JIUN MASUDA
CONSULTIEG ENGINEER
SEIYU BLDG, TOKIO

MADE BY______ DATE______ **FILE NO**______

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CALCULATIONS FOR

熊本縣坪井川橋設計々算書

昭和三年七月

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

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CALCULATIONS FOR

Tsuboi-gawa-Bashi for Kumamoto Ken.

General data

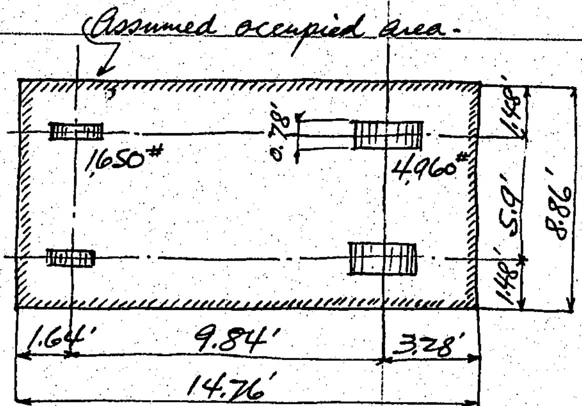
Width of Roadway = 15'0" clear, Bascule span length 50'0" Fixed span length 25'0"

Assumed Loading.

Uniform Load on Roadway $w = \frac{100000}{170+l} \geqq 500\ kg/m^2$ or say 100 #/□'

where w = uniform load in kg/m^2.
l = span length in meters.

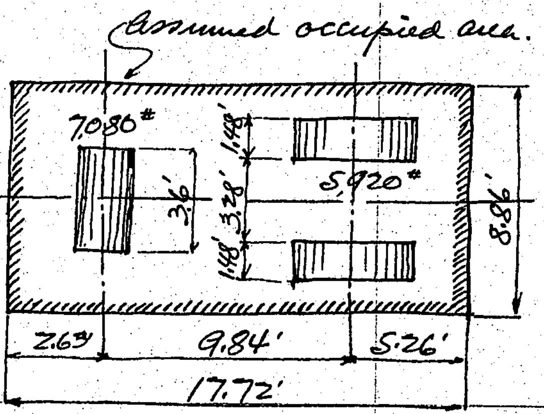
6 ton motor truck loading



1. Row of Motor traffic on Roadway with occupied width of 8.86'
Unoccupied space of motor truck shall be filled with the uniform load specified above.
Impact into consideration.
Impact.
$i = \frac{20}{60+l} \geqq 0.3$

where i = Coefficient of impact.
l = loaded length of span in meters.

8 ton Road Roller loading.



One Road Roller on span without impact.

Allowable working strength.

Structural steel or Reinforcing bars.

Tension	1200 kg/cm^2 net or 17000 #/□" net.	
Compression	1,200 " gross or 17,000 " gross.	
Compression members.	1,500 (1-0.0055 l/r) $\geqq$ 1,000 kg/cm^2 or 14,000 #/□"	

where l = length of member in centimeters.
r = radius of gyration of section (least).

Bending stress. Tension 1200 kg/cm^2 net or 17000 #/□" net.
Compression 1200 (1-0.012 l/b) $\geqq$ 1100 kg/cm^2
equivalent 17000 (1-0.012 l/b) $\geqq$ 15600 #/□"
where l = unsupported length in centimeters (or inch)
b = width of flange in centimeters (or inch)
For Pin fibre 1800 kg/cm^2 net or 25600 #/□" net.

Shearing strength

For plate	900 kg/cm^2	or = 12,800 #/□"
" pin	900 "	"
" reinforcing bars.	900 "	"
" machine driven shop rivets	850 "	12,100 "
" " " field rivets	750 "	10,600 "

Bearing values.

For pin	1,800 kg/cm^2	or = 25,600 #/□"
" machine driven shop rivets	1,700 "	24,100 "
" " field rivets	1,500 "	21,300 "

Roller 45d equivalent 64d.
where d = diameter of Roller in centimeters (or inch).

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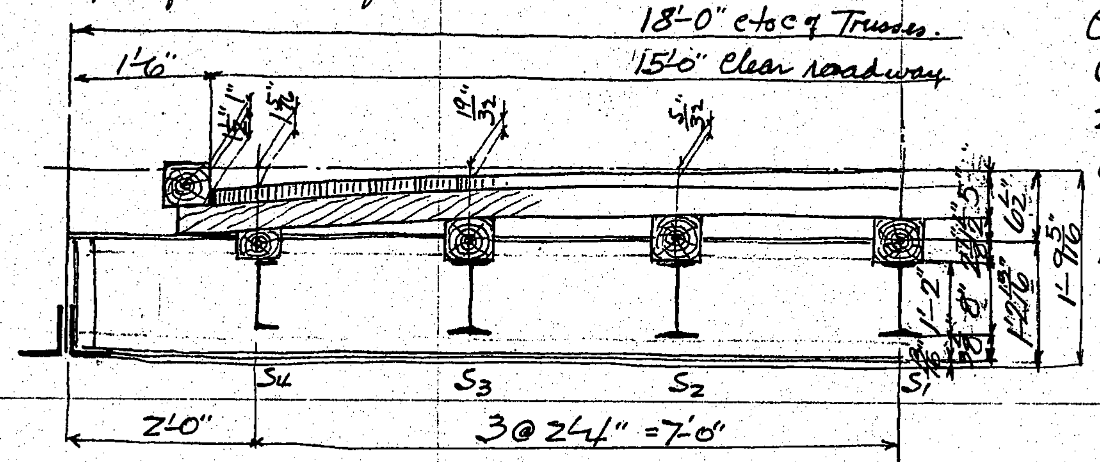
CALCULATIONS FOR

Tsuboi gawa Bashi for Kumamoto Ken.

Reinforced concrete 1:2:4 mixture

Direct Compression	35 kg/cm²	or 500 #/□"
Bearing	45	640
Compressive fibre stress	45	640
Combined stress	35	500
Punching shear	9	128
Shear plain concrete	4	57
Bond stress plain bar	6	85
deformed bar	9	128.

Design of Timber floor



Span length 2'4" or 2.33'

Creosoted wood-block pavement 2½" thick @ 5# =	12.5#
Asphalt felt for water proofing	0.3
2½" creosoted planking	12.5
dust, water, nails etc.	1.2
	26.5 #/'

Dead Load moment $\frac{1}{10} \times 26.5 \times 2.33^2 = 14$ '#

Dead Load Shear $\frac{1}{2} \times 26.5 \times 2.33 = 31$ #

Live Load motor truck rear wheel 4960
30% impact 1490
6450 #

motor truck front wheel $\frac{1}{3} \times 6450 = 2150$ #

Distribution of wheel concentration

Contact surface between wheel and pavement			0.66'
2½" wood-block pavement distribution	2@.21	=	0.42
Longitudinal distribution	a =		1.08'
Transverse distribution	b = 0.78 + .42 =		1.20'

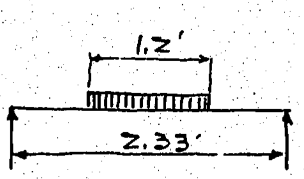
Distribution assumed 2.0' wide

Motor truck rear wheel = 6450 ÷ 2 = 3225 # per ft. strip.

moment at center $\frac{3225}{2} \times \frac{2.33}{2} = 1880$ '#

less $\frac{3225}{2} \times \frac{1.2}{4} = -484$

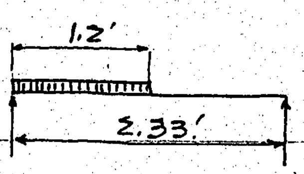
1,396 '#



For continuity of span take moment as 0.8 × 1,396 = 1,116 '#

Dead load moment = 14

total moment = 1,130 '#



L.L. Shear $3325 \times \frac{1.73}{2.33} = 2,395$ #

Dead Load shear 31

Total Shear 2,426 #

Assumed 2½" planking fibre stress $= \frac{1130 \times 12 \times 6}{12 \times 2.5^2} = 1085$ #/□" ok

Unit shear $= \frac{2,426}{12 \times 2.5} = 81$ #/□" ok

Design of Stringers Span length 10'-0"

Dead Load

Floor	2.33 @ 26.5# =	61.7
Nailing piece	15 × 37 @ 60.0 =	11.0
Stringer assumed.		18.0
		90.8 # per lin ft. of span.

Dead load moment $= \frac{1}{8} \times 90.8 \times 10^2 = 1,130$ '#

End Shear $= \frac{1}{2} \times 90.8 \times 10 = 454$ #

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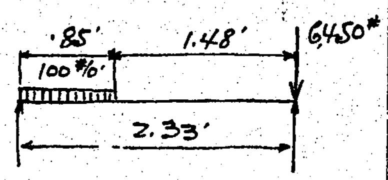
Tsuboi Gawa Bashi for Kumamoto Ken.

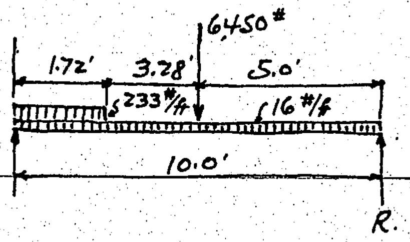
Live Load.



Uniform load on stringer due to side of truck $= \frac{100 \times .85 \times .425}{2.33} = 16^{\#}$ per lin ft of stringer

Reaction R.

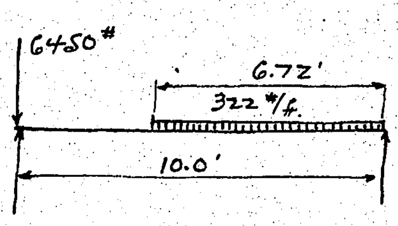
motor truck rear wheel.	$6450 \div 2 =$	$3,225^{\#}$
$16^{\#}$ uniform load.	$16 \times 10 \div 2 =$	80
$233^{\#}$ "	$\frac{233 \times 1.72 \times .86}{10} =$	35
		$3340^{\#}$



Moment at center of span	$3340 \times 5 =$	$16,700'^{\#}$
less	$16 \times 5 \times 2.5 =$	-200
		$16,500'^{\#}$

End Shear

Rear wheel concentration		$6,450^{\#}$
Unif. load	$\frac{322 \times 6.72 \times 3.36}{10} =$	727
		$7177^{\#}$



Summary for moment and shear

	moment	end shear.
Dead Load	$1130'^{\#}$	454
Live Load	16500	7177
	$17,630'^{\#}$	$7631^{\#}$

Section modulus required $= \frac{17630 \times 12}{15600} = 13.55^{(in)^3}$

Use $8" \times 4"$ @ $18.01^{\#}$ I beam section modulus $= 13.99$ in³

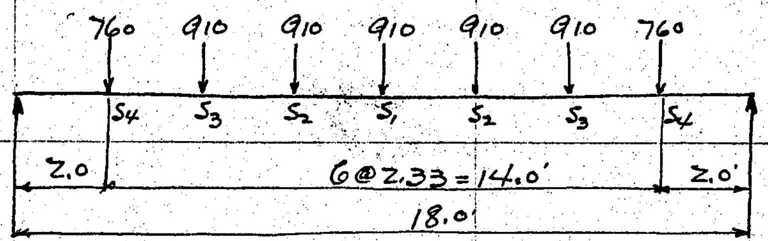
unit shear $= \frac{7831}{0.28 \times 8} = 3410^{\#}/\square"$ ok.

Design of Floor Beam   Span length 18'-0", spacing 10.0'

Dead Load.

D.L. stringer concentration

$S_1, S_2, + S_3$. $90.8 \times 10 = 908^{\#}$ Call this $910^{\#}$ (page 2)



S_4 Floor	1.92 @ 26.5	$= 50.5$
nailing piece	.5 × .25 @ 60	$= 7.5$
Stringer		$= 18.0$
		$76.0^{\#}/f$

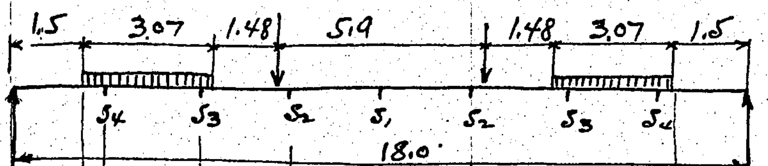
$76.0 \times 10 = 760^{\#}$

Reaction $= 2.5 \times 910 = 2280$
760
$3,040^{\#}$

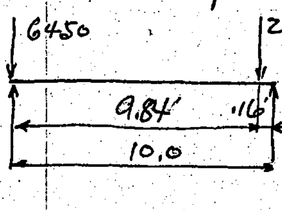
Dead load moment	$3040 \times 9.0 =$	$27360'^{\#}$
less	$910 \times 3 \times 2.33 =$	6350
"	$760 \times 3 \times 2.33 =$	5,310
		$15,700'^{\#}$
Floor beam assumed $46^{\#}/f$	$\frac{1}{8} \times 46 \times 18^2 =$	1,870
		$17,570'^{\#}$

End Shear	Int. floor beam	End floor beam
Stringer concentration	3040	1,520
wt. of floor beam $46 \times 9 =$	412	412
	$3,452^{\#}$	$1,932^{\#}$
details of floor + stringer say	78	68
	$3,530^{\#}$	$2,000^{\#}$

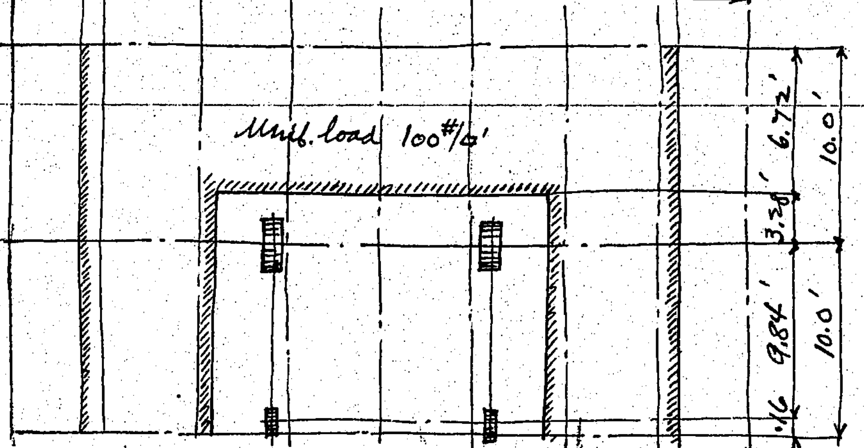
Live Load. motor truck rear wheel concentration with impact $= 6,450^{\#}$
front wheel " " " $= 2,150^{\#}$



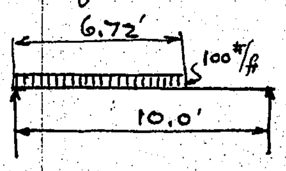
Reaction on floor beam due to front wheel



$\frac{2150 \times .16}{10} = 34^{\#}$
rear wheel $= 6450$
$6,484^{\#}$



Uniform load on the behind of motor truck



$\frac{100 \times 6.72 \times 3.36}{10} = 226^{\#}/f$ of floor beam

Uniform load on the side of truck
$100 \times 10 = 1000^{\#}/f$ of floor beam.

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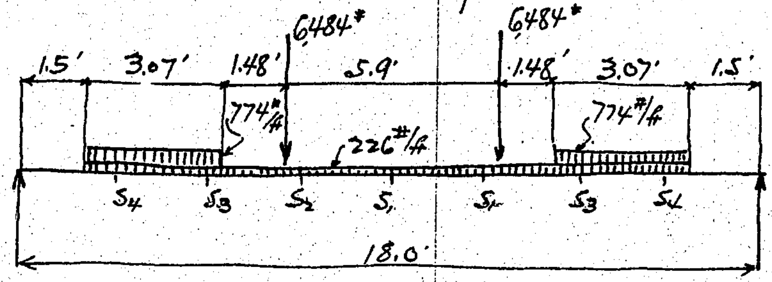
CALCULATIONS FOR

Tsuboi gawa Bashi for Kumamoto Ken.

Max. Live load moment on floor beam.



Wheel concentration. reaction = 6,484 #
moment = 6480 × 6.05 = 39,200 '#
Unif. load reaction 226 × 15 ÷ 2 = 1,690 #
moment 1690 × 9 = 15,200 '#
less 1690 × $\frac{7.5}{2}$ = −6,350
8,850 '#

Unif. load. reaction 774 × 3.07 = 2,375 #
moment 2375 × 9 = 21,350
less 2375 × 5.96 = 14,150
7,200 '#

Summary for moments and shears.

	moment	End shear
Dead Load	17,370 '#	3530
Live Load	55,250	10549
	72,820 '#	14,079 #

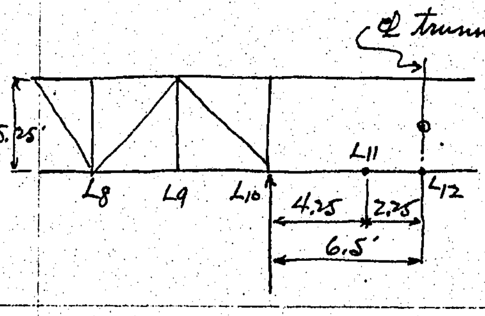
Total Live Load moment & shear

	moment	End shear
Wheel concentration	39,200 '#	6,484 #
Unif. load	8,850	1690
"	7,200	2375
	55,250 #	10,549 #

Section modulus required = $\frac{72820 \times 12}{15,600}$ = 56.0 "³

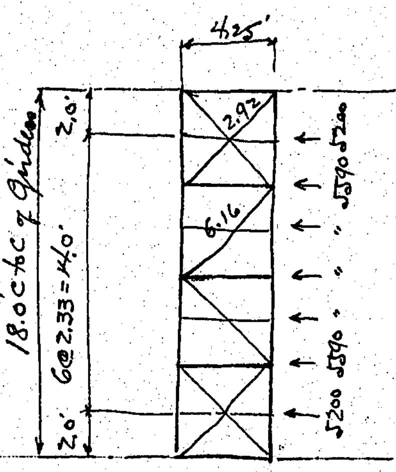
Use 1 I beam 14" × 6" @ 46.01 # section modulus = 62.946 "³ ok
Unit shear = $\frac{14,079}{0.4 \times 14}$ = 2510 #/□" ok.

Lateral Bracing between panel points L10 & L11.



Dead Load.
Floor beam concentration 3,530
lateral bracing say 300
3830 # on one panel

Total load on bracing = 3830 × 5.5 (say) × 2 = 42,200 #
or 42,200 ÷ 18' = 2345 # per lin ft. of bracing.
bracing say 55 " "
Total 2400 #



max moment at center = $\frac{2400 \times 18^2}{8}$ = 97,200 '#

End shear = 2400 × 9 = 21,600 #
Chord stress = $\frac{97200}{4.25}$ = 22,900 # tension.

S.R. = $\frac{22900}{17000}$ = 1.35 □" net (or $\frac{22900}{14,000}$ = 1.64 □" gross. for floor beam at L10)

Use 2 Ls 3" × 2½" × ⅜" = 3.84 □" − 4 × .33 = 2.52 □" net for lower flange area only.
Diagonal 0-2 stress = 21600 × $\frac{2.92}{2.13}$ ÷ 2 = 15800 # C or T

S.R. = $\frac{15800}{17000}$ = 0.93 □" net or $\frac{15800}{14000}$ = 1.13 □" gr
Use 1 L 3" × 2½" × ⅜" = 1.92 □" − .33 = 1.59 □" net ok $l/r = \frac{2.4 \times 12}{.538} = 54$
Diagonal 2-4 stress = 5590 × 1.5 × $\frac{6.16}{4.25}$ = 13870 # T
S.R. = $\frac{12200}{17000}$ = 0.82 □" net

Use 1 L 3" × 2½" × ⅜" = 1.92 □" − .33 = 1.59 □" net ok. $l/r = \frac{2.5 \times 12}{.538} = 56$

Assumed section of floor beam at L11
4 Ls 3" × 2½" × ⅜"
1 web 20" × 5/16"

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CALCULATIONS FOR

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Design of main truss. Span length 50'-0" C to C of Bearings or 56'-6" C to C of End Bearing & trunnion shaft.

Dead panel loads.

Intermediate panel load.

Floor beam concentration	=	3,530# (Page 3)
Handrail 10'@20#	=	200
main truss 10 @ 240	=	2400
lateral bracing 10 @ 30	=	300
Total		6,430#

Call this 6,500#

End panel load (at panel pt. L_0)

Say 3,300#

Panel load at L_{10}.

floor beam concentration

floor.	2.65 × 9' × 7.13 =	1,700#
nailing piece	11.1 × 3.5 × 7.13 =	277
Stringer	18 × 3.5 × 7.13 =	449
floor beam	46 × 9 =	414
		2840#

panel load

floor beam concentration	=	2840#
handrail 5'@20# assumed	=	100
main truss and girder 7.13 × 245	=	1,745
lateral bracing 7.13 × 30	=	215
		4,900#

Panel load at L_{11}.

floor beam concentration

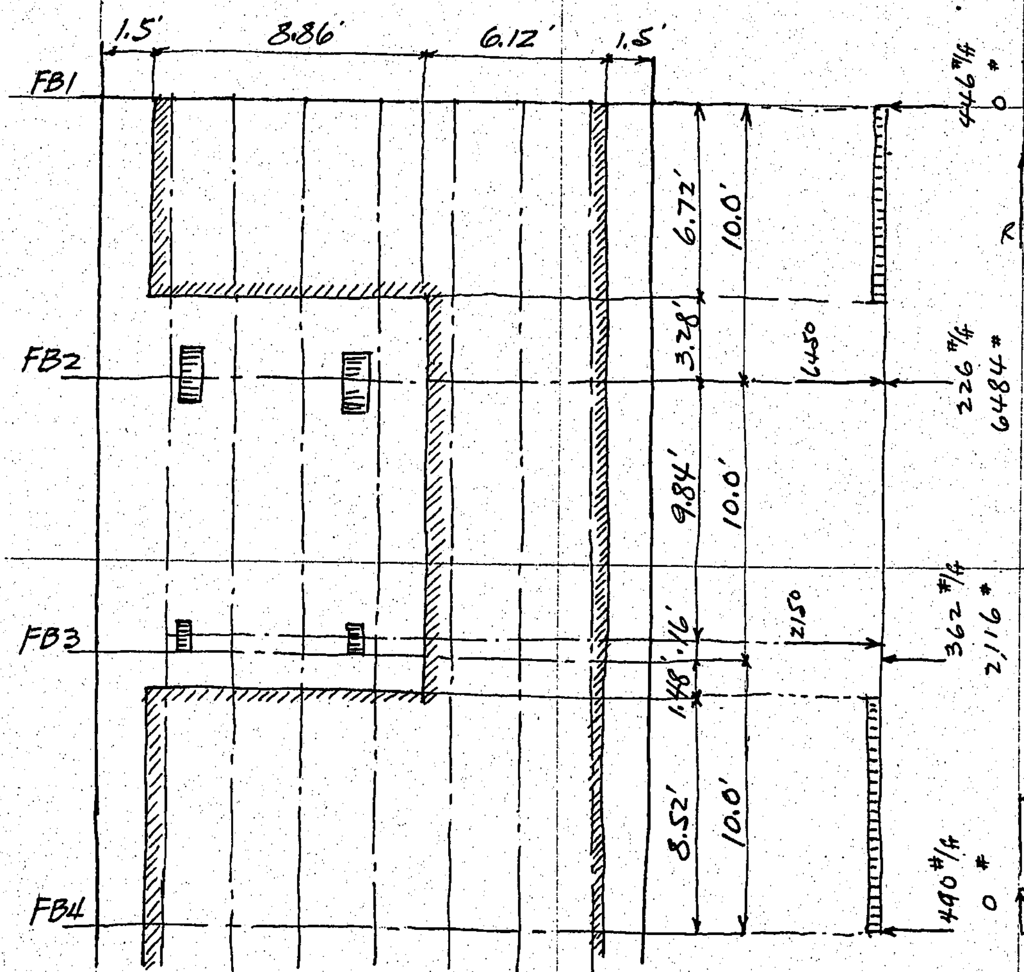
floor	26.5 × 9 × 2.13 =	508#
nailing piece	11.1 × 3.5 × 2.13 =	83
Stringer	18 × 3.5 × 2.13 =	127
floor beam	50 × 9 =	450
		1,168#

Panel load.

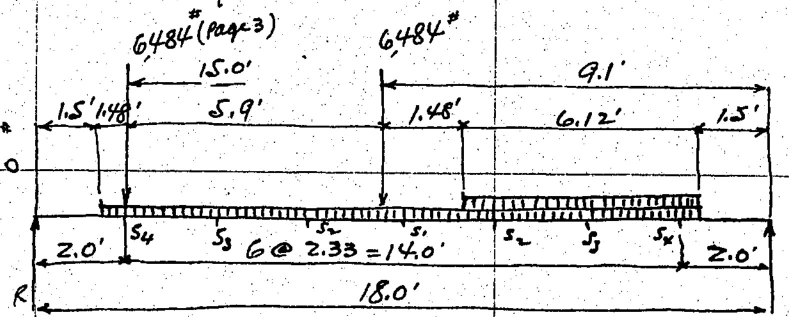
floor beam concentration		1,168#
main girder 3.25 @ 250	=	810
lateral bracing 2.13 @ 50	=	107
		2085

Call this 2,100#

Live Panel loads.



Concentration due to floor beam FB2.



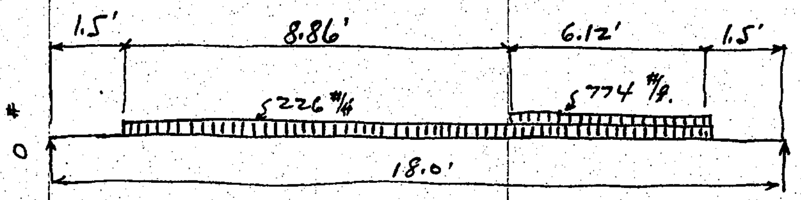
Left Reaction R.

Case of no unif load between FB1 & FB2

Wheel Conc.	6,484 × 9.1 = 59,000		59,000
"	6484 × 15.0 = 97,300		97,000
unif. load.	226 × 15 × 9 = 30,500	500 × 6.12 × 4.56 =	14,000
"	774 × 6.12 × 4.56 = 21,600		170,000
	208,400		

$R = \frac{208400}{18} = 11600\#$ $\qquad R_1 = \frac{170000}{18} = 9,500\#$

Concentration due to floor beam FB1. (rear wheel on FB2)



Unif. load. Conc. load.

226 × 15 ÷ 2 =		1695
$\frac{774 \times 6.12 \times 4.56}{18}$	=	1,200
from other panel 500 × 15 ÷ 2	=	3750
Reaction	=	6,645# Call this 6650#

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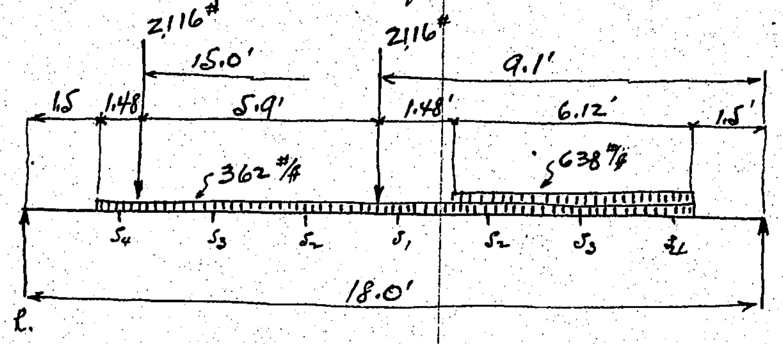
Concentration due to floor beam FB3.



Left Reaction R.

Front wheel concentration	2116 × 9.1 =	19,240
〃	2116 × 15 =	31,700
Unif. load	362 × 15.9 =	48,900
	638 × 6.12 × 4.56 =	17,800
		117,640

$R = \frac{117640}{18} = 6540^{\#}$

Concentration due to uniform load only for intermediate floor beam.

$R = 1{,}000 \times 15 \div 2 = 7{,}500^{\#}$

do. for end floor beam.

$R = 500 \times 15 \div 2 = 3750^{\#}$

Panel concentration due to floor beam at L11.

rear wheel concentration	6484 × 9.1 =	59,000
〃	6484 × 15.0 =	97,300
Uniform load	240 × 6.12 × 4.56 =	6,700
		163,000

$R = \frac{163{,}000}{18} = 9100^{\#}$

do. for uniform load only on L11

240#/ft.

$R = 240 \times 15 \div 2 = 1{,}800^{\#}$

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Stresses of main truss members.

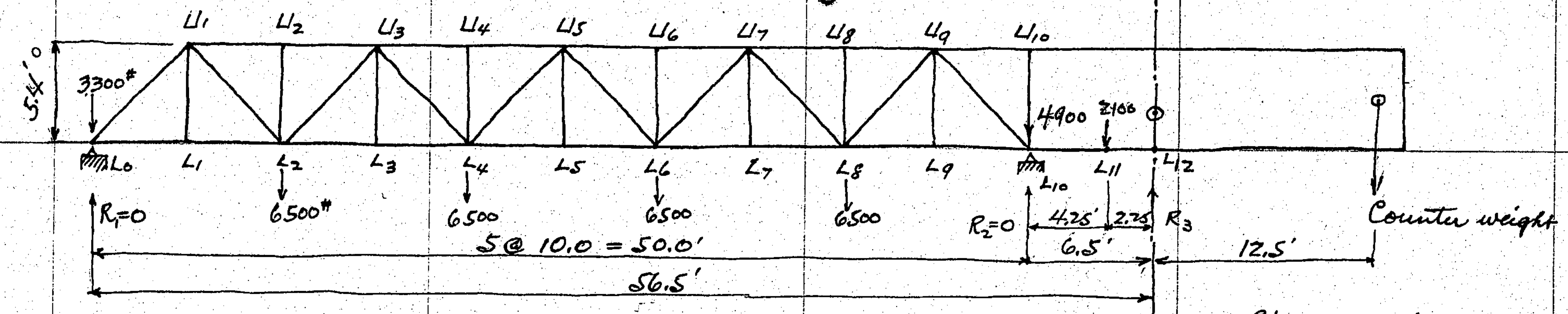
Dead Load stresses. Dead panel load. 6,500# at L_2, L_4, L_6 + L_8 (See page 5)

assumption. 3,300 at L_0

Dead load Reactions. 4,900 at L_{10}

$R_1 + R_2 = 0$. 2100 at L_{11}

℄ Trunnion shaft.



Stress + sign tension.

Dead Load stresses. lever arm 5.4'

moment at U_1	3300 × 5 = −16500'#	
〃 L_2	3300 × 10 = −33,000'#	
moment at U_3	3300 × 15 = −49500 6500 × 5 = −32,500 9800# −82,000'#	
moment at L_4	−82,000 9,800 × 5 = −49,000 −131,000'#	
moment at U_5	3300 × 25 = −82,500 6500 × 4 × 5 = −130,000 −212,500'#	
moment at L_6	−212,500 16,300 × 5 = −81,500 −294,000'#	
moment at U_7	3300 × 35 = −115500 6500 × 5 × 9 = −292500 −408,000'#	
moment at L_8	−408,000 22800 × 5 = −114,000 −522,000'#	
moment at U_9	3300 × 45 = −148,500 6500 × 16 × 5 = −520,000 −668,500'#	
moment at L_{10}	−668,500 29300 × 5 = −146,500 −815,000'#	

Chord members.

Stress L_0-L_2 = 16500 ÷ 5.4 = − 3,100# C

〃 U_1-U_3 = 33,000 ÷ 5.4 = + 6,100# T

Stress L_2-L_4 = 82000 ÷ 5.4 = − 15,200# C

Stress U_3-U_5 = 131000 ÷ 5.4 = + 24,300# T

Stress L_4-L_6 = 212,500 ÷ 5.4 = − 39,400# C

Stress U_5-U_7 = 294,000 ÷ 5.4 = + 54,400# T

Stress L_6-L_8 = 408,000 ÷ 5.4 = − 75,700# C

Stress U_7-U_9 = 522000 ÷ 5.4' = + 96,500# T

Stress L_8-L_{10} = 668,500 ÷ 5.4' = −123,700# C

Stress U_9-U_{10} = 815000 ÷ 5.4 = + 151,000# T

moment at 12.
(℄ trunnion shaft)

3300 × 56.5 = 186,500
6500 × 5 × 20 = 650,000
6500 × 4 × 6.5 = 169,000
4900 × 6.5 = 31,800
2100 × 2.25 = 4,700
1,042,000'#

Shear at 12 = 36,300 #

Between 10-12 plategirder 5'-6½" 6 to b.g flg. L's assumed.
effective depth 65.3" = 5.45' assumed

Stress at panel 12 = 1,042,000 ÷ 5.45 = ± 191,500 # T or C

moment at panel 11.

1,042,000 − 36,300 × 2.25 = − 960,300'#

flange stress = $\frac{960,300}{5.45}$ = ± 176,500 # T or C.

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JIUN MASUDA
CONSULTIEG ENGINEER
SEIYU BLDG, TOKIO

MADE BY K. Inaba. DATE 3-■-7 FILE NO
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CALCULATIONS FOR

Tsuboi-Gawa-Bashi for Kumamoto Ken

Diagonal members. D.L. Stresses.
Shear at several panels

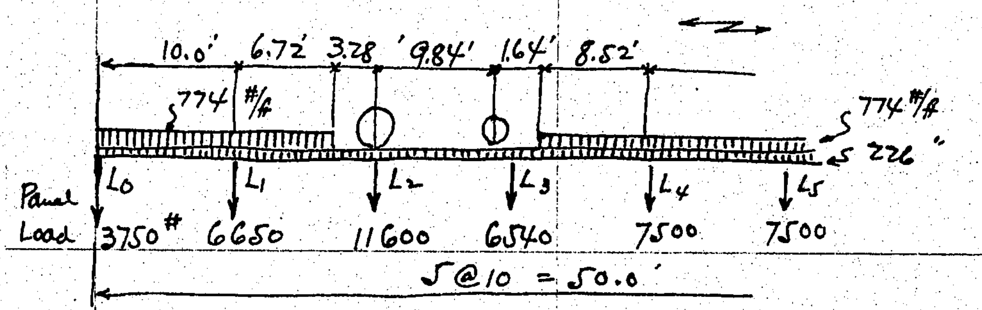
L_0-L_2		=	-3,300#	
L_2-L_4	-3300-6500	=	-9,800	
L_4-L_6	-9,800-6500	=	-16,300	
L_6-L_8	-16300-6500	=	-22,800	
L_8-L_{10}	-22,800-6500	=	-29,300	
$L_{10}-L_{11}$	-29,300-4900	=	-34,200	
$L_{11}-L_{12}$	-34,200-2100	=	-36,300#	

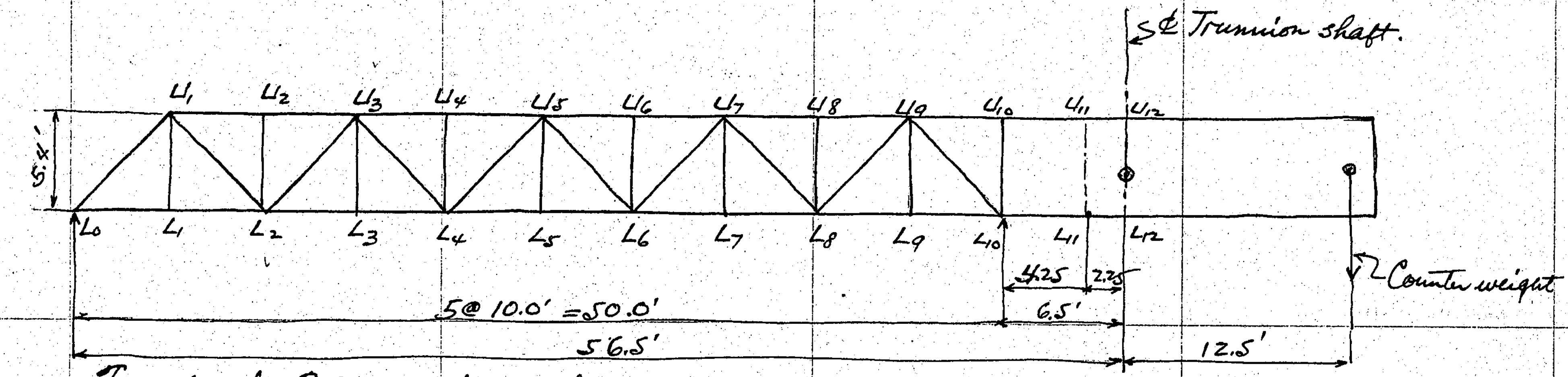
Max shear at trunnion shaft
$= -36300-245\times\frac{225}{2} = -36,600$#

Length of diagonal members $\sqrt{5^2+5.4^2} = 7.35'$
Coefficient $= 7.35 \div 5.4 = 1.36$

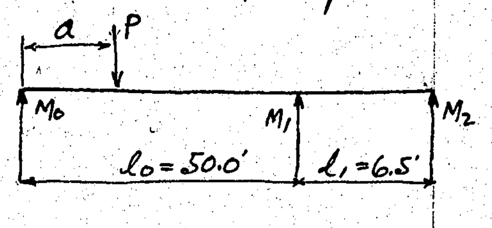
Stress $L_0-U_1 = 3,300 \times 1.36 =$	4,500# T	Stress	$U_1-L_2 =$	4,500# C
$L_2-U_3 = 9800 \times 1.36 =$	13,300 T		$U_3-L_4 =$	13,300 C
$L_4-U_5 = 16300 \times 1.36 =$	22,200 T		$U_5-L_6 =$	22,200 C
$L_6-U_7 = 22800 \times 1.36 =$	31,000 T		$U_7-L_8 =$	31,000 C
$L_8-U_9 = 29,300 \times 1.36 =$	39,800 T		$U_9-L_{10} =$	39,800 C

Live Load Stresses.
Live panel load.





Formulas for 2 span continuous beam.
Load in the 1st. span.

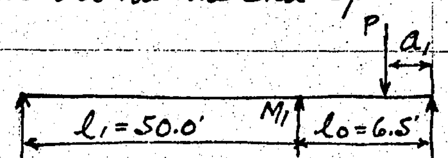


$$M_0 l_0 + 2M_1(l_0+l_1) + M_2 l_1 = -\frac{Pa}{l_0}(l_0^2-a^2) \quad \text{in which } M_0 \,\&\, M_2 = 0.$$

$$2M_1(l_0+l_1) = -\frac{Pa}{l_0}(l_0^2-a^2)$$

$$\therefore M_1 = -\frac{Pa(l_0^2-a^2)}{2(l_0+l_1)l_0} = -\frac{Pa(50^2-a^2)}{2(50+6.5)\times 50} = -\frac{Pa(2500-a^2)}{5650} \text{ 1\#}$$

Load in the 2nd span

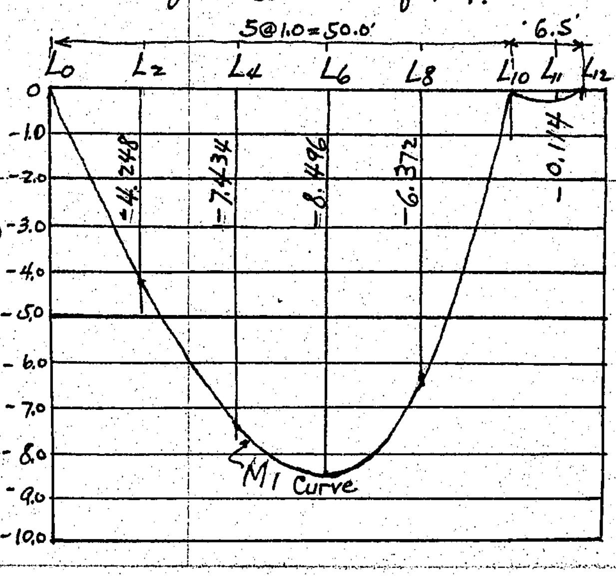


$$M_1 = -\frac{Pa_1(6.5^2-a^2)}{2(6.5+50)\times 6.5} = -\frac{Pa(42.25-a_1^2)}{734.5} \text{ 1\#}$$

Influence line of moment M_1.

Unit load at Panel pt.	a	a^2	$2500-a^2$	$-\frac{2500-a^2}{5650}$	$-\frac{a(2500-a^2)}{5650}$
L_0	0	0	2,500	-0.4425	0
″ L_2	10	100	2,400	-0.4248	-4.248
″ L_4	20	400	2,100	-0.3717	-7.434
″ L_6	30	900	1,600	-0.2832	-8.496
″ L_8	40	1600	900	-0.1593	-6.372
″ L_{10}	50	2,500	0	0	0
	a_1	a_1^2	$42.25-a_1^2$	$-\frac{42.25-a_1^2}{734.5}$	$-\frac{a_1(42.25-a_1^2)}{734.5}$
″ L_{11}	2.25	5.063	37.187	-0.0506	-0.114
″ L_{12}	0	0	42.250	-0.0575	0

Influence line of M_1.



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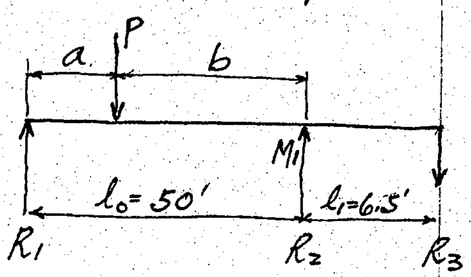
CALCULATIONS FOR

Tsuboi-Gawa-Bashi for Kumamoto Ken.

Influence line of Reactions
Load at 1st span.

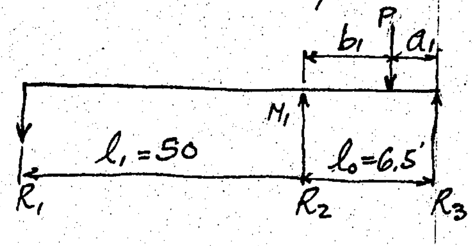


$$R_1 = \frac{Pb}{l_0} + \frac{M_1}{l_0} = \frac{Pb+M_1}{l_0} = \frac{Pb+M_1}{50}$$

$$R_2 = \frac{Pa}{l_0} - \frac{M_1}{l_0} - \frac{M_1}{l_1} = \frac{Pa-M_1}{l_0} - \frac{M_1}{l_1} = \frac{Pa-M_1}{50} - \frac{M_1}{6.5}$$

$$R_3 = +\frac{M_1}{l_1} = +\frac{M_1}{6.5}.$$

Load at 2nd span.



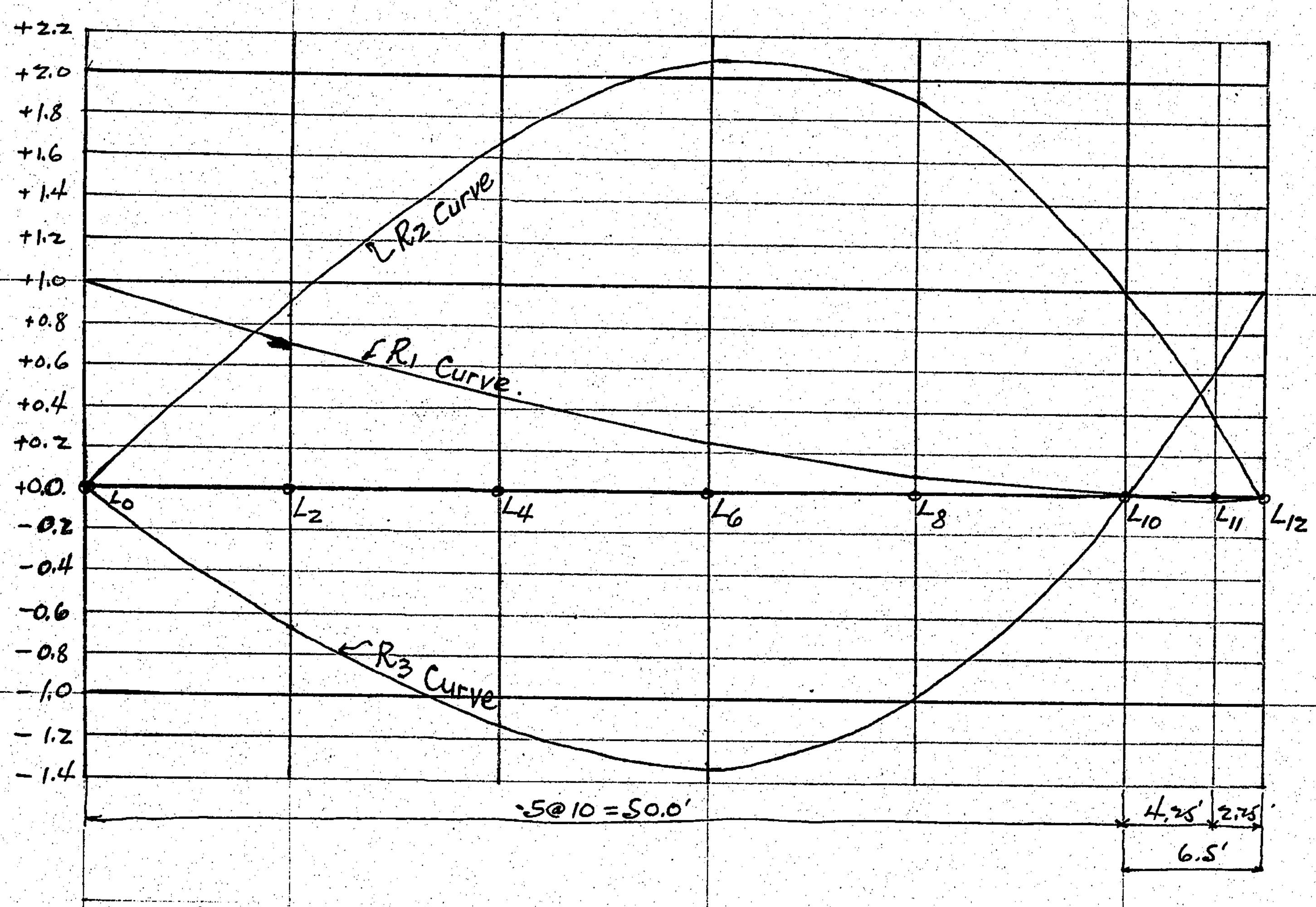
$$R_1 = \frac{+M_1}{l_1} = \frac{+M_1}{50}$$

$$R_2 = \frac{Pa_1}{l_0} - \frac{M_1}{l_0} - \frac{M_1}{l_1} = \frac{Pa_1-M_1}{l_0} - \frac{M_1}{l_1} = \frac{Pa_1-M_1}{6.5} - \frac{M_1}{50}$$

$$R_3 = \frac{Pb_1}{l_0} + \frac{M_1}{l_0} = \frac{Pb_1+M_1}{l_0} = \frac{Pb_1+M_1}{6.5}$$

Influence line of Reactions.
Unit load at

Panel pt.	a	b	M_1	$R_1 = \frac{Pb+M_1}{50}$	$R_2 = \frac{Pa-M_1}{50} - \frac{M_1}{6.5}$	$R_3 = \frac{+M_1}{6.5}$
" L_0	0	50	0	+1.0000	0.0000	0.0000
" L_2	10	40	−4.248	0.7150	0.2850 + 0.6535 = 0.9385	−0.6535
" L_4	20	30	−7.434	0.4513	0.5487 + 1.1437 = 1.6924	−1.1437
" L_6	30	20	−8.496	0.2301	0.7699 + 1.3071 = 2.0770	−1.3071
" L_8	40	10	−6.372	0.0726	0.9274 + 0.9803 = 1.9077	−0.9803
" L_{10}	50	0	0	0.0000	1.0000 + 0 = 1.0000	−0.0000
	a_1	b_1	M_1	$R_1 = \frac{+M_1}{50}$	$R_2 = \frac{Pa_1-M_1}{6.5} - \frac{M_1}{50}$	$R_3 = \frac{Pb_1+M_1}{6.5}$
" L_{11}	2.25	4.25	−0.114	−0.0023	0.3637 + 0.0023 = 0.3660	+0.6363
" L_{12}	0	6.5	0	0.0000	0.0000	+1.0000



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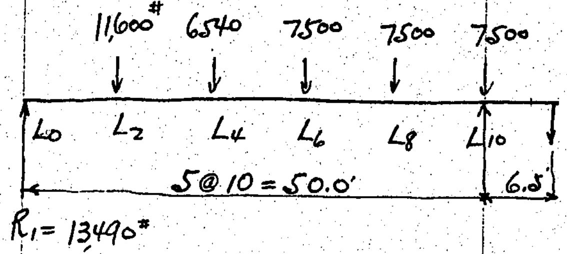
CALCULATIONS FOR

Tsuboi-Gawa-Bashi for Kumamoto Ken.

Live Load stresses of Chord members.

