JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

MADE BY ________ DATE ________ FILE NO ________
CHECKED BY ________ DATE ________ PAGE NO ________

CALCULATIONS FOR

昭和十年　月

三重縣
長島海野線 江ノ浦可動橋應力計算書

JIUN MASUDA
CONSULTING ENGINEER
~~—~~ BLDG, TOKYO
SHOWA

MADE BY J. Masuda DATE 9-12-17 **FILE NO.**

CHECKED BY ________ DATE ________ **PAGE NO.** 1

CALCULATIONS FOR

Design of Enoura Bascule span for Mie-Ken.

The bridge is to be built across bay to extend Nagashima-cho limit beyond the bay. The total length of the bridge 96.0 meters about and the roadway 3.6 meters throughout. The second span from the north end will be bascule span for navigation to utilize the broad inner bay as a part of harbor. We decided to adopt a Strauss overhead counterweight bascule after minute investigation of first cost of construction and the operating cost and also other features of several types of bascule bridge, and we believe the adopted type best suit to the site. Part beside bascule span will be designed by prefectural engineers and the bascule span only designed by our office.

The clear span of the bascule bridge 10.40 meters and the total length of span beyond turning trunnion 12.724 meters and the rear arm for concrete counterweight 2.80 meters; the deck constructed with timber floor 3.6 meter wide clear. The bascule pier to support entire bascule leaf consists of 2 $2.5^m \times 4.0^m$ concrete caissons 10.0 meter long sunk 3.5 meters into the bottom ground and 0.6^m above top of low water level. Above these caissons concrete floor and framings are built to carry operating house and machinery set as well as bascule leaf complete.

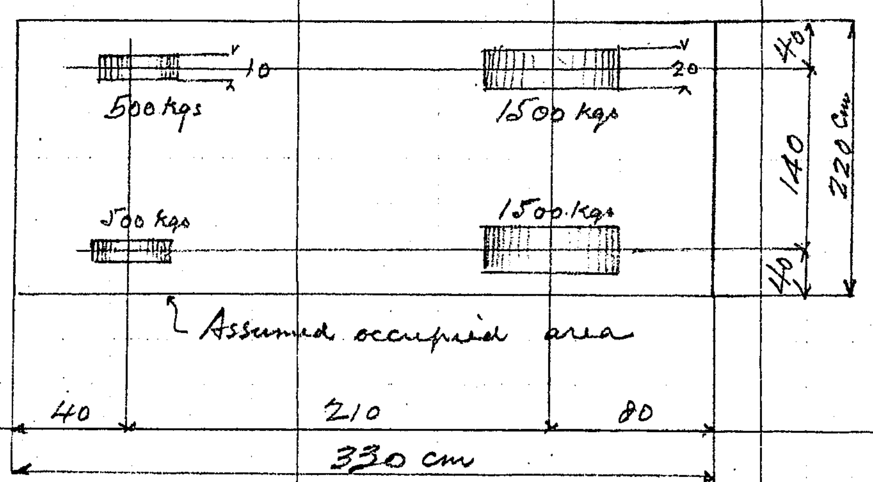
Assumed loadings

Uniform live load on roadway $w = \frac{100.000}{170+l} \leqq 500\ kg/m^2$

where l = span length in meter
w = uniform live load in kg per square meter.

Motor truck loading

4.0 ton motor truck loading assumed as follows.



One motor truck on one span unoccupied spaces around the motor truck shall be filled with the uniform live load specified above.

Impact coefficient for motor truck loading

coef = $\frac{20}{60+l}$ where l = loaded length in meters
max. impact 30%

No impact for uniform live load.

Allowable unit stresses of materials
structural steel or reinforcing bars

Tension ________ 1200 kg/cm^2
Extreme fibre stress ________ 1200 "
Shear of web (gross section) ________ 900 "
Compression members $1500(1 - 0.0055\ l/r)$ not over ________ 1000 "

where l = unsupported length of member in cm
r = least radius of gyration in cm

JIUN MASUDA
CONSULTING ENGINEER
BLDG, TOKYO
SHOWA

MADE BY J. Masuda DATE 9-12-17 FILE NO
CHECKED BY DATE PAGE NO 2

CALCULATIONS FOR

Design of Enoura Bascule Span for Mie-Ken

Compression flange of girder 1200 (1 - 0.012 l/b) not over	1100 kgs/cm²
where l = unsupported length of flange in cm	
b = width of flange in cm	
Shear on shop driven rivets (machine driven)	850 "
" " field " " and turned bolts (machine driven)	750 "
Shear on pins	900 "
Bearing on shop driven rivets (machine driven)	1700 "
" " field " " (" ")	1500 "
" " pins	1800 "

Concrete

Direct compression	35 kgs/cm²
Fibre stress due to bending	45 "
Combined stress, direct and bending compression members	35 "
Punching shear of concrete	9 "
Shear of plain concrete	4 "
Bearing value	45 "
Bond stress for plain bar	6 "

Weight of materials assumed

Cast iron	7250	kgs per cubic meter
Structural steel	7850	" " "
Cast steel	7860	" " "
Reinforced concrete	2400	" " "
Plain concrete	2200	" " "
Cement mortar	1700	" " "
Granite	2600	" " "
Sand	1700	" " "
Earth	1600	" " "
Wood or timber	650	" " "

Considering wind or temperature stress in addition to dead, live and impact stresses, the allowable unit stresses shall be increased 25%. In case of Seismic stresses unit stress increased 60%

Seismic acceleration assumed 1500 mm/sec² or say k = 0.15

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

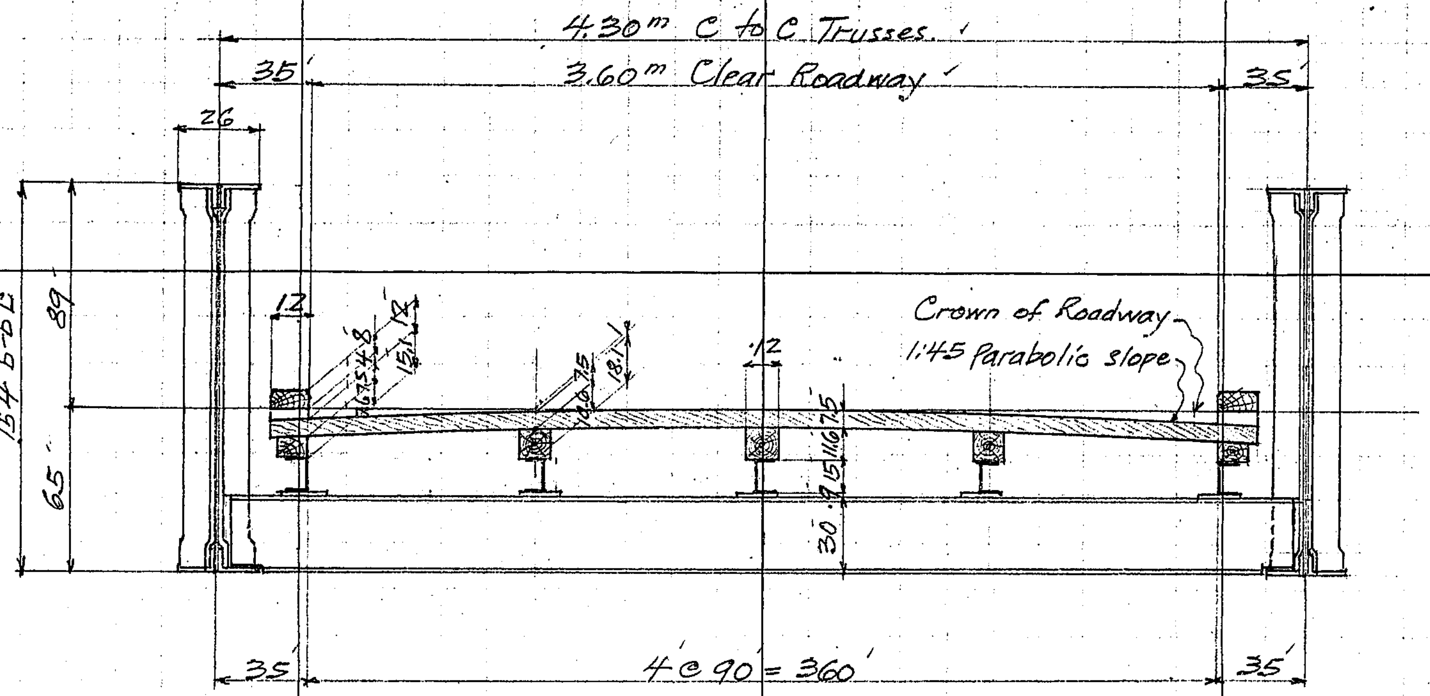
MADE BY K. Inaba DATE 9-6-4 FILE NO
CHECKED BY M J DATE 9-6-7 PAGE NO 3

CALCULATIONS FOR

Design of Enoura Bascule Bridge for Mie-ken.

Design of Bascule span.

Cross section of Bridge assumed as shown on sketch below.



Scale 1:30.

Design of Timber floor. Span length 0.90 meter.

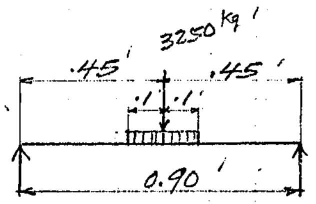
Dead Load: 7.5 cm planking @ 8.0 kg = 60 kg/m²

Dead Load moment = 1/10 × 60 × 0.90² = 5 kgm

Dead Load shear = 1/2 × 60 × 0.90 = 27 kg

Live Load: 4 ton motor truck rear wheel concentration = 1,500
30% impact = 450
1,950 kg

width of rear wheel assumed as 20 cm.



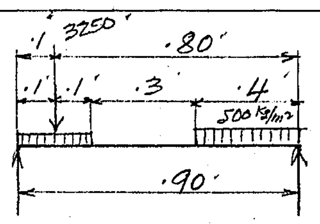
Uniform live load w = 500 kg per sq. meter.

Effective width of planking for one wheel assumed as 60 cm.

Load for one meter strip = $\frac{1950}{0.60}$ = 3250 kg

Live Load moment 1625 × 0.45 = 731
less 1625 × 0.05 = −81
650

For continuity of planking, moment may be taken as
650 × 8/10 = 520 kgm for one meter strip.



max. end shear.

Unif. load. $\frac{500 \times 0.4 \times 0.2}{0.9}$ = 44

rear wheel 3250 × $\frac{.8}{.9}$ = 2890
2934 kg

Summary of moments and shears.

	moment	shear
Dead Load	5	27
Live Load	520	2934
	525 kgm	2961 kg

Allowable unit strength of Japanese Akamatsu assumed as follows.

Bending fibre stress = 70 kg/cm²
Shear across grain = 25

Section modulus required = $\frac{525 \times 100}{70}$ = 750 cm³

depth of planking req'd. = $\sqrt{\frac{750 \times 6}{100}}$ = 6.7 cm
wearing course say 0.8
7.5 cm

use 7.5 cm planking, $S_m = \frac{100 \times 7.5^2}{6} = 937$ cm³

unit shear = $\frac{2961}{100 \times 7.5} \times \frac{3}{2}$ = 6 kg/cm²

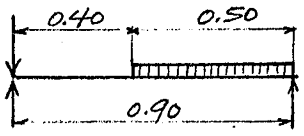
Design of Enoura-Bascule Bridge for Mie-ken

Design of Stringer. Span length = 2.14 m, spacing 0.90 m.
Dead Load:

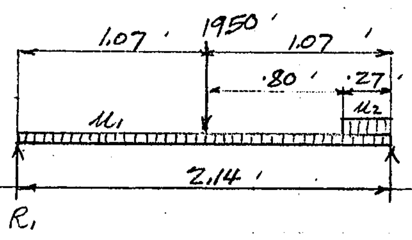
planking	0.90 @ 60 kg	=	54
nailing piece	.12 × .116 @ 650	=	9
stringer assumed		=	20
bolts, nails &c say		=	2
			85 kg per lin meter.

Dead Load moment = 1/8 × 85 × 2.14² = 49 kgm
Dead Load shear = 1/2 × 85 × 2.14 = 91 kg

Live Load:

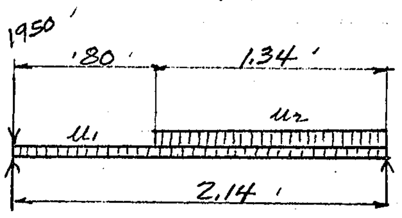


4 ton motor truck rear wheel concentration with impact = 1950 kg
Uniform load w = 500 kg/m²
on side of truck $\frac{500 \times 0.50^2}{2 \times .90}$ = 70 kg per lin. m = u_1
on front & rear of truck 500 × 0.90 = 450 " "
diff = 380 " " = u_2



Live Load moment.
Reaction R_1
u_2 $\frac{380 \times .27 \times .135}{2.14}$ = 6
u_1 70 × 2.14 ÷ 2 = 75
wheel 1950 ÷ 2 = 975
1056 kg.

moment 1056 × 1.07 = 1130
less 70 × 1.07 × .535 = − 40
1090 kgm.



Live Load shear.
u_2 $\frac{380 \times 1.34 \times .67}{2.14}$ = 160
u_1 70 × 2.14 ÷ 2 = 75
wheel = 1950
2185 kg

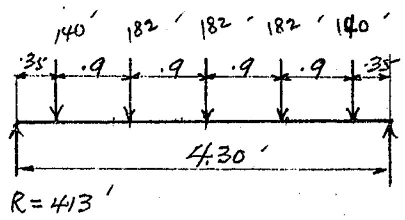
Summary of moments and shears.

	moment	shear
Dead Load	49	91
Live Load	1090	2185
	1139 kgm	2276 kg

Section modulus required = $\frac{1139 \times 100}{1100}$ = 103.6 cm³
Use 1 [150 × 75 @ 18.6 kg Sm. = 115.2 cm³
Shear on web = $\frac{2276}{15 \times .65}$ = 234 kg/cm²

Design of Floor Beam. Span length = 4.30 m, spacing = 2.14 m c to c.
Dead Load:

Stringer concentration on floor beam
Intermediate stringers 2 @ 91 = 182 kg
Side stringers say 2 @ 70 = 140 "



weight of floor beam assumed as 50 kg per lin meter.
Dead Load moment
413 × 2.15 = 888
182 × 0.90 = − 164
140 × 1.80 = − 252
1/8 × 50 × 4.30² = 116
588 kgm.

Dead Load shear
1/2 × 50 × 4.30 = 108
413
521 kg.

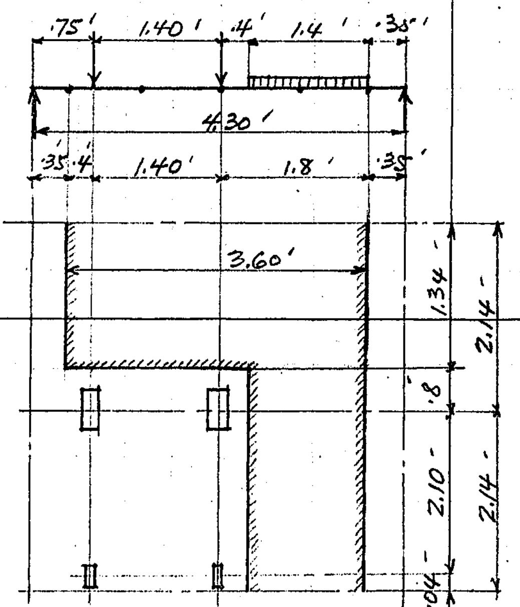
JIUN MASUDA
CONSULTING ENGINEER
~~BLDG~~ BLDG, TOKYO
SHOWA

MADE BY *K. Inaba* DATE *9-6-4* **FILE NO** ____
CHECKED BY *M. J* DATE *9-6-7* **PAGE NO** *5*

CALCULATIONS FOR

Design of Enoura Bascule Bridge for Mie-Ken.

Live Load: 4 ton motor truck rear wheel concentration with impact = 1950 kg
" " front " " " = 650 "



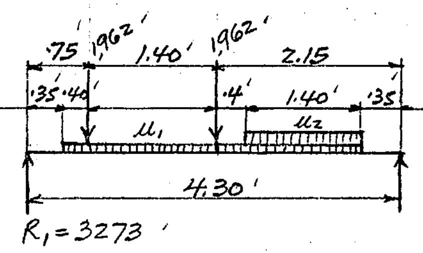
wheel load on floor beam.
front wheel $650 \times 0.04 \div 2.14 =$ 12
rear " = 1950
1962 kg

Uniform load on floor beam.
rear of truck $\frac{500 \times 1.34 \times .67}{2.14} =$ 210 kg/lin.m. = U_1

side of truck $500 \times 2.14 =$ 1070 "
diff. = 860 " = U_2

Reaction R_1
U_1 $210 \times 1.80 =$ 378
U_2 $\frac{860 \times 1.40 \times 1.05}{4.30} =$ 294

wheel $1962 \times 1/2 =$ 981
" $1962 \times 3.55 \div 4.30 =$ 1620
max end shear = 3273 kg



Max. moment
$3273 \times 2.15 =$ 7040
$1/2 \times 210 \times 1.80^2 =$ −340
$1962 \times 1.40 =$ −2750
3950 kgm

Summary of moments and shears.

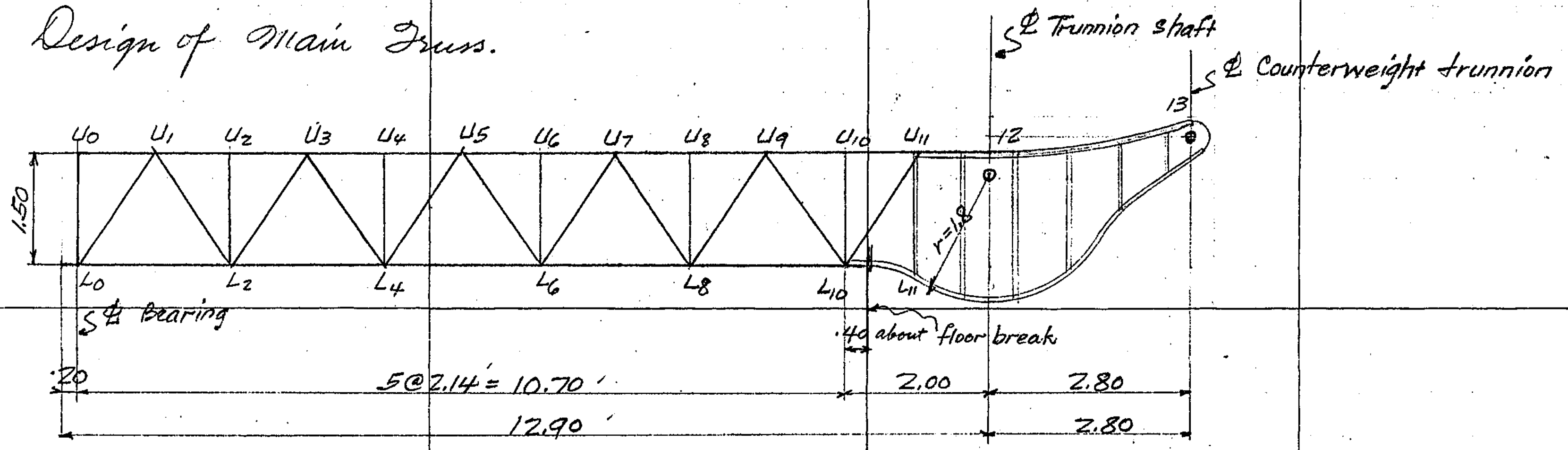
	moment	shear
Dead Load	588	521
Live Load	3950	3273
	4538 kgm	3794 kg

Section modulus required = $\frac{4538 \times 100}{1100} = 412.5\ cm^3$

use 1 I-beam 300×150 @ 48.3 kg, $S_m = 633.2\ cm^3$

shear on web = $\frac{3794}{30 \times 0.8} = 158\ kg/cm^2$

Design of Main Truss.



Dead Load:

Floor planking	3.90	@ 60 =	234	
Copings	2@ 0.12 × 0.09	@ 650 =	14	
nailing pieces	5@ 0.12 × 0.096	@ " =	37	
				285
Stringers	5	@ 20 =	100	
floor beams	50 × 4.30 = 215	÷ 2.14 =	100	
lateral bracings say			80	
handrails say	2	@ 15 =	30	
Main trusses assumed	2	@ 190 =	380	
				690
miscellaneous say				25
				1000 kg/m for 2 trusses.

JIUN MASUDA
CONSULTING ENGINEER
~~[illegible]~~ BLDG, TOKYO
SHOWA

MADE BY K. Inaba DATE 9-6-6 FILE NO

CHECKED BY M. J DATE 9-6-7 PAGE NO 6

CALCULATIONS FOR

Design of Enoura Bascule Bridge for Mie-ken.

Dead load for one truss = 1000 ÷ 2 = 500 kg per lin. meter

Panel loads.

for panel point L_0 1.27^m @ 500 = 635 kg

" " $L_2, L_4, L_6 + L_8$ 2.14 @ 500 = 1,070

" " L_{10} 1.47 @ 500 = 735 + 200 = 935 kg say. (extra floor beam + truss)

Dead load moments at panel points — no reaction at L_0 assumed.

Panel point	Computation	moment	20% impact	Total m.	Shear at left side
M_1	635 × 1.07	= −680	−140	−820 kgm.	−635×1.2=−760 kg; 760×1.23=940
L_2	635 × 2.14	= −1360	−270	−1630	
M_3	635 × 3.21 = −2040 1070 × 1.07 = −1145	−3185	−640	−3825	−1705×1.2=−2050; 2050×1.23=2520
L_4	635 × 4.28 = −2720 1070 × 2.14 = −2290	−5010	−1,000	−6,010	
M_5	635 × 5.35 = −3400 1070 × 1.07×4 = −4580	−7980	−1600	−9580	−2775×1.2=−3330; 3330×1.23=4100
L_6	635 × 6.42 = −4080 1070 × 1.07×6 = −6870	−10950	−2190	−13140	
M_7	635 × 7.49 = −4760 1070 × 1.07×9 = −10,310	−15070	−3010	−18080	−3845×1.2=−4610; 4610×1.23=5670
L_8	635 × 8.56 = −5440 1070 × 1.07×12 = −13740	−19180	−3840	−23020	
M_9	635 × 9.63 = −6120 1070 × 1.07×16 = −18320	−24440	−4890	−29330	−4915×1.2=−5900; 5900×1.23=7260
L_{10}	635 × 10.70 = −6800 1070 × 1.07×20 = −22900	−29700	−5940	−35640	
U_{11}	635 + 4@1070 + 935 = 5850 kg. 5850 × 1.07 = −6260 −29700	−35960	−7190	−43150	−5850×1.2=−7020; 7020×1.23=8630
12	5850 × 2.00 = −11,700 700 × .93 × .47 = −310 −29700	−41,710	−8340	−50050	−6500×1.2=−7800

Diagonal length = $\sqrt{1.50^2+1.07^2}$ = 1.843^m Coef. = 1.843 ÷ 1.50 = 1.23

増田淳氏関係資料（独立行政法人 土木研究所蔵）

Design of Enoura Bascule Bridge for Mie-Ken

Dead Load stresses for truss members.

Members	moment	lev. arm	stress
L_0-L_2	820	÷ 1.50	− 550 kg
L_2-L_4	3825	〃	− 2550
L_4-L_6	9580	〃	− 6390
L_6-L_8	18080	〃	− 12050
L_8-L_{10}	29330	〃	− 19550
$L_{10}-L_{11}$	43150	〃	− 28800
U_1-U_3	1630	÷ 1.50	+ 1090
U_3-U_5	6010	〃	+ 4010
U_5-U_7	13140	〃	+ 8760
U_7-U_9	23020	〃	+ 15350
U_9-U_{11}	35640	〃	+ 23750

members	Shear	coef.	stress
L_0-U_1	760	× 1.23 =	+ 940 kg
U_1-L_2	〃	〃	− 940
L_2-U_3	2050	〃	+ 2520
U_3-L_4	〃	〃	− 2520
L_4-U_5	3330	〃	+ 4100
U_5-L_6	〃	〃	− 4100
L_6-U_7	4610	〃	+ 5670
U_7-L_8	〃	〃	− 5670
L_8-U_9	5900	〃	+ 7260
U_9-L_{10}	〃	〃	− 7260
$L_{10}-U_{11}$	7020	〃	+ 8630

Live Load: 4 ton motor truck rear wheel concentration = 1500

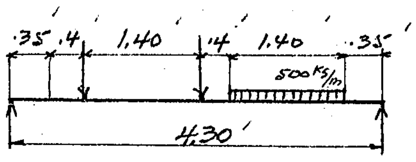
Impact coef. = $\frac{20}{60+12.7}$ = 27.5% ... 410

1910 kg

Front wheel with impact, say 1910 ÷ 3 = 640

Uniform live load on roadway = 500 kg per sq. meter.

Max. wheel concentration on main truss assumed as follows.



Rear wheel concentration.

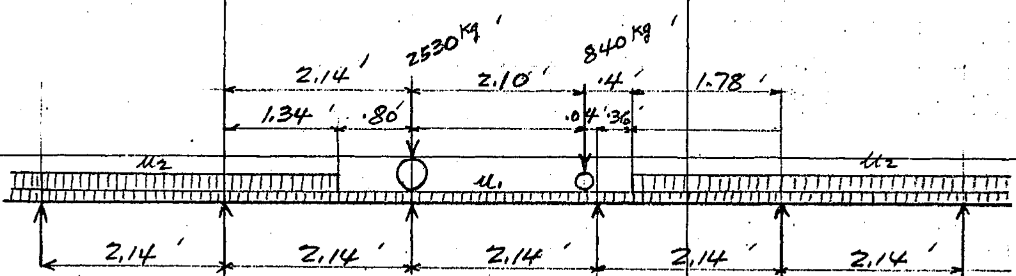
1910 × 2.15 ÷ 4.30 = 955
1910 × 3.55 ÷ 4.30 = 1575

2530 kg

Front wheel concentration
2530 ÷ 3 = 840

Unif. load on side of truck.
500 × 1.40 × 1.05 ÷ 4.3 = 170 kg per lin. m = U_1

Unif. load on front and rear of truck
500 × 1.80 = 900
900 − 170 = 730 〃 〃 = U_2



730 × 1.34 = 980
730 × 1.78 = 1300

Rear wheel			2530			
front 〃			20 ----	820		
Unif. load U_2	1560 ----	780			780 ----	1560
〃 〃		670 ----	310	540 ----	760	
〃 U_1	360	360	360	360	360	360
Summary	1920	1810	3220	1720	1900	1920

Let us assume the live load panel concentration of 1920 kg throughout and an extra concentration of 3220 − 1920 = 1300 kg for motor truck.

Design of Enoura Bascule Bridge for Mie-Ken.

Influence values of end reaction.

Load on		End reaction R_F	Trunnion reaction R_T
L_2	10.56 ÷ 12.70 =	0.840	0.160
L_4	8.42 ÷ 〃 =	0.663	0.337
L_6	6.28 ÷ 〃 =	0.495	0.505
L_8	4.14 ÷ 〃 =	0.326	0.674
L_{10}	2.00 ÷ 〃 =	0.158	0.842
for full load.		2.482	2.518

loads on $L_4, L_6, L_8 + L_{10}$	1.642	0.160	loads on L_2
〃 〃 $L_6, L_8 + L_{10}$	0.979	0.497	〃 〃 $L_2 + L_4$
〃 〃 $L_8 + L_{10}$	0.484	1.002	〃 〃 $L_2, L_4, + L_6$
〃 〃 L_{10}	0.158	1.676	〃 〃 $L_2, L_4, L_6 + L_8$

Live Load stresses of truss members.

$L_0 - L_2$

2.482 × 1920 × 1.07 = 5100
0.840 × 1300 × 1.07 = 1170
6270 ÷ 1.50 = + 4180 kg

$U_1 - U_3$

2.482 × 1920 × 2.14 = 10200
0.840 × 1300 × 2.14 = 2340
12540 ÷ 1.50 = − 8370 kg

$L_2 - L_4$

4765 × 3.21 = 15300
1920 × 1.07 = − 2060
0.663 × 1300 × 3.21 = 2770
16010 ÷ 1.50 = + 10680 kg

$U_3 - U_5$

4765 × 4.28 = 20400
1920 × 2.14 = − 4110
0.663 × 1300 × 4.28 = 3690
19980 ÷ 1.50 = − 13330 kg

$L_4 - L_6$

4765 × 5.35 = 25490
1920 × 1.07 × 4 = − 8220
0.495 × 1300 × 5.35 = 3440
20710 ÷ 1.50 = + 13820 kg

$U_5 - U_7$

4765 × 6.42 = 30600
1920 × 2.14 × 3 = − 12330
0.495 × 1300 × 6.42 = 4130
22400 ÷ 1.50 = − 14950 kg

$L_6 - L_8$

2.518 × 1920 × 5.21 = 25200
1920 × 1.07 × 4 = − 8220
0.505 × 1300 × 5.21 = 3420
20400 ÷ 1.50 = + 13600 kg

$U_7 - U_9$

4830 × 4.14 = 20000
1920 × 2.14 = − 4110
0.674 × 1300 × 4.14 = 3630
19520 ÷ 1.50 = − 13020 kg

Design of Enoura Bascule Bridge for Mie-Ken.

$L_8 - L_{10}$

4830	× 3.07' =	14830'	
1920	× 1.07' = −	2060'	
0.674 × 1300	× 3.07' =	2690'	
		15460 ÷ 1.50' =	+10300 kg'

$U_9 - U_{11}$

4830	× 2.00' =	9660'	
0.842 × 1300	× 2.00' =	2190'	
		11850 ÷ 1.50' =	− 7900 kg'

$L_{10} - L_{11}$

4830	× 0.93' =	4490'	
0.842 · 1300	· 0.93 =	1020'	
		5510 ÷ 1.50' =	+ 3,680 kg'

Diagonals

$L_0 - U_1$	2.482 × 1920' = 4765' × 1.23' = −5860'		
	0.840 × 1300' = 1092' × 1.23' = −1340'		
			−7,200 kg'
$U_1 - L_2$			+ 7,200 kg'
$L_2 - U_3$	1.642 × 1920' = 3150' × 1.23' = −3870'		
	0.663 × 1300' = 860' × 1.23' = −1060'		
			−4,930' kg
$U_3 - L_4$			+ 4,930' 〃
$L_4 - U_5$	0.979 × 1920' = 1880' × 1.23 = − 2310'		
	0.495 × 1300' = 640' × 1.23 = − 790'		
			−3,100 kg'
$U_5 - L_6$			+ 3,100 〃'
$L_6 - U_7$	0.484 × 1920' = 930' × 1.23 = − 1140'		
	0.326 × 1300' = 420' × 1.23 = − 520'		
			−1,660 kg'
$U_7 - L_8$			+1,660 〃'
$L_8 - U_9$	0.158 × 1920' = 300' × 1.23 = − 370'		
	0.158 × 1300' = 210' × 1.23 = − 260'		
			− 630 kg'
$U_9 - L_{10}$			+ 630 〃'
$L_{10} - U_{11}$	2.518 × 1920' = 4830' × 1.23 = + 5940'		
	0.842 × 1300' = 1100' × 1.23 = + 1350'		
	5930'		+7,290 kg'
$U_9 - L_{10}$	1.676 × 1920' = 3220' × 1.23 = − 3960'		
	0.674 × 1300' = 880' × 1.23 = − 1080'		
			−5040 kg'
$L_8 - U_9$			+5040 〃'

Design of Enoura Bashi for Mie-ken

$U_7 - L_8$	1.002 × 1920 =	1920 × 1.23 =	− 2360	
	0.505 × 1300 =	660 × 1.23 =	− 810	
				− 3170 kg
$L_6 - U_7$				+ 3170 "
$U_5 - L_6$	0.497 × 1920 =	950 × 1.23 = −	1170	
	0.337 × 1300 =	440 × 1.23 = −	540	
				− 1,710 "
$L_4 - U_5$				+ 1,710 "
$U_3 - L_4$	0.160 × 1920 =	310 × 1.23 = −	380	
	0.160 × 1300 =	210 × 1.23 = −	260	
				− 640 "
$L_2 - U_3$				+ 640 "
$U_1 - L_2 = L_0 - U_1$				——

Summary of Dead Load and Live Load stresses.

members.	D.L. stress	L.L. stress	Summary	2/3 D.L.+L.L.	Design stress Compression	Design stress Tension
$L_0 - L_2$	− 550	+ 4,180		+ 3,810	550	3,810
$L_2 - L_4$	− 2,550	+ 10,680		+ 8,980	2,550	8,980
$L_4 - L_6$	− 6,390	+ 13,820		+ 9,560	6,390	9,560
$L_6 - L_8$	− 12,050	+ 13,600		+ 5,670	12,050	5,670
$L_8 - L_{10}$	− 19,550	+ 10,300		——	19,550	——
$L_{10} - L_{11}$	− 28,800	+ 3,680		——	28,800	——
$U_1 - U_3$	+ 1,090	− 8,370		− 7,640	7,640	1,090
$U_3 - U_5$	+ 4,010	− 13,330		− 10,660	10,660	4,010
$U_5 - U_7$	+ 8,760	− 14,950		− 9,110	9,110	8,760
$U_7 - U_9$	+ 15,350	− 13,020		− 2,790	2,790	15,350
$U_9 - U_{11}$	+ 23,750	− 7,900		——		23,750
$L_0 - U_1$	+ 940	− 7,200		− 6,570	6,570	940
$U_1 - L_2$	− 940	+ 7,200		+ 6,570	940	6,570
$L_2 - U_3$	+ 2,520	{ + 640 / − 4,930	+ 3,160	− 3,250	3,250	3,160
$U_3 - L_4$	− 2,520	{ − 640 / + 4,930	− 3,160	+ 3,250	3,160	3,250
$L_4 - U_5$	+ 4,100	{ + 1,710 / − 3,100	+ 5,810	− 370	370	5,810
$U_5 - L_6$	− 4,100	{ − 1,710 / + 3,100	− 5,810	+ 370	5,810	370
$L_6 - U_7$	+ 5,670	{ + 3,170 / − 1,660	+ 8,840			8,840
$U_7 - L_8$	− 5,670	{ − 3,170 / + 1,660	− 8,840		8,840	
$L_8 - U_9$	+ 7,260	{ + 5,040 / − 630	+ 12,300			12,300
$U_9 - L_{10}$	− 7,260	{ − 5,040 / + 630	− 12,300		12,300	

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

MADE BY K. Inaba DATE 9-6-7 FILE NO

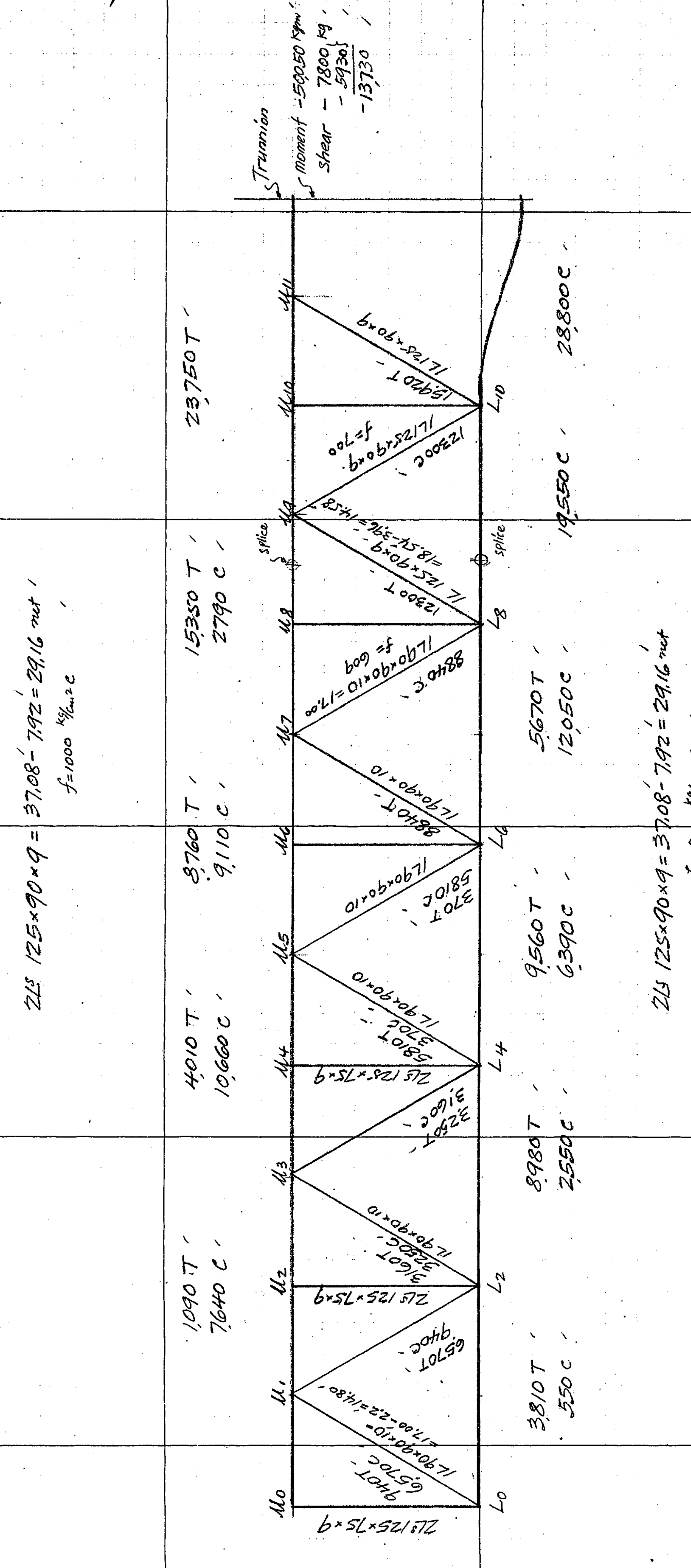
CHECKED BY M. J DATE 9-6-8 PAGE NO 11

CALCULATIONS FOR

Design of Enoura Bascule Bridge for Mie-Ken

$L_{10}-M_{11}$ + 8,630 + 7,290 + 15,920 + 15,920

Stress Diagram of Main Truss.



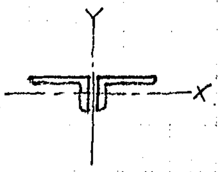
JIUN MASUDA
CONSULTING ENGINEER
~~J.J.J.~~ BLDG, TOKYO
SHOWA

MADE BY K. Inaba DATE 9-6-7 FILE NO
CHECKED BY M. J DATE 9-6-8 PAGE NO 12

CALCULATIONS FOR

Design of Enoura Bascule Bridge for Mie ken.

Chord section.



2Ls 125×90×9 = 37.08 cm² gr − 7.92 = 29.16 cm² net

radius of gyration r_x = 2.60 cm

unsupported length for top chord 107 cm l/r = 107/2.6 = 41.1

" " bottom " 214 " l/r = 214/2.6 = 82.3

Allowable unit compression.

Top chord: f = 1500 (1−0.0055×41.1) = 1160 c

Bottom chord f = 1500 (1−0.0055×82.3) = 820 c

Capacity of this section.

for top chord. Tension 29.16 @ 1200 = 35000 kg
Compression 37.08 @ 1000 = 37080 "

for bottom chord. Tension 35000 kg
Compression 37.08 @ 820 = 30400 "

Flange section at ℄ of trunnion.

max. moment 50050 kgm, Shear = 13730 kg

~~Depth of girder assumed 200 cm b-b of flange Ls~~ web 2000×9 = 180

effective depth say 195 cm.

flange stress = 50050/1.95 = 25700 kg T or C

flange area = 25700 ÷ 1200 = 21.42
1/8 web = 180÷8 = − 22.50
− 1.08

Use 2Ls 125×90×9 = 37.08 − 7.92 = 29.16 For top flange.
1 cov.pl. 260 × 9 = 23.40 − 3.96 = 19.44
60.48 gr. 48.60 net

2Ls 125×90×13 = 52.52 − 17.16 = 35.36 For bottom flange.
1 cov.pl. 260 × 12 = 31.20 − 10.56 = 20.64
83.72 gr. 56.00 net

Diagonals.

$L_{10}-U_{11}$ 15920 kg T
U_9-L_{10} 12,300 " C

1L 125×90×9 = 18.54 − 3.96 (2-19φ rivets) = 14.58 net

l/r = 184.3/1.90 = 97. ~~f = 1500(1−0.0055×97)~~ = 700 kg/cm² C

Capacity of this section
Tension 14.58 @ 1200 = 17500 kg 8-19φ rivets
Compression 18.54 @ 700 = 12,980 " 6-19φ "

L_0-U_1 to U_7-L_8 max. stress 8840 T or 8840 C

1L 90×90×10 = 17.00 − 2.20 = 14.80 net

l/r = 184.3/1.71 = 108. f = 1500 (1−0.0055×108) = 609 kg/cm² c

Capacity of this section
Tension 14.80 @ 1200 = 17750 kg 8-19φ rivets
Compression 17.00 @ 609 = 10350 " 5-19φ "

Design of Enoura-Bascule Bridge for Mie-Ken

Live Load Deflection at end of bascule leaf for 1,000 kg load on Lo. of one truss

General equation to deflection

$$\Delta = \Sigma \frac{SL}{EA} T \quad \text{or} \quad \frac{1}{E} \Sigma \frac{SL}{A} T$$

Where Δ = Deflection at any point in cm.;
S = Stress of each member in kg.;
T = Stress of each member in kg. due to a unit load on the panel point at which deflection is desired in the direction of the deflection.;
L = length of each member in cm.;
A = gross sectional area of each member in cm².;
E = Modulus of elasticity of steel in kg/cm² = 2,100,000.

Members	L	A	L/A	Stress S	T	$\frac{SL}{A}T$
L_0-L_2	214.0	37.08	5.77	− 714	− 0.714	+ 2,940
L_2-L_4	〃	〃	〃	− 2,140	− 2.140	+ 26,420
L_4-L_6	〃	〃	〃	− 3,565	− 3.565	+ 73,300
L_6-L_8	〃	〃	〃	− 4,995	− 4.995	+ 144,000
L_8-L_{10}	〃	〃	〃	− 6,420	− 6.420	+ 238,000
$L_{10}-L_{12}$	say 200.0	say 83.72	2.39	− 7,850	− 7.850	+ 147,300
U_1-U_3	214.0	37.08	5.77	+ 1,427	+ 1.427	+ 11,750
U_3-U_5	〃	〃	〃	+ 2,855	+ 2.855	+ 47,050
U_5-U_7	〃	〃	〃	+ 4,280	+ 4.280	+ 105,700
U_7-U_9	〃	〃	〃	+ 5,710	+ 5.710	+ 188,100
U_9-U_{11}	〃	〃	〃	+ 7,140	+ 7.140	+ 294,200
$U_{11}-U_{12}$	say 93.0	say 60.48	1.54	+ 6,510	+ 6.510	+ 65,300
L_0-U_1	184.3	17.00	10.84	+ 1,230	+ 1.230	+ 16,400
U_1-L_2	〃	〃	〃	− 〃	− 〃	〃
L_2-U_3	〃	〃	〃	+ 〃	+ 〃	〃
U_3-L_4	〃	〃	〃	− 〃	− 〃	〃
L_4-U_5	〃	〃	〃	+ 〃	+ 〃	〃
U_5-L_6	〃	〃	〃	− 〃	− 〃	〃
L_6-U_7	〃	〃	〃	+ 〃	+ 〃	〃
U_7-L_8	〃	〃	〃	− 〃	− 〃	〃
L_8-U_9	〃	18.54	9.95	+ 〃	+ 〃	+ 15,050
U_9-L_{10}	〃	〃	〃	− 〃	− 〃	〃
$L_{10}-U_{11}$	〃	〃	〃	+ 〃	+ 〃	〃
						1,520,410

$$\text{Deflection} = \frac{1520410}{2100000} = 0.724 \text{ cm}$$

JIUN MASUDA
CONSULTING ENGINEER
~~???~~ SHOWA BLDG, TOKYO

MADE BY K. Inaba DATE 9-6-7 FILE NO

CHECKED BY M J DATE 9-6-8 PAGE NO 13

CALCULATIONS FOR

Design of Enoura Bascule bridge for Mie-ken.

Dead Load Deflection at end of bascule leaf.

General equation to deflection.

$$\Delta = \Sigma \frac{SL}{EA} T \quad \text{or} \quad \frac{1}{E} \Sigma \frac{SL}{A} T$$

where Δ = Deflection at any point in cm.;
S = Stress of each member in kg.;
T = stress of each member in kg. due to a unit load on the panel point at which deflection is desired in the direction of the deflection.
L = length of each member in cm.
A = gross sectional area of each member in cm²;
E = modulus of elasticity of steel in kg/cm² = 2,100,000.

Members	L.	A.	L/A	Dead Load stress S.	T	$\frac{SL}{A}T$
L_0-L_2	214.0	37.08	5.77	− 460	− 0.714	1,900
L_2-L_4	〃	〃	〃	− 2,130	− 2.140	26,300
L_4-L_6	〃	〃	〃	− 5,320	− 3.565	109,400
L_6-L_8	〃	〃	〃	− 10,040	− 4.995	289,400
L_8-L_{10}	〃	〃	〃	− 16,300	− 6.420	604,000
$L_{10}-L_{12}$	say 200.0	say 83.72	2.39	− 24,000	− 7.850	450,000
U_1-U_3	214.0	37.08	5.77	+ 910	+ 1.427	7,500
U_3-U_5	〃	〃	〃	+ 3,340	+ 2.855	55,000
U_5-U_7	〃	〃	〃	+ 7,300	+ 4.280	180,300
U_7-U_9	〃	〃	〃	+ 12,800	+ 5.710	422,000
U_9-U_{11}	〃	〃	〃	+ 19,800	+ 7.140	816,000
$U_{11}-U_{12}$	say 93.0	say 60.48	1.54	+ 21,400	+ 6.510	214,500
L_0-U_1	184.3	17.00	10.84	+ 780	+ 1.230	10,400
U_1-L_2	〃	〃	〃	− 780	− 〃	10,400
L_2-U_3	〃	〃	〃	+ 2,100	+ 〃	28,000
U_3-L_4	〃	〃	〃	− 2,100	− 〃	28,000
L_4-U_5	〃	〃	〃	+ 3,420	+ 〃	45,600
U_5-L_6	〃	〃	〃	− 3,420	− 〃	45,600
L_6-U_7	〃	〃	〃	+ 4,730	+ 〃	63,100
U_7-L_8	〃	〃	〃	− 4,730	− 〃	63,100
L_8-U_9	〃	18.54	9.95	+ 6,050	+ 〃	74,000
U_9-L_{10}	〃	〃	〃	− 6,050	− 〃	74,000
$L_{10}-U_{11}$	〃	〃	〃	+ 7,200	+ 〃	88,100
						3,706,600

$$\text{Dead Load Deflection} = \frac{3,706,600}{2,100,000} = 1.77 \text{ cm.}$$

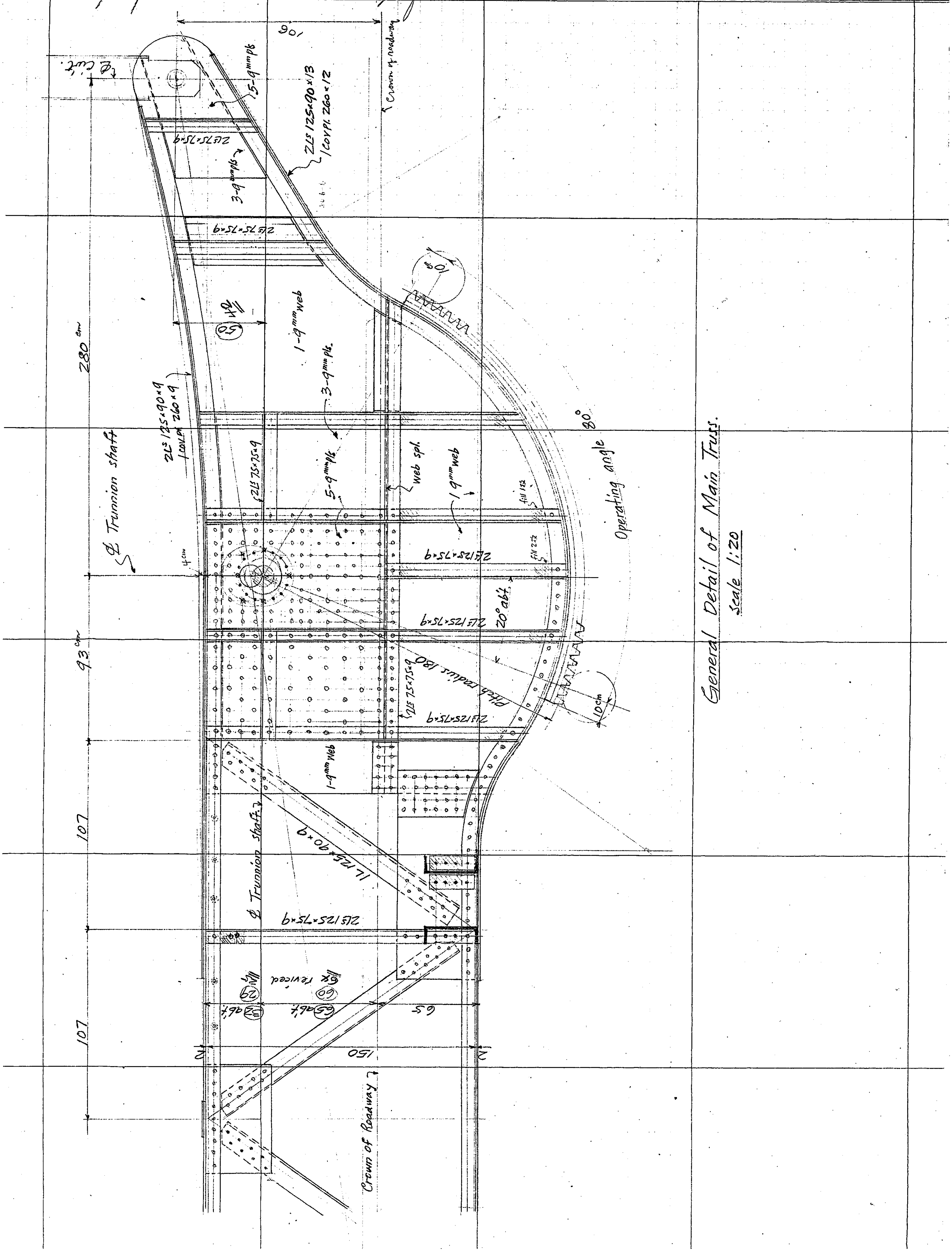
No camber to be given to main truss.

