JIUN MASUDA
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SEIYU BLDG, TOKIO

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CALCULATIONS FOR

昭和三年十月
岡山縣高梁川架橋
常盤橋設計ノ算書
及材料調書

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MADE BY J. Masuda DATE 3-9-18 FILE NO
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CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken

General layout of bridge

Cantilever type

anchor span	2 @ 40.0 meters	=	80.0
Suspended span	1 — 35.	=	35.0
Cantilever arm	2 @ 10	=	20.0
	Total		135.0 meters.

Total length of bridge between parapet walls 459.44 meters
135.00
324.44 meters

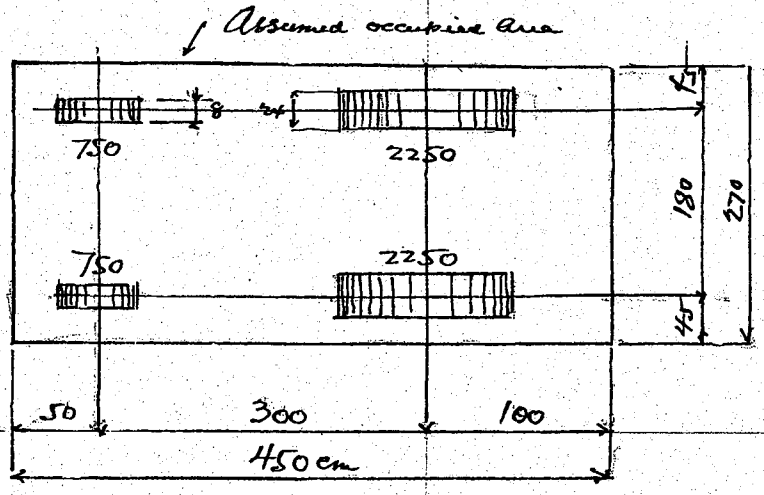
This 324.44 meters will be divided into 15 spans 5 spans on left bank and 10 spans on right approximate span length 21.6 meters between piers about
width of Roadway 4.85 meters clear or 16.0 R 5 cm Granolithic pavement on 13 cm reinforced concrete slab.

Assumed loadings

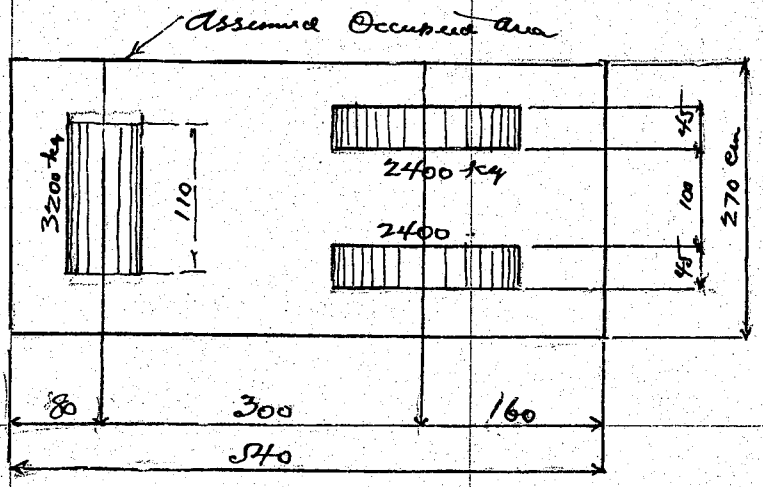
Uniform load on Roadway $w = \frac{100.000}{170+l} \leq 500$ kg/m²

where w = Uniform load in kg per sq meter
l = Span length in meter

6 ton motor truck loading



8 ton road roller



One row of motor traffic on roadway with occupied width of 270 cm : Unoccupied space around the motor trucks shall be filled with uniform load specified above.
One road roller on span
Impact for motor truck loading
Coef = $\frac{20}{60+l}$ where l = loaded length in meter
max impact 30%.
No impact for road roller and uniform live load.

Allowable Working Strength
Structural Steel & Reinforcing Bars.

Tension net	1200	kg/cm²
Extreme fibre stress net	1200	"
Shear of web gross section	900	"
Compression member		"
$1500\left(1 - 0.0055 \frac{l}{r}\right)$ not over	1000	"

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

Compression flange of girder

$1200\left(1 - 0.012 \frac{l}{b}\right)$ not over	1100	"
Shear on shop driven rivets (machine driven).	850	"
" " field " " and turned bolts (machine driven)	750	"
Shear on pin	900	"
Bearing on shop driven rivets (machine driven)	1700	"
" " field	1500	"
" " pin	1800	"

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CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken

Rollers $45d$ kg where d = diameter of roller in cm

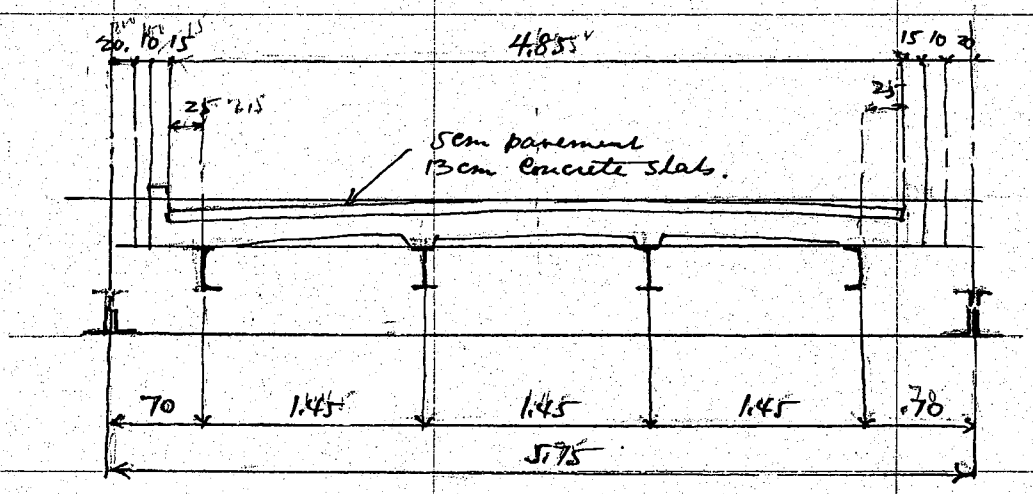
Concrete 1:2:4 mixture

Direct Compression	35	kg/cm²
Fibre stress due to bending	45	"
Combined stress direct and bending	35	"
Punching shear of Concrete	9	"
Shear of plain Concrete	4	"
Bearing	45	"
Bond stress for plain bars	6	"
" " deformed bars	9	"

Considering wind & temperature stress in addition to dead, live and impact stresses the allowable working strength shall be increased 25%. In case of earthquake increase unit stress 80%. Seismic accelleration 1000 m/sec² or $k = .10$

Design of truss spans

Cross section of bridge assumed as shown on Sketch



Design of Floor slabs. span length 1.45 metres

Dead Load

pavement 5cm granolithic	@ 22 kg	=	110
Concrete slab 13cm	@ 24 kg	=	312
misc concrete say			20
			442 kg per sq meter

Dead load moment = $\frac{1}{10} \cdot 442 \cdot 1.45^2$ = 93 kgm

Shear = $\frac{1}{2} \cdot 442 \cdot 1.45$ = 320 kg.

Live Load motor truck loading

Rear wheel		2250
Impact	30%	675
		2925 kg.
Front wheel	2925 ÷ 3 =	975 "

Distribution of wheel Concentration

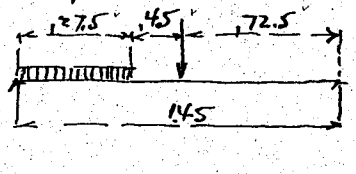
Contact between wheel and pavement		20
distribution	2 × 5 =	10
Longitudinal distribution	a =	30 cm
Transverse distribution	b = 24+10 =	34 cm

Effective width $E = \frac{2}{3}l + a$ where l = span length in meters

$= 1.27$ meters

Load per meter strip 2925 ÷ 1.27 = 2300 kg.

Uniform live load 500 kg per sq meter



Uniform load	$\frac{500 \cdot .275^2}{2 \cdot 1.45} \cdot .725$ =	9	
		835	
motor truck	$\frac{2300}{2} \cdot .725$ =	467	
		844	kg meter
for continuity of slab.	0.8 · 844 =	675	kgm

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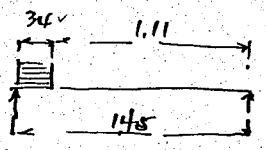
CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken

End shear



$2300^{v} \cdot \frac{1.28}{1.45}^{v} = 2030^{v}$ kg.

Summary for moments and shears

	moment	shear
Dead Load	93 v	320 v
Live Load	675 v	2030 v
	768 v kgm	2350 v kg.

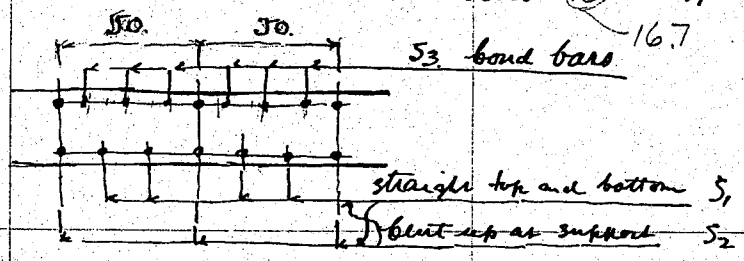
Effective depth required for $f_s = 1200$ kg/cm² and $f_c = 45$ kg/cm²

$R = \frac{M}{bd^2}$ $d = \sqrt{\frac{M}{bR}}^{v}$ $R = 7.18^{v}$ $d = \sqrt{\frac{768 \cdot 100}{100 \cdot 7.18}}^{v} = 10.35^{v}$ cm use 13cm v slab insulation at bottom 2.5 cm

Steel area rqd $= \frac{768 \cdot 100}{7/8 \cdot 10.5 \cdot 1200}^{v} = 695^{v}$ cm² per metre strip

Spacing 13 mm bars $\frac{133 \cdot 100}{6.95}^{v} = 19.1^{v}$ cm use ~~16.7~~ cm spacing.

Bond Stress 13 mm bars ~~15~~ 16.7 cm spacing.



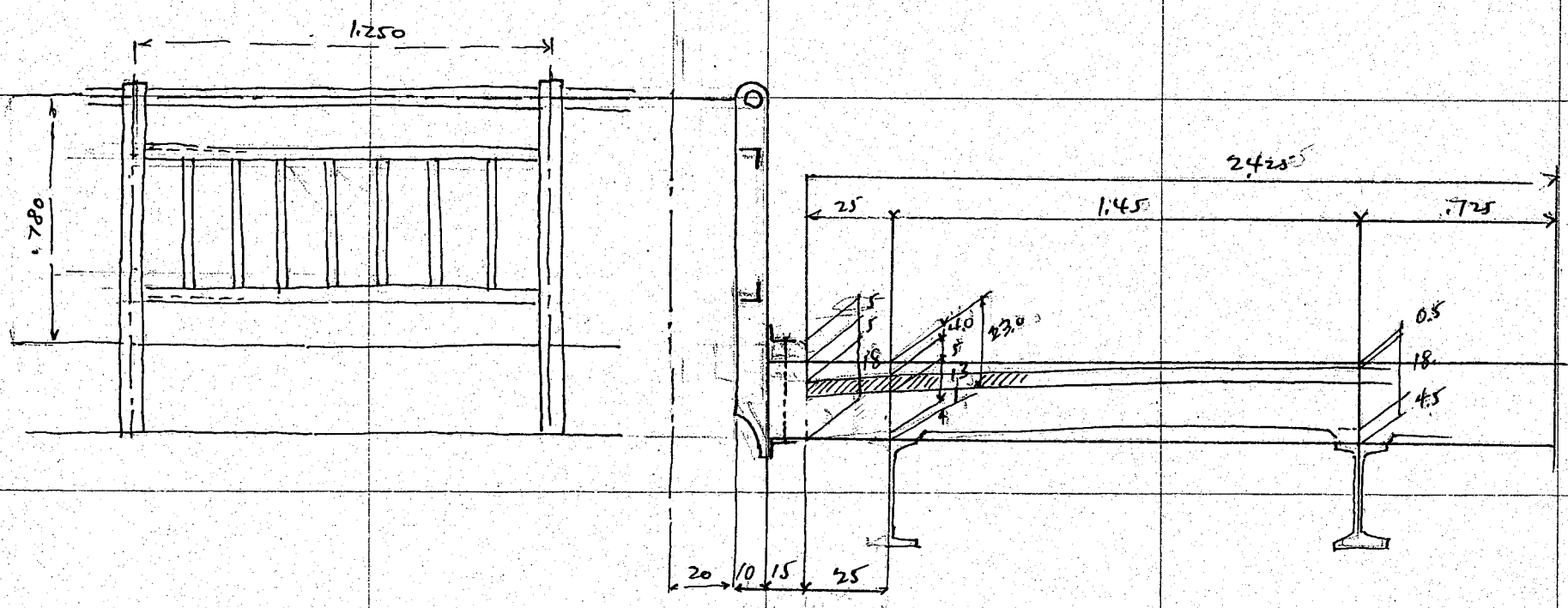
S2 lapped at support

		dia	circumference		
S_1	13 mm	4.08 v	2 v	=	8.16 v
S_2	"	-	~~8~~ 4	=	~~32.64~~ v 16.32
S_3	9 mm	2.85	6	=	~~40.80~~ v 15.95 ~~14.83~~ 40.43

Unit Bond $= \frac{2350}{7/8 \cdot 10.50 \cdot \frac{~~40.80~~}{40.43}}^{v} = ~~6.33~~^{v}$ kg/cm² 6.33

The unit bond over the specified allowable unit stress. However try the plain bar throughout the bridge to reduce the cost of bridge

Overhanging slab.



Approximate weight of Handrail. panel length 1.25 m

Grate verticals	7 -	2.5c · 1.3 · .50 · 0.785	=	8.92 v
Post.	1 I	100 · 75 @ 12.89 · 1.45	=	14.80 v
Cap. Casting.				2.50 v
Connection	2 L s	2 L s 100 · 75 · 7 @ 9.23 · 0.075	=	1.40 v
misc bolts etc				1.38 v
				29.00 v ÷ 1.25 v = 23.20 v
2" gas pipe	3.65 m per ft or			5.45 v
2 L s 45.45.6	@ 3.95 kg			7.90 v
				36.55 v

Call this 37.0 kg per lin metre.

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CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken.

Weight of Coping and slab beyond outside Stringer.

Coping .15 · (23)✓ @ 2400✓ = (83) 101 kg.

Dead Load

	load		arm		moment	
Handrail	38.7✓	·	(325)✓ 45		(12.00)	16.6
Coping	(83) 101	·	(45) 325		(37.40)	32.8
Slab + pavement 442✓ · .25✓ =	110✓	·	.125✓		13.80✓	
	(230) 248		(.27) .234		63.20✓	

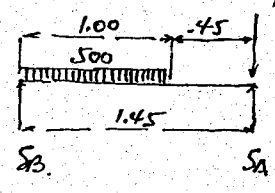
Live Load moment is small use slab 13cm and reinforcement same as for slab of intermediate span.

Design of I beam Stringer Span length 5.00 meters spacing 1.45✓ meters
Inside stringer SA.

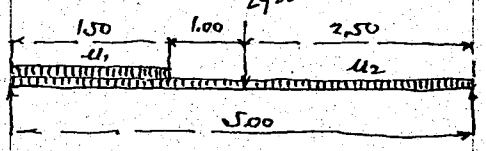
Dead Load floor slab and pavement 442✓ · 1.45✓ = 641✓
beam assumed 50✓
691✓

Dead load moment = 1/8 · 691 · 5.0²✓ = 2160✓ kgm
Dead load shear = 1/2 · 691 · 5.0 = 1730✓ kg.

Live load motor truck rear wheel with impact 2925✓ kg.
Uniform live load 500✓ kg per square meter.



Load on stringer SA $\frac{500 \cdot 1.00 \cdot .50}{1.45}$✓ = 172✓ kg. M_2
full load 500 · 1.45✓ = 725✓
553✓ kg M_1



M_1 Reaction $553 \cdot \frac{1.50 \cdot .75}{5.00}$✓ = 124.5✓

Moment due to motor truck $\frac{2925}{2}$✓ · 2.50✓ = 3660✓
M_2 1/8 · 172 · 5.0²✓ = 537✓
M_1 124.5 · 2.50✓ = 311✓
4508✓

End shear

M_1 553✓ · $\frac{4.0}{5.00}$✓ + 2.0✓ = 885✓
M_2 172 · $\frac{5.0}{2}$ = 430✓
1315✓
2925✓
4240✓ kg.

motor truck loading

Summary for moments and shears

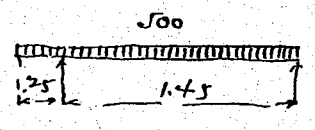
	moments	shear
Dead Load	2160✓	1730✓
Live Load	4508✓	4240✓
	6668✓	5970✓

Section modulus req'd = $\frac{666800}{1100}$ = 605.0✓
use 300 · 150 · I @ 48.34✓ kg S_m = 633.2✓
Unit stress = $\frac{666800}{633.2}$✓ = 1050✓ kg/cm²

Stringer SB. Outside stringer span length 5.0 meters
Dead Load beyond stringer see page 4
Handrail coping and slab. direct (230) 248
Due to Cantilever effect 63.20 ÷ 1.45 = extra 43✓
slab + pavement between SA-B 442 · $\frac{1.45}{2}$✓ 321✓
Beam assumed 50✓
(644) kg per lin. meter.
662 2060

Dead load moment = 1/8 · (644) 662 · 5.0²✓ = (2010) 1660 kgm
Dead load shear = 1/2 · (644) 662 · 5.0✓ = (1610)✓ 1660

Live load motor truck loading rear wheel Concentration with impact = 2925✓ kg.
Uniform load 500 · $\frac{1.70^2}{2 \times 1.45}$✓ = 499✓ call this 500 kg.



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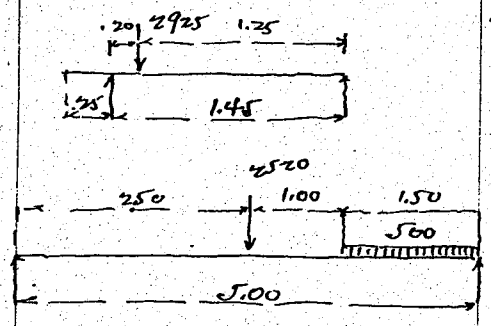
CALCULATIONS FOR

Design of Jokiwa-Bashi for Okayama-Ken



motor truck loading $2925 \cdot \frac{1.25}{1.45}$ v = 2520 v kg.

Load in. uniform load $500 \cdot \frac{1.50^2}{2 \cdot 5.0}$ v = 112.5 v

Moment due to motor truck $\frac{2520}{2}$ v · 2.50 v = 3150 v

" " " uniform load 112.5 · 2.50 v = 282 v

3432 v kgm

max End shear Uniform load $500 \cdot \frac{4.0^2}{2 \cdot 5.0}$ v = 800 v

motor truck rear wheel 2520 v

3320 v kg.

Summary for moments and shears

	moment	shear
Dead Load	2010 ~~2060~~	1610 ~~1660~~
Live Load	3432 v	3320 v
	5442 kgm	4930 kg
	~~5492~~	~~4980~~

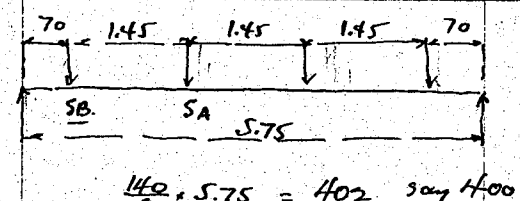
Troy 1E 300 × 90 × 10 @ 43.76 v kg S_n = 493.5 v

~~574200~~

Unit stress = $\frac{544200}{493.5}$ = 1100 v kg/cm².

Design of Intermediate Floor Beam span length 5.75 v meters spacing 5.0 meters

Dead Load.



Concentration at SA 691 · 5.0 v = 3460 v

without Cent. action SB (662 (641 43) · 5.0 = ~~3000~~ ~~3100~~

see page 4 (60) 6199

662

6460 kg.

~~6560~~

moment about SA. ~~6860~~

6460 · 2.15 = 13900 ~~14400~~

3000 · 1.45 = ~~4350~~ ~~4500~~

~~3100~~

9550 ~~9600~~

Dead load beam assumed 140 kg/m $m = \frac{1}{8} \cdot 140 \cdot 5.75^2$ v = 578 v

40128 kgm

~~40178~~

~~6860~~ ~~6960~~

End shear ~~6460~~ + 400 v = ~~6860~~ kg.

Live load motor truck loading rear wheel Concentration with impact = 2925 v kg

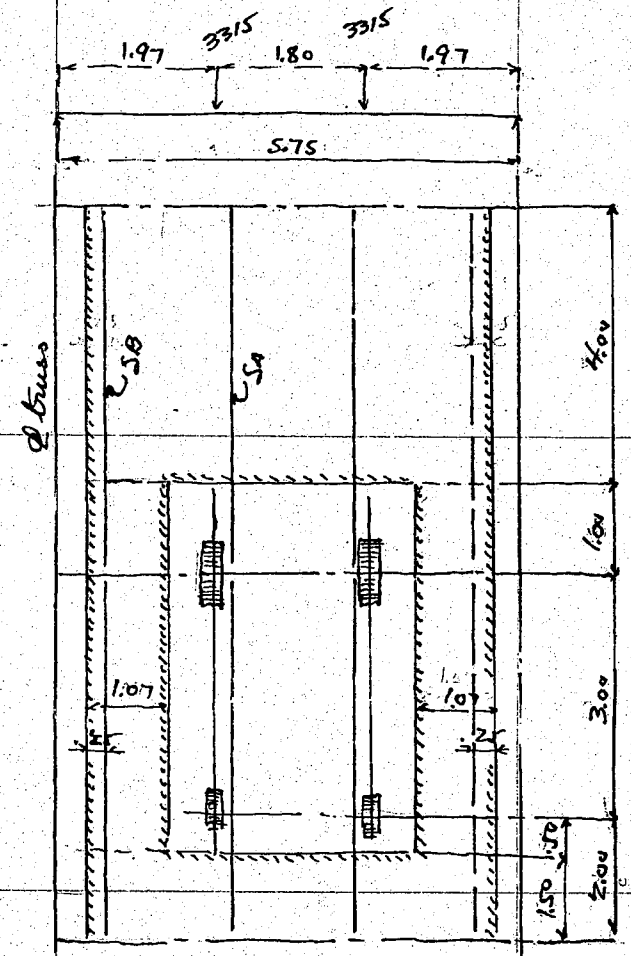
front " " " " = 975 v "

motor truck loading.

Front wheel. $975 \cdot \frac{7}{5}$ v = 390 v

rear wheel 2925 v

3315 v kg.



moment due to motor truck loading.

3315 v · 1.97 v = 6520 v kgm

Uniform live load 500 kg per square meter

SA. 500 · 1.45 v = 725 v kg front and rear of motor truck.

SB 500 · 975 v = 487 v "

Uniform live load on sides of motor truck)

500 · 1.07 v = 535 v kg.

SB $535 \cdot \frac{.885}{1.45}$ v = 326 v kg per lin meter

SA 535 − 326 = 209 v " " " "

Concentration on floor beam due to uniform load

load on front and rear of motor truck

SA. $725 \cdot \frac{4.0^2}{2 \cdot 5.0}$ v + $725 \cdot \frac{1.5^2}{2 \cdot 5.0}$ v = 1325 v kg

SB 487 v · do + 487 v · do = 890 v "

SA. $209 \cdot \frac{100 \cdot 4.5}{5.0}$ v + $209 \cdot \frac{3.5 \cdot 3.25}{5.0}$ v = 665 v "

SB. 326 · do v + 326 · do v = 1035 v "

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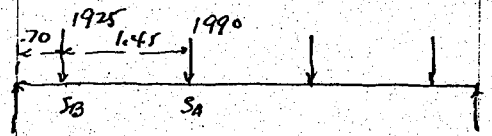
CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken.

Summary Concentration due to uniform load.

On SA 1325 + 665 = 1990 kg
SB 890 + 1835 = 1925 kg
3915

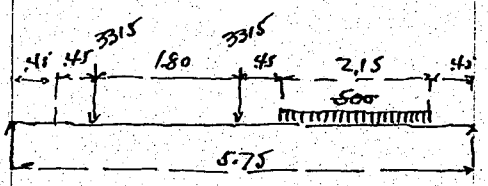


Moment at SA.

3915 · 2.15 = 8400
1925 · 1.45 = 2790
5610

Summary moment due to motor truck loading 6520
" " Uniform live load 5610
12130 kgm

Max Endshear
Due to motor truck loading.



$2 \cdot 3315 \cdot \frac{3.95}{5.75} = 4550$

Uniform load on side of motor truck

$500 \cdot \frac{2.15 \cdot 1.52}{5.75} = 284$

Reaction $284\left(\frac{1.00 \cdot 4.5}{5.0} + \frac{3.5 \cdot 3.25}{5.0}\right) = 900$ kg.

front and rear. SA 1325
" " SB 890
3115 kg.

motor truck 4550
7665 kg.

Summary for moments and shears

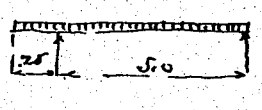
Section modulus req'd $= \frac{22308}{1100} = 2030$

	moment	shear
Dead Load	10178	6860 or 6960
Live Load	12130	7665
	22258 kgm	14525 kg
	22308	14625

use 450 · 175 I @ 114.68 kg Sm = 2169

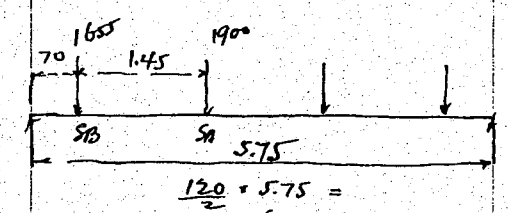
Design of End Floor Beam span length 5.75 m projection .25 meter

Dead Load



Load on floor beam from stringer

SA. $691 \cdot \frac{5.25^2}{2 \cdot 5.00} = 1900$
SB 619 (601) $\cdot \frac{5.25^2}{2 \cdot 5.00} = 1700$ 1655
3555 3600



Moment at SA.

3600			
3555	· 2.15	=	7650 7750
1655	· 1.45	=	2400 2460
1700			5250 5290

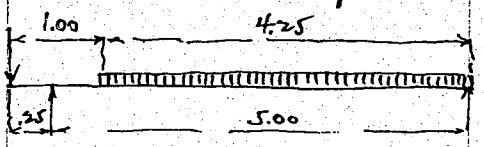
$\frac{120}{2} \cdot 5.75 =$

Dead Load beam assumed 120 kg/m $\frac{1}{8} \cdot 120 \cdot 5.75^2 = 495$
3945 5745 kgm

End shear = 3555 + 345 = 3900 kg. 5785

Live Load motor truck rear wheel concentration with impact 2925

Uniform live load on rear of motor truck, sides of motor truck neglected



motor truck loading $2925 \cdot \frac{5.25}{5.00} = 3075$

Moment = $3075 \cdot 1.97 = 6060$

Concentration due to uniform load

SA. $725 \cdot \frac{4.25^2}{2 \cdot 5.00} = 1310$
SB $487 \cdot$ " " $= 880$
2190

Moment at SA.

2190	· 2.15	=	4710
880			
1925	· 1.45	=	1280

3430
6060
9490 kgm

due to motor truck

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CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-ken

Max End shear
motor truck loading 2×3075 ✓ × 3.95 ✓ / 5.75 = 4230 ✓
Uniform live load 2190 ✓
6420 ✓

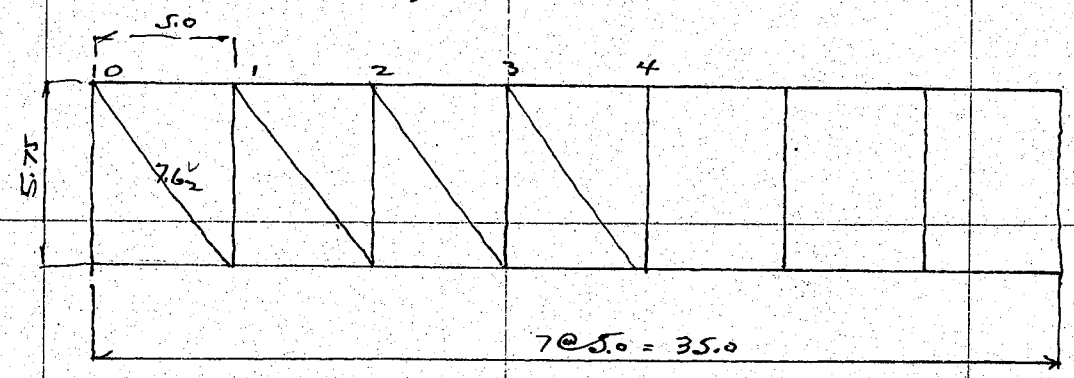
Summary for moments and shears

	moment	shear
Dead Load	~~5745~~ 5785	~~3900~~ 3945
Live Load	9490 ✓	6420 ✓
	~~15235~~ kgm	~~10320~~ kg
	15275	10365

Section modulus req'd = 1527500 / 1100 = 1388. ✓
Use II 450×175 @ 91.66 kg Sm = 1743 ✓
Unit stress = 1527500 / 1743 ✓ = 873 ✓ kg/cm²

Design of Suspended Span Span length 7@5.0 m = 35.0 m

Lower Lateral Bracings.



Wind load
loaded chord 400 ✓
Unloaded chord 200 ✓
600 ✓ × 5.0 ✓ = 3000 ✓ kg.

5.75² ✓ 33.0625 ✓
5.00² ✓ = 25.0000 ✓
58.0625 ✓ → 7.62 ✓

Sec θ = 7.62 ✓ / 5.75 ✓ = 1.328 ✓
tan θ = 5.00 ✓ / 5.75 ✓ = 0.870 ✓

Diagonal Stress

Panel				SR net	19mm Rivet	Mse	
0-1	3000 ✓ / 7 × 1.328 ✓	× 21.0 ✓ =	12000 ✓ ÷ 1200 ✓ =	10.0 ✓	5.65 ✓	6	1L 125×75×10 = 19.00 ✓ − 2.2 ✓ = 16.80 ✓
1-2		15.0 ✓ =	8500 ✓ =	7.07 ✓	4.00 ✓	4	1L 75×75×9 = 12.69 ✓ − 1.98 ✓ = 10.71 ✓
2-3		10.0 ✓ =	5680 ✓ =	4.73 ✓	2.70 ✓	4	〃
3-4		6.0 ✓ =	3400 ✓ =	2.83 ✓	1.60 ✓	4	〃

Approximate weight of stringer
with details 2@ 50 ✓ = 100 ✓
〃 〃 2@ 45 ✓ = 90 ✓
190 ✓ kg per lin meter.

Approximate weight of Intermediate floor beam
I 450×175 @ 114.68 ✓
details say 10.32 ✓
125.00 ✓ kg per lin meter
125 ✓ × 5.75 ✓ = 718 ✓ kg per piece

approximate weight of End floor beam
I 450×175 @ 91.66 ✓
10.34 ✓
102.00 ✓ kg × 5.75 ✓ = 586 ✓ kg

approximate weight of lower lateral bracings

41 ✓	125×75×10	@	14.91 ✓ × 7.3 ✓ =	436 ✓
101 ✓	75×75×9	@	9.96 ✓ × 7.3 ✓ =	726 ✓
	Center connection		7@15 =	105 ✓
				1267 ✓

1267 ✓ ÷ 35.0 = 36.2 ✓ kg per meter
panel load 36.2 ✓ × 5 ✓ = 180. ✓ kg.

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CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken

Panel Dead Load.

floor slab and pavement	442 × 4.85	=	2140	
Coping Handrails	2@130	=	260	
			2400 × 5 =	12000
Structural Steel Stringers		190		
Floor beam	718 ÷ 5.0 =	144		
Lateral bracings		36		
		370 × 5.0	=	1850
				13850

For one truss 13850 ÷ 2 = 6925 kg

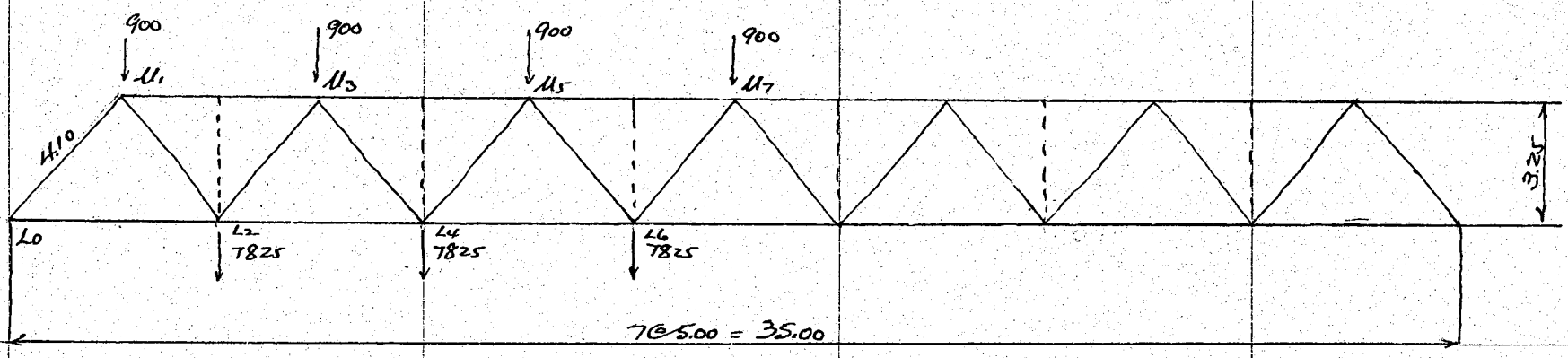
Weight of one truss assumed 360 kg per lin. metre

Upper half	180 × 5.0 =	900	kg.
Lower half		900	"

Lower panel concentration = 6925 + 900 = 7825
upper panel concentration 900
8725 kg

Load on vertical say 450 kg.

Dead Load concentration at End panel say 8725 ÷ 2 = 4360 kg



$\sec\theta = \frac{4.10}{3.25} = 1.261$ $\tan\theta = \frac{2.50}{3.25} = 0.77$

Reaction	900 × 3.5 =	3150	
	7825 × 3.0 =	23475	
		26625	kg.
L_0-U_1	26625 × 1.261 =	33600	"
L_0-L_2	26625 × 0.77 =	20500	"

U_1-U_3	moment at L_2	26625 × 5.0 =	133100	
		900 × 2.5 =	2200	
			130900 ÷ 3.25 =	40250 kg.
L_2-L_4	moment at U_3	26625 × 7.5 =	199600	
		900 × 5.0 =	4500	
		7825 × 2.5 =	19600	
			24100	
			175500 ÷ 3.25 =	54000 kg.
U_3-U_5	moment at L_4	26625 × 10.0 =	266300	
		900 × 4 × 2.5 =	9000	
		7825 × 5.0 =	39100	
			− 48100	
			218200 ÷ 3.25 =	67200 kg.

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CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-ken

L4-L6 moment at U5
26625 · 12.50 = 333000
900 · 6. · 2.5 = 13500
7825 · 4 · 2.5 = 78250
91750
241250 ÷ 325 = 74100 kg.

U5-U7 moment at L6
26625 · 15.00 = 400.000
900 · 9. 2.5 = 20250
7825 · 6 · 2.5 = 117500
−137750
262250 ÷ 325 = 80600 kg.

L6-L6' moment at U7
26625 · 17.50 = 466000
900 · 12 · 2.5 = 27000
7825 · 9 · 2.5 = 176500
−20350
26250 ÷ 325 = 80600 kg.

Diagonals

	26625			
	900			
U1-L2	25725	× 1.261 =	32500	T
	7825			
L2-U3	17900		22600	C
	900			
U3-L4	17000		21400	T
	7825			
L4-U5	9175		11600	C
	900			
U5-L6	8275		10450	T
	7825			
L6-U7	450		570	C

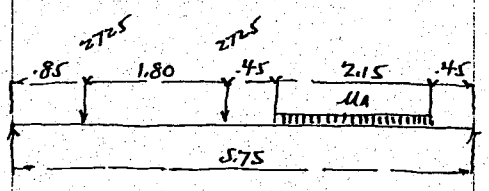
Live load on truss

uniform live load $w = \frac{100.000}{170+35} = 488$ kg/m²

motor truck loading impact $= \frac{20}{60+35} = 21.1\%$

Rear wheel	2250	Front wheel	750
impact 21.1%	475		158
	2725 kg.		908 kg

Max load on truss



Rear wheel 2 · 2725 · $\frac{3.95}{5.75}$ = 3740 kg.

Front wheel 2 · 908 · " = 1247 "

Uniform load UA 488 · 2.15 · $\frac{1.52}{5.75}$ = 278 kg.

Full load 488 · $\frac{4.85}{2}$ = 1185 "
UB. 907 "

UA	278	5.0	= 1390 kg.			
U1	907	4.0	= 3628 "	3628 · $\frac{2.0}{5.0}$	= 1450	3628 - 1450 = 2178
U2	907	1.5	= 1360 "	1360 · $\frac{.75}{5.00}$	= 204	1360 - 204 = 1156
U3	907	5.0	= 4535 "	4535 · $\frac{1}{2}$	= 2267	

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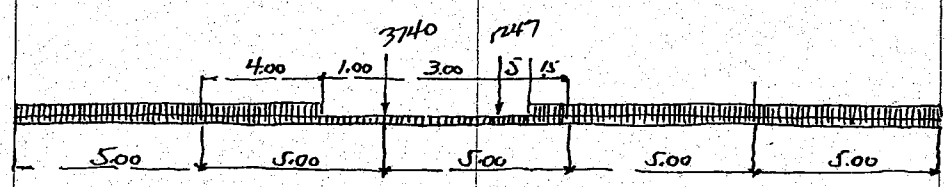
CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-ken



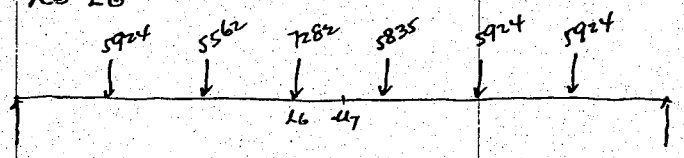
motor truck front wheel $1247 \times \frac{2.0}{5.0} = 498$

$1247 - 498 = 749$

1340	1390	1390	1390	
2267				
2178	1450			
	204	1156		
		2267	2267	
			2267	
5835	3740	4813	5924	for uniform load.
	3740			
	498	749		
5835	8282	5562	5924	for motor truck and uniform load.

