JIUN MASUDA
CONSULTIEG ENGINEER
JIJI BLDG TOKYO

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CALCULATIONS FOR

靜岡縣清水港線上設備巴川鐵道橋設計書

昭和四年三月

JIUN MASUDA
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MADE BY K. I DATE 4-3-11 FILE NO

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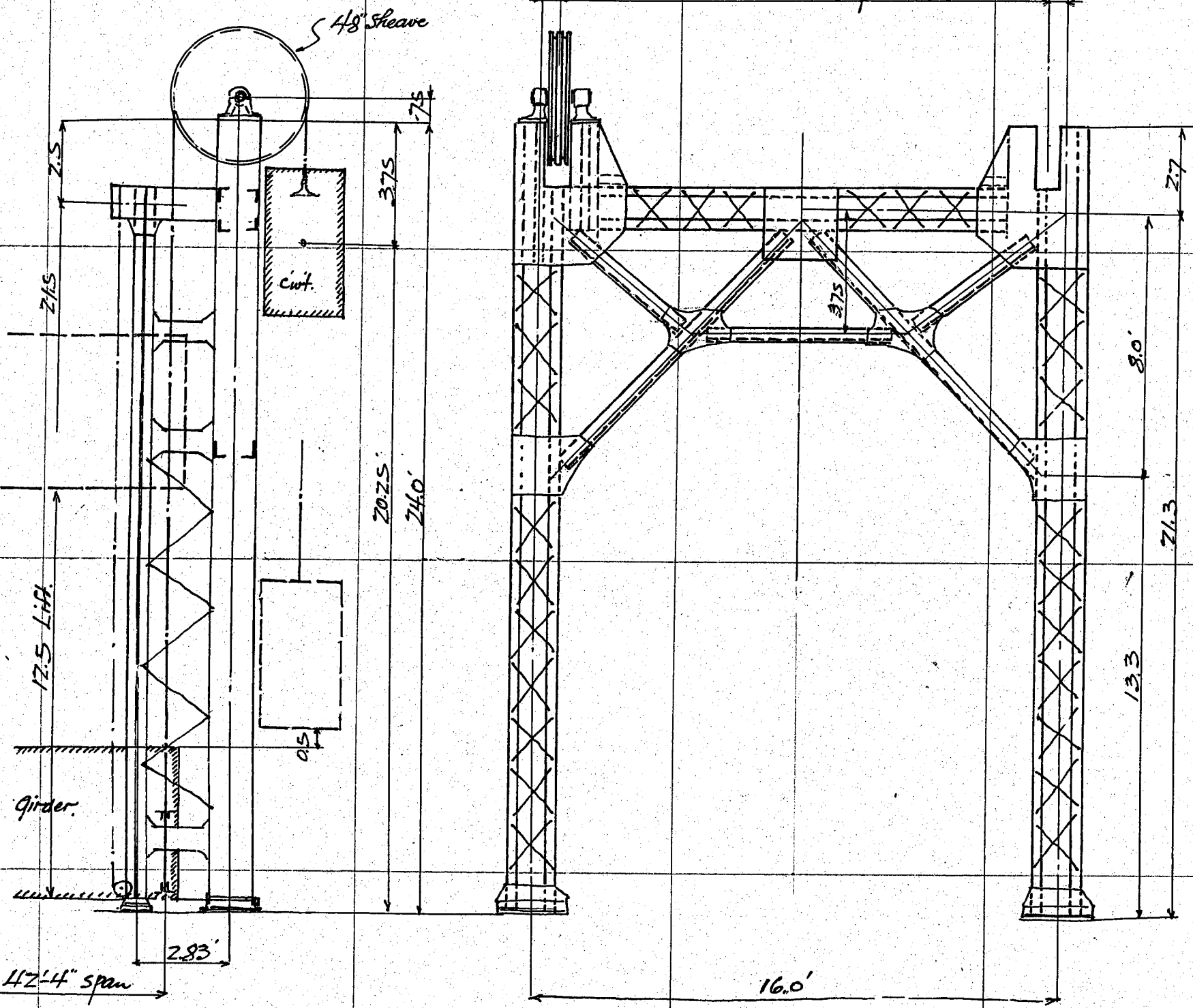
CALCULATIONS FOR

40 ft. Lift Bridge for Shizuoka Ken
Design of Tower.



Dead Load of moving span.

Weight of Structure		20.0 tons.
" " track	44'@ 200# = 8800# =	4.0
Operator's houses	2 @ 2.0 tons =	4.0
machinery.	=	5.0
		33.0 tons or 74,000# (37000# for one tower)

Counter weight Taking 95% of the above weight or 33 × .95 = 31.4 tons or 70,000#
(35000# for one tower)
volume of counter weight
use punch scrap concrete, 225 #/cut ft.
70,000 ÷ 225 = 310 cut ft (155 cut ft for one tower).

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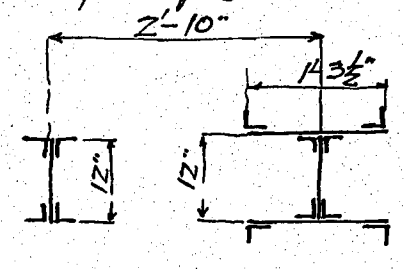
CALCULATIONS FOR

40 ft Lift Bridge for Shizuoka ken.

Weight of Tower Frame.



Main post.		Average length		
8 Ls	3½ × 3½ × ⅜"	23.0'	@ 8.5	= 1,564
2 Pls.	15" × ⅜"	23.0	@ 19.13	= 880
1 Pl.	11½ × ⅜"	23.0	@ 14.66	= 336
				2780 # × 2 = 5560 #
Sub post.				
4 Ls	3½ × 3½ × ⅜	22.0	@ 8.5	= 748
1 Pl.	12" × ⅜	22.0	@ 15.3	= 337
				1085 × 2 = 2170 #
Strut				
4 Ls	3½ × 3½ × ⅜	17.5	@ 8.5	= 425
Bracing				
2 × 2 Ls	5" × 3½ × ⅜	10.0	@ 10.4	= 416
2 × 2 Ls	"	4.5	@ "	= 188
1 × 2 Ls	"	6.0	@ "	= 125
				729
				8884
Rivet heads and miscellaneous details say 35%				= 3116
				12,000 #
Shoes and anchor Bolts say				1000
Sheaves and Bearings			2 @ 800	= 1600
				14,600 #

Stress in post.

Load on main post say 5800 #
" " Sub " " 1500 # } 7300

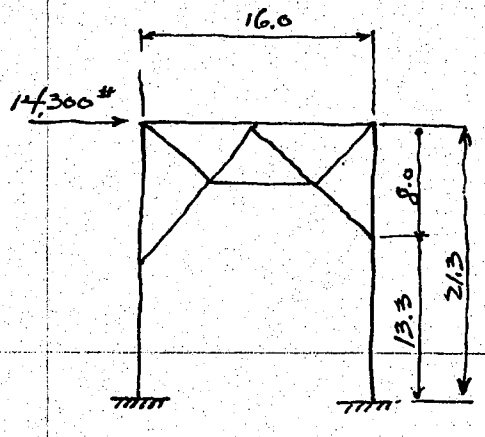
Load from liftspan	37000 ÷ 2 =	18500 #	15% impact
" " counterwt.	35000 ÷ 2 =	17500	2,800
Wt. of tower		5800	2,600
		41800	5400
15% impact for moving parts		5400	
Total load on one post.		47,200 #	

Section assumed.

