مراجعه steel
رابعه انشاءات
م/ا عزى ⑤

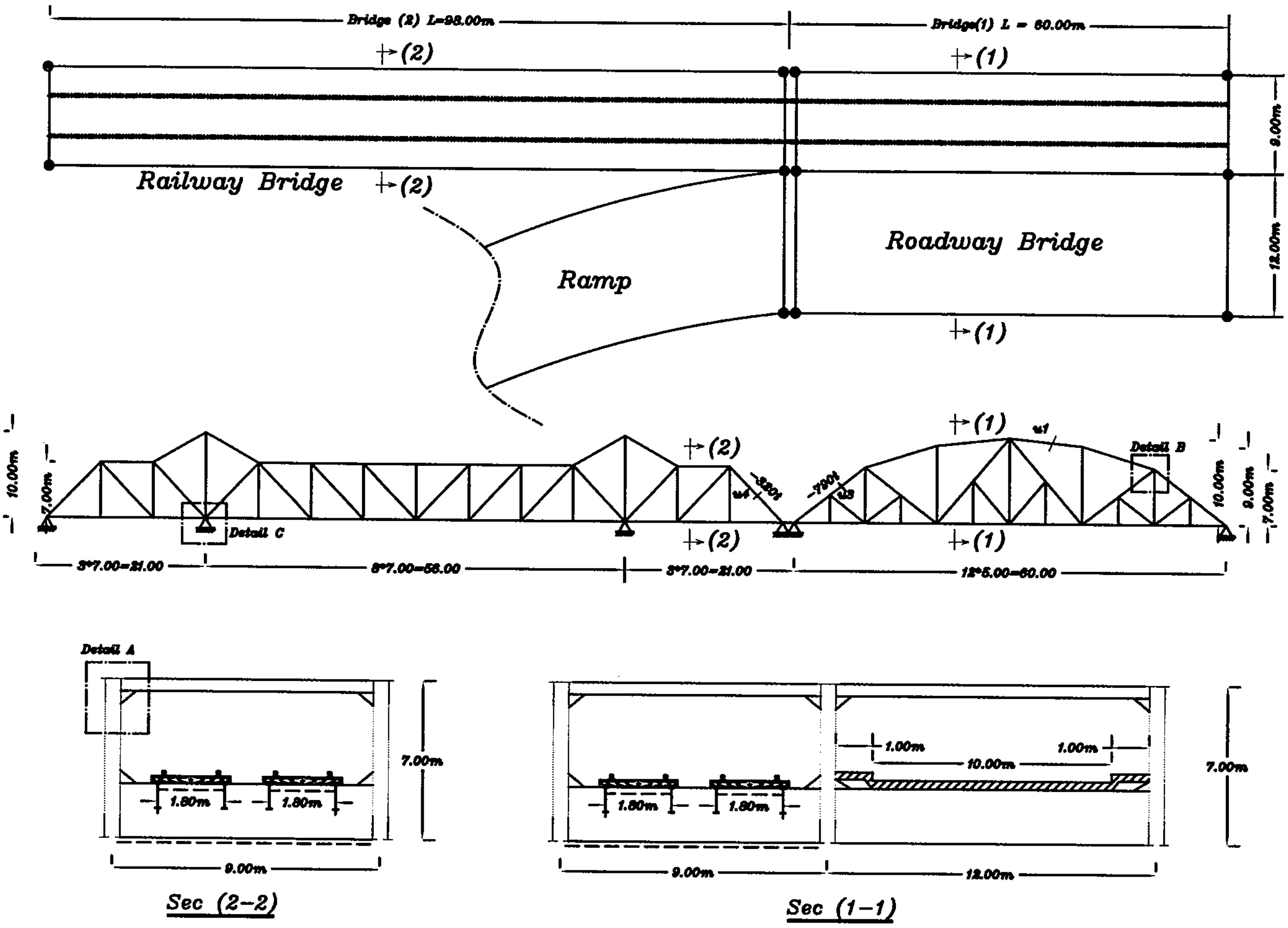
Final Term Revision

Part 3

Examples

2013-2014

- *Material of Construction is steel 44*
- *any missing data may be reasonably assumed*



A combined road–railway through bridge is adjoined at Bridge (1) , with three main camel–back truss system , as shown is the figure, Railway is double–track line and the roadway is 10.00m wide with two sidewalks 1.00m each as shown in section (1–1). Only the rail way line is continual over Bridge 2 with the through truss configuration as shown as shown in the figure above it is required to :

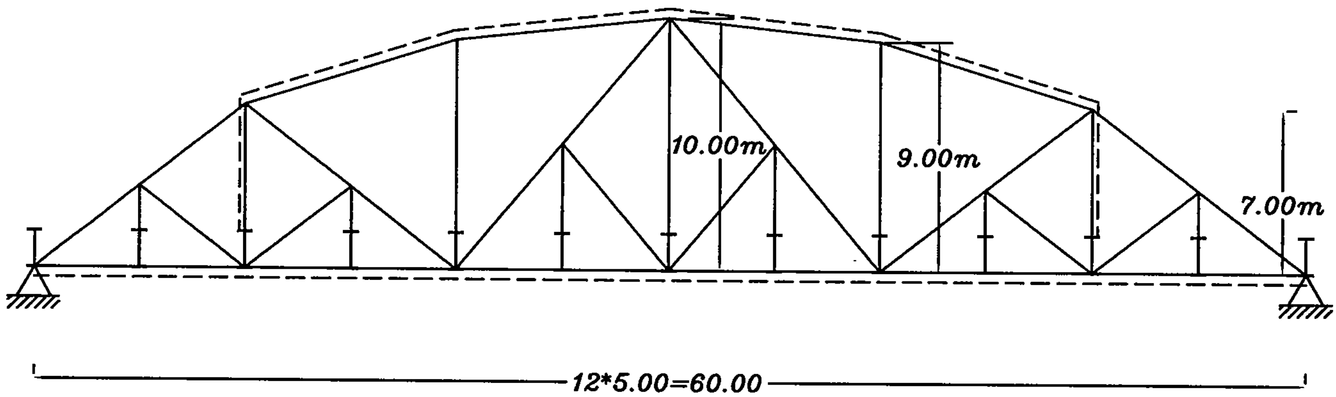
1–Draw a complete general layout for both bridges (1)&(2) to reasonalble sclae (plans, elevations & cross sections) showing the required bracings of both bridges

2-Draw to scale 1:10 .assume any missind Data (DetailA,B,C)

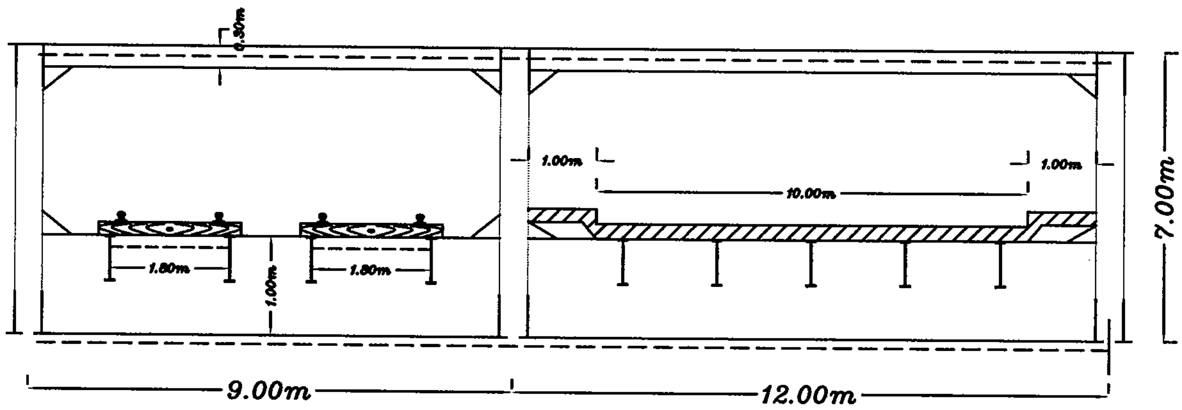
3-For the marked member calculate the max. forces due to Live load+Impact

4-Design the two marked members U3 , U4.

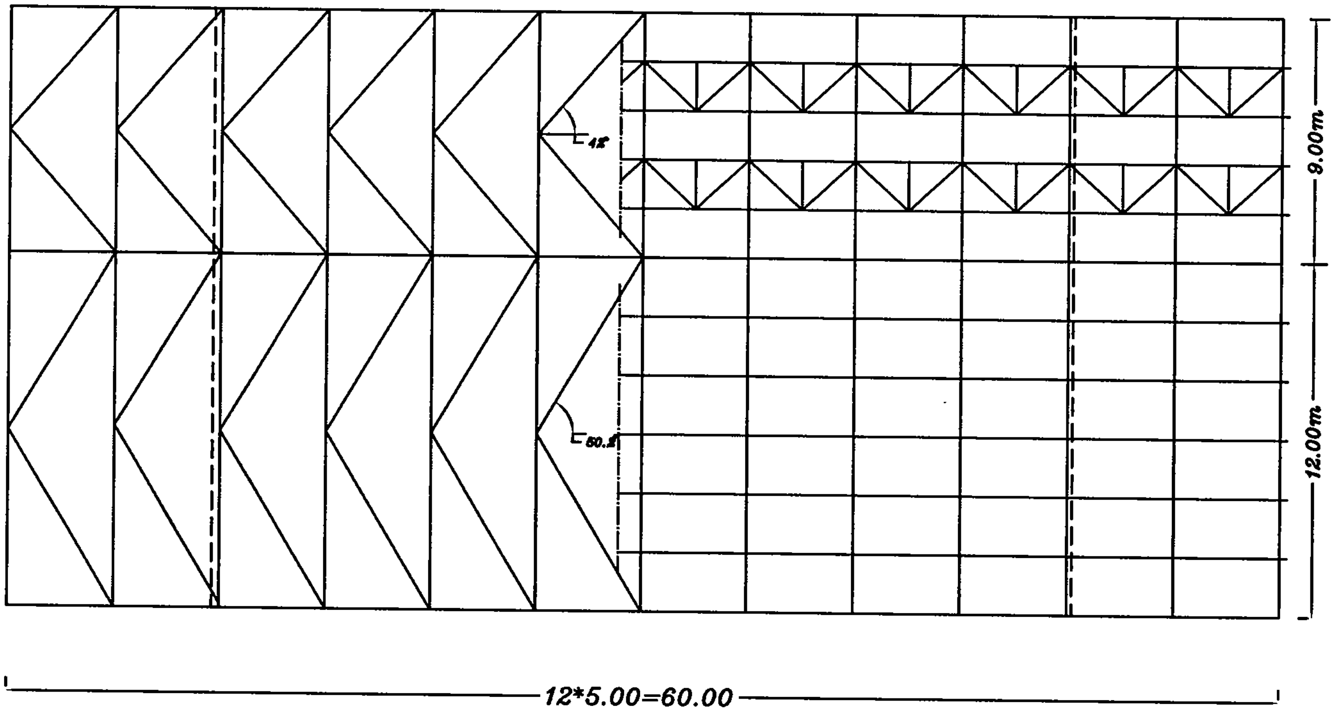
Bridge one



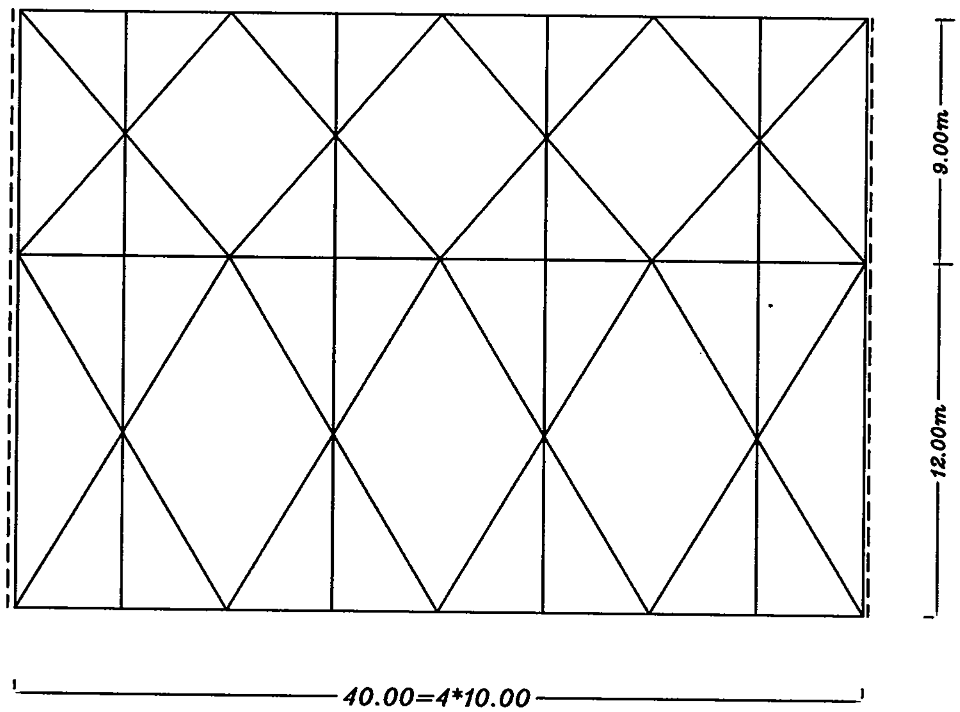
Elevation



Sec (1-1)