JIUN MASUDA
CONSULTING ENGINEER
~~?~~ BLDG, TOKYO
SHOWA

MADE BY K. Inaba DATE 9-6-8 FILE NO.
CHECKED BY DATE PAGE NO. 14

CALCULATIONS FOR

Design of Enoura Bascule Bridge for Mie-ken.



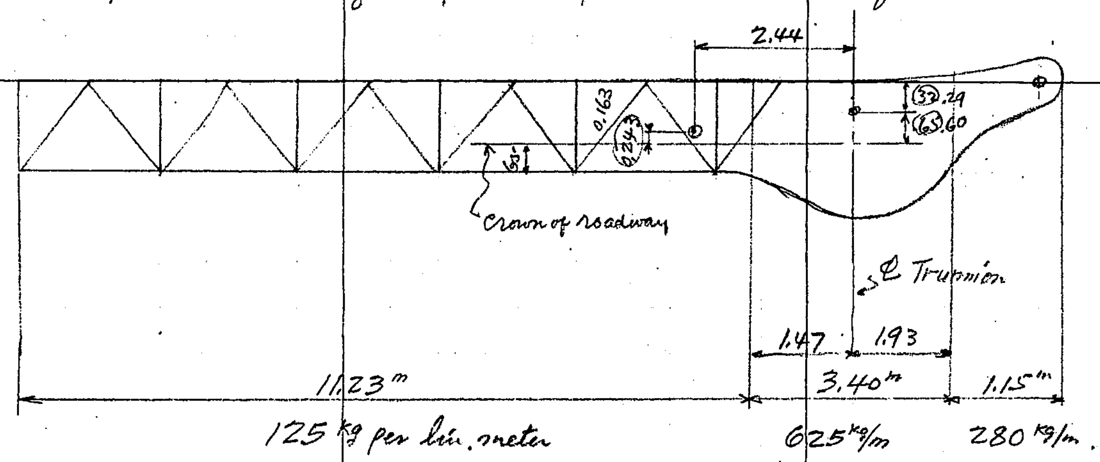
増田淳氏関係資料
（独立行政法人 土木研究所蔵）

Design of Enoura Bascule Bridge for Mie-Ken.

Approximate weight of Main truss.

Member		Section		Unit wt.		Length		Weight	moment ab't crown of roadway at Trunnion: vert. arm	Moment	hor. arm	moment
Top chord		2Ls 125×90×9	@	14.60	×	15.60	=	455	1.08	481	5.00	2,280
〃		1 Cov. pl. 260×9	@	18.37	×	5.00	=	92	0.98	90	−0.20	−18
bottom chord		2Ls 125×90×9	@	14.60	×	9.30	=	272	−0.55	−150	8.25	2245
〃		2Ls 125×90×13	@	20.60	×	7.50	=	309	−0.35	−108	0.00	0
〃		1 cov. pl. 260×12	@	24.49	×	6.10	=	149	−0.55	−82	−0.70	−104
diagonals		8Ls 90×90×10	@	13.30	×	1.70	=	181	0.20	36	8.42	1524
〃		3Ls 125×90×9	@	14.60	×	1.70	=	74	0.20	15	2.54	188
verticals		12Ls 125×75×9	@	13.50	×	1.54	=	249	0.20	50	7.35	1830
web pls.	上部	1 Pl. 1200×9	@	84.78	×	3.10	=	263	0.50	132	−0.35	−92
〃	下部 丸形	1 Pl. 1,000×9	@	70.65	×	2.80	=	198	−0.40	−79	−0.20	−40
〃	按搭部	1 Pl. 800×9	@	56.52	×	1.50	=	85	0.93	79	−3.35	−285
〃	前 〃 (L_{10})	1 Pl. 500×9	@	42.39	×	1.05	=	45	−0.35	−16	1.72	77
Side pls.	上部	2 Pls 1,030×9	@	72.77	×	2.00	=	291	0.45	131	0.00	0
〃	trunnion	2 Pls 600×9	@	42.39	×	1.00	=	85	0.47	40	0.00	0
〃	按搭部	2 Pls 450×9	@	31.79	×	1.00	=	64	1.05	67	−2.60	−167
〃	〃	2 Pls 500×9	@	35.33	×	0.75	=	53	1.15	61	−2.80	−148
Splice pls.	前部 vert. spl.	2 Pls 270×9	@	19.08	×	0.45	=	17	−0.30	−5	1.23	21
〃	Hor. spl. =4枚	2 Pls 270×9	@	〃	×	0.90	=	34	0.04	1	−0.40	−14
〃	後部 vert. spl.	2 Pls 270×9	@	〃	×	0.70	=	27	0.75	20	−1.85	−50
Stiff. Ls	vert. stiff Ls.	4Ls 125×75×9	@	13.50	×	1.80	=	97	0.10	10	0.00	0
〃	〃	6Ls 〃	@	〃	×	2.00	=	162	0.00	0	0.00	0
〃	〃	2Ls 〃 (主桁)	@	〃	×	0.85	=	23	0.70	16	−1.85	−43
〃	〃	2Ls 〃 (?)	@	〃	×	0.65	=	18	1.02	18	−2.55	−46
〃	hor. stiff Ls.	10Ls 75×75×9	@	9.96	×	0.60	=	60	0.22	13	0.00	0
〃	Fillers	4 fills 75×9	@	5.30	×	0.60	=	13	−0.40	−5	0.00	0
〃	〃	8 〃 75×9	@	〃	×	0.80	=	34	−0.50	−17	0.00	0
Gusset pls.		9 Pls 400×9	@	28.26	×	0.60	=	153	0.26	40	4.97	761
〃		2 Pls 400×9	@	〃	×	0.50	=	28	0.20	6	12.70	356
fillers, top of verticals		5 Pls 75×9	@	5.30	×	0.20	=	5	0.77	4	7.35	37
tie pls.	top chord panel pts.	5 Pls 200×9	@	14.13	×	0.26	=	18	0.98	18	7.35	132
〃	〃 end	1 Pl. 260×9	@	18.37	×	0.40	=	7	0.75	5	12.70	89
Splice of chords		2	@	25.00			=	50	0.20	10	3.60	180
Rivet heads and misc. details say							=	239	0.23	55	2.77	662
								3,850 kg		+1398		+10,382
										−462		−1007
									0.243 m	+936	2.44 m	+9375
									−0.080			
									0.163 m			

Approximate weight of truss per lin. meter as follows.



11.23 @ 125 = 1,405
3.40 @ 625 = 2,125
1.15 @ 280 = 320
3850 kg

Design of Enoura Bascule Bridge for Mie-Ken.

Design of Lateral Bracings.

Seismic load on bracings. k assumed as 0.15

Dead load of bridge 1000 kg/lin m.

Seismic panel loads.

Intermediate panel points 1000 × 0.15 × 2.14 = 320 kg

Wind load on bracings. 600 kg per lin meter of bridge when bridge closed and locked.

Wind panel loads.

Intermediate panel points 600 × 2.14 = 1285 kg

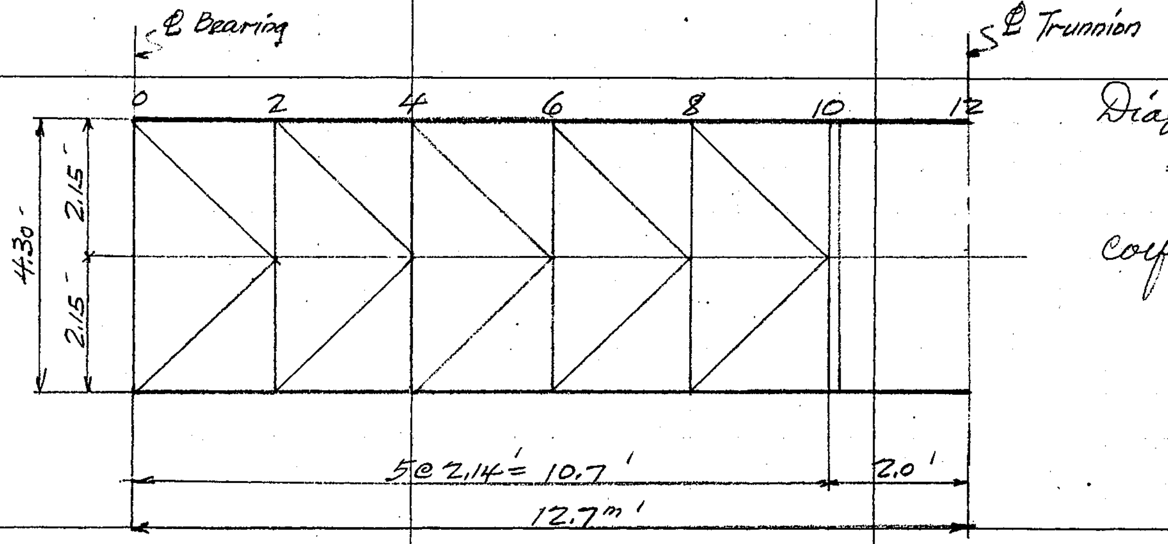
front end " " (L0) 600 × 1.27 = 760 "

300 kg per lin meter of bridge when bridge opened.

Intermediate panel point 300 × 2.14 = 640 kg

front end " " 300 × 1.27 = 380 "

Wind load governs for both cases.



Diagonal length

$= \sqrt{2.15^2 + 2.14^2} = 3.03$ m

Coef. $= \frac{3.03}{2.15} = 1.41$

Wind stress in lateral bracing.

Bridge closed and front lock being applied. moving load of 600 kg/m.

Shear in panels.

Stress in diagonals.

0-2.

1285 × 2.14 × 10 = 27500

1285 × 2.00 × 5 = 12850

40350 ÷ 12.70 = 3180 × 1.41 ÷ 2 = 2240 kg T or C — 0-2

2-4

1285 × 2.14 × 6 = 16500

1285 × 2.00 × 4 = 10280

26780 ÷ 12.70 = 2110 × 1.41 ÷ 2 = 1490 kg T or C — 2-4

4-6

1285 × 2.14 × 3 = 8250

1285 × 2.00 × 3 = 7710

15960 ÷ 12.70 = 1260 × 1.41 ÷ 2 = 890 kg T or C — 4-6

6-8

1285 × 2.14 × 6 = 16500 ÷ 12.70 = 1300 × 1.41 ÷ 2 = 920 kg T or C — 6-8

8-10 1285 × 2.14 × 10 = 27500 ÷ 12.70 = 2170 × 1.41 ÷ 2 = 1530 kg T or C — 8-10

Use 2L 75×75×9 = 25.38 − 7.92 = 17.46 net radius of gyration = 2.25, l = 303, l/r = 135,

f = 1500 (1 − 0.0055 × 135) = 387 kg/cm² C

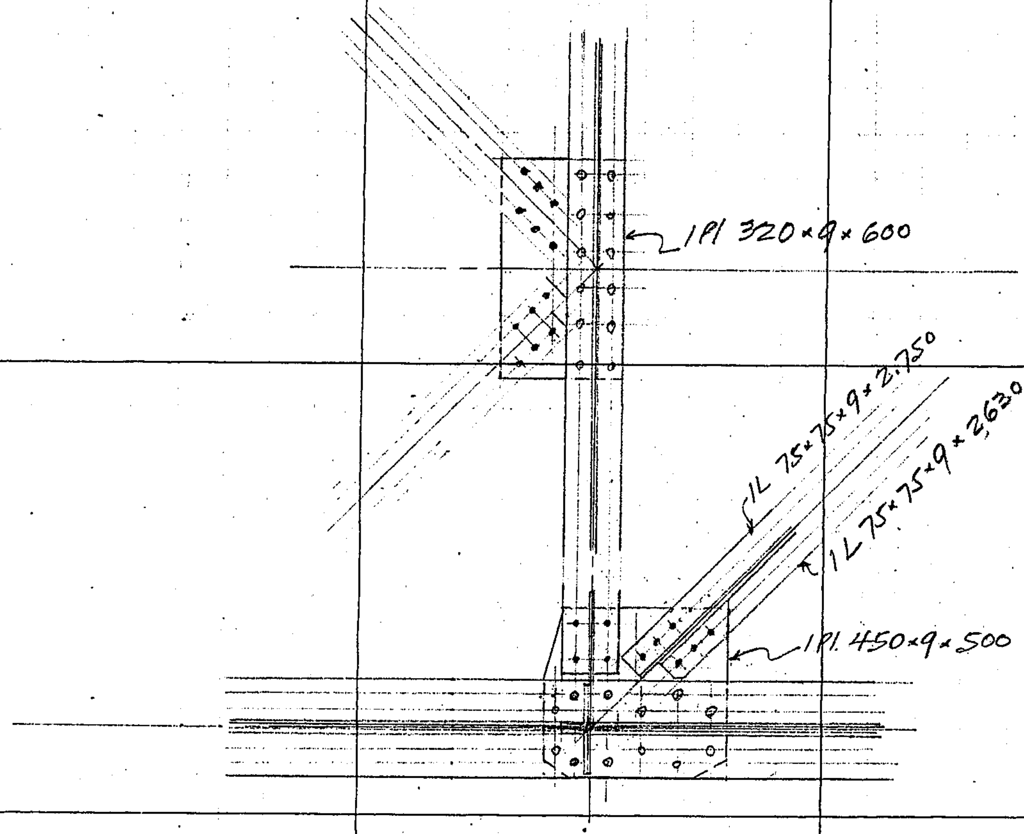
This section good for 25.38 @ 387 = 9820 kg C

or 17.46 @ 1200 = 20950 " T

Use 6-19φ rivets for connection.

Design of Enoura Bascule Bridge for Mie-ken.

Approximate weight of Lateral Bracings.



Diagonals		10 Ls 75×75×9 @ 9.96 × 2.63 =	262		
〃		10 Ls 〃 @ 〃 × 2.75 =	274		
				536	
Gusset plates	center	4 Pls 320 × 9 @ 22.61 × 0.60 =	54		
〃	〃	1 Pl. 600 × 9 @ 42.39 × 0.63 =	27		
〃	side	10 Pls 450 × 9 @ 31.79 × 0.50 =	159		
				240	
				776	
Rivet heads say				24	
				800	kg.

weight per linear meter of bracing = 800 ÷ 10.70 ≒ 75 kg

Approximate weight of structural steel for Bascule leaf.

Stringers	5 @ 20 × 11.30	=	1,130
floor beams	5 @ 215	=	1,075
〃 (L_{10})	2 @ 205	=	410
lateral bracings		=	800
main trusses	2 @ 3850	=	7,700
handrails	2 @ 15 × 12.0	=	360
floor breaks	2 @ 200	=	400
Shoes say	2 @ 350	=	700
misc. details say			125
			12,700 kg.

JIUN MASUDA
CONSULTING ENGINEER
~~JIJI~~ BLDG, TOKYO
SHOWA

MADE BY *K. Inaba* DATE *9-6-11* FILE NO ____
CHECKED BY *M. J* DATE *9-7-20* PAGE NO *18*

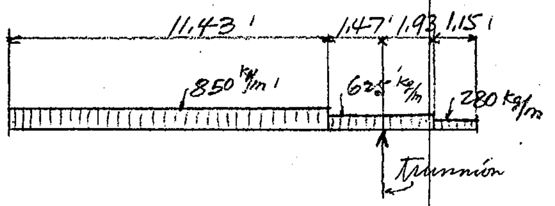
CALCULATIONS FOR

Design of Enoura Bascule Bridge for Mie-ken.

Approximate Estimate of Counterweight.

Dead load of Bascule leaf.

Floor Planking with nails + bolts	3.90′	@ 60′ =	234′
copings	2 @ 0.12 × 0.09	@ 650 =	14′
nailing pieces	5 @ 0.12 × 0.096	@ 〃 =	37′
			285′
Stringers	5	@ 20 =	100′
floor beams	50 × 4.3 = 215′	÷ 2.14 =	100′
lateral bracing			75′
handrails say	2	@ 15 =	30′
main truss	2	@ 125 =	250′
			555′
		misc. say	10′
			850′ kg/m of bridge.



moment about trunnion shaft.

front arm.

	850′ × 11.43′ × 7.185′ =	69800′	
	625′ × 1.47′ × 0.735′ =	680′	
front shoe	2 × 20′ × 12.70′ =	510′	
air buffers	2 × 80′ × 12.70′ =	2030′	
floor break	150 × 12.70′ =	1900′	
〃	150 × 1.60′ =	240′	
extra wt. at L_0	200 × 12.70′ =	2540′	
〃 〃 L_0	260 × 1.70′ =	440′	
rack (front)	90 × 0.80 × 0.40′ =	30′	
			78170′

rear arm.

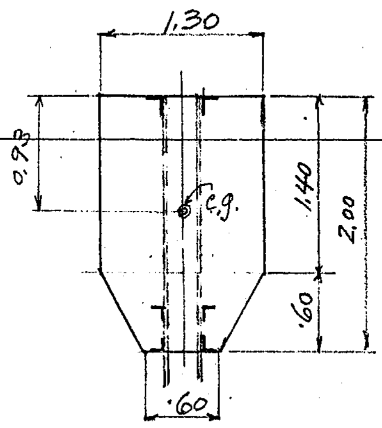
	280 × 1.15′ × 2.505′ =	810′	
	625 × 1.93′ × 0.965′ =	1160′	
boss + shaft	150 × 2.80′ =	420′	
rack (rear)	90 × 2.0 × 0.80′ =	140′	
			−2530′
			75640′ kgm.

Counterweight required $= \frac{75640'}{2.80} = 27000'$ kg

less counterweight frame — 3600′ → 23400′ kg

Counterweight concrete required $= \frac{23400'}{2200} = 10.63'$ cub. m. of plain concrete.

Cross section of cwt. $= \frac{10.63'}{4.70'} = 2.27\ m^2$,

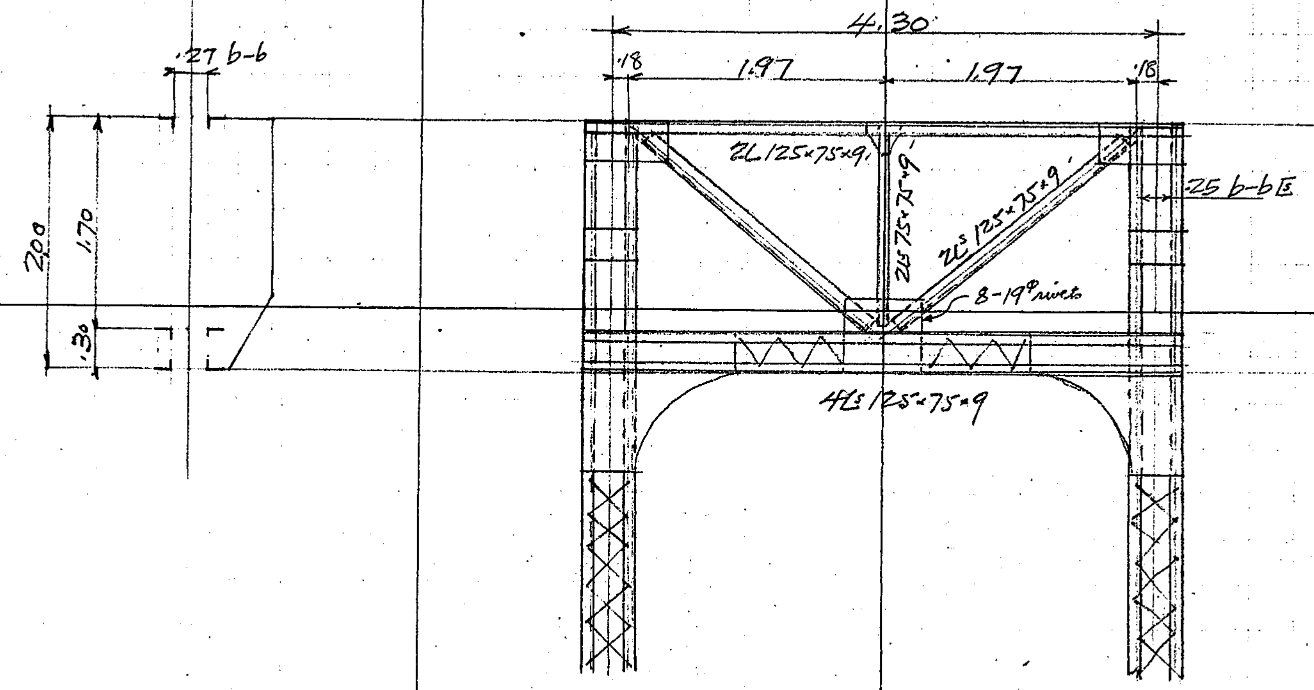


$1.30 \times 1.40' = 1.82'$
$0.95 \times 0.60' = 0.57'$
$2.39'$ sq.m × 4.70′ = 11.23′ cub. meters — max. volume.
adjusting hollow 2 @ 1.0 × 1.5 × 0.4′ = 1.20′
10.03′ 〃 — min. volume.
10.63′ 〃 — Standard volume.

Center of gravity. $1.82 \times 0.70' = 1.275'$
$0.57 \times 1.663 = 0.948'$
$2.223 \div 2.39 = 0.93'$

Design of Enoura Bascule Bridge for Mie-Ken.

Design of Counterweight girder.

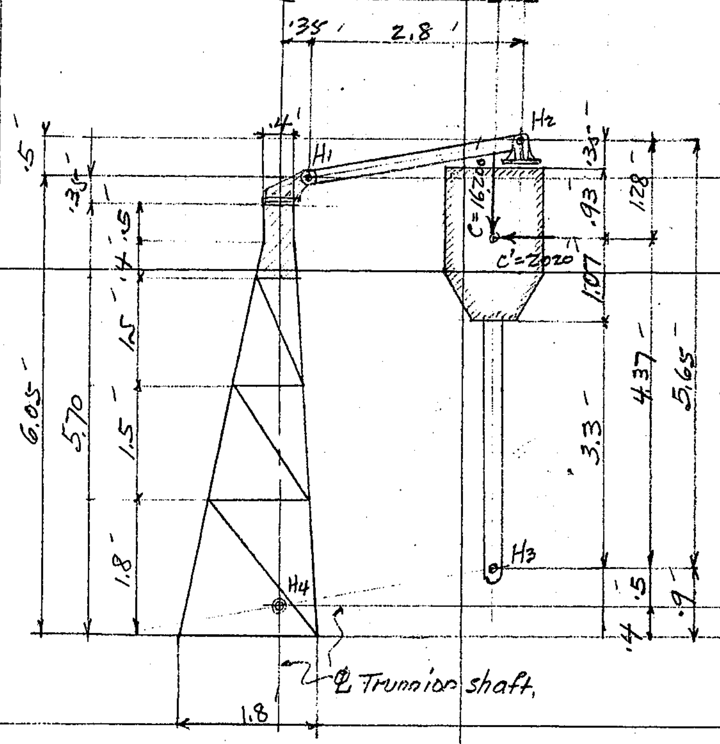


Moment at center = 1/4 × 27000 × 2.15 = 14,500 kgm
top chord stress = 14500 ÷ 1.80 × 1.20 = 9680 kg C (20% impact 含)
use 2L 125×75×9 = 34.38 cm²

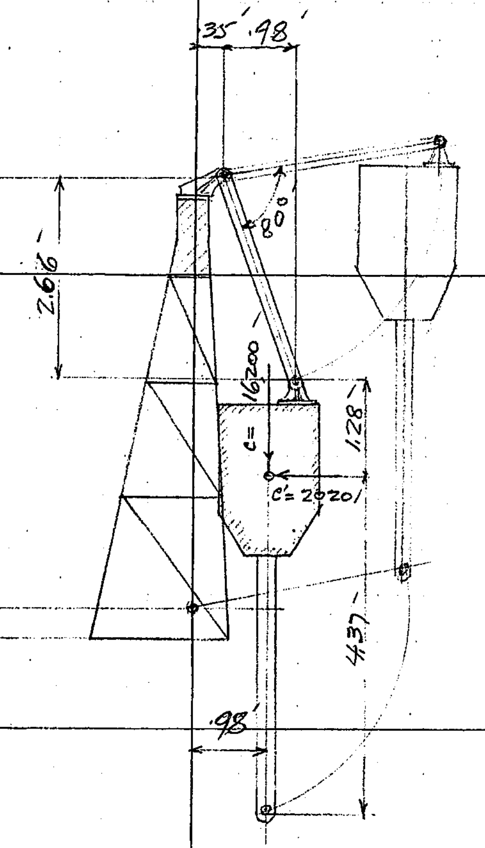
Shear = 1/4 × 27000 = 6750 kg diagonal length
Diagonal stress = 6750 × 1.53 × 1.2 = 12400 kg T (20% impact 含) = $\sqrt{1.97^2+1.7^2}$ = 2.60
req = 10.33 cm² net Coef. = 2.60/1.70 = 1.53
use 2L 125×75×9 = 34.38 − 7.92 = 26.46 net

Design of Counterweight links and Columns

vertical load on column = 27000 ÷ 2 = 13500
20% impact = 2700
16200 kg C on one column.



Bridge closed.



Bridge Opened.

Seismic load.
13500 × 0.15 ≒ 2020 kg (one col.)
wind load. 200 kg/m²
2.0 × 2.35 × 200 = 940 kg (〃)
deceleration 5% say
0.05 × 13500 = 680 kg (〃)

Seismic force governs in all cases.

Coef. seco for cwt link.
Bridge closed.
$\sqrt{0.5^2+2.8^2}$ = 2.84
Coef. = 2.84 ÷ 2.80 = 1.02

Bridge opened.
$\sqrt{.98^2+2.66^2}$ = 2.84
Coef. = 2.84 ÷ 0.98 = 2.90

Design of Ensoura Bascule Bridge for Mie-ken.

Seismic thrust on hinge H_2.

$2020 \times \frac{4.37}{5.65}' = 1560'$ kg on one hinge

link thrust $1560 \times 1.02' = 1590'$ " on one link Bridge closed

or $1560 \times 2.90' = 4530'$ " " Bridge opened.

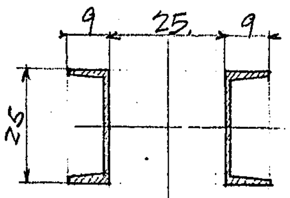
Seismic thrust on hinge H_3

$2020 \times \frac{1.28}{5.65}' = 460'$ kg on one hinge.

Bending moment on column

$460 \times 3.30' = 1520'$ kgm (one col.)

Column section.

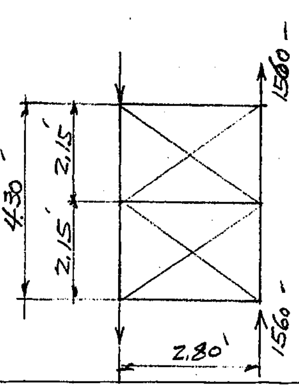


$2[\ 250 \times 90 \times 9' = 88.14$ cm², section modulus $= 2 @ 334.5' = 669$ cm³,

Direct compression $= 16200 \div 88.14' = 184'$

Bending stress $= \frac{1520 \times 100}{669}' = \frac{227'}{411'}$ kg/cm²

Link Bracing.



Diagonal length $= \sqrt{2.8^2 + 2.15^2}' = 3.50'$ coef. $= 3.50 \div 2.15' = 1.63'$

Diagonal stress $= 1560 \times 1.63' = 2540'$ kg T $SR = \frac{2540}{1200 \times 1.6}' = 1.32'$ cm² net

use 1L $75 \times 75 \times 9' = 12.69' - 1.98' = 10.71$ cm² net. 3-19φ rivets for connection.

Max. link thrust $= 4530$ kg. $SR = 4.50$ cm² gr.

use 1[$250 \times 90 \times 9' = 44.07$ cm², gr.

least radius of gyration $= 2.64'$ $l = 280'$ $l/r = \frac{280}{2.64}' = 106'$

Allowable unit compression on link.

$f = 1500(1 - 0.0055 \times 106)' = 625' \times 1.60 = 1000'$ kg/cm² C

Approximate weight of Counterweight framing.

Columns.	4[250×90×9	@ 34.60'	× 5.30'	=	733'
chords.	6L' 125×75×9	@ 13.50'	× 4.73'	=	383'
diagonals	4L "	@ "	× 2.40'	=	130'
vertical	2L' 75×75×9	@ 9.96'	× 1.60'	=	32'
	Details say 50%			=	639'
					1917'
		Call this			2000 kg'

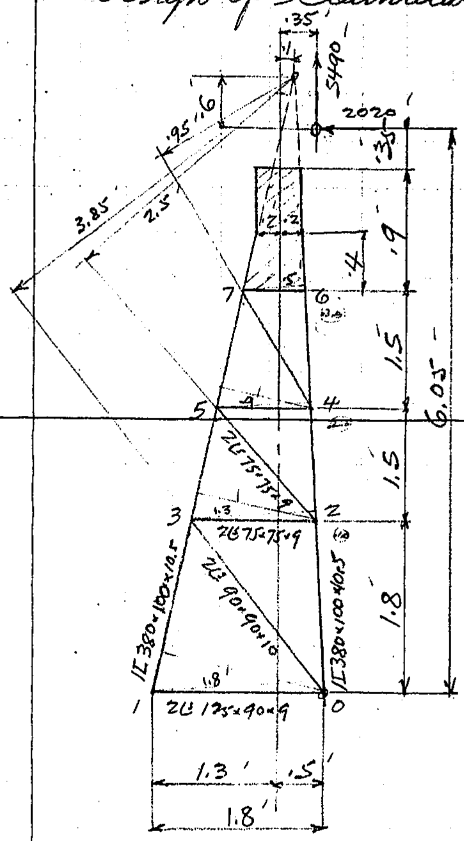
1278

Approximate weight of Counterweight links.

Links	2[' 250×90×9'	@ 34.60'	× 3.10'	=	215'
struts	2[' "	@ "	× 4.30'	=	298'
"	2L' 75×75×9	@ 9.96'	× 2.80'	=	56'
diagonals	4L' 75×75×9	@ "	× 3.50'	=	140'
	details say 30%'			=	213'
					922'
		Call this			920 kg

Design of Enausa Bascule Bridge for Mie-Ken.

Design of Counterweight tower.



Seismic hor. thrust = 2020 kg on one frame.
" vert. " = 2020 × 2.66/0.98 = 5490 kg

Column 1-3.
2020 × 6.05 = 12230
5490 × 0.15 = − 820
11410 ÷ 1.8 = 6340 kg C

0-2
2020 × 4.25 = 8590
5490 × 1.25 = + 6870
15460 ÷ 1.3 = 11900 kg T

3-5
2020 × 4.25 = 8590
5490 × 0.05 = − 270
8320 ÷ 1.3 = 6400 kg C

2-4
2020 × 2.75 = 5550
5490 × 0.95 = + 5220
10770 ÷ 0.90 = 11960 kg T

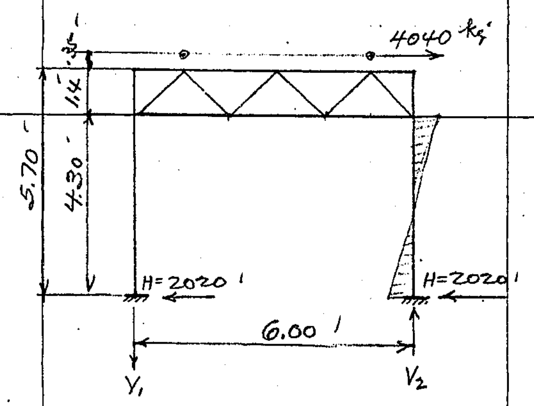
5-7
2020 × 2.75 = 5550
5490 × 0.05 = + 270
5820 ÷ 0.90 = 6470 kg C

4-6
2020 × 1.25 = 2530
5490 × 0.65 = + 3570
6100 ÷ 0.50 = 12,200 kg C

Diagonals. moment about intersection point of columns.
2020 × 0.60 = 1210
5490 × 0.25 = −1370
− 160 kgm

0-3 − 160 ÷ 3.85 = 40 kg C
2-5 − 160 ÷ 2.50 = 60 "
4-7 − 160 ÷ 0.95 = 170 "

Sway Bracing of tower.



Seismic thrust 2 × 2020 = 4040 kg.
vert. reaction $V_2 = -V_1$ = 4040 × 6.05 / 6.0 = 4080 kg
moment on col. = ± 2020 × 4.3/2 = 4340 kgm

max. vert. load = 4080
dead load say 1500
5580 kg C

Use 1[380 × 100 × 10.5 = 69.39 cm² gr − 13.97 = 55.42 cm² net

3 × 1.05 × 2.2 = 6.93
2 × 1.6 × 2.2 = 7.04
13.97

direct comp. = 5580/69.39 = 81
bending stress = 4340 × 100/762.2 = 569
650 kg/cm²

f = 1500 (1 − 0.0055 × 180/2.83) = 975 × 1.6 = 1560 kg/cm²

JIUN MASUDA
CONSULTING ENGINEER
~~JIJI~~ SHOWA BLDG, TOKYO

MADE BY K. Inaba DATE 9-6-12 FILE NO ____
CHECKED BY M. J. DATE 9-7-21 PAGE NO 22

CALCULATIONS FOR

Design of Enoura Bascule Bridge for Mie-ken.

Approximate weight of Counterweight tower.

Columns	2L's 380×100×10.5 @	54.50 × 5.80 =	632	
diagonals	2L's 75×75×9 @	9.96 × 1.40 =	28	
"	2L's " @	" × 1.50 =	30	
"	2L's 90×90×10 @	13.30 × 2.00 =	53	
horizontals	2L's 75×75×9 @	9.96 × 0.80 =	16	
"	2L's " @	" × 1.20 =	24	
"	2L's 125×90×9 @	14.60 × 1.80 =	53	
			836	
		details 50%	418	
			1254×2 =	2508
Top strut	4L's 125×90×9 @	14.60 × 6.38 =	373	
"	2web 450×9 @	31.79 × 6.38 =	404	
bottom tie	2L's 125×90×9 @	14.60 × 6.00 =	175	
bracings	6L's 75×75×9 @	9.96 × 1.30 =	78	
			1030	
		details 35% say =	360	
				1390
Shoes, anchor bolts &c say				302
				4200 kg

Summary of structural steel for Bascule proper.

Bascule leaf complete	12,700
Counterweight framing complete	2000
Counterweight links with bracings	920
Counterweight tower with sway bracing	4200
Steel under main trunnion bearings say	1500
floor beams over bascule pier	400
steel under machinery bearings	800
miscellaneous details say	480
	23,000 kg

JIUN MASUDA
CONSULTING ENGINEER
~~[illegible]~~ SHOWA BLDG, TOKYO

MADE BY K. Inaba DATE 9-6-13 FILE NO ______
CHECKED BY M. J. DATE 9-7-21 PAGE NO 23

CALCULATIONS FOR

Design of Enoura Bascule Bridge for Mie-ken.

Approximate position of Center of gravity of Bascule leaf.

					vert arm	moment	hor. arm	moment
Floor planking	3.90 × 11.30	@ 55	=	2425	−0.05	−121	7.25	17570
Coping	2 × 0.12 × 0.09 × 11.30	@ 650	=	160	0.035	6	7.25	1160
nailing pieces	0.116 × 0.12 × 11.30	@ "	=	100	−0.133	−13	7.25	725
"	2 × 0.106 × 0.12 × 11.30	@ "	=	190	−0.138	26	7.25	1380
"	2 × 0.076 × 0.12 × 11.30	@ "	=	130	−0.153	20	7.25	940
floor breaks	2 × 0.171 × 0.15 × 3.90	@ "	=	130	−0.096	13	7.25	940
				3,135 kg		−69		22715

Summary of floor.

					vert arm	moment	hor. arm	moment
Stringers	5 @ 11.30	@ 20	=	1130	−0.286	−323	7.25	8200
floor beams	5	@ 215	=	1075	−0.500	−538	8.42	9050
"	2	@ 205	=	410	−0.500	−205	1.85	758
lateral bracings				800	−0.630	−504	7.35	5880
main trusses	2	@ 3850	=	7700	0.163	1255	2.44	18780
handrails	2 @ 11.50	@ 10	=	230	0.470	108	6.95	1598
floor breaks	2 @	150	=	300	0.000	0	7.15	2145
front shoes	2	@ 20	=	40	−0.680	−27	12.70	508
air buffers	2	@ 80	=	160	−0.500	−80	12.50	2000
rack	2 @ 2.80	@ 90	=	500	−0.900	−450	−0.50	−250
trunnion boss + shaft	2 @	100	=	200	0.600	120	0.00	0
cwt " "	2 @	75	=	150	1.100	165	−2.80	−420
				12695 kg		1648		48919
						−2127		−670
				12,695 kg	−0.038 m	−479	+3.800 m	48,249
				3135		−69		22715
				15,830	−0.035 m	−548	+4.480 m	70964

Counterweight required.

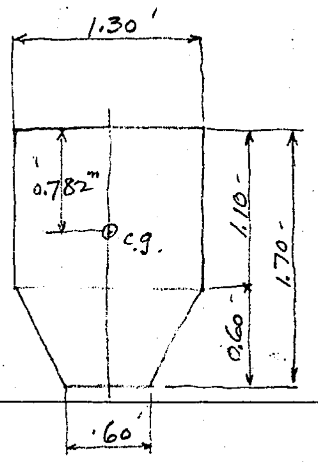
moment of bascule leaf abut trunnion = + 70964
front reaction assumed 600 kg (2 girders) × 12.70 = − 7620
63344 kgm

Counterweight req'd. = $\frac{63344}{2.80}$ = 22,600 kg

Counterweight framing 2000
" link with bracing $\frac{920}{2}$ = 460
2460

required cwt. concrete = 20,140 kg

volume = $\frac{20140}{2200}$ = 9.16 cub. m



cross section = $\frac{9.16}{4.70}$ = 1.95 m²

1.30 × 1.10 = 1.43 × 0.55 = .787
0.95 × 0.6 = 0.57 × 1.363 = .778
2.00 0.782 m, 1.565

2 × 4.7 = 9.4 m³ @ 2200 = 20700
2460
23160 kg
22600
560 kg

但書 ± 1000 kg 内外ヲ自由ニ adjust シ得ル様設備スルコト.

Design of Enoura Bascule Bridge for Mie-Ken.

Estimate of Operating power.

Rack force to overcome journal frictions

moment due to frictional resistance of journals

$$M_F = \frac{Pfr}{100} = \frac{PfD}{200}$$

where M_F = moment due to frictional resistance of journals in kgm;
P = resultant load on shaft in kg;
f = coefficient of friction between shaft + boss = 0.150 assumed;
$r = \frac{D}{2}$ = radius of shaft in cm.

Then we have

$$M_F = \frac{0.150PD}{200} = 0.00075\,PD \text{ kgm.}$$

assuming the radius of rack circle as 1.80 meters, rack force F_R will be denoted as follows

$$F_R = \frac{M_F}{R} = \frac{0.00075PD}{1.80} = 0.000417\,PD \text{ kg}$$

Vertical load on trunnion shaft.

weight of moving leaf	=	15830	see on page 23
Counterweight	=	22600	
		38430 kg	

Vertical load on counterweight trunnion shaft = 22600 kg

Horizontal load on trunnion shaft due to wind, wind pressure during operation assumed as 25 kg/m²

11.30 × 4.50 @ 25 = 1270 kg

Resultant load on trunnion during wind $= \sqrt{38430^2+1270^2} = 38450$ kg

Assuming the diameters of trunnion and cwt. trunnion shafts as 10.0 and 7.5 cm respectively, we have the rack force due to frictional resistance of

main trunnion shaft 0.000417 PD = 0.000417 × 38430 × 10.0 = 160
cwt. " " 0.000417 × 22600 × 7.5 = 70

Rack force in case of no wind F_R = 230 kg

Rack force during wind approximately same as above.

Rack force due to the Inertia of the moving bodies.

$$F = M\alpha$$

$$M = \frac{Wc^2}{gr^2} \quad \text{or} \quad M \cdot r^2 = \frac{Wc^2}{9.80}$$

where
F = Rack force to overcome the inertia;
M = Equivalent mass at the circle in kg;
α = acceleration or retardation in m/sec²;
c = distance of c.g. of moving body from its center of rotation in m;
W = weight of moving body in kg;
r = radius of rack circle = 1.80 m;
g = acceleration of gravity = 9.80 m/sec².

For moving leaf $M \cdot r^2 = 15830 \times 4.48^2 \div 9.80 = 32500$
" counterweight " $= 22600 \times 2.80^2 \div 9.80 = 18100$
Summary 50600

Equiv. mass $M = \frac{50600}{1.80^2} = 15620$ kg.

増田淳氏関係資料
(独立行政法人 土木研究所蔵)

Design of Enoura Bascule Bridge for Mie-ken.

Time of operation assumed as follows.

acceleration during 20
unif. speed " 2'40" = 160
retardation " 20
200 sec

or 3 min and 20 sec.' for 80 degree operation.'

Equivallent time for unif. speed = $\frac{20}{2} + 160 + \frac{20}{2} = 180$ sec.'

Uniform speed at rack circle

$\frac{2\pi \times 1.80 \times 80°}{180 \times 360°} = 0.014$' meter per sec.

Acceleration $\alpha = \frac{0.014}{20 \text{ sec}} = 0.0007$' meter per sec per sec.

Rack force due to inertia

$F_R = M\alpha = 15620 \times 0.0007' = 11$' kg

Rack force to overcome the eccentricity. Eccentricity being assumed as 5 cm.

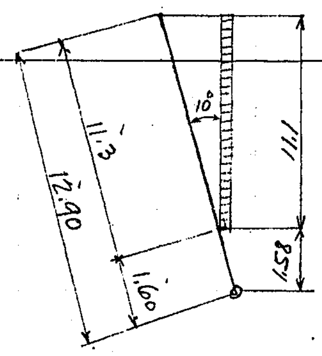
Eccentric moment $M_E = 38430 \times 0.05' = 1920$' kgm

$F_R = \frac{M_E}{R} = \frac{1920}{1.80}' = 1067$' kg

Rack force due to wind pressure. wind pressure assumed as 25 kg/m² during operation.

Cos 10° = 0.9848' 11.30 × 0.9848' = 11.1'
1.60 × " ' = 1.58'

11.1 ÷ 2 = 5.55'
1.58'
arm = 7.13 m'



wind pressure 25 × 4.50 × 11.1' = 1250' kg
wind moment about trunnion shaft

$M_w = 1250 \times 7.13' = 8910$' kgm

Rack force $F_R = \frac{8910}{1.80}' = 4950$' kg

JIUN MASUDA
CONSULTING ENGINEER
~~丸ビル~~ BLDG, TOKYO
SHOWA

MADE BY K. Inaba DATE 9-6-28 FILE NO ____
CHECKED BY M. J DATE 9-7-23 PAGE NO 26

CALCULATIONS FOR

Design of Enoura Bascule Bridge for Mie-Ken.

Operating power required.

Theoritical Horse-Power required to produce a rack force of 100 kg.

1 HP = 4560 kgm/min or 76 kgm/sec.

$$HP = \frac{100 \times v}{76} = \frac{100 \times 0.014}{76} = 0.01843$$

Efficiency of gear sets.

$$\eta = \underset{\text{worm}}{0.700} \times \underset{\text{spur}}{(0.94)^4} \times \underset{\text{rack+pinion}}{0.94} = 0.514$$

Operating power required in case of no wind.

	Rack force		Theoritical HP	Actual HP
Journal friction	230	× 0.01843 ÷ 100 =	0.0424 ÷ 0.514 =	0.0825
Inertia	11	" " =	0.0020 "	0.0039
Eccentricity	1067	" " =	0.1965 "	0.3820
	1308 kg		0.2409 HP	0.4684 HP

Operating power required during 25 kg wind

		Theoritical HP	Actual HP
Journal friction	230	0.0424	0.0825
Inertia	11	0.0020	0.0039
Eccentricity	1067	0.1965	0.3820
Wind	4950	0.9130	1.7760
	6258 kg	1.1539 HP	2.2444 HP

Use 1 - 3 HP Crane motor (totally enclosed)

Max. intensity of wind pressure against which this motor safely be able to operate the bridge.

Safe over-load on motor specified at 40% for a continuous driving of 3 minutes.

max. power produced by this motor = 3 × 1.40 = 4.20 HP during 3 min.

max. power utilized to overcome wind resistance = 4.20 - 0.47 = 3.73 HP

Allowable max. wind pressure during operation

$$= 25 \times \frac{3.73}{1.776} = 52.5 \text{ kg/m}^2$$

The velocity of above wind will be = 23.2 meters per second.

$$\left(P = \frac{V^2}{10.25} \quad \text{or} \quad V^2 = 10.25P \right)$$

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

CALCULATIONS FOR

MADE BY A. Inaba DATE 9-7-18 FILE NO
CHECKED BY M. J. DATE 9-7-23 PAGE NO 27

Design of Enoura Bascule Bridge for Mie-Ken.