Chord Stresses

L6-L6'



Reaction

5924	× 9/7	=	7610
5835	× 7/7	=	2500
7282	× 4/7	=	4160
5562	× 5/7	=	3980
			18250

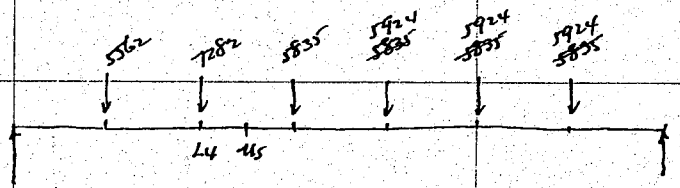
Moment at U7

18250	× 17.5	=	319.500
7282	× 1	=	7282
5562	× 3	=	16686
5924	× 5	=	29620
53588	× 2.50	=	−134100
			185400
	÷ 3.25	=	57.000 kg.

U5-U7

Moment at L6

18250	× 15.0		274.000
5562	× 1	=	5562
5924	× 2	=	11848
17410	× 5.0	=	87000
			187000
	÷ 3.25	=	57500 kg.



Reaction

5924	× 6/7	=	5090
5835	× 4/7	=	3340
7282	× 5/7	=	5200
5562	× 6/7	=	4770
			18400

L4-L6

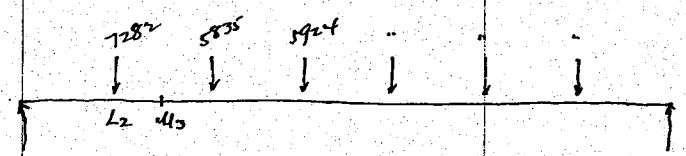
Moment at U5

18400	× 12.50	=	230.000
7282	× 1	=	7282
5562	× 3	=	16686
23968	× 2.5	=	59900
			170100
	÷ 3.25	=	52300 kg.

U3-U5

Moment at L4

18400	× 10.0	=	184000
5562	× 5.0	=	27800
			156200
	÷ 3.25	=	48000 kg.



Reaction

5924	× 10/7	=	8470
5835	× 5/7	=	4170
7282	× 6/7	=	6250
			18890

L2-L4

Moment at U3

18890	× 7.5	=	141800
7282	× 2.5	=	18200
			123600
	÷ 3.25	=	38100 kg.

U1-U3

Moment at L2

18890	× 5.0	=	94500
	÷ 3.25	=	29100 kg.

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CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-ken.

L_0-L_2

moment at U_1 18890 · 2.5 ÷ 3.25 = 14520 kg

End post L_0-U_1 18890 · 1.261 = 23800 "

U_1-L_2 " " = 23800 "

Impact for diagonal members

5 panels @ 5.0 = 25.0 I = 23.5 %
4 " = 20.0 = 25.0
3 " = 15.0 = 26.7

motor truck loading

without impact	Rear wheels	2·2250 · 395/575	=	3100		3100		3100
		23.5%		730	25%	775	26.7%	828
				3830		3875		3928
	Front wheels	1/3		1275		1290		1310

Loading for L_6-U_7-L_6'

Uniform load	695	1390	1390
	204	1156	2267
		2267	2267
	899	4813	5924
motor truck	3928		
	523	787	
	5350	5600	5924

For convenience's sake and for on safe side use uniform panel concentration of 5924 throughout the diagonal members.

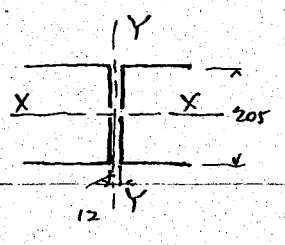
L_2-U_3-L_4 5924 · 15/7 · 1.261 = 16000 kg

L_4-U_5-L_6 " · 10/7 · " = 10680 "

L_6-U_7-L_6' " · 6/7 · · = 6400 "

Chord Sections

L_0-U_1 and U_1-U_3.

Assumed section: 

HL 150 × 100 × 9 = 86.76 · 5.39^2 + 1445.6 = 4445.6

axis YY $r = \sqrt{\frac{4445.6}{86.76}} = 7.16$

$P = 1500\left(1 - 0.0055 \cdot \frac{500}{7.16}\right) = 925$ kg/cm²

$P = 1500\left(1 - 0.0055 \times \frac{410}{7.16}\right) = 1030$ "

$P = 1500\left(1 - 0.0055 \cdot \frac{(410+250)}{7.16}\right) = 740$ kg/cm²

axis XX

HL 150 × 100 × 9 = 86.76 · 7.96^2 + 701.2 = 6161

$r = \sqrt{\frac{6161}{86.76}} = 8.43$

L_0-U_1 57400 ÷ 86.76 = 662 kg/cm²

U_1-U_2-U_3 69350 ÷ 925 = 75.0 cm

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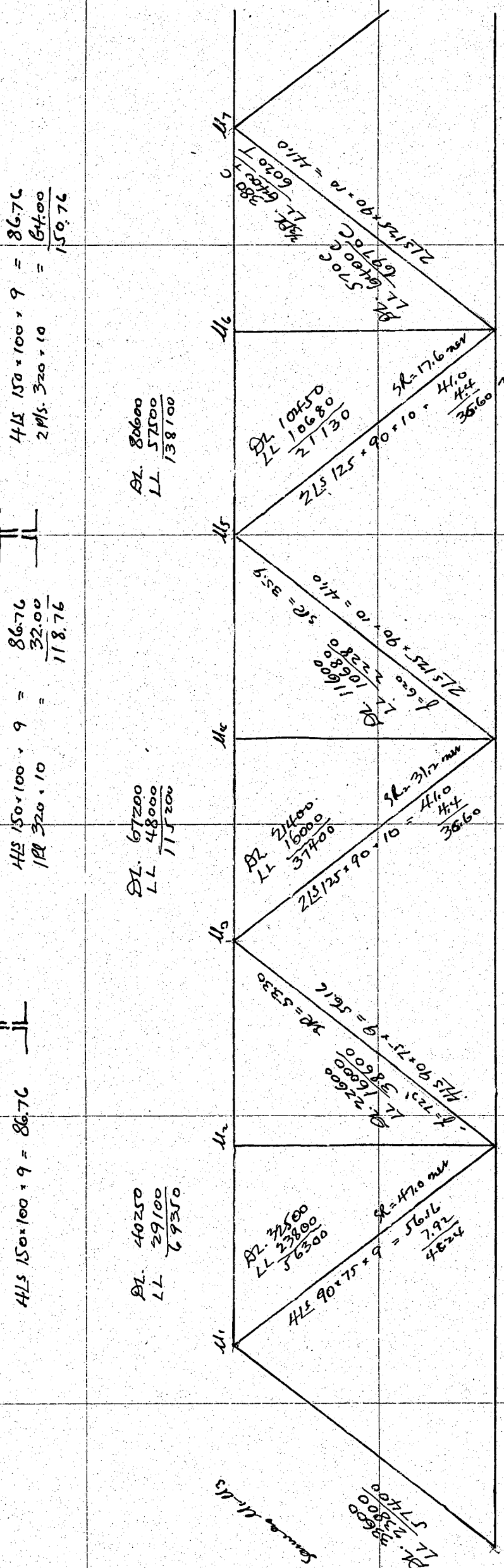
CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken



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（独立行政法人 土木研究所蔵）

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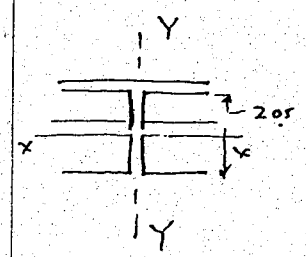
CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken

U3-U5



4LS 150×100×9 = 86.76
1Pl. 320×10 = 32.00
118.76

axis YY.

4LS 150×100×9 = 86.76 · 5.37² + 1945.6 = 4445.6
1Pl 320×10 = 32.00 2730.0
118.76 7175.6

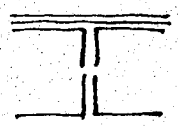
$\Sigma ec = \frac{344}{118.76} = 2.90$

$r = \sqrt{\frac{7175.6}{118.76}} = 7.78$

$P = 1500\left(1 - 0.0055 \cdot \frac{500}{7.78}\right) = 970$

SR = 115200 ÷ 970 = 118.90

U5-U7



4LS 150×100×9 = 86.76
2Pls 320×10 = 64.00 · 11.25 = 720
150.76

$\Sigma ec = \frac{720}{150.76} = 4.79$

axis YY

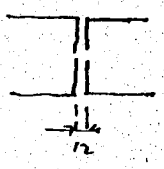
4LS 150×100×9 = 86.76 · 5.37² + 1945.6 = 4445.6
2Pls 320×10 = 64.00 5460.0
150.76 9905.6

$r = \sqrt{\frac{9905.6}{150.76}} = 8.10$

$P = 1500\left(1 - 0.0055 \cdot \frac{500}{8.10}\right) = 990$

SR = 138100 ÷ 990 = 139.80 cm

L2-U3



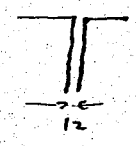
HLS 90×75×9 = 56.16 · 3.34² + 435.2 = 1062

$r = \sqrt{\frac{1062}{56.16}} = 4.35$

$P = 1500\left(1 - 0.0055 \cdot \frac{410}{4.35}\right) = 723$

SR = 38600 ÷ 723 = 53.30 a cm

L4-U5



2LS 125×90×10 = 41.0 · 2.82² + 276.2 = 602.2

$r = \sqrt{\frac{602.2}{41.}} = 3.84$

$P = 1500\left(1 - 0.0055 \cdot \frac{410}{3.84}\right) = 620.$

SR = 22280 ÷ 620 = 35.90 a cm

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CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-ken.

Approximate weight of truss.

L_0-U_1	86.76	@ .785	× 4.10	=	279.0
U_1-U_3	"		× 5.00	=	340.0
U_3-U_5	118.76		× 5.00	=	466.0
U_5-U_7	150.76		× 5.00	=	592.0
L_0-L_2	91.18		× 5.00	=	358.0
L_2-L_4	91.18		× 5.00	=	358.0
L_4-L_6	126.38		× 5.00	=	496.0
L_6-L_7	142.88		× 2.50	=	280.0
U_1-L_2-U_3	2 - 56.6		× 4.10	=	361.0
diag.	4 - 41.00		× 4.10	=	527.0
vert.	3 - 36.00		× 3.25	=	276.0
					4333.0 × 2 = 8666.
			Details say 30%.		2600
					11266 say 11300 kg.

Load on shoe

Dead load

Intermediate panels		26600
End panel		4360
		30960 call this 31000 kg.

Live load — rear wheel at end panel point — see page 10

Uniform load	1390 ÷ 2 =	695
" "		1450
Motor truck		3740
		5885
5835 × 6/7	=	5000
5924 × 15/7	=	12700
		23585 call this 24000
Dead load		31000
	Total	55000 kg.

Approximate weight of structural steel in span

stringers	190 × 35.0		6650
floor beam	6 × 718 =	4300	5470
	2 × 586 =	1170	
Lateral Bracing	say		1300
trusses	2 @ 11300		22600
misc shoes &c	say		1000
			37020 kg.

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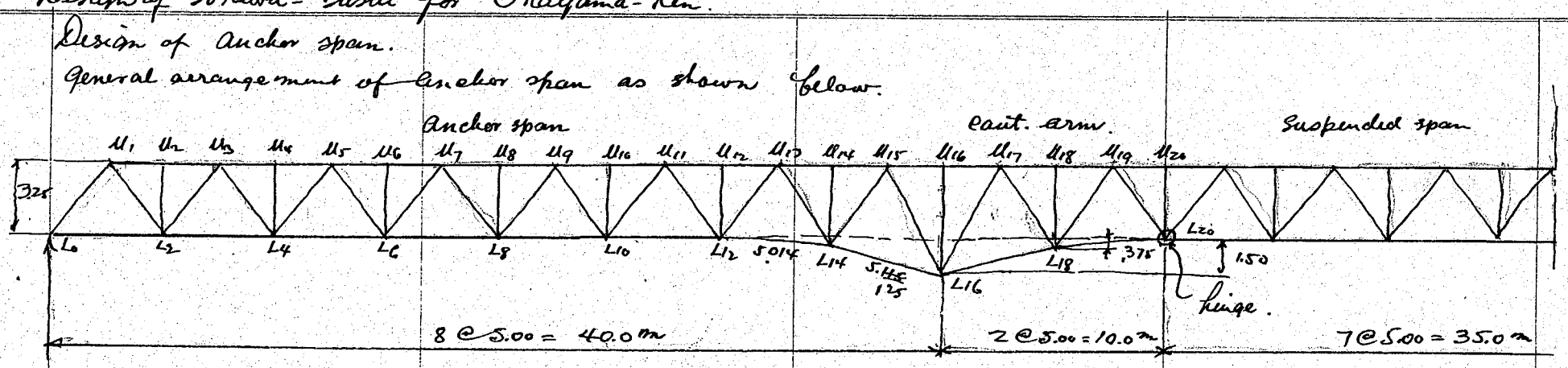
CALCULATIONS FOR

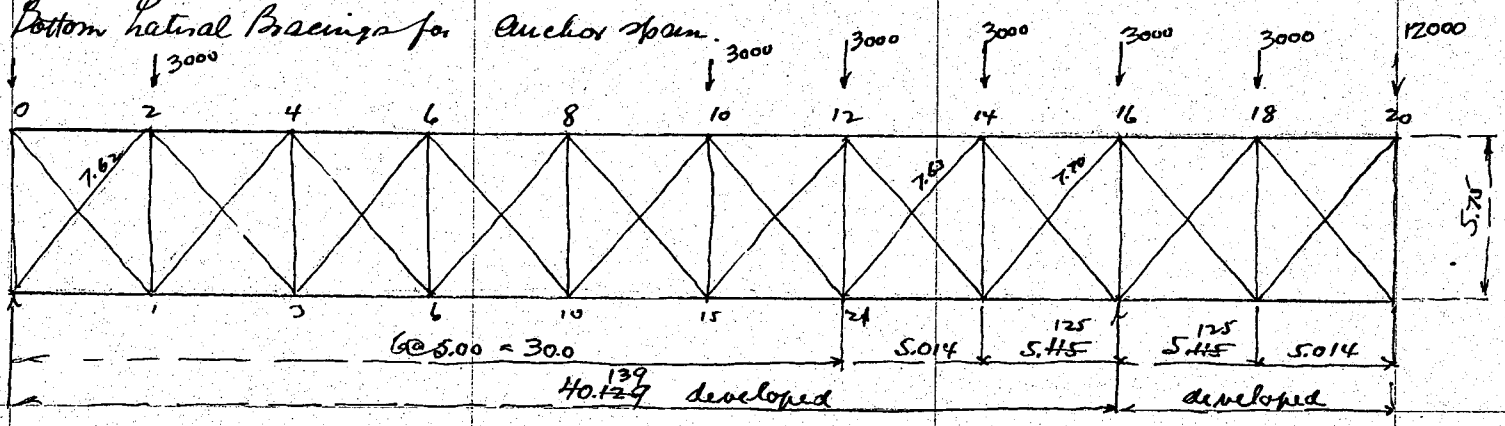
Design of Tokiwa-Bashi for Okayama-ken.

Design of anchor span.

General arrangement of anchor span as shown below.



Bottom Lateral Bracings for Anchor span.



wind load
loaded chord 400
unloaded chord 200
600
600 · 5. = 3000 lcq.

$\frac{7.62}{5.75} = 1.328$

Stress in diagonals.

				SR.		Rivet
18-20	12000 · $\frac{7.63}{5.75}$	=	15900 ÷ 1200	= 13.25	net	7.5
16-18	15000 · $\frac{7.70}{5.75}$	=	20100 "	= 16.75	net	9.45

Reaction at L0. between 0-16 10550 (10900)
due to cant. action. − 3410
7490 (7140) lcq.

12000 · 10.129 = 121700
3000 · 5.115 = 15350
137050 ÷ 40.129 = − 3410

Reaction at L16

between 0-16 10450 (10100)
Cantilever action 3410 } 13510. (13860)
Direct Cantilever 15000
28860 (28410)

R_{16} 3000 · $\frac{21}{40.129}$ · 5.0 = 7830 (7480)
3000 · $\frac{35.014}{40.129}$ = 2620
10450 (10100) lcq
R_0. 21000 − 10450 (10100) = 10550 (10900) lcq

					SR		Rivet
14-16.	1	13860 (13510)	× $\frac{7.70}{5.75}$	=	18560 (18100) ÷ 1200 =	15.50 (15.10) cm	8.5 (8.7)
14-12	3000 · $\frac{21}{40.129}$ · 5.0	= 7830 (7480)					
		3410 (10890)	× $\frac{7.63}{5.75}$	=	14900 (14500)	12.40 (12.10)	6.8 (6.9)
12-10	$\frac{3000 \cdot 5.0}{40.129}$ · 15	= 11240 (5600)					
		3410 (9010)	× 1.328	=	11950	= 9.95	5.6
10-8	× 10	= 3740					
		3410 (7150)	× "	=	9500	= 7.90	4.46
8-6	× 6	= 2240					
		3410 (5650)	× "	=	7500	= 6.25	3.5
6-4	× 3	= 1120					
		3410 (4530)	× "	=	6020	= 5.01	2.8
4-2	× 1	= 370					
		3410 (3780)	× "	=	5010	= 4.17	2.4
2-0		= 7140 (7490)	× "	=	9460 (9940)	= 7.90 (8.28)	4.45 (4.65)

use. 1L 125 × 75 × 10 = 19.00 − 2.2 = 16.80 $^{cm^2}$ net beyond panel 10 and bet. 0-2

1L 75 × 75 × 9 = 12.69 − 1.98 = 10.71 $^{cm^2}$ net between 2 to 10

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CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken

Approximate weight of lower lateral Bracings.

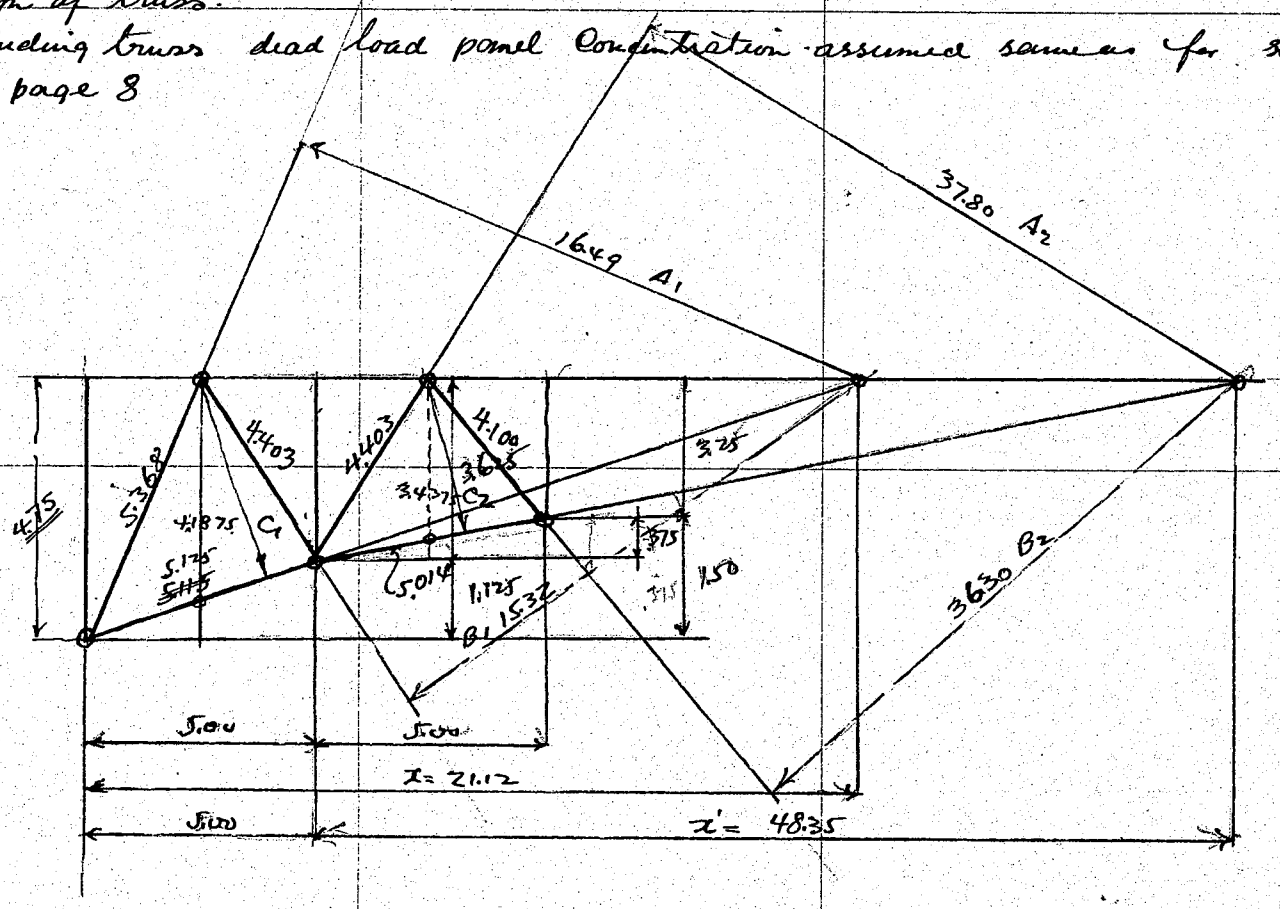
12 Ls	125 × 75 × 10 @ 14.91	× 7.3	=	1305
8 Ls	75 × 75 × 9 @ 9.96	× 7.3	=	582
	Gusset connection 10 @ 15 kg		=	150
				2037

2037 ÷ 50 = 40.6 kg per lin meter.

Besides the above strut at L16 shall be added ; for Estimate of steel weight bottom lateral say— 2500 kg.

Design of truss.

Including truss dead load panel concentration assumed same as for suspended span.
See page 8



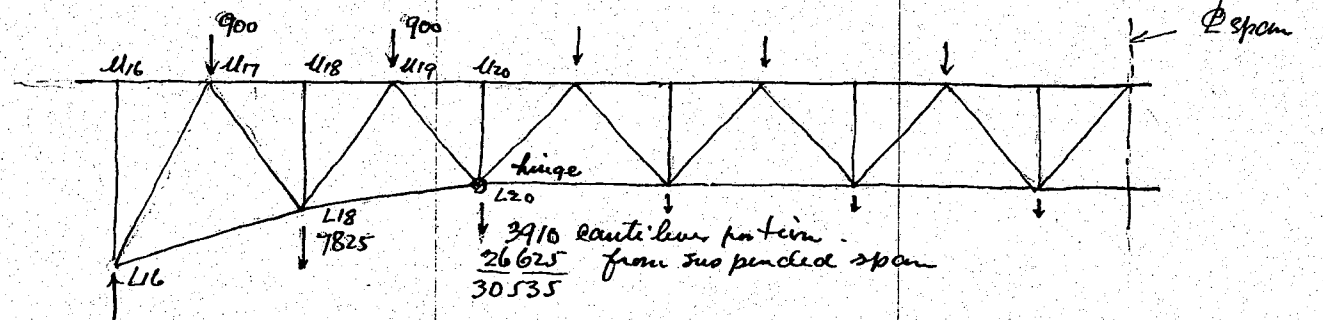
$x = \frac{4.75 \times 5.00}{1.125} = 21.12$ $\quad x' = \frac{3.625 \times 5.00}{.375} = 48.35$

$A_1 = \frac{18.62 \times 4.75}{5.368} = 16.49$ $\quad A_2 = 45.85 \times \frac{3.625}{4.403} = 37.80$

$B_1 = \frac{18.62 \times 3.625}{4.403} = 15.32$ $\quad B_2 = 45.85 \times \frac{3.25}{4.100} = 36.30$

$C_1 = 4.1875 \times \frac{5.00}{5.115} = 4.100$ $\quad C_2 = 3.4375 \times \frac{5.00}{5.014} = 3.42$

Dead load Stresses
Cantilever arm



Chord stress.

U16 - U17 moment L16

30535 × 10	=	305350	
7825 × 5	=	39130	
900 × 4 × 2.5	=	39250	
		9000	
		353480 ÷ 4.75	= 74400 kg.

L16 - L18 moment at U17

30535 × 7.5	=	228700	
7825 × 2.5	=	19600	
900 × 5.0	=	4500	
		252800 ÷ 4.10	= 61.600 kg.

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CALCULATIONS FOR

Design of Tokiwa - Bashi for Okayama - ken

U17-U19 moment at L18
30535 × 5.0 = 152500
900 × 2.5 = 2250
154750 ÷ 3625 = 42600 kg.

L18-L20 moment at U19
30535 × 2.5 = 76250 ÷ 3.42 = 22300 kg.

Diagonals.

U19-L20
30535 × 4335/3630 = 36200 kg.

U19-L18
30535 × 43.35 = 1320.000
900 × 45.85 = 41.250
1361250 ÷ 37.80 = 36.000 kg.

U17-L18
30.535 × 11.12 = 339.500
7825 × 16.12 = 126.100
900 × 13.62 = 12300
477900 ÷ 15.32 = 31200 kg

L16-U17
— — — 477900
900 × 18.62 = 16800
494700 ÷ 16.49 = 30.000 kg.

Dead Load Stresses between piers.

Negative moment due to cantilever load

U1	- 22100	kgm
L2	- 44200	"
U3	- 66200	"
L4	- 88300	"
U5	- 110400	"
L6	- 132500	"
U7	- 154600	"
L8	- 176700	"
U9	- 198900	"
L10	- 221000	"
U11	- 243000	"
L12	- 265000	"
U13	- 287000	"
L14	- 309000	"
U15	- 331000	"
L16	- 353600	"

Reaction at Lo
7825 × 3.5 = 27387
900 × 4.0 = 3600
as simple beam 30987 kg.

Chord stresses

Lo-L2 moment at U1
30987 × 2.5 = ~~77500~~ ~~77.200~~
- 22100
~~49100~~ 55400 ÷ 3.25 = ~~15100~~ 17000 kg.

U1-U3 moment at L2
30987 × 5.0 = 155.000
900 × 2.5 = - 2250
152750
- 44200
108550 ÷ 3.25 = 33400 kg

L2-L4 moment at U3.
30987 × 7.5 = 232500
900 × 5.0 = - 4500
7825 × 2.5 = - 19560
208440
- 66200
142240 ÷ 3.25 = 43800 kg.

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U3-U5 moment at L4	30987 × 10 =	309870	
	900 · 4 · 2.5 =	− 9000	
	7825 · 5.0 =	− 39150	
		261720	
		− 88300	
		173420 ÷ 325 =	53400 kg. C
L4-L6 moment at U5	30987 · 12.5 =	387500	
	900 · 6 · 2.5 =	− 13500	
	7825 · 4 · 2.5 =	− 78250	
		295750	
		− 110400	
		185350 ÷ 325 =	57000 kg. T
U5-U7 moment at L6	30987 · 15.0 =	465,000	
	900 · 9 · 2.5 =	− 20250	
	7825 · 6 · 5.0 =	− 117.200	
		327550	
		− 132500	
		195050 ÷ 325 =	60.000 kg. C
L6-L8 moment at U7	30987 × 17.5 =	542500	
	900 · 12 · 2.5 =	− 27000	
	7825 · 9 · 2.5 =	− 176000	
		339500	
		− 154600	
		184900 ÷ 325 =	56900 kg. T
U7-U9 moment at L8	30987 · 20. =	619740	
	900 · 16 · 2.5 =	− 36000	
	7825 · 6 · 5. =	− 234500	
		349240	
		− 176700	
		172540 ÷ 325 =	53.000 kg C
L8-L10 moment at U9	same as U7	339500	
		− 198900	
		140600 ÷ 325 =	43300 kg T
U9-U11 moment at L10	same as L6	327550	
		− 221000	
		106550 ÷ 325 =	32.800 kg C
L10-L12 moment at U11	Same as U5	295750	
		− 243000	
		52750 ÷ 325 =	16250 kg T
U11-U13 moment at L12	Same as L4	261720	
		− 265000	
		− 3280 ÷ 325 =	1000 kg T
L12-L14 moment at U13	Same as U3.	208440	
		− 287000	
		78560 ÷ 3.42 =	23000 kg C
L13-U15 moment at L14	Same as L2	152750	
		− 309000	
		− 156250 ÷ 3.625 =	43000 kg T
L14-L16 moment at U15	Same as U1	71200	
		− 331000	
		− 259800 ÷ 4.100 =	63300 kg C
U15-U17 moment at L16		− 353600 ÷ 4.75 =	74400 kg T

End Reaction 30987
negative Reaction 353600 ÷ 40 = 8840 due to cantilever moment.
22147 kg.

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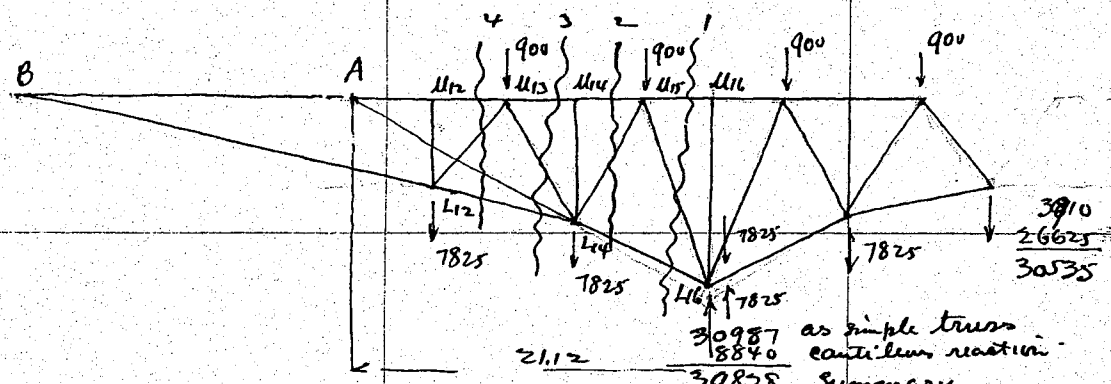
CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken.

Diagonal stresses

L_0-U_1	22147	× 1.261 =		27900
	900			
U_1-L_2	21247	× " =		26800
	7825			
L_2-U_3	13422	=		16900
	900			
U_3-L_4	12522	=		15800
	7825			
L_4-U_5	4697	=		5930
	900			
U_5-L_6	3797	=		4800
	- 7825			
L_6-U_7	-4028	=		5080
	- 900			
U_7-L_8	-4928	=		6210
	- 7825			
L_8-U_9	- 12753	=		16100
	- 900			
U_9-L_{10}	- 13653	=		17200
	- 7825			
L_{10}-U_{11}	-21478	=		27100
	- 900			
U_{11}-L_{12}	22378	× 1.261 =		28000



as simple truss
cantilever reaction
Summary

max load on shoe at L16
79988
7825
87813 kg.

max load on shoe at L0
30987
- 8840
22147 kg.

Cantilever arm

30535	× 10.0 =	305350	
7825	× 5.0 =	39250	
1800	× 5.0 =	9000	
40160		353600 ÷ 40 =	8840

U_{15}-L_{16} moment A. Cantilever arm m 353600
Section 1-1
40160 × 21.12 = 848000
- 1201600
79988 × 21.12 = + 1690000
488.400 ÷ 16.49 = 29600 kg C

L_{14}-U_{15} moment A
Section 2-2
488400
900 × 18.62 = - 16750
471650 ÷ 15.32 = 30800 kg T

U_{13}-L_{14} moment B. Cantilever moment - 353600
Section 3-3
39828 × 53.35 = 2125000
1771.400

900 × 50.85 = 45.800
7825 × 48.35 = 378.000
423800
1347600 ÷ 37.80 = 35600 kg C

L_{12}-U_{13} moment B
Section 4-4
1347600
900 × 45.85 - 41200
1306400 ÷ 36.30 = 36000 kg T

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CALCULATIONS FOR

Design of Tokiwa Bashi for Okayama-Ken

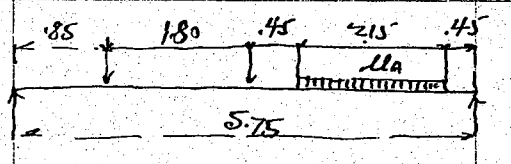
Live Load for 40 meter Anchor span.

Uniform live load = $\frac{100.000}{170+40}$ = 476

Impact = $\frac{20}{60+40}$ = 20.0 %.

Motor truck rear wheel 2250 front wheel 750
impact 20% 450 impact 150
2700 kg. 900 kg

Max load on truss



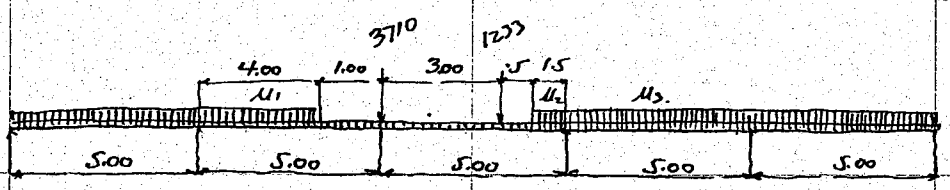
Rear wheel 2 · 2700 · $\frac{3.95}{5.75}$ = 3710

Front wheel 2 · 900 · $\frac{3.95}{5.75}$ = 1233

Uniform load u_A 476 · 2.15 = $\frac{1.52}{5.75}$ = 271

full load 476 · $\frac{4.85}{2}$ = 1155

u_B ---------- 884

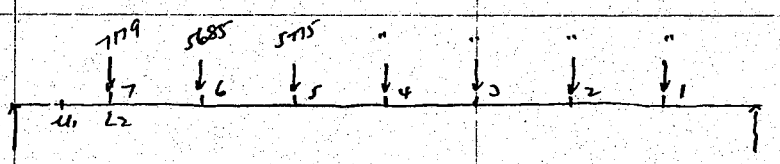


u_A	271 · 5.0	=	1355 kg.
u_1	884 · 4.0	=	3540
u_2	884 · 1.5	=	1330
u_3	884 · 5.0	=	4420

	1355	1355	1355	1355
	2210			
	2120 ---	1420		
		200 ---	1130	
			2210 ---	4420
	5685	2975	3695	5775
		3710		
		494 ---	739	
	5685	7179	6434	5775

u_1	3540 · $\frac{2.0}{5.0}$	= 1420	3540 − 1420 = 2120
u_2	1330 · $\frac{.75}{5.0}$	= 200	1330 − 200 = 1130
u_3	4420 · $\frac{1}{2}$	= 2210	
front wheel	1233 · $\frac{2.0}{5.0}$	= 494	1233 − 494 = 739

Reaction moment for Anchor span. Load between piers only.



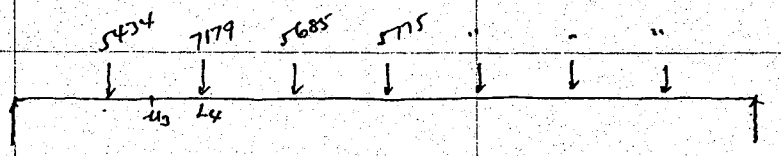
Reaction

5775 ·	$\frac{15}{8}$	=	10850
5685 ·	6/8	=	4260
7179 ·	7/8	=	6280
			21390 kg.

End post L_0-u_1 21390 · 1.261 = 27000 kg.

L_0-L_2 moment at u_1 21390 · 2.5 ÷ 3.25 = 16430 kg.

u_1-u_3 moment at L_2 21390 · 5.0 ÷ 3.25 = 32860 "

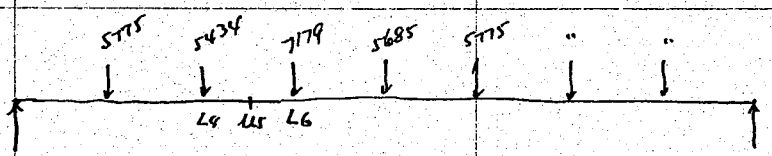


Reaction

5775 ·	$\frac{10}{8}$	=	7220
5685 ·	5/8	=	3560
7179 ·	6/8	=	5390
5434 ·	7/8	=	4760
			20930

L_2-L_4 moment at u_3 20930 · 7.50 = 157000
5434 · 2.50 = − 13600
143400 ÷ 3.25 = 44100

u_3-u_5 moment at L_4 20930 · 10.0 = 209300
5434 · 5.0 = − 27200
182100 ÷ 3.25 = 56000



Reaction

5775 ·	$\frac{13}{8}$	=	9380
5685 ·	4/8	=	2840
7179 ·	5/8	=	4500
5434 ·	6/8	=	4075
			20795

L_4-L_6. moment at u_5 20795 · 12.5 = 260.900
5434 · 2.5 = 13600
5775 · 7.5 = 43250
56850
203150 ÷ 3.25 = 62600 kg

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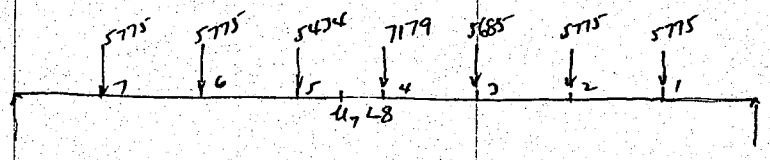
U_5-U_7 moment at L6 — 20795 · 15.0 = 312000
5434 · 5.0 = 27170
5775 · 10.0 = 57750
84920
227080 ÷ 3.25 = 70.000 kg.



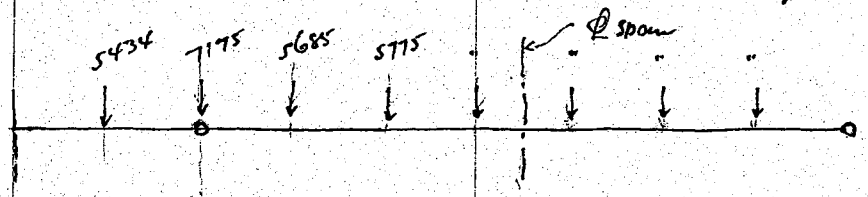
Reaction
5775 × 16/8 = 11550
5685 × 3/8 = 2130
7179 × 4/8 = 3590
5434 × 5/8 = 3400
20670

L6-L8 moment at U_7 — 20670 · 17.5 = 362.000
5434 × 2.5 = 13600
5775 × 20.0 = 115500
129100
232900 ÷ 3.25 = 71600 kg.

U_7-U_9 moment at L8 — 20670 · 20.0 = 413400
5434 × 5.0 = 27200
5775 × 25.0 = 144500
171700
241700 ÷ 3.25 = ~~77300~~ 74400 kg.

L8-L10 Same as L6-L8
U_9-U_{11} Same as U_5-U_7
L10-L12 Same as L4-L6
U_{11}-U_{13} Same as U_3-U_5
L12-L14 — 143400 ÷ 3.42 = 42000 kg
U_{13}-U_{15} — 21390 · 5.0 ÷ 3.625 = 29500 "
L14-L16 — 21390 · 2.5 ÷ 4.100 = 13030 "

Chord stresses of Cantilever arm
Live Load and impact taken same as for anchor span.



Reaction from suspended span
5775 × 15/87 = 12400
5685 × 6/7 = 4875
17275
7175
24450

L18-L20 — 24450 · 2.5 ÷ 3.42 = 17900

U_{17}-U_{19} moment at L18 — 24450 · 5.0 ÷ 3.625 = 33800 kg.

L16-L18 moment at U_{17} — 24450 · 7.5 = 183.000
5434 · 2.5 = 13600
196600 ÷ 4.10 = 48000 kg.

