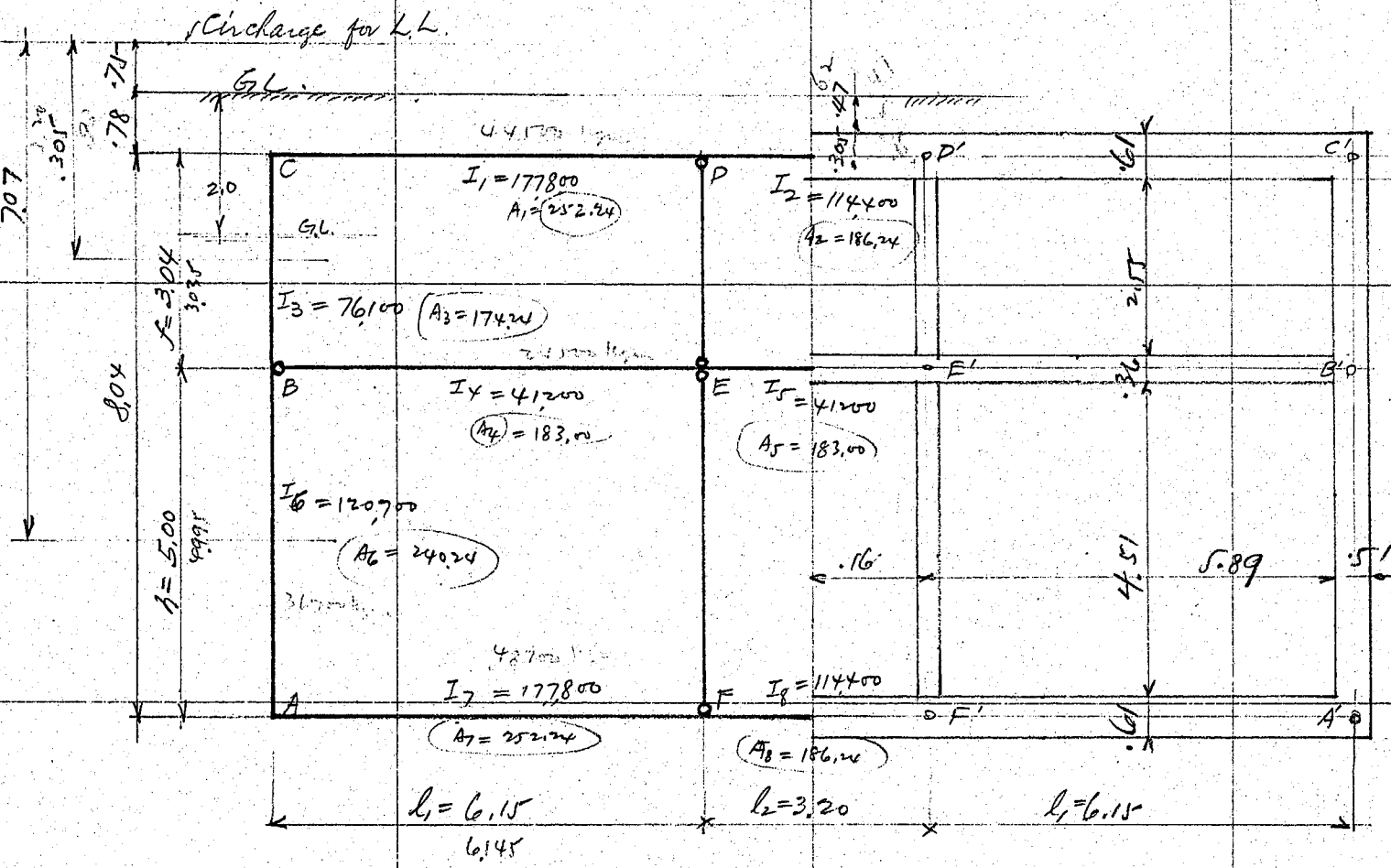
CALCULATIONS FOR

E型鉄骨.

Main dimensions



Loads on structure.

Load on Top beam. w_1 = 13,900 kg/linm. C ~ D

" " middle " w_2 = 5,100 " "

" " bottom " $w_3 = w_1 + w_2$ = 19,000 " A ~ F

Load on side wall.

Upper wall.

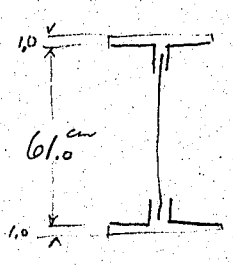
1/3 × 1600 × 3.05 = 1630
1/3 × 400 × 0.30 = 40
1670 kg/m² × 4 = 6680 kg/m = q_4

Lower wall

1/3 × 1600 × 7.07 = 3,770
1/3 × 400 × 4.32 = 580
4350 × 4 = 17,400 kg/m = q_2

Moments of inertia of each member.

I_1 --- CD



4@ 150×100×12	= 114.24	×	28.1² + 4@640	= 90,200 + 260	= 92800
2 cov pl. 330×10	= 66.00	×	31²	=	6340
1 web 600×12	= 72.00		1.2×60³/12	=	21600
	252.24				I_1 = 177800 cm⁴

I_2 --- DD'

4@ 92800
1 web. 2160
I_2 114400

200 cm pl.

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CALCULATIONS FOR

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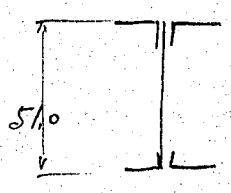
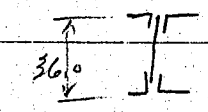
I_3 — C C'



4Cs 150×100×12 = 114.2 × 23.1² + 640×4 = 61,000 + 2600 = 63,600
1 web 500×12 = 60.00 1.2×50³÷12 = 12,500
174.2 76,100 cm⁴

I_3 = 76,100 cm⁴

I_4 — D D'



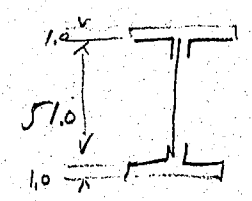
4Cs 150×100×15 = 141.00 × 15.49² + 785×4 = 33800 + 3100 = 36900
1 web 350×12 = 42.00 1.2×35³÷12 = 4300
183.00

I_4 = 41,200 cm⁴

I_5 — E E'

$I_5 = I_4$ = 41,200

I_6 — A B



4Cs 150×100×12 = 114.24 × 23.1² + 640×4 =
1 web 500×12 = 60.00
2 comps 330×10 = 66.00 × 26² =
240.24

63,600
12,500
44600

I_6 = 120,700 cm⁴

I_7 — A F

Same as I_1

I_7 = 177,800

I_8 — F F'

Same as I_2

I_8 = 114,400

$\alpha = \frac{I_2}{I_1}\cdot\frac{l_1}{l_2} = \frac{114400}{177800}\times\frac{6.15}{3.20} = 1.236$

$\beta = \frac{I_3}{I_1}\cdot\frac{l_1}{f} = \frac{76100}{177800}\times\frac{6.15}{3.04} = 0.866$

$\gamma = \frac{I_4}{I_1} = \frac{41200}{177800} = 0.232$

$\eta = \frac{I_5}{I_1}\cdot\frac{l_1}{l_2} = \frac{41200}{177800}\times\frac{6.15}{3.20} = 0.446$

$\delta = \frac{I_6}{I_1}\cdot\frac{l_1}{h} = \frac{120700}{177800}\times\frac{6.15}{5.10} = 0.835$

$\xi = \frac{I_7}{I_1} = \frac{177800}{177800} = 1.000$

$\lambda = \frac{I_8}{I_1}\cdot\frac{l_1}{l_2} = \frac{114400}{177800}\times\frac{6.15}{3.20} = 1.236$

$C_{AB} = C_{BA} = q_2 l^2 \div 12 = \frac{17400\times 5.00^2}{12} = 36200$

$C_{AF} = C_{FA} = w_3 l_1^2 \div 12 = \frac{19000\times 6.15^2}{12} = 59900$

$C_{BC} = C_{CB} = q_1 l^2 \div 12 = \frac{6680\times 3.04^2}{12} = 5140$

$C_{CD} = C_{DC} = \frac{w_1 l_1^2}{12} = \frac{13900\times 6.15^2}{12} = 43800$

$C_{DD'} = \frac{w_1 l_2^2}{12} = \frac{13900\times 3.20^2}{12} = 11900$

$C_{EE'} = \frac{w_2 l_2^2}{12} = \frac{5100\times 3.2^2}{12} = 4350$

$C_{FF'} = \frac{w_3 l_2^2}{12} = \frac{19000\times 3.2^2}{12} = 16200$

$H_{EB} = \frac{w_2 l_1^2}{8} = \frac{5100\times 6.15^2}{8} = 24100$

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CALCULATIONS FOR

Condition equations

	θ_A	θ_B	θ_C	θ_D	θ_E	θ_F	R		
1	$4(\delta+\varepsilon)$	2δ				2ε	-6ε	=	$C_{AB}-C_{AF}$
2	2δ	$4(\beta+\delta)$	2β					=	$C_{BC}-C_{BA}$
3		2β	$4(1+\beta)$	2			-6	=	$C_{CD}-C_{CB}$
4			2	$2(2+\alpha)$			-6	=	$C_{DD'}-C_{DE}$
5					$3\delta+2\gamma$		-3γ	=	$C_{EE'}-H_{EB}$
6	2ε					$2(\alpha+2\varepsilon)$	-6ε	=	$C_{FA}-C_{FF'}$
7	6ε		6	6	3γ	6ε	$-3(4+4\varepsilon+\delta)$	=	$-H_{EB}$

	θ_A	θ_B	θ_C	θ_D	θ_E	θ_F	R	=	
	−	+	−	+	+	−	+		
1	7.340	1.67				2.00	−6.00	=	−23700
2	1.67	6.804	1.732					=	−31,060
3		1.732	7.464	2.00			−6.00	=	+38660
4			2.00	6.472			−6.00	=	−31,900
5					1.588		−0.696	=	−19750
6	2.00					6.472	−6.00	=	+43,700
7	6.00		6.00	6.00	0.696	6.00	−24.696	=	−24100

① $\theta_A = \frac{1}{7.34}(-23700) = -3230$

$\theta_B = \frac{1}{6.804}\{+1.67\times 3230 - 31060\} = -3770$

$\theta_C = \frac{1}{7.464}\{+38660 + 1.732\times 3770\} = +6050$

$\theta_D = \frac{1}{6.472}\{-31900 - 2\times 6050\} = -3060$

$\theta_E = \frac{1}{1.588}(-19750) = -12430$

$\theta_F = \frac{1}{6.472}\{43700 + 6460\} = +7760$

$R = \frac{1}{-24.696}\{-24100 + 19380 - 36300 + 18360 + 8650 - 4660\} = +2455$

② $\theta_A = \frac{1}{7.34}\{-23700 + 6300 - 15520 + 14730\} = -2480$

$\theta_B = \frac{1}{6.804}\{-31060 + 4140 + 10480\} = -5500$

$\theta_C = \frac{1}{7.464}\{38660 + \frac{9530}{6530} + 6120 + 14730\} = +\frac{9250}{8850}$

$\theta_D = \frac{1}{6.472}\{-31900 - \frac{18500}{12100} + 14730\} = -\frac{5510}{4510}$

$\theta_E = \frac{1}{1.588}\{-19750 + 1710\} = -11350$

$\theta_F = \frac{1}{6.472}\{43700 + \frac{4960}{6460} + 14730\} = +\frac{9870}{10030}$

$R = \frac{1}{-24.696}\{-24100 + \frac{14880}{19400} - \frac{55300}{36300} + 7900 + 18360 - 59200 + 33060\} = +3360$

③ $\theta_A = \frac{1}{7.34}\{-23700 + 9190 - 19740 + 20160\} = -1920$

$\theta_B = \frac{1}{6.804}\{-31060 + 3200 - 16010\} = -6450$

$\theta_C = \frac{1}{7.464}\{38660 + 11170 + 11020 + 20160\} = +10850$

$\theta_D = \frac{1}{6.472}\{-31900 - 21700 + 20160\} = -5170$

$\theta_E = \frac{1}{1.588}\{-19750 + 2340\} = -10970$

$\theta_F = \frac{1}{6.472}\{43700 + 3840 + 20160\} = +10450$

$R = \frac{1}{-24.696}\{-24100 + 11520 - 65700 + 31000 - 62700 + 7630\} = +4120$

④ $\theta_A = \frac{1}{7.34}\{-23700 + 10770 - 20900 + 24720\} = -1240$ 850

$\theta_B = \frac{1}{6.804}\{-31060 + 2070 - 18800\} = -7020$ 7700

$\theta_C = \frac{1}{7.464}\{38660 + 12170 + 10340 + 24720\} = +11500$ 11800

$\theta_D = \frac{1}{6.472}\{-31900 - 23000 + 24720\} = -4660$ 3800

$\theta_E = \frac{1}{1.588}\{-19750 + 2870\} = -10630$ 10400

$\theta_F = \frac{1}{6.472}\{43700 + 2480 + 24720\} = +10950$ 11300

$R = \frac{1}{-24.696}\{-24100 + 7440 - 69000 + 27950 + 7400 - 65700\} = +4700$ 5700

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(5)

$Q_A = \frac{1}{7.34}\{-23700 + 11730 - 21900 + 28200\} = -773$

$Q_B = \frac{1}{6.804}\{-31060 + 1290 - 19900\} = -7300$

$Q_C = \frac{1}{7.464}\{+38660 + 12650 + 9320 + 28200\} = +11900$

$Q_D = \frac{1}{6.472}\{-31900 - 23800 + 28200\} = -4250$

$Q_E = \frac{1}{1.588}\{-19750 + 3270\} = -10380$

$Q_F = \frac{1}{6.472}\{43700 + 1546 + 28200\} = +11350$

$R = \frac{1}{-24.696}\{-24100 + 4635 - 71400 + 25500 + 7230 - 68100\} = +5110$

(6)

$Q_A = \frac{1}{7.34}\{-23700 + 12190 - 22700 + 30660\} = -483$

$Q_B = \frac{1}{6.804}\{-31060 + \text{~~8060~~}\ 12940 - 20600\} = -\text{~~6440~~}\ 7470$

$Q_C = \frac{1}{7.464}\{+38660 + \text{~~11100~~}\ 12940 + 8500 + 30660\} = +\text{~~11910~~}\ 12170$

$Q_D = \frac{1}{6.472}\{-31900 - \text{~~23820~~}\ 24340 + 30660\} = -\text{~~3870~~}\ 3950$

$Q_E = \frac{1}{1.588}\{-19750 + 3560\} = -10200$

$Q_F = \frac{1}{6.472}\{43700 + 966 + 30660\} = +11650$

$R = \frac{1}{-24.696}\{-24100 + 2900 - \text{~~71500~~}\ 73000 + \text{~~23220~~}\ 23700 + 7100 - 69900\} = +5400$

(7)

$Q_A = \frac{1}{7.34}\{-23700 + 12470 - 23500 + 32400\} = -290$

$Q_B = \frac{1}{6.804}\{-31060 + 484 - 21060\} = -7590$

$Q_C = \frac{1}{7.464}\{+38660 + 13150 + 7900 + 32400\} = +12350$

$Q_D = \frac{1}{6.472}\{-31900 - 24700 + 32400\} = -3740$

$Q_E = \frac{1}{1.588}\{-19750 + 3760\} = -10070$

$Q_F = \frac{1}{6.472}\{+43700 + 580 + 32400\} = +11850$

$R = \frac{1}{-24.696}\{-24100 + 1740 - 74100 + 22450 + 7010 - 71100\} = +5590$

(8)

$Q_A = \frac{1}{7.34}\{-23700 + 12670 - 23700 + 33540\} = -162$

$Q_B = \frac{1}{6.804}\{-31060 + 270 - 21380\} = -7670$

$Q_C = \frac{1}{7.464}\{+38660 + 13280 + 7480 + 33540\} = +12460$

$Q_D = \frac{1}{6.472}\{-31900 - 24920 + 33540\} = -3597$

$Q_E = \frac{1}{1.588}\{-19750 + 3880\} = -9990$

$Q_F = \frac{1}{6.472}\{+43700 + 324 + 33540\} = +11990$

$R = \frac{1}{-24.696}\{-24100 + 972 - 74750 + 21595 + 6950 - 71900\} = +5720$

(9)

