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SHOWA

CALCULATIONS FOR

MADE BY_____DATE_____FILE NO_____
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埼玉県皆野小柱線
上吉野橋設計々算書

昭和八年十二月

（扶環設計精算書ヲ除ク）

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken.

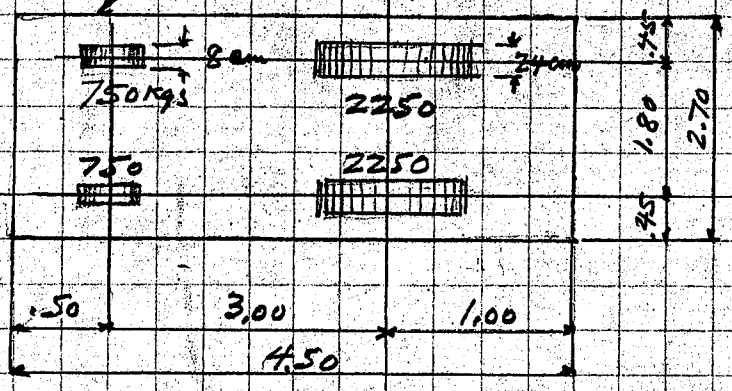
This bridge is to be built over the Arakawa in the Chichibu-District on main highway line between Minano Station and Otamura. The total length of bridge is 120.70 metres about out to out consisting 3-34.0 metre arch spans and reinforced concrete abutments on both approaches. The type of arch is open-spandrel reinforced concrete. The width of roadway 5.5 metres clear between curb lines. Handrails will be reinforced concrete and the pavement 3.8 cm asphalt block on 1.2 cm cement mortar cushion.

Assumed Loadings

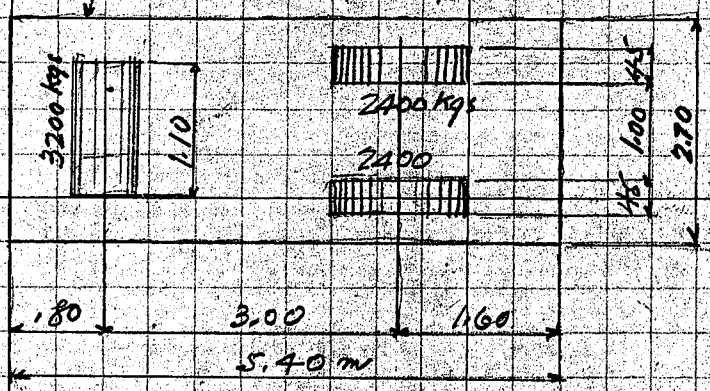
Uniform load $w = \frac{100.000}{170+l} \leq 500$ kgs/m²

where w = uniform load in kgs per sq. meter
l = span length in metes

6 Ton motor truck loading



8 Ton Road Roller Loading



2 Rows of motor traffic lies on roadway with occupied width of 270 cm each; unoccupied space around motor truck and road roller shall be filled with uniform load specified above. One road roller on one span assumed.

Impact for motor truck loading

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

No impact for road roller and uniform live load.

Allowable Working Strength

Reinforcing bar	1200	kgs/cm²	for tension.
	900	"	" shear
Concrete 1:2:4 mixture			
Direct Compression		35	Kgs/cm²
Fibre stress due to bending		45	"
Combined stress direct and bending (Compression member)		35	"
Punching shear of Concrete		9	"
Shear of plain concrete		4	"
Bearing		45	"
Bond stress		6	"
Combined direct and bending stress for Arch Ring		45	"

For arch ring considering temperature stress the allowable unit strength can be increased 25-%

Range of temperature change ± 15° C modulus of elasticity. 140,000 kgs/cm²

Coefficient of expansion 0.000012

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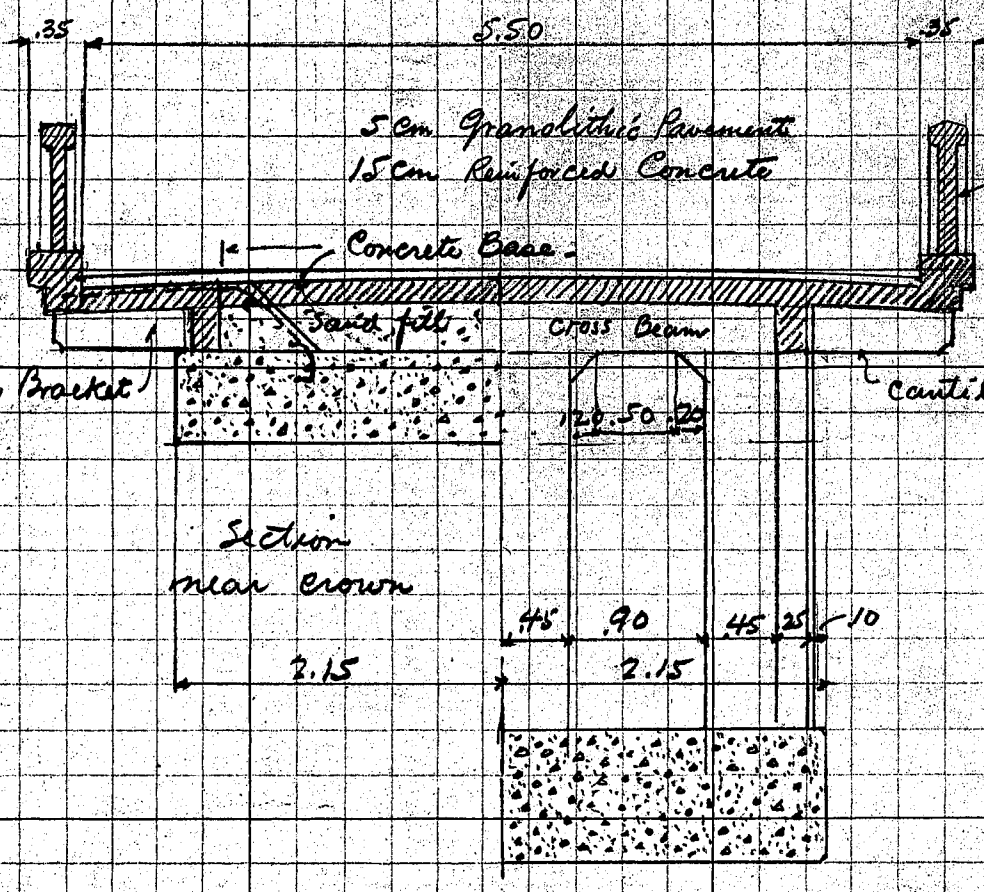
CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken.

Cross Section of Bridge floor. (Arch Span).



Section
Intermediate Panel.

Dimensions of arch ring assumed

Crown thickness.	60 cm	
Springing	135 cm	2.25 times of crown
span length on neutral axis		34.0 meters
Rise on neutral axis		5.75 meters
Ratio rise to span length		1 : 5.92

Panel length 2.0 meters span being devided into 17 panels ; 3 panels at crown shall be filled with sand & gravel below concrete base and others reinforced concrete slab.

Design of Concrete slab for highway floor.
Span length 2.0 meters longitudinal reinforcement

Dead Load

Pavement	3.8 asphalt block on cement cushion	=	110
Concrete slab	15 cm @ 24	=	360
Miscellaneous	Say		20
			490 kg

Dead Load moment = $\frac{1}{10} \times 490 \times 2.0^2$ = 196.0 kg m
Dead Load shear = $\frac{1}{2} \times 490 \times 2.0$ = 490 kgs.

Live Load
motor trucks loading

Rear wheel	2250	
impact 30%	675	
	2925	kgs
Front wheel	2925 ÷ 3 =	975 "

Distribution of wheel Concentration
longitudinal distribution on floor slab = a

Contact on pavement 20
distribution 2.0 = 10
a = 30 cm

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Transverse distribution b

width of wheel 24
Distribution $2 \times 5 =$ 10
$b =$ 34 cm

effective width $= \frac{2l}{3} + b = \frac{2 \times 200}{3} + 34 = 167$ cm

Distance between wheels of motor trucks when running side by side = .90
Distribution for 2 wheels

$1.67 + .90 = 2.57$

for one wheel average $= 2.57 \div 2 = 1.29$ meters.

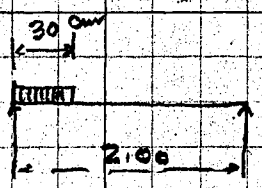
Load per meter strip $2925 \div 1.29 = 2270$ kgs.

Moment at center of span assuming wheel concentrated at point.

$= \frac{2270}{2} \times 1.00 = 1135$ kgm

For continuity of slab. $0.8 \times 1135 = 908$ kgm

End shear say



$2270 \times \frac{1.85}{2.00} = 2100$ kgs.

Summary for moments and shears

	moment	shear
Dead Load	196	490
Live Load	908	2100
	1104 kgm	2590 kgs.

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

$R = \frac{M}{bd^2}$ $d = \sqrt{\frac{M}{bR}}$ where $R = 7.13$

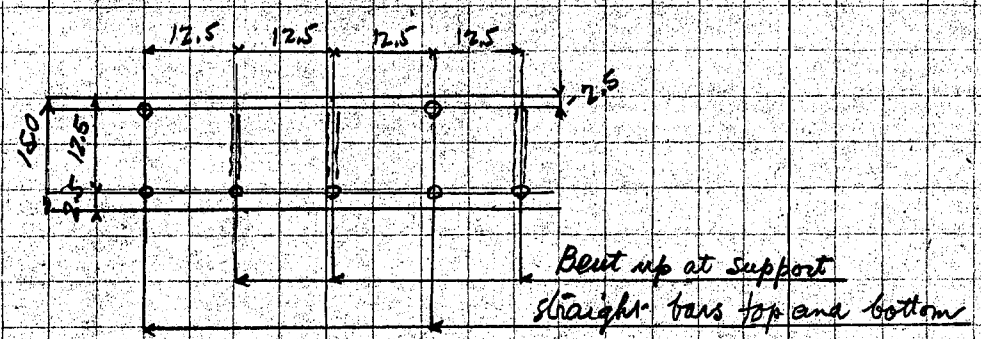
$d = \sqrt{\frac{1104 \times 100}{100 \times 7.13}} = 12.4$ cm

Use slab 15 cm thick including 2.5 centimeters insulation at bottom

Steel area required (approx) $= \frac{1104 \times 100}{\frac{7}{8} \times 12.5 \times 1200} = 8.45$ cm² per meter strip.

12 mm bars $\frac{1.13 \times 10.0}{8.45} = 13.4$ cm spacing use 12.5 cm spacing

Typical arrangement of reinforcing bars.



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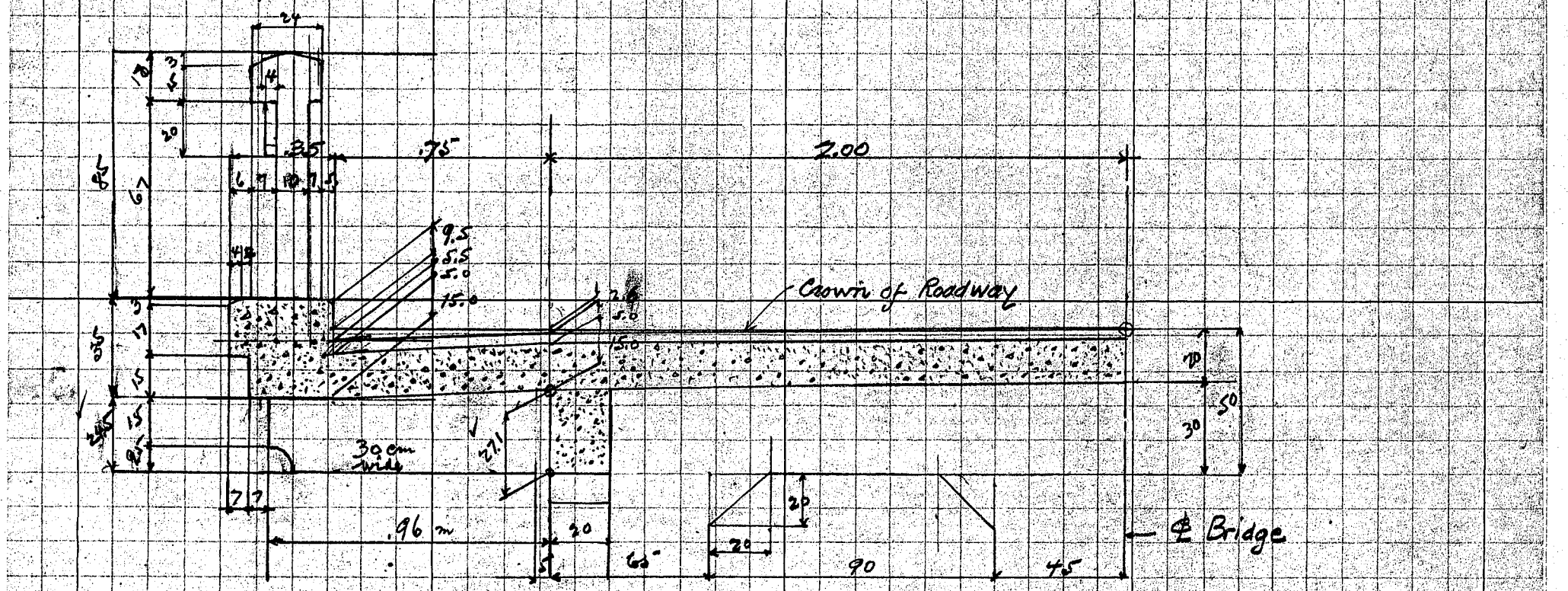
CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken
Construction of Concrete Handrails.



Weight of Handrail

Top Rail	.18 × .24 × .043		
Less.		.0036	
		0.0396	
Panel	67 × 10 =	0.0670	
	0.1066 @ 2400 =	256 kg per lin. meter	
Post	.24 × .30 × .85 =	.0612 @ 2400 =	147 kgs.
Moulding	2 - .15 × .20 × .04 =	.0024 @ 2400 =	6 kgs.

Dead Load for 2 meter panel

Top rail and Panel	256 × 1.700 =	435.0	
Post		147.0	
moulding		6.0	
		588.0 kgs.	
Average weight	588.0 ÷ 2.0 =	294.0 kgs per lin. meter.	
Add for misc		6.0	
		310.0 kgs per lin. meter.	

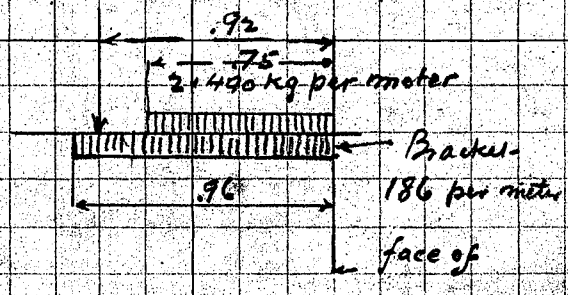
Weight of Coping

.20 × .35 =	0.070	
.15 × .28 =	0.042	
0.112 @ 2400 =	269 kgs per meter	

Approximate Weight of Cantilever Bracket.
Section in average .30 × .25.8 = 0.0775
Weight = 0.0775 @ 2400 = 186 kgs per lin. meter.
or 186 × .96 =

Design of Cantilever Bracket Panel length 2.0

Dead Load



	weight	Arm	moments
Handrail	620 ×	.92 =	570
Coping	538 ×	.91 =	490
Slab + pavement	735 ×	.375 =	276
Cantilever	179 ×	.48 =	86
	2072 kgs.		1422 kg meters

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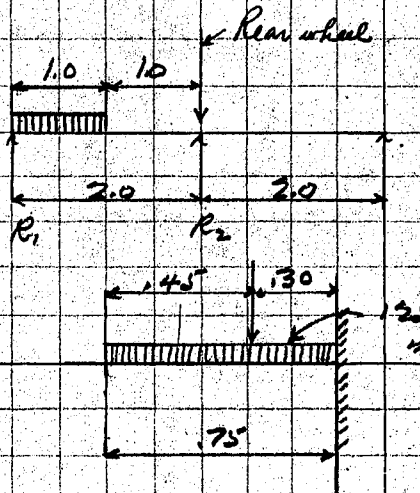
CALCULATIONS FOR

Design of Mina-no-Bashi for Saitama-Ken

Cantilever Bracket

Live Load.



Rear wheel Concentration with impact = 2925 kgs.
Uniform load 500 kgs per sq meter

Load on R_2 Rear wheel 2925 kgs.
" " Uniform load $500 \times \frac{0.5}{2.0} = 125$ kgs. per meter.

Moment due to motor truck concentration $2925 \times .30 = 877$
" " " Uniform load $125 \times \frac{.75^2}{2} = 35$
912 kgm

End shear $2925 + 94 = 3019$ kgs.

Summary for moment and shear

	Moment	Shear
Dead Load	1422	2072
Live Loads	912	3019
	2334 kgm	5091 kgs.

Approximate Steel Area required for Cantilever Beams Lever arm assumed 7/8 of effective depth of beam. Depth of beam 42 cm effective 38 cm

Required steel area for moment $= \frac{233400}{7/8 \times 38 \times 1200} = 5.85$ cm²

Try 3-16 mm bars. $3 \times 2.01 = 6.03$ cm² at top as main reinforcement

Steel percentage $= \frac{6.03}{38 \times 30} = 0.53\%$ $k = .329$ $j = .89$ $kj = .291$

Stress in concrete $fc = \frac{233400 \times 2}{.291 \times 30 \times 38^2} = 37.0$ kg/cm²

Stress in steel $fs = \frac{233400}{0.0053 \times .89 \times 30 \times 38^2} = 1142$ kg/cm²

Max end shear $\frac{5091}{30 \times 38 \times .89} = 5.02$ kg/cm²

Shear over 4.0 kg/cm² to be taken care of by stirrups.

Cross Beam Clear span .90 meter.

Dead Load
Slab and pavement 980 Kgs per meter
Beam under slab $.30 \times .30 \times 2400 =$ 216 kgs " "
1196

Total load on span $1196 \times 0.90 = 1075$

Assuming the span partially fixed, the coefficient for moment shall be taken as 1/10

Dead Load Moment $1/10 \times 1196 \times .90^2 = 96.8$ kg m

Dead Load Shear $1/2 \times 1075 = 538$ kgs.

Live Load motor truck rear wheel on ℄ of span with uniform load at rear
Rear wheel concentration with impact 2925 kgs
Uniform load 125 kgs per lin. meter of span.

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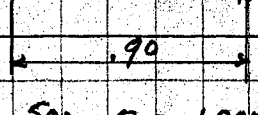
CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Moment due to motor trucks $\frac{2925}{2} \times .45 = 658.0$
for continuity say $658. \times 0.8 = 526.0$
Moment due to uniform load $\frac{1}{10} \times 125 \times .90^2 = \underline{10.1}$
536.1 kgm

End shear assuming no distribution of wheel load



Motor trucks 2925.0
Uniform load $\frac{1}{2} \times 125 \times .90 = 56.0$
" " $\frac{1}{4} \times 875 \times .45 = 99.0$
3080.0

$500 \times 2 = 1000$
$\frac{125}{875}$ kgs.

$875 \times .45 = 394$

Summary for moments and shears

	Moment	Shear
Dead Load	96.8	538.
Live Load	536.1	3080.
	632.9 kgm	3618 kgs

The total moments given above is for both positive and negative sides

Approximate Steel area required for positive side.
Depth of beam say 44 cm effective depth say 40 cm

$$\text{Steel area required} = \frac{63290}{7/8 \times 40 \times 1200} = 1.51 \text{ cm}^2$$

Try 2 - 12 mmϕ bars 2@ 1.13 = 2.26 cm^2

Approximate Steel area required for negative side
Depth say 64 cm Do Steel say 60 cm

$$\text{Steel area required} = \frac{63290}{7/8 \times 60 \times 1200} = 1.00 \text{ cm}^2$$

Use 2 - 12 mmϕ bars 2@ 1.13 = 2.26 cm^2

Unit stresses in Steel reinforcement and Concrete are well under the specified working Strength, use 2 - 12 mmϕ bars at top and bottom of beam.

Longitudinal Beam.
This beam used for strut between columns and partly ornament of side view of arch elevation. Reinforcement is longitudinal same as for slab. Figure reinforcement to carry live load wheel concentration without load distribution.

Dead Load beam 20 cm wide depth 42cm from top of slab.
weight $.42 \times .20 = 0.084$ @ 2400 = 202 kgs

Dead Load Moment $= \frac{1}{10} \times 202 \times 2.0^2 = 80.8$ kgm

Dead Load Shear $= \frac{1}{2} \times 202 \times 2.0 = 202$ kgs.

Live Load motor trucks rear wheel with impact = 2925.0 kgs.
Uniform live load neglected.

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CALCULATIONS FOR

Design of Minami-Baski for Saitama-Ken

Live Load moment = $\frac{2925}{2} \times 1.0$ = 1463 kg-m
for continuity 1463 × 0.8 = 1170
Live Load shear = say 2925 kgs.

Summary for moments and shears

	moment	shear
Dead Load	80.8	202
Live Load	1170.0	2925
	1250.8 kgm	3127 kgs.

Approximate reinforcing bars required

$$As = \frac{125080}{7/8 \times 38 \times 1200} = 3.14 \text{ cm}^2$$

2ry 2-16 mm bars 2@2.01 = 4.02 cm²

On negative side. Section of beam 20 × 38

Steel percentage = $\frac{4.02}{20 \times 38}$ = .53 % k = .327 j = .89 kj = .291

Stress in concrete = $\frac{125080 \times 2}{.291 \times 20 \times 38^2}$ = 29.8 kgs/cm²

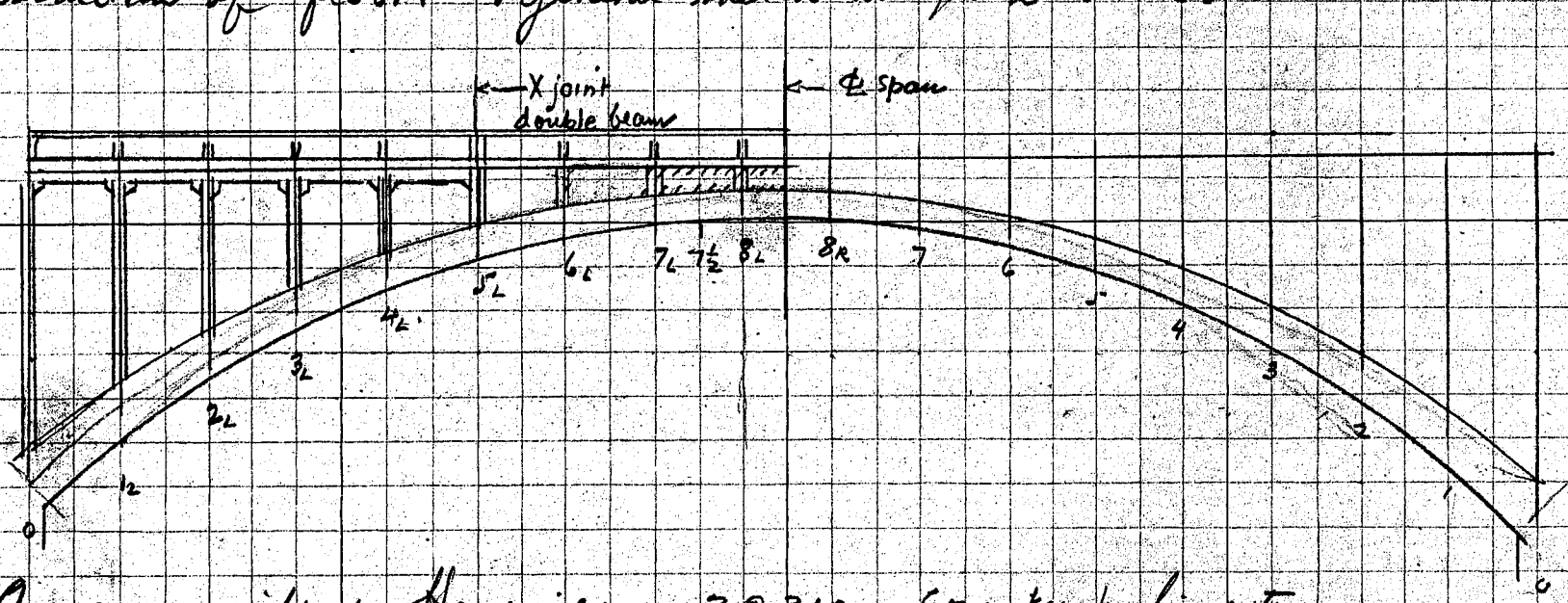
In final detail end filler has been used on safe side.

Unit shear = $\frac{3127}{20 \times 38 \times .89}$ = 4.6 kg/cm²

will require no stirrups at end on account of filler

Dead Load of Deck Construction on Arch Ring

Span length of Arch is divided into 17 panels @ 2.00 metres each. 3 panels at crown filled with sand and gravel and paved on 15 cm Concrete base, next panel no filler and the panels following to this, the spandrels are open with same construction of floor. General sketch is given below:



Average weight of Handrails 2@310 = 620 kgs per lin. meter
panel concentration 620 × 2.0 = 1240 kgs

Handrails			620
Copings	2@	269	= 538
Pavement Slab whole width	}	490 × 5.5	= 2695
			3853 kgs per meter

Panel concentration = 3853 × 2 = 7706 kgs.

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Cantilever Bracket on outside.
Standard size = 179 kgs. see page 14 On both sides 2@179 = 358 Kgs.
Double brackets at expansion joint = $179 \times \frac{40}{30} = 239$ On both sides 2@239 = 478 Kgs.

Longitudinal Beams panels 0 to 5
20 cm wide 27 cm under slab.
main section = .20 × .27 × 2.00 = .108 cubic meters
filler 2@ $\frac{.20 \times .25 \times .20}{2}$ = .010
.118 @ 2400 = 283 kgs.
both sides 283 × 2 = 566 kgs.

Longitudinal walls at

panel point 5	1.0m	.20 × 1.00 × 1.00	= 0.200	@ 2 = 0.400	@ 2400	= 960 kgs	
6_L	1.0	.20 × 1.00 × .85	= 0.170	0.340	} .60	1440	
6_R	1.0	.20 × 1.00 × .65	= 0.130	@ 2 = 0.260			
7_L	1.0	.20 × 1.00 × .50	= 0.100	0.200	} .29	695	
7_R	0.5	.20 × 0.50 × .45	= 0.045	0.090			
between 7-8 ($7\frac{1}{2}$)		.20 × 1.00 × .40	= 0.080	0.160		= 384	
8_L		.20 × 1.00 × .30	= 0.060	0.120		= 288	
8_R							
between 8-8' ($\frac{1}{2}$)		.20 × 0.50 × .30	= 0.030	0.060		= 144	

Standard Cross beams with fillet.
.30 × .29 × 3.60 = .313
2@ .30 × .20 × .20 = .024
.337 @ 2400 = 810 kgs.
double Cross beams 810 × $\frac{4}{3}$ = 1080

Column section
Outside .30 × .70 = 0.21
2@ .05 × .20 = 0.02
2 × 0.23 = 0.46
Middle .30 × .90 = 0.27
0.73 Sq. meter.
weight per lin. meter 0.73 @ 2400 = 1750 kgs per meter
Double panel 1750 × $\frac{4}{3}$ = 2330 kgs per meter

Load at

Panel 0	1750	× 5.35	= 9400	kgs
1	"	× 4.10	= 7180	"
2	"	× 3.05	= 5340	"
3	"	× 2.15	= 3760	"
4	"	× 1.50	= 2620	"
5	2330	× 0.90	= 2100	"
6	1300	× 0.50	= 650	"

at Panel 6 — Column to outside wall.
outside col. .45 × .30 = .135
2 @ .135 = .27
middle col. .30 × .90 = .27
.54
wt = .54 @ 2400 = 1300 kgs.

Cross beam at panel point ⑦
vol. .30 × .50 × 3.60 = .540
weight .540 @ 2400 = 1300 kgs.

Sand and Gravel filling

					vol.		wt		loads
Panel Point 7	7_L	0.35	× .50 ×	3.60	= .63	@	1700	=	1070 kgs
between 7-8		1.00	× .45 ×	3.60	= 1.62	@	"	=	2760 "
	8_R	0.50	× .40 ×	3.60	= .72	@	"	=	2300 "
	8_L	0.50	× .35 ×	3.60	= .63	@	"	=	1070 "
between 8-8' ($\frac{1}{2}$)		0.50	× .35 ×	3.60	= .63	@	"	=	1070 "

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Panel load on Arch Ring. (Summary)

Note! - 12 meter wide over pier and abutment assumed loaded direct on pier and abutment.

Panel Point 0

Handrails coping slab and pavement	3853 × 1.15	=	4425	
Cantilever Brackets			358	
Longitudinal beam	283 × 1.15	=	326	
Standard Cross Beam with fillets			810	
Columns Section			9400	
				15319 Kgs.

Panel Point 1

Handrails. copings slab and pavement	3853 × 2.00	=	7706	
Cantilever Brackets			358	
Longitudinal beam	283 × 2.00	=	566	
Standard Cross Beam with fillets			810	
Part A.				9440
Column section				7180
				16620 Kgs.

Panel Point 2

Part A Same as for Panel Point 1.				9440
Column section				5340
				14780 Kgs

Panel Point 3

Part A Same as for Panel Point 1				9440
Column section				3760
				13200 Kgs

Panel Point 4

Part A				9440
Column Section				2620
				12060 Kgs

Panel Point 5

Handrails copings slab and pavement	3853 × 2.00	=	7706	
Cantilever Brackets			478	
Longitudinal beam	283 × 1.00	=	283	
Longitudinal wall			960	
Double Cross Beam			1080	
Column section			2100	
				12607 Kgs.

Panel Point 6

Handrails copings slab and pavement	3853 × 2.00	=	7706	
Cantilever Brackets			358	
Longitudinal walls			1440	
Standard Cross beams			810	
Columns			650	
				10964 Kgs

Panel Point 7

Handrails copings slab and pavement	3853 × 1.50	=	5780 ◎	
Cantilever Brackets			358	
Longitudinal walls			695	
Cross beams			1300	
Sand filling			1070	
				9203 Kgs.

Note marked ◎ Considered distributed uniform which is so exact meaning.

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Panel Point 7½

Handrails copings slab and pavement	3853 · 1.0	= 3853	
Longitudinal walls		384	
Sand and Gravel fil		2760	
			6997 kgs.

Panel Point 8

Handrails copings slab and pavement	3853 · 1.0	= 3853	
Cantilever Brackets		358	
Longitudinal walls		288	
Sand and Gravel fill		2300	
			6799 kgs.

Crown (½)

Handrails Copings slab and pavement	3853 × 0.5	= 1927	
Longitudinal walls		144	
Sand and Gravel fill		1070	
			3141 kgs.

Approximate weight of Arch Ring.
Crown thickness .60 at springing 1.35 metres width of Arch ring = 4.30

		Vol.		weight
0	1.90 × 1.00 × 4.30 =	8.170	@ 2400 =	19.600
1	1.30 × 2.00 × 4.30 =	11.200		26850
2	1.05 × 2.00 " =	9.03		21600
3	0.90 × 2.00 " =	7.74		18600
4	0.78 × 2.00 " =	6.70		16100
5	0.71 × 2.00 " =	6.10		14640
6	0.65 × 2.00 " =	5.59		13400
7	0.63 × 1.50 " =	4.06		9750
7½	0.62 × 1.00 " =	2.67		6410
8	0.61 × 1.00 " =	2.62		6300
Cr.	0.60 × 0.50 " =	1.29		3100
		65.17		156350

Summary for Dead Load

Panel Point	0	1	2	3	4	5	6	7	7½	8	Cr.
Deck	15319	16620	14780	13200	12060	12607	10964	9203	6997	6799	3141
Arch Ring.	19600	26850	21600	18600	16100	14640	13400	9750	6410	6300	3100
	34919	43470	36380	31800	28160	27247	24364	18953	13407	13099	6241 kgs.
For Round numbers	34900	43500	36400	31800	28200	27300	24400	19000	13400	13100	6250

Horizontal thrust at crown assuming hinges at crown and springing.
moment taken at springing Span Length 34.0 metres Rise 5.75 metres on
neutral axis of arch ring.

