昭和九年六月

埼玉縣
秩父町

# 佐久良橋應力計算書

秩父町

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

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CALCULATIONS FOR

Design of Sakurano-Watashi Bridge for Chichibucho.

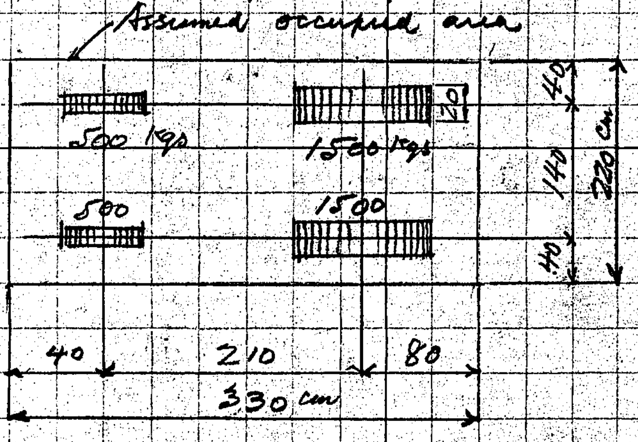
This bridge shall be built across Arakawa at Sakurano-Watashi between Chichibuchō and Beshō-mura. After investigation of general layout of the bridge site and economic design we decided to adopt reinforced concrete deck arch bridge and concrete girder approaches.
Clear roadway between handrails 3.0 meters; 3.5 cm granolithic pavement wooden handrails. Total length of concrete structure 176 meters out to out, consisting of 4 - 38.0 meter arch spans and 3 - 6.0 meter girder spans.

Assumed loadings

Uniform live load $w = \frac{100,000}{170+l} = 500$ kgs/m²

where $l$ = Span length in meters
$w$ = Uniform live load in kgs per sq. meter.

Motor truck load Total weight of motor truck assumed 4.0 tons and wheel concentration assumed as following sketch



One motor truck on the bridge; unoccupied spaces shall be filled around by the uniform live load

Impact for motor truck loading
Coef. $= \frac{20}{60+l}$ where $l$ = loaded length in meters
max impact 30%

No impact for Uniform live load.

Allowable Working strength
Reinforcing bars 1200 kgs/cm² for tension
900 " " shear

| | | |
|---|---|---|
| Concrete | 1:2:4 mixture | 1:2½:5 mixture |
| Direct compression | 35 kgs/cm² | 31.5 kgs/cm² |
| Fibre stress due to bending | 45 " | 40.5 " |
| Combined stress, direct and bending compression member and arch ring | 35 " | 31.5 " |
| Punching shear of Concrete | 9 " | 8.1 " |
| Shear of plain concrete | 4 " | 3.6 " |
| Bearing value | 45 " | 40.5 " |
| Bond stress plain bars | 6 " | 5.4 " |

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

Seismic acceleration 1000 mm/sec².
Range of temperature change ± 15°C Coefficient of expansion 0.000012
Modulus of elasticity of concrete 140.000 kgs/cm²
" " " " steel 2100.000 "

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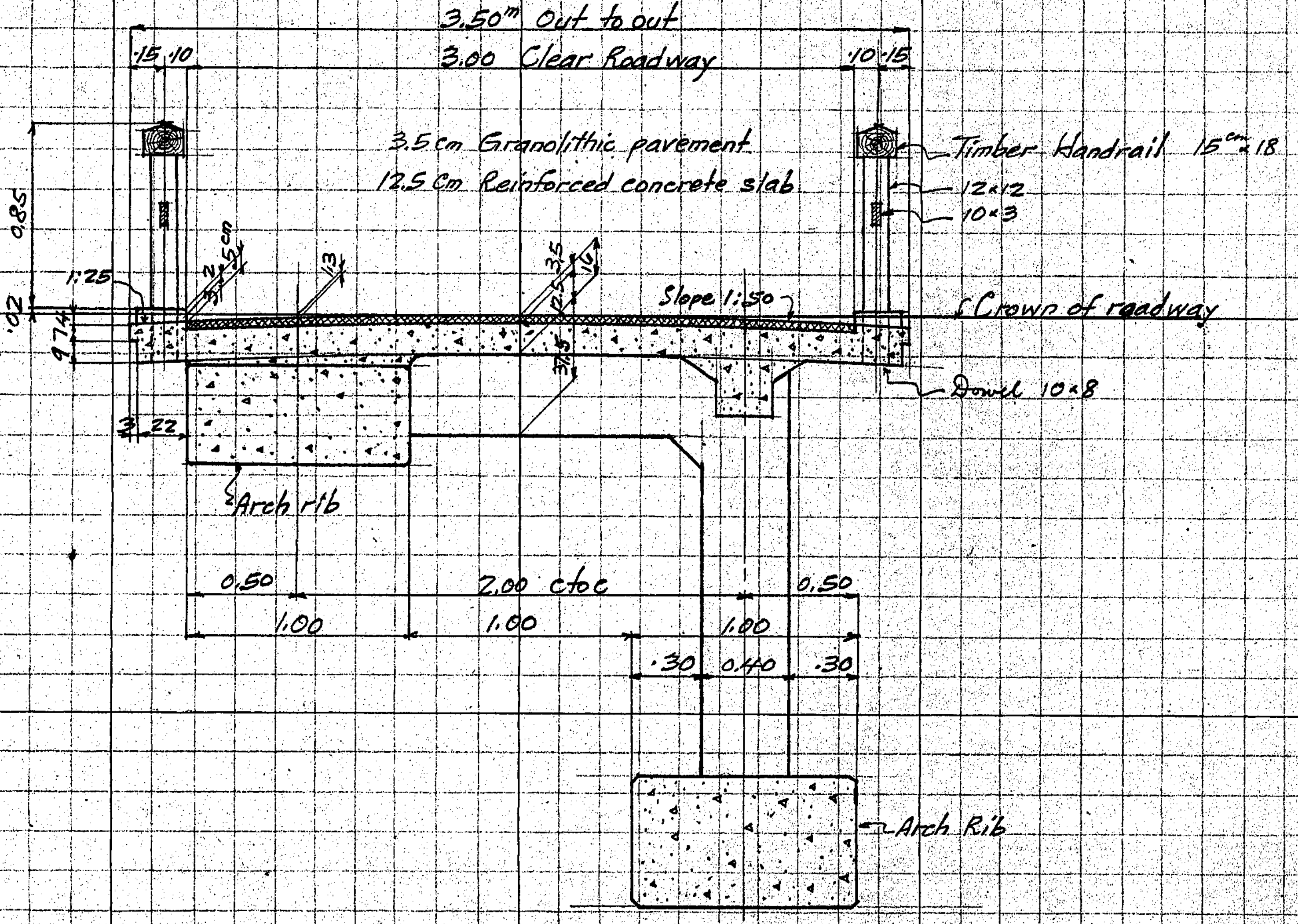
CALCULATIONS FOR

Design of Sakura-Bashi for Chichibu-cho

Cross section of Bridge floor. (Arch span).



Crown Section. Section at Intermediate Panel.
Scale 1:30.

Dimensions of arch ring assumed
Crown thickness 45 cm, Thickness ratio $= \frac{100}{45} = 2.22$
Springing " 100 ",
Span length on neutral axis 38.00 meters, Rise ratio $= \frac{7.50}{38.00} = \frac{1}{5.07} = 0.197$
Rise on neutral axis 7.50 ",
No. of panels 13 panel length = 2.923 meters.
width of arch ring 2 rings @ 1.00 = 2.00 meters throughout.

Design of Concrete slab for highway floor.
Span length 2.00 meters, overhanging arms on both sides.

Dead Load.

| | | | | | |
|---|---|---|---|---|---|
| Pavement | 3.5 cm | @ | 22 kg | = | 77 |
| floor slab | 12.5 " | @ | 24 " | = | 300 |
| miscellaneous say | | | | = | 13 |
| | | | | | 390 kg per square meter |

Weight of handrail.

| | | |
|---|---|---|
| Toprail | 0.18×0.15×1.461 @ 650 = | 25.6 |
| Post | 0.12×0.12×0.90 @ " = | 8.4 |
| 貫 | 0.10×0.03×1.461 @ " = | 2.8 |
| 根固メ | | 3.5 |
| | | 40.3 ÷ 1.461 = 27.6 kg per lin. meter. |

Call this 30 kg.

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

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CALCULATIONS FOR

Design of Sakura-Bashi for Chichibu-Cho

Dead Load moment and shear on overhanging arm.

Moment $= \frac{1}{2} \times 390 \times 0.75^2 = -110$
handrail $30 \times 0.60 = -18$
$-128$ kgm

Shear $= 390 \times 0.750 = 293$
handrail $30$
$323$ kg

Dead Load moment and shear for center span.

moment $= \frac{1}{8} \times 390 \times 2.00^2 = 195$
overhanging effect $= -128$
$67$ kgm

Shear $= \frac{1}{2} \times 390 \times 2.00 = 390$ kg

Live Load 4 ton motor truck rear wheel $= 1500$
30% impact $= 450$
$1950$ kg

Front wheel with impact say $\frac{1950}{3} = 650$ "
Uniform live load $w = 500$ kg per sq. meter.

Distribution of wheel concentration on slab.

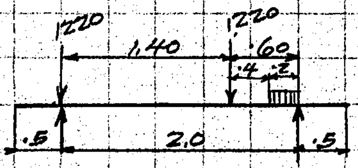
Longitudinal distribution on floor slab.
Contact between wheel + pavement $= 20$
distribution $2 @ 3.5 = 7$
$a = 27$ cm

Transverse distribution on slab.
width of wheel $20$
distribution $2 @ 3.5 = 7$
$b = 27$ cm

Effective width of slab against rear wheel load
$E = \frac{2}{3} \cdot l + a = \frac{2}{3} \times 2.0 + 0.27 = 1.60$ meters
Load per meter strip of slab.
$= 1950 \div 1.60 = 1{,}220$ kg

Live Load moment and shear for center span.

moment.

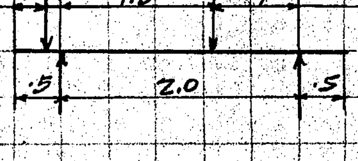


Reaction $= 1220 \times \frac{1.40}{2.00} = 834$ kg
$0.20 \times 500 \times \frac{1.9}{2.0} = 95$
$949$ kg

moment $= 949 \times 0.60 = 569$
$0.20 \times 500 \times 0.50 = -50$
$519$ kgm

Shear $0.20 \times 500 \times \frac{0.10}{2.00} = 5$
$1220 \times \frac{0.160}{2.00} = 366$
$1220$
$1{,}591$ kg

Live Load moment and shear on overhanging arm.



Concentration assumed to be carried by slab of 1.0 meter wide.
moment $= 1950 \times 0.1 = -195$ kgm
Shear $= 1950$ kg

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CONSULTING ENGINEER
SHOWA ~~JIJI~~ BLDG, TOKYO

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CALCULATIONS FOR

Design of Sakura-Bashi for Chichibu Cho

Summary of moments and shears on slab.

| | Center span | | Overhanging arm. | |
|---|---|---|---|---|
| | moment | shear | moment | shear |
| Dead Load | 67 | 390 | -128 | 323 |
| Live Load | 519 | 1591 | -195 | 1950 |
| | 586 kgm | 1981 kg | -323 kgm | 2273 kg |

Effective depth required for $f_s = 1200 \text{ kg/cm}^2$, $f_c = 40.5 \text{ kg/cm}^2$ for 1:2.5:5 concrete

$$d = \sqrt{\frac{M}{bR}} \quad \text{where } R = 6.04$$

$$d = \sqrt{\frac{586 \times 100}{100 \times 6.04}} = 9.85 \text{ cm}$$

Use 10.0 cm effective depth with an insulation of 2.5 cm at bottom or 12.5 cm over all.

Steel area required for moment

$$A_s = \frac{M}{f_s j d} = \frac{586 \times 100}{1200 \times 7/8 \times 10} = 5.58 \text{ cm}^2 \text{ per meter strip.}$$

use $12^{mm\phi}$ bars at 20 cm ctoc = $5.66 \text{ cm}^2$.
Bent up rod in every other row.

unit shear.

$$\text{for center span } v = \frac{V}{bjd} = \frac{1981}{100 \times 7/8 \times 10} = 2.26 \text{ kg per sq. cm.} < 4.0$$

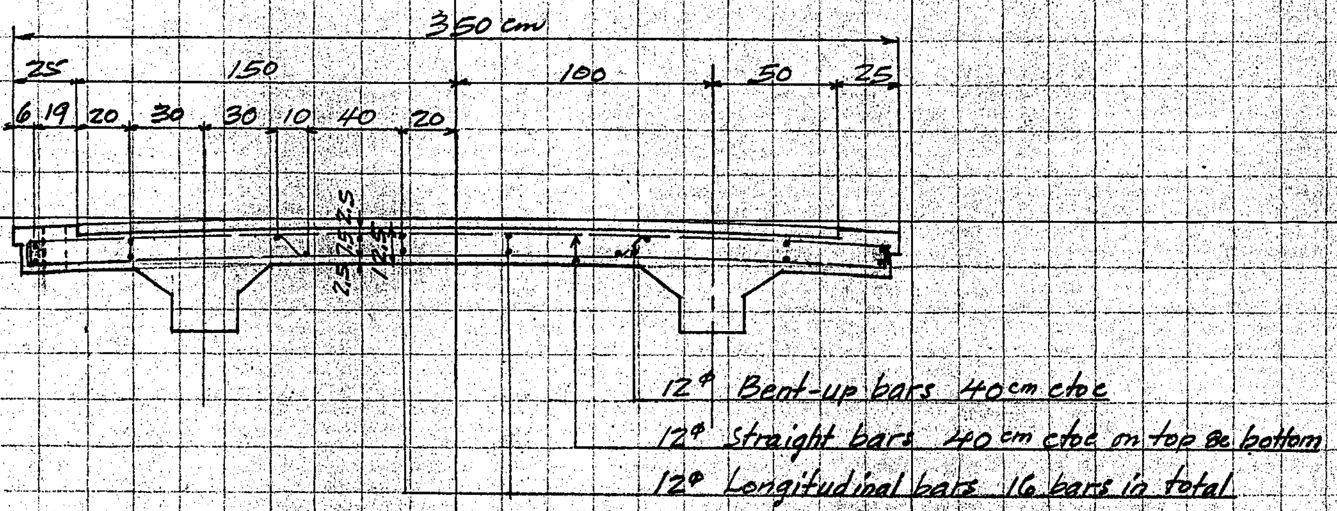
$$\text{for overhanging arm } v = \text{''} = \frac{2273}{100 \times 7/8 \times 10} = 2.60 \quad \text{''} \quad \text{''} \quad < 4.0$$

Temperature bars (longitudinal)
Cross sectional area of slab.

$$\begin{array}{rr} 300 \times 12.5 = & 3750 \\ 25 \times 16 \times 2 = & 800 \\ \hline & 4550 \text{ cm}^2 \end{array}$$

$$3/1000 \times 4550 = 13.65 \text{ cm}^2$$

use more than 12 - $12^{mm\phi}$ bars



$12^{\phi}$ Bent-up bars $40^{cm}$ ctoc
$12^{\phi}$ Straight bars $40^{cm}$ ctoc on top & bottom
$12^{\phi}$ Longitudinal bars 16 bars in total

Arrangement of slab reinforcements.

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

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CALCULATIONS FOR

# Design of Sakura Bashi for Chichibu-Cho

## Design of Longitudinal Beam.

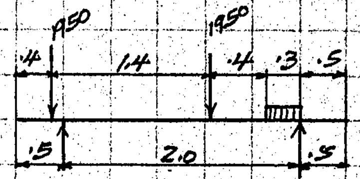
span length = 2.92 meters, spacing 2.00 meters c to c.

### Dead Load.

Floor and pavement 1.75 @ 390 = 682
handrail 30
Stem of beam $0.275 \times 0.25$ @ 2400 = 165
fillets $0.15 \times 0.10$ @ 〃 = 36
miscellaneous say 17
930 kg per lin meter.

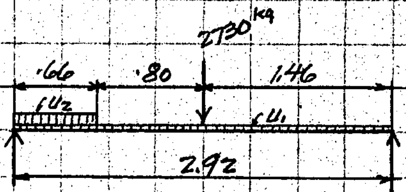
Dead Load moment $= 1/10 \times 930 \times 2.92^2 = 793$ kgm
Dead Load shear $= 1/2 \times 930 \times 2.92 = 1{,}360$ kg

### Live Load.



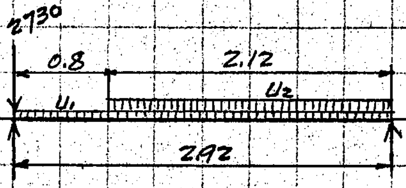
max. wheel concentration on beam.
rear wheel $1950 \times 2.1 \div 2.0 = 2048$
〃 $1950 \times 0.7 \div 2.0 = 682$ } 2,730 kg
unif. load $500 \times 0.3 \times 0.15 \div 2.0 = u_1 \doteqdot 10$ kg per lin m. on side of truck

unif. load $\frac{500 \times 2.5^2}{2 \times 2.0} = 780$ 〃 〃 on front + rear of truck.
$-10$
$u_2 = 770$



moment
unif. load $u_2$ $770 \times 0.66 \times 0.33 \div 2.92 = 57$
rear wheel $2730 \div 2 = 1365$
$1{,}422 \times 1.46 = 2075$
unif. load $u_1$ $1/8 \times 10 \times 2.92^2 = 11$
2076

for continuity of beam, moment will be taken as
$m = 2076 \times 8/10 = 1{,}660$ kgm.



Shear.
unif. load $u_2$ $770 \times 2.12 \times 1.06 \div 292 = 592$
〃 〃 $u_1$ $10 \times 2.92 \div 2 = 15$
rear wheel 2730
3337 kg.

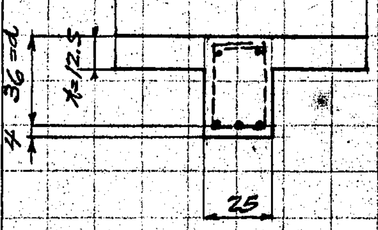
Summary of moments and shears.

| | moment | shear |
|---|---|---|
| Dead Load | 793 | 1360 |
| Live Load | 1660 | 3337 |
| | 2453 kgm | 4697 kg |

Approx. steel area required
$= \frac{2453 \times 100}{1200 \times \frac{7}{8} \times 36} = 6.5 \text{ cm}^2$

Try 3-19φ = 8.50 cm²

Steel ratio $p = \frac{8.50}{100 \times 36} = 0.0024$



ratio $t/d = 12.5/36 = 0.347$
neutral axis in flange
$k = 0.231$, $j = 0.923$

steel stress $f_s = \frac{2453 \times 100}{8.50 \times 0.923 \times 36} = 870$ kg/cm² < 1200 ✓

Concrete stress $f_c = \frac{870 \times 0.231}{15(1-0.231)} = 17.4$ 〃 < 40.5

Shear stress $v = \frac{4697}{25 \times 0.923 \times 36} = 5.65$ 〃 Use stirrups.

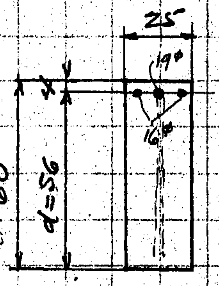
Stirrup spacing. for 9mmφ U-stirrup $A_s = 2 @ .636 = 1.27$ cm²

spacing at support $= \frac{3}{2} \frac{A_s f_s j d}{V} = \frac{3 \times 1.27 \times 1200 \times .923 \times 36}{2 \times 4697} = 16.2$ cm

Use 15 cm spacing near support.
50 cm about near center of span.

# Design of Sakura-Bashi for Chichibu-Cho

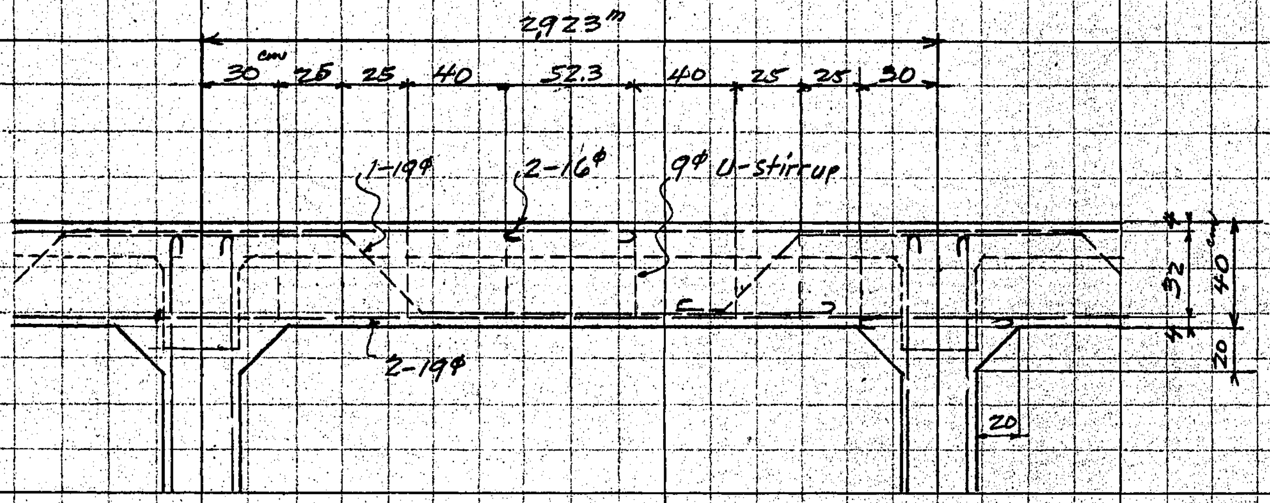
At the end of span, negative moment assumed as −2453 kgm, eff. depth as 56 cm.



$$\text{Eff. depth required} = \sqrt{\frac{2453\times100}{25\times6.04}} = 40.3 \text{ cm}$$

$$\text{steel area required} = \frac{2453\times100}{1200\times7/8\times56} = 4.17 \text{ cm}^2$$

Use 2-16φ bars = 4.02
bent-up. 1-19φ " = 2.84
6.86 cm²



Typical detail of Longitudinal Beam. Scale 1:30

Design of Cross Beam and Spandrel Columns.

Dead Load.

Dead Load on cross beam assumed.

$w' = w\left(\frac{l_1}{l_2} - 0.5\right)$ where $l_1$ = Shorter span length of slab = 2.00

$l_2$ = longer " " " = 2.92

$= 390\left(\frac{2.00}{2.92} - 0.5\right)$ $w$ = weight of floor slab + pavement = 390 kg/m²

$= 390 \times 0.185 = 72$ kg/m²

Load on cross beam

floor slab + pavement 72 × 2.92 = 210
web of beam .30 × .375 @ 2400 = 270
480 kg/lin.m.

D.L. on column

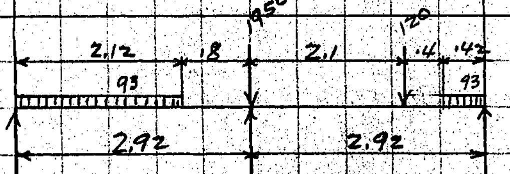
480 × 3.5 ÷ 2 = 840
col. wt. .3 × .4 × 4.5 @ 2400 = 1300
2140 kg

Dead Load moment 1/12 × 480 × 2.00² = ± 160 kgm
Dead Load shear 1/2 × 480 × 2.0 = 480 kg

Live Load.

Rear wheel concentration with impact = 1950 kg
front " " " " = 650 "
uniform live load 500 kg/m²
Load for cross beam assumed as
rear wheel concentration = 1950 kg
front " " 650 × 0.185 = 120 "
unif. load 500 × 0.185 = 93 kg/m²
Max. load on cross beam.

Concentration 120 × 0.82 ÷ 2.92 = 34
1950
1984 kg



Unif. load 93 × 0.42 × 0.21 ÷ 2.92 = 3
93 × 2.12 × 1.06 ÷ 2.92 = 72
75 kg/m

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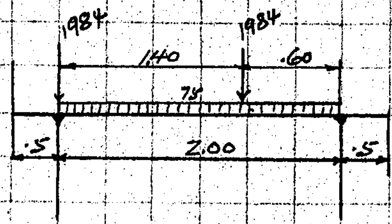
CALCULATIONS FOR

Design of Sakura-Bashi for Chichibu-Cho



Reaction $1984 \times 1.40 \div 2 =$ 1390 kg

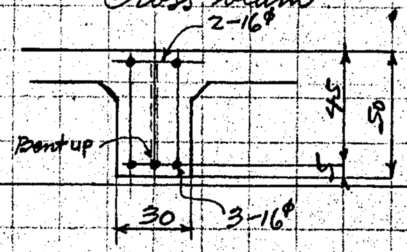
moment $1390 \times 0.6 =$ 834
$834 \times \frac{8}{12} =$ 556
$\frac{1}{12} \times 75 \times 2.0^2 =$ 25
± 581 kgm

Shear $1984 \times 0.6 \div 2.0 =$ 595
1984
2579 kg.

Summary of moments + shears.

| | Beam | | Column top | | Column bottom | |
|---|---|---|---|---|---|---|
| | moment | shear | moment | vert. load | moment | vert load |
| Dead Load | ± 160 | 480 | say ± 160 | 840 | say ∓ 80 | 2140 |
| Live Load | ± 581 | 2579 | say ± 581 | say 2579 | " ∓ 290 | 2579 |
| | ± 741 kgm | 3059 kg | ± 741 kgm | 3419 kg | ∓ 370 kgm | 4719 kg |

Cross beam.



Steel area required for cross beam. Eff. depth 50-5 = 45 cm.

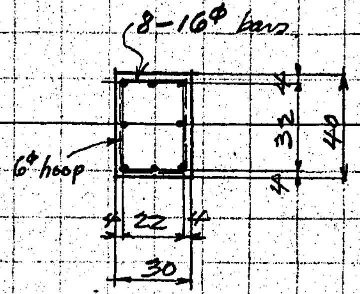
$A_s = \frac{741 \times 100}{1200 \times 7/8 \times 45} = 1.57$ cm²

Use 3-16$^\phi$ bars = 6.03 cm².

unit shear $= \frac{3059}{30 \times 7/8 \times 45} = 2.6$ kg/cm²

Use 9$^\phi$ U-stirrups. spacing 50 cm c to c about.

Spandrel column.



Top of column. $N = 3419$ kg, $m = 661$ kgm. $h = 40$ cm, $b = 30$ cm
try 3-16$^\phi$ bars on both sides

$A_s = 6 @ 2.01 = 12.06$ cm²  $z = \frac{661}{3419} = 0.193^m$ or 19.3 cm

$p_0 = 2p = \frac{12.06}{30 \times 40} = 0.010$  $z/h = 19.3/40 = 0.482$

$d'/h = 4/40 = 0.100$

$k = 0.528$, $L = 0.131$ (Tension over part of section)

$f_c = \frac{661 \times 100}{0.131 \times 30 \times 40^2} = 10.5$ kg/cm²

$f_s = 15 \times 10.5 \left( \frac{36}{.528 \times 40} - 1 \right) = 112$ kg/cm².

Bottom of column $N = 4719$ kg, $m = 330$ kgm.

$z = \frac{330 \times 100}{4719} = 7.0$ cm  $z/h = 7.0/40 = 0.175$

$p_0 = 0.010$, $d'/h = 0.100$, $h = 40$ cm, $b = 30$ cm. as before.

$k' = 1.64$ (whole section under compression)

$f_c = \frac{N k'}{b h} = \frac{4719 \times 1.64}{30 \times 40} = 6.5$ kg/cm²

$f_s \doteq 6.5 \times 15 = 98$ kg/cm². compression.

Use 6$^\phi$ hoops, spacing 30 cm at top + bottom, 50 cm max.

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

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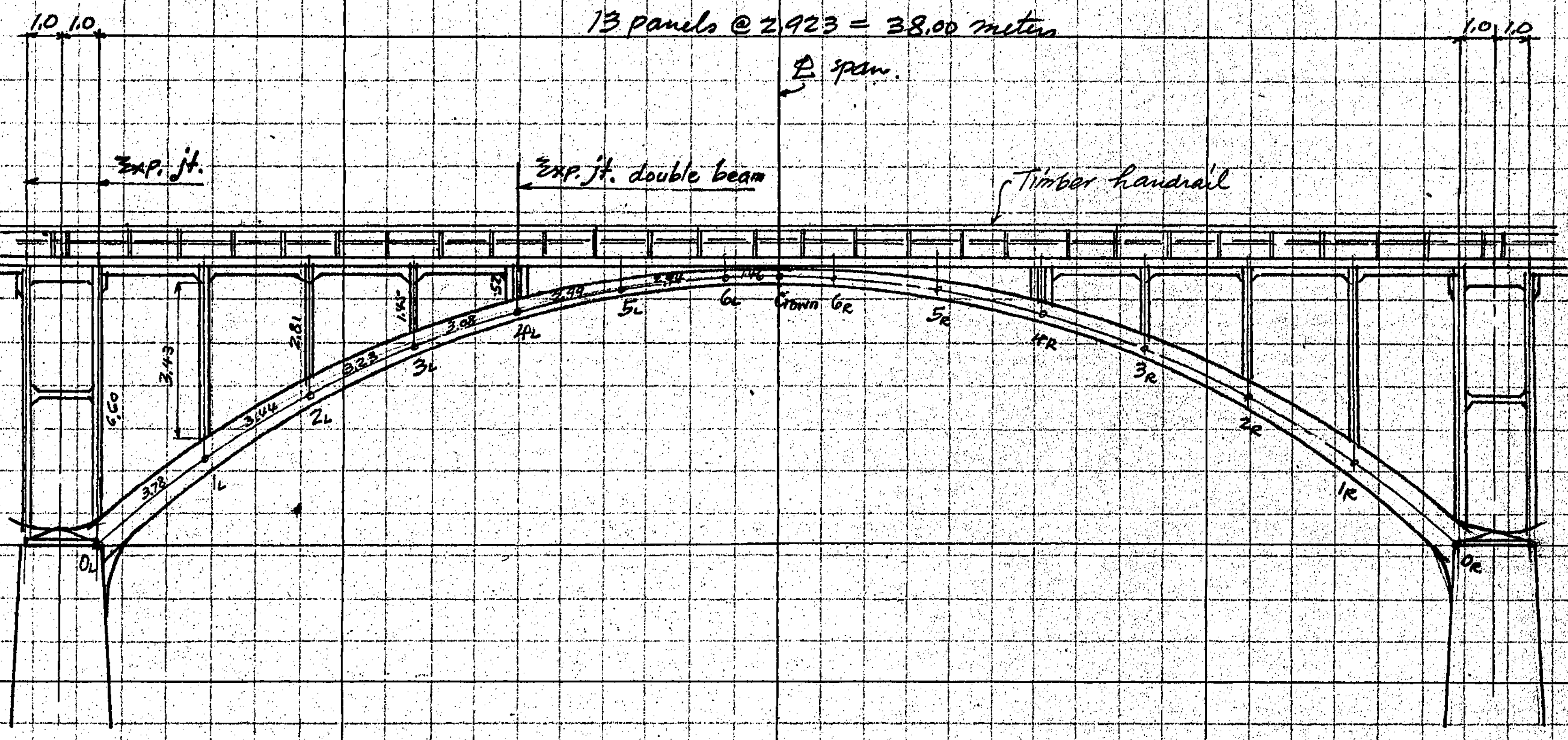
CALCULATIONS FOR

Design of Sakura-Bashi for Chichibu-Cho.

Dead Load of Deck construction on Arch ring.

Span length of Arch is divided into 13 panels @ 2.923 meters each.



Dead Load on one ring.

Deck construction.

Handrail = 30

Slab & pavement 1.75 @ 390 = 682

712 kg per lin meter.

panel load = 2.923 @ 712 = 2,080 kg.

Longitudinal beam

Stem 0.275×0.25 @ 2400 = 165

fillet 0.15×0.10 @ " = 36

miscellaneous say 19

220 kg per lin meter.

panel load 2.623 @ 220 = 580 kg. for panel pt. 1, 2, + 3
(2.923 − 0.30)

for panel point 4

Longitudinal beam say 580 ÷ 2 = 290

" wall .25 × .68 × 1.26 @ 2400 = 510

800 kg

for panel point 5 .25 × .43 × 1.26 @ 2400 = 325

fill. .20 × .70 × 1.31 @ " = 440

765 kg

for panel point 6. .07 × .70 × 2.20 @ 2400 = 260 kg

for Crown .04 × .70 × 1.46 @ " = 100 "

Cross beam. stem .30 × .375 × 2.40/2 @ 2400 = ~~325~~ "

325 × .5/.3 = 540 " for panel pt 4 only

Columns.

for panel point 1. .30 × .40 × 3.43 @ 2400 = 990 kg

" " 2 .30 × .40 × 2.81 @ " = 810 "

" " 3. .30 × .40 × 1.45 @ " = 420 "

" " 4 2 × .25 × .40 × .52 @ " = 250 "

"

" " 0. .30 × .50 × 6.60 @ 2400 = 2380

strut. .30 × .30 × 0.85 @ " = 180

2560 kg

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

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CALCULATIONS FOR

Design of Sakura-Bashi for Chichibu-Cho

Summary for Dead Load of deck construction on arch ring.

Panel point 0.

| | | | | |
|---|---|---|---|---|
| Deck | 2.462 @ 712 | = | 1,750 | |
| longitudinal beam | 580 ÷ 2 | = | 290 | |
| 〃 〃 | ·25 × ·50 × ·85 @ 2400 | = | 255 | |
| cross beam. | $325 \times \frac{\cdot 18}{\cdot 30}$ | = | 160 | |
| column | | = | 2,560 | |
| | ·15 × ·50 × ·40 @ 2400 | = | 70 | |
| | | | | 5,085 kg |

Panel point 1.

| | | |
|---|---|---|
| Deck | 2,080 | |
| longitudinal beam | 580 | |
| cross beam | 325 | |
| column | 990 | |
| | | 3,975 kg |

Panel point 2.

| | | |
|---|---|---|
| Deck | 2080 | |
| longitudinal beam | 580 | |
| cross beam | 325 | |
| column | 810 | |
| | | 3,795 kg |

Panel point 3.

| | | |
|---|---|---|
| Deck | 2080 | |
| longitudinal beam | 580 | |
| cross beam | 325 | |
| column | 420 | |
| | | 3,405 kg |

Panel point 4.

| | | |
|---|---|---|
| Deck | 2080 | |
| longitudinal beam | 800 | |
| cross beam | 540 | |
| column | 250 | |
| | | 3,670 kg |

Panel point 5.

| | | |
|---|---|---|
| Deck | 2,080 | |
| longitudinal beam with filling | 765 | |
| cross beam | 325 | |
| | | 3,170 kg |

Panel point 6.

| | | | | |
|---|---|---|---|---|
| Deck | 2.19 @ 712 | = | 1560 | |
| longitudinal beam with filling | | = | 260 | |
| Cross beam | 325 ÷ 1.2 | = | 270 | |
| | | | | 2090 kg |

Crown

| | | | | |
|---|---|---|---|---|
| Deck | 1.46 @ 712 | = | 1,040 | |
| longitudinal beam with filling | | = | 100 | |
| cross beam | | | 270 | |
| | | | | 1,410 kg |

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

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CALCULATIONS FOR

Design of Sakura-Bashi for Chichibu-Cho.

Approximate weight of Arch ring (one ring)

| Panel point | average thickness | | length | | width | | volume | | unit wt. | | total weight | Strut between rings |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.96 | × | 1.89 | × | 1.00 | = | 1.815 | @ | 2400 | = | 4,360 kg | |
| 1 | 0.85 | | 3.61 | | 〃 | | 3,070 | @ | 〃 | | 7,370 | |
| 2 | 0.70 | | 3.34 | | 〃 | | 2.338 | @ | 〃 | | 5,610 | + 140 = 5750 |
| 3 | 0.60 | | 3.16 | | 〃 | | 1.895 | @ | 〃 | | 4,550 | |
| 4 | 0.52 | | 3.04 | | 〃 | | 1.580 | @ | 〃 | | 3,790 | + 140 = 3,930 |
| 5 | 0.48 | | 2.97 | | 〃 | | 1.426 | @ | 〃 | | 3,420 | |
| 6 | 0.46 | | 2.20 | | 〃 | | 1.012 | @ | 〃 | | 2,430 | |
| Crown | 0.45 | | 1.46 | | 〃 | | 0.657 | @ | 〃 | | 1,580 | |
| Strut | .3×.4×0.50×2 | | | | | = | 0.120 | | | | | |
| | | | | | | | 13,913 cub.m. | | | | | |

Summary for Dead Load on arch ring.

| Panel point | 0 | 1 | 2 | 3 | 4 | 5 | 6 | crown |
|---|---|---|---|---|---|---|---|---|
| Deck | 5085 | 3975 | 3795 | 3405 | 3670 | 3170 | 2090 | 1410 |
| arch ring | 4360 | 7370 | 5750 | 4550 | 3930 | 3420 | 2430 | 1580 |
| Summary | 9,445 | 11,345 | 9,545 | 7,955 | 7,600 | 6,590 | 4,520 | 2,990 |
| Panel load in round no. | 9,400 kg | 11,300 | 9,500 | 8,000 | 7,600 | 6,600 | 4,500 | 3,000 kg |

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

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CALCULATIONS FOR

Design of Sakura-Bashi for Chichibu-Cho

Approximate Horizontal thrust and Vertical load on piers and abutments.

