☐Loading

(First than loadings)

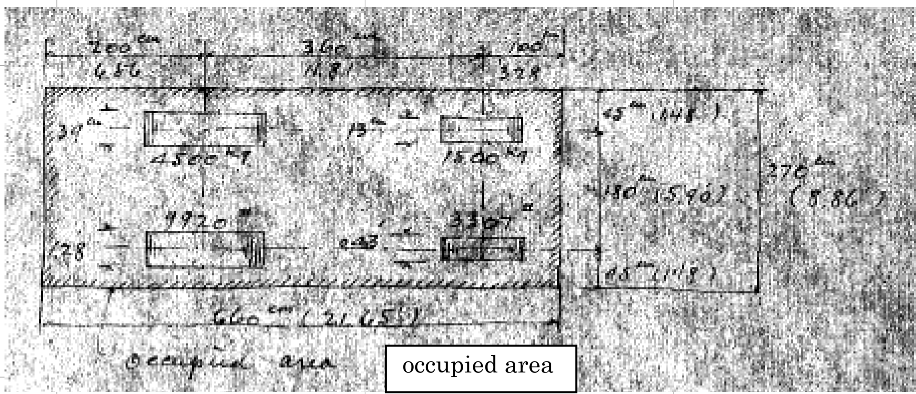
Uniform Load

for carriageway $w = \frac{120000}{170+l} \leqq 600\ {}^{kg}/{}_{m^2}$ or $125\ {}^{\#}/{}_{\circ'}$

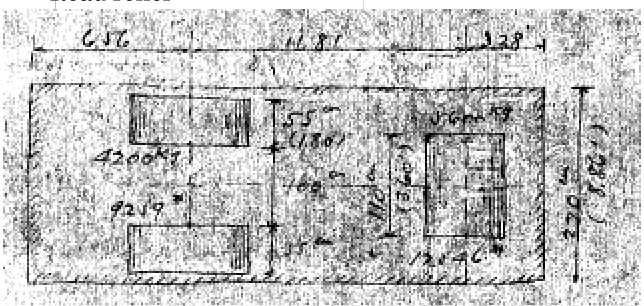
for footway $w = \frac{100000}{170+l} \leqq 500\ {}^{kg}/{}_{m^2}$ or $100\ {}^{\#}/{}_{\circ'}$

where l = span length in meters

motor car loading (12.0 tons)



Road roller



Impact

$I = \frac{20}{60+l}$ where l = loaded length in meters

max impact limited to 30%

No impact for uniform load and road roller concentration

☐weight of materials

creosoted wood?? block pavement	60
mortar	110
Plane concrete	140
Reinforced concrete	150
structural steel	490
cast steel	491
cast iron	450
wrought iron	487
masonry granite	160
earth	100
Bond and grand	110

モルタル

□Allowable working strength of materials.

structural ??? ?? reinforced bars.

Tension	1200 kg/cm²	or	17000 #/□"
Extreme fiber stress (net)	1200 〃	or	17000 〃
shearing of web (gross section)	900 kg/cm²	or	12800 〃

Compression members $1500(1-0.0055\frac{l}{r}) \leqq 1000$ kg/cm²

where l = length of member in centimeter
r = ???

Equivalent formula for inch 1bs unit
$21300(1-0.0055\frac{l}{r}) \leqq 14000$ #/□"

compression flange of plate girder
$1200(1-0.012\frac{l}{b}) \leqq 1100$ kg/cm²
where l = unsupported length of flange in cm
b = width of flange in cm

Equivalent formula for inch 1bs unit
$17000(1-0.012\frac{l}{r}) \leqq 15400$ #/□"

shearing on shop driven rivets (machine rivets) 17000 #/□"
shearing on field driven rivets and turned bolts (machine) 10000 #/□"
Extreme fiber of pin 18000 kg/cm² or 25600 #/□"
Bearing on shop rivets 24000〃
Bearing on field rivets of turned bolts 20000〃
????? roller 45d kg/cm where d = diameter of roller in cm
or inch 1bs unit 610d 1bs/in where d = 〃 in inch
Bearing on masonry 1:2:4 concrete 45 kg/cm² or 640 #/□"
l/r for compression member not over 120 for ??? ??? 140 for ??? ???
l/r for ??? ??? ??? ??? to 200

Strength of concrete 1:2:4 mixture

Direct compression for column	35 kg/cm²	or	500 1bs/□"
compression fibre stress	45		640
combined stress for column	35		500
combined stress for arch	15		640
punching shear	9		128
shear plain concrete	4		58
Bond stress for plain bar	6		85
Bond stress for deformed bar	9		130
shear for reinforced concrete with web reinforcement			128
l/r for reinforced concrete compression ??? limited to			50