U_{15}-U_{17} moment at L16 — 24450 · 10.0 = 244500
5434 · 5.0 = 27200
271700 ÷ 4.75 = 57200 kg.

Stresses due to negative moment.

	moment			
L0-L2	~~5720~~ 271700 × 1/16	= 17000	÷ 3.25	= 5220
U_1-U_3		34000	÷ "	10450
L2-L4		50900	"	15700
U_3-U_5		67800	"	20900
L4-L6		84800	"	26100
U_5-U_7		102000	"	31400
L6-L8		119000	"	36600
U_7-U_9		136000	"	41800
L8-L10		153000	"	47000
U_9-U_{11}		170.000	"	52200

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CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken

U_0-L_{12}	187000	÷ 3.25	=	57500	
U_{11}-U_{13}	204000	3.25	=	62700	
L_{12}-L_{14}	221000	3.42	=	64600	
U_{13}-U_{15}	238000	3.625	=	65700	
L_{14}-L_{16}	255000	4.10	=	62200	

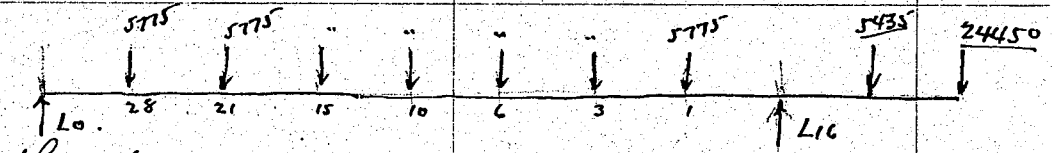
Diagonal stresses Cantilever arm

L_{20}-U_{19} 24450 × 43.35/36.30 = 29200 Note. Full uniform load + motor truck assumed

U_{19}-L_{18} 24450 × 43.35/37.80 = 28000

U_{17}-L_{18} 24450 × 11.12 = 272.000
5434 × 16.12 = 87.600
359 600 ÷ 15.32 = 23450 kg
L_{16}-U_{17} ÷ 16.49 = 21800 kg.

Diagonal stresses. anchor span.

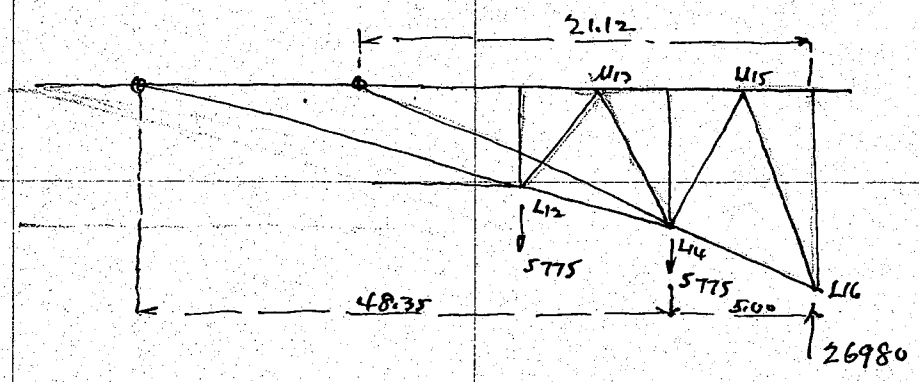


Live load for web members full uniform load of 5775 kg assumed throughout between pins.

Cantilever moment at L_{16} = 5435 × 5.0 = 27200
24450/29885 × 10.0 = 244500
271700 ÷ 40 = 6780 kg.

L

L_0-U_1-L_2	5775/8 × 28 = 20200	× 1.261 =	25500 v	6780	= 6780	× 1.261 =	8560	
L_2-U_3-L_4	21 = 15200	=	19200 v	720+6780	= 7500	" =	9460	
L_4-U_5-L_6	15 = 10850	=	13700 v	2170+6780	= 8950	× 1.261 =	11300	
L_6-U_7-L_8	10 = 7220	=	9100	4330+6780	= 11110	" =	14000 v	
L_8-U_9-L_{10}	6 = 4330	=	5460	7220+6780	= 14000	" =	17700 v	
L_{10}-U_{11}-L_{12}	3 = 2170	=	2740	10850+6780	= 17630	" =	22200 v	



Reaction 5775 × 3.5 = 20200
extra reaction 6780
26980

Reaction 5775/8 × 21 = 15200
6780
21980

U_{15}-L_{16}. 26980 × 21.12 ÷ 16.49 = 34500 kg.
L_{14}-U_{15} 26980 × 21.12 ÷ 15.32 = 37100 "

U_{13}-L_{14} 21980 × 53.35 ÷ 37.80 = 31000 "
L_{12}-U_{13} ÷ 36.30 = 32300 "

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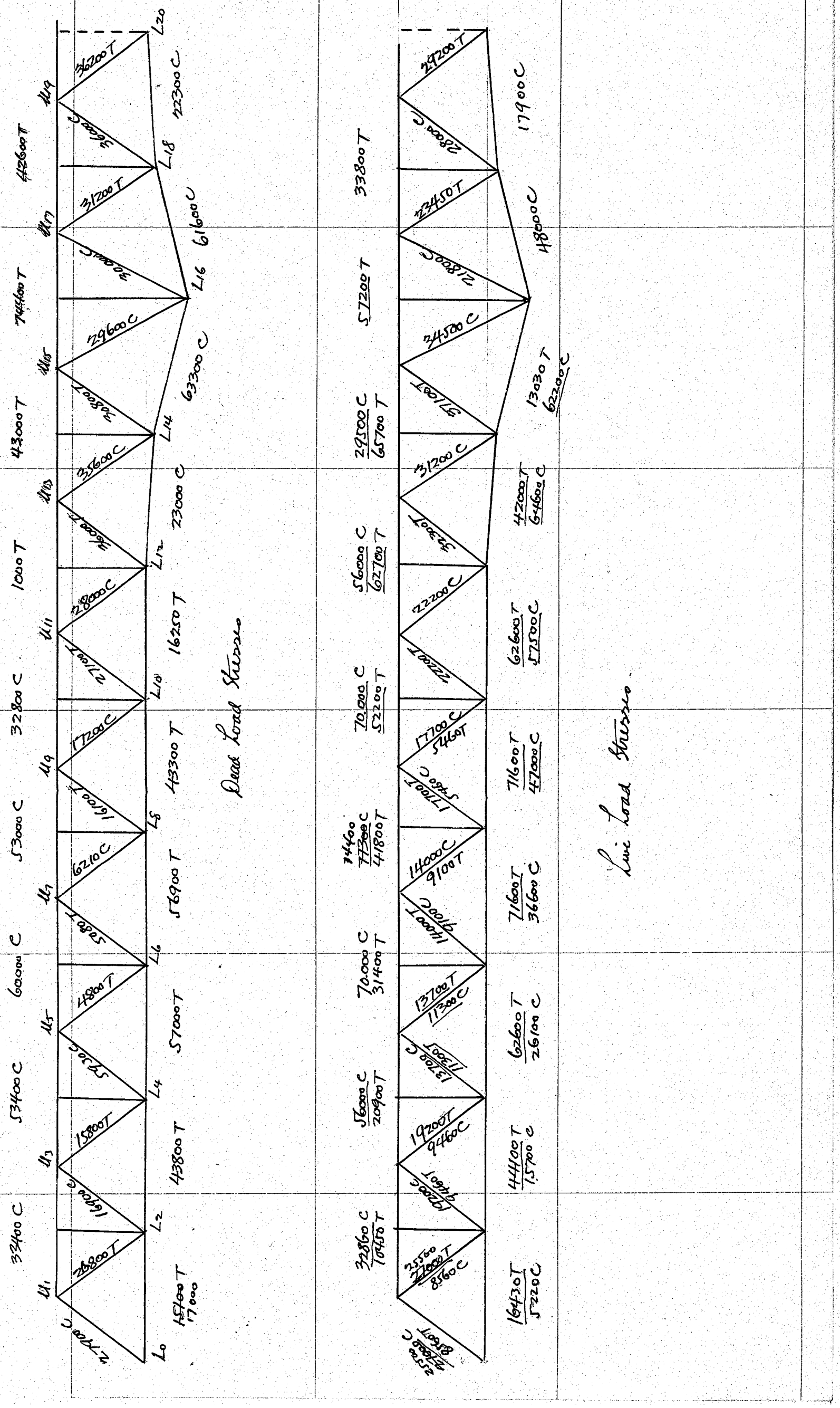

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CALCULATIONS FOR

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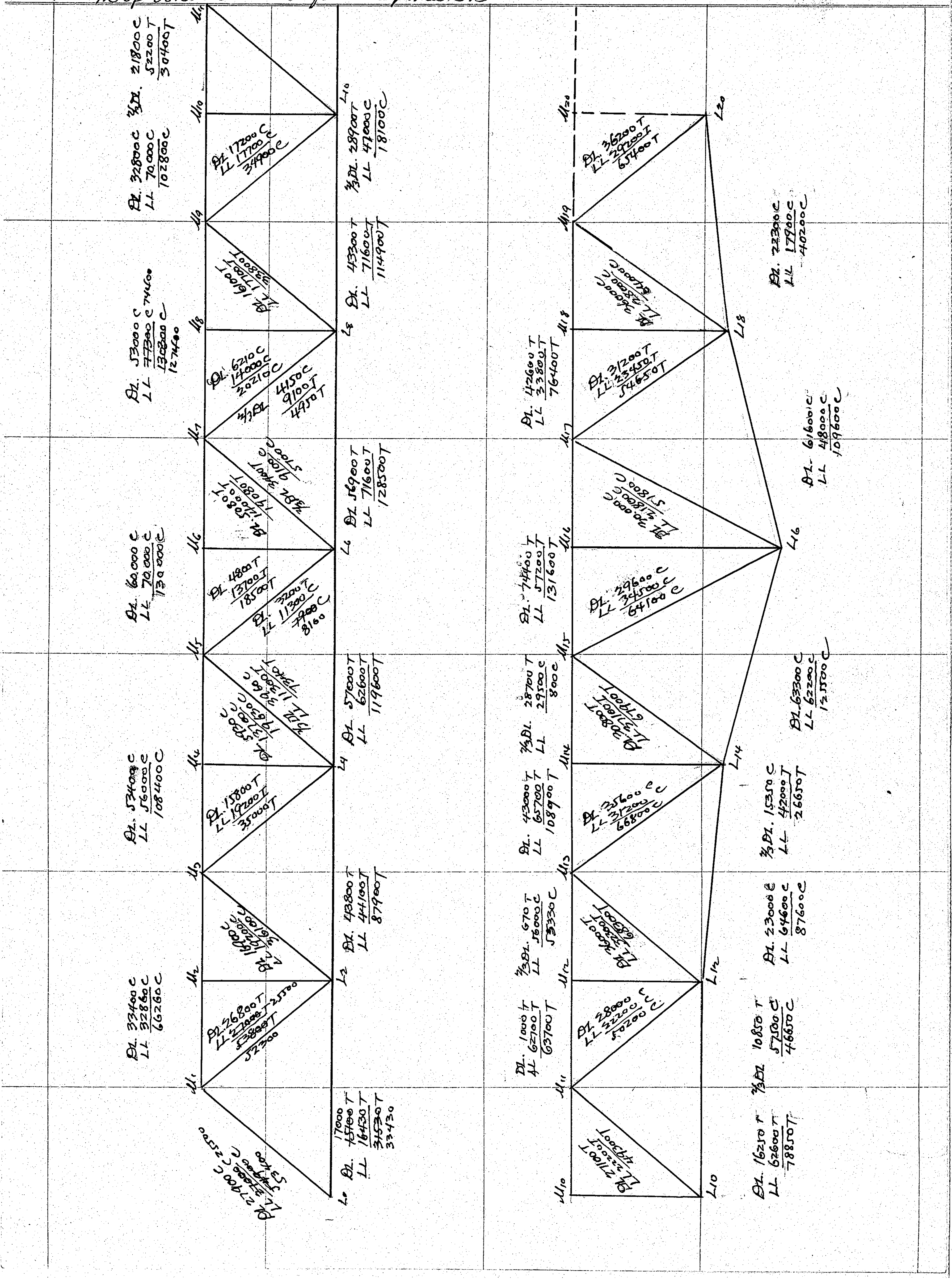

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(独立行政法人 土木研究所蔵)

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CALCULATIONS FOR

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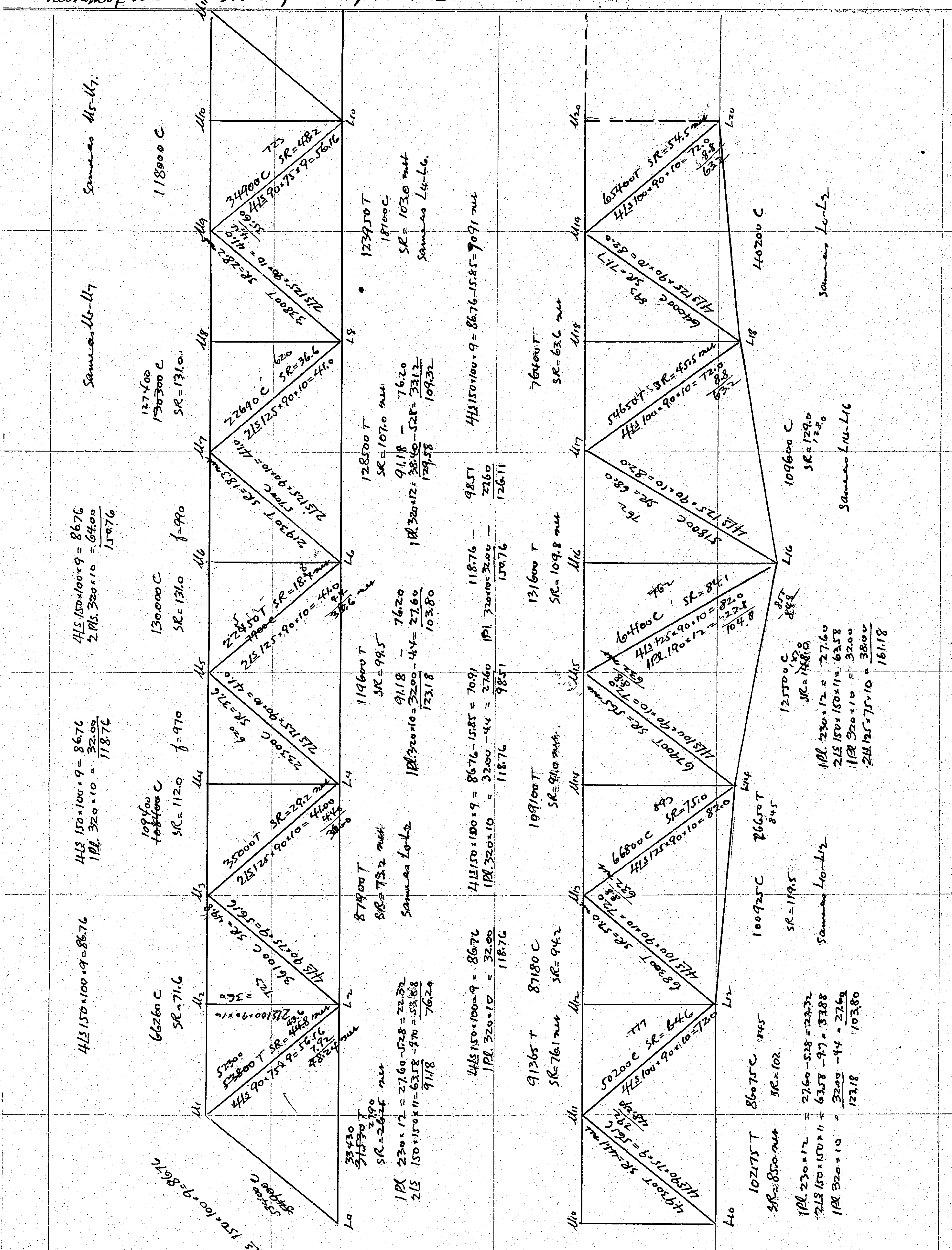

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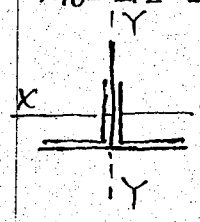
CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-ken.

For sections of ~~top~~ chord member refer page 11 and 13.

Compression members for bottom chord.

L10-L12-L14 axis YY.



1Pl. 320×10	=	32.00		=	2730
2Ls 150×150×11	=	63.58	× 4.67² + 1326	=	2716
1Pl. 230×12	=	27.60			
		123.18			5446

$r = \sqrt{\frac{5446}{123.18}} = 6.65$

axis XX.

1Pl. 320×10	=	32.00	× 24.0	=	768.0
2Ls 150×150×11	=	63.58	× 19.43	=	1238.0
1Pl 230×12	=	27.60	× 11.50	=	317.0
		123.18	18.9		2323.0

Moment of inertia

1Pl. 320×10	=	32.00	× 5.10²	=	833
2Ls 150×150×11	=	63.58	× 0.53² + 1326	=	1344
1Pl 230×12	=	27.60	× 7.4² + 1214	=	2730
		123.18			4907

$r = \sqrt{\frac{4907}{123.18}} = 6.31$

$P = 1500\left(1 - 0.0055 \times \frac{500}{6.31}\right) = 845$ kg/cm²

$P = 1500\left(\text{"} \times \frac{501}{6.31}\right) = \text{say } 845$ "

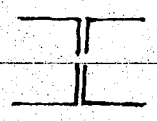
L11-L16 axis XX

1Pl. 320×10	=	32.00		=	2730
2Ls 150×150×11	=	63.58	× 4.67² + 1326	=	2716
1Pl. 230×12	=	27.60			
2Ls 125×75×10	=	38.00	× 4.82² + ~~422~~ 5944	=	1476 +1304
		161.18			~~6750~~ 6922

$r = \sqrt{\frac{6922}{161.18}} = 6.55$ ~~6.47~~

$P = 1500\left(1 - 0.0055 \times \frac{511.5}{6.55}\right) = 855$ ~~848~~ kg/cm²

U11-L12

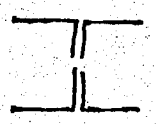


4Ls 100×90×10 = 72.0 × 3.54² + 677.6 = 1578.6

$r = \sqrt{\frac{1578.6}{72.0}} = 4.68$

$P = 1500\left(1 - 0.0055 \times \frac{410}{4.68}\right) = 777.$

U13-L14



4Ls 125×90×10 = 82.0 × 4.55² + 1269.2 = 2964.2

$r = \sqrt{\frac{2964.2}{82}} = 6.02$

$P = 1500\left(1 - 0.0055 \times \frac{443}{6.02}\right) = 893$ kg/cm²

$P = 1500\left(1 - 0.0055 \times \frac{536.8}{6.02}\right) = 762$ "

approximate weight of truss.

chord. L0U1	86.76	@	.785	×	4.10	= 279.0
U1-U3	"			×	5.00	= 340.0
U3-U5	118.76			×	5.00	= 465.0
U5-U7	150.76			×	5.00	= 590.0
U7-U9	"			×	5.00	= 590.0
U9-U11	"			×	5.00	= 590.0
U11-U13	118.76			×	5.00	= 465.0
U13-U15	"			×	5.00	= 465.0
U15-U17	150.76			×	5.00	= 590.0
U17-U19	86.76			×	5.00	= 340.0
U19-U21	"			×	5.00	= 340.0
						5054.0

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CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken.

Bottom chord	$L_0-L_2-L_4$	91.18	@ .785	×	10.0	=	715.0	
	L_4-6 L_8-L_{10}	123.18	@ "	×	10.0	=	970.0	
	L_6-L_8	129.58	"	×	5.0	=	~~1020~~ 510.0	
	$L_{10}-L_{12}-L_{14}$	123.18	"	×	10.04	=	975.0	
	$L_{14}-L_{16}-L_{18}$	2 - 161.18	"	×	5.11	=	1295.0	
	$L_{18}-L_{20}$	91.18	@ .785	×	5.04	=	360.0	
Diagonals		~~56.~~						4825.0
		4 - 56.16	@ .785	×	4.10	=	723.0	
		6 - 41.00	@ "	×	4.10	=	793.0	
		3 - 72.00	"	×	4.10	=	694.0	
		2 - 72.00	"	×	4.40	=	498.0	
		2 - 82.00	"	×	4.40	=	567.0	
		2 - 82.00	"	×	5.40	=	695.0	
Verticals -								3970.0
		7 - 36.00	@ .785	×	3.25	=	643	
		2 -		×	3.62	=	204	
		1 -		×	4.75	=	134	
							981.0	
							14830	
			Details 30%.				4450	
							19280	

Approximate weight of structural steel in Anchor span-

stringers	190 × 50.0	=	9500
Floor beams	say 11 × 718	=	7900
Lateral Bracings			2037
trusses	2 @ 19280	=	38560
shoes	say		2500
			60497 say 60.50 tons

Load on shoe.

	L_0	L_{16}
Dead Load		
P18	22147	79988
Live load p20	21390	56865
	43537	136853
Cant. live	45000	137.000

Live load on L_{16}

cantilever arm	~~24450~~	p21
	29885	p22
extra reaction	6780	
between piers 5775 × 3.5 -	20200	
	56865	

Structural Steel in truss spans

Anchor spans	2 @ 60.50 tons	=	121.0
Suspended span			37.0
			158.0 tons

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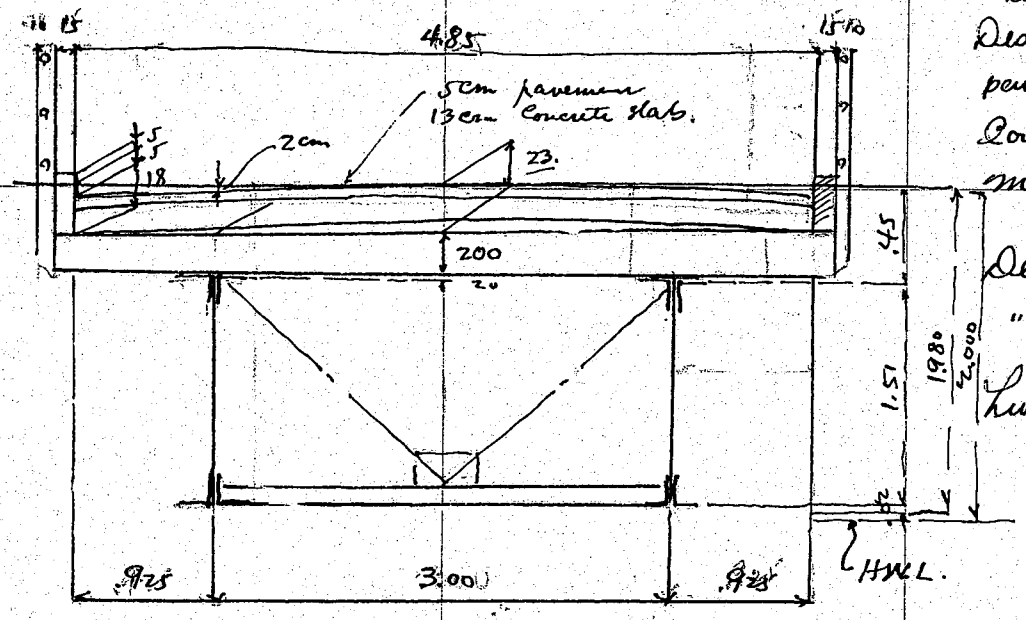
CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-ken.

Design of girder span — span length 21.21 metres — 14 @ 1.515 = 21.21
Out to out 21.53
32 cm for bearing.

Cross section of Bridge as shown below.



Design of floor slab. span length 1.515 m

Dead load
pavement 5 cm granolithic pavement @ 22 kg = 110
Concrete slab. 13 cm @ 24 kg 312
misc. concrete say 20
442

Dead load moment = $\frac{1}{10} \times 442 \times 1.515^2 = 101.5$
" " shear = $\frac{1}{2} \times 442 \times 1.515 = 335.0$

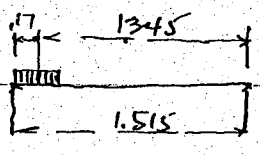
Live load motor truck loading
Rear wheel 2250
Impact 30% 675
2925 kg.
Front wheel $\frac{1}{3} \times 2925 = 975$ "

Transverse distribution b = 34 cm

Effective width $E = \frac{3}{3} l + b$ where $l = 1.515$
$= 1.35$

Load per meter Strip $2925 \div 1.35 = 2170$
Live load moment $= \frac{2170}{2} \times \frac{1.515}{2} = 823$
for continuity $= .8 \times 823 = 658$ kgm

End shear



End shear $2170 \times \frac{1.345}{1.515} = 1928$

Summary for moments and shears

	moment	shear
Dead load	101.5	335
Live load	658.0	1928
	759.5	2263

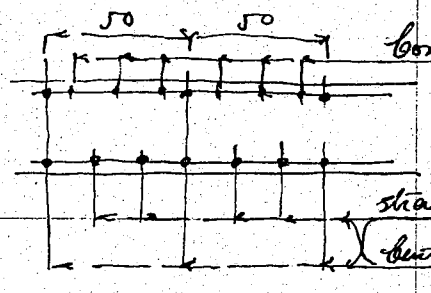
Effective depth reqd for $f_s = 1200$ kg/cm² and $f_c = 45$ kg/cm²

$R = \frac{M}{bd^2}$ $d = \sqrt{\frac{M}{bR}}$ $R = 7.18$ $d = \sqrt{\frac{759.5 \times 100}{100 \times 7.18}} = 10.3$ cm

use 13 cm slab insulation at bottom 2.5 cm

Steel area required $= \frac{759.5 \times 100}{7/8 \times 10.5 \times 1200} = 6.88$ cm² per meter strip

Spacing 13 mm bars $\frac{1.33 \times 100}{6.88} = 19.3$ cm use 1.67 cm spacing



	dia	circumference		
S_1	13 mm	4.08	× 2 =	8.16
S_2	"	"	× 8 =	32.64 16.32
S_3	"	2.85	× 6 =	17.10 11.95
				40.43

Unit Bond $= \frac{2263}{7/8 \times 10.50 \times 40.43} = 6.03$ 16.18

use plain bar.

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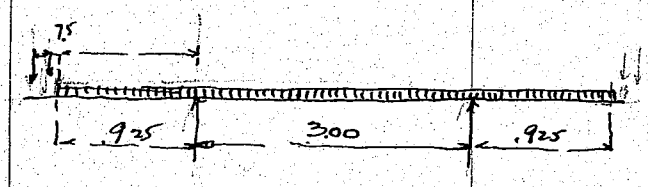
CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken.

Cross beam spacing 1.515 meters
Cantilever portion.
Dead Load



Floor slab and pavement 442 × 1.515 = 670
Coping .15 × .28 @ 2400 = say 100 152 kg per meter.
Handrail assumed 37 × 1.515 460 / 37 / 56 kg per meter
Cross beam assumed 32 kg per lin meter.

670 × .925	= 620	× .462	=	286
Coping	152	× 1.000	=	152
Handrail	56	× 1.125	=	63
	828			501
Beam 32 × 1.075 =	33	× 5.03	=	16
	861 kg.			517

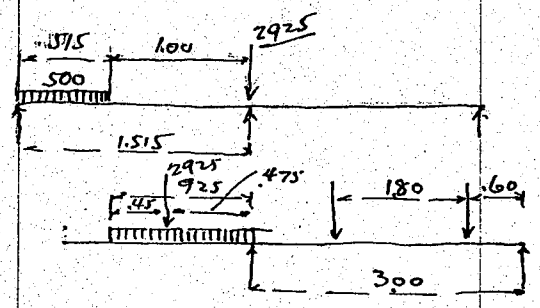
~~Extra reaction 517 × 86 ÷ 3.00 =~~
max load on support
from cantilever 861
between support & 702 × 1.5 = 105
966 kg.

Between support Floor slab and pavement 670
beam assumed 32
702 kg

$m = \frac{1}{8} \times 702 \times 3.0^2 =$ 788.0
Less moment 517.0
271.0 kgm

Live Load motor truck loading Rear wheel weight 30% impact = 2925 kg
Uniform live load 500 kg per square meter

$500 \frac{.515^2}{2 \times 1.515} = 44$



Cantilever moment 2925 × .475 = 1390
~~1.515~~ × 44 × $\frac{.925^2}{2}$ = 19
1409 kgm

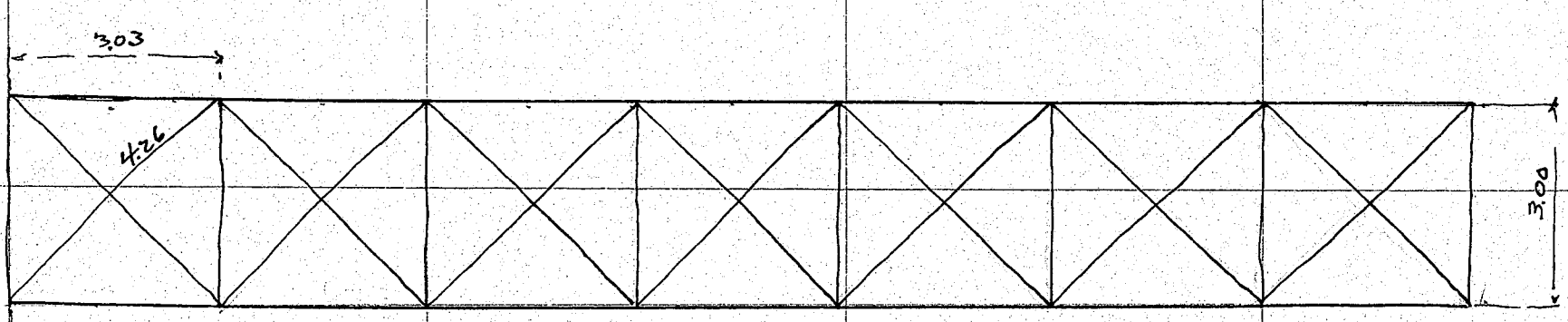
Between support 2925 × .60 = 1755
uniform load $\frac{1}{8} \times 44 \times 3.0^2$ = 49
1804

Summary for moments

	Cantilever	Center Span
Dead Load	702	271
Live load	1409	1804
	2111	2075

Section modulus regd $\frac{211100}{1100}$ = 192.0
II 200 × 100 @ 25.95 kg Sm = 217.5

Bottom Lateral Bracings



3.0^2 = 9.00
3.03^2 = 91809
18.1809 − 4.26^2

Sec θ = $\frac{4.26}{3.00}$ = 1.42

wind load 200 × 3.03 = 606. kg.
3
1818.

Diagonal stress in End panel 1818 × 1.42 = 2580 use 1L 75 × 75 × 9 = 12.690 cm

For Sway. Bottom strut. 2L 75 × 75 × 9 = 25.380 cm
braces. 1L 75 × 75 × 9 = 12.69

Transverse frame 2L 75 × 75 × 9 @ 9.96 × 2.0 = 40
2L do × 3.0 = 60
misc. 5 @ 8 40
140

140 ÷ 303 = 46 kg per lin meter.

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CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken.

Lateral Bracing 2L 75×75×9 @ 9.96 × 4.0 = 80
@ inter Connection 15
95

7@95 = 665

95 ÷ 3.03 = say 32 kg per lin. meter.

Cross Beam II 200×100 @ 25.95 kg × 5.15 = 133.5
detail say 11.5
145.0 kg.

145.0 ÷ 1.515 = 96.0.

Cross beam	96.0
Lateral Bracing	32.0
Cross frame	46.0
	174.0 kg per lin meter.

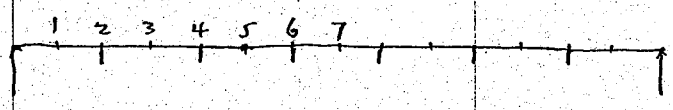
Main Girder span length 21.21 meters
Dead Load.

Floor and pavement	442 × 4.85	=	2145
Coping.	2@100	=	200
Handrail.	2@37	=	74
			2419 ÷ 2 = 1210

Structural Steel

Cross beam Lateral & Cross frame = 174.0 ÷ 2 = 87.0
Girder assumed 323.0
410.0 — — — 410
1620 kg per meter

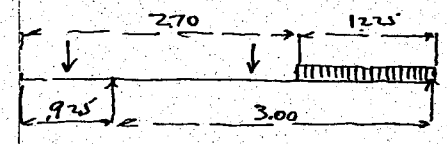
End shear say $\frac{1620}{2}$ × 21.21 = 17200 kg.



Moment at 2 $\frac{1}{2}$ × 1620 × 3.03 × 18.18 = 44500 kgm
at 4 $\frac{1}{2}$ × 1620 × 6.06 × 15.15 = 74500 "
at 6 $\frac{1}{2}$ × 1620 × 9.09 × 12.12 = 89300 "
at 7. $\frac{1}{2}$ × 1620 × 10.605 × 10.605 = 91100 "

Live Load uniform live load = $\frac{100.000}{170+21.21}$ = 523. say 500 kg. per sq meter.

Motor truck loading rear wheel 2250
Impact $\frac{20}{50+21.21}$ = 24.6% 553
2803.0 kg.
front wheel 935.0



max load on girder. 2 × 2803 × $\frac{2.575}{3.000}$ = 4810
front wheel 4810 ÷ 3 = 1603
unif load. 500 × 1.225 = 612.0
MA. reaction = 612.0 × $\frac{.612}{3.00}$ = 125 kg per lin. meter.

full uniform load 500 × $\frac{3.925^2}{2 \times 3.000}$ = 1285. kg per lin meter.
125
MB 1160 kg.

MA.	125 × 1.515	=	189.				
MB1	1160 × 0.515	=	600	600 × $\frac{.257}{1.515}$	= 101	600 − 101	= 499
MB2	" × 1.045	=	1210	1210 × $\frac{.522}{1.515}$	= 416	1210 − 416	= 794
MB3	" × 1.515	=	1760				

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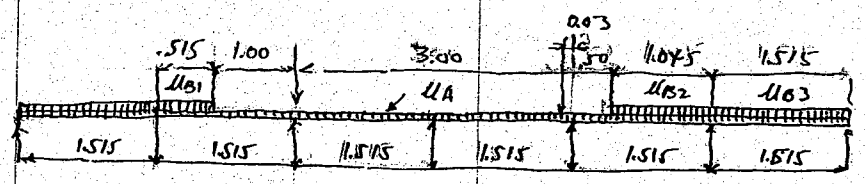
CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-ken.



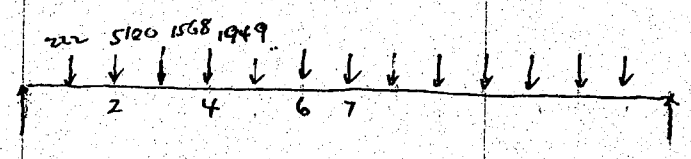
	189	189	189	189	189	189
	880					
	499	101		416	794	
					880	1760
1949	1568	290	189	605	1863	1949
		4810	33	1570		
		5100	222	2175		

Motor truck front wheel

$1603 \times \frac{1.485}{1.515} = 1570$

$1603 - 1570 = 33$

Moment at 2.

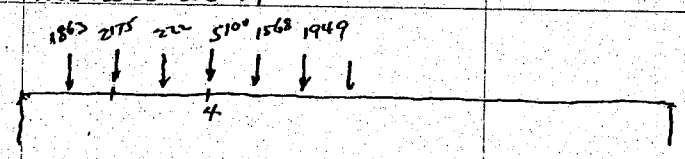


Moment. $13466 \times 3.03 = 40750$
$222 \times 1.515 = -330$
40420 kg m

Reaction

$1949 \times$	$\frac{5}{14}$	=	7660
$1568 \times$	$11/14$	=	1230
$5100 \times$	$13/14$	=	4370
$222 \times$	$13/14$	=	206
			13466

Moment at H

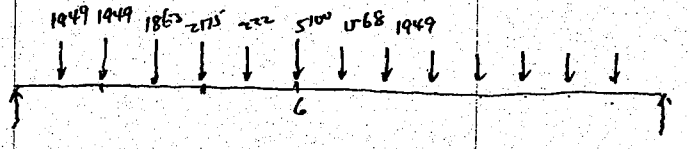


Moment $13425 \times 6.060 = 81300$
$222 \times 1.515 = 336$
$2175 \times 3.030 = 6600$
$1863 \times 4.545 = 8460$
-15396
65904 kg m

Reaction

$1949 \times$	$36/14$	=	5010
$1568 \times$	$9/14$	=	1005
$5100 \times$	$10/14$	=	3640
$222 \times$	$11/14$	=	175
$2175 \times$	$12/14$	=	1865
$1863 \times$	$13/14$	=	1730
			13425

Moment at 6

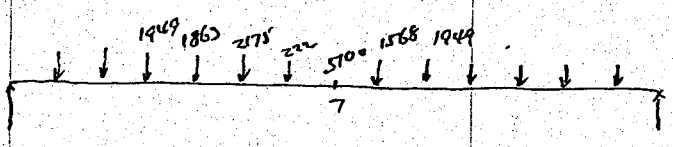


Moment $13265 \times 9.09 = 120300$
$222 \times 1.515 = 336$
$2175 \times 3.030 = 6600$
$1863 \times 4.545 = 8460$
$1949 \times 13.635 = 26550$
41946
78354 kg m

Reaction

$1949 \times$	$\frac{46}{14}$	=	6400
$1568 \times$	$7/14$	=	784
$5100 \times$	$8/14$	=	2918
$222 \times$	$9/14$	=	143
$2175 \times$	$10/14$	=	1555
$1863 \times$	$11/14$	=	1465
			13265

Moment at 7



Moment $13178 \times 10.605 = 140.000$
$222 \times 1.515 = 336$
$2175 \times 3.03 = 6600$
$1863 \times 4.545 = 8460$
$1949 \times 22.725 = 44300$
59696
80304 kg m

Reaction

$1949 \times$	$\frac{51}{14}$	=	7100
$1568 \times$	$6/14$	=	671
$5100 \times$	$7/14$	=	2550
$222 \times$	$8/14$	=	127
$2175 \times$	$9/14$	=	1400
$1863 \times$	$10/14$	=	1330
			13178

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CALCULATIONS FOR

Design of Tokiwa - Bashi for Okayama-Ken

max End shear

5100 1568 1949

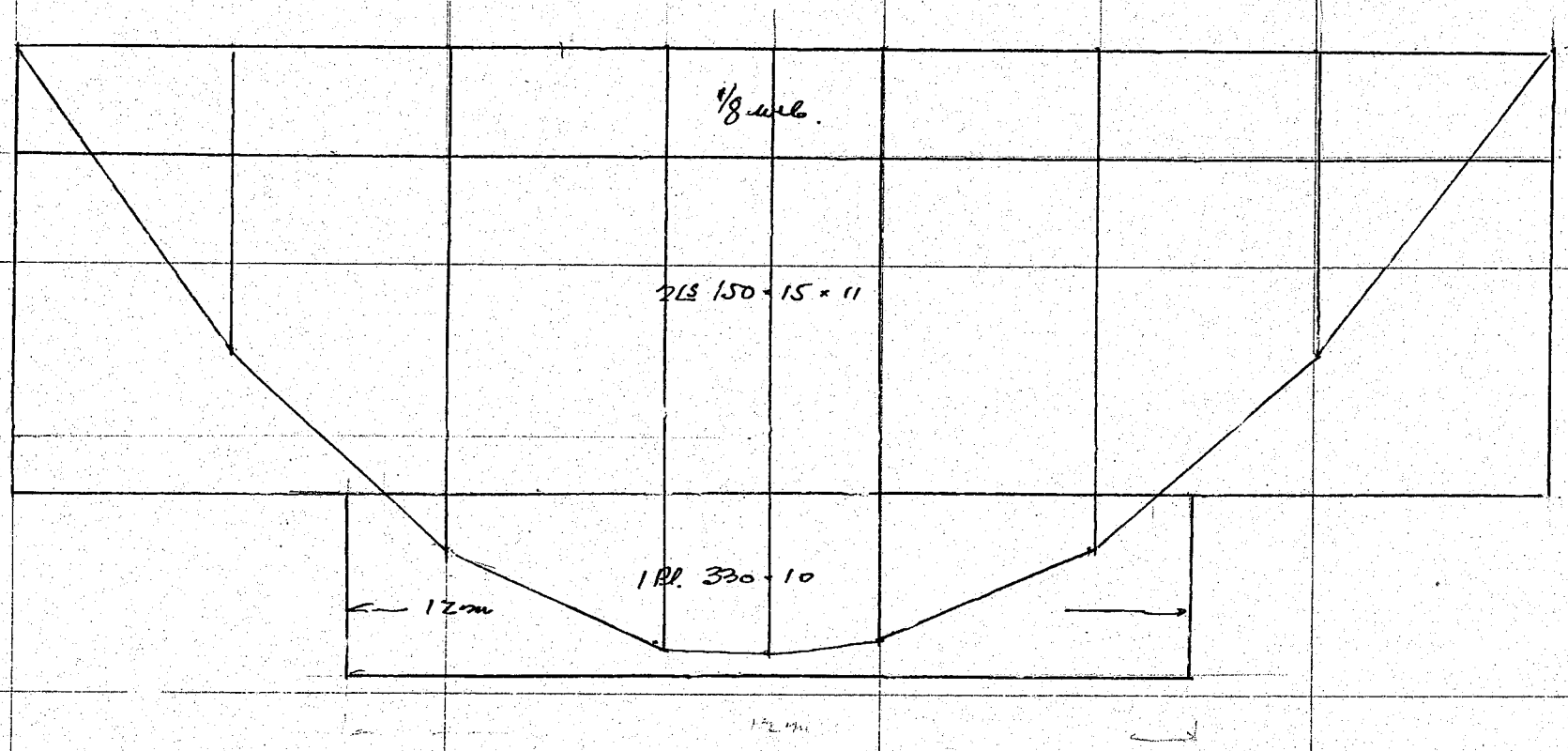
Eastern

1949 . 78/14 = 10880
1568 . 13/14 = 1455
5100
17435 kg.