Sectional area reqd. = 47200 / 14000 = 3.37 □"

8 Ls	3½ × 3½ × ⅜"	=	8 × 2.48 = 19.84 □"	− 12 × .375 = 15.34
2 Pls	15" × ⅜"	=	11.25	− 8 × .375 = 8.25
1 Pl.	11½ × ⅜"	=	4.31	− 2 × .375 = 3.56
			35.40 □" gr	27.15 □" net.

Transverse Seismic or wind stress. Acceleration of earthquake assumed 2500 mm/sec² or k = 0.25



Seismic force due to

Counterwt.	35000 × 0.25 =	8500 #
Tower	11600 × 0.25 =	2900
		11400 #

Wind pressure assumed at 300 kg/m² or 60 #/□'.

exposed area of liftspan = 4.7 × 2 × 22' = 202 □'

Wind pressure due to liftspan = 202 × 60 = 12100

" " tower 1.5 × 24 × 60 = 2200

14300 #

Wind stress governs.

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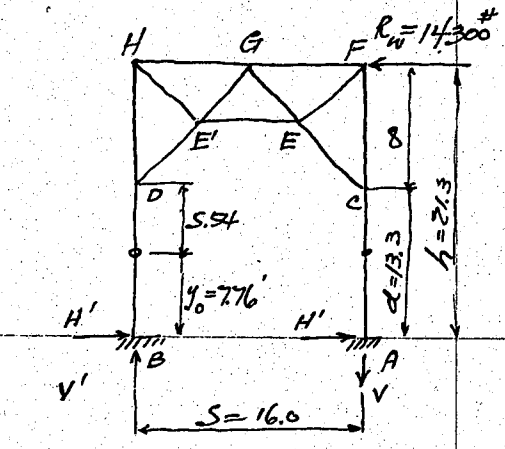
CHECKED BY DATE PAGE NO 3

CALCULATIONS FOR

40 ft. Lift span for Shizuoka Ken.

Transverse wind stress on tower frame.



$H = H' = \frac{R}{2} = \frac{14300}{2} = 7{,}150^{\#}$

$V = -V' = \frac{R(h-\frac{d}{2})}{S} = \frac{14300\,(21.3-6.65)}{16} = 13{,}100^{\#}$

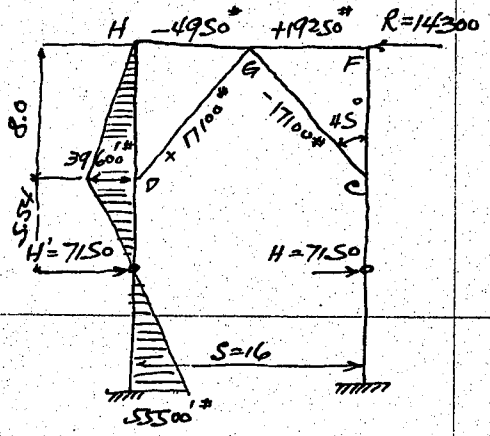
Point of contra-flexure

$y_0 = \frac{d}{2}\left(\frac{d+2h}{2d+h}\right) = \frac{13.3}{2}\left(\frac{13.3+42.6}{26.6+21.3}\right) =$ 7.76' above base.

$M_B = -M_A = H\,y_0 = 7150 \times 7.76' = 55{,}500$ '#

$M_D = 7150 \cdot 5.94 = 39{,}600$ '#

$HG = \frac{7150 \cdot 5.94}{8} = -4{,}950^{\#}$



$GF = +4950 + 14300 = +19{,}250^{\#}$

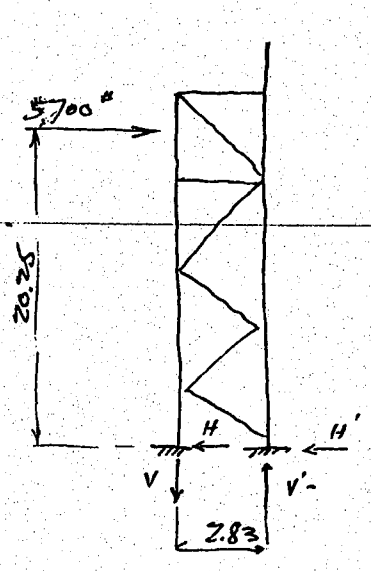
$GD = -GC = \frac{(4950+19250)\cdot 1.414}{2} = \frac{34200}{2} = 17{,}100^{\#}$

Longitudinal Seismic stress on tower bent.

Seismic force due to counter wt. and tower $= \frac{11400}{2} = 5700^{\#}$ on one side

$V' = -V = \frac{5700 \times 20.25}{2.83} = 40{,}800^{\#}$

$H = H' = \frac{5700}{2} = 2{,}850^{\#}$



Summary for Stresses.

	Reaction V	Reaction H	Stress in member HG	GF	DG + GC	moment M_A + M_B,	M_C + M_D
Dead load Stresses	47200	—	—	—	—	—	—
Wind Stresses	13100	7150	4950	19250	17100	55500	39600
Seismic stresses	40800 *	5700 *	3950 *	15350 *	13600 *	44300 *	31600 *
DL + W.L	60300	7150	4950	19250	17100	55500	39600
DL + S.L	88000 *	5700 *	3950 *	15350 *	13600 *	44300 *	31600 *
DL + WL + SL	148300	12850	8900	34600	30700	99800	71,2000
min	−6700						

Note Mark * indicates transverse seismic stresses (by propotion)

Load on pier

Dead load main post 2c 41800 = 83600
Sub post 2c 1500 = 3000
Live Load (Cooper E40) 2c 78000 = 156000
242600* on one pier

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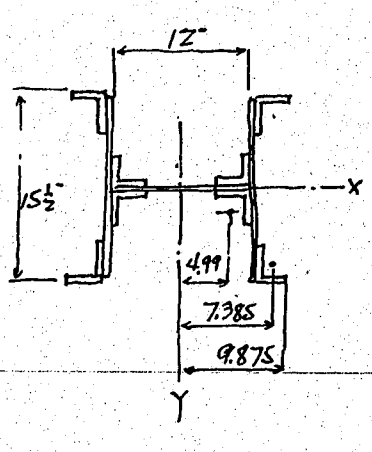
CALCULATIONS FOR

40 ft Light span for Shizuoka Ken.

Section for main post.



max. load during wind 60300# M_A = 55500 1#
" during wind + earthquake 148,300 M_A = 99,800

moment of inertia about Y–Y axis

4 Ls 3½ × 3½ × ⅜	= 4 × 2.48 =	9.92"	2.9 × 4 + 9.92 × 7.385² =	553
4 Ls "	=	9.92	2.9 × 4 + 9.92 × 4.99² =	259
2 Pls 15" × ⅜	=	11.25	11.25 × 6.19² =	431
1 Pl. 11½ × ⅜	=	4.31		48
		35.40"		1291 "4

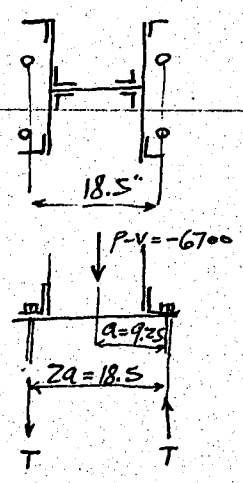
Radius of gyration $R_y = \sqrt{\frac{1291}{35.4}} = 6.04"$ $\frac{l}{r_y} = \frac{21.3 \times 12}{6.04} = 42.3$

Stress during wind = $\frac{60300}{35.4} \pm \frac{55500 \times 12 \times 9.875}{1291} = 1705 \pm 5090 = 6795$ #/□" C or 3385 #/□" T

Stress during wind + earthquake = $\frac{148300}{35.4} \pm \frac{99800 \times 12 \times 9.875}{1291} = 4210 \pm 9160 = 13370$ #/□" C or 4950 #/□" T

Allowable stress = $1200 - 5\frac{l}{r} = 1200 - 5 \times 42.3 = 989$ kg/cm² = 14000 #/□"
Allowable stress during wind = 14000 × 1.25 = 17500 #/□"
" " " wind + earthquake = 14000 × 1.4 = 19600 " ok
Unit ~~Stress~~ Shear = 12850 ÷ 4.31 = 2980 #/□" ok
Use same section throughout the column.