Moment at (U1)



Reaction at L0 or R1

Panel point	load	R1 unit load	R1
L2	11,600	0.715	8,300#
L4	6,540	0.4513	2,910
L6	7,500	0.2301	1,730
L8	7500	0.0726	550
L10	7500	0.0000	0
			13,490#

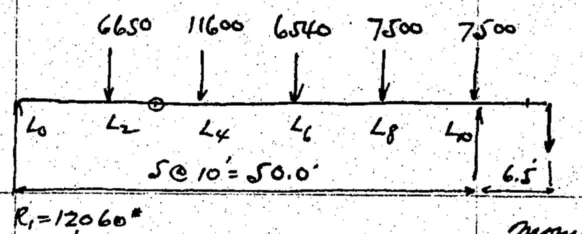
Moment at U_1 = 13490 × 5 = 67,500'# Stress L_0-L_2 = 67,500 ÷ 5.4 = 12,500# T

Moment at (L2)

Loading same as for U_1. R_1 = 13,490#

moment at L_2 = 13490 × 10 = 134,900'# Stress in U_1-U_3 = 134,900 ÷ 5.4 = 25,000 #C

Moment at (U3)



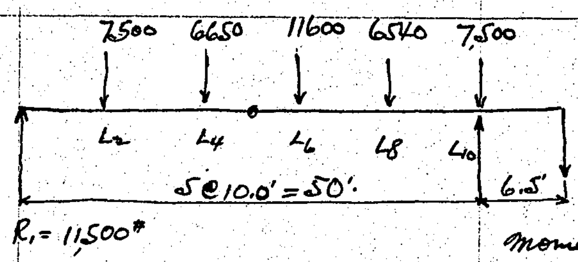
Load at	load	R1 unit load	R1
L2	6650#	0.7150	4,760#
L4	11,600	0.4513	5,240
L6	6,540	0.2301	1,510
L8	7,500	0.0726	550
L10	7,500	0.0000	0
			12060

moment at U_3 12,060 × 15 = 181,100
less. 6650 × 5 = 33250
147,850 Stress in L_2-L_4 = 147850/5.4 = 27,400#T

Moment about (L4)

Loading same as for U_3.
moment at L_4 12060 × 20 = 241,200
less. 6,650 × 10 = -66,500
174,700 Stress U_3-U_5 = 174,700/5.4 = 32,400#C

Moment about (U5)



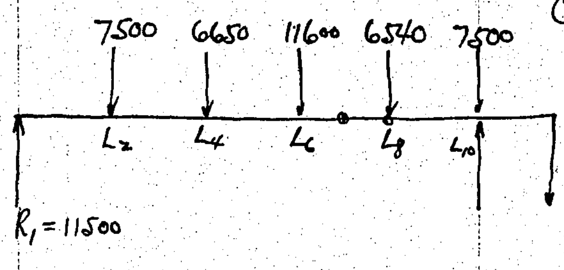
Load at	load	R1 unit load	R1
L2	7500	0.7150	5,355
L4	6650	0.4513	3,000
L6	11600	0.2301	2,670
L8	6540	0.0726	475
L10	7,500	0.0000	0
		R_1 =	11,500#

moment at U5. 11,500 × 25 = 287,500
less 7500 × 15 = -112,500
" 6650 × 5 = -33250
141,750'# Stress in L_4-L_6 = 141,750/5.4 = 26,280#T

Moment at (L6)

Loading same as for (U5)
moment at L_6 11500 × 30 = 345,000
less 7500 × 20 = -150,000
" 6650 × 10 = -66500
128,500'# Stress in U_5-U_7 = 128,500/5.4 = 23,800#C

Moment at (U7) + (L8)



Case 1. Loading same as for U5 R_1 = 11,500#
moment at (U7) 11500 × 35 = 403,000
less -7500 × 25 = -187,500
" -6650 × 15 = -99,800
" -11600 × 5 = -58000
-14,250
57,700'# Stress in L_6-L_8 = 57700/5.4 = 10,700#T

moment at (L8) -14250 × 5 = -71,250
+57,700
-13,550'# Stress in U_7-U_9 = 13550/5.4 = 2,510#T

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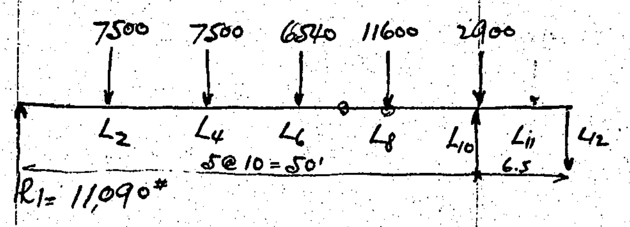
CALCULATIONS FOR

Tsuboi-gawa-Bashi for Kumamoto Ken

moment at (U7) & (L8) Case 2. Reaction R_1

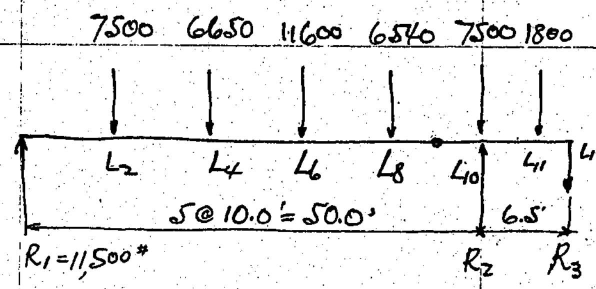


Load at	R_1 unit load	load	R_1
L_2	0.7150	7,500	5,360#
L_4	0.4513	7,500	3,380
L_6	0.2301	6,540	1,505
L_8	0.0726	11,600	845
L_{10}	0.0000	2,900	0
			11,090#

moment at U_7 11090 × 35 = 388,000'#
less 7,500 × 40 = −380,000
" 6450/7,500 × 5 = − 32,700
+55,300'# Stress in L_6-L_8 = $\frac{55,300}{5.4}$ = 10,250# T

moment at L_8.
Loading same as for U_7 R_1 = 11,090#
moment +55300
11,090 − 7,500×2 − 6,540 = −10,450 × 5 = −52,250
+3,050'# Stress U_7-U_9 = $\frac{3050}{5.4}$ = 570# C

moment at (U9) (neg. max moment)



Panel pt.	load	R_1 unit load	R_1	R_2 unit load	R_{2max}	R_3 unit load	R_{3max}	M_1 unit load	M_1 max
L_2	7,500	0.7150	5,360	0.9385	7040	−0.6535	−4,900	−4.248	−31,800
L_4	6,650	0.4513	3,000	1.6921	11,250	−1.1437	−7,610	−7.434	−49,400
L_6	11,600	0.2301	2,670	2.0770	24,080	−1.3071	−15,150	−8.496	−98,500
L_8	6,540	0.0726	475	1.9077	12,480	−0.9803	−6,410	−6.372	−41,600
L_{10}	7,500	0.0000	0	1.0000	7,500	−0.0000	0	0.0000	0
L_{11}	1,800	−0.0023	− 5	0.3660	660	(+0.6363)	(+1,150)	−0.1140	− 205
			11,500#		63,010#		−34,070# max or (−32,920#)		−211,505'#

L_{11} loaded.
Moment at U_9 −32,920 × 11.5 = −378,500
−1,800 × 9.25 = − 17,000
−7,500 × 5.0 = − 37,500
+63,010 × 5.0 = +315,000
−118,000'#

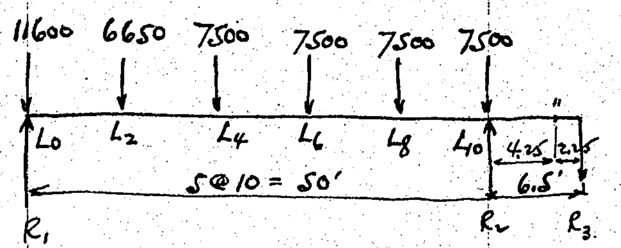
L_{11} unloaded. −34,070 × 11.5 = − 392,500
− 7,500 × 5 = − 37,500
+ 62,350 × 5 = + 311,500
−118,500'#

Stress in L_8-L_{10} = $\frac{118,500}{5.4}$ = 22,000# C

moment at L_{10} or M_1 = −211,505'# Stress in U_9-U_{11} = $\frac{211,505}{5.4}$ = 39,150# T for truss.
for girder flg stress = $\frac{211505}{5.45}$ = 38,800# T or C

max. reactions. max. reaction R_2 = 63010#
" " R_3 = −34,070# or (−32,920# when L_{11} is loaded).
or 11,600 × 1.0 = +11,600#

Max. reaction R_1.



Panel pt.	load	R_1 unit load	R_1 max.
L_0	11600	1.0000	+11,600#
L_2	6,650	0.7150	+ 4750
L_4	7,500	0.4513	+ 3,380
L_6	7,500	0.2369	+ 1725
L_8	7,500	0.0726	+ 545

R_1 max. = +22,000#

R_1 min = −0.0023 × 11600 = −27#

moment at (U11 L11) R_{3max} × 2.25 = −34,070 × 2.25 = −76,700'# flange stress = $\frac{-76700}{5.45}$ = 14,050# T or C

moment at (U12 L12) moment = 0.

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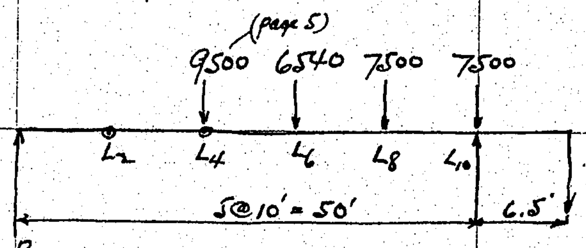
CALCULATIONS FOR

Tsuboi-Gawa-Bashi for Kumamoto Ken.

Live Load stresses of diagonal members.
Shear at several panels. ratio of diagonal to vertical = 1.36 (page 8)
Panel L_0-L_2 Loading same as for moment at (U_1) (page 10)
Shear for L_0-L_2 = Reaction R_1 = +13,490#

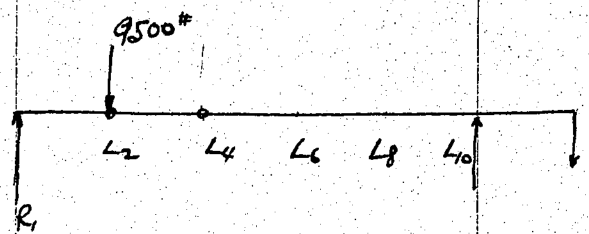
Stress in L_0-U_1 = 13,490 × 1.36 = 18350# C
U_1-L_2 = 18,350# T

Panel L_2-L_4.
positive shear



Reaction R_1.
L_4 9,500 × .4513 = 4,280
L_6 6,540 × .2301 = 1,505
L_8 7,500 × .0726 = 545
Pos. shear = 6,330#

negative shear.

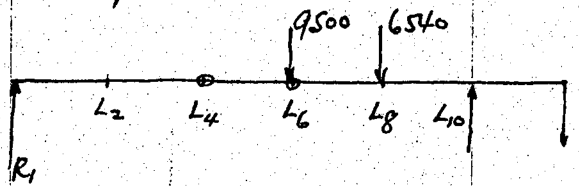


Reaction R_1 = .7150 × 9500 = 6,780
−9,500
neg. shear = −2,720#

Stress in diagonal L_2-U_3 = 6330 × 1.36 = 8,630# C
or = 2720 × 1.36 = 3,700# T

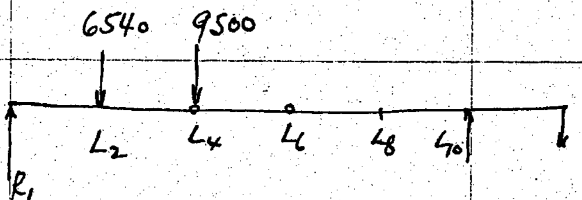
Stress in diagonal U_3-L_4 = = 8,630# T
or = 3700# C

Panel L_4-L_6.
positive shear



Reaction R_1
L_6 0.2301 × 9500 = 2,185#
L_8 0.0726 × 6540 = 475
pos. shear = 2,660#

Neg. shear

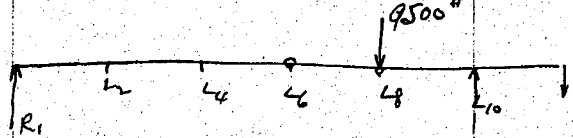


Reaction R_1
L_2 0.7150 × 6540 = 4670#
L_4 0.4513 × 9500 = 4290
16,040 8,960
−16,040
neg. shear = −7,080

Stress in diagonal L_4-U_5 = 2660 × 1.36 = 3,620# C
or = 7080 × 1.36 = 9,640# T

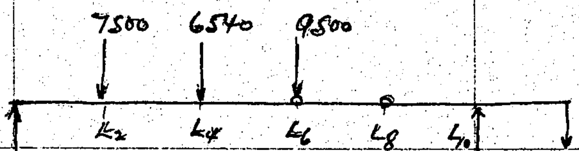
Stress in diagonal U_5-L_6 = 3,620# T
or = 9,640# C

Panel L_6-L_8.
Positive shear



Reaction R_1 = 0.0726 × 9,500 = 690# positive shear.

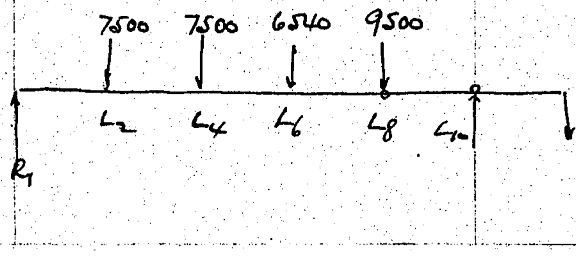
negative shear



Reaction R_1
L_2 .7150 × 7,500 = 5,360
L_4 .4513 × 6540 = 2,950
L_6 .2301 × 9,500 = 2,185
23,540 10,495
−23,540
negative shear = −13,045#

Stress in diagonals.
L_6-U_7 = 690 × 1.36 = 940# C
or = 13045 × 1.36 = 18,300# T
U_7-L_8 = 940# T
or 18,300# C

Panel L_8-L_{10}



Reaction R_1
L_2 .7150 × 7500 = 5,360#
L_4 .4513 × 7,500 = 3385
L_6 .2301 × 6540 = 1,505
L_8 .0726 × 9500 = 690
neg shear = −31,040# + 10,940# = −20,100#

Stress in diagonals.
L_8-U_9 = 20,100 × 1.36 = 27,300# T
U_9-L_{10} = 27300# C

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CALCULATIONS FOR

Tsuboi-Gawa-Bashi for Kumamoto Ken.

Shear at L_{11} (Right side) Reaction R_3 max. when L_{11} loaded = 32,920# (see on page 11)
add load at L_{11} = 1800
34,720# pos. shear.

Shear at L_{11} Reaction at L_{11} when L_{11} unloaded = 34,070# "

Live Load max reactions.

Reaction R_1 max. = + 22000# R_1 min. = −27# see on page 11
R_2 max = + 63010 R_2 min = 0 "
R_3 max = + 11,600 R_3 min = −34,070# "

Wind Load stresses. Wind load assumed at 10#/□' of the road surface perpendicular to it when the bridge is opened.
Wind panel load for one truss. panel length = 10.0' width of Bridge = 20' say.
Panel load = 10×20×10÷2 = 1000# which is less than dead panel load.
It is not necessary to investigate the wind stresses.

Summary for Stresses of members.

members		D.L.S.	D.L.S. with 30% imp.	2/3 D.L.S.	L.L.S. with 30% imp.	Total stresses		S.R. for 14000#/□" C, 17000 " T
Chord.	$U_1 - U_3$	6100# T	7,930# T	5,300# T	25000# C	7930# T	19700 C	1.41□" gr
	$U_3 - U_5$	24300 T	31,600 T	21,100 T	32,400 C	31600 T	11,300 C	1.86□" net
	$U_5 - U_7$	54400 T	71,700 T		23,800 C	71,700 T		4.22□" net
	$U_7 - U_9$	96,500 T	125,500 T		2,510 T	128010 T		7.53□" net
	$U_9 - U_{10}$	151,000 T	196,000 T		39,150 T	235,150 T		13.82□" net
	$L_0 - L_2$	3100 C	4,030 C	2,700 C	12,500 T	9800 T	4,030 C	0.58□" net
	$L_2 - L_4$	15,200 C	19,800 C	13,200 C	27,400 T	14,200 T	19,800 C	1.42□" gr
	$L_4 - L_6$	39,400 C	51,200 C		26,280 T		51,200 C	3.66□" gr
	$L_6 - L_8$	75,700 C	98,500 C		10,700 T		98500 C	7.05□" gr
	$L_8 - L_{10}$	123,700 C	161,000 C		22,000 C		183000 C	13.10□" gr
								S.R. for 13000#/□" C, 17000 " T
Diagonals	$L_0 - U_1$	4,500 T	5,850 T	3900 T	18,350 C	5,850 T	14,450 C	1.11□" gr
	$U_1 - L_2$	4,500 C	5,850 C	3,900 C	18,350 T	14450 T	5850 C	0.85□" net
	$L_2 - U_3$	13300 T	17,300 T		{8,630 C, 3,700 T}	21000 T		1.24□" net
	$U_3 - L_4$	13,300 C	17,300 C		{8,630 T, 3,700 C}		21,000 C	1.62□" gr
	$L_4 - U_5$	22,200 T	28,800 T		{3,620 C, 9640 T}	38440 T		2.26□" net
	$U_5 - L_6$	22,200 C	28,800 C		{3620 T, 9640 C}		38440 C	2.96□" gr
	$L_6 - U_7$	31,000 T	40,300 T		{940 C, 18,300 T}	58600 T		3.45□" net
	$U_7 - L_8$	31,000 C	40,300 C		{940 T, 18,300 C}		58,600 C	4.56□" gr
	$L_8 - U_9$	39,800 T	51,700 T		27300 T	79000 T		4.65□" net
	$U_9 - L_{10}$	39,800 C	51,700 C		27300 C		79000 C	for 14000#/□" C 5.64□" gr

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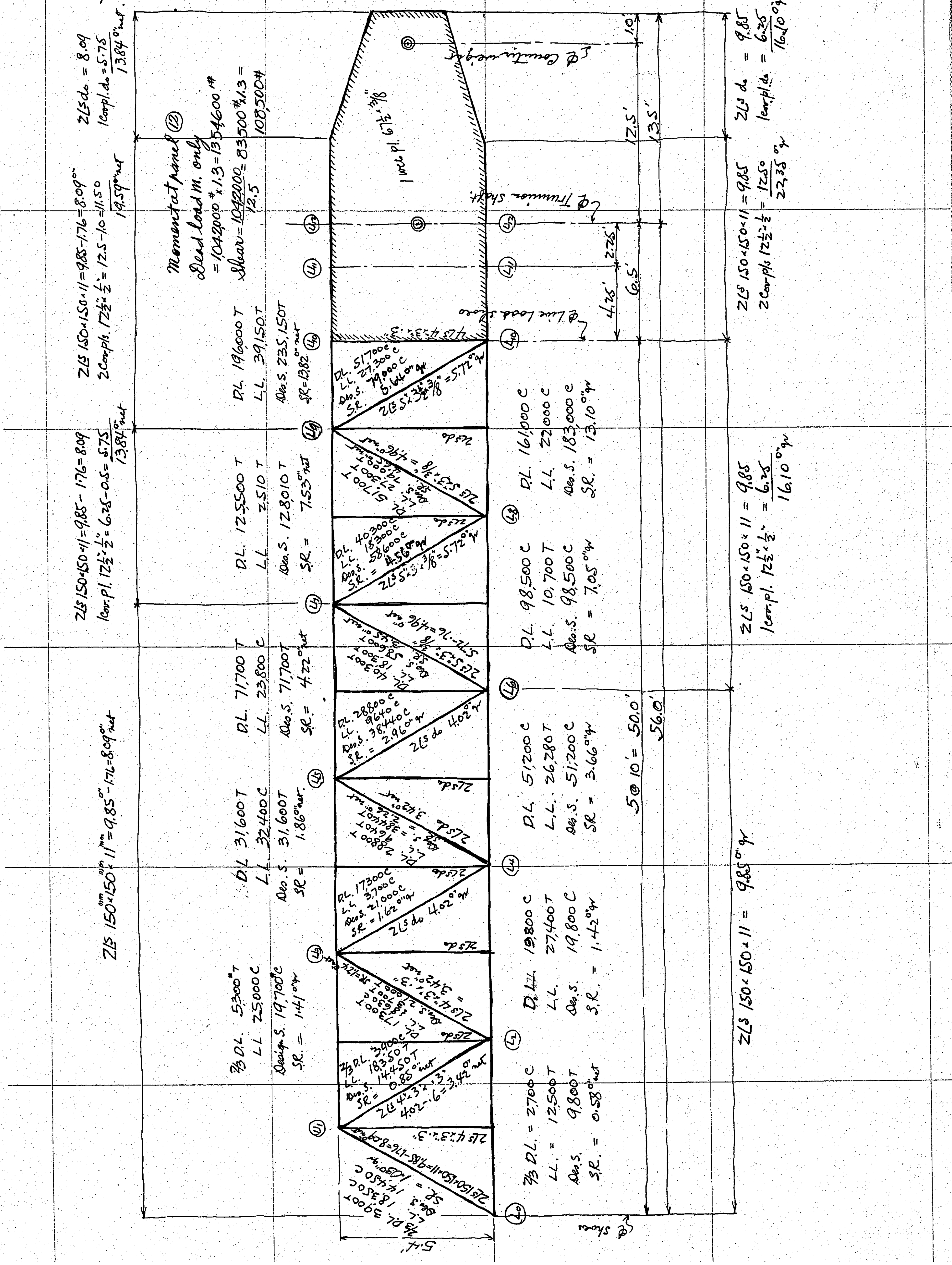
CALCULATIONS FOR

Tsuboi-gawa-Bashi for Kumamoto Ken



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Tsuboi-gawa-Bashi for Kumamoto Ken,

Design of Truss members.

Chord members.

U_5-U_7 Stress $=71,700^{\#}T$ Section required $= \frac{71,700}{17000} = 4.22^{\square''}$ net

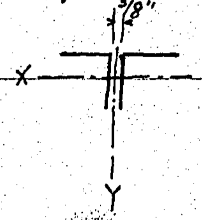
try $2L^s$ $150^{mm} \times 150^{mm} \times 11$ $= 9.85^{\square''} - 1.76 = 8.09^{\square''}$ net ok

U_3-U_5 Stress $=31600^{\#}T$

Use same section as for U_5-U_7.

U_1-U_3 Stress $19,700^{\#}C$

try $2L^s$ $150 \times 150 \times 11$ $= 9.85^{\square''}$ gr



Radius of gyration Y–Y = 2.63"

do X–X = 1.87"

length of member for

Y–Y = 10' = 120"

X–X = 5' = 60"

$l/r_y = 120/2.63 = 45.6$

$l/r_x = 60/1.87 = 32.0$

Allowable unit stress $= 21300\,(1-0.0055\,\frac{l}{r}) = 21300 \times (1-0.0055 \times 45.6)$

$= 16000^{\#}/\square''$ limit it at $14000^{\#}/\square''$ C.

Section required $= 19700 \div 14000 = 1.41^{\square''}$ ok

L_0-U_1 Stress $= 14450^{\#}C$

try $2L^s$ $150 \times 150 \times 11 = 9.85^{\square''}$ gr length of member $= 5.4 \times 1.36 = 7.35' = 88''$ $l/r_x = 88/1.87 = 47.3$

Allowable unit stress $= 21300\,(1-0.0055 \times 47.3) = 15750^{\#}/\square''$ use $14000^{\#}/\square''$ C.

section required $= 14450 \div 14000 = 1.03^{\square''}$ ok.

U_7-U_9 Stress $128010^{\#}T$ section req'd $= 128010 \div 17000 = 7.53^{\square''}$

$2L^s$ $150 \times 150 \times 11 = 9.85 - 1.76 = 8.09^{\square''}$ net.

1 Cov. pl. $12\frac{1}{2}'' \times \frac{1}{2}''$ $= 6.25 - 0.5 = \underline{5.75}$

$13.84^{\square''}$ net

U_9-U_{10} Stress $= 235150^{\#}T$ Section required $= 235150 \div 17000 = 13.82^{\square''}$ net

$2L^s$ $150 \times 150 \times 11 = 9.85 - 1.76 = 8.09^{\square''}$ net

2 Cov. pls. $12\frac{1}{2}'' \times \frac{1}{2}''$ $= 12.5 - 1.0 = \underline{11.50}$

$19.59^{\square''}$ net

L_4-L_6 Stress $= 51,200^{\#}C$

try $2L^s$ $150 \times 150 \times 11 = 9.85^{\square''}$ gr largest $l/r = 45.6$ allowable stress $= 14000^{\#}/\square''$ see U_1-U_3

section required $= 51200 \div 14000 = 3.66^{\square''}$ gr ok

L_0-L_4 use same section as for L_4-L_6

L_8-L_{10} Stress $= 183,000^{\#}C$

try $2L^s$ $150 \times 150 \times 11 = 9.85$

1 cov. pl. $12\frac{1}{2}'' \times \frac{1}{2}''$ $= \underline{6.25}$

$16.10^{\square''}$ gr

$l/r_x = 60/1.72 = 34.9$

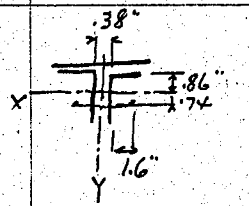
$l/r_y = 120/3.04 = 39.5$

Allowable stress

$= 21300\,(1-0.0055 \times 39.5) = 16700^{\#}/\square''$

limit it at $14000^{\#}/\square''$

section required $= \frac{183000}{14000} = 13.10^{\square''}$ gr ok.



neutral axis x–x.

$2L^s$ $9.85 \times 2.1 = 20.3$

$1Pl$ $\underline{6.25} \times .25 = \underline{1.6}$

16.10 $21.9 \div 16.1 = 1.36''$

$\underline{-.5}$

$.86''$

moment of inertia I_x

$2L^s$ $17.7 \times 2 + 9.85 \times .74^2 = 40.8$

$1Pl$ $6.25 \times 1.11^2 =$ $\underline{7.7}$

$47.9''^4$

radius of gyration $r_x = \sqrt{\frac{47.9}{16.1}} = 1.72''$

moment of inertia I_y

$2L^s$ $17.7 \times 2 + 9.85 \times 1.8^2 = 67.3$

$1Pl.$ $\underline{81.8}$

$149.1''^4$

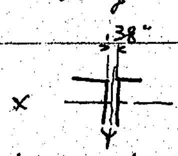
radius of gyration $r_y = \sqrt{\frac{149.1}{16.1}} = 3.04''$

Diagonal members.

L_4-U_5 Stress $= 38440^{\#}T$ section req'd $= \frac{38440}{17000} = 2.26^{\square''}$ net

U_5-L_6 " $= 38440^{\#}C$

try $2L^s$ $4'' \times 3'' \times .3'' = 4.02^{\square''}$ gr $- .6 = 3.42^{\square''}$ net



$r_x = 1.28''$

$r_y = 1.28''$ $l/r = 7.35 \times 12/1.28 = 68.7$

Allowable unit compression.

$= 21300\,(1-0.0055 \times 68.7) = 13,300^{\#}/\square''$

Section required $= \frac{38440}{13300} = 2.89^{\square''}$ gr ok.

U_1L_2, L_2-U_3, U_3-L_4 use same section as for U_5-L_6.

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CALCULATIONS FOR

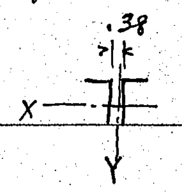
Tsuboi Gawa Bashi for Kumamoto Ken.

Diagonal members continued.

$L_8 - U_9$ Stress = 79000 # T Section required = 79000 ÷ 17000 = 4.65 □" net.
Use 2Ls 5" × 3" × 3/8" = 5.72□" − .76□" = 4.96□" net ok.

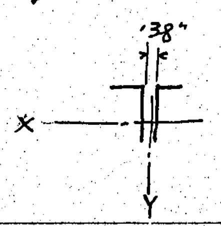
$L_6 - U_7$, Use same section as for $L_8 - U_9$.

$U_7 - L_8$, Stress = 58600 #C.
try 2Ls 5" × 3" × 3/8" = 5.72□" gr
radius of gyration r_x = 1.60" length of member = 7.36' = 88"
" r_y = 1.23"
l/r_y = 88 ÷ 1.23 = 71.5



allowable unit compression = 21300 (1 − 0.0055 × 71.5) = 12900 #/□"
Section required = 58600 / 12900 = 4.56 □" ok.

$U_9 - L_{10}$ Stress = 79000 # C
try 2Ls 5" × 3½" × 3/8" = 6.1□" gr
Radius of gyration = r_x = 1.60"
" r_y = 1.46" length of member = 88"
l/r_y = 88 ÷ 1.46 = 60.3



allowable unit compression = 21300 (1 − 0.0058 × 60.3) = 14200 #/□" c
limit it at 14000 #/□"
Section required = 79000 ÷ 14000 = 5.64□" gr ok.

Girder portion depth of girder 5' 7½" = 5.62' b to b of flange Ls.
at panel (11) moment = −960300 '# effective depth say 5.45' web pl. 67" × ½"
30% impact = −289000
−1249300 '#
flange stress = 1249000 / 5.45 = 229,000 # T or C.

Assumed flange section
2Ls 150 × 150 × 11 = 9.85□" gr − 1.76 = 8.09□" net
2 cov. pls. 12½" × ½" = 12.50 − 1.0 = 11.50
22.35□" gr 19.59□" net

flange area required = 229000 / 15600 = 14.66□" gr for comp. flange.
1/8 web area = 33.5 × 1/8 = − 4.20
10.46□" gr ok.

flange area req'd. = 229000 / 17000 = 13.45 □" net for tension flange.
1/8 web area = 4.20
9.25□" net ok.

At panel pt. (12) moment = 1042000 '#
30% impact = 312600
1354600 '#
flange stress = 1354600 / 5.45 = 249,000 # T or C.

Assumed flange section
2Ls 150 × 150 × 11 = 9.85□" gr − 1.76 = 8.09□" net
2 cov. pls. 12½" × ½" = 12.50 − 1.0 = 11.50
22.35□" gr 19.59□" net.

flange area req'd for compression flange.
= 249000 / 15600 = 15.95 □" gr
1/8 web = − 4.20
11.75 □" gr ok.

flange area req'd for tension flange
= 249000 / 17000 = 14.65□" net
1/8 web area = 4.20
10.45 □" net ok.

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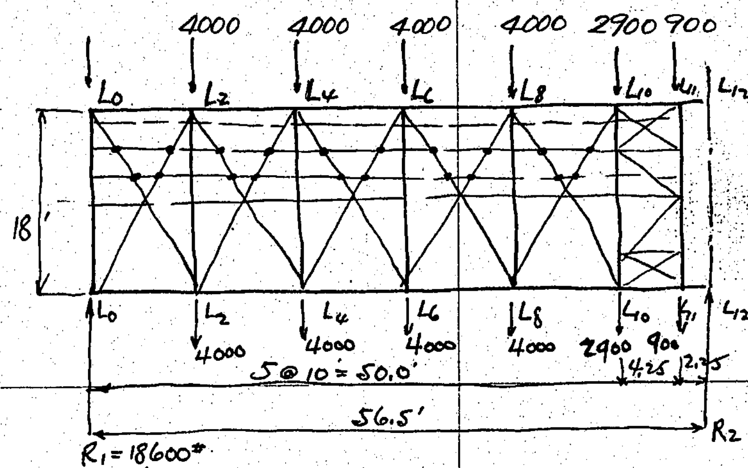
Tsuboi-Gawa-Bashi for Kumamotoken.

Lateral Bracing



Reaction R_1

4000 × 10 × 10 = 400,000
4000 × 4 × 6.5 = 104,000
2900 × 6.5 = 18,900
900 × 2.25 = 2,000
524900 × 2 = 1049,800

R_1 = 1049,800 ÷ 56.5 = 18,600#

End shear for full load R_1 = 18600#
Diagonal length = $\sqrt{10^2 + 18^2}$ = 20.6'
Coefficient = $\frac{20.6}{18}$ = 1.145

Span length 56.5' < 50 meter
Wind load.
Unloaded chord 130# per ft.
loaded " 270 "
400# per ft of span

Panel load = 400 × 10 = 4,000#

Earthquake acceleration assumed 2500 mm/sec² k=0.25
Dead panel load 6500#
Seismic panel load = 6500 × 0.25 = 1625#
Seismic stresses are not necessary to be investigated farther

Chord stress
moment at L6.
18600 × 30 = + 558,000
8000 × 10 × 3 = − 240,000
+ 318,000'#

Stress in L4-L8 = $\frac{318000}{18}$ = 17,700# T or C

Lower chord member L0 to L8 are proportioned to the compressive stress of more than #1270 200,000# 200,000 × .25 = 50,000# C
Chord section is ample for wind stress.

Diagonal stresses
Stress in L0L2.
18600 × 1.145 = 21300 # T or C
for one member = 21300 ÷ 2 = 10650 # T or C
S.R. = $\frac{10650}{17000}$ = 0.625 □" net
or = $\frac{10650}{14000}$ = 0.75 □" gr

Use L 75 × 75 × 9 = 1.97 □" gr − 0.33 = 1.64 □" net ok
rivet ¾" $\frac{10650}{4420}$ = 2.4 rivets
use 4 rivets

Use the same section and details for all diagonal members as for L0-L2

Wind pressure during the bridge is opening wind pressure assumed 20% for this case
Exposed area of bridge = 3.5 □' per lin ft. for one truss or wind panel load
= 3.5 × 2 × 20 = 140# per lin. ft. of bridge.
Assumed section is ample

Wind thrust on end shoes.
R_1 = 18,600#
End panel load = 2000
20,600# ÷ 2 = 10,300# for one shoe.

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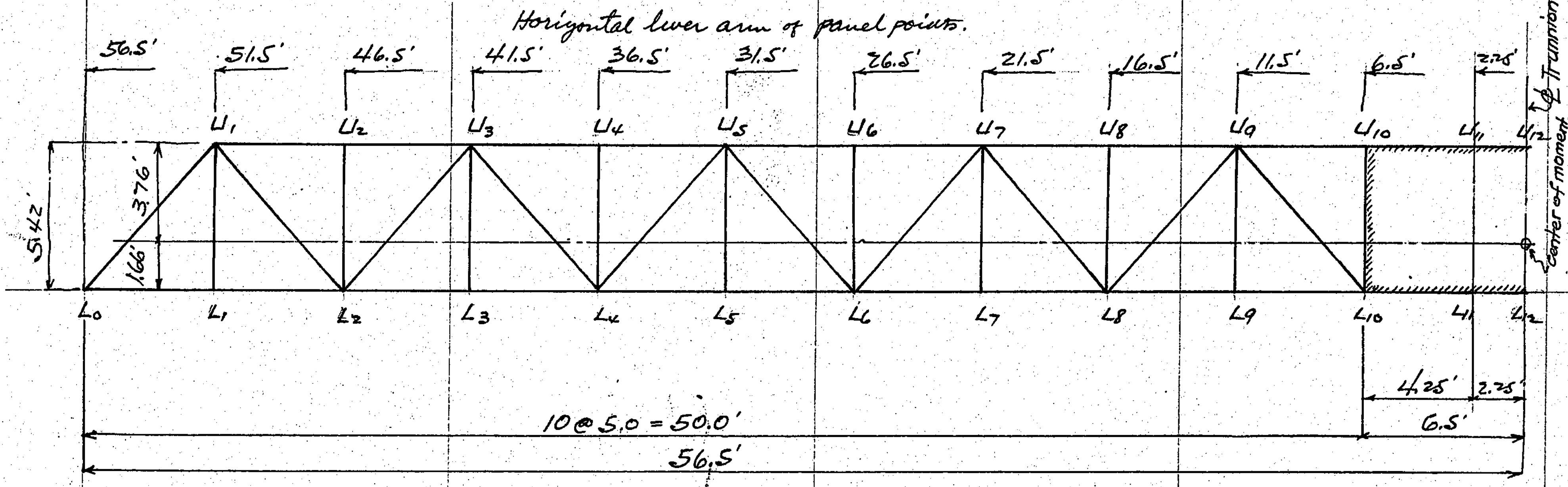
CALCULATIONS FOR

Tsuboi Gawa Bashi for Kumamoto Ken.

Center of gravity of River arm.



Taking moment about the crown of roadway at ℄ trunnion shaft. moment counter clockwise positive.

Names	Dimension	Length	no.	Total required	unit wt. #	Total wt. lbs.	Horiz. lev. arm	Horizontal moment (+)	Vert. lev. arm (+)	Vert. lev. arm (−)	Vertical moment (+)	Vertical moment (−)
Wood block pavement	15.0'×0.21'	54.25	1	171.00 cf	60.0	10,250#	29.38	301,000		0.17		1,745
Coping 日本杉	0.42×42	54.25	1	9.57	35.0	334	〃	9810		0.12		40
planking 〃	15.5×0.21	54.25	1	176.50	〃	6,180	〃	181,500		0.35		2,161
nailing piece 〃	3.2×0.33	54.25	1	57.30	〃	2,007	〃	59,000		0.63		1,265
nails (wood block)		2½"	5000	5000.0#	1/120	42	〃	1,230		0.25		11
〃 (planking)		6"	900	900.0	1/20	45	〃	1,330		0.46		21
Bolts (nailing piece)	½"φ	0.4	370	370	0.4	148	〃	4,350		0.63		93
Checkered pl. & Ls	12"×3/8"	16.5	2	33 ft	15.3	505	〃	14,810		0.06		30
nailing piece on F.B.	0.5×0.8	15.5	6	3.72 cf	35.0	130	31.5	4,100		0.48		62
						(19,641)		(577,130)				(−5,428)
Stringers S1S2S3	I beam 8"×4"	54.25	5	271.3 ft	18.01	4,890	29.38	143,500		1.12		5,475
〃 S4	[8"×2½"	54.25	2	108.5"	15.12	1,643	〃	48,250		1.12		1,840
Interm. floor beams	I beam 14"×6"	18.0	5	90 "	46.01	4,145	26.5	109,800		1.13		4,675
End 〃	4Ls 3"×2½"×3/8" 1 Pl. 20"×5/16"	18.0	2	36 "	50.0	1,800	29.38	52,900		0.86		1,546
						(12,478)		(354,450)				(−13,536)
Lateral bracing	1L 75×75×9	19.0	10	190 "	6.69	1,270	31.5	40,050		1.63		2,070
gusset pls.	16½"×3/8"	1.75	8	14 "	21.04	295	31.5	9,300		1.72		508
〃 〃	14"×3/8"	1.37	2	2.74	17.85	49	56.1	2,750		1.72		84
〃 〃	16½"×3/8"	1.54	2	3.08	21.04	65	6.5	420		1.72		112
〃 〃	6"×3/8"	1.5	5	7.5	7.65	57	31.5	1,800		1.72		98
Conn. to Stringers (L)	L 75×75×9	0.3	40	12.0	6.69	80	31.5	2,520		1.54		123
~~Bracing~~ between L0-L1	L 3"×2½"×3/8"	2.4	6	14.4	6.53	94	43.8	410		1.63		153
guss. plates	12"×3/8"	2.0	3	6.0	15.3	92	50.8	470		1.72		158
〃	12"×3/8"	1.2	6	7.2	15.3	110	36.7	400		1.72		189
〃	6"×3/8"	1.5	2	3.0	7.65	23	43.8	100		1.72		40
Rivet heads &c.			6	6.0	15.0	90	29.38	2,640		1.74		157
						(2,225)		(60,860)				(−3,692)
Handrail gas pipe	2"φ	54.25	2	108.5	3.68	400	29.38	11,740	2.37		948	
〃 pl.	1½"×½"	54.25	2	108.5	2.55	277	29.38	8,150	2.16		598	
〃 bottom L	2½"×2½"×¼"	54.25	2	108.5	4.1	445	29.38	13,070	0.62		276	
〃 bars.	¾"φ	1.5	174	261.0	1.50	392	29.38	11,500	1.39		545	
guss. plates top	10¾"×3/8"	1.17	20	23.4	13.71	321	31.5	10,100	2.04		655	
〃 bottom	10×3/8"	1.17	10	11.7	12.75	149	34.0	5,070	0.31		46	
〃 〃	14"×3/8"	1.21	10	12.1	17.85	216	26.5	5,730	0.06		13	
Conn. Ls,	5"×3"×3/8"	1.21	20	24.2	9.80	237	26.5	6,280		0.41	97	

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CALCULATIONS FOR

Tsuboi-Gawa-Bashi for Kumamoto Ken.

Center of Gravity of River Arm continued

Names	Dimension	Length	no.	Total required	unit wt. #.	Total wt lbs.	Horiz. lev. arm	Horizontal moment (+)	vert. lev. arm (+)	vert. lev. arm (−)	vertical moment (+)	vertical moment (−)
Handrail post ⑪	L̲s 3"×2"×3/8"	3.7	4	14.8′	5.9	87	2.25	196	1.33		116	
misc. details			22	22.	10.0	220	31.5	6,940	1.70		374	
						(2,744)		(78,776)			(+3,668)	
Main truss & girder												
Chord. L_0-U_1	L 150×150×11	6.69	4	26.76	16.77	448	54.04	24,210	1.03		462	
〃 Flg L̲s top U_1-U_{12}	〃	51.50	4	206.0	〃	3460	25.15	89,200	3.76		13,000	
〃 〃 Spl. L̲s.	L 5½"×5½"×7/16"	2.25	4	9.0	15.75	142	24.08	3,420	3.73		530	
〃 Flg. L̲s Bott. L_0-L_{12}	L 150×150×11	56.92	4	227.68	16.77	3820	28.46	108,600		1.66		6350
〃 〃 Spl. L̲s.	L 5½"×5½"×7/16"	2.25	4	9.0	15.75	142	28.96	4,110		1.63		232
〃 〃 Spl. L̲s top U_1	〃	2.33	4	9.32	〃	147	51.33	7,550	3.43		505	
〃 lug L̲s L_0	L 3"×3"×3/8"	0.87	4	3.48	7.2	25	55.79	1,395		0.49		12
〃 Bent cov. pl. U_1	Pl. 12½"×3/8"	1.75	2	3.5	15.94	56	51.50	2,880	3.70		207	
〃 Cov. pl. top U_7-U_{12}	Pl. 12½"×½"	25.19	2	50.38	21.25	1,070	12.60	13,490	3.95		4,225	
〃 〃 〃 U_9-U_{12}	〃	12.37	2	24.74	21.25	526	6.19	3,250	3.99		2,095	
〃 〃 Spl. $U_{10}-U_{12}$	〃	5.38	2	10.76	〃	229	4.33	993	4.03		925	
〃 〃 bott. L_5-L_{12}	〃	30.06	2	60.12	〃	1,275	15.03	19,150		1.85		2360
〃 〃 〃 $L_{10}-L_{12}$	〃	7.90	2	15.80	〃	336	3.95	1,325		1.89		635
〃 〃 〃 Spl. 〃	〃	2.25	2	4.5	〃	96	4.35	418		1.93		185
〃 Spl. L̲s ⑩-⑫	L̲s. 5½"×5½"×7/16"	2.25	8	18.0	15.75	284	4.35	1,235		1.63		463
guss. pl. L_0	Pl. 19½"×3/8"	1.94	2	3.88	24.86	97	55.98	5,420		0.96		93
Fills. 〃	〃 9"×7/16"	1.12	2	2.24	13.39	30	56.50	1,695		0.66		20
Sole pl. L_0	Pl. 10"×3/4"	1.08	2	2.16	25.5	55	56.50	3,110		1.81		100
guss. Pl. U_1	〃 16¾"×3/8"	2.0	2	4.00	21.36	86×8	51.20	3,520	3.16		217	
〃 top & Bott.	〃 8½"×3/8"	1.08	18	19.44	10.84	211	31.50	6,650	0.75		158	
〃 L_2	〃 17½"×3/8"	2.33	2	4.66	22.31	104	46.50	4,840		1.03		107
〃 U_3	〃 16¼"×3/8"	2.33	2	4.66	20.72	97	41.50	4,020	3.18		308	
〃 L_4	〃 18¾"×3/8"	2.50	2	5.00	23.27	116	36.50	4,240		1.00		116
〃 U_5	〃 18¾"×3/8"	2.62	2	5.24	〃	122	31.50	3,840	3.10		378	
〃 L_6	〃 18½"×3/8"	2.83	2	5.66	23.59	133	26.50	3,530		0.99		132
〃 U_7	〃 21½"×3/8"	2.83	2	5.66	27.41	155	21.50	3,340	2.96		459	
〃 L_8	〃 21¼"×3/8"	3.08	2	6.16	27.1	167	16.50	2,760		0.87		145
〃 U_9	〃 21¾"×3/8"	3.27	2	6.54	27.73	181	11.50	2,080	2.95		534	
〃 L_{10}	〃 15"×3/8"	2.0	2	4.00	19.13	77	5.60	431		1.13		87
Fills. chord.	〃 6"×3/8"	0.5	38	19.00	7.65	145	31.50	4,570	1.04		151	
〃 〃	〃 5¾"×3/8"	2.25	4	9.0	7.35	66	26.50	1,750	1.05		69	
Vertical U_1-L_1	L̲s 4"×3"×0.3	4.8 mean	4	19.20	6.84	131	51.50	6,750	0.66		87	
〃 $U_2-L_2, U_4-L_4, U_6-L_6, U_8-L_8$	〃 〃	5.48	16	87.68	〃	600	31.50	18,900	1.16		696	
〃 $U_3-L_3, U_5-L_5, U_7-L_7, U_9-L_9$	〃 〃	5.58	16	89.28	〃	611	26.50	16,200	1.06		649	
〃 $U_{10}-L_{10}$	〃 〃	5.53 mean	8	44.64	〃	305	6.50	1,980	1.08		303	
〃 Fills U_1-L_1	Pl. 2½"×3/8"	0.81	2	1.62	3.19	5	51.50	257		1.30		7
〃 〃 U_2-L_2 to $U_{10}-L_{10}$	〃 〃	〃	30	24.30	〃	78	26.50	2,070	1.96		153	
〃 〃 $U_{10}-L_{10}$	〃 〃	0.79	2	1.58	〃	5	6.50	33	1.05		5	
Diagonal U_1 to L_6	L̲s 4"×3"×0.3"	5.98	20	119.60	6.84	820	39.00	32,000	1.05		862	
〃 lug L̲s L_4 to L_6	L̲s 3"×3"×3/8"	0.59	16	9.44	7.20	67	31.5	2,110	1.05		70	
〃 L_6 to L_8	L̲s 5"×3"×3/8"	5.98	8	47.84	9.80	468	21.5	10,080	1.05		493	
〃 lug L̲s. 〃 〃	L̲s 3"×3"×3/8"	0.62	16	9.92	7.20	71	21.5	1,525	1.05		75	
〃 fills 〃	Pl. 5"×3/8"	0.46	8	3.68	6.38	24	21.5	516	1.05		25	
〃 L_8-U_9	L̲s 5"×3"×3/8"	6.06	4	24.24	9.80	238	14.0	3,330	1.05		250	
〃 U_9-L_{10}	L̲s 5"×3½"×3/8"	6.06	4	24.24	10.40	253	9.0	2,280	1.05		266	
〃 lug L̲s L_8 to L_{10}	L̲s 5"×3"×3/8"	1.08	16	16.28	9.80	159	11.15	1,830	1.05		167	
〃 fills. 〃	Pl̲s. 5"×3/8"	0.67	4	2.68	6.38	17	11.15	196	1.05		18	
washers	3"φ×3/8"		20	20.0	0.72	14	39.0	546	1.05		15	
Rivets heads truss & girder	7/8"φ			6000 head	.213	1280	21.5	27,500	1.05		1345	

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CALCULATIONS FOR

Tsuboi-Gawa Bashi for Kumamoto Ken

Center of gravity of River Arm continued.

Names	Dimension	Length	no	Total req'd.	Unit wt. #	Total wt. lbs.	Horiz. lev. arm	horiz. moment (+)	Vert. lev. arm (+)	Vert. lev. arm (−)	Vert. moment (+)	Vert. moment (−)
girder web	Pls. 67½"×⅜"	6.83	2	13.66#	86.05	1,176#	3.42	4002	1.05		1235	
" Side P/s.	" 55¾"×⅜"	3.20	4	12.80	71.10	911	1.60	1458	1.05		957	
" "	" 62"×⅜"	5.59	4	22.36	79.10	1,767	2.80	4950	1.05		1856	
" floor break L	Ls. 4½"×3½"×⅜"	0.96	2	1.92	9.80	19	7.30	139	0.0		0	
" "	" 4"×3"×⅜"	2.62	2	5.24	8.50	45	4.75	214	0.0		0	
" "	" 4"×3"×⅜"	0.6	2	1.20	"	10	2.95	30	0.0		0	
" "	" 4"×3"×⅜"	0.69	2	1.38	"	17	1.37	23	0.0		0	
" " fill.	Pl. 3"×⅜"	0.46	2	0.92	3.83	4	1.37	5		0.08		0
" " Pl.	" 8"×⅜"	0.96	2	1.92	10.20	20	1.50	30	0.07		1	
" " L	Ls. 4"×3"×⅜"	1.36	2	2.72	8.50	23	1.62	37	0.0		0	
" " fill.	Pl. 3"×⅜"	0.67	2	1.34	3.83	5	1.62	8		0.08		0
" " Pl.	" 9¼"×⅜"	6.75	2	13.50	11.79	159	4.42	703	0.07		11	
" Stiff. Ls. a	Ls. 5"×3½"×⅜"	1.92	8	15.36	10.40	160	0.96	154	0.51		82	
" " " b	" 4"×3½"×⅜"	.94	4	3.76	9.10	34	1.45	49	0.51		17	
" " " d	" 5"×3½"×⅜"	1.94	4	7.76	10.40	81	1.00	81	0.51		41	
" " " f	" 4"×3½"×⅜"	1.26	4	5.04	9.10	46	1.00	46		1.10		51
" " " g	" 4"×3½"×⅜"	2.34	4	9.36	"	85	1.00	85	2.67		227	
" fills. b	Pl. 3½"×⅜"	0.67	4	2.68	4.46	12	1.60	19	0.51		6	
" " f	" 3½"×⅜"	0.98	4	3.92	"	17	1.00	17		1.20		20
" " g	" 3½"×⅜"	2.06	4	8.24	"	37	1.10	41	2.58		96	
						(23,672)		(477,216)			(+34,231)	(−11,115)
Rack Bracket	Pl. 31½"×⅜"	2.75	2	5.50	40.17	221	2.25	498		3.0		663
" flg Ls.	Ls. 6"×4"×⅜"	3.0	4	12.00	12.30	148	2.40	356		4.4		652
" Cov. Pl.	Pl. 12½"×½"	3.0	2	6.00	21.25	128	2.40	307		4.5		577
" Stiff. Ls.	Ls. 5"×3½"×⅜"	2.4	4	9.60	10.4	100	1.10	110		3.2		320
" "	Ls. "	1.83	4	7.32	"	76	2.60	198		2.85		216
" fill.	Pl. 3½"×⅜"	1.70	4	6.80	4.46	30	1.10	33		3.25		98
" "	" "	.98	4	3.92	"	17	2.60	44		2.80		48
" top Ls.	Ls 150×150×11	2.75	4	11.00	16.77	185	1.38	257		2.08		385
" bent Pl.	Pl. 12½"×½"	1.56	2	3.16	21.25	67	2.85	191		2.17		145
Rack casting			2		400	800	1.38	1104		4.50		3600
						(1772)		(3098)				(6704)
End locks.			1		300	300	56.5	16,950		1.25		375
Live load shoes			2		100	200	6.5	1,300		2.0		400
gaspipe + accessories		50.0	1	50.00	10	500	28.25	14,125		1.35		675
Trunnion bearing casting			4		200	800	0.5	400	0.5		400	
						(1800)		(32,775)			(+400)	(−1450)
				total		64,332#		+1,584,305'#			+38,299	−41,925

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CALCULATIONS FOR

Design of Tsuboi-Gawa-Bashi for Kumamoto Ken.

Center of gravity of Rear arm.