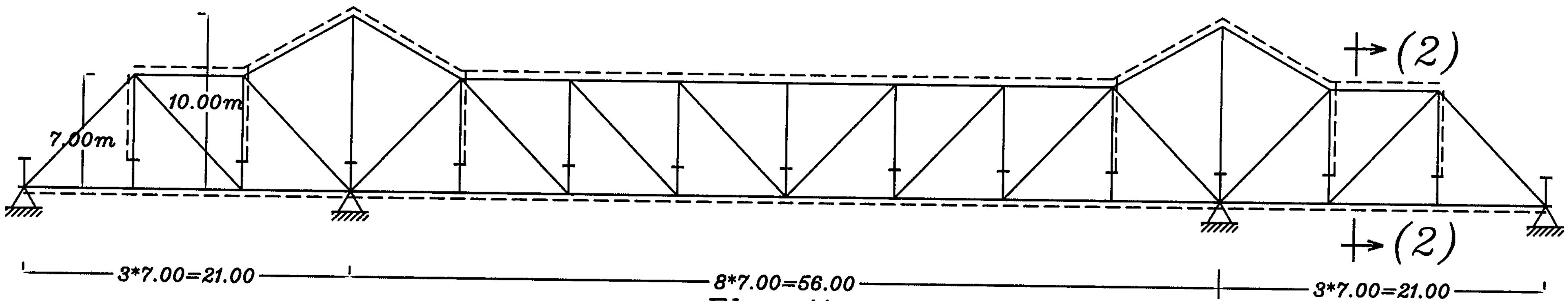


Plan of lower bracing

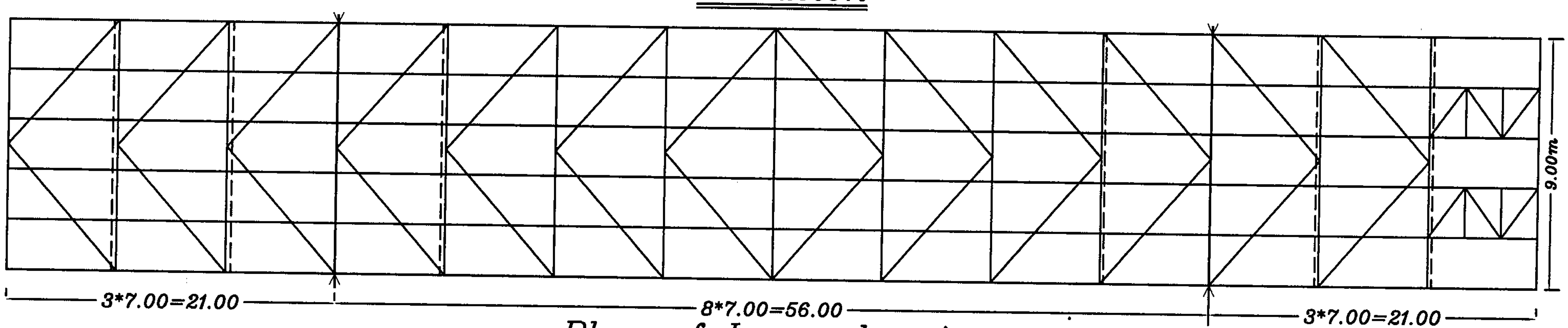


Plan of upper bracing

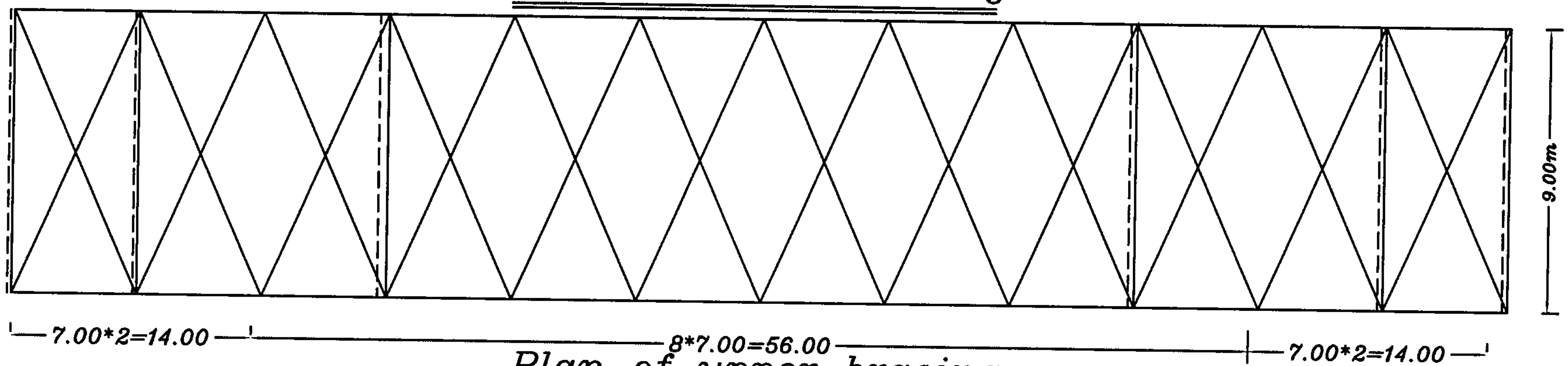
Bridge two



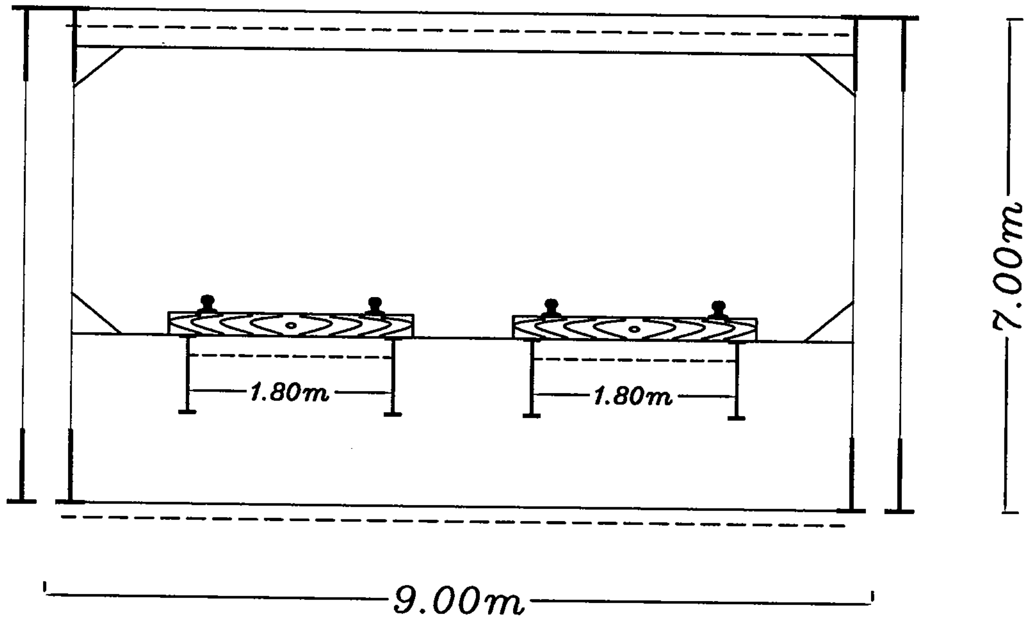
Elevation



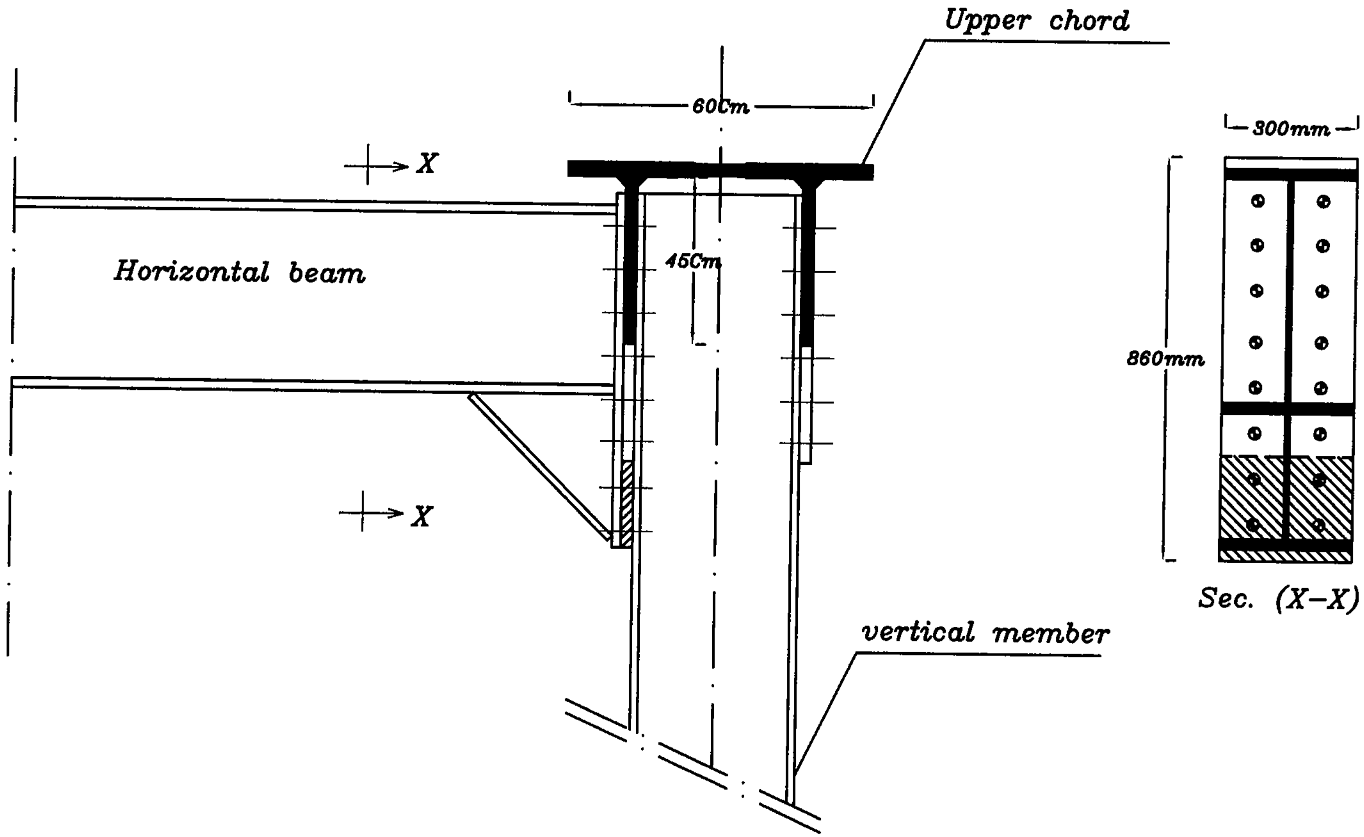
Plan of Lower bracing



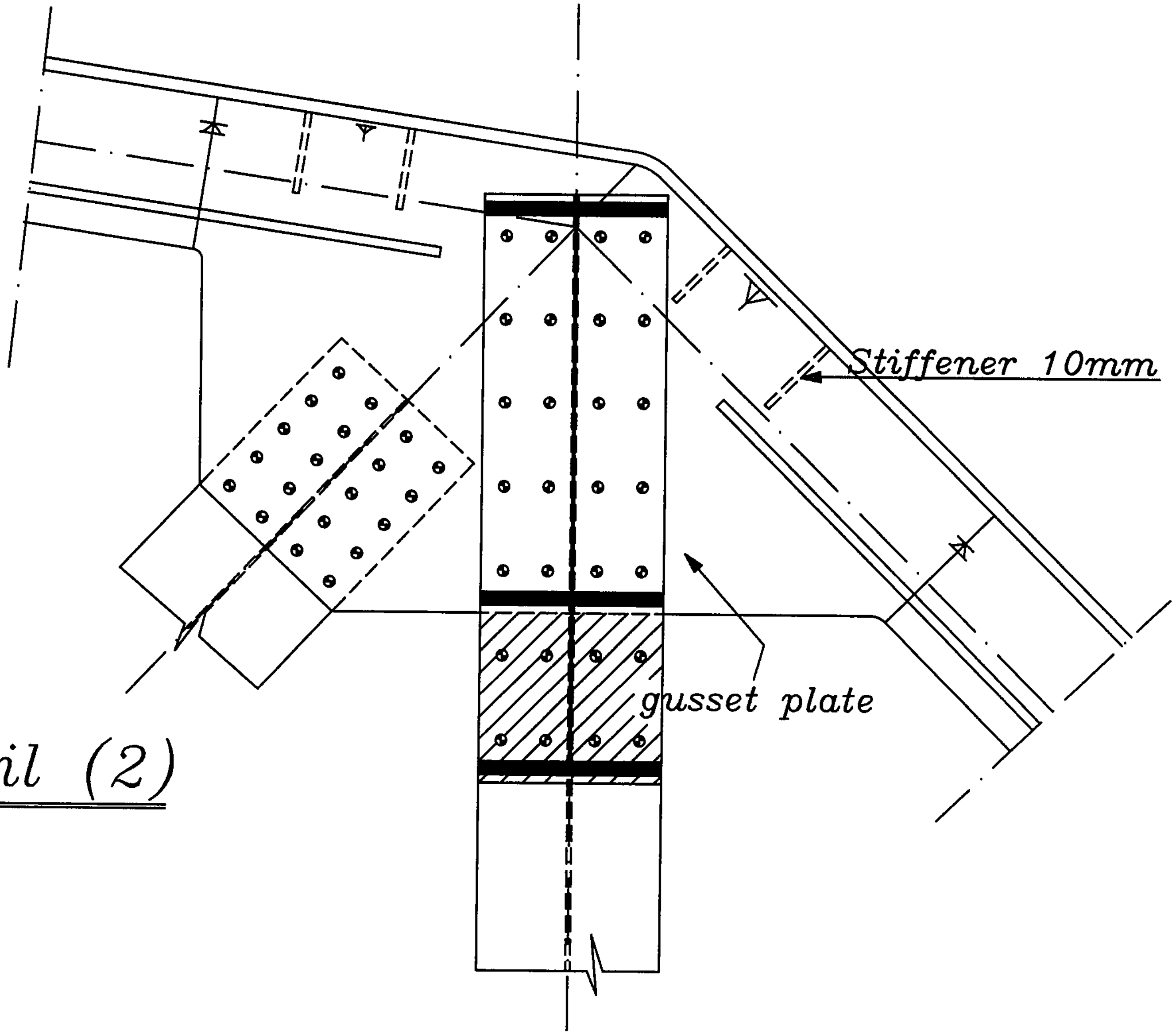
Plan of upper bracing



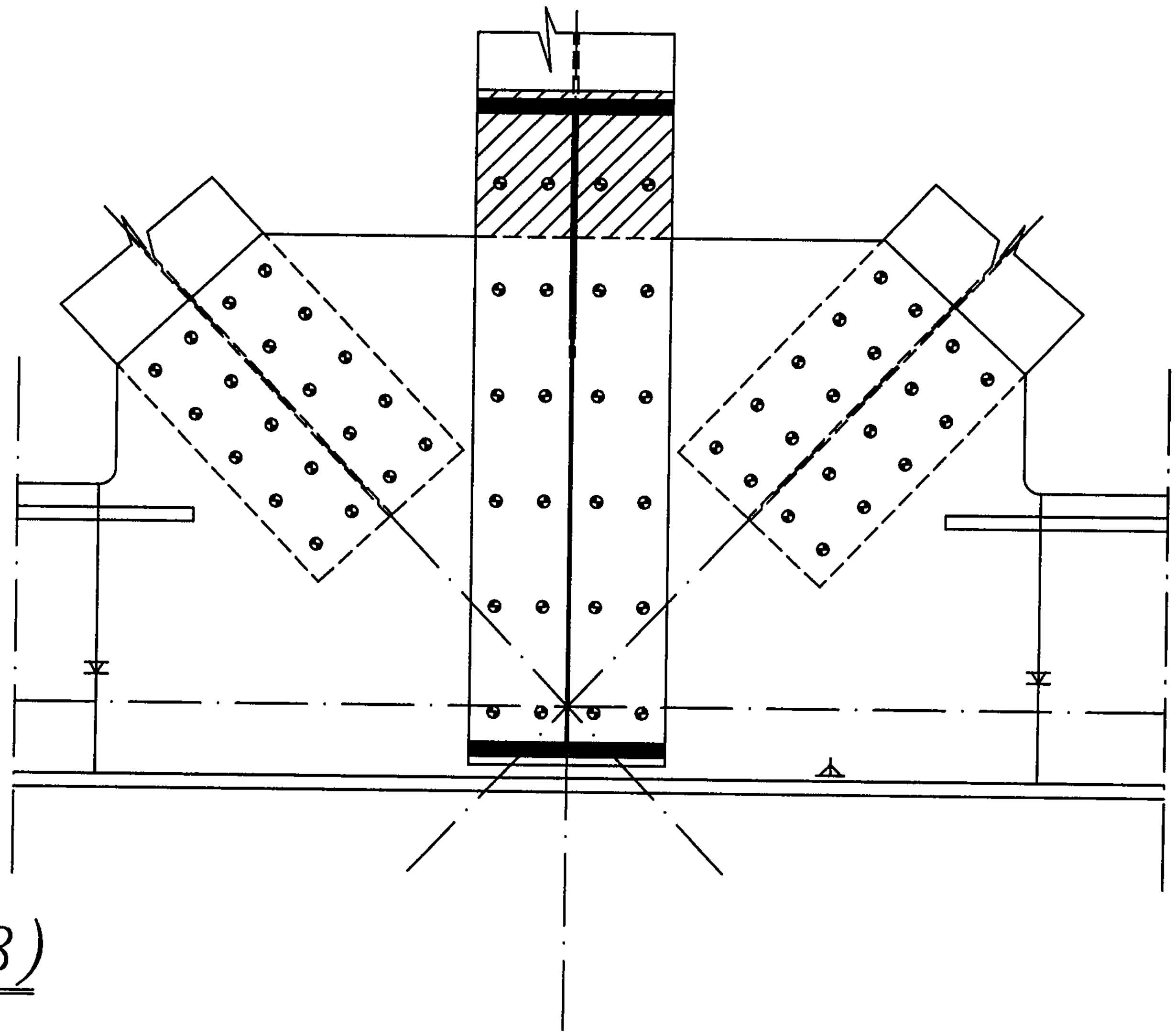
Sec (2-2)