$Q_A = \frac{1}{7.34}\{-23700 + 12810 - 23980 + 34320\} = -75$ -87

$Q_B = \frac{1}{6.804}\{-31060 + 125 - 21580\} = -7720$ +50

$Q_C = \frac{1}{7.464}\{+38660 + 13370 + 7194 + 34320\} = +12530$ +70

$Q_D = \frac{1}{6.472}\{-31900 - 25060 + 34320\} = -3500$ -97

$Q_E = \frac{1}{1.588}\{-19750 + 3980\} = -9925$ -65

$Q_F = \frac{1}{6.472}\{+43700 + 150 + 34320\} = +12080$ +90

$R = \frac{1}{-24.696}\{-24100 + 450 - 75250 + 21000 + 6910 - 72500\} = +5810$ +90

(10)

$Q_A = \frac{1}{7.34}\{-23700 + 12900 - 24160 + 34860\} = -13$ -62

$Q_B = \frac{1}{6.804}\{-31060 + 22 - 21710\} = -7750$ +30

$Q_C = \frac{1}{7.464}\{+38660 + 13420 + 7000 + 34860\} = +12590$ +60

$Q_D = \frac{1}{6.472}\{-31900 - 25180 + 34860\} = -3435$ -65

$Q_E = \frac{1}{1.588}\{-19750 + 4045\} = -9890$ -35

$Q_F = \frac{1}{6.472}\{+43700 + 26 + 34860\} = +12140$ +60

$R = \frac{1}{-24.696}\{-24100 + 78 - 75600 + 20610 + 6880 - 72900\} = +5880$ +70

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CALCULATIONS FOR

(11)				(14)		
+44	$Q_A = \frac{1}{7.34}\{-23,700 + 12,930 - 24,280 + 35,280\}$	= + 31		$Q_A = \frac{1}{7.34}\{-23,700 + 13025 - 24,500 + 35,760\}$	= + 80	+4
+30	$Q_B = \frac{1}{6.804}\{-31,060 - 53 - 21,800\}$	= − 7,780		$Q_B = \frac{1}{6.804}\{-31,060 - 133 - 21,930\}$	= − 7,810	+10
+40	$Q_C = \frac{1}{7.464}\{+38,660 + 13,470 + 6870 + 35,280\}$	= + 12,630		$Q_C = \frac{1}{7.464}\{+38,660 + 13,520 + 6660 + 35,760\}$	= + 12,670	+10
−15	$Q_D = \frac{1}{6.472}\{-31,900 - 25,260 + 35,280\}$	= − 3380		$Q_D = \frac{1}{6.472}\{-31,900 - 25,340 + 35,760\}$	= − 3,315	−15
−30	$Q_E = \frac{1}{1.588}\{-19,750 + 4090\}$	= − 9860		$Q_E = \frac{1}{1,588}\{-19,750 + 4150\}$	= − 9,820	−10
+50	$Q_F = \frac{1}{6.472}\{+43,700 - 62 + 35,280\}$	= + 12,190		$Q_F = \frac{1}{6.472}\{+43,700 - 160 + 35,760\}$	= + 12,250	0
+40	$R = \frac{1}{-24.696}\{-24,100 - 186 - 75,900 + 20,280 + 6860 - 73,100\}$	= + 5920		$R = \frac{1}{-24.696}\{-24,100 - 480 - 76,000 + 19,900 + 6835 - 73,500\}$	= + 5970	+10
(12)				(15)		
+26	$Q_A = \frac{1}{7.34}\{-23,700 + 12,980 - 24,380 + 35,520\}$	= + 57		$Q_A = \frac{1}{7.340}\{-23,700 + 13,030 - 24,500 + 35,820\}$	= + 89	+9
+20	$Q_B = \frac{1}{6.804}\{-31,060 - 96 - 21,870\}$	= − 7800		$Q_B = \frac{1}{6,804}\{-31,060 - 148 - 21,940\}$	= − 7,810	0
+20	$Q_C = \frac{1}{7.464}\{+38660 + 13,500 + 6760 + 35,520\}$	= + 12650		$Q_C = \frac{1}{7.464}\{+38,660 + 13,525 + 6630 + 35,820\}$	= + 12,680	+10
−40	$Q_D = \frac{1}{6.472}\{-31,900 - 25,260 + 35,520\}$	= − 3340		$Q_D = \frac{1}{6,472}\{-31,900 - 25,360 + 35,820\}$	= − 3,310	−5
−20	$Q_E = \frac{1}{1.588}\{-19,750 + 4120\}$	= − 9,840		$Q_E = \frac{1}{1,588}\{-19,750 + 4135\}$	= − 9820	0
+30	$Q_F = \frac{1}{6.472}\{+43700 - 114 + 35,520\}$	= + 12,220		$Q_F = \frac{1}{6,472}\{+43,700 - 178 + 35,820\}$	= + 12,255	+5
+25	$R = \frac{1}{-24.696}\{-24,100 - 340 - 75,900 + ~~19450~~ 20650 + 6850 - 73,300\}$	= + 5945		$R = \frac{1}{-24,696}\{-24,100 - 534 - 76,100 + 19,860 + 6835 - 73,530\}$	= + 5975	+5
(13)				check.		
+19	$Q_A = \frac{1}{7.34}\{-23,700 + 13030 - 24,440 + 35,670\}$	= + 76				
−0	$Q_B = \frac{1}{6.804}\{-31,060 - 130 - 21,900\}$	= − 7,800				
+10	$Q_C = \frac{1}{7.464}\{+38660 + 13,500 + 6680 + 35,670\}$	= + 12,660				
−10	$Q_D = \frac{1}{6.472}\{-31,900 - 25,320 + 35,670\}$	= − 3330				
−10	$Q_E = \frac{1}{1.588}\{-19750 + 4135\}$	= − 9830				
+30	$Q_F = \frac{1}{6.472}\{+43,700 - 152 + 35,670\}$	= + 12,250				
+15	$R = \frac{1}{-24.696}\{-24,100 - 456 - 75,950 + 19,990 + 6840 - 73,500\}$	= + 5960				

$Q_A = +95$
$Q_B = -7810$
$Q_C = +12,690$
$Q_D = -3305$
$Q_E = -9820$
$Q_F = +12260$
$R = +5980$

check.	Q_A	Q_B	Q_C	Q_D	Q_E	Q_F	R	
①	+697	−13030				+24,720	−35880	= ✓ −23,693 23700
②	+159	−53130	+21980	−				(×) −30991 31060
③			−13520	+94700	−66610		−35880	✓ + 38990 38660
④				+25380	−21400		−35880	✓ − 31900 31900
⑤					−15600		− 4160	✓ − 19760 19750
⑥	+190					+79400	−35880	✓ + 43710 43700
⑦	+570		+76150	−19830	−6835	+73600	−147700	✓ − 24045 24100

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CALCULATIONS FOR

Moments of fixture.

$$\begin{cases} M_{FF'} = 2\lambda\theta_F + C_{FF'} = 2\times 1.236\times 12260 + 16200 = 46550 \\ M_{FA} = 2\varepsilon(2\theta_F+\theta_A-3R) - C_{FA} = 2(24520+95-17940) - 59900 = -46550 \end{cases} \Big\} M_F = -46550 \text{ kgm}$$

$$\begin{cases} M_{AF} = 2\varepsilon(2\theta_A+\theta_F-3R) + C_{AF} = 2(190+12260-17940) + 59900 = 48920 \\ M_{AB} = 2\delta(2\theta_A+\theta_B) - C_{AB} = 1.670(190-7810) - 36200 = -48930 \end{cases} \Big\} M_A = -48930$$

$$\begin{cases} M_{BA} = 2\delta(2\theta_B+\theta_A) + C_{BA} = 1.670(-15620+95) + 36200 = +10280 \\ M_{BC} = 2\beta(2\theta_B+\theta_C) - C_{BC} = 1.732(-15620+12690) - 5140 = -10220 \end{cases} \Big\} M_B = -10250$$

$$\begin{cases} M_{CB} = 2\beta(2\theta_C+\theta_B) + C_{CB} = 1.732(25380-7810) + 5140 = +35540 \\ M_{CD} = 2(2\theta_C+\theta_D-3R) - C_{CD} = 2(25380-3305-17940) - 43800 = -35530 \end{cases} \Big\} M_C = -35540$$

$$\begin{cases} M_{DC} = 2(2\theta_D+\theta_C-3R) + C_{DC} = 2(-6610+12690-17940) + 43800 = +20080 \\ M_{DD'} = 2\alpha\theta_D - C_{DD'} = -2\times 1.236\times 3305 - 11900 = -22070 \end{cases} \Big\} M_D = -20080$$

$$\begin{cases} M_{EB} = 3\gamma(\theta_E-R) + H_{EB} = 3\times 0.232(-9820-5980) + 24100 = +13100 \\ M_{EE'} = 2\gamma\theta_E - C_{EE'} = -2\times 0.446\times 9820 - 4350 = -13110 \end{cases} \Big\} M_E = -13110$$

End shear.

S_{AF} $\frac{w_3 l_1}{2} = \frac{1900\times 6.15}{2} = 58400$

$\frac{48930-46550}{6.15} = \frac{400}{58800}$ kg $= S_{AF}$

58000 " $= S_{FA}$

$R_F = 88400$ kg

$S_{FF'}$ $\frac{w_3 l_2}{2} = \frac{1900\times 3.2}{2} = 30400$ kg $= S_{FF'} = S_{F'F}$

S_{AB} $\frac{q_2 l}{2} = \frac{17400\times 5.0}{2} = 43500$

$\frac{48930-10250}{5.0} = \frac{7700}{51200}$ kg $= S_{AB}$

35800 " $= S_{BA}$

S_{BE} $\frac{w_2 l_1}{2} = \frac{5100\times 6.15}{2} = 15700$

$\frac{13110}{6.15} = \frac{2100}{17800}$ kg $= S_{EB}$

1360 " $= S_{BE}$

$S_{EB} = 17800$

$R_E = S_{EE'} = \frac{8200}{26000}$ kg

S_{Bc} $\frac{q_1 f}{2} = \frac{6680\times 3.04}{2} = 10200$

$\frac{35540-10250}{3.04} = \frac{8300}{18500}$ kg $= S_{eB}$

1900 " $= S_{Bc}$

S_{BA} 31800

$R_B = S_{Bc}$ 1900

37700 kg

S_{cD} $\frac{w_1 l_1}{2} = \frac{1390\times 6.15}{2} = 42700$

$\frac{35540-20080}{6.15} = \frac{2500}{45200}$ kg $= S_{cD}$

40200 " $= S_{Dc}$

$S_{Dc} = 40200$

$S_{DD'}$ $\frac{w_1 l_2}{2} = \frac{1390\times 3.2}{2} = 2220$ kg $= S_{DD'} = S_{D'D}$

$R_D = S_{DD'} = 22200$

62400 kg

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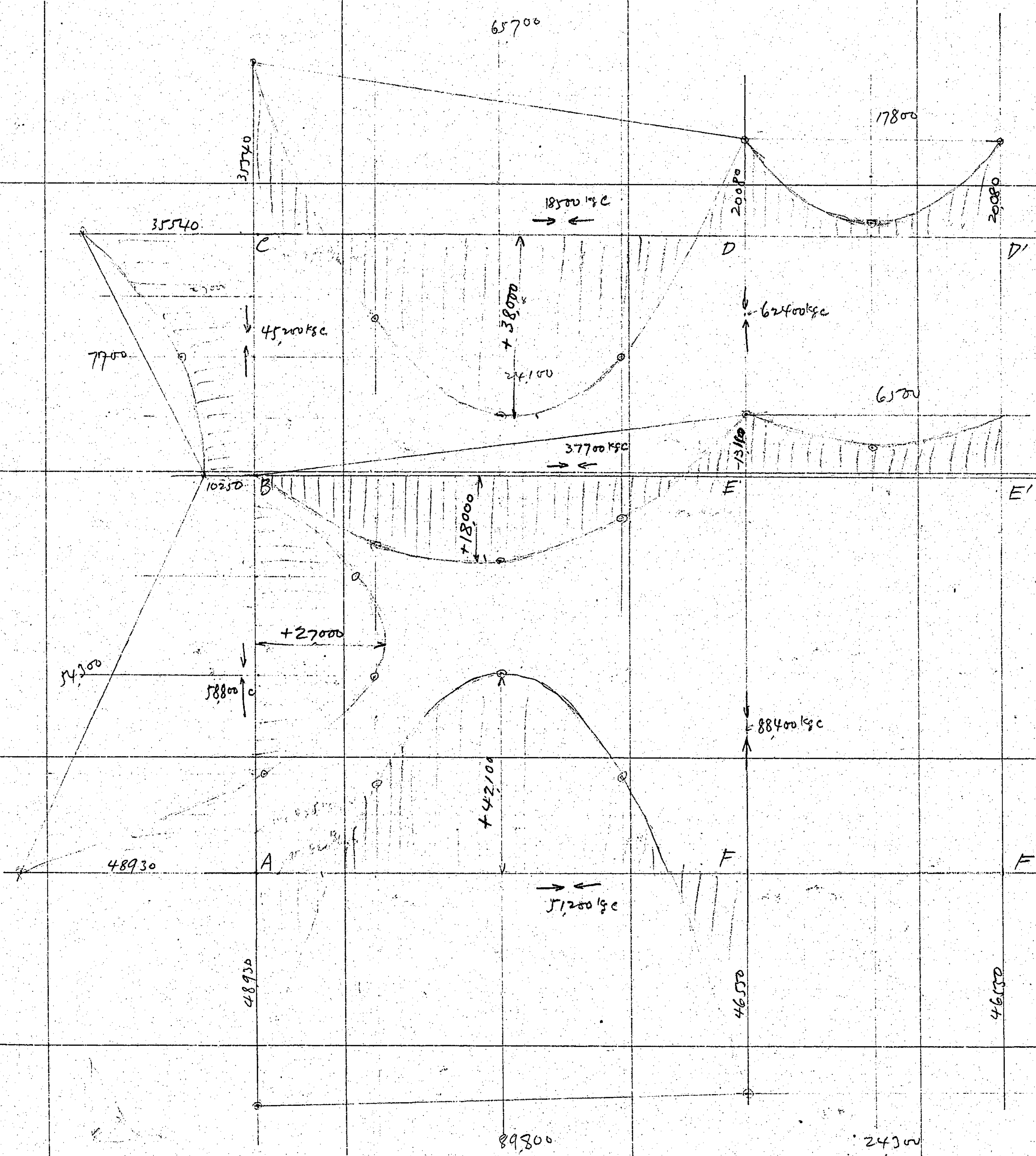
CALCULATIONS FOR

Moment and Shear diagram



229 3421 δ 4750 bearing on 12" pl.
2851 ʃ 3960

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CALCULATIONS FOR

Top beam section.

pos. moment 38000 kgm.

Flange stress $\frac{38000}{0.58} = 65500$ kg

unit B. stress $\frac{65500}{82,12} = 798$ $\quad \frac{65500}{99.12} = -661.$

Direct comp. $\frac{18500}{252.24} = \frac{-73}{725}$ kg/cm² T $\quad \frac{-73}{-734}$ kg/cm² C.

neg. moment 35540 kgm

flg stress $= \frac{35540}{0.74} = 48000$ kg.

unit bending stress $= \frac{48000}{56.82} = 845$ $\quad \frac{48000}{68,82} = -698$

Direct stress say $\frac{45200}{273.84} = \frac{-165}{680}$ kg/cm² T $\quad \frac{-165}{-863}$ kg/cm² C.