Summary for moments and shears.

	②	④	⑥	center	End shear
Dead Load	44500	74500	89300	91100	17200
Live Load	40420	65900	78350	80300	17430
	84920	140400	167650	171400	34630 kg

1/100 scale.



Section of main girder.

Depth of web. 1500 × 9 = 1350 cm 1/8 web = 16.900 cm back to back 1,510 m

assumed section

2 L 150 × 150 × 11	=	63.58	× 4.07	= 258.50
1 Pl 330 × 10	=	33.00	× 0.5	= −16.50
		96.58	2.0	232.00

Effective depth 1.510 − .038 = 1.462 m.

Flange stress 171400 ÷ 1.462 = 117100 kg.

SR = 117100 ÷ 1200 = 97.3

16.9

80.84 cm net.

2 L 150 × 150 × 11	=	63.58	− 9.70	= 53.88
1 Pl. 330 × 10	=	33.00	− 4.4	= 28.60
		96.58		82.48 cm net.

Approximate weight of main girder

	1 web.	1500 × 9	@	105.98	× 21.53	= 2280
	4 L	150 × 150 × 11	@	24.95	× 21.53	= 2150
	2 Pls.	330 × 10	@	25.90	× 12.00	= 621
Int. Stiffs	26 L	125 × 90 × 10	@	16.09	× 1.50	= 627
	8 L	125 × 90 × 13	@	20.61	× 1.50	= 248
	4 fills	180 × 11	@	15.60	× 1.20	= 75
web splice	4 Pls.	300 × 9	@	21.19	× 1.20	= 101
web + flange splice.						200
Sole plates + shoes.						200
Rivet heads &c						240
						6.742 kg.

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CALCULATIONS FOR

Design of Tokiwa Bashi for Okayama-Ken.

Summary for structural steel in girder span

Cross beam	15 @ 145.0	=	2.175	
Lateral Bracing			665	
Sway frame	8 @ 140	=	1.120	
main girders	2 @ 6742	=	13.484	
			17.4444	call this 17.5 tons
	for 15 spans @ 17.5	=	262.0 tons.	

Total steel in Bridge.

Girder spans	262.0		
truss spans	158.0		
		420.0	tons
misc steel.		3.0	
		423.0	tons

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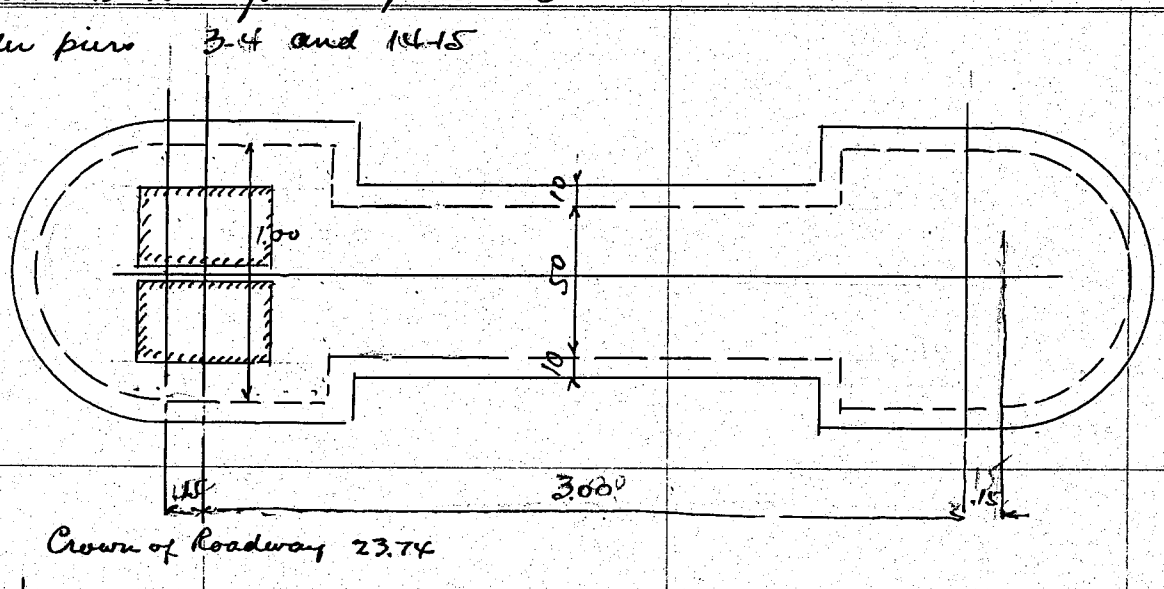
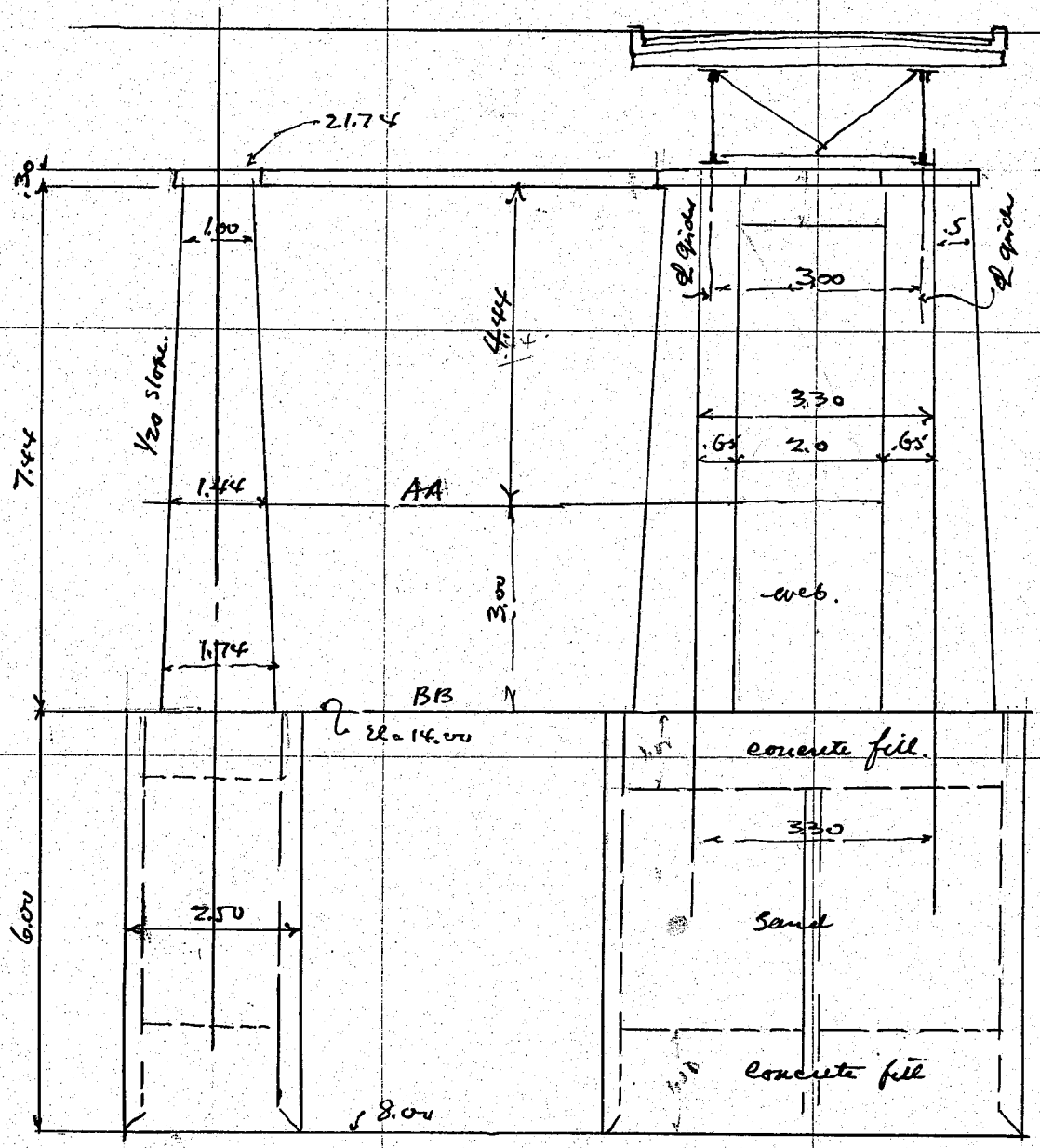
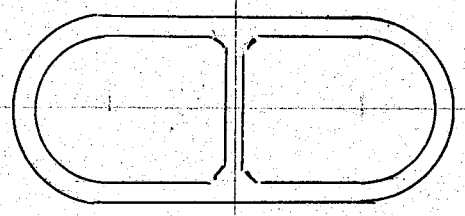
CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-ken

Design of girder piers 3-4 and 14-15







Volume of Concrete

Coping.

1.20 ϕ	=	1.13
2-.65 × 1.20	=	1.56
1.8 × .70	=	1.26
		4.19

4.13 × 0.3 = 1.24 cubic meters

Shaft.

Top area

1.0 ϕ		.78
2-.65 × 1.0	=	1.30
		2.08

Bottom

1.74 ϕ	=	2.38
2-.65 × 1.74	=	2.26
		4.64

6.72 ÷ 2 = 3.36

vol = 3.36 × 7.44 = 25.0 cubic meters

top strut.

.70 × 0.5 × 2.0 = 0.70 cubic m

web at bottom between shafts

2.0 × 0.5 × 3.0 = 3.00 cubic meters

Summary.

Coping	1.24
Shafts	25.00
top Strut	0.70
bottom web	3.00
	29.94 cubic meters

Concrete in well

well shell.	2.50 ϕ		4.91
Outside area	2.5 × 3.3	=	8.25
shell do			13.16
Inside area	1.90 ϕ	=	2.84
	1.90 × 3.3	=	6.27
			9.11
			4.05 sq meter
			.65
			4.70
Partition wall	.30 × 1.90	=	5.70
filler say.	2-.20×.20		.08
			.65

volume in well shell. 4.70 × 6.0 = 28.2 cubic meters

Top filling Inside area 9.11

partition less -.65

8.46 × 1.0 = 8.46 cubic m

Bottom filling say 8.46 × 1.5 = 12.70

21.16

Intermediate filling 8.46 × 3.5 = 29.60 " "

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CALCULATIONS FOR

Design of Tokiwa - Bashi for Okayama-Ken.

weight of coping and shaft. 29.94 @ 2200 = 66.000

well. Shell - 28.2 @ 2400 = 67600
Concrete filling 21.16 @ 2200 = 46500
Sand filling 29.60 @ 1700 = 50400

164,500
230,500 kg.

Superimposed load.
Dead load say End R. 2 @ 17200 = 34400 Load on pier = 68800 kg.
Live Load. uniform live load $\frac{100.000}{170 + 2 \cdot (21.53)}$ = 470 kg per sq meter.

Load per meter 470 . 4.85 = 2280 kg.
Full live load assumed Load on pier 2280 . 21.53 = 49000 kg.

Summary
Dead Load 68800
Live Load 49000
117800 kg.

Bottom area of well.
2.7$^{\phi}$ = 5.72
2.7 . 3.3 = 8.90
14.62 square meters

Friction of well. Circumferential area of well.
2.50$^{\phi}$ = 7.85
3.3 x 2 = 6.60
14.45 . 6.0 = 86.7 square meters.
Friction of well assumed 1000 kg per sq meter. Total friction 86700 kg.

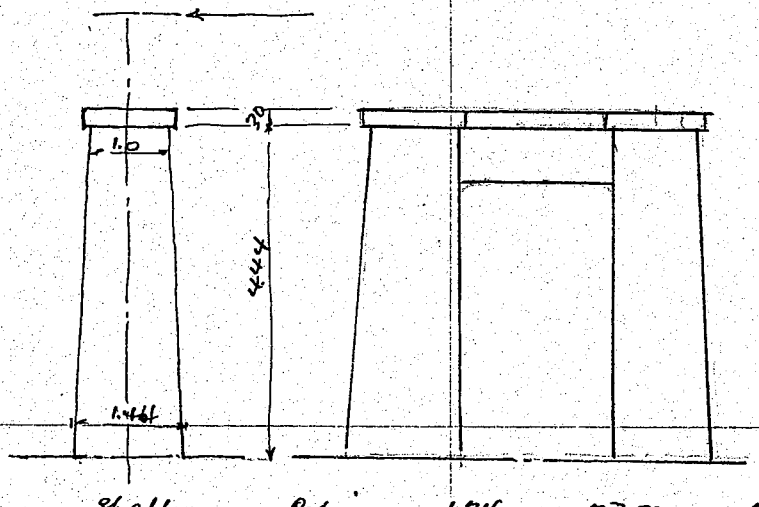
Total load on Bottom of well.
Dead and Live loads 117800
230.500
348300
Less friction 86700
261,600 kg.

Unit bearing pressure on soil 261.600 ÷ 14.62 = 17.900 kg. per sq meter
or 1.66 tons /0'

Friction of well assumed 500 kg per square meter Total friction 43300 kg.
Total load on Bottom of well 348300
-43300
305000

Unit bearing pressure on soil 305000 ÷ 14.62 = 20800 kg per sq meter
or 1.935 tons /0'

Reinforcement in the shaft due to earthquake. Seismic force assumed k = 0.1



Coping 1.24 Cubic meters
Shaft.
Top area 2.08
Bottom area 1.44$^{\phi}$ 1.63
1.44 . 1.30 = 1.82
3.45

vol. 2.08 . 4.44 = 9.15 . 2.22 = 20.30
1.37/2 . 444 = 3.04 . 1.48 = 4.50
12.19 2.04 24.80

						Arm		
Shaft.	Coping	1.24	. 2200 = 2720	x 0.1 =	272	. 4.59	=	1250
	Shaft	12.19	. 2200 = 26800		2680	. 2.04	=	54600
	Strut.	0.70	. 2200 = 1540		154	. 4.09	=	630
			31060		3106			7340

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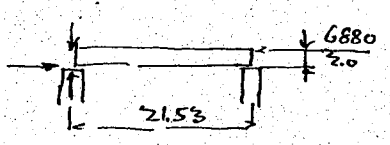
CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken

Superimposed dead Load. 68800 Hor. Force 6880 kg.



$R = 6880 \cdot \frac{2}{21.53} = 640$ kg. Horizontal $R = 6880$.

This vertical load neglected.

Moment due to Hor. force = 6880 · 4.74 = 32600
shaft say 7340
39940 tog metres.

Concrete stress as uniform section without reinforcement.

Moment of inertia of section.

$1.30 \cdot \frac{1.44^3}{12} = 0.324$
$1.44^4 \cdot 0.0049 = 0.210$
0.534

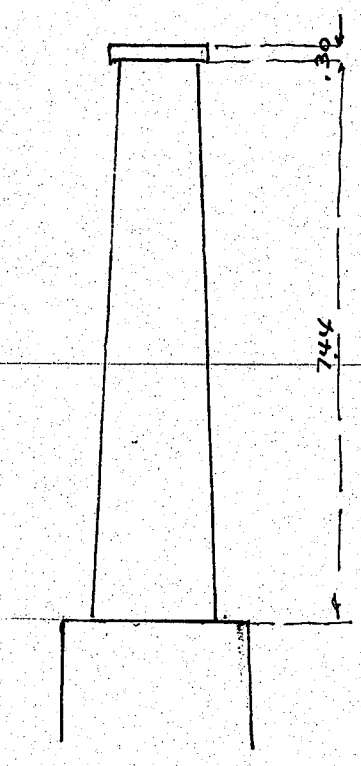
Max pressure in concrete $= \frac{39940 \cdot .72}{0.534} = 53800$ kg/m²
= 5.38 kg/cm²

Direct load
Superimposed load. 68800
weight of shaft 31060
99860
area = 3.49
unit p = 99860 ÷ 3.49 = 28700
53800
82500
8.25 tog/cm²

Approximate reinforcement in shaft due horizontal moment
Steel area $= \frac{3994000}{7/8 \times 140 \times 1200} = 27.10$ cm² not counting direct pressure.

22 mm bars $\frac{27.1}{3.8} = 7.10$ for both shafts.

Reinforcement in the shaft at top of well due to Earthquake



				arm	
coping	1.24 @2200 =	2720	· 0.1 = 272	· 7.57 =	2060
shaft	25.00	55.000	5500	· 3.25 =	17900
Steel	0.70	1540	154	· 7.09 =	1090
web.	3.00	6600	660	· 1.50 =	990
		65860	6586	3.35	22040

Moment due to Superimposed load
6880.0 · 7.74 = 53200
Shaft. 22040
75240

Area of section 4.624 sq metres
Moment of inertia of section
$1.30 \cdot \frac{1.74^3}{12} = .570$
$0.0049 \cdot 1.74^4 = .448$
1.018

Fibre stress $= \frac{75240 \cdot .87}{1.018} = 64300$ kg/m²
29000
93300 Compression or 9.33 kg/cm² C
35300 tension. 3.53 " /cm² T

Direct load.
Superimposed load 68800
wt of shaft 65860
134660
134660 ÷ 4.624 = 29000

Approximate Steel area neglecting tension in Concrete and not counting direct load
Steel area $= \frac{7524000}{7/8 \cdot 170 \times 1200} = 42.10$ cm² 22 mm bars $= \frac{42.1}{3.80} = 11.1$

Dry reinforcement 14 - 19 mm @ 2.84 = 39.80 for both sides 2 · 39.80 = 79.60

Steel % = $\frac{79.60}{40400} \cdot 100 = 0.197$ %.

Equivalent square to give same moment of inertia $b = \frac{1.018 \times 12}{1.74^3} = 2.32$ m.

$\frac{z}{k} = 0.329$ $k = \frac{0.60}{0.33}$ Coef $C_2 = \frac{0.11012}{0.0788}$

Concrete stress $f_c = \frac{75240.00}{2.32 \times 174^2 \times 0.0788} = \frac{10.60}{13.6}$ kg/cm²

Steel stress $f_s = 15 \times \frac{10.60}{13.6} \left(\frac{\frac{0.11012}{170}}{\frac{.60}{1.60} \times 174} - 1 \right) = \frac{100}{591}$ kg/cm²
1.60

1.63

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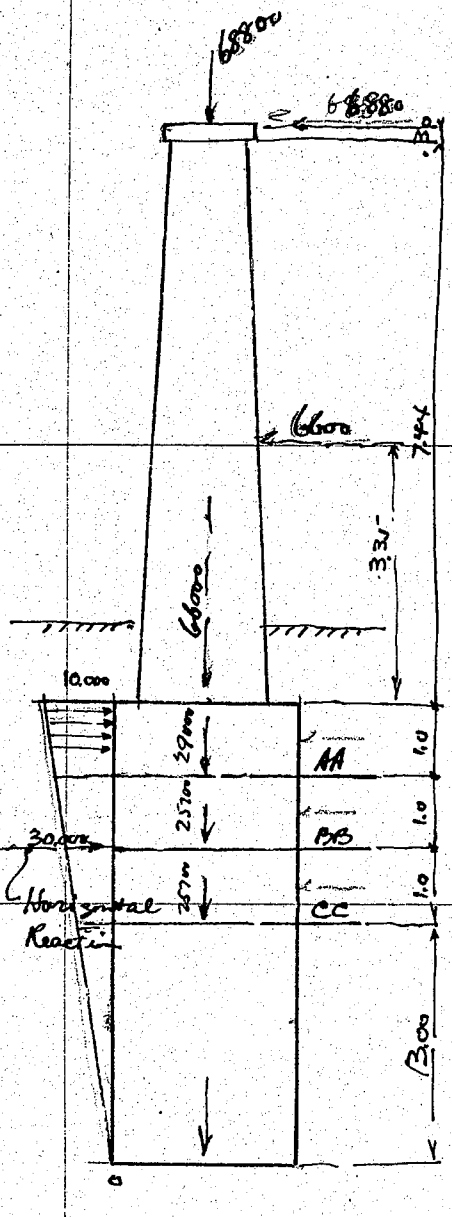
CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-ken.



Note:—
Total load at base.
say 300.000 kg.
Hor. Reaction. say 30.000 kg.
assumed distributed triangular shape as shown in sketch

electrical reinforcement in the well. Section AA of well

Superimposed Dead load	6880	× 8.74	=	60100	
Shaft	6600	× 4.35	=	28700	
well. 13.16 × 2200 = 29000	× 0.1 = 2900	× 0.50	=	1450	
					90250
negative moment					4720
8330 × 0.5 = 4160					4995
1670/2 × 0.67 = 835 560					85255 kgm.
4995					85530
4720					

Section BB.

Superimposed Dead load	6880	× 9.74	=	67000	
Shaft	6600	× 5.35	=	35300	
well 1. meter	2900	× 1.50	=	4350	
well. 4.70 × 2400 = 11300	2570	× 0.50	=	1280	
8.46 × 1700 = 14400					107930
25700 × 0.1					17770
					90160 tgm

Horizontal reaction.

moment	2 × 6670 × 1.0 =	13340
	2 × 3330/2 × 1.33 =	4430
		17770

Section CC

Superimposed Dead load	6880	× 10.74	=	74000	
Shaft	6600	× 6.35	=	41900	
well -	2900	× 2.50	=	7250	
well	2570	× 1.50	=	3860	
well	2570	× 0.50	=	1280	
	21520.				128290
					37500
					90790 tgm.

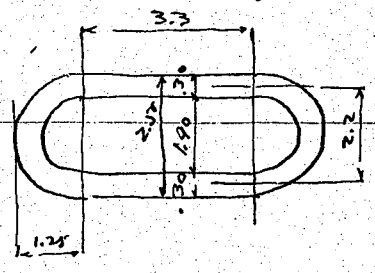
Reacting moment

3 × 5000 × 1.5 =	22500
3 × 2500 × 2.0 =	15000
	37500

Total load, section. CC. 215200 kg.

Section of well shell. 4.05 square meters $\frac{215200}{4.05} = 53100^{kg/m^2}$ .30 thick $5310 \times 0.3 = 15900^{kg/m}$

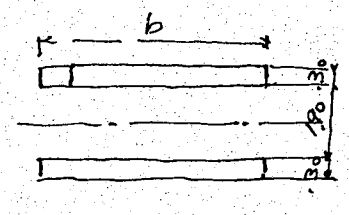
moment of inertia of section



Outside			inside		
$\frac{3.3 \times 2.5^3}{12}$	=	4.30	$\frac{3.3 \times 1.9^3}{12}$	=	1.885
0.049×2.5^4	=	1.915	0.049×1.9^4	=	0.639
		6.215			2.524

$6.215 - 2.524 = 3.691\ m^4$

Equivalent moment of inertia of straight section.



$2 \times 0.30 \times b \times 1.1^2 + 2 \times b \frac{0.3^3}{12} = I.$

$.725b + 0.0456b = .7295b = 3.691 \quad b = 5.05$ meters.

Total moment say 91.000 kgm $\frac{91000}{5.05} = 18000^{kgm/}$ per meter strip.

Stress in the ring due to Hor. moment $\frac{18000}{2.2} = 8200$ C, 8200 T

direct load 15900 C, 15900 C

9790 C. 6610 T

24100 7700 C

$fc = \frac{9790}{100 \times 30} = \frac{8.0}{327}\ kg/cm^2$

~~Steel area req'd = $\frac{16610}{1200 \times 18}$ = 3.06 a cm per meter strip~~

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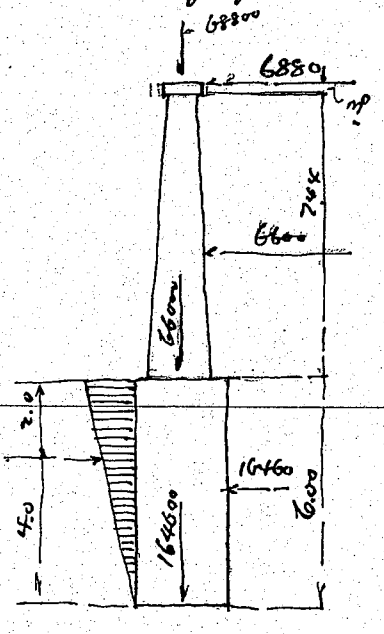
CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken.

Stability of pier during Earthquake. $k = 0.1$



well shell	67600	× 0.1	=	6760	× 3.00	=	20300
top fill. 8.46 × 2206	= 18600	× 0.1	=	1860	× 5.50	=	10220
	46500			4650			2490
bottom 21.16 × 2200	= ~~28000~~	× 0.1	=	~~2800~~	× 0.75	=	~~2100~~
Int. fill.	50400	× 0.1	=	5040	× 3.25	=	16400
	~~164600~~			~~16460~~	~~2.98~~		49020
	183100			18310	2.70		49410
					say 3.00		

Moment about bottom of well.

				arm		
Dead Load Super.	68800 × 0.1	6880	×	13.74	=	94500
Shafts.	66000	6600	×	9.35	=	61800
	183100	18310				5500
well.	~~164600~~	~~16460~~	×	3.00	=	~~49300~~
	~~299400~~ kg	~~29940~~				~~205600~~
	317900	31790				211300
	call this ~~300000~~ kg.	say 30000				
						127100
	~~299400~~ × 4 =					~~114600~~
	31790					~~85000~~ kgm.
	86700 × 2.5 =					84200

Moment of inertia of bottom of well.

$3.3 \times \frac{2.5^3}{12} = 4.30$

$0.049 \times 2.5^4 = 1.985$

6.215

$\frac{84200}{6.215} = 16800$

Jetting Stress $= \frac{86000 \times 1.25}{6.215} = 17300$ kg/m²

Driven $\frac{299400}{317900} \div 14.67 = 21700$ $\quad 20400$

37700

28500 lb/in² C or 3.57 ~~3.5~~ tons/ft.

If some frictional resistance the pressure will be reduced considerably.

Reinforcement in the well shell.

at partition wall moment taken as

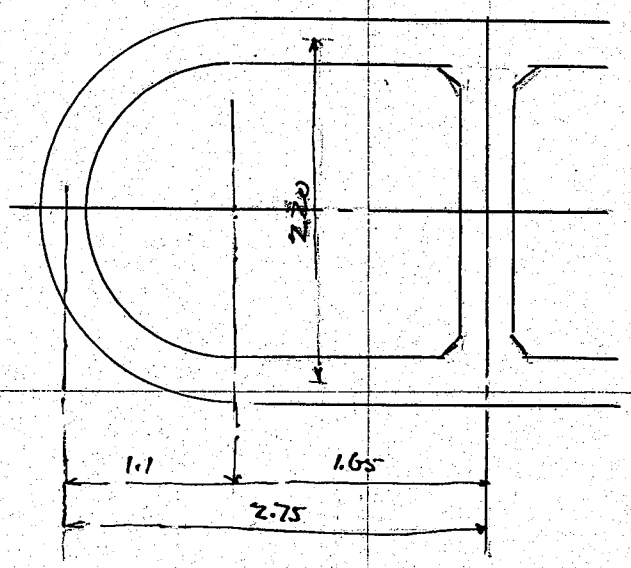
$m = \frac{1}{12} \cdot w \cdot 2.75^2$

Reinforcement in the circular ends. Same as above.

Surcharge assumed 1.0 metre above top of well.

Thickness of ring 30. cm insulation 3.0 cm.

Steel area req = $\frac{m \text{ in cm}}{\frac{7}{8} \cdot 27.0 \cdot 1200}$



Side pressure on well

			moment kg cm	Steel area req'd a cm	spacing of 13 mm bars
2.	$\frac{1}{3} \times 1700 \times 2 =$	1135 kg	71500	2.52	52.8 cm
3		1700	107000	3.78	35.2
4		2265	143000	5.05	26.4
5		2840	179000	6.31	21.1
6		3400	214000	7.55	17.6
7		3970	250000	8.82	15.1
8		4530	286000	10.10	13.2
9		5100	322000	11.35	11.7
10		5670	358000	12.60	10.6

Girder Piers 1-2 and 16-17.

Height of shaft. 1 metre less. Below 8m use same side pressure as temporary work.

Detail of well same as above.

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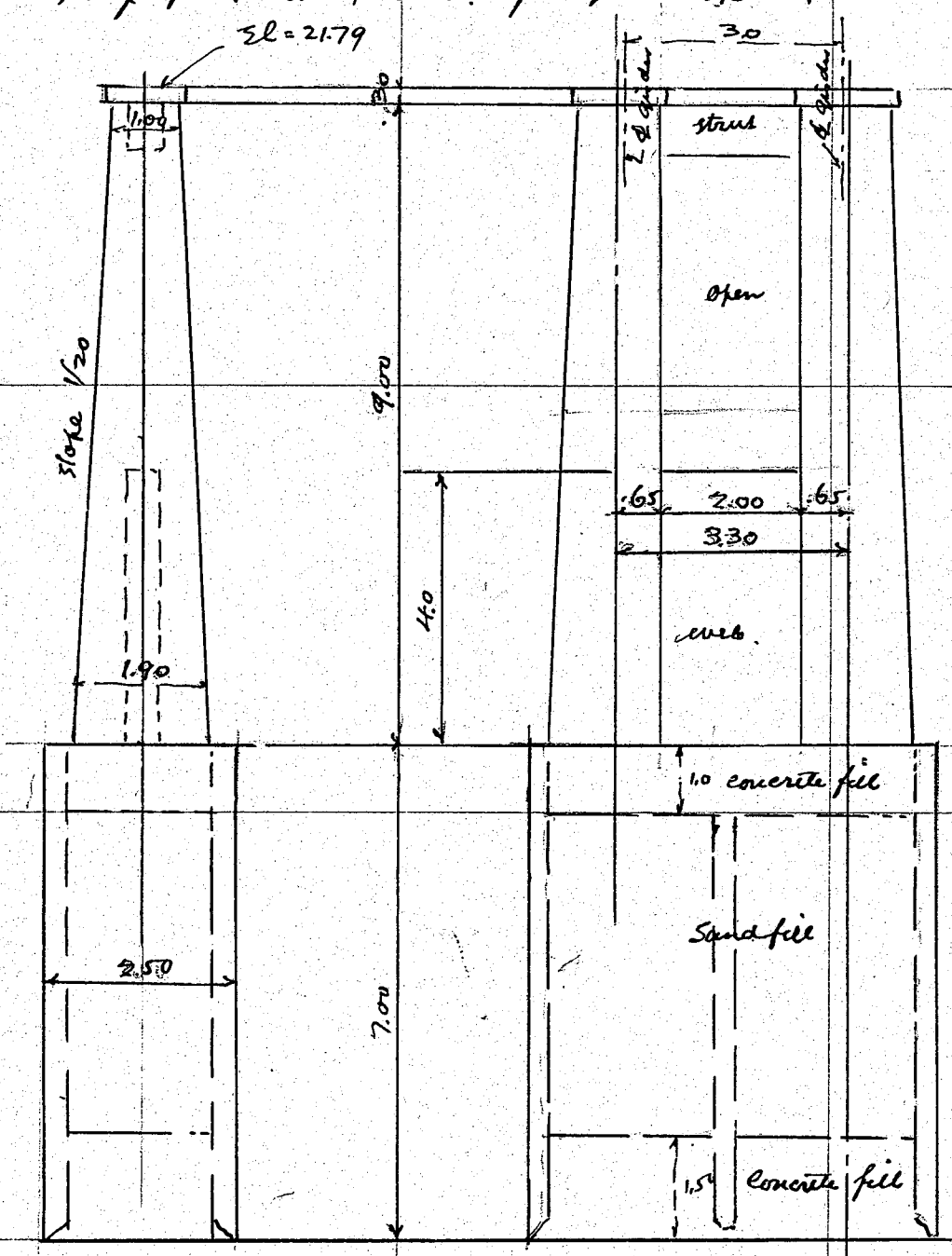
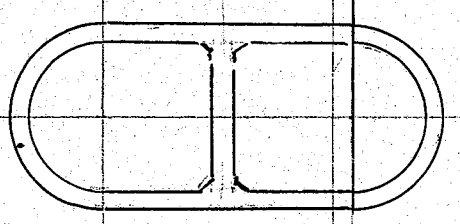
CALCULATIONS FOR

Design of Tokewa-Bashi for Okayama-Ken
Design of piers nos 9 to 13. for girder spans.





Volume of Concrete
Coping - 4.13 × 0.3 = 1.24 cubic m

Shaft
Top area 1.0^d .78
2 × .65 × 1.0 = 1.30
2.08

bottom 1.90^d 2.84
2 × .65 × 1.90 = 2.47
5.31
7.39

Average 7.39 ÷ 2 = say 3.70
vol = 3.70 × 9.0 = 33.3 cubic meters

~~top~~ Strut = 0.70 cubic meters

Bottom web.
2.0 × 0.5 × 4.0 = 4.0 cubic meters

Summary
coping 1.24
shaft. 33.30
strut 0.70
web. 4.00
39.24 cubic meters

Concrete in well.

vol in shell 4.70 × 7.0 = 33.0

Top filling 8.46 × 1.0 = 8.46
~~bottom~~ filling 8.46 × 1.5 = 12.70
21.16

Intermediate filling
8.46 × 4.5 = 38.10 cubic meters

weights of pier
coping and shaft 39.24 × 2200 = 86400
94200
well shell 33.0 × 2400 = 79100
Concrete fill. 8.46 × 2200 = 18600
" " 12.70 × 2200 = 27900
Sand fill. 38.10 × 700 = 64700

189300
283500 kg.
275900

Superimposed dead load 68800
Live load 49000

117800
401300 kg
393500

Total load

Bottom area of well 14.62 Square meters
Circumferential area of well. 14.45 × 7.0 = 101.0 square meters

Friction of well assumed 1000 kg/m^2
Summary load at bottom

Ds Live load 393500
401300
friction less 101000
300300 kg.
292500

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CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-ken.

Unit bearing pressure on soil = ~~292500~~ ~~300300~~ ÷ 14.62 = ~~20.000~~ ~~20500~~ kg/m²
or ~~1.91~~ 1.86 tons/0'

Reinforcement in the shaft at the top of well. due to Earthquake.

Shaft.; Coping	1.24	× 2200	=	2720	× 0.1 = 272	× 9.15	=	2490
Shaft.	33.30	"	=	73300	7330	× 3.84	=	28100
Street	0.70	"	=	1540	154	× 8.65	=	1330
web.	4.00	"	=	8800	880	× 2.00	=	1760
				86360	8636	3.90		33680

Moment due to Super imposed load 6880. × 9.3 = 64000
Shaft. 33680
97680

Dried load. Superimposed dead load 68800
Shaft. 86360
155160 kg.

Cross sectional area of shaft. 5.31 m²
Dried pressure 155160 / 5.31 = 29200

Moment of inertia of section.

1.30 × 1.90³/12 = 0.744
0.0049 × 1.90⁴ = 0.639
1.383

Fibre stress = 97680 × .95 / 1.383 = 67000
29200
96200 Compression 9.62 kg/cm² C
37800 tension 3.78 kg/cm² T

Dry reinforcement. 14 - 19mm ø 2.84 = 39.80 for both sides 2 × 39.80 = 79.60 cm²

Steel % = 79.60 × 100 / 242 × 190 = 0.173 %

Equivalent width to give same moment of inertia.
h = 1.383 × 12 / 1.90³ = 2.42 m.

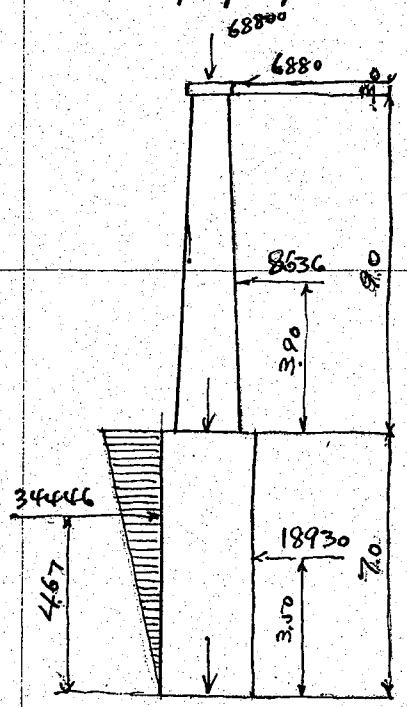
Eccentricity = 97680 / 155160 = .630 e/h = .630 / 1.90 = .332

k = 0.59 C₂ = 0.0995

Concrete stress fc = 9768000 / 242 × 190² × 0.0995 = 11.20 kg/cm²

Steel stress fs = 15 × 11.20 (186 / .59 × 190 − 1) = 111 kg/cm²

Stability of pier during Earth quake k = 0.1



moment about bottom of base.