Power required for Hand operation.
Time of operation assumed as 25 min. or 1500 sec.
Uniform speed at rack circle
$$\frac{2\pi \times 1.8 \times 80^\circ}{1500 \times 360} = 0.00167 \text{ meter per sec.}$$

Rack force to overcome
Journal friction 230
Inertia negiligible —
Eccentricity 1067
1297 kg for no wind
wind 12.5 kg/m² intensity 2475 kg against wind pressure
3772

Resultant efficiency of operating mechanism
$$\eta = (0.94)^7 = 0.648$$

work done required by hand = 1297×0.00167÷0.648 = 3.34 kgm/sec for no wind
3772×0.00167÷0.648 = 9.72 " against 12.5 kg wind

Energy developed by one operator.
Let arm of crank = 35 cm or 0.35 meter
rotating power on crank by one operator for continuous operation = 10 kg
no. of revolution of crank shaft = 60 per min or 1 per sec.

work done by one operator per second.
$$10 \times \pi \times 0.35 \times 2 \times 1 = 22.0 \text{ kgm per sec.}$$

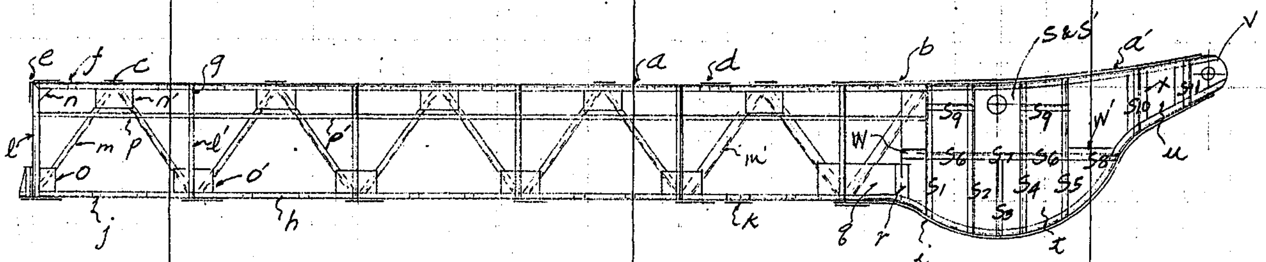
JIUN MASUDA
CONSULTING ENGINEER
BLDG, TOKYO
SHOWA

MADE BY M. Jinda DATE 9-7-14 FILE NO
CHECKED BY DATE PAGE NO 28

CALCULATIONS FOR

Design of Enoura-Bashi for Mie-Ken

Center of gravity for moving leaf
Moment about Center of trunnion shaft
For structural steel



Name	description	Unit wt.	length	wt.	Hor. arm	Hor. M	Vert. arm	Vert. M
Top flange (a)	2Ls 125×90×9	14.600 ×	9.594 =	280.1	+7.867	+2204	-0.228	- 64
" " "	2Ls	"	" ×	3.070 =	89.6	+1.535	+ 138	-0.248	- 22
" " "	2Ls	"	" ×	2.805 =	81.9	-1.402	- 115	-0.372	- 30
" " (b)	1Pl 260 × 9	18.369 ×	2.290 =	42.1	+1.145	+ 48	-0.280	- 12
" " "	1Pl "	" ×	1.405 =	25.8	-.700	- 18	-0.329	- 8
" " "	1Pl 180 × 9	12.717 ×	1.290 =	16.4	-2.035	- 33	-0.507	- 8
" tie (c)	5Pls 190 × 9	13.424 ×	260 =	17.5	+7.350	+ 129	-0.255	- 4
" splice (d)	1Pl 260 × 9	18.369 ×	500 =	9.2	+3.640	+ 33	-0.255	- 2
" " "	1Pl 85 × 9	6.005 ×	500 =	3.0	+3.640	+ 11	-0.203	- 1
" " "	2Pls 75 × 9	5.299 ×	500 =	5.3	+3.640	+ 19	-0.198	- 1
" " (e)	1Pl 260 × 9	18.369 ×	430 =	7.9	+12.650	+ 100	-0.197	- 2
" Fills (f)	10 Fills 85 × 9	6.005 ×	130 =	7.8	+7.147	+ 56	-0.204	- 2
" " (g)	5 Fills 70 × 9	4.946 ×	170 =	4.2	+6.325	+ 27	-0.170	- 1
" cut Ls (a')	2Pls 40 × 9	2.826 ×	1.300 =	- 7.3	-2.035	+ 15	-0.498	+ 4
Bottom flg (h)	2Ls 125×90×9	14.60 ×	11.402 =	333.2	+7.169	+ 2,389	+1.268	+ 422
" " "	"	" " ×	562 =	16.4	+1.199	+ 20	+1.308	+ 21
" " "	"	" " ×	1.960 =	57.2	0	0	+1.632	+ 93
" " "	"	" " ×	964 =	28.1	-1.245	- 35	+1.135	+ 32
" " "	"	" " ×	440 =	12.8	-1.675	- 21	+0.525	+ 7
" " "	"	" " ×	1.255 =	36.6	-2.380	- 87	+0.050	+ 2
" " (i)	1Pl 260 × 12	24.492 ×	822 =	20.1	+1.879	+ 38	+1.296	+ 26
" " "	"	" " ×	562 =	13.8	+1.199	+ 17	+1.336	+ 18
" " "	"	" " ×	1.960 =	48.0	0	0	+1.685	+ 81
" " "	"	" " ×	964 =	23.6	-1.245	- 29	+1.165	+ 27
" " "	"	" " ×	440 =	10.8	-1.675	- 18	+.555	+ 6
" " "	"	" " ×	1.180 =	28.9	-2.350	- 68	+0.095	+ 3
" Fills (j)	9Pls 85 × 9	6.005 ×	130 =	7.0	+7.802	+ 55	+1.243	+ 9
" Splice (k)	1Pl 260 × 9	18.369 ×	500 =	9.2	+3.530	+ 32	+1.295	+ 12
" " "	1Pl 85 × 9	6.005 ×	500 =	3.0	+3.530	+ 11	+1.243	+ 4
" " "	2Pls 75 × 9	5.299 ×	500 =	5.3	+3.530	+ 19	+1.238	+ 7
" " "	2 Fills 75 × 4	2.355 ×	250 =	1.2	+3.405	+ 4	+1.238	+ 1
Vertical (l)	2Ls 125×75×9	13.500 ×	1.510 =	40.8	+12.678	+ 517	+0.530	+ 22
" (l')	8Ls "	" " ×	1.540 =	166.3	+7.372	+ 1,226	+0.520	+ 86
" "	2Ls "	" " ×	1.565 =	42.3	+2.022	+ 86	+0.515	+ 22
Diagonal (m)	1L 90×90×10	13.300 ×	1.565 =	20.8	+12.120	+ 252	+0.510	+ 11
" "	"	" " ×	" =	20.8	+11.140	+ 232	+0.510	+ 11
" "	"	" " ×	1.605 =	21.3	+9.990	+ 213	+0.525	+ 11
" "	"	" " ×	1.565 =	20.8	+9.000	+ 187	+0.510	+ 11
" "	"	" " ×	1.605 =	21.3	+7.850	+ 167	+0.525	+ 11
" "	"	" " ×	1.565 =	20.8	+6.860	+ 143	+0.510	+ 11
" "	"	" " ×	1.605 =	21.3	+5.710	+ 122	+0.525	+ 11
" "	"	" " ×	1.565 =	20.8	+4.720	+ 98	+0.510	+ 11
" (m')	1L 125×90×9	14.600 ×	1.610 =	23.5	+3.590	+ 84	+0.520	+ 12
" "	"	" " ×	1.535 =	22.4	+2.575	+ 58	+0.490	+ 11
" "	"	" " ×	1.625 =	23.7	+1.445	+ 34	+0.500	+ 12
				1725.6		+8784 / -424		1525 / -157

Design of Enoura-Bashi for Mie-Ken

gusset	(n)	1 Pl	240 × 9	16956 ×	199 =	3.4	+12600	+ 43	-0.140	0
〃	(n')	4 Pls	340 × 9	24021 ×	485 =	46.6	+8420	+ 392	-0.075	- 3
〃	〃	1 Pl	370 × 9	26141 ×	620 =	16.2	+3070	+ 50	-0.065	- 1
〃	(o)	1 Pl	400 × 9	28260 ×	440 =	12.4	+12630	+ 157	+1.090	+ 14
〃	(o')	3 Pls	395 × 9	27907 ×	550 =	46.0	+8420	+ 387	+1.090	+ 50
〃		1 Pl	430 × 9	30380 ×	555 =	16.9	+4140	+ 70	+1.090	+ 18
Handrail	(p)	1 L	65×50×7	5.94 ×	2.030 =	12.1	+11630	+ 141	+0.151	+ 2
〃	(p')	4 Ls	〃	〃 ×	2.070 =	49.2	+6280	+ 309	+0.151	+ 7
〃	〃	1 L	〃	〃 ×	1.065 =	6.3	+1465	+ 9	+0.151	+ 1
〃 gusset		1 Pl	110 × 9	7772 ×	.155 =	1.2	+12605	+ 15	+0.180	0
〃 〃		5 Pls	60 × 9	4239 ×	305 =	6.5	+6277	+ 41	+0.165	+ 1
At L0		2 Ls	116×75×9	13.0 ×	396 =	10.3	+12722	+ 131	+1.083	+ 11
〃		2 Fills	160 × 9	11304 ×	310 =	7.0	+12770	+ 89	+1.050	+ 7
〃		1 Fill	110 × 8	6908 ×	390 =	2.7	+12700	+ 34	+1.090	+ 3
Washer		6 Pls	70φ	302 ×	9 =	1.6	+7350	+ 12	+0.545	+ 1
At L10		1 L	100×75×10	13.0 ×	245 =	3.2	+1716	+ 5	+1.143	+ 4
〃		1 L	〃	〃 ×	185 =	2.4	+1764	+ 4	+1.173	+ 3
		1 Fill	70 × 9	4946 ×	175 =	0.9	+1695	+ 2	+1.100	+ 1
〃		1 Fill	〃	〃 ×	115 =	0.6	+1785	+ 1	+1.130	+ 1
Web plate	(g)	1 Pl	520 × 9	36738 ×	1.060 =	38.9	+1775	+ 69	+1.030	+ 40
〃 splice	(r)	2 Pls	260 × 9	18369 ×	430 =	15.8	+1245	+ 20	+1.010	+ 16
Web plate	(s)	1 Pl	935 × 9	66058 ×	3.230 =	213.4	-.500	- 107	+0.180	+ 38
〃 〃	(t)	1 Pl	1090 × 9	77009 ×	2.300 =	177.1	+.010	+ 2	+1.135	+ 201
〃 〃	(u)	1 Pl	630 × 9	44510 ×	1.150 =	51.2	-2330	- 119	-0.245	- 13
Side pls	(s')	2 Pls	900 × 9	63585 ×	1.700 =	216.2	-.015	- 3	+0.250	+ 54
〃 〃	〃	2 Pls	590 × 9	41684 ×	.910 =	75.9	0	0	+0.175	+ 13
〃 〃	(v)	2 Pls	345 × 9	24374 ×	650 =	31.7	-2660	- 84	-0.360	- 11
〃 〃	〃	2 Pls	410 × 9	28967 ×	560 =	32.4	-2750	- 89	-0.400	- 13
Web splice	(w)	2 Pls	140 × 9	9891 ×	310 =	6.1	+1090	+ 7	+0.640	+ 4
〃 〃	(w')	2 Pls	〃	〃 ×	610 =	12.1	-1230	- 15	+0.640	+ 8
〃 〃	(x)	2 Pls	270 × 9	19076 ×	620 =	23.7	-1890	- 45	-0.070	- 2
Stiffener	(s1)	2 Ls	125×75×9	13.5 ×	1.740 =	47.0	+.913	+ 43	+0.592	+ 28
〃	(s2)	2 Ls	〃	〃 ×	1.960 =	52.9	+.317	+ 17	+0.700	+ 37
〃	〃	2 Fills	70 × 9	4946 ×	872 =	8.6	+.340	+ 3	+1.150	+ 10
〃	(s3)	2 Ls	125×75×9	13.5 ×	1.082 =	29.2	-.017	0	+1.172	+ 34
〃	〃	2 Fills	70 × 9	4946 ×	910 =	9.0	-.040	0	+1.172	+ 11
〃	(s4)	2 Ls	125×75×9	13.5 ×	1.970 =	53.2	-.317	- 17	+0.693	+ 37
〃	〃	2 Fills	70 × 9	4946 ×	873 =	8.6	-.340	- 3	+1.152	+ 10
〃	(s5)	2 Ls	125×75×9	13.5 ×	1.780 =	48.1	-.913	- 44	+0.558	+ 27
〃	(s6)	4 Ls	〃	〃 ×	621 =	33.5	0	0	+0.657	+ 22
〃	(s7)	2 Ls	〃	〃 ×	600 =	16.2	0	0	+0.657	+ 11
〃	(s8)	2 Ls	〃	〃 ×	655 =	17.7	-1260	- 22	+0.657	+ 12
〃	(s9)	4 Ls	〃	〃 ×	621 =	33.5	0	0	+0.017	+ 1
〃	(s10)	2 Ls	75×75×9	9.96 ×	790 =	15.7	-1878	- 29	-0.068	- 1
〃	(s11)	2 Ls	〃	〃 ×	565 =	11.3	-2578	- 29	-0.325	- 4
Hole for Main Trunnion		1 Pl	210φ	2720 ×	045 = -	12.2	0	0	0	0
〃 〃 C.W.T. Trunnion		1 Pl	170φ	1780 ×	053 = -	9.4	-2800	+ 26	-0.420	+ 4
Fills	(v)	2 Pls	420 × 4	13188 ×	420 =	11.1	-2800	- 31	-0.420	- 5
Gusset of Lateral		1 Pl	445 × 9	31439 ×	505 =	15.9	+12647	+ 201	+1.295	+ 21
〃 〃		4 Pls	〃	〃 ×	475 =	59.7	+7242	+ 432	+1.295	+ 77
〃 〃		1 Pl	〃	〃 ×	550 =	17.3	+1870	+ 32	+1.307	+ 23
〃 〃		2 Fills	85 × 9	6005 ×	190 =	2.3	+1870	+ 4	+1.295	+ 3
Rivet heads					=	253.1	+3150	+ 797	+0.550	+ 139
Sole plate					=	32.7	+12700	+ 415	+1.319	+ 43
Main trunnion					=	136.4	0	0	0	0
C.W.T. trunnion					=	54.6	-2800	- 153	-0.420	- 23

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

MADE BY M. Jinda DATE 9-7-17 FILE NO.

CHECKED BY DATE PAGE NO. 30

CALCULATIONS FOR

Design of Enoura-Bashi for Mie-Ken

			Weight	Harm	H·m	Varm	V·m
Rack		=	315.1	- 470	- 148	+ 1.550	+ 488
			4126.7		+ 12,744		+ 2,564
					- 1,362		- 233
					+ 11,382		+ 2,331
	For two trusses		8253.4		+ 22,764		+ 4,662
For stringers, Floor Beams and lateral bracings							
ST 1, 2 & 3	5 [s 150 × 75 · 18.6 × 6605	=	614.3	+ 9.588	+ 5,890	+ 0.906	+ 557
ST 4, 5 & 6	5 [s 〃 〃 × 4625	=	430.1	+ 3.963	+ 1,704	+ 0.906	+ 390
Splice	5 Pls 120 × 9 · 8.478 × 340	=	14.4	+ 6.280	+ 90	+ 0.906	+ 13
Rivet heads		=	9.9	+ 7.270	+ 72	+ 0.980	+ 10
FB 1, 2 & 3	5 I's 300 × 150 · 48.3 × 4180	=	1009.5	+ 8.420	+ 8,500	+ 1.140	+ 1,151
Gusset	4 Pls 330 × 9 · 23.315 × 600	=	56.0	+ 7.440	+ 417	+ 1.295	+ 73
Fills	15 Pls 150 × 9 · 10.598 × 150	=	23.8	+ 8.420	+ 200	+ 0.986	+ 23
〃	10 Pls 〃 〃 × 170	=	18.0	+ 8.420	+ 152	+ 0.986	+ 18
	10 Ls 150 × 90 × 9 · 16.400 × 210	=	34.4	+ 8.420	+ 290	+ 0.931	+ 32
FB 4	2 [s 300 × 90 · 38.1 × 4230	=	322.3	+ 1.873	+ 604	+ 1.140	+ 367
Gusset	1 Pl 610 × 9 · 43.097 × 620	=	26.7	+ 1.960	+ 52	+ 1.295	+ 35
Tie plate	3 Pls 230 × 9 · 16.250 × 430	=	21.0	+ 1.873	+ 39	+ 0.986	+ 21
〃 〃	2 Pls 250 × 9 · 17.663 × 430	=	15.2	+ 1.873	+ 28	+ 0.986	+ 15
Lac.	16 Bars 60 × 9 · 4.239 × 571	=	38.7	+ 1.873	+ 72	+ 1.295	+ 50
〃	16 Bars 〃 〃 × 528	=	35.8	+ 1.873	+ 67	+ 0.986	+ 35
	2 Ls 150 × 90 × 9 · 16.400 × 430	=	14.1	+ 1.873	+ 26	+ 0.931	+ 13
Rivet heads		=	27.8	+ 6.280	+ 175	+ 1.140	+ 32
Lateral		=	545.9	+ 7.320	+ 3,996	+ 1.270	+ 693
			3257.9		+ 22,374		+ 3,528
For Floor Breaks & Air buffers							
FL 2	2 c 113.9	=	227.8	+ 7.275	+ 1,657	+ 0.670	+ 153
Front air buffer	2 c 80	=	160	+ 12.500	+ 2,000	+ 1.140	+ 182
Rear air buffer	2 c 30	=	60	- 2.700	- 162	+ 0.050	+ 3
For Floor			447.8		+ 3,495		+ 338
Nailing piece	1 c 120 × .116 · 650 × 10.85	=	98.2	+ 7.275	+ 714	+ 0.773	+ 76
〃 〃	2 c 120 × .106 〃 × 10.85	=	179.4	+ 7.275	+ 1,305	+ 0.778	+ 140
〃 〃	2 c 120 · .076 〃 × 10.85	=	128.6	+ 7.275	+ 936	+ 0.793	+ 102
〃 〃	2 c 191 × .181 〃 × 3.90	=	175.3	+ 7.395	+ 1,296	+ 0.740	+ 130
Coping	2 c 150 × .085 〃 × 11.25	=	186.5	+ 7.275	+ 1,357	+ 0.610	+ 114
Planking	3.90 × .075 · 730 × 10.85	=	2316.7	+ 7.275	+ 16,854	+ 0.690	+ 1,599
Bolts		=	99.7	+ 7.200	+ 718	+ 0.775	+ 77
			3184.4		+ 23,180		+ 2,238

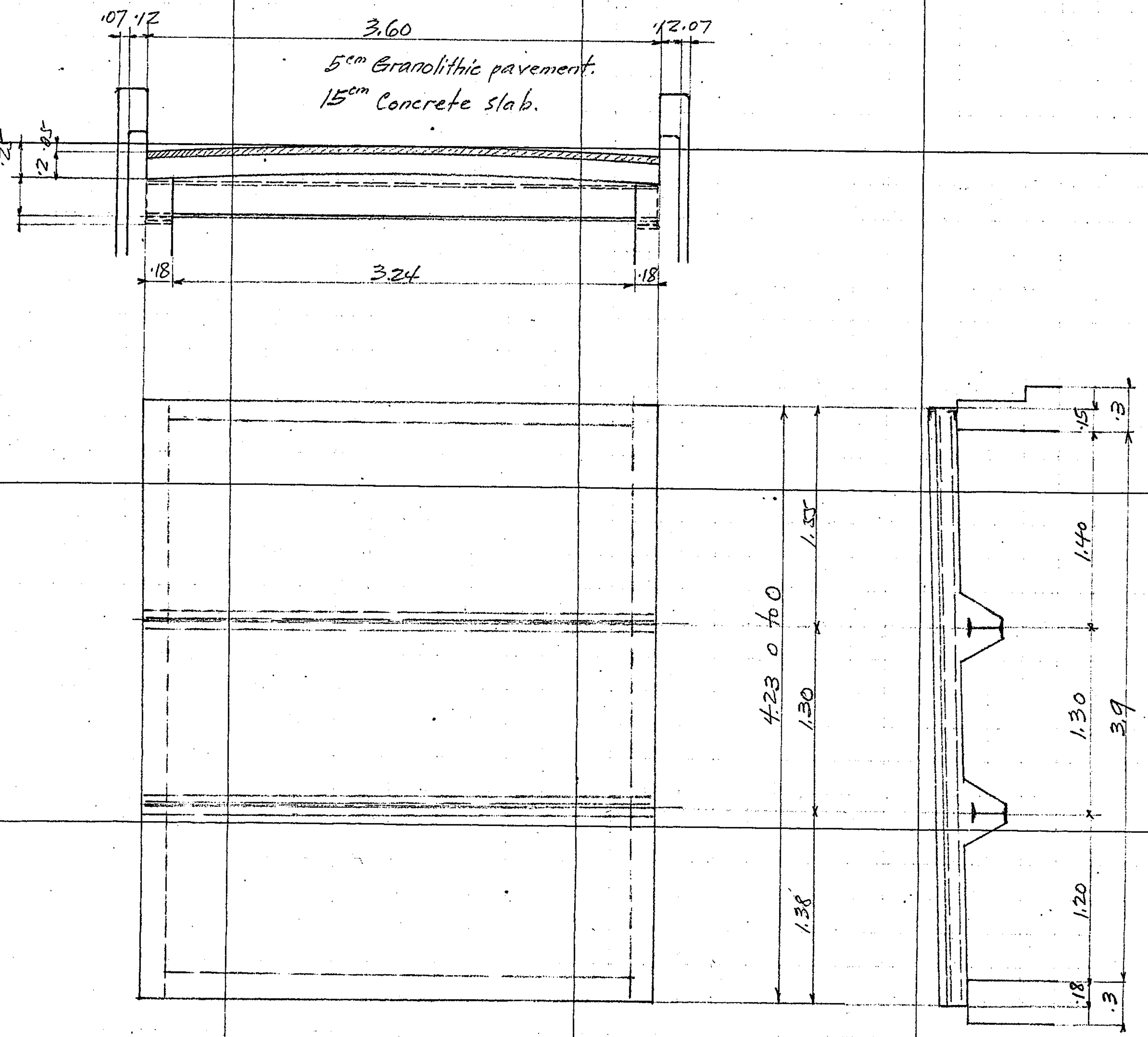
Center of Gravity of Moving leaf	Total Wt.	Harm	H.m	Varm	V.m
	15,143.5	4.742 m	71,813	.711	+ 10,766

Design of Enoura Bascule Bridge for Mie-Ken.

Design of Bascule Pier.

Floor slab. Span length 1.48m, 1.30, and 1.30m, Clear width 3.60 meters.

General sketch of floor slab on bascule pier.



scale 1/40

Dead load.

5cm Granolithic pavement @ 22kg	=	110
15cm Concrete floor slab @ 24 "	=	360
		470 kg/m2

For 1.48m span

Dead load moment = $1/10 \times 470 \times 1.48^2$ = 103 kgm

Dead load shear = $5/8 \times 470 \times 1.48$ = 433 kg.

Live load   4 ton motor truck rear wheel concentration = 1500

30% impact = 450

1950 kg

Uniform live load assumed as 500 kg per sq. meter.

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

MADE BY K. Inaba DATE 9-11-29 FILE NO
CHECKED BY DATE PAGE NO 32

CALCULATIONS FOR

Design of Enoura Bascule Bridge for Mie-Ken.

Distribution of wheel load on floor slab.

Longitudinal distribution a.

Contact between wheel and pavement		=	0.20
distributions	2@.05	=	0.10
		a =	0.30 m

Transverse distribution b.

width of rear wheel assumed as			0.20
distributions	2@.05	=	0.10
		b =	0.30 m

Effective width of slab $E = \frac{2}{3} l + a = \frac{2}{3} \times 1.48 \times 0.30 = 1.29^m$

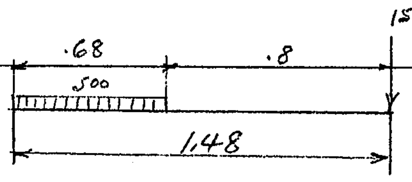
Load per meter strip of slab $= \frac{1950}{1.29} = 1,510$ kg

Live load moment

$\frac{1}{4} \times 1510 \times 1.48 = 558$ as a simple beam.

moment $= \frac{8}{10} \times 558 = 446$ kgm as a continuous beam.

Live load shear



unif. load	$500 \times .68 \times .34 \div 1.48 =$	78
wheel load		1510
		1588 kg

Summary of moments and shears.

	moment	shear.
Dead load	103	435
Live load	446	1588
	549 kgm	2023 kg

Effective depth required for $f_s = 1200$, $f_c = 45$ kg/cm²

$d = \sqrt{\frac{549 \times 100}{100 \times 7.13}} = 8.8$ cm

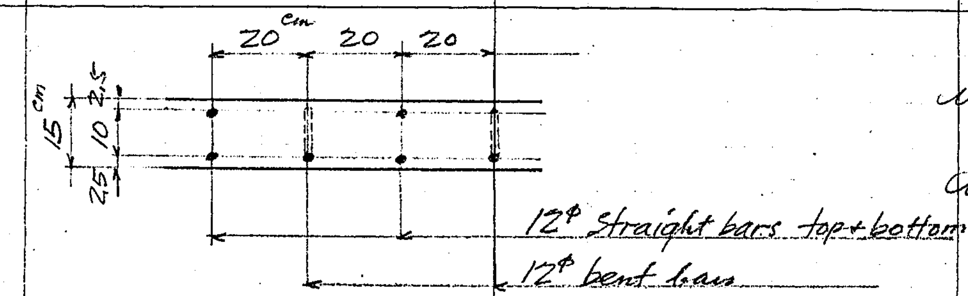
use 12.5 cm eff. depth with an insulation of 2.5 cm.
(機械室ノ天井ナルヲ以テ防水ノ意味ヨリ特ニ厚サヲ増セリ)

Steel area required

$= \frac{549 \times 100}{1200 \times \frac{7}{8} \times 12.5} = 4.18$ cm²

Use 12 mmφ bars at 20 cm c to c = 5.65 cm²

Unit shear $= \frac{2023}{100 \times \frac{7}{8} \times 12.5} = 1.85$ kg/cm²



Design of Floor Beam. Span length 3.42 m, Spacing 1.48 and 1.30 m

Dead Load.

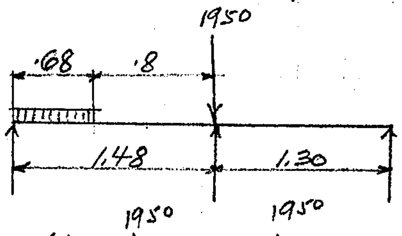
Floor slab and pavement from end span		435
" center "	$\frac{1}{2} \times 470 \times 1.3 =$	305
Concrete fillet say	$0.27 \times .30 @ 2400 =$	195
beam assumed as		55
		990 kg per lin meter

Dead load moment $= \frac{1}{8} \times 990 \times 3.42^2 = 1,450$ kgm

Dead load shear $= \frac{1}{2} \times 990 \times 3.42 = 1,690$ kg

Design of Enoura Bascule Bridge for Mie-ken.

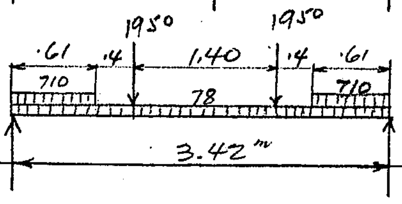
Live Load. 4 ton motor truck rear wheel with impact = 1950 kg
Uniform live load assumed as 500 kg/m²



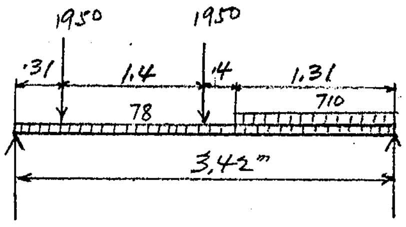
unif. load $500 \times .68 \times .34 \div 1.48 = 78$ kg/m. of floor beam.

$500 \times 5/8 \times 1.48 = 463$
$500 \times 1/2 \times 1.30 = 325$
788 kg/m of floor beam

$788 - 78 = 710$ kg/m.



Live Load moment
Rear wheel $1950 \times 1.01 = 1970$
unif. load. $710 \times .61 \times .305 = 132$
" $1/8 \times 78 \times 3.42^2 = 114$
2216 kgm.



Live Load shear.
Rear wheel $1950 \times 1.71 \div 3.42 = 975$
$1950 \times 3.11 \div 3.42 = 1,773$
$710 \times 1.31 \times .655 \div 3.42 = 178$
$78 \times 3.42 \div 2 = 133$
3,059 kg.

Summary of moments and shears.

	moment	shear
Dead Load	1450	1690
Live Load	2216	3059
	3666 kgm	4749 kg

Section modulus reqd. $= \frac{3666 \times 100}{1100} = 333$ cm³

Use I beam 250×125 @ 55.5 kg
for which section modulus = 587 cm³

(Bending stress = ヨリシテハ 250×125 @ 38.3 kg ノ I beam = テモ充分ナレドモ Trunnion Bearings ヲ
連結スル Strut トシテ共用セルヲ以テ特ニ重キ方ノ Section ヲ使用スルモノトス)

Unit shear on web gross section $= \frac{4749}{25 \times 1.0} = 190$ kg/cm² ✓

Flange stress $= \frac{3666 \times 100}{587} = 625$ kg/cm² ✓

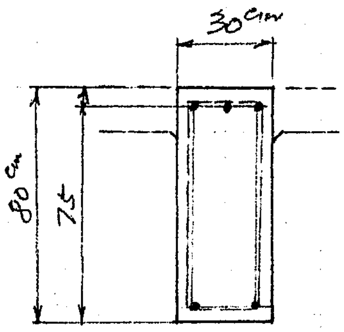
Design of Enoura Bascule Bridge for Mie-ken.

Design of Operating house floor.
Cantilever beams.

Loads on beam.

floor slab.	0.15 × 2.0 @ 2400 =	720
beam.	0.30 × 0.50 @ " =	360
operating house say		500
misc loads say		120
		1700 kg per lin m.

Cantilever moment = ½ × 1700 × 1.9² = 3070
from outside beam 700 × 1.8 = 1260
4330 kgm



Shear = 1700 × 1.9 = 3230
700
3930 kg

Eff. depth req'd. = $\sqrt{\frac{4330 \times 100}{30 \times 7.13}}$ = 45 cm

Use 75cm eff. depth with an insulation of 5cm.

Steel area req'd. = $\frac{4330 \times 100}{1200 \times \frac{7}{8} \times 75}$ = 5.50 cm²

Use 3-19φ bars = 8.50 cm².

Unit shear = $\frac{3930}{30 \times \frac{7}{8} \times 75}$ = 2.0 kg/cm²

Unit bond = $\frac{3930}{3 \times 5.97 \times \frac{7}{8} \times 75}$ = 3.34 "

Center beam.

Loads on beam

floor slab.	0.15 × 1.85 @ 2400 =	665
beam	0.50 × .65 @ " =	780
" fillet	0.20 × .20 @ " =	96
machinery + bearings say		1200
misc, say		259
		3,000 kg/lin m

moment = 1/10 × 3000 × 3.6² = ± 3890 kgm
Shear = ½ × 3000 × 3.6 = 5400 kg

Eff. depth req'd. = $\sqrt{\frac{3890 \times 100}{50 \times 7.13}}$ = 33 cm

Use 75cm eff. depth with 5cm insulation.

Steel req'd. = $\frac{3890 \times 100}{1200 \times \frac{7}{8} \times 75}$ = 4.94 cm²

Use 4-22φ = 15.204 cm²

(横振レニ対スル不定応力ニ備フル為メ鉄筋量ヲ増加セリ)

CALCULATIONS FOR

Design of Enoura Bascule Bridge for Mie-Ken.

Stability of Bascule Pier. (Refer to the design drawings).

Trunnion load.

weight of moving leaf = 15,830 (see on page 23)
Counterweight with framings = 22600 "
38430 kg on trunnion shafts.

weight of counterweight tower 4200 kg on pier.

Weight and center of gravity of machinery room and shafts.

Moments taken about ℄ Trunnion shaft.

Names.		Volume	Hor. moment + arm	+ M	− arm	− M	Vert. moment arm	M.
Fixed floor + pavement.	4.23 × 3.60 × 0.15 =	2.29			0.57	1.31	0.78	1.79
fillets	3.6 × .27 × .3 × 2 =	0.58			0.65	0.38	1.00	0.58
copings	1.2 × 2.6 × .35 × 2 =	2.18	0.50	1.09			0.45	0.98
"	0.19 × 0.9 × 2.2 × 2 =	0.75	0.40	0.30			0.75	0.56
"	0.12 × 0.6 × 2.0 × 2 =	0.29			1.70	0.49	0.90	0.26
Columns.	1.78 × 2.10 × 5.53 × 2 =	41.30	0.35	14.45			3.42	141.25
" front side	1.78 × 0.30 × 2.60 × 2 =	2.78	1.55	4.31			1.95	5.42
" insides	0.90 × 0.20 × 5.30 × 2 =	1.91	0	0			3.45	6.59
hollows. less	0.32 × 2.40 × 2.35 × 2 = (−)	3.61	0.35		1.26		1.82	(−) 6.57
" "	0.8 × 0.5 × 0.9 × 2 = (−)	0.72	0.90		0.65		1.70	(−) 1.22
front and rear walls.	3.24 × 0.3 × 2.25 × 2 =	4.37			0.55	2.40	1.90	8.30
Side walls.	2.10 × 0.3 × 2.0 × 2 =	2.52			1.75	4.41	2.00	5.04
machinery floor slab	4.20 × 0.15 × 4.28 =	2.70			0.70	1.89	3.08	8.31
beams.	0.65 × 0.50 × 3.20 × 3 =	3.12			0.60	1.87	3.50	10.93
" fillets	0.20 × 0.20 × 3.20 × 2 =	0.26			0.70	0.18	3.25	0.85
"	0.30 × .40 × 2.70 =	0.32			1.00	0.32	3.35	1.07
walls. 3 walls	1.30 × 1.60 × 2.40 =	4.99			1.50	7.48	5.00	24.95
operating house floor slab	2.20 × 3.2 × 0.15 =	1.06			1.80	1.91	3.08	3.26
" " "	1.10 × 1.90 × 0.15 =	0.31			0.15	0.05	3.08	0.96
beam.	0.30 × 0.50 × 6.60 =	0.99			1.70	1.68	3.40	3.36
Shelfs for wood span	1.40 × 0.50 × 0.50 =	0.35			3.05	1.07	2.00	0.70
" "	1.20 × 0.35 × 1.20 =	0.50			2.98	1.49	2.85	1.43
bearing blocks	1.25 × 0.60 × 0.8 × 2 =	1.20	0.75	0.90			2.60	3.12
" "	$2.0^{\square m}$ × 0.6 =	1.20			0.50	0.60	2.70	3.24
		71.64^{m^3}		+ 21.05		− 27.53		225.16
	multiply by 2400.	172,000 Kg		+ 50500		− 66,100		540,000
floorbeams.		450			0.65	− 290	1.05	470
exp. metals say		450	1.50	680			0.70	320
metals under trunnion		1500	0	0			2.00	3000
	Total weight =	174400 kg		+ 51,180		− 66,390		543790
					arm	51,180		—
					-0.09^m	− 15,210	3.12^m	543790
					rear of trunnion		under trunnion	

Design of Enoura Bascule Bridge for Mie Ken

Dead load from rear beam span.

planking	0.30 × 4.0 × 5.4 @ 650 =	4210
earth filling say ½ × 0.20 × 3.60 × 10.8 @ 1600 =		3110
Stringers	2 × 0.15 × 0.12 × 6.0 @ 650 =	140
main beams 3 @ 133	× 5.4 =	2155
floor beams 2 @	80 =	160
handrails say 2 @ 0.060 × 5.40	@ 650 =	420
misc. say		105
		10,300 kg

Total Dead loads on well.

		Hor. arm	Hor. moment	vert. arm	vert. moment
loads on trunnion	38400	0	0	0	0
Tower	4,200	0.40	1,680	-2.50	-10,500
machinery room + shaft	174,400	-0.09	-15,210	3.12	543,790
rear beam span	10,300	-3.00	-30900	1.50	15,450
	227,300 kg	-0.20 m	-44,430	2.42 m	548,740

Trunnion shaft ノ垂直中心線ヲ well ノ中心ヨリ 20cm 前方ニ設置シ Dead load ノ eccentricity ヲ零トナスベシ 即チ well ヨリ上ノ構造物全体ノ重心ヲ well ノ中心線ニ一致セシムベシ.

Weight and center of gravity of well.

Crossection of well.

gross area	4.0 × 2.50 =		10.00 m²
Hollow area	2 × 1.55 × 1.90 =	-5.89	
fillets	4 × 0.20 × 0.20 =	+0.16	
			-5.73
	net area =		4.27 m²

Top 1.2 m	10.00 × 1.20 =	12.00	×	9.40 =	112.8
next 5.5	4.27 × 5.50 =	23.50	×	6.05 =	142.1
bottom 3.3 (10.0)	10.00 × 3.30 =	33.00	×	1.65 =	54.4
		68.50			309.3
multiply by	2400	164400 kg			742,000
Sand fillings	5.73 × 5.50 =	31.50	×	6.05	190.5
multiply by	1600	50400 kg			305,000
Total weight		214,800 kg		4.87 m	1,047,000
Total weight for 2 wells		429,600 kg			

Dead load bearing pressure on foundation.

Total load on the wells	=	227,300	
Total weight of wells	=	429,600	
			656900 kg
skin friction 1200 kg/m² assumed. 13 × 2 @ 1200	=		-31200
			625700 kg

unit bearing pressure $= \frac{625700}{10.0 \times 2} = 31285$ kg/m² or (= 2.86 tom/□')

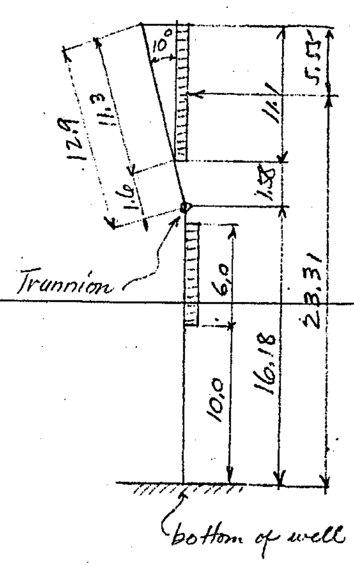
JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

MADE BY K. Inaba DATE 9-11-30 FILE NO
CHECKED BY DATE PAGE NO 37

CALCULATIONS FOR

Design of Enoura Bascule Bridge for Mie-Ken.

Stability of Bascule Pier during 50 kg/m² wind, direction along ℄ Bridge.
Wind moment about bottom of well.



wind pressure on bascule leaf
= 50 × 4.50 × 11.1 = 2,500 kg arm = 23.31 m
wind pressure on bascule pier
= 50 × 7.0 × 6.0 = 2,100 kg arm = 13.00 m.

Overturning wind moment
2,500 × 23.31 = 58300
2,100 × 13.00 = 27,300
4600 85,600 kgm.

Eccentricity $\varepsilon = \frac{85,600}{656,900} = 0.13$ m

Resultant pressure within middle third. .195

max. bearing pressure = $\frac{656900}{5.0 \times 4.0}\left(1 \pm \frac{6 \times 0.13}{4.0}\right)$ = 39,280 kg/m² (3.59 tons/□)
or 26,480 (2.42 ")

Stability of Bascule Pier during earthquake, direct of thrust along ℄ Bridge.
acceleration assumed as 1500 mm/sec² or k = 0.15

		Seismic thrust	arm	moment
Total loads on wells.	227,300 × 0.15 =	34,100 ×	12.42 =	423,000
weight of wells.	429,600 × 0.15 =	64,400 ×	4.87 =	313,500
	656,900 kg	98,500 kg		736,500 kgm

Eccentricity $\varepsilon = \frac{736500}{656900} = 1.12$ meters

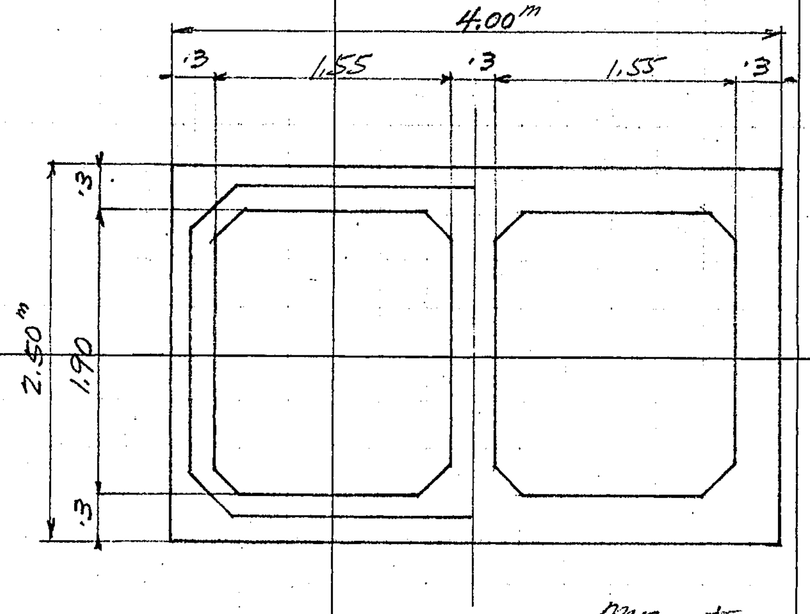
For safe side, neglecting the resistance due to side pressure of earth on the wells, the resultant pressure is outside of the middle third. Neglecting tension on heel of the wells,
Pressure area = 2.00 − 1.12 = 0.88 × 3 × 5.0 = 13.2 sq. meter.

max. bearing pressure = $\frac{656900}{13.2}$ = 49,700 kg/m² (or 4.55 tons/□)

増田淳氏関係資料（独立行政法人 土木研究所蔵）

Design of Enoura - Bascule Bridge for Mie-Ken.

Design of well.



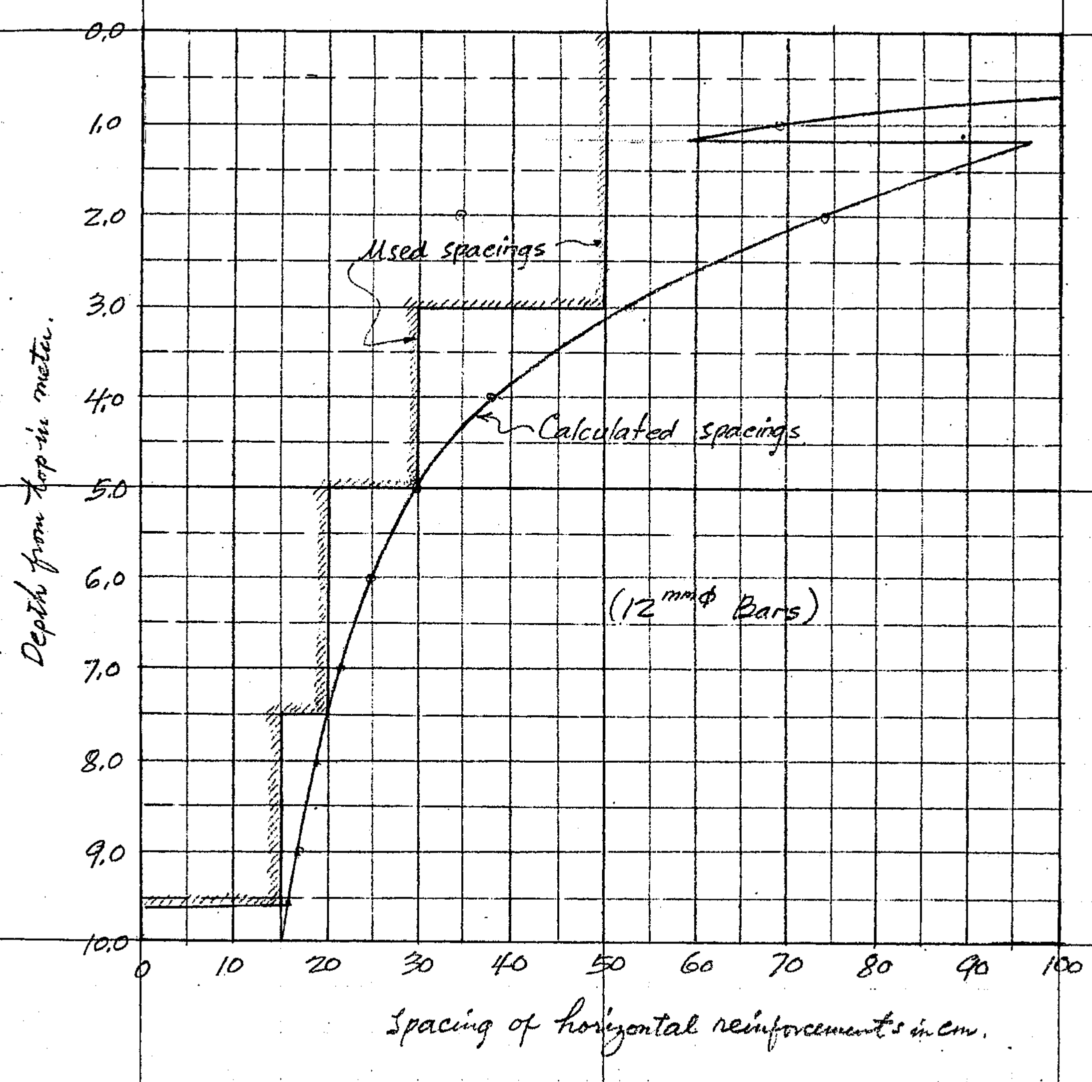
沈下作業中wellニ及ボス土圧ハ作業ノ方法ニアリテ異ナルベキモ最悪ナル場合ヲ採リ低水位マデ築島ヲナシタル場合即チ井筒ノ全長ニ対シ土圧ノ加ハル場合ヲ考慮スルモノトス. Curb shoeノ高サヲ40cmト仮定スレバ最低部ノ鉄筋位置ハ頂上ヨリ9.6mナリ.

Span length of side wall = 1.90 + 0.3 = 2.20m

moment on wall assumed as $\pm \frac{1}{12} wl^2$

Effective depth say 30 - 3 = 27cm for 1.2 ~ 9.6m depth.
15 - 2.5 = 12.5 for 0 ~ 1.2m.