Dead Load

| panel point | load |  | arm |  | moment |
|---|---|---|---|---|---|
| 0 | 5100<br>4300 | × | 0.700 | = | 3,000 |
| 1 | 11,300 | × | 2.923 | = | 33,000 |
| 2 | 9,500 | × | 5.846 | = | 55,600 |
| 3 | 8,000 | × | 8.769 | = | 70,200 |
| 4 | 7,600 | × | 11.692 | = | 88,900 |
| 5 | 6,600 | × | 14.615 | = | 96,500 |
| 6 | 4,500 | × | 17.538 | = | 79,000 |
| crown | 1,500 | × | 19,000 | = | 28,500 |
| Vertical Reaction = 58,400 kg |  |  |  |  | 454,700 |

Horizontal thrust

$$H_D = \frac{454700}{7.50} = 60{,}600 \text{ kg}$$

for one ring

Live Load  Uniform live load say 500 × 1.5 = 750 kg per lin meter for one ring.

$$\text{Horizontal thrust } H_L = \frac{750 \times 19.0^2}{2 \times 7.5} = 18{,}100 \text{ kg}$$

$$\text{Vertical reaction} = 750 \times 19.0 = 14{,}300 \text{ kg}$$

Summary of superimposed loads.

On arch pier.

|  | Horizontal thrust | Vertical load. |
|---|---|---|
| Dead Load | $H_D$ = 60,600 | $V_D$ = 58,400 |
| Live Load | $H_L$ = 18,100 | $V_L$ = 14,300 |
|  | $H$ = 78,700 kg | $V$ = 72,700 kg |

On arch Abutment.

|  |  |  |  |  |  |
|---|---|---|---|---|---|
| Dead Load | arch | 60,600 |  | 58,400 |  |
|  | girder | — |  | 4300 |  |
|  |  |  | 60,600 |  | 62,700 |
| Live Load | arch | 18,100 |  | 14300 |  |
|  | girder | — |  | 4800 |  |
|  |  |  | 18100 |  | 19,100 |
|  |  | H = | 78,700 kg | V = | 81,800 kg |

Center of gravity of super structure

| arch ring.<br>panel point | load | vert. arm | moment | Deck. |
|---|---|---|---|---|
| 0 | 4,300 | 0.70 | 3,000 | 5100 |
| 1 | 7300 | 2.45 | 17,900 | 4000 |
| 2 | 5,700 | 4.25 | 24,200 | 3800 |
| 3 | 4,600 | 5.60 | 25,800 | 3400 |
| 4 | 3,900 | 6.55 | 25,500 | 3700 |
| 5 | 3400 | 7.15 | 24,300 | 3200 |
| 6 | 2400 | 7.45 | 17,900 | 2100 |
| Crown. | 800 | 7.50 | 6,000 | 700 |
|  | 32400 |  | 144,600 | 26,000 |
| Deck | 26,000 | say 7.00 | 182000 |  |
|  | 58,400 kg | 5.60 m | 326600 |  |

above springing

増田淳氏関係資料（独立行政法人 土木研究所蔵）

**JIUN MASUDA**
CONSULTING ENGINEER
~~[illegible]~~ BLDG, TOKYO
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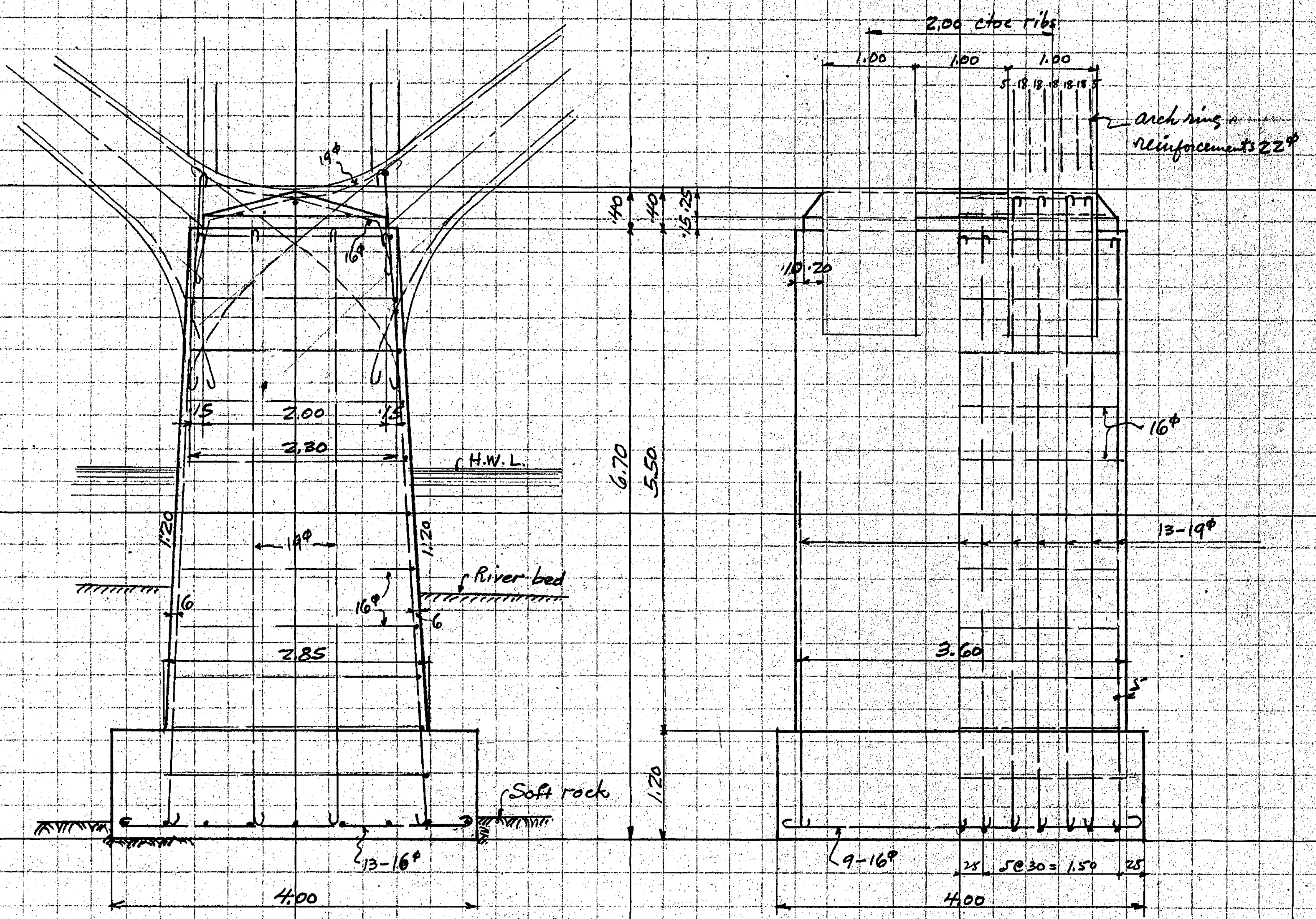
CALCULATIONS FOR

## Design of Sakura-Bashi for Shichiku-Cho

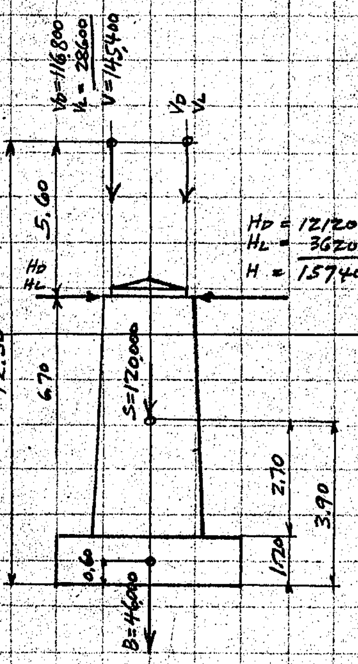
Design of Arch pier.
General dimensions as shown on sketch below.



Scale 1:60.

Approximate volume of concrete and weight of pier.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Top of shaft. | 1.00 × .25 × 3.27 | = | 0.82 | × | 5.73 | = | 4.70 |
| 〃 | 2.00 × .15 × 3.40 | = | 1.02 | × | 5.58 | = | 5.69 |
| Shaft. | 2.43 × 3.60 × 5.50 | = | 48.10 | × | 2.59 | = | 124.61 |
| | | | 49.94 m³ | | 2.70 m | | 135.00 |
| Base | 1.20 × 4.00 × 4.00 | = | 19.20 | | 0.60 m | | |
| | | | 69.14 m³ | | | | |



weight of shaft. S = 49.94 @ 2400 = 120,000 kg
〃 〃 base B = 19.20 @ 〃 = 46,000 〃

Superimposed loads on pier

| | Horizontal thrust | | Vertical load. | |
|---|---|---|---|---|
| Dead Load | 2@60600 = | 121,200 = $H_D$ | 2@ 58400 = | 116,800 = $V_D$ |
| Live Load | 2@ 18100 = | 36,200 = $H_L$ | 2@ 14300 = | 28600 = $V_L$ |
| | | 157400 kg = H | | 145400 kg = V |

(13)

**JIUN MASUDA**
CONSULTING ENGINEER
BLDG, TOKYO
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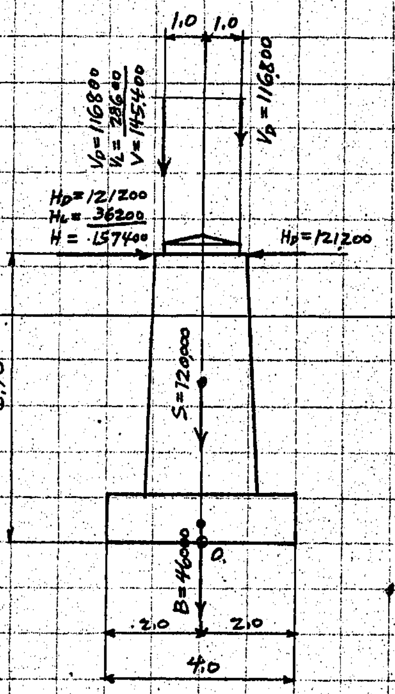
CALCULATIONS FOR

# Design of Sakura-Bashi for Chichibu-Cho.

## Stability of Pier at normal state.



Taking moment about center of base 0.

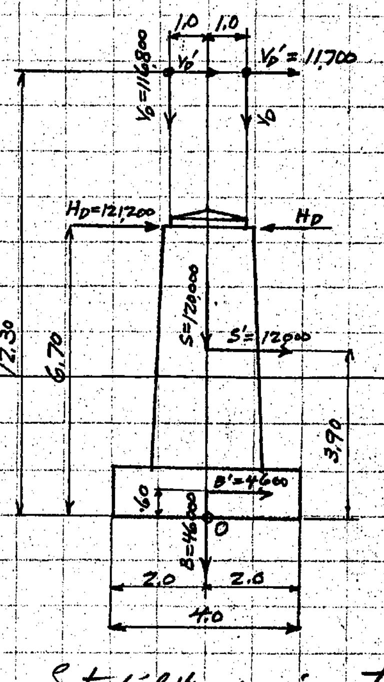
| Load marks | Horizontal loads | Vertical loads | | arms | | Moments |
|---|---|---|---|---|---|---|
| V | | 145,400 | × | -1.00 | = | -145,400 |
| $V_D$ | | 116,800 | × | 1.00 | = | 116,800 |
| H | 157,400 | | × | 6.70 | = | 1,054,500 |
| $H_D$ | - 121,200 | | × | 6.70 | = | - 812,000 |
| S | | 120,000 | × | 0 | = | 0 |
| B | | 46,000 | × | 0 | = | 0 |
| | 36,200 kg | 428,200 kg | | 0.50 m | | 213900 |

Resultant force within middle third.

max. toe pressure $= \frac{428200}{4.0\times4.0}\left(1\pm\frac{\overset{.750}{6\times0.50}}{4.0}\right) = 46840\ ^{kg}/_{m^2}\ (4.30\ ^{tons}/_{□'})$
or 6690 "

Above pressure will safely be carried by soft rock foundation directly on which the pier will be built.

## Stability during Earthquake.



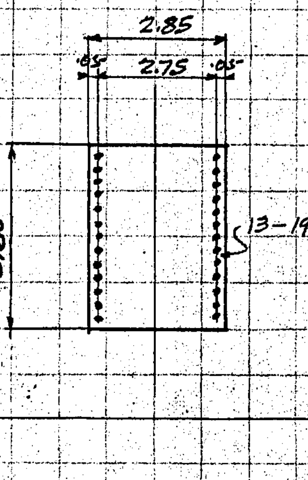
| Load marks | Hor. loads | Vert. loads | | arms | | moments |
|---|---|---|---|---|---|---|
| $2V_D$ | | 233,600 | × | 0 | = | 0 |
| $2V_D'$ | 23,400 | | × | 12.30 | = | 288,000 |
| $H_D-H_D$ | 0 | | | | | — |
| S | | 120,000 | × | 0 | = | 0 |
| S' | 12,000 | | × | 3.90 | = | 46,800 |
| B | | 46000 | × | 0 | = | 0 |
| B' | 4600 | | × | 0.60 | = | 2800 |
| | 40,000 kg | 399,600 kg | | 0.845 m | | 337,600 |

Resultant force outside of middle third, neglecting tension.
pressure area $(2.00-0.845)3\times4.0 = 13.86$ sq. meters.
max. toe pressure $\doteqdot \frac{399600\times2}{13.86} = 57600\ ^{kg}/_{m^2}\ (5.27\ ^{tons}/_{□'})$

## Stability during transverse earthquake.

All figures same as above. max. toe pressure = 57,600 $^{kg}/_{m^2}$

## Stresses at bottom of shaft during earthquake.



| | | | | | | |
|---|---|---|---|---|---|---|
| $2V_D$ | | 233,600 | × | 0 | = | 0 |
| $2V_D'$ | 23400 | | × | 11.10 | = | 259,700 |
| $H_D-H_D$ | 0 | | | | | — |
| S | | 120,000 | × | 0 | = | 0 |
| S' | 12,000 | | × | 2.70 | = | 32,400 |
| | 35,400 kg | 353,600 kg | | 0.826 m | | 292,100 |

Steel area = 13-19φ = 36.85 $\quad {}^{z}/_{h} = {}^{82.6}/_{285} = 0.290,$

$P_0 = \frac{36.85\times2}{285\times360} = 0.00072 \quad {}^{d'}/_{h} = {}^{5}/_{285} = 0.0175$

$k = 0.66, \quad L = 0.096$

$$f_c = \frac{292100\times100}{0.096\times360\times285^2} = 10.4\ ^{kg}/_{cm^2}$$

$$f_s = 15\times10.4\left(\frac{\overset{.49}{280}}{.66\times285}-1\right) = 76\ ^{kg}/_{cm^2}$$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

**JIUN MASUDA**
CONSULTING ENGINEER
~~JIJI~~ BLDG. TOKYO
SHOWA

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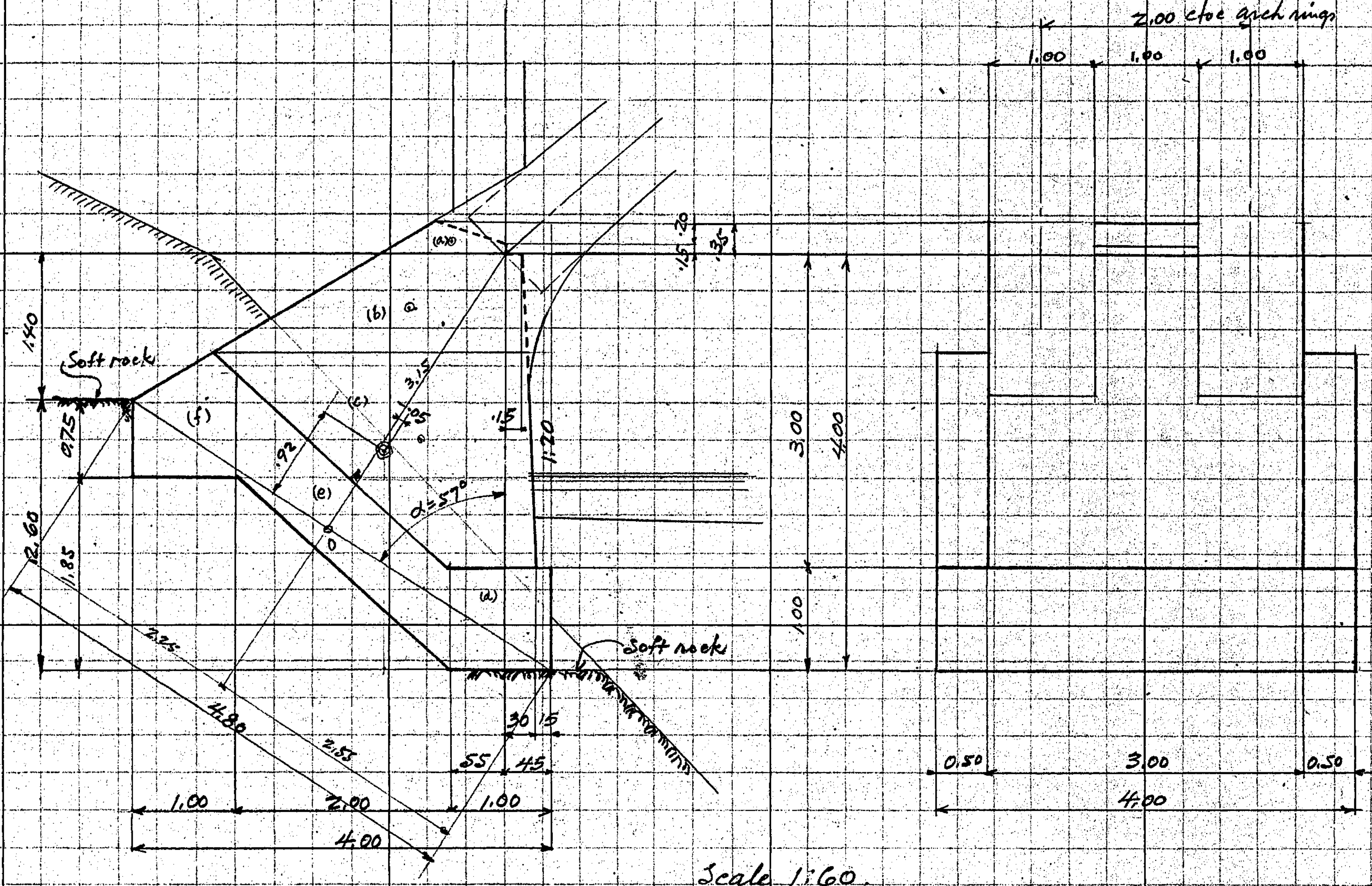
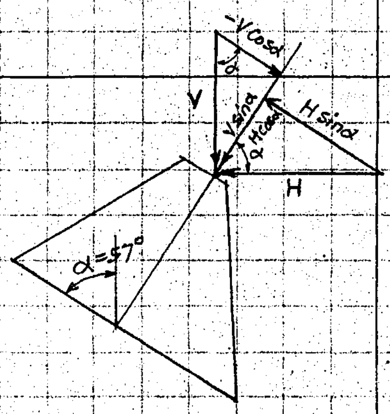
CALCULATIONS FOR

## Design of Sakura Bashi for Chichibu-Cho.

Design of Arch abutment A1.
General dimensions as follows.



Scale 1:60.



Inclination of average base plane against vertical = α = 57°

$\sin\alpha = \sin 57^\circ = 0.839$

$\cos\alpha = \cos 57^\circ = 0.545$

Normal force $N = H\cos\alpha + V\sin\alpha$

tangential force $T = H\sin\alpha - V\cos\alpha$

Normal and tangential components of superimposed loads.

| | Normal component | Tangential component |
|---|---|---|
| Horizontal thrust | $0.545H + 0.839V$ N. | $0.839H - 0.545V$ T. |
| Dead load $H_D = 121{,}200$<br>$V_D = 125400$ | $66{,}000 + 105{,}200 = 171{,}200 (N_D)$ | $101{,}700 - 68{,}400 = 33{,}300 (=T_D)$ |
| Live Load $H_L = 36{,}200$<br>$V_L = 38{,}200$ | $19{,}700 + 32{,}000 = 51{,}700$ | $30{,}300 - 20{,}800 = 9{,}500$ |
| | N = 222,900 kg | T = 42,800 kg |
| | arm. = 0 | arm = 3.15 m |

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

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CALCULATIONS FOR

Design of Sakura-Bashi Chichibu-Cho.

Approximate volume of concrete and weight of abutment. (arms measured from toe.)

| | | | | vert arm | moment | hor. arm | moment |
|---|---|---|---|---|---|---|---|
| Body, top | (a) | 1.20 × 0.25 × 3.00 = | 0.90 | 4.15 | 3.73 | 0.95 | 0.86 |
| 〃 | (b) | 2.20 × 0.95 × 3.00 = | 6.27 | 3.46 | 21.70 | 1.40 | 8.78 |
| 〃 | (c) | 1.95 × 2.05 × 3.00 = | 12.00 | 2.22 | 26.64 | 1.25 | 15.00 |
| Base | (d) | 1.00 × 1.00 × 4.00 = | 4.00 | 0.50 | 2.00 | 0.50 | 2.00 |
| 〃 | (e) | 1.00 × 2.00 × 4.00 = | 8.00 | 1.43 | 11.45 | 2.00 | 16.00 |
| 〃 | (f) | 1.00 × 1.00 × 4.00 = | 4.00 | 2.35 | 9.40 | 3.50 | 14.00 |
| | | | 35.17 m³ | 2.13 m | 74.92 | 1.61 m | 56.64 |

Vertical load B = 35.17 @ 2400 = 84400 kg

Normal component $N_B$ = 84400 × 0.839 = + 70,800 kg arm −0.05 m (graphically measured)
tangential 〃 $T_B$ = 84400 × 0.545 = − 46,000 kg arm +0.92 m

Seismic force.

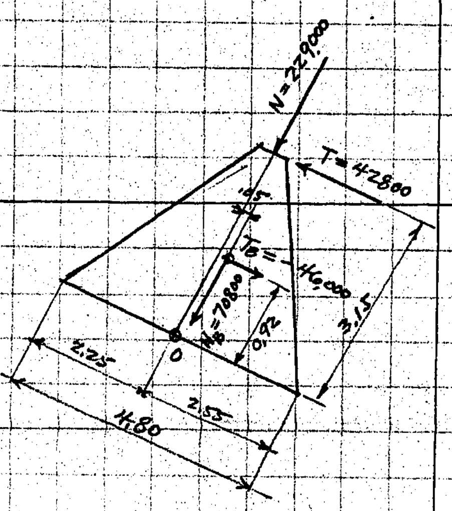
Dead Load, $V_D$ = 125400 kg

normal component $N_D'$ = 125400 × 0.10 × 0.545 = 6,800 kg arm −3.60 (graphically measured)
tangential 〃 $T_D'$ = 125400 × 0.10 × 0.839 = 10,500 〃 arm 9.15

wt. of abutment B = 84400 kg

normal component $N_B'$ = 84400 × 0.10 × 0.545 = 4600 kg
tangential 〃 $T_B'$ = 84400 × 0.10 × 0.839 = 7,100 〃

Stability of abutment at normal state.



Taking moment about origine O.

| Load marks | Tang. loads | Norm. load | arm | moment |
|---|---|---|---|---|
| N | | 229,000 | × 0 | = 0 |
| T | 42,800 | | × 3.15 | = 134,800 |
| $N_B$ | | 70800 | × −0.05 | = − 3,500 |
| $T_B$ | −46000 | | × 0.92 | = − 42,300 |
| | − 3,200 kg | 299,800 kg | 0.297 m | 89,000 |

Eccentricity e = 2.55 + 0.297 − 2.40 = 0.447 m

Resultant force within middle third.

max. toe pressure = $\frac{299800}{4.80 \times 4.00}\left(1 \pm \frac{\overset{.509}{6 \times 0.447}}{4.80}\right)$ = 23600 kg/m² (2.16 tons/□')
7670

Stability of abutment during earthquake.

| Load marks | Tang. load | Norm. load | arm | moment |
|---|---|---|---|---|
| $N_D$ | | 171,200 | × 0 | = 0 |
| $T_D$ | 33,300 | | × 3.15 | = 104,900 |
| $N_D'$ | | ± 6,800 | × −3.60 | = ∓ 24,500 |
| $T_D'$ | ± 10,500 | | × 9.15 | = ± 96,100 |
| $N_B$ | | 70,800 | × −0.05 | = − 3,500 |
| $T_B$ | − 46,000 | | × 0.92 | = − 42,300 |
| $N_B'$ | | ± 4,600 | × −0.05 | = ∓ 200 |
| $T_B'$ | ± 7,100 | | × 0.92 | = ± 6,500 |
| | 4900 | 253,400 | 0.54 m | 137,000 |
| | − 30,300 | 230,600 | − 0.08 m | − 18,800 |

max. toe pressure = $\frac{253400}{4.00 \times 4.80}\left(1 \pm \frac{\overset{.675}{6 \times 0.54}}{4.80}\right)$ = 22100 kg/m² (2.02 tons/□')
or 4300 〃

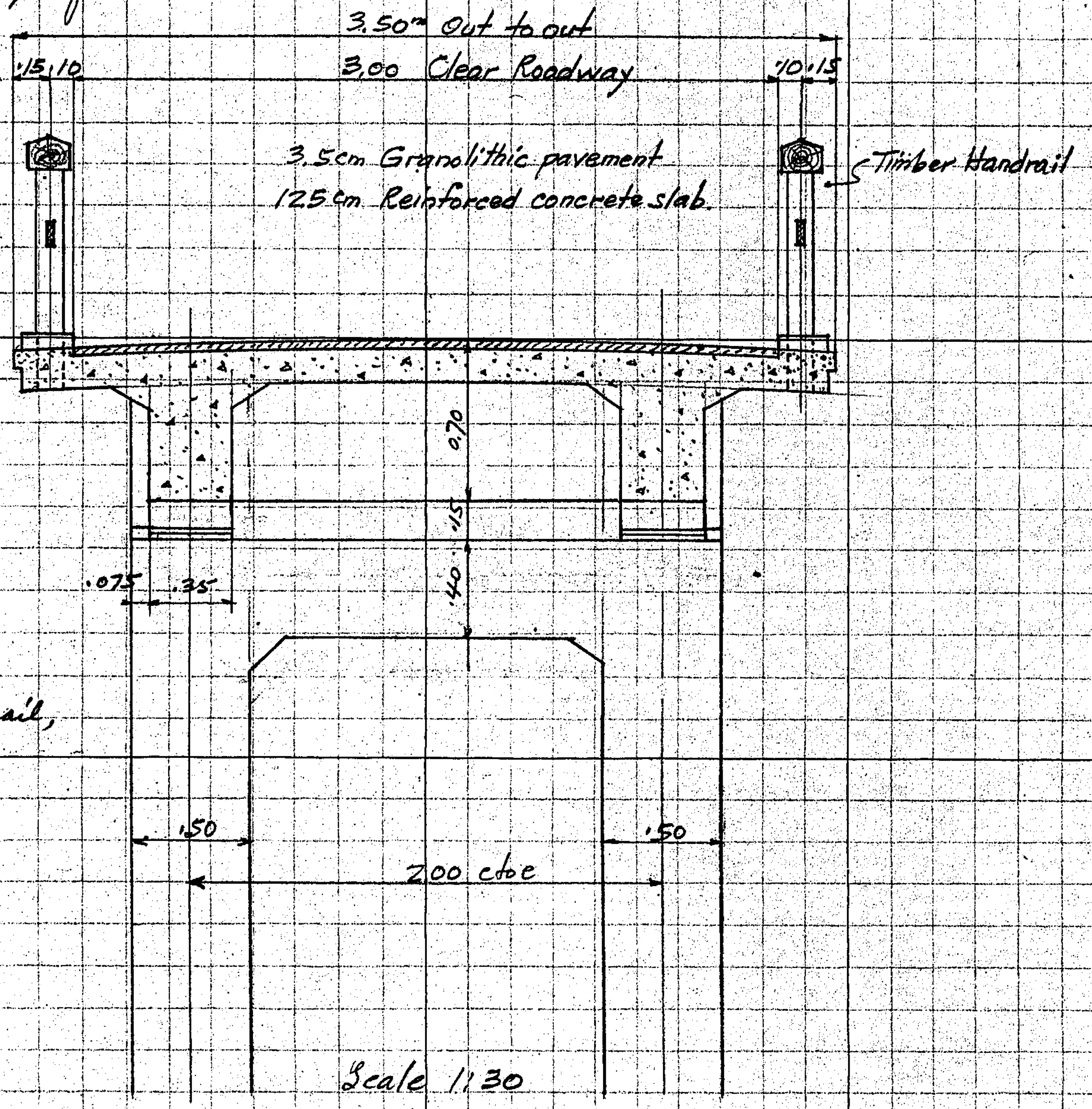
max. heel pressure = $\frac{230600}{4.0 \times 4.80}\left(1 \pm \frac{\overset{.10}{6 \times 0.08}}{4.80}\right)$ = 13,200 〃 (1.21 tons/□')
or 10,800 〃

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

Design of Sakura-Bashi for Chichibu-cho.

Design of Approach Concrete girder span.

Cross section of Bridge floor.



Note. For dimensions of floor slab and handrail, refer to page 2.

Scale 1:30

Floor slab and handrail, use same detail as for arch span.

Design of main beam. span length 5.70 meter about. (6.0 m ctoc piers)
Spacing 2.00 " ctoc.

Dead Load.

| | | | |
|---|---|---|---|
| floor slab and pavement | 1.75 | @ 390 = | 682 |
| handrail | | | 30 |
| stem of beam | 0.35×0.53 | @ 2400 = | 446 |
| fillets | 0.15×0.10 | @ " = | 36 |
| miscellaneous say | | | 6 |
| | | | 1,200 kg per lin meter |

Dead Load moment = $1/10 \times 1200 \times 5.70^2 =$ 3900 kgm
Dead Load shear = $5/4 \times 1200 \times 5.70 \div 2 =$ $-4280$ kg for fixed end
$3/4 \times 1200 \times 5.70 \div 2 =$ $+2570$ " " free "

Live Load. 4 ton motor truck rear wheel with impact = 1950 kg
" " " front " " = 650 "
Uniform live load on roadway = 500 kg/m²

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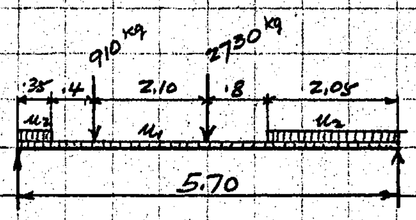
CALCULATIONS FOR

Design of Sakura-Bashi for Chichibu-Cho.

max. wheel concentration on main beam (see on page 5)

rear wheel 2730 kg
front " 2730 ÷ 3 = 910 "

Uniform load $u_1$ = 10 kg/lin m throughout.
" $u_2$ = 770 " on front and rear of truck.



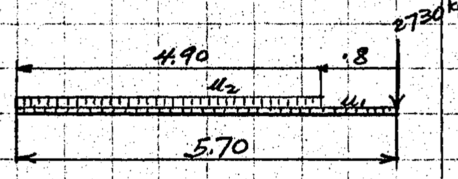
Moment.

reaction

770 × .35 × .175 ÷ 5.70 = 8
770 × 2.05 × 4.675 ÷ 5.70 = 1,295
10 × 5.70 ÷ 2 = 29
2730 ÷ 2 = 1365
910 × 0.75 ÷ 5.70 = 120
2,817 kg

2817 × 2.85 = 8,030
770 × 2.05 × 1.825 = − 2,880
10 × $2.85^2$ ÷ 2 = − 40
5110

For continuity of beam, moment will be taken as 8/10 of above value
m = 5110 × 8/10 = 4,090 kgm



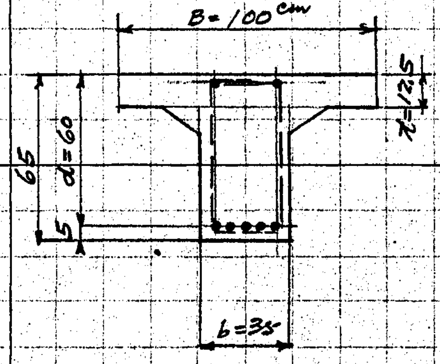
Shear.

Unif. load $u_1$ 10 × 5.70 ÷ 2 = 29
" " $u_2$ 770 × 4.90 × 2.45 ÷ 5.7 = 1621
1650 × $\frac{5}{4}$ = 2060

rear wheel 2730
End shear for fixed end = −4790 kg
" " " free end 1650 × 3/4 + 2730 = +3,970 "

Summary for moment and shear.

| | fixed end | | free end | | near center of span |
|---|---|---|---|---|---|
| | neg. moment | shear | moment | shear | pos. moment. |
| Dead Load | − 3,900 | − 4,280 | — | + 2,570 | + 3,900 |
| Live Load | − 4,090 | − 4,790 | — | + 3,970 | + 4,090 |
| | − 7,990 kgm | − 9,070 kg | — | + 6,540 kg | + 7,990 kgm |



approximate steel area required for pos. moment.

$$A_s = \frac{7990 \times 100}{1200 \times 7/8 \times 60} = 12.70 \text{ cm}^2$$

try 5-19φ bars = 14.18 cm²

$$\text{Steel ratio } p = \frac{14.18}{100 \times 60} = 0.0024$$

ratio t/d = 12.5/60 = 0.21

Neutral axis in web.

k = 0.23 , j = 0.924

$$f_s = \frac{7990 \times 100}{14.18 \times .924 \times 60} = 1,017 \text{ kg/cm}^2$$

$$f_c = \frac{1017 \times .23}{15(1 - .23)} = 20.3 \quad "$$

$$\text{unit shear} = \frac{6540}{35 \times .924 \times 60} = 3.37 \quad " \quad \text{at free end.}$$

Total perimeter of bars req'd. for bond stress

$$= \frac{6540}{6.0 \times .924 \times 60} = 19.65 \text{ cm} \quad \text{Use } 4\text{-}19^\phi = 23.9 \text{ cm of perimeter.}$$

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

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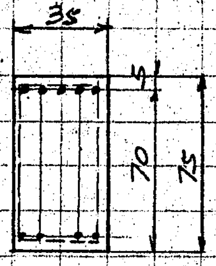
CALCULATIONS FOR

Design of Sakura-Bashi for Ohichiku-Cho.

For neg. moment at fixed end.

$M = -7990$ kgm, $V = -9070$ kg.



Effective depth reqd. $= \sqrt{\frac{7990 \times 100}{35 \times 6.04}} = 61.4$ cm.

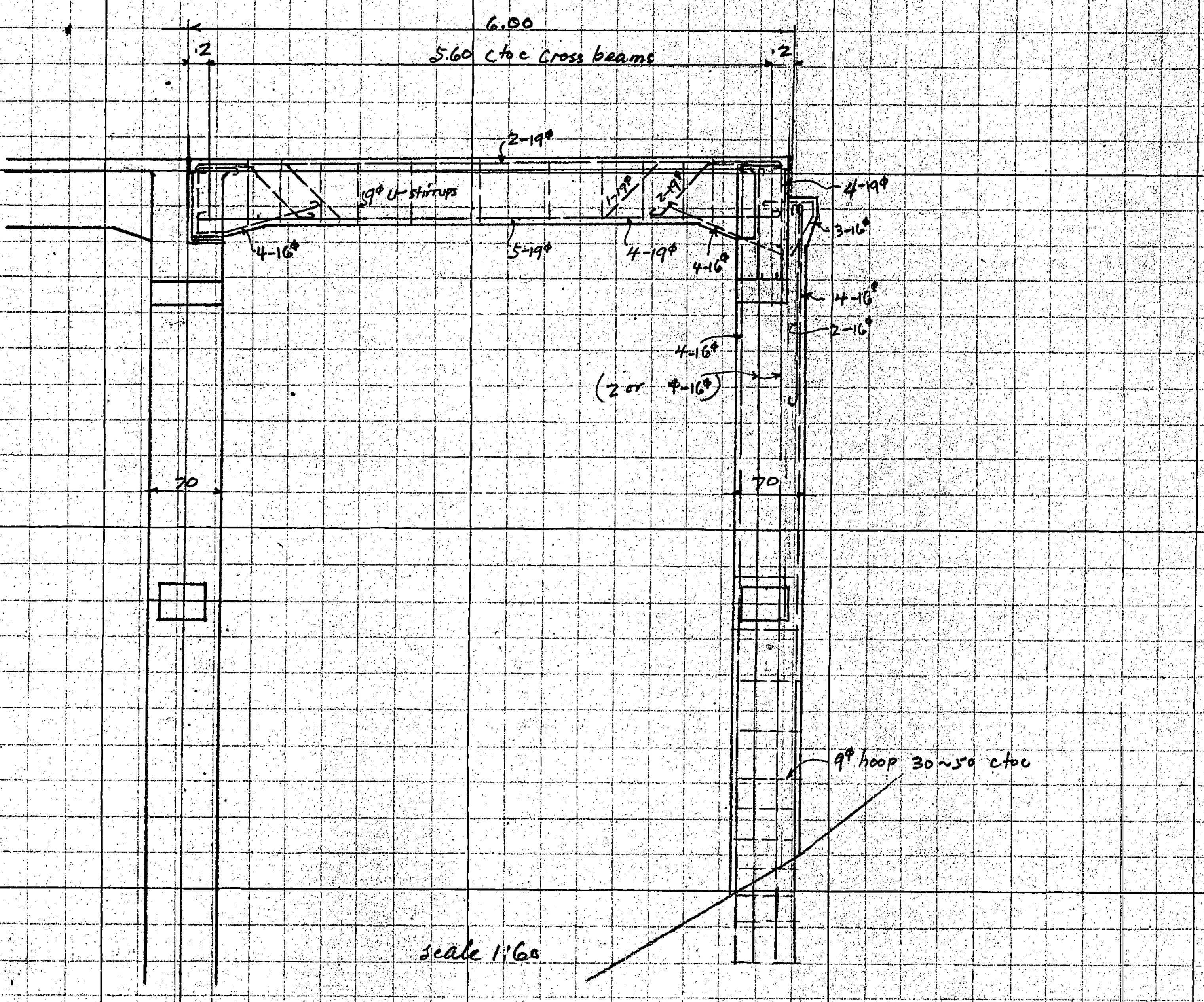
use 70 cm eff. depth

Steel area reqd. $= \frac{7990 \times 100}{1200 \times 7/8 \times 70} = 10.88$ cm²

Use 5-19ϕ = 14.18 cm²   $p = \frac{14.18}{35 \times 70} = .00578$,  $j = 0.888$

unit shear $= \frac{9070}{35 \times .888 \times 70} = 4.17$ kg/cm²  use 9mmϕ U-stirrups 30cm ctoc

bond bars reqd. $\frac{9070}{6 \times .888 \times 70} = 24.3$ cm  more than 4-19ϕ bars.



scale 1:60

End span   Span length 5.70 meter about. Both ends partially fixed to piers, moment and shear will be taken as follows referring to above calculations.

| | Center of span<br>pos. moment. | End of span<br>neg. moment. | shear. |
|---|---|---|---|
| Dead load | 3900 | -2440 | 3420 |
| Live load. | 4090 | -2550 | 4380 |
| | +7990 kgm | -4990 kgm | 7800 kg. |

(coef. 1/16)

moment at bottom of pier column say $\frac{4990}{2} = +2500$ kgm.