Dead Load	Superimposed load	68800	× 0.1 =	6880	× 16.3	=	112000
	Shaft	86360	=	8636	× 10.9	=	94200
	well	189300	=	18930	× 3.5	=	66200
		344460		34446			272400
Less moment		34446 × 4.67 =					− 161.000
							111,400 kgm.

Frictional couple not counted.

Moment of inertia of bottom of well p38 6.215

Fibre stress = 111400 × 1.25 / 6.215 = 22400 kg/m²
Direct load 344460 ÷ 14.62 = 23600
46,000 kg/m² or 4.28 tons/0'

Note:- This bearing pressure shall be reduced if count the frictional resistance.

Reinforcement in ring of well

Surcharge 1.0 meter for figure see page 38.0

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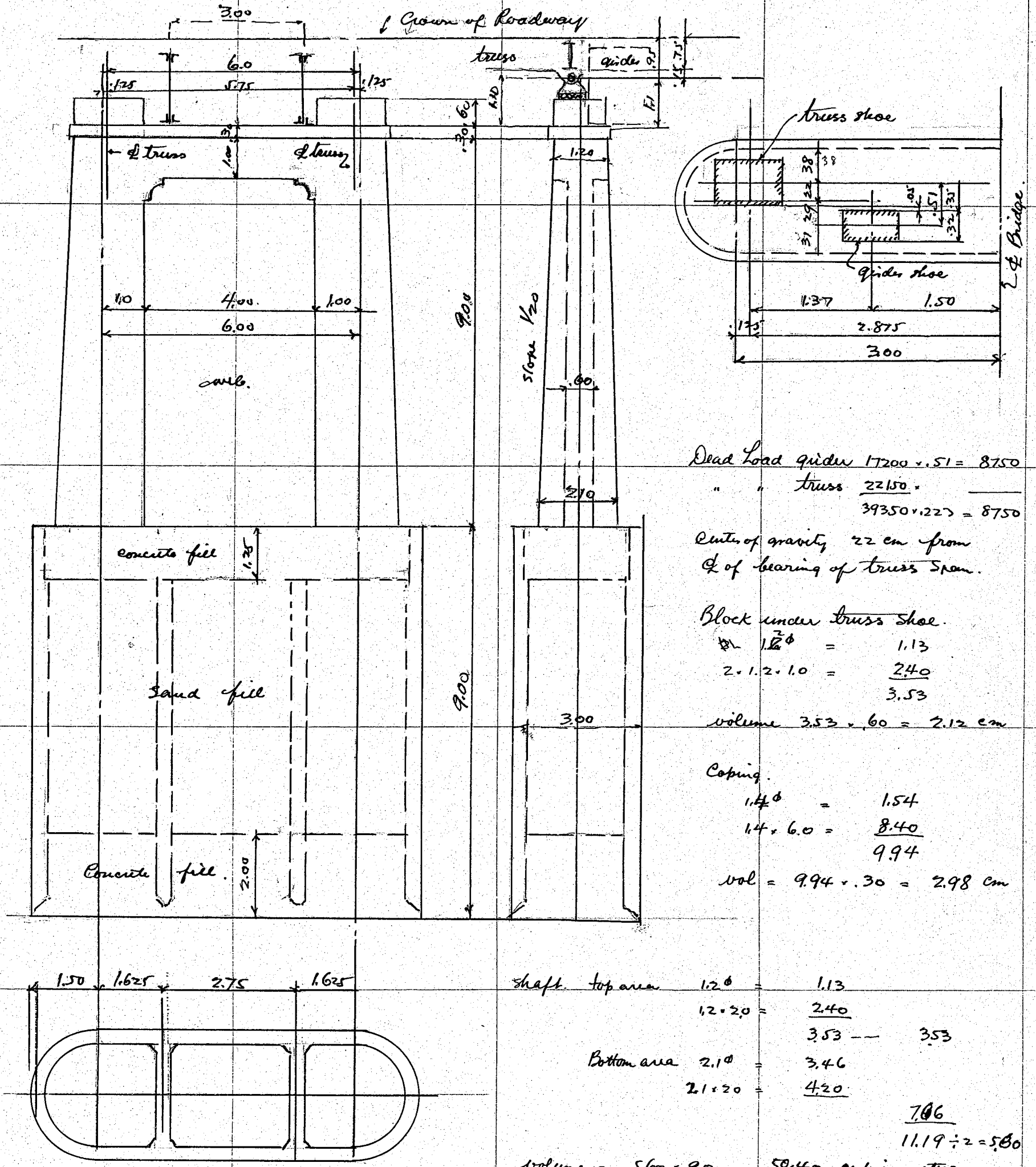
CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken.
Design of piers - 5 and 8.



Dead Load girder 17200 × .51 = 8750
" " truss 22150 ×
39350 × .223 = 8750

Center of gravity 22 cm from
℄ of bearing of truss span.

Block under truss shoe.
1.2² ϕ = 1.13
2 × 1.2 × 1.0 = 2.40
3.53
volume 3.53 × .60 = 2.12 cm

Coping.
1.4 ϕ = 1.54
1.4 × 6.0 = 8.40
9.94
vol = 9.94 × .30 = 2.98 cm

shaft top area 1.2 ϕ = 1.13
1.2 × 2.0 = 2.40
3.53 — 3.53
Bottom area 2.1 ϕ = 3.46
2.1 × 2.0 = 4.20
7.66
11.19 ÷ 2 = 5.60
volume = 5.60 × 9.0 = 50.40 cubic metres
Top strut under coping.
1.00 × 1.25 about × 4.00 = 5.00 cubic meters
web 0.60 × 4.0 × 8.0 = 19.20 " "

Summary

block	2.12	@ 2200 =	4660	× 9.60	= 44800
coping	2.98	=	6550	× 9.15	59900
shaft	50.40	=	111000	× 3.94	437000
strut	5.00	=	11000	× 8.50	93500
web.	19.20	=	42200	× 4.00	169000
	79.70		175410	4.57	804200

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CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken.

Concrete in well.

Outside 3.0 ϕ = 707 inside 2.4 ϕ = 452 partition
3.0 × 6.0 = 18.00 2.4 × 6.0 = 8.4 .30 × 2.4 = .72
25.07 12.92 2-.20×.20 .08
− 12.92 12.92 − 1.60 = 11.32 .80
12.15 2@.80 = 1.60.

Sectional area of well shell. 12.15 + 1.60 = 13.75
volume = 13.75 × 9.0 = 124.0 cubic meters.

Top concrete filling 11.32 × 1.25 = 14.15 cubic meters
bottom " " 11.32 × 2.00 = 22.64 " "
Int. Sand filling 11.32 × 5.75 = 65.00 " "

weight of well.

Shell.	124.0	@ 2400	=	298000
Concrete filling top	14.15	@ 2200	=	31100
bottom	22.64	"	=	49800
Sand filling intermediate	65.00	@ 1700	=	110700
				489600
Shaft.				175410
Total wt of pier.				665010 kg.

Dead Load on pier.

Dead load from girder span 2@17200 = 34400
" " " truss span 2@22150 = 44300
78700 kg.

Live load. Uniform live load $w = \frac{100.000}{170 + (40 + 21.53)} = 432$ kg per square meter.

Total load 432 × 4.85 × $\frac{61.53}{2}$ = 64300.
Dead Load 78700
143.000 kg.

Friction of well 1000 kg per square meter
Circumferential area 3.0 ϕ = 9.42
6.0 × 2 = 12.00
21.42 × 9.0 = 193.0

Frictional force 193000 kg.

Load on base. Superimposed load. 143.000
weight of pier 665.000
808.000
Less friction 193.000
615.000 kg.

Bottom area of well. 3.20 ϕ = 804
3.20 × 6 = 19.20
27.24

Unit bearing on soil.
615.000 ÷ 27.24 = 22600 kg/m²
2.10 tons/0'

Seismic force from dead load. truss span 44300 × 0.1 = 4430
girder span 34400 × 0.1 = 3440
vertical reaction neglected.
Point of application @ pin for truss span
" " " top of pier for girder span.

moment due to earthquake at top of well

Dead load truss span	44300	× 0.1 =	4430	× 10.40	=	46.000
" " girder span	34400		3440	× 9.30	=	32.000
" " shaft.	175400		17540	× 4.57	=	80420
	254100		25410	6.23		158.420 kgm.

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MADE BY J. Masuda DATE 3-10-1 **FILE NO** ____
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CALCULATIONS FOR

Design of Jokiwa - Bashi for Okayama-Ken

Sectional area 7.66 sq. meters.

moment of inertia of section. $\frac{2.00}{600} \times \frac{2.10^3}{12} = 1.547$ ~~4.625~~

$0.049 \times 2.10^4 = 0.950$

~~5.575~~ 2.497

Equivalent square to give same moment of inertia $b = \frac{\frac{2.497}{5.575} \times 12}{2.10^3} = 3.23$ m.

Dried load. $254100 \div 7.66 = 33200$ Fibre stress $= \frac{158420 \times 1.05}{\frac{5.575}{2.497}} =$ 66500 / 33200 / 99700 comp. 9.97 kg/cm² C / 33300 tension 3.33 " T

Approximate Steel area neglecting tension in concrete and not counting direct load.

Steel area $= \frac{15842000}{7/8 \times 205 \times 1200} = 73.50$ □ cm.

Try 18 - 19 mm @ 2.84 = 51.0 for both sides $2 \times 51.0 = 102.0$ □ cm

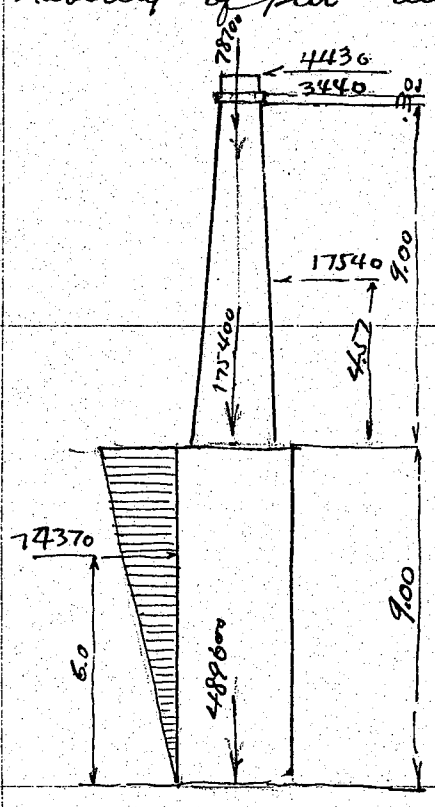
Steel % $= \frac{102.0 \times 100}{210 \times 323.} = 0.15\%$

$\Sigma c = \frac{158420}{254100} = 0.625$ $\Sigma/k = \frac{0.625}{2.10} = .298$ $k = 0.66$ $C_2 = 0.0999$

Concrete Stress $fc = \frac{15842000}{323 \times 210^2 \times 0.0999} = 11.12$ kg/cm²

Steel stress $fs = 15 \times 11.12 \left(\frac{205}{0.66 \times 210} - 1 \right) = 80$ kg/cm²

Stability of pier during Earthquake.



44300	× 0.1 =	4430	× 19.40 =	86000
34400	=	3440	× 18.30 =	63000
175400	=	17540	× 13.57 =	238000
489600	× 0.1 =	48960	× 4.5 seq =	220.000
743700		74370		607000
	74370 × 6.0 =			− 446000
				161,000

Area of base. 27.24 sq meters.

moment of inertia of section

$6.00 \times \frac{3.23}{12} = 16.37$

$0.049 \times 3.2^4 = 5.15$

21.52

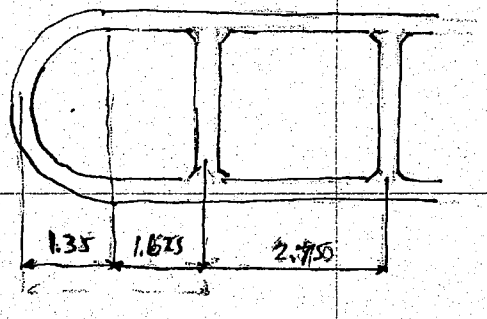
fibre stress $= \frac{161.000 \times 1.60}{21.52} = 12000$

Direct load $743700 \div 27.24 = \frac{27300}{39300}$ kg/m² or 3.65 tons/10 unit

This bearing pressure will be reduced if count the frictional resistance.

No tension on bearing; vertical reinforcement in the well will take no tensions.

Reinforcement in the ring.



Between partitions moment taken as

$m = \frac{1}{12} w s^2$ assumed

Reinforcement in the circular ends. Same as above.

Surcharge 1.0 meter above top of well.

Thickness of ring 30 cm insulation 3 cm

For reinforcement see page 38.0

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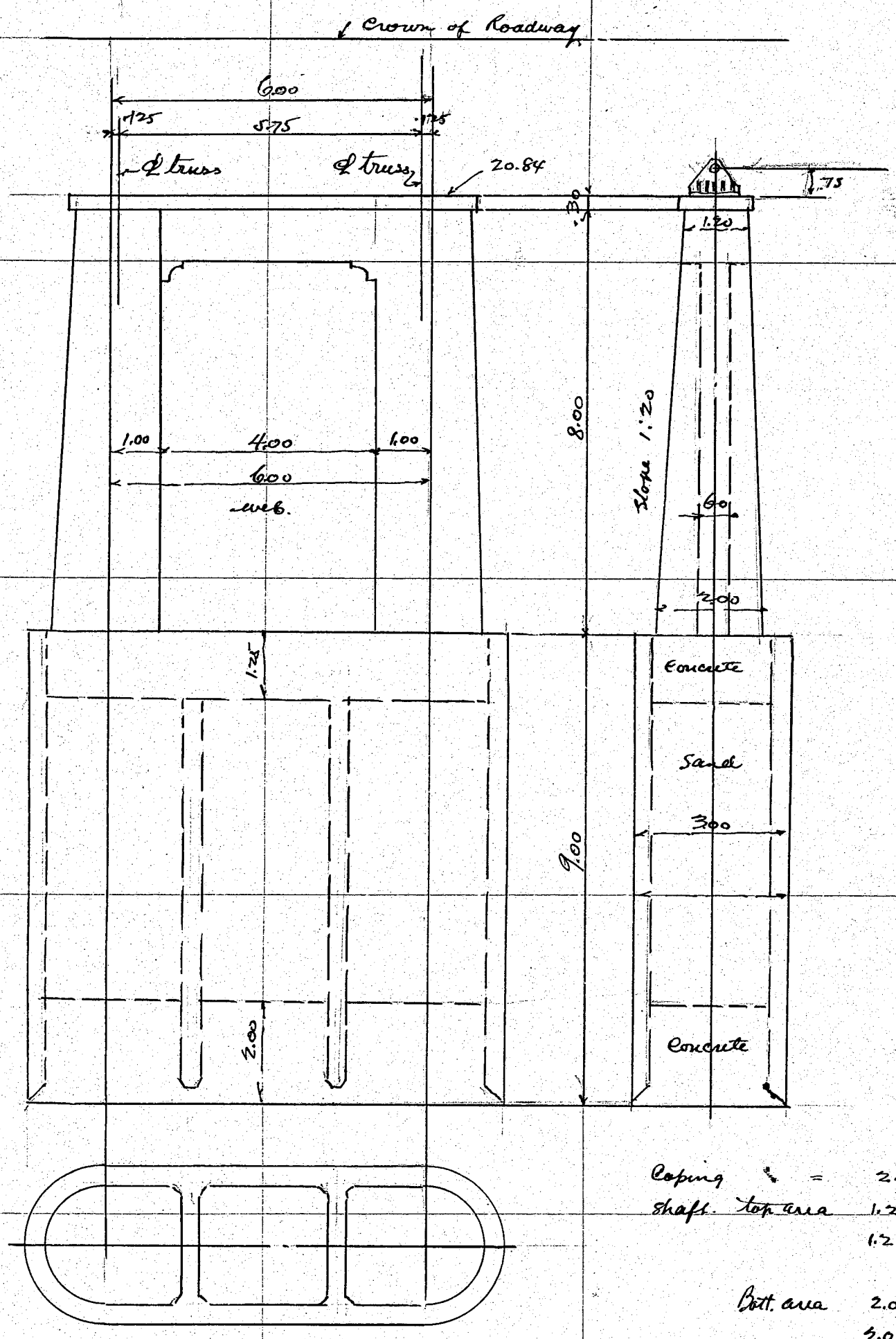
CALCULATIONS FOR

Design of Tokeiwa-Bashi for Okayama-Ken.

Design of piers 6 and 7



Coping ⅄ = 2.98 cubic meters
Shaft. top area 1.2 ϕ = 1.13
1.2 × 2.0 = 2.40
3.53
Bott. area 2.0 ϕ = 3.14
2.0 × 2.0 = 4.00
7.14
10.68 ÷ 2 = 5.34

volume = 5.34 × 8.0 = 42.75 cubic meters.

Top stout under coping
1.00 × 1.25 about × 4.00 = 5.00 cubic meters
web. 0.60 × 4.0 × 7.0 = 16.80 cubic meters

Summary

coping	2.98	@	2200	=	6550 / 2660	×	8.15	= 534.00
shaft	42.75	@		=	94000	×	3.56	= 335.000
stout	5.00	@		=	11000	×	7.50	= 82.500
web.	16.80	@		=	37000	×	3.50	= 129600
	67.53				148550		4.024	900500

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CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken.

Well : same as p42

weight of well.

Shell	1240	@ 2400	=	298.000
Concrete filling top	14.15	@ 2200	=	31100
" " bottom	22.64	"	=	49800
Sand filling intermediate	65.00	@ 1700	=	110700
	225.79			

489600
148550
Total weight of pier 638150

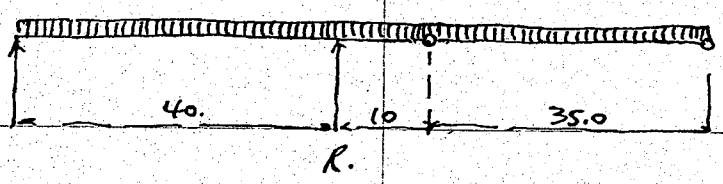
Dead load on pier

page. 27 80.000 × 2 = 160.000 kg.

Live Load Uniform live load on two span and one suspended span fully loaded.

$w = \frac{100.000}{170+85} =$ 377 kg per sq meter.

Assume 400 kg per sq. meter. × 4.85 = 1940 kg per lin meter of span.



End reaction suspended span 1940 × 17.5 = 34.000

max reaction R

$1940 \times \frac{50.0^2}{2 \cdot 40} =$ 60700

$34.000 \cdot \frac{50}{40} =$ 42500

103200 kg.

Summary

Dead Load	say	~~638400~~	160.000
Live Load		~~1032~~	103200
			263200

Superimposed load. 263200
weight of pier 638100
Total 901300 kg.
Friction of well. p42 193000
708300

Unit bearing on soil = 708300 ÷ 27.24 = 26000 kg/m²
2.42 tons/0'

Seismic force Moment due to seismic force at top of well.

Superimposed Dead Load	160.000 × 0.1	=	16000	· 9.05	=	145000
" shaft	$\frac{148550}{308550} \times 0.1$	=	14855	· 4.04	=	60050
						205050 kg meter.

Direct load on pier due to seismic force neglected.

Sectional area 7.14 sq meters
moment of inertia of section

2.00 × $\frac{2.0^3}{12}$	=	1.333
0.049 × 2.0^4	=	0.785
		2.118

Equivalent square to give same moment of inertia $b = \frac{2.118 \times 12}{2.0^3} =$ 3.16 m

Direct load 308550 ÷ 7.14 = 43200 kg/m² Fibre stress $\frac{205050 \times 1.0}{2.118}$ = 97000

43200
140200 C 14.02 kg/cm²
53800 T 5.38 "

Try 18-19 mm bars @ 2.84 = 57.0 For both sides 102.0 0 cm

steel % = $\frac{102. \times 100}{316 \cdot 200} =$ .161 %

Eccentricity = $\frac{205050}{308550} =$ 0.665 $e/h = \frac{0.665}{2.00.} =$ .333 $k =$ 0.58 Coef = 0.0984

Concrete Stress $f_c = \frac{205050}{316 \times 200^2 \times 0.0984} =$ 16.5 kg/cm²

Steel Stress $f_s = 15 \times 16.5 \left(\frac{195}{0.58 \times 200} - 1 \right) =$ 168 kg/cm²

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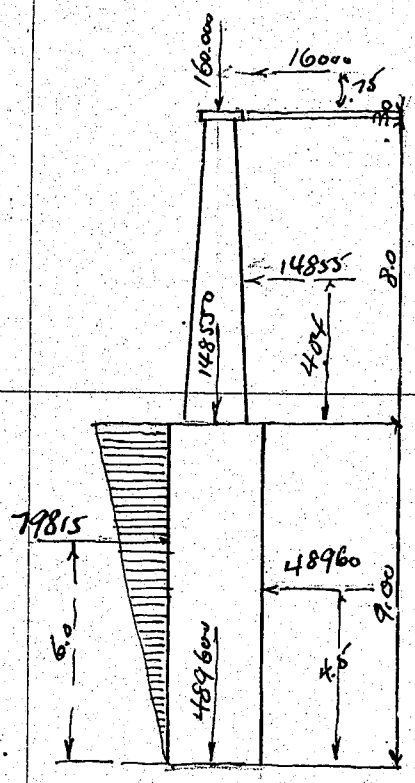
CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken.

Stability of pier during Earthquake.



160000	× 0.10 =	16000	× 18.05	=	289,000
148550	× 0.10 =	14855	× 13.04	=	194.000
489600	× 0.10 =	48960	× 4.50	=	221,000
79815		79815			704000
		79815 × 6.0		−	479000
					225000

Area of base 27.24 sq metres.

Moment of inertia 21.52 m^4

Fibre stress = $\frac{225000 \times 1.60}{21.52}$ = 16700

Direct load 79815 ÷ 27.24 = 29300

46000 kg/m^2 4.28 tons/ft^2

This ~~limit~~ bearing pressure will be reduced if count the frictional resistance of well. No tension for well.

Reinforcement same as for Pier nos 5 and 8

Stability during floord water level at top of coping.

volume of pier. shafts. 67.53

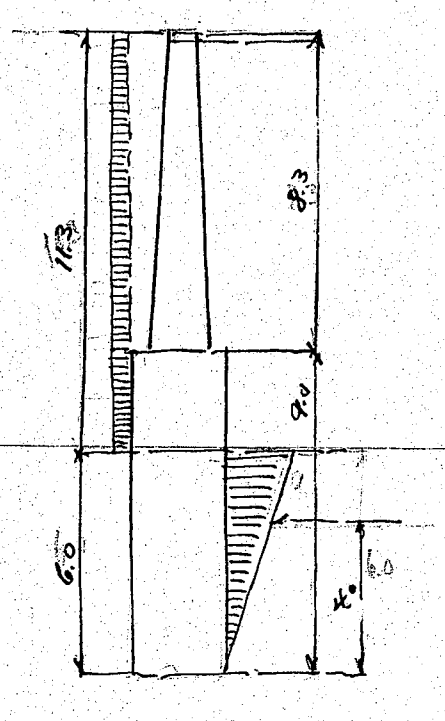
well. say. 225.79

293.32 @1000 = 293320 kg.

Weight of pier and superimposed load 798150

less buoyancy −293320

504830 kg. ÷ 27.24 = 18500 kg per sq m.



velocity assumed 3.14 metre per second.

Horizontal force = $\frac{1000}{9.8} \cdot 3.14^2$ = 1000 kg per sq metre.

Component for 15° Skew. 1000 × .259 = 259 kg/m^2

Total pressure assumed 259 × 8.0 × 11.3 = 23450 kg

Moment = 23450 × 11.65 = 273000

4 × 23450 = 93700

179300 kgm.

Fibre stress = $\frac{179300 \times 1.60}{21.52}$ = 13350

18500

31850 C = 2.96 tons/ft^2

5150 C

Direct p

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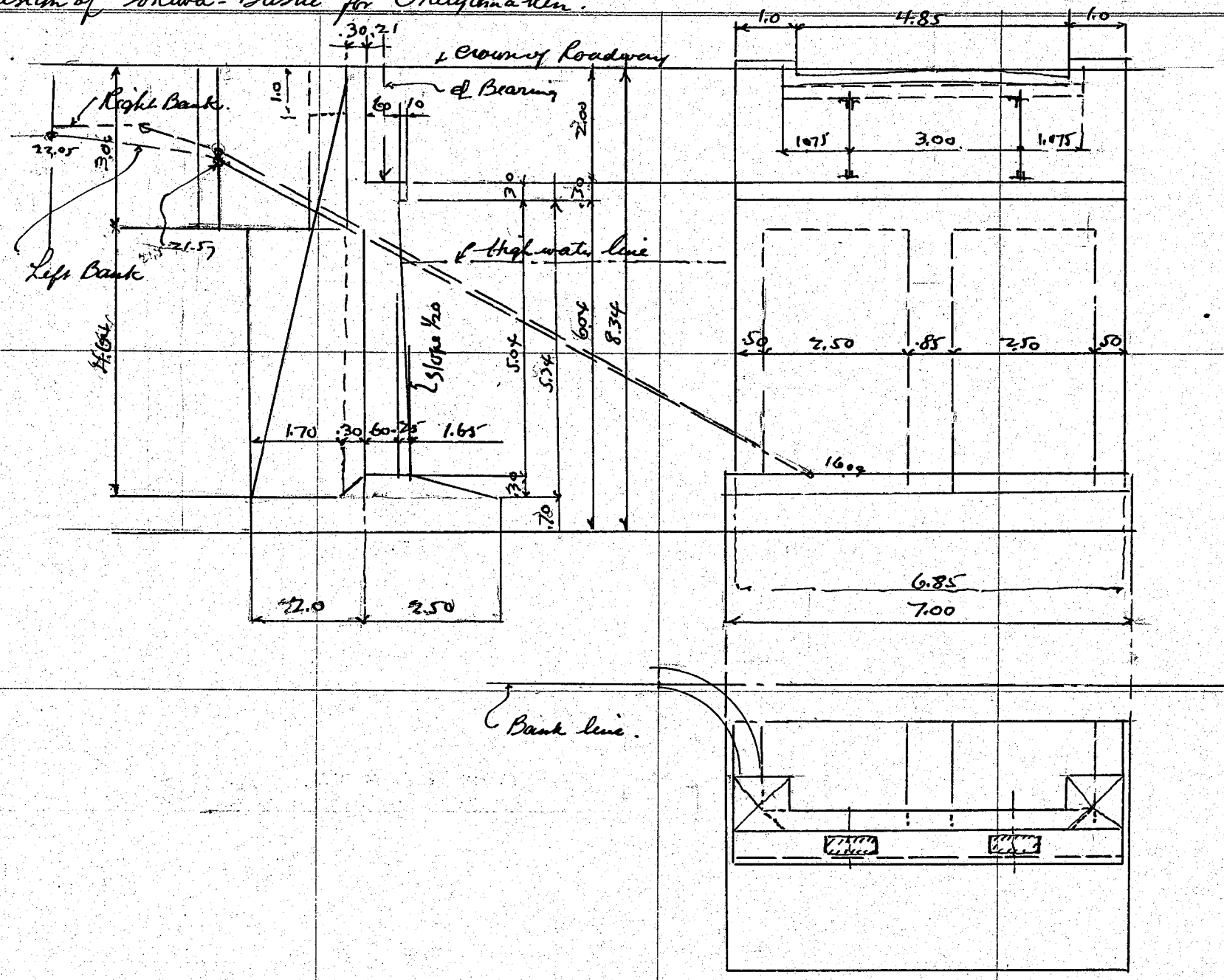
CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-ken.



						Wt		Arm		Moment
1	Parapet wall.	3.0 · 0.3 · 5.85	=	5.26	@ 2400 =	12600	·	1.85	=	23300
2	Under pedistal	2 - .70 · .50 · 1.00	=	1.70		1680		1.35	=	2270
3	Coping	.70 · .30 · 6.85	=	1.44		3460		2.35		8120
4	Shaft	.60 · 5.04 · 6.85	=	20.80		50.000		2.30		115000
5	"	$\frac{.25}{2}$ · 5.04 · 6.85	=	4.31		10320		2.68		27700
6	Base	.70 · 4.50 · 7.00	=	22.10		53000		2.25		119000
7	" fillet	.30 $\frac{.30}{2}$ · 7.00	=	0.31		745		1.90		1420
8	"	.30 · .85 · 7.00	=	1.78		4270		2.42		10300
9	"	$\frac{.30 \cdot 1.65}{2}$ · 7.00	=	1.73		4150		3.40		14100
10	Wing	2 - 4.64 · .50 · 2.0	=	9.28		22200		1.00		22200
11	"	2 - .5 · 1.0 · 3.0	=	3.00		7200		1.50		10800
12	"	2 - .3 · 3.0 · 3.0	=	5.40		12960		0		
13	Bathuss	$\frac{1.70 \cdot 7.34}{2}$ · .85	=	5.30		12700		1.13		14350
14	"	.30 · 4.64 · .85	=	1.18		2830		1.85		5240
				82.59		198.115		1.88		373.800 kg

Earth fill assumed	front	1.70 · 3.5 · 7.0	=	41.7	@ 1600 =	66.700	·	3.65	= 243.000
	rear	2.0 · 7.0 · 7.5	=	105.0	@ " =	168.000	·	1.00	= 168.000
Superimposed load						60.400	·	2.21	= 133.500
Dead load				344.00		198.115			= 373.800
Live Load		4.85 · 5.00 · $\frac{21.53}{2}$	=	26000		493215	·	1.86	= 918300
				60400 kg					

Earth pressure cwt = 1600 kg per cubic meter 1 metre surcharge assumed.

Hor. P	1 meter	$\frac{1}{3}$ · 1600 · 1.0 =	530 kg
" "	9.34	$\frac{1}{3}$ · 1600 · 9.34 =	4986 "
			4450 "

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CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken.

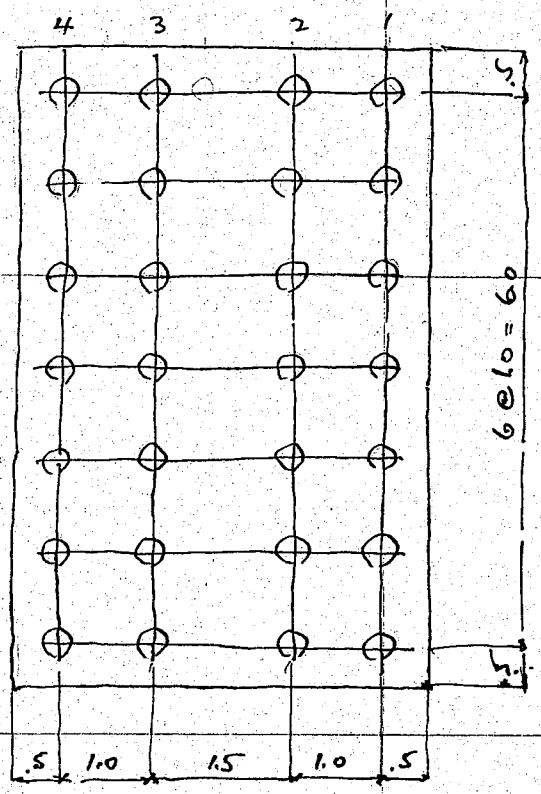
Horizontal moment about the bottom of base.

Rear.	530	· 8.34	= 4410	· 4.17	= 18.400		
	4450/2	· 8.34	= 18500	· 2.78	= 51400		
			22910		69800 ×7	=	489.000
Front.	213/2	· 4.00	= 4260	· 1.33	= 5670 ×7	=	39600
							449400
					Vertical moment.		918.300
							1367700

Point of application of reactant at base = $\frac{1367700}{493215} = \frac{2.77}{0.52}$. 2.77 - 2.25 = 0.52 m

max toe pressure = $\frac{493215}{7.0 \cdot 4.5}\left(1 \pm \frac{6. \times 0.52}{4.5}\right)$ = 26600 C 2.47 tons
4830 C 0.45 "

Load on piling neglecting soil bearing.



4	3	2	1	
2.42	7.26	14.50	19.33	
4.83	4.83	4.83	4.83	
7.25	12.09	19.33	24.16	tons/o m.

During Earthquake. (force from rear)

4	3	2	1	
2.80	9.66	20.0	26.8	tons/a m

Force from front

4	3	2	1
25.00	21.80	12.50	3.12
.77	.77	.77	0.77
25.77	22.57	13.27	3.89

use Concrete pile.

Horizontal moment due to Earthquake k = 0.1

		Hor. Force		arm		moment
1	parapet wall	1260	·	6.84	=	8620
2	under pedestal	168	·	7.84	=	1320
3	Coping.	346	·	6.19	=	2140
4	Shaft	5000	·	3.52	=	17600
5	"	1032	·	2.68	=	2770
6	Base	5300	·	0.35	=	1860
7	"	74	·	0.80	=	59
8	"	427	·	0.85	=	363
9	"	415	·	0.80	=	332
10	wing	2220	·	3.02	=	6700
11	"	720	·	6.87	=	4950
12	"	1296	·	6.87	=	8900
13	buttress	1270	·	3.15	=	4000
14	"	283.	·	3.02	=	855
		19811				60469
Superimposed dead load.		3440	·	6.04	=	20.800
		23251 kg				81.269 kg-m

Earth pressure (rear) due to earthquake k = 0.1 without surcharge.

from $0.185 \times 1600 \times 8.34^2 \times 7.0 = 144.000$ kg
" $4.0^2 \times 7.0 = 33200$ "

This horizontal force assumed act horizontally at rear face of abutment.
Earth fill assumed same as ordinary case.

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CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-ken.

Horizontal moment due to Earth fill at rear

168000 × 0.1 = 16800 @ 4.45 (about) = 74700

Summary for Horizontal moment

Body of abutment	19815		60469
Superimposed load (dead only).	34400		20800
Earth fill rear	168000		74700
" " front	66700	× 0. =	———
Earth pressure 144000 × 2.78	———	=	400.000
	467215	555969 - say	556.000

Vertical moment at heel 918300 − 2600 × 2.25 = 861.000

1417.000

Resultant arm = $\frac{1417.000}{467215}$ = 3.03

2.25

Ecc. - 0.78

Horizontal moment due to Earth fill at front.

66700 × 0.1 = 6670 @ 2.45 (about) = 16300

Summary for Horizontal moment

Body of abutment	19815		60469
Superimposed dead load only	34400		20800
Earth fill rear	168000		———
" " front	66700		16300
Earth pressure say 33200 × 1.33	———		44200
	467215		141769 call this -142000

vertical moment at heel 861.000

719000

Resultant arm = $\frac{719000}{467215}$ = -1.54

2.25

0.71 Ecc.

Toe Pressure.

Eccentricity at front $\frac{467215}{7 \times 4.5}\left(1 \pm \frac{6 \times 0.78}{4.5}\right)$ = cause tension at rear.

Pressure area 1.47 × 3 = 4.41

$\frac{467215 \times 2}{7 \times 4.41}$ = 30200 kg 2.80 tons/0'

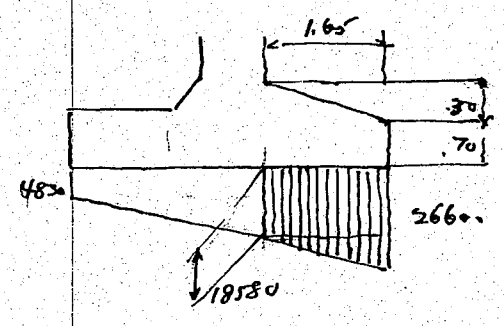
max heel pressure

Eccentricity at rear $\frac{467215}{7 \times 4.5}\left(1 \pm \frac{6 \times 0.71}{4.5}\right)$ = 28800 (kg/m²) 2.68 tons/0'

770 (c) .07 "

Details.

Reinforcement in the toe.



Moment due to upward pressure. arm

18580 × 1.65 = 30600 × .825 = 25200

$\frac{8020}{2}$ × 1.65 = $\frac{6620}{37220}$ × .55 = 3640

28840 kg m.

Downward moment

Concrete say .85 @ 2400 = 2040

Earth fill 3.5 @ 1600 = 5600

7640 × $\frac{1.65^2}{2}$ = 10400

18440 kg m

Shear = 37220

7640 × 1.65 = 12600

24620 kg/meter strip

Effective depth .90 meter

Steel area = $\frac{18440}{7/8 \times .90 \times 1200}$ = 19.50 cm per meter strip

19mm bars @ 2.84 Spacing = $\frac{2.84 \times 100}{19.5}$ = 14.6 cm

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CALCULATIONS FOR

Design of Jokiwa-Bashi for Okayama-Ken

Reinforcing bars in Heel.

Downward load. 7.6 × 1600 = 12200
Concrete say .70 @ 2400 = 1680

13880

Max upward pressure during earthquake. 28800 normal state. min. 13880 / 4830
14980 / 2 = 9050 ckg.

Span length 3.175 $m = \frac{1}{10} \cdot 9050 \cdot 3.175^2 = 9100$

Steel area required $= \frac{910000}{7/8 \cdot 60 \cdot 1200} = 14.45$ □cm

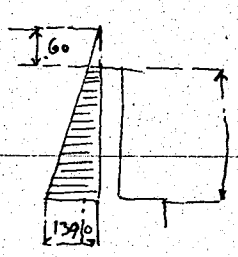
16 mm bars @ 2.01 sp $= \frac{2.01 \times 100}{14.45} = 13.9$ cm

This moment will be reduced toward the shaft.

End shear $9050 \cdot \frac{2.5}{2} = 11300$ ckg. $\frac{11300}{7/8 \cdot 60 \cdot 100} = 2.15$ kg/cm²

Reinforcement in the parapet wall.

pressure will be carried by both cantilever and horizontal beam between buttress walls.



Earth pressure $\frac{1}{3} \times 1600 \cdot .60 = 320$ kg / sq meter
$\frac{1}{3} \times 1600 \cdot 2.60 = 1390$ " "
1070

Cantilever moment one metre strip

moment $320 \cdot 2.0 \cdot 1.0 = 620$
$\frac{1070}{2} \cdot 2.0 \cdot .67 = 715$
1335 kgm

Effective depth required for $f_s = 1200$ kg/cm² and $f_c = 45$ $R = 7.18$

$d = \sqrt{\frac{1335 \times 100}{100 \cdot 7.18}} = \sqrt{186} = 13.7$ 30 cm wall.

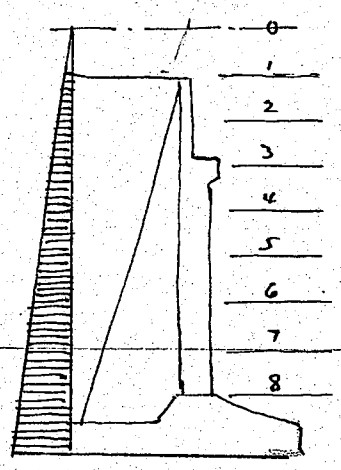
Steel area $= \frac{133500}{7/8 \cdot 27 \times 1200} = 4.70$ □cm.

