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MADE BY ____ DATE ____ FILE NO ____

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CALCULATIONS FOR

昭和三年十二月

# 神戸市苅藻嶋運河橋設計々算書

附材料計筭書

MADE BY K. Inaba DATE 3-12-27 **FILE NO**

CHECKED BY DATE **PAGE NO** 1

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Data of Bridge.

Bridge Site Karumojima Canal in the city of Kobe.

Span lengths Swing spans 2 @ 72.25' = 144.5'
Approach spans 2 @ 31.50 = 63.0
Spaces between bearings 2 @ 2.25 = 4.5
212.0' between end bearings.
2 @ 0.52 = − 1.04
210.96' between faces of key walls.

Effective width of Roadway 15.0'

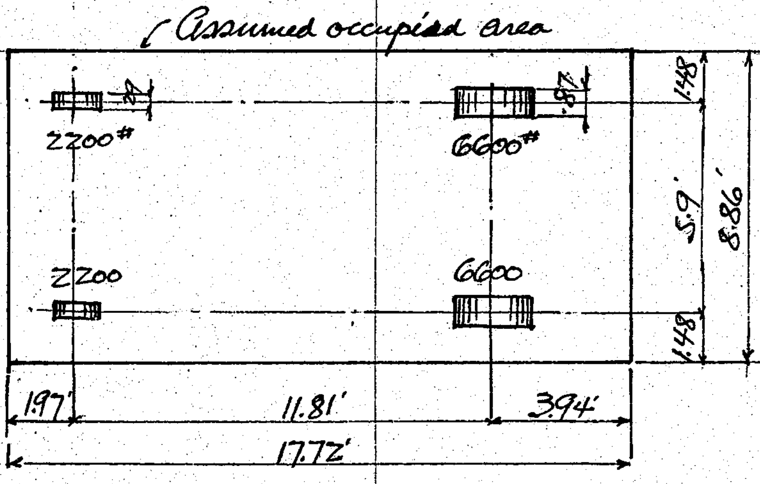
Type of Bridge Swing spans Half-through plate girders 16'-6" c to c.
Approach spans Deck I-Beam Bridges 4'-6" spacings.

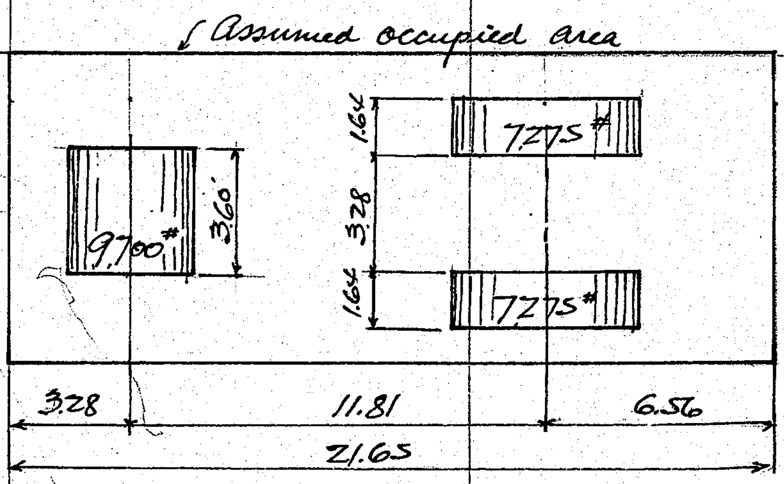
Assumed Loadings

Uniform load on ~~Roadvon~~ Roadway $w = \frac{120000}{170+l} \leq 600\ ^{kg}/_{m^2}$ or $125\ ^{\#}/_{\square}$.

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

Motor truck loading 8 ton motor truck, Road Roller loading 11 ton





1 row of motor traffic on roadway with occupied width of 8.86':
Unoccupied space of roadway to be filled with uniform load specified above.

Impact for motor truck loading

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

No impact for road roller and uniform load.

Road roller assumed one on the whole swing spans or one on approach span.

Allowable working strength.

Structural steel and reinforcements

| | | | |
|---|---|---|---|
| Tension | $1200\ ^{kg}/_{cm^2}$ | or | $17000\ ^{\#}/_{\square}$. |
| Extreme fibre stress | 1200 " | or | 17000 " |
| Shear of web gross section | 900 " | or | 12800 " |

Compression member $1500(1-0.0055\frac{l}{r})$ or not over $1000\ ^{kg}/_{cm^2}$
where $l$ = length of member in cm.
$r$ = least radius of gyration in cm

Equivalent formula for inch-lbs.
$21300(1-0.0055\frac{l}{r})$ or not over $14000\ ^{\#}/_{\square}$

Compression flange of plate girder.
$1200(1-0.012\ ^{l}/_{b}) \leq 1100\ ^{kg}/_{cm^2}$
where $l$ = unsupported length of flange in cm.
$b$ = width of flange in cm.

Equivalent formula in inch-lbs.
$17000(1-0.012\ ^{l}/_{b}) \leq 15600\ ^{\#}/_{\square}$.

MADE BY K. Inaba. DATE 3-12-27 FILE NO

CHECKED BY DATE **PAGE NO** 2

CALCULATIONS FOR

Karumojima Swing Bridge for city of Kobe.

| | |
|---|---|
| Shearing on shop driven rivets (machine driven) | 12000 #/□" |
| Shear on field driven rivets and turned bolts (machine driven | 10000 " |
| Extreme fibre stress of pin | 24000 |
| Bearing on shop rivets | 24000 |
| Bearing on field rivets and turned bolts | 20000 |
| Bearing on pin | 24000 |

Expansion Roller 45 d kg/cm
where d = diameter of roller in cm.

In inch-lbs. 610 d # per lin inch
where d = diameter of roller in inches.

Strength of concrete 1:2:4 mixture

| | | | |
|---|---|---|---|
| Bearing | 45 kg/cm² | or | 640 #/□" |
| Compression fibre stress | 45 " | " | 640 " |
| Shear for plain concrete | 4 " | " | 58 " |
| Punching shear | 9 " | " | 128 " |
| Bond stress of plain bars. | 6 " | " | 85 " |
| Bond stress of deformed bars | 9 " | " | 128 " |
| Shear for reinforced concrete | 9 " | " | 128 |

Considering wind and temperature stresses in addition to dead live and impact stresses, the allowable working strength shall be increased 25%.
Considering earthquake the working strength shall be increased 80%.
Seismic acceleration assumed 2000 mm/sec²

Unit weight of materials.

| | |
|---|---|
| Cast iron | 450 #/cub.ft. |
| wrought iron | 487 |
| Structural steel | 490 |
| cast steel | 491 |
| reinforced concrete | 150 |
| plain concrete | 140 |
| cement mortar | 110 |
| Sand | 110 |
| Earth | 100 |
| wood | 40 |
| asphalt block pavement | 130 |
| wood-block pavement | 54 |
| Sea water | 64 |
| creosoted wood | 54 |

MADE BY K. Inaba. DATE 3-11-10 FILE NO
CHECKED BY M. Jinda DATE 3-11-26 PAGE NO 3

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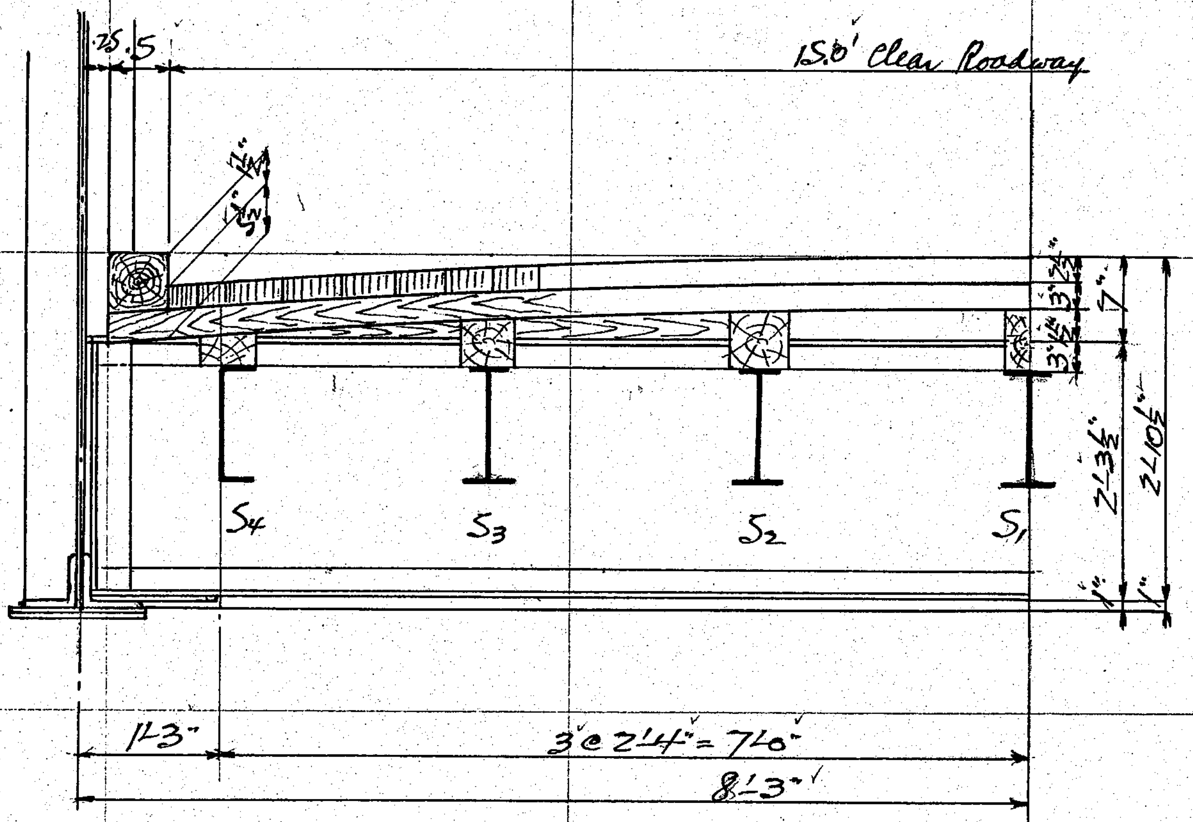
CALCULATIONS FOR

Kamuojima Swing Bridge for City of Kobe.

Design of floor.
Cross section of Bridge is shown in the sketch below.



Wooden floor.
Dead Load.

2'4" or 2.33' span.

| | |
|---|---|
| creosoted woodblock 2½" thick @ 4.5 = | 11.2 |
| Asphalt felt for water proofing | 0.3 |
| 3" planking @ 4.5 = | 13.5 |
| dust, water, nails etc. | 1.0 |
| | 26.0 #/□' |

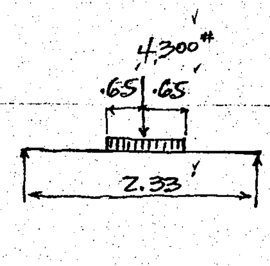
Dead Load moment = $\frac{1}{10} \times 26 \times 2.33^2 = 14'^{\#}$
" Shear = $\frac{1}{2} \times 26 \times 2.33 = 30^{\#}$

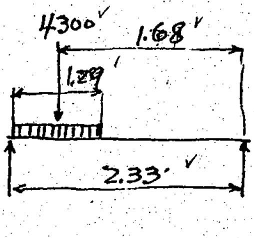
Live Load

Motor truck rear wheel concentration = 6.600#
30% impact 1980
8580 call this 8,600#

motor truck front wheel concentration with impact
say $\frac{1}{3} \times 8600 = 2870^{\#}$ call this 2900#

Longitudinal distribution $0.66 + 0.21 \times 2 = 1.08' = a$
Transverse distribution $0.87 + 0.21 \times 2 = 1.29 = b$
Effective width of floor $E = \frac{2}{3}l + a = \frac{2}{3} \times 2.33 + 1.08 = 2.63'$
On account of imperfect connection between floor boards,
Effective width assumed 2.0'
motor truck rear wheel concentration = $8600 \div 2 = 4300^{\#}$ per ft. strip
Live Load moment = $\frac{1}{4} \times 4300 \times 2.33 = 2{,}505'^{\#} - \frac{4300}{2} \times \frac{.65}{2} = 1{,}805'^{\#}$
for continuity of floor $m = \frac{8}{10} \times 1{,}805 = 1{,}440'^{\#}$
End shear $4300 \times \frac{1.68}{2.33} = 3{,}100^{\#}$





Summary for moments and end shears.

| | moments | end Shears |
|---|---|---|
| Dead Load | 14 | 30 |
| Live Load. | 1440 | 3100 |
| | 1,454'# | 3130# |

Extreme fibre stress = $\frac{1454 \times 12 \times 6}{12 \times 3^2} = 970^{\#}/□''$ ok.

Unit Shear = $\frac{3130}{12 \times 3} = 87^{\#}/□''$ ok.

11

MADE BY K. Inaba DATE 3-11-11 **FILE NO**

CHECKED BY M. Jinda DATE 3-11-26 **PAGE NO** 4

CALCULATIONS FOR

R

Karumojima Swing Bridge for City of Kobe.

Design of Intermediate Stringers S1, S2, and S3. 2.33' Spacing, Span length 16'-0"

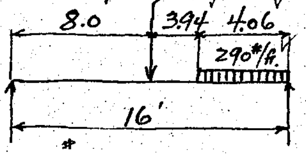
Dead Load

Floor 2.33' @ 26 = 61
nailing piece .5 × .38 @ 55 = 10
beam assumed 32
103 # per lin ft. of span.

Dead Load moment = $\frac{1}{8} \times 103 \times 16^2 = 3,300'\#$
Dead Load end shear = $\frac{1}{2} \times 103 \times 16 = 825\#$

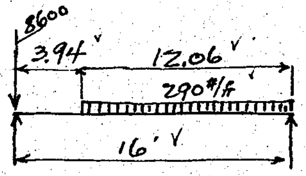
Live Load

Motor truck rear wheel concentration with impact = 8,600#
Uniform load on roadway



$w = \frac{120000}{170+l} = \frac{120000}{170+\frac{16}{3.28}} = 687^{kg/m^2}$ Specify at $600^{kg/m^2}$ or 125#/□'

Uniform load on stringer = 125 × 2.33 = 290# per lin. ft. of span.
Left reaction motor truck rear wheel concentration = $\frac{1}{2} \times 8600 =$ 4,300
Uniform load $\frac{290 \times 4.06^2}{2 \times 16} =$ 150
4,450#



moment = 4,450 × 8.0 = 35,600'#
end shear = $\frac{290 \times 12.06^2}{2 \times 16} =$ 1,320
8600
9,920#

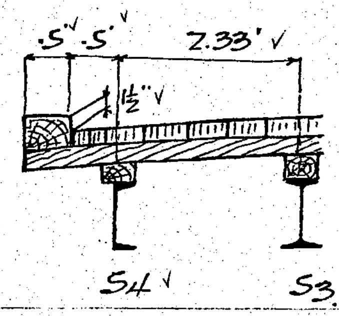
Summary for moments and end shears.

| | moments | end shears. |
|---|---|---|
| Dead Load. | 3,300 | 825 |
| Live Load. | 35,600 | 9,920 |
| | 38,900 | 10,745 |

Section modulus required = $\frac{38900 \times 12}{15600} = 30.0''^3$

Use I-beam 12" × 5" @ 31.99# whose section modulus = 36.69"³ Ok.
Unit shear = $\frac{10745}{.35 \times 12} =$ 2,560#/□" Ok

Design of Fascia Stringer S4. span length 16.0'
Dead Load.

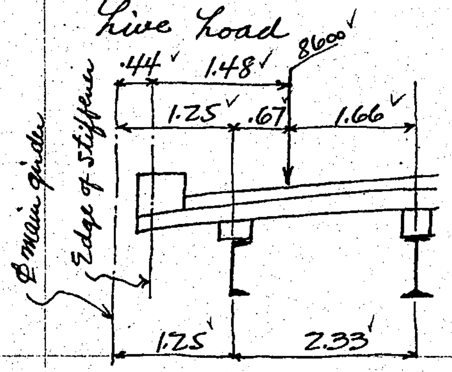


Load on stringer S4.
floor 3.33 @ 26 = 86.5 × 1.67 = 144.2
Coping .5 × 1.2 @ 55 = 3.3 × 3.08 = 10.2
89.8 × 1.72 154.4

Load on stringer 154.4 ÷ 2.33 = 66
nailing piece .26 × .5 @ 55 = 7
beam assumed 26
99# per lin. ft. of span.

Dead Load moment = $\frac{1}{8} \times 99 \times 16^2 = 3,170'\#$
" " end shear = $\frac{1}{2} \times 99 \times 16 = 792\#$

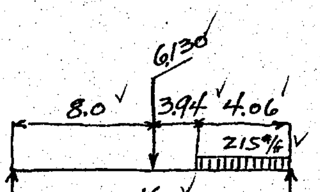
Live Load



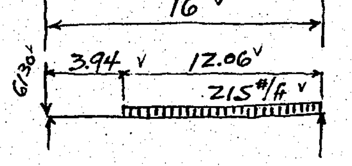
Transverse distribution of wheel load.
$\frac{8600 \times 1.66}{2.33} = 6,130\#$

Uniform load $\frac{125 \times 2.83^2}{2 \times 2.33} = 215\#$ per lin. ft. of span.

Live Load Left reaction
Rear wheel concentration = $\frac{1}{2} \times 6130 = 3065\#$
Uniform load $\frac{215 \times 4.06^2}{2 \times 16} =$ 111
3,176#



moment = 3,176 × 8.0 = 25,400'#
end shear = $\frac{215 \times 12.06^2}{2 \times 16} =$ 980
6130
End Shear = 7,110#



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MADE BY K. Inaba DATE 3-11-11 **FILE NO**
CHECKED BY M. Jinda DATE 3-11-26 **PAGE NO** 5

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Summary for moments and end shears.

| | moments | end shears |
|---|---|---|
| Dead Load | 3,170 | 792 |
| Live Load | 25400 | 7110 |
| | 28,570'# | 7,902# |

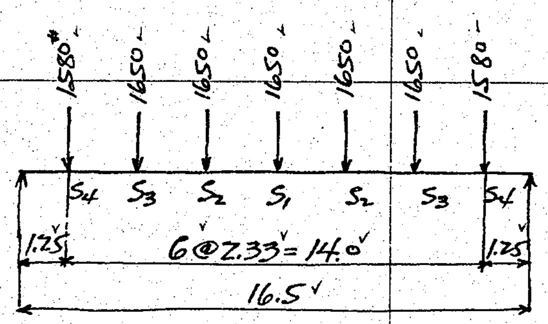
Section modulus required = $\frac{28570 \times 12}{15600} = 22.0''^3$

Use 1-I $12'' \times 3\frac{1}{2}''$ @ 26.1# whose S.m. = $26.44''^3$

unit shear = $\frac{7902}{.375 \times 12} = 1760$#/□" ok.

Design of Intermediate floor beam. Spacing 16.0' span length 16.5'

Dead Load.



Stringer concentration on floor beam.
S1, S2, and S3. 2@ 825 = 1,650# each
S4. 2@ 792 = 1580# say.

End shear or reaction
2.5 @ 1650 = 4,130#
1,580
5,710#

Moment stringer concentration 5,710 × 8.25 = 47,200
1,650 × 2.33 × 3 = − 11,500
1580 × 2.33 × 3 = − 11,000
24,700'#

End shear " " 5,710#

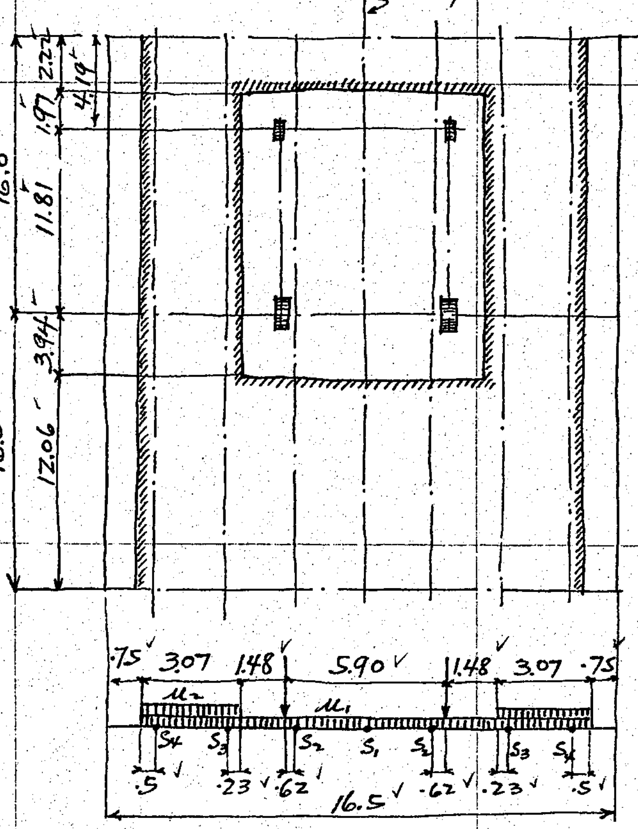
Summary for Dead Load moments and shears.

| ~~Stringer concentration~~ | moment | Shear |
|---|---|---|
| Own wt of floor beam | 2790 | 675 |
| Stringer concentration | 24700 | 5710 |
| | 27,490'# | 6,385# |

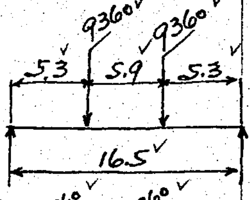
Dead wt of floor beam assumed 80# per lin. ft.
nailing piece on floor beam .06 × .5 @55 = 2
82# "

Dead Load moment = $\frac{1}{8} \times 82 \times 16.5^2 = 2,790$'#
end shear $\frac{1}{2} \times 82 \times 16.5 =$ 675#

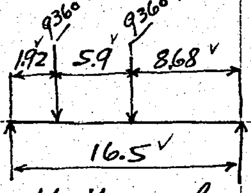
Live Load.



Live Load on floor beam
Concentration due to motor truck directly on floor beam.
Rear wheel concentration with impact = 8600#
Front wheel " " $\frac{2900 \times 4.19}{16} =$ 760
9,360#

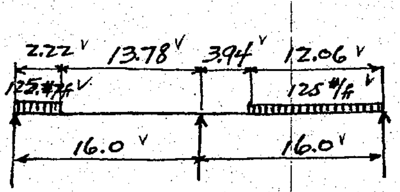


moment due to motor truck wheel concentrations.
m = 9360 × 5.3 = 49,700'#



End shear due to motor truck wheel concentrations
9360 × 8.68 = 81,300
9360 × 14.58 = 136,500
217,800 ÷ 16.5 = 13,200#

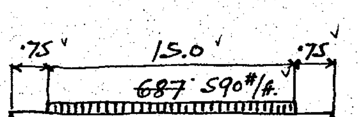
Uniform load $u_1$. Reaction on floor beam.



$\frac{125 \times 12.06^2}{2 \times 16} = 570$
$\frac{125 \times 2.22^2}{2 \times 16} =$ say 20
$u_1 =$ 590# per lin ft. of floor beam.

Uniform load $u_2$ 125 × 16 = 2,000
$u_1 =$ − 590
$u_2 =$ 1,410# per lin. ft. of floor beam.

Moment due to uniform load $u_1$.



Reaction = 590 × 7.5 = 4,420#
moment = 4420 × 8.25 = 36,400
$\frac{590 \times 7.5^2}{2}$ = −16,600
19,800'#
End shear = 4,420#

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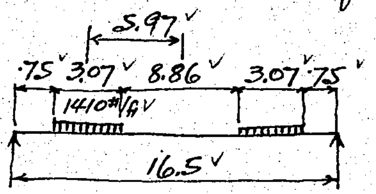
CHECKED BY M. Jinda DATE 3-11-26 **PAGE NO** 6

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

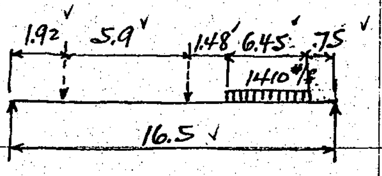
Moment due to uniform load U2.



Reaction 1,410 × 3.07 = 4,330#

Moment 4,330 × 8.25 = 35,700
4330 × 5.97 = − 25,900
9,800'#

End shear for extreme position of motor truck wheels for max end shear (see the last page.)



End shear = $\frac{1410 \times 6.45 \times 3.98}{16.5}$ = 2,200#

Summary for Live Load moments and end shears.

| | moments | end shears. |
|---|---|---|
| Motor truck wheel concentrations | 49,700 | 13,200 |
| Uniform load U1 | 19,800 | 4420 |
| Uniform load U2. | 9,800 | 2200 |
| | 79,300'# | 19,820# |

Summary for Dead and Live Load moments and end shears.

| | moments | end shears. |
|---|---|---|
| Dead Load | 27,490 | 6,385 |
| Live Load | 79,300 | 19,820 |
| | 106,790'# | 26,205# |

Depth back to back of flange Ls 2'-3½" or 2.29' effective depth say 2.15'

web plate 27" × 5/16" = 8.44 □" ⅛ web = 1.05 □"

flange stress = $\frac{106,790}{2.15}$ = 49,700#

flange area required = $\frac{49700}{17,000}$ = 2.92 □" net.
1.05
1.87 □" net.

Use 2 Ls 75mm × 75mm × 9mm = 1.97 × 2 = 3.94 □" gr − .75 = 3.19 □" net ok.

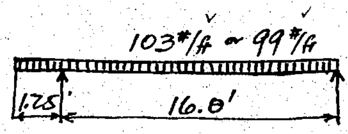
Design of End Floor Beam. Span length = 16.5'

Dead Load.

Stringer concentration on floor beam due to stringers S1, S2, and S3.

Dead Load on stringer = 103# per lin. ft. of stringer

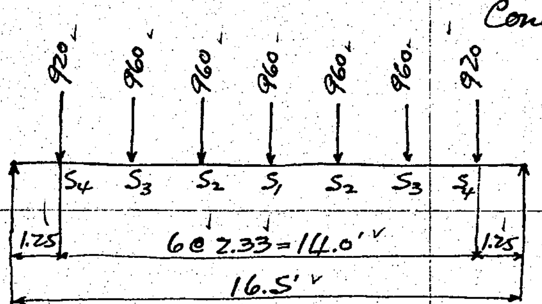
Concentration on end floor beam = $\frac{103 \times 17.25^2}{2 \times 16}$ = 960#



Stringer concentration on floor beam due to fascia stringer S4.

Dead Load on stringer = 99# per lin. ft. of stringer.

Concentration on end floor beam = $\frac{99 \times 17.25^2}{2 \times 16}$ = 920#



Reaction 2.5 @ 960 = 2400
920
3,320#

Dead Load moments due to stringer concentration.

3320 × 8.25 = 27,400
960 × 2.33 × 3 = − 6,700
920 × 2.33 × 3 = − 6,430
14,270'#

Dead Load End shear, do = 3,320#

Dead Load of floor beam with nailing piece = 82# per lin. ft. assumed.

Dead Load moment due to own wt. of floor beam

⅛ × 82 × 16.5² = 2,790'#

do, end shear = ½ × 82 × 16.5 = 675#

Summary for Dead Load moments and End Shears.

| | moments | end shears |
|---|---|---|
| Stringer concentrations | 14,270 | 3,320 |
| own wt. of floor beam | 2,790 | 675 |
| | 17,060'# | 3,995# |

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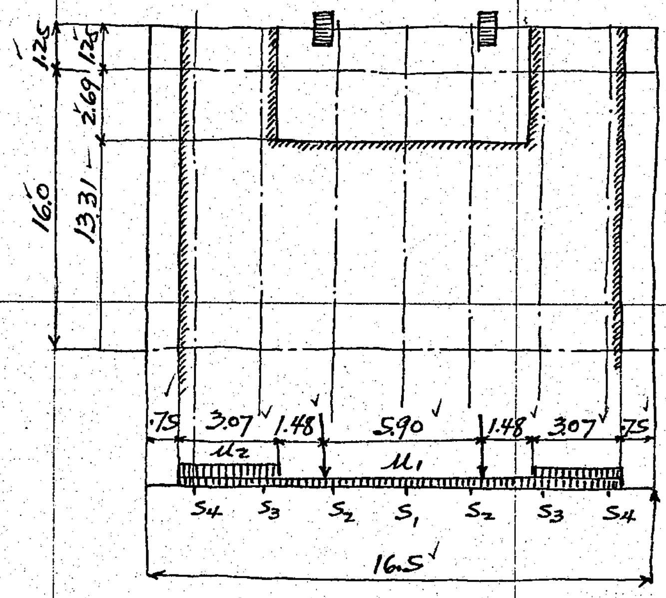
CHECKED BY M. Jinda DATE 3-11-26 **PAGE NO** 7

CALCULATIONS FOR

Kanimojima Swing Bridge for City of Kobe.

Live Load

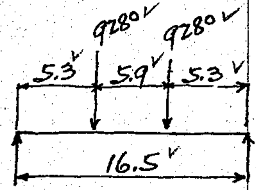


Live Load on Floor Beam.

Motor truck wheel concentrations directly on floor beam assumed.

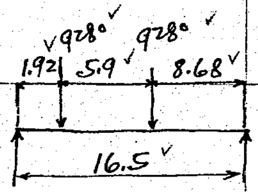
Rear wheel concentration with impact = 8,600#

reaction on floor beam = $\frac{8600 \times 17.25}{16} = 9,280\#$



Moment due to rear wheel concentrations.

$9,280 \times 5.3 = 49,200'\#$



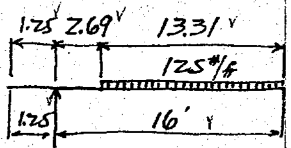
End shear due to rear wheel concentrations

$9280 \times 8.68 = 80,500$

$9280 \times 14.58 = 135,300$

$215,800 \div 16.5 = 13,070\#$

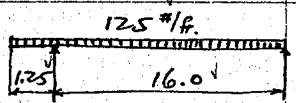
Uniform load $u_1$. reaction.



$\frac{125 \times 13.31^2}{2 \times 16} = 680\#/ft = u_1$.

Uniform load $u_2$.

Reaction.

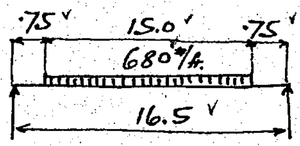


$\frac{125 \times 17.25^2}{2 \times 16} = 1,160$

$u_1 = 680$

$480\#/ft = u_2$.

Moment due to uniform load $u_1$.



Reaction $680 \times 7.5 = 5,100\#$

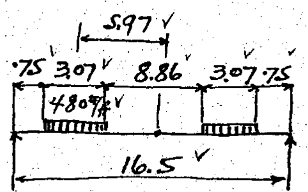
moment $5100 \times 8.25 = 42,000$

$\frac{680 \times 7.5^2}{2} = -19,100$

$22,900'\#$

End shear 5,100#

Moment due to uniform load $u_2$.



Reaction = $480 \times 3.07 = 1,470\#$

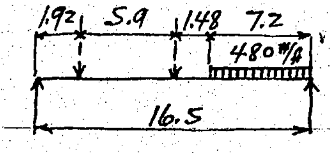
moment = $1470 \times 8.25 = 12,120$

$1470 \times 5.97 = -8780$

$3,340'\#$

End shear for extreme position of motor truck wheel for max end shear (see the last page)

End shear = $\frac{480 \times 7.2^2}{2 \times 16.5} = 755\#$



Summary for Live Load moments and end shears.

| | moments | end shears. |
|---|---|---|
| Motor truck concentrations | 49,200 | 13,070 |
| Uniform load $u_1$ | 22,900 | 5,100 |
| Uniform load $u_2$ | 3340 | 755 |
| | 75,440'# | 18,925# |

Summary for Dead and Live Load moments and shears.

| | moments | end Shears. |
|---|---|---|
| Dead Load. | 17,060 | 3,995 |
| Live Load | 75,440 | 18,925 |
| | 92,500'# | 22,920# |

Use the same section as for intermediate floor beam.

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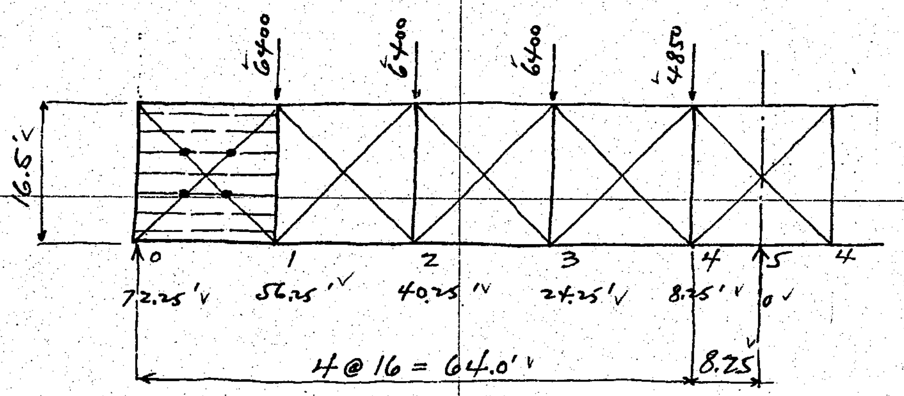
CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe

Design of Lateral Bracing.

Wind Load assumed 400# per lin. ft. of Bridge when the bridge is closed. (full load).
100# " " " " " " opened for windward girder (moving load)
50# " " " " " " " leeward girder ( " )

Acceleration of earthquake assumed 2000 mm/sec² or k = 0.2



Diagonal length = $\sqrt{16.5^2 + 16^2}$ = 23.0'

Coefficient = $\frac{23.0}{16.5}$ = 1.39

Panel Loads for Bridge closed.

wind load 400 × 16 = 6,400#    panel load at 4 = 400 × 12.13 = 4,850#

Seismic force floor beam reaction 6385 × 2 = 12,770
main girder assumed 340 × 16 × 2 = 10 890
23,660 × .2 = 4,730# wind load governs.

wind load governs the section.

Wind stress for Bridge closed.

Shear at panel

0-1 11,250#
1-2 11,250 - 6,400 = 4,850
2-3 4,850 - 6,400 = -1,550
3-4 -1550 - 6400 = -7,950
4-5 -7950 - 4850 = -12,800

Reaction at panel pt 0.

6,400 × 120.75 = 773,000    24.25+40.25+56.25 = 120.75
4,850 × 8.25 = 40,000
813,000 ÷ 72.25 = 11,250#

Diagonal Stresses.

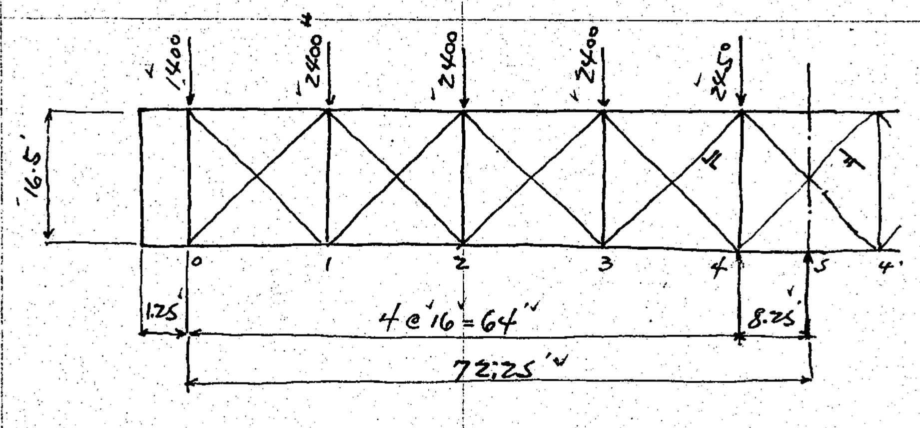
| | | | S.R. | 7/8" rivet no. | Section |
|---|---|---|---|---|---|
| 0-1 | 11,250 × 1.39 = | 15,650#T | 0.92 □" net | 2.6 use 6 | 2L$s$ 4×3×3/8" = 4.96 - .66 = 4.30 □" net. |
| 1-2 | 4,850 × " = | 6,750 | 0.40 | 1.1 6 | 2L$s$ do |
| 2-3 | 1,550 × " = | 2,150 | 0.13 | 0.4 6 | 2L$s$ do |
| 3-4 | 7,950 × " = | 11,050 | 0.65 | 1.8 6 or more | 2L$s$ do |
| 4-5 | 12,800 × " = | 17,800 | 1.05 | 3.0 6 or more. | 2L$s$ do. |

Wind Panel load for bridge opening.

Panel load. 100 × 16 = 1600 on wind-ward girder
50 × 16 = 800 " leeward "
total 2400#

End panel load.
= 2400 × $\frac{17.25-8.0}{16}$ = 1,390 Call this 1,400

panel load at 4.
= 2400 $\frac{8.25+8}{16}$ = 2,450#



Shear at panel

0 - 1 1,400#
1 - 2 1400 + 2400 = 3,800
2 - 3 3800 + 2400 = 6,200
3 - 4 6,200 + 2,400 = 8,600
4 - 5 8600 + 2,450 = 11,050

Diagonal Stresses. SR. f=17,300

| | | | |
|---|---|---|---|
| 0-1 | 1400 × 1.39 = | 1950#T | 0.09 □" |
| 1-2 | 3800 × " = | 5280 | 0.~~56~~ 25 |
| 2-3 | 6,200 × " = | 8,610 | 0.40 |
| 3-4 | 8,600 × " = | 11,950 | 0.56 |
| 4-5 | 11,050 × " = | 15,360 | 0.72 |

Previous section is ample
"
"
"
"

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CHECKED BY M. Jinda DATE 3-11-21 **PAGE NO** 9

CALCULATIONS FOR

Karumojima Bashi for City of Kobe.

Approximate weight of steel for Floor system and Lateral Bracing.

| Stringers. | Reqd. no. | Dimension | Length | Weight. |
|---|---|---|---|---|
| $S_1, S_2$ & $S_3$ | 40 | I-beams 12"×5"@31.99 | × 16.0' = | 20,470# |
| " | 5 | " " | × 16.5' = | 2,637 |
| $S_4$ | 16 | Is 12"×3½"@26.1 | × 16.0' = | 6,680 |
| " | 2 | Is " | × 16.5' = | 862 |
| Bracket $S_1, S_2$ & $S_3$ | 10 | Is 12"×5"@31.99 | × 1.2' = | 384 |
| " $S_4$ | 4 | Is 12"×3½"@26.1 | × 1.2 = | 125 |
| Conn. Ls | 200 | Ls 75×75×9@6.69 | × 0.8 = | 1,070 |
| Rivet heads etc. | | | | 172 |

32,400# or = 14.47 tons.

$$\frac{32400}{147 \times 2} = 110\text{\# per lin. ft. of one main girder.}$$

Floor Beams. 8 required (Floor Beam on Drum excluded)

| | | | | |
|---|---|---|---|---|
| Flange | 2 | Ls | 75×75×9 @ 6.69 × 16.5' = | 221# |
| " | 2 | Ls | 75×75×9 @ 6.69 × 15.5' = | 208 |
| web | 1 | Pl | 27"×5/16 @ 28.69 × 16.5' = | 473 |
| Stiffeners | 8 | Ls | 75×75×9 @ 6.69 × 2.29' = | 123 |
| Connection | 2 | Ls | 90×90×10 @ 8.96 × 2.20' = | 39 |
| fillers | 2 | Pls | 3½"×3/8" @ 4.46 × 1.77' = | 16 |
| " | 2 | " | 3½"×3/8 @ 4.46 × 1.86' = | 17 |
| Rivet heads &c | | | | 33 |

1,130# × 8 = 9040# = 4.04 tons

$$\frac{1130}{16.5} = 68.5\text{\# per lin. ft. of floor beam.}$$

Panel dead load on one main girder $= \frac{1130}{2} = 565$#

Lateral Bracing Panels 0-1, 1-2, 2-3, 3-4 8 reqd.

| | | | | |
|---|---|---|---|---|
| Lateral | 2 | Ls | 4"×3"×3/8" @ 8.45 × 21.50' = | 363 |
| " | 4 | Ls | " " × 10.50' = | 355 |
| Center conn. | 1 | Pl | 14"×3/8" @ 17.85 × 2.00' = | 36 |
| Hangers | 4 | Ls | 65×65×8 @ 5.15 × 0.75' = | 15 |
| Conn. Ls | 4 | Ls | 4"×3"×0.3 @ 6.84 × 0.6 = | 16 |
| Rivets heads &c | | | say | 20 |

805# × 8 = 6440# or = 2.88 tons.

Panels 4-4 1 required.

| | | | | |
|---|---|---|---|---|
| Lateral | 2 | Ls | 4"×3"×3/8" @ 8.45 × 22.0 = | 372 |
| " | 4 | Ls | " " × 10.75 = | 363 |
| Center conn. | 1 | Pl | 14"×3/8" @ 17.85 × 2.0 = | 36 |
| Hangers | 4 | Ls | 65×65×8 @ 5.15 × 0.75 = | 15 |
| conn. Ls | 4 | Ls | 4"×3"×0.3 @ 6.84 × 0.6 = | 16 |
| Rivet heads &c. | | | | 23 |

825# × 1 = 825# or = 0.37 tons

Total for Lateral Bracings = 7265# or 3.25 tons

Average weight of lateral bracing

$$= \frac{7265}{147} = 49.4\text{\# per lin. ft. of Bridge or } 24.7\text{\# per lin. ft. of one girder.}$$

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CHECKED BY DATE PAGE NO 10

CALCULATIONS FOR

Karumojima Bashi for City of Kobe.

Design of Main Girders.

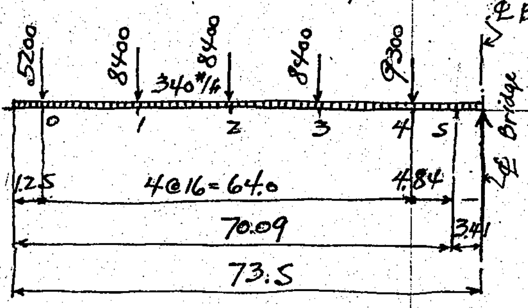
Dead Load:

Let us figure for 2 following cases.

Case (a) Bridge opened.

Case (b) Bridge closed and both ends raised by a certain uplifting force (or as a continuous beam on 3 supports.)

Case (a) Bridge opened.



Panel # Loads:

| | | |
|---|---|---|
| Floor | 8 × 26 = 208.0 | page 3 |
| Coping | = 3.3 | " 4 |
| Nailing pieces | 8 × 2.5+7 = 27.0 | " |
| Stringers | 110.0 | " 9 |
| Lateral Bracings | 20.6 | " (revised to 24.7) |
| | 368.9# per lin. ft. for one girder. | |

340
700

Own weight of main girder
assumed 340# per lin. ft.
30% impact = 100
440#/lin ft.

When the Bridge is opened, 30% impact assumed for Dead Load.

panel pt. 0 368.9 × 9.25 = 3,410
floor beam 565 } 580
nailing pieces 15 }
3990 × 1.3 ÷ 5,200#

panel pt. 1, 2 & 3 368.9 × 16.0 = 5,900
floor beam &c = 580
6480# × 1.3 ÷ 8,400#

panel pt. 4 368.9 × 16.25 = 5990
# floor beam ~~& say~~ on drum = 1160
7150 × 1.3 ÷ 9,300#

panel pt. 5 none.

Moment due to panel loads.

Panel points 0 0

Panel point 1 5200 × 16.0 = −83,200'#

panel point 2 5200 × 2 = 10400
8400 × 1 = 8400
18,800 × 16 = −300,800'#

panel point 3 5200 × 3 = 15600
8400 × 3 = 25200
40800 × 16 = −652,800

Panel point 4. 5200 × 4 = 20800
8400 × 6 = 50400
71,200 × 16 = −1,140,000

panel point 5 5200 × 68.84 = 358000
8400 × 3 × 36.84 = 928,000
9300 × 4.84 = 45000
−1,331,000'#

Cent support 1,331,000 + 39700 × 3.41 = 1,467,000'#

Moments due to own weight of girder.

$\frac{1}{2} \times 440 \times 1.25 = -340'\#$

$\frac{1}{2} \times 440 \times 17.25^2 = -65,400'\#$

$\frac{1}{2} \times 440 \times 33.25^2 = -243,500'\#$

$\frac{1}{2} \times 440 \times 49.25^2 = -533,500'\#$

$\frac{1}{2} \times 440 \times 65.25^2 = -936,200'\#$

$\frac{1}{2} \times 440 \times 70.09^2 = -1,080,000'\#$

$\frac{1}{2} \times 440 \times 73.5^2 = -1,188,000'\#$

Dead Load Shear due to panel loads.

| | | |
|---|---|---|
| Panel points 0 (end support). | | 0 |
| " 1 | | 5,200# |
| " 2 | 5200 + 8,400 | = 13,600# |
| " 3 | 13,600 + 8,400 | = 22,000# |
| " 4 | 22,000 + 8,400 | = 30,400# |
| " 5 | 30,400 + 9,300 | = 39,700# |
| Center support. | | = 39,700# |

Shear due to own weight of main girder.

| | | |
|---|---|---|
| 440 × 1.25 | = | 550# |
| 440 × 17.25 | = | 7,590# |
| 440 × 33.25 | = | 14,630# |
| 440 × 49.25 | = | 21,680# |
| 440 × 65.25 | = | 28,700# |
| 440 × 70.09 | = | 30,850# |
| 440 × 73.50 | = | 32,350# |

Summary of Dead Load moments for Case (a).

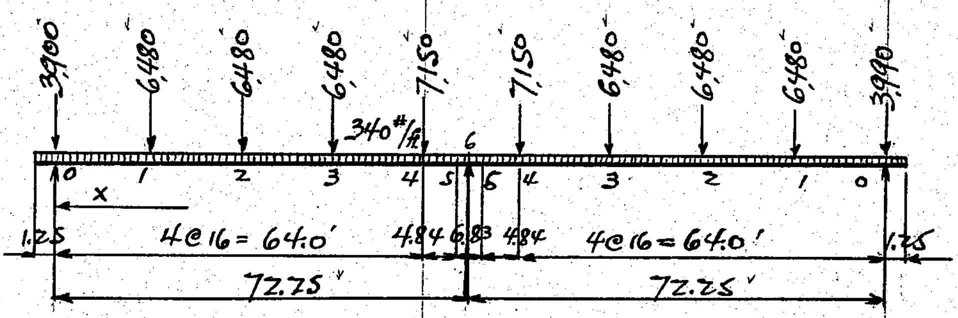
| moments due to | panel pt. 0 | panel pt 1. | panel pt. 2 | panel pt. 3. | panel pt. 4. | panel pt. 5 | Center Support |
|---|---|---|---|---|---|---|---|
| panel concentrations | 0 | −83,200 | −300,800 | −652,800 | −1,140,000 | −1,331,000 | −1,467,000 |
| own weight of girder | −340 | −65,400 | −243,500 | −533,500 | −936,200 | −1,080,000 | −1,188,000 |
| | −340'# | −148,600'# | −544,300'# | −1,186,300'# | −2,076,200'# | −2,411,000'# | −2,655,000 |

Summary of Dead Load Shear for Case (a).

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Shear due to panel concentration | − 0 | − 5,200 | −13,600 | − 22,000 | −30,400 | − 39,700 | −39,700 |
| Own weight of girder | −550 | −7,590 | −14,630 | −21,680 | −28,700 | −30,850 | −32,350 |
| | −550# | −12,790# | −28,230# | −43,680# | −59,100# | −70,550# | −72,050# |

Karumojima Bashi for City of Kobe.

Case (B) Bridge closed and both ends raised by a certain uplifting force.



Let us figure the moments & shears for the bridge as a continuous beam of 2 equal spans of 72.25' each.
panel concentration see the last page.
Reffering to the diagrams on page 364 in Hool's Reinforced Concrete construction Vol. 2.
Influence diagrams on next page are made.

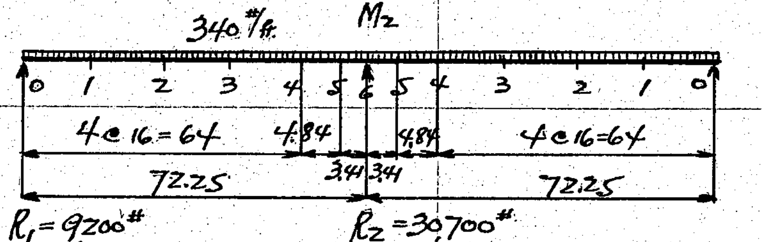
Constant k for several panel points $k = \frac{x}{\ell}$ $\ell/10 = 72.25/10 = 7.225$

| panel pts. | distance from left end. | k | Ordinate for $M_2$ | $R_1$ | Center Reaction $R_2$ | Shear at Center Support |
|---|---|---|---|---|---|---|
| 0 end | 0 ÷ 72.25 = | 0 | 0 | 1.000 | 0 | 0 |
| 1 | 16.0 ÷ " = | 0.222 | 0.524 × 7.225 = 3.786 | 0.726 | 0.327 | 0.276 |
| 2 | 32.0 ÷ " = | 0.443 | 0.882 × " = 6.372 | 0.469 | 0.619 | 0.528 |
| 3 | 48.0 ÷ " = | 0.665 | 0.916 × " = 6.618 | 0.244 | 0.849 | 0.755 |
| 4 | 64.0 ÷ " = | 0.886 | 0.468 × " = 3.381 | 0.067 | 0.979 | 0.935 |
| 5 | 68.84 ÷ " = | 0.953 | 0.201 × " = 1.452 | 0.027 | 0.993 | 0.970 |
| 6 Center | 72.25 ÷ " = | 1.000 | 0 | 0 | 1.000 | 1.000 |
| 5 | | 1.047 | 1.452 | 0.023 | 0.993 | 0.023 |
| 4 | | 1.114 | 3.381 | 0.047 | 0.979 | 0.047 |
| 3 | | 1.335 | 6.618 | 0.091 | 0.849 | 0.091 |
| 2 | | 1.557 | 6.372 | 0.088 | 0.619 | 0.088 |
| 1 | | 1.778 | 3.786 | 0.056 | 0.327 | 0.056 |
| 0 | | 2.000 | 0 | 0 | 0 | 0 |

Moments and shears due to own weight of girder 340# per lin ft. (no impact in this case).