Anchor Bolts 4 Bolts.



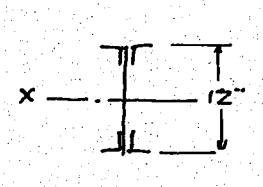
Tension on 2 Bolts $T = -\frac{Ma}{2a} + \frac{P-V}{2} = -\frac{99800 \times 12}{18.5} - \frac{6700}{2} = 68100$#

Tension for one bolt = $\frac{68100}{2} = 34050$#

Area req'd = $\frac{34050}{16000 \times 1.4} = 1.520$" net

Use 4 – 1⅝"ϕ bolts 30" long

Sub Columns



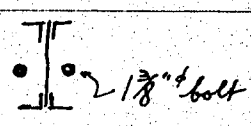
Moment of inertia about x–axis.

4 Ls 3½ × 3½ × ⅜	=	9.92	2.9 × 4 + 9.92 × 4.99² =	259
1 Pl. 11½ × ⅜"	=	4.31		48
		14.23 in²	− 10.375 = 10.48" net	307 "4

Radius of gyration $r_x = \sqrt{\frac{307}{14.23}} = 4.65"$

$\frac{l}{r_x} = \frac{21.5 \times 12}{4.65} = 55.4$

Unit tension = $\frac{40800}{10.48} = 3890$ #/□" ok

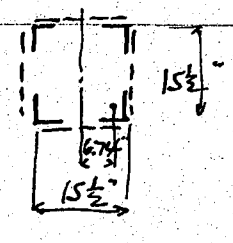


Unit. comp. = $\frac{40800}{14.23} = 2870$ #/□" ok

Anchor bolts
Area req'd. = $\frac{40800}{16000 \times 1.25} = 2.04$ for 2 bolts
Use 2 – 1⅜"ϕ bolts. 24".

Section of Top Struts

4 Ls 3½ × 3½ × ⅜" = 9.92" Stress = 34600 #C
Unit stress = $\frac{34600}{9.92} = 3490$ #/□" ok



moment of inertia 4 Ls 2.9 × 4 + 9.92 × 6.74² = 463 "4

$r = \sqrt{\frac{463}{9.92}} = 6.82$"

$\frac{l}{r} = \frac{16 \times 12}{6.82} = 28.2$ ok

Use 8 – ⅞"ϕ rivets or more.

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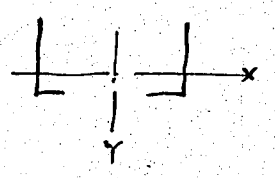
CALCULATIONS FOR

40 ft. lift span for Shizuoka Ken.

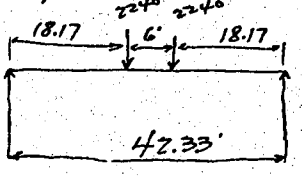
Stress in diagonal



30700 # T or C
2 L's 5"×3½"×⅜" = 6.10"sq − 1.50 = 4.60" net
Unit stress = 30700/4.6 = 6680 #/" T ok
or = 30700/6.1 = 5030 #/" C ok
r_x = 1.6" l/r = 6×12/1.6 = 45 ok
Use 8 − ⅞" ϕ rivets

Flange area of main girder for the additional dead load due to Operator's houses and Machinery.

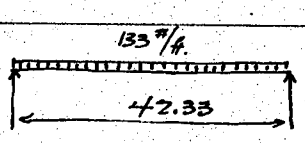
Operator's house



2 tons or 4480 # at center of span. assumed. (for one girder)
Reaction = 2240 #
moment = 2240 × 18.17 = 40,700 '#

Machineries

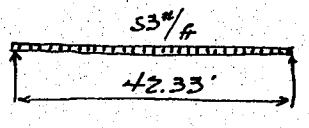
2.5 tons or 5600 # distributed over span.
or w = 5600/42.33 = 133 # per lin. ft. of span



moment = 133 × 42.33²/8 = 29,800 '#

Increased wt. of structural steel &c.

1.0 tons or 2240 # distributed over span.
or w = 2240/42.33 = 53 # per lin. ft. of span.



moment = 53 × 42.33²/8 = 11,900 '#

Summary of moment

Operating house	40,700
machineries	29,800
Steel increased	11,900
	82,400 '#

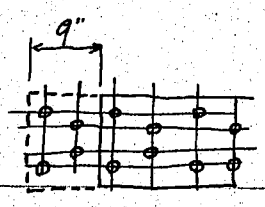
Flange section (Standard.)

2 Cov pls. 13½" × ⅜" = 10.1 × .375 = 3.79
2 L's 6" × 6" × ½" = 11.5 × 2.43 = 27.90
21.6 × 1.47 = 31.69

Effective depth of girder = 58.0 − 1.47 × 2 = 55.06"
Flange area to be increased = 82400 × 12/(55.06 × 16000) = 1.12 "sq at center of span.

⅛" of cov. pl. = 13⅜ × ⅛ = 1.69 "sq

Use 2 L's 6" × 6" × ½"
2 Cov pls. 13½" × 7/16" instead of 2 cov pls. 13½" × ⅜".



Cover plate length shall be added 1.12 × 16000/6010 = 3 rivets

Use 4 extra rivets or 9" elongated on both sides.

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CALCULATIONS FOR

40 ft. Lift Span for Shizuoka Ken

Design of Operating machinery

Weight of lift

Lift span	20.	assumed
Track	4.	"
Operator's house	4	"
Machine part	5	
	33.	
Counter weight 33×95	= 31.4	
	64.4	say 65 tons.