Names	Dimension	Length	no.	Total required	unit wt #	Total wt #	Horiz. lev. arm	Horiz. moment (−)	Vert. lev. arm (+)	Vert. lev. arm (−)	Vert. moment (+)	Vert. moment (−)
Cov. Pl. top & Bott.	12½" × ½"	6.83	4	27.32	21.25	580	3.42	1,980	1.04		604	
〃 〃 Top	〃	13.33	2	26.66	〃	567	6.67	3,780	3.60		2,000	
〃 〃 Bottom	〃	10.35	2	20.70	〃	440	5.18	2,280		1.50		660
Flange Ls Top.	mm 150×150×11	13.33	4	53.32	16.77	895	6.67	5,960	3.45		3,085	
〃 Bottom	〃	11.6	4	46.40	〃	762	5.8	4,410		1.38		1,050
Web Pl.	67½ × ⅜	13.33	2	26.66	86.1	2,300×.86	6.07	12,000	1.04		2,030	
Side Pls.	55¾" × 7/16"	5.66	4	22.64	83.0	1870	2.83	5,300	1.04		1,945	
〃	62" × ⅜"	2.58	4	10.32	79.1	817	1.29	1,053	1.04		850	
Stiff. Ls.	5"×3½"×⅜"	5.60	16	89.60	10.37	932	3.33	3,100	1.04		970	
〃	〃	4.7	4	18.8	〃	195	8.66	1,690	1.04		203	
〃	〃	3.83	4	15.32	〃	159	11.56	1,840	1.04		166	
Fills.	3½" × 7/16"	3.75	4	15.00	5.21	78	8.70	678	1.04		81	
	〃	2.87	4	11.47	〃	60	11.52	690	1.04		63	
Hor. Stiff. Ls. a	5"×3½"×⅜"	2.28	8	18.24	10.37	189	1.14	215	0.51		97	
〃 c	4×3½"×⅜"	1.25	4	5.00	9.11	46	1.63	75	0.47		22	
fills.	3½" × ⅜"	.96	4	3.84	4.46	17	1.63	28	0.50		9	
Floorbreak Ls.	4"×3"×⅜"	9.60	4	38.40	8.45	324	5.83	1,890		0.07		23
〃 fills	3" × ⅜"	8.1	4	32.4	3.83	124	6.1	760		0.10		12
〃 〃	3" × 7/16"	7.22	4	28.88	4.46	129	6.66	860		0.10		13
〃 Pls.	7/8" × ⅜"	10.60	4	42.40	9.09	385	6.30	2,420	0.03		12	
〃 Stiff Ls.	6"×4"×⅜"	0.86	4	3.44	12.27	42	11.0	462		0.12		5
〃 〃	5"×3½"×⅜"	10.2	4	40.80	10.37	425	11.0	4,680		0.52		221
〃 〃	〃	.96	4	3.84	〃	40	11.0	440		0.52		21
Cwt. Bearing Pls.	17" × ½"	1.67	4	6.68	28.9	193	12.5	2,410	1.04		201	
〃 Key Pls.	9" × ½"	1.42	4	5.68	15.3	87	12.5	1,085	1.58		138	
Rack Bracket Ls	150×150×11	4.32	4	17.28	16.77	290	2.13	618		2.10		609
〃 〃 Ls	5"×3½"×⅜"	2.39	4	9.56	10.37	99	1.06	105		3.09		305
〃 〃 〃	5"×3½"×⅜"	1.94	4	7.76	〃	81	1.10	89		2.97		241
〃 〃 fills.	3½" × ⅜"	1.60	4	6.40	4.46	29	2.35	67		3.09		90
〃 〃 〃	〃	1.1	4	4.40	〃	20	2.42	48		2.97		59
〃 〃 Web	31½" × ⅜"	4.3	2	8.60	40.17	345×.69	1.7	392		2.74		633
〃 〃 Ls.	6"×4"×⅜"	5.4	4	21.60	12.27	266	2.5	665		3.60		958
〃 〃 Pl.	12½" × ½"	6.4	2	12.80	21.25	272	2.7	735		3.69		1,010
Rack. Casting			2		750	1500	2.5	3,750		4.00		6,000
Rivet heads				3,400	.213	725	4.55	3,300	1.0		725	
		Total	=			15,283#		−69,855 '#			+13,201 '#	−11,910 '#

Summary for moment and weight of structure.

	Horizontal moment	vertical moment	weight of structure.
River arm	+1,584,305 '#	{ + 38,299 '# { − 41,925	64,332 #
Rear arm	− 69,855	{ + 13,201 { − 11,910	15,283 #
Total	+ 1,514,450 '#	− 2,335 '#	79,615 #

Center of gravity of moving part.

Hor. distance from trunnion shaft $= \frac{+1514.450}{79.615} = 19.0'$ *river side*

Vert. dist from crown of Roadway $= \frac{-2335}{79615^{\#}} = -0.029'$ *below crown of Roadway.*

Counter weight required $= \frac{1514450}{12.5} = 121,000^{\#}$ or $\underline{54.1}$ *tons*

Center of gravity of river arm $= \frac{1584305}{64332} = 24.65'$

Center of gravity of rear arm $= \frac{-69855}{15283} = -4.57'$

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CALCULATIONS FOR

Tsuboi-Gawa-Bashi for Kumamoto Ken.

Approximate weight of steel req'd for Super Structure

River arm.

Floor System	13,218#	or 5.90 tons
Lateral bracing	2,225	0.99
main trusses & girders	23,672	10.57
Rack Brackets & casting	1,772	0.79
Handrail	2,744	1.25
Gas pipes, Shoes, etc.	1,800	0.80
Total =	45431#	or 20.30 tons.
Rear arm	15283	or 6.83
Summary	60,714#	or 27.13 tons
Counter weight girders (see below ~~next page~~)	6,960	3.11
	67,674#	30.24 tons.

Design of Counter weight girders. span length 18.0' Counterweight 120,250# or 53.7 tons. (revised to 54.1 tons)

Load on counter weight girders. = $\frac{120250}{18}$ = 6690#/ft. for one girder = 6690 ÷ 2 = 3345 #/lin ft.

Uniform load on counter wt. girder = 3345 #/ft.

Assume 30% impact = 1005

4350 #/lin ft.

max bending moment = $\frac{1}{8} \cdot 4350 \times 18^2$ = 176300'#

" end shear = $\frac{1}{2} \cdot 4350 \cdot 18$ = 39,300#

effective depth say 4.04 - 2×0.064 = 3.9'

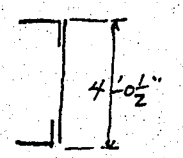
flange stress = $\frac{176300}{3.9}$ = 45,200 # T or C

flange area req'd = $\frac{45200}{15600}$ = 2.90 □"

Assumed Section of girder

2Ls 4"×3"×3/8"

1 web pl. 48"×3/8"



Use 1L 4"×3"×3/8" = 2.48 □" - 0.76 = 1.72 □" net

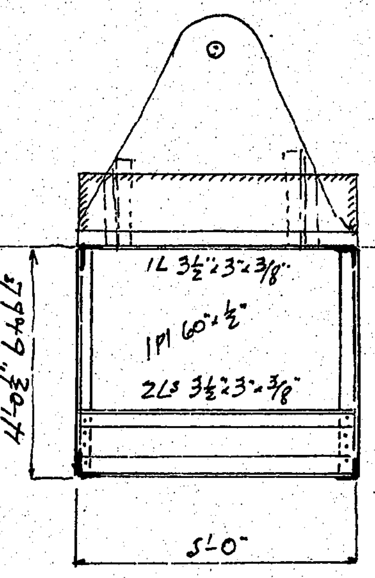
1/8 web area = $\frac{1}{8} \cdot 48 \cdot \frac{3}{8}$ = 2.25 | 2.25

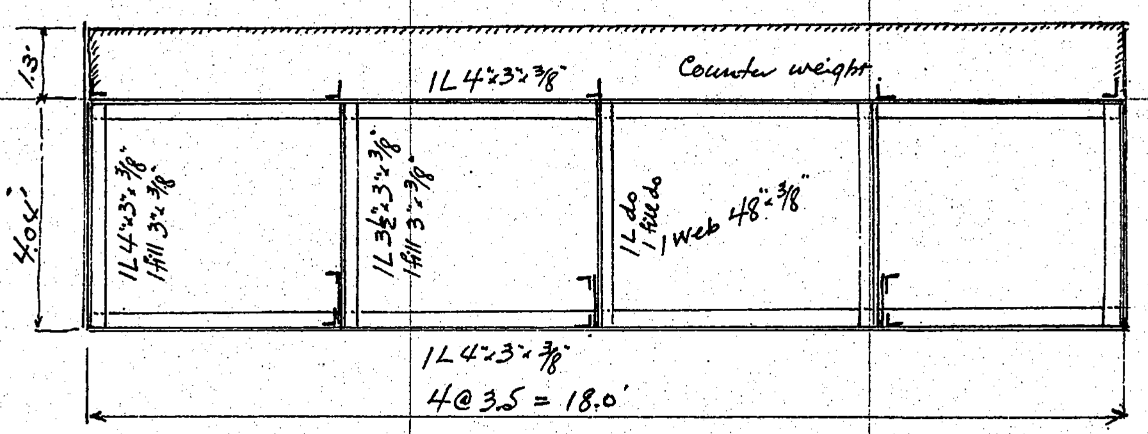
4.73 □" | 3.97 □" net

End shear = 39,300#

rivet for end connection = $\frac{39300}{6010}$ = 6.5 rivets

Use more than 8 - 7/8" φ rivets.





Approximate weight of Counter weight Girders.

4 flange Ls	4"×3"×3/8"	× 18.0'	= 72.0' @ 8.45	= 608#
2 web pls.	48"×3/8"	× 18.0'	= 36.0 @ 61.2	= 2205
4 stiff Ls.	4"×3"×3/8"	× 3.98	= 15.92 @ 8.45	= 135
6 stiff Ls.	3½"×3"×3/8"	× 3.98	= 23.88 @ 7.81	= 187
8 strut Ls	3½"×3"×3/8"	× 5.0	= 40.0 @ 7.81	= 313
3 "	" " "	"	× 15.0 @ 7.81	= 117
3 " pl.	12"×3/8"	× 5.0	= 15.0 @ 15.3	= 230
10 fills pls	3"×3/8"	× 3.54	= 35.4 @ 3.83	= 136
2 "	3½"×3/8"	× 4.9	= 9.8 @ 4.46	= 44
4 lateral brac.	Ls 3½×3½×3/8	× 6.5	= 26.0 @ 8.5	= 221
3 guss pls.	9"×3/8"	× 1.0	= 3.0 @ 11.48	= 35
4 " "	9"×3/8"	× 0.7	= 2.8 @ 11.48	= 32
2 hang. pls	60"×½"	× 5.5'	= 11.0 @ 102.0	= 1123
8 brackets			@ 50	= 400
Rivets heads etc	3% say			= 174
				5,960# = 2.66 tons.
Cast steel hangers	2 @ 500		=	1,000
				6,960# = 3.11 tons.

Total volume of counter weight = 5.34 × 5.0 × 18.0 = 481 cub ft.

vol. of steel = $\frac{6960}{490}$ = 14 cub ft. less 14

volume of concrete = 467 cub ft.

Total ~~weight~~ required weight for steel scrap concrete

= 120250 - 6960 = 113,290#

Required unit weight of steel scrap concrete

= $\frac{113290}{467}$ = 243# per cub. ft.

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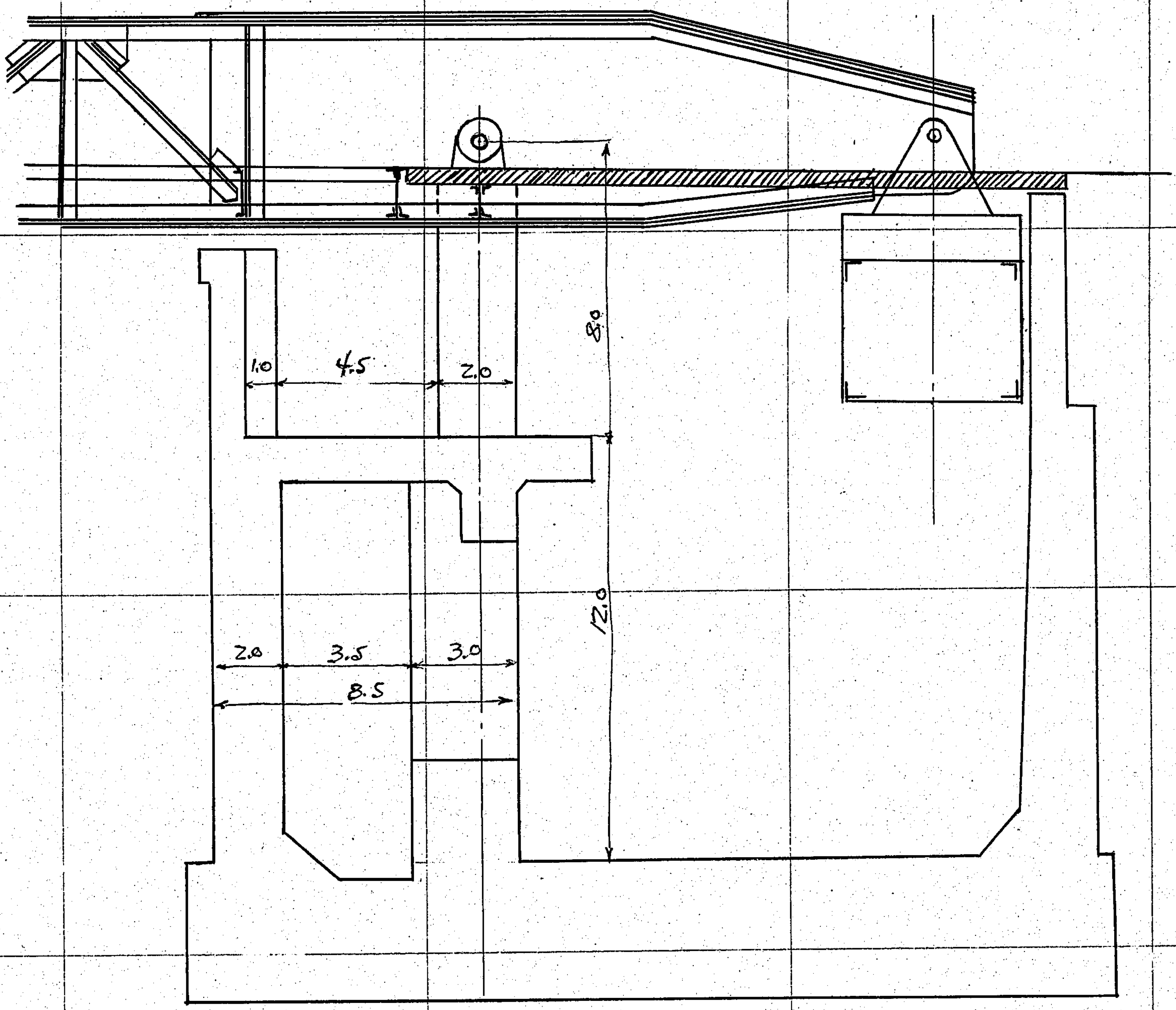
CALCULATIONS FOR

Tsuboi-gawa-Bashi for Kumamoto ken.
Design of Trunnion Bearing columns

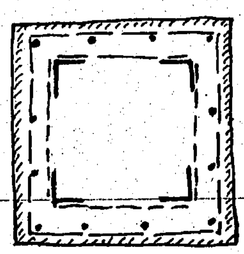


Load on column
Weight of Super structure = 78,800# (revised 79,615#)
Counter weight = 120,250
199,050# ÷ 2 = 99,500# for one bearing
30% Impact assumed = 29,900
129,400# ÷ 2 = 64,700# for one column

Section req'd = $\frac{64700}{14000}$ = 4.62□"

Use 4Ls 100×100×10 = 2.95×4 = 11.8□" gr
with lacing bars.

Strut. 1 I beam 14"×6"@46.01#



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CALCULATIONS FOR

Tsuboi-gawa-Bashi for Kumamoto Ken.

Design of Trunnion Bearings.

Dead Load (for two trusses)

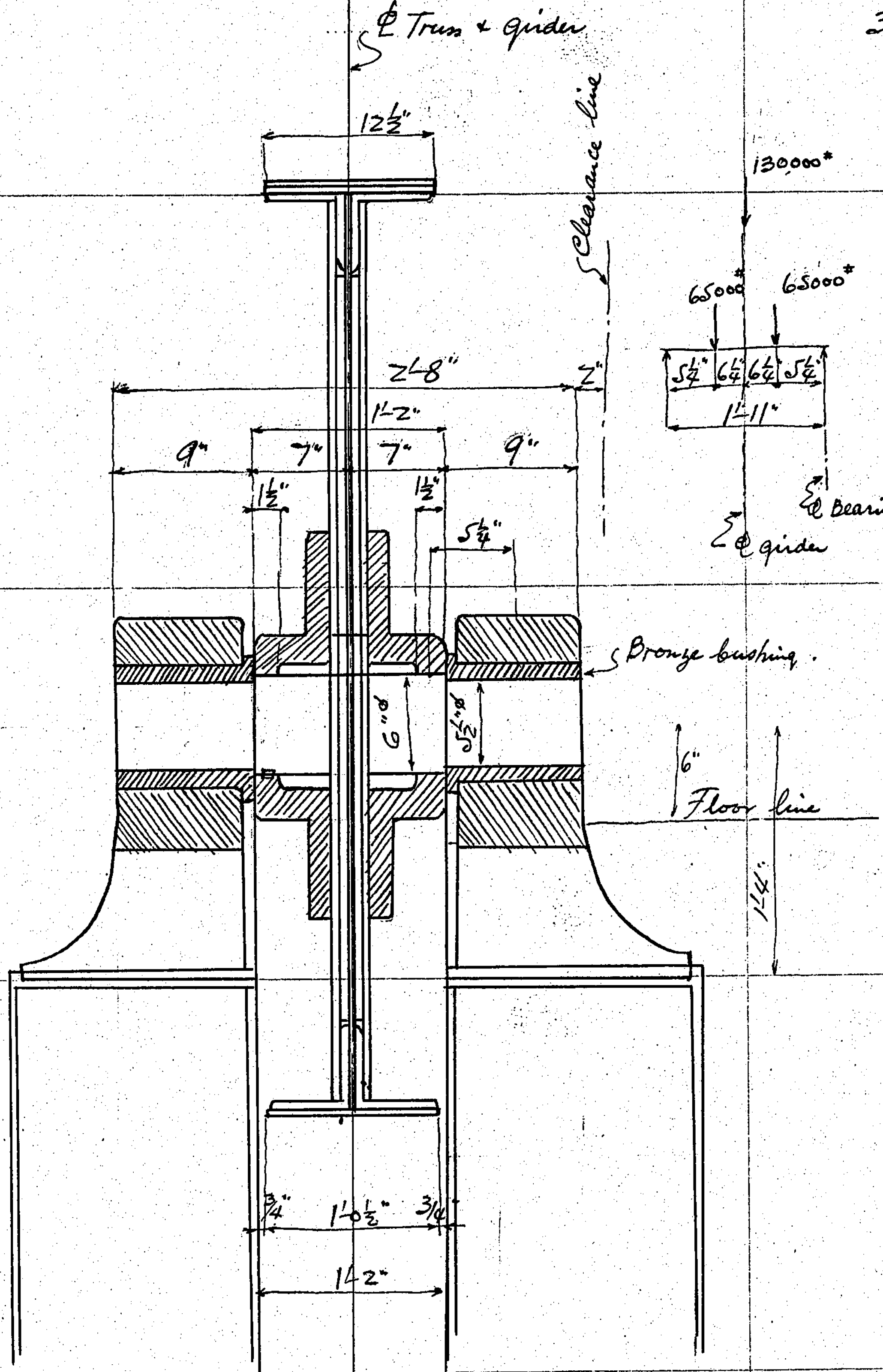
River arm	60,700#
Rear arm	14,070
racks & shaft	4,030
Counter wt.	120,250
	199,050 ÷ 2 = 99,500# for one truss.
30% impact	= 29900
total	129,400#

Call this 130,000#

Bending moment on pin
= 65000 × 5.25" = 341,000"#
Use 5½"ᵈ pin (resist. m = 392,000 "#)
inside of bearing pedestals 6"ᵈ (509,000"#)

Unit bearing pressure on inside bearing (steel)
Bearing width 1½" assumed.
Unit bearing = $\frac{65000^\#}{6'' \times 2}$ = 5,410#/□" ok

Unit bearing pressure on outside bearing (bronze)
bearing width assumed at 9"
Unit bearing = $\frac{65000}{5.5 \times 9}$ = 1,310#/□" ok

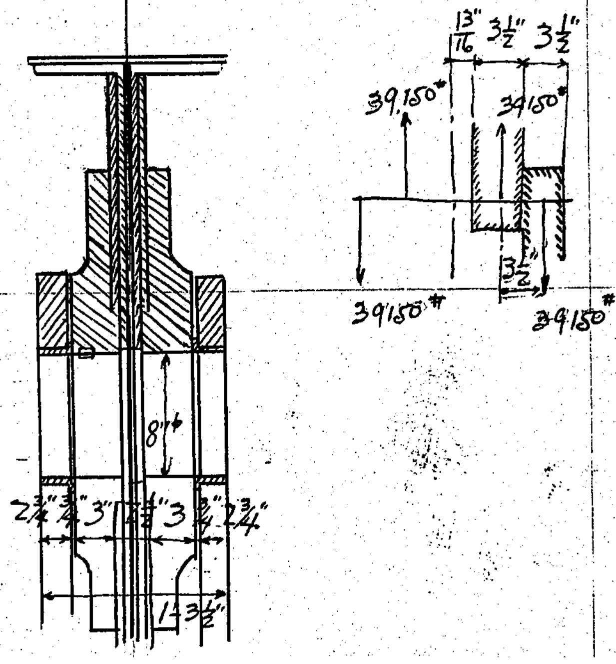


Design of Hinge for Counterweight.

Counter weight 120,250#
30% impact 36,200
156,450 ÷ 2 = 78,300# for one girder

moment on pin 39150 × 3.5" = 137,000 "#
Use 8"ᵈ pin resisting m = 1,206,400 "# ok.

Unit bearing pressure on outside bronze bearing
= $\frac{39150}{8 \times 3.5}$ = 1,400#/□" on bronze ok.



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Tsuboi-gawa Bashi for Kumamoto Ken

Design of operating machinery.

General data.

Dist c to c of Trusses.	18.0'
Rack radius	5.25'
Diameter of trunnion shaft.	$5\frac{1}{2}'' = 0.458'$
" " pin for counter weight	8" = 0.667'
Angle of opening	75 degrees

Dead load (moving)(one truss only)

River arm	30,350#
Rear arm	7040
Rack and shaft	2,000
Counter weight	60,120
Total weight	99,500# for one girder

Distance center of gravity of river arm to trunnion = 26.1'

" " " rear arm to trunnion = 5.78'

" center to center of counter weight to trunnion = 12.5'

Eccentricity of total moving part to trunnion = 0.17' assumed.

Area of floor (one truss) = 55.0 × 9.02 = 496 □'

Distance center of gravity of floor area from trunnion = 29.5'

Inertia of moving mass: $F = M\alpha$

where M = the equivalent mass at the rack circle.
α = the acceleration in ft. per sec²

If a given weight W has its gravity center a distance C from the center of rotation the equivalent mass (not weight) reduced to a rack of radius r may be had from the formula

$$M = \frac{WC^2}{32.2\,r^2} \quad \text{or} \quad Mr^2 = \frac{WC^2}{32.2}$$

Applying these formulas with the data given

Mr^2 (for river arm)	$30350 \times 26.1^2 \div 32.2 =$	642,000
Mr^2 (for rear arm)	$7040 \times 5.78^2 \div 32.2 =$	7,300
Mr^2 (for rack shaft)	$2,000 \times 0^2 \div 32.2 =$	0
Mr^2 (for counter weight)	$60,120 \times 12.5^2 \div 32.2 =$	292,000
Mr^2 (for eccentricity of moving part)	$99,500 \times 0.17^2 \div 32.2 =$	100
		941,400
M = (Round numbers)	$941,400 \div 5.25^2$ =	34,200 #

For 75 degree angular rotation the length of travel on the rack is

$$\frac{(2\pi)(5.25)(75\ \text{deg.})}{360\ \text{deg.}} = 6.87'$$

Assuming total time of opening at 1 min 20 sec. the first 20 sec. may be assumed as constituting the period of acceleration, the last 20 sec. the period of retardation, leaving the intermediate period of 40 sec. for uniform motion. The uniform speed therefore becomes.

$$\text{uniform speed} = \frac{6.87}{\left(\frac{20}{2}+40+\frac{20}{2}\right)} = 0.115\ \text{ft. per sec.}$$

the acceleration is therefore

$$\frac{0.115}{20} = 0.00575\ \text{ft. per sec}^2$$

and $F = M\alpha = 34,200 \times 0.00575 = \underline{197}$ # (for one rack)

Wind resistance.

The tangential force at the rack circle due to 10# wind

$$\frac{496\,\square' \times 10\#/\square' \times 29.5}{5.25} = \underline{27,850}\ \# \text{ (for one rack)}$$

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Frictional resistance

Load on trunnion (dead load) = 99,500#

wind load pinion reaction 27850

Total 107,350# (one girder)

radius of trunnion shaft = 5½" ÷ 2 = 2.75"

rack radius = 5'-3" = 63"   Coeff. of friction for bronze bearing = 0.15 assumed

frictional force on rack circle

$= \frac{107350^{\#} \times 2.75}{63} \times 0.15 = 700^{\#}$ (one rack)

pinion reaction due to eccentricity of moving part   eccentricity assumed at 2" or 0.17'

pinion reaction $= \frac{99500 \times 0.17}{5.25} = 3,210^{\#}$ on rack circle (one rack)

Frictional resistance due to counterweight friction on pin

frictional moment on counterweight pin = 60120 × 44" × 0.15 = 36100 "#

frictional force on rack circle = $\frac{36100}{63"} = 570^{\#}$ (one rack)

Total tangential force at Rack circle.

Inertial	197#
wind	27,850
Frictional	700
Eccentrical	3210
counterweight frictional	570
	32,527# say 32,500#

Theoritical HP required

average speed at rack circle = 0.115 ft. per sec

total tangential force at rack circle = 32500#

required theoritical HP $= \frac{32500^{\#} \times 0.115 \frac{ft}{sec} \times 60^{sec}}{33000 \text{ '\#/min}} = 6.8$ HP

Gearing   average effency 0.92 assumed.

Total efficiency for 5 sets of gearing $(0.92)^6 = .605$

" " 6 sets " $(0.92)^7 = .557$

Actual required HP

for 5 set gearing 6.8 ÷ 0.605 = 11.2 HP   10.4

" 6 set gearing 6.8 ÷ 0.557 = 12.2 HP

Use 2 – 7.5HP motors.

7.5

14

13

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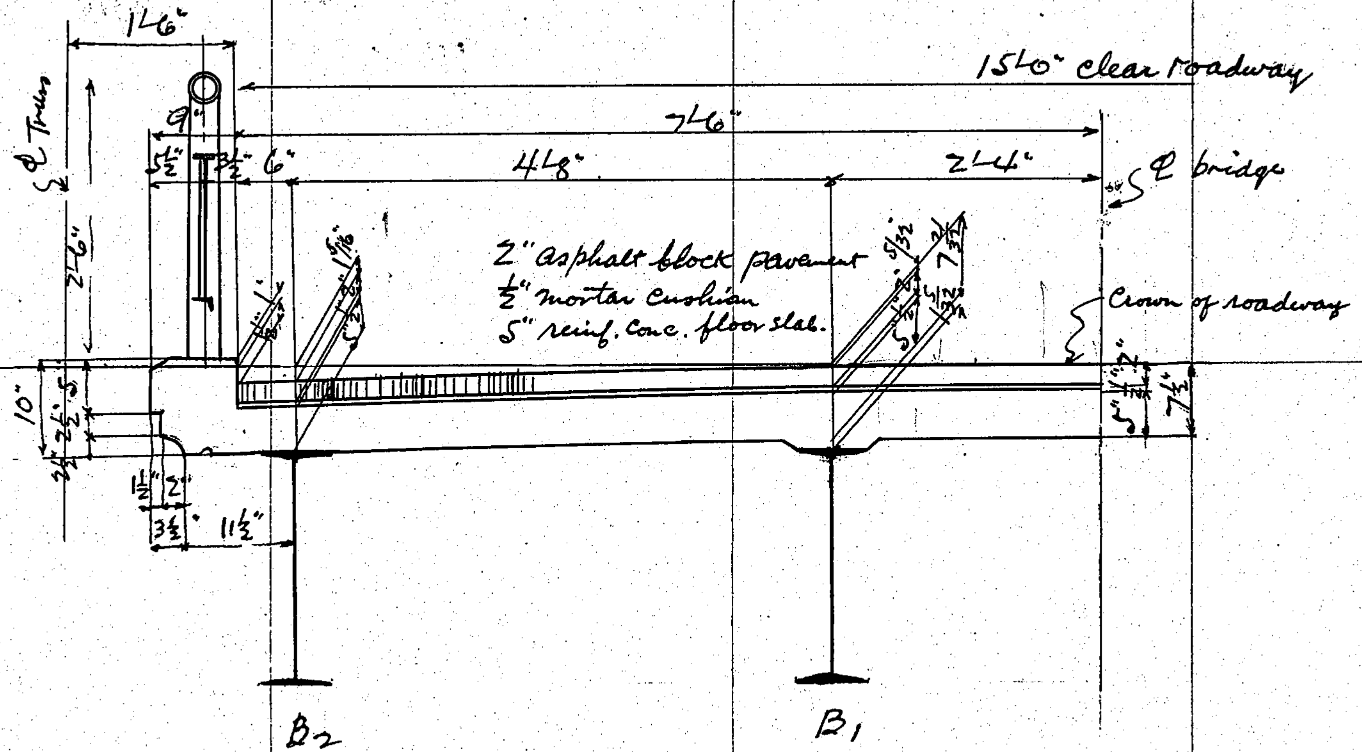
CALCULATIONS FOR

Tsuboi-gawa-Bashi for Kumamoto Ken.

Design of approach girder span. Span length (29'-0") Clear Roadway 15'-0"



Design of floor slab span length 4'-8" or 4.67'

Dead Load

2" asphalt block pavement	@	$\frac{130}{12}$ =	21.7 #/□'
½" Cement mortar cushion	@	$\frac{110}{12}$ =	4.6
5" reinforced concrete slab.	@	$\frac{150}{12}$ =	62.5
			88.8 #/□'

Call this 90#/□'

Dead load moment = $\frac{1}{10} \times 90 \times 4.67^2$ = 197'#

End shear = $\frac{1}{2} \times 90 \times 4.67$ = 210#

Live load. motor truck rear wheel 4,960#
30% impact 1490
6450#

motor truck front wheel 2150#

Distribution of wheel concentration

Contact surface between wheel and pavement 0.66'

2" asphalt block pavement + ½" mortar cushion 2×0.21 = 0.42'

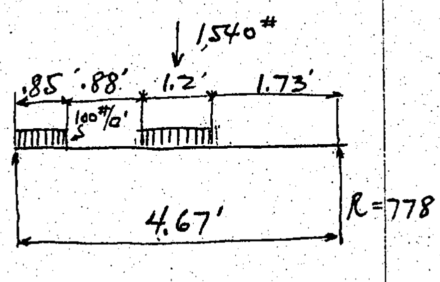
Longitudinal distribution a = 1.08'

Transverse " b = 0.78 + .42 = 1.20'

Effective width of floor slab $e = \frac{2}{3}l + a = \frac{2}{3} \times 4.67 + 1.08 = 4.20'$

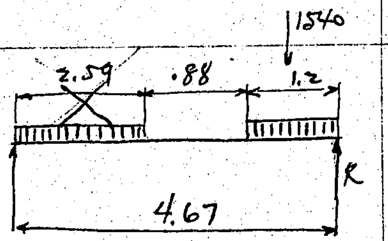
motor truck rear wheel = 6450 ÷ 4.2 = 1,540# per ft strip of slab.

" front wheel = 2150 ÷ 4.2 = 510#



Reaction R = 1540 ÷ 2 = 770#
85 × 0.43 ÷ 4.67 = 8
778#

moment = 778 × 2.335 = 1,820'#
less 1540 ÷ 2 × $\frac{0.6}{2}$ = 230
1,590'#



for continuity of slab moment = 1590 × 0.8 = 1,275'#

End shear 1540 × 4.07 ÷ 4.67 = 1343#
~~2.59 × 1.3 ÷ 4.67~~ = ~~72~~
~~1415~~#
1343

Summary for moment & shears.

Dead load	moment	197	Shear	210
Live load	"	1,275	"	1343 ~~1415~~ 1343
		1,472'#		~~1625~~# 1553

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CALCULATIONS FOR

Tsuboi-Gawa-Bashi for Kumamoto Ken.

Effective depth required $= \sqrt{\frac{1472 \times 12}{12 \times 102}} = 3.84''$

Use 5" over all with 1" insulation at bottom.

Steel area req'd $= \frac{1472 \times 12}{17000 \times \frac{7}{8} \times 4} = 0.297^{\square}{}''$ per ft. strip.

Use 2 - ½"ø bars = .393 □" per ft strip

unit shear $= \frac{1553}{12 \times \frac{7}{8} \times 4.0} = 37.0$ #/□" ok.

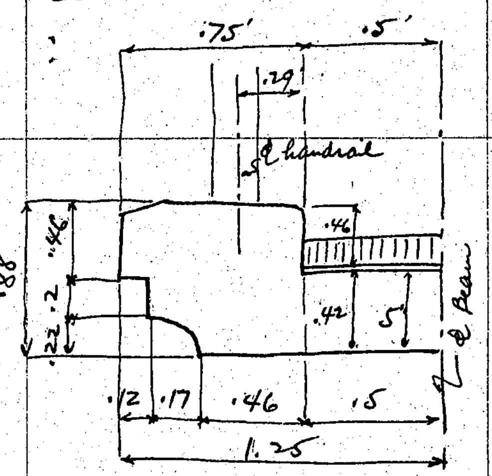
perimeter req'd for bond stress $= \frac{1553}{85 \times \frac{7}{8} \times 4.0} = 5.22''$

Unit bond for plain bar = 85 #/□"

2 - ½"ø bars perimeter = 2 × 1.571 = 3.142"
2 - ⅜"ø bars " = 2 × 1.178 = 2.356
total perimeter = 5.498" ok

Unit bond $= \frac{1553}{5.498 \times \frac{7}{8} \times 4.0} = 80.6$ #/□" ok.

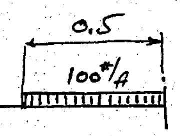
Cantilever slab.



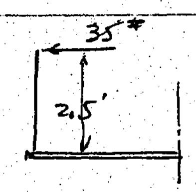
Dead load moment.

Asphalt block pavement	21.7 × 0.5 =	10.9 × .25 =	2.7		
mortar cushion	4.6 × 0.5 =	2.3 × .25 =	0.6		
slab	62.5 × 0.5 =	31.3 × .25 =	7.8		
Coping	.46 × .75 × 150 =	51.7 × .88 =	45.5		
"	.2 × .63 × 150 =	18.9 × .81 =	15.3		
"	.24 × .5 × 150 =	18.0 × .75 =	13.5		
handrail		20.0 × .79 =	15.8		
		153.1 # × .655	101.2 '#	c.g. = $\frac{101.2}{153.1}$ = .655'	

Live load moment $= \frac{1}{2} \times 100 \times 0.5^2 = 13$ '#
end shear = 100 × 0.5 = 50 #



Handrail
live load moment = 35 × 2.5 = 88 '#



Summary for moment and shear

	moment	end shear
Dead load	102	153
Live load unif load	13	50
" handrail thrust	88	—
	203 '#	203 #

Steel area req'd $= \frac{203 \times 12}{17000 \times \frac{7}{8} \times 4} = .04$ □" per ft strip.

Use 1 - ½"ø = 0.196 □"

unit bond $= \frac{203}{1.571 \times \frac{7}{8} \times 4} = 37$ #/□" ok.

Design of main beam B1, span length = 29'-0" spacing 4.67'

Dead load

Floor	92.8 × 4.67 =	434
main beam assumed at		100
		534
fillet etc		11
		545 # per ft of span

(wt. of floor 90%' fillet etc 28)

Dead load moment $= \frac{1}{8} \times 545 \times 29^2 = 57300$ '#
" end shear $= \frac{1}{2} \times 545 \times 29 = 7900$ #

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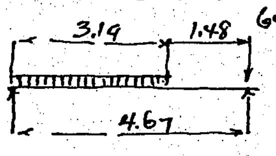
Design of main beams continued

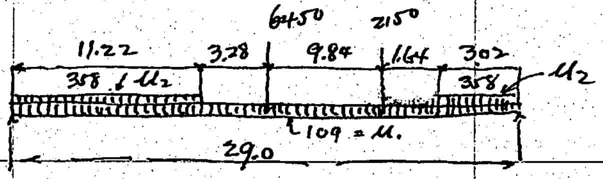
Live Load — Rear wheel with impact 6450#
front " " 2150#

max load on beam



Uniform load on side of truck u_1, $\frac{100 \times 3.19^2}{2 \times 4.67} = 109$# per lin ft

Unif. load rear and front of truck 100 × 4.67 = 467
less −109
u_2 358 # per lin ft.

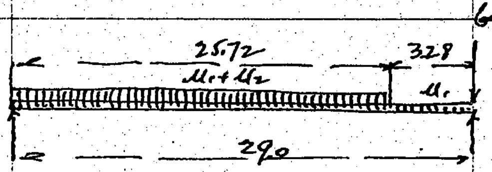


Reaction Rear wheel 6450 ÷ 2 = 3225
Front wheel $\frac{2150 \times 4.66}{29}$ = 345
3570#

Unif. load u_2
358 × 11.22 × 23.39 = 94000
358 × 3.02 × 1.51 = 1630
95630 ÷ 29 = 3300#

Moment
motor truck 3570 × 14.5 = 51700
Unif. load u_1 1/8 · 109 · 29² = 11450
Unif. load u_2 3300 × 14.5 = 47800
less 358 × 11.22 × 8.89 = −35700
12100
75250 #

End shear



Rear wheel of motor truck 6450
Uniform load u_1 109 × 14.5 = 1580
Uniform load u_2 $\frac{358 \times 25.72^2}{2 \times 29}$ = 4090
12120 #

Summary for moments and shears

	moment	shear
Dead Load	57300	7900
Live Load	75250	12120
	132550 #	20020 #

Section modulus req'd $\frac{132550 \times 12}{15400}$ = 103.2

Use 1 I 20" × 7½" @ 88.96# Sm = 167.13

Unit stress = $\frac{132550 \times 12}{167.13}$ = 9500 #/□"

Design of Outside main Beam B_2 span length 29'0" spacing 4.67'

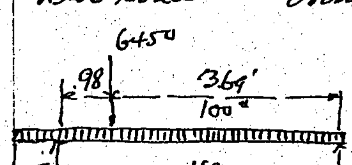
Dead Load Taking moment at B_1 (page 27).
Floor between beams 928 × 4.67 × 2.33 = 1010
Floor coping HR &c outside 153.1 × (4.67 + .655) = 828
1838 ÷ 4.67 = 392

Rail slice 400
beam assumed 100

500 # per lin ft of span

Dead Load moment = 1/8 · 500 · 29² = 52500 #
" " shear = ½ · 500 · 29 = 7250 #

Live Load Transverse distribution of motor wheel.



Load on beam $6450 \times \frac{3.69}{4.67}$ = 5100 #
front wheel 5100 ÷ 3 = 1700 #
Unif load $\frac{100 \times 5.17 \times 2.58}{4.67}$ = 286 # per ft of span

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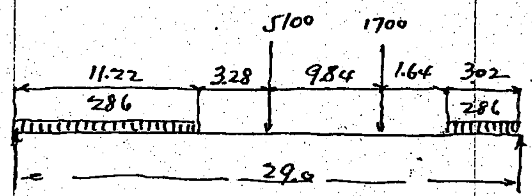
CALCULATIONS FOR

Tsuboigawa-Bashi for Kumamoto-Ken

Live load moment



Reaction

Rear wheel 5100 × 14.5 = 74000
Front wheel 1700 × 4.66 = 7920
81920 ÷ 29 = 2820 #

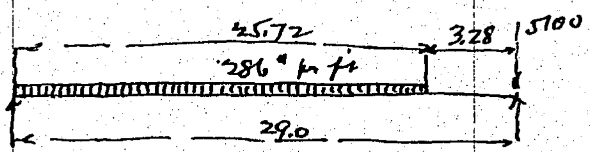
Uniform load

286 × 11.22 × 23.39 = 75000
286 × 3.02 × 1.51 = 1300
76300 ÷ 29 = 2630 #

moment

motor truck 2820 × 14.5 = 40900
Uniform load 2630 × 14.5 = 38200
286 × 11.22 × 8.89 = -28600
9600
50500 '#

End shear



Uniform load 286 × 25.72 × 12.86/29 = 3260
motor truck loading 5100
8360 #

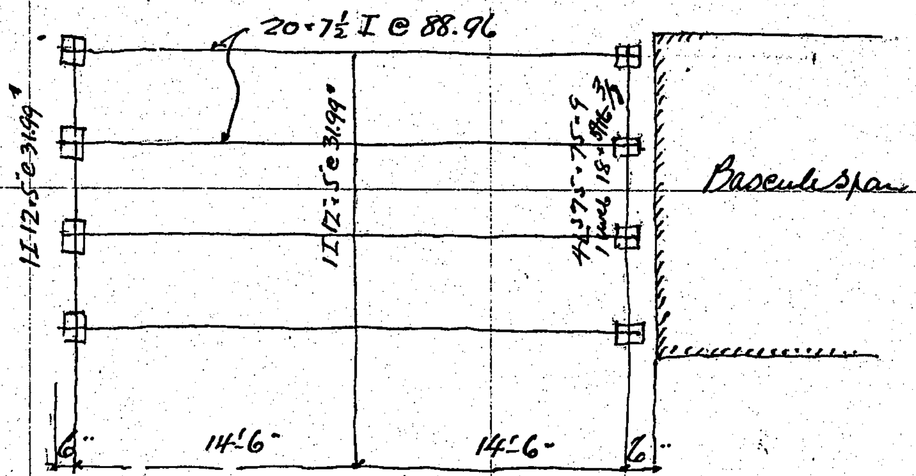
Summary for moments and shears

	moment	shear
Dead Load	52500	7250
Live Load	50500	8360
	103000 '#	15610 #

Section modulus reqd = 103000 × 12 / 15400 = 80.2

Use I beam 20" × 7½" @ 88.96 # section modulus = 167.13

Unit stress = 103000 × 12 / 167.13 = 7400 #/□"



Approximate weight of steel for approach span

main beam	4 Is	20" × 7½"	@ 88.96 #	×	30.0	= 10700
Cross beams	6 Is	12 × 5"	@ 31.99	×	4.65	= 892
Connection Ls	24 Ls	5 × 3½ × 3/8	@ 10.37	×	.75	= 187
Cross beam	12 Ls	75 × 75 × 9	@ 6.69	×	4.65	= 373
	3 pls.	18 × 3/8	@ 22.95	×	4.65	= 320
Conn Ls	12 Ls	5 × 3½ × 3/8	@ 10.37	×	1.40	= 174
Shoes	8 @	50 #				= 400
	Rivets &c					158

13204 # or 5.89 tons

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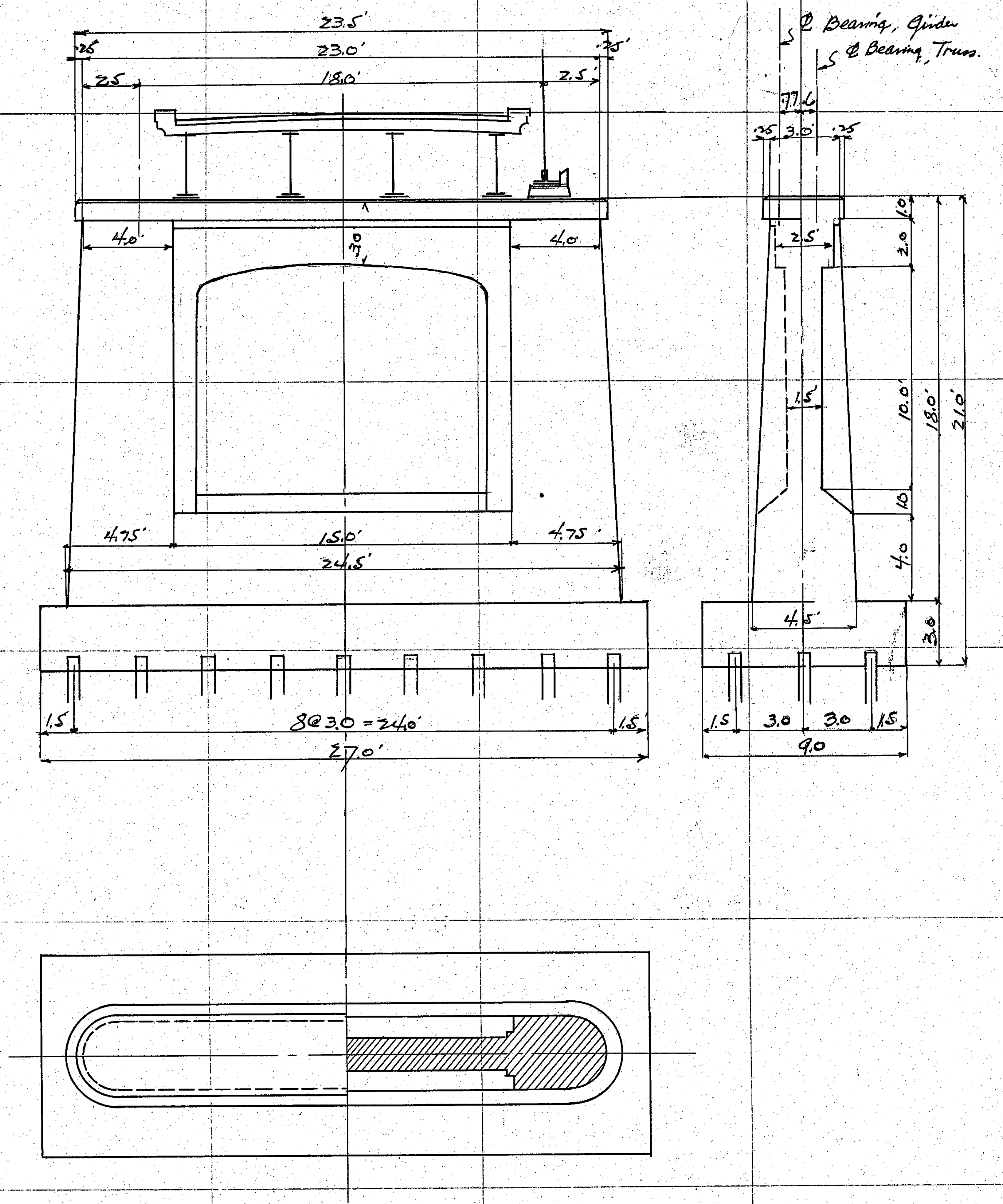
CALCULATIONS FOR

Tsuboi-gawa-bashi for Kumamoto Ken.
Design of Pier between Bascule and Fixed spans.



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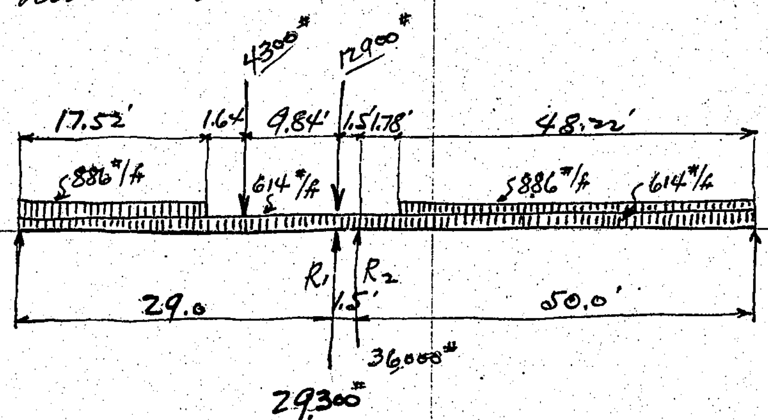
CALCULATIONS FOR

Tsuboi-gawa-Bashi for Kumamoto Ken.

Super imposed loads.

Dead load. from bascule span — none.
from fixed span. (7900 + 7250) × 2 = 30,300#

Live Load.



Live load from fixed span.
due to wheel concentration — R1
4,300 × 19.16 = 82,400
12,900 × 29.0 = 374,000
456,400 ÷ 29 = 15,700#

due to unif. load — R1
$\frac{886 \times 17.52^2}{2 \times 29}$ = 4685#
$614 \times \frac{29}{2}$ = 8900
13,585#

total R1 = 29,285#
Call this 29,300#

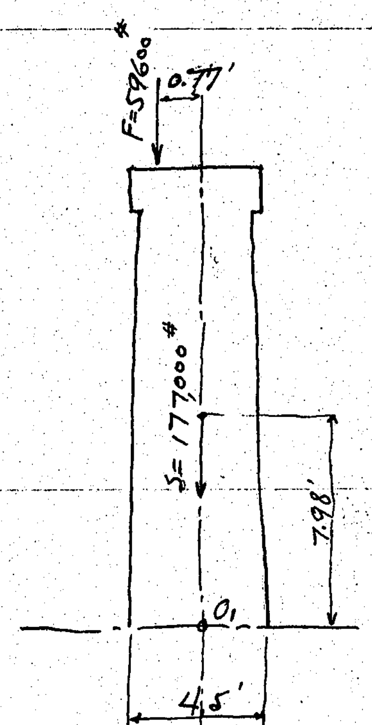
Live load from bascule span — Reaction R2 (uniform load only loaded.)
$\frac{886 \times 48.22^2}{2 \times 50}$ = 20,600#
614 × 50 ÷ 2 = 15,400
total R2 = 36,000#

Summary for super imposed loads.

	Fixed span	Bascule Span.
Dead load	30,300#	0.
Live load	29,300	36,000
	59,600#	36,000#

Stability of shaft.

Case 1. Stability at normal state in full load. Super imposed load -
from fixed span 51,000#
" bascule span 36,000#
max. stress in shaft occurs in case of no load from bascule span.



Center of gravity and weight of shaft.

		cub.ft.				
Coping	1.0 × 3.5 × 22.3 =	78.0 @150.	11700# ×	17.5' =	204,700
Shaft (2cols)	3.75 × 3.75 × 2 × 17.0 =	488.0 @ "	71,700 ×	7.7 =	552,000
Strut (top)	2.25 × 2.5 × 15.0 =	84.4 @ "	12,700 ×	15.9 =	202,000
wall	1.5 × 9.75 × 15.0 =	219.3 @ "	32,900 ×	9.8 =	322,000
"	1.0 × 1.0 × 19.0 =	19.0 @ "	2900 ×	9.8 =	28,400
"	4.6 × 4.3 × 15.0 =	296.7 @ "	44,500 ×	2.2 =	97,900
		1185.4 cub.ft.	176,400#	7.98'	1,407,000

or = 5.5 $\frac{1}{2}$ yd. Call this 177,000#

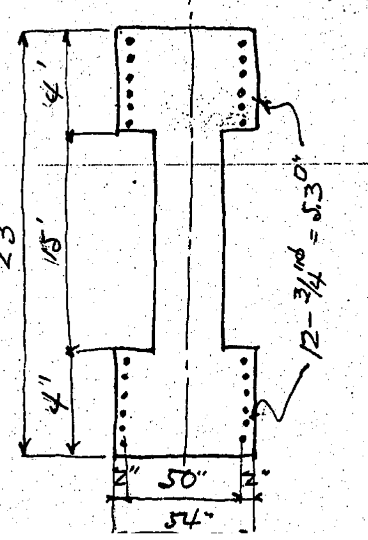
Taking moment about O1
F 59600 × 0.77 = 45900'#
S 177,000'
236,600#

Eccentricity e = $\frac{45900}{236600}$ = 0.2

Assumed section is as follows.

steel area required for moment = $\frac{45900 \times 12}{17000 \times \frac{7}{8} \times 52}$ = 0.71□"

Use 12 - 3/4 rd = 5.30□"



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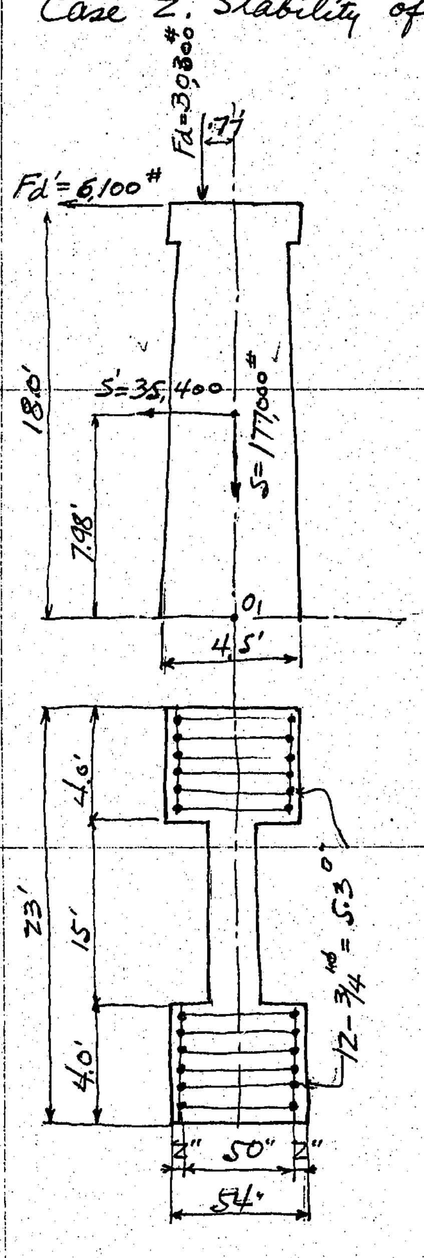
CALCULATIONS FOR

Tsuboi-gawa-Bashi for Kumamoto Ken.