$R_1 = \frac{3}{8} w\ell = \frac{3}{8} \times 340 \times 72.25 = 9200\#$

$R_2 = \frac{10}{8} w\ell = \frac{10}{8} \times 340 \times 72.25 = 30700\#$



Shear at panel pt. 0 +9,200#

panel pt. 1
9200
340 × 16 = -5440
+3,760#

panel pt. 2.
9200
340 × 32 = -10880
-1,680#

panel pt. 3
9200
340 × 48 = -16320
-7,120#

panel pt. 4.
9200
340 × 64 = -21750
-12,550#

panel pt. 5
9200
340 × 68.84 = -23400
-14,200#

At center supp. $\frac{R_2}{2} = \frac{30700}{2} = -15,350\#$

$M_2 = -0.125 w\ell^2 = -0.125 \times 340 \times 72.25^2 = -221,600'\#$

moment at.

panel pt. 1
$9200 \times 16 = 147,100$
$340 \times 16^2 \div 2 = -43,500$
+103,600'#

panel pt. 2
$9200 \times 32 = 294,400$
$340 \times 32^2 \div 2 = -174,000$
+120,400'#

panel pt. 3
$9200 \times 48 = 441,600$
$340 \times 48^2 \div 2 = -391,500$
+50,100'#

panel pt. 4
$9200 \times 64 = 588,600$
$340 \times 64^2 \div 2 = -695,800$
-107,200'#

panel pt. 5
$9200 \times 68.84 = 633,200$
$340 \times 68.84^2 \div 2 = -805,000$
-171,800'#

at center support. $M_2$ = -221,600'#

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MADE BY K. Inaba DATE 3-11-32 FILE NO

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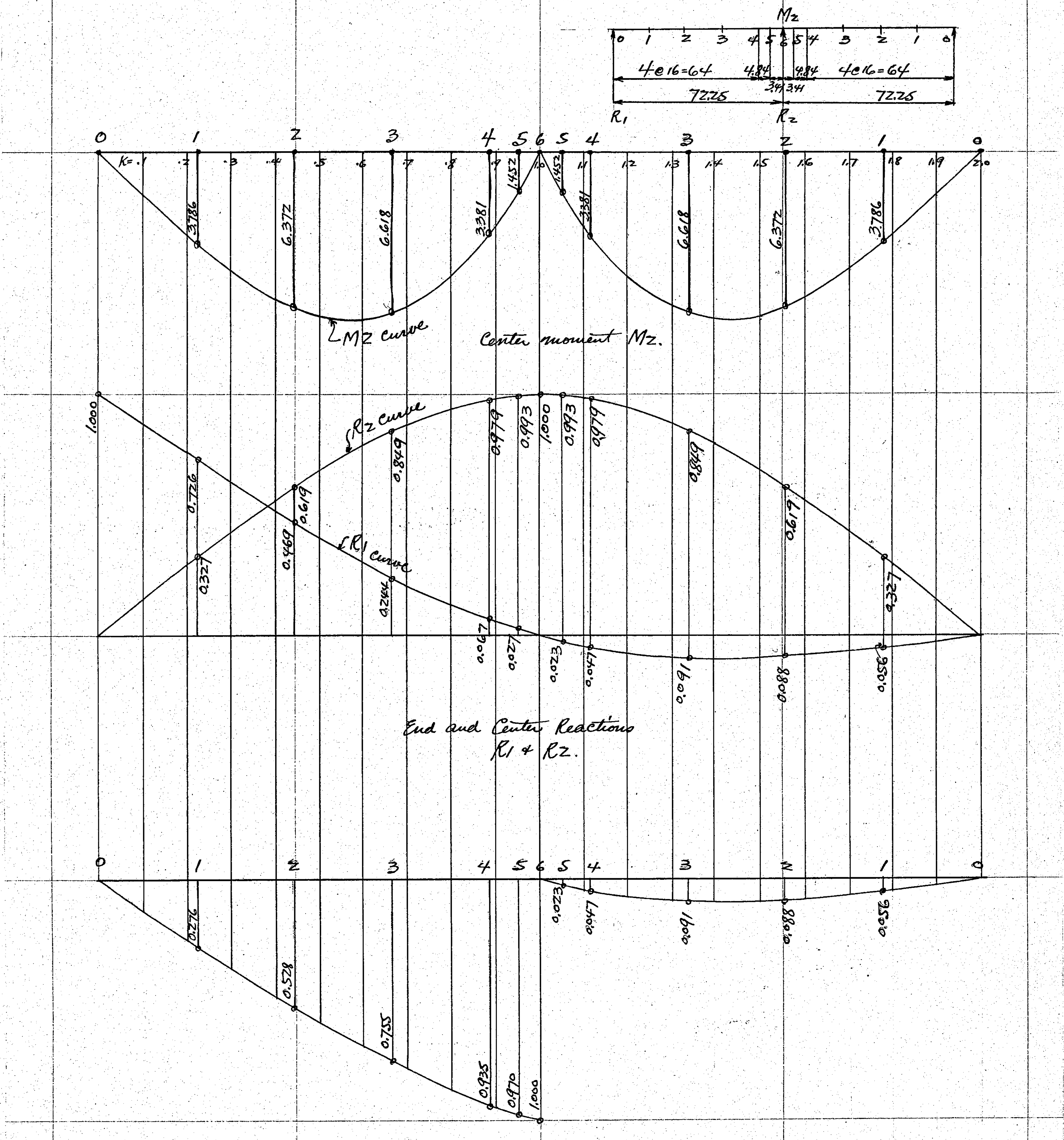
CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Diagrams of moments, Shears and Reactions for 2 span continuous beam.
span length $l_1 = l_2 = 72.25'$



Center moment Mz.

End and Center Reactions R1 & R2.

Shear at center support.

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（独立行政法人 土木研究所蔵）

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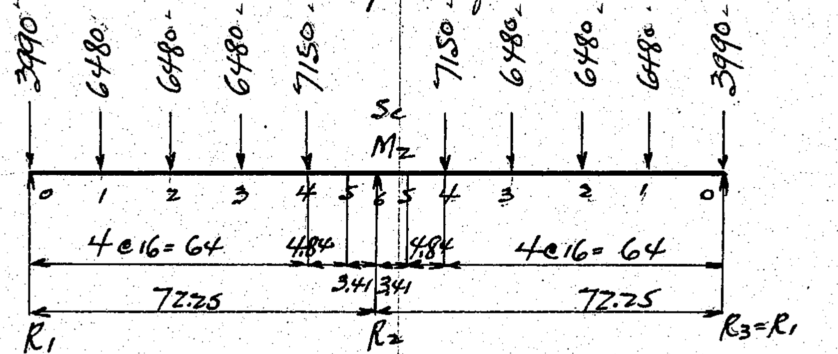
CHECKED BY M. Jinda DATE 3-12-8 **PAGE NO** 13

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Case B. Moments and Shears due to Dead Panel Concentrations.

In this case no impact for dead load.



Shear at center support

| Panel | Loads | Mz unit | Mz | R1 unit | R1 | R2 unit | R2 | Sc unit | Sc |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 3990# | 0.000 | 0 | 1.000 | 3900 | 0.000 | 0 | 0 | 0 |
| 1 | 6480 | -3.786 | -24540 | 0.726 | 4,705 | 0.327 | 2,120 | -0.276 | -1,790 |
| 2 | 6480 | -6.372 | -41,300 | 0.469 | 3,040 | 0.619 | 4,010 | -0.528 | -3,420 |
| 3 | 6480 | -6.618 | -42,870 | 0.244 | 1,585 | 0.849 | 5,500 | -0.755 | -4,894 |
| 4 | 7150 | -3.381 | -24,190 | 0.067 | 481 | 0.979 | 7,000 | -0.935 | -6,684 |
| 4 | 7150 | -3.381 | -24,190 | -0.047 | -336 | 0.979 | 7,000 | -0.047 | -336 |
| 3 | 6480 | -6.618 | -42,870 | -0.091 | -590 | 0.849 | 5,500 | -0.091 | -590 |
| 2 | 6480 | -6.372 | -41300 | -0.088 | -570 | 0.619 | 4,010 | -0.088 | -570 |
| 1 | 6480 | -3.786 | -24,540 | -0.056 | -360 | 0.327 | 2,120 | -0.056 | -360 |
| 0 | 3990 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0 | 0 |

Mz = -265,800'#  R1 = +11,945#  R2 = 37,260#  Sc = -18,644#  Call this -18,640#

End shear Se = 11,945 - 3,990 = +7,955#

Shear at

panel pt. 1 = Se = +7,955
" 2  7,955 - 6,480 = +1,475
" 3  1,475 - 6,480 = -5,005
" 4  -5,005 - 6,480 = -11,485
" 5  -11,485 - 7,150 = -18,635

(Center support Se = -18635#) ok.

Moment at

panel pt. 1  7,955 · 16 = +127,300'#

2  7955 · 32 = 254,500
6480 · 16 = -103,700
+150,800'#

3  7955 · 48 = 382,000
6480 · 16 · 3 = -311,000
+71,000'#

4  7955 · 64 = 509,200
6480 · 16 · 6 = -622,000
-112,800'#

5  6480 · 3 = -19440
-7,150
+7,955
-18,635 · 4.84 = -90,000
-112,800
-202,800'#

At center support Mz
-18635 · 3.41 = -63,500
-202,800
(Mz = -266,300'#) ok.

Summary of Dead Load moments and shears for Case (b)

| Moment due to | Panel pt 1 | panel pt. 2 | panel pt. 3 | panel pt. 4 | panel pt. 5 | Center support |
|---|---|---|---|---|---|---|
| panel concentration | +127,300 | +150,800 | +71,000 | -112,800 | -202,800 | -265,800 |
| Own weight of Girder | +103,600 | +120,400 | +50,100 | -107,200 | -171,800 | -221,600 |
|  | +230,900'# | +271,200'# | +121,100'# | -220,000'# | -374,600'# | -487,400'# |

| Shear due to | Panel pt. 0 | panel pt 1 | panel pt. 2 | panel pt. 3 | panel pt. 4 | panel pt. 5 | Center supports |
|---|---|---|---|---|---|---|---|
| panel concentration | +7,955 | +7,955 | +1,475 | -5,005 | -11,485 | -18,635 | -18,640 |
| own wt. of girder | +9,200 | +3,760 | -1,680 | -7,120 | -12,550 | -14,200 | -15,350 |
|  | +17,155# | +11,715# | -205# | -12,125# | -24,035# | -32,835# | -33,990# |

Reactions due to panel concentration  R1 = +11,945  R2 = +37,260
" " own wt. of girder  " = +9,200  " +30,700
+21,145#  +67,960#

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MADE BY K. Inaba DATE 3-11-22 FILE NO

CHECKED BY M. Jinda DATE 3-12-8 PAGE NO 14

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Live load moments & Shears for main girder.

Let us figure for 2 following cases.

Case (C) Whole span acting as a continuous beam over three supports.

Case (d) One arm acting as a simple span.

Case (C) Whole span acting as a continuous beam over three supports.

Floor Beam concentrations

Concentration due to motor truck wheel directly on floor beam.

Rear wheel concentration.

Impact coefficient $= i = \frac{70}{60+\frac{144.5}{3.28}} = 19.3\%$

Rear wheel concentration $= 6610$

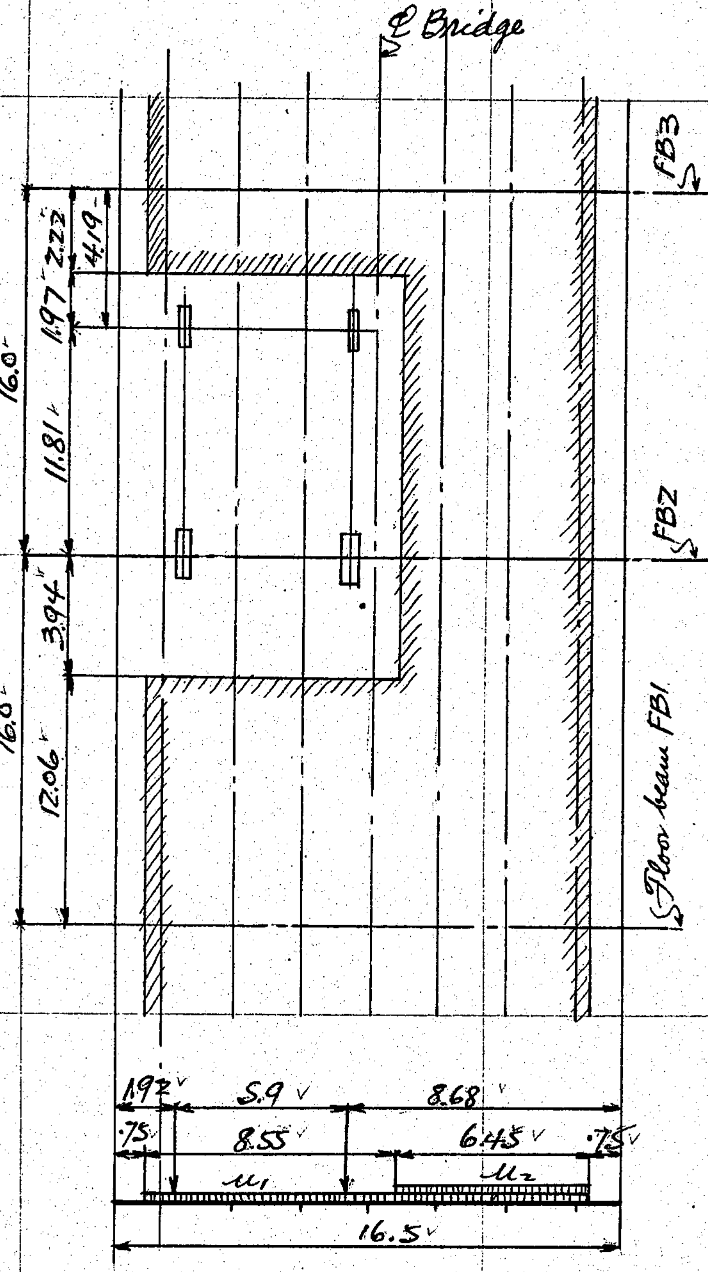
impact $6610 \times .193 = \underline{1.276}$

$7886^{\#}$ call this $7900^{\#}$

Front wheel concentration with impact $= \frac{7886}{3} =$ say $2600^{\#}$

Uniform load on roadway

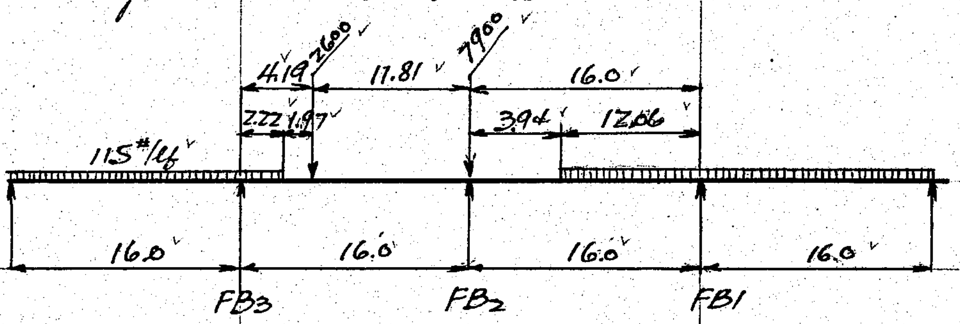
$w = \frac{120000}{170+l} = \frac{120000}{170+\frac{144.5}{3.28}} = 560\ ^{kg}/_{m^2}$ or $115^{\#}/\square'$



Floor Beam Reaction due to full uniform load only.

panel load $115 \times 16 \times 7.5 = 13800^{\#}$

Longitudinal distribution



motor truck front wheel

on FB3. $\frac{2600 \times 11.81}{16} = 1920^{\#}$

on FB2 $\frac{2600 \times 4.19}{16} = 680$

rear wheel $= \underline{7900}$

$8580^{\#}$

Uniform load $M_1$.

$115 \times 2.22 = 255^{\#} \times \frac{1.16}{16} = 18^{\#}$

$115 \times 12.06 = 1390^{\#} \times \frac{6.03}{16} = \underline{524}$

$M_1 = 542^{\#}/_{ft}$ on FB2

on FB3 $255 - 18 = 237^{\#}/_{ft}$

$115 \times 8 = \underline{920}$

$M_1 = 1157^{\#}/_{ft}$ on FB3.

on FB1 $1390 - 524 = 866^{\#}$

$115 \times 8 = \underline{920}$

$M_1 = 1786^{\#}/_{ft}$ on FB1.

Uniform load $M_2$

total load $115 \times 16.0 = 1840^{\#}$ on each floor beam

$M_2 = 1840 - 542 = 1298^{\#}$ on FB2

$M_2 = 1840 - 1157 = 683^{\#}$ " FB3

$M_2 = 1840 - 1786 = 54^{\#}$ " FB1.

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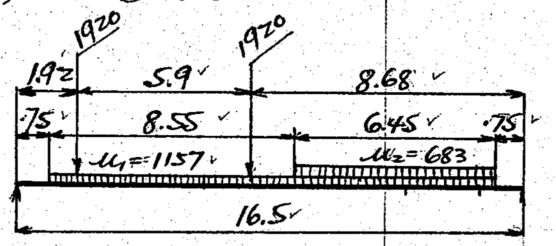
MADE BY K. Inaba DATE 3-11-23 FILE NO
CHECKED BY M. Jinda DATE 3-12-8 PAGE NO 15

CALCULATIONS FOR

Karumojima Swing Bridge for city of Kobe.

Floor Beam concentration on main girder.

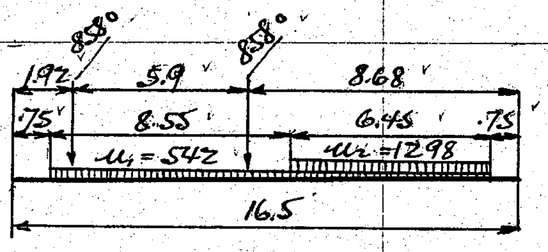
Floor Beam FB3.



Front wheel
1920 × 8.68 = 16670
1920 × 14.58 = 28,000
44,670 ÷ 16.5 = 2710#

Unif. load $M_1$ 1,157 × 15.0 ÷ 2 = 8,680
" " $M_2$ 683 × 6.45 × 3.98 ÷ 16.5 = 1060
12,450# on FB3

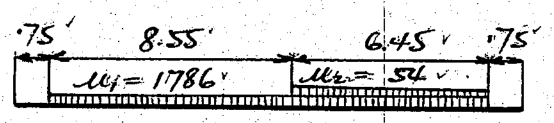
Floor Beam FB2



Wheels
8580 × 8.68 = 74,500
8580 × 14.58 = 125,000
199,500 ÷ 16.5 = 12,100#

Unif. load $M_1$ 542 × 15.0 ÷ 2 = 4,070
" " $M_2$ 1298 × 6.45 × 3.98 ÷ 16.5 = 2020
18,~~220~~# on FB2
190

Floor Beam FB1.

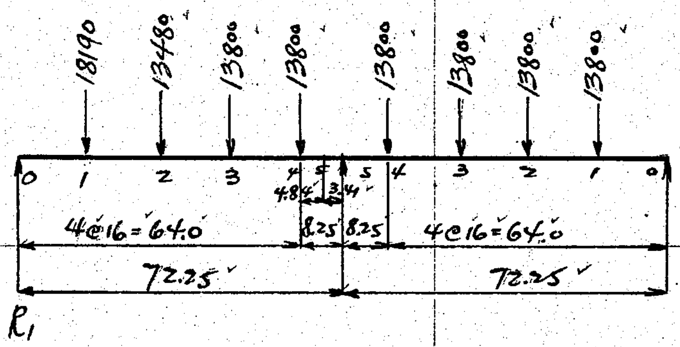


Unif. load $M_1$ 1786 × 15.0 ÷ 2 = 13,400
" " $M_2$ 54 × 6.45 × 3.98 ÷ 16.5 = 80
13,480# on FB1

Floor Beam concentration due to uniform load only 115 × 16 × 7.5 = 13800#

Moments & Shears in main girder due to Live Loads for case (e)

Moment & Shear at panel point 1.



Reaction $R_1$

| Panel | loads | $R_1$ unit | $R_1$ |
|---|---|---|---|
| 1 | 18,190 | 0.726 | 13,220 |
| 2 | 13,480 | 0.469 | 6,320 |
| 3 | 13,800 | 0.224 | 3365 |
| 4 | 13800 | 0.067 | 925 |

End Shear = $R_1^L$ = +23830# Left span loaded.

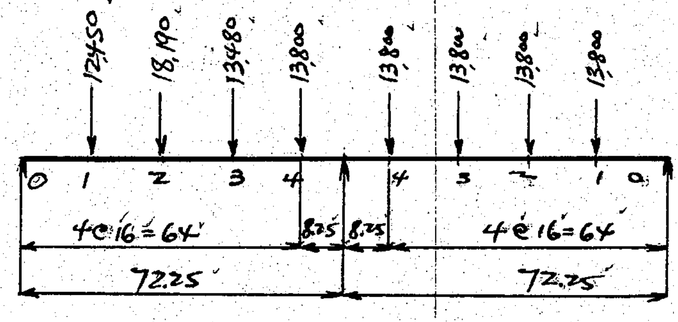
| | | | |
|---|---|---|---|
| 4 | 13800 | −0.047 | − 650 |
| 3 | 13800 | − 0.091 | − 1,255 |
| 2 | 13800 | − 0.088 | − 1,215 |
| 1 | 13800 | − 0.056 | − 770 |

$R_1^R$ = − 3890# Right span loaded.

End Shear = $R_1$ + 19,940# Both spans loaded.

moment at panel pt. 1.
23,830 × 16.0 = +381,800'# Left span loaded
19,940 × 16.0 = +319,000'# Both spans loaded.

Moments and Shears at panel point 2. Reaction $R_1$



| Panel | loads | $R_1$ unit | $R_1$ |
|---|---|---|---|
| 1 | 12450 | 0.726 | 9040 |
| 2 | 18,190 | 0.469 | 8550 |
| 3 | 13,480 | 0.244 | 3290 |
| 4 | 13,800 | 0.067 | 925 |

= $R_1^L$ = + 21,805# Left span loaded.

| | | | |
|---|---|---|---|
| 4 | 13800 | −0.047 | − 650 |
| 3 | " | −0.091 | − 1255 |
| 2 | " | −0.088 | − 1215 |
| 1 | " | −0.056 | − 770 |

= $R_1^R$ = −3,890# Right span loaded.
= $R_1$ = +17,915# Both spans loaded.

Shears.
21805 − 12450 = +9355# Left span loaded
17915 − 12450 = +5465# Both spans "

moment at panel point 2.
21,805 × 32 = 698,000
12,450 × 16 = −199,200
+498,800'# Left span loaded.
498800 − 3890 × 32 = +374300'# Both spans loaded.

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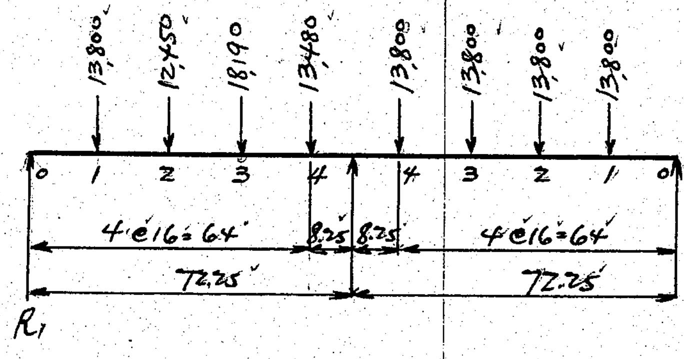
CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Moments and Shears at panel point 3.



Reaction $R_1$

| Panel | loads | $R_1$ unit | $R_1$ |
|---|---|---|---|
| 1 | 13800 | 0.726 | 10020 |
| 2 | 12450 | 0.469 | 5840 |
| 3 | 18190 | 0.244 | 4440 |
| 4 | 13480 | 0.067 | 900 |

$R_1^L$ = + 21200# Left span loaded.

| Panel | loads | $R_1$ unit | $R_1$ |
|---|---|---|---|
| 4 | 13800 | -0.047 | - 650 |
| 3 | 13800 | -0.091 | - 1255 |
| 2 | 13800 | -0.088 | - 1215 |
| 1 | 13800 | -0.056 | - 770 |

$R_1^R$ = - 3890# Right span loaded

$R_1$ = + 17310# Both spans loaded.

Shears.

21,200 = 13800 - 12450 = -5050# Left span loaded

17,310 - 13800 - 12450 = - 8940# Both spans ..

Moment at panel pt. 3

21,200 × 48 = + 1,018,000

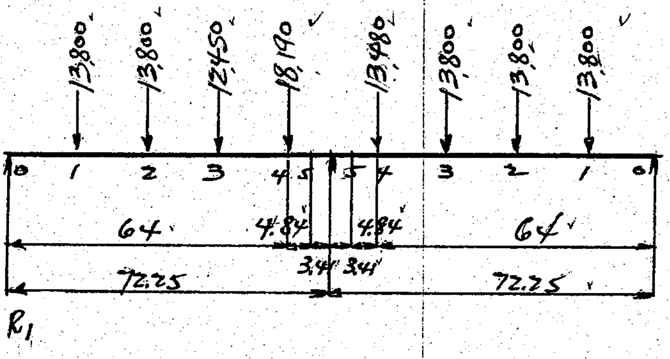
13,800 × 32 = - 441,500

12,450 × 16 = - 199,200

+377,300# Left span loaded.

377,300 - 3890 × 48 = + 190,600 Both spans ..

Moments and shears at panel pt. 4



Reaction R1.

| panel | load | $R_1$ unit | $R_1$ |
|---|---|---|---|
| 1 | 13800 | 0.726 | 10,020 |
| 2 | 13800 | 0.469 | 6470 |
| 3 | 12450 | 0.244 | 3040 |
| 4 | 18190 | 0.067 | 1220 |

$R_1^L$ = +20750# Left span loaded.

| panel | load | $R_1$ unit | $R_1$ |
|---|---|---|---|
| 4 | 13480 | -0.047 | - 635 |
| 3 | 13800 | -0.091 | - 1255 |
| 2 | 13800 | -0.088 | - 1215 |
| 1 | 13800 | -0.056 | - 770 |

$R_1^R$ = - 3875# Right span loaded.

$R_1$ = +16,875# Both spans loaded.

Shears.

+20,750 - 13800 × 2 - 12450 = -19,300# Left span loaded

+ 16,875 - 13800 × 2 - 12,450 = - 23,175 Both spans ..

Moment at panel pt. 4.

20750 × 64 = + 1,328,000

13,800 × 16 × 5 = - 1,104,000

12,450 × 16 = - 199,400

+ 24,600# Left span loaded.

+24,600 - 3875 × 64 = -223,400# Both spans ..

Moments at panel pt. 5.

13,800 × 2 + 12450 + 18190 = -58,240#

$R_1^L$ = 20,750

-37,490# Left span loaded.

-58,240

$R_1$ 16,875

-41,365# Both spans ..

Shears Same as for panel pt. 4

-19,300# Left span loaded

-23,175 Both spans ..

moment -37490 × 4.84 = -181,700

moment about 4 = + 24,600

-157,100# Left span loaded.

moment -41,365 × 484 = - 200,400

moment at 4 = - 223,400

-423,800# Both spans loaded.

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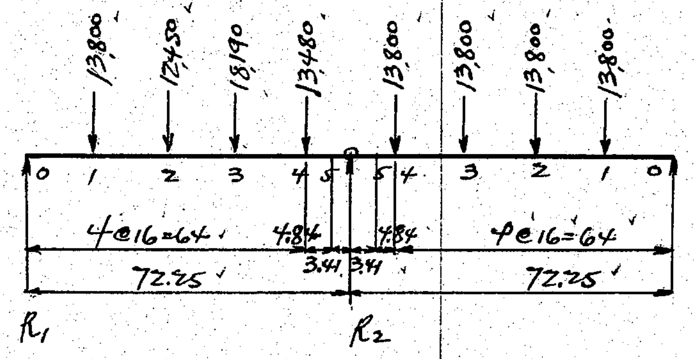
CALCULATIONS FOR

Karumojima Swing Bridge for city of Kobe.

Max. negative moments and shear at center support. moment.



| panel | Loads | Mz unit | Mz |
|---|---|---|---|
| 1 | 13,800 | 3.786 | − 52,250 |
| 2 | 12,450 | 6.372 | − 79,500 |
| 3 | 18,190 | 6.618 | − 120,500 |
| 4 | 13,480 | 3.381 | − 45,600 |
| 4 | 13,800 | 3.381 | − 46,700 |
| 3 | 13,800 | 6.618 | − 91,500 |
| 2 | 13,800 | 6.372 | − 88,000 |
| 1 | 13,800 | 3.786 | − 52,250 |

Mz = −576300'#

Shear at center support same as for panel pt 4.
or −19,300# Left span loaded.
−23,175# Both spans "

Max neg. moment at panel pt. 5
Loading same as for center support.

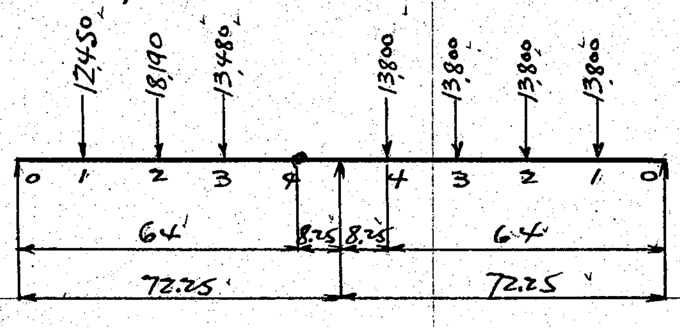
Reaction R₁

| panel | Load | R₁ unit | R₁ |
|---|---|---|---|
| 1 | 13800 | 0.726 | 10,020 |
| 2 | 12,450 | 0.469 | 5,840 |
| 3 | 18,190 | 0.244 | 4,440 |
| 4 | 13,480 | 0.067 | 900 |
| 4 | 13,800 | −0.047 | − 650 |
| 3 | 〃 | −0.091 | −1,255 |
| 2 | 〃 | −0.088 | −1,215 |
| 1 | 〃 | −0.056 | − 770 |

R₁ = +17,310#

moment
17,310 × 68.84 = +1,192,000
13,800 × 52.84 = − 730,000
12,450 × 36.84 = − 459,000
18,190 × 20.84 = − 380,000
13,480 × 4.84 = − 65,300
−442,300'#

Max. neg. moment at panel pt. 4.



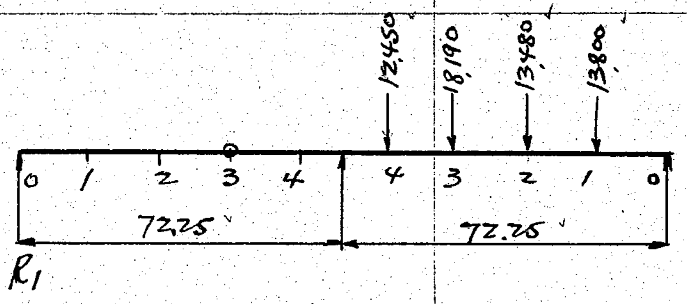
Reaction R₁

| Panel | Loads | R₁ unit | R₁ |
|---|---|---|---|
| 1 | 12,450 | 0.726 | 9,040 |
| 2 | 18,190 | 0.469 | 8,550 |
| 3 | 13,480 | 0.244 | 3,290 |
| 4 | 0 | 0.067 | 0 |
| 4 | 13,800 | −0.047 | −650 |
| 3 | 〃 | −0.091 | −1,255 |
| 2 | 〃 | −0.088 | −1,215 |
| 1 | 〃 | −0.056 | − 770 |

R₁ = +16990#

moment =
16,990 × 64 = + 1,085,500
12,450 × 48 = − 597,500
18,190 × 32 = − 584,000
13,480 × 16 = − 216,000
− 312,000'#

Max. neg. moment at panel pt. 3



Reaction R₁

| Panel | Loads | R₁ unit | R₁ |
|---|---|---|---|
| 4 | 12,450 | −0.047 | − 585 |
| 3 | 18,190 | −0.091 | − 1,660 |
| 2 | 13,480 | −0.088 | − 1,185 |
| 1 | 13,800 | −0.056 | − 770 |

− 4,200#

moment = − 4200 × 48 = −201,800'#

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CHECKED BY M. Jinda DATE 3-12-8 PAGE NO 18

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Max. neg. moment at panel pt. 2. Reaction $R_1$ = -4,200#
Loading same as for panel pt. 3. moment = -4200 × 32 = -134,200'#

Max. neg. moment at panel pt. 1 Reaction $R_1$ = -4200#
moment = -4200 × 16 = -67,100'#
〃 〃 〃 Center support. moment = -576,300'#

Max. neg. reaction $R_1$
Loading same as above Reaction $R_1$ = -4,200#
max. neg. shear throughout the left span = -4,200#

Live Load moments and Shears in case (C).

| moments | | panel pt 0 | panel pt 1 | panel pt 2 | panel pt 3 | panel pt 4 | panel pt 5 | Center support. |
|---|---|---|---|---|---|---|---|---|
| Pos. moment, Left span loaded | ($C_1$) | 0 | +381,000'# | +498,800'# | +377,300'# | +24,600'# | -157,100'# | -297,850'# |
| 〃 〃 Both spans 〃 | ($C_2$) | 0 | +319,000 | +374,300 | +190,600 | -223,400 | -423,800 | -576,300 |
| neg. moment | ($C_2$) | 0 | -67,100'# | -134,200'# | -201,800 | -312,000 | -442,300 | -576,300'# |

Shears.

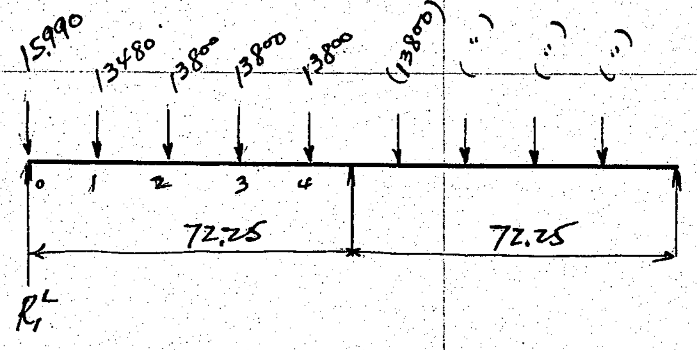
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Shear Left span loaded | ($C_1$ | +23,830 | +23,830# | +9355# | -5050# | -19,300# | -19,300# | -19,300# |
| Both spans 〃 | ($C_3$) | +19,940 | +19,940 | +5465 | -8,940 | -23,175 | -23,175 | -23,175 |

max. end reaction $R_1$ = +36,520# See end of this page.
min end 〃 $R_1$ = -4,200#

max. center Reaction $R_2$
Left span loaded = +41,450#
Both spans 〃 = +79,400#
min. or no load = 0

| panel | Loads | $R_2$ unit | $R_2$ |
|---|---|---|---|
| 1 | 13,800 | 0.327 | 4,520 |
| 2 | 13,800 | 0.619 | 8,520 |
| 3 | 12,450 | 0.849 | 10,570 |
| 4 | 18,190 | 0.979 | 17,840 |
| | | | 41,450 Left span loaded |
| 4 | 13,480 | 0.979 | 13,200 |
| 3 | 13,800 | 0.849 | 11,710 |
| 2 | 〃 | 0.619 | 8,520 |
| 1 | 〃 | 0.327 | 4,520 |
| | | | 37,950 |
| | | | 79,400# Both spans loaded |

Max end Reaction.



| Panel pt. | Loads | $R_1$ unit | $R_1$. |
|---|---|---|---|
| 0 | 15,990 | 1.000 | 15,990 |
| 1 | 13,480 | 0.726 | 9,780 |
| 2 | 13,800 | 0.469 | 6,460 |
| 3 | 13,800 | 0.244 | 3,365 |
| 4 | 13,800 | 0.067 | 925 |
| | | | $R_1^L$ = +36,520# Left span loaded |
| 4 | 13,800 | -0.047 | -650 |
| 3 | 〃 | -0.091 | -1,255 |
| 2 | 〃 | -0.088 | -1,215 |
| 1 | 〃 | -0.056 | -770 |

$R_1^R$ = +3,890# Right span loaded
$R_1$ = +32,630# Both spans 〃.

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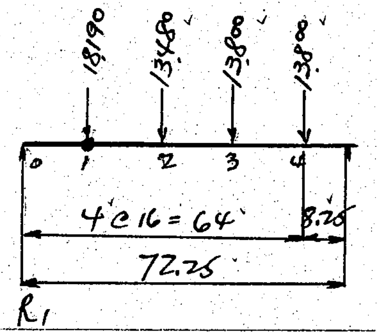
CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Case (d) Live Load moments & Shears for One arm acting as a simple beam.

Moment and shears at panel pt. 1.

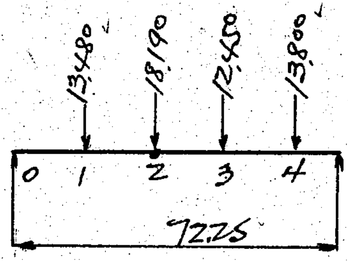


Reaction R1.

18,190 × 56.25 = 1,025,000
13,480 × 40.25 = 542,500
13,800 × 24.25 = 334,500
13,800 × 8.25 = 114,000
R1 = 2,016,000 ÷ 72.25 = 27,900#

moment = 27,900 × 16 = 446,000'#
Shear = 27,900#

Moment and Shears at panel pt. 2

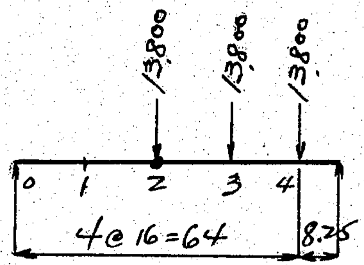


moment

Reaction R1

13480 × 56.25 = 757,000
18,190 × 40.25 = 734,000
12,450 × 24.25 = 302,000
13800 × 8.25 = 114,000
1,907,000 ÷ 72.25 = 26,400#

moment = 26400 × 32 = 845,000
13,480 × 16 = −216,000
moment = 629,000'#



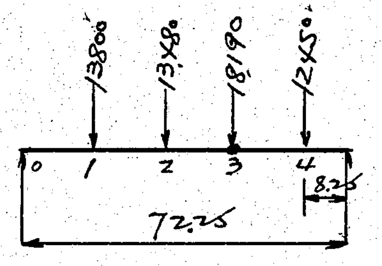
Shear In this case no uniform live load at the behind of motor truck and the panel load at the position of rear wheel will be reduced to 13,700# abt. so that unif. load governs Shear

13,800 × 40.25 = 555,000
13,800 × 24.25 = 335,000
13,800 × 8.25 = 114,000
1,004,000 ÷ 72.25 = 13,900# max shear at panel pt. 2

Max. End reaction R1

13700 × 72.25 = 990,000
13480 × 56.25 = 758,000
13,800 × 8.25 = 113,800
18,190 × 40.25 = 732,000
12,450 × 24.25 = 302,000
2895800 ÷ 72.25 = 40,100#

Moment and Shear at panel pt. 3.

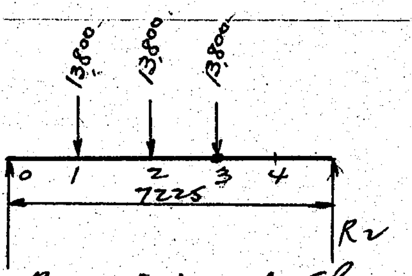


Reaction R1

13,800 × 56.25 = 776,000
13,480 × 40.25 = 542,000
18,190 × 24.25 = 442,000
12,450 × 8.25 = 102,600
1,862,600 ÷ 72.25 = 25,800#

moment

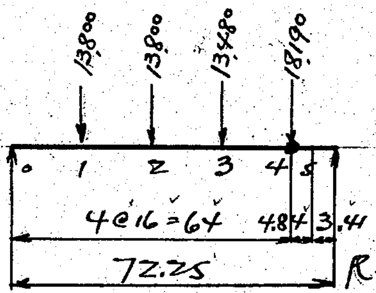
25800 × 48.0 = 1,240,000
13,800 × 32.0 = −442,000
13480 × 16.0 = −215500
moment = 582,500'#



Shear

13,800 × 16 × 6 = 1,325,000 ÷ 72.25 = −18400# = Shear = R2

Moment and Shear at panel pt. 4 & 5



Reaction R2

13800 × 16 × 3 = 662,000
13480 × 48 = 647,000
18190 × 64 = 1,165,000
2,474,000 ÷ 72.25 = −34250# = Shear at 4 & 5

moment at panel pt. 4 = 34250 × 8.25 = 282,000'#
" " " 5 = 34,250 × 3.41 = 117,000'#

| Moment & Shears in Case (d) | panel pt. 0. | panel pt. 1 | panel pt. 2. | panel pt. 3. | panel pt. 4 | Panel pt. 5. | Center support. |
|---|---|---|---|---|---|---|---|
| Moments | 0 | +446,000'# | +629,000 | +582,500 | +282,000 | +117,000 | 0 |
| Shears | +27,900# | +27,900# | +13,900 | −18,400 | −34250 | −34,250 | −34,250# |
| Max. reactions | +40,100# | | | | | | +34,250# |

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CHECKED BY M. Jinda DATE 3-12-8 PAGE NO 20

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Summary of Dead Load and Live Load moments + Shears.

Cases (a) + (c), or (a) + (d), or (b) + (c), respectively, may occur at the same time and therefore, the corresponding stresses at any points have to be combined so as to give the max. & min stresses at that panel point.

Cases (a) + (c) can occur simultaneously when the bridge is closed and the end wedges driven only so far as to touch the end supports. In this case however, loads covering one arm only should not be considered, since the far end would be lifted, thus eliminating the continuity of the span, the assumption which is often made that, that end will be held down by a concentrated load is not justified. In this stress calculation, effects of variable moment of inertia of the girder and temperature change are neglected.

| | Moments in | End support | panel pt. 1 | Panel pt. 2 | panel pt. 3 | Panel pt. 4 | panel pt. 5 | Center support |
|---|---|---|---|---|---|---|---|---|
| D.L. | Case (a) | − 340 | − 148,600 | −544,300 | −1,186,300 | −2,076,200 | −2,411,000 | −2,655,000 |
| | Case (b) | 0 | +230,900 | +271,200 | + 121,100 | − 220,000 | − 374,600 | − 487,400 |
| L.L. | Case (C1) max. pos. m | 0 | +381,000 | +498,800 | +377,300 | + 24,600 | − 157,100 | − 297,900 |
| | Case (C2) " neg. m. | 0 | − 67,100 | −134,200 | − 201,800 | −312,000 | − 442,300 | −576,300 |
| | " (C3) Both arms " | 0 | + 319,000 | +374,300 | + 190,600 | −233,400 | − 423,800 | − 576,300 |
| | Case (d) | 0 | + 446,000 | +629,000 | +582,500 | +282,000 | + 117,000 | 0 |
| | Combined moments | Should not be combined with case A | | | | | | |
| | Case (a) + (C2) or (C3) | − 340 | + 170,400 | −170,000 | −995,700 | −2,388,200 | −2,853,300 | −3,231,300 |
| | Case (a) + (d) | − 340 | + 297,400 | + 84,700 | − 603,800 | − 1,794,200 | − 2,294,000 | − 2,655,000 |
| | Case (b) + (C1), (C2) or (C3) | 0 | + 611,900 | +770,000 | +498,400<br>− 80,700 | − 195,400 | − 531,700 | − 785,300 |
| | Max. & min moments | Reversal stress in succession add 50% of smaller stress * | | | | | | |
| | max. (pos.) moments | — | + 611,900 # | +770000 # | +498,400 # | − 195,400 # | − 531,700 # | − 785,300 # |
| | min (neg) moments. | −340 | − 148,600 | −544,300 | −1,186,300 | −2,388,200 | −2,853,300 | −3,231,300 |
| | Design moment. | − 340 | + 686,200 * | +1,042,200 * | −1,435,500 * | −2,388,200 | −2,853,300 | −3,231,300 |

Note: In case (C2) Stresses between end support and panel pt. 3 should not be combined with that of case (a) because left arm is not loaded in case (C2) (See loading condition on page 17)

| | Shears in | End support | Panel pt. 1 | panel pt. 2 | Panel pt. 3 | Panel pt. 4 | panel pt. 5 | Center support. |
|---|---|---|---|---|---|---|---|---|
| D.L. | Case (a) | − 550 # | − 12,790 # | − 28,230 # | − 43,680 # | − 59,100 # | − 70,550 # | − 72,050 # |
| | Case (b) | + 17,155 | + 11,715 | − 205 | − 12,125 | − 24,035 | − 32,835 | − 33,990 |
| L.L. | Case (C1) | + 23,830 | + 23,830 | + 9,355 | − 5,050 | − 19,300 | − 19,300 | − 19,300 |
| | Case (C3) | + 19,940 | + 19,440 | + 5,465 | − 8,940 | − 23,175 | − 23,175 | − 23,175 |
| | Case (d) | + 27,900 | + 27,900 | + 13,900 | − 18,400 | − 34,250 | − 34,250 | − 34,250 |
| | Combined Shear | | | | | | | |
| | Case (a) + (C3) | + 19,390 | + 6,650 | − 22,765 | − 52,620 | − 82,275 | − 93,725 | − 95,225 |
| | Case (a) + (d) | + 27,350 | + 15,110 | − 14,330 | − 62,080 | − 93,350 | − 104,800 | − 106,300 |
| | Case (b) + (C1) or (C3) | + 40,985 | + 35,545 | + 9,150 | − 21,065 | − 47,210 | − 56,010 | − 57,165 |
| | Max and min Shear | | | | | | | |
| | max. Shear | + 40985 # | + 35545 # | + 9150 | − 12,125 # | − 24,035 # | − 32,835 # | − 33,990 # |
| | min Shear | − 550 | − 12,790 | − 28,230 | − 62,080 | − 93,350 | − 104,800 | − 106,300 |
| | Design Shear | + 41,260 * | + 41,940 * | − 32,805 * | − 62,080 | − 93,350 | − 104,800 | − 106,300 |

Reactions on end + center supports.

| | Reactions in | End Support (R1) | Center support (R2) |
|---|---|---|---|
| D.L. | Case (a) | 0 | + 144,100 # |
| | Case (b) | + 21,145 # | + 67,960 |
| L.L. | Case (C1) Left arm loaded | + 36,520 | + 41,450 |
| | Case (C3) Both arms " | + 32,630 | + 79,400 |
| | Case (C4) Right arm " | − 4,200 | |
| | Case (d) | + 40,100 | + 34,250 |
| | max. reaction | + 57,665 # | + 223,500 # |
| | min. reaction | − 4,200 | + 67,960 # |

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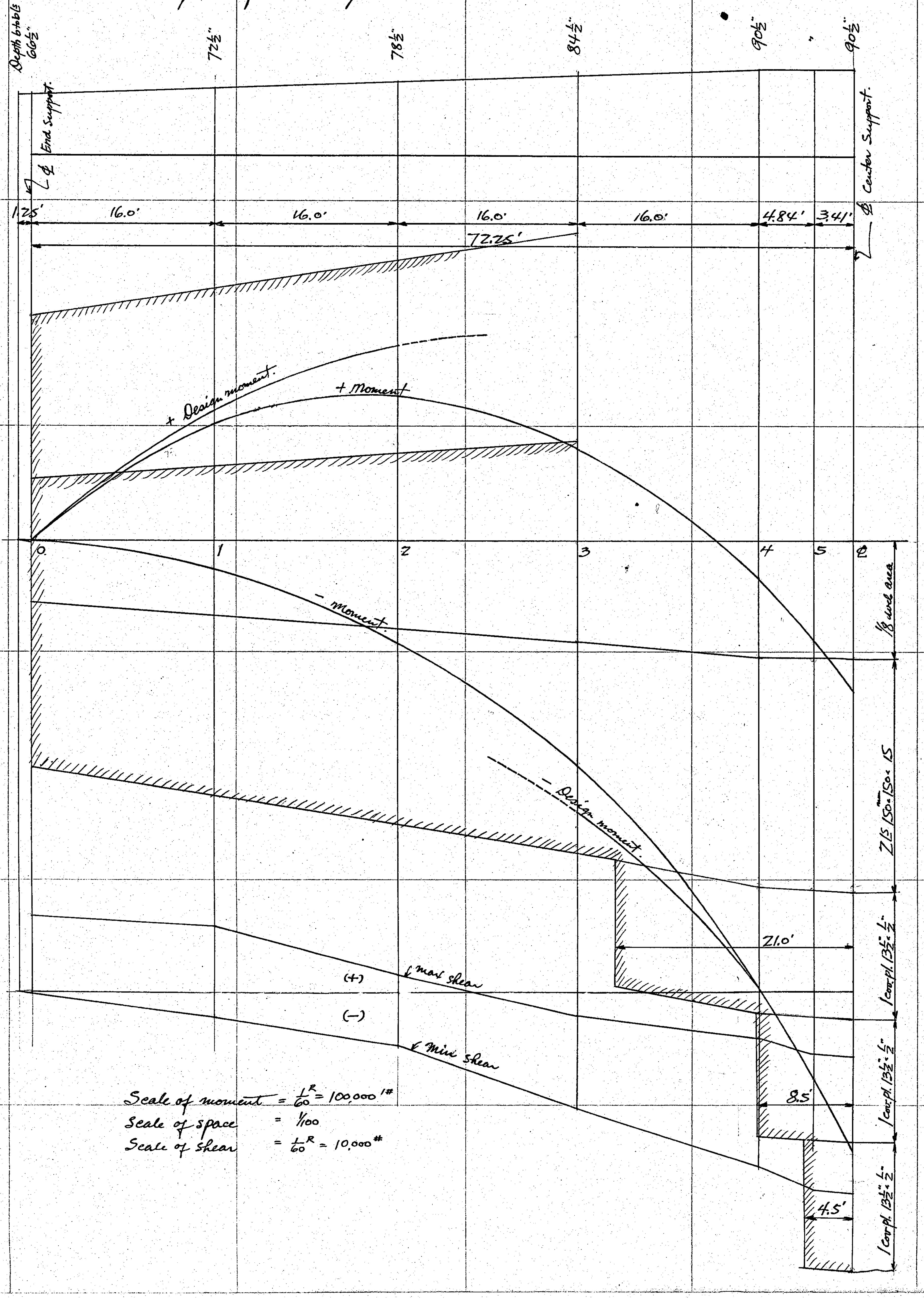
CHECKED BY M. Jinda DATE 3-12-8 PAGE NO 21

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Moment Diagrams for Main Girder.



