T. M. Keene
1891

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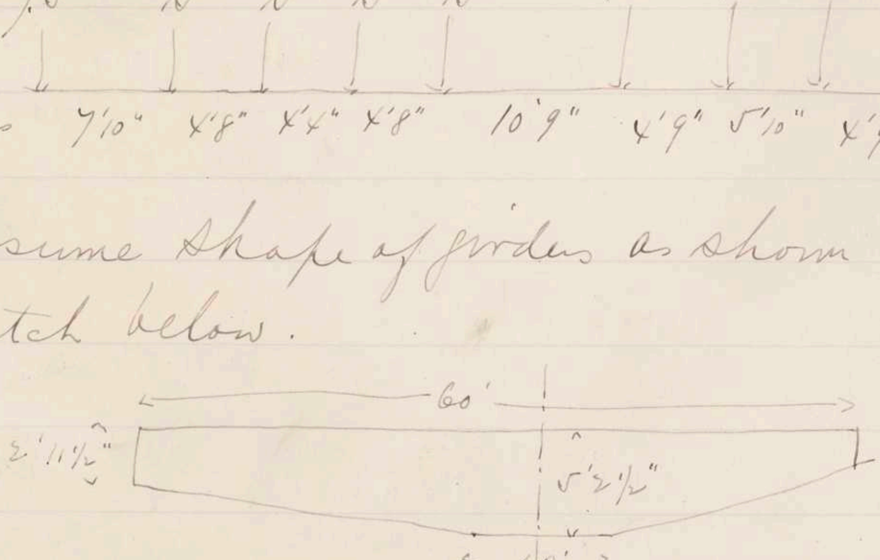
Design for a Turntable.

Specifications.
Length 60' feet.
Depth of girder at center 5 ft 2½ in.
" " " " ends 2 ft 11½ in.
Foundation. Piles.
Bearings. D. H. Andrews' Patent.

Live load. Locomotive and tender shown below. —

Loads (tons)	7.5	15	15	15	15	10	10	10	10
Distances	7'10"	4'8"	4'4"	4'8"	10'9"	4'9"	5'10"	4'9"	

Assume shape of girders as shown in sketch below.



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Dead Load.

Assume the weight of the girder, bearings, bracing, &c. at 100 lbs. per linear foot per girder, and the weight of the floor, consisting of ties, rails, spikes, bolts, &c. as 150 lbs. per linear foot per girder.

The total dead load then, is 250 lbs per linear foot per girder.

Having found the live and dead loads on the turntable, we will next see to what conditions of stress the table is subjected when the live load is placed in different positions on it.

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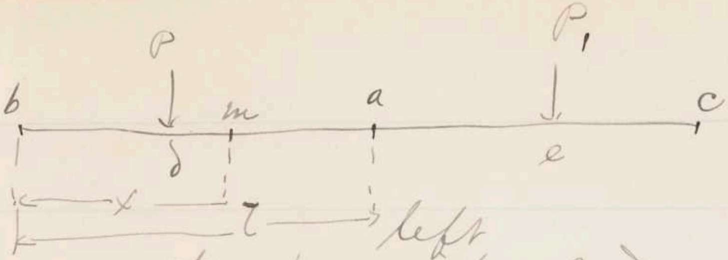


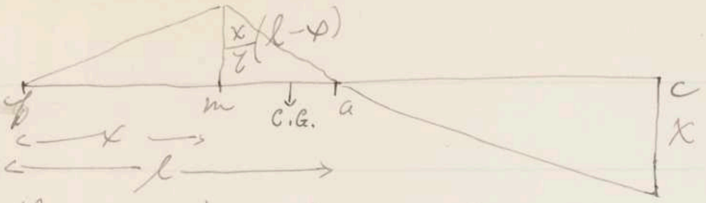
a = center b = ~~right~~ left end abut.

c = right end abut.

A turntable is a double cantilever being free to move up and down at b and c. When the center of gravity of the loads lies in ac the 2 supports are at a and c, and when it lies in ab the 2 supports are a and b

The turntable being symmetrical about a, we will consider the moments and shears on ab only.

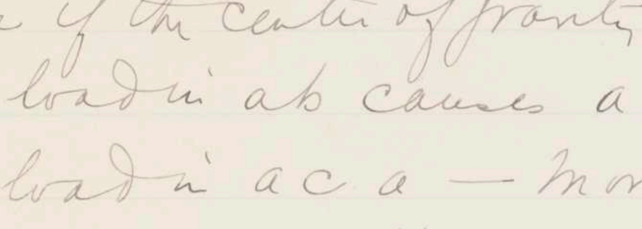
In the first place, assume that ~~that~~ the center of gravity of the loads ~~is~~ lies in ab. Then the influence line for the moment at any point in ab such as m is as shown below, ~~m~~ moments represented above the line being positive, and those below it negative



Hence if the center of gravity lies in ab a load in ab causes a + moment and a load in ac a — moment at m

Next assume the center of gravity of the loads lying in ac.

Then the influence line for moments at m is as follows.—



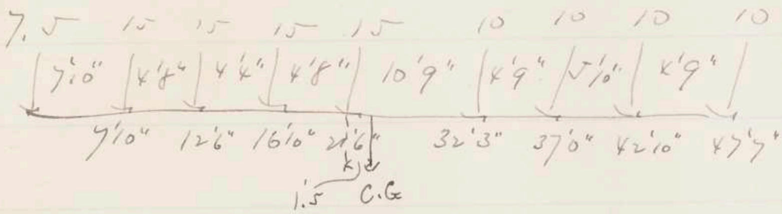
That is, a load to the left of m causes a — moment at m and a load to the right of m has no effect.

The influence line will evidently be the same as the above if the center of gravity of the loads is just over the center support.

We may now proceed to calculate the max. moments & shears at different points on the girder.

First of all we must find the center of gravity of the given loco. and tender.

We find this by taking moments about one of the end loads, say that on the loco. truck wheels and divide the sum of these moments by the sum of the loads.

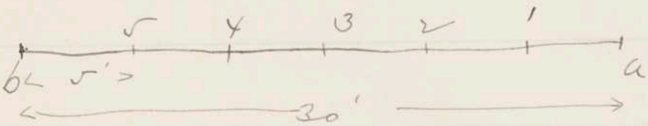


7.5	×	0	=	0
15	×	$7\frac{5}{6}$	=	117.5
15	×	$12\frac{1}{2}$	=	187.5
15	×	$16\frac{5}{6}$	=	252.5
15	×	$21\frac{1}{2}$	=	322.5
10	×	$32\frac{1}{4}$	=	322.5
10	×	37	=	370
10	×	$42\frac{5}{6}$	=	428.33
10	×	$47\frac{7}{12}$	=	475.83
107.5				2476.63

107.5) 2476.63

23.

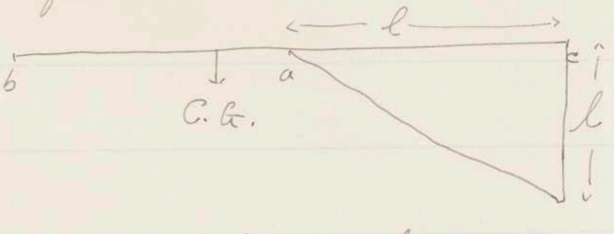
Next assume some points on the girder at which to find the max. moments and shears. For convenience, let us take for these points the center a the end b and 5 points situated between a and b and 5 feet apart.



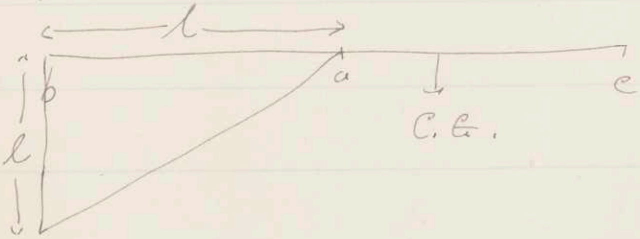
Calculation of max. moments.

(a) Center.

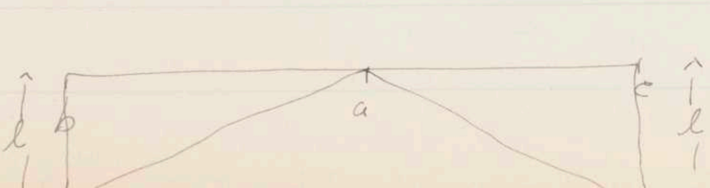
Influence line when C.G. of loads is in ab



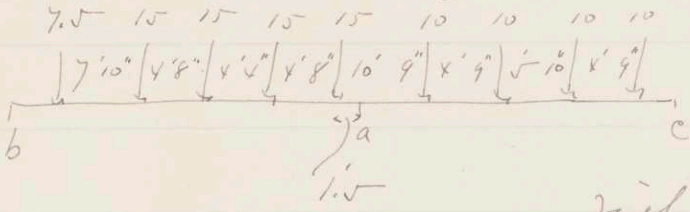
Influence line when C.G. is in ac.



Influence line when C.G. is just at a)



The max. live moment will occur when the center of gravity of the loads is at a. Its value is found as follows



Consider the loads to the ~~left~~ right of a

$$
\begin{aligned}
-10 \times 9.25 &= -90.25 \\
-10 \times 14 &= -140 \\
-10 \times 19.833 &= -198.33 \\
-10 \times 24.583 &= \underline{-245.83} \\
&\quad -674.41 \text{ ft. lbs.}
\end{aligned}
$$

Max. live M at a in inch lbs =
-674.41×24000 for 2 girders
divide by 2 to get moment on one girder.

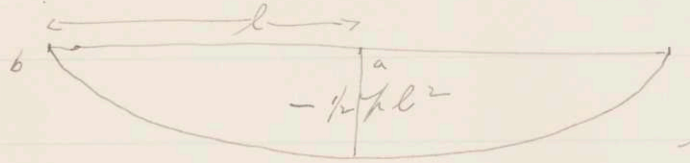
$$-\frac{674.41 \times 24 \text{ in}}{2} = -8{,}08\cancel{4}^{0}{,}\cancel{4}^{0}00 \text{ in. lbs.} =$$

max. live moment at a for 1 girder.

Dead Moment at a

The center of gravity of the dead load will be at a, the table being balanced

The curve of moments for the dead load is as shown below. —



p = dead load per linear foot.