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CALCULATIONS FOR

Design of Minano - Bashi for Saitama - Ken

Panel Pt	Load		Arm		Moment
0	34900	×	0	=	
1	43500	×	2.0	=	870.00
2	36400	×	4.0	=	1456.00
3	31800	×	6.0	=	1910.00
4	28200	×	8.0	=	2255.00
5	27300	×	10.0	=	2730.00
6	24400	×	12.0	=	2925.00
7	19000	×	14.0	=	2660.00
7½	13400	×	15.0	=	2010.00
8	13100	×	16.0	=	2095.00
C.	6250	×	17.0	=	1062.00
	278250 ✓				19973.00 ✓

Horizontal Thrust
$= \frac{19973.00}{5.75} = 347500$

Dead Load moment
eccentricity assumed ½ of Crown
depth say 5 cm

$m = 347500 \times 0.05 = 17400$ kgm

Dead Load Thrust at Springing say $347500 \times 1.26 = 438000$ kgs
Eccentricity for moment say ½ of Springing Depth. $13.5 \times \frac{1}{12} = 1.13$ cm

Moment $= 438000 \times 0.113 = 49500$ kgm

Live Load Thrust and moment. See page 681 Hool and Johnson's Concrete Engineers' Handbook. $M_s = \frac{1.35}{.60} = 2.25$ Rise Ratio $\frac{5.75}{34.00} = 1.169$

Uniform Live Load $500 \times 5.5 = 2750$ kgs assumed
Motor truck rear wheel with impact say 2925 kgs (approximate)
$4 @ 2925 = 11700$ kgs.
For 2 meter panel Equivalent uniform load say 5850 kg or assume $2750 \times 2 = 5500$ kgs.

for Crown section $w = 5500$ kgs
for Springing section $w = 2750$ kgs

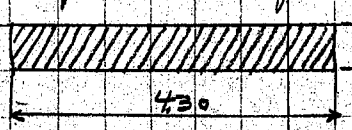
Live Load Thrust at Crown $= 0.38 \times 5500 \times 34 = 71000$ kgs

At Crown + Moment $= 0.0048 \times 5500 \times 34^2 = 30500$ kgm
− Moment $= 0.00391 \times 5500 \times 34^2 = 24800$

Live Load thrust at Springing $= 0.535 \times 2750 \times 34 = 49100$ kgs
for + Moment
Thrust at Springing for − moment $= 0.38 \times 2750 \times 34 = 35600$ kgs.

At Springing + moment $= 0.0282 \times 2750 \times 34^2 = 89600$ kgm
− moment $= 0.0230 \times 2750 \times 34^2 = 73200$ kgm

Temperature stresses
$E = 1.400.000.000$ kg/m² Coef of expansion $\alpha = 0.000012$ for 1°C
Variation of temperature ±15°C $l = 34.0$ m $EWT = 252000$ kg
Moment of inertia of Crown section



22φ bars 28 cm c to c top and bottom
$3.801 \times 16 = 60.82$ cm² at top or bottom
for average 1 meter strip $\frac{60.82}{4.30} = 14.15$ cm²

For top and bottom reinf $= 2 \times 14.15 = 28.30$ cm²

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken.

Moment of inertia of Concrete section $\frac{1}{12} \times 1.00 \times .60^3 = .0180$

Steel reinf. $\frac{28.30 \times 15}{10000} (.30 - 0.045)^2 = \frac{.00275}{.02075}$ m⁴

For fall of temperature

Temperature Thrust at crown $T_c = -27.5 \times \frac{252000 \times 0.02075}{5.75^2} = -4350$ kgs for 4.3 metre = 18700 kgs

Moment at crown $Mc = -22 \times \frac{5.75 \times 18700}{100} = -23650$ kgm

Thrust at Springing say $T_s = 18700 \times 1.26 = 23600$ kgs.

Moment at Springing say $M_s = -23650 + 18700 \times 5.75 = -8385.0$ kgm.

Approximate average stress — Crown section 2.580 + .042 = 2.622 m²

Dead Load	347500	÷ 2.622	=	132000 kgs
Live load	71000	÷ 2.622	=	27000 "
temperature	18700	÷ 2.622	=	7100 "

Fibre Stresses in Arch Ring

Crown section

	Thrust		Moment	Approx. Average stress
Dead Load	+ 347500	say	+ 17400.	132000
live load	+ 71000		+ 3050.0	27000
temperature	− 18700		+ 23650	− 7100
Rib shortening	− 11000		+ 1370.0	− 4200
	388800		+ 8545.0	147700

Eccentricity $\frac{8545.0}{388800} = .0220$ $\varepsilon/h = \frac{.0220}{.600} = .368$

$d/h = .10$ assumed — $p = 0.00497$ — $k = .108$

$$fc = \frac{8545000}{.108 \times 430 \times 60^2} = 61.2 \text{ kg/cm}^2$$

Springing negative moment — Compression on lower fibre.

	Thrust		Moment
Dead Load	438000	say	− 49500
Live Load	35600		− 73200
Temperature	− 23600		− 83850
Rib shortening	− 13800		− 49000
	436200 kg		255550 kgm

Eccentricity 0.585 $d = 135$ $\varepsilon/d = 0.433$ steel ratio = say 0.0042

d/h assumed $\frac{1}{10}$ for approximation — $k = 0.103$

$$fc = \frac{25555000}{0.103 \cdot 430 \cdot 135^2} = 31.6 \text{ kg/cm}^2.$$

for 120 cm springing $\varepsilon/d = \frac{0.585}{1.20} = 0.488$ steel ratio = say 0.0047

d/h assumed $\frac{1}{10}$ for approximation $k = 0.103$

$$fc = \frac{25555000}{0.103 \times 430 \times 120^2} = 39.3 \text{ kgs/cm}^2$$

Looks like 120 cm depth or 2 × crown thickness ample enough for springing section.
However use 135 metre springing for ample safety of arch ring.

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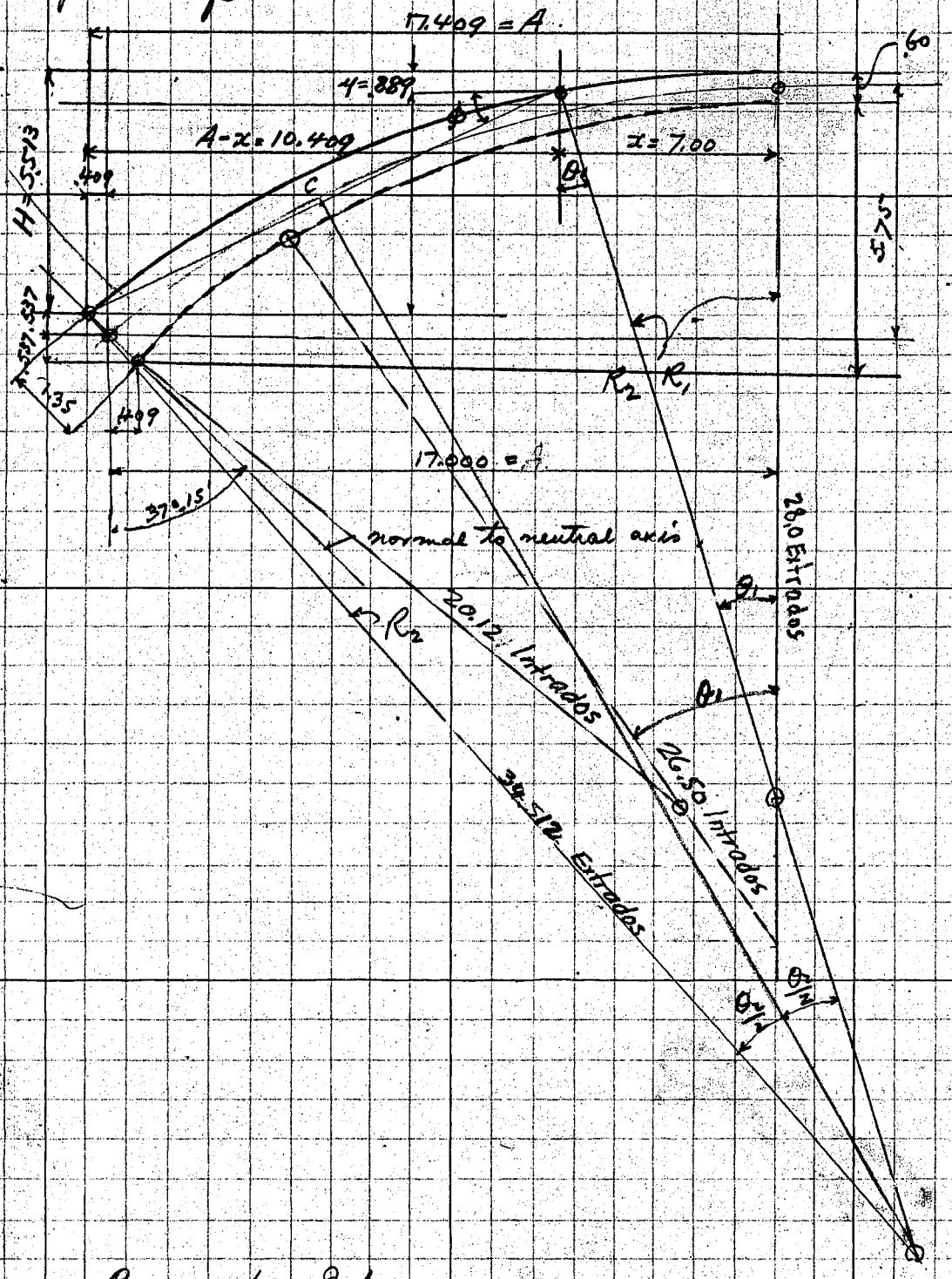
CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Determination of curves for Arch Ring.

From preliminary load and calculated thrust the pressure line to be drawn in large scale; and the intrados and the extrados curves selected on both sides of pressure line. these arch ring curves sketched and then figured exact. The following is the process of calculation.



Curves for Extrados.

$R_1 = 28.000\ m \qquad x = 7.000$

$y = R_1 - \sqrt{R_1^2 - x^2}$

$= 28.000 - \sqrt{28.0^2 - 7.0^2}$

$= 0.889\ m$

$\theta_1 = \sin^{-1}\frac{x}{R_1} = \frac{7.00}{28.00}$

$\theta_1 = 14° - 28' - 39''$

$\phi = \tan^{-1}\frac{H-y}{A-x} = \frac{5.513 - 0.889}{17.409 - 7.000} = \frac{4.624}{10.409}$

$= 23° - 58' - 18''$

$\frac{\theta_2}{2} = \phi - \theta_1 = 9° 29' - 29''$

$c = \frac{H-y}{\sin\phi} = \frac{4.624}{\sin\phi} = 11.382\ m$

$R_2 = \frac{c/2}{\sin\frac{\theta_2}{2}} = 34.512\ m.$

Curves for Intrados.

$R_1 = 26.500\ m \qquad x = 13.00 \qquad y = 26.500 - \sqrt{26.5^2 - 13.0^2} = 3.408\ m$

$\theta_1 = \sin^{-1}\frac{13.00}{26.50} = 29° - 22' - 39''$

$\phi = \tan^{-1}\frac{2.579}{3.591} = 35° - 41' - 07''$

$\frac{\theta_2}{2} = \phi - \theta_1 = 6° - 18' - 28''$

$c = \frac{2.579}{\sin\phi} = 4.421\ 2$

$R_2 = \frac{c/2}{\sin\frac{\theta_2}{2}} = 20.120\ m$

With above dimensions arch ring curves to be drawn, and the dead load on arch ring and arch ring itself shall be re figured.

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken.

Revised panel load. See page no 8

Longitudinal walls at

Panel point 5		.20	× 1.00	× 1.00	= 0.200	@ 2	= 0.400		@ 2400	=	960 kgs
	4_L	.20	× 1.00	× 0.81	= 0.162	@ 2	= 0.324	.576	@ 2400	=	1380 "
	4_R	.20	× 1.00	× 0.63	= 0.126	@ 2	= 0.252				
	7_L	.20	× 1.00	× 0.50	= 0.100	@ 2	= 0.200	.282	@ 2400	=	680 "
	7_R	.20	× 0.50	× 0.41	= 0.041	@ 2	= 0.082				
	$7\frac{1}{2}$	.20	× 1.00	× 0.33	= 0.066	@ 2	= 0.132		@ 2400	=	320 "
	8_L	.20	× 1.00	× 0.27	= 0.054	@ 2	= 0.108		@ "	=	260 "
	8_R										
	$8\frac{1}{2}(C_L)$	.20	× 0.50	× 0.27	= 0.027	@ 2	= 0.054		@ "	=	130 "

Column load at

Panel Point 0	1750	× 5.25	=	9200 kgs
1	"	× 4.07	=	7120 "
2	"	× 3.05	=	5340 "
3	"	× 2.18	=	3820 "
4	"	× 1.47	=	2580 "
5	2330	× 0.90	=	2100 "
6	1300	× 0.45	=	585 "

Cross beam at panel point 7 vol = .30 × .43 × 3.60 = .465 m^3
wt = 465 @ 2400 = 1120 kgs

Sand and gravel filling

Panel Point 7_L	0.35	× 1.40	× 3.60	= .505 vol		@ 1700	=	860	kgs.
$7\frac{1}{2}$	1.00	× .35	× 3.60	= 1.260		"	=	2140	"
8_L	0.50	× .31	× 3.60	= .56	1.08	"	=	1840	"
8_R	0.50	× .29	× 3.60	= .52					
$8\frac{1}{2}(C_L)$	0.50	× .28	× 3.60	= .505		"	=	860	"

Refer to page 9.

Panel Point 0

Handrails coping slab and pavement	3858 × 1.15	= 4425
Cantilever Brackets		358
Longitudinal beam	283 × 1.15	= 326
Standard cross beam with fillet		810
Column section		9200
		15119 kgs

Panel Point 1

Part A See page 9	9440
Column section	7120
	16560 kgs.

Panel Point 2

Part A	9440
Column section	5340
	14780 kgs

Panel Point 3

Part A	9440
Column section	3820
	13260 kgs.

Panel Point 4

Part A	9440
Column section	2580
	12020 kgs

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CALCULATIONS FOR

Design of Minami-Bashi for Saitama-Ken

Panel Point 5
- Handrail copings slab and pavement 3853 × 2.00 = 7706
- Cantilever Brackets 478
- Longitudinal beams 283 × 1.00 = 283
- Longitudinal walls 960
- Double Cross beams 1080
- Columns 2100

12607 Kgs

Panel Point 6
- Handrail copings slab + pavement 3853 × 2.00 = 7706
- Cantilever Brackets 358
- Longitudinal walls 1380
- Standard Cross beams 810
- Columns 585

10839 Kgs

Panel Point 7
- Handrail copings slab + pavement 3853 × 1.50 = 5780
- Cantilever Brackets 358
- Longitudinal walls 680
- Cross beams 1120
- Sand filling 860

8798 Kgs

Panel Point 7½
- Handrail copings slab + pavement 3853 × 1.00 = 3853
- Longitudinal walls 320
- Sand and gravel fill 2140

6313 Kgs.

Panel Point 8
- Handrail copings slab + pavement 3853 × 1.00 = 3853
- Cantilever Brackets 358
- Longitudinal walls 260
- Sand and gravel fill 1840

6311 Kgs.

At crown
- Handrail copings slab + pavement 3853 × 0.5 = 1927
- Longitudinal walls 130
- Sand and gravel fill 860

2917 Kgs.

Arch Ring

Panel Point			vol m³		cwt
	0	1.58 × 1.00 × 4.30 =	6.80	@ 2400 =	16300
	1	1.24 × 2.00	10.70		25700
	2	.97 × 2.00	8.35		20000
	3	.82 × 2.00	7.05		16900
	4	.72 × 2.00	6.20		14900
	5	.655 × 2.00	5.64		13500
	6	.625 × 2.00	5.38		12900
	7	.61 × 1.50	3.94		9450
	7½	.61 × 1.00	2.62		6300
	8	.61 × 1.00	2.62		6300
	C.	.60 × 0.5	1.29		3100
			60.59 m³		145350 Kgs

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CALCULATIONS FOR

Design of Muranno-Bashi for Saitama-Ken

Summary for Dead Load

Panel Point	0	1	2	3	4	5	6	7	7½	8	C₈
Decks	15119	16560	14780	13260	12020	12607	10839	8798	6313	6311	2917
Arch Ring	16300	25700	20000	16900	14900	13500	12900	9450	6300	6300	3100
	31419	42260	34780	30160	26920	26107	23739	18248	12613	12611	6017.
For Round number	31400	42300	34800	30200	26900	26100	23700	18200	12600	12600	6000

Horizontal thrust at crown assuming hinges at crown and springing moment taken at hinge at springing. Span length 34.0 meters Rise 5.75 m on neutral axis,

Panel Point	Load		Arm	Moment
0	31400	×	0	
1	42300	×	2.0	84600
2	34800	×	4.0	139200
3	30200	×	6.0	181200
4	26900	×	8.0	215200
5	26100	×	10.0	261000
6	23700	×	12.0	284500
7	18200	×	14.0	255000
7½	12600	×	15.0	189000
8	12600	×	16.0	201600
C₈	6000	×	17.0	102000
	264800 kgs			1913300

Horizontal thrust

$= \frac{1913300}{5.75} = 333000$ kgs.

From these vertical loads and thrust the line of thrust to be drawn up to see whether the assumed arch ring is fitted or not.

Dead Load of Columns on Pier -

Pavement and Concrete slabs. 490 × 1.20 × 5.50 = 3240 kgs.

Handrail and Coping 1.50 × 1.20 × .50 = .90
.20 × .15 × .30 = .09
Cantilever portion 1.20 × .27 × .95 = .308
1.298 × 2 = 2596

Outside wall.
Section 1.20 × .50 = .600
2 - .20 × .60 = .240
.840 × 5.60 = 4.70 @ 2 = 19.400

Pavement + Slabs 3240
all extra 6270.0
65940 kgs.

Cross beam with fillet. (" ")
$\frac{2}{3} \times .33\frac{1}{3} \times 2 =$ = 0.460

Columns (inside of Facia beams).
Section .20 × .90 = .18
2 × .18 × 5.40 = 1.950

Coping. area
2.30 ⁰ = 4.15 × .25 = .1.04
1.90 ⁰ = 2.84 × .20 = .0.56
1.60 ⁰ = 2.01 × .15 = .0.30
2 - 1.20 × .30 × .90 = 0.648
2.548

Skew back
2.30 × .25 = .575
1.50 × 1.07 = 1.605
2.180 × 430 = 9370
26.152 @ 2400 = 62700

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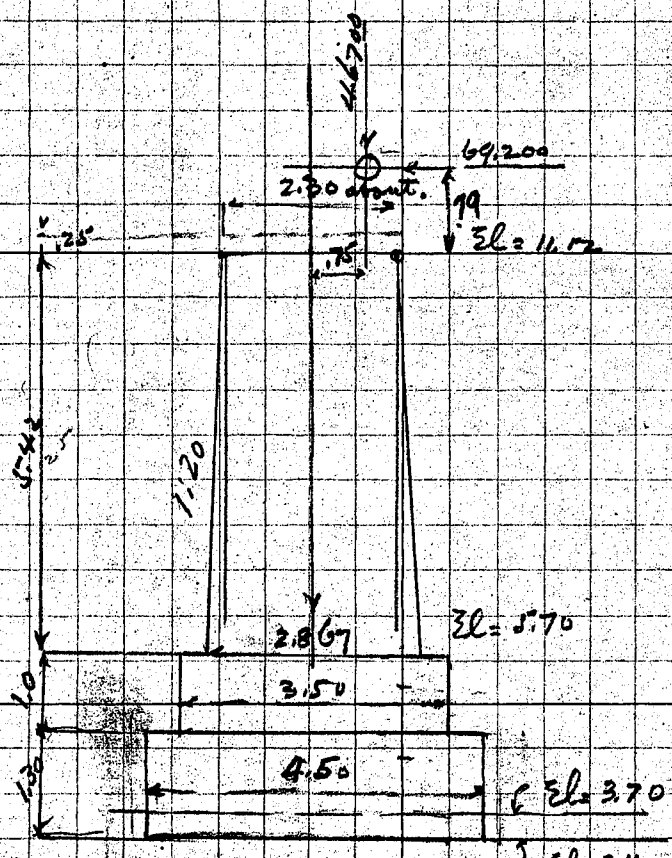
CALCULATIONS FOR

Design of Minami-Bashi for Saitama-Ken

Design of Piers.

Superimposed dead load ppr6 264800 × 2 = 529.600
Load from col on pier 65940
595540 kgs
Call this 595.000 "



Note: For grade of bridge, length of shaft variable for both piers.

volume of concrete in pier

top area 2.30φ 4.15
2.30 × 4.30 = 9.90
14.05

bottom area 2.86φ 6.46
2.86 × 4.30 12.34
18.80
32.85 ÷ 2 = 16.43

volume = 16.43 × 5.42 = 89.00 cubic m

Base. 3.5φ 9.62
3.5 × 4.3 = 15.05
24.67

volume = 24.67 × 1.0 = 24.67 cubic m

Base. 4.5 × 8.8 × 1.3 = 51.40

Total volume of concrete shaft 89.00
Base 24.67
" 51.40
165.07 @ 2200 = 363,000 kgs.

Total Dead Load on Base = Superimposed load 595000
wt of pier 363000
958,000 kgs

Live Load on span. uniform load = 100,000 / 170+34 = 490 kgs/m²

On safe side use 500 kgs/m² 500 × 5.5 = 2750 kgs throughout on one span and no load on other span, On this assumption the motor truck loading neglected

Vertical load 2750 × 17.0 = 46700 kgs.

Horizontal thrust f × 2750 × 34²/5.75 = 69200 kgs.

moment at base 69.200 × 8.51 = 590.000
46700 × .75 = − 35.000
555 000

Total load Dead load 958.000
Live Load 46700
1004700

e = 555.000 / 1004700 = 0.552

Soil Pressure = 1004700 / (4.5 × 8.8) (1 ± (6 × 0.552)/4.5) = 44000 kg/m² or 6700 kg/m²
4.1 tons/ft² or .61 kg/ft²

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Seismic stress in pier - acceleration assumed 1000 mm/sec² or k=.10

	load	k=0.1	Arm above springing
Dead load on deck for one span	240.000 kgs	24000 kgs	6,25 m
" " " arch ring (one span)	290.000 "	29000 "	3,32 m

Pier No 1. Moment about the bottom of base El - 3.40 m.

	k=.10	arm	moment
Slab and deck	24000	6.25 + 8.51	354,000
Arch Ring	29000	3.32 + 8.51	343.000
On pier	6594	11.20	73 800
Shaft	19600	4.90	96 000
Base	5430	1.80	9800
"	11.100	0.65	7200
	95724		883800 kgs.
say	95.700		

Total load 95.7000 kgs. on pier.

Eccentricity = $\frac{883800}{95.7000}$ = .924 m

Bearing on soil $P = \frac{95.7000}{4.5 \times 8.8}\left(1 \pm \frac{6 \times .924}{4.5}\right)$ = 54000 C or 5600 T kg/m²
492 tm/m' " 0.51 tm/m'

neglecting bond $P = \frac{955000}{3.99 \times 8.8} \times 2$ = 54400 C kg/m²

Design of Abutment A

Abutment 3.45 meters extending to the rear width 5.92 meters as shown on sketch on pp 19.

Approximate Concrete in abutment walls.

Front wall	0.50 × 5.92 =	2.96
projection fillet	2 - .029 × 1.20 =	.69
	2 - $\frac{.30 \times .30}{2}$ =	.09
Sidewalls	2 - 0.50 × 2.40 =	2.40
	6.14	× 6.00 = 37.0 cubic meters

weight 37.00 × 2400 = 88,800 kgs.

Coping and Handrail - say (270 + 310) = 580 580 × 1.70 = say 1000 kgs.
On both sides 2000 kgs

weight of Light post above bottom of slab say
volume = 1.20 × .50 × 1.50 = .90 wt .90 × 2400 = 2160
light pole and fixture say 340
2500 kgs.

On both sides 2 × 2500 = 5000 Kgs.

Weight of Earth fill vol 4.92 × 2.40 × 6.00 = 71.00 cubic meters
weight 71.00 @ 1700 = 121,000 kgs.

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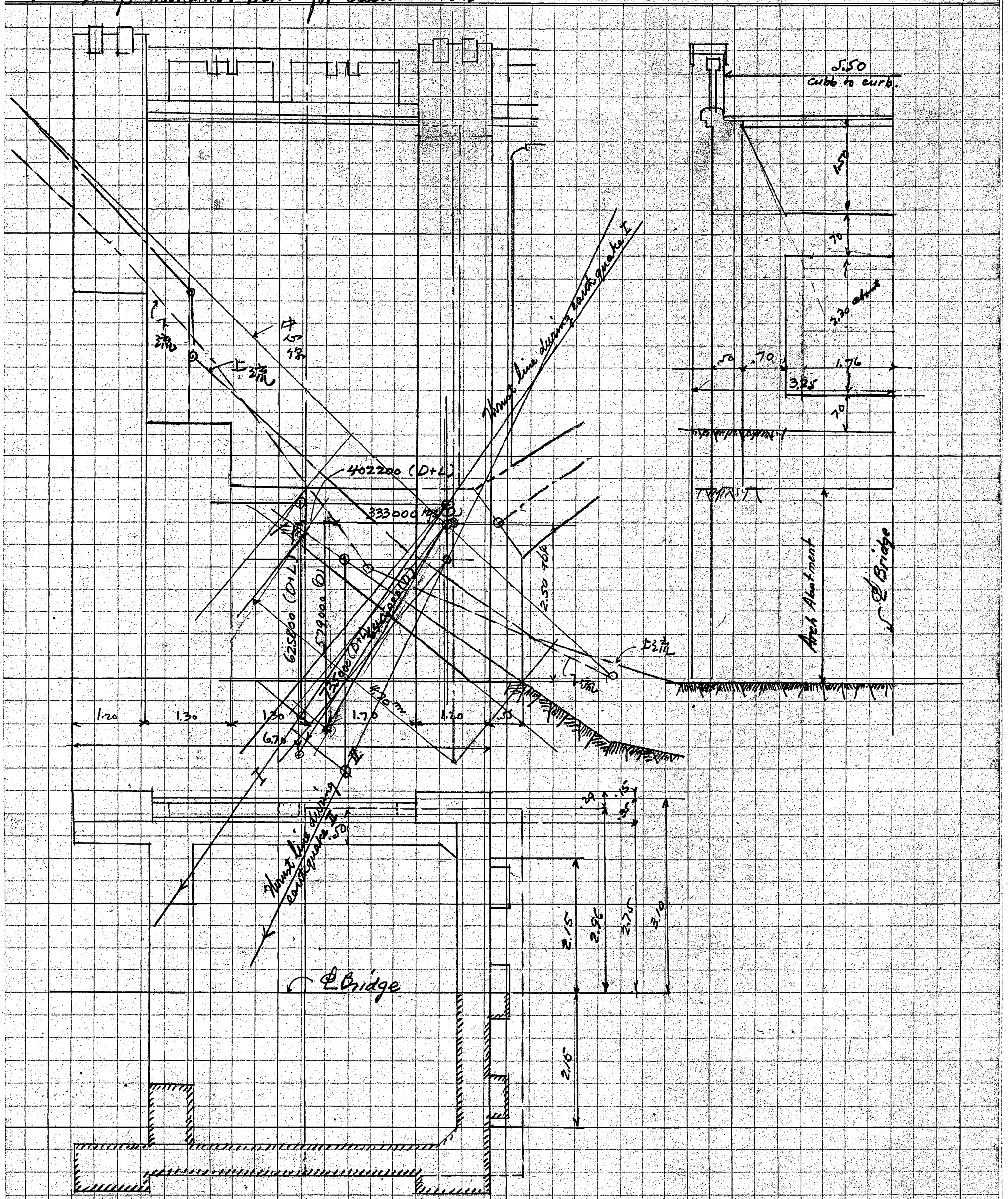
CALCULATIONS FOR

Design of minano. Bashi for Saitama-Ken



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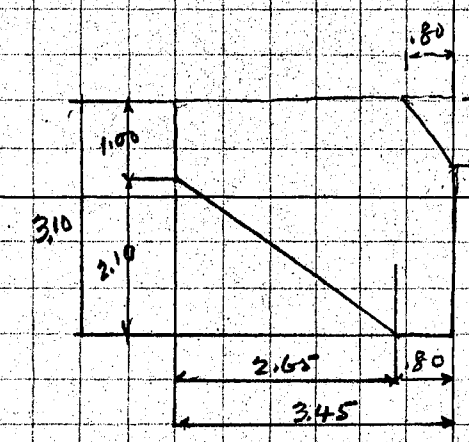
CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Dead Load thrust at springing 333.000 kgs
" " vertical reaction. 264800 "

Dead Load body of abutment



Area =	3.10 × 3.45	=	10.70	× 1.725	=	18.40
−	2.10 × 2.65 / 2	=	− 2.78	× 2.565	=	− 7.12
−	.80 × 1.08 / 2	=	− 0.43	× 0.266	=	− 0.11
			7.49			11.17

ℓ gravity = $\frac{11.17}{7.49}$ = 1.49 m

Total volume of abutment 7.49 × 5.92 = 44.3 m³
weight = 44.3 × 2200 = 97.500 kgs.

center of gravity of all vertical load.

Arch span	264800	× .40	=	106.000
Coping & Handrail	2000	× 2.60	=	5200
light posts	5,000	× 1.15	=	5700
walls -	88.800	× 1.45	=	129.000
Earth fill	121.000	× 2.50	=	302.000
Abutment body	97.500	× 1.49	=	145.000
	579.100	× 1.195	=	692.900

Horizontal thrust 333000 kgs.

Live Load 46700 kgs Horizontal thrust = 69200. kgs.

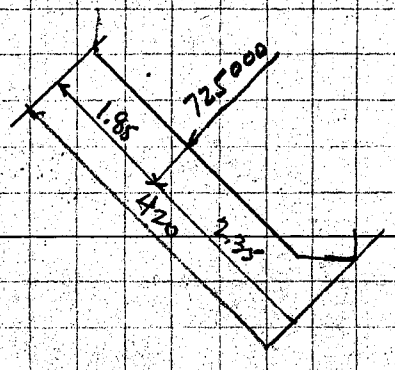
Combined live and dead loads and thrusts.

Center of gravity of dead and live loads.

Dead load	579100	× 1.195	=	692.900
Live Load	46700	× 0.55	=	25700
	625-800	1.150		718600

Total Horizontal thrust Dead load thrust 333.000
Live load thrust 69200
402200 kgs.

By graphic normal thrust to bottom of base Say 725000 kgs.
Eccentricity = 2.10 − 1.85 = 0.25
.357



Soil pressure = $\frac{725.000}{4.2 \times 5.92}\left(1 \pm \frac{6. \times 0.25}{4.2}\right)$ = 39600 kgs/m² or 18800 kgs/m²
29200 3.64 tons/□' or 1.72 tons/□'

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken.

Stability during earthquake.
Acceleration assumed 1000 mm/sec² or Horizontal load kh=.10
Summary of horizontal thrust due to seismic acceleration.

			Arm from bottom		
Slab and deck	120,000 · 0.1 =	12000	· 8.75	=	105.000
Arch ring	145.000	14500	5.82	=	84.500
Copings + Handrails	2000	200	9.50	=	1900
Light posts	5000	500	9.60	=	4800
walls	88800	8880	3.55	=	31500
Earth fill	121000	12100	3.55	=	43000
Abutment body.	97.500	9750	1.75	=	17100
	579.300	57,930	4.96		287,800

Dead Load Hor. Thrust 333,000 × 2.50 = 834,000

390,930 ----- 2.87 ----- 1121.800 ---I

275 070 ----- 1.99 ----- 546.200 ---II

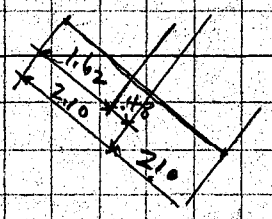
Case I is seismic thrust added to dead load thrust
Case II " " " reduced from dead load thrust.

