Dawdy

Steelwork
des ifm.

NOTE

Concrete Roof substituted
for Timber Roof on
13 March, 1936.

For Calculations on
this see p. 33 et seq.

C.H.C.
13 3/31

INDEX.

Re-calculate owing to C.P.W's. getting his design altered. See NEW Drawing

Side Beams for ceiling.

Beams A A. type. effective span = 14'

$w = 9 \times 68$

$= 612$ lbs. per ft. run.

$Z' = \frac{wl^2}{64} = \frac{612 \times 14^2 \times 12}{64 \times 2240}$

$= 10.04$ inch^3 units.

Select NB 13-7 [Z = 13.9]

8" x 4" x 18 [Z = 13.9]

$Z'' = \frac{wl^2}{64} = \frac{18 \times 14^2 \times 12}{64 \times 2240}$

$= .295$ inch^3 units.

$+ \Sigma Z = 10.04 + 0.30 = 10.34$ inch^3 units

Safe.

Equal reactions $= \frac{14}{4480} \left[\begin{matrix} 612 \\ 18 \end{matrix} \right] = \frac{14 \times 630}{4480}$

$= 1.97$ tons.

and total load $= L = 3.94$ tons.

Purlins Beams Type B3.

Effective span = 21.5'

$w = 68 \times 14$

$= 952$ lbs. per ft. run.

$$Z' = \frac{wl^2}{64} = \frac{952 \times 21.5^2 \times 12}{64 \times 2240}$$

$= 36.83$ inch^3 units.

Select NBSB-11 $13'' \times 5'' \times 35$ [$Z = 43.6$].

$$Z'' = \frac{w'l^2}{64} = \frac{35 \times 21.5^2 \times 12}{64 \times 2240}$$

$= 1.36$ inch^3 units.

and $\Sigma Z = 36.83 + 1.36 = 38.19$ inch^3 units

Safe.

$$\text{Equal reactions} = \frac{21.5}{4480}\left[\frac{952}{35}\right] = \frac{21.5 \times 987}{4480}$$

$\therefore R = 4.74$ tons.

and total load = $L = 9.48$ tons.

Ceiling beams type CC.

Effective span = 28.5'

Central load $W = 4.74$ tons.

Distributed load $w = 68 \times 9$

$= 612$ lb. per ft. run.

$$M = \frac{Wl}{4} + \frac{wl^2}{8}$$

$$\therefore I' = \frac{Wl}{32} + \frac{wl^2}{64}$$

$$= \frac{4.74 \times 28.5 \times 12}{32} + \frac{612 \times 28.5^2 \times 12}{64 \times 2240}$$

$= 50.66 + 41.61$

$= 92.27$ inch^3 units.

Select- NBS 63- 16 20" × 6½" × 65 [Z = 122.6].

$$I'' = \frac{w'l^2}{64} = \frac{65 \times 28.5^2 \times 12}{64 \times 2240}$$

$= 4.42$ inch^3 units.

and $\Sigma I = 92.27 + 4.42 = 96.69$ inch^3 units. Safe.

Equal Reaction $= 2.37 + \frac{28.5}{4480}\left[\begin{matrix}612\\65\end{matrix}\right]$

$= 2.37 + \frac{28.5 \times 677}{4480}$

$= 2.37 + 4.31$

$= 6.68$ tons.

Columns Type ①.

Height = 26'

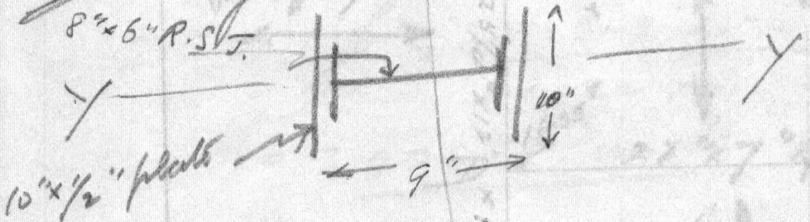
Load on top = 13.36 + 4.74

= 18.10 tons.

Load cannot be eccentric on X-axis.
allow for 1" eccentricity on Y-axis.