$\frac{78 \times 1.2}{8} = \frac{45.12}{71.70}$ $\frac{57.12}{11.7}$ $\frac{}{68.82}$

90.12
90.12
93.6
273.84

Bottom beam.

pos. moment 42100 kgm

flg. stress $= \frac{42100}{0.58} = 72,600$ kg

unit B. S $= \frac{72600}{82.12} = 884$ $\quad \frac{72600}{99.12} = -733$

Direct stress, $\frac{5120}{252.24} = \frac{-203}{681}$ kg/cm² T $\quad \frac{-203}{-936}$ kg/cm² C

$\frac{91 \times 1.2}{8} = \frac{45.12}{13.65}$ $\frac{57.12}{13.65}$ $\frac{}{70.77}$

neg. moment 48930 kgm

(at A. flg stress $= \frac{48930}{.87} = 56200$ kg.

unit bending stress $= \frac{56200}{58.77} = 957$ $\quad \frac{56200}{70.77} = -795$

Direct stress say $\frac{58800}{289.40} = \frac{-203}{754}$ T $\quad \frac{-203}{-998}$ C

90.12
99.12
$91 \times 1.2 = 109.10$
289.40

at F neg. m. 46530

flg stress $\frac{46530}{0.58} = 80300$

unit bending S. $= \frac{80300}{82,12} = 978$ $\quad \frac{80300}{99.12} = 810$

Direct stress $= \frac{5120}{252.24} = \frac{-203}{775}$ T $\quad \frac{203}{1013}$ C

Side Beam.
Lower member.

Pos. m = 27000 kgm
Flg. stress = $\frac{27000}{.48}$ = 56300 kg.

unit B.S. = $\frac{56300}{80.62}$ = 698 $\qquad \frac{56300}{97.62}$ = 577

Direct stress say $\frac{58800}{240.24}$ = -243 → 455 T $\qquad$ 243 → 820 C

90.12
90.12
60.
240.24

22φ Rivet pitch

Single shear of shop rivet = 4752 kg = r $\qquad h' = 51 - 12 = 39$ cm between rivet lines

Shear = 51200 kg $\qquad \left(\frac{F + \frac{1}{8} web}{F}\right)$

rivet pitch $p = \frac{r h'}{V} = \frac{4752 \times 39}{38000} = 4.9$ cm × 1.10 = 5.4 cm

$p = \frac{4752 \times 48}{43600} = 5.25$ cm × 1.12 = (5.9) cm

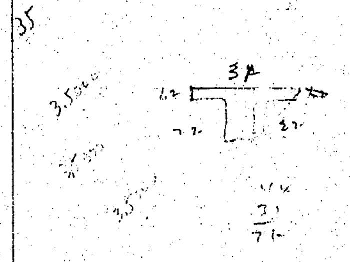
EB. $\qquad p = \frac{4752 \times 23}{16500} = 6.6 \times 1.1 =$ (7.3) cm

$r = \frac{pV}{h} = \frac{38000 \times p}{39} = 975 \cdot p$

$p = 7.0$

$r = 975 \times 7.0 = 6810$ kg

bearing resistance $\qquad 7.5 \times 7 \times 3.5 = 1840$ → 4970 — 4752 BS



Solution of Condition equations.
final

①

$\theta_A = \frac{1}{7.324}\{-20500 + 7810 \times 1.662 - 12260 \times 2 + 5980 \times 6\} = +526$ (12975, 24520, 35900)

$\theta_B = \frac{1}{6.740}\{-31640 - 874 - 21690\} = -8050$

$\theta_C = \frac{1}{7.416}\{+36940 + 13740 + 6610 + 35900\} = +12570$

$\theta_D = \frac{1}{6.460}\{-30920 - 25140 + 35900\} = -3120$

$\theta_E = \frac{1}{1.527}\{-18760 + 4000\} = -9670$

$\theta_F = \frac{1}{6.460}\{+41980 - 1052 + 35900\} = +11900$

$R = \frac{1}{-24669}\{-22900 - 3156 - 75400 + 18740 + 6470 - 71400\} = +5990$

② (+169)

$\theta_A = \frac{1}{7.324}\{-20500 + 13380 - 23800 + 35940\} = +685$

(0) $\theta_B = \frac{1}{6.740}\{-31640 - 1139 - 21460\} = -8050$ (−8050)

(−45) $\theta_C = \frac{1}{7.416}\{+36940 + 13750 + 6240 + 35940\} = +12525$ (+12430)

(−20) $\theta_D = \frac{1}{6.460}\{-30920 - 25050 + 35940\} = -3100$ (−3050)

(0) $\theta_E = \frac{1}{1.527}\{-18760 + 4005\} = -9670$ (−9670)

(−50) $\theta_F = \frac{1}{6.460}\{+41980 - 1370 + 35940\} = +11850$ (+11750)

(+20) $R = \frac{1}{-24669}\{-22900 - 4110 - 75200 + 18600 + 6470 - 71100\} = +6010$ (+6050)

③

$\theta_A = \frac{1}{7.324}\{-20500 + 13380 - 23760 + 36300\} = +740$ (23500 corrected to 23760)

$\theta_B = \frac{1}{6.740}\{-31640 - 1230 - 21250\} = -8030$ (1289 corrected to 1230; 8040 corrected to 8030)

$\theta_C = \frac{1}{7.416}\{+36940 + 13730 + 6100 + 36300\} = +12555$

$\theta_D = \frac{1}{6.46}\{-30920 - 25110 + 36300\} = -3055$

$\theta_E = \frac{1}{1.527}\{-18760 + 4050\} = -9630$

$\theta_F = \frac{1}{6.46}\{41980 - 1480 + 36300\} = +11880$ (1552 corrected to 1480)

$R = \frac{1}{-24669}\{-22900 - 4440 - 75300 + 18340 + 6440 - 71300\} = +6050$

④

$\theta_A = \frac{1}{7.324}\{-20500 + 13350 - 23760 + 36300\} = +736$

$\theta_B = \frac{1}{6.740}\{-31640 - 1223 - 21450\} = -8060$

$\theta_C = \frac{1}{7.416}\{+36940 + 13770 + 6110 + 36300\} = +12570$

$\theta_D = \frac{1}{6.460}\{-30920 - 25140 + 36300\} = -3060$

$\theta_E = \frac{1}{1.527}\{-18760 + 4045\} = -9640$

$\theta_F = \frac{1}{6.460}\{+41980 - 1472 + 36300\} = +11900$

$R = \frac{1}{-24669}\{-22900 - 4416 - 75400 + 18370 + 6450 - 71400\} = +6050$

⑤

$\theta_A = \frac{1}{7.324}\{-20500 + 13400 - 23800 + 36300\} = +737$

$\theta_B = \frac{1}{6.740}\{-31640 - 1225 - 21460\} = -8060$

$\theta_C = \frac{1}{7.416}\{36940 + 13775 + 6120 + 36300\} = +12570$

$\theta_D = \frac{1}{6.460}\{-30920 - 25140 + 36300\} = -3060$

$\theta_E = \frac{1}{1.527}\{-18760 + 4045\} = -9640$

$\theta_F = \frac{1}{6.460}\{+41980 - 1474 + 36300\} = +11890$

$R = \frac{1}{-24669}\{-22900 - 4420 - 75400 + 18360 + 6450 - 71400\} = +6050$

$\theta_A = +740$
$\theta_B = -8060$
$\theta_C = +12570$
$\theta_D = -3060$
$\theta_E = -9640$
$\theta_F = +11890$
$R = +6050$

check.

		θ_A	θ_B	θ_C	θ_D	θ_E	θ_F	R						
+22	1	+5400	−13400				+23780	−36300	=	−	20520	−20500	✓	0.1%
+5	2	+1225	−54300	+21470					=	−	31605	−31640	✓	0.1
	3		−13770	+93200	−6120			−36300	=	+	37010	+36940	✓	0.2
	4			+25140	−19775			−36300	=	−	30935	−30920	✓	—
−	5					−14720		−4045	=	−	18765	−18760	✓	—
+6	6	+1474					+76800	−36300	=	+	41974	+41980	✓	—
	7	+4420		+75400	−18370	−6450	+71310	−149250	=	−	22900	−22900	✓	—

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CALCULATIONS FOR

E型 鉄筋構成

Solution of 7 simultaneous equations.

①

$\theta_A = \frac{1}{7324}\{18400 + 13400 + 36300 - 23800\} = +6050$

$\theta_B = \frac{1}{6740}\{-46730 - 10050 - 21480\} = -11600$

$\theta_C = \frac{1}{7416}\{20630 + 19800 + 6120 + 36300\} = +11180$

$\theta_D = \frac{1}{6460}\{-19920 - 22360 + 36300\} = -930$

$\theta_E = \frac{1}{1527}\{-9490 + 4050\} = -3560$

$\theta_F = \frac{1}{6460}\{25530 - 12100 + 36300\} = +7700$

$R = \frac{1}{-24669}\{-11580 - 36300 - 67100 + 5380 + 2380 - 46200\} = +6210$

②

$\theta_A = \frac{1}{7324}\{18400 + 19280 + 37260 - 15400\} = +8140$ (10300)

$\theta_B = \frac{1}{6740}\{-46720 - 13510 - 19100\} = -11780$ (12000) (+180)

$\theta_C = \frac{1}{7416}\{20630 + 20120 + 37260 + 1860\} = +10770$ (10300) (-410)

$\theta_D = \frac{1}{6460}\{-19920 - 21540 + 3726\} = -650$ (350) (-280)

$\theta_E = \frac{1}{1527}\{-9490 + 4150\} = -3500$ (3400) (-60)

$\theta_F = \frac{1}{6460}\{25530 - 16280 + 37260\} = +7200$ (6500) (-500)

$R = \frac{1}{-24669}\{-11580 - 48800 - 64600 + 3900 + 2340 - 43200\} = +6560$ (7000) (+350)

③

$\theta_A = \frac{1}{7324}\{18400 + 19940 - 13000 + 42000\} = +9200$

$\theta_B = \frac{1}{6740}\{-46730 - 15280 - 17600\} = -11820$

$\theta_C = \frac{1}{7416}\{20630 + 20180 + 7000 + 42000\} = +11270$

$\theta_D = \frac{1}{6460}\{-19920 - 22540 + 42000\} = -71$

$\theta_E = \frac{1}{1527}\{-9490 + 4680\} = -3150$

$\theta_F = \frac{1}{6460}\{25530 - 18400 + 42000\} = +7610$

$R = \frac{1}{-24669}\{-11580 - 55200 - 67600 + 426 + 2110 - 45650\} = +7190$

④

$\theta_A = \frac{1}{7324}\{18400 + 19640 - 13220 + 43140\} = +9010$

$\theta_B = \frac{1}{6740}\{-46730 - 14970 - 19250\} = -12010$

$\theta_C = \frac{1}{7416}\{20630 + 20570 + 142 + 43140\} = +11390$

$\theta_D = \frac{1}{6460}\{-19920 - 22780 + 43140\} = +68$

$\theta_E = \frac{1}{1527}\{-9490 + 4805\} = -3070$

$\theta_F = \frac{1}{6460}\{+25530 - 18020 + 43140\} = +7840$

$R = \frac{1}{-24669}\{-11580 - 54060 - 68300 - 408 + 2054 - 47050\} = +7270$

⑤

$\theta_A = \frac{1}{7324}\{18400 + 19950 - 15680 + 43620\} = +9050$

$\theta_B = \frac{1}{6740}\{-46730 - 15030 - 19460\} = -12055$

$\theta_C = \frac{1}{7416}\{20630 + 20600 - 136 + 43620\} = +11430$

$\theta_D = \frac{1}{6460}\{-19920 - 22860 + 43620\} = +130$

$\theta_E = \frac{1}{1527}\{-9490 + 4860\} = -3033$

$\theta_F = \frac{1}{6460}\{25530 - 18100 + 43620\} = +7900$

$R = \frac{1}{-24669}\{-11580 - 54220 - 68700 - 780 + 2030 - 47400\} = +7320$

⑥

$\theta_A = \frac{1}{7324}\{18400 + 20040 - 15800 + 43920\} = +9090$

$\theta_B = \frac{1}{6740}\{-46730 - 15100 - 19530\} = -12070$

$\theta_C = \frac{1}{7416}\{20630 + 20600 - 260 + 43920\} = +11450$

$\theta_D = \frac{1}{6460}\{-19920 - 22900 + 43920\} = +170$

$\theta_E = \frac{1}{1527}\{-9490 + 4895\} = -3010$

$\theta_F = \frac{1}{6460}\{25530 - 18180 + 43920\} = +7940$

$R = \frac{1}{-24669}\{-11580 - 54540 - 68700 - 1020 + 2010 - 47650\} = +7355$

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CALCULATIONS FOR

⑦

$$Q_A = \frac{1}{7.324}\{18400 + 20050 + 44130 - 15880\} = +9,110$$

$$Q_B = \frac{1}{6.740}\{-46730 - 15125 - 19550\} = -12,080$$

$$Q_C = \frac{1}{7.416}\{20630 + 20640 + 44130 - 340\} = +11,475$$

$$Q_D = \frac{1}{6.460}\{-19920 - 22950 + 44130\} = +195$$

$$Q_E = \frac{1}{1527}\{-9490 + 4915.7\} = -2998$$

$$Q_F = \frac{1}{6.460}\{25530 - 18220 + 44130\} = +7970$$

$$R = \frac{1}{-24669}\{-11580 - 54660 - 68850 - 1170 + 2005 - 47810\} = +7380$$

⑧

$$Q_A = \frac{1}{7324}\{18400 + 20090 + 44280 - 15940\} = +9130$$

$$Q_B = \frac{1}{6740}\{-46730 - 15170 - 19600\} = -12085$$

$$Q_C = \frac{1}{7.416}\{20630 + 20650 + 44280 - 390\} = +11490$$

$$Q_D = \frac{1}{6460}\{-19920 - 22980 + 44280\} = +214$$

$$Q_E = \frac{1}{1527}\{-9490 + 4936\} = -2984$$

$$Q_F = \frac{1}{6460}\{25530 - 18260 + 44280\} = +7980$$

$$R = \frac{1}{-24669}\{-11580 - 54770 - 68950 - 1284 + 1996 - 47870\} = +7395$$

⑨

$$Q_A = \frac{1}{7324}\{18400 + 20090 + 44370 - 15960\} = +9135$$

$$Q_B = \frac{1}{6740}\{-46730 - 15170 - 19640\} = -12100$$

$$Q_C = \frac{1}{7416}\{20630 + 20660 + 44270 - 478\} = +11500$$

$$Q_D = \frac{1}{6460}\{-19920 - 23000 + 44370\} = +225$$

$$Q_E = \frac{1}{1527}\{-9490 + 4945\} = -2978$$

$$Q_F = \frac{1}{6460}\{25530 - 18270 + 44370\} = +8000$$

$$R = \frac{1}{-24669}\{-11580 - 54800 - 69000 - 1350 + 1992 - 48000\} = +7410$$

⑩

$$Q_A = \frac{1}{7324}\{18400 + 20100 + 44460 - 16000\} = +9140$$

$$Q_B = \frac{1}{6740}\{-46730 - 15180 - 19640\} = -12100$$

$$Q_C = \frac{1}{7416}\{20630 + 20670 + 44460 - 450\} = +11510$$

$$Q_D = \frac{1}{6460}\{-19920 - 23020 + 44460\} = +235$$

$$Q_E = \frac{1}{1527}\{-9490 + 4915\} = -2970$$

$$Q_F = \frac{1}{6460}\{25530 - 18280 + 44460\} = +8010$$

$$R = \frac{1}{-24669}\{-11580 - 54820 - 69060 - 1410 + 1988 - 48060\} = +7420$$

⑪

$$Q_A = \frac{1}{7324}\{18400 + 20100 + 44520 - 16020\} = +9150$$

$$Q_B = \frac{1}{6740}\{-46730 - 15200 - 19670\} = -12100$$

$$Q_C = \frac{1}{7416}\{20630 + 20680 + 44520 - 470\} = +11510$$

$$Q_D = \frac{1}{6460}\{-19920 - 23020 + 44520\} = +245$$

$$Q_E = \frac{1}{1527}\{-9490 + 4960\} = -2967$$

$$Q_F = \frac{1}{6460}\{25530 - 18300 + 44520\} = +8010$$

$$R = \frac{1}{-24669}\{-11580 - 54900 - 69060 - 1470 + 1985 - 48060\} = +7420$$

Check.