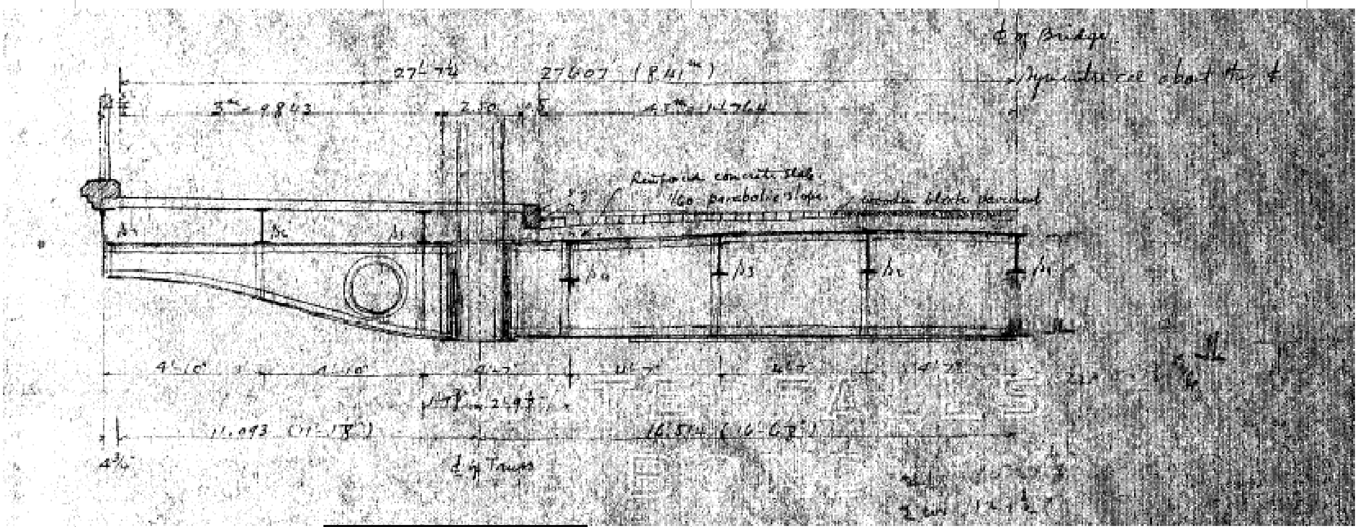
□Miscellaneous ???

Ratio ??? ??? of ??? ?? of steel and concrete n = 15
Expansion ??? of concrete 0.0000011 per 1℃
〃 〃 〃 0.0000012 〃
Temperature change for concrete ??? ±15℃
〃 〃 〃 steel ??? ±30℃

standard temperature assumed 20℃
Acceleration of earthquake 3300 $^{mm}/_{sec^2}$

☐Assumed cross section of bridge

Roadway	9 meters = 29.5285' clear
sidewalk	3 meters = 9.843' clear
span length	12@15'-3 $\frac{1}{2}$" = 183'-6"



WATERRALLS
BOND

under carriage way

☐Design of floor slab span length 4'-7" = 4.58'

Dead load

3" wooden block pavement		$15^{\#}$
1" mortar cushion $\frac{110}{12}$	say	10
floor slab assumed		75
$\frac{1}{2}$" allowance		6
		$106^{\#}$

Dead load moment = $\frac{1}{10} \times 106 \times 4.58^2 =$ 223'#

〃 〃 shear = $\frac{1}{2} \times 106 \times 4.58 =$ 243#

Live load

concentration

motor truck loading wheel conc 9920#

30% impact 2980

12900#

Front wheel say 12900 ÷ 3 = 4300#

Live load distribution

Transverse thickness 4" .66

20cm .66

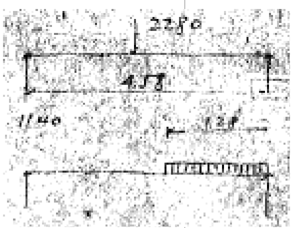
Longitudinal a = 1.32

Transverse distribution for b = 1.28 + 0.66 = 1.94

Effective width = $\frac{2}{3}(4.58+1.94)+1.32$

Load per ft 12900 ÷ 5.67 = 2280#

Live load moment



m = 1140 × 2.29 = 2610'#

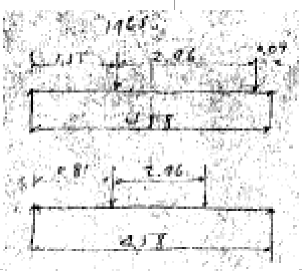
for continuity of slab m = 2610 × 0.8 = 2090'#