Both cases plotted on diagram and then the resultant scaled off.
in case I = 690000 kgs. normal to base 690.000 kgs
in case II 635000 kgs. " " " 620000 kgs.

Soil pressure in Case I Ecc = .48 1.90 .695

$$P = \frac{690.000}{4.2 \times 5.92} \times \left(1 \pm \frac{6 \times .48}{4.2}\right) = 46800 \text{ kgs/m}^2 \text{ or } 8750 \text{ kgs/m}^2$$
$$4.79 \text{ tons/ft}^2$$

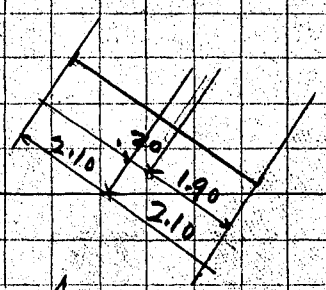
278



Soil pressure in case II Eccentricity .286

$$P = \frac{635000}{4.2 \times 5.92} \times \left(1 \pm \frac{6 \times .20}{4.2}\right) = 33000 \text{ kgs/m}^2 \text{ or } 18300 \text{ kgs/m}^2$$
$$3.02 \text{ tons/ft}^2$$

256.



Assumed abutment is stable enough as seen in figures above. Calculated

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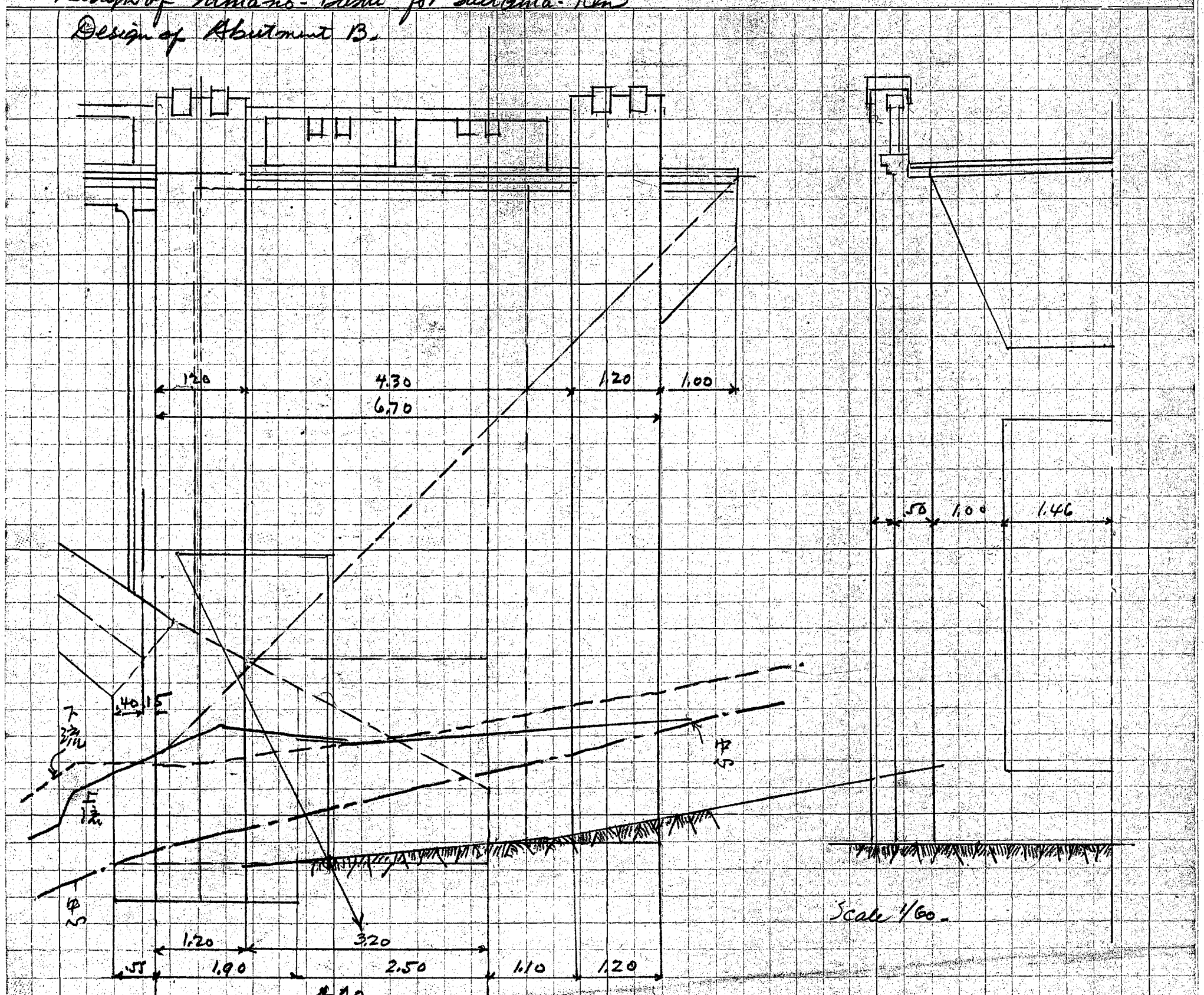
CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken
Design of Abutment B.



Rear projection of this abutment 4.95 m width 5.92 metres Sketch as shown and details not shown similar to Abutment A, See sketch on pp 19

Approximate Concrete in abutment walls.

Front wall	0.50 × 5.92	× 5.80	=	17.20
Projection	2 - 0.29 × 1.20	× 9.60	=	6.70
fillet	2 - $\frac{.30 \times .30}{2}$	× 6.00	=	0.54
Side walls.	2 - 0.50 × 3.20	× 7.20	=	23.00
				47.44 cubic metres

weight 47.44 @ 2400 = 114,000 Kgs.

Coping and Handrail say 5.80 × 3.20 = 18.50 2@1850 = 3700 Kgs

Weight of Light Pole and Pedestal On both sides 5000 Kgs.

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CALCULATIONS FOR

Design of Mina-no-Bashi for Saitama-Ken

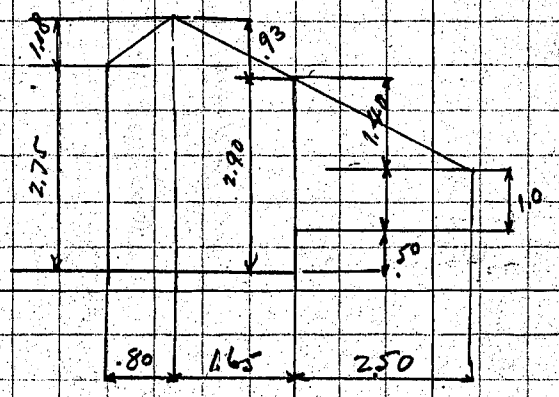
weight of Earth fill.

vol =	3.20	× 4.92	× 6.00	=	94.20	× 1.6	=	150.80
	3.20	× 4.92	× 1.80/2	=	14.20	× 2.13	=	30.20
					108.40	1.69		181.00

weight of fill 108.4 @1700 = 184500 kgs.

Dead Load vertical reaction at springing 264800 kgs.
Thrust from arch ring. 333000 kgs.

Dead Load body of Abutment



	Area			arm		
	2.75 × .80	=	2.200	× .40	=	0.88
	1.08 × .80/2	=	.432	× .53	=	0.23
						7.78
	2.90 × 1.65	=	4.790	× 1.625	=	
	1.65 × .93/2	=	.770	× 1.35	=	1.04
	2.50 × 1.0	=	2.500	× 3.70	=	9.25
	2.50 × 1.40/2	=	1.750	× 3.28	=	5.73
			12.442	2.00		24.93

vol. = 12.442 × 5.92 = 73.70 cubic metres
wt = 73.70 @2200 = 162.000 kgs.

Resultant for Dead Load
moment about face of abutment and bottom plane of rear base.
vertical load

Arch span	264800	× 0.40	=	106.000
Coping and Handrail	3700	× 3.35	=	12.400
Light posts	5000	× 1.15	=	5.800
walls	114.000	× 1.87	=	213.000
Earth fill	184500	× 2.74	=	505.000
Abutment body	162.000	× 2.00	=	324.000
	734.000 kgs.	1.52		1166.200
Hor. thrust	333.000	× 2.79		930.000
				2096.200

Point of Resultant = 2096200/734000 = 2.85 m

Eccentricity 4.95/2 − 2.85 = 0.375

Soil pressure $P = \frac{734000}{4.95 \times 5.92}\left(1 \pm \frac{6 \times 0.375}{4.95}\right)$ = 36400 kgs/m² or 13700 kgs/m²
333 tons/o' 1.25 tons/o'

Live Load vertical load 46700 kgs.
Horizontal thrust 69200 kgs.

Live Load moment.

LL	46700	× 0.40	=	18.700
DL.	734000			1166.200
	780700			1184.900
DL. Hor. Thrust	333000	× 2.79		930.000
	69200	× 2.79		193.000
				2307.900

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CALCULATIONS FOR

Design of Minamo-Bashi for Saitama-Ken

Point of Resultant $= \frac{2307900}{780700} = 2.96$

Eccentricity $2.96 - 2.475 = .485$ (911)

Bearing Pressure $P = \frac{780200}{4.95 \times 5.92} \left(1 \pm \frac{6 \times .485}{4.95}\right) =$ 48300 kgs/m² or 11000 kgs/m²
(5.88) (2.53) 3.87 tons/□' or 1.805 tons/□'

Seismic Stability acceleration assumed 1000 mm/sec² or Hor. thrust k = 0.1

Summary of Seismic horizontal thrust.

		Hor Thrust	Arm (about)		
Slab and deck	120,000 × 0.1 =	12000	9.04	=	108,500
Arch Ring	145,000	14500	6.11	=	88500
Copings + Handrail	3700	370	9.65	=	4600
Light posts.	5000	500	9.66	=	4800
walls	114,000	11400	5.70	=	65000
Earth fill	184,500	18450	5.70	=	105000
Abutment body	162,000	16200	1.20	=	19400
	734200	73420			± 395800

Dead load moment about face of abutment :- 1166200

Dead Load Hor. Thrust = 333,000 × 2.79 = 930.000

406420 2492.000 ----- case I

259580 1700400 ----- case II

Line of resultant $\frac{2492000}{734200} = 3.39$ m Ecc = 0.915 case I

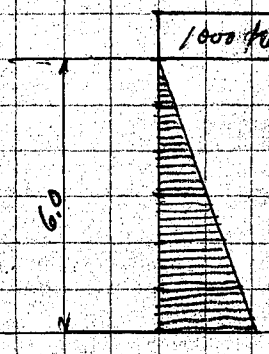
$\frac{1700400}{734200} = 2.32$ m Ecc = 0.155 case II

Bearing Pressure $P = \frac{734200 \times 2}{4.68 \times 5.92} =$ 53000 kgs/m² or 4.85 tons/□' case I
(237)

Bearing Pressure $P = \frac{734200}{4.95 \times 5.92} \left(1 \pm \frac{6 \times 0.155}{4.95}\right) =$ 29800 kgs/m² or 2940 kgs/m²

Design of Abutment walls.

Front wall. Span Length 5.40 meters.



Horizontal pressure for surcharge 330 kgs.

Depth	Earth Pressure		Total	
1	567	+ 330 . =	897	kgs per meter
2	1130		1460	
3	1700		2030	
4	2260		2590	
5	2830		3160	
6	3400		3730	

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CALCULATIONS FOR

Design of Minamo-Bashi for Saitama-Ken

Moment assumed to wl^2

Depth	Kgs	moment kgs/m	Depths	Reinf. cm²	Reinf. bars	Spacing
1	897	2620	45 40	6.24	16	32.2
2	1460	4250	50 45	9.00	16	22.3
3	2030	5910	55 50	11.27	16	17.85
4	2590	7550	60 55	13.10	16	15.35
5	3160	9200	65 60	14.65	16	13.7
6	3730	10900	70 65	15.95	16	12.6 cm

at Depth 6 meters $m = \frac{1}{10} \times 3730 \times 5.4^2 = 10{,}900$ kg/m

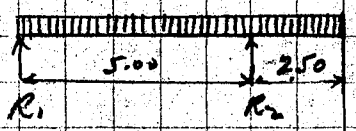
Effective depth required $= \sqrt{\frac{10900}{7.13}} = 39$ cm

Reinforcing Bars $\frac{1090000}{1200 \times 7/8 \times 65} = 15.95$ cm²

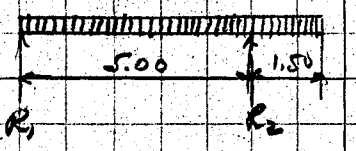
Using 16 mm ϕ bars = 2.011 cm²

Spacing $= \frac{2.011 \times 100}{15.95} = 12.6$ cm

Side walls. span length 5.00 meters assumed.



for depth 1 and 2 meters



for depth 3 to 6 meters

Depth	Unit Pressure	− moment	+ moment
1	897 kgs/m²	−2800	0
2	1460 "	−4560	0
3	2030 "	−2280	+4070
4	2590 "	−2910	+5190
5	3160 "	−3550	+6350
6	3730 "	−4190	+7460
7	2610	−2940	
8	2590	−2920	

Moment as simple cantilever span.

Depth 1.0 Cantilever moment $= \frac{1}{2} \times 897 \times 2.5^2 = 2800$ kgm

Simple span $= \frac{1}{8} \times 897 \times 5.0^2 = 2800$

-2800

0000 kgm

$R_2 = \frac{897 \times 7.50^2}{2 \times 5.0} = 5050$ kgs.

Depth 2.0 Cantilever moment $= \frac{1}{2} \times 1460 \times 2.5^2 = 4560$ kgs m

$R_2 = \frac{1460 \times 7.5^2}{2 \times 5.0} = 8200$ kgs.

Depth 3.0 Cantilever moment $= \frac{1}{2} \times 2030 \times 1.5^2 = 2280$ kgm

$R_2 = \frac{2030 \times 6.5^2}{2 \times 5.0} = 8600$ kgs.

+ Moment at 5. meter span

$m = \frac{1}{8} \times 2030 \times 5^2 = 6350$

less Cantilever m 2280

4070 kgm

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Depth 4.0 Cantilever moment $= \frac{1}{2} \times 2590 \times 1.5^2 = -2910$

Simple span $= \frac{1}{8} \times 2590 \times 5.0^2 = +8100$

-2910

5190 kgm

Depth 5.0 and 6 meter slab as shown on table on pp26

Depth 7.0 span length 3.20 meters overhanging 1.50 about

Unit Earth pressure from inside with 1000 Kg surcharge

Outside 3m $P = 3980 + 330 = 4310$ Kgs. cantilever moment

$P = 1700 \times \frac{3}{5} = 1700$

2610 Kgs. net $\frac{1}{2} \times 2610 \times 1.5^2 = 2940$ kgm

Depth 8.0 span length 1.50 meters about cantilever 1.5 meter

Inside $P = 4530 + 330 = 4860$ cantilever moment

Outside $P = 1700 \times \frac{4}{5} = 2270$ $\frac{1}{2} \times 2590 \times 1.5^2 = 2920$ kgm

2590 Kgs net.

Reinforcing Bars in wall.

Depth	moment	Depth Effective.	Reqd Section	Size	Spacing
1	−2800 kgm	45 cm	5.90	16ϕ	34.00
2	−4560	"	9.65	"	20.50
3	+4070	"	8.60	"	23.40
4	+5190	"	11.00	"	18.30
5	+6350	"	13.30	"	15.10
6	+7460	"	15.80 cm²	16ϕ	12.75
7	+2940	"	6.20	"	32.50
8	−2920	"	6.20	"	32.50

Depth 6.0 meter moment +7460 kgm

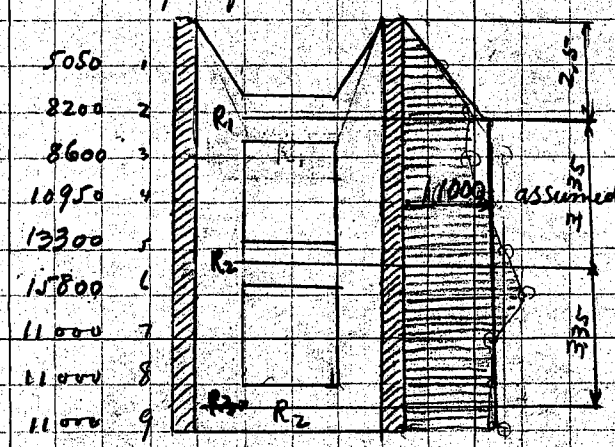
Effective depth reqd $= \sqrt{\frac{7460 \times 100}{100 \times 7.13}} = 32.4$ cm 50 cm over all

Reinforcing Bars $= \frac{746000}{1200 \times \frac{7}{8} \times 45} = 15.8$ cm²

Use 16 mmϕ bars 2.011 cm²

Spacing $\frac{2.011 \times 100}{15.8} = 12.75$ cm

Design of frame between sidewalls of abutment B



R_1 $3.35 \times 11000 = 36850 \times 1.833 = 30700$

$\frac{2.5}{2} \times 11000 = 13750 \times 5.00 = 68800$

50600 Kgs. 99500

$30700 \div 3.35 = 9150$

$R_1 = 99500 \div 3.35 = 29700$ kgs

R_2 = say $11000 \times 3.35 = 36800$ less $9150 = 27650$

$R_3 = 11000 \times 2.17 = 23900$ "

Reinf. Bars $29700 \div 1200 = 24.8$ cm² $19^{\phi} = 2.835 \times 9 = 25.5$

$27650 \div 1200 = 23.1$ cm² $2.835 \times 9 = 25.5$

$23900 \div 1200 = 19.9$ cm² $2.835 \times 7 = 19.8$

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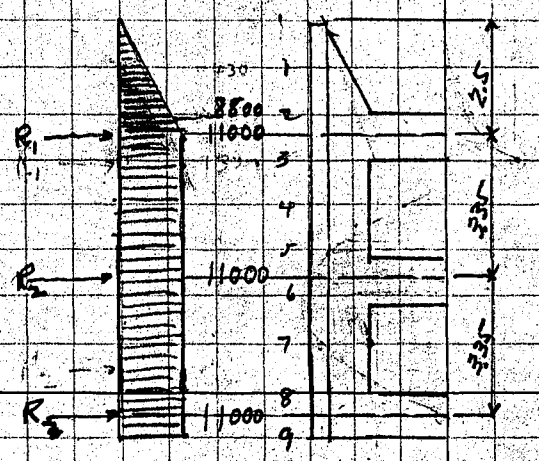
CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Buttress Beam



Moment at R_1 = 615.00

Moment at top of strut = $\frac{8800 \times 2}{2} \times .67 = 5900$ kgm

For other point moment assumed $\frac{1}{10} wl^2$

$m = \frac{1}{10} \times 11000 \times 3.35^2 = 12300$ kgm for 1 m

$A_s = \frac{590000}{1200 \times \frac{7}{8} \times 140} = 4.0$ cm² 2-19φ @ 2.835 = 5.7 cm²

$A_s = \frac{1230000}{1200 \times \frac{7}{8} \times 140} = 8.4$ cm² 3-19φ @ 2.835 = 8.5 cm²

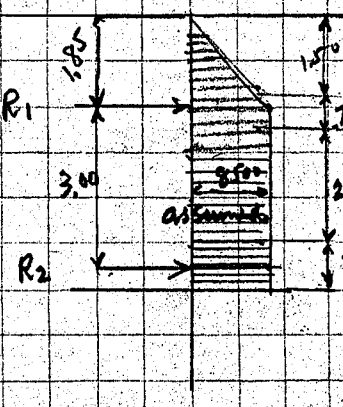
Effective depth of concrete for max. moment $d = \sqrt{\frac{1230000}{60 \times 7.13}} = 54$ cm

Depth used 150 cm Concrete stress etc.

Arm for Reinforcing bars - 140 cm

Design of frame between sidewalls of Abutement A.

Depth	Unit Pressure	Reaction
1	897	3680
2	1460	6150
3	2030	8550
4	1590	7250
5	3160	8850
6	3730	



8500 kgs uniform at lower portion and triangular pressure at top as shown on sketch assumed

3.35×8500	= 28500	× .182	=	37600
$\frac{1.85}{2} \times 8500$	= 7880	× .362	=	28600
	36380			66200

$R_1 = 66200 \div 3.00 = 22100$ kgs 18.5 cm² 8-19φ =

$R_2 = 36380 - 22100 = 14280$ kgs. 11.9 cm² 4-19φ =

Bending moment Cantilever portion

$7880 \times \frac{1.85}{3} = -4850$ kgm

Bending moment at Center of span $\frac{1}{8} \times 8500 \times 3^2 = +9570$

-2425

$+7145$ kgm. nett.

Depth of beam .60 × 1.20

Depth required for $d = \sqrt{\frac{485000}{60 \times 7.13}} = 34$ cm

Depth of beam 1.20

Reinf. $= \frac{485000}{1200 \times 7/8 \times 110} = 4.2$ cm² } Use proper reinforcement in details.

Reinf. $= \frac{714500}{1200 \times 7/8 \times 110} = 6.17$ cm²

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CALCULATIONS FOR

埼玉県皆野小柱線
皆野橋拱環設計精算書

昭和九年四月

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

General Description of the Bridge.

The proposed Minano Bashi is to cross the Arakawa on main highway line between Minano-station and Otamura across the river, Chichibu-gun district. The total lenght of the bridge is 120.70 meters divided to out consisting 3-34.0 meter each spans and approaches. The width of roadway 5.5 meters clear between curb line, paved with 3.8 cm asphaltic blocks on cement mortar cushion and the handrail thereto ornamental concrete mouldings.

Design of deck construction, piers & abutments completed last fall except final calculation of arch ring stresses which will now be figured.

Dead load on arch ring given on page no. 10 previous calculation of this bridge presented November, 1933. and the assumed live load on page no. 1.

Assumed live loads, allowable working stresses and other datas shall be repeated again in this calculation as below.

Assumed live loads

uniform load $w = \frac{100.000}{170 + l} \leqq 500$ kgs/m²

where w = uniform load in kgs per sq meter.
l = span lenght in meter

6 ton motor trucks loading and 8 ton Road Roller loading as specified by the Engineer's department of Naimu-sho.
2 rows of motor traffic lanes on roadway with occupied width of 270 cm each; unoccupied space around motor trucks and road roller shall be filled with uniform load specified above. One road roller on one span assumed.

Impact for motor trucks loading

$\text{Coef} = \frac{20}{60 + l}$ where l = loaded length in meter
max impact 30%

No impact for road roller and uniform live load.

Allowable working strength

Reinforcing bar	1200	kg/cm²	for tension
	900	"	" shear
Concrete 1:2:4 mixture			
Direct compression	35	kgs/cm²	
Fibre stress due to bending	45	"	
Combined stress direct and bending (compression member)	35	"	
Punching shear of concrete	9	"	
Shear of plain concrete	4	"	
Bearing	45	"	
Bond stress	6	"	
Combined direct and bending stresses for arch ring	45	"	

For arch ring considering temperature stress the allowable unit strength can be increased 25%
Range of temperature change ± 15°C. Modulus elasticity = 140.000 kgs/cm²
Coefficient of expansion 0.000012

Cross section of bridge and other detailed construction are given on previous calculation papers made for design of substructure.

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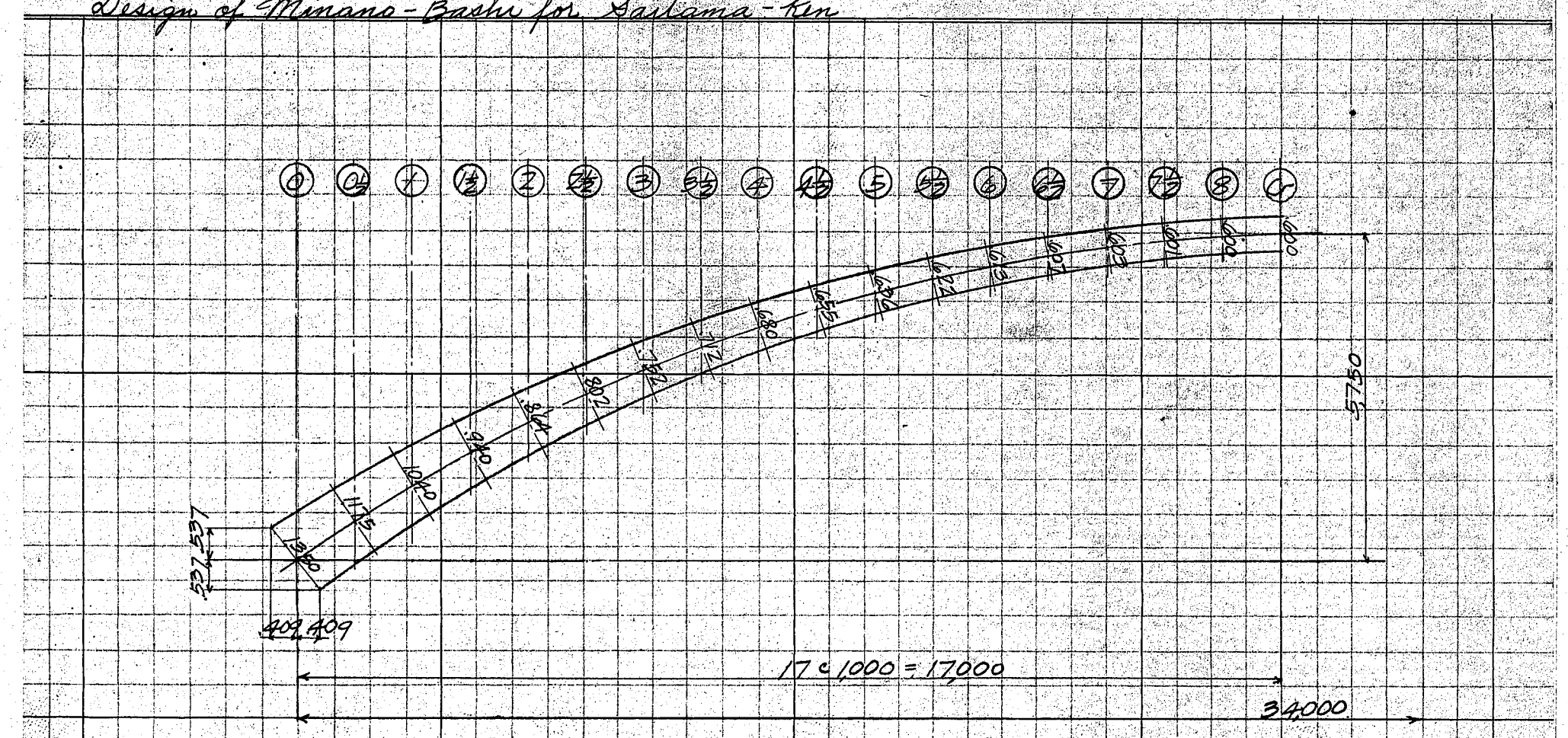
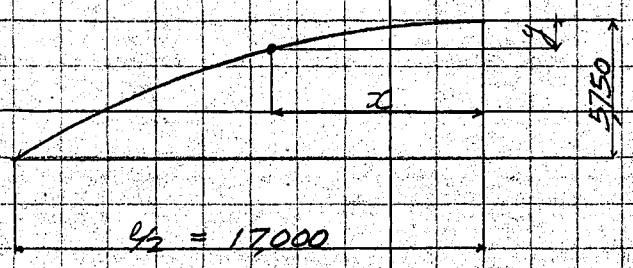
CALCULATIONS FOR

Design of Minano-Bashi for Saitama-ken





Division	x	y	Thickness	ds
Crown	0.000	0.000	0.600	.500
8	1.000	0.020	0.600	1.001
7½	2.000	0.080	0.601	1.003
7	3.000	0.180	0.603	1.007
6½	4.000	0.320	0.607	1.012
6	5.000	0.475	0.613	1.019
5½	6.000	0.680	0.622	1.026
5	7.000	0.920	0.636	1.035
4½	8.000	1.200	0.655	1.046
4	9.000	1.520	0.680	1.059
3½	10.000	1.860	0.712	1.072
3	11.000	2.270	0.752	1.086
2½	12.000	2.720	0.802	1.104
2	13.000	3.220	0.864	1.124
1½	14.000	3.770	0.940	1.148
1	15.000	4.400	1.040	1.179
½	16.000	5.025	1.175	1.221
Springing 0	17.000	5.750	1.350	.623
				$\frac{S}{2}$ = 18.865
				S = 36.530

Design of arch ring

Reinforcements 22$^{mm}\phi$ bars 27^{cm} c. to c. = 3.801$^{sq.cm}$ × 3.704 = 14.08 sq.cm

22$^{mm}\phi$ bars 13.5^{cm} c. to c. = 2 @ 14.08 = 28.16 sq.cm at springings

Equivalent area of 1 meter strip reinforcements $\frac{14.08 \cdot 15}{10,000}$ = 0.021 sq.m near crown

0.042 sq.m near springing

Division	d	d^3	$I_c = \frac{1}{12}d^3$	$(\frac{d}{2} - .045)^2$		I_s	$I = I_c + I_s$
Crown	.600	.2160	.01800	.0650	× .021	.00137	.01937
8	.600	.2160	.01800	.0650	× "	.00137	.01937
7½	.601	.2171	.01809	.0655	× "	.00138	.01947
7	.603	.2193	.01827	.0660	× "	.00139	.01966
6½	.607	.2236	.01863	.0671	× "	.00141	.02004
6	.613	.2303	.01919	.0686	× "	.00144	.02063

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~~SHOWA~~ BLDG, TOKYO
SHOWA

MADE BY M. Jinda DATE 8-10-12 FILE NO
CHECKED BY H.T. DATE 8-11-1 PAGE NO 3

CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Division	d	d^3	$I_c = \frac{1}{12}d^3$	$(\frac{d}{2}-.045)^2$		I_s	$I = I_c + I_s$
5½	.622	.2406	.02005	.0708	× .021	.00149	.02154
5	.636	.2573	.02144	.0745	× "	.00156	.02300
4½	.655	.2810	.02334	.0801	× "	.00168	.02502
4	.680	.3144	.02620	.0870	× "	.00183	.02803
3½	.712	.3609	.03007	.0967	× "	.00203	.03210
3	.752	.4253	.03544	.1096	× "	.00230	.03774
2½	.802	.5158	.04298	.1267	× "	.00266	.04564
2	.864	.6450	.05375	.1498	× "	.00315	.05690
1½	.940	.8306	.06922	.1806	× .042	.00759	.07681
1	1.040	1.1249	.09374	.2256	× "	.00948	.10322
½	1.175	1.6222	.13518	.2948	× "	.01238	.14756
Sp. 0	1.350	2.4604	.20503	.3969	× "	.01667	.22170