1	67050	-20100		16020	-44520
2	15200	-81600	19670		
3		-20660	85 (60) (490)		-44520
4			23020	1583	-44520
5				-4530	-49600
6	18300			51750	-44520
7	54900		69060	1470	-1985 48060 -183045

+18450	+18400	+50
-46730	-46730	0
+20670	+20630	+40 ✓
-19917	-19920	0
-9490	-9490	0
+25530	+25530	0
-11540	-11580	-40 ✓

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CALCULATIONS FOR

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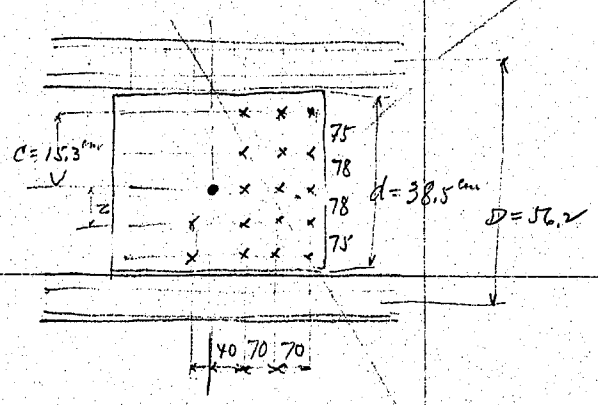
Detail design.
Splice of Bottom Beam AF.



web area $W = 60 \times 1.2 = 72.00$ cm²

Area of 2 splice pls. $A = \frac{WD^2}{d^2} = \frac{72.00 \times 56.2^2}{38.5^2} = 153.5$ cm²

thickness of 1 pl $t = \frac{A}{2d} = \frac{153.5}{38.5 \times 2} = 1.995$ cm

Rivet value of 22φ rivet bearing on 12 mm pl. = 3960 kg field rivet

vert. shear $V = 40000$ kg

moment carried by ½ web $M_w = \frac{1}{8} W S D = \frac{1}{8} \times 72.0 \times 1000 \times 56.2 = 506000$ kg cm

Rivet stress due to

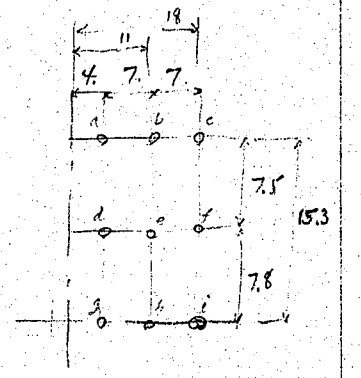
vert. shear $R_s = \frac{V}{n} = \frac{40000}{15} = 2670$

moment $R_m = \frac{M_w c}{\Sigma z^2} = \frac{506000 \times 15.3}{1780} = 4350$ kg

Σz^2.

$7.8^2 = 60.8$
$15.3^2 = 234.0$
$294.8 \times 3 \times 2 = 1,780$

19830,000
913.m
2670.000

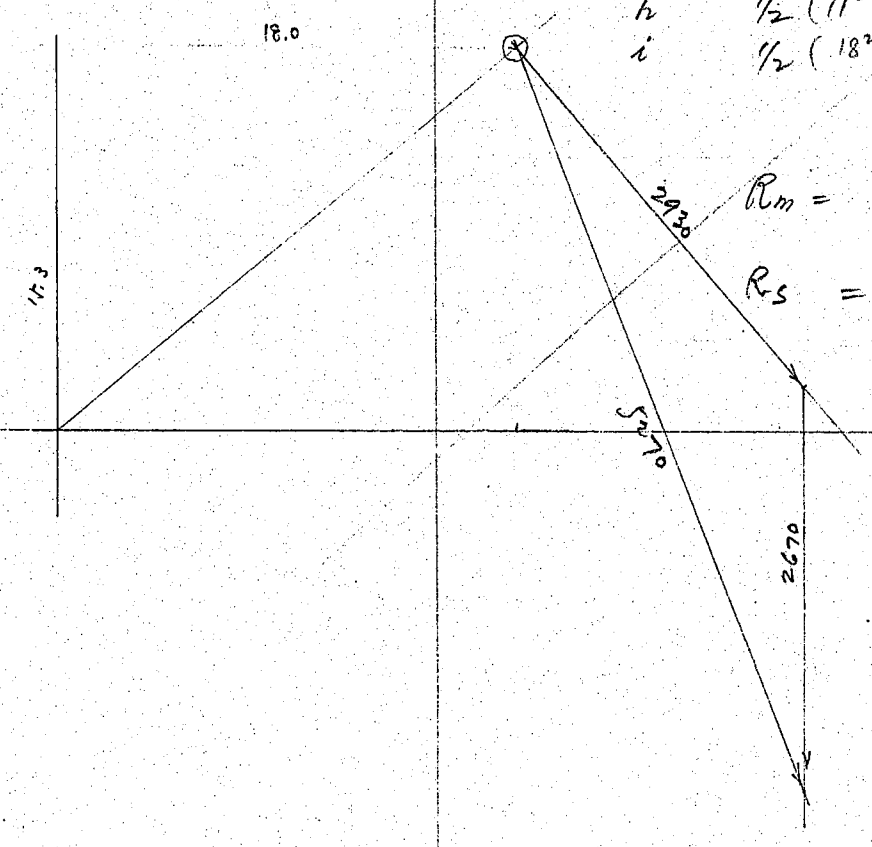


resultant rivet stress

$R = \sqrt{R_s^2 + R_m^2} = \sqrt{2670^2 + 4350^2} = 5195$ kg.

			z^2	z.
z^2 for a.	$4^2 + 15.3^2$	= 16 + 234 =	250	15.8 cm
b	$11^2 +$ "	= 121 + " =	355	18.9
c	$18^2 +$ "	= 324 + " =	558	23.6 = c.
d	$4^2 + 7.8^2$	= 16 + 61 =	77	
e	$11^2 +$ "	= 121 + 61 =	182	
f	$18^2 +$ "	= 324 + 61 =	385	
g	$\frac{1}{2}[4^2)$	= 8 =	8	
h	$\frac{1}{2}(11^2)$	= 61 =	61	
i	$\frac{1}{2}(18^2)$	= 162 =	162	

2038 × 2 = 4076



$R_m = \frac{506000 \times 23.6}{4076} = 2930$ kg.

$R_s = \frac{40000}{15} = 2670$

2260
2670
4910

3960
450
4410

Use 4 rows.

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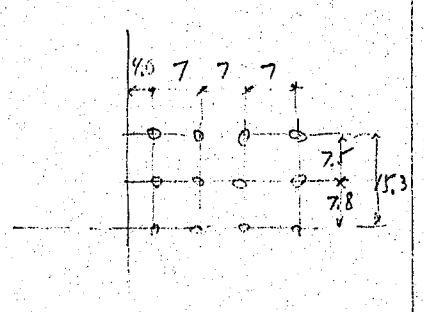
CALCULATIONS FOR

Use 4 rows



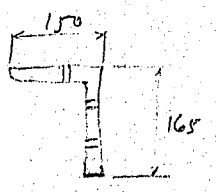
ΣZ^2 . $7.8^2 = 60.8$
$15.3^2 = 234.0$
$294.8 \times 2 \times 4 = 2,360$

$R_S = \frac{V}{n} = \frac{40000}{20} = 2,000$ kg

$R_m = \frac{M_w \cdot C}{\Sigma Z^2} = \frac{506000 \times 15.3}{2360} = 3280$ "

$R = \sqrt{R_s^2 + R_m^2} = \sqrt{4000000 + 10430000} = 3800$ kg ✓ < 3960

Flange splice



Spl. angle 165×150×15 (10本及び12mm)

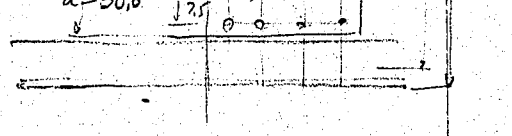
$16.5 \times 1.5 = 19.80$ cm² $- 6.0 = 13.8$ net
$19.8 \times 1000 = 19800 \div 2850 = 6.95$ use 10 rivets
$13.8 \times 1200 = 16770$
for 15mm $6.95 \times \frac{15}{12} = 8.7$

$15.0 - 1.2 = 13.8 \times 1.2 = 16.56 - 3.0 = 13.56$ net
$16.56 @ 1000 = 16560 \div 2850 = 5.8$ rivet use 6 rivets
$13.56 @ 1200 = 16280$

16.5
15.0
$31.50 \times 1.5 = 47.3$
L 150×100×12 $= 28.6$
18.7 cm² $\times 2 = 37.4$ cm²

1/8 web $= \frac{60 \times 1.2}{8} = 9.0$ cm²

Side member



web spl. pl $W = 50 \times 1.2 = 60.0$

$A = \frac{W D^2}{d^2} = \frac{60 \times 46.2^2}{30^2} = 142.3$

$t = \frac{142.3}{30 \times 2} = 23.7$ cm use 15mm spl. ls.

Using 15mm spl ls.
12 − 6 = 6 mm
$W' = 50 \times 0.6 = 30.0$
$A = 71.15$
$t = 1.19$ use 12mm pl.
1.30
1.49

1/8 web $= \frac{60}{8} = 7.5$
$10 \times 1.3 = 3.0$
4.50 ×

$M_w = 45 \times 1000 \times 46.2 = 2080000$ kg·cm
$V = 11500$ kg Shop spl.

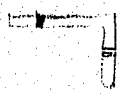
$\Sigma Z^2 =$ $3.5^2 = 12.3$
$11.0^2 = 121.0$
$133.3 \times 2 \times 4 = 1067$

$R_S = \frac{11500}{16} = 720$

$R_m = \frac{208000 \times 11.}{1067} = 2145$

$R = \sqrt{720^2 + 2145^2} = \sqrt{\frac{578000}{4600 \text{ cm}}} = 2263$ kg ✓
√5.118 cm

CALCULATIONS FOR



flange angle spl. L 150×100×15

vert. leg

1.5×10 = 15.0 cm² − 3.75 = 11.25 net

15.0 @100 = 15000 ÷ 2850 = 5.3 field $\frac{15000}{3421} = 4.4$

11.25 @120 = 13500

use 6 rivets

hor. leg. 欠損 12 mm

15.0−1.2 = 13.8×1.2 = 16.56 − 3.00 = 13.56 net

16.56@100 = 16560 ÷ 2850 = 5.8 use 6 rivets

13.56 @120 = 16270

End connection of Middle beam

Shear V = 12880

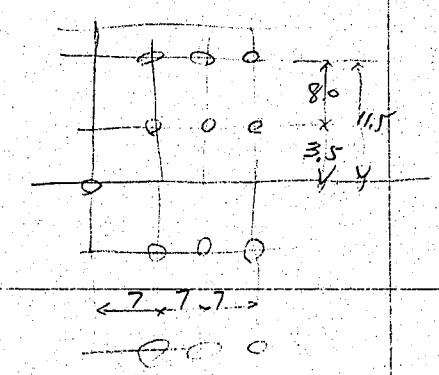
no. of rivets $n = \frac{12880}{2850} = 4.5$

Middle beam

web spl: web 350×12 = 42.0 = W 1/8 web area = $\frac{42}{8}$

$M_W = \frac{1}{8} \times 42 \times 1000 \times 31.2 = 164{,}000$ kg cm.

V = 9500



$R_m = \frac{164.000 \times 11.5}{867} = 2175$

$R_V = \frac{9500}{12} = 790$

$R = \sqrt{2175^2 + 790^2} = 2315$ kg

6×400

4730.000
624 cm²
7.58 kg/cm²

Σz^2

$3.5^2 = 12.3$

$11.5^2 = 132.2$

$144.5 \times 3 \times 2 = 867$

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CALCULATIONS FOR

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Solution of condition equations. (normal state)