Spacing 13 mm bars $= \frac{1.33 \times 100}{4.70} = 28.3$ cm

Use 13 mm bars 30 cm spacing about in both directions.

Reinforcement in the front wall. Span length 3.175 meters

Surcharge assumed 1.0 meter



Depth			$m = \frac{1}{10} w l^2$	d	Req Section	spacing
3.0	× ⅓ × 1600	= 1600	1610	.58	2.64	50.5
4.0	× "	= 2133	2140	.63	3.88 24	41.0
5.0	× "	= 2666	2680	.68	3.74	35.6
6.0	× "	= 3200	3220	.73	4.20	31.7
7.0	× "	= 3733	3760	.78	4.60	29.0
8.0	× "	= 4266	4290	.82	5.00	26.6 cm

Steel area required $= \frac{4290.00}{7/8 \cdot 82 \cdot 1200} = 5.0$ □cm

13 mm bars spacing. $\frac{1.33 \times 100}{5.0} =$

Buttress wall at center. Surcharge 1.0 meter

$P = \frac{1}{3} \times 1600 \cdot 8.34 = 4450$ moment at 8.34 $533 \cdot \frac{7}{8.34} \cdot \frac{3.67}{4.17} = 18500$ 14350
$\frac{1}{3} \times 1600 \cdot 1.0 = 533$
3917 $\frac{3917}{2} \cdot \frac{8.34}{7} \cdot \frac{2.46}{2.78} = 45300$ 35000
63800 47350 kgm

$P = \frac{1}{3} \cdot 1600 \cdot 6.84 = 3650$ moment at 6.84 $533 \cdot 5.84 \cdot 2.92 = 9100$
533
3117 $\frac{3117}{2} \cdot 5.84 \cdot 1.95 = 17700$
26800 kgm

$P = \frac{1}{3} \cdot 1600 \cdot 5.34 = 2850$ moment at 5.34 $533 \cdot 4.34 \cdot 2.17 = 5020$
533
2317 $\frac{2317}{2} \cdot 4.34 \cdot 1.45 = 7300$
12320 kgm

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SEIYU BLDG, TOKIO

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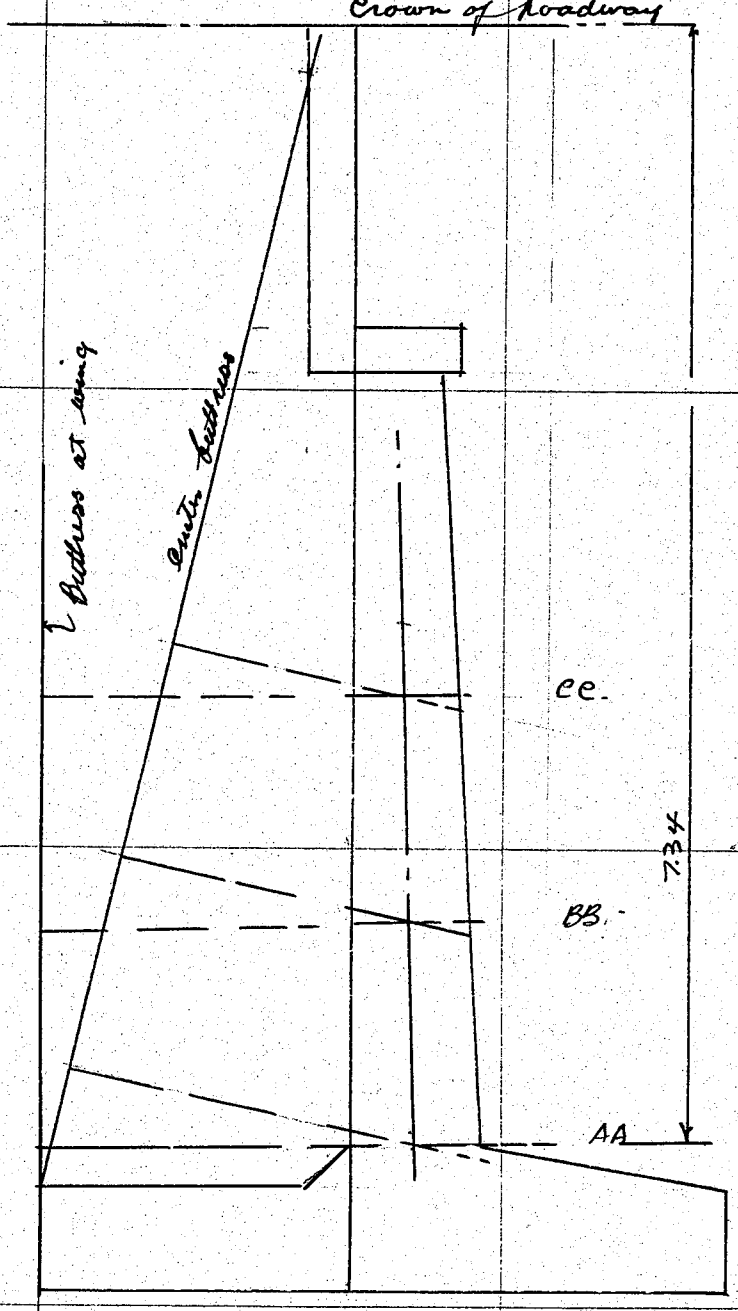
CALCULATIONS FOR

Design of Tokiwa-Bashi for Okayama-Ken



Centre buttress. Section AA.

moment = 49350 × 3.35 = ~~165000~~ 165000 + ~~8500~~ 8600

Stat area = ~~173500~~ 173600 / (7/8 × 2.65 × 1200) = ~~59.40~~ 59.4 / ~~57.00~~ 57.0

22 mm bars 3.80 no = 59.4/57.0 / 3.80 = ~~15.0~~ 15.6

Section BB.

moment = 26800 × 3.35 = 89700

Stat area = 89700 / (7/8 × 2.50 × 1200) = 34.2

22 mm bars 3.80 no = 34.2 / 3.80 = 9.0

Section CC

moment = 12320 × 3.35 = 41250

Stat area = 41250 / (7/8 × 1.85 × 1200) = 21.3

22 mm bars 3.8 no = 21.3 / 3.8 = 5.6

Buttress wall at wing.

Section AA.

moment = 49350 × 1.75 = ~~83000~~ 86400

Stat area = 86400 / (7/8 × 2.75 × 1200) = ~~28.8~~ 29.9

22 mm bars 3.80 no = 29.9 / 3.8 = ~~7.6~~ 7.9

Section BB.

moment = 26800 × 1.75 = 46900

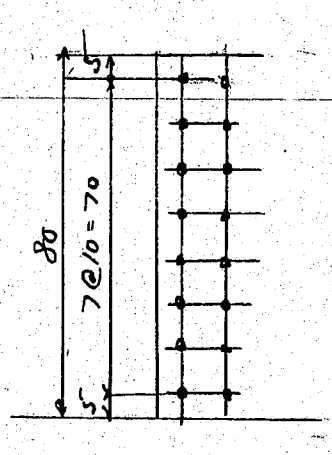
Stat area = 46900 / (7/8 × 2.70 × 1200) = 16.5

22 mm bars 3.80 no = 16.5 / 3.8 = 4.3

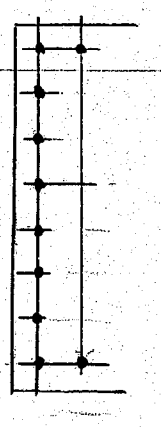
Section CC. moment = 12320 × 1.75 = 21600

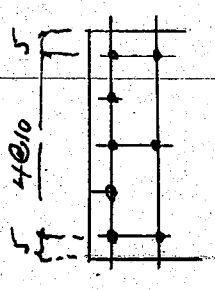
Stat area = 21600 / (7/8 × 2.65 × 1200) = 7.77

22 mm bars 3.80 no = 7.77 / 3.8 = 2.04



Centre Buttress





Buttress at wing.

change width to .80 in the final drawing.

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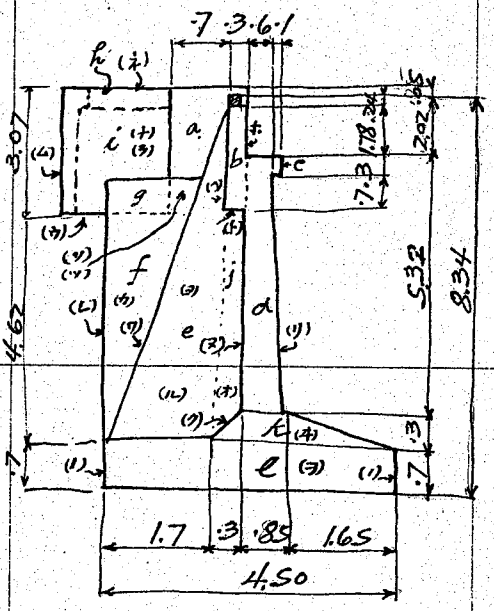
CALCULATIONS FOR

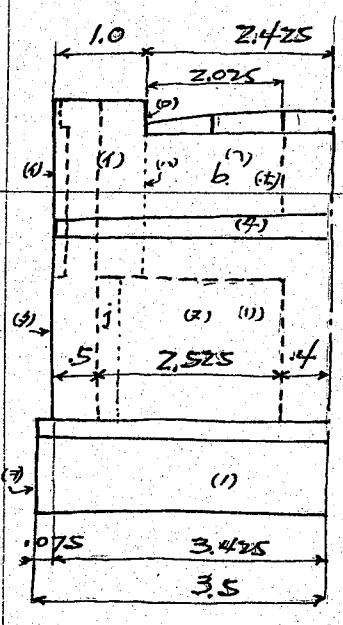
Tokiwa-Bashi for Okayama ken.

Materials for Abutment. A1 & A2.
Concrete 1:2:4 mixture

	Section	Length	Req'd.no.	Total volume	Remarks
Column	1.0 m × 1.0 m	3.07 m	2	6.140 m³	a.
Parapet wall.	.3 × 2.78	2.025	2	3.378	b
Coping. shaft.	.1 × .3	6.85	1	.206	c
front wall.	.725 × 5.32	6.85	1	26.420	d
Buttress A center.	.8 × 1.15	7.10	1	6.532	e
" B. Sides	.5 × 2.0	4.62	2	9.240	f
" " fillet rear	.25 × .5	1.00	2	.250	g
Wing wall. Coping	.1 × .3	2.52	2	.151	h
"	.3 × 3.07	2.90	2	5.342	i
fillet buttress B & front wall	.3 × .15	4.62	2	.416	j
base	.3 × 1.825	7.00	1	3.833	k
"	.7 × 4.5	7.00	1	22.050	l
				83.958 m³	



Forms.		Width	Length	Req'd.no.	Total area	Remarks
Column	front & out side	2.0 m	2.07 m	2	8.28 ㎡	(1)
"	in side	1.0	.28	1	.56	(ロ)
"	"	.7	1.79	2	2.51	(ハ)
"	rear side	.7	3.07	2	4.30	(ニ)
Parapet wall.	front.	1.78	4.85	1	8.63	(ホ)
" "	rear	1.78	2.025	2	11.26	(ヘ)
" "	bottom	.3	2.025	2	1.22	(ト)
front wall.	Coping	.4	6.85	1	2.74	(チ)
"	wall front.	5.02	6.85	1	34.39	(リ)
"	" rear	5.02	2.525	2	25.35	(ヌ)
buttress A.	Sides	.85	7.40	2	12.58	(ル)
" "	"	.30	4.47	2	2.68	(ヲ)
" "	rear	.80	7.55	1	6.04	(ワ)
" B	Both Sides	1.00	4.62	4	18.48	(カ)
" "	"	1.00	4.62	4	18.48	(ヨ)
front wall	both ends.	.725	5.32	2	7.71	(タ)
buttress B	rear	.50	4.62	2	4.62	(レ)
" "	out sides	1.00	1.00	2	2.00	(ソ)
" "	in side	.70	1.00	2	1.40	(ツ)
wing wall	coping	.40	2.52	2	2.02	(ネ)
"	~~both~~ out side	2.77	2.52	2	13.96	(ナ)
"	in side	3.07	3.14	2	19.28	(ラ)
"	end plane	.30	3.07	2	1.84	(ム)
"	bottom "	.30	1.70	2	1.02	(ウ)
base		.30	1.825	2	1.10	(ヰ)
"	front + rear	.70	7.00	2	9.80	(ノ)
"	both ends	.70	4.50	2	6.30	(オ)
"	fillet	.42	2.53	2	2.13	(ク)
					230.68 m²	



Reinforcements for abutments plain bars. 2.687 kg/tons for one abutment

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CALCULATIONS FOR

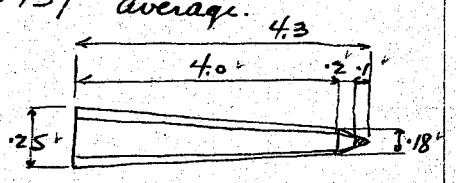
Tokiwa-Bashi for Okayama Ken

Materials for abutment continued.
蹴込石 化崗石.

·24'×·20'×4.85' = .233 ✓ Cub meters for one abutment.

Reinforced Concrete piles 18cm at tip 4.3m long. 28 piles req'd. for one abutment.
Concrete for pile. Sectional area at butt .25'×.25' = .0625 ✓
less chamfers .05'×.05'×2' = (−).0050 ✓
.0575 ✓ sq m

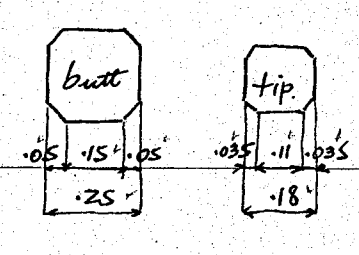
Sectional area at tip .18'×.18' = .0324 ✓
less chamfers .035×.035'×2' = (−).0025 ✓
.0299 ✓
.0874÷2 = .0437 ✓ sq m average.



Volume of concrete .0437'×4.0' = 0.175 ✓ m³
·14'×.14'×.2' = 0.004 ✓
0.179 ✓ m³ for one pile

Reinforcements for pile (plain bars) 43.2 ✓ kg or 0.043 ✓ kg ton per pile.

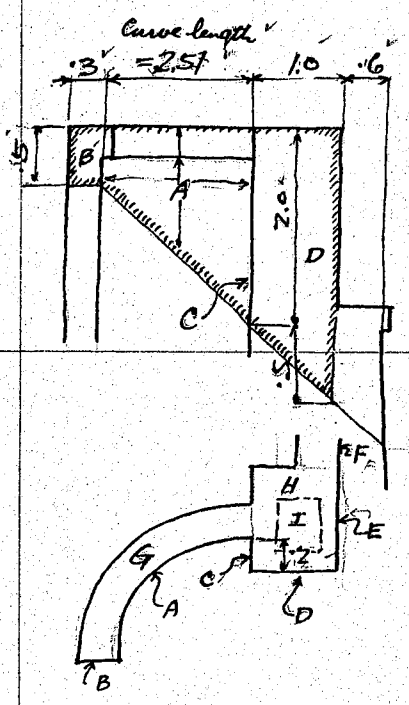
Forms for pile top perimeter = .25'×4' = 1.00 ✓ m say
bottom " = .18'×4' = .72 ✓
1.72 ✓ ÷2 = .86 ✓ m × 4.0' = 3.44 ✓ sq m per pile
tip neglected



Cast iron shoe 4.7 ✓ kg per pile see drawing

人造洗石仕上

		Width	Length	Reqd. no.	Area	Remarks.
Wing wall	out side	1.35 ✓	2.51 ~~2.51~~	2 ✓	6.78 ✓ sq m 6.78 ✓	A
" "	end face	.3 ✓	.5 ✓	2 ✓	.30 ✓	B
Column	rear	.2 ✓	2.0 ✓	2 ✓	.80 ✓	C
"	out side	1.0 ✓	2.25 ✓	2 ✓	4.50 ✓	D
"	front	1.00 ✓	2.07 ✓	2 ✓	4.14 ✓	E
Parapet wall	front	1.0 ✓	1.78 ✓	2 ✓	3.56 ✓	F
Coping	coping top.	0.4 ✓	2.83 ✓	2 ✓	2.26 ✓	G
Column.	top.	1.0 ✓	1.0 ✓	2 ✓	2.00 ✓	H
less light pedestal area		.8 ✓	.8 ✓	2 ✓	(−)1.28 ✓	I
					23.06 ✓	



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CALCULATIONS FOR

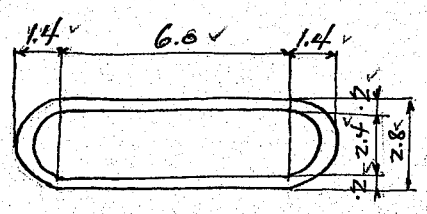
(3)

Tokiwa-Bashi for Okayama ken.

Materials for wells.
2.8m × 9.0m well. for piers P6 & P7.
Concrete 1:2:4 mixture.
Shell. top 1.2m.

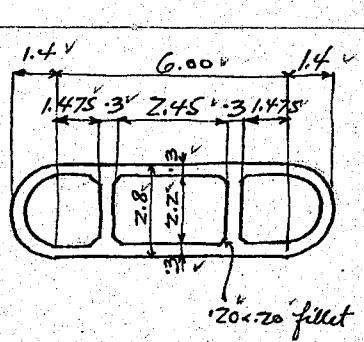
Total area of well. 6.0 × 2.8 = 16.800 om
2.8φ = 6.158
22.958 om

Area of hollow space 6.0 × 2.4 = 14.400
2.4φ = 4.524
18.924 om



Net area of shell = 4.034 om

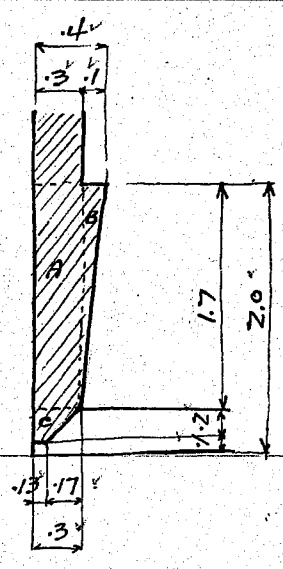
Volume of shell for top 1.2m = 4.034 × 1.2 = 4.841 m3



Shell, intermediate 5.8m

Total area of well. = 22.958 om
Area of hollow spaces. 2.45 × 2.2 = 5.390
1.475 × 2.2 × 2 = 6.490
22φ = 3.801
less fillets .2 × .2 × 4 = (−) .160
15.521
Net area of shell = 7.437 om

Volume of intermediate 5.8m shell 7.437 × 5.8 = 43.135 m3



Shell, bottom 2.0 meters.

Shell projection cutting edge.
A 7.437 × 1.7 = 12.643
B 17.710 × .085 = 1.505
C .22 × .2 × 1.998 = .879
15.027 m3

Area of projection
= .1 × 1.7 / 2 = .085 om

total length of projection
= 5.4 × 2 + 6.91 = 17.71 m

Summary for Shell.
top 1.2m 4.841
int. 5.8m 43.135
bottom 2.0m 15.027
63.003 cub. meters.

Top filling.
Area of hollow space 18.924 om
volume of top filling 18.924 × 1.2 = 22.709 m3

Bottom filling
Total area of well 22.958
total vol. of well 2m long 22.958 × 2 = 45.916 m3
" " shell " (−) 15.027
30.889 m3

Sand filling area of hollow spaces. = 15.521 om
Sand fill 15.521 × 5.8 = 90.022 m3

Summary for 2.8m × 9.0m well.
Concrete for shell 63.003
Concrete for top filling 22.709
" " bottom " 30.889
53.598
total concrete 116.601 m3
Sand filling 90.022
total volume of well ——— 206.623 m3

Reinforcements for well shell, plain bars 4.101 kg.tons for one well, see drawing.
Steel for Curb shoe 1.034 kg.tons " " "

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CALCULATIONS FOR

(4)

Tokiwa Bashi for Okayama Ken.

Materials for well.

2.8ᵐ × 7.0ᵐ well for Piers P5 and P8.

Concrete 1:2:4 mixture.

Shell, top 1.2ᵐ = 4.841 ✓

" intermediate 3.8ᵐ 7.437 × 3.8 = 28.261 ✓

" bottom 2ᵐ 15.027 ✓

total concrete for shell = 48.129 ᵐ³ ✓

top filling = 22.709 ✓

bottom " = 30.889 ✓

53.598 ᵐ³ ✓

total concrete = 101.727 ᵐ³

note:- Section same as for 2.8 × 9.0ᵐ well see last page.

Sand filling 15.521 × 3.8 = 58.980 ✓

total volume of well = 160.707 ᵐ³ ✓

Reinforcements, plain bars. 2.923 ✓ kg tons. see drawing.

Steel for curb shoe 1.034 ✓ kg tons

Forms for well.

2.8ᵐ × 9.0ᵐ well.

Total length of perimeter

Outside. 6.0 × 2 = 12.00ᵐ ✓

2.8φ = 8.80 ✓

20.80ᵐ ✓ length × 8.70ᵐ = 180.96 ᵒᵐ ✓

inside top 1.2ᵐ 6.0 × 2 = 12.00 ✓

2.4φ = 7.54 ✓

19.54ᵐ ✓ × 1.20ᵐ = 23.45 ✓

" bottom 7.8ᵐ 2(2.05+1.275×2) = 9.200 ✓

1.8 × 4 = 7.200 ✓

2.2φ = 6.912 ✓

.2 × 1.41 × 8 = 2.256 ✓

25.568ᵐ ✓ mean length × 7.65 = 195.60 ✓

Total form for 2.8 × 9.0ᵐ well = 400.01 ᵒᵐ + 15.52 (bottom of top filling) = 415.53 ᵒᵐ ✓

2.8ᵐ × 7.0ᵐ well.

Outside 20.80 × 6.70ᵐ = 139.36 ✓

inside top 1.2ᵐ 19.54 × 1.20 = 23.45 ✓

" bottom 5.8ᵐ 25.568 × 5.65 = 144.46 ✓

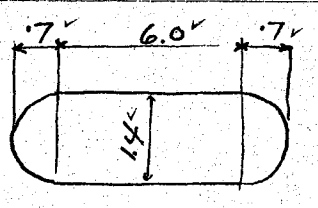
Total form for 2.8 × 7.0ᵐ well = 307.27 ᵒᵐ + 15.52 (bottom of top filling) = 322.79 ᵒᵐ ✓

Concrete for Shaft. Piers P6 and P7.

Coping rectangle .3 × 1.4 × 6.0 = 2.520 ✓

Circular ends 1.4φ (.537) × .3 = .462 ✓

2.982 ᵐ³ ✓



Shaft top area 6.0 × 1.2 = 7.20 ᵒᵐ ✓

1.2φ = 1.13 ✓

8.33 ᵒᵐ ✓

bottom area 6.0 × 2.04 = 12.24 ✓

2.04φ = 3.27 ✓

15.51 ᵒᵐ ✓

23.84 ÷ 2 = 11.92 ᵒᵐ ✓

11.92 × 8.70 = 100.128 ᵐ³ ✓

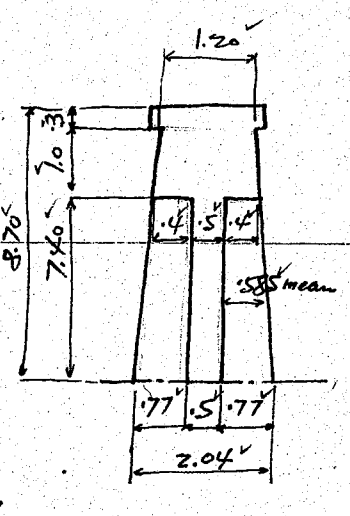
less depression 7.4 × 4.0 − .585 × 2 = (−) 34.632 ✓

add moulding .5 × .5 × .4 × 2 = (+) 0.200 ✓

65.696 ᵐ³ ✓

Coping 2.982 ✓

total concrete for shaft P6+P7 = 68.678 ᵐ³ ✓ for one pier



Reinforcements for Shaft ~~1.708~~ 1.322 ✓ kg tons of plain bars.

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CALCULATIONS FOR

(5)

Tokiwa-Bashi for Okayama Ku

Concrete for Shaft Piers P5 and P8.

Coping — Same as for P6 = 2.982 m³

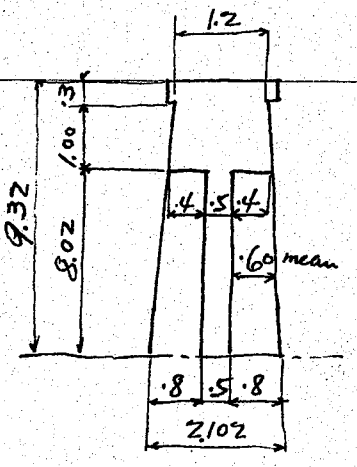
truss seat — area .8 × 1.2 = .96 m²
1.2φ ÷ 2 = .565
1.525 m

volume of seat = 1.525 × .82 × 2 = 2.501 m³

Shaft — top area 6.0 × 1.2 = 7.20
1.2φ = 3.27 (1.13)
8.33 m

bottom area 6.0 × 2.10 = 12.61
2.10φ = 3.46
16.07 m
2440 ÷ 2 = 12.20 m²

volume = 12.20 × 9.02 = (+) 110.044
less depression = 8.02 × 4.0 × .6 × 2 = (−) 38.496
add moulding = .5 × .5 × .4 × 2 = (+) 0.200
total volume for Shaft = 71.748 m³
" " coping = 2.982
" " truss seats = 2.501



Total concrete for shaft P5 and P8 = 77.231 m³ for one pier

Reinforcements for shaft 2.036 kg/tons of plain bars.

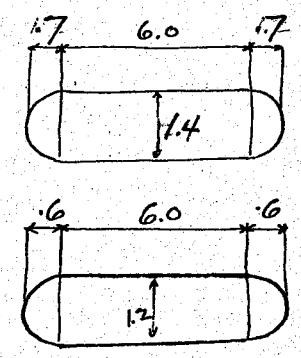
Forms for Shaft. Piers P6 and P7.

Coping — total length of perimeter. 6.0 × 2 = 12.00
1.4φ = 4.40
16.40 m × .4 = 6.56 m²

Shaft — total length of perimeter at top 6.0 × 2 = 12.00
1.2φ = 3.77
15.77

at bottom 6.0 × 2 = 12.00
2.04φ = 6.41
18.41
34.18 ÷ 2 = 17.09 m average.

Area = 17.09 × 8.40 = 143.56 m²
depression both sides .585 × 2 × 7.4 × 2 = 17.32 moulding neglected
" top .40 × 2 × 4.0 = 3.20
164.08
Coping 6.56
Total form for shaft, Pier P6 + P7 = 170.64 m²



Forms for Shaft. Piers P5 and P8.

Coping same as for P6 = 6.56 m²

truss seats. perimeter .8 × 2 + 1.2 = 2.80
1.2φ ÷ 2 = 1.88
4.68 × 2 = 9.36 m × .82 = 7.68 m² for 2 seats.

Shaft. total length of perimeter at top 15.77 m
" at bottom 6.0 × 2 = 12.00
2.102φ = 6.60
18.60
34.37 ÷ 2 = 17.19 m average.

Area = 17.19 × 9.02 = 155.05 m²
depression both sides .6 × 2 × 8.02 × 2 = 19.25
" top .4 × 2 × 4.0 = 3.20
177.50
truss seats + Coping = 7.68 + 6.56 = 14.24
Total form for Shaft Piers P5 + P8 = 191.74 m²

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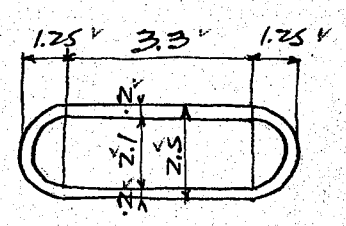
(6)

CALCULATIONS FOR

Tokiwa-Bashi for Okayama Ken.

Materials for wells
2.5m × 6.0m well for piers P1, 2, 3, 4, 14, 15, 16 & 17, (8 wells required)
Concrete 1:2:4 mixture.
Shell. top 1.0m

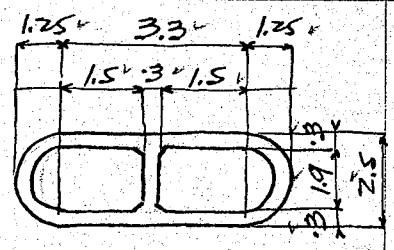


Total area of well
3.3 × 2.5 = 8.250
2.5φ = 4.909
13.159 om

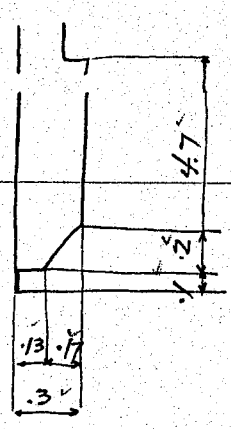
Area of hollow space
3.3 × 2.1 = 6.930
2.1φ = 3.464
10.394 om

net area of shell = 2.765 om

Volume of top 1.0 meter of shell = 2.765 × 1.0 = 2.765 m3



Shell. Botton 5.0m
Total area of well = 13.159 om
Area of hollow spaces. 1.5 × 1.9 × 2 = 5.700
1.9φ = 2.835
less fillets .2 × .2 × 2 = (−) .080
8.455
net area of shell = 4.704 om



Volume of 5.0m of shell.
4.704 × 4.70 = 22.109
Cutting edge .22 × .2 × 13.67 = .601
22.710 cub.m.

Total volume of shell = 2.765 + 22.710 = 25.475 m3

mean length of perimeter for cutting edge.
2 × 3.3 = 6.60
2.25φ = 7.07
13.67 m

Top filling
Area of hollow space = 10.394 om
total volume of top filling concrete = 10.394 m3

Sand filling area of hollow spaces = 8.455 om
total volume of sand filling = 8.455 × 3.5 = 29.593 m3

Bottom filling total area of well = 13.159 om
volume of 5m well = 13.159 × 5.0 = 65.795 cub.m
less sand filling = (−) 29.593
less botton 5m shell = (−) 22.710
total volume of bottom filling = 13.492 m3

Summary

Concrete for shell	25.475	
" top filling	10.394	
" bottom "	13.492	
	23.886	total concrete for well = 49.361
Sand filling	29.593	
total volume of well.	= 78.954	

Reinforcements for shell = 1.623 Kg tons of plain bars. Steel for curb shoe = 0.690 kgtons/pier

Concrete for well 2.5m × 7.0m piers P9, 10, 11, 12 and 13. (5 wells req'd.)

Concrete for shell	25.475 + 4.704 = 30.179 m3	
" top filling	10.394	
" bottom filling	13.492 = 23.886	total concrete for well = 54.065 m3
Sand filling	29.593 + 8.455 = 38.048 m3	
total volume of well	= 92.113 m3	

Reinforcements for shell = 2.055 Kg tons of plain bars. Curb shoe = 0.690 kgtons/pier

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CALCULATIONS FOR

(7)

Tokiwa-Bashi for Okayama Ken.

Forms for well.

2.5ᵛ × 6.0ᵐ well for Piers P1ᵛ, 2ᵛ, 3ᵛ, 4ᵛ, 14ᵛ, 15ᵛ, 16ᵛ and 17ᵛ (8 wells req'd.)

Total length of perimeter

Outside	3.3ᵛ × 2ᵛ	= 6.60ᵐ ✓	
	2.5Φᵛ	= 7.85 ✓	
		14.45ᵐ ✓ × 5.7ᵛ =	82.37 ✓ᵒᵐ
inside top 1.0ᵐ	3.3ᵛ × 2ᵛ	= 6.60 ✓	
	2.1Φᵛ	= 6.60 ✓	
		13.20 ✓ × 1.0ᵛ =	13.20 ✓ᵒᵐ
" bottom 5.0ᵐ ✓	1.3ᵛ × 4ᵛ	= 5.20 ✓	
	1.9Φᵛ	= 5.97 ✓	
	1.5ᵛ × 2ᵛ	= 3.00 ✓	
	.2ᵛ × 1.41ᵛ × 4ᵛ	= 1.13 ✓	
		mean length 15.30 ✓ × 4.85ᵛ =	74.21 ✓ᵒᵐ
bottom of top filling or area of hollow spaces of partitions		=	8.46ᵛ
Total form for 2.5ᵛ × 6.0ᵐ well =			178.24 ✓ᵒᵐ.

2.5ᵛ × 7.0ᵛᵐ well for Piers P9ᵛ, 10ᵛ, 11ᵛ, 12ᵛ and 13ᵛ (5 wells req'd.)

form for 6ᵐ well	= 178.24 ✓ᵒᵐ
add Outside 1 meter	14.45 ✓
add inside 1 meter	15.30 ✓
Total form for 2.5ᵛ × 7.0ᵛᵐ well =	207.99 ✓ᵒᵐ

Concrete for Shaft

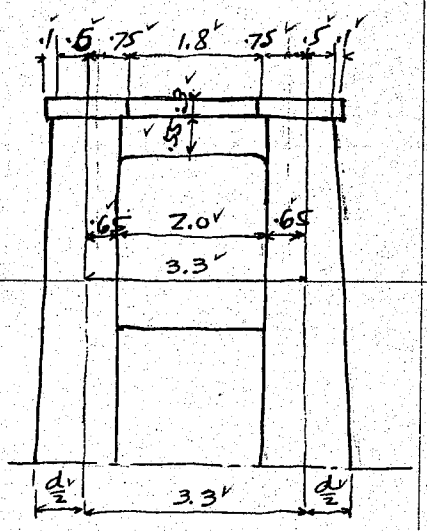
Coping

Piers P1ᵛ, 2ᵛ, 3ᵛ, 4ᵛ, 9ᵛ, 10ᵛ, 11ᵛ, 12ᵛ, 13ᵛ, 14ᵛ, 15ᵛ, 16ᵛ & 17ᵛ

1.2ᵛ × .75ᵛ × .3ᵛ × 2ᵛ	=	.540 ✓
1.2Φᵛ × .3ᵛ	=	.339 ✓
.7ᵛ × .3ᵛ × 1.8ᵛ	=	.378 ✓
		1.257 ✓ᵐ³ for all piers

Strut. .5ᵛ × .55ᵛ × 7.0ᵛ = 0.550 ✓ᵐ³ " "

Coping & Strut total vol = 1.807 ✓ᵐ³

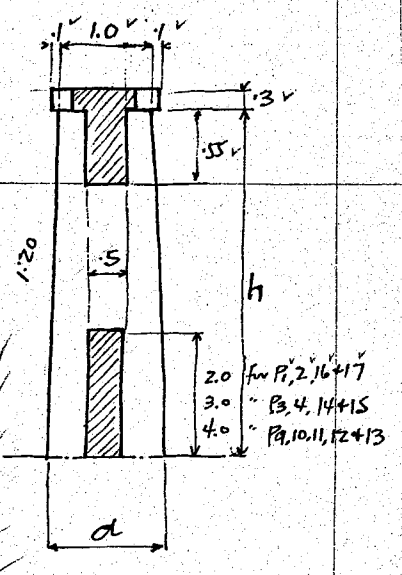


Top section of shaft

1.0ᵛ × .65ᵛ × 2ᵛ	=	1.300 ✓
1.0Φᵛ	=	.785 ✓
		2.085 ✓ᵒᵐ for each pier.

Bottom section of shaft.

.65ᵛ × dᵛ × 2ᵛ	=	1.3dᵛ
dΦᵛ	=	dΦ ✓
		1.3d + dΦ ✓



Wall.

0.5ᵛ × 2.0ᵛ × 2.0ᵛ	=	2.00ᵛ ᵐ³ for piers P1, 2, 16+17
0.5ᵛ × 2.0ᵛ × 3.0ᵛ	=	3.00ᵛ " for piers P3, 4, 14+15
0.5ᵛ × 2.0ᵛ × 4.0ᵛ	=	4.00ᵛ " for piers P9, 10, 11, 12+13.

Total volume of Shaft.

Piers	Height h	Width d	1.3d + dΦ = Bottom area	Top area	Mean area	Volume	Coping+Strut+wall	Total
P1ᵛ + P16ᵛ	6.12ᵐ ✓	1.61ᵛ	2.093ᵛ + 2.036ᵛ = 4.129 ✓	2.085 ✓	3.107 ✓	19.015 ✓	+ 1.807ᵛ + 2.00ᵛ =	22.822 ✓
P2ᵛ	6.22ᵛ	1.62ᵛ	2.106ᵛ + 2.061ᵛ = 4.167 ✓	"	3.126 ✓	19.444 ✓	" "	23.251 ✓
P17ᵛ	6.07ᵛ	1.61ᵛ	2.093ᵛ + 2.036ᵛ = 4.129 ✓	"	3.107 ✓	18.859 ✓	" "	22.666 ✓
P3ᵛ	7.32ᵛ	1.73ᵛ	2.249ᵛ + 2.351ᵛ = 4.600 ✓	"	3.343 ✓	24.471 ✓	" 3.00ᵛ	29.278 ✓
P4ᵛ	7.42ᵛ	1.74ᵛ	2.262ᵛ + 2.378ᵛ = 4.640 ✓	"	3.363 ✓	24.953 ✓	" "	29.760 ✓
P14ᵛ	7.22ᵛ	1.72ᵛ	2.236ᵛ + 2.324ᵛ = 4.560 ✓	"	3.323 ✓	23.992 ✓	" "	28.799 ✓
P15ᵛ	7.17ᵛ	1.72ᵛ	2.236ᵛ + 2.324ᵛ = 4.560 ✓	"	3.323 ✓	23.826 ✓	" "	28.633 ✓
P9ᵛ	8.97ᵛ	1.90ᵛ	2.470ᵛ + 2.835ᵛ = 5.305 ✓	"	3.695 ✓	33.144 ✓	" 4.00ᵛ	38.951 ✓
P10ᵛ	8.92ᵛ	1.89ᵛ	2.457ᵛ + 2.806ᵛ = 5.263 ✓	"	3.674 ✓	32.772 ✓	" "	38.579 ✓
P11ᵛ	8.87ᵛ	1.89ᵛ	2.457ᵛ + 2.806ᵛ = 5.263 ✓	"	3.674 ✓	32.588 ✓	" "	38.395 ✓
P12	8.82ᵛ	1.88ᵛ	2.444ᵛ + 2.776ᵛ = 5.220 ✓	"	3.653 ✓	32.219 ✓	" "	38.026 ✓
P13	8.77ᵛ	1.88ᵛ	2.444ᵛ + 2.776ᵛ = 5.220 ✓	"	3.653 ✓	32.037 ✓	" "	37.844 ✓

~~Reinforcements for Shaft.~~

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CALCULATIONS FOR

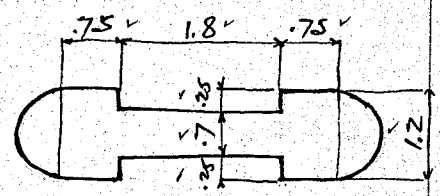
(8)

Tokiwa-Bashi for Okayama Ken.