Required minimum $K = \frac{26 \times 12}{120} = 2.23$"

Top Section K.10



9"×10"×71½.

Eccentricity on Y-axis.

$\frac{L}{R} = \frac{26 \times 12}{2.25} = 138.7$ Safe stress = 2 tons per sq. in.

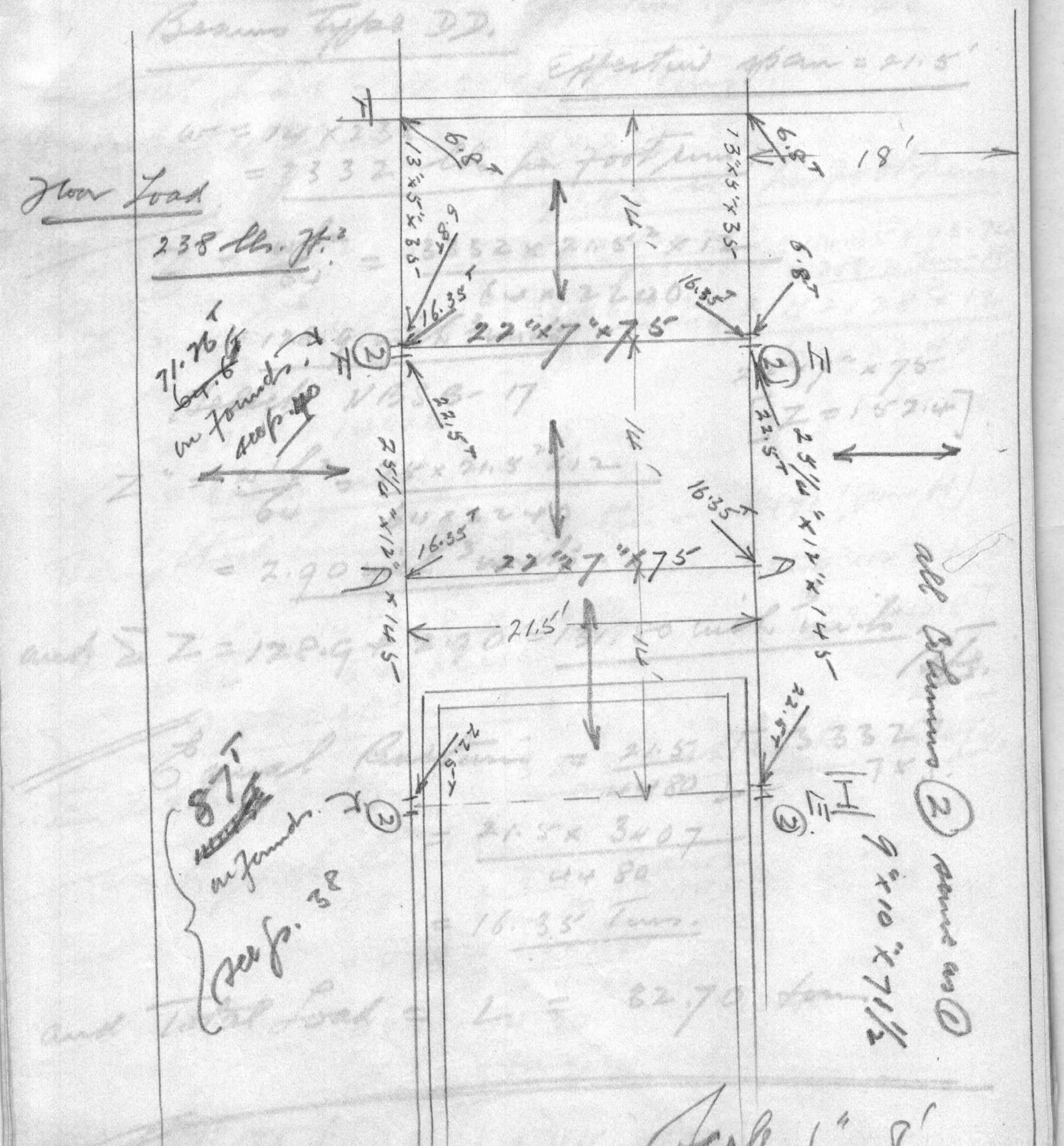
1" eccentricity coefficient = 1.99
Equivalent concentric load = 1.99 × 18.1 = 36.02 tons.
weight of Column = $\frac{26 \times 71.5}{2240}$ = 0.83 "
36.85 tons.

and Safe load = 2 × 20.2 = 40.4 tons. Safe.