Scale of moment $= \frac{1}{60}^{R} = 100,000'^{\#}$

Scale of space $= 1/100$

Scale of shear $= \frac{1}{60}^{R} = 10,000^{\#}$

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CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Sections of main girder

Section at center support. Design moment = $-3,231,300'^{\#}$ Shear = $-106,300^{\#}$

Assumed flange section
2Ls 150 × 150 × 15 = 13.26 × 1.67 = −22.13
3 cov. pls. $13\frac{1}{2} \times \frac{1}{2}$ = 20.25 × 0.75 = + 15.18
33.51 × 0.21 = − 6.95

Flange area
2Ls 150mm × 150 × 15 = 13.26 − 3.54 = 9.72
3 cov. pls $13\frac{1}{2}" \times \frac{1}{2}"$ = 20.25 − 4.50 = 15.75
33.51 □" gr 25.47 □" net

Allowable unit compression on flange.
$= 17000\left(1 - 0.012\,\frac{l}{b}\right) =$
$= 17000\left(1 - 0.012 \times \frac{16 \times 12}{13.5}\right) = 14,100$ #/□" C

Depth of girder = $90\frac{1}{2}"$ b to b of flg. Ls
Effective depth = 90.5 − 2 × .21 = 90.08"
Use 90" × 7/16" web pl. $\frac{1}{8}$ web area = $\frac{1}{8} \times 39.38 = 4.92$ □"
Flange stress = $\frac{3231,300 \times 12}{90.08} = 430,000$ # T or C

Flange area required = $\frac{430,000}{17,000} = 25.30$ □" net
$\frac{1}{8}$ web area = − 4.92
20.38 □" net Ok

Flange stress tension = $\frac{430,000}{25.47 + 4.92} = 14,150$ #/□" T ok
" " compression = $\frac{430,000}{33.51 + 4.92} = 11,200$ #/□" C ok

Unit shear in web = $\frac{106300}{39.38} = 2,700$ #/□" ok

Section at panel pt. 5 Design moment = $-2853,300'^{\#}$ Shear = $-104,800^{\#}$

Assumed flange section
2Ls 150 × 150 × 15 = 13.26 × 1.67 = −22.13
2 cov. pls $13\frac{1}{2}" \times \frac{1}{2}"$ = 13.50 × 0.5 = + 6.75
26.76 × .58" = −15.38

Flange area
2Ls 150 × 150 × 15 = 13.26 − 3.54 = 9.72
2 cov. pls $13\frac{1}{2}" \times \frac{1}{2}"$ = 13.50 − 3.00 = 10.50
26.76 □" gr 20.22 □" net

Allowable unit compression on flange = 14,100 #/□"

Depth of girder = $90\frac{1}{2}"$ b to b of flange Ls.
Effective depth = 90.5 − 1.16 = 89.34"
Use 90" × 7/16" web $\frac{1}{8}$ web area = 4.92 □"
Flange stress = $\frac{2853300 \times 12}{89.34} = 383,000$ # T or C

Flange area required = $\frac{383000}{17000} = 22.53$ □" net
$\frac{1}{8}$ web = 4.92
17.61 □" net

Flange stress tension = $\frac{383000}{20.22 + 4.92} = 15,300$ #/□" T ok
" " compression = $\frac{383000}{26.76 + 4.92} = 12,100$ #/□" C ok

Section at panel pt. 4 Design moment = $-2388,200'^{\#}$ Shear = $-93350^{\#}$

Assumed flange section
2Ls 150 × 150 × 15 = 13.26 + 1.67 = −22.13
1 cov. pl. $13\frac{1}{2} \times \frac{1}{2}$ = 6.75 × 0.25 = +1.69
20.01 × 1.02 = −20.44

Flange area
2Ls 150 × 150 × 15 = 13.26 − 3.54 = 9.72
1 cov. pl. $13\frac{1}{2} \times \frac{1}{2}$ = 6.75 − 1.50 = 5.25
20.01 □" gr 14.97 □" net

Depth of girder = $90\frac{1}{2}"$ b to b Ls
Effective depth = 90.5 − 2.04 = 88.46"
Flange stress = $\frac{2,388,200 \times 12}{88.46} = 324,000$ # T or C

Flange area req'd = $\frac{324,000}{17000} = 19.07$ □" net
$\frac{1}{8}$ web area = 4.92
14.15 □" net

Section at panel pt. 3. Design moment = $-1435,500'^{\#}$ Shear = $-62,80^{\#}$

Assumed flange section
2Ls 150 × 150 × 15 = 13.26 − 3.75 = 9.51 □" net

Allowable unit compression on flange.
$= 17000\left(1 - 0.012 \times \frac{16 \times 12}{12.44}\right) = 13850$ #/□" C

Depth of girder = $84\frac{1}{2}"$ b to b of flange Ls
Use 84" × 7/16" web $\frac{1}{8}$ web area = $\frac{1}{8} \times 36.75 = 4.59$ □"
Effective depth = 84.5 − 3.34 = 81.16"
Flange stress = $\frac{1435500 \times 12}{81.16} = 212,000$ # T or C

Flange area req'd. = $\frac{212000}{17000} = 12.47$ □" net
4.59
7.88 □" net

Flange stress comp. = $\frac{212000}{13.26 + 4.59} = 11,900$ #/□" C ok

Section at panel pt. 2. Design moment = $-1042,200'^{\#}$, Shear = $-32,805^{\#}$

Assumed section
2Ls 150 × 150 × 15 = 13.26 − 3.75 = 9.51 □" net

Depth of girder = $78\frac{1}{2}"$ b to b Ls
effective depth = 78.5 − 3.34 = 75.16"
$\frac{1}{8}$ web area = $\frac{1}{8} \times 34.13 = 4.27$ □"
Flange stress = $\frac{1042,200 \times 12}{75.16} = 166,500$ # T or C
Flange area req'd = $\frac{166500}{17000} = 9.80$
4.27
5.53 □" net ok

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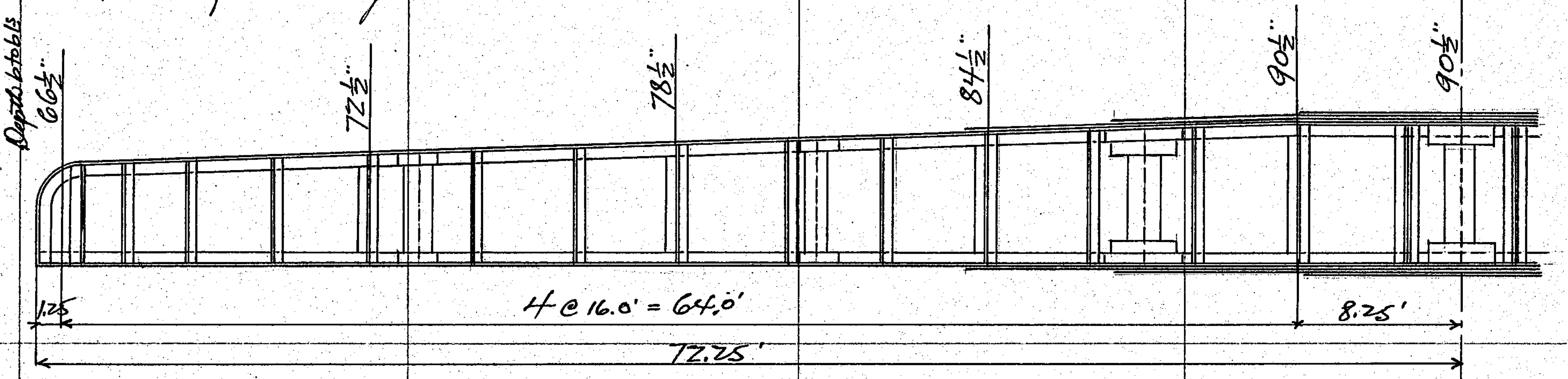
CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Sketch of main girder.



Approximate weight of main girder.

| | | | | | Z required | | |
|---|---|---|---|---|---|---|---|
| 2 Flange Ls | 150 × 150 × 15 | @ | 22.55 | × | 146.26 | = | 6600 |
| 2 " | " | @ | " | × | 156.30 | = | 7050 |
| 2 web P/s. | 73" × 7/16" | @ | 108.6 | × | 19.72 | = | 4280 |
| 2 " | 80½" × 7/16" | @ | 119.8 | × | 19.75 | = | 4,740 |
| 2 " | 87" × 7/16" | @ | 129.4 | × | 17.58 | = | 4,545 |
| 2 " | 90" × 7/16" | @ | 133.9 | × | 16.06 | = | 4,300 |
| 2 Cov. p/s. | 13½" × ½" | @ | 22.95 | × | 52.16 | = | 2,395 |
| 2 " | " | @ | " | × | 35.33 | = | 1,622 |
| 2 " | " | @ | " | × | 16.38 | = | 752 |
| 12 spl. Ls | 150 × 150 × 15 | @ | 22.55 | × | 2.06 | = | 556 |
| 6 spl. P/s. | 13" × 3/8" | @ | 16.58 | × | 2.04 | = | 203 |
| 16 " | 5" × 5/8" | @ | 10.63 | × | 1.90 | = | 323 |
| 8 spl. Ls | 150 × 150 × 15 | @ | 22.55 | × | 3.21 | = | 577 |
| 4 spl. P/s. | 8½" × ½" | @ | 14.45 | × | 2.54 | = | 147 |
| 4 fills | 3" × 5/8" | @ | 6.38 | × | 2.54 | = | 65 |
| 8 spl. P/s. | 9½" × 5/8" | @ | 20.19 | × | 3.06 | = | 493 |
| 4 " | 12½" × 7/16" | @ | 18.59 | × | 5.14 | = | 382 |
| 4 " | " | @ | " | × | 5.75 | = | 427 |
| 4 " | 18½" × 7/16" | @ | 27.52 | × | 4.70 | = | 517 |
| 2 " | " | @ | " | × | 5.90 | = | 324 |
| 4 tie p/s. | 13½" × 3/8" | @ | 17.21 | × | 2.62 | = | 180 |
| 64 stiff. Ls. | 5" × 3½" × 3/8" | @ | 10.37 | × | mean 6.50 | = | 4,315 |
| 4 " | 150 × 150 × 11 | @ | 16.77 | × | 7.40 | = | 499 |
| 4 fills | 17⅜" × 5/8" | @ | 36.93 | × | 4.54 | = | 656 |
| 6 fills | 8" × 5/8" | @ | 17.00 | × | 5.52 | = | 563 |
| 4 fills | 13¼" × 5/8" | @ | 28.16 | × | 6.54 | = | 737 |
| 4 " | 7" × 5/8" | @ | 14.88 | × | 6.54 | = | 389 |
| 2 bearing p/s. | 13½" × ½" | @ | 22.95 | × | 3.3 | = | 152 |
| Rivet heads and miscellaneous details say, | | | | | | | 1,671 |
| | | | | | | | 49,460# = 22.10 tons. |

49,460# ÷ 146.26' = 338# per lin. ft. of main girder.

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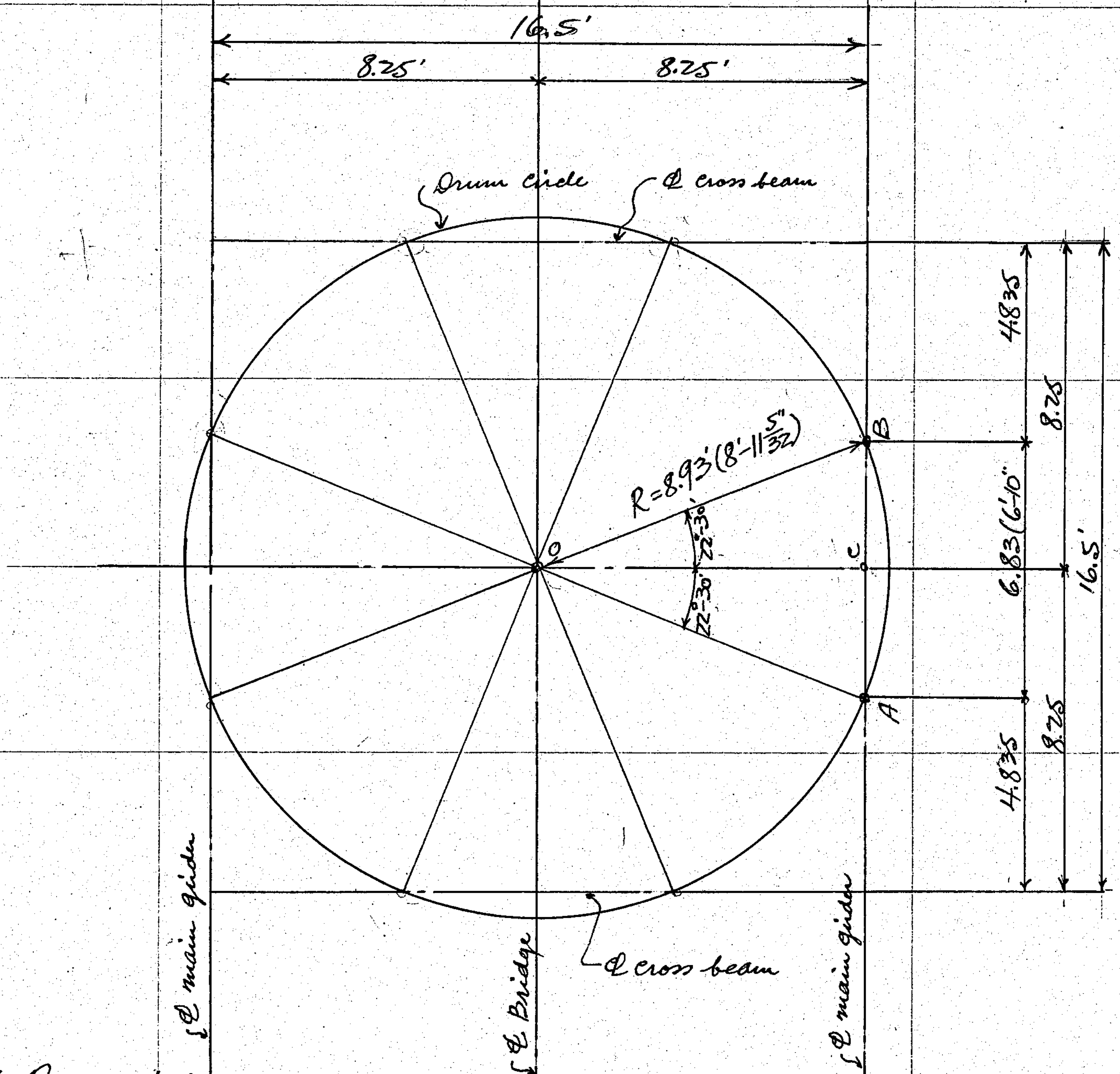
CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.
Drum circle.



Radius of Drum circle

$\mathrm{OC} = 8.25''$   $\sec 22°\text{-}30' = 1.0824$,   $\tan 22°\text{-}30' = 0.4142$

radius $\mathrm{OB} = \overline{\mathrm{OC}} \sec 22°\text{-}30' = 8.25 \times 1.0824 = 8.9298' = 8'\text{-}11\frac{5}{32}''$

Chord $\mathrm{AB} = 2 \times \overline{\mathrm{OC}} \times \tan 22°\text{-}30' = 2 \times 8.25 \times 0.4142 = 6.8343 = 6'\text{-}10''$.

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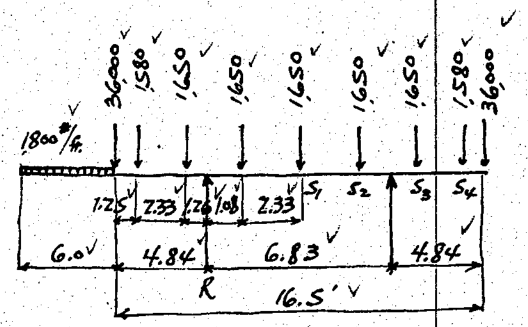
CALCULATIONS FOR

(22)

Karumojima Swing Bridge for Kobe City

Design of Cross Beam on Drum. Span length 16.5' with 6' Cantilever Bracket on one side.

Dead Load.



Moments and Shears due to Stringer concentrations and operating house.

Operating house 18'×6' = 108 □' @ 200#/□' assumed = 21,600#

weight for one cross beam = 10,800#

load on cross beam (cantilever) = $\frac{10800}{6}$ = 1,800# per lin. ft.

Cantilever moment = $\frac{1}{2}$ × 1800 × $6^2$ = −32,400'#

Shear = 1,800 × 6 = −10,800#

Reaction R = 10,800 × 11.25 ÷ 6.83 = 17,800# --- $\frac{1}{2}$ of this to be transfered to cross beam & main girder assumed.

Stringer concentrations on floor beam.

$S_1, S_2$ + $S_3$ ····· 2 @ 825 = 1,650# each. page 5

$S_4$ ·········· 2 @ 792 = 1,580# " "

Load from main girder at end.

$R_2$ = 144,100# ÷ 4 = 36,000#

Reaction = 1650 × 2.5 = 4,120#

1580

$\frac{17800}{2}$ + 36000 = 44900

R = 50,600#

moment at Support 44900 × 4.83 = −217,000

1580 × 3.59 = −5670

1650 × 1.26 = −2080

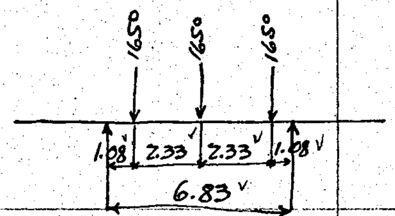
Shear = −48,130# −224,750'# at support.

Moment at 2' outside of support.

44900 × 2.84 = −127,500

1580 × 1.59 = −2500

Shear = −46480# −130,000'# at 2' outside of support.



Moment at center Reaction = 1650 × 1.5 = 2,475#

2475 × 3.41 = + 8,440

1650 × 2.33 = − 3,840

+ 4,600

Shear −48130
+50,600
− 1,650
+ 820#

Neg. moment at support = −224,750

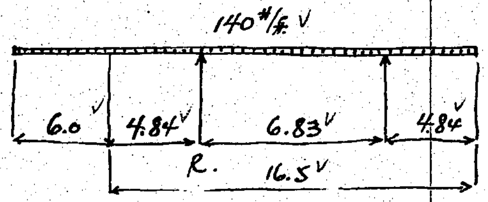
−220,150'# at center.

Moments + Shears due to own weight of floor beam.

Reaction R. $\frac{140 \times 17.67^2}{2 \times 6.83}$ = + 3,200#

$\frac{140 \times 4.84^2}{2 \times 6.83}$ = − 240

+ 2,960#



moment at fixed point of Cantilever bracket.

= 140 × $6.0^2$ ÷ 2 = −2,520'#

Shear = 140 × 6.0 = − 840#

moment at 2' outside of support.

= 140 × $8.84^2$ ÷ 2 = − 5460'#

Shear = 140 × 8.84 = − 1,240#

moment at Support.

= 140 × $10.84^2$ ÷ 2 = − 8,230'#

Shear = 140 × 10.84 = − 1,520#

moment at center.

2960 × 3.41 = + 10,100

140 × $14.25^2$ ÷ 2 = − 14,200

− 4,100'#

Shear 140 × 14.25 = −1,950

+2,960

+ 1,010#

Summary for Dead Load moments

| | Cantilever | 2' out side of support. | at support | at center. |
|---|---|---|---|---|
| Weight of operating house. | −32,400 | −32,400 | −32,400 | −16,200 |
| Stringer concentrations | | −130,000 | −224,750 | −220,150 |
| Own weight of cross beam. | −2,520 | −5,460 | −8,230 | −4,100 |
| | −34,920'# | −167,860'# | −265,380'# | −240,450'# |

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CHECKED BY DATE PAGE NO 26

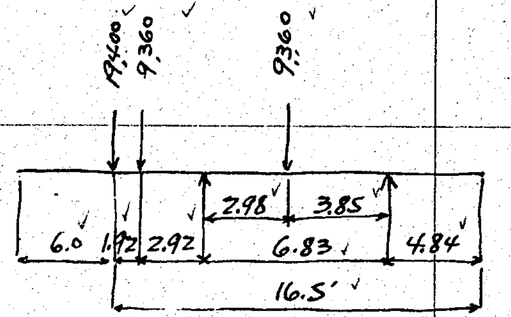
CALCULATIONS FOR

## Karumojima Swing Bridge for City of Kobe.

Summary for Dead Load Shear.

| | Cantilever | 2' outside of Support. | At Support. | At center. |
|---|---|---|---|---|
| Weight of operating house. | − 10,800 | } − 46,480 | } − 48,130 | } + 820 |
| Stringer concentrations | | | | |
| Own weight of crossbeam. | − 840 | − 1,240 | − 1,520 | + 1,010 |
| | − 11,640 # | − 47,720 # | − 49,650 # | + 1,830 # |

Live Load:



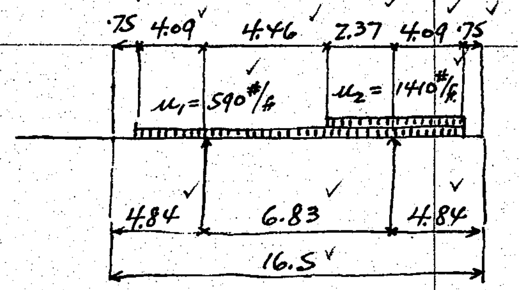
Motor truck rear wheel concentration with impact = 9360 # page 5
moment at support = 9360 × 2.92 = − 27,300 '#
Shear = − 9360 #
(revised to 19,400)
Live Load from main girder = 77350 ÷ 4 = 19,400 Assumed for safe side.
moment at Support = 19400 × 4.84 = − 93600 '#
Shear = − 19,400
total moment = − 27,300 − 93,600 = − 120,900 '# at support.
total shear = − 9360 − 19,400 = − 28,760 #

Moment at 2' outside of support.
rear wheel concentration 9360 × 0.92 = 8600
main girder 19,400 × 2.84 = 55000
− 63,600 '#
Shear 9360 + 19,400 = − 28,760 #

moment at center
motor truck wheel Reaction = $\frac{9360 \times 2.98}{6.83}$ = 4080

Moment at center = 4080 × 3.41 = + 13,900 '#
neg. moment = $\frac{27300 + 93600}{2}$ = − 60,450
− 46,550 '#

Shear at center. $\frac{-120900}{6.83}$ = − 17,670
+ 4080
Right reaction = − 13,590 # Shear = + 13,590 #



Moments and Shears due to uniform live load.
moment at support = ½ × 590 × 4.09² = − 4,940 '#
Shear = 590 × 4.09 = − 2410 #
moment at 2' outside of support.
= ½ × 590 × 2.09² = − 1,290 '#
Shear = 590 × 2.09 = − 1230 #
Reaction, Unif. load u1 = 590 × 7.5 = 4420 #
" " u2 = $\frac{1410 \times 6.46 \times 0.86}{6.83}$ = − 1150
+ 3,270 # Shear = − 1150 #

moment at center = 3270 × 3.41 = + 11,150
$\frac{590 \times 7.5^2}{2}$ = − 16,600
− 5,450 '#

Summary for Live Load moments.

| | Cantilever | 2' Outside of support. | At support. | At. center. |
|---|---|---|---|---|
| motor truck rear wheel concentration | — | − 8,600 | − 27,300 | } − 46,550 |
| main girder | — | − 55,000 | − 93,600 | |
| Unif. load. | — | − 1290 | − 4,940 | − 5,450 |
| | | − 64,890 '# | − 125,840 '# | − 52,000 '# |

Summary for Live Load Shear.

| | | | |
|---|---|---|---|
| motor truck rear wheel concentration | − 9,360 | − 9,360 | } + 13,590 |
| main girder | − 19,400 | − 19,400 | |
| Uniform load. | − 1230 | − 2,40 | − 1150 |
| | − 29,990 # | − 31,170 # | + 12,440 # |

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CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Summary of Dead Load + Live Load moments.

| | Cantilever | 2' outside of support | at support | at center. |
|---|---|---|---|---|
| Dead Load. | − 34920 | − 167,860 | −265,380 | −240,450 |
| Live Load. | ——— | − 64,890 | −125,840 | − 52000 |
| | − 34,920'# | −232,750'# | −391,220'# | −292,450'# |

Summary for Dead Load and Live Load Shears.

| | Cantilever | 2' outside of support | at support | at center. |
|---|---|---|---|---|
| Dead Load | − 11,640 | − 47,720 | − 49,650 | + 1,830 |
| Live Load. | ——— | − 29,990 | − 31,170 | +12,440 |
| | −11,640# | − 77,710# | −80,820# | +14,270# |

Section of Floor Beam on Drum.

Section at support. moment = −391,220'#, Shear = − 80,820#

Assumed flange section.

2Ls 5" × $3\frac{1}{2}$" × $\frac{1}{2}$" = 8.00 − 2.0 = 6.00

1cov.pl. 11" × 3/8" = 4.13 − .75 = 3.38

12.13°" gr. 9.38°" net

Center of gravity 2Ls 8.0 × .89 = − 7.12

1Pl. 4.13 × .19 = + 0.79

12.13 × .52 = + 6.33

Allowable unit compression on flange.

$17000\left(1-0.012\times\frac{6.83\times12}{11}\right) = 15470$ #/°"

Depth of Beam = 2'-$6\frac{1}{2}$" b to b Ls. or 30.5"

use web pl. 30" × $\frac{3}{8}$" = 11.25°" $\frac{1}{8}$ web = 1.41°"

Effective depth. = 30.5 − 1.04 = 29.46" = 2.45'

Flange stress = $\frac{391,220}{2.45}$ = 159,700# T or C.

Flange area req'd = $\frac{159,700}{17000}$ = 9.40

$\frac{1}{8}$ web area = 1.41

7.99°" net. o/c.

Flange stress comp. = $\frac{159700}{12.13+1.41}$ = 11800#/°" o/c

Shear in web = $\frac{80,820}{11.25}$ = 7180#/°" o/c.

Use the same section for Center of span as above.

Section at 2' outside of support. moment = − 232,750'# Shear = −77,710#

Assumed flange section

2Ls 5" × $3\frac{1}{2}$" × $\frac{1}{2}$" = 8.00 − 1.0 = 7.0°" net.

Allowable unit compression on flange

$= 17000\left(1-0.012\times\frac{6.83\times12}{10.38}\right) = 15380$ #/°"

Depth of beam $27\frac{1}{2}$" b to b Ls.

use 27" × 3/8 web = 10.1°" $\frac{1}{8}$ web = 1.26°"

effective depth = 27.5 − 1.8 = 25.7" = 2.14'

flange stress = $\frac{232,750}{2.14}$ = 108,800# T or C

flange area req'd = $\frac{108,800}{17000}$ = 6.40

$\frac{1}{8}$ web area = 1.26

5.14°" net. o/c.

Comp. flange stress = $\frac{108800}{7.0+1.26}$ = 13150#/°" o/c

unit shear on web = $\frac{77710}{10.1}$ = 7,720#/°" o/c

Section for Cantilever bracket under operating house. moment = − 34,920'# shear = − 11,640#

Assumed section of flange.

2Ls 4" × 3" × 3/8" = 4.97°" − .66 = 4.31°" net.

Depth of beam 27.5" b to b Ls.

use 27" × 3/8" web = 10.1°" $\frac{1}{8}$ web = 1.26°"

effective depth = 27.5 − 1.54 = 26" = 2.17'

flange stress = $\frac{34920}{2.17}$ = 16,100# C or T

flange area req'd. = $\frac{16100}{17000}$ = 0.95°" o/c.

MADE BY K. Masa. DATE 3-12-45 FILE NO
CHECKED BY DATE PAGE NO 28

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Approximate weight of Floor Beam on Drum. 2 required

| | | | | | |
|---|---|---|---|---|---|
| 2 Flange Ls | 5″ × 3½″ × ½″ | @ 13.61 | × 16.5′ | = | 449. |
| 2 " " | " " | @ " | × 16.4′ | = | 446 |
| 1 web pl. | 30″ × 3/8″ | @ 38.25 | × 16.4′ | = | 627 |
| 1 cov. pl. | 11″ × 3/8″ | @ 14.03 | × 10.2 | = | 143 |
| 1 " | " | @ " | × 12.5 | = | 176 |
| 16 Stiff Ls | 4″ × 3″ × 3/8″ | @ 8.45 | × 2.46 | = | 332 |
| 4 " | 75 × 75 × 9 | @ 6.69 | × 2.46 | = | 66 |
| 4 " | 75 × 75 × 9 | @ " | × 2.21 | = | 59 |
| 4 fills | 13″ × ½″ | @ 22.1 | × 1.94 | = | 172 |
| 4 " | 3″ × ½″ | @ 5.1 | × 1.94 | = | 40 |
| 4 " | 3″ × ½ | @ " | × 1.69 | = | 34 |
| 2 conn. Ls | 150 × 150 × 15 | @ 22.55 | × 2.21 | = | 100 |
| 2 fills | 9¼ × ½″ | @ 15.73 | × 1.69 | = | 53 |
| 2 Ls | 5″ × 3½″ × ½ | @ 13.61 | × 1.08 | = | 29 |
| 2 Pls. | 17″ × 5/8″ × | @ 36.13 | × 3.42 | = | 247 |
| Rivet heads and variations | | | | = | 107 |
| | | | | | 3,080 # |

3080 ÷ 16.5 = 187 #/lin ft. of floor beam.

Approximate weight of Cantilever Bracket. 2 required

| | | | | | |
|---|---|---|---|---|---|
| 2 flg. Ls | 4″ × 3″ × 3/8″ | @ 8.45 | × 7.00 | = | 118. |
| 2 " Ls | " | @ " | × 7.2 | = | 122 |
| 1 web Pl. | 27″ × 3/8″ | @ 34.43 | × 7.0 | = | 241 |
| 6 Stiff Ls | 75 × 75 × 9 | @ 6.69 | × 2.3 | = | 92 |
| 1 conn. L | 100 × 100 × 10 | @ 10.02 | × 2.2 | = | 22 |
| 1 fill | 4″ × 3/8″ | @ 5.10 | × 1.7 | = | 9 |
| 1 " | 4″ × 5/8 | @ 8.50 | × 2.2 | = | 19 |
| 1. tension pl. | 6″ × ¾″ | @ 15.30 | × 2.3 | = | 35 |
| 1 con. L8 | 4″ × 3½″ × ½″ | @ 12.81 | × 1.08 | = | 14 Cut from 100 × 100 × 13 |
| Rivet heads and miscellaneous details | | | | = | 23 |
| | | | | | 695 # |

695 ÷ 6 = 116 #/4 of span.

Approximate wt. of Lateral Bracing between Cantilever brackets 1 required

| | | | | | |
|---|---|---|---|---|---|
| 2 Ls | 3″ × 2½″ × 3/8″ | @ 6.53 | × 8.2 | = | 107. |
| 4 pls | 12″ × 3/8 | @ 15.30 | × 1.5 | = | 92 |
| 1 pl. | 6″ × 3/8 | @ 7.65 | × 1.0 | = | 8 |
| Rivet heads &c. say | | | | | 8 |
| | | | | | 215 # |

Approximate wt. of Strut between ends of Brackets. 1 required

| | | | | | |
|---|---|---|---|---|---|
| 1 [ | 12″ × 3½″ | @ 26.1 | × 16.5 | = | 431 |
| 2 Ls | 4″ × 3″ × 3/8 | @ 8.45 | × .8 | = | 7 |
| Rivet heads &c. | | | | | 2 |
| | | | | | 440 # |

Approximate wt. of frames & floor for operating house. 1 required.

| | | | | | |
|---|---|---|---|---|---|
| 6 col. Ls | 75 × 75 × 9 | @ 6.69 × | 7.0 | = | 281 |
| 2 " | 4″ × 3″ × 3/8″ | @ 8.45 × | 7.0 | = | 118 |
| 1 [ | 12″ × 3½″ | @ 26.1 × | 16.5 | = | 431 |
| 5 [s | " | @ " × | 6.5 | = | 848 |
| 2 brace. Ls | 3″ × 2½″ × 3/8 | @ 6.53 × | 16.0 | = | 209 |
| 3-12 4 " Ls | " | @ " × | 8.0 | = | 209 2096 |
| 3-9 Details say | 25% | | | = | 524 |
| | | | | | 2620 # |

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

**JIUN MASUDA**
CONSULTING ENGINEER
SEIYU BLDG, TOKIO

MADE BY K. Inaba DATE 3-12-16 **FILE NO**

CHECKED BY DATE **PAGE NO** 29

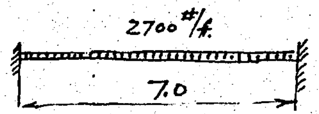
CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Design of Drum.

Radius of Drum = 8.93'
Total length of drum = 8.93 × 2 × 3.1416 = 56.1 ft.
Developed length of span = 56.1 ÷ 8 = 7.0 ft.
max. load on drum
Dead Load reaction on center support
main girder 144100
operating house say 10000
154100#
Live Load " " " = 77350
231450#

Dead Load moments & Shears.



Load on drum 154,100 ÷ 28.05 = 5,500#
weight of drum &c assumed 200
5,300# per lin ft. of drum

moment at center = $\frac{1}{24}$ × 5300 × $7^2$ = 10,800'#
moment at support = $\frac{1}{12}$ × 5300 × $7^2$ = 21,600'#
Shear " = $\frac{1}{2}$ × 5300 × 7 = 18,550#

Live Load moments & Shears.

Load on drum = 77,350 ÷ 28.05 = 2750# per lin ft. of drum
moment at center = $\frac{1}{24}$ × 2750 × $7^2$ = 5600'#
moment at Support = $\frac{1}{12}$ × 2750 × $7^2$ = 11,200'#
Shear " " = $\frac{1}{2}$ × 2750 × 7 = 9,630#

| Summary for moments & shears. | moment at support | moment at center | Shear at support. |
|---|---|---|---|
| Dead Load | 21,600 | 10,800 | 18,550 |
| Live Load. | 11,200 | 5,600 | 9,630 |
| 50% allowance for eccentric loading | 16,400 | 8,200 | 14,090 |
| | 49,200'# | 24600'# | 42,270# |

Section of drum.
assumed flange section
2Ls 150×150×19 = 16.56 − 4.5 = 12.06□" net.

Depth of drum 24"
use web pl. 24" × $\frac{1}{2}$ = 12.0□"
$\frac{1}{8}$ web area = $\frac{1}{8}$ × 12 = 1.5□"
effective depth = 24 − 3.3 = 20.7" = 1.72'
flange Stress = $\frac{49200}{1.72}$ = 28600# C or T.
flange area required = $\frac{28600}{17000}$ = 1.68□" net.

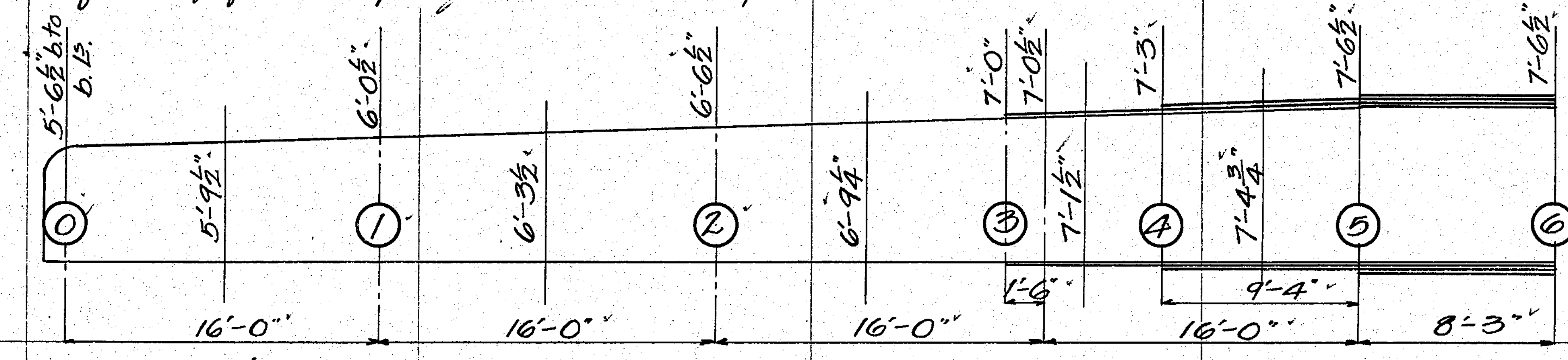
Approximate weight of Drum.

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 flange Ls | 150×150×19. | @ | 28.17 | × 56.1 = | 6,210 |
| 1 web pl. | 24" × $\frac{1}{2}$" | @ | 40.80 | × 56.1 = | 2,290 |
| 64 stiff. Ls. | 5" × $3\frac{1}{2}$" × 3/8" | @ | 10.37 | × 2.0 = | 1,328 |
| 16 fills | 7" × 5/8" | @ | 14.88 | × 1.0 = | 238 |
| 16 spl. Ls | 150×150×15 | @ | 22.55 | × 2.8 = | 1,010 |
| 8 pl. & pl/s | 12" × 3/8"<br>15" × $\frac{1}{2}$ | @<br>@ | 15.30<br>25.50 | × 1.5 =<br>× 56.1 = | 184<br>1,430 |
| Rivet heads & miscellaneous details | | | | | 440 |
| | | | | | 13130# |

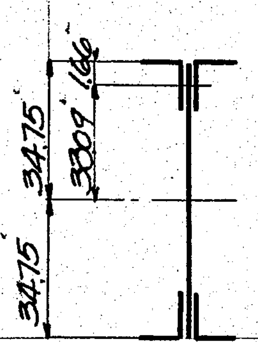
MADE BY J. Matano DATE 3-12-10 FILE NO
CHECKED BY M. Jinda DATE 3-12-12 PAGE NO 30

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.
Deflection of main girder at end Bearing.



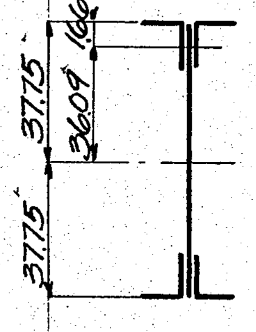
moment of inertia
at panel 1.



4 Ls. 150×150×15  26.51×33.09$^2$ +85.44 = 29,112.51
1 Pl. 69 × $\frac{7}{16}$  11,976.89
41,089.40 "$^4$
= 1.98 (m$^4$) = $I_1$

$\frac{bd^3}{12} = \frac{4375\times69^3}{12} = 11,976.89$

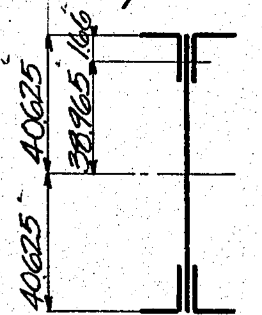
at panel 2



4 Ls. 150×150×15  26.51×36.09$^2$ +85.44 = 34,614.4
1 Pl. 75 × $\frac{7}{16}$  = 15,380.9
49,995.3
= 2.41 = $I_2$

$\frac{4375\times75^3}{12} = 15,380.9$

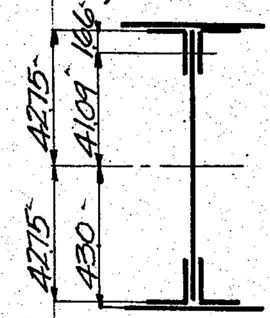
at panel 3.



4 Ls. 150×150×15  26.51×38.965$^2$ + 85.44 = 40,334.81
1 Pl. 80¾ × $\frac{7}{16}$  = 19,196.6
59,531.41
= 2.87 = $I_3$

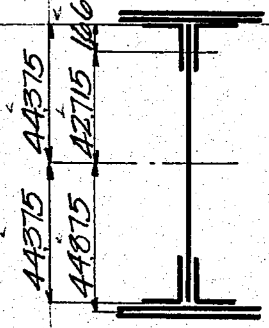
$\frac{4375\times80.75^3}{12} = 19,196.6$

at panel 4



2 Cov. Pls  13½ × ½  135×43$^2$  + 0.28  = 24,961.8
4 Ls.  do  26.51×41.09$^2$ + 85.44  = 44,844.6
1 Pl.  85 × $\frac{7}{16}$  = 22,390.0
92,196.4
= 4.45 = $I_4$

at panel 5.



4 cov. Pls.  do.  270×44.875$^2$ + 2.25  = 54,373.9
4 Ls.  do  26.51×42.72$^2$ +85.44  = 48,392.5
1 Pls.  88¼ × $\frac{7}{16}$  = 25,057.7
127,824.1
= 6.16 = $I_5$

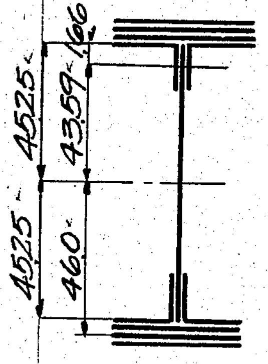
MADE BY J. Matano DATE 3-12-11 FILE NO.

CHECKED BY M. Jinda DATE 3-12-12 PAGE NO. 31

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

at panel 6



| | | | |
|---|---|---|---|
| 6 Cov. Pl/s | $13\frac{1}{2} \times \frac{1}{2}$ | $40.5 \times 46.0^2 + 38.0$ | $= 85,701.8$ |
| 4 Ls | $150 \times 150 \times 15$ | $26.51 \times 43.59^2 + 85.44$ | $= 50,456.7$ |
| 1 Pl. | $90 \times \frac{7}{16}$ | | $= 26,518.1$ |
| | | | $= 162,736.6$ |
| | | | $= 7.85 = I_6$ |

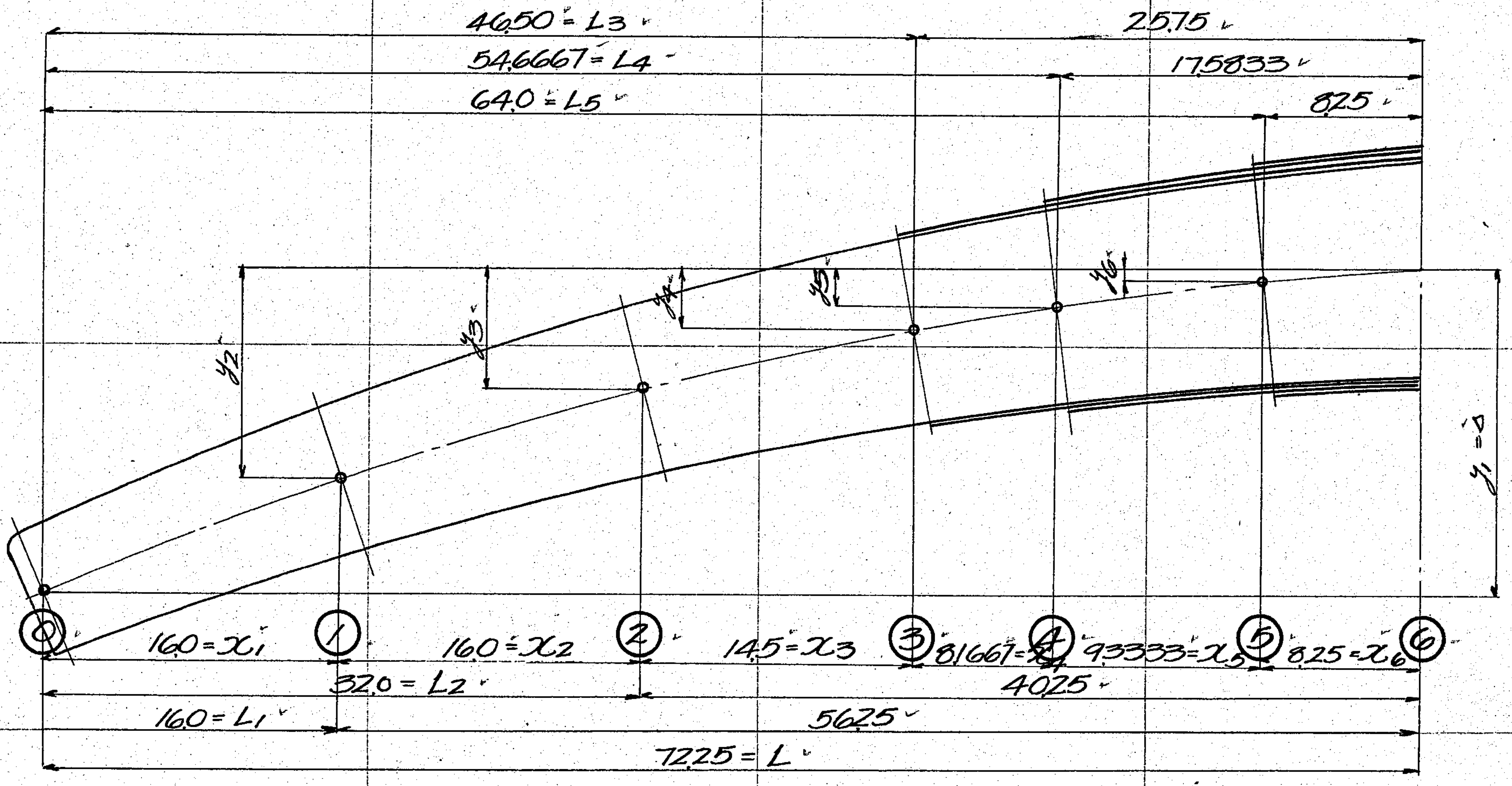
Dead Load. Floor system complete = 368.9 – 238.0 –
main girder 340.0
708.9 Call this 710# per lin ft of girder.