Forms for Pier Shafts Piers P1, 2, 3, 4, 9, 10, 11, 12, 13, 14, 15, 16 and 17 (13 piers)

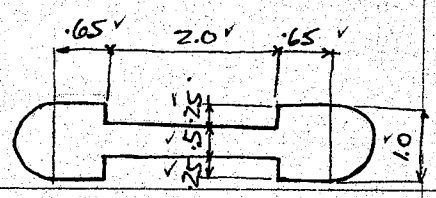
Coping total length of perimeter

.75 × 4	=	3.00 m
1.2 π	=	3.77
.25 × 4	=	1.00
1.8 × 2	=	3.60
		11.37 m × .4 = 4.55 sq m



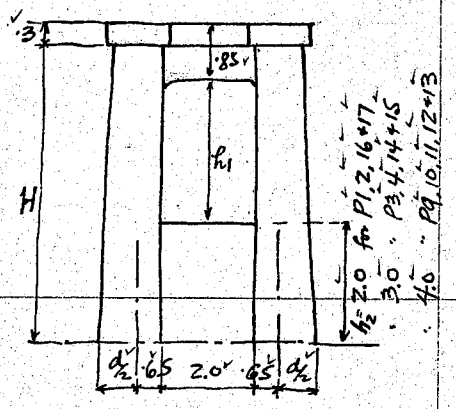
Shaft total length of perimeter at top.

.65 × 4	=	2.60
1.0 π	=	3.14
.25 × 4	=	1.00
2.0 × 2	=	4.00
		10.74 m for all piers



total length of perimeter at bottom

.65 × 4	=	2.60
d π	=	d π
(d-0.5) 2	=	2d-1.0
2.0 × 2	=	4.0
		5.6 + 2d + d π



Hollow area.

(2h1 + 2.0) 0.5 = h1 + 1

Piers	Height H.	h2 + .55	h1	Hollow area.	Sides + top area.		area to be reduced.
P1 & P16	6.12 m	- 2.55	= 3.57	× 2 × 2 = -14.28	+ 4.57	=	- 9.71 sq m
P2	6.22	"	= 3.67	" -14.68	+ 4.67	=	- 10.01
P17	6.07	"	= 3.52	" -14.08	+ 4.52	=	- 9.56
P3	7.32	- 3.55	= 3.77	" -15.08	+ 4.77	=	- 10.31
P4	7.42	"	= 3.87	" -15.48	+ 4.87	=	- 10.61
P14	7.22	"	= 3.67	" -14.68	+ 4.67	=	- 10.01
P15	7.17	"	= 3.62	" -14.48	+ 4.62	=	- 9.86
P9	8.97	- 4.55	= 4.42	" -17.68	+ 5.42	=	- 12.26
P10	8.92	"	= 4.37	" -17.48	+ 5.37	=	- 12.11
P11	8.87	"	= 4.32	" -17.28	+ 5.32	=	- 11.96
P12	8.82	"	= 4.27	" -17.08	+ 5.27	=	- 11.81
P13	8.77	"	= 4.22	" -16.88	+ 5.22	=	- 11.66

Forms for Shaft.

Piers	Height H.	width d.	perimeter at bottom. d π + 2d + 5.6		Perimeter at top.	mean perimeter	area of shaft.	Coping	reduction	Total area
P1 & P16	6.12	1.61	5.06 +	8.82 = 13.88 m	10.74 m	12.31 m	75.34 sq m	+ 4.55 sq m	- 9.71 sq m =	70.18 sq m
P2	6.22	1.62	5.09 +	8.84 = 13.93	"	12.34	76.75	+ "	- 10.01 =	71.29
P17	6.07	1.61	5.06 +	8.82 = 13.88	"	12.31	74.72	+ "	- 9.56 =	69.71
P3	7.32	1.73	5.44 +	9.06 = 14.50	"	12.62	92.38	+ "	- 10.31 =	86.62
P4	7.42	1.74	5.47 +	9.08 = 14.55	"	12.65	93.86	+ "	- 10.61 =	87.80
P14	7.22	1.72	5.40 +	9.04 = 14.44	"	12.59	90.90	+ "	- 10.01 =	85.44
P15	7.17	1.72	5.40 +	9.04 = 14.44	"	12.59	90.27	+ "	- 9.86 =	84.96
P9	8.97	1.90	5.97 +	9.40 = 15.37	"	13.06	117.15	+ "	- 12.26 =	109.44
P10	8.92	1.89	5.94 +	9.38 = 15.32	"	13.03	116.23	+ "	- 12.11 =	108.67
P11	8.87	1.89	5.94 +	9.38 = 15.32	"	13.03	115.58	+ "	- 11.96 =	108.17
P12	8.82	1.88	5.91 +	9.36 = 15.27	"	13.01	114.75	+ "	- 11.81 =	107.49
P13	8.77	1.88	5.91 +	9.36 = 15.27	"	13.01	114.10	+ "	- 11.66 =	106.99

Reinforcements for Shafts. plain bars.

Piers	P1, P2, P16 & P17	0.991 kg ton / pier.
Piers	P3, P4, P14 & P15	1.162 " "
Piers	P5 & P8	2.036 " "
Piers	P6 & P7	~~1.708~~ 1.822 " "
Piers	P9, P10, P11, P12 & P13	1.043 " "

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CALCULATIONS FOR

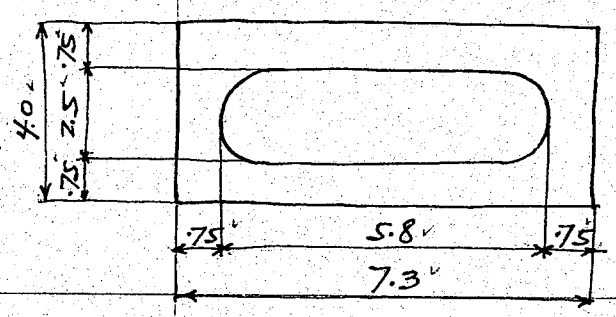
(9)

Tokiwa-Bashi for Okayama Ken.

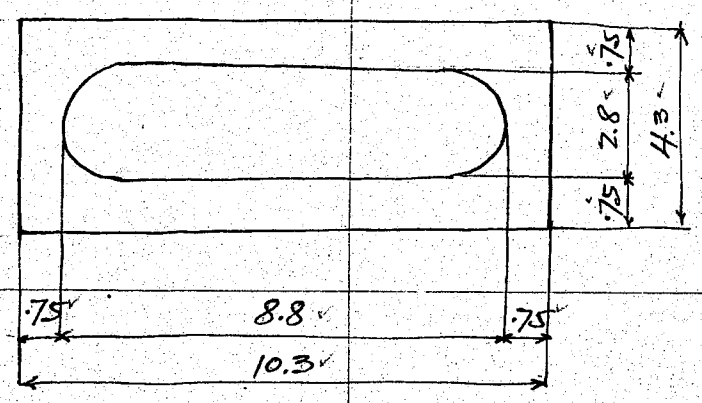
Excavation for piers above top of wells.

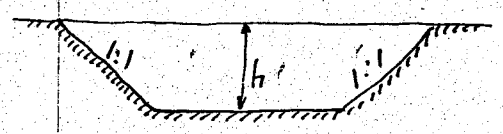
Piers	Bottom area of excavation Length	width	Depth	mean Area Length	width	Excavation in Cub. m.
P1	7.3m ✓	4.0m ✓	0.9 ✓	8.20 ✓	4.9 ✓	36.2 ✓
P2	〃 ✓	〃 ✓	0.6 ✓	7.9 ✓	4.6 ✓	21.8 ✓
P3	〃 ✓	〃 ✓	1.5 ✓	8.8 ✓	5.5 ✓	72.6 ✓
P4	〃 ✓	〃 ✓	1.4 ✓	8.7 ✓	5.4 ✓	65.8 ✓
P5	10.3 ✓	4.3 ✓	2.5 ✓	12.8 ✓	6.8 ✓	217.6 ✓
P6	〃 ✓	〃 ✓	1.9 ✓	12.2 ✓	6.2 ✓	143.7 ✓
P7	〃 ✓	〃 ✓	0.9 ✓	11.2 ✓	5.2 ✓	52.4 ✓
P8	〃 ✓	〃 ✓	1.1 ✓	11.4 ✓	5.4 ✓	67.7 ✓
P9	7.3 ✓	4.0 ✓	0.7 ✓	8.0 ✓	4.7 ✓	26.3 ✓
P10	〃 ✓	〃 ✓	0.5 ✓	7.8 ✓	4.5 ✓	17.6 ✓
P11	〃 ✓	〃 ✓	— ✓	— ✓	— ✓	—
P12	〃 ✓	〃 ✓	0.6 ✓	7.9 ✓	4.6 ✓	21.8 ✓
P13	〃 ✓	〃 ✓	1.3 ✓	8.6 ✓	5.3 ✓	59.3 ✓
P14	〃 ✓	〃 ✓	0.4 ✓	7.7 ✓	4.4 ✓	13.6 ✓
P15	〃 ✓	〃 ✓	0.8 ✓	8.1 ✓	4.8 ✓	31.1 ✓
P16	〃 ✓	〃 ✓	0.3 ✓	7.6 ✓	4.3 ✓	9.8 ✓
P17	〃 ✓	〃 ✓	0.8 ✓	8.1 ✓	4.8 ✓	31.1 ✓

for 2.5m well



for 2.8m well





平均巾 $b' = b + h'$
平均長 $l' = l + h'$

Excavation for Abutment
橋台，掘鑿土量．其底面ノ面積ニ平均根切ヲ乗ジタルモノヲ以テ表ハス（仕様書）
Mean penetration 5.1m ✓ for both abutment.
Bed area of abutment = 4.5 × 7.0 = 31.5 ✓ om.
Excavation = 31.5 × 5.1 ✓ = 160.7 m³ ✓ for each abutment.

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CALCULATIONS FOR

10

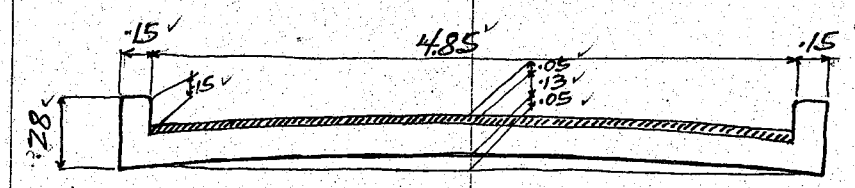
Tokiwa-Bashi for Okayama Ken.

Materials for Bridge floor.

Total Length of Bridge o to o of slab.
459.405 m call this 459.40 m

Exp. jt's. 16 @ .12 = 1.92
Const. jt's 1 @ .02 = .02
" 25 @ .01 = .25
= 2.19

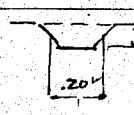
Net length of slab. = 457.21 m



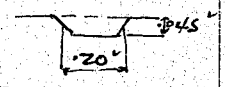
Cross section of slab. 4.85 × .13 = .631
.28 × .15 × 2 = .084
.715 om

Concrete for floor slab 1:2:4 mixture
Slab. .715 × 457.21 = 326.905
Fillet on floor beam for girder spans = 5.4
" floor beam + Stringers for truss " = 3.155
335.46 m3

Fillet on floor beam for girder span.
.2 × .05 / 2 × 4.85 = .024 m3
Total 15 × 15 × .024 = 5.4 m3



Fillet on stringer for truss span.



.2 × .045 × 2 = .018 om
Length of slab for truss span. 135.53 m
Const. jt. 10 @ .01 = - .10
Exp. jt .12 + .02 = - .14
135.29 m

Volume of fillet on Stringer = .018 × 135.29 = 2.435 m3
" " " floor beam = 30 × .024 = .72
3.155 m3

Area of Pavement Granolithic concrete.
4.85 × 457.21 = 2217.47 om
drains 1.18 × .2 × .15 = - 3.54
2213.93 om

Area of Artificial Granite finish
width of finish for coping = .15 + .15 + .28 = .58 m
total area = 457.21 × 2 × .58 = 530.36 om

Forms for Slab.
width coping .15 + .28 + .15 = .58 × 2 = 1.16
slab 4.85
6.01 m

total area = 6.01 × 457.21 = 2747.83
Expansion jt's. 15 @ 1.07 = + 16.05
" 2 @ .99 = + 1.98
2765.86 om

Less top of floor beams 3.0 × .90 = - 127.06
" 225 × .51 = - 114.75
Less top of Stringers 135.29 × .48 = - 64.94
total area of form for slab. 2559.17 om

Expansion jt. .13 × 4.13 × 2 = 1.07 om for girder spans.
" .13 × 3.8 × 2 = .99 " truss spans.

Top of floor beams .175 × #5.15 = .900 om for truss
" " .10 × 5.15 = .51 om for girder
top of stringers + .15 × 2 + .09 × 2 = .48 om/m.

Reinforcements for floor slab.
Girder span 26.802 kg tons.
Truss span 12.201
total 39.003 kg tons.

Cast iron Drains. 118 drains req'd.
Casting 15 × 20 = 300 × 1.5 = 450 cub cm
65 × 1.5 × 1.5 = 146
less holes. 2 × 17 × 1.5 × 4 = - 204
392 cub cm @ 0.0072 = 2.82 kg per drain (.75 %)

118 @ .282 = 3328 kg or (88.7 %)

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CALCULATIONS FOR

Tokiwa-Bashi for Okayama-ken.

Materials for Light pedestal.

Granite:

	断面	長	單量	員数	總量
上ヨリ弔一段 Ⓓ	0.65×0.65	0.3	0.127 立方米	1	0.127 立方米
弔二段	0.33×0.33	0.3	0.033	4	0.132
弔三段	0.65×0.65	0.3	0.127	1	0.127
弔四.伸五段 Ⓒ	0.35×0.15	0.3	0.016	8	0.128
〃 〃 〃	0.15×0.15	0.3	0.007	8	0.056
弔六段八段 Ⓑ	0.4×0.4	0.38	0.061	8	0.488
弔七段 Ⓐ	0.35×0.15	0.38	0.020	4	0.080
〃 〃	0.22×0.22	0.38	0.0.18	4	0.072
					1.210 立方米

親柱電燈用青銅金物

屋根	34cm×34cm×.15cm	173.4cm³	1	173.4
支欹	3×3×15÷3	45.0	1	45.0
上様	6'×.3'×.34'	61.2	4	244.8
中〃	2'×.3'×.30'	18.0	4	72.0
下〃	3'×.3'×.30'	27.0	4	108.0
底	32'×32'×.2'	204.8	1	204.8
柱	3'×.3'×35'	31.5	8	252.0
				1,100.0cm³ = 0.0011m³

0.0011m³ @ 8154 = 8.97kg

親柱四本分 8.97×4 = 35.88kg

鋳鉄金物 支金 一ヶ所 3.5瓩 4ヶ 14.0kg

〃 支金 1 〃 9.0

23.0kg

親柱四本分 4@23.0 = 92.0kg

Concrete 1:2:4 mix.

top. 0.2×0.2 = 0.04

bottom. 0.5×0.5 = 0.25

0.29÷2 = 0.145 0m × 2.65 = 0.384 m³ 一本分

親柱四本分 = 0.384×4 = 1.536 m³

Reinforcements Plain bars

0.046 kg/ton. 一本分

親柱四本分 0.046×4 = 0.184 kg/ton.

Lamp Bracket 20 Lamps. (bronze 1.5kg per lamp)

Form for light pedestal

top. 0.2×4 = 0.8

bottom 0.5×4 = 2.0

2.8÷2=1.4 × 2.65 = 3.71 0m

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NO.	Description	Section	Length	Unit wt.	Total wt. of Main Section	Total wt. of Details
		Anchor Spans (Both sides)				
		End Post	Lo-U1	4-Required		
2	ls	150 × 100 × 9	4530	17.02	1542	
2	,	,	4430	,	150.8	
4	,	75 × 75 × 9	295	9.96	11.8	
2	Pls	170 × 12	200	160.14	64	
1	Pl.	670 × 12	1.100	63.114	69.4	
1	,	315 × 9	400	22.255	8.9	
2	Pls.	165 × 12	530	15.543	16.5	
2	,	145 × 9	400	10.244	8.2	
					305.0 + 121.2 = 426.2	
						4
						1,704.8
		Top Chord	U1–U5	4-Required		
1	Cov. Pl.	320 × 10	4930	25.120	123.8	
4	ls	150 × 100 × 9	8.965	17.02	610.3	
7	Pls.	170 × 12	200	160.14		22.4
2	,	270 × 12	420	25.434		21.4
1	Pl.	630 × 12	875	59.346		51.9
1	Fill.	200 × 12	350	18.840		6.6
4	ls.	150 × 100 × 12	560	22.410		50.2
1	Pl.	320 × 10	560	25.120		14.1
1	Fill.	200 × 12	330	18.840	+	6.2
2	Pls.	145 × 9	210	10.244		4.3
					734.1 + 177.1 = 911.2	
						4
						3,644.8
			U5-U7	4-Required		
1	Cov. Pl.	320 × 10	5.210	25.120	130.9	
1	, ,	,	5.770	,	144.9	
4	ls.	150 × 100 × 9	,	17.02	392.8	
1	Pl.	615 × 12	770	57.933		44.6
4	Pls.	170 × 12	200	160.14		12.8
1	Pl.	270 × 12	420	25.434		10.7
1	Pl.	615 × 12	770	57.933		44.6
1	Pl.	320 × 12	1.190	30.144		35.9
1	Fill.	320 × 10	560	25.120		14.1
1	,	200 × 12	350	18.840		6.6
4	ls.	150 × 100 × 12	560	22.41		50.2
2	Pls.	145 × 9	210	10.244		4.3
					668.6 + 223.8 = 892.4	
						4
						3569.6
			U7–U11	4-Required		
1	Cov. Pl.	320 × 10	8.600	25.120	216.0	
1	,	,	9.160	,	230.1	
4	ls	150 × 100 × 9	,	17.02	623.6	
6	Pls.	170 × 12	200	160.14		19.2
2	Pls.	270 × 12	420	25.434		21.4
1	Pl.	615 × 12	870	57.933		50.4
1	Pl.	320 × 12	1.190	30.144		35.9
1	Fill.	320 × 10	560	25.120		14.1

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1	Fill.	200 ×	12	350	18.840		6.6
2	Pls.	145 ×	9	210	10.244		4.3
4	L	150 × 100 ×	12	560	22.41		50.2
						10697 +	2021 = 12718
							4
							50872
				U11 – U13	4 – Required		
1	Pl.	570 ×	12	910	53.694		48.9
1	Fill.	320 ×	10	450	25.120		11.3
1	Pl.	" ×	"	1.165	"		29.3
3	Pls.	170 ×	12	200	16.014		9.6
1	Pl.	270 ×	12	420	25.434		10.7
1	"	635 ×	12	1.105	59.817		66.1
1	Cov. Pl.	320 ×	10	6035	25.120	1516	152.6
4	L	150 × 100 ×	9	"	17.02	4109	
4	"	150 × 100 ×	12	705	22.41		63.2
						5625 +	2391 = 8016
							4
							32064
				U13 – U17	4 – Required		
1	Cov. Pl.	320 ×	10	4.495	25.120	1129	
1	"	" ×	"	8.964	"	2252	
4	L	150 × 100 ×	9	"	17.02	6103	
4	Pl.	170 ×	12	200	16.014		12.8
1	Fill.	200 ×	12	405	18.840		7.6
1	Pl.	270 ×	12	420	25.434		10.7
1	"	350 ×	12	560	32.970		18.5
1	"	320 ×	10	2.070	25.120		52.0
1	"	" ×	"	1.125	"		28.3
4	L	150 × 100 ×	12	705	22.41		63.2
1	Fill.	200 ×	12	405	18.840		7.6
1	Pl.	775 ×	12	1.050	73.005		76.7
2	Pls.	145 ×	9	285	10.244		5.8
2	Pls.	145 ×	9	285	10.244		5.8
						9484 +	2890 = 12374
							4
							49496
				U17 – U19	2 – Required		
4	L	150 × 100 ×	9	5.749	17.02	3914	
1	Pl.	730 ×	12	965	68.766		66.4
1	"	320 ×	10	587	25.12		14.7
1	"	" ×	"	1.240	"		31.1
2	Pls.	170 ×	12	200	16.014		6.4
1	"	270 ×	12	420	25.434		10.7
1	"	635 ×	12	1.090	59.817		65.2
1	"	155 ×	9	315	10.951		3.4
						3914 +	1978 = 5893
							2
							11786
				U17' – U19	2 – Required		
4	L	150 × 100 ×	9	5.749	17.02	3914	
1	Pl.	730 ×	12	965	68.766		66.4
1	"	320 ×	10	587	25.120		14.7
1	"	" ×	"	1.240	"		31.1

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2	Pls.	170 × 12	200	16.014		6.4	
1	Pl.	270 × 12	420	25.434		10.7	
1	,,	635 × 12	1.160	59.817		69.4	
1	,,	260 × 9	315	18.369		58	
					391.4 +	2045 = 5959	
						2	
						11918	
		Summary of Top Chord			18,718.0 +	5,814.0 = 24,532.8	
		Bottom Chord L0 - L4		4-Required			
2	Ls	150×150×11	9.585	24.95	4783		
1	Pl.	230 × 12	3.860	21.666	836		
1	Pl.	,,	3.820	,,	828		
2	Ls.	100×90×10	471	14.13		133	
1	Fill.	100 × 13	471	10.205		4.8	
2	,,	195 × 11	330	16.838		11.1	
2	Pls.	210 × 9	445	14.837		13.2	
2	Fills.	80 × 11	445	6.908		6.1	
1	Pl.	820 × 12	915	77.244		70.7	
2	Ls	150×150×11	500	24.95		250	
4	Pls.	210 × 9	445	14.837		26.4	
4	Fills.	80 × 11	445	6.908		12.3	
1	Pl.	610 × 12	1.070	57.462		61.5	
2	Fills.	80 × 13	745	8.164		12.2	
1	L.	150×150×15	845	33.55		28.3	
1	Pl.	125 × 13	845	12.756		10.8	
1	Pl.	315 × 9	445	22.255		9.9	
1	,,	360 × 9	570	25.434		14.5	
1	,,	,,	750	,,		19.1	
1	,,	170 × 9	205	12.011		2.5	
					644.7 +	341.7 = 986.4	
						4	
						3,945.6	
			L4 - L6	4-Required			
1	Cov.Pl.	320 × 10	6.020	25.120	1512		
2	Ls	150×150×11	6.270	24.95	3129		
1	Pl.	230 × 12	4.020	21.666	87.1		
4	Pls.	210 × 9	445	14.837		264	
4	Fills.	80 × 11	445	6.908		123	
2	Pls.	360 × 9	1.405	25.434		71.5	
1	Pl.	545 × 12	1.120	51.339		57.5	
1	Pl.	610 × 12	1.120	57.462		64.4	
2	Pls.	170 × 9	205	12.011		4.9	
					5512 +	237.0 = 788.2	
						4	
						3152.8	
			L6 - L10	4-Required			
1	Cov.Pl.	320 × 12	8.720	30.144	2629		
2	Ls	150×150×11	8.720	24.95	4351		
1	Pl.	230 × 12	3.870	21.666	838		
1	,,	,,	,,	,,	838		
4	Fills.	80 × 13	745	8.164		24.3	
2	Ls	150×150×15	845	33.55		56.7	
2	Pls	125 × 13	845	12.756		21.6	
1	Pl.	320 × 15	1.545	37.680		58.2	

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1	Pt.	545	× 12	970	51.339		498	
4	Pts.	210	× 9	445	14.837		264	
4	Fills.	80	× 11	445	6.908		123	
1	Pt.	410	× 9	730	28.967		21.1	
1	Pt.	170	× 9	205	12.011		25	
1	Fill.	320	× 2	900	5.024		45	
						8656	+ 277.4 = 1,143.0	
							4	
							4,572.0	

L10 - L12 4-Required

1	Cov. Pt.	320	× 10	5.635	25.120	141.6		
2	Ls	150 × 150 × 11		5.638	24.950	281.3		
1	Pt.	230	× 12	3.750	21.666	81.2		
1	"	610	× 12	1.230	57.462		70.7	
2	Pts.	210	× 9	445	14.837		132	
2	Fills.	80	× 11	"	6.908		6.1	
1	Pt.	320	× 12	1.085	30.144		327	
1	Fills.	320	× 2	540	5.024		27	
1	Pt.	170	× 9	205	12.011		25	
1	"	440	× 9	1.475	31.086		459	
2	Pts.	210	× 9	765	14.837		227	
2	Fills.	80	× 11	"	6.908		10.6	
1	Pt.	725	× 12	1.220	68.295		833	
1	"	205	× 9	895	14.483		130	
1	"	450	× 9	"	31.793		285	
1	"	320	× 10	1.170	25.120		294	
						5041	+ 361.3 = 8654	
							4	
							3461.6	

L12 - L14 4-Required

1	Cov. Pt.	320	× 10	5.010	25.12	125.9		
2	Ls	150 × 150 × 11		5.035	24.95	251.2		
1	Pt.	230	× 12	3.880	21.666	84.1		
4	Pts.	210	× 9	665	14.837		395	
4	Fills.	80	× 11	"	6.908		184	
1	Pt.	810	× 12	1.145	76.302		874	
1	"	205	× 9	910	14.483		132	
1	"	530	× 9	"	37.445		341	
1	"	320	× 10	1.015	25.12		255	
						4612	+ 218.1 = 6793	
							4	
							27172	

L14 - L16 4-Required

1	Cov. Pt.	320	× 10	5650	25.12	141.9		
2	Ls.	150 × 150 × 11		5.655	24.95	282.2		
1	Pt.	230	× 12	3.775	21.666	81.8		
2	Ls.	125 × 75 × 10		4.695	14.91	140.0		
2	"	"		210	"		63	
2	Pts.	200	× 11	670	17.27		231	
2	Fills.	60	× 1	"	471		.6	
2	Ls	125 × 75 × 10		500	14.91		149	
2	Pts.	200	× 9	440	14.13		124	
2	Fills.	60	× 1	"	47		.4	

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2	Fills	270 × 11	450	23.315	21.0		
1	Pl.	955 × 12	1.790	89.961	161.0		
1	"	285 × 9	450	20.135	9.1		
1	"	515 × 9	1.320	36.385	48.0		
1	"	320 × 10	560	25.12	14.1		
1	"	125 × 12	560	11.775	6.6		
2	Pls	200 × 12	1.000	18.84	37.7		
					645.9 + 355.2 =	1,001.1	
						4	
						4004.4	

L16 - L18 4 Required.

1	Cov. Pl.	320 × 10	5.080	25.12	127.6		
2	L	150×150×11	4,615	24.95	230.3		
1	Pl.	230 × 12	3.565	21.666	77.2		
2	L	125×75×10	4.695	14.91	140.0		
2	"	"	210	"		6.3	
2	Pls	200 × 9	665	14.13		18.8	
1	Pl.	810 × 12	1.145	76.302		87.4	
1	Pl.	205 × 9	945	14.483		13.7	
1	"	530 × 9	945	37.445		35.4	
2	Pls	210 × 9	665	14.837		19.7	
2	Fills	80 × 11	665	6.908		9.2	
					575.1 +	140.5 =	765.6
							4
							3062.4

L18 - L20 2 Required.

2	L	150×150×11	4.905	24.95	244.8		
1	Pl.	230 × 12	3.590	21.666	77.8		
2	Fills	80 × 11	440	6.908		6.1	
2	Pls	210 × 9	440	14.837		13.1	
1	Pl.	745 × 12	960	70.179		67.4	
2	Pls	440 × 11	530	37.994		40.3	
1	Pl.	475 × 9	595	33.559		20.0	
					322.6 +	146.9 =	469.5
							2
							939.0

L18 - L20' 2 Required.

2	L	150×150×11	5.120	24.95	255.5		
1	Pl.	230 × 12	3.590	21.666	77.8		
2	Pls.	210 × 9	440	14.837		13.1	
2	Fills	80 × 11	440	6.908		6.1	
2	Pls	460 × 11	730	39.721		58.0	
1	Pl.	960 × 12	965	90.432		87.3	
1	"	475 × 9	830	33.559		27.9	
					333.3 +	192.4 =	525.7
							2
							1051.4

Summary of Bottom Chord 18,303.0 + 8,603.4 = 26,906.4

Diagonal U1 - L2 4 Req'd.

4	L	90 × 75 × 9	3,590	11.02	157.8		
8	"	"	230	"		20.3	
2	Pls	150 × 12	170	14.13		4.8	
					157.8 +	25.1 =	182.9

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						4 ✓
						731.6 ✓
			L2 – U3	4 – Required		
4 ✓	L ✓	90 ✓ × 75 ✓ × 9 ✓	3,580 ✓	11.02 ✓	157.8 ✓	
2 ✓	Pls. ✓	150 ✓ × 12 ✓	170 ✓	14.13 ✓		4.8 ✓
					157.8 ✓ +	4.8 ✓ = 162.6 ✓
						4 ✓
						650.4 ✓
			U3 – L4 & L8 – U9	8 – Required		
2 ✓	L ✓	125 ✓ × 90 ✓ × 10 ✓	3,640 ✓	16.09 ✓	117.1 ✓	
4 ✓	″ ✓	90 ✓ × 90 ✓ × 10 ✓	220 ✓	13.34 ✓		11.7 ✓
2 ✓	Pls. ✓	125 ✓ × 12 ✓	170 ✓	11.775 ✓		4.0 ✓
					117.1 ✓ +	15.7 ✓ = 132.8 ✓
						8 ✓
						1062.4 ✓
			U9 – L10	4 – Required		
2 ✓	L ✓	90 ✓ × 75 ✓ × 9 ✓	3,575 ✓	11.02 ✓	78.8 ✓	
2 ✓	″ ✓	″ ✓	3,705 ✓	″ ✓	81.7 ✓	
2 ✓	Pls. ✓	150 ✓ × 12 ✓	170 ✓	14.13 ✓		4.8 ✓
					160.5 ✓ +	4.8 ✓ = 165.3 ✓
						4 ✓
						661.2 ✓
			L4 – U5, U5 – L6, L6 – U7 & U7 – L8	16 – Required		
2 ✓	L ✓	125 ✓ × 90 ✓ × 10 ✓	3,640 ✓	16.09 ✓	117.1 ✓	
2 ✓	Pls. ✓	125 ✓ × 12 ✓	170 ✓	11.775 ✓		4.0 ✓
					117.1 ✓ +	4.0 ✓ = 121.1 ✓
						16 ✓
						1937.6 ✓
			L10 – U11	4 – Required		
2 ✓	L ✓	90 ✓ × 75 ✓ × 9 ✓	3,570 ✓	11.02 ✓	78.7 ✓	
2 ✓	″ ✓	″ ✓	3,700 ✓	″ ✓	81.5 ✓	
8 ✓	″ ✓	″ ✓	230 ✓	″ ✓		20.3 ✓
2 ✓	Pls. ✓	150 ✓ × 12 ✓	170 ✓	14.13 ✓		4.8 ✓
					160.2 ✓ +	25.1 ✓ = 185.3 ✓
						4 ✓
						741.2 ✓
			U11 – L12	4 – Required		
4 ✓	L ✓	100 ✓ × 90 ✓ × 10 ✓	3,540 ✓	14.13 ✓	200.1 ✓	
8 ✓	″ ✓	″ ✓	200 ✓	″ ✓		22.6 ✓
2 ✓	Pls. ✓	170 ✓ × 12 ✓	180 ✓	16.014 ✓		5.8 ✓
					200.1 ✓ +	28.4 ✓ = 228.5 ✓
						4 ✓
						914.0 ✓
			L12 – U13	4 – Required		
2 ✓	L ✓	100 ✓ × 90 ✓ × 10 ✓	3,540 ✓	14.13 ✓	100.0 ✓	
2 ✓	″ ✓	″ ✓	3,605 ✓	″ ✓	101.9 ✓	
2 ✓	Pls. ✓	170 ✓ × 12 ✓	180 ✓	16.014 ✓		5.8 ✓
8 ✓	L ✓	100 ✓ × 90 ✓ × 10 ✓	265 ✓	14.13 ✓		30.0 ✓

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					201.9 +	35.8 = 237.7 × 4 = 950.8
			U13 – L14	4 – Required		
2	Ls	125 × 90 × 10	3.825	16.09	123.1	
2	〃	〃	3.890	〃	125.2	
8	〃	100 × 90 × 10	265	14.13		30.0
2	Pls	170 × 12	180	16.014		5.8
					248.3 +	35.8 = 284.1 × 4 = 1136.4
			L14 – U15	4 – Required		
2	Ls	100 × 90 × 10	3.835	14.13	108.4	
2	〃	〃	3.965	〃	112.1	
8	〃	〃	265	〃		30.0
2	Pls	170 × 12	180	16.014		5.8
					220.5 +	35.8 = 256.3 × 4 = 1025.2
			U15 – L16	4 – Required		
4	Ls	125 × 90 × 10	4.715	16.09	303.5	
1	Pl	190 × 12	3.635	17.898	65.1	
4	Pls	150 × 10	405	11.775		19.1
8	Ls	100 × 90 × 10	340	14.13		38.4
					368.6 +	57.5 = 426.1 × 4 = 1704.4
			L16 – U17	4 – Required		
2	Ls	125 × 90 × 10	4.715	16.09	151.7	
2	〃	〃	4.780	〃	153.8	
3	Pls	170 × 12	180	16.014		8.6
					305.5 +	8.6 = 314.1 × 4 = 1256.4
			U17 – L18	4 – Required		
2	Ls	100 × 90 × 10	3.835	14.13	108.4	
2	〃	〃	3.965	〃	112.1	
2	Pls	170 × 12	180	16.014		5.8
8	Ls	100 × 90 × 10	200	14.13		22.6
					220.5 +	28.4 = 248.9 × 4 = 995.6
			L18 – U19	4 – Required		
2	Ls	125 × 90 × 10	3.825	16.09	123.1	
2	〃	〃	3.890	〃	125.2	
2	Pls	170 × 12	180	16.014		5.8
8	Ls	100 × 90 × 10	200	14.13		22.6
					248.3 +	28.4 = 276.7 × 4 = 1106.8

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U19 - L20 4-Required

2 -	L -	100 × 90 × 10	3290 -	14.13 ✓	93.0 ✓	
2 -	" -	"	3355 ✓	" ✓	94.8 ✓	
2 -	FB. -	170 × 12	180 -	16.014 ✓		5.8 ✓
8 -	L ✓	100 × 90 × 10	265 -	14.13 ✓		30.0 ✓
					187.8 ✓ +	35.8 ✓ = 223.6 ✓
						4 ✓
						894.4 ✓

Summary of Diagonals 14,161.6 + 1,606.8 = 15,768.4 ✓

Verticals L2-U2, L4-U4, L6-U6, L8-U8 & L10-U10 20-Required

2 ✓	L ✓	100 × 90 × 10	3.145 ✓	14.13 ✓	88.9 ✓	
1 ✓	FL. ✓	194 × 12 ✓	200 ✓	18.275 ✓		3.7 ✓
1 ✓	" ✓	200 ✓ × 14 ✓	212 ✓	21.980 ✓		4.7 ✓
					88.9 ✓ +	8.4 ✓ = 97.3
						20 ✓
						1946.0 ✓

L12-U12 4-Required

1 -	L. ✓	100 × 90 × 10	3.145	14.13 ✓	44.4	
1 ✓	" ✓	"	3.150	" ✓	44.5	
1 ✓	FL. ✓	194 ✓ × 12 ✓	200	18.275 ✓		3.7 ✓
1 ✓	" ✓	200 ✓ × 14 ✓	215	21.980 ✓		4.7 ✓
					88.9 +	8.4 = 97.3
						4
						389.2

L14-U14 & L18-U18 8-Required

1 ✓	L ✓	100 × 90 × 10	3.505	14.13	49.7	
1 -	" ✓	" ✓	3.535	" ✓	49.9	
1 ✓	FL. ✓	194 ✓ × 12 ✓	200 ✓	18.275 ✓		3.7 ✓
1 ✓	" ✓	200 ✓ × 8 ✓	212 ✓	12.56 ✓		2.7 ✓
					99.6 +	6.4 ✓ = 106.0
						8 ✓
						848.0

L16-U16 4-Required

4 ✓	L ✓	100 × 90 × 10	4.195 ✓	14.13 ✓	237.1 ✓	
1 ✓	FL ✓	190 ✓ × 12 ✓	720 ✓	17.898 ✓		12.9 ✓
1 ✓	" ✓	" ✓	200 ✓	" ✓		3.6 ✓
1 ✓	" ✓	200 ✓ × 8 ✓	212 ✓	12.56 ✓		2.7 ✓
					237.1 ✓ +	19.2 ✓ = 256.3 ✓
						4 ✓
						1025.2 ✓

L20-U20 2-Required

2 ✓	L ✓	100 × 90 × 10	2.596 ✓	14.13 ✓	73.4 ✓	
1 ✓	FL ✓	194 ✓ × 12 ✓	200 ✓	18.275 ✓		3.7 ✓
1 ✓	" ✓	200 ✓ × 8 ✓	212 ✓	12.560 ✓		2.7 ✓
					73.4 ✓ +	6.4 ✓ = 79.8 ✓
						2 ✓
						159.6 ✓

✓

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CALCULATIONS FOR

Material list of Takiwa-bashi for Okayama-ken

L20'-U20' 2-Required

2'	L-	100×90×10	2490	14.13	704	
1-	H-	190 × 12	200	17.898		3.6
1-	"	200 × 8	212	12.560		2.7
					704 +	6.3 = 767
						2
						1534

Summary of Verticals 4,1664 + 3550 = 4,5214

Brackets BT 1 R L 24-Required

1	H.	190 × 8	200	11.932	2.4
1	L	75×75×9	3.145	9.96	31.3
1	Bar	65 × 8	395	4.082	1.6
1	"	"	630	"	2.6
1	"	"	585	"	2.4
1	"	"	470	"	1.9
1	H.	385 × 8	700	24.178	16.9
1	L	75×75×9	"	9.96	7.0
					66.1
					24
					1,586.4

BT2 R L 8-Required

1	H	190 × 8	200	11.932	2.4
1	L	75×75×9	3.000	9.96	29.9
1	Bar	65 × 8	395	4.082	1.6
1	"	"	630	"	2.6
1	"	"	585	"	2.4
1	"	"	470	"	1.9
1	H.	700 × 8	720	43.960	31.7
1	L	75×75×9	1.120	9.96	11.2
					83.7
					8
					669.6

BT3 4 Required.