Load on foundation = 18.1 + 0.83

= 18.93 tons.

Plan Vault.


Floor Load
238 lbs. ft.²
71.76ᵀ
on founds.
see p. 40
6.8ᵀ
13"x5"x35–
8.9ᵀ
16.35ᵀ
22"x7"x75–
14'
18'
22.5ᵀ
25½"x12"x145–
21.5'
87ᵀ
on founds.
see p. 38
all Beams ② same as ①
9"x10"x7½
Scale 1" – 8'

VAULT.

Beams Type DD.

Effective span = 21.5'

$w = 14 \times 238$
$= 3332$ lbs. per foot run.

$Z' = \frac{wl^2}{6u} = \frac{3332 \times 21.5^2 \times 12}{6u \times 2240}$

$= 128.9$ inch^3 units.

Select NBSB-17 22" × 7" × 75 [Z = 152.4].

$Z'' = \frac{w'l^2}{6u} = \frac{75 \times 21.5^2 \times 12}{6u \times 2240}$

$= 2.90$ inch^3 units.

and $\Sigma Z = 128.9 + 2.90 = 131.80$ inch^3 units. Safe.

Equal Rafters $= \frac{21.5}{4480}\left[\frac{3332}{75}\right]$.

$= \frac{21.5 \times 3407}{4480}$

$= 16.35$ Tons.

and Total Load = L = 32.70 tons.

Beams type EE.

Effective span = 28'

Central Load = W = 16.35 Tons.

Distributed load = w = 9 × 238

= 2142 lbs. per foot run.

$M = \frac{Wl}{4} + \frac{wl^2}{8} = \frac{16.35 \times 28}{4} + \frac{2142 \times 28^2}{8 \times 2240} = 114.45 + 93.74$

$= 208.2$ Tons-Ft.

$\therefore Z' = \frac{Wl}{32} + \frac{wl^2}{64} = \frac{16.35 \times 28 \times 12}{32} + \frac{2142 \times 28^2 \times 12}{64 \times 2240}$

$= 171.7 + 140.6$

$= 312.3$ inch^3 units.

The lightest beam to carry this is a 171 (Jones M) 25 1/4" × 12" × 145 [Z = 340.8].

$Z'' = \frac{w'l^2}{64} = \frac{145 \times 28^2 \times 12}{64 \times 2240}$

$= 9.52$ inch^3 units

$\therefore \Sigma Z = 312.3 + 9.5 = 321.8$ inch^3 units. Ref:

Equal Reactions

$= 8.18 + \frac{28}{4480}\left[\begin{matrix}2142\\145\end{matrix}\right]$.

$= 8.18 + \frac{28 \times 2287}{4480}$

$= 8.18 + 14.30 = 22.48$

$= 22.5$ tons.

Total Load = 45 tons.

Beams type FF.

Effective span = 14'

Load = $w = 9 \times 238$

$= 2142$ lbs. per ft. run.

$$Z' = \frac{wl^2}{64} = \frac{2142 \times 14^2 \times 12}{64 \times 2240}$$

$= 35.14$ inch^3 units.

Select NBS 13 - 11

13" × 5" × 35

[$Z = 43.6$].

$$Z'' = \frac{w'l^2}{64} = \frac{35 \times 14^2 \times 12}{64 \times 2240}$$

$= 0.58$ inch^3 units.

and $\Sigma Z = 35.14 + 0.58 = 35.72$ inch^3 units.

Safe.