End shear = $2280 \times \frac{3.94}{4.58}$

For double wheel b = 0.9m + t + 2d = 2.95 + 1.28 + 0.66

Effective width = $\frac{2}{3}(4.58+4.89)+1.32 = 7.6372^{m}$ = 6.56'

load per ft strip = 12900 ÷ 6.56 = 1965



Live load moment = $1965 \times \frac{3.03}{4.58} \times 1.55 = 1077'^{\#}$

Live load moment = 1965 × 0.81 = 1592'#

for continuity 1592 × 0.8 = 1275'# say

Sum many for moment and shear

	moment	shear
D.L	223	243
L.L	2090	1960
	2313'#	2203#

Effective depth of slab for steel 17000#/☐" concrete 640#/☐" n = 15

$d = \sqrt{\frac{M}{bk}} = \sqrt{\frac{2313}{102}} = 4.75"$

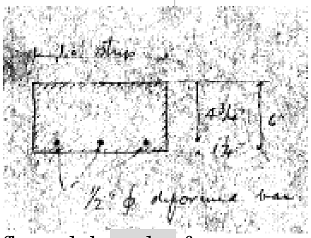
make slab 6" thick ??? $1\frac{1}{4}$" insulation

steel req'd = $\frac{2313 \times 12}{\frac{7}{8} \times 4.75 \times 17000}$ = 0.393☐"

use $\frac{1}{2}$"φ bar 6" spacing

its area = 0.39☐"

perimeter 2 @ 1.57 = 3.14"



Bond stress = $\frac{2203}{\frac{7}{8}\times 4.75\times 3.14}$ = 169#/□" > 130#

use $\frac{1}{2}$"φ 4" spacing

its area = 3 @ 0.1963 = 0.5889□"

perimeter 3 @ 1.57 = 4.71"

Bond stress = $\frac{2203}{\frac{7}{8}\times 4.75\times 4.71}$ = 113#/□" < 130#

deformed bar used

□Design of floor slab under footway span length = 4'-10" = 4.83

Dead load

1" mortar ???	10#
4" slab	50
	60#／sq ft say

Dead load moment $\frac{1}{8}\times 60\times 4.83^2 = 175'$#

〃 〃 shear $\frac{1}{2}\times 60\times 4.83 = 145$#

Live load Uniform load ??? ??? = 100#/□'

Live load moment $\frac{1}{8}\times 100\times 4.83^2 = 292'$#

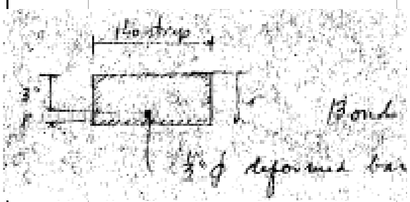
Live load shear $\frac{1}{2}\times 100\times 4.83 = 242$#

Sum many for moment and shear

	moment	shear
Dead load	175	145
Live load	292	242
	467'#	387#

Action of slab

Effective depth of slab d = $\sqrt{\frac{467}{102}}$ = 2.2" make 4" thick with 1" insulation



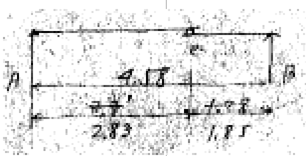
steel area reqd $\frac{467\times 12}{\frac{7}{8}\times 3\times 17000}$ = 0.126□"

use $\frac{1}{2}$"φ 1.0' spacing its area = 0.196□"

its perimeter = 1.57"

Bond stress $\frac{387}{0.875\times 3\times 1.57}$ = 94# deformed bar used.

□Design of floor slab span length 4'-7" = 4.58'



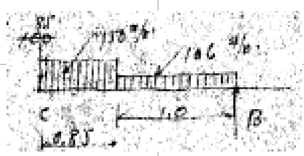
Dead load 60#/□'

Live load 100

Reaction on due to D.L = $60\times\frac{2.82}{2} = 85$#

〃 〃 L.L = $100\times\frac{3.58^2}{2\times 2.83} = 225$# say

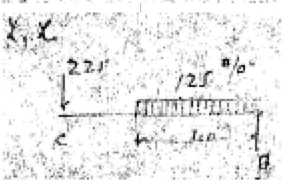
BC as a cantilever arm



D.L = 106#/□'

D.L moment = $106\times\frac{1}{2}+150\times 0.85\times 1.43+85\times 1.85$

= $53+182+157 = 392'$#



L.L moment = $225\times 1.85+125\times\frac{1}{2} = 417+63 = 480'$#

Total mt = $392+480 = 872'$# < 2213'#