All the dead moments are negative

The dead moment at a will be, then, $-\frac{1}{2}pl^2 = -\frac{250 \cdot 30 \cdot 30 \cdot 12}{2} =$

$-$ 1,350,000 ~~112500~~ in. lbs. per girder -

Total Max. moment at a =

$-$ 8.080.000 $-$ 1.350.000 ~~112500~~ =

$-$ 9.430000 ~~8.192.500~~ in. lbs. for one girder

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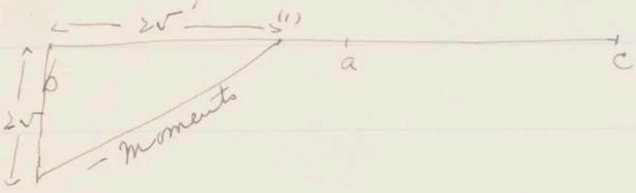
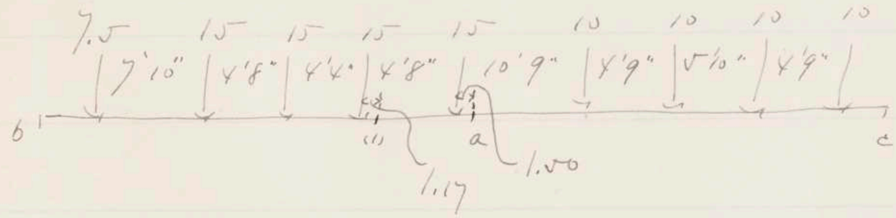
(1). The max. live moment at (1) will occur when the center of gravity of the loads is just at the center of the table. This moment will be negative

The influence line for moments at (1) when center of gravity of loads is just at center is shown below. —





1.50
4.67
6.17
5.
1.17
4.33
5.50
4.67
10.17
7.83
18.00

$-15 \times 1.17 = -17.55$

$-15 \times 5.50 = -82.50$

$-15 \times 10.17 \quad -152.50$

$-7.5 \times 18.00 = -135.00$

-387.55

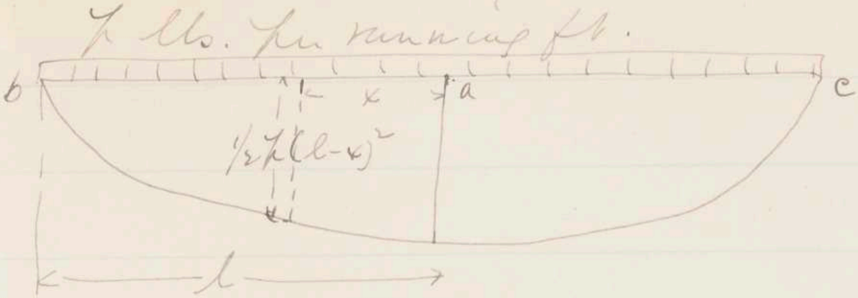
24000

$2)\overline{-9290000}$

$-4,645,000$ in lbs. = Max. live moment for one girder.

Dead Moment at (1)

The formula for dead moment at any point on girder at a distance x from the center is $M_x = \frac{1}{2}p(l-x)^2$



Substituting in the formula, we get $M_{(1)}$ (dead) $= -\frac{250 \cdot 25 \cdot 25 \cdot 12}{2}$
$-$ 937.200 ~~781,100~~ in. lbs. for one girder

Total max. M at (1) for one girder
$=$ $-$ 4.645 000 $-$ 937.200 ~~781,100~~ $=$
$-$ 5.582.200 ~~4.723.100~~ in. lbs.

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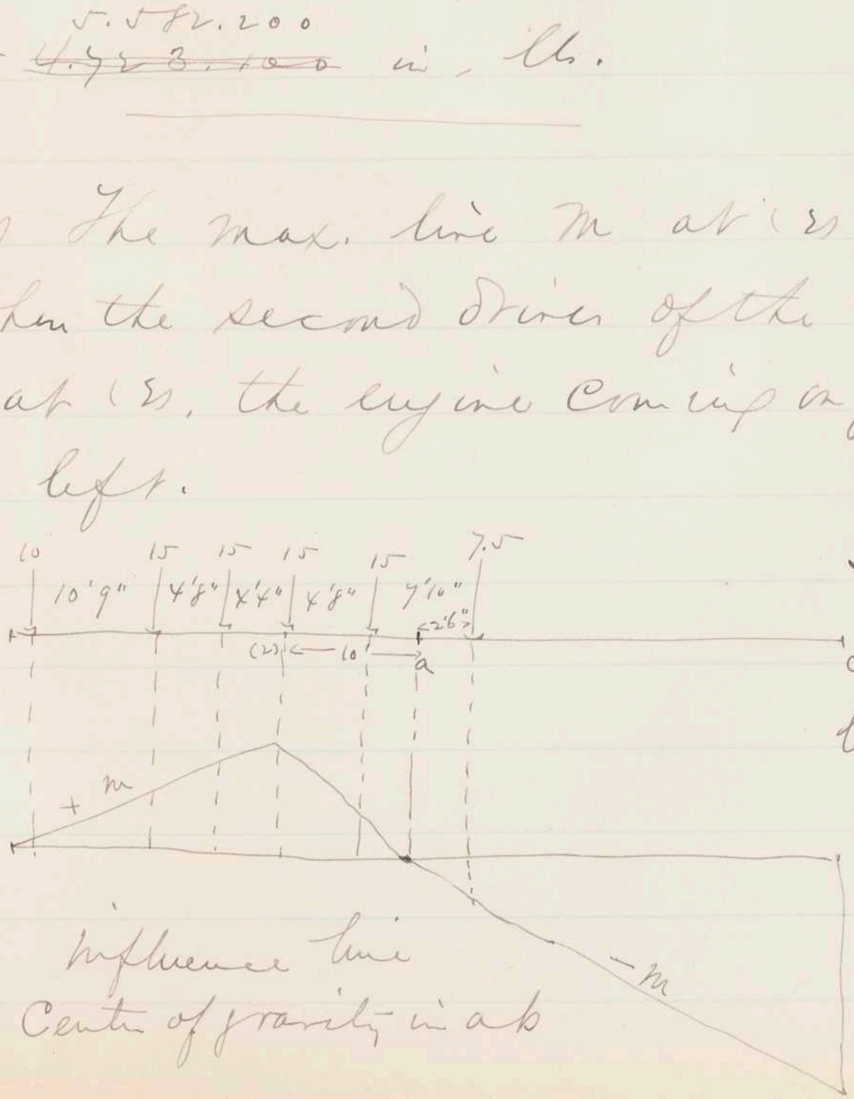
(2) The max. live M at (2) occurs when the second driver of the loco. is at (2), the engine coming on from the left.

Note.—
Same M occurs if C. G. of loads is over Center.



Its value is as follows. —

$$M = \frac{(-7.5 \times 2.5 + 15 \times 5.33 + 15 \times 10 + 15 \times 14.33 + 15 \times 19 + 10 \times 29.75)\,20}{30}$$

$$- 10 \times 19.75 - 15 \times 9 - 15 \times 4.33$$

$= 275$ ft. lbs for 2 girders

$M = \frac{275 \times 24000}{2} = +3,300,000$ in. lbs. = Max. live M at (2) for one girder

Dead M.

Substitute in formula $M = -\frac{1}{2} p (l-x)^2$

x being 10

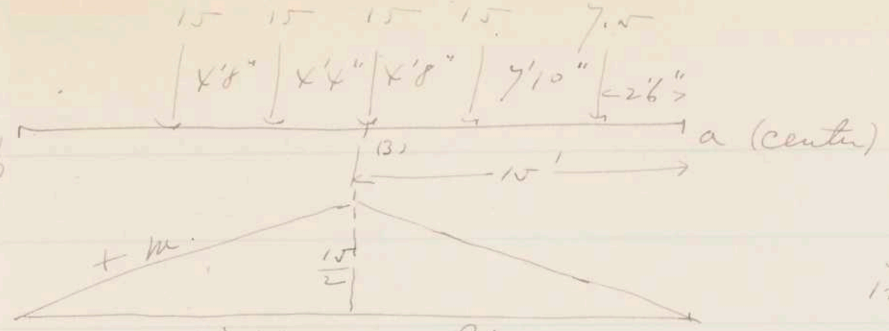
$M = -\frac{200 \times 20 \cdot 20 \cdot \cancel{12}^{6}}{\cancel{8}} = -600.000$ in. lbs. for one girder

Total Max. M at (2) =

$+3.3\$00.000 - 600.000 =$

$\underline{+2,700,000}$ in lbs for one girder

(3) Max. live M occurs at (3) when the second driver is at (3) the engine coming on from the left.



influence line.

7'10"
4'8"
12'6"
15'
12'6"
2'6"
7 10
10 4
4 8
15
4 4
19 4
4 8
24

$$M = \frac{(7.5 \times 2.5 + 15 \times 10.33 + 15 \times 15 + 15 \times 19.33 + 15 \times 24) \cdot 15}{\frac{30}{2}}$$

$$- 15 \times 9 - 15 \times 4.33 = +324.5 \text{ ft. lb.}$$

for 2 girders

Max. live moment at (3) for one girder

$$= + \frac{324.5 \times 24000}{2} = +3{,}894{,}000 \text{ in. lbs.}$$

Dead moment at (3)

Apply formula $M_x = -\frac{1}{2} p (l-x)^2$

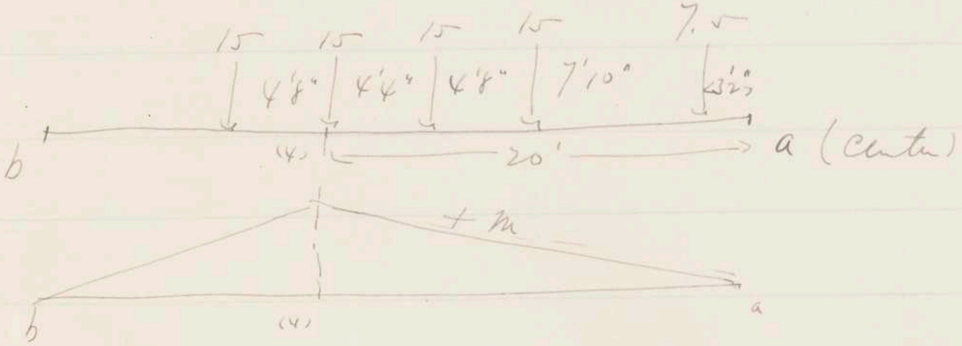
$x = 15$

$$M_{(3)} = -\frac{250 \cdot 15 \cdot 15 \cdot 12}{2} = -337.500 \text{ in lbs.}$$

for one girder

Total max. M at (3) = + 3.894.000 − 337.500 = +3.556.500 in. lbs. for one girder

(4) Max. live M. at (4) occurs when the 3rd driver is at (4) the loco. coming on from the left. This moment is positive:



3 2
7 10
11
4 8
15 8
4 4
20
4 8
24 8

$$M = \frac{\left(+7.5 \times 3.167 + 15 \times 11 + 15 \times 15.67 + 15 \times 20 + 15 \times 24.67\right) \cdot 10}{30}$$

$$- 15 \times 4.67$$

$= +294.88$ ft. lbs. for 2 girders

$M = \dfrac{294.88 \times 24\,000}{2} = +3{,}940,000$ in. lbs = max. live M. at (4) for one girder.

Dead Moment.

$M_x = -\frac{1}{2} p (l-x)^2 \quad x = \cancel{\ } 20$

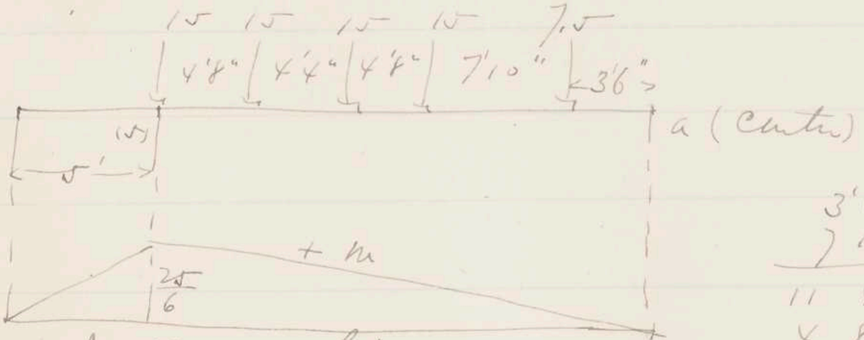
$M_{(4)} = -\dfrac{250 \cdot 10 \cdot 10 \cdot \overset{6}{\cancel{12}}}{\cancel{2}} = -150{,}000$ in. lb. for one girder

Total max. M. at (4) =

+ 3,940,000 − 150000 = + 3,790,000 in. lbs

for one girder

(5) Max. live M at (5) occurs when the last driver is at (5) the loco. coming on the table from the left. This moment is positive.



Influence line.

$M_{(5)} = \frac{(7.5 \times 3.5 + 15 \times 11.33 + 15 \times 16 + 15 \times 20.33 + 15 \times 25) \cdot 5}{30}$

3'6
7 10
11 4
4 8
15
4 4
20 4
4 8
25

= + 186 ft. lbs for 2 girders.