Span. 42'4" C. to C. Bearings
Lift 12'6"

Power required for vertical Lift span

1. unbalanced loads.
   $33 \times .05 \times 2240 = 1.65 \times 2,240 = 3,700^{\#}$
2. friction between guides and tracks.
   Wind pressure 30 #/sq. ft.
   total wind load $42.5 \times 4.75 \times 30 = 6,100^{\#}$
   friction $6,100 \times .15$ ------ $= 920^{\#}$
3. Vertical wind loads.
   Wind pressure 3 #/sq. ft. on the horizontal projection.
   loads $= 3 \times 42.5 \times 13 \times \frac{1}{2}$ ---- $= 830^{\#}$
4. Snow loads.
   1 #/sq. ft. assumed
   load $= 1 \times 42.5 \times 13 \times \frac{1}{2}$ ------ $= 280^{\#}$
5. Force required for accelerating the Span

$$F_1 = \frac{Wa}{g}$$

where F_1 = force required in lbs.
W = total weight of all moving load $65 \times 2,240 = 135,600^{\#}$
a = acceleration in ft. per sec.^{2}
operating time of lift 12'6" 1 min 20 sec.
acceleration time 20 sec.
retardation time 20 sec.
uniform motion 40 sec.
uniform speed $\frac{12.5}{\frac{20}{2}+40+\frac{20}{2}} = \frac{12.5}{60} = 0.208$ ft. per sec.

$$a = \frac{0.208}{20} = 0.01 \text{ ft. per sec.}^2$$

then

$$F_1 \frac{135,600 \times 0.01}{32.2} = 42^{\#} \text{ say } 50^{\#}$$

Total load $= 5,780^{\#}$ take $5,800^{\#}$

6. Friction of gears.
   assume. 2 spur gears and 1 worm gear.
   Total efficiency $= .93 \times .93 \times .65 = 56\%$
7. Force req'd. to bent the cables on and off of sheaves and drum.
   Total efficiency $= 95 \times 95 = 90\%$

$$\text{Power } P = \frac{5,800 \times 12.5}{33,000 \times .56 \times .9} = \frac{144.000}{33.000} = 4.4 \text{ H.P}$$

take 7.5 H.P

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MADE BY _____ DATE _____ FILE NO _____
CHECKED BY _____ DATE _____ PAGE NO 1

CALCULATIONS FOR

Material list for 40'-0" lift span, Shizuoka-Ken

主桁 for lift span

No.	Description	Section	Length	Total wt #
8	蓋鈑	13½" × 7/16"	16'-1¼	2,586
4	〃	〃	23'-3½	1,871
4	添接鈑	〃	3'-7½	291
8	山形	6 × 6 × ½	43'-6	6,821
4	腹鈑	56 × 3/8	21'-9	6,212
8	添接鈑	5½ × 3/8	2'-4	131
4	〃	13 × 3/8	3'-8¼	245
28	補剛材	5 × 3½ × 3/8	4'-7½	1,347
40	〃	4 × 3½ × 3/8	4'-8	1,699
8	塡材	7 × ½	3'-8¼	351
12	〃	3½ × ½	3'-8¼	263
3440	鉚頭 (工場鉚) 徑 7/8"			663
208	〃 (現場鉚)	〃		40
				22,520

縦桁

12	山形	4 × 4 × 7/16	11'-6	1,559
12	〃	〃	12'-1⅝	1,646
6	腹鈑	25½ × 3/8	9'-5¾	1,850
12	鈑	16 × 3/8	3'-11	782
48	添接鈑	3½ × 3/8	1'-6¼	326
24	〃	12¼ × 3/8	1'-5¼	539
24	塡材	10 × 7/16	1'-5¼	513
24	補剛材	6 × 3½ × 3/8	2'-0⅝	576
12	隅柬	3½ × 3½ × 3/8	1'-6½	157
12	〃	〃	2'-10	289
12	連結山形	5 × 3½ × 3/8	1'-1½	140
12	塡材	3½ × 3/8	0'-6¾	30
1650	鉚頭 (工場鉚) 徑 7/8"			319
432	〃 (現場鉚)	〃		83
				8,809

縦桁

16	山形	3½ × 3½ × 3/8	4'-10½	664
16	〃	〃	5'-10¼	795
8	鈑	15 × 7/16	5'-10¼	1,045
10	山形	6 × 6 × 7/16	0'-7½	172
1240	鉚頭 (工場鉚) 徑 7/8			239
384	〃 (現場鉚)			74
				2,989

繋構

6	山形	3½ × 3 × 3/8	12'-4½	586
12	〃	〃	6'-1	577
24	〃	3½ × 3½ × 3/8	0'-8	136
6	鈑	7 × 3/8	2'-0½	110
12	〃	14½ × 3/8	1'-9½	398
66	鉚頭 (工場鉚) 徑 7/8			13
670	〃 (現場鉚)	〃		129
				1,949

36,267.

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CALCULATIONS FOR

Material list for 40'-0" lift span, Shizuoka-Ken

Operating house & Center panel of Lift span

NO.	description	Section	Length	unit wt.	total wt.	
4	L	3½ × 3½ × ⅜	5'-11	8.5	201.2	
4	〃	〃	5'-6	〃	187.0	
2	Web p/s.	25 × ⅜	5'-11	31.88	377.3	
2	L	4 × 3½ × ⅜	1'-5	9.1	25.8	
4	〃	3½ × 3½ × ⅜	1'-6	8.5	51.0	
2	p/s.	11 × ⅜	1'-2	14.03	32.7	
2	〃	〃	1'-0	〃	28.1	
2	L	3½ × 3½ × ⅜	6'-8	8.5	113.3	
2	p/s.	15 × ⅜	2'-1	19.13	79.7	
4	Lac bars	3 × ½	2'-11	5.10	59.5	
1	L	3 × 3 × ⅜	7'-4½	7.2	53.1	
2	L	〃	3'-8	〃	52.8	
1	p/.	8 × ⅜	1'-5	10.2	14.5	
4	〃	11 × ⅜	1'-3	14.03	70.2	
2	L	3½ × 3½ × ⅜	0'-7	8.5	9.9	
4	〃	3½ × 3 × ⅜	4'-1	7.9	129.0	
2	p/s	6 × ⅜	1'-5½	7.65	22.3	
2	〃	8½ × ⅜	1'-4	10.84	28.9	
4	L	4 × 3½ × ⅜	4'-10½	9.1	177.5	
4	〃	4 × 3½ × ⅜	5'-10¼	〃	213.1	
2	Web p/s.	23 × ⅜	5'-10¼	29.33	343.4	
4	L	6 × 6 × 7/16	1'-4	17.2	91.7	
2	L	6 × 3½	2'-3	17.9	80.6	
2	L	3½ × 3½ × ⅜	0'-5½	8.5	7.8	
2	L	6 × 3½	6'-9	17.9	241.7	
1	p/.	44 × ⅜	6'-9	56.1	378.7	
					3070.8 #	110

Drum box. 4 Reqd.

3	L	3½ × 3½ × ⅜	2'-0	8.5	51.0	
2	p/s.	20 × ⅜	2'-0	25.5	102.0	
1	p/.	20½ × ⅜	2'-0	26.14	52.3	
2	L	3½ × 3½ × ⅜	1'-8	8.5	28.3	
2	〃	〃	1'-1	〃	18.4	
3	〃	〃	1'-2	〃	19.8	
2	p/s	20 × ⅜	1'-9	25.5	89.3	
					361.1	
					× 4	
					1,444.4	40

End Panel 2 Reqd.

1	C	6 × 3½	3'-7½	17.9	64.9	
2	L	3½ × 3½ × ⅜	0'-5½	8.5	7.9	
4	〃	6 × 3½ × ⅜	0'-3	11.7	11.7	
4	〃	4 × 3½ × ⅜	5'-0½	9.1	183.5	
4	〃	〃	6'-1	〃	221.4	
2	Web p/s.	19 × ⅜	6'-0	24.23	290.8	
4	L	6 × 6 × 7/16	1'-0	17.2	68.8	
2	p/s.	15 × ⅜	2'-0	19.13	76.5	
4	L	6 × 4 × ⅜	0'-3	12.3	12.3	
4	〃	4 × 3½ × ⅜	0'-8½	9.1	25.8	

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MADE BY_____ DATE_____ **FILE NO**_____

CHECKED BY_____ DATE_____ **PAGE NO** 3

CALCULATIONS FOR

Material list for 400' lift span. Shizuoka-Ken.