Use simillar detail as above.

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

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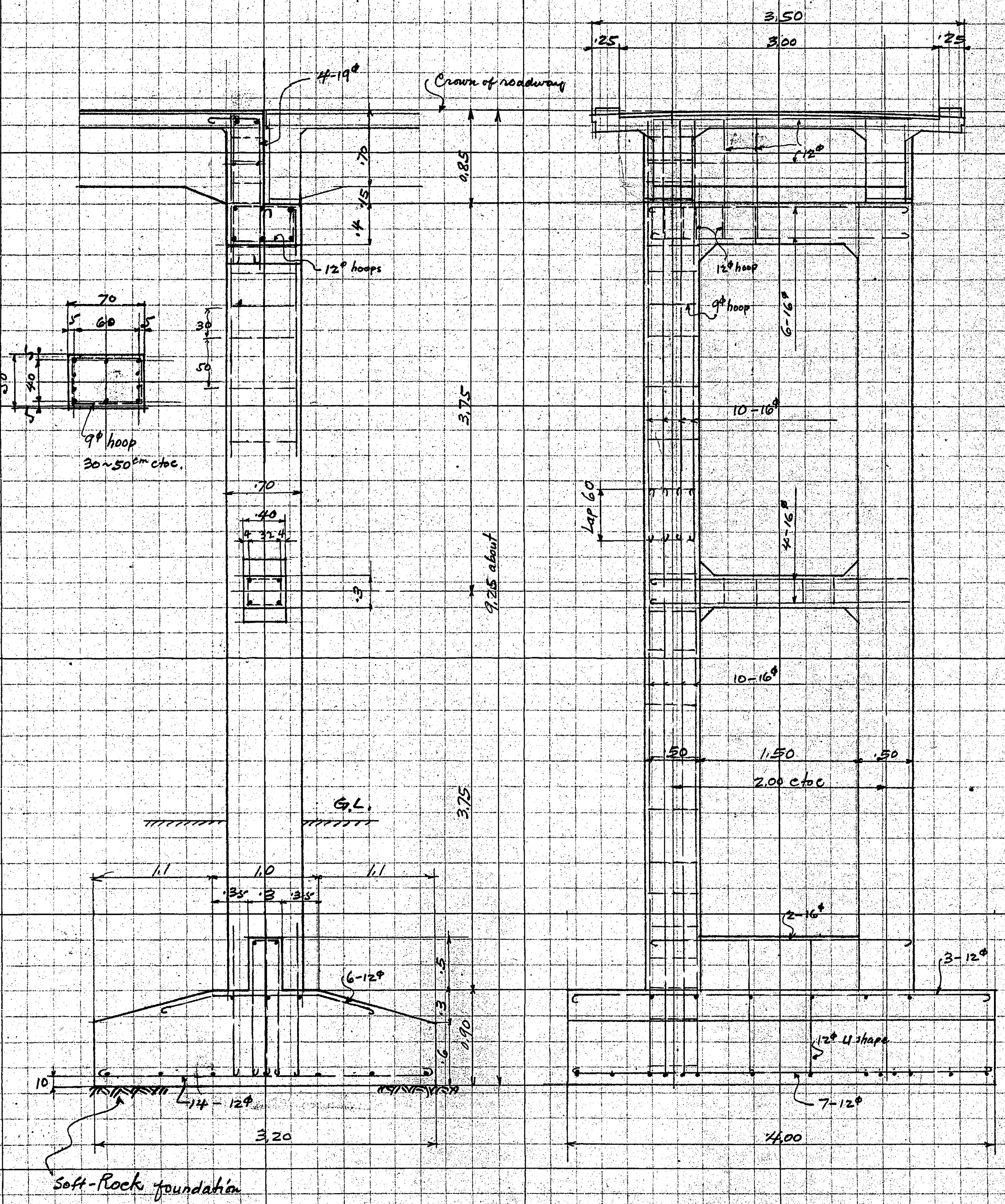
CALCULATIONS FOR

Design of Sakura-Bashi for Chichibu-Cho

Design of Pier P2

General dimensions assumed as follows.



General Sketch of Pier P2.
Scale 1:40.

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CALCULATIONS FOR

Design of Sakura-Bashi for Chichibu-Cho.

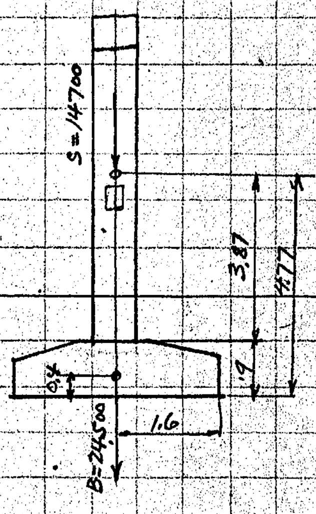
Approximate volume of concrete and weight of pier.

Shaft.

| | | | | | | |
|---|---|---|---|---|---|---|
| Columns. | 2@ 0.70×0.50 × 7.50 = | 5.25 | × | 3.75 = | | 19.68 |
| top strut | 0.40×0.70 × 1.50 = | 0.42 | × | 7.30 = | | 3.07 |
| center strut | 0.40 × 0.30 × 1.50 = | 0.18 | × | 3.75 = | | 0.68 |
| fillet | 0.15 × 0.15 × 0.70 = | 0.02 | × | 7.05 = | | 0.14 |
| 〃 | 2@ 0.15 × 0.15 × 0.40 = | 0.02 | × | 3.75 = | | 0.08 |
| bottom strut | 0.30 × 0.50 × 1.50 = | 0.23 | × | 0.25 = | | 0.06 |
| | | 6.12m³ | | 3.87m | | 23.71 |

Base.

| | | | | |
|---|---|---|---|---|
| 2.10×0.30 × 4.00 = | 2.52 | × | 0.72 = | 1.81 |
| 3.20 × 0.60 × 4.00 = | 7.68 | × | 0.30 = | 2.31 |
| | 10.20 m³ | | 0.40 m | 4.12 |



Summary of volume and weight

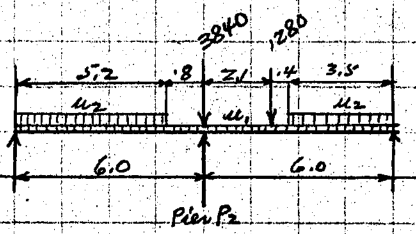
| | | | | |
|---|---|---|---|---|
| Shaft | 6.12m³ | @ 2,400 | = | 14,700 |
| base | 10.20 | @ 〃 | = | 24,500 |
| | 16.32m³ | | | 39,200 kg |

Superimposed loads on pier.
Dead Load.

1,200 × 6.0 × 2 = 14,400 kg on the whole pier

Live Load.

| | | |
|---|---|---|
| 4ton motor truck rear wheel concentration = | 1500 | |
| Impact coef. = $\frac{20}{60+12}$ = 28 % | 420 | 2wheels |
| | 1,920 kg | 3,840 kg |
| front wheel with impact say 1920 ÷ 3 = | 640 〃 | 1,280 〃 |



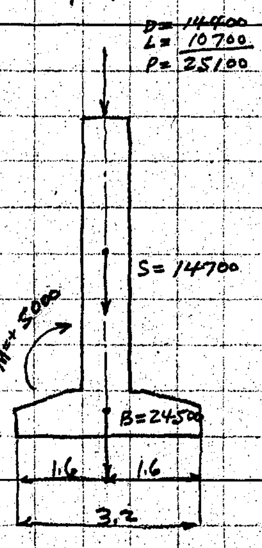
Uniform live load 500 kg per sq. meter

Unif. load on front + rear of truck 3.0 @ 500 = 1500 kg per lin. meter.
〃 〃 〃 Side of truck (3.0-2.2)=0.8 @ 500 = 400 〃 〃 = $u_1$
1100 〃 〃 = $u_2$

Load on pier $P_2$.

| | | | |
|---|---|---|---|
| Unif. load | $u_1$ | 400 × 6.00 = | 2400 |
| 〃 〃 | $u_2$ | 1100×3.5×1.75÷6.0 = | 1120 |
| 〃 〃 | $u_2$ | 1100 × 5.2 × 2.6 ÷ 6.0 = | 2480 |
| front wheel | | 1280 × 3.9 ÷ 6.0 = | 830 |
| rear 〃 | | | 3840 |
| | | | 10,670 kg call this 10,700 kg |

Stability of Pier at normal state.



Vertical load on pier foundation.

| | | |
|---|---|---|
| superimposed D. L. | 14400 | |
| 〃 L. L. | 10700 | |
| | | 25,100 |
| weight of shaft | 14700 | |
| 〃 〃 base | 24500 | |
| | | 39200 |
| | | 64,300 kg. |

max. moment on bottom of column = +2,500 × 2 = 5000 kg-m for 2 columns.

Eccentricity $e = \frac{5000}{64,300} = 0.08$ m.

max. toe pressure $= \frac{64300}{3.20 \times 4.00}\left(1 \pm \frac{\overset{.15}{0.08 \times 6}}{3.20}\right) = 5770$ kg/m² (5.28 ton/m²)
or 4270 〃

The base will be built directly on soft rock, and above toe pressure may safely be beared.

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

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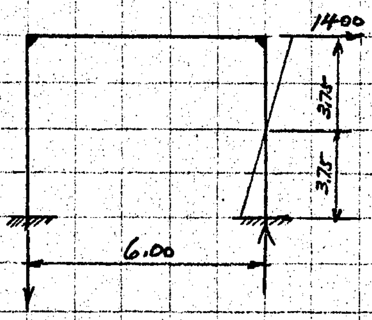
CALCULATIONS FOR

## Design of Sakura-Bashi for Chichibu-Cho.

### Stability against longitudinal earthquake.



Seismic acceleration assumed 1,000 mm/sec² or k = 0.10

Seismic thrust = 14400 × 0.10 = 1,400 kg

Seismic moment assumed.

$m = 1400 \times 3.75 = 5250$ kgm

Dead Load moment 1220 × 2 = 2440

7,690 kgm for 2 columns.

Seismic reaction

1400 × 7.5 ÷ 6.0 = 1750

Dead Load reaction = 14400

16,150 kg

weight of pier shaft 14700

30,850

weight of pier base 24500

55,350 kg.

Eccentricity $e = \frac{7690}{55350} = 0.139$ m

max. toe pressure $= \frac{55350}{3.20 \times 4.0}\left(1 \pm \overset{.26}{\frac{6 \times 0.139}{3.20}}\right) = 5450$ kg/m² (4.98 tons/□')
or 3200

### Stability against transverse earthquake.

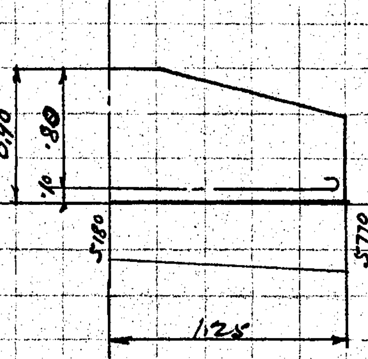
| Seismic moment | | | weight |
|---|---|---|---|
| Deck | 1400 × 8.40 = | 11,800 | 14400 |
| Shaft | 1500 × 4.77 = | 7,200 | 14700 |
| Base | 2500 × 0.40 = | 1,000 | 24500 |
| | | 20,000 kgm | 53600 kg |

Ecc. $= \frac{20000}{53600} = 0.373$ m

resultant force within middle third.

max. toe pressure $= \frac{53600}{3.20 \times 4.0}\left(1 \pm \overset{.563}{\frac{6 \times 0.373}{4.0}}\right) = 6550$ kg/m² (5.99 tons/□')
or 1840

### Cantilever footing.



at normal state.

Upward pressure. 5770
5180
10950 ÷ 2 = 5475 × 1.25 = 6840 kg arm 0.64 m

Downward pressure

| | | | |
|---|---|---|---|
| Concrete | 0.75 × 1.25 @ 2400 = | 2250 kg | arm 0.58 m |
| earth | 1.80 × 1.25 @ 1600 = | 3600 kg | arm 0.64 m |

Moment on footing

| | | |
|---|---|---|
| upward pressure | 6840 × 0.64 = | 4380 |
| concrete weight | − 2250 × 0.58 = | − 1310 |
| earth weight | − 3600 × 0.64 = | − 2300 |
| | 990 kg | 770 kgm |

Steel area required $= \frac{770 \times 100}{1200 \times 7/8 \times 80} = 0.92$ cm²

Use 12 mmφ bars at 50 cm ctoc = 2.26 cm² on both direction.

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

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CALCULATIONS FOR

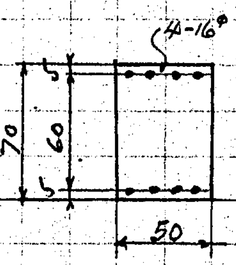
# Design of Sakura-Bashi for Chichibu-Cho.

## Design of pier column.

moments + vertical loads on column (one column)

| | Top of column | | Bottom of column | |
|---|---|---|---|---|
| | moment | vert. load | moment | vert load. |
| Dead Load. | -2440 | 7200 | + 1220 | 14600 |
| Earthquake | -2630 | 900 | + 2630 | 900 |
| | -5070 kgm | 8100 kg | + 3850 kgm | 15500 kg. |
| | ecc = 0.626m | | ecc = 0.249 m | |
| Dead Load | - 2440 | 7200 | + 1220 | 14600 |
| Live Load. | - 2550 | 5400 | + 1280 | 5400 |
| | - 4990 kgm | 12,600 kg | + 2500 kgm | 20,000 kg |
| | ecc = 0.396m | | ecc = 0.125 m. | |

Top of column.



$d'/h = 5/70 = 0.072 \qquad e/h = 39.6/70 = 0,566$

$A_s = 4\text{-}16^{\phi} = 8.04\ \text{cm}^2 \qquad p_0 = \dfrac{8.04\times 2}{70\times 50} = .0046$

$K = 0.395, \quad L = 0.104$

$f_c = \dfrac{4990\times 100}{0.104\times 50\times 70^2} = 19.6\ \text{kg/cm}^2$

$f_s = 15\times 19.6\left(\dfrac{\overset{1.35}{65}}{.395\times 70} - 1\right) = 397\ \text{kg/cm}^2$

| | K | L |
|---|---|---|
| .05 | .40 | .108 |
| .10 | .39 | .1005 |

Bottom of column.

$e/h = 12.5/70 = 0.18$ Compression over whole section

$k_1 = 1.87.$

$f_c = \dfrac{20000}{35\times 70}\times 1.87 = 15.3\ \text{kg/cm}^2$

$f_s \doteqdot 15.3\times 15 = 230\ \text{kg/cm}^2$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

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

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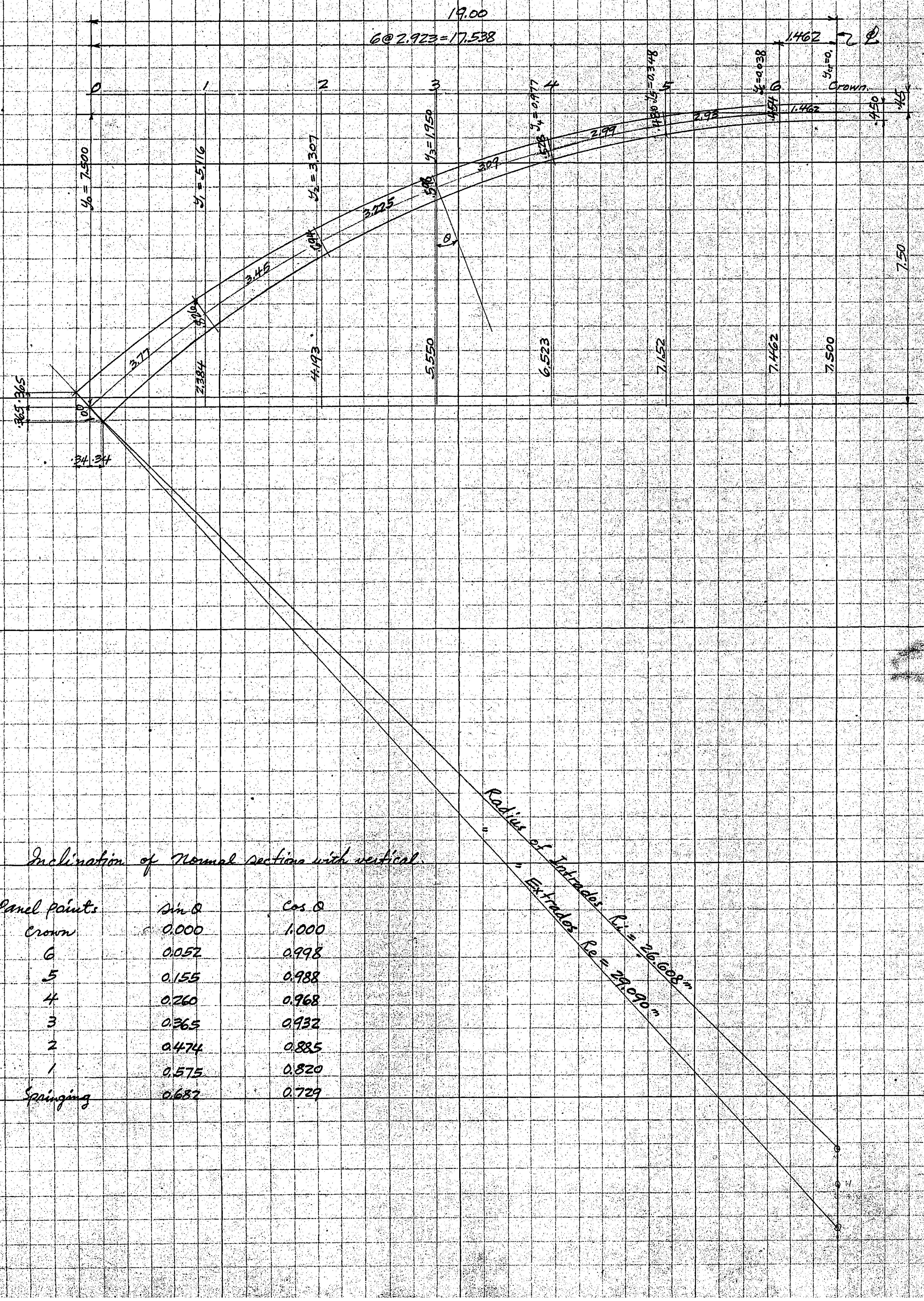
CALCULATIONS FOR

## Design of Sakura-Bashi for Chichibu-Cho.

Nominal dimensions of arch ring.



Inclination of Normal sections with vertical.

| Panel points | sin θ | cos θ |
|---|---|---|
| Crown | 0.000 | 1.000 |
| 6 | 0.052 | 0.998 |
| 5 | 0.155 | 0.988 |
| 4 | 0.260 | 0.968 |
| 3 | 0.365 | 0.932 |
| 2 | 0.474 | 0.885 |
| 1 | 0.575 | 0.820 |
| Springing | 0.682 | 0.729 |

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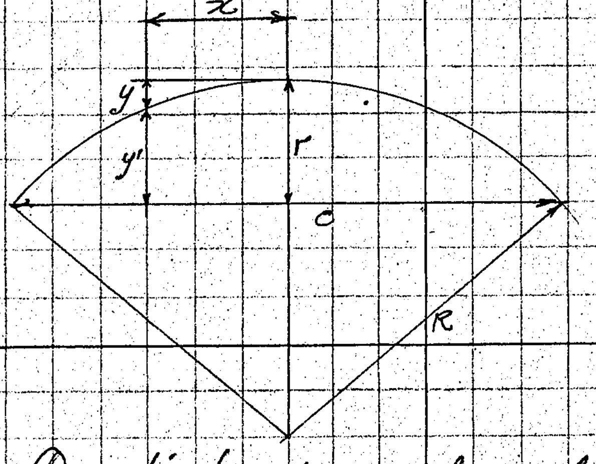
CALCULATIONS FOR

## Design of Sakura-Bashi for Chichibu-Cho

Radii of Extrados, Intrados and Neutral axis. (neutral axis being approximately a circular curve.)



$$R = \frac{c^2}{8r} + \frac{r}{2}$$

| | $c$ | $c^2$ | $8r$ | $c^2/8r$ | $r/2$ | $R$ |
|---|---|---|---|---|---|---|
| Extrados | 38.68 | 1496.1424 | 58.88 | 25.4101 | 3.68 | 29.090 m |
| Intrados | 37.32 | 1392.7824 | 61.12 | 22.788 | 3.82 | 26.608 |
| Neutral axis | 38.00 | 1444.0000 | 60.00 | 24.067 | 3.75 | 27.817 |

Co-ordinates of several panel points.

General equation.

$$y' = r - R + \sqrt{R^2 - x^2} \quad \text{and} \quad y = r - y'.$$

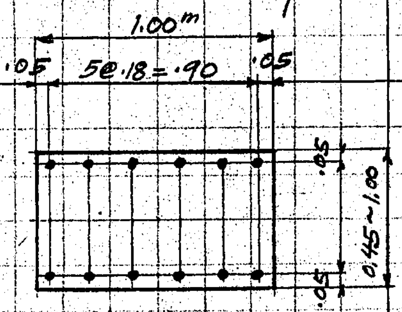
for $r = 7.500$, $R = 27.817$

$$y' = -20.317 + \sqrt{773.7855 - x^2}$$

| Panel points | $x$ | $x^2$ | $R^2-x^2$ | $\sqrt{R^2-x^2}$ | $y'$ | $y$ | Thickness of rib | Length of division=ds |
|---|---|---|---|---|---|---|---|---|
| Crown | 0.000 | 0.0000 | 773.7855 | 27.817 | 7.500 | 0.000 | 0.450 | 0.731 |
| 6 | 1.462 | 2.1374 | 771.6481 | 27.779 | 7.462 | 0.038 | 0.454 | 2.196 |
| 5 | 4.385 | 19.2282 | 754.5573 | 27.469 | 7.152 | 0.348 | 0.480 | 2.960 |
| 4 | 7.308 | 53.4069 | 720.3786 | 26.840 | 6.523 | 0.977 | 0.528 | 3.040 |
| 3 | 10.231 | 104.6734 | 669.1121 | 25.867 | 5.550 | 1.950 | 0.598 | 3.158 |
| 2 | 13.154 | 173.0277 | 600.7578 | 24.510 | 4.193 | 3.307 | 0.694 | 3.338 |
| 1 | 16.077 | 258.4699 | 515.3156 | 22.701 | 2.384 | 5.116 | 0.826 | 3.610 |
| Springing 0. | 19.000 | 361.0000 | 412.7855 | 20.317 | 0.000 | 7.500 | 1.000 | 1.885 |

$S/2 = 20.918$
$S = 41.836$

Cross section of arch ring.



Axial reinforcements in arch ring. (one ring)
6-22φ bars on top and bottom throughout the rib.
Steel area = 12 @ 3.801 = 45.612 cm²
Equivalent concrete area for steel = 14 @ 45.612 = 638.568 cm²
or 0.0639 sq. meters.

Moments of inertia of arch ring at several sections.

| Panel points | depth $d$ | $d^3$ | $I_c$ $\frac{1}{12} \cdot d^3$ | $\left(\frac{d}{2}-0.05\right)^2$ | $14A_s$ | $I_s$ | $I$ $I_c+I_s$ |
|---|---|---|---|---|---|---|---|
| Crown | 0.450 | .09111 | .00759 | .0306 | .0639 | .00196 | .00955 |
| 6 | 0.454 | .0936 | .00780 | .0313 | " | .00200 | .00980 |
| 5 | 0.480 | .1106 | .00922 | .0361 | " | .00231 | .01153 |
| 4 | 0.528 | .1472 | .01227 | .0458 | " | .00293 | .01520 |
| 3 | 0.598 | .2138 | .01782 | .0620 | " | .00396 | .02178 |
| 2 | 0.694 | .3343 | .02786 | .0882 | " | .00564 | .03350 |
| 1 | 0.826 | .5636 | .04697 | .1318 | " | .00842 | .05539 |
| Springing 0. | 1.000 | 1.0000 | .08333 | .2025 | " | .01294 | .09627 |

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CALCULATIONS FOR

# Design of Sakura-Bashi for Chichibu Cho

Values of several terms for the calculations of Hc, Mc, and Vc.

| panel pts. | $x$ | $x^2$ | $y$ | $y^2$ | $ds$ | $I$ | $ds/I$ | $x\,ds/I$ | $x^2\,ds/I$ | $y\,ds/I$ | $y^2\,ds/I$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crown | 0.000 | 0.0000 | 0.000 | 0.0000 | 0.731 | 0.00955 | 76.54 | 0.00 | 0.00 | 0.00 | 0.00 |
| 6 | 1.462 | 2.1374 | 0.038 | 0.0014 | 2.196 | 0.00980 | 224.08 | 327.60 | 478.95 | 8.52 | 0.31 |
| 5 | 4.385 | 19.2282 | 0.348 | 0.1211 | 2.960 | 0.01153 | 256.72 | 1,125.72 | 4936.26 | 89.34 | 31.09 |
| 4 | 7.308 | 53.4069 | 0.977 | 0.9545 | 3.040 | 0.01520 | 200.00 | 1461.60 | 10,681.38 | 195.40 | 190.90 |
| 3 | 10.231 | 104.6734 | 1.950 | 3.8025 | 3.158 | 0.02178 | 145.00 | 1483.50 | 15,177.64 | 282.75 | 551.36 |
| 2 | 13.154 | 173.0277 | 3.307 | 10.9362 | 3.338 | 0.03350 | 99.64 | 1,310.66 | 17240.48 | 329.51 | 1,089.68 |
| 1 | 16.077 | 258.4699 | 5.116 | 26.1735 | 3.610 | 0.05539 | 65.17 | 1,047.74 | 16,844.48 | 333.41 | 1,705.73 |
| Springing o. | 19.000 | 361.0000 | 7.500 | 56.2500 | 1.885 | 0.09627 | 19.58 | 372.02 | 7,068.38 | 146.85 | 1,101.38 |
| Summary for one-half of span | | | | | 20.918 | | 1,086.73 | 7128.84 | 72,427.57 | 1,385.78 | 4,670.45 |

| | | Crown | | | | Panel point 6 | | | | Panel point 5 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Panel Pts. | $x$ | $m$ | $m\,ds/I$ | $mx\,ds/I$ | $my\,ds/I$ | $m$ | $m\,ds/I$ | $mx\,ds/I$ | $my\,ds/I$ | $m$ | $m\,ds/I$ | $mx\,ds/I$ | $my\,ds/I$ |
| Crown | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | | | | |
| 6 | 1.462 | 1.46 | 327.16 | 478.30 | 12.44 | 0.00 | 0.00 | 0.00 | 0.00 | | | | |
| 5 | 4.385 | 4.39 | 1,127.00 | 4941.91 | 392.20 | 2.92 | 749.62 | 3287.10 | 260.87 | 0.00 | 0.00 | 0.00 | 0.00 |
| 4 | 7.308 | 7.31 | 1462.00 | 10,684.30 | 1428.37 | 5.85 | 1,170.00 | 8,550.36 | 1,143.09 | 2.92 | 584.00 | 4267.87 | 570.57 |
| 3 | 10.231 | 10.23 | 1,483.35 | 15,176.21 | 2892.53 | 8.77 | 1,271.65 | 13,010.30 | 2479.72 | 5.85 | 848.25 | 8,678.48 | 1,654.09 |
| 2 | 13.154 | 13.15 | 1,310.27 | 17,235.18 | 4,333.06 | 11.69 | 1,164.79 | 15,321.62 | 3861.97 | 8.77 | 873.84 | 11,494.49 | 2,889.80 |
| 1 | 16.077 | 16.08 | 1,047.93 | 16,847.66 | 5,361.23 | 14.62 | 952.79 | 15,317.96 | 4874.45 | 11.69 | 761.84 | 12,248.08 | 3,897.56 |
| Springing | 19.000 | 19.00 | 372.02 | 7,068.38 | 2,790.15 | 17.54 | 343.43 | 6,525.23 | 2575.75 | 14.62 | 286.26 | 5438.93 | 2,146.95 |
| Summary | | | 7,129.73 | 72,431.94 | 17,209.98 | | 5652.28 | 62,012.57 | 15,195.85 | | 3354.19 | 42,127.85 | 11,158.97 |

| | | Panel point 4 | | | | Panel point 3 | | | | Panel point 2 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Panel Pts. | $x$ | $m$ | $m\,ds/I$ | $mx\,ds/I$ | $my\,ds/I$ | $m$ | $m\,ds/I$ | $mx\,ds/I$ | $my\,ds/I$ | $m$ | $m\,ds/I$ | $mx\,ds/I$ | $my\,ds/I$ |
| 4 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 | | | | | | | | |
| 3 | 2.923 | 2.92 | 423.40 | 4,331.82 | 825.63 | 0.00 | 0.00 | 0.00 | 0.00 | | | | |
| 2 | 5.846 | 5.85 | 582.89 | 7,667.36 | 1,927.63 | 2.92 | 290.95 | 3827.13 | 962.17 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1 | 8.769 | 8.77 | 571.54 | 9,188.68 | 2,924.01 | 5.85 | 381.24 | 6,129.28 | 1,950.45 | 2.92 | 190.30 | 3,059.40 | 973.56 |
| Springing | 11.692 | 11.69 | 228.89 | 4,348.91 | 1,716.68 | 8.77 | 171.72 | 3,262.62 | 1,287.87 | 5.85 | 114.54 | 2,176.32 | 859.07 |
| Summary | | | 1,806.72 | 25,536.77 | 7,393.95 | | 843.91 | 13,219.03 | 4,200.49 | | 304.84 | 5,235.72 | 1,832.63 |

| | | Panel point 1 | | | | Springing | | | |
|---|---|---|---|---|---|---|---|---|---|
| Panel Pts. | $x$ | $m$ | $m\,ds/I$ | $mx\,ds/I$ | $my\,ds/I$ | $m$ | $m\,ds/I$ | $mx\,ds/I$ | $my\,ds/I$ |
| 1 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 | | | | |
| Springing | 2.923 | 2.92 | 57.17 | 1,086.30 | 428.80 | 0.00 | 0.00 | 0.00 | 0.00 |
| Summary | | | 57.17 | 1,086.30 | 428.80 | | 0.00 | 0.00 | 0.00 |

General Equation of Crown Thrust

$$H_c = \frac{\int\frac{ds}{I}\int my\frac{ds}{I} - \int m\frac{ds}{I}\int y\frac{ds}{I}}{2\left[\int\frac{ds}{I}\int y^2\frac{ds}{I} - \left(\int y\frac{ds}{I}\right)^2\right]} = \frac{A}{B}, \quad B = 2\left[1086.73\times4670.45 - 1385.78^2\right] = 6,310,263.84$$

| Loaded Point | $\int\frac{ds}{I}$ | $\int my\frac{ds}{I}$ | Product | $\int m\frac{ds}{I}$ | $\int y\frac{ds}{I}$ | Product | A | B | Hc | |
|---|---|---|---|---|---|---|---|---|---|---|
| Crown | 1086.73 | 17,209.98 | 18,702,601.57 | 7,129.73 | 1,385.78 | 9880,237.24 | 8,822,364.33 | 6,310,263.84 | 1.3981 ✓ | cr |
| 6 | 〃 | 15,195.85 | 16,513,786.07 | 5652.28 | 〃 | 7,832,816.58 | 8680,969.49 | 〃 | 1.3757 ✓ | 6 |
| 5 | 〃 | 11,158.97 | 12,126,787.47 | 3354.19 | 〃 | 4648,169.42 | 7,478,618.05 | 〃 | 1.1852 ✓ | 5 |
| 4 | 〃 | 7,393.95 | 8,035,227.28 | 1806.72 | 〃 | 2,503,716.44 | 5,531,510.84 | 〃 | 0.8766 ✓ | 4 |
| 3 | 〃 | 4200.49 | 4,564,798.50 | 843.91 | 〃 | 1,169,473.60 | 3,395,324.90 | 〃 | 0.5381 ✓ | 3 |
| 2 | 〃 | 1,832.63 | 1,991,574.00 | 304.84 | 〃 | 422,441.18 | 1,569,132.82 | 〃 | 0.2487 ✓ | 2 |
| 1 | 〃 | 428.80 | 465,989.82 | 57.17 | 〃 | 79,225.04 | 386,764.78 | 〃 | 0.0613 ✓ | 1 |
| Springing | 〃 | 0.00 | 0.00 | 0.00 | 〃 | | 0.00 | 〃 | 0.0000 ✓ | 0 |

**JIUN MASUDA**
CONSULTING ENGINEER
~~[illegible]~~ SHOWA BLDG. TOKYO

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CALCULATIONS FOR

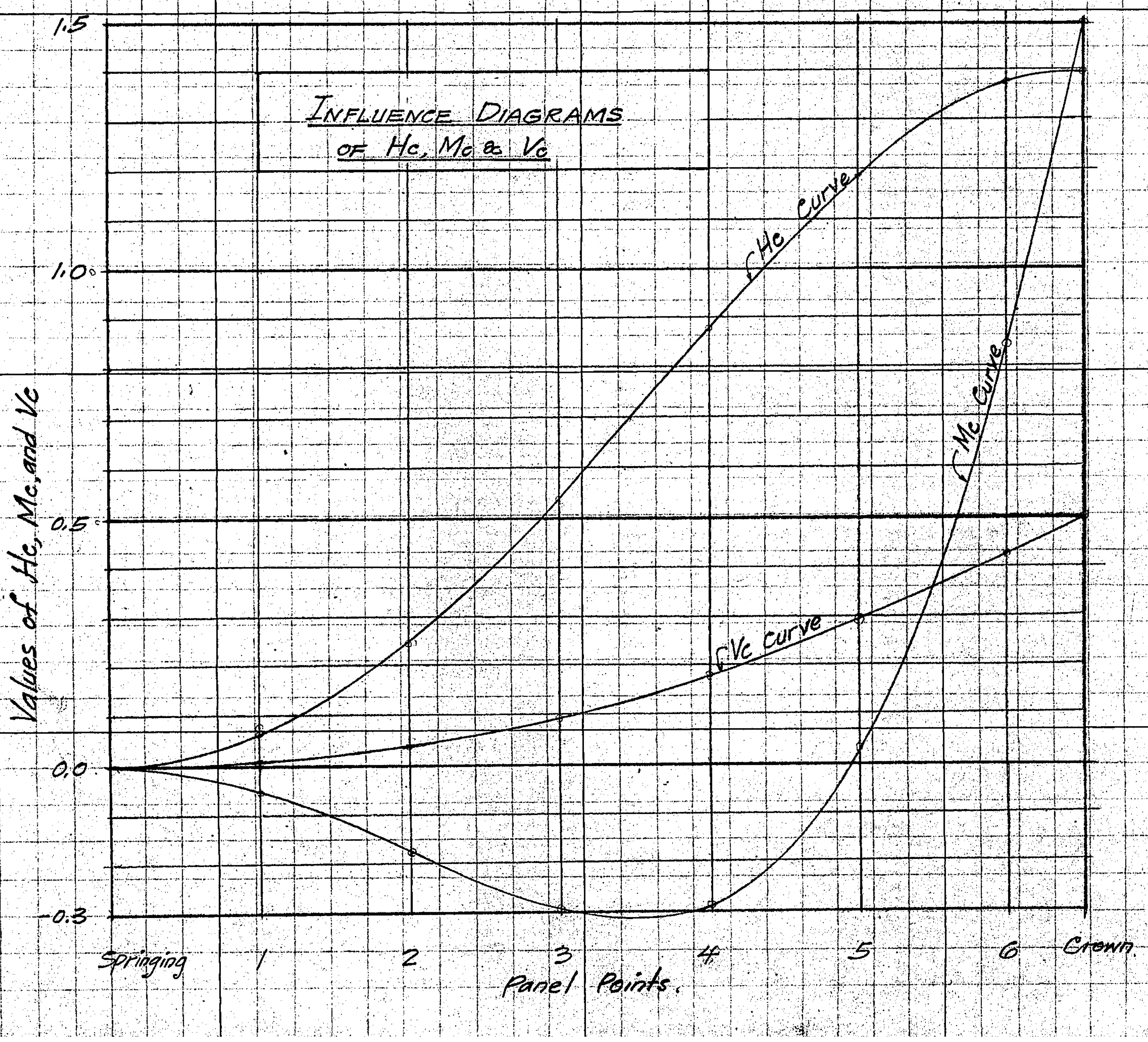
## Design of Sakura Bashi for Chichibu - Cho.