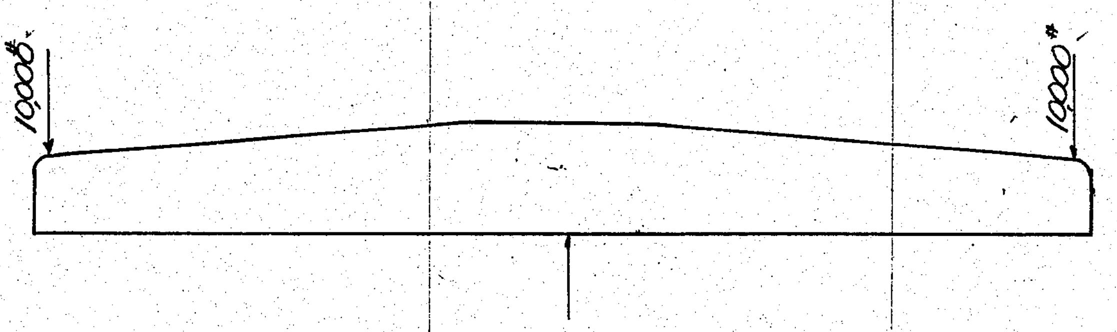
238
48.2

$$y_1 = \Delta = \frac{wl^4}{8EI_6} + \frac{w}{8E}\left[\frac{L_1^4}{I_1} - \frac{L_1^4}{I_2} + \frac{L_2^4}{I_2} - \frac{L_2^4}{I_3} + \frac{L_3^4}{I_3} - \frac{L_3^4}{I_4} + \frac{L_4^4}{I_4} - \frac{L_4^4}{I_5} + \frac{L_5^4}{I_5} - \frac{L_5^4}{I_6}\right]$$

$$= \frac{710 \times 72.25^4}{8 \times 30,000,000 \times 144 \times 7.85} + \frac{710}{8 \times 30,000,000 \times 144}\left[\frac{16^4}{1.98} - \frac{16^4}{2.41} + \frac{32^4}{2.41} - \frac{32^4}{2.87} + \frac{46.5^4}{2.87} - \frac{46.5^4}{4.45} + \frac{54.6667^4}{4.45} - \frac{54.6667^4}{6.16} + \frac{64^4}{6.16} - \frac{64^4}{7.85}\right] = 0.10824$$

$= 1\frac{5}{16}$" ..... Dead load deflection at end of girder.





$$y_1 = \Delta = \frac{PL^3}{3EI_6} + \frac{P}{3E}\left[\frac{L_1^3}{I_1} - \frac{L_1^3}{I_2} + \frac{L_2^3}{I_2} - \frac{L_2^3}{I_3} + \frac{L_3^3}{I_3} - \frac{L_3^3}{I_4} + \frac{L_4^3}{I_4} - \frac{L_4^3}{I_5} + \frac{L_5^3}{I_5} - \frac{L_5^3}{I_6}\right]$$

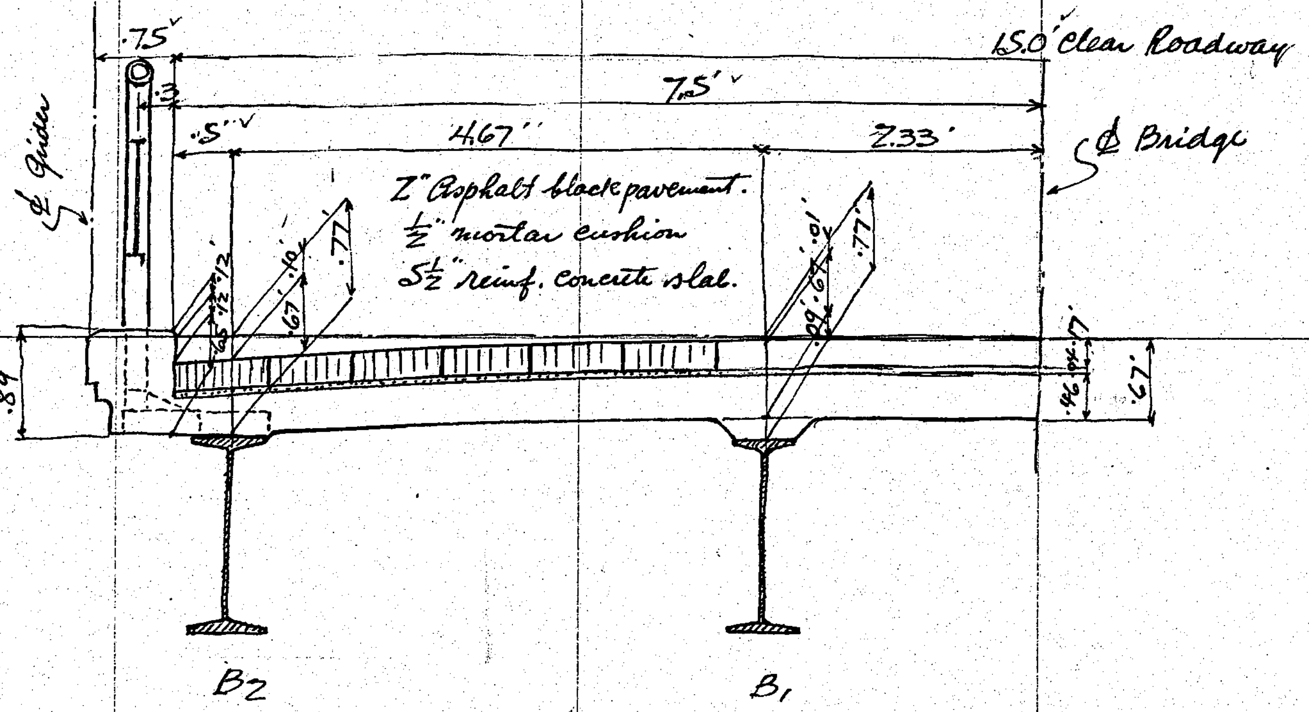
$$= \frac{10,000 \times 72.25^3}{3 \times 30,000,000 \times 7.85 \times 144} + \frac{10,000}{144 \times 3 \times 30,000,000}\left[\frac{16^3}{1.98} - \frac{16^3}{2.41} + \frac{32^3}{2.41} - \frac{32^3}{2.87} + \frac{46.5^3}{2.87} - \frac{46.5^3}{4.45} - \frac{54.6667^3}{4.45} - \frac{54.6667^3}{6.16} + \frac{64^3}{6.16} - \frac{64^3}{7.85}\right] = 0.05966' = \frac{23}{32}"$$

..... Deflection at end due to 10,000# load at end.

amount of uplift for 4200# reaction $= 0.42 \times \frac{23}{32} = \frac{19}{64}$"

Karunojima Swing Bridge for City of Kobe.

Design of Approach Beam span. Span length = 31'6"
Cross Section of Bridge as shown on sketch below.



Design of Floor Slab. span length = 4'-8" or 4.67'
Dead Load.

2" Asphalt block pavement @ 130/12 = 21.7
½" Cement mortar cushion @ 110/12 = 4.6
5½" Reinforced conc. floor slab @ 150/12 = 68.7
95.0 #/□' Call this 100 #/□' of road surface.

Dead Load moment = $\frac{1}{10} \times 100 \times 4.67^2$ = 218 '#
End Shear = $\frac{1}{2} \times 100 \times 4.67$ = 234 #

Live Load. motor truck rear wheel concentration
Impact coefficient = $\frac{20}{60+l} = \frac{20}{60+\frac{4.67}{3.28}}$ = 32.5% use 30% impact.

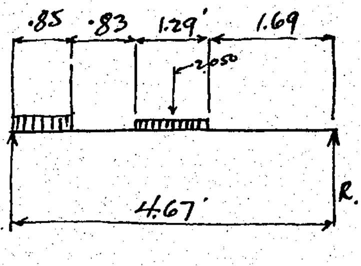
Rear wheel concentration = 6600
impact 30% = 1,980
8580 Call this 8,600 #

Front wheel concentration with impact
= $\frac{1}{3} \times 8600$ = 2870 call this 2,900 #

Uniform load on roadway = 125 #/□'

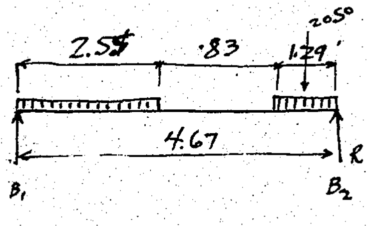
Distribution of wheel concentration
Contact Surface between wheel and pavement = 0.66'
2" pavement and ½" cushion 2×0.21 = 0.42
Longitudinal distribution a = 1.08'
Transverse " b = 0.87+0.42 = 1.29'

Effective width of floor slab = $\frac{2}{3}l + a = \frac{2}{3} \times 4.67 + 1.08$ = 4.20'
motor truck rear wheel = 8600 ÷ 4.2 = 2,050 # per ft. strip of slab.
" " front wheel = 2900 ÷ 4.2 = 690 #



Reaction R = $2050 \times \frac{1}{2}$ = 1,025
$\frac{125 \times .85^2}{2 \times 4.67}$ = 10
1,035 #

moment = 1,035 × 2.335 = 2,415
$\frac{2050}{2} \times .32$ = − 328
2,087 '#



for continuity of slab, moment = 0.8 × 2087 = 1,670 '#
End Shear 2050 × 4.02 ÷ 4.67 = 1,763
$\frac{125 \times 2.55^2}{2 \times 4.67}$ = 87
1,850 #.

Summary for moments and shears
Dead Load moment 218 Shear 234
Live Load " 1,670 " 1,850
1,888 '# 2,084 #

# Karumojima Swing Bridge for City of Kobe.

Effective depth of slab required $= \sqrt{\frac{m}{R}}$ where $R = 102.$

$$= \sqrt{\frac{1888 \times 12}{12 \times 102}} = 4.3''$$

Use $5\frac{1}{2}''$ over all with 1" insulation at bottom.

Steel area required. $= \frac{1888 \times 12}{17000 \times \frac{7}{8} \times 4.5} = .338\square''$ per ft. strip

Use $2 - \frac{1}{2}''\phi$ bars $= .393\square''$ per ft. strip.

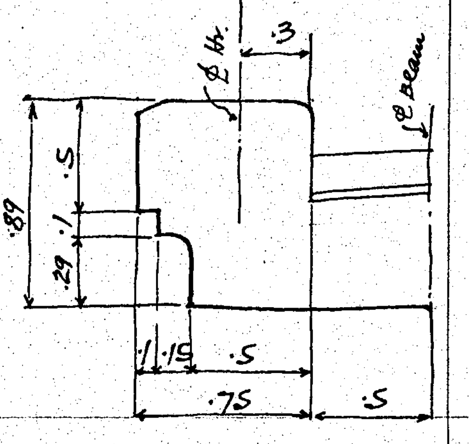
Unit shear $= \frac{2084}{12 \times \frac{7}{8} \times 4.5} = 44.1 \#/\square''$ ok.

perimeter of bars required for bond stress $= \frac{2084}{85 \times \frac{7}{8} \times 4.5} = 6.22''$ unit bond for plain bar $= 85\#/\square''$

$2 - \frac{1}{2}''\phi$ main bars perimeter $= 2 @ 1.571 = 3.142''$
$2 - \frac{1}{2}''\phi$ bond bars " = " " $= 3.142$
total perimeter $= 6.284''$

Unit bond $= \frac{2084}{6.284 \times \frac{7}{8} \times 4.5} = 84\#/\square''$ ok.

Cantilever slab.
Dead Load.

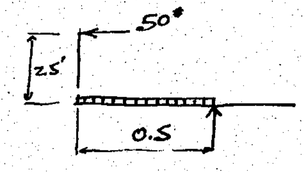


Dead Load moment.

| | | | |
|---|---|---|---|
| Asphalt block pavement | $21.7 \times 0.5 =$ | $10.9 \times 0.25 =$ | 2.7 |
| mortar cushion | $4.6 \times 0.5 =$ | $2.3 \times 0.25 =$ | 0.6 |
| Slab. | $68.7 \times 0.5 =$ | $34.4 \times 0.25 =$ | 8.6 |
| Coping | $.5 \times .75 \times 150 =$ | $56.2 \times 0.88 =$ | 49.5 |
| [illegible] | $.1 \times .65 \times 150 =$ | $9.8 \times 0.88 =$ | 8.1 |
| " | $.29 \times .5 \times 150 =$ | $21.7 \times 0.75 =$ | 16.3 |
| handrail | assumed | $20.0 \times 0.80 =$ | 16.0 |
| | | $155.3 \times .655 =$ | $101.8'\#$ |

Dead Load moment $= 102.'\#$
Dead Load shear $= 155\#$

Live Load.



moment $= \frac{1}{2} \times 125 \times 0.5^2 = 16'\#$
Shear $= 125 \times 0.5 = 63\#$
live load on handrail 50# per lin ft. horizontal.
moment $= 50 \times 2.5 = 125'\#$

Summary for Moments and Shears.

| | Moment | Shear. |
|---|---|---|
| Dead Load ~~mom~~ | 102 | 155 |
| Live Load on floor | 16 | 63 |
| " on handrail | 125 | — |
| | $243'\#$ | $218\#$ |

Steel area required $= \frac{243 \times 12}{17000 \times \frac{7}{8} \times 4.5} = .044\square''$ per ft strip.

Use $1 - \frac{1}{2}''\phi$ bar $= 0.196\square''$

Design of Main Beam B1. Span length $= 31.5'$ spacing $4.67'$
Dead Load.

| | | |
|---|---|---|
| Floor | $4.67 @ 100 =$ | 467. |
| main beam assumed | | 100 |
| | | 567 Call this 570# per lin ft of beam. |

Dead Load moment $= \frac{1}{8} \times 570 \times 31.5^2 = 70750'\#$
" end shear $= \frac{1}{2} \times 570 \times 31.5 = 8,980\#$

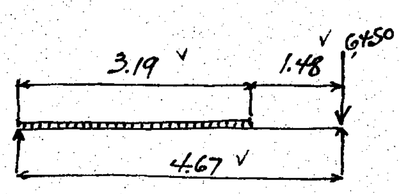
MADE BY K. Inaba DATE 3-12-17 FILE NO
CHECKED BY DATE PAGE NO 34

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Live Load

Max. load on Beam B1.



Motor truck wheels.

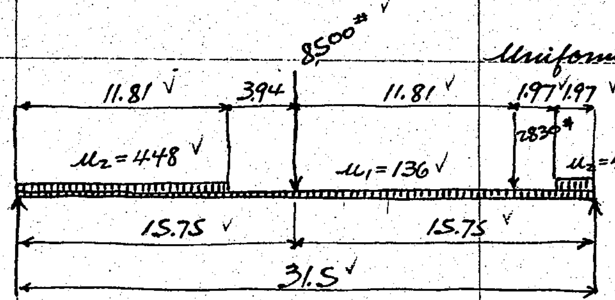
Impact coefficient = $\frac{20}{60+l} = \frac{20}{60+\frac{31.5}{3.28}} = 28.7\%$.

Rear wheel concentration 6600
28.7% impact 1,895
8,495 Call this 8,500#

Front wheel concentration with impact $8500 \times \frac{1}{3} = 2830$#

Uniform load on side of truck $w_1 = \frac{125 \times 3.19^2}{2 \times 4.67} = 136$# per lin ft.

Uniform load rear and front of truck $125 \times 4.67 = 584$
less 136
$w_2$ = 448# per lin ft

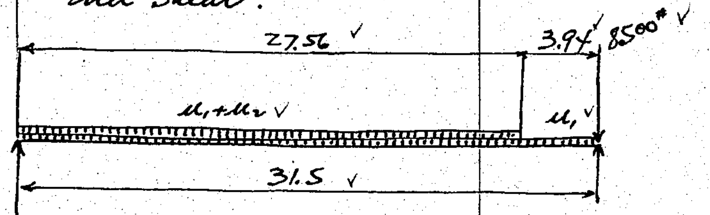


moment.
motor truck $4604 \times 15.75 =$ 72,500
Unif. load $w_1$ $\frac{1}{8} \times 136 \times 31.5^2 =$ 16,870
" " $w_2$ $4,330 \times 15.75 =$ 68,200
less $448 \times 11.81 \times 9.85 = -$ 52,170
105,400'#

Reaction Rear wheel $8500 \div 2 = 4250$
Front " $\frac{2830 \times 3.94}{31.5} = \underline{354}$
4,604#

Uniform load $w_2$
$448 \times 11.81 \times 25.59 = 135500$
$448 \times 1.97 \times 0.99 = \underline{870}$
$136370 \div 31.5 = 4330$#

End Shear.



Rear wheel of motor truck 8,500
Uniform load $w_1$ $136 \times 15.75 =$ 2,140
" " $w_2$ $\frac{448 \times 27.56^2}{2 \times 31.5} =$ 5400
16,040#.

Summary for moments and shears.

| | moment | Shear |
|---|---|---|
| Dead Load. | 70750 | 8980 |
| Live Load. | 105400 | 16,040 |
| | 176,150'# | 25,020# |

Section modulus required = $\frac{176150 \times 12}{15600} = 135.5''^3$

Use 1 I $20'' \times 7\frac{1}{2}''$ @ 88.96# Sm. = $167.13''^3$

Unit Stress = $\frac{176150 \times 12}{167.13} = 12650$ #/□" ok

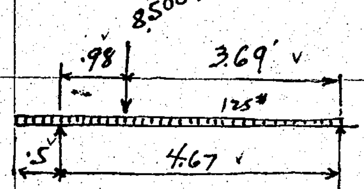
Unit Shear = $\frac{25020}{0.6 \times 20} = 2085$ #/□" ok.

Design of Outside main Beam B2. span length = 31.5' spacing 4.67'

Dead Load. Taking moment at B1. see page 32.
Floor between Beams $100 \times 4.67 \times 2.33 =$ 1,088
Floor coping H.R. &c outside $155.3 \times (4.67 + .655) =$ 827
$1,915 \div 4.67 = 410$# per lin. ft.
beam assumed 100
510

Dead Load moment $= \frac{1}{8} \times 510 \times 31.5^2 = 63200$'#
" Shear $= \frac{1}{2} \times 510 \times 31.5 = 8030$#

Live Load Transverse distribution of motor truck wheels.



Load on Beam. $\frac{8500 \times 3.69}{4.67} = 6720$#

front wheel $6720 \div 3 = 2240$#

Uniform load $\frac{125 \times 5.17 \times 2.58}{4.67} = 357$# per ft. of span.

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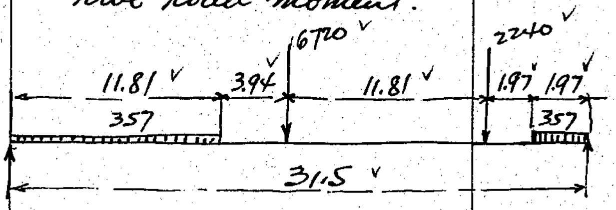
MADE BY K. Inaba DATE 3-12-17 FILE NO

CHECKED BY DATE PAGE NO 35

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Live Load moment.



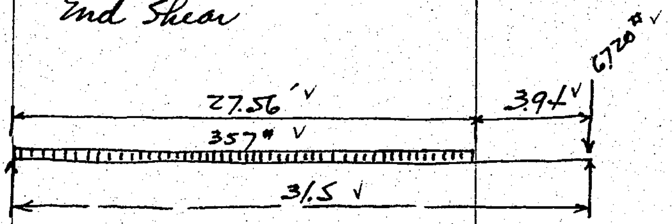
Reaction

Rear wheel. 6,720 × 15.75 = 105,800
front wheel 2,240 × 3.94 = 8830
114,630 ÷ 31.5 = 3,640 #

Uniform load 357 × 11.81 × 25.59 = 108,000
357 × 1.97 × .98 = 700
108,700 ÷ 31.5 = 3,450 #.

Moment
motor truck 3,640 × 15.75 = 57,300
unif. load. 3450 × 15.75 = 54,300
357 × 11.81 × 9.85 = −41,500
70,100 '#

End Shear



Uniform load. $\frac{357 \times 27.56^2}{2 \times 31.5} = 4310$ #

motor truck rear wheel = 6720
11,030 #

Summary for moments and shears.

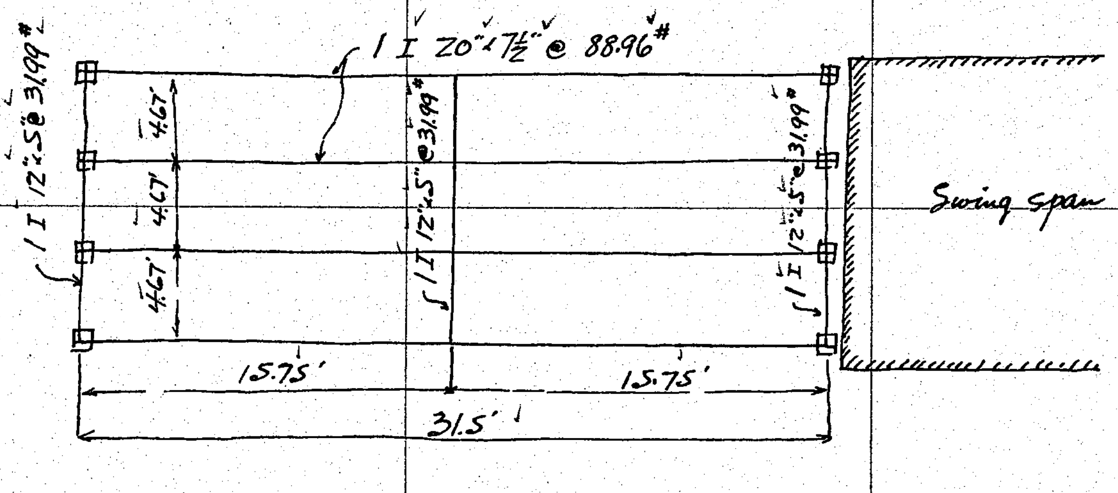
| | moment | Shear |
|---|---|---|
| Dead Load | 63,200 | 8030 |
| Live Load. | 70,100 | 11,030 |
| | 133,300 '# | 19,060 # |

Section modulus required = $\frac{133300 \times 12}{15600} = 102.5$ "3

Use I beam 20" × 7½" @ 88.96# Sm. = 167.13 "3

unit stress = $\frac{133300 \times 12}{167.13} = 9570$ #/○" ok

unit Shear = $\frac{19060}{20 \times 0.6} = 1590$ #/○" ok.



Approximate weight of steel for Approach span Z required.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| main beams | 4 Is | 20" × 7½" | @ | 88.96 | × | 32.5 | = | 11,560 # |
| Cross beams | 9 Is | 12" × 5" | @ | 31.99 | × | 4.67 | = | 1,333 |
| Connections | 36 Ls | 75 × 75 × 9 | @ | 6.69 | × | .75 | = | 181 |
| handrail conn. | 28 Ls | 75 × 75 × 9 | @ | 6.69 | × | 1.20 | = | 225 |
| Shoes | 14 8 p/s. | 6" × 3/8" @ 60# | @ | 7.65 | × | 0.8 | = | 86 480 |
| | Rivet heads and variations say | | | | | | = | 165 |
| | | | | | | | | 14,030 # or 6.27 tons. |

MADE BY K. Inaba DATE 3-12-17 FILE NO

CHECKED BY DATE PAGE NO 36

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Summary for Steel.

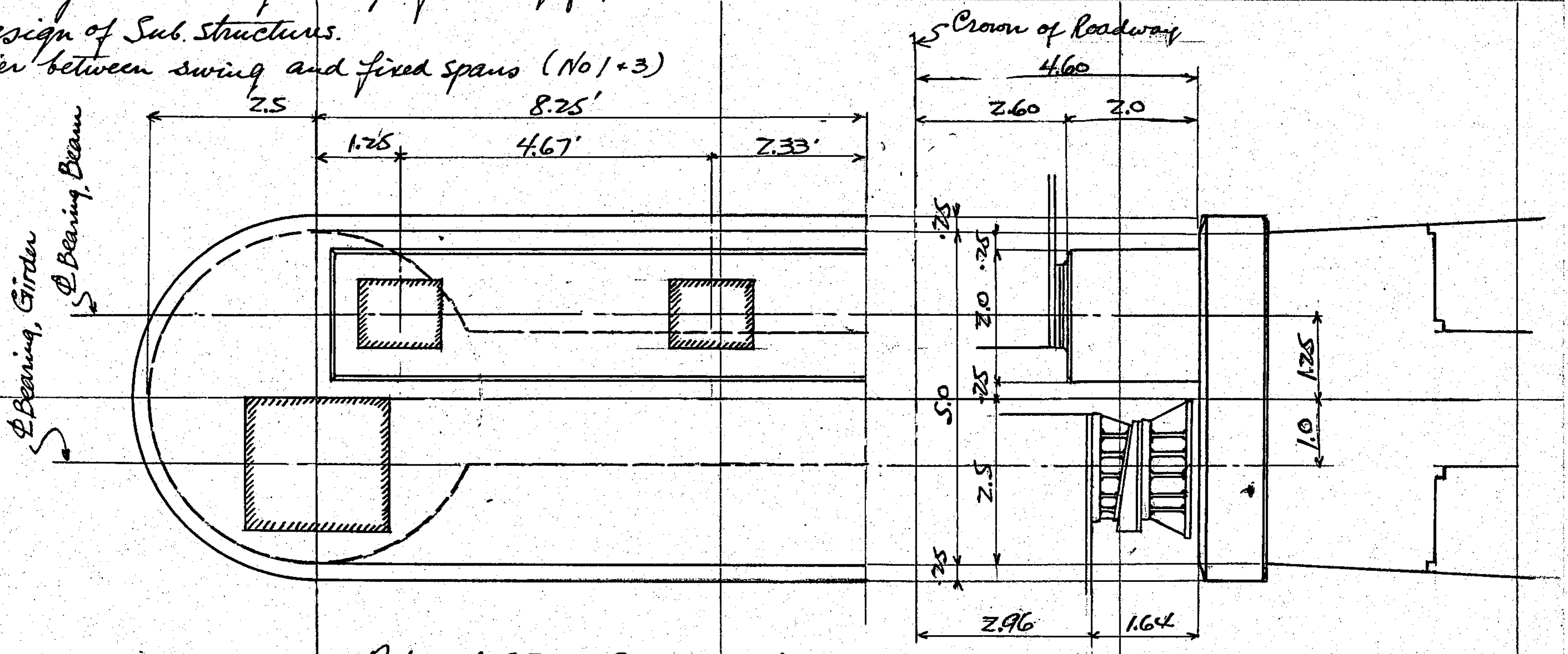
Swing Span.

| | | | | |
|---|---|---|---|---|
| Stringers | | 32,400# = | 14.470 tons. | |
| Lateral Bracings | 8 @ 805 = | 6,440 = | 2.880 | |
| Do for center panel. | 1 @ 825 = | 825 = | 0.370 | |
| Floor Beams. | 8 @ 1,130 = | 9,040 = | 4.040 | |
| Do on the drum. | 2 @ 3,080 = | 6,160 = | 2.750 | |
| Cantilever Brackets for operating house. | 2 @ 695 = | 1,390 = | 0.620 | |
| Lateral Bracing between Brackets | | 215 = | 0.096 | |
| Struts between ends of Brackets. | | 440 = | 0.196 | |
| Operating house, floor + framing | | 2,640 = | 1.170 | |
| main Girders | 2 @ 49,460 = | 98,920 = | 44.200 | |
| Stays | 2 @ 350 = | 700 = | 0.313 | |
| Do | 2 @ 500 = | 1000 = | 0.446 | |
| Drum | | 13,130 = | 5.860 | |
| | | | | 77.411 tons |
| Approach Beam spans. | 2 spans @ | 6.27 tons | = | 12.540" |
| | | | | 89.951 tons |
| Handrail | 32.5 × 4 = 130' @ 20# = | 2600# or = | | 1.160 |
| | | | | 91.111 tons. |
| Expansion joints, steel | say 4 @ 0.3 = | | | 1.200 |
| | | | | 92.311 tons. |

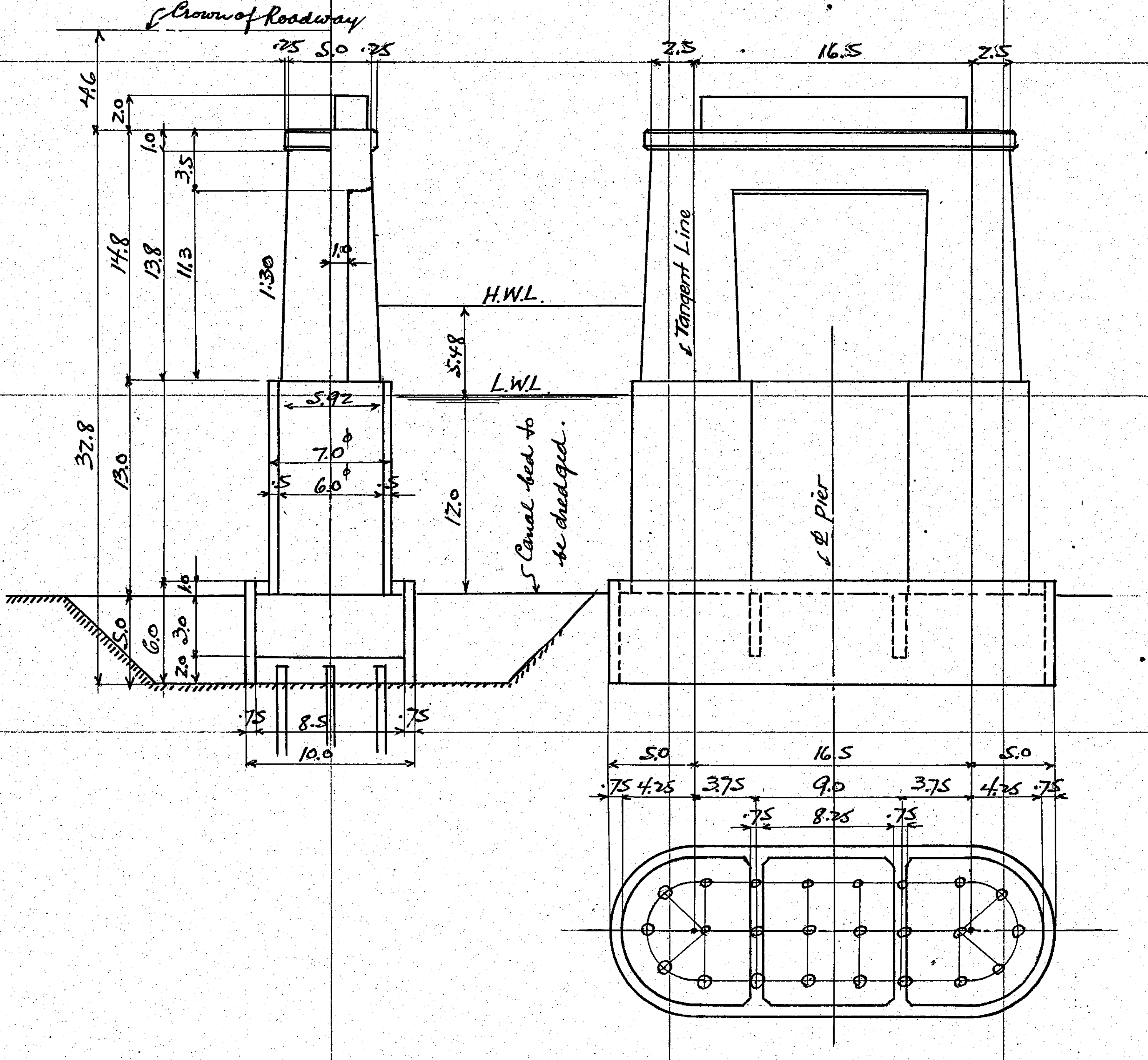
Karumojima Swing Bridge for City of Kobe.

Design of Sub. structures.

Pier between swing and fixed spans (No 1+3)



Detail for Top of Pier Scale 1:30



Sketch for Piers nos. 1 + 3.
Scale 1: 100.

**JIUN MASUDA**
CONSULTIEG ENGINEER
JIJI BLDG, TOKYO

MADE BY K. Inaba DATE 3-12-18 FILE NO
CHECKED BY DATE PAGE NO 38

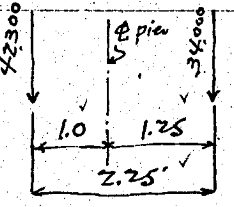
CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Super imposed Loads on pier.

| | Swing span | fixed span. | |
|---|---|---|---|
| Dead Load. | 2 @ 21145 = 42,300 | 2 @ 8980 = 17960<br>2 @ 8030 = 16,060<br>say 34,000 | Inside Beams B1.<br>Out side " B2 |
| Live Load. | 2 @ 36520 = 73,000<br>115,300# | 2 @ 16040 = 32,080<br>2 @ 11030 = 22,060<br>say 54100<br>88,100# | |

Center of gravity of Dead Loads.



$2.25 \times \frac{34000}{42300+34000} = 1.0'$

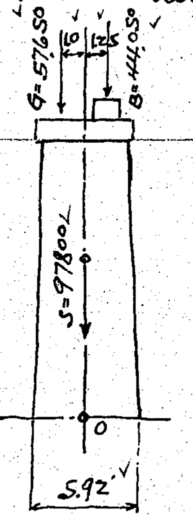
Design of shaft.

Concrete.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Base of Beams. | 2.0 × 2.0 × 16.0 = | 64.0 | @ 150 = | 9600 | × | 15.8 = | 151,700 |
| Coping | 5.5 × 1.0 × 16.5 = | 90.8 | @ " = | 13,630 | × | 14.3 = | 195,000 |
| " ends. | 5.5$^{\phi}$ × 1.0 = | 23.8 | @ " = | 3,570 | × | 14.3 = | 51,000 |
| Shaft | 5.46 × 16.5 × 13.8 = | 1243.0 | @ " = | 186,500 | × | 6.7 = | 1249,500 |
| " ends. | 5.46$^{\phi}$ × 13.8 = | 323.2 | @ " = | 48,500 | × | 6.52 = | 316,000 |
| depression, less | 3.55 × 11.3 × 11. = | − 441.0 | @ " = | − 66,700 | × | 5.45 = | − 360,500 |
| | | 1303.8 cub.ft<br>(6.04 立坪) | | 195,600# | × | 8.2 = | 1,602,700 |

Columns 2 × 7.0$^{\phi}$ × 13.0 = 1,000.0 cub.ft @ 150 = 150,000# arm 6.5'
(4.63 立坪)

Case 1. Stability at normal state.



Taking moment about pt. 0

G = 57,650# × 1.0 = + 57650
B = 44,050 × 1.25 = − 55100
S = 97,800 × 0.0 = 0

199,500# 2,550'#

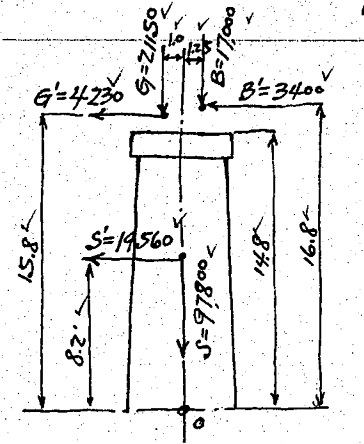
moment of inertia of bottom section 5.92' dia. (Steel neglected).

$0.0491 d^4 = 0.0491 \times 5.92^4 = 60.4^{\text{c.f.t}}$

Area of bottom Section = 27.53□'

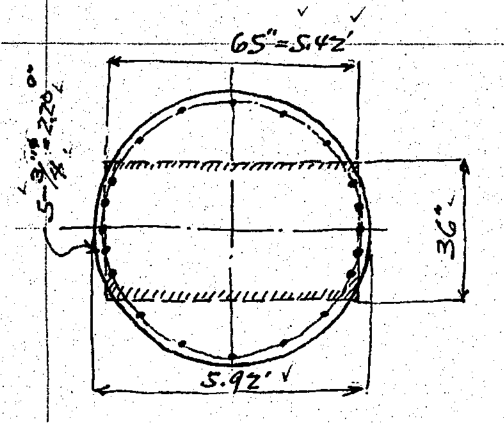
max fibre stress = $\frac{199500}{27.53} \pm \frac{2550 \times 2.96}{60.4} = 7250 \pm 125 = 7400$ #/□' = 51.4 #/□" c o/c
or 7,100 " = 49.3 " " ok.

Case 2. Stability during earthquake k assumed 0.20



Taking moment about point O.

| Loads. | Vert. forces | Hor. forces. | | lev. arms | moments |
|---|---|---|---|---|---|
| G | 21,150 | | × | 1.0 | 21,150 |
| G' | | 4,230 | × | 15.8 | 66,800 |
| B | 17,000 | | × | − 1.25 | − 21,250 |
| B' | | 3,400 | × | 16.8 | 57,100 |
| S | 97,800 | | × | 0 | 0 |
| S' | | 19,560 | × | 8.2 | 160,500 |
| | ΣV = 135,950# | ΣH = 27,190# | × | 2.09' | ΣM = 284,300'# |



For the sake of simple calculation, let us assume the bottom section to be 36" × 65" rectangular column.

Steel ratio $p_0 = 2p = \frac{2.20 \times 2}{36 \times 65} = 0.0019$

$d'/h = 3/65 = 0.046$ $\quad e/h = 2.09' \div 5.42' = 0.385$

$k = .50$ , $L = .095$ from the prepared diagrams.

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

$$f_c = \frac{M}{Lbh^2} = \frac{284300 \times 12}{0.095 \times 36 \times 65^2} = 236 \text{ \#/□" ok}$$

$$f_s = n f_c \left(\frac{d}{kh} - 1\right) = 15 \times 2\overset{3}{4}6 \left(\frac{62}{.50 \times 65} - 1\right) = 3240 \text{ \#/□" ok.}$$

Section at Bottom of Column.

Case 1. Stability at normal state.

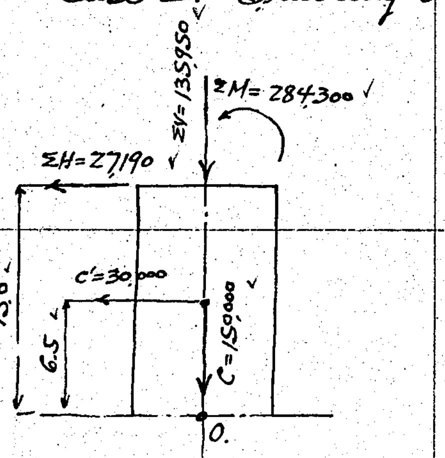
| | | | |
|---|---|---|---|
| Vertical load on column | = 199,500# | | moment = 2,550'# |
| weight of column | = 150,000 | | |
| | 349,500# | | |

moment of inertia of column section = $0.0491 \times 7^4 = 118''''$ (Steel neglected)

Area of section = 38.48 □'

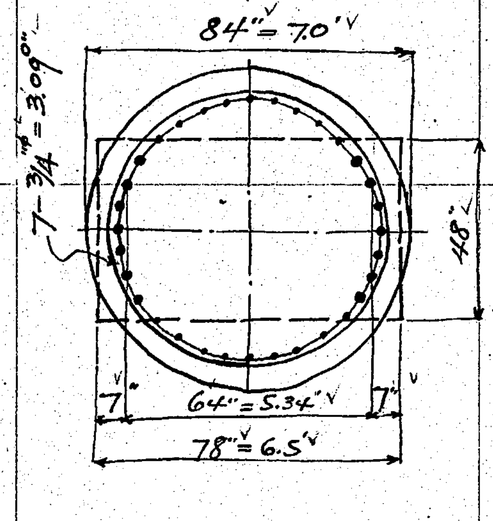
max. fibre stress = $\frac{349{,}500}{38.48} \pm \frac{2550 \times 3.5}{118} = 9{,}080 \pm 71$ = 9151 #/□' or 63.5 #/□" c ok
or = 9009 ″ or 63.1 ″ c ″

Case 2. Stability during earthquake. $k = 0.2$



Taking moment about 0.

| Loads. | vert. forces | Hor. forces. | lev. arm | moment. |
|---|---|---|---|---|
| ΣV | 135,950 | | × 0 = | 0 |
| ΣH | | 27,190 | × 13.0 = | 353,300 |
| ΣM | | | = | 284,300 |
| C | 150,000 | | × 0 = | 0 |
| C' | | 30,000 | × 6.5 = | 195,000 |
| | ΣV= 285,950# | ΣH= 57,190# | ×2.91 ΣM= | 832,600 |



Column Assumed 78" × 48" rectangular section.

Steel ratio $p_0 = 2p = \frac{3.09 \times 2}{48 \times 78} = .0017$

$d'/h = 7/78 = 0.09$ $\quad \varepsilon/h = 2.91/6.5 = 0.45$

From the prepared diagrams.

$K = .402$, $L = 0.084$

$$f_c = \frac{832{,}600 \times 12}{.084 \times 48 \times 78^2} = 407 \text{ \#/□" ok}$$

$$f_s = 15 \times 407 \left(\frac{71}{.402 \times 78} - 1\right) = 7770 \text{ \#/□" ok}$$

$$\text{Unit Shear} = \frac{57{,}190}{48 \times \frac{7}{8} \times 78} = 17.5 \text{ \#/□" ok}$$

$$\text{Unit bond} = \frac{57190}{2.36 \times 7 \times \frac{7}{8} \times 78} = 50.7 \text{ \#/□" ok.}$$

Base

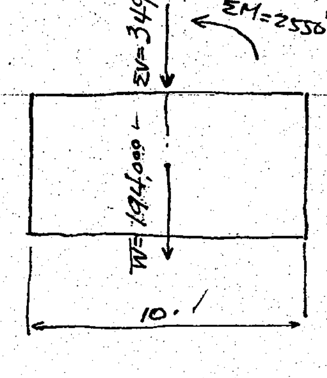
| | | | |
|---|---|---|---|
| Concrete | 10 × 5 × 16.5 | = | 825 |
| ends | $10^{\phi} \times 5.0$ | = | 393 |
| top of well | .75 × 1.0 × 16.5 × 2 | = | 25 |
| ends | .75 × 1.0 × 9.25ϕ | = | 50 |
| | | | 1,293 cub.ft. @ 150 = 194,000# |
| | | | (6.0立坪) |

total concrete for pier

| | |
|---|---|
| Shaft | 6.04 |
| column | 4.63 |
| base | 6.00 |
| | 16.67 立坪. |

Stability of Pier

Case 1. Stability at normal state.



| | | |
|---|---|---|
| Vertical load on Base | = | 349,500# |
| Weight of Base | = | 194000 |
| | | 543,500# |

moment = 2550'#

$$\text{Eccentricity } \varepsilon = \frac{2550}{543500} = 0.047$$

Area of Base = $16.5 \times 10 = 165$
$10'^{\phi} = 79$
$244$ □'

$$\text{max. toe pressure} = \frac{543{,}500}{244}\left(1 \pm \frac{6 \times 0.047}{10}\right) = 2,290 \text{ \#/□' or } 1.07 \text{ tons/□'}$$
$$= 2,160 \quad ″ \qquad 0.96 \quad ″$$

max. load on one pile = $1.07 \times 3 \times 3 = 9.2$ tons.

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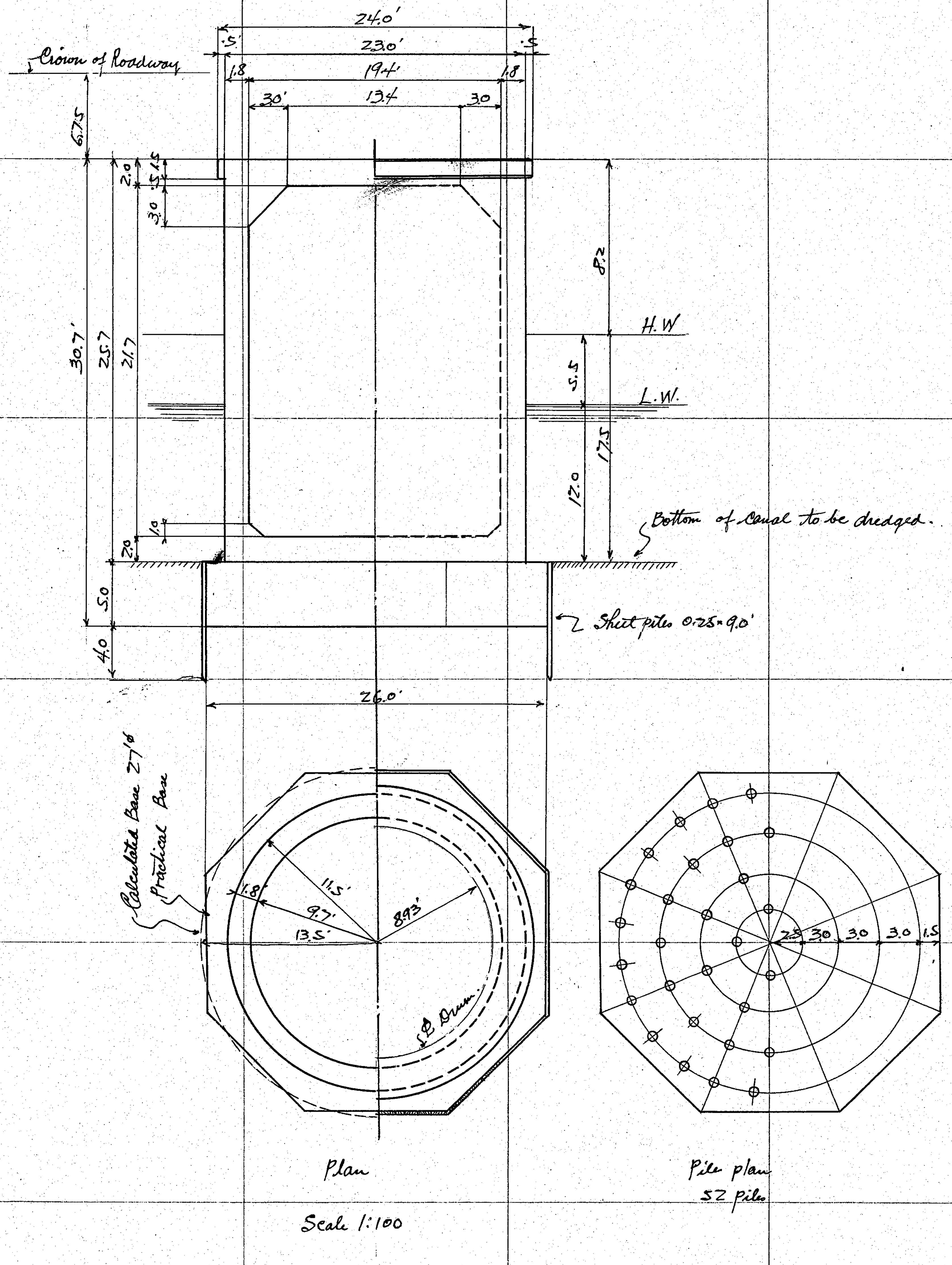
CHECKED BY DATE PAGE NO 40

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Design of Center pier (No.2)

Main Dimensions of Pier as shown on sketch below.



Scale 1:100

MADE BY K. Inaba DATE 3-12-22 FILE NO
CHECKED BY M. J. DATE 4-1-20 PAGE NO 41

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

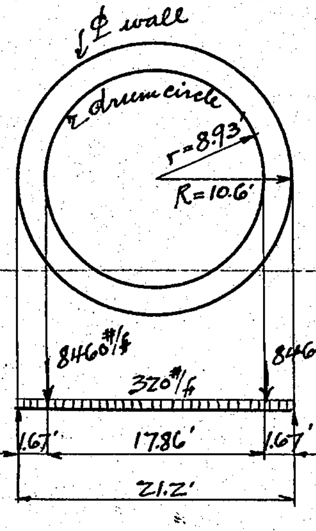
Design of Top slab.

21.2' diameter c to c of walls.
Slab thickness assumed 2.0'

| | | |
|---|---|---|
| Dead Load | = 2 @ 150 = | 300 |
| center pivot &c | say | 20 |
| | | 320# per sq. ft. of slab. |

Super imposed load from drum.

| | | | |
|---|---|---|---|
| Dead Load from main girder | 2 @ 144,100 = | 288,200 | |
| " operating house | say | 10,000 | |
| " Drum, rollers &c | say | 21,800 | Live load. |
| | | 320,000 | # + 155000 = 475000# |



Load per lin ft. of drum circle = $\frac{475,000}{8.93 \times 3.142 \times 2} = 8,460^{\#}$

Bearing power of sand fill under the slab neglected for safe side.
Refering to American Civil Engineering Pocket Book on page 313.
Considering the slab as simply supported around its circumference.

$R$ = the radius of slab = 10.6'
$w$ = Uniform load on slab on sq. unit of area = 320#/□
$r$ = the radius of drum circle = 8.93'
$W$ = load from roller per linear unit of drum circle = 8460#/lin. ft.

Total load on slab = $w\pi R^2 + 2W\pi r$

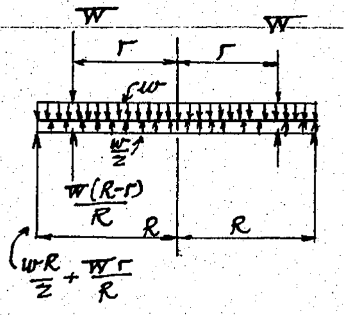
Reaction per linear unit = $\frac{w\pi R^2 + 2W\pi r}{2\pi R} = \frac{wR}{2} + \frac{Wr}{R}$

Consider a strip with a unit width to be cut out of slab, center line Coinciding with the diameter of slab, the reaction at each end of strip is $\frac{wR}{2} + \frac{Wr}{R}$

The load on strip is $2wR + 2W$ so that

a load $2wR + 2W - \left(\frac{wR}{2} + \frac{Wr}{R}\right) \times 2 = 2wR + 2W - wR - \frac{2Wr}{R}$

$$= wR + \frac{2W(R-r)}{R}$$



must act along the side to maintain the equilibrium, or a $\frac{wR}{2} + \frac{W(R-r)}{R}$ along each side.

Taking moment at center of this imaginary strip.

$$M = \left(\frac{wR}{2} + \frac{Wr}{R}\right)R + \frac{W(R-r)}{R} \times r + \frac{w}{2} \cdot \frac{R^2}{2} - Wr - \frac{wR^2}{2}$$

$$= \frac{wR^2}{2} + Wr + Wr - \frac{Wr^2}{R} + \frac{wR^2}{4} - Wr - \frac{wR^2}{2}$$

$$= Wr - \frac{Wr^2}{R} + \frac{wR^2}{4}$$

$$= Wr\left(1 - \frac{r}{R}\right) + \frac{wR^2}{4} \quad = \text{apparent moment.}$$

If a second strip be taken at right angle to the first strip another moment will be obtained equal in value to the moment in first strip. Calling the true unit stress $St$. its value on each side of slab will be

$St = S - pS.$
where $p$ = factor of lateral contraction = 0.2 for concrete
(see Merriman's Mechanics of materials P361)
or $St = S - 0.2S = 0.8S$

Stresses are proportional to the moment at that point so the true moment can be taken 80% of apparent moment.

$$M_t = 0.8\left[Wr\left(1 - \frac{r}{R}\right) + \frac{wR^2}{4}\right]$$

Substituting numerical values for each terms

$$M_t = 0.8\left[8,460 \times 8.93\left(1 - \frac{8.93}{10.6}\right) + \frac{320 \times 10.6^2}{4}\right] = 0.8(11940 + 9000) = 16,700^{\prime\#}/\text{ft strip.}$$

Moment as a continuous slab = $16700 \times 0.8 = 13,350^{\prime\#}$

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CHECKED BY M.J. DATE 4-1-20 **PAGE NO** 42

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

End Shear = Reaction = $\frac{wR}{2} + \frac{Wr}{R} = \frac{320 \times 10.6}{2} + \frac{8460 \times 8.93}{10.6} = 8830^{\#}$ per lin ft.

Shear under drum circle = $W + \frac{w\pi r^2}{2\pi r} = W + \frac{wr}{2} = 8460 + \frac{320 \times 8.93}{2} = 9890^{\#}$ per lin ft.

Effective depth req'd = $\sqrt{\frac{13350 \times 12}{12 \times 102}} = 11.5''$ Use 24" depth over all with 2" insulation.

Steel area required = $\frac{13350 \times 12}{17000 \times \frac{7}{8} \times 22} = 0.49\,\square''$

Use 5/8"φ bars 6" c to c = $0.614\,\square''$ on both directions on both sides.

Unit shear at end support = $\frac{8830}{12 \times \frac{7}{8} \times 57} = 15\,\#/\square''$ ok.