Upper chord
60Cm
X
X
Horizontal beam
45Cm
vertical member
300mm
860mm
Sec. (X–X)

Detail (1)



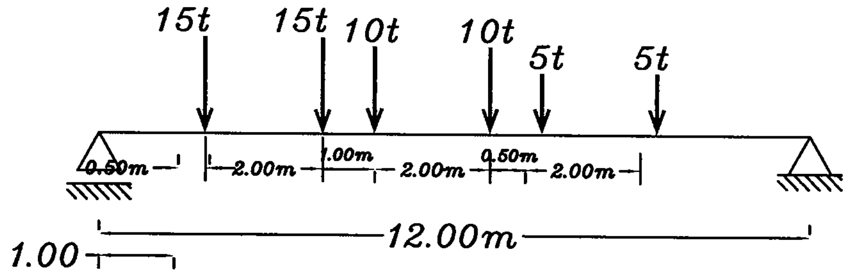
Detail (2)



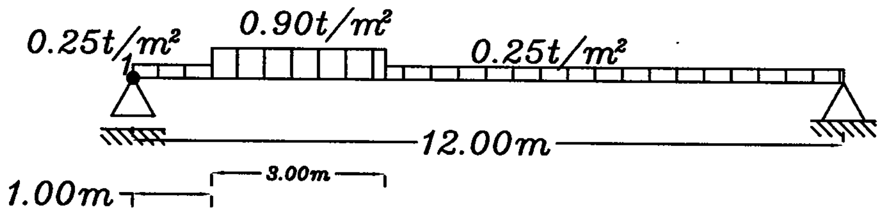
Detail (3)

Question 3

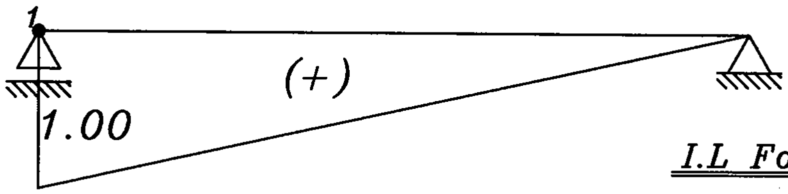
For road way part



Strip1
Get R



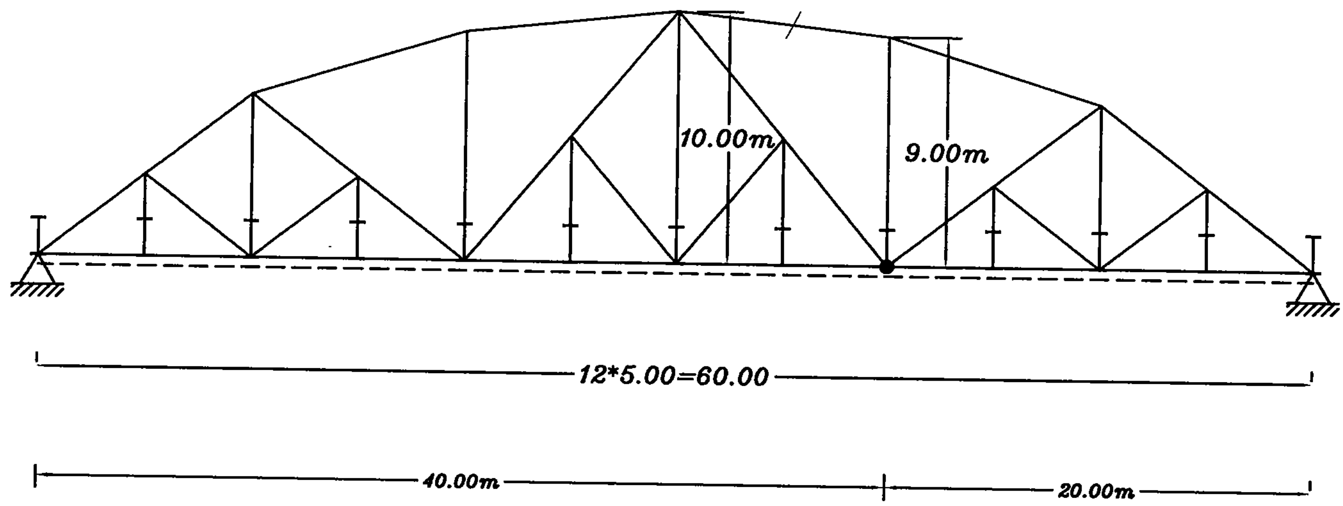
Strip2
Get W

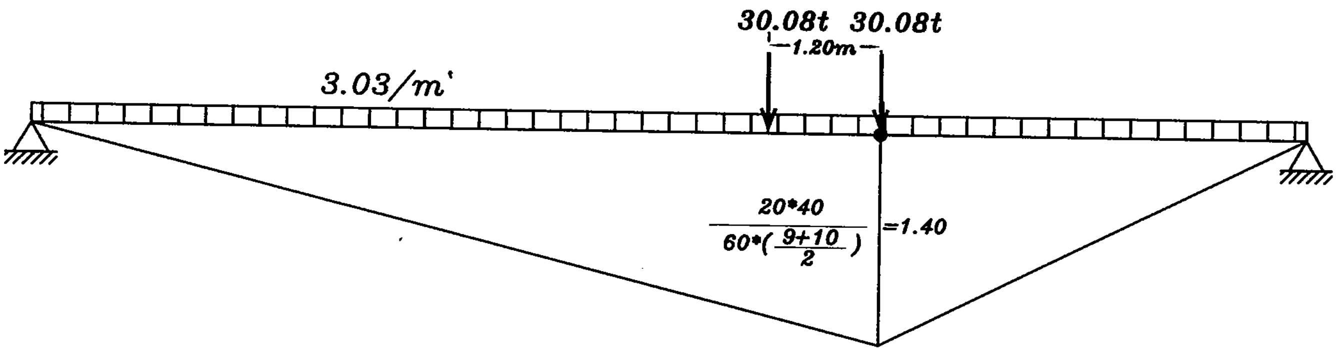


I.L For Reaction
@ 1

$$R_1 = 15*\left(\frac{10.5+8.5}{12}\right) + 10*\left(\frac{7.5+5.5}{12}\right) + 5\left(\frac{4.5+2.5}{12}\right) = \boxed{30.08t}$$

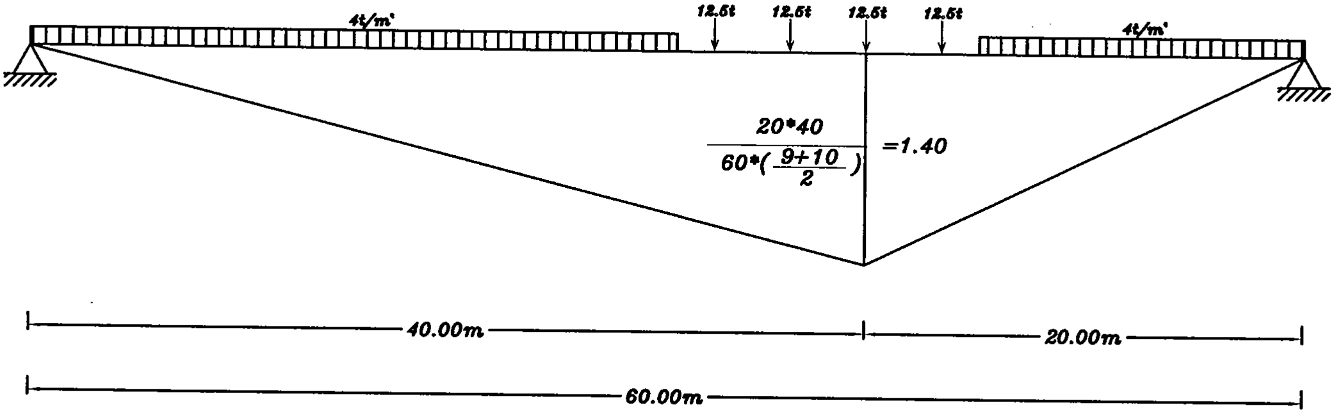
$$W_1 = 0.25*1.0*0.958 + 0.9*3*0.79 + 0.25*8.00*0.33 = \boxed{3.032t/m'}$$





$$F_{\underset{Road}{LL+I}} = 30.08*1.40 + 30.08*1.358 + 3.03*0.5*1.40*60 = \boxed{210.22t}$$

For rail way part



$F_{LL_{Rail}} = 3*12.5*1.344+12.5*1.288+4(36*0.63+17.6*0.616) = \boxed{200.58t}$

$(1+I) = 0.73+\frac{2.16}{\sqrt{60.0}-0.2} = 1.01 \boxed{< 1.1, \text{ ues } 1.1}$

$F_{LL+I_{Rail}} = 200.58*2*1.1 = \boxed{441.276t}$

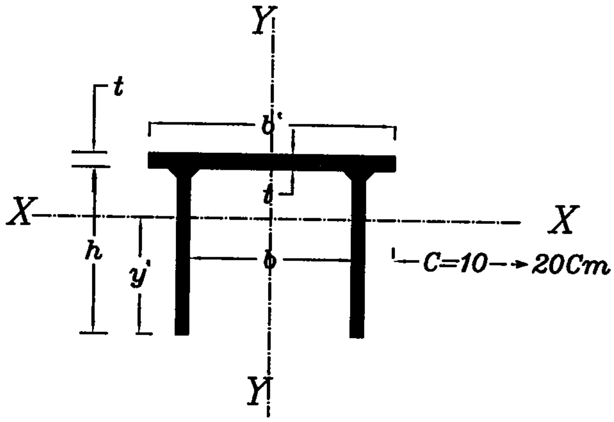
$F_{LL+I_{Rail+Road}} = 441.276t+210.22t = \boxed{-651.496t \text{ Comp.}}$

Question 4

Design of U3 (−790t Comp.)

1) assume compression stress to be :

$F_c = 1.3 t/Cm^2$ For St.44



$h = \dfrac{\text{Pannel length}}{10 \longrightarrow 15} = \dfrac{500}{10 \longrightarrow 15}$

h = 50Cm to 33.3Cm

use h = 45Cm

use b = 45Cm

b' = b+2*(10 ⟶ 20Cm)

b' = 45+2*(10 ⟶ 20Cm) = 65Cm to 85Cm use b' = 65Cm

2) $F_c = \dfrac{\text{max. force}}{\text{area}}$ $\quad 1.3 = \dfrac{790}{\text{area}}$

area = 607.7Cm^2

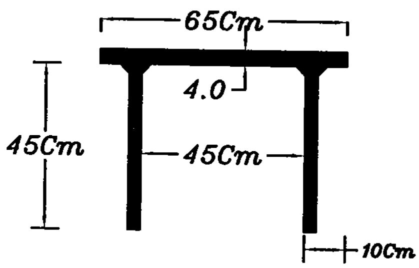
A=2ht+b'*t = ...Cm^2

607.7 = 2*45*t+65*t , t =3.92Cm

take t = 4.00Cm

Checks

1−Check Compactness



$\dfrac{b}{t} = \dfrac{45-2*1}{4.0} = 10 < \dfrac{64}{\sqrt{2.8}} = 38.2$

$\dfrac{C}{t} = \dfrac{10-4.0-1}{4.0} = 1.2 < \dfrac{21}{\sqrt{2.8}} = 12.5$

$\dfrac{h}{t} = \dfrac{45-1}{4.0} = 11 < \dfrac{30}{\sqrt{2.8}} = 17.9$

2-Check global buckling

$$y' = \frac{(2ht*0.5h)+b'*t(h+0.5t)}{2ht+b't} = ...Cm$$

$$y' = \frac{(45*4.0*22.5*2)+(65*4*47.5)}{(45*4.0*2)+(65*4)} = 32.9Cm$$

$$I_X = 2*\frac{t*h^3}{12} + 2*t*h*(y'-0.5h)^2 + b'*t*(y'-h-0.5t)^2 = ...Cm^4$$

$$I_X = 2*\frac{4.0*45^3}{12} + 2*4.0*45*(32.9-22.5)^2 + 4.0*65*(47-32.9)^2$$

$$I_X = 151378 \quad Cm^4$$

$$I_Y = [\frac{4.0*65^3}{12}] + 2*4.0*45*(22.5+2)^2 = 307631 \quad Cm^4$$

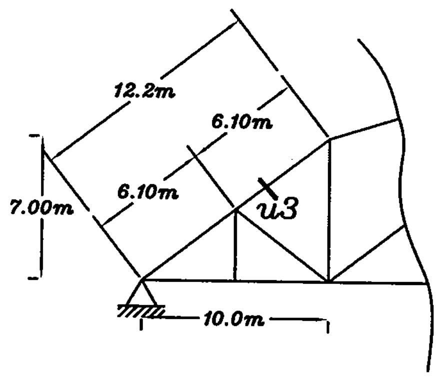
$$A = (4.0*2*45) + (65*4.0) = 620 \quad Cm^2$$

Calculate $r_X = \sqrt{\frac{I_X}{A}} = \sqrt{\frac{151378}{620}} = 15.62Cm$

Calculate $r_Y = \sqrt{\frac{I_Y}{A}} = \sqrt{\frac{307631}{620}} = 22.27Cm$

$$\lambda_{in} = \frac{0.85L}{r_X} = \frac{0.85*610}{15.62} = 33.19 < 90$$

$$\lambda_{out} = \frac{L_{Out}}{r_Y} = \frac{0.85*1220}{22.27} = 46.56 < 90$$



3-Check Compressive Stresses

actual stresses $= f_{ca} = \frac{790}{620} = 1.27 \ t/Cm^2$

allwable stresses $= F_c = 1.6 - 8.5*10^{-5} * \lambda^2_{max.}$ For St.44

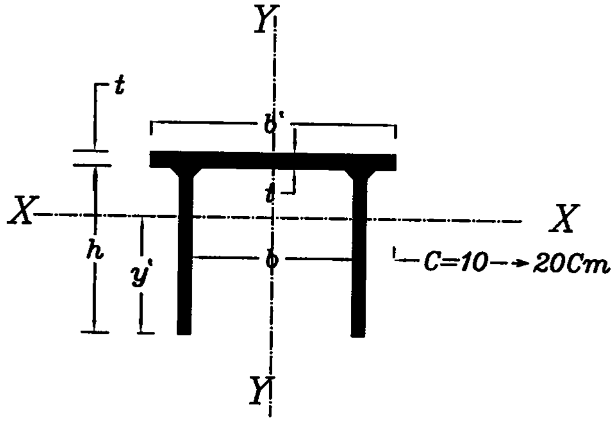
allwable stresses $= F_c = 1.6 - 8.5*10^{-5} * 46.5^2 = 1.41 \ t/Cm^2$

Question 4

Design of U4 (−320t Comp.)