① $\theta_A = \frac{1}{8.340}\{-30400 + 11560 - 32550 + 49600\} = -2,150$

$\theta_B = \frac{1}{5.940}\{-35500 + 3080 - 19300\} = -8700$

$\theta_C = \frac{1}{7.072}\{48900 + 13380 + 6820 + 36300\} = +14800$

$\theta_D = \frac{1}{5.782}\{-24000 - 29600 + 36300\} = -2990$

$\theta_E = \frac{1}{1.639}\{-16400 + 6260\} = -6,190$

$\theta_F = \frac{1}{8.198}\{31800 + 5880 + 49650\} = +10660$

$R = \frac{1}{-29.451}\{-25600 + 17650 - 88800 + 17940 + 6410 - 87500\} = +5430$

② $\theta_A = \frac{1}{8340}\{-30400 + 12480 - 29150 + 44350\} = -302$

$\theta_B = \frac{1}{5.940}\{-35500 + 430 - 22750\} = -9740$

$\theta_C = \frac{1}{7.072}\{48900 + 14960 + 5980 + 32580\} = +14480$

$\theta_D = \frac{1}{5.782}\{-24000 - 28960 + 32580\} = -3520$

$\theta_E = \frac{1}{1639}\{-16400 + 5620\} = -6580$

$\theta_F = \frac{1}{8198}\{31800 + 826 + 44350\} = +9410$

$R = \frac{1}{-29.451}\{-25600 + 2480 - 86900 + 21120 + 6810 - 77200\} = +5410$

③ $\theta_A = \frac{1}{8340}\{-30400 + 13970 - 25750 + 44400\} = +266$

$\theta_B = \frac{1}{5.940}\{-35500 - 380 - 22250\} = -9790$

$\theta_C = \frac{1}{7.072}\{48900 + 15030 + 7040 + 32460\} = +14630$

$\theta_D = \frac{1}{5.782}\{-24000 - 29260 + 32460\} = -3600$

$\theta_E = \frac{1}{1639}\{-16400 + 5760\} = -6600$

$\theta_F = \frac{1}{8.198}\{31800 - 780 + 44400\} = +9210$

$R = \frac{1}{-29.451}\{-25600 - 2180 - 87800 + 21600 + 6830 - 75600\} = +5520$

④ $\theta_A = \frac{1}{8.340}\{-30400 + 14030 - 25200 + 45300\} = +448$

$\theta_B = \frac{1}{5.940}\{-35500 - 643 - 22480\} = -9880$

$\theta_C = \frac{1}{7.072}\{48900 + 15170 + 7200 + 33120\} = +14770$

$\theta_D = \frac{1}{5.782}\{-24000 - 29540 + 33120\} = -3530$

$\theta_E = \frac{1}{1639}\{-16400 + 5710\} = -6630$

$\theta_F = \frac{1}{8198}\{31800 - 1230 + 45300\} = +9260$

$R = \frac{1}{-29.451}\{-25600 - 3680 - 88600 + 21200 + 6860 - 76000\} = +5630$

⑤ $\theta_A = \frac{1}{8340}\{-30400 + 14170 - 25350 + 46200\} = +554$

$\theta_B = \frac{1}{5.940}\{-35500 - 795 - 22700\} = -9940$

$\theta_C = \frac{1}{7.072}\{48900 + 15270 + 7060 + 33800\} = +14850$

$\theta_D = \frac{1}{5.782}\{-24000 - 29700 + 33800\} = -3440$

$\theta_E = \frac{1}{1639}\{-16400 + 5830\} = -6450$

$\theta_F = \frac{1}{8198}\{31800 - 1517 + 46200\} = +9330$

$R = \frac{1}{-29.451}\{-25600 - 4545 - 89100 + 20640 + 6670 - 76550\} = +5720$

⑥ $\theta_A = \frac{1}{8340}\{-30400 + 14250 - 25540 + 46950\} = +631$

$\theta_B = \frac{1}{5.940}\{-35500 - 905 - 22820\} = -9980$

$\theta_C = \frac{1}{7.072}\{48900 + 15330 + 6880 + 34320\} = +14910$

$\theta_D = \frac{1}{5.782}\{-24000 - 29820 + 34320\} = -3370$

$\theta_E = \frac{1}{1639}\{-16400 + 5920\} = -6400$

$\theta_F = \frac{1}{8198}\{31800 - 1725 + 46950\} = +9400$

$R = \frac{1}{-29.451}\{-25600 - 5180 - 89500 + 20220 + 6625 - 77180\} = +5790$

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CALCULATIONS FOR

D型 杭径

⑦	$Q_A = \frac{1}{8.340}\{-30400+14310-25700+47500\} = +685$	$Q_A = \frac{1}{8.340}\{-30400+14400-26000+48500\} = +780$	(10)	+14
	$Q_B = \frac{1}{5.940}\{-35500-982-22900\} = -10000$	$Q_B = \frac{1}{5.940}\{-35500-1120-23090\} = -10050$		+10
	$Q_C = \frac{1}{7.072}\{48900+15360+6740+34740\} = +14970$	$Q_C = \frac{1}{7.072}\{48900+15430+6480+35460\} = +15050$		+20
	$Q_D = \frac{1}{5.782}\{-24000-29940+34740\} = -3320$	$Q_D = \frac{1}{5.782}\{-24000-30100+35460\} = -3322$		-18
	$Q_E = \frac{1}{1639}\{-16400+5990\} = -6355$	$Q_E = \frac{1}{1639}\{-16400+6120\} = -6280$		-10
	$Q_F = \frac{1}{8198}\{31800-1875+47500\} = +9450$	$Q_F = \frac{1}{8198}\{31800-2135+48500\} = +9540$		+30
	$R = \frac{1}{-29451}\{-25600-5620-89800+19920+6580-77500\} = +5840$	$R = \frac{1}{-29451}\{-25600-6400-90300+19340+6500-78300\} = +5935$		+25
⑧	$Q_A = \frac{1}{8340}\{-30400+14340-25850+47900\} = +719$	$Q_A = \frac{1}{8340}\{-30400+14420-26100+48700\} = +794$	(11)	+14
	$Q_B = \frac{1}{5940}\{-35500-1030-23000\} = -10020$	$Q_B = \frac{1}{5940}\{-35500-1138-23120\} = -10060$		+10
	$Q_C = \frac{1}{7072}\{48900+15400+6640+35050\} = +14990$	$Q_C = \frac{1}{7072}\{48900+15450+6444+35610\} = +15050$		0
	$Q_D = \frac{1}{5.782}\{-24000-29980+35050\} = -3270$	$Q_D = \frac{1}{5.782}\{-24000-30100+35610\} = -3195$		-27
	$Q_E = \frac{1}{1639}\{-16400+6050\} = -6320$	$Q_E = \frac{1}{1639}\{-16400+6140\} = -6260$		-20
	$Q_F = \frac{1}{8198}\{31800-1970+47900\} = +9490$	$Q_F = \frac{1}{8198}\{31800-2172+48700\} = +9550$		+10
	$R = \frac{1}{-29451}\{-25600-5900-89950+19620+6540-77900\} = +5880$	$R = \frac{1}{-29451}\{-25600-6520-90300+19180+6480+78400\} = +5950$		+15
			(12)	
⑨	$Q_A = \frac{1}{8340}\{-30400+14370-25950+48250\} = +752$	$Q_A = \frac{1}{8340}\{-30400+14420-26120+48800\} = +804$		+10
	$Q_B = \frac{1}{5940}\{-35500-1078-23040\} = -10040$	$Q_B = \frac{1}{5940}\{-35500-1153-23120\} = -10060$		0
	$Q_C = \frac{1}{7072}\{48900+15430+6540+35300\} = +15030$	$Q_C = \frac{1}{7072}\{48900+15450+6390+35700\} = +15050$		0
	$Q_D = \frac{1}{5.782}\{-24000-30060+35300\} = -3240$	$Q_D = \frac{1}{5.782}\{-24000-30100+35700\} = -3180$		-15
	$Q_E = \frac{1}{1639}\{-16400+6090\} = -6290$	$Q_E = \frac{1}{1639}\{-16400+6160\} = -6250$		-10
	$Q_F = \frac{1}{8198}\{31800-2060+48200\} = +9510$	$Q_F = \frac{1}{8198}\{31800-2200+48800\} = +9570$		+15
	$R = \frac{1}{-29451}\{-25600-6170-90180+19450+6510-78030\} = +5910$	$R = \frac{1}{-29451}\{-25600-6600-90300+19090+6470-78500\} = +5950$		-0

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CALCULATIONS FOR

D 型 構框

(13) $\theta_A = \frac{1}{8.340}\{-30400 + 14430 - 26190 + 48820\} = +800$ -4

$\theta_B = \frac{1}{5.940}\{-35500 - 1145 - 23110\} = -10060$ 0

$\theta_C = \frac{1}{7.072}\{48900 + 15450 + 6360 + 35700\} = +15050$ 0

$\theta_D = \frac{1}{5.782}\{-24000 - 30100 + 35700\} = -3180$ 0

$\theta_E = \frac{1}{1639}\{-16400 + 6160\} = -6250$ 0

$\theta_F = \frac{1}{8.198}\{31800 - 2185 + 48820\} = +9570$ 0

$R = \frac{1}{-29.451}\{-25600 - 6515 - 90300 + 19080 + 6470 - 78500\} = +5950$ 0

$\theta_A = +800$
$\theta_B = -10060$
$\theta_C = +15050$
$\theta_D = -3180$
$\theta_E = -6250$
$\theta_F = +9570$
$R = +5950$

Check.

	θ_A	θ_B	θ_C	θ_D	θ_E	θ_F	R	=	
1	+6,670	-14425				+26,200	-48850	-30,405 ✓	-30,400
2	+1,147	-59,780	+23,140					-35,493 ✓	-35,500
3		-15,450	+106,400	-6360			-35,700	+48,890 ✓	+48,900
4			+30,100	-18,400			-35,700	-24,000 ✓	-24,000
5					-10,240		-6,160	-16,400 ✓	-16,400
6	+2190					+78,500	-48850	+31,840 ✓	+31,800
7	+6,565		+90,300	-19,080	-6470	+78,500	-175,250	-25,435 ✓	-25,600

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CALCULATIONS FOR

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D 型

Solution of condition eqns. 地震 時.

①

$\theta_A = \frac{1}{8.340}\{1600 + 14420 - 26200 + 48800\} = +4635$

$\theta_B = \frac{1}{5.940}\{-17800 - 6650 - 23120\} = -8020$

$\theta_C = \frac{1}{7.072}\{2100 + 12320 + 6360 + 35700\} = +7990$

$\theta_D = \frac{1}{5.782}\{-18500 - 15980 + 35700\} = +211$

$\theta_E = \frac{1}{1.639}\{-13600 + 6160\} = -4540$

$\theta_{F_1} = \frac{1}{8.198}\{25000 - 12780 + 48800\} = +7450$

$R = \frac{1}{-29.451}\{-21200 - 38000 - 47900 - 1290 + 4700 - 61100\} = +5595$

②

$\theta_A = \frac{1}{8.340}\{1600 + 11500 - 20380 + 45900\} = +4635$

$\theta_B = \frac{1}{5.940}\{-17800 - 6650 - 12270\} = -6190$

$\theta_C = \frac{1}{7.072}\{2100 + 9510 - 422 + 33600\} = +6335$

$\theta_D = \frac{1}{5.782}\{-18500 - 12670 + 33600\} = +420$

$\theta_E = \frac{1}{1.639}\{-13600 + 5790\} = -4770$

$\theta_F = \frac{1}{8.198}\{25000 - 12680 + 45900\} = +7110$

$R = \frac{1}{-29.451}\{-21200 - 38040 - 38000 - 2520 + 4915 - 58300\} = +5200$

③

$\theta_A = \frac{1}{8.340}\{1600 + 8880 - 19450 + 41500\} = +$ ~~4380~~ 4045

$\theta_B = \frac{1}{5.940}\{-17800 -$ ~~6280~~ 5800 $- 9730\} = -$ ~~5700~~ 5610

$\theta_C = \frac{1}{7.072}\{2100 +$ ~~8760~~ 8620 $- 840 + 33240\} = +$ ~~6120~~ 5810

$\theta_D = \frac{1}{5.782}\{-18500 -$ ~~12240~~ 11620 $+ 33240\} = +$ ~~435~~ 187

$\theta_E = \frac{1}{1.639}\{-13600 + 5740\} = -$ ~~4800~~ 5020

$\theta_F = \frac{1}{8.198}\{25000 -$ ~~11980~~ 11070 $+ 41500\} = +$ ~~7150~~ 6920

$R = \frac{1}{-29.451}\{-21200 -$ ~~35900~~ 33200 $-$ ~~36700~~ 34850 $-$ ~~2610~~ 1120 $+$ ~~4970~~ 5200 $-$ ~~58600~~ 56800 $\} = +$ ~~5100~~ 4820

④

$\theta_A = \frac{1}{8.340}\{1600 + 8050 - 18940 + 39550\} = +3630$

$\theta_B = \frac{1}{5.940}\{-17800 - 5200 - 8930\} = -5380$

$\theta_C = \frac{1}{7.072}\{2100 + 8260 - 374 + 29820\} = +5630$

$\theta_D = \frac{1}{5.782}\{-18500 - 11260 + 29820\} = +10$

$\theta_E = \frac{1}{1.639}\{-13600 + 4990\} = -5260$

$\theta_F = \frac{1}{8.198}\{25000 -$ ~~11070~~ 9930 $+ 39550\} = +6670$

$R = \frac{1}{-29.451}\{-21200 - 29770 - 33800 - 60 + 5440 - 54700\} = +4550$

⑤

$\theta_A = \frac{1}{8.340}\{1600 + 7720 - 18250 + 37350\} = +3410$

$\theta_B = \frac{1}{5.940}\{-17800 - 4890 - 8650\} = -5280$

$\theta_C = \frac{1}{7.072}\{2100 + 8120 - 20 + 27300\} = +5300$

$\theta_D = \frac{1}{5.782}\{-18300 - 10600 + 27300\} = -315$

$\theta_E = \frac{1}{1.639}\{-13600 + 4710\} = -5430$

$\theta_F = \frac{1}{8.198}\{25000 - 9340 + 37350\} = +6470$

$R = \frac{1}{-29.451}\{-21200 - 28000 - 31800 + 1890 + 5620 - 53100\} = +4300$

⑥

$\theta_A = \frac{1}{8.340}\{1600 + 7570 - 17700 + 35300\} = +3210$ -200

$\theta_B = \frac{1}{5.940}\{-17800 - 4600 - 8140\} = -5140$ -140

$\theta_C = \frac{1}{7.072}\{2100 + 7900 + 630 + 25800\} = +5150$ -150

$\theta_D = \frac{1}{5.782}\{-18500 - 10300 + 25800\} = -518$ +203

$\theta_E = \frac{1}{1.639}\{-13600 + 4450\} = -5580$ +150

$\theta_F = \frac{1}{8.198}\{25000 - 8780 + 35000\} = +6290$ -180

$R = \frac{1}{-29.451}\{-21200 - 26350 - 30900 + 3110 + 5780 - 51600\} = +4110$ -190

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CALCULATIONS FOR

D-7L

(7)	$Q_A=\frac{1}{8.340}\{1600+7370-17210+33720\}$	$=+3050$	-155	$Q_A=\frac{1}{8.340}(1600+7130-16300+31100)$	$=+2820$ -77 (10)
	$Q_B=\frac{1}{5.940}\{-17800-4380-7910\}$	$=-5060$	-80	$Q_B=\frac{1}{5.940}(-17800-4040-7510)$	$=-4940$ -30
	$Q_C=\frac{1}{7.072}\{2100+7770+1040+24660\}$	$=+5030$	-120	$Q_C=\frac{1}{7.072}(2100+7590+1750+22740)$	$=+4840$ -45
	$Q_D=\frac{1}{5.782}\{-18500-10060+24660\}$	$=-675$	+157	$Q_D=\frac{1}{5.782}(-18500-9680+22740)$	$=-940$ +65
	$Q_E=\frac{1}{1639}(-13600+4250)$	$=-5700$	+120	$Q_E=\frac{1}{1639}(-13600+3925)$	$=-5900$ -60
	$Q_F=\frac{1}{8.198}(25000-8360+33720)$	$=+6150$	-140	$Q_F=\frac{1}{8.198}(25000-7860+31100)$	$=+5890$ ~~+30~~ -70
	$R=\frac{1}{-29.451}(-21200-25100+30200+4050+5900-50450)$	$=+3970$	-140	$R=\frac{1}{-29.451}(-21200-23150+29050+5660+6110-49150)$	$=+3765$ -25
(8)	$Q_A=\frac{1}{8.340}(1600+7260-16840+32600)$	$=+2950$	-105	$Q_A=\frac{1}{8.340}(1600+7080-16400+30900)$	$=+2780$ -40 (11)
	$Q_B=\frac{1}{5.940}(-17800-4230-7730)$	$=-5010$	-50	$Q_B=\frac{1}{5.940}(-17800-3985-7440)$	$=-4920$ -20
	$Q_C=\frac{1}{7.072}(2100+7700+1350+23830)$	$=+4950$	-80	$Q_C=\frac{1}{7.072}(2100+7560+1880+22600)$	$=+4830$ -10
	$Q_D=\frac{1}{5.782}(-18500-9900+23830)$	$=-790$	+115	$Q_D=\frac{1}{5.782}(-18500-9660+22600)$	$=-960$ +20
	$Q_E=\frac{1}{1639}(-13600+4110)$	$=-5790$	+90	$Q_E=\frac{1}{1639}(-13600+3900)$	$=-5920$ +10
	$Q_F=\frac{1}{8.198}(25000-8070+32600)$	$=+6040$	-110	$Q_F=\frac{1}{8.198}(25000-7600+30900)$	$=+5900$ +10
	$R=\frac{1}{-29.451}(-21200-24200-29700+4740+6000-49600)$	$=+3865$	-105	$R=\frac{1}{-29.451}(-21200-22800-29000+5760+6120-48400)$	$=+3720$ -45
(9)	$Q_A=\frac{1}{8.340}(1600+7180-16530+31720)$	$=+2875$	-75	$Q_A=\frac{1}{8.340}(1600+7050-16150+30550)$	$=+2765$ -15 (12)
	$Q_B=\frac{1}{5.940}(-17800-4125-7605)$	$=-4970$	-40	$Q_B=\frac{1}{5.940}(-17800-3965-7420)$	$=-4915$ -5
	$Q_C=\frac{1}{7.072}(2100+7630+1580+23200)$	$=+4885$	-65	$Q_C=\frac{1}{7.072}(2100+7550+1920+22310)$	$=+4790$ -40
	$Q_D=\frac{1}{5.782}(-18500-9770+23200)$	$=-875$	-85	$Q_D=\frac{1}{5.782}(-18500-9580+22310)$	$=-1000$ +40
	$Q_E=\frac{1}{1639}(-13600+4000)$	$=-5850$	+70	$Q_E=\frac{1}{1639}(-13600+3850)$	$=-5950$ +30
	$Q_F=\frac{1}{8.198}(25000-7870+31720)$	$=+5960$	-80	$Q_F=\frac{1}{8.198}(25000-7565+30550)$	$=+5850$ -70
	$R=\frac{1}{-29.451}(-21200-23600-29300+5250+6070-48900)$	$=+3790$	-75	$R=\frac{1}{-29.451}(-21200-22700-28750+6000+6160-47800)$	$=+3680$ -40

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CALCULATIONS FOR

(13)

$Q_A = \frac{1}{8340}(1600 + 7050 - 16020 + 3030) = +2750$ -15

$Q_B = \frac{1}{5940}(-1780 - 3945 - 7360) = -4900$ -15

$Q_C = \frac{1}{7072}(2100 + 7520 + 2080 + 22080) = +4765$ -5

$Q_D = \frac{1}{5782}(-18500 - 9530 + 22080) = -1028$ +28

$Q_E = \frac{1}{1639}(-13600 + 3810) = -5970$ +20

$Q_F = \frac{1}{8198}(25000 - 7520 + 3030) = +5830$ -20

$R = \frac{1}{-29451}(-21200 - 22550 - 28580 + 6170 + 6180 - 4780) = +3660$ -20

(14)

$Q_A = \frac{1}{8340}(1600 + 7030 - 15950 + 30030) = +2725$ -25

$Q_B = \frac{1}{5940}(-1780 - 3910 + 7320) = -4890$ -10

$Q_C = \frac{1}{7072}(2100 + 7510 + 2056 + 21970) = +4760$ +5

$Q_D = \frac{1}{5782}(-18500 - 9520 + 21970) = -1047$ +19

$Q_E = \frac{1}{1639}(-13600 + 3790) = -5980$ +10

$Q_F = \frac{1}{8198}(25000 - 7460 + 30030) = +5805$ -25

$R = \frac{1}{-29451}(-21200 - 22360 - 28570 + 6280 + 6190 - 47630) = +3645$ -15

(15)

$Q_A = \frac{1}{8340}(1600 + 7010 - 15880 + 29900) = +2715$ -10

$Q_B = \frac{1}{5940}(-1780 - 3890 - 7310) = -4880$ -10

$Q_C = \frac{1}{7072}(2100 + 7500 + 2095 + 21860) = +4745$ -15

$Q_D = \frac{1}{5782}(-18500 - 9490 + 21860) = -1060$ +10

$Q_E = \frac{1}{1639}(-13600 + 3770) = -6000$ +20

$Q_F = \frac{1}{8198}(25000 - 7430 + 29900) = +5800$ -5

$R = \frac{1}{-29451}(-21200 - 22280 - 28470 + 6360 + 6210 - 47600) = +3630$ -15

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A +740 A
B −800 B
C +1260 C
D −300 D
E −960 E
F +1190 F
R +600 R

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CALCULATIONS FOR

F 型 鉄塔框

Solution of condition equations.