Miscellaneous terms for calculating H_o, M_o and V_o

Division	x	x^2	y	y^2	ds	I	ds/I	$x\frac{ds}{I}$	$x^2\frac{ds}{I}$	$y\frac{ds}{I}$	$y^2\frac{ds}{I}$
Crown	0.000	.0000	.000	.0000	.500	.01937	25.81	0.00	0.00	0.00	0.00
8	1.000	1.0000	.020	.0004	1.001	.01937	51.68	51.68	51.68	1.03	0.02
7½	2.000	4.0000	.080	.0064	1.003	.01947	51.52	103.04	206.08	4.12	0.33
7	3.000	9.0000	.180	.0324	1.007	.01966	51.22	153.66	460.98	9.22	1.66
6½	4.000	16.0000	.320	.1024	1.012	.02004	50.50	202.00	808.00	16.16	5.17
6	5.000	25.0000	.475	.2256	1.019	.02063	49.39	246.95	1,234.75	23.46	11.14
5½	6.000	36.0000	.680	.4624	1.026	.02154	47.63	285.78	1,714.68	32.39	22.02
5	7.000	49.0000	.920	.8464	1.035	.02300	45.00	315.00	2,205.00	41.40	38.09
4½	8.000	64.0000	1.200	1.4400	1.046	.02502	41.81	334.48	2,675.84	50.17	60.21
4	9.000	81.0000	1.520	2.3104	1.059	.02803	37.78	340.02	3,060.18	57.43	87.29
3½	10.000	100.0000	1.860	3.4596	1.072	.03210	33.40	334.00	3,340.00	62.12	115.55
3	11.000	121.0000	2.270	5.1529	1.086	.03774	28.78	316.58	3,482.38	65.33	148.30
2½	12.000	144.0000	2.720	7.3984	1.104	.04564	24.19	290.28	3,483.36	65.80	178.97
2	13.000	169.0000	3.220	10.3684	1.124	.05690	19.75	256.75	3,337.75	63.60	204.78
1½	14.000	196.0000	3.770	14.2129	1.148	.07681	14.95	209.30	2,930.20	56.36	212.48
1	15.000	225.0000	4.400	19.3600	1.179	.10322	11.42	171.30	2,569.50	50.25	221.09
½	16.000	256.0000	5.025	25.2506	1.221	.14756	8.27	132.32	2,117.12	41.56	208.82
Sp. 0	17.000	289.0000	5.750	33.0625	.623	.22170	2.81	47.77	812.09	16.16	92.91
			Summary		18.265		595.91	3,790.91	34,489.59	656.56	1,608.83

	x	m	$m\frac{ds}{I}$	$mx\frac{ds}{I}$	$my\frac{ds}{I}$	m	$m\frac{ds}{I}$	$mx\frac{ds}{I}$	$my\frac{ds}{I}$	m	$m\frac{ds}{I}$	$mx\frac{ds}{I}$	$my\frac{ds}{I}$
		at Crown				Division at 8				Division at 7½			
Crown	0.000	0.00	0.00	0.00	0.00								
8	1.000	1.00	51.68	51.68	1.03	0.00	0.00	0.00	0.00				
7½	2.000	2.00	103.04	206.08	8.24	1.00	51.52	103.04	4.12	0.00	0.00	0.00	0.00
7	3.000	3.00	153.66	460.98	27.66	2.00	102.44	307.32	18.44	1.00	51.22	153.66	9.22
6½	4.000	4.00	202.00	808.00	64.64	3.00	151.50	606.00	48.48	2.00	101.00	404.00	32.32
6	5.000	5.00	246.95	1,234.75	117.30	4.00	197.56	987.80	93.84	3.00	148.17	740.85	70.38
5½	6.000	6.00	285.78	1,714.68	194.33	5.00	238.15	1,428.90	161.94	4.00	190.52	1,143.12	129.55
5	7.000	7.00	315.00	2,205.00	289.80	6.00	270.00	1,890.00	248.40	5.00	225.00	1,575.00	207.00
4½	8.000	8.00	334.48	2,675.84	401.38	7.00	292.67	2,341.36	351.20	6.00	250.86	2,006.88	301.03
4	9.000	9.00	340.02	3,060.18	516.83	8.00	302.24	2,720.16	459.40	7.00	264.46	2,380.14	401.98
3½	10.000	10.00	334.00	3,340.00	621.24	9.00	300.60	3,006.00	559.12	8.00	267.20	2,672.00	496.99
3	11.000	11.00	316.58	3,482.38	718.64	10.00	287.80	3,165.80	653.31	9.00	259.02	2,849.72	587.98
2½	12.000	12.00	290.28	3,483.36	789.56	11.00	266.09	3,193.08	723.76	10.00	241.90	2,902.80	657.97
2	13.000	13.00	256.75	3,337.75	826.74	12.00	237.00	3,081.00	763.14	11.00	217.25	2,824.25	699.55
1½	14.000	14.00	209.30	2,930.20	789.06	13.00	194.35	2,720.90	732.70	12.00	179.40	2,511.60	676.34
1	15.000	15.00	171.30	2,569.50	753.72	14.00	159.88	2,398.20	703.47	13.00	148.46	2,229.90	653.22
½	16.000	16.00	132.32	2,117.12	664.91	15.00	124.05	1,984.80	623.35	14.00	115.78	1,852.48	581.79
0	17.000	17.00	47.77	812.09	274.68	16.00	44.96	764.32	258.52	15.00	42.15	716.55	242.36
			3,790.91	34,489.59	7,059.76		3,720.81	30,698.68	6,403.19		2,702.39	26,959.45	5,747.68

JIUN MASUDA
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MADE BY M. Junda DATE 8-10-16 FILE NO
CHECKED BY H.J. DATE 8-11-1 PAGE NO 4

CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

		Division at 7				Division at 6½				Division at 6			
	x	m	$m\frac{ds}{I}$	$mx\frac{ds}{I}$	$my\frac{ds}{I}$	m	$m\frac{ds}{I}$	$mx\frac{ds}{I}$	$my\frac{ds}{I}$	m	$m\frac{ds}{I}$	$mx\frac{ds}{I}$	$my\frac{ds}{I}$
7	3.00	0.00	0.00	0.00	0.00								
6½	4.00	1.00	50.50	202.00	16.16	0.00	0.00	0.00	0.00				
6	5.00	2.00	98.78	493.90	46.92	1.00	49.39	246.95	23.46	0.00	0.00	0.00	0.00
5½	6.00	3.00	142.89	857.34	97.17	2.00	95.26	571.56	64.78	1.00	47.63	285.78	32.39
5	7.00	4.00	180.00	1,260.00	165.60	3.00	135.00	945.00	124.20	2.00	90.00	630.00	82.80
4½	8.00	5.00	209.05	1,672.40	250.86	4.00	167.24	1,337.92	200.69	3.00	125.43	1,003.44	150.52
4	9.00	6.00	226.68	2,040.12	344.55	5.00	188.90	1,700.10	287.13	4.00	151.12	1,360.08	229.70
3½	10.00	7.00	233.80	2,338.00	434.87	6.00	200.40	2,004.00	372.74	5.00	167.00	1,670.00	310.62
3	11.00	8.00	230.24	2,532.64	522.64	7.00	201.46	2,216.06	457.31	6.00	172.68	1,899.48	391.98
2½	12.00	9.00	217.71	2,612.52	592.17	8.00	195.52	2,322.24	526.37	7.00	169.33	2,031.96	460.58
2	13.00	10.00	197.50	2,567.50	635.95	9.00	177.75	2,310.75	572.36	8.00	158.00	2,054.00	508.76
1½	14.00	11.00	164.45	2,302.30	619.98	10.00	149.50	2,093.00	563.62	9.00	134.55	1,883.70	507.25
1	15.00	12.00	137.04	2,055.60	602.98	11.00	125.62	1,880.34	552.73	10.00	114.20	1,713.00	502.48
½	16.00	13.00	107.51	1,720.16	540.24	12.00	99.24	1,587.84	498.68	11.00	90.97	1,455.52	457.12
0	17.00	14.00	39.34	668.78	276.21	13.00	36.53	621.01	210.05	12.00	33.72	573.24	193.89
			2,235.49	23,332.26	5,096.30		1,819.81	19,836.77	4,454.12		1,454.63	16,560.20	3,828.09

		Division at 5½				Division at 5				Division at 4½			
	x	m	$m\frac{ds}{I}$	$mx\frac{ds}{I}$	$my\frac{ds}{I}$	m	$m\frac{ds}{I}$	$mx\frac{ds}{I}$	$my\frac{ds}{I}$	m	$m\frac{ds}{I}$	$mx\frac{ds}{I}$	$my\frac{ds}{I}$
5½	6.00	0.00	0.00	0.00	0.00								
5	7.00	1.00	45.00	315.00	41.40	0.00	0.00	0.00	0.00				
4½	8.00	2.00	83.62	668.96	100.34	1.00	41.81	334.48	50.17	0.00	0.00	0.00	0.00
4	9.00	3.00	113.34	1,020.06	172.28	2.00	75.56	680.04	114.85	1.00	37.78	340.02	57.43
3½	10.00	4.00	133.60	1,336.00	248.50	3.00	100.20	1,002.00	186.37	2.00	66.80	668.00	124.25
3	11.00	5.00	143.90	1,582.90	326.65	4.00	115.12	1,266.32	261.32	3.00	86.34	949.74	195.99
2½	12.00	6.00	145.14	1,741.68	394.78	5.00	120.95	1,451.40	328.98	4.00	96.76	1,161.12	263.19
2	13.00	7.00	138.25	1,797.25	445.17	6.00	118.50	1,540.50	381.57	5.00	98.75	1,283.75	317.98
1½	14.00	8.00	119.60	1,674.40	450.89	7.00	104.65	1,465.10	394.53	6.00	89.70	1,255.80	338.17
1	15.00	9.00	102.78	1,541.70	452.23	8.00	91.36	1,370.40	401.98	7.00	79.94	1,199.10	351.74
½	16.00	10.00	82.70	1,323.20	415.57	9.00	74.43	1,190.88	374.01	8.00	66.16	1,058.56	332.45
0	17.00	11.00	30.91	525.47	177.73	10.00	28.10	477.70	161.58	9.00	25.29	429.93	145.42
			1,138.84	13,526.62	3,725.54		870.68	10,778.82	2,655.36		647.52	8,346.02	2,126.62

		Division at 4				Division at 3½				Division at 3			
	x	m	$m\frac{ds}{I}$	$mx\frac{ds}{I}$	$my\frac{ds}{I}$	m	$m\frac{ds}{I}$	$mx\frac{ds}{I}$	$my\frac{ds}{I}$	m	$m\frac{ds}{I}$	$mx\frac{ds}{I}$	$my\frac{ds}{I}$
4	9.00	0.00	0.00	0.00	0.00								
3½	10.00	1.00	33.40	334.00	62.12	0.00	0.00	0.00	0.00				
3	11.00	2.00	57.56	633.16	130.66	1.00	28.78	316.58	65.33	0.00	0.00	0.00	0.00
2½	12.00	3.00	72.57	870.84	197.39	2.00	48.38	580.56	131.59	1.00	24.19	290.28	65.80
2	13.00	4.00	79.00	1,027.00	254.38	3.00	59.25	770.25	190.79	2.00	39.50	513.50	127.19
1½	14.00	5.00	74.75	1,046.50	281.81	4.00	59.80	837.20	225.45	3.00	44.85	627.90	169.08
1	15.00	6.00	68.52	1,027.80	301.49	5.00	57.10	856.50	251.24	4.00	45.68	685.20	200.99
½	16.00	7.00	57.89	926.24	290.90	6.00	49.62	793.92	249.34	5.00	41.35	661.60	207.78
0	17.00	8.00	22.48	382.16	129.26	7.00	19.67	334.39	113.10	6.00	16.86	286.62	96.95
			466.17	6,247.70	1,648.01		322.60	4,489.40	1,226.84		212.43	3,065.10	867.79

JIUN MASUDA
CONSULTING ENGINEER
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MADE BY M. Jinda DATE 8-10-17 FILE NO
CHECKED BY H.J. DATE 8-11-1 PAGE NO 5

CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

	x	Division at 2½ m	m ds/I	mx ds/I	my ds/I	Division at 2 m	m ds/I	mx ds/I	my ds/I	Division at 1½ m	m ds/I	mx ds/I	my ds/I
2½	12.00	0.00	0.00	0.00	0.00								
2	13.00	1.00	19.75	257.65	63.60	0.00	0.00	0.00	0.00				
1½	14.00	2.00	29.90	418.60	112.72	1.00	14.95	209.30	56.36	0.00	0.00	0.00	0.00
1	15.00	3.00	34.26	513.90	150.74	2.00	22.84	342.60	100.50	1.00	11.42	171.30	50.25
½	16.00	4.00	33.08	529.28	166.23	3.00	24.81	396.96	124.67	2.00	16.54	264.64	83.11
0	17.00	5.00	14.05	238.85	80.79	4.00	11.24	191.08	64.63	3.00	8.43	143.31	48.47
			131.04	1958.28	574.08		73.84	1139.94	346.16		36.39	579.25	181.83

	x	Division at 1 m	m ds/I	mx ds/I	my ds/I	Division at ½ m	m ds/I	mx ds/I	my ds/I
1	15.00	0.00	0.00	0.00	0.00				
½	16.00	1.00	8.27	132.32	41.56	0.00	0.00	0.00	0.00
0	17.00	2.00	5.62	95.54	32.32	1.00	2.81	47.77	16.16
			13.89	227.86	73.88		2.81	47.77	16.16

Crown thrust $H_o = \dfrac{\int \frac{ds}{I} \int my \frac{ds}{I} - \int m \frac{ds}{I} \int y \frac{ds}{I}}{2\left[\int \frac{ds}{I} \int y^2 \frac{ds}{I} - \left(\int y \frac{ds}{I}\right)^2\right]} = \dfrac{A}{B}$ $\quad B = 1,055,293.70$

Loaded Pt.	$\int \frac{ds}{I}$	$\int my \frac{ds}{I}$	Product	$\int m \frac{ds}{I}$	$\int y \frac{ds}{I}$	Product	A	÷	B	H_o
Crown	5.9591	7,059.76	42,069,815.8 -	37,909.1	656.56	24,889,597.87	17,180,217.1	÷	1,055,293.70	1.6280
8	"	6,403.19	38,157,249.5 -	32,208.1	"	21,146,550.1	17,010,699.4	"		1.6119
7½	"	5,747.68	34,250,999.9 -	27,023.9	"	17,742,811.8	16,508,188.1	"		1.5643
7	"	5,096.30	30,369,361.3 -	22,354.9	"	14,677,333.1	15,692,028.2	"		1.4870
6½	"	4,454.12	26,542,546.5 -	18,198.1	"	11,948,144.5	14,594,402.0	"		1.3830
6	"	3,828.09	22,811,971.1 -	14,546.3	"	9,550,518.7	13,261,452.4	"		1.2567
5½	"	3,225.54	19,221,315.4 -	11,388.4	"	7,477,167.9	11,744,147.5	"		1.1129
5	"	2,655.36	15,823,555.8 -	8,706.8	"	5,716,536.6	10,107,019.2	"		0.9577
4½	"	2,126.62	12,672,741.2 -	6,475.2	"	4,251,357.3	8,421,383.9	"		0.7980
4	"	1,648.01	9,820,656.4 -	4,661.7	"	3,060,685.8	6,759,970.6	"		0.6406
3½	"	1,226.84	7,310,862.2 -	3,226.0	"	2,118,062.6	5,192,799.6	"		0.4921
3	"	867.79	5,171,247.4 -	2,124.3	"	1,394,730.4	3,776,517.0	"		0.3579
2½	"	574.08	3,421,000.1 -	1,310.4	"	860,356.2	2,560,643.9	"		0.2426
2	"	346.16	2,062,802.1 -	738.4	"	484,803.9	1,577,998.2	"		0.1495
1½	"	181.83	1,083,543.2 -	363.9	"	238,922.2	844,621.0	"		0.0800
1	"	73.88	440,258.3 -	138.9	"	91,196.2	349,062.1	"		0.0331
½	"	16.16	96,299.1 -	28.1	"	18,449.3	77,849.8	"		0.0074
0	"	0	0 -	0	"	0	0	"		0

Crown moment $M_o = \dfrac{-H_o 2 \int y \frac{ds}{I} + \int m \frac{ds}{I}}{2 \int \frac{ds}{I}} = \dfrac{C}{D}$ $\quad D = 1,191.82$

Loaded Pt.	H_o	$\int y \frac{ds}{I}$	Product	$\int m \frac{ds}{I}$	C	÷	D	M_o
Crown	-2×1.6280	656.56 -	213.776	3,790.91	+ 1,655.15	÷	1,191.82	+ 1.3871
8	1.6119	"	- 211.662	3,220.81	+ 1,104.19	"		+ .9265
7½	1.5643	"	- 205.411	2,702.39	+ 648.28	"		+ .5439
7	1.4870	"	- 195.761	2,735.49	+ 282.88	"		+ .2374
6½	1.3830	"	- 181.604	1,819.81	+ 3.77	"		+ .0032
6	1.2567	"	- 165.020	1,454.63	- 195.57	"		- .1641
5½	1.1129	"	- 146.137	1,138.84	- 322.53	"		- .2706
5	.9577	"	- 125.758	870.68	- 386.90	"		- .3246
4½	.7980	"	- 104.787	647.52	- 400.35	"		- .3359
4	.6406	"	- 84.118	466.17	- 375.01	"		- .3147

JIUN MASUDA
CONSULTING ENGINEER
[illegible] BLDG, TOKYO
SHOWA

MADE BY M. Jinda DATE 8-10-17 FILE NO
CHECKED BY H.T. DATE 8-11-1 PAGE NO 6

CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Loaded Pt.	Ho	$\int y \frac{ds}{I}$	Product	$\int m \frac{ds}{I}$	C	D	Mo
3½ - 2 ×	.4858	.65656	-.63791	.32260	-.31531	÷ 1,191.82	-.2646
3	.3579	"	-.46997	.21243	-.25754	"	-.2161
2½	.2426	"	-.31856	.13104	-.18752	"	-.1573
2	.1495	"	-.19631	.07384	-.12247	"	-.1028
1½	.0800	"	-.10505	.03639	-.06866	"	-.0576
1	.0331	"	-.04346	.01389	-.02957	"	-.0248
½	.0074	"	-.00972	.00281	-.00691	"	-.0058
0	0	"	0	0	0	"	0

Crown shear $V_o = \frac{\int mx \frac{ds}{I}}{2\int x^2 \frac{ds}{I}} = \frac{E}{F}$

Vertical shear at crown

Loaded Pt.	E		F	V_o	$1 - V_o$
Crown	34,489.59	÷	68,979.18 =	.5000	.5000
8	30,698.08		"	.4450	.5550
7½	26,959.45		"	.3908	.6092
7	23,323.26		"	.3381	.6619
6½	19,836.77		"	.2876	.7124
6	16,560.20		"	.2401	.7599
5½	13,526.62		"	.1961	.8039
5	10,778.82		"	.1563	.8427
4½	8,346.02		"	.1210	.8790
4	6,247.70		"	.0906	.9094
3½	4,489.40		"	.0651	.9348
3	3,065.10		"	.0444	.9556
2½	1,958.28		"	.0283	.9717
2	1,139.94		"	.0165	.9835
1½	579.25		"	.0084	.9916
1	227.86		"	.0033	.9967
½	47.77		"	.0007	.9993
0	0		"	0	0

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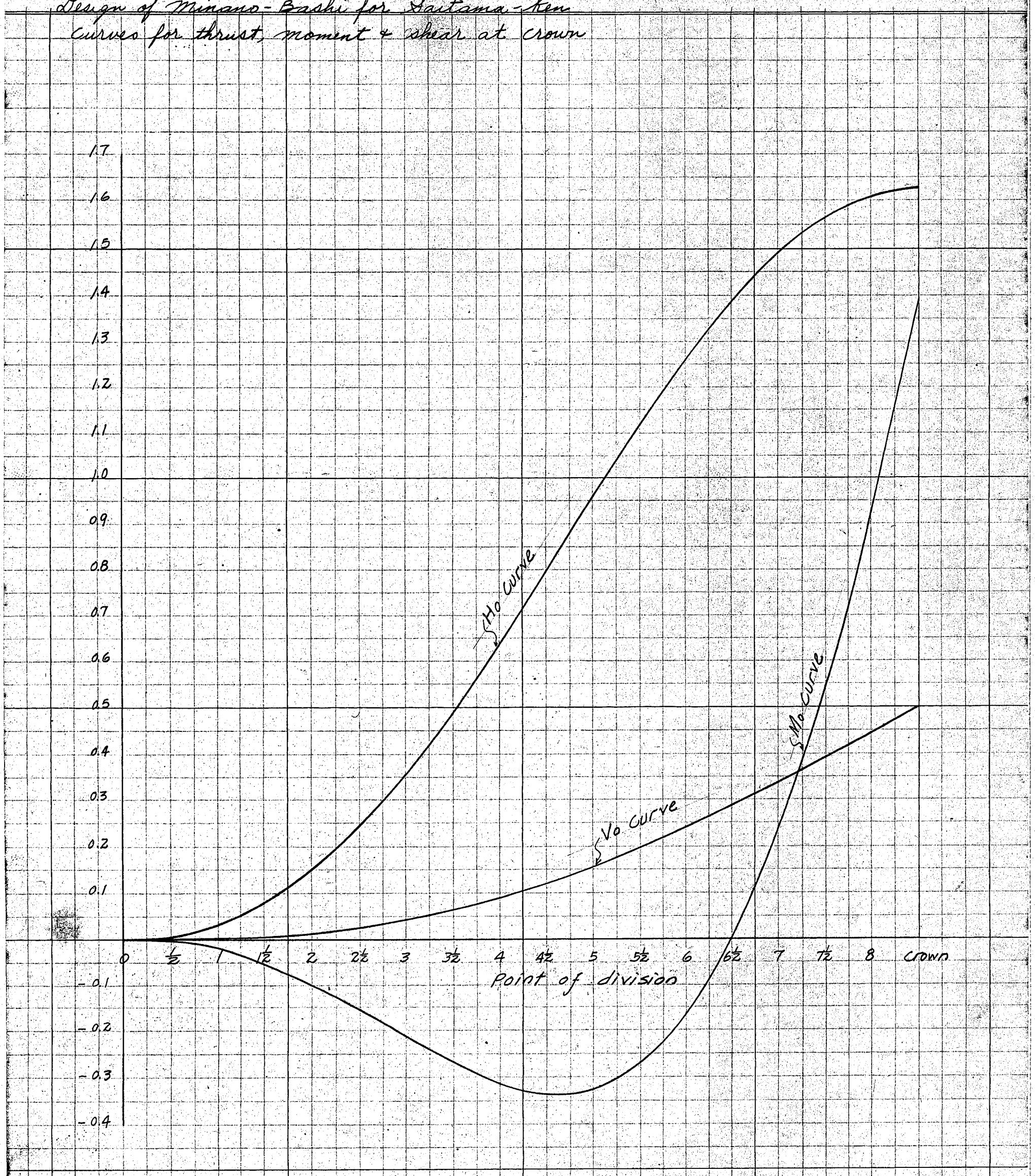
CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken
Curves for thrust, moment & shear at crown



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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Moment at various point for unit load

Let x and y co-ordinates at center of sections

d' lever arm of unit load about center of sections, origin at crown.

For left hand sections $M_L = M_o + H_o y + V_o x - d'$

" right " " $M_R = M_o + H_o y - V_o x$

Moment at various points

Points	M_o	Point 8 x = 1.000 y = .020					Point 7 x = 3.000 y = .180				
		$H_o y$	$V_o x$	d'	M_L	M_R	$H_o y$	$V_o x$	d'	M_L	M_R
Crown	+1.3871	0.0326	0.5000	1.000	+0.9197	+0.9197	0.2930	1.5000	3.000	+0.1801	+0.1801
8	+.9265	0.0322	0.4450		+.4037	+0.5137	0.2901	1.3350	2.000	+0.5516	-0.1184
7½	+.5439	0.0313	0.3908		+0.9660	+0.1844	0.2816	1.1724	1.000	+0.9979	-0.3469
7	+.2374	0.0297	0.3381		+0.6052	-0.0710	0.2677	1.0143		+1.5194	-0.5092
6½	+.0032	0.0277	0.2876		+0.3185	-0.2567	0.2489	0.8628		+1.1149	-0.6107
6	-.1641	0.0251	0.2401		+0.1011	-0.3791	0.2262	0.7203		+0.7824	-0.6582
5½	-.2706	0.0223	0.1961		-0.0522	-0.4444	0.2003	0.5883		+0.5180	-0.6586
5	-.3246	0.0192	0.1563		-0.1491	-0.4617	0.1724	0.4689		+0.3167	-0.6211
4½	-.3359	0.0160	0.1210		-0.1989	-0.4409	0.1436	0.3630		+0.1707	-0.5553
4	-.3147	0.0128	0.0906		-0.2113	-0.3925	0.1153	0.2718		+0.0724	-0.4712
3½	-.2646	0.0098	0.0651		-0.1897	-0.3199	0.0886	0.1953		+0.0193	-0.3713
3	-.2161	0.0072	0.0444		-0.1645	-0.2533	0.0644	0.1332		-0.0185	-0.2849
2½	-.1573	0.0049	0.0283		-0.1241	-0.1807	0.0437	0.0849		-0.0287	-0.1985
2	-.1028	0.0030	0.0165		-0.0833	-0.1163	0.0269	0.0495		-0.0264	-0.1254
1½	-.0576	0.0016	0.0084		-0.0476	-0.0644	0.0144	0.0252		-0.0180	-0.0684
1	-.0248	0.0007	0.0033		-0.0208	-0.0274	0.0060	0.0099		-0.0089	-0.0287
½	-.0058	0.0001	0.0007		-0.0050	-0.0064	0.0013	0.0021		-0.0024	-0.0066
0	0	0	0		0	0	0	0		0	0

Points	M_o	Point 6 x = 5.000 y = .475					Point 5 x = 7.000 y = .920				
Crown	+1.3871	0.7733	2.5000	5.000	-0.3396	-0.3396	1.4978	3.5000	7.000	-0.6151	-0.6151
8	+.9265	0.7657	2.2250	4.000	-0.0828	-0.5328	1.4829	3.1150	6.000	-0.4756	-0.7056
7½	+.5439	0.7430	1.9540	3.000	+0.2409	-0.6671	1.4392	2.7356	5.000	-0.2813	-0.7525
7	+.2374	0.7063	1.6905	2.000	+0.6342	-0.7468	1.3680	2.3667	4.000	-0.0279	-0.7613
6½	+.0032	0.6569	1.4380	1.000	+1.0981	-0.7779	1.2724	2.0132	3.000	+0.2888	-0.7376
6	-.1641	0.5969	1.2005		+1.6333	-0.7677	1.1562	1.6807	2.000	+0.6728	-0.6886
5½	-.2706	0.5286	0.9805		+1.2385	-0.7225	1.0239	1.3727	1.000	+1.1260	-0.6194
5	-.3246	0.4549	0.7815		+0.9118	-0.6512	0.8811	1.0941		+1.6506	-0.5376
4½	-.3359	0.3791	0.6050		+0.6482	-0.5618	0.7342	0.8470		+1.2453	-0.4487
4	-.3147	0.3043	0.4530		+0.4426	-0.4634	0.5894	0.6342		+0.9089	-0.3595
3½	-.2646	0.2337	0.3265		+0.2946	-0.3564	0.4527	0.4557		+0.6438	-0.2676
3	-.2161	0.1700	0.2220		+0.1759	-0.2681	0.3293	0.3108		+0.4240	-0.1976
2½	-.1573	0.1152	0.1415		+0.0994	-0.1836	0.2252	0.1981		+0.2640	-0.1322
2	-.1028	0.0710	0.0825		+0.0507	-0.1143	0.1375	0.1155		+0.1502	-0.0808
1½	-.0576	0.0380	0.0420		+0.0224	-0.0616	0.0736	0.0588		+0.0748	-0.0428
1	-.0248	0.0157	0.0165		+0.0074	-0.0256	0.0305	0.0231		+0.0288	-0.0174
½	-.0058	0.0035	0.0035		+0.0012	-0.0058	0.0068	0.0049		+0.0059	-0.0039
0	0	0	0		0	0	0	0		0	0

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken.

7

Points Mo	Point 4 x = 9000 y = 1520					Point 3 x = 11.000 y = 2270				
	Hoy	Vox	d'	ML	MR	Hoy	Vox	d'	ML	MR
Crown+.3871	2.4746	4.5000	9000	-0.6383	-0.6383	3.6956	5.5000	11.000	-0.4173	-0.4173
8 +.9265	2.4501	4.0050	8.000	-0.6184	-0.6284	3.6590	4.8950	10.000	-0.5195	-0.3095
7½ +.5439	2.3777	3.5172	7.000	-0.5612	-0.5956	3.5510	4.2988	9.000	-0.6063	-0.2039
7 +.2374	2.2602	3.0429	6.000	-0.4595	-0.5453	3.3755	3.7191	8.000	-0.6680	-0.1062
6½ +.0032	2.1022	2.5884	5.000	-0.3062	-0.4840	3.1394	3.1636	7.000	-0.6938	-0.0210
6 -.1641	1.9102	2.1609	4.000	-0.0930	-0.4148	2.8527	2.6411	6.000	-0.6703	+0.0475
5½ -.2706	1.6916	1.7649	3.000	+0.1859	-0.3439	2.5263	2.1571	5.000	-0.5872	+0.0986
5 -.3246	1.4557	1.4067	2.000	+0.5378	-0.2756	2.1740	1.7193	4.000	-0.4313	+0.1301
4½ -.3359	1.2130	1.0890	1.000	+0.9661	-0.2119	1.8115	1.3310	3.000	-0.1934	+0.1446
4 -.3147	0.9737	0.8154		+1.4744	-0.1564	1.4542	0.9966	2.000	+0.1361	+0.1429
3½ -.2646	0.7480	0.5859		+1.0693	-0.1025	1.1171	0.7161	1.000	+0.5686	+0.1364
3 -.2161	0.5440	0.3996		+0.7275	-0.0717	0.8124	0.4884		+1.0847	+0.1079
2½ -.1573	0.3688	0.2547		+0.4662	-0.0432	0.5507	0.3113		+0.7047	+0.0821
2 -.1028	0.2272	0.1485		+0.2729	-0.0241	0.3394	0.1815		+0.4181	+0.0551
1½ -.0576	0.1216	0.0756		+0.1396	-0.0116	0.1816	0.0924		+0.2164	+0.0316
1 -.0248	0.0503	0.0297		+0.0552	-0.0042	0.0751	0.0363		+0.0866	+0.0140
½ -.0058	0.0112	0.0063		+0.0117	-0.0009	0.0168	0.0077		+0.0187	+0.0033
0 0	0			0	0	0			0	0

Points Mo	Point 2 x = 13000 y = 3220					Point 1 x = 15.000 y = 4.400				
Crown+.3871	5.2422	6.5000	13.000	+0.1293	+0.1293	7.1632	7.5000	15.000	+1.0503	+1.0503
8 +.9265	5.1903	5.7850	12.000	-0.0982	+0.3318	7.0924	6.6750	14.000	+0.6939	+1.3439
7½ +.5439	5.0370	5.0804	11.000	-0.3387	+0.5005	6.8829	5.8620	13.000	+0.2888	+1.5648
7 +.2374	4.7881	4.3953	10.000	-0.5792	+0.6302	6.5428	5.0715	12.000	-0.1483	+1.7087
6½ +.0032	4.4533	3.7388	9000	-0.8047	+0.7177	6.0852	4.3140	11.000	-0.5976	+1.7744
6 -.1641	4.0466	3.1213	8.000	-0.9962	+0.7612	5.5295	3.6015	10.000	-1.0331	+1.7639
5½ -.2706	3.5835	2.5493	7.000	-1.1378	+0.7636	4.8968	2.9415	9.000	-1.4323	+1.6847
5 -.3246	3.0838	2.0319	6.000	-1.2089	+0.7273	4.2139	2.3445	8.000	-1.7662	+1.5448
4½ -.3359	2.5696	1.5730	5.000	-1.1933	+0.6607	3.5112	1.8150	7.000	-2.0097	+1.3603
4 -.3147	2.0627	1.1778	4.000	-1.0742	+0.5702	2.8186	1.3590	6.000	-2.1371	+1.1449
3½ -.2646	1.5846	0.8463	3.000	-0.8337	+0.4737	2.1652	0.9765	5.000	-2.1229	+0.9241
3 -.2161	1.1524	0.5772	2.000	-0.4865	+0.3591	1.5748	0.6660	4.000	-1.9753	+0.6927
2½ -.1573	0.7812	0.3679	1.000	-0.0082	+0.2560	1.0674	0.4245	3.000	-1.6654	+0.4856
2 -.1028	0.4814	0.2145		+0.5931	+0.1641	0.6578	0.2475	2.000	-1.1975	+0.3075
1½ -.0576	0.2576	0.1092		+0.3097	+0.0908	0.3520	0.1260	1.000	-0.5796	+0.1684
1 -.0248	0.1066	0.0429		+0.1247	+0.0389	0.1456	0.0495		+0.1703	+0.0713
½ -.0058	0.0238	0.0091		+0.0271	+0.0089	0.0326	0.0105		+0.0373	+0.0163
0 0	0	0		0	0	0	0		0	0