General Equation of Crown Moment $M_c = \frac{-H_c 2\int y\frac{ds}{I} + \int m\frac{ds}{I}}{2\int\frac{ds}{I}} = \frac{C}{D}$, $D = 2\times 1{,}086.73 = 2{,}173.46$

| Loaded points | $-2H_c$ | $\int y\frac{ds}{I}$ | Product | $\int m\frac{ds}{I}$ | C | D | $M_c$ |
|---|---|---|---|---|---|---|---|
| Crown | -2.7962 | 1385.78 | -3874.92 | 7,129.73 | 3254.81 | 2173.46 | + 1.4975 |
| 6 | -2.7514 | 〃 | -3812.84 | 5,652.28 | 1839.44 | 〃 | + 0.8463 |
| 5 | -2.3704 | 〃 | -3284.85 | 3354.19 | 69.34 | 〃 | + 0.0319 |
| 4 | -1.7532 | 〃 | -2429.55 | 1806.72 | - 622.83 | 〃 | - 0.2866 |
| 3 | -1.0762 | 〃 | -1491.38 | 843.91 | - 647.47 | 〃 | - 0.2979 |
| 2 | -0.4974 | 〃 | - 689.29 | 304.84 | - 384.45 | 〃 | - 0.1769 |
| 1 | -0.1226 | 〃 | - 169.90 | 57.17 | - 112.73 | 〃 | - 0.0519 |
| Springing | -0.0000 | 〃 | - 0.00 | 0.00 | 0.00 | 〃 | 0.0000 |

General Equation of Crown Shear $V_c = \frac{\int mx\frac{ds}{I}}{2\int x^2\frac{ds}{I}} = \frac{E}{F}$, $F = 2\times 72{,}427.57 = 144{,}855.14$

| Loaded point | E | F | $V_c$ | Reaction $R_R$ | | | |
|---|---|---|---|---|---|---|---|
| Crown | 72,431.94 | 144,855.14 | 0.5000 | Crown | -0.5000 | 0.5000 | crown |
| 6 | 62,012.57 | 〃 | 0.4281 | $6_L$ | -0.4281 | 0.5719 | $6_R$ |
| 5 | 42,127.85 | 〃 | 0.2908 | $5_L$ | -0.2908 | 0.7092 | $5_R$ |
| 4 | 25,536.77 | 〃 | 0.1763 | $4_L$ | -0.1763 | 0.8237 | $4_R$ |
| 3 | 13,219.03 | 〃 | 0.0913 | $3_L$ | -0.0913 | 0.9087 | $3_R$ |
| 2 | 5,235.72 | 〃 | 0.0361 | $2_L$ | -0.0361 | 0.9639 | $2_R$ |
| 1 | 1086.30 | 〃 | 0.0075 | $1_L$ | -0.0075 | 0.9925 | $1_R$ |
| Springing | 0.00 | 〃 | 0.0000 | $0_L$ | -0.0000 | 1.0000 | $0_R$ |



**JIUN MASUDA**
CONSULTING ENGINEER
~~[illegible]~~ BLDG, TOKYO
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CALCULATIONS FOR

## Design of Sakura-Bashi for Shichiku-Cho.

Influence Surface of moment.

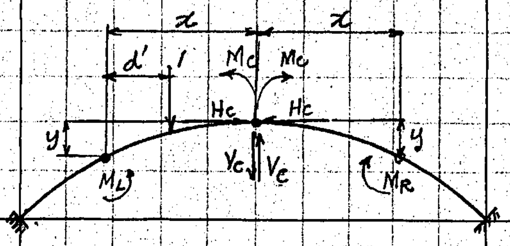
Let $x$ and $y$ be co-ordinates of panel points, origine at crown.

$d'$ = lever arm of unit load about the panel point in consideration.

Moment at

Left hand sections $M_L = M_c + H_c y + V_c x - d'$

Right hand sections $M_R = M_c + H_c y - V_c x$.



Moment at various points.

| Loaded Points | $M_c$ | Panel point 6. | $x=1.462$, $y=0.038$ | | | | Panel point 5. | $x=4.385$, $y=0.348$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $H_c y$ | $V_c x$ | $d'$ | $M_L$ | $M_R$ | $H_c y$ | $V_c x$ | $d'$ | $M_L$ | $M_R$ |
| Crown | +1.4975 | 0.0531 | 0.7310 | 1.462 | 0.8196 | 0.8196 | 0.4865 | 2.1925 | 4.385 | -0.2085 | -0.2085 |
| 6 | +0.8463 | 0.0523 | 0.6259 | 0.000 | 1.5245 | 0.2727 | 0.4787 | 1.8772 | 2.923 | 0.2792 | -0.5522 |
| 5 | +0.0319 | 0.0450 | 0.4251 | | 0.5020 | -0.3482 | 0.4124 | 1.2752 | 0.000 | 1.7195 | -0.8309 |
| 4 | -0.2866 | 0.0333 | 0.2578 | | 0.0045 | -0.5111 | 0.3051 | 0.7731 | | 0.7916 | -0.7546 |
| 3 | -0.2979 | 0.0204 | 0.1335 | | -0.1440 | -0.4110 | 0.1873 | 0.4004 | | 0.2898 | -0.5110 |
| 2 | -0.1769 | 0.0095 | 0.0528 | | -0.1146 | -0.2202 | 0.0865 | 0.1583 | | 0.0679 | -0.2487 |
| 1 | -0.0519 | 0.0023 | 0.0110 | | -0.0386 | -0.0606 | 0.0213 | 0.0329 | | 0.0023 | -0.0635 |
| Springing | 0.0000 | 0.0000 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 0.0000 | | 0.0000 | 0.0000 |

| Points | $M_c$ | Panel Point 4. | $x=7.308$, $y=0.977$ | | | | Panel Point 3. | $x=10.231$, $y=1.950$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crown | +1.4975 | 1.3659 | 3.6540 | 7.308 | -0.7906 | -0.7906 | 2.7263 | 5.1155 | 10.231 | -0.8917 | -0.8917 |
| 6 | +0.8463 | 1.3441 | 3.1286 | 5.846 | -0.5270 | -0.9382 | 2.6826 | 4.3799 | 8.769 | -0.8602 | -0.8510 |
| 5 | +0.0319 | 1.1579 | 2.1252 | 2.923 | 0.3920 | -0.9354 | 2.3111 | 2.9752 | 5.846 | -0.5278 | -0.6322 |
| 4 | -0.2866 | 0.8564 | 1.2884 | 0.000 | 1.8582 | -0.7186 | 1.7094 | 1.8037 | 2.923 | 0.3035 | -0.3809 |
| 3 | -0.2979 | 0.5257 | 0.6672 | | 0.8950 | -0.4394 | 1.0493 | 0.9341 | 0.000 | 1.6855 | -0.1827 |
| 2 | -0.1769 | 0.2430 | 0.2638 | | 0.3299 | -0.1977 | 0.4850 | 0.3693 | | 0.6774 | -0.0612 |
| 1 | -0.0519 | 0.0599 | 0.0548 | | 0.0628 | -0.0468 | 0.1195 | 0.0767 | | 0.1443 | -0.0091 |
| Springing | 0.0000 | 0.0000 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 0.0000 | | 0.0000 | 0.0000 |

| Points | $M_c$ | Panel Point 2. | $x=13.154$, $y=3.307$ | | | | Panel Point 1. | $x=16.077$, $y=5.116$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crown | + 1.4975 | 4.6235 | 6.5770 | 13.154 | -0.4560 | -0.4560 | 7.1527 | 8.0385 | 16.077 | 0.6117 | 0.6117 |
| 6 | + 0.8463 | 4.5494 | 5.6312 | 11.692 | -0.6651 | -0.2355 | 7.0381 | 6.8826 | 14.615 | 0.1520 | 1.0018 |
| 5 | + 0.0319 | 3.9195 | 3.8252 | 8.769 | -0.9924 | 0.1262 | 6.0635 | 4.6752 | 11.692 | -0.9214 | 1.4202 |
| 4 | -0.2866 | 2.8989 | 2.3191 | 5.846 | -0.9146 | 0.2932 | 4.4847 | 2.8344 | 8.769 | -1.7365 | 1.3637 |
| 3 | -0.2979 | 1.7795 | 1.2010 | 2.923 | -0.2404 | 0.2806 | 2.7529 | 1.4678 | 5.846 | -1.9232 | 0.9872 |
| 2 | -0.1769 | 0.8225 | 0.4749 | 0.000 | 1.1205 | 0.1707 | 1.2723 | 0.5804 | 2.923 | -1.2472 | 0.5150 |
| 1 | -0.0519 | 0.2027 | 0.0987 | | 0.2495 | 0.0521 | 0.3136 | 0.1206 | 0.000 | 0.3823 | 0.1411 |
| Springing | 0.0000 | 0.0000 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | 0.0000 | | 0.0000 | 0.0000 |

| Points | $M_c$ | Springing. | $x=19.000$, $y=7.500$ | | | | Crown. | $x=0.000$, $y=0.000$ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crown | + 1.4975 | 10.4858 | 9.5000 | 19.000 | 2.4833 | 2.4833 | | | | 1.4975 | 1.4975 |
| 6 | + 0.8463 | 10.3178 | 8.1339 | 17.538 | 1.7600 | 3.0302 | | | | 0.8463 | 0.8463 |
| 5 | + 0.0319 | 8.8890 | 5.5252 | 14.615 | -0.1689 | 3.3957 | | | | 0.0319 | 0.0319 |
| 4 | -0.2866 | 6.5745 | 3.3497 | 11.692 | -2.0544 | 2.9382 | | | | -0.2866 | -0.2866 |
| 3 | -0.2979 | 4.0358 | 1.7347 | 8.769 | -3.2964 | 2.0032 | | | | -0.2979 | -0.2979 |
| 2 | -0.1769 | 1.8653 | 0.6859 | 5.846 | -3.4717 | 1.0025 | | | | -0.1769 | -0.1769 |
| 1 | -0.0519 | 0.4598 | 0.1425 | 2.923 | -2.3726 | 0.2654 | | | | -0.0519 | -0.0519 |
| Springing | 0.0000 | 0.0000 | 0.0000 | 0.000 | 0.0000 | 0.0000 | | | | 0.0000 | 0.0000 |

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

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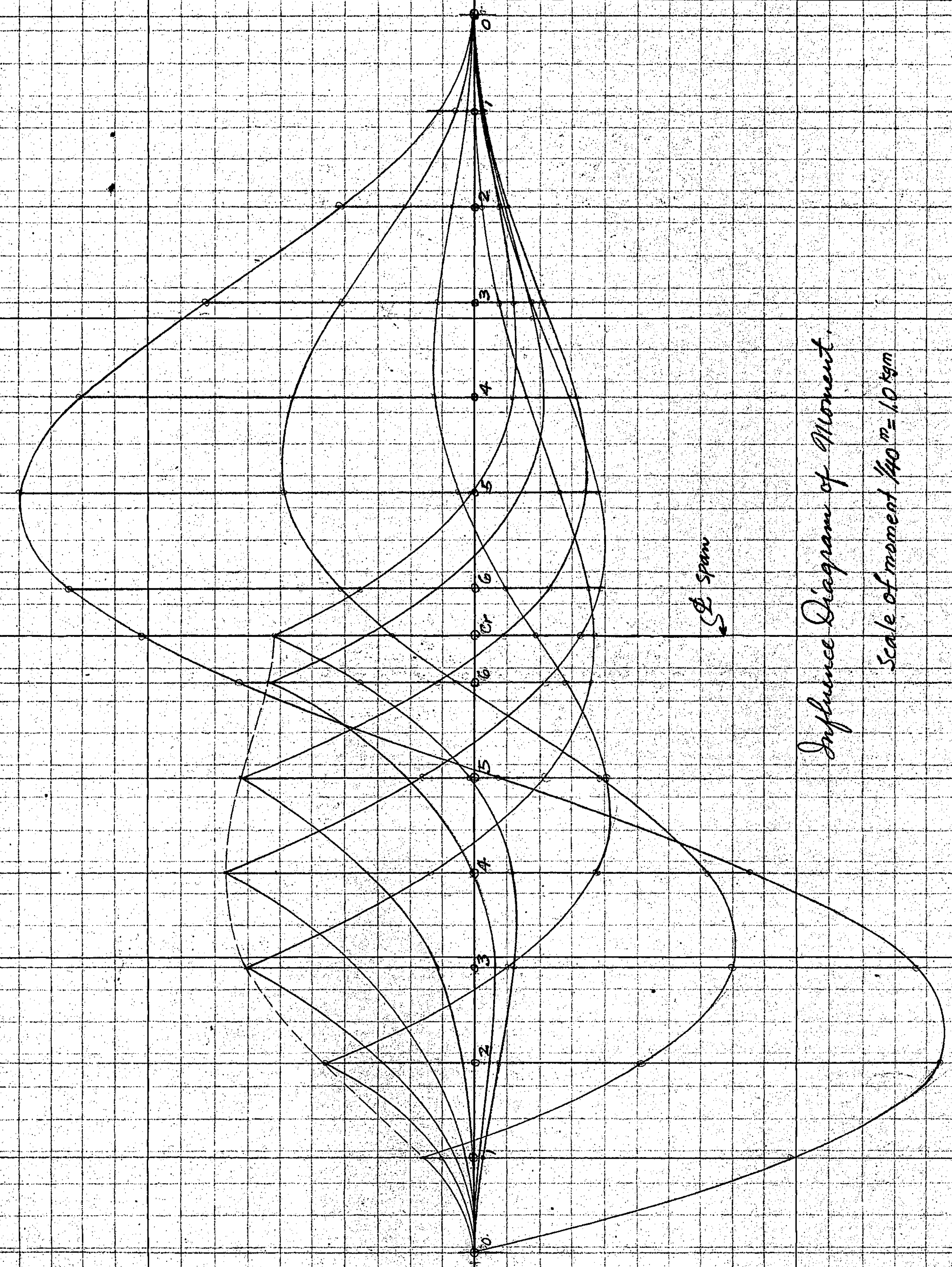
CALCULATIONS FOR

Design of Sakura-Bashi for Chichibu-Cho.



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

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CALCULATIONS FOR

# Design of Sakura-Bashi for Chichibu-Cho.

Dead Load stresses in Arch Ring.
Dead Load moments at several panel points.

| Loaded Points | Dead Load | Crown | | Panel Point 6 | | Panel Point 5 | | Panel point 4 | |
|---|---|---|---|---|---|---|---|---|---|
| | | M unit | M | M unit | M | M unit | M | M unit | M |
| Springing | 9400 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 | 0 |
| 1 | 11,300 | -0.0519 | - 590 | -0.0386 | - 440 | 0.0023 | 30 | 0.0628 | 710 |
| 2 | 9,500 | -0.1769 | - 1,680 | -0.1146 | - 1,090 | 0.0679 | 650 | 0.3299 | 3,130 |
| 3 | 8,000 | -0.2979 | - 2,380 | -0.1440 | - 1,150 | 0.2898 | 2,320 | 0.8950 | 7,160 |
| 4 | 7,600 | -0.2866 | - 2,180 | 0.0045 | 30 | 0.7916 | 6010 | 1.8582 | 14,120 |
| 5 | 6,600 | 0.0319 | 210 | 0.5020 | 3,310 | 1.7195 | 11,350 | 0.3920 | 2,590 |
| 6 | 4,500 | 0.8463 | 3,810 | 1.5245 | 6,860 | 0.2792 | 1,260 | -0.5270 | - 2,370 |
| Crown | 3,000 | 1.4975 | 4,490 | 0.8196 | 2,460 | -0.2085 | - 630 | -0.7906 | - 2,370 |
| 6 | 4,500 | 0.8463 | 3,810 | 0.2727 | 1,230 | -0.5522 | - 2,490 | -0.9382 | - 4,220 |
| 5 | 6,600 | 0.0319 | 210 | -0.3482 | - 2,300 | -0.8309 | - 5,480 | -0.9354 | - 6,170 |
| 4 | 7,600 | -0.2866 | - 2,180 | -0.5111 | - 3,880 | -0.7546 | - 5,740 | -0.7186 | - 5,460 |
| 3 | 8,000 | -0.2979 | - 2,380 | -0.4110 | - 3,290 | -0.5110 | - 4,090 | -0.4394 | - 3,510 |
| 2 | 9,500 | -0.1769 | - 1,680 | -0.2202 | - 2,090 | -0.2487 | - 2,360 | -0.1977 | - 1,880 |
| 1 | 11,300 | -0.0519 | - 590 | -0.0606 | - 690 | -0.0635 | - 720 | -0.0468 | - 530 |
| Springing | 9400 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 | 0 |
| | | Σ + moment | + 12,530 | | + 13,890 | | + 21,620 | | + 27,710 |
| | | Σ - 〃 | - 13,660 | | - 14,930 | | - 21,510 | | - 26,510 |
| | | Summary | - 1,130 kgm | | - 1,040 kgm | | + 110 kgm | | + 1,200 kgm |

| Loaded Points | Dead Load | Panel Point 3 | | Panel Point 2 | | Panel Point 1 | | Springing | |
|---|---|---|---|---|---|---|---|---|---|
| | | M unit | M | M unit | M | M unit | M | M unit | M |
| Springing | 9400 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 | 0 |
| 1 | 11,300 | 0.1443 | 1,630 | 0.2495 | 2,820 | 0.3823 | 4,320 | -2.3726 | -26,800 |
| 2 | 9,500 | 0.6774 | 6,430 | 1.1205 | 10,650 | -1.2472 | - 11,850 | -3.4717 | -33,000 |
| 3 | 8,000 | 1.6855 | 13,480 | -0.2404 | - 1,920 | -1.9232 | - 15,390 | -3.2964 | - 26,370 |
| 4 | 7,600 | 0.3035 | 2,310 | -0.9146 | - 6,950 | -1.7365 | - 13,200 | -2.0544 | - 15,600 |
| 5 | 6,600 | -0.5278 | - 3,480 | -0.9924 | - 6,550 | -0.9214 | - 6,080 | -0.1689 | - 1,110 |
| 6 | 4,500 | -0.8602 | - 3,870 | -0.6651 | - 2,990 | 0.1520 | 680 | 1.7600 | 7,920 |
| Crown | 3,000 | -0.8917 | - 2,670 | -0.4560 | - 1,370 | 0.6117 | 1,840 | 2.4833 | 7,450 |
| 6 | 4,500 | -0.8510 | - 3,830 | -0.2355 | - 1,060 | 1.0018 | 4,510 | 3.0302 | 13,650 |
| 5 | 6,600 | -0.6322 | - 4,170 | 0.1262 | 830 | 1.4202 | 9,370 | 3.3957 | 22,400 |
| 4 | 7,600 | -0.3809 | - 2,890 | 0.2932 | 2,230 | 1.3637 | 10,360 | 2.9382 | 22,330 |
| 3 | 8,000 | -0.1827 | - 1,460 | 0.2806 | 2,250 | 0.9872 | 7,900 | 2.0032 | 16,030 |
| 2 | 9,500 | -0.0612 | - 580 | 0.1707 | 1,620 | 0.5150 | 4,890 | 1.0025 | 9,520 |
| 1 | 11,300 | -0.0091 | - 100 | 0.0521 | 590 | 0.1411 | 1,600 | 0.2654 | 3,000 |
| Springing | 9400 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 | 0 | 0.0000 | 0 |
| | | Σ + moment | + 23,850 | | + 20,990 | | + 45,470 | | + 102,300 |
| | | Σ - 〃 | - 23,050 | | - 20,840 | | - 46,520 | | - 102,880 |
| | | Summary | + 800 kgm | | + 150 kgm | | - 1,050 kgm | | - 580 kgm |

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

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CALCULATIONS FOR

Design of Sakura-Bashi for Chichibu-Cho.

Dead Load Horizontal Thrust

| Loaded points | | Dead Load | H unit | H. |
|---|---|---|---|---|
| Crown | $\frac{1}{2}$×3000 = | 1,500 | 1.3981 | 2,095 |
| 6 | | 4,500 | 1.3757 | 6,190 |
| 5 | | 6,600 | 1.1852 | 7,820 |
| 4 | | 7,600 | 0.8766 | 6,660 |
| 3 | | 8,000 | 0.5381 | 4,310 |
| 2 | | 9,500 | 0.2487 | 2,365 |
| 1 | | 11,300 | 0.0613 | 690 |
| Springing | | 9,400 | 0.0000 | 0 |
| | | 58,400 kg | | 30,130 |

Dead Load Thrust = 30130 × 2 = 60,260 kg

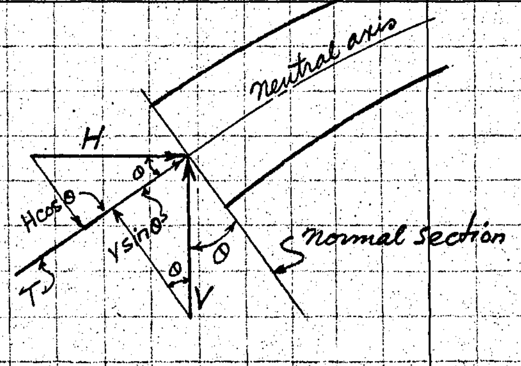
Dead Load Vertical Shear.

| Reaction | | Σ Loads | | V |
|---|---|---|---|---|
| 58,400 | − | 56,900 | = | 1,500 |
| 〃 | | 52,400 | | 6,000 |
| 〃 | | 45,800 | | 12,600 |
| 〃 | | 38,200 | | 20,200 |
| 〃 | | 30,200 | | 28,200 |
| 〃 | | 20,700 | | 37,700 |
| 〃 | | 9,400 | | 49,000 |
| 〃 | | — | | 58,400 |

Dead Load Normal Thrust.

$$T = H\cos\theta + V\sin\theta$$

where
H = Horizontal thrust,
V = vertical shear,
T = normal thrust,
θ = angle between plane of section and vertical



| Panel Points | Hor. thrust H | Cos θ | Vert. shear V | sin θ | H cos θ | V sin θ | Normal thrust T |
|---|---|---|---|---|---|---|---|
| Crown | 60,260 | 1.000 | 1,500 | 0.000 | 60,260 | 0 | 60,260 kg |
| 6 | 〃 | 0.998 | 6,000 | 0.052 | 60,100 | 310 | 60,410 |
| 5 | 〃 | 0.988 | 12,600 | 0.155 | 59,500 | 1,950 | 61,450 |
| 4 | 〃 | 0.968 | 20,200 | 0.260 | 58,300 | 5,250 | 63,550 |
| 3 | 〃 | 0.932 | 28,200 | 0.365 | 56,100 | 10,300 | 66,400 |
| 2 | 〃 | 0.885 | 37,700 | 0.474 | 53,300 | 17,880 | 71,180 |
| 1 | 〃 | 0.820 | 49,000 | 0.575 | 49,400 | 28,200 | 77,600 |
| Springing | 〃 | 0.729 | 58,400 | 0.682 | 43,900 | 39,800 | 83,700 |

Summary of Dead Load Stresses.

| Panel points | Positive moment | negative moment | Normal thrust |
|---|---|---|---|
| Crown | — | − 1,130 kgm | 60,260 kg |
| 6 | — | − 1,040 | 60,410 |
| 5 | + 110 kgm | — | 61,450 |
| 4 | + 1,200 | — | 63,550 |
| 3 | + 800 | — | 66,400 |
| 2 | + 150 | — | 71,180 |
| 1 | — | − 1050 | 77,600 |
| Springing | — | − 580 | 83,700 |

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

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CALCULATIONS FOR

Design of Sakura-Bashi for Chichibu-Cho.

Live Load stresses in arch Ring.

Truck Load. 40 ton motor truck rear wheel concentration 1,500

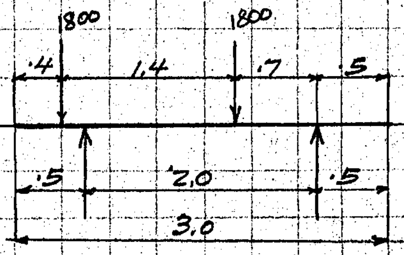
Impact coef. $= \frac{20}{60+38} = 20\ \%$ 300

1800 kg

front wheel with impact say 1,800 ÷ 3 = 600 "

max. concentration on one arch ring.

Rear wheel



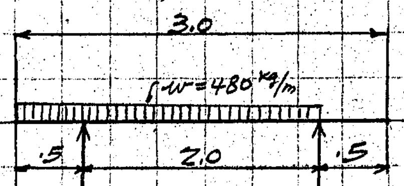
1800 × 0.70 ÷ 2.0 = 630
1800 × 2.10 ÷ 2.0 = 1890
2520 kg

Front wheel 2520 ÷ 3 = 840 "

Uniform Live Load.

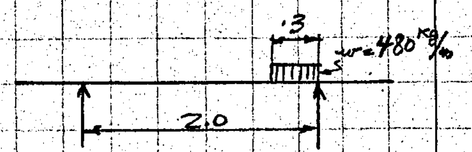
$w = \frac{100,000}{170+38} = 480$ kg per square meter.

max. load on one arch ring.



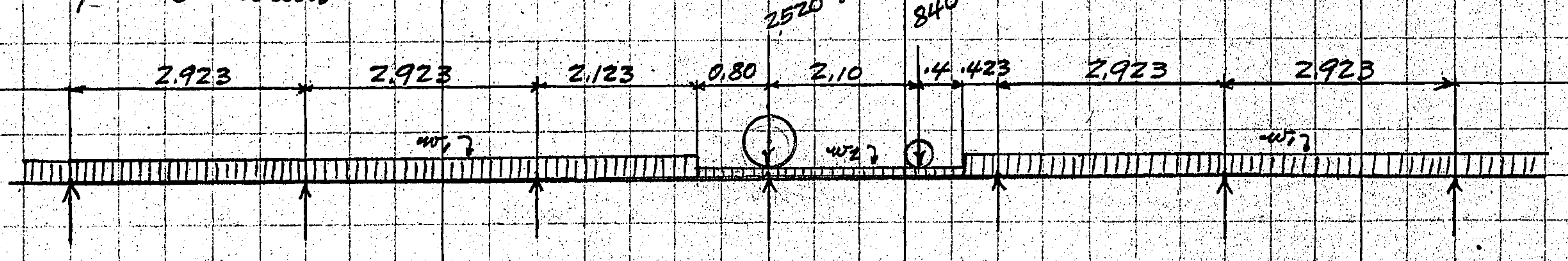
$w_1 = \frac{1}{2\times2.0} \times 480 \times 2.5^2 = 750$ kg per lin. meter on front + rear of truck

$w_2 = \frac{1}{2\times2.0} \times 480 \times 0.3^2 = 10$ " " " on sides of truck.



$\frac{1}{2} \times 750 \times 2.923 =$
750 × 0.423 = 320
750 × 2.123 = 1,590
10 × 2.5 = 25
10 × 0.8 = 8

Panel Loads.



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1100 | 1100 | 1100 | 23 | 297 | 1100 | 1100 | unif. load $w_1$ |
| 1100 | 1100 | 1012 | 578 | 1100 | 1100 | 1100 | " " |
| | | | 14 | 11 | | | " $w_2$ |
| | | 1 | 7 | | | | " " |
| | | | 237 | 603 | | | front wheel |
| | | | 2520 | | | | rear wheel |
| 2200 | 2200 | 2113 | 3379 | 2011 | 2200 | 2200 | Summary |
| | | -87 | +1,179 | -189 | | | |

Let us assume a uniform panel load of 2200 kg throughout and an extra single concentration of 1100 kg at the panel point at which the max. moment is desired, except as follows.

for crown panel load $= 2200 \times \frac{1}{2} = 1,100$ kg
panel pt. 6 " $= 2200 \times \frac{3}{4} = 1,650$ "

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

CALCULATIONS FOR

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Design of Sakura-Bashi for Chichibu-Cho.

Maximum live load moments and its corresponding normal thrusts.

Crown section.

Positive moment.

| Loaded Points | Loads | M unit | M | H unit | H | V unit | V | Normal thrust |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | H.cosθ = |
| 5L | 2200 | 0.0319 | 70 | 1.1852 | 2610 | -0.2908 | - 640 | 12840×1.000 = 12840 |
| 6L | 1650 | 0.8463 | 1400 | 1.3757 | 2270 | - 0.4281 | - 710 | Vsinθ = |
| Crown | 1100 | 1.4975 | 1650 | 1.3981 | 1540 | +0.5000 | + 550 | 1100×0.000 = 0 |
| 〃 | 1100 | 〃 | 1650 | 〃 | 1540 | + 〃 | + 550 | 12840 kg |
| 6R | 1650 | 0.8463 | 1400 | 1.3757 | 2270 | +0.4281 | + 710 | |
| 5R | 2200 | 0.0319 | 70 | 1.1852 | 2610 | +0.2908 | + 640 | |
| | | | 6240 kgm | | 12840 kg | | +1100 kg | |

negative moment.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1L | 2200 | -0.0519 | - 110 | 0.0613 | 130 | -0.0075 | - 20 | normal thrust |
| 2L | 〃 | -0.1769 | - 390 | 0.2487 | 550 | -0.0361 | - 80 | |
| 3L | 3300 | -0.2979 | - 990 | 0.5381 | 1780 | -0.0913 | - 300 | 8190 |
| 4L | 2200 | -0.2866 | - 630 | 0.8766 | 1930 | -0.1763 | - 390 | 0 |
| 4R | 〃 | -0.2866 | - 630 | 0.8766 | 1930 | 0.1763 | 390 | 8190 kg |
| 3R | 〃 | -0.2979 | - 660 | 0.5381 | 1190 | 0.0913 | 200 | |
| 2R | 〃 | -0.1769 | - 390 | 0.2487 | 550 | 0.0361 | 80 | |
| 1R | 〃 | -0.0519 | - 110 | 0.0613 | 130 | 0.0075 | 20 | |
| | | | - 3910 kgm | | 8190 kg | | - 100 kg | |

Panel point 6.

Positive moment

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4L | 2200 | 0.0045 | 10 | 0.8766 | 1930 | - 0.1763 | - 390 | Normal thrust |
| 5L | 〃 | 0.5020 | 1100 | 1.1852 | 2610 | -0.2908 | - 640 | Hcosθ = |
| 6L | 1650 | 1.5245 | 2520 | 1.3757 | 2270 | 0.5719 | 940 | 12140×0.998 = 12120 |
| 〃 | 1100 | 〃 | 1680 | 〃 | 1520 | 〃 | 630 | Vsinθ = |
| Crown | 1100 | 0.8196 | 900 | 1.3981 | 1540 | 0.5000 | 550 | 1800×0.052 = 90 |
| 6R | 1650 | 0.2727 | 450 | 1.3757 | 2270 | 0.4281 | 710 | 12210 kg |
| | | | 6660 kgm | | 12140 kg | | 1800 kg | |

Negative moment.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1L | 2200 | -0.0386 | - 90 | 0.0613 | 130 | -0.0075 | - 20 | normal thrust |
| 2L | 〃 | -0.1146 | - 250 | 0.2487 | 550 | -0.0361 | - 80 | |
| 3L | 〃 | -0.1440 | - 320 | 0.5381 | 1190 | -0.0913 | - 200 | 9230×0.998 = 9210 |
| 5R | 〃 | -0.3482 | - 770 | 1.1852 | 2610 | 0.2908 | 640 | 1220×0.052 = 60 |
| 4R | 3300 | -0.5111 | -1690 | 0.8766 | 2890 | 0.1763 | 580 | 9270 kg |
| 3R | 2200 | -0.4110 | - 900 | 0.5381 | 1190 | 0.0913 | 200 | |
| 2R | 〃 | -0.2202 | - 480 | 0.2487 | 550 | 0.0361 | 80 | |
| 1R | 〃 | -0.0606 | - 130 | 0.0613 | 130 | 0.0075 | 20 | |
| | | | -4630 kgm | | 9230 kg | | 1220 kg | |

Panel point 5

Positive moment.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1L | 2200 | 0.0023 | 10 | 0.0613 | 140 | - 0.0075 | - 20 | normal thrust |
| 2L | 〃 | 0.0679 | 150 | 0.2487 | 550 | -0.0361 | - 80 | |
| 3L | 〃 | 0.2898 | 640 | 0.5381 | 1190 | -0.0913 | - 200 | 10750× 0.988 = 10620 |
| 4L | 〃 | 0.7916 | 1740 | 0.8766 | 1930 | -0.1763 | - 390 | 3460× 0.155 = 540 |
| 5L | 3300 | 1.7195 | 5670 | 1.1852 | 39[illegible] | 0.7092 | 2340 | 11160 kg |
| 6L | 2200 | 0.2792 | 610 | 1.3757 | 3030 | 0.8237 | 1810 | |
| | | | 8820 kgm | | 10750 kg | | 3460 kg | |

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Panel point 5

Negative moment.

| Loaded Points | Loads | M Unit | M. | H Unit | H | V Unit | V | normal thrust |
|---|---|---|---|---|---|---|---|---|
| Crown | 1100 | −0.2085 | −230 | 1.3981 | 1540 | 0.5000 | 550 | 11530 × 0.988 = 11400 |
| 6R | 1650 | −0.5522 | −910 | 1.3757 | 2270 | 0.4281 | 710 | 2910 × 0.155 = 450 |
| 5R | 3300 | −0.8309 | −2740 | 1.1852 | 3910 | 0.2908 | 960 | 11850 kg |
| 4R | 2200 | −0.7546 | −1660 | 0.8766 | 1930 | 0.1763 | 390 | |
| 3R | 2200 | −0.5110 | −1130 | 0.5381 | 1190 | 0.0913 | 200 | |
| 2R | 2200 | −0.2487 | −550 | 0.2487 | 550 | 0.0361 | 80 | |
| 1R | 2200 | −0.0635 | −140 | 0.0613 | 140 | 0.0075 | 20 | |
| | | | −7360 kgm | | 11530 kg | | 2910 kg | |

Panel point 4.

Positive moment.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1L | 2200 | 0.0628 | 140 | 0.0613 | 140 | −0.0075 | −20 | normal thrust |
| 2L | 〃 | 0.3299 | 730 | 0.2487 | 550 | −0.0361 | −80 | 7380 × 0.968 = 7140 |
| 3L | 〃 | 0.8950 | 1970 | 0.5381 | 1190 | −0.0913 | −200 | 3980 × 0.260 = 1040 |
| 4L | 3300 | 1.8582 | 6130 | 0.8766 | 2890 | 0.8237 | 2720 | 8180 kg |
| 5L | 2200 | 0.3920 | 860 | 1.1852 | 2610 | 0.7092 | 1560 | |
| | | | 9830 kgm | | 7380 kg | | 3980 kg | |

Negative moment.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6L | 1650 | −0.5270 | −870 | 1.3757 | 2270 | 0.5719 | 940 | normal thrust |
| Crown | 1100 | −0.7906 | −870 | 1.3981 | 1540 | 0.5000 | 550 | |
| 6R | 2750 | −0.9382 | −2580 | 1.3757 | 3780 | 0.4281 | 1180 | 14010 × 0.968 = 13560 |
| 5R | 2200 | −0.9354 | −2060 | 1.1852 | 2610 | 0.2908 | 640 | 4000 × 0.260 = 1040 |
| 4R | 〃 | −0.7186 | −1580 | 0.8766 | 1930 | 0.1763 | 390 | 14600 kg |
| 3R | 〃 | −0.4394 | −970 | 0.5381 | 1190 | 0.0913 | 200 | |
| 2R | 〃 | −0.1977 | −440 | 0.2487 | 550 | 0.0361 | 80 | |
| 1R | 〃 | −0.0468 | −100 | 0.0613 | 140 | 0.0075 | 20 | |
| | | | −9470 kgm | | 14010 kg | | 4000 kg | |

Panel Point 3.