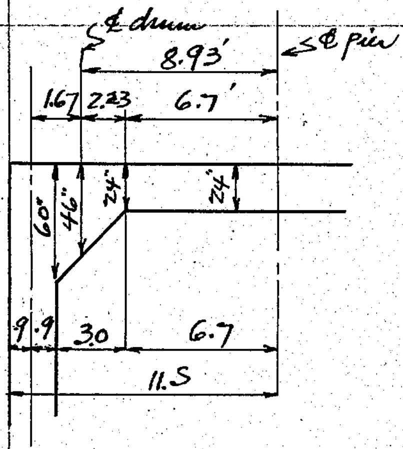
Unit shear at drum circle = $\frac{9890}{12 \times \frac{7}{8} \times 43} = 22\,\#/\square''$ ok

Unit bond " " = $\frac{9890}{3.93 \times \frac{7}{8} \times 43} = 67\,\#/\square''$ ok

Shear at end of fillet = $\frac{320 \times 6.7}{2} = 1070^{\#}$ per lin ft.

Unit Shear " " = $\frac{1070}{12 \times \frac{7}{8} \times 22} = 4.6\,\#/\square''$ ok

Unit bond " " = $\frac{1070}{3.93 \times \frac{7}{8} \times 22} = 14\,\#/\square''$ ok.



Design of Shell.

Internal pressure due to sand fill.

weight of sand 110

water filling the boid of sand say $64.0 \times 0.4$ = 26

$136^{\#}$/cub. ft.

depth of sand filling = 21.7'

Surcharge due to slab = $\frac{320}{136}$ = 2.3

24.0' @ 136 = 3,260 #/□' on bed area.

Bottom side pressure due to filling = $\frac{3260}{3}$ = 1090 #/□' of wall.

Horizontal tension on wall = $1090 \times 9.7 = 10560^{\#}$ per ft strip.

Horizontal steel req'd. = $\frac{10560}{17000} = 0.62\,\square''$ per ft strip of wall.

Use 3/4"φ bars 1.0' c to c on both sides = $0.884\,\square''$ per ft. at bottom.

At section 4' above bottom.

Side pressure 20 @ 136 ÷ 3 = 910 #/□'

Hor. tension on wall = $910 \times 9.7 = 8830^{\#}$ per ft strip of wall.

Hor. steel req'd. = $\frac{8830}{17000} = 0.52\,\square''$ per ft strip.

Use 7/8"φ bars 1.0' c to c on both sides = $0.61\,\square''$ per ft. strip of wall.

Weight of pier.

| | | | | | |
|---|---|---|---|---|---|
| Top slab say | $24.0'^{\phi} \times 2.0$ = | 905 @ 150 = | 135,700 | × 22.7 = | 3,080,000 |
| Shell | $21.2\pi \times 1.8 \times 21.7$ = | 2,602 @ " = | 390,500 | × 10.85 = | 4,240,000 |
| fillet top | $1.5 \times 3.0 \times 17.4 \times \pi$ = | 246 @ " = | 36,900 | × 20.7 = | 764,000 |
| " bottom | $.5 \times 1.0 \times 18.73 \times \pi$ = | 29 @ " = | 4,400 | × 0.33 = | 1,000 |
| | | 3,782 cub ft (17.5立坪) | 567,500# | | |
| Sand + water fill | $19.4^{\phi} \times 21.7$ = 6420 − 275 = | 6145 @ 136 = (28.5坪) | 836,000 | × 10.8 = | 9,020,000 |
| | | | 1,403,500 | × 12.2 = | 17,105,000 at top of bott. ~~of~~ slab |
| Bottom slab | $23.0'^{\phi} \times 2.0$ = | 831 @ 150 = (3.9坪) | 124,500 | × 1.0 = | 125,000 |
| | | | 1,403,500 | × 14.2 = | 19,945,000 |
| | | | 1,528,000 | × 13.14' | 20,070,000 at top of Base |
| Base | $27.0'^{\phi} \times 5.0$ = | 2,863 cub ft @ 140 = (13.3立坪) | 401,000 | | |
| | | | 1,929,000 # | | |

total concrete = 17.5 + 3.9 + 13.3 = 34.7 立坪

MADE BY K. Inaba DATE 3-12-24 FILE NO

CHECKED BY M. J. DATE 4-1-20 PAGE NO 43

CALCULATIONS FOR

Kanumojima Swing Bridge for City of Kobe.

Stresses during transpotation.

The shaft will be transpotea as a floating open casson, the height of casson assumed 17.0'.

Weight of Casson.

| | | | | |
|---|---|---|---|---|
| Shell | 21.2π × 1.8 × 15.0 | = 1800 | @ 150 = | 270,000 |
| fillet, bottom | | = 29 | @ " = | 4,400 |
| Bottom slab | | = 831 | @ " = | 124,500 |
| | | 2660 (12.3#) | | 398,900 # |

Gross sectional area of casson = $23'^{\phi}$ = 415.5°

weight of sea water to be displaced = 415.5 @ 64 = 26600 # per ft strip

depth of casson to sink = $\frac{398900}{26600}$ = 15.0'

Stress on shell.

Compression on shell at bottom = 64 × 13 × 11.5 = 9,560 #

Unit compression = $\frac{9560}{1.8 \times 144}$ = 37 #/°" ok

Design of Bottom slab

Upward pressure on bottom = 64 × 15 = 960

impact say 50% = 480

1,440 #/°'

less weight of slab 2 @ 150 = − 300

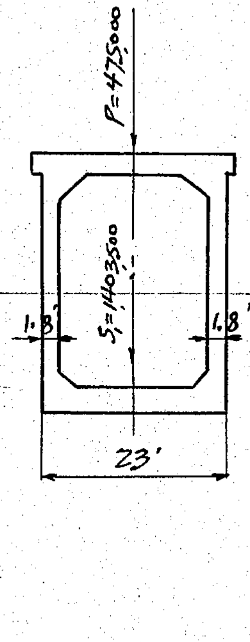
1140 #/°' upward.

Upward pressure due to max. live load = 1570 #/°' see page 39.

Latter case governs.

Stability of Pier shaft

Case 1 Stability at normal state (Section at top of bottom slab).



Super imposed load.

| | |
|---|---|
| Dead load | 320,000 |
| Live load | 155000 |
| | 475,000 |
| weight of shaft with sand + water fill = | 1403,500 |
| | 1,878,500 # |

Area of shell ring = 21.2π × 1.8 = 120 °' = 17,280 °"

Unit compression on shell = $\frac{1878500}{17280}$ = 109 #/°" ok.

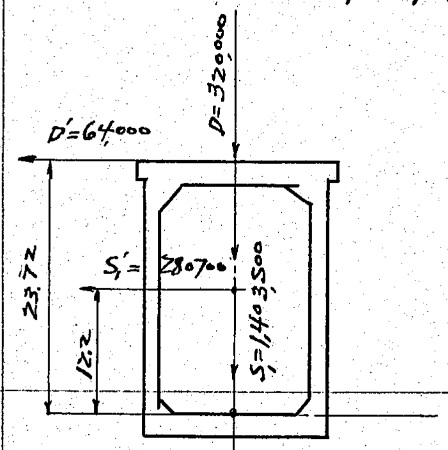
MADE BY K. Imata DATE 3-12-24 **FILE NO**

CHECKED BY M.J. DATE 4-1-20 **PAGE NO** 44

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

Case 2. Stability of pier shaft during Earthquake (Section at top of bottom slab)

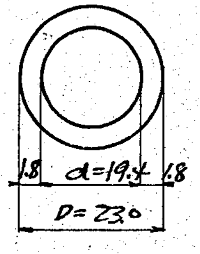


Taking moment about center of bottom section.

| Loads | Hor. forces | Vert. forces | lev arm. | moment. |
|---|---|---|---|---|
| $P_D$ | | 320,000 | × 0 = | 0 |
| D' | 64,000 | | × 23.7 = | 1,517,000 |
| $S_1$ | | 1,403,500 | × 0 = | 0 |
| $S_1'$ | 280700 | | × 12.2 = | 3,425,000 |
| | ΣH = 344,700 # | ΣV = 1,723,500 # | × 2.87 | ΣM = 4942,000 '# |

Area of circular ring = 120 □'

moment of inertia of bottom section



$I = 0.049087(D^4 - d^4)$

$= 0.049087(23^4 - 19.4^4)$

$= 6,770^{(')4}$

Extreme fibre stress $= \frac{1,723,500}{120} \pm \frac{4,942,000 \times 11.5}{6770}$

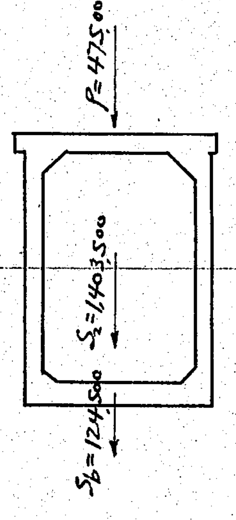
= 14,370 ± 8,400

= 22770 #/□' C or 158 #/□" C ok

5970 #/□' C or 42 #/□" C ok

Stability of shaft at Bottom of bottom slab.

Case 1 Stability at normal state.



Super imposed Dead + Live load = 475,000
weight of shaft with fills = 1403,500
" " bottom slab = 124,500
2003,000 #

Bottom area = 415.5 □'

Unit bearing pressure $= \frac{2003000}{415.5} = 4820$ #/□' or 33.5 #/□" on base

Upward pressure on bottom slab = 4,820
less Sand + water fill 136 × 21.7 = − 2,950
less wt. of slab 150 × 2 = − 300
1570 #/□'

Moment at center as a simply supported circular slab.

$m = \frac{1}{4} w R^2 = \frac{1}{4} \times 1570 \times 10.6^2 = 44100$ '# apparent moment.

Factor of lateral contraction for concrete say 0.2

True moment = 0.8 × 44100 = 35 200 '# as a simple slab.

for continuity of slab moment = 0.8 × 35200 = 28,200 '# as a continuous slab.

Shear at support $= 1570 \times \pi \times 10.6^2 = 555,000$ #

$555000 \div 21.2\pi = 8330$ # per lin ft of support.

Effective depth req'd $= \sqrt{\frac{28200 \times 12}{12 \times 102}} = 16.6"$ use 24" depth overall with 2" insulation

Steel area req'd. $= \frac{28200 \times 12}{17000 \times \frac{7}{8} \times 22} = 1.03$ □" per ft strip.

Use 7/8"φ bars 6" c to c = 1.20 □" on both direction.

~~Unit Shear at support $= \frac{8330}{12 \times \frac{7}{8} \times 22} = 36$ #/□" ok~~

Unit bond $= \frac{8330}{55 \times \frac{7}{8} \times 22} = 79$ #/□" ok

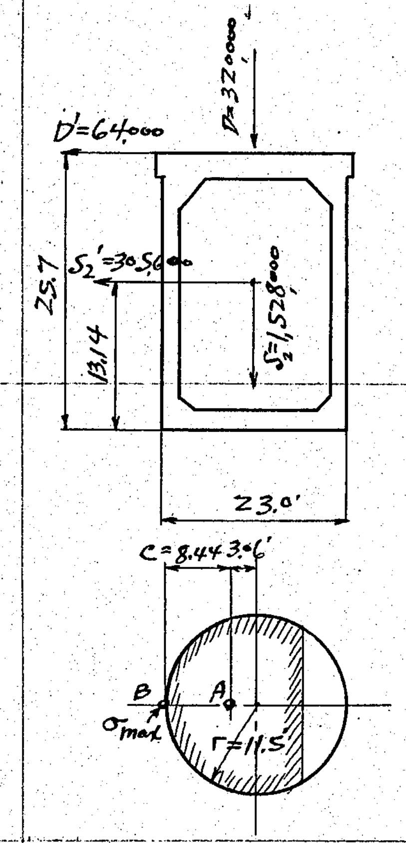
MADE BY K. Inaba DATE 3-12-24 FILE NO

CHECKED BY M.J. DATE 4-1-20 PAGE NO 45

CALCULATIONS FOR

Karumojima Swing Bridge for city of Kobe.

Case 2 Stability of Pier Shaft during earthquake $K = 0.2$



| Loads | Hor forces | Vert. forces | | lev. arm | | moment |
|---|---|---|---|---|---|---|
| D | | 320,000 | × | 0 | = | 0 |
| D' | 64,000 | | × | 25.7 | = | 1645,000 |
| $S_2$ | | 1,528,000 | × | 0 | = | 0 |
| $S_2'$ | 305,600 | | × | 13.14 | = | 4,015,000 |
| | ΣH=369,600 | ΣV=1848,000 | × | 3.06' | = | ΣM=5660,000 |

$$\frac{d}{8} = \frac{23}{8} = 2.88' < 3.06$$ tension occurs.

neglecting tension

(See Hutte Des Ingenieurs Taschenbuch I page 699)

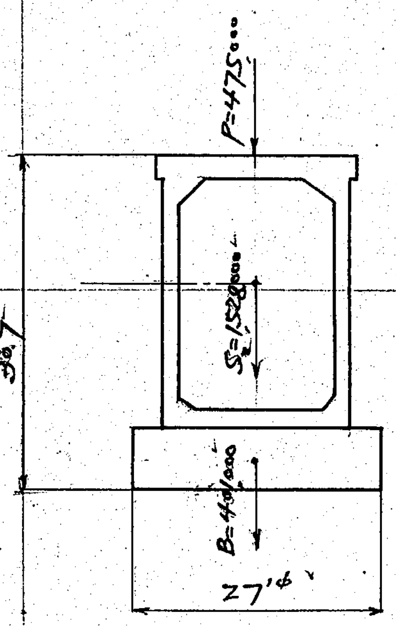
$$\sigma_{max} = \left(0.372 + 0.056\frac{c}{r}\right)\frac{P}{c\sqrt{rc}}$$

where $c$ = distance $\overline{AB}$ = 11.5-3.06 = 8.44'
$r$ = radius of base = 11.5'
$P$ = vert. loads = 1,848,000#

$$\sigma_{max.} = \left(0.372 + 0.056\frac{8.44}{11.5}\right)\frac{1848000}{8.44\sqrt{11.5 \times 8.44}} = 9190$$ #/□' or 64#/□" C ok.

Stability of Pier as a whole.

Case 1. Stability at normal state.



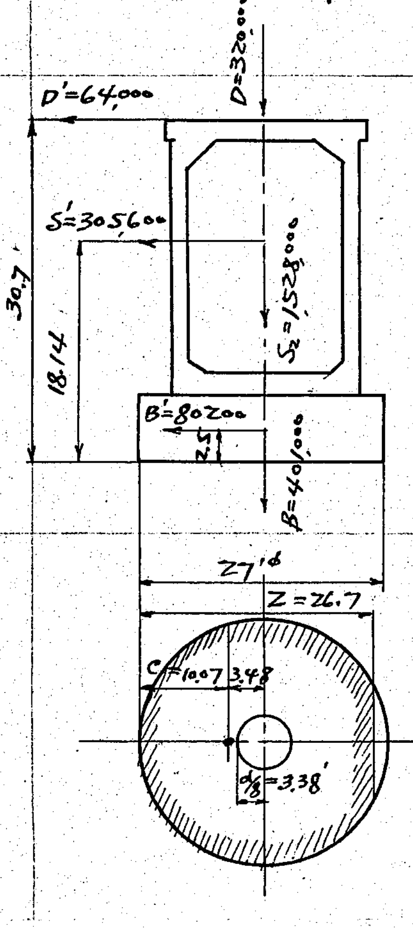
| | |
|---|---|
| Super imposed Dead + Live Load | 475,000 |
| weight of Shaft with fills | 1,528,000 |
| weight of base | 401,000 |
| | 2404,000 # |

Area of Base = 27'φ = 573 □'

Bearing pressure = $\frac{2404000}{573}$ = 4190 #/□' or 1.87 tons/□' ok

Load on one pile = $\frac{2404000}{52}$ = 46200# or 20.6 tons.

Case 2 Stability during Earthquake $K = 0.2$



| Loads | Hor forces | Vert. forces | | lev. arm | | moment |
|---|---|---|---|---|---|---|
| D | | 320,000 | × | 0 | = | 0 |
| D' | 64,000 | | × | 30.70 | = | 1,965,000 |
| S | | 1,528,000 | × | 0 | = | 0 |
| S' | 305,600 | | × | 18.14 | = | 5540,000 |
| B | | 401,000 | × | 0 | = | 0 |
| B' | 80,200 | | × | 2.50 | = | 200,000 |
| | ΣH = 449,800 | ΣV = 2249,000 | × | 3.43' | = | 7705,000 |

$$\frac{d}{8} = \frac{27}{8} = 3.38'$$ neglecting tension $C$ = 13.5-3.43 = 10.07'

$$\sigma_{max.} = \left(0.372 + 0.056\frac{10.07}{13.5}\right)\frac{2249000}{10.07\sqrt{13.5 \times 10.07}} = 7930$$ #/□' or 3.54 tons/□'

neutral axis $\frac{Z}{c} = 2.33 + 0.58\left(\frac{c}{r}\right)^2$

$$Z = \left[2.33 + 0.58\left(\frac{10.07}{13.5}\right)^2\right]10.07 = 26.7'$$

max loads on one extreme pile = 3.0 × 3.5 × 3.28
= 34.4 tons

$3.54 \times \frac{24.7}{26.7} = 3.28$ tons/□'

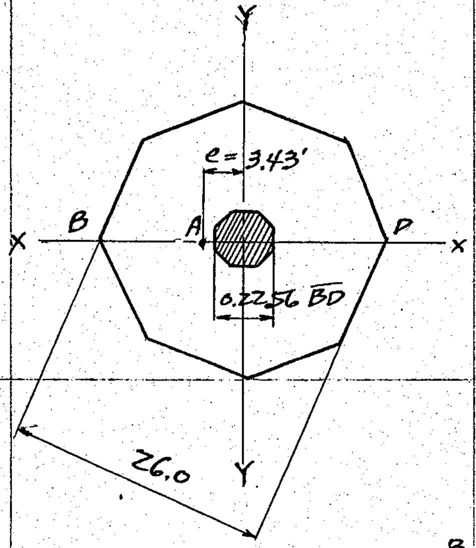
MADE BY K. Inaba DATE 3-12-27 FILE NO

CHECKED BY M.J. DATE 4-1-20 PAGE NO 46

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

If the tension at heel be assumed to be taken care of by the coheasion between pile and base concrete



All figures for the octagonal base.

Shorter diameter = 26'

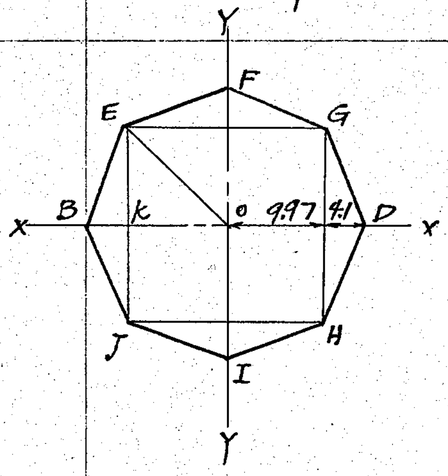
longer diameter = $26 \times \sec 22^\circ\text{-}30' = 26 \times 1.0824 = 28.14'$

See Turneaure and maurer's Principles of reinforced concrete construction page 422.

half width of core = $0.1128 \times 28.14 = 3.174'$

Eccentricity = 3.43' see page 45

moment of inertia of octagonal area about axis Y-Y.



$\overline{BD} = 28.14'$

$\overline{OB} = \overline{OE} = 14.07'$

$\overline{OK} = \overline{EK} = \dfrac{14.07}{1.4142} = 9.97'$

$\overline{EJ} = 2 \times 9.97 = 19.94'$

$\overline{BK} = 14.07 - 9.97 = 4.1$

moment of inertia

□ EJHG $19.94^4 \div 12 \qquad = 13,160$

△ BJE+GDH $\dfrac{19.94 \times 4.1^3}{36} \times 2 + \dfrac{19.94 \times 4.1}{2}(1.37+9.97)^2 \times 2 = 13,586$

△ EFG+HIJ $\dfrac{4.1 \times 9.97^3}{36} \times 2 + \dfrac{9.97 \times 4.1}{2} \times 3.32^2 \times 4 = \underline{1106}$

$27852''^4$

Overturning moment at bottom of base = 7,705,000'#

Total vertical pressure on bottom of base = 2,249,000 #

Area of base $19.94^2 = 397.5$

$\dfrac{19.94 \times 4.1}{2} \times 4 = \underline{163.5}$

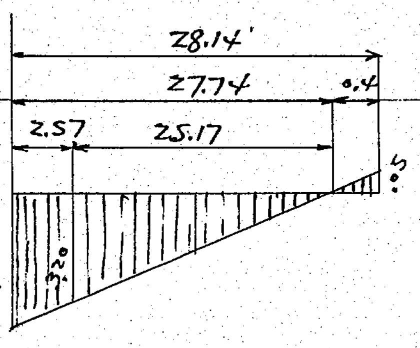
$561.0 \,\square'$

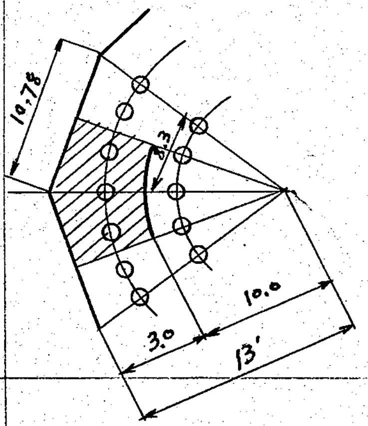
max. toe pressure $= \dfrac{2249000}{561} \pm \dfrac{7705000}{27852} \times 14.07$

$= 4010 \pm 3890$

$= 7900 \,\#/\square'$ C or 3.53 tons/□' C

or $120 \,\#/\square'$ T or 0.05 ton/□' T





Shaded area $= \dfrac{5.39+4.15}{2} \times 3 \times 2 = 28.6 \,\square'$

Area for one pile $= \dfrac{28.6}{3} = 9.55 \,\square'$

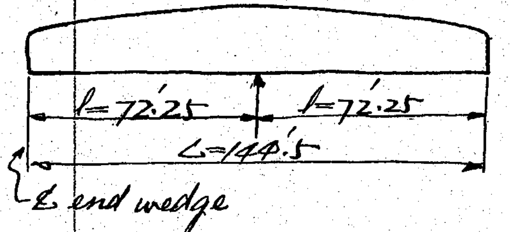
max. load on one pile $= 9.55 \times 3.20 = \underline{\underline{30.5}}$ tons

tension on one pile (approximate)

$\dfrac{0.4 \times 0.05}{2} \times 3.5 = 0.035$ ton

Design of operating time, horse-power and Gear Ratio (1st method. preliminary)

| | | |
|---|---|---|
| max dead load center reaction | 144,100×2 | = 288,000# |
| Operator house | say | 10,000 |
| Drum & c | say | 10,000 |
| | | 308,000 |



$W_T$ = total turning w't = 308,000# = 154 tons
$W_{T_1}$ = w't used for mass equivalent = 308,000×9 = 277,000 = 138.5 tons
L = length c to c end wedges = 2l = 144.5 ft
B = width c to c of girders = 16.5 ft
t = specified time for turning 90° = 90 seconds
$P_1$ = necessary no of H.P to turn 90° in 90 seconds
r = Rack Radius at pitch line = 10. ft
$r_d$ = radius of drum = 9. ft say

1st trial

Horse power required.

$$P_1 = \frac{9W_{T_1}(L^2+B^2)}{29t^3} + \frac{\sqrt{W_T^3}}{50t} = \frac{9\times 138.5(144.5^2+16.5^2)}{29\times 90^3} + \frac{\sqrt{154^3}}{50\times 90}$$

$$= 1.25 + 0.425 = 1.675\ H.P \quad \text{approx. value.}$$

Rack force X

$R_1$ = the constant resistance at the Rack due to rolling friction of Rollers.

Roller friction $P_R = \frac{2W_T f_r}{d}$ where $f_r$ = coefficient of friction of Rolling motion = 0.02
d = dia of Roller = 12"

$$= \frac{2\times 308,000\times 0.2}{12}$$

$$= 1,030\#$$

$$R_1 = 1030\times\frac{r_d}{r} = 1030\times\frac{9}{10} = 927 \quad \text{say } 930\#$$

M = mass equivalent concentrated at Rack

$$= \frac{W_{T_1}\times 2000}{g r^2}\left(\frac{L^2+B^2}{12}\right) = \frac{277,000}{32.2\times 10^2}\left(\frac{144.5^2+16.5^2}{12}\right) = 151,600\#$$

$$c = \tfrac{1}{4}\ \text{Rack circle} = \frac{10\times 2\times\pi}{4} = 15.7\ ft$$

formula.

$$550P_1\sqrt{\frac{M}{c}} = \frac{(1-f)\times 1^2 - R_1X_1}{\sqrt{2(1-f)X_1 - R_1}}$$

where f = total frictional resistance of all mechanism from motor to Rack = .5
$X_1$ = tangential force acting at radius r, delivered by motor, with no deduction for friction in mechanism between motor and Rack.

evaluating 1st side of formula

$$550P_1\sqrt{\frac{M}{c}} = 550\times 1.675\sqrt{\frac{151,600}{15.7}} = 90,530$$

approx. value $X_1$

$$X_1 = 10\sqrt[3]{\frac{605P_1^2M}{c}} = 10\sqrt[3]{\frac{605\times 1.675^2\times 151,500}{15.7}} = 10\sqrt[3]{16,400,000} = 2540\#$$

let $X_1 = 2540\times 1.5 = 3800$

evaluating 2nd side of formular

$$\frac{(1-.5)3800^2 - 930\times 3800}{\sqrt{2(1-.5)3800 - 930}} = 70,000$$

if $X_1 = 4{,}500$

$$\frac{(1-.5)\,4500^2 - 930\times4500}{\sqrt{2(1-.5)4500-930}} = 100{,}000$$

if $X_1 = 4{,}304$

$$\frac{(1-.5)\,4304^2 - 930\times4{,}304}{\sqrt{2(1-.5)4304-930}} = 90{,}546 \text{ nearly}$$

use $X_1 = 4{,}304^{\#}$

Time. $t$ = total time for opening $90° = \frac{CX_1}{550P_1} + \frac{550P_1M}{(1-f)X_1^2-R_1X_1} = \frac{15.7\times4304}{550\times1.675} + \frac{550\times1.675\times151{,}600}{.5\times4303^2-930\times4{,}303}$

$= 73.3 + 26.55 = 100$. sec.

2nd trial.

let $P_1 = 1.9$ HP
$R_1 = 930^{\#}$
$M = 151{,}600$
$C = 15.7^{\#}$
$f = .5$

$$550P_1\sqrt{\frac{M}{C}} = 550\times1.9\sqrt{\frac{151.600}{15.7}} = 102{,}620.$$

if $X_1 = 4{,}550.^{\#}$

$$\frac{(1-f)X_1^2-R_1X_1}{\sqrt{2(1-f)X_1-R_1}} = \frac{.5\times4550^2-930\times4{,}550}{\sqrt{2(.5)\times4550-930}} = 101{,}700$$

use $X_1$ $4{,}580^{\#}$

total time $t = \frac{CX_1}{550P_1} + \frac{550P_1M}{(1-f)X_1^2-R_1X_1} = \frac{15.7\times4580}{550\times1.9} + \frac{550\times1.9\times151{,}600}{.5\times4580^2-930\times4580}$

$= 68.81 + 25.89 = 94.7$ sec

3rd trial

let $P_1 = 2.124$
$R_1$, $M$, $C$, and $f$ same as 2nd trial.

$$550P_1\sqrt{\frac{M}{C}} = 550\times2.124\sqrt{\frac{151{,}600}{15.7}} = 114{,}790$$

if $X_1 = 4{,}790^{\#}$

$$\frac{(1-f)x_1^2-R_1X_1}{\sqrt{2(1-f)X_1-R_1}} = \frac{.5\times4790^2-930\times4790}{\sqrt{2\times.5\times4790-930}} = 112{,}950$$

if $X_1 = 4{,}830^{\#}$

$$\frac{(1-f)x_1^2-R_1X_1}{\sqrt{2(1-f)X_1-R_1}} = \frac{.5\times4830^2-930\times4830}{\sqrt{2\times.5\times4830-930}} = 114{,}800$$

use $X_1 = 4{,}830^{\#}$

total time $t = \frac{CX_1}{550P_1} + \frac{550P_1M}{(1-f)X_1^2 - R_1X_1} = \frac{15.7\times4830}{550\times2.124} + \frac{550+2.124\times151{,}600}{.5\times4830^2-930\times4830}$

$= 64.9 + 24.7 = 89.6$ sec

finally. use $P_1 = 2.124$ H.P (for inertia and friction only)
$R_1 = 930$ #
$M = 151{,}600$
$C = 15.7$ ft
$f = .5$

Rack stress $X = (1-f)X_1 = (1-.5)\times4830 = 2{,}415$ #

$t_1$ = time of acceleration $= \frac{550P_1M}{(1-f)X_1^2-R_1X_1} = 24.7$ sec
$t_2$ = time of uniform velocity $= \frac{CX_1}{550P_1} - \frac{550P_1M}{(1-f)X_1^2-R_1X_1} = 64.9-24.7 = 40.2$ sec
$t_3$ = time of retardation $= t_1 = 24.7$ sec
$t$ = total time $= t_1+t_2+t_3 = 89.6$ sec

Gear ratio;–
$v$ = max velocity of pinion at pitch circle of Rack
$= \frac{550P_1}{X_1} = \frac{550\times2.124}{4{,}830} = 0.2418$ ft/sec
during time $t_1$ pinion travels
$\frac{0.2418}{2}\times24.7 = 2.986$ ft
" " $t_2$
$0.2418\times40.2 = 9.720$ ft
" " $t_3$
$\frac{0.2418}{2}\times24.7 = 2.986$ ft
total $15.692 = C$

dia of main pinion = 8"
rev. per min. of pinion $= \frac{0.2481\times60\times12}{8\times\pi} = 8.095$ r.p.m.

Rev. per min of motor = 1,090 assumed
gear ratio $= \frac{1090}{8.095} = 134.65$

Turning in 50 mile per hour wind;–
H.P reqd for wind only $= \frac{V\cdot hv^2l^3}{\underset{const.}{151{,}305}\,r^2}$ (公式) where $h$ = hight = 10 ft assumed
$= \frac{\overset{mile}{50}\times\overset{ft}{10}\times\overset{ft}{.2418^2}\times\overset{ft}{72.25^3}}{151{,}305\times\underset{ft}{10^2}} = 0.729$ H.P

H.P reqd for inertia and friction = 2.124 H.P

Total H.P $= 2.124+0.729 = \underline{\underline{2.853}}$

Design of Bridge operating machinery (2nd method. finally)

Data:

$L$ = distance center to center end wedges ---- = 144'6" (72'3 × 2)
$B$ = distance center to center girder ------ = 16'6"
$r$ = Rack radius ---------- = 10'0"
angle of swing ------------ = 90 deg.
$W_T$ = moving load

| | |
|---|---|
| max dead load center reaction | 288,200 |
| operator house | 10,000 |
| drum &c. | 10,000 |
| | 308,200# say 310,000# --(W_T) |

$W_{T_1}$ = weight used for mass equivalent = 310,000×.9 = 279,000#
$t$ = specified time for turning 90° ----- 90 seconds
$P$ = necessary number of horse power to turn. 90° in 90 sec.
$r_d$ = radius of drum -------------- = 90

$C = \frac{1}{4}$ of circum of Rack circle = distance traveled by main pinion in opening 90°

$$= \frac{r \times 2 \times \pi}{4} = \frac{10 \times 2 \times \pi}{4} = 15.708'$$

$t_1$ = time of acceleration = 20 sec.
$t_2$ = 〃 uniform velocity = 50
$t_3$ = 〃 retardation = 20
total 90 sec.

$$v = \text{uniform speed} = \frac{C}{\frac{t_1}{2}+t_2+\frac{t_3}{2}} = \frac{15.708}{10+50+10} = 0.2244 \text{ ft per sec.}$$

$$\alpha = \text{acceleration} = \frac{v}{t_1} = \frac{0.224}{20} = 0.0112 \text{ ft per sec}^2$$

$M$ = mass concentrated at Rack cir. having same polar moment of inertia as moving part

$$= \frac{I}{r^2} = \frac{W_{T_1}}{gr^2}\left(\frac{L^2+B^2}{12}\right)$$

where $I$ = mt. of inertia of span: this may be calculated by following approximate formula:

$$= \frac{W_{T_1}}{g}\left(\frac{L^2+B^2}{12}\right). \text{ in which } g = 32.2$$

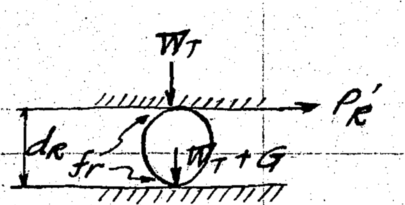
$$M = \frac{279{,}000}{32.2 \times 10^2}\left(\frac{144.5^2+16.5^2}{12}\right) = 152{,}800$$

$F$ = Tangential force at Rack. (for acceleration) $= M\alpha = 152{,}800 \times 0.0112 = \underline{1710.\#}$ --(1)

Rolling friction

$P_R$ = force required at Rack cir. due to rolling friction of Roller

$P_R'$ = 〃 at drum cir. 〃 〃 〃. (center of roller) ( 8.93 ft R)



$d_R$ = dia of roller = 12"

$f_r$ = Coefficent of friction of rolling motion = 0.02
$m$ = moment of friction couple

$$P_R' = \frac{m}{d_R} = \frac{W_T f_r + (W_T+G) f_r}{d_R}$$

G is neglect.

**JIUN MASUDA**
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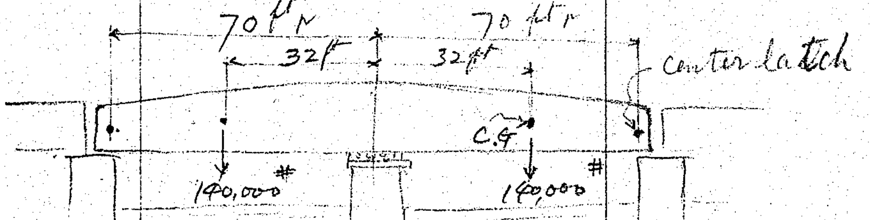
CALCULATIONS FOR

Approximate shock at Center latch of Karumajima swing Brigde.

moving weight used for mass equivalent = 140,000 × 2 = 280,000#
Center of gravity a distance from center of rotation = 32 ft radius.
Rack radius at pitch line - - = 10 ft
specified time for turning 90° = 90 sec.

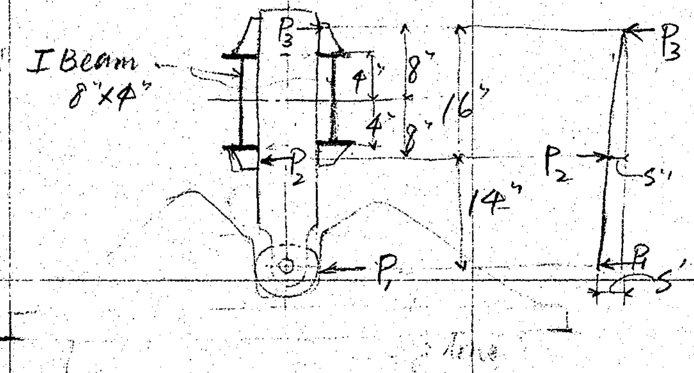
distance traveled by main pinion in opening 90° = $\frac{10 \times 2\pi}{4}$ = 15'.708
uniform speed at rack circle = 0.2244 ft per sec.
" " at Center of latch = $0.2244 \times \frac{70}{10}$ = 1.57 ft per sec
finary speed passed near center latch = 0.8 ft per sec assumed.



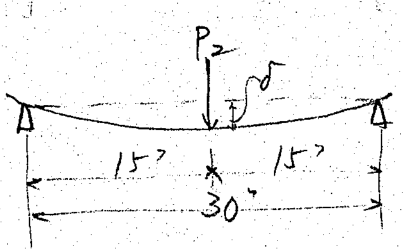
M = Equivalent mass at Center latch = $\frac{140,000 \times 32^2}{32.2 \times 70^2}$ = 910.# for one end

Kinetic Energy of moving body = $f.s = \frac{1}{2}MV^2 = \frac{910 \times 1.57^2}{2}$ = 1,120 ft-lbs

1st trial;—



let S' = 1/2" then $P_1 = \frac{1,120 \times 12}{.5}$ = 27,000# (12 tons)
$S'' = .5 \times \frac{16}{30} = .267$"
$P_3 = 27,000 \times \frac{14}{16}$ = 23,600#
$P_2$ = 27,000 + 23,600 = 50,600#
unsupported length of I Beam = 30"



$\delta_2 = \frac{50,600 \times 30^3}{48 \times 30,000,000 \times 3.574_I}$ = .266" for $P_2$

$\delta_3 = \frac{23,600 \times 30^3}{48 \times 30,000,000 \times 3.574}$ = .124" for $P_3$

total deflection = $\delta_2 + \delta_3$ + torsion     torsion = .110" assumed
= .266 + .124 + .11 = .5"

2nd trial
let S' = 3/4"   $P_1 = \frac{1120 \times 12}{.75}$ = 18,000# (8 tons)
$S'' = .75 \times \frac{16}{30}$ = .4"
$P_3 = 18,000 \times \frac{14}{16}$ = 15,800     $P_2$ = 18,000 + 15,800 = 33,800#
$\delta_2 = \frac{33,800 \times 30^3}{48 \times 30,000,000 \times 3.574}$ = .177"     $\delta_3 = \frac{15,800 \times 30^3}{48 \times 30,000,000 \times 3.574}$ = .083"

total deflection = $\delta_2 + \delta_3$ + torsion = .177 + .083 + .14 = .4" = 5", OK

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

$$P_R' = \frac{2 W_T f_r}{d_R} = \frac{2 \times 310.000 \times 0.02}{12} = 1,030^{\#}$$

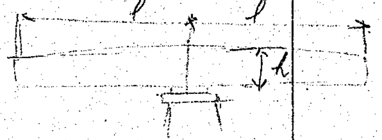
$$P_R = 1030 \times \frac{8.93}{10} = 920^{\#} \text{ — — — — — — — — — — — — — — — (2)}$$

Wind resistance

$V$ = wind velocity = 50 mils per hour (pressure $= 0.004V^2 = 10^{lbs}$ per sq ft.)

$P_W$ = total pressure at Rack cir.

$$= \frac{V h v l^3}{275.1 r^2}$$ (公式) ( Hovey's movable bridges VOL II)



where $l = \frac{L}{2} = 144.5 = 72.25$

$h$ = hight = 10.0 assume

$v$ = uniform velocity = 0.224 ft per sec. (see page 1)

$$P_W = \frac{50 \times 10 \times 0.224 \times 72.25^3}{275.1 \times 10^2} = 1,540^{\#} \text{ — — — — — — — — — — — — (3)}$$

Gear efficiency

| | | |
|---|---|---|
| worm gear | 1 pair | 75% (angle of inclination of thread = 18° abt) |
| bevel gear | 1 " | 85 |
| spure gear | 1 " | 95 |
| Rack and pinion | | 85 |

$\mathcal{E}$ = total efficiency = .75 × .85 × .95 × .85 = .51 — — — — — — — — — — (4)

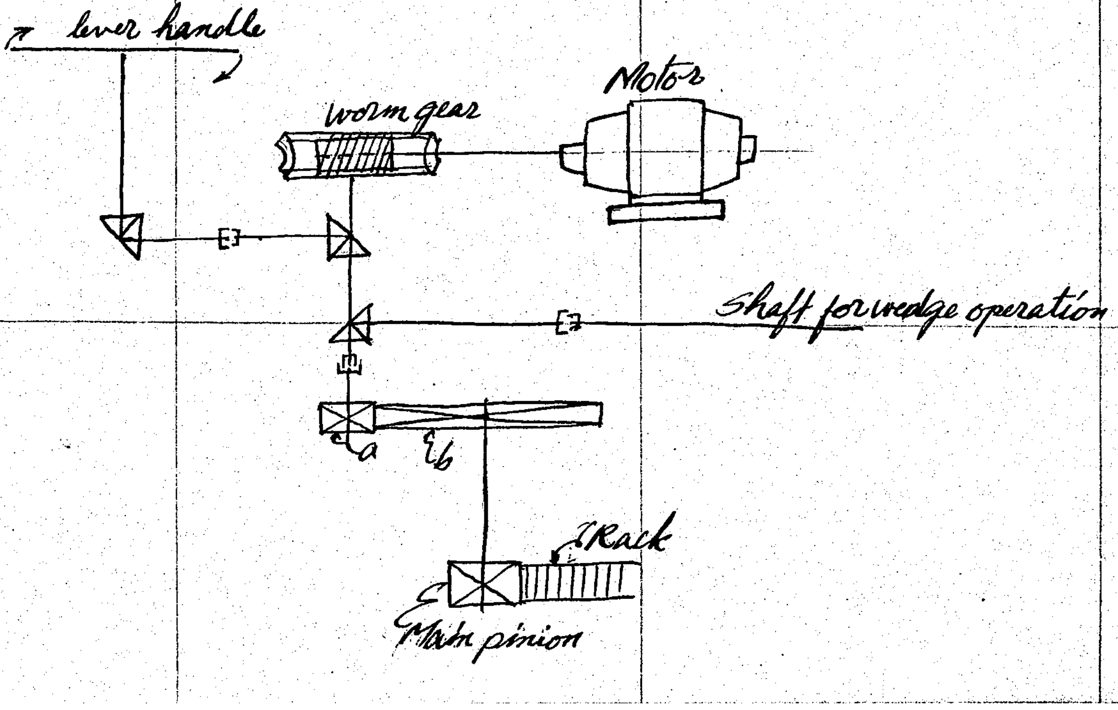
Horse power

$$H.P = \frac{(F + P_R + P_W) \times V}{550 \times \mathcal{E}} = \frac{(1,710 + 920 + 1,540) \times 0.224}{550 \times .51} = 3.33$$

Motor

5 H.P Cran motor. water proof (type I.M.C)
1090. R.P.M at full load
60 cycle 220 volt.

7)1090(15.5
7
16



Rack and pinion

let. $s$ = unit fiber stress in the material
$F$ = load on tooth of pinion
$p$ = circular pitch
$f$ = width of tooth face
$y$ = constant depending on number and sharpe of gear teeth.
$D.P$ = diametral pitch
$n$ = no of teeth of pinion
$D$ = pitch dia of pinion
$R_p$ = no of revolution per min of pinion

$$F = \frac{H.P \times \varepsilon}{v \times 60 \times .85} = \frac{5 \times 33,000 \times .51}{.2244 \times 60 \times .85} = 7,350^{\#} \quad \text{-------------} \quad (A)$$

$$s = \frac{F}{p s y}$$

take $p = 1.5708''$ $(D.p = 2)$
$f = 4\frac{1}{2}''$ $y = 0.077$ (for 15° involut tooth)

$$s \quad \frac{7350}{1.5708 \times 4.5 \times 0.077} = 13,500\ ^{\#}/\square''$$

(allowable $s = 16,000^{\#}/\square''$)

take $n = 16$
$D = 8''$
$$R_p = \frac{0.2244 \times 60 \times 12}{\pi \times 8} = 6.4286$$

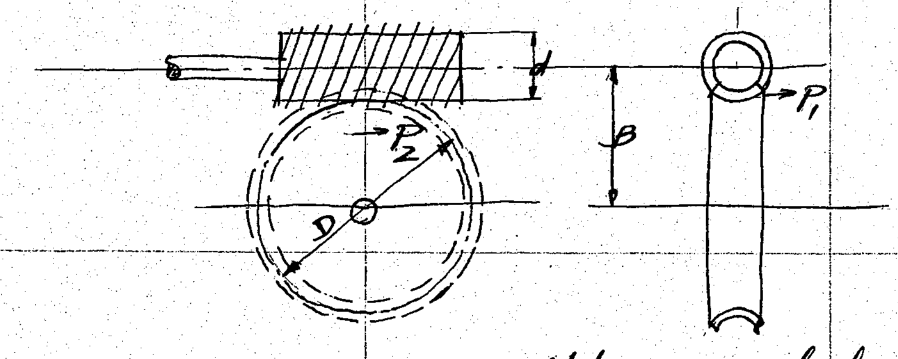
Gear ratio

$G$ = total gear ratio between motor shaft and main pinion shaft.
$R_m$ = R.P.m of motor shaft = 1,090.

$$G = \frac{R_m}{R_p} = \frac{1090}{6.4286} = 169.6$$

$G_1$ = gear ratio between pinion (a) and wheel (b)
$= \frac{99}{18} = 5.5$ take
$G_w$ = gear ratio between worm and worm wheel $= \frac{G}{G_1}$
$$= \frac{169.6}{5.5} = 30.83$$

Worm and worm wheel



$P$ = circular pitch of worm wheel and worm $= \frac{3}{4}''$
$n$ = no of thread of worm $= 3$
$G_w$ = gear ratio $= 30.83$
$N$ = no of teeth of worm wheel $= 30.83 \times 3 = 92.49$ say 92.

$D$ = pitch dia of worm wheel $= \dfrac{N \cdot P}{\pi} = \dfrac{92 \times .75}{\pi} = 21.963''$

$T$ = throat dia of worm wheel $= \dfrac{(92+2) \times .75}{\pi} = 22.440$

$d$ = pitch dia of worm $= 2.162''$ say

$B = \dfrac{21.963 + 2.162}{2} = 12\frac{1}{16}''$

$\alpha$ = angle of inclination of thead

$\tan\alpha = \dfrac{3 \times .75}{\pi \times 2.162} = .3313$

$\therefore \alpha = 18^\circ\text{-}20'$

$\varepsilon_w$ = gear efficiency $= 75\%$

$P_1 = \dfrac{5 \times 33000 \times 12}{1090 \times \pi \times 2.162} = 267^{\#}$

$P_2 = 267 \times \dfrac{\pi \times 2.162}{.75 \times 3} \times .75 = 605^{\#}$

$S = \dfrac{F}{pfy}$

where $F = P_2 = 605$ $p = .75''$ $y = 0.117$ $f = 1.7''$

$S = \dfrac{605}{.75 \times 1.7 \times .117} = 4{,}056\ ^{\#}/\square''$

(allowable $S = 7{,}500.\ ^{\#}/\square''$)

horizntal thrust on bearing $= 605^{\#}$
thrust ball bearing SKF NO 3910 (working load $750^{\#}$ at 1100 R.P.M)
radial ball bearing SKF NO RL12 ( 〃 〃 $650^{\#}$ 〃 )

$R_w$ = R.P.M of worm wheel $= 1090 \times \frac{3}{92} = 35.54$ ------(8)

$a$ = addendum $= .3183 \times .75 = .2387$

$o.d$ = outside dia of worm $= 2.162 + 2 \times .2387 = 2.639''$

$w$ = whole depth of tooth $= 0.6866 \times .75 = .515''$

$b.d$ = bottom dia of worm $= 2.639 - 2 \times .515 = 1.609''$

Spur gear

Pinion(a):

$P_2$ = load on tooth of worm wheel $= 605^{\#}$

$D_w$ = pitch dia of 〃 $= 21.963''$

$D$ = 〃 of pinion (a) $= 6''$ assumed.