①

$\theta_A = \frac{1}{6.388}(-5860 + 9620 - 23600 + 36000) = +2530$

$\theta_B = \frac{1}{6.396}(-16670 - 3020 - 25300) = -7040$

$\theta_C = \frac{1}{8.008}(+11320 + 14100 + 6000 + 3600) = +8430$

$\theta_D = \frac{1}{6.254}(-2980 - 16860 + 3600) = +2590$

$\theta_E = \frac{1}{1.539}(-7980 + 5270) = -1760$

$\theta_F = \frac{1}{6.254}(+5360 - 5060 + 3600) = +5800$

$R = \frac{1}{-24879}(-16800 - 15200 - 50600 - 15600 + 1550 - 34800) = +5280$

②

$\theta_A = \frac{1}{6.388}(-5860 + 8400 - 11600 + 31700) = +3550$ +5000

$\theta_B = \frac{1}{6.396}(-16670 - 5970 - 16860) = -6180$ −5000

$\theta_C = \frac{1}{8.008}(+11320 + 10000 - 5180 + 3170) = +5980$ +2500

$\theta_D = \frac{1}{6.254}(-2980 - 5000 + 3170) = +3800$ +2300

$\theta_E = \frac{1}{1.539}(-7980 + 4640) = -2170$ −1600

$\theta_F = \frac{1}{6.254}(+5360 - 10000 + 31700) = +4330$ +2300

$R = \frac{1}{-24879}(-16800 - 30000 - 15000 - 13800 + 1400 - 13800) = +3540$ +1500

③

$\theta_A = \frac{1}{6.388}(-5860 + 5970 - 4600 + 9000) = +710$

$\theta_B = \frac{1}{6.396}(-16670 - 850 - 5000) = -3520$

$\theta_C = \frac{1}{8.008}(+11320 + 7050 - 4600 + 9000) = +2840$

$\theta_D = \frac{1}{6.254}(-2980 - 5680 + 9000) = +55$

$\theta_E = \frac{1}{1.539}(-7980 + 1320) = -4330$

$\theta_F = \frac{1}{6.254}(+5360 - 1420 + 9000) = +2070$

$R = \frac{1}{-24879}(-16800 - 4260 - 17050 - 330 + 3800 - 12420) = +1893$

④

$\theta_A = \frac{1}{6.388}(-5860 + 4205 - 4140 + 11350) = +870$ +160

$\theta_B = \frac{1}{6.396}(-16670 - 1040 - 8690) = -3660$ +140

$\theta_C = \frac{1}{8.008}(+11320 + 7330 - 110 + 11350) = +3730$ +890

$\theta_D = \frac{1}{6.254}(-2980 - 7460 + 11350) = +145$ +90

$\theta_E = \frac{1}{1.539}(-7980 + 1663) = -4110$ −220

$\theta_F = \frac{1}{6.254}(+5360 - 1740 + 11350) = +2395$ +325

$R = \frac{1}{-24879}(-16800 - 5220 - 22380 - 870 + 3610 - 14370) = +2255$ +362

⑤

$\theta_A \; (-5860 + 4370 - 4790 + 13530) = +1135$ +265

$\theta_B \; (-16670 - 1355 - 7480) = -3990$ +330

$\theta_C \; (+11320 + 8000 - 290 + 13530) = +4070$ +340

$\theta_D \; (-2980 - 8140 + 13530) = +385$ +240

$\theta_E \; (-7980 + 1980) = -3900$ −210

$\theta_F \; (+5360 - 2270 + 13530) = +2660$ +265

$R \; (-16800 - 6810 - 24420 - 2310 + 3420 - 15950) = +2530$ +275

⑥

$\theta_A \; (-5860 + 4765 - 5320 + 15180) = +1372$ +237

$\theta_B \; (-16670 - 1640 - 8160) = -4140$ +150

$\theta_C \; (+11320 + 8290 - 770 + 15180) = +4250$ +180

$\theta_D \; (-2980 - 8300 + 15180) = +592$ +207

$\theta_E \; (-7980 + 2220) = -3745$ −155

$\theta_F \; (+5360 - 2744 + 15180) = +2830$ +190

$R \; (-16800 - 8230 - 25500 - 3530 + 3290 - 17100) = +2730$ +200

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CALCULATIONS FOR

F 打設

⑦	Q_A	(-5860 +4945 -5700 +16380)	=	+1530	+118	Q_A	(-5860 + 5190 -6420 +18540)	= + 1793	+1815	+33 (10) (27)
	Q_B	(-16670 - 1827 -8520)	=	- 4275	+185	Q_B	(-16670 - 2140 -9110)	= - 4370	-4385	+20 (30) (13)
	Q_C	(+11320 +8470 -1184 +16380)	=	+ 4370	+120	Q_C	(+11320 + 8760 -1980 +18540)	= + 4575	+4601	+30 (28) 31
	Q_D	(-2980 - 8740 +16380)	=	+ 746	+154	Q_D	(-2980 - 9150 +18540)	= + 1025	+1047	+35 (22) 17
	Q_E	(-7980 + 2400)	=	-3625	-120	Q_E	(-7980 + 2715)	= - 3425	-3410	-35 (45) -40
	Q_F	(+5360 - 3060 +16380)	=	+ 2990	+140	Q_F	(+5360 - 3586 +18540)	= + 3250	+3282	+40 (32) 50
	R	(-16800 -9180 -26220 -4480 + 3185 -17950)	=	+ 2875	+145	R	(-16800 -10750 -27450 -6150 + 3010 -19500)	= + 3122	+3143	+32 (21) 48
⑧	Q_A	(-5860 +5045 -5980 +17250)	=	+1637	1710 +107	Q_A	(-5860 + 5230 -6564 +18860)	= + 1826		+11 (11) 22
	Q_B	(-16670 -1955 -8760)	=	- 4280	4315 +35	Q_B	(-16670 -2180 -9220)	= -4390		+7 17
	Q_C	(+11320 +8580 -1490 +17250)	=	+ 4455	4515 +85	Q_C	(+11320 +8790 -2094 +18860)	= + 4608		+7 26
	Q_D	(-2980 -8910 +17250)	=	+ 858	940 +112	Q_D	(-2980 -9216 +18860)	= + 1065		+ 18 22
	Q_E	(-7980 + 2530)	=	- 3545	3492 -80	Q_E	(-7980 + 2762)	= - 3390		- 20 15
	Q_F	(+5360 -3275 + 17250)	=	+ 3090	3162 +100	Q_F	(+5360 - 3657 +18860)	= + 3290		+8 32
	R	(-16800 -9820 -26750 -5150 +3115 -18550)	=	+ 2975	3045 +100	R	(-16800 -10955 -27645 -6390 +2978 -19740)	= + 3158		+15 21
⑨	Q_A	(-5860 +5110 -6180 +17850)	=	+1710	+1760 +73	Q_A	(-5860 +5240 -6580 +18950)	= +1840		+14 (12)
	Q_B	(-16670 -2040 -8930)	=	- 4320	-4350 +40	Q_B	(-16670 -2197 -9230)	= - 4390		0
	Q_C	(+11320 +8660 -1716 +17850)	=	+ 4510	+4545 +55	Q_C	(+11320 +8800 -2130 +18950)	= + 4612		+4
	Q_D	(-2980 -9020 +18850)	=	+ 935	+ 990 +77	Q_D	(-2980 -9224 +18950)	= + 1079		+14
	Q_E	(-7980 +2615)	=	- 3490	-3450 -55	Q_E	(-7980 + 2775)	= - 3385		-5
	Q_F	(+5360 -3420 + 17850)	=	+ 3160	+3210 +70	Q_F	(+5360 - 3680 + 18950)	= +3300		+10
	R	(-16800 -10250 -27050 -5610 + 3065 -18960)	=	+ 3042	+3090 +67	R	(-16800 -11040 -27670 -6474 + 2975 -19800)	= +3170		+12

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CALCULATIONS FOR

F 711

(13)	θ_A	$\begin{pmatrix} -5860 + 5243 - 6600 \\ +19020 \end{pmatrix}$	= +	1848	+1855	+8
	θ_B	$(-16670 - 2208 - 9240)$	= −	4397	-4405	+7
	θ_C	$\begin{pmatrix} +11320 + 8810 - 2158 \\ +19020 \end{pmatrix}$	= +	4620	+4630	+8
	θ_D	$(-2980 - 9240 + 19020)$	= +	1087	+1095	+8
	θ_E	$(-7980 + 2787)$	=	−3375	-3365	−10
	θ_F	$(+5360 - 3696 + 19020)$	=	+3307	+3315	+7
	R	$\begin{pmatrix} -16800 - 11080 - 27720 \\ -6520 + 2965 - 19840 \end{pmatrix}$	=	+3175	+3180	+5
(14)	θ_A	$\begin{pmatrix} -5860 + 5260 - 6630 \\ +19080 \end{pmatrix}$	= +	1855	0	
	θ_B	$(-16670 - 2215 - 9280)$	= −	4402	-3	
	θ_C	$\begin{pmatrix} +11320 + 8820 - 2190 \\ +19080 \end{pmatrix}$	= +	4625	-5	
	θ_D	$(-2980 - 9250 + 19080)$	= +	1096	+1	
	θ_E	$(-7980 + 2795)$	= −	3370	+5	
	θ_F	$(+5360 - 3710 + 19080)$	= +	3315	0	
	R	$\begin{pmatrix} -16800 - 11130 - 27750 \\ -6575 + 2960 - 19890 \end{pmatrix}$	= +	3173	-7	

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CALCULATIONS FOR

F 形

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①	Q_A (9860 + 5250 − 6630 + 19050)	= +4310	Q_A (9860 + 7520 − 4860 + 23650)	= +5660	+160
	Q_B (−24670 − 5150 − 9270)	= −6110	Q_B (−24670 − 6760 − 9420)	= −6390	+90
	Q_C (5740 + 12250 − 2190 + 19050)	= +4350	Q_C (+5740 + 12800 − 3520 + 23650)	= +4830	+130
	Q_D (−1920 − 8700 + 19050)	= +1350	Q_D (−1920 − 9660 + 23650)	= +1930 ✓	+170
	Q_E (−6450 + 2790)	= −2380	Q_E (−6450 + 3460)	= +1940	−130
	Q_F (3840 − 8620 + 19050)	= +2280	Q_F (+3840 − 11320 + 23650)	= +2590	+160
	R (−13600 − 25850 − 26100 − 8100 + 2090 −13670)	= +3430	R (−13600 − 33960 − 29000 − 11580 + 1705 −15550)	= +4100	+160
②	Q_A (9860 + 7300 − 4560 + 20580)	= +5200	+890	Q_A (+9860 + 7630 − 5180 + 24600)	= +5780	+5870	+120 (+90)
	Q_B (−24670 − 6210 ~~− 12550~~ 8720)	= −6200	+90	Q_B (−24670 − 6900 − 9670)	= −6450	−6490	+60 (+40)
	Q_C (5740 + ~~13520~~ 12430 − 2700 + 20580)	= +4500	+150	Q_C (+5740 + 12920 − 3860 + 24600)	= +4920	+4980	+90 (+60)
	Q_D (−1920 − ~~9270~~ 9000 + 20580)	= +1545	+195	Q_D (−1920 − 9840 + 24600)	= +2052	+2140	+120 (+90)
	Q_E (−6450 + 3020)	= −2230 ✓	−150	Q_E (−6450 + 3605)	= −1850	−1790	−90 (−60)
	Q_F (+3840 − 10400 + 20580)	= +2240 ✓	−40	Q_F (+3840 − 11560 + 24600)	= +2700	+2780	+110 (+80)
	R (−13600 − 31200 − 27000 − 9270 + 1960 −13450)	= +3720	+290	R (−13600 − 34700 − 29500 − 12320 + 1630 −16200)	= +4210	+4290	+110 (+80)
③	Q_A (+9860 + 7400 − 4480 + 22320)	= +5500	+300	Q_A (+9860 + 7750 − 5360 + 25260)	= ~~+5840~~ +5920		
	Q_B (−24670 − 6570 − 9020)	= −6300	+100	Q_B (−24670 − ~~6980~~ 7070 − 9980)	= ~~−6520~~ −6530		
	Q_C (+5740 + 12620 − 3090 + 22320)	= +4700	+200	Q_C (+5740 + 13080 − 4280 + 25260)	= +4975 + 5030		
	Q_D (−1920 − 9400 + 22320)	= +1760	+215	Q_D (−1920 − ~~9950~~ 10060 + 25260)	= ~~+2140~~ + 2200		
	Q_E (−6450 + 3270)	= −2070	+60	Q_E (−6450 + 3770 −)	= −1743 ✓		
	Q_F (+3840 − 11000 + 22320)	= +2430	+190	Q_F (+3840 − ~~11680~~ 11840 + 25260)	= ~~+2785~~ + 2835		
	R (−13600 − 33000 − 28200 − 10550 + 1910 −14600)	= +3940	+220	R (−13600 − ~~35500~~ − ~~29850~~ 30200 − ~~14460~~ 12680 + 1530 − ~~16720~~ 17010)	= ~~+4350~~ 4285 + 4340		

⑥

$Q_A = 6,083$

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CALCULATIONS FOR

F 7"