2	Web Pl.	8 × 3/8	1' 7	10.2	32.8	
2	L's	6 × 6 × 7/16	1' 0	17.2	34.4	
2	Pl's	10½ × 3/8	1' 2½	13.39	32.4	
2	L's	6 × 3½	3' 5½	17.9	123.8	
2	L's	3½ × 3½ × 3/8	0' 5½	8.5	7.8	
1	L	6 × 4½ 16 × 6 × 3/8	1' 6	14.9	22.4	
					1,216.7 ✓	
					2 ✓	
					2,433.4	60
	End Floor Beam.		2 Reqd.			
2	Flg. L's	4 × 4 × 7/16	11' 6	11.3	259.9	
1	"	"	12' 1⅝	"	137.1	
1	"	"	12' 2⅝	"	138.1	
1	Web Pl.	24 × 3/8	9' 4	30.6	285.6	
2	Fills	3½ × 3/8	0' 6 23/24	4.46	5.9	
2	Web Pl.	17 × 3/8	4' 0	21.68	173.4	
2	L's	3½ × 3½ × 3/8	2' 11	8.5	49.6	
2	"	"	1' 9	"	29.8	
4	Pl's.	12¼ × 3/8	1' 5	15.62	110.7	
4	L's	6 × 3½ × 3/8	1' 11½	11.7	91.6	
4	Fills	10 × 7/16	1' 5	11.88	67.3	
2	"	10½ × 7/16	1' 2¾	15.62	38.4	
2	Fills	13½ × 7/16	1' 2¾	20.08	49.4	
2	L's	4 × 4 × 7/16	1' 1½	11.3	25.4	
2	"	"	1' 5½	"	33.0	
2	Web. Pl's.	17½ × 3/8	3' 3	22.31	145.0	
2	L's	4 × 4 × 7/16	1' 6½	11.3	34.8	
2	"	"	1' 1	"	24.5	
2	"	"	3' 3	"	73.5	
2	Tension Pl.	14 × ½	1' 5½	23.8	69.4	
					1,842.4 ✓	
					2 ✓	
					3,684.8 ✓	130

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CHECKED BY_____ DATE_____ **PAGE NO** 4

CALCULATIONS FOR

Material list for 406' lift span. Shizuoka-Ken

✓ Center Lock ✓ 2 Req'd.

2	P/s	14 × ½	1 ∠ 8½	23.8	81.
2	Ls	6 × 3½ × ⅜	1 ∠ 2	11.7	27.
2	〃	4 × 4 × ⅜	0 ∠ 8	9.8	13.
1	P/.	14 × ⅜	1 ∠ 8	17.85	30
1	L	6 × 3½ × ⅜	1 ∠ 8	11.7	20.
2	Shim p/s	6 × ½	1 ∠ 2	10.2	24.
1	〃	4½ × ½	1 ∠ 2	7.65	9
					204
					2
					408

Cast steel and iron (Shoes and Center lock)

Cast steel shoe		83.5# × 2	167.
〃		256. × 2	512.
Steel p/.		45 × 2	90
Cast iron shoe		286 × 2	572.
Center lock (cast iron)		48 × 2	96
〃 (cast steel)		74.5 × 2	149
			1,586

Anchor bolts or bolts

8	Anchor bolts	1¼"ϕ	2'0 long	9.2 × 8	74.
16	bolts	1"ϕ	2¾ 〃	1.48 × 16	24.
8	Anchor bolts	1"ϕ	1'0 〃	3.1 × 8	25
24	bolts	¾"ϕ	¾ 〃	.78 × 24	19
8	Taped bolts	½"ϕ	1½ 〃	.154 × 8	1
					143

(Lift girder Span. Rivet head計) total wt. --- 49,037.4# = Tons.

変更部分, Rivet head --- 340.0

49.377.4 = 22.043

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CHECKED BY_____ DATE_____ **PAGE NO** 5

CALCULATIONS FOR

Material list for 404' lift span, Shipbuilding

		Main towers		2 Required.	
4	L	3½×3½×⅜	23'-8⅝"	8.5	806.4
12	"	"	21'-10¾"	"	2233.4
2	Pls	15×⅜	23'-8⅝"	19.13	907.5
2	"	"	21'-10¾"	"	837.7
2	"	11½×⅜	21'-10¾"	14.66	642.0
4	"	44×⅜	3'-9¼"	56.10	846.2
4	"	17½×⅜	1'-7¾"	22.31	146.9
4	"	20½×⅜	2'-3"	26.14	235.2
10	"	8½×⅜	1'-7¾"	10.84	178.4
8	Lac. Bars	3×7/16	2'-4"	4.46	83.2
4	Washers	3"ϕ×7/16		@ 0.9	3.6
2	Pls (a	19¾×⅜	2'-2"	25.18	109.2
2	" (b	"	3'-5"	"	172.1
2	L (c	6×4×½	1'-7¾"	16.2	53.3
4	" (d	4×3×½	"	11.1	73.1
4	Fills (f	3¼×½	"	5.53	36.4
24	L (g	3½×3½×⅜	0'-11½"	8.5	195.4
4	" (h	6×4×½	1'-2½"	16.2	78.3
4	" (j	4×3×½	0'-8"	11.1	29.6
4	Fills (k	3¼×½	0'-8"	5.53	14.8
4	" (m	8×⅜	6'-4¼"	10.2	259.2
4	L (n	6×4×½	0'-11"	16.2	59.4
4	Fills (p	4½×⅜	0'-6"	5.74	11.5
2	L (c'	6×4×½	1'-10"	16.2	59.4
4	Pls (r	12½×⅝	2'-0½"	26.56	216.7
8	L (s	3½×3½×⅜	3'-9¼"	8.5	256.4
2	Pls (t	15×⅜	3'-9¼"	19.13	144.3
2	" (u	"	1'-9"	"	67.0
4	L (v	3½×3½×⅜	2'-0"	8.5	68.0
8	" (w	"	1'-3¼"	"	86.4
4	" (x	"	2'-9¼"	"	94.2
2	Pls (y	15×⅜	2'-9¼"	19.13	106.0
8	L (z	6×4×½	0'-11"	16.2	118.8
4	" (a,	"	1'-2½"	"	78.3
4	Fills (b,	6×⅜	0'-8"	7.65	20.4
4	L	3½×3½×⅜	12'-4"	8.5	419.3
32	Lac. Bars	2½×⅜	1'-7½"	3.19	165.9
4	Pls (d'	22×⅝	2'-1"	46.75	389.5
2	"	22½×⅝	2'-0"	28.69	114.8
2	tie Pls	15×⅜	"	19.13	76.5
4	"	12×⅜	1'-3"	15.30	76.5
32	Lac. bars	2½×⅜	1'-8"	3.19	170.2
4	L	5×3×⅜	9'-11"	9.8	388.7
4	Pls	11½×⅜	1'-3"	14.66	73.3
2	"	14½×⅜	1'-3"	18.49	46.2
4	"	12×⅜	2'-3"	15.30	137.7
4	L	5×3×⅜	4'-2"	9.8	163.3
4	Pls	8½×⅜	1'-3"	10.84	54.2
8	Lac. Bars.	2½×⅜	1'-5½"	3.19	37.2
2	L	5×3×⅜	5'-10"	9.8	114.3
2	Pls	8½×⅜	1'-3"	10.84	27.1
7	Lac. Bars.	2½×⅜	1'-5½"	3.19	32.6
2	L	4×3×⅜	1'-7¾"	8.5	28.0
2	Pls	11½×⅜	"	14.66	48.3
2	"	17½×⅜	"	22.31	73.4

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MADE BY_____ DATE_____ **FILE NO**_____

CHECKED BY_____ DATE_____ **PAGE NO** 6

CALCULATIONS FOR

Material list for 40'-0 lift span, Shyuokaken.