$M_{(5)}$ for one girder =

$+ \frac{186 \times 24000}{2} = + 2,232,000$ in. lbs. =

Max. live moment at (5) for one girder

Dead moment

Apply formula $M_x = -\frac{1}{2} p (l-x)^2$

$x = 25$

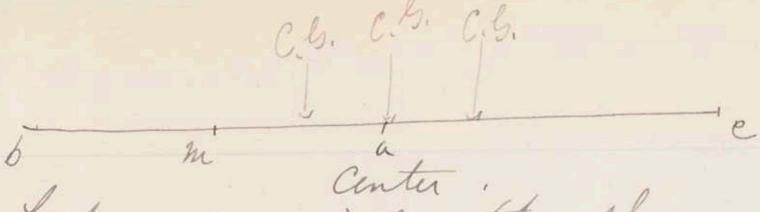
$$M_{(5)} = -\frac{200 \cdot 5 \cdot 5 \cdot \cancel{12}^{6}}{\cancel{4}} = -37500 \text{ in. lbs}$$

for one girder

Total max. M at (5) for one girder =
$+ 2,232000 - 37500 = +2,194,500$ in. lbs.

(b) Left hand end abutment.
The moment at b is always 0.
as the table merely rests on the abutment.

We will next consider the Maximum Shears at the same points at which we found the Max. moments. Before doing so, however, it may be well to study the effect of different loadings and to draw influence lines for a few cases.



Let us consider the shear at any point m in the span ab for loads at different parts of the turntable.

Suppose first that the center of gravity of the loads on the table lies in ab; that is, the table is supported at a and b.

Then a load to the left of m will cause a negative shear, and one to the right of m, between m and a will cause positive shear.

A load in ac, though it cannot cause a downward reaction at b, since the table merely rests there, ~~causes~~ diminishes the upward reaction, ~~and hen~~ at b, and hence decreases the positive shear at m. If there is negative shear in m, of course a load in ac will increase the shear.

Next suppose the center of gravity of the loads in ac.

Then ~~a load~~ the table is supported at a and c and the table ~~a~~ is raised ~~above~~ off of the abutment at b.

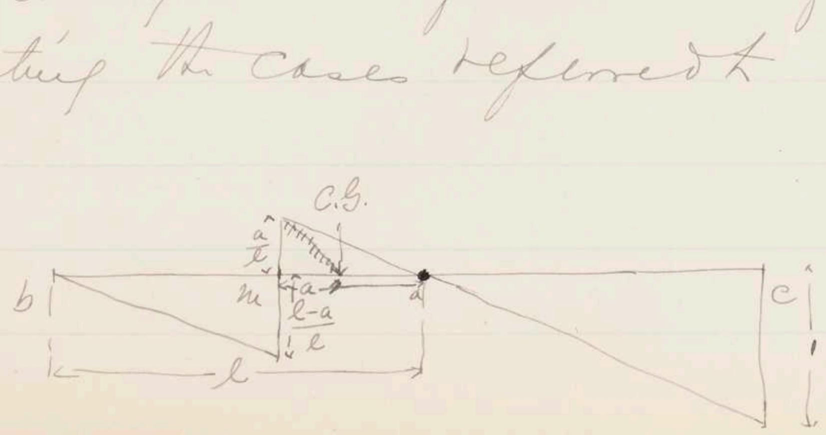
Then clearly a load on ~~at~~ the right of m will have no effect, while a load on ~~at~~ the left of m will cause a negative shear at m

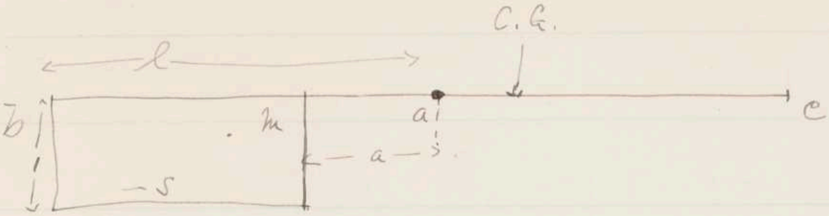
Lastly, suppose the center of gravity just over the center.

This case is similar to the ~~to~~ preceding: the only loads causing any effect are those between m and b, which cause negative shear at 'm'.

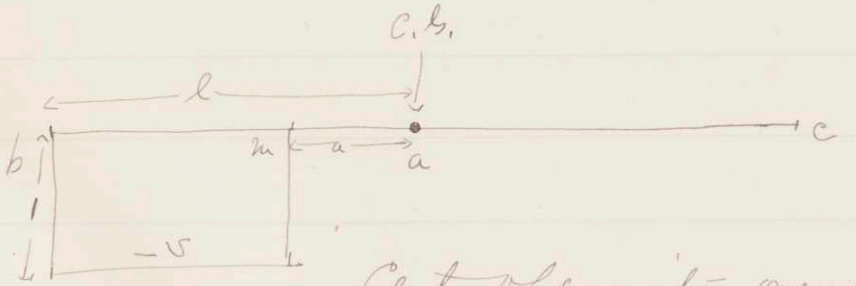
The following are influence lines for the pt. m illustrating the cases referred to above.

Center of gravity in ab





Center of gravity of loads on table in ac

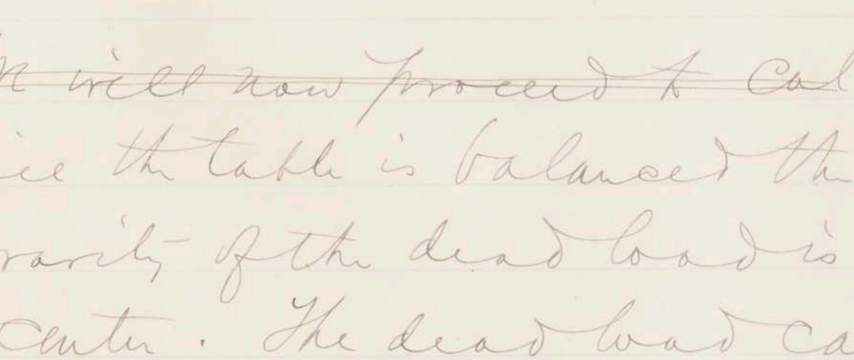


Center of gravity over center.

~~We will now proceed to Cal~~

Since the table is balanced the Center of gravity of the dead load is over the center. The dead load causes a negative shear at points in ab and positive shear in ac

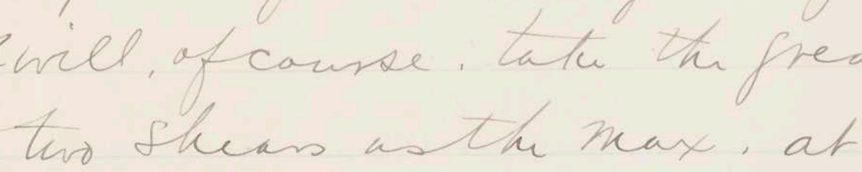
The curve of shears for the dead load is as follows.—



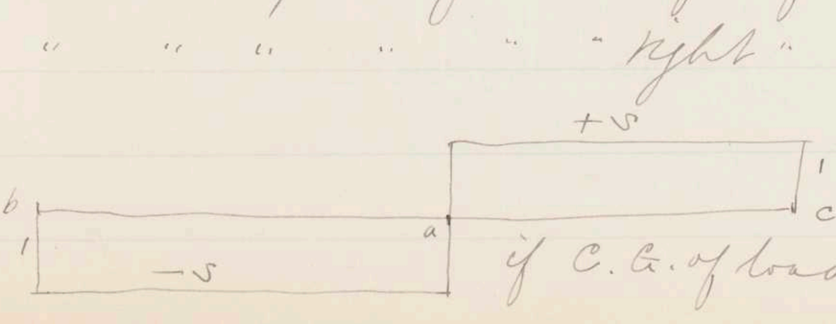
We will now proceed to calculate the max. shears at the center of the turntable (a), the left end abutment (b), and the intermediate five points (1), (2), (3), (4), and (5)

(a) Center.

The max. shear at (a) will occur when the center of gravity of the loads is just at (a). It will be seen, however, that the shear at a point just to the left of (a) will be greater than that at a point just to the right of a. We will, of course, take the greater of the two shears as the max. at a.



Shear at a point just to left of a = -67.5 tons
" " " " " " right " " = +40 "



Influence line for shear at a if C.G. of load is at a

Hence the max. live shear at a is 67.5 tons for 2 girders. and $-\frac{67.5 \times \cancel{}\,2000}{2} =$

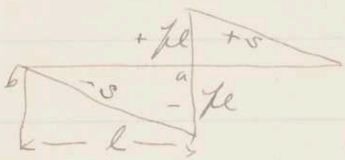
-67.500 lbs per girder

<u>Dead Shear at (a)</u>

For a point just to the left of a, the dead shear $= -pl$

For pt. just to right

$S = +pl$.



curve of dead shears

M consider the pt. just to the left.

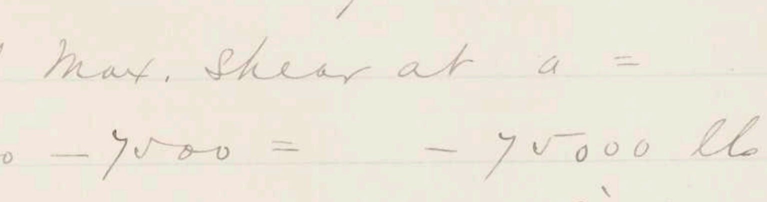
So dead S at (a) $= -pl =$

$-250 \times 30 = -7500$

Total Max. shear at a =

$-67500 - 7500 = -75000$ lbs for one girder.

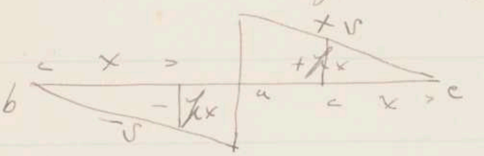
(1) The max. S occurs at (1) when ~~the center of gravity of the loads is over the center of the turntable~~.



Influence line for shear at (1) C.G. of loads at a

Hence the Max. live S at (1) = -52.5 tons for ~~one~~ 2 girders = -52500 lbs for 1 girder.

<u>Dead Shear.</u>



Curve of dead Shears.

Dead Shear at a distance x from left end abutment = $-px$

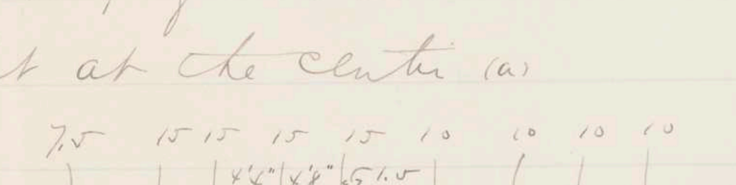
Then dead S at (1) = -250×25

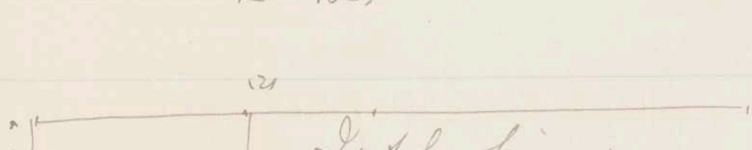
= -6250 lbs for 1 girder.

<u>Total max. S at (1)</u> = $-52500 - 6250 =$

-58750 lbs for 1 girder.

(2) Max. S at (2) occurs when center of gravity of loads on the table lies just at the center (a)





Infl. line.