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Points	Mo	Springing		x = 17.000 y = 5.750		
		Hoy	Vox	d'	ML	MR
Crown	+.1387	9.3610	8.5000	17.000	+2.2481	+2.2481
8	+.9265	9.2684	7.5650	16.000	+1.7599	+2.6299
7½	+.5439	8.9947	6.6436	15.000	+1.1822	+2.8950
7	+.2374	8.5503	5.7477	14.000	+0.5354	+3.0400
6½	+.0032	7.9523	4.8892	13.000	-0.1553	+3.0663
6	-.1641	7.2260	4.0817	12.000	-0.8564	+2.9802
5½	-.2706	6.3992	3.3337	11.000	-1.5377	+2.7949
5	-.3246	5.5068	2.6571	10.000	-2.1607	+2.5251
4½	-.3359	4.5885	2.0570	9.000	-2.6904	+2.1956
4	-.3147	3.6835	1.5402	8.000	-3.0910	+1.8286
3½	-.2646	2.8296	1.1067	7.000	-3.3283	+1.4583
3	-.2161	2.0579	0.7548	6.000	-3.4034	+1.0870
2½	-.1573	1.3950	0.4811	5.000	-3.2812	+0.7566
2	-.1028	0.8596	0.2805	4.000	-2.9627	+0.4763
1½	-.0576	0.4600	0.1428	3.000	-2.4548	+0.2596
1	-.0248	0.1903	0.0561	2.000	-1.7784	+0.1094
½	-.0058	0.0426	0.0119	1.000	-0.9513	+0.0249
0	0	0	0	0	0	0

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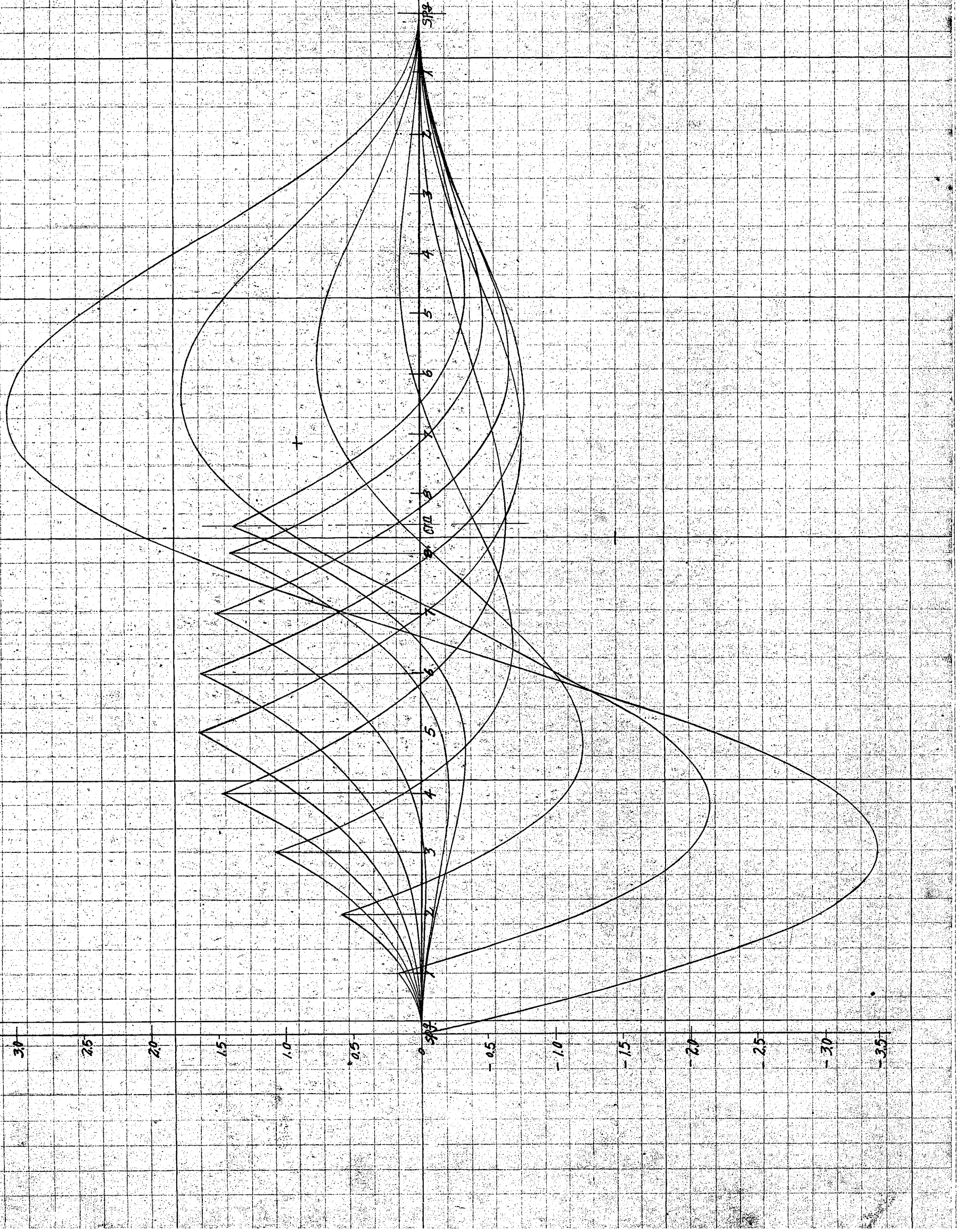
CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Influence diagram



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CALCULATIONS FOR

Design of minami-Bashi for Saitama-Ken

Dead Load of arch ring

point of division						Vol. m^3			wt.
Crown	.600	×	.500	× 4.300	=	1.290	@ 2,400	=	3,100
8	.601	×	1.000	×	=	2.584	×	=	6,200
7½	.603	×	1.000	×	=	2.593	×	=	6,200
7	.607	×	1.000	×	=	2.610	×	=	6,300
6½	.614	×	1.000	×	=	2.640	×	=	6,300
6	.624	×	1.000	×	=	2.683	×	=	6,400
5½	.638	×	1.000	×	=	2.743	×	=	6,600
5	.656	×	1.000	×	=	2.821	×	=	6,800
4½	.681	×	1.000	×	=	2.928	×	=	7,000
4	.715	×	1.000	×	=	3.075	×	=	7,400
3½	.760	×	1.000	×	=	3.268	×	=	7,800
3	.817	×	1.000	×	=	3.513	×	=	8,400
2½	.889	×	1.000	×	=	3.823	×	=	9,200
2	.978	×	1.000	×	=	4.205	×	=	10,100
1½	1.088	×	1.000	×	=	4.678	×	=	11,200
1	1.238	×	1.000	×	=	5.323	×	=	12,800
½	1.453	×	1.000	×	=	6.248	×	=	15,000
0	1.650	×	.500	×	=	3.548	×	=	8,500
						60.573 m^3			145,300 kg.

Summary for dead load (See sheet no. 16)

Division	Crown	8	7½	7	6½	6	5½	5	4½	4	3½
Deck	2,917	6,311	6,313	8,798	0	10,759	0	12,607	0	12,020	0
Arch ring	3,100	6,200	6,200	6,300	6,300	6,400	6,600	6,800	7,000	7,400	7,800
	6,017	12,511	12,513	15,098	6,300	17,159	6,600	19,407	7,000	19,420	7,800
For Round Number	6,000	12,500	12,500	15,100	6,300	17,200	6,600	19,400	7,000	19,400	7,800

Division	3	2½	2	1½	1	½	0
Deck	13,260	0	14,780	0	16,560	0	15,119
Arch ring	8,400	9,200	10,100	11,200	12,800	15,000	8,500
	21,660	9,200	24,880	11,200	29,360	15,000	23,619
For Round Number	21,700	9,200	24,900	11,200	29,400	15,000	23,600

Dead Load moments at various panel points

Crown

	Load	M_o	M		Load	M_o	M
Crown	6,000	+.3871	+ 8,323	1½	11,200	-.0576	- 645
8	12,500	+.9265	+11,581	1	29,400	-.0248	- 729
7½	12,500	+.5439	+ 6,799	½	15,000	-.0058	- 87
7	15,100	+.2374	+ 3,585	0	23,600	0	0
6½	6,300	+.0032	+ 20				+ 30,308
6	17,200	-.1641	- 2,823				- 31,583
5½	6,600	-.2706	- 1,786				- 1,275
5	19,400	-.3246	- 6,297				2
4½	7,000	-.3359	- 2,351				- 2,550 kg.
4	19,400	-.3147	- 6,105				
3½	7,800	-.2646	- 2,064				
3	21,700	-.2161	- 4,689				
2½	9,200	-.1573	- 1,447				
2	24,900	-.1028	- 2,560				

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CALCULATIONS FOR

Design of Minami-Bashi for Saitama-Ken

Pt of divi.	Load	Point 8		Point 7		Point 6		Point 5	
		Munit	M	Munit	M	Munit	M	Munit	M
0	23600	0	0	0	0	0	0	0	0
½	15000	-.0050	- 80	-.0024	- 40	+.0012	+ 20	+.0059	+ 90
1	29400	-.0208	- 610	-.0089	- 260	+.0074	+ 220	+.0288	+ 850
1½	11200	-.0476	- 530	-.0180	- 200	+.0224	+ 250	+.0748	+ 840
2	24900	-.0833	- 2,070	-.0264	- 660	+.0507	+ 1,260	+.1502	+ 3,740
2½	9200	-.1241	- 1,140	-.0287	- 260	+.0994	+ 910	+.2640	+ 2,430
3	21700	-.1645	- 3,570	-.0185	- 400	+.1759	+ 3,820	+.4240	+ 9,200
3½	7800	-.1897	- 1,480	+.0193	+ 150	+.2946	+ 2,300	+.6438	+ 5,020
4	19400	-.2113	- 4,100	+.0724	+ 1,400	+.4426	+ 8590	+.9089	+ 17,630
4½	7000	-.1989	- 1,390	+.1707	+ 1,190	+.6482	+ 4540	+.1.2453	+ 8720
5	19400	-.1491	- 2,890	+.3167	+ 6,140	+.9118	+ 17,690	+.1.6506	+ 32,020
5½	6600	-.0522	- 340	+.5180	+ 3420	+.1.2385	+ 8170	+.1.1260	+ 7430
6	17200	+.1011	+ 1,740	+.7824	+ 13460	+.1.6333	+ 28,090	+.6728	+ 11,570
6½	6300	+.3185	+ 2,000	+.1.1149	+ 7020	+.1.0981	+ 6,920	+.2888	+ 1,820
7	15100	+.6052	+ 9,140	+.1.5194	+ 22,940	+.6342	+ 9,580	-.0279	- 420
7½	12500	+.9660	+ 12,080	+.9979	+ 12,470	+.2409	+ 3,010	-.2813	- 3,520
8	12500	+.1.4037	+ 17,550	+.5516	+ 6,900	-.0828	- 1,040	-.4756	- 5,950
Crown	12000	+.9197	+ 11,040	+.1801	+ 2,160	-.3396	- 4,080	-.6151	- 7,380
8	12500	+.5137	+ 6,420	-.1184	- 1,480	-.5328	- 6,660	-.7056	- 8,820
7½	12500	+.1844	+ 2,300	-.3469	- 4340	-.6671	- 8340	-.7525	- 9,410
7	15100	-.0710	- 1,070	-.5092	- 7,690	-.7468	- 11,280	-.7613	- 11,500
6½	6300	-.2567	- 1,620	-.6107	- 3850	-.7779	- 4,900	-.7376	- 4,650
6	17200	-.3791	- 6,520	-.6582	- 11,320	-.7677	- 13,200	-.6886	- 11,840
5½	6600	-.4444	- 2,930	-.6586	- 4350	-.7225	- 4,770	-.6194	- 4,090
5	19400	-.4617	- 8,960	-.6211	- 12,050	-.6512	- 12,630	-.5376	- 10,430
4½	7000	-.4409	- 3,090	-.5553	- 3,890	-.5618	- 3930	-.4487	- 3,140
4	19400	-.3925	- 7,610	-.4712	- 9,140	-.4634	- 8,990	-.3595	- 6,970
3½	7800	-.3199	- 2,500	-.3713	- 2,900	-.3564	- 2780	-.2676	- 2,090
3	21700	-.2533	- 5,500	-.2849	- 6,180	-.2681	- 5,820	-.1976	- 4,290
2½	9200	-.1807	- 1,660	-.1985	- 1,830	-.1836	- 1,690	-.1322	- 1220
2	24900	-.1163	- 2,900	-.1254	- 3,120	-.1143	- 2,850	-.0808	- 2,010
1½	11200	-.0644	- 720	-.0684	- 770	-.0616	- 690	-.0428	- 480
1	29400	-.0274	- 810	-.0287	- 840	-.0256	- 750	-.0174	- 510
½	15000	-.0064	- 100	-.0066	- 100	-.0058	- 90	-.0039	- 60
0	23600	0	0	0	0	0	0	0	0
			+ 62270		+ 77250		+ 95370		+ 101,360
			- 64190		- 75670		- 94490		- 98,780
			- 1920		+ 1580		+ 880		+ 2580

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~~HIBIYA~~ SHOWA BLDG, TOKYO

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-ken

Pt. of divi.	Load	Point 4		Point 3		Point 2		Point 1		Springing	
		Munit	M	Munit	M	Munit	M	Munit	M	Munit	M
0	23,600	0	0	0	0	0	0	0	0	0	0
½	15,000	+.0117	+ 180	+.0187	+ 280	+.0271	+ 410	+.0373	+ 560	-.9513	- 14,270
1	29,400	+.0552	+ 1,620	+.0866	+ 2,550	+.1247	+ 3,670	+.1703	+ 5,010	-1.7784	- 52,280
1½	11,200	+.1396	+ 1,560	+.2164	+ 2,420	+.3092	+ 3,460	-.5796	- 6,490	-2.4548	- 27,490
2	24,900	+.2729	+ 6,800	+.4181	+ 10,410	+.5931	+ 14,770	-1.1975	- 29,820	-2.9627	- 73,770
2½	9,200	+.4662	+ 4,290	+.7047	+ 6,480	-.0082	- 80	-1.6654	- 15,320	-3.2812	- 30,190
3	21,700	+.7275	+ 15,790	+1.0847	+ 23,540	-.4865	- 10,560	-1.9753	- 42,860	-3.4034	- 73,850
3½	7,800	+1.0693	+ 8,340	+.5686	+ 4,440	-.8337	- 6,500	-2.1229	- 16,560	-3.3283	- 25,960
4	19,400	+1.4744	+ 28,600	+.1361	+ 2,640	-1.0742	- 20,840	-2.1371	- 41,460	-3.0910	- 59,970
4½	7,000	+.9661	+ 6,760	-.1934	- 1,350	-1.1933	- 8,350	-2.0097	- 14,070	-2.6904	- 18,830
5	19,400	+.5378	+ 10,430	-.4313	- 8,370	-1.2089	- 23,450	-1.7662	- 34,260	-2.1607	- 41,920
5½	6,600	+.1859	+ 1,230	-.5872	- 3,880	-1.1378	- 7,510	-1.4323	- 9,450	-1.5377	- 10,150
6	17,200	-.0930	- 1,600	+.6703	- 11,530	-.9962	- 17,130	-1.0331	- 17,770	-.8564	- 14,730
6½	6,300	-.3062	- 1,930	-.6938	- 4,370	-.8047	- 5,070	-.5976	- 3,760	-.1553	- 980
7	15,100	-.4595	- 6,940	-.6680	- 10,090	-.5792	- 8,750	-.1483	- 2,240	+.5354	+ 8,080
7½	12,500	-.5612	- 7,020	-.6063	- 7,580	-.3387	- 4,230	+.2888	+ 3,610	+1.1822	+ 14,780
8	12,500	-.6184	- 7,730	-.5195	- 6490	-.0982	- 1,230	+.6939	+ 8,670	+1.7599	+ 22,000
Crown	12,000	-.6383	- 7,760	-.4173	- 5,010	+.1293	+ 1,650	+1.0503	+ 12,600	+2.2481	+ 27,080
8	12,500	-.6284	- 7,860	-.3095	- 3,870	+.3318	+ 4,150	+1.3439	+ 16,800	+2.6299	+ 32,870
7½	12,500	-.5956	- 7,450	-.2039	- 2,550	+.5005	+ 6,260	+1.5648	+ 19,560	+2.8950	+ 36,190
7	15,100	-.5453	- 8,230	-.1062	- 1,600	+.6302	+ 9,520	+1.7087	+ 25,800	+3.0400	+ 45,900
6½	6,300	-.4840	- 3,050	-.0210	- 130	+.7177	+ 4,520	+1.7744	+ 11,180	+3.0663	+ 19,320
6	17,200	-.4148	- 7,130	+.0475	+ 820	+.7612	+ 13,090	+1.7639	+ 30,340	+2.9802	+ 51,260
5½	6,600	-.3439	- 2,270	+.0986	+ 650	+.7636	+ 5,040	+1.6847	+ 11,120	+2.7949	+ 18,450
5	19,400	-.2756	- 5,350	+.1301	+ 2520	+.7273	+ 14,110	+1.5448	+ 29,970	+2.5251	+ 48,990
4½	7,000	-.2119	- 1,480	+.1446	+ 1,010	+.6607	+ 4,620	+1.3603	+ 9,520	+2.1956	+ 15,370
4	19,400	-.1564	- 3,030	+.1429	+ 2,770	+.5702	+ 11,060	+1.1449	+ 22,210	+1.8286	+ 35,470
3½	7,800	-.1025	- 800	+.1364	+ 1,060	+.4737	+ 3,690	+.9241	+ 7210	+1.4583	+ 11,370
3	21,700	-.0717	- 1,560	+.1079	+ 2,340	+.3591	+ 7,790	+.6927	+ 15,030	+1.0870	+ 23,590
2½	9,200	-.0432	- 400	+.0821	+ 760	+.2560	+ 2,360	+.4856	+ 4,470	+.7566	+ 6,960
2	24,900	-.0241	- 600	+.0551	+ 1,370	+.1641	+ 4,090	+.3075	+ 7,660	+.4763	+ 11,860
1½	11,200	-.0116	- 130	+.0316	+ 350	+.0908	+ 1,020	+.1684	+ 1,890	+.2596	+ 2,910
1	29,400	-.0042	- 120	+.0140	+ 410	+.0389	+ 1,140	+.0713	+ 2,100	+.1094	+ 3,220
½	15,000	-.0009	- 10	+.0033	+ 50	+.0089	+ 130	+.0163	+ 240	+.0249	+ 370
0	23,600	0	0	0	0	0	0	0	0	0	0
			+85,600		+66,870		+ 116,550		+ 245,550		+436,040
			-82,450		-66,820		- 113,700		- 234,060		-444,390
			+ 3,150		+ 50		+ 2,850		+ 11,490		- 8,350

Dead Load thrust at several panel points.

Point	Load	Hounit	Ho	Point	Load	Hounit	Ho
Crown	6,000	1.6280	9,770	3	21,700	.3579	7,760
8	12,500	1.6119	20,130	2½	9,200	.2426	2230
7½	12,500	1.5643	19,550	2	24,900	.1495	3720
7	15,100	1.4870	22,450	1½	11,200	.0800	900
6½	6,300	1.3830	8,720	1	29,400	.0331	970
6	17,200	1.2567	21,610	½	15,000	.0074	110
5½	6,600	1.1129	7340	0	23,600	0	0
5	19,400	.9577	18,570		264,800		165,680
4½	7,000	.7980	5580				× 2
4	19,400	.6406	12,430				331,360 kg.
3½	7,800	.4921	3840				

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Point	Ho		Cos θ		Normal thrust	Vertical shear		Sin θ		Normal T.	Total N.T.
Crown	33,360	×	1.000	=	33,360	0	×	0	=	0	33,360
8	'	×	.999	=	33,000	12,250	×	.035	=	430.	33,430
7	'	×	.995	=	33,000	38,550	×	.105	=	4,050	334,050
6	'	×	.984	=	326,000	61,000	×	.181	=	11,040	337,040
5	'	×	.967	=	320,500	85,900	×	.255	=	21,900	342,400
4	'	×	.945	=	313,000	112,300	×	.327	=	36,700	349,700
3	'	×	.916	=	303,500	140,650	×	.400	=	56,300	359,800
2	'	×	.882	=	292,200	173,150	×	.471	=	81,500	373,700
1	'	×	.841	=	278,800	211,500	×	.542	=	114,600	393,400
Springing	'	×	.793	=	262,800	264,800	×	.609	=	161,200	424,000

Summary of Dead Load stresses

	Crown	8	7	6	5	4	3	2	1	Springing
Moment	-2,550	-1,920	+1,580	+880	+2,580	+3,150	+50	+2,850	+1,440	-8,350
Normal T.	33,360	33,430	334,050	337,040	342,400	349,700	359,800	373,700	393,400	424,000
Eccentricity	0.008	0.006	0.005	0.003	0.008	0.009	—	0.008	0.029	0.020 m

Live Load stresses :-

Uniform Live Load $w = \frac{100,000}{170+340} = 490$ kg/m²

Motor truck loading Impact coefficient $= \frac{20}{60+340} = 2.13\%$

motor truck rear wheel concentration
2.13% impact

	2,250
	480
	2,730 kg.

front wheel with impact say 2,730 ÷ 3 = 910 kg.

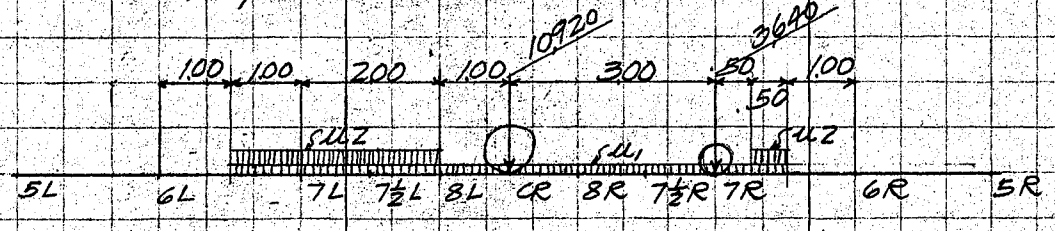
2 motor trucks on arch rib

Rear wheels	4 @ 2,730 =	10,920 kg.
Front wheels	4 @ 910 =	3,640 kg.

Uniform load

Side of motor truck	490 × 0.1 =	50 kg/m ------ u1
front & rear of " "	490 × 5.5 =	2,700 kg/m
		2,650 kg/m ------ u2

Crown stress, positive moment



unif. l.	u1	13	37	50	50	50	50	50	38	13	
" "	u1		25						25		
" "	u2	660	1,990	2,650							
" "	u2		1,325	1,325					828	497	
wheels						10,920			3,640		
		673	3,377	1,375		50			4,531	510	
				2,700		10,970			50		

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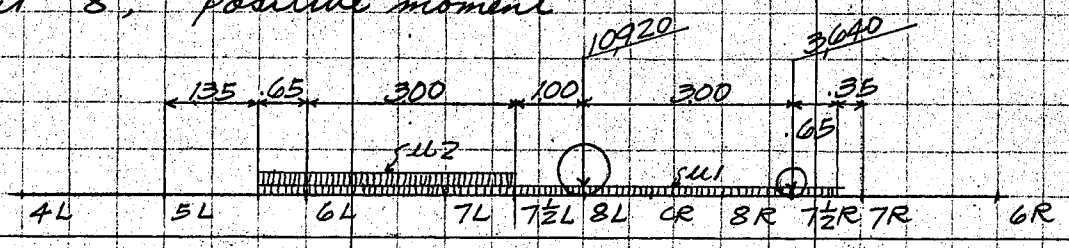
CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Point	Load	Munit	Moment	Hunit	H Thrust
6L	673	-.1641	- 110	12567	850
7L	3,377	+.2374	+ 800	14870	5,020
7½L	2,700	+.5439	+1,470	15643	4,220
8L	1,375	+.9265	+1,270	16119	2,220
Crown	10,970	+1.3871	+15,200	16280	17,850
8R	50	+.9265	+ 50	16119	80
7½R	50	+.5439	+ 30	15643	80
7R	4,531	+.2374	+ 110	14870	6,740
6R	510	-.1641	- 80	12567	640
			+18,930		37,700 kgo
			- 190		
			+18,740 kgm		

Point 8, positive moment

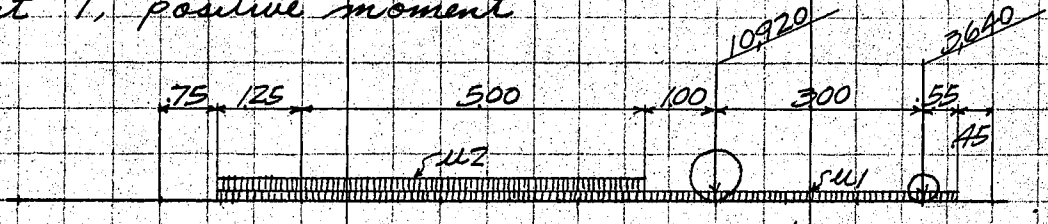


unif. l	w1	5	29	50	50	50	50	50	22	11
" "	w1		50	25					25	
" "	w2	280	1,440	2,650	1,325					
" "	w2		2,650	1,325						
wheels					10920			3640		
		285	4,169	4,050	10970		50		11	
				1,375		50		3,687		

Point	Load	Munit	Moment	Hunit	H Thrust	Vunit	Vert. Shear
5L	285	-.1491	- 40	.9577	270	-.1563	- 40
6L	4,169	+.1011	+ 420	1.2567	5,250	-.2401	- 1,000
7L	4,050	+.6052	+ 2,450	1.4870	6,020	-.3381	- 1,370
7½L	1,375	+.9660	+ 1,330	1.5643	2,150	-.3908	- 540
8L	10,970	+1.4037	+15,380	1.6119	17,680	.5550	+6,080
Crown	50	+.9197	+ 50	1.6280	80	.5000	+ 30
8R	50	+.5137	+ 30	1.6119	80	.4450	+ 20
7½R	3,687	+.1844	+ 680	1.5643	5,760	.3908	+1,440
7R	11	-.0710	—	1.4870	20	.3381	—
			+20,340		37,310 kgo		+7,570
			- 40				-2,970
			+20,300 kgm				+4,600 kgo

Normal thrust
37,310 × .999 = 37,300
4,600 × .035 = 160
37,460 kgo

Point 7, positive moment



unif. l	w1	20	43	100	100	50	50	50	25	
" "	w1		50			25			20	8
" "	w2	1,035	2,278		1,990	660				
" "	w2		2,650	5,300	2,650					
wheels						10920		3,640		
		1,055	5,021	5,400	4,740	11,655		50		8
							50		3,685	

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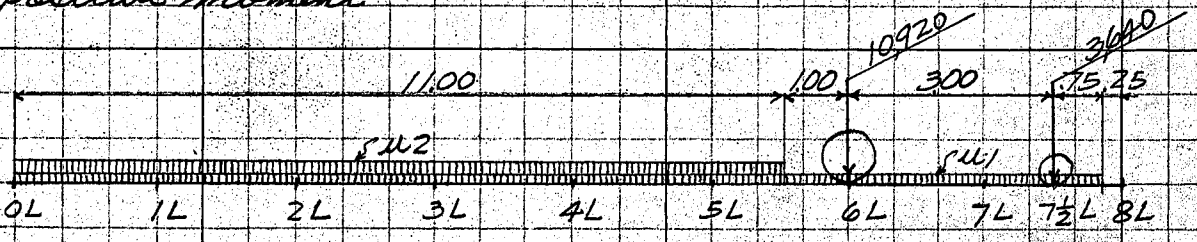
CALCULATIONS FOR

Design of Minano - Bashi for Saitama-Ken

Point	Load	Munit	Moment	Hunit	H Thrust	Vunit	Vert. Shear
3L	1,055	- .0185	- 20	.3579	380	-.0444	- 50
4L	5,021	+ .0724	+ 360	.6406	3,220	-.0906	- 460
5L	5,400	+ .3167	+ 1,710	.9577	5,170	-.1563	- 840
6L	4,740	+ .7824	+ 3,710	1.2567	5,950	-.2401	- 1,140
7L	11,655	+ 1.5194	+ 17,710	1.4870	17,340	.6619	+ 7,710
7½L	50	+ .9979	+ 50	1.5643	80	.6092	+ 30
8L	50	+ .5516	+ 30	1.6119	80	.5550	+ 30
CROWN	3,685	+ .1801	+ 660	1.6280	6,000	.5000	+ 1,840
8R	8	- .1184	—	1.6119	10	.4450	—
			+24,230		38,230 kgo		+9,610
			- 20				-2,490
			+24,210 kgm				+7,120 kgo

Normal thrust
38,230 × .995 = 38,050
7,120 × .105 = 750
38,800 kgo

Point 6, positive moment



	0L	1L	2L	3L	4L	5L	6L	7L	7½L	8L
unif. l u1	50	100	100	100	100	100	100	50	25	
" " u1								25	25	14
" " u2	2,650	5,300	5,300	5,300	5,300	2,650				
" " u2						1,990	660			
wheels							10,920	3,640		
	2,700	5,400	5,400	5,400	5,400	4,740	11,680	75		14
								3,690		

Point	Load	Munit	Moment	Hunit	H Thrust	Vunit	Vert. Shear
0L	2,700	0	0	0	0	0	0
1L	5,400	+ .0074	+ 40	.0331	180	-.0033	- 20
2L	5,400	+ .0507	+ 270	.1495	810	-.0165	- 90
3L	5,400	+ .1759	+ 950	.3579	1,930	-.0444	- 240
4L	5,400	+ .4426	+ 2,390	.6406	3,460	-.0906	- 490
5L	4,740	+ .9118	+ 4,320	.9577	4,540	-.1563	- 740
6L	11,680	+ 1.6333	+ 19,080	1.2567	14,690	+.7599	+ 8,880
7L	75	+ .6342	+ 50	1.4870	110	+.6619	+ 50
7½L	3,690	+ .2409	+ 890	1.5643	5,770	+.6092	+ 2,250
8L	14	- .0828	—	1.6119	20	+.5550	+ 10
			+27,990 kgm		31,510 kgo		+11,190
							- 1,580
							+9,610 kgo

Normal thrust
31,510 × .984 = 31,000
9,610 × .181 = 1,740
32,740 kgo

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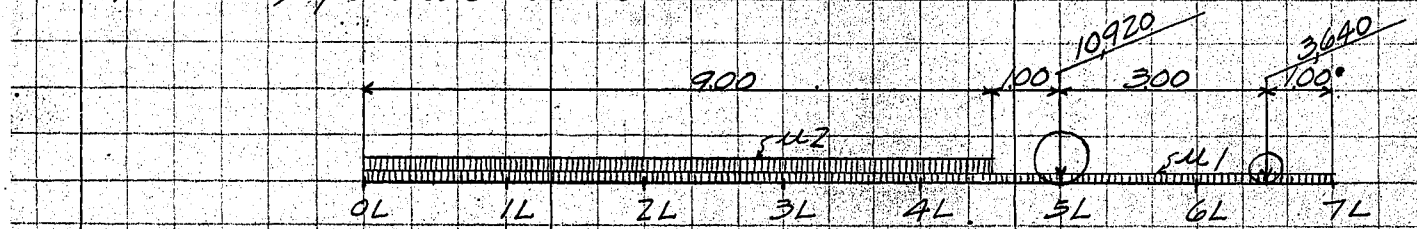
CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Point 5, positive moment