Depth from top.	Earth pressure	Moment $\frac{1}{12}wl^2 = \frac{2.2^2}{12}w$	Steel area required	Spacing for 12mmφ bars.
1	1/3×1600×1 = 533 kg/m²	215 kgm	1.64 cm²	69.0 cm ctoc
2	2 1,067	430.	1.52	74.4
3	3 1,600	605	2.14	52.8
4	4 2,133	860	3.04	37.2
5	5 2,667	1075	3.79	29.8
6	6 3,200	1290	4.55	24.8
7	7 3,733	1,505	5.31	21.3
8	8 4,267	1,720	6.07	18.6
9	9 4,800	1,935	6.83	16.5
9.6	9.6 5,120	2,065	7.29	15.5



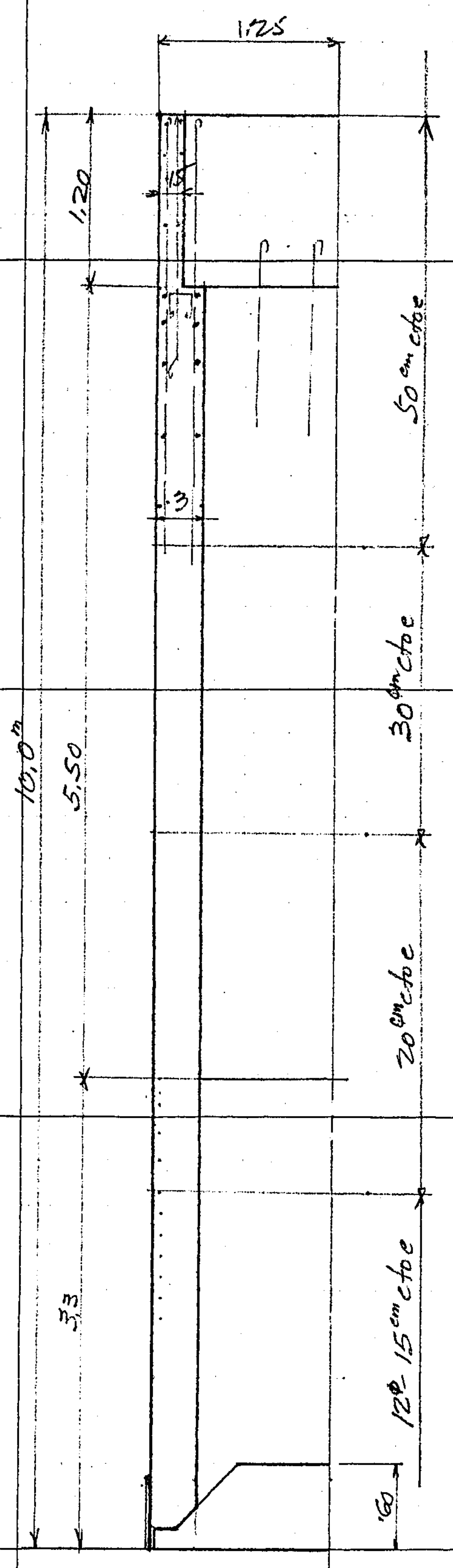
JIUN MASUDA
CONSULTING ENGINEER
~~FUJI~~ SHOWA BLDG, TOKYO

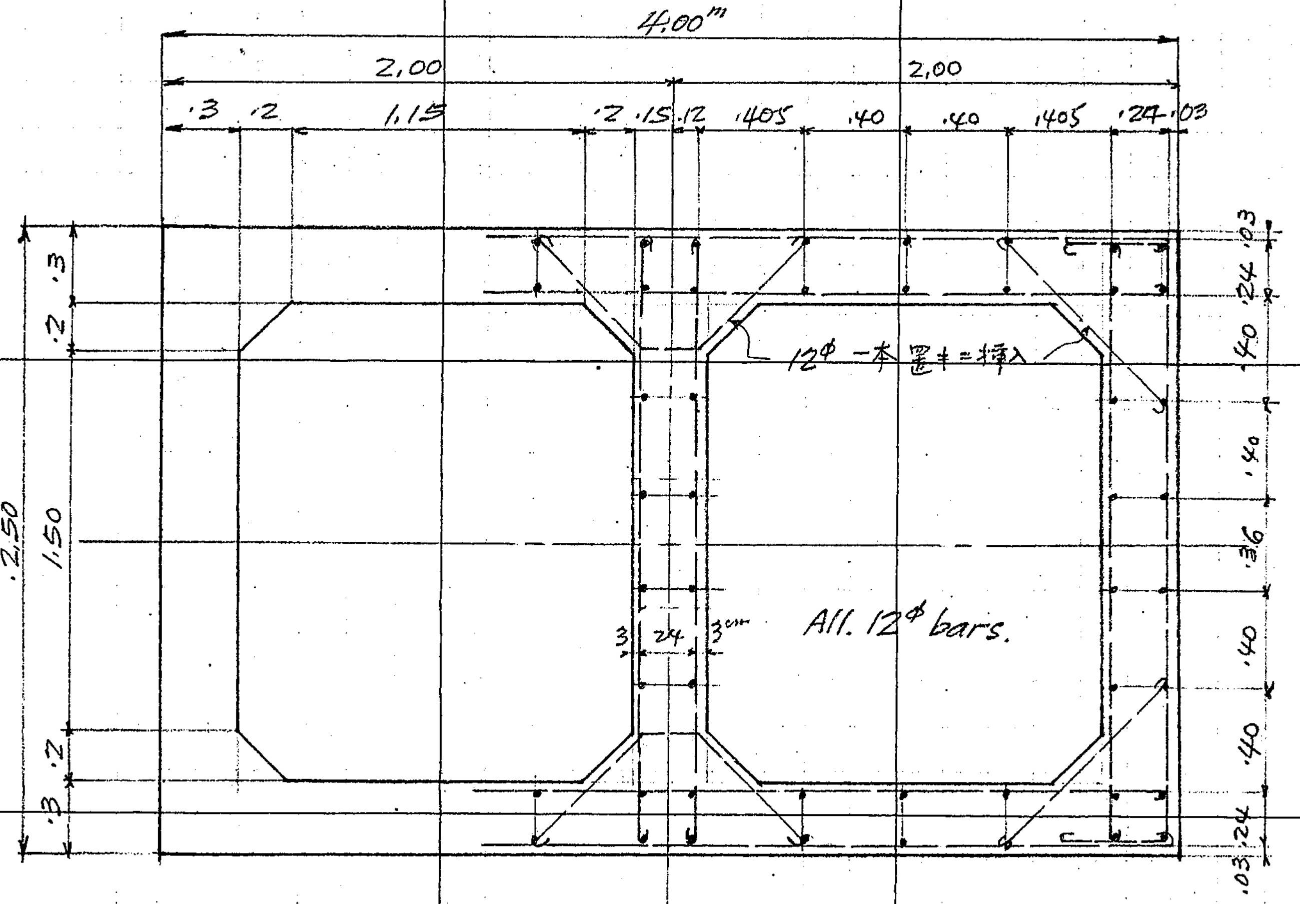
MADE BY K. Inabal DATE 9-11-30 FILE NO ____
CHECKED BY ____ DATE ____ PAGE NO 39

CALCULATIONS FOR

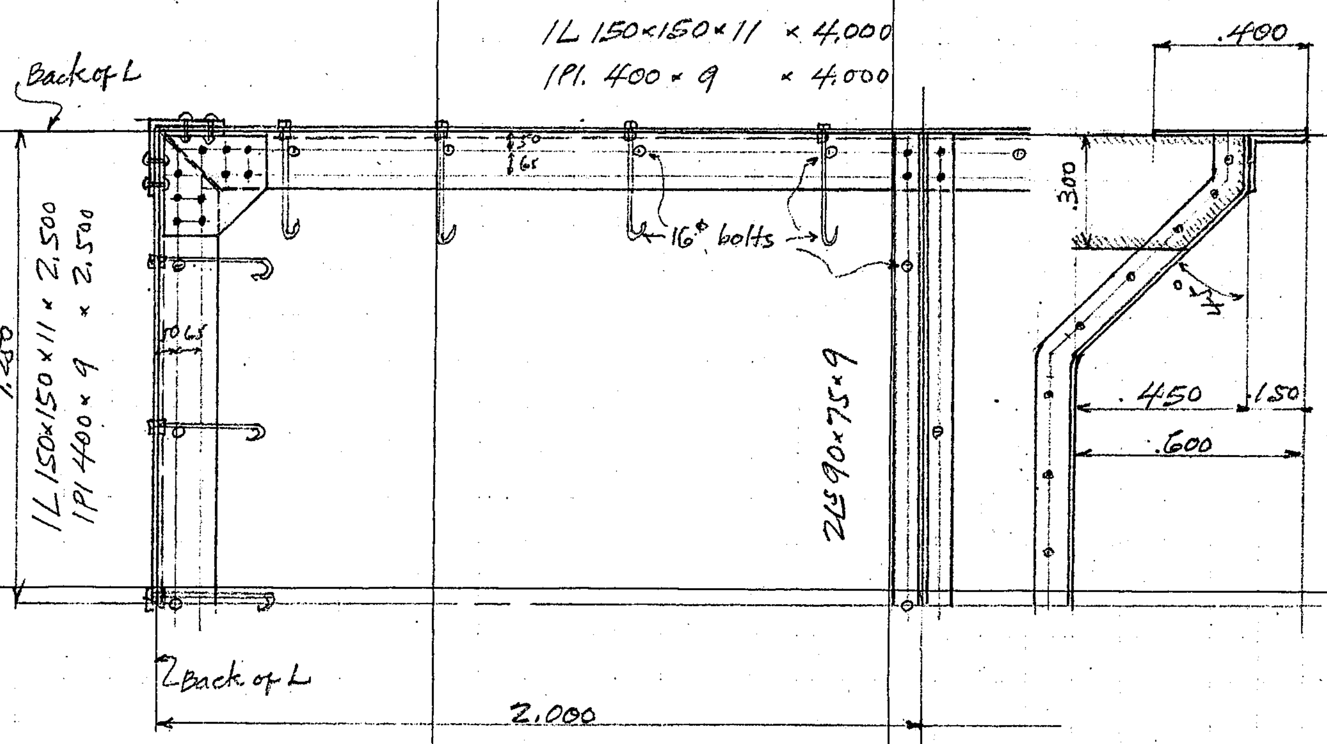
Design of Enoura Bascule Bridge for Mie-Ken.

Dimensions, reinforcements, and shoe of well.



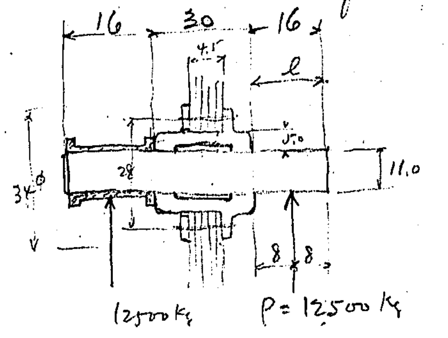


Cross section of well.
scale 1:30.



Sketch of Curb shoe.
Scale 1:20.

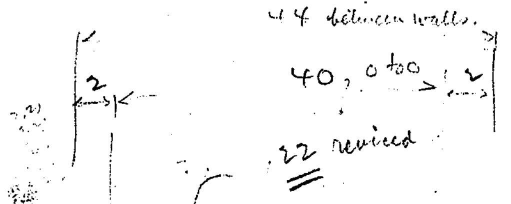
Trunnion shaft.



Load on trunnion
DL no impact say 8,000
cwt 17,000
25000 kg for one truss

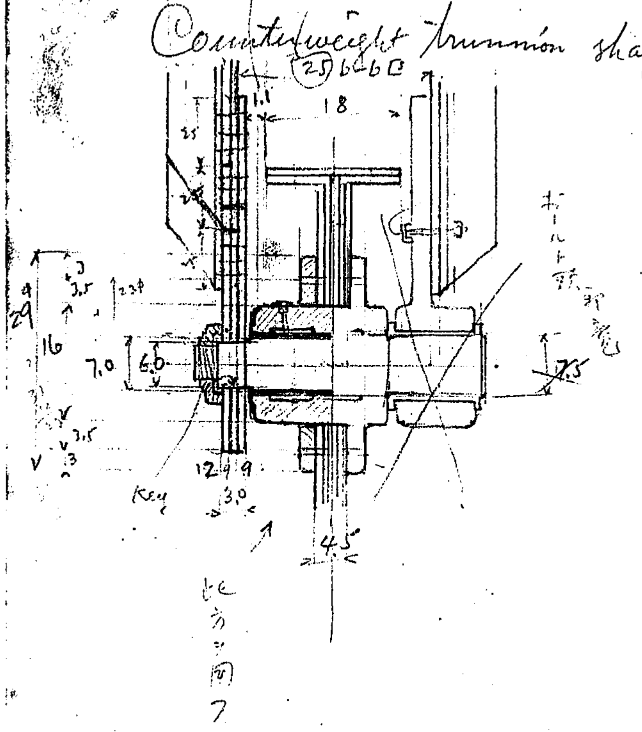
Dia. of shaft.

$$d = 0.172\sqrt[3]{Pl} = 0.172\sqrt[3]{\frac{12500\times 16}{58.45}} = 10.05\ \text{cm} \quad \text{use } 11.0\ \text{cm}\phi$$



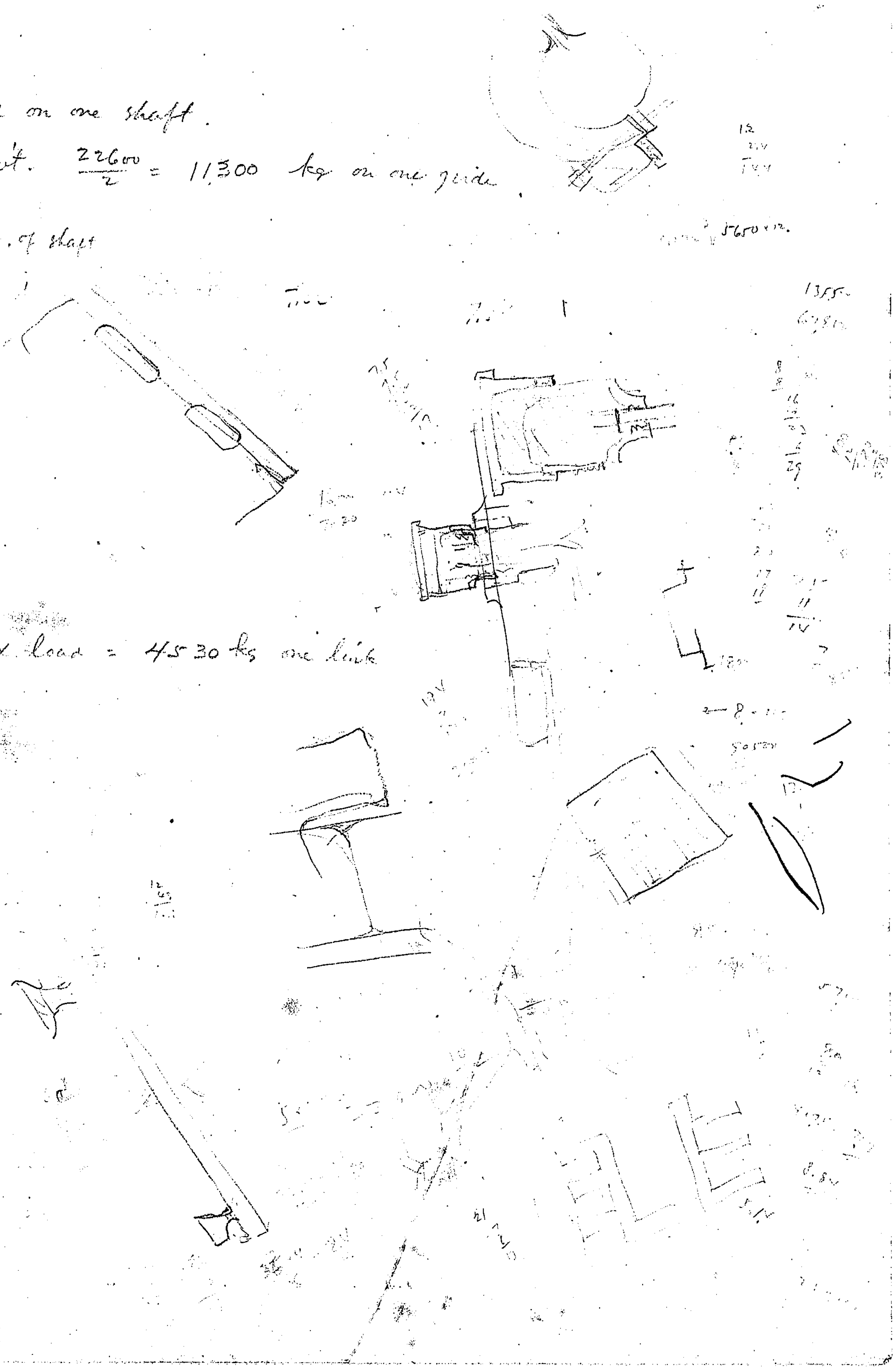
Bearing pressure on bronze bushing $= \frac{12500}{11\phi\times 16} = 71\ \text{kg/cm}^2$

Counterweight trunnion shaft.

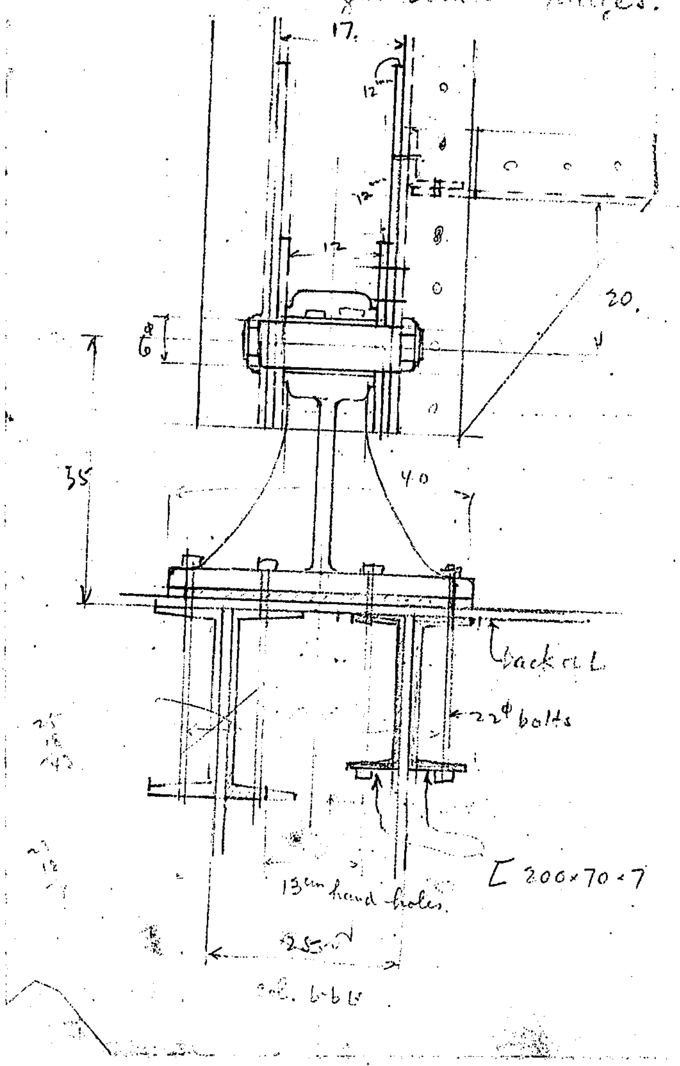


Load on one shaft.
Cwt. $\frac{22600}{2} = 11,300$ kg on one guide.

Dia. of shaft



Counterweight link hinges.



max load = 4530 kg one link

三重所

江ノ浦の動橋機械計算書

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

MADE BY K. Inaba DATE 9-6-20 FILE NO

CHECKED BY M. J DATE 9-7-23 PAGE NO Mc 1

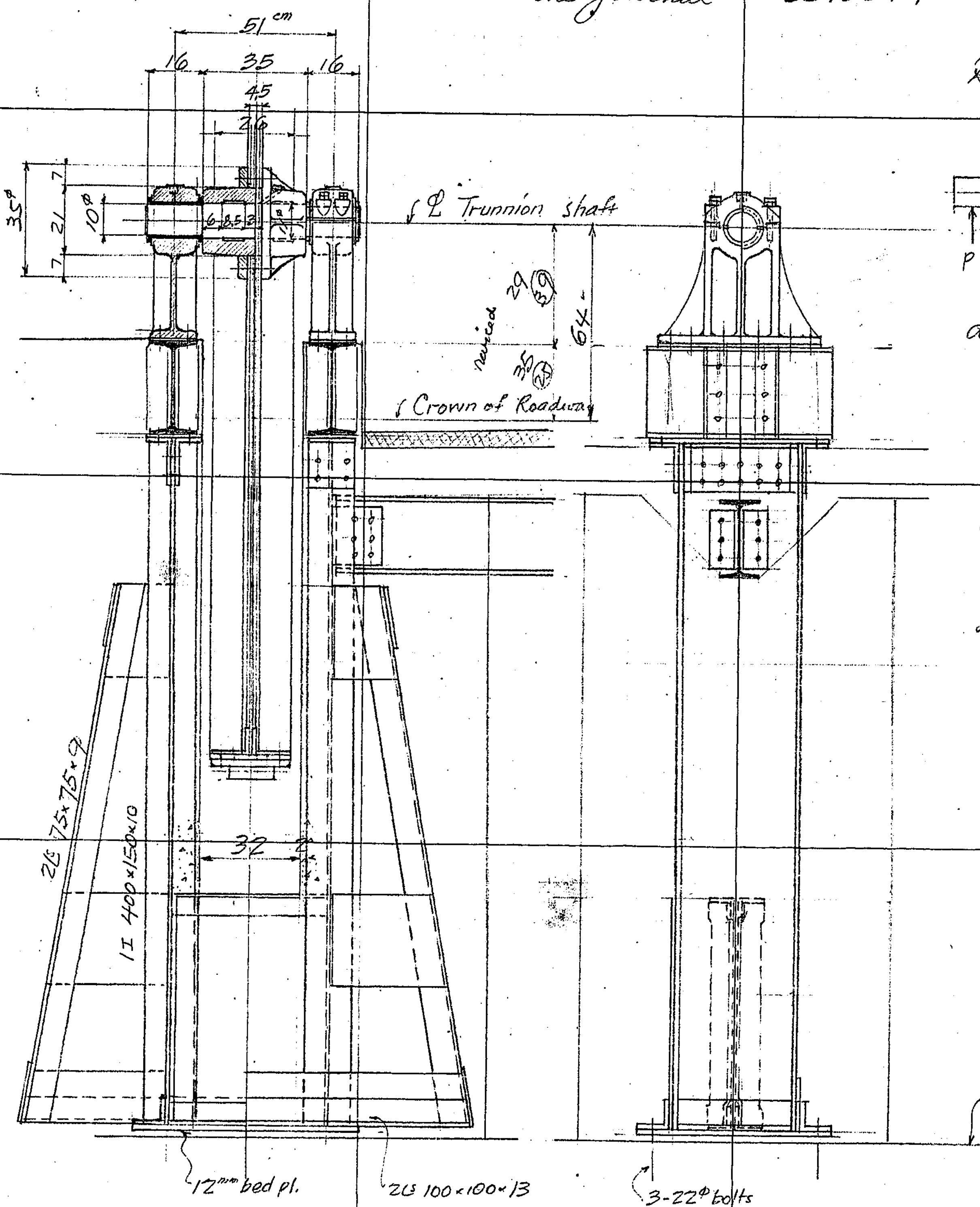
CALCULATIONS FOR

Machine Design of Enoura Bascule Bridge for Mie-ken

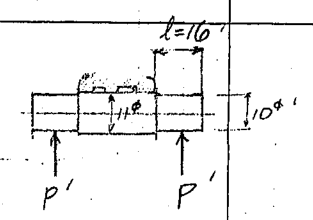
Main trunnion shaft and Bearings
Load on main trunnion.

weight of Bascule leaf	=	15,830 '	see on page 23.
Counterweight	=	22,600 '	" "
		38,430 ' kg	

Load on one journal = 38430 ÷ 4 ' = 9600 ' kg



Diameter of shaft.



$d = 0.1814 \sqrt[3]{Pl}$ for $s = 850$ kg/cm²

$= 0.1814 \sqrt[3]{9600 \times 16}$ '

$= 9.72$ cm ' use 10 cmφ shaft

Pressure on bronze bushing

$= \frac{9600}{10 \times 16}$ ' $= 60$ ' < 140

Unit shear

$= \frac{9600}{78.54}$ ' $= 122$ kg/cm² < 500

Scale 1:20

Approximate weight of Structural steel under main trunnion bearings.

Chairs		2 Is ' 300×150×8 ' @	48.30 ' × 0.60 ' =	58 '	revised to 2Is 400×150×10
"	, stiffeners	8 Ls ' 75×75×9 ' @	9.96 ' × 0.28 ' =	22 '	
Column	, cap pls	2 Pls ' 190 × 12 ' @	17.89 ' × 0.60 ' =	21 '	
"	top Ls	4 Ls ' 150×90×12 ' @	21.50 ' × 0.31 ' =	27 '	
"	"	4 Ls ' " ' @	" ' × 0.15 ' =	13 '	
"		2 Is ' 400×150×10 ' @	72.00 ' × 2.25 ' =	324 '	
stay		4 Ls ' 75×75×9 ' @	9.96 ' × 1.80 ' =	72 '	
base pl.		1 Pl. ' 620×12 ' @	58.40 ' × 0.72 ' =	42 '	
base Ls		2 Ls ' 100×100×13 ' @	19.10 ' × 1.45 ' =	55 '	
"		4 Ls " ' @	" ' × 0.38 ' =	29 '	
guss pls		1 Pl ' 170×9 ' @	12.01 ' × 1.45 ' =	17 '	
"		2 Pls ' " ' @	12.01 ' × 0.45 ' =	11 '	
tie pls	side	4 Pls ' 200×9 ' @	14.13 ' × 0.40 ' =	23 '	
"	rear	1 Pl ' 500×9 ' @	35.33 ' × 0.71 ' =	25 '	
"	front+rear	4 Pls ' 300×9 ' @	21.20 ' × 0.40 ' =	34 '	

Machine Design of Enoura Bascule Bridge for Mie ken.

tie pls top	4Pls 200×9 @	14.13 × 0.30 =	17
diaphragm	1Pl 480×9 @	33.91 × 0.75 =	25
"	4Ls 90×75×9 @	11.00 × 0.50 =	22
"	4Ls " " @	" × 0.75 =	33
anchor bolts	6 – 22φ bolts × 0.60 @	2.30 =	14
rivet heads say		=	26
			910 kg

For 2 trunnions 2 @ 910 = 1820 kg

Counterweight trunnion shaft and boss.

Load on shaft.

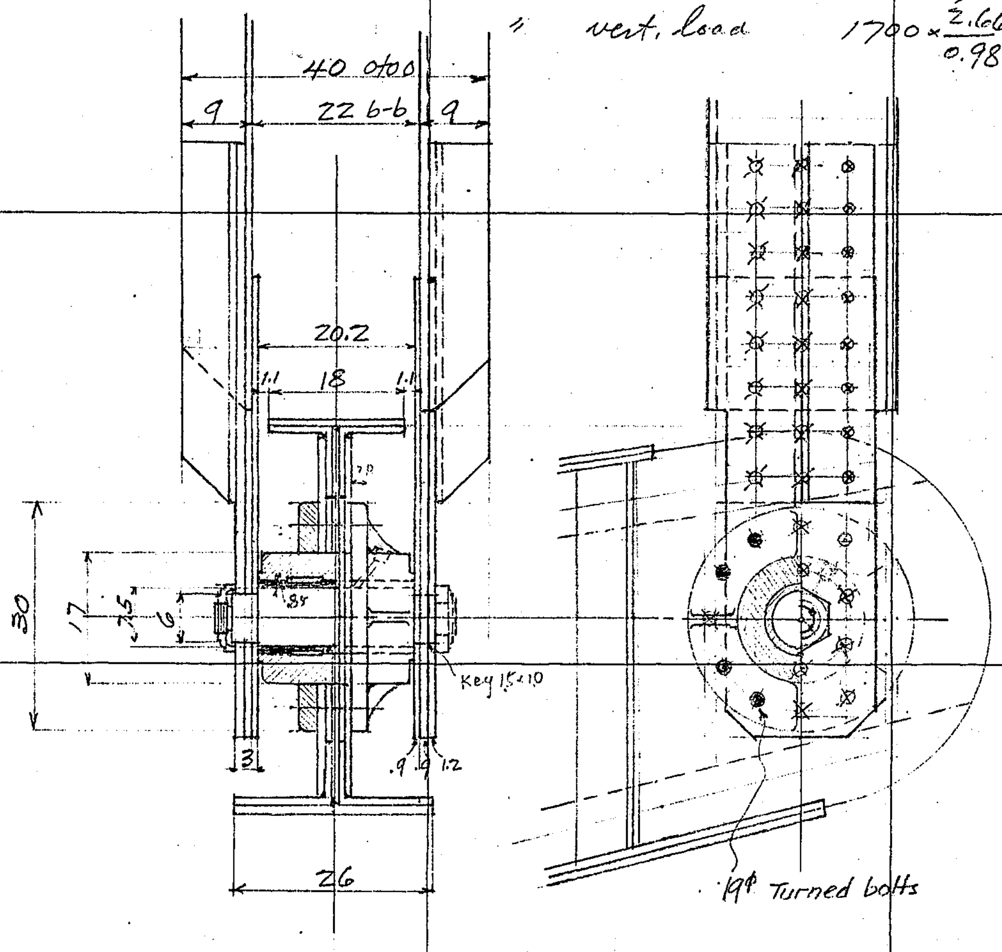
Counterweight 22600 kg

for one shaft. 11,300 kg

Seismic thrust 11300 × 0.15 = 1700 see on page 19.

" vert. load $1700 \times \frac{2.66}{0.98} =$ 4600 kg

15900 kg during earthquake for one shaft.



Scale 1:10

$d = 0.1814 \sqrt[3]{8000 \times 3} = 5.2$ cm

use 6.0φ

Bearing on steel $= \frac{8000}{6 \times 3} = 445$ kg/cm²

Bearing on bushing $= \frac{16000}{7.5 \times 20} = 107$ "

Shear $= \frac{8000}{28.27} = 283$ kg/cm²

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

MADE BY K. Inaba DATE 9-6-21 FILE NO

CHECKED BY M. J DATE 9-7-23 PAGE NO Mc 3

CALCULATIONS FOR

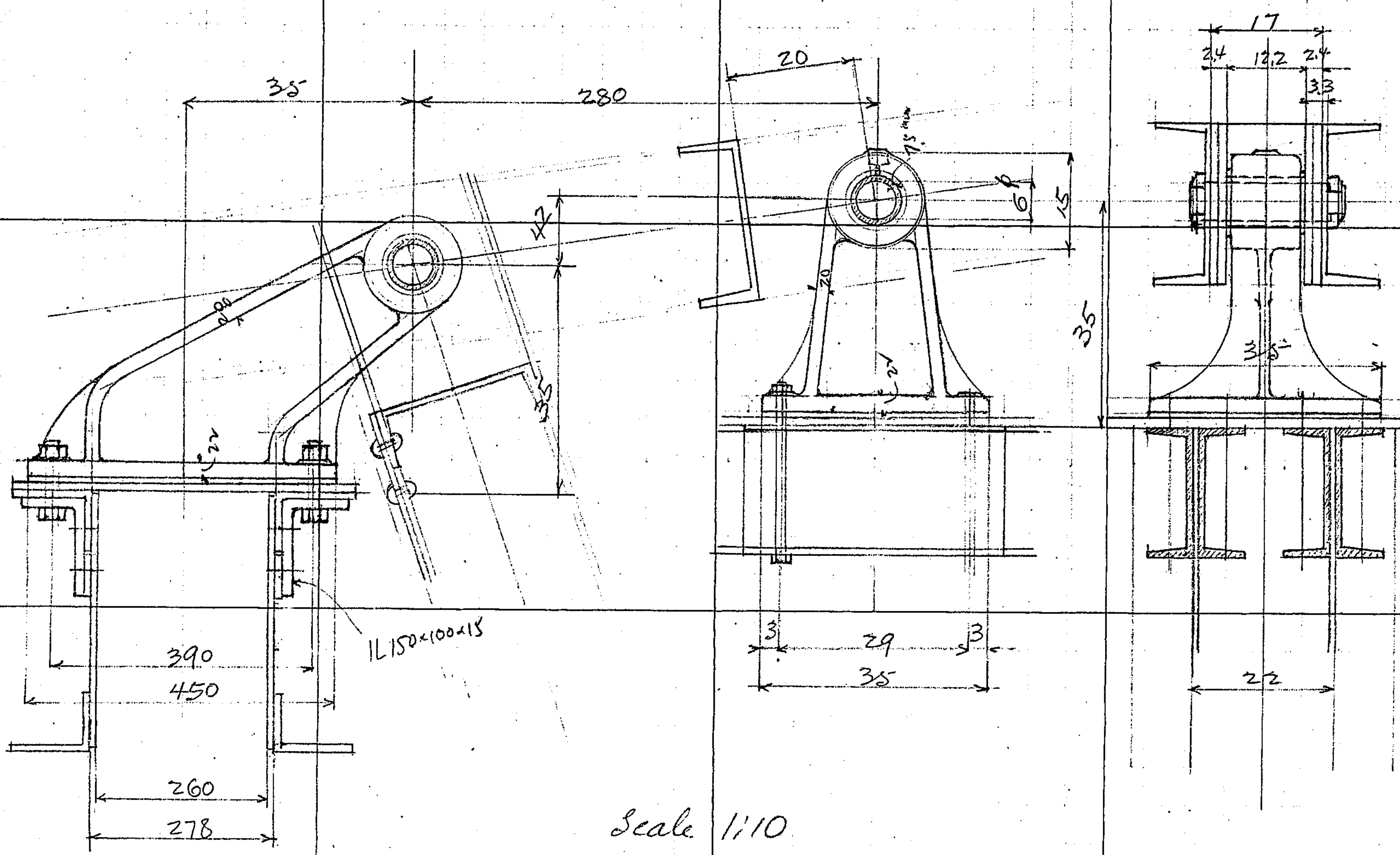
Machine Design of Enoura Bascule Bridge for Mie Ken

Countenweight link pin and bearing.

max. thrust on pin

Seismic thrust 1700 × 2.90' = 4930 kg on one pin

use 6.0 cm φ pin.



Scale 1/10

Machine Design of Enoura Bascule Bridge.

Design of Gearing.

Gear ratio between motor and rack.

Synchronous speed of 3 HP motor assumed as 1,700 rev. per minute

Speed under full load say 94% of 1700 = 1,600 " "

Speed of rack circle = $\frac{80°}{360° \times 3\ min}$ = 0.074 rev. per minute

Total gear ratio = $\frac{1600}{0.074}$ = 21,620

Gear ratio of each gear set assumed as follows.

Gear set		Gear ratio
Worm gear	20° inclination, double threaded	49 : 2 = 24.500
1st gear	15° involute teeth, spur gear.	44 : 15 = 2.933
2nd "	" " "	44 : 15 = 2.933
3rd "	" " "	44 : 15 = 2.933
4th "	" " "	44 : 15 = 2.933
Main pinion & rack	" "	180 : 15 = 12.000

Total gear ratio = 21,780

Diameters, power transmitted, speed, and accumulated efficiency of gears.

Gearings	wheels	No. of rev./min. n	module	Pitch dia. D_p m.m.	Speed v m/min	Efficiency η	Power transmitted HP × η
Worm gear	worm	1,600.00				1.000	3.00
	worm wheel $1600 \times \frac{2}{49}$ =	65.30				0.700	2.10
1st gear	Pinion	65.30	6	90	18.47	0.700	2.10
	Spur wheel $64 \times \frac{15}{44}$ = (65.30)	22.26	6	264	18.47	0.658	1.97
2nd gear	Pinion	22.26	9	135	9.44	0.658	1.97
	Spur wheel $21.81 \times \frac{15}{44}$ = (22.26)	7.59	9	396	9.44	0.618	1.85
3rd gear	Pinion	7.59	12	180	4.29	0.618	1.85
	Spur wheel $7.44 \times \frac{15}{44}$ = (7.59)	2.59	12	528	4.29	0.581	1.74
4th gear	Pinion	2.59	14	210	1.71	0.581	1.74
	Spur wheel $2.54 \times \frac{15}{44}$ = (2.59)	0.88	14	616	1.71	0.546	1.64
Pinion and Rack	main pinion	0.88	20	300	0.83	0.546	1.64
	rack $0.86 \times \frac{15}{180}$ = (.88)	0.074	20	3,600	0.83	0.514	1.54

CALCULATIONS FOR

Machine Design of Enoura Bascule Bridge.

Dimension and strength of gear teeth.
15° Involute machine cut teeth.
· Steel pinion and cast iron spur wheel.

Gearings	wheels	Pitch dia. D_p, mm.	Outside dia. D_o, mm.	Module $M_c = \frac{D_p}{N}$	face F, mm.	Cir. pitch P, mm.	addendum $H_1 = M_c$	length H	No. of teeth N	Load on tooth $W = \frac{4560 \cdot HP}{V}$
1st. gear	Pinion	90	102	6	56	18.850	6	13.000	15	518 kg
	Spur wheel	264	276	6	52	18.850	6	13.000	44	486
2nd. gear	pinion	135	153	9	70	28.274	9	19.500	15	952
	Spur wheel	396	414	9	64	28.274	9	19.500	44	894
3rd. gear	pinion	180	204	12	106	37.699	12	26.000	15	1966
	spur wheel	528	552	12	100	37.699	12	26.000	44	1850
4th. gear	pinion	210	238	14	116	43.982	14	30.333	15	2320
	spur wheel	616	644	14	110	43.982	14	30.333	44	2190
Pinion + rack	main pinion	300	340	20	146	62.832	20	43.333	15	4510
	rack	3600	3640	20	140	62.832	20	43.333	180	4230

(4th gear and pinion + rack loads: for one set.)

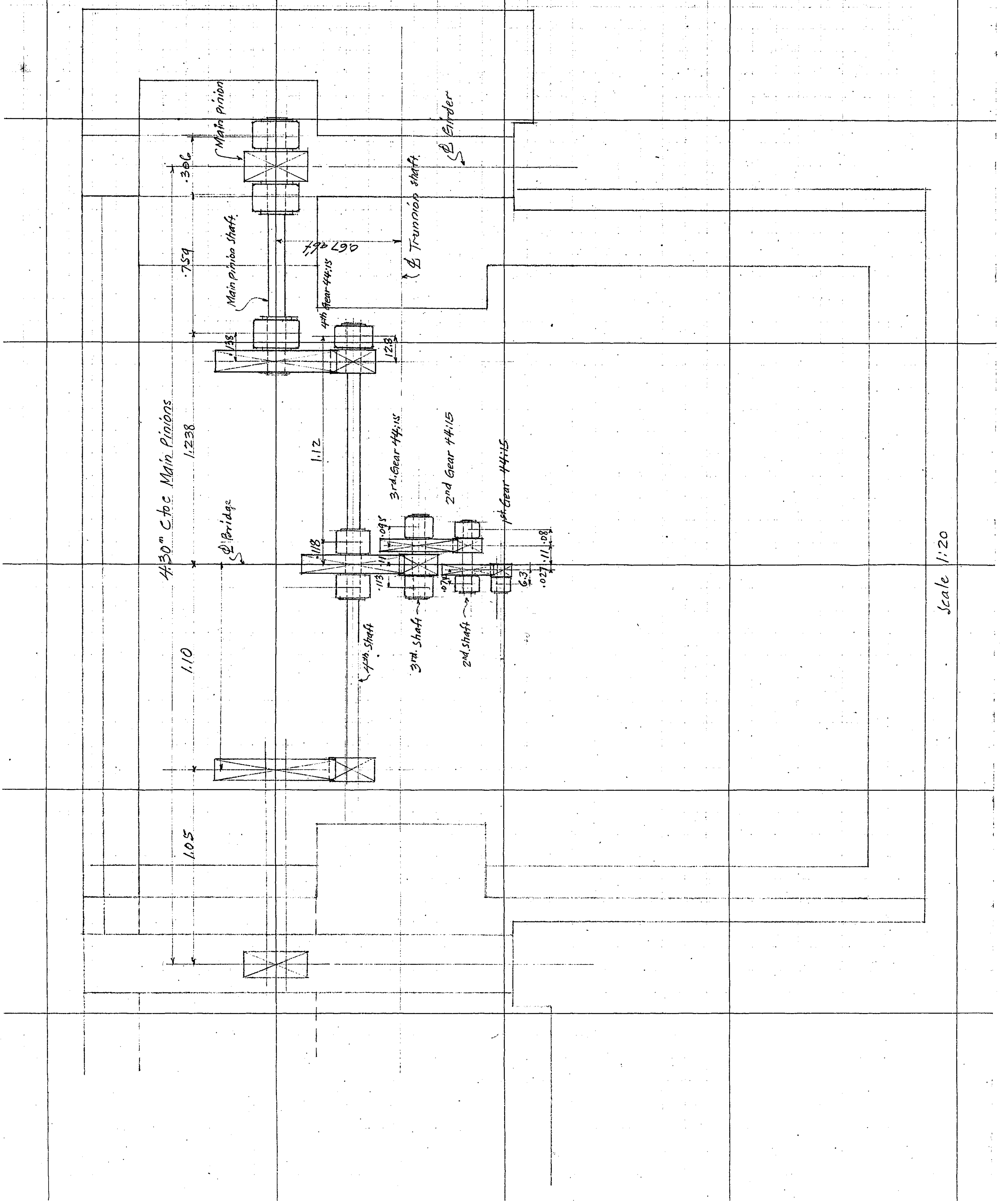
Allowable strength of gear teeth.
Wilfred Lewis's formula.

Safe load on tooth
$W = SPfy$

where
W = Safe load on the tooth in kg;
P = circular pitch in cm;
f = face of the tooth in cm;
S = permissible fibre stress in the material at the root of the tooth in kg/cm²
y = a factor depending upon the form of the tooth (= $2x/3p$).

Gearings	wheels	Materials	No. of teeth N	allowable stress S kg/cm²	Cir. Pitch P cm	face f cm	factor y (15° involute)	Safe load W kg	Load on tooth	
1st. gear	Pinion	steel	15	1400	1.8850	5.6	0.0780	1,154	518	
	Spur wheel	cast iron	44	550	"	5.2	0.1084	585	486	= 1.204
2nd. gear	Pinion	steel	15	1400	2.8274	7.0	0.0780	2160	952	
	spur wheel	cast iron	44	550	"	6.4	0.1084	1,078	894	= 1.207
3rd. gear	Pinion	steel	15	1400	3.7699	10.6	0.0780	4,360	1,966	
	Spur wheel	cast iron	44	550	"	10.0	0.1084	2,250	1,850	= 1.217
4th. gear	Pinion	steel	15	1400	4.3982	11.6	0.0780	5,570	2,320	
	Spur wheel	cast iron	44	550	"	11.0	0.1084	2,885	2,190	= 1.318
pinion + rack	main pinion	steel	15	1400	6.2832	14.6	0.0780	~~10,400~~ 10,020	4,510	
	rack	cast iron	180	550	"	14.0	0.1200	5,810	4,230	= 1.374

Machine Design of Enoura - Bascule Bridge for Mie-Ken
Design of Power transmission shafts.
General arrangement of shafting assumed as following sketch.



Machine Design of Enoura Bascule Bridge for Mie-Ken

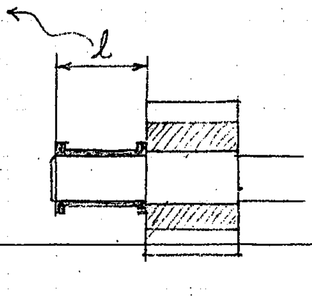
Loads on shaft.

Shaft.	Power transmitted N. HP	No. of rev/min n	Load on tooth W. kg. Pinion	Load on tooth W. kg. Wheel	Coef. of equivalent Combined moment km	kt
1st. Shaft.	2.10	65.30	518		1.50	1.50
2nd. Shaft.	1.97	22.26	952	486	〃	〃
3rd. Shaft.	1.85	7.59	1966	894	〃	〃
4th. Shaft.	½ × 1.74	2.59	2320	1850	〃	〃
Main pinion shaft.	½ × 1.64	0.88	4510	2190	〃	〃

Torsional moment on shafts.

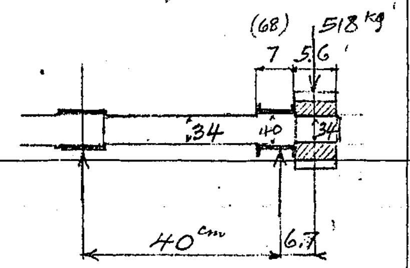
$$N = \frac{2\pi RWn}{4560} \quad \text{or} \quad T = RW = \frac{4560}{2\pi}\cdot\frac{N}{n} = 726\frac{N}{n}\ \text{kgm} \quad \text{or} \quad 72600\,\frac{N}{n}\cdot\text{kg.cm}$$

Shafts	N/n	T	Assumed dia of shaft in mm.	Assumed bearing length in m.m.
1st. Shaft.	0.0322	2,340 kg.cm	40	70
2nd. 〃	0.0885	6,420	50	90
3rd. 〃	0.2440	17,700	68	120
4th. 〃	0.3360	24,400	80	140
Main pinion shaft.	0.9320	67,600	104	160



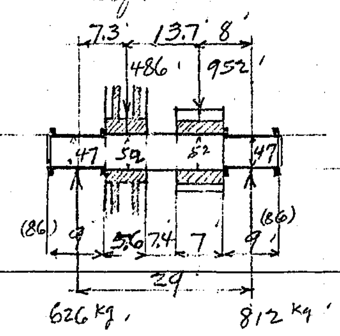
Bending moment on shafts.
Dead load moment of shaft (due to weight of shaft) neglected.

1st. Shaft.



1st. Pinion. $M = 518 \times 6.3 = 3{,}260$ kg.cm

2nd. shaft.

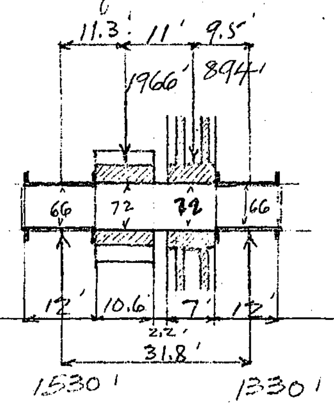


1st. wheel reaction
$952 \times 8 = 7620$
$486 \times 21.7 = 10550$
$18170 \div 29 = 626$ kg

$M = 626 \times 7.3 = 4570$ kg.cm

2nd. Pinion reaction $486 + 952 - 626 = 812$ kg
$M = 812 \times 8 = 6500$ kg.cm

3rd. shaft.



2nd. wheel reaction
$1966 \times 11.3 = 22210$
$894 \times 22.3 = 19950$
$42160 \div 31.8 = 1330$ kg

$M = 1330 \times 9.5 = 12630$ kg.cm

3rd. pinion
$M = 1530 \times 11.3 = 17280$ 〃

増田淳氏関係資料
(独立行政法人 土木研究所蔵)

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

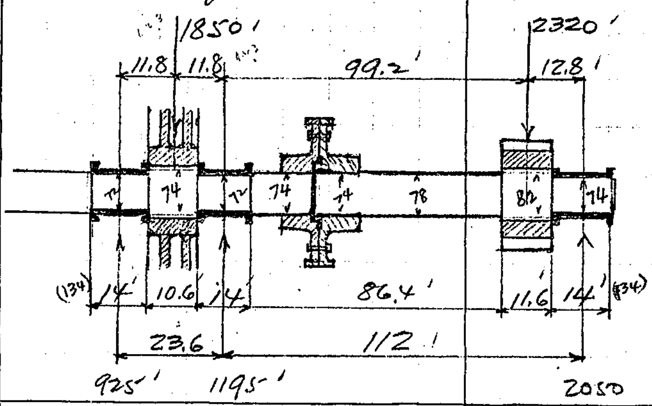
MADE BY K. Inaba DATE 9-7-3 **FILE NO** ____

CHECKED BY ______ DATE ______ **PAGE NO** Mc 8

CALCULATIONS FOR

Machine Design of Enoura Bascule Bridge for Mie-ken

4th. Shaft.



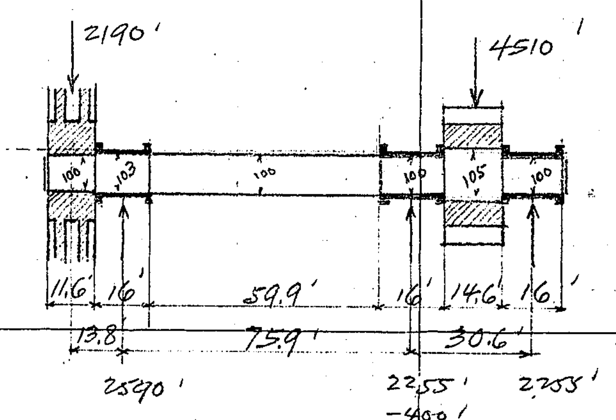
3rd. wheel reaction 925 kg

$M = 925 \times 11.8 = 10900$ kg.cm

4th pinion reaction $\dfrac{2320 \times 99.2}{112} = 2050$ kg

$M = 2050 \times 12.8 = 26250$ kg.cm

Main Pinion shaft.



4th. wheel $M = 2190 \times 13.8 = 30200$ kg.cm

at edge of wheel $M' = 2190 \times 5.8 = 12700$ "

main pinion $M = 2255 \times 15.3 = 34500$ kg.cm

Combined moments due to Torsion and Bending.

Equivallent torsional moment $T_E = \sqrt{(K_m M)^2 + (K_t T)^2} = 1.50\sqrt{M^2+T^2}$, for $K_m = K_t = 1.50$

Equivallent bending moment $M_E = \frac{3}{8}K_m M + \frac{5}{8}\sqrt{(K_m M)^2 + (K_t T)^2} = 0.1875(3M + 5\sqrt{M^2+T^2})$

Required diameter of shaft,

for equivallent torsional moment, $d_t = \sqrt[3]{\dfrac{16T_E}{S_s\pi}} = 0.210\sqrt[3]{T_E}$ for steel shaft $S_s = 550$ kg/cm²

" " bending moment, $d_m = \sqrt[3]{\dfrac{32M_E}{S\pi}} = 0.210\sqrt[3]{M_E}$ " " " $S = 1100$ "

Shafts.		Bending moment M	Torsional moment T	M^2	T^2	$\sqrt{M^2+T^2}$	T_E	M_E	Req'd dia of shaft d m.m.	use	Bearing length
1st. Shaft.	Pinion	3,260	2,340	10.63 (10)⁶	5.48 (10)⁶	4010	6,020	5590	38.2	40	72
2nd. shaft.	Pinion	6,500	6,420	42.25 (10)⁶	41.2 (10)⁶	9,140	13,700	12,230	50.2	52	86
	wheel	4,570	"	20.90 (10)⁶	"	7880	11,800	9860	47.8	50	86
3rd. Shaft.	Pinion	17280	17,700	298.5 (10)⁶	313.0 (10)⁶	24700	37,000	32,900	70.0	72	120
	wheel	12630	"	159.8 (10)⁶	"	21,750	32,600	27,500	67.1	69	120
4th. Shaft.	Pinion	26,250	24,400	689.0 (10)⁶	595.0 (10)⁶	35800	53,700	48,300	79.2	82	134
	wheel	10,900	"	118.8 (10)⁶	"	26700	40000	31,100	71.8	74	"
main pinion shaft.	pinion	34,500	67,600	1190 (10)⁶	4565 (10)⁶	75,850	113,700	90500	101.7	105	160
	wheel	30,200	"	912 (10)⁶	"	74,000	111,000	86400	100.9	103	160
	edge of "	12,700	"	161.3 (10)⁶	"	68750	103,000	71600	98.4	100	

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

Machine Design of Enoura Bascule Bridge for Mie-ken.

Dimension of gears in millimeters.