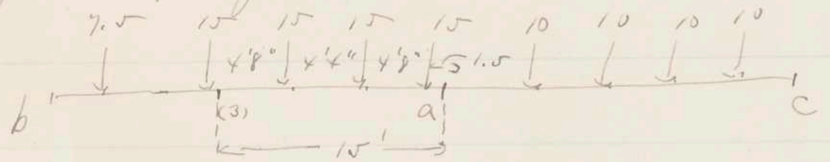
Max. live S = -37.5 tons for 2 girders =

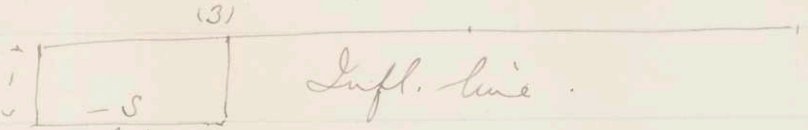
-37500 lbs for 1 girder.

Dead S. $= -px = -250 \times 20 = -5000$

Total max. S at (2) $= -37500 - 5000 =$
-42500 lbs for 1 girder.

(3) Max. S at (3) occurs when center of gravity of loads is at center (a)



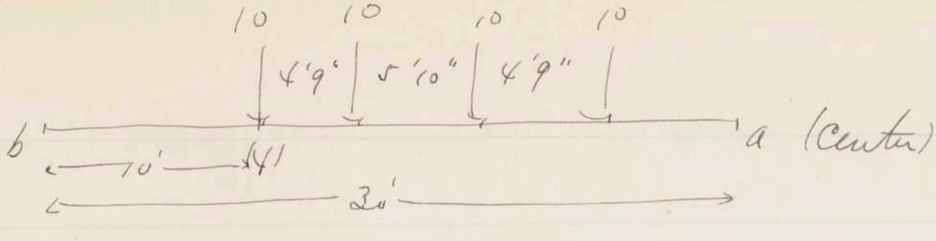


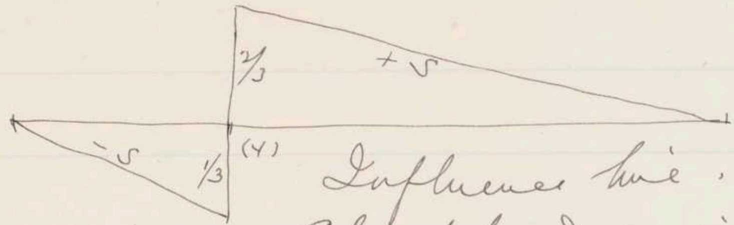
Max. line S. at (3) $= -22.5$ tons for 2 girders
$= -22500$ lbs for 1 girder.

Dead S at (3) $= -px = -250 \times 15$
$= -3750$ lbs for 1 girder.

Total max. S at (3) $= -22500 - 3750 =$
-26250 lbs for 1 girder.

(4) Max. S at (4) occurs when the first tender wheel is at (4) the loco. going off the table to the left.
This shear is positive





Influence line.
C.G. of loads in ab

$$\text{Max. live } S = +\frac{10\,(20' + 15'3" + 9'5" + 4'8")}{30'}$$

$$= +\frac{\cancel{10} \times 49.33}{\cancel{30}\;3} = +16.444 \text{ tons for 2 girders}$$

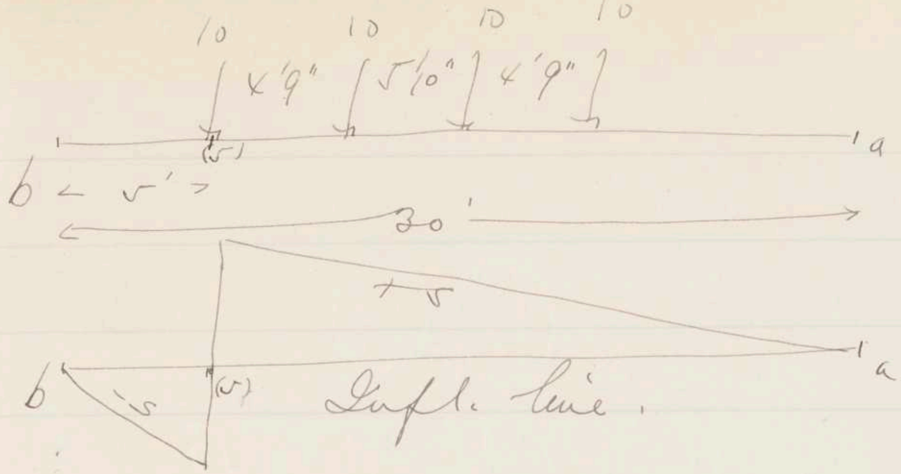
Max. live S = +16440 lbs for 1 girder.

Dead S = $-px$ = $-250 \times 10 = -2500$ lbs

Total max. S at (4) = 16440 − 2500

= +13940 lbs for one girder.

(5) Max. S at (5) occurs when the 1st wheel of the tender is at (5) the engine going off to the left.
This Shear is positive.



$$\text{Max. live } S = +10\,\frac{(25' + 20'3" + 14'5" + 9'8")}{30'}$$

$$= +\frac{69.333}{3} = +23.11 \text{ tons for 2 girders}$$

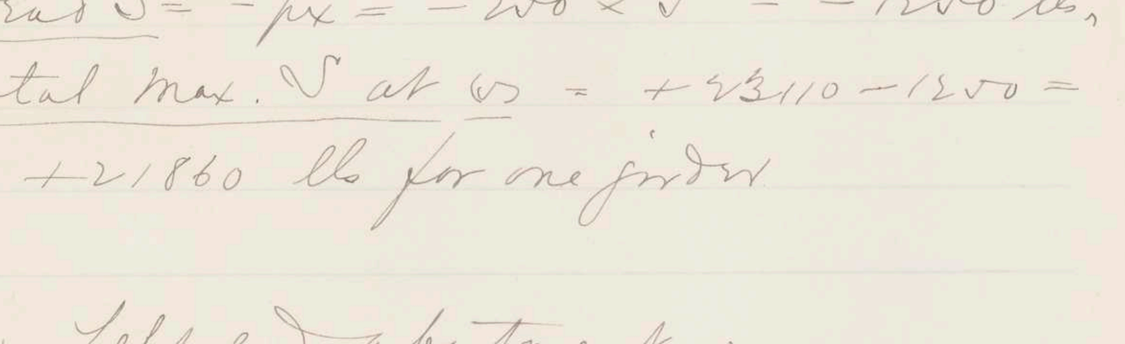
$S = +23110$ lbs for 1 girder.

Dead $S = -px = -250 \times 5 = -1250$ lbs, for 1 girder

Total max. S at (5) $= +23110 - 1250 =$
$+21860$ lbs for one girder

(b) Left end abutment.

Max. S occurs at b when the 1st driver is at (b) the loco. going off to the left. This shear is of course positive



Infl. line. C.G. of loads lying in ab

All the loads cause + S except the loads on the last 2 axles of the tender, which cause − S. Since they lie in the other half of the turntable, and therefore decrease the downward reaction at b, It can scarcely be said, though, that they cause negative shear. Since if the other loads were taken off, they would cause no shear whatever at b. It is more correct then, to say that they diminish the + S at b.

$$\text{max. live } S = 15 + \frac{15\left(\begin{matrix}25'4" + 21' + 16'4" \; \cancel{15'7"} \\ \cancel{4'8" + 9' + 13'8"}\end{matrix}\right)}{30'} +$$

$$\frac{10\,(5'7" + 0'10")}{30} - \frac{10\,(5' + 9'9")}{30}$$

$$= 15 + \frac{\cancel{15}}{\cancel{30}_2}(62.67) + \frac{\cancel{10}}{\cancel{30}_3}(6.4167) - \frac{\cancel{10}}{\cancel{30}_3}(14.75)$$

$$= 15 + 31.33 + 2.1\cancel{389}^{4} - 4.92$$

$$= +\ 43.55 \text{ tons for 2 girders}$$

$$= +\ 43550 \text{ lbs for 1 girder.}$$

Dead S = $-px$ but $x = 0$ ∴ S = 0

Total max. S at b (left end abutment)

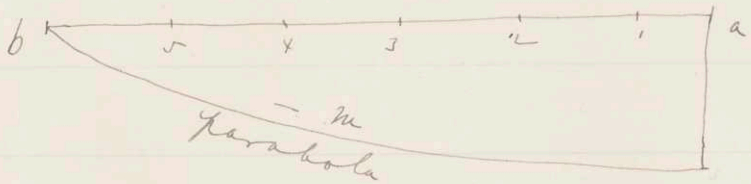
= +43550 lbs for 1 girder.

Table of Max. Moments & Shears.

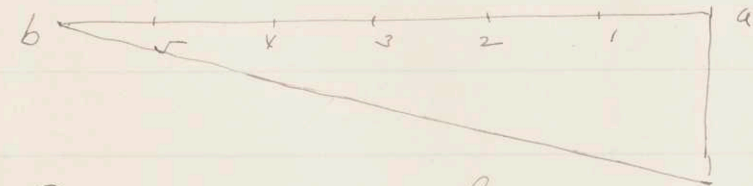
Location of points	Max. Moments (in. lbs.)	Max. Shears (lbs.)
Center a	− 9.430,000	−75000
5' to left of a (1)	− 5.582.200	−58750
10' to left of a (2)	+ 2.700,000	−42500
15' to left of a (3)	+ 3.556.500	−26250
20' to left of a (4)	+ 3.790.000	+ 13940
25' to left of a (5)	+ 2.194.500	+ 21860
Left end abut. b	0	+ 43550

The variation in Moments & Shears at the different points may be shown graphically.

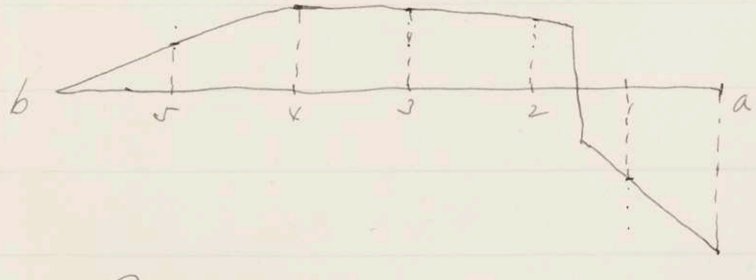
Curve of Dead moments.



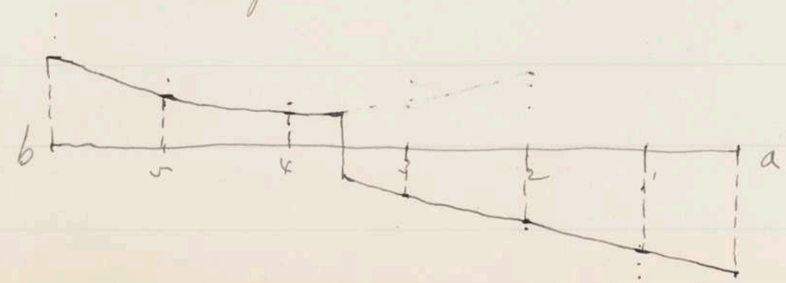
Curve of dead Shear.