⑦	Q_A (+9860 +7800 −5670 +26040)	= + 5,960	+40	Q_A (9860 +7850 −5840 +26520)	= + 6,010	+ 6020	+10
	Q_B (−24670 −7120 −10080)	= − 6,550	+20	Q_B (−24670 −7180 −10210)	= − 6,580	− 6,585	+5
	Q_C (+5740 +13120 −4400 +26040)	= + 5,060	+30	Q_C (5,740 +13180 −4580 +26520)	= + 5,100	+5,100	+5
	Q_D (−1920 −10120 +26040)	= + 2,240	+40	Q_D (−1920 −10,200 +26520)	= + 2,305	+2315	+15
	Q_E (−6450 +3815)	= − 1,713	−30	Q_E (−6450 +3880)	= − 1,672	−1670	−5
	Q_F (+3840 −11920 +26040)	= + 2,875	+40	Q_F (+3840 −12020 +26520)	= + 2,932	+2940	+12
	R (−13600 −35750 −30360 −13,440 +1505 −17,250)	= + 4380	+40	R (−13600 −36060 +30600 −13830 +1470 −17600)	= + 4430	+ 4435	+10
⑧	Q_A (9860 +7820 −5750 +26280)	= + 5,990	+30	Q_A (9860 +7860 −5880 +26610)	= + 6,020	0	
	Q_B (−24670 −7150 −10150)	= − 6570	+20	Q_B (−24670 −7190 −10225)	= − 6580	−5	
	Q_C (5740 +13150 −4480 +26280)	= + 5,080	+20	Q_C (+5740 +13180 −4630 +26610)	= + 5110	+10	
	Q_D (−1920 −10160 +26280)	= + 2,270	+30	Q_D (−1920 −10,220 +26610)	= + 2315	0	
	Q_E (−6450 +3830)	= − 1690	−25	Q_E (−6450 +3,895)	= − 1660	−10	
	Q_F (3840 −11,980 +26280)	= + 2900	+25	Q_F (+3840 −12040 +26610)	= + 2945	+5	
	R (−13600 −35950 −30500 −13620 +1485 −17400)	= + 4405	+25	R (−13600 −36120 −30660 −13900 +1478 −17670)	= + 4440	+5	
⑨	Q_A (9860 +7840 −5800 +26430)	= + 6,000	+10				
	Q_B (−24670 −7164 −10180)	= − 6575	+5				
	Q_C (5740 +13170 −4540 +26430)	= + 5095	+15				
	Q_D (−1920 −10190 +26430)	= + 2,290	+20				
	Q_E (−6450 +3870)	= − 1677	−13				
	Q_F (+3840 −12000 +26430)	= + 2,920	+20				
	R (−13600 −36000 −30600 −13740 +1475 −17520)	= + 4420	+15				

(10) (11)

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CALCULATIONS FOR

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	Q_A	Q_B	R	
(1)	5.546	1	−5.319	= −9870
(2)	1	5.546	−5.319	= +11,250
(3)	1.773	1,773	−7092	= 0

① $Q_A = \frac{1}{5.546}(-9870 - 3,188 + 2292) = -1940$

$Q_B = \frac{1}{5546}(11250 + 1940 + 2292) = +2,792$

$R = \frac{1}{-7092}(+3440 - 4950) = 213.$

② $Q_A = \frac{1}{5.546}(-9870 - 2792 + 1132) = -2080$

$Q_B = \frac{1}{5.546}(11250 + 2080 + 1132) = 2610$

$R = \frac{1}{-7092}(3690 - 4630) = 132.5$

③ $Q_A = \frac{1}{5.546}(-9870 - 2610 + 704) = -2125$

$Q_B = \frac{1}{5.546}(11250 + 2125 + 704) = 2540$

$R = \frac{1}{-7092}(3770 - 4505) = 103.7$

④ $Q_A = \frac{1}{5.546}(-9870 - 2540 + 551) = -2140$ +15

$Q_B = \frac{1}{5546}(11250 + 2140 + 551) = 2512$ −28

$R = \frac{1}{-7092}(3795 - 4453) = 93.1$ −10.6

⑤ $Q_A = \frac{1}{5.546}(-9870 - 2512 + 495) = -2144$ +4

$Q_B = \frac{1}{5.546}(+11250 + 2144 + 495) = 2504$ −8

$R = \frac{1}{-7092}(3800 - 4440) = 90.3$ −2.8

⑥ $Q_A = \frac{1}{5.546}(-9870 - 2500 + 480) = -2145$ +1

$Q_B = \frac{1}{5546}(11250 + 2145 + 480) = 2500$ −4

$R = \frac{1}{-7092}(3800 - 4430) = 88.9$ −1.4

⑦ $Q_A = \frac{1}{5.546}(-9870 - 2500 + 473) = -2145$ ○

$Q_B = \frac{1}{5546}(+11250 + 2145 + 473) = +2500$ ○

$R = \frac{1}{-7092}(3805 - 4435) = 88.9$ ○

$-11,900 + 2500 - 473 = -9873$ ✓

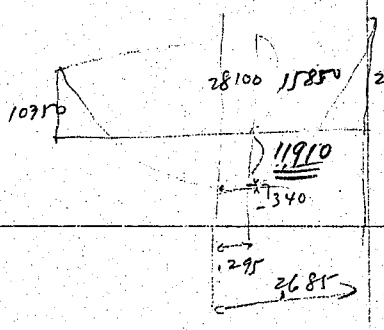
$-2145 + 13870 - 473 = +11,252$ ✓

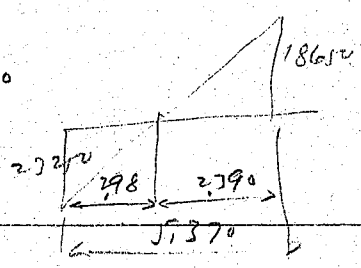
$-3805 + 4435 - 630 = 0$ ✓

$Q_A = -2,145$

$Q_B = +2,500$

$Q_C = +87$





$28100 \times \left(\frac{1295}{2685}\right)^2 = 339$ or 340

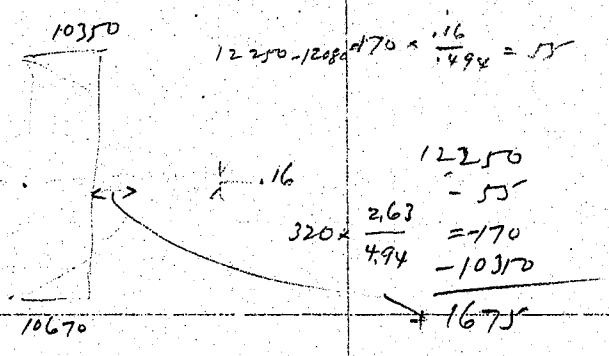
$22710 - 10350 = 12360 \times \frac{2.39}{5.37} = 5500 + 10350 = 15850$

$28100 - 340 - 15850 = 11910$

$28100 \times \left(\frac{1295}{2685}\right)^2 = 340$

$23030 - 10670 = 12360 \times \frac{2.39}{5.37} = 5500 + 10670 = 16170$

$28100 - 340 - 16170 = 11590$



$12250 - 12080 = 170 \times \frac{.16}{.494} = 55$

$320 \times \frac{2.63}{4.94}$

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CALCULATIONS FOR

口形, 十二 断面

地震時.

① $\theta_A = \frac{1}{5.546}(-3820 - 2439 + 3630) = -474$

$\theta_B = \frac{1}{5.546}(5960 + 474 + 3600) = +1815$

$R = \frac{1}{-7.092}(840 - 3220) = +336$

$(-4440 + 1350 - 734) = -3824$ +4

$(-800 + 7492 - 734) = 5958$ −2

$-1418 + 2390 - 978 = -6$ +6

② $\theta_A = \frac{1}{5.546}(-3820 - 1815 + 1790) = -694$

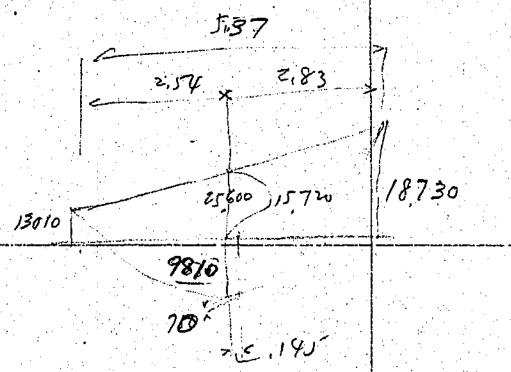
$\theta_B = \frac{1}{5.546}(5960 + 694 + 1790) = +1523$

$\theta_C = \frac{1}{-7.092}(1230 - 2700) = +207$

③ $\theta_A = \frac{1}{5.546}(-3820 - 1520 + 1100) = -765$

$\theta_B = \frac{1}{5.546}(5960 + 765 + 1100) = +1410$

$\theta_C = \frac{1}{-7.092}(1355 - 2500) = +161$



④ $\theta_A = \frac{1}{5.546}(-3820 - 1410 + 856) = -789$ +24

$\theta_B = \frac{1}{5.546}(5960 + 789 + 856) = +1370$ −40

$R = \frac{1}{-7.092}(1400 - 2430) = +145$ −16

$25600 \times \frac{.145^2}{2.685^2} = 70.$

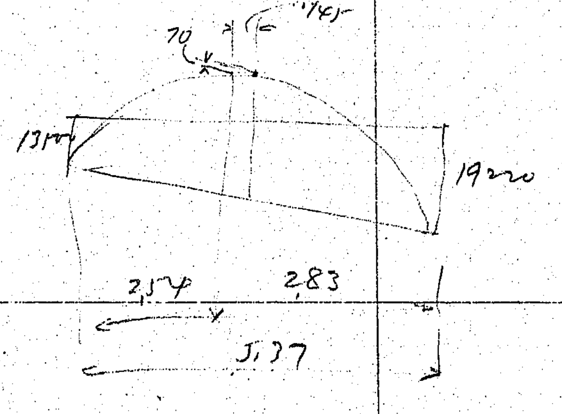
$\frac{18730 - 13010}{5720} \times \frac{2.54}{5.37} = 2710$
13010
15720

25600
− 15720
− 70
9810

⑤ $\theta_A = \frac{1}{5.546}(-3820 - 1370 + 770) = -797$ +8

$\theta_B = \frac{1}{5.546}(5960 + 797 + 770) = +1357$ −13

$R = \frac{1}{-7.092}(1410 - 2405) = +140$ −5



⑥ $\theta_A = \frac{1}{5.546}(-3820 - 1357 + 744) = -800$ +3

$\theta_B = \frac{1}{5.546}(5960 + 800 + 744) = +1353$ −4

$\theta_C = \frac{1}{-7.092}(1418 - 2400) = +138$ −2

$\theta_A = \frac{1}{5.546}(-3820 - 1353 + 734) = -800$ 0

$\theta_B = \frac{1}{5.546}(5960 + 800 + 734) = 1351$ −2

$R = \frac{1}{-7.092}(1418 - 2395) = 138$ 0

$5720 \times \frac{2.54}{5.37} = 2710$
13500
16210

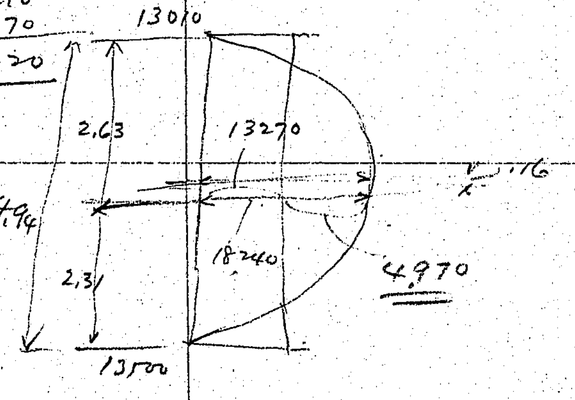
25600
− 16210
− 70
9320

18730
− 18000

$330 \times \frac{.13}{0.50} = 90$

$18330 - 90 = 18240$

$490 \times \frac{2.63}{4.94} = 260$
13010
13270
18240
4970



θ_A −800
θ_B = +1350
R = 138

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CALCULATIONS FOR

12 型 1 +. 計算

(第 3 回) $\theta_A = -1970$ — 2 回 — $\theta_B = +2160$ R = 88.

① $\theta_A = \frac{1}{5.674}(-8620 - 2160 + 485) = -1815$

$\theta_B = \frac{1}{5.674}(+9950 + 1815 + 485) = +2160$

$R = \frac{1}{-7.348}(+3330 - 3965) = +86$

−10310 ✓ 2158 (7) −468 = −8620 (19) ✓

−1817 ✓ 12244 (38) −468 ✓ = 9950 (3)

−3335 3960 (2) −624 +X 3

② $\theta_A = \frac{1}{5.674}(-8620 - 2160 + 474) = -1818$ +3

$\theta_B = \frac{1}{5.674}(9950 + 1818 + 474) = +2158$ −2

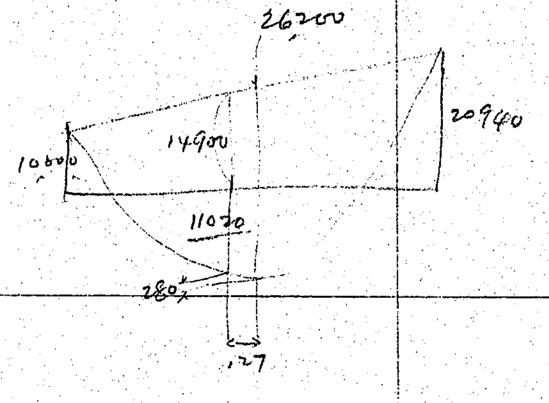
$R = \frac{1}{-7.348}(3338 - 3960) = +84.7$ −1.3

$\theta_A = -1817$
$\theta_B = +2157$
R = 85

③ $\theta_A = \frac{1}{5.674}(-8620 - 2158 + 467) = -1817$ ⊖

$\theta_B = \frac{1}{5.674}(9950 + 1817 + 467) = +2158$

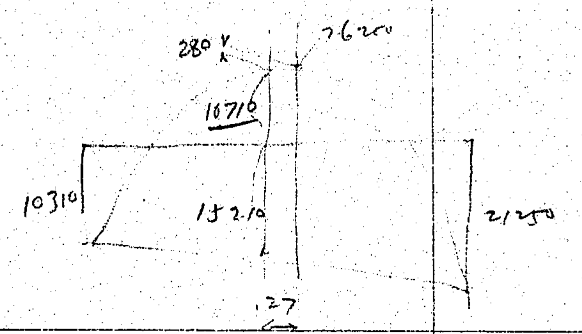
$\theta_C = \frac{1}{-7.348}(3336 - 3960) = +85$



$26200 \times \frac{.127^2}{2.59^2} = 280$

$10940 \times \frac{2.32}{5.18} = 4900$
10000
14900

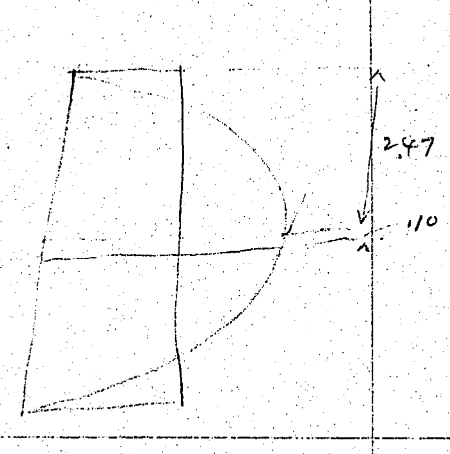
26200
− 280
− 14900
11020



21250
10310
10940 $\times \frac{2.32}{5.18} = 4900$
10310
11210

26200
− 280
− 15210
10710

$170 \times \frac{1.1}{1.494} = 30$



12250
− 30

$310 \times \frac{2.57}{4.94} = 160$
10200
− 10160
2060

−560 1080 137

増田淳氏関係資料
(独立行政法人 土木研究所蔵)

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CALCULATIONS FOR
ロ型ノ十 計5

地震時

$R_C \quad \theta_A = -520, \quad \theta_B = ~~1080~~ \; 1070, \quad R = 137.$

~~-3060~~ -2950	1070	-755	=	-2815	-225	-2685	(+55)	-2745	-115	-2635	-5
~~-540~~ -520	6070	-755	=	4815	+45	4845	(+75)	4775	+	4795	-25
~~-992~~ -955	1965	-1007	=	-52	-52	+4	(+4)	-34	-34	+3	+3