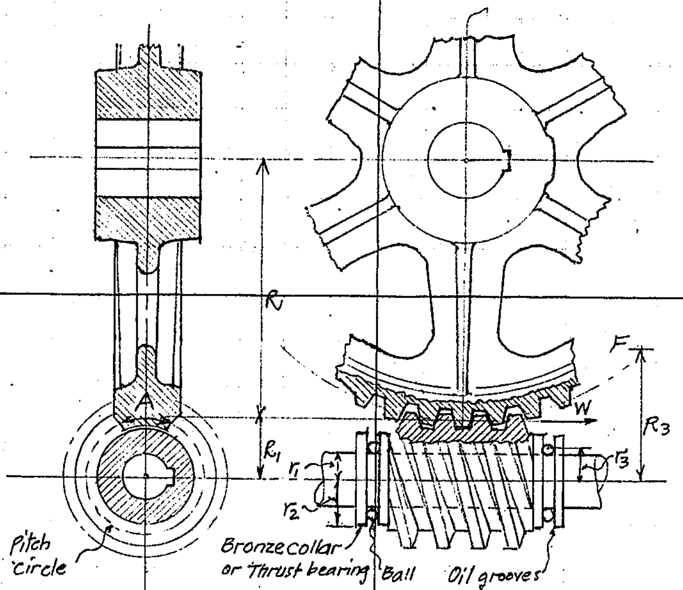
Pinions			Steel pinion 1st Pinion	2nd pinion	3rd pinion	4th Pinion	Main Pinion
Pitch diameter	D		90.	135.	180.	210	300
no. of teeth	N		15	15	15	15	15
module	Mc		6	9	12	14	20
Circular pitch	P		18.850	28.274	37.699	43.982	62.832
face	F		56	70	106	116	146
addendum	Ad.		6	9	12	14	20
dedendum	Da.	$= \frac{7}{6} Ad$	7	10.5	14	16.333	23.333
bore	d		34	52	72	82	105
Hub dia	H	$= 0.085D + 3.5P$	74	110	147	172	246
hub length	L	$= 1\frac{1}{4} d$ or $1\frac{1}{4} F$ of wheel	64	80	125	138	175
limit of hub dia	$D - 2Dd$		76	114	152	177.33	253.33
				Single key			double keys
key			10×8	15×10	20×13	24×16	20×13
key way depth in shaft			4.5	5	7	8	7
〃 〃 in hub			3.5	5	6	8	6

Spur wheels.			Cast iron wheel. 1st wheel	2nd wheel	3rd wheel	4th wheel	rack
Pitch diameter	D		264	396	528	616	3600
no. of teeth	N		44	44	44	44	180
module	Mc		6	9	12	14	20
Circular pitch	P		18.85	28.274	37.699	43.982	62.832
face	F		50.	64	100	110	140
addendum	Ad		6	9	12	14	20
dedendum	Dd	$= \frac{7}{6} Ad$	7	10.5	14	16.333	23.333
bore	d		52	72	74	100	
Hub dia.	H	$= 0.085D + 3.5P$	90	134	178	208	
hub length	L	$= 1\frac{1}{4} d$ or $1\frac{1}{4} F$ use the greater.	65	90 (86)	125	138	
key			15×10	20×13	20×13	28×18	
keyway depth in shaft			5	7	7	9	
〃 〃 in hub			5	6	6	9	
			4	4	4	4	

Machine Design of Enoura-Bashi for Mie-Ken.

Design of worm gear.

Let. W = The force at the pitch line of worm and wheel in kg;
R = the radius of the wheel in cm;
R_1 = the radius of the worm in cm;
P = the circular pitch of the teeth on the wheel in cm;
r_1 = the radius of the inner circle of the thrust collar at the end of the worm in cm;
r_2 = the outer radius of the collar in cm;
r_3 = the radius of the ball thrust bearing if used instead of thrust collar in cm;
F = The force acting to rotate the shaft in kg;
R_3 = the lever arm of F;
f = the coef. of friction between the teeth;
f_1 = the coef. of friction between the collar and the worm or of a rolling friction for ball bearing;
A = the arc of contact at the pitch line circle in cm;
F_w = the force required to move the load W, neglecting friction in kg;
F_t = the force required to overcome the friction between the teeth in kg,
F_c = the force required to overcome the collar friction in kg;
F_b = the force required to overcome the rolling friction of the ball bearing if it be used instead of thrust collar.



Then

$F = F_w + F_t + F_c$ in case of the thrust bearing being used,
$F = F_w + F_t + F_b$ 〃 〃 〃 ball bearing 〃 〃

in which

$$F_w = \frac{WP}{2\pi R_3} \quad \text{for single thread worm,}$$

$$= \frac{3WP}{2\pi R_3} \quad \text{for triple thread worm.}$$

$$F_t = \frac{fWR_1}{R_3},$$

$$F_c = \frac{f_1 W\left[\frac{2}{3}\cdot\frac{r_2^3 - r_1^3}{r_2^2 - r_1^2}\right]}{R_3} \quad \text{for thrust collar,}$$

$$F_b = \frac{f_1 W r_3}{R_3} \quad \text{for ball bearing.}$$

Efficiency of worm gear.

$$E = \frac{P}{P + 2f\pi R_1} \quad \text{for single threaded worm (Friction of thrust collar or ball bearing not included)}$$

$$= \frac{3P}{3P + 2f\pi R_1} \quad \text{for triple threaded worm (〃)}$$

Machine Design of Enoura Bascule Bridge for Mie-ken.

Now we have decided as follows:
gear ratio 74/3 , tripple threaded worm.
helix angle of worm = 20°-00'
angle of side of tooth = 14°-30'
module 4.5 , circular pitch = 14.137 mm, addendum = 4.5 mm, dedendum = 5.25 mm
lead of worm $l = 3p = 3 \times 1.4137 = 4.2411$ mm
pitch diameter of worm $D_1 = \cot\beta \cdot \frac{l}{\pi} = \cot 20° \frac{l}{\pi} = 2.74748 \times \frac{42.411}{3.146} = 37.0905$ mm
diameter of worm at bottom of thread = 37.0905 − 10.500 = 26.5905 $R_1 = 1.8545$ cm

Worm wheel.
no. of teeth $N = 74$, circular pitch $p = 14.137$
pitch dia. of wheel $D = \frac{14.137 \times 74}{\pi} = 332.9952$, $R = 16.6498$ cm
Arc of contact for 90°, $A = \frac{\pi R_1}{2} = \frac{3.146 \times 1.8545}{2} = 2.9130$ cm

Diameter of motor shaft $d_1 = 2r_1$
Torsional moment on the shaft $= T = 72600 \frac{N}{n} = \frac{72600 \times 3}{1600} = 136$ kgcm.

Impact factor k_t taken as 1.50
Equiv. torsional moment $= T_E = 136 \times 1.50 = 204$ kgcm
required diameter of motor shaft $d_1 = 2r_1 = \sqrt[3]{\frac{16 \times 204}{530\pi}} = 1.235$ cm use 30 mm
$r_1 = 1.50$ cm.

$FR_3 = 204$ kgcm.

$F_w R_3 = \frac{3WP}{2\pi} = \frac{3W \times 1.4137}{2\pi} = 0.674\,W$

$F_t R_3 = fWR_1 = 0.10\,W \times 1.8545 = 0.185\,W$

$F_b R_3 = f_1 W R_3 = 0.01\,W \times 3.20$ (say) $= 0.032\,W$

Summary $= 0.891\,W$

$FR_3 = F_w R_3 + F_t R_3 + F_b R_3$

∴ $204 = 0.819\,W$ (0.891)

Total load on pitch line $= W = \frac{204}{0.819}$ (891) $= 249$ kg (229)

worm wheel tooth.
a coef. $k_n = \frac{W}{NPA} = \frac{249}{3 \times 1.4137 \times 2.913} = 20.15$ (229; 18.54)

Speed at pitch line $v = \frac{1600 \times \pi \times 3.7091}{100} = 186.5$ m/min.

For which allowable value of k_n from prepared diagram
$k_n = 23.0$ ✓

Efficiency of worm gearing.
$E = \frac{3P}{3P + 2f\pi R_1} = \frac{3 \times 1.4137}{3 \times 1.4137 + 2 \times 0.10\pi \times 1.8545} = \frac{4.2417}{5.4067} = 0.785$
efficiency of ball bearing 0.990
" " bearings $0.98 \times 0.94 = 0.921$ (ball ん, ホールナセ)
Total efficiency $\eta = 0.785 \times 0.99 \times 0.921 = 0.715$

Machine Design of Enoura Bascule Bridge for Mie-ken

Design of Hand Operating mechanism.

Time of operation 25 min assumed.

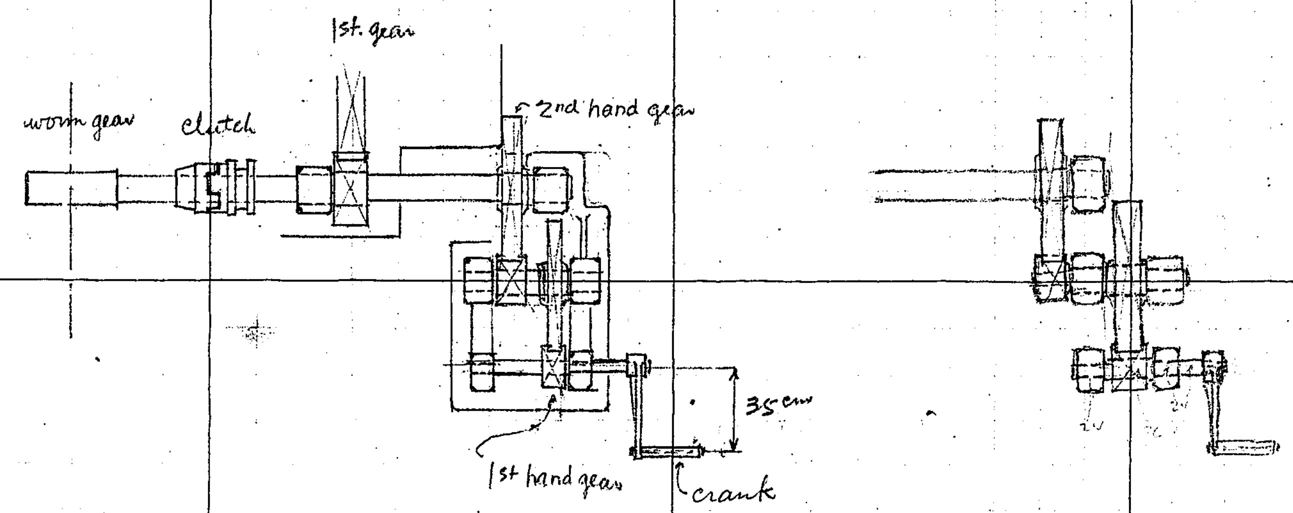
no. of revolution of trunnion shaft = $\frac{80}{360\times25}$ = 0.0089 /min

no. of revolution of crank shaft assumed 60 /min.

Resultant gear ratio = $\frac{60}{0.0089}$ = 6740.

Gears	gear ratio		
rack and pinion	180 : 15	$\left(\frac{44}{15}\right)^4 \times \frac{180}{15} = 889$	$\frac{6740}{889} = 7.58$
4th. gear	44 : 15		
3rd. 〃	44 : 15		
2nd. 〃	44 : 15		
1st. 〃	44 : 15		
2nd. hand operating gear	44 : 15	$\frac{44\times39}{15\times15} = 7.63$	
1st. 〃 〃 〃	39 : 15		

Resultant actual gear ratio = 889 × 7.63 = 6760



Force on crank assumed 10 kg

Torsional moment = 10 × 35 = 350 kg.cm

Machine Design of Enoura Bascule Bridge for Mie-Ken.

Gear calculation. Steel pinion, S=1400, Cast iron wheel S = 550. in W = SPfy

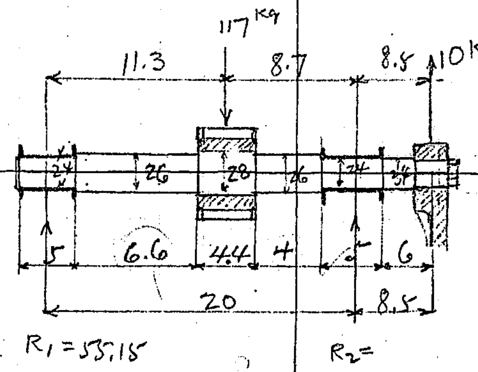
Gearings	wheels	no. of teeth N	module Mc	Pitch dia Dp	Out side dia Do	Face f	Cir. Pitch P	Coef. y	Safe load on tooth W.	
1st. hand oper. gear	pinion	15	4	60	68	40	12.566	0.078	548	
	wheel	39	〃	156	164	34	〃	0.107	251	2.28
2nd. 〃 〃 〃	pinion	15	5	75	85	50	15.708	0.078	857	
	wheel	44	〃	220	230	44	〃	0.1084	413	1.92

Load on Teeth.

				hub length
1st. pinion	PH_1	$10 \times 350 \div 30 =$	117 kg	44
1st. wheel	WH_1	$117 \times 0.94 =$	110 kg	〃
2nd. pinion	PH_2	$110 \times 78 \div 37.5 =$	229 〃	56
2nd. wheel	WH_2	$229 \times 0.94 =$	215 〃	〃
1st. pinion	P_1	$215 \times 110 \div 45 =$	525 〃	
1st. wheel	W_1	$525 \times 0.94 =$	493 〃	

Design of Shaft.

1st. Hand operating shaft.



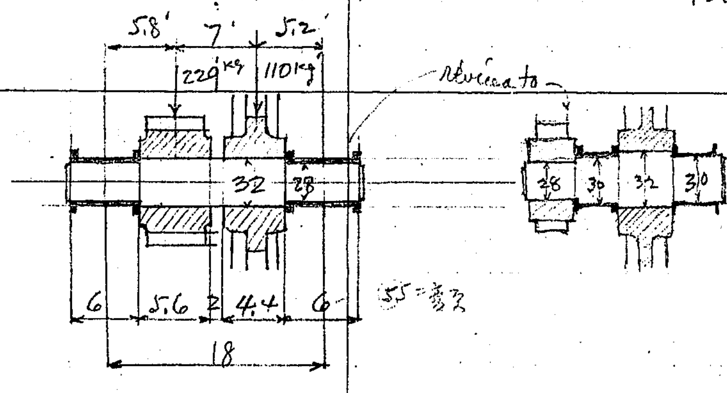
reactions $10 \times 8.5 \div 20 = 4.25$
$117 \times 8.7 \div 20 = 50.90$
55.15 kg max.

Bending moment M at pinion
$= 55.15 \times 11.3 = 624$ kgcm

〃 〃 〃 at bearing
$= 10 \times 8.5 = 85$ 〃

Torsional moment T
$= 10 \times 35 = 350$ 〃

2nd shaft.



Reaction $229 \times 12.2 = 2790$
$110 \times 5.2 = 572$
$3312 \div 18 = 184$ kg

$M = 184 \times 5.8 = 1067$ kg cm at pinion
$= 184 \times 3 = 552$ 〃 at bearing

$T = 229 \times 3.75 = 858$ 〃 throughout

Shafts		Bending moment M	Torsional moment T	M^2	T^2	$\sqrt{M^2+T^2}$	T_E	M_E	req'd. d	used dia
1st. shaft	pinion	624	350	389000	123000	716	1075	1020	2.15	26 mm
	bearing	85	350	7200	123000	361	542	390	1.71	24
		1390				1580	2370		2.80	30
2nd shaft	pinion	1067	858	1137000	736000	1370	2055	1890	2.67	32
	bearing	552	0	305000	0	552	830	830	1.98	(28) - 30

JIUN MASUDA
CONSULTING ENGINEER
~~JIJI~~ SHOWA BLDG, TOKYO

CALCULATIONS FOR

MADE BY K. Inaba DATE 9-7-18 FILE NO_____
CHECKED BY_____ DATE_____ PAGE NO Mc12

Machine Design of Enoura Bascule Bridge for Mie-Ken.

Design of Hand operating mechanism.
Gear ratio.

Hand operating gear	15 : 44
1st. gear	44 : 15
2nd. "	44 : 15
3rd. "	44 : 15
4th. "	44 : 15
rack and pinion	180 : 15

Resultant gear ratio

$$= \left(\frac{44}{15}\right)^3 \times \frac{180}{15} = 303$$

Revolution of trunnion shaft per min for 25 min. operation

$$\frac{80}{360 \times 25} = 0.0089 \text{ rev./min.}$$

Required no. of revolution of crank for 25 min operation

$$0.0089 \times 2610 =$$

Hub length

Cast iron

H ÷ 1.8

max bore

3÷15

0.085D +3.5P

H.	Mc	P	D							
	3	9.425	45	3.83	33	= 37	7	38	"	21
+3	4	12.566	60	5.10	43	48	9.3	50.7	"	28
	5	15.708	75	6.38	55	51	11.7	63.3	"	35

110 × 7.8 = 858 25
229 × 3.75 858

増田淳氏関係資料
(独立行政法人 土木研究所蔵)

Design of Enoura Bascule Bridge for Nue-Ken.

Power required for Hand operation.

Time of operation assumed as 30 min. or 1800 sec.

uniform speed at rack circle

$$\frac{2\pi \times 1.8 \times 80^\circ}{1800 \times 360^\circ} = 0.0014 \text{ meter per sec.}$$

Rack force to overcome

Journal friction	230
Inertia	negligible
Eccentricity	1067
	1297 kg for no wind
wind $12.5\ ^{kg}/_{m^2}$ intensity	2475
	3772 kg against wind pressure.

Total efficiency of operating mechanism.

$$\eta = (0.94)^6 = 0.69$$

work done required = $1297 \times 0.0014 \div 0.69 = 2.84$ kgm/sec for no wind
$3772 \times 0.0014 \div 0.69 = 7.66$ " against 12.5 kg wind.

Energy developed by one operator.

Let arm length of crank = 35 cm

rotating power on crank by one operator for continuous operation = 10 kg

no. of revolution of crank shaft = 60 per min or 1 rev/sec.

work done by one operator = $10 \times \pi \times 0.35 \times 2 \times 1 = 22$ kgm per sec.

JIUN MASUDA
CONSULTING ENGINEER
SEIYU BLDG, TOKIO

MADE BY______ DATE______ FILE NO______

CHECKED BY______ DATE______ PAGE NO______

CALCULATIONS FOR

$0.181 \sqrt[3]{9600 \times 16} = 9.68^{cm}$ $100^{cm}\phi$

1536m

53.5

18 10.1^{ϕ}

三寿加七佃方高橋材料計算書

JIUN MASUDA
CONSULTING ENGINEER
~~[illegible]~~ SHOWA BLDG, TOKYO

CALCULATIONS FOR

MADE BY______ DATE______ FILE NO______
CHECKED BY______ DATE______ PAGE NO______

昭和十年　月

三重縣

長島海野線

江ノ浦可動橋架設工事

材料計算書

JIUN MASUDA
CONSULTING ENGINEER
~~JIJI~~ BLDG, TOKYO
SHOWA

MADE BY M. Jinda DATE 9-7-4 FILE NO.
CHECKED BY ______ DATE ______ PAGE NO M1

CALCULATIONS FOR

Materials of Enoura-Bashi for Mie-Ken

		Moving Girders			Z-Required		
Top chord	2	Ls	125×90×9	@146	× 9.056	264.4	
Bottom chord	2	〃	〃	〃	× 9.340	272.7	
Vertical	2	〃	125×75×9	@135	× 1.540	41.6	
〃	8	〃	〃	〃	× 1.540	166.3	
〃	2	〃	〃	〃	× 1.565	42.3	
Diagonals	5	〃	90×90×10	@133	× 1.565	104.1	
〃	3	〃	〃	〃	× 1.605	64.0	
〃	1	〃	125×90×9	@146	× 1.610	23.5	
〃	1	〃	〃	〃	× 1.535	22.4	
〃	1	〃	〃	〃	× 1.625	23.7	
Top Flange	2	Ls	125×90×9	〃	× 6.800	198.6	
〃 〃	1	Pl	260×9	@18369	× 5.100	93.7	
Bottom Flange	2	Ls	125×90×13	@20.6	× 7.550	311.1	
〃 〃	1	Pl	260×12	@24492	× 6.060	148.4	
Web Plate	1	〃	1,115×9	@78775	× 3.140	247.4	
〃 〃	1	〃	1,075×9	@75949	× 2.860	217.2	
〃 〃	1	〃	740×9	@52281	× 1.420	74.2	
Side plate	2	Pls	950×9	@67118	× 1.700	228.2	
〃 〃	2	〃	440×9	@31086	× 740	46.0	
gusset plate	1	Pl	240×9	@16956	× 255		4.3
〃 〃	4	Pls	340×9	@24021	× 485		46.6
〃 〃	1	Pl	370×9	@26141	× 620		16.2
〃 〃	1	〃	400×9	@28260	× 455		12.9
〃 〃	3	Pls	〃	〃	× 550		46.6
〃 〃	1	Pl	435×9	@30733	× 555		17.1
〃 〃	1	〃	520×9	@36738	× 1,060		38.9
Tie plate	5	Pls	190×9	@13424	× 260		17.5
Splice	2	Pls	260×9	@18369	× 500		18.4
〃	2	〃	85×9	@6005	× 500		6.0
〃	4	Pls	75×9	@5299	× 500		10.6
〃	2	Fills	75×4	@2355	× 250		1.2
〃	1	Pl	260×9	@18369	× 430		7.9
Handrail	1	L	65×50×7	@594	× 2.105		12.5
〃	4	〃	〃	〃	× 2.115		50.3
〃	1	〃	〃	〃	× 1.065		6.3
Filler	1	Fill	110×8	@6908	× 390		2.7
〃	19	Fills	85×9	@6005	× 130		14.8
〃	5	〃	70×9	@4946	× 170		4.2
gusset	1	Pl	110×9	@7772	× 185		1.4
〃	5	Pls	60×9	@4239	× 305		6.5
Floor beam conn.	2	Ls	125×75×9	@135	× 396		10.7
〃	2	Fills	160×9	@11304	× 310		7.0
〃	1	L	100×75×10	@130	× 245		3.2
〃	1	〃	〃	〃	× 185		2.4
〃	1	Fill	70×9	@4946	× 175		0.9
〃	1	〃	〃	〃	× 115		0.6
Splice	2	Pls	260×9	@18369	× 465		17.1
〃	2	〃	140×9	@9891	× 310		6.1
Pin plate	2	〃	590×9	@41684	× 920		76.7
〃	2	〃	445×9	@31439	× 620		39.0
Stiffener	2	Ls	125×75×9	@135	× 1.770		47.8
	2	〃	〃	〃	× 1.965		53.1
〃	2	Fills	70×9	@4946	× 885		8.8
〃	2	Ls	125×75×9	@135	× 1.080		29.2
〃	2	Fills	70×9	@4946	× 915		9.1

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

CALCULATIONS FOR

MADE BY M. Jinda DATE 9-7-4 FILE NO
CHECKED BY DATE PAGE NO M2

Materials of Enoura-Bashi for Mie-Ken

Stiffener	2	Ls 125×75×9 c	13.5 ×	1.980		53.5
〃	2	Fills 70 × 9 c	4.946 ×	885		8.8
〃	2	Ls 125×75×9 c	13.5 ×	1.840		49.7
〃	8	〃 〃 c	〃 ×	621		67.1
〃	2	〃 〃 c	〃 ×	600		16.2
〃	2	〃 〃 c	〃 ×	670		18.1
〃	2	Pls 140 × 9 c	9.891 ×	610		12.1
〃	2	Ls 75×75×9 c	9.96 ×	840		16.7
〃	2	Pls 270 × 9 c	19.076 ×	730		27.9
〃	2	Ls 75×75×9 c	9.96 ×	610		12.2
Gusset of lateral	1	Pl 445 × 9 c	31.439 ×	520		16.3
〃	4	Pls 〃 c	〃 ×	485		61.0
〃	1	Pl 455 × 9 c	32.146 ×	550		17.7
〃	2	Fills 85 × 9 c	6.005 ×	190		2.3
	17	Wash. 70φ c	30.2 ×	9		4.6
	2	Fills 420 × 4 c	13.188 ×	550		14.5
					2,589.8 +	1,053.3 = 3,643.1 kgs.
Summary of moving girders			2 c 3,643.1		=	7,286.2 Kgs

Floor Beams FB 1 — 1-Required

1	I 300 × 150 c	48.3 ×	4.240		204.8
3	Pls 150 × 9 c	10.598 ×	150		4.8
2	〃 c	〃 ×	170		3.6
2	Ls 150×90×9 c	16.4 ×	210		6.9
					220.1

FB2 & FB3 — 4-Required

1	I 300 × 150 c	48.3 ×	4.240		204.8
3	Pls 150 × 9 c	10.598 ×	150		4.8
2	〃 〃 c	〃 ×	170		3.6
2	Ls 150×90×9 c	16.4 ×	210		6.9
1	Pl 330 × 9 c	23.315 ×	600		14.0
					234.1

FB4 — 1-Required

2	[s 300 × 90 c	38.1 ×	4.240		323.1
3	Pls 230 × 9 c	16.250 ×	430		21.0
2	Pls 250 × 9 c	17.663 ×	430		15.2
2	Ls 150×90×9 c	16.4 ×	430		14.1
16	bars 60 × 9 c	4.239 ×	528		35.8
1	Pl 610 × 9 c	43.097 ×	620		26.7
16	bars 60 × 9 c	4.239 ×	571		38.7
					474.6

Summary of Floor Beams

FB 1	1 c 220.1 =	220.1	
FB2 & FB3	4 c 234.1 =	936.4	
FB4	1 c 474.6 =	474.6	
			1,631.1 kgs

JIUN MASUDA
CONSULTING ENGINEER
~~JIJI~~ BLDG, TOKYO
SHOWA

MADE BY M. Jinda DATE 9-7-5 FILE NO.
CHECKED BY DATE PAGE NO M3

CALCULATIONS FOR

Materials of Enoura-Bashi for Mie-Ken

		Stringers	1-Required	
$ST1^R_L, 2^R_L$ & 3	5	[s 150 × 75 c	18.6 × 6.605	614.3
〃 〃 〃	5	P/s 120 × 9 c	8.478 × 340	14.4
$ST4^R_L, 5^R_L$ & 6	5	[s 150 × 75 c	18.6 × 4.615	429.2
		Summary of stringers		1,057.9 kgs
		Lateral Bracings	1-Required	
BL1	8	Ls 75×75×9 c	9.96 × 2.610	208.0
〃	8	〃 〃 c	〃 × 2.730	217.5
BL2	2	〃 〃 c	〃 × 2.595	51.7
〃	2	〃 〃 c	〃 × 2.715	54.1
		Summary of Lateral bracings		531.3 kgs
		SHOES	1-Required	
Sole plate	2	c	32.7	65.4
Bed casting	2	c	65.2	130.4
Wedge	8	Bars 50 × 25 c	9.813 × 220	17.3
Bolts	4	bolts 19φ × 60 c	0.301	1.2
Anchor bolts	8	〃 22φ × 450 c	1.598	12.8
Washer	8	Wash. 80φ c	39.5 × 9	2.8
				229.9 kgs
		Counterweight tower	1-Required	
Column	2	[s 380 × 100 c	54.5 × 5.485	597.9
〃	2	〃 〃 c	〃 × 5.360	584.2
〃 top	2	Ls 75×75×9 c	9.96 × 480	9.6
〃 〃	2	P/s 600 × 9 c	42.390 × 815	69.1
〃 〃	2	〃 400 × 9 c	28.260 × 600	33.9
〃 〃	2	Ls 75×75×9 c	9.96 × 510	10.2
Bracing	4	〃 〃 c	〃 × 1.255	50.0
〃	4	P/s 250 × 9 c	17.663 × 425	30.0
〃	4	Ls 75×75×9 c	9.96 × 705	28.1
〃	4	P/s 310 × 9 c	21.902 × 375	32.9
〃	4	Ls 75×75×9 c	9.96 × 1.460	58.2
〃	4	P/s 240 × 9 c	16.956 × 425	28.8
〃	4	Ls 75×75×9 c	9.96 × 1.120	44.6
〃	4	P/s 300 × 9 c	21.195 × 435	36.9
〃	4	Ls 90×90×10 c	13.3 × 1.985	105.6
〃	4	P/s 390 × 9 c	27.554 × 415	45.7
Base	4	Ls 90×75×9 c	11.0 × 415	18.3
〃	28	〃 75×75×9 c	9.96 × 152	42.4
〃	4	〃 100×75×10 c	13.0 × 152	7.9
〃	4	P/s 355 × 9 c	25.081 × 430	43.1
〃	4	Ls 90×75×9 c	11.0 × 430	18.9
〃	4	Ls 125×90×9 c	14.6 × 2.100	122.6
〃	2	P/s 430 × 12 c	40.506 × 650	52.7
〃	2	〃 415 × 12 c	39.093 × 650	50.8
Top strut	4	Ls 125×90×9 c	14.6 × 5.620	328.2
〃 〃	2	P/s 390 × 9 c	27.554 × 6.370	351.0
〃 〃	2	〃 530 × 12 c	49.926 × 1.330	132.8
〃 〃	8	Ls 125×90×9 c	14.6 × 350	40.9
〃 〃	16	bars 60 × 9 c	4.239 × 668	45.3

JIUN MASUDA
CONSULTING ENGINEER
BLDG, TOKYO
SHOWA

MADE BY M. Jinda DATE 9-7-5 FILE NO.
CHECKED BY DATE PAGE NO M4

CALCULATIONS FOR

Materials of Enoura-Bashi for Mie-Ken

Top strut	1	Pl 310 × 9	21.902 × 520	11.4
〃 〃	2	Pls 400 × 9	28.260 × 520	29.4
〃 〃	4	Pls 250 × 9	17.663 × 520	36.7
〃 〃	8	bars 60 × 9	4.239 × 654	22.2
〃 〃	4	Ls 100×75×10	13.0 × 400	20.8
〃 〃	4	〃 150×100×15	27.7 × 405	44.9
〃 〃	4	〃 75×75×9	9.96 × 382	15.2
〃 〃	4	Fills 65 × 9	4.592 × 405	7.4
〃 〃	4	〃 70 × 9	4.946 × 140	2.8
〃 〃	6	Ls 75×75×9	9.96 × 400	23.9
〃 〃 tie	2	〃 125×90×9	14.6 × 5.610	163.8
Sway bracing	6	〃 75×75×9	9.96 × 965	57.7
〃 〃	2	Pls 420 × 9	29.673 × 550	32.6
〃 〃	3	〃 240 × 9	16.956 × 505	25.7
〃 〃	2	〃 250 × 9	17.663 × 505	17.8
Diaphragm DM1	4	Ls 75×75×9	9.96 × 390	15.5
〃 〃	2	〃 90×75×9	11.0 × 250	5.5
〃 〃	2	Pls 250 × 9	17.663 × 390	13.8
Ladder	17	bolts 16φ × 420	0.767	13.0
Anchor	16	〃 22φ × 560	1.926	30.8
〃	16	Wash. 100φ	61.7 × 9	8.9
Base	4	Ls 90×75×9	11.0 × 300	13.2
		Summary of counterweight tower		3,633.6 Kgs
		Counterweight Frame	1-Required	
Columns	4	[s 250 × 90	34.6 × 4.800	664.3
〃	8	Ls 100×75×10	13.0 × 510	53.0
〃	4	Pls 200 × 12	18.840 × 830	62.5
〃	4	〃 200 × 9	14.130 × 450	25.4
〃	4	〃 〃	〃 × 640	36.2
〃 top	4	[s 200 × 70	21.1 × 1.250	105.5
〃 〃	4	〃 200 × 70	〃 × 485	40.9
〃 〃	4	Pls 445 × 9	31.439 × 490	61.6
〃 〃	4	〃 190 × 9	13.424 × 255	13.7
〃 〃	12	Ls 65×65×8	7.66 × 180	16.5
〃 〃	2	Pls 695 × 12	65.469 × 885	115.9
〃	40	bars 60 × 9	4.239 × 553	93.8
〃	2	Pls 390 × 9	27.554 × 490	27.0
〃	2	〃 〃	〃 × 420	23.1
〃	4	〃 310 × 9	21.902 × 390	34.2
Top strut	2	Ls 125×75×9	13.5 × 3.890	105.0
〃 〃	1	Pls 310 × 9	21.902 × 510	11.2
〃 〃	12	bars 60 × 9	4.239 × 688	35.0
Sway bracings	4	Ls 125×75×9	13.5 × 2.045	110.4
〃 〃	6	Pls 130 × 9	9.185 × 240	13.2
〃 〃	2	Ls 75×75×9	9.96 × 1.165	23.2
〃 〃	4	Pls 370 × 9	26.141 × 485	50.7
Bottom strut	4	Ls 125×75×9	13.5 × 3.890	210.1
〃 〃	4	Pls 850 × 9	60.053 × 1.035	248.6
〃 〃	4	Ls 125×75×9	13.5 × 920	49.7
〃 〃	2	Pls 580 × 9	40.977 × 840	68.8
〃 〃	16	Bars 60 × 9	4.239 × 328	22.2
〃 〃	4	Pls 310 × 9	21.902 × 510	44.7
〃 〃	8	bars 60 × 9	4.239 × 652	22.1

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

MADE BY M. Jinda DATE 9-7-6 FILE NO

CHECKED BY DATE PAGE NO M5

CALCULATIONS FOR

Materials of Enoura-Bashi for Mie-Ken.

Bottom strut	2	Pls 370 × 9 c	26141 × 510	26.7
〃 〃	8	bars 60 × 9 c	4239 × 673	22.8
	16	bolts 16ϕ × 85 c	0237	3.8
	2	Pls 190 × 9 c	13424 × 265	7.1
		Summary of Counterweight Frame		2448.9 Kgs
		Counterweight Link	1-Required	
Link	4	[250 × 90 c	34.6 × 3031	419.5
〃	8	Pls 200 × 12 c	18840 × 240	36.2
〃	8	〃 240 × 12 c	22608 × 375	67.8
〃	4	Ls 90 × 75 × 9 c	11.0 × 225	9.9
〃	4	Pls 300 × 9 c	21195 × 350	29.7
〃	4	〃 330 × 9 c	23315 × 605	56.4
〃	4	〃 〃 c	〃 × 605	56.4
〃	48	bars 60 × 9 c	4239 × 464	94.4
Strut	2	[250 × 90 c	34.6 × 3940	272.6
Bracings	2	Ls 75 × 75 × 9 c	9.96 × 2870	57.2
〃	2	〃 〃 c	〃 × 1375	27.4
〃	1	L 〃 c	〃 × 2241	22.3
〃	2	Pls 210 × 9 c	14837 × 480	14.2
〃	2	〃 280 × 9 c	19782 × 390	15.4
〃	2	Ls 75 × 75 × 9 c	9.96 × 1395	27.8
Bolts	32	Bolts 19ϕ × 45 c	267	8.5
		Summary of counterweight Link	=	1215.7 Kgs
		Floor Break		
		FL 1	1-Required	
	1	L 100 × 100 × 10 c	14.9 × 3605	53.7
	1	Bar 30 × 10 c	2355 × 3605	8.5
	11	Bolts 16ϕ × 210 c	.548 (Washers included)	6.0
				68.2
		FL 2 & FL3	2-Required	
	1	L 100 × 75 × 10 c	13.0 × 3605	46.9
	1	Check. Pl 230 × 9 c	16250 × 3605	58.6
	11	Bolts 16ϕ × 210 c	.548 (Washers included)	6.0
				111.5
		FL 4	1-Required	
	1	L 100 × 75 × 10 c	13.0 × 3605	46.9
	1	Pl 170 × 9 c	12011 × 3605	43.3
	1	Bar 30 × 10 c	2355 × 3605	8.5
	5	Ls 65 × 65 × 8 c	7.66 × 190	7.3
	5	Bolts 12ϕ × 400 c	.415	2.1
	5	〃 12ϕ × 300 c	.326	1.6
				109.7

Summary of floor breaks

FB 1	1 c	68.2 =	68.2
FB 2 & 3	2 c	111.5 =	223.0
FB 4	1 c	109.7 =	109.7
			400.9 Kgs

JIUN MASUDA
CONSULTING ENGINEER
~~####~~ BLDG, TOKYO
SHOWA

MADE BY *M. Jinda* DATE 9-9-3 FILE NO ____
CHECKED BY ____ DATE ____ PAGE NO M6

CALCULATIONS FOR

Materials of Enoura-Bashi for Mie-Ken

		Trunnion Bearings	2-Required	
Bearings	2	Is 400 × 150 @	720 × 600	86.4
〃	16	∟s 75×75×9 @	9.96 × 375	59.8
Columns	2	Is 400 × 150 @	72.0 × 2,238	322.3
Top plate	2	Pls 190 × 12 @	17.898 × 580	20.8
〃 angle	4	∟s 150×90×12 @	21.5 × 320	27.5
〃 〃	4	〃 〃 @	〃 × 150	12.9
Bed plate	1	Pl 620 × 12 @	58.404 × 720	42.1
Bottom strut	2	Pls 160 × 9 @	11.304 × 1,290	29.2
〃 〃	2	∟s 100×100×13 @	19.1 × 1,290	49.3
Bottom angle	2	〃 〃 @	〃 × 320	12.2
strut	4	〃 75×75×9 @	9.96 × 1,780	70.9
〃	4	Pls 280 × 9 @	19.782 × 310	24.5
〃	4	〃 310 × 9 @	21.902 × 415	36.4
〃	2	〃 190 × 9 @	13.424 × 390	10.5
〃	2	〃 195 × 9 @	13.777 × 390	10.7
Diaphragm	1	Pl 490 × 9 @	34.619 × 740	25.6
〃	4	∟s 90×75×9 @	11.0 × 500	22.0
〃	4	〃 〃 @	〃 × 750	33.0
Anchor	6	Bolts 22φ × 600	@ 2.047	12.3
〃	6	Wash. 80φ @	39.5 × 9	2.1
	12	Bolts 12φ × 490	@ .495	5.9
	18	〃 12φ × 150	@ .193	3.5
	2	∟s 125×90×9 @	14.6 × 500	14.6
				934.5 Kgs
Summary of Trunnion Bearings			2 @ 934.5 = 1,869.0 Kgs	
		FLOOR BEAM FB5	1-Required	
	1	I 250 × 125 @	55.5 × 3,770	209.2
	4	∟s 150×90×9 @	16.4 × 190	12.5
				221.7 Kgs
		FLOOR BEAM FB6	1-Required	
	1	I 250 × 125 @	55.5 × 3,580	198.7
	2	Pls 150 × 9 @	10.598 × 280	5.9
	4	Bolts 12φ × 300	@ .326	1.3
				205.9 Kgs
Summary of floor beams				427.6 Kgs

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

MADE BY M. Jinda DATE 9-7-9 FILE NO
CHECKED BY DATE PAGE NO M7

CALCULATIONS FOR

Materials of Enoura-Bashi for Mie-Ken

Numbers of Rivet heads

Moving Leaf						
	19ϕ shop rivets	4,776 'c	0.0476	=	227.3 '	
	" field rivets	468 'c	"	=	22.3 '	
	16ϕ Shop rivets	144 'c	0.0210	=	3.0 '	
	" field rivets	24 'c	"	=	0.5 '	
					253.1 '	
Floor Beams						
	19ϕ shop rivets	452 'c	0.0476	=	21.5 '	
	" field "	264 'c	"	=	12.6	
					34.1	
Stringers						
	19ϕ shop rivets	20 'c	0.0476	=	1.0 '	
	" field "	188 'c	"	=	8.9 '	
					9.9 '	
Lateral Bracings						
	19ϕ shop rivets	192 'c	0.0476	=	9.1 '	
	" field "	228 'c	"	=	10.9 '	
					20.0 '	
Summary of Moving span						317.1 kgs '
Counterweight tower						
	19ϕ shop rivets	1,774 'c	0.0476	=	84.4 '	
	" field "	440 'c	"	=	20.9 '	
						105.3 kgs '
Counterweight						
	19ϕ shop rivets	1,512 'c	0.0476	=	72.0 '	
	" field "	524 'c	"	=	24.9 '	
						96.9 kgs '
Link						
	19ϕ shop rivets	452 'c	0.0476	=	21.5 '	
	" field "	172 'c	"	=	8.2 '	
						29.7 kgs '
Floor Breaks						
	19ϕ shop rivets	178 'c	0.0476	=	8.5 '	
	10ϕ " "	74 'c	0.0149	=	1.1 '	
						9.6 kgs '
Trunnion Bearings						
	19ϕ shop rivets	1,536 'c	0.0476	=	73.1 '	
	" field "	24 'c	"	=	1.1 '	
						74.2 ' kgs
Floor Beam on Pier						
	19ϕ shop rivets	32 'c	0.0476	=	1.5 '	
						1.5 kgs '
						634.3 kgs '

7/8

Materials of Enoura-Bashi for Mie-Ken.

Grand Summary of Structural steel

Moving span

Main Girders	7,286		
Floor beam	1,631		
Stringers	1,058		
Lateral bracings	531		
Summary for Moving Leaf. =		10,506 kgs	
Counterweight tower		3,634 kgs	
Counterweight frame		2,449 kgs	
Link		1,216 "	
Floor Breaks		401 "	
Trunnion Bearings		1,869 "	
Floor Beam on Pier		428 "	
Rivet heads		634 "	
			21,137 kgs
Shoes (cast steel)			230 kgs
			21,367 kg tons

JIUN MASUDA
CONSULTING ENGINEER
BLDG, TOKYO
SHOWA

MADE BY M. Jinda DATE 9-7-9 FILE NO
CHECKED BY DATE PAGE NO M9

CALCULATIONS FOR

Materials of Enoura-Bashi for Mie-Ken

Materials of Flooring

Planking (250 sbt × 75 × 3900)

	1 @ 3900 × 75 × 10,850 =	3.174 cub.m.

角材

Nailing piece	1 @ 120 × 116 × 3430 =	0.048	
〃 〃	2 @ 120 × 106 × 3430 =	0.087	
〃 〃	2 @ 120 × 76 × 3430 =	0.063	
〃 〃	1 @ 120 × 116 × 3830 =	0.053	
〃 〃	2 @ 120 × 106 × 3830 =	0.097	0.624
〃 〃	2 @ 120 × 76 × 3830 =	0.070	
〃 〃	1 @ 120 × 116 × 3590 =	0.050	
〃 〃	2 @ 120 × 106 × 3590 =	0.091	
〃 〃	2 @ 120 × 76 × 3590 =	0.065	
End piece	2 @ 191 × 191 × 3900 =	0.285	
Coping	2 @ 150 × 127 × 3440 =	0.131	
〃	2 @ 〃 × 4280 =	0.163	0.431
〃	2 @ 〃 × 3590 =	0.137	
		1.340 cub m.	

Bolts (Washer included)

25 bolts	16φ × 145 @ 0.558 =	13.9
50 〃	16φ × 135 @ 0.542 =	27.1
40 〃	16φ × 105 @ 0.495 =	19.8
6 〃	16φ × 210 @ 0.661 =	4.0
28 〃	16φ × 295 @ 0.795 =	22.3
16 〃	16φ × 360 @ 0.785 =	12.6
		99.7 kgs

釘 (五寸釘) 540 本
= 12.7 kgs

Materials of counterweight

Concrete 1 : 2 : 4 mixture

	1.300 × .150 × 3.900 =	0.761
	1.300 × 1.210 × 4.700 =	7.393
	½ @ (1300 + 620) × 340 × 4700 =	1.534
less	2 @ .200 × .090 × .525 =	- .019
		9.669 cub m

Volume of structural steel to be reduced from Counterweight concrete.

Columns	4 ⌶ 250 × 90 × 9	@ 44.07 cm² ×	1,550 =	273 cm³
〃 top	4 〃 200 × 70 × 7	@ 26.92 ×	1,250 =	135
〃 〃	2 Pls 315 × 12	@ 37.80 ×	703 =	53
〃 〃	4 〃 190 × 9	@ 17.10 ×	255 =	17
〃 〃	4 〃 445 × 9	@ 40.05 ×	421 =	67
〃	4 〃 310 × 9	@ 27.90 ×	390 =	44
〃	8 bars 60 × 9	@ 5.40 ×	553 =	24
〃	4 Pls 295 × 9	@ 26.55 ×	1,035 =	110
top strut	2 ∟s 125 × 75 × 9	@ 17.19 ×	3,890 =	134
〃 〃	1 Pl 310 × 9	@ 27.90 ×	510 =	14
〃 〃	12 bars 60 × 9	@ 5.40 ×	688 =	45
〃 〃	4 Pls 370 × 9	@ 33.30 ×	436 =	58
〃 〃	2 〃 190 × 9	@ 17.10 ×	207 =	7

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

CALCULATIONS FOR

MADE BY M. Jinda DATE 9-7-9 FILE NO
CHECKED BY DATE PAGE NO M10

Materials of Enoura-Bashi for Mie-Ken

Sway bracing	4 Ls 125×75×9 c	1719 × 2045 =	141	1.002
〃 〃	6 Pls 130 × 9 c	1170 × 240 =	17	
〃 〃	2 Ls 75×75×9 c	1269 × 1165 =	30	
〃 〃	2 Pls 580 × 9 c	5220 × 840 =	88	
Bottom strut	4 Ls 125×75×9 c	1719 × 3890 =	267	
〃 〃	16 bars 60 × 9 c	540 × 328 =	28	
〃 〃	4 Pls 310 × 9 c	2790 × 510 =	57	
〃 〃	8 bars 60 × 9 c	540 × 652 =	28	
〃 〃	2 Pls 370 × 9 c	3330 × 510 =	34	
〃 〃	8 bars 60 × 9 c	540 × 673 =	29	
Rivet heads	1,350 @ 0.0476 ÷	0.00785 × 0.01 =	82	
Reinforcements	158 ÷	〃 × 〃 =	201	
			1983 ÷	10,000 = 0.198 m^3
	Total Volume of Concrete			9.471 m^3

Forms

sides	2 c	1.300 × 1.260	=	3.28
〃		(620 + 1.300) × .340	=	.65
less	2 c	.200 × .575	=	.71
front & rear	2 c	.050 × 3.900	=	.39
〃	2 c	1.210 × 4.700	=	11.37
〃	2 c	.481 × 4.700	=	4.52
bottom		.370 × 4.700	=	1.74
less	2 c	.270 × .370	= −	.20
block		1.300 × 3.900	=	5.07
〃	2 c	.100 × 3.900	=	.78
〃	14 c	.100 × 1.300	=	1.82
				29.63 sq.m

Reinforcements, plain bars (see drawing) 0.158 kg ton

CALCULATIONS FOR

Materials of Enoura Bascule Bridge for Mie-ken

Materials of Timber Fenders.
Fender for Bascule Pier.
Timbers 内地松又ハ杉 押角材

Horizontal members	1 - 15cm × 10cm × 650cm =	0.098
〃	1 - 18 × 18 × 650 =	0.211
〃	1 - 18 × 12 × 650 =	0.140
〃	8 - 18 × 18 × 150 =	0.389
〃	8 - 12 (18) × 12 × 150 =	0.259
Vertical members	5 - 18 × 10 × 80 =	0.072
〃	6 - 18 × 10 × 318 =	0.343
		1.512 cub. m.

Bolts galvanized.

Top row.	11 - 22mmφ × 28cm @ 1.60 =	17.60
other rows	35 - 〃 × 58 @ 2.50 =	87.50
		105.1 kg.

Springs made of spring steel, galvanized. 35 required for this fender.

Fender for Front pier
Timbers 内地松又ハ杉 押角材.

Horizontal members.	6 - 18 × 17.4 × 460 =	0.864
vertical 〃	7 - 18 × 12 × 330 =	0.499
		1.363 cub. m.

Bolts galvanized	30 - 22mmφ × 78cm @ 3.10 =	93.00
〃	12 - 〃 × 28 @ 1.60 =	19.20
		112.20 kg.

Springs made of spring steel, galvanized. 35 required for this fender.

JIUN MASUDA
CONSULTING ENGINEER
BLDG, TOKYO
SHOWA

MADE BY K. Inaba DATE 9-12-17 FILE NO
CHECKED BY M.J. DATE 9-12-21 PAGE NO M12

CALCULATIONS FOR

Materials of Gonoura Bascule Bridge for Mie-ken.

Materials required for Bascule Pier.
Deck over Pier.
Concrete 1:2.5:5 mixture.

Slab.	3.60 × 4.23 × 0.15	=	2.284
Cross beam stems	0.288 × 3.24 × 0.27 × 2	=	0.504
			2.788 cub. m.

Reinforcements. Plain round bars. see Drawing no. 9. 0.191 kg ton.

Forms. 松板正三粍厚

bottom of slab	4.29 × 3.24	=	13.90
rear end face	0.17 × 3.60	=	0.61
			14.51 sq. m.

Granolithic pavement 50 mm thick
3.60 × 4.23 = 15.23 sq. m.

Shafts and Machinery Room.
Concrete 1:2.5:5 mixture.