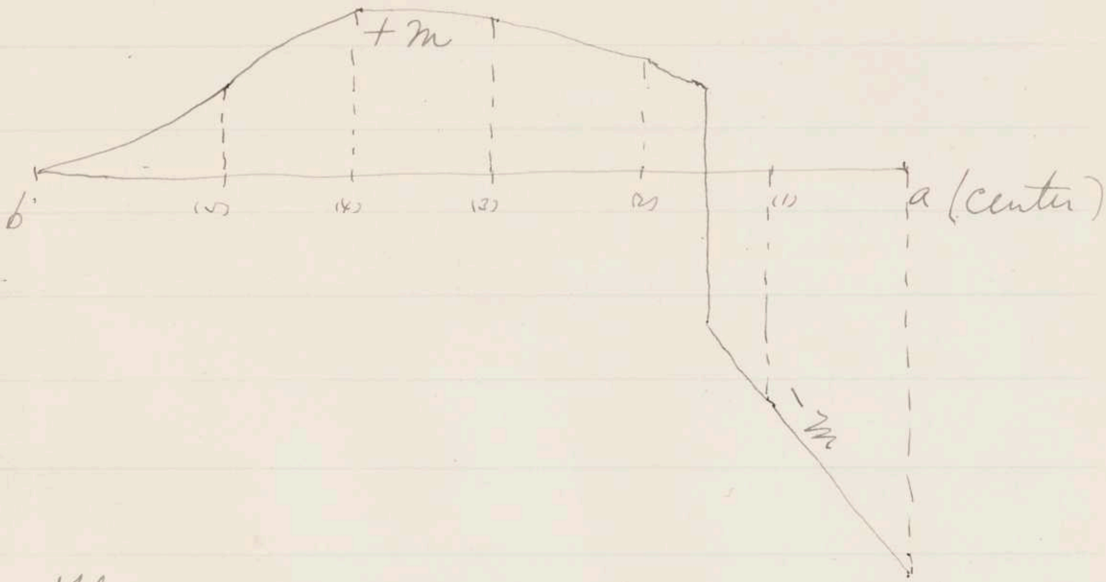
Curve of max. live Moments.



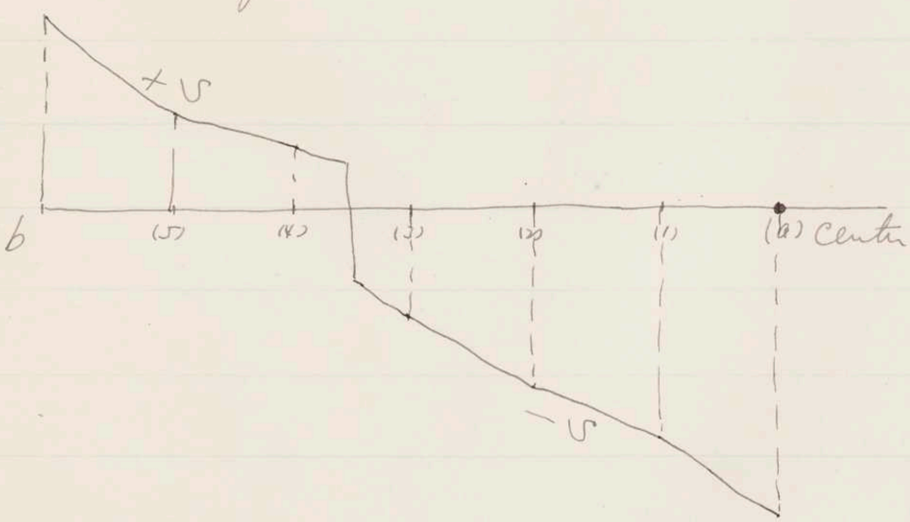
Curve of live shears.



The curve of Max. Moments would be as shown below. —

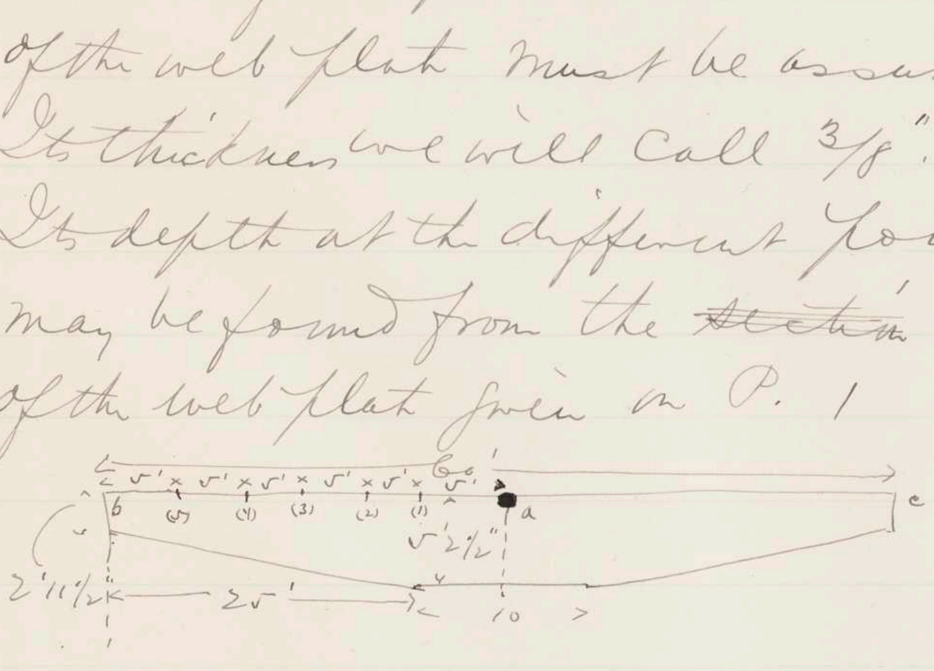


The curve of Max. Shears is as follows. —



Having found the max. moments at the different points, we may now proceed to find the flange stresses in the girder at these points, from which we may find the required flange area.

In the first place the dimensions of the web plate must be assumed. Its thickness we will call 3/8". Its depth at the different points may be found from the ~~sketch~~ shape of the web plate given on P. 1



Depth at a = 5'2½" = 62.5"

" " b = 2'11½" = 35.5"

" " (1) = 5'2½" = 62.5"

" " (2) = $62.5 - \frac{27}{5} = 56.1$

" " (3) = $62.5 - \frac{27 \cdot 2}{5} = 50.7''$

" " (4) = $62.5 - 27 \cdot \frac{3}{5} = 44.3''$

" " (5) = $62.5 - 27 \cdot \frac{4}{5} = 38.9''$

$$\begin{array}{r} 62.5'' \\ 35.5'' \\ \hline 27'' \end{array}$$

The flange stresses may now be computed by the formula $f = \frac{M}{h}$ or better, the required flange area may be found by the formula

$A = \frac{M}{fh} - 1/6 A h$ $f = 7000$ for compression and 8000 for tension

(a) Center. ($-M$ here causes comp. in bottom flange)

$A = \frac{9.430\cancel{000}}{7\cancel{000} \times 62.5} - \frac{1}{\cancel{6}_2} \times \frac{3}{8} \times \overset{3}{\cancel{48}}$* for bottom flange

* to allow for weakening by rivet holes

$A = 21.6 - 3 = 18.6$ □" = required flange area at center. (for bottom flange)

(1) ~~At~~ Bottom flange.

$A = \frac{5582200}{7000 \times 62.5} - 3$

$= \overset{12.76\ -\ 3}{\cancel{13}} \cancel{sq. in} = \overset{9.76}{\cancel{10}}$ sq. in.

(2) Top flange

$A = \frac{2700000}{7000 \times 56.1} - 1/6 \times 3/8 \times 42$

$= 6.9 - 2.6 = 4.3$ sq. in.

(3) Top flange.

$$A = \frac{3556000}{7000 \times 50.7} - 1/6 \times 3/8 \times 36$$

$$= 11 - 2.25 = 8.75 \text{ sq. in.}$$

(4) Top flange

$$A = \frac{3990000}{7000 \times 44.3} - 1/6 \times 3/8 \times 32$$

$$= 13.5 - 2 = 11.5 \text{ sq. in.}$$

(5) Top flange

$$A = \frac{2,194,500}{7000 \times 38.9} - 1/6 \times 3/8 \times 27$$

$$= 10.9 - 1.7 = 9.2 \text{ sq. in.}$$

Table of Required Flange areas.

Flanges in compression.

Center (a)	18.6	sq. in	bottom flange
(1)	~~[illegible]~~ 9.76	"	" "
(2)	4.3	" "	top "
(3)	8.75	" "	" "
(4)	11.5	" "	" "
(5)	9.2	" "	" "
b	0	or theoretically - 1/6 th	

By the preceding table we see that the values for required flange areas vary so much, and with so little regularity, that to use several horizontal plates economically, we should have to cut some if not all of them off at some point such as (2) and put them on again at some other point such as (4).
To have as little waste material as possible, then, since several long horizontal plates can not be used to advantage, we may put one thick horizontal plate at the center of the girder extending far enough to cover point (1) and cut it off there, using angles sufficiently heavy to provide area enough ~~for~~ at all points between point (1) and the end of the girder.

Having decided on this method we may now study the flange which are in tension under the maximum stress.

Center (a) $f = 8000$ for tension (top flange)

$$\text{Then } A = \frac{9430000}{8000 \times 62.5} - 3 = 18.86 - 3$$
$$= 15.86$$

Now at (a) there will be a horizontal plate with 2 rivets in a section fastening it to the angles. ~~Therefore~~ These rivet holes take about a sq. inch apiece out of the gross area of the flange. ~~The net area will be the~~ But the net area should be 15.86 sq. in. and therefore the gross area of the flange at (a) should be 15.86 + 2 = 17.86 sq. in.

(1) Top flange. $A = \dfrac{5582000}{8000 \times 62.5} - 3$

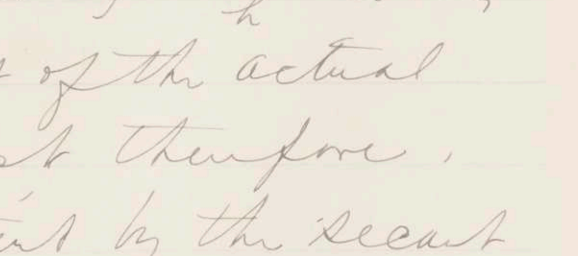
$$= 11.2 - 3 = 8.2 \text{ sq. in.}$$

at (1) there is also a horiz. plate. and we must add 2 sq. in in to get the gross area required.

A, then = 8.2 + 2 = 10.2 sq. in.

At the point (1), another element enters into our consideration of flange stress and area. Namely, the inclination of the bottom flange, which we neglected ~~to~~ before in calculating the bottom flange area at (1).

The flange being inclined, the stress found by the formula $f = \frac{M}{h}$ is only the horiz. component of the actual flange stress. We must therefore, multiply the quotient by the secant of the angle which the flange makes with the horizontal. This secant is equal to $\frac{\sqrt{25^2 + 2.25^2}}{25}$



Hence in getting the stress in the bottom flange at (1) and

$$\begin{array}{r} 62.5 \\ 35.5 \\ \hline 12 \overline{)27} \\ 2.25 \end{array}$$

all subsequent points, we must multiply the stress obtained by the formula by $\frac{\sqrt{2.25^2+25^2}}{25} = \frac{25.101}{25} = 1.004$

Going back to the calculation of fl. area at (1) on P. 30. we multiply the fraction $\frac{558200}{7000 \times 62.5}$ by 1.004 getting as result

$12.81 - 3 = 9.81$ sq. in

which is the correct fl. area necessary

(2) Bottom flange.

$$A = \frac{2700000}{8000 \times 56.1} \times 1.004 - 2.6$$

$$= 6.\cancel{97}^{05} - 2.6 = \cancel{4.35}^{3.45} \text{ sq. in}$$

At (2) there is no hor. plate and the only rivet in a section is that fastening the Ls to the web plate. This rivet hole takes a sq. in. out of the gross area which should be therefore $3.45 + 1 =$ 4.45 sq. in. = gross area at (2)

(3) Bottom flange

$$A = \frac{3556.500}{8000 \times 50.7} \times 1.004 - 2.25$$

$$= 8.84 - 2.25 = 5.59 \text{ sq. in.}$$

No hor. plate at B, so ~~subtract~~ add 1 sq. in only for gross area = 6.59 sq. in.