Equal Reactions.

$$= \frac{14}{4480}\left[\begin{matrix}2142\\35\end{matrix}\right]$$

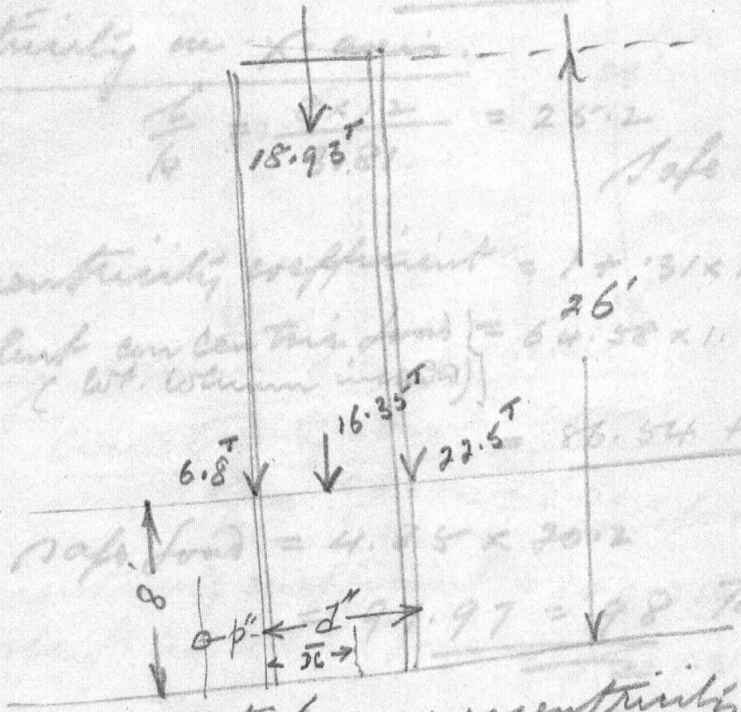
$$= \frac{14 \times 2177}{4480}$$

$= 6.8$ tons.

and total load = $L = 13.6$ tons.

Columns Type (2).

Case I. Height = 8'.



There cannot be any eccentricity on the Y-axis.

To find its eccentricity on the X-axis.

$$(6.8 + 18.93 + 16.35 + 22.5)(p + \bar{x}) = 6.8p + (18.93 + 16.35)\left(p + \frac{d}{2}\right) + 22.5(p + d).$$

$$64.58p + 64.58\,\bar{x} = 6.8p + 35.28p + \frac{35.28 \times d}{2} + 22.5p + 22.5d$$

$$64.58\,\bar{x} = (17.64 + 22.5)\,d.$$

$$\therefore \bar{x} = \frac{40.14}{64.58}\,d = 0.6215\,d.$$

and eccentricity $= (.6215 - .5)\,d.$

$= .1215\,d.$ inches.

Try Section K.10 as before. 9 "×10"×71½

Then eccentricity = .1215 × 9 = 1.0935
= 1.1 inches.

Eccentricity on X-axis.

$\frac{L}{k} = \frac{8 \times 12}{3.81} = 25.2$ Safe Stress = 4.85 tons per sq. in.

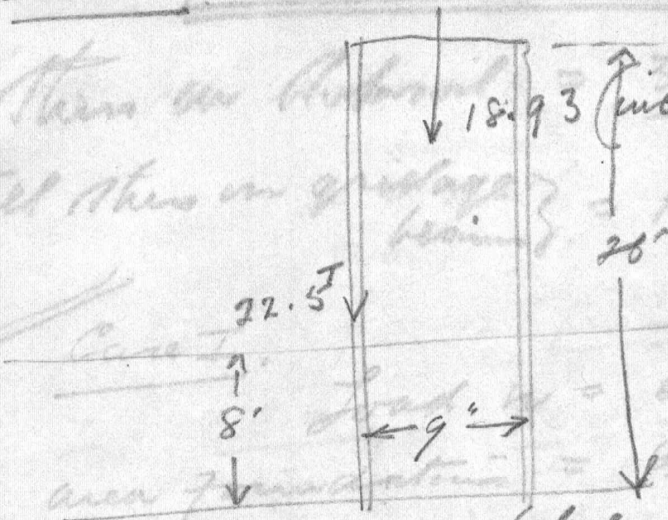
1.1" eccentricity coefficient = 1 + .31 × 1.1 = 1 + .34 = 1.34

Equivalent Concentric load (Wt. Wheels included) = 64.58 × 1.34
= 86.54 tons.

and safe load = 4.85 × 20.2
= 97.97 = 98 Tons. Safe.
2

Load on foundation = 64.6 tons.
2

Case II.