Column footings	2.20 × 3.70 × 1.20 × 2	=	19.536
Column under slab	1.78 × 2.10 × 3.03 × 2	=	22.652
〃	0.23 × 0.90 × 3.03 × 2	=	1.254
rear walls.	0.50 × 1.10 × 3.03 × 2	=	3.333
〃	0.30 × 1.10 × 3.03	=	1.000
〃	0.50 × 1.00 × 1.55 × 2	=	1.550
〃	0.30 × 1.00 × 1.55	=	0.465
machinery slab	4.50 × 4.24 × 0.15	=	2.862
Cantilever slab.	2.20 × 3.18 × 0.15	=	1.049
〃	1.10 × 1.90 × 0.15	=	0.314
〃 beams	0.30 × 0.53 × 1.80 × 2	=	0.572
end 〃	0.30 × 0.40 × 1.80	=	0.216
rear 〃	0.30 × 0.65 × 0.98	=	0.191
longitudinal 〃	0.30 × 0.40 × 1.60	=	0.192
〃	0.30 × 0.40 × 1.10	=	0.132
〃 fillets	0.30 × 0.15 × 0.15 × 2	=	0.014
transverse beams	0.50 × 0.65 × 3.24 × 3	=	3.159
〃 〃 flange fillets	0.20 × 0.20 × 3.24 × 2	=	0.259
〃 〃 〃 〃 端	0.30 × 0.20 × 6.80	=	0.408
〃 〃 end fillets	0.50 × 0.40 × 0.50 × 2	=	0.200
〃 〃 〃 〃	0.25 × 0.40 × 0.50	=	0.050
slab fillets	0.20 × 0.20 × 1.60	=	0.064
Colum above slab.	1.09 × 2.40 × 2.35 × 2	=	12.295
〃 〃 〃 coping	1.19 × 2.60 × 0.35 × 2	=	2.166
portion under girders	0.32 × 0.91 × 1.70 × 2	=	0.990
Side walls.	0.30 × 2.15 × 1.80 × 2	=	2.322
Column	0.37 × 2.15 × 1.15 × 2	=	1.830
〃	0.23 × 2.15 × 0.90 × 2	=	0.890
Side walls front part	0.37 × 2.20 × 1.25 × 2	=	2.035
〃	0.30 × 0.32 × 1.61 × 2	=	0.309
〃 Copings	0.12 × 0.32 × 2.00 × 2	=	0.154
〃 〃	0.19 × 0.58 × 2.15 × 2	=	0.474
Hollows less (ピニオン穴)	0.95 × 0.85 × 0.67 × 2	= (−)	1.082
〃 〃 (窓)	0.65 × 0.65 × 0.30 × 1	= (−)	0.127
〃 〃 (出入口)	1.55 × 0.90 × 0.30 × 1	= (−)	0.419
	1.28 × 2.40 × 0.15 × 2	=	0.922 上下柱間スラブの厚に相当する部分

Materials of Genoura Bascule Bridge for Mie-Ken.

Front wall	3.24 × 1.61 × 0.30	=	1.565
〃	3.24 × 0.55 × 0.20	=	0.356
Hollows less (窓)	0.65 × 0.65 × 0.30 × 2	= (−)	0.254
Rear wall	0.30 × 3.84 × 2.09	=	2.408
〃 brackets	0.40 × 0.35 × 1.18 × 3	=	0.496
〃 〃 top	0.50 × 0.50 × 0.50	=	0.125
〃 〃 〃	0.45 × 0.50 × 0.50 × 2	=	0.225
Bearing blocks (sides)	0.80 × 0.63 × 0.95 × 2	=	0.958
〃 〃	0.80 × 0.40 × 0.30 × 2	=	0.192
〃 〃 (center)	1.75 × 0.45 × 0.54	=	0.425
〃 〃 〃	0.60 × 0.94 × 0.64	=	0.361
〃 〃 〃	0.20 (2.6) × 0.78 × 0.64	=	0.130
〃 〃 〃	0.60 × 0.70 × 0.64	=	0.269
			89.487 cub. m.

Reinforcements, Plain round bars, see drawing sheet no. 9. 4.870 kg tons.

Forms. 松杉製厚正三積11.

Shaft below beam	8.22 × 2.38	× 2	=	39.13
rear walls 〃 〃	1.10 × 2.38	× 6	=	15.71
〃 〃	1.00 × 0.90	× 6	=	5.40
〃 〃	1.30 × 0.41	× 1	=	0.53
shaft below slab (内)	1.33 × 0.65	× 2	=	1.73
〃 〃	1.60 × 0.65	× 2	=	2.08
〃 (外)	2.10 × 0.80	× 2	=	3.36
〃 〃	2.10 × 0.80	× 2	=	3.36
machinery floor.	4.50 × 3.24		=	14.58
column less	.23 × .90	× 2	= (−)	0.41
cantilever floor.	2.20 × 3.18		=	7.00
〃	1.10 × 1.90		=	2.09
wall less	0.30 × 1.80		= (−)	0.54
Side of beams. 端	1.65 × 2.84		=	4.69
〃 中	1.46 × 2.61		=	3.81
〃 〃	1.53 × 2.84		=	4.35
haunch add.	0.50 × 0.17	× 5 say	=	0.43
Side of beam	0.80 × 2.70		=	2.16
〃	0.80 × 1.80		=	1.44
〃	1.05 × 1.50	× 2	=	3.15
〃	1.30 × 0.98		=	1.27
fillets add.	0.30 × 0.06	× 4	=	0.07
Side of canti. slab	0.15 × 8.58		=	1.29
Side walls. 内	4.36 × 2.48	× 2	=	21.63
〃 〃	0.22 × 2.20	× 2	=	0.97
〃 外	2.87 × 2.48	× 2	=	14.24
〃 〃	1.70 × 2.70	× 2	=	9.18
Column.	8.82 × 2.35	× 2	=	41.45
〃 端下	0.92 × 1.78	× 2	=	3.28
〃 copings	7.58 × 0.35	× 2	=	5.31
rear brackets 側	.35 × 1.18	× 6	=	2.48
〃 〃	.50 × .50	× 6	=	1.50
〃 下	.50 × .50	× 3	=	0.75
Side bearing blocks	1.65 × 0.80	× 2	=	2.64
Center 〃 〃	7.48 × 0.60 say		=	4.49
				224.60 sq. m.

④

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

CALCULATIONS FOR

MADE BY K. Inaba DATE 9-12-18 FILE NO
CHECKED BY M. J DATE 9-12-22 PAGE NO M14

Materials of Enoura Bascule Bridge for Mie-Ken.

Well for Bascule Pier 2-required.

Cross sections

Top section.

gross area	2.50 × 4.00	=	10.00
hollow area	2.20 × 3.70 = 8.14		
fillet, less.	2@ 0.20 × 0.20 = - 0.08		
			8.06
	net area	=	1.94 sq. m.

Intermediate section.

gross area	2.50 × 4.00	=	10.00
hollow area	2@ 1.90 × 1.55 = 5.89		
fillet, less	4@ 0.20 × 0.20 = -0.16		
			5.73
			4.27 sq. m

Bottom section.

gross area	2.50 × 4.00	=	10.00
hollow "	2.05 × 3.55	=	7.28
			2.72 sq. m

Cutting edge

gross area		10.00
hollow "		10.00
		0.00 sq. m.

Concrete

Shell concrete 1:2.5:5 mixture.

Top 1.2 m	1.94 × 1.20	=	2.328	
intermediate 8.5 m	4.27 × 8.50	=	36.295	
bottom 0.15 m	2.72 × 0.15	=	0.408	
cutting edge 0.15 m	0.00 × 0.15	=	0.000	
				39.031 cub. m.

Bottom filling 1:2:4 mixture.

upper 3.0 m	5.73 × 3.00	=	17.190	
lower 0.15 m	7.28 × 0.15	=	1.092	
bottom 0.15 m	10.00 × 0.15	=	1.500	
				19.782 cub. m

Top filling 1:4:8 mixture.
5.73 × 0.50 = 2.865 cub. m.

Sand filling
5.73 × 5.00 = 28.650 cub. m

Reinforcements, Plain round bars.
See Drawing sheet no. 9 — 2.265 kg tons.

Curb shoe. Structural steel
See drawing sheet no. 9 — 0.889 kg ton.

JIUN MASUDA
CONSULTING ENGINEER
~~JIJI~~ BLDG, TOKYO
SHOWA

MADE BY K. Inaba DATE 9-12-18 FILE NO ____
CHECKED BY M. J DATE 9-12-22 PAGE NO M15

CALCULATIONS FOR

Materials of Enoura Bascule Bridge for Mie-ken.

Forms of well. 杉板厚五三種製.

Outside	13.00′	× 9.60′	=	124.80′
Inside. top.	11.80′	× 1.20′	=	14.16′
int. portion	2@ 6.90′	× 8.50′	=	117.30′
bottom "	11.20′	× 0.21′	=	2.35′
				258.61 sq. meters

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

MADE BY ____ DATE ____ **FILE NO** ____
CHECKED BY ____ DATE ____ **PAGE NO** ____

CALCULATIONS FOR

昭和九年一月

三重縣北牟婁郡長島町
長島海野線

江ノ浦橋可動橋概算設計

第一案	13.0m clear span	32,200 円	see on page 15	次 (1~15)
第二案	11.0m clear span	29,600 円	See on page 22.	(16~22)
第三案	11.00	〃	—	See on page 23.	(23~25)
第四案	11.00	〃	29,300 円	See on page 28	(26~28)
第五案	10.40	〃	25,400 円	本設計	([illegible])

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

MADE BY K. I. DATE 9-1-12 **FILE NO**
CHECKED BY ____ DATE ____ **PAGE NO** (1)

CALCULATIONS FOR
13m [illegible] span
Preliminary Design of Enoura-Bashi for Mie-Ken

Deflection of moving leaf.

Dead Load.

planking	9cm @ 8kg = 72kg × 4.0 =		288 kg
nailing pieces	5 @ 12	=	60
stringers	3 @ 40	=	120
main beams	2 @ 200	=	400
floor beam			70
lateral bracings			50
handrails	2 @ 50	=	100
Copings	2 @ 75	=	150
misc say			62
			1300 kg/lin meter.

For one main beam = $\frac{1300}{2}$ = 650 kg/lin m.

$\frac{1560,000,000,000}{8,400,000 \; I} = \frac{185800}{I}$

$\Delta = \frac{wl^4}{4EI} = \frac{6.5 \times 700^4}{4 \times 2,100,000 \times I} = \frac{185800}{I(cm^4)}$

650 kg/m or w = 6.5 kg/cm

Δ

7.0m 7.0m

Bending moment = ½ × 650 × 7.0² = 15,900 kgm
Shear = 650 × 7.0 = 4550 kg

~~Try web 500 × 9 = 45.0 cm² 1/8 web area = 5.63 cm²~~
~~eff. depth say 50.00 − 4. = 46 cm.~~

~~Flange stress = $\frac{15900}{0.46}$ = 34500 kg~~

~~Flange area reqd. = $\frac{34500}{1200}$ = 28.80~~
~~less 1/8 web = 5.63~~
~~23,17 cm² net,~~

~~Use 2Ls 90 × 90 × 10 = 34.00 − 4 × 2.2 = 25.2 cm² net.~~

I = 2 × 125 + 68.00 × 22.94² = 36,000
$\frac{0.9 \times 50^3}{12}$ = 9,400
45,400 cm⁴

Δ = $\frac{185800}{45400}$ = 4.10 cm

Try web 600 × 9 = 54.00 cm² 1/8 web area = 6.75 cm²
eff. depth say = 60.00 − 5.12 = 54,88 cm

Flange stress = $\frac{15900}{.5488}$ = 29,000 kg

Flange area reqd. = 29000 ÷ 1200 = 24.15
− 6.75
17.40 cm² net

Use 2Ls 90 × 90 × 10 = 34.00 − 8.8 = 25.20 cm² net.

weight of beam
4Ls @ 13.3 = 53.2
1 web @ 42.4
95.6
details 30% = 28.7
124.3
call it 125 kg/lin m.

2.12
27.94
61.

2Ls	2 × 125 + 68.00 × 27.94² =	53300
1 web	$\frac{0.9 \times 60^3}{12}$ =	16200
		I = 69,500 cm⁴

Deflection at front end Δ = $\frac{185800}{69500}$ = 2.68 cm

増田淳氏関係資料（独立行政法人 土木研究所蔵）

JIUN MASUDA
CONSULTING ENGINEER
~~IIII~~ SHOWA BLDG, TOKYO

MADE BY ________ DATE ________ **FILE NO** ________

CHECKED BY ________ DATE ________ **PAGE NO** ②

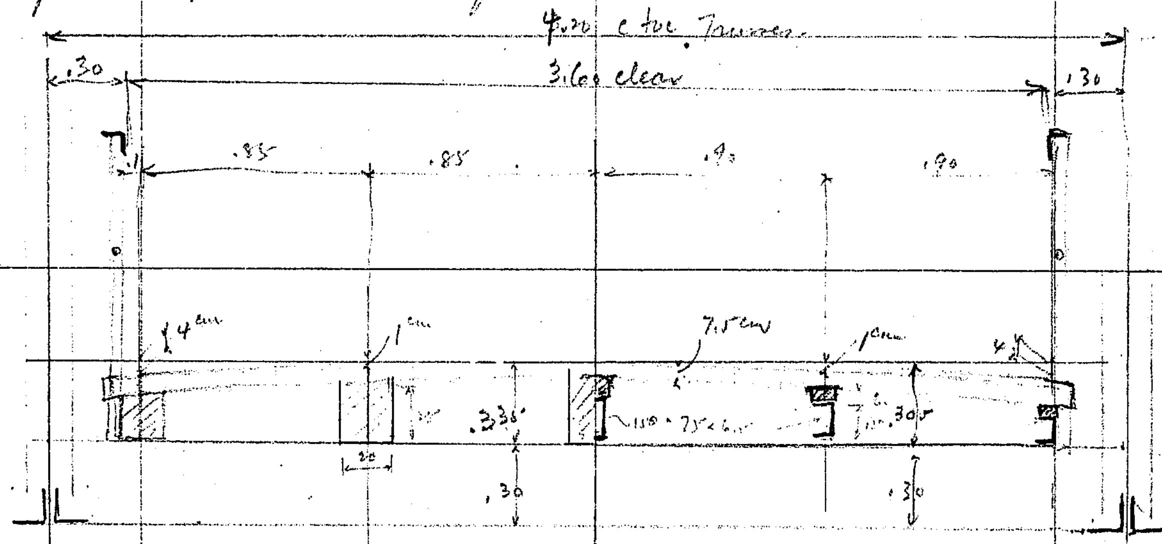
CALCULATIONS FOR

エノ浦橋

Preliminary Design of Enoura-Bashi for Mie-ken.

Effective width of roadway = 3.60 meters
Bascule span 13.0 meter clear.

Cross section of Bridge assumed as follows:



Planking Span length 0.90 meter
Dead Load 9cm planking @ 8 kg = 72 kg/m2

D.L. m = 1/10 × 72 × 0.9² = 6 kgm
Shear = 1/2 × 72 × 0.9 = 32 kg.

Live Load. 4 ton motor truck rear wheel = 1500
30% imp. = 450
1950 kg.

Eff. width 有効 = 2/3 l + a = 2/3 × 0.9 + 0.2 = 0.80 m

Load/m strip = 1950/.8 = 2440 kg

L.L. m = (2440 × 0.9)/4 = 549

549 × 8/10 = 440 kgm.

Shear = 2440 kg.

Summary of m & V

	m.	V
D.L.	6	32
L.L.	440	2440
	446 kgm	2472 kg.

S m req'd. = (446 × 100)/60 = 743 cm³

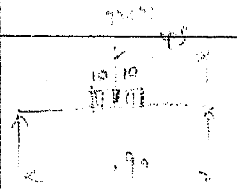
d² = (743 × 6)/100 = 44.6

d = √44.6 = 6.7 cm
.8

Use 7.5 cm

Shear stress = 2472/(100 × 7.5) = 3.3 kg/cm² × 1.5 = 5 < 25

1950/6 = 3250



731
−81
650

650 × 8/10 = 520
5
525

(525 × 100)/70 = 750
808

(525 × 150)/60 = 875

(100 × 7.5²)/6 = 937

Stringer 比較	木材		鉄材	
	.12 × .35 × 2.0 = 0.10 @ 45 =	4.50	20kg × 2.0 = 40kg @ .22 =	8.80
	防腐剤注入	2.50	加工 .10 × .06 × 2.0 = .012 @ 45 =	.54
	仕掛取付大2割	1.00	防腐剤	0.45
	ボールト 4本 @ 0.20 =	0.80	大2割	.21
		9.80 円		10.00 円

150
3.96
153.96

1.98 × 2 =

154

1.3

JIUN MASUDA
CONSULTING ENGINEER
~~[illegible]~~ BLDG, TOKYO
SHOWA

CALCULATIONS FOR

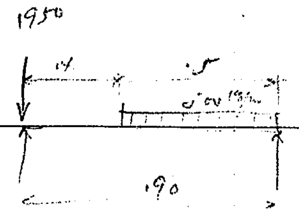
MADE BY K I DATE 9-1-15 FILE NO
CHECKED BY DATE PAGE NO 9

Preliminary Design of Enoura-Bashi for Mie-Ken

Stringers. Span length 2.00 meters spacing say 0.9 m
wooden stringer

Planking 0.90 @ 60 = 54
beam .125 × .2 @ 700 = 35
90 kg/m

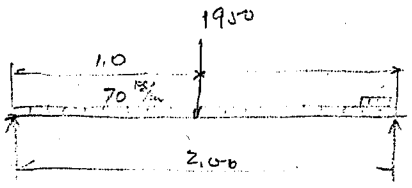
DL m = 1/10 × 90 × 2.0² = 36 kgm
S = 1/2 × 90 × 2 = 90 kg



Load on beam

(500 × .5²)/(2 × .9) = 70 kg/m w1

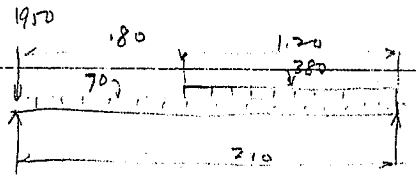
500 × .9 = 450
380 kg/m



LL m = 1/8 × 70 × 2.0² = 35
(1950 × 2.0)/4 = 975
1010 kgm

P .6 @ 60 = 36
w .125 × .09 × 600 = 6
c .125 × .09 @ ... = 7
S ... 50

shear



(380 × 1.2²)/(2 × 2.0) = 137
70 × 1.0 = 70
1950
2157 kg

Summary of moment & shear

	moment	shear
DL	36	90
LL	1010	2157
	1046 kgm	2247 kg

Sm reqd. = (1046 × 100)/60 = 1745 cm³

~~20 × 25 cm~~
~~(20 × 25²)/6 = 2083 cm³~~

use 18 × 25 cm
Sm = (18 × 25²)/6 = 1875 cm³
shear = 2247/(18 × 25) × 3/2 = 7.5 kg/cm²

864.3
85.8
778.5 / 7.5 = 103.8

for steel stringer say.

Sm reqd = (1046 × 100)/1100 = 95.2 cm³

use I 150 × 75 × 6.5 @ 18.6 kg Sm = 115.2 cm³

864.3
93
771.3 / 7.5 = 102.8

Floor beam span length 3.20 m spacing 2.0 m
DL

Planking 54 × 2 = 108
Stringers 35 × 5 × 2.0 ÷ 4.2 = 83
Floor beam 50
9
250 kg/lin m.

106
1.9 × 7² = 93

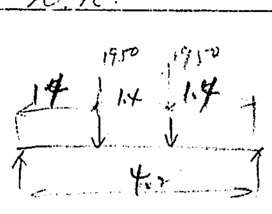
DL m = 1/8 × 250 × 4.2² = 552 kgm
shear = 1/2 × 250 × 4.2 = 525 kg

2.2 × 7.0² = 108
864.3
756.3

756.3 / 7.5 = 101.

LL

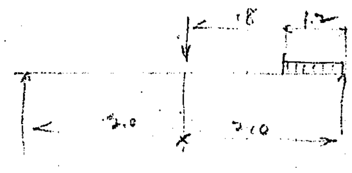
DL m 41
40
1044
1125 kgm × 100 / 1100 = 102.3



wheel load. m = 1950 × 1.4 = 2730 kgm

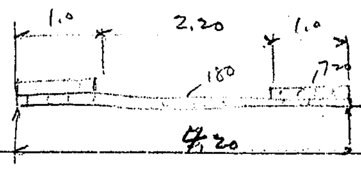
S = 1950 × 2.1
1950 × 3.5 } = 10920/4.2 = 2600 kg.

Preliminary Design of Enoura-Bashi for ...-Ken



Unif. load
500 × 2.0 = 1000
$\frac{500\times0.6\times1.2}{2.0}$ = 180
720

m
720 × 0.5 = 360
1/8 × 180 × 4.2² = 396
756 kgm.



Shear
1950 × $\frac{3.5}{5.6}$ / 4.2 = 2600
$\frac{720\times1.4\times1.0}{4.2}$ = 240
180 × 2.1 = 380 } 620
3220 kg.

Summary

	m	V
DL	552	525
LL	2730	2600
	756	620
	4038 kgm	3745 kg.

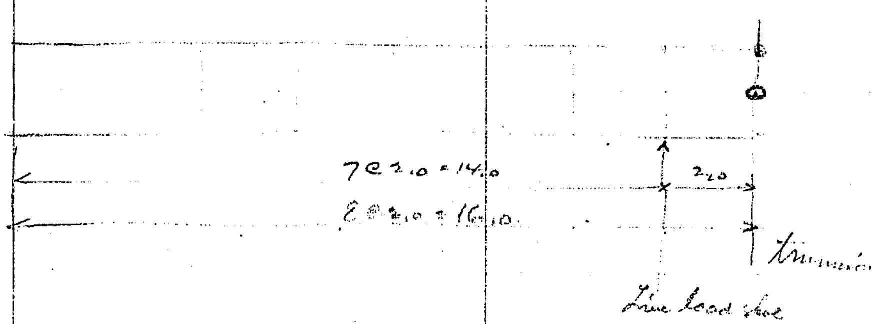
Sm reqd. = $\frac{403800}{1100}$ = 367 cm³
use I 300 × 150 × 8 @ 48.3 kg Sm = 633.2
Shear = $\frac{3745}{0.8\times30}$ = 156 kg/cm².

Design of main girders.

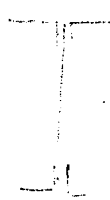
Dead Load.

Floor planking	3.8 @ 60 kg =	228
... stringers	5 @ 32 =	160
floor beams	$50\times\frac{42}{2.0}$ =	105
lateral		50
main beams say	2 @ 350 =	700
Handrails	2 @ 50 =	100
misc say		57
		1400 kg/m

700 for 1 girder.
Impact 140
840



Dead Load m = 1/8 × 840 × 16.0² = 107500 kgm
Shear V = 840 × 16 = 13,450 kg



Ig web 1500 × 9 = 135 1/8 web = 16.9

Flange stress = $\frac{107500}{1.40}$ = 7700

Flg. area = $\frac{7700}{1200}$ = 64.
17
47 cm² net

use 2L 150 × 150 × 12 = 69.12 − 12 = 57.12 net

368

Joint 2L 150 × 100 × 9

.12 × 1 @ ...

$\frac{90}{15}$ = 6 .012 / 6 / .072 / .928 × 12 ... 5% = 202 / 130 / 830 4 ...

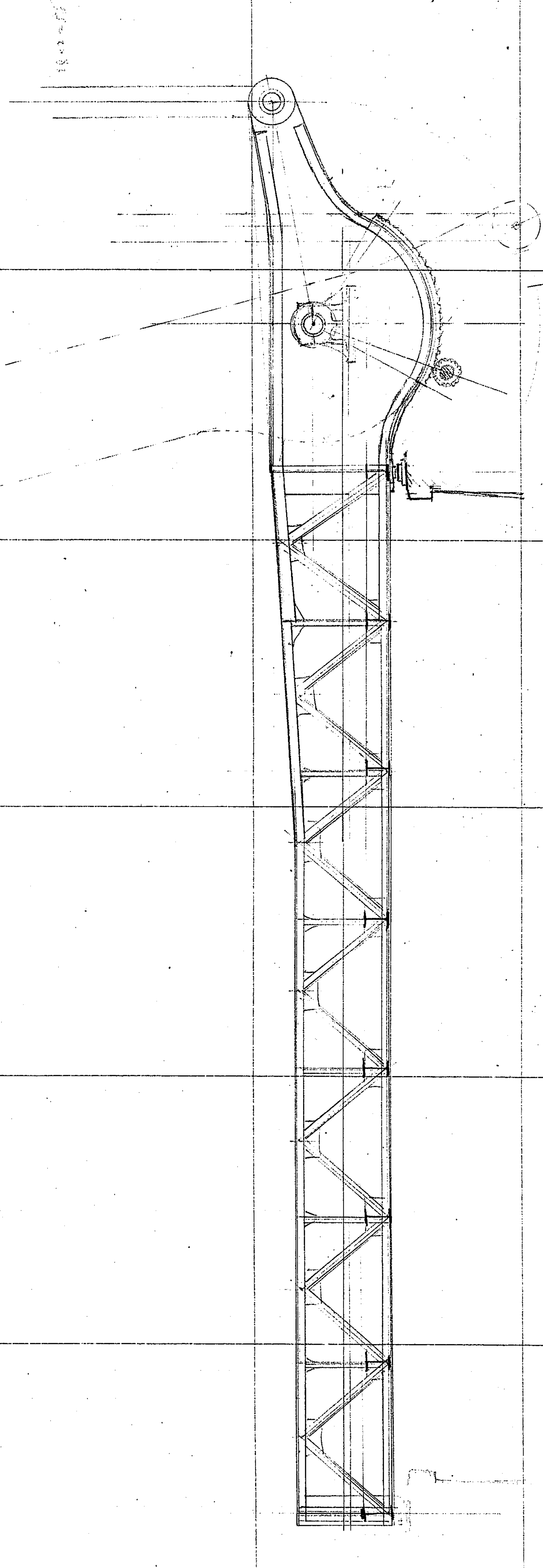
JIUN MASUDA
CONSULTING ENGINEER
~~IIII~~ SHOWA BLDG, TOKYO

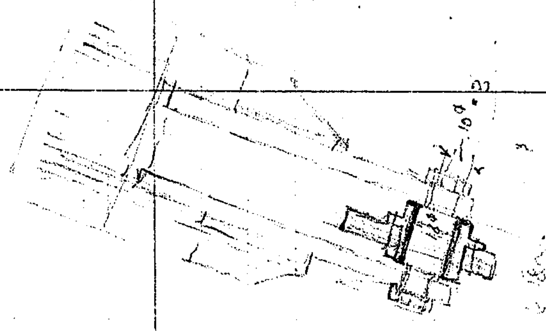
MADE BY________ DATE________ **FILE NO**________

CHECKED BY________ DATE________ **PAGE NO** 5

CALCULATIONS FOR

三重 (?) ノ(12)ノ浦橋 (?)





三重 12八崎 ハ橋

Counterweight tower
Counterweight

river arm $\frac{700 \times 16.2^2}{2 \times 3.0} = 30600$

rear arm $\frac{400 \times 3.0^2}{2 \times 3.0} = -600$

30,000 kg for one truss

cwt. col. 7×100 = 700
1.5×100 = 150
850×2 = 1700
frame 8U 15×100
80/200 × 4.5 = 900
1400
Steel 4000 kg

Counterweight required 2 @ 30000 = 60000 kg.
Structural steel parts say 4000
Cwt. conc = 56,000 kg

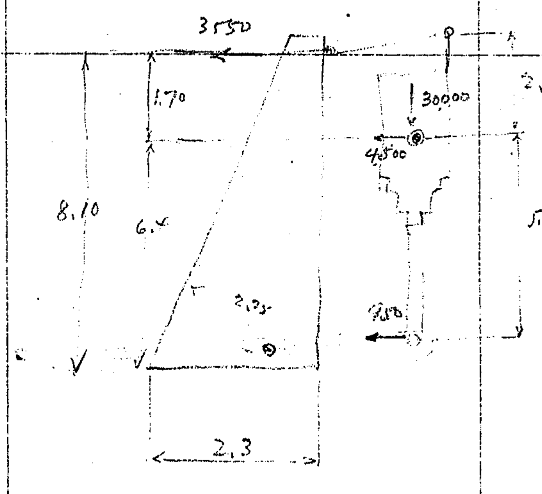
Dimension of cwt. .. unit weight say 2200 kg./cub.m.

volume $= \frac{56000}{2200} = 25.46$ cub.m

cross section $= \frac{25.46}{5.00} = 5.10$ sq. m

1.50 × 3.40 × 5.0

wind press on cwt. 3.7 × 2.5 × 150 = 1400 kg



Bridge closed.

wind pressure 30% or 150 kg/m² 3.7 × 2.5 × 150 = 1400 kg for one tower col.
deceleration 5% 0.05 × 30000 = 1500 " "
Seismic thrust k=0.15 0.15 × 30000 = 4500 " "

Seismic thrust on top of tower column

$\frac{4500 \times 5.6}{7.6} = 3550$ kg for one col.

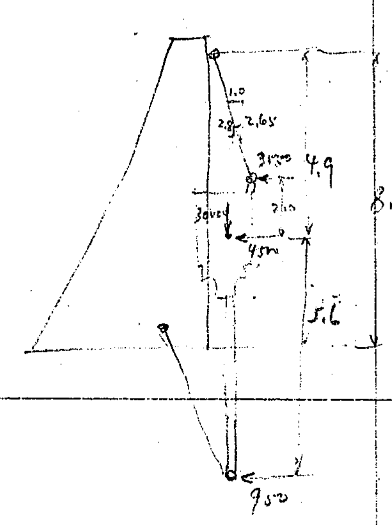
on cwt trunnion $\frac{4500 \times 2.0}{7.6} = 950$ kg for one truss.

Stress in vert. col.
$= \frac{3550 \times 8.1}{2.3} = 12500$ kg T or C

Stress in stay $= \frac{3550 \times 8.1}{2.25} = 12800$ kg T or C

Cwt link say 3500 " T or C

moment on cwt. col. = 950 × 4.0 = 3800 kgm
vert. load on " = 30,000 kg C



Bridge opened
Seismic thrust on top of tower col.
$4500 \times \frac{5.6}{7.6} = 3550$ kg
on cwt trunnion 950 kg.

Stress in vert. col. 12500
3550 × 2.65 = 9400
21,900 kg T or C ○

Stay 12800 kg T or C ○
Cwt link 3550 × 2.85 = 10100 " " ○

Cwt. col M = 3800 kgm, V = 30000 kg C ○.

crosswise earthquake
moment on vert. col. = 3550 × 5.52 = 19600 kgm for one col.
vert. load. $\frac{3550 \times 8.1}{6.2} = 4600$ kg T or C

JIUN MASUDA
CONSULTING ENGINEER
BLDG, TOKYO

CALCULATIONS FOR

MADE BY K. I. DATE 9-1-18 FILE NO
CHECKED BY DATE PAGE NO 7

Enoura-bashi for Mie-ken

Sections of Tower column.

vertical member (縦) $S_{s} = \frac{21900}{1200} = 18.3$ cm² net ÷ 1.6 = 11.4 net or 22 cm² gr.

横. Sm. reqd. = $\frac{19600 \times 100}{1100} = 1780$ cm³

2∟ 150×150×11 = 64.00 × 26.5² + 633×2 = 46200
1 web 600×9 = 54.00 0.9×60³/12 = 16 ...
118.00 gr I = 62400

$Sm = \frac{62400}{30.5} = 2045$ cm³

横 stren $\frac{19600 \times 100}{2045} = 958$
4600 ÷ 118 = 26
984 kg/cm² C

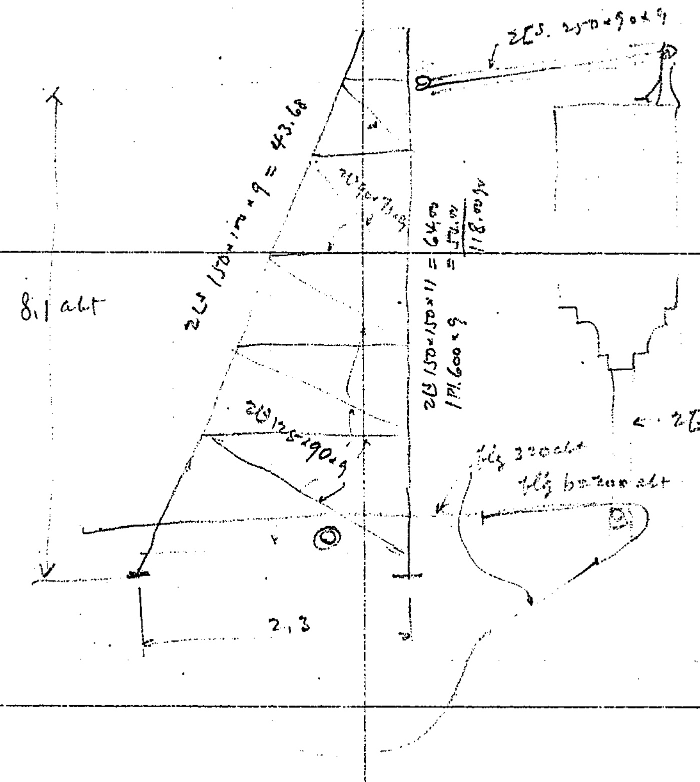
958
4600 ÷ 118/1.2 = 32
990 " T

Stay 2∟ 150×100×9 = 43.68 cm² gr
9
34.68 net

Cut. link 2[250×90×9 = 88.14 gr

Cut col. 2[300×90×9 = 97.14 cm² gr Sm = 429×2 = 858 cm³

Stren = $\frac{3800 \times 100}{858}$ = 443 T or C
30000 ÷ 97.14 = 309 C
752 kg/cm² C
or 134 " T



増田淳氏関係資料
(独立行政法人 土木研究所蔵)

Encuma-Bashi for Mie-ken

Estimate of HP required
Load on main trunnion shafts.
River arm 700 × 16.2 = 11,350
Rear " 400 × 3.0 = 1200
Cwt. 30000
42550 × 2 = 85,100 kg for 2 trunnions.

Load on Cwt trunnion 30,000 × 2 = 60000 " " " "

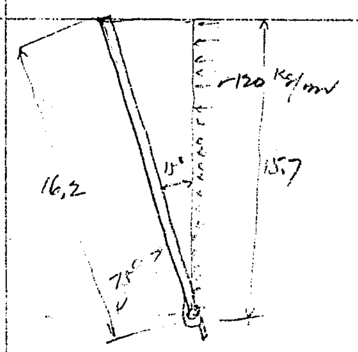
Moment due to frictional resistance

$M_F = \frac{PfD}{200} = \frac{0.150\,PD}{200} = 0.00075\,PD$ kgm

main trunnion 15 cm φ assumed. 0.00075 × 85,100 × 15 = 960
Cwt " 18 " " 0.00075 × 60000 × 18 = 810
M_F = 1770 kgm

Wind load. 25 kg/m² (or 5 #/□') during operation.

16.2 m cos 15° = 16.2 × 0.966 = 15.7 m
width of bridge = 4.70 m
wind load on river arm. = 4.70 @ 25 = 118 kg call this 120 kg/m
wind moment about trunnion



$M_w = \frac{120 \times 15.7^2}{2} = 14,800$ kgm

Total moment
Frictional moment M_F = 1,770
Wind " M_w = 14,800
Inertia and eccentricity say = 3430
20,000 kgm

① 1 HP = 4560 kgm/min or 76 kgm/sec.
Time of operation
20
260
20
300 sec = 5 min assumed

20/2 = 10
260
10
280

Theoritical HP req'd. = $\frac{20000}{280 \times 76}$ = 0.94 actual HP. = $\frac{0.94}{0.5}$ = 1.88 HP

25 kg wind (5 #)

② For time of operation
20 + 140 + 20 = 180 sec = 3 min
10 + 140 + 10 = 160

Theoritical HP. = $\frac{20000}{160 \times 76}$ = 1.65 actual HP = $\frac{1.65}{0.5}$ = 3.3 HP.

③ Time of operation
20 + 100 + 20 = 140 or 2 min 20 sec
10 + 100 + 10 = 120

Theoritical HP = $\frac{20000}{120 \times 76}$ = 2.20 Actual HP = $\frac{2.20}{0.5}$ = 4.40 HP.

50 kg wind (10 #) ④
10 #/□' or 50 kg/m² wind +I.L. M = 34800 kgm
Time of operation (3 min 30 sec) 210 − 20 = 190 sec.
Theoritical HP = $\frac{34800}{190 \times 76}$ = 2.41 HP ~~actual~~ HP = $\frac{2.41}{0.50}$ = 4.82 HP.

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

CALCULATIONS FOR

MADE BY K. J. DATE 9-1-20 FILE NO
CHECKED BY DATE PAGE NO 9

Encoura-hashi for mia-ku

Time of operation assumed 3'-30" or 210 sec. unif speed 190 sec.
Rack radius = 180 cm assumed.

Total distance travelled $= \frac{\pi \times 180^{cm} \times 75^\circ}{180} = 236$ cm

unif. speed $= \frac{236}{190} = 1.24$ cm/sec

rack force $= \frac{2.5^{HP} \times 76 \times 100}{1.24} = 15{,}350$ kg

$15350 \div 2 = \underline{7680}$ kg for one rack. max.

no. of rev. of rack $= \frac{75^\circ}{360^\circ} \times \frac{60^{sec}}{190^{sec}} = 0{,}066$ /min

no. of rev. of motor shaft assumed 1100

Total gear ratio $= \frac{1100}{0.066} = 16700$

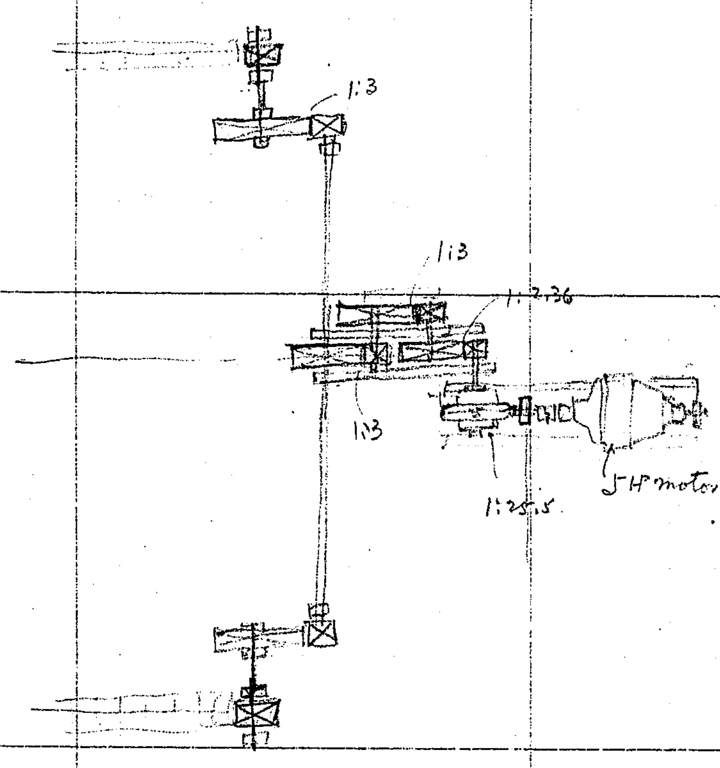
gear ratio

		16,700
worm gear	1/25.5	653
spur gear	$(1/3.0)^3 = 1/27$	24.3
"	1/2.36	10.3
rack + pinion $\frac{360}{35}$ =	1/10.3	1.00

$$\frac{1}{25.5} \times \left(\frac{1}{3}\right)^3 \times \frac{1}{2.36} \times \frac{1}{10.3} = \frac{1}{16700}$$

Efficiency (rack + pinion: friction ~ 含まれている ~ ~)

$$\eta = \underset{\text{worm}}{0.67} \times \underset{\text{spur}}{(0.93)^4} \times \underset{\text{rack+pinion}}{\cancel{0.93}} = \underline{0.501}$$



Rack force $\frac{20000}{1.80} = 11{,}100$ kg

unif. speed of rack circle $t = 2'-20"$

$= \frac{\pi \times 3.60 \times 80}{360 \times 2'} = 1.258$ m/min

work done for one operation

$= 11{,}100 \times 1.258 = 13950$ kgm/min

Theoretical HP. reqd $= \frac{13950}{4560} = \underline{3.06}$

actual HP reqd $= \frac{3.06}{0.5} = \underline{6.12\ HP}$

JIUN MASUDA
CONSULTING ENGINEER
~~[illegible]~~ BLDG, TOKYO
SHOWA

MADE BY K. I. DATE 9-1-23 FILE NO.

CHECKED BY DATE PAGE NO 10

CALCULATIONS FOR

Preliminary Design of Enoura-Bashi for Mie-ken.

Approximate Estimate of Bascule Bridge proper.

Structural steel for Bascule leaf.

	Stringers	5 [150×75×6.5 @ 18.6 kg × 14.8 m	=	1375	} 3200	
	Floor beams	7 I 300×150×8 @ 48.3 × 4.4	=	1490		
	"	2 [300×90×9 @ 38.1 × 4.4	=	335		
		details + rivet heads say 6%	=		190	
						3,390
	lateral bracings say	14.5 m @ 50 kg	=			725
	handrails	14.0 × 2 @ 15 kg	=			420

Main truss.

front arm	Chords	2 L 150×100×9 @ 17.1 × 10.0×2	=	684	} 1907	
	"	2 L 150×150×12 @ 27.1 × 5.5×2	=	596		
	verticals	14 L 125×90×9 @ 14.6 × 1.3	=	266		
	diagonals	10 L 90×90×10 @ 13.3 × 1.5	=	200		
	"	5 L 130×130×9 @ 17.9 × 1.8	=	161		
		rivet heads + details say 35%	=		668	
					2575	

rear arm	Flanges top + bott.	4 L 150×150×12 @ 27.1 × 5.0	=	542	} 2674	
	" "	2 cov. pls 320×12 @ 30.14 × 5.5	=	332		
	web pls	1 pl 1200×9 @ 84.78 × 4.8	=	407		
	"	1 pl 900×9 @ 63.59 × 3.0	=	191		
	side pls trunnion	2 pls 1200×12 @ 113.04 × 2.1	=	475		
	" "	2 pls 800×12 @ 75.36 × 1.1	=	166		
	" cwt. tr.	2 pls 450×12 @ 42.39 × 1.1	=	93		
	" "	2 pls 600×12 @ 56.52 × 0.7	=	79		
	Stiffeners, vert. L	10 L 125×90×9 @ 14.6 × 2.0	=	292		
	" "	4 L " @ 14.6 × 0.8	=	47		
	" hor. L	2 L 75×75×9 @ 9.96 × 2.5	=	50		
		rivet heads + misc details say 10%	=		266	
		[illegible] detail 100% 全体=9 [illegible] 64%			2940	

Summary for one main beam = 2575 + 2940 = 5515		
for two beams. 2 @ 5515	=	11,030
shoes say 2 @ 350	=	700
expansion joint say		735
Summary of steel for bascule leaf	=	**17,000 kg**

JIUN MASUDA
CONSULTING ENGINEER
~~JIJI~~ SHOWA BLDG, TOKYO

MADE BY k. I. DATE 9-1-23 FILE NO

CHECKED BY DATE PAGE NO 11

CALCULATIONS FOR

Preliminary Estimate of Enoura-Bashi for Mie-ken

Structural steel for counterweight tower.

vertical post	2Ls 150×150×11 @ 25.1 × 8.3 =	417	
〃	1 web 600 ×9 @ 42.39 × 8.3 =	352	
inclined post	2Ls 150×100×9 @ 17.1 × 8.5 =	291	
diagonals	2Ls 125×90×9 @ 14.6 × 2.7 =	79	
〃	2Ls 〃 @ 〃 × 2.3 =	67	
〃	2Ls 〃 @ 〃 × 1.9 =	56	
〃	2Ls 〃 @ 〃 × 1.5 =	44	
horizontals	2Ls 150×100×9 @ 17.1 × 2.3 =	79	
〃	2Ls 125×90×9 @ 14.6 × 1.9 =	56	
〃	2Ls @ 〃 × 1.4 =	41	
〃	2Ls 〃 @ 〃 × 1.1 =	32	
〃	6Ls 75×75×9 @ 9.96 × 0.5 =	30	
		1544×2 =	3088
Top strut.	4Ls 150×90×9 @ 16.4 × 6.2 =	407	
〃	2pls 500×9 @ 35.33 × 6.2 =	438	
braces	2×4Ls 125×90×9 @ 14.6 × 4.0 =	467	
			1312
			4400
	Details say 50% =		2200
	shoes + bolts		400
	Summary for counterweight tower =		7000 kg

Structural steel for counterweight links.

links	4Ls 250×90×9 @ 34.6 × 3.3 =	406	
struts	2Ls 250×90×9 @ 34.6 × 4.0 =	277	
laterals	4Ls 125×90×9 @ 14.6 × 3.3 =	193	
			876
	Details say 37% =		324
			1200

Structural steel for counterweight frame.

Columns.	4Ls 300×90×9 @ 38.1 × 7.2 =	1,098	
Strut	4Ls 100×100×10 @ 14.9 × 4.4 =	262	
frame longitudl	4Ls 〃 @ 〃 × 4.6 =	274	
〃 cross	12Ls 〃 @ 〃 × 1.6 =	286	
〃 〃	2pls 300×9 @ 21.2 × 1.6 =	68	
〃 vert.	6Ls 100×100×10 @ 14.9 × 2.7 =	242	
〃 side diag	4Ls 〃 @ 〃 × 3.5 =	209	
〃 top & bott diag	4Ls 〃 @ 〃 × 2.9 =	173	
			2612
	Details say 37% =		968
			3580
	extra diaphragms + pin pls etc say		420
			4000

Structural steel for Bascule pier floor.

floor beam	2 Is 300×150×8 @ 48.3 × 3.6 =	348	
	Shoes etc say	52	
			400

388
289
677

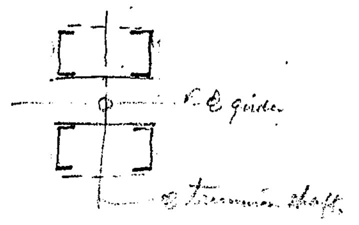
JIUN MASUDA
CONSULTING ENGINEER
~~????~~ BLDG, TOKYO
SHOWA

MADE BY K. I. DATE 9-1-23 **FILE NO**
CHECKED BY DATE **PAGE NO** 12

CALCULATIONS FOR

Preliminary Estimate of [illegible] for [illegible]

Structural steel under trunnion bearings.



4 ⌶ 250 × 90 × 9 @ 34.6 × 2.8 =	388		
2 webs 600 × 9 @ 42.39 × 2.8 =	238		
	626		
base pls, cap pls, tie pls, lacings, anchorings &c	674		
	1,300		
for two trunnions 2 @ 1300 =		2,600	

Structural steel under machinery bearings

4th gear base 2 @ 3.0 m @ 35 kg =	210	
worm gear base 2.8 m @ 40 kg =	112	
motor base 4.4 m @ 60 kg =	264	
ladder & misc bases say	214	
		800

Summary of structural steel.

Bascule leaf complete	17,000	(including handrails & exp jts)
Counterweight tower complete	7,000	
counterweight link complete	1,200	
counterweight frame "	4000	
Steel col. under main trunnion bearings	2600	
floor over bascule pier (2 floor beams only)	400	
steel under machinery bearings, ladder &c	800	
	33000 kg	

Volume of floor timbers

plankings	3.90 × 14.7 = 57.3 m² × 0.075 =	4.01 cub m
nailing pieces	5 × 0.12 × 0.08 × 14.7 =	0.71
copings	2 × 0.15 × 0.15 × 14.7 =	0.66
	misc timber	0.22
		5.60 cub m

Materials of Bascule Pier.

Fixed floor.

Concrete 1:2:4 mix	3.6 × 5.2 = 18.7 m² @ 0.15 =	2.81
	coping 2 × 0.15 × 0.25 × 5.2 =	.39
		3.20 cub m
forms say	3.6 × 5.2 =	18.7 m²
reinforcements	3.2 m³ @ 130 kg =	0.42 tons
granolithic pav.	5 cm	18.7 m²

Walls & columns.

Concrete 1:2:4 mix

front columns	2 @ 2.15 × 2.3 × 5.20 =	51.40	43.1
" " canti. arm	2 @ 1.30 × 0.7 × 1.30 =	2.37	
rear columns	2 @ 0.6 × 0.6 × 2.50 =	1.80	
front & rear walls	2 @ 0.3 × 2.3 × 3.50 =	4.83	
Side walls	2 @ 0.3 × 2.3 × 3.00 =	4.14	
machinery base 4th gear	2 @ 0.6 × 0.8 × 1.30 =	1.25	
" 1,2,3rd gear	0.8 × 0.7 × 1.50 =	0.84	
" motor & [illegible]	0.5 × 0.7 × 2.70 =	0.95	
machinery floor	4.2 × 3.2 × 0.15 =	2.02	
" "	2.6 × 3.3 × 0.15 =	1.29	
beams	1.6 × 0.6 × 3.2 =	3.07	0.82
	2 × 0.6 × 0.6 × 2.4 =	1.73	77.0 cub m
	0.25 × 0.3 × 6.5 =	0.49	

JIUN MASUDA
CONSULTING ENGINEER
~~JJJJ~~ BLDG, TOKYO
SHOWA

MADE BY K. I. DATE 9-1-20 FILE NO ______
CHECKED BY ______ DATE ______ PAGE NO 13

CALCULATIONS FOR

Preliminary Estimate of Encasa Basin for Mie-ken.