1)assume compression stress to be :

$F_c = 1.3 t/Cm^2$ For St.44



$$h = \frac{\text{Pannel length}}{10 \longrightarrow 15} = \frac{700}{10 \longrightarrow 15}$$

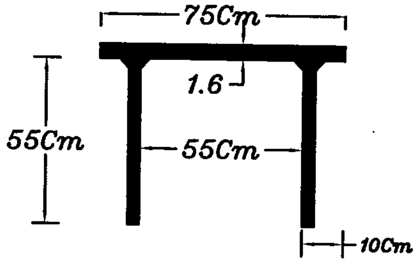
h = 70Cm to 46.6Cm

use h = 55Cm

use b = 55Cm

b'= b+2*(10 ⟶ 20Cm)

b'= 55+2*(10 ⟶ 20Cm) = 75Cm to 95Cm use b' = 75Cm



$$2) F_c = \frac{\text{max. force}}{\text{area}} \qquad 1.3 = \frac{320}{\text{area}}$$

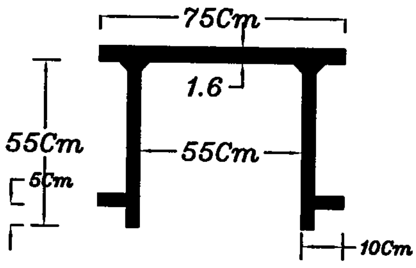
area = 246.1 Cm^2

A=2ht+b'*t = ...Cm^2

246.1 = 2*55*t+55*t , t =1.49Cm use t = 16mm

take t = 1.60Cm

Checks



1−Check Compactness

$$\frac{b}{t} = \frac{55-2*1}{1.6} = 33 < \frac{64}{\sqrt{2.8}} = 38.2$$

$$\frac{C}{t} = \frac{10-1.6-1}{1.6} = 4.6 < \frac{21}{\sqrt{2.8}} = 12.5$$

$$\frac{h}{t} = \frac{55-1}{1.6} = 33 > \frac{30}{\sqrt{2.8}} = 17.9$$ unsafe use stiffener

2-Check global buckling

$$y' = \frac{(2ht*0.5h)+b'*t(h+0.5t)}{2ht+b't} = ...Cm$$

$$y' = \frac{(55*1.6*27.5*2)+(75*1.6*55.8)}{(55*1.6*2)+(75*1.6)} = 38.9Cm$$

$$I_X = 2*\frac{t*h^3}{12} + 2*t*h*(y'-0.5h)^2 + b'*t*(y'-h-0.5t)^2 = ...Cm^4$$

$$I_X = 2*\frac{1.6*55^3}{12} + 2*1.6*55*(38.9-27.5)^2 + 1.6*75*(55.8-38.9)^2$$

$$I_X = 101512 \quad Cm^4$$

$$I_Y = [\frac{1.6*75^3}{12}] + 2*1.6*55*(27.5+0.8)^2 = 197206 \ Cm^4$$

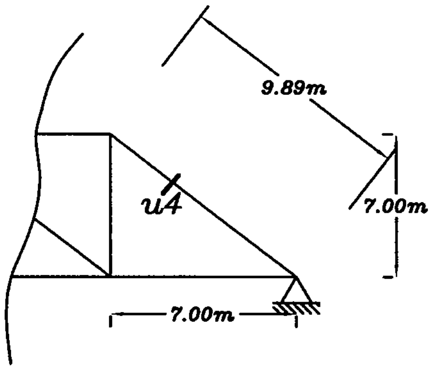
$$A = (1.6*2*55) + (75*1.6) = 296 \ Cm^2$$

Calculate $r_X = \sqrt{\frac{I_X}{A}} = \sqrt{\frac{101512}{296}} = 18.51Cm$

Calculate $r_Y = \sqrt{\frac{I_Y}{A}} = \sqrt{\frac{197206}{296}} = 25.81Cm$

$$\lambda_{in} = \frac{0.85L}{r_X} = \frac{0.85*989}{15.62} = 53.81 < 90$$

$$\lambda_{out} = \frac{L_{Out}}{r_Y} = \frac{0.85*989}{22.27} = 37 < 90$$



3-Check Compressive Stresses

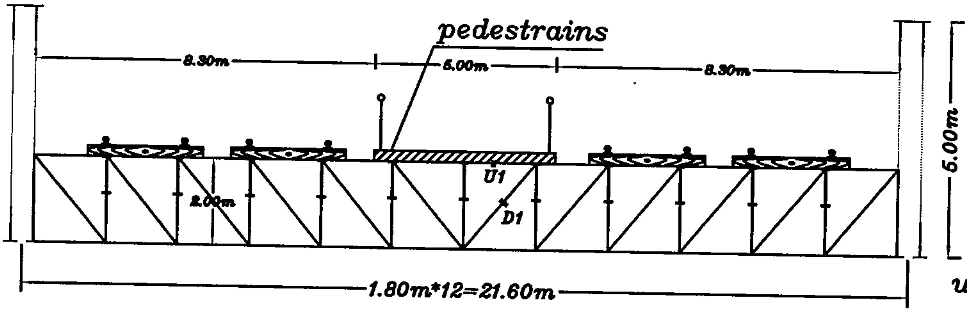
actual stresses $= f_{ca} = \frac{320}{296} = 1.08 \ t/Cm^2$

allwable stresses $= F_c = 1.6 - 8.5*10^{-5} * \lambda^2_{max.}$ For St.44

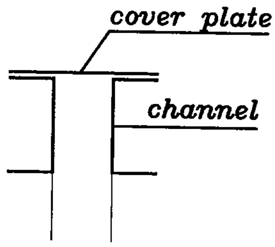
allwable stresses $= F_c = 1.6 - 8.5*10^{-5} * 53.8^2 = 1.35 \ t/Cm^2$

- Material of Construction is steel 44
- any missing data may be reasonably assumed

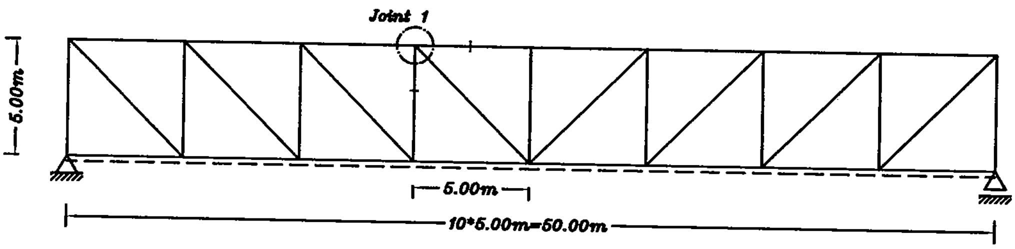
For the shown Road–rail way pony bridge having a X.G – truss of a 21.60m span and span of the bridge is 50.00m, spacing between X.G is 5.00m <u>it is required to:</u>



Cross Section

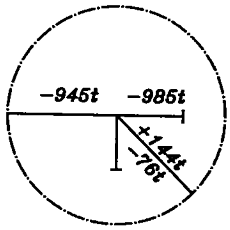


upper chord section for X.G truss



Knowing that $b = 420mm$ $\delta = 0.12$ Cm/t

Main Truss



Joint 1

1–for the above mentioned bridge draw to scale 1:100 Complete General lay out.

2–Calculate the design forces for the upper chord U1 (x.g).

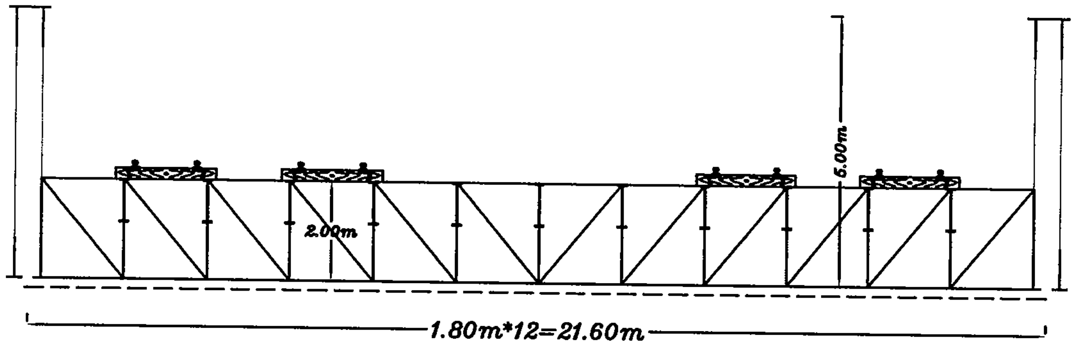
3–Calculate max. and min. force due to LL+I Only for D1 (x.g).

4–design a suitable double channel sction for the upper chord.

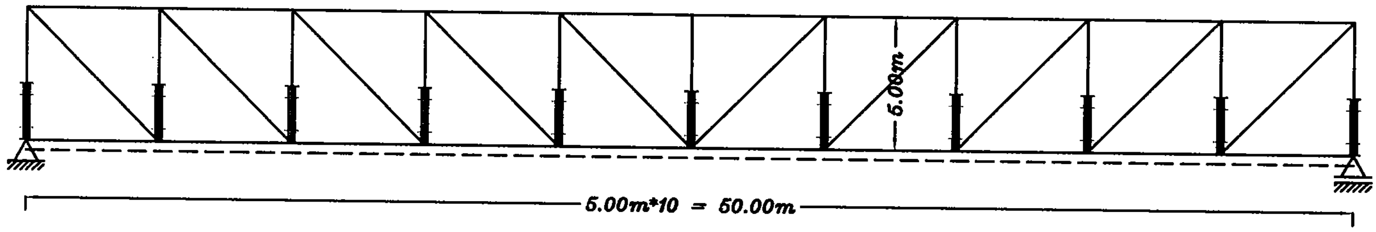
5–design a suitable section for two marked member in the main truss.

the live load on roadway part from pedestrains and it equal 300Kg/m²

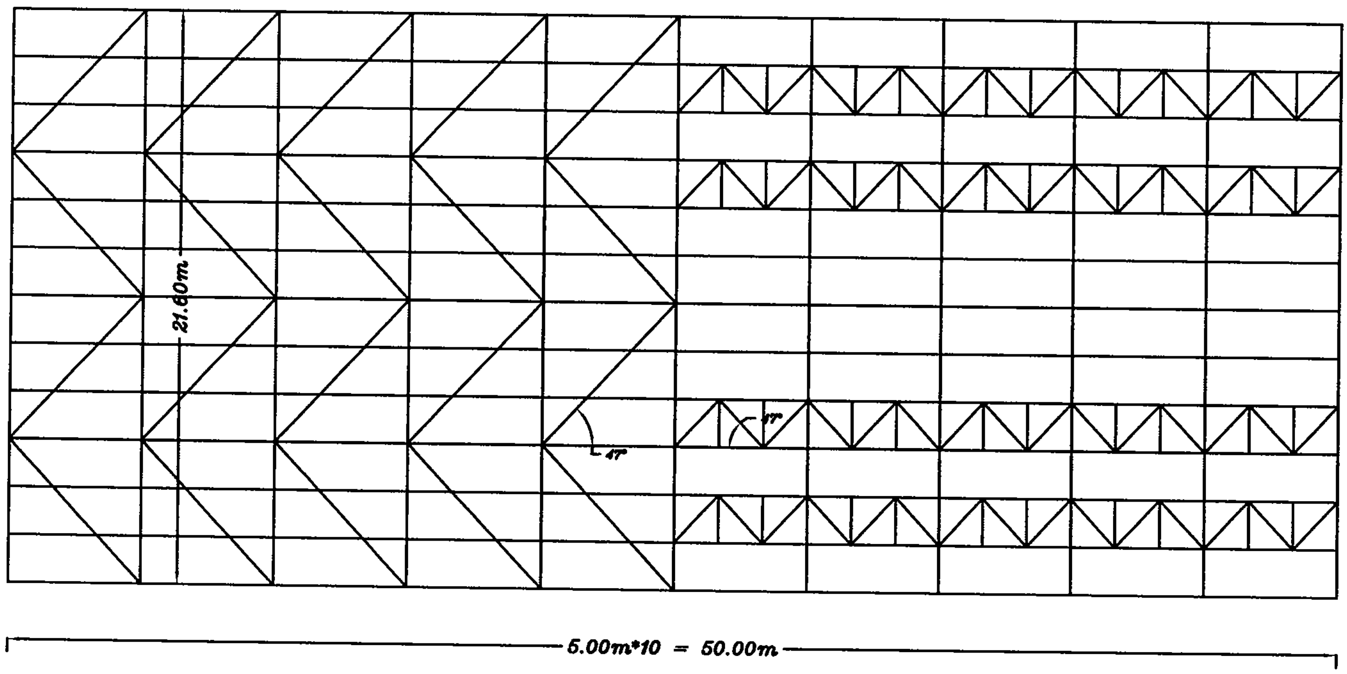
Question 1



Cross Section



Elevation



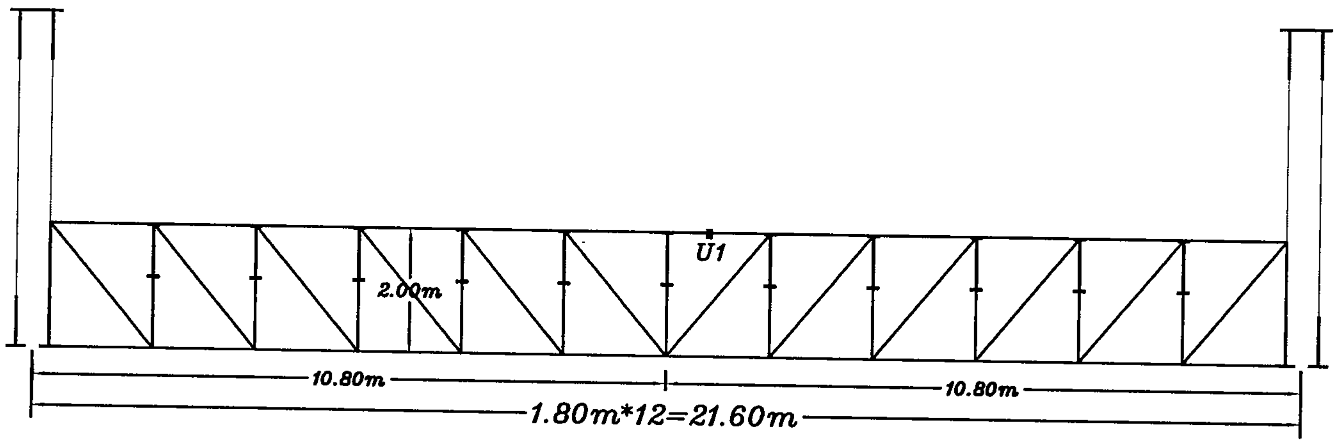
Plan of Lower Bracing

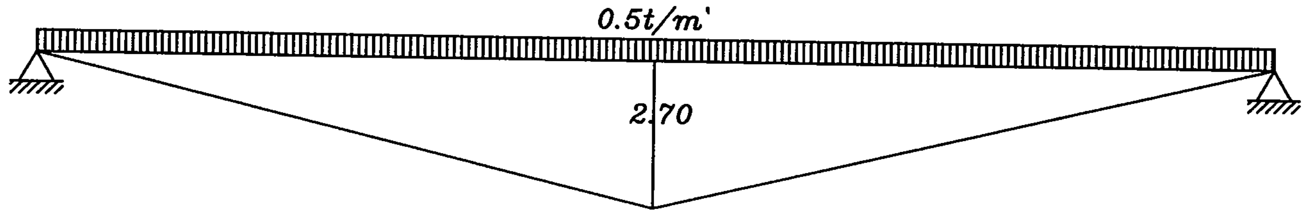
Question 2

upper chord u1

Dead loads

1−assume o.w of the truss is 0.5t/m'





$$F_{o.w} = 0.5*21.60*2.70*0.5 = 14.58t$$

2−due to rail and road part

2−i rail way part

$$W_{Dead} = 600/2 + 40/2 + O.W = ...Kg/m'$$

$$W_{Dead} = 0.6/2 + 0.04/2 + 0.15 = 0.47t/m'$$

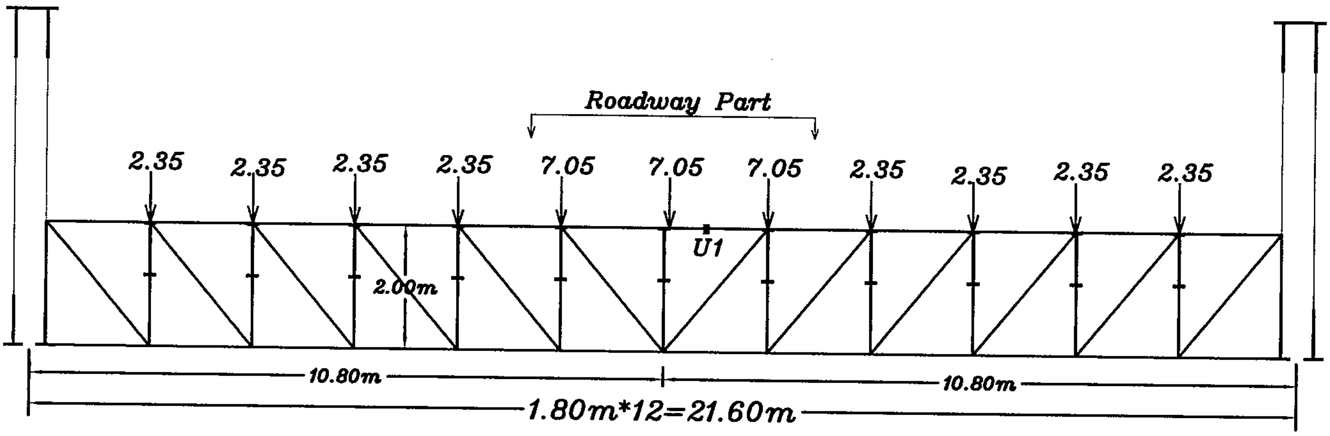
$$R_d = W_d * S = 0.47 * 5.00 = \boxed{2.35t}$$