Stability of Pier shaft continued:

Case 2. Stability of shaft during Earthquake



Acceleration assumed at 2000 mm/sec² or K=0.2

Superimposed dead load.

from fixed span = 30,300# (see page 32)

from bascule span = none.

Taking moment about O1.

Loads	Hor. forces	vert. forces		lever arm		moment
Fd		30300	×	0.77	=	23,300
Fd'	6100		×	18.0	=	108,000
S		177,000	×	0	=	0
S'	35400		×	7.98	=	283,000
	ΣH = 41,500#	ΣV = 207,300#			ΣM =	414,300'#

Eccentricity $e = \frac{414300}{207,300} = 2.0'$

Assumed section at bottom of shaft is as shown in the sketch below.

$d'/h = 2/54 = 0.037$, $e/h = 2.0/4.5 = 0.445$

$p_0 = 2p = \frac{5.3 \times 2}{54 \times 96} = 0.002$

From the prepared diagrams

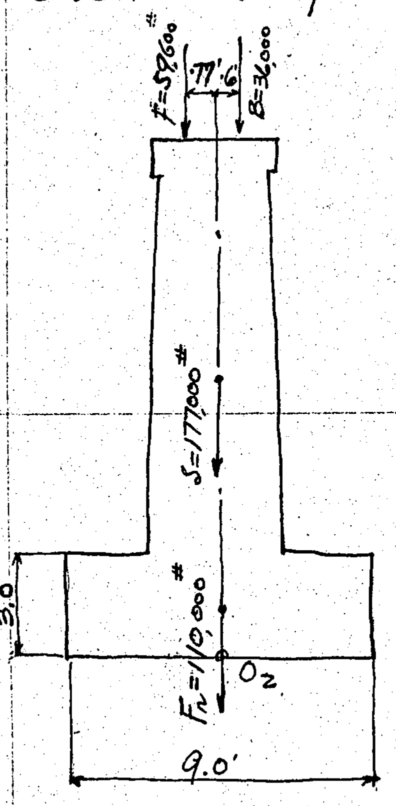
$K = 0.43$, $L = 0.092$

Concrete Stress $f_c = \frac{M}{Lbh^2} = \frac{414300 \times 12}{0.092 \times 96 \times 54^2} = 193 \#/\square''$ ok.

Steel Stress $f_s = nf_c\left(\frac{d}{kh} - 1\right) = 15 \times 193\left(\frac{52}{0.43 \times 54} - 1\right) = 3590 \#/\square''$ ok.

Stability of Pier as a whole:

Case 1. Stability at normal state



Weight of foundation base = 3.0 × 9.0 × 27 = 730 cu.ft @ 150 = 109500#

(or 3.4 坪) Call this 110,000#.

Taking moment about O2

Load			lever arm		moment
F =	59600#	×	0.77	=	45900'#
S =	177,000	×	0	=	—
Fn =	110,000	×	0	=	—
B =	36000	×	−0.6	=	−21600
	382,600				24,300'#

Eccentricity $E = \frac{24,300}{382,600} = 0.064'$

Resultant force within middle third.

max toe pressure $= \frac{382,600}{27 \times 9}\left(1 \pm \frac{6 \times 0.064}{9}\right) = 1640 \#/\square' = 0.73 \text{ ton}/\square'$ or $1,510 \#/\square' = 0.67$ "

Load on one pile = 0.71 × 3.0 × 3.0 = 6.4 tons.

Use pine piles 0.6'⌀ at tip 15.0' long for which spacings shall be 3.0' in both directions.

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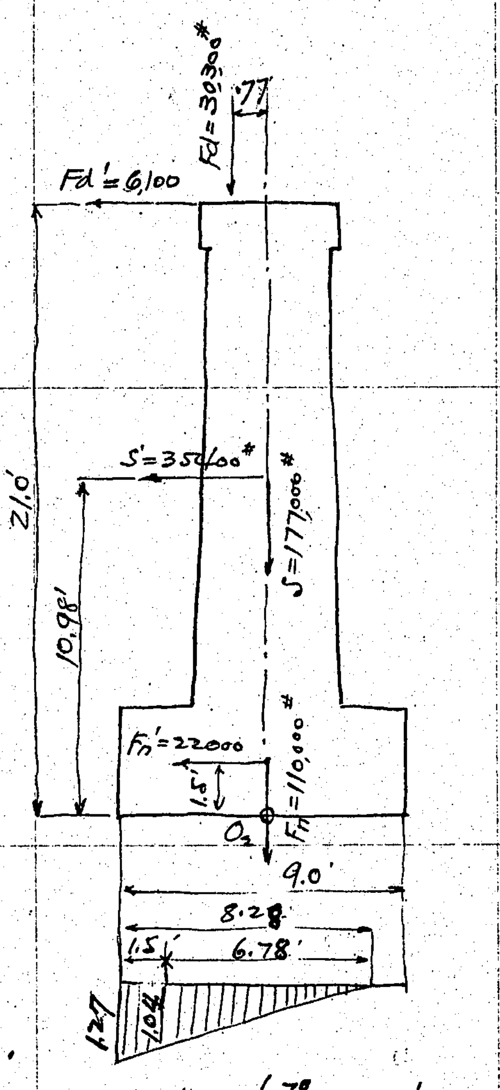
CALCULATIONS FOR

Tsuboi-Gawa-Bashi for Kumamoto Ken.

Case 2. Stability during Earthquake. acceleration = 2000 mm/sec² say $k = 0.2$

Taking moment about O_2

Loads	Hor. forces	vert. forces	lever arm	moment
Fd		30,300# ×	0.77 =	23300 '#
Fd"	6,100 #	×	21.0 =	108,000
S		177,000 ×	0 =	0
S'	35,400	×	10.98 =	389,000
Fn		110,000 ×	0 =	0
Fn'	22,000	×	1.5 =	33,000
	ΣH = 63,500#	ΣV = 317,300#	ΣM =	553,300 '#



$1.27 \times \frac{6.78}{8.28} = 1.04$ tons/□'

Eccentricity $= \frac{553,300}{317,300} = 1.74'$

Resultant force out of middle third, neglecting tension

Pressure area $= (4.5 - 1.74) \times 3 = 8.28$ □' per ft strip

max toe pressure $= \frac{317300 \times 2}{8.28 \times 27} = 2840$ #/□' or 1.27 tons/□'

Load on one extreme pile $= 1.04 \times 3.0' \times 3.0' = 9.36$ tons OK

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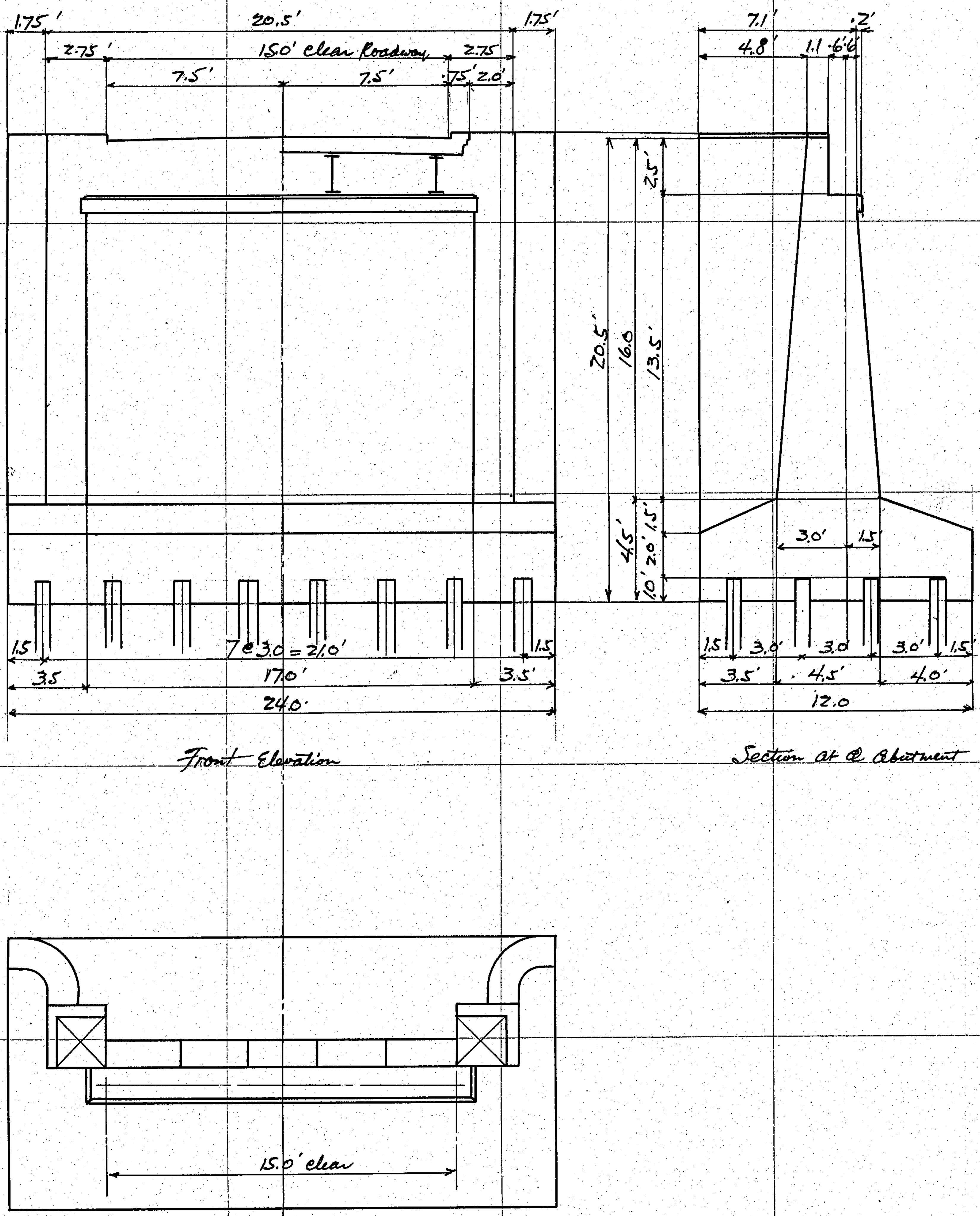
CALCULATIONS FOR

Tsuboi-gawa Bashi for Kumamoto Ken.
Design of Abutment for fixed span.



Super imposed loads on abutment

Dead load	30,300	See page 32
Live load	29,300	"
Total =	59,600	on whole abutment

Acceleration of earthquake assumed at 2000 mm/sec²
or Seismic coefficient k = 0.2.

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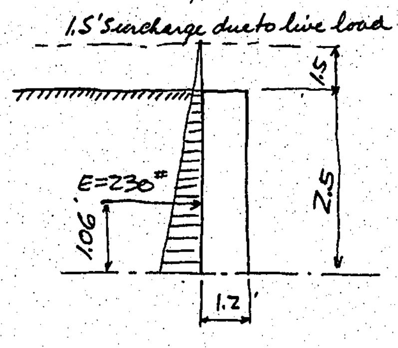
Tsuboi-gawa Bashi for Kumamotoken

Parapet wall.

Case 1. Stability of parapet wall at normal state.



Earth pressure at 1.5' deep $= \frac{100}{3} \times 1.5 = 50\ \#/\square'$

" , 4.0' " $= \frac{100}{3} \times 4.0 = 133$ "

$183 \div 2 = 92\ \#/\square'$ average pressure on wall.

Total earth pressure on wall 1 ft strip.

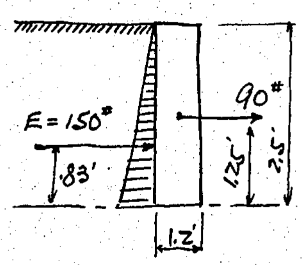
$E = 92 \times 2.5 = 230^{\#}$

moment on wall $= 230 \times 1.06 = 244'^{\#}$

Steel area required for moment $= \frac{244 \times 12}{17000 \times \frac{7}{8} \times 12} = 0.016\square''$ per ft strip of wall.

Use $\frac{1}{2}''\phi$ bars 24" spacing $= 0.098\square''$ per ft strip.

Case 2. Stability of parapet wall during earthquake.



From the prepared table, earth pressure during earthquake of $k = 0.2$

$E = 0.24\ wh^2 = 0.24 \times 100 \times 2.5^2 = 150^{\#}$ per ft strip of wall

weight of wall $= 1.2 \times 2.5 @ 150 = 450^{\#} = P.$

Seismic force $P' = 450 \times .2 = 90^{\#}$

moment $90 \times 1.25 = 113'^{\#}$

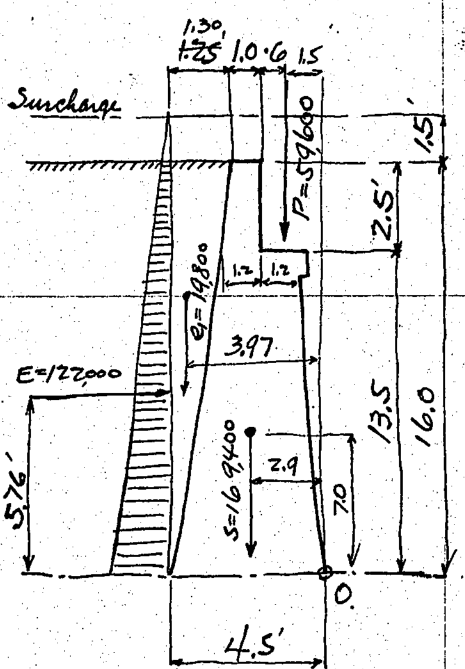
$150 \times 0.83 = 125$

$240^{\#}$ $238'^{\#}$

Assumed section is ample.

Stability of shaft.

Case 1. Stability at normal state.



Center of gravity and weight of shaft. — moment about point O.

				hor. arm.	m.h.	vert arm	m.v.
Parapet wall.	$1.1 \times 2.5 \times 15.0 = 41.3$ cu.ft.	@ 150 =	6,200#	2.7'	16,700	14.7'	91,100
Shaft	$3.45 \times 13.5 \times 17.0 = 792.0$	@ " =	118,800	2.2	261,400	6.1	725,000
Column	$2.75 \times 1.75 \times 2 \times 16 = 154.0$	@ " =	23,100	3.5	80,900	18.0	185,000
"	$2.75 \times 1.0 \times 2 \times 2.5 = 13.8$	@ " =	2,100	3.5	7,400	14.8	31,100
wing walls	$1.0 \times 4.0 \times 2 \times 16 = 128.0$	@ " =	19,200	6.5	124,900	8.0	153,500
	1,129.1 cu.ft or 5.22 tsubo		169,400#		491,300		1,185,700

Center of gravity of shaft. =

Horizontal arm $= \frac{491300}{169,400} = 2.9'$ from O.

Vertical arm $= \frac{1,185,700}{169,400} = 7.0'$ from O.

Weight of earth wedge on rear $= \frac{1.30}{2} \times 16 \times 19 \times 100 = 19,800^{\#}$

Earth pressure

top. $\frac{1}{3} \times 100 \times 1.5 = 50$

bottom $\frac{1}{3} \times 100 \times 17.5 = 583$

Average. $= 633 \div 2 = 317\ \#/\square'$

Total earth pressure

$E = 317 \times 16 \times 24$

$= 122,000^{\#}$

Taking moment about O.

Loads.	Horiz. forces.	Vert. forces.		lever arm		moment.
P		59600	×	− 1.5	=	− 89400#
S		169,400	×	− 2.9	=	− 491,000
e_1		19,800	×	− 3.97	=	− 78,600
E	122000		×	5.76	=	703000
	ΣH = 122,000#	ΣV = 248,800#			ΣM =	+ 44,000'#

Distance of Resultant force $= \frac{44,000}{248,800} = 0.18'$ out of O.

Eccentricity $\varepsilon = \frac{4.5}{2} + .18 = 2.43'$

Moment on shaft at bottom section $= 248,800 \times 2.43$

$= 604,000'^{\#}$

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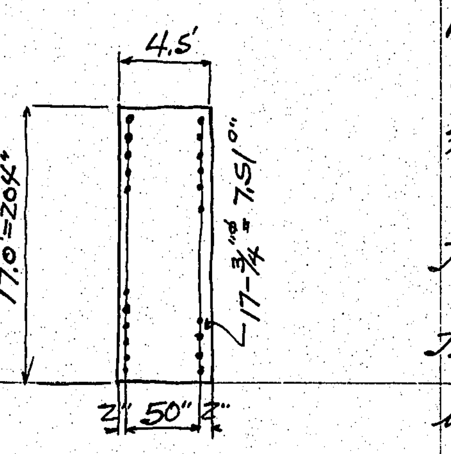
Assumed section of shaft is as shown in the sketch below.



$p_0 = 2p = \frac{2 \times 7.51}{54 \times 204} = 0.00136$

$d'/h = 2/54 = 0.037$, $\varepsilon/h = 2.43/4.5 = 0.54$

From the prepared diagrams, we have

$K = .295$, $L = .0725$

$f_c = \frac{M}{Lbh^2} = \frac{604000 \times 12}{0.0725 \times 204 \times 54^2} = 168$ #/□"

$f_s = nf_c\left(\frac{d}{Kh} - 1\right) = 15 \times 168\left(\frac{52}{.295 \times 54} - 1\right) = 5700$ #/□" ok

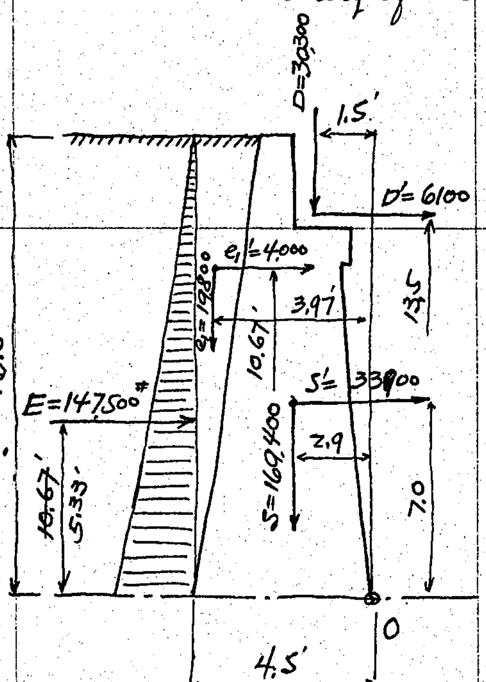
Unit shear $= \frac{122000}{204 \times \frac{7}{8} \times 52} = 13.1$ #/□" ok

Unit bond $= \frac{122000}{40'' \times \frac{7}{8} \times 52} = 67$ #/□" ok.

Case 2. Stability of Abutment shaft during earthquake.

Earth pressure during earthquake $E = 0.24 \times 100 \times 16^2 \times 24 = 147{,}500$ #

Taking moment about point O.



Loads	Hor. forces	Vert. forces	lever arm	moment
D		30,300#	× −1.5	= − 45,500
D'	6100#		× +13.5	= + 82,300
S		169,400	× − 2.9	= −491,000
S'	33,900		× + 7.0	= +237,300
e_1		19,800	× − 3.97	= − 78,600
e_1'	4,000		× +10.67	= + 42,600
E	147,500		× + 5.33	= + 786,000
	ΣH = 191,500#	ΣV = 219,500#		ΣM = +533,100 '#

Distance of Resultant force from pt O. $= \frac{533100}{219500} = 2.43'$

Eccentricity $\varepsilon = \frac{4.5}{2} + 2.43 = 4.68'$ right.

Moment on wall $= 219500 \times 4.68 = 1{,}028{,}000$ '#

Assumed section same as for case 1.

$p_0 = 0.00136$, $d'/h = 2/54 = 0.037$, $\varepsilon/h = 4.68/4.5 = 1.04$

From the prepared diagrams, we have

$K = .20$ $L = .064$

$f_c = \frac{1028000 \times 12}{0.064 \times 204 \times 54^2} = 325$ #/□" ok

$f_s = 15 \times 325\left(\frac{52}{.2 \times 54} - 1\right) = 18630$ #/□" ok < (17000×1.8 = 30600)

Unit Shear $= \frac{191500}{204 \times \frac{7}{8} \times 52} = 20.6$ #/□" ok

Unit bond $= \frac{191500}{40 \times \frac{7}{8} \times 52} = 105$ #/□" ok < (85×1.8 = 153 #/□")

Case 3. Seismic forces reversal to Case 2 without earth pressure.
Clearly safe.

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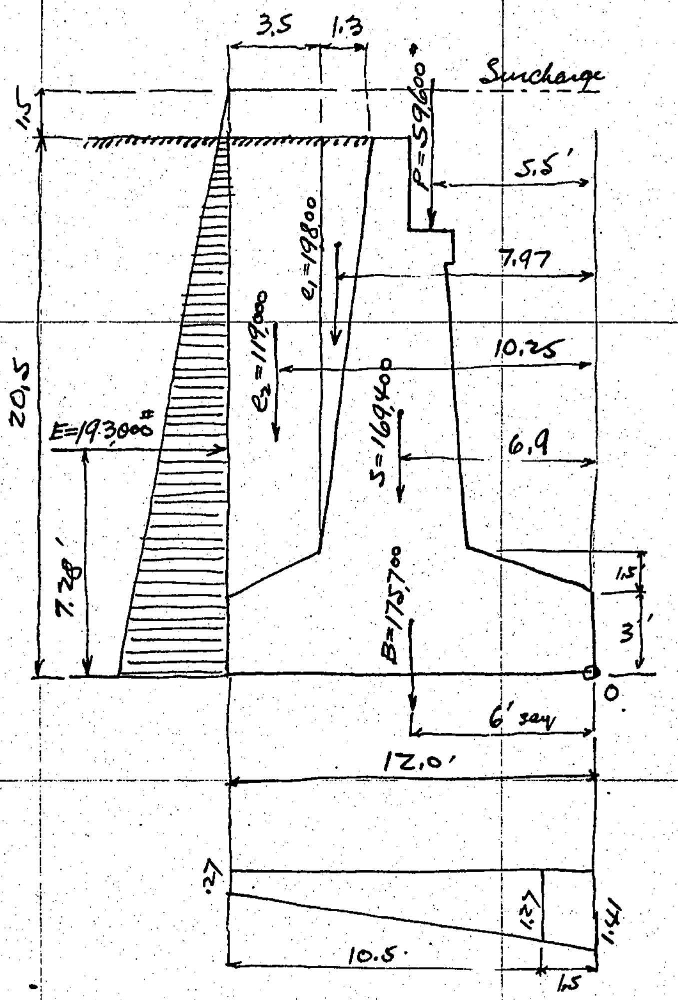
CALCULATIONS FOR

Tsuboi-gawa Bashi for Kumamoto Ken.

Stability of Abutment as a whole.

Case 1. Stability at normal state.



Weight of earth on rear footing

$e_2 = 3.5 \times 20 \times 17 \times 100 = 119{,}000^{\#}$

Weight of base.

B = 12 × 3 × 24 = 864 ~~c.f.~~ (c.g. × 1.5' = 1295)

8.25 × 1.5 / 12+.75 × 24 = 297 (× 3.64 = 1080)

1171 c.f. @ 150 = 175,700 #. (2375 + 1171 = 2.03')

= 5.42 ct

Earth pressure top. 100 ÷ 3 × 1.5 = 50

bottom 100 ÷ 3 × 22.0 = 733

783 ÷ 2 = 392 #/□' average unit.

E = 392 × 20.5 × 24 = 193,000 #

Taking moment about pt. O.

Loads.	Hor. forces.	Vert. forces.	lever arm.	moment.
P.		59,600# ×	− 5.5 =	− 328,000'#
S		169,400 ×	− 6.9 =	− 1,168,000
B		175,700 ×	− 6.0 =	− 1,053,000
e_1		19,800 ×	− 7.97 =	− 157,700
e_2		119,000 ×	− 10.25 =	− 1,220,000
E	193,000	×	+ 7.28 =	+ 1,405,000
	ΣH = 193,000#	ΣV = 543,500#		ΣM = − 2,521,700'#

Distance of resultant force from pt. O.

$= \frac{-2521.700}{543,500} = 4.65'$ left of O.

Eccentricity = 6.0 − 4.65 = 1.35'

Resultant force within middle third.

max. toe pressure = $\frac{543,500}{12 \times 24}\left(1 \pm \frac{6 \times 1.35}{12}\right)$ = 3160 #/□' = 1.41 tons/□'

or 603 " = 0.27 "

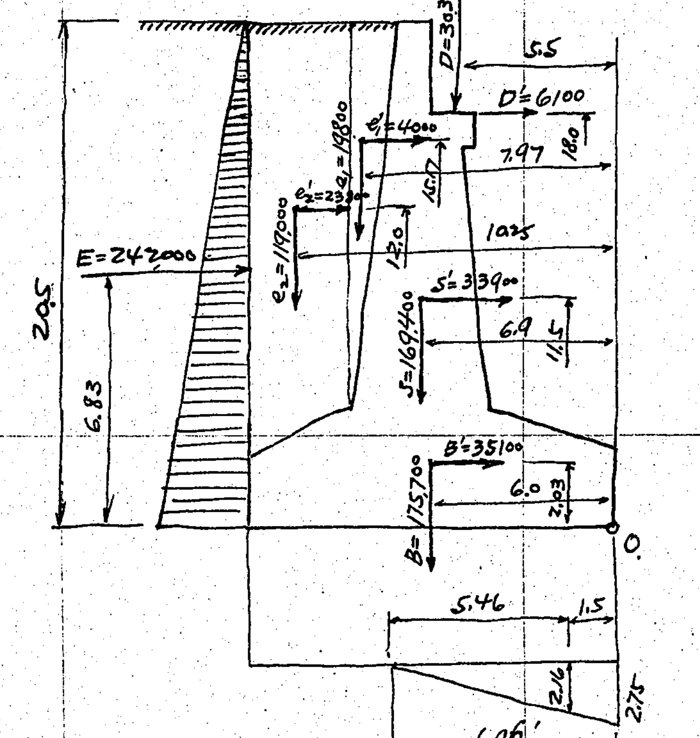
max. load on one pile at extreme row.

= 1.27 × 3 × 3 = 11.4 tons.

Case 2. Stability during earthquake.

Earth pressure during earthquake.

$= 0.24 \times 100 \times 20.5^2 \times 24 = 242{,}000^{\#}$



Loads	Hor. forces	Vert. forces	lever arm	moment.
D		30,300	× − 5.5 =	− 166,800
D'	6,100		× + 18.0 =	+ 109,800
S		169,400	× − 6.9 =	− 1,168,000
S'	33,900		× + 11.5 =	+ 390,000
B		175,700	× − 6.0 =	− 1,053,000
B'	35,100		× + 2.03 =	+ 71,200
e_1		19,800	× − 7.97 =	− ~~1,577,000~~ 157,700
e_1'	4,000		× + 15.17 =	+ 60,700
e_2		119,000	× − 10.25 =	− 1,220,000
e_2'	23,800		× + 12.0 =	+ 285,600
E	242,000		× + 6.83 =	+ 1,653,000
	ΣH = 344,900#	ΣV = 514,200#		ΣM = − 1,195,200'#

Distance of Resultant force from point O.

$= \frac{-1,195,200}{514,200} = 2.32'$

Eccentricity = 6.0 − 2.32 = 3.68'

Resultant force out of middle third, neglecting tension.

pressure area = 2.32 × 3 × 24 = 167 □'

max. toe pressure = $\frac{514,200 \times 2}{167}$ = 6160 #/□' C or 2.75 tons/□'.

max. load on one pile at extreme row (toe).

= 2.16 × 3 × 3 = 19.4 tons.

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Tsuboi-Gawa Bashi for Kumamoto Ken.

Case 3. Stability during earthquake for seismic forces reversed to Case 2.

Reffering to the figure for Case 2. reversing the seismic forces and taking off earth pressure.

Loads	Hor. forces	Vert. forces		lever arm		moment.
D		30,300	×	− 5.5	=	− 166,800
D'	6,100		×	− 18.0	=	− 109,800
S		169,400	×	− 6.9	=	− 1,168,000
S'	33,900		×	− 11.5	=	− 390,000
B		175,700	×	− 6.0	=	− 1,053,000
B'	35,100		×	− 2.03	=	− 71,200
e_1		19,800	×	− 7.97	=	− 157,700
e_2		119,000	×	− 10.25	=	− 1,220,000
	ΣH=75100#	ΣV=514200#				ΣM= 4,336,500'#

Distance of Resultant force from point O.

$= \frac{4,336,500}{514,200} = 8.44'$ left of pt. O.

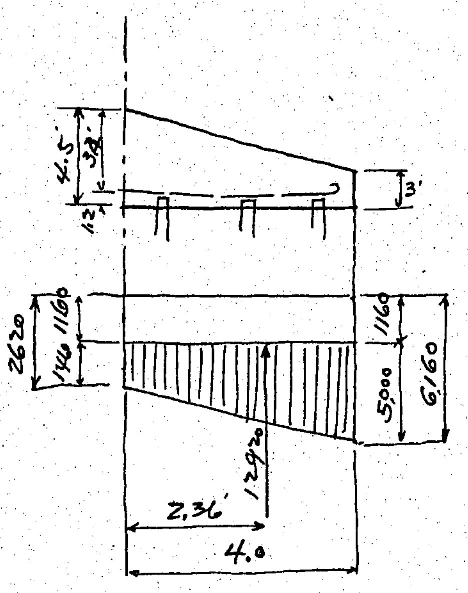
Eccentricity $= 8.44 - 6.0 = 2.44'$ left.

Resultant force out of middle third, neglecting tension.

pressure area $= (12-8.44) \times 3 \times 24 = 256$ □'

max toe pressure $= \frac{514200 \times 2}{256} = 4,020$ #/□' $= 1.80$ tons/□'

Design of Cantilever footing at toe.



Upward pressure. Case 1 1.41 tons/□' or 3160 #/□'

Case 2 2.75 or 6160 : Case 2 governs ~~the section~~.

downward pressure, concrete 3.75 × 150 = 560

earth fill 6.0 × 100 = 600

1160 #/□'

total upward pressure 5000

1460

6460 ÷ 2 = 3,230 × 4 = 12,920 # per ft strip. ~~per lin note of base.~~

moment on footing = 12920 × 2.36 = 30500'# per ft strip

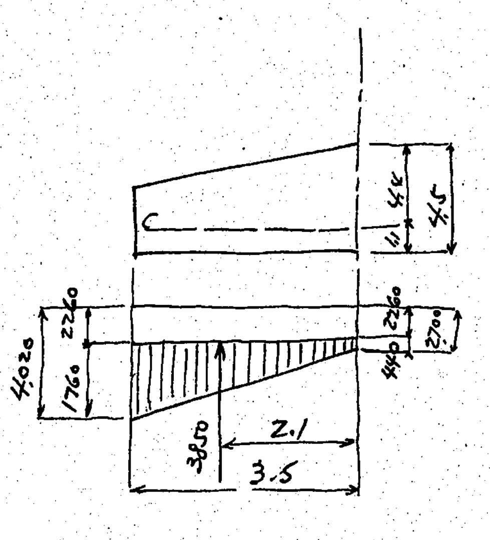
Steel area req'd $= \frac{30500 \times 12}{17000 \times 1.8 \times \frac{7}{8} \times 4\phi''} = 0.34$ □" per ft strip.

Use 3/4"□ bars 1.0' spacing = 0.442 □" per ft strip ok.

Unit shear $= \frac{12920}{12 \times \frac{7}{8} \times 41} = 30$ #/□" ok

Unit bond $= \frac{12920}{2.36 \times \frac{7}{8} \times 41} = 152$ #/□" ok < 85 × 1.8 = 153 #/□" allowable.

Footing at Heel.



upward pressure. Case 3. 4020 #/□' at heel.

downward " concrete 3.75 × 150 = 560

earth fill 17 × 100 = 1700

2260 #/□'

moment 3850 × 2.1 = 8100'#

Steel req'd $= \frac{8100 \times 12}{30600 \times \frac{7}{8} \times 4\phi} = .089$

use 3/4"□ bars 2.0" spacing = 0.22 □" per ft strip ok

Unit shear $= \frac{3850}{12 \times \frac{7}{8} \times 41} = 9$ #/□" ok

Unit bond $= \frac{3850}{\frac{2.36}{2} \times \frac{7}{8} \times \frac{38}{41}} = 91$ #/□" ok. < 153 #/□" allowable.

440

1760

2200 ÷ 2 × 3.5 = 3850#

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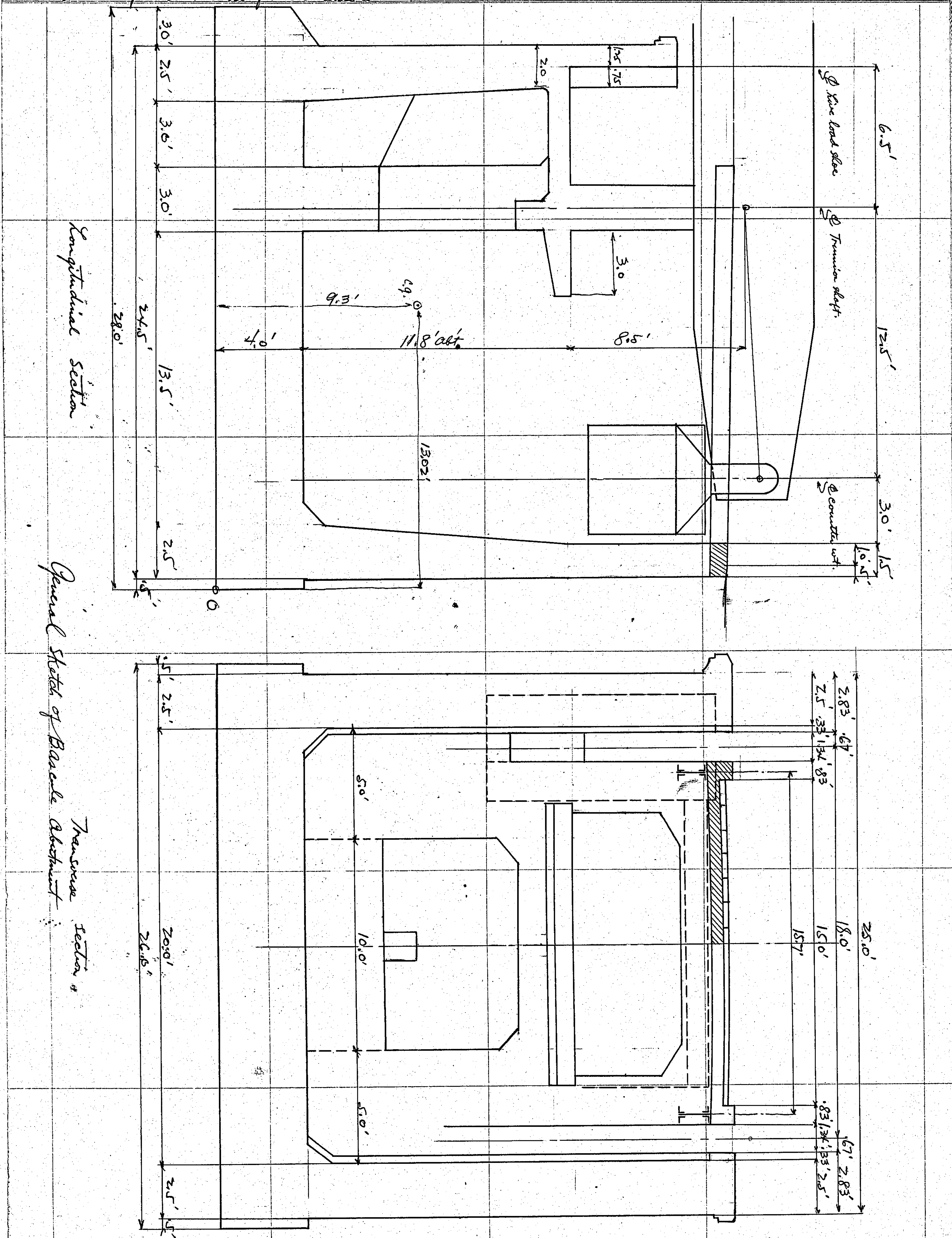
CALCULATIONS FOR

Tsuboi gawa Bashi for Kumamoto ken



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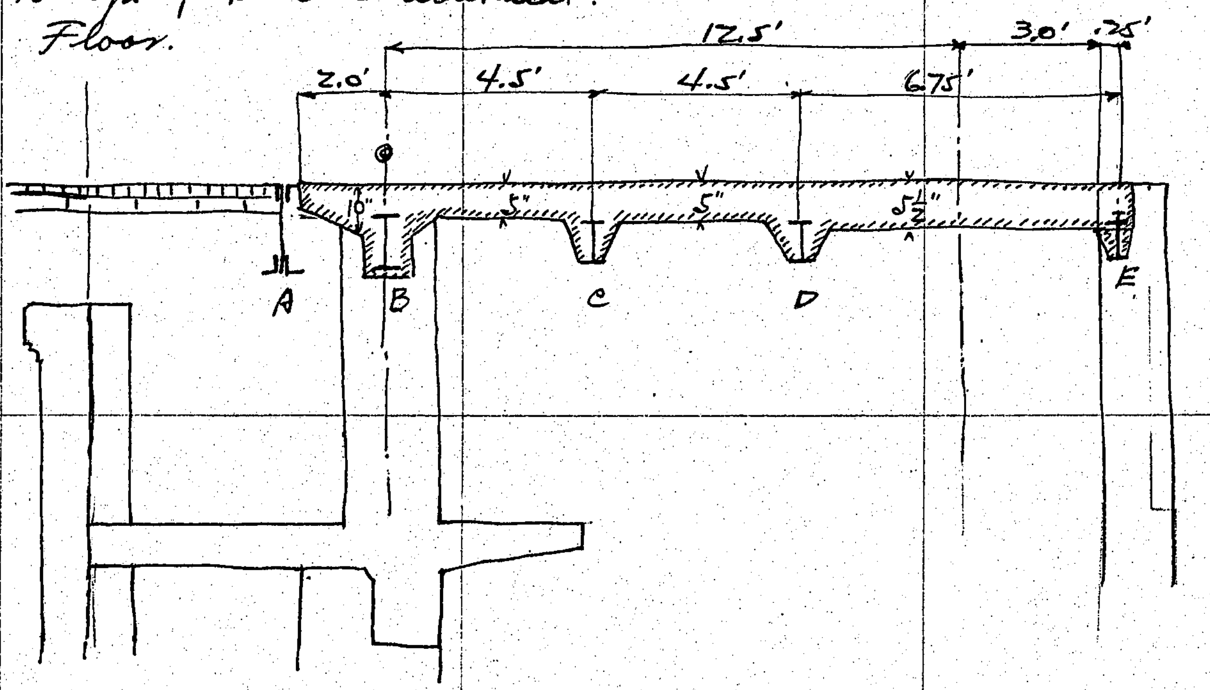
Tsuboi Gawa Bashi for Kumamoto Ken

Design of Bascule abutment.

Floor.



Slab.

Overhanging Slab AB. span length 2.0'

Dead load wt. of floor 21.7 + 4.6 + 150/12 × 7.5 = 120 #/□'

Dead load moment = ½ × 120 × 2.0² = 240 '# per ft strip

End shear = 120 × 2 = 240 #

Live Load motor truck concentration Rear wheel 6450 # including 30% impact see page 27

front wheel 2150 "

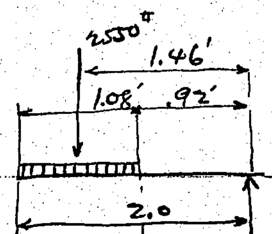
Distribution longitudinal a = 1.08'

transverse b = 1.20'

Effective width of slab. e = ⅔ l + b = ⅔ × 2 + 1.2 = 2.53'

Motor truck rear wheel 6450 ÷ 2.53 = 2550 # per ft strip

" front wheel 2150 ÷ 2.53 = 850 "

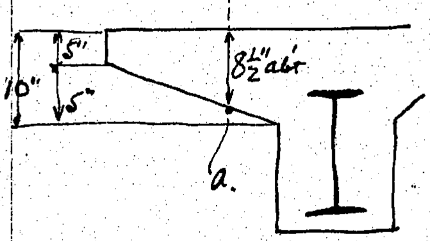


Live load moment = 2550 × 1.46' = 3720 '#

End shear = 2550 #

Summary of moment & shears.

	moment	End shear
Dead Load	240 '#	240 #
Live Load	3720	2550
	3960	2790 #



Steel req'd. at fixture = $\frac{3960 \times 12}{17000 \times \frac{7}{8} \times 9}$ = 0.30 □" per ft strip.

Use 2 - ½" □ bars = 0.393 □" per ft strip perimeter 2 × 1.571 = 3.142

add 2 - ⅜" " for lack of bond 2 × 1.178 = 2.356

5.498"

Unit shear = $\frac{2790}{12 \times \frac{7}{8} \times 9}$ = 29.5 #/□" ok

Unit bond = $\frac{2790}{5.498 \times \frac{7}{8} \times 9}$ = 64.5 #/□" ok.

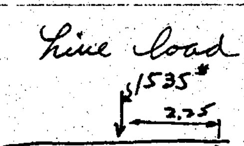
Unit bond at pt. a = $\frac{2790}{5.498 \times \frac{7}{8} \times 7.5}$ = 77.3 #/□" ok.

Slab between B.C. and cd span length 4.5'

Dead Load Dead load moment = 1/10 × 90 × 4.5² = 182

End shear = ½ × 90 × 4.5 = 203

Live load motor truck rear wheel concentration 6450 #

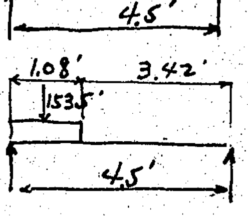


Effective width of slab = ⅔ l + b = ⅔ × 4.5 + 1.2 = 4.2'

rear wheel per ft strip = $\frac{6450}{4.2}$ = 1535 #

Live load moment = $\frac{1535}{2} \times \frac{4.5}{2}$ = 1730 '# for continuity of slab take 80%

moment = 1730 × .8 = 1385 '#



End shear = $\frac{1535 \times 3.96}{4.5}$ = 1350 #

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CALCULATIONS FOR

Tsuboi Gawa-Bashi for Kumamoto ken

Summary for moments & shears.

	moment	shear
Dead load	182	203
Live load	1385	1350
total	1,567 '#	1,553 #

Effective depth of slab $= \sqrt{\frac{1567 \times 12}{12 \times 102}} = 3.92''$

Use 5" depth over all with 1" insulation at bottom

Steel area required $= \frac{1567 \times 12}{17000 \times \frac{7}{8} \times 4} = 0.316$ □" per ft strip.

Use 2 - ½"⌀ bars = 0.393□" ok

Unit shear $= \frac{1553}{12 \times \frac{7}{8} \times 4} = 37$ #/□" ok

Req'd perimeter of reinforcing bars $= \frac{1553}{85 \times \frac{7}{8} \times 4} = 5.23''$

Use 2 - ½"⌀ bars = perimeter = 2 × 1.571 = 3.142"
2 - ⅜"⌀ " = " = 2 × 1.178 = 2.356
5.498"

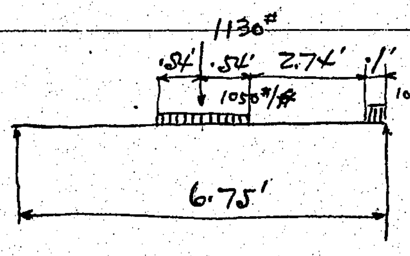
Unit bond $= \frac{1553}{5.498 \times \frac{7}{8} \times 4} = 81.0$ #/□" ok.

Slab between D & E. Span length = 6.75'

Dead load.
2" asphalt block pavement @ $\frac{130}{12}$ = 21.7 #/□'
½" cement mortar cushion @ $\frac{110}{12}$ = 4.6
5½" reinf. concrete slab @ $\frac{150}{12}$ = 68.7
95.0 #/□'

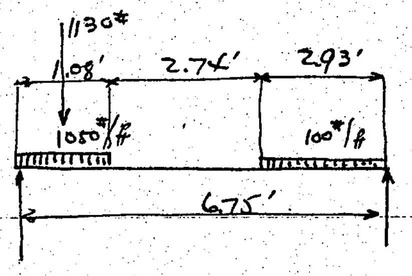
Dead load moment $= \frac{1}{10} \times 95 \times 6.75^2 = 433$ '#
" end shear $= \frac{1}{2} \times 95 \times 6.75 = 321$ #

Live load
motor truck rear wheel concentration = 6,450# including 30% impact (see page 27)
Longitudinal distribution a = 1.08'
Transverse " b = 1.20'
Effective width of slab $= \frac{2}{3}l + b = \frac{2}{3} \times 6.75 + 1.2 = 5.7'$
motor truck rear wheel concentration = 6450 ÷ 5.7 = 1130# per ft strip of slab.
" front wheel " = 2150 ÷ 5.7 = 377 "



R = 1130 × ½ = 565.0#
100 × 0.1 × 0.05 = 0.5
565.5#

moment = 565.5 × 3.38 = 1910
less $1050 \times \frac{0.54^2}{2}$ = −153
1,757 '#



for continuity of slab take moment at $\frac{8}{10}$
live load moment = 1757 × $\frac{8}{10}$ = 1460 '#
Reaction 1130 × 6.21 = 7020
$100 \times \frac{2.93^2}{2}$ = 430
End shear = 7450 ÷ 6.75 = 1104 #

Summary of moment & shears.

	moments	end shears
Dead load	433	321
Live load	1460	1,104
	1893 '#	1425 #

Effective depth of slab $= \sqrt{\frac{1893 \times 12}{12 \times 102}} = 4.31''$

Use 5½" depth over all with 1" insulation

Steel area req'd $= \frac{1893 \times 12}{17000 \times \frac{7}{8} \times 4.5} = .349$ □" per ft strip

Use 2 - ½"⌀ bars = .393□" ok

Unit shear $= \frac{1425}{12 \times \frac{7}{8} \times 4.5} = 30.2$ #/□" ok

perimeter of bars req'd. for bond stress.
$= \frac{1425}{85 \times \frac{7}{8} \times 4.5} = 4.26''$

Use 2 - ½"⌀ bars = 3.142
1 - ⅜"⌀ bar = 1.178
4.320" per ft strip of slab

bond stress $= \frac{1425}{4.32 \times \frac{7}{8} \times 4.5} = 83.8$ #/□" ok.

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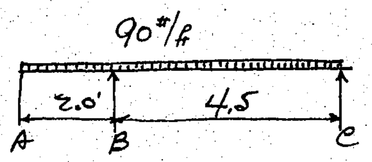
Tsuboi gawa Bashi for Kumamoto Ken.

Cross Beam B. (strut for bearing columns) Span length = 13.2'

Dead Load. Reaction on B due to weight of floor

$= \frac{90 \times 6.5^2}{2 \times 4.5} = 423$ # per ft.



Dead load of beam

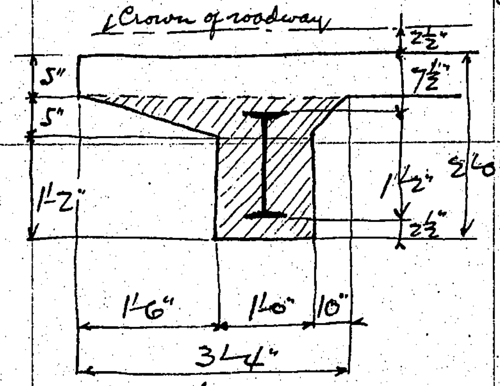
Steel / I-beam 14"×6" @ 46.01#

Concrete 2.17×0.42 = .912

1.0 × 1.17 = 1.170

2.082 @ 150 = 313.0

359# per ft. call this 360# per ft of span.



Dead load moment $= \frac{1}{10} \times 360 \times 13.2^2 = 6,270$ '#

" Shear $= \frac{1}{2} \times 360 \times 13.2 = 2,380$ #

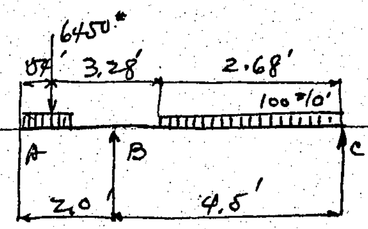
Live Load

Rear wheel concentration 6450# including 30% impact

front " " 2150 "

Reaction at B

due to rear wheel concentration $= \frac{6450 \times 5.96}{4.5} = 8540$ #



due to uniform live load $= \frac{100 \times 2.68^2}{2 \times 4.5} = 79.8$ #/ft call this 80# per lin ft

" " $= \frac{100 \times 6.5^2}{2 \times 4.5} = 470$ "

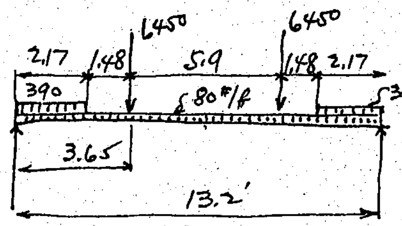
Live load moment

reaction rear wheel 6450

unif. load $80 \times \frac{13.2}{2} = 528$

" $390 \times 2.17 = 738$

Reaction = 7716#

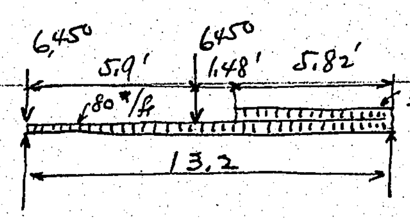


moment 7716 × 3.65 = 28,170 '#

less $528 \times \frac{13.2}{4}$ = −1,740

" 738 × 2.57 = −1,900

m = 24,530 '#



End shear

Rear wheel concentration = 6450

" $6450 \times \frac{7.3}{13.2}$ = 3570

Unif. load 80 × 6.6 = 528

" $\frac{390 \times 5.82^2}{2 \times 13.2}$ = 502

11,050#

Summary for moments & shears.

	moment	end shear
Dead load	6,270	2380
Live load	24,530	11050
	30,800'#	13,430#

section modulus required $= \frac{30,800 \times 12}{17000} = 21.8$ (")³

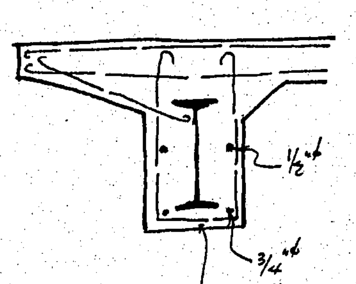
Use 1 I − 14"×6" @ 46.01#

section modulus = 62.95(")³ ok

unit shear $= \frac{13430}{0.4 \times 14} = 2400$ #/□" ok

Rivet no for connection $= \frac{13430}{6010} = 2.3$ — 7/8" rivets

or $\frac{13430}{4420} = 3.1$ — 3/4" rivets.