Positive moment

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1L | 2200 | 0.1443 | 320 | 0.0613 | 140 | −0.0075 | 20 | Normal thrust |
| 2L | 〃 | 0.6774 | 1490 | 0.2487 | 550 | −0.0361 | 80 | |
| 3L | 3300 | 1.6855 | 5560 | 0.5381 | 1780 | 0.9087 | 3000 | 4400 × 0.932 = 4100 |
| 4L | 2200 | 0.3035 | 670 | 0.8766 | 1930 | 0.8237 | 1810 | 4910 × 0.365 = 1790 |
| | | | 8040 kgm | | 4400 kg | | 4910 kg | 5890 kg |

Negative moment.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5L | 2200 | −0.5278 | −1160 | 1.1852 | 2610 | 0.7092 | 1560 | normal thrust |
| 6L | 1650 | −0.8602 | −1420 | 1.3757 | 2270 | 0.5719 | 940 | |
| Crown | 2200 | −0.8917 | −1960 | 1.3981 | 3080 | 0.5000 | 1100 | 16650 × 0.932 = 15520 |
| 6R | 1650 | −0.8510 | −730 | 1.3757 | 2270 | 0.4281 | 710 | 5640 × 0.365 = 2060 |
| 5R | 2200 | −0.6322 | −1390 | 1.1852 | 2610 | 0.2908 | 640 | 17580 kg |
| 4R | 〃 | −0.3809 | −840 | 0.8766 | 1930 | 0.1763 | 390 | |
| 3R | 〃 | −0.1827 | −400 | 0.5381 | 1190 | 0.0913 | 200 | |
| 2R | 〃 | −0.0612 | −130 | 0.2487 | 550 | 0.0361 | 80 | |
| 1R | 〃 | −0.0091 | −20 | 0.0613 | 140 | 0.0075 | 20 | |
| | | | −8050 kgm | | 16650 kg | | 5640 kg | |

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CALCULATIONS FOR

## Design of Sakura-Bashi for Chichibu Cho.

### Panel Point 2

Positive moment

| Loaded Points | Loads | M unit | M | H unit | H | V unit | V | Normal thrust |
|---|---|---|---|---|---|---|---|---|
| 1L | 2200 | 0.2495 | 550 | 0.0613 | 140 | -0.0075 | - 20 | 7380× 0.885 = 6530 |
| 2L | 3300 | 1.1205 | 3700 | 0.2487 | 820 | 0.9639 | 3,180 | 4490× 0.474 = 2130 |
| 5R | 2200 | 0.1262 | 280 | 1.1852 | 2,610 | 0.2908 | 640 | 8,660 kg |
| 4R | 〃 | 0.2932 | 650 | 0.8766 | 1,930 | 0.1763 | 390 | |
| 3R | 〃 | 0.2806 | 620 | 0.5381 | 1,190 | 0.0913 | 200 | |
| 2R | 〃 | 0.1707 | 380 | 0.2487 | 550 | 0.0361 | 80 | |
| 1R | 〃 | 0.0521 | 110 | 0.0613 | 140 | 0.0075 | 20 | |
| | | | 6,290 kgm | | 7,380 kg | | 4490 kg | |

Negative moment.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3L | 2200 | -0.2404 | -530 | 0.5381 | 1,190 | 0.9087 | 2,000 | Normal thrust |
| 4L | 〃 | -0.9146 | -2,010 | 0.8766 | 1,930 | 0.8237 | 1,810 | |
| 5L | 3300 | -0.9924 | -3,280 | 1.1852 | 3,910 | 0.7092 | 2,340 | 13110×0.885 = 11,600 |
| 6L | 1650 | -0.6651 | -1,100 | 1.3757 | 2,270 | 0.5719 | 940 | 8350×0.474 = 3960 |
| Crown | 1100 | -0.4560 | - 500 | 1.3981 | 1,540 | 0.5000 | 550 | 15,560 kg |
| 6R | 1650 | -0.2355 | - 390 | 1.3757 | 2,270 | 0.4281 | 710 | |
| | | | -7,810 kgm | | 13,110 kg | | 8,350 kg | |

### Panel Point 1.

Positive moment.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1L | 2200 | 0.3823 | 840 | 0.0613 | 140 | 0.9925 | 2180 | Normal thrust |
| 6L | 1650 | 0.1520 | 250 | 1.3757 | 2270 | 0.5719 | 940 | |
| Crown | 1100 | 0.6117 | 670 | 1.3981 | 1,540 | 0.5000 | 550 | 14710 × 0.820 = 12,070 |
| 6R | 1650 | 1.0018 | 1650 | 1.3757 | 2270 | 0.4281 | 710 | 13940× 0.575 = 8,020 |
| 5R | 3300 | 1.4202 | 4,690 | 1.1852 | 3,910 | 0.2908 | 960 | 20,090 kg |
| 4R | 2200 | 1.3637 | 3,000 | 0.8766 | 1,930 | 0.1763 | 390 | |
| 3R | 〃 | 0.9872 | 2170 | 0.5381 | 1,190 | 0.0913 | 200 | |
| 2R | 〃 | 0.5150 | 1130 | 0.2487 | 550 | 0.0361 | 80 | |
| 1R | 〃 | 0.1411 | 310 | 0.0613 | 140 | 0.0075 | 20 | |
| | | | 14,710 kgm | | 13,940 kg | | 6,030 kg | |

Negative moment.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2L | 2200 | -1.2472 | - 2740 | 0.2487 | 550 | 0.9639 | 2120 | Normal thrust |
| 3L | 3300 | -1.9232 | - 6350 | 0.5381 | 1,780 | 0.9087 | 3,000 | |
| 4L | 2200 | -1.7365 | - 3820 | 0.8766 | 1,930 | 0.8237 | 1,810 | 6870× 0.820 = 5630 |
| 5L | 〃 | -0.9214 | - 2030 | 1.1852 | 2610 | 0.7092 | 1560 | 8490× 0.575 = 4880 |
| | | | - 14,940 kgm | | 6,870 kg | | 8490 kg | 10,510 kg |

### Springing

Positive moment.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6L | 1650 | 1.7600 | 2,900 | 1.3757 | 2270 | 0.5719 | 940 | Normal thrust |
| Crown | 1100 | 2.4833 | 2,730 | 1.3981 | 1,540 | 0.5000 | 550 | |
| 6R | 1650 | 3.0302 | 5,000 | 1.3757 | 2270 | 0.4281 | 710 | 13800× 0.729 = 10,050 |
| 5R | 3300 | 3.3957 | 11,200 | 1.1852 | 3,910 | 0.2908 | 960 | 3850× 0.682 = 2630 |
| 4R | 2200 | 2.9382 | 6,460 | 0.8766 | 1,930 | 0.1763 | 390 | 12,680 kg |
| 3R | 〃 | 2.0032 | 4,400 | 0.5381 | 1,190 | 0.0913 | 200 | |
| 2R | 〃 | 1.0025 | 2,200 | 0.2487 | 550 | 0.0361 | 80 | |
| 1R | 〃 | 0.2654 | 580 | 0.0613 | 140 | 0.0075 | 20 | |
| | | | 35,470 kgm | | 13,800 kg | | 3850 kg | |

# Design of Sakura-Bashi for Chichibu-Cho.

Springing.

Negative moment.

| Loaded points | Loads | M unit | M | H unit | H | V unit | V | normal thrust |
|---|---|---|---|---|---|---|---|---|
| 1L | 2,200 | -2.3726 | - 5,220 | 0.0613 | 140 | 0.9925 | 2,180 | 6690 × 0.729 = 4880 |
| 2L | 3,300 | -3.4717 | -11,460 | 0.2487 | 820 | 0.9639 | 3,180 | 10730 × 0.682 = 7,320 |
| 3L | 2,200 | -3.2964 | - 7,150 | 0.5381 | 1,190 | 0.9087 | 2,000 | 12,200 kg |
| 4L | 〃 | -2.0544 | - 4,520 | 0.8766 | 1,930 | 0.8237 | 1,810 | |
| 5L | 〃 | -0.1689 | - 370 | 1.1852 | 2,610 | 0.7092 | 1,560 | |
| | | | - 28,720 kgm | | 6,690 kg | | 10,730 kg | |

Temperature stress in arch ring.

Horizontal thrust

$$H_T = \frac{E\varepsilon t . l \int \frac{ds}{I}}{2\left[\int \frac{ds}{I} \int y^2 \frac{ds}{I} - \left(y \frac{ds}{I}\right)^2\right]} = \frac{G}{B}$$

where $E = 1,400,000,000$ kg/m²
Coef. of exp. $\varepsilon = 0.000012$ for 1°C
variation of temperature assumed as $t = \pm 15°C$
$l$ = span length = 38.000 meters
$E\varepsilon t = \pm 252,000$
$B = 6,310,263.84$

For fall of 15°c in temperature

$$H_T = \frac{-252,000 \times 38.00 \times 1086.73}{6,310,263.84} = -1,650 \text{ kg}$$ for one meter strip of ring.

Crown moment.

$$M_{TC} = -\frac{H_T \int y \frac{ds}{I}}{\int \frac{ds}{I}} = +\frac{1650 \times 1385.78}{1,086.73} = +2,110 \text{ kgm}$$

Temperature stresses at several panel points for 15°c fall.

| | | | | | | | moment | | | | | normal thrust |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Panel points | $M_{TC}$ | | $H_T$ | | $y$ | | $M_T$ | $H_T$ | | $\cos\theta$ | | $T_T$ |
| Crown | 2110 | - | 1650 | × | 0.000 | = | 2,110 kgm | -1,650 | × | 1.000 | = | - 1,650 kg |
| 6 | 〃 | - | 〃 | × | 0.038 | | 2,050 | 〃 | × | 0.998 | = | - 1,650 |
| 5 | 〃 | - | 〃 | × | 0.348 | | 1,540 | 〃 | × | 0.988 | = | - 1,630 |
| 4 | 〃 | - | 〃 | × | 0.977 | | 500 | 〃 | × | 0.968 | = | - 1,600 |
| 3 | 〃 | - | 〃 | × | 1.950 | | - 1,110 | 〃 | × | 0.932 | = | - 1,540 |
| 2 | 〃 | - | 〃 | × | 3.307 | | - 3,340 | 〃 | × | 0.885 | = | - 1,460 |
| 1 | 〃 | - | 〃 | × | 5.116 | | - 6,330 | 〃 | × | 0.820 | = | - 1,350 |
| Springing | 〃 | - | 〃 | × | 7.500 | | - 10,260 | 〃 | × | 0.729 | = | - 1,200 |

Average stresses in arch ring.

Concrete area at crown $0.450 \times 1.000 = 0.450$
Steel area equivallent $0.00456 \times 14 = 0.064$
$0.514$ square meter.

Thickness ratio $= \frac{1.000}{0.450} = 2.22$

Rise ratio $= \frac{7.500}{38.000} = 0.197$

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CALCULATIONS FOR

## Design of Sakura-Bashi for Chichibu-Cho.

Dead Load Average stress.

| D.L. Crown thrust | | crown area | | | Coef. | | Average stress |
|---|---|---|---|---|---|---|---|
| 60,260 | ÷ | 0.514 | = | 117,200 | × 0.940 | = | 110,200 kg/m2 |

Live Load average stress.

| panel points | | H. | | crown area | | | Coef. | | Average stress |
|---|---|---|---|---|---|---|---|---|---|
| Crown | pos. m. | 12840 | ÷ | 0.514 = | 24,970 | × | 0.890 | = | 22,200 kg/m2 |
| 6 | pos. m. | 12,140 | ÷ | 〃 = | 23,600 | × | 0.890 | = | 21,000 |
| 5 | pos. m. | 10,750 | ÷ | 〃 = | 20,900 | × | 0.890 | = | 18600 |
| 4 | pos. m | 7,380 | ÷ | 〃 = | 14,350 | × | 0.890 | = | 12,770 |
| 3 | neg. m. | 16650 | ÷ | 〃 = | 32,400 | × | 0.950 | = | 30,780 |
| 2 | neg. m | 13,110 | ÷ | 〃 = | 25,500 | × | 0.950 | = | 24,240 |
| 1 | pos. m. | 13,940 | ÷ | 〃 = | 27,100 | × | 0.910 | = | 24,680 |
| | neg. m. | 6,870 | ÷ | 〃 = | 13,370 | × | 0.950 | = | 12,700 |
| Springing | pos. m. | 13,800 | ÷ | 〃 = | 26,850 | × | 0.910 | = | 24450 |
| | neg. m. | 6,690 | ÷ | 〃 = | 13,020 | × | 0.950 | = | 12,370 |
| crown | neg. m. | 8190 | ÷ | 〃 = | 15,940 | × | 0.960 | = | 15,300 |

Average temperature stress for 15°c fall.

−1650 ÷ 0.514 = 3,210 × 0.790 = −2,540 kg/m2

Fibre stresses in Arch Ring.

Crown.

Positive moment.

| Loads. | Normal thrust | moment | Average Stress | |
|---|---|---|---|---|
| Dead Load | 60260 | − 1,130 | 110,200 | C |
| Live Load | 12,840 | 6,240 | 22,200 | |
| Rib shortening | − 860 | 1,100 | − 1,320 | R |
| | 72,240 | 6,210 | 131,080 | |

$$R = \frac{\text{Temp.}}{E\varepsilon t + \text{Temp}} \times C = \frac{2540}{252,000 + 2540} C = 0.010\,C$$

$\varepsilon_{cc} = 6210/72,240 = 0.086$, $\varepsilon/h = .086/.45 = 0.191$, $h = 45\text{cm}$

$d'/h = 5/45 = 0.111$, $P_0 = 45.6/4500 = 0.0101$, $b = 100\text{cm}$

$k = 0.98$, $L = 0.108$

$$f_c = \frac{6210 \times 100}{0.108 \times 100 \times 45^2} = 28.4 \text{ kg/cm}^2 < 45$$

$$f_s = 15 \times 28.4 \left(\frac{40}{.98 \times 45} - 1\right) = \text{———}$$

| | | | | |
|---|---|---|---|---|
| Dead Load | 60260 | − 1,130 | 110,200 | C |
| Live Load | 12,840 | 6240 | 22200 | |
| Temperature | − 1,650 | 2110 | − 2540 | |
| Rib shortening | − 840 | 1080 | − 1300 | R |
| | 70,610 | 8300 | 128560 | |

$\varepsilon_{cc} = 8300/70610 = 0.118$, $\varepsilon/h = 11.8/45 = 0.262$

$k = 0.81$, $L = 0.122$

$$f_c = \frac{8300 \times 100}{0.122 \times 100 \times 45^2} = 33.6 \text{ kg/cm}^2 < 56.$$

$$f_s = 15 \times 33.6 \left(\frac{40}{.81 \times 45} - 1\right) = 50 \;〃 < 1500$$

Negative moment.

| | | | |
|---|---|---|---|
| Dead Load | 60260 | − 1130 | 110200 |
| Live Load | 8190 | − 3910 | 15300 |
| Rib shortening | − 820 | + 1050 | − 1260 |
| | 57,630 | − 3,990 | 124,240 |

$\varepsilon_{cc} = 0.069$ $\varepsilon/h = 0.153$

| | | | |
|---|---|---|---|
| Dead Load | 60260 | − 1130 | 110,200 |
| Live Load | 8190 | − 3910 | 15,300 |
| Temperature | 1650 | − 2110 | 2,540 |
| Rib shortening | − 830 | + 1060 | − 1,280 |
| | 69270 | − 6090 | 126,760 |

$\varepsilon_{cc} = 0.088$ $\varepsilon/h = 0.195$

It is unnecessary to investigate more.

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CALCULATIONS FOR

## Design of Sakura-Bashi for Chichibu-Cho

### Panel Point 6. Positive moment.

| Loads | Normal thrust | moment | Average stress |
|---|---|---|---|
| Dead Load | 60410 | −1,040 | 110,200 |
| Live Load | 12,210 | 6,660 | 21,000 |
| Rib Shortening | − 850 | 1060 | − 1,310 |
| | 71,770 | 6680 | 129,890 |

$\xi_{cc} = 0.093$, $\xi/h = 9.3/454 = 0.205$, $h = 45.4$ cm
$d'/h = 5/45.4 = 0.110$, $P_0 = 45.61/4540 = 0.010$, $b = 100$ cm
$K = 0.95$, $L = 0.111$
$f_c = \frac{6680\times100}{0.111\times100\times45.4^2} = 29.2$ kg/cm² ✓
$f_s = 15\times29.2\left(\frac{40.4}{.95\times45.4}-1\right) =$ ——

| | | | |
|---|---|---|---|
| Dead Load | 60,410 | −1,040 | 110,200 |
| Live Load | 12210 | 6660 | 21,000 |
| Temperature | −1,650 | 2050 | − 2,540 |
| Rib shortening | − 840 | 1040 | − 1290 |
| | 70,130 | 8,710 | 127,370 |

$\xi_{cc} = 0.124$, $\xi/h = 12.4/45.4 = 0.273$,
$K = 0.79$, $L = 0.123$
$f_c = \frac{8710\times100}{0.123\times100\times45.4^2} = 34.4$ kg/cm²
$f_s = 15\times34.4\left(\frac{40.4}{.79\times45.4}\overset{.13}{-}1\right) = 67$ kg/cm²

### Panel Point 5. Positive moment.

| | | | |
|---|---|---|---|
| Dead Load | 61,450 | 110 | 110,200 |
| Live Load | 11,160 | 8,820 | 18,600 |
| Rib Shortening | − 830 | 780 | −1,290 |
| | 71,780 | 9,710 | 127,510 |

$\xi_{cc} = 0.135$, $\xi/h = 13.5/48 = 0.281$, $h = 48.0$ cm, $b = 100$ cm
$d'/h = 5/48 = 0.104$, $P_0 = 45.61/4800 = 0.0095$
$K = 0.775$, $L = 0.123$
$f_c = \frac{9710\times100}{0.123\times100\times48^2} = 34.2$ kg/cm² $< 45$
$f_s = 15\times34.2\left(\frac{43}{.775\times48}\overset{.16}{-}1\right) = 82$ $< 1,200$

| | | | |
|---|---|---|---|
| Dead Load | 61450 | 110 | 110,200 |
| Live Load | 11,160 | 8820 | 18,600 |
| Temperature | −1,630 | 1,540 | −2,540 |
| Rib shortening | − 810 | 760 | −1,260 |
| | 70,170 | 11,230 | 125,000 |

$\xi_{cc} = 0.160$, $\xi/h = 16/48 = 0.333$
$K = 0.68$, $L = 0.126$
$f_c = \frac{11230\times100}{0.126\times100\times48^2} = 38.7$ kg/cm² $< 56$
$f_s = 15\times38.7\left(\frac{43}{.68\times48}\overset{.32}{-}1\right) = 186$ $< 1500$

### Panel Point 4. Positive moment.

| | | | |
|---|---|---|---|
| Dead Load | 63550 | 1,200 | 110,200 |
| Live Load | 8,180 | 9,830 | 12,770 |
| Rib shortening | − 780 | 240 | − 1,230 |
| | 70950 | 11,270 | 121,740 |

$\xi_{cc} = 0.159$, $\xi/h = 15.9/52.8 = 0.301$, $h = 52.8$ cm, $b = 100$ cm
$d'/h = 5/52.8 = 0.095$, $P_0 = 45.61/5280 = 0.0086$
$K = 0.73$, $L = 0.122$
$f_c = \frac{11270\times100}{0.122\times100\times52.8^2} = 33.1$ kg/cm²
$f_s = 15\times33.1\left(\frac{47.8}{.73\times52.8}\overset{.24}{-}1\right) = 120$ kg/cm²

| | | | |
|---|---|---|---|
| Dead Load | 63550 | 1,200 | 110,200 |
| Live Load | 8180 | 9,830 | 12,770 |
| Temperature | −1600 | 500 | −2,540 |
| Rib shortening | − 760 | 240 | −1,200 |
| | 69,370 | 11770 | 119,230 |

$\xi_{cc} = 0.170$, $\xi/h = 17.0/52.8 = 0.322$
$K = 0.695$, $L = 0.123$
$f_c = \frac{11770\times100}{0.123\times100\times52.8^2} = 34.4$ kg/cm²
$f_s = 15\times34.4\left(\frac{47.8}{.695\times52.8}\overset{.30}{-}1\right) = 155$ kg/cm²

### Panel Point 1. Positive moment.

| | | | |
|---|---|---|---|
| Dead Load | 77,600 | −1,050 | 110,200 |
| Live Load | 20,090 | 14,710 | 24,680 |
| Rib shortening | − 720 | − 3360 | − 1,350 |
| | 96,970 | 10,300 | 133,530 |

$\xi_{cc} = 0.106$, $\xi/h = 10.6/82.6 = 0.128$, $h = 82.6$ cm, $b = 100$ cm
$d'/h = 5/82.6 = 0.0605$, $P_0 = 45.61/8260 = 0.0055$

| | | | |
|---|---|---|---|
| Dead Load | 77,600 | −1050 | 110,200 |
| Live Load | 20,090 | 14,710 | 24,680 |
| Temperature | 1,350 | 6,330 | 2,540 |
| Rib shortening | − 730 | −3,420 | −1,370 |
| | 98,310 | 16,570 | 136,050 |

$\xi_{cc} = 0.169$, $\xi/h = 16.9/82.6 = 0.205$

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CALCULATIONS FOR

Design of Sakura-Bashi for Chichibu-Cho.

Panel Point 1. Negative moment.

| Loads | Normal thrust | moment | Average stress |
|---|---|---|---|
| Dead Load | 77,600 | -1,050 | 110,200 |
| Live Load | 10,510 | -14,940 | 12,700 |
| Rib shortening | -650 | -3,070 | -1,230 |
| | 87,460 | -19,060 | 121,670 |

$\xi_{cc} = 0.207$, $\xi/h = 20.7/82.6 = 0.251$

$k = 0.83$, $L = 0.112$

$f_c = \frac{19060\times100}{0.112\times100\times82.6^2} = 25.0$ kg/cm²

$f_s = 15\times25\left(\frac{77.6}{.83\times82.6}\overset{.13}{-1}\right) = 49.0$ 〃

| | | | |
|---|---|---|---|
| Dead Load | 77,600 | -1,050 | 110200 |
| Live Load | 10,510 | -14,940 | 12700 |
| Temperature | -1,350 | -6,330 | -2,540 |
| Rib shortening | -590 | -2990 | -1200 |
| | 86,170 | -25,310 | 119,160 |

$\xi_{cc} = 0.294$, $\xi/h = 29.4/82.6 = 0.356$

$k = 0.62$, $L = 0.117$

$f_c = \frac{25310\times100}{0.117\times100\times82.6^2} = 31.8$ kg/cm²

$f_s = 15\times31.8\left(\frac{77.6}{.62\times82.6}\overset{.52}{-1}\right) = 248$ 〃

Springing

Positive moment.

| | | | |
|---|---|---|---|
| Dead Load | 83,700 | -580 | 110,200 |
| Live Load | 12,680 | 35,470 | 24450 |
| Rib shortening | -640 | -5450 | -1350 |
| | 95,740 | 29440 | 133,300 |

$\xi_{cc} = 0.308$, $\xi/h = 30.8/100 = 0.308$, $h=100$, $b=100$ cm

$d/h = 5/100 = 0.05$, $p_0 = 45.61/10000 = 0.0045$

$k = 0.69$, $L = 0.113$

$f_c = \frac{29440\times100}{0.113\times100\times100^2} = 26.0$ kg/cm² $< 45$

$f_s = 15\times26\left(\frac{95}{.69\times100}\overset{.38}{-1}\right) = 148$ 〃 $< 1200$

| | | | |
|---|---|---|---|
| Dead Load | 83,700 | -580 | 110,200 |
| Live Load | 12,680 | 35,470 | 24450 |
| Temperature | 1,200 | 10,260 | 2,540 |
| Rib shortening | -650 | -5530 | -1370 |
| | 96,930 | 39,620 | 135820 |

$\xi_{cc} = 0.409$, $\xi/h = 40.9/100 = 0.409$

$k = 0.54$, $L = 0.112$

$f_c = \frac{39620\times100}{0.112\times100\times100^2} = 35.4$ kg/cm² $< 56$

$f_s = 15\times35.4\left(\frac{95}{.54\times100}\overset{.76}{-1}\right) = 404$ kg/cm² $< 1500$

Negative moment.

| | | | |
|---|---|---|---|
| Dead Load | 83700 | -580 | 110,200 |
| Live Load | 12,200 | -28,720 | 12,370 |
| Rib shortening | -590 | -4970 | -1230 |
| | 95,310 | -34,270 | 121,340 |

$\xi_{cc} = 0.360$, $\xi/h = 36/100 = 0.360$

$k = 0.60$, $L = 0.113$

$f_c = \frac{34270\times100}{0.113\times100\times100^2} = 30.3$ kg/cm² $< 45$

$f_s = 15\times30.3\left(\frac{95}{.60\times100}\overset{.585}{-1}\right) = 266$ 〃 $< 1200$

| | | | |
|---|---|---|---|
| Dead Load | 83,700 | -580 | 110,200 |
| Live Load | 12,200 | -28,720 | 12,370 |
| Temperature | -1,200 | -10,260 | -2,540 |
| Rib shortening | -570 | -4,850 | -1,200 |
| | 94,130 | -44,410 | 118,830 |

$\xi_{cc} = 0.472$, $\xi/h = 47.2/100 = 0.472$

$k = 0.47$, $L = 0.110$

$f_c = \frac{44410\times100}{0.110\times100\times100^2} = 40.4$ kg/cm² $< 56$

$f_s = 15\times40.4\left(\frac{95}{.47\times100}\overset{1.02}{-1}\right) = 618$ kg/cm² $< 1500$

MADE BY K. Inaba DATE 9-5-21 FILE NO
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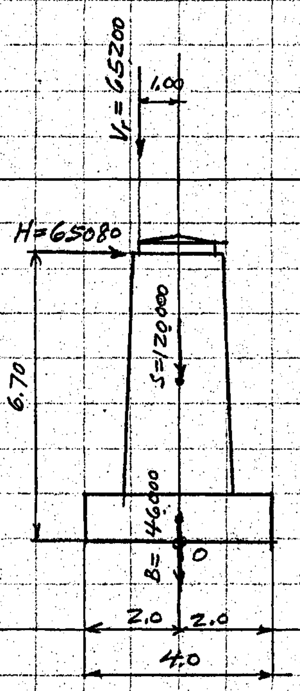
Design of Sakura Bashi for Chichibu – Cho.

Stability of Pier during Erection of Arch Ring.

Horizontal thrust and vertical load on Pier due to arch ring on one side only.

| Loaded Point | Load. | H. unit | Hor. Thrust H |
|---|---|---|---|
| 0 | 4360 | 0.0000 | 0 |
| 1 | 7370 | 0.0613 | 450 |
| 2 | 5750 | 0.2487 | 1430 |
| 3 | 4550 | 0.5381 | 2450 |
| 4 | 3930 | 0.8766 | 3440 |
| 5 | 3420 | 1.1852 | 4060 |
| 6 | 2430 | 1.3757 | 3340 |
| Crown | 790 | 1.3981 | 1100 |
| | 32600 x 2 | | 16270×4 |
| | = 65200 kg | | = 65080 kg for one span of two rings. |



Taking moments at center of base 0.

| Load marks | Horizontal loads | Vertical loads | | arms | | moment about 0. |
|---|---|---|---|---|---|---|
| Vr | | 65200 | × | -1.00 | = | - 65200 |
| S | | 120,000 | × | 0 | = | |
| B | | 46,000 | × | 0 | = | |
| H | 65080 | | × | 6.70 | = | 436000 |
| | 65080 kg | 231200 kg | | 1.60^m | | 370,800 |

Resultant force outside of middle third, neglecting tension,

pressure area = (2.00 - 1.60) × 3 × 4.0 = 4.80 sq. meters.

max. toe pressure = $\frac{231200 \times 2}{4.80}$ = 96400 kg/m2 (8.8 tons/□')

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

CALCULATIONS FOR

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昭和九年六月

埼玉縣
秩父町

佐久良橋材料調書

秩父町

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CONSULTING ENGINEER
~~JIJI~~ BLDG, TOKYO
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MADE BY M. Jinda DATE 9-5-19 FILE NO
CHECKED BY K. Inaba DATE 9-5-25 PAGE NO M1

CALCULATIONS FOR

Materials of Sakura-Bashi for Chichibu-Cho.

Area of pavement for entire bridge
3.5cm Granolithic pavement
Paved area 3.00 × 176.00 = 528.0 sq.m

Materials of floor construction for Concrete Beam Spans. (3 spans)
Floor slab
Concrete 1:2.5:5 mixture
Cross sectional area
Slab .125 × 3.00 = .375
Coping 2@ .16 × .25 = .080
less 2@ .03 × .09 = −.005
0.450 sq.m

Concrete
NO. 1 .450 × 5.995 = 2.698
NO. 2 & 2A 2@ .450 × 5.99 = 5.391
End of No.1 2@ .400 × .400 × .160 = .051
less handrail 4@ .100 × .150 × .160 = −.010
Base of 〃 24@ .200 × .200 × .050 = .048
less 〃 24@ .060 × .080 × .160 = −.018
〃 〃 24@ .120 × .120 × .050 = −.017
8.143 cub.m

Forms
NO. 1 2.590 × 5.795 = 15.01
NO. 2 2@ 2.590 × 5.99 = 31.03
less cross beam .300 × 1.20 = −.36
〃 〃 〃 2@ .350 × 1.20 = −.84
〃 〃 〃 .500 × 1.20 = −.60
End of NO. 1 .235 × 3.00 = .71
〃 〃 〃 2@ .210 × .20 = .08
〃 〃 〃 2@ .160 × .95 = .30
Hole of handrail 2@ .500 × .25 = .25
〃 〃 2@ .500 × .16 = .16
〃 〃 24@ .280 × .16 = 1.08
〃 〃 24@ .800 × .05 = .96
End of NO. 1 2@ .035 × .20 = .01
47.79 sq.m

Reinforcements, plain bars (see sheet no. 3) 0.704 kg ton

Expansion joint, 9mm 厚エラスタイト三枚組合セ挿入 4箇所 (cross beam 箇所共)

踏掛石(た詰用) 4@ .20 × .25 × .75 = 0.150 cub.m

Main beam & Cross beam
Concrete 1:2.5:5 Mixture
MB1. 2 Required
Beam .350 × .525 × 5.150 = 0.946
End fillets 2@ ½ × .100 × .350 × 0.400 = 0.014
Side 〃 2@ ½ × .100 × .150 × 5.150 = 0.077
1.037

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Materials of Sakura-Bashi for Chichibu-Cho

MB2 4-Required
same part as for MB1 = 1.037
Bearing .345 × .100 × 0.625 = 0.022
" .335 × .325 × 0.625 = 0.068
1.127

CB1 2-Required
Beam .335 × .371 × 1.650 = 0.205
fillet 1/2 × 2 @ .150 × .150 × .335 = 0.008
" 1/2 × .050 × .050 × 1.300 = 0.002
0.215

Summary of Concrete
MB1 2 @ 1.037 = 2.074
MB2 4 @ 1.127 = 4.508
CB1 2 @ .215 = 0.430
7.012 cub. m

Forms
MB1 2-Required
side 2 @ .425 × 5.150 = 4.38
" fillet 2 @ .100 × .400 = 0.08
" " 2 @ .180 × 5.150 = 1.85
Bottom .350 × 4.350 = 1.52
" 2 @ .350 × .413 = .29
8.12

MB2 4-Required
same part as for MB1 = 8.12
Bearing 2 @ .420 × .625 = .53
" 2 @ .113 × .335 = .08
8.73

CB1 2-Required
side .371 × 1.650 = .61
fillet (less) .100 × .150 = - .02
" .150 × .150 = .02
Bottom .335 × 1.350 = .45
" 2 × .335 × .212 = .14
1.20

Summary of Forms
MB1 2 @ 8.12 = 16.24
MB2 4 @ 8.73 = 34.92
CB1 2 @ 1.20 = 2.40
53.56 sq. m

Reinforcements, plain bars (see sheet no. 3) 1.012 kg ton

SHOE SH1, SH2 4-Required (see sheet no. 6)
2 Pls 300 × 12 @ 28.260 × .350 = 19.8
4 Ls 50 × 50 × 8 @ 5.78 × .300 = 6.9
2 Bolts 12ϕ × 600 @ .59 = 1.2
27.9 × 4 = 111.6 kgs

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CONSULTING ENGINEER
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CALCULATIONS FOR

## Materials of Sakura-Bashi for Chichibu-Cho.

### Summary of materials of floor construction for Concrete Beam Spans.

| | Concrete (1:2.5:5 mix) | Forms | Reinforcements |
|---|---|---|---|
| Floor slab | 8.143 | 47.79 | 0.704 |
| Beam & Cross beam | 7.012 | 53.56 | 1.012 |
| | 15.155 cub.m | 101.35 sq.m | 1.716 kg.tons |

Expansion joint, made of $9^{mm}$ Elastite, $9^{mm}$ thick between slabs, $27^{mm}$ thick 〃 beams } 4 箇所

踏掛石, granite 25×20×75 1ヶ1 四ケ分 0.150 cub.m.

SHOE, SH1 & SH2 structural steel $112^{kg}$ or 0.112 kg.tons
Reinforcements for collar of handrail post 8番鉄線 長 $0.7^{m}$ 24箇所分 計 $16.8^{m}$

### Materials of Floor construction for 4 Arch Spans.

Floor slab

Concrete 1:2.5:5 Mixture 1-required

NO3 8 c .450 × 11.682 = 42.055
NO4 4 c .450 × 14.606 = 26.291
Fill near crown 4 c .067 × 1.80 × 4.00 = 1.930
Base of handrail 208 c .20 × .20 × .005 = .416
less 〃 208 c .06 × .08 × .016 = − .160
〃 〃 208 c .12 × .12 × .005 = − .150
70.382 cub.m

Forms 1-required.

NO3 8 c 2.790 × 11.682 = 260.74
NO4 4 c 2.790 × 10.606 = 118.36
〃 4 c 2.090 × 4.000 = 33.44
less cross beam 8 c .265 × 1.400 = − 2.97
〃 〃 〃 24 c .300 × 1.300 = − 9.36
〃 〃 〃 8 c .500 × 1.300 = − 5.20
〃 〃 〃 8 c .300 × 1.450 = − 3.48
〃 〃 〃 8 c .300 × 1.100 = − 2.64
Handrail 208 c .280 × .160 = 9.32
〃 208 c .800 × .050 = 8.32
406.53 sq.m

Reinforcements, plain bars (see sheet no.3) 5.924 kg.tons

Expansion joints $9^{mm}$ 厚エラスタイト三枚組合セ挿入 (Cross beam 箇所共) 8 箇所

### Longitudinal Beam & wall (LB1 & LW1)

注意 各径間ニ於テ左右寸法ノ異ナルモノハ其平均値ヲ採ル

Concrete 1:2.5:5 mixture

LB1 16-Required.

Beam .250 × .275 × 2.768 = .190
〃 2 c .250 × .275 × 2.623 = .361
〃 .250 × .275 × 2.523 = .173
fillet 3.5 c .20 × .20 × .250 = 0.35
〃 .10 × .15 × 2.508 = 0.38
〃 2 c .10 × .15 × 2.623 = 0.79
〃 .10 × .15 × 2.523 = .038
0.914 cub.m

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

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CALCULATIONS FOR

Materials of Sakura-Bashi for Chichibu-Cho

LW1 8-Required
Wall 2@ .642 × .25 × 2.673 = .858 ✓
〃 2@ .222 × .25 × 2.923 = .324 ✓
〃 2@ .062 × .25 × 1.462 = .045 ✓
fillet outside .100 × .15 × 5.058 = .076 ✓
〃 .100 × .15 × 2.523 = .038 ✓
〃 .100 × .15 × 2.235 = .034 ✓
1.375 ✓

Summary of concrete
LB1 16@ 0.914 = 14.624 ✓
LW1 8@ 1.375 = 11.000 ✓
25.624 cub. m.

Forms
LB1 16-Required
Side .355 × 2.768 = .98 ✓
〃 .355 × 2.508 = .89 ✓
〃 4@ .355 × 2.623 = 3.72 ✓
〃 2@ .355 × 2.523 = 1.79 ✓
Bottom .25 × 2.273 = .57 ✓
〃 2@ .25 × 2.223 = 1.11 ✓
〃 .25 × 2.123 = .53 ✓
fillet side 7@ .20 × .200 = .28 ✓
〃 bottom 7@ .25 × .283 = .50 ✓
10.37 ✓

LW1 8-Required
Side (外) 2@ .722 × 2.673 = 3.86 ✓
〃 (内) 2@ .742 × 2.523 = 3.74 ✓
〃 2@ .327 × 2.385 = 1.56 ✓
〃 2@ .317 × 2.235 = 1.42 ✓
〃 2@ .087 × 2.000 = .35 ✓
〃 2@ .112 × .388 = .09 ✓
〃 2@ .063 × 1.312 = .17 ✓
11.19 ✓

Summary of forms
LB1 16@ 10.37 = 165.92 ✓
LW1 8@ 11.19 = 89.52 ✓
255.44 Sq. m.

Reinforcements, plain bars (see sheet no. 3) 3.712 kg tons ✓

Cross frames
Concrete 1 : 2.5 : 5 mixture
AT $0_L^R$ 8-Required (Cross beam only)
Beam .284 × .25 × 1.750 = .124 ✓
fillet ½@ .05 × .05 × 1.520 = .002 ✓
.126 ✓

AT $1_L^R$ 8-Required
Beam .371 × .30 × 1.600 = .178
fillet .15 × .15 × .300 = .007
〃 .05 × .05 × 1.520 = .004
} .189 ✓
Column 2@ .30 × .40 × 4.897 = 1.175 ✓
1.364 ✓

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CALCULATIONS FOR Materials of Sakura-Bashi for Chichibu-Cho.

AT $2^R_L$ 8-Required
Same part as for 1 = .189
column 2c .30 × .40 × 3.197 = .767
.956

AT $3^R_L$ 8-Required
Same part as for 1 = .189
column 2c .30 × .40 × 1.917 = .460
.649

AT $4^R_L$ 8-Required
Beam 2c .371 × .235 × 1.600 = .279
fillet 2c .15 × .15 × .235 = .011
" .05 × .05 × 1.520 = .004
column 4c .235 × .40 × .997 = .375
.669

AT $5^R_L$ 8-Required
Beam .371 × .30 × 1.600 = .178
fill 2c 0.35 × .30 × .325 = .007
fillet .05 × .05 × 1.520 = .004
.189

AT $6^R_L$ 8-Required
Beam .371 × .30 × 1.000 = .111
fill 2c .05 × .11 × .300 = .003
fillet .05 × .05 × 1.100 = .003
.117

Cross frame on pier 3-Required
Slab .450 × 1.990 = .896
Longitudinal beam 2c .250 × .475 × 1.700 = .404
" end 4c .135 × .250 × .319 = .043
" fillet 2c .100 × .300 × .250 = .015
" " 2c .100 × .150 × 1.500 = .045
Cross beam 2c .375 × .235 × 1.500 = .264
" fillet .05 × .05 × 1.750 = .004
" " 2c .15 × .15 × .235 = .011
" " 4c .125 × .10 × .500 = .025
Column 4c .30 × .50 × 6.780 = 4.068
" top 4c .10 × .30 × .500 = .060
Strut 2c .30 × .30 × 1.700 = .306
" fillet 4c .15 × .15 × .300 = .027
6.168

Summary of concrete
at 0 8c .126 = 1.008
at 1 8c 1.364 = 10.912
at 2 8c .956 = 7.648
at 3 8c .649 = 5.192
at 4 8c .669 = 5.352
at 5 8c .189 = 1.512
at 6 8c .117 = .936
on pier 3c 6.168 = 18.504
51.064 cub. m

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

**JIUN MASUDA**
CONSULTING ENGINEER
~~JIJI~~ BLDG, TOKYO
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CALCULATIONS FOR

Materials of Sakura-Bashi for Chichibu-Cho

Forms

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| AT $0^R_L$ | 8-Required | | | | | | | |
| Side | | .284 | × | 1.750 | = | | .50 | |
| 〃 less fillet | | .100 | × | .150 | = | − | .02 | |
| Bottom | | .250 | × | 1.750 | = | | .44 | |
| | | | | | | | .92 | |
| AT $1^R_L$ | 8-Required | | | | | | | |
| Beam side | 2 c | .371 | × | 1.600 | = | | 1.19 | 1.73 |
| 〃 less fillet | 2 c | .100 | × | .150 | = | − | .03 | |
| 〃 fillet | 2 c | .150 | × | .150 | = | | .05 | |
| 〃 bottom | | .300 | × | 1.300 | = | | .39 | |
| 〃 〃 | 2 c | .212 | × | .300 | = | | .13 | |
| Column | 2 c | .30 | × | 4.895 | = | | 2.94 | |
| 〃 | 2 c | .30 | × | 4.385 | = | | 2.63 | |
| 〃 | 4 c | .40 | × | 4.472 | = | | 7.16 | |
| 〃 | 4 c | .075 | × | .400 | = | | .12 | |
| 〃 | 4 c | .075 | × | .420 | = | | .13 | |
| | | | | | | | 14.71 | |
| AT $2^R_L$ | 8-Required | | | | | | | |
| Same part as for 1 | | | | | = | | 1.73 | |
| Column | 2 c | .30 | × | 3.195 | = | | 1.92 | |
| 〃 | 2 c | .30 | × | 2.685 | = | | 1.61 | |
| 〃 | 4 c | .40 | × | 2.772 | = | | 4.44 | |
| 〃 | 4 c | .075 | × | .400 | = | | .12 | |
| 〃 | 4 c | .075 | × | .420 | = | | .13 | |
| | | | | | | | 9.95 | |
| AT $3^R_L$ | 8-Required | | | | | | | |
| Same part as for 1 | | | | | = | | 1.73 | |
| Column | 2 c | .30 | × | 1.915 | = | | 1.15 | |
| 〃 | 2 c | .30 | × | 1.405 | = | | .84 | |
| 〃 | 4 c | .40 | × | 1.492 | = | | 2.39 | |
| 〃 | 4 c | .075 | × | .400 | = | | .12 | |
| 〃 | 4 c | .075 | × | .420 | = | | .13 | |
| | | | | | | | 6.36 | |
| AT $4^R_L$ | 8-Required | | | | | | | |
| Beam side | 2 c | .371 | × | 1.600 | = | | 1.19 | |
| 〃 less fillet | 2 c | .100 | × | .150 | = | − | .03 | |
| 〃 fillet | 2 c | .150 | × | .150 | = | | .05 | |
| 〃 bottom | 2 c | .235 | × | 1.300 | = | | .61 | |
| 〃 〃 | 4 c | .212 | × | .235 | = | | .20 | |
| Column | 4 c | .235 | × | .995 | = | | .94 | |
| 〃 | 4 c | .235 | × | .485 | = | | .46 | |
| 〃 | 4 c | .400 | × | .572 | = | | .92 | |
| 〃 | 4 c | .075 | × | .400 | = | | .12 | |
| 〃 | 4 c | .075 | × | .420 | = | | .13 | |
| | | | | | | | 4.59 | |
| AT $5^R_L$ | 8-Required | | | | | | | |
| Beam side | 2 c | .371 | × | 1.600 | = | | 1.19 | |
| 〃 〃 | 4 c | .035 | × | .325 | = | | .05 | |
| 〃 less fillet | 2 c | .100 | × | .150 | = | − | .03 | |
| 〃 bottom | | .300 | × | 1.100 | = | | .33 | |
| | | | | | | | 1.54 | |

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

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

MADE BY M. Iida DATE 9-5-22 FILE NO

CHECKED BY K. Inaba DATE 9-5-31 PAGE NO M 7

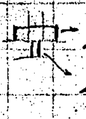
CALCULATIONS FOR

Materials of Sakura-Bashi for Chichibu-cho.