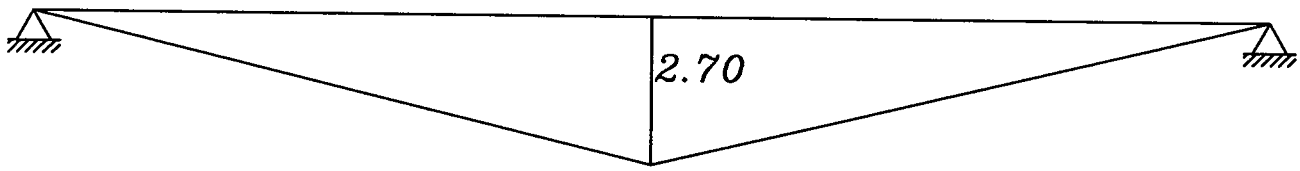
2−ii road way part

$$W_d = (\underbrace{0.21}_{t_{R.C}}*\underbrace{2.5}_{\gamma_c}+\underbrace{0.175}_{F.C})*\overbrace{1.80}^{Spacing} + \underbrace{0.15}_{O.W}$$

$$W_d = 1.41t\backslash m'$$

$$R_d = W_d * S = 1.41 * 5.00 = \boxed{7.05t}$$

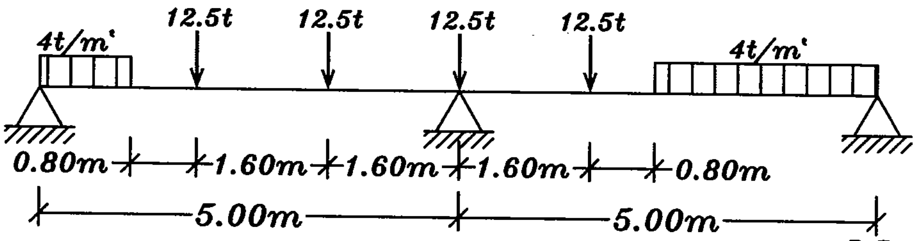




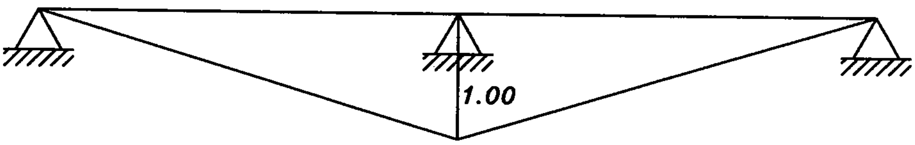
$F_{D.L} = 4*2.35*2*1.125+2*7.05*2.25+7.05*2.70 = 71.91t$

$F_{D.L_{u1}} = 71.91t + 14.58t = \boxed{-86.49t \text{ (comp.)}}$

upper chord u1
Live Load + impact
Railway Part



I.L Reaction



$R_{LL} = 3*12.5*0.680+12.5*0.680+4*1.0*0.1+4*2.6*0.26$

$R_{LL} =$ **37.10t**

$$(1+I) = 0.73 + \frac{2.16}{\sqrt{L_1} - 0.2}$$

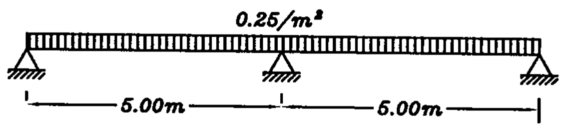
$L_1 = 2*21.6 = 43.2m$

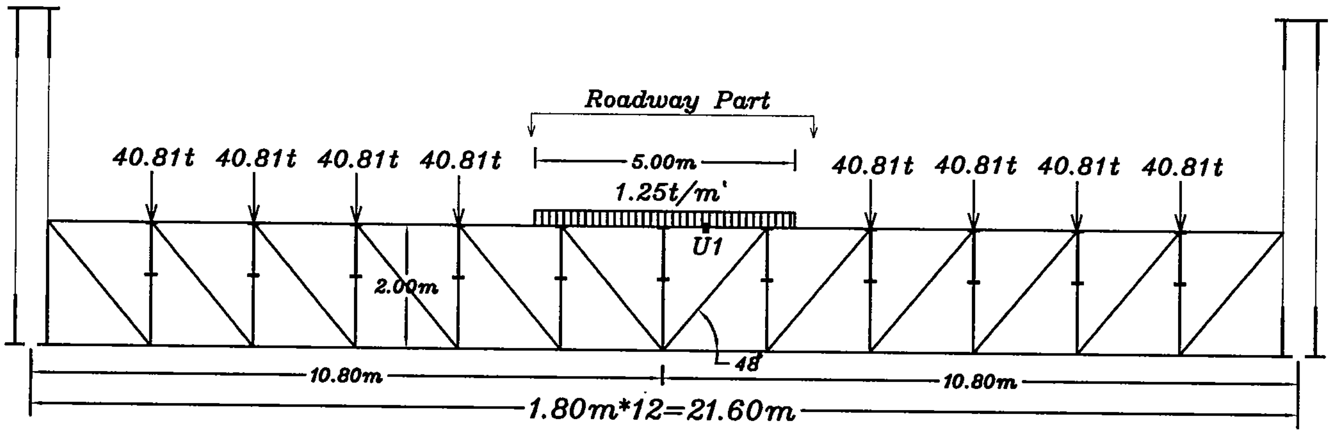
$$(1+I) = 0.73 + \frac{2.16}{\sqrt{43.2} - 0.2} = 1.06 \quad < 1.1 \text{ use } 1.1$$

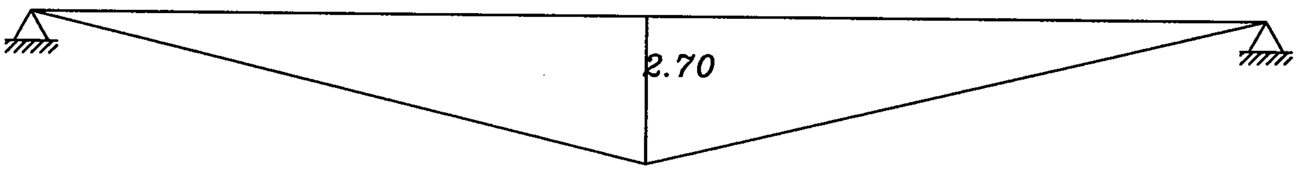
$R_{LL+I} = 37.10*1.1 = 40.81t$

Roadway Part

$W_{LL} = 0.25*5 = 1.25t/m'$







$F_{L.L+I} = 4*40.81*2*1.125+2*1.25*2.5*2.38 = 382.16t$

Design Values

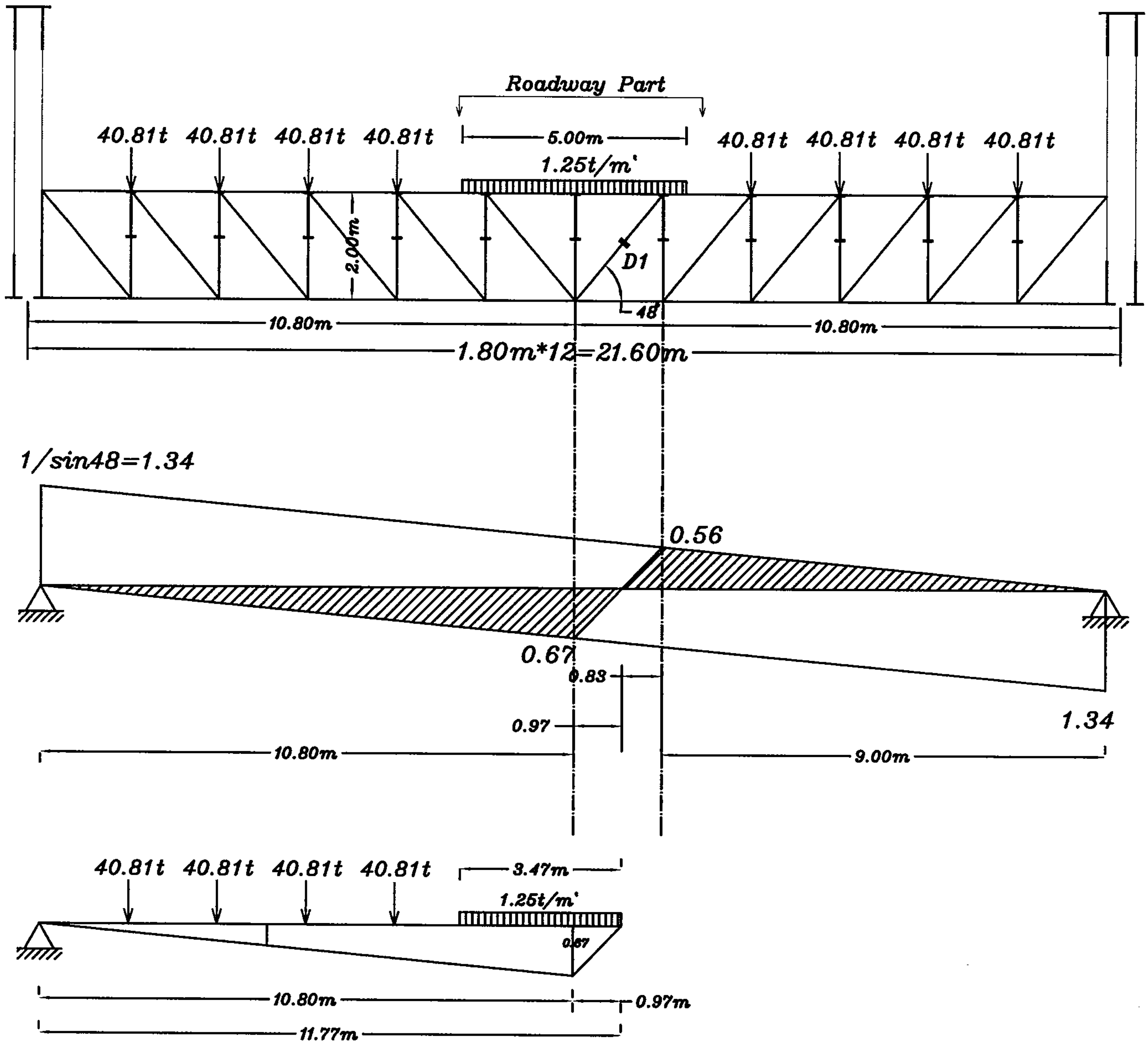
$F_{max.} = 382.16t+86.49 =$ **−468.65t (comp.)**

$F_{min.} =$ **−86.49 (comp.)**

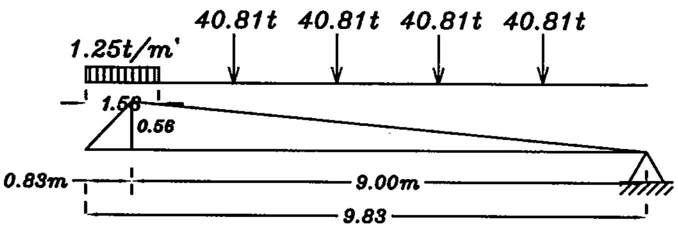
Question 3

Diagonal D2

Live Load + impact



$F_{L.L+I(tens.)}=1.25*0.97*0.335+1.25*2.5*0.59+4*40.81*0.28=+47.95t$

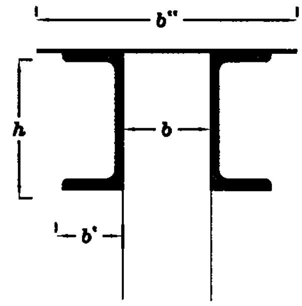


$F_{L.L+I(comp.)}=1.25*0.83*0.28+1.25*0.7*0.54+4*40.81*0.28 \ =-46.4t$

Question 4

1)assume compression stress to be :

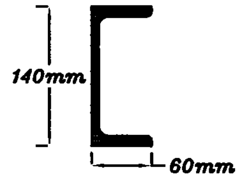
$F_c = 1.3 t/Cm^2$ For St.44



$$h = \frac{\text{Pannel length}}{10 \longrightarrow 15} = \frac{180}{10 \longrightarrow 15} = 12Cm \text{ to } 18Cm$$

use h = 14Cm

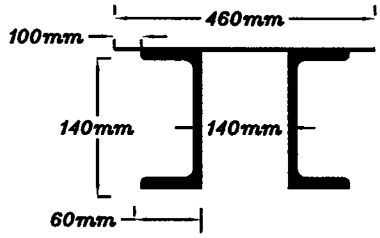
use b = 14Cm



choose U.P.N 140 channel from tables

b' from tables = 60 mm

$b'' = 14+2*6+2*10 = 46Cm$



$$2) F_c = \frac{\text{max. force}}{\text{area}} \qquad 1.5 = \frac{468.6}{\text{area}}$$

area = $324.4 Cm^2$

$A = 2*C + b''*t$, $324.4 = 2*20.4 + 46*t$, $t = 6.16$

try bigger c channel use U.P.N 240

use h = 24Cm use b = (0.80--1.00)*24 = 18Cm

use b' = 8.5Cm from tables U.P.N 240

$b'' = 18+2*8.5+2*10 = 55Cm$

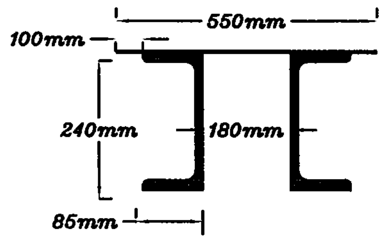
$A = 2*C + b''*t$, $324.16 = 2*42.3 + 55*t$, $t = 4.35$

take **t = 4.00Cm**

Checks

1-Check Compactness

$$\frac{b}{t} = \frac{18}{4.0} = 4.5 < \frac{64}{\sqrt{2.8}} = 38.2$$

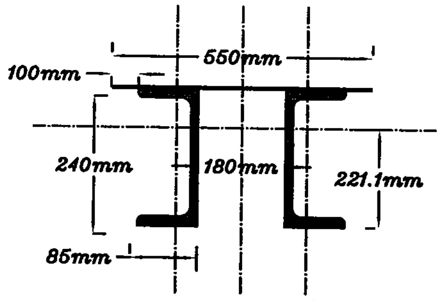


$$\frac{C}{t} = \frac{10}{4.0} = 2.5 < \frac{21}{\sqrt{2.8}} = 2.5$$

channel is non compact sec. from tables

2-Check global buckling

$$y' = \frac{2*42.30*12+55*4*(2+24)}{2*42.30+55*4} = 22.11Cm$$



$$I_X = 2*(3600+42.30*(22.11-12)^2)+55*4(26-22.11)^2 = \boxed{19176.20Cm^4}$$

$$I_Y = [\frac{4.0*55^3}{12}]+2*(248+42.30*(11.23)^2) = \boxed{66623.484\ Cm^4}$$

$$A = 55*4 + 2*42.30 = 304.6\ Cm^2$$

Calculate $r_X = \sqrt{\frac{I_X}{A}} = \sqrt{\frac{19176}{304.6}} = 7.93Cm$

Calculate $r_Y = \sqrt{\frac{I_Y}{A}} = \sqrt{\frac{66623}{304.6}} = 14.79Cm$

$$\lambda_{in} = \frac{0.85L}{r_X} = \frac{0.85*180}{7.93} = 19.3 < 90$$

$$\lambda_{out} = \frac{L_{Out}}{r_Y} = \frac{0.85*180}{14.79} = 10.34 < 90$$

3-Check Compressive Stresses

actual stresses $= f_{ca} = \frac{468.6}{304} = 1.54\ t/Cm^2$

allwable stresses $= F_c = 1.6-8.5*10^{-5} * \lambda^2_{max.}$ For St.44

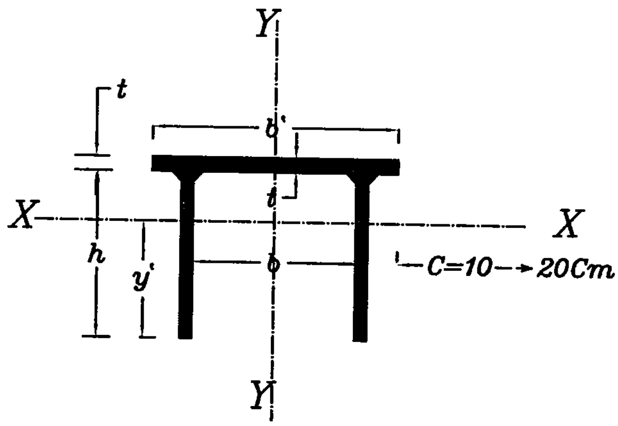
allwable stresses $= F_c = 1.6-8.5*10^{-5} * 19.3^2 = 1.56\ t/Cm^2$