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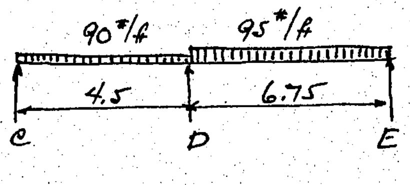
CALCULATIONS FOR

Tsuboi gawa Bashi for Kumamotoken.

Cross Beam at D. span length 15.7' about.

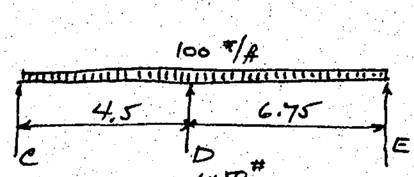
Dead Load.

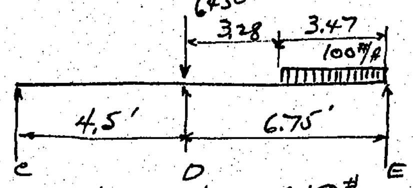


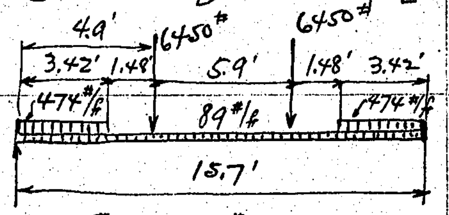
Load on Beam D.
due to floor CD = 90 × 4.5/2 = 203
DE = 95 × 6.75/2 = 304
Beam steel assumed 45
" Concrete 1.2 × 1.0 × 150 = 180
732# per lin ft of span.

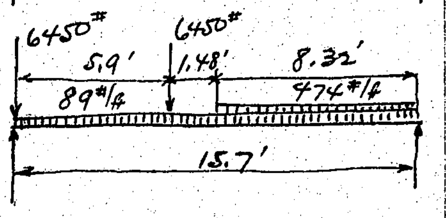
Dead load moment = 1/10 × 732 × 15.7² = 18050'#
" end shear = 1/2 × 732 × 15.7 = 5,750#

Live load









Load on Beam D
due to uniform load fully loaded 100 × (4.5+6.75)/2 = 563 # per ft.
due to rear wheel concentration = 6450#
due to unif. load at rear of truck = 3.47² × 100 / 2 × 6.75 = 89 # per lin ft.

Live load moment
Reaction rear wheel concentration = 6450
unif. load. 474 × 3.42 = 1620
moment 8070 × 4.9 = 39550
less 1620 × 3.19 = − 5170
add unif. load m 1/8 × 89 × 15.7² = 2740
37,120'#

End shear
due to rear wheel concentration = 6,450
" 6450 × 9.8/15.7 = 4,020
unif. load 89 × 15.7 ÷ 2 = 700
" 474 × 8.32² / 2 × 15.7 = 1050
12,220#

Summary of moment and shears.

	moment	End shear	Section modulus required
Dead load	18,050	5,750	= 55170 × 12 / 17,000 = 38.95(")³
Live load	37,120	12,220	
	55,170'#	17,970#	

Use 1 I 10" × 6" @ 42.02#
Section modulus = 42.32(")³ ok.
Unit shear = 17970 / 0.4 × 12 = 3750 #/□" ok
Rivet no for conn. 17970 / 6010 = 3 − 7/8 rivets
or 17970 / 4420 = 4.1 − 3/4" rivets

Cross beam at C
Use 1 I 10" × 6" × 42.02#

Dead load concentration on fascia beam due to cross beam C.
Floor 90 × 4.5 = 405
Beam steel 45
" Concrete 180
630# per ft of cross beam
Concentration on fascia beam = 630 × 15.7 ÷ 2 = 4940#

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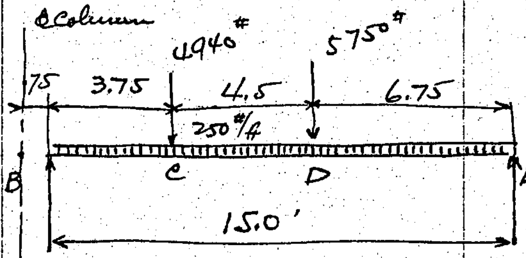
CALCULATIONS FOR

Tsuboi Gawa Bashi for Kumamoto Ken.

Fascia Beam span length = 15.0' Distance c to c of beams = 15.7'

Dead Load

Dead load concentration due to cross beam C = 4940 (see on page 44)
" " " " D = 5750 (" ")



Coping 0.83×1.4 @ 150 = 174
Beam assumed = 60#
metal for floor ~~brick~~ break say 16
250 # per lin ft of beam.

Reaction due to concentration
5750 × 6.75 = 38,800
4940 × 11.25 = 55,600
94400 ÷ 15 = 6,290#

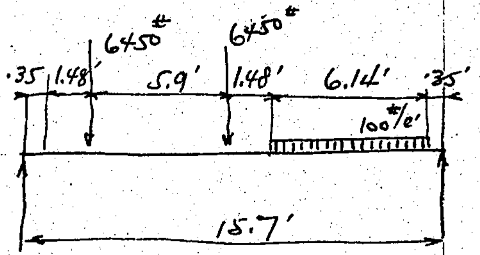
Dead load moment at C due to concentration
6290 × 3.75 = 23,600'#
do at D
6290 × 8.25 = 51,800
less 4940 × 4.5 = −22250
29,558'#

Dead load in beam = ⅛×250×15² = 7030
36580'#

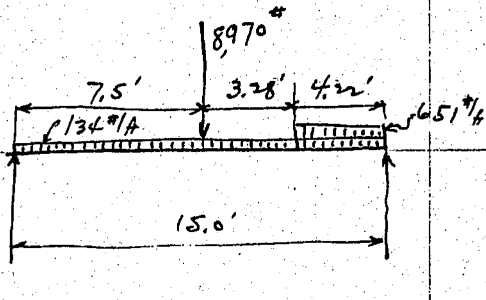
Dead load End Shear
Concentration 6,290#
dead load beam 250×7.5 = 1875
8165#

Live Load

Transverse distribution
Reaction 6450 × 7.97 = 51400
6450 × 13.87 = 89,500
140900 ÷ 15.7 = 8,970#

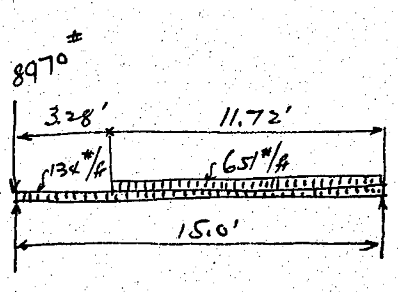


rear wheel reaction =
front wheel say 8970 ÷ 3 = 2990#
Unif. load side of truck = 100×6.14×3.42 / 15.7 = 134 # per ft
Unif. load full loaded = 100 × 15.7/2 = 785 # per ft.



Reaction concentration 8970 ÷ 2 = 4485
Unif load 134 × 7.5 = 1005
651×4.22² / 2×15 = 386
5,876#

Live load moment = 5,876 × 7.5 = 44,100'#
less 134×7.5² / 2 = −3770
40,330'#



End shear
Rear Wheel concentration = 8970
Uniform load 134 × 7.5 = 1005
651×11.72² / 2×15 = 2980
12,955#

Summary for moments & shears.

	moment	end shear
Dead Load	36580	8165
Live Load	40 330	12955
	76,910'#	21,120#

Assumed flange section
2 L S 75×75×9 = 3.94 − 0.66 = 3.24□"
⅛ web area 16"×5/16" = 0.63 0.63
4.57□" gr 3.87□" net

depth of beam 16½" = 1.38'
Effective depth = 1.38 − .15 = 1.23'
flange stress = 76,910 / 1.23 = 62,500#

flange area reqd = 62500 / 17000 = 3.68 □" net ok

or 62500 / 15600 = 4.01 □" gr. ok

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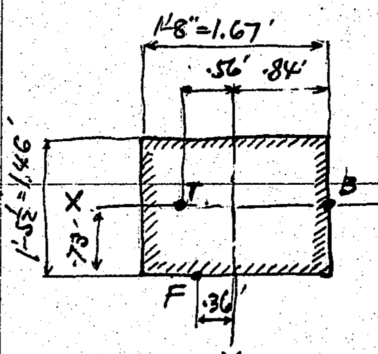
Tsuboi gawa Bashi for Kumamotoken

Trunnion Bearing columns

Super imposed loads.

		X.	moment	Y.	moment
Load from trunnion	T = 64,700#	−.56	−36,200'#	0	0
Load from Cross beam B	B = 13,430	+.84	+11,280	0	0
Load from facia beam	F = 21,120	−.36	−7,600	−.73	−15,420
	99,250#		Mx = −32,520'#		My = −15,420'#



Point of application of resultant force.

$X = \frac{-32520}{99250} = -0.33' = -4.0"$

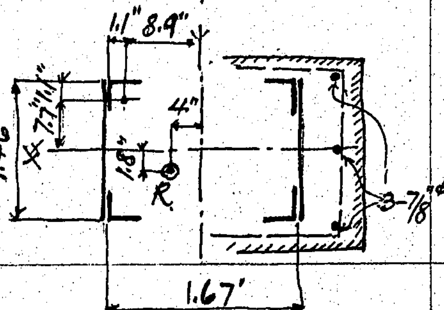
$Y = \frac{-15420}{99250} = -0.15' = -1.8"$

Assumed section

4Ls 100×100×10 = 4×2.95 = 11.8 □"

2Pls 17"×3/8" = 6.4×2 = 12.8

24.6 □" gr.



Moment of inertia of the section. Iy.

4Ls 100×100×10 = 4×42 + 2.95×4×8.9² = 952

2Pls 17"×3/8" = 6.4×2×9² = 1,038

Iy = 1,990 (in)⁴

Moment of inertia Ix.

4Ls = 4×42 + 2.95×4×7.7² = 716

2Pls. 153.5×2 = 307

Ix = 1,023 (in)⁴

Stress of column.

Direct compression = 99,250 ÷ 24.6 = 4,040 #/□" C

Bending stress (X-eccentricity) = $\frac{32520 \times 12 \times 10"}{1990}$ = 1,960 " T or C.

do. (Y-eccentricity) = $\frac{15420 \times 12 \times 8.75}{1023}$ = 1580 #/□" T or C.

max fibre stress = 7580 #/□" C.

min " = 500 #/□" C.

Floor for machinery room. span length say 6.5'

Dead load 1.0×150 = 150 #/□'

Live load 500

650 #/□'

moment = 1/10 × 650 × 6.5² = 2,750 '#

end shear = 650 × 6.5 ÷ 2 = 2,110 #

Effective depth = $\sqrt{\frac{2750}{102}}$ = 5.2"

Use 12" depth over all with 1½" insulation at bott.

Steel req'd = $\frac{2750 \times 12}{17000 \times \frac{7}{8} \times 10.5}$ = 0.212 □" per ft. strip

Use 2 − ½"ϕ bars = 0.393□" per ft. strip.

Unit shear = $\frac{2110}{12 \times \frac{7}{8} \times 10.5}$ = 19 #/□" ok

Unit bond = $\frac{2110}{3.142 \times \frac{7}{8} \times 10.5}$ = 73 #/□" ok.

Cantilever slab for machinery room. overhanging span = 3.0'

total load on beam = 650 #/□'

moment = ½ × 650 × 3.5² = 3,980 '#

end shear = 650 × 3.5 = 2280 #

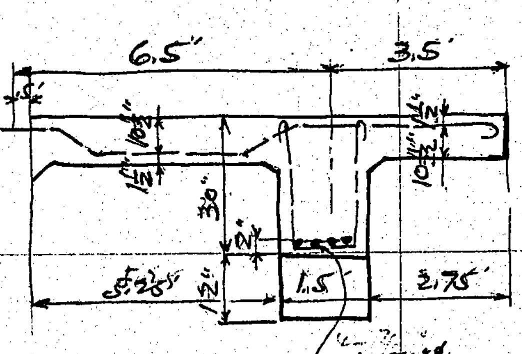
Use 12" slab with 1½" insulation at top.

Steel req'd = $\frac{3980 \times 12}{17000 \times \frac{7}{8} \times 10.5}$ = 0.305 □" per ft. strip.

Use 2 − ½"ϕ bars = 0.393 □"

Unit shear = $\frac{2280}{12 \times \frac{7}{8} \times 10.5}$ = 21 #/□" ok

Unit bond = $\frac{2280}{1.571 \times 2 \times \frac{7}{8} \times 10.5}$ = 79 #/□" ok



Cross beam span length = 12.0' say

load on beam $\frac{650 \times 10^2}{2 \times 6.5}$ = 5,000#

moment = 5000 × 12² ÷ 10 = 72,000 '#

Shear = 6×5000 = 30,000#
6×150 = 900

Steel req'd = $\frac{72000 \times 12}{17000 \times \frac{7}{8} \times 28"}$ = 2.07 □"

Use 4 − 7/8"ϕ = 2.41 □"

unit shear = $\frac{30000}{18 \times \frac{7}{8} \times 40}$ = 48 #/□" ok

unit bond = $\frac{30000}{11.0 \times \frac{7}{8} \times 40}$ = 78 #/□" ok.

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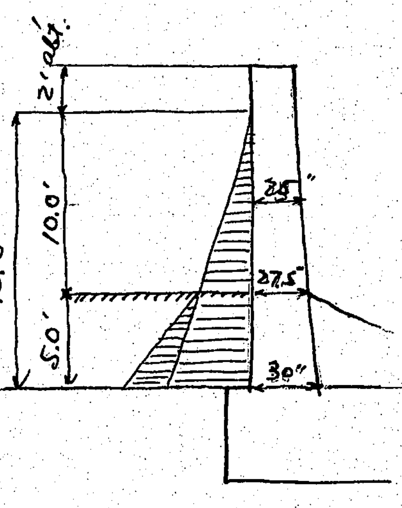
CALCULATIONS FOR

Tsuboi gawa Bashi for Kumamoto ken.

Front wall of Bascule Abutment Horizontal span length 10.0'



At Bottom water pressure = 15 × 62.5 = 938 #/□'
Earth " = ⅓ × 100 × 5 = 167
1105 #/□'

at 10' deep.
water pressure = 10 × 62.5 = 625 #/□'
at 5' deep
water pressure = 5 × 62.5 = 313 #/□'

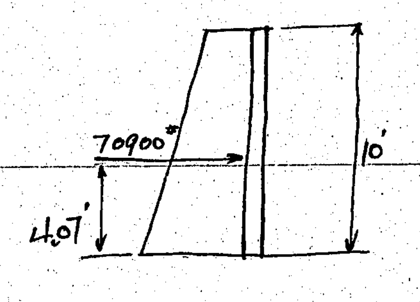
Section at 15' depth, Horizontal span = 10.0'
moment = 1/10 × 1105 × 10² = 11,050 '#
Shear = ½ × 1105 × 10 = 5,525 #
Effective depth = $\sqrt{\frac{11050}{102}}$ = 10.4"

Use 30" depth over all with 1½" insulation
Steel required = $\frac{11050 \times 12}{17000 \times \frac{7}{8} \times 28.5}$ = 0.31 □" Use ¾"□ 1.0' c to c = 0.442 □"

At section 10' deep. span length = 20.0'
moment = 1/10 × 625 × 10² = 6,250 '#
Shear = ½ × 625 × 10 = 3,130 #
effective depth = $\sqrt{\frac{6250}{102}}$ = 7.9"

total depth 27.5" with 1½" insulation
Steel required $\frac{6250 \times 12}{17000 \times \frac{7}{8} \times 26}$ = .194 □" Use ⅝"□ 1.0' c to c = 0.307 □"
Unit shear = $\frac{3130}{12 \times \frac{7}{8} \times 26}$ = 11.5 #/□" ok
Unit bond = $\frac{3130}{1.964 \times \frac{7}{8} \times 26}$ = 70 #/□" ok

Counter fort wall at center of wall
reaction on counter fort at top 313 × 10 = 3,130
at bottom 1105 × 10 = 11,050
average = 14180 ÷ 2 = 7090 # per hor. ft. strip



total load on counterfort = 7090 × 10 = 70900 #
moment = 70900 × 4.07 = 288,500 '#
effective depth of counter fort wall = 103"
Steel area req'd at bottom = $\frac{288500 \times 12}{17000 \times \frac{7}{8} \times 103}$ = 2.26 □"
Use 6 – ¾"□ = 2.65 □"

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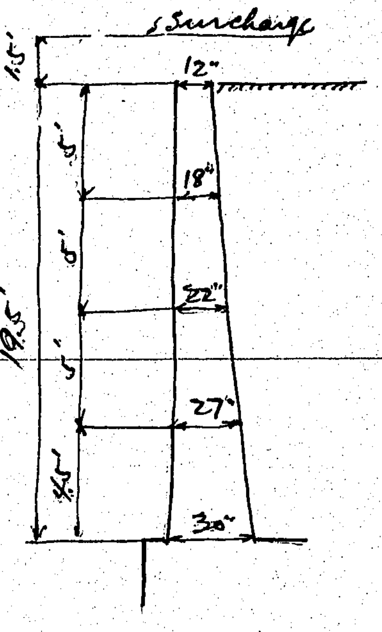
Tsuboi Gawa Bashi for Kumamoto Ken.

Rear wall for Bascule Abutment. Total height of wall 19.5'

Case 1. at normal state.



Earth pressure 5' deep. $\frac{1}{3}\times100\times6.5 = 217$ #/□'
10' " $\frac{1}{3}\times100\times11.5 = 383$ "
15' " $\frac{1}{3}\times100\times16.5 = 550$ " } Horizontal beam design.
19.5' " $\frac{1}{3}\times100\times21.0 = 726$ " — vertical cantilever design.

Design the wall of lowest 4.5' as a vertical cantilever wall and upper 15' of wall as horizontal beams of span length 20'.

At section 15' deep. moment $= \frac{1}{10}\times550\times20^2 = 22{,}000$ '#

Effective depth $= \sqrt{\frac{22000}{102}} = 14.7"$

Use 27" depth with 2" insulation

Steel required $= \frac{22000\times12}{17000\times\frac{7}{8}\times25} = 0.711$ □" per ft strip.

Use 3/4"□ bars 7½" spacing $= 0.71$ □"

end shear $= 555\times10 = 5550$ #

unit shear $= \frac{5550}{12\times\frac{7}{8}\times25} = 21$ #/□" ok.

Unit bond $= \frac{5550}{2.356\times\frac{12}{7.5}\times\frac{7}{8}\times25} = 67$ #/□" ok.

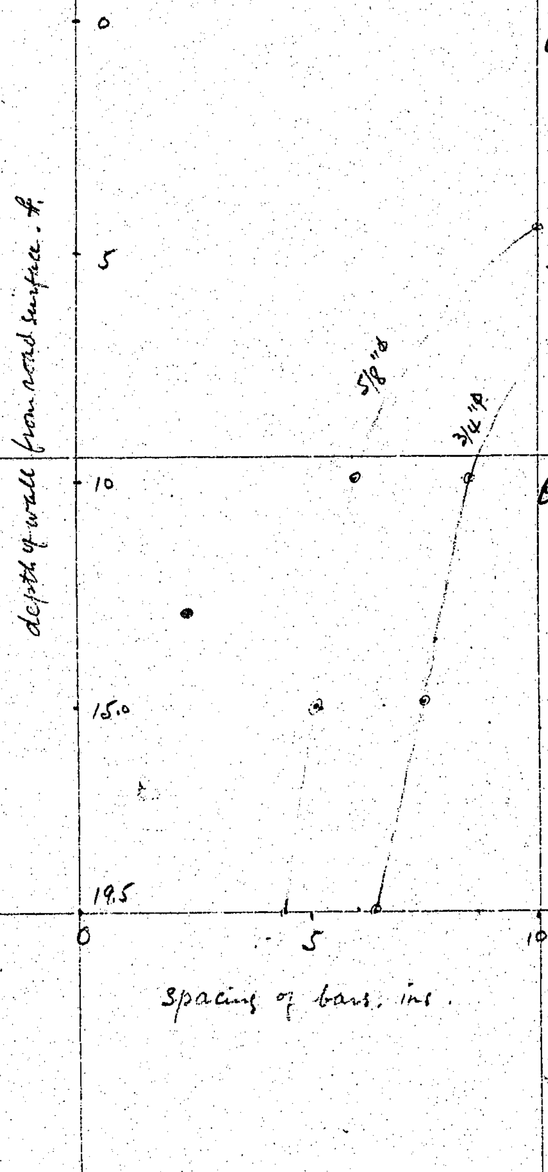
At section 10' deep. moment $= \frac{1}{10}\times383\times20^2 = 15{,}330$ '# total depth 22"
Shear $= \frac{1}{2}\times383\times20 = 3{,}830$ # effective " 20"

Steel req'd $= \frac{15330\times12}{17000\times\frac{7}{8}\times20} = 0.62$ □"

Use 3/4"□ bars 8.5" spacing $= 0.623$ □"

Unit shear $= \frac{3830}{12\times\frac{7}{8}\times20} = 18$ #/□" ok.

Unit bond $= \frac{3830}{2.356\times\frac{12}{8.5}\times\frac{7}{8}\times20} = 66$ #/□" ok.



At section 5' deep. moment $= \frac{1}{10}\times217\times20^2 = 8680$ '# ~~total depth = 18"~~
Shear $= \frac{1}{2}\times217\times20 = 2170$ # ~~effective depth = 16"~~

Steel req'd $= \frac{8680}{17000\times\frac{7}{8}\times16} = .365$ □"

Use 3/4"□ bars 14" spacing $= 0.378$ □"
or 5/8"□ " 10" spacing $= 0.368$ □"

unit shear $= \frac{2170}{12\times\frac{7}{8}\times16} = 13$ #/□" ok

Unit bond $= \frac{2170}{2.356\times\frac{12}{14}\times\frac{7}{8}\times16} = 77$ #/□" ok.

At bottom section
moment $= \frac{1}{10}\times726\times20^2 = 29{,}000$ '# ~~total depth = 30"~~
end shear $= \frac{1}{2}\times726\times20 = 7{,}260$ # effective depth = 28"

Steel req'd $= \frac{29000\times12}{17000\times\frac{7}{8}\times28} = 0.836$ □"

Use 2 - 3/4"□ = 0.884 □"

unit shear $= \frac{7260}{12\times\frac{7}{8}\times28} = 25$ #/□" ok.

Unit bond $= \frac{7260}{4.712\times\frac{7}{8}\times28} = 63$ #/□" ok

Negative moment will occur at the bottom of wall due to the deflection of wall.
Use 1 - 3/4"□ bar vertically for this cantilever moment in addition.

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CALCULATIONS FOR

Tsuboi Gawa Bashi for Kumamoto Ken.

Rear wall of Bascule abutment

Case 2. During earthquake. acceleration 2000 mm/sec² or k = 0.2

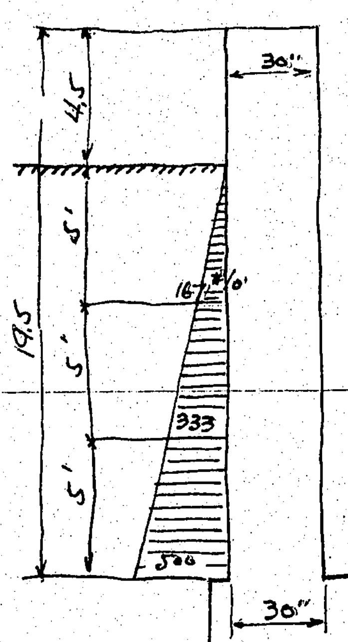
Earth pressure during earthquake 0.48 wh for k = 0.2

	Depth				Weight of wall	Seismic force	Total
Earth pressure at depth	5'	0.48 × 100 × 5 =	240 #/□'	wt. of wall	150 × 1.5 = 225 × .2 =	45	285 #/ft
"	10'	0.48 × 100 × 10 =	480 "		150 × 1.83 = 275 × .2 =	55	535
"	15'	0.48 × 100 × 15 =	720 "		150 × 2.25 = 340 × .2 =	70	790
"	19.5'	0.48 × 100 × 19.5 =	935 "		150 × 2.5 = 375 × .2 =	75	1,010

Depth	Load on beam	moment	Steel req'd		
5' (from top)	285 #/ft	$\frac{1}{10}$ × 285 × 20² = 11,400 '#	$\frac{11400 \times 12}{30600 \times \frac{7}{8} \times 16}$ = 0.32 □"	Assumed section is ample	0.368 □"
10	535	$\frac{1}{10}$ × 535 × 20² = 21,400 '#	$\frac{21400 \times 12}{30600 \times \frac{7}{8} \times 20}$ = 0.384 □"	do	0.623 □"
15	790	$\frac{1}{10}$ × 790 × 20² = 31,600 '#	$\frac{31600 \times 12}{30600 \times \frac{7}{8} \times 25}$ = 0.566 □"	do	0.710 □"
19.5	1010	$\frac{1}{10}$ × 1010 × 20² = 40,400 '#	$\frac{40400 \times 12}{30600 \times \frac{7}{8} \times 28}$ = 0.646 □"	do	0.836 □"

Side wall for Bascule abutment span length = 16' say. Earth fill 15' assumed.

Case 1. At normal state



Earth pressure

		p	moment	Shear
at 4.5' from top.		0		
at 9.5' "	$\frac{1}{3}$ × 100 × 5 =	167 #/□'	$\frac{1}{10}$ × 167 × 16² = 4,270 '#	1,340 #
at 14.5 "	$\frac{1}{3}$ × 100 × 10 =	333 "	$\frac{1}{10}$ × 333 × 16² = 8,540 '#	2,670 "
at 19.5 "	$\frac{1}{3}$ × 100 × 15 =	500 "	$\frac{1}{10}$ × 500 × 16² = 12,800 '#	4,000 "

At 9.5' from top.
Steel req'd = $\frac{4270 \times 12}{17000 \times \frac{7}{8} \times 28}$ = 0.123 □" use ½"ϕ – 1'0" spacing = 0.196 □"

At 14.5' from top.
Steel req'd = $\frac{8540 \times 12}{17000 \times \frac{7}{8} \times 28}$ = 0.246 □" use 5/8"ϕ 1'0" spacing = 0.307 □"

At 19.5' from top.
Steel req'd = $\frac{12800 \times 12}{17000 \times \frac{7}{8} \times 28}$ = 0.369 □" use 5/8"ϕ 9" spacing = 0.490 □"

Unit shear = $\frac{4000}{12 \times \frac{7}{8} \times 28}$ = 14 #/□" ok.

Unit bond = $\frac{4000}{1.96 \times \frac{12}{9} \times \frac{7}{8} \times 28}$ = 62.5 #/□" ok.

Case 2. During earthquake

Earth pressure	depth	earth pressure	Weight of wall	Seismic force	total load on wall
4.5' from top	0	0			
9.5'	5	0.48 × 100 × 5 = 240 #/□'	150 × 2.5 = 375 × .2 =	75	315 #/ft of span
14.5'	10	0.48 × 100 × 10 = 480 #/□'	" 375 × .2 =	75	555 "
19.5'	15	0.48 × 100 × 15 = 720 #/□'	" 375 × .2 =	75	795 "

Section	load on beam	moment	Steel required		Bond stress
9.5' from top	315 #/ft	$\frac{1}{10}$ × 315 × 16² = 8070 '#	$\frac{8070 \times 12}{30600 \times \frac{7}{8} \times 28}$ = 0.129 □"	ok	
14.5 "	555	$\frac{1}{10}$ × 555 × 16² = 14,200	$\frac{14200 \times 12}{30600 \times \frac{7}{8} \times 28}$ = 0.227 □"	ok	
19.5 "	795	$\frac{1}{10}$ × 795 × 16² = 20,350	$\frac{20350 \times 12}{30600 \times \frac{7}{8} \times 28}$ = 0.325 □"	ok	100 #/□" ok.

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CALCULATIONS FOR

Tsuboi Gawa Bashi for Kumamoto Ken.

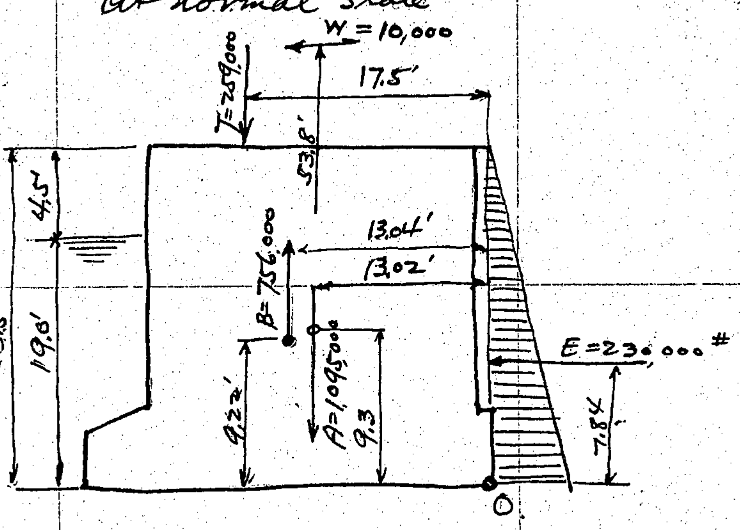
Center of gravity of abutment structure. Taking moment about pt. O. reffering to the sketch on page ~~39.~~ 40

	Section	length	no	volume	unit wt.	total wt.	hor. lev. arm	Hor. moment	vert. lev. arm	Vert. moment
Floor slab.	0.46 × 16.66	× 18.0	1	138 cub.ft	@ 150	20700#	10.5'	217,500'#	23.2'	480,500
pavement	15.0	× 18.0	1	(270)□'	@ 26.3	7100	10.5	74,600	23.5	167,000
Coping.	.83 × 1.2	× 18.0	2	36	@ 150	5400	10.5	56,700	23.5	127,000
Cross beam B concrete	2.083□'	× 13.2	1	27.5	@ 150	4,100	17.5	71,800	22.2	91,000
〃 steel		13.2	1		@ 46	610	17.5	10,700	22.2	13,500
Cross beam C+D Concrete	1.0 × 1.2	× 15.7	2	37.7	@ 150	5650	10.75	60,800	22.3	126,000
〃 steel		15.7	2		@ 42	1320	10.75	14,200	22.3	29,400
Fascia beam steel		15.0	2		@ 60	1,800	9.0	16,200	22.0	39,600
Column (bearing)	2.0 × 2.5 × 7		2	70.0	@ 150	10,500	17.5	183,700	16.5	173,200
〃 steel		13'	4		@ 200	10,400	17.5	182,000	16.5	171,600
Slab, machinery room	1.0 × 9.5 × 13'		1	123.5	@ 150	18,530	18.2	337,000	15.3	283,500
beam 〃	1.5 × 1.5 × 10		1	22.5	@ 〃	3,380	17.2	58,100	14.0	47,300
Column	5.0 × 3.0 × 11.8		2	354	@ 〃	53,100	18.0	956,000	9.9	526,000
Beam	3.0 × 3.5 × 10.0		1	105	@ 〃	15,750	18.0	283,500	5.75	90,600
Front wall	1.0 × 5.5 × 15.0		1	82.6	@ 150	12,380	24.5	303,500	19.0	235,400
〃 (col.)	2.5 × 5.5 × 1.0		2	27.5	@ 〃	4,120	23.5	96,900	19.0	78,300
〃	2.25 × 11.8 × 20.0		1	53.1	@ 〃	7,990	23.8	189,700	9.0	71,700
〃 rib.	1.5 × 3 × 4.5		1	20.3	@ 〃	3,040	21.0	63,900	6.0	18,200
Rear wall	1.75 × 19.5 × 20.0		1	682.0	@ 〃	102,400	1.75	179,000	12.9	1,321,000
Side wall	2.5 × 19.5 × 24.5		2	2390.0	@ 〃	358,000	12.75	4,565,000	13.75	4,921,000
Base	4.0 × 28. × 26.		1	2912.0	@ 〃	437,000	14.0	6,115,000	2.0	874,000
machinery &c.						10000	20.0	200,000	19.0	190,000
				7081.7 cub.ft = 32.8 立坪		1093,250#	13.02'	14,238,800	9.3'	10,075,800

Call this 1,095,000#

Stability of Bascule abutment.

At normal state



Load on abutment

weight of abutment		1,095,000#
Load from trunnion	64700 × 4 =	259,000
Earth pressure =	$\frac{100 \times 23.5^2}{6} \times 25 =$	230,000

Bouyant effect.

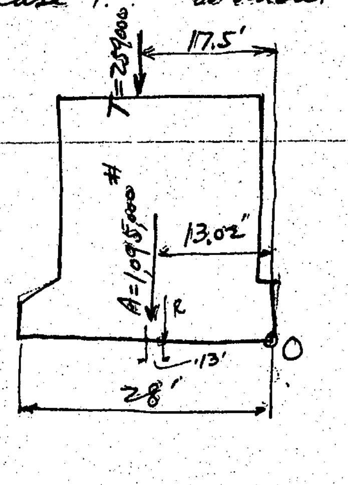
			M_h		M_v
24.5 × 25.0 × 15 × 62.5 = 574,000#	12.75'	7,320,000'#	11.5	6,600,000
4.0 × 28 × 26 × 62.5 = 182,000	14.0'	2,550,000	2.0	364,000
756,000#	13.04'	9,870,000'#	9.22'	6,964,000'#

Wind pressure.

496□' × 2 × 10 = 9920# call this 10,000# (see page 35)

vertical lev. arm = 24.3 + 29.5 = 53.8' above foundation bed.

Case 1. Without earth pressure wind load & bouyancy (acting A + T)



Taking moment about pt. O in the next sketch.

Loads.

T = 259000# × 17.5' = 4,530,000

A = 1095,000 × 13.02' = 14,250,000

1,354,000# — 13.87' — 18,780,000'#

eccentricity E = 14.0 − 13.87 = 0.13'

Resultant force within middle third.

max toe pressure = $\frac{1,354,000}{26 \times 28}\left(1 \pm \frac{6 \times 0.13}{28}\right)$ = 1914 #/□' = 0.85 ton/□' at heel

or 1807 #/□' = 0.81 〃 at toe.

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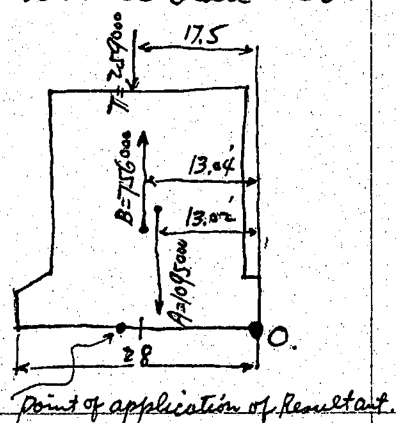
CALCULATIONS FOR

Tsuboi Gawa Bashi for Kumamoto Ken.

At normal state Case 2. Considering Bouyancy without earth pressure + wind (acting A, T. + B)



Taking moment about O.

Loads.

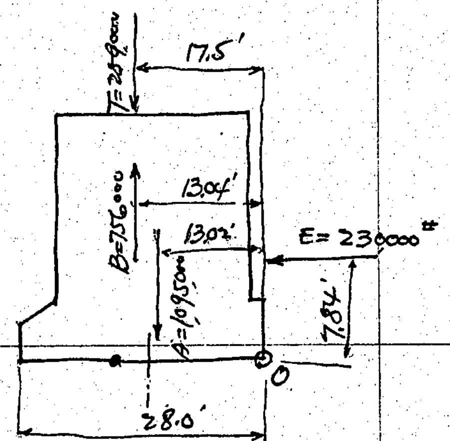
T	259,000 ×	17.5 =	4,530,000
A	1,095,000 ×	13.02 =	14,250,000
B	− 756,000 ×	13.04 =	− 9860,000
	598,000	14.92"	8,920,000 '#

Eccentricity = 14.0 − 14.92 = −0.92"

Resultant force within middle third.

max. toe pressure = $\frac{598000}{26 \times 28}\left(1 \pm \frac{6 \times 0.92}{28}\right)$ = 983 #/□' = 0.44 tons/□' toe or 660 "□' = 0.29 "□' heel.

At normal state Case 3. Considering Bouyancy and Earth pressure without wind (acting A, T, B + E)



Taking moment about O.

Loads.	Hor. forces	vert forces	lev. arm	moments.
T		259,000 ×	17.5	4,530,000
A		1,095,000 ×	13.02	14,250,000
B		−756,000 ×	13.04	−9860000
E	230,000	——— ×	7.84	1,800,000
	ΣH = 230,000 #	ΣV = 598,000	17.90'	10,720,000

Eccentricity E = 14.0 − 17.9 = −3.9'

Resultant force within middle third

max. toe pressure = $\frac{598000}{28 \times 26}\left(1 \pm \frac{6 \times 3.9}{28}\right)$ = 1,508 #/□' = 0.67 tons/□' toe; 135 "□' = 0.06 "□' heel.

At normal state Case 4. Considering earth pressure without bouyancy + wind (acting A, T, + E)

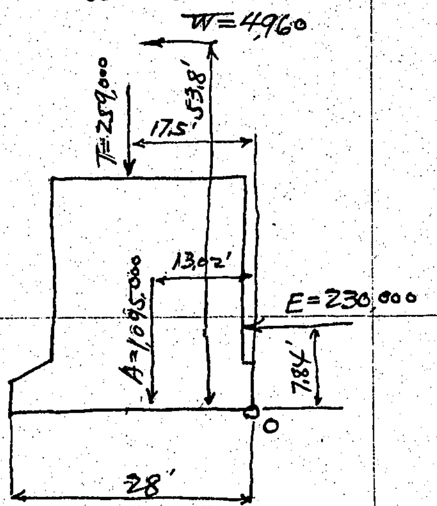
Reffering to the above sketch in ~~case~~ case 3.

T		259000 ×	17.5'	= 4,530,000
A		1,095,000 ×	13.02	= 14,250,000
E	230000	——— ×	7.84	= 1,800,000
	ΣH = 230000 #	ΣV = 1,354,000 #	15.2'	20,580,000 '#

Eccentricity E = 14.0 − 15.2 = −1.2'

max toe pressure = $\frac{1,354,000}{26 \times 28}\left(1 \pm \frac{6 \times 1.2}{28}\right)$ = 2335 #/□' or 1.04 tons/□' toe; 1,380 "□' or 0.62 "□' heel.

At normal state Case 5 Considering wind without bouyancy (acting A, T, E + W)



Taking moment about O.

Loads	Hor. force	vert. force	lev. arm	moment.
T		259,000 ×	17.5' =	4,530,000
A		1,095,000 ×	13.02 =	14,250,000
E	230,000	×	7.84 =	1,800,000
W.	10,000	——— ×	53.8 =	538,000
	ΣH = 240,000 #	ΣV = 1,354,000 #	15.6'	21,118,000 '#

Eccentricity E = 14.0 − 15.6 = −1.6'

Resultant force within middle third

max. toe pressure = $\frac{1,354,000}{26 \times 28}\left(1 \pm \frac{6 \times 1.6}{28}\right)$ = 2500 #/□' = 1.12 tons/□' e toe; 1,220 "□' = 0.55 "□' heel.

Stability during Earthquake.

Earth pressure = $0.24 wh^2 = 0.24 \times 100 \times 23.5^2 \times 25$ = 331,000 #

Seismic force T' = 259,000 × 0.2 = 51,800 #

A' = 1,095,000 × 0.2 = 219,000 #

Water pressure H = $\frac{62.5 \times 19^2}{2} \times 25$ = 282,000 #

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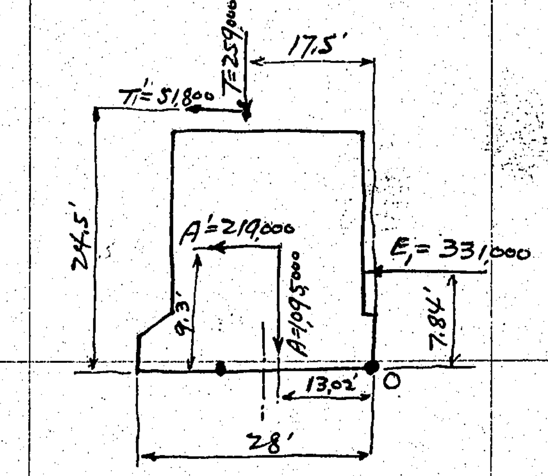
Tsuboi gawa Bashi for Kumamoto Ken.

Stability of abutment during earthquake.

Case 6 Without bouyancy (acting A, T, E, A' & T')



Taking moment about pt. O in the figure

Loads.	Hor. force	Vert force	lev. arm	moment.
T		259,000	× 17.5' =	4,530,000
T'	51,800		× 24.5 =	1,270,000
A		1,095,000	× 13.02 =	14,280,000
A'	219,000		× 9.3 =	2,035,000
E1	331,000		× 7.84 =	2,595,000
	ΣH = 601,800	ΣV = 1354,000	18.25	ΣM = 24,680,000

Eccentricity E = 14.0 − 18.25 = −4.25'

Resultant force within middle third

max. toe pressure = $\frac{1,354,000}{26 \times 28}\left(1 \pm \frac{6 \times 4.25}{28}\right)$ = 3,550 #/□' or = 1.59 tons/□' toe
or = 170 " or = 0.08 " heel.

Case 7. Considering bouyancy (acting A, E, T, B, A' & T')

Reffering to the above case.

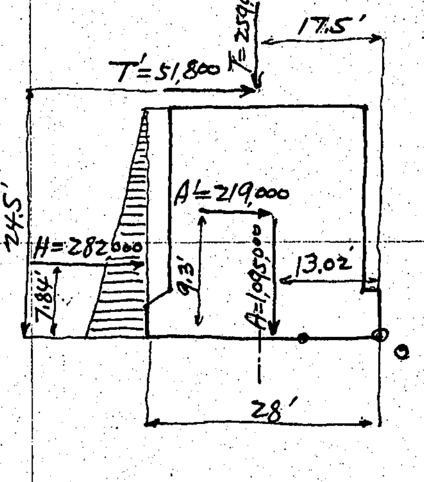
	ΣH = 601,800	ΣV = 1,354,000		ΣM = 24,680,000
Bouyancy		−756,000	× 13.04	= −9,860,000
	ΣH = 601,800	ΣV = 598,000#	24.8'	ΣM = 14,820,000

Eccentricity E = 14.0 − 24.8 = −10.8'

Resultant force out of middle third. Pressure area = (14 − 10.8) × 3 = 9.6"

max toe pressure = $\frac{598,000 \times 2}{9.6 \times 26}$ = 4,785 #/□' = 2.14 tons/□'

Case 8. Seismic forces reversed to case 1. without earth pressure (acting T, T', A, A' & H)



Taking moment about O.

Loads.	Hor. forces	Vert. forces	lev. arm	moment
T		259,000	× 17.5 =	4,530,000
T'	51,800		× 24.5 =	−1,270,000
A		1,095,000	× 13.02 =	14,280,000
A'	219,000		× 9.3 =	−2,035,000
H	282,000		× 7.84 =	−2210,000
	ΣH = 552,800#	ΣV = 1,354,000#	9.8'	ΣM = 13,265,000'#

Eccentricity E = 14.0 − 9.8 = 4.2'

Resultant force within middle third

max. top pressure = $\frac{1354,000}{26 \times 28}\left(1 \pm \frac{6 \times 4.2}{28}\right)$ = 3530 #/□' = 1.58 tons/□' heel.
or = 186 " = 0.08 " toe.

Max. bearing pressures on foundation for several cases

	forces acting on abutment	Bearing pressure at toe	Bearing pressure at heel.
At normal state			
Case 1	A, T.	0.81 ton/□'	0.85 ton/□'
Case 2	A, T, B.	0.44	0.29
Case 3	A, T, B, E.	0.67	0.06
Case 4	A, T, E.	1.04	0.62
Case 5	A, T, E, W.	1.12	0.55
During earthquake.			
Case 6	A, T, E1, A', T'	1.59	0.08
Case 7	A, T, B, E1, A', T'	2.14	— tension neglected.
Case 8	A, T, A', T', H.	0.08	1.58

where

A = Weight of abutment = 1095,000# Seismic force A' = 219,000#
T = load from trunnion = 289,000# " T' = 51,800#
B = bouyancy of water = 756,000
E = earth pressure normal = 230,000
E1 = do. during earthquake = 331,000
W = wind force = 10,000
H = water pressure = 282,000

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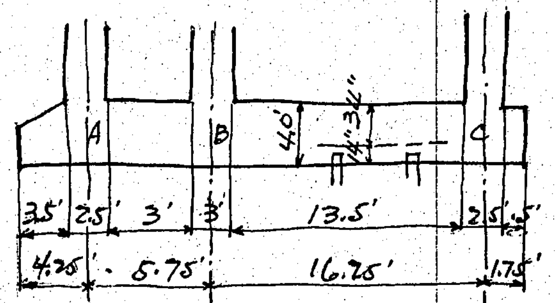
Tsuboi Gawa Bashi for Kumamoto Ken.

Design of Abutment Base.
Slab BC.

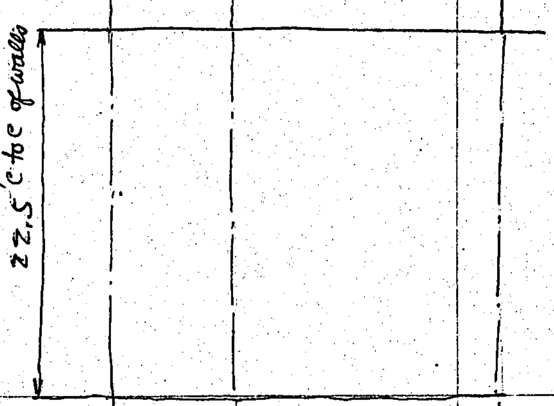


Slab BC. Case 1. Governs the section. 0.85 tons/□' or 1,915 #/□'
Design as a rectangular slab of 16.25' × 22.5' fixed at four sides.
Shorter span $= l_1 = 16.25'$
longer span $= l_2 = 22.5'$
load for shorter span $= w(1.5 - \frac{l_1}{l_2}) = 1915(1.5 - \frac{16.25}{22.5}) = 1,490$ #/□'

load for longer span $= w(\frac{l_1}{l_2} - 1.5) = 1915(\frac{16.25}{22.5} - 0.5) = 425$ "
Reducing wt. of base concrete 4 × 150 = 600 #/□'. w for longer span = 890 #/□' do for shorter span 175 #/□' downward

Shorter span

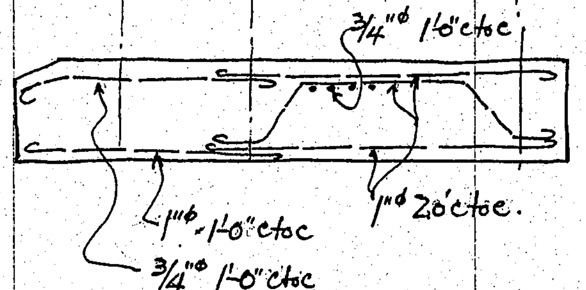
moment $= \frac{1}{10} \times 890 \times 16.25^2 = 23500$ '#
end shear $= \frac{1}{2} \times 890 \times 16.25 = 7230$ #
effective depth $= \sqrt{\frac{23500}{102}} = 15.3''$



Use 34" effective depth total depth 48".
Steel req'd. for shorter span $= \frac{23500 \times 12}{17000 \times \frac{7}{8} \times 34} = 0.56$ □" per ft strip.

Use 1"φ bars 1.0" c to c = 0.7854 □" per ft strip on top.
Unit shear $= \frac{7230}{12 \times \frac{7}{8} \times 34} = 20$ #/□" ok.

Unit bond $= \frac{7230}{3.142 \times \frac{7}{8} \times 34} = 77$ #/□" ok.



Longer span

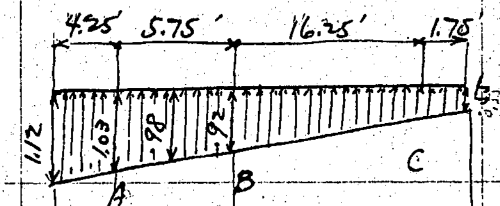
moment $= \frac{1}{10} \times 175 \times 22.5^2 = 8860$ '#
end shear $= \frac{1}{2} \times 175 \times 22.5 = 1970$ #
Steel req'd. $= \frac{8860 \times 12}{17000 \times \frac{7}{8} \times 34} = 0.21$ □" per ft strip

Use 7/8"φ bars 1.5' c to c $= 0.401$ □" per ft strip.
Unit shear $= \frac{1970}{12 \times \frac{7}{8} \times 34} = 6$ #/□" ok

Unit bond $= \frac{1970}{2.75 \times \frac{7}{8} \times 34} = 28$ #/□" ok.

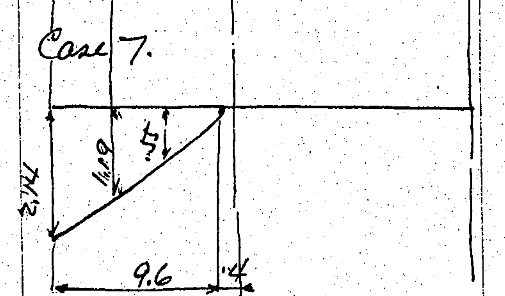
Slab AB. span length 5.75'
~~Load~~ Case 5 at normal state 1.12 tons/□' at toe & 0.55 tons/□' at heel.
Case 7 during earthquake 2.14 " at toe & 0 at heel.
(Case 5 governs the section average load on beam AB = 0.98 tons/□' = 2200 #/□'
less wt. of base conc. 4 × 150 = 600
1,600 #/□'

Case 5



moment $= \frac{1}{10} \times 1600 \times 5.75^2 = 5,290$ '#
Shear $= \frac{1}{2} \times 1600 \times 5.75 = 4,600$ #
steel req'd. $= \frac{5290 \times 12}{17000 \times \frac{7}{8} \times 34} = 0.125$ □" per ft strip.

Case 7.