2	L's	3½"×3½"×⅜"	0'-8½"	8.5	12.0
4	"	"	1'-0"	"	34.0
4	Fills.	3"×⅜"	0'-3½"	3.83	4.5
10	Pls.	8½"×⅜"	1'-7¾"	10.84	178.4
2	L's	3½"×3½"×⅜"	1'-3"	8.5	21.3
4	Fills.	3"×⅜"	0'-3½"	3.83	4.5
					12,220.4# ✓
					2 ✓
					24,440.8# ✓ or 10.911 ✓ Tons

✓Side Column ✓4-Required

4	L's	3½"×3"×⅜"	21'-7½"	7.9	683.4
1	Pl.	11½"×⅜"	"	14.66	317.0
2	L's	6"×4"×½"	0'-11¼"	16.2	30.4
1	Fill.	5½"×⅜"	1'-0½"	7.01	7.3
1	"	"	0'-6"	"	3.5
1	L's	6"×4"×½"	0'-5½"	16.2	7.4
2	Pls.	13½"×⅝"	1'-5½"	28.69	83.7
2	L's	3½"×2½"×⅜"	0'-11½"	7.2	13.8
1	Pl.	12"×⅜"	1'-1"	15.3	16.6
1	L.	6"×4"×½"	"	16.2	17.5
4	Pls.	12"×⅜"	"	15.3	66.3
3	"	10"×⅜"	1'-0"	12.75	38.3
8	L's.	2½"×2½"×⅜"	1'-10"	4.7	68.9
1	Pl.	7½"×⅜"	"	9.56	17.5
1	L.	6"×4"×⅜"	2'-5¼"	12.3	30.0
1	Pl.	11"×⅜"	0'-11"	14.03	12.9
2	Pls	8½"×⅜"	2'-5¼"	10.84	52.9
2	E's	6"×3"@14.49#	2'-1¼"		61.0
4	L's	6"×6"×7/16"	0'-5"	17.2	28.7
2	Pls.	6"×½"	0'-10"	10.2	17.0
2	L's	3½"×3½"×⅜"	0'-11½"	8.5	16.3
1	C	12"×3½"@26.10#	3'-3"		84.8
1	"	"	2'-1¼"		54.9
1	"	"	1'-5¼"		37.5
1	"	9"×3"@19.37#	1'-7"		30.7
2	L's	3½"×3½"×⅜"	0'-8¼"	8.5	12.0
					1,810.3 ✓
					4 ✓
					7,241.2# ✓ or 3.235 Tons

Anchor bolts ⅞"ϕ for Columns 4 Req'd.

1	Anchor Bolt	⅞"	3'-6"	@18.0	18.0
2	"	"	2'-0"	@11.3	22.6
6	"	"	3'-6"	@18.0	112.8
9	Washers	4"×½"	0'-4"	6.8	20.8
					175.0
					4 ✓
					700.0#

Total wts. of Towers	32382.0
¾"ϕ Rivet heads	1,150.0
	33,532.0 or 14.970 Tons

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MADE BY_____ DATE_____ **FILE NO**_____

CHECKED BY_____ DATE_____ **PAGE NO** 7

CALCULATIONS FOR

Material list for 40'-0" lift span. Shizuoka-Ken

Rail Joint — 4 Required.

1	Jointing Casting		@ 55.0 #		55.0
9	Caststeel beveled washers		@ 1.16		10.4
6	Lag Screw $\frac{7}{8}$"ϕ	× 0'-6"	@ 1.4		8.4
6	Bolts $\frac{7}{8}$"ϕ	× 0'-6½	@ 1.68		10.1
3	" "	× 0'-5	@ 1.43		4.3
1	Pl. 10 × ½	× 1'-6"	17.0		25.5
1	" 9 × ½	× 1'-4½"	15.3		21.0
					134.7
				× 4	Tons.
					538.8 or 0.241

Counter Weight girders — 2 Required

4	Ls	6 × 3½ × $\frac{3}{8}$	× 16'-6"	11.7	772.2
1	Pl.	29 × $\frac{3}{8}$	" "	36.98	510.2
24	Ls	4 × 3" × .300	× 3'-5½"	6.84	567.7
6	Pls	5½ × $\frac{3}{8}$	2'-4½	7.01	99.9
12	Ls	4 × 3 × .300	1'-10	6.84	150.5
6	Pls	5½ × $\frac{3}{8}$	2'-4½"	7.01	99.9
12	Fills	4 × $\frac{3}{8}$	2'-5½	5.10	150.4
8	Ls	4 × 3 × .300	"	6.84	134.5
8	"	"	1'-10	"	100.3
4	"	"	2'-5¼	"	133.4
2	Pls	28½ × $\frac{3}{8}$	3'-9½"	36.34	275.6
4	"	24 × $\frac{3}{8}$	3'-5 $\frac{5}{8}$	30.60	424.6
2	Ls	8 × 3	2'-5	19.30	93.3
4	Ls	4 × 3 × .300	0'-6	6.84	13.7
					3526.2
				× 2	
					7,052.4
		$\frac{3}{4}$"ϕ Rivet heads			195.0
					7,247.4 # or 3.235 Tons.

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MADE BY_____ DATE_____ **FILE NO**_____

CHECKED BY_____ DATE_____ **PAGE NO** 8

CALCULATIONS FOR

Material list for 40'-0" lift span, Shizuoka-Ken

Ladder for Main Girder of Lift or Fixed — 2-Req'd

2	Bars	$2\frac{1}{2}" \times \frac{3}{8}"$	1'-0"	3.19	6.4
1	,	,	3'-4"	,	10.6
1	,	,	2'-9"	,	8.8
1	Rod	$\frac{3}{4}"\phi$	1'-6"	1.052	2.3
					28.1
					2
					56.2

Ladder for Counter Weight — 1-Req'd

1	Bars	$2\frac{1}{2}" \times \frac{3}{8}"$	11'-6"	3.19	36.7
1	,	,	7'-9"	,	24.7
4	,	,	0'-6"	,	6.4
4	Rod	$\frac{3}{4}"\phi$	1'-6"	1.502	9.0
2	L	$3" \times 3" \times \frac{1}{4}"$	2'-3"	4.90	22.0
2	,	$2\frac{1}{2}" \times 2\frac{1}{2}" \times \frac{1}{4}"$	0'-11½"	4.10	7.9
4	Pls.	$5\frac{1}{2}" \times \frac{1}{4}"$	0'-5½"	4.675	8.7
2	L	$3" \times 3" \times \frac{1}{4}"$	3'-6"	4.9	34.4
4	Pls.	$6" \times \frac{1}{4}"$	0'-8"	5.1	13.7
2	L	$2\frac{1}{2}" \times 2\frac{1}{2}" \times \frac{1}{4}"$	3'-0"	4.1	24.6
2	Bars	$2\frac{1}{2}" \times \frac{3}{8}"$	0'-9"	3.14	4.8
2	Pipe	$\frac{3}{4}"\phi$	3'-6"	1.502	10.5
2	,	,	2'-7"	,	7.8
1	Checkered Pl.	$21" \times \frac{5}{16}"$	2'-6"	22.31	55.8
8	Pedestals for $\frac{3}{4}"\phi$ pipe			0.54	4
					267.4