Question 5

Design of Upper chord

1)assume compression stress to be :

$F_c = 1.3 t/Cm^2$ For St.44



$$h = \frac{\text{Pannel length}}{10 \longrightarrow 15} = \frac{500}{10 \longrightarrow 15}$$

$h = 50Cm$ to $33.3Cm$

use $h = 45Cm$

use $b = 42Cm$ (given)

$b' = b + 2*(10 \longrightarrow 20Cm)$

$b' = 42 + 2*(10 \longrightarrow 20Cm) = 62Cm$ to $82Cm$ use $b' = 62Cm$

2) $F_c = \frac{\text{max. force}}{\text{area}}$ $\quad 1.3 = \frac{985}{\text{area}}$

area $= 757.7 Cm^2$

$A = 2ht + b'*t = \ldots\ldots Cm^2$

$757.7 = 2*45*t + 62*t$ $\quad , \; t = 4.98Cm$

take $t = 5.00Cm$

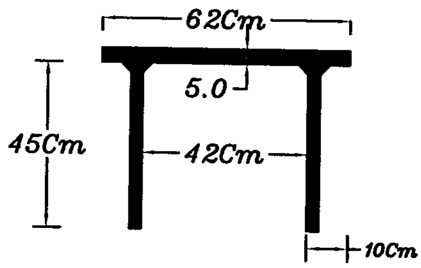
Checks

1-Check Compactness

$$\frac{b}{t} = \frac{42-2*1}{5.0} = 8 < \frac{64}{\sqrt{2.8}} = 38.2$$

$$\frac{C}{t} = \frac{10-5.0-1}{5.0} = 0.8 < \frac{21}{\sqrt{2.8}} = 12.5$$

$$\frac{h}{t} = \frac{45-1}{5.0} = 8.80 < \frac{30}{\sqrt{2.8}} = 17.9$$



2-Check global buckling

$$y' = \frac{(2ht*0.5h)+b'*t(h+0.5t)}{2ht+b't} = ...Cm$$

$$y' = \frac{(45*5.0*22.5*2)+(62*5*47.5)}{(45*5.0*2)+(62*5)} = 32.7Cm$$

$$I_x = 2*\frac{t*h^3}{12} + 2*t*h*(y'-0.5h)^2 + b'*t*(y'-h-0.5t)^2 = ...Cm^4$$

$$I_x = 2*\frac{5.0*45^3}{12} + 2*5.0*45*(32.7-22.5)^2 + 5.0*62*(47.5-32.7)^2$$

$$I_x = 191304 \quad Cm^4$$

$$I_Y = \left[\frac{5.0*62^3}{12}\right] + 2*5.0*45*(21+2.5)^2 = 348753 \ Cm^4$$

$$A = (5.0*2*45) + (62*5.0) = 760 \ Cm^2$$

Calculate $r_X = \sqrt{\frac{I_X}{A}} = \sqrt{\frac{191304}{760}} = 15.87Cm$

Calculate $r_Y = \sqrt{\frac{I_Y}{A}} = \sqrt{\frac{348753}{760}} = 21.42Cm$

$$\lambda_{in} = \frac{0.85L}{r_X} = \frac{0.85*500}{15.87} = 26.78 < 90$$

$$\lambda_{out} = \frac{L_{Out}}{r_Y} = \frac{1144.62}{21.42} = 53.43 < 90$$

$$L_{out} = 2.5\sqrt[4]{E*I_y*a*\delta}$$

$$L_{out} = 2.5\sqrt[4]{2100*348753*500*0.12} = 1144.62 \ Cm$$

3-Check Compressive Stresses

actual stresses $= f_{ca} = \frac{985}{760} = 1.29 \ t/Cm^2$

allwable stresses $= F_c = 1.5-7.5*10^{-5} * \lambda^2_{max.}$ For St.44

allwable stresses $= F_c = 1.5-7.5*10^{-5} * 53.4^2 = 1.28 \ t/Cm^2$

لاحظ انه تم تغيير المعادله التى يتم منها حساب ال F_c وذلك لان تخانة الPlate اكبر من ٥ سم

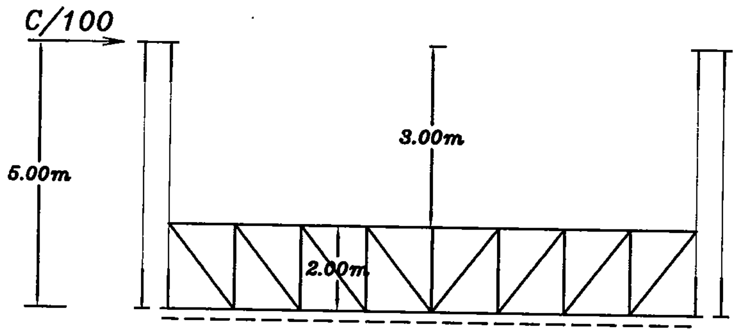
Design of Vertical member

$F_{V.max} = -F_D * Sin\,\alpha = 144 * Sin45^\circ = -102$ (Comp.)

$F_{V.min} = -F_D * Sin\,\alpha = 76 * Sin45^\circ = +54$ (tems.)

Calculation Of moment affecting Vertical member

1-Elastic Force



Where C is the max comp. force in the upper chord

$M_{add} = C/100 * a = 985/100*3.0 = \boxed{29.5\ m.t}$

a= Hm.g − Hx.g = 3.00 m

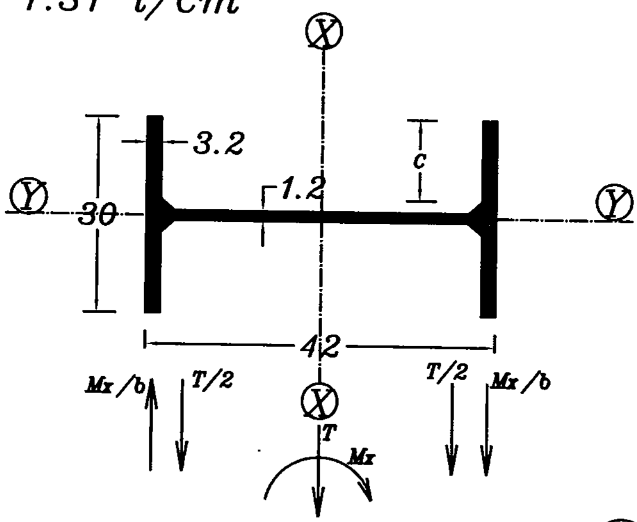
neglect the effect of wind on vertical member

Design as (M+T)

1)assume tension stresses to be :

$$F_{max.} = \frac{F_{sr}}{1-\frac{T_{min.}}{T_{max.}}} = \frac{2.00}{1-\frac{54}{-102}} = 1.31\ t/Cm^2$$

$F_t = 1.31\ t/Cm^2$



$$Force\ in\ flange = \frac{M_x}{b} + \frac{T}{2} = \frac{29.5*100}{42} + \frac{54}{2} = 97.23\ t$$

$$2)F_t = \frac{max.\ force\ T_{D+LL+I}}{area} \qquad 1.31 = \frac{97.2}{area}$$

$$get\ A = 74\ \ Cm^2$$

$$b = 42Cm$$

$$\frac{b}{t_w} = \frac{64}{\sqrt{Fy}} \qquad \frac{42}{t_w} = \frac{64}{\sqrt{2.8}} \qquad t_w = 1.09\ Cm \quad use\ t_w = 1.20\ Cm$$

$$A = b_f * t_f = ...Cm^2$$

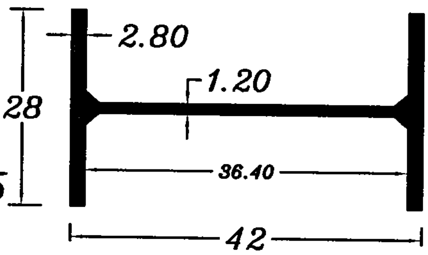
$$b_f * t_f = 74\ \ Cm^2 \qquad take\ b_f = 10*t_f$$

$$t_f = 2.72\ Cm \quad use\ t_f = 2.80\ Cm \qquad b_f = 74/2.80 = 28\ Cm$$

1-Check Compactness

$$\frac{b}{t_w} \leq \frac{64}{\sqrt{Fy}} = \frac{42-2*2.80-2*1}{1.20} = 28 < 38$$

$$\frac{C}{t_f} \leq \frac{21}{\sqrt{Fy}} = \frac{14-1.2/2-1}{2.80} = 4.40 < 12.5$$



2-Check global buckling

$$I_X = \frac{t_w * d_w^3}{12} + 2b_f * t_f * (d_w/2 + t_f/2)^2 = ...Cm^4$$

$$I_X = \frac{1.2*36.4^3}{12} + 2*2.8*28*(21-1.4)^2 = 65059\ \ Cm^4$$

$$I_Y = 2* \frac{t_f * b_f^3}{12} = ...Cm^4$$

$$I_Y = 2* \frac{2.8*28^3}{12} = 10244\ \ Cm^4$$

$$A = (1.2*36.4) + (2*28*2.8) = 200\ \ Cm^2$$

Calculate $r_X = \sqrt{\frac{I_X}{A}} = \sqrt{\frac{65059}{200}} = 18.1 Cm$

Calculate $r_Y = \sqrt{\frac{I_Y}{A}} = \sqrt{\frac{10244}{200}} = 7.15 Cm$

$\lambda_{in} = \frac{\text{buckling length inplane} = L_{in}}{\text{raduis of gyration @ Y axis} = r_Y} \ngtr 90$ (RailWay)

$\lambda_{in} = \frac{0.7*500}{7.15} = 49 < 90$

$\lambda_{out} = \frac{1.20*500}{18.10} = 33 < 90$

<u>3-Check maximum Stresses-case of (M+T)</u>

$\frac{f_{ta}}{F_t} + \frac{f_{bx}}{F_t} A_1 = \ldots\ldots \ngtr 1$ use $\boxed{A_1 = 1.00}$

actual stresses $= f_{ta} = \frac{+54}{200} = 0.27\ t/Cm^2$

$f_t = 1.624\ t/Cm^2$

$f_{bx} = M*y/I_x = [(29.5*100*42/2)/65059] = 0.95\ t/Cm^2$

$\frac{0.27}{1.624} + \frac{0.95}{1.624} = 0.75 < 1.00$ safe

fatigue stresses $\frac{54-(-102)}{200} = 0.78 < 2.00\ t/Cm^2$ safe

<u>check for case of (M+N)</u>

actual stresses $= f_{ca} = \frac{102}{200} = 0.51\ t/Cm^2$

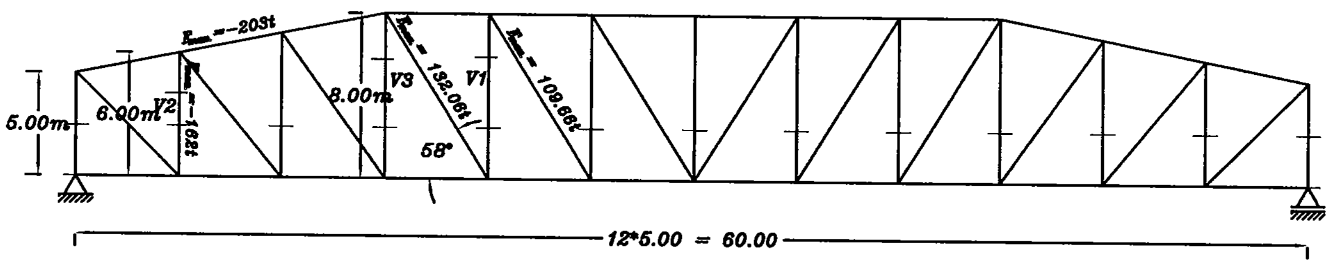
allwable stresses $= F_c = 1.6 - 8.5*10^{-5} * \lambda^2_{max.}$ For St.44

allwable stresses $= F_c = 1.6 - 8.5*10^{-5} * 49.0^2 = 1.40\ t/Cm^2$

$\frac{0.51}{1.40} + \frac{0.95}{1.624} = 0.94 < 1.00$ safe

- *Material of Construction is steel 44*
- *any missing data may be reasonably assumed*

For the Shown Through–Pony bridge Double track the bridge width is 9.00m it is required to :



1–Complete General Lay out.