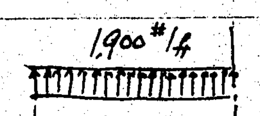


Use 3/4"φ 1.0" c to c = 0.442 □"
Unit shear $= \frac{4600}{12 \times \frac{7}{8} \times 34} = 13$ #/□" ok

Unit bond $= \frac{4600}{2.36 \times \frac{7}{8} \times 34} = 66$ #/□" ok

Cantilever footing at toe.

upward pressure $= (1.12 + 1.03) \div 2 = 1.08$ tons/□' $= 2420$ #/□"
downward " $= 4 \times 150 = 600$
1,820 #/□"



moment $= \frac{1}{2} \times 1840 \times 4.25^2 = 16,630$ '#
Shear $= 1840 \times 4.25 = 7820$ #
Steel req'd. $= \frac{16630 \times 12}{17000 \times \frac{7}{8} \times 34} = 0.395$ □" per ft strip.

Use 1"φ 1.0" c to c $= 0.7854$ □" "
Unit shear $= \frac{7820}{12 \times \frac{7}{8} \times 34} = 22$ #/□" ok Unit bond $= \frac{7820}{3.142 \times \frac{7}{8} \times 34} = 84$ #/□" ok.

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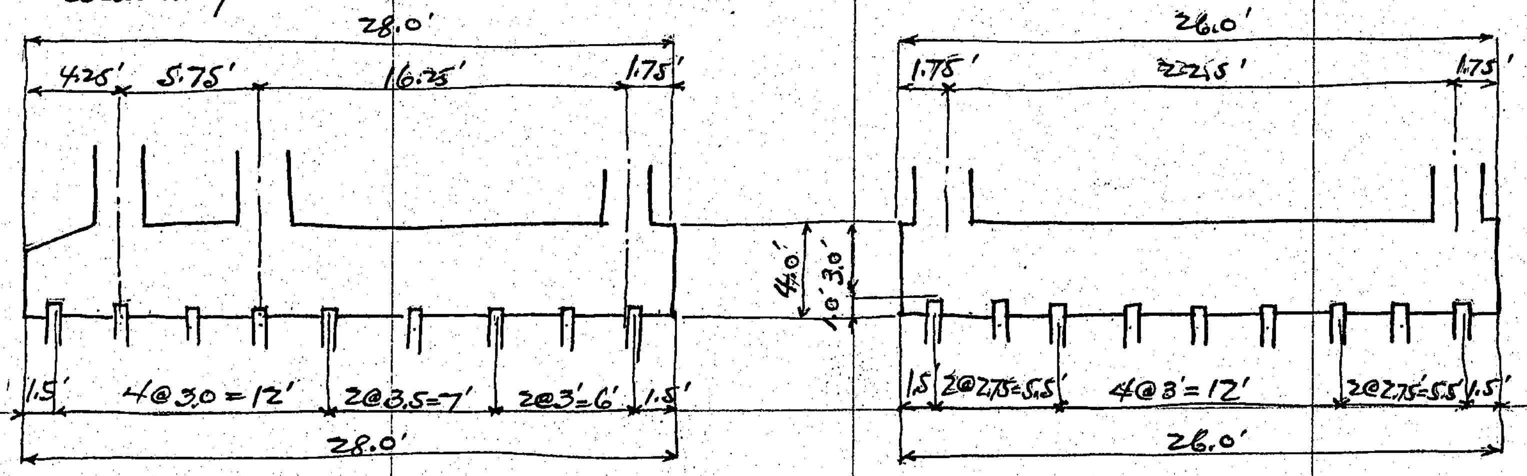
CALCULATIONS FOR

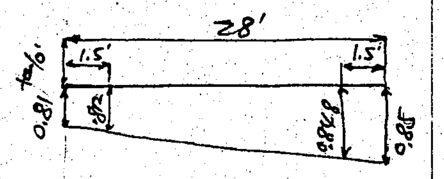
Tsuboi gawa Bashi for Kumamoto Ken.

Foundation piles.



max. load on one pile

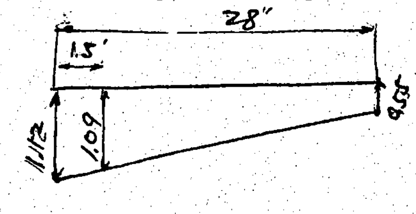
Normal state Case 1.



Max load on one extreme pile at heel = 0.848 × 3×3 = 7.64 tons.

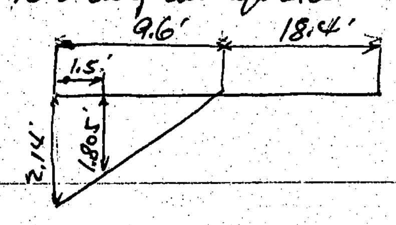
do at toe = 0.812 × 3×3 = 7.31

Normal state Case 5.



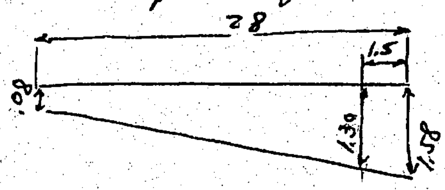
max. load on one pile at toe = 1.09 × 3 × 3 = 9.81 tons.

During earthquake Case 7.



max. load on one pile at toe = 1.805 × 3×3 = 16.25 tons.

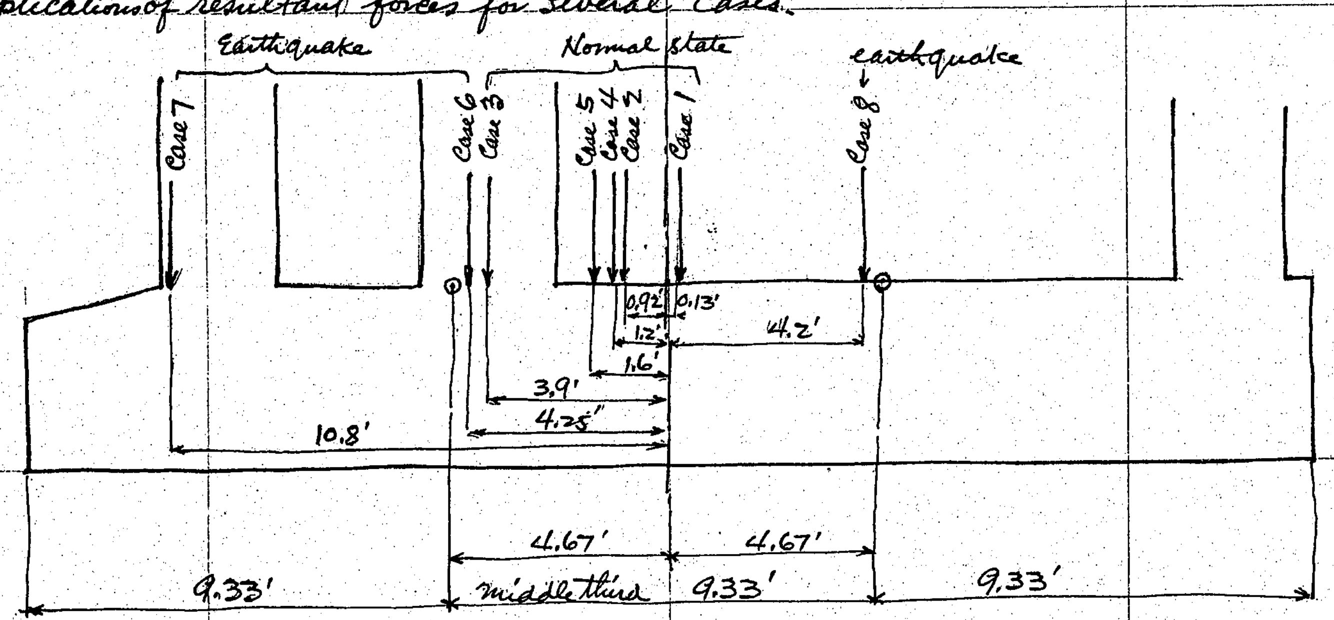
During earthquake Case 8.



max. load on one pile at heel. = 1.30 × 3×3 = 11.70 tons.

Use pine piles 0.6'φ × 18.0' long.

Point of application of resultant forces for several cases.



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CALCULATIONS FOR

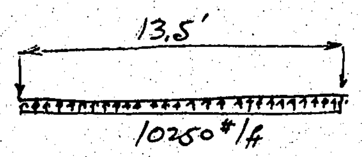
Tsuboi gawa Bashi for Kumamoto ken

Design of Cross beam for base. Span length 13.5' say

Load on beam from base BC = 7230 #/f.
from base AB = 4600
total 11830 #/f

These loads do not occur at the same time, but let us take the both loads for the safe side.

less wt of web. 3.5×3×150 = 1680
10,250 #/f



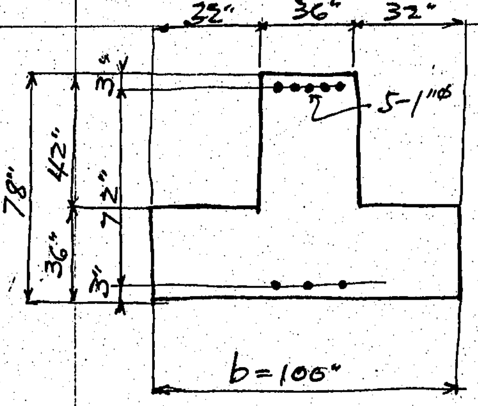
moment = $\frac{1}{10}$ × 10250 × 13.5² = 187000 '#

end shear = $\frac{1}{2}$ × 10250 × 13.5 = 69,200 #

Assumed section

total depth of beam = 78"

effective depth = 75" say



Steel req'd = $\frac{187000 \times 12}{17000 \times \frac{7}{8} \times 75}$ = 2.01 □"

Use 5-1"φ bars = 3.93 □"

Δ = t/d = 36/75 = 0.48, Δ² = 0.23, d' = 3"

$p = \frac{3.93}{100 \times 75}$ = 0.000 52, $p' = \frac{1}{2}p$ = 0.00026, $\frac{d'}{d} = \frac{3}{75}$ = .04

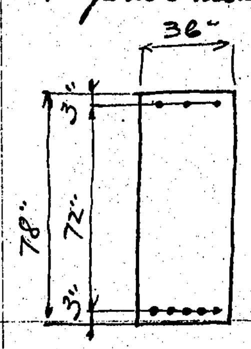
$$k = \frac{p + p'\left(\frac{d'}{d}\right) + \frac{\Delta^2}{2n}}{p + p' + \frac{\Delta}{n}} = \frac{0.00052 + 0.00026 \times 0.04 + \frac{0.23}{30}}{0.00052 + 0.00026 + \frac{0.48}{15}} = \frac{.00823}{.03298} = 0.251$$

neutral axis in the flange.

$$f_s = \frac{187000 \times 12}{3.93 \times \frac{7}{8} \times 75} = 8,700 \text{ #/□" ok}$$

$$f_c = \frac{f_s k}{n(1-k)} = \frac{8700 \times 0.251}{15(1-0.251)} = 197 \text{ #/□" ok}$$

negative moment.



Negative moment at support assumed same as for pos. moment at center of span.

m = 187,000 '#

Steel req'd = 2.01

use 5-1"φ bars = 3.93 □"

$p = \frac{3.93}{36 \times 75}$ = 0.00146

k = 0.187, j = 0.938

$$f_s = \frac{187000 \times 12}{3.93 \times 0.938 \times 75} = 8120 \text{ #/□" ok}$$

$$f_c = \frac{8120 \times 0.187}{15(1-0.187)} = 125 \text{ #/□" ok}$$

$$\text{Unit shear} = \frac{69200}{36 \times .938 \times 75} = 27 \text{ #/□" ok}$$

$$\text{Unit bond} = \frac{69200}{3.142 \times 5 \times 0.938 \times 75} = 63 \text{ #/□" ok}$$

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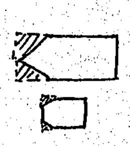
MADE BY Y. H. DATE 3-7-9 FILE NO
CHECKED BY R. I DATE 3-7-15 PAGE NO ~~56~~

CALCULATIONS. FOR

Material list of Tsuboigawa-bashi for Kumamoto-Ken

NO.	Description	Length	Weight/ft.	Total Wt.	±X From Trunnion	±Y From Trunn.	+X Moment	−X Moment	+Y Mom.	−Y Mom.	Remarks
2	Flg. Ls. 150×150×11	27'-6"	@ 16.77	922	+37'-9"	+3'-3"	34,806		2,997		
2	〃	27'-11 3/4"	〃	938	+42'-11 1/8"	−2'-2"	40,266			2,033	
2	Ls. 〃	6'-8 1/2"	〃	225	+53'-9"	+ 10"	12,094		187		
6	Ls. 4×3×0.3	5'-11 3/4"	@ 6.84	245	+44'-1 1/4"	+ 7 1/2"	10,805		153		
6	Washers 3"×3/8		@ 0.75	5	+44'-0"	+ 6 1/2"	220		3		
4	Ls. 4×3×0.3	5'-11 3/4"	@ 6.84	164	+31'-6"	+ 7 1/2"	5,166		103		
8	Ls. 3×3×3/8	0'-7 1/8"	@ 7.20	34	〃	〃	1,071		21		
4	Washers 3"×3/8		@ 0.75	3	〃	〃	95		2		
4	Ls. 5×3×3/8	6'-0 3/4"	@ 9.72	236	+21'-6"	+ 7"	5,074		138		
8	Ls. 3×3×3/8	0'-7 1/2"	@ 7.20	36	〃	〃	774		21		
4	fillers 5×3/8	0'-5 1/2"	@ 6.38	12	〃	〃	258		7		
2	Ls. 5×3×3/8	6'-0 3/4"	@ 9.72	118	+14'-0"	〃	1,652		69		
4	〃	1'-1"	〃	42	〃	〃	588		24		
1	filler 5×3/8	0'-8"	@ 6.38	4	〃	〃	56		2		
2	Ls. 5×3 1/2×3/8	6'-0 3/4"	@ 10.37	126	+9'-0"	〃	1,134		73		
4	〃	1'-1"	〃	45	〃	〃	405		26		
1	filler 5×3/8	0'-8"	@ 6.38	4	〃	〃	36		2		
1	L. 4×3×0.3	4'-8 1/4"	@ 6.84	32	+51'-6"	+ 1 1/4"	1,648		3		
1	〃	4'-11"	〃	34	〃	〃	1,751		4		
~~1~~	~~filler 2 1/2×3/8~~	~~0'-9 3/4"~~	~~@ 3.19~~	~~3~~	~~〃~~	~~〃~~	~~155~~		0		
10	Ls. 4×3×0.3	5'-5 3/4"	@ 6.84	375	+26'-6"	+ 6"	9,938		188		
10	〃	5'-7"	〃	382	〃	〃	10,123		191		
15	filler 2 1/2×3/8	0'-9 3/4"	@ 3.19	39	〃	〃	1,034		20		
1	〃	0'-9 1/2"	〃	3	〃	〃	80		2		
10	Pls. 10 3/4×3/8	1'-2"	@ 13.71	160	+29'-0"	+ 8"	4,640		107		
5	Pls. 10×3/8	1'-2"	@ 12.75	74	〃	〃	2,146		49		
5	〃 14×3/8	1'-2 1/2"	@ 17.85	108	〃	〃	3,132		72		
10	Ls. 5×3×3/8	1'-2 1/2"	@ 9.72	117	+26'-6"	− 11"	3,101			107	
2	Flg. Ls. 150×150×11	19'-8 1/4"	@ 16.77	660	+14'-2 5/8"	+3'-3"	9,385		2,145		
2	〃	24'-6 3/4"	〃	824	+16'-7 7/8"	−2'-2"	13,725			1,786	
1	Cov. Pl. 12 1/2×1/2	20'-9 3/4"	@ 21.25	442	+14'-9 3/8"	+3'-4 3/4"	6,533		1,501		
1	〃	6'-10 1/2"	〃	146	+8'-11 1/4"	+3'-5 1/4"	1,305		502		
1	〃	25'-8 1/4"	〃	546	+17'-2 5/8"	−2'-3 3/4"	9,402			1,263	
4	Ls. 5 1/2×5 1/2×7/16	2'-3"	@ 15.70	141	+26'-6"	+ 6 1/2"	3,737		76		Cut 150×150×11
2	fillers 5 3/4×3/8	2'-3"	@ 7.33	33	〃	〃	875		18		
2	Ls. 3×3×3/8	0'-10 1/2"	@ 7.20	13	+55'-10"	−1'-1"	726			14	
1	filler 9×7/16	1'-1 1/2"	@ 13.39	15	+56'-6"	−1'-2 3/16"	848			19	
1	Pl. 19 1/4×3/8	1'-11 1/4"	@ 24.55	48	+55'-11 3/8"	−1'-5 1/16"	2,686			71	
2	Ls. 5 1/2×5 1/2×7/16	2'-4"	@ 15.70	73	+51'-6"	+3'-2 9/16"	3,760		235		Cut 150×150×11
1	Pl. 12 1/2×3/8	1'-9 1/2"	@ 15.94	29	〃	+3'-4 1/16"	1,494		98		
1	Pl. 16 3/4×3/8	2'-0"	@ 21.36 (−6)	37	+51'-0"	+2'-8"	1,887		99		
9	Pls. 8 1/2×3/8	1'-1"	@ 10.84 (−9)	97	+31'-6"	+ 6 1/2"	3,056		53		
1	Pl. 17 1/2×3/8	2'-4"	@ 22.31	52	+46'-6"	−1'-6 3/4"	2,418			81	
1	Pl. 16 1/4×3/8	2'-4"	@ 20.72	48	+41'-6"	+2'-8 3/8"	1,992		130		
1	Pl. 18 1/4×3/8	2'-6"	@ 23.27	58	+36'-5 1/4"	−1'-6 3/8"	2,113			89	
1	〃	2'-7 1/4"	〃	61	+31'-6"	+2'-7 3/8"	1,922		1,60		
1	Pl. 18 1/2×3/8	2'-10"	@ 23.59	67	+26'-6"	−1'-6 1/4"	1,776			102	
1	Pl. 21 1/2×3/8	2'-10"	@ 27.41 84	78	+21'-6"	+2'-5 3/4"	1,677		193		
1	Pl. 21 1/4×3/8	3'-1"	@ 27.10	84	+16'-6"	−1'-4 7/8"	1,386			118	
1	Pl. 21 3/4×3/8	3'-3 1/4"	@ 27.73	91	+11'-6"	+2'-5 5/8"	1,047		225		
1	Sole Pl. 10×3/4	1'-1"	@ 25.50	28	+56'-6"	−2'-3 7/8"	1,582			65	
19	fillers 5 3/4×3/8	0'-6"	@ 7.33	70	+34'-0"	+ 6 1/2"	2,380		38		
1	Pl. 14×3/8	1'-4 1/2"	@ 17.85	25	+56'-2"	−2'-2 7/8"	1,404			56	
4	Pls. 16 1/2×3/8	1'-9"	@ 21.04	147	+31'-6"	〃	4,631			329	
4	Ls. 5 1/2×5 1/2×7/16	2'-3"	@ 15.70	141	+4'-4 1/2"	+ 6 1/2"	617		76		Cut 150×150×11
2	fillers 12 1/2×1/2	2'-3"	@ 21.25	96	〃	〃	420		52		

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CALCULATIONS FOR

Material list of Tsuboigawa-bashi for Kumamoto-Ken

No.	Description	Length	Wt./ft.	Total Wt.	±X From Trunnion	±Y From Trun.	+X Moment	-X Moment	+Y Mom.	-Y Moment	Remarks
1	Pl. 12½ × ½	5'4⅝	@21.25	114	+4'4½	+3'5¾	499		397		
2	Ls. 5 × 3½ × ⅜	5'7⅛	@10.37	116	+2'1 7/16	+6½	246		63		
1	Pl. 14 × 5/16	5'6½	@14.88 (-11)	71	+2'3	+3	160		18		
1	L. 3 × 2 × ¼	4'0½	@4.04	16	〃	+1'7½	36		26		
1	〃	4'1	〃	16	〃	〃	36		26		
1	L. 3 × 3 × ⅜	0'5¾	@7.20	3	〃	-4	7			1	
1	〃	0'9½	〃	6	〃	〃	14			2	
1	Pl. 16½ × ⅜	1'9½	@21.04 (-7)	31	+6'7	-2'2⅞	204			69	
1	L. 4½ × 3½ × ⅜	0'11½	@9.75	9	+7'3¼	-6	65			5	Cut 5 × 3½ × ⅜ Ls
1	Washers 3" × ⅜		@0.75	1	+6'11	-8	7			1	
1	Pl. 9¼ × ⅜	6'9	@11.79	80	+4'4½	-4⅞	350			32	
1	L. 4 × 3 × ⅜	2'11	@8.45	25	+4'8¾	-5¾	118			12	
1	L. 〃	0'7¼	〃	5	+2'11⅜	〃	15			2	
1	L. 〃	0'8½	〃	6	+1'4¼	〃	8			3	
1	L. 〃	1'2⅜	〃	10	+1'7¼	〃	16			5	
1	filler 3 × ⅜	0'8	@3.83	3	+1'7¼	-6½	5			2	
1	〃	0'5¼	〃	2	+1'6	〃	3			1	
1	Pl. 8 × ⅜	0'11½	@10.20	10	+1'5¾	-4⅞	15			4	
1	Pl. 12½ × ⅜	1'9	@15.94 (-5)	23	+2'6	-2'2⅞	58			52	
2	Ls. 4 × 3½ × ⅜	1'2⅜	@9.10	22	+1'7¼	-1	35			2	} (b)
2	fillers 3½ × ⅜	0'8	@4.46	6	〃	-¼	10			0	
6	Ls. 5 × 3½ × ⅜	5'7⅛	@10.37	348	-4'2½	+6½		1,464	189		
2	fillers 3½ × 7/16	4'8	@5.21	49	-5'5¾	〃		268	27		
2	〃	3'9	〃	39	-8'7¾	+6¼		337	20		
2	〃	2'10½	〃	30	-11'5¾	+5½		344	14		
2	Ls. 5 × 3½ × ⅜	4'8½	@10.37	98	-8'7½	+6¼		845	51		
2	Ls. 〃	3'10	〃	79	-11'6	+5½		909	36		
2	Ls. 4 × 3½ × ⅜	1'3	@9.10	23	-1'7½	-1		37		2	} (c)
2	fillers 3½ × ⅜	0'11½	@4.46	9	-1'9	-¼		16		0	
2	Ls. 4 × 3 × ⅜	1'3	@8.45	21	-1'7½	-6½		34		11	
2	fillers 3 × ⅜	0'11½	@3.83	7	-1'9	-7 5/16		12		4	
2	Ls. 4 × 3 × ⅜	2'0	@8.45	34	-3'3⅜	-6½		112		18	
4	fillers 3 × ⅜	1'8¾	@3.83	26	-3'5	-7 5/16		89		16	
2	Ls. 4 × 3 × ⅜	1'0	@8.45	17	-4'10	-6½		82		9	
2	〃	3'1½	〃	53	-6'11	〃		367		29	
2	〃	2'2¼	〃	37	-9'7½	〃		356		20	
2	filler 3 × 7/16	0'8¾	@4.46	7	-4'11⅝	-7 5/16		35		4	
2	〃 3 × ⅜	〃	@3.83	6	〃	〃		30		4	
2	〃 〃	2'10¼	〃	22	-7'0⅞	〃		156		13	
2	〃 3 × 7/16	〃	@4.46	25	〃	〃		177		15	
2	〃 〃	1'11	〃	17	-9'9¼	〃		166		10	
2	〃 3 × ⅜	〃	@3.83	15	〃	〃		147		9	
2	Ls. 5 × 3½ × ⅜	1'0¼	@10.37	21	-11'0¼	-1'0½		231		22	
2	〃	0'11¾	〃	20	〃	〃		220		21	
2	Ls. 6 × 4 × ⅜	0'10¼	@12.27	21	-11'0½	-7¾		232		14	
2	Pin Pls. 17 × ½	1'8	@28.9	96	-12'6	+8½		1,200	68		
2	〃 9 × ½	1'5	@15.3	43	〃	+1'3½		538	56		
2	Pls. 7⅛ × ⅜	10'7½	@9.10	193	-6'3¾	-5⅝		1,218		91	
4	Ls. 5 × 3½ × ⅜	4'2½	@10.37	174	±0	-1⅞				27	(e)
4	Ls. 〃	1'11¼	〃	80	±0	+6½			43		(d)
4	Ls. 4 × 3½ × ⅜	1'3 1/16	@9.10	46	〃	〃			25		(f)
4	〃	2'4 1/16	〃	85	〃	〃			46		(g)
4	fillers 3½ × ⅜	0'11¾	@4.46	17	〃	-1'9¼				30	(f)
4	〃	2'0¾	〃	37	〃	+2'3¾			359	86	(g)
4	Flg. Ls. 150 × 150 × 11	9'10½	@16.77	662	-6¾	+6½		373	359		} a 150 × 150 × 11 × 17'4½
2	〃	7'11	〃	266	-9'5	+2'7		2,505	687		
				3298			1807	12,500	3151	648	

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CALCULATIONS FOR

Material list of Tsuboigawa-bashi for Kumamoto-Ken

No.	Description	Length	Wt/ft	Total Wt.	±X From Trunnion	±Y From Trunn.	+X Moment	-X Moment	+Y Mom.	-Y Moment	Remarks
2	Flg.Ls. 150×150×11	6'-3½	@16.77	211	-8'-8	-1'-9		1,829		369	6+a=16'-2"
1	Web Pl. 67½×3/8	13'-6½	@86.05(62)	1,103	+ 10½	+ 6½	965		598		
1	〃 53×3/8	7'-10	@67.60	530	-9'-1½	+ 5½		4836	243		
2	Side Pl. 62×3/8	5'-7⅞	@79.10	885	+ ½	+ 6½	37		480		
2	〃 55¾×7/16	7'-10	@82.93	1,299	- 8	+ 6½		866	704		
2	Cov. Pl. 12½×½	9'-10½	@21.25	420	+ 6¾	+ 6½	236		228		
1	〃 〃	7'-9½	〃	166	-9'-5	+2'-9		1,563	457		
1	〃 〃	4'-11½	〃	105	-7'-11	-2'-0		831		210	
1	〃 〃	10'-1	〃	214	-1'-9½	+3'-5¼		383	736		
1	〃 〃	14'-8½	〃	313	+ 6¾	-2'-4¼	176			737	
2	Ls. 150×150×11	7'-0⅜	@16.77	237	- 9 1/16	-2'-6		187		593	
4	Ls. 5×3½×3/8	2'-5¼	@10.37	101	± 0	-3'-7/16				367	
4	fillers 3½×¾	1'-7¼	@8.93	57	〃	-3'-8½				211	
2	〃	1'-0	〃	18	+ 2'-7¼	-3'-4¾	47			61	
2	Ls. 5×3½×3/8	1'-10½	@10.37	39	+ 2'-7½	-3'-4 3/16	102			131	
2	〃	1'-11¾		41	- 2'-4½	-3'-4 13/16		97		139	
2	fillers 3½×¾	1'-1¼	@8.93	20	- 2'-4¾	-3'-3¼		48		65	
1	Bent Pl. 12½×½	1'-7¼	@21.25	34	+ 2'-10½	-2'-8½	98			92	5×3/8×1'-10=12"
1	Web Pl. 30¼×3/8	7'-0½	@38.57(-60)	212	- 4"	-3'-8		71		777	15×3/8×2'-6=47/60
2	Flg.Ls. 6×4×½	8'-3	@16.15	266	-1'-1½	-4'-9		299		1,264	
1	Cov. Pl. 14½×½	9'-2½	@24.65	227	-1'-6	-4'-9½		341		1,083	
2	fillers 4×¾	7'-6	@10.20	153	-1'-1½	-3'-8½		172		567	
8	〃 3½×5/16	0'-5½	@3.72	14	+ 5/8	-2'-7¼	1			37	
2	〃 4×5/16	0'-9	@4.25	6	- 3'-11	-2'-7¾		24		16	
280	R.H. ¾"φ		@0.1425	40	+28'-6	+ 6	1,140		20		S.R. 170, F.R. 110 } L0-L4 近
986	〃 7/8"φ		@0.2125	210	+22'-6	〃	4725		105		S.R.
865	〃 〃		〃	184	+28'-6		5244		92		F.R.
2,777	〃 〃		〃	590	- 1'-11	+ 1½		1,131	74		S.R. 2317, F.R. 460
				19,626			251,710	25,178	15,953	13,500	
				× 2			×			2	
				39,252			503,420	50,356	31,906	27,000	

110

Floor beam FB1 1-Req'd.

No.	Description	Length	Wt/ft	Total Wt.
1	L. 3½×3×3/8	1'-8¾	@7.81	13
2	Flg.Ls. 3×3×3/8	17'-10¾	@7.20	258
2	〃	17'-10¼	〃	257
1	Web Pl. 19¾×5/16	〃	@20.99	375
4	Ls. 4×3×3/8	1'-6	@8.45	51
4	fillers 3×3/8	1'-0½	@3.83	16
4	〃	1'-1¼	〃	17
4	Ls. 3½×3×3/8	1'-6⅞	@7.81	49
2	〃	1'-7½	〃	25
2	fillers 3×3/8	1'-1¾	@3.83	9
2	Ls. 5×3½×3/8	0'-2½	@10.37	4
2	〃 3×3×3/8	0'-6¼	@7.20	8
2	Pls. 5¼×5/16	0'-11⅝	@5.58	11
1	Checkerd Pl. 13×3/8	16'-11¾	@17.65	300
~~2~~	~~Pls. 2½×3/8~~	~~0'-9⅞~~	~~@3.19~~	~~5~~
~~2~~	~~Ls. 5×3×3/8~~	~~0'-11~~	~~@9.72~~	~~18~~ 18
2	Ls. 3½×3½×3/8	1'-6⅞	@8.50	26
2	〃	1'-6⅝	〃	26
2	fillers 12½×3/8	1'-1	@15.94	35
526	R.H. ¾"φ		@0.1425	75
2	Pls. 8⅞×½	0'-9⅞	@15.09	125
				~~1590~~
				1603

+56'-6 -1'-4¼

+735 90570 ~~90,570~~ 417 2,170 2,170

S.F. F.R. C.S. 84 53 168 252

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SEIYU BLDG, TOKIO

MADE BY Y. H. DATE 3-7-10 **FILE NO** ______

CHECKED BY R. I DATE 3-7-16 **PAGE NO** 59

CALCULATIONS FOR

Material list of Tsuboigawa-bashi for Kumamoto-Ken

No.	Description.	Length.	Wt/ft.	Total Wt.	±X From Trunnion	±Y From Trun.	+X Moment.	-X Moment	+Y Mom	-Y Moment.	Remarks
				Floor beams FB2 & FB3 1-Req'd.							
5	I. 14 × 6	17'-9½	@46.01	4093							
2	Pls. 15 × ⅜	1'-2	" 19.13	45							
1	Pl. 10½ × ⅜	1'-2¼	" 13.39	16							
1	filler 3 × ⅜	1'-0¾	" 3.83	4							S.R. 30
840	R. H. ¾"φ		" 0.1425	120							F.R. 390
				4278	+26'-6"	-1'-7¾	113.367			7.042	
				FB4		1-Req'd.					
1	Flg Ls. 3 × 3 × ⅜	17'-10	@7.20	128							
1	"	17'-0	"	122							
1	"	17'-9½	"	128							
1	"	17'-11½	"	129							
1	Web Pl. 19¾ × 5/16	15'-5	@20.99	324							
2	Ls. 100 × 100 × 10	1'-6	@10.00	30							
2	filler 4 × ⅜	1'-0½	" 5.10	11							
4	Pls. 5½ × ⅜	1'-0½	" 7.01	29							
4	Ls. 3½ × 3 × ⅜	1'-6⅞	" 7.81	49							
4	filler 3 × ⅜	1'-1¼	" 3.83	17							
2	"	1'-1¾	" "	9	145"						
2	Ls. 3½ × 3 × ⅜	1'-7½	" 7.81	25							
2	Pls. 15 × ⅜	1'-4⅜	" 19.13	52	25						-9 × ⅜ × 0-4½
1	Pl. "	1'-5	" " (-2)	25							
1	check Pl. 9 × ⅜	18'-3¾	" 12.24	224							
1	filler 3 × ⅜	0'-10½	" 3.83	3							
1	" "	1'-0¼	" "	4							S.R. F.R.
506	R. H. ¾"φ		@0.1425	72							C.S. 92 127 80
24	bolts head ~~& nut~~		" 0.253	6			-61				12-bolts ¾" × 1¾
1	Pl. 14 × ⅜	1'-3½	@17.85 (-5)	18	+ 2'-3	-1'-4¼	3161			1902	
				1405							-9 × ⅜ × 0-40
				Stringers.							
10	I. 8 × 2½	9'-11	@15.12	1499							
134	Ls. 6 × 4 × ⅜	0'-5½	" 12.27	753							
3	Ls. 100 × 100 × 10	0'-5½	" 10.01	14							
25	I. 8 × 4	9'-11	" 18.01	4465							
1	I. 9 × 3	0'-7⅞	" 19.37	12							
548	R. H. ¾"φ		@0.1425	78							
				6821	+ 31'-6.	-1'-7 9/16	214.862			11.118.	
				Stringers S10E & S12E							
2	I. 9 × 3	4'-2	@19.37	161							
2	I. 9 × 4	"	" 21.00	175							
16	Ls. 6 × 4 × ⅜	0'-5¼	" 12.27	90							S.R. 28
56	R.H. ¾"φ		" 0.1425	8							
10	bolts head & nut ¾"φ		" 0.5	5							
				439	+4'-4½	-1'-6 13/16	1921			688	
				S11E							
3	I. 12 × 3½	4'-1½	@26.1	323							
3	Ls. 3½ × 3½ × ⅜	0'-10	" 8.5	21							
6	Ls. 6 × 4 × ⅜	0'-8½	" 12.27	52							

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MADE BY Y. H. DATE 3-7-10 FILE NO ______

CHECKED BY R. I DATE 3-7-16 PAGE NO 60

CALCULATIONS FOR

Material list of Tsuboigawa-bashi for Kumamoto-Ken

NO.	Description	Length	Wt/ft.	Total Wt.	±X From Trunnion	±Y From Trunn.	+X Moment.	-X Moment.	+Y Mom.	-Y Moment.	Remarks
3	fillers 3 1/2 × 3/8	0'11	@4.46	12							
3	" "	0'10 3/4	" "	12							S.R. 5 F.R. 4
18	R. H. 3/4"φ		@ 0.1425	3							
				423	+4'4 1/2	-1'8 5/16	1,851.			716.	
				S13							
2	Ls. 3 × 3 × 3/8	4'2	@ 7.20	60							
1	L. 3 1/2 × 3 × 3/8	0'10 3/4	" 7.81	7							
1	L. "	1'2	" "	9							
1	Pl. 9 × 1/2	1'2	" 15.30	18							
1	Pl. 10 3/4 × 1/2	2'2 1/4	@18.28	40							
1	L. 2 1/2 × 2 1/2 × 5/16	0'10 3/4	" 5.00	4							F.R. 8 S.R. 14 C.S. 4
48	R.H. 3/4"φ		@ 0.1425	7							
6	bolts head & nuts 5/8"φ		@ 0.31	2							
				147	+4'4 1/2	-1'11 3/8	643			286.	
				S14							
1	[. 8 × 3	4'11	@ 19.30	95							
2	Ls. 6 × 4 × 3/8	0'5 1/2	" 12.27	11							
1	L. 6 × 5 1/2 × 3/8	0'5	" 14.90	6							Cut 6 × 6 × 3/8
1	L. 5 1/2 × 3 1/2 × 3/8	0'5 1/2	" 10.37	5							
32	R.H. 3/4"φ		" 0.1425	5							
				122	+54'0	-1'7 9/16	6,588.			199	
				Cross beam CB1							
1	[. 8 × 3	1'10 1/4	@ 19.30	36.							
2	Ls. 6 × 4 × 3/8	0'5 1/2	" 12.27	11							
1	filler 3 × 3/8	0'5 1/2	" 3.83	2							
1	" 5 1/2 × 3/8	0'6 3/4	" 7.01	4							S.R. 4
1	Pl. 9 1/4 × 3/8	0'10	" 11.79	10							F.R. 7
22	R.H. 3/4"φ		@ 0.1425	3							
				66	+51'5 3/8	-1'7 9/16	3396			108	
				Bottom lateral bracings							
5	Ls. 75 × 75 × 9	18'11 1/2	@ 6.67	632							
10	"	9'2 1/2	" "	614							
5	Pls. 7 × 3/8	2'2 1/2	" 8.93	99	+31'6	-2'1 7/8	47,471.			3,249	
40	Ls. 5 × 3 × 3/8	0'5	" 9.72	162							
2	Ls. 75 × 75 × 9	4'8	" 6.67	62							
2	"	2'0 1/4	" "	27							
2	"	2'4 1/8	" "	31							
4	"	0'6 1/4	" "	14	+4'4 1/2	-2'1 7/8	1,028			507	
1	"	5'2 3/8	" "	35							
1	"	4'8 1/4	" "	31							
2	Pls. 7 × 3/8	1'11 3/4	" 8.93	35							S.R. 116 F.R. 250
732	R.H. 3/4"φ		@ 0.1425	104	+31'0	-2'1	3,224			217.	
				1,846			51,723			3,973	
	Summary of Structural Steel			56,402 ✓ 56402			991,192 ✓	50,356	31,906	55,202 ✓	

3-9-15 [illegible]

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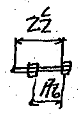
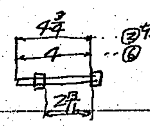
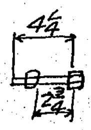
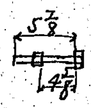
CALCULATIONS FOR

Material list of Tsuboigawa-bashi for Kumamoto-Ken

No.	Name	Unit weight	Total Weight	±X from Trunnion	±Y from Trunn.	+X Moment	−X Moment	+Y Mom.	−Y Moment	Remarks
			○ Cast steel buffer blocks 2-Req'd.							
1	buffer blocks	@ 50.00	50							
16	bolts heads 7/8"φ	" 0.38	6							
			56×2= 112	−11'1"	−1'7½"		1241		182	
			○ Live load Shoes on bascule abutment. 2-Req'd. (Cast Steel)							
1	Shoe	@ 88.00	88							
16	bolt heads 3/4"φ	" 0.38	6							
			94×2= 188	+6'6"	−2'5½"	1,222			462	
			* Racks 2-Req'd (Cast Steel)							
1	Rack	@ 873.00	873.							
56	bolt heads 1"φ	" 0.6	34							
			907×2= 1,814	−1'0"	−5'1"		1,814		9,221	
			○ Pins for counter weight Girder							
2	Pins	@ 118.50	237							
2	Washers 8¾"×¼"	" 2.00	4							
2	nut	" 7.80	16							
			257	−12'6"	+8½"		3,213	182	[illegible]	
			× Trunnion Boss 2-Req'd. (Cast Steel).							
1	boss	@ 146.00	146.							TB1
1	"	" 516.00	516							TB2
48	bolts heads 1"φ	" 0.55	26							
			688×2= 1,376							
			× Trunnion Shaft 2-Req'd							
2	Shaft	@ 303.0	606							
			× Ser buffer 2-Req'd. (Cast iron).							
1	buffer	@ 193.0	193.							
13	bolts 7/8"φ	@ 0.37	5							
			198×2= 396	+56'0½"	−1'8 7/16"	22,193			674	
			× locking							
			1,463	+27'5 9/16"	−1'5 17/32"	40,180			2,138	
	Summary of Casting		6,212			63,595	6,268	182	12,677	
	Summary of Casting		6212			23,337 / 63,595	6268	182	10,510 / 12,677	

○ ノ材料ハ鉄部ニ加入
× ノ 〃 ハ M.Shaft ニテ計上

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MADE BY Y. H. DATE 3-7-12 FILE NO ______

CHECKED BY R. I DATE 3-7-17 PAGE NO 62

CALCULATIONS FOR

Material list of Tsuboigawa-bashi for Kumamoto-Ken

No.	Description	Volume (cub. ft)	Unit Wt.	Total Wt.	±X From Trunnion	±Y From Trunn.	+X Moment	-X Moment	+Y Mom.	-Y Moment	Remarks
	Wooden flooring										
	Creosoted Wooden beam (longitudinal)										
2	5 3/8 × 3 3/8 × 9'-8 3/4	2.450	@35.00	86							
2	〃 × 4 × 〃	2.903	〃	102							
2	〃 × 4 3/8 × 〃	3.192	〃	112							
1	6 × 4 1/2 × 〃	1.824	〃	64							
8	5 3/8 × 3 3/8 × 9'-6	9.568	〃	335							
8	〃 × 4 × 〃	11.338	〃	397							
8	〃 × 4 3/8 × 〃	12.428	〃	435							
4	6 × 4 1/2 × 〃	7.125	〃	249							
2	5 3/8 × 2 5/8 × 3'-11 3/4	0.631	〃	22							
2	〃 × 2 3/4 × 〃	0.816	〃	29							
2	〃 × 3 1/8 × 〃	0.927	〃	32							
1	6 × 3 1/4 × 〃	0.539	〃	19							
266	Washers 2 1/2 × 1/8 × 0'-2 1/2		@1.063	59							
266	beveled Washers 1 3/4 × 1/4 × 0'-1 3/4		〃 1.488	58							
70	bolts 3/8" × 0'-4		@0.580	41							
70	〃 〃 × 0'-4 3/4		〃 0.640	45							
105	〃 〃 × 0'-5 1/4		〃 0.680	71							
9	〃 〃 × 0'-4		〃 0.580	5							
6	〃 〃 × 0'-3 1/2		〃 0.54	3							
6	〃 〃 × 0'-2 3/4		〃 0.47	3							
				2167	+29'-4 1/2	-1'-1 1/8	63,656			2,505	
	Creosoted Wooden Cross beam										
8	6 × 4 5/8 × 7'-11	10.894	@35.00	381							
2	〃 〃 8'-11 1/2	3.082	〃	108							
10	bolts 3/4" × 0'-4 1/4		@0.90	9							
30	Washers 2 1/2 × 1/8 × 0'-2 1/2		〃 1.063	7	+24'-4 1/2	-10 1/2	13,114			471	
30	B. W. 2 1/2 × 1/4 × 〃		〃 2.125	13							
20	bolt 3/4" × 0'-5		〃 1.00	20							
2	Ls. 1 1/2 × 1 1/2 × 1/8 × 14'-8		〃 1.23	36	+26'-6	-8 1/2	1007			27	
16	screw 3/8" × 0'-3		〃 0.095	2							
				576			14,121			498	
	Creosoted Wooden planks										
6	13 × 2 1/2 × 8'-3	11.151	@35.00	390							
58	〃 〃 7'-11	103.438	〃	3,620							
2	12 3/4 × 2 1/2 × 7'-11	3.501	〃	123							
22	12 × 2 1/2 × 7'-11	36.228	〃	1268							
8	〃 〃 × 9'-0 1/4	15.011	〃	525							
2	11 3/4 × 2 1/2 × 9'-0	3.665	〃	128							
1050	nails 5 1/2"		@0.041	43							
				6,097	+29'-4 1/2	-10 1/8	179,099			5,146	
	Creosoted Wooden block pavement (目地ヲ含ム)										
1	15'-0 × 53'-8	805 □'	@13.30	10,707	+29'-4 1/2	-7 5/8				6,799	
12,100	nails 4 1/2"		@0.033	399	〃	-〃				253	
2	1 3/4 × 1 3/4 × 15'-0	1.003 cub.ft	@35.00	35	〃	-7 3/4				23	Wooden plank
				11,141			327,267			7,075	

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JIUN MASUDA
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SEIYU BLDG, TOKIO

MADE BY Y. H. DATE 3-7-12 FILE NO

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CALCULATIONS FOR

Material list of Tsuboigawa-bashi for Kumamoto-Ken

No	Description	Volume	Unit Wt.	Total Wt.	±X From Trunnion	±Y From Trunn.	+X Moment	-X Moment	+Y Mom.	-Y Moment	Remarks
	Creosoted Wooden Coping										
2	5×3½×3'-3	0.791	@35.00	28							
2	5½×5×4'-1⅞	1.902	"	67							
18	" " ×5'-0	17.190	"	602							
2	" " ×4'-2½	1.607	"	56	+29'-4½	-7 9/16	25.909			557.	
68	bolts ¾"φ×8¾		@1.46	99							
136	Washers 2½×⅛×0'-2½		@1.063	30							
2	5×3×3'-11	0.817	@35.00	29		-7¾				19.	
2	" " 1'-2½	0.252	"	9		"				6	
2	1⅞×1½ 5'-2½	1.926	"	67	+5'-0	-5⅝	580.			29	
6	bolts ¾"φ×7¾		@1.34	8		"				3	
12	Washers 2½×⅛×0'-2½		@1.063	3		"				1	
				998			26.489			615	
	Summary of Wooden flooring			20.979			610.632			[illegible] 15.839	
	Hand Rails for moving span										
40	Ls 3×2×¼	7'-10¼	3.404	461							
2	Gas pipe 2"φ	4'-9¾	3.652	35							
18	" "	4'-11½	"	326							
2	" "	4'-5	"	32							
18	Ls 2½×2¼×¼	4'-10½	4.10	360							
2	"	4'-1½	"	34							
44	"	0'-1½	"	23							
18	bars 1½×½	5'-3	2.55	241							
2	" "	4'-6	"	23							
172	Rod ¾"φ	1'-7¼	1.502	414							
20	Washers 3"φ×⅜	0'-4¾	3.83	30							
198	Screw 5/16"φ	0'-¾	0.026	5	+31'-6	+11⅞					
88	R.H. ½"φ		0.045	4							
2	bars 1½×½	5'-0¾	2.55	26							
2	Ls. 2½×2½×¼	4'-8¼	4.10	38 22,657							X, 材料 [illegible]
×2	Casting posts		75.0	150							M. shur = 7 計上ス
×6	bolt heads		0.157	1							
×12	" " and nails		0.5	6			69,584		2186		
				2209	+31'-6	+11⅞	69.584		2186		

Summary of weight and moment

~~Structural Steel~~	56402	991.192	50356	31906	55202
Casting	6.212	63.595	6268	182	12.677
Wooden flooring	20.979	610.632			15.839
Handrails	2.209	69.583		2186	
	85.802	1.735.003	56.624	34274	83.718
	[illegible]	1690479	56624	34171	82328

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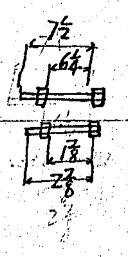
CALCULATIONS FOR

Material list of Tsuboigawa-bashi for Kumamoto-Ken

No.	Description	Length	Weight/ft.		Total Wt.	Remarks.
		Counter weight	Girder	1-Req'd.		
2	Ps. 58 × ¾	5'-8¾	@ 147.90	(-143.8)	1551	
4	Ps. 19½ × ¾	2'-5	〃 49.70	(-12.75)	455	
8	Ls. 200ᵐᵐ × 6" × 15ᵐᵐ	2'-5¾	〃 30.47	(-16.86)	537	Cut from 200ᵐᵐ × 200ᵐᵐ × 15ᵐᵐ
8	fillers 6 × ¾	1'-5½	〃 15.30		178	
4	Ls. 3 × 3 × ⅜	3'-6½	〃 6.67		95	Ls. 75ᵐᵐ × 75ᵐᵐ × 9ᵐᵐ
2	Ls. 〃	3'-10	〃 〃		51	〃
4	Ls. 3½ × 3 × ⅜	1'-2	〃 7.81		36	
4	Ls. 〃	0'-8½	〃 〃		22	
4	Ps. 14 × ⅜	1'-3	〃 17.85	(-27.9)	61	
3	Ls. 3½ × 3 × ⅜	4'-11	〃 7.81		115	
4	Ls. 6 × 6 × ⅜	3'-11¾	〃 16.77		267	Ls. 150ᵐᵐ × 150ᵐᵐ × 11ᵐᵐ
4	fillers 6 × ⅜	3'-6¼	〃 7.65		108	
6	Ls. 3½ × 3 × ⅜	3'-11¾	〃 7.81		186	
6	fillers 3 × ⅜	3'-6¼	〃 3.83		81	
2	Flg. Ls. 4 × 3 × ⅜	17'-11	〃 8.45		303	
2	〃 〃	〃	〃 〃		303	
2	Ps. 10 × 5/16	1'-1	〃 10.63	(-16.55)	17	
2	Ls. 3 × 3 × ⅜	5'-4½	〃 6.67		72	Ls. 75ᵐᵐ × 75ᵐᵐ × 9ᵐᵐ
2	Ps. 10 × 5/16	1'-1	〃 10.63	(-21.16)	21	
2	Ps. 11 × 5/16	1'-5½	〃 11.69		34	
2	Ls. 3 × 3 × ⅜	5'-7¼	〃 6.67		75	Ls. 75ᵐᵐ × 75ᵐᵐ × 9ᵐᵐ
1	Ps. 10 × 5/16	2'-2	〃 10.63		23	
4	Ls. 3½ × 3 × ⅜	4'-9⅝	〃 7.81		149	
2	Ps. 12 × ⅜	4'-9⅝	〃 15.30		146	
4	Ls. 5 × 3 × ⅜	5'-0	〃 9.72		194	
2	Ps. 10 × ⅜	1'-0⅜	〃 12.75	(-3.4)	23	
1	L. 3 × 3 × ⅜	2'-5½	〃 6.67		16	Ls. 75ᵐᵐ × 75ᵐᵐ × 9ᵐᵐ
1	L. 〃	2'-5	〃 〃		16	〃
1	L. 〃	5'-3	〃 〃		35	〃
1	P. 8½ × ⅜	1'-7½	〃 10.84	(-4.32)	13	
2	Ls. 3½ × 3 × ⅜	4'-9⅝	〃 7.81		74	
1	P. 12 × ⅜	4'-9⅝	〃 15.30		73	
2	Web Ps. 48 × ⅜	17'-11	〃 61.20		2,193	
2	Ls. 3½ × 3 × ⅜	1'-5	〃 7.81		22	
2	〃 〃	4'-2½	〃 〃		66	
1	〃 〃	4'-6½	〃 〃		35	
1978	Rivet heads ¾"φ		〃 0.1425		282	
72	Bolt heads 1"φ		〃 0.565		41	
112	〃 ¾"φ		〃 0.250		28	
					7997	
4	Counter weight hanger (cast steel)		@ 697.00		2788	
4	phosphor bronze bushing		@ 20.00		80	
					10,865	



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CONSULTING ENGINEER
SEIYU BLDG, TOKIO

MADE BY Y. H. DATE 3-7-12 **FILE NO** ______

CHECKED BY R. I DATE 3-7-18 **PAGE NO** 65

CALCULATIONS FOR

Material list of Tsuboigawa-bashi for Kumamoto-Ken

Column Under Trunnion Bearing 2-Req'd.