Try Column K.10 as before. 9"×10"×71½.

Eccentricity on X-axis.

$\frac{L}{k} = \frac{96}{3.81} = 25.2$ Safe stress = 4.85 Tons/in².

4½" eccentricity coefficient = 1 + 0.31 × 4.5" = 1 + 1.4 = 2.4

Equivalent concentric load = 2.4 × 22.5"
= 54.0 tons.

Superimposed load
including wt. of Column } = 18.93 "

72.93 tons.

and Safe load = 20.2 × 4.85
= 97.97 = 98 tons. Safe.

+ Load on foundation = 18.93 + 22.5"
= 41.43 tons.

Gridage foundations.

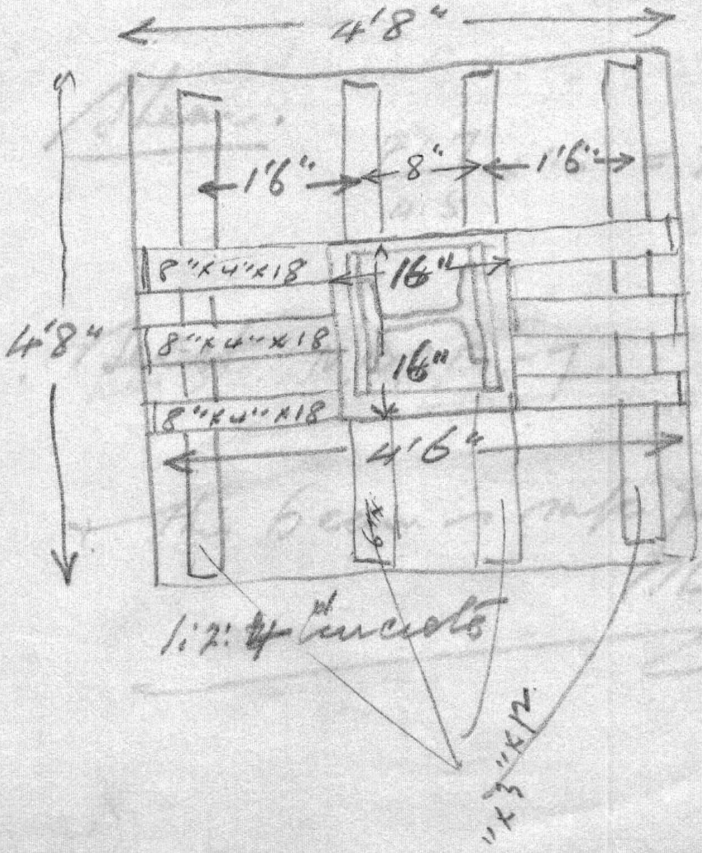
Stress on Subsoil = 3 T per ft.²

Steel Stress on gridage beams } = 12 T per in.²

Case I.

Load W = 65 tons.

area foundations = $\frac{65}{3}$ = 21.7 ft.²



NOTE. all Steel beams a minimum covering of concrete of 3" + horizontal section of foundn. to be constant throughout its depth.

See R.B. p. 430 for formulae.

Load per beam = $\frac{65}{3}$ = 21.7 tons.

$L = 4.5'$

$P = 1.6'$

$f = 12^T$ per in^2.

$\therefore Z = \frac{3PW}{12} = \frac{P \times W}{4} = \frac{1.6 \times 21.7}{4}$

$= 8.68$ inch^3 units

$\therefore$ Select N.B.S.B.-6 $7'' \times 3\frac{5}{8}'' \times 15^-$

[$Z = 10.2$].

Shear.

$\frac{21.7}{4.5} \times 1.6 = 7.7$ tons.

NOT safe.

see p. 396.

$\therefore$ Select N.B.S.B.-7 $8'' \times 4'' \times 18$

[$Z = 13.9$].

+ this beam is safe for Shear.

Bottom flr.

Load per beam = $\frac{6\frac{1}{2}}{4} = 1.6$ tons.