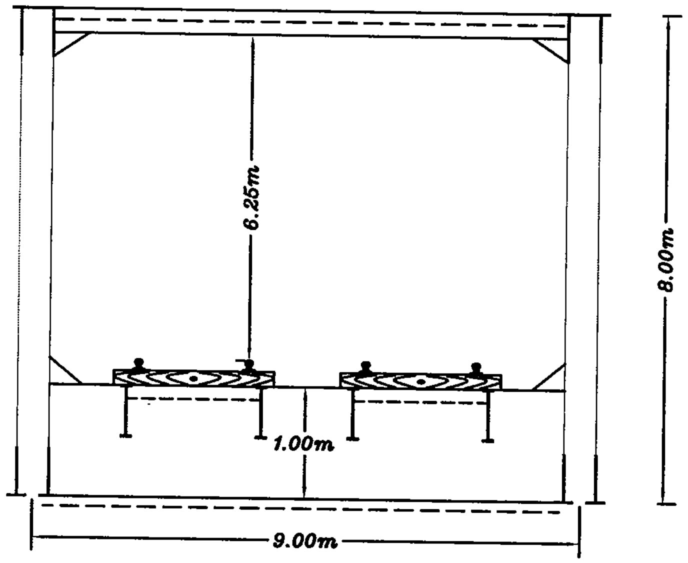
2–Design the two marked vertical member (V1 & V2) use M27.

given that the inner distance between the gusset plate = 50Cm

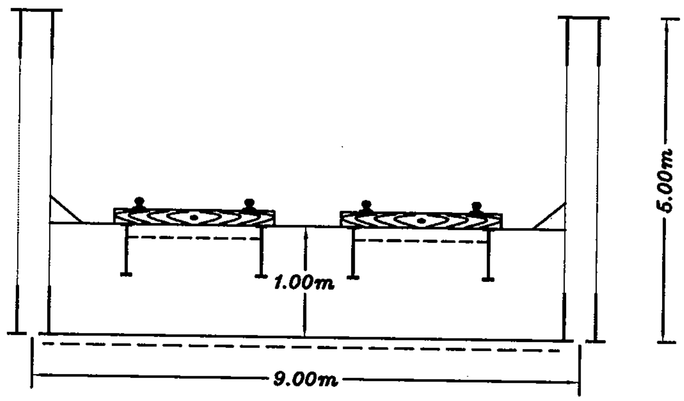
$F_{ST} =$ 1.90 t/Cm²

Example Four

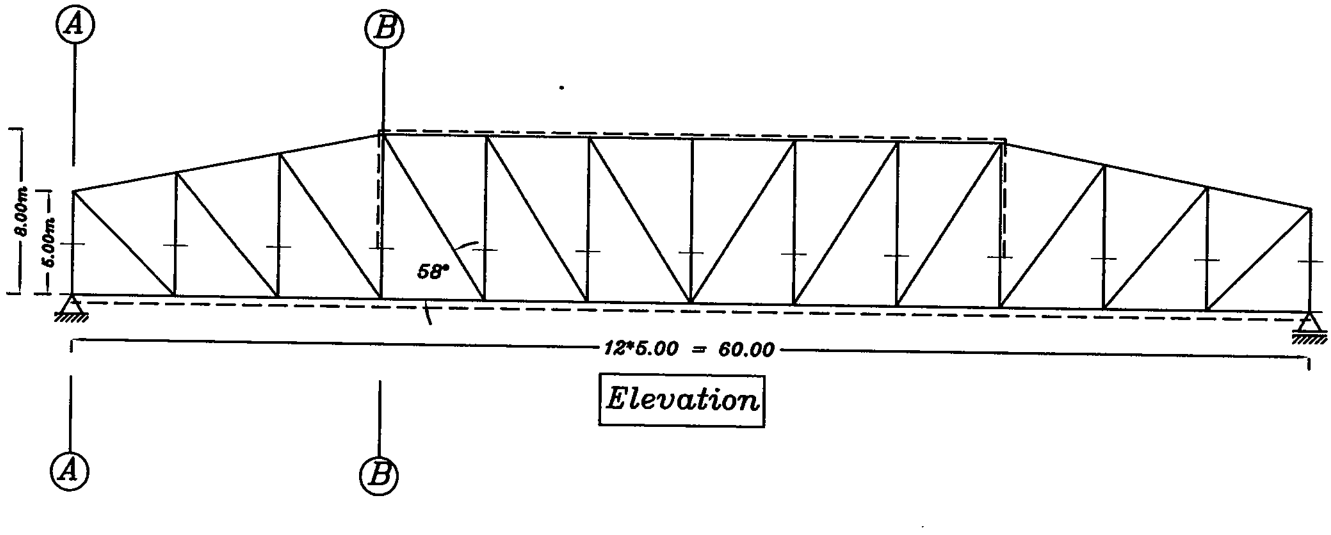
Question 1



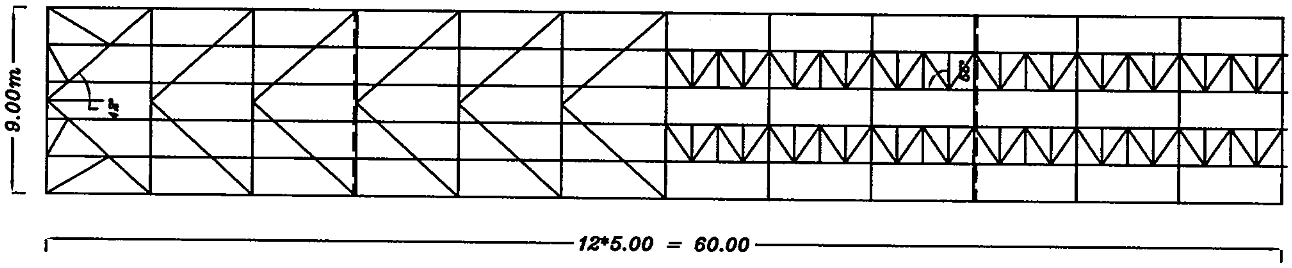
Section B–B



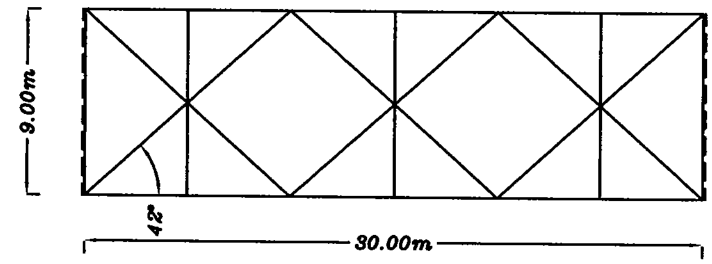
Section A–A



Elevation



plan of lower bracing



plan of upper bracing

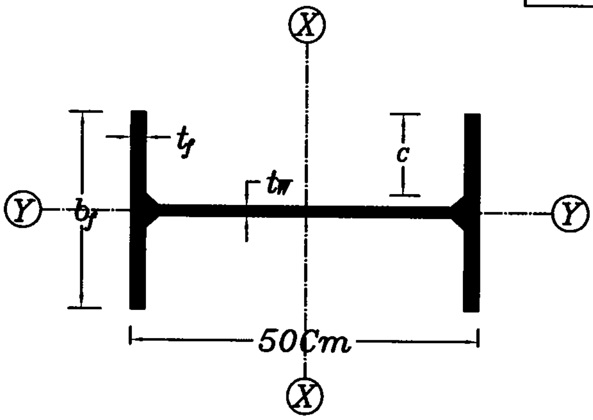
Example Four

Question 2

Design of Vertical member (V1)

this member is vertical in through bridge so it is subjected to axial force only (compression Force)

$F_{V.max} = -F_D * \sin\alpha = -109.66 * \sin 58^\circ = \boxed{-93\ (Comp.)}$



1) assume compression stress to be :

$F_c = 1.1 t/Cm^2$ to $1.4 t/Cm^2$ For St.44

2) $F_c = \frac{max.\ force}{area}$ $\quad 1.1 = \frac{93}{area}$ $\quad A = 84 Cm^2$

$b = 50 Cm$ given

$\frac{b}{t_w} = \frac{64}{\sqrt{F_y}}$ $\quad \frac{50}{t_w} = \frac{64}{\sqrt{2.8}}$ $\quad t = 1.30\ Cm$ use $t = 1.40\ Cm$

$A = 2*b_f*t_f + b*t_w = ...Cm^2$

$84 = 50*1.40 + 2*b_f*t_f$

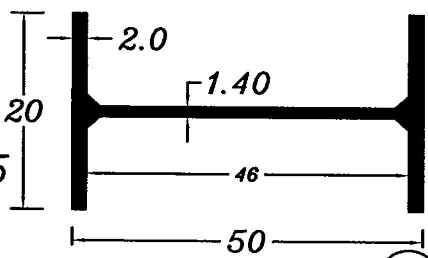
$b_f*t_f = 14.0\ Cm^2$ $\quad$ take $b_f = min.$, $t_f = min.$

$b_{f\ min.} = 6\phi + t_w + 2S \triangleq 20 Cm$ $\quad$ use $t_f = 2.00 Cm$

1-Check Compactness

$\frac{b}{t_w} \leq \frac{64}{\sqrt{F_y}} = \frac{50-2*2.0-2*1}{1.40} = 31.4 < 38$

$\frac{C}{t_f} \leq \frac{21}{\sqrt{F_y}} = \frac{20-0.70-1}{3.20} = 5.70 < 12.5$



2-Check global buckling

$$I_X = \frac{t_W * d_W^3}{12} + 2b_f * t_f * (d_W/2 + t_f/2)^2 = ...Cm^4$$

$$I_X = \frac{1.4*46^3}{12} + 2*2.0*20*(25-1.0)^2 = 57435 \ Cm^4$$

$$I_Y = 2* \frac{t_f * b_f^3}{12} = ...Cm^4$$

$$I_Y = 2* \frac{2.0*20^3}{12} = 2666.67 \ Cm^4$$

$$A = (1.4*46) + (2*20*2.0) = 144 \ Cm^2$$

Calculate $r_X = \sqrt{\frac{I_X}{A}} = \sqrt{\frac{57435}{144}} = 19.97Cm$

Calculate $r_Y = \sqrt{\frac{I_Y}{A}} = \sqrt{\frac{2666.6}{144}} = 4.30Cm$

$$\lambda_{in} = \frac{buckling \ length \ inplane = L_{in}}{raduis \ of \ gyration \ @ \ Y \ axis = r_Y} \ngtr 90 \quad (RailWay)$$

$$\lambda_{in} = \frac{0.7*800}{4.30} = 130 > 90 \ unsafe \quad use \ b_f = 28Cm$$

$r_Y = 6.44$
$A = 176.4Cm^2$

$$\lambda_{in} = \frac{0.7*800}{6.44} = 87 < 90 \quad safe$$

$$\lambda_{out} = \frac{0.85*800}{19.9} = 34 < 90$$

3-Check Compressive Stresses

actual stresses $= f_{ca} = \frac{93}{176} = 0.53 \ t/Cm^2$

allwable stresses $= F_c = 1.6 - 8.5*10^{-5} * \lambda^2_{max.}$ For St.44

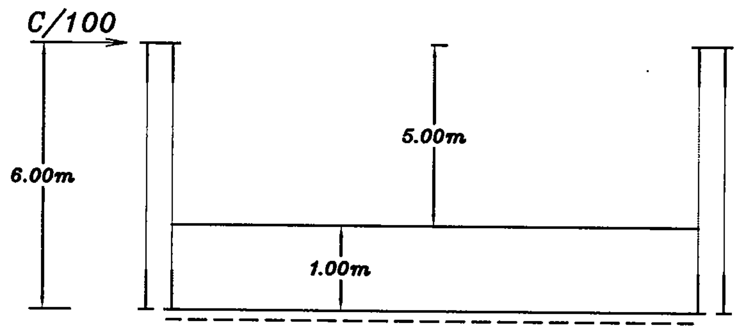
allwable stresses $= F_c = 1.6 - 8.5*10^{-5} * 87.0^2 = 0.95 \ t/Cm^2$

Design of Vertical member (V2)

this member is vertical in pony bridge so it is subjected to axial force and moment.

Calculation Of moment affecting Vertical member

1-Elastic Force



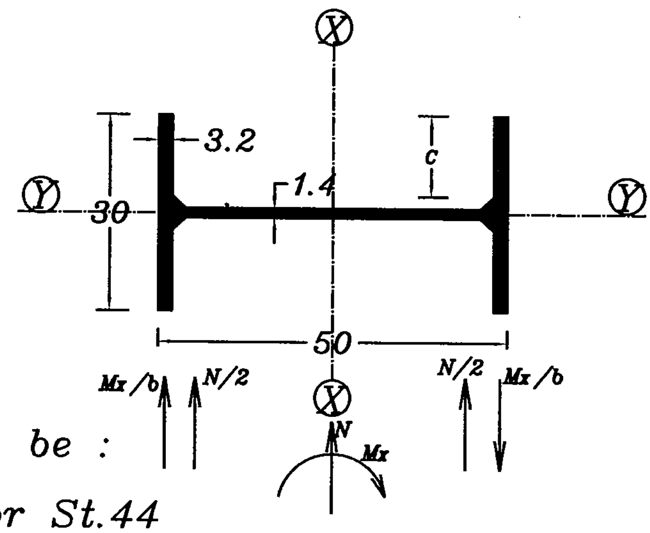
Where C is the max comp. force in the upper chord

$M_{add} = C/100 * a = 203/100*5.0 = \boxed{10.15 m.t}$

$a = Hm.g - Hx.g = 5.00\ m$

neglect the effect of wind on vertical member

Design as (M+N)



1)assume compression stress to be :

$F_c = 1.1 t/Cm^2$ to $1.4 t/Cm^2$ For St.44

$$\text{Force in flange} = \frac{M_x}{b} + \frac{N}{2} = \frac{10.15*100}{50} + \frac{162}{2} = 101.3\ t$$

$2) F_c = \frac{max.\ force}{area}$ $\quad 1.1 = \frac{101.3}{area}$ $\quad A = 92 Cm^2$

$b = 50 Cm$ given

$\frac{b}{t_w} = \frac{64}{\sqrt{Fy}}$ $\quad \frac{50}{t_w} = \frac{64}{\sqrt{2.8}}$ $\quad t = 1.30\ Cm$ use $t = 1.40\ Cm$

$A = b_f * t_f = ...Cm^2$

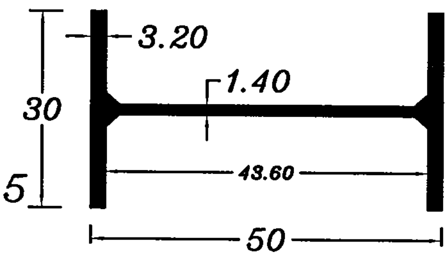
$b_f * t_f = 92\ Cm^2$ $\quad$ take $b_f = 10*t_f$

$t_f = 3.03\ Cm$ use $t_f = 3.20\ Cm$ $\quad b_f = 92/3.20 = 30\ Cm$

1-Check Compactness

$\frac{b}{t_w} \le \frac{64}{\sqrt{Fy}} = \frac{50-2*3.20-2*1}{1.40} = 30 < 38$

$\frac{C}{t_f} \le \frac{21}{\sqrt{Fy}} = \frac{15-1.4/2-1}{3.20} = 4.15 < 12.5$



2-Check global buckling

$I_X = \frac{t_w * d_w^3}{12} + 2b_f * t_f * (d_w/2 + t_f/2)^2 = ...Cm^4$

$I_X = \frac{1.4*43.6^3}{12} + 2*3.2*30*(21-1.4)^2 = 83428\ Cm^4$

$I_Y = 2* \frac{t_f * b_f^3}{12} = ...Cm^4$

$I_Y = 2* \frac{3.2*30^3}{12} = 14400\ Cm^4$

$A = (1.4*43.6)+(2*30*3.2) = 253\ Cm^2$

Calculate $r_X = \sqrt{\frac{I_X}{A}} = \sqrt{\frac{83428}{253}} = 18.1 Cm$

Calculate $r_Y = \sqrt{\frac{I_Y}{A}} = \sqrt{\frac{14400}{253}} = 7.54 Cm$

$$\lambda_{in} = \frac{buckling\ length\ inplane = L_{in}}{raduis\ of\ gyration\ @\ Y\ axis = r_Y} \ngtr 90 \quad (RailWay)$$

$$\lambda_{in} = \frac{0.7*600}{7.54} = 55 < 90$$

$$\lambda_{out} = \frac{1.20*600}{18.10} = 39 < 90$$

<u>check for case of (M+N)</u>

actual stresses $= f_{ca} = \frac{162}{253} = 0.64\ t/Cm^2$

allwable stresses $= F_c = 1.6 - 8.5*10^{-5} * \lambda^2_{max.}$ For St.44

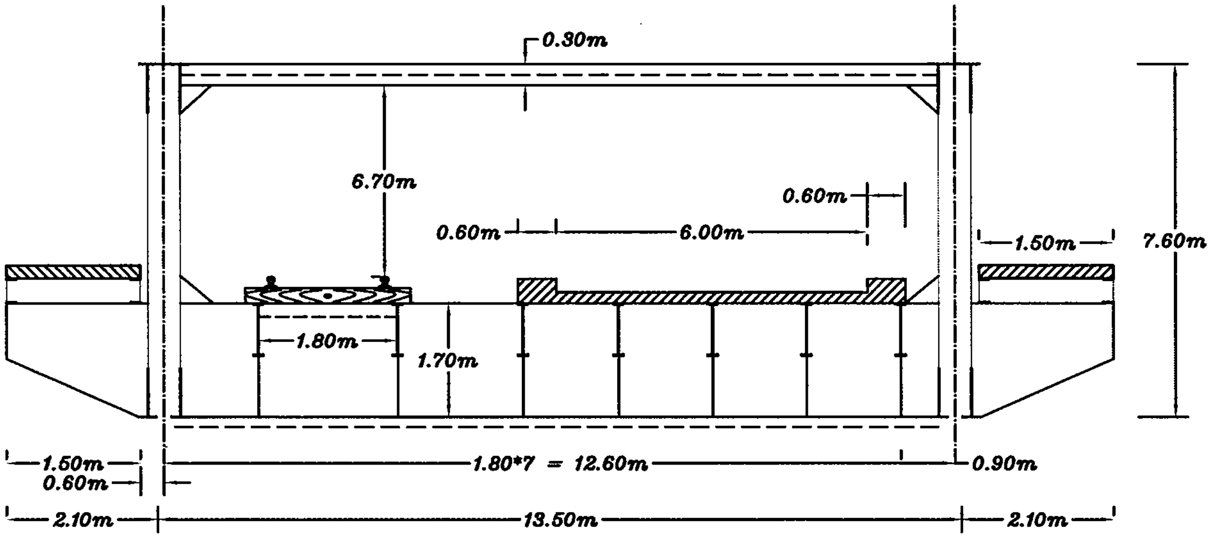
allwable stresses $= F_c = 1.6 - 8.5*10^{-5} * 55.0^2 = 1.34\ t/Cm^2$