(4) Bottom flange

$$A = \frac{3.790.000}{8000 \times 44.3} \times 1.004 - 2.$$

$$= 10.75 - 2 = 8.75 \text{ sq. in.}$$

No hor. plate. So add 1 sq. in Gross area = 9.75 sq. in

(5) Bottom flange.

$$A = \frac{2,194.500}{38.9 \times 8000} \times 1.004 - 1.7$$

$$= 7.08 - 1.7 = 5.38 \text{ sq. in}$$

No hor. plate so add 1 sq. in;

Gross area = 6.38 sq. in.

(6) M = 0. Required fl. area = 0.

We now examine the flange areas for both top and bottom flanges and take the maximums as the areas to use.
We get the following:

(a) 18.6 sq.in.

(1) 9.81 sq.in

(2) 4.45 " "

(3) 8.75 " "

(4) 11.5 " "

(5) 9.2 " "

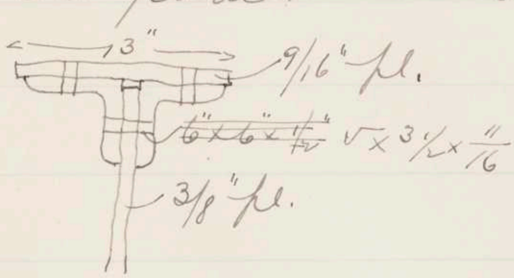
(b) 0

Evidently, if only one hor. plate is used and that only covering pts. (a) and (1) the angles used must be large enough to give sufficient area at any point between (1) and b. That is, they must have a gross area of at least 11.5 sq.in. which is the area required at (4).

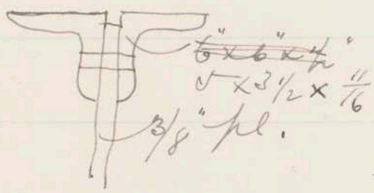
We will use 2 ~~6 × 6 × ½~~ $5'' \times 3\frac{1}{2}'' \times \frac{11}{16}''$ ∠s @ ~~5.76~~ 5.7 = ~~11.52~~ 11.4 sq.in

At (a), the required area is 18.6 sq.in., we must then put on a hor. plate here

whose gross area will be $18.6 - 11.\cancel{4} = 7.^{2}$ sq. in
We will use a plate $13'' \times 9/16'' = 7.32$ and
cut this plate off just beyond the point (1)
since farther than that it is not needed.
The flange section, then, at the center (a)
and at the point (1) is as follows.—



The fl. section at any other pt. is as follows.—



Having designed our flange sections,
we may now calculate the spacing
of the horizontal rivets, which connect
the Ls with the web plate.
We do this by first finding the intensity of
hor. shearing stress between the web
and the flanges at the pts (a) (1) &c.
and on the upper flange, the intensity of vertical shearing

stress due to the actual wheel loads coming down on the flanges through the ties, which are notched down over the top flange. We then divide in the case of the top flange the resultant of these two intensities by the lesser of the two values of shearing ~~and bearing~~ strength of ~~the~~ a rivet and bearing strength between a rivet and the web plate. We will use 7/8" rivets.

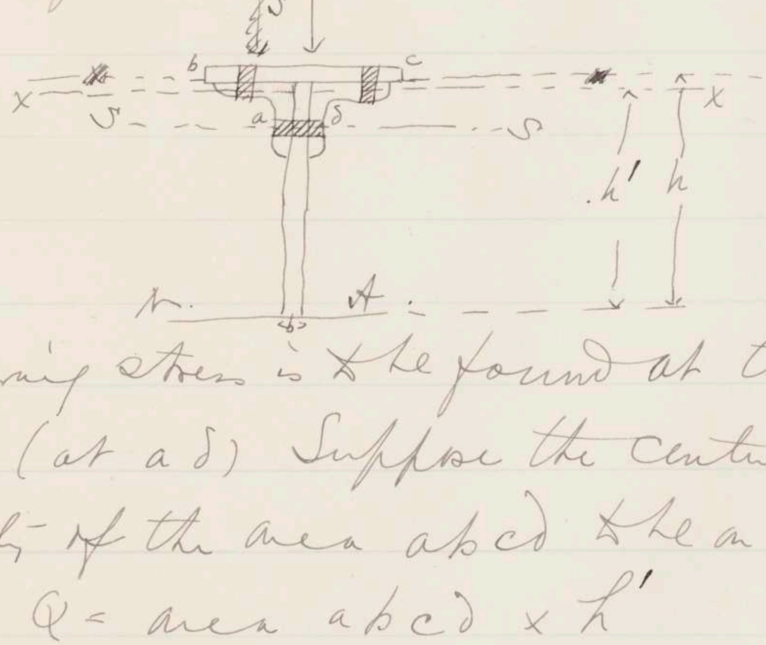
The value of a 7/8" rivet in double shear as it is in this case, is 7500 × 2 × area of rivet = 7500 × 2 × .6 = 9000 lbs. Value in bearing against the 3/8" web plate is 12000 × 7/8 × 3/8 = 3940 lbs. We therefore take as criterion, the latter value, or 3940 lbs.

(The above values, 7500 and 12000, are for machine driven rivets)

<u>Intensity of shearing stress</u>

1st. Horizontal shearing stress

This is computed by the formula $s = \frac{SQ}{I}$ in which s = the intensity of hor. shear. stress. S = ~~Shear~~ max. shear at given pt. Q = ~~max~~ statical moment, about the neutral axis of the section, of that part of the section above the point where the shearing stress is to be found. I = moment of inertia of the section about its neutral axis.



Shearing stress is to be found at the hor. rivet (at a d) Suppose the center of gravity of the area abcd to be on xx

Then Q = area abcd $\times h'$

$I = \frac{1}{12} b h^3$ + area abcd $\times h' \times h' \times 2$ (approx)

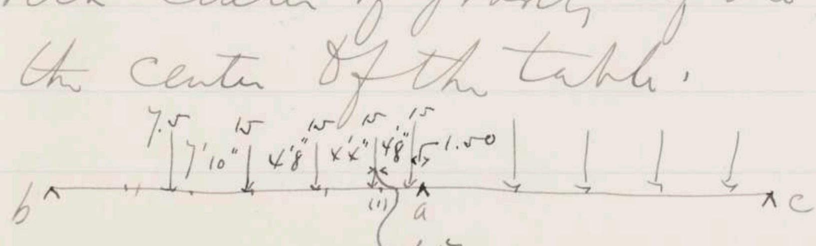
The bottom flange being inclined from pt (1) to b, it carries a certain part of the shear, relieving the web somewhat and rendering the intensity of shearing stress ~~less that~~ between the web and the flanges less than it would otherwise be.

This component of the shear borne by the lower flange is equal to the vertical component of the flange stress at any point due to the moment at that point corresponding to the loading giving max. shear at that point.

At (a) the center, the lower flange is horiz. and the web bears the whole shear.

(1) Here the lower flange begins to incline, and ~~the~~ takes a certain part of the shear, which we will compute.

Loading giving max. S at (1) [see P. 20] is with center of gravity of the loads at the center of the table.



M at (1) with same loading =

−5,582,200 in. lbs. [see P. 10]

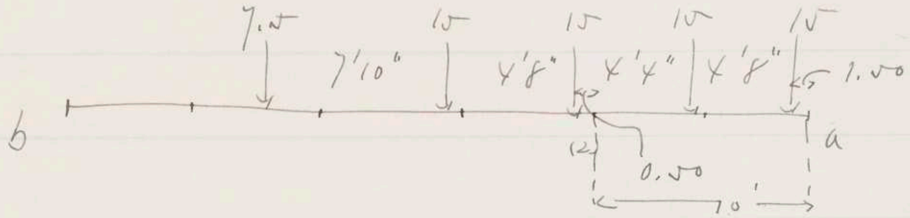
Hor. Comp. Flange stress = $\frac{5582200}{62.5}$ = 90,100 lbs.

Vert. component = $90,100 \times \frac{2.25}{25}$ = 8110 lbs.

∴ Flange (lower) at (1) bears 8110 lbs of the shear. And web carries

58750 (see P. 26) − 8110 = 50640 lb.

(2) Loading giving max. S at (2) is with center of gravity at center of table [See P. 21]



Live M at (2) = $-\left[15\,(0.50 + 5.17) + 7.5 \times 13\right]$

= −182.55 ft tons for 2 girders

= $-\frac{182.55 \times 24000}{2}$ = −2,190,000 in. lbs for 1 girder

Dead M. at (2) = $\frac{1}{2} p\,(l-x)^2 \quad x = 10$

= $-\frac{250 \times 20 \cdot 20}{2}$ = −50000 ~~i~~ ft. lbs

= −50000 × 12 = −600.000 in. lbs. [see P. 11]

Total M. at (2) = −2,190000 − 600.000 =

−2,790,000 in lbs. for one girder.

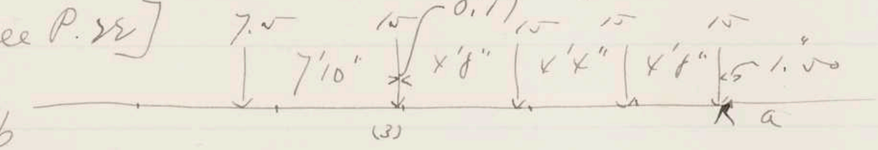
Hor. Comp Flange stress $= \dfrac{2,790,000}{56.1} = 49700$ lbs.

Vert. comp. of fl. stress $= 49700 \times \frac{2.25}{25} =$ 4480 lbs.

∴ Web. at (2) carries a shear of

$\underbrace{42500}_{}$ [See P. 26] $- 4480 = 38020$ lbs.

(3) Loading giving max. S at (3) is with center of gravity of the loads at (a) [See P. 32]



Live M corresponding $=$ ~~[illegible]~~

$-\{15 \times 0.17 + 7.5 \times 8\} = 2.55 + 60.0 =$

-62.55 ft. tons for 2 girders $=$

$-\dfrac{62.55 \times 24000}{2} = -751,000$ in. lbs.

for 1 girder.

Dead M at (3) {see P. 12} $= -337,500$ in lbs.

Total M at (3) $= -751,000 - 337,500 =$

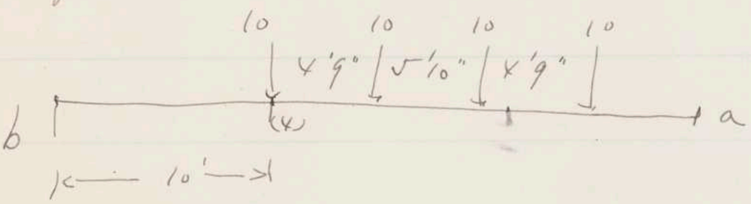
$-1,088,500$ in. lbs.

H. C. Flange stress $= \dfrac{1,088,500}{50.7} = 21,400$ lbs.

V. C. fl. stress $= 21400 \times \frac{2.25}{25} = 1930$ lbs.

∴ Web at (3) carries a shear =
26250 [see P. 26] − 1930 =
24320 lbs.

(4) Loading giving Max. S at (4)
is as follows (see P 23)



Moment corresponding $= + \dfrac{16.45 \times 10 \times 24000}{2}$

10 × 20
" " 15.25
" " 9.42
" " 4.67

$= +1,975,000$ in. lbs.

$\frac{10}{30} = \frac{1}{3}$ 3) 49.34
16.45

Dead M at (4) [See P. 13] − 150,000 in lbs

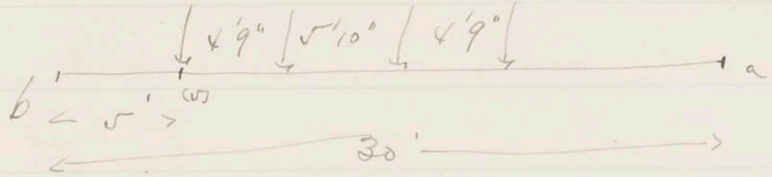
Total M = 1,975,000 − 150,000 = 1825,000 in lbs.

