# 下關市跳開橋 昇開橋

## 概算設計

純径間長 二〇、〇米 跳開橋（バスキュール）

工費 二〇二、〇〇〇円 （一〇頁参照）

仝上 昇開橋（リフト） （昇程 一〇米）

工費 一六七、〇〇〇円 （二〇頁参照）

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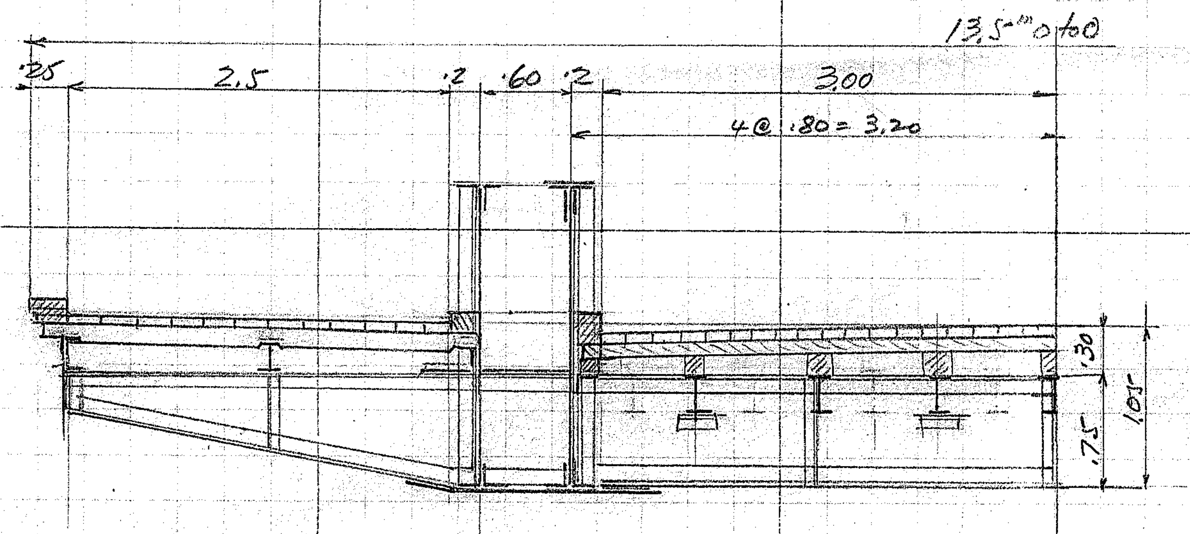
CALCULATIONS FOR

下関唐島 バスキュール橋

Bascule span. 20.0m. clear.
width 6.0m roadway, sidewalks 2.5m each.
loading 2nd class loading.



scale 1:150

Roadway floor. 7.5cm wood block pav.
10 cm planking

Sidewalk floor. 5cm planking

Stringers 250×125 @ 38.3kg

30
-16.5
13.5
3.5
10

Floor beam
Dead Load.

Roadway.
pavement 6.5 @ 9.5 = 62
planking 10 @ 6.5 = 65
nailing piece $\frac{.1 \times .15}{.8}$ @ 680 = 12
Stringer 40 ÷ .8 = 50
11
200 kg/m²

3.6m @ 200 = 720
floor beam. 150
870 kg/m.

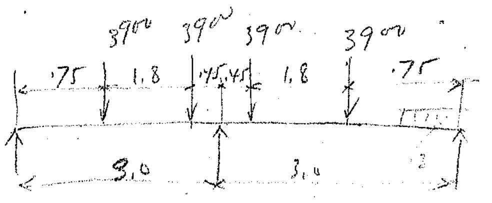
Side walk.
planking 5 @ 6.5 = 3.3
Cross beam. = 20
Stringer 40
7
100

3.6 @ 100 = 360
120
480 kg/m.

D.L. m. $\frac{1}{8} \times 870 \times 6.4^2$ = 4460
$\frac{1}{2} \times 480 \times 3^2$ = -2160
100 × 3 = -300
2000 or -2,160 kgm.

Side span  9.0^m span.  3 girders 3^m c.to c.

8 ton truck



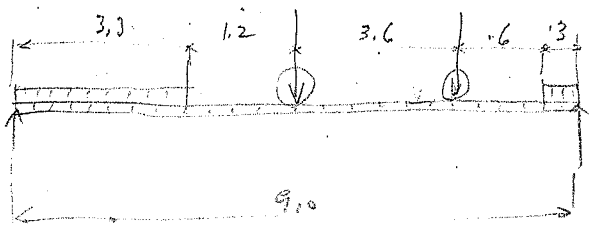
$3000 \times 1.3 = 3900$ kg

$3900 \times \dfrac{2.55 + .75}{3.0} = 4290 \times 2 = 8580$ kg on Center girder

4290 " " side "

front & rear of truck
unif load  $500 \times 3.0 = 1500$ kg/m  for center girder

" $500 \times 1.5 = 750$
$400 \times 2.5 = 1000$
1750 " " side "



Side of truck

$.3 \times 500 = 150 \times \frac{.15}{3.0} = 7.5 \times 2 = 15$ kg/m Center girder

7.5 / [illegible] .1008. Side girder

Live Load moment

Center girder.

wheel. rear $8580 \times \frac{1}{2} = 4290$
front $2860 \times \frac{.9}{9} = 290$
$4580 \times 4.5 = 20,600$

unif. load. $1500 \times .3 \times .15 = 70$
$1500 \times 3.3 \times 7.35 = 36380$
$36450 \div 9 = 4060 \times 4.50 = 18,250$
$4950 \times 2.85 = -14100$
24,750 kgm

Side girder

wheel. $20600 \div 2 =$ ~~10,300~~ 10300

$750 \times .3 \times .15 = 40$
$750 \times 3.3 \times 7.35 = 18200$
$18240 \div 9 = 2025 \times 4.5 = 9120$
$2475 \times 2.85 = -7050$

$\frac{1}{8} \times 1000 \times 9^2 = 10120$

22,490 kgm

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CALCULATIONS FOR

(1B)

D.L.

Center girder

asphalt block 3.8 cm @ 21 = 80
cushion 1.2 " @ 17 = 20
slab 15 @ 24 = 360
460 × 3.0 = 1380 kg.

Stringer 1 @ 40 = 40
floor beam 200
girder lateral 480
720
2100 kg/m

80
150
60
290 × 1.5 = 4[illegible]

$m = \frac{1}{8} \times 2100 \times 9^2 = 21{,}300$ kgm

Side girder.

floor. roadway 1.5 @ 460 = 690
Stringer 40
2 @ 30 = 60
100
floor beam 200
girder. 400
150

side walk floor.
pav. 3.0 @ 17 = 50
slab. 13 @ 24 = 312
360
1900

$m = \frac{1}{8} \times 1900 \times 9^2 = 19{,}300$ kgm

Summary

| | Center girder | Side girder |
|---|---|---|
| DL | 21,300 | 19,300 |
| LL | 24,800 | 22,500 |
| | 46,100 kgm | 41,800 kgm |

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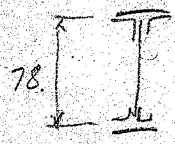
CALCULATIONS FOR

1c

Side span

Center girder section



1 web 770×9 = 69.3 $\frac{1}{8}$ web = 8,7 cm²

Flg stress = $\frac{46100 \times 100}{75}$ = 61500

Flg area = $\frac{61500}{1200}$ = 51.3

8.7

42.6 net

2∠ 100×100×13 = 43.42 − 13 = 30.42

1 cov. pl. 220×10 = 22.0 − 5 = 17.00

65.42 47.42 net.

Approx. wt. of main gr.

2 flg's @ 65.4 = 131.8

1 web 9×77 = 69

200 @ .785×9.5 = 1,490

details 40% = 610

2100

Summary for structural steel in fixed span.

| | | | |
|---|---|---|---|
| Stringer | 2 @ 40 | = 80 × 9.5 = | 760 |
| " | 2 @ 25 | = 50 × 9.5 = | 475 |
| floor beam | 4 @ 1500 | = | 6,000 |
| lateral br. | | = | 1,500 |
| main girders | 3 @ 2.100 | = | 6300 |
| Shoes | 4 @ 250 | = | 1,000 |
| Exp. jt. | 2 @ 100 | = | 1900 |
| | | | 17,935 kg call this 18 tons. |

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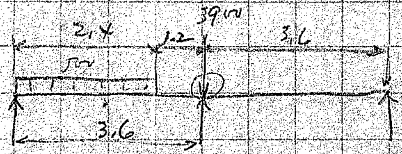
CALCULATIONS FOR

下夷

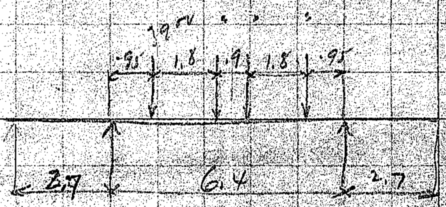
L.L.



Unif load on front + rear of truck

$\frac{500 \times 2.4 \times 1.2}{3.6} = 400$ kg/m.

rear wheel 3000 × 1.3 = 3900 kg.



M. 7800 × 2.75 = 21,450
3900 × 1.8 = − − 7,000
14,450 kgm

1/8 × 400 × 6.4² = 2050
16500 kgm.

neg. m.

3.6 @ 400 = 1440 kg/m.

1/2 × 1440 × 2.7² = −5250 kgm

Summary

| | moment at center | at support |
|---|---|---|
| DL | 2000 | −2160 |
| LL | 16500 | −5250 |
| | + 18500 kgm | −7400 kgm |

web. 750 × 9 = 67.5 1/8 web = 8.45 cm²

flg. stress = $\frac{18500 \times 100}{70}$ = 26500 kg

flg. area = $\frac{26500}{1200}$ = 22.1 cm²
−8.5
13.6 cm² net

2L 125 × 75 × 9 = 34.3 − 9 = 25.3 net.

weight of floor beam.

4L 125 × 75 × 9 @ 13.5 × 6.4 = 346
1 web 750 × 9 @ 53.0 × 6.4 = 339
685
details 40% = 275
960 kg.

Cantilever arm Assump.

960 × $\frac{2.7}{6.4}$ = 400 kg.

wt. of one complete floor beam.

Canti. arms 2 @ 400 = 800
Center span 960
1760 kg

Main bascule girder.
Dead Load.

| | | |
|---|---|---|
| Roadway floor. | 6.4" @ 200 = | 1280 |
| Sidewalk . 2.75×2 = | 5.5 @ 100 = | 550 |
| hand rails | 2 @ 100 = | 200 |
| floor beams. | 1760 ÷ 3.6 = | 490 |
| lateral bracings | | 250 |
| main girder assumed (Inside girders) | | 900 (1100) |
| | | 130 |
| | | 3800 kg/m. ÷ 2 = 1900 kg/m for one girder |
| Outside girders | | 800 〃 ÷ 2 = 400 〃 |

Max. D.L. m. of main girder.

$\frac{1}{2} \times 1900 \times 14.7^2 = 205000$ kgm.
30% imp. = 61500
266500 kgm.

⑫ [illegible]
Web. $2000 \times 9 = 180$ 1/8 web = 22.5
flg. stress $= \frac{266500}{1.93} = 138000$ kg.
flg. area $= \frac{138000}{1200} = 115.0$
22.5
92.5 cm² net
Ex. load on end. shoe, lock, buffer, floor break etc 10.0
102.5 〃

Use
2L's 150×150×11 = 64.0 − 11 = 53.00
2 cov. pls 320×12 = 76.8 − 12 = 64.8
140.8 cm² gr. 117.8 cm² net.

Approx. wt. of main girder.
main section 2 flanges @ 140.8 = 281.6
1 web pl. = 180
461.6
details say 50% 238.4
700.0 cm² gr. @ .785 = 550 kg/m
wt. of one girder = 22.2 m @ 550 = 12200 kg

Outside main girder say 10000 kg.

Lateral bracing 〃 20 m @ 250 = 5000

Summary of Structural Steel for Bascule leaf.

| | | | |
|---|---|---|---|
| Stringers | | 7 @ 40 × 22.2 = | 6210 |
| 〃 | | 4 @ 30 × 〃 = | 2670 |
| floor beams | | 7 @ 1760 = | 12320 |
| lateral bracings | | 5000 | 6,000 |
| 〃 〃 | strut framing | 1000 | |
| main girders | inside gr. | 2 @ 12200 = | 24,400 |
| 〃 | outside 〃 | 2 @ 10000 = | 20,000 |
| Shoes | | 4 @ 500 = | 2,000 |
| floor breaks | | 2 @ 2000 = | 4000<br>400 |
| | | | 78,000 tons |

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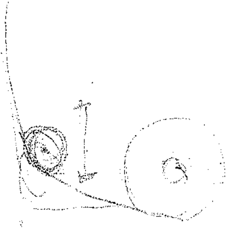

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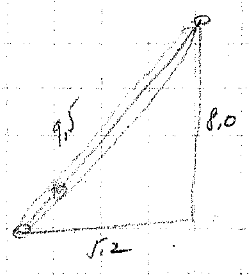
CALCULATIONS FOR

Bala~~c~~ncing Link



vert. comp. of link pull.

| | | | | |
|---|---|---|---|---|
| 4000 × 22.2 = | 88,800 kg | × 11.8 m = | 1,048,000 |
| outside girder 2 @ 10,000 = | 20,000 | × 2.5 = | 50,000 |
| rack | 2,200 | × 2.2 = | 5,000 |
| | 111,000 kg | | 1,103,000 kgm. |
| | wt. of moving leaf complete | | moment abt. trunnion |

vert. comp of link pull = $\frac{1103{,}000}{8.2}$ = 134,700 kg

67,400 kg for one link

Link pull 67400 × $\frac{9.5}{8.0}$ = 80,000 kg
30% impact = 24,000
104,000 kg.

SR. = $\frac{104000}{1200}$ = 78 cm² net

Use 2 ⊏ 380 × 100 × 13 = 171.42 − $\left\{\begin{matrix}20\\26\end{matrix}\right\}$ = 125.00 net
l/r = 55 about

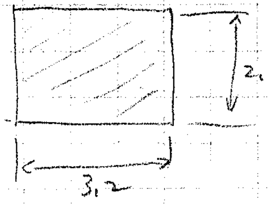
approx. wt. of one link

2 ⊏ 380 × 100 @ 67.3 kg × 10 = 1350
details say 70% 950
2300 kg. one (link)

Counterweight required

moment about trunnion = 1103,000 kgm

Cw't reqd. = $\frac{1103000}{5.6}$ = 197,000 kg (全体ニテ)



volume of cwt. assumed as.
2.2 × 3.2 × 8.0 = 56.3 m³

density of cwt. concrete = $\frac{197000}{56.3}$ = 3500 kg/m³ (223#/ft)

$7850x + (1-x)2200 = 3500$ 0.23 @ 7850 = 1805
$5650x = 1300$ 0.77 @ 2200 = 1695
$x = \frac{1300}{5650} = 0.23$ 3500 kg

Total vol. of conc = 56.3 @ .77 = 43.4 cub m
Steel scrap = 56.3 @ 1805 = 10,170 kg ① 案

$7850x + (1-x)1700 = 3500$ 0.293 @ 7850 = 2300
$6150x = 1800$ 0.707 @ 1700 = 1200
$x = \frac{1800}{6150} = 0.293$ 3500

Total vol. of mortar = 56.3 @ .707 = 39.8 cub.m
steel scraps = 56.3 @ 2300 = 12,950 kg. ② 案

Blance girders.

moment on balance beam
Link pull　　1103,000÷2 = 551,500
own wt. of beam.　　1/2×800×8.2² = 26,900
　　578,400 kgm.
Link wt.　　2300×8.2 = 18,900
　　597,300 kgm.
~~30~~ 20 % impact　　= 119,700
　　717,000 " one girder.

flg stress = 717000 / 1.95 = 368,000
flg area = 368000 / 1200 = 307 cm²
1/8 web　200×1.2÷8 = 30
　　277 net.

Use 2∠ˢ 150×150×19 = 106.8 − 19.0 = 87.8
2pls 230×12 = 55.2 − 12 = 43.2
3 cov. pls 320×19 = 182.0 − 28.5 = 153.5
344.0 gr　　284.0 cm² net.

2 flgs @ 344 = 688
1 web pl. 1.2×200 = 240
　　928
60% details = 557
1485 @ .785×15.6 = 18,200 kg (一本分)

Lateral bracings
Diagonals with gusset pls. 6,000
cross struts + longi. strut, cwt grs 14000
　　20,000 (全体)

Countermeight tower　say　23000 kg (全体ニテ)

Summary of structural steel:
Bascule leaf complete　78,000
balance girders 2@18,200 = 36400
laterals cwt grs etc 20000
　　56,400
Links 2@ 2300 = 4600
Counterweight tower complete 23,000
grillage under trunnion 2@1500 = 3,000
floor beam ~~over~~ bascule pier = 1,500
　　500
　　167000 kg
fixed span　18000
　　185,000 kg or 185 tons.

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CALCULATIONS FOR
20m Bascule span.

Estimate of Operating power.

Journal friction

$$M_F = \frac{Pfr}{100} = \frac{PfD}{200}$$

67400
28200
98.00

$90000 \times \frac{3.6}{8.2} = 40.00$

| Journals. | Dia. D. | Load P | f | | | |
|---|---|---|---|---|---|---|
| Link pins | 18 | 80,000 | × 0.15 | ÷ 200 | × 4 | = 4320 |
| trunnion shaft | 18 | 40,000 | 〃 | 〃 | 2 | = 1080 |
| 〃 〃 | 30 | 190,000 | 〃 | 〃 | 2 | = 8550 |
| | | | | | | 13950 kgm. |

Rack force $F_F = \frac{13950}{2.20}$ = 6350 kg for 2 racks.

Eccentricity

End reaction assumed as 2@500 = 1000 kg.
moment 1000 × 22.5 = 22500 kgm
Rack force $F_E = \frac{22500}{2.20}$ = 10200 kg for 2 racks.

Wind moment 70 kg/m² wind assumed during operation

$12.3^m \times 22.2 \times 11.8 \times 70^{kg}$ = 225500 kgm

Rack force $F_W = \frac{225500}{2.2}$ = 102500 kg

Summary of Rack forces.

| | |
|---|---|
| Journal friction | 6350 |
| eccentricity | 10200 |
| inertia | 950 |
| wind | 102500 |
| | 120000 kg for 2-racks. |

flier ヲ高メテ rack radius ヲ 3.5m トスル
rack force $120,000 \times \frac{2.2}{3.5}$ = [illegible]

Time of operation assumed as 60 sec.

15 ÷ 2 = 7.5
30 = 30.0
15 ÷ 2 = 7.5

Equivallent time of unif. speed = 45.0 sec

Unif. speed at rack circle $= \frac{2\pi \times 2.2}{45} \times \frac{85}{360}$ = 0.0725 m/sec.

Theoritical HP req'd $= \frac{120000 \times 0.0725}{76}$ = 114.5

gear efficiency say $(0.94)^7$ = 0.648

Actual HP req'd. $= \frac{114.5}{0.648}$ = 177 HP. — 60 sec. 30+15 = 45

$177 \times \frac{45}{75}$ = 106 HP 90 sec 60+15 = 75

$177 \times \frac{45}{105} \div 0.94$ = 81 HP 120 sec. 90+15 = 105

一段ヲ増加

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CALCULATIONS FOR

20m Bascule

Estimate of cost.

| | | | | | |
|---|---|---|---|---|---|
| Bascule proper. | | | | | |
| wood block pavement. | 22×6.0 = | 132m² @ 7.00 = | 920 | | |
| 10cm planking 米松 | 22×6.4 = | 141 ″ @ 6.00 = | 850 | | |
| 5″ ″ ″ | 2×3×22 = | 132 ″ @ 3.50 = | 460 | | |
| nailing pieces, copings &c | | 10m³ @ 45.00 = | 450 | | |
| bolts + nails &c | | 1.0ton @ 250 = | 250 | | |
| cast iron drains | 16 | 16 @ 5.0 | 80 | | |
| | | | | 3,000 | |
| Structural steel (バスキュール 1ヶ) | | 167.00ton @ 300 = | | 50,100 | |
| Cw't. concrete 1:1.5:3 | | 43.4m³ @ 18 = | 780 | | |
| Steel scraps. | | 10.2 ton @ 70 = | 715 | | |
| reinforcement | | 1.5 ″ @ 130 = | 195 | | |
| | | | | 1690 | |
| Operating house | 木造 | 900 | | | |
| | 階段及手摺等 | 200 | | | |
| | 鋼材 | 400 | | | |
| | | (仕上 塗 含む) | | 1500 | |
| | | | | | 56,300 円 |
| | | | | 予備金 700 | |
| Mechanical equipments: | | | | | |
| Forged steel parts | 8.45 ton @ 1800 | = | 15,200 | | |
| cast steel ″ | 21.75 | 1,300 | 28,300 | | |
| cast iron ″ | 14.95 | 700 | 10,500 | | |
| rolled steel ″ | 7.10 | 650 | 4600 | | |
| phosphor bronze ″ | 1.65 | 3,300 | 5400 | | |
| | 53.90 ton. | | | 64,000 | |
| Electrical equipments | 2-50HP motors. @ | 2300 = | 4600 | | |
| | 3-3HP ″ @ | 600 = | 1800 | | |
| Electric wiring complete | | | 3200 | | |
| | | | | 9600 | |
| | | | | | 73,600 |
| | | | | 予備金 | 10,000 |
| Fixed span. | | | | | |
| Asphalt block pav. | 6.0×9.4 = | 56.5m² @ 3.6 = | 200. | | |
| cement mortar fin. | | 50 @ 1.2 = | 60 | | |
| slab, concrete | | 17.5m³ @ 15 = | 260 | | |
| reinf. | | 2.5 ton @ 130 = | 330 | | |
| forms. | 13.0×10 = | 130m² @ 1.5 = | 200 | | |
| | | | | 1050 | |
| Structural steel | | 18.0 ton @ 240 = | | 4300 | |
| | | | | | 5400 |
| Handrails 全長 | 80m @ 100kg = | 8.0 ton @ 200 = | | 1600 | |
| 親柱 及袖高欄一部 | | 4 ケ @ 1500 = | | 6000 | |
| gates | | 2 ケ @ 1000 | | | |
| | | | | | 7600 |
| | | | | | 2000 |
| | | 上部工 計 | | | 155600 円 |

10万予算

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CALCULATIONS FOR

20m Bascule span.

Sub structures.
Bascule Abutment.
Floor.

Asphalt block pav. 6.0 × 6.5 = 39.0m² @ 3.6 = 140.
Concrete. 0.20 × 6.6 × 6.5 = 8.6
0.40 × 0.3 × 6.6 × 2 = 1.6
0.30 × 0.50 × 6.6 × 2 = 2.0
0.13 × 2.5 × 6.6 = 2.1
0.13 × 3.6 × 6.6 = 3.1
0.25 × 0.2 × 6.6 × 2 = 0.7
1.9
20.0m³ @ 15.0 = 300
Steel 20. @ 125 = 2.5 tons @ 130 = 325
forms. 13 × 6.6 = 86m² @ 1.5 = 130
105
1,000

abutment body,
13.3 + 13
concrete. walls. 0.3 × 2.2 × 26.3 = 17.4
" 0.6 × 13.3 = 8.0
col. 1.5 × 2.6 × 1.5 × 2 = 11.7
" 0.8 × 2.5 × 3.5 × 2 = 14.0
" 1.6 × 2.7 × 13.5 × 2 = 116.5
floor. 0.20 × 3.3 × 13.2 = 8.7
" 0.40 × 0.30 × 3.3 × 8 = 3.2
col. .6 × .6 × 2.5 × 2 = 1.8
Stairs 0.7 × 1.25 × 2.0 = 1.8
6.9
190m³ @ 15.0 = 2,850
Steel 190 @ 60 kg = 11.5 tons @ 130 = 1,500
26.6 + 16 = 43
forms 3.0 × 43. × 2 258
13.3 × 3.3 = 44
0.4 × 3.3 × 16 = 20
1.6 × 3.6 × 2 = 11
1.5 × 2.5 × 4 = 15
30
378 m² @ 1.5 = 570
60 × 125 = 7500
130 × 50 = 6500
14,000

wells. conc. 4.0 × 9.0 × 4.5 × 2 = 324.0
7.5 × 3.0 × 2 = 45.0
36 − 28.5 = 7.5
569m³ @ 15 = 5,540
112 @ 125 = 14.
86 @ 60 = 5.2
19.2
steel. 20 tons @ 130 = 2,600
forms 50 × 7.5 × 2 750 m² @ 1.5 = 1,130
26 + 24
Excav. (Sinking) 540m³ @ 5 = 2,700
sand fill 28.5 × 3.0 × 2 171 @ .6 = 100
Conc. sheet piles .2 × .25 × 7.0m 28 本 @ 25 = 700
割栗 50
基角 500
Shoes 2.5 tons @ 240 600
160
19,000
20,000
2,000
10 @ 15 = 150
1.5 @ 130 = 200
180 @ 1.0 = 180
530 ÷ 28 = 19
6
25

[illegible]

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CALCULATIONS FOR

20 m Bascule.

Pier between fixed and bascule spans.

Conc. shaft 1.8 × 3.6 × 8 = 52$^{m^3}$ @ 15 = 780
steel 52 @ 35 = 1.8 ton @ 130 = 230
form 3.6 × 20 = 72$^{m^2}$ @ 1.5 = 110
80
1,200

well conc. 2.2$^\phi$ = 3.80
2.2 × 7.2 = 15.85
19.65 × 3.7 = 73

1.6$^\phi$ = 2.0
1.6 × 7.2 = 11.5
13.50
19.65
6.15 × 4.8 = 30
105$^{m^3}$ @ 15 = 1580

3 × 3 × .3 × 1.6 × 4.8 = 22
127$^{m^3}$ @ 15 = 1900
Steel 7.0 ton @ 130 = 910
form. 21.4 × 8.5 = 182
29 × 8.5 = 246
428 @ 1.5 = 640
Sand fill 280 @ .6 = 170
Excav. (sinking) 19.65 × 8.5 = 167$^{m^3}$ @ 5 = 840
Shoe. 1.5 ton @ 240 = 360
雑費 80
400
5300
6500 円
豫備 1000

Abutment.

Shaft conc. 0.6 × 4.0 × 8.0 = 19.0
0.4 × 5.0 × 15.0 = 30.
6.6 × 4.0 × 15.0 = 36
5
85$^{m^3}$ @ 15 = 1280
steel 85 @ 40 = 3.5 ton @ 130 = 460
forms 5 × 40 = 200$^{m^2}$ @ 1.5 = 300
granite .3 × .3 × 13 = 1.3 @ 120 = 160
2200

wells.
conc. 4 × 6 × 4.5 × 2 = 216
6.68 × 4.5 × 2 = 60
276 @ 15 = 4140
steel 7.0 ton @ 130 = 900
form. 20 + 16.5 = 36.5 × 2 × 9 = 660$^{m^2}$ @ 1.5 = 990
sand fill. 17.35 × 4.5 × 2 160 @ .6 = 100
shoes. 2.0 ton @ 240 = 480
Excav. (sinking) 24 × 9.0 × 2 432$^{m^3}$ @ 5 = 2160
雑費 530
sheet piles 289 @ 25 = 500
9800
12000 円
豫備 2000

Summary of cost for the entire Bridge

~~Substructures~~ ~~Bascule Abutment 1 Set 22,000~~
~~Pier 1 " 7500~~
~~abutment 1 " 14,000~~
~~43,500~~
~~Superstructures Complete (see page 7.) 155,600~~
~~Total net cost. = 199,100~~ 円 總工費

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CALCULATIONS FOR

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下関市彦島町連絡道路跳開橋 (20" clear span)

| | | | | |
|---|---|---|---|---|
| Estimate of cost. | | | | |
| Superstructures:- | | | | |
| Bascule proper. | Floor complete | | 3000 | |
| | Structural steel | 167.0 tons @ 300 = | 50,100 | |
| | counterweight complete | | 1,700 | |
| | operating house | | 1,500 | |
| | finishing, and misc. exp. | | 700 | |
| | | | | 57000 円 |
| | mechanical equipment | 54.0 tons @ 1300 = | 70,000 | |
| | electric " | 2-50HP motors @3300 = 6600 | | |
| | " gates lock | 4 - 1HP " @ 400 = 1600 | | |
| | | 1 - 2HP " @ 500 500 | | |
| | | wiring etc. 4900 | | |
| | | | 13,600 | |
| | | | | 83,600 |
| Fixed span | Floor complete | | 1,100 | |
| | Structural steel | 18.0 tons @ 240 = | 4300 | |
| | | | | 5,400 |
| Handrails | handrails | 8.0 tons @ 200 = | 1600 | |
| | light pedestals. | 4 sets @ 1500 = | 6,000 | |
| | | | | 7600 |
| Gates and locking | | 5 sets @ 1,000 = | | 5000 |
| | | Summary = | | 158600 円 |
| Substructures | | | | |
| Bascule abutment. | | | | |
| | Roadway floor complete | = | 1,100 | |
| | body | | 5,900 | |
| | wells | 2 wells @ 7500 = | 15,000 | |
| | | | | 22000 |
| Front pier. | | | | |
| | shaft | | 1,500 | |
| | well | | 6000 | |
| | | | | 7,500 |
| Abutment | shaft | | 2900 | |
| | | | 11,100 | |
| | | | | 14000 |
| | | | | 43,500 円 |
| Total cost of the entire bridge | | 158,600 + 43,500 = 202,100 円 | | |
| | | Call this 202,000 円 | | |

Time of operation 20 sec.
Angle of 〃 90°
no. of rev. of rack $n = \frac{60}{80^{sec}} = 0.75$ rev/min.
motor speed. 1800 rev/min.
Gear ratio req'd $= \frac{1800}{0.75} = \underline{2400}$

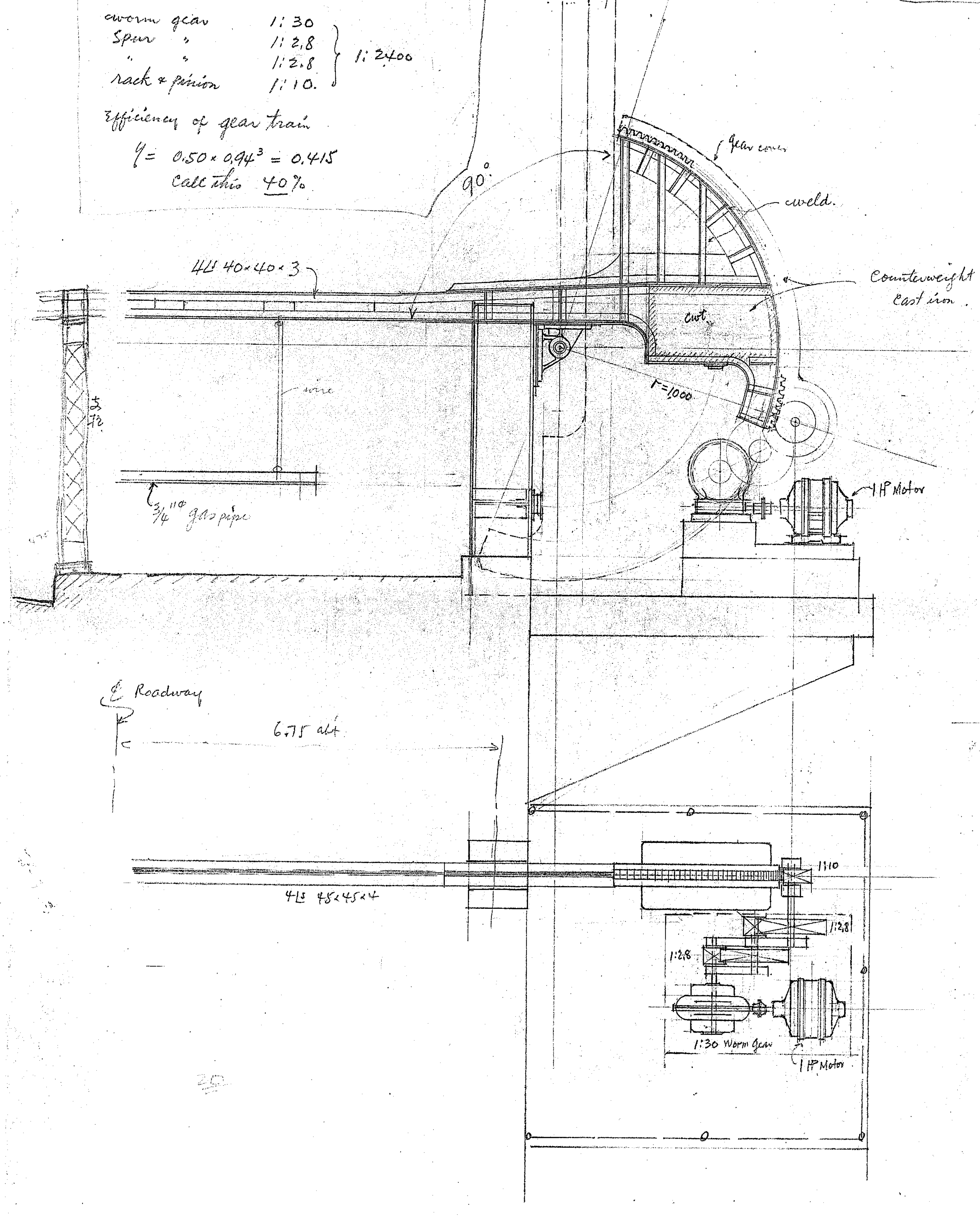
| | | |
|---|---|---|
| worm gear | 1:30 | } 1:2400 |
| Spur 〃 | 1:2.8 | |
| 〃 〃 | 1:2.8 | |
| rack & pinion | 1:10. | |

Efficiency of gear train
$\eta = 0.50 \times 0.94^3 = 0.415$
Call this $\underline{40}$%

彦島連絡可動橋用遮断機

縮尺 1:20

一箇所当り 1500円以内



Gate. 1:20

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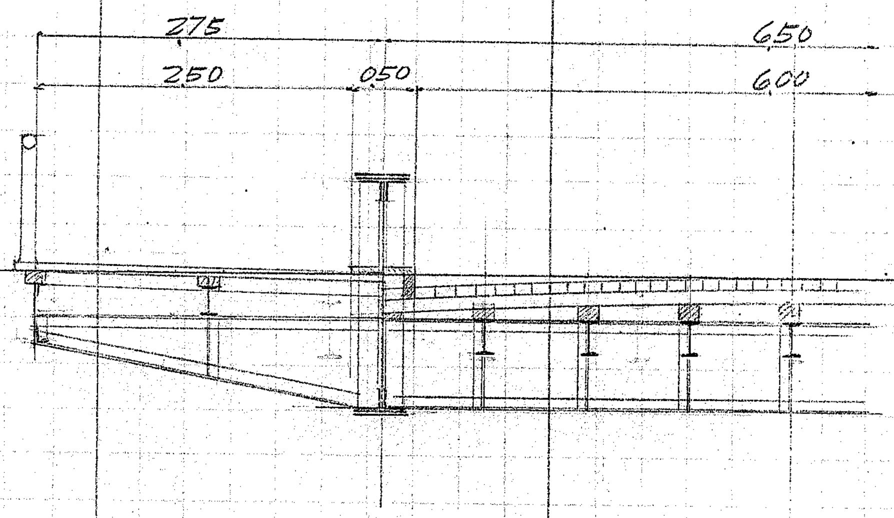
Cross section of bridge



$\frac{650}{8} = 81$

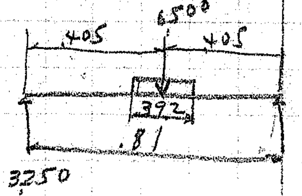
Scale 1:60

| | | | |
|---|---|---|---|
| 6.1 cm pavement | @ 9.6 | = | 58.5 |
| 10 cm planking | @ 6.0 | = | 60 |
| misc. | | | 1.5 |
| | | | 120 kg/m² |

Dead load moment $\frac{1}{10} \times 120 \times .81^2 = 8$ kgm

motor truck rear wheel 3,000
impact 30 % 900
3,900 kg

Effective width of planking for one wheel assumed as 60 cm
load on one meter strip 3900 ÷ .60 = 6,500 kg



live load moment 3250 × .405 = 1316
3250 × .098 = - 318
998 kgm

12.2
27
392

moment 998
8
1,006 kgm

Section modulus required $\frac{1006 \times 100}{70} = 1440$ cm³

section modulus $\frac{100 \times 10^2}{6} = 1660$ cm³

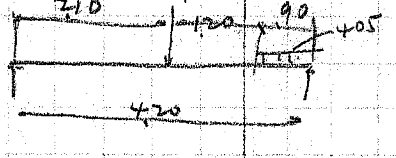
Stringer dead load
pavement & planking 120
nailing piece .120 × .15 × 600 = 11
40 52
171 kg 183 kg

250 × 125 @ 38.3 kg

dead load moment $\frac{1}{8} \times 171 \times 4.2^2 = 377$ kgm

5@4.2 = 21.0

$\frac{1}{2} \times 3{,}900 = 1{,}950$ live load moment
$\frac{405 \times .90^2}{2 \times 4.20} = 39$
1,989

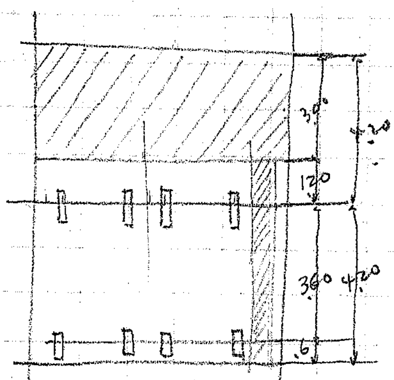


1,989 × 2.10 = 4,180 kgm
377
4557

S.M. required $\frac{4557 \times 100}{1100} = 380$ cm³
414

500 × .81 = 405

Floor beam



$\frac{3900}{3} = 1{,}300$ kg

$1{,}300 \times \frac{.6}{4.2} = 186$

3900

4,086 kg

$\frac{500 \times 300}{4.2} \times 1.5 = 535$ kg

$4{,}086 \times 4 \times \frac{3.55}{6.50} = 8{,}920$ kg

dead load moment

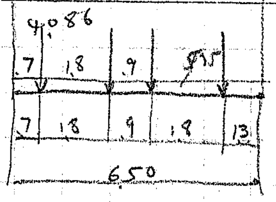
$120 \times 4.2 = 504$

$\frac{63 \times 7 \times 4.2}{6.5} = 285$

own weight 151

940 kg/m

$\frac{1}{8} \times 940 \times 6.50^2 = 4{,}960$ kgm



live load moment

$8{,}920 \times 3.25 = 29{,}000$
$4{,}086 \times 2.55 = -10{,}410$
$4{,}078 \times 0.75 = -3{,}060$

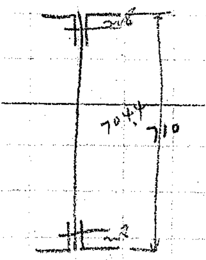
15,530 kgm

$\frac{1}{8} \times 535 \times 6.5^2 = 2830$

18,360 kgm

summary

18,360
4,960
23,320 kgm



flange stress $= \frac{23{,}320}{\cancel{0.704}\ .654} =$ ~~33,200~~ 35,500 kg

$\frac{1}{8}$ web area $\frac{70 \times .9^2}{8} = 7.9$ cm²

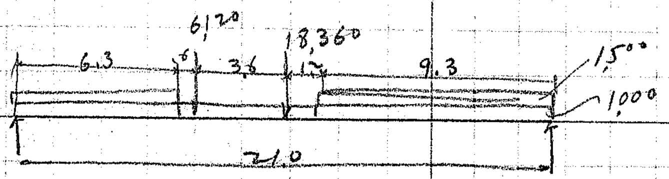
required section $= \frac{\cancel{33200}\ 35500}{1{,}200} =$ ~~28.0~~ 29.6 cm²

7.9
21.6
20.9 cm²

2∟s $100 \times 75 \times 10 = 33.00 - 8.8 = 24.20$ cm² ✓

$20 \cdot 3.3 = 66$
$70 \times .9 = 63$
$129 @ .785 = 101$
$40\% = 40$
141 kg/m

Design of main girder



| | | |
|---|---|---|
| Dead load | pavement & planking | $120 \times 3.25 = 390$ |
| | stringer | $3.5 \times 63 = 220$ |
| | floor beam | $\frac{1}{2}$ $142 \times 6.5 \div 4.2 = 110$ |
| | lateral | 100 |
| | side walk | 60 |
| | stringer | $2 \cdot 70 = 140$ |
| | floor beam | $120 \times 2.75 \div 4.2 = 79$ |
| main girder | handrail | 550 |
| | | 1,650 kg/m |

Dead load moment $\frac{1}{8} \times 1{,}650 \times 21.0^2 = 91{,}000$ kgm

live load $400 \times 2.5 = 1{,}000$ kg
$500 \times 3.0 = 1{,}500$ kg

moment

$\frac{1}{2} \times 18{,}360 \times 10.5 = 96{,}400$

$\frac{6120 \times 6.9}{21.0} = 2010 \times 10.5 = 21{,}100$

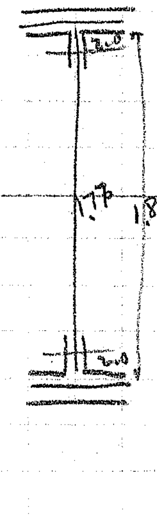
$\frac{1500 \times 6.3}{21.0} \times 3.15 = 1{,}416 \times 10.5 = 14{,}860$

$\frac{1500 \times 9.3}{21.0} \times 16.35 = 10{,}850 \times 10.5 = 114{,}000$

$1{,}500 \times 9.3 = 13{,}950 \times 5.85 = -81{,}600$

$\frac{1}{8} \times 1{,}000 \times 21.0^2 = 55{,}000$

219,760 kgm
91,000
310,760 kgm



$\frac{1}{8} \times$ web area $\frac{180 \times 1.1}{8} = 24.7$ cm²

flange stress $\frac{310760}{1.77} = 175{,}500$

required section $\frac{177500}{1200} = 148.$

$-24.7$

123.3 cm²

2∟s $150 \times 150 \times 12 = 69.12 - 12 = 57.12$

2pl $340 \times 12 = 81.6 - 12.0 = 69.6$

126.72

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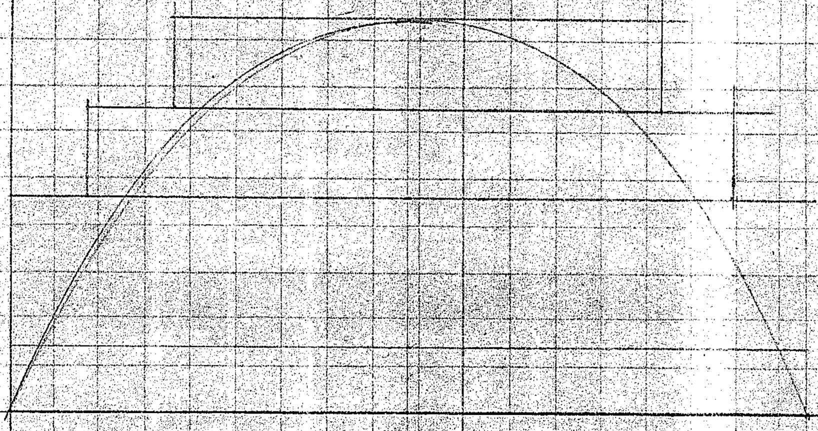

$\frac{310 \times 24.7}{151.4} = 506$

$\frac{310 \times 57.12}{157.4} = 1170$

| | | | | | | |
|---|---|---|---|---|---|---|
| main section | 1 web pl | 1800 × 11 | @ 155.4 | × 21.6 | = | 3360 |
| | 4 flange Ls | 150 × 150 × 12 | @ 27.1 | × 21.6 | = | 2,340 |
| | 2 cov pl | 340 × 12 | @ 32.0 | × 17.0 | = | 1,090 |
| | 2 " | 340 × 12 | @ 32.0 | × 13.0 | = | 830 |
| | | | | | | 7,620 |
| Details | ~~40~~ 55 % | | | | | 3,050 4190 |
| | | | | | | 10,670 11810 |
| | | | | | | 2 |
| | | | | | | 21,340 kg 23,620 |

Total weight of moving span

| | | | | | |
|---|---|---|---|---|---|
| pavement & planking | | 120 × 6.5 | × 21.6 | = | 16,850 |
| " | 2 @ | 60 × 2.9 | × 21.6 | = | 7,520 |
| stringer | 7 @ | 83 | × 21.6 | = | 9,530 9,000 |
| " | 4 @ | 50 | × 21.6 | = | 4,320 |
| floor beam | 6 @ | 145 ✓ | × 6.5 ✓ | = | 5,160 |
| " | 12 @ | 120 ✓ | × 2.75 ✓ | = | 3,960 |
| lateral | | 288 | × 21.6 | = | ~~4,320~~ 5400 |
| handrail | 2 @ | 75 | × 21.6 | = | 3,240 |
| main girder | | | | | 22000 |
| | | | | | 76,900 say 77 tons |
| | | | | | 80 |

for one counter weight 38.5 tons

$38.5 \div 2.4 = \frac{16.0 m^3}{60 \times 1.2} = 2.2^m$

structural steel of moving span ~~49290~~ 50,460 kg
shoes 3,000 kg

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assumed weight of moving span (bridge & machinery) = 80 tons

moving span & counterweight 160 tons

Force for acceleration

$$F = \frac{Wa}{0.98}$$

$$= \frac{160{,}000 \times 0.0126}{0.98}$$

$$= 2060 \text{ kg} \checkmark$$

time of operation acc 15 sec

unif 30 mean 45 sec

ret. 15

mean speed of operation $\frac{8.5}{45} = 0.189$ m/sec

$a = \frac{0.189}{15.} = 0.0126$ m/sec² ✓

Frictional force of girder & track assumed as 15% of wind load

wind pressure 50 kg/m²

horizontal pressure = 1.8 × 221 × 50 = 1,990 kgs ✓

$F_1 = 1{,}990 \times 0.15 = 299$ kg ✓

Journal friction assumed as 15% of applied load

$F_2 = \frac{160{,}000 \times 0.15}{10} = \frac{24{,}000}{10}$ kgs = ~~24,000~~ 2400

Force required for unbalanced load ~~10,000~~ 5,000 kgs

150
25
15

10

Total force

2060 ✓

300 ✓

~~24,000~~ ~~4000~~ 2400 + 1200

~~26,359~~ kgs ~~7560~~ 6000

$\frac{\cancel{26359}\,7560 \times 85 \times 60}{45} =$ ~~299,000~~ 85,700 kgm/min ✓

~~7~~ 1100 / 270

$\frac{\cancel{10{,}000}\,5{,}000 \times 85 \times 60}{45} =$ ~~113,500~~ 56600 kgm/min.

8.8

8.5

efficiency of gear drum dia assumed as 70 cm circumference 2.20 m

RPM = $\frac{85 \times 60}{2.2 \times 45}$ = 5.15 ✓ RPM of motor 1100 ✓

6

worm gear $\frac{1100}{10}$ = 110

spur gear $\frac{1}{2774}$ 3 set

efficiency (0.7) × 0.94 × 0.94 × 0.94 = 0.581

Required HP $\frac{\cancel{299{,}000}\,85{,}700}{4{,}560 \times 0.581} =$ ~~11.3~~ 32.4 HP × $\frac{1500}{7560}$ = 23.9 32.4 × $\frac{6000}{7560}$ = 25.7

21.4

47.1

$\frac{\cancel{113{,}500}\,56600}{4{,}560 \times 0.581} =$ ~~4.28~~ 21.4 HP

21.4

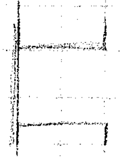
45.3 HP

~~15.58~~ HP

53.8 HP

Design of tower, load on one column 40 tons of moving load & 5 tons acc.

Required section $= \frac{45{,}000}{1200} = 37.5$ cm²



2 ⊏s 380×100 c 54.5 kg sectional area 109 cm²

approximate weight of tower

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| front column | 4 | ⊏s | 380×100 | c 54.5 | × | 14.4ᵐ | = | 3,140 |
| 〃 | 2 | Pl | 500×10 | c 39.3 | × | 14.4 | = | 1,132 |
| rear column | 4 | ⊏s | 380×100 | c 54.5 | × | 13.7 | = | 2,990 |
| top beam | 4 | ⊏s | 380×100 | c 54.5 | × | 1.9 | = | 414 |
| hor. bracing | 12 | Ls | 150×150×11 | c 25.1 | × | 2.1 | = | 632 |
| dia. bracing | 12 | Ls | 150×150×11 | c 25.1 | × | 2.8 | = | 844 |
| sway bracing | 4 | Ls | 150×150×11 | c 25.1 | × | 7.1 | = | 713 |
| 〃 | 4 | Ls | 150×150×11 | c 25.1 | × | 6.8 | = | 682 |
| 〃 | 4 | Ls | 150×150×11 | c 25.1 | × | 6.0 | = | 602 |
| 〃 | 4 | Ls | 150×100×9 | c 17.1 | × | 6.0 | = | 410 |
| top strut | 2 | Ls | 300×100 | c 46.8 | × | 7.4 | = | 693 |

17,252 kg

Details & rivet 45 % 5,548 7350

17,800 kg 19,600 左(側)

Operating house

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4 | ⊏s | 300×100 | c 46.8 | × | 5.5 | = | 1,030 |
| 4 | ⊏s | 300×90 | c 38.1 | × | 5.0 | = | 762 |
| ~~4~~ | ~~Ls~~ | ~~150×150×11~~ | ~~c 25.1~~ | ~~×~~ | ~~2.4~~ | ~~=~~ | ~~241~~ |
| 2 | Ls | 150×150×11 | c 25.1 | × | 1.5 | = | 75 |
| 4 | ⊏s | 300×100 | c 46.8 | × | 9.6 | = | 1,800 |
| 4 | Ls | 150×150×11 | c 25.1 | × | 9.6 | = | 963 |

4,871

Details & rivet 80 % 2429 3,900

7,300 kg 8,770

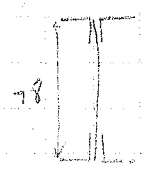
tower 17,800 19,600

25,100 kg 28,370 一左(側).

summary 17,800 19,600
25,100 28,370
42,900 kg 48,000 kg

Structural steel of side span

main girder



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4 | Ls | 150×150×12 | c 27.1 | × | 9.50 | = | 1,030 |
| 2 | Pls | 340×12 | c 32.0 | × | 9.50 | = | 608 |
| 1 | Web | 770×9 | c 54.4 | × | 9.50 | = | 517 |

2,155

details & rivet head 33 % 715 805

3,870 kg

structural steel of one span

| | | | | |
|---|---|---|---|---|
| main girder | 3 c ~~2,890~~ 3020 | = | ~~8,610~~ 9,060 | |
| stringer | 2 c 53 × 9.5 | = | 1,010 | |
| 〃 | 4 c 50 × 9.5 | = | 1,900 | |
| floor beam | 4 c 145 × 6.5 | = | 3,780 | |
| 〃 | 8 c 120 × 27.5 | = | 2,640 | |
| lateral | ~~200~~ 250 × 9.5 | = | ~~1900~~ 2,380 | |
| | | | ~~19,840~~ kg | 20,770 |
| shoe | | | 1,160 | 1290 |
| | | | 21,000 kg | 22,000 |

for 2 spans ~~42,000~~ kg 44,900

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structural steel for side span
for 2 span 42,000 kg
handrail 40~~75~~ @ 9.5 = ~~2,850~~ kg
100

Total weight of structural steel

| | | | |
|---|---|---|---|
| moving span | ~~49,240~~ kg | 50,500 ✓ | |
| 〃 shoe | ~~3,000~~ kg | 3000 ✓ | |
| tower | ~~42,900~~ kg | 48,000 | 46,000 + 2,000 |
| side span | ~~42,000~~ kg | 44,000 | |
| floor break | 4/40,000 | 8,000 ✓ | |
| gate | | 2,000 | |
| cut girder | | 11,000 | |
| | | 166,500 | |

handrail

| | | |
|---|---|---|
| moving span | ~~3,240~~ | 4,400 ~~kg~~ |
| fixed span | ~~2,850~~ | 3,700 |
| | 6,090 ~~kg~~ | 8,100 kg |

gate I
4 @ 5.8 × 12.5 = 290
11 × 12.5 = 140
2 @ 10 × 6.0 = 120
550

Cut girder

| | | | | | |
|---|---|---|---|---|---|
| 2 Pl | 3,000 × 9 | @ | 212.7 × 6.00 = | 2,550 |
| 4 Ls | 150×150×11 | @ | 25.1 × 6.00 = | 600 |
| 4 Ls | 〃 | @ | 25.1 × 1.00 = | 100 |
| 2 Pls | 3,000 × 9 | @ | 212 × 1.00 = | 424 |
| | | | | 3,674 |
| details & rivet head 50 % | | | | 1,836 |
| | | | | 5,500 |

Total weight of structural steel

| | | | | |
|---|---|---|---|---|
| moving span | | 50,500 kg | ✓ | |
| 〃 shoe | | 3,000 〃 | ✓ | |
| tower | | 48,000 〃 | ✓ | |
| side span | 2@22,000 = | 44,000 〃 | ✓ | |
| floor break | | 8,000 〃 | ✓ | |
| gate | | 2,000 〃 | ✓ | |
| cut girder | | 11,000 〃 | ✓ | |
| | | 166,500 kg | | 166.5 tons |

handrail casting

| | | | |
|---|---|---|---|
| moving span | 4,400 kg | ✓ | |
| fixed span | 3,700 〃 | | |
| | 8,100 kg 〃 | | 8.1 tons ✓ |

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Pavement
Fixed span roadway asphalt block pavement
2 c 6.00 × 9.60 = 116 m²
Sidewalk cement mortar finish
4 c 250 × 9.60 = 96 m²

moving span roadway wood block pavement
1 c 6.00 × 222 = 133 m²

Concrete slab
Fixed span (roadway 15 cm, sidewalk 10 cm thick)
2 c 12.5 × 9.60 = 240 m²

Planting
moving span (roadway 10 cm, side walk 5 cm thick)
1 c 12.5 × 22.2 = 278 m²

Concrete floor for machinery + operating room (20 cm thick)
1 c 0.2 × 3.5 × 9.5 = 6.7 m³

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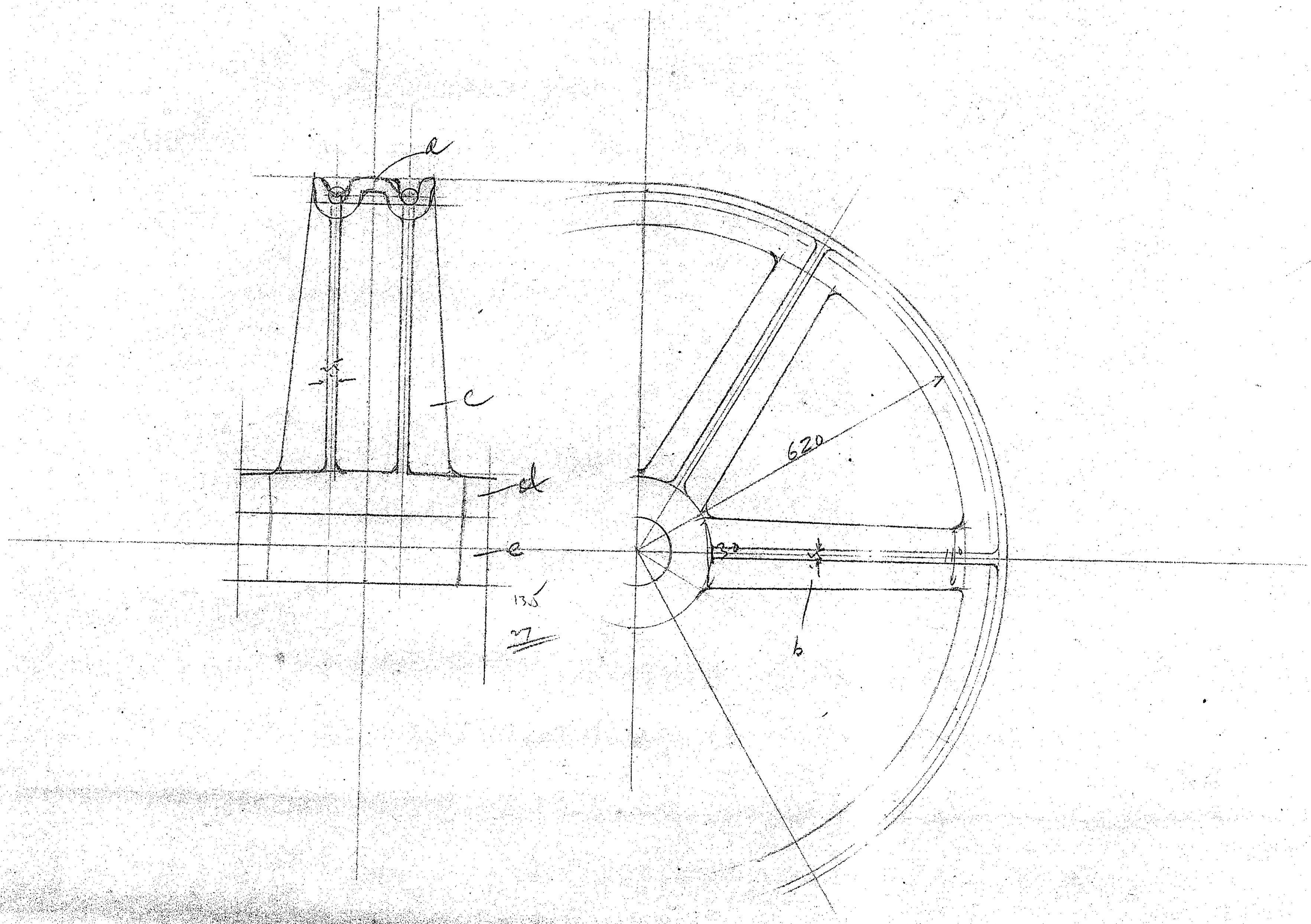
（独立行政法人 土木研究所蔵）

Cwt Sheave



a 4.5 × 21.0 × 124 × 3.14 = 36,800
b 12 c 12.0 × 2.5 × 4.5 = 16,200
c 6 c 26 × 2.5 × 45 = 17,600
d $13.5^2 \times \pi \times 44$ = 25,200
e $6.0^2 \times \pi \times 44$ = − 5,000
90,800 × 0.00786 = 714 kg — 47
118
832

17,600

length of wire rope
4 c 20mmϕ — 34 meters long
8 c 30mmϕ — 18 meters long

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CONSULTING ENGINEER
~~JIJI~~ SHOWA BLDG, TOKYO

MADE BY A. I. DATE 11-5-4 **FILE NO**
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(20)

CALCULATIONS FOR
下関市 20m Lift Bridge.

Estimate of Cost.
Super structures:—

| | | | | | | |
|---|---|---|---|---|---|---|
| Lift span proper. | Floor complete. | | | 3000 | | |
| | structural steel | 123 tons @ 300 = | | 36900 | | |
| | counterweight complete | 2 @ 400 = | | 800 | | |
| | operating house | | | 1500 | | |
| | finishing and misc expences | = | | 800 | | |
| | | | | | 43000 円 | |
| | Mechanical equipment. | 30 tons @ 1300 = | | 39000 | | |
| | electrical | 3-20HP motors @ 2500 = | 7500 –(一台豫備) | | | Σ6 |
| | | gates 2-2HP @ 500 = | 1000 | | | |
| | | locks 1-3HP @ 700 = | 700 | | | |
| | | wiring | 3500 | | | |
| | | cable 架設 | 3000 | 15700 | | |
| | | | | | 54700 円 | |
| Fixed spans. | Floor complete | 2 @ 1200 = | | 2400 | | |
| | structural steel | 44 tons @ 240 = | | 10600 | | |
| | | | | | 13000 | |
| Handrails | handrails | 8. tons @ 200 = | | 1600 | | |
| | light pedestals | 4 sets @ 1500 = | | 6000 | | |
| | | | | | 7600 | |
| Gates and locking | | 3 sets @ 1500 = | | | 4500 | |
| | | | | | 200 | |
| | | | | | 123000 円 | |

Substructures.

| | | | | |
|---|---|---|---|---|
| piers | 2@ 8000 = | | 16000 | |
| abutments | 2@ 14000 = | | 28000 | |
| | | | | 44000 |

Total cost of the entire bridge 123,000 + 44,000 = 167,000 円