$L = 4.5'$
$P = 1.6'$
$f = 12^T$ per sq in.

$\therefore I = \frac{3 P \times L^2}{12} = \frac{P \times L^2}{4} = \frac{1.6 \times 6^4}{4}$

$= 6.4$ units^3 units.

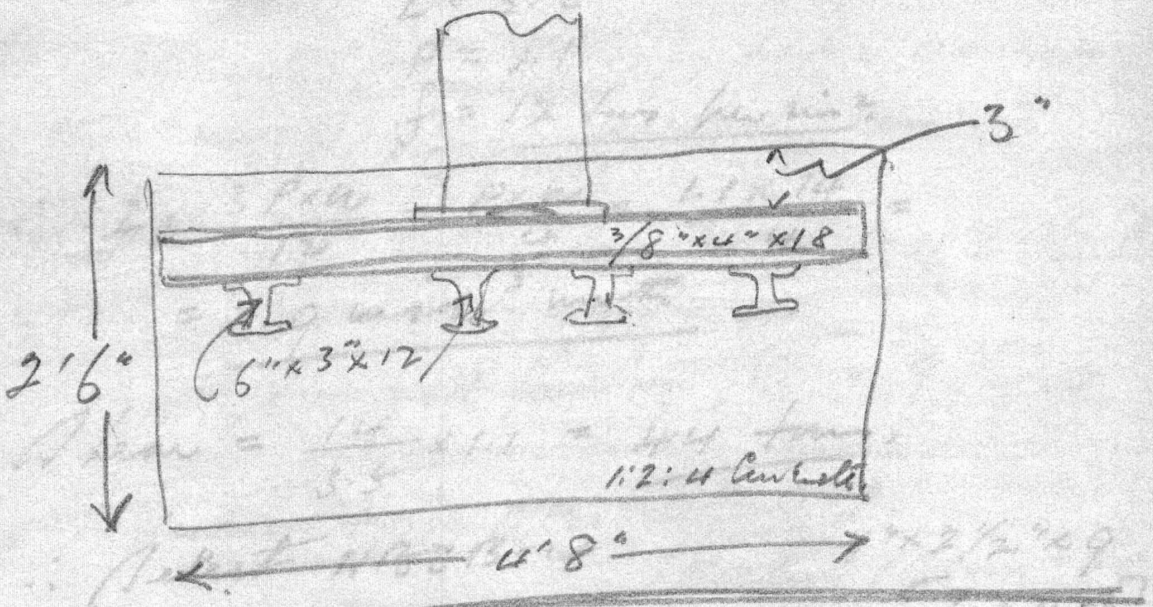
Shear $= \frac{16}{4.5} \times 1.6 = 5.7$ tons.

∴ Select N.B.S.B. – 5" 6"×3"×12
[Z = 6.9].

Max. Shear = 5.3^T

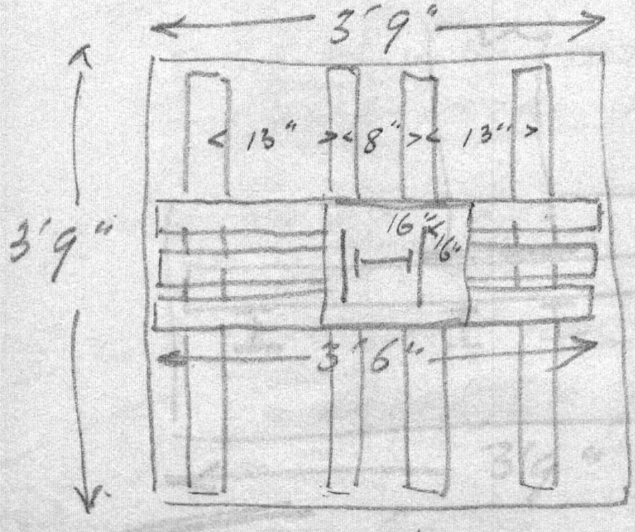
Rep. 296
R.B.

This value may be accepted.



Case II. Load = 42 tons.

Area found = $\frac{42}{3}$ = 14 ft²



all Rs, Is. 5" x 2½" x 9