No.	Description	Length	Weight/ft.	Total Wt.	Remarks
8	Ls. 4 × 4 × 3/8	11-11¾	@ 9.80	939	
1	Pl. 14 × 3/8	4-9	" 17.85	85	
2	Ls. 6 × 3½ × 3/8	1-6½	" 11.64	36	
2	fillers 6 × 3/8	0-11½	" 7.65	15	
2	" 8 × 3/8	0-8½	" 10.20	14	
2	Ls. 6 × 6 × 3/8	0-8	" 14.90	20	
4	" 4 × 4 × 3/8	1-2⅝	" 9.80	48	
2	Ls. 6 × 3½ × 3/8	1-6½	" 11.64	36	
2	fillers 6 × 3/8	0-11½	" 7.65	15	
1	Pl. 14 × 3/8	4-9	" 17.85	85	
1	L. 6 × 4 × 3/8	5-1½	" 12.27	63	
2	Pls. 16½ × 3/8	1-6	" 20.72	62	
2	Ls. 6 × 6 × 3/8	0-8	" 14.90	20	
2	Pls. 23 × 3/4	5-1½	" 58.70	602	
32	Lac bars 2½ × 3/8	2-0	" 3.19	204	
1	Pl. 6 × ½	6-3½	" 10.20	64	
2	Pls. "	2-10	" "	58	
1	" 14½ × 3/8	1-3¾	" 18.49	24	
1	" "	4-9	" "	88	
8	Ls. 6 × 6 × 3/8	1-7½	" 14.90	194	
4	fillers 6 × 3/8	1-5½	" 7.65	45	
8	Ls. 5 × 3½ × 3/8	1-5¾	" 10.37	123	
8	Ls. 5 × 3 × 3/8	"	" 9.72	115	
2	Pls. 19½ × 3/8	2-10¼	" 24.86	142	
2	Pls. 19½ × 3/8	2-2¾	" "	111	
4	Ls. 4 × 4 × 3/8	1-2⅝	" 9.80	48	
2	Ls. 6 × 6 × 3/8	0-8	" 14.90	20	
2	fillers 8 × 3/8	0-8½	" 10.20	14	
2	Pls. 16½ × 3/8	11-11¾	" 20.72	496	
2	Ls. 6 × 6 × 3/8	1-3½	" 14.90	39	
2	filler 6 × 3/8	0-8	" 7.65	10	
2	Ls. 5 × 3 × 3/8	0-2½	" 9.72	4	
1	Pl. 9½ × 3/8	1-9	" 12.11	21	
1	" 16½ × 3/8	2-2¾	" 20.72	46	
1	L. 4 × 3½ × 3/8	0-8	" 9.10	(6) — 6	
2	Ls. "	0-8⅞	" "	13	
1	filler 5½ × 3/8	0-8	" 7.01	5	
1	Pl. 16½ × 3/8	1-4¾	" 20.72	29	
30	Lac bars 2½ × 3/8	1-4¼	" 3.19	130	
4	Anchor bolts 1¼"	2-6	" 11.30	45	
2	Pls. 21 × 3/4	2-5½	" 53.60	263	
1	Pl. 18½ × 5/16	2-8½	" 19.66	53	
2	Ls 3½ × 3½ × 3/8	0-10	" 8.50	14	
2	Ls 4 × 3 × 3/8	0-9¼	" 8.45	13	
1	Pl. 9¼ × 3/8	1-4	" 11.79	16	
2	Ls. 6 × 4 × 3/8	1-2	" 12.27	29	
1	Pl. 14 × 3/8	1-4	" 17.85	24	
				4601 × 2 = 9202	

Strut SM.

No.	Description	Length	Weight/ft.	Total Wt.	Remarks
1	L. 4 × 4 × 3/8	4-5⅝	@ 9.8	44	
1	" "	0-8½	" "	7	
1	filler 3½ × 3/8	0-8½	" 4.46	3	
1	Pl. 6½ × 3/8	0-11¼	" 8.29	8	
				62	

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CHECKED BY R. I DATE 3-7-18 **PAGE NO** 66

CALCULATIONS FOR

Matrial list of Tsuboigawa-bashi for Kumamoto-Ken

NO.	Description	Length	Weight/ft.	Total wt.	Remarks
		Floor Break FK3			
1	L. 5 × 3 × 3/8	17′-3	@ 9.72	168	
1	Pl. 3 × 3/8	17′-2	" 3.83	66	
2	fillers 2½ × ¼	0′-2½	" 2.125	1	
7	Anchor bolts 5/8″φ	1′-0	" 1.25	9	
					244
		FK2 R/L			
2	Ls. 3 × 3 × 3/8	12′-0¾	@ 7.20	174	
2	Pls. 5¼ × 3/8	11′-9 5/8	" 6.69	158	
2	Ls. 3½ × 3½ × 3/8	2′-0¼	" 8.50	34	
2	" 4 × 3 × 3/8	0′-2½	" 8.45	4	
4	Anchor bolts ½″φ	0′-9	" 0.61	2	
					372
		FK1 R/L			
2	Ls. 3 × 3 × 3/8	12′-4¾	@ 7.20	179	
2	Pls. 5¼ × 3/8	12′-0¼	" 6.69	161	
2	Ls. 4 × 3 × 3/8	0′-2½	" 8.45	4	4
					344 344
		Fascia girder FG1 R/L			
8	Ls. 3 × 3 × 3/8	15′-0¾	@ 7.20	868	
2	Web Pl. 16 × 5/16	14′-0¼	" 17.00	477	
4	Pls. 5 × 5/16	0′-10¼	" 5.31	18	
6	filler 5¼ × 3/8	0′-8 3/8	" 6.69	28	
2	Pls. 5 × 5/16	0′-10½	" 5.31	9	
2	" 6 × 5/16	1′-0	" 6.38	13	
2	" "	1′-1	" "	14	
2	Ls. 5 × 3 × 3/8	0′-6¼	" 9.72	10	
4	"	0′-7	" "	23	
4	Pls. 9½ × ½	1′-0	" 16.15	65	
4	Anchor bolts 1″φ	1′-0	" 3.52	14	
4	Washers 4 × 3/8	0′-4	" 5.10	7	
					1,546
		Floor Beam FG2 & FG3			
1	Is. 14 × 6	13′-0 5/8	@ 46.01	601	
3	Is. 10 × 6	15′-7	" 42.02	1964	
4	Ls 6 × 4 × 3/8	0′-11	" 12.27	45	
12	Ls "	0′-8	" "	98	
					2,708
		Checkerd Plate Covers for Column Under trunnion Bearing CP1 R/L & CP2 R/L			
2	checkerd Pls. 22½ × 3/8	2′-10¾	@ 30.60	177	
2	" 20 × 3/8	2′-8½	" 25.50	140	
2	Ls. 3 × 3 × 5/16	2′-9¾	" 6.10	34	
2	"	1′-8	" "	20	
2	bars 2½ × 3/8	3′-0 7/8	" 3.19	20	
2	"	1′-5¼	" "	9	
2	"	1′-10 5/8	" "	12	
2	"	3′-2	" "	20	
2	"	1′-7	" "	10	
2	Ls. 3 × 3 × 5/16	1′-9½	" 6.10	22	
2	"	2′-7¾	" "	32	
2	"	1′-5¼	" "	18	
12	Anchor bolts ½″φ	0′-9	" 0.61	7	521

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MADE BY Y. H. DATE 3-7-15 FILE NO
CHECKED BY R. I DATE 3-7-19 PAGE NO 67

CALCULATIONS FOR

Material list of Tsuboigawa-bashi for Kumamoto-Ken

No.	Description	Length.	Weight #/ft.	Total weight	Remarks
		Hand Rails on bascule abut ment.			
4	Ls. 3 × 2 × 1/4	3' 3 1/4	@ 4.04	53	
4	" "	3' 4 3/4	" "	55	
4	" "	3' 6 1/4	" "	57	
6	Pls. 6 1/2 × 3/8	0' 8	" 8.29	33	
6	Ls. 3 1/2 × 3 1/2 × 3/8	0' 6 1/2	" 8.50	28	
6	Washers 2 1/2"φ × 3/8		" 0.52	3	
6	fillers 3 × 3/8	0' 4 3/4	" 3.83	9	
4	Gas pipe 2"φ	6' 3 1/2	" 3.652	92	
4	bars 1 1/2 × 1/2	6' 4 1/2	" 2.55	65	
40	Rod 3/4"φ	1' 7 1/4	" 1.502	96	
4	Ls 2 1/2 × 2 1/2 × 1/4	6' 0	" 4.10	98	
8	"	0' 1/2	" "	4	
44	Screw 5/16"φ	3/4	" 0.026	1	
20	F.R. 1/2"φ	Grip 1 3/4	" 0.22	4	
24	S.R. 3/4"φ	" 3/4	" 0.43	10	
				608	
1909	Shop rivets 3/4"φ	grip 1"	@ 0.46	878	1549
126	Field " "	" 1"	" "	58	
8	bolts "	2 1/4	" 0.66	5	
				941	
		Gear Cover	2-Req'd.		
1	Pl. 15 1/4 × 1/16	2' 2 1/2	@ 3.24	7.15	
2	Washers 1 × 1 1/4	0' 1	" 4.25	0.36	
2	Anchor bolts 1/4"φ	0' 4	" 0.07	0.14	
				7.5	
				× 2	
				15.	
	Summary of bascule abut ment.			16,453 ✓	

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MADE BY Y. H. DATE 3-7-15 FILE NO
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CALCULATIONS FOR

Material list of Tsubogawa-bashi for Kumamoto-Ken

No.	Description	Length	Weight #/ft.	Total weight	Remarks
		Fixed Girder Span G1 & G2			
4	Is. 20 × 7½	30′-0	@ 88.96	10.675	
24	Ls. 3½ × 3½ × 3/8	1′-6½	〃 8.50	315	
15	Pls. 12 × 5/8	1′-3	〃 25.50	478	
12	Pls 5½ × 3/8	1′-1½	〃 7.01	95	
12	Ls. 3 × 3 × 3/8	0′-11½	〃 7.20	83	
9	[s. 12 × 3½	4′-6½	〃 26.10	1067	
18	Ls. 3½ × 3½ × 3/8	0′-9½	〃 8.50	121	
176	Shop Rivets ¾″ϕ	Grip 1½	〃 0.54	95	
134	Field 〃 〃	〃 1¼	〃 0.49	66	
16	Anchor bolts 1¼″ϕ	2′-0	〃 10.07	161	
16	Washers 6 × 3/8	0′-6	〃 7.65	61	
1	Pl. 10¼ × 3/8	1′-0	〃 13.07	13	
1	L. 3½ × 3½ × 3/8	0′-6½	〃 8.50	5	
2	Ls. 6 × 3½ × 3/8	1′-3½	〃 11.64	30	
1	Pl. 11½ × 3/8	1′-0	〃 14.66	15	
1	L. 3½ × 3½ × 3/8	1′-0	〃 8.50	9	
1	L 4 × 3 × 3/8	1′-4½	〃 8.45	12	
2	Pls 10½ × ½	1′-4½	〃 17.85	49	
1	L. 3½ × 3½ × 3/8	1′-4½	〃 8.50	12	
1	L. 〃	1′-0	〃 〃	9	
1	Pl. 14 × 5/8	1′-7⅞	〃 29.75	47	
					13.418.
		Floor break FK4			
1	L. 5 × 3 × 3/8	17′-0	@ 9.72	165	
1	L. 3 × 3 × 3/8	16′-6	〃 7.20	119	
1	Web Pl. 9 × 5/16	16′-6	〃 9.56	158	
1	bars 2 × 3/8	17′-0	〃 2.55	43	
108	Shop Rivets 5/8″ϕ	Grip ¾	〃 0.27	29	
					514
		Hand Rail for fixed Girder Span			
24	Ls. 3 × 2 × ¼	3′-5¾	@ 4.04	333	
12	Washers 3″ × 3/8	0′-4¾	〃 3.83	18	
12	〃 2½″ϕ × 3/8		〃 0.52	6	
2	Gas pipe 2″ϕ	4′-0½	〃 3.652	30	
8	〃 〃	4′-11½	〃 〃	145	
2	bars 1½ × ½	4′-1½	〃 2.55	21	
8	〃	5′-3	〃 〃	107	
2	Ls. 2½ × 2½ × ¼	3′-9	〃 4.10	31	
8	〃	4′-10½	〃 〃	160	
20	〃	0′-1½	〃 〃	10	
76	Rod ¾″ϕ	1′-7¼	〃 1.502	183	
96	Screw 5/16″ϕ	¾	〃 0.026	2	
24	Field Rivets ½″ϕ	Grip 1¾	〃 0.22	5	1051
2	Gas pipe 2″ϕ	4′-6¼	〃 3.625	33	
2	bars 1½ × ½	4′-9	〃 2.55	24	
2	Ls. 2½ × 2½ × ¼	4′-4½	〃 4.10	36	
2	〃	0′-1½	〃 〃	1	
14	Rod ¾″ϕ	1′-7¼	〃 1.502	34	

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CALCULATIONS FOR

Material List of Tsuboigawa-bashi for Kumamoto-Ken

	No.	Description		Length	Weight #/ft.	Total Weight		Remarks
X	1	Casting Post			@ 410.00	410	✓	PT8
X	1	〃	〃		〃 96.00	96	✓	PT9.
	2	gas pipe	2"φ	4'-6¼	@ 3.625	33		
	2	bars	1½ × ½	4'-9	〃 2.55	24		
	2	Ls.	2½ × 2½ × ¼	4'-4½	〃 4.10	36		
	2	Ls.	〃	0'-1½	〃 〃	1		
	14	Rods	¾"φ	1'-7¼	〃 1.502	34		
	11	Tapped bolts	½"φ × 0'-3		〃 0.222	2.44		
	4	〃 〃	¾"φ	0'-4	〃 0.638	2.55		
	2	bolts	⅜"φ	0'-1	〃 0.055	0.11		
	6	〃	¾"φ	0'-4½	〃 0.94	5.64		
	6	〃	〃	0'-1½	〃 0.426	2.56		
X	2	〃	⅝"φ	0'-4½	〃 0.62	1.24		
X	4	〃	¾"φ	0'-1½	〃 0.426	1.70		X ハ材料ハ M. Sheet
	4	Screw	½"φ	⅞	〃 0.056	0.22		ニテ計上ス
						1,829	✓	

Summary of Fixed Girder Span 15,761

不動部

Live load shoe (Cast Iron) 2-Req'd.

1	bearing				573
6	bolts	¾"φ ×	0'-8	@ 1.19	7
4	Anchor bolts	1"φ ×	2'-0	〃 5.76	23
					603 × 2 = 1,206

Cast Iron pedestal on pier 2-Req'd.

1	Pedestal				265
4	Anchor bolts	1"φ ×	2'-0	@ 5.76	23
2	bolts	⅞"φ	0'-3½	〃 1.18	2
					290 × 2 = 580

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CALCULATIONS FOR

Material list of Tsutoigawa-hashi for Kumamoto-Ken

Total summary of Weight

Moving part

Structural Steel	56,402#
Hand rails (for bascule span)	2,052
" " (" on " abutment)	1,549
Pin for Counter Weight girder	257
Structural Steel (−), 部引	167
	60,603
Counter Weight girder	7,997
" " " (−), 部引	247
	68,671# = 30.657 tons

Bascule abutment and Column of Under Trunnion bearing

Structural Steels	14,889#
Gear Covers	15
	14,904 ①

Fixed Girder Span

Structural Steels	13,932#
Hand rails	1,320
	15,252 ②

① 14,904
② 15,252
③ 1,786
31,942# = 14.261 tons

Cast Steel for Moving part

Buffer blocks	112#
Counter Weight hanger	2,868
live load shoe	188
	3,168# = 1.414 tons

Cast iron (不動部引)

live load shoe	1,206
Pedestal	580
	1,786# ③

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CALCULATIONS FOR

Material List for Tsuboigawa Bashi Kumamoto Ken.

Bascule abutment.

Concrete 1:2:4 mix.

Concrete for fixed floor.

Descriptions	Reqd. no.	Section	Length	Volume	Remarks.
Coping	2	0.8 × .79 ×	14.7	18.6 cub. f.	
Slab.	1	15.0 × .46 ×	18.02	124.3	
holes of trunnion bearing less	2	3.2 × .46 ×	.8	− 2.4	
Cross beam	2	.95 × .9 ×	15.0	25.7	
end cross beam	1	.73 × .9 ×	15.0	9.9	
Beam between columns	1	1.0 × 1.15 ×	12.0	13.8	Stem
"	1	2.09 × .39 ×	12.0	9.8	Chamfer
" haunch	1	1.0 × 0.5 ×	1.0	.5	haunch of stem to column
Fascia beam	2	.85 × 1.38 ×	13.2	31.0	Stem
cornous	2	1.4 × 1.2 ×	2.67	9.0	projection from coping
				240.2 cub ft or 1.112 立坪	

Concrete for Front wall.

Coping projection	1	.25 × 1.0 ×	16.6	4.2	
wall	1	1.25 × 5.8 ×	16.0	116.0	Above floor level.
" less window	3	1.3 × 1.25 ×	4.0	− 19.5	hole for window
"	1	2.25 × 12.0 ×	19.4	523.8	under floor level
"	1	1.0 × 0.5 ×	19.4	9.7	Chamfer
"	2	1.7 × 2.25 ×	4.68	35.8	under live load shoes.
				670.0 cub ft or 3.102 立坪	

Concrete for Rear wall.

wall	1	1.5 × 6.65 ×	20.0	199.5	upper part
"	1	2.0 × 12.0 ×	20.0	480.0	lower part
chamfer	1	1.0 × .45 ×	20.0	9.0	bottom.
				688.5 cub. ft. = 3.188 立坪	

Concrete for Side wall (upstream side)

Coping	1	.25 × 1.0 ×	28.0	7.0	Outside projection
"	1	.3 × 1.0 ×	16.0	4.8	inside "
wall	1	2.5 × 19.8 ×	16.0	792.0	rear side of column
"	1	2.8 × 19.8 ×	8.75	485.1	front " "
less depression	1	6.8 × 1.25 ×	10.0	− 85.0	rear
"	1	3.0 × 1.25 ×	3.5	− 13.1	front
chamfer	1	1.0 × .23 ×	13.0	3.0	bottom rear
"	1	1.0 × .5 ×	3.0	1.5	" front
				1,195.3 cub. ft. = 5.534 立坪	

Concrete for side wall (downstream side)

Coping	1	.25 × 1.0 ×	15.0	3.8	Outside projection
"	1	1.0 × 1.25 ×	5.0	6.3	"
"	1	.5 × 1.0 ×	5.0	2.5	"
"	1	.3 × 1.0 ×	14.5	4.4	inside
wall	1	2.5 × 19.8 ×	16.0	792.0	rear part
"	1	2.8 × 13.1 ×	8.75	321.0	front part
"	1	2.8 × 6.7 ×	4.75	89.1	"
"	1	7.0 × 0.75 ×	8.8	46.2	side of man hole
less depression	1	6.8 × 1.25 ×	10.0	− 85.0	rear
Bracket	3	6.0 × 2.75 ×	1.0	49.5	
"	1	5.5 × 1.0 ×	5.5	30.3	
Strut	2	1.0 × 1.5 ×	5.0	15.0	end of bracket.

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Material list for Tsuboi gawa Bashi Kumamoto ken.

Coping	1	.4 × 1.0 ×	13.7	5.5	end
〃	2	.25 × 1.0 ×	6.5	3.3	Side
Base of operator's house	3	0.7 × 0.7 ×	6.7	9.8	
〃 〃	2	0.7 × 0.7 ×	5.3	5.2	
〃 〃	1	0.7 × 0.5 ×	6.0	2.1	Step at entrance.
				1,301.0 cub.ft. = 6.023 立坪	

Concrete for columns and machinery room floor.

Column	2	2.0 × 2.3 ×	6.89	63.4	inside column
〃	2	1.3 × 2.0 ×	2.3	12.0	top bracket
〃	2	.5 × 2.0 ×	2.25	4.5	〃
〃	2	3.0 × 4.7 ×	8.5	239.7	below floor level.
Slab	1	11.0 × 1.0 ×	12.0	132.0	between columns.
〃	2	4.25 × 1.0 ×	1.0	8.5	both sides of cantilever
〃	2	4.75 × 1.0 ×	3.7	35.2	〃 〃 fixed span
fill concrete on slab.	2	2.24 × 1.1 ×	4.5	22.2	〃 〃 〃
〃 〃	2	.25 × 1.1 ×	1.0	0.6	〃 〃 〃
vertical wall	1	1.5 × 3.5 ×	11.0	57.8	under slab.
〃	1	1.5 × 3.0 ×	7.5	33.8	〃
Beam	2	1.5 × 1.5 ×	4.25	19.1	stem
〃	2	1.0 × .25 ×	1.5	.8	haunch
Base of machinery	1	1.48 × .58 ×	2.23	1.9	gasoline engine stand
〃	1	1.0 × .61 ×	1.17	.7	indicator stand
〃	1	0.8 × .96 ×	1.9	1.5	clutch handle.
〃	1	.98 × .61 ×	1.54	.9	indicator gearing
〃	1	.83 × .61 ×	.83	.4	〃
〃	1	.92 × .83 ×	.92	.7	exhaust pipe stand
〃	1	2.25 × .5 ×	4.3	4.8	water tank
less depression	1	.5 × .5 ×	2.0	− .5	spur wheel W4
〃	1	.67 × .5 ×	5.0	− 1.7	
				638.3 cub.ft. or 2.955 立坪	

Concrete for Base

Base	1	25.0 × 4.0 ×	26.0	2600.0	
〃	1	3.0 × 3.5 ×	26.0	273.0	cantilever footing at toe
add slope on top surface	1	13.5 × 0.05 ×	18.0	12.2	0.1' slope
inverted beam	1	3.0 × 3.5 ×	20.0	210.0	stem
〃 〃	2	1.0 × .25 ×	3.0	1.5	chamfer
less pump tank	1	1.8 × 1.0 ×	3.0	− 5.4	
〃	1	1.8 × 0.5 ×	1.0	− 0.9	
				3,090.4 cub.ft. = 14,307 立坪	

Summary of concrete for Bascule abutment

Concrete for		
fixed floor	1.112 立坪	
front wall	3.102	
rear wall	3.188	
upstream side wall	5.534	
downstream side wall	6.023	35.109 立坪
Column and floor	2.955	
base	14.307	
Total	36.221 立坪	

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Material List for Tsuboi-gawa Bashi Kumamoto Ken.

Reinforcements. plain bars.

for fixed floor on bascule abutment	0.568 ton	See drawing
" bascule abutment	8.317	
total =	8,885 tons.	

Forms for Bascule abutment.

Forms for fixed floor on abutment.

Descriptions	req'd no	width	length	area	remarks.
bottom and end	1	22.55	× 14.2	320.2	1.1×.5 + 5.35 + 3.1 + 2.55 + .8 + 3.3 + 1.5 + .48 = 22.55
less column area	2	1.0	× 6.5	− 13.0	
fascia stringers	2	3.7	× 13.2	97.7	
corner projection	2	1.4	× 2.67	7.5	
Curb	2	.33	× 14.5	9.6	
			total	422.0 ㎡	11.72 面坪

Forms for front wall					
outside	1	25.0	× 16.8	420.0	bottom of coping to top of base
less window	3	1.3	× 4.0	− 15.6	
outside	2	2.8	× 3.0	16.8	outside of main girder
Coping	1	1.35	× 16.6	22.4	on window
"	2	1.35	× 3.15	8.5	outside of girders
depression for truss bearings	2	2.0	× 3.15	12.6	
"	2	1.5	× 1.12	3.4	
Sides & top of window	3	1.25	× 6.4	24.0	
inside	1	17.9	× 16.8	300.7	
less window	3	1.2	× 4.0	− 14.4	
Side of bearing cols.	2	1.0	× 3.6	7.2	
			total	785.6 ㎡ =	21.82 面坪

Forms for rear wall					
outside	1	25.0	× 18.65	466.3	
inside	1	20.0	× 18.65	373.0	
			total	839.3 ㎡ =	23.31 面坪

Forms for upstream side wall					
Outside	1	24.75	× 19.8	490.1	
Coping under side	1	.35	× 25.0	8.8	
inside	1	19.8	× 18.0	356.4	
" depression	1	33.6	× 1.25	42.0	
" "	1	13.0	× 1.25	16.3	
" under coping	1	.3	× 14.5	4.4	
			total	918.0 ㎡ =	25.50 面坪

Forms for downstream side wall					
out side	1	24.75	× 19.8	490.1	
coping under side	1	0.75	× 11.7	8.8	
" "	1	1.25	× 5.0	6.3	
" "	1	.5	× 5.0	2.5	
wall bottom	1	.5	× 7.0	3.5	
less bracket area	3	1.0	× 5.5	− 16.5	
Bracket sides	6	5.0	× 5.5	165.0	
" end faces	3	1.0	× 7.5	22.5	
Strut insides	2	1.5	× 5.0	15.0	
" outsides	1	1.5	× 13.7	20.6	

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CALCULATIONS FOR

Material list for Tsuboigawa Bashi Kumamoto ken.

Bracket coping	2	0.35 ×	7.25	5.1	under side of coping
〃 〃	1	0.5 ×	13.7	6.9	〃 〃
〃 strut bottom	1	1.0 ×	13.0	13.0	
add side of bracket	2	0.5 ×	5.5	5.5	
base of operator's house	1	0.7 ×	38.8	27.2	outside
〃	2	0.7 ×	21.2	29.7	inside
insides	1	19.8 ×	18.0	356.4	
〃 depression	1	33.6 ×	1.25	42.0	
〃 〃	2	2.8 ×	6.7	37.5	side of man hole.
under coping	1	.3 ×	14.5	4.4	
			total	1,245.5 □' =	34.60 面坪

Forms for column and machinery room floor

under side of slab.	1	5.25 ×	19.4	101.9	fixed span
Beam	1	3.0 ×	10.0	30.0	sides
〃	1	1.5 ×	8.5	12.8	bottom
slab	1	5.25 ×	14.0	73.5	cantilever arm
〃	2	1.0 ×	4.25	8.5	both ends
wall	2	3.5 ×	11.0	77.0	both sides
〃	2	3.0 ×	7.5	45.0	〃
〃	1	1.5 ×	7.5	11.3	end faces
step on slab.	2	1.1 ×	5.5	12.1	
base of machinery	1	7.4 ×	.58	4.3	gasoline engine stand
〃	1	4.7 ×	.61	2.9	indicator stand
〃	1	5.4 ×	.96	5.2	clutch handle
〃	1	5.0 ×	.61	3.1	indicator gearing
〃	1	3.4 ×	.61	2.1	〃
〃	1	3.7 ×	.83	3.1	exhaust pipe stand
〃	1	13.2 ×	.5	6.6	water tank
depression	1	5.0 ×	.5	2.5	spur wheel TO4
〃	1	5.0 ×	1.67	8.4	
Column	2	2.0 ×	6.8	27.2	above floor level.
〃	4	1.3 ×	2.3	12.0	〃
〃	4	.5 ×	2.25	4.5	〃
〃	4	2.3 ×	7.0	64.4	〃
〃	2	3.0 ×	7.5	45.0	below floor level
〃	4	5.0 ×	7.5	150.0	〃
			total	713.4 □' =	19.82 面坪

Forms for Base.

Sides	2	4.0 ×	28.0	224.0	
front face	1	3.0 ×	26.0	78.0	
〃	1	4.0 ×	26.0	104.0	
inverted T-beam	2	7.0 ×	19.4	271.6	
pump tank	1	1.0 ×	9.6	9.6	
〃	1	.5 ×	5.6	2.8	
				690.0 □' =	19.17 面坪

Summary of Forms for Bascule abutment

Fixed floor on abutment	11.72	
Front wall	21.82	144.22 面坪 (sum of bracketed items)
Rear wall	23.31	
upstream side wall	25.50	
downward 〃	34.60	
Column + machinery room floor	19.82	
Base	19.17	
	155.94 面坪	

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CALCULATIONS FOR

Material List for Tsuboigawa Bashi Kumamoto ken

Basule abutments

防水セメントモルタル仕上 調合 1:2

外面仕上 壁 周囲長 = (24.75 + 25.0) × 2 = 99.5' × 12.0 (高) = 1,194 □'

基礎天 横 0.5 × 26 × 2 = 26

〃 前後 1.25 × 26 × 2 = 65

基礎横 0.5 × 26 × 3 = 39

1,324 □'

内面仕上 中 2.5' × 79.5 = 199 □'

1,523 □' = 42.3 面坪

構造目地防水鉄板 6" × 3/16" × 6'-0" 16枚

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CALCULATIONS FOR

Material List for Tsuboi-gawa-Bashi for Kumamoto Ken.

Foundation piles　末口 0.6′ × 15.0′
9 × 9 = 81 本

割栗石地形
26′ × 28′ × 1.5′ = 1,092 立 = 5.06 立坪

Excavation
底面ノ面積 = 26 × 28 = 728 平方尺
平均根切高 = 17.5′
掘鑿土坪 = 728 × 19.5 / 216 = 65.7 立坪

窓　幅 1.2′ 長 4.0′ 三ケ所 引違戸 杉製 鉄網硝子入 六枚

マンホール用 アングル 2L 3″×3″×3/8″ × 6′-8″
フロワープレート 角材 2 — 0.45 × 0.3 × 6.6′
マンホール蓋 鐵鈑 3Pls — 18″ × 4″ × 2′-6″
カンヌキ 鐵棒 3/4″ φ × 4′-6″
} 附属ボールト共

跳込石 5 — 0.6′ × 0.9′ × 3.0′ = 8.1 立

ポンプ台 木製 杉材 一ケ所 附属ボールト共

鋪装 巾 15′ × 長 18′ = 270 平方尺
less 1.0 × 3 × 2 = −6
264 □′ = 7.33 面坪

Material list for Pier
Concrete 1:2:4 mixture

Description	reqd. no	Section		length	volume	Remarks.
Coping	1	3.4 × 1.0	×	20.0	68.0	straight portion
〃	1	3.4φ	×	1.0	9.1	Circular ends
Shaft	2	3.75 × 2.5	×	17.0	318.8	straight portions
〃	1	3.75φ	×	17.0	187.8	Circular ends
~~top strut~~	1	.4 × 3.0	×	15.0	18.0	upper layer
〃	1	2.5 × 2.0	×	15.0	75.0	lower layer
panel wall	1	9.6 × 1.5	×	13.0	187.2	center wall
〃	2	1.0 × 2.5	×	9.6	48.0	both ends.
Bottom strut	1	1.0 × 2.85	×	15.0	42.8	
〃	1	4.35 × 4.0	×	15.0	261.0	
Base	1	3.0 × 9.0	×	27.0	729.0	
				total	1944.7 cub.ft = 9.003 立坪	

Forms

Description	reqd. no	width		length	area	remarks
Coping	2	1.2	×	20.0	48.0	Straight portion
〃	1	1.2	×	3.4φ	12.8	Circular ends
Shaft	2	17.0	×	20.0	680.0	Straight portion
〃	1	3.75φ	×	17.0	200.3	Circular ends
depression	2	0.25	×	15.0	7.5	top
〃	2	0.5	×	13.0	13.0	arch bottom
〃	4	0.55	×	13.0	28.6	sides of shaft
〃	4	0.5	×	9.6	19.2	ends of curtain wall
〃	2	0.7	×	13.0	18.2	elongation due to slope

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Material List for Tsubodgawa Bashi Kumamoto Ken.

Base	2	3.0	×	27.0	162.0	both sides
"	2	3.0	×	9.0	54.0	both ends.
				total	1,243.6□' = 34.54 面坪	

Reinforcements plain bars. 1.559 tons see drawing

割栗地形 27'×9'×1.5' = 364.5立 = 1.69立坪

地形杭 末口0.5+長12.0 — 9×3 = 27本.

根鑿 9.0×27.0×10 = 2430立 = 11.25立坪

Material list for Abutment

Concrete 1:2:4 mixture

Description	reqd. no	section		length	volume	remarks
parapet wall	1	1.3×1.86	×	15.0	36.3	
columns	2	2.75×2.75	×	16.08	243.2	
shaft	1	3.54×13.41	×	15.0	712.1	between curb lines
"	2	1.65×1.0	×	13.41	44.3	outside of "
coping	1	.2×1.0	×	17.4	3.5	front side
"	2	.2×1.0	×	1.2	.5	both sides
wing walls	2	1.0×4.0	×	16.83	134.6	
Base	1	4.5×4.5	×	24.0	486.0	under shaft
"	1	3.5×3.75	×	24.0	315.0	footing at heel
"	1	4.0×3.75	×	24.0	360.0	" " toe
				total	2335.5 = 10.812 立坪	

Forms for abutment

Description	reqd. no	width		length	volume	remarks
parapet wall	2	1.92	×	15.0	57.6	both sides
shaft	1	13.41	×	17.0	228.0	front side
"	2	1.65	×	13.41	44.3	both ends
" coping	1	0.2	×	18.6	3.7	under side (front + sides)
"	1	13.41	×	15.0	201.2	rear side
Columns	2	1.0	×	2.67	5.3	between curb line + end of shaft
"	2	4.5	×	16.08	144.7	front + out sides
"	2	2.73	×	16.08	87.8	rear + inside
wing walls	2	4.7	×	16.83	158.2	in side
"	2	3.1	×	16.83	104.3	out side
"	2	1.0	×	17.58	35.2	end of wing
Base	2	3.0	×	24.0	144.0	front + rear
"	2	3.0	×	12.0	72.0	ends lower rectangle
"	2	1.5	×	8.25	24.8	" upper trapezoid
				total	1311.1□' = 36.42 面坪	

Reinforcements plain bars 1.429 tons see drawing

割栗地形 12.0×24.0×1.5 = 432 = 2.0立坪

地形杭 末口0.5長15.0 — 4×8 = 32本

根鑿 12.0'×24.0×14.0' = 4032立 = 18.67立坪

継込石 5ー 0.95×0.6×3.0 = 8.55立

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Material List for Tsuboigawa Bashi Kumamoto Ken.

material list for fixed span.

Concrete for slab 1:2:4 mixture

Description	reqd. no	section		length	volume.
Slab	1	0.42×15.0 =	6.300		
Coping	2	.75×.42 =	.630		
"	2	.54×.40 =	.432		
fillet	2	.093×0.7 =	.130		
		total	7.492	×30.15 = 225.9 cub ft = 1.046 立坪	

Forms

Description	reqd. no	width	length	area	Remarks.
Slab	1	12.52	× 30.15 =	377.5	15.0−.62×4=12.52
coping	2	0.41	× 30.15 =	24.7	Curb line
"	2	1.57	× 30.15 =	94.7	outside + bottom
				496.9 □' = 13.80 面坪	

pavement (asphalt block)

15.0 × 30.15 = 452.3 □' = 12.56 面坪

ケーレー, エヌスミレト　φ 6" 及 3/8" ヒ1

0.5 × 15×2 = 15.0 □'

0.82 × .75×2 = 1.23

0.21 × 15 = 3.15

19.38 □'

Reinforcements plain bars 0.815 ton see drawing

Drain Casting 4 required

蓋	0.44 × 0.6 × 0.08 =	.0211	
蓋 引	0.08 × 0.23 × 0.08 × 6 =	−.0088	
		.0123 cub ft	
箱	0.06 × .08 × .72 × 2 =	.0069	
	.06 × .08 × .88 =	.0042	
	.04 × .1 × 2.08 =	.0083	
	.04 × .42 × 1.8 =	.0302	
	.04 × .25 × .25÷2 =	.0013	
		.0509 cub ft.	

total = 0.0632 cub ft @ 450# = 28.4 # or 3.44 貫

for 4 drains 4 @ 3.44 貫 = 13.76 貫

material list for Bascule span

wood-block pavements

φ 15.0 × 長 54.25 = 813.8 □' = 22.61 面坪

増田淳氏関係資料
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CONSULTING ENGINEER
SEIYU BLDG, TOKIO

MADE BY K. Inaba DATE 3-8-29 FILE NO

CHECKED BY DATE PAGE NO 79

CALCULATIONS FOR

Material List of Tsuboi-gawa Bashi for Kumamoto ken.

Wooden flooring for Bascule span.

クレオソリューム =回塗 内地產赤松

	巾	厚	長	才數	員數	總才數	摘要
床板							
	1.085R	× 0.21R	× 8.3R	15.76	6	94.6	
	1.085	× 0.21	× 7.96	15.11	58	876.4	
	1.12	× 0.21	× 7.96	15.60	2	31.2	
	1.06	× 0.21	× 7.96	14.77	22	324.9	
	1.06	× 0.21	× 9.07	16.83	8	134.6	
	.985	× 0.21	× 9.05	15.60	2	31.2	
						計 1,492.9才	
敷桁	0.45	× 0.28	× 9.79 =	10.28	2	20.6	縦桁上ノモノ
	0.45	× 0.335	× 9.79	12.30	2	24.6	〃
	0.45	× 0.37	× 9.79	13.59	2	27.2	〃
	0.50	× 0.38	× 9.79	15.50	1	15.5	〃
	0.45	× 0.28	× 9.56	10.05	8	80.4	〃
	0.45	× 0.335	× 9.56	12.01	8	96.1	〃
	0.45	× 0.37	× 9.56	13.27	8	106.2	〃
	0.50	× 0.38	× 9.56	15.13	4	60.5	〃
	0.45	× 0.28	× 4.00	4.20	2	8.4	〃
	0.45	× 0.335	× 4.00	5.03	2	10.1	〃
	0.45	× 0.37	× 4.00	5.55	2	11.1	〃
	0.50	× 0.38	× 4.00	6.34	1	6.3	〃
	0.50	× 0.345	× 7.96	11.44	8	91.5	横桁上ノモノ
	0.50	× 0.345	× 9.01	12.96	2	25.9	〃
						計 584.4才	
地覆木	0.42	× 0.295	× 3.27	3.38	2	6.8	
	0.46	× 0.42	× 5.01	8.06	2	16.1	
	0.46	× 0.42	× 5.03	8.10	18	145.8	
	0.46	× 0.42	× 4.23	6.81	2	13.6	
	0.42	× 0.25	× 3.94	3.45	2	6.9	
	0.42	× 0.25	× 1.22	1.07	2	2.1	
	1.49	× 0.125	× 5.24	8.14	2	16.3	
						計 207.6才	
						合計 2,284.9才	
締付金物 (ボールト, ワッシャー, 釘 等)							
ボールト	5/8"φ × 0'-4"			76	@ 0.58	= 44#	縦桁用
〃	〃 × 0'-4¾"			76	@ 0.64	= 49	〃
〃	〃 × 0'-5½"			114	@ 0.68	= 78	〃
ワッシャー	2½" × ⅛" × 0'-2½"			266	@ 1.068	= 59	〃
ベベルワッシャー	1¾" × ¼" × 0'-1½"			266	@ 1.488	= 57	〃
ボールト	¾"φ × 0'-4½"			10	@ 0.90	= 9	横桁用
〃	〃 × 0'-5"			20	@ 1.00	= 20	〃
ワッシャー	2½" × ⅛" × 0'-2½"			30	@ 1.063	= 7	〃
ベベルワッシャー	2½" × ¼" × 0'-2½"			30	@ 2.125	= 13	〃
アングル	1½" × 1½" × ⅛" × 1'-4⅛"			2	@ 1.23	= 36	〃
木栓	3/8"φ × 0'-3"			16	@ 0.095	= 2	〃
釘	5½"			1050	@ 0.041	= 43	床板用
						417# = 59.5貫	

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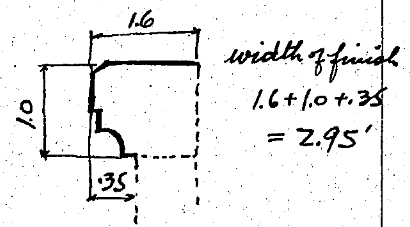
CALCULATIONS FOR

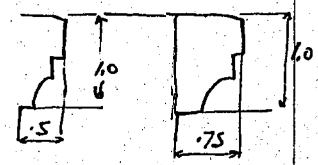
Material List for Tsuboi-gawa Bashi for Kumamoto ken.

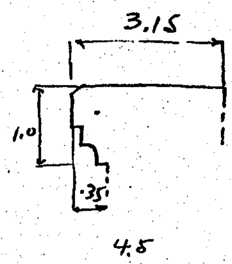
Artificial Granite finishing (人造洗出仕上)

Bascule abutment.

Description		width	Length	Reqd. no.	Area	Remarks
Coping	front wall	2.95	16.6	1	48.97	
"	downstream, side	1.75	11.34	1	19.95	
"	Bracket, side	1.50	23.2	1	34.80	
"	Col. front.	1.35	3.15	2	8.51	
"	top downstream	3.55	11.4	1	40.47	
"	"	3.0	7.6	1	22.80	
"	less	1.5	2.7	1	(−) 4.05	
"	top	0.2	6.15	1	1.23	
"	"	2.0	2.1	1	4.20	
"	" bracket	0.4	23.2	1	9.36	
base of operating house		0.8	38.8	1	31.04	
"	" entrance	0.7	6.5	1	4.55	
Coping	upstream	4.5	25.1	1	112.95	
Coping	fixed floor	1.0	15.5	2	31.00	} 41.88° = 1.16坪
"	"	1.6	3.4	2	10.88	
					376.66° = 10.46 面坪	
					1.16	
					9.30	

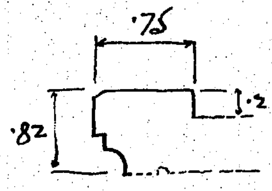






Fixed span

Description	width	Length	Reqd. no.	Area
Coping	1.77	30.15	2	106.73
				106.73° = 2.96 面坪



Abutment.

Description		width	Length	Reqd. no.	Area
wing	side	3.0	4.0	2	24.00
"	top.	1.0	4.0	2	8.00
wall	front	1.75	6.5	2	22.75
"	"	1.0	2.58	2	5.16
Col.	top.	2.75	2.75	2	15.13
less	light pedestal area	2.0	2.0	2	(−) 8.00
					67.04° = 1.86 面坪

Light pedestal

Description	width	Length	Reqd. no.	Area
Sides	8.0	3.5	1	28.00
top.	2.0	2.0	1	4.00
casting area	1.18	1.18	1	(−) 1.40
				30.60° = 0.85 面坪

Summary.

Bascule abutment including fixed floor.		10.46
Fixed span		2.96
abutment		1.86
Light pedestal	4 @ .85 =	3.40
		18.68 面坪

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CALCULATIONS FOR

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坪井川機械部計算書

増田淳氏関係資料
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Bridge Operating Machanism.

Operating time of Bridge from 0° to 75° 1 min. 20 seconds.

Speed of Rack circle $\frac{2\pi \times 5.25 \times 75}{360} = 6.8723^{ft.}$

Where Radius of Rack Circle = 5'3"

Horse power = $\frac{P \times 6.8723}{33,000 \times .65}$ = 0.00032 P

where P = Total load at pitch circle of Rack

gear efficiency = $(0.93)^6$ = .65 for gear 6 sets

Horse power at 10# wind $\frac{32,500 \times 6.87}{33,000 \times .65}$ = 10.4 HP.

Take 2-7.5 H.P Motors P is $\frac{2 \times 7.5}{0.00032}$ = 46,880# that is the wind of

$10 \times \frac{46,880}{32,500}$ = 14.4#/sq.ft. about.

Motor 2-7.5 H.P 828 R.P.m 60 cycle A.C

Operating gears

Speed at Rack circle

$$\frac{15'' \times \pi}{12} \times 828 \times \frac{16}{55} \times \frac{15}{52} \times \frac{15}{52} \times \frac{16}{54} \times \frac{15}{51} =$$

$$3.927 \times 828 \times 0.002109504 = 6.8591^{ft./min}$$

Let
Load on teeth W
Dia of spur wheel D
〃 〃 pinion d
Revolution per min. of motor R
Gear efficiency 0.93

Load on teeth at 1st gear $W_1 = \frac{H.P \times 33,000 \times 12}{\pi \times d \times R}$

$$= \frac{15 \times 33,000 \times 12}{\pi \times 4 \times 828}$$

$$= 570.89^{\#}$$

$S = \frac{W}{P.F.y}$ ---- Wilfred Lenis's formula.

where
S = the unit fiber stress in the material
W = the total tooth pressure
P = the circlar pitch
F = the width of the tooth face
y = a constant depending on the number and slope of the gear teeth

1st. Gear

pinion :- W = 570.89#

P = .7854"

F = 2½"

y = 0.077

$$S = \frac{570.89}{.7854 \times 2.5 \times 0.077} = \frac{570.89}{.13607}$$

= 3776 #/□" (allowable stress = 6,000#/□")

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Tooth speed $\frac{\pi \times 4}{12} \times 828 = 867.08$ ft/min

D.P (diametral pitch) 4
N (No. of teeth) 16
P.D (pitch dia) 4"
O.D (outside dia) $= (16+2) \times \frac{1}{4} = 4.5''$
R (R.P.M) 828

Spur wheel:-

F 2"
y .112
$S = \frac{570.89}{.7854 \times 2 \times .112} = 3,245$ #/□"
D.P 4
N 55
P.D 13.75
O.D $(55+2) \times \frac{1}{4} = 14.25''$
R $828 \times \frac{16}{55} = 240.872$

2nd Gear

Pinion:-

$W = \frac{570.89 \times 13.75}{5} \times 0.93$
$= 1,460.0511$ #

Tooth speed $= \frac{\pi \times 5}{12} \times 828 \times \frac{16}{55}$
$= 1.309 \times 240.872$
$= 315.301$ ft/min

Cir pitch P 1.0472"
F. 3"
y 0.075

$S = \frac{1460.0511}{1.0472 \times 3 \times .075} = 6,197$ #/□" (allowable stress 8,500 #/□")

D.P 3
N 15
P.D 5"
O.D $(15+2) \times \frac{1}{3} = 5.6667''$
R 240.872

Spur wheel:-

F 2.5"
D.P 3
N 52
P.D 17.3333"
O.D $\frac{52+2}{3} = 18.''$
R $240.872 \times \frac{15}{52} = 69.482$

3rd Gear:-

Pinion

$W = \frac{1460.0511 \times 17.3333}{6} \times .93$
$= 3922.670$ #

Tooth speed $= \frac{\pi \times 6}{12} \times 69.482 = 109.142$ ft/min

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P 1.2566
F $3\frac{3}{4}''$
y .075

$$S = \frac{3922.67}{1.2566 \times 3.75 \times .075} = \frac{3922.67}{.3533}$$

$= 11,100 \ \#/\square''$ (allowable stress 14,000 #/□")

D.P $2\frac{1}{2}$
N 15
P.D 6"

$$O.D = \frac{15+2}{2.5} = 6.8''$$

R 69.482

Spur wheel:-
F $3\frac{1}{4}''$
D.P $2\frac{1}{2}$
N 52
P.D 20.8"

$$O.D = \frac{52+2}{2.5} = 21.6''$$

$$R \quad \frac{69.482 \times 15}{52} = 20.043$$

4th Gear
Pinion:-

$$W = \frac{3922.67 \times 20.8}{8} \times .93$$

$= 9,485.016 \#$

$$\text{Tooth speed} = \frac{\pi \times 8}{12} \times 20.043 = 41.98 \ \text{ft/min}$$

P 1.5708
F 5"
y .077

$$S = \frac{9485.016}{1.5708 \times 5 \times .077} = \frac{9485.016}{.604758}$$

$= 15,684 \ \#/\square''$ (allowable stress 18,000 #/□")

D.P 2
N 16
P.D 8"

$$O.D = \frac{16+2}{2} = 9''$$

R 20.043

Spur wheel:-
F $4\frac{1}{2}''$
D.P 2
N 54
P.D 27"

$$O.D = \frac{54+2}{2} = 28''$$

$$R = \frac{20.043 \times 16}{54} = 5.9387$$

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5th Gear

Pinion:-

$W = \frac{9485.016 \times 27}{12} \times .93$

$= 19847.40^{\#}$

Tooth speed $= \frac{\pi \times 12}{12} \times 5.9389 = 18.66$ ft/min.

P 2.5133"
F 6½"
y .075

$S = \frac{19847.40}{2.5133 \times 6.5 \times .075} = \frac{19847.40}{1.2252}$

$= 16,200^{\#}/□''$ (allowable stress 20,000#/□")

D.P 1¼
N 15
P.D 12"
O.D $= \frac{15+2}{1.25} = 13.6''$
R 5.9387

Spur wheel:-

F 6"
D.P 1¼
N 51
P.D 40.8"
O.D $= \frac{51+2}{1.25} = 42.4''$
R $\frac{5.9387 \times 15}{51} = 1.7467$

Rack and Pinion

Pinion:-

$W = \frac{19847.40 \times 40.8}{15} \times .93$

$= 50,206^{\#}$

Tooth speed $= \frac{\pi \times 15}{12} \times 1.7467 = 6.859$ ft/min.

P 3.1416"
F 8½"
y .092 (20° involute)

$S = \frac{50,206}{3.1416 \times 8.5 \times .092} = \frac{50,206}{2.45673}$

$= 20,436^{\#}/□''$ (allowable stress 23,000#/□")

D.P 1
N 15
P.D 15"
O.D $= \frac{15+2}{1} = 17''$
R 1.7467

Rack:-

F 8"
D.P 1
Radius of pitch circle 5'3"

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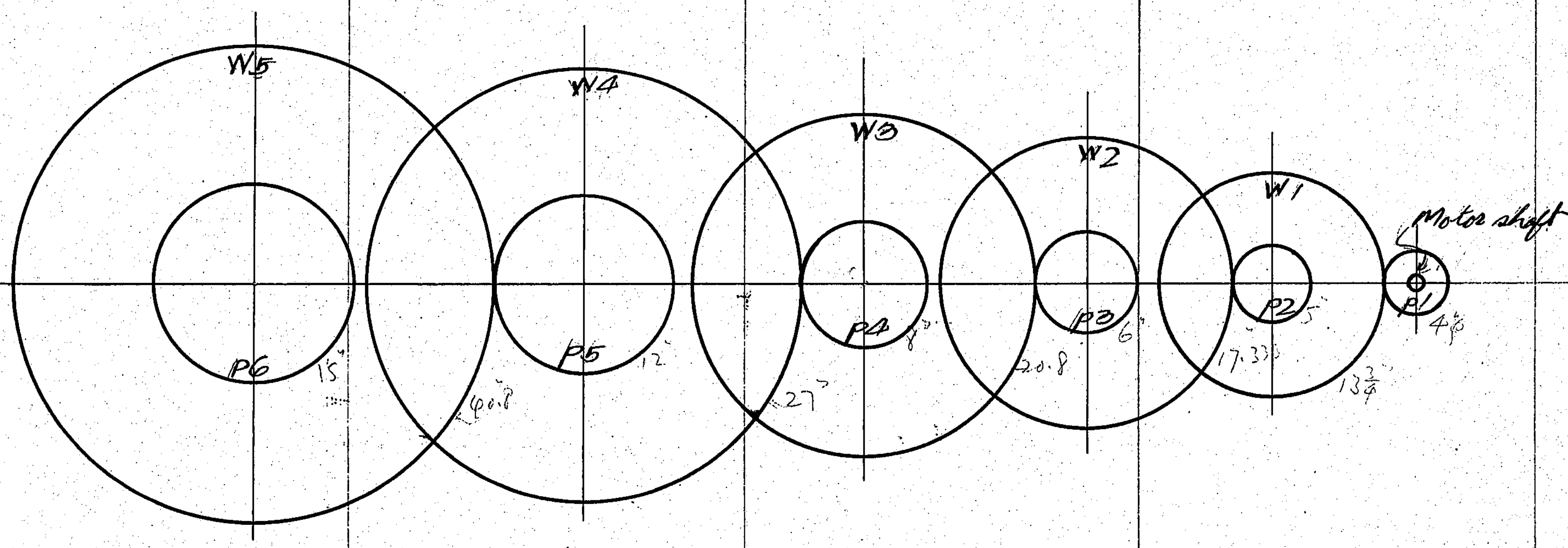
CALCULATIONS FOR



GEAR TABLE (Machine cut Gear.)