Forms

front columns	2 @ 10.0 × 5.20	=	104.0
" cantil.	2 @ 3.3 × 1.30	=	8.6
rear columns	2 @ 2.4 × 2.50	=	12.0
front + rear walls	2 @ 2.3 × 3.5 × 2	=	32.2
side walls	2 @ 2.3 × 3.0 × 2	=	27.6
machinery base	2 @ 2.0 × 0.8	=	3.2
"	0.7 × 4.5	=	3.2
"	0.35 × 6.6	=	2.3
machinery floor	4.20 × 3.20	=	13.6
"	2.6 × 3.30	=	8.6
beams	1.8 × 10	=	18.0
"	1.8 × 4.8	=	8.6
"	0.8 × 6.5	=	5.2
misc forms say			22.9
			270 sq.m.

Reinforcements

beams + slabs	26.0 m³ @ 130 kg	=	3380
front cols	51. @ 45	=	2300
			320
			6.00 tons

Front well 3.20φ – 30 cm thick × 10.0 m long. (一本分)

Concrete 1:2:4 mix

Shell	3.20φ – 2.60φ = 2.733 × 10.0 =	27.33	
top + bott. fill	2.60φ = 5.309 × 5.0 =	26.55	3.5 + 1.5 = 5.0 m
		1.62	
		55.50 cub.m.	

25.45
22.60
48.05

Concrete 1:4:8 mix fill 2.60φ = 5.309 × 0.6 = 3.2
Sand fill 5.309 × 4.4 = 23.4

Reinforcement 55.5 @ 75 = 4.2 tons
Curb shoe 1.00 ton # 4PL 500×10, 1L 150×100×12

Forms. 3.20φ = 10.05, 2.60φ = 8.17 } 18.22 × 10 = 182 m²

Rear well. 2.0φ — 25 cm thick × 10.0 m long. (一本分)

Concrete 1:2:4 mix

Shell	2.00φ – 1.5φ = 1.375 × 10.0 =	13.75
top + bottom fill	1.5φ = 1.767 × 4.0 =	7.05 (2.8 + 1.2 = 4.0 m)
		1.20
		22.0 m³

Concrete 1:4:8 fill 1.5φ = 1.767 × 0.6 = 1.1 m³
Sand fill 1.767 × 5.4 = 9.5 m³

12.18
5.30
17.48

Reinforcements 22.0 m³ @ 75 = 1.7 tons
Curb shoe = 0.6 ton

Forms 2.0φ = 6.28, 1.5φ = 4.71, 10.99 × 10 = 110. m²

JIUN MASUDA
CONSULTING ENGINEER
~~JIJI~~ SHOWA BLDG, TOKYO

CALCULATIONS FOR

MADE BY K. I DATE 9-1-23 FILE NO ____
CHECKED BY ____ DATE ____ PAGE NO 14

Preliminary Estimate of [illegible]-Bashi for [illegible]

Unit cost of Concrete

	1:2:4 mix		1:4:8 mix	
Cement	2.0 @ 4.50 =	9.00	1.0 @ 4.50 =	4.50
sand	0.5 @ 2.50 =	1.25		1.25
gravel	1.0 @ 2.50 =	2.50		2.50
labour	2.0 @ 1.00 =	2.00		2.00
		14.75 円/m³		10.25 円/m³

Cost of one well.

Front well 3.2φ × 10.0

Concrete 1:2:4	55.50 m³ @ 14.75 =	820
〃 1:4:8	3.20 〃 @ 10.25 =	33
sand fill	23.40 〃 @ 1.50 =	35
reinforcements	4.20 tons @ 115.0 =	483
curb shoe	1.00 〃 @ 220.0 =	220
forms	182.00 m² @ 1.20 =	218
well sinking 吊下ゲ設備及吊下ゲ作業	1200 × 0.30 =	360
〃 沈下費 根入 5.5 m	@ (約26円) 35.00 =	193
		38
		2,400 円

Rear well. 2.0φ × 10.0

Concrete 1:2:4	22.00 @ 14.75 =	324
〃 1:4:8	1.10 @ 10.25 =	11
Sand fill	9.50 @ 1.00 =	14
reinforcements	1.70 @ 115.0 =	196
curb shoe	0.60 @ 220.0 =	132
forms	110.0 @ 1.20 =	132
well sinking 吊下ゲ設備及吊下ゲ作業	1200 × 0.2 =	240
〃 沈下費 根入 6.0 m	@ (約29円) 15.00 =	90
		11
		1,150 円

Estimate of shaft.

Concrete 1:2:4	77.00 m³ @ 14.75 =	1135
reinforcements	6.00 tons @ 115.0 =	690
forms	270. m² @ 1.5 =	405
		2230 円

Fixed floor over [illegible]

Concrete 1:2:4	3.2 m³ @ 14.75 =	47
reinforcement	0.42 @ 115.00 =	48
forms	18.7 @ 1.50 =	28
granolithic pavement	18.7 @ 2.00 =	37
		160 円

JIUN MASUDA
CONSULTING ENGINEER
~~JIJI~~ SHOWA BLDG, TOKYO

MADE BY K. I. DATE 9-1-24 FILE NO.
CHECKED BY DATE PAGE NO. 15

CALCULATIONS FOR

Preliminary Estimate of Enoura-Bashi for Mie-Ken

Summary of cost. 13.0m clear span.

Structural steel complete	33.00 tons @ 250 =		8250	
timber deck for moving leaf	57.30 m² @ 12 =		690	
Counterweight concrete	25.5 m³ @ 14.75 = 376			
form	90.0 m² @ 1.50 = 135			
reinforcements	0.50 ton @ 115.0 = 59			
		570		
operating house		430		
			1000	
mechanical equipment say		9000		
electrical " "		2500		
			11500	
Summary for super structure			=	21,440
Bascule pier				
Fixed floor		160		
Shafts, machinery floor, walls etc		2230		
front wells 弁下ノ沼害ニ一本	2 @ 2400 =	4800		
rear wells "	2 @ 1150 =	2300		
			9490	
Front pier reinforcing		800		
Extra cost for wooden floor over nabouring spans		470		
			1,270	
				10,760
				32,200

22500

124

11. 3.7 ×4.40 150

11.7
13
73.2

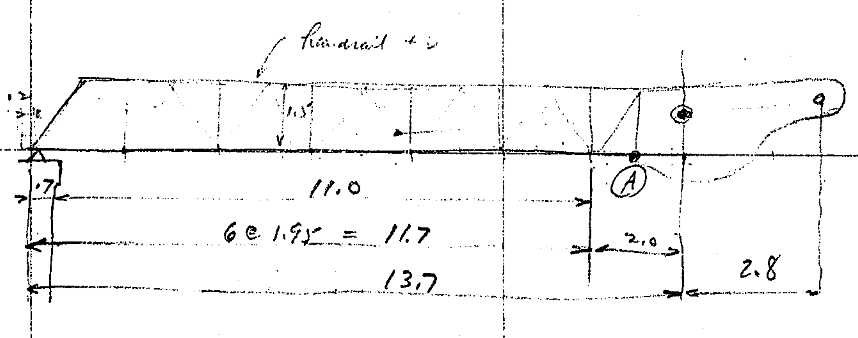
JIUN MASUDA
CONSULTING ENGINEER
~~3111~~ BLDG, TOKYO
SHOWA

MADE BY K. Inaba DATE 9-2-27 FILE NO.
CHECKED BY DATE PAGE NO. 16

CALCULATIONS FOR
11.0m clear span. 其1
Preliminary design of Enoura-bashi for Mie-ken.

Construction of bridge same as before.
Design of main girder.
Dead Load of moving leaf.

Floor planking	3.8m @ 60 kg	=	228
stringers	5 @ 20	=	100
nailing pieces	5 @ 10	=	50
floor beam	215 ÷ 2	=	108
lateral bracings say			50
handrails say	2 @ 15 kg	=	30
main truss say	2 @ 200	=	400
misc. say			34
			1000 kg/lin m.



or 500 kg per lin meter for one girder
20% impact say $\frac{100}{600}$ " for stress calculation only

Truss sections.

D.L. moment $= \frac{1}{2} \times 13.9^2 \times 600 = 58{,}000$ kgm. } at trunnion.
" shear $= 13.9 \times 600 = 8{,}340$ kg

D.L. m. $= \frac{1}{2} \times 12.9^2 \times 600 = 50000$ kgm } at point (A)
" shear $= 12.9 \times 600 = 7{,}740$ kg

Depth of truss assumed as 1.5m between neutral axes.

Chord stress $= \frac{50000}{1.5} = 33{,}330$ kg T or C

net area reqd $= \frac{33330}{1200} = 27.80$ cm² net

use 2L 150×90×9 = 41.88 − 7.92 = 33.96 cm² net (4-19φ rivet)

$\frac{l}{r} = \frac{200}{2.6} = 77.$

$f = 1500(1 - 0.0055 \times 77) = 864$ kg/cm² C. (.576)

allowable comp. on chord = 41.88 @ 864 = 36,200 kg C. ✓

Diagonal length
$1.5^2 = 2.25$
$1.0^2 = \frac{1.00}{3.25}$ $\sqrt{3.25} = 1.80$ coef. $= \frac{1.8}{1.5} = 1.20$

max. diagonal stress = 7740 × 1.20 = 9300 kg T. SR = 7.75 cm² net 19φ rivet no. 4.4 use 5
7140 × 1.20 = 8600 kg C. SR = $\frac{8600}{632}$ = 13.60 cm² gr. 4.1 " 5

for 1L 90×90×10 = 17.00 − 2.2 = 14.80 net

$\frac{l}{r} = \frac{180}{1.71} = 105$

$f = 1500(1 - 0.0055 \times 105) = 632$ (.421)

good for 17.00 @ 632 = 10750 kg C.
14.80 @ 1200 = 17750 kg T

JIUN MASUDA
CONSULTING ENGINEER
~~~~ SHOWA BLDG, TOKYO

MADE BY K. I. DATE 9-2-27 FILE NO.

CHECKED BY DATE PAGE NO. 17

CALCULATIONS FOR

Preliminary design of Enoura-Bashi for Mie-Ken

Counter weight.

river arm moment = 1/2 × 500 × 13.9² = 48300
rear arm = 1/2 × 300 × 3.0² = −1300
47000 kgm. about trunnion shaft.

Counter weight reqd. = 47000 / 2.8 = 16800 kg

for 2-girders 2 @ 16800 = 33600 kg.

Structural steel for cwt. framing = − 3600
Cwt. concrete reqd = 30,000

vol. of cwt concrete = 30000 / 2200 = 13.63 m³

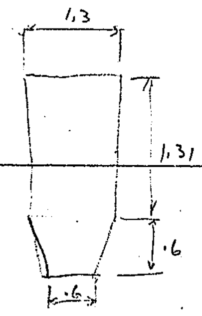
13.63 / 4.6 = 3.00 cub m. per lin meter of cwt.

1.5 × 2.0 × 4.6
1.4 × 2.15 × 4.6
1.3 × 2.3 × 4.6

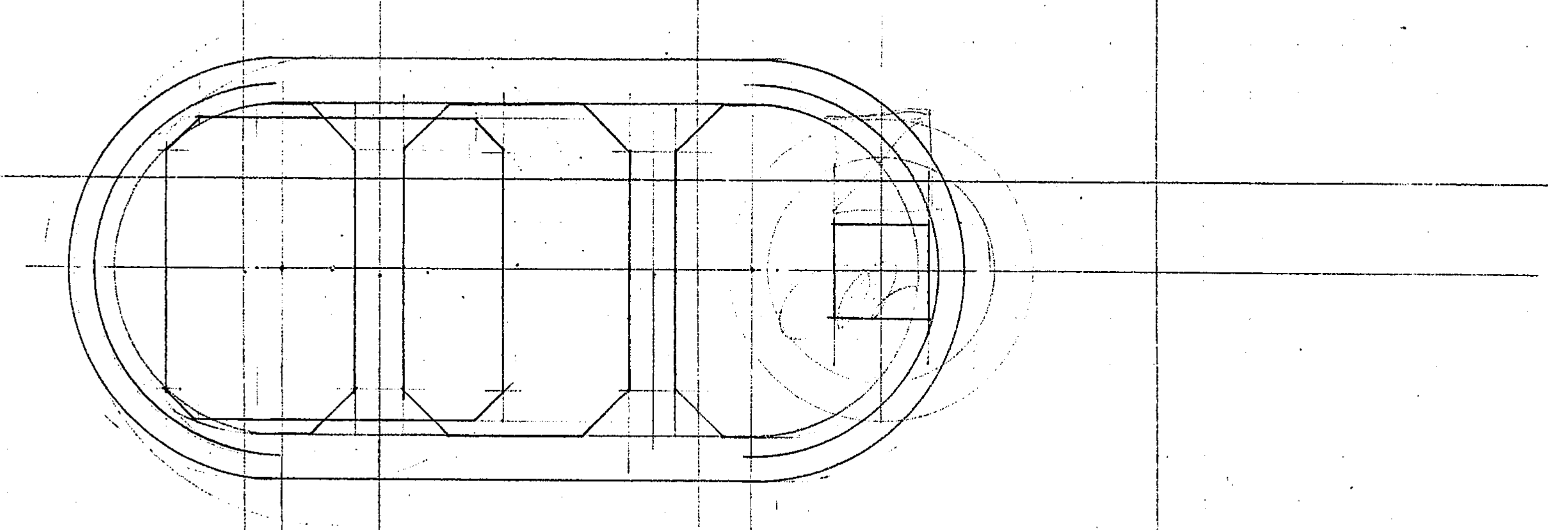
for length of cwt. 6.00 m

13.63 / 6.0 = 2.27 m²

1.30 × 1.75 × 6.00 = 13.63
1.20 × 1.90 × 6.00 = "



1.3
0.6
1.90 ÷ 2 = 0.95 × 0.6 = 0.57
2.27
1.70 ÷ 1.3 = 1.31


~~~~

Preliminary Design of Ensuna-Bashi for Mie-ken

Estimate of operating power reqd.

Load on main trunnion shafts

River arm 600 × 13.9 = 8340
rear arm 300 × 3.0 = 900
extra steel at trunnion say 1160
10400
cwt. = 16800
27,200 × 2 = 54400 kg on 2-trunnion shafts.

Load on cwt trunnion 16800 × 2 = 33600 kg " 2 — " "

Moment due to frictional resistance

$M_F = \frac{PfD}{200} = \frac{0.150 \times PD}{200} = 0.00075\ P^{kg} D^{cm}$ kgm.

main trunnion 12 cm φ assumed 0.00075 × 54400 × 12 = 490
cwt. 15 cm φ " 0.00075 × 33600 × 15 = 380
$\therefore M_F$ = 870 kgm

Wind load 25 kg/m² (5 #/□') during operation.

13.9 m cos 15° = 13.9 × .966 = 13.4 m
width of bridge = 4.70 m
wind load on river arm = 4.70 @ 25 = 118 call this 120 kg/m
wind moment abt trunnion

$M_W = \frac{120 \times 13.4^2}{2} = 10,760$

Total moment

Frictional moment M_F = 870
wind " M_W = 10760
Inertia + ecc. say = 1770
13,400 kgm

$\frac{13400}{20000}$ = 67% or 2/3 of the former design.

	Time of operation	reqd. HP.	
25 kg or 5 # wind	5 min	1.26	
	3	2.20	3.06 HP
	2'–20"	2.95	4.1 HP
50 kg or 10 # wind	3'–30"	3.20	

JIUN MASUDA
CONSULTING ENGINEER
~~????~~ SHOWA BLDG, TOKYO

MADE BY K. I. DATE 9-3-1 FILE NO
CHECKED BY DATE

CALCULATIONS FOR
11.0 m Clear span #
Preliminary Estimate of Enoura Bashi for Mie-ken

Estimate of Bascule bridge proper.

Structural steel for bascule leaf.

Stringers	5I 150×75×6.5 @18.6 kg × 12.5	=	1162		
floor beams.	6I 300×150×8 @ 48.3 × 4.40	=	1275		
〃	2I 300×90×9 @ 38.1 × 4.40	=	335		
				2772	
	details say 6%	=		168	
				2940 kg	
lateral bracings say	12.0 @ 50 kg	=			600
handrails say	2@ 12.5 @ 10 〃	=			250

Main truss.

Chords. top. ⊏	2⊏ 150×90×9	@ 16.4 × 13.5	=	443		
〃 〃 ⊓	2⊏ 150×90×12	@ 21.5 × 4.0	=	172		
〃 〃 Cov.	1Pl. 320×9	@ 22.61 × 5.0	=	113		
〃 bott. ⊏	2⊏ 150×90×9	@ 16.4 × 13.0	=	426		
〃 〃 ⊓	2⊏ 150×90×12	@ 21.5 × 5.0	=	215	2116	
〃 〃 cov	1Pl 320×12	@ 30.14 × 6.0	=	181	534	
					2650	
web. ⊥	1Pl. 1200×9	@ 84.78 × 3.1	=	263		
〃 T.	1Pl 1000×9	@ 70.65 × 3.1	=	219		
〃 end	1Pl 800×9	@ 56.52 × 1.5	=	84		
Side pls tr.	2Pls 1200×12	@ 113.04 × 2.1	=	475		
〃 〃	2Pls 800×9	@ 56.52 × 1.1	=	124		166
〃 Cut. tr	2Pls 450×12	@ 42.39 × 1.1	=	93		
〃 〃	2Pls 600×9	@ 42.39 × 0.7	=	59		26
						68
Stiffeners Vert. ∟	10∟ 125×90×9	@ 14.6 × 2.0	=	292		
〃 〃	4∟ 〃	〃 @ 〃 × 0.8	=	47		
〃 hor. ∟	2∟ 75×75×9	@ 9.96 × 2.5	=	50		
verticals	12∟ 125×90×9	@ 14.6 × 1.5	=	263		
diagonals	12∟ 90×90×10	@ 13.3 × 1.7	=	271	3852	
					308	
rivet heads, chord spl. etc say 8%			=	300		
				4090 kg		

for 2 trusses	2 @ 4090	=	detail 57% 8180 kg
Shoes say	2 @ 350	=	700
Exp. jt. say	2 @ 550	=	1100
			13,770 kg
			Call this 13,800 kg

3.3949 (1.84252
28 · 8 · 364 · 3.39 · 264 · 1349 · 1456 · 3682 · 3684 · 736 · 13264
21.5×4 · 30.14×2 · 184×2
200 · 43 · 60.0 · 141.0 · 368. · 613. · 7??
2.25 · 1.1449 · 3.3949 · 161086 · 13???

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

MADE BY K. I. DATE 9-3-2 FILE NO
CHECKED BY DATE PAGE NO 20

CALCULATIONS FOR

Preliminary Estimate of Enoura-Bashi for Mie-ken

Structural steel for counterweight tower.

Columns	front+rear	2⊏	380×100×10.5	@	54.5 × 7.30 =	796	
diagonals		8∟	125×75×9	@	13.5 × av. 1.70 =	184	
horizontals		6∟	〃 〃	@	13.5 × " 1.10 =	89	
〃	top	2∟	75×75×9	@	9.96 × 0.50 =	70	
〃	bott	2∟	125×90×9	@	14.6 × 2.0 =	58	
						1137×2 = 2274	
					detail 50%		1137
Top strut		4∟	125×90×9	@	14.6 × 6.0 =	350	
〃		2Pls	450 ×9	@	31.79 × 6.0 =	381	
brace		2∟	150×90×9	@	16.4 × 6.0 =	197	
〃		4∟	〃	@	〃 × 3.8 =	249	
〃		2∟	125×75×9	@	13.5 × 2.4 =	65	
							1242
					detail 35%		435
							5088
Shoes + anchor bolts say							312
							5400 kg

Structural steel for cw't links with bracings complete say — 1,100 kg

〃 〃 〃 cw't. frame say — 3600 〃

Structural steel for bascule pier floor. say — 400

Steel under trunnions say 2 @ 1300 = 2600

〃 〃 machinery bearings — 800

Summary of structural steel for bascule proper.

bascule leaf, complete	13,800
cw't tower complete	5400
cw't link 〃	1100
〃 frame 〃	3600
Steel under main trunnion bearings	2600
floor over bascule pier (2 floor beams only)	400
Steel under machinery bearings	800
	300
	28000 kg

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

MADE BY k. I. DATE 9-3-2 FILE NO
CHECKED BY DATE PAGE NO 21

CALCULATIONS FOR
Preliminary Estimate of Enoura-Bashi for Mie-ken

Cost of one well.

Front well 3.0φ × 10.0 m

Concrete 1:2:4	48.0 m³ @ 14.75	=	708
〃 1:4:8	2.8 〃 @ 10.25	=	29
Sand filling	20.0 〃 @ 1.20	=	24
reinforcements	3.6 ton @ 115.00	=	414
Curb shoe	1.0 〃 @ 220.00	=	220
forms.	170. m² @ 1.20	=	204
well sinking 予下ゲ沈設			360
沈下費	5.5 m @ 30.00		165
			26
			2150 円

Rear well 1.8φ × 10.0

Concrete 1:2:4	18.00 m³ @ 14.75	=	266
〃 1:4:8	0.80 m³ @ 10.25	=	8
Sand fill	7.20 m³ @ 1.20	=	9
reinforcements	1.4 tons @ 115.00	=	161
Curb shoes	0.55 ton @ 220.00	=	110
forms	100. m² @ 1.20	=	120
well sinking 予下ゲ沈設			240
沈下費	6.0 m @ 15.00	=	90
			6
			1010 円

Shaft.

Concrete 1:2:4	68.00 m³ @ 14.75	=	1003
reinforcements	5.50 ton @ 115.00	=	632
forms	260.0 m² @ 1.50	=	390
			5
			2030 円

Fixed floor over bascule pier say 150 円

JIUN MASUDA
CONSULTING ENGINEER
~~IIII~~ BLDG, TOKYO
SHOWA

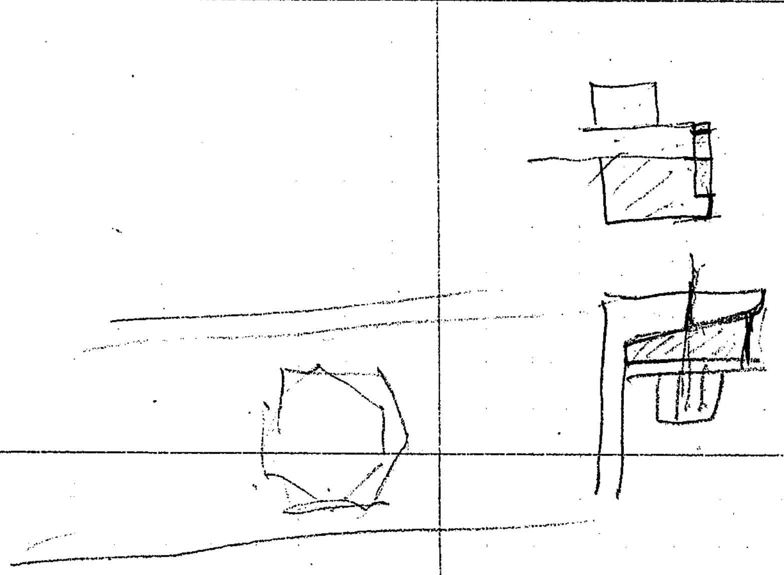
CALCULATIONS FOR

MADE BY K. Inata DATE 9-3-2 FILE NO
CHECKED BY ______ DATE ______ PAGE NO 22

Preliminary Estimate of Enoura-Bashi for Mie-Ken.

Summary of cost.

Item	Calculation	Subtotal	Total	Grand total
Structural steel complete.	28.000 tons @ 250.00 =		7,000	
Timber deck for moving leaf	48.40 m² @ 12.00 =		600	
Counterweight concrete	13.7 m³ @ 14.75 = 202.			
" forms	80 m² @ 1.50 = 120.			
reinforcements	0.50 ton @ 115.00 = 58			
		380		
Operating house say		320		
			700	
mechanical equipment		9000		
Electrical "		2500		
			11500	
Summary for supper structure =				19,800
Bascule pier				
Fixed floor		150.		
shaft, machinery floor, walls etc		2030		
front wells	2 @ 2150 =	4300		
rear "	2 @ 1010 =	2020		
			8500	
Front pier reinforcing with fenders say			800	
Extra cost for wooden floor over naboring spans say 2 @ 250 =			500	
				9,800
				29600 ¥

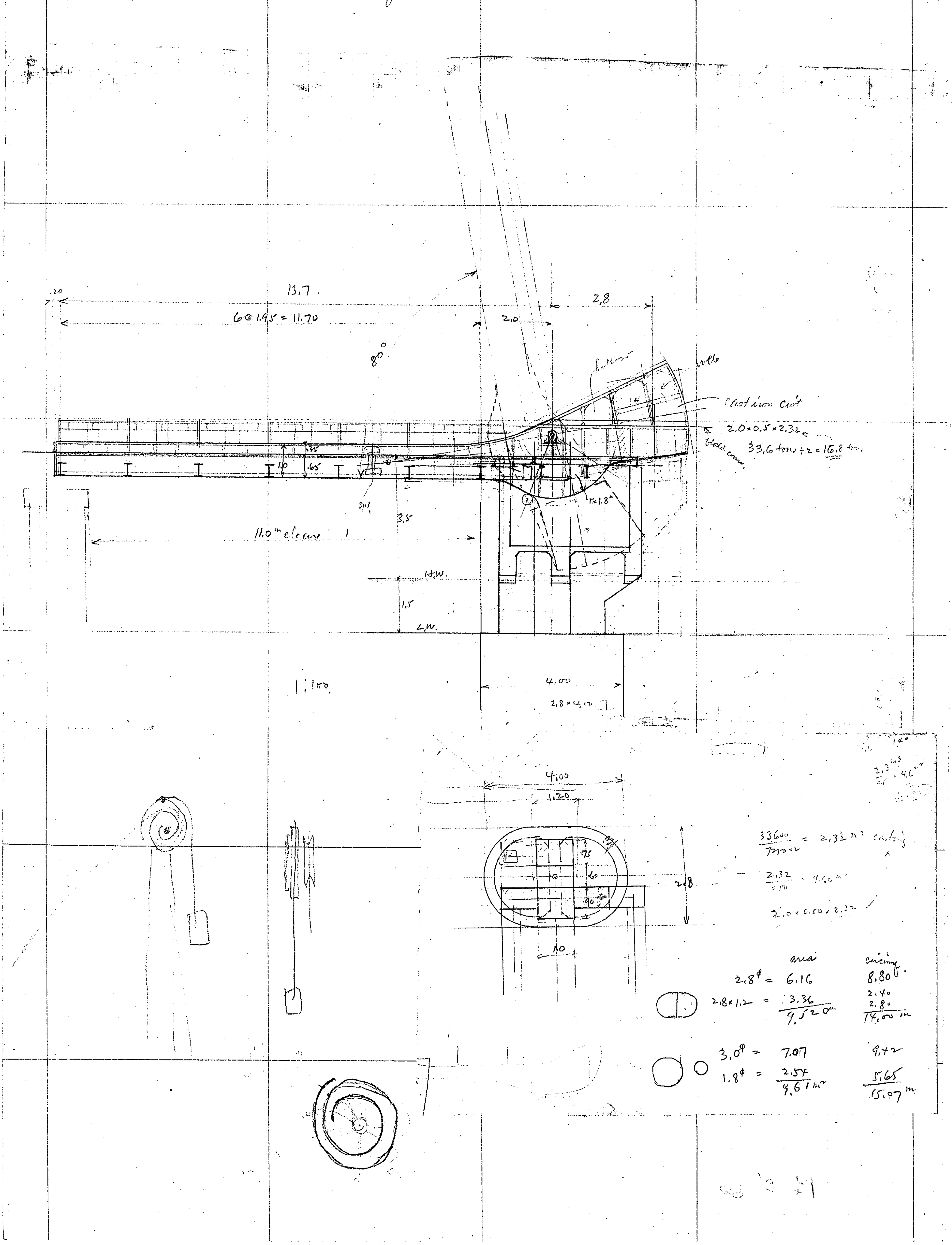


増田淳氏関係資料
(独立行政法人 土木研究所蔵)

JIUN MASUDA
CONSULTING ENGINEER
BLDG, TOKYO
SHOWA

MADE BY K. I. DATE 9-3-5 FILE NO.
CHECKED BY DATE PAGE NO. 23

CALCULATIONS FOR 11.0 m Clear way, B.2.
Preliminary Design of Enoura Bashi for Mie-ken.



増田淳氏関係資料
（独立行政法人 土木研究所蔵）

Inoura Bashi for Mie Ken

Design of main girders.

moment $1/2 \times 600 \times 11.9^2 = 42500$ kgm

Try web pl. 1000 × 9 = 90.0 cm² 1/8 web area = 11.25 cm²
Eff. depth say 101. − 4 = 97 cm
Flg stress = $\frac{42500}{.97}$ = 43,800 kg
Flg area = 43800 ÷ 1200 = 36.50 cm²
1/8 web = 11.25
25.25 cm² net

Use 2∟ 150×90×9 = 41.88 − 7.92 = 33.96 cm² net

Approximate weight of main girder.

Flange	top	2∟	150×90×9	@	16.4	× 18.00 =	590
〃	bott	2∟	〃	@	〃	× 12.00 =	393
〃	〃	2∟	150×90×12	@	21.5	× 6.50 =	280
〃	top.	1 cov pl.	320×9	@	22.61	× 4.00 =	90
〃	bott	〃	320×12	@	30.14	× 5.50 =	166
web		1 Pl.	1000×9	@	70.65	× 11.50 =	810
〃		1 Pl	1500×9	@	105.98	× 4.00 =	424
〃		1 Pl	1200×9	@	84.78	× 2.20 =	187
〃		1 Pl	500×9	@	35.33	× 2.80 =	99
							3039
Side pls		2 Pls	1800×9	@	127.17	× 2.00 =	508
〃		2 Pls	800×9	@	56.52	× 1.00 =	113
Stiffeners.	end.	4∟	125×90×10	@	16.1	× 0.99 =	64
〃	〃	2 fills	180×9	@	12.72	× 0.82 =	21
〃	int.	46∟	135×75×9	@	13.5	× 1.01 =	627
〃	near trimmer	8∟	135×75×9	@	13.5	× 1.80 =	194
〃	〃	4∟	75×75×9	@	9.96	× 1.80 =	72
Field spl. of main girder say							200
Shop spl. of web.				2 @		40 =	80
							1879
Cut. frame. top		2∟	150×90×9	@	16.4	× 4.00 =	131
〃 rear		2∟	〃	@	〃	× 2.50 =	82
		6∟	135×75×9	@	13.5	× 0.80 =	65
		1 Pl.	1800×9	@	127.17	× 2.00 =	254
		gusset pls	say				30
		misc say				=	100
							712
							5630
rivet heads say 5%							270
							5900 kg

220 × 13.5 = 3060
750 × 3.8 = 2840
5900

增田淳氏関係資料 (独立行政法人 土木研究所蔵)

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

CALCULATIONS FOR

MADE BY K. I. DATE 9-3-35 FILE NO
CHECKED BY DATE PAGE NO 25

Enoura Bashi

Counterweight required

river arm moment = 1/2 × 540 × 13.92 = 52100
rear arm " = 1/2 × 750 × 3.82 = - 5400
46,700 kgm abt trunnion shaft.

Cwt. reqd. = $\frac{46700}{2.8}$ = 16700 kg.

2 @ 16700 = 33400 kg.

Cast iron cwt. vol. = $\frac{33400}{2 \times 7250}$ = 2.30 cub m. on each girder

2.0 × 2.30 × 0.50 = 2.30
2.0 × 1.92 × 0.60 = 2.30

Summary of structural

Stringers + floor beams			3000
lateral bracings			600
handrails say	12m × 2 @ 30	=	720
main girders with cwt frame	2 @ 5900	=	11,800
shoes say	2 @ 350	=	700
exp. jt + floor breaks	2 @ 550	=	1100
			80

Summary for bascule leaf complete = 18,000

Steel under main trunnion bearings.	2600
floor over bascule pier	200
steel under machinery bearings	800
	3600

21,600 kg. 6.4 tons 河

JIUN MASUDA
CONSULTING ENGINEER
~~___~~ BLDG, TOKYO
SHOWA

MADE BY K. I. DATE 9-3-13 FILE NO 26
CHECKED BY ______ DATE ______ PAGE NO ______

CALCULATIONS FOR

11.00 clear span 案 3

Preliminary Estimate of Enoura-Bashi for Mie-Ken.

Estimate of Bascule bridge proper.

Structural steel for bascule leaf.

Stringers and floor beams			2940
lateral bracings			600
handrails			250
main trusses	2@4090	=	8180
Shoes	2@350	=	700
Exp. jt + floor breaks	2@550	=	1100
			13770
		call this	13,800

Structural steel for

Counter weight tower	5400 × .9	=	4900
Cw't links with bracings		=	1100
Cw't frame		=	3000
floor beam over Bascule pier			400
Steel under trunnion bearings			1300
" " machinery bearings			800 ← 機械倫
			200
			25,500 kg.

Materials of Bascule pier.

Fixed floor.

Concrete 1:2:4 mix.

Slab.	3.60 × 4.3 = 15.5 m² @ 0.15 =		2.32
Copings	2 × 0.15 × .30 × 4.3 =		0.39
			2.71 m³
forms.	3.6 × 4.3	=	15.5 m²
reinforcements	2.71 @ 130	=	0.35 tons
granolithic pav.		=	15.5 m²

walls + columns with floorings.

front + rear walls	2@ 0.3 × 2.1 × 3.20	=	4.03
side walls	2@ 0.3 × 2.1 × 2.00	=	2.52
Shafts	2@ 1.9 × 2.5 × 5.20	=	49.40
less groves	2@ 0.4 × 1.8 × 2.50	= −	3.60
add proj.	2@ 0.2 × 1.0 × 4.80	=	1.92
Cantilever walls.	2@ 0.50 × 1.5 × 2.60	=	3.90
"	1@ 0.30 × 1.5 × 2.60	=	1.17
floor slab, machinery pl.	4.5 × 3.30 × 0.15	=	2.23
" operating house	3.7 × 2.1 × 0.10	=	0.78
" "	1.8 × 1.2 × 0.10	=	0.22
beams. main	3@ 0.5 × 0.65 × 3.20	=	3.12
fillets	3@ .2 × .2 × 3.20	=	0.38
" longitudinal	0.30 × 0.4 × 2.70	=	0.32
fillets	3@ 0.5 × 0.4 × 0.4	=	0.24
"	2@ 0.3 × 0.2 × 0.2	=	0.02
beams operating h. 周回	0.3 × 0.4 × 6.5	=	0.78
bearing brackets of I beam.	3@ .4 × .4 × 1.8	=	0.86
			78.29 cub m.
forms say			270 sq. m.
reinf. say			6.00 tons.

$1.5 \times 2 = 3$ ...

182 / 57 / 239

$10.77 \div 4.70 = 2.29$

4.4 / 4.3 / 4.70

増田淳氏関係資料（独立行政法人 土木研究所蔵）

JIUN MASUDA
CONSULTING ENGINEER
BLDG, TOKYO
SHOWA

MADE BY K. I. DATE 9-3-13 FILE NO
CHECKED BY DATE PAGE NO 27

CALCULATIONS FOR

Preliminary Estimate of Enoura-Bashi for mic-ken

Well: 2.50 × 4.6 × 10.0 30cm thick 一本分

Shell concrete 1:2:4

Cross section. 2.50 × 4.0 = 10.00
2 × 1.55 × 1.9 = − 5.89
4 × 0.2 × 0.2 = + 0.16
− 5.73
4.27 m² net

shell say 4.27 × 10.0 = 42.70
fill 5.73 × 4.5 = 25.80
68.50 m³

1:4:8 fill 5.73 × 0.60 = 3.44
Sand fill 5.73 × 4.9 = 28.0

reinforcements 68.5 @ 75 = 5.1 tons
Curb shoe say 1.5 "

Forms. outside 13.0 × 9.5 = 123.5
inside 11.8 × 1.2 = 14.1
" 13.8 × 8.8 = 121.4
259 m²

Estimate of cost for bascule pier
Fixed floor.
Concrete 1:2:4. 2.71 m³ @ 14.75 = 40
forms 15.5 m² @ 1.50 = 23
reinforcements 0.35 ton @ 115.00 = 40
pavement granolithic 5cm 15.5 m² @ 2.00 = 31
6
140 円

Shaft, machinery room + operating room floor
Concrete 1:2:4 78.29 m³ @ 14.75 = 1155
forms 270 m² @ 1.50 = 405
reinforcements 6.00 ton @ 115.00 = 690
2250 円

well concrete 1:2:4 shell 68.50 m³ @ 14.75 = 1010
" 1:4:8 fill 3.44 " @ 10.25 = 35
Sand filling 28.0 " @ 1.50 = 42
forms 259. m² @ 1.20 = 310
reinforcements 5.1 ton @ 115.00 = 586
curb shoe 1.5 " @ 220.00 = 330
well 沈下設備 = 600
" 沈下掘鑿費 挿入 5.5 m 約27円 @ 45 = 248
39
3,200

for 2 wells 2 @ 3200 = 6,400
8,790
Call this 8,800 円

Preliminary Estimate of Enoura-Bashi for Mie-ken

Summary of cost. 11.00m clear span # 3.

Structural steel complete	25.50 tons	@ 250.=	=	6380	
timber deck for moving leaf	45.0 m²	@ 12.=	=	540	
Counterweight 13.7m³ form + reinf #				380	
Operating house				300	
					7,600
Machinery equipment				9000	
electrical "				2500	
					11,500
					19,100
Bascule pier				8800	
front pier reinforcing			500		
timber fenders	4 @ 100	=	400		
extra cost for wooden floor over nabouring spans		=	500		
				1400	
					10,200
					29,300

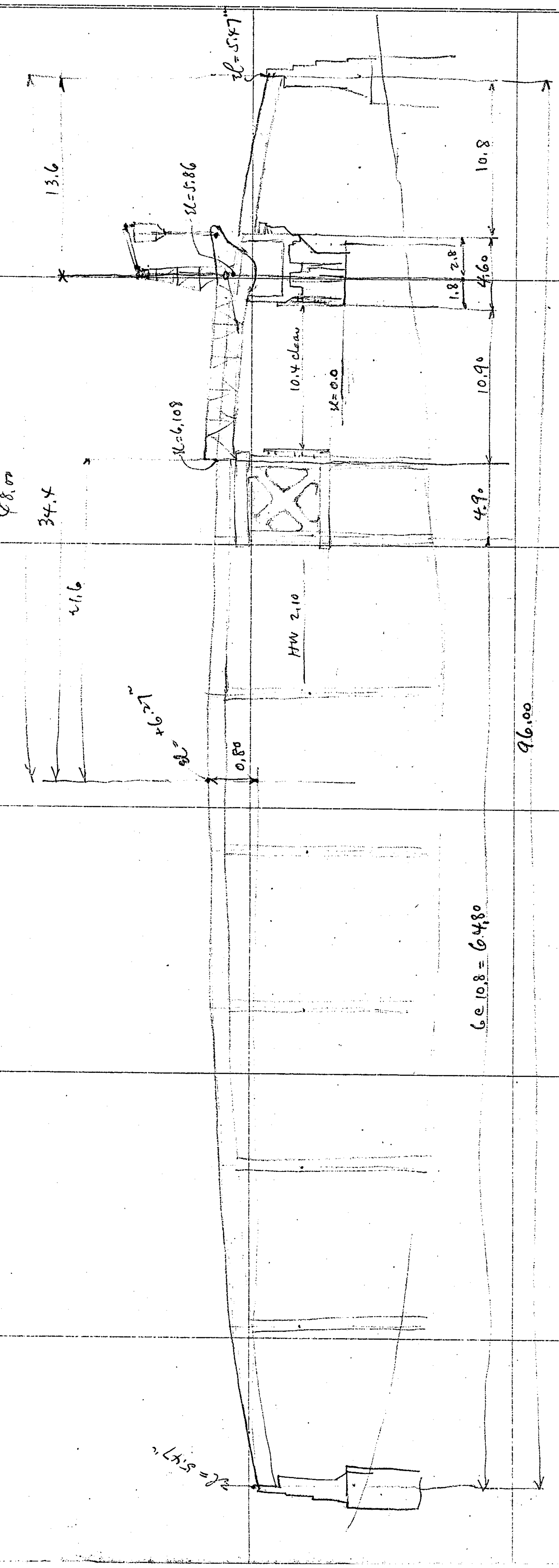
16700
11500
1500

JIUN MASUDA
CONSULTING ENGINEER
~~3111~~ BLDG, TOKYO
SHOWA

CALCULATIONS FOR

MADE BY ______ DATE ______ FILE NO ______

CHECKED BY ______ DATE ______ PAGE NO ______



Spring buffer.
Kinetic energy of moving part.

moving leaf.	15830 kg	mass = $\frac{15830}{9.80}$ = 1580 kg	
arm.	4.48 m	v = 4.48×0.0108 = 0.0484	take ½ = 0.0242 m/sec
Cw't.	22600 kg	mass = $\frac{22600}{9.80}$ = 2310 kg	
arm	2.80 m	v = 2.80×0.0108 = 0.0303	×½ = 0.0152 m/sec.

Average angular speed of leaf. Time of operation assumed 2′-30″ or 150″ − 30 = 130″

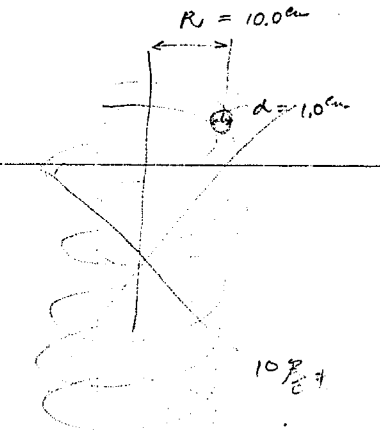
$\omega = \frac{80°}{130''} = 0.615°/sec$ or 37′/sec. tan 37′ = 0.01077

Kinetic energy
moving leaf $\frac{1}{2} \times 1580 \times 0.0242^2 = 0.463$
cw't $\frac{1}{2} \times 2310 \times 0.0152^2 = 0.267$
0.730 kgm

Stroke 5 cm. assumed.
Average pressure on buffer
$= \frac{0.73}{0.05} = 14.6$ kg

max. pressure = 14.6×2 = 29.2 kg
for one buffer 29.2÷2 = 14.6 kg.

retardation of cw't 5%
22600×0.05 = 1130 kg
1130×2.66 = 3000 kg
$3000 \times \frac{.85}{2.8} = 912$ kg
for one buffer 450 kg
50% say 225 kg.



$P = \frac{S\pi d^3}{16R} = \frac{5000 \times 3.14 \times 1^3}{16 \times 10} = 100$ kg

$f = \frac{4S\pi R^2 Hs}{Gd^2} = \frac{4 \times 5000 \times 3.14 \times 10^2 \times 10}{740000 \times 1.2} = 85.$ cm

4 巻
R = 5 cm φ
d = 1.2 cm φ

$P = \frac{5000 \times 3.14 \times 1.2^3}{16 \times 5} = 340$ kg

$f = \frac{4 \times 5000 \times 3.14 \times 5^2 \times 4.8}{740000 \times 1.2^2} = 7.08$ cm

ratio $\frac{2R}{d} = \frac{2 \times 5}{1.2} = 8.3$

$f\pi G d^2 = 32PR^2 l$, $= \frac{32PR^2 l}{\pi f G d^4}$

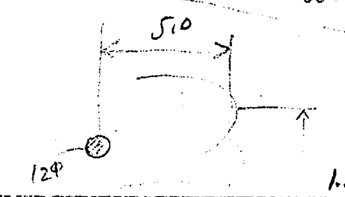
$\frac{\pi d^2}{4} l$ … $= \frac{8PR^2}{...}$

$\frac{2GP}{3...} \cdot \frac{2 g \cdot 5^2 \pi d^2 l}{5 \times 8} = \frac{\pi d^2 l}{8}$

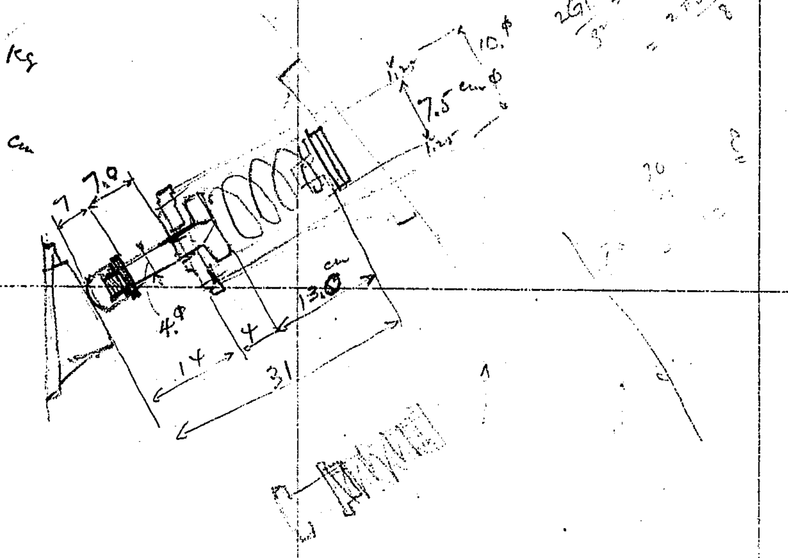
4 巻
R = 5 cm φ
d = 1.0 cm φ

$P = \frac{5000 \times 3.14 \times 1^3}{16 \times 5} = 196$ kg

$f = \frac{4 \times 5000 \times 3.14 \times 5^2 \times 4}{740000 \times 1.0^2} = 8.5$ cm



1.2×4.5 = 5.4
1.8×4 = 7.2
12.6 cm



5.0
1.2
6.2
.8
7.0

JIUN MASUDA
CONSULTING ENGINEER
~~[illegible]~~ SHOWA BLDG, TOKYO

CALCULATIONS FOR

4.3 / .26 / 4.56

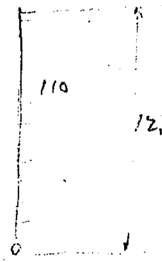
MADE BY______ DATE______ **FILE NO**______
CHECKED BY______ DATE______ **PAGE NO** 2

2000

HP reqd.
Load on trunnion
wt. of moving leaf 15830
wt. 22600
38430 kg
Load on Cwt. trunnion 22600 kg

Frictional moment
38430 × 0.00075 × 10 = 288
22600 × 0.00075 × 7.5 = 127
415 kgm = M_F

wind moment.
25 kg/m² × 4.5 = 113 kg/m call this 110.



moment = $110 \times \frac{12.9^2}{2} = 9150$ kgm. = M_W

Summary of m.
friction = 415
wind = 9150
inertia + ecc = 3000
12565 call this 12600 kgm

theoritical rack force = $\frac{12600}{1.8} = 7000$ kg

unif speed of rack circle for 2'-20" operation
$v = \frac{\pi \times 3.60 \times 80}{360 \times 2.0} = 1.258$ m/min

unit work done = 7000 × 1.258 = 8800 kgm/min

Theoritical HP reqd. = $\frac{8800}{4560} = 1.93$

Actual HP " = $\frac{1.93}{0.5} = 3.86$ HP.

for 3' operation
$3.86 \times \frac{120}{160} = 2.90$ HP.

for 3'-20"
$3.86 \times \frac{120}{180} = 2.57$ HP.

9150 / 1600 / 7 / 565

No. of rev. of motor 1650 (Synchronous speed 1720 の 95% 1720×95% = 1650 say)
" rack $\frac{80}{360 \times 3} = 0.0740$

total gear ratio = $\frac{1650}{0.074} = 22300$

Efficiency say

worm	1 : 25	25.0 ×	0.700 ×
spur gear	(1 : 2.94)4	74.3 ×	(0.94)4 = 0.780 ×
rack + pinion	1 : 12	12.0	0.940

Product 22300

η = 0.520

514 / 5.15 / 1.58

147700 / 161 / 147861

増田淳氏関係資料
(独立行政法人 土木研究所蔵)

Gearing.

worm gear	20° inclination	51/2
1st gear		44/15
2nd "		"
3rd "		"
4th "		"
main pinion + rack		

total gear ratio

$$= \frac{51 \times 44^4 \times 200}{2 \times 15^4 \times 17} = 22280 \doteqdot \underline{\underline{22300}}$$

Diameters, power transmitted, speed, and accumulated efficiency of gears.