$f_t = 1.624\ t/Cm^2$

$f_{bx} = M*y/I_x = [(10.1*100*50/2)/83428] = 0.30\ t/Cm^2$

$$\frac{0.64}{1.34} + \frac{0.30}{1.624} = 0.66 < 1.00 \qquad safe$$

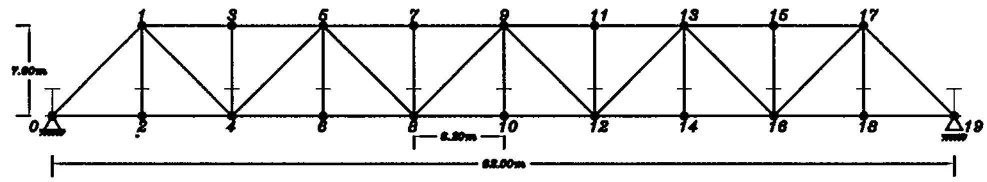
Example 4



a rail–road through welded truss bridge of the shown cross section has s span of 62.00m divided into ten equal pannels 6.20m each, and depth of 7.60m each as shown in figure

it is required to

1–Draw to scale 1:200 a fully Dimensioned layout for the bridge (Elevation, Plans, and cross sections) showing all necessary bracing.

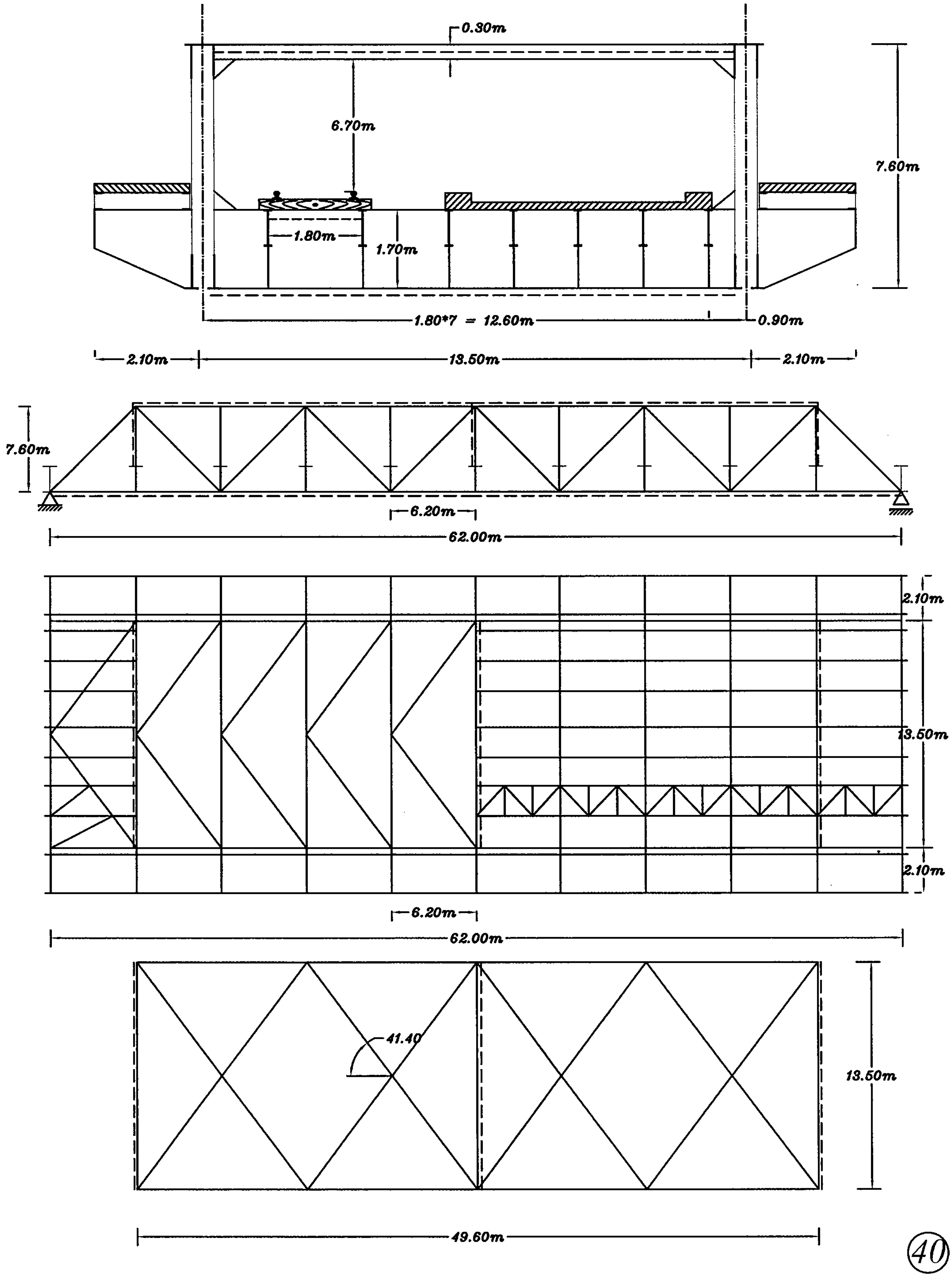


2–Draw the I.L of the diagonal member 4–5 and chord member 6–8.

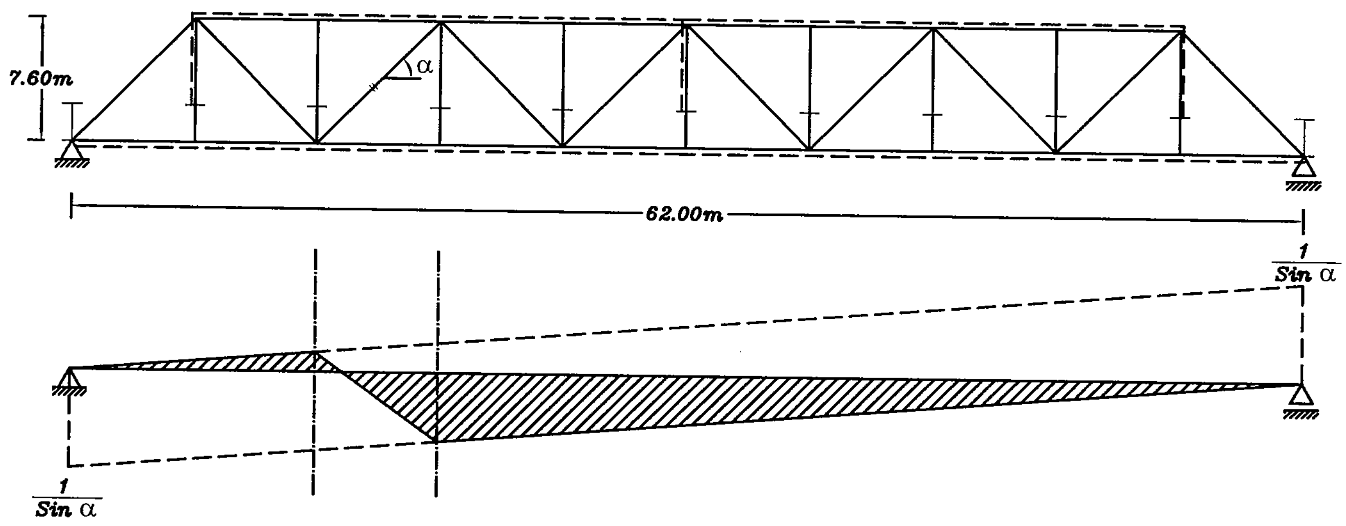
3–calculate force in member 6–8 due to L.L+I only.

4–if all vertical member cancelled state the effect of that.

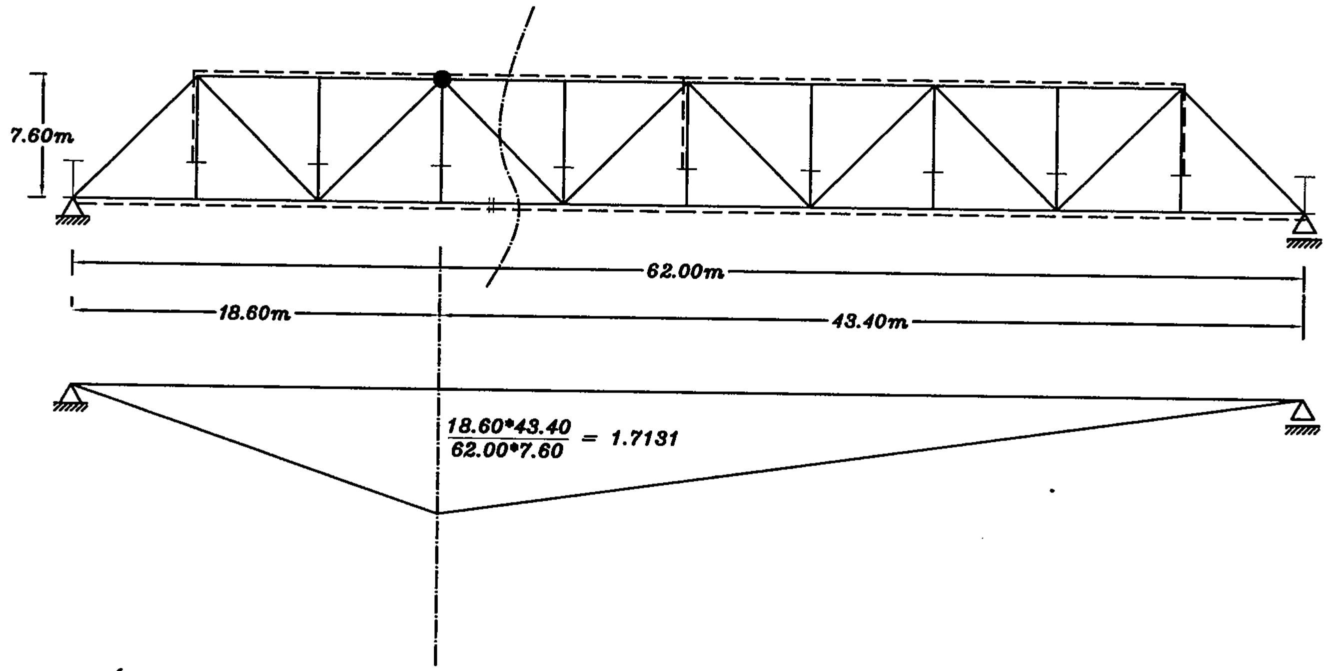
Question 1


0.30m
6.70m
7.60m
1.80m
1.70m
1.80*7 = 12.60m
0.90m
2.10m
13.50m
2.10m
7.60m
6.20m
62.00m
2.10m
13.50m
2.10m
6.20m
62.00m
41.40
13.50m
49.60m

Question 2



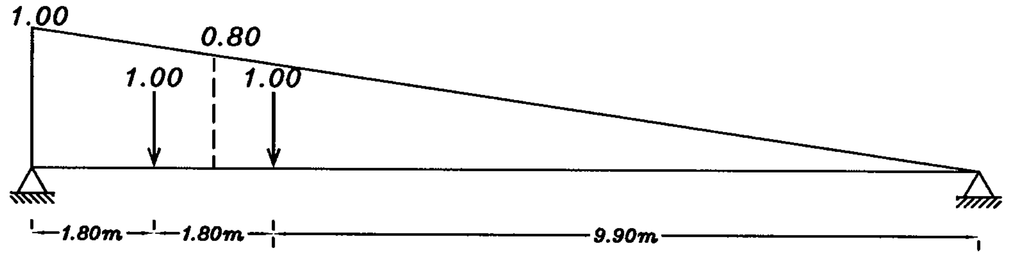
(influence line for member 4–5) *(Diagonal member)*



(influence line for member 6–8) *(Lower Chord member)*

Question 3

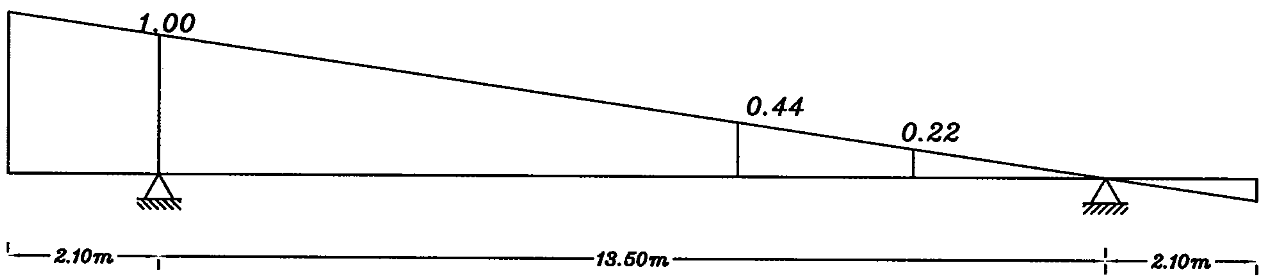
Strip in Railway

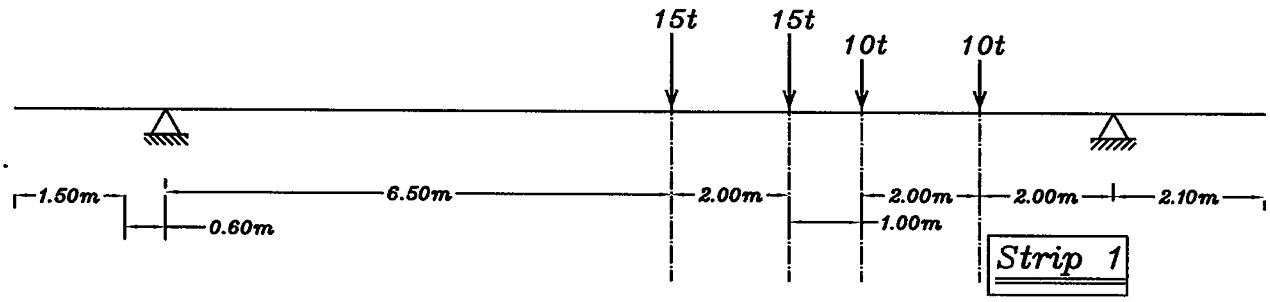