Mark	No. of teeth N	out dia O.D	pitch dia P.D	Cir. pitch P	Diam. pitch D:P	Width F	R.P.m R	Tooth Speed	Load on tooth W	Material	dia. of shaft
P1	16	4.5"	4"	.7854	4	2½"	828	867.1 ft/min	570#	M.H.S	1½"
W1	55	14¼	13¾"	〃	〃	2	240.9	〃		C.S	
P2	15	5.6667"	5"	1.0472"	3	3"	〃	315.3	1,460	M.H.S	
W2	52	18	17.3333	〃	〃	2½"	69.5	〃		C.S	
P3	15	6.8	6	1.2566"	2½	3¾	〃	109.1	3,923	M.H.S	
W3	52	21.6	20.8	〃	〃	3¼	20.0	〃		C.S	
P4	16	9	8	1.5708"	2	5"	〃	42.0	9,485	M.H.S	
W4	54	28	27	〃	〃	4½	5.9	〃		C.S	
P5	15	13.6	12	2.5133"	1¼	6½"	〃	18.7	19,847	M.H.S	
W5	51	42.4	40.8	〃	〃	6	1.75	〃		C.S	
P6	15	17	15"	3.1416	1	8½	〃	6.86	50,206	M.H.S	
Rack			10'-6"	〃	〃	8		〃		C.S	

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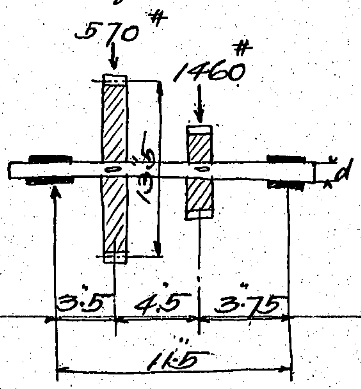
Shaft.

1^{st} shaft



max. bending moment $M_b = \frac{570 \times 3.5 + 1{,}460 \times (3.5+4.5)}{11.5} \times 3.75$

$= 4{,}460$ in-lbs

max. twisting moment $M_t = 570 \times \frac{13.75}{2}$

$= 3{,}920.$ in-lbs

Equivalent twisting moment $M_e = 4{,}460 + \sqrt{4{,}460^2 + 3{,}920^2}$

$= 10{,}720$ in-lbs

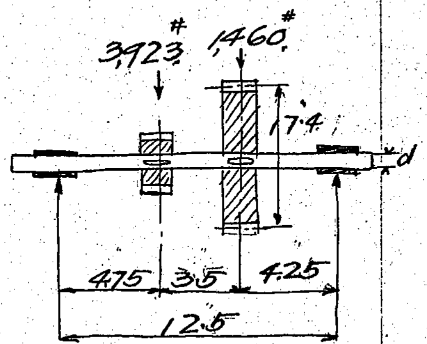
let I_p = polar moment of inertia.
f = working stress for steel. 9000#/□"
d = dia of shaft in ins.

$M_e = I_p \times \frac{1}{\frac{d}{2}} f = \frac{\pi d^3}{16} f$

$\therefore d = \sqrt[3]{\frac{16}{\pi} \frac{M_e}{f}} = 1.72 \sqrt[3]{\frac{M_e}{f}}$

$= 1.72 \sqrt[3]{\frac{10{,}720}{9{,}000}} = 1.72 \times 1.06 = 1.823''$ say $2\frac{1}{4}''$.

2^{nd} shaft.



$M_b = \frac{1{,}460 \times 4.25 + 3{,}920 \times (3.5+4.25)}{12.5} \times 4.75$

$= 13{,}920$ in-lbs.

$M_t = 1{,}460 \times \frac{17.4}{2}$

$= 12{,}700$ in-lbs.

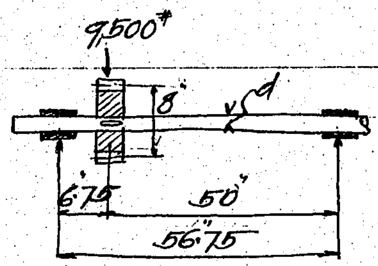
$M_e = 13{,}920 + \sqrt{13{,}920^2 + 12{,}700^2} = 13{,}920 + 18{,}870$

$= 32{,}790.$ in-lbs

$\therefore d = 1.72 \sqrt[3]{\frac{M_e}{f}} = 1.72 \sqrt[3]{\frac{32{,}790}{9{,}000}} = 1.72 \times 1.535$

$= 2.64''$ say 3".

3^{rd} shaft.



$M_b = \frac{9{,}500 \times 50}{56.75} \times 6.75 = 56{,}500$ in-lbs

$M_t = 9{,}500 \times \frac{8}{2} = 38{,}000$ in-lbs

$M_e = 56{,}500 + \sqrt{56{,}500^2 + 38{,}000^2} = 56{,}500 + 68{,}100$

$= 124{,}600$ in-lbs

$\therefore d = 1.72 \sqrt[3]{\frac{124{,}600}{9{,}000}} = 1.72 \times 2.40 = 4.128''$ say $4\frac{7}{16}''$

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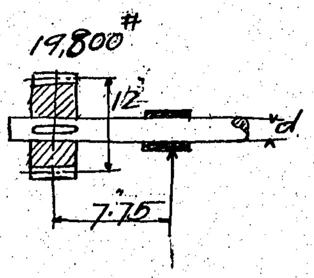
4th shaft.



$M_b = 19{,}800 \times 7.75 = 153{,}500$ in-lbs

$M_t = 19{,}800 \times 12 \times \frac{1}{2} = 118{,}800$

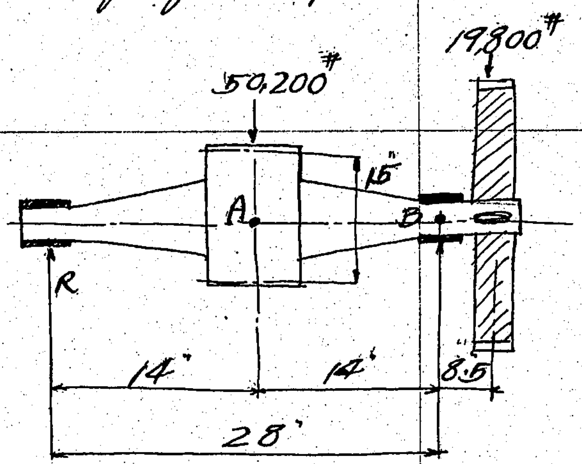
$M_e = 153{,}500 + \sqrt{153{,}500^2 + 118{,}800^2} = 153{,}500 + 194{,}000$

$= 347{,}500$ in-lbs

$d = 1.72 \sqrt[3]{\frac{347{,}500}{9{,}000}} = 1.72 \times 3.38$

$= 5.81''$ say 6"

Shaft of Rack pinion



$R = \frac{50{,}200 \times 14 - 19{,}800 \times 8.5}{28}$

$= 19{,}100$#

M_b at $A = 19{,}100 \times 14 = 267{,}400$ in-lbs

M_t 〃 $= 50{,}200 \times \frac{15}{2} = 376{,}500$

M_e 〃 $= 267{,}400 + \sqrt{267{,}400^2 + 376{,}500^2} = 267{,}400 + 461{,}800$

$= 729{,}200$ in-lbs

d 〃 $= 1.72 \sqrt[3]{\frac{729{,}200}{9{,}000}} = 1.72 \times 4.327$

$= 7.44''$ say 8"

M_b at $B = 19{,}800 \times 8.5 = 168{,}300$ in-lbs

M_t 〃 $=$ ---------- $376{,}500$

M_e 〃 $= 168{,}300 + \sqrt{168{,}300^2 + 376{,}500^2} = 168{,}300 + 412{,}400$

$= 580{,}700$ in-lbs

d 〃 $= 1.72 \sqrt[3]{\frac{580{,}700}{9{,}000}} = 1.72 \times 4.01 = 6.897''$ say 7"

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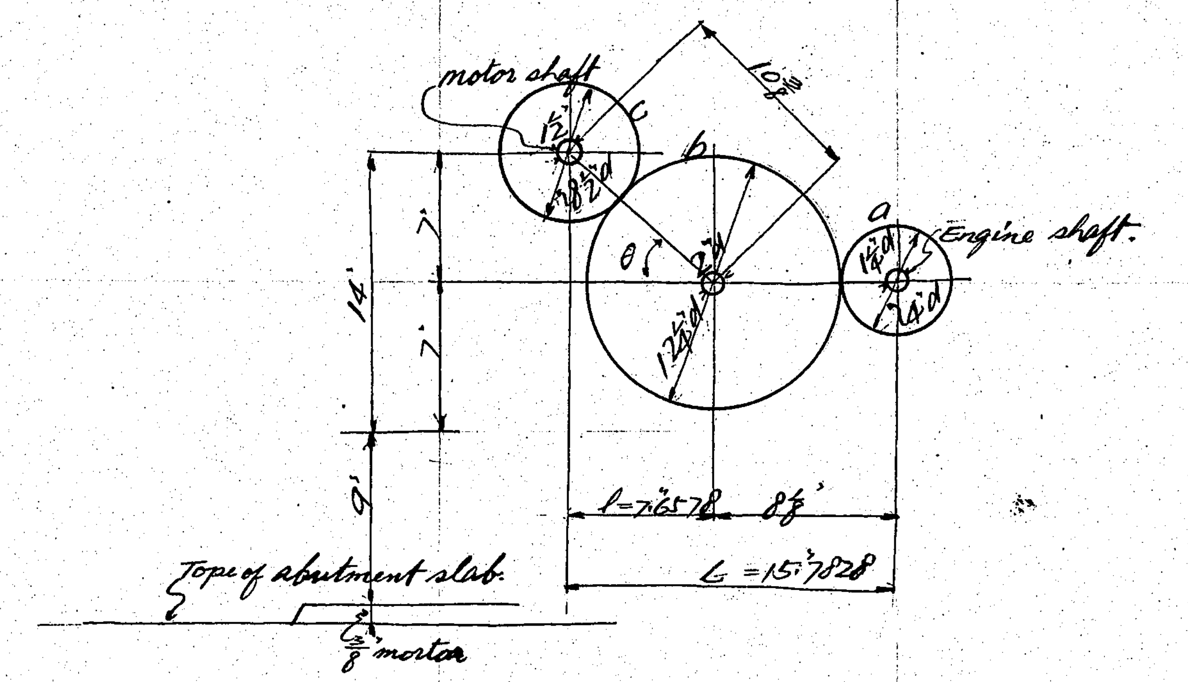
CALCULATIONS FOR

Gears for Gasoline engine.



$\sin\theta = \frac{7}{10.375} = .6747 \quad \therefore \theta = 42°\text{-}26'$

$l = 10.375 \times \cos 42°\text{-}26' = 10.375 \times .7381 = 7.6578''$

$L = 7.6578 + 8.125 = \text{-------------} \; 15.7828''$

Motor { revolution per min. 828.
{ horse power 7.5×2 = 15

Gasoline engine { revol. per min 1,200. about
{ horse power 12. 〃

Gear efficiency -------- 93% assume

pitch dia of ⓐ pinion 4"

pitch dia of ⓒ wheel ;— $828 \times \frac{12}{15} \times .93^2 = 573. \quad 4'' \times \frac{1200}{573} = 8.38$ say 8½" dia

revolution per min of ⓒ wheel $1200 \times \frac{4}{8.5} = 564.7$

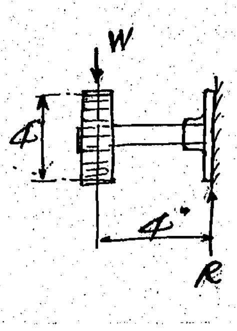
operating time for raising span by Engine = 1 min 20 sec. $\times \frac{828}{564.7}$

= 1 min. 57 sec.

GEAR TABLE (Gasoline engine power transmission)

Mark	No of teeth	pitch dia.	outside dia	Cir. pitch	Diam. pitch	width	R.P.M	tooth speed	material		Required	
a	16	4"	4½"	.7854	4	2¾"	1,200.		M.H.S		1	
b	49	12¼"	12¾"	〃	〃	2½"			C.S		1	
c	34	8½"	9"	〃	〃	2"	564.7		〃		1	

Shaft of ⓐ pinion.



$W = \frac{H.P \times 33{,}000 \times 12}{R.P.M \times \pi \times D} = \frac{12 \times 33{,}000 \times 12}{1{,}200 \times \pi \times 4}$

$= 315^{\#}$

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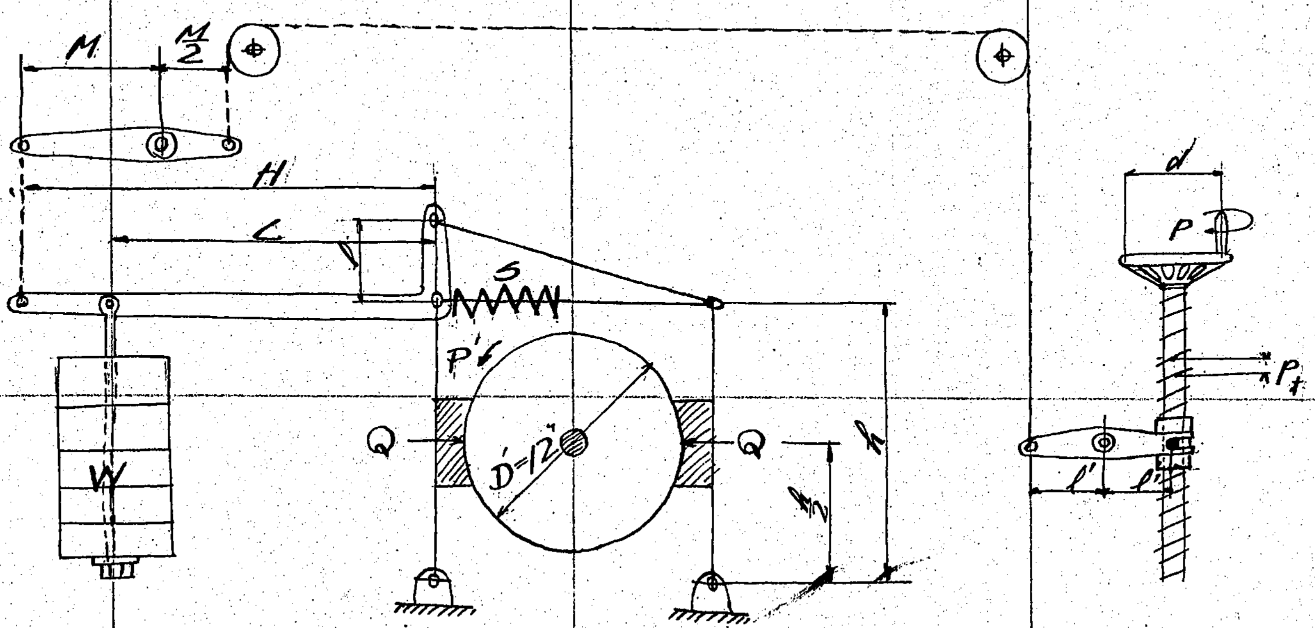
max. bending moment. $M_b = 315 \times 4 = 1,260$ in-lbs
max. twisting moment. $M_t = 315 \times 2 = 630$
equivalent twisting moment. $M_e = 1,260 + \sqrt{1,260^2 + 630^2}$
$= 2,670$ in-lbs

$$M_e = I_p \times \frac{1}{\frac{d}{2}} f = \frac{\pi d^3}{16} f$$

$$\therefore d = \sqrt[3]{\frac{16 M_e}{\pi f}} = 1.72 \sqrt[3]{\frac{M_e}{f}} = 1.72 \sqrt[3]{\frac{2670}{9,000}} = 1.72 \times .67$$

$= 1.15$ say $1\frac{1}{4}$"

Hand Brake



let

pitch dia of motor pinion.	$D = 4"$	arm.	$l = 4\frac{1}{2}"$
dia of Brake pulley	$D' = 12"$	"	$M = 10"$
torque of motor pinion.	$P = 570^{\#}$	pitch of screw thread	$P_t = \frac{3}{8}"$
equivalent torque of Brake pulley.	P'	dia of handle	$d = 12\frac{1}{2}"$
horizontal force of Brake shoe.	Q	hand power	p
cast iron weight	W	coeff. of friction of Brake.	$\mu = .3$
arm.	$h = 17"$	efficiency of screw and	
"	$H = 141"$	stiffness of wire rope	$y = .4$
"	$L = 127"$	Spring force.	$S = 50^{\#}$

$$P' = \frac{P \times D}{D'} = \frac{570 \times 4}{12} = 190^{\#}$$

$$Q = \frac{P'}{2} \times \frac{1}{\mu} = \frac{190}{2} \times \frac{1}{.3} = 317^{\#}$$

$$W = \frac{Q \frac{h}{2}}{h} \times \frac{l}{L} + S = \frac{317 \times 4.5}{2 \times 19} + 50 = 87.5^{\#} \text{ say } 175^{\#}$$

Hand power $p = W \times \frac{L}{H} \times \frac{M}{\frac{M}{2}} \times \frac{P_t}{\pi \times d} \times \frac{1}{y}$

$$= 175 \times \frac{19}{23} \times \frac{10}{5} \times \frac{.375}{\pi \times 12.5} \times \frac{1}{.4} = 6.7^{\#}$$

Spring :—
Wire gage No. 8 — dia of steel 0.162
outside dia of Coil. $1\frac{3}{4}"$ — deflection of 1 coil by load of $100^{\#}$. 0.354

let.
load ———— $= 50^{\#}$
total deflection $= 3"$
No of coil $= \frac{3}{.354} \times 2 = 17$.

total length of spring at no load $= 0.162 \times 17 + 3" + \Delta = 5.75 + \Delta$ say 7"

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CALCULATIONS FOR

Indicater mechanism.

For 75 degree anglar rotation the length of travel on the rack is 6.8723

No. of revolution of spure wheel W4 $= 6.8723 \times 12 \times \frac{1}{\pi \times dp} \times \frac{N_{w5}}{N_{p5}}$

where dp . dia of pinion $= 15''$

N_{p5} No of teeth of pinion P5 $= 15$

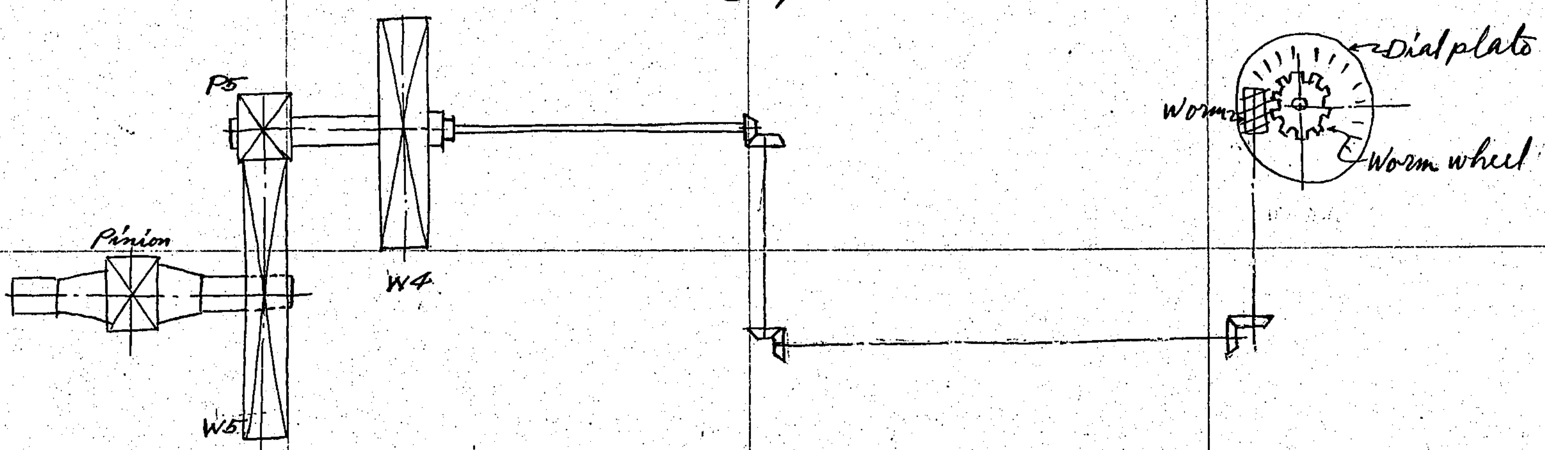
N_{w5} 〃 〃 wheel W5 $= 51$

then

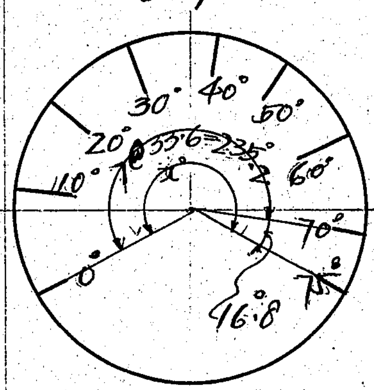
No of revol. of W4 $= 6.8723 \times 12 \times \frac{1}{\pi \times 15} \times \frac{51}{15}$

$= 1.7500 \times \frac{51}{15}$

$= 5.950$



Dial plate.



Worm & worm wheel

Ratio of revolution for worm & wormwheel.

$= 5.95 \times \frac{3}{2}$

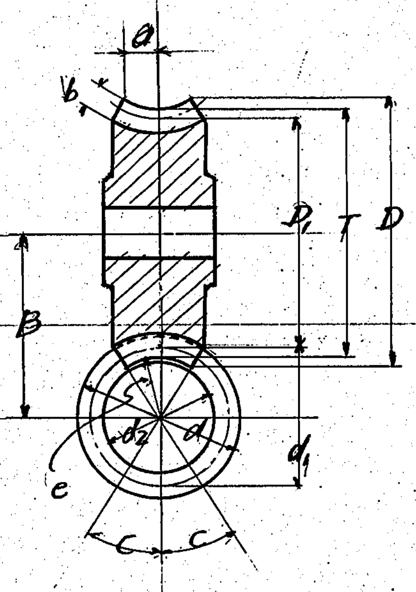
$= 8.925$ say 8.5

rotation angle of wormwheel $= 360 \times \frac{5.95}{8.5} = 252°$

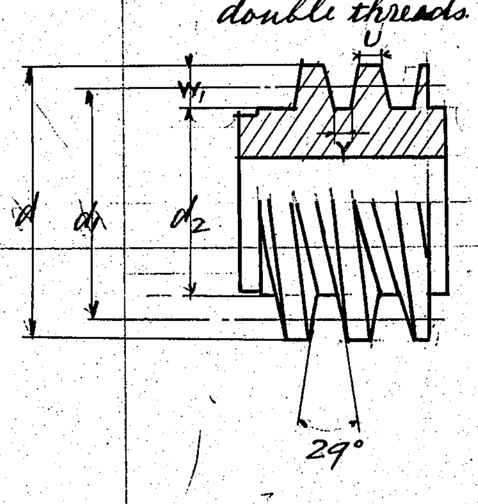
$252 \times \frac{1}{7.5} = 33.6°$ or $33°36'$

$(33.6 \times \frac{1}{2} + 33.6 \times 7 =$

$16.8 + 235.2 = 252°$



double threads



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let

N = no of teeth in worm wheel = 17
n = no of thread in worm = 2
p = circular pitch = $\frac{1}{2}$" take

D_1 = pitch dia. of worm wheel $= 17 \times \frac{1}{2} \times \frac{1}{\pi} = 2.706$"
T = throat dia. of worm wheel $= (17+2) \times \frac{1}{2} \times .3183 = 3.024$

d = outside dia of worm = 1.987 take
~~F = face of worm wheel = $(0.5 \times 1.987 + 0.17 \times \frac{1}{2}) \times \sin 30° \times 2$~~

$= (1. + .085) \times .5 \times 2 = 1.085$"

S = addendum $= .3183 \times \frac{1}{2} = .159$"
d_1 = pitch dia of worm $= 1.987 - 2 \times .159 = 1.669$"

W_1 = hole depth of tooth $= 0.6866 \times \frac{1}{2} = .343$

d_2 = bottom dia. of worm $= 1.987 - 2 \times .343 = 1.301$

$B = (D_1 + d_1) \times \frac{1}{2} = (2.706 + 1.669) \times \frac{1}{2} = 2\frac{3}{16}$"

$C = \frac{1}{2} d_1 - S = \frac{1}{2} \times 1.669 - .159 = .6755$
U = width of worm thread at top $= .335 \times \frac{1}{2} = .168$
Y = " " " at bottom $= .31 \times \frac{1}{2} = .155$

Air buffer.

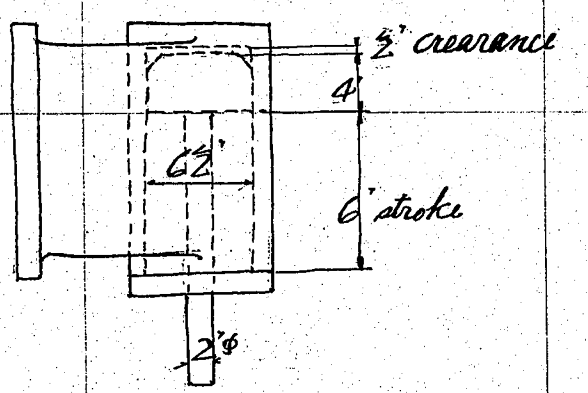
Compression of air pv^n = constant
efficiency of compression ε = 70% assume

dia of piston $d = 6\frac{1}{2}$"
area of piston a = 33.18 sq in
applied load on piston 900# assume
unit pressure of air $p = \frac{900}{a}$ + atm. pressure $= \frac{900}{33.18} + 14.5$
$= 41.62$#/sq in. absolute.

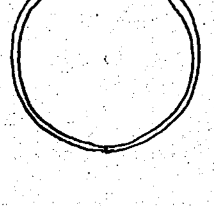
Ratio of Compression $R = \frac{41.62}{14.5} \times \frac{1}{.7} = 4.1$

Thickness of air cylinder $t = \frac{pd}{2f} + \frac{1}{4}$"
where p = internal air pressure $41.62 - 14.5 = 27.12$#/sq.in
f = working stress of cast iron 1,500#/sq.in

$t = \frac{27.12 \times 6.5}{2 \times 1,500} + \frac{1}{4} = .3$ say $\frac{3}{4}$"



Piston ring :–
width $\frac{3}{8}$"
thickness $\frac{5}{16}$" abt
No of ring 2



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CALCULATIONS FOR

<u>Spring buffer.</u>

Load for 1 Rack
excentric load $3210^{\#}$ at pitch cir. (radious = 5'-3")
enertia 197 〃 (〃 〃)
3407

Load on spring buffer. $W = 3,407 \times \frac{5.25}{11.25} = 1,590^{\#}$ $1,600^{\#}$ say

dia of steel $\frac{d}{8} = \sqrt[3]{\frac{D \times W}{46}}$ wher D = dia of coil = 6"

$= \sqrt[3]{\frac{6 \times 1600}{46}} = \sqrt[3]{210} = 5.95$ say $d = \frac{3}{4}$"

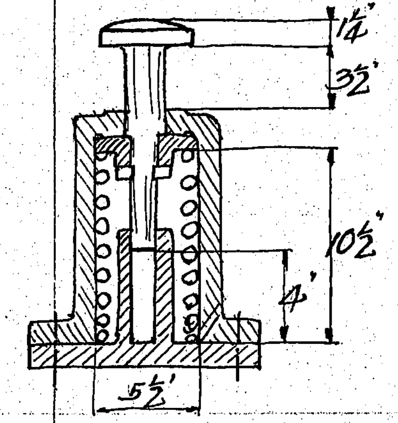
total deflection $f = 4$"
no of coil $n = \frac{8 \times 4 \times 6}{6^2} = 5.3$ say 6

if deflection 3"
$n = \frac{8 \times 3 \times 6}{6^2} = 4$

From Mark's table
outside dia of coil $5\frac{1}{2}$"
dia of steel $\frac{3}{4}$"
deflection of 1 coil by load of $100^{\#}$ = 0.0226"

∴ deflection of 1 coil by load of $2,000^{\#} = 0.0226 \times \frac{2000}{100} = 0.452$"

if total deflection $3\frac{1}{2}$"
No of coil $\frac{3.5}{.452} = 7.74$ say 8.



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CALCULATIONS FOR

Morvable gate and Locking machanism....

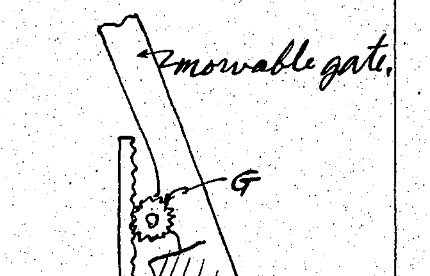
Wind resistance
- Wind pressure $10^{\#}/sq.ft$
- length of gate 15'-0" assume
- mean width of gate 3'-4"
- pitch radius of pinion $2\frac{1}{2}$"

moment. $10 \times \frac{3.4}{12} \times \frac{15^2}{2} = 320$ ft-lbs

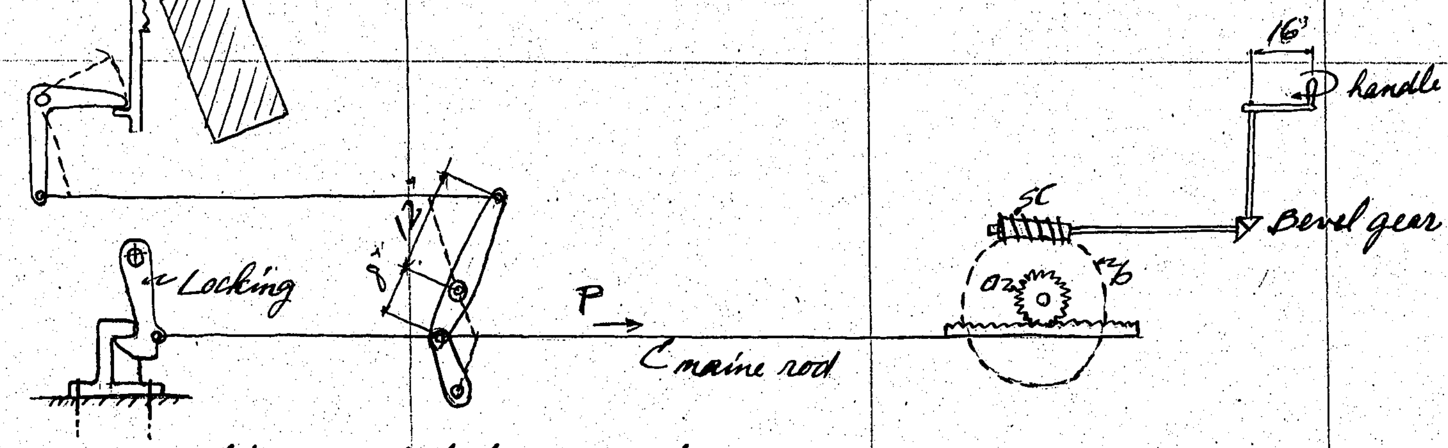
tangential force at Rack circle $320 \times \frac{12}{2.5} = 1,540^{\#}$

Excentric load ------------------------- $960^{\#}$ assume

2,500



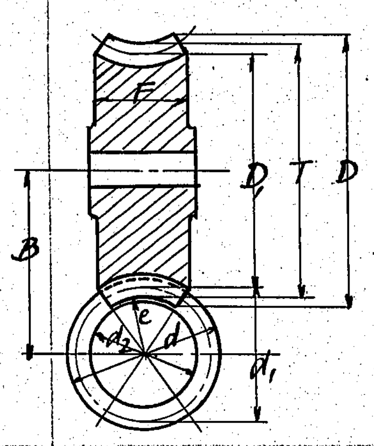
Force at maine rod P.
Gate $2500 \times \frac{12}{8} = 3700^{\#}$
Locking ------ $300^{\#}$ assume
$4000^{\#}$

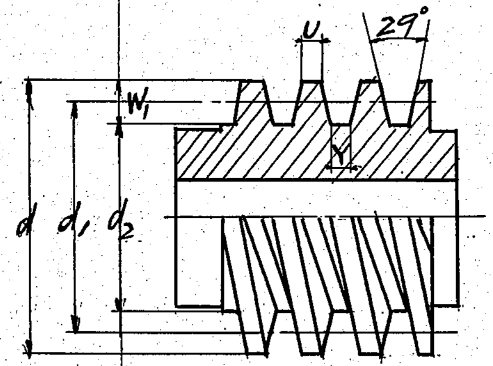


let,
- pitch dia of pinion a = 6"
- no of teeth in wormwheel = N
- no of threads in worm = n
- rivolution ratio = $\frac{N}{n}$ = 36 say
- efficiency of worm gear = .70
- " Bevel gear = .95

then hand power $4000 \times \frac{6}{16 \times 2 \times 36} \times \frac{1}{.7 \times .95} = 31.3^{\#}$ when 10" wind

Worm and Wormwheel.





- N = no of teeth in worm wheel = 72
- n = no of threads in worm = 2
- P = circular pitch = $\frac{3}{4}$" take
- D_1 = pitch dia. of worm wheel $= 72 \times \frac{3}{4} \times \frac{1}{\pi} = 17.1882$
- T = throat dia of " $= (72+2) \times \frac{3}{4} \times \frac{1}{\pi} = 17.6657$
- d = outside dia. of worm $= 2.9143$ take

F = face of worm wheel $= (.5 \times 2.9143 + .17 \times \frac{3}{4}) \times \sin 35° \times 2$
$= (1.4572 + .1275) \times .57358 \times 2 = 1.8179$ say 2"

- s = addendum $= .3183 \times \frac{3}{4} = .23875$
- d_1 = pitch dia of worm $= 2.9143 - 2 \times .23875 = 2.4368$
- W_1 = hole depth of tooth $= 0.6866 \times \frac{3}{4} = .515$
- d_2 = bottom dia of worm $= 2.9143 - 2 \times .515 = 1.8843$

$\tan \alpha = \frac{.75 \times 2}{\pi \times 2.44} = \frac{1.5}{7.665} = .1957 \therefore \alpha = 11°-5'$ alt

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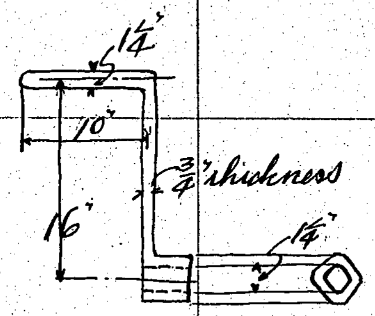
$B = (D_1 + d_1) \times \frac{1}{2} = (17.1882 + 2.4368) \times \frac{1}{2} = 9\frac{13}{16}"$

$e = \frac{1}{2} d_1 - s = \frac{1}{2} \times 2.4368 - .23875 = .97965"$

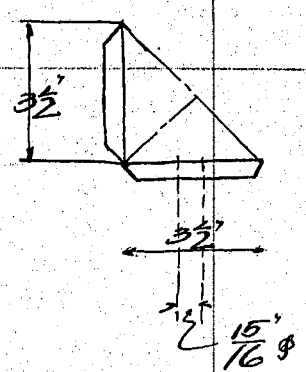
U = width of worm thread at top $= .335 \times \frac{3}{4} = .25125"$

Y = 〃 〃 at bottom $= .31 \times \frac{3}{4} = .2325"$

Handle



Bevel wheel

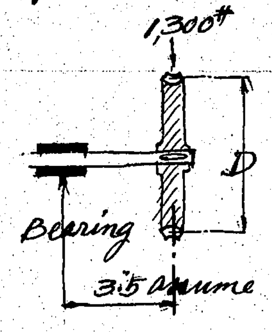


pitch dia	$3\frac{1}{2}"$
circular pitch	$\frac{1}{4}\pi$
diametral pitch	4
no of teeth	14
outer dia	3.853"

Pinion (a)

dia of pitch circle	6"
diametral pitch	$2\frac{1}{2}"$
no of teeth	15
width of tooth	4"
outside dia $(15+2) \times \frac{1}{2.5} =$	6.8"

Shaft of worm wheel.



max. bending mt. $M_b = 1{,}300 \times 3.5 = 4{,}550''\#$

max. twisting mt. $M_t =$ 〃 $\times 8.6 = 11{,}180''\#$

equivalent twisting mt. $M_e = 4{,}550 + \sqrt{4{,}550^2 + 11{,}180^2}$

$= 4{,}550 + 12{,}100 = 16{,}650''\#$

$M_e = \frac{\pi d^3}{16} f \quad \therefore d = \sqrt[3]{\frac{16 M_e}{\pi f}} = 1.72 \sqrt[3]{\frac{M_e}{f}} = 1.72 \sqrt[3]{\frac{16650}{9000}}$

$= 1.72 \times 1.228 = 2.112$ say $2\frac{1}{8}"$

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CALCULATIONS FOR

Pinion of Gate (G)

tangential force at pitch cir. 2,500#

dia of pitch circle 5"
diametral pitch 3
circular pitch 1.0472
no of teeth 15
outer dia (15+2) × 1/3 = 5.667
width of tooth 2 1/2
degree of involut 15°

$$S = \frac{2500^{\#}}{1.0472 \times 2.5 \times 0.075} = \frac{2500}{.1964} = 12,730^{\#}/\square''$$

(allowable stress 20,000#/□")

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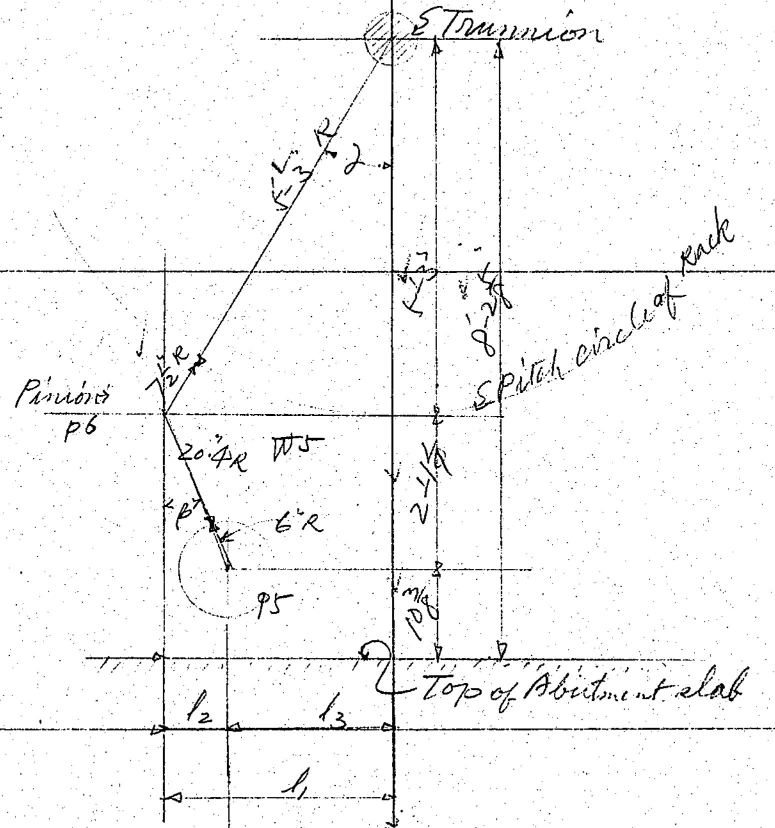
CALCULATIONS FOR

Distance of Bearing :—



$\cos\alpha = \dfrac{5'\text{-}3''}{(5'\text{-}3'')+7\tfrac{1}{2}} = .8936$

$\therefore \alpha = 26^\circ\text{-}40'$

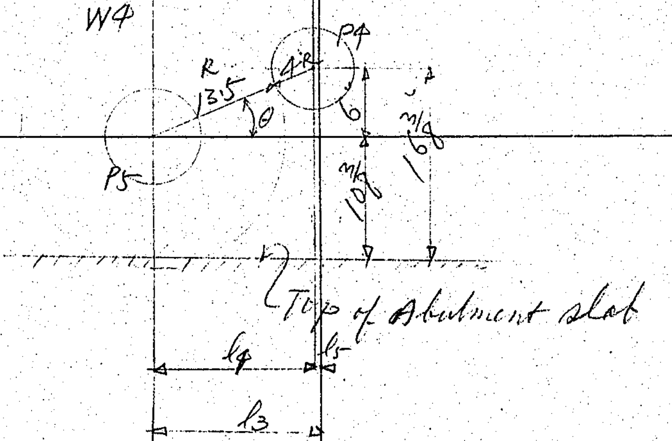
$l_1 = 70.5 \times \sin\alpha = 70.5 \times .4488 = 31.6404$

$\cos\beta = \dfrac{25.25}{26.4} = .9564$

$\therefore \beta = 16^\circ\text{-}59'$

$l_2 = 26.4 \times \sin\beta = 26.4 \times .2921 = 7.7114$

$l_3 = l_1 - l_2 = 31.6404 - 7.7114 = 23.929$

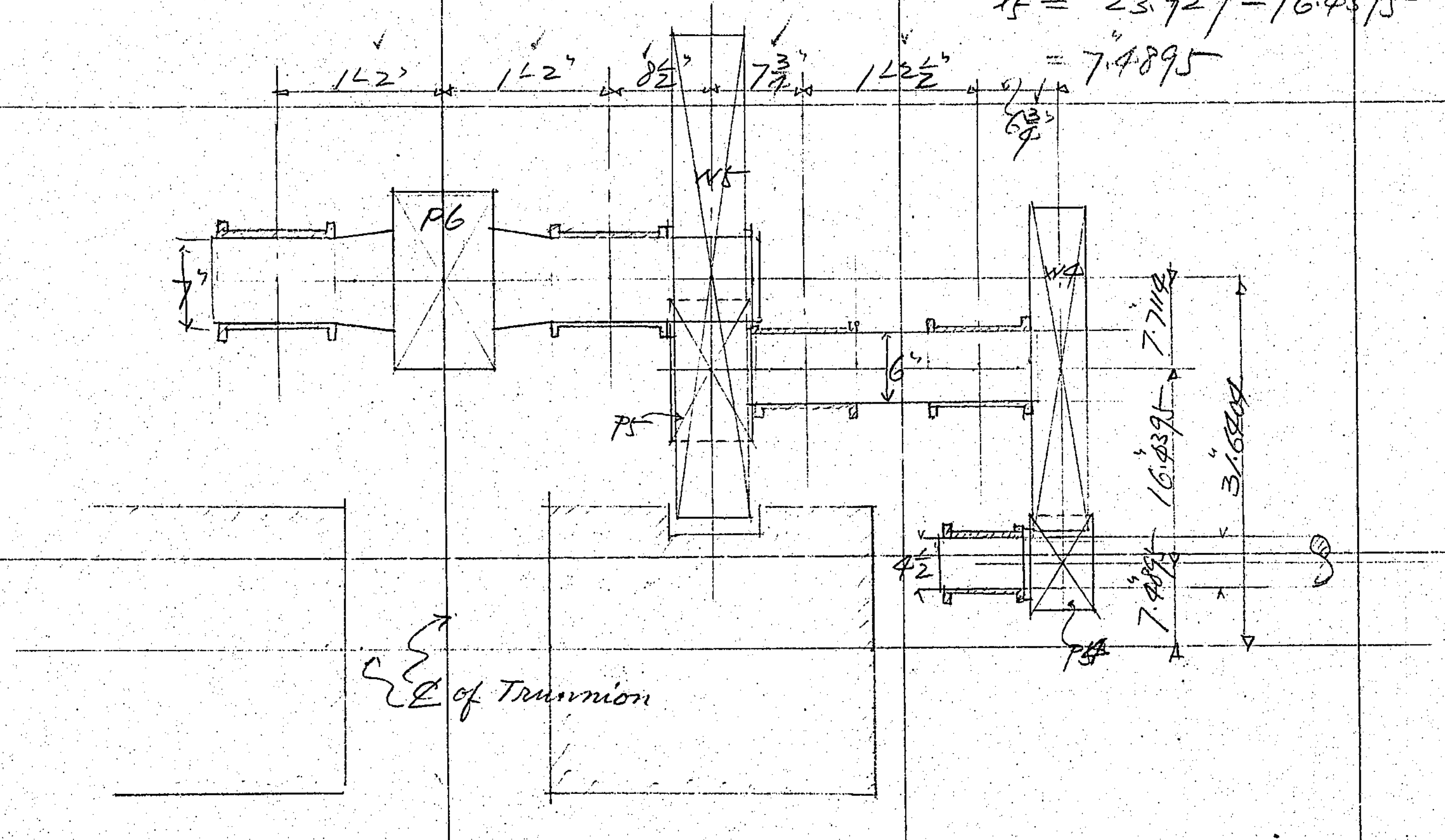


$\sin\theta = \dfrac{6}{13.5+4} = .3429$

$\therefore \theta = 20^\circ\text{-}3'$

$l_4 = 17.5\cos\theta = 17.5 \times .9394 = 16.4395$

$l_5 = 23.929 - 16.4395 = 7.4895$



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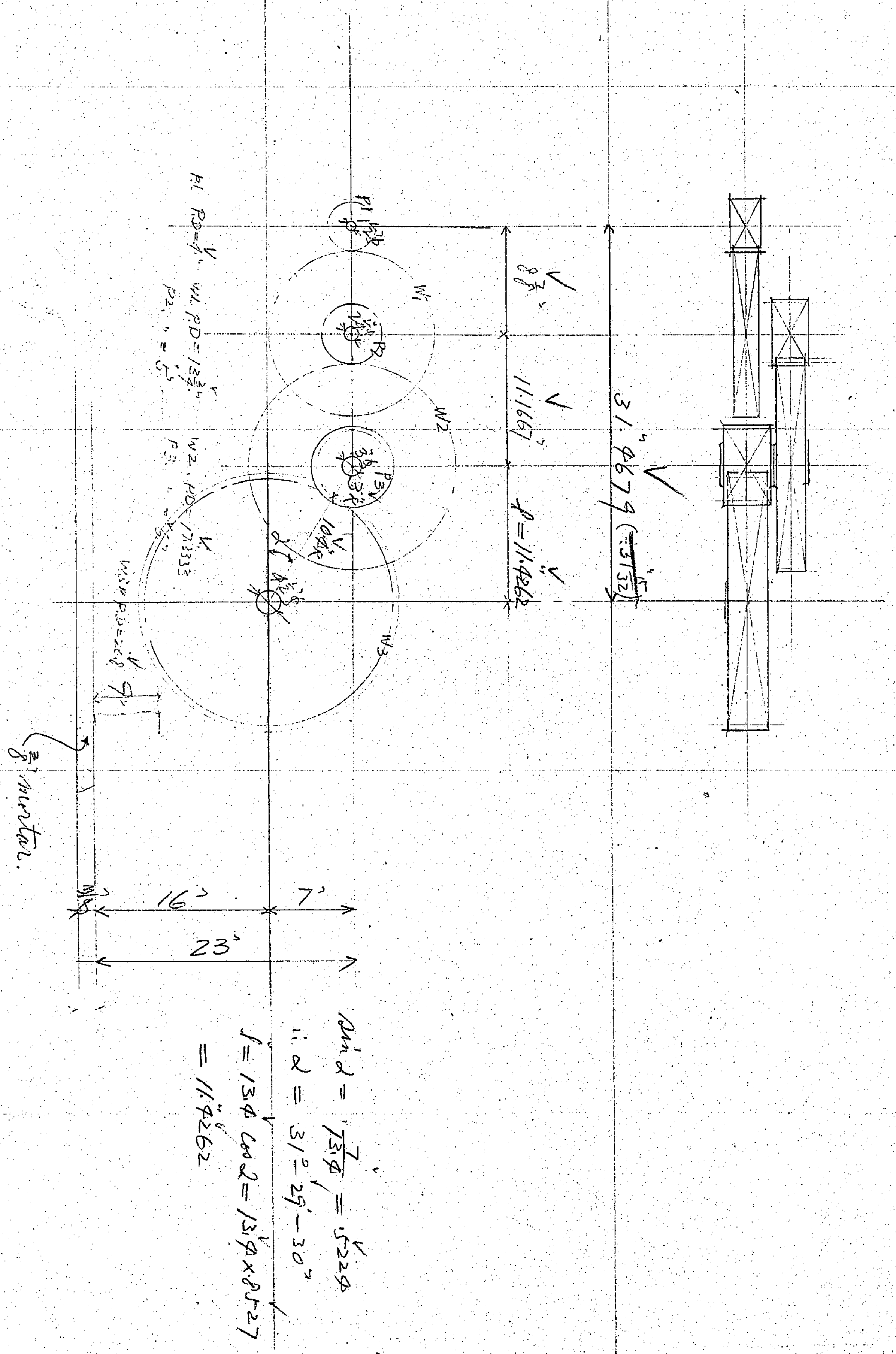
CALCULATIONS FOR



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CALCULATIONS FOR

(欠外)

熊本縣坪井川バスチュール機械装置豫算表（月島機械作製）

材料	重量(封度)	単價/貫	単價/封度	単價/噸	代金
鋳鉄	9,780.10	円 2.117	円 .235	円 526.40	円 2,298.320
半硬鋼	3,041.92	3.901	.470	1,052.80	1,430.230
燐青銅	641.80	8.300	1.000	2,240.00	641.800
砲金	52.63	7.470	.900	2,016.00	47.370
鍛造物	512.10	4.150	.500	1,120.00	256.050
軸類(半軟鋼)	2,100.50	1.162	.140	313.60	294.070
フレーム類(構造鋼)	3277.90	1.121	.135	302.40	442.520
真鍮	13.75	7.470	.900	2,016.00	12.380
鋳鋼	8,676.80	3.486	.420	940.80	3,644.260
キー	.40	16.600	2.000	4,480.00	.800
銅	20.30	15.355	1.850	4,144.00	37.560
リベット	26.00	.830	.100	224.00	2.600
ボールト	1,496.45	2.241	.270	604.80	404.040
可鍛鋳鉄	50.40	5.644	.680	1,523.20	34.270
購入品					296.190
ポンプ(モーター共)					230.000
電気部分(モーター除ク)					1,600.000
機械加工工作					940.000
					12,612.460

	12,612.460
paint	85.000
packing	200.000
freight	450.000
	13,347.460
GC	800.540
	14,148.000
利益	1,810.000
合計	15,958.000
motor	2,242.000
Gasoline engine	1,300.000 (試運打合会費 150円 但シ汽車製造 3 70円同前)
總合計	19,500.000円

但シ
重量ハ仕上リ重量
単價ハ材料費、仕上賃共
電気部分品ハ500円内外ノ超過アル見込ミ。

増田淳氏関係資料
(独立行政法人 土木研究所蔵)

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