AT $6^R_L$ 8 - Required

| | | | | | | |
|---|---|---|---|---|---|---|
| Beam side | 2 c | .371 | × | 1.000 | = | .74 |
| 〃 〃 | 4 c | .05 | × | .110 | = | .02 |
| 〃 bottom | | .30 | × | 1.050 | = | .32 |
| | | | | | | 1.08 |

Cross frame on Pier 3 - Required

| | | | | | | |
|---|---|---|---|---|---|---|
| Slab | | 3.890 | × | 1.990 | = | 7.74 |
| 〃 less column | 4 c | .145 | × | .500 | = | - .29 |
| 〃 〃 Beam | 2 c | .245 | × | 1.500 | = | - .74 |
| 〃 〃 〃 | 4 c | .100 | × | .125 | = | - .05 |
| 〃 〃 〃 | 2 c | .250 | × | 1.700 | = | - .85 |
| handrail  | 4 c | .05 | × | .800 | = | .16 |
| 〃 | 4 c | .16 | × | .280 | = | .18 |
| Beam side | 2 c | .405 | × | 1.700 | = | 1.38 |
| 〃 〃 | 2 c | .405 | × | 1.500 | = | 1.22 |
| 〃 bottom | 2 c | .25 | × | 1.500 | = | .75 |
| 〃 〃 | 4 c | .25 | × | .320 | = | .32 |
| 〃 side | 2 c | .371 | × | 1.750 | = | 1.30 |
| 〃 〃 less | 2 c | .100 | × | .150 | = | - .03 |
| 〃 〃 | 2 c | .150 | × | .150 | = | .05 |
| 〃 bottom | 2 c | .235 | × | 1.200 | = | .56 |
| 〃 〃 | 4 c | .190 | × | .235 | = | .18 |
| 〃 〃 | 4 c | .100 | × | .180 | = | .07 |
| column | 4 c | .300 | × | 6.780 | = | 8.14 |
| 〃 | 4 c | .300 | × | 6.585 | = | 7.90 |
| 〃 | 8 c | .500 | × | 6.325 | = | 25.30 |
| 〃  | 4 c | .500 | × | .470 | = | .94 |
| 〃 | 8 c | .100 | × | .300 | = | .24 |
| 〃 less strut | 4 c | .300 | × | .600 | = | - .72 |
| Strut side | 4 c | .300 | × | 1.700 | = | 2.04 |
| 〃 〃 | 8 c | .150 | × | .150 | = | .18 |
| 〃 bottom | 2 c | .300 | × | 1.400 | = | .84 |
| 〃 〃 | 4 c | .300 | × | .215 | = | .26 |
| | | | | | | 57.07 |

Summary of Forms

| | | | | |
|---|---|---|---|---|
| at 0 | 8 c | .92 | = | 7.36 |
| at 1 | 8 c | 14.71 | = | 117.68 |
| at 2 | 8 c | 9.95 | = | 79.60 |
| at 3 | 8 c | 6.36 | = | 50.88 |
| at 4 | 8 c | 4.59 | = | 36.72 |
| at 5 | 8 c | 1.54 | = | 12.32 |
| at 6 | 8 c | 1.08 | = | 8.64 |
| on pier | 3 c | 57.07 | = | 171.21 |
| | | | | 484.41 sq.m. |

Reinforcements, Plain bars (see sheet no. 4) 7.672 ~~kg~~ tons

Expansion joints, 3-9mm 厚エラスタイト挿入 8 箇所 (Panel Pt. 4 柱3用)

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CHECKED BY K. Inaba DATE 9-5-31 PAGE NO M8

CALCULATIONS FOR

Materials of Sakura-Bashi for Chichibu-Cho.

Summary of materials of floor construction for arch span (4-spans complete)

| | Concrete (1:2.5:5 mix) | Forms | Reinforcements |
|---|---|---|---|
| Floor slab | 70.382 | 406.53 | 5.924 |
| Longitudinal beam & wall | 25.624 | 255.44 | 3.712 |
| Cross frames | 51.064 | 484.41 | 7.672 |
| | 147.070 cub.m. | 1,146.38 sq.m. | 17.308 kg.tons |

| | | | | |
|---|---|---|---|---|
| Expansion joints, | Between | slabs | 1-9$^{mm}$厚 エラスタイト挿入 | 14箇所 |
| | between | cross beams | 3-9$^{mm}$厚 エラスタイト挿入 | |
| | 〃 | Columns at 4 | 〃 〃 | 8 〃 〃 |

Reinforcements for collar of handrail post 8番鉄線 長0.7$^{m}$ 208箇所

計145.6m

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

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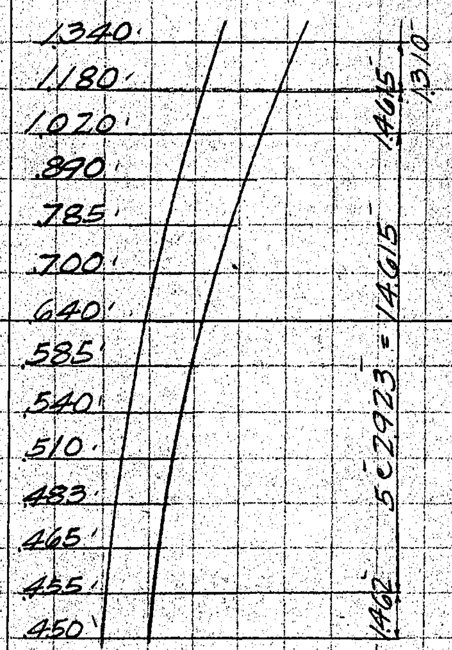
CALCULATIONS FOR

Materials of Sakura-Bashi for Chichibu-cho

Materials of arch ring for entire span
Concrete 1:2:4 mixture

arch ring 4-Required
2 c 1.340 × 0.655 = 1.755
2 c 1.180 × 1.3858 = 3.270
2 c 1.020 × 1.4615 = 2.981
2 c .890 × 1.4615 = 2.601
2 c .785 × 1.4615 = 2.295
2 c .700 × 1.4615 = 2.046
2 c .640 × 1.4615 = 1.871
2 c .585 × 1.4615 = 1.710
2 c .540 × 1.4615 = 1.578
2 c .510 × 1.4615 = 1.491
2 c .483 × 1.4615 = 1.412
2 c .465 × 1.4615 = 1.359
2 c .455 × 1.4618 = 1.330
.450 × 1.462 = .658
area 26.357
× 2.000
52.714 cub.m.



On abutment 2-Required
0.150 × 0.740 = 0.111
½ × 0.520 × 0.650 = 0.169
½ × 0.230 × 1.150 = 0.132
area 0.412
× 2.000
.824 cub.m

On pier 6-Required
0.150 × 0.740 = 0.111
½ × 0.520 × 0.870 = 0.226
½ × 0.230 × 1.150 = 0.132
area 0.469
× 2.000
.938 cub.m.

Strut 16-Required
0.300 × 0.400 × 1.00 = .120 cub.m

Summary of concrete
arch ring 4 c 52.714 = 210.856
on abutment 2 c .824 = 1.648
on pier 6 c .938 = 5.628
strut 16 c .120 = 1.920
220.052 cub.m.

Forms (see arch ring concrete)
arch ring 16 c 26.357 = 421.71
on abutment 8 c 0.412 = 3.30
on pier 24 c 0.469 = 11.26
strut 16 c 1.10 × 1.00 = 17.60
upper side 16 c 1.00 × 9.00 = 144.00
less strut end − 32 c .30 × .40 = − 3.84
" Cross beam end − 16 c .30 × .27 = − 1.30
Summary of Forms 592.73 sq.m.

**JIUN MASUDA**
CONSULTING ENGINEER
~~[illegible]~~ BLDG, TOKYO
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CALCULATIONS FOR

## Materials of Sakura-Bashi for Chichibu-Cho

Reinforcements, plain bars (see sheet no. 5) 21.383 kg tons

Materials of girder Pier P1

Concrete 1:2.5:5 mixture

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Base | | 3.200 × | .600 × | 4.000 = | | 7.680 | 10.623 |
| 〃 | | 2.100 × | .300 × | 4.000 = | | 2.520 | |
| strut | | .500 × | .300 × | 1.500 = | | .225 | |
| 〃 | | .400 × | .300 × | 1.500 = | | .180 | |
| 〃 fillet | 2 c | .150 × | .150 × | .400 = | | .018 | |
| column | 2 c | .700 × | .500 × | 8.277 = | | 5.794 | |
| cross beam | | 1.171 × | .700 × | 1.500 = | | 1.230 | |
| fillet | | .150 × | .150 × | .700 = | | .016 | |
| bracket | 2 c | .520 × | .400 × | .650 = | | .270 | |
| fillet | ½ c | .050 × | .050 × | 2.200 = | | .003 | |
| less (踏掛石) | | .200 × | .085 × | 3.000 = | − | .051 | |
| 〃 slab | 2 c | .200 × | .160 × | .513 = | − | .033 | |
| | | | | | | 17.852 cub. m. | |

Forms

| | | | | | | |
|---|---|---|---|---|---|---|
| Base, front & rear | 2 c | .600 × | 4.000 = | | 4.80 | 13.04 |
| 〃 side | 2 c | .600 × | 3.200 = | | 3.84 | |
| 〃 〃 | 2 c | .300 × | 2.100 = | | 1.26 | |
| Strut 〃 | 2 c | .500 × | 1.500 = | | 1.50 | |
| 〃 〃 | 2 c | .300 × | 1.500 = | | .90 | |
| 〃 fillet | 4 c | .150 × | .150 = | | .09 | |
| 〃 bottom | | .400 × | 1.200 = | | .48 | |
| 〃 〃 fillet | 2 c | .213 × | .400 = | | .17 | |
| Column, outside | 2 c | .700 × | 7.900 = | | 11.06 | |
| 〃 〃 | 2 c | .300 × | .377 = | | .23 | |
| 〃 inside | 2 c | .700 × | 6.965 = | | 9.75 | |
| 〃 less strut | 2 c | .300 × | .500 = | − | .30 | |
| 〃 〃 〃 | 2 c | .400 × | .600 = | − | .48 | |
| 〃 front | 2 c | .500 × | 8.200 = | | 8.20 | |
| 〃 rear | 2 c | .500 × | 7.653 = | | 7.65 | |
| 〃 〃 | 4 c | .075 × | .550 = | | .17 | |
| Cross beam | | 1.085 × | 1.500 = | | 1.63 | |
| 〃 〃 | | 1.171 × | 1.500 = | | 1.76 | |
| 〃 〃 fillet | 2 c | .150 × | .150 = | | .05 | |
| 〃 〃 bottom | | .700 × | 1.200 = | | .84 | |
| 〃 〃 〃 | 2 c | .213 × | .700 = | | .30 | |
| Bracket | 4 c | .520 × | .650 = | | 1.35 | |
| 〃 less | 2 c | .220 × | .250 = | − | .11 | |
| 〃 〃 | 2 c | .160 × | .483 = | − | .15 | |
| 〃 out | 2 c | .400 × | .520 = | | .42 | |
| 〃 bottom | 2 c | .400 × | .650 = | | .52 | |
| | | | | | 55.93 sq m. | |

Reinforcements, plain bars (see sheet no. 6) 0.630 kg ton

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

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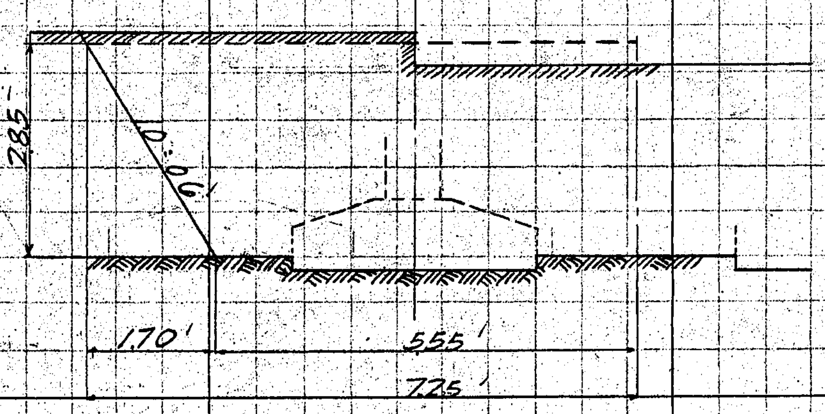
CALCULATIONS FOR

## Materials of Sakura-Bashi for Chichibu-Cho

Excavation



| | | | | |
|---|---|---|---|---|
| Soft rock | 3.20 · .20 · 4.00 | = | 2.6 cub.m. |

For sand & gravel
33.3 68.2
1/2 · (5.55 · 6.00 + 7.25 · 9.40) · 2.85 = 144.6 cub.m.

Materials of girder pier P2
Concrete 1:2.5:5 mixture

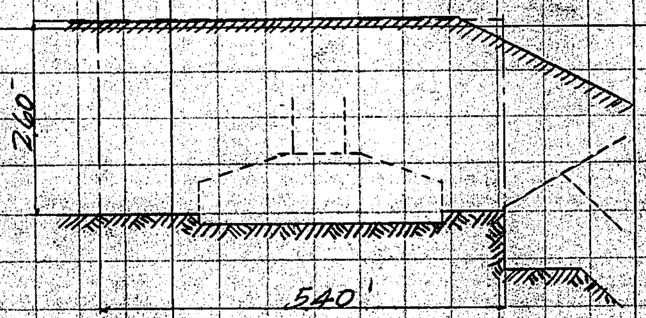
| | | | | |
|---|---|---|---|---|
| Same part for girder pier P1 | | | = | 10.623 |
| column | 2 c | .700 · .500 · 7.703 | = | 5.392 |
| cross beam | | .400 · .700 · 1.500 | = | .420 |
| 〃 〃 | | .658 · .335 · 2.500 | = | .551 |
| 〃 〃 fillet | | .150 · .150 · .700 | = | .016 |
| 〃 〃 〃 | | .050 · .050 · 1.400 | = | .004 |
| | | | | 17.006 cub.m |

Forms

| | | | | |
|---|---|---|---|---|
| Same part for girder pier P1 | | | = | 13.04 |
| column outside | 2 c | .700 · 7.703 | = | 10.78 |
| 〃 〃 | 2 c | .335 · .650 | = | .44 |
| 〃 inside | 2 c | .700 · 7.153 | = | 10.01 |
| 〃 less strut | 2 c | .300 · .500 | = | − .30 |
| 〃 〃 〃 | 2 c | .400 · .600 | = | − .48 |
| 〃 front | 2 c | .500 · 7.727 | = | 7.73 |
| 〃 〃 | 4 c | .075 · .550 | = | .17 |
| 〃 rear | 2 c | .500 · 8.352 | = | 8.35 |
| cross beam | 2 c | 1.062 · 1.500 | = | 3.19 |
| 〃 〃 fillet | 2 c | .150 · .150 | = | .05 |
| 〃 〃 bottom | | .700 · 1.200 | = | .84 |
| 〃 〃 〃 | 2 c | .213 · .700 | = | .30 |
| | | | | 54.12 sq.m |

Reinforcements, plain bars (see sheet no.6) 0.626 kg. ton

Excavation



MADE BY M. Jinda DATE 9-5-23 FILE NO

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CALCULATIONS FOR

Materials of Sakura-Bashi for Chichibu-Cho.

Soft rock
same as for girder pier P1 = 2.6 cub.m.

For sand 5.40' × 7.60' × 2.60' = 106.7 cub.m.

Materials of column on abutment A1 & A2 (桁橋支脚) 2-Required

Concrete 1 : 2.5 : 5 mixture

column 2'c .700' × .500' × 6.872' = 4.810
strut .400' × .300' × 1.500' = .180
〃 fillet 2'c .150' × .150' × .400' = .018
cross beam .744' × .700' × 1.500' = .781
〃 〃 .485' × .314' × 2.500' = .381
〃 〃 fillet .150' × .150' × .700' = .016
〃 〃 〃 .050' × .050' × 1.400' = .004
Bearing 2'c .300' × .100' × .700' = .042
6.232 cub.m.

Forms

Column outside 2'c .700' × 6.872' = 9.62
〃 〃 2'c .485' × .305' = .30
〃 inside 2'c .700' × 5.978' = 8.37
〃 〃 less strut 2'c .400' × .600' = − .48
〃 front 2'c .500' × 6.552' = 6.55
〃 rear 2'c .500' × 7.177' = 7.18
cross beam 2'c 1.062' × 1.500' = 3.19
〃 〃 fillet 2'c .150' × .150' = .05
〃 〃 bottom .700' × 1.200' = .84
〃 〃 〃 2'c .213' × .700' = .30
Bearing 4'c .100' × .300' = .12
〃 2'c .465' × .700' = .65
Column front 4'c .075' × .550' = .17
36.86 sq.m.

Reinforcements, plain bars (see sheet no.6) 0.449 kg-ton

Materials of Pier P3 & P4 2-Required

concrete 1 : 2.5 : 5 mixture

Base 4.000' × 1.200' × 4.000' = 19.200
Shaft 2.582' × 3.000' × 5.638' = 43.672
〃 2'c 1.982' × .300' × 5.638' = 6.705
〃 circular end .600$^\phi$' × 5.638' = 1.594
〃 top 2.000' × .150' × 3.400' = 1.020
〃 〃 2.000' × .125' × 3.000' = .750
〃 〃 1/3'c 2.000' × .400' × .250' = .067
73.008 cub.m.

Forms

Base 4'c 1.200' × 4.000' = 19.20
Shaft, side 2'c 1.982' × 5.638' = 22.35
〃 2'c 3.000' × 5.638' = 33.83
〃 circular end .600$^\phi$' × 5.638' = 10.63
〃 less archring 4'c 1.000' × 1.500' = − 6.00

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CALCULATIONS FOR

Materials of Sakura-Bashi for Chichibu-Cho

| | | | |
|---|---|---|---|
| shaft, top | 2'c | .300'×1.000'= | .60' |
| 〃 〃 | 4'c | .300'×.200'= | .24' |
| 〃 〃 | 2'c | .250'×2.000'= | 1.00' |
| | | | 81.85 sq.m' |

Reinforcements, plain bars (see sheet no.7) 1.186 kg tons'

Excavation

| | | |
|---|---|---|
| Soft rock | 4.00'×.20'×4.00' | = 3.2 cub.m' |
| Gravel with bolders | 7.1×7.1×2.1 | = 105.9 cub.m' |

Materials of Pier P5

Concrete 1:2.5:5 mixture

| | | | |
|---|---|---|---|
| Base | | 4.000'×1.200'×4.000'= | 19.200' |
| shaft | | 2.612'×3.000'×6.238'= | 48.881' |
| 〃 | 2c | 2.012'×.300'×6.238'= | 7.531' |
| 〃 circular end | | .600ᵠ ×6.238'= | 1.763' |
| 〃 top | | 2.000'×.150×3.400'= | 1.020' |
| 〃 〃 | | 2.000'×.125×3.000'= | .750' |
| 〃 〃 | 1/3× | 2.000'×.400'×.250'= | .067' |
| | | | 79.212 cub.m' |

Forms

| | | | |
|---|---|---|---|
| Base | 4'c | 1.200'×4.000'= | 19.20' |
| Shaft, side | 2'c | 2.012'×6.238'= | 25.10' |
| 〃 | 2'c | 3.000'×6.238'= | 37.43' |
| 〃 circular end | | .600ᵠ×6.238'= | 11.76' |
| 〃 less archring | 4'c | 1.000'×1.500'= | − 6.00' |
| shaft, top | 2'c | .300'×1.000'= | .60' |
| 〃 〃 | 4'c | .300'×.200'= | .24' |
| 〃 〃 | 2'c | .250'×2.000'= | 1.00' |
| | | | 89.33 cub.m' |

Reinforcements, plain bars (see sheet no.7) 1.251 kg. tons'

Excavation

| | | |
|---|---|---|
| Soft rock | 4.00'×.20'×4.00' | = 3.2 cub.m' |
| Gravel with bolders | 5.90'×5.90'×.90' | = 31.3 cub.m' |

Materials of abutment A1

concrete 1:2.5:5 mixture

| | | |
|---|---|---|
| Base | 1.000'×1.000'×4.000'= | 4.000' |
| 〃 | 1.000'×2.110'×4.000'= | 8.440' |
| 〃 | .905'×1.000'×4.000'= | 3.620' |
| Body | 2.620'×2.400'×3.000'= | 18.864' |
| | | 34.924 cub.m' |

Reinforcements, plain bar (see sheet no.8) 0.711 kg tons'

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

MADE BY M. Imda DATE 9-5-24 FILE NO
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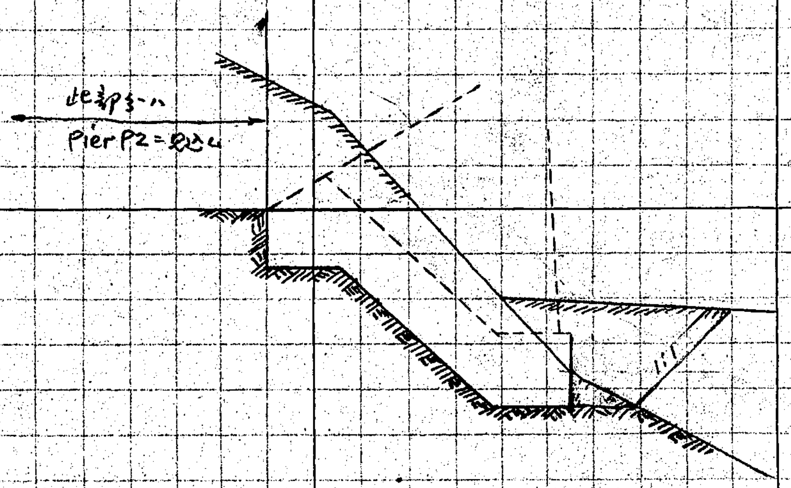
CALCULATIONS FOR

## Materials of Sakura-Bashi for Chichibu-Cho.

Forms

| | | | | | |
|---|---|---|---|---|---|
| Base, front | | 1.000 · 4.000 = | 4.00 | | |
| 〃 side | 2/2 c | 1.000 · 1.000 = | 1.00 | } | 両側及背面ハ<br>型枠半数ヲ見込ミ<br>他ハ混凝ヲ岩盤<br>ニ密着セシム |
| 〃 〃 | 2/2 c | 1.000 · 2.110 = | 2.11 | | |
| 〃 〃 | 2/2 c | .905 · 1.000 = | .91 | | |
| 〃 rear | 1/2 c | .750 · 4.000 = | 1.50 | | |
| Body front | | 3.000 · 3.000 = | 9.00 | | |
| 〃 side | 2 c | 2.400 · 2.620 = | 12.58 | | |
| 〃 front less archring | 2 c | 1.000 · 1.500 = - | 3.00 | | |
| 〃 rear | | 3.000 · 3.370 = | 10.11 | | |
| 〃 front top | 2 c | .150 · 1.000 = | .30 | | |
| Base top | | 4.000 · 3.020 = | 12.08 | | |
| | | | 50.59 sq.m. | | |

Excavation



| | | |
|---|---|---|
| Soft Rock | 3.80 · 1.30 · 4.00 = | 19.8 cub.m |
| Earth | .80 · 2.30 · 5.50 = | 10.1 |
| | 1.00 · 1.40 · 6.50 = | 9.1 |
| | | 19.2 cub. m |

## Materials of abutment A2

Concrete 1 : 2.5 : 5 mixture

| | | |
|---|---|---|
| Base | 1.000 · 1.650 · 4.000 = | 6.600 |
| 〃 | .650 · 1.450 · 4.000 = | 3.770 |
| 〃 | .650 · 2.200 · 4.000 = | 5.720 |
| 〃 | .700 · .750 · 4.000 = | 2.100 |
| Body | .814 · 1.450 · 3.000 = | 3.541 |
| 〃 | 1.400 · 1.700 · 3.000 = | 7.140 |
| | | 28.871 cub.m |

Forms

| | | | |
|---|---|---|---|
| Base front | | 1.000 · 4.000 = | 4.00 |
| 〃 side | 2/2 c | 1.000 · 1.650 = | 1.65 |
| 〃 〃 | 2/2 c | .650 · 1.450 = | .94 |
| 〃 〃 | 2/2 c | .650 · 2.200 = | 1.43 |
| 〃 〃 | 2/2 c | .700 · .750 = | .53 |
| Body side | 2 c | .814 · 1.450 = | 2.36 |
| 〃 〃 | 2 c | 1.400 · 1.700 = | 4.76 |
| 〃 front with base front | | 3.000 · 4.000 = | 12.00 |
| 〃 top | | .300 · 1.000 = | .30 |
| 〃 〃 | | .630 · 3.000 = | 1.89 |
| 〃 front less archring | 2 c | 1.000 · 1.500 = - | 3.00 |
| | | | 26.86 sq.m |

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

MADE BY M. Jinda DATE 9-5-24 FILE NO
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CALCULATIONS FOR

## Materials of Sakura-Bashi for Chichibu-Cho

Reinforcement, plain bars (see sheet no. 8) 0.739 kg ton

Excavation
Soft rock body of abutment 1.70 · 4.00 · 4.00 = 27.2
above top of 〃 1/2 · 1.50 · 2.80 · 4.00 = 8.4 背部垂直面迄ヲ見込ム
35.6 cub.m

## Materials of abutment A3

Concrete 1:2.5:5 mixture

| | | | | | |
|---|---|---|---|---|---|
| Base | .600 | 1.200 | 3.000 | = | 2.160 |
| Body | .600 | .650 | 3.000 | = | 1.170 |
| Parapet | .250 | .560 | 3.000 | = | .420 |
| Wing | .500 | .250 | .842 | = | .105 |
| | | | | | 3.855 cub.m |

Forms

| | | | | | |
|---|---|---|---|---|---|
| Base, front | | .600 | 3.000 | = | 1.80 |
| Body, front | | .600 | 3.000 | = | 1.80 |
| Parapet, front | | .560 | 3.000 | = | 1.68 |
| Wing, front | 2ヶ | .500 | .842 | = | .84 |
| 〃 , curb | 2ヶ | .250 | .282 | = | .14 |
| | | | | | 6.26 sq.m |

Reinforcements, plain bars (see sheet no. 9) 0.100 kg ton

Excavation
soft rock 1/2 × 2.10 · 3.90 · 3.000 = 12.3 背部垂直面マデヲ見込ム
2ヶ 1/2 × 1.40 · 2.60 · 1.000 = 3.6 両端ヨリ0.4:1勾配ヲ見込ム
15.9 cub.m

踏掛石（花崗石） 4ヶ .200 · .250 · .750 = 0.150 cub.m

## Materials of Protection wall for abutment A2

Concrete 1:2.5:5 mixture

| | | | | | |
|---|---|---|---|---|---|
| Base | .300 | .900 | 5.800 | = | 1.566 |
| Wall | .420 | .600 | 5.700 | = | 1.436 |
| 〃 | .235 | 1.400 | 5.300 | = | 1.744 |
| 〃 top | .540 | .200 | 5.020 | = | .542 |
| | | | | | 5.288 cub.m |

Forms

| | | | | | |
|---|---|---|---|---|---|
| Body, face | | 2.350 | 5.400 | = | 12.69 |
| 〃 , side | 2ヶ | .235 | 1.000 | = | .47 |
| | | | | | 13.16 sq.m |

Reinforcements, plain bars (see sheet no. 9) 0.110 kg ton

玉石練積

| | | | | | |
|---|---|---|---|---|---|
| side of abutment A2 | 2ヶ | .50 | 4.50 | = | 4.50 |
| 〃 〃 〃 〃 | 2ヶ | .50 | 3.30 | = | 3.30 |
| above top of 〃 〃 | | 3.70 | 5.00 | = | 18.50 |
| | | | | | 26.30 sq.m |

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

MADE BY M. Jinda DATE 9-5-25 FILE NO
CHECKED BY M. J. DATE 9-6-1 PAGE NO M16

CALCULATIONS FOR

## Materials of Sakura-Bashi for Chichibu-Cho

Excavation
Soft rock
混凝土壁ノ部分

| | | | |
|---|---|---|---|
| Base | | .30 × .90 × 5.80 = | 1.6 |
| Body & front | 1/2 c | 1.00 × 1.80 × 5.40 = | 4.9 |
| | | | 6.5 |

練積石垣ノ部分

| | | | |
|---|---|---|---|
| side of abut. A2 | 2 c | .50 × .85 × 7.40 = | 6.3 |
| above top 〃 〃 | | .85 × 1.30 × 4.00 = | 4.4 |
| | | | 10.7 |

Summary of soft rock excavation 17.2 cub. m

Earth
front of concrete wall 1/2 c 1.00 × 1.80 × 7.80 = 7.0 cub. m

## Materials of Protection wall for abutment A3

Concrete 1 : 2.5 : 5 mixture

| | | | |
|---|---|---|---|
| Base | | .300 × .700 × 5.000 = | 1.050 |
| wall | | .360 × .650 × 4.900 = | 1.147 |
| 〃 | | .215 × 1.850 × 4.400 = | 1.750 |
| 〃 top | say | .535 × .200 × 4.050 = | .433 |
| | | | 4.380 cub. m |

Forms

| | | |
|---|---|---|
| Base, front | .300 × 5.000 = | 1.50 |
| Body, front | 2.700 × 4.500 = | 12.15 |
| | | 13.65 sq. m |

Reinforcements, plain bars (see sheet no. 9) 0.094 kg tons

Excavation
Soft rock

| | | | |
|---|---|---|---|
| wall and base | | .65 × 2.60 × 4.70 = | 7.9 |
| above top of both ends | 2/2 c | .85 × .50 × 1.60 = | .7 |
| | | | 8.6 cub. m. |

MADE BY M. Jinda DATE 9-5-29 FILE NO
CHECKED BY M J DATE 9-6-1 PAGE NO M17

CALCULATIONS FOR

Materials of Sakura-Bashi for Chichibu Cho.