Ladder for Column — 1-Req'd

~~2~~	~~Rods~~	~~$\frac{3}{4}"\phi$~~	~~1'-6"~~	~~.502~~	~~1.3~~
1	C	$6" \times 22\frac{1}{2}"$ @ 12.04#	3'-0"		36.1
1	,	,	2'-6"		30.1
1	,	,	1'-6"		18.1
2	L	$3" \times 3" \times \frac{1}{4}"$	2'-4"	4.9	22.8
2	,	,	3'-0"	,	29.4
6	Pls.	$6" \times \frac{1}{4}"$	0'-8"	5.1	20.5
3	L	$2\frac{1}{2}" \times 2\frac{1}{2}" \times \frac{1}{4}"$	3'-3"	4.1	40.0
3	,	$3\frac{1}{2}" \times 2\frac{1}{2}" \times \frac{1}{4}"$	0'-5½"	4.9	6.8
2	Pipe	$\frac{3}{4}"\phi$	4'-8"	1.13	10.6
2	,	,	3'-0"	,	7.8
1	Checkered Pl.	$39" \times \frac{5}{16}"$	4'-6"	22.31	100.4
84	Rods	$\frac{3}{4}"\phi$	1'-6"	1.502	180
8	Pedestals for $\frac{3}{4}"\phi$ Pipe				.4
					340.0

for 4 Col's.

Total wt. for ladders	6640#
$\frac{3}{4}"\phi$ Rivet heads	130
	6771.6# or 0.303 Ton

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MADE BY_____ DATE_____ **FILE NO**_____

CHECKED BY_____ DATE_____ **PAGE NO** 9

CALCULATIONS FOR

Material list for 40'-0 lift span, Shizuoka-Ken

TOTAL WEIGHT SUMMARY FOR LIFT 40'-0" SPAN 1 Required.

	TONS.	
Main girders (リベット含む)	22.043	40.248
Towers (")	14.970	
Counter w't girder (")	3.235	
Ladders	0.303	
Rail joint.	0.241	
	40.792	

GRAND TOTAL WEIGHT.

	TONS.
40'-0" LIFT SPAN	40.792 × 1 = 40.792
40'-0 FIXED "	17.984 × 5 = 89.920
30'-0" " "	11.966 × 1 = 11.966
	142.678

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MADE BY K. I. DATE 4-3-15 FILE NO
CHECKED BY DATE PAGE NO 10

CALCULATIONS FOR

40 ft Lift span for Shizuoka ken.

Track construction with Wood Floor

Cross sleepers	檜材	8"×9"×7'-0"	16	挺
Longitudinal sleepers	〃	3½"×9"×7'-6"	4	〃
〃 〃	〃	3½"×9"×7'-0"	2	〃
Cross Beams	內地産赤松	3"×4"×3'-0"	15	〃
〃	〃	4½"×6"×5'-0"	4	〃
Floor Boards	〃	厚正一寸巾七九寸	40	面坪
〃	〃	3½"×9"×3'-0"	6	本
Bolts for Longdl. Sleepers		¾"ϕ×4"	60	〃
Rails		60#/yard×33'-0"	2	挺
〃		〃 ×5'-5½"	4	〃 一端特殊加工共
Guard Rails		〃 ×18'-11¼"	4	〃
〃 L3		4"×3"×⅜"×6'-0½"	2	〃
Bolts & Fills.			10	本

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MADE BY__________ DATE__________ **FILE NO**______

CHECKED BY__________ DATE__________ **PAGE NO**______

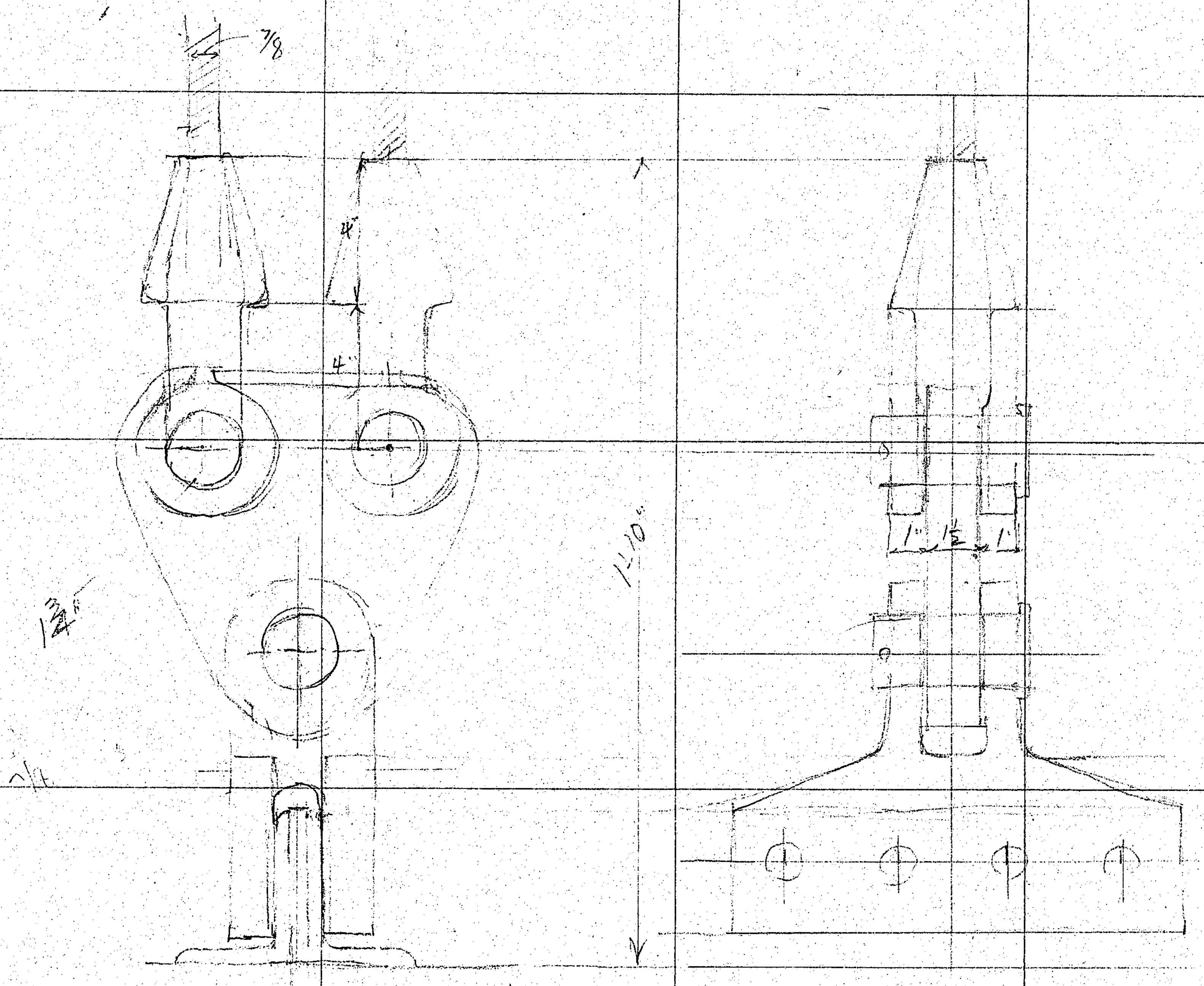
CALCULATIONS FOR

Equalizer $\frac{33}{4}$ tons = 8.25 ton × 2240 = 18.500 #

Size of cable. Try 2⅜" .875φ – breaking strength 26.82 tons

factor of safety = $\frac{26.82}{8.25}$ = 3.25   using 2 cables – factor of safety 6.5

structural steel section – $\frac{18.500}{16.000}$ = 1.16 □"   Diameter nut. 1¼"φ   use 1⅞"φ ½ grooves each cable