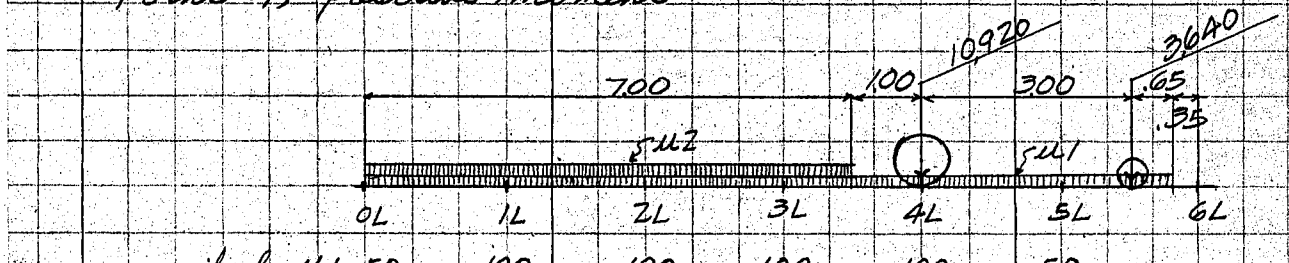
	0L	1L	2L	3L	4L	5L	6L	7L
unif. l. u1	50	100	100	100	100	100	100	50
" " u2	2,650	5,300	5,300	5,300	2,650			
" " "					1,990	660		
wheels						10,970	1,870	1,870
	2,700	5,400	5,400	5,400	4,740	11,680	1,920	1,870

Point	Load	Munit	Moment	Hunit	H Thrust	Vunit	Vert. Shear
0L	2,700	+ .00	+ 0	0	0	0	0
1L	5,400	+ .0288	+ 160	.0331	180	- .0033	- 20
2L	5,400	+ .1502	+ 810	.1495	810	- .0165	- 90
3L	5,400	+ .4240	+ 2,290	.3579	1,930	- .0444	- 240
4L	4,740	+ .9089	+ 4,310	.6406	3,040	- .0906	- 430
5L	11,680	+ 1.6506	+ 19,300	.9577	11,190	+ .8427	+ 9,840
6L	1,920	+ .6728	+ 1,290	1.2567	2,410	+ .7599	+ 1,460
7L	1,870	- .0279	- 50	1.4870	2,780	+ .6619	+ 1,240
			+ 28,160		22,340 kgs		+ 12,540
			- 50				- 780
			+ 28,110 kgm				+ 11,760 kgs

Normal thrust

22,340 × .967 = 21,600
11,760 × .255 = 3,000
24,600 kgs

Point 4, positive moment



	0L	1L	2L	3L	4L	5L	6L
unif. l. u1	50	100	100	100	100	50	
" " "						49	34
" " u2	2,650	5,300	5,300	2,650			
" " "				1,990	660		
wheels					10,920	1,820	1,820
	2,700	5,400	5,400	4,740	11,680	1,919	1,854

Point	Load	Munit	Moment	Hunit	H Thrust	Vunit	Vert. Shear
0L	2,700	0	0	0	0	0	0
1L	5,400	+ .0552	+ 300	.0331	180	- .0033	- 20
2L	5,400	+ .2729	+ 1,470	.1495	810	- .0165	- 90
3L	4,740	+ .7275	+ 3,450	.3579	1,700	- .0444	- 210
4L	11,680	+ 1.4744	+ 17,230	.6406	7,480	+ .4094	+ 10,630
5L	1,919	+ .5378	+ 1,030	.9577	1,840	+ .8427	+ 1,620
6L	1,854	- .0930	- 170	1.2567	2,330	+ .7599	+ 1,410
			+ 23,480		14,340 kgs		+ 13,660
			- 170				- 320
			+ 23,310 kgm				+ 13,340 kgs

Normal thrust 14,340 × .945 = 13,550
13,340 × .327 = 4,360
17,910 kgs

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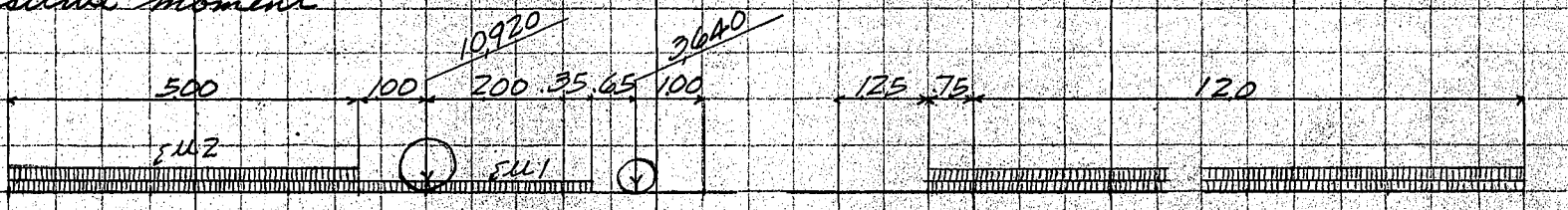
CALCULATIONS FOR

Design of Minano-Bashi for Saitama-ken

Point 3, positive moment



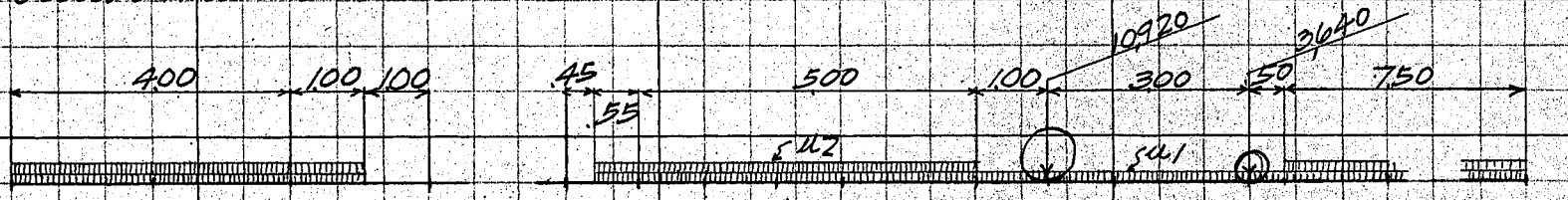
unif. l.	u1	50	100	100	100	50			50	100	100	100	50
" " "						16	2	7	30				
" "	u2	2650	5300	2650					2650	5300	5300	5300	2650
" " "				1990	660			373	1615				
wheels					10920	1870	1820						
		2700	5400	4740	11680	1886	1822	380	4345	5400	5400	5400	2700

Point	Load	Munit	Moment	Hunit	H Thrust	Vunit	Vert. Shear
0 L	2,700	0	0	0	0	0	0
1 L	5,400	+ .0866	+ 470	.0331	180	- .0033	- 20
2 L	4740	+ .4181	+ 1,980	.1495	710	- .0165	- 80
3 L	11,680	+ .0847	+ 12,650	.3579	4,180	+ .9556	+ 11,160
4 L	1,886	+ .1361	+ 260	.6406	1,210	+ .9094	+ 1,710
5 L	1822	- .4313	- 790	.9577	1,740	+ .8427	+ 1,530
7 R	380	- .1062	- 40	1.4870	570	+ .3381	+ 130
6 R	4,345	+ .0475	+ 210	1.2567	5,460	+ .2401	+ 1,040
5 R	5,400	+ .1301	+ 700	.9577	5,170	+ .1563	+ 840
4 R	5,400	+ .1429	+ 770	.6406	3,460	+ .0906	+ 490
3 R	5,400	+ .1079	+ 580	.3579	1,930	+ .0444	+ 240
2 R	5,400	+ .0551	+ 300	.1495	810	+ .0165	+ 90
1 R	5,400	+ .0140	+ 80	.0331	180	+ .0033	+ 20
0 R	2,700	0	0	0	0	0	0
			+ 18,000		25,600 kgo		+ 17,250
			- 830				- 100
			+ 17,170 kgo				+ 17,150 kgo

Normal thrust

25,600 * .916 = 23,450
17,150 * .400 = 6,860
30,310 kgo

point 2, positive moment



unif. l.	u1	50	100	50		25	50	50	25	100	100	100	100	50
" " "				37	13	8	20		50					
" "	u2	2650	5300	2650	660		1325	2650	2650	1325	2650		1490	2485	2650
" " "				1990		401	1057		2650					2650	
wheels										5460	5460	3640			
		2700	5400	4727	673	409	2700		4050	8210	5560	5230	5235	2700	
							2427	2700							

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CALCULATIONS FOR

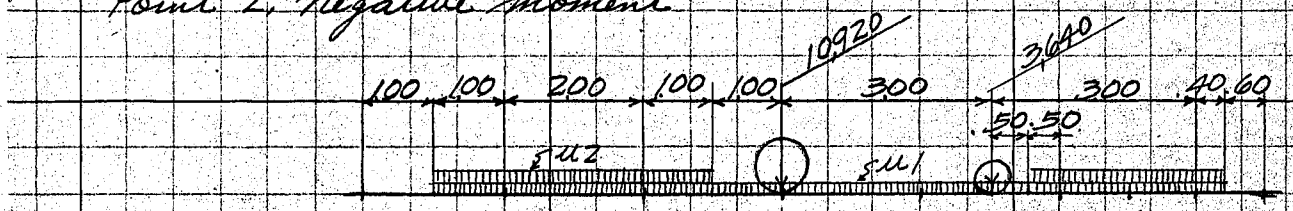
Design of Minano-Bashi for Saitama-Ken

Point	Load	Munit	Moment	Hunit	H Thrust	Vunit	Vert. Shear
0 L	2,700	0	0	0	0	0	0
1 L	5,400	+ .1247	+ 670	.0331	180	- .0033	- 20
2 L	4,727	+ .5931	+ 2,800	.1495	710	- .0165	- 80
3 L	673	- .4865	- 330	.3579	240	+ .9556	+ 670
8 L	409	- .0982	- 40	.16119	060	+ .5550	+ 230
Crown	2,427	+ .1293	+ 310	.16280	3950	+ .5000	+ 1,210
8 R	2,700	+ .3318	+ 900	.16119	4,350	+ .4450	+ 1,200
7½ R	2,700	+ .5005	+ 1,350	.15643	4,220	+ .3908	+ 1,050
7 R	4,050	+ .6302	+ 2,550	.14870	6,020	+ .3381	+ 1,370
6 R	8,210	+ .7612	+ 6,250	.12567	10,320	+ .2401	+ 1,970
5 R	5,560	+ .7273	+ 4,040	.9577	5,320	+ .1563	+ 870
4 R	5,230	+ .5702	+ 2,980	.6406	3,350	+ .0906	+ 470
3 R	5,235	+ .3591	+ 1,880	.3579	1,860	+ .0444	+ 230
2 R	5,400	+ .1641	+ 890	.1495	810	+ .0165	+ 90
1 R	5,400	+ .0389	+ 210	.0331	180	+ .0033	+ 20
0 R	2,700	0	0	0	0	0	0
			+ 24,820		42,170 Kgs		+ 9,380
			- 380				- 100
			24,440 Kgm				+ 9,280 Kgs

Normal Thrust

42,170 × .882 = 37,200
9,280 × .471 = 4,370
41,570 Kgs

Point 2. Negative moment



unif. l. w1	13	37				25	50	25	
" " "		50	100	100	100	50	16	4	
" " w2	660	1990	2650			1325	1325		
" " "		2,650	1990	660	166	1159	2,650	212	
" " "							848		
wheels				10,920	1,820	1820			
	673	4,727	4,740	11,680	2,086	4379	2214		
						2700	216		

Point	Load	Munit	Moment	Hunit	H Thrust	Vunit	Vert. Shear
2 L	673	+ .5931	+ 400	.1495	100	.9835	660
3 L	4,727	- .4865	- 2,300	.3579	1,690	.9556	4,520
4 L	4,740	- 1.0742	- 5,090	.6406	3,040	.9094	4,310
5 L	11,680	- 1.2089	- 14,130	.9577	11,200	.8427	9,850
6 L	2,086	- .9962	- 2,080	1.2567	2,630	.7599	1,580
7 L	4379	- .5792	- 2,540	1.4870	6,510	.6619	2900
7½ L	2700	- .3387	- 910	1.5643	4220	.6092	1,640
8 L	2214	- .0982	- 220	1.6119	3570	.5550	1230
Crown	216	+ .1293	+ 30	1.6280	350	.5000	110
			- 27,270		33,310 Kgs		26,800 Kgs
			+ 430				
			- 26,840 Kgm				

Normal thrust 33,310 × .882 = 29,400
26,800 × .471 = 12,620
42,020 Kgs

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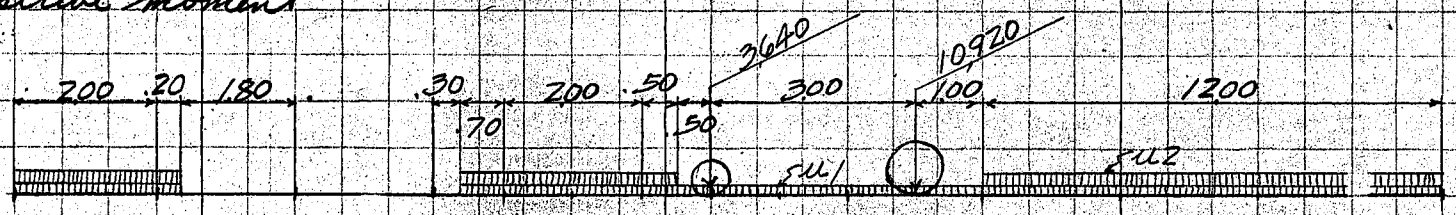
CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Point 1, positive moment



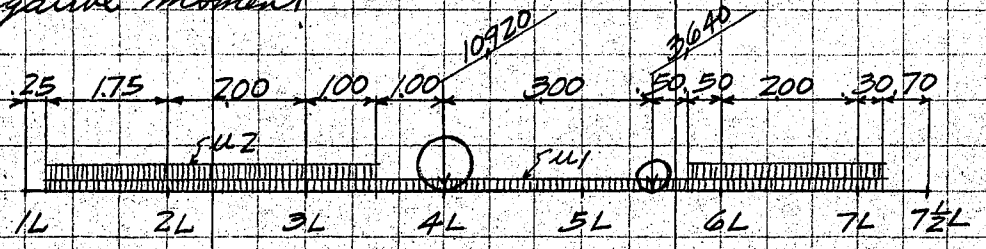
unif. l. w1	.50	.50			12	23				.50	1.00	1.00	1.00	.50
" " "		.10	—			.25	.50	.50	.50	.50	.25			
" " w2		5.03	27	650	1,205	2,650	994	333			2,650	5,300	5,300	2,650
" " "	2,650	2,650				1,325	1,375							
wheels								3,640	5,460	5,460				
	2,700	3,213	27	662	2,700	4,023	5,535	8,210	5,400	5,400	2,700			
					2,578	2,369	50							

Point	Load	M unit	Moment	H unit	H Thrust	V unit	Vert. Shear
0 L	2,700	0	0	0	0	0	0
1 L	3,213	+ .1703	+ 550	.0331	110	.9967	3,200
2 L	27	+ 1.1975	- 30	.1495	—	.9835	30
7 L	662	- .1483	- 100	.14870	980	.6619	440
7½ L	2,578	+ .2888	+ 740	.15643	4,030	.6092	1,570
8 L	2,700	+ .6939	+ 1,870	.16119	4,350	.5550	1,500
Crown	2,369	+ 1.0503	+ 2,490	.16280	3,860	.5000	1,180
8 R	4,023	+ 1.3439	+ 5,410	.16119	6,480	.4450	1,790
7½ R	50	+ 1.5648	+ 80	.15643	80	.3908	20
7 R	5,535	+ 1.7087	+ 9,460	.14870	8,230	.3381	1,870
6 R	8,210	+ 1.7639	+ 14,480	.12567	10,320	.2401	1,970
5 R	5,400	+ 1.5448	+ 8,340	.9577	5,170	.1563	840
4 R	5,400	+ 1.1449	+ 6,180	.6406	3,460	.0906	490
3 R	5,400	+ .6927	+ 3,740	.3579	1,930	.0444	240
2 R	5,400	+ .3075	+ 1,660	.1495	810	.0165	90
1 R	5,400	+ .0713	+ 390	.0331	180	.0033	20
0 R	2,700	0	0	0	0	0	0
			+ 55,390		39,990 Kgs		15,250 Kgs
			- 130				
			+ 55,260 Kgm				

Normal thrust

39,990 × .841 = 33,620
15,250 × .542 = 8,260
41,880 Kgs

Point 1, Negative moment



unif. l. w1	.38	.49					.13	.2
" " "		.50	1.00	1.00	1.00	1.00	.50	
" " w2	2.030	2,610	1,990	660	166	1,160	676	119
" " "		2,650	2,650			2,650	2,650	
wheels				10,920	1,820	1,820		
	2,068	5,359	4,740	11,680	2,086	5,730	3,389	121

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CALCULATIONS FOR

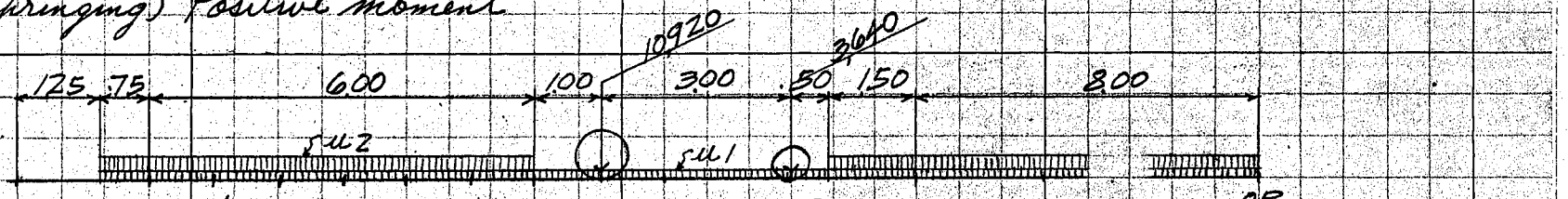
Design of Minami-Bashi for Saitama-Ken

Point	Load	M unit	Moment	H unit	H Thrust	V unit	Vert. Shear
1 L	2,068	+ .1703	+ 350	.0331	70	.9967	2060
2 L	5359	- 1.1975	- 6420	.1495	800	.9835	5270
3 L	4740	- 1.9753	- 9360	.3579	1,700	.9556	4530
4 L	11,680	- 2.1371	-24950	.6406	7,480	.9094	10,620
5 L	2086	- 1.7662	- 3680	.9577	2,000	.8427	1,760
6 L	5730	- 1.0331	- 5920	1.2567	7,200	.7599	4350
7 L	3389	- .1483	- 500	1.4870	5040	.6619	2240
7½ L	121	+ .2888	+ 30	1.5643	190	.6092	70
			-50,830		24480 Kgs		30900 Kgs
			+ 380				
			-50,450 kgm				

Normal thrust

24,480 × .841 = 20,580
30,900 × .542 = 16,750
37,330 kgs

Point 0, (Springing) Positive moment



unif. l. u1	7	30					50	100	100	100	100		50
" " "		25	50	50	50	50	50	25					
" " u2	370	1,615		2,650		2,650		1,325		1,490	2,485		
" " "		1,325	2,650		2,650		2,650				2,650	5,300	2,650
wheels								5,460	5,460	3,640			
	377	2,995		2,700		2,700		6,860	5,560	5,230	5,235	5,400	2,700
			2,700		2,700		2,700						

Point	Load	M unit	Moment	H unit	H Thrust	V unit	Vert. Shear
6 L	377	- .8564	- 320	1.2567	470	.7599	290
7 L	2,995	+ .5354	+ 1,600	1.4870	4,450	.6619	1,980
7½ L	2,700	+ 1.1822	+ 3,190	1.5643	4,220	.6092	1,640
8 L	2,700	+ 1.7599	+ 4,750	1.6119	4,350	.5550	1,500
Crown	2,700	+ 2.2481	+ 6,070	1.6280	4,390	.5000	1,350
8 R	2,700	+ 2.6299	+ 7,100	1.6119	4,350	.4450	1,200
7½ R	2,700	+ 2.8950	+ 7,810	1.5643	4,220	.3908	1,060
7 R	6,860	+ 3.0400	+20,850	1.4870	10,200	.3381	2,320
6 R	5,560	+ 2.9802	+16,560	1.2567	6,980	.2401	1,330
5 R	5,230	+ 2.5251	+13,200	.9577	5,010	.1563	820
4 R	5,235	+ 1.8286	+ 9,570	.6406	3,350	.0906	470
3 R	5,400	+ 1.0870	+ 5,860	.3579	1,930	.0444	240
2 R	5,400	+ .4763	+ 2,570	.1495	810	.0165	90
1 R	5,400	+ .1094	+ 590	.0331	180	.0033	20
0 R	2,700	0	0	0	0	0	0
			+ 99,720		54,910 Kgs		14,310 Kgs
			- 320				
			+99,400 Kgm				

Normal thrust

54,910 × .793 = 43,550
14,310 × .609 = 8,720
52,270 Kgs

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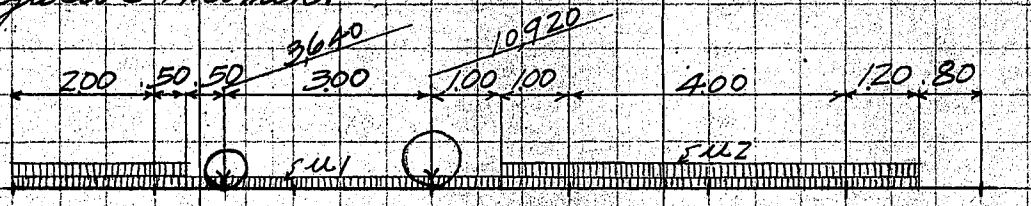
CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Point a, Negative moment

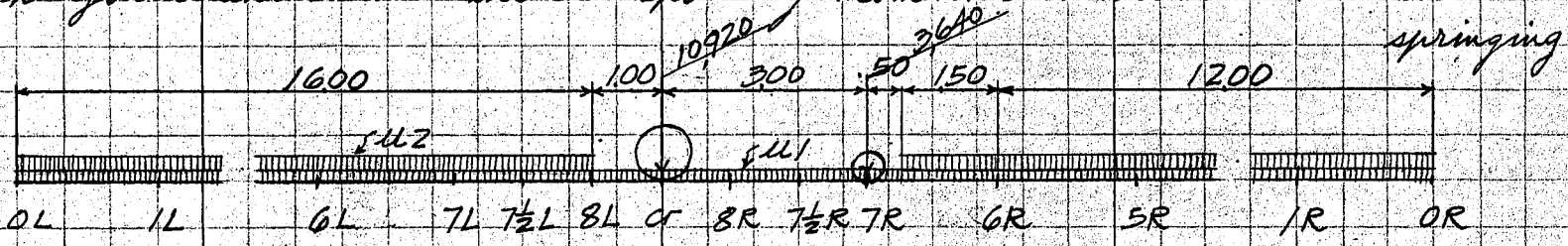


		0L	1L	2L	3L	4L	5L	6L	7L
unif. ℓ	w1	50	100	100	100	100	100	50	
" "	"							42	18
" "	w2	2,650	2,650		660	1,990		2,650	
" "	"		1,160	166		2,650	5,300	2,226	954
wheels			1,820	1,820	10,970				
		2,700	5,730	2,086	11,680	4,740	5,400	4,968	972

Point	Load	M unit	Moment	H unit	H Thrust	V unit	Vert. Shear
0 L	2,700	0	0	0	0	0	0
1 L	5,738	- 1.7784	- 10,200	.0331	190	.9967	5,720
2 L	2,086	- 2.9627	- 6,180	.1495	310	.9835	2,050
3 L	11,682	- 3.4034	- 39,780	.3579	4,180	.9556	11,160
4 L	4,738	- 3.0910	- 14,650	.6406	3,040	.9094	4,310
5 L	5,400	- 2.1607	- 11,670	.9577	5,170	.8427	4,550
6 L	4,968	- .8564	- 4,250	1.2567	6,240	.7599	3,770
7 L	972	+ .5354	+ 520	1.4870	1,450	.6619	640
			- 86,730		20,580 kgs		32,200 kgs
			+ 520				
			- 86,210 kgm				

Normal thrust 20,580 × .793 = 16,320
32,200 × .609 = 19,600
35,920 kgs

Maximam horizontal thrust with the corresponding moment and vertical shear at springing



		0L	1L	6L	7L	7½L	8L	℄	8R	7½R	7R	6R	5R	1R	0R
unif. ℓ	w1	50	100	100	75	50	50	50	50	50	75	100	100	100	50
" "	w2	2,650	5,300	5,300	2,650	2,650					1,490	2,485			
" "	"				1,325	1,325						2,650	5,300	5,300	2,650
wheels						10,970					3640				
		2,700	5,400	5,400	4,050	1,375	50				5,705	5,235	5,400	5,400	2,700
					2,700	10,970	50								

Point	Load	M unit	Moment	H unit	H Thrust	V unit	Vert. Shear
0 L	2,700	0	0	0	0	0	0
1 L	5,400	- 1.7784	- 9,600	.0331	180	.9967	5,380
2 L	5,400	- 2.9627	- 16,000	.1495	810	.9835	5,310
3 L	5,400	- 3.4034	- 18,380	.3579	1,930	.9556	5,160
4 L	5,400	- 3.0910	- 16,690	.6406	3,460	.9094	4,910
5 L	5,400	- 2.1607	- 11,670	.9577	5,170	.8427	4,550
6 L	5,400	- .8564	- 4,620	1.2567	6,780	.7599	4,100
7 L	4,050	+ .5354	+ 2,170	1.4870	6,020	.6619	2,680
7½L	2,700	+ 1.1822	+ 3,190	1.5643	4,220	.6092	1,640
8 L	1,375	+ 1.7599	+ 2,420	1.6119	2,220	.5550	760
Crown	10,970	+ 2.2481	+ 24,650	1.6280	17,860	.5000	5,490
8 R	50	+ 2.6299	+ 130	1.6119	80	.4450	20

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

7½R	50	+ 28950	+ 140	15643	80	.3908	20
7 R	5205	+ 30400	+ 15820	14870	7,740	.3381	1,760
6 R	5235	+ 29802	+ 15600	12567	6,580	.2401	1,260
5 R	5400	+ 25251	+ 13630	9577	5,170	.1563	840
4 R	5400	+ 18286	+ 9870	6406	3,460	.0906	490
3 R	5400	+ 10870	+ 5870	3579	1,930	.0444	240
2 R	5400	+ 4763	+ 2570	1495	810	.0165	90
1 R	5400	+ 1094	+ 590	0331	180	.0033	20
0 R	2700	0	0	0	0	0	0
			+ 96650		74680 Kgs		44720 Kgs
			- 76960				
			+ 19690 Kgm				

Temperature stresses

Crown thrust $H_o = \dfrac{Ewtl\int\frac{ds}{I}}{2\left[\int\frac{ds}{I}\int y^2\frac{ds}{I} - \left(\int\frac{y\,ds}{I}\right)^2\right]}$

where E = 1400,000,000 Kgs/m²
coef. of Exp. w = 0.000012 for 1°C
variation of temperature ± 15°C
l = span length 34.00 meters
Ewt = 252,000 Kgs

For fall of 15°C in temperature

$H_o = -\dfrac{252000 \times 34.00 \times 59591}{105529.37} = -4,840$ Kgs for 4.30 meter wide $-4,840 \times 4.30 = -20,800$ Kgs

$M_o = -\dfrac{H_o\int y\frac{ds}{I}}{\int\frac{ds}{I}} = 20,800 \times \dfrac{65656}{59591} = 22,900$ Kgm

Temperature stress at various panel points

panel point				Moment		Normal thrust
8	M = 22,900 - 20,800	×	.020	= + 22,480 Kgm	- 20,800 × .999	= - 20,780 Kgs
7	22,900 - "	×	.180	= + 19,160	" × .995	= - 20,700
6	22,900 - "	×	.475	= + 13,070	" × .984	= - 20,470
5	22,900 - "	×	.920	= + 3,750	" × .967	= - 20,120
4	22,900 - "	×	1.520	= - 8,700	" × .945	= - 19,650
3	22,900 - "	×	2.270	= - 24,300	" × .916	= - 19,050
2	22,900 - "	×	3.220	= - 44,050	" × .882	= - 18,350
1	22,900 - "	×	4.400	= - 68,600	" × .841	= - 17,500
0	22,900 - "	×	5.750	= - 96,600	" × .793	= - 16,500

Average stress in arch ring

Amount of average stress in arch ring for entire span is only approximate average stresses are found by the diagram prepared by Mr. J. Masuda, the same diagrams are published in Concrete Engineer's Hand book by Hool and Johnson's (on page 685).