1	H	190 × 8	200	11.932	2.4
1	L	75×75×9	3.000	9.96	29.9
1	H.	280 × 8	670	17.584	11.8
1	"	700 × 8	695	43.960	30.6
1	L	75×75×9	1.850	9.96	18.4
1	"	"	2.130	"	21.2
1	H.	500 × 8	700	31.400	22.0
2	L	100×90×10	350	14.13	9.9
					146.2
					4
					584.8

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CALCULATIONS FOR

Material list of Tokiwa-bashi for Okayamaken

			BT4 R/L	2-Required	
1-	Fl.	190 - x 8 -	200	11.932	2.4
1-	L-	75 x 75 x 9	3400 -	9.96	33.9
1-	L-	〃	1.170 -	〃	11.7
1-	Bar	65 - x 8 -	395 -	4.082	1.6
1-	〃	〃	630 -	〃	2.6
1-	〃	〃	585 -	〃	2.4
1-	〃	〃	470 -	〃	1.9
1-	Fl.	350 - x 8 -	610 -	21.980	13.4
2.	Washer	60ϕ x 8 -		@ .18	.4
					70.3
					2.
					140.6

			BT5 R/L	2-Required	
1-	Fl.	190 - x 8 -	200 -	11.932	2.4
1-	L-	75 x 75 x 9	2,500 -	9.96	24.9
1-	Bar	65 - x 8 -	395 -	4.082	1.6
1-	〃	〃	630 -	〃	2.6
1-	〃	〃	585 -	〃	2.4
1-	〃	〃	470 -	〃	1.9
1-	Fl.	350 - x 8 -	610 -	21.98	13.4
					49.2
					2 -
					98.4

Summary of Brackets 307.8

BOLTS at U19, U21, U19' & U21'

20	Bolts	19ϕ	60	@ 0.310	6.3
8	〃	〃	50	〃 0.286	2.3
					8.6

Summary of bolts 8.6

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CALCULATIONS FOR

Material list of Tokiwabashi for Okayama-Ken

No.	Description	Section	Length	Unit Weight	Total Weight Main Section	Details
		ANCHOR SPAN BOTH SIDE				
		FLOOR BEAMS FB1, FB2, FB3 & FB4		1-Reqd.		
2	I.	450 × 175	5,695	@ 114.68 ✓	1306.2 ✓	
12	"	"	5,715	" ✓	7864.8 ✓	
8	L.	100 × 90 × 10	335	14.13 ✓		37.9 ✓
24	"	"	250	" ✓		84.8 ✓
4	fillers	90 × 7	310	4.946 ✓		6.1 ✓
					9171.0 ✓ +	128.8 ✓ = 9299.8 ✓
		FB5		4-Reqd.		
2	L.	100 × 90 × 10	5,490	14.13 ✓	155.1 ✓	
2	"	"	5,680	" ✓	160.5 ✓	
1	Web Pl.	815 × 8	5,680	51.182 ✓	290.7 ✓	
2	L.	100 × 90 × 10	585	14.13 ✓		16.5 ✓
8	"	90 × 75 × 9	805	11.02 ✓		71.0 ✓
6	"	"	825	" ✓		54.5 ✓
8	fillers	75 × 10	630	5.888 ✓		29.7 ✓
8	"	70 × 10	260	5.495 ✓		11.4 ✓
					606.3 ✓ +	183.1 ✓ = 789.4 ✓
						× 4
						3157.6 ✓
		FB6		2-Reqd.		
4	L.	100 × 90 × 10	5,520	14.13 ✓	312.0	
1	Web Pl.	510 × 8	4,780	32.028 ✓	153.1	
2	Pls.	450 × 8	710	28.260 ✓		40.1 ✓
4	"	140 × 8	330	8.792 ✓		11.6 ✓
8	L.	90 × 75 × 9	504	11.02 ✓		44.4 ✓
6	"	"	524	" ✓		34.6 ✓
8	fillers	75 × 10	330	5.888 ✓		15.5 ✓
8	"	70 × 10	240	5.495 ✓		10.6 ✓
3	L.	100 × 90 × 10	500	14.13 ✓		21.2 ✓
4	"	"	350	" ✓		19.8 ✓
2	"	"	5,400	" ✓	152.6 ✓	
3	Pls.	180 × 8	500	11.304 ✓		17.0 ✓
2	Pls.	360 × 8	700	22.608 ✓		31.7 ✓
3	Pls.	245 × 8	430	15.386 ✓		19.8 ✓
2	L.	75 × 75 × 9	1,695	9.96 ✓		33.8 ✓
2	"	"	1,765	" ✓		35.2 ✓
4	"	"	1,760	" ✓		70.1 ✓
4	Washers	60ϕ × 8		@ 0.17 ✓		0.7 ✓
					617.7 ✓ +	406.1 ✓ = 1023.8 ✓
						× 2 ✓
						2047.6 ✓
		FB7 & FB9		1-Reqd.		
2	I.	450 × 175	5,630	@ 114.68 ✓	1291.3 ✓	
8	L.	100 × 90 × 10	250	14.13 ✓		28.3 ✓
					1291.3 ✓ +	28.3 ✓ = 1319.6 ✓
		Summary of floor beams			14122.9 ✓ +	1701.7 ✓ = 15824.6 ✓

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CALCULATIONS FOR

Material List of Tokiwa-bashi for Okayama-Ken.

STRINGER S1, S4R & S7 1-Reqd.

28	Pl.	300 × 90	4,950	@ 43.76	6,065.1	
8	"	"	4,930	"	1,725.9	
104	Ls.	90 × 90 × 10	210	13.34		291.3
20	"	"	245	"		65.4
					7,791.0 +	356.7 = 8,147.7

S2, S3, S5R & S6 1-Reqd.

28	Pl.	300 × 150	4,950	@ 48.34	6,699.9	
8	"	"	4,930	"	1,906.5	
104	Ls.	90 × 90 × 10	210	13.34		291.3
20	"	"	245	"		65.4
24	"	150 × 100 × 9	190	17.02		77.6
					8,606.4 +	434.3 = 9040.7

S10R 4-Reqd.

1	I.	300 × 90	4,720	@ 43.76	206.5	
1	L	90 × 90 × 10	245	13.34		3.3
2	Ls.	"	210	"		5.6
					206.5 +	8.9 = 215.4
						× 4
						861.6

S11 4-Reqd.

1	I.	300 × 150	4,720	@ 48.34	228.2	
1	L.	90 × 90 × 10	245	13.34		3.3
2	Ls.	"	210	"		5.6
					228.2 +	8.9 = 237.1
						× 4
						948.4

BRACKETS BK1R & BK2R 1-Reqd.

16	Ls.	90 × 90 × 10	210	13.34		44.8
8	"	"	155	"		16.5
8	Pls.	250 × 8	260	15.70		32.7
						94.0 × 1 = 94.0

BK4R & BK3R 4-Reqd.

2	Ls.	90 × 75 × 9	210	11.02		4.6
1	L.	"	121	"		1.3
1	Pl.	200 × 8	260	12.56		3.3
						9.2 × 4 = 36.8

BK5R 2-Req'd.

1	Pl.	320 × 10	370	25.12		9.3
1	L.	90 × 90 × 10	280	13.34		3.7
						13.0 × 2 = 26.0

Summary of Stringers 18,136.2 + 1019.0 = 19,155.2

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CALCULATIONS FOR

Material list of Tokiwa-bashi for Okayama-Ken

BOTTOM LATERAL BRACINGS Hard-Rivd.

2	Ls.	125 × 75 × 10	7,145	14.91	213.1		
2	〃	〃	3,470	〃	103.5		
2	〃	〃	3,510	〃	104.7		
2	Pls.	400 × 9	705	28.26		39.8	
6	Ls.	75 × 75 × 9	7,140	9.96	426.7		
6	〃	〃	3,525	〃	210.7		
6	〃	〃	3,515	〃	210.1		
6	Pls.	240 × 9	660	16.956		61.0	
2	Ls.	75 × 75 × 9	7,140	9.96	142.2		
2	〃	〃	3,525	〃	70.2		
2	〃	〃	3,515	〃	70.0		
2	Pls.	320 × 9	720	22.608		32.6	
2	Ls.	125 × 75 × 10	7,140	14.91	212.9		
2	〃	〃	3,470	〃	103.5		
2	〃	〃	3,500	〃	104.4		
2	Pls.	400 × 9	905	28.26		51.2	
2	Ls.	125 × 75 × 10	7,110	14.91	212.0		
2	〃	〃	3,475	〃	103.6		
2	〃	〃	3,475	〃	103.6		
2	Pls.	400 × 9	905	28.26		51.2	
4	Ls.	125 × 75 × 10	7,130	14.91	425.2		
4	〃	〃	3,475	〃	207.2		
4	〃	〃	3,490	〃	208.1		
16	〃	75 × 75 × 9	295	9.96		47.0	
4	Pls.	560 × 9	1,205	39.564		190.7	
2	Ls.	125 × 75 × 10	6,920	14.91	206.4		
2	〃	〃	3,360	〃	100.2		
2	〃	〃	3,395	〃	101.2		
2	Pls.	560 × 9	1,005	39.564		79.5	
					3639.5 +	553.0 =	4192.5

Summary of bracings 4192.5

Rivet Heads

27,232	Shop rivet heads.	@ 0.065	1,770.11	
22,348	Field 〃 〃	〃	1,452.6	
			3,222.7	3,222.7

Total Summary of Weight for Anchor spans

Top chords	18,718.8	+ 5,814.0	=	24,532.8
Bottom chords	18,303.0	+ 8,603.4	=	26,906.4
Diagonals	14,161.6	+ 1,606.8	=	15,768.4
Virticals	4,166.4	+ 355.0	=	4,521.4
Floor beams	14,122.9	+ 1,701.7	=	15,824.6
stringers	18,136.2	+ 1,019.0	=	19,155.2
Laterals	3,639.5	+ 553.0	=	4,192.5
Brackets		3,079.8	=	3,079.8
Rivet Heads				3,222.7
Bolts				8.6
				117,212.4

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CALCULATIONS FOR

Material list of Tokiwa-bashi for Okayama-Ken

Suspended span. U19 - U21. 2 Required.

4	L	150×100×9	4.345	17.02	295.8	
2	Pls	170 × 12	200	16.014		6.4
1	Pl.	270 × 12	420	25.434		10.7
					295.8 +	17.1 = 312.9
						× 2
						625.8

U19' - U21' 2 Req'd.

4	L	150×100×9	4.319	17.02	294.0	
2	Pls	170 × 12	200	16.014		6.4
1	Pl.	270 × 12	420	25.434		10.7
					294.0 +	17.1 = 311.1
						2
						622.2

U21 - U23 4 Req'd.

4	L	150×100×9	4.795	17.02	326.4	
1	Pl.	640 × 12	1.055	60.288		63.6
3	Pls	170 × 12	200	16.014		9.6
1	Pl	270 × 12	420	25.434		10.7
1	Fill	200 × 12	350	18.840		6.6
4	L	150×100×12	560	22.41		50.2
1	Pl	210 × 9	315	14.837		4.7
1	"	145 × 9	315	10.244		3.2
2	Pls.	"	210	10.244	326.4 +	4.3 = 479.5
					326.4 +	152.9 = 479.3
						1917.2

U23 - U25 4 Req'd.

1	Cov.Pl.	320 × 10	4.795	25.12	120.5	
4	L	150×100×9	5.076	17.02	345.6	
1	Pl.	635 × 12	980	59.817		58.6
3	Pls	170 × 12	200	16.014		9.6
1	Pl.	270 × 12	420	25.434		10.7
1	Fill	200 × 12	350	18.84		6.6
4	L	150×100×12	560	22.41		50.2
1	Pl	320 × 10	700	25.12		17.6
2	Pls.	145 × 9	210	10.244	466.1 +	153.3 = 619.4
					466.1 +	157.6 = 623.7
						4
						2,494.8

U25 - U27. 4 Req'd.

1	Cov Pl.	320 × 10	4.830	25.12	121.3	
1	"	"	5.461	"	137.2	
4	L	150×100×9	5.461	17.02	371.8	
1	Pl.	615 × 12	840	57.933		48.7
4	Pls	170 × 12	200	16.014		12.8
1	Pl.	270 × 12	420	25.434		10.7
					630.3 +	72.2 = 702.5
						4
						2,810.0

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CALCULATIONS FOR

Material list of Tokiwa-bashi for Okayama-Ken

			At. U27.		2 Req'd.	
1	Pl.	550 x 12	840	51.81		43.5
1	"	320 x 12	1.190	30.144		35.9
1	Fill	320 x 10	560	25.12		14.1
4	L	150x100x12	560	22.41		50.2
2	Pls.	145 x 9	210	10.244		4.3
						148.0
						282
						296.0

Summary for top chord 68708 + 18952 = 87660

			Bottom Chord	L20-L22	2-Required		
2	L	150x150x11	5.740	24.95	286.4		
1	Pl.	230 x 12	3.465	21.666	75.1		
1	"	900 x 12	1.040	84.78		88.2	
2	Pls.	410 x 11	815	35.404		57.7	
2	Fills.	80 x 11	445	6.908		6.1	
2	Pls.	210 x 9	820	14.837		24.3	
1	Pl.	475 x 9	720	33.559		24.2	
2	"	210 x 9	445	14.837		13.2	
2	Fills.	80 x 11	"	6.908		6.1	
1	Pl.	655 x 12	1.220	61.701		75.3	
2	Pls.	80 x 13	745	8.164		12.2	
1	L	150x150x15	845	33.550		28.3	
1	Pl.	125 x 13	"	12.756		10.8	
1	"	170 x 9	205	12.011		2.5	
1	"	430 x 9	1.495	30.38		45.4	
					361.5 +	394.3	= 755.8
						2	
						1511.6	

			L20	L22	2 Required		
2	L	150 x 150 x 11	5.495		24.95	274.2	
1	Pl.	230 x 12	3.465		21.666	75.1	
1	"	870 x 12	1.040		81.454		85.2
2	"	505 x 11	740		43.607		64.5
2	Fills.	80 x 11	520		6.908		7.2
2	Pls.	210 x 9	820		14.837		24.3
1	Pl.	475 x 9	475		33.559		15.9
2	Pls.	210 x 9	445		14.837		13.2
2	Fills.	80 x 11	445		6.908		6.1
1	Pl.	655 x 12	1.220		61.701		75.3
2	Pls.	80 x 13	745		8.164		12.2
1	L	150x150x15	845		33.55		28.3
1	Pl.	125 x 13	845		12.756		10.8
1	"	170 x 9	205		12.011		2.5
1	"	430 x 9	1.495		30.38		45.4
					349.3 +	390.9	= 740.2
							2
							1,480.4

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CALCULATIONS FOR

Material list of Tokiwa-bashi for Okayama-Ken

L22 - L26 — 4 Required

1	Cov. Pl.	320 ×	11	4.795	27.632	132.5	
2	L	150 × 150 ×	11	8.720	24.95	435.1	
2	Pls	230 ×	12	3.870	21.666	167.7	
4	〃	210 ×	9	445	14.837		26.4
4	Fills	80 ×	11	445	6.908		12.3
1	Pl.	610 ×	12	970	57.462		55.7
1	〃	170 ×	9	205	12.011		2.5
1	〃	360 ×	9	820	25.434		20.9
2	Pls	80 ×	13	745	8.164		12.1
1	L	150 × 150 ×	15	845	33.55		28.3
1	Pl.	125 ×	13	845	12.756		10.8
1	〃	320 ×	11	1,035	27.632		28.6
						735.3 +	197.6 = 932.9
							4
							3731.6

L26 - L26' — 2 Required

1	Cov. Pl.	320 ×	11	6.270	27.632	173.3	
2	L	150 × 150 ×	11	6.270	24.95	312.9	
1	Pl.	230 ×	12	4.040	21.666	87.5	
2	Pls	80 ×	11	4.790	6.908	66.2	
2	〃	545 ×	12	1.110	51.339		114.0
4	〃	210 ×	9	595	14.837		35.3
2	〃	170 ×	9	205	12.011		4.9
2	〃	360 ×	9	1.435	25.434		73.0
						639.9 +	227.2 = 867.1
							2
							1,734.2

Summary for Bottom chord. 5,642.6 + 2,815.2 = 8,457.8

Diagonal L20 U21 — 4 Required.

2	L	125 × 90 × 10		3.295	16.09	106.0	
2	〃	〃		3.360	〃	108.1	
2	Pls	170 ×	12	180	16.014		5.8
8	L	100 × 90 ×	10	200	14.13		22.6
						214.1 +	28.4 = 242.5
							4
							970.0

U21 L21

2	L	90 × 75 ×	9	3.570	11.02	78.7	
2	〃	〃		3.700	〃	81.5	
2	Pls	150 ×	12	170	14.13		4.8
8	L	90 × 75 ×	9	230	11.02		20.3
						160.2 +	25.1 = 185.3
							4
							741.2

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CALCULATIONS FOR

Material list of Toteiwa-bashi for Okayama-Ken

L22 U23 4 Required.

2	L	90 × 75 × 9	3.580	11.02	78.9	
2	"	"	3.710	"	81.8	
2	Pls	150 × 12	170	14.13		4.8

160.7 + 4.8 = 165.5
× 4
662.0

U23 L24 4 Required.

2	L	125 × 90 × 10	3.640	16.09	117.1	
2	Pls	125 × 12	170	11.775		4.0
4	L	90 × 90 × 10	295	13.34		15.7

117.1 + 19.7 = 136.8
× 4
547.2

L24-U25. 2 U25-L26 8 Required.

2	L	125 × 90 × 10	3.640	16.09	117.1	
2	Pls	125 × 12	170	11.775		4.0

117.1 + 4.0 = 121.1
× 8
968.8

L26 - U27 4 Required.

2	L	125 × 90 × 10	3.620	16.09	116.5	
2	Pls	125 × 12	170	11.775		4.0

116.5 + 4.0 = 120.5
× 4
482.0

Summary for Diagonals. 4011.2 + 360.0 = 437 t.2

Verticals L22-U22. L24-U24 & L26-U26 12 Req'd.

2	L	100 × 90 × 10	3.145	14.13	88.9	
1	Pl.	194 × 12	200	18.275		3.7
1	"	200 × 14	212	21.98		4.7

88.9 + 8.4 = 97.3
× 12
1,167.6

Summary for Verticals 1,066.8 + 100.8 = 1,167.6

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CALCULATIONS FOR

Material list of Tokiwa-bashi for Okayama-Ken

No.	Description	Section	Length	Unit Weight	Total Weight Main Section	Total Weight Details	
			SUSPENDED SPAN				
			FLOOR BEAMS FB2 & FB3		1-Reqd.		
6	I-s.	450 × 175	5,715	@ 114.68	3,932.4		
12	L-s.	100 × 90 × 10	250	14.13		42.4	
					3,932.4 +	42.4 =	3974.8
			FB'8		2-Reqd.		
1	I	450 × 175	5,730	@ 114.68	657.1		
4	L-s.	100 × 90 × 10	335	14.13		18.9	
					657.1 +	18.9 =	676.0
							× 2
							1,352.0
		Summary for floor beams			5,246.6 +	80.2 =	5,326.8
			STRINGER S1		10-Reqd.		
1	I.	300 × 90	4,950	@ 43.76	216.6		
4	L-s.	90 × 90 × 10	210	13.34		11.2	
					216.6 +	11.2 =	227.8
							× 10
							2,278.0
			S2 & S3		1-Reqd.		
10	I-s.	300 × 150	4,950	@ 48.34	2392.8		
40	L-s.	90 × 90 × 10	210	13.34		112.1	
10	"	150 × 100 × 9	190	17.02		32.3	
					2392.8 +	144.4 =	2,537.2
			$S9^{R}_{L}$		4-Reqd.		
1	I.	300 × 90	4,720	@ 43.76	206.5		
4	L-s.	90 × 90 × 10	210	13.34		11.2	
					206.5 +	11.2 =	217.7
							× 4
							870.8
			S12 & S13		4-Reqd.		
1	I.	300 × 150	4,720	@ 48.34	228.2		
4	L-s.	90 × 90 × 10	210	13.34		11.2	
1	L	150 × 100 × 9	190	17.02		3.2	
					228.2 +	14.4 =	242.6
							× 4
							970.4
			BRACKET $BK3^{R}_{L}$ & $BK4^{R}_{L}$		4-Reqd.		
2	L-s.	90 × 75 × 9	210	11.02		4.6	
1	L.	"	121	"		1.3	
1	PL.	200 × 8	260	12.56		3.3	
						9.2 × 4 =	36.8

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CALCULATIONS FOR

Material List of Tokiwa Bashi for Okayama Ken

Summary for Stringers 6,297.6 + 395.6 = 6,693.2

BOTTOM LATERAL BRACINGS 1-Req'd.

5	Ls.	75 × 75 × 9	7.140	9.96	355.6		
5	"	"	3,525	"	175.6		
5	"	"	3,515	"	175.0		
5	Pls.	240 × 9	600	16.956		50.9	
2	Ls.	125 × 75 × 10	6,910	14.91	206.1		
2	Ls.	"	3,355	"	100.0		
2	Ls.	"	3,390	"	101.1		
2	Pls.	400 × 9	805	28.260		45.5	
					1,113.4 +	96.4 =	1,209.8

Summary for bracings 1,113.4 + 96.4 = 1,209.8

BRACKETS BTM. AT L22, L24 & L26 12-Req'd.

1	Pl.	190 × 8	200	11.932		2.4	
1	L.	75 × 75 × 9	3.130	9.96		31.2	
1	Bars.	65 × 8	395	4.082		1.6	
1	"	"	630	"		2.6	
1	"	"	585	"		2.4	
1	"	"	470	"		1.9	
1	Pl.	385 × 8	700	24.178		16.9	
1	L.	75 × 75 × 9	700	9.96		7.0	
						66.0 × 12 =	792.0

Summary for Brackets 792.0

RIVET HEADS

Shop rivets heads.	7,204	@	0.065	= 468.3
Field " "	6,098	"	"	= 396.4
				864.7

Total Summary of Weight for Suspended Span

	Main Section		Details	Total
Top chords	6,870.8	+	1,895.2	= 8,766.0
Bottom "	5,642.6	+	2815.2	= 8,457.8
Diagonals	4,011.2	+	360.0	= 4,371.2
Verticals	1,066.8	+	100.8	= 1,167.6
Floor Beams	5,246.6	+	80.2	= 5,326.8
Stringers	6,297.6	+	395.6	= 6,693.2
Bottom Lateral Bracings	1113.4	+	96.4	= 1,209.8
Brackets			792.0	= 792.0
Rivet Heads			864.7	= 864.7
				37,649.1

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MADE BY Y. H. DATE 3-11-23 FILE NO
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CALCULATIONS FOR

Material list of Takiwa-bashi for Okayama-Ken

No.	Description	Section	Length.	Unit Weight	Total Weight
		EXPANSION JOINT	EJ1 & EJ3	1-Reqd.	
14	ls.	100 × 75 × 10	4.970	12.95 ✓	901.1 ✓
1	"	125 × 75 × 10	4.970	14.91 ✓	74.1 ✓
15	bars	30 × 10	4,950	2.355 ✓	1749 ✓
75	ls.	125 × 75 × 10	150	14.91 ✓	167.7 ✓
30	Pls.	150 × 9	165	10.598 ✓	52.5 ✓
30	"	"	200	10.598 ✓	63.6 ✓
15	"	"	215	" ✓	34.2 ✓
495	Rivet heads	10ϕ		@ 0.01 ✓	5.0 ✓
600	" "	19ϕ		" 0.065 ✓	39.0 ✓
140	bolts	16ϕ	45	" 0.172 ✓	24.1 ✓
5	Anchor bolts	16ϕ	300	" 0.568 ✓	2.8 ✓
					1539.0 ✓ × 1 = 1,539.0 ✓
		EJ2 & EJ4		1-Reqd.	
14	Checkered Pls.	230 × 9	4,950	16.25 ✓	1126.1 ✓
1	"	240 × 9	"	16.956 ✓	83.9 ✓
15	ls.	65 × 65 × 8	4.970	7.66 ✓	571.1 ✓
75	"	125 × 75 × 10	150	14.91 ✓	167.7 ✓
30	Pls.	150 × 9	165	10.598 ✓	52.5 ✓
30	"	"	200	" ✓	63.6 ✓
15	"	"	215	" ✓	34.2 ✓
1095	Rivet heads	19ϕ		@ 0.065 ✓	71.2 ✓
150	bolts	16ϕ	45	" 0.172 ✓	25.8 ✓
					2196.1 ✓ × 1 = 2,196.1 ✓
				Summary for Girder span	3,735.1 ✓
		EJ5		1-Reqd.	
2	ls.	125 × 75 × 10	4.970	14.91 ✓	148.2 ✓
2	bars	30 × 10	4,950	2.355 ✓	23.3 ✓
4	ls.	65 × 65 × 8	385	7.66 ✓	11.8 ✓
4	"	"	160	7.66 ✓	4.9 ✓
4	Pls.	175 × 8	385	12.364 ✓	19.0 ✓
4	"	160 × 9	210	11.304 ✓	9.5 ✓
68	Rivet heads	10ϕ		@ 0.01 ✓	0.7 ✓
96	"	19ϕ		" 0.065 ✓	6.2 ✓
8	bolts	19ϕ	45	" 0.272 ✓	2.2 ✓
					225.8 ✓ × 1 = 225.8 ✓
		EJ6		1-Reqd.	
2	Checkered Pls.	240 × 9	4.950	16.956 ✓	167.9 ✓
2	ls.	65 × 65 × 8	4.970	7.66 ✓	76.1 ✓
4	"	"	385	7.66 ✓	11.8 ✓
4	"	"	160	" ✓	4.9 ✓
4	Pls.	175 × 9	385	12.364 ✓	19.0 ✓
4	"	160 × 9	210	11.304 ✓	9.5 ✓
164	Rivet heads	19ϕ		@ 0.065 ✓	10.7 ✓
8	bolts	19ϕ	45	" 0.272 ✓	2.2 ✓
					302.1 ✓ × 1 = 302.1 ✓
				Summary for Truss span	527.9 ✓
		Summary for expansion joint			4,263.0 ✓

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MADE BY I. M. DATE 3-11-20 FILE NO
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CALCULATIONS FOR

Material list of Tokiwa-bashi for Okayama Ken

	SHOES (cast steel only)			1-Reqd.		
4	Cast steel shoes	RS1		@ 83.8	335.2	0
4	" "	bed Pls.	BP1	" 93.0	372.0	0
4	" "	brackets	CS1	" 97.5	390.0	
4	" "	shoe	CS2	" 345.0	1380.0	
					2477.2 ×1 =	2477.2
	ACCESSORIES FOR SHOES 1-Reqd.					
4	Pins	100φ		184	61.65	45.4
8	Nuts				@ 1.70	13.6
8	Pls.	70 × 13		370	7.144	21.1
16	Rollers	90φ		360	49.93	287.6
32	Pins	25φ		45	3.85	5.5
8	bars	30 × 13		470	3.062	11.5
8	Ls.	150 × 100 × 9		470	17.07	64.0
8	Pls.	117 × 6		386	5.511	17.0
16	Anchor bolts	32φ		700	@ 5.2	83.2
16	Pls.	150 × 10		150	11.775	28.3
32	bolts	25φ		125	@ 0.9	28.8
4	Pins	120φ		430	88.78	152.7
8	Nuts				@ 2.1	16.8
16	Anchor bolts	32φ		700	@ 5.2	83.2
16	Washers	150 × 10		150	11.775	28.3
					887.0 ×1 =	887.0
	STEEL CASTING BRACKET AT L16 4-Reqd.					
2	Casting				@ 67.0	134.0 ×4 = 536.0
	STEEL CASTING BLOCK AT L20 & L20' 1-Reqd					
2	Castings	PT1			@ 63.4	126.8
2	"	PT2			" 59.4	118.8
2	"	SP1			" 49.7	99.4
2	"	SP2			" 33.4	66.8
2	"	RK1			" 44.8	89.6
4	"	PD1	R L		" 65.4	261.6
2	"	SP3			" 35.8	71.6
2	"	SP4			" 51.3	102.6
					937.2 ×1 =	937.2
	ACCESSORIES FOR CASTINGS AT L20 & L20' 1-Reqd.					
2	Pins	100φ		168	61.65	20.7
4	Nuts				@ 1.70	6.8
2	Pls.	190 × 5		195	7.458	2.9
14	Screws	6φ		15	@ 0.005	0.1
2	Pin	100φ		189	61.66	23.3
4	Nuts				@ 1.70	6.8
2	Pls.	190 × 5		190	7.458	2.8
14	Screws	6φ		15	@ 0.005	0.1
8	bolts	25φ		120	@ 0.87	7.0
					70.5 ×1 =	70.5
	Summary of Shoes except Casting					957.5
	Casting only					3950.4

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CALCULATIONS FOR

Material list of Tokiwabashi for Okayama Ken

No.	Description	Section	Length	Unit Weight	Total Weight
		HAND RAIL POSTS HP1, HP2$^{L}_{R}$, HP5$^{L}_{R}$ & HP6$^{L}_{R}$		1-Reqd	
412	I$_s$	100 × 75	1.292	@ 12.89 ✓	6.861.4 ✓
1640	L$_s$	100 × 75 × 7	50	9.23 ✓	756.9 ✓
824	L$_s$	75 × 75 × 9	114	9.96 ✓	935.6 ✓
1648	fillers	53 × 10	60	4.161 ✓	411.4 ✓
1640	bolts	10ϕ	30	@ 0.04	65.6 ✓
1648	"	16ϕ	60	" 0.20	329.6 ✓
824	"	10ϕ	35	" 0.05	41.2 ✓
4944	Rivet heads	10ϕ		" 0.01	49.4 ✓
					9,451.1 ×1= 9,451.1 ✓
		HP3		1-Reqd.	
162	I$_s$	100 × 75	1,092	@ 12.89 ✓	2,280.3 ✓
648	L$_s$	100 × 75 × 7	50	9.23 ✓	299.1 ✓
324	"	125 × 75 × 10	96	14.91 ✓	367.1 ✓
162	bolts	16ϕ	345	@ 0.637	103.2 ✓
324	"	10ϕ	35	@ 0.05	16.2 ✓
1944	Rivet heads	10ϕ		@ 0.01	19.4 ✓
					3085.3 ✓ ×1= 3,085.3 ✓
		HP4 & HP7$^{L}_{R}$		1-Reqd.	
48	I$_s$	100 × 75	1.017	@ 12.89 ✓	629.2 ✓
184	L$_s$	100 × 75 × 7	50	9.23 ✓	84.9 ✓
48	"	125 × 75 × 10	76	14.91 ✓	544 ✓
48		"	160	" ✓	114.5 ✓
96	fillers	60 × 10	80	4.71 ✓	36.2 ✓
48	Anchor bolts	16ϕ	200	@ 0.4	19.2 ✓
96	bolts	16ϕ	75	" 0.22	21.1 ✓
96	"	10ϕ	35	" 0.05	4.8 ✓
576	Rivet heads	10ϕ		" 0.01	5.8
8	L$_s$	100 × 100 × 7	50	10.60 ✓	4.2 ✓
					9743 ×1= 9743 ✓
		HAND RAILS		1-Reqd.	
382	Gas pipe	50ϕ	1.501	5.44	3,119.2 ✓
196	"	"	1,236	"	1317.9 ✓
14	"	"	1,871	"	142.5 ✓
4	"	"	473	"	10.3 ✓
12	"	"	1,208	"	78.9 ✓
12	"	"	1,855	"	121.1 ✓
12	"	"	1,475	"	96.3 ✓
764	L$_s$	45 × 45 × 6	1,480	3.950 ✓	4466.3 ✓
392		"	1,215	" ✓	1,881.3 ✓
28		"	1,850	" ✓	204.6 ✓
8		"	450	" ✓	14.2 ✓
24		"	1,170	" ✓	110.9 ✓
24		"	1,845	" ✓	174.9 ✓
24		"	1.435	" ✓	136.0 ✓
5,348	bars	30 × 10	435	2.355	5478.6 ✓
1,280		40 × 5	240	1.570	482.3 ✓
640	fillers	40 × 5	100	"	100.5 ✓
23,952	Rivet heads	10ϕ		@ 0.01	239.5 ✓
2,560	screw	6ϕ		" 0.006	15.4 ✓

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MADE BY Y. H. DATE 3-11-10 FILE NO
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CALCULATIONS FOR

Material list of Tokiwa-bashi for Okayama-Ken

4	gas pipe	50φ	996	5.44		21.7	
4	"	"	1,460	"		31.8	
8	L.	45 × 45 × 6	975	3.95		30.8	
8	"	"	1,440	"		45.5	
						18,320.5 × 1 =	18,320.5
			CAPS OF HANDRAIL POST CP1, CP2 & CP3 1-Req'd.				
618	Cap.			@	2.88	1,779.8	
4	"			"	3.10	12.4	
2,488	Screw	10φ	25	"	0.016	39.8	
2,444	"	6φ	15	"	0.005	12.2	
						1,844.2 × 1 =	1,844.2
			LAMP POSTS LP1 & LP2 1-Req'd.				
20	Gas pipe	63φ (2½φ)	1,550		8.62	267.2	
20	"	76φ (3φ)	1,150		11.28	259.4	
48	L.	100 × 75 × 7	50		9.23	22.2	
80	Screw	8φ	15	@	0.007	0.6	
96	"	10φ	20	"	0.015	1.4	
48	bolt	10φ	30	"	0.05	2.4	
40	"	19φ	80	"	0.35	14.0	
20	anchor bolt	19φ	200	"	0.6	12.0	
20	Cast iron LP1 & LP2			@	81.0	1,620.0	
						2,199.2 × 1 =	2,199.2
			Summary for Hand Rails & Lamp Posts				35,874.0

Grand Total Weight for Truss Span.

Anchor spans	0	117,212.4
Center Span	6	37,649.1
Expansion joint		527.9
Shoes except Cast steel	0	957.5
Cast steel		3,950.4
		160,297.3

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CHECKED BY F. Y. DATE 〃 〃-20 PAGE NO 86

CALCULATIONS FOR

Material list of Tokiwa-bashi for Okayama-Ken

No.	Description		Length	Unit Weight	Total Weight
	MAIN-GIRDER	$G1^{R}_{L}$	2-Req'd.		
8	Flg. Ls.	150 × 150 × 11	10.765	24.950	2,148.7
2	Web Pl.	1500 × 9	3,895	105.975	825.5
2	〃	〃	6,870	〃	1,456.1
2	Cov. Pl.	330 × 10	6,115	25.905	316.8
2	〃	〃	6,000	〃	310.9
8	Stiff. Ls.	125 × 90 × 13	1,488	20.610	245.3
24	〃	125 × 90 × 10	1,510	16.09	583.1
2	〃	〃	1,466	〃	47.2
8	fillers	90 × 11	975	7.772	60.6
4	〃	222 × 11	320	19.170	24.5
2	〃	70 × 11	138	6.045	1.7
4	Pls.	300 × 9	1,206	21.195	102.2
2	〃	330 × 11	870	28.496	49.6
4	〃	165 × 11	780	14.248	44.5
2	fillers	90 × 11	1,186	7.772	18.4
2	Pls.	330 × 10	860	25.905	44.6
4	Ls.	150 × 150 × 11	860	24.950	85.8
2	Pls.	289 × 8	470	18.149	17.1
6	〃	290 × 8	665	18.212	72.7
2	Sole Pls.	320 × 19	500	47.728	47.7
4	Ls.	125 × 90 × 10	300	16.090	19.3
2	fillers	90 × 11	258	7.772	4.0
2	Pls.	175 × 10	315	13.738	8.7
					6,535.0 × 2 = 13,070.0
	END CROSS FRAME	CF1	2-Req'd.		
2	Ls.	75 × 75 × 9	1,795	9.96	35.8
2	〃	〃	1,805	〃	36.0
4	〃	65 × 65 × 8	200	7.66	6.1
4	〃	〃	205	〃	6.3
2	Is	200 × 100	255	@ 25.95	13.2
1	I	〃	430	〃 〃	11.2
2	Pls.	300 × 8	355	18.840	13.4
1	Pl.	235 × 8	430	14.758	6.3
2	Ls.	75 × 75 × 9	2,954	9.960	58.8
2	Washers	60 ϕ × 8		@ 0.178	0.4
2	Ls.	75 × 75 × 9	130	9.96	2.6
					190.1 × 2 = 380.2
	INTERMEDIATE CROSS FRAME	CF2	6-Req'd.		
2	Ls.	75 × 75 × 9	1,765	9.960	35.2
2	〃	〃	2,705	〃	53.9
2	Pls.	190 × 8	300	11.932	7.2
2	〃	220 × 8	240	13.816	6.6
1	Pl.	185 × 8	310	11.618	3.6
					106.5 × 6 = 639.0
	CROSS BEAM	CB5			
2	Is.	200 × 70	5,130	21.12	216.7 × 1 = 216.7

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MADE BY Y. H. DATE 3-10-12 FILE NO
CHECKED BY F Y DATE " " -20 PAGE NO 87

CALCULATIONS FOR

Material list of Tokiwa-bashi for Okayama-Kin

No.	Description		Length	Unit Weight	Total Weight	
			CROSS BEAMS CB1 ● 2, 3 ● CB4			
14	ls.	200 × 100	5,130	25.95 ✓	1863.7 ✓	
16	Pls.	205 × 10	240	16.093 ✓	61.8 ✓	
8	fillers	100 × 10	205	7.850 ✓	12.9 ✓	
12	Pls.	100 × 10	305	" ✓	28.7 ✓	
					1,967.1 ✓ × 1 = ✓	1,967.1 ✓
			BOTTOM LATERAL BRACINGS CB1, CB2 ● CB3			
7	ls.	75 × 75 × 9	3,740	9.960 ✓	260.8 ✓	
7	"	"	1,830	" ✓	127.6 ✓	
7	"	"	1,820	" ✓	126.9 ✓	
7	Pls.	150 × 8	470	9.420 ✓	31.0 ✓	
					546.3 ✓ × 1 = ✓	546.3 ✓
			BED PLATE BP1	4-Req'd.		
1	Pl.	340 × 35	500	93.415 ✓	46.7 ✓	
2	ls.	75 × 75 × 9	200	9.96 ✓	4.0 ✓	
					50.7 ✓ × 4 =	202.8
			ANCHOR BOLTS	8-Req'd		
1	bolts	35ϕ	700	@ 6.5 ✓	6.5 ✓	
1	Washer	150 × 10	150	11.775 ✓	1.8 ✓	
					8.3 ✓ × 8 = ✓	66.4 ✓
			RIVET HEADS			
5,032	Shop Rivets heads		22ϕ	@ 0.096	483.1 ✓	
1,070	Field " "		"	" "	102.7 ✓	
374	Shop " "		19ϕ	" 0.065	24.3 ✓	
838	Field " "		"	" "	54.5 ✓	
216	Shop " "		16ϕ	" 0.039	8.4 ✓	
168	Field " "		"	" "	6.6 ✓	
					679.6 ✓ × 1 = ✓	679.6 ✓

Total Weight for 1-span 17768.1

			LAMP POST BRACKET BK1	10-Req'd. (for 15 span)		
2	ls.	90 × 75 × 9	275.	11.020 ✓	6.1 ✓	
2	Pls.	145 × 9	275	10.244 ✓	5.6 ✓	
1	filler	125 × 8	145	7.850 ✓	1.1 ✓	
1	Pl.	120 × 25	205	23.550 ✓	4.8 ✓	
					17.6 ✓ × 10 = ✓	176.0 ✓

Total Weight for 15 span

Main girder 17768.1 × 15 = 266,521.5
lamp post brackets 176.0 ✓
266,697.5 or 266,698 Kg. Tons
Expansion joint 3,735.1 ✓
270,432.6 or 270,433 Kg. Tons

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CALCULATIONS FOR

Total Summary

	Truss Span	Girder Spans
	Kg.	Kg.
Structural steel ○	155,819.0	266,697.5
Expansion joint	527.9 ✓	3,735.1 ✓
Cast steel	3,950.4 ✓	
Hand-rails		Kg.
		35,874.6
	160,297.3	270,432.6

Kg.	
160,297.3	
270,432.6	
35,874.6	
466,604.5	= 466,605 Tons