Bending moment of pin $\frac{18.500}{2}$ # × 1.25 = $\frac{23.100}{2}$ "# = 11.550 "#

dia of pin = 1¾"φ pin good for 12.600 unit 24.000 #/□"

bearing area. 1¾ × 1½ = 2.62   18.500 ÷ 2.62 = 7050 #/□" ok

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CALCULATIONS FOR

MADE BY ______ DATE ______ **FILE NO** ______

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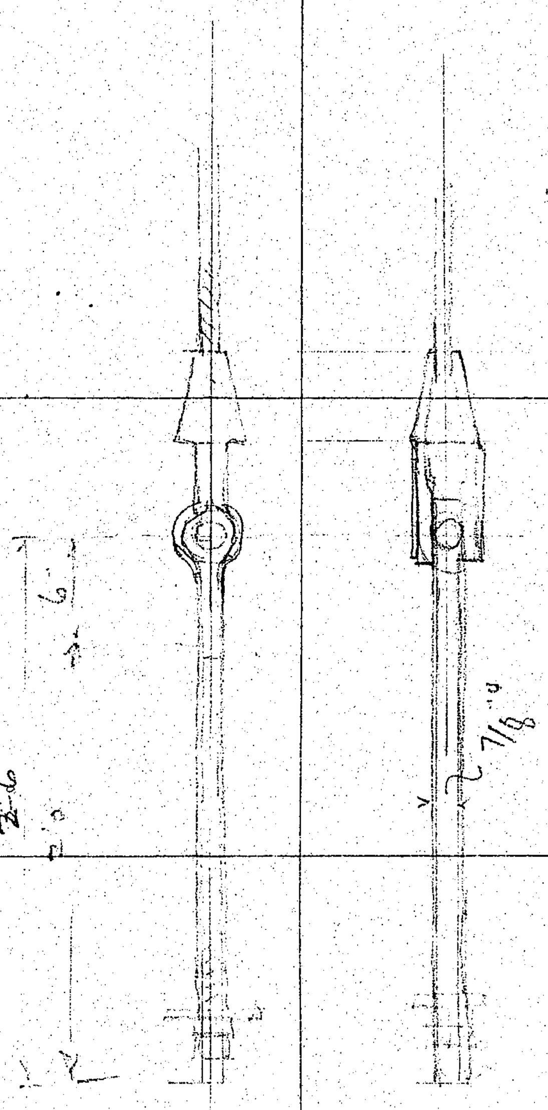
Operating rope. $\frac{5800}{16000}$ = .363 7/8" bars threaded



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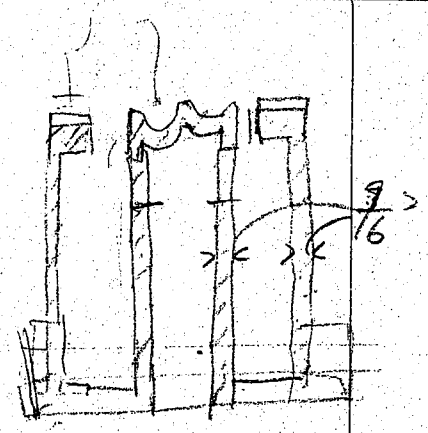
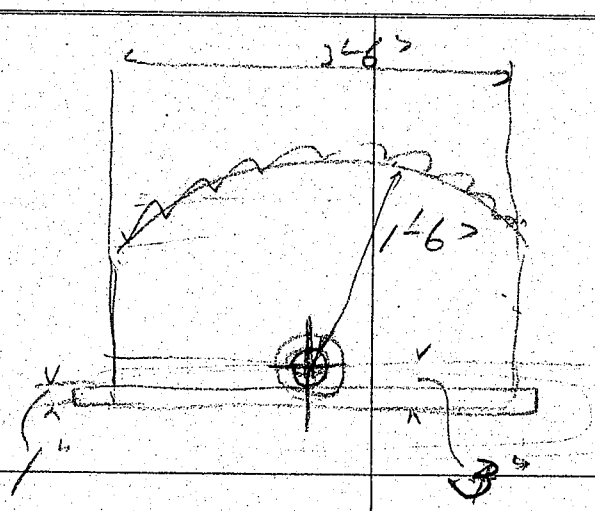
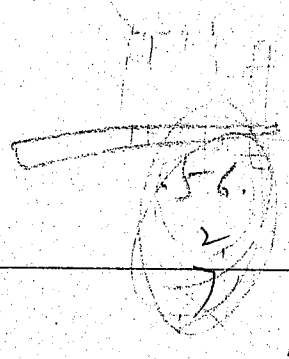
CALCULATIONS FOR



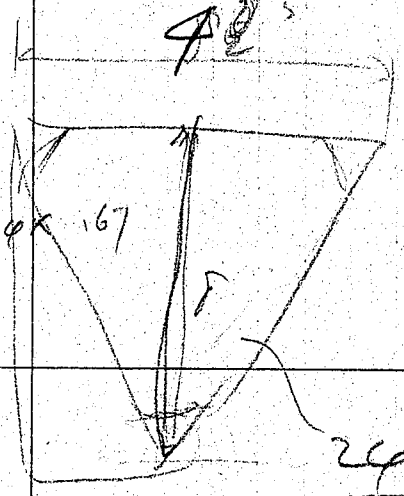




$16" \times \frac{3}{4}" \times 3.5' = 40.8 \times 3.5 = 560\#$

$30.6 \times 3.5 \times 3.5 = 370.$

35



$20.4 \times 16.7 = 137\#$

23.5

77.

231

24

$6\frac{1}{2}" \times \frac{5}{8}" \times 0'-9\frac{1}{2}" = @13.8 \times .79 = 10.9\#$

$2\frac{1}{2}" \times \frac{5}{16}" \times 2'-7" = @2.66 \times 2.58 = 6.9$

$4" \times 1" \times 216" = @4.25 \times 2.5 = 10.5$

$6" \times 3" \times 0'-9" = @6.38 \times .75 = 4.8$

$33.1 \times .92 = 30.1$

31 #

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CALCULATIONS FOR

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1. General Plan and Elevation of Lift man
2. Details of main girder
3. " " floor beam etc
4. Towers
5. "
6. Detail counter weight & Rope.
7. Tower sheave bearing & shaft
8. General arrangement of machinery & floor and rail
9. details of drum & bearings. Capstan & bum
10. " " worm gear.
11. bearings. couplings for operating shafts
12. Common Bearings
13. Details of gears.
14. General arrangement of End locking
15. Machinery for end locking
16. End locking guide & pin. Rail guide lefts ma
17. details of air buffer
18. Wiring diagram.