Concrete area at crown .600
Equivalent steel area .021
for 4.30 meter wide .621 × 4.30 = 2.67 sq. meters

Thickness ratio = $\dfrac{\text{depth at springing}}{\text{depth at crown}} = \dfrac{1350}{600} = 2.25$

Rise ratio = $\dfrac{5750}{3400} = 0.1692$

averge stresses

	hor. thrust at crown			Coef.		average stresses
Dead Load stresses	331,360	÷	2.67 = 124,200	×	.91 =	113,000 Kg./m²

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Live load stresses

Crown	+ moment	37,700	÷	2.67	=	14120	c .88	=	12420
Point 8	+ moment	37,310	÷	"	=	13970	c .88	=	12300
Point 7	+ moment	38230	÷	"	=	14320	c .88	=	12600
Point 6	+ moment	31,510	÷	"	=	11810	c .88	=	10400
Point 5	+ moment	22340	÷	"	=	8370	c .88	=	7360
Point 4	+ moment	14340	÷	"	=	5370	c .88	=	4730
Point 3	+ moment	25,600	÷	"	=	9,590	c .88	=	8440
Point 2	+ moment	42,170	÷	"	=	15800	c .89	=	14080
	- moment	33310	÷	"	=	12480	c .91	=	11360
Point 1	+ moment	39990	÷	"	=	14970	c .89	=	13320
	- moment	24480	÷	"	=	9170	c .92	=	8440
Point 0	+ moment	54,910	÷	"	=	20570	c .89	=	18300
	- moment	20,580	÷	"	=	7700	c .92	=	7080
For temperature 15°C fall		-20,800	÷	"	=	-7,790	c .80	=	-6230

Fibre stresses in arch ring

Crown section, Positive moment

	Thrust	Moment	Average Stress
Dead Load	+331,360	- 2550	+113,000
Live Load	+ 37,700	+ 18,740	+ 12,420
Rib shortening	- 10,100	+ 11,130	- 3030
	+358,960	+ 27,320	+122,390

122390 ÷ 252000 = 0486, ecc. = .076

$e/h = \frac{.076}{60} = .127$, $d'/h = \frac{4.5}{60.0} = .075$

$P_o = zp = \frac{28.16}{6,000} = .00469$, $h = 60$, $b = 430$

$K = 1.60$

$f_c = \frac{358,960 \times 1.60}{60 \times 430} = 22.3 \text{ kg/cm}^2 < 45.0$

Dead Load	+331,360	- 2550	+113,000
Live Load	+ 37,700	+ 18,740	+ 12,420
Temperature	- 20,800	+ 22,900	- 6,730
Rib shortening	- 9,600	+ 10,580	- 2,880
	+338,660	+ 49,670	+116,310

116310 ÷ 252000 = 0.462, ecc. = .146, $e/h = .243$

$d'/h = .075$, $P_o = .00469$, $h = 60$, $b = 430$

$K = .84$ $L = 1078$

$f_c = \frac{49,670 \times 100}{1078 \times 430 \times 60^2} = 29.8 \text{ kg/cm}^2 < 45.0 \times 1.25 = 56.2$

$f_s = 15 \times 29.8 \times \left(\frac{555}{.84 \times 60} - 1\right) = 44.7 \text{ kg/cm}^2$

Point 8, positive moment

	Thrust	Moment	Average Stress
Dead Load	+331,430	- 1920	+113,000
Live Load	+ 37,460	+ 20,300	+ 12,300
Rib shortening	- 10,070	+ 10,900	- 3,020
	+358,820	+ 29,280	+122,280

122,280 ÷ 252,000 = 0.485, ecc. = .082, $e/h = \frac{.082}{.600} = .137$, $d'/h = .075$, $P_o = .00469$, $h = 60$, $b = 430$

$K = 1.64$

$f_c = \frac{358,820 \times 1.64}{60 \times 430} = 22.8 \text{ kg/cm}^2$

Dead Load	+331,430	- 1920	+113,000
Live Load	+ 37,460	+ 20,300	+ 12,300
Temperature	- 20,780	+ 22,480	- 6,230
Rib shortening	- 9,580	+ 10,360	- 2,880
	+338,530	+ 51,220	+116,190

116,190 ÷ 252,000 = .461, ecc = .151, $e/h = .252$

$d'/h = .075$, $P_o = .00469$, $h = 60$, $b = 430$

$K = .81$, $L = 1098$

$f_c = \frac{51,140 \times 100}{1098 \times 430 \times 60^2} = 30.1 \text{ kg/cm}^2$

$f_s = 15 \times 30.1 \times \left(\frac{555}{.81 \times 60} - 1\right) = 64.1 \text{ kg/cm}^2$

Point 7, Positive moment

	Thrust	Moment	Average stress
Dead Load	+334,050	+ 1,580	+113,000
Live Load	+ 38,800	+ 24,210	+ 12,600
Rib shortening	- 10,080	+ 9,330	- 3,030
	+362,770	+ 35,120	+122,570

122,570 ÷ 252,000 = .487, ecc. = .097, $e/h = \frac{.097}{.603} = .161$, $d'/h = \frac{4.5}{603} = .0746$, $P_o = \frac{28.16}{6,030} = .00467$

$h = 60.3$, $b = 430$

$K = 1.775$

$f_c = \frac{362,770 \times 1.775}{603 \times 430} = 24.8 \text{ kg/cm}^2$

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Dead Load	+334050	+1,580	+113,000
Live Load	+38800	+24210	+12,600
Temperature	-20,700	+19160	-6,230
Rib Shortening	-9560	+8850	-7,880
	+342,590	+53800	+116,490

116,490 ÷ 252,000 = .462, ecc. = .157, e/h = .260
d'/h = .0746, Po = .00467, h = 60.3, b = 430
K = .790, L = .1095
$f_c = \frac{53800 \times 100}{.1095 \times 430 \times 60.3^2} = 31.4$ kg/cm²
$f_s = 15 \times 31.4 \times \left(\frac{55.8}{.790 \times 60.3} - 1\right) = 80.6$ kg/cm²

Point 6, Positive moment

	Thrust	Moment	Average Stress
Dead Load	+337,040	+880	+113,000
Live Load	+32,740	+27,990	+10,400
Temperature	-20,470	+13,020	-6,230
Rib Shortening	-9,290	+5910	-2,830
	+340,020	+47,800	+114,340

114,340 ÷ 252,000 = .454, ecc. = .141, e/h = .141/.613
= .230, d'/h = 0734, Po = .00459, h = 61.3, b = 430
K = 1.88
$f_c = \frac{340020 \times 1.88}{430 \times 613} = 24.3$ kg/cm²

Point 5, Positive moment

	Thrust	Moment	Average Stress
Dead Load	+342,400	+2,580	+113,000
Live Load	+24,600	+28,110	+7,360
Temperature	-20,120	+3750	-6,230
Rib Shortening	-8,880	+1,660	-2,750
	+338,000	+36,100	+117,380

111,380 ÷ 252,000 = .442, ecc. = .107, e/h = .168
d'/h = .0708, Po = .00443, h = 63.6, b = 430
K = 1.818
$f_c = \frac{338,000 \times 1.818}{430 \times 63.6} = 22.5$ kg/cm²

Point 4, Positive moment

	Thrust	Moment	Average Stress
Dead Load	+349,700	+3,150	+113,000
Live Load	+17,910	+23,310	+4,730
Temperature	+19,650	+8,700	+6,230
Rib Shortening	+9,900	+4,390	+3,140
	+397,160	+39,550	+127,100

127,100 ÷ 252,000 = .504, ecc. = .0996, e/h = .146
d'/h = .0662, Po = .00414, h = 68.0, b = 430
K = 1.713
$f_c = \frac{397,160 \times 1.713}{430 \times 68.0} = 23.3$ kg/cm²

Point 3, Positive moment

	Thrust	Moment	Average Stress
Dead Load	+359,800	+50	+113,000
Live Load	+30,310	+17,170	+8,440
Temperature	+19,050	+24,300	+6,230
Rib Shortening	+9,900	+12,620	+3,240
	+419,060	+54,140	+130,910

130,910 ÷ 252,000 = 0.519, ecc. = .129, e/h = .1715
d'/h = .0598, Po = .00375, h = 75.2, b = 430
K = 1.864
$f_c = \frac{419,060 \times 1.864}{430 \times 75.2} = 24.2$ kg/cm²

Point 2, Positive moment

	Thrust	Moment	Average Stress
Dead Load	+373,700	+2,850	+113,000
Live Load	+41,570	+24,440	+14,080
Temperature	+18,350	+44,050	+6,230
Rib Shortening	+9,950	+23,900	+3,380
	+443,570	+95,240	+136,690

136,690 ÷ 252,000 = .542, ecc. = .215, e/h = .2485
d'/h = .0521, Po = .00326, h = 86.4, b = 430
K = .814, L = .1054
$f_c = \frac{95240 \times 100}{.1054 \times 430 \times 86.4^2} = 28.7$ kg/cm²
$f_s = 15 \times 28.2 \times \left(\frac{81.9}{.814 \times 86.4} - 1\right) = 69.8$ kg/cm²

Point 2, Negative moment

	Thrust	Moment	Average Stress
Dead Load	+373,700	+2,850	+113,000
Live Load	+42,020	-26,840	+11,360
Temperature	-18,350	-44,050	-6,230
Rib Shortening	-8,400	-20,150	-2,860
	+388,970	-88,190	+115,270

115,270 ÷ 252,000 = .458, ecc. = .227, e/h = .263
d'/h = .0521, Po = .00326, h = 86.4, b = 430
K = .78, L = .1065
$f_c = \frac{88,190 \times 100}{.1065 \times 430 \times 86.4^2} = 25.8$ kg/cm²
$f_s = 15 \times 25.8 \times \left(\frac{81.9}{.78 \times 86.4} - 1\right) = 83.2$ kg/cm²

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken.

Point 1, Positive moment

	Thrust	Moment	Average Stress
Dead Load	+393,400	+11,490	+113,000
Live Load	+ 41,880	+55,260	+ 13,320
Rib shortening	+ 9,000	+35,250	+ 3,200
	+444,280	+102,000	+129,520

129,520 ÷ 252,000 = .514, ecc. = .2295, e/h = .221
d'/h = .0433, P_0 = .00542, h = 104.0, b = 430
k = .908, L = .1085

$$f_c = \frac{102000 \times 100}{.1085 \times 430 \times 1040^2} = 20.2 \text{ kg/cm}^2$$

$$f_s = 15 \times 20.2 \times \left(\frac{99.5}{.908 \times 1040} - 1\right) = 164 \text{ kg/cm}^2$$

Dead Load	+393,400	+11,490	+113,000
Live Load	+ 41,880	+55,260	+ 13,320
Temperature	+ 17,500	+68,600	+ 6,230
Rib shortening	+ 9,450	+37,000	+ 3,360
	+462,230	+172,350	+135,910

135,910 ÷ 252,000 = .540, ecc. = .373, e/h = .359
d'/h = .0433, P_0 = .00542, h = 104.0, b = 430
k = .623, L = .1186

$$f_c = \frac{172350 \times 100}{.1186 \times 430 \times 1040^2} = 31.3 \text{ kg/cm}^2$$

$$f_s = 15 \times 31.3 \times \left(\frac{99.5}{.623 \times 1040} - 1\right) = 251.5 \text{ kg/cm}^2$$

Point 1, Negative moment

	Thrust	Moment	Average stress
Dead Load	+393,400	+11,490	+113,000
Live Load	+ 37,330	- 50,450	+ 8,440
Temperature	- 17,500	- 68,600	- 6,230
Rib shortening	- 7,800	- 30,600	- 2,780
	+405,430	-138,160	+112,430

112,430 ÷ 252,000 = .446, ecc. = .341, e/h = .328
d'/h = .0433, P_0 = .00542, h = 104.0, b = 430
k = .673, L = .1182

$$f_c = \frac{138,160 \times 100}{.1182 \times 430 \times 1040^2} = 25.1 \text{ kg/cm}^2$$

$$f_s = 25.1 \times 15 \times \left(\frac{995}{.673 \times 1040} - 1\right) = 158.5 \text{ kg/cm}^2$$

Point 0, Positive moment

	Thrust	Moment	Average Stress
Dead Load	+424,000	- 8,350	+113,000
Live Load	+ 52,270	+99,400	+ 18,300
Rib shortening	+ 8,810	+53,200	+ 3,330
	+485,080	+144,250	+134,630

134,630 ÷ 252,000 = .534, ecc. = .2975, e/h = .220
d'/h = .0333, P_0 = .00417, h = 135.0, b = 430
k = .897, L = .1055

$$f_c = \frac{144250 \times 100}{.1055 \times 430 \times 1350^2} = 17.5 \text{ kg/cm}^2$$

$$f_s = 15 \times 17.5 \times \left(\frac{1305}{.897 \times 1350} - \right) = 20.5 \text{ kg/cm}^2$$

Dead Load	+424,000	- 8,350	+113,000
Live Load	+ 52,270	+99,400	+ 18,300
Temperature	+ 16,500	+96,600	+ 6,230
Rib shortening	+ 9,240	+54,100	+ 3,490
	+502,010	+241,750	+141,020

141,020 ÷ 252,000 = .560, ecc. = .481, e/h = .356
d'/h = .0333, P_0 = .00417, h = 135.0, b = 430
k = .609, L = .1126

$$f_c = \frac{241,750 \times 100}{.1126 \times 430 \times 135.0^2} = 27.4 \text{ kg/cm}^2$$

$$f_s = 15 \times 27.4 \times \left(\frac{130.5}{.609 \times 1350} - 1\right) = 2420 \text{ kg/cm}^2$$

Point 0, Negative moment

	Thrust	Moment	Average Stress
Dead Load	+424,000	- 8,350	+113,000
Live Load	+ 35,920	- 86,210	+ 7,080
Rib shortening	- 7,670	- 44,900	- 2,900
	+452,250	-139,460	+117,180

117,180 ÷ 252,000 = .465, ecc. = .3085, e/h = .2285
d'/h = .0333, P_0 = .00417, h = 135.0, b = 430
k = .875, L = .1063

$$f_c = \frac{139,460 \times 100}{.1063 \times 430 \times 1350^2} = 16.7 \text{ kg/cm}^2$$

$$f_s = 15 \times 16.7 \times \left(\frac{130.5}{.875 \times 1350} - 1\right) = 26.3 \text{ kg/cm}^2$$

Dead Load	+424,000	- 8,350	+113,000
Live Load	+ 35,920	- 86,210	+ 7,080
Temperature	- 16,500	- 96,600	- 6,230
Rib shortening	- 7,280	- 42,600	- 2,750
	+436,140	-233,760	+111,100

111,100 ÷ 252,000 = .441, ecc. = .536, e/h = .397
d'/h = .0333, P_0 = .00417, h = 135.0, b = 430
k = .547, L = .1117

$$f_c = \frac{233,760 \times 100}{.1117 \times 430 \times 135.0^2} = 26.7 \text{ kg/cm}^2$$

$$f_s = 15 \times 26.7 \times \left(\frac{130.5}{.547 \times 1350} - 1\right) = 307.0 \text{ kg/cm}^2$$

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CALCULATIONS FOR

Design of Minano-Bashi for Saitama-Ken

Deflection of arch ring due to moment

Crown deflection due to dead load

$\Delta y = \frac{1}{E}\left(2M_0\int_0^{\frac{l}{2}} x\frac{ds}{I} + 2H_0\int_0^{\frac{l}{2}} xy\frac{ds}{I} - \int_0^{\frac{l}{2}} mx\frac{ds}{I}\right)$

$\int x\frac{ds}{I} = 3{,}790.91$, $\int xy\frac{ds}{I} = 7{,}059.76$

Point	M_0	H_0	$2M_0\int x\frac{ds}{I}$	$2H_0\int xy\frac{ds}{I}$	$-\int mx\frac{ds}{I}$	Sum	Load	Product
Crown	+ 1.3871	1.6280	+ 10,517	22,987	- 34,490	- 986	6,000	- 5,916,000
8	+ .9265	1.6119	+ 7,025	22,759	- 30,699	- 915	12,500	- 11,438,000
7½	+ .5439	1.5643	+ 4,124	22,087	- 26,959	- 748	12,500	- 9,350,000
7	+ .2374	1.4870	+ 1,800	20,996	- 23,323	- 527	15,100	- 7,958,000
6½	+ .0037	1.3830	+ 74	19,527	- 19,837	- 786	6,300	- 1,807,000
6	- .1641	1.2567	- 1,244	17,744	- 16,560	- 60	17,200	- 1,032,000
5½	- .2706	1.1129	- 2,052	15,714	- 13,527	+ 135	6,600	+ 891,000
5	- .3246	.9577	- 2,461	13,522	- 10,779	+ 282	19,400	+ 5,471,000
4½	- .3359	.7980	- 2,547	11,267	- 8,346	+ 374	7,000	+ 2,618,000
4	- .3147	.6406	- 2,386	9,045	- 6,248	+ 411	19,400	+ 7,973,000
3½	- .2646	.4921	- 2,006	6,948	- 4,489	+ 453	7,800	+ 3,533,000
3	- .2161	.3579	- 1,638	5,053	- 3,065	+ 350	21,700	+ 7,595,000
2½	- .1573	.2426	- 1,193	3,425	- 1,958	+ 274	9,200	+ 2,521,000
2	- .1028	.1495	- 779	2,111	- 1,140	+ 192	24,900	+ 4,781,000
1½	- .0576	.0800	- 437	1,130	- 579	+ 114	11,200	+ 1,277,000
1	- .0248	.0331	- 188	467	- 228	+ 51	29,400	+ 1,499,000
½	- .0058	.0074	- 44	104	- 48	+ 12	15,000	+ 180,000
0	- 0	0	0	0	0	0	23,600	0

+ 38,339,000
- 37,496,000
+ 843,000

Deflection $\Delta y = \frac{843{,}000 \times 100}{1{,}400{,}000{,}000 \times 4.30} = 0.014^{cm}$ fall

Crown deflection due to temperature

For fall of temperature $\Delta y = \frac{2wtl\left(\int\frac{ds}{I}\int xy\frac{ds}{I} - \int x\frac{ds}{I}\int y\frac{ds}{I}\right)}{2\left[\int\frac{ds}{I}\int y^2\frac{ds}{I} - \left(\int y\frac{ds}{I}\right)^2\right]} - \frac{2wtl \times A}{B}$

$A = 1{,}718{,}021.71$

$B = 1{,}055{,}293.70$

$\frac{A}{B} = 1.6280$

Deflection at crown for 15° fall of temperature

$\Delta y = -2 \times .000012 \times 15 \times 3400 \times 1.6280 \times 100 = -1.993^{cm}$ fall

Crown deflection due to rib shortening

average stress due to dead load	= + 113,000
rib shortening	= - 2,570
temperature 15° fall	= - 6,230
	+ 104,200

Ratio 104,200 ÷ 252,000 = .414

$-1.993 \times .414 = -0.825^{cm}$ fall

Deflection due to dead load moment	- 0.014
" " temperature 15° fall	- 1.993
" " rib shortening	- 0.825
	- 2.832 cm fall

CALCULATIONS FOR

Design at Minano-Bashi for Saitama-Ken

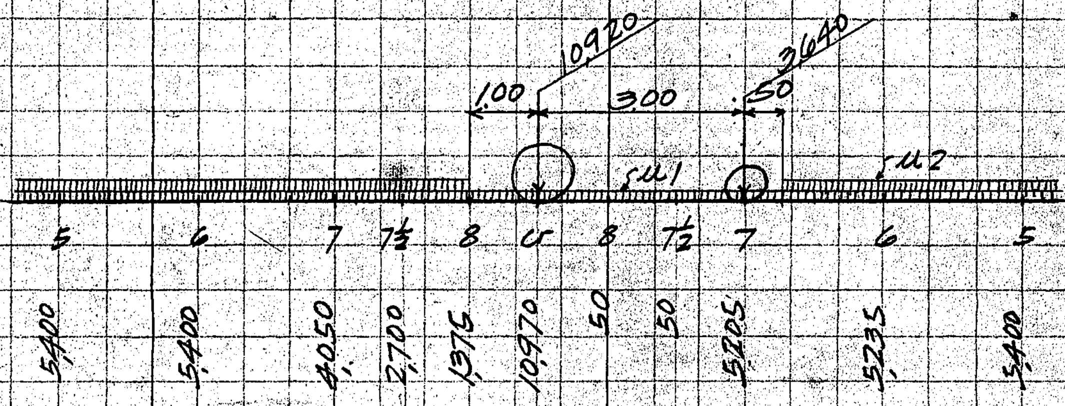
average stress due to dead load = + 113,000
rib shortening = − 2,730
+ 110,270

Ratio 110,270 ÷ 252,000 = 0.438
− 1.993 × 0.438 = − 0.873 fall

Deflection due to dead load moment − 0.014
" " rib shortening − 0.873
− 0.887 fall

Deflection at crown due to live load
Live load thrust

Point	Load	H_0	Thrust	
0	2700	0	0	
1	5,400	.0331	180	
2	5,400	.1495	810	
3	5,400	.3579	1,930	− M
4	5,400	.6406	3,460	
5	5,400	.9577	5,170	
6	5,400	1.2567	6,790	
7	4,050	1.4870	6,020	
7½	2,700	1.5643	4,220	
8	1,375	1.6119	2,220	
Crown	10,970	1.6280	17,860	+ M
8	50	1.6119	80	
7½	50	1.5643	80	
7	5,205	1.4870	7,740	
6	5,235	1.2567	6,580	
5	5,400	.9577	5,170	
4	5,400	.6406	3,460	
3	5,400	.3579	1,930	− M
2	5,400	.1495	810	
1	5,400	.0331	180	
0	2700	0	0	



+ M = 38,220 ÷ 2.67 = 14,310 @ .88 = 12,590
− M = 36,470 ÷ 2.67 = 13,660 @ .93 = 12,700
average thrust for live load = 25,290 kgs

average stresses due to live load = 25,290
rib shortening − 610
24,680 kgs

ratio 24,680 ÷ 252,000 = .098

Deflection due to live load − 1.993 × .098 = − 0.195 cm fall

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CALCULATIONS FOR

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埼玉縣
坊野村[illegible]

2.3
8.42
79
8.51

23
24490
223.54
1.36

2.5 x 5.0
2
12.5

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CALCULATIONS FOR

Preliminary Estimate of Cost for Minami Bashi for Saitama-Ken.

Total length of Bridge

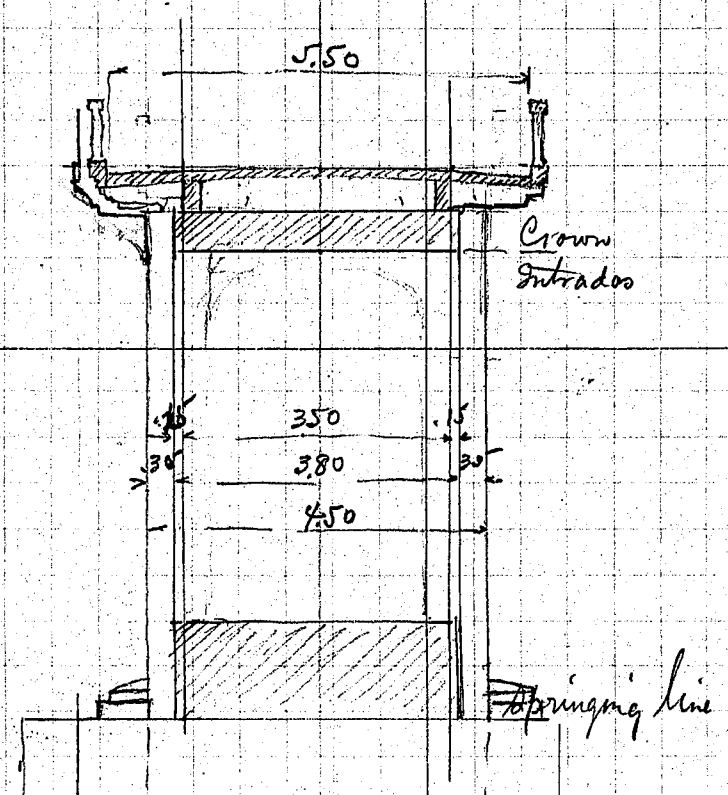
130.31
23.54
106.77
1.50
108.27

between back to back of Pilaster at both ends about wing walls of both abutments.

and 2@4.0 = 8.00

Clear roadway 5.50 meters Granolithic Pavement
Type of bridge - 3 spans of Reinforced Concrete arch

General Cross section of Bridge -



Slab. span length 2.0 meters.
effective depth required say 12.5 cm
total depth 15.0 cm

Granolithic pavement 5 cm.

Dead load

granolithic pavement .05 x 5.50 = .275

Slab beam copings

Slab .15 x 5.50 = .825
beam 2-.30 x .50 = .300
coping 2-.30.40 .240

1.365
.450
2.085

Cross beam say .50 x .30 x 6.00 / 2.0

Cross walls. say average 2.0 meters

.15/3 @ .30 x 3.5 x 2.0/2.0 = 1.050

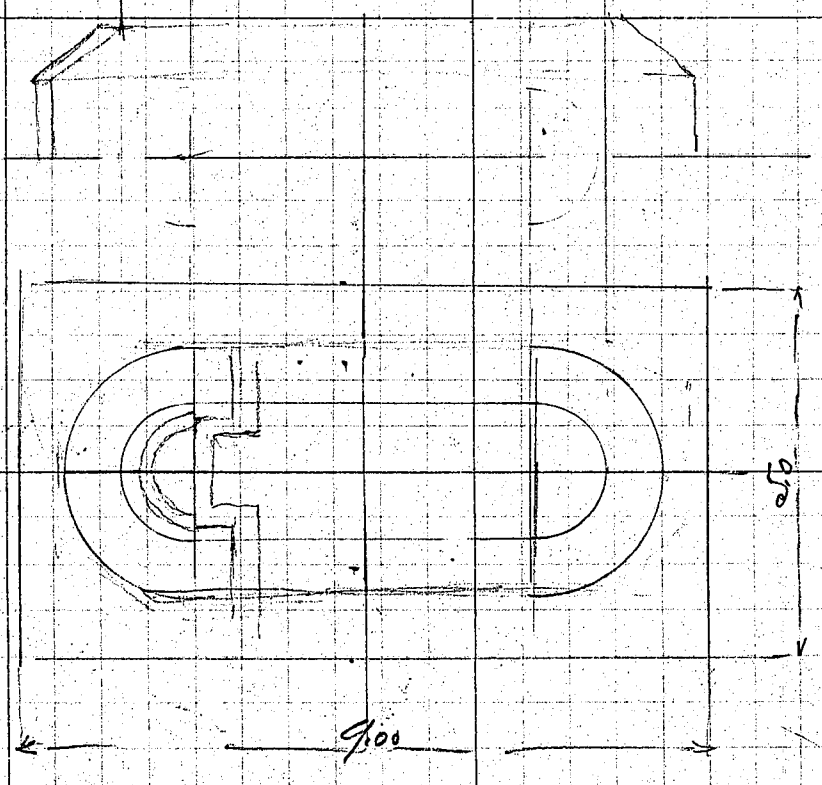
3.135

weight 3.135 @ 2400 = 7520. kg per lin. meter

Handrail -

.20 x .80 = .160
coping extra say .104
2 x .20 = .40 @ 2400 = 960

Dead load. Deck 7520
HR 960
8480 say 8.500 kg per lin. meter.



Span length of Arch Ring

span length 34.0 Rise 5.75 on neutral axis.

Crown .50 x 3.80 = 1.90
springings 1.15 x 3.80 = 4.37
2) 6.27 + 3.14 cubes.
10%. 31
3.45

weight 3.45 x 2400 = 8.300 kg per lin. meter

Total Dead Load

Deck complete 8500
Arch ring 8300
16.800

Dead load Thrust

1/8 x 16.800 x 34.2/5.75 = 422,000 kg

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JIJI BLDG, TOKYO

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CALCULATIONS FOR

Preliminary Estimate of Post for Minano Bashi for Saitama-Ken.

Unit thrust at crown $\frac{422.000}{50. \times 3.80} = 222$ kg/cm²

400 / 50 / 20.00

Live Load Thrust 500 × 5.5 = 2750 kg per lin. meter

Live Load thrust $\frac{1}{8} \times 2750 \times \frac{3.4^2}{5.25} = 69.200$ kg

Unit thrust at crown $\frac{69200}{50. \times 380} = 3.65$
22.20
25.85

Assuming eccentricity 1/6 of crown depth, $= \frac{50}{6} = 8.3$ cm

Revised section of Arch ring Crown .60 × 4.20 = 25.2

.60 × 2.50 = 1.35 Springing 1.35 × 4.20 = 5.67

2] 8.19 (4.10 @ 2400
82
2] 9.01 (4.50 @ 2400 = 10.8 ton

Revised Dead load Deck complete 8500
Arch ring 10800
19300

Thrust $\frac{1}{8} \times 19300 \times \frac{3.4^2}{5.25} = 485.000$

Unit thrust $= \frac{485000}{60 \times 420} = 19.3$ kg/cm² in average.
25200

Live Load unit thrust $\frac{69200}{60. \times 420} = \frac{2.7}{22.0}$

eccentricity 10 cm

Total Thrust D 485.000 kgs.
L. Load 70.000
555.000 kgs

approximate Concrete cum per

2.00 × .30 = .60
2.00 × .20 = .60
2 @ 1.20 = 2.40 × 6.0 = 14.40
4.95
Cross beam 2 - .30 × 1.50 × 5.5 = 4.95
1.40
Slab - .15 × 5.5 × 1.7 1.40
20.75 @ 2400 = 50.000 kg
misc 10.000
60.000 kg

Concrete say 22.0 cubic meters

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CALCULATIONS FOR

Preliminary Estimate of Cost for Minano - Bashi for Saitama - Ken

Weight of Pier. Shaft 12.80 × 7.00 × 6.5 = 127.5 cubic metres

Base 5.00 × 9.00 × 2.00 = 90.0

217.5 cubic metres @ 2400 kgs = 522.000 kgs

Total weight of Superstructure on pier. 19.300 × 34.0 = 656.000

60.000

716.000 kgs.

Total load on base — Dead 522.000

1238.000 kgs

Live Load Thrust. say 70.000

50% 35.000

105.000

Live Load say $\frac{2750 \times 34.0}{2} = \frac{93500}{2}$ kg say $\frac{100.000}{2}$

Total load 1238.000 + 50.000 = 1288.000

moment at base due to live load-thrust.

100.000 × 9.5 = 950.000 kgm.

Eccentricity $\frac{950.000}{1288.000} = .736$ say .75

$\frac{36}{450}$

Max intensity for 4.50 × 9.00 base.

$\frac{1288.000 \times 2}{4.50 \times 9.00 \times -} = 63,700$ kg per sq metre.

400,000 / 50

Assumed base 5.00 × 9.00 OK

166 kgs/cm² (25)

25 × 4.91 = 123.0 cm²

2

246

60 × 420 × 200

246 × 2 = say 500 kgs

wh = 500 × .785 = 400 kg

(36) 400 × 40.0 = 16.000

3

48

Estimate of Cost.

1 Deck construction - Total Concrete - 3,135 × 110 = 345.0 cubic metres.

Reinforcement. 1.3% 45 @ 7850 = 354 tons.

2 Arch Rings. 3@ 4.5 × 34.0 = 460.0 cubic metres

Reinforcement 48.0 tons

3 On pier and abutment say 4@18 cubic metres = 72.0 cubic metres

Reinf 0.5% .36 @ 7850 = 2.8 tons say 3.0 tons

4 Shaft of pier and base. 2 @ 217.5 = 435.0 cubic metres

Reinforcement say 10.0 tons.

5 Abutment Body. 2 @ 80.0 = 160.0 cubic metres

Reinf. 1.0 ton

	Total Concrete	Total Reinf.
1	345.0	35.4
2	460.0	48.0
3	72.0	3.0
4	435.0	10.0
5	160.0	1.0
	1472.0	99.4

1472 @ 13 = 19.000

100 tons 120 = 12.000

31.000

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CALCULATIONS FOR

Preliminary Estimate of Case Minami Bashi for Saitama Ken

	110 × 6.0 × 3 = 2000 sq. @ 2㎡	4㎜ 7㎜ 11㎜		11㎜
	110 × 55 = 605 @ 2㎡	= 1510 –		1510
	HR. 12㎡ – 220	2640 –		2640
				420
				1㎜
				16570
	Pier. 9.0 × 2(3+9)	= 216.0 – 2㎡ =	432.0㎥	31㎜
				47570
	Excavation	2@5m =	10㎜ =	8㎜
				55578

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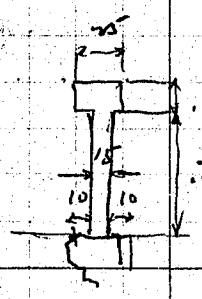
CALCULATIONS FOR

Preliminary design of Hiranuma-Bashi for Saitama-Ken

Concrete slab - Pavement — 15 cm thick -
5 cm Granolithic Pavement
5 cm × 5.5 = .275 @ 2200 = 605 kg per lin. metre

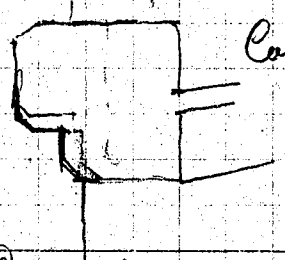
Handrail.



volume. .15 × .70 = .105
.15 × .75 = .038
.143
"more say 7
.150 @ 2400 = 360 kg per lin. metre.

for both sides - 2@360 = 720 kg per lin. metre.

Concrete slab and Copings
Concrete slab .15 × 5.5 = .825



Coping .25 × .30 = .0875
.10 × .25 = .025
2@.1125 = .225
1.050 @ 2400 = 2520 kg per lin. metre

Cross beam and Cantilever Bracket.

30 cm wide full length .30 × .32 × .400 = .407
Cantilever Bracket 2 - .30 × .32 × .95 = .182
.589 @ 2400 = 1414 kg
1.5 .75/2 filler .30 × .20/2 × 4 × .30 .024
.613 @ 2400 = 1470 kg

2 - 20 cm wide — 1470 × 4/3 = 1960 kg

Cantilever Bracket and Anchorage.
Anchorage under slabs only.
2 - .30 × .32 × 1.80 = .345 @ 2400 = 830 kg.

longitudinal wall.

at 8	say	2 - .20 × .55	× 2.00	= .28	@ 2400	= 670 kg
at 7		2 - .20 × .50	× 2.00	= .40		= 960 "
at 6		2 - .20 × .80	× 2.00	= .64		= 1540 "
at 5		2 - .20 × 1.00	× 0.80	= .32		= 770 "
				1.64		

longitudinal beam (Standard section).
2 - .20 × .32 × 1.70 = .218
filler say .32
.250 @ 240 = 600 kg for one panel.

Column load
Cross section.
.30 × .90 = .27
2 - .70 × .30 = .42
2 - (.015 + 0.020) = .07
.76

Panel -	4	.76 ×	1.40	= 1.06	@ 2400	= 2540
	3	.76 ×	2.10	= 1.60		= 3840
	2	" ×	3.00	= 2.28		= 5470
	1	" ×	4.10	= 3.12		= 7500
Panel	5	4/3 × .76 ×	.90	= .91	@ 2400	= 2180
Panel	6	.30 × .50 ×	3.80	= .54		
				9.51		

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CALCULATIONS FOR

Preliminary Design of Miyano-Bashi for Saitama-Ken

B

On pier...

pavement 605 kg per lin. meter

Handrail post. .20 × .30 × .85 = .054 2@.054 = .108
Handrail above coping .100 × .50 × 1.40 = .70 2@.70 = 1.400
1.656 @ 2400 = 3970 kgs.

slab and coping. 1.050 × 0.80 = .840 cubic meters
Cross beam under slab. .613 " "
Longitudinal beam .250/2 .125
Column proper .76 × 5.30 4.030
5.083 @ 2400 = 12.200 kgs.
2@ 12.200 = 24400 kgs.

