DESIGN OF UEDA HIGHWAY BRIDGE
NAGANO-KEN

DESIGNED BY T. M. KISHIDA
OCT. 1923

TRACED BY S. YAGI

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

PRELIMINARY ESTIMATE OF UEDA BRIDGE

[I] GENERAL DESCRIPTION

This Bridge will cross Chikuma-gawa 10 Ken down stream of the present Ueda Bridge on the main highway between Ueda and Matsumoto. The total length of bridge between end bearings is about 666 feet.

[II] ASSUMED LOADING OF BRIDGE

1. Uniform live load

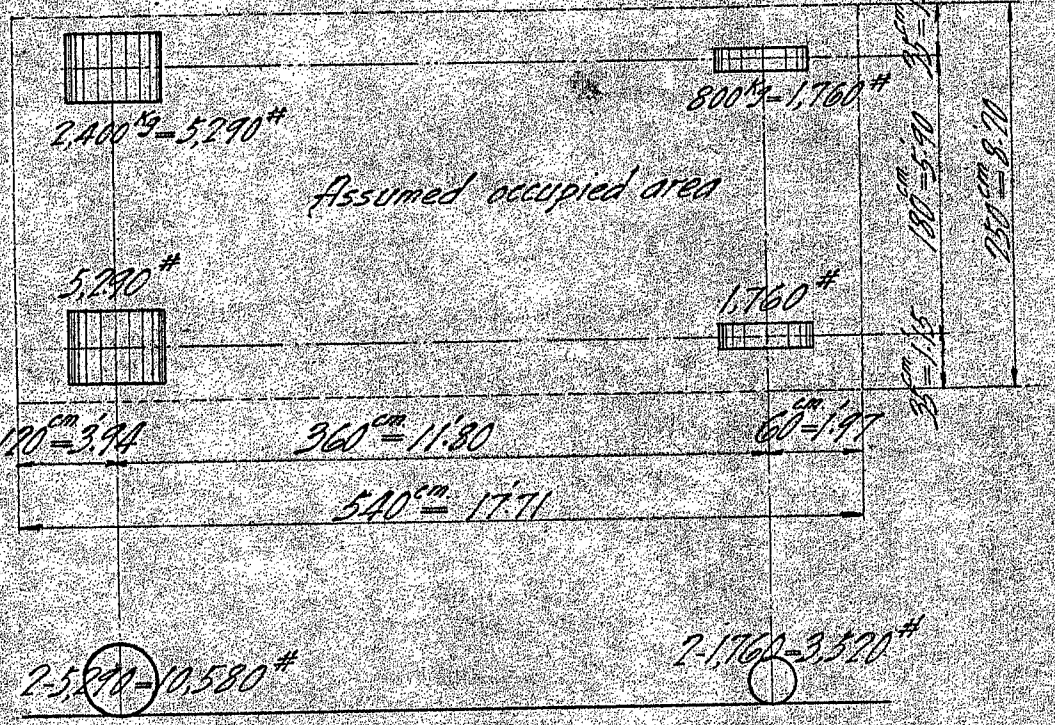
$$g^{kg/m^2} = \frac{10,000}{170+l}$$ with max. of $500^{kg/m^2}$

where, l — span length in meter

No impact considered for this uniform load.

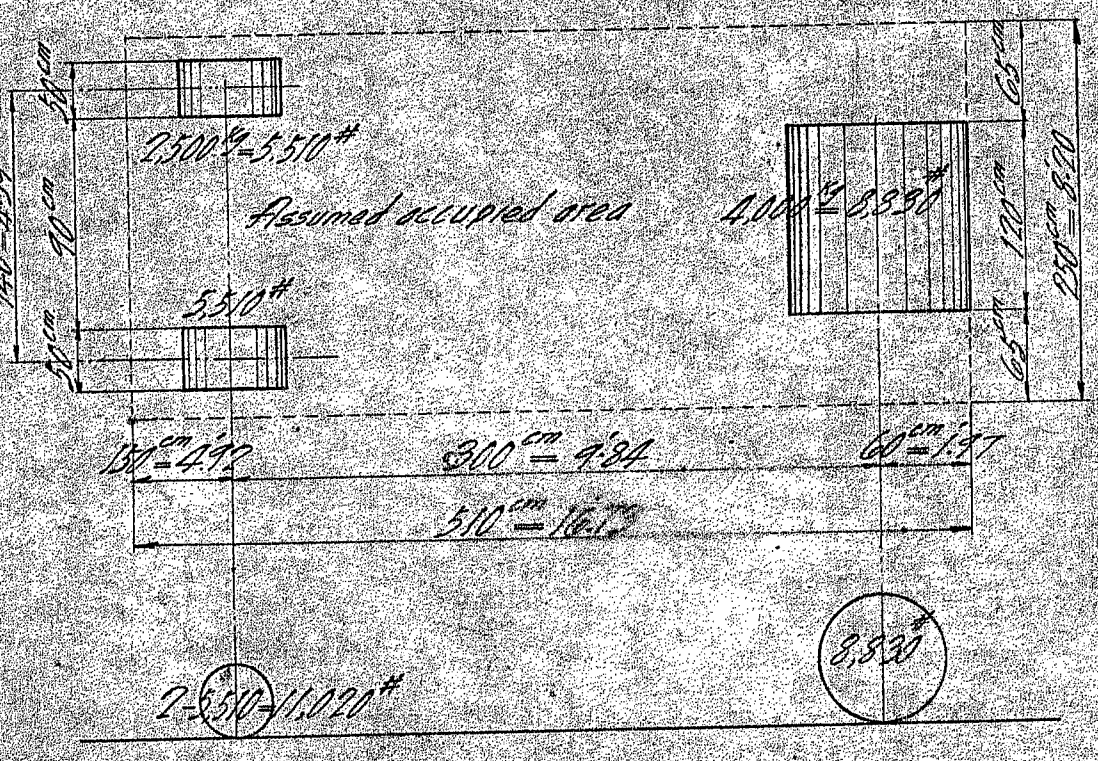
2. Motor truck loading

Total weight — 6.4 tons = 14,100#



3. Road roller

Total weight = 9 tons = 19,850#



増田淳氏関係資料
（独立行政法人 土木研究所蔵）

Notes; One road roller on span is assumed without impact

When the trucks are running side by side, the roadway is filled with the uniformly distributed load and the impact is taken as specified below.

Impact coefficient $I = \frac{20}{60+l}$

where, l = loaded length in meters

Load distribution on reinforced concrete slab

$e = 0.6l + b$ with max. of 2 m

where, e = effective width on slab

l = span length of slab

b = width of wheel

Wind pressure only;

250 kg/m² = 51.2 #/□'

Wind pressure 150 kg/m² = 30.7 #/□' combined with moving load of 500 kg/m = 336 #/ft.

point of application 1.8 m = 5.91 above roadway

Side pressure on handrail.

70 kg/m = 47 #/ft

[III] Assumed Constants and Unit Stresses

1. Constants

Temperature change; ± 30°C for steel

± 15°C for concrete

Expansion coefficients per centi-grade 0.000012

Moduli of elasticity;

E_b 143,000 kg/cm² = 2,040,000 #/□' for concrete

E_e 2,150,000 kg/cm² = 30,600,000 #/□' for steel

$n = E_e \div E_b = 15$

Weights; 2,400 kg/m³ = 150 #/cub. ft for reinforced concrete

7,850 kg/m³ = 489.6 #/cub. ft for structural steel

2. Working unit stresses

a. Concrete (1:2:4)

Compressive strength		140 kg/cm²	= 1,990 #/□'
Bearing		45	= 640
Direct compression		35	= 498
Compression due to moment only	Positive moment	45	= 640
	Negative moment	50	= 711
Compression due to moment and direct compression combined	Strut and column	35	= 498
	arch	45	= 640
Punching shear		9	= 128
Shear	without web reinforcement	4	= 57
	with web reinforcement	9	= 128
Bond stress (plain bar)		6	= 85

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

b. Reinforcing bars

Tension ---------- 1,200 Kg/cm² = 17,080 #/□"

Compression ---------- 1,200 = 17,080

Shearing ---------- 920 = 12,800

c. Structural steel

Tension; axial tension on net section ---------- 1,200 Kg/cm² = 17,080 #/□"

Compression; axial compression on gross section ---------- 1,200 = 17,080

for columns, ---------- $1,500\left(1-0.0055\frac{l}{r}\right)$ Kg/cm² ≤ 1,000 Kg/cm²

or $21,330\left(1-0.0055\frac{l}{r}\right)$ #/□" ≤ 14,223 #/□"

where "l" is the length of the member in cm or in inches

Direct compression on steel castings; ---------- 1,125 Kg/cm² = 16,000 #/□"

Bending; bending on extreme fiber of rolled shapes, built sections, girders

and steel castings on net section (tension) ---------- 1,200 = 17,080

on gross section (compression) $1,200\left(1-0.012\frac{l}{b}\right)$ or $17,080\left(1-0.012\frac{l}{b}\right)$

where "l" is the unsupported length of flange, and

"b" the width of flange

on extreme fibers of pins ---------- 1,800 = 25,600

Shearing; shear on plate girder webs and pins ---------- 900 = 12,800

on power driven rivets ---------- 850 = 12,100

on hand driven rivets and turned bolts ---------- 750 = 10,670

Bearing; pins ---------- 1,800 = 25,600

power driven rivets ---------- 1,700 = 24,200

hand driven rivets and turned bolts ---------- 1,500 = 21,330

expansion rollers ---------- 450 Kg/cm = 6000 #/inch

where "d" is the diameter of the roller in cm or in inches

on masonry and concrete (1:2:4) ---------- 45 Kg/cm² = 640 #/□"

$\frac{l}{r}$; for compression main members $\frac{l}{r} \leqq 100$

for compression secondary members $\frac{l}{r} \leqq 150$

for all tension members $\frac{l}{r} \leqq 200$

Alternate stress; Members subject to alternate stresses of tension and compression shall be proportioned for the stresses giving the largest section. If the alternate stresses occur in succession during the passage of motor trucks, each stress shall be increased by 50 % of the smaller. The connections shall in all cases be proportioned for the latter stresses. Wherever the live and dead load stresses are of opposite character, only $\frac{2}{3}$ of the dead load stresses shall be considered as effective in counteracting the live load stresses, but does not apply for the members subject to

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

alternate stresses.

Combined stresses; Members subject to both axial and bending stresses shall be proportioned so that the combined fiber stresses will not exceed the allowed tensile stress.

For stresses produced by longitudinal and lateral or wind forces combined with those from live and dead loads and centrifugal forces, the unit stresses may be increased 25% over those given above, but the section shall not be less than required for live and dead loads and centrifugal forces.

[IV] STUDY OF ECONOMICAL LAYOUT

$$l = \sqrt{\frac{c}{a.p}}$$

where, l = economic span length in ft.

c = cost of one intermediate pier in yen assumed as constant.

$a.l$ = weight of 2 trusses and lateral systems in lbs. per ft.

p = price of steel in yen per lbs.

Assuming the value of a for Kendo as 7

$p = 0.15$ yen

$c = 30,000$ yen

$$l = \sqrt{\frac{30,000}{7 \times 0.15}}$$

$= 169$ ft

Total length of bridge between end bearings 666 ft.

Make span length 165 ft

4 @ 165' = 660'

3 @ 2' = 6'

666' OK

[V] SELECTION OF TRUSS TYPE

We must consider first the type of the truss, because the bridge site is situated in Ueda city and required to subjoin somewhat beautiful sight. For this reason 2 types decided to compare, one of which is curved pratt type and other through tied arch. According to the results of each estimations the latter type is too much expensive by 16 percent for the former, but as superior for aesthetic view, we would select the through tied arch.

Estimation of curved pratt type are attached to the end.

[VI] DESIGN OF TIED ARCH.

Span length 165 ft between center line of end bearings.

1. Floor slab

Panel length 15 ft

Assumed dead load 6" reinforced concrete slab 75 #/□'

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

3"wood block and ½" mortar cushion 20 #/□'

curb $\frac{9"\times 15.5"}{144}\times 150 = 145$ #/ft. W=95 #/□'

$\frac{9.5"\times 3"}{144}\times 150 = 30$ #/ft.

Handrail 35 #/ft.

Overhanging arm of slab.

Roadway $95\times 0.5 = 47.5$ #

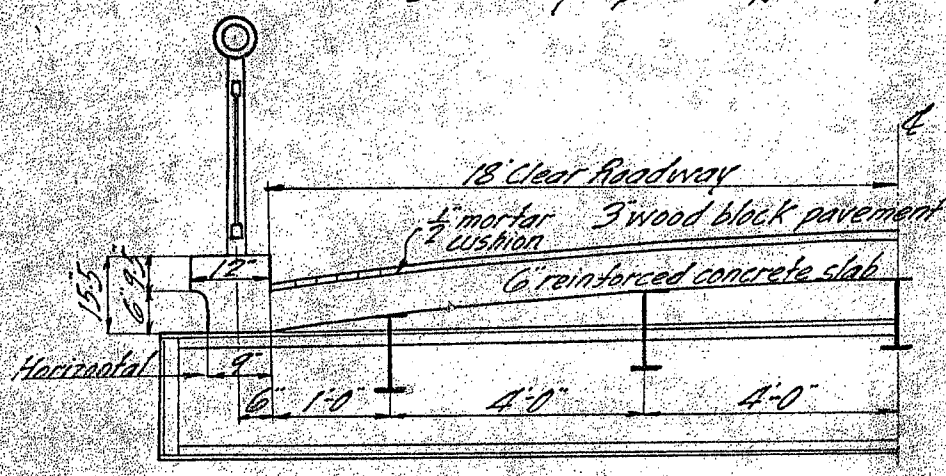
curb $145\times 1.375 = 199.5$

" $30\times 1.875 = 56.0$

Total $p = 270$ #/ft. $M_1 = 303$ #

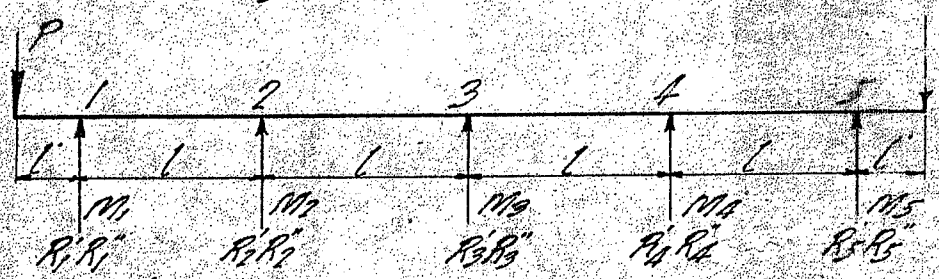
Handrail $35\times 1.5 = 52.5$ #

summary $p = 305$ #/ft. $M_1 = 355.5$ #



4 spans continuous beam with overhanging arms at both ends.

a. Load on overhanging arm.



Load on left arm.

M_1 = given $M_5 = 0$ assumed

By the theorem of three moments,

$$\begin{cases} M_2 = \frac{15}{56} M_1 \\ M_3 = \frac{4}{56} M_1 \\ M_4 = \frac{1}{56} M_1 \end{cases}$$

Summary for symmetrical loading.

	Neg. M_1	Pos. M_2	Neg. M_3	Pos. M_4	Neg. M_5
load on left arm	$-\frac{56}{56}M_1$	$\frac{15}{56}M_1$	$-\frac{4}{56}M_1$	$\frac{1}{56}M_1$	0
load on right arm	0	$\frac{1}{56}M_1$	$-\frac{4}{56}M_1$	$\frac{15}{56}M_1$	$-\frac{56}{56}M_1$
summary	$-\frac{56}{56}[M_1]$	$+\frac{16}{56}[M_1]$	$-\frac{8}{56}[M_1]$	$+\frac{16}{56}[M_1]$	$-\frac{56}{56}[M_1]$

Reaction at supports. Load on left arm.

$$\left.\begin{aligned} R_1' &= P \\ R_1'' &= \frac{M_2 - M_1}{l} = +\frac{71[M_1]}{56\,l} \end{aligned}\right\} R_1 = P + \frac{71[M_1]}{56\,l}$$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

$$R_2' = \frac{M_1 - M_2}{l} = -\frac{7[M_1]}{56\,l} \qquad R_2'' = \frac{M_3 - M_2}{l} = -\frac{19[M_1]}{56\,l} \Bigg\} \; R_2 = -\frac{90[M_1]}{56\,l}$$

$$R_3' = \frac{M_2 - M_3}{l} = +\frac{19[M_1]}{56\,l} \qquad R_3'' = \frac{M_4 - M_3}{l} = +\frac{5[M_1]}{56\,l} \Bigg\} \; R_3 = +\frac{24[M_1]}{56\,l}$$

$$R_4' = \frac{M_3 - M_4}{l} = -\frac{5[M_1]}{56\,l} \qquad R_4'' = \frac{M_5 - M_4}{l} = -\frac{1[M_1]}{56\,l} \Bigg\} \; R_4 = -\frac{6[M_1]}{56\,l}$$

$$R_5' = \frac{M_4 - M_5}{l} = +\frac{1[M_1]}{56\,l} \qquad R_5'' = 0 \Bigg\} \; R_5 = +\frac{1[M_1]}{56\,l}$$

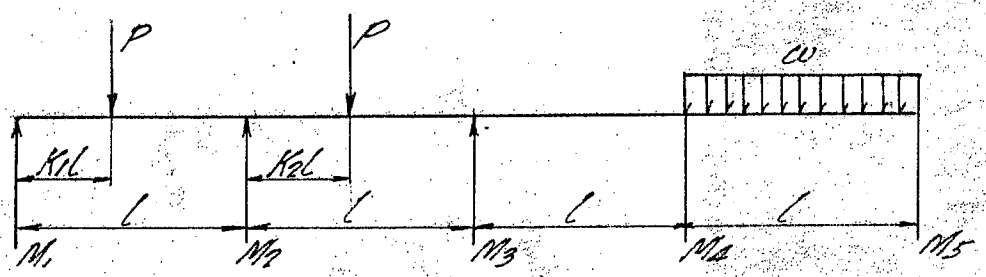
Summary for symmetrical loading

$$R_1 = R_5 = P + \frac{72[M_1]}{56\,l}$$

$$R_2 = R_4 = -\frac{96[M_1]}{56\,l}$$

$$R_3 = +\frac{48[M_1]}{56\,l}$$

b. Load on 1st span.



M_1 and M_5 assumed zero

For concentric load

$$M_1 + 4M_2 + M_3 = -Pl(K_1 - K_1^3)$$

$$M_2 + 4M_3 + M_4 = 0$$

$$M_3 + 4M_4 + M_5 = 0$$

$$M_2 = -\frac{15}{56} Pl(K_1 - K_1^3)$$

$$M_3 = +\frac{4}{56} Pl(K_1 - K_1^3)$$

$$M_4 = -\frac{1}{56} Pl(K_1 - K_1^3)$$

$$R_1 = P(1 - K_1) - \frac{15}{56} P(K_1 - K_1^3)$$

$$R_2 = PK_1 + \frac{34}{56} P(K_1 - K_1^3)$$

$$R_3 = -\frac{24}{56} P(K_1 - K_1^3)$$

$$R_4 = +\frac{6}{56} P(K_1 - K_1^3)$$

$$R_5 = -\frac{1}{56} P(K_1 - K_1^3)$$

For uniform load

$$M_1 + 4M_2 + M_3 = -\frac{1}{4} wl^2$$

$$M_2 + 4M_3 + M_4 = 0$$

$$M_3 + 4M_4 + M_5 = 0$$

$$M_2 = -\frac{15}{224} wl^2$$

$$M_3 = +\frac{4}{224} wl^2$$

$$M_4 = -\frac{1}{224} wl^2$$

$$R_1 = +\frac{97}{224} wl$$

$$R_2 = +\frac{146}{224} wl$$

$$R_3 = -\frac{24}{224} wl$$

$$R_4 = +\frac{6}{224} wl$$

$$R_5 = -\frac{1}{224} wl$$

c. Load on 2nd span.

For concentric load

$$M_1 + 4M_2 + M_3 = -Pl(2K_2 - 3K_2^2 + K_2^3)$$

$$M_2 + 4M_3 + M_4 = -Pl(K_2 - K_2^3)$$

$$M_3 + 4M_4 + M_5 = 0$$

For uniform load

$$M_1 + 4M_2 + M_3 = -\frac{1}{2} wl^2$$

$$M_2 + 4M_3 + M_4 = -\frac{1}{4} wl^2$$

$$M_3 + 4M_4 + M_5 = 0$$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

$$M_2 = -\frac{15}{56}Pl(2K_2 - 3K_2^2 + K_2^3) + \frac{4}{56}Pl(K_2 - K_2^3) \qquad M_2 = -\frac{11}{224}wl^2$$

$$M_3 = +\frac{4}{56}Pl(2K_2 - 3K_2^2 + K_2^3) - \frac{16}{56}Pl(K_2 - K_2^3) \qquad M_3 = -\frac{12}{224}wl^2$$

$$M_4 = -\frac{1}{56}Pl(2K_2 - 3K_2^2 + K_2^3) + \frac{4}{56}Pl(K_2 - K_2^3) \qquad M_4 = +\frac{3}{224}wl^2$$

$$R_1 = -\frac{15}{56}P(2K_2 - 3K_2^2 + K_2^3) + \frac{4}{56}P(K_2 - K_2^3) \qquad R_1 = -\frac{11}{224}wl$$

$$R_2 = +\frac{34}{56}P(2K_2 - 3K_2^2 + K_2^3) - \frac{24}{56}P(K_2 - K_2^3) + P(1 - K_2) \qquad R_2 = +\frac{122}{224}wl$$

$$R_3 = -\frac{24}{56}P(2K_2 - 3K_2^2 + K_2^3) + \frac{40}{56}P(K_2 - K_2^3) + PK_2 \qquad R_3 = +\frac{128}{224}wl$$

$$R_4 = +\frac{6}{56}P(2K_2 - 3K_2^2 + K_2^3) - \frac{24}{56}P(K_2 - K_2^3) \qquad R_4 = -\frac{18}{224}wl$$

$$R_5 = -\frac{1}{56}P(2K_2 - 3K_2^2 + K_2^3) + \frac{4}{56}P(K_2 - K_2^3) \qquad R_5 = +\frac{3}{224}wl$$

Summary for uniform load moment and reaction

Full uniform load.

$$M_2 = -\frac{24}{224}wl^2 = -\frac{3}{28}wl^2 \qquad R_1 = \frac{88}{224}wl = R_5$$

$$M_3 = -\frac{16}{224}wl^2 = -\frac{1}{14}wl^2 \qquad R_2 = \frac{256}{224}wl = R_4$$

$$M_4 = -\frac{24}{224}wl^2 = -\frac{3}{38}wl^2 \qquad R_3 = \frac{208}{224}wl$$

[A] Dead load moment at slab.

overhanging arm $P = 305^{\#}$ $P = 270^{\#}$

$M_1 = 355.5^{1\#}$ $M_1 = 303^{1\#}$

(1) Reactions due to load on overhanging arm

$$R_1 = R_5 = P + \frac{72}{56}\frac{[M_1]}{l} \qquad R_1 = R_5 = P + \frac{72}{56}\frac{[M_1]}{l}$$

$$= 305 + 1.283\frac{355.5}{4} \qquad = 270 + 1.283\frac{303}{4}$$

$$= 305 + 1.283 \times 88.9 \qquad = 270 + 1.283 \times 76$$

$$= 305 + 114 \qquad = 270 + 98$$

$$= 419^{\#} \qquad = 368^{\#}$$

$$R_2 = R_4 = -\frac{96}{56}\frac{[M_1]}{l} \qquad R_2 = R_4 = -\frac{96}{56}\frac{[M_1]}{l}$$

$$= -1.715 \times 88.9 \qquad = -1.715 \times 76$$

$$= -152^{\#} \qquad = -130^{\#}$$

$$R_3 = -\frac{48}{56}\frac{[M_1]}{l} \qquad R_3 = -\frac{48}{56}\frac{[M_1]}{l}$$

$$= 0.856 \times 88.9 \qquad = 0.856 \times 76$$

$$= 76^{\#} \qquad = 65^{\#}$$

(2) Reactions due to uniform load on 4 spans

$R_1 = R_5 = 0.393 \times 95 \times 4 = 150^{\#}$ $R_1 = R_5 = 0.393 \times 95 \times 4 = 150^{\#}$

$R_2 = R_4 = 1.142 \times 95 \times 4 = 434^{\#}$ $R_2 = R_4 = 1.142 \times 95 \times 4 = 434^{\#}$

$R_3 = 0.928 \times 95 \times 4 = 352^{\#}$ $R_3 = 0.928 \times 95 \times 4 = 352^{\#}$

Summary.

$R_1 = R_5 = 419 + 150 = 569^{\#}$ $R_1 = R_5 = 368 + 150 = 518^{\#}$

$R_2 = R_4 = -157 + 434 = 282^{\#}$ $R_2 = R_4 = -130 + 434 = 304^{\#}$

$R_3 = 76 + 352 = 428^{\#}$ $R_3 = 65 + 352 = 417^{\#}$

Moment at the 1st support $M_1 = -355.5^{1\#}$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

Maximum moment at end span

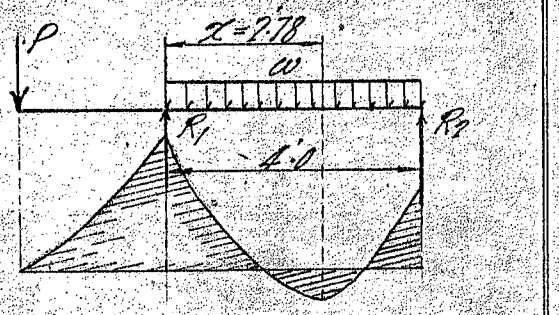
$S = R_1 - P - w.x = 0$

or $x = \frac{R_1 - P}{w} = \frac{569 - 305}{95} = 2.78$

Mat 2.78 $= -355.5 + 264 \times 2.78 - \frac{95 \times 2.78^2}{2}$

$= -355.5 + 735 - 367$

$= +12.5$ lft say $+13$ lft



Moment M_2 at 2nd support

$+\frac{16}{56} \times 355.5 = +101$

$-\frac{3}{28} \times 95 \times 4^2 = -163$

-62 lft

Max. moment at 2nd span

$S = R_1 + R_2 - P - w.x = 0$

or $x = \frac{R_1 + R_2 - P}{w} = \frac{564 + 282 - 305}{95} = \frac{506}{95} = 5.75$

Mat 5.75: $569 \times 5.75 = 3,270$

$282 \times 1.75 = 494$

$+3,764$

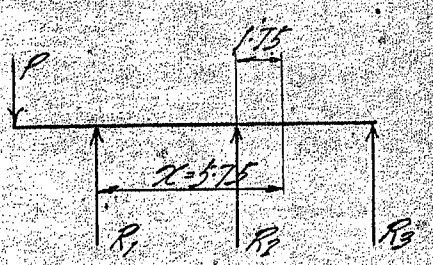
less $305 \times 5.75 = 1,752$

$95 \times \frac{5.75^2}{2} = 1,563$

$M_1 = 355.5$

$-3,670.5$

$+93.5$ lft say 94 lft



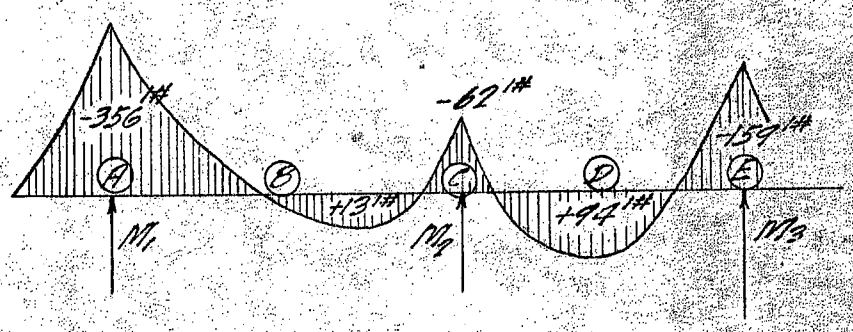
Moment M_3 at center support

$-\frac{8}{56} \times 355.5 = -50.8$

$-\frac{95}{14} \times 4^2 = -108.5$

-159.3 lft say -159 lft

Summary of dead load moments.



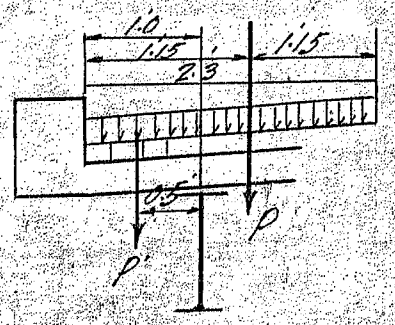
[B] Live load moment of slab

Maximum moment due to concentrated load will be determined by trials; the figures below will not be an absolute maximum, but one of the maximum. Design of concrete slab will be made for possible maximum moment under judgement of designer.

Motor truck rear wheel with $\frac{1}{3}$ impact

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

wheel 5,290
1/3 impact 1,760
P=7,050 P'=7,050 × 10/23=3,060#



(1) Max. negative moment at 1st support.

$M_1 = -3,060 \times 0.5 = -1,530^{\#}$

Assuming this load distributed over 2 feet longitudinally

Moment M_1 per feet $-1,530 \div 7 = -765^{\#}$ ---------- [1]

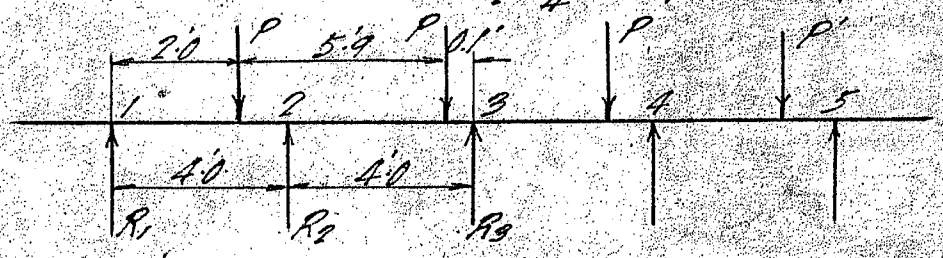
Considering the bending moment due to horizontal pressure to the curb.

$M_1 = -800^{\#}$

(2) Max. positive moment at center of end span.

P=7,050

K_1=0.5 assumed $K_2 = \frac{3.9}{4} = 0.975$



$R_1 = P \times 0.5 - \frac{15}{56} P (0.5 - 0.5^3)$

$= P \times 0.4$

5 percent increased for other loadings

$\therefore R_1 = +0.42P$

$\therefore M = +0.42 \times 7,050 \times 2 = +5,920$

less $\frac{7,050}{2} \times \frac{1.15}{2} = -2,020$

+3,900

Where assuming the load distribution is as follows.

In the direction of slab span $d = 2'3$

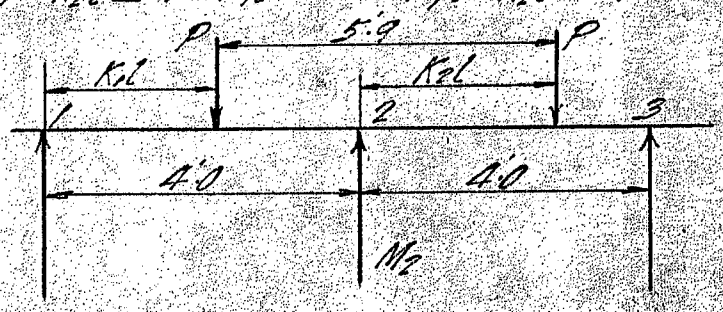
In the direction of stringer $d = 0.6 \times 4' + 1' = 3'4$

For one foot strip

$M = 3,900 \div 3.4 = 1,150$ ---------- [2]

(3) Moment M_2 at 2nd support

$5.9 - K_2 l = 4 - K_1 l$ $K_1 l = K_2 l - 1.9$ $\therefore K_1 = K_2 - 0.475$



$M_2' = -\frac{15}{56} P l (K_1 - K_1^3)$

$K_1^3 = K_2^3 - 3 \times 0.475 \times K_2^2 + 3 \times 0.475^2 \times K_2 - 0.475^3$

$= K_2^3 - 1.425 K_2^2 + 0.677 K_2 - 0.107$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

$$\therefore K_1 - K_1^3 = -0.368 + 0.323K_2 + 1.425K_2^2 - K_2^3$$

$$\therefore M_2' = -\frac{15}{56}Pl\left[-0.368 + 0.323K_2 + 1.425K_2^2 - K_2^3\right]$$

$$M_2'' = -\frac{15}{56}Pl\left[2K_2 - 3K_2^2 + K_2^3\right] + \frac{4}{56}Pl\left[K_2 - K_2^3\right]$$

$$M_2' + M_2'' = -\frac{15}{56}Pl\left[-0.368 + 2.323K_2 - 1.575K_2^2\right] + \frac{4}{56}Pl\left[K_2 - K_2^3\right]$$

$$= -\frac{1}{56}Pl\left[-5.52 + 30.9K_2 - 23.6K_2^2 + 4K_2^3\right]$$

$$\frac{d\left[M_2' + M_2''\right]}{dK_2} = -\frac{1}{56}Pl\left[30.9 - 47.2K_2 + 12K_2^2\right] = 0$$

$$12K_2^2 - 47.2K_2 + 30.9 = 0$$

$$K_2 = \frac{47.2 \pm \sqrt{2228 - 1480}}{24}$$

$$= 0.828 \qquad K_2^2 = 0.685 \qquad K_2^3 = 0.567$$

$$\therefore K_1 = 0.353$$

$$\therefore K_1' = 1.412$$

$$K_2' = 3.312$$

$$M_2' + M_2'' = -\frac{1}{56}Pl\left[-5.52 + 30.9 \times 0.828 - 23.6 \times 0.685 + 4 \times 0.567\right]$$

$$= -\frac{1}{56}Pl\left[+6.27\right]$$

$$= -0.110 \times 7,050 \times 4$$

$$= -3,120\text{'}\#$$

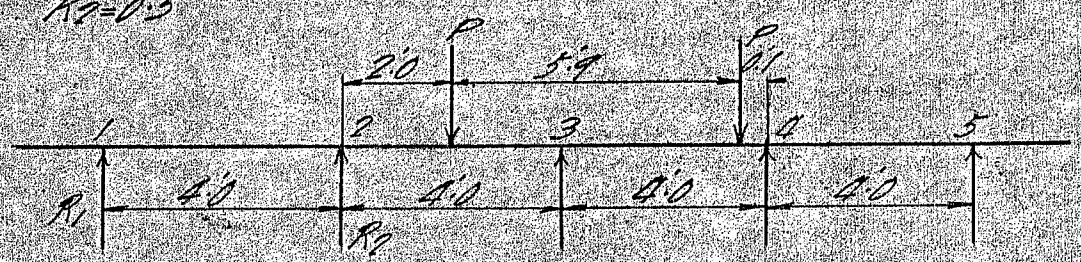
For one foot strip

$$M_2 = -3,120 \div 3.4 = -920\text{'}\# \quad \ldots\ldots\ldots\ldots [3]$$

Uniform live load on 4th span neglected

(4) Max. Positive moment at center of 2nd span

$K_2 = 0.5$



$$R_1 = -\frac{15}{56}P\left[1.0 - 0.75 + 0.125\right] + \frac{4}{56}P\left[0.5 - 0.125\right]$$

$$= -\frac{0.375}{56}P\left[1.5 - 1\right]$$

$$= -0.0067P \times 11$$

$$= -0.0737P$$

$$= -520\#$$

$$R_2 = +\frac{34}{56}P \times 0.375 - \frac{24}{56}P \times 0.375 + P \times 0.5$$

$$= +P \times 0.567$$

$$= +4,000\#$$

M: $-520 \times 6 = -3,120$

$+4,000 \times 2 = +8,000$

$+4,880$

less $-2,020$

$+2,860\text{'}\#$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

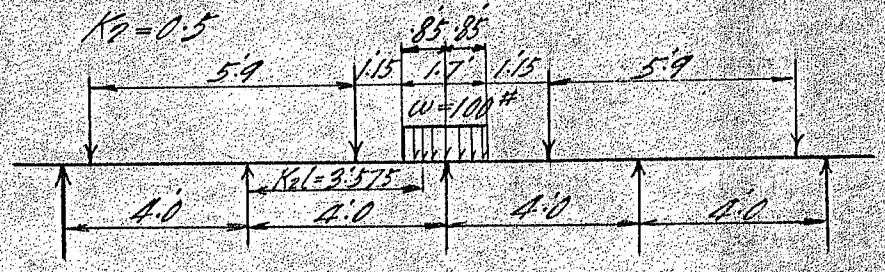
For one foot strip

$M = 2,860 \div 3.4 = 840^{\#}$ ------ [4]

Effect of other load neglected

(5) Moment M_3 at center support.

$K_2 = 0.5$



$M_3 = +\left[\frac{4}{56}Pl \times 0.375 - \frac{16}{56}Pl \times 0.375\right] \times 2$

$= -0.0067 \times 24 \times Pl$

$= -4,530^{\#}$

For one foot strip

$M_3 = -4,530^{\#} \div 3.4 = -1,330^{\#}$

Effect of uniform live load

$K_2 l = 3.575 \quad K_2 = 0.895 \quad K_2^2 = 0.801 \quad K_2^3 = 0.717$

$M_3 = +\frac{4}{56}Pl\,[1.79 - 2.403 + 0.717] - \frac{16}{56}Pl\,[0.895 - 0.717]$

$= [+0.0074 - 0.0508]\,Pl$

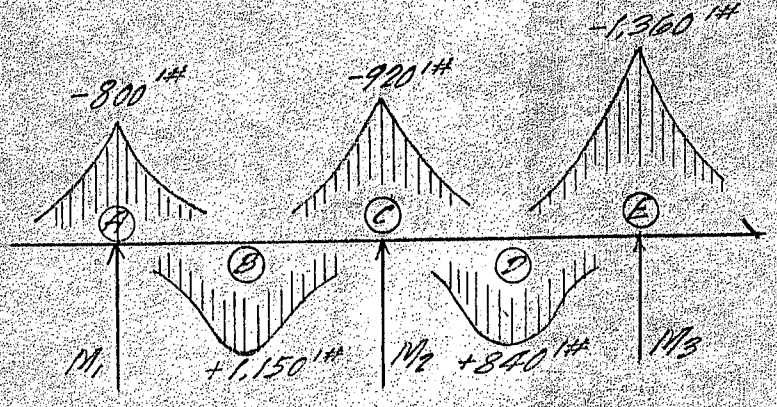
$= -0.0434\,Pl$

$= -0.0434 \times 100 \times 1.7 \times 4$

$= -29.5^{\#}$ say $-30^{\#}$

Summary; $M_3 = -1,360^{\#}$ ------ [5]

Summary of live load moments



Summary of dead and live load moments

	A	B	C	D	E
Dead load moments	-356	neglected	-62	+90 (assumed)	-159
Live load moments	-765	+1,150	-920	+840	-1,360
	$-1,121^{\#}$	$+1,150^{\#}$	$-982^{\#}$	$+930^{\#}$	$-1,519^{\#}$

Design the roadway slabs for negative moment of $-1,550^{\#}$

" for positive moment of $+1,200^{\#}$

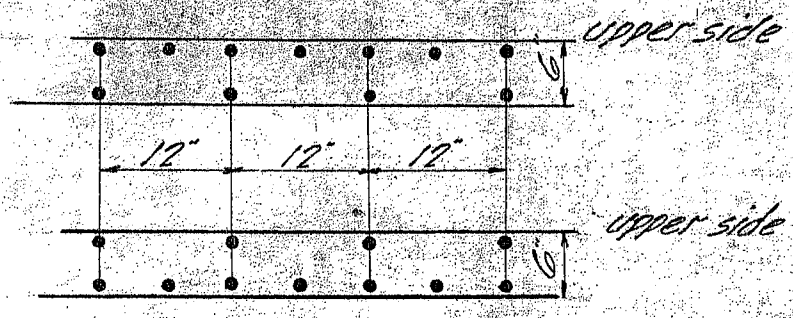
From table make the thickness of the slab 6 inches and reinforcing bars

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

½"ϕ spaced 6 inches c/cs.
Where area of ½"ϕ = 0.1963 □"

For Ⓐ Ⓒ Ⓔ

For Ⓑ Ⓓ

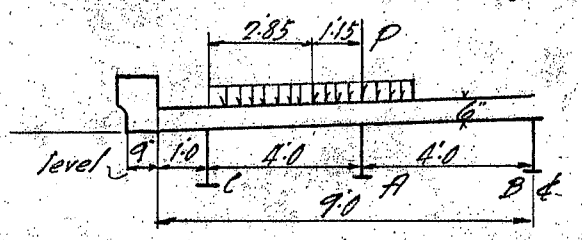


2. Stringer

Span length 15'-0" spaced 4'-0"

Motor truck with ⅓ impact ..... 7,050# for rear wheel

and ..... 2,350# for front wheel



Max. Concentrated wheel load for stringer A and C

for rear wheel $P = 7,050$#

for front wheel $P' = 2,350$#

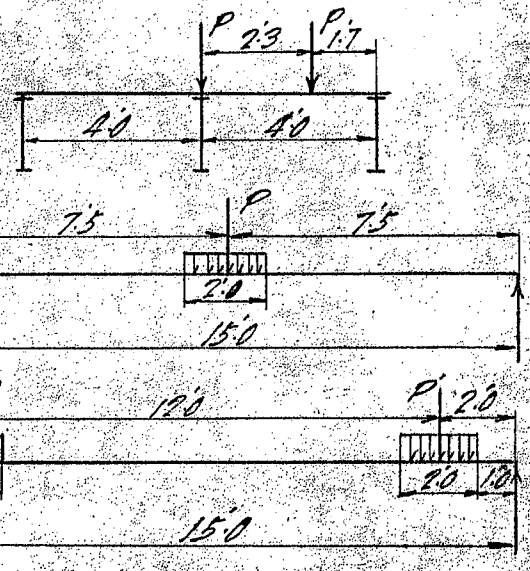
For stringer A uniform load of 2.85 ft must be considered and its quantity is as follows.

$$Pu = 100 \times 2.85 \times \frac{1.425}{4} = 101.5 \text{ \#/ft}$$

Max. Concentrated wheel load for stringer B

$$P = 7,050 \times \left(1 + \frac{1.7}{4}\right) = 10,040\text{\#}$$

$$P' = 3,350\text{\#}$$



$$\text{Live load moment} = \frac{Pl}{4} - \frac{P}{l} \times \eta - \frac{P(l-1)}{4}$$

$$\text{Live load shear} = 39' \times \frac{14}{15} + P' \times \frac{2}{15} - P \times \frac{44}{15}$$

Dead load :-

Max. dead load reaction from slab.

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

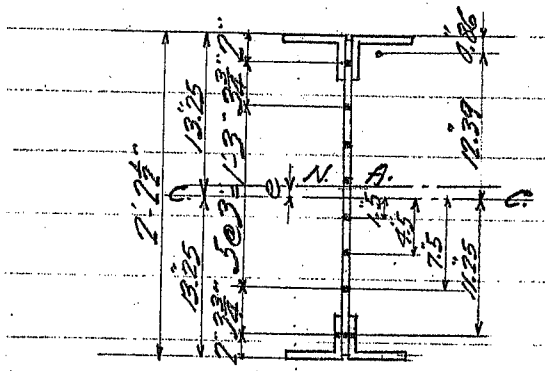
(UEDA-BASHI)

Checked of Floor Beam Section

Actual Max. Bending moment 220,880 ⁱ#

" " Shear 37,493 #

Section



2-Flg. L. 5.3 1/2 × 3/8 = 6.10 = 6.10

1-Web Pl. 26 × 5/16 = 8.13 − 8 2.19/16 × (3/8 + 1/8) = 5.94

2-Flg. L. 5.3 1/2 × 3/8 = 6.10 − 2 0.66/8 × (.) = 5.44

20.33 gross. 17.48 net.

$$e = \frac{2 \times \frac{3}{8} \times 11.25}{17.48} = 0.42$$

$y_t = 13.25 + 0.42 = 13.67$ $y_c = 12.83$

Moment of Inertia about Neutral axis

IN-A

For Flanges $2(3.2 \cdot 2 + 6.10 \times 12.39^2) - 2 \times \frac{3}{8} \times \frac{7}{8} \times 11.25^2$ = 1802.58

(6.4, 936.42, 1885.64 − 83.06)

For Web $\frac{1}{12} \times \frac{5}{16} \times 26^3 - 2 \times \frac{5}{16} \times \frac{7}{8} \times (1.5^2 + 4.5^2 + 7.5^2 + 11.25^2)$ = 345.43

(457.71, 118.28, 2.25, 20.25, 56.25, 205.3125, 196.5625)

2148.01

less 17.48×0.42^2 3.08

2144.93 net

Section modulus of one Flange about neutral axis

$Q = 6.10 \times (12.39 - 0.42) = 73.02$ (11.97) $^{in^3}$

Actual Stresses.

$$f_t = \frac{220.880 \times 12 \times 13.67}{2144.93} = +16,890\ ^{\#}/_{in^2}\ \text{Tension}$$

$$f_c = \frac{220.880 \times 12 \times 12.83}{2144.93} = -15,850\ ^{\#}/_{in^2}\ \text{Compression}$$

Allowable Stresses.

$f_t = +17068\ ^{\#}/_{in^2}$ tension

$f_c = -(17068 - 205\frac{l}{b})$

$= -(17068 - 205 \times \frac{48}{10.31}) = -16114\ ^{\#}/_{in^2}$ compression (954)

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

For stringer C: $w' = 569^{\#}$

" A: $w' = 282^{\#}$

" B: $w' = 428^{\#}$

L 15 A	For C	For A	For B
Dead load reaction from slab	569	282	428
Stringer assumed	37.3	37.3	37.3
Total dead loads	$g = 606.3^{\#}/_{\#}$	$g = 319.3^{\#}/_{\#}$	$g = 465.3^{\#}/_{\#}$
Dead load moments $= \frac{1}{8}gl^2$	$M_g = 17,100^{\prime\#}$	$M_g = 8,980^{\prime\#}$	$M_g = 13,100^{\prime\#}$
Dead load shears $= \frac{1}{2}gl$	$Q_g = 4,550^{\#}$	$Q_g = 2,390^{\#}$	$Q_g = 3,490^{\#}$
Wheel load with impact	$P = 7,050^{\#}$	$P = 7,050^{\#}$	$P = 10,040^{\#}$
Live load moments $= \frac{P(l-1)}{4}$	$M_p = 24,700^{\prime\#}$	$M_p = 24,700^{\prime\#}$	$M_p = 35,200^{\prime\#}$
	$P' = 2,350^{\#}$	$P' = 2,350^{\#}$	$P' = 3,350^{\#}$
Live load shears $= P'\frac{44}{15}$	$Q_p = 6,900^{\#}$	$Q_p = 6,900^{\#}$	$Q_p = 9,830^{\#}$
$M_g + M_p$	$41,800^{\prime\#}$	$33,680^{\prime\#}$	$48,300^{\prime\#}$
$Q_g + Q_p$	$11,450^{\#}$	$9,290^{\#}$	$13,320^{\#}$

For stringer A: B.M. due to uniform load

$M_{pu} = \frac{1}{8}Pul^2 = \frac{1}{8} \times 101.5 \times 225 = 2,860^{\prime\#}$

Shear due to uniform load

$Q_{pu} = \frac{1}{2}Pul = \frac{1}{2} \times 101.5 \times 15 = 762^{\#}$

$\therefore M_g + M_p + M_{pu} = 33,680 + 2,860 = 36,540^{\prime\#}$

$Q_g + Q_p + Q_{pu} = 9,290 + 762 = 10,052^{\#}$

Allowable stress :- $\sigma_c' = 17,080\left(1 - 0.012\frac{l}{b}\right)$

$= 17,080 - 205\frac{l}{b}$ assuming $\frac{l}{b} = 18$

$= 17,080 - 3,690$

$= 13,390^{\#}/\square''$

Section mod. required For B $\frac{48,300 \times 12}{13,390} = 43.3^{(n)3}$

Use 15" x 37.3 # I-Beam

Sect. mod. $= 54.1^{(n)3}$ Sect area $= 10.91\ \square''$

Web thickness $= 0.332''$ gage $= 3\frac{1}{2}''$

grip $= \frac{7}{16}''$ max rivet in flange $= \frac{3}{4}''$

width of flange $= 6.75$

Weight per lin ft.: $37.3 \times 5 = 186.5$

$\underline{15.5}$ ---- for connecting angles

$202.0^{\#}/_{ft}$

say $200^{\#}/_{ft}$

3. Floor Beam connected to post.

Intermediate floor beam

span length 21'5" spaced 15'

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

Dead load: Concentration from end stringer

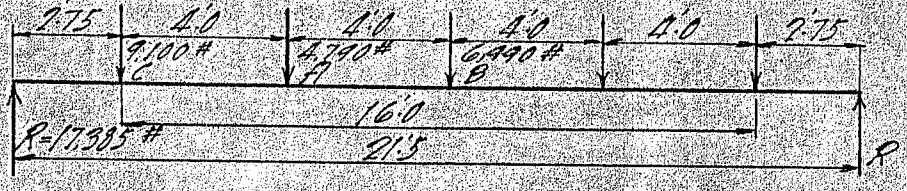
$606.3 \times 15 = 9,100^{\#}$

Concentration from stringer A

$319.3 \times 15 = 4,790^{\#}$

Concentration from stringer B

$465.3 \times 15 = 6,990^{\#}$



Reaction: $R = 9,100 + 4,790 + \frac{6,990}{2} = 17,385^{\#}$

Moment due to concentration:

$17,385 \times \frac{21.5}{2} = 187,000$

less $9,100 \times 8 = 72,800$

$4,790 \times 4 = 19,160$

$91,960$

$95,040^{1\#}$

Floor beam assumed $90^{\#}$ A

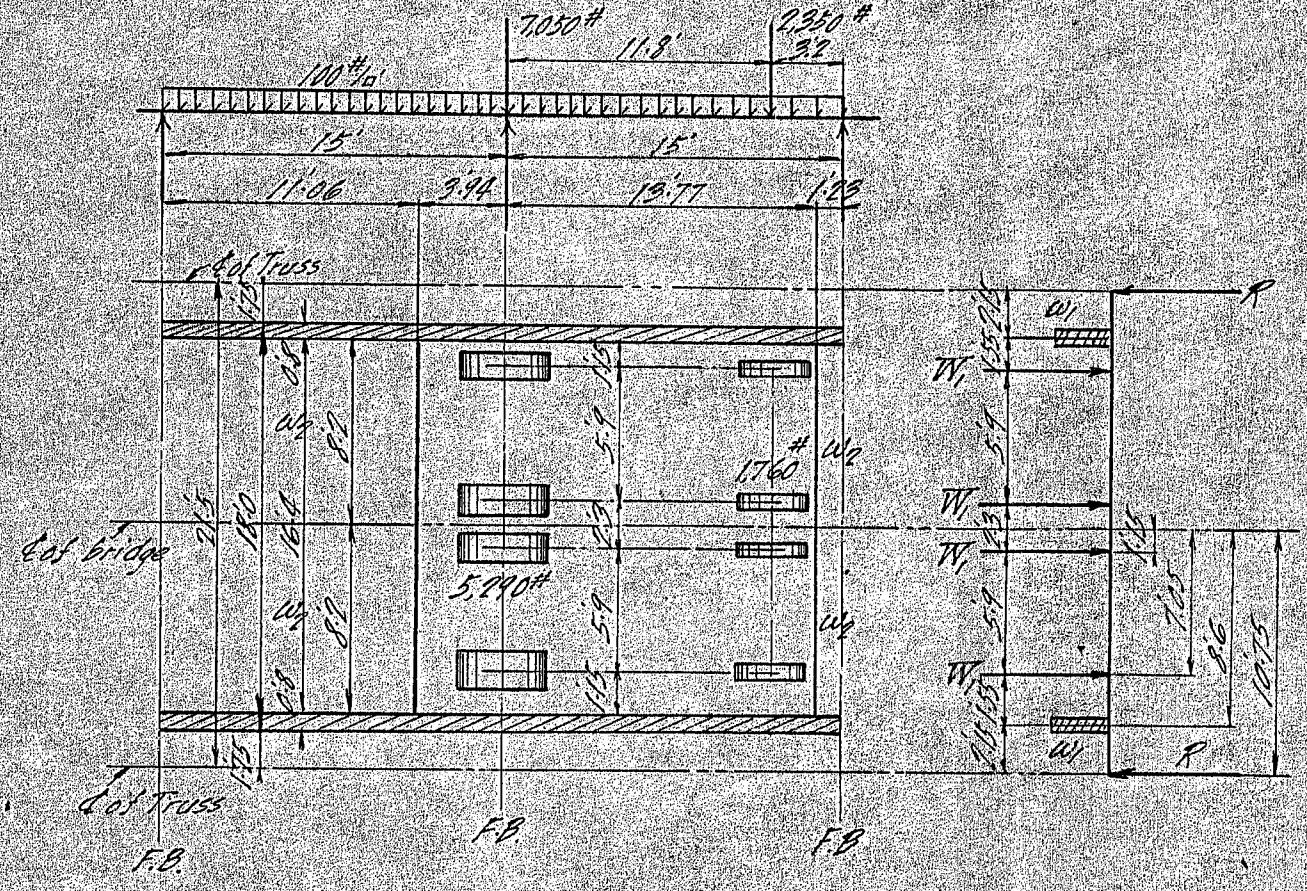
Moment due to its own weight $= \frac{1}{8} \times 90 \times 21.5^2 = 5,200^{1\#}$

Summary of dead load moment:

$95,040 + 5,200 = 100,240^{1\#}$

[A] Live load. Max. moment at floor beam.

Case I 2 motor trucks with impact and uniform load at both sides.



Reaction from motor trucks (with impact)

$W_1 = 7,050 + 2,350 \times \frac{3.2}{13} = 7,550^{\#}$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

Reaction from uniform load (both sides)

$W_1 = 100 \times 15 \times 0.8 = 1{,}200^{\#}$

$R = 7{,}550 \times 2 + 1{,}200 = 16{,}300^{\#}$

Moment due to live load :-

	$16{,}300 \times 10.75$	$= 175{,}200$
less	$1{,}200 \times 8.6$	$= 10{,}300$
	$7{,}550 \times (7.05 + 1.15)$	$= 61{,}900$
		$72{,}200$
		$103{,}000^{\#}$

Case II 2 motor trucks without impact and uniform load fully surrounded.

$W_2 = 5{,}290 + 1{,}760 \times \frac{3.2}{15} = 5{,}666^{\#}$

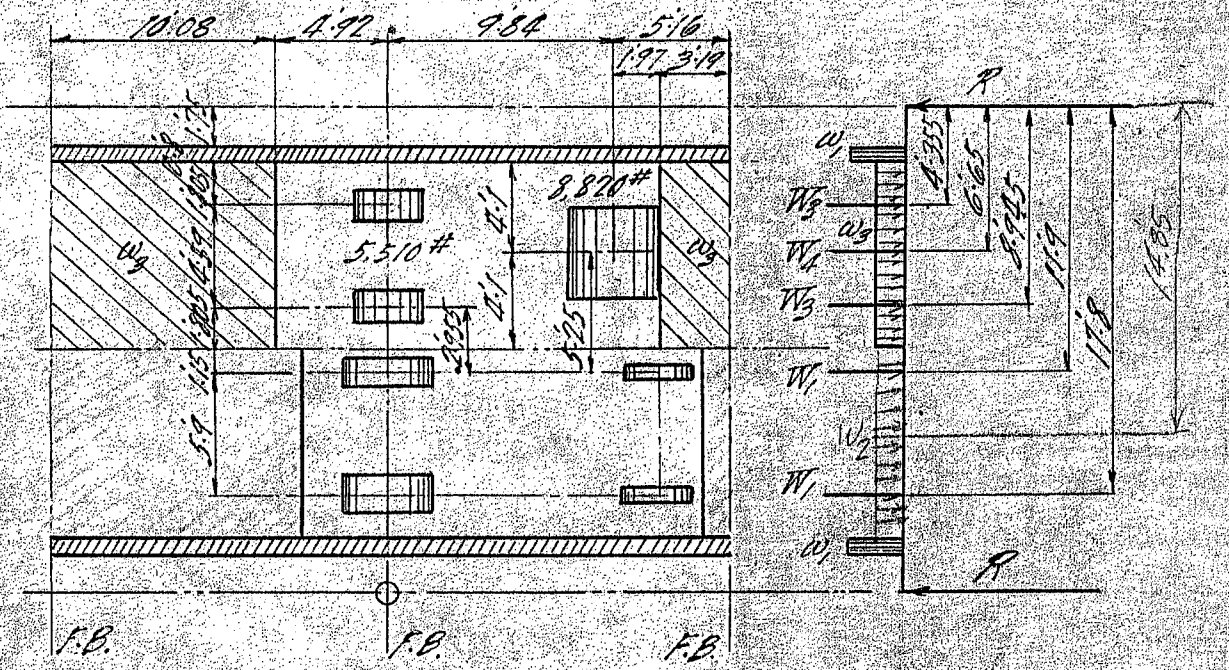
$w_2 = \frac{100}{15} \times 8.7 \times \left[\frac{11.06^2}{2} + \frac{1.03^2}{2}\right] = 3{,}380^{\#}$

$R = 5{,}666 \times 2 + 1{,}200 + 3{,}380 = 15{,}912^{\#}$

Moment :-

	$15{,}912 \times 10.75$	$= 171{,}200$
less	$1{,}200 \times 8.6$	$= 10{,}300$
	$5{,}666 \times (7.05 + 1.15)$	$= 46{,}400$
	$3{,}380 \times 4.1$	$= 13{,}850$
		$70{,}550$
		$100{,}650^{\#}$

Case III 1 motor truck with impact, 1 road roller and uniform load.



$W_3 = 5{,}510^{\#}$

$W_4 = 8{,}820 \times \frac{5.16}{15} = 3{,}035^{\#}$

$w_3 = \frac{100}{15} \times 8.2 \times \left[\frac{10.08^2}{2} + \frac{3.19^2}{2}\right] = 2{,}780 + 280 = 3{,}060^{\#}$ (+330×14.85)

$R = 1{,}200 + \frac{1}{21.5}\left[7{,}550 \times (17.8 + 11.9) + 5{,}510 \times (8.945 + 4.355) + (3035 + 3{,}060) \times 6.65\right]$

$= 1{,}200 + \frac{1}{21.5}\left[224{,}000 + 73{,}400 + 40{,}500\right]$ / +50200

$= 16{,}400^{\#}$

$19{,}250^{\#}$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

Moment :- 19250 206900
16,900 × 10·75 = ~~181,900~~
less 3760.00
22,200
~~104,700~~ #
104300

Case IV Motor truck running along the curb in Case III (+3380×7.65)

$R = \frac{1}{21.5}[2,400 \times 2.55 + 7,550 \times 31.3 + 5,510 \times 14.9 + 6,095 \times 7.45]$

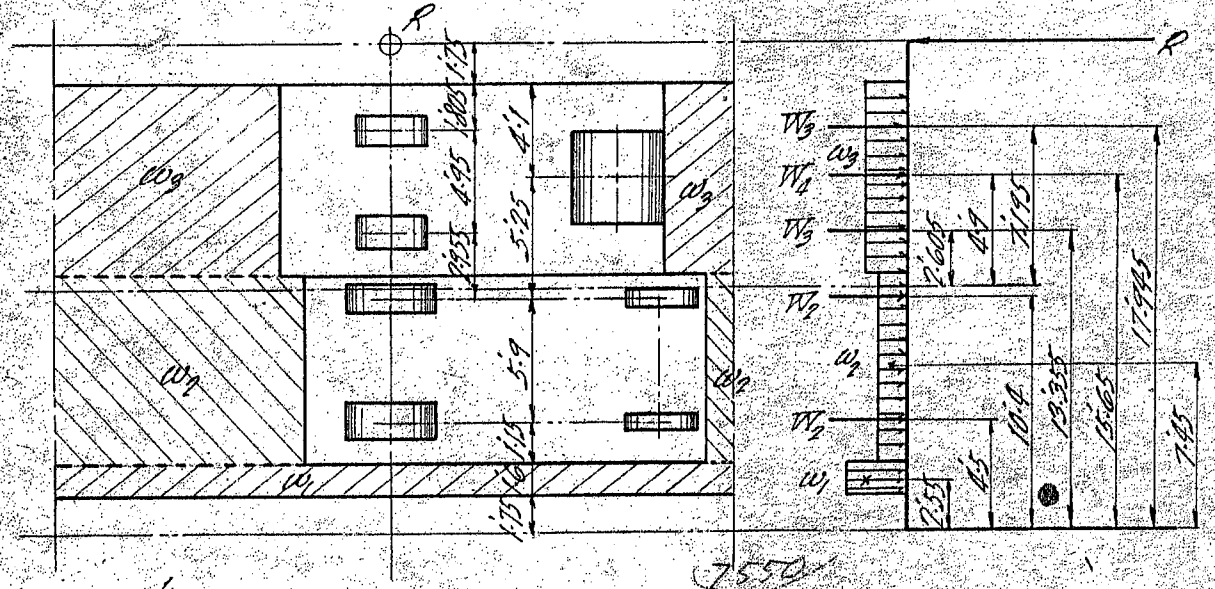
$= \frac{1}{21.5}[6,120 + 236,100 + 82,200 + 45,400]$ (+5289.7)

19680
$= ~~17,200~~$ #

Moment :- 19680 211,300
~~17,200~~ × 10·75 = ~~185,000~~
less 7,550 × 9.8 = 73,980
3,060 × 0.8/8.2 × 0.4 = 120
3380×4.9 = 16560 90660
74,100
110,900 # Max. moment
120640

[B] Max. shear at floor beam

Case V 1 motor truck without impact, 1 road roller and uniform load surrounded.



(7550)

$R = \frac{1}{21.5}[5,510 \times (17.945 + 13.355) + 6,095 \times 15.65 + 5,660 \times (10.4 + 4.5) + 3,380 \times 7.45 + 2,400 \times 2.55]$

$= \frac{1}{21.5}(172,200 + 95,500 + ~~84,500~~ + 25,180 + 6,120)$ 112500

$= ~~17,830~~$ # 19120

Case VI Motor truck with impact in Case V.

$R = \frac{1}{21.5}[172,200 + 95,500 + 6,120 + 7,550 \times 14.9]$

$= 17,970$ # ------ Max. shear

Bending moment considered

17,970 × 10·75 = 193,250

less 5,510 × (7.195 + 2.605) = 54,000

6,095 × 4.9 = 29,820

3,380 × 0.8/8.2 × 0.4 = 130

83,950

109,300 ---- smaller

Summary of dead and live load moments

増田淳氏関係資料
(独立行政法人 土木研究所蔵)

~~$=100,240+110,900=211,140^{\#}$~~ 120440 = 220890

Shear due to dead load :-

Shear due to own weight $=\frac{1}{2}\times 90\times 21{\cdot}5 = 968$

Reaction from stringers $= 17,385$

$18,353$

Summary of dead and live load shears

~~$=18,353+17,970=36,323^{\#}$~~ 9140 37493

Economical height of the floor beam.

$$h=\sqrt{\frac{4ML}{3\times 6[fL(1-\frac{2}{m})+\text{sect. area of stiffener}]}}$$

$$=\sqrt{\frac{4\times 211,140\times 12\times 21{\cdot}5\times 12}{3\times 17,080\times L[\frac{5}{16}\times 21{\cdot}5\times 12\times(1-\frac{2}{8})+22]}}$$

$= 619$

$= 24"{\cdot}9$

Section of floor beam :-

Try $26"\times\frac{5}{16}$ $\quad A_w = 8{\cdot}125\ \square"$

Back to back of L's $26\frac{1}{4}"$ $\quad \frac{A_w}{8} = 1{\cdot}015\ \square"$

Assuming the effective depth of girder $= h_o = 25" = 2{\cdot}08$

Flange area required $= \frac{M}{6h_o} - \frac{A_w}{8} = \frac{211,140}{17,080\times 2{\cdot}08} - 1{\cdot}015$ 220890

$= 5{\cdot}945 - 1{\cdot}015$ 6217

$= 4{\cdot}93\ \square"$ net 5262

Use $2\text{-}L\ \ 5\times 3\frac{1}{2}\times\frac{3}{8}" = 2@3{\cdot}05 = 6{\cdot}10\ \square"$ gross area

$6{\cdot}10 - 2\frac{3}{8}\times(\frac{7}{8}+\frac{1}{8}) = 5{\cdot}35\ \square"$ net area

Effective depth of girder $= h_o = 26{\cdot}5 - 0{\cdot}86\times 2 = 24"{\cdot}78 = 2"{\cdot}07$

$6'_e = 17,080 - 205\frac{1}{b}$

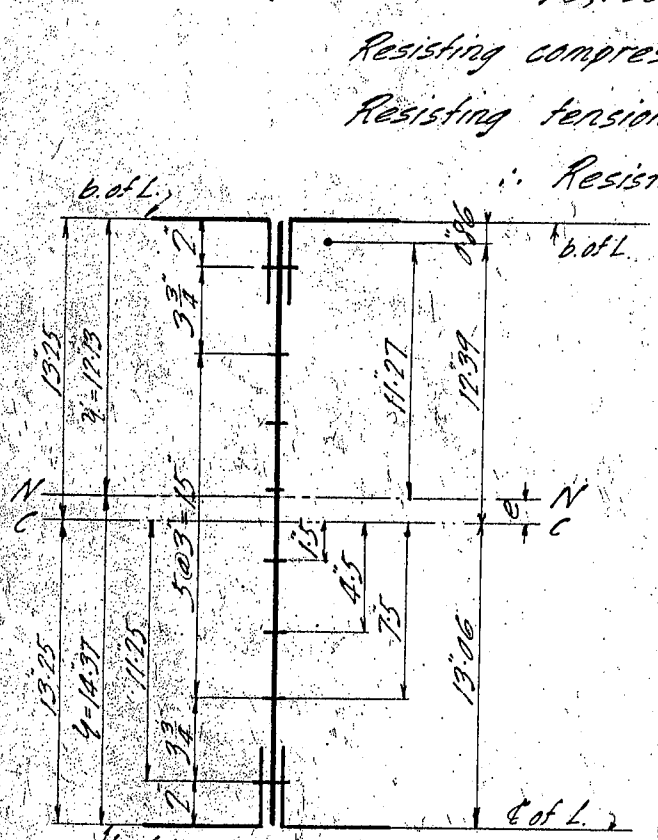
$= 17,080 - 205\frac{48}{10{\cdot}312}$

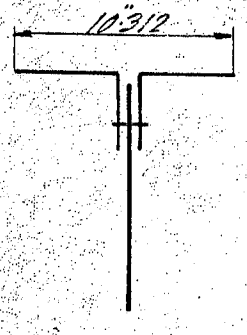
$= 16,126\ ^{\#}\square"$

Resisting compression $= 16,126\times 6{\cdot}10 = 98,500^{\#}$

Resisting tension $= 17,080\times 5{\cdot}35 = 91,500^{\#}$

$\therefore$ Resisting compression > Resisting tension





2-L	$5\times 3\frac{1}{2}\times\frac{3}{8}=6{\cdot}10$	$=6{\cdot}10$
1-Pl.	$26\times\frac{5}{16}=8{\cdot}13-8\times\frac{5}{16}=5{\cdot}63$	
2-L	$5\times 3\frac{1}{2}\times\frac{3}{8}=6{\cdot}10-4\times\frac{3}{8}=4{\cdot}60$	
	$20{\cdot}33\ \square"$ gross	$16{\cdot}33\ \square"$ net.

$$e=\frac{2\times\frac{3}{8}\times(11{\cdot}25+13{\cdot}06)}{16{\cdot}33}=1"{\cdot}12$$

Moment of inertia :-

For Flange $2\times(7\times 3{\cdot}1+6{\cdot}10\times\overline{12{\cdot}39}^2)-2\frac{3}{8}\times(\overline{11{\cdot}25}^2+\overline{13{\cdot}06}^2)=1832{\cdot}77$

For web $\frac{1}{12}\times\frac{5}{16}\times 26^3-2\times\frac{5}{16}\times(1{\cdot}5^2+4{\cdot}5^2+7{\cdot}5^2+\overline{11{\cdot}25}^2)=329{\cdot}39$

$2161{\cdot}16$

$=20{\cdot}48$

less $16{\cdot}33\times\overline{1{\cdot}12}^2$

$2141{\cdot}68^{(11)4}$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

$G_t = 6.10 \times 11.27 = 68.75^{(in)3}$

section mod. $= \frac{I}{y} = \frac{2141.68}{14.37} = 149.03^{(in)3}$

$\therefore$ Resisting moment $= 17,080 \times 149.03 = 2,646,000^{in\#} = 212,200^{ft\#}$

section mod. $= \frac{I}{y} = \frac{2141.68}{10.13} = 176.56^{(in)3}$

Resisting moment $= 16,126 \times 176.56 = 2,850,000^{in\#} = 237,400^{ft\#}$

Rivet spacing in flanges

$$p \leq \frac{N}{S} h_o \frac{A + A_w/8}{A} = \frac{5470}{36,713} \times 24.78 \times \frac{7.115}{6.1} = 4.3" \quad \text{say } 4"$$

Clear distance between stiffeners

$$d \geq \frac{t}{40}\left(12,800 - \frac{5G_t}{11}\right)$$

$$\geq \frac{1}{40} \times \frac{5}{16} \times \left(12,800 - \frac{36,323 \times 68.75}{\frac{5}{16} \times 2,141.68}\right)$$

$$\geq 71"$$

Make 48"

Outstanding leg of the intermediate stiffeners

$\frac{1}{30}$ × depth of floor beam + 2" = 2.9 take 4"

For the leg contacted the web of floor beam take 3"

Axial compression of the end stiffener; calculating as column

try 2 Ls $3\frac{1}{2} \cdot 3\frac{1}{2} \times \frac{3}{8}$ = 4.96 □" gross area

$\rho = 1.07$

$\therefore \frac{l}{\rho} = \frac{26.5}{1.07} = 24.8$

Actual stress $36,323 \div 4.96 = 7,330^{\#}/_{□"}$

Allowable stress $1,500 \times (1 - 0.0055 \times 24.8) = 1,295^{kg}/_{cm^2}$

Maximum $= 1,000^{kg}/_{cm^2} = 14,223^{\#}/_{□"}$

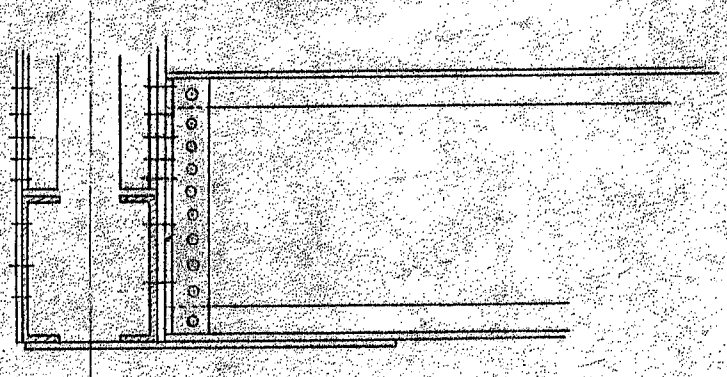
Weight of one intermediate floor beam

Web	1-Pl	$26 \times \frac{5}{16}$"	@ 27.63 × 20.375	= 564.0
Flanges	4-Ls	$5 \times 3\frac{1}{2} \times \frac{3}{8}$"	@ 10.40 × 20.375	= 846.0
Stiffeners	8-Ls	$4 \times 3 \times \frac{5}{16}$"	@ 7.20 × 2.180	= 125.3
End stiffeners	4-Ls	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$"	@ 8.50 × 2.50	= 73.1
Fillers	4-Pls	$3\frac{1}{2} \times \frac{3}{8}$"	@ 4.46 × 1.652	= 28.9
Shelf Ls	10-Ls	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{16}$"	@ 7.20 × 0.700	= 50.4
Rivet heads	450-$\frac{7}{8}$"ϕ rivets		@ 0.1928	= 86.7
Total				1,777.4#

Weight per lin. ft. of truss

$1,777.4 \div 15 = 118.7^{\#}/_{ft}$

say $120^{\#}/_{ft}$



(18)

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

End floor beam

Span length 21·5 ft.

Projection of stringer 12"

Dead load:-

Concentration from end stringer C and cantilever bracket.

$606{\cdot}3 \times (\frac{15}{7}+1) = 5,150^{\#}$

Concentration from end stringer A and cantilever bracket.

$319{\cdot}3 \times (\frac{15}{7}+1) = 2,710^{\#}$

Concentration from end stringer B and cantilever bracket.

$465{\cdot}3 \times (\frac{15}{7}+1) = 3,960^{\#}$

$R = 5,150 + 2,710 + 3,960 = 9,840^{\#}$

Moment due to concentration :-

$9,840 \times \frac{21{\cdot}5}{2} = 105,600$

less $5,150 \times 8 = 41,200$

$2,710 \times 4 = \underline{10,840}$

$\underline{52,040}$

$53,560^{\#}$

Floor beam assumed $90^{\#}$ ft

Moment due to own wt. $= \underline{5,200^{\#}}$

Summary of dead load moment $= 58,760^{\#}$

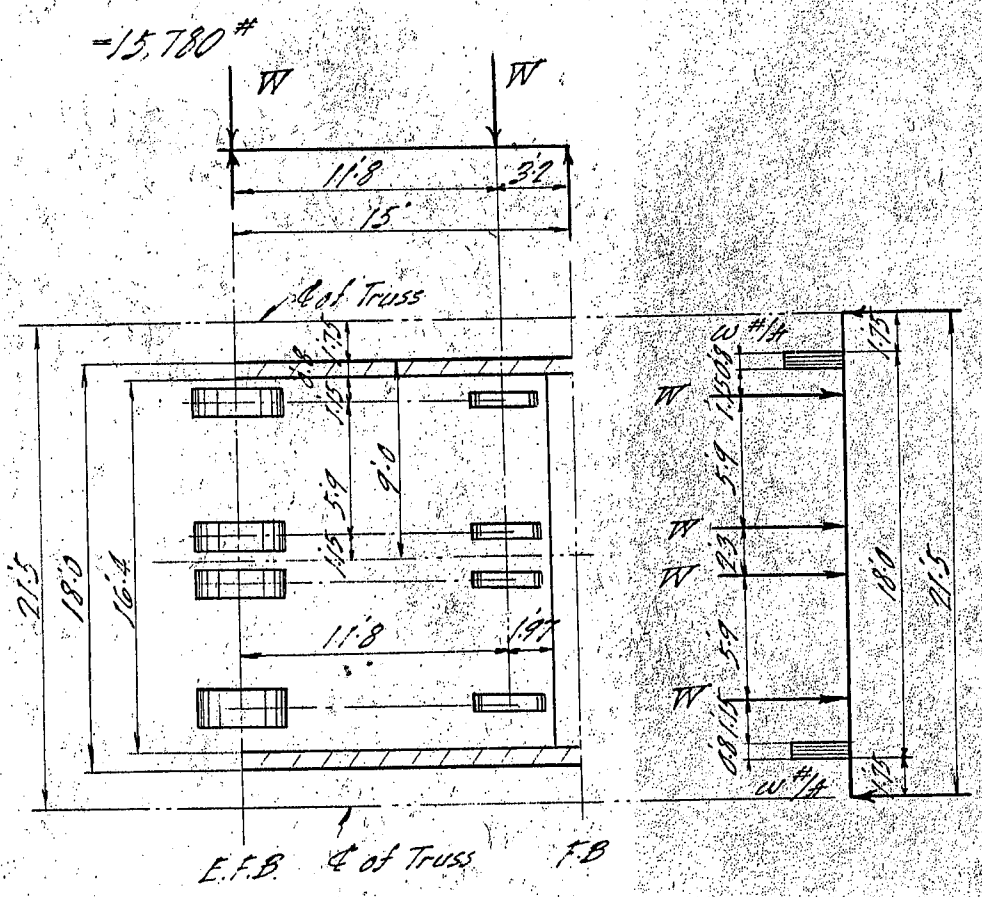
Live load :-

$W = 7,050 + 2,350 \times \frac{3{\cdot}2}{15} = 7,550^{\#}$

$w = 100 \times (\frac{15}{2}+1) = 850^{\#/ft}$

$R = 7,550 \times 2 + 850 \times 0{\cdot}8$

$= 15,780^{\#}$



増田淳氏関係資料
（独立行政法人 土木研究所蔵）

Live load moment.

$15,780 \times \frac{21.5}{2}$ = 169,800

less $7,550 \times 8.2 = 61,900$

$680 \times 8.6 = 5,850$ ——— 67,750

102,050 #

Summary dead and live load moments

$58,760 + 102,050 = 160,810$ #

Shear due to dead load

$9840 + 968$ = 10,808 #

Shear due to live load

$7,550 \times \frac{18.60 + 12.70 + 16.40 + 4.50}{21.5} = 16,200$

$850 \times 1.6 \times \frac{2.55}{21.5}$ = 161

16,361 #

Summary of dead and live load shears ---- 27,169 #

Section of end floor beam like as intermediate floor beam

4. Cantilever bracket at end panel

Projection 1.0 ft

dead load ... 428 #/ft

dead load moment = $428 \times \frac{1}{2} = 214$ #

live load ... motor truck with impact --- 7,050 #

bracket concentration ----- 10,040 #

load on one ft strip ---------- 5,020 #

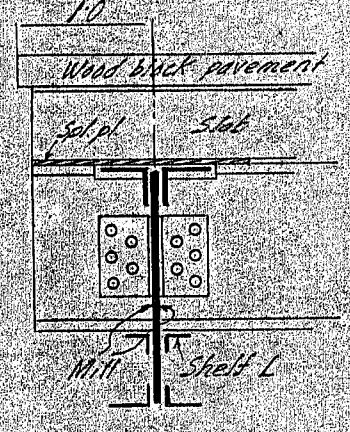
live load moment = $5,020 \times \frac{1}{2} = 2,510$ #

Summary of dead and live load moments

$214 + 2,510 = 2,724$ #

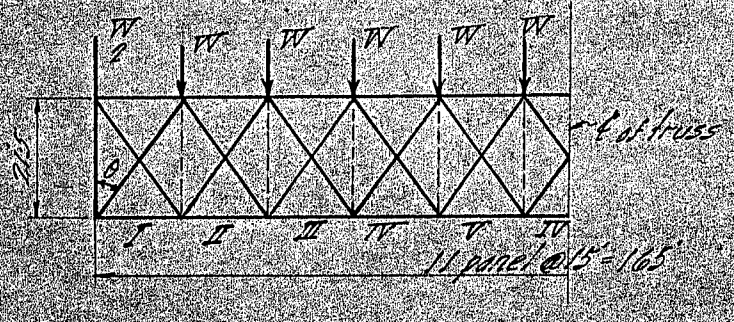
sect. mod. req'd. = $\frac{2,724 \times 12}{17,000} = 1.915$ in.³ net

Use 15"×37.3 # I-beam



5. Lateral system connected to tie

a Bottom laterals



Length of diagonals = $\sqrt{15^2 + 21.5^2} = 26.2116$

$\sec\theta = \frac{26.2116}{21.5} = 1.219$

$\tan\theta = \frac{15}{21.5} = 0.698$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

(1) Static wind pressure [illegible] per sq. ft. of exposed surface

Panel [illegible] 30.7 x 5' = [illegible]

Force concentration = 154 x .15 = 2.31 [illegible]

(2) Moving wind pressure 336 lbs. per lin. ft.

Panel concentration = 336 x .15 = 5040# = W_2

Total wind pressure = $W_1 + W_2$ = 7,350#

	Panels		I	II	III	IV	V	VI
Stresses in Diagonals	Static wind	coefficient c=	5	4	3	2	1	0
		Stress = $\frac{5}{7} W_1 \sec\theta$	±7,050	±5,640	±4225	±2817	±1,409	0
	Moving wind	coefficient C=	5	4.05	3.70	2.45	1.90	1.25
		Stress = $\frac{5}{7} W_2 \sec\theta$	±15,480	±12,450	±9,800	±7,530	±5,530	±3,840
	Total		±22,530	±18,090	±14,065	±10,347	±6939	±3840
Stresses in chords	Coef. for adjoining panel pt. C=		2.5	7.	11.5	13	14.5	15
	Stress = C W tan θ		±12,800	±35,900	±53900	±66,700	±74,400	±77,000

Note:- Stresses in pounds.

Coefficients "c" taken from Table 9, 12 and 13 in Kona

Stress in end floor beam = 5.5 x W

Section of laterals.

Use 2 ls 4 x 3 x $\frac{5}{16}$ = 4.18 □" gross area

I_1 = 1.27 I_2 = 1.17

Assuming $\frac{l}{r}$ = 120

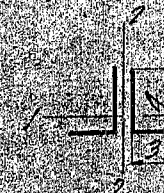
l required = 120 x 1.17 = 140.4 = 11.7'

Allowable stress = 1,500 (1 - 0.00055 $\frac{l}{r}$)

= 1,500 (1 - 0.00055 $\frac{10.5 \times 12}{1.17}$)

= 611.5 lbs/in²

= 8,700 #/□"



Actual stress = 22,530 ÷ 4.18 = 5,400 #/□"

The section of panel II III IV V & VI same as in panel I

Weight per lin. ft. of truss $\frac{72 \times 4 \times 3.4 \times 3.16}{15}$ = 50 #

b. Upper laterals

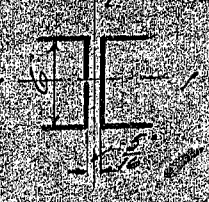
Assume wind load 4' x 51.25 = 205 #/ft

Panel concentration W = 205 x 15 = 3,080#

Max stress in Diagonal = 2.5 x 3,080 x 1.414

= 9,400 #

Use 4 ls 3 x 3 x $\frac{5}{16}$ = 7.12 □" gross area



I_2 = 1.38"

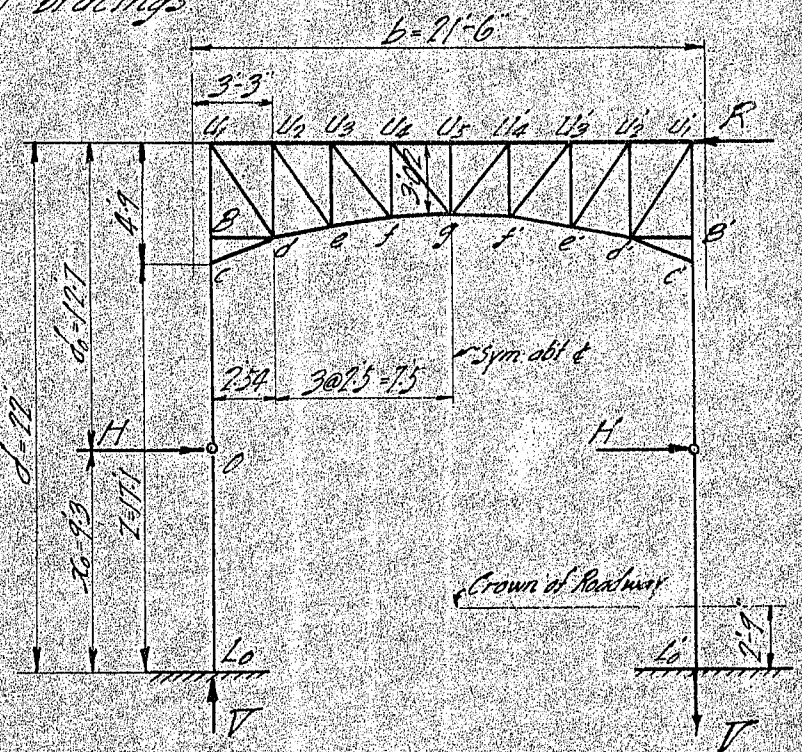
l required = 1.50 x 1.38 = 207"

= 17.25'

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

6 Sway bracings

a. Portal bracings



Panel load = 3,080 #

R = 3,080 × 5.5 = 16,940 #

H = 8,470 #

x_o is the distance between L_o and the pt. of inflexion of post.

$$x_o = \frac{L}{2}\,\frac{2d+I}{d+2I}$$

$$= \frac{17.1}{2} \times \frac{44+17.1}{22+34.2}$$

$$= 8.55 \times \frac{61.1}{56.1}$$

$$= 9.30$$

$$d_o = d - x_o$$

$$= 22 - 9.30$$

$$= 12.70$$

Stress of portal bracings:-

Member	Stress #	Member	Stress #	Member	Stress #	Member	Stress #
	(max.)				(max.)		(max.)
U1-U2	+10,773	U6-g	+12,618	U'6-U'4	+7,719	U'4-g	-12,618
U2-U3	+ 6,159	U2-b	- 6,311	U'3-U'2	- 2,839	U'2-b'	+ 6,311
U3-U4	- 886	U3-e	- 8,192	U'3-U'4	-10,218	U'3-e'	+ 8,192
U4-U5	- 3,270	U4-f	- 4,717	U'4-U'5	- 8,470	U'4-f'	+ 4,717
	(max.)		(max.)		(max.)		(max.)
c-d	-54,537	U5-g	0	c'-d'	+64,525	B'-d'	-47,863
d-e	-19,584	g-f'	+31,185	d'-e'	+19,544		
e-f	-14,759			e'-f'	+14,759		
f-g	- 8,044			f'-g	+ 8,044		
					(max.)		
U1-b	- 8,547			U'1-b'	+12,965		
U2-e	+ 7,826			U'2-e'	- 7,826		
U3-f	+10,509			U'3-f'	-10,509		

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

Post:-

Bending moment at posts.

$M_{L_0} = Hx_0$

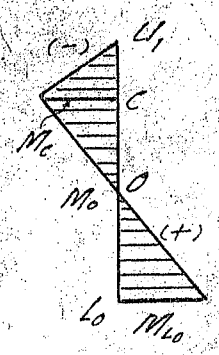
$= 8,470 \times 9.30 = 78,771^{\#}$ ---- positive

$M_{U_0} = 0$

$M_c = H(66 - 49)$

$= 8,470 \times (19.7 - 4.9) = 66,066^{\#}$ ---- negative

$M_{U_1} = 0$



Section of Portal bracings

For upper chords Use 2-L 4×3×$\frac{3}{8}$"

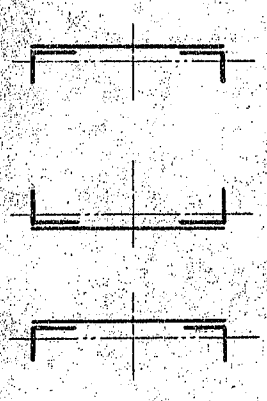
1-Pl. 12×$\frac{5}{16}$"

For lower chords Use 2-L 4×3×$\frac{3}{8}$"

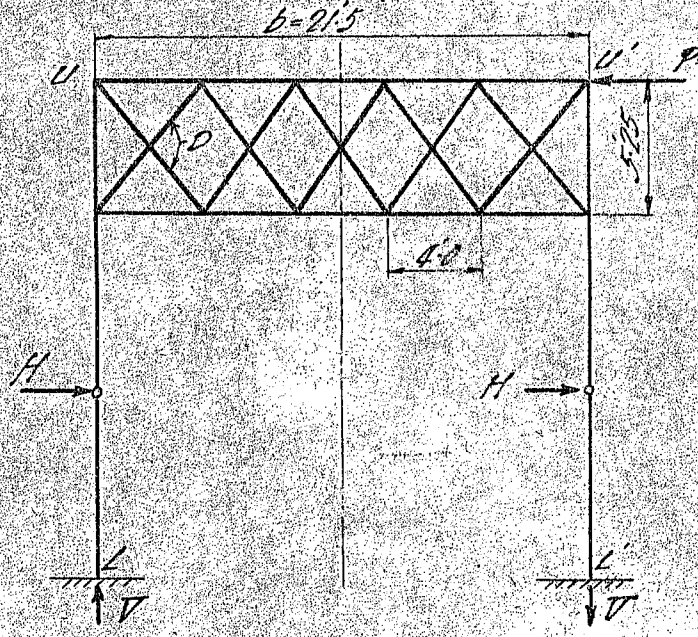
1-Pl. 12×$\frac{5}{16}$"

For web members 2-L 3×3×$\frac{5}{16}$"

1-Pl. 12×$\frac{5}{16}$"



b. Intermediate sway bracings



P=3,080#

H=1,540#

For diagonal members

Use 1-L 3×3×$\frac{5}{16}$×5'-6"

For upper chords

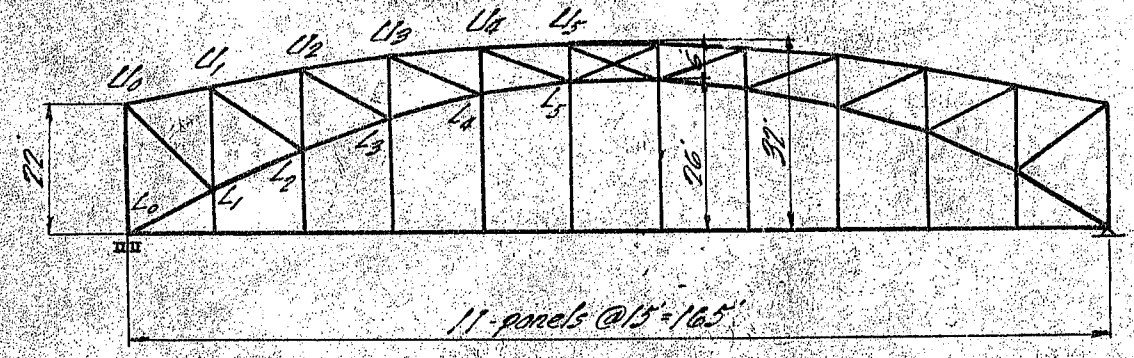
Use 4-Ls 4×3×$\frac{5}{16}$"

For lower chords

Use 2-Ls 4×3×$\frac{5}{16}$"



7. Trusses.



a. Dead load.

Panel concentration Slab and pavement 95×18=1,710

Hand rail and curb 220×2= 440

2,150 #/ft.

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

Stringers	= 200
floor beams	= 120
lower laterals	= 50
upper laterals with sway bracings	= 160
2 trusses assumed	= 920
	1,450
	3,600 #/ft

For one truss $g = 3,600 \div 2 = 1,800$ #/ft

$\therefore$ Panel concentration $1,800 \times 15 = 27,000$ #

b. Live load.

Uniform load $g = \frac{100,000}{170 + \frac{165}{3.28}} = 454$ kg/m² $= 930$ #/lin

For one truss $w = 93 \times 9 = 837$ #/ft

$\therefore$ Panel concentration $837 \times 15 = 12,555$ #

Design of the Tied Arch.

General work equation : Singly indeterminate.

$$1.\delta_a + \mathcal{L}_a = \Sigma[P_m \delta_{ma}] - X_a \delta_{aa} + 1.\delta_{at} \quad \text{---------- (1)}$$

excluding the works of inelastic deformations of supports.

where, $P_1, P_2, \ldots P_m$ = actual external loads, including support reaction, but redundant quantity excluded.

X_a = actual redundant quantity (hor. thrust or stress of tie)

δ_a = actual displacement of the support in the direction of the virtual condition $X_a = -1$

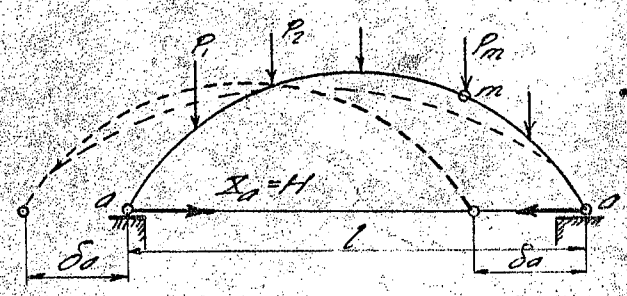
$\mathcal{L}_a$ = virtual works, obtained by multiplying the support reactions of the principal system for the virtual condition $X_a = -1$, by the projections of the actual deformations of the supports.

δ_{ma} = linear displacements of the point m, in the direction of P_m, for the virtual condition $X_a = -1$

δ_{aa} = linear displacement of the point a for $X_a = -1$ measured in that direction.

δ_{at} = actual displacement due to temperature change

X_a has no vertical component or $\mathcal{L}_a = 0$



$$1.\delta_a + \mathcal{L}_a = 1.\Delta l$$

$$X_a = \frac{\Sigma[P_m \delta_{ma}] + 1.\delta_{at} - 1.\Delta l}{\delta_{aa}}$$

(1) X_a due to external load only $= \frac{\Sigma[\delta_{ma} \cdot P_m]}{\delta_{aa}}$

When the influence line of X_a is wanted, it is enough to find X_a when only one unit load is active, thus:

$P_m = 1$ only $\quad X_a = 1 \frac{\delta_{ma}}{\delta_{aa}}$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

(2) X_a due to temperature change $= \frac{\delta a t}{\delta a a} = \pm \frac{\varepsilon t}{\delta a a}$; + sign for temp rise

where, ε = coefficient of temperature elongation

t = change of temperature

(3) X_a due to accidental abutment displacement $= -\frac{1 \cdot \Delta t}{\delta a a}$

For Tied arch assuming the stress of tie as X_a

$1 \cdot \delta a$ = 1× strain of tie $= \Sigma [P_m \delta a a] - X_a \delta a a + 1 \cdot \delta a t$ ------ (2)

Assuming A_t = area of tie

t_t = temperature change of tie

l_t = length of tie

$$\text{Strain of tie} = \frac{X_a \cdot l_t}{E A_t} + \varepsilon t_t l_t \quad \text{------ (3)}$$

Solving these formula

$$X_a = \frac{\Sigma [P_m \delta m a] + 1 \cdot \delta a t - (1) \varepsilon t_t l_t}{\delta a a + (1) \frac{l_t}{E A_t}}$$

(1) X_a due to external load $= \frac{\Sigma [P_m \delta m a]}{\delta a a + (1) \frac{l_t}{E A_t}}$ ---------- (4)

For influence line of X_a $\quad X_a = (1) \frac{\delta m a}{\delta a a + (1) \frac{l_t}{E A_t}}$ ------ (5)

for truss body

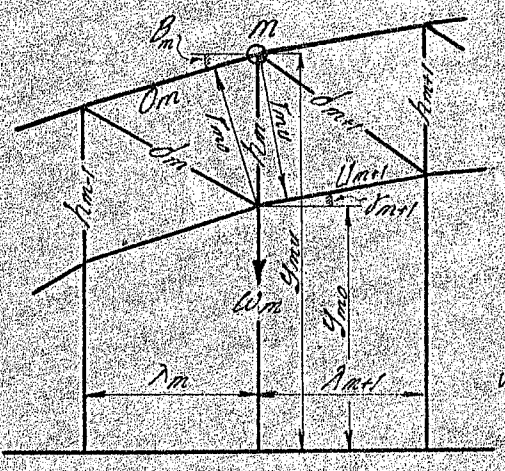
(2) X_a due to temperature change $= -\frac{1 \cdot \delta a t + (1) \varepsilon t_t l_t}{\delta a a + (1) \frac{l_t}{E A_t}}$

when uniform temperature

$$X_a = \frac{(1) \varepsilon t_0 l_t - (1) \varepsilon t_t l_t}{\delta a a + (1) \frac{l_t}{E A_t}} = (1) \frac{\varepsilon l_t \Delta t}{\delta a a + (1) \frac{l_t}{E A_t}}$$

$\Delta t = t_0 - t_t = +35°C$

Calculation of $\delta m a$ and $\delta a a$:-



Assuming

y_a = stress of member due to $X_a = 1$

s = length of member

A = area of member

Δs = strain of member due to $X_a = 1$

$$\Delta s = \frac{y_a s}{E A} \quad \text{------ (6)}$$

where, $y_a = \pm (1) \frac{y_m}{f_m}$

$$\therefore \Delta s = \pm (1) \frac{y_m}{f_m} \frac{s}{E A_t} \frac{A_t}{A}$$

$$= \pm \frac{(1)}{E A_t} \frac{y_m s}{f_m} \frac{A_t}{A} \quad \text{------ (6)}$$

Elastic load for $\delta m a$ - curve

$$w_m = \frac{1}{h_m} \left(-\Delta' O_m + \Delta' U_{m+1} + \Delta' d_m - \Delta' d_{m+1} - \Delta h_{m-1} \frac{h_m}{\lambda_m} + \Delta h_m \frac{h_{m+1}}{\lambda_{m+1}} \right)$$

Neglecting web

$$w_m = \frac{1}{h_m} \left(-\Delta' O_m + \Delta' U_{m+1} \right) = \frac{-\Delta O_m \sec \theta_m + \Delta U_{m+1} \sec \gamma_{m+1}}{h_m}$$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

$$= -\frac{\Delta O_m}{r_{mo}} + \frac{\Delta U_{m+1}}{r_{mv}}$$

$$= \frac{(1)}{EA_t}\left[\frac{y_{mo}O_m}{r_{mo}^2}\frac{A_t}{A_{mo}} + \frac{y_{mv}U_{m+1}}{r_{mv}^2}\frac{A_t}{A_{mv}}\right] \text{------- (7)}$$

$$\text{or } w_m = \frac{y_{mo}O_m}{r_{mo}^2}\frac{A_t}{A_{mo}} + \frac{y_{mv}U_{m+1}}{r_{mv}^2}\frac{A_t}{A_{mv}}$$

For preliminary design, put $\frac{A_t}{A_{mo}} = 1$ $\quad \frac{A_t}{A_{mv}} = \frac{1.5}{1} = 1.5$

$$w_m = \frac{(1)}{EA_t}\left[\frac{y_{mo}O_m}{r_{mo}^2} + 1.5\frac{y_{mv}U_{m+1}}{r_{mv}^2}\right] \text{----------- (7)}$$

And draw the curve by the next load ($M=1$)

$$w_m = \frac{y_{mo}O_m}{r_{mo}^2} + 1.5\frac{y_{mv}U_{m+1}}{r_{mv}^2} \text{----------- (7")}$$

Then we have,

$$\delta_{ma} = (1)\frac{\eta}{EA_t} \text{----------- (8)}$$

Calculation of δ_{aa}

$$\delta_{aa} = \frac{1}{(1)}\sum \varphi_a^2 \frac{s}{EA}$$

$$= \frac{1}{(1)}\sum\left[O_m^2\frac{O_m}{EA_{mo}} + U_{m+1}^2\frac{U_{m+1}}{EA_{mv}}\right]$$

$$= \frac{1}{(1)}\sum\left[\frac{(1)^2 y_{mo}^2}{r_{mo}^2}\frac{O_m}{EA_t}\frac{A_t}{A_{mo}} + \frac{(1)^2 y_{mv}^2}{r_{mv}^2}\frac{U_{m+1}}{EA_t}\frac{A_t}{A_{mv}}\right]$$

$$= \frac{1}{EA_t}\sum\left[\frac{y_{mo}^2 O_m}{r_{mo}^2}\frac{A_t}{A_{mo}} + \frac{y_{mv}^2 U_{m+1}}{r_{mv}^2}\frac{A_t}{A_{mv}}\right] \text{---------- (9)}$$

From (5) we have

$$X_a = \frac{(1)\frac{\eta}{EA_t}}{\frac{(1)}{EA_t}\sum\left[\frac{y_{mo}^2 O_m}{r_{mo}^2} + 1.5\frac{y_{mv}^2 U_{m+1}}{r_{mv}^2}\right] + (1)\frac{l_t}{EA_t}}$$

$$= (1)\frac{\eta}{\sum\left[\frac{y_{mo}^2 O_m}{r_{mo}^2} + 1.5\frac{y_{mv}^2 U_{m+1}}{r_{mv}^2}\right] + l_t} \text{-------- (10)}$$

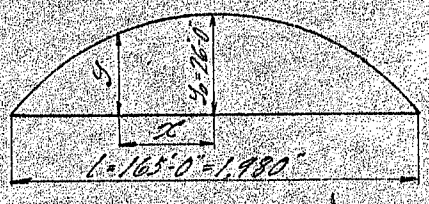
$$= (1)\frac{\eta}{\sum w_m y_m + l_t}$$

Omitted the calculation for preliminary design.
Final design continued immediately.

Calculation of "y_{mo}" [Parabola]

$$y = y_0\left\{1 - \left(\frac{x}{\frac{l}{2}}\right)^2\right\}$$

$$= \frac{y_0(l^2 - 4x^2)}{l^2}$$



$l^2 = 3,920,400$ $\quad y_0 = 312"$

	x	x^2	$4x^2$	$l^2 - 4x^2$	$y_0(l^2-4x^2)$	$\frac{y_0(l^2-4x^2)}{l^2}$
y_{10}	810	656,100	2,624,400	1,296,000	404,352,000	103.140
y_{20}	630	396,900	1,587,600	2,332,800	727,833,600	185.652
y_{30}	450	202,500	810,000	3,110,400	970,444,800	247.537
y_{40}	270	72,900	291,600	3628,800	1,132,185,600	288.793
y_{50}	90	8,100	32,400	3,888,000	1,213,056,000	309.421

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

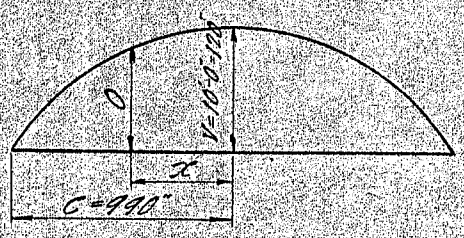
Calculation of 「y_{mu}」 [Circular arc]

$$r^2 = \frac{V^2+C^2}{2V} = \frac{120^2+990^2}{2\times120} = 4,143.75$$

$$\therefore O = \sqrt{r^2-x^2} - (r-V)$$

$r^2 = 17,170,664.0625$

$(r-V) = 4,023.75$



$y_{mu} = O + [22'-0" = 264"]$

	r^2-x^2	$\sqrt{r^2-x^2}$	O	y_{mu}
y_{1u}	16,514,564.0625	4,063.812	40.062	304.062
y_{2u}	16,773,764.0625	4,095.574	71.824	335.824
y_{3u}	16,968,164.0625	4,119.243	95.493	359.493
y_{4u}	17,097,764.0625	4,134.944	111.194	375.194
y_{5u}	17,162,564.0625	4,142.773	119.023	383.023

Calculation of 「U_m」 [Length of lower chord]

$$\therefore U_m = \sqrt{\lambda^2 + (y_{mo+1} - y_{mo})^2} \qquad \lambda = 15'-0" = 180" \qquad \lambda^2 = 32,400$$

	$y_{mo+1} - y_{mo}$	$(y_{mo+1} - y_{mo})^2$	$\lambda^2 + (y_{mo+1} - y_{mo})^2$	U_m
U_1	103.140	10,637.859600	43,037.859600	207.456
U_2	82.508	6,807.570064	39,207.570064	198.009
U_3	61.884	3,830.248321	36,230.248321	190.342
U_4	41.256	1,702.057536	34,102.057536	184.668
U_5	20.628	425.514384	32,825.514384	181.178

Calculation of 「O_m」 [Length of upper chord]

$$O_m = \sqrt{\lambda^2 + (y_{mu+1} - y_{mu})^2}$$

$\lambda^2 = 32,400$

	$y_{mu+1} - y_{mu}$	$(y_{mu+1} - y_{mu})^2$	$\lambda^2 + (y_{mu+1} - y_{mu})^2$	O_m
O_1	40.062	1,604.963844	34,004.963844	184.404
O_2	31.767	1,009.142289	33,409.142289	182.781
O_3	23.664	559.984896	32,959.984896	181.549
O_4	15.701	246.521401	32,646.521401	180.683
O_5	7.829	61.293241	32,461.293241	180.170

Calculation of 「t_{mu}」

$$t_{mo} = \frac{(y_{mu} - y_{mo})\lambda}{U_m}$$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

	$(y_{mv}-y_{mo})$	$(y_{mv}-y_{mo})\lambda$	r_{mv}	r_{mv}^2
r_{0v}	264·000	47,520·000	229·061	52,468·942
r_{1v}	200·922	36,165·960	187·648	33,360·292
r_{2v}	150·181	27,032·580	142·021	20,169·964
r_{3v}	111·956	20,152·080	109·126	11,908·484
r_{4v}	86·401	15,552·180	85·839	7,368·334
r_{5v}	73·602	13,248·360	73·602	5,417·254

Calculation of $\lceil r_{mo} \rfloor$

$$r_{mo}=\frac{(y_{mv}-y_{mo})\lambda}{Om}$$

	$(y_{mv}-y_{mo})$	$(y_{mv}-y_{mo})\lambda$	Om	r_{mo}	r_{mo}^2
r_{10}	200·922	36,165·960	184·404	196·123	38,464·231
r_{20}	150·181	27,032·580	182·782	147·895	21,872·931
r_{30}	111·956	20,152·080	181·549	111·001	12,321·222
r_{40}	86·401	15,552·180	180·683	86·074	7,408·733
r_{50}	73·602	13,248·360	180·170	73·533	5,407·102

Value of $\lceil \frac{At}{Amo} \rfloor$ and $\lceil \frac{At}{Amv} \rfloor$

Net area of Tie $At=22·09\ \square''$

Member	Amo	At/Amo	Member	Amv	At/Amv
O_1	23·39 $\square''$	0·94	U_1	22·09	1·00
O_2	23·39	0·94	U_2	20·52	1·08
O_3	23·39	0·94	U_3	17·58	1·26
O_4	23·39	0·94	U_4	14·64	1·51
O_5	29·27	0·75	U_5	14·64	1·51
O_6	29·27	0·75	U_6	14·64	1·51

Calculation of $\lceil w_{in} \rfloor$ $\quad w_{in}=\frac{y_{mo}\,Om\,At}{r_{mo}^2\,Amo}+\frac{y_{mv}\,U_{m+1}\,At}{r_{mv}^2\,Amv}$

	$y_{mo}\times Om$	$\frac{y_{mo}\times Om}{r_{mo}^2}$	$\frac{y_{mo}\times Om}{r_{mo}^2}\frac{At}{Amo}$	$y_{mv}\times U_{m+1}$	$\frac{y_{mv}\times U_{m+1}}{r_{mv}^2}$	$\frac{y_{mv}\times U_{m+1}}{r_{mv}^2}\frac{At}{Amv}$	w_{in}
w_0'				54768·384000	1·043825	1·043825	1·043825
w_1'	19019·428560	0·494471	0·464803	60207·012558	1·804751	1·949131	2·413934
w_2'	33933·112736	1·551375	1·458293	63922·363518	3·169186	3·993174	5·451467
w_3'	44940·094813	3·647373	3·428531	66386·853324	5·574753	8·417877	11·846408
w_4'	52179·985619	7·043038	5·282279	67976·898532	9·225545	13·930573	19·212852
w_5'	55748·381570	10·310215	7·732661	68944·140000	12·726769	19·217421	26·950082

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

Calculation of $\bar{\delta}_{aa}$

$$\bar{\delta}_{aa} = \frac{y_{mo}^2 \, O_n \, A_t}{r_{mo}^2 \, A_{mo}} + \frac{y_{mv}^2 \, O_{n+1} \, A_t}{r_{mv}^2 \, A_{mv}}$$

	$\frac{y_{mo}^2 O_n}{r_{aa}}$	$\frac{y_{mo}^2 O_n A_t}{r_{mo}^2 A_{mo}}$	$\frac{y_{mv}^2 O_{n+1}}{r_{mv}^2}$	$\frac{y_{mv}^2 O_{n+1} A_t}{r_{mv}^2 A_{mv}}$	$\bar{\delta}_{aa}$
0			275.569800	275.569800	275.569800
1	50.999799	47.939755	548.756199	542.656695	640.596450
2	288.087666	270.729086	1064.304565	1341.023751	1611.752837
3	902.859770	848.688184	2004.084680	3026.167867	3874.856051
4	2123.980073	1525.485053	3461.364131	5226.667388	6752.152441
5	3190.497036	2392.647773	4874.645243	7360.714317	9753.362090
					22908.289669

$$\Sigma \bar{\delta}_{aa} - 45816.579338 = \Sigma w_n' y_n$$

Calculation of $\bar{X}_a$

$$X_a = \frac{\eta_m}{\Sigma w_n' y_n + l_t}$$

where $\Sigma w_n' y_n = 45816.579338$

$l_t = 1980.000000$

47796.579338

η_m :-

	w_n'	$2w_n'$	$3w_n'$	$4w_n'$	$5w_n'$
w_1'	2.413934				
w_2'	5.451467	10.902934			
w_3'	11.846408	23.692816	35.539224		
w_4'	19.212852	38.425704	57.638556	76.851408	
w_5'	26.950882	53.900164	80.850246	107.800328	134.750410
	65.874743	126.921618	174.028026	184.651736	134.750410

$\eta_1 = \lambda [w_1' + w_2' + w_3' + w_4' + w_5'] = 180 \times 65.874743 = 11857.45374$

$\eta_2 = \lambda [w_1' + 2 \times (w_2' + w_3' + w_4' + w_5')] = 180 \times 129.335552 = 23280.39936$

$\eta_3 = \lambda [w_1' + 2w_2' + 3(w_3' + w_4' + w_5')] = 180 \times 187.344894 = 33722.08092$

$\eta_4 = \lambda [w_1' + 2w_2' + 3w_3' + 4 \times (w_4' + w_5')] = 180 \times 233.507828 = 42031.40904$

$\eta_5 = \lambda [w_1' + 2w_2' + 3w_3' + 4w_4' + 5w_5'] = 180 \times 260.457910 = 46882.42380$

	η_m	$\Sigma w_n' y_n + l_t$	X_a
X_{a1}	11857.45374	47796.579338	0.248
X_{a2}	23280.39936	〃	0.487
X_{a3}	33722.08092	〃	0.706
X_{a4}	42031.40904	〃	0.879
X_{a5}	46882.42380	〃	0.981
			3.301

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

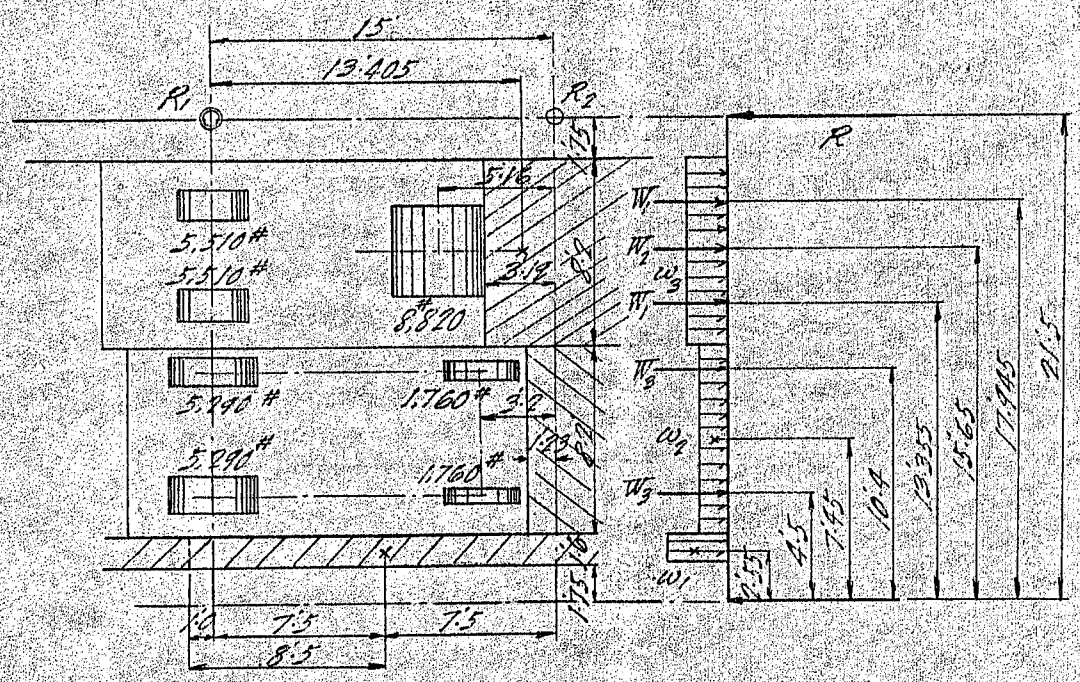
Total influence surface of $\Gamma X_a \rfloor$

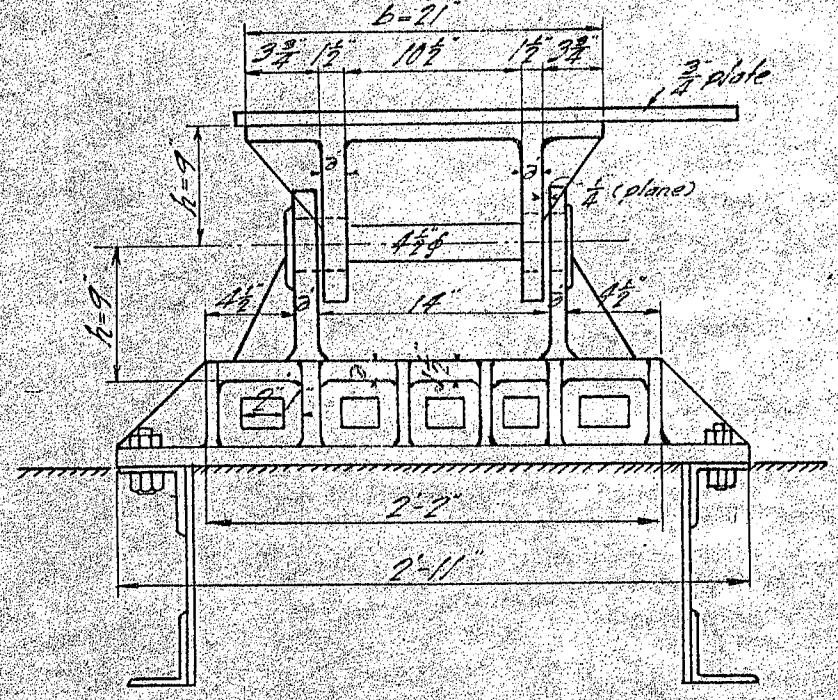
$3.301 \times .2 = 6.602$

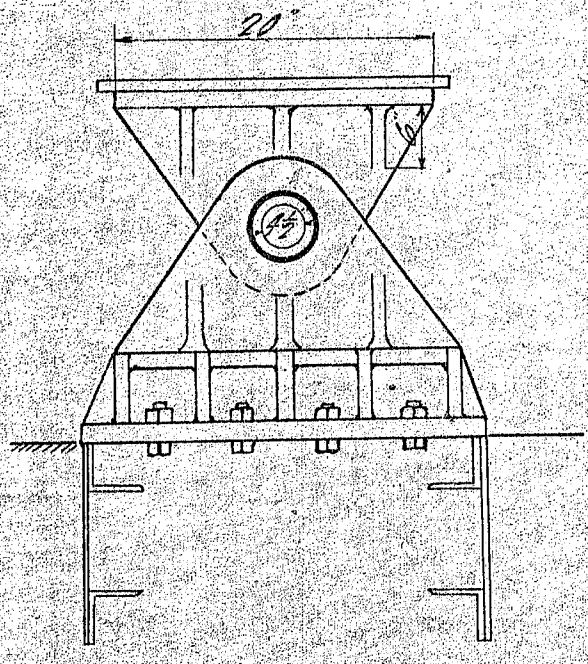
$6.602 \times 15 = 99.03$

End Bearings

Maximum Reaction at support







1. Bed plate

Bearing area required $= \frac{226,600}{641} = 354$ □"

Use 22"×35" = 770 □"

thickness $= 1\frac{1}{2}$"

2. Roller

try 4"ϕ 600 × 4 = 2,400 #/in. ft.

Length required $= \frac{226,600}{2,400} = 94.5$"

4-rollers 94.5 ÷ 4 = 23.6

Use 4-rollers 4" dia. × 2'-2"

3. Pin

Assuming the thickness of pin plate $1\frac{1}{2}$"

$\frac{226,600}{2} = 113,300 = 25,600 \times d \times 1\frac{1}{2}$

$d = 2.96$"

Use $4\frac{1}{2}$"ϕ = 15.904 □" gross

Resisting moment = 229,000 in# by Table

Max. moment arm = 229,000 ÷ 113,300 = 2.02"

Resisting shear = 12,800 × 15.904 = 204,000 #

4. Cast steel rib shoe.

$\frac{a}{h} = \frac{1}{3}\left[1 - \sqrt{1 - \frac{3}{\frac{b}{na'} - 1}}\right]$ $\frac{a}{h} = \frac{1.5}{9} = \frac{1}{6}$ $\frac{b}{na'} = 5$

$na' = \frac{b}{5} = \frac{21}{5} = 4.2$" n = no. of ribs = 2

$a' = 2.1$ Make lift $a' = 1\frac{1}{2}$" clearance = $\frac{1}{4}$" moment arm = $1\frac{3}{4}$"

Sect. mod. for the lower fiber of the rib $= \frac{na'h^2}{6}\left\{1 + \frac{\left(\frac{h}{a}\right)^2 - 3\left(\frac{h}{a}\right) + 3}{2\left(\frac{h}{a}\right)^2 - 3\left(\frac{h}{a}\right)}\right\}$

$= \frac{2 \times 1.5 \times 9^2}{6}\left\{1 + \frac{6 \times 6 - 3 \times 6 + 3}{2 \times 6 \times 6 - 3 \times 6}\right\}$

$= 56.2$ (in)³

∴ Resisting moment of the rib = 14,000 × 56.2 = 788,000 in#

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

Member	y/r	Influence area			Stress in pound		
		Compression	Tension	Summary	Dead load	Live load	Total
Hanger					+ 27,000	+ 17,970*	+ 44,970
Tie			+ 99,030	+99,030	+178,236	+ 88,230	+ 266,466

*F.B. Max. Reaction

Upper Chords

U_0-U_1	0.526	-45,898	+ 14,310	- 31,588	- 29,908	− 24,192 + 6891	5,546 - 54,100 -28443
U_1-U_2	1.255	-41,362	+ 9,545	- 31,817	- 71,875	− 50,792 + 11,551	- 122,667 212220
U_2-U_3	2.230	-36,818	+ 4,988	- 31,830	- 127,765	− 79,085 + 10,740	- 206,850 299-93
U_3-U_4	3.355	- 32,954	+ 1,114	- 31,845	- 192,312	− 105,095 + 3,771	- 297,407
U_4-U_5	4.208	- 31,920	0	- 31,920	- 241,775	− 125,916 + 0	- 367,691
U_5-U_5	4.204	- 31,770	0	- 31,770	- 240,410	− 125,241 + 0	- 365,651

Lower Chords

L_0-L_1	1.153	- 99,030	0	- 99,030	- 205,506	− 101,729 + 0	- 307,235
L_1-L_2	1.665	- 59,020	+ 4,230	- 54,790	- 164,206	− 88,546 + 8,593	25-1049 - 255,752
L_2-L_3	2.365	- 36,106	+ 9,412	- 26,685	- 113,598	− 77,761 + 23,598	203158 - 141,954
L_3-L_4	3.294	- 20,816	+12,020	- 8,796	- 52,153	− 63,222 + 34,808	195-279 - 115,975
L_4-L_5	4.371	- 9,981	+11,675	+ 1,694	+ 13,328	− 40,864 + 50,900	31 971 - 27,536 + 64,228 84660
L_5-L_5	5.204	- 2,604	+ 4,354	+ 6,750	+ 63,594	− 13,255 + 48,996	119218 + 112,590

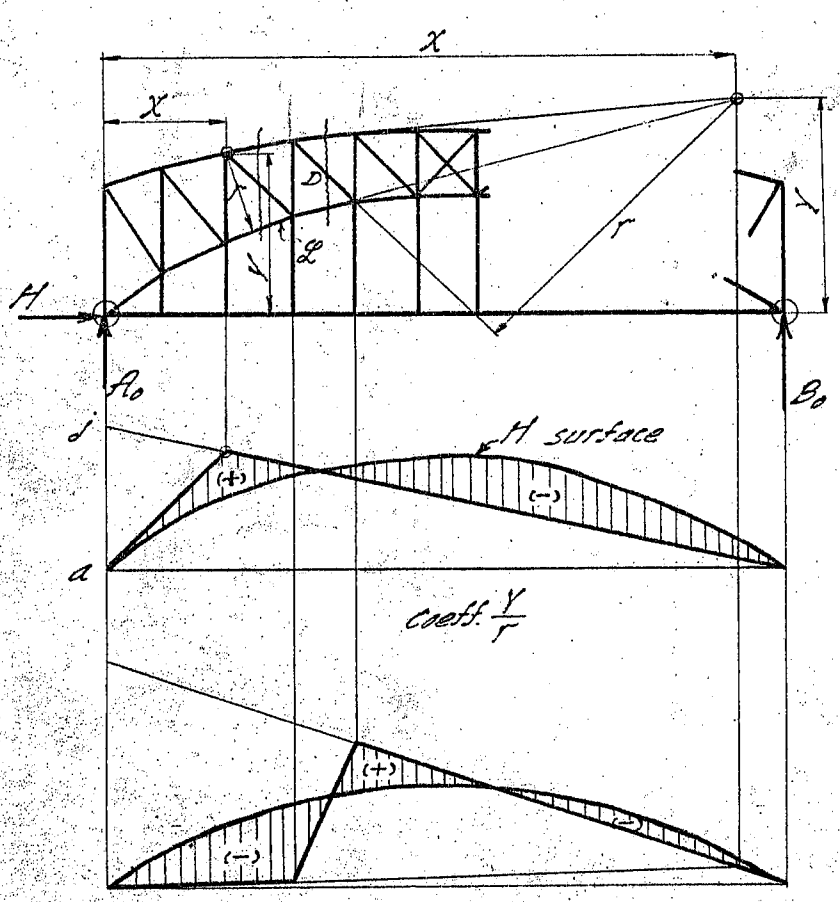
Diagonals

U_0-L_1	0.688	- 14,081	+ 45,895	+ 31,814	+ 34,467	− 3,021 + 31,642	75020 + 65,109
U_1-L_2	0.865	- 6,859	+ 38,789	+ 31,930	+ 49,559	− 5,684 + 33,841	82242 + 83,400
U_2-L_3	1.186	- 2,782	+ 34,639	+ 31,857	+ 62,275	− 3,359 + 38,286	10224 +100,561
U_3-L_4	1.216	- 7,450	+ 34,341	+ 31,891	+ 67,802	− 14,258 + 47,879	122510 +117681
U_4-L_5	0.917	- 24,316	+ 61,216	+ 31,841	+ 52,654	− 25,878 + 55,181	120774 +107835
U_5-L_5	0	- 49,553	+ 49,553	0	0	± 49,091	± 49,091

Verticals

U_0-L_0	0.573	- 57,619	+ 14,066	- 43,553	- 44,890	− 37,208 + 8,565	82,098 57985
U_1-L_1	0.574	- 34,009	+ 7,167	- 31,842	- 33,134	− 22,907 + 3,887	- 56043 53040
U_2-L_2	0.551	- 36,198	+ 4,400	- 31,798	- 31,537	− 20,303 + 2,904	- 51,840 49056
U_3-L_3	0.405	- 45,889	+ 14,074	- 31,815	- 25,277	− 20,316 + 6913	- 45,593 − 34,722 38,256
U_4-L_4	0.206	- 98,582	+ 66,718	- 31,864	- 11,815	− 14,907 + 14,068	+ 2,253 01,971
U_5-L_5	0.183	- 92,382	+ 124,248	+ 31,866	+ 10,497	− 16,758 + 22,503	− 6,261 97,110 + 33,000 41,377

増田淳氏関係資料
（独立行政法人 土木研究所蔵）



Stress influence surface:-

1) Chord member

$$A_0x - m - Hy - Qr = 0$$

$$Q = \frac{A_0x - m}{r} - H\frac{y}{r}$$

$$= Q_0 - H\frac{y}{r}$$

$$= \frac{y}{r}\left(Q_0\frac{r}{y} - H\right)$$

$$\therefore aj = 1.\frac{x}{r}\frac{r}{y} = 1.\frac{x}{y}$$

2) Web member

$$A_0x - m - Hy - Dr = 0$$

$$D = \frac{y}{r}\left(D_0\frac{r}{y} - H\right)$$

[1] Upper Chords

(a) $U_6 - U_1$

	$S_0\frac{r}{y}$	$-(S_0\frac{r}{y} - H)$
0	0	0
1	1.586	−1.338
2	1.427	−0.940
3	1.267	−0.563
4	1.110	−0.231
5	0.952	+0.029
5′	0.793	+0.188
4′	0.634	+0.245
3′	0.476	+0.230
2′	0.317	+0.170
1′	0.159	+0.089
0′	0	0

$$S = -(S_0\frac{r}{y} - H)\frac{y}{r}$$

$$\frac{y}{r} = \frac{103.140}{196.123} = 0.526$$

$$= -(2.841 + 0.116) \times 15 = -44.355$$

$$\frac{1}{2} = -0.116 \times 133 = -1.543$$

$$\frac{1}{2} = +0.015 \times 1.7 = +0.255$$

$$= +(0.922 + 0.015) \times 15 = +14.055$$

$$(-45.898) + (+14.310) = -31.588$$

$$-24.908$$

(b) $U_1 - U_2$

	$-S_0\frac{r}{y}$	$-(S_0\frac{r}{y} - H)$
0	0	0
1	0.793	−0.545
2	1.586	−1.059
3	1.410	−0.704
4	1.234	−0.355
5	1.057	−0.076
5′	0.881	+0.100
4′	0.705	+0.174
3′	0.529	+0.177
2′	0.352	+0.135
1′	0.176	+0.072
0′	0	0

$$\frac{y}{r} = \frac{185.648}{147.895} = 1.255$$

$$= -(2.703 + 0.038) \times 15 = -41.115$$

$$\frac{1}{2} = -0.038 \times 6.5 = -0.247$$

$$\frac{1}{2} = +0.050 \times 8.5 = +0.425$$

$$= +(0.558 + 0.050) \times 15 = +9.120$$

$$(-41.362) + (+9.545) = -31.817$$

$$-71.875$$

(c) $U_2 - U_3$

0	0	0
1	0.529	−0.281
2	1.057	−0.570
3	1.586	−0.880
4	1.388	−0.505
5	1.190	−0.209

$$\frac{y}{r} = \frac{247.537}{111.001} = 2.230$$

$$= -(2.449 + 0.005) \times 15 = -36.810$$

(d) $U_3 - U_4$

0	0	0
1	0.397	−0.149
2	0.793	−0.306
3	1.190	−0.484
4	1.586	−0.707
5	1.359	−0.378

$$\frac{y}{r} = \frac{288.793}{86.074} = 3.355$$

$$= -(2.176 + 0.014) \times 15 = -33.850$$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

	$S_0\frac{f}{y}$	$-(S_0\frac{f}{y}-H)$	
5'	0.991	-0.010	$\frac{1}{2}$ = -0.005 × 1.56 = -0.008
4'	0.793	+0.086	$\frac{1}{2}$ = +0.043 × 13.44 = +0.578
3'	0.595	+0.111	
2'	0.397	+0.090	= +(0.251+0.043) × 15 = +4.410
1'	0.198	+0.050	
0'	0	0	(-36.818)+(+4.988) = -31.830

-127.764

	$S_0\frac{f}{y}$	$-(S_0\frac{f}{y}-H)$	
5'	1.133	-0.152	
4'	0.906	-0.027	$\frac{1}{2}$ = -0.014 × 7.78 = -0.109
3'	0.680	+0.026	$\frac{1}{2}$ = +0.013 × 7.22 = +0.094
2'	0.453	+0.034	= +(0.055+0.013) × 15 = +1.020
1'	0.227	+0.021	
0'	0	0	(-32.459)+(+1.114) = -31.845

-192.312

(e) U_4-U_5

0	0	0	$\frac{y}{r}=\frac{309.421}{73.533}=4.208$
1	0.317	-0.069	
2	0.635	-0.148	
3	0.952	-0.246	
4	1.270	-0.391	
5	1.587	-0.601	= -2.128 × 15 = -31.920
5'	1.323	-0.349	
4'	1.058	-0.179	
3'	0.794	-0.088	
2'	0.529	-0.042	
1'	0.265	-0.017	
0'	0	0	

-241.775

(f) U_5-U_5

0	0	0	$\frac{y}{r}=\frac{309.421}{73.602}=4.204$
1	0.264	-0.016	
2	0.529	-0.042	
3	0.793	-0.087	
4	1.057	-0.178	
5	1.322	-0.341	= -2.118 × 15 = -31.770
5'	1.586	-0.605	
4'	1.269	-0.390	
3'	0.952	-0.246	
2'	0.634	-0.147	
1'	0.314	-0.066	
0'	0	0	

-240.410

(II) Lower Chords

(a) L_1-L_2

0	0	0	$\frac{y}{r}=\frac{304.062}{182.648}=1.665$
1	0.538	+0.290	$\frac{1}{2}$ = +0.150 × (13.2+15.0) = +4.230
2	0.484	-0.003	$\frac{1}{2}$ = -0.002 × 1.8 = -0.004
3	0.430	-0.276	
4	0.377	-0.502	
5	0.323	-0.658	
5'	0.269	-0.712	= -(3.930+0.002) × 15 = -58.980
4'	0.215	-0.664	
3'	0.161	-0.545	
2'	0.108	-0.379	
1'	0.054	-0.194	
0'	0	0	(-58.984)+(+4.230) = -54.754

-164.206

(b) L_0-L_1

0	0	0	$\frac{y}{r}=\frac{264.000}{229.061}=1.152$
1	0	-0.248	
2	0	-0.487	
3	0	-0.706	
4	0	-0.879	
5	0	-0.981	= -6.602 × 15 = -99.030
5'	0	-0.981	Tie = +178.236
4'	0	-0.879	
3'	0	-0.706	
2'	0	-0.487	
1'	0	-0.248	
0'	0	0	

-205.506

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

(c) L_2-L_3

	$\frac{5}{6}\frac{f}{V}$	$+(\frac{5}{6}\frac{f}{V}-H)$
0	0	0
1	0.439	+0.191
2	0.877	+0.396
3	0.780	+0.074
4	0.682	-0.197
5	0.585	-0.396
5'	0.487	-0.494
4'	0.390	-0.489
3'	0.292	-0.414
2'	0.195	-0.292
1'	0.097	-0.151
0'	0	0

$\frac{Y}{f}=\frac{335.829}{142.021}=2.365$

$+(0.581+0.037)\times 15=+9.870$

$\frac{1}{2}=+0.037\times 4.18 \quad =+0.151$

$\frac{1}{2}=-0.099\times 10.92 \quad =-1.081$

$-(2.236+0.095)\times 15=-35.025$

$(-36.106)+(+9.421)=-26.685$

$+13.598$

(d) L_3-L_4

	$\frac{5}{6}\frac{f}{V}$	$+(\frac{5}{6}\frac{f}{V}-H)$
0	0	0
1	0.364	+0.116
2	0.728	+0.241
3	1.092	+0.386
4	0.956	+0.077
5	0.819	-0.162
5'	0.683	-0.298
4'	0.546	-0.333
3'	0.410	-0.296
2'	0.273	-0.214
1'	0.137	-0.111
0'	0	0

$\frac{Y}{f}=\frac{359.493}{109.126}=3.294$

$(+0.745+0.039)\times 15=+11.730$

$\frac{1}{2}=+0.039\times 4.87 \quad =+0.190$

$\frac{1}{2}=-0.081\times 10.13 \quad =-0.821$

$-(1.252+0.081)\times 15=-19.995$

$-(20.816)+(+11.920)=-8.896$

-52.153

(e) L_4-L_5

0	0	0
1	0.305	+0.057
2	0.611	+0.124
3	0.916	+0.210
4	1.221	+0.342
5	1.047	+0.066
5'	0.872	-0.109
4'	0.698	-0.181
3'	0.523	-0.183
2'	0.349	-0.138
1'	0.174	-0.074
0'	0	0

$\frac{Y}{f}=\frac{375.194}{85.839}=4.371$

$+(0.733+0.033)\times 15=+11.490$

$\frac{1}{2}=+0.033\times 5.62 \quad =+0.185$

$\frac{1}{2}=-0.055\times 9.38 \quad =-0.516$

$-(0.576+0.055)\times 15=-9.465$

$(+11.675)+(-9.981)=+1.694$

$+13.328$

(f) L_5-L_5'

0	0	0
1	0.256	+0.008
2	0.513	+0.026
3	0.769	+0.063
4	1.026	+0.147
5	1.282	+0.301
5'	1.068	+0.087
4'	0.855	-0.024
3'	0.641	-0.065
2'	0.427	-0.060
1'	0.214	-0.034
0'	0	0

$\frac{Y}{f}=\frac{383.023}{73.602}=5.204$

$+(0.545+0.044)\times 15=+8.835$

$\frac{1}{2}=+0.044\times 11.79 \quad =+0.519$

$\frac{1}{2}=-0.012\times 3.21 \quad =-0.039$

$-(0.159+0.012)\times 15=-2.565$

$(+9.354)+(-2.604)=+6.750$

$+65.594$

(III) Diagonals

(a) L_0-L_1

0	0	0
1	1.346	+1.338
2	1.427	+0.994
3	1.269	+0.803
4	1.110	+0.231
5	0.951	-0.029
5'	0.793	-0.265

$\frac{Y}{f}=\frac{231.671}{[illegible]}=0.688$

$+(2.841+0.116)\times 15=44.355$

$\frac{1}{2}=+0.116\times 13.28=+1.540$

$\frac{1}{2}=-0.033\times 1.72=-0.026$

(b) L_1-L_2

0	0	0
1	0.230	-0.018
2	1.699	+1.212
3	1.510	+0.864
4	1.321	+0.442
5	1.133	+0.152
5'	0.944	-0.037

$\frac{Y}{f}=\frac{429.852}{496.816}=0.865$

$\frac{1}{2}=-0.009\times(15+0.22)=-0.137$

$\frac{1}{2}=+0.606\times 14.78 \quad =+8.957$

$+(1.246+0.076+0.606)\times 15=+28.930$

$\frac{1}{2}=+0.076\times 12 \quad =+0.912$

$\frac{1}{2}=-0.019\times 3 \quad =-0.057$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

	$S_o\frac{f}{r}$	$+(S_o\frac{f}{r}-H)$
4'	0.634	-0.245
3'	0.476	-0.230
2'	0.317	-0.170
1'	0.159	-0.089
0'	0	0

$-(0.922+0.015)\times 15 = -14.055$

$(+45.895)+(-14.081)=+31.814$

$+39.467$

	$S_o\frac{f}{r}$	$+(S_o\frac{f}{r}-H)$
4'	0.755	-0.124
3'	0.566	-0.140
2'	0.378	-0.109
1'	0.189	-0.059
0'	0	0

$-(0.432+0.019)\times 15 = -6.765$

$(+38.789)+(-6.954)=+31.830$

$+49.559$

(c) $U_2 \sim L_3$

0	0	0
1	0.194	-0.054
2	0.387	-0.100
3	1.810	+1.104
4	1.584	+0.705
5	1.358	+0.377
5'	1.131	+0.150
4'	0.905	+0.026
3'	0.679	-0.027
2'	0.453	-0.034
1'	0.226	-0.022
0'	0	0

$\frac{Y}{\Gamma}=\frac{428.802}{394.911}=1.086$

$-(0.054+0.050)\times 15 = -1.560$

$\frac{1}{2}=-0.050\times 1.25 = -0.0625$

$\frac{1}{2}=+0.552\times 13.75 = +7.590$

$+(1.232+0.552+0.013)\times 15=+26.955$

$\frac{1}{2}=+0.013\times 7.22 = +0.094$

$\frac{1}{2}=-0.014\times 7.78 = -0.109$

$-(0.056+0.014)\times 15 = -1.050$

$(+34.639)+(-2.7815)=+31.8575$

$+62.275$

(d) $U_3 \sim L_4$

0	0	0
1	0.138	-0.110
2	0.277	-0.210
3	0.415	-0.291
4	1.974	+1.095
5	1.692	+0.711
5'	1.410	+0.429
4'	1.128	+0.249
3'	0.846	+0.140
2'	0.564	+0.077
1'	0.282	+0.034
0'	0	0

$\frac{Y}{\Gamma}=\frac{428.279}{352.319}=1.216$

$-(0.320+0.146)\times 15 = -6.990$

$\frac{1}{2}=-0.146\times 3.15 = -0.460$

$\frac{1}{2}=+0.549\times 11.85=+6.5057$

$+(1.640+0.549)\times 15=+32.835$

$(+39.3407)+(-7.450)=+31.8907$

$+69.802$

(e) $U_4 \sim L_5$

0	0	0
1	0.010	-0.238
2	0.020	-0.467
3	0.030	-0.676
4	0.038	-0.841
5	2.466	+1.485
5'	2.055	+1.074
4'	1.644	+0.765
3'	1.233	+0.527
2'	0.822	+0.335
1'	0.411	+0.163
0'	0	0

$\frac{Y}{\Gamma}=\frac{428.044}{466.677}=0.917$

$-(1.381+0.421)\times 15 = -27.030$

$\frac{1}{2}=-0.421\times 5.48 = -2.307$

$\frac{1}{2}=+0.743\times 9.52 = +7.073$

$+(2.864+0.743)\times 15=+54.105$

$(+61.216)+(-29.316)=+31.841$

$+52.654$

(f) $U_5 \sim L_5'$

0	0	0
1		-0.240
2		-0.480
3		-0.721
4		-0.961
5		-1.201
5'		+1.201
4'		+0.961
3'		+0.721
2'		+0.480
1'		+0.240
0'		0

$-(0.402+0.601)\times 15 = -45.045$

$\frac{1}{2}=-0.601\times 7.5 = -4.508$

$\frac{1}{2}=+0.601\times 7.5 = +4.508$

$+(2.402+0.601)\times 15=+45.045$

$(-49.553)+(+49.553)=0$

(IV) Verticals

(a) $L_6 \sim L_0$

0	1.745	-0.873

$\frac{Y}{\Gamma}=\frac{103.140}{180.000}=0.573$

(b) $U_1 \sim L_1$

0	0	0

$\frac{Y}{\Gamma}=\frac{493.695}{852.026}=0.579$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

	$S_0 \frac{F}{V}$	$+(S_0 \frac{F}{V} - H)$	
1	1.586	-1.338	$-(3.715+0.116)\times 15 = -57.465$
2	1.428	-0.941	
3	1.269	-0.563	
4	1.110	-0.231	$\frac{1}{2} = -0.116 \times 13.28 = -0.154$
5	0.952	+0.029	$\frac{1}{2} = +0.015 \times 1.72 = +0.026$
5'	0.793	+0.188	
4'	0.635	+0.244	
3'	0.476	+0.230	$+(0.921+0.015)\times 15 = +14.040$
2'	0.317	+0.170	
1'	0.159	+0.089	
0'	0	0	$(-57.619)+(+14.066) = -43.553$

-44.890

(c) $U_2 - L_2$

0	0	0	$\frac{V}{F} = \frac{494.211}{897.436} = 0.551$
1	0.133	+0.115	$+(0.115+0.111)\times 15 = +3.390$
2	0.266	+0.221	$\frac{1}{2} = +0.111 \times 2.44 = +0.271$
3	1.850	-1.144	$\frac{1}{2} = -0.572 \times 12.56 = -7.184$
4	1.619	-0.740	
5	1.387	-0.406	$-(1.321+0.572+0.023)\times 15 = -28.140$
5'	1.156	-0.175	
4'	0.925	-0.046	$\frac{1}{2} = -0.023 \times 11.90 = -0.274$
3'	0.694	+0.012	$\frac{1}{2} = +0.006 \times 3.10 = +0.019$
2'	0.462	+0.025	$+(0.042+0.006)\times 15 = +0.720$
1'	0.231	+0.017	
0'	0	0	$(-36.198)+(+4.400) = -31.798$

-31.537

(e) $U_4 - L_4$

0	0	0	$\frac{V}{F} = \frac{650.530}{3156.521} = 0.206$
1	-0.265	+0.513	
2	-0.530	+1.017	$+(3.031+0.970)\times 15 = +60.015$
3	-0.795	+1.501	
4	-1.060	+1.939	$\frac{1}{2} = +0.970 \times 6.91 = +6.703$
5	-3.250	-2.269	$\frac{1}{2} = -1.135 \times 8.09 = -9.182$
5'	-2.709	-1.728	
4'	-2.167	-1.288	
3'	-1.625	-0.914	$-(4.825+1.135)\times 15 = -89.400$
2'	-1.083	-0.596	

	$S_0 \frac{F}{V}$	$+(S_0 \frac{F}{V} - H)$	
1	0.175	+0.073	$\frac{1}{2} = +0.037 \times (15+0.86) = +0.587$
2	1.710	-1.223	$\frac{1}{2} = -0.612 \times 14.14 = -8.654$
3	1.520	-0.814	$-(1.265+0.612+0.080)\times 15 = -29.355$
4	1.330	-0.451	
5	1.140	-0.159	$\frac{1}{2} = -0.080 \times 12.50 = -1.000$
5'	0.950	+0.031	$\frac{1}{2} = +0.016 \times 2.50 = +0.040$
4'	0.760	0.119	
3'	0.570	0.136	$+(0.420+0.016)\times 15 = +6.540$
2'	0.380	0.107	
1'	0.190	0.058	
0'	0	0	$(-39.009)+(+7.167) = -31.842$

-33.134

(d) $U_3 - L_3$

0	0	0	$\frac{V}{F} = \frac{510.091}{1145.525} = 0.445$
1	0.052	+0.196	$+(0.578+0.275)\times 15 = +12.795$
2	0.105	+0.382	
3	0.157	+0.549	$\frac{1}{2} = +0.275 \times 4.65 = +1.279$
4	2.103	-1.224	$\frac{1}{2} = -0.612 \times 10.35 = -6.334$
5	1.802	-0.821	
5'	1.502	-0.521	
4'	1.202	-0.323	$-(2.025+0.612)\times 15 = -39.555$
3'	0.901	-0.195	
2'	0.601	-0.114	
1'	0.300	-0.052	
0'	0	0	$(-45.889)+(+14.074) = -31.815$

-25.277

(f) $U_5 - L_5$

0	0	0	$\frac{V}{F} = \frac{309.421}{1692.216} = 0.183$
1	-0.814	+0.566	
2	-1.629	+1.142	$+(5.824+1.546)\times 15 = +110.550$
3	-2.443	+1.737	
4	-3.258	+2.379	
5	-4.072	+3.141	$\frac{1}{2} = +1.546 \times 8.86 = +13.698$
5'	+1.163	-2.144	$\frac{1}{2} = -1.072 \times 6.14 = -6.582$
4'	+0.931	-1.810	
3'	+0.698	-1.404	$-(4.648+1.072)\times 15 = -85.800$
2'	+0.466	-0.953	

増田淳氏関係資料
(独立行政法人 土木研究所蔵)

	$S_0\frac{r}{y}$	$+(S_0\frac{r}{y}-H)$
1	+0.542	-0.294
0	0	0

(-98.582)+(+66.718)=-31.864

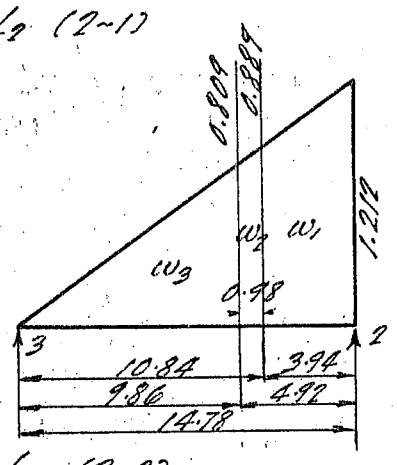
-11.815

	$S_0\frac{r}{y}$	$+(S_0\frac{r}{y}-H)$
1	+0.233	-0.481
0	0	0

(+124.248)+(-92.382)=+31.866

+10.497

L_1-L_2 (2-1)



$1.212\times\frac{10.84}{14.78}=\frac{13.13808}{14.78000}=0.889$

$1.212\times\frac{9.86}{14.78}=\frac{11.95032}{14.78000}=0.809$

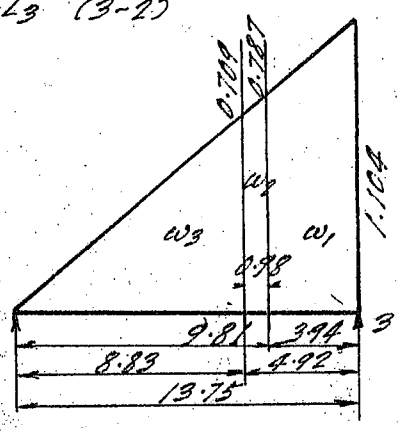
$9\times(1.212+0.889)\times3.94-9\times2.101\times3.94=9\times8.277794=75$

$141\times(0.889+0.809)\times0.98-141\times1.698\times0.98=141\times1.66404=235$

$418.5\times0.809\times9.86-418.5\times7.97674=3.338$

$75+235+3.338=3.648$

U_2-L_3 (3-2)



$1.104\times\frac{9.81}{13.75}=\frac{10.83024}{13.75000}=0.787$

$1.104\times\frac{8.83}{13.75}=\frac{9.74832}{13.75000}=0.709$

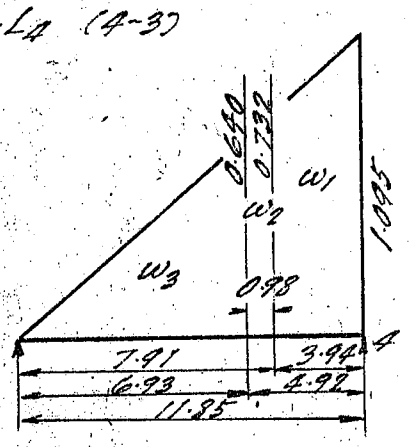
$9\times(1.104+0.787)\times3.94=9\times1.891\times3.94=9\times7.45054=67$

$141\times(0.787+0.709)\times0.98=141\times1.496\times0.98=141\times1.46608=207$

$418.5\times0.709\times8.83=418.5\times6.26047=2.620$

$67+207+2.620=2.894$

U_3-L_4 (4-3)



$1.095\times\frac{7.91}{11.85}=\frac{8.66145}{11.85000}=0.732$

$1.095\times\frac{6.93}{11.85}=\frac{7.58835}{11.85000}=0.640$

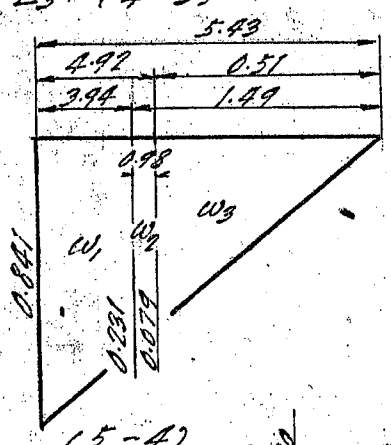
$9\times(1.095+0.732)\times3.94=9\times1.827\times3.94=9\times7.19838=66$

$141\times(0.732+0.640)\times0.98=141\times1.372\times0.98=141\times1.34456=190$

$418.5\times0.640\times6.93=1,857$

$66+190+1,857=2,113$

U_4-L_5 (4-5)



$0.841\times\frac{1.49}{5.43}=\frac{1.25309}{5.43000}=0.231$

$0.841\times\frac{0.51}{5.43}=\frac{0.42891}{5.43000}=0.079$

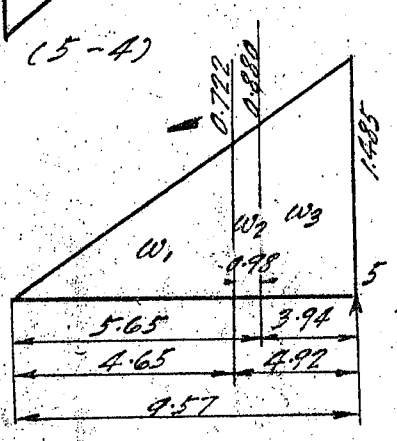
$9\times(0.841+0.231)\times3.94=9\times1.072\times3.94=9\times4.22368=38$

$141\times(0.231+0.079)\times0.98=141\times0.310\times0.98=141\times0.30380=43$

$418.5\times0.079\times0.51=418.5\times0.04029=17$

$38+43+17=98$

(5-4)



$1.485\times\frac{5.63}{9.57}=\frac{8.36055}{9.57000}=0.880$

$1.485\times\frac{4.65}{9.57}=\frac{6.90525}{9.57000}=0.722$

$9\times(1.485+0.880)\times3.94=9\times2.365\times3.94=9\times9.3181=84$

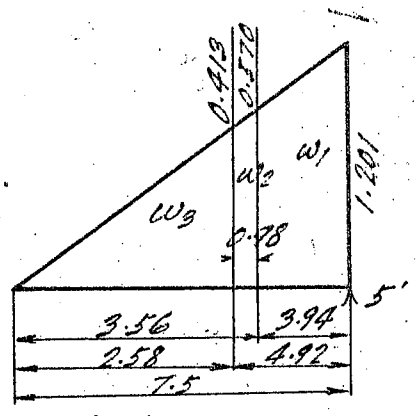
$141\times(0.880+0.722)\times0.98=141\times1.602\times0.98=141\times1.56996=221$

$418.5\times0.722\times4.65=418.5\times3.3573=1,405$

$84+221+1,405=1,710$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

$U_5 - L_5$



$1.201 \times \frac{3.56}{7.50} = 0.570$

$1.201 \times \frac{2.58}{7.50} = 0.413$

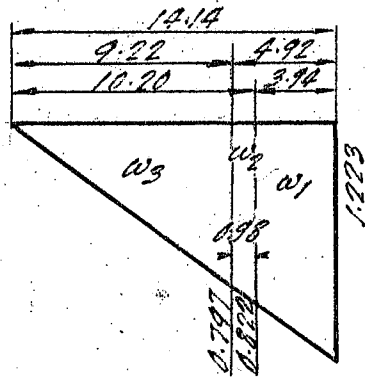
$9 \times 3.94 \times (1.201 + 0.570) = 63$

$141 \times 0.98 \times (0.570 + 0.413) = 136$

$418.5 \times 2.58 \times 0.413 = 446$

$63 + 136 + 446 = 645$

$U_1 - L_1$ (2-1)



$1.223 \times \frac{10.20}{14.14} = \frac{12.4746}{14.1400} = 0.882$

$1.223 \times \frac{9.22}{14.14} = \frac{11.27606}{14.14000} = 0.797$

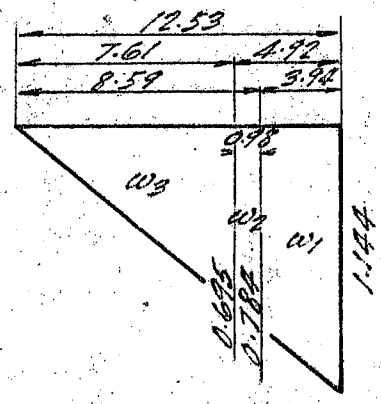
$9 \times (1.223 + 0.882) \times 3.94 - 9 \times 2.105 \times 3.94 - 9 \times 8.2937 - 75$

$141 \times (0.882 + 0.797) \times 0.98 - 141 \times 1.679 \times 0.98 - 141 \times 1.64542 - 232$

$418.5 \times 9.22 \times 0.797 - 418.5 \times 7.34834 - 3,075$

$75 + 232 + 3,075 - 3,382$

$U_2 - L_2$ (3-2)



$1.144 \times \frac{8.59}{12.53} = \frac{9.82696}{12.5300} = 0.784$

$1.144 \times \frac{7.61}{12.53} = \frac{8.70584}{12.53000} = 0.695$

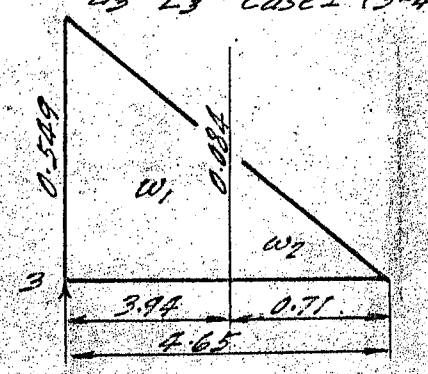
$9 \times (1.144 + 0.784) \times 3.94 = 9 \times 1.928 \times 3.94 = 9 \times 7.59632 = 68$

$141 \times (0.784 + 0.695) \times 0.98 = 141 \times 1.479 \times 0.98 = 141 \times 1.44942 = 204$

$4185 \times 0.695 \times 7.61 = 4185 \times 5.28895 = 2,213$

$68 + 204 + 2,213 = 2,485$

$U_3 - L_3$ Case I (3-4)



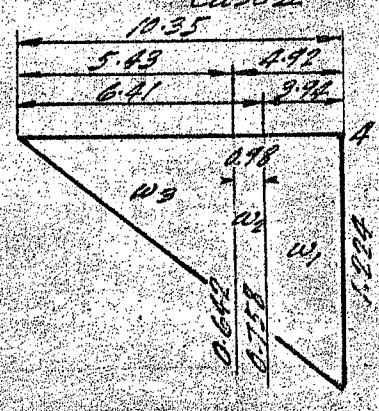
$0.549 \times \frac{0.71}{4.65} = \frac{0.38979}{4.65000} = 0.084$

$9 \times (0.549 + 0.084) \times 3.94 = 9 \times 0.633 \times 3.94 = 9 \times 2.49402 = 22$

$141 \times 0.084 \times 0.71 = 141 \times 0.05964 = 8$

$22 + 8 = 30$

Case II



$1.224 \times \frac{6.41}{10.35} = \frac{7.84584}{10.35000} = 0.758$

$1.224 \times \frac{5.43}{10.35} = \frac{6.64632}{10.35000} = 0.642$

$9 \times (1.224 + 0.758) \times 3.94 = 9 \times 1.982 \times 3.94 = 9 \times 7.80908 = 70$

$141 \times (0.758 + 0.642) \times 0.98 = 141 \times 1.4 \times 0.98 = 141 \times 1.372 = 193$

$418.5 \times 0.642 \times 5.43 = 418.5 \times 3.48606 = 1,459$

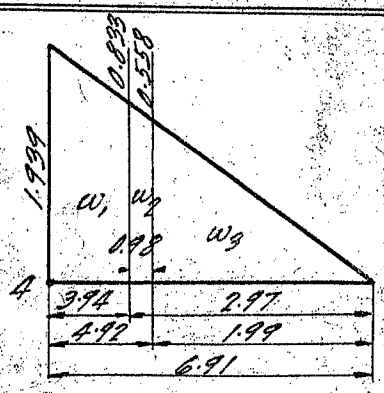
$70 + 193 + 1,459 = 1,722$

$U_4 - L_4$ Case I (4-5)

$1.939 \times \frac{2.97}{6.91} = \frac{5.75883}{6.91000} = 0.833$

$1.939 \times \frac{1.49}{6.91} = \frac{3.85861}{6.91000} = 0.558$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）



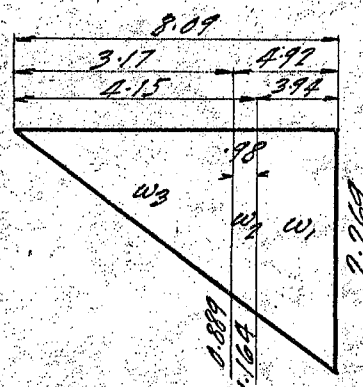
Case II (5-4)

$9\times(1.999+0.833)\times3.94-9\times2.772\times3.94-9\times10.92168=98$

$141\times(0.833+0.558)\times0.98-141\times1.391\times0.98-141\times1.36318=192$

$418.5\times0.558\times1.99=418.5\times1.11042=465$

$98+192+465=755$



U_5~L_5 Case I (5-5)

$2.269\times\frac{4.15}{8.09}=\frac{9.41635}{8.09000}=1.164$

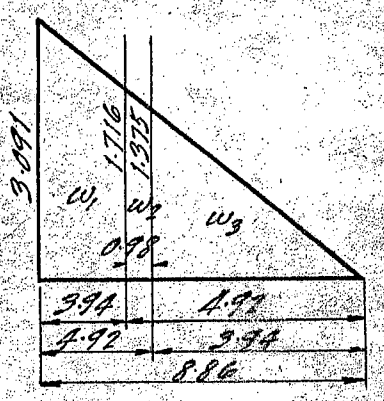
$2.269\times\frac{3.17}{8.09}=\frac{7.19273}{8.09000}=0.889$

$9\times(2.269+1.164)\times3.94=9\times3.433\times3.94=9\times13.52602=122$

$141\times(1.164+0.889)\times0.98=141\times2.053\times0.98=141\times2.01194=284$

$418.5\times0.889\times3.17=418.5\times2.81813=1,179$

$122+284+1,179=1585$



Case II (5-5)

$3.091\times\frac{4.92}{8.86}=\frac{15.20772}{8.86000}=1.716$

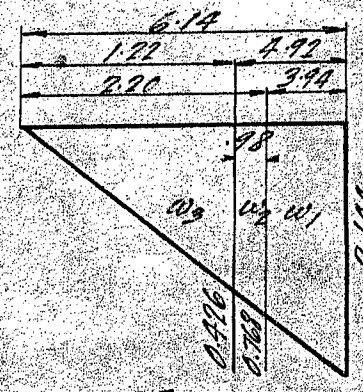
$3.091\times\frac{3.94}{8.86}=\frac{12.17854}{8.86000}=1.375$

$9\times(3.091+1.716)\times3.94=9\times4.807\times3.94=9\times18.93958=170$

$141\times(1.716+1.375)\times0.98=141\times3.091\times0.98=141\times3.02918=427$

$418.5\times1.375\times3.94=418.5\times5.4175=2,267$

$170+427+2,267=2,864$



Case I

$2.144\times\frac{2.20}{6.14}=\frac{4.7168}{6.1400}=0.768$

$2.144\times\frac{1.22}{6.14}=\frac{2.61568}{6.14000}=0.426$

$9\times(2.144+0.768)\times3.94=9\times2.912\times3.94=9\times11.47328=103$

$141\times(0.768+0.426)\times0.98=141\times1.194\times0.98=141\times1.17012=165$

$418.5\times0.426\times1.22=418.5\times0.51972=218$

$103+165+218=486$

$W_1=5,510\,\#$

$W_2=8.820\times\frac{5.16}{15}=3,040\,\#$

$w_1=93\times\left[\frac{10.08\times\frac{10.08}{2}+3.14\times\frac{3.14}{2}}{15}\right]=346\,\#/\#$

$W_3=5.290+1.760\times\frac{3.2}{15}=5.290+375=5.665\,\#$ $W_3=7.050+2.350\times\frac{3.2}{15}=7.550\,\#$

$w_3=93\times15=1395\,\#/\#$

$w_2=\frac{93}{2\times15}(10.06^2+1.73^2)=3.1\times123.81=384\,\#/\#$

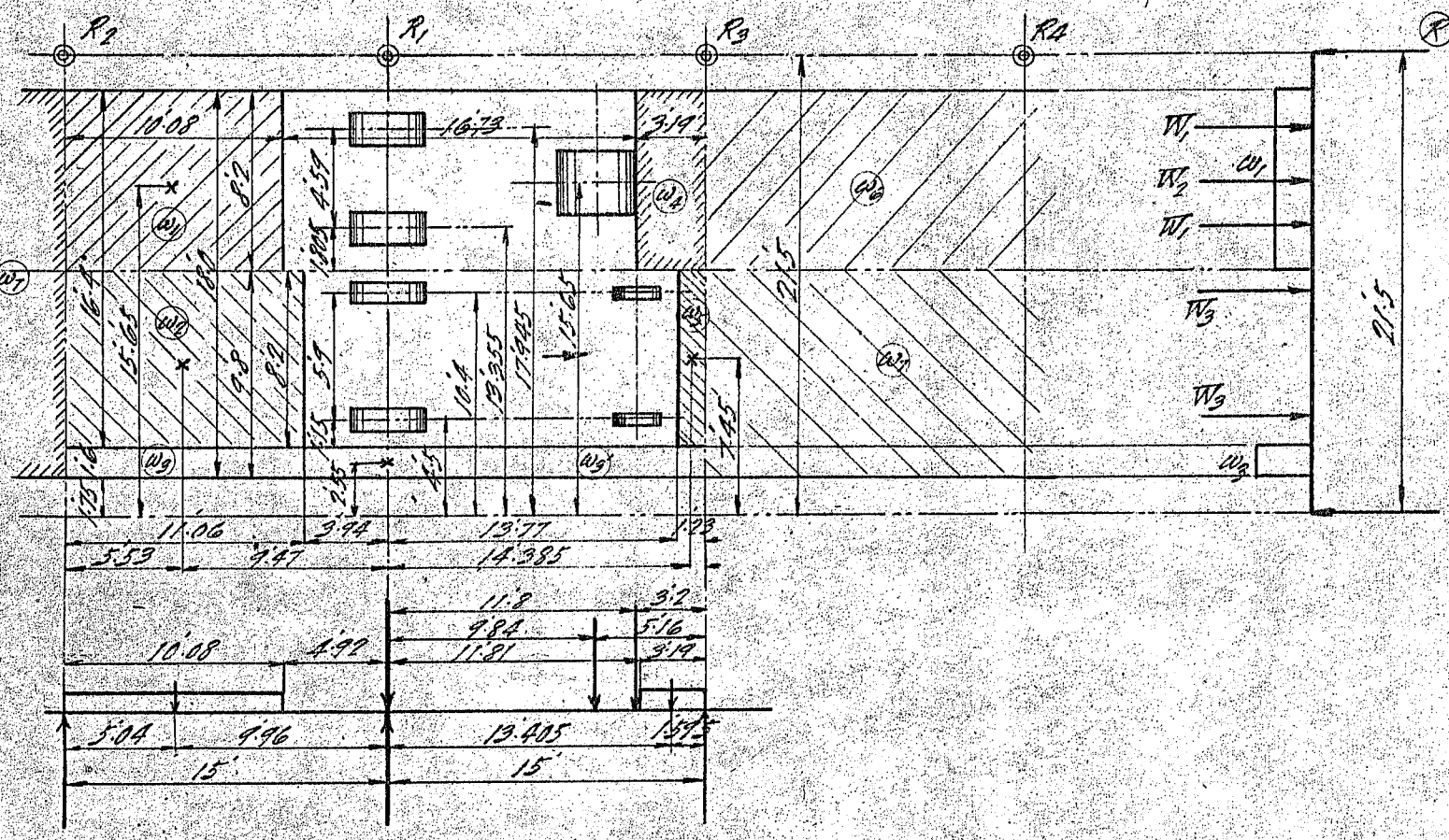
$R_1=\frac{1}{215}\left[5.510(17.945+13.955)+3040\times15.65+346\times8.2\times15.65+5.665(10.4+4.5)\right.$

$\left.+1.395\times16\times2.55+384\times8.2\times7.45\right]$

$=8.022+2.213+2.065+3.926+265+1.091$

$=17.582\,\#$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）



$$\text{Max. Reaction} = 8,022 + 2,213 + 2,065 + 7,550 \times \frac{10.4+4.5}{21.5} + 265$$

$$= 17,797\ \#$$

$$R_2 = 93 \times 10.08 \times 8.2 \times \frac{9.96}{15} \times \frac{15.65}{21.50} + 93 \times 11.06 \times 8.2 \times \frac{9.47}{15} \times \frac{7.45}{21.50} +$$

$$1,395 \times \frac{1}{2} \times 1.6 \times \frac{2.55}{21.50} + 93 \times 9 \times 7.5$$

$$= 3,715 + 1,845 + 192 + 6,278$$

$$= 11,970\ \#$$

$$R_3 = \left(93 \times 3.19 \times 8.2 \times \frac{13.405}{15} + \frac{1395}{2} \times 8.2\right) \times \frac{15.65}{21.50} + 1,395 \times 1.6 \times \frac{2.55}{21.50} +$$

$$(8,820 - 3,040) \times \frac{15.65}{21.50} + (1,760 - 375) \times \frac{10.4+4.5}{21.5} + 93 \times 1.93 \times 8.2 \times \frac{14.385}{15} \times \frac{7.45}{21.50}$$

$$+ \frac{1395}{2} \times 8.2 \times \frac{7.45}{21.50}$$

$$= 5,746 + 265 + 4,207 + 960 + 2,294$$

$$= 13,472\ \#$$

$$R_4 = 12,555\ \#$$

Live load stresses calculation by influence method.

(1) $L_6 - U_1$ case I

1. $1.338 \times 17,582 = 23,525$
2. $0.940 \times 13,472 = 12,664$
3. $0.563 \times 12,555 = 7,068$ * $12,555 - 418.5 \times 1.7$
4. $0.231 \times 11,844$ * $= 2,736$ $= 12,555 - 711 = 11,844$

$45,993$

$\therefore$ Max. stress of $U_1 - U_1 = 0.526 \times 45,993 = 24,192\ \#$ compression

5. $0.029 \times 6,988$ * $= 203$ * $12,555 - 418.5 \times 13.3$
5'. $0.188 \times 11,970 = 2,250$ $= 12,555 - 5,567 = 6988$
4'. $0.245 \times 17,587 = 4,308$

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

3' 0.230 × 13,472 = 3,097

2'&1' (0.170+0.089) × 12,555 = 3,252

13,100

∴ Min. stress of $U_0 - U_1$ = 0.526 × 13,100 = 6,891 # tension

(2) $U_1 - U_2$

1 0.545 × 11,970 = 6,524

2 1.099 × 17,582 = 19,323

3 0.704 × 13,472 = 9,484

4 0.355 × 12,555 = 4,457 * 12,555 − 418.5 × 8.5

5 0.076 × 8,998* = 684 −12,555 − 3,557 − 8,998

40,472

∴ Max. stress of $U_1 - U_2$ = 1.255 × 40,472 = 50,792 # compression

5' 0.100 × 12,283* = 1,228 * 12,555 − 418.5 × 6.5

4' 0.174 × 13,472 = 2,344 −12,555 − 272 = 12,283

3' 0.577 × 17,582 = 3,112

2' 0.135 × 11,970 = 1,616

1' 0.072 × 12,555 = 904

9,204

∴ Min. stress of $U_1 - U_2$ = 1.255 × 9,204 = 11,551 # tension

(3) $U_2 - U_3$

1 0.281 × 12,555 = 3,528

2 0.570 × 13,472 = 7,679

3 0.880 × 17,582 = 15,472

4 0.509 × 11,970 = 6,093

5 0.209 × 12,555 = 2,623 * 12,555 − 418.5 × 13.44

5' 0.010 × 6,930* = 69 −12,555 − 5,625 − 6,930

35,464

∴ Max. stress = 2.230 × 35,464 = 79,185 # compression

4' 0.086 × 11,902* = 1,024 * 12,555 − 418.5 × 1.56

3' 0.111 × 17,582 = 1,952 −12,555 − 653 = 11,902

2' 0.090 × 13,472 = 1,212

1' 0.050 × 12,555 = 628

4,816

∴ Min stress of $U_2 - U_3$ = 2.230 × 4,816 = 10,740 # tension

(4) $U_3 - U_4$

1,2,5 (0.149+0.306+0.152) × 12,555 = 7,621

3 0.484 × 13,472 = 6,520

4 0.707 × 17,582 = 12,430

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

5' 0.378 × 11.970 = 4.525

4' (0.024 × (12.555 − 418.5 × 7.22) = 229

31.325

∴ Max stress of U_3-U_4 = 3.355 × 31.325 = 105.095 # compression

3' 0.026 × (13.473 − 418.5 × 7.78) = 275

2' 0.034 × 17.582 = 598

1' 0.021 × 11.970 = 251

1.124

∴ Min stress of U_3-U_4 = 3.355 × 1.124 = 3.771 # tension

5. U_4-U_5

1.2.3.4.3.2&1' (0.069+0.148+0.246+0.179+0.088+0.042+0.017) × 12.555

0.789 × 12.555 = 9.906

4 0.391 × 13.472 = 5.268

5 0.606 × 17.582 = 10.655

5' 0.342 × 11.970 = 4.094

29.923

∴ Max stress of U_4-U_5 = 4.208 × 29.923 = 125.916 # compression

Min stress of U_4-U_5 = 0

6. U_5-U_5'

1.2.3.4.3.2&1' (0.016+0.042+0.087+0.178+0.246+0.147+0.066) × 12.555

0.782 × 12.555 = 9.818

5 0.341 × 11.970 = 4.082

5' 0.605 × 17.582 = 10.637

4' 0.390 × 13.472 = 5.254

29.791

∴ Max stress of U_5-U_5' = 4.204 × 29.791 = 125.241 # compression

∴ Min. stress of U_5-U_5' = 0

7. Tie

1.2.3.4.3.2&1' (0.248+0.489+0.706+0.879+0.706+0.487+0.248) × 12.555

3.763 × 12.555 = 47.244

4 0.879 × 11.970 = 10.522

5&5' 0.981 × (17.582 + 13.472) = 30.464

88.230

∴ Max. stress = 88.230 # tension

Min. stress = 0

8 L_0-L_1

Max. stress 1.153 × 88.230 = 101.729 # compression

Min. stress = 0

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

9. L_1~L_2

1. 0.290 × 17,797 = 5,161

∴ Min. stress of L_1~L_2 = 1.665 × 5,161 = 8,593 # tension

2, 3, 4, 3', 2', 8', (0.003 + 0.276 + 0.502 + 0.545 + 0.374 + 0.194) × 12,555

1.894 × 12,555 = 23,842

5 0.658 × 11,970 = 7,876

5' 0.712 × 17,582 = 12,518

4' 0.664 × 13,472 = 8,945

53,181

∴ Max. stress of L_1~L_2 = 1.665 × 53,181 = 88,546 # compression

10. L_2~L_3

1 0.191 × 13,472 = 2,573

2 0.390 × 17,582 = 6,857

3 0.074 × (11,970 − 4185 × 10.92) = 548

9,978

∴ Min. stress of L_2~L_3 = 2.365 × 9,978 = 23,598 # tension

5, 2', 8', (0.396 + 0.292 + 0.151) × 12,555

0.839 × 12,555 = 10,534

5' 0.494 × 13,472 = 6,655

4' 0.489 × 17,582 = 8,598

3' 0.414 × 11,970 = 4,956

4 0.197 × (12,555 − 4185 × 4.08) = 2,137

32,880

∴ Max. stress of L_2~L_3 = 2.365 × 32,880 = 77,761 # compression

11. L_3~L_4

1 0.116 × 12,555 = 1,456

2 0.247 × 13,472 = 3,327

3 0.386 × 17,582 = 6,787

4 0.077 × (11,970 − 4185 × 10.13) = 525

12,085

∴ Min. stress of L_3~L_4 = 3.294 × 12,085 = 39,808 # tension

5 0.162 × (12,555 − 4185 × 4.87) = 1,704

5' 0.298 × 11,970 = 3,567

4' 0.333 × 17,582 = 5,855

3' 0.296 × 13,472 = 3,987

8', 2', 1 (0.214 + 0.111) × 12,555 = 4,080

19,193

∴ Max. stress of L_3~L_4 = 3.294 × 19,193 = 63,222 # compression

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

12. L4~L5

1 & 2	(0.057+0.124)×12.555	=2.272
3	0.210×13.472	=2.829
4	0.342×17.582	=6.013
5	0.066×(11.970-4.185×9.38)	= 531
		11.645

∴ Max. stress of L4~L5 = 4.371×11.645 = 50900 # tension

5'	0.109 ×(12.555-4.185×5.62)	= 1.112
4'	0.181 ×13.472	=2.438
3'	0.183 ×17.582	=3.218
2'	0.138 ×11.970	=1.652
1'	0.074 ×12.555	= 929
		9.349

∴ Min. stress of L4~L5 = 4.371×9.349 = 40.864 # compression

13 L5~L5'

1,2&3	(0.008+0.026+0.093)×12.555	=1.218
4	0.147 ×13.472	=1.980
5	0.301 ×17.582	=5.292
5'	0.687×(11.970-4.185×5.21)	= 925
		9.415

∴ Max. stress of L5~L5' = 5.204×9.415 = 48.996 # tension

4'	0.024×(11.970-4.185×11.79)	= 169
3'	0.065 ×17.582	=1.143
2'	0.060 ×13.472	= 808
1'	0.034 ×12.555	= 427
		2.547

∴ Min. stress of L5~L5' = 5.204×2.547 = 13.255 # compression

14. L6~L1

1	1.338 ×17.582	=23.525
2	0.940 ×13.472	=12.664
3	0.563 ×12.555	= 7.068
4	0.231 ×(12.555-4.185×1.72)	= 2.734
		45.991

∴ Max. stress of L6~L1 = 0.688×45.991 = 31.642 # tension

5	0.029×(12.555-4.185×13.28)	= 203
5'	0.188 ×11.970	=2.250
4'	0.245 ×17.582	=4.308
3'	0.230 ×13.472	=3.099

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

2'&1' (0.170+0.089)×12.555 = 3,252

13,112

∴ Min. stress = 0.688 × 13,112 = 9,021 # compression

15. U_1~L_2

1' 0.018(12,555-418.5×14.78) = 115

5' 0.037(12,555-418.5×12.00) = 279

4' 0.124 × 13,472 = 1,671

3' 0.140 × 17,582 = 2,461

2' 0.109 × 11,970 = 1,304

1' 0.059 × 12,555 = 741

6,571

∴ Min. stress of U_1~L_2 = 0.865 × 6,571 = 5,684 # compression.

2 1.212 × 14,494 + 3,648 = 21,215

3 0.804 × 13,472 = 10,831

4 0.442 × 12,555 = 5,549

5 0.152 × (11,294 - 418.5 × 3.00) = 1,527

39,122

∴ Max. stress of U_1~L_2 = 0.865 × 39,122 = 33,841 # tension

16 U_2~L_3

1 0.054 × 13,472 = 727

2 0.100 × (14,494 + 9 × 125) = 1,405

3' 0.027 × (12,555 - 418.5 × 7.22) = 258

2&1' (0.034 + 0.022) × 12,555 = 703

3,093

∴ Min. stress of U_2~L_3 = 1.086 × 3,093 = 3,358 # compression

3 1.104 × (14,494 + 2,897 = 18,898

4 0.705 × 13,472 = 9,498

5&5' (0.377 + 0.150) × 12,555 = 6,616

4' 0.026 (12,555 - 418.5 × 7.78) = 242

35,254

∴ Max stress of U_2~L_3 = 1.086 × 35,254 = 38,286 # tension

17 U_3~L_4

1 0.110 × 12,555 = 1,381

2 0.210 × 13,472 = 2,829

3 0.291 × (14,494 + 9 × 315) = 4,226

8,436

∴ Min stress of U_3~L_4 = 1.216 × 8,436 = 10,258 # compression

2 1.055 × (14,494 + 2,113) = 18,185

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

5 0.707×13,472 = 9,525

5,4,3,2&1 (0.429+0.249+0.140+0.077+0.034)×12,555 = 11,664

39,374

∴ Max. stress of U3-L4 = 1.216×39,374 = 47,879# tension

18. U4-L5

1&2 0.705×12,555 = 8,857

3 0.676×13,472 = 9,107

4 0.841×12,189+98 = 10,349

28,213

∴ Min. stress of U4-L5 = 0.917×28,213 = 25,878# compression

5 1.485×14,494+1,710 = 23,234

5' 1.074×13,472 = 14,469

4,3,2&1' (0.765+0.527+0.335+0.169)×12,555 = 22,473

60,176

∴ Max. stress of U4-L5 = 0.917×60,176 = 55,181# tension

19. U5-L5'

1,2&3 (0.240+0.480+0.721)×12,555 = 18,092

4 0.961×13,472 = 12,947

5 1.201×14,494+645 = 18,052

49,091

∴ Max. & Min. stress of U5-L5' = 49,091# comp. & tension

20. U6-L6

0 1.745×14,494 = 25,292

1 1.338×13,472 = 18,026

2&3 (0.941+0.563)×12,555 = 18,883

4 0.231×(12,555-418.5×1.72) = 2,734

64,935

∴ Max. stress of U6-L6 = 0.573×64,935 = 37,208# compression

5 0.029×(12,555-418.5×13.28) = 2,057

5' 0.188×11,970 = 2,250

4 0.244×17,582 = 4,290

3 0.230×13,472 = 3,099

2&1' (0.170+0.089)×12,555 = 3,252

14,948

∴ Min. stress of U6-L6 = 0.573×14,948 = 8,565# tension

21. U1-L1

1 1.073×(12,555-418.5×14.14) = 485

5' 0.031×(7,324-418.5×12.50) = 227

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

4' 0.119 × 13.472 = 1.603
3' 0.136 × 17.582 = 2.391
2' 0.107 × 11.970 = 1.281
1' 0.058 × 12.555 = 728
6.715

∴ Min. stress of U_1~L_1 = 0.579 × 6.715 = 3.889 # tension

2 1.223 × 14.494 + 3.382 = 21.108
3 0.814 × 13.472 = 10.966
4 0.451 × 12.555 = 5.662
5 0.159 × (12.555 − 418.5 × 2.50) = 1.830
39.566

∴ Max. stress of U_1~L_1 = 0.579 × 39.566 = 22.909 # compression

22. U_2~L_2

1.2'&1' (0.115+0.025+0.017) × 12.555 = 1.971
2 0.221 × (14.494 + 9 × 2.44) = 3.218
3' 0.012 × (12.555 − 418.5 × 11.90) = 91
5.270

∴ Min. stress of U_2~L_2 = 0.551 × 5.270 = 2.904 # tension

3 1.124 × 14.494 + 2.485 = 19.066
4 0.740 × 13.472 = 9.969
5&5' (0.406 + 0.175) × 12.555 = 7.294
4' 0.046 × (12.555 − 418.5 × 3.10) = 518
36.847

∴ Max. stress of U_2~L_2 = 0.551 × 36.847 = 20.303 # compression

23. U_3~L_3

1 0.196 × 12.555 = 2.402
2 0.382 × 13.472 = 5.146
3 0.549 × 14.494 + 30 = 7.987
15.535

∴ Min. stress of U_3~L_3 = 0.445 × 15.535 = 6.913 # tension

4 1.224 × 14.494 + 1.722 = 19.463
5 0.821 × 13.472 = 11.061
5.4.3.2&1 (0.521 + 0.333 + 0.195 + 0.114 + 0.052) × 12.555 = 15.179
45.653

∴ Max. stress of U_3~L_3 = 0.445 × 45.653 = 20.316 # compression

24. U_4~L_4

1&2 (0.519 + 1.017) × 12.555 = 19.209
3 1.501 × 13.472 = 20.221

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

4 1.939 × 14.494 + 755 = 28.859

68.289

∴ Min. stress of U4~L4 = 0.206 × 68.289 = 14.068 # tension

5 2.269 × 14.494 + 1.585 = 34.472

5' 1.728 × 13.472 = 23.279

4.3.2&1' (1.288 + 0.919 + 0.596 + 0.294) × 12.555 = 38.883

96.634

∴ Max. stress of U4-L4 = 0.206 × 96.634 = 19.907 # compression

25. U5~L5

1.2&3 (0.566 + 1.142 + 1.737) × 12.555 = 43.252

4 2.379 × 13.472 = 32.050

5 3.091 × 14.494 + 2.865 = 47.666

122.968

∴ Max. stress of U5~L5 = 0.183 × 122.968 = 22.503 # tension

5' 2.144 × 14.494 + 486 = 31.561

4' 1.810 × 13.472 = 24.384

3.2&1' (1.404 + 0.953 + 0.481) × 12.555 = 35.631

91.576

∴ Min stress of U5~L5 = 0.189 × 91.576 = 16.758 # compression

∴ Determination of each section

(a) Tie

S = + 266.466 #

Required net area $\frac{266.466}{17.000} = 15.67$ □"

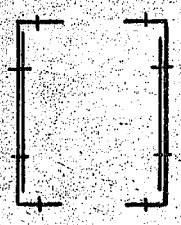
2-Pls. 16 × 3/8" 7.45

2-L5 12"@25# 14.64

22.09 gross

Less 8 × .387 / 4 × .379 4.59

17.50 □" net



(b) Lower Chords.

(1) L5~L5'

S = + 112.590 #

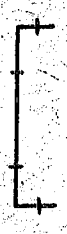
Required net area $\frac{112.590}{17.000} = 6.62$ □"

Use 2-L3 12"@25# 7.37 × 2 = 14.64 gross

Less 8 × .387 = 3.10

11.54 □" net





(2) L4~L5

S = + 64.228 #

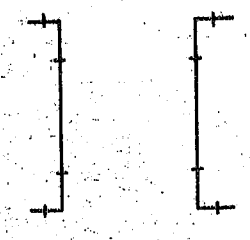
Required net area $\frac{64.228}{17.000} = 3.78$ □"

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

Use 2-L 12" @ 25# 7.32 × 2 = 14.64 gross

Less 8 × .387 3.10

11.54 □" net



(3) L3 - L4

135279

S = ~~-115.375~~ #

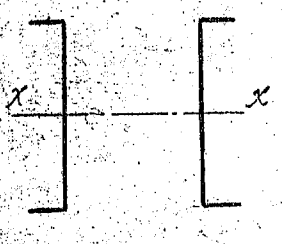
$I_x = 2 \times 143.5 = 287.0$ (")⁴

$r_x = \sqrt{\frac{287.0}{14.64}} = 4.43$"

Allowable stress $S_e = 21{,}330\left(1 - 0.0055 \times \frac{184.668}{4.43}\right) = 16{,}424$ #/□"

Required gross area $\frac{135.279}{14.223} = 8.51$ □"

Use 2-L 12"@25# 7.32 × 2 = 14.64 □" gross



(4) L2 - L3.

203158

S = ~~-141.359~~ #

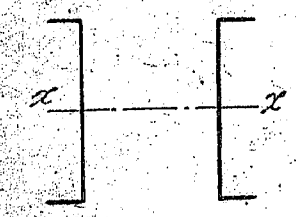
$I_x = 2 \times 161.2 = 322.4$ (")⁴

$r_x = \sqrt{\frac{322.4}{17.58}} = 4.27$"

Allowable stress $S_e = 21{,}330\left(1 - 0.0055 \times \frac{203158}{141.359 \times 4.27}\right) = 16{,}161$ #/□"

Required gross area $\frac{141.359}{14.223} = 9.45$ □"

Use 2-L 12" @ 30# 8.79 × 2 = 17.58 □" gross



(5) L1 - L2

25-7049

S = ~~-252.752~~ #

$I_x = 2 \times 178.8 = 357.6$ (")⁴

$r_x = \sqrt{\frac{357.6}{20.52}} = 4.17$"

Allowable stress $S_e = 21{,}330\left(1 - 0.0055 \times \frac{198.009}{4.17}\right) = 15{,}761$ #/□"

Required gross area $\frac{252.752}{14.223} = 17.77$ □"

Use 2-L 12"@35# 10.26 × 2 = 20.52 □" gross



(6) L0 - L1

S = -307.235 #

$I_x = I_L + I_1 = (143.5 + 31.25) \times 2 = 349.5$ (")⁴

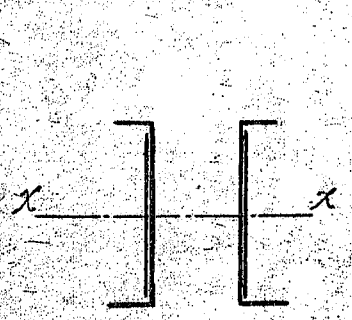
$r_x = \sqrt{\frac{349.5}{22.09}} = 3.98$"

Allowable stress $S_e = 21{,}330\left(1 - 0.0055 \times \frac{207.456}{3.98}\right) = 15{,}209$ #/□"

Required gross area $\frac{307.235}{14.223} = 21.60$ □"

Use 2-L 12" @25# } (3.725 + 7.32) × 2 = 22.09 □" gross

2-Pls. 10" × 3/8"



(6) Top Chords

(1) U5 - U5'

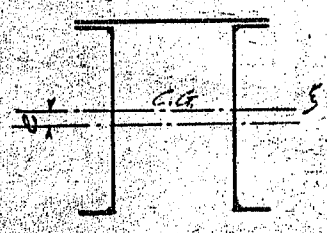
S = -365,651 #

$e = \frac{8.75 \times 6.22}{29.25} = 1.86$"

$I_x = (178.8 + 10.26 \times 1.86^2) \times 2 = 428.59$

$8.75 \times (6.22 - 1.86)^2 = 166.39$

594.92 (")⁴



増田淳氏関係資料
（独立行政法人 土木研究所蔵）

$\rho_s = \sqrt{\frac{594.9}{29.25}} = 4.51"$

Allowable stress $S_c = 21.330(1 - 0.0055 \times \frac{180}{4.51}) = 16.637\ \#/\square"$

Required gross area $\frac{365.651}{14.223} = 25.71\ \square"$

Use 2-E 12" @ 35# $10.26 \times 2 = 20.52$

1-Cov. pl. $20" \times \frac{7}{16}"$ $\underline{8.75}$

$29.27\ \square"$ gross

(2) $U_4 - U_5$

$S = -367,691\ \#$

$e = \frac{8.75 \times 6.22}{29.25} = 1.86"$

$I_g = (178.8 + 10.26 \times 1.86^2) \times 2 = 428.59$

$8.75 \times (6.22 - 1.86)^2 = \underline{166.33}$

$594.9\ (in)^4$

$\rho_g = \sqrt{\frac{594.9}{29.25}} = 4.51"$

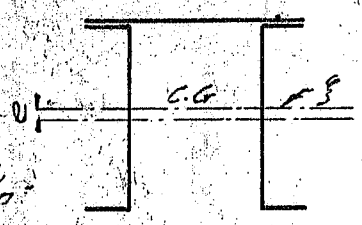
Allowable stress $S_c = 21,330(1 - 0.0055 \times \frac{180.17}{4.51}) = 16637\ \#/\square"$

Required gross area $\frac{367.691}{14.223} = 25.85\ \square"$

Use 2-E 12" @ 35# $10.26 \times 2 = 20.52$

1-Cov. pl. $20" \times \frac{7}{16}" = 8.75$

$29.27\ \square"$ gross

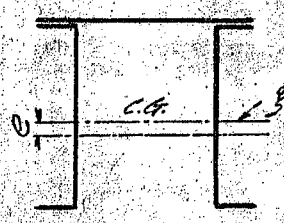


(3) $U_3 - U_4$, $U_2 - U_3$, $U_1 - U_2$ and $U_6 - U_1$

Use 2-E 12" @ 25# 14.64

1-Cov. pl. $20" \times \frac{7}{16}"$ $\underline{8.75}$

$23.39\ \square"$ gross



$e = \frac{8.75 \times 6.22}{23.39} = 2.33"$

$I_g = (143.5 + 7.32 \times 2.33^2) \times 2 = 366.48$

$8.75 \times (6.22 - 2.33)^2 = \underline{132.41}$

$498.90\ (")^4$

$\rho_g = \sqrt{\frac{498.9}{23.39}} = 4.62"$

$U_3 - U_4$ 299293

$S = -297,407\ \#$ 299293

Allowable stress $S_c = 21.330(1 - 0.0055 \times \frac{180.683}{4.62}) = 16.637\ \#/\square"$

Required gross area $\frac{297.407}{14.223} = 20.91\ \square"$ 21.04

Use 2-E 12" @ 25# 14.64

1-Cov. pl. $20" \times \frac{7}{16}"$ $\underline{8.75}$

$23.39\ \square"$ gross

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

U_2-U_3 212220

$S = -206.850$ #

212220

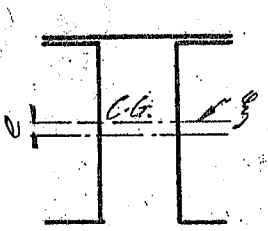
Allowable stress $Se = 21.330\left(1 - 0.0055 \times \frac{181.549}{4.62}\right) = 16.637$ #/□"

Required gross area $\frac{206.850}{14.223} = 14.54$ □" 14.92

Use 2-E 12"@25# $7.32 \times 2 = 14.64$

1-Cov.pl. $20" \times \frac{7}{16}"$ 8.75

23.39 □" gross



U_1-U_2 123443

$S = -122.667$ #

123443

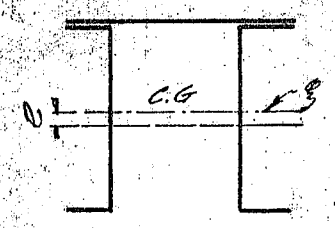
Allowable stress $Se = 21.330\left(1 - 0.0055 \times \frac{182.782}{4.62}\right) = 16.637$ #/□"

Required gross area $\frac{122.667}{14.223} = 8.62$ □" 7.03

Use 2-E 12"@25# $7.32 \times 2 = 14.64$

1-Cov.pl. $20" \times \frac{7}{16}"$ 8.75

23.39 □" gross



U_6-U_5 57546

$S = -54.100$ #

57546

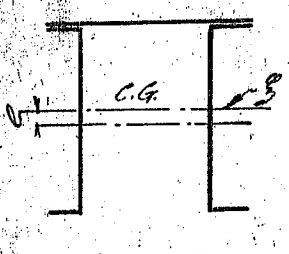
Allowable stress $Se = 21.330\left(1 - 0.0055 \times \frac{184.404}{4.62}\right) = 16.637$ #/□"

Required gross area $\frac{54.100}{14.223} = 3.80$ □" 4.05

Use 2-E 12"@25# $7.32 \times 2 = 14.64$

1-Cov.pl. $20" \times \frac{7}{16}"$ 8.75

23.39 □" gross



(d) Diagonals

(1) U_5-L_5

$S = \pm 49.091$ #

Required net area $\frac{49.091}{17.000} = 2.89$ □"

Use 4-L $3 \times 3 \times \frac{5}{16}"$ $4 \times 1.78 = 7.12$

Less $8 \times 0.3125 = 2.50$

4.62 □" net



(2) U_4-L_5 120774

$S = +107.895$ #

120774

Required net area $\frac{107.895}{17.000} = 6.30$ □" 7.10

Use 4-L $3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}"$ $4 \times 2.48 = 9.92$

Less $\frac{7}{8} \times 8 \times 0.375 = 2.63$ 3.00

6.92 □" net.

7.29



(3) U_3-L_4 122810

$S = +117.681$ #

122810

Required net area $\frac{117.681}{17.000} = 6.92$ □" 7.22

Use 4-L $3\frac{1}{2} \times 3\frac{1}{2} \times \frac{7}{16}"$ $4 \times 2.87 = 11.49$



増田淳氏関係資料
（独立行政法人 土木研究所蔵）

Less $8 \times 0.4375 = 3.50$

7.99 □" net

(4) U_2-L_3

$S = +100,561$ #

Required net area $\frac{100,561}{17,000} = 5.92$ □"

Use 4-L $3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$" $4 \times 2.48 = 9.92$

Less $8 \times 0.375 = 3.00$

6.92 □" net

(5) U_1-L_2

$S = +83,400$ #

Required net area $\frac{83,400}{17,000} = 4.91$ □"

Use 4-L $3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{16}$" $4 \times 2.09 = 8.36$

Less $8 \times 0.3125 = 2.50$

5.86 □" net

(6) U_0-L_1

$S = +71,109$ #

Required net area $\frac{71,109}{17,000} = 4.18$ □"

Use 4-L $3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{16}$" $4 \times 2.09 = 8.36$

Less $8 \times 0.3125 = 2.51$

5.86 □" net

(e) Verticals

(1) U_5-L_5

$S = +99,000$ #

Required net area $\frac{99,000}{17,000} = 7.83$ □"

Use 4-L $3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{16}$" $4 \times 2.09 = 8.36$

$8 \times 0.3125 = 2.50$

5.86 □" net

(2) U_4-L_4

$S = -31,722$ #

$I_g = (2.25 + 2.09 \times 0.94^2) \times 4 = 18.2$ (")^4

$\rho_g = \sqrt{\frac{18.2}{8.36}} = 1.47$"

Allowable stress $S_c' = 21,330(1 - 0.0055 \times \frac{86.401}{1.47}) = 14,291$ #/□"

Required gross area $\frac{31,722}{14,223} = 2.23$ □" 2.72 □"

Use 4-L $3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{16}$" $4 \times 2.09 = 8.36$ □" gross

(3) L_3-L_3

$S = -45,597$ #

$\rho_g = 1.44$"

Allowable stress $S_c' = 21,330(1 - 0.0055 \times \frac{111.956}{1.44}) = 12,201$ #/□"

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

Required gross area $\frac{15.593}{1.201} = 12.98$ □"

Use 4-L5 $3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{16}$" $4 \times 2.09 = 8.36$ □" gross

(4) $U_9 - L_2$

$S = -51,840$ #

$I_g = \{3.4 + 2.09 \times (1.26 + 0.153)^2\} \times 4 = 30.40$

Pl. $\frac{12 \times (\frac{5}{16})^3}{12} = .31$

30.71 (in)^4

$\rho_g = \sqrt{\frac{30.71}{12.11}} = 1.59$"

Allowable stress $Se = 21,330(1 - 0.0055 \times \frac{156.181}{1.59}) = 10,238$ #/□"

Required gross area $\frac{51,840}{10,238} = 5.06$ □"

Use 4-L5 $4 \times 3 \times \frac{5}{16}$" $4 \times 2.09 = 8.36$

1-Pl. $12 \times \frac{5}{16}$" $= 3.75$

12.11 □" gross

(5) $U_1 - L_1$

$S = -56,043$ #

$\rho_g = 1.59$"

Allowable stress $Se = 21,330(1 - 0.0055 \times \frac{200.922}{1.59}) = 6,306$ #/□"

Required gross area $\frac{56,043}{6,306} = 8.89$ □"

Use 4-L5 $4 \times 3 \times \frac{5}{16}$" $4 \times 2.09 = 8.36$

1-Pl. $12 \times \frac{5}{16}$" $= 3.75$

12.11 □" gross

(6) $U_0 - L_0$ (3.38)

$S = -82,098$ #

$e = \frac{6.25 \times 6.16}{23.39} = 1.65$"

$I_g = (14.35 + 7.32 \times 1.65^2) \times 2 = 341.5$

$6.25 \times (6.16 - 1.65)^2 = 127.1$

468.6 (in)^4

$\rho_g = \sqrt{\frac{468.6}{20.89}} = 4.74$"

Allowable stress $Se = 21,330(1 - 0.0055 \times \frac{264}{4.74}) = 14,718$ #/□"

Required gross area $\frac{82,098}{14,223} = 5.77$ □"

Use 2-L5 12"@ 25 # $7.32 \times 2 = 14.64$

1-Cov. Pl. $20 \times \frac{5}{16}$" 6.25

20.89 □" gross

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

HIGHWAY BRIDGE UEDABASHI

OVER

CHIKUMA-GAWA AT UEDA-SHI

NAGANO-KEN

LIST OF MATERIALS

MADE BY K. KITAMURA

CHECKED BY A. GOTO

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

No	Description	Dimension Size	Dimension Length	Weight (#) unit	Weight (#) Total	Remarks
		4 - End Vertical	Posts			L₀ - U₀
1	Pl	20" × 5/16	20'-8 1/2"	21.25	440	Cover plate
2	Cs	12" @ 25#	23'-0"	25.00	1150	
18	Flats	2 1/2 × 7/16	2'-2 3/8"	3.72	147	Lacing bars
2	pls	20 × 3/8	1'-8 1/2"	25.50	87	Tie pls
1	"	20 × 5/16	1'-5 1/2"	21.25	31	Cor. pls
1	"	"	0'-9 1/2"	"	17	"
2	"	34 × 1/2	3'-6 1/2"	57.80	389	Gusset pls.
2	"	31 1/2 × 1/2	2'-4"	53.55	213	"
4	Ls	3 1/2 × 3 1/2 × 3/8	2'-10"	8.50	96	
4	"	3 1/2 × 3 1/2 × 5/16	2'-1"	7.20	60	Diaghragm
1	Pl	12 × 5/16	2'-1"	12.75	27	
2	Ls	5 1/2 × 3 1/2 × 3/8	0'-11"	11.00	20	Cut from 6 × 3 1/2 × 7/16
2	pls	3 1/2 × 5/16	0'-5"	3.72	3	Filler
2	"	3 × 5/16	1'-8 1/2"	3.19	11	"
4	Ls	2 1/2 × 2 1/2 × 5/16	0'-10"	5.00	17	
1	Pl	10 1/2 × 7/16	1'-11 1/2"	24.54	48	Splice pl
1	"	26 1/2 × 3/4	2'-6 1/2"	67.58	163	Gusset
715	R H	3/4 ϕ		0.1242	89	Shop Rivets
140	"	"		"	17	Field Rivets
				Wt = 3,030		
				4 × Wt = 12,120		
		4 - Upper Chords		U₀ - U₁		
1	Pl	20 × 7/16	14'-10 1/2"	29.75	442	Cover pls
2	Ls	12" @ 25#	15'-0"	25.00	744	
12	Flats	2 1/2 × 7/16	2'-2 3/8"	3.72	98	Lacing bars
2	pls	20 × 3/8	1'-8 1/2"	25.50	87	Tie pls
2	"	26 × 1/2	3'-1"	44.20	232	Gusset pls.
2	"	10 1/4 × 3/8	0'-10 3/4"	13.07	23	Splice pls
1	"	16 1/2 × 7/16	1'-11 1/4"	24.54	48	" "
1	"	16 × 5/16	1'-7"	17.00	27	Gusset pls
1	"	15 3/4 × 5/16	2'-10	16.74	47	" "
2	"	3 1/4 × 5/16	1'-5 3/4"	3.45	10	Splice pls
328	Rivet Head	3/4" ϕ		0.1242	41	Shop Rivets
244	Rivet Head	3/4" ϕ		0.1242	30	Field Rivets
				Wt = 1,829		
				4 · wt = 7316		
		4 - Upper Chords		U₁ - U₂ - U₃		
1	Pl	20 × 5/16	15'-3 1/4"	29.75	454	Cover pls
1	"	20 × 7/16	15'-2"	"	451	"
2	Ls	12 @ 25#	15'-3 3/16"	25.00	763	
2	"	"	15'-1 15/16"	"	758	"
24	Flats	2 1/2 × 7/16	2'-2 3/8"	3.72	196	Lacing bars
4	pls	20 × 3/8	1'-8 1/2"	25.50	174	Tie pls
2	"	26 × 1/2	3'-7"	44.20	284	Gusset pls
2	"	22 3/4 × 1/2	4'-1 3/4"	38.68	269	" "
2	"	10 1/4 × 3/8	0'-10 1/2"	13.07	23	Spl. pls.
2	"	"	0'-10 3/4"	"	23	" "

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

No	Description	Dimension Size	Dimension Length	Weight (lb) Unit	Weight (lb) Total	Remarks
2	pls	16½ . 2/16	1'-11½"	24.54	96	Spl. pls
2	"	3¼ . 5/16	1'-5 3/4"	3.45	10	" "
2	"	"	1'-5½	"	10	" Flats
2	"	15 . 5/16	2'-10"	15.94	90	Gusset pls
928	R H	¾ ϕ		01242	115	Shop Rivets
320	"	"		"	40	Field "
				Wt = 3756		
				4. Wt = 15024		
		4 - Upper Chords		U3 - U4 - U5		
1	pl	20 . 7/16	15'-1¼	29.75	449	Cover pls
1	"	"	15'-0 3/4"	"	448	" "
2	ls	12 @ 25#	15'-1 9/16"	25.00	755	
2	"	12 @ 35#	15'-0 11/16	35.00	1054	
20	Flats	2½ . 7/16	2'-2 3/8	3.72	164	Lacing bars
4	pls	20 . ⅜	1'-8½"	25.50	174	Tie pls
2	"	22¾ . ½	4'-3"	38.68	284	Gusset pls
2	"	10¼ . ⅜	0'-10 3/4"	13.07	23	spl. pls
2	"	5 . ¼	0'-10	4.25	7	Fillers
1	"	16½ . 7/16	1'-11½"	24.54	48	splice pls
2	"	3¼ . 5/16	1'-5½	3.45	10	splice pls
1	"	15 . 5/16	2'-9½"	15.94	44	Gusset pls
908	R H	¾" ϕ		0.1242	113	Shop Rivets
432	"	"		"	54	Field "
				Wt = 3627		
				4. Wt = 14508		
		2 - Upper Chords		U5 - U6		
1	pl	20 . 7/16	15'-0½"	29.75	447	Cover pls
2	ls	12 @ 35#	15'-0 7/16	35.00	1053	
8	Flats	2½ x 7/16	2'-2 3/8	3.72	65	Lacing bars
2	pls	20 x ⅜	1'-8½"	25.50	87	Tie plates
4	"	22½ x ½	4'-1"	38.25	542	Gusset pls
4	"	10¼ x ⅜	0'-10½"	13.07	46	Splice pls
2	"	16½ x 7/16	1'-11"	24.54	94	" "
4	"	3¼ x 5/16	1'-5½"	3.45	20	" Flats
2	"	14¾ . 5/16	2'-9"	15.68	86	Gusset plate
512	R H	¾" ϕ		0.1242	64	Shop Rivets
224	"	"		"	28	Field Rivets
				Wt = 2532		
				2. Wt = 5064		

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

NO	Description	Dimension size	Dimension Length	Weight (#) Unit	Weight (#) Total	Remarks
		4-Lower Chords L_0-L_1-L_2				
2	Ls	12 @ 25 #	16'-6"	25.00	817	⊂ 16'-7"
2	Pls.	10 × 3/8	14'-10"	12.75	378	side plates
2	Ls	12 @ 35 #	16'-6 11/16"	35.00	1159	
52	Flats	2 1/2 × 7/16	2'-2 3/8"	3.72	475	Lacing bars
8	Pls.	20 × 3/8	1'-8 1/2"	25.50	348	Tie plates
2	"	40 1/2 × 1/2	3'-6 3/4"	68.85	341	Gusset pls.
2	"	10 1/2 × 3/8	0'-11"	13.39	25	spl. pls.
2	"	5 × 1/4	0'-10"	4.25	7	Fillers
2	"	3 1/4 × 3/4	1'-6 3/4"	8.29	26	Spl. Flats - Top
2	"	"	1'-5 3/4"	"	25	" " Bottom
3	"	12 × 5/16	1'-0 1/2"	12.75	40	Diaphragm
6	Ls	2 1/2 × 2 1/2 × 5/16	1'-0 1/2"	5.00	31	"
4	"	3 × 3 × 3/8	0'-8 3/4"	7.20	21	
1152	Rivet Head	3/4 ϕ		0.1242	143	Shop Rivets
296	"	"		"	37	Field Rivets
				wt. = 3823		
				4 × wt. = 15292		
		4-Lower Chords L_2-L_3				
2	Ls	12 @ 30 #	15'-11 1/2"	30.00	956	
28	Flats	2 1/2 × 7/16	2'-2 3/8"	3.72	229	Lacing bars
4	Pls.	20 × 3/8	1'-8 1/2"	25.50	174	Tie plates
2	"	38 1/2 × 1/2	3'-5 1/2"	65.45	311	Gusset pls (2'-4 1/2")
2	"	35 × 1/2	3'-8"	59.50	302	" " (2'-6 1/4")
4	"	10 1/2 × 3/8	0'-11"	13.39	49	splice plates
4	"	5 × 3/8	0'-10"	2.125	7	Filler
4	"	3 1/4 × 3/4	1'-6 3/4"	8.29	52	splice plates
2	"	"	1'-5 1/4"	"	24	" "
2	"	"	1'-5 1/2"	"	24	" "
2	"	12 × 5/16	1'-0 1/2"	12.75	27	Diaphragm
4	Ls	2 1/2 × 2 1/2 × 5/16	1'-0 1/2"	5.00	21	"
372	Rivet Head	3/4" ϕ		0.1242	46	Shop Rivets
112	"	"		"	14	Field "
				wt. = 2236		
				4 × wt. = 8944		
		4-Lower Chords L_3-L_4-L_5				
2	Ls	12 @ 35 #	15'-5 3/4"	25.00	774	
2	"	"	15'-7 1/4"	"	759	
48	Flats	2 1/2" × 7/16	2'-2 3/8"	3.72	392	Lacing bars
	Pls	20 × 3/8	1'-8 1/2"	25.50	348	Tie pls.
2	"	37 1/4 × 1/2	3'-11"	54.33	249	Gusset pls
2	"	10 1/4 × 3/8	0'-10 3/8"	13.07	23	Splice pls.
2	"	3 1/4 × 3/4	1'-7 1/2"	8.29	27	" Flats
2	"	"	1'-5 1/4"	"	24	"
4	"	12 × 5/16	1'-0 1/2"	12.75	53	Diaphragm
8	Ls	2 1/2 × 2 1/2 × 5/16	1'-0 1/2"	5.00	42	"
692	Rivet Head	3/4" ϕ		0.1242	86	Shop Rivets
256	"	"		"	32	Field "

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

NO	Description	Dimension size	Dimension Length	Weight (#) Unit	Weight (#) Total	Remarks
				wt. = 1859		
				4 x wt. = 11436		
			2- Lower Chords L_5-L_5'			
2	L_5	12 @ 75#	15'-0 3/8"	25.00	754	
20	Flats	2 1/2 x 7/16	2'-2 3/8"	3.72	164	Lacing bars
4	p/s	20 x 3/8	1'-8 1/2"	25.50	174	Tie p/s.
4	"	33 3/4 x 1/2	5'-2"	57.38	794	(3'-5 5/8") Gusset p/s
4	"	10 1/4 x 3/8	0'-10 1/2	13.07	46	Splice p/s.
4	"	3 1/4 x 3/4	1'-6 3/4"	8.29	52	Splice Flats
4	"	"	1'-5 1/4"	"	48	" "
2	"	12 x 5/16	1'-0 1/2"	12.75	27	Diaphragm
4	L_5	2 1/2 x 2 1/2 x 5/16	1'-0 1/2"	5.00	21	"
404	Rivet Head	3/4" ϕ		0.1242	50	Shop Rivets
128	"	"		"	16	Field "
				wt. = 2146		
				2 x wt. = 4292		
			4- Ties L_0-T_1-J_1			
2	L_5	12 @ 75#	19'-0 1/2"	25.00	952	
2	p/s	10 x 3/8	19'-0 1/2"	12.75	486	Side p/s-
44	Flats	2 1/4 x 5/16	1'-1 15/16"	2.39	122	Lacing bars
2	p/s	9 x 5/16	1'-0"	9.56	19	Tie plates
2	"	7 1/2 x 1/2	2'-1"	12.75	53	Gusset p/s-
1	"	26 x 5/16	1'-6 1/4"	27.63	70	" "
2	"	12 x 3/8	1'-6 1/2"	15.30	47	Splice p/s-
2	"	"	2'-6 1/2"	"	78	" "
2	"	10 x 3/8	1'-3 1/2"	12.75	33	" "
568	Rivet Head	3/4" ϕ		0.1242	71	Shop Rivet
228	"	"		"	28	Field "
				wt. = 1,959		
				4 x wt. = 7,836		
			4- Ties J_1-T_2-T_3-J_2			
2	L_5	12 @ 75#	29'-11 3/4"	25.00	1499	
2	p/s-	10 x 3/8	29'-11 3/4"	12.75	764	Reinf. p/s-
76	Flats	2 1/4 x 5/16	1'-1 15/16"	2.39	211	Lacing bars-
4	p/s-	9 x 5/16	1'-0"	9.56	38	Tie plates
4	"	7 1/2 x 1/2	2'-1"	12.75	106	Gusset p/s
2	"	26 x 5/16	2'-6 1/4"	27.63	139	" "
948	Rivet Head	3/4" ϕ		0.1242	118	Shop Rivets
240	"	"		"	30	Field "
				wt. = 2.905		
				4 x wt = 11.620		
			4- Ties J_2 ~ T_4 ~ J_3			
2	L_5	12 @ 75#	20'-7 3/4"	25.00	1011	
2	p/s-	10 x 3/8	20'-7 3/4"	12.75	516	Reinf. p/s.
52	Flats	2 1/4 x 5/16	1'-1 15/16"	2.39	124	Lacing bars
2	p/s-	9 x 15/16	1'-0"	9.56	19	Tie p/s

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

NO	Description	Dimension		Weight (#)		Remarks
		Size	Length	Unit	Total	
2	pls	$7\frac{1}{2} \times \frac{1}{2}$	2'-1"	17.75	53	Gusset pls.
1	"	$26 \times \frac{5}{16}$	1'-6$\frac{1}{4}$"	27.63	70	" "
4	"	$12 \times \frac{3}{8}$	1'-6$\frac{1}{2}$"	15.30	94	splice pls.
4	"	"	2'-6$\frac{1}{2}$"	"	156	" "
4	"	$10 \times \frac{3}{8}$	1'-3$\frac{1}{2}$"	12.75	66	" "
694	Rivet Head	$\frac{3}{4}$" ϕ		0.1242	85	Shop Rivets
152	"	"		"	19	Field "
				Wt. =	2.233	
				4 x Wt. =	8.932	
		2- Ties $J_3 - T_5 - T_5' - J_3'$				
2	Ls	$12 @ 75^{\#}$	24'-8$\frac{3}{4}$"	75.00	1236	
2	pls.	$10 \times \frac{3}{8}$	24'-8$\frac{3}{4}$"	12.75	631	Side pls.
58	Flats	$2\frac{1}{4} \times \frac{5}{16}$	1'-1$\frac{15}{16}$"	2.39	161	Lacing bars
4	pls.	$9 \times \frac{5}{16}$	1'-0"	9.56	38	Tie pls
4	"	$7\frac{1}{2} \times \frac{1}{2}$	2'-1"	12.75	106	Gusset pls
2	"	$26 \times \frac{5}{16}$	2'-6$\frac{1}{4}$"	27.63	139	" "
708	Rivet Head	$\frac{3}{4}$" ϕ		0.1242	88	Shop Rivets
240	"	"		"	30	Field "
				Wt. =	2429	
				2 x Wt. =	4.858	
		4- Hangers $T_1 - L_1$				
4	Ls	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{16}$	7'-3$\frac{1}{2}$"	7.20	210	
6	Flats	$2\frac{1}{4} \times \frac{5}{16}$	1'-1$\frac{3}{8}$"	2.39	16	Lacing bars
1	plat	$12 \times \frac{5}{16}$	1'-5$\frac{1}{2}$"	12.75	19	Tie pls.
1	"	"	0'-10"	"	11	" "
63	Rivet Head	$\frac{3}{4}$" ϕ		0.1242	8	Shop Rivets
72	"			"	9	Field "
				Wt. =	273	
				4 x Wt. =	1.092	
		4- Hangers $T_2 - L_2$				
4	Ls	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{16}$	14'-2$\frac{3}{4}$"	7.20	410	
15	Flats	$2\frac{1}{4} \times \frac{5}{16}$	1'-1$\frac{3}{8}$"	2.39	40	Lacing bars
1	pl.	$12 \times \frac{5}{16}$	1'-5$\frac{1}{2}$"	12.75	19	Tie pls
1	"	"	0'-10"	"	11	" "
102	Rivet Head	$\frac{3}{4}$" ϕ		0.1242	13	Shop Rivets
72	"	"		"	9	Field "
				Wt. =	502	
				4 x Wt. =	1008	
		4- Hangers $T_3 - L_3$				
4	Ls	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{16}$	19'-5$\frac{1}{4}$"	7.20	560	
21	Flats	$2\frac{1}{4} \times \frac{5}{16}$	1'-1$\frac{3}{8}$"	2.39	56	Lacing bars
1	pl.	$12 \times \frac{5}{16}$	1'-5$\frac{1}{2}$"	12.75	19	Tie pls.
1	"	"	0'-10"	"	15	" "
123	Rivet Head	$\frac{3}{4}$" ϕ		0.1242	16	Shop Rivets
72	"	"		"	9	Field "
				Wt. =	671	

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

NO	Description	Dimension		Weight (#)		Remarks
		Size	Length	Unit	Total	
				4 × Wt. =	2,694	
			4- Hangers T_4 ~ L_4			
4	Ls	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{16}$	22'-11"	7.20	660	
26	Flats	$2\frac{1}{4} \times \frac{5}{16}$	1'-5$\frac{3}{8}$"	2.39	69	Lacing bars
1	Pl.	$12 \times \frac{5}{16}$	1'-5$\frac{1}{2}$"	12.75	19	Tie Pl.
1	"	"	0'-10"	"	11	" "
148	Rivet Head	$\frac{3}{4}$" ϕ		0.1742	18	Shop Rivet
72	"	"		"	9	Field "
				Wt. =	786	
				4 × Wt. =	3,144	
			4- Hangers T_5 ~ L_5			
4	Ls	$3\frac{1}{2}" \times 3\frac{1}{2}" \times \frac{5}{16}"$	24'-7$\frac{3}{4}$"	7.20	710	
28	Flats	$2\frac{1}{4} \times \frac{5}{16}$	1'-1$\frac{3}{8}$"	2.39	75	Lacing bars
1	Pl.	$12 \times \frac{5}{16}$	1'-5$\frac{1}{2}$"	12.75	19	Tie Pl.
1	"	"	0'-10"	"	11	" "
156	Rivet Head	$\frac{3}{4}$" ϕ		0.1742	19	Shop Rivets
72	"	"		"	9	Field "
				Wt. =	843	
				4 × Wt. =	3,372	
			4- Diagonals U_0 ~ L_1			
4	Ls	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{16}$	18'-5$\frac{1}{2}$"	7.20	532	
20	Flats	$2\frac{1}{4} \times \frac{5}{16}$	1'-1$\frac{3}{8}$"	2.39	53	Lacing bars
2	Pls.	$12 \times \frac{5}{16}$	1'-0$\frac{1}{2}$"	12.75	27	Tie Pls.
120	Rivet Head	$\frac{3}{4}$" ϕ		0.1742	15	Shop Rivets
80	"	"		"	10	Field "
				Wt. =	637	
				4 × Wt. =	2,548	
			4- Diagonals U_1 ~ L_2			
4	Ls	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{5}{16}$	16'-2"	7.20	466	
17	Flats	$2\frac{1}{4} \times \frac{5}{16}$	1'-1$\frac{3}{8}$"	2.39	45	Lacing bars
2	Pls.	$12 \times \frac{5}{16}$	1'-0$\frac{1}{2}$"	12.75	27	Tie Pls.
108	Rivet Head	$\frac{3}{4}$" ϕ		0.1242	13	Shop Rivets
80	"	"		"	10	Field "
				Wt. =	561	
				4 × Wt. =	2244	

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

No	Description	Dimension Size	Dimension Length	Weight (#) Unit	Weight (#) Total	Remarks
		4 - Diagonals $U_2 \sim L_3$				
2	Ls	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$	$15'-2\frac{1}{2}"$	8.50	259	
2	"	"	$14'-8\frac{3}{4}$	"	250	
14	Flats	$2\frac{1}{4} \times \frac{5}{16}$	$1'-1\frac{3}{8}"$	2.39	37	Lacing bars
2	Pls	$12 \times \frac{5}{16}$	$1'-5\frac{1}{2}$	12.75	37	Tie Plates
112	R-H	$\frac{3}{4}"\phi$		0.1242	14	Shop Rivets
104	"	"		"	13	Field Rivets
				Wt = 610		
				4. Wt = 2440		
		4 - Diagonals $U_3 \sim L_4$				
2	Ls	$3\frac{1}{2} \times 3\frac{1}{2} \times \frac{7}{16}$	$14'-5\frac{1}{2}"$	9.80	283	
2	"	"	$13'-6"$	"	265	
12	Flats	$2\frac{1}{4} \times \frac{5}{16}$	$1'-1\frac{3}{8}"$	2.39	32	Lacing bars
2	Pls	$12 \times \frac{5}{16}"$	$1'-9"$	12.75	43	Tie Pls
112	R H	$\frac{3}{4}"\phi$		0.1242	14	Shop Rivets
116	"	"		"	14	Fild Rivets
				Wt = 651		
				4× Wt = 2604		
		4 - Diagonals $U_4 \sim L_5$				
2	Ls	$3\frac{1}{2}, 3\frac{1}{2} \times \frac{3}{8}$	$13'-8\frac{1}{2}"$	8.50	233	
2	"	"	$12'-7\frac{1}{2}"$	"	215	
12	Flats	$2\frac{1}{4} \times \frac{5}{16}$	$1'-1\frac{3}{8}"$	2.39	32	Lacing bars
2	Pls	$12 \times \frac{5}{16}$	$1'-5\frac{1}{2}"$	12.75	37	Tie plates
104	R H	$\frac{3}{4}"\phi$		0.1242	13	Shop Rivets
100	"	"		"	12	Field "
				Wt = 542		
				4. Wt = 2168		
		2 - Diagonals $U_5 \sim L_5$				
2	Ls	$3 \times 3 \times \frac{5}{16}$	$13'-9\frac{1}{16}"$	6.10	167	
2	Ls	"	$13'-5\frac{13}{16}"$	"	165	
12	flats	$2\frac{1}{4} \times \frac{5}{16}$	$1'-1\frac{13}{16}$	2.39	33	Lacing bars
1	Pl	$12 \times \frac{5}{16}$	$1'-0\frac{1}{2}"$	12.75	13	Tie plate
2	Pls	$12 \times \frac{5}{16}$	$0'-10"$	12.75	21	Tie plates
100	R H	$\frac{3}{4}"\phi$		0.1242	12	Shop Rivets
64	"	"		"	8	Fild Rivets
				Wt = 419		
				2× Wt = 838		
		2 - Diagonals $U_5' \sim L_5'$				
2	Ls	$3 \times 3 \times \frac{5}{16}$	$6'-6\frac{1}{2}"$	6.10	80	
2	"	"	$5'-11\frac{1}{2}"$	"	73	
2	"	"	$6'-1"$	"	75	
2	"	"	$5'-8"$	"	70	
10	flats	$2\frac{1}{4} \times \frac{5}{16}$	$1'-1\frac{13}{16}$	2.39	28	Lacing bars
4	Pls	$12 \times \frac{5}{16}$	$0'-10$	12.75	42	Tie pls
2	Pls	$7\frac{1}{2} \times \frac{1}{2}$	$3'-0\frac{1}{2}"$	12.75	78	Splice pls
104	R H	$\frac{3}{4}"\phi$		0.1242	17	Shop Rivets
80	"	"		"	10	Field Rivets

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

No	Description	Dimension Size	Dimension Length	Weight (#) Unit	Weight (#) Total	Remarks
				Wt =	473	
				2× Wt =	946	
		4 - Verticals		$U_1 - L_1$		
4	Ls	4×3×5/16	15'-3½"	7.20	440	Flange Angle
1	Pl	12×5/16	15'-1"	12.75	192	Web pls
1	"	7×½	2'-2½"	11.90	26	Fillers
224	R.H	¾"ϕ		0.1242	24	Shop Rivets
124	"	"		"	15	Field "
				Wt =	701	
				4× Wt =	2804	
		4 - Verticals		$U_2 - L_2$		
4	Ls	4×3×5/16	11'-1½"	7.20	320	Flange Angle
1	Pl	12×5/16	10'-11"	12.75	139	Web plates
1	"	7×½	2'-2½"	11.90	26	Filler
168	R.H	¾"ϕ		0.1242	21	Shop rivets
1	"	"		"	15	Fild "
				Wt =	521	
				4× Wt =	2084	
		4 - Verticals		$U_3 - L_3$		
4	Ls	3½×3½×5/16	8'-0"	7.20	230	Flange Angle
1	Pl	12×5/16	7'-9½"	12.75	99	Web plates
1	"	7×½	2'-2½"	11.90	26	Filler
1	"	"	0'-6"	"	6	"
124	R.H	¾"ϕ		0.1242	15	shop Rivets
104	"	"		"	13	Fild "
				Wt =	389	
				4× Wt =	1556	
		4 - Verticals		$U_4 - L_4$		
4	Ls	3½×3½×5/16	5'-11"	7.20	170	Flange Angle
1	Pl	12×5/16	5'-8½"	12.75	73	Web plates
1	"	7×½	1'-7"	11.90	19	Filler
1	"	"	0'-6"	"	6	"
96	R.H	¾"ϕ		0.1242	12	Shop Rivets
92	"	"		"	11	Fild "
				Wt =	291	
				4× Wt =	1164	
		4 - Verticals		$U_5 - L_5$		
4	Ls	3½×3½×5/16	4'-10¼"	7.20	140	Flange Angle
1	Pl	12×5/16	4'-7¾"	12.75	59	Web pl
2	Pls	7×½	0'-6"	11.90	12	Fillers
80	R.H	¾"ϕ		0.1242	10	Shop Rivets
72	"	"		"	9	Fild "
				Wt =	230	
				4× Wt =	920	

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

NO	Description	Dimension Size	Dimension Length	Weight (#) Unit	Weight (#) Total	Remarks
		2 – Portal Bracings				
2	Ls	4 x 3 x 3/8	19'-9 1/2"	8.50	336	
1	Pl	12 x 5/16	20'-3 1/2"	12.75	259	
2	Ls	4 x 3 x 3/8	20'-7"	8.50	350	
1	Pl	12 x 5/16	22'-6"	12.75	287	Bent Plate
4	Ls	3 x 3 x 5/16	3'-8 1/2"	6.10	90	D1
2	Pl	12 x 5/16	3'-6"	12.75	89	D1
4	Ls	3 x 3 x 5/16	3'-4"	6.10	81	D2
2	Pl	12 x 5/16	3'-1 1/2"	12.75	80	"
4	Ls	3 x 3 x 5/16	3'-2 1/4"	6.10	78	D3
2	Pl	12 x 5/16	2'-11 3/4"	12.75	76	"
4	Ls	3 x 3 x 5/16	3'-1 1/2"	6.10	76	D4
2	Pl	12 x 5/16	2'-11"	12.75	74	"
4	Ls	3 x 3 x 5/16	3'-7"	6.10	87	V1
2	Pls	12 x 5/16	3'-4 1/2"	12.75	86	"
4	Ls	3 x 3 x 5/16	3'-0 1/2"	6.10	74	V2
2	Pls	12 x 5/16	2'-10	12.75	72	"
4	Ls	3 x 3 x 5/16	2'-9 3/4"	6.10	69	V3
2	Pls	12 x 5/16	2'-7 1/4"	12.75	66	"
2	Ls	3 x 3 x 5/16	2'-8 1/2"	6.10	33	V4
1	Pl	12 x 5/16	2'-6"	12.75	32	"
4	Ls	3 x 3 x 5/16	1'-5 1/2"	6.10	36	H
2	Pls	12 x 5/16	1'-3"	12.75	32	"
4	"	13 x 5/16	1'-6 1/4"	13.81	84	Gusset plates
4	"	12 3/4 x 5/16	1'-1 1/2"	13.55	61	" "
4	"	"	1'-1"	"	59	" "
4	"	12 1/2 x 5/16	1'-1"	13.28	58	" "
2	"	7 1/2 x 5/16	0'-11 1/4"	7.97	15	" "
4	"	21 x 5/16	3'-3 1/2"	22.31	164	" "
4	"	13 1/2 x 5/16	1'-2 3/4"	14.34	71	" "
4	"	13 1/4 x 5/16	1'-1 1/4"	14.08	62	" "
2	"	12 3/4 x 5/16	1'-5 3/4"	13.55	40	" "
1586	R.H	3/4 · ϕ		0.1242	196	Shop Rivets
396	"	"		0.1242	49	Field "
				Wt = 3322		
				2 x Wt = 6644		
		8 – Sway Bracings		B1, B2, B3 & B4		
6	Ls	4 x 3 x 1/16	19'-8 1/2"	7.20	851	
10	"	3 x 3 x 5/16	5'-6 1/2"	6.10	338	
4	"	3 1/2 x 3 1/2 x 5/16	1'-11 3/4"	7.20	57	
4	"	"	0'-11 1/4"	"	27	
2	Pls	12 x 5/16	2'-3 1/4"	12.75	58	
3	"	"	2'-8 1/2"	"	104	
4	"	15 1/2 x 5/16	1'-7 1/2"	16.47	107	(1'-4 1/2")
2	"	15 x 5/16	2'-2 1/2"	15.94	44	(1'-3 1/2")
2	"	"	2'-0"	"	41	
4	"	10 1/2 x 5/16	1'-3 1/2"	11.16	58	
15	Ring filler	2 1/2 ϕ x 5/16		16.69	7	
400	Rivet Head	3/4 · ϕ		0.1242	50	Shop Rivets

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

No	Description	Dimension Size	Dimension Length	Weight (#) Unit	Weight (#) Total	Remarks
178	Rivet Head	3/4"ϕ		0.1242	22	Field Rivets
				Wt =	1764	
				8 × Wt =	14112	
		2 - Sway Bracings Bs				
6	Ls	4. 3. 5/16	19'	7.20	851	
10	"	3. 3. 5/16	5'-6 1/2"	6.10	338	
8	"	3 1/2. 3 1/2. 5/16	0'-11 1/4"	7.20	54	
2	pls	12. 5/16	2'-3 1/4"	12.75	58	
3	"	"	2'-8 1/2"	"	104	
4	"	15 1/2. 5/16	1'-7 1/2"	16.47	107	
2	"	15. 5/16	2'-2 1/2"	15.94	44	
2	"	11. 5/16	1'-3	11.69	29	
4	"	10 1/2. 5/16	1'-3 1/2"	11.16	58	
15	Ring fillers	2 1/2"ϕ. 5/16		16.69	7	
380	R.H	3/4"ϕ		0.1242	47	Shop Rivets
178	"	"		"	22	Field Rivets
				Wt =	1719	
				2. Wt =	3438	
		11 - Top Laterals				
4	Ls	3. 3. 5/16	23'-9"	6.10	580	
8	"	"	11'-5 1/2"	"	559	
18	pls	5 1/2. 5/16	0'-10	5.84	88	Tie pls.
1	"	"	1'-0 1/2"	"	6	" "
2	"	7 1/2. 1/2	2'-6"	12.75	64	Splice plates
340	Rivet Head	3/4"ϕ		0.1242	42	Shop Rivets
176	"	"		"	22	Field "
				Wt =	1361	
				11. wt =	14971	
		2 - Lower Laterals for End				
1	Ls	4. 3. 5/16	24'-0 1/2"	7.20	173	
1	"	"	23'-10"	"	172	
3	"	"	11'-7 1/4"	"	251	
1	"	"	11'-4 3/4"	"	82	
1	Pl	8 1/2. 1/2	2'-6"	14.45	36	Splice plates
4	Ls	3 1/2. 3 1/2. 3/8	1'-0 3/4"	8.50	36	
8	"	2 1/2. 2 1/2. 5/16	1'-1"	5.00	43	
4	pls	12 3/4. 3/8	1'-1"	16.26	71	
244	Rivet Head	3/4"ϕ		0.1242	30	Shop Rivets
88	"	"		"	11	Field "
				Wt =	904	
				2. wt =	1808	
		9 - Lower Laterals for Intermediate.				
2	Ls	4. 3. 5/16	24'-0 1/2"	7.20	346	
4	"	"	11'-7 1/4"	"	334	
1	Pl	8 1/2. 1/2	2'-6"	14.45	36	Splice plates
4	Ls	3 1/2. 3 1/2. 3/8	1'-0 3/4"	8.50	36	

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

No	Description	Dimension Size	Dimension Length	Weight (#) Unit	Weight (#) Total	Remarks
8	Ls	2½ x 2½ x 5/16	1'-1"	5.00	43	
4	pls	12 3/4 x 3/8	1'-1"	10.20	70	
244	R H	3/4" ϕ		0.1242	30	Shop Rivets
88	"	"		"	11	Field "
				Wt =	906	
				2. Wt =	1812	
		2 End Floor Beams				
4	Ls	5 x 3½ x 3/8	20'-3¾"	10.4	845	Flange Angle
1	pl	26 x 5/16	20'-3¾"	27.63	551	Web plate
4	Ls	3½ x 3½ x 3/8	2'-1¾"	8.50	73	End stiffener
8	"	4 x 3 x 5/16	2'-2⅛"	7.20	125	Interm. Stiff
10	"	3½ x 3½ x 5/16	0'-8½"	7.20	51	Supp. Angle
4	pls	3½ x 3/8	1'-7¼"	4.46	29	Fillers
10	"	7½ x 3/8	0'-8"	9.56	64	"
390	R H	3/4" ϕ		0.1242	48	Shop Rivets
100	"	"		"	12	Field "
				Wt =	1809	
				2. Wt =	3616	
		10 - Intermediate Floor Beams				
4	Ls	5 x 3½ x 3/8	20'-4½"	10.4	848	Flange Angle
1	pls	26 x 5/16	20'-4½"	27.63	563	Web plate
4	Ls	3½ x 3½ x 3/8	2'-1¾"	8.50	73	End stiffener
8	"	4 x 3 x 5/16	2'-2⅛"	7.2	125	Int. "
10	"	3½ x 3½ x 5/16	0'-8½"	7.2	51	Supp. Angle
4	pls	3½ x 3/8	1'-7¼"	4.46	29	Fillers
10	"	7½ x 3/8	0'-8"	9.56	64	"
390	R H	3/4" ϕ		0.1242	48	Shop Rivets
100	"	"		"	12	Field "
				Wt =	1813	
				10 x Wt =	18130	
		2 - Brackets				
2	Ls	15 @ 37.3 #	0'-10 15/32"	37.3	56	C_1
2	"	"	1'-4"	"	78	C_2
1	"	"	"	"	39	C_3
5	pls	6¾ x 3/8	1'-10"	8.61	79	Splice plates
2	"	6¾ x 5/8	0'-10"	14.34	24	Fillers
10	Ls	6 x 3½ x 3/8"	0'-8½"	11.70	83	Connection Ls
114	R H	3/4" ϕ		0.1242	14	Shop rivets
36	"	"		"	4	Field "
				Wt =	377	
				2. Wt =	754	
		5 Stringers				
4	Ls	15 @ 37.3 #	14'-10 9/16"	37.3	2173	S_1
4	"	"	"	"	2165	S_2
2	"	"	"	"	1081	S_3
18	"	"	14'-10 3/16"	"	9756	S_4

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

No	Description	Dimension Size	Dimension Length	Weight unit	Weight Total	Remarks
18	Is	15@37.3#	14'-10 3/16"	3.73	974	Ss
9	"	"	"	"	4857	Sc
220	Ls	6x3 1/2x 3/8	0'-8 1/2"	11.70	1823	Connection Ls
1100	R.H	3/4 ϕ"		0.1242	137	Shop Rivets
696	"	"		"	86	Field "
				Wt = 31802 lbs		
		Handrails				
22	pipes	Ex.dia 2 3/8"	14'-9	5.793	1880	gass pipe
5	"	"	0-9 1/2"	"	23	"
115	"	Ex dia 1.66"	3'-9"	2.272	980	"
176	bars	1/2 x 1	3'-2 1/4"	5.10	2861	
88	"	1 1/2 x 3/4	5'-0"	3.83	1685	
176	"	3/4 - 5/8	1'-8"	1.91	560	
176	"	"	1-6 1/2"	"	518	
176	"	"	1-2 3/4	"	413	
176	"	1 1/2 x 1/2	1'-8 1/2"	2.55	767	
35	Cast Iron post	6" ϕ	3'-3"	215.00	5375	
49	Coller	Int. 3" ϕ 1/4" thick	0'-2	2.00	98	
115	"	Int 1 11/16 ϕ 1/4 thick	0'-1 1/2	1.00	115	
264	Bands	1" x 1/4"	0'-4"	0.26	69	
88	"	"	0'-5"	0.33	29	
2	Coller	Int 3ϕ. 1/4 thick	0'-4"	2.80	6	Exp. joint
2592	R.H	3/8" ϕ		0.018	47	Top.
				Steel wt = 6851 lbs		
				Cast Iron wt = 8575 lbs		
		2 - Expansion Shoes				
1	Cast steel	Top shoe			346	
1	"	Bottom "			403	
2	"			84.00	168	
1		Bed			331	
4	Rollers	4" ϕ	2'-2"	1-Roller 87.54	350	
2	pls	3 1/2 x 7/16	1'-5 1/2"	5.21	15	Spacer
2	"	5 x 1/2	2'-2"	8.50	37	Side guard
8	Bolts	1" ϕ	0'-4 1/4"	1.86	15	With Nut
14	"	1/2" ϕ		0.20	3	Top
		Steel		Wt = 420		
		Cast steel		Wt = 1248		
		2. Steel		Wt = 840		
		2. Cast steel		Wt = 2496 lbs		
		2 - Fixed Shoes				
1	Cast steel	Top shoe			346	
1	"	Bottom "			996	
8	Bolts	1" ϕ	0'-3 1/4"	1.60	13	With Nut
				Wt = 1355		
		Cast steel 2. wt = 2710 lbs				

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

No	Description	Dimensin Size	Length	Weight unit	Total	Remarks
		4 Pins				
1	pin	$4\frac{1}{2}$" ϕ	1'-9 $\frac{3}{4}$"	83.00	91	
2	Nuts	$5\frac{3}{4}$, 1 $\frac{3}{4}$	0'-6 $\frac{5}{8}$"	7.00	14	
				Wt =	105	
				4. Wt =	420 lbs	
		4 - Anchor grillage				
4	Ls	$3\frac{1}{2}$, $3\frac{1}{2}$, $\frac{3}{8}$	1'-10"	8.50	62	
2	pls	12, $\frac{3}{8}$	"	15.30	56	
4	Ls	$3\frac{1}{2}$, $3\frac{1}{2}$, $\frac{5}{16}$	0'-10 $\frac{1}{2}$"	7.20	25	
4	"	$2\frac{1}{2}$, $2\frac{1}{2}$, $\frac{5}{16}$	2'-1 $\frac{3}{4}$"	5.00	43	
80	R.H	$\frac{3}{4}$" ϕ		0.1242	10	Shop Rivets
				Wt =	196	
				4. Wt =	784 lbs	
	Total Weight of one Span					
	for steel			= 2741.92 lbs		
	for Cast steel			= 5.206		
	for Cast iron			= 8575		
	Total Weight of 4 Spans					
	for Steel			= 10957.68 lbs	= 4.89 tons	
	for Cast steel			= 20.824	= 9.296	
	for Cast iron			= 34.300	= 15.313	

増田淳氏関係資料
（独立行政法人 土木研究所蔵）

Copyright © (2004) by P.W.R.I.

All rights reserved. No part of this book may be reproduced by any means, nor transmitted, nor translated into a machine language without the written permission of the Chief Executive of P.W.R.I.

この資料は、独立行政法人土木研究所理事長の承認を得て刊行したものである。したがって、本資料の全部又は一部の転載、複製は、独立行政法人土木研究所理事長の文書による承認を得ずしてこれを行ってはならない。