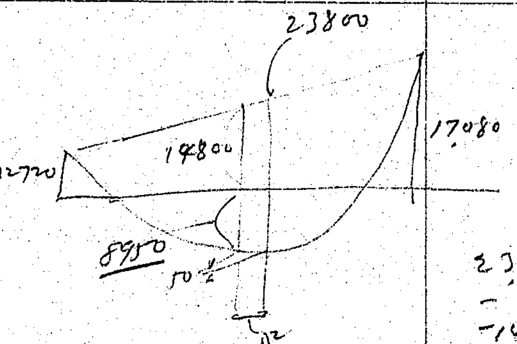
$\theta_A = -520 \quad \theta_B = 1065 \quad R = 137$ ト假定

$\theta_A = \frac{1}{5.674}(-2630 - 1065 + 700) = -528$

$\theta_B = \frac{1}{5.674}(4770 + 528 + 700) = 1056$

$R = \frac{1}{-7.348}(970 - 1940) = 132$

$\theta_A = \frac{1}{5.674}(-2630 - 1056 + 728) = -521$



$23800 \times \frac{.12^2}{2.59^2} = 50$

$4360 \times \frac{2.47}{5.18} = 2080$
12720
14800

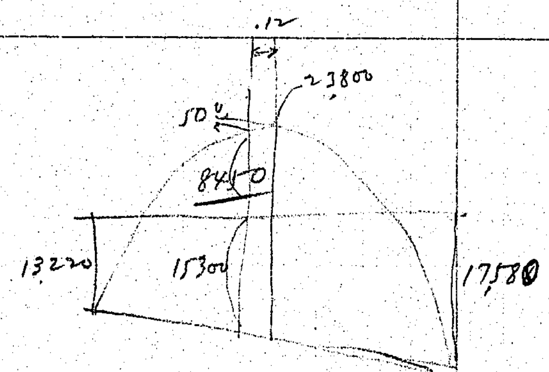
23800
- 50
- 14800
8950

$\theta_B = \frac{1}{5.674}(4770 + 521 + 728) = 1061$

$R = \frac{1}{-7.348}(+957 - 1948) = 135$

$\theta_A = \frac{1}{5.674}(-2630 - 1061 + 744) = -520$ (-1)

$\theta_B = \frac{1}{5.674}(4770 + 520 + 744) = 1063$ (+2)



2080
13220
15300

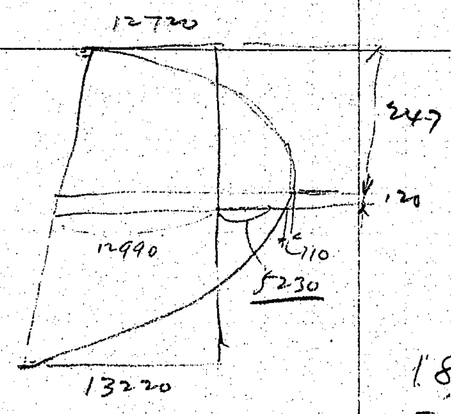
23800
- 50
- 15300
8450

$R = \frac{1}{-7.348}(955 - 1953) = 136$ (+1)

$\theta_A = \frac{1}{5.674}(-2630 - 1063 + 750) = -519$

$\theta_B = \frac{1}{5.674}(4770 + 519 + 750) = 1063$

$R = \frac{1}{-7.348}(953 - 1953) = 136$



$330 \times \frac{.17}{.50} = 110$

$500 \times \frac{2.67}{4.94} = 270$
12720
12990

18330
- 110
- 12990
5230

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CALCULATIONS FOR

H型 1次 ラーメン

一次時	Q_A = ~~+1245~~	−7180	+1560	+433	= −5983	103	+33	−1240
	Q_B = +1560	−1245	+8905	−433	= +7227	77	−13	+1560
	R = +78	−2385	+2890	−578	= +7	5	+7	+78

$Q_A = \frac{1}{5,704}(-5950 - 1560 + 433) = -1,240$

$Q_B = \frac{1}{5,704}(7240 + 1240 + 433) = +1,562$

$R = \frac{1}{-7,408}(2295 - 2890) = +80$

$Q_A = \frac{1}{5,704}(-5950 - 1562 + 446) = -1,238$

$Q_B = \frac{1}{5,704}(7240 + 1238 + 446) = +1565$

$R = \frac{1}{-7,408}(2292 - 2896) = +81.5$

$Q_A = \frac{1}{5,704}(-5950 - 1565 + 453) = -1,237$

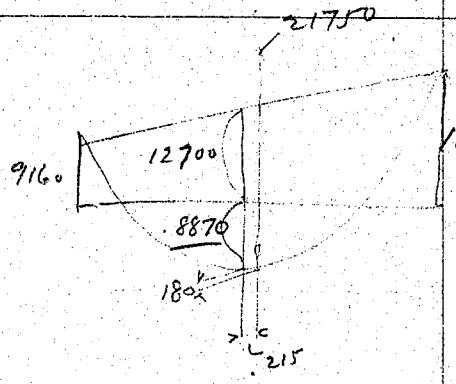
$Q_B = \frac{1}{5,704}(7240 + 1237 + 453) = +1565$

$R = \frac{1}{-7,408}(2290 - 2898) = +82$

$Q_A = \frac{1}{5,704}(-5950 - 1565 + 456) = -1237$

~~$Q_B = \frac{1}{5,704}(7240 + 1237 + 456) = 1565$~~

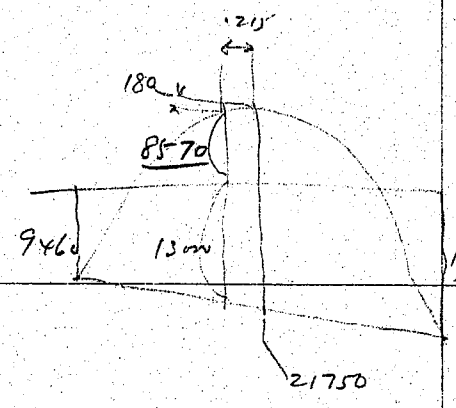
$R = \frac{1}{-7,408}(2290 - 2898) = 82$



$21750 \times \frac{1215^2}{2385^2} = 180$

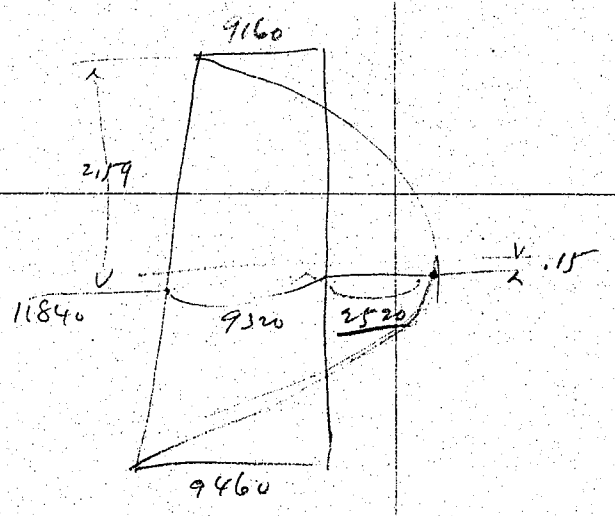
$7780 \times \frac{317}{477} = 3540$
9160
12700

21750
− 180
− 12700
8870



$7790 \times \frac{217}{477} = 3540$
9460
$13,000$ V

21750
− 180
− 13000
8570



$310 \times \frac{107}{1488} = 60$

11900
60
11840

$300 \times \frac{2,159}{488} = 160$
9160
9320

11840
9320
2520

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CALCULATIONS FOR

12型1次訂正

地震時.	θ_A = -80 (-60) (-55)	θ_B = 550 (570) (555)	R = 132 (120) (120→)	
-456	+550	-733	= -639	239
-80	+3140	-733	= +2327	123
-148	+1018	-978	= -108	108
-342	570	-666	= -438	38
-60	3250	-666	= 2524	74
-111	1055	-889	= 55	55
-314	555	-666	= -428	25
-55	3165	-666	= +2464	64
-102	1027	-889	= 36	36

θ_A = 55
θ_B = 555 RC
R = 125

$\theta_A = \frac{1}{5,704}(-400 - 555 + 694) = -46$
$\theta_B = \frac{1}{5,704}(2450 + 46 + 694) = 559$
$R = \frac{1}{-7,408}(85 - 1035) = 128$

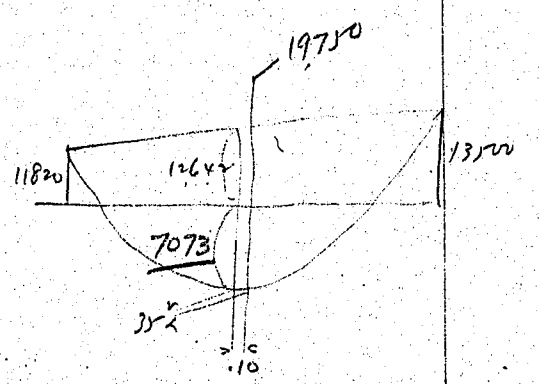
$\theta_A = \frac{1}{5,704}(-400 - 559 + 711) = -43,5$
$\theta_B = \frac{1}{5,704}(2450 + 43,5 + 711) = 562$
$R = \frac{1}{-7,408}(81 - 1040) = 129,5$

$\theta_A = \frac{1}{5,704}(-400 - 562 + 719) = -42,6$ -.9
$\theta_{13} = \frac{1}{5,704}(2450 + 42,6 + 719) = 563$ +1
$R = \frac{1}{-7,408}(79 - 1043) = 130$ +.5

$\theta_A = \frac{1}{5,704}(-400 - 563 + 722) = -42,2$ -.4
$\theta_{13} = \frac{1}{5,704}(2450 + 42,2 + 722) = 563$ 0
$R = \frac{1}{-7,408}(78 - 1043) = 130,3$ +.3

$\theta_A = \frac{1}{5,704}(-400 - 563 + 72\cancel{4}) = -42,0$
$\theta_{13} = \frac{1}{5,704}(2450 + 42,1 + 72\cancel{4}) = 56\cancel{4}$
$R = \frac{1}{-7,408}(78 - 104\cancel{4}) = 130,\cancel{4}$

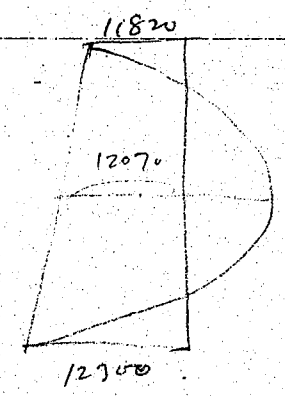
-240 ✓	+56\cancel{4} ✓	-724 ✓	= -400 0
-42,1 ✓	+3219 ✓	-724 ✓	= +2451 1
-78 ✓	+1044 ✓	-966 ✓	= 0 0



$19750 \times \frac{\cdot 10^2}{2385} = 35$
$1680 \times \frac{2,385}{4,77} = 822$
11820
12642

19750
- 35
- 12642
7073

35
822
12350
-13160
19750
6590



$480 \times \frac{2,54}{4,88} = 250$
11820
12070

17930
12070
1860

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CALCULATIONS FOR

12型，三訂ひ

当時.	$Q_A = -950$ -920 -910	$Q_B = 1270$ 1230	$R = 80$		
	-5590	$+1270$	-467	$= -4787$	197本 JJ 40
	-950	$+7480$	-467	$= 6063$	183本 J1 38
	-1847	$+2470$	-622	$= +1$	1/1本
	-5420	$+1230$	-467	$= -4657$	C7本
	-920	$+7245$	-467	$= 5858$	22本
	-1790	$+2392$	-622	$= -20$	20本

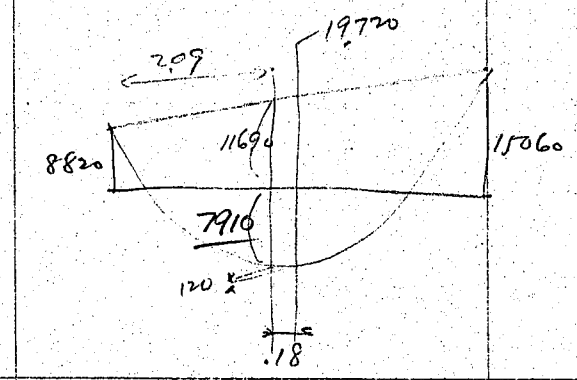
$Q_A = -910$
$Q_B = 1230$ 2t
$R = 80$

$Q_A = \frac{1}{5.890}(-4590 - 1230 + 467) = -909$
$Q_B = \frac{1}{5.890}(5880 + 909 + 467) = 1232$
$R = \frac{1}{-7.780}(1767 - 2392 + 622) = 80.8$

$-5345 + 1233 - 476 = -4588$ (-2)
$-908 + 7270 - 476 = 5886$ (+6)
$-1766 + 2400 - 634 = 0$ ✓

$Q_A = \frac{1}{5.89}(-4590 - 1232 + 471) = -909$
$Q_B = \frac{1}{5.89}(5880 + 909 + 471) = 1233$
$R = \frac{1}{-7.78}(1767 - 2400) = 81.4$

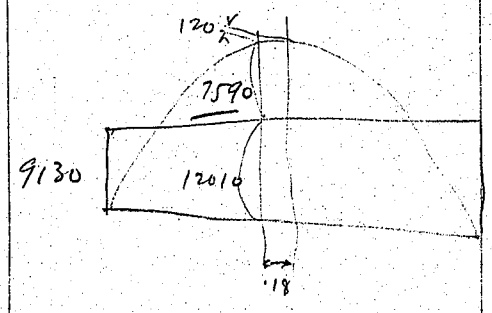
$Q_A = \frac{1}{5.89}(-4590 - 1233 + 475) = -908$
$Q_B = \frac{1}{5.89}(5880 + 908 + 475) = 1233$
$R = \frac{1}{-7.78}(1766 - 2400) = 81.5$



$19720 \times \frac{.118^2}{2.27^2} = 120$

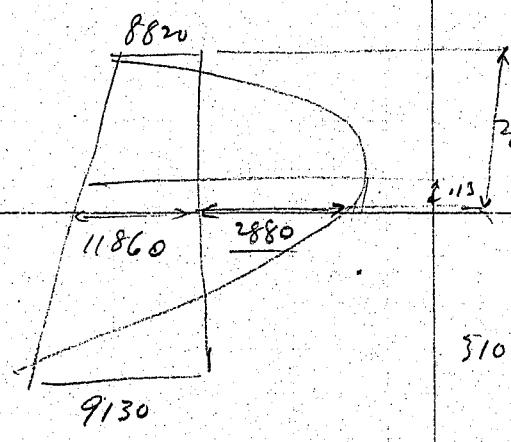
$6240 \times \frac{.209}{4.54} = 2870$
$\frac{8820}{11690}$

19720
-11690
-120
7910



2880
9130
12010

19720
-120
-12010
7590



11900
40
11860

$310 \times \frac{2.57}{4.88} = 160$
8820
-8980
11860
2880

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CALCULATIONS FOR

ロ型ノ三訂正

地震時

θ_A = ~~+89~~ 222 , θ_B = ~~320~~ 300 , R = 130

+1307 + 300 -5 − 758 = 887 37* 849 1*
+222 + 1767 -30 − 758 = 1352 152* 1231 31*
+432 + 584 -10 − 1011 = 48 48* .5 5*

θ_A + 223
θ_B + 296
R + 130

$\theta_A = \frac{1}{5.89}(850 - 296 + 759) = 223$

$\theta_B = \frac{1}{5.89}(1200 - 223 + 759) = 295$

$R = \frac{1}{-7.78}(-434 - 574) = 129.7$

$\theta_A = \frac{1}{5.89}(850 - 295 + 756) = 22.3$

$\theta_B = \frac{1}{5.89}(1200 - 223 + 756) = 294$

$R = \frac{1}{-7.78}(-434 - 572) = 129.5$

上
17920
11645
6275

下
17920
12145
5775

横
17930
11790
6140

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