$\varepsilon_s$ = efficiency of 1-bevel gear $= 85\%$

$F$ = load on tooth of pinion (a)

$= \dfrac{605 \times 21.963 \times .85}{6} = 1{,}880.^{\#}$

$R_a$ = R.P.M of pinion (a) $= 35.54$

$f$ = width of tooth $= 3''$

$p$ = circuler pitch $= 1.0472''$

$D.P$ = diametral pitch $= 3$

$y$ = ------- $0.083$

$S = \dfrac{1{,}880}{1.0472 \times 3 \times 0.083} = 7{,}200\ ^{\#}/\square''$

(allowable $S = 15{,}000\ ^{\#}/\square''$)

$N$ = no of teeth = 18

Spure wheel (b)

$N = 18 \times 5.5 = 99$

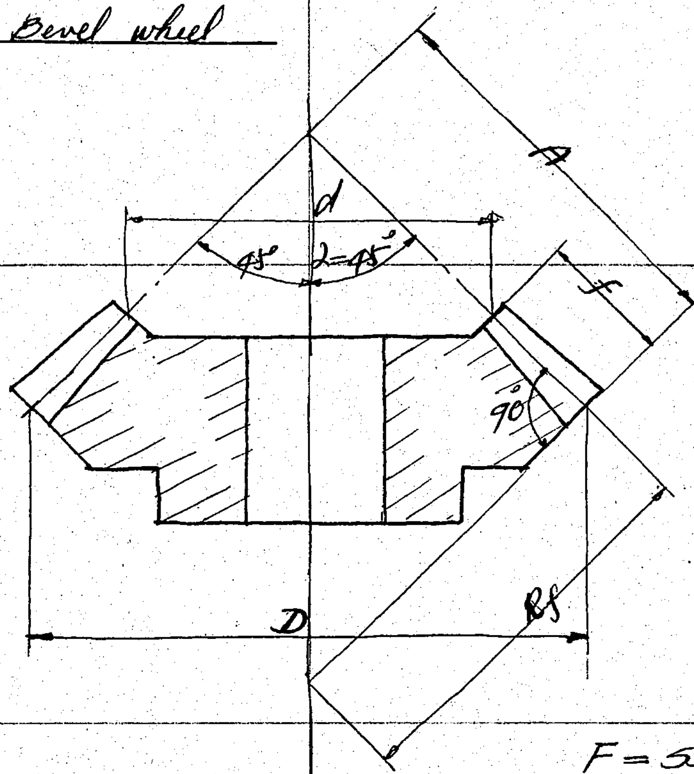
$D$ = pitch dia = $\frac{99}{3} = 33''$

chack for load on tooth of main pinion

~~$F$ = load on tooth of main pinion~~ = $\frac{1,880 \times .95 \times 33}{8}$

= 7,350.# equal to (A)

Bevel wheel



$p$ = circular pitch on outside pitch cir = $1.''5708$
$D.P$ = diametral pitch = 2.
~~$D$ = pitch dia at outside end of teeth~~ = $7.''5$
$d$ = 〃 at inside 〃 〃 = $\frac{2}{3}D$
$N$ = no of teeth = 15
$N'$ = formative no of teeth corresponding to radius $R_f$

$= N \sec\alpha = 15 \times \sec 45^\circ = 15 \times 1.4142 = 21.21$

$f = \frac{1}{3}A = \frac{1}{3} \times \frac{D}{2} \times \sec 45^\circ = \frac{7.5}{3 \times 2} \times 1.4142 = 1\frac{3}{4}''$ abt

$F$ = load on tooth $= 605 \times \frac{21.963}{7.5} = 1770.\#$

$F = Sf'py$ where $f' = f\left(\frac{A-f}{A}\right) = f\left(\frac{1-\frac{1}{3}}{1}\right) = \frac{2}{3}f$

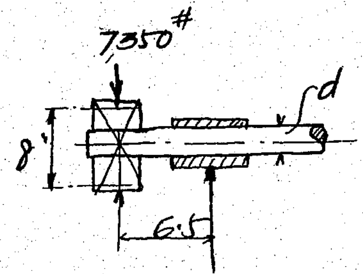
$y = 0.092$

$\therefore S = \frac{F}{f'py} = \frac{1,770}{\frac{2}{3} \times 1.75 \times 1.5708 \times 0.092} = 9,530\ \#/\square''$

(allowable $S = 18,000\ \#/\square''$)

$O.D$ = outside dia $= D + (2\cos\alpha / D.P) = D + 0.45\,p = 7.5 + 0.45 \times 1.5708 = 8.''207$

Main pinion shaft



max. bending mt $M_b = 7,350 \times 6.5 = 47,780\ ''\#$
max twisting mt $M_t = 7,350 \times \frac{8}{2} = 29,400$
Equivalent twisting mt $M_e = 47,780 + \sqrt{47,780^2 + 29,400}$

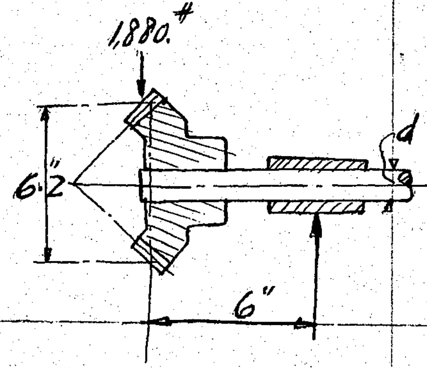
$= 103,900\ ''\#$

let $I_p$ = polar moment of inertia
$f$ = working stress for mild steel = $9,000\ \#/\square''$
~~$d$ = dia of shaft~~

$M_e = I_p \times \frac{1}{\frac{d}{2}} f = \frac{\pi d^3}{16} f \quad \therefore d = \sqrt[3]{\frac{16}{\pi} \frac{M_e}{f}} = 1.72 \sqrt[3]{\frac{M_e}{f}} = 1.72 \sqrt[3]{\frac{103,900}{9,000}}$

$= 1.72 \times 2.26 = 3.''88$ say 4"

Shaft for pinion (a)



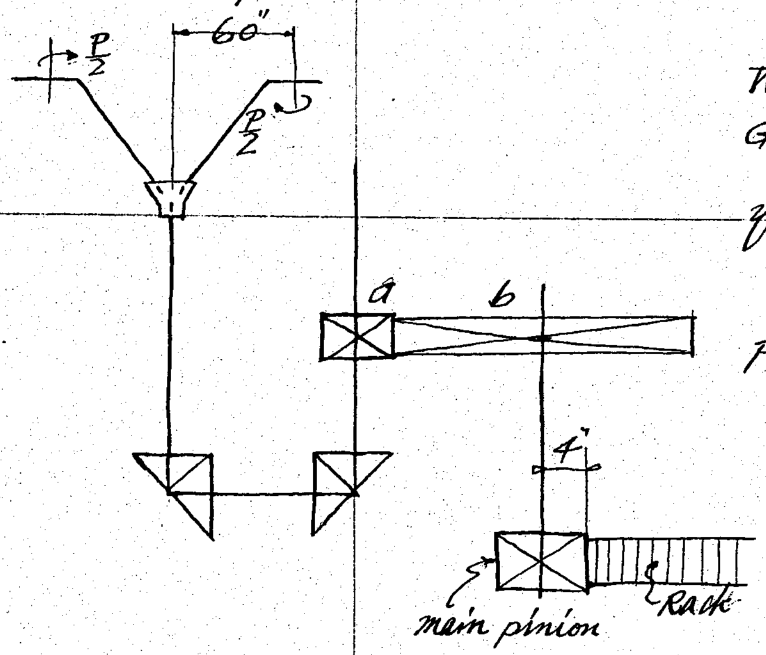
$M_b = 1{,}880 \times 6 = 11{,}280\ ''\#$

$M_t = 1{,}880 + \frac{6.2}{2} = 5{,}828$

$M_e = 11280 + \sqrt{11{,}280^2 + 5828^2} = 24{,}000$

$d = 1.72\sqrt[3]{\frac{24{,}000}{9000}} = 1.72 \times 1.387 = 2.386''$ say $2\frac{1}{2}''$

Hand operation



W = load on tooth of Rack = 4,200# say
G = gear ratio between (a) and (b) = 5.5
$\eta$ = total gear efficiency = .85 × .85 × .95 × .85
= .58

$P = \text{hand power} = \frac{W \times 4''}{60'' \times 5.5 \times \eta} = \frac{4200 \times 4}{60 \times 5.5 \times .58}$
$= 88\#$ (2 men)

C = dist. traveled by main pinion in opening 90°
= 15.708 ft (see page 1)

R = revolution of main pinion
$= \frac{15.708 \times 12}{8 \times \pi} = 7.5$

Distance of wolk $= \frac{2 \times 60}{12} \times \pi \times 7.5 \times 5.5 = 1{,}296$ ft = 3.61 町

(310間 [illegible]
1.13 [illegible])

Roller bearing

P = allowable max load = 400 d l for steel casting
where d = dia of Roller = 12" say
l = length of cylindlical surface = 7" say

$P = 400 \times 12 \times 7 = 33{,}600\#$

mean actual load $P' = \frac{W}{N}$

where W = total moving load = 310,000
N = no of Roller = 22

$P' = \frac{310{,}000}{22} = 14{,}100\#$

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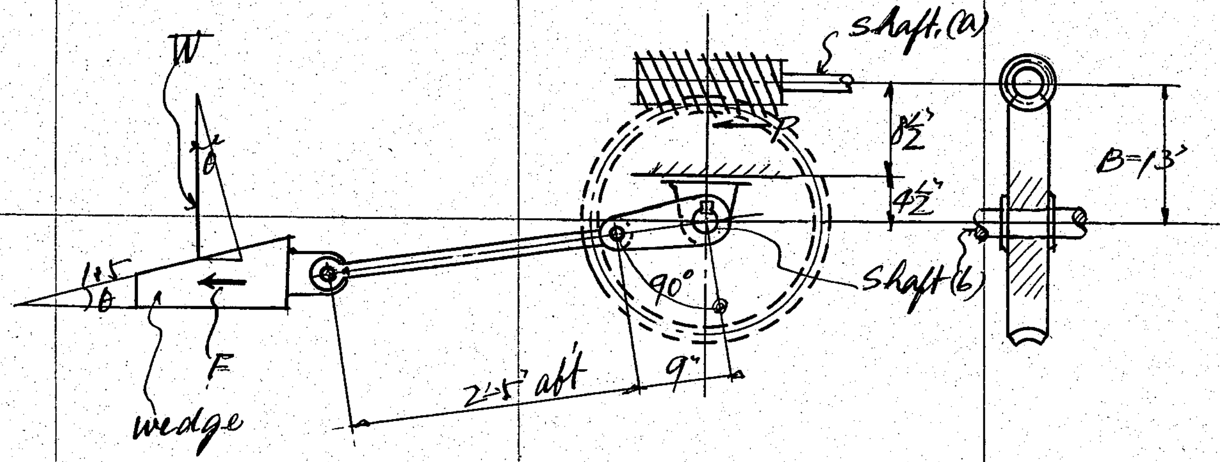
CALCULATIONS FOR

Wedge



$W$ = vertical load on wedge $= 4,200^{\#}$
$\varepsilon$ = efficiency of wedge $= 70\%$ assume.

$F$ = horizontal force $= \frac{4,200 \times \tan\theta}{.70} = \frac{4,200 \times \frac{1}{5}}{.70}$
$= 1,200^{\#}$ for 1 wedge

for 2 wedge $1,200 \times 2 = 2,400.^{\#}$

$S$ = horizontal stroke of wedge $= 10\frac{11}{32}$" aft $\doteqdot 0.86^{ft}$ aft
$R_a$ = revolution per min of shaft (a) drive by motor $= 35.54$ (same as page 4. (B))

$G$ = gear ratio of worm gear $= \frac{1}{44}$ say

$R_b$ = revolution per min of shaft (b) $= R_a \times G = 35.54 \times \frac{1}{44} = 0.808$

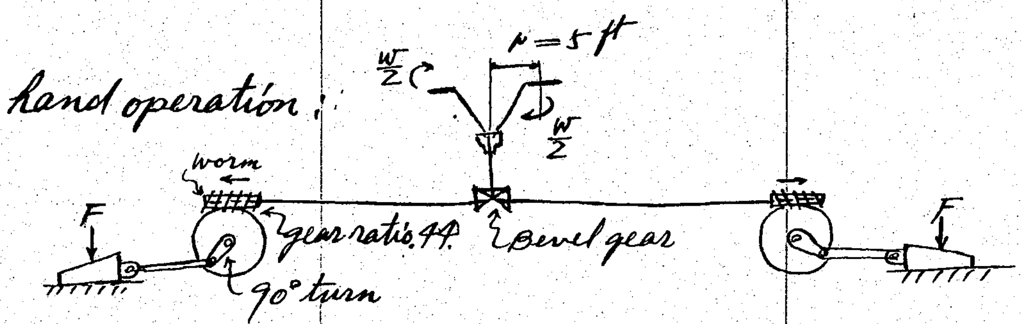
$t$ = time for rotate 90° shaft (b) $= 60 \times \frac{90}{R_b \times 360} = \frac{60 \times 90}{.808 \times 360}$
$= \underline{18.6 \text{ seconds}}$

$\eta$ = total efficiency of gears and links
$= .75 \times .85 \times .85 \times .85 \times .60 \times .70 = 0.19$

$H.P$ = horse power for 4 wedges $= \frac{4F \times S}{33000} \times \frac{1}{\eta} \times \frac{60}{18.6}$

$= \frac{4 \times 1200 \times .86 \times 60}{33000 \times 18.6 \times .19} = \underline{2.12}$

hand operation:



$\eta'$ = total efficiency $= .85 \times .85 \times .60 \times .70 = .30$
$S$ = stroke of wedge $= 0.86^{ft}$
$R_h$ = no of turn of handle for wedge stroke $10.35'' = 44 \times \frac{90}{360} = 11.$
$w$ = handle power $= \frac{4F \times S}{\pi \times 2r \times R_h \times \eta'} = \frac{4 \times 1,200 \times 0.86}{\pi \times 5 \times 2 \times 11 \times 0.30} \doteqdot 40^{\#}$
$l$ = distance of walk $= \pi \times 2r \times 11 = \pi \times 10 \times 11 = 346.$ ft $= 0.96$ (町)

Worm gear for wedge (see Page 56 fig)

$P$ = circular pitch of worm wheel = $1\frac{1}{2}''$

$n$ = no. of threads of worm = 1

$N$ = no of teeth of worm wheel = 44

$D$ = Pitch dia of 〃 〃 $= \frac{N \cdot P}{\pi} = \frac{44 \times 1.5}{\pi} = 21.''008$

$T$ = throat dia of 〃 〃 $= \frac{(44+2) \times 1.5}{\pi} = 21.''963$

$d$ = pitch dia of worm $= 4.992$

$B = (21.008 + 4.992) \times \frac{1}{2} = 13.''$

$\alpha$ = angle of inclination of worm thread

$\tan \alpha = \frac{P}{\pi \times d} = \frac{1.5}{\pi \times 4.992} = 0.0956$

$\alpha = 5°-30'$ abt. (natural lock thread)

$\varepsilon_w$ ~~= gear efficiency = 60 %~~

$w$ = handle force at 5 ft. radius = $80^{\#}$ say

$\varepsilon_t$ = total efficiency between handle and worm wheel:

$= .85 \times .85 \times .60 = .43$

$P$ = load on tooth of worm wheel $= \frac{w \times 2 \times 5 \times 12 \times \pi}{2 \times P} \times \varepsilon_t = \frac{80 \times 120 \times \pi}{2 \times 1.5} \times 0.43$

$= 4{,}320^{\#}$

$S = \frac{F}{Pfy}$ where $F = P = 4{,}320^{\#}$

$f$ = width of tooth of worm wheel = $3''$

$y = 0.11$

$S = \frac{4{,}320}{1.5 \times 3 \times 0.11} = 8{,}700^{\#}/\square''$

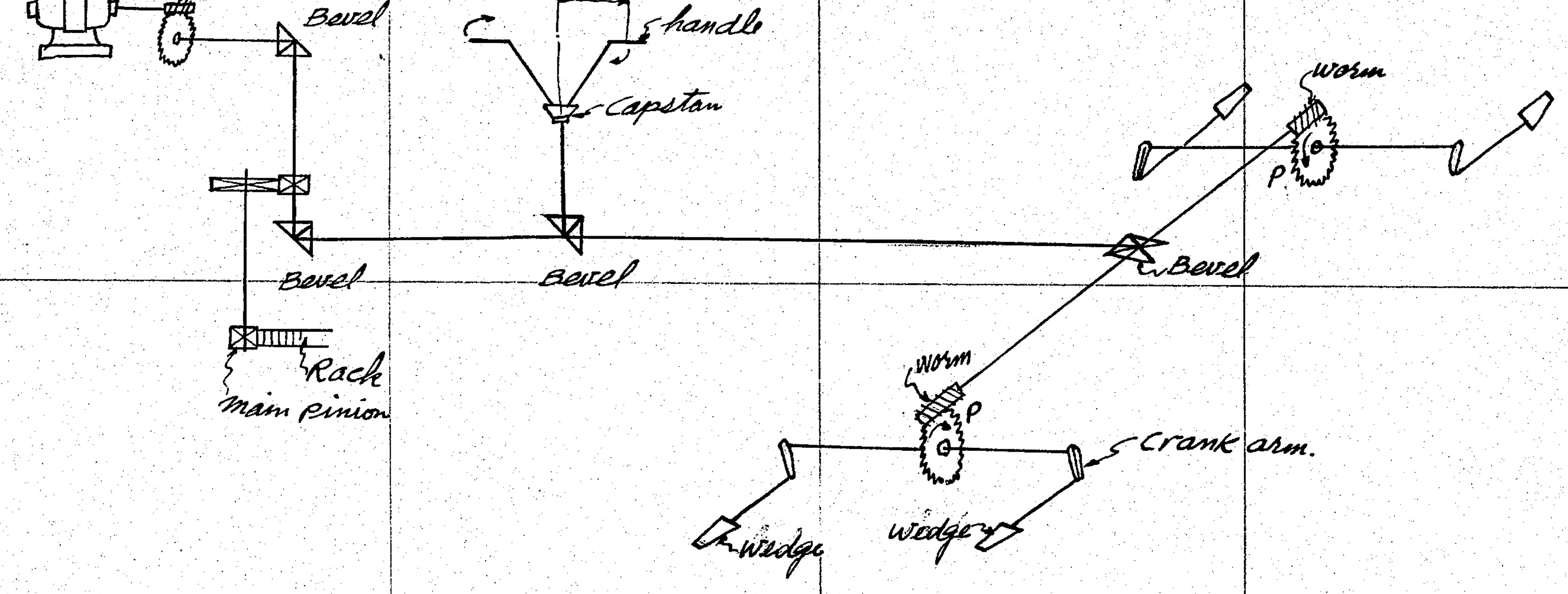
(allowable $S = 15{,}000^{\#}/\square''$)

$a$ = addendum $= .3183 \times 1.5 = .''4775$

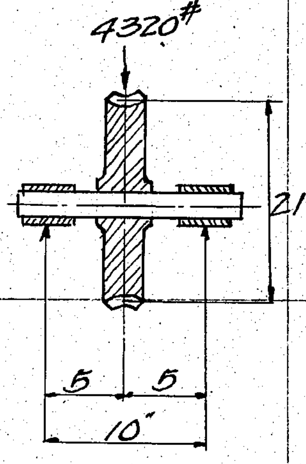
o.d = outside dia of worm $= 4.992 + .4775 \times 2 = 5.''947$

$h$ = whole depth of tooth $= 0.6866 \times 1.5 = 1.''030$

b.d = bottom dia of worm $= 5.947 - 2 \times 1.03 = 3.''887$



## Shaft of worm wheel for wedge



max bending m't. $Mb = \frac{4320 \times 10}{4} = 10{,}800''\#$

max twisting m't. $Mt = \frac{4320 \times 21}{2} = 45{,}360$

equivalent twisting m't. $Me = 10{,}800 + \sqrt{10{,}800^2 + 45360^2}$

$= 57{,}400''\#$

working stress $= 12{,}000^{\#}/\square''$ for Medium hard steel

dia of shaft $d = 1.72\sqrt[3]{\frac{57{,}400}{12000}} = 1.72 \times 1.685 = 2.898''$

say $3\frac{1}{8}''\phi$

## Thrust Bearing for worm shaft

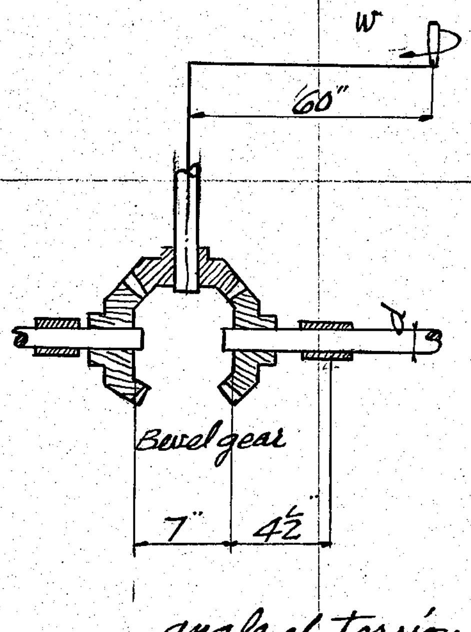
thrust $= 4320^{\#}$

use SKF thrust ball bearing heavy type NO. 512

washer SKF NO 512 U

allowable load $= 6{,}000^{\#}$

## Main shaft of wedge operation



$d$ = dia of shaft

$w$ = hand power $= 80^{\#}$

load on tooth $= \frac{80 \times 60 \times 2}{2 \times 7} \times .75 = 510.^{\#}$

$Mb = 510 \times 4.5 = 2{,}300''\#$

$Mt = 510 \times \frac{7}{2} = 1{,}790''\#$

$Me = 2{,}300 + \sqrt{2{,}300^2 + 1{,}790} = 5{,}210''\#$

working stress $= 9{,}000^{\#}/\square''$ for milde steel

$d = 1.72\sqrt[3]{\frac{5210}{9{,}000}} = 1.72 \times .83 = 1.42''$ say $2''\phi$

angle of torsion of $2''\phi$ shaft ;

working limit of angle of torsion one degree for a length equal to twenty diameters.

let $n$ = no of degree in angle of torsion
$T$ = twisting moment $= 1{,}790''\#$
$C$ = modulus of transvers elasticity of material of shaft
$= 10{,}000{,}000$ for mild steel
$l$ = unit length for Calculation $= 20d = 40''$
$L$ = Total length $= 70$ ft.

$n = 583.61\frac{Tl}{Cd^4} = 583.61\frac{1790 \times 40}{10{,}000{,}000 \times 2^4} = 0.26°$ - for 40" long

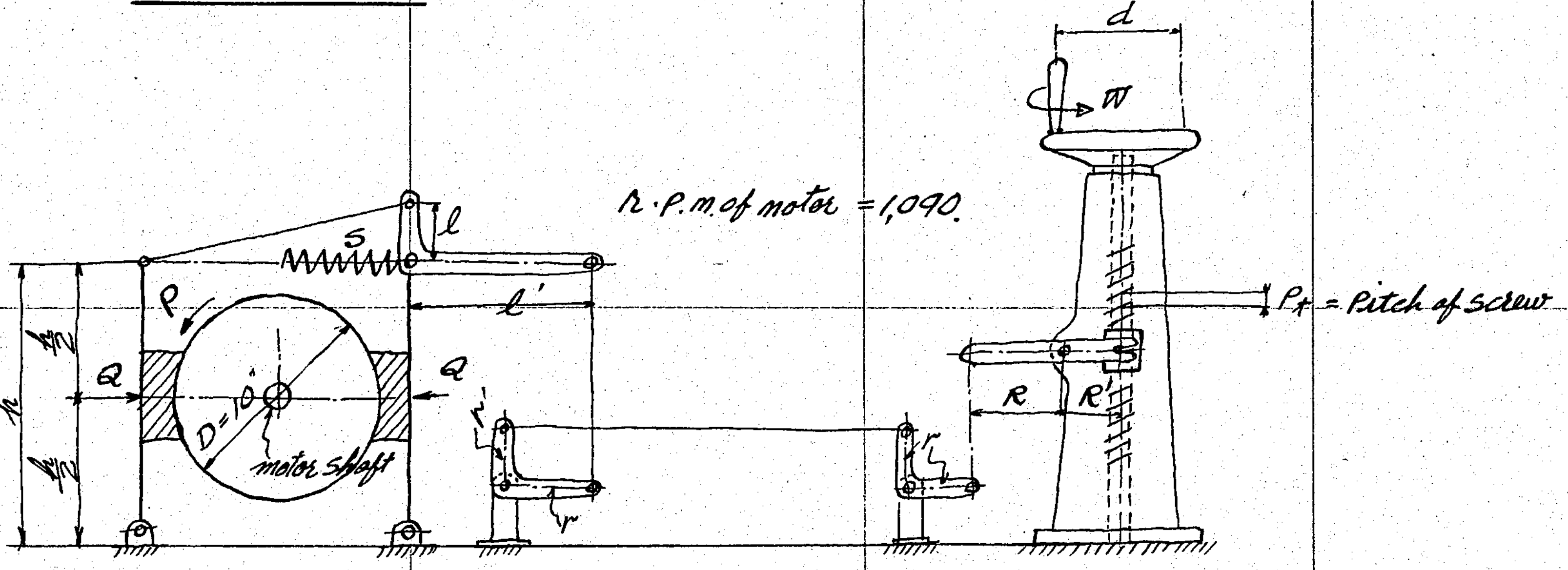
for $L$ $n' = 583.61\frac{1790 \times 70 \times 12}{10{,}000{,}000 \times 2^4} = 5.5°$

unsupporting length of $2''\phi$ shaft ;

$L$ = unsupporting length $= 100\sqrt[3]{d^2} = 100\sqrt[3]{2} = 100 \times 1.26$

$= 126'' = 10'6''$

## Hand Brake



$P$ = load on Brake pulley $= \frac{H.P \times 33,000 \times 12}{\pi \times D \times 1090} = \frac{5 \times 33,000 \times 12}{\pi \times 10 \times 1090} = 58.^{\#}$ say 60

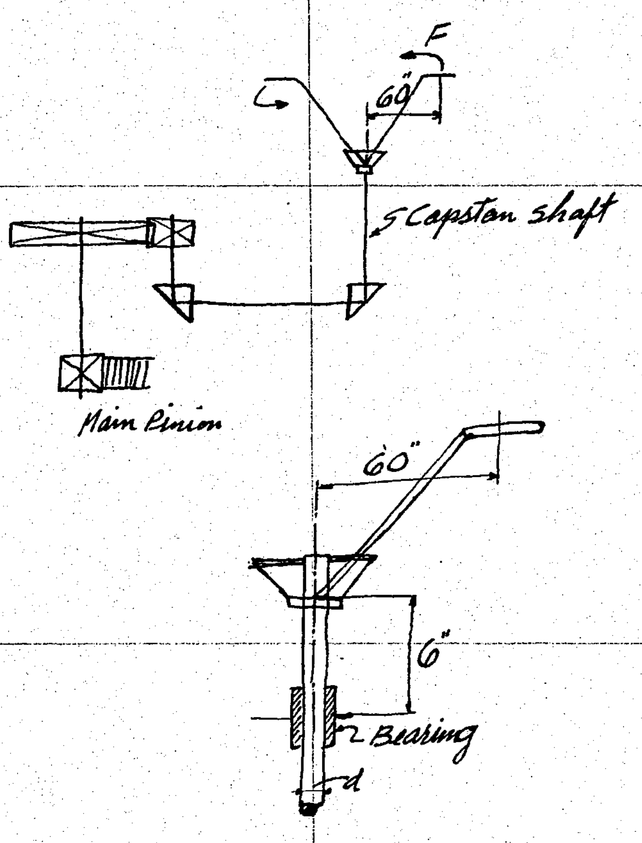
$Q = \frac{P}{2} \times \frac{1}{\mu} = \frac{60}{2} \times \frac{1}{.3} = 100^{\#}$ where $\mu$ = Coeff. of friction of Brake shoe = .3 say

$W$ = hand power $= \left(Q \times \frac{\frac{h}{2}}{h} + S\right) \times \frac{l}{l'} \times \frac{r}{r'} \times \frac{R}{R'} \times \frac{P_t}{\pi D} \times \frac{1}{\eta}$

where $S$ = force of spring = $50^{\#}$ say
$h = 14''$
$l = 4''$  $l' = 17''$
$r = 8\frac{1}{2}$  $r' = 7''$
$R = 8''$  $R' = 7''$  $P_t = \frac{1}{2}''$
$d = 12''$  $\eta$ = efficiency = 30%

$$W = (100 \times \tfrac{1}{2} + 50) \times \frac{4}{17} \times \frac{8.5}{7} \times \frac{8}{7} \times \frac{.5}{\pi \times 12} \times \frac{1}{.3} = 1.5^{\#}$$

## Shaft for Capstan



hand power = 100# say
radius of handle = 60"

$M_b = 100 \times 6 = 600''^{\#}$

$M_t = 100 \times 60 = 6,000$

$M_e = 600 + \sqrt{600^2 + 6,000^2} = 6650$

$d = 1.72 \sqrt[3]{\frac{6,650}{9000}} = 1.72 \times .90 = 1.55''$ say $2''\phi$

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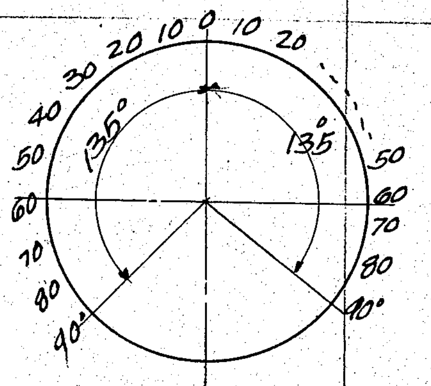
CHECKED BY DATE PAGE NO 60

CALCULATIONS FOR

## Indicator for span operate

L = Pinion travel for 90° span operate = $\frac{10\times2\times\pi}{4} = 15'.708$

N = no. of revolution of pinion shaft = $\frac{10\times2\times\pi\times12}{4\times8\times\pi} = 7.5$

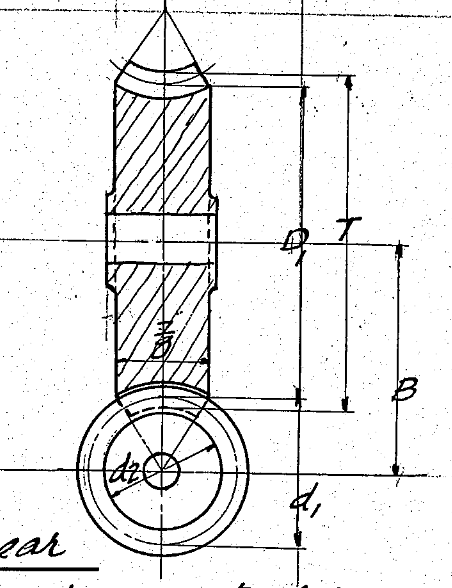


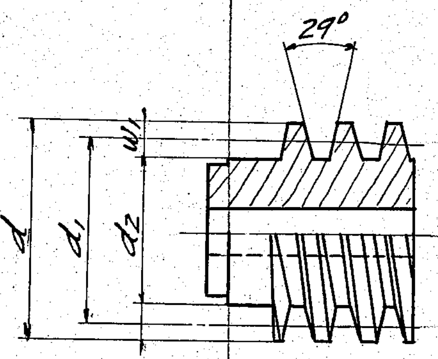
$R_t$ = total ratio of gearing = $\frac{7.5\times360}{135} = 20$

$R_w$ = revolution ratio for worm gear = 10

$R_v$ = 〃 〃 for Bevel gear = 2

Rotating angle of worm wheel = 135°





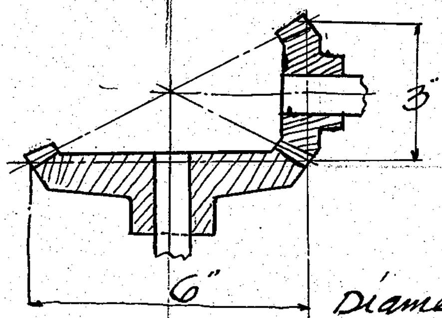
doublethreads.

## Worm gear

N = no. of teeth in worm wheel = 20
n = no. of threads in worm = 2
P = circular pitch of teeth = $\frac{3}{8}''$
$D_1 = 20\times\frac{3}{8}\times\frac{1}{\pi} =$ $2''.387$
$T = (20+2)\times\frac{3}{8}\times.3183$ = $2''.626$
$d_1 =$ $1''.738$
$B = \frac{2.387+1.738}{2} =$ $2.0625 = 2\frac{1}{16}''$

$d = \frac{3}{8}''\times.3183\times2 + 1''.738 = .1193\times2+1.738$
$= 1''.977$

## Bevel gear



Diametral pitch 5
No of teeth = 15

Diametral pitch 5
No. of teeth = 30

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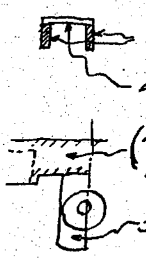
CALCULATIONS FOR

material list of movable gate



| name | Total wt. (#) | arm ± X | arm ± Y. | ±X m't. (ft.lbs) | ±Y m't. (ft/lbs) |
|---|---|---|---|---|---|
| gate (桧) | 43.2 | | | 343.5 | 15.3 |
| c.i block & screw | 3.6 | | | 30.0 | 0.7 |
| ⊥ 1¼ × 1½ × $\frac{3}{16}$ × 8'4 @1.66 | 13.8 | | | 115.0 | 1.1 |
| 9 sug Rods @.261 | 2.3 | | | 19.2 | .2 |
| end cover pl. | 4.1 | | | 65.4 | 1.5 |
| | 67.0 | | | 573.1 | 18.8 |
| Counter w't case :- | | | | | |
| 4 × ⅞ × 1'0 @11.9 | 11.9 | + 1'3¾ | + 5 | + 15.1 | + 5.0 |
| 4¼ × ½ × 1'0 , 7.23 | 7.2 | + , | + 7¼" | + 9.1 | + 4.3 |
| (4¼ × 4 × 0'9¼<br>2¾ × 2½ × ") 57.8<br>− 23.8<br>@34.0 | 26.2 | + 4⅝ | + 5½" | + 10.2 | + 12.1 |
| 3¼ × 2 × 0'8 @22.1 | 14.8 | + 1" | − 0½" | + 1.2 | − 0.6 |
| (−)(3½" × 2 × 0'5½) @23.8 | −(10.9) | −(− 1½) | +(− 2") | + 1.4 | + 1.9 |
| 6" × 4" × 1'0" @81.6 | 81.6 | − 2" | + 1½" | − 13.9 | + 10.6 |
| 12" × 7¼" × 1'10¾" @295.8 | 562.0 | − 1'3⅜ | + 1½" | − 741.8 | + 73.0 |
| −(6¼ × 8 × 0'7½) @170.0 | −(106.3) | −(− 1'10) | − (2½") | + 194.5 | − 22.3 |
| −(5¼ × 2 × 0'9½) @35.7 | −(28.2) | −(1'10) | − (−3½) | + 51.6 | + 8.2 |
| −(8¾" × 6¼ × 1'0¼") @185.9 | −(189.6) | −(− 1⅛) | − (− 0⅝) | + 176.3 | + 1.9 |
| | 368.7 × .92<br>≒ 339. | | | − 296.3 × .92<br>≒ −(272.6) ft lbs. | + 94.1 × .92<br>= +(86.7) ft lbs. |
| 1 Pl. 10½ × ¼ × 1'10¾ @8.925 | 17.0 | − 1'3⅞" | + 2" | − 22.4 | + 2.9 |
| 1 Cast iron 7 × 5¾ × 7½ | 79.0 | − 1'10 | + 2½ | − 144.0 | + 16.6 |
| total | 502.0 | | | + 133.5'# | 125.0'# |

---(I)

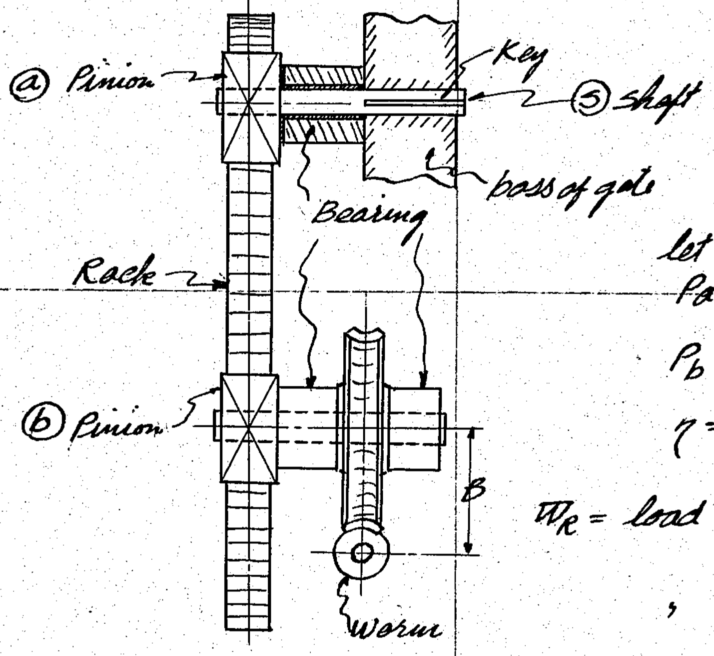
arm for X 133.5 ÷ 502 = .266 ≒ 3$\frac{3}{16}$"
" , Y 125.0 ÷ 502 = .249 ≒ 3"

Wind resistance :-
Wind pressure 10#/sq ft.
Length of gate 15 ft assume
men width of gate 3.4"

$$\text{moment } 10 \times \frac{3.4}{12} \times \frac{15^2}{2} = 320 \text{ ft. lbs} \qquad \text{------(II)}$$

Total m't (I) + (II) = 112.5 + 320. = 445.0 ft. lbs.

## Gears for movable gate



m't. of load at shaft ⑤ = 445 ft-lbs for 10#/□ft wind and unbalanced load

" " " = 133.5 ft-lbs for unbalanced load only. (no wind)

let

$P_a$ = pitch dia of ⓐ pinion = 6"

$P_b$ = " " of ⓑ " = $3\frac{3}{4}$

$\eta$ = gear efficiency = 93%

$W_R$ = load at Rack = $\frac{445 \times 12}{\frac{P_a}{2}} \times \frac{1}{\eta} = \frac{445 \times 12}{3 \times .93}$ = 1,920# at 10# wind

" " $\frac{133.5 \times 12}{3 \times .93}$ - - - - - - = 575# at no wind

Pinion ⓑ :-

$W_b$ = load at tooth = $\frac{W_R}{\eta} = \frac{1920}{.93}$ = 2,100#

P.D = Pitch dia - - - - - = $3\frac{3}{4}$

D.P = diametral pitch - - - - = 4

P = circular pitch - - - - = .7854"

F = face of tooth - - - - = 2"

N = no of teeth - - - - = 15

y = Constant - - - - = .075

unit fiber stress $S = \frac{2100}{.7854 \times 2 \times .075}$ = 17,800 #/□"

(allowable S = 20,000 #/□")

Pinion ⓐ :-

D. P = 4

P = .7854"

F = 2"

N = 24

P.D = 6"

Worm gear :-

P = circular pitch = 0.75"

N = no of teeth of worm wheel = 26.

P.D = pitch dia of " = $\frac{.75 \times 26}{\pi}$ = 6.207"

F = face of teeth = 1.1" assume

y = - - - - - - = .100

$W_w$ = load on tooth of worm wheel = $\frac{2,100 \times 3.75}{6.207}$ = 1,270.#

unit fiber stress $S = \frac{1270}{.75 \times 1.1 \times .100}$ = 15,400 #/□"

(allowable S = 20,000 #/□")

n = no of thread of worm = 1.

pitch dia of worm = 1.793

B = C. to C. of worm and worm wheel = $\frac{6.207+1.793}{2}$ = 4"

增田淳氏関係資料（独立行政法人 土木研究所蔵）

$s$ = addendum $= .3183 \times .75 = .2387$
$d$ = outside dia of worm $= 1.793 + 2 \times .2387 = 2.270$
$w$ = whole depth of tooth $= .6866 \times .75 = .515''$
$d_2$ = bottom dia of worm $= 2.270 - 2 \times .515 = 1.24''$

$\alpha$ = angle of inclination of worm thread

$$\tan\alpha = \frac{.75}{1.793 \times \pi} = .1331 \quad \therefore \alpha = 7^\circ\text{-}40'$$

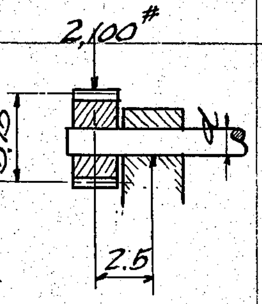
$\eta$ = gear efficiency $= 65\%$

Handle:-

arm $= 13''$

handle power $= 2{,}100 \times \dfrac{3.75 \times \pi}{13 \times 2 \times \pi} \times \dfrac{1}{26} \times \dfrac{1}{.65} = 17.95 \doteqdot 18^{\#}$ at $10^{\#}$ wind

Shaft for pinion ⓑ :-



$M_b = 2{,}100 \times 2.5 = 5{,}250''\text{-}\#$

$M_t = 2{,}100 \times 1.875 = 3{,}940$

$M_e = 5{,}250 + \sqrt{5{,}250^2 + 3940^2} = 5{,}250 + 6{,}560 = 11{,}810''\text{-}\#$

$$d = 1.72\sqrt[3]{\frac{M_e}{f}} = 1.72\sqrt[3]{\frac{11{,}810}{12{,}000}} = 1.72 \times .99 = 1.70'' \text{ say } 1\tfrac{3}{4}''$$

where $f = 12{,}000^{\#}/\square''$ for medium hard steel (半硬鋼)

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CHECKED BY______ DATE______ **PAGE NO** 64

CALCULATIONS FOR

Material list of Karumojima Swing bridge for City of Kobe

| No | Descr' | Section | Length ft. in | Weight per ft. | | |
|---|---|---|---|---|---|---|
| | | | √MAIN GIRDER | | MG1 R/L | √4 Required. |
| 2 | Flg Ls | 150×150×15 | 8'-0" | 22.55 | 361 | |
| 2 | " | " | 27'-4 3/4" | " | 1,236 | |
| 2 | " | " | 27'-1 5/8" | " | 1,224 | |
| 2 | " | " | 29'-11 7/16" | " | 1,351 | |
| 2 | " | " | 27'-1 1/4" | " | 1,222 | |
| 4 | Splice Ls | " | 2'-0 3/4" | " | | 186 |
| 2 | " | " | 2'-0 1/2" | " | | 92 |
| 1 | L | 5×3 1/2×3/8 | 5'-4 1/4" | 10.4 | | 56 |
| 1 | " | " | 5'-5 1/4" | " | | 57 |
| 2 | " | " | 5'-5 5/8" | " | | 114 |
| 2 | Fills. | 12 3/8" × 5/8" | 4'-6 1/2" | 26.29 | | 239 |
| 2 | Ls | 5×3 1/2×3/8 | 5'-7 3/4" | 10.40 | | 118 |
| 2 | " | " | 5'-9 1/8" | " | | 120 |
| 2 | " | " | 5'-10 7/8" | " | | 123 |
| 1 | L | " | 5'-11 3/8" | " | | 62 |
| 1 | " | " | 6'-0 5/8" | " | | 63 |
| 2 | Ls | " | 6'-2 5/8" | " | | 129 |
| 2 | " | " | 6'-4 5/8" | " | | 133 |
| 1 | L | " | 6'-5 3/8" | " | | 67 |
| 1 | " | " | 6'-6 5/8" | " | | 68 |
| 2 | Ls | " | 6'-8 5/8" | " | | 140 |
| 2 | " | " | 6'-10 5/8" | " | | 143 |
| 1 | L | " | 6'-11 3/8" | " | | 72 |
| 1 | " | " | 7'-0 5/8" | " | | 73 |
| 2 | " | " | 7'-2 5/8" | " | | 150 |
| 1 | Filler | 8" × 5/8" | 5'-0 1/4" | 17.00 | | 85 |
| 1 | Filler | 8" × 5/8" | 5'-6 1/4" | " | | 94 |
| 1 | " | " | 6'-0 1/4" | " | | 102 |
| 1 | Pl. | 13" × 5/8" | 2'-0 1/2" | 16.58 | | 34 |
| 2 | Pls | 5" × 5/8" | 1'-10 3/4" | 10.63 | | 40 |
| 2 | " | " | 1'-10 1/2" | " | | 40 |
| 2 | " | 12 1/2" × 7/16" | 5'-1 3/4" | 18.59 | | 191 |
| 2 | " | 13" × 5/8" | 2'-0 1/2" | 16.58 | | 68 |
| 2 | " | 5" × 5/8" | 1'-10 3/4" | 10.63 | | 40 |
| 2 | " | " | 1'-10 1/2" | " | | 40 |
| 2 | " | 12 1/2 × 7/16" | 5'-9" | 18.59 | | 214 |
| 2 | " | 13" × 5/8" | 2'-7" | 16.58 | | 86 |
| 2 | " | 15" × 5/8" | 2'-7 3/4" | 19.13 | | 101 |
| 1 | Pl. | " | 2'-10 1/2" | " | | 55 |
| 2 | Cov. pls | 13 1/2" × 1/2" | 9'-9 1/2" | 22.95 | 449 | |
| 1 | Web pl. | 73" × 7/16" | 19'-8 11/16" | 108.60 | 2,142 | |
| 1 | " | 80 1/2" × 7/16" | 19'-9 1/4" | 119.75 | 2,368 | |
| 1 | " | 87" × 7/16" | 17'-6 3/4" | 129.40 | 2,273 | |
| 4 | Ls | 150×150×15 | 3'-2 1/2" | 22.55 | | 289 |
| 2 | Pls | 9 1/2" × 5/8" | 3'-0 3/4" | 20.19 | | 124 |
| 2 | Pls | " | 3'-0 1/2" | " | | 123 |
| 2 | " | 18 1/2" × 7/16" | 4'-8 1/4" | 27.52 | | 258 |
| 1 | Pl. | 13 × 1/2 | 2'-3" | 22.10 | | 50 |
| 1 | " | 13 1/2" × 5/8" | 2'-1" | 17.21 | | 36 |
| | | | | | 12,626 | 4,275 = 16,901 |
| | | | | | | × 4 |
| | | | | | | 67,604 |

MADE BY________ DATE________ **FILE NO**________

CHECKED BY________ DATE________ **PAGE NO** 65

CALCULATIONS FOR

Material list of Karumojima Swing bridge for City of Kobe.