Between column

4.00
3.60

Slab. .15 × 3.60 × 1.40 = .755 cubic-meter
Cross beam under slab.
2 - .30 × .33 × 3.60 = .712

Concrete under coping & Cantilever

under pavement	2 -	.50 × 1.40 × 1.45	= 2.030
coping -	2 -	.20 × 1.40 × 0.50	= .280
fillet	2 -	.30×.30/2 × 1.40	= .126
Colm.		5.60	
section	1.40 × .70	= .98	
	.60 × 1.70	= 1.02	
	2.00 × 5.60	= 11.200	
	15.103 @ 2400	= 36300 kgs.	

6.50
3.60
2.90

approximate concrete in one span

Slab and coping.	1.050 × 33.70	= 35.40
Cross beam and Cantilever brackets.		
	8 × .613 =	4.900
" "	2 @ .816 =	1.632
	2 @ .613 =	1.226
	6 @ .345 =	2.070
	9.828	9.83

34.0
.3
33.7 meter

Longitudinal beams & walls.

10 @ .25 =	2.50	
2 @ 1.64 =	3.28	
	5.78	

Columns

1-4-5-6	2 × 9.51 =	19.02
		70.03 cubic meters for one span

12 spans per lin. meter

Arch ring -

8	.62 × 4.30 × 2.0	=	5.33
7	.65 ×	=	5.60
6	.70	=	6.02
5	.75	=	6.45
4	.85	=	7.30
3	.95	=	8.16
2	1.10	=	9.46
1	1.30	=	11.20
0	1.55 × 4.30 × 1.0	=	6.66
			66.18 cubic meters

100.
40
170 @ = 5. cubic
3kg

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C

CALCULATIONS FOR

Preliminary Design of Minamo-Bashi for Saitama-Ken.

Concrete on pier.

Columns on both ends. 2 @ 5.083 = 10.16
between cols. 15.10
25.26 Cubic meters

Concrete in pier shape

3 × 4.30 = 12.90
3¢ 7.06
19.96 × 7.80 = 156.0 Cubic meters

Base. 2 × 5 · 9 − 90.0 Cubic meters
246

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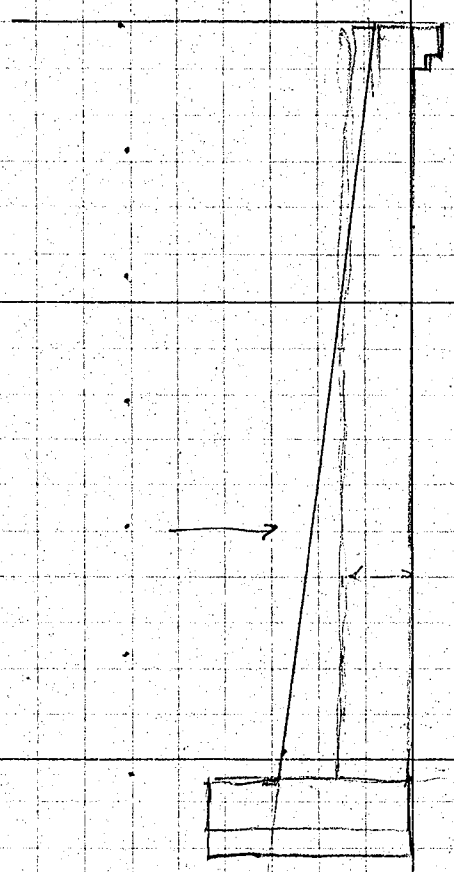
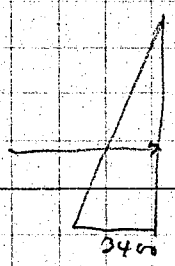
CALCULATIONS FOR

Design of abutment
sidewall... 6.0 metre high.





Earth pressure $\frac{1908}{3} = 567$ 1
1134 2
1700 3
2270 4
2836 5
3402 6

$\frac{340 \times 6.0 = 1020.0}{2}$

Moment = $10200 \times 2 = 20400$ kgm.

$d = \sqrt{\frac{2040000}{100 \times 7.13}} = 13.$

2860

$\frac{1}{10} \times \frac{3400}{3.6} \times 6^2 = 12,200$

$\sqrt{\frac{12,200 \times 100}{100 \times 7.13}} = \sqrt{171.0} = 41.$ cm

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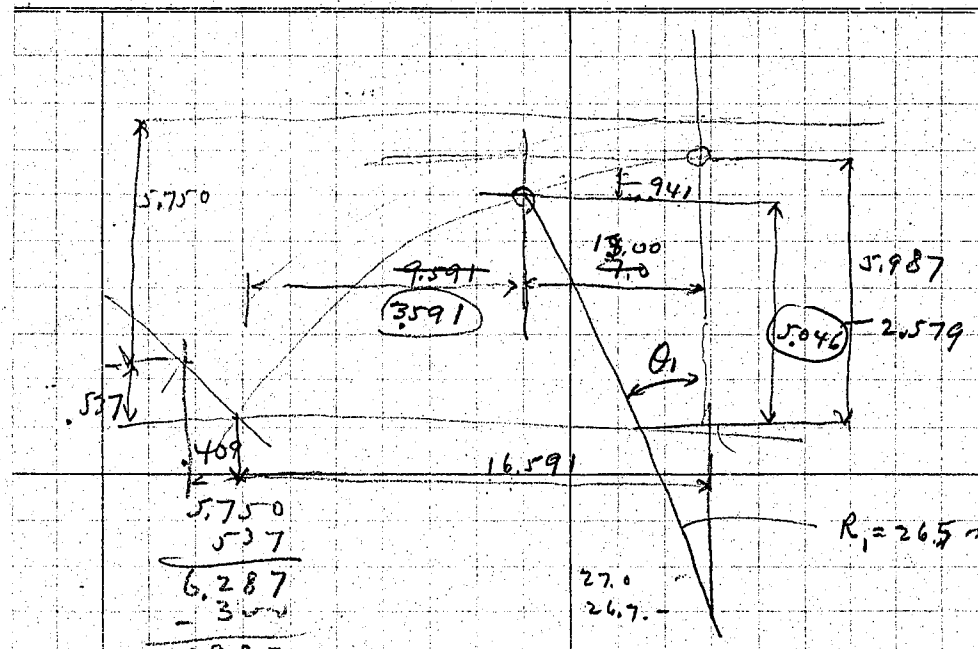
CALCULATIONS FOR



5.987
3.408
2.579

5.987
.941
5.046

$$\sin\theta_1 = \frac{13.00}{26.50} = \frac{7.0}{26.50}$$

$$y = 26.50 - \sqrt{26.50^2 - 7.0^2}$$

13.00
13
39
169

702.25
169.00
533.25

702.25
49
6525

712.84
49
663.89 — 2.822 0961
1.411 0480 — 26.700 / 25.766 / .934

2.726 9309
1.363 4654 — 26.500 / 23092 / 3.408

2.815 0795
1.407 5397 — 26.500 / 25.559 / .941

0.845 0980
1.422 4559
9.421 8521 — 15° 18' 58.5"

$$\phi = \tan^{-1}\frac{H-y}{A-x} = \frac{5.046}{9.591} = 0.702\,9472$$

.981 8639
9.721 0833 — 27° 44' 59"
7827
3006

sin. .667 7863
2360
9.668 0223

$$\frac{\theta_2}{2} = \phi - \theta_1 = 27°44'59" - 15°18'58.5"$$

12° 26' 00.5"

sin. 9.333 0511
48
9.333 0559

(48)

$$C = \frac{5.046}{\sin\phi} = \frac{0.7029472}{9.6680223} = 1.0349249$$

1.0349249
30100
0.7338949

10.837

$$K_2 = \frac{C/2}{\sin\frac{\theta_2}{2}} = \frac{0.7338949}{9.3330559} = 0.4008390$$

— C 25.167

$$\theta_1 = \sin^{-1}\frac{13.00}{26.50} = 1.1139434 - 1.4232459$$

9.690 6975
5476
1499 2245 — 29° 22' 40"

$$\phi = \tan^{-1}\frac{2.579}{3.591} = 0.4114513 = 0.5552154$$

9.856 2359
8562042
317 266 — 35° 41' 07"

sin. 9.765 8957
205
9.765 9162

$$\frac{\theta_2}{2} = \phi - \theta = 35°41'07" - 29°22'40"$$

6° 18' 27"

sin. 9.040 3424
5150
9.040 8574

11428
5110

$$C = \frac{2.579}{\sin\phi} = \frac{0.4114513}{9.7659162} = 0.6455351$$

30100
0.9445051

4.4212

$$R_2 = \frac{C/2}{\sin\frac{\theta_2}{2}} = \frac{0.9445051}{9.0408574} = 1.3036477$$

— 20.121 m

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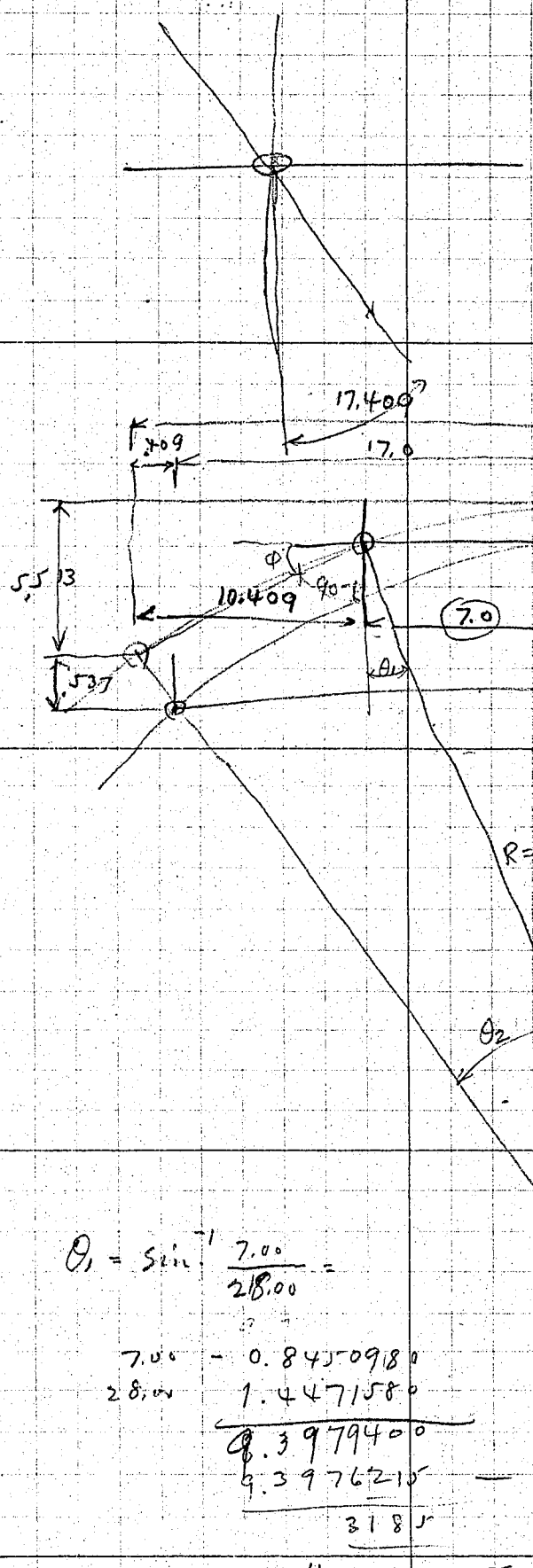
CALCULATIONS FOR



5.375
.30
6.005
.537
5.513

$R_1 = 28.00$ m $x = 7.0$ m.

$y = 28.00 - \sqrt{28.00^2 - 7.0^2}$

784.
49
.735 — 2.866873
1.433436
28
27.111
.889

$\theta_1 = \sin^{-1} \frac{7.00}{28.00} =$

7.00 — 0.845098 0
28.00 — 1.447158 0
9.397940 0
9.397621 5 — 14° - 28' - 39"
3185

$\phi = \tan^{-1} \frac{H-y}{A-x} = \frac{5.513 - .889}{17.40 - 7.0} = \frac{4.624}{10.40} =$

5.513
.889
4.624

0.6650178
1.0170333
9.6479845
6479028 — 23° - 58' - 14.5"
818
60
3480

$\frac{\theta_2}{2} = \phi - \theta_1$ — 23° - 58' - 14.5
14 - 28 - 39.0
9° - 29' - 35.5" — $\sin\frac{\theta_2}{2} = .21685360$

$\sin\phi$ 9.6088145
688
9.6088142
2840

7564 .2173016

$C = \frac{4.624}{\sin\phi} = \frac{0.6650178}{9.6088142}$
1.0562036
0561804
232

11.3816 — 1.0562036
0.3010300
.7551736
.2173016
.5378720 — 34.504 meters

$C = 11.382$

$R_2 = \frac{C}{\sin\frac{\theta_2}{2}} = \frac{0.5281018}{0.2173016}$
0.3108002

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CALCULATIONS FOR

Arch Ring

cr.	.60	× 0.50	× 4.30	=	1.29p	@ 2400 =	3100
8	.61	× 1.00		=	2.620	=	6300
7½	.61	× 1.00		=	2.620	=	6300
7	.61	× 1.50		=	3.94	=	9450
6	.625	× 2.00			5.38		12900
5	.655	× 2.00			5.64		13500
4	.72	× 2.00			6.20		14900
3	.82	× 2.00			7.05		16900
2	.97	× 2.00			8.35		20000
1	1.24	× 2.00			10.70		25700
0	1.58	× 1.00			6.80		16300
					60.59		145350 ✓

longitudinal wall.

5. — .20 × 1.05 × 1.00 =
0.84
0.63

6000 — cr
1260
18600 — 8
1260
31200 — 7½
1820
49400 — 7
23700
73100 — 6
26100
99200 — 5
26900
126100 — 4
30200
156300 — 3
34800
191100 — 2
42300
233400
31400
264800

Abutment.

approximate volume of Concrete -

Foot - 2 - 1.20 × .50 × 1.20 = 1.44 × 2 = 2.88

Handrail - 2@310 kg = 6cw.

Side wall	.50 × 4.80 × 6.0w	=	14.40
buttress	.60 × 1.0w × 6.0w	=	3.60
front wall	3.00 × .50 × 6.0w	=	9.00
fillet + c	1.20 × .20 × 8.00 = 2.90		2.90
	.30 × .20 / 2 × 6.00 = .27		.27
Rear pedestal	1.20 × .80 × 3.20	=	3.08
			67.70

~~32.68~~ 33.80 × 2 = ~~65.36~~ 67.60 cubic metres.

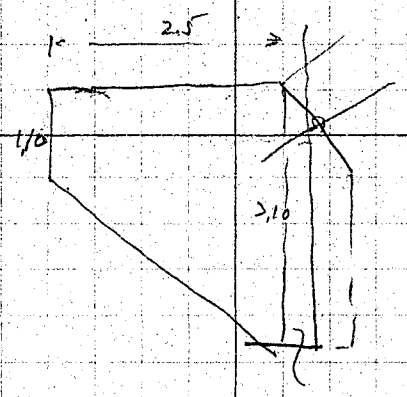
~~2.64~~

~~68.00~~ cubic metres

70.0w " "

slab -

Volume of abutment



3.10
1.10
4.20

3.10 × .25

2.10 × 2.5 × 6.0w = 31.5
3.10 × .25 × 6.0w = 4.9
36.40

.55 × 2.5 × 4.30 = 5.90
42.30
2.70
45.00 cubic metres

.45 × 6.0

approximate concrete.

Deck construction.

slab and coping - coping . 0.224
slab 0.825
1.049 × 34.30 = 36.000

Cantilever Brackets - 0.0775 × 32 = 2.58
0.103 × 4 = .41
2.99

longitudinal beam 0.118 × 20 = 2.36

longitudinal walls .400
.576
.282
.132
.108
.054
1.552 × 2 = 3.104

Cross beam .337 × 12 = 4.05
double ¾ .337 × 2 = .675
solid as T .465 × 2 = .930
1.548 — 1.485

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CALCULATIONS FOR

C2

Column.

9200
7120
5340
3820
2580
2100
585
30745
2
61490 ÷ 2400 = 25.60

Summary

36.00
2.99
2.36
3.11
5.48
25.60
75.54 cubic meters

Arch Ring. (6059 × 2 = 12120 / 3)

Concrete on pier cap 25.0

75.5 × 3 = 226.5
1800
500
4526

Deck construction. 75.5 × 3 = 226.5 @ 23.0 tons
Arch Rings 121.0 × 3 = 363.0 24.0 tons
On pier. - 2 = 25 × 2 = 50.0 5.0
Shaft and base of pier 165 × 2 = 330.0 12.0
abutments. 2 × 45 = 90.0 3.0
abutments. 2@80 = 160.0 12.0
1.
1219.5 @ 120 = 14700

480 × 9
34
780
85
165.

Reinforcing Bars 79 @ 120 = 9500

forms 1100
pavements 605 @ 4 2420
Handrails. 220 @ 12 2640

6.×2

Excavation. 1000
Copper for Piers 600
Electric wiring. 1200
Misc. 200
4960
20" × 220 440
5400

4 days

79

Reinf in arch ring see page D(3) 8-10-11

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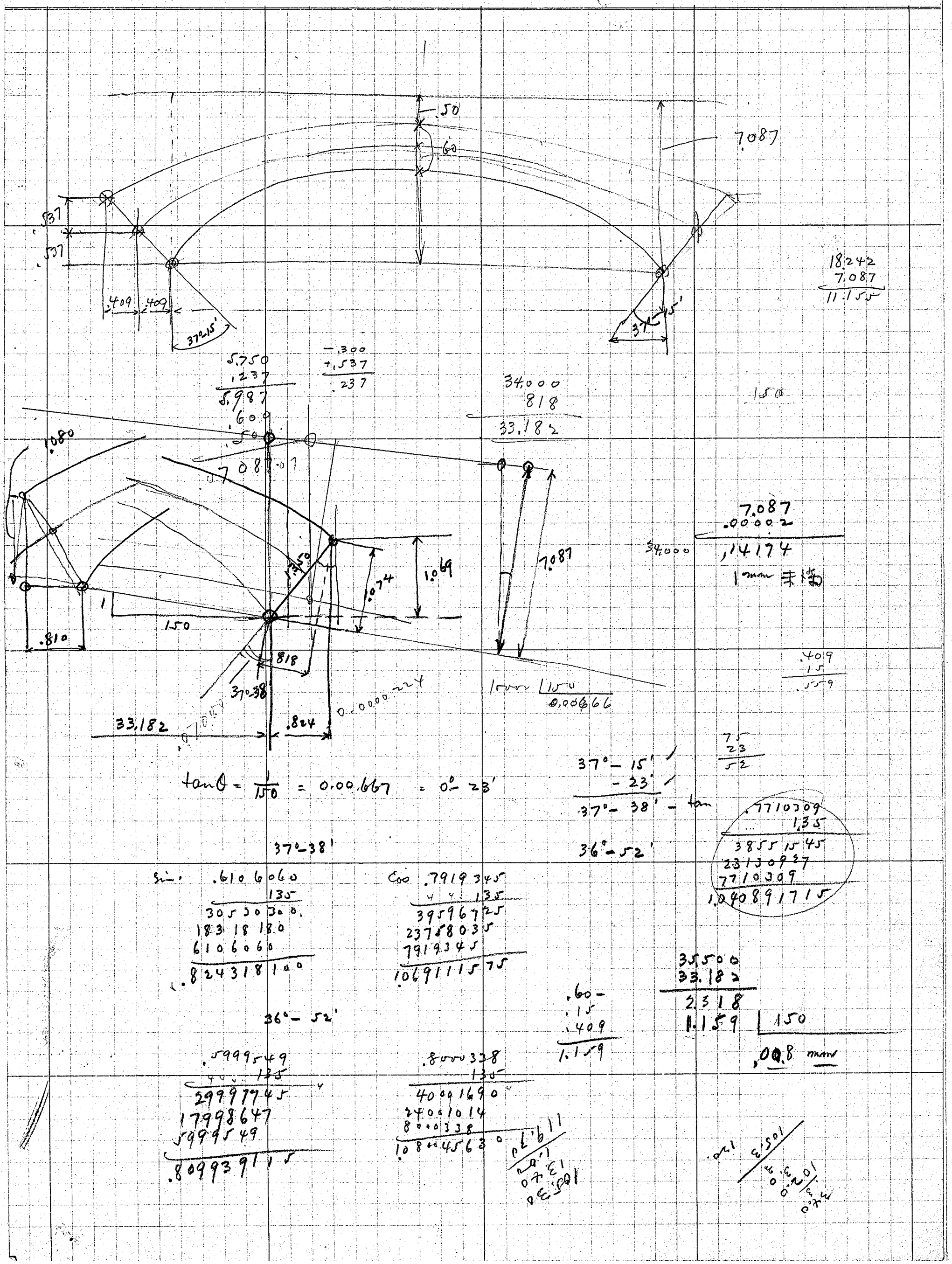
CALCULATIONS FOR



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CALCULATIONS FOR 村料表

Estimate of Cost Minano - Badai for Saitama-Ken

Pier -

volume of Concrete in pier.

shaft

Top section	2.32 φ	4.15	+	2.32 × 4.30	= 14.12
Bottom section	2.90	6.60	+	2.90 × 4.30	= 19.07
					33.19
					16.60 sq. m average

2.32 + 58 = 2.90

9.97 + 4.10 = 14.1

12.47 + 6.60 = 19.07

vol = 16.60 × 5.827 = 96.80

Base (Top)

3.5φ − 9.62 + 3.5 × 4.3 = 24.67

1.505 + 9.62

vol = 24.67 × 1.0 = 24.67

4.30 + 4.50 = 8.80

Base (Bottom) vol = 4.5 × 1.5 × 0.80 = 59.30

Top of pier △

2.32 + 1.50 = 3.82

1.91 × 1.0 × 4.30 = 8.20

Ornament − 1.80φ − 2.50 × .50 = 1.25

Total Concrete

Ornament	1.25
top of shaft	8.20
shaft	96.80
Base top	24.67
1.4 bottom	59.30
	190.22 cubic meters.
	15.80
	174.42 cubic meters.

For pier no 2 4.5 × 8.8 × 0.5 = (15.8)

average volume of Concrete

190.22
174.42
364.64
182.32 cubic meters

form of Concrete

dia.

2.32 + 2.90 = 5.22

2.61 − 8.20 / 8.60 / 16.80 × Say 6.80 = 114.0

5.80 + 1.00

Base, 3.5φ − 11.0 / 8.6 / 19.6 × 1.00 = 19.6

Base. (9.0 + 17.6) × 1.00 = 40.0

26.6

173.6 square meters

Reinforcing Bars.

In shaft	22φ	54 −	2.98	× 10.0 −	= 1610
hoops.	16φ	12 −	1.08	× 200	= 380
In base.	19φ	30	2.23	× 4.80	= 320
	19	7 −	"	× 9.00	= 140
	19	12	"	× 4.00	= 110
					2560 kgs.

Excavation of rock. .20 × 4.5 × 8.8 = 8.0 cubic meters

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CALCULATIONS FOR

D 2

Estimate of Cost Minami-Bashi for Saitama-Ken

Reinforcing Bars in part of arch rings

200		
106		
224		
106		
125		
871		
1200		
1071 × 2 =	2040	
	100	
	2140	
	Call this -	2500
		2500
	Total wt.	5000 —

Excavation for Piers

Pier no 1. $5.5 \times 10.0 \times 3 = 165$ cubic meters

Pier no 2 $5.5 \times 10.0 \times 1.7 = 94$ cubic meters.

259
130

Summary of Materials.

	Pier No 1	Pier no 2	average	
Concrete.	190.0	174.0	182.0	m^3
Reinforcing Bars			5.0	tons
forms			175.0	m^2
Excavation of rock			8.0	m^3
" " Sand + gravel			130.0	m^3

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CALCULATIONS FOR

Materials of Minami-Bashi for Saitama-Ken.

Abutment No. 1 (左岸第1橋台)

Concrete 1:2:4 mixture			118.82 cub. meters
forms			282.99 sq. meters.
reinforcements. plain bars.			
in abutment body		1.571	
in front wall		0.904	
in side walls	2@717.3 =	1.435	
in buttress frame and coping		0.488	
			4.398 kg-tons.
Excavation.			
Earth.	7.0 × 0.8 × 13.0	=	72.80 cub.m.
rock	6.0 × 0.50 × 10.0	=	30.00 "
Granite	0.4 × 0.3 × 5.5	=	0.66 "

Abutment no. 2. (大田井寄)

Concrete 1:2:4 mixture.			183.00 cub. meters
forms			490.50 sq. meters.
reinforcements. plain bars.			
in Abutment body		1.606	
in front wall		0.937	
in Side walls.	2@1310 =	2.620	
in buttress frame and coping		0.974	
			6.137 kg tons.
Excavation			
Earth	7.0 × 1.0 × 8.3 =		58.10 cub.m.
rock	6.0 × 0.5 × 7.3 =		21.90 "
Granite	0.40 × 0.30 × 5.5 =		0.66 "

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	混	枠
大田村	183.—	490.—
皆野町	119.—	283.—
	302.— 立方米	773.— 平方米

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CALCULATIONS FOR

Minano Baishi 村 for Saitama-ken.

皆野町.

Abutment [C] 太田村側

concrete

✓ (0.58)(2.75)(4.3) = 6.5
✓ (0.43)(1.45)(4.3) = 2.7
✓ (1.5)(0.3)(4.3) = 1.9
o (0.3)(4.8)(0.8)(2) = 2.3
o (0.3)(4.8)(0.9) = 1.3
(1.9)(0.3)(6.5) = 3.7
o/2 (1.2)(0.3)(8.4)(4.) = 12.1
o ~~(0.3)(1.2)(9.84)(2) = 11.8~~
(0.5)(9.18)(2.3)(2) = 21.2
(0.5)(9.48)(2.5)(2) = 23.7
(0.5)(9.78)(1.9)(2) = 18.6
o (0.55)(4.9)(5.72) = 15.4
✓ [(0.3)(1.9) + (0.3)(2.5)](4.9) = 6.5
✓ (0.9)(4.4)(4.9) = 19.4
✓ (2.2)(2.55)(4.9) = 27.5
(1.55)(2.1)(0.5)(2) = 3.2
× (1.)(0.6)(8.5)(2) = 10.2
× (1.)(0.6)(2.92)(3) = 5.2
× (0.3)(0.35)(15.) = 1.6
183.— cub.M.

form (M)

(4.3)(3.55) = 15.3
(0.56)(4.2)(2) = 4.7
(1.3)(0.3)(2) = 0.8
(4.1)(4.8) = 19.7
(6.3)(0.3)(2) = 3.8
(6.7)(9.18)(2) = 123.0
(1.74)(8.4) = 14.6
(1.2)(0.29)(4.) = 1.4
(1.55)(2.1) = 3.3
A (4.1)(5.7)(4) = 93.5
(0.5)(9.18)(2) = 9.2
(0.9)(4.9) = 4.4
(2.3)(9.18)(2) = 42.2
(4.3)(6.3)(2) = 54.2
(4.2)(2.1) = 8.8
(4.92)(6) = 29.6
(2)(8.5)(2) = 34.—
(3.2)(2.92)(3) = 28.—
490.5 squ.M.

× — frame & coping.
o — front wall.
✓ — abutment body.

[C] Abutment 皆野村側

Frame Concrete
(0.6)(0.7)(3.52)(2) = 2.95
(0.7)(0.6)(4.2)(2) = 3.52
coping
(0.3)(0.35)(4.3)(2) = 0.9
side wall
(0.15)(1.2)(3.2)(2) = 1.15
(0.5)(1.2)(3.2)(2) = 3.84
(0.5)(1.3)(4.8)(2) = 6.20
(0.5)(1.3)(5.8)(2) = 7.55
(0.5)(2.9)(6.8)(2) = 19.7
(0.5)(2.6)(2.) = 2.6
(0.5)(0.3)(2)(2) = 0.6
(0.15)(1.2)(8.8)(2) = 10.58
(0.5)(0.3)(1.2)(2) = 0.36
front wall
(0.544)(5.756)(4.92) = 15.4
(0.3)(0.7)(4.95)(2) = 2.08
(0.3)(0.9)(4.95) = 1.34

Abutment body.
(1.5)(0.6)(1/2)(4.3) = 1.94
(1.5)(0.55+0.3)(1/2)(4.3) = 2.74
(1.0)(2.9)(4.92) = 14.20
(2.08)(2.6)(1/2)(4.92) = 13.30
(2.08)(0.3)(4.92) = 3.07
(0.559)(2)(4.3) = 4.80
1182 cub.m.

[M] forms

side wall.
(1.2)(3.2)(4.) = 15.3
(1.3)(4.8)(4) = 25.0
(3.0)(5.8)(4) = 69.6
(1.2)(6.1+0.15)(2) = 15.0
body (0.5)(2.+1.+1)(2) = 4.0
✓ (1.)(2.6)(2) = 5.2
✓ (2.6)(2.08) = 5.42
✓ (0.3)(2.08)(2) = 1.25
s.w. (0.15+0.5)(2.2) = 2.08
s.w. (0.3)(1.2)(0.5) = 0.18

front wall
(0.56)(2.)(2) = 2.24
(4.3)(5.6) = 24.10
(0.8)(4.3) = 3.44
(1.3)(5.0)(2) = 13.00
(1.5)(5.0) = 7.50
(0.9)(5.9)(2) = 10.62
(1.0)(5.9)(2) = 11.80
(4.9)(6.) = 29.4
copi. & frame
(65)(4.3)(2) = 5.60
(2.6)(3.52) = 9.15
(2.1)(3.52) = 7.04
(1.4)(4.2)(2) = 11.75
(0.6)(2.3+1.3)(2) = 4.32
282.99 squ.M.

4.4
8.6
2
14.0

111 2.2 4.4 2.2 6.8 3.2

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CALCULATIONS FOR

Materials of Minano-Bashi for Saitama-Ken.

Forms for floor system and handrails for one span. 3 required.

Handrails	0.2 × 4 × 35.0	=	28.00
Coping and curb	2 × 0.85 × 35.0	=	59.40
floor slab	5.0 × 35.0	=	175.00
beams	2 × 1.0 × 35.0	=	70.00
cross beams	20 × 1.0 × 6.0	=	12.00
Spandrel wall at center	4 × 0.6 × 14.0	=	33.60
Spandrel columns.	12 × 6.8 × 2.5	=	204.00
3	6 × 6.8 × 0.5	=	20.40
on pier	1 × 14.0 × 6.0	=	84.00
Summary			686.40 sq. meter.
	for 3 spans @ 686.4 =		2059.2 "

Staging for arching one span
10.0 × 33 = 165. sq.m. @ (18.m.= 2970 ¤)
for 3 spans 3 @ 165 = 495. sq.m

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CALCULATIONS FOR

Estimate of Cost for Nisia-no-Bashi for Saitama-ken

D 3

approximate Concrete in arch span. per c,
One span.

~~20~~ .15 × 5.5 = .825
2 - .35 × .35 (245)
1.070 × 35.5 =
.20 × .27 =

17.5
2
35.0
5.0
40.0

main.	2×16 = 32 —	32ϕ	@	2.98	×	40.0	=	3800 -
main.	30 —	22ϕ	@		×	10.0	=	900 -
transverse	136 —	16ϕ	@	1.58	×	4.30	=	930 -
stirrups.								1700
								7330
								3
								2199.0 - 22 tons

Summary of Concrete

	Concrete	Reinf bars
Approx slab coping beam & cols. on pier.	70.0 × 3 = 210.0	23.0
	~~20.0~~ × 2 = ~~20.0~~	4.0
arch ring	60.0 × 3 = 180.0	22.0
	440.0 m³	49.0 tons
	1×7	16.3

Reinforcing bars. — 49.0 tons