Gearings	wheels	no. of rev/min n	pitch dia. D_p m.m.	Speed v m/min	Efficiency η	HP transmitted $HP \times \eta$
worm	worm	1650			1.000	3.000
	worm wheel	$1650 \times \frac{2}{51} = 67.4$			0.700	2.10
1st gear	pinion	67.4	90 (6)	19.1	0.700	2.10
	wheel	$67.4 \times \frac{15}{44} = 23.0$	264	19.1	0.658	1.98
2nd gear	Pinion	23.0	(150) (10)(9) 135	10.8 9.75	0.658	1.98
	wheel	$23.0 \times \frac{15}{44}$ 7.82	(440) 396	" 9.75	0.619	1.86
3rd gear	Pinion	7.82	180 (12)	4.42	0.619	1.86
	wheel	$7.82 \times \frac{15}{44} = 2.67$	528	"	0.582	1.75
4th gear	Pinion	2.67	210 (14)	1.76	0.582	1.75
	wheel	$2.67 \times \frac{15}{44}$ 0.91	616	"	0.547	1.64
~~main~~ pinion		0.91	300 (20)	0.86	0.547	1.64
rack		$0.91 \times \frac{15}{180} = 0.076$	3600	0.86	0.520	1.56

Dimensions of gear teeth. 15° involute cut teeth. ~~forged~~ steel pinion, cast iron spur wheel.

Gearings	Pitch dia D_p mm		Outside dia D_o mm	Module $M_c = \frac{D_p}{N}$	face f mm	Cir. pitch p mm	addendum $H_1 = M_c$	Length H	no. of teeth N	Load on tooth $W = \frac{4560 \times HP\eta}{v}$	allowable	v
1st gear												
pinion	90	steel		6	5.6	18.85	6		15	500 kg	(900)	19.1
wheel	264	c.i.		6	5.2	"	6		44	473	(360)	"
2nd gear												
pinion	(150) 135	steel		(10) 9	~~8.6~~ 70	(3.1416) 2.8274	(10) 9		15	(836) 926	(2600)	(10.8) 9.75
wheel	(440) 396	c.i.		(10) 9	~~8.0~~ 64	"	(10) 9		44	(785) 870	(1000)	"
3rd gear												
Pinion	180	steel		12	10.0	3.7699	12		15	全 1920	3800	4.42
wheel	528	c.i.		12	9.4	"	12		44	部 1805	1500	"
4th gear												
Pinion	210	steel		14	11.6	4.3982	14		15	二本 2268	5000	1.76
wheel	616	c.i.		14	11.0	"	14		44	宛 2125	1950	"
~~main Pinion~~	~~306~~	f.s.		18	~~14.6~~	~~5.6549~~	~~18~~		17	半 4270	8500	0.875
rack	3600	c.s.		18	14.0	"	18		200	宛 4065	3300	"
main pinion	300	steel		20	14.6	6.2832	20		15	半分宛 4345 ~~3830~~	8690	
rack	3600	c.i.		20	14.0	"	20		180	~~3660~~ 4135	4350 / 827 / 4135	

7.33

~~v = 0.860~~
~~v = 0.973~~

Strength of gear teeth

$W = Spfy$ where W = the load on the tooth in kg
p = the circular pitch in cm
f = the face of the tooth in cm
S = the permissible fibre stress in the material at the root of the tooth in kg/cm²
y = a factor depending upon the form of the tooth

module	Gearings		materials	no of teeth N	allowable stress S	Circular pitch p	face f	15° involute factor y	Spy	allowable W	load on tooth	
6	1st gear	pinion	steel	15	1400 kg/cm²	1.885	5.6	0.078	206	1154	500	
		wheel	cast iron	44	550	〃	5.2	0.108	112	583	473	1.23
(10) 9	2nd gear	pinion	steel	15	1400	(3.1416) 2.8274	(8.6) 7.0	0.078	(343) 309	(2950) 2160	(836) 926	
		wheel	cast iron	44	550	〃 〃	(8.0) 6.4	0.108	(187) 168	(1496) 1075	(785) 870	(1.9?) 1.23
12	3rd gear	pinion	steel	15	1400	3.7699	~~10.6~~ 10.0	0.078	462	4900	1920	
		wheel	cast iron	44	550	〃	10.0 9.4	0.108	224	2240	1805	1.24
14	4th gear	pinion	steel	15	1400	4.3982	11.6	0.078	480	5570	2268	
		wheel	cast iron	44	550	〃	11.0	0.108	261	2870	2125	1.35
~~18~~	~~main pinion~~		~~forged steel~~	~~17~~	~~1550~~	~~5.6549~~	~~14.6~~	~~0.084~~	~~733~~	~~10700~~	~~4270~~	
	~~rack~~		~~cast steel~~	~~200~~	~~1400~~	~~〃~~	~~14.0~~	~~0.120~~	~~814~~	~~11400~~	~~4065~~	
20	main pinion		steel	15	1400	6.2832	14.6	~~0.084~~ 0.078	~~740~~ 686	~~10800~~ 10,010	~~3850~~ 4345	
	rack		cast iron	180	550	〃	14.0	0.120	415	5800	~~3660~~ 4135	~~1.19~~ 1.35

(allowable W for the 4th gear and main pinion/rack: for one set.)

$\frac{30}{150}$ $\frac{1}{5}$ $\frac{3}{6}$

Shafts.

Loads on shaft.

Shafts	H.P. transmitted N.	no of rev. per min n	Load on tooth W. Pinion	Load on tooth W. wheel	Coef. of equiv. combined moment Km	Kt
1st shaft	2.10	19.1	500		1.50	1.50
2nd 〃	1.98	9.75	926	473	〃	〃
3rd 〃	1.86	4.42	1920	870	〃	〃
4th 〃	½ × 1.75	1.76	2268	1805	〃	〃
5th 〃	½ × 1.64	0.973	main p. 3850	2125	〃	〃

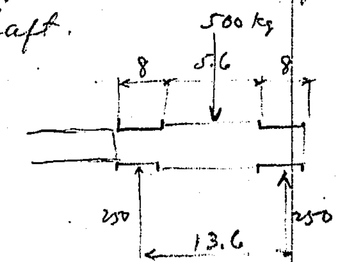
Torsional moment on shafts

$N = \frac{2\pi R W n}{4560}$ or $T = RW = \frac{4560}{2\pi}\frac{N}{n} = 726\frac{N}{n}$, kgm $= 72600 \frac{N}{n}$ kg.cm

Shafts	N/n	T kgcm	approx. dia in mm		bearing length	
1st shaft	0.110	8,000 kgcm	45	× 1.8	= 81 mm	use 8. cm
2nd 〃	0.203	14,800	55	〃	99	10.
3rd 〃	0.421	30,600	70	〃	126	12.
4th 〃	0.497	36,100	75	〃	135	14.
5th 〃	0.843	61,200	90	× 1.6	144	14.

Bending moment on shafts

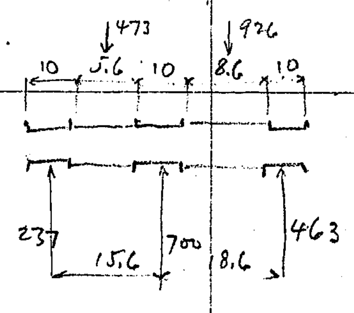
1st shaft.



$m = 250 \times 6.8 = 1700$ kg cm

$\frac{0.125 \times 13.6^2}{8} = \frac{}{1700}$

2nd shaft.



2nd pinion $m = 463 \times 9.3 = 4300$ kg cm

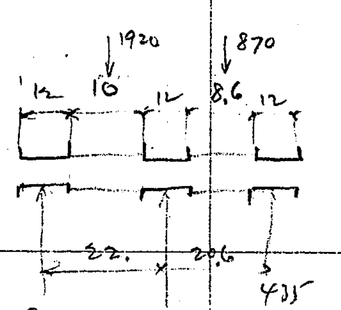
$\frac{0.19 \times 18.6^2}{8} = \frac{}{4300}$

1st wheel $237 \times 7.8 = 1900$

$\frac{0.19 \times 15.6^2}{8} = \frac{}{1900}$

$\frac{19 \times 18.6^2}{8}$

3rd shaft



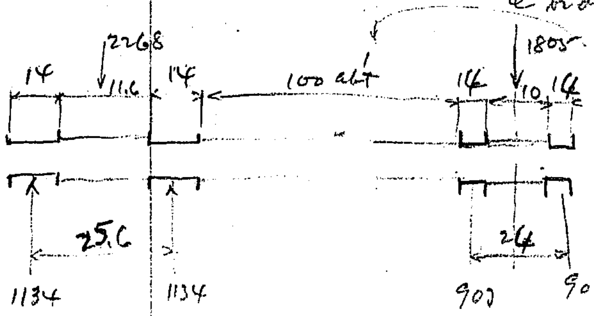
3rd pinion $m = 960 \times 11 = 10500$

$\frac{0.30 \times 22^2}{8} = \frac{}{10500}$ kg cm

2nd wheel $435 \times 10.3 = 4500$

$\frac{0.30 \times 20.6^2}{8} = \frac{}{4500}$

4th shaft



4th pinion $m = 1134 \times 12.8 = 14500$

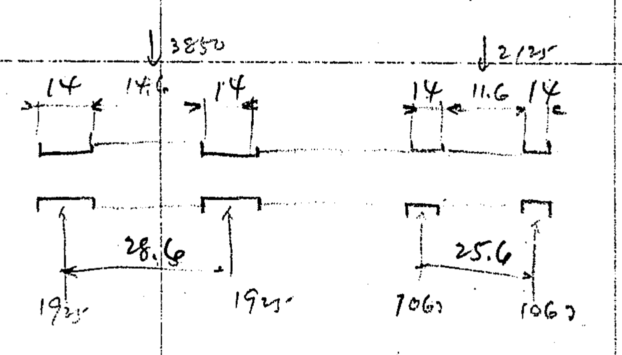
$\frac{0.35 \times 25.6^2}{8} = \frac{}{14500}$ kg cm.

3rd wheel $903 \times 12 = 10,800$

$\frac{0.35 \times 24^2}{8} = \frac{}{10800}$

no wheel $\frac{0.35 \times 11.4^2}{8} = 600$

5th shaft



main pinion $m = 1925 \times 14.3 = 27500$

$\frac{0.50 \times 28.6^2}{8} = \frac{100}{27600}$ kg cm.

4th wheel $1063 \times 12.8 = 13600$

$\frac{50 \times 25.6^2}{8} = \frac{}{13600}$

JIUN MASUDA
CONSULTING ENGINEER
~~IIII~~ BLDG, TOKYO
SHOWA

CALCULATIONS FOR

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

CHECKED BY __________ DATE __________ **PAGE NO** 6.

Combined moment due to Torsion and bending

Equiv. torsional moment $T_E = \sqrt{(K_m M)^2 + (K_t T)^2} = 1.50\sqrt{M^2+T^2}$ for $K_m = K_t = 1.50$

Equiv. bending moment $M_E = \frac{3}{8} K_m M + \frac{5}{8}\sqrt{(K_m M)^2 + (K_t T)^2} = 0.1875\left(3M + 5\sqrt{M^2+T^2}\right)$ " "

	Bending M (kg cm)	Torsion T (kg cm)	M^2	T^2	$\sqrt{M^2+T^2}$	T_E	M_E	reqd. dia of shaft	use	bearing length
1st shaft										
Pinion	700	8000	0.5(10)^6	64(10)^6	8000	12100	8000	48.2	50 mm φ	85 mm (90)
wheel	—									
								no wheel — 49		use
2nd shaft										
Pinion	4300	14800	18.5(10)^6	219(10)^6	15410	23100	16900	59.8	60	105 (110)
wheel	1900	"	3.6(10)^6	"	14920	22400	15100	59.2	60	
3rd shaft										
Pinion	10500	30600	110.3(10)^6	937(10)^6	32350	48500	36200	76.6	77	135 (140)
wheel	4500	"	20.3(10)^6		30900	46400	31500	75.5	76	
4th shaft										
pinion	14500	36100	210.2(10)^6	1303(10)^6	38900	58300	44600	81.5	82	145 (150)
wheel	10800	"	116.6(10)^6	"	37680	56500	41400	80.5	81	
	600		0.4(10)^6	"	36100	54100	34200	79.4	80	
5th shaft										
pinion	27600	61200	762.0(10)^6	3745(10)^6	67180	100800	78500	97.7	98	145 (150)
wheel	13600	"	185.0(10)^6	"	62700	94100	66400	95.5	96	

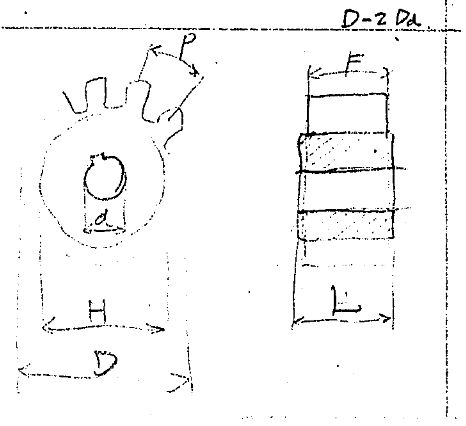
Required diameter of shaft:

for Equiv. torsional moment $d_t = \sqrt[3]{\frac{16 T_E}{S_s \pi}} = 0.210\sqrt[3]{T_E}$ for $S_s = 550$ kg/cm² Steel shaft

for " bending " $d_m = \sqrt[3]{\frac{32 M_E}{S\pi}} = 0.210\sqrt[3]{M_E}$ for $S = 1100$ " "

			1st	2nd	3rd	4th	5th
Shaft dia	d.		5.0	6.0	7.7	8.2	9.8
Cir. pitch	P		(P) 1.885	(w) 1.885	2.8274	3.7699	4.3982
				(P) 2.8274	3.7699	4.3982	6.2832
Pitch dia.	D	pinion	9.0	13.5	18.0	21.0	30.0
face	F		5.6	7.0	10.6	11.6	14.6
hub dia	H	0.085D+3.5P	1.765 / 6.60 } 7.4	1.15 / 9.9 } 11.	1.53 / 13.2 } 14.7	1.79 / 15.4 } 17.2	2.9 / 22.0 } 24.9
hub length	L	1¼F or 1¼d	7.0	8.75	13.3	14.5	18.3
dedendum	Da.		0.7	1.05	1.40	1.633	2.333
	D-2Da.		7.6 ✓	11.4 ✓	15.2 ✓	17.7 ✓	25.3 ✓

30.0 / 4.7 / 25.3



255 / 220 / 2455

増田淳氏関係資料
(独立行政法人 土木研究所蔵)

Enoura Bascule Bridge,
Rear Spring Buffer.

Kinetic energy of moving part in unif. speed.

$E = 1.25$ kgm or 125 kg.cm.

stroke of buffer assumed 4.0 cm
max. pressure of spring for one buffer

$P = \frac{125}{2} \times \frac{1}{4.0} \times 2 = 31.3$ kg req'd.

design a spring whose deflection will be 4.0cm under a load of 50 kg

R=5.0

d=1.0

$\frac{2R}{d} = \frac{10}{1} = 10$

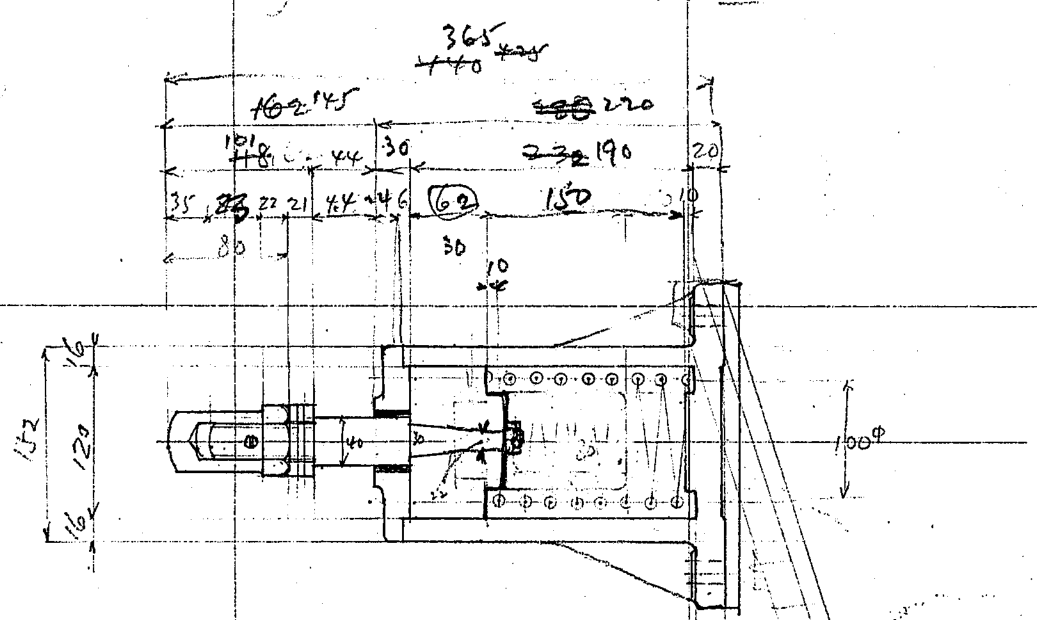
$f = \frac{32PR^2l}{\pi G d^4} = \frac{32PR^2 \times 2\pi nR}{\pi G d^4} = \frac{64R^3}{Gd^4} nP$

for $R=5$, $d=1$, $G=740{,}000$

$f = \frac{64 \times 5^3}{740000 \times 1^4} nP = 0.108\,nP$

for $n = 8$, $P = 50$

$f = 0.108 \times 8 \times 50 = 4.32$ cm.



518
466
58

518
400
118

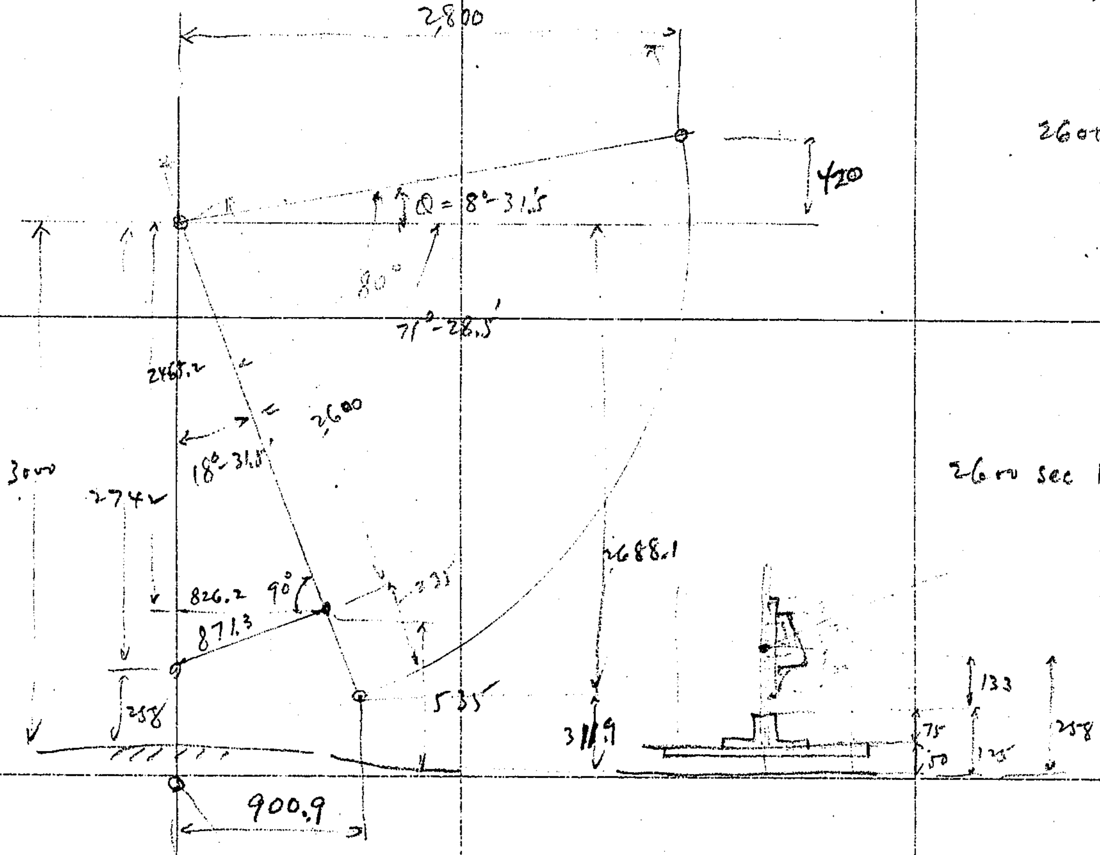
100

JIUN MASUDA
CONSULTING ENGINEER
SHOWA BLDG, TOKYO

CALCULATIONS FOR

MADE BY K. I. DATE 9-8-11 FILE NO
CHECKED BY DATE PAGE NO (2)

Enoura-Bashi for Mie-Ken
Rear Spring Buffer.



$\tan \theta = \frac{420}{2800} = 0.15000 \quad \theta = 8°-31.5'$

$2600 \tan 18°-31.5' = 2600 \times 0.3351 = 871.3$

1.05449 / 16 / 1.05465

3346 / 5 / 3351

$2600 \sec 18°-31.5' \doteq 2600 \times 1.05465 = 2742.1$

.31730 / 46 / 31776

0.94832 / − 15 / 0.94817

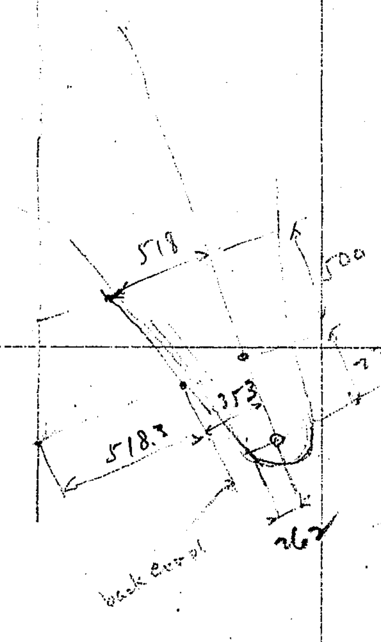
$2600 \sin 18°-31.5' = 2600 \times 0.31776 = 826.176$

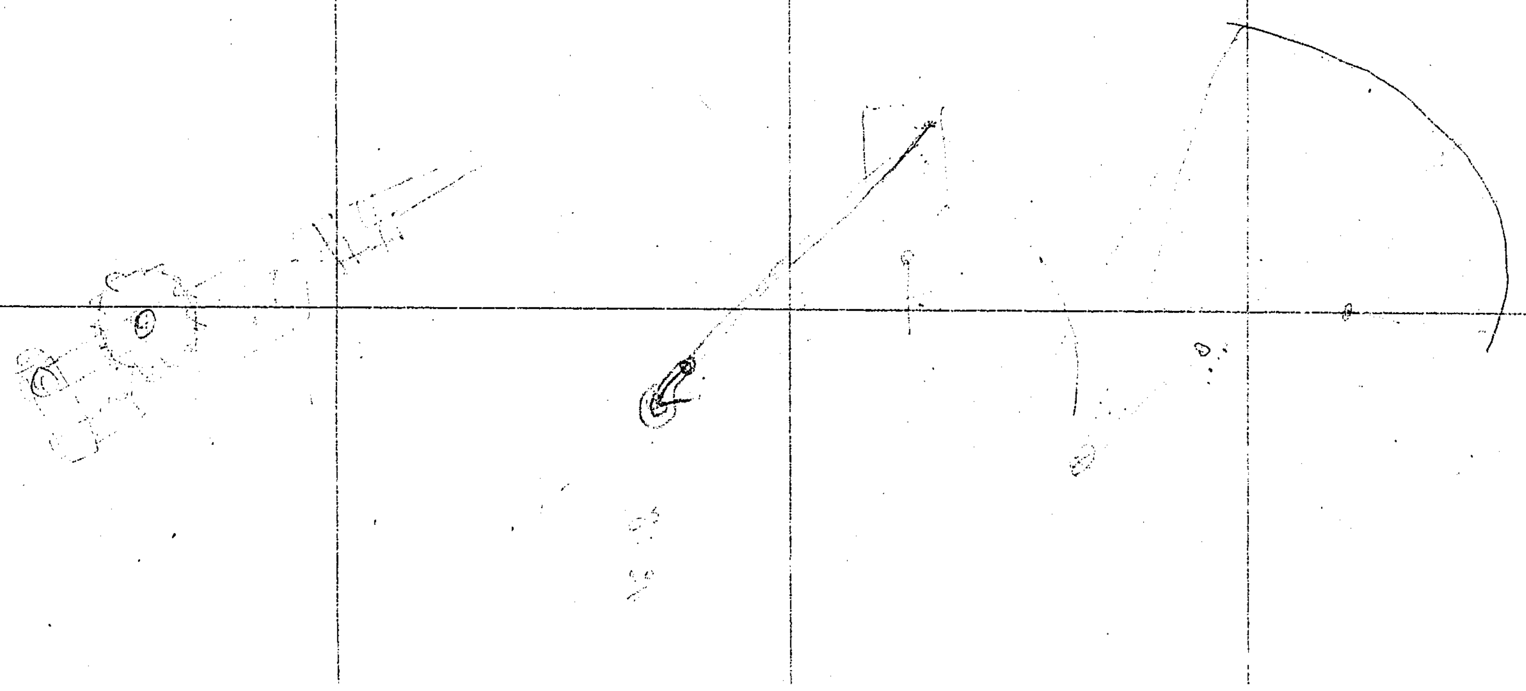
$2600 \cos \quad " \quad = 2600 \times 0.94817 = 2465.242$

$2835 \times 0.31776 = 900.85$

$2835 \times 0.94817 = 2688.06$

2690.62





JIUN MASUDA
CONSULTING ENGINEER
BLDG, TOKYO
SHOWA

CALCULATIONS FOR

MADE BY K. I. DATE 9-8-10 FILE NO
CHECKED BY DATE PAGE NO

Enoura Bascule Bridge

Rear Spring Buffer.

Kinetic energy of moving part in unif. speed,
$E = 1.25$ kgm. or 125 kgcm.

$R = 4.0$, $d = 1.0$
$\frac{2R}{d} = \frac{8}{1} = 8$

Stroke assume $f = 5.0$ cm, $P = \frac{125}{5} \times 2 = 50$ kg, ($\frac{50}{2} = 25$ kg for 1 spring) allowable max stress $S = 5600$ kg/cm²
$G = 740{,}000$

volume of spring steel $= V_c = \frac{2G \cdot Pf}{S^2} = \frac{2 \times 740{,}000 \times 25 \times 5}{5600^2} = 5.9$ cm³

and $V_c = \frac{1}{4}\pi d^2 l = \frac{\pi \times 1^2 l}{4} = 0.7854\, l$

$\therefore l = \frac{5.9}{0.7854} = 7.52$ cm

$f = \frac{32PR^2 l}{\pi G d^4} = \frac{32 \times 25 \times 4^2 \times 7.52}{\pi \times 740{,}000 \times 1} = 0.44$

$Pf = \frac{S^2 \pi d^2 l}{8G}$

$R = 2.4$, $d = 0.6$
$\frac{2R}{d} = \frac{4.8}{0.6} = 8$

$l = 2n\pi R = 8\pi \times 2.4 = 60.3$ cm

$f = \frac{32 \times 25 \times 2.4^2 \times 60.3}{\pi \times 740{,}000 \times 0.6^4} = 0.922$ cm

$P = \frac{5600 \times \pi \times 0.6^3}{16 \times 2.4} = 99$ kg

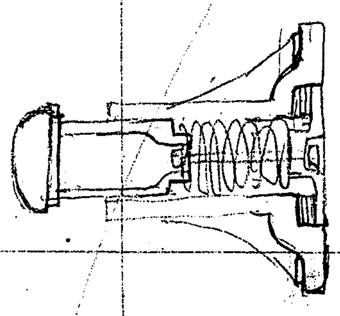
$f = \frac{32 \times 25 \times 2.4^2 \times 120.6}{\pi \times 740{,}000 \times 0.6^4} = 1.84$ cm

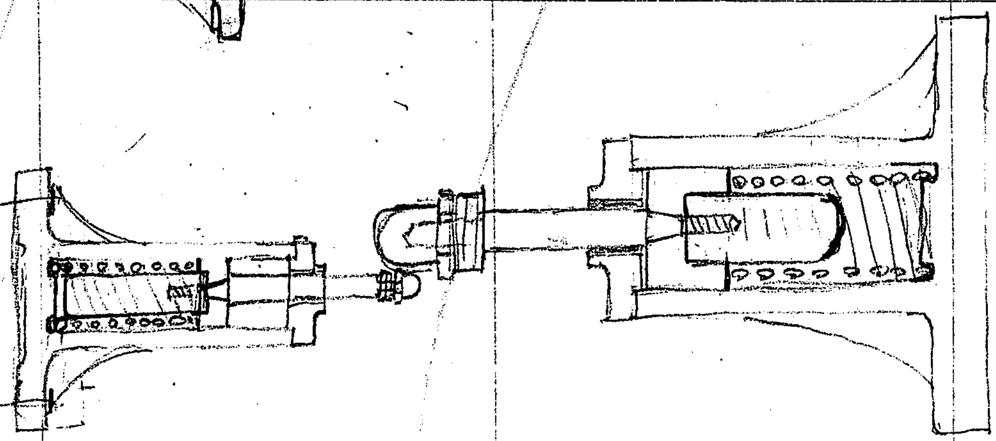
for $P = 40$ kg: $f = 1.84 \times \frac{40}{25} = 2.95$ $40 \times 2.95 / 2 = 59$ $59 \times 2 = 118$

$\frac{2R}{d} = \frac{10}{1} = 10$, $d = 1.0$

$f = \frac{32PR^2 l}{\pi G d^4} = \frac{32PR^2 n \pi 2R}{\pi G d^4} = \frac{64nR^3}{Gd^4}P = \frac{64 \times 5^3}{740{,}000 \times 1^4} nP$

$= 0.0108\, nP = 0.0108 \times 10 \times 50 = 5.4$ cm
($n = 8$, $P = 50$) $= 0.0108 \times 8 \times 50 = 4.32$ cm





$25 \times 2 = 50$
$50 \times 72 = 3600$ kgcm
$\frac{50 \times 12^2}{2}$

増田淳氏関係資料（独立行政法人 土木研究所蔵）

JIUN MASUDA
CONSULTING ENGINEER
~~BLDG~~ BLDG, TOKYO
SHOWA

MADE BY K. I. DATE 9-8-7 FILE NO
CHECKED BY DATE PAGE NO

CALCULATIONS FOR

Enoura Bascule Bridge

Design of front air-buffer.

Kinetic energy of moving part in unif. speed.

$E = 1.25\ kgm \times \frac{1}{2} = 0.6\ kgm$

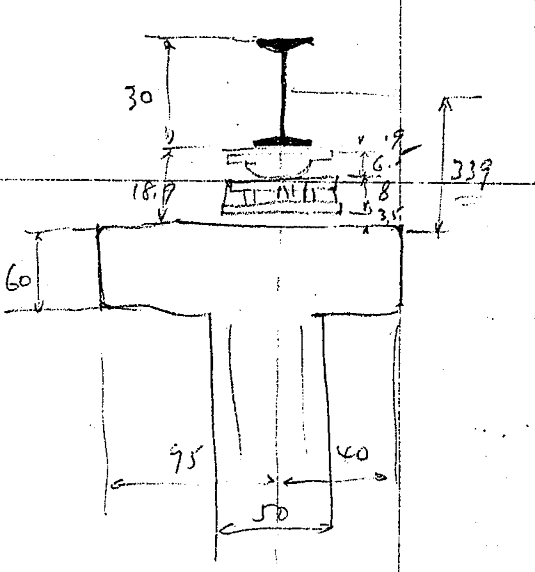
d = diameter of cylinder

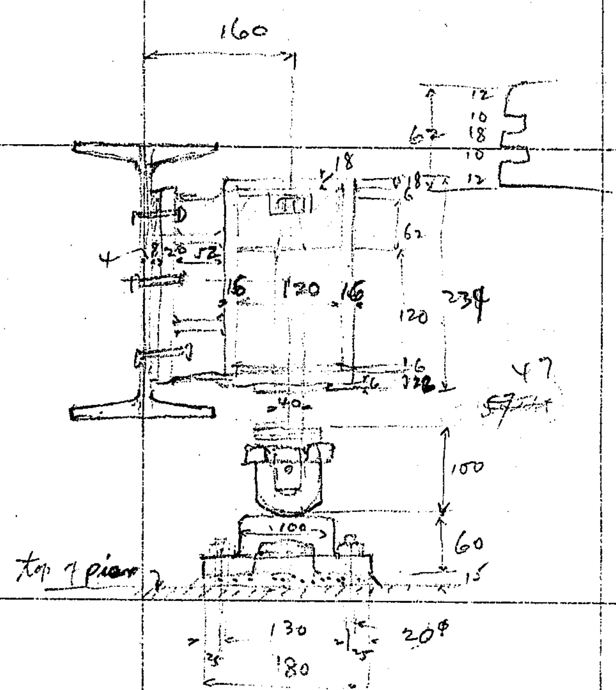
p = max. unit air pressure in cyl. limitted 5 kg/cm²

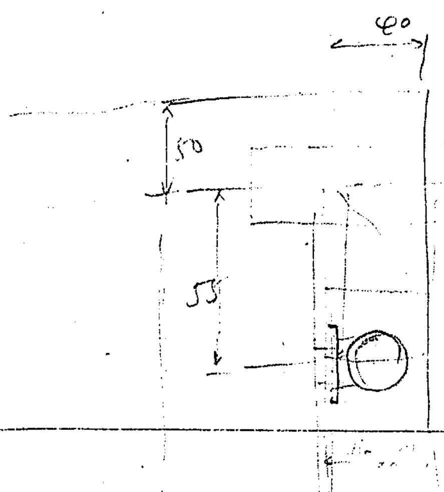
s = stroke in cm assumed 12

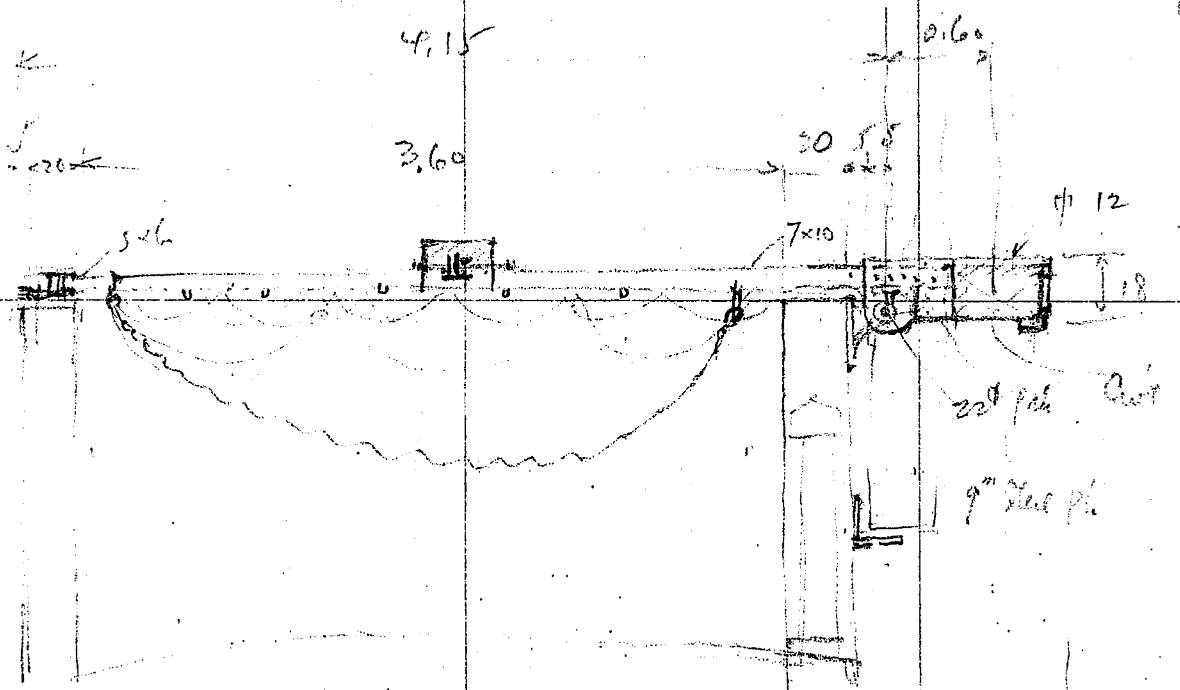
η = Efficiency of buffer say 50%

$d = 15.96\sqrt{\frac{0.625}{5\times12\times0.5}} = 15.96\times0.145 = 2.3\ cm$ use 120 mm φ × stroke 120 mm









2nd 5×6 = 30
4 7×80 = 70/100 +2 = 10 cm²

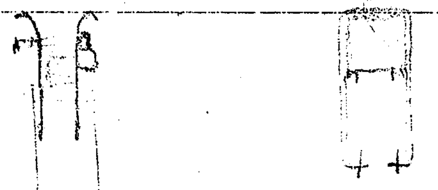
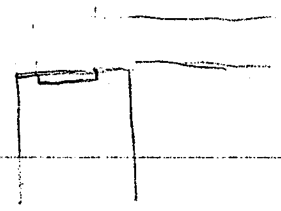
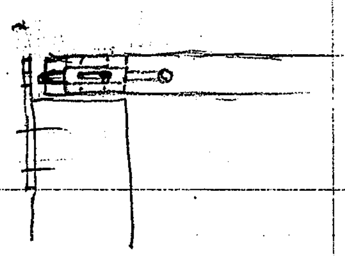
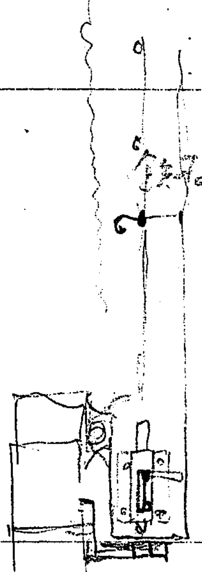
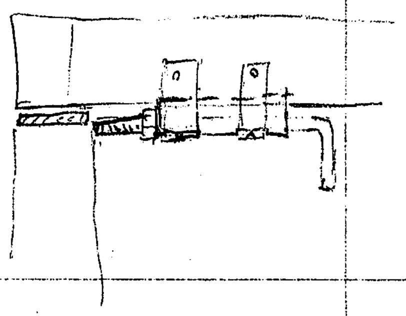
$\frac{650}{1000}$ = 3.25 kg/m
3.25 × 4.15 = 13.5 kg
.433 × 4.15 = 1.80 m

13.5 × 1.8 = 24.3 kgm

Cut. = $\frac{24.3}{0.6}$ = 40.5 kg

vol. of cut. 40.5 / 0.00725 = 5600 cm³

~~18 × 15 × 25 = 6750~~
18 × 13 × 25 = 5850

470 × 9 × 775 @ 33.2 × 25.7 × .34 = 8.7 kgm

24.3
− 8.7
15.6 kgm

cut. = $\frac{15.6}{0.6}$ = 26 kg

or $\frac{26}{.00725}$ = 3600 cm³

Cut. 16 × 10 × 25 = 4000

木 13.5
鉄 8.7
錘鉄 36.0
58.2 kg

12.85

13.5
20.0
51
84.5 kg

30 × ~~105~~ .25 = 5

24.3
5.1
19.0
$\frac{19.0}{0.4}$ = 47.5 kg / .00725 = 6550 cm³

×25×20 = 8500 cm³

12 × 30 = 360 × 18 cm

~~12×30×20~~ 14 × 20 × 25

180
20
160

190 6

JIUN MASUDA
CONSULTING ENGINEER
~~IIII~~ SHOWA BLDG, TOKYO

CALCULATIONS FOR

MADE BY______ DATE______ FILE NO______
CHECKED BY______ DATE______ PAGE NO______

module 4

$P = 12.566$ mm

$l = 3P = 37.698$

$d = \frac{l}{1.143} = 33$ mm

$33 - 9.32 = 23.68$

$d' = 74 \times 4 = 296$ mm

module 4.5

$P = 14.137$

$l = 42.411$

$d = 37.1$

$37.1 - 10.5 = 26.6$

$d' = 74 \times 4.5 = 333$ mm

$\frac{43\pi}{50} = 2.7$ cm

$P = 15$ mm

$l = 2P = 30$

$\cot 20^\circ = 2.74748 = \frac{3.1416\,d}{l}$

$l = \frac{3.1416}{2.74748}\,d \doteqdot 1.143\,d$

for $l = 3.0$ cm

$d = \frac{l}{1.143} = \frac{3.0}{1.143} = 2.62$

$18.85 \times 2 = 37.7$

P 20

$l = 40$

$d = \frac{40}{1.143} = 35.0$

35.0
16
19.0

$\frac{45}{1.143} = 39.4$ — d

39.4
10.6
28.8

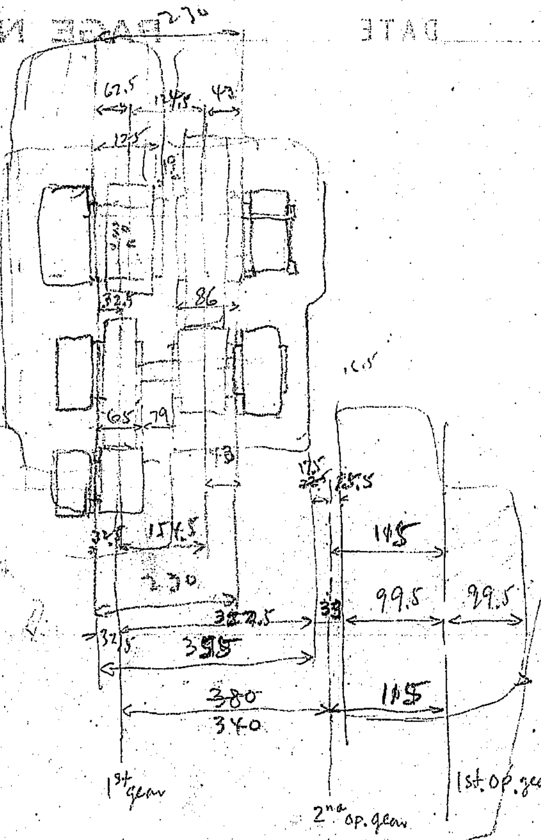
$\frac{74 \cdot 15}{\pi} = 353$

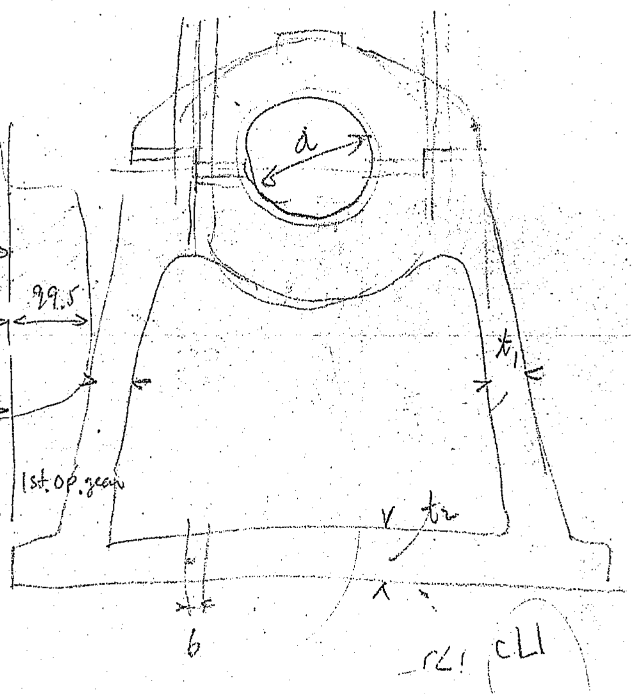
20°

24.0

33.1
14
19

39.4
10.0
29.4





d	t_1	t_2	t_3 (web)	b (bolt base)
50	12.5	22	12.5	
55	15	23	15	18
70	20	28	18	20
86	25	32	20	
110	28	35	~~25~~	22

	p	w
1st shaft	68	86
2nd	86	120
3rd	120	134
4th	134	160

19,150

48,730
38,640

137,800
103,720

184,310
166,200
123,260

483,000
39[illegible]

1466

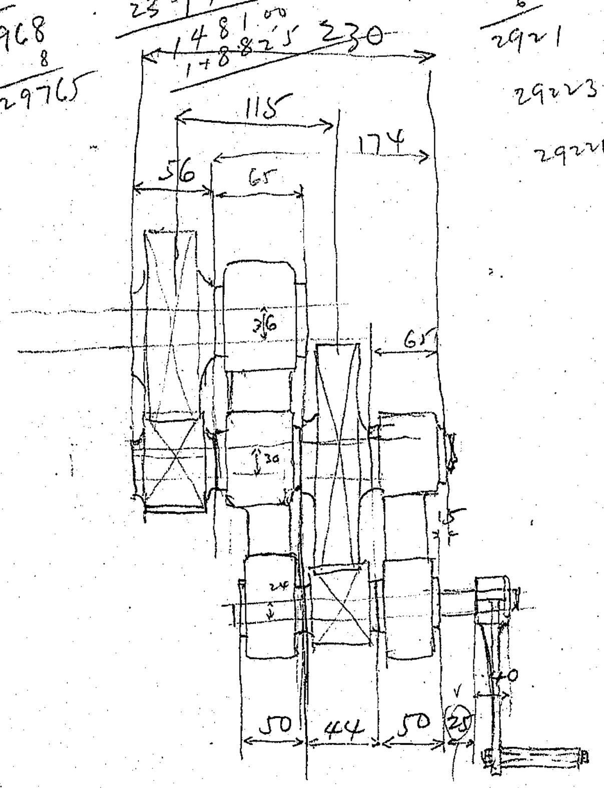
$20^2 = 400$

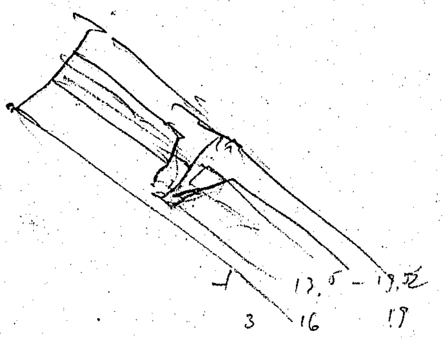
$147.5^2 = 21756.25$

22156.25 (148.85
1
121
24 96
4 2556
288 2304
8 25225
2968 23744
8 148100
29765 148825

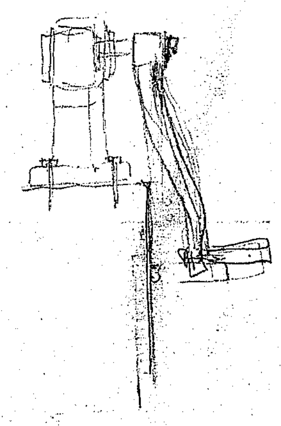
21756.25
400
21356.25 (146.137
1
113
24 96
4 1756
286 1716
6 4025
2921 2921
110400
29223 87669
29226 2273100

65
28
22
115

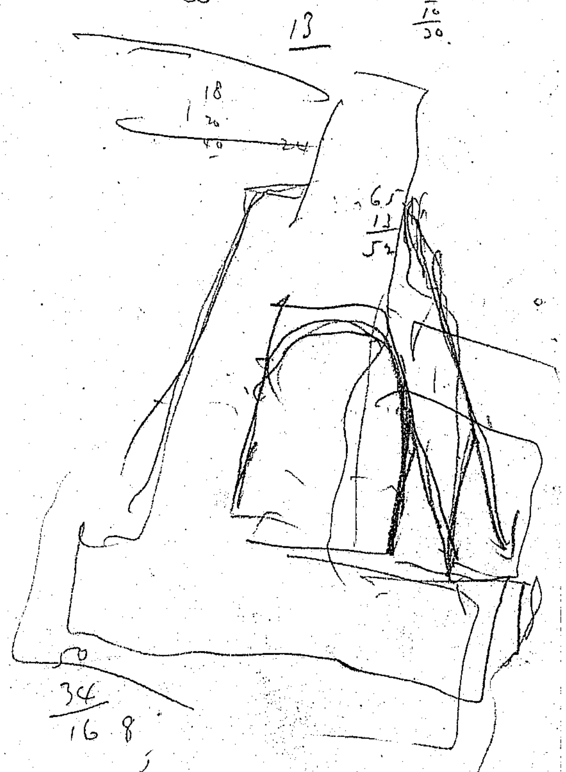




3 16 19
1 19 208



20 13 20/10/30



50
34
16 8

40 33 28

40
12
8 28