Materials of handrails (杉小節正角材)

| 部材名 | 負数 | 断面 | 長 | 容積 | 摘要 |
|---|---|---|---|---|---|
| 男柱 | 4 | 30×25 | 167 | 0.501 cub.m | P1 |
| 束 | 244 | 12×12 | 102 | 3.584 cub.m | P2 |
| 笠木 | 2 | 18×15 | 220 | 0.119 | T1 |
| 〃 | 8 | 〃 | 303 | 0.654 | T2 |
| 〃 | 4 | 〃 | 297 | 0.321 | T3 |
| 〃 | 96 | 〃 | 295 | 7.646 | T4 |
| 〃 | 6 | 〃 | 349 | 0.565 | T5 |
| 〃 | 2 | 〃 | 197 | 0.106 | T6 |
|  | 118 |  |  | 9.411 cub.m |  |
| 貫 | 2 | 10×3 | 217 | 0.013 | M1 |
| 〃 | 8 | 〃 | 300 | 0.072 | M2 |
| 〃 | 4 | 〃 | 294 | 0.035 | M3 |
| 〃 | 96 | 〃 | 292 | 0.841 | M4 |
| 〃 | 6 | 〃 | 346 | 0.062 | M5 |
| 〃 | 2 | 〃 | 197 | 0.012 | M6 |
|  | 118 |  |  | 1.035 cub.m |  |

MADE BY K. Inaba DATE 9-5-18 FILE NO
CHECKED BY M J DATE 9-5-30 PAGE NO M18

CALCULATIONS FOR

Materials of Sakura-Bashi for Chichibu-Cho

Materials of Arch Centering for one span.
All members in the longest dimensions.

| 部材名 | 材種 | 員数 | 断面 | 長 | 容積 | | 摘要 |
|---|---|---|---|---|---|---|---|
| 敷板 | 米松,杉又ハ松 | 36 | 10cm×6cm × | 4.30m | 0.929 | | 両端部用 正角材 |
| 〃 | 〃 | 200 | 20×6 × | 4.30 | 10.320 | | 中間部用 〃 |
| | | | | | | 11.249 立米 | |
| 縁板 | 〃 | 2 | 25×3 × | 3.80 | 0.057 | | 敷板一端補剛用 |
| 〃 | 〃 | 2 | 20×3 × | 3.40 | 0.041 | | 〃 |
| 〃 | 〃 | 2 | 〃 × | 3.20 | 0.038 | | 〃 |
| 〃 | 〃 | 2 | 〃 × | 3.10 | 0.037 | | 〃 |
| 〃 | 〃 | 2 | 〃 × | 3.00 | 0.036 | | 〃 |
| 〃 | 〃 | 3 | 〃 × | 2.90 | 0.052 | | 〃 |
| | | | | | | 0.261 立米 | |
| 櫛型 | 〃 | 6 | 40×20 × | 3.60 | 1.728 | | 0-1 格間用 押角材 |
| 〃 | 〃 | 6 | 30×20 × | 3.90 | 1.404 | | 1-2 〃 〃 |
| 〃 | 〃 | 6 | 〃 × | 3.40 | 1.224 | | 2-3 〃 〃 |
| 〃 | 〃 | 6 | 〃 × | 3.60 | 1.296 | | 3-4 〃 〃 |
| 〃 | 〃 | 12 | 〃 × | 3.20 | 2.304 | | 4-5及ヒ5-6 〃 〃 |
| 〃 | 〃 | 3 | 〃 × | 3.40 | 0.612 | | 6-6 〃 〃 |
| 櫛型板 | 〃 | 18 | 25×6 × | 0.50 | 0.135 | | 0 格点用 〃 |
| | | | | | | 7.803 立米 | |
| 横梁 | 〃 | 2 | 30×20 × | 3.60 | 0.432 | | 上部用 〃 |
| 〃 | 〃 | 8 | 25×20 × | 3.60 | 1.440 | | 〃 〃 |
| 〃 | 〃 | 6 | 20×20 × | 3.60 | 0.864 | | 〃 〃 |
| 束木 | 〃 | 6 | 25×25 × | 1.50 | 0.563 | | 0 格点用 〃 |
| 〃 | 〃 | 6 | 20×20 × | 2.90 | 0.696 | | 1 〃 〃 |
| 〃 | 〃 | 6 | 〃 × | 4.80 | 1.152 | | 2 〃 〃 |
| 〃 | 〃 | 6 | 〃 × | 4.10 | 0.984 | | 2 〃 〃 |
| 〃 | 〃 | 6 | 〃 × | 0.95 | 0.228 | | 2 〃 〃 |
| 〃 | 〃 | 6 | 〃 × | 2.35 | 0.564 | | 3 〃 〃 |
| 〃 | 〃 | 6 | 〃 × | 3.40 | 0.816 | | 4 〃 〃 |
| 〃 | 〃 | 6 | 〃 × | 4.00 | 0.960 | | 5 〃 〃 |
| 〃 | 〃 | 6 | 〃 × | 4.10 | 0.984 | | 5 〃 〃 |
| 〃 | 〃 | 6 | 〃 × | 4.35 | 1.044 | | 6 〃 〃 |
| 斜材 | 〃 | 6 | 20×15 × | 2.25 | 0.405 | | 0-1 格間用 〃 |
| 〃 | 〃 | 6 | 〃 × | 4.15 | 0.747 | | 1-2 〃 〃 |
| 〃 | 〃 | 6 | 〃 × | 2.60 | 0.468 | | 2-3 〃 〃 |
| 〃 | 〃 | 6 | 〃 × | 3.70 | 0.666 | | 3-4 〃 〃 |
| 〃 | 〃 | 6 | 〃 × | 4.40 | 0.792 | | 4-5 〃 〃 |
| 〃 | 〃 | 6 | 〃 × | 5.00 | 0.900 | | 5-6 〃 〃 |
| 〃 | 〃 | 6 | 〃 × | 5.20 | 0.936 | | 6-6 〃 〃 |
| 縦梁 | 〃 | 6 | 〃 × | 5.50 | 0.990 | | 0-2 〃 〃 |
| 〃 | 〃 | 6 | 〃 × | 6.00 | 1.080 | | 〃 〃 〃 |
| 〃 | 〃 | 18 | 〃 × | 4.50 | 2.430 | | 2-3-4-5-6 〃 〃 |
| 〃 | 〃 | 12 | 〃 × | 5.50 | 1.980 | | 3-4-5-6 〃 〃 |
| 横梁 | 〃 | 18 | 〃 × | 3.40 | 1.836 | | 各格点用 〃 |
| | | | | | | 23.957 立米 | |
| 縦貫 | 〃 | 6 | 15×9 × | 0.90 | 0.073 | | 格点1 繋材 〃 |
| 〃 | 〃 | 12 | 〃 × | 3.30 | 0.535 | | 1-2及3-4 格間用 〃 |
| 〃 | 〃 | 6 | 〃 × | 1.70 | 0.138 | | 格点2 繋材 〃 |
| 〃 | 〃 | 6 | 〃 × | 1.00 | 0.081 | | 〃 〃 〃 |

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

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

MADE BY K. Inaba DATE 9-5-18 FILE NO
CHECKED BY M. J DATE 9-5-30 PAGE NO M19

CALCULATIONS FOR

Materials of Sakura-Bashi for Chichibu-Cho.

| 部材名 | 材種 | 員数 | 断面 | 長 | 容積 | | 摘要 |
|---|---|---|---|---|---|---|---|
| 縦貫 | 米松,杉又ハ栗 | 12 | 15×9 | 3.00 | 0.486 | | 4-5 & 56 格間用 押角材 |
| 〃 | 〃 | 3 | 〃 | 3.10 | 0.126 | | 6-6 〃 〃 |
| 〃 | 〃 | 6 | 〃 | 2.80 | 0.227 | | 2-3 〃 〃 |
| 〃 | 〃 | 35 | 〃 | 3.20 | 1.512 | | 3-4-5-6-6 〃 〃 |
| 横貫 | 〃 | 52 | 〃 | 3.40 | 2.387 | | |
| 〃 | 〃 | 8 | 〃 | 5.70 | 0.616 | | |
| 〃 | 〃 | 16 | 〃 | 6.40 | 1.382 | | 第一及第二径ヨハ8本 〃 |
| 〃 | 〃 | 4 | 〃 | 5.80 | 0.313 | | 〃 〃 ハ不用 〃 |
| 縦筋違 | 〃 | 8 | 〃 | 4.40 | 0.475 | | 中央一列用 〃 |
| 〃 | 〃 | 16 | 〃 | 3.80 | 0.821 | | 両側二列用 〃 |
| 横筋違 | 〃 | 4 | 〃 | 4.70 | 0.254 | | 6 ノ上段 〃 |
| 〃 | 〃 | 4 | 〃 | 4.50 | 0.243 | | 5 〃 〃 |
| 〃 | 〃 | 4 | 〃 | 4.00 | 0.216 | | 4 〃 〃 |
| 〃 | 〃 | 4 | 〃 | 2.20 | 0.119 | | 3 〃 〃 |
| 〃 | 〃 | 20 | 〃 | 4.40 | 1.188 | | 6,5,4,3,2 ノ中段 〃 |
| 〃 | 〃 | 4 | 〃 | 2.40 | 0.130 | | 1 ノ上段 〃 |
| 〃 | 〃 | 32 | 〃 | 4.40 | 1.901 | | 6,5,4,3 ノ下段 } 第一第二径間ハ不用 |
| 〃 | 〃 | 8 | 〃 | 4.70 | 0.508 | | 2,1 ノ 〃 |
| 〃 | 〃 | 4 | 〃 | 4.20 | 0.227 | | 0 第一第四径ヨハ内二本ハ半長 |
| | | | | | | 13.958 立米 | |
| 支柱 | 杉丸太 | 40 | 末口 18cmφ | 4.50 | 一本当リ<br>@ 0.140 = | 5.600 〃 | 6,5,4,3 用 |
| 根杭 | 松丸太 | 60 | 末口 18cmφ | 5.50 | @ 0.178 = | 10.680 〃 | 第一,第二径間ハ { 12本 4.80m 他ハ4.50 要 |
| 〃 | 〃 | 6 | 〃 | 3.50 | @ 0.105 = | 0.630 〃 | 第一,第四 〃 ハ内3本 2.00 |
| 猫木 | 米松,松又ハ杉 | 42 | 20×6 | 平均0.20 | 0.101 | | 斜材根留用 |
| 塡隙材 | 〃 | 30 | 15×5 | 0.20 | 0.045 | | 2,5 間隙塡充用 |
| 楔 | 〃 | 24 | 10×8 | 0.20 | 0.038 | | 0,2,5 打込ミ用 |
| | | | | | | 0.184 〃 | |
| 楔 | 樫又ハ栗 | 108 | 20×11 | 0.30 | | 0.713 〃 | 下段縦梁上部用 |

MADE BY K. Inaba DATE 9-5-18 FILE NO
CHECKED BY M. J DATE 9-5-30 PAGE NO M20

CALCULATIONS FOR

Materials of Sakura-Bashi for Chichibu-Cho.

ボールト

| 締付箇所 | 径 | 長 | 本数 | 摘要 | |
|---|---|---|---|---|---|
| 櫛型 ト 櫛型 | 19粍 | 43糎 | 72 | 6糎角厚3粍座金ニ枚宛共 | |
| 〃 束木 | 〃 | 38 | 24 | 〃 | 0 |
| 〃 斜材 | 〃 | 33 | 84 | 〃 | |
| 櫛型枝 ト 束木 | 〃 | 34 | 36 | 〃 | 0 |
| 束木 ト 縦梁 | 〃 | 28 | 24 | 〃 | 0 |
| 斜材 ト 〃 | 〃 | 43 | 42 | 〃 | |
| 〃 ト 斜材 | 〃 | 23 | 3 | 〃 | 6-6 |
| 縦貫 ト 束,斜材等 | 〃 | 32 | 108 | 〃 | 0-6 |
| 〃 〃 | 〃 | 41 | 12 | 〃 | 〃 |
| 支柱 ト 縦貫筋違 | 〃 | 41 | 58 | 〃 | 3-6 |
| 〃 〃 | 〃 | 32 | 18 | 〃 | 〃 |
| 縦梁 ノ 継手 | 〃 | 18 | 54 | 〃 | 〃 |
| 束,支柱,杭 ト 横貫筋違 | 〃 | 32 | 348 | 〃 | 0-6 |
| 〃 〃 | 〃 | 41 | 54 | 〃 | 〃 |
| 〃 〃 | 〃 | 66 | 34 | 〃 | 2,5 |
| 〃 〃 | 〃 | 57 | 16 | 〃 | 2,5 |
| 支柱 ト 支柱 | 〃 | 38 | 24 | 〃 | 0-6 |
| 支柱ト根杭ノ継手 | 〃 | 23 | 104 | 〃 | 3-6 |

上記ボールト ヲ 長サニ依リ分類スレバ 次表ノ通リ

| 径 | 長 | 本数 | 一本重 | 總重量 |
|---|---|---|---|---|
| 粍 | 糎 | 本 | 瓩 | 瓩 |
| 19 | 18 | 54 | 0.76 | 41.0 |
| 〃 | 23 | 107 | 0.87 | 93.1 |
| 〃 | 28 | 24 | 0.98 | 23.5 |
| 〃 | 32 | 474 | 1.07 | 507.2 |
| 〃 | 33 | 84 | 1.10 | 92.4 |
| 〃 | 34 | 36 | 1.12 | 40.3 |
| 〃 | 38 | 48 | 1.21 | 58.1 |
| 〃 | 41 | 124 | 1.27 | 157.5 |
| 〃 | 43 | 114 | 1.32 | 150.5 |
| 〃 | 57 | 16 | 1.63 | 26.1 |
| 〃 | 66 | 34 | 1.83 | 62.2 |
| | | 1,115本 | | 1,251.9 kg |

鎹 長五寸

| 締付箇所 | 種別 | 本数 | |
|---|---|---|---|
| 櫛型 | 正鎹 | 24 | |
| 〃 | 手違 〃 | 6 | |
| 櫛形ト 横梁 | 〃 〃 | 72 | |
| 束木ト 〃 | 正 〃 | 78 | ② ノ下部6本共 |
| 〃 ト 縦梁 | 〃 〃 | 108 | |
| 横梁ト 〃 | 手違 〃 | 78 | |
| 縦梁 ト 支柱又ハ杭 | 正 〃 | 84 | |
| | | 450挺 | |

内 正鎹計 294挺

手違鎹計 156 〃 152

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

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

MADE BY K. Inaba DATE 9-5-19 FILE NO

CHECKED BY DATE 9-5-30 PAGE NO M21

CALCULATIONS FOR

Materials of Sakura-Bashi for Chichibu-cho.

塵除工 材料 1径間分

| 部材名 | 材種 | 員数 | 断面 | 長 | 容積 | | 摘要 |
|---|---|---|---|---|---|---|---|
| 塵除木 | 松丸太 | 12 | 末口 15cmφ | 4.50m @ | 0.101 = | 1.212 立米 | |
| 土台木 | 〃 | 12 | 〃 | 2.50 | 0.050 = | 0.600 | |
| 〃 | 〃 | 12 | 〃 | 1.50 | 0.029 | 0.348 | |
| 土台及支柱 | 〃 | 48 | 末口15φ二ツ割 | 2.50 | 0.025 | 1.200 | |
| 土台木 | 〃 | 36 | 〃 〃 | 1.50 | 0.014 | 0.504 | |
| 支柱 | 〃 | 24 | 〃 〃 | 2.00 | 0.020 | 0.480 | |
| 〃 | 〃 | 24 | 〃 〃 | 1.30 | 0.012 | 0.288 | |
| | | | | | | 4.632 | |

ボールト (一径分塵除12基用)

| 径 | 長 | 員数 | 一本重 | |
|---|---|---|---|---|
| 19粍 | 37糎 | 72 | 1.19 | 85.7 |
| 〃 | 28 〃 | 84 | 0.98 | 82.3 |
| 〃 | 20 〃 | 72 | 0.81 | 58.3 |
| | | | | 226.3 瓩 |

昭和九年四月

埼玉縣秩父郡
秩父町橋技

橋梁架設工事概算設計

工事費概算　九頁
材料概算　十一乃至十四頁

MADE BY K. Inaba DATE 9-4-10 FILE NO ____
CHECKED BY ____ DATE ____ PAGE NO 1

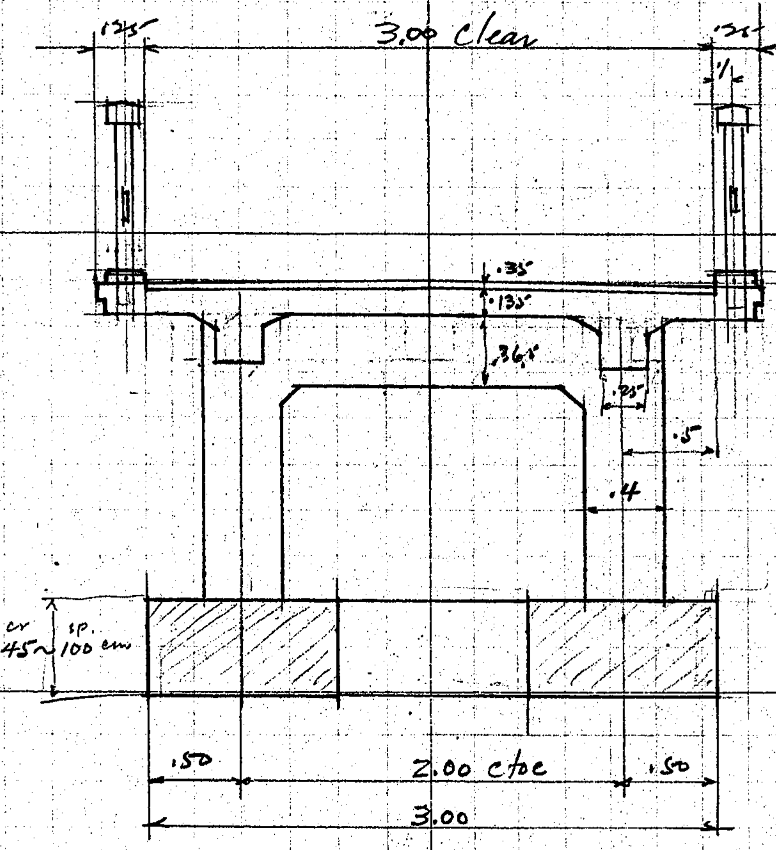
CALCULATIONS FOR

2.0
14 2.8
6 .7

Estimate of Cost for Bessho-Bashi for Chichibu-Cho.

Total length of Bridge 175 meters.
4 arch spans @ 38.00 meters, Rise = 7.5 meters, Road-way 3.0 meter clear

Assumed cross section of bridge.



Design of Floor slab.
Dead Load.
pavement 3.5 cm @ 22 kg = 77
slab 13.5 " @ 24 " = 324
9
410 kg/m2

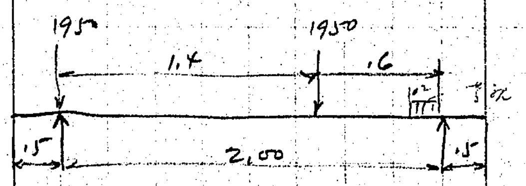
weight of handrail
Top rail .18×.15 = .0270
post. .12×.12×1/1 = .0144
?? .03×.10 = .0030
0.0444 @ 650 = 29 say 30

Overhanging moment = ½×410×0.75² = -115
handrail 30×0.6 = -18
-133 kgm

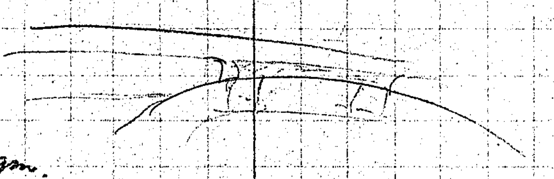
moment at center of span
1/8×410×2.00² = 205
-133
+72 kgm

Live load. 4 ton motor truck rear wheel = 1500 kg
30% imp 450
1950 kg.
front wheel with imp = 1950/3 = 650 "

Unif live load 500 kg/m2.
max. m. at center of span.
1950×1.4/2 = 1365 kg
m = 1365×.6 = 819 kgm.



overhang m. 500×.5²/2 = -63 kgm.
or 1950×.1 = -195 "

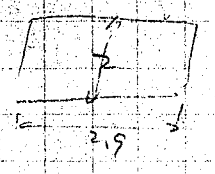


1950×.3 6m
1950×1/2
1950×.7×.6

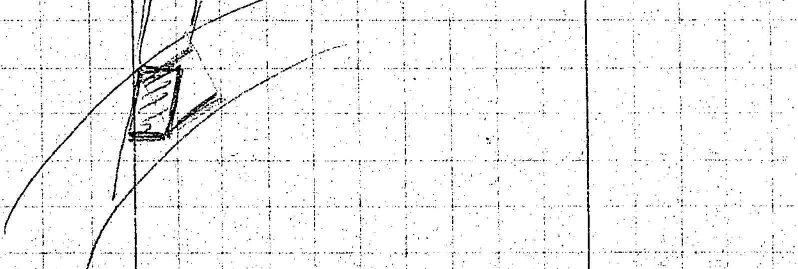
Summary of moments on slab.

| | Center of span | overhanging slab. |
|---|---|---|
| DL | +72 | -133 |
| LL | +819 | -195 |
| | 891 kgm | -328 kgm. |

$$d = \sqrt{\frac{891\times100}{100\times7.13}} = 11.2$$
2.5
13.7



load ヲ隣接二方向ニ分ッテ計算スル



12×.2 = .0400
.12×.12 = .0144
0.0256×.05 =
0.00128 @ 2400 = 3.1
770×1

750

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CALCULATIONS FOR

別所橋 [illegible]

Longitudinal beam. span length 2.90m spacing 2.0m c to c.

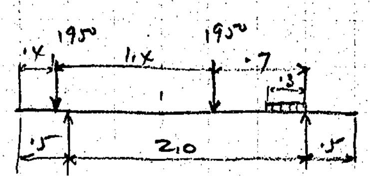
D.L.

flow + pav. 1.75 @ 410 = 718
handrail 30
Stem of beam .25 × .27 × 2400 = 162
fillets &c say 40
950 kg/lin m.

D.L moment = $1/10 \times 950 \times 2.90^2 = 800$ kgm.
" shear = $1/2 \times 950 \times 2.9 = 1380$ kg

Live Load. max load

$1950 \times 0.7 = 1365$
$1950 \times 2.1 = \underline{4090}$



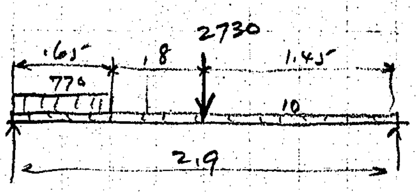
$5455 \div 2 = 2730$ kg front wheel $\frac{2730}{3} = 910$ kg.

$\frac{500 \times .3^2}{2 \times 2.0} =$

10 kg/lin m.

$\frac{500 \times 2.5^2}{2 \times 2} = 780$ kg/m.

$\frac{10}{770}$



moment

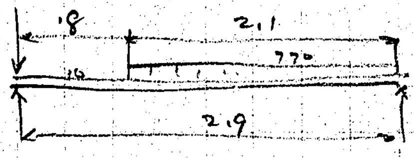
$1/10 \times 10 \times 2.9^2 =$ 10

$\frac{770 \times .65^2}{2 \times 2.9} = 58$

$2730 \div 2 = \underline{1365}$

$1420 \times 1.45 = 2060 \times \frac{8}{10} = \underline{1650}$

$\underline{\underline{1660}}$ kgm.



Shear.

$\frac{770 \times 2.1^2}{2 \times 2.0} = 850$

$10 \times 1.45 = 15$

$\underline{2730}$

$\underline{\underline{3595}}$ kg.

Steel reqd $= \frac{1660 \times 100}{1200 \times \frac{7}{8} \times 35} = 4.52$ cm²

use 3 − 16φ = 6.03 cm²

unit shear $= \frac{3595}{25 \times \frac{7}{8} \times 35} = 4.7$ kg/cm² use stirrups

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CALCULATIONS FOR

埼玉県 別所橋

Dead Load on Arch ring.

floor and pavement 3.50 @ 410 = 1435
handrail 2 @ 30 = 60
beams 2 @ 162 = 3.24
31

1850 × 2.92 = 5,400 kg
Cross beam stem .365 × .3 × 2.4 @ 2400 = 630
6030 kg. for each panel pt.

Spandrel columns

① colum 2 @ .14 × .3 × 4.5 @ 2400 = 2590
strut .3 × .3 × 1.6 @ " = 350
2940 kg.
② 2 @ .14 × .3 × 3.0 @ 2400 = 1730
③ " " × 1.8 @ " = 1040
④ " " × 1.0 @ " = 580
⑤ " " × .5 @ " = 290
⑥ —
⑦ —

Arch ring
① 2 @ 1.0 × .9 × 4.0 @ 2400 = 17300 kg.
② " @ " × .8 × 3.5 @ " = 13400
③ " @ " × .65 × 3.2 @ " = 10000
④ " @ " × .55 × 3.0 @ " = 7900
⑤ " " × .5 × 2.55 @ " = 7,100
⑥ " " × .45 × 2.92 @ " = 6,300
~~⑦ " " × .45 × 2.92/2 @ " = 3,200~~

19.6
21.6
41.2

Summary of panel dead loads on arch ring.

| panel points | floor | column | arch ring | Summary | call this |
|---|---|---|---|---|---|
| 1 | 6030 | 2940 | 17,300 | 26,270 | 26,300 kg. |
| 2 | " | 1730 | 13400 | 21,160 | 21,200 |
| 3 | " | 1040 | 10000 | 17,070 | 17,100 |
| 4 | " | 580 | 7900 | 14,510 | 14,500 |
| 5 | " | 290 | 7100 | 13,420 | 13,400 |
| 6 | " | — | 6300 | 12,330 | 12,300 |
| | | | | | 104,800 |

6300
1300
7600 ÷ 2.92
6030
13630 ÷ 2.92
1.6

6 × 6 50 × 2 100

13000

4.5 × 13 = 59
7.0 × 26 = 182
241 ÷ 3 = 720

4.0 × 7 = 28
8.0 × 28 = 224
252 × 1.6 = 405 / 1125

24/2 72 × 50 = 3600
3600 × 2 = 7200
~~6800~~
5000

118,000

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CALCULATIONS FOR

埼玉県別所橋.

Approximate Dead Load thrust.

| Panel pt. | Panel load | | arm | | m. |
|---|---|---|---|---|---|
| 1 | 26300 | × | 1 | = | 26300 |
| 2 | 21,200 | | 2 | | 42400 |
| 3 | 17100 | | 3 | | 51,300 |
| 4 | 14500 | | 4 | | 58,000 |
| 5 | 13400 | | 5 | | 67,000 |
| 6 | 12300 | | 6 | | 73,800 |
| 7 | | | | | |

318,800 × 2.92 = 931,000

Hor. thrust $\doteqdot \frac{931000}{7.5}$ = 124,000 kg for 2 rings

Rise ratio $\frac{7.5}{38.0} \doteqdot \frac{1}{5}$ = 0.20 = r

Thickness ratio 100 ÷ 45 = 2.20 = A.

$w_c$ weight of arch ring (at crown) plus average weight of superstructure in kg/m.

arch ring at crown = 6300
floor average 6030
columns " 1320
7350
13650 ÷ 2.92 = 4800 = $w_c$

$w_c l$ = 4800 × 38 = 178,500

$T_c$ = 178500 × 0.73 = 131,000 kg

$T_s$ = 178500 × 0.985 = 176,000 kg

2055 × 38 = 78000
07,000

4,500,000

Live Load

$\frac{100,000}{170+38}$ = 480

Crown. $w$ = 480 × 3.0 = 1440 kg/m   $wl^2$ = 1440 × 38² = 2080000
moment 0.005 × 2080,000 = 10400 kgm   $wl$ = 1440 × 38 = 54,700
thrust 0.33 × 54,700 = 18,050 kg

Springing
(−) moment − 0.0222 × 2080,000 = − 46,200 kgm
thrust 0.365 × 54700 = 200,000 kg

(+) moment 0.028 × 208000 = + 58,200 kgm
thrust 0.45 × 54700 = 246,000 kg

| Summary | Crown moment | thrust | Springing moment | thrust (normal) | moment | nor. thrust |
|---|---|---|---|---|---|---|
| DL | say 2,000 | 131,000 | say − 480 | 176,000 | − 480 | 176,000 |
| LL | 10400 | 18000 | − 46,200 | 200,000 | + 58200 | 246000 |
| | 12,400 kgm | 149,000 kg | − 51,000 kgm | 376,000 kg | + 53,400 kgm | 422,000 kg |

sp + 26600 (#) 2.54 533,400#
cr + 9800 (#) 1.17' 45,040
0.20 % of h
sp, e = .005'
cr e = 0.012' 1.88 % of h

$\frac{.5}{250}$

510
450
20,000

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$\frac{100}{19000}$

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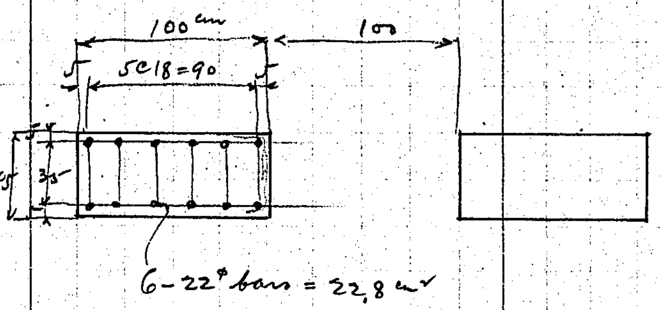
CALCULATIONS FOR

埼玉県別所橋

Stress in arch
Crown section



$N = 149{,}000$ kg
$m = 12{,}400$ kgm

$ecc = \frac{12400\times100}{149000} = 8.3$ cm

$e/h = 8.3/45 = 0.185$

$p_0 = \frac{22.8\times4}{45\times200} = 0.0101$

$d'/h = 5/45 = 0.111$

.101
.98

$K = 0.99$ , $L = 0.105$

.108
.1020

$f_c = \frac{12400\times100}{0.105\times200\times45^2} = 29.7$ kg/cm²

$f_s = 15\times29.1\left(\frac{40}{.99\times45}-1\right) =$ —

Springing section

$N = 422{,}000$ kg
$m = +53{,}400$ kgm

$e = \frac{43400\times100}{422000} = 10.3$ cm

$e/h = 10.3/100 = 0.103$
$d'/h = 5/100 = 0.05$
$p_0 = \frac{22.8\times4}{100\times200} = 0.00456$

$K = 1.46$

$f_c = \frac{422000\times1.46}{20000} = \underline{\underline{30.8}}$ kg/cm² C.

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CALCULATIONS FOR

埼玉縣別所橋

Materials

Arch span superstructure. 4 spans required

Concrete

Floor slab 3.50 × 0.135 = 0.473
beam. 2 × 0.25 × 0.265 = 0.133
fillets 2 × 0.15 × 0.10 = 0.030
0.636 × 40.0 = 25.5 cub.m ✓
Cross beams 14@0.365 × 0.30 × 2.40 = 3.7 " ✓

Columns. ⓪ 0.4×0.3×2 × 7.0 = 1.68
Sts, 0.3×0.3 × 1.6 = 0.14
1.82
① 1.23
2 0.72
3 0.43
4 0.24
5 0.12
6 0.10
7 0.05
4.71 × 2 = 9.4 cub m ✓

Arch ring
0 1.0×2 × 2.0 = 4.00
1 7.24
2 5.58
3 4.17
4 3.29
5 2.96
6 2.63
29.84 × 2 = 59.7 cub.m. ✓
misc say = 1.7 ✓
100.00 cub.m. ✓

Form.
Floor slab + beam. 4.40 × 40.0 = 176.0
cross beam. 14 @ .37 × 2.4 × 2 = 25.0
columns. 24 @ 1.4 × 3.3 = 111.0
ring side 4 @ 0.70 × 41.0 = 115.0
misc say = 23.0
450.0 m2 ✓

Reinforcements
Floor slab beam + cols. 38.6 m³ @ 130 kg = 5.00 tons ✓
Arch ring 60 m³ @ 90 " = 5.40 " ✓
10.40 tons. ✓

Pavement 35 mm granolithic pavement
3.0 × 40 = 120.0 m2

Handrail 2 @ 40 m = 80.0 m

2×7 = 1.4
45
70
56
63.0

1.0
45
1.45
.7
43
1.4
172
43
60.

.6×.3×1
18
6
1.08

.3×.4

1.16
1.08
38
41.8

6
10
4
43
.12×3
.4 8.

4650
820
6)740(123
6
140
120
20
18
7

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CALCULATIONS FOR
埼玉県別所町

Arch piers. 3 piers required.
Concrete 1:2.5:5
shaft. 2.5 × 3.5 × 6.0 = 52.5
base 1.0 × 4.0 × 3.7 = 14.8
67.3 cubm.

form. shaft. 12 × 6 = 72.0
1.0 × 15.4 = 15.4
2.6
90.0 m2

reinforcements 67.3 @ 22 kg = 1.5 tons.

Excavation 7 × 7 × 2 = 100 cubm

Arch abutment conc. 4 × 2.5 × 3.2 = 32.00 m3
毛 form. 40.0 m2
本. steel 32 @ 22 kg = 0.7 ton.
rock Excav. 4 × 4 × 1.2 = 20.0 m3

6 m Side span.
Concrete 1:2.5:5
slab + pav. 3.5 × 0.135 = 0.473
beam .35 × 0.5 × 2 = 0.350
fillet 0.2 × 0.3 × 2 = 0.120
0.943 × 6.0 = 5.7 m3
form. 3.5 + .34 + .07 = 3.91
4 × 0.50 = 2 m
5.91 × 6.0 = 35.5
4.5
40.0 m2

steel 5.7 @ 130 kg = 0.75 ton.

pavement 3.0 × 6 = 18 m2

handrail 2 @ 6 = 12 m

~~Side span pier~~ 2 req'd

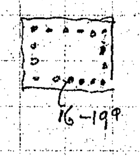
Conc 1:2.5:5 col. 0.6 × 0.7 × 8 × 2 = 6.7
beam 0.6 × 0.6 × 2.5 = 0.9
base 3.5 × .9 × 3.5 = 11.0
18.6 m3 ✓

form 2.6 × 8 × 2 = 41.6
2.4 × 2.5 = 6.0
0.9 × 14 = 12.6
60. m2

reinforcement 18.6 @ 65 kg = 1.2 ton ✓

Excavation 6 × 6 × 2 = 72 m3

$\frac{114}{187} = 0.61$


16-19φ

2.0 .16
1.6 .14
64
16
.224

4.6 × 3 = 120 ℓ
1.2
150 × 00 = 1 m
20 × 4 = 80 × 2

352
1.6
411 2
352
563

.18
1.58
1.98
2.91 m

1.58
.6
.948

180
240
120
360
10 m

2.2
18

176
.22
396

80
10
800
8

16
22
32
32
352 × 8

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CALCULATIONS FOR

埼玉縣別所橋

95 100/20

Estimate of cost.

Arch super structure, one span. 40m [4 req'd]

| | | | | | |
|---|---|---|---|---|---|
| Concrete 1:2.5:5 | 100.00 m³ | @ | 12.00 | = | 1,200 |
| forms | 450.00 m² | @ | 1.50 | = | 675 |
| reinforcements | 10.50 tons | @ | 120.00 | = | 1,260 |
| pavements | 120.00 m² | @ | 2.00 | = | 240 |
| handrails | (片側 x2) 80.00 m | @ | 2.50 | = | 200 |
| Expansion jt etc say | | | | | 25 |
| | | | | | 3,600 円 |

Arch pier [3 req'd]

| | | | | | |
|---|---|---|---|---|---|
| Concrete 1:2.5:5 | 67.3 | @ | 12.00 | = | 808 |
| form | 90.0 | @ | 1.50 | = | 135 |
| reinforcements | 1.5 | @ | 120.00 | = | 180 |
| excavation | 100.0 m³<br>to #32 | @ | 1.00 | = | 100<br>27 |
| | | | | | 1,250 円 |

Arch abutment Te [1 req'd]

| | | | | | |
|---|---|---|---|---|---|
| Concrete 1:2.5:5 | 32.00 | @ | 12.00 | = | 384 |
| form | 40.00 | @ | 1.50 | = | 60 |
| reinforcements | 0.70 | @ | 120.00 | = | 84 |
| rock excavation | 20.00 m³ | @ | 5.00 | = | 100<br>22 |
| | | | | | 650 円 |

Arch abutment Tn [1 req'd] say 350 円

6m Side span [3 req'd]

| | | | | | |
|---|---|---|---|---|---|
| Concrete 1:2.5:5 | 5.7 m³ | @ | 12.00 | = | 68 |
| forms | 40.0 | @ | 1.80 | = | 72 |
| reinforcements | 0.75 | @ | 120.0 | = | 90 |
| pavements | 18 | @ | 2.00 | = | 36 |
| handrail | 12 m | @ | 2.50 | = | 30<br>4 |
| | | | | | 300 円 |

Side span pier [2 req'd]

| | | | | | |
|---|---|---|---|---|---|
| Concrete 1:2.5:5 | 18.6 | @ | 12.00 | = | 223 |
| form | 60.0 | @ | 1.50 | = | 90 |
| reinf. | 1.20 | @ | 120.00 | = | 144 |
| excavation | 72.0 | @ | 1.00 | = | 72<br>21 |
| | | | | | 550 円 |

21278.55

26642.51

Side span abutment Tn say 250 円

| | | | | | | |
|---|---|---|---|---|---|---|
| Centering | 材料費 | 2 spans | @ | 2700 | = | 5400 |
| | 仕拵費 | 2 〃 | @ | 100 | | 200 |
| | 組立取外 | 4 〃 | @ | 270 | | 1080 |
| | | | | | | 6680 ÷4 = 1670円/span. |

20
34
24
25

3×180×.2

10
4
40 ~~~~ 70

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CALCULATIONS FOR

塙[illegible]別所橋

Summary of cost.

Superstructure

| | | | |
|---|---|---|---|
| Arch spans | 4 @ 3600 = | 14400 | |
| Centering | 4 @ 1700 = | 6800 | |
| Side spans | 3 @ 300 = | 900 | |
| | | | 22,100 |

Substructure

| | | | |
|---|---|---|---|
| Arch piers | 3 @ 1250 = | 3750 | |
| Arch abutments 左岸 | | 650 | |
| 〃 右岸 | | 350 | |
| Side span piers | 2 @ 550 = | 1100 | |
| Side span abutment 右岸 | | 250 | |
| | | | 6,100 |
| | | | 28,200 円 |
| | 2@750 [illegible] Conc, 1号 | | − 1,200 |
| | Summary of cost. = | | 27,000 円 |

volume of concrete.

| | | | |
|---|---|---|---|
| Arch superstructure | 4 @ 100 = | 400. | |
| Side span | 3 @ 6 = | 18 | |
| Arch pier | 3 @ 67 = | 201 | $2 \times \frac{4}{5} = 1.6$ |
| Arch abutment | | 32 | $2 \times \frac{4}{6} = 1.33$ |
| 〃 | | 20 | |
| Side span pier | 2 @ 19 = | 38 | $\frac{27 \times 4}{10}$ |
| 〃 abutment | | 11 | |
| | | 720 cub meters | |

| | |
|---|---|
| Gravel | 720 cub m |
| Sand | 360 〃 |
| Cement | 1,150 Barrels. |

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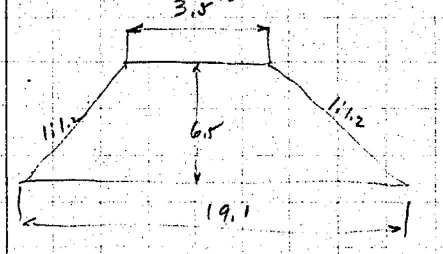
CALCULATIONS FOR

塙之路別計概.

Estimate of approach road making



左岸

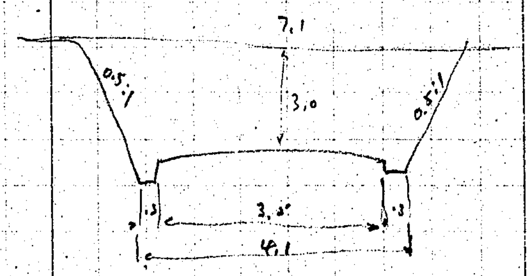
Sectional area of banking — volume of filling

$\frac{3.5+19.1}{2}$ = 11.3 × 6.5 = 73.4 m2 × 14.0 = 1028

$\frac{3.5+17.9}{2}$ = 10.7 × 6.0 = 64.2 × 10.0 = 642

$\frac{3.5+9.5}{2}$ = 6.5 × 2.5 = 16.3 × 36.0 = 587

盛土 計 2,257 m3



右岸

5.6 × 3.0 = 16.8
2
17.0 × 90.0 = 1530 m3 切取計

切取 軟岩 800 m3 @ 2.00 = 1,600
土砂 730 〃 @ 0.45 = 329
盛土 2257 m3 @ 0.8 = 1806
3,735 円

資材見込
Concrete 1:2.5:5 — 10円見当
1:2:4 — 12 〃
砂利 砂 豊富なり

補助
補助認可の左種国議による
申請書類 { 概算書 — 補助認可
精算書 — 補助額決定

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CALCULATIONS FOR
秩父町櫻沢橋梁（概算設計）

Materials.

Floor construction for one arch span.

Concrete 1:2.5:5 mix.

Cross section

Slab. 0.125 × 3.00 = 0.375
coping 2@ 0.16 × 0.22 = 0.070
" 2@ 0.07 × 0.03 = 0.004
Stem of beam 2@ 0.25 × 0.275 = 0.138
fillets 2@ 0.15 × 0.10 = 0.030
0.617

hr. 1 Post根固め 2@ 0.22×0.22 × 0.04 ÷ 1.46 = 0.003
0.620 sq.m. × 38.00 = 23.60

Crown fill say 2× 0.50 × 0.125 × 8.8 1.10
23.70 cub.m

form. (slab) 3.50 + (stem) .275×4 + (coping side) .16×2 + (pav.) .035×2 =
3.5 + 1.10 + .32 + .07 = 4.99 m × 38.00 = 190.00
joint say 4@ .620 ≒ 3.00
193.0 sq. m.

reinforcements 23.70 m³ @ 130 kg = 3.10 kg tons.

Cross beams and columns for one span.

cross beam .30 × .375 × 2.40 = 0.270 × 10 = 2.70
" .270 × .25/.3 = 0.225 × 4 = 0.90
3.60
Columns. 2780×4 kg / 2400 = 4.63
8.23 m 3.

forms. .375 × 2 × 2.4 = 1.80
.375 × .30 × 2 = 0.23
2.03 × 14 = 29.0
(.3 + .4) × 2 = 1.4
Columns 1.40 × 9.73 × 4 = 55.0
84.0 m²

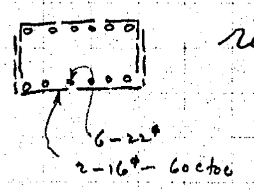
Reinforcements 8.23 m³ @ 175 kg = 1.45 tons.

2.2% .181 1.42

Arching and struts 13.

Concrete 1:2:4 13.913 × 4 = 55.70 m³

form. 0.65 × 21.1 × 8 = 110
struts 1.10 × 1.0 × 4 = 4.4
115.0 m²



reinforcements 55.70 m³ @ 95 kg = 5.30 tons.

φ22×6

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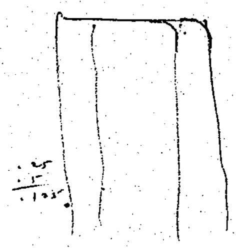

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CALCULATIONS FOR

横浜橋梁

Deck construction over pier.

flow. Concrete 1:2.5:5 0.65 × 2.00 = 1.30 cub. m
forms 5.99 × 2.00 = 12.00 m²
reinf. 1.30 @ 130 kg = 0.17 ton.

Columns.

Conc. 1:2.5:5.

0.30 × 0.50 × 6.8 × 4 = 4.08
0.30 × 0.30 × 1.7 × 2 = 0.31
0.30 × 0.30 × 1.5 × 2 = 0.27
0.34

cross beam
5.00 m³ + 0.5 = 5.50 m³

form. 1.60 × 4 × 6.8 = 43.5
1.20 × 1.7 × 2 = 4.1
1.20 × 1.5 × 2 = 3.6
1.8

53.0 m² + 4.0 = 57.0

reinforcements 5.00 m³ @ 175 = 0.88 ton + .08 = 0.96

Summary of materials for superstructure of arch span.

| | for one span | | | | for 4 spans | | | |
|---|---|---|---|---|---|---|---|---|
| | Concrete | | form | reinf. | Concrete | | form | reinf. |
| | 1:2:4 | 1:2.5:5 | | | 1:2:4 | 1:2.5:5 | | |
| Floor on span | | 23.70 | 193 | 3.10 × 4 | | 95.0 | 772 | 12.40 |
| cross beam + column. | | 8.23 | 109 | 1.45 × 4 | | 33.0 | 436 | 5.80 |
| floor over pier | | 1.30 | 12 | 0.17 × 3 | | 4.0 | 36 | 0.50 |
| cross beam + col, over pier | | 5.50 | 57 | 0.96 × 3 | | 17.0 | 171 | 2.90 |
| | | | | | | 149 m³ | 1415 m² | 21.60 ton |
| Arch ring | 55.7 | | 115 | 5.30 | 223. m³ | | 460 m² | 21.20 ton |

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CALCULATIONS FOR

榛名橋梁

Materials of Girder spans.

Floor.

Concrete 1:2.5:5

| | | | | |
|---|---|---|---|---|
| cross section | slab | | 0.375 | |
| | Coping | | 0.074 | |
| | Stem of beam | 0.35 × 0.50 × 2 = | 0.350 | |
| | fillets | 0.15 × 0.10 × 2 = | 0.030 | |
| | | | 1.011 | |
| | | | 0.840 × 6.00 = | 5.04 |
| | Cross beams | .30 × .65 × 1.65 × 2 | = | 0.64 |
| | | | | .02 |
| | | | | 5.70 m³ |

| | | | |
|---|---|---|---|
| form | 4.99 + 0.41 | = 5.40 × 6.0 = | 32.4 |
| | cross beam | .65 × 4 × 1.65 = | 4.3 |
| | | | .3 |
| | | | 37.0 m² |
| reinforcements | | 5.70 @ 130 = | 0.74 ton |

for 3 spans.

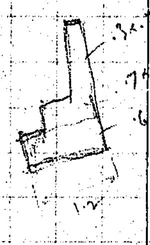
| | | |
|---|---|---|
| 1:2:5 concrete | 3 @ 5.70 = | 17.1 m³ |
| forms | 3 @ 37. = | 111. m² |
| reinforcements | 3 @ .74 = | 2.22 tons. |

Materials of arch piers.

| | | | |
|---|---|---|---|
| Concrete 1:2.5:5 | | | 69.14 say 70. m³ |
| forms. | 12.35 × 5.90 = | 72.9 | |
| | 1.20 × 16.0 = | 19.2 | |
| | | | 92. m² |
| reinforcements | 70 m³ @ 15 kg = | | 1.05 tons. |
| Excavation | 6 × 6 × 2.0 = | 72.0 m³ earth | |
| | 4 × 4 × .2 = | 3.2 " rock | |

Arch abutment

| | | | | |
|---|---|---|---|---|
| 左岸 | Concrete 1:2.5:5 | | | 36.0 m³ |
| | form. | 3.0 × 11.0 = | 33.0 | |
| | | 1.0 × 16 = | 16.0 | |
| | | | 1.0 | |
| | | | | 50.0 m² |
| | reinforcements | 36.0 @ 25 kg = | | 0.90 ton. |
| | Excavation | 3.0 × 5 = | 15.0 m³ earth | |
| | | 1.3 × 5 × 4 = | 26.0 m³ rock. | |
| 右岸 | Concrete | | | 18. m³ |
| | form | | | 25 m² |
| | reinforcements | | | 0.5 ton |
| | excavation | | | 15.0 m³ rock |



.21
.35
.72
1.28 × 4.0 = 5.12

.49
1.0
.3 × .3
.09
.1
.55

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CALCULATIONS FOR

橋洛橋梁

Side span piers

Concrete 1:2.5:5 — 16.5 m3

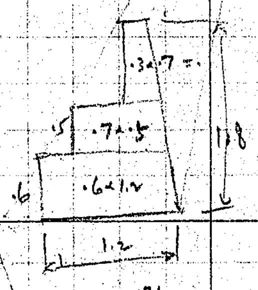
forms
column 2.4 × 7.5 × 2 = 36.0
~~top strut~~ 2.30 × 2.4 = 5.5
~~center strut~~ 1.4 × 1.5 = 2.1
butt's " 1.0 × 1.5 = 1.5
base 16 × 14.4 = 8.6
1.3
53.0 m2

reinforcements 16.5 @ 50 kg = 0.8 ton.

Excavation 5.0 × 6.0 × 2.5 = 75 m3
rock ち 85 % 3.

Side span abutment A3

Concrete 1:2.5:5 — Say 3.0 m3
form 20.0 m2
reif. 0.25 ton
excav. rock. 3 10.0 m3



.21
.35
.72
1.28 × 4.0 = 5.12

3.6 × 4 = 14.4
1.28 × 2 = 2.6
17.0

Concrete for protection of abutments 3 reqd.

Concrete 1:2.5:5 say 3.0 × 3.0 × 0.2 = 1.8 m3
form 13.0 m2
reif. 1.8 @ 60 = 0.10 ton.
excav. rock. 5.0 m3
} × 3

3×1

handrails 木製 2 @ 176 = 352 m.

pavements 膠石 3.5 cm 3.0 × 176 = 528 m2

秩父町大字大宮別所地内

橋梁概算書

1.734 × 38 × $\frac{620}{1.46}$ =

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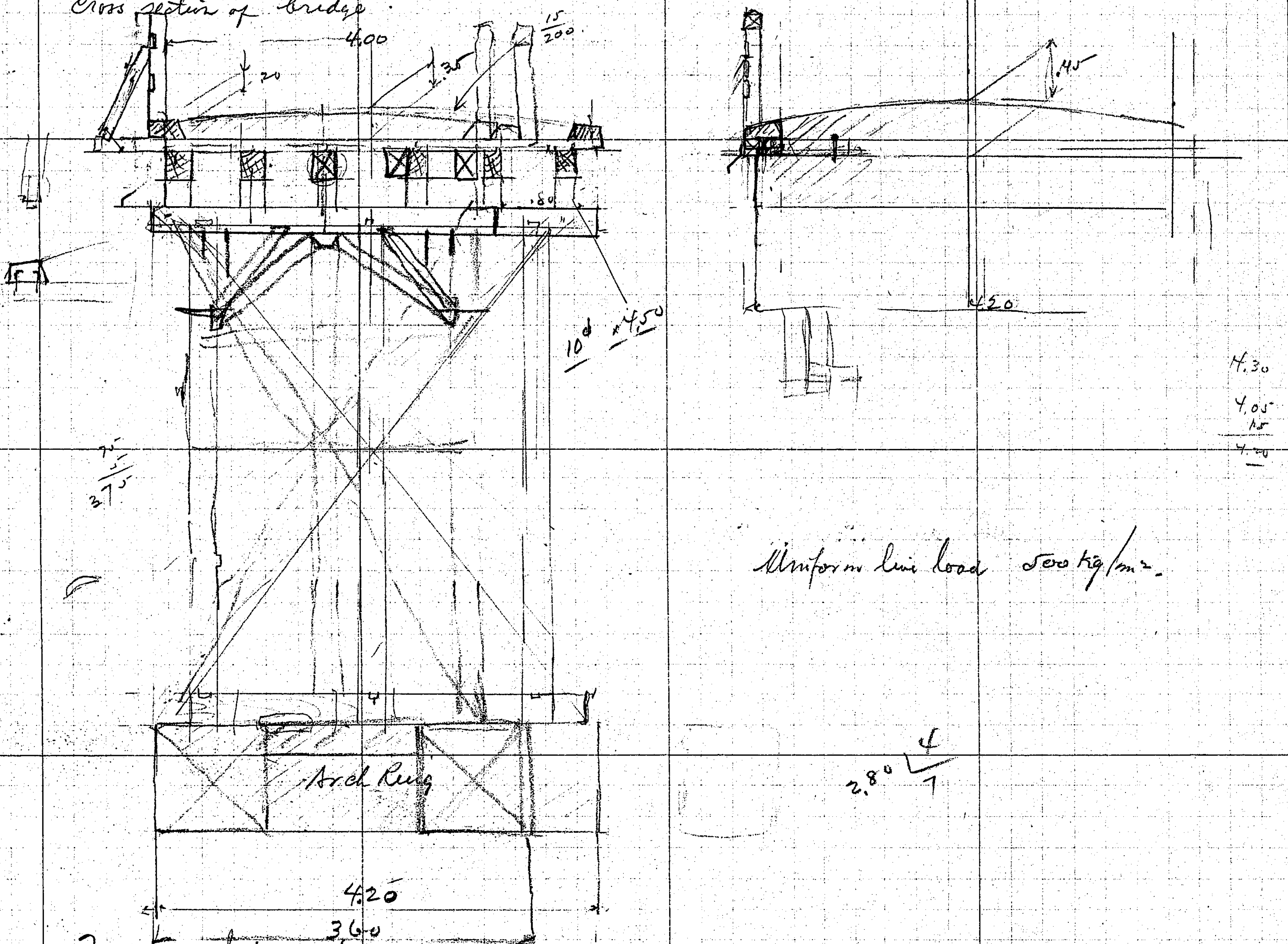
CALCULATIONS FOR

Estimate of Cost Betshō Bashi for Chichibu Chō.

Total length of bridge 252 meters
5- arch spans @ 44.5 about Rise 9.0 m
Arch rings and piers will be built in reinforced concrete Roadway near crown sand fill. and the other part wooden structure covered with earth and gravel.
Clear roadway 4.0 meters.
Cross section of bridge.



Uniform live load 500 kg/m².

Transverse Joist
Dead load Earth and gravel filling .35 @ 1700 = 595
weight of Joist 65
660 kgs/m².
.650.
live load. 500
1160

moment = 1/10 × 1160 × .75² = 65.2 kgm

for 10 cm wide 65.2 kgm.
section modulus. 0.0,9,8,175 d³. 1000

fibre stress = 6520 / 98.175 = 66.5

Longitudinal Beams span length 3.20 m
Dead load floor- 660 × .75 = 495
beam say 36
525
live load. 500 × .75 = 375
900 kg / per lin meter.
M = 1/8 × 900 × 3.20² = 1150 kgm

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CALCULATIONS FOR

Estimate of Cost Besshō Bashi for Chichi-bu-chō -

fibre stress assumed 60 kg/cm² $f = \frac{6M}{bd^2}$ $d^2 = \sqrt{\frac{6M}{bf}}$

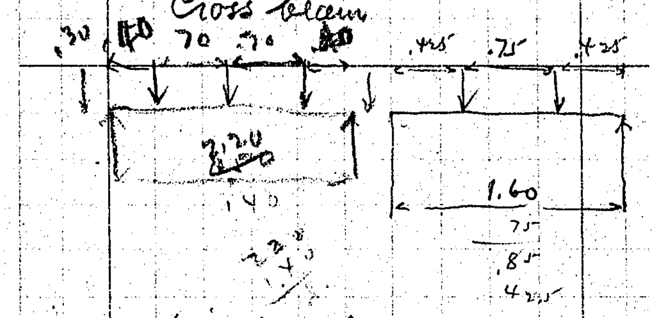
width of beam say 15 cm

$d = \sqrt{\frac{115000 \times 6}{15 \times 60}} = \sqrt{770} = 28$ cm

width of beam say ~~20~~ 18 cm

$d = \sqrt{\frac{115000 \times 6}{18 \times 60}} = \sqrt{639} = 25.3$ 67 × 8.57

Cross beam



.75
.85
4.25

2.20
1.40

Dead load on cross beam $\left\{ \begin{matrix} 525 \times 3.20 = \\ 900 \; 375 \times 3.20 = \end{matrix} \right\}$ 2880 kg
Live load " " "

moment = 2880 × .425 = 1220 kgm

for continuity .8 × 1220 = 975 kgm

$\boxed{900 \times \frac{70}{75}} = 840$

840 × 3.20 = 2700

width of beam 20

$d = \sqrt{\frac{975 \times 6}{\cancel{20} \times 60}}$ ~~2770~~ 2170 $= \sqrt{487.5} = 22$ cm.

$\sqrt{\cancel{1382}}$ ~~1085~~ 87 ~~37~~ ~~340~~ 29.6

75

use 21 × 21 cm 7.5 8 17

25 × 30

~~moment~~ = 4050 × ~~1.25~~ 1.10 = ~~5060~~ 4460
2700 × .70 = 1890
3170
400
~~2700 × 1.1~~

1350 × 3.0

1350
4050
4460
1890
2570
400
~~2770~~ 2170

~~load~~ on ~~Center~~ col. say 2900 × 2 = 5800 kgs.

Length of col. say 5.0 m

2700 × .25 = 6900 (?)

$P = 42\left(1 - \frac{l}{60d}\right)$ = 22.5 $\left(1 - \frac{500}{60 \times 18}\right) =$

463
.537

$d = \boxed{18}$ 20 ✓ area = ~~$d^2$~~ 25.4. 254 × 22.5 = 5720 kg. Ok.

d 1260 = 314 314 × 22.5 = 7050 kg Ok

Concrete arch ring -

Dead load on deck.

fill. average. ~~4.0~~ 3.0 × .32 @ 1700 = 1630 2180 kg per lin. meter -

macconcrete say 200 200

Handrails say 2 @ 60 - 120 120

Transv. beams. 200 250

long. beam 250 200 250

Bent. 250

250

2550 250

1500 3250 kg per lin. meter.

~~4000~~ 2000 " " " "

250

15.0
15
15
15
18 × 26.

Live load

Dead load arch ring - say .80 × ~~4.20~~ 2.20 = ~~3.36~~ 1.76

135
.60

~~3.36~~ 1.76 @ 2400 = ~~8070~~ kg per lin. meter 4220 5220

3200 2550 ~~2550~~

Total dead load 11320 ~~6770~~ 7770

" live load 2000 2000

13320 - 8770

120
60
180
90
80

span linear 44.5 Rise ~~9.0~~ 10.5

Thrust at crown $= \frac{1}{8} \times \frac{\overset{8770}{\cancel{13300}} \times 44.5^2}{\underset{10.5}{\cancel{9.0}}} = \overset{207000}{\cancel{362000}}$ kg.

Unit thrust $\frac{\overset{2.20}{\cancel{4.20}} \times \overset{6.0}{\cancel{.60}}}{} = \overset{13200}{\cancel{25200}}$ $\frac{\overset{207000}{\cancel{362000}}}{\underset{13200}{\cancel{25200}}} = \overset{15.7}{\cancel{14.6}}$ kg/cm²

24.2

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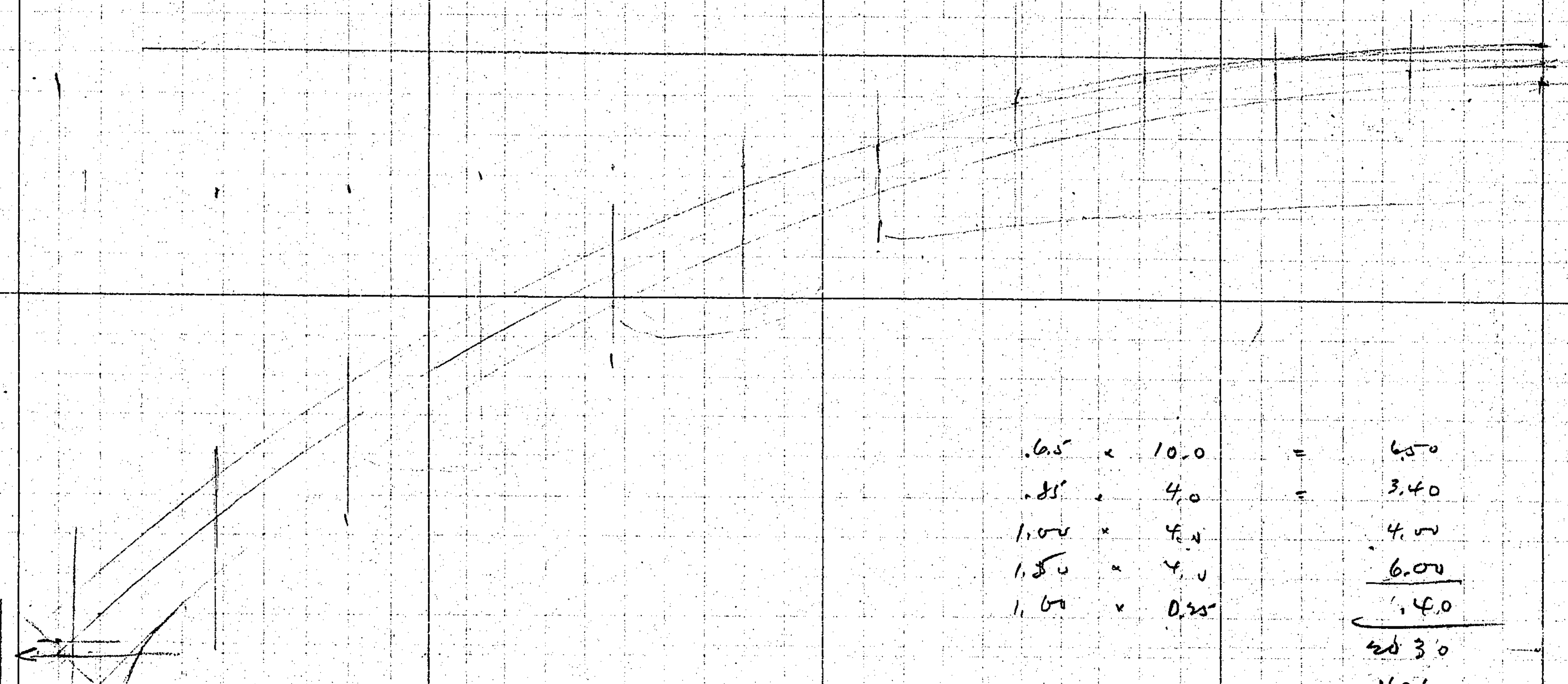
CALCULATIONS FOR

Estimate of Cost Bes sho Bashi for Chichi-bu cho

volume of concrete say

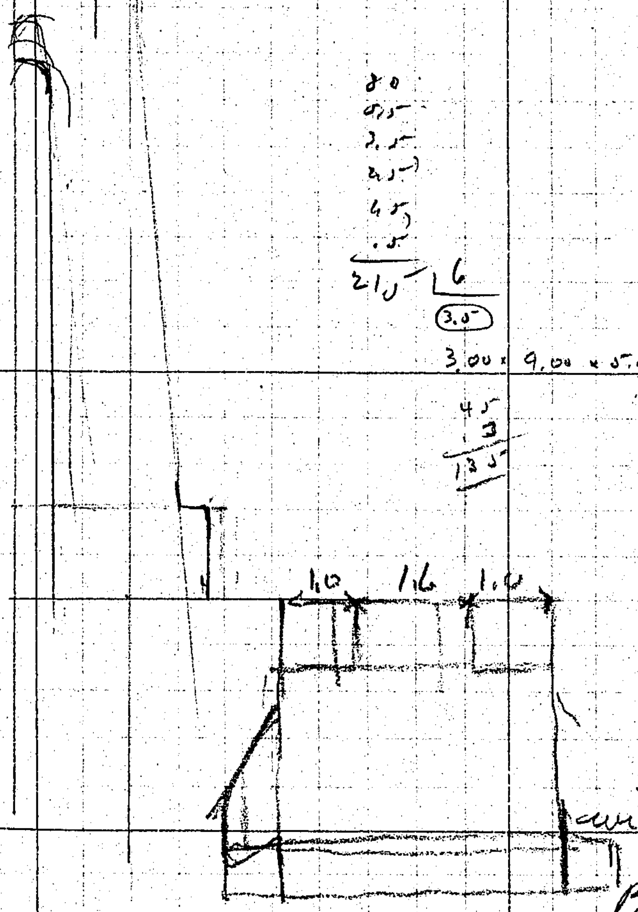


| | | | | |
|---|---|---|---|---|
| .65 | × | 10.0 | = | 6.50 |
| .85 | × | 4.0 | = | 3.40 |
| 1.00 | × | 4.0 | | 4.00 |
| 1.50 | × | 4.0 | | 6.00 |
| 1.60 | × | 0.25 | | .40 |
| | | | | 20.30 |
| | | | | 40.60 |

44.00 × 2.20 97
~~40.60~~ × ~~4.00~~ = ~~170~~ ~~cubic meters~~.

$\frac{\overset{97}{170} @ 2400}{44.5} = \overset{5220}{\cancel{9200}}$ kg/m

44.5
2.5



8.0
8.5
2.5
2.5
4.5
.5
21.0 ÷ 6
(3.5)
3.00 × 9.00 × 5.0

4.5
3
13.5

Pier

Total dead load. say ~~12000~~ 7800 × 45 = 54,0000 | 351000
Pier own wt. 160 @ 2400 = 384000 | 300000
924000 | 651000
live load on one span 2000 × 22.5 = ~~45000~~ | 35000
~~969000~~ | 686000

unbalanced live load thrust

$\frac{\overset{1500}{\cancel{2000}} \times 44.5^2}{8 \times ⑨ 10.5} = \overset{35300}{\cancel{55000}}$ kgs.

moment = $\overset{35300}{55,000} \times \overset{7.5}{\cancel{9.5}} = \overset{265000}{\cancel{522,000}}$ kgm.

Eccentricity = $\frac{\overset{265000}{\cancel{522000}}}{\underset{651000}{\cancel{924000}}} = \overset{.707}{\cancel{0.566}}$ m

.845

0.566 × 6 = ~~3.40~~ m
.707 × 6 4.27

width of base ~~5.0~~ × ~~5000~~ = ~~25.0~~
5.0 360 18.0

Bearing Pressure = $\frac{\overset{686000}{\cancel{969,000}}}{\underset{18.0}{\cancel{25.0}}} (1 \pm \frac{6 \times 0.\overset{.707}{\cancel{566}}}{5.00}) =$

381 1.68
32
~~39000~~ 70500 kgs/m² or ~~6.0~~ 6.5 tons/☐'

approximate concrete in pier

Base 1.2 × 5.0 × 5.0 = 30.0 | 30 | 30
Shaft (3.6) × (5.0) × 8.5 = ~~153.0~~ | 130 | 75
30 4.0 × 6.2 183.0 cubic meters | 160 cubic meters. | 105
4 Required ~~them~~

Abutment 2.5 × ~~5.0~~ 4.0 × 5.0 = ~~62.5~~ 50 cubic meters

2 required them

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CALCULATIONS FOR

Estimate of Cost Bessho Bashi for Chichibu Cho.

5×97 = 485 5 × 170 = 850
4×105 = 420 4 × 160 = 640
2×50 = 100 2@ 62.5 = ~~125~~
1005
1615 cubic meters

1165
.90. 30 40. tons
125 12
(42) 4
56. tons

12
12
8
30

1600
1000
2000
1000
8000
1200
5000

1800

350
3.×32 = 96. × 60 = 6000
misc. 250
85
4
340
Extra. 60
400

forms piers.

9 9
10
6
~~16~~ × 9.5 = 150 square meters. 4 @ 150 = 600
abutment say 100
700 sq meters

Arch ring on side 2 @ 45 = 90 @ 5 × 90 450 sq meters

bottom 50 × 4.5 = 225 5@ 1120 sq meters.

staging - 45 × 4.50 = 200 square meters each span

Estimate of Cost for four piers -

| | | | | | | |
|---|---|---|---|---|---|---|
| Concrete (1:2.5:5) | 420<br>640 | @ | 11.00<br>(1.00) | = | 7050 | = 4620 |
| Reinf. bars. | ~~12~~ 8 | @ | 115.00 | = | 1380.00 | 920 |
| form. | ~~700~~<br>600 | @ | 1.20 | = | 840.00 | 720 |
| Excavation. | | | | | 500.00 | 400 |
| | | | | | 9770 | 6660 |

125
125

360
40
14400

3 abutments.

| | | | | | |
|---|---|---|---|---|---|
| concrete | 100<br>~~125~~ | @ | 11.00 | 1375 | 1210 |
| Reinf. bars. | ~~4~~2 | @ | 115.00 | 460 | 230 |
| forms | | | | 100.00 | 100 |
| excavation. | | | | 300.00 | 200 |
| | | | | 2235.00 | 1740 |

Arch Rings 5 Span.

| | | | | | | |
|---|---|---|---|---|---|---|
| Concrete | 485<br>~~850~~ | @ | 12.00 | = | 10200 | 5820 |
| Reinf. bars. | ~~40~~ 30 | @ | 115.00 | = | 46~~00~~ | 3450 |
| forms. side | 450. | @ | 1.20 | = | 540 | 2000 |
| " bottom | 1120 | | 2.50 | = | 2800 | 6500 |
| Staging - | ~~200~~ sq. for one span. ~~1000~~ @ 180 | | 900 | | 1000 | |
| | | | | | 28140 | 17770 |

1.00
50
20
15
4
180
5
900
40

28140
9770
2235
40145

17770
6660
1740
26170
1000
27170

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CALCULATIONS FOR

Estimate of Cost Besho Bashi for Chichibu chō -

Cost of Timber Deck

10$^{d}$ Plk: 10 - .078 × 4.50 = .35 @ 15.90 = 5.60
long. beam - 6 - .18 × .26 × 1.0 = .281 =
extra say .09
.37 @ 32.00 = 12.00
Cross beam 2 - .21 × .21 × 4.0 = .35/3.2 .11 @ 35.00 = 3.85
3 - .20 - .32 × 4.0 = .38/3.2 .12 @ 20.00 = 2.40
Handrail ~~8~~ - .15 × .15 - 1.0 .18 @ 31.57 = 5.70

23.85
10.00
33.85
3.15
37.00

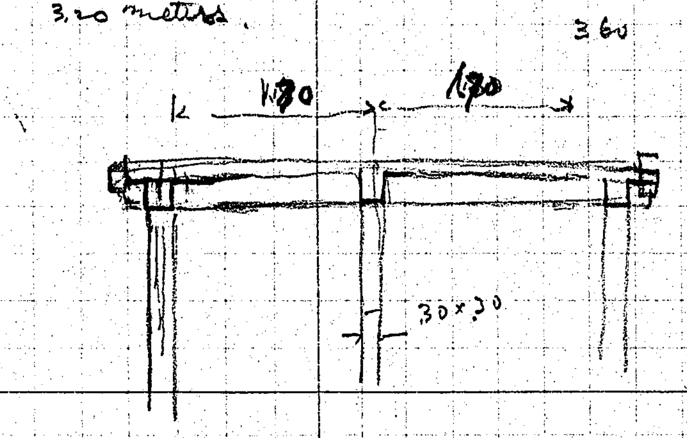
5.70
~~5.00~~
1.00 misc
11.70

37. per lin. meter × 170 = 6300.00
34.00
11 @ 250 = 2750.00
25
9050
approach span 850
9900.00

Earth fill 250 meters @ 1.2 = 300 cubic meters @ 1.2 = 350.00
砂利敷 .06 × 4.0 = .24 × 250 = 60 " " @ 20.00 = 200.00
.30
50 @ ? 1 tsubo 20.00
100
650
石垣 — 500
1150
9900

Wooden Deck - 11050
Concrete structure - 40145
Total Cost. 51195

Concrete Deck -
span 3.20 meters.



3.40
30
3.70
15

approximate concrete.
0.15 × 4.30 = .645
beam say 3 - .30 × .40 = .360
1.005 cubic meters per meter.

Columns. approx. 3 - .30 × .30 × 4.0 = 1.080/3.20 = .34
misc concrete say .16
.50

1.5
2
.2

Total 1.50 m³/lin. meter

Reinforcing Bars - say 130. kg.

60
1.20
3.60

forms 4.5
2.4
6.9
5.65
17.55 sq meters per lin meter

.80 × 4.5 = 3.60
3.60 × 4.0 = 14.40
18.00/3.2 = 5.65

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CALCULATIONS FOR

Estimate of Cost Bessho Bashi for Chichibu Cho.

Estimate of Cost.

| | | | |
|---|---|---|---|
| Concrete | - | 1.50 × 12.0 = | 18.0 |
| reinf. bars | - | 130 @ 115 = | 15.0 |
| form | - | 125 @ .80 = | 10.0 |
| | | | 43.0 |

1"
34

Total length.
340
.5
170
20
190.

43.0 × 190 = 8160

Center fill. 4.0 × .15 = .60 @ 12 = 7.20
fills etc .80
8.00 × 65 m = 520

13
.5
65

Pavement. 250 × 4.0 = 1000 — 1000 @ 3.00 3000

Handrails. 3000

14680
11050
3630

concrete 40145
Concrete Deck. 14680
54825

丸太 18φ 18<u>20</u>

18×26 40 45 — ×.80

21.×21. 43 84 — .80

18 — 3 . 15 90

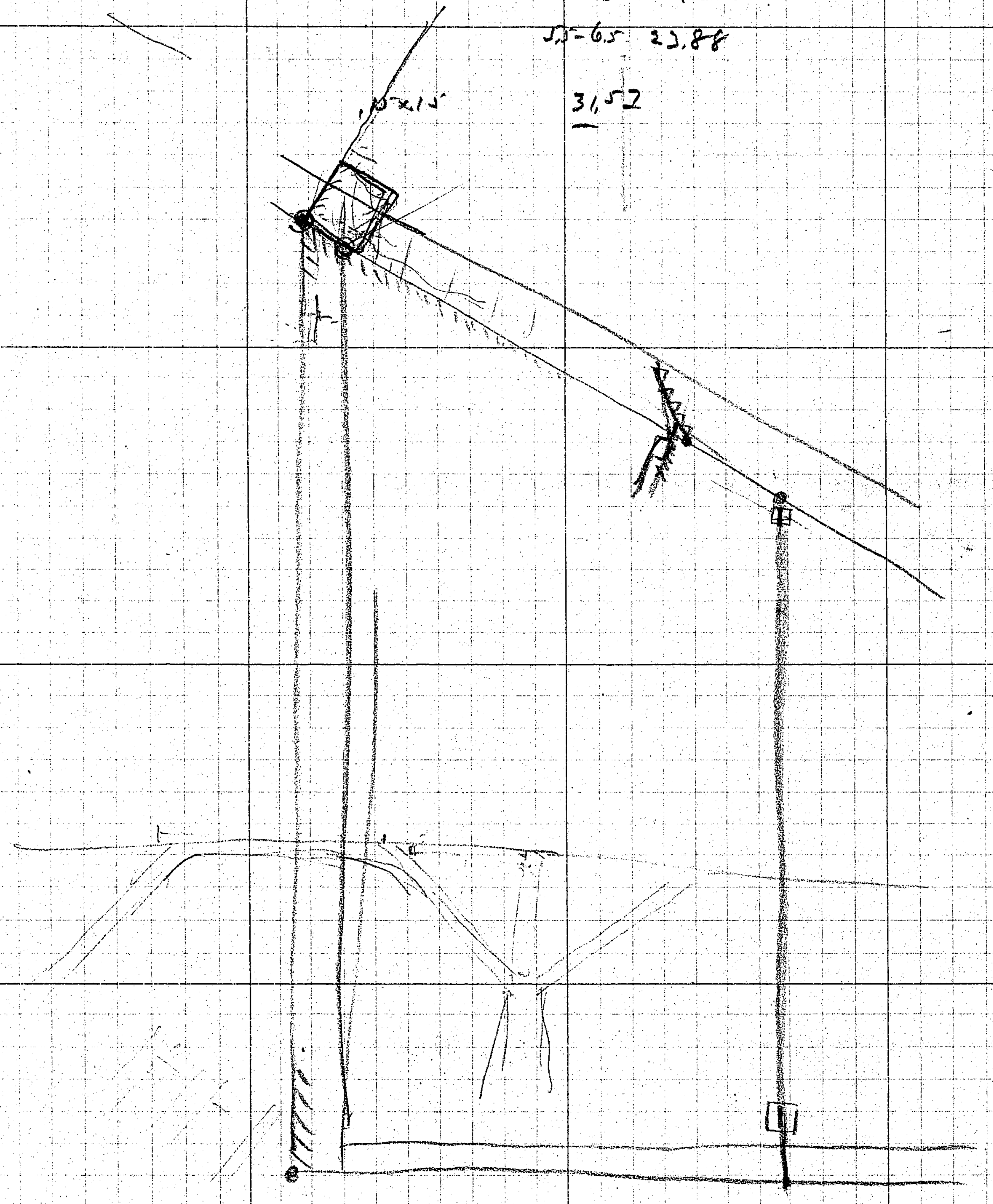
3.5 17.85

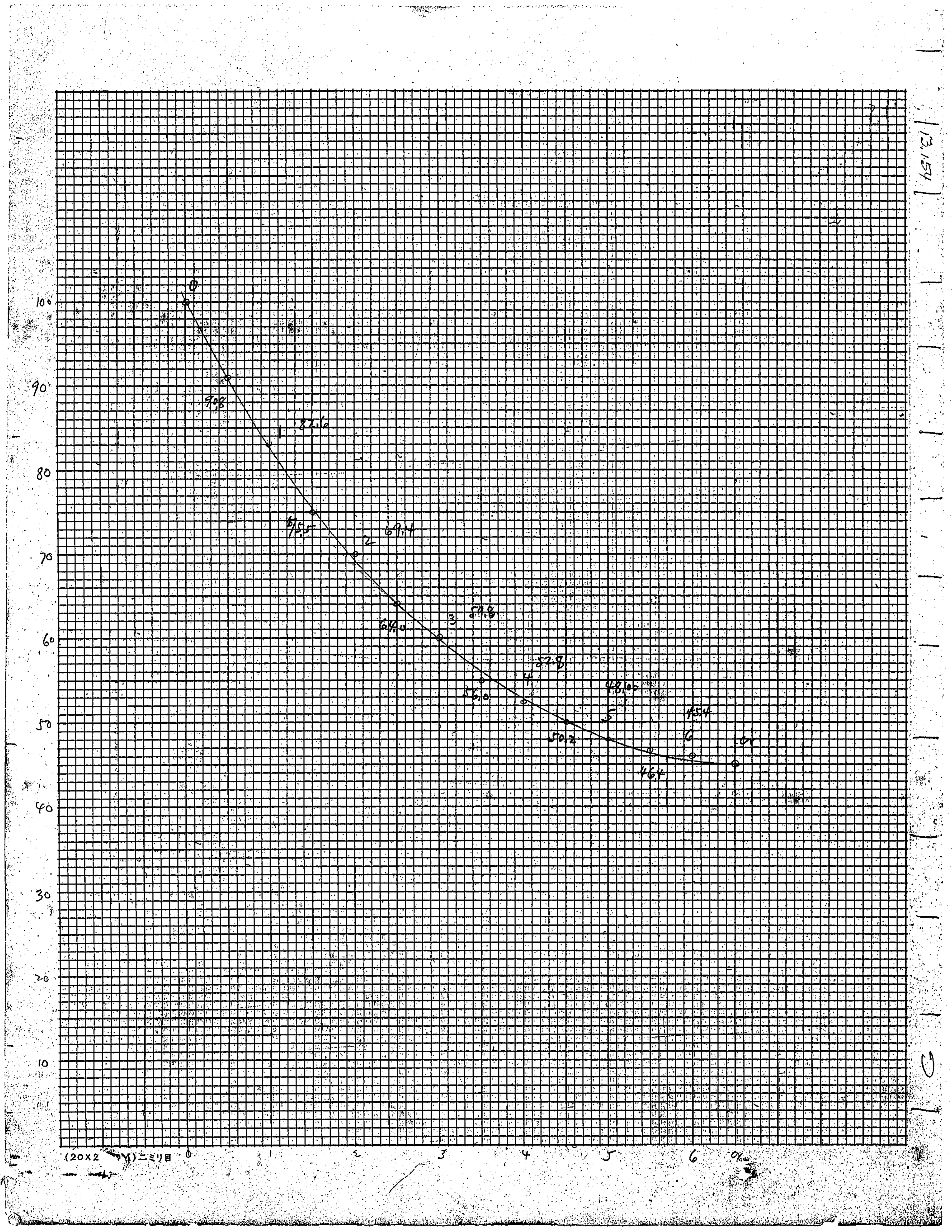
3.5-4 19.96

4.5-4.5 21.92

5.5-6.5 23.88

15×15 31.52




13.154
100
90
80
70
60
50
40
30
20
10
0
90.8
1
82.6
75.5
2
69.4
64.0
3
59.8
56.0
4
52.8
50.2
5
48.00
46.4
6
45.4
6½
0
1
2
3
4
5
6
6½
(20×2 M)ニミリ目