N.C. Flange Stress $= \dfrac{1,~~97~~825,000}{44.3} = 4~~..~~1200$ lbs

V.C. Fl. stress $= 4~~..~~1200 \times \dfrac{2.25}{25} =$ ~~4000~~ 3710 lbs.

∴ Web at (4) carries a shear of
13940 − ~~4000~~ 3710 = ~~9940~~ 10230 lbs.

(5) Loading giving max. V at (5)
is as follows [see P. 23]



M. corresponding $= + \dfrac{23.11 \times 5 \times 24000}{2} =$

$$
\begin{array}{r}
10 \times \; 25 \\
20.25 \\
14.42 \\
9.67 \\
\hline
\end{array}
$$

+ 1,386,600 in. lb.

$\frac{10}{30} \times 69.34 = 23.11$

Dead M at (5) [See P. 15] = −37500 in. lb.
Total M. at (5) = +1,386.600 − 37.500 =
1,349,100 in. lb.

Flange Stress (V.C.) $= \dfrac{1,349,100}{38.9} \times \dfrac{2.25}{25} = 3120$ lb.

∴ Web at (5) carries a shear of
[See P. 26]
21860 − 3120 = ~~19750~~ 18740 lb.

(b) Left end abut. M here = 0.
hence flange carries no component of
the shear at all:
[See P. 26]
∴ Web at (b) carries a shear of 43550 lb.

Table of shears borne by the web.

(a) −7500 lbs.

(1) −50640 "

(2) −38020 "

(3) −24320 "

(4) +10230 "

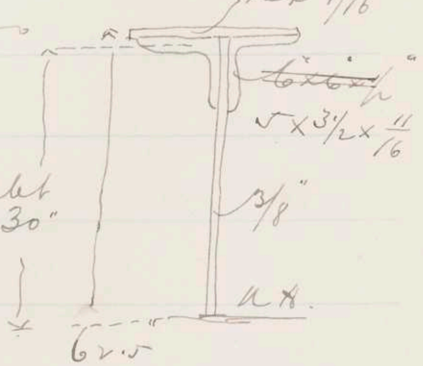
(5) +18740 "

(6) +43550 "

These values of S are substituted in the formula $s = \frac{SQ}{I}$, from which we get the intensity of shearing stress between flange & web. and hence the proper spacing of hor. rivets in flange.

(a)

$s = \frac{SQ}{I}$ $S = 7500$



$13'' \times 9/16'' = 7.32$

$2\angle s\ 6 \times 6 \times \frac{1}{2} = 11.\cancel{44}\ 72$ lower

$18.\cancel{76}\ 72$ flange

$16.\cancel{44}\ 72$ upper ~~lower~~ flange.

$18.\cancel{44}\ 72$

$2)\ 35.\cancel{68}\ 44$

$17.\cancel{86}\ 72$

$Q = 17.\cancel{44}\ 72 \times 30 = \cancel{535.2}\ 531.6$

$$I = \cancel{35.2}^{\sqrt{32}} \times 2 \times 30 + \frac{1}{12}\cdot\frac{5}{8}\cdot 62.5 \times 62.5 \times 62.5$$

$$= \cancel{32112}^{31920} + 763\overset{4}{0} = \cancel{39782}^{39550}$$

$$s = \frac{75000 \times \cancel{35.2}^{\sqrt{32}}}{\cancel{39782}^{550}} = 1010 \text{ lbs}$$

Least value of rivet = 3940 lbs.

$\therefore$ pitch $= \frac{3940}{1010} = 3\frac{3}{4}''$

Then pitch for bottom flange = $3\frac{3}{4}''$ at center of table.

Top flange. Vert. shearing stress comes in in top flange. as ties rest right on flange. Consider ~~##~~ max. wheel load (7.5 tons) to be distributed over 36"

Then average vert. shear. stress will be

$$\frac{7.5 \times 2000}{36} = 417 \text{ lbs.}$$

The true intensity of shearing stress between top flange & web is the resultant of the hor. and vert. stresses.

~~Max. it is ...~~

We therefore assume the pitch a

trifle smaller. Compute from it the hor. shearing stress on one rivet. And also find the no. of rivets in 36" and divide the wheel load by it. [or multiply the vert. intensity of shearing stress, 417 lb, by pitch]

(a) Assume pitch as 3½"

Then hor. shear. stress on rivet =

$3\frac{1}{2} \times 1010 = 3540$

Vert. shear. stress $= 417 \times 3\frac{1}{2} = 1460$

Resultant $= \sqrt{3540^2 + 1460^2} =$

$= 3830.$

$$\begin{array}{r} 125 \\ 213 \\ \hline 1463 \end{array}$$

This resultant comes less than 3940, the least value of 1 rivet. therefore 3½" pitch is safe for centre of table.

(1) $S = 50640$ ~~Q and I same as~~

Hor. plate is cut at (1)

$Q = \dfrac{11.\cancel{52}^{4} + 10.\cancel{52}^{4}}{2} \times 30 = \cancel{330.6}\ 327$

$$\begin{array}{r} 11.52 \\ 10.52 \\ \hline 2)22.04 \\ \hline 11.02 \end{array}$$

$I = \cancel{330.6}\ 327 \times 30 \times 2 + \frac{1}{12} \cdot \frac{3}{8} \cdot 62.5^3$

$= \cancel{19836}\ 19620 + 7630 = \cancel{27466}\ 27250$

$$\begin{array}{r} 19836 \\ 7630 \\ \hline 27466 \end{array}$$

$$s = \frac{50640 \times \cancel{330.6}\ 327}{\cancel{27466}\ 27250} = 610$$

Pitch for bottom flange $= \frac{3940}{610} = 6\frac{1}{4}''$

Top flange. Assume pitch as 5''

Resultant stress on rivet =

$$\sqrt{2085^2 + 3050^2} =$$

$$\sqrt{13650000} = 3700$$

$$\begin{array}{r} 417.5 \\ \hline 2085 \\ 610 \\ 5 \\ \hline 3050 \end{array}$$

less than 3940 so safe and as near as possible to exact pitch. pitches not being calculated closer than 1/4''.

Hence pitch in top flange at (1) = 5''

(2) $V = 38020 \qquad Q = \frac{11.412 + 10.412}{2} \times 27 = \cancel{298}\ 294$ [ht of web = 56.1'']

$$I = \cancel{298}\ 294 \times 27 \times 2 + \frac{1}{12} \times \frac{3}{8} \times 56.1^3$$

$$= \cancel{16100}\ 15870 + 5500 = \cancel{21600}\ 21370$$

$$s = \frac{38020 \times \cancel{298}\ 294}{\cancel{21600}\ 21370} = \cancel{534}\ 524 \text{ lb per } \square''$$

Pitch in bottom flange $= \frac{3940}{\cancel{5??}\ 524} = \cancel{7}\ 7\frac{1}{2}''$

Top flange.

Assume pitch as $5\frac{3}{4}$

$5\frac{1}{4} \times 5\frac{3}{4} = \cancel{2880}\ \cancel{2970}\ 3010$

$417 \times 5\frac{3}{4} \quad \cancel{2240}\ 2400$

Resultant $= \sqrt{\cancel{2970}^2 + \cancel{2240}^2} = \cancel{3680}\ \cancel{3760}\ 3840$
$\qquad\qquad \cancel{2880}\ 3010 \quad 2400$

less than 3940

Hence pitch in top flange will be $5\frac{3}{4}''$ at (2)

(3) $S = 24320 \quad Q = \left(= \frac{11.4 + 10.4}{2}\right)\ \cancel{11.02}\ 10.9 \times 24$ [ht of web $= 50.1$]

$= \cancel{264}\ 262$

$I = \cancel{264}\ 262 \times 24 \times 2 = \frac{1}{12} \cdot \frac{3}{8} \cdot 50.1^3$

$= \cancel{12710}\ 12580 + 3920 = \cancel{16630}\ 16500$

$s = \frac{24320 \times \cancel{264}\ 262}{\cancel{16630}\ 16500} = \cancel{386}\ 386$

Pitch in bot. flange $= \frac{3940}{386} = 10''$

Top flange.

Assume pitch $= 6\frac{3}{4}''$

$6\frac{3}{4} \times 386 = 2620$

$6\frac{3}{4} \times 417 = 2750$

Resultant $= \sqrt{2620^2 + 2750^2} = 3780 < 3940$

Hence pitch in top flange $= 6\frac{3}{4}$" at (3)

~~4~~

(4) $V = 10230$ $Q = \cancel{11.02}\ 10.9 \times 21$ $\left[\text{ht of web} = 44.3 \right.$

$= \cancel{231}\ 229$

$I = \cancel{231}\ 229 \times 21 \times 2 + \frac{1}{12} \cdot \frac{3}{8} \times \overline{44.3}^3$

$= \cancel{9750}\ 9620 + 2600 = \cancel{12350}\ 12220$

$s = \frac{10230 \times \cancel{231}\ 229}{\cancel{12350}\ 12220} = 192$

Pitch in lower flange $= \frac{3940}{192} = 20$"

Top flange.

Assume pitch $= 8\frac{1}{2}$"

$8\frac{1}{2} \times 192 = 1630$

$8\frac{1}{2} \times 417 = 3550$

Resultant $= \sqrt{1630^2 + 3550^2} = 3920 < 3940$

Hence pitch in top flange $= 8\frac{1}{2}$" at (4)

The pitches which have been calculated vary considerably. but as is customary. we will consider the pitches in the top and bottom flanges as the same. And we will also limit the pitch to 7", which is about as large a pitch as it is advisable to use. Hence. beginning at the end abutment, we will put in 10 rivets with a pitch of $3\frac{1}{2}$" then 10 with a 5" pitch, 10 with 7" pitch, 10 with 6" pitch, 10 with 5" pitch 10 with 4" pitch. and from there to the center 14 with $3\frac{1}{2}$" pitch.

The vertical flange rivets, where they occur. are not exposed to as large a stress as the horizontal rivets, since Q in the formula $s = \frac{SQ}{I}$ will evidently be smaller. Also. they are not affected by the vertical shearing stress caused by the loads directly. Hence we may pitch them farther apart than the hor.

rivets, It is customary, however, to stagger them with the horizontal rivets, and we will do so, thus being on the safe side.

Rivets required to carry reactions.

At the end abutments, the max. reaction is 43880 lbs. Hence 12 rivets @ 3940 lbs bearing, and 9000# double shear are required. The drawing [see Fig 4] shows 18 in double shear for each girder

At the center the max. reaction is 107500 lbs. No. of rivets required = 28. The drawing [see Sect. of center bearing] shows 52

We will proceed now to calculate the spacing of stiffeners, which prevent the web from buckling. This is computed by a column formula applied to the web, which is thrown into the form

$$l = 70t\sqrt{\frac{8000A}{S} - 1}$$

l = dist. bet. stiffeners, measured at

an angle of 45° with the neutral axis of the ~~section~~ girder, t = thickness of web. A = area of ~~web~~ portion of web whose length is the distance bet. the flange angles. (meas. normally) and whose width is 1", ~~the~~ its thickness being of course the thickness of the web. 3/8".