## ✓MAIN GIRDER MG2 ✓2 Required.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | Flg Ls | 150×150×15 | 32'-2" | 22.55 | 1,451 | | |
| 2 | " | " | 32'-4⅝" | " | 1,449 | | |
| 2 | Web pls | 90" × 7/16" | 16'-0¾" | 133.90 | 4302 | | |
| 2 | Cov pls | 13½" × ½" | 10'-9" | 22.95 | 493 | | |
| 2 | " | " | " | " | 493 | | |
| 2 | " | " | 16'-0¾" | " | 737 | | |
| 2 | " | " | 16'-0¾" | " | 737 | | |
| 2 | " | " | 16'-4⅝" | " | 752 | | |
| 2 | " | " | 13'-10⅛" | " | 635 | | |
| 1 | " | " | 3'-5" | | | 78 | |
| 4 | Ls | 5"×3½"×⅜" | 7'-4⅝" | 10.40 | | 307 | |
| 4 | " | 150×150×11 | 7'-5¼" | 16.77 | | 499 | |
| 8 | " | 5"×3½"×⅝" | 7'-5¼" | 16.80 | | 1,000 | |
| 4 | Fills | 13 × ⅝" | 6'-6½" | 27.63 | | 723 | |
| 4 | " | 7" × ⅝" | " | 14.88 | | 389 | |
| 2 | pls | 19½" × ⅜" | 3'-6¼" | 24.86 | | 175 | |
| 2 | " | 8½" × ½" | 2'-6½" | 14.45 | | 73 | |
| 2 | Fills | 3" × ⅝" | " | 6.38 | | 32 | |
| 2 | pls | 16½" × ⅝" | 6'-0" | 35.06 | | 421 | |
| 1 | Pl. | 13½" × ½" | 3'-3" | 22.95 | | 75 | |
| 2 | pls | " | 9'-9" | " | | 448 | |
| | | | | | 11,049✓ | 4,220✓ = | 15,269✓ |
| | | | | | | | × 2✓ |
| | | | | | | | 30,538✓ |

## ✓SPLICE PLATE at CENTER

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | pls | 8½" × ½" | 2'-6½" | 14.45 | 73 | |
| 2 | Fills | 3" × ⅝" | " | 6.38 | 32 | |
| 2 | " | 3½" × ½" | 0'-6" | 5.95 | 6 | |
| 1 | Fill | 8 × ⅝" | 1'-5" | 17.00 | 24 | |
| 1 | " | 11⅝" × ⅝" | 1'-5" | 24.71 | 35 | |
| 1 | " | 3" × ⅝" | 2'-1½" | 6.38 | 14 | |
| 1 | " | " | 2'-10¾" | " | 18 | |
| 2 | pls | 8½" × ½" | 3'-4¾" | 14.45 | 98 | |
| | | | | | 300✓ × 1 = | 300✓ |

## ✓BRACKETS

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | pls | 13" × ⅜" | 2'-1¾" | 10.58 | 71 | |
| 2 | Ls | 75×75×9 | 8'-7½" | 6.69 | 115 | |
| 2 | Ls | " | 8'-3¾" | " | 111 | |
| 2 | Ls | 3½"×3"×⅜" | 1'-4½" | 7.90 | 31 | |
| 2 | Ls | " | 1'-7¾" | " | 26 | |
| 2 | Pls. | 23½"×⅜" | 7'-4½" | 29.96 | 442 | |
| | | | | | 796✓ × 1 = | 796 |

✓Summary for MAIN GIRDER 99,238#✓

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CALCULATIONS FOR

Material list of Karumojima Swing bridge for City of Kobe

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ✓ | ✓ | ✓ | FLOOR BEAM | FB1 | ✓ 2 Required | ✓ | |
| 4 | Ls | 75×75×9 | 16'-4" | 6.69 | 437 | | |
| 1 | Web pl. | 27 × 5/16" | 16'-4" | 28.69 | 469 | | |
| 4 | Ls | 90×90×10 | 2'-9 3/8" | 8.96 | | 100 | |
| 4 | Fills | 3½" × 3/8" | 1'-9¼" | 4.46 | | 32 | |
| 7 | Ls | 90×90×10 | 2'-3½" | 8.96 | | 144 | |
| 2 | Pls | 6" × 5/16" | 0'-9¾" | 6.38 | | 10 | |
| 4 | Ls | 75×75×9 | 0'-6¼" | 6.69 | | 14 | |
| 14 | Ls | 3½"×3"×3/8" | 0'-6½" | 7.90 | | 60 | |
| 14 | Ls | " | 0'-5" | " | | 46 | |
| 7 | Pls | 6¾" × 3/8" | 0'-8" | 8.61 | | 40 | |
| 2 | Ls | 3½×3×3/8" | 1'-0 5/8" | 7.90 | | 17 | |
| 4 | " | " | 1'-0¼" | " | | 32 | |
| 4 | " | " | 0'-10¾" | " | | 28 | |
| 4 | " | " | 0'-8½" | " | | 22 | |
| 1 | Pls | 12½" × 3/8" | 1'-4 5/8" | 15.94 | | 21 | |
| 2 | " | " | 1'-3¾" | " | | 42 | |
| 2 | " | " | 1'-2¼" | " | | 38 | |
| 2 | " | 12" × 3/8" | 1'-0½" | 15.30 | | 32 | |
| | | | | | 906✓ | 678✓ = | 1,584✓ |
| | | | | | | | × 2✓ |
| | | | | | | | 3,168✓ |
| | | | | FB2 | ✓ 6 Required. | | |
| 2 | Ls | 75×75×9 | 16'-4" | 6.69 | 219 | | |
| 2 | " | " | 15'-5¾" | " | 207 | | |
| 1 | Web pl. | 27 × 5/16" | 16'-4" | 28.69 | 469 | | |
| 2 | Ls | 5×3½×3/8" | 2'-2¾" | 10.40 | | 46 | |
| 2 | Fills. | 7½" × 3/8" | 1'-9¼" | 9.56 | | 34 | |
| 2 | Ls | 75×75×9 | 0'-11½" | 6.69 | | 13 | |
| 2 | Pls | 8" × 5/16" | 0'-10" | 8.50 | | 14 | |
| 8 | Ls | 75×75×9 | 2'-3½" | 6.69 | | 123 | |
| | | | | | 895✓ | 230✓ = | 1125✓ |
| | | | | | | | × 6✓ |
| | | | | | | | 6750✓ |
| | ✓ | | | FB3 R L | ✓ 2 Required. | | |
| 1 | Flg L | 5×3½×½" | 15'-4" | 13.60 | 209 | | |
| 1 | " | " | 16'-4" | " | 222 | | |
| 1 | " | " | 16'-6" | " | 224 | | |
| 1 | " | " | 15'-6" | " | 211 | | |
| 1 | Web pl | 30" × 3/8" | 16'-4" | 38.25 | 625 | | |
| 2 | Ls | 150×150×15 | 2'-2½" | 22.55 | | 100 | |
| 2 | Fills | 9" × ½" | 1'-8¼" | 15.30 | | 52 | |
| 4 | Ls | 75×75×9 | 2'-2½" | 6.69 | | 59 | |
| 4 | Fills | 3" × ½" | 1'-8¼" | 5.10 | | 34 | |
| 16 | Ls | 4"×3"×3/8" | 2'-5½" | 8.50 | | 334 | |
| 4 | Fills | 13" × ½" | 1'-11¼" | 22.10 | | 171 | |
| 4 | Ls | 75×75×9 | 2'-5½" | 6.69 | | 66 | |
| 4 | Fills | 3" × ½" | 1'-11¼" | 5.10 | | 40 | |
| 1 | Cov. pl | 11" × 3/8" | 10'-2½" | 14.03 | | 143 | |
| 1 | " | " | 12'-7" | " | | 177 | |
| 2 | Pls | 19 × 5/8" | 3'-4¾" | 40.38 | | 274 | |
| 2 | Ls | 5×3½×½" | 1'-1" | 13.60 | | 29 | |
| 1 | pl | 6" × ½" | 2'-7" | 10.20 | | 26 | |
| 1 | " | " | 0'-11 3/8" | " | | 10 | |
| | | | | | 1,491✓ | 1,515✓ = | 3,006✓ |

CALCULATIONS FOR

Material list of Karumojima Swing bridge for city of Kobe

× 2
6,012

FLOOR BREAK FK1 2 Required.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | [ | 12 × 3½" | 17'-0" | 26.10 | 444 | |
| 1 | L | 90×90×10 | 16'-6" | 8.96 | 148 | |
| 7 | Fillers | 3½ × ⅜" | 0'-7½" | 4.46 | | 20 |
| | | | | | 592 | 20 = 612 |

× 2
1,224

Summary of FLOOR BEAMS 17,154

BOTTOM LATERAL BRACINGS

| | | | | | |
|---|---|---|---|---|---|
| 12 | Ls | 4×3 × ⅜ | 21'-1½" | 8.50 | 2,155 |
| 12 | " | " | 10'-2" | " | 1,037 |
| 12 | " | " | 10'-4½" | " | 1,058 |
| 6 | Pls | 14½" × ⅜" | 1'-10½" | 18.49 | 208 |
| 24 | " | 7" × ⅜" | 0'-10½" | 8.93 | 188 |
| 24 | Ls | 90×90 × 10 | 0'-7" | 8.96 | 125 |
| 2 | Ls | 4"×3" × ⅜" | 20'-11" | 8.50 | 356 |
| 2 | " | " | 21'-1½" | " | 359 |
| 2 | " | " | 10'-4½" | " | 176 |
| 2 | " | " | 10'-2" | " | 173 |
| 4 | " | " | 10'-2" | " | 346 |
| 2 | Pls | 14½" × ⅜" | 2'-3½" | 18.49 | 85 |
| 8 | Ls | 90×90 × 10 | 0'-7" | 8.96 | 42 2 |
| 8 | Pls | 7" × ⅜" | 0'-10½" | 8.93 | 63 |
| 2 | Ls | 4"×3" × ⅜" | 21'-1½" | 8.50 | 359 |
| 4 | " | " | 10'-2½" | " | 348 |
| 1 | Pl. | 17½" × ⅜" | 2'-9½" | 22.31 | 62 |
| 9 | Ls | 90×90 × 10 | 0'-7" | 8.96 | 47 |
| 4 | Pls | 7" × ⅜" | 1'-0½" | 8.93 | 37 |
| 1 | L | 90×90 × 10 | 1'-0½" | 8.96 | 9 |
| 1 | Pl | 7" × ⅜" | 1'-0" | 8.93 | 9 |

7,242 × 1 = 7,242#

Summary for LATERAL BRACINGS = 7,242#

**JIUN MASUDA**
CONSULTIEG ENGINEER
JIJI BLDG, TOKYO

MADE BY______ DATE______ **FILE NO**______

CHECKED BY______ DATE______ **PAGE NO** 68

CALCULATIONS FOR

Material list of Karumojima Swingbridge for city of kobe

## STRINGERS

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | S1. | | 16 Required | |
| 1 | [ | 12" × 3½" | 15'-11" | @ 26.10 | | 415 |
| 4 | Ls | 90×90×10 | 0'-10" | 8.96 | | 30 |
| | | | | | | 445 × 16 = 7,120 |
| | | | S2 | | 2 Required. | |
| 1 | I | 12 × 3½ | 16'-5" | @ 26.10 | | 428 |
| 4 | Ls | 90.90×10 | 0'-10" | 8.96 | | 30 |
| | | | | | | 458 × 2 = 916 |
| | | | S3 & S5 | | 22 Required | |
| 1 | I | 12 × 5 | 15'-11" | @ 31.99 | | 509 |
| 4 | Ls | 90×90×10 | 0'-10" | 8.96 | | 30 |
| | | | | | | 539 × 22 = 11,858 |
| | | | S4 | | 2 Required | |
| 1 | I | 12 × 5 | 16'-5" | @ 31.99 | | 525 |
| 4 | Ls | 90×90×10 | 0'-10" | 8.96 | | 30 |
| | | | | | | 555 × 2 = 1,110 |
| | | | S6 & S6A. | | 12 Required. | |
| 1 | I | 12 × 5 | 15'-11" | @ 31.99 | | 509 |
| 4 | Ls | 90×90×10 | 0'-10" | 8.96 | | 30 |
| | | | | | | 539 × 12 = 6,468 |
| | | | S7 & S7A | | 2 Required. | |
| 1 | I | 14" × 6" | 16'-5" | @ 46.01 | | 755 |
| 4 | Ls | 90×90×10 | 0'-10" | 8.96 | | 30 |
| | | | | | | 785 × 2 = 1,570 |
| | | | S8 | | 1 Required. | |
| 1 | I | 12" × 5 | 8'-7½" | @ 31.99 | | 276 |
| 3 | Ls | 90×90×10 | 0'-10" | 8.96 | | 22 |
| 1 | L | 6"×3½"×⅜" | " | 11.70 | | 10 |
| | | | | | | 308 × 1 = 308 |
| | | | S9 | | 1 Required. | |
| 1 | I | 12" × 5" | 5'-3" | @ 31.99 | | 168 |
| 3 | Ls | 90×90×10 | 0'-10" | 8.96 | | 22 |
| 1 | L | 6"×3½"×⅜" | " | 11.70 | | 10 |
| | | | | | | 200 × 1 = 200 |
| | | | S10 | | 2 Required. | |
| 1 | I | 12" × 5" | 15'-11" | @ 31.99 | | 509 |
| 4 | Ls | 90×90×10 | 0'-10" | 8.96 | | 30 |
| 1 | I | 14" × 6" | 1'-8" | @ 46.01 | | 77 |
| 1 | L | 6" × 4"×½" | 1'-8" | 16.20 | | 27 |
| 2 | Ls | 3"×3"×⅜" | 1'-0¾" | 7.20 | | 15 |
| | | | | | | 658 × 2 = 1,316 |
| | | | S11 | | 2 Required. | |
| 1 | I | 12" × 5" | 13'-5" | @ 31.99 | | 429 |
| 4 | Ls | 90×90×10 | 0'-10" | 8.96 | | 30 |
| | | | | | | 459 × 2 = 918 |

MADE BY______________ DATE______________ **FILE NO**______________

CHECKED BY______________ DATE______________ **PAGE NO** 69

CALCULATIONS FOR

Material list of Karumojima Swing bridge for City of Kobe

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | S12 | | 2 Required. | |
| 1 | [ | 6" × 3½" | 3'-1¾" | @ 17.90 | | 71 |
| 1 | L | 3½" × 3" × ⅜" | 0'-5¼" | 7.90 | | 3 |
| | | | S13 | | 4 Required. | 74 × 2 = 148 |
| 1 | I | 8" × 4" | 2'-5" | @ 18.01 | | 44 |
| 4 | Ls | 6" × 3½" × ⅜" | 0'-5½" | 11.70 | | 21 |
| | | | | | | 65 × 4 = 260 |
| | | | S14 | | 1 Required. | |
| 1 | [ | 15" × 4" | 2'-3" | @ 41.94 | | 94 |
| 2 | Ls | 90×90×10 | 0'-10" | 8.96 | | 15 |
| 4 | " | " | 0'-7¼" | " | | 22 |
| | | | | | | 131 × 1 = 131 |
| | | | S15 | | 1 Required | |
| 1 | [ | 12" × 3½" | 2'-3" | @ 26.10 | | 59 |
| 2 | Ls | 90×90×10 | 0'-7½" | 8.96 | | 11 |
| 2 | " | 6" × 3½" × ⅜" | 0'-10" | 11.70 | | 19 |
| | | | | | | 89 × 1 = 89. |
| | | | S16 | | 1 Required. | |
| 1 | [ | 10" × 3½" | 2'-0½" | @ 23.55 | | 48 |
| 1 | L | 6" × 3½" × ⅜" | 0'-8½" | 11.70 | | 8 |
| 1 | Pl. | 5½" × ⅜" | " | 7.01 | | 5 |
| | | | | | | 61 × 1 = 61 |
| | | STRUTS | ST1 & ST1A | | 16 Required. | |
| 1 | [ | 9" × 3½" | 2'-3" | @ 22.27 | | 50 |
| 4 | Ls | 90×90×10 | 0'-6½" | 8.96 | | 19 |
| | | | | | | 69 × 16 = 1,104 |
| | | | ST2 | | 2 Required. | |
| 1 | I | 12" × 5 | 4'-7" | @ 31.99 | | 147 |
| 4 | Ls | 90×90×10 | 0'-10" | 8.96 | | 30 |
| | | | | | | 177 × 2 = 354 |
| | | | ST3 | | 2 Required | |
| 1 | I | 8" × 4" | 5'-1¼" | @ 18.01 | | 90 × 2 = 180 |
| | | | ST4 | | 2 Required. | |
| 1 | [ | 8" × 3" | 2'-9¼" | @ 19.30 | | 53 |
| 2 | Ls | 3½" × 3 × ⅜" | 0'-5¼" | 7.90 | | 7 |
| 1 | L | 6" × 3½" × ⅜" | 0'-5" | 11.70 | | 5 |
| | | | | | | 65 × 2 = 130 |
| | | | ST5 | | 2 Required. | |
| 1 | I | 14" × 6" | 4'-6½" | @ 46.01 | | 209 |
| 4 | Ls | 90×90×10 | 0'-10" | 8.96 | | 30 |
| | | | | | | 239 × 2 = 478 |
| | | STRINGER | S10A | | 2 Required. | |
| 1 | I | 12" × 5" | 15'-11" | @ 31.99 | | 509 |
| 4 | Ls | 90×90×10 | 0'-10" | 8.96 | | 30 |
| | | | | | | 539 × 2 = 1,078 |

Summary of Stringers & Struts 35,797 ✓

CALCULATIONS FOR

Material list of Karumojima Swing bridge for City of Kobe

OPERATING HOUSE FLOOR FRAMING

| | | | | | |
|---|---|---|---|---|---|
| 4 | [s | 9"×3½" @ 22.27# | 6'-4" | | 564 |
| 8 | Ls | 90×90×10 | 0'-5½" | 8.96 | 33 |
| 8 | " | " | 0'-4¾" | " | 29 |
| 1 | [ | 9"×3½" @ 22.27# | 3'-9" | | 84 |
| 4 | Ls | 90×90×10 | 0'-5½" | 8.96 | 16 |
| 1 | L | " | 0'-6¾" | " | 5 |
| 1 | Pl | 16½×⅜" | 1'-6" | 21.04 | 32 |
| 1 | L | 6"×3½"×⅜" | 0'-6½" | 11.70 | 6 |
| 1 | Pl | 8½"×⅜" | 0'-10½" | 10.84 | 10 |
| 1 | Pl | 7½"×1/16" | 2'-5 | 1.59 | 4 |
| 1 | [ | 8"×2½"@ 15.12# | 3'-2½" | | 49 |
| | | | | | 832✓ |

CALCULATIONS FOR

# Material list of Karumojima Swing bridge for city of Kobe

## CANTILEVER for OPERATING HOUSE

| | | | | | |
|---|---|---|---|---|---|
| 1 | [ | 9 × 3½ | 15'-5⅜" | @ 22.27 | 344 |
| 1 | " | " | 10'-5" | " | 366 |
| 2 | [s | " | 5'-5" | " | 241 |
| 2 | Ls | 150×150×15 | 6'-5¼" | 22.55 | 290 |
| 1 | L | 75 × 75 × 9 | 5'-8 | 6.69 | 38 |
| 2 | Ls | " | 8'-11¼" | " | 120 |
| 1 | L | 90×90 × 10 | 10'-5 | 8.96 | 147 |
| 2 | pl/s | 14¾" × ⅜" | 1'-3" | 18.81 | 47 |
| 1 | pl. | 6½" × ⅜" | 0'-9½" | 8.29 | 7 |
| 1 | Pl. | 10 × ⅜" | 1'-11½" | 12.75 | 25 |
| 2 | pl/s | 9¼ × ⅜" | 0'-11" | 11.79 | 22 |
| 2 | " | 10¾" × ⅜" | 1'-0½" | 13.71 | 29 |
| 2 | " | 16¾ × ⅜" | 1'-8" | 21.36 | 71 |
| 2 | " | 20¼" × ⅜" | 2'-8" | 25.82 | 138 |
| 2 | " | 27 × ⅜" | 3'-8" | 34.43 | 253 |
| 2 | " | 5½" × ⅜" | 1'-4¾" | 7.01 | 20 |
| 2 | Fills | 8¼ × ⅜" | 1'-11½" | 10.52 | 41. |
| 2 | Ls | 75 × 75 × 9 | 6'-11¾" | 6.69 | 93 |
| 2 | Ls | 90×90×10 | 5'-7" | 8.96 | 100 |
| 2 | " | " | 5'-4¼" | " | 96 |
| 2 | " | " | 6'-4" | " | 113 |
| 2 | " | " | 1'-0⅝" | " | 19 |
| 2 | " | 150×150×15 | 2'-2⅞" | 22.55 | 101. |
| 2 | " | " | 0'-7" | " | 26 |
| 2 | pl/s | 13" × ⅜" | 2'-1¾" | 16.58 | 71 |
| 2 | " | 16½" × ⅜" | 1'-4¾" | 21.04 | 59 |
| 1 | pl. | 8¼ × ⅜" | 2'-0¾" | 10.52 | 22 |
| 2 | Ls | 75×75×9 | 7'-7½" | 6.69 | 102 |
| 1 | L | " | 16'-6½" | " | 111 |
| | | | | | 3,112 |

Summary of OPERATING HOUSE 3,944.

## BRACKET for MAIN PINION SHAFT.

| | | | | | |
|---|---|---|---|---|---|
| 1 | pl. | 18" × ½" | 4'-5⅞" | 30.60 | 137 |
| 1 | " | 17" × ⅜" | 1'-10" | 21.68 | 40 |
| 1 | " | 12 × ⅜" | " | 15.30 | 28 |
| 1 | L | 100×100×10 | 2'-2" | 10.02 | 22 |
| 1 | pl. | 12¾" × ⅜" | 1'-1" | 16.26 | 18 |
| 1 | L | 90×90×10 | 1'-6" | 8.96 | 13 |
| 1 | Fill | 5" × 10" | 0'-9" | 6.38 | 5 |
| 2 | Ls | 100×100×10 | 4'-1" | 10.02 | 82 |
| 1 | Pl. | 18" × ½" | " | 30.60 | 125 |
| 1 | Fill | 8½" × ⅜" | 0'-10" | 10.84 | 9 |
| 1 | Pl. | 17⅞" × ½" | 1'-6¾" | 30.39 | 48 |
| 4 | Ls | 4 × 3 × ⅜" | 1'-9" | 8.50 | 60 |
| 1 | Web pl. | 9¾" × ½" | " | 16.58 | 29 |
| 4 | Ls | 5" × 3½ × ⅜" | 0'-9½" | 10.40 | 33 |
| 4 | Washers | 3¼ × ⅜" | | @ 0.75 | 3 |
| 1 | Fill | 10" × ⅜" | 2'-0" | 12.75 | 26 |
| 1 | Pl. | 12" × ½" | 3'-7½" | 20.40 | 74 |
| 2 | Ls | 100×100×10 | 1'-6" | 10.02 | 30 |
| 1 | pl | 12" × ½" | 3'-4½" | 20.40 | 69 |
| 1 | L | 90×90×10 | 1'-1" | 8.96 | 10 |
| 1 | L | 100×100×10 | 4'-2⅞" | 10.02 | 43 |
| 3 | Ls | 90×90×10 | 1'-1" | 8.96 | 29 |
| | | | | | 933 |

CALCULATIONS FOR

Material list of Karumojima Swing bridge for City of Kobe

SEGMENT A1, A2 & A3 of DRAM — 4 Required

| | | | | | |
|---|---|---|---|---|---|
| 4 | Flg Ls | 150×150×19 | 14'-0$\frac{5}{16}$" | 28.16 | 1580 |
| 1 | Web pl. | $23\frac{1}{2}$ × $\frac{1}{2}$" | " | 39.95 | 560 |
| 16 | Ls | 5×$3\frac{1}{2}$"×$\frac{1}{2}$" | 1'-$10\frac{1}{2}$" | 13.60 | 408 |
| 4 | Ls | 130×130×15 | 2'-$7\frac{1}{2}$" | 19.38 | 204 |
| 2 | pls | 12 × $\frac{1}{2}$ | 1'-$6\frac{1}{2}$" | 20.40 | 63 |
| 1 | pl. | $12\frac{3}{4}$" × $\frac{1}{2}$" | 1'-$10\frac{1}{4}$" | 21.68 | 40 |
| 8 | Fills | $3\frac{1}{2}$" × $\frac{3}{4}$" | 0'-$1\frac{3}{4}$" | 8.93 | 70 |
| 4 | " | $7\frac{1}{2}$ × $\frac{3}{4}$" | " | 19.13 | 75 |
| 2 | pls | 14" × $\frac{1}{2}$" | 3'-$5\frac{1}{2}$" | 23.80 | 165 |
| | | | | | 3165 × 4 = 12,660 |
| 1 | Fill. | $8\frac{1}{2}$" × $\frac{3}{4}$" | 1'-0" | 21.68 | 22 (+ |
| | | | | | 12,682 |

CENTER PLATE — P1 & P2 — 2 Reqd.

| | | | | | |
|---|---|---|---|---|---|
| 1 | pl. | 34" × $\frac{3}{4}$" | 2'-10" | 86.70 | 246 × 2 = 492 |

CAP PLATE

| | | | | | |
|---|---|---|---|---|---|
| 1 | pl. | 8"φ × $\frac{3}{8}$ | | @ 5.3 | 5 × 1 = 5 |

RADIAL ROD SPACER — 2 Required

| | | | | | |
|---|---|---|---|---|---|
| 1 | I | 6 × $2\frac{1}{2}$" | 15'-11 | 12.04 | 192 |
| 1 | " | | 13'-$3\frac{1}{2}$ | " | 160 |
| 4 | pls | $4\frac{1}{2}$ × $\frac{1}{2}$ | 1'-$5\frac{1}{2}$ | 7.65 | 45 |
| 1 | L | 6×$3\frac{1}{2}$×$\frac{1}{2}$ | 14'-$5\frac{1}{16}$ | 15.30 | 221 |
| 1 | " | " | 12'-$0\frac{1}{4}$ | " | 184 |
| 2 | pl | $3\frac{1}{2}$ × $\frac{1}{2}$ | 1'-$8\frac{1}{2}$ | 5.95 | 20 |
| 2 | " | 6" × $\frac{1}{2}$ | 1'-6" | 10.20 | 31 |
| 22 | Ls | $3\frac{1}{2}$×$2\frac{1}{2}$×$\frac{3}{8}$ | 0'-6" | 7.20 | 79 |
| 11 | bolt | $\frac{3}{4}$φ | 0'-$3\frac{1}{4}$" | @ 0.78 | 9 |
| | | | | | 941 × 2 = 1,882 |

RADIAL STRUT — 8 Required

| | | | | | |
|---|---|---|---|---|---|
| 2 | Bent Ls | $3\frac{1}{2}$×3×$\frac{3}{8}$" | 8'-$1\frac{5}{8}$" | 7.90 | 129 |
| 2 | Ls | " | 7'-$6\frac{5}{8}$ | " | 119 |
| 1 | pl | 21 × $\frac{3}{8}$ | 1'-$10\frac{1}{2}$" | 26.78 | 50 |
| 1 | " | $11\frac{1}{2}$ × $\frac{3}{8}$" | 1'-0" | 14.66 | 15 |
| 1 | Bent pl. | $7\frac{1}{2}$ × $\frac{3}{8}$ | 1'-3" | 9.56 | 12 |
| 12 | Lac bars | $2\frac{1}{4}$ × $\frac{3}{8}$" | 1'-$0\frac{1}{2}$" | 2.87 | 36 |
| 12 | Washers | $2\frac{1}{4}$φ × $\frac{3}{8}$ | | @ 0.42 | 5 |
| | | | | | 366 × 8 = 2928 |

Summary of DRAM. STRUT. etc. 18922

MADE BY________ DATE________ **FILE NO**________
CHECKED BY________ DATE________ **PAGE NO** 73

CALCULATIONS FOR

Material list of Karumojima Swing bridge for City of Kobe

ROLLER. 22 Required.

| | | | | |
|---|---|---|---|---|
| 1 | Cast stee Roller | @ | 163.0# | 163 × 22 = 3,586 ✓ |
| 2 | Phosphor bronze bushing. | @ | 1.7 | 3 × 22 = 66 ✓ |
| 2 | Bolts 1/2"φ × 0'-1"  | @ | 0.14 | 1 |
| | | | | 167 × 22 = 3674 ✓ |

RADIAL ROD & CENTER CASTING

| | | | | |
|---|---|---|---|---|
| 1 | Cast steel centering. | @ | 460.0# | 460 |
| 22 | Radial rods | @ | 58.5 | 1,287 |
| 44 | for 1 5/8"φ bolt nuts | @ | 2.0 | 88 |
| 22 | " 1 1/2"φ " " | @ | 1.1 | 24 |
| | | | | 1,859 ✓ |

UPPER TRACK T1

| | | | | |
|---|---|---|---|---|
| 8 | Cast steel tracks | @ | 429.0# | 3,432 |
| 176 | Pins 7/8"φ × 0'-4 1/2" | @ | 0.7 | 123 |
| 176 | Hex. Nuts for 7/8"φ bolts | @ | 0.22 | 39 |
| | | | | 3,594 ✓ |

LOWER TRACK LT1. LT2. LT3 & LT4.

| | | | | |
|---|---|---|---|---|
| 1 | Cast steel track | @ | 7,340.0# | 7,340. |
| 50 | Pins. 7/8"φ × 0'-4 1/4" | @ | 1.01 | 51 |
| 50 | Hex. Nuts. for 7/8"φ bolts | @ | 0.22 | 11. |
| 16 | Bolts 7/8"φ × 0'-3 1/4" | @ | 1.14 | 18 |
| 16 | " 1"φ × 0'-4 1/2" | @ | 1.86 | 30. |
| 88 | Anchor bolts 1"φ × 1'-0" | @ | 3.1 | 273 |
| | | | | 7,723 ✓ |

CENTER CASTING (Cast iron)

| | | | | |
|---|---|---|---|---|
| 1 | Cast iron | @ | 866.0 | 866 ✓ |
| 1 | Pin. 1 1/4"φ × 0'-3 1/2" with hex nut | @ | 2.39 | 2 |
| 8 | Anchor bolts 1 1/2"φ × 1'-9" | @ | 11.6 | 93 |
| | | | | 961 ✓ |

Total of Rollers, Tracks & Center Casting = 17,811# ✓ ✓

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

Material list of Karumojima Swing bridge for City of Kobe

Grand Summary of Weight. for Swing span (Rivet ヲ含マズ")

| | | | | |
|---|---|---|---|---|
| Summary of | Main girders | 99.238# ✓ | | |
| 〃 〃 | Floor beams | 17,154 ✓ | | |
| 〃 〃 | Latoral bracings | 7,242 ✓ | | |
| 〃 〃 | Stringers & struts | 35,797 ✓ | | |
| 〃 〃 | Operating house | 3,944 ✓ | | |
| 〃 〃 | Drum, strut etc. | 18,922 ✓ | | |
| 〃 〃 | Roller track, and Center Casting | 17,811 ✓ | | Tons |
| | | 200,108 | or | 89.334 |

| | # | | Tons |
|---|---|---|---|
| Structural steel | 184,358 | or | 82.303 |
| Cast steel | 14,818 | | 6.615 |
| Cast iron | ,866 | | 0.387 |
| Phosphorbronze | 66 | | 0.029 |
| | 200,108 | | 89.334 |

MADE BY________ DATE________ **FILE NO**________

CHECKED BY________ DATE________ **PAGE NO** 75

CALCULATIONS FOR

Material list of Karumojima Swingbridge for City of Kobe

## FIXED GIRDER SPAN $G1^{R}_{L}$ . G2 & ST1

| | | | | | |
|---|---|---|---|---|---|
| 4 | I | 20 × 7½ @ 88.96# | 32'-9" | 88.96 | 11.654 |
| 28 | Ls | 3½ × 3½ × 3/8 | 1'-6½" | 8.50 | 367 |
| 4 | Pls | 10 × 3/8 | 1'-2½ | 12.75 | 62 |
| 4 | 〃 | 11 × 3/8 | 0'-11 | 14.03 | 51 |
| 4 | Ls | 3½ × 3½ × 3/8 | 0-11 | 8.50 | 31 |
| 8 | Pls | 12 × 5/8 | 1'-3 | 25.50 | 255 |
| 8 | 〃 | 15 × 5/8" | 1'-3 | 31.88 | 319 |
| 9 | [s | 12 × 3½ @ 26.1# | 4'-6½ | 26.10 | 1,067 |
| 18 | Ls | 3½ × 3½ × 3/8 | 0'-9½ | 8.50 | 121 |
| 16 | Anchor bolts | 1¼"φ × 2'-0" | | @ 10.00 | 160 |
| 16 | Washers | 6" × 3/8" | 0'-6 | 7.65 | 61 |
| | | | | | 14,148 |

## FLOOR BREAK

| | | | | | |
|---|---|---|---|---|---|
| 1 | Cov. Pl. | 3½ × ½ | 16'-9" | 5.95 | 100 |
| 1 | L | 5 × 3 × 3/8 | 16'-10 | 9.72 | 163 |
| 1 | Web Pl. | 8½ × 5/16 | 15'-1" | 903 | 136 |
| 1 | L | 75 × 75 × 9 | 16'-2 | 6.69 | 108 |
| 1 | 〃 | 90 × 90 × 10 | 16-10 | 8.96 | 151 |
| 1 | [ | 12 × 3½ @ 26.1# | 17-0 | 26.10 | 444 |
| 1 | L | 75 × 75 × 9 | 16'-2 | 6.69 | 108 |
| 4 | Ls | 〃 | 0'-10½ | 〃 | 23 |
| 12 | 〃 | 65 × 65 × 8 | 0-5½ | 5.15 | 28 |
| 2 | Pls | 5¼ × 5/16 | 0'-8½ | 5.58 | 8 |
| 2 | Ls | 4 × 3 × 5/16" | 0'-6¾ | 684 | 8 |
| 2 | 〃 | 〃 | 0-7½ | 〃 | 9 |
| 2 | 〃 | 〃 | 0-7 15/16 | 〃 | 9 |
| 1 | 〃 | 〃 | 0-8 1/16 | 〃 | 5 |
| 6 | Fills (Shim) | 2½ × ½ | 0-5½ | 4.25 | 12 |
| 6 | Bolts | ¾"φ | 0-3½ | @ 0.82 | 5 |
| | | | | | 1,317 |

Summary of GIRDER & FLOORBREAK - 15465

## Material list of Karumojima Swing bridge for City of Kobe

### HANDRAILS (for fixed girder spans.)

| | | | | | | |
|---|---|---|---|---|---|---|
| 10 | Cast iron (~~格子~~) HR1 | | @ | 130# | 1,300 | |
| 2 | " " HR2 | | @ | 85 | 170 | |
| 2 | " " HR3 | | @ | 120 | 240 | |
| 12 | " (post) HP1 & HP2 | | @ | 75 | 900 | |
| 10 | Gas pipe | $2''\phi \times 5'\text{-}0\frac{3}{4}''$ | @ | 18.5 | 185 | |
| 2 | " " | " $\times 3'\text{-}6\frac{1}{8}''$ | @ | 13. | 26 | |
| 4 | Anchor bolts | $\frac{5}{8}''\phi \times 0'\text{-}9''$ | @ | 1 | 4 | |
| 2 | pls | $2\frac{1}{2}'' \times \frac{3}{8}''$ $0'\text{-}5\frac{1}{2}''$ | | 3.19 | 3 | |
| 24 | Anchor bolts | $\frac{5}{8}''\phi \times 0'\text{-}9''$ | @ | 1 | 24 | |
| 12 | pls | $2\frac{1}{2} \times \frac{3}{8}''$ $0'\text{-}7\frac{1}{2}''$ | | 3.19 | 24 | |
| 202 | Tap bolts | $\frac{5}{16}''\phi$ $0'\text{-}1\frac{1}{2}$ abt. | @ | 0.035 | 7 | |
| | | | | | 2883 | |

### HAND RAIL POST HP3 & HP4

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | Cast iron. | | @ | 530 | 530.0 | See sheet no 27 |
| 6 | bolts | $\frac{3}{4}''\phi \times 0'\text{-}4\frac{3}{4}''$ | @ | .97 | 5.8 | |
| 6 | Screws. | " $\times 0'\text{-}1\frac{1}{2}''$ | @ | .35 | 2.1 | |
| 3 | " | " $\times 0'\text{-}3\frac{3}{4}''$ | @ | .63 | 1.9 | |
| 3 | " | $\frac{5}{16}''\phi \times 0'\text{-}1\frac{1}{2}''$ | @ | .05 | 0.2 | |
| 4 | Tapped bolts | $\frac{1}{2}''\phi \times 0'\text{-}2\frac{3}{4}''$ | @ | .22 | 0.9 | |
| 6 | " | " $\times 0'\text{-}3$ | @ | .24 | 1.4 | |
| 4 | " | $\frac{5}{8}''\phi \times 0'\text{-}3\frac{3}{4}''$ | @ | .43 | 1.7 | |
| 4 | " | $\frac{3}{4}''\phi \times 0'\text{-}4''$ | @ | .65 | 2.6 | |
| 1 | Cast iron. | | @ | 401.00 | 401.0 | |
| 6 | Bolts | $\frac{3}{4}''\phi \times 0'\text{-}4\frac{3}{4}''$ | @ | .97 | 5.8 | |
| 6 | Screw bolts | " $\times 0'\text{-}7\frac{1}{2}''$ | @ | .35 | 2.1 | |
| | | | | | 955.5 | |

Summary of HAND RAILS — 3838.5

### Total summary for Fixed Girder Span 2 Required.
(Rivet ヲ含マズ)

| | | | |
|---|---|---|---|
| | | | TONS |
| Summary of Girder span | 15,465# | or | 6.904 |
| " " Handrails | 3,838.5 | " | 1.714 |
| | 19,303.5 | | 8.618 |
| | | | 2 |
| | | | 17.236 |

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CHECKED BY K.I. DATE 4-4-2 PAGE NO 77

CALCULATIONS FOR

Material list of Karumojima Swing bridge for City of Kobe

Wooden Flooring for Span
内地産赤松（クレヲソート注入）

| 床板 | 面積 | 厚 | 才数 | 負数 | 總才数 | 摘要 |
|---|---|---|---|---|---|---|
| | 16.00×15.40 | 0.25 | 513.3 | 8 | 4,106 | |
| | 〃 ×15.90 | 〃 | 530.0 | 1 | 530 | |
| | 2.38× 3.2 | 0.30 | 19.0 | 1 | 19 | Capstan hole |
| | 1.4 ×16.00 | 0.25 | 46.7 | 2 | 93 | End |
| | -2.38×4.67 | 〃 | 23.2 | 1 | -23 | Capstan hole |
| | -1.83×1.83 | 〃 | 7.0 | 1 | -7 | Man hole |
| | 2.38×4.67 | 0.30 | 27.8 | 2 | 56 | |
| | -2.38×3.2 | 0.25 | 15.9 | 1 | -16 | |
| | | | | | 4758才 | |

| 敷桁 | 巾 厚 | 長 | 才数 | 負数 | 總才数 | 摘要 |
|---|---|---|---|---|---|---|
| | 0.50×0.38 | 5.50 | 8.7 | 2 | 17 | on stringer |
| | 〃 〃 | 7.70 | 12.2 | 14 | 171 | 〃 |
| | 〃 〃 | 8.20 | 13.0 | 1 | 13 | 〃 |
| | 〃 〃 | 5.0 | 7.9 | 1 | 8 | 〃 |
| | 〃 〃 | 1.10 | 1.7 | 2 | 3 | 〃 |
| | 〃 0.37 | 7.70 | 11.9 | 32 | 381 | 〃 |
| | 〃 〃 | 7.95 | 12.3 | 4 | 49 | 〃 |
| | 〃 〃 | 1.05 | 1.6 | 〃 | 6 | 〃 |
| | 〃 0.33 | 7.70 | 10.6 | 32 | 339 | 〃 |
| | 〃 〃 | 7.95 | 10.9 | 4 | 44 | 〃 |
| | 〃 〃 | 0.95 | 1.3 | 〃 | 5 | 〃 |
| | 0.40×0.27 | 7.70 | 6.9 | 32 | 221 | 〃 |
| | 〃 〃 | 7.95 | 7.2 | 4 | 29 | 〃 |
| | 0.50× 〃 | 0.80 | .9 | 〃 | 4 | 〃 |
| | 〃 ×0.38 | 4.17 | 6.6 | 〃 | 26 | side of holes |
| | 0.60 〃 | 8.3 | 15.8 | 20 | 316 | on floor beam |
| | | | | | 1,632才 | |
| 地覆木 | 0.50×0.34 | 9.40 | 13.3 | 4 | 53 | |
| | 〃 〃 | 8.00 | 11.3 | 28 | 316 | |
| | 0.70 〃 | 8.25 | 16.4 | 4 | 66 | |
| | | | | | 435才 | |

| 木塊 | 面積 | 負数 | 平方呎 | |
|---|---|---|---|---|
| | 15.00×14.70 | 1 | 220.50 | |
| | -6.2″ϕ | 14 | -3.2 | Lub. hole |
| | -.54 ×1.13 | 1 | -0.6 | Ind. holes |
| | -1.79ϕ | 〃 | -2.5 | Cap. hole |
| | -1.83×1.83 | 1 | -3.3 | |
| | -0.5 ×0.67 | 16 | -5.4 | drain |

2,190.0×.093 = 203.7 平方米

| | | |
|---|---|---|
| Asphalt felt | 15.42×14.73 | 2,271.4 ×.093 = 211.2 平方米 |

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CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

締付金物 (ボールト.ワッシヤー釘等)

| | | | | |
|---|---|---|---|---|
| Bolt | $\frac{5}{8}$"φ × 0'-6" | 228 | @ .75 | 171 |
| 〃 | 〃 0'-5½" | 152 | .71 | 108 |
| 〃 | 〃 0'-5" | 152 | .66 | 100 |
| 〃 | 〃 0'-7½" | 14 | .88 | 12 |
| 〃 | 〃 0'-5½" | 90 | .71 | 64 |
| Washer | 2½"φ × ⅛" | 740 | .174 | 129 |
| Beveled washer | 1¾" × ¼" × 1¾" | 520 | .277 | 113 |
| Nail | 6" | 2,750 | .0517 | 142 |
| | | | | 839 lbs. |

Drains 16 drains Required
Weight of Casting 104 cub. inch × 0.26# = 27.04 × 16 = 433 lbs.

Drain pipe copper plate 16 drain pipe Required
$(5\frac{1}{4}" + 4\frac{1}{4}") \times \frac{1}{32}" \times 1'-3\frac{1}{2}"$ = 4.4 × 0.322# = 1.42 × 16 = 23 lbs.

Capstan Cover. 1 Required
Weight of casting 97.53 × 0.26 = 254#

Indicator Cover 1 Required
Weight of casting 253.8 × 0.26 = 66#

Lubricator cover 14 Required
Weight of casting 119.6 × 0.26 = 31 × 14 = 434#

Manhole Cover 1 Required
Weight of casting 1029.8 × 0.26 = 268#

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CHECKED BY K. I. DATE 4-4-4 **PAGE NO** 79

CALCULATIONS FOR

Kasumojima Swing Bridge for City of Kobe.

Material List for Floor of Operating house

Concrete for Floor Slab

| | | |
|---|---|---|
| | 16.58 × 6.0 × .42 | = 41.78 |
| | 1.75 × .50 × .19 | = .17 |
| less | 3.25 × 2.0 × .42 | = -2.73 |
| " | 1.17 × .17 × .42 | = - .08 |
| " | .17 × .08 × .33 | = - .04 |
| " | .25ϕ × .42 | = - .02 |
| " | 2 × .29ϕ × .42 | = - .06 |
| " | .58ϕ × .42 | = - .11 |
| " | .13ϕ × .42 | = - .01 |

38.90 cul. ft × .0283 or 1.101 cub. meters

Form for Floor Slab

| | | | |
|---|---|---|---|
| | 16.58 × 6.0 | = 99.48 | bottom area of slab. gross |
| | .42 × 28.58 | = 12.00 | 3 side |
| | .42 × 10.5 | = 4.41 | manhole |
| | .42 × 3.32 | = 1.39 | hole |
| | .42 × .58ϕ | = .76 | " |
| | .42 × .25ϕ | = .33 | " |
| | 2 × .42 × .29ϕ | = .76 | " |
| — | .42 × .13ϕ | = .17 | " |
| less | 6 × .29 × 5.42 | = -9.43 | top on stringer |
| " | .29 × 15.45 | = -4.48 | " " floor beam |
| " | -3.25 × 2.0 | = - 6.50 | |
| " | 1.17 × 1.7 | = - .20 | |
| " | .25ϕ | = - .05 | |
| " | 2 × .29ϕ | = - .13 | |
| " | .58ϕ | = - .26 | |
| " | .13ϕ | = - .01 | |
| " | .17 × .08 | = - .01 | |

98.22 sq. ft. × .093 = 9.13 sq. m.

Reinforcements for Floor Slab 0.173 ton.

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CALCULATIONS FOR

Karumojima Swing Bridge for city of Kobe.

Material List for Fixed Floor

Asphalt-block pavement

Area 2 spans @ 32.21 × 15.0 = 966.3
- 2×(15.0×.36×.667) = 7.2 End circular segments
- 4×(.67×.5) = 1.34 drain holes

957.76 sq. ft. (88.97 m²)

Concrete for Slab for 2 Spans

Area of Slab 966.3
-7.2
959.1 sq. ft.

thickness .46
441.2 cub ft.

Coping 4×32.21×.75×.77 = 74.4
〃 -4×32.21×.25×.20 = 6.4
〃 -4×32.21×.12×.08 = 1.2
66.8

fillets 4×.80×.09×31.7 = 9.1

517.1 cub. ft. or (14.634 m³)

Mortar Cushion for 2 Span

Area 959.1 (89.2 m²)
thickness 0.417
400 cub. ft. or (1.132 m³)

Forms for Floor Slab for 2 span

Area of Slab 959.1□'
Stringer less 4×.625×31.86 = -79.7
〃 〃 4×.625×31.62 = -79.1
〃 add. 8×.09×31.74 = 22.9
coping 4×1.52×32.21 = 195.8
1,019.0□' or (94.8 m²)

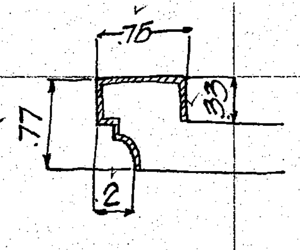
coping
bottom .75
side .77
1.52

Reinforcements for Slab for 2 span
2@1.061 = 2.122 tons

Drain 8 drain required
8@ 28.7 lbs. = 229.6 lbs.

Expansion Joint Carey Elastite filling 二箇所

Artificial granite finishing
2.05 × 32.21 = 66.03
4
264.1 sq. ft. or (24.6 m²)



.75
.33
.77
.20
2.05

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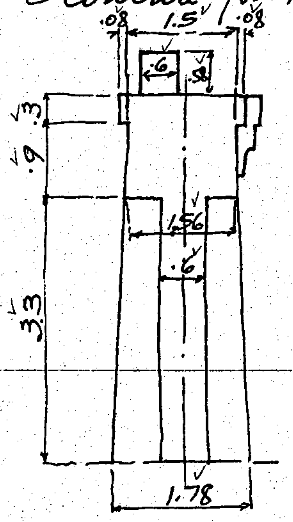
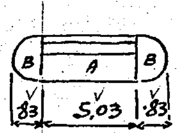
CALCULATIONS FOR

Karumojima Swing Bridge for city of Kobe

List of materials for Side pier (Pier Nos. 1 + 3).

Concrete for Pier. 1:2:4 mixture.



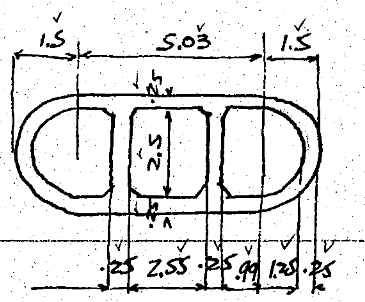


| | | |
|---|---|---|
| Base of Beam | 0.6×0.58×5.03 = | 1.750 $m^3$ |
| Coping A | 1.66×5.03×0.3 = | 2.505 |
| 〃 B | $1.66^{\phi}$ ×0.3 = | 0.649 |
| Shaft. Both sides | $1.64^{\phi}$ × 4.2×2 = | 17.744 |
| Top strut. | 1.53×0.9×3.56 = | 4.902 |
| wall | 0.6×3.3×3.5 = | 6.930 |
| projection at Center | .15×.3×.5×3 = | .068 |
| 〃 | .15×.3×1.6 = | .072 |
| | | 34.62 $m^3$ 34.62 $m^3$ |

Concrete for Ring + fill.

$2.20^{\phi}$ × 4.0×2 = 30.411

Total concrete for Shaft. = 65.031 $m^3$



Concrete for well.

Out side area 3.0×5.03 = 15.09
$3.0^{\phi}$ = 7.07
22.16 ☐m

Inside area, ring 2.5×5.03 = 17.58
$2.5^{\phi}$ = 4.91
17.49

net area at top + bottom = 4.67 ☐m

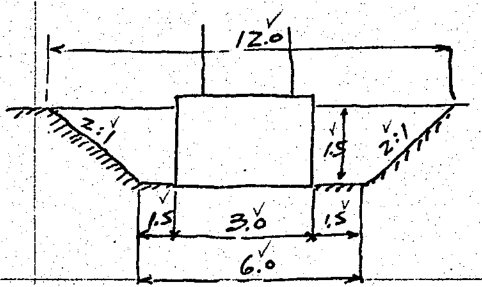
Intermediate section 4.67
partition wall 2.5×.25×2 = 1.25
fillets .25×.25×4 = .25
net area at middle section = 6.17 ☐m

Concrete for Shell.
top .3m 4.67×.3 = 1.401
int. .9m 6.17×.9 = 5.553
bott. .6m 4.67×.6 = 2.802
9.756 $m^3$

Concrete for fill.
int. .9m 22.16−6.17 = 15.99×.9 = 14.391
bott .6m 17.49×.6 = 10.494
24.885

Summary of concrete for Side pier.

| | |
|---|---|
| Concrete for Shaft. | 65.031 |
| 〃 〃 well | 9.756 |
| 〃 〃 fill. | 24.885 |
| total = | 99.672 cub. m. |



Excavation.
mean area of section = 9×1.5 = 13.5 ☐m
mean length = $\frac{11+17}{2}$ = 14.0
excavation = 13.5×14 = 189 cub. m.

Piles. 内地産赤松 末口五寸 長15尺 —— 24本

Reinforcements plain bars 3.267 Kg. tons

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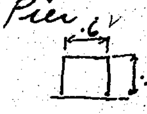
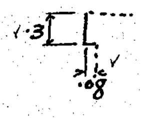
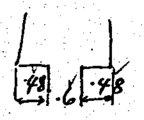
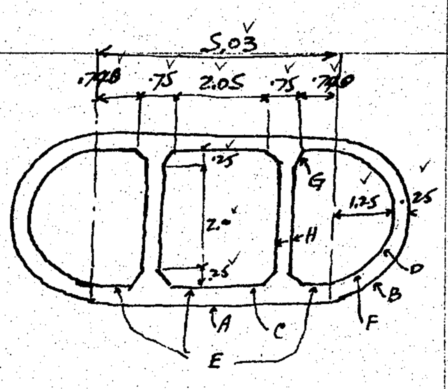
CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

(3)

| | | | | |
|---|---|---|---|---|
| Forms of Pier  | Base of Beam Bearings. | .58 × 5.03 × 2 = | 5.83 om | |
| | " | .58 × .60 × 2 = | .70 | |
|  | Coping, straight portion | .38 × 5.03 × 2 = | 3.82 | |
| | " , circular ends. | .38 × 1.66ϕ = | 1.98 | |
| | Projection at center | .15 × .3 × 2 = | .09 | |
| | Top strut, straight portion | 0.9 × 5.03 × 2 = | 9.05 | |
|  | " , circular ends | 0.9 × 1.53ϕ = | 4.33 | |
| | Projection at center | .15 × .5 × 6 = | .45 | |
| | Bottom of strut. | 0.96 × 3.66 = | 3.51 | |
| | wall. bothsides | 3.30 × 3.50 × 2 = | 23.10 | |
| | " bottom | 0.6 × 3.0 = | 1.80 | |
| | Shaft. 2 columns. | 1.67ϕ × 3.3 × 2 = | 34.63 | |
| | " less wall end. | 0.6 × 3.3 × 2 = | (−) 3.96 | |
| | | | | 85.33 |
| | Shaft. Ring outside | 2.2ϕ × 4 × 2 = | 55.29 | |
| | " " inside | 1.9ϕ × 4 × 2 = | 47.75 | |
| | " " bottom | 2.05ϕ × 0.15 × 2 = | 1.93 | |
| | | | | 104.97 |
|  | A well. Shell outside | 1.8 × 5.03 × 2 = | 18.11 | |
| | B " " " | 3.0ϕ × 1.8 = | 16.96 | |
| | c " " inside, top + Bott. | 0.9 × 5.03 × 2 = | 9.05 | |
| | d " " " " | 2.5ϕ × 0.9 = | 7.07 | |
| | E " " " int. | 3.53 × .9 × 2 = | 6.35 | |
| | F " " " " | 2.5ϕ × 0.9 = | 7.07 | |
| | G " " " " | 0.~~28~~35 × 0.9 × 8 = | 2.52 | |
| | H " " " " | 2.0 × .9 × 4 = | 7.20 | |
| | " " Bottom | 0.25 × 5.03 × 2 = | 2.52 | |
| | " " " | 0.25 × 1.38ϕ = | 1.08 | |
| | " Partition wall bottom | 0.25 × 2.5 × 2 = | 1.25 | 77.93 |
| | | | | 79.18 m² |
| | | | | 269.48 m² |

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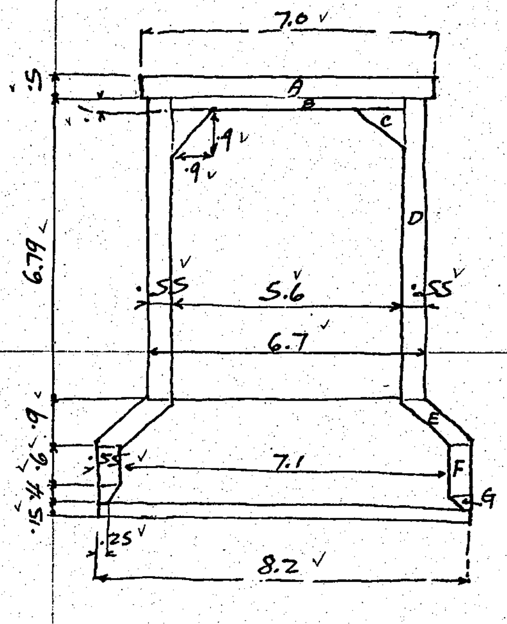
CHECKED BY M.J. DATE 4-3-29 PAGE NO 83

CALCULATIONS FOR

Karumojima Swing Bridge for City of Kobe.

List of materials for Center pier. (Pier No. II).

Concrete. 1:2:4 mixture. Concrete for Shell and Top slab.



Top slab A. $7.0^{\phi} \times 0.5 = 19.242$ cub.m.
" B $5.6^{\phi} \times 0.1 = 2.463$
" C $.9 \times .45 \times 5.0^{\phi} = 6.362$
28.067

Shell. D. $6.7^{\phi} = 35.26$ $^{om}$
$5.6^{\phi} = 24.63$
$10.63 \times 6.79 = 72.178$

" E $7.45^{\phi} = 43.59$
$6.35^{\phi} = 31.67$
$11.92 \times 0.9 = 10.728$

" F $8.2^{\phi} = 52.81$
$7.1^{\phi} = 39.59$
$13.22 \times 0.6 = 7.932$

" G. $8.2^{\phi} = 52.81$
$7.4^{\phi} = 43.01$
$9.80 \times 0.4 = 3.9\overset{2}{\cancel{4}}0$
94.758

Total concrete for Shell + top slab = 122.825 cub.m.

Concrete for Bottom filling 1:2:4 mixt.
$6.35^{\phi} = 31.67 \times 0.9 = 28.503$
$8.2^{\phi} = 52.81 \times 1.15 = 60.732$
less F+G = $-11.852$
77.383 $m^3$

Total concrete for center pier = 200.208 $m^3$

Sand filling
$5.6^{\phi} = 24.63 \times 6.69 = 164.775$
less C = $-6.362$
158.413 $m^3$

Area of Forms

| | | | |
|---|---|---|---|
| A | Coping | $0.65 \times 7.0^{\phi}$ = | 14.29 $^{om}$ |
| B | Slab, bott. | $3.8^{\phi}$ = | 11.34 |
| C | " fillet | $1.27 \times 4.7^{\phi}$ = | 18.75 |
| D | Shell outside | $6.7^{\phi} \times 6.79$ = | 142.92 |
| D | " inside | $5.6^{\phi} \times 5.79$ = | 101.81 |
| E | " outside | $1.17 \times 7.45^{\phi}$ = | 27.38 |
| F, G | " " | $1.0 \times 8.2^{\phi}$ = | 25.76 |
| E | " inside | $1.17 \times 6.35^{\phi}$ = | 23.34 |
| F | " " | $0.6 \times 7.1^{\phi}$ = | 13.38 |
| G | " " | $0.5 \times 7.4^{\phi}$ = | 11.62 |
| G | " " | $0.1 \times 7.8^{\phi}$ = | 2.45 |
| | | | 393.04 $^{om}$ |

Curb Shoe Structural steel = 1.031 Kg tons. see drawing
Reinforcements Plain Bars = 6.543 "
Piles 内地産赤松 末口 0.5尺 長 15尺 ----- 52本
Drain pipe gas pipes 4 — $1\frac{1}{2}''^{\phi} \times 2.0^{m}$ long.
gas pipe for electric cable 1 — $2\frac{1}{2}''^{\phi} \times 7.0^{m}$ "

Cement mortar finishing 27.5 $^{om}$ mean thickness 1.75 cm. (or 0.48 $m^3$)
well island Steel sheetpile 10 m long. 延長 31.4 m.
Sand fill $10^{\phi} \times 5.8$ = 456 $m^3$
well sinking 7.3 m about.
Excavation for well sinking $8.2^{\phi} \times 7.3 = 386$ $m^3$ about.

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MADE BY 鋼山 DATE 40 FILE NO
CHECKED BY DATE PAGE NO

CALCULATIONS FOR

1/4 1円
5/16 1.3
3/8 1.5

| 材料 | 重量 | 単價/錢 | 代 | | | 金 | | |
|---|---|---|---|---|---|---|---|---|
| | | | 給油設備 | 制動機 | エンドロック | セレーターグリスター | インジケーター | ゲート |
| | | | 自.12~18&25 | 19 & 20 | 21 | 22 | 23 & 24 | 26-27 |
| 鋳鉄 | | | 2,570. | | | | | |
| 半硬鋼 | | | 320. | | | | | |
| 燐青銅 | | | 540. | | | | | |
| 砲金 | | | 16. | | | | | |
| 火造り物 | | | 250. | | | | | |
| 軸類 | | | 2,180. | | | | | |
| フレーム類 | | | 550. | | | | | |
| 黄銅 | | | | | | | | |
| 鋳鋼 | | | 287. | | | | | |
| 鋼 | | | | | | | | |
| 鉄ボールト | | | 200. | | | | | |
| 可鍛鋳鉄 | | | 40. | | | | | |
| 綱入品 | | | 361.6円 | ナシ | 18.4円 | 4.0円 | ナシ | 1.0円 |
| 機械加工費 | | | | | | | | |
| | | ~~±296~~ | | | | | | |

11~18&25 = 1/4 grease cup 21ヶ × 1.0 = 21.0円
5/16 〃 10 × 1.3 = 13.0
3/8 〃 8 × 1.5 = 12.0
Copper pipe 19.6
ボールベヤリング 296.0
361.6円

Copper Pipe 3'6 × 14 = 49呎 × 0.4 = 19.6円

21 | 1/4 8 × 1円 × = 8
5/16 8 × 1.3 = 10.4
18.4円

22 | 1/4φ 4 × 1 = 4円

26.27 1/4φ 1 × 1 = 1円

| grease cup | 1/4 | 5/16 | 3/8 |
|---|---|---|---|
| 11 | / | / | / |
| 12 | 2+ | / | / |
| 13 | 1+ | 4+ | 2+4 |
| 14 | / | / | / |
| 15 | / | / | / |
| 16 | 2+16 | 2+1+2. | 1+1 |
| 17 | | 1+ | |
| 18 | / | / | / |
| 25 | / | / | / |
| | 21ヶ | 10ヶ | 8ヶ |

| | 1/4 | 5/16 | 3/8 |
|---|---|---|---|
| 19 | / | / | / |
| 20 | / | / | / |

| | 1/4 | 5/16 | 3/8 |
|---|---|---|---|
| 21 | 4+4 | 8 | |
| | 8ヶ | 8ヶ | |

| | 1/4 | 5/16 | 3/8 |
|---|---|---|---|
| 22 | 4+ | | |
| | 4ヶ | | |

| | | | |
|---|---|---|---|
| 23 | / | / | / |
| 24 | / | / | / |

| | 1/4 | 5/16 | 3/8 |
|---|---|---|---|
| 26 | 1 | / | / |
| 27 | / | / | / |
| | 1ヶ | | |

昭和四年四月成

神戸市苅藻島スヰング

機械部材料計算書

**JIUN MASUDA**
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CHECKED BY DATE PAGE NO 1

CALCULATIONS FOR

MHS 130.

Karumojima Bridge

List of material for Machine part

MATERIAL MARKS

| Material | Mark |
|---|---|
| Cast steel | C.S. |
| Hard steel | H.S |
| Medium hard steel(半硬鋼) | M.H.S. |
| Medium mild steel(半軟鋼) | M.M.S |
| Mild steel (軟鋼) | M.S |
| Cast iron | C.I |
| Mariable cast iron | M.I |
| Gun metal | G.M. |
| Brass | B. |
| Phosphor bronge | P.B. |

| Sheet no. | Mark | Name | Material | Reqd. no. | Wt. of one | Total wt. | Remarks |
|---|---|---|---|---|---|---|---|
| | | | | | # | # | |
| 12 | M.P | Main Pinion | M.H.S | 1 | 70.0 | 70.0 | Machine cut |
| 〃 | G1 | Pinion | 〃 | 1 | 38.0 | 38.0 | 〃 |
| 〃 | | Bushing | P.B. | 1 | 5.7 | 5.7 | 内面=油溝 |
| 〃 | G2 | Spur wheel | C.S | 1 | 237.0 | 237.0 | Machine cut |
| 〃 | CL | Claw clutch | M.H.S | 1 | 22.0 | 22.0 | |
| 〃 | BW1 | Bevel wheel | C.S | 6 | 20.0 | 120.0 | Machine cut |
| 〃 | BW1A | 〃 | 〃 | 1 | 20.0 | 20.0 | 〃 |
| 〃 | BW2 | 〃 | 〃 | 2 | 19.0 | 38.0 | 〃 |
| 〃 | A1 | Capstan | C.I | 1 | 98.0 | 98.0 | |
| 〃 | A2 | Lever handle | M.S | 2 | 60.0 | 120.0 | |
| 〃 | B6 | Bearing | C.I | 2 | 19.0 | 38.0 | |
| 〃 | | Bushing | P.B | 2 | 4.2 | 8.4 | 内面=油溝 |
| 〃 | | $\frac{1}{4}''\phi$ Grease cup | B | 2 | | | |
| 〃 | | $\frac{3}{4}''\phi$ turned bolt | M.S | 4 | 0.69 | 2.8 | |
| 〃 | | Filler $3 \times \frac{3}{8} \times 0'9$ | 〃 | 2 | 0.96 | 1.9 | |
| 〃 | R.A | Rack | C.S | 5 | 374.0 | 1870.0 | Machine cut |
| 〃 | | $\frac{7}{8}''\phi$ turned bolt | M.S | 8 | 1.3 | 10.4 | |
| | | | | | | 2700.2 | |
| 13 | M.W. | Worm | M.H.S. | 1 | 20.0 | 20.0 | Machine cut |
| 〃 | | Worm wheel | P.B | 1 | 54.0 | 54.0 | 〃 |
| 〃 | | Wheel center | C.I | 1 | 78.0 | 78.0 | |
| 〃 | | $\frac{1}{2}''\phi$ Machine bolt | M.S. | 8 | 0.3 | 2.4 | |
| 〃 | MWB | Gear box | C.I | 1 sd | 232.0 | 232.0 | |
| 〃 | | End cover | M.S | 1 | | | with $\frac{1}{4}''\phi$ screw |
| 〃 | | SKF radial ball bearing | No. RL 12 | 2 | | | |
| 〃 | | 〃 thrust 〃 〃 | No 3910 | 2 | | | |
| 〃 | | Felt ring | | 1 | | | |
| 〃 | | Hole plate cover | M.S. | 2 | 0.1 | 0.2 | with hinge |
| 〃 | | Bushing | P B | 2 | 3.0 | 6.0 | |
| 〃 | | $\frac{3}{8}''\phi$ Grease cup | B | 2 | | | |
| 〃 | | $\frac{1}{4}''\phi$ 〃 〃 | 〃 | 1 | | | |
| 〃 | | $\frac{5}{8}$ Turned bolt | M.S. | 10 | 0.43 | 4.3 | |
| 〃 | | $\frac{3}{4}''\phi$ 〃 〃 | 〃 | 8 | 0.78 | 6.2 | |
| 〃 | | Filler $2\frac{1}{2} \times \frac{1}{4} \times 1'6$ | 〃 | 2 | 2.3 | 4.6 | |
| 〃 | | Beveled washer | 〃 | 4 | 1.2 | 4.8 | $2 \times \frac{3}{8} \times 0'6\frac{1}{2}$ |

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MADE BY R.I DATE ______ FILE NO ______

CHECKED BY ______ DATE ______ PAGE NO 2

CALCULATIONS FOR

Karumojima Bridge

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 13 | | 5/8"φ bolt for drain | M.S. | 1 | 0.2 | 0.2 | |
| 〃 | WW | Worm | M.H.S | 2 | 78.0 | 156.0 | Machine cut |
| 〃 | | Worm wheel | P.B | 2 | 155.0 | 310.0 | 〃 |
| 〃 | | Wheel Center | C.I | 2 | 71.0 | 142.0 | |
| 〃 | | 5/8"φ Machine bolt | M.S | 12 | 0.4 | 4.8 | |
| 〃 | WWB^R | Gear box (Right hand) | C.I | 1 set | 318.0 | 318.0 | |
| 〃 | WWB^L | 〃 〃 (Left hand) | 〃 | 1 set | 318.0 | 318.0 | |
| 〃 | | SKF. ball bearing | No 512 | 4 | | | With no 512 U |
| 〃 | | Bushing for worm shaft | P.B | 4 | 9.0 | 36.0 | |
| 〃 | | 〃 〃 Worm wheel shaft | 〃 | 4 | 5.5 | 22.0 | |
| 〃 | | 3/8"φ Grease cup | B | 4 | | | |
| 〃 | | Hole Plate Cover | M.S. | 4 | 1.0 | 4.0 | With hinge |
| 〃 | | 5/8"φ Turned bolt | 〃 | 20 | 0.43 | 8.6 | |
| 〃 | | 3/4"φ 〃 〃 | 〃 | 16 | 0.78 | 12.5 | |
| 〃 | | Baveled washer | 〃 | 8 | 1.2 | 9.6 | 2 × 3/8 × 0'-6 |
| 〃 | | 5/16"φ Grease cup | B | 4 | | | |
| 〃 | | 5/8"φ bolt for drain | M.S | 2 | 0.2 | 0.4 | |
| | | | | | | 1754.6 | |
| 14 | S1 | Shaft | M.M.S. | 1 | 29.5 | 29.5 | With Keys |
| 〃 | | 3½"φ dia Collar | 〃 | 1 | 2.8 | 2.8 | with Key bolt |
| 〃 | S2 | Shaft | 〃 | 1 | 17.3 | 17.3 | With Key |
| 〃 | S3 | 〃 | 〃 | 1 | 125.0 | 125.0 | 〃 |
| 〃 | | 4"φ Collar | 〃 | 1 | 2.2 | 2.2 | with Key bolt |
| 〃 | S4 | Shaft | 〃 | 1 | 161.3 | 161.3 | With Key |
| 〃 | S5 | 〃 | 〃 | 1 | 48.6 | 48.6 | 〃 |
| 〃 | S6 | Capstan shaft | 〃 | 1 | 27.7 | 27.7 | 〃 |
| 〃 | PS | Pinion shaft | 〃 | 1 | 239.1 | 239.1 | 〃 |
| | | | | | | 653.5 | |
| 15 | WS1 | Shaft | M.M.S | 1 | 48.0 | 48.0 | with key |
| 〃 | WS2 | 〃 | 〃 | 1 | 49.0 | 49.0 | 〃 |
| 〃 | WS3 | 〃 | 〃 | 1 | 135.0 | 135.0 | 〃 |
| 〃 | WS4 | 〃 | 〃 | 5 | 171.0 | 855.0 | 〃 |
| 〃 | WS5 | 〃 | 〃 | 2 | 167.0 | 334.0 | 〃 |
| 〃 | J1 | Jaw Coupling | C.I | 20 | 12.0 | 240.0 | 10 Pair |
| 〃 | MC | Flange Coupling | M.S | 1<br>1 | 5.5 | 11.0 | 1 Pair |
| 〃 | | ½"φ Machine bolt | 〃 | 5 | 0.23 | 1.2 | |
| | | | | | | 1673.2 | |
| 16 | PB1 | Bracket of pinion shaft | C.S | 1 | 309.0 | 309.0 | |
| 〃 | | Bushing | P.B | 1 | 11.5 | 11.5 | 内面=油溝 |
| 〃 | | 3/8"φ Grease cup | B | 1 | | | |
| 〃 | | 1"φ turned bolt | M.S | 6 | 1.86 | 11.2 | |
| 〃 | | Filler 16½×⅜×1'-9 | 〃 | 1 | 36.8 | 36.8 | |
| 〃 | PB2 | Bearing of Pinion shaft | C.I | 1 | 107.0 | 107.0 | With tap bolt |
| 〃 | | Bearing Cap | 〃 | 1 | | | with Knock |
| 〃 | | Bushing | P.B | 2 | 7.9 | 15.8 | 半円形,内面=油溝 |
| 〃 | | 3/8"φ Grease Cup | B | 1 | | | |
| 〃 | | 1"φ turned bolt | M.S. | 4 | 1.8 | 7.2 | |

MADE BY R.I DATE ______ **FILE NO** ______
CHECKED BY ______ DATE ______ **PAGE NO** 3

CALCULATIONS FOR

Karumojima Bridge

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 116 | B2 | Bearing of bevel | C.S. | 1 | 91.0 | 91.0 | |
| 〃 | | Bushing (Flange) | P.B | 1 | 4.911 | 4.9 | 内面=油溝 |
| 〃 | | 〃 (no Flange) | 〃 | 1 | 3.7 | 3.7 | 〃 |
| 〃 | | 5/16"ϕ Grease cup | B | 2 | | | |
| 〃 | | 3/4"ϕ turned bolt | M.S. | 6 | 0.82 | 4.9 | |
| 〃 | | Filler 11 × 3/8 × 1'-3" | 〃 | 1 | 17.5 | 17.5 | |
| 〃 | B3 | Bearing of bevel | C.S | 1 } | 91.0 | 91.0 | with tap bolt |
| 〃 | | Bearing Cap | 〃 | 1 } | | | with knock |
| 〃 | | Bushing (Flange) | P.B. | 2 | 2.49 | 5.0 | 半円.内面=油溝 |
| 〃 | | 〃 (no. Flange) | 〃 | 2 | 1.8 | 3.6 | 内面=油溝 |
| 〃 | | 3/4"ϕ turned bolt | M.S. | 8 | 0.78 | 6.2 | |
| 〃 | | 5/16"ϕ Grease cup | B | 1 | | | |
| 〃 | | 1/4"ϕ 〃 〃 | 〃 | 2 | | | |
| 〃 | B4 | Bearing | C.I | 2 } | 26.0 | 52.0 | with tap bolt |
| 〃 | | Bearing cap | 〃 | 2 } | | | with knock & copper pipe |
| 〃 | | Bushing | P.B. | 4 | 2.37 | 9.5 | 半円.内面=油溝 |
| 〃 | | 5/16"ϕ Grease cup | B | 2 | | | |
| 〃 | | 3/4"ϕ turned bolt | M.S. | 4 | 0.78 | 3.2 | |
| 〃 | B.5 | Bearing | C.I | 16 } | | | with tap bolt |
| 〃 | | Bearing cap | 〃 | 16 } | 26.0 | 416.0 | with knock |
| 〃 | | Bushing | P.B. | 32 | 1.37 | 43.8 | 半円.内面=油溝 |
| 〃 | | 1/4"ϕ Grease cup | B | 16 | | | |
| 〃 | | 3/4"ϕ turned bolt | M.S | 32 | 0.75 | 25.0 | |
| 〃 | | Filler 3 × 1/4 × 0'-10½ | 〃 | 16 | 2.2 | 35.2 | for adjust |
| 〃 | | Filler 8 × 3/8 × 1'-4" | 〃 | 1 | 13.6 | 13.6 | for PB2 |
| 〃 | | Beveled washer | 〃 | 36 | 0.6 | 21.6 | for 3/4"ϕ bolts |
| | | | | | | 1346.2 | |
| 17 | C1 | Handle stand | C.I | 2 | 30.0 | 60.0 | |
| 〃 | | Handle | M.S | 2 | 7.0 | 14.0 | |
| 〃 | | 1¼"ϕ × 6⅜" shaft | 〃 | 1 | 2.5 | 2.5 | with key |
| 〃 | | Screw handle | 〃 | 2 | 0.5 | 1.0 | |
| 〃 | | 1/2"ϕ screw pin | M.H.S | 2 | 0.15 | 0.3 | |
| 〃 | C2 | Lever | M.I | 1 | 6.1 | 6.1 | |
| 〃 | C3 | Hanger of weight | M.S. | 1 | 3.7 | 3.7 | with nut & washer |
| 〃 | | 3/4"ϕ Pin | M.H.S. | 1 | 0.4 | 0.4 | |
| 〃 | C4 | Balance weight | C.I | 2 | 26.0 | 52.0 | |
| 〃 | C4A | 〃 〃 | 〃 | 1 | 23.0 | 23.0 | |
| 〃 | C5 | Pillow block | 〃 | 2 | 12.0 | 24.0 | |
| 〃 | | Bushing | G.M. | 2 | 1.5 | 3.0 | |
| 〃 | | Filler 3 × 1/4 × 0'-7⅜ | M.S. | 2 | 1.7 | 3.4 | |
| 〃 | | 5/8"ϕ turned bolt | 〃 | 4 | .5 | 2.0 | |
| 〃 | C6 | Pillow block | C.I | 1 | 14.0 | 14.0 | |
| 〃 | | Pin | M.H.S | 1 | 3.2 | 3.2 | with cotter |
| 〃 | | 5/8"ϕ turned bolt | M.S. | 4 | 0.5 | 2.0 | |
| 〃 | B1 | Bearing of bevel gear | C.I | 1 } | 98.0 | 98.0 | with tap bolts |
| 〃 | | Bearing Cap | 〃 | 1 } | | | with brass knock |
| 〃 | | Bushing | PB | 2 | 2.6 | 5.2 | 半円.油溝 |
| 〃 | | 〃 | 〃 | 1 | 4.2 | 4.2 | 鍔上面=油溝 |
| | | | | | | 322.0 | |

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

Karumojima Bridge

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 18 | CC | Claw clutch (Fix) | C.S. | 2 | 22.0 | 44.0 | |
| 〃 | | 〃 〃 (Sliding) | 〃 | 2 | 20.0 | 40.0 | |
| 〃 | R1 | Rod | MMS | 1 | 31.0 | 31.0 | |
| 〃 | R2 | 〃 | 〃 | 1 | 53.0 | 53.0 | |
| 〃 | R3 | Fork rod | M.S | 1 | 22.0 | 22.0 | |
| 〃 | | 1"φ Pin | M.HS | 2 | 0.8 | 1.6 | with cotter |
| 〃 | R4 | Fork end | M.S | 3 | 7.0 | 21.0 | |
| 〃 | | Nut | 〃 | 3 | 1.1 | 3.3 | |
| 〃 | | 1"φ Pin | M.H.S | 3 | 0.8 | 2.4 | with cotter |
| 〃 | CS1 | Shaft | MMS | 1 | 7.0 | 7.0 | with keys |
| 〃 | CS2 | 〃 | 〃 | 1 | 10.0 | 10.0 | 〃 |
| 〃 | CS3 | 〃 | 〃 | 1 | 5.0 | 5.0 | 〃 |
| 〃 | C7 | Pillow block | C.I | 2 | 8.0 | 16.0 | |
| 〃 | | Bushing | G.M | 2 | 0.8 | 1.6 | |
| 〃 | | 5/8"φ Turned bolt | M.S | 4 | 0.4 | 1.6 | |
| 〃 | C8 | Pillow block | C.I | 1 | 9.0 | 9.0 | |
| 〃 | C9 | Shifter | G.M | 4 | 2.7 | 10.8 | 半円形 |
| 〃 | | ½"φ Machine bolt | M.S | 4 | 0.4 | 1.6 | |
| 〃 | C10 | Arm | 〃 | 1 | 20.0 | 20.0 | with ¾"φ bolt |
| 〃 | C11 | 〃 | 〃 | 1 | 8.0 | 8.0 | |
| 〃 | C12 | 〃 | 〃 | 1 | 10.0 | 10.0 | with ¾"φ bolt |
| 〃 | C13 | Lever | M.I | 1 | 12.0 | 12.0 | |
| 〃 | C14 | Angle lever | 〃 | 1 | 12.0 | 12.5 | |
| 〃 | C15 | Lever | 〃 | 1 | 7.0 | 7.0 | |
| 〃 | C16 | Roller bracket | C.I | 1 | 13.0 | 13.0 | |
| 〃 | | Roller | M.S | 2 | 2.0 | 4.0 | |
| 〃 | | 5/8"φ Pin | M.H.S | 2 | 0.5 | 1.0 | with cotter |
| 〃 | | 5/8"φ turned bolt | M.S | 4 | 0.5 | 2.0 | |
| 〃 | | Filler 5"×¼"×0'-8" | 〃 | 1 | 2.8 | 2.8 | |
| | | | | | | 373.2 | |
| 19 | H10 | Fork rod | M.S | 1 | 7.0 | 7.0 | |
| 〃 | H11 | 〃 | 〃 | 1 | 10.0 | 10.0 | |
| 〃 | | ¾"φ Pin | MHS | 4 | 0.4 | 1.6 | with cotter |
| 〃 | H12 | Lever | M.I | 1 | 4.5 | 4.5 | |
| 〃 | H13 | 〃 | 〃 | 2 | 4.0 | 8.0 | |
| 〃 | H14 | 〃 | 〃 | 1 | 4.0 | 4.0 | |
| 〃 | H15 | Fork rod (1"φ) | M.S | 1 | 3.2 | 3.2 | |
| 〃 | | 〃 〃 (1½"φ) | 〃 | 1 | 7.8 | 7.8 | |
| 〃 | | ¾"φ Pin | MHS | 3 | 0.4 | 1.2 | with cotter |
| 〃 | H16 | Shaft | MMS | 1 | 11.0 | 11.0 | with keys |
| 〃 | H17 | 〃 | 〃 | 1 | 3.5 | 3.5 | 〃 |
| 〃 | H18 | Pillow block | C.I | 4 | 11.0 | 44.0 | |
| 〃 | | Bushing | G.M | 4 | 0.8 | 3.2 | |
| 〃 | H19 | Guide block | C.I | 1 | 8.8 | 8.8 | |
| 〃 | | Bushing | G.M | 1 | 1.7 | 1.7 | |
| 〃 | H20 | Lever | M.I | 1 | 11.5 | 11.5 | |
| 〃 | | Cross head | M.S | 1 | 6.5 | 6.5 | with washer & cotter |
| 〃 | H21 | Handle wheel | C.I | 1 | 21.0 | 21.0 | |
| 〃 | | Handle | M.S | 1 | 1.2 | 1.2 | |
| 〃 | H22 | Handle stand | C.I | 1 | 80.0 | 80.0 | |
| 〃 | | Screw spindle | MHS | 1 | 18.0 | 18.0 | with nut & washer |

増田淳氏関係資料（独立行政法人 土木研究所蔵）

MADE BY R.I DATE FILE NO
CHECKED BY DATE PAGE NO 5

CALCULATIONS FOR

Karumojima Bridge

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 19 | | 5"ϕ × 1/4 washer | M.S. | 1 | 1.5 | 1.5 | with screws. |
| 〃 | H23 | 1 3/4"ϕ Pin | 〃 | 1 | 4.2 | 4.2 | with key bolt |
| 〃 | H24 | Needle | B | 1 | 0.1 | 0.1 | with brass screws |
| 〃 | H25 | Dial Plate | B | 1 | 2.4 | 2.4 | |
| | | | | | | ~~205.9~~ — 265.9 ✓ | |
| 20 | H1 | Brake Pulley | C.I | 1 | 34.0 | 34.0 | |
| 〃 | H2 | Brake shoe (Plate) | M.S | 4 | 4.5 | 18.0 | |
| 〃 | | Shoe | wood | 4 | | | with brake sheet & screw<br>2 spare |
| 〃 | | Casting | C.I | 2 | 2.5 | 5.0 | |
| 〃 | | 1/2"ϕ turned bolt | M.S. | 8 | | 1.9 | |
| 〃 | | 5/8"ϕ 〃 〃 | 〃 | 6 | | 4.3 | |
| 〃 | | 7/8"ϕ Pin | M.H.S | 3 | 2.9 | 8.7 | with cotter |
| 〃 | | 1 3/4"ϕ × 1/16 washer | M.S | 4 | 0.1 | .4 | |
| 〃 | H3 | Lever | 〃 | 2 | 11.5 | 23.0 | |
| 〃 | | 3/8" turned bolt | 〃 | 3 | 0.1 | 0.3 | |
| 〃 | | 3/4"ϕ Pin | M.H.S | 1 | 0.5 | 0.5 | with cotter |
| 〃 | | 1 1/2" × 7/16 washer | M.S. | 2 | 0.1 | 0.2 | |
| 〃 | H44 | Guide block | 〃 | 1 | 3.3 | 3.3 | with cotter |
| 〃 | | 1 3/4"ϕ × 3/8 washer | 〃 | 2 | 0.2 | 0.4 | |
| 〃 | H55 | Driving lever (Rod) | 〃 | 1 | 2.0 | 2.0 | with nut |
| 〃 | | Fork end | M.I | 1 | 3.5 | 3.5 | |
| 〃 | | 1 5/8"ϕ × 3/8 washer | M.S | 2 | 0.2 | 0.4 | |
| 〃 | H66 | Adjusting Rod | 〃 | 1 | 2.7 | 2.7 | with nuts |
| 〃 | H77 | Spring grund | G.M. | 2 | 0.4 | 0.8 | |
| 〃 | H88 | Spring | H.S | 1 | 0.6 | 0.6 | |
| 〃 | H99 | Brake bed | C.I | 1 | 32.0 | 32.0 | |
| | | | | | | 142.0 ✓ | |
| 21 | W1 | Wedge shoe | C.S. | 4 | 250.0 | 250.0 | |
| 〃 | | 7/8"ϕ turned bolt | M.S. | 40 | 1.3 | 52.0 | |
| 〃 | W2$^R$ | Wedge (Right hand) | C.S | 2 | 92.0 | 184.0 | |
| 〃 | W2$^L$ | 〃 (left hand) | 〃 | 2 | 92.0 | 184.0 | |
| 〃 | | 5/16"ϕ Grease cup | B | 8 | | | |
| 〃 | | 1/4"ϕ 〃 〃 | 〃 | 4 | | | |
| 〃 | | Bushing | P.B | 4 | 1.1 | 4.4 | |
| 〃 | W3 | Bearing block | C.S. | 4 | 285.0 | 1140.0 | |
| 〃 | W4 | Link bar | M.S | 4 | 30.5 | 122.0 | |
| 〃 | | Fork end | 〃 | 4 | 23.0 | 92.0 | |
| 〃 | | Pin. nut | 〃 | 8 | 5.0 | 40.0 | |
| 〃 | W5 | Link | C.S. | 4 | 38.0 | 152.0 | |
| 〃 | | 1/4"ϕ grease cup | B | 4 | | | |
| 〃 | | Bushing | P.B | 8 | 0.8 | 6.4 | |
| 〃 | W6 | Link | C.S. | 8 | 28.5 | 228.0 | |
| 〃 | W7 | Pin & nut | MHS | 4 | 6.5 | 26.0 | |
| 〃 | W8 | 〃 〃 | 〃 | 4 | 12.0 | 48.0 | |
| 〃 | WB | Bearing | C.I | 4 } | 81.5 | 326.0 | with top bolt |
| 〃 | | Bearing Cap | 〃 | 4 } | | | with brass Knock |
| 〃 | | Bushing | P.B | 8 | 5.9 | 47.2 | 半円形内面ニ油溝 |
| 〃 | | Turned bolts | M.S | 16 | 1.2 | 19.2 | |

MADE BY R.I DATE FILE NO
CHECKED BY DATE PAGE NO 6

CALCULATIONS FOR

Karumojima Bredge

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 21 | W56 | Shaft | MHS | 2 | 62.0 | 124.0 | with keys |
| 〃 | W57 | 〃 | M.M.S | 2 | 240.0 | 480.0 | 〃 |
| 〃 | W58 | 〃 | 〃 | 2 | 158.0 | 316.0 | 〃 |
| 〃 | J2 | Jaw Coupling | C I | 8 | 24.0 | 192.0 | 4 Pair |
| 〃 | AB1 | Anchor bolts | M.S | 16 | 15.7 | 251.0 | |
| 〃 | AP2 | Anchor | 〃 | 8 | 11.0 | 88.0 | |
| | | | | | | 4372.2 | |
| 22 | L1 | Latch bar | MHS | 2 | 108.0 | 216.0 | |
| 〃 | | $1\frac{3}{8}\phi$ Pin | M.H.S | 2 | 4.0 | 8.0 | with cotter |
| 〃 | | $2\frac{1}{4}\phi$ pin | 〃 | 2 | 7.0 | 14.0 | 〃 |
| 〃 | L2 | Trip | CI | 2 | 16.5 | 33.0 | |
| 〃 | | Bushing | GM | 4 | 1.82 | 7.3 | with oil groove |
| 〃 | L3 | Roller | MHS | 2 | 12.5 | 25.0 | |
| 〃 | | Bushing | PB | 2 | 1.25 | 2.5 | |
| 〃 | L4 | Roller | M S | 2 | 3.5 | 7.0 | |
| 〃 | | Bushing | GM | 2 | 0.52 | 1.0 | |
| 〃 | L5 | Link | M I | 2 | 19.3 | 38.6 | |
| 〃 | | Pin ($1\frac{1}{4}\phi$) | MHS | 2 | 1.4 | 2.8 | with Key screw |
| 〃 | L6 | Link | M I | 2 | 16.0 | 32.0 | |
| 〃 | L7 | 〃 (Fork bar) | M S | 2 | 13.0 | 26.0 | |
| 〃 | | Eye bar | 〃 | 2 | 7.4 | 14.8 | |
| 〃 | | Pin ($1\frac{3}{8}\phi$) | M.H.S | 2 | 1.8 | 3.6 | with cotter |
| 〃 | L8 | Link | M.I | 2 | 23.3 | 46.6 | |
| 〃 | | Pin ($1\frac{3}{8}\phi$) | M.H.S | 2 | 1.9 | 3.8 | with cotter |
| 〃 | L9 | Guide of Latch bar | C.S | 8 | 11.0 | 88.0 | |
| 〃 | | Bushing | P.B | 8 | 3.2 | 25.6 | |
| 〃 | | $\frac{5}{8}\phi$ Turned bolts | M.S | 32 | .45 | 14.4 | |
| 〃 | LB | Bearing block | C.I | 4 | 18.0 | 72.0 | |
| 〃 | | Bushing | G.M | 4 | 2.0 | 8.0 | |
| 〃 | | $\frac{1}{4}\phi$ Grease cup | B | 4 | | | |
| 〃 | | $\frac{5}{8}\phi$ Turned bolt | M.S | 16 | 0.45 | 7.2 | |
| 〃 | L10 | Latch catch | C.S | 2 | 299.0 | 598.0 | |
| 〃 | LS | Shaft | M.M.S | 2 | 53.0 | 106.0 | |
| 〃 | | $3\frac{1}{4}\phi$ Caller | M.S | 4 | 2.8 | 11.2 | with Key bolt |
| 〃 | AB2 | Anchor bolt | 〃 | 8 | 11.0 | 88.0 | |
| 〃 | AP1 | Anchor | 〃 | 4 | 8.0 | 32.0 | |
| 〃 | L7 | Sleeve nut | 〃 | 2 | 6.0 | 12.0 | |
| | | Beveled washer | 〃 | 48 | 0.2 | 9.6 | For LB & L9 |
| | | | | | | 1554.0 | |
| 23 | IW1 | Worm wheel | MS | 1 | 1.5 | 1.5 | machine cutt |
| | IW2 | Worm | 〃 | 1 | 1.6 | 1.6 | 〃 |
| | IB1 | Bevel wheel | CI | 1 | 6.0 | 6.0 | 〃 |
| | IB2 | Bevel pinion | 〃 | 1 | 2.0 | 2.0 | 〃 |
| | IB3 | Bevel wheel | 〃 | 4 | 2.0 | 8.0 | 〃 |
| | IS1 | Shaft. | M.S | 1 | 13.0 | 13.0 | with Keys |
| | IS2 | 〃 | 〃 | 1 | 3.0 | 3.0 | 〃 |
| | IS3 | 〃 | 〃 | 1 | 20.0 | 20.0 | 〃 |
| | IS4 | 〃 | 〃 | 1 | 18.0 | 18.0 | 〃 |

MADE BY R.1 DATE ______ FILE NO ______

CHECKED BY ______ DATE ______ PAGE NO 7

CALCULATIONS FOR

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 23 | | $1\frac{3}{4}^{\phi}$ Collar | M.S | 1 | 0.5 | 0.5 | with key bolts |
| 〃 | I 1 | Dial plate | B | 1 | 3.3 | 3.3 | with brass screws |
| 〃 | I 2 | Needle | 〃 | 1 | 0.06 | 0.06 | |
| 〃 | I 3 | Spindle | M.S | 1 | 0.6 | 0.6 | with washer & screw |
| 〃 | I 4 | Bracket of worm | B | 1 | 6.0 | 6.0 | |
| 〃 | I 5 | Bracket of Bevel | C.I | 1 | 8.5 | 8.5 | |
| 〃 | I 6 | 〃 | 〃 | 1 | 8.4 | 8.4 | |
| 〃 | I 7 | 〃 | 〃 | 1 | 8.1 | 8.1 | |
| 〃 | | $\frac{1}{2}^{\phi}$ turned bolt | M.S | 11 | 0.24 | 0.24 | |
| 〃 | I 8 | Coupling | C.I | 1 | 2.0 | 2.0 | |
| 〃 | | $\frac{3}{8}^{\phi}$ turned bolt | M.S | 4 | | 0.2 | |
| 〃 | I 9 | Stand | C.I | 1 | 6.5 | 6.5 | |
| 〃 | | $1\frac{1}{2}^{\phi}$ Gas pipe (5'6) | | 1 | 12.1 | 12.1 | |
| | | | | | | 129.66 | |
| 24 | IG1 | Spur gear | C.I | 1 | 3.1 | 3.1 | machine cut |
| 〃 | IG2 | 〃 | 〃 | 1 | 3.3 | 3.3 | 〃 |
| 〃 | IG3 | Rack | G.M | 1 | 6.2 | 6.2 | 〃 |
| 〃 | IG4 | Pinion | C.I | 1 | 1.2 | 1.2 | 〃 |
| 〃 | IW1A | worm wheel | M.S | 1 | 1.5 | 1.5 | 〃 |
| 〃 | IW2 | Worm | M.S | 1 | 1.6 | 1.6 | 〃 |
| 〃 | I 10 | Gear box (base) | C.I | 1 | 36.0 | 36.0 | |
| 〃 | | 〃 (Cover) | 〃 | 1 | | | |
| 〃 | | 〃 (end Cover) | 〃 | 1 | | | |
| 〃 | | $\frac{1}{2}^{\phi}$ turned bolts | M.S. | 4 | 0.23 | 0.9 | |
| 〃 | | $\frac{3}{8}^{\phi}$ 〃 〃 | 〃 | 4 | 0.1 | 0.4 | |
| 〃 | | $\frac{1}{4}$ 〃 〃 | B | 3 | 0.04 | 0.1 | |
| 〃 | I 11 | Needle | 〃 | 2 | 0.24 | 0.5 | with brass screws |
| 〃 | I 12 | 〃 | 〃 | 1 | 0.36 | 0.46 | |
| 〃 | I 13 | Shaft | M.S | 1 | 1.0 | 1.0 | with keys |
| 〃 | I 14 | 〃 | 〃 | 1 | 1.0 | 1.0 | 〃 |
| | | | | | | ~~56.46~~<br>56.1 | |
| 25. | F.B. | E 8×3 @ 19.3 | M.S | 2 | 68.0 | 136.0 | $3'6\frac{1}{4}$ |
| 〃 | | 〃 | 〃 | 1 | 10.1 | 10.1 | $0'6\frac{1}{4}$ |
| 〃 | | 〃 | 〃 | 2 | 20.1 | 40.2 | $1'0\frac{1}{2}$ |
| 〃 | | C 8×4 @ 25.731 | 〃 | 2 | 48.0 | 96.0 | $1'10\frac{3}{8}$ |
| 〃 | | Pl. $7\frac{1}{8}$ × $\frac{5}{16}$ | 〃 | 1 | 7.7 | 7.7 | $1'0\frac{1}{4}$ |
| 〃 | | 〃 $12\frac{1}{4}$ × $\frac{5}{16}$ | 〃 | 1 | 17.8 | 17.8 | $1'4\frac{3}{8}$ |
| 〃 | | Conn. L^s 3×3×$\frac{5}{16}$ | 〃 | 8 | 3.2 | 25.6 | $0'6\frac{1}{4}$ |
| 〃 | M.B | Base of Motor | C.I | 1 | 214.0 | 214.0 | |
| 〃 | | $\frac{5}{8}^{\phi}$ tap bolt | M.S | 4 | 0.54 | 2.2~~6~~ | |
| 〃 | | $\frac{3}{4}^{\phi}$ turned bolt | 〃 | 6 | 0.75 | 4.5 | Anchor |
| 〃 | | Bevelled washer | 〃 | 6 | 0.7 | 4.2 | $2\frac{1}{2}$×$\frac{3}{8}$×$2\frac{1}{2}$ |
| 〃 | ⊗ | Anchor bolt $\frac{7}{8}^{\phi}$ × $0'8\frac{1}{4}$ | 〃 | 6 | 1.98 | 11.9 | |
| 〃 | ¤ | 〃 〃 × $0'7\frac{5}{8}$ | 〃 | 12 | 1.88 | 22.56 | |
| 〃 | ◎ | 〃 $\frac{3}{4}^{\phi}$ × 〃 | 〃 | 10 | 1.33 | 13.3 | |
| 〃 | ⊗ | 〃 〃 × $0'4\frac{3}{4}$ | 〃 | 2 | 0.97 | 1.9~~4~~ | |
| 〃 | ⊗ | 〃 $\frac{5}{8}^{\phi}$ × $0'7\frac{1}{2}$ | 〃 | 2 | 0.88 | 1.8~~6~~ | |
| 〃 | ⊙ | 〃 〃 × $0'7\frac{1}{4}$ | 〃 | 8 | 0.68 | 5.4~~4~~ | |
| 〃 | ○ | 〃 $\frac{1}{2}^{\phi}$ × $0'7$ | 〃 | 8 | 0.52 | 4.2~~6~~ | |

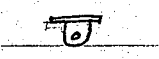
増田淳氏関係資料
（独立行政法人 土木研究所蔵）

**JIUN MASUDA**
CONSULTIEG ENGINEER
JIJI BLDG, TOKYO

MADE BY________ DATE________ **FILE NO**________

CHECKED BY________ DATE________ **PAGE NO** 8

CALCULATIONS FOR

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 25 | P1. | Plate | M.S | 1 | 3.2 | 3.2 | |
| 〃 | P2 | Beveled Pl. | 〃 | 1 | 4.0 | 4.0 | |
| 〃 | P3 | Plate | 〃 | 2 | 3.2 | 6.4 | |
| 〃 | P4 | 〃 | 〃 | 1 | 2.5 | 2.5 | |
| 〃 | P5 | 〃 | 〃 | 2 | 2.6 | 5.2 | |
| 〃 | P6 | 〃 | 〃 | 1 | 4.4 | 4.4 | |
| 〃 | P7 | 〃 | 〃 | 1 | 15.9 | 15.9 | |
| 〃 | | washer ($2\frac{1}{2}^{\phi} \times \frac{1}{8}$) | 〃 | 16 | | 2.8 | |
| 〃 | | Beveled washer | 〃 | 12 | | 8.0 | $2\frac{1}{2} \times \frac{3}{8} \times 2\frac{1}{2}$ |
| | | | | | | 671.8 | |
| 26 | | Worm | M.H.S. | 2 | 7.5 | 15.0 | machine cut |
| 〃 | | Worm wheel | C.S. | 2 | 12.5 | 25.0 | |
| 〃 | | Gear box | C.I | $2^{set}$ | 39.0 | 78.0 | |
| 〃 | | Bushing ($1\frac{3}{4}^{\phi}$ shaft) | P.B | 4 | 1.0 | 4.0 | |
| 〃 | | 〃 (Worm shaft) | 〃 | 4 | 0.5 | 2.0 | |
| 〃 | | $\frac{3}{8}^{\phi}$ turned bolt | M.S | 10 | 0.1 | 1.0 | |
| 〃 | a | Pinion | M.H.S | 2 | 15.0 | 30.0 | machine cut |
| 〃 | b | 〃 | 〃 | 2 | 5.5 | 11.0 | 〃 |
| 〃 | | Rack | 〃 | 2 | 15.0 | 30.0 | |
| 〃 | | Guide for Rack | C.I | 2 | 15.5 | 31.0 | |
| 〃 | | $1\frac{3}{4}^{\phi}$ shaft | M.H.S. | 2 | 6.5 | 13.0 | with Keys |
| 〃 | | $2^{\phi}$ Pin | 〃 | 2 | 11.3 | 22.6 | 〃 |
| 〃 | | Bracket | C.S. | 2 | 24.0 | 48.0 | |
| 〃 | | Bushing | P.B | 2 | 2.0 | 4.0 | |
| 〃 | | $\frac{1}{4}^{\phi}$ grease cup | B | 1 | | | |
| 〃 | | Counter weight case | C.I | 2 | | 340.0 | with $\frac{3}{8}$" screw |
| 〃 | | Block | 〃 | 2 | | 79.0 | |
| 〃 | | Cover Pl. | M.S | 2 | | 17.0 | |
| 〃 | | $\frac{1}{2}^{\phi} \times 4\frac{3}{8}$ bolt | 〃 | 12 | 0.39 | 4.7 | |
| 〃 | | Handle | 〃 | 2 | 7.0 | 14.0 | |
| | | | | | | 769.3 | |
| 27 | | Gate | 檜（日本） | 2 | | | |
| 〃 | |  | C.I | 14 | 0.3 | 4.2 | with screws |
| 〃 | | ⊥ $1\frac{1}{4} \times 1\frac{1}{2} \times \frac{3}{16} \times 8'4"$ | M.S. | 2 | 14.0 | 28.0 | |
| 〃 | | ○—○ | 〃 | 18 | 0.1 | 2.3 | |
| 〃 | | End Cover | 〃 | 2 | 5.0 | 10.0 | with screws |
| 〃 | | Gear Cover | 〃 | 2 | 7.0 | 14.0 | 〃 |
| 〃 | | Buffer block | Wood | 2 | | | 〃 |
| 〃 | | Rubber sheet | Rubber | 2 | | | |
| 〃 | | Plate $1\frac{1}{4} \times \frac{3}{8} \times 0'4\frac{1}{2}$ | M.S. | 4 | 0.6 | 2.4 | |
| | | | | | | 60.99 | |

**JIUN MASUDA**
CONSULTIEG ENGINEER
JIJI BLDG, TOKYO

MADE BY M.K DATE ______ **FILE NO** ______
CHECKED BY ______ DATE ______ **PAGE NO** ______

CALCULATIONS FOR

刈藻島スチング機械部予算

重量及代金

| 材料 | 単価 円/封度 | 運転設備 | | ブレーキ | | エンドロック | | センターリングクラッチ | | インジケーター | | ゲート | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 重量 | 代金 | 重量 | 代金 | 重量 | 代金 | 重量 | 代金 | 重量 | 代金 | 重量 | 代金 |
| | | # | 円 | # | 円 | # | 円 | | 円 | | 円 | | 円 |
| 鋳鉄 | .24 | 2570. | 617. | 225. | 54 | 520 | 125 | 105 | 25. | 92. | 22 | 533 | 128 |
| 半硬鋼 | .47 | 320 | 150 | 32. | 15 | 200 | 94 | 275 | 129 | — | — | 122 | 57 |
| 燐青銅 | 1.00 | 550 | 550 | — | — | 58 | 58 | 285 | 29 | — | — | 10 | 10 |
| 砲金 | .90 | 16 | 14 | 6 | 5 | — | — | 165 | 15 | 7. | 6. | — | — |
| 火造物 | .50 | 250 | 125 | 45 | 23 | 255 | 128 | 62. | 31 | — | — | 14 | 7 |
| 軸類 | .15 | 2,180 | 327 | 20 | 3 | 800 | 123 | 106. | 16 | 65. | 10 | — | — |
| フレーム類 | .135 | 550 | 74 | 48 | 6 | 88 | 12 | 42 | 6 | — | — | 73 | 10 |
| 真鍮 | .90 | — | — | 3 | 3 | — | — | — | — | 11 | 10 | — | — |
| 鋳鋼 | .42 | 2870 | 1210 | — | — | 2140 | 899 | 686 | 288 | — | — | 73 | 31 |
| 銅 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| ボールト | .27 | 200 | 54 | 7 | 2 | 323 | 87 | 110 | 30 | 2 | 1 | 11 | 3. |
| 可鍛鋳鉄 | .68 | 40 | 27 | 32 | 22 | — | — | 118. | 80 | — | — | — | — |
| 購入品 | | — | 370. | — | 8 | — | 19 | — | 4 | — | 1 | — | 1. |
| 機械切歯費 | | | 700. | | — | | | | | | 15 | | 39. |
| 合計 | | ~~6963~~ 9,546# | ~~3129.0~~ 4217円 | 418# | 141.0円 | 4384# | 1545.0円 | 1549# | 653円 | 177# | 65円 | 836# | 286円 |

以上ハ材量費並ニ工賃ニシテ、一般ニ単価低廉ニ失スル様ニアレバ単価ヲ引上ゲ尚之ニ
プレキ、荷造費運賃、工場費割掛並ニ利益等一切加算スレバ下記ノ如シ、

| | | | | |
|---|---|---|---|---|
| 運転設備一切 | | ~~6963~~ 9546 封度 (噸≒4.25) | ~~4650.0~~ 6150.円 (噸当1,447.円) | 図面 12-18 ~~& 25~~ |
| ブレーキ | 1式 | 418 | 330.0 | 19 & 20 |
| エンドロック | 〃 | 4,384 | 2,550.0 | 21 |
| センターリングクラッチ | 〃 | 1,549 | 1,120.0 | 22 |
| インジケーター | 2種類 | 177 | 250.0 | 23 ~~& 24~~ |
| ゲート | 1式 | 836 | 600.0 | 26 & 27 |
| 總合計 | | ~~14,327 ≒ 6.396 噸~~ 16910 ≒ 7.5 噸 | ~~9,500.0~~ ~~10,500.0~~ 11,000.0 (噸当り≒1,470円) | |
| 電気設備（5HPモーター一台並ニ電気設備一切） | | | 3,500.0 | |
| | | | ~~13,000.0円~~ ~~15,~~ 14,500.円 | |

2240)2520 V6
2240
1580
1,568