Center. $l = 70 \cdot \frac{3}{8} \sqrt{\frac{8000 \cdot 21}{7000} - 1}$

$A = (62.5 - 3\frac{1}{2} \times 2) \times 3/8$

$= 56 \times 3/8 = 21$

$S = -7000$ [see P. 46]

$l = 32.6''$

d = hor. dist. bet. stiffeners $= \frac{l}{\sqrt{2}} = 23''$

$d = 23''$

(1) $l = \frac{210}{8} \sqrt{\frac{8000 \cdot 21}{50640} - 1} = 59.3''$

$d = \frac{l}{\sqrt{2}} = 41.8''$

(2) $$\partial = \frac{e}{\sqrt{2}} = \frac{1}{\sqrt{2}}\left[\frac{210}{8}\sqrt{\frac{8000\,(49\cdot\frac{3}{8})}{38020}} - 1\right]$$

$$\partial = 53''$$

(3) $$\partial = \frac{1}{\sqrt{2}}\left[\frac{210}{8}\sqrt{\frac{8000\,.(44\cdot 3/8)}{24320}} - 1\right]$$

$$\partial = 82''$$

(4) $$\partial = \frac{1}{\sqrt{2}}\left[\frac{210}{8}\sqrt{\frac{8000\,(37\cdot 3/8)}{10230}} - 1\right]$$

$$\partial = 182''$$

(5) $$\partial = \frac{1}{\sqrt{2}}\left[\frac{210}{8}\sqrt{\frac{8000\,(32\cdot 3/8)}{18440}} - 1\right]$$

$$\partial = 76''$$

(6) $$\partial = \frac{1}{\sqrt{2}}\left[\frac{210}{8}\sqrt{\frac{8000\,(29\cdot 3/8)}{43550}} - 1\right]$$

$$\partial = 18.5''$$

Spacing of stiffeners is as follows: —

Center 23"

(1) ~~23"~~ 42"

(2) ~~42"~~ 53"

(3) 82"

(4) 182"

(5) 76"

(6) 18.5"

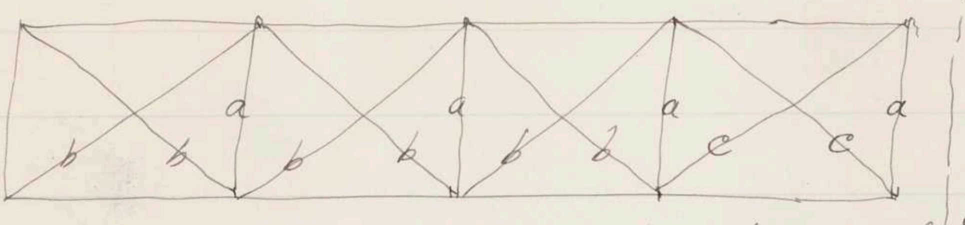
It would be impossible to employ exactly these figures. So we arrange the stiffeners as advantageously as possible, taking care to keep inside the above limits.

Bracing:

To prevent the 2 girders from spreading apart laterally, two systems of lateral bracing are used. Consisting of horizontal bracing extending diagonally across from one girder to the other, from both top and bottom flanges. and vertical bracing extending diagonally

from the bottom flange of one girder to the top flange of the other.
The horizontal bracing is attached to the flanges at points about 7 feet apart and the vertical bracing is attached to Ls ~~two~~ rivetted to the inside of the web at the same points.
The arrangement is as follows,—
horizontal bracing.—

Center



As is shown above, besides line the diagonal hor. bracing there are hor. braces extending across from one girder to the other at top and bottom and placed at right angles to the girders themselves (see bars a a a a
The bracing b b b b b b consists of round bars. about 1/2" in diam. provided with sleeve nuts for tightening the bars.

These bars are connected to the flanges by flat plates (abt 3/8" thick) which are rivetted to the flanges. The bars themselves are flattened at the ends and a hole bored through them, through which the rivets attaching them to the connecting plates are passed. [See Plan Fig 2]

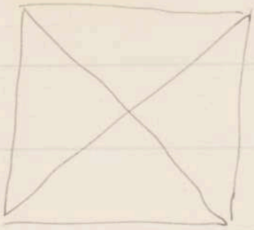
Attached to the same connecting plates are the braces a a a a which with the exception of the one nearest the center which is not properly a mere brace, consist of 2 Ls side by side. as shown in Fig 2

The remaining ~~bar~~ pieces of the hor. bracing or c c are made of Ls to give greater strength at the center, where the greatest strain occurs

All the horizontal bracing is clearly shown in the drawing.

Vertical bracing.

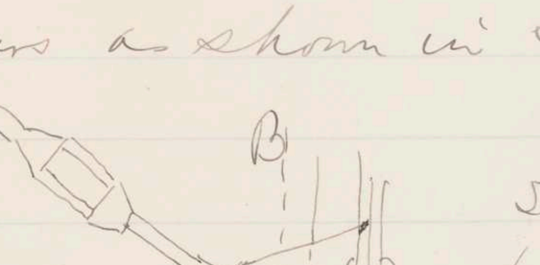
arrangement as follows;—



In the turntable in question there are 4 ~~on each side of center~~ ~~Systems~~ Systems of vert. bracing on each side of the center as shown above. They are hidden by the horizontal braces a a a a

These diag. vert. braces ~~consist of~~ are bars like b b b &c. and are made the same size as the latter. They are connected the web of the girders as shown in sketch below.–

Side elev. looking from end of table inside.



Cross section through B B

The third system from the end of the girder consist of Ls instead of bars & give greater strength near the center. These Ls are connected in the same manner as the bars.

Bearings.

End bearings.

The end bearings of the turntable are of a form patented by Mr. D. N. Andrews. of the Boston Bridge Co. and are designed & give as little frictional resistance as possible. They are shown in Figs 1, 2, 3 and 4.

A frame made up of plates and Ls and somewhat resembling two short girders placed side by side. is securely fastened & the web of the main girders (and ⊥ & them) by 4 6×3×½ Ls

The upper flanges of these short girders as we may call them are bent over beyond the main girders ~~and~~ until they join the bottom flanges. thus forming a sort of box in which the wheel is placed. The details may clearly be seen in Figs 1, 2, 3 and 4. To lessen friction as much as possible. the wheels which roll on the circular track turn on a nest of steel rollers. about 3/8" in diam. thus forming an almost frictionless bearing. The axles of the wheels also. are fitted to their bearings in such a manner that by unscrewing some bolts. ~~the~~ the axle of either wheel may be moved upward and inward, thus taking up the back lash as it were. due to wear.

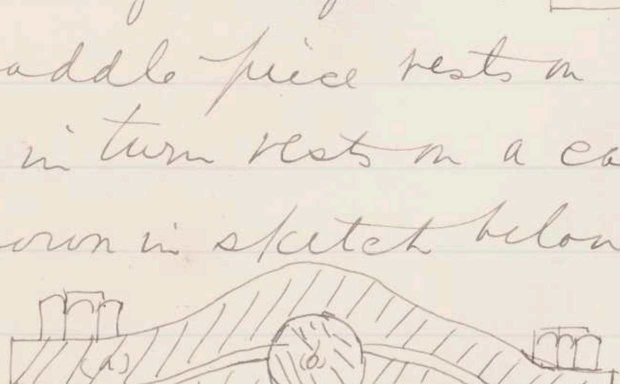
Center Bearing.

This bearing is also one of Mr. Andrews patents. and is very ingenious. The ~~me~~ main support.

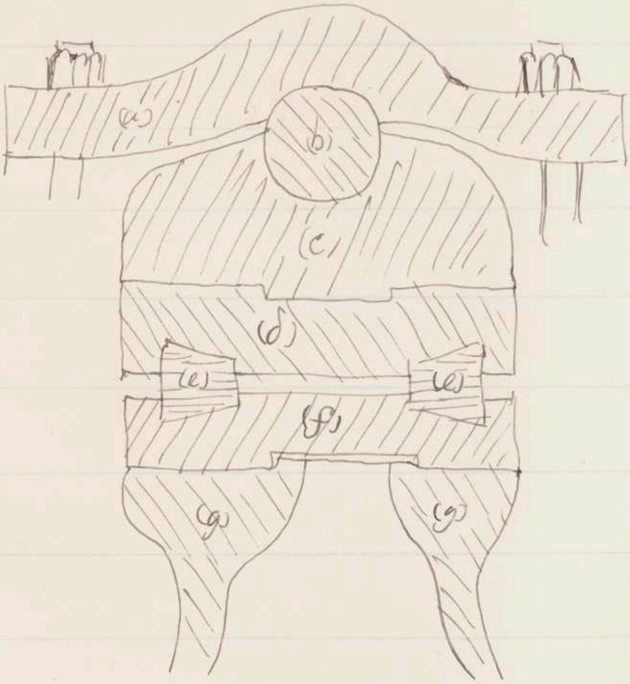
And in fact ~~a~~ the only center support of the table is a large hollow ~~iron~~ iron casting, firmly bolted to the stone block beneath it. On top of this casting are two steel discs, with a nest of conical rollers lying between them in a groove. On which the table turns.

The load goes from the web into a sort of box girder, from which it goes into a series of long bolts which are firmly attached to the bottom of the box girder, and which at the top, are fastened to a saddle piece, of this form (a)

This saddle piece rests on a long pin (b) which in turn rests on a casting (c) as shown in sketch below



This casting is supported on a steel disc (d) and ~~through~~ from this disc, the load passes through the nest of conical rollers (e)(e) & another similar steel and disc (f) and thence to the main casting. (g)



The details of the box girder are shown in Fig

Foundation.

The ground being assumed soft and yielding, it is necessary to use piles. allowing 8 tons load to each pile, the standard pile being about 12" in diameter at the top, tapering to about 6" at the bottom, and about 30' long.

At the end abutments, the max. reaction under each wheel of the table is 43880 lbs = 21.94 tons. The dead load causes no reaction
Hence this reaction must be distributed over at least 3 piles
We will form the lower course of masonry forming the end abutment of blocks 5'3" × 4' × 1'6" each block of stone resting on 4 piles.

(live) 107.5 + (dead) $\frac{200 \times 60 \times 2}{2000} = 122.5$

At the center, the max. reaction is ~~107.5~~ tons necessitating 16 piles under the pier.
We will use for the lower course, a square stone block 8' × 8', resting

on 16 piles, as shown by the figure. The details of the rest of the masonry may best be explained by reference to the drawing.

Under the center bearing are 2 square stone blocks ~~1'8"~~ 1'6" thick and respectively 6' and 7' square. These 2 blocks distribute the load sufficiently on the lower block. which in turn divides it equally over the 16 piles.

The circular end abutments under the rail, need not be made of ashlar but of sufficiently good quality of masonry to distribute the load well over the lower course of equal stone blocks. which divide it over the 4 piles on which each block rests.

Details:-

The table ~~x~~ rolls at its ends. on a circular track made out of ordinary 80 lb rail. This track rests on ~~wooden~~ oak blocks. 6" x 8" x 2'6" spaced about 2' apart. There are about 90 of these blocks in all. They are drift bolted to the masonry on which they rest.

The cross ties on the table are of yellow pine 6"x8"x10' spaced 2' apart c/c.

The table can accomodate ~~about~~ 31 tracks, the distance between the ~~outside~~ rail of one track & the nearer rail of the next track being (at the edge of the circular abutment) 2' c/c.

Drainage.

To drain the pit within the circular wall of masonry. a catch basin is provided, of ample proportions. The bottom of the pit is graded down on all sides & the opening of the catch basin. in order that all the water falling into the pit may find its way out by this means. The opening is made large enough to allow a hoe ~~to~~ or some suitable instrument to be thrust down, when it becomes necessary to clean out the ~~b~~ basin. The drain is made of 6' pipe. and is placed 2'6" above the bottom of the catch basin. to allow the sediment to settle in the basin, from whence it can be taken conveniently.

The drain pipe passes out at a slight grade between the piles and empties at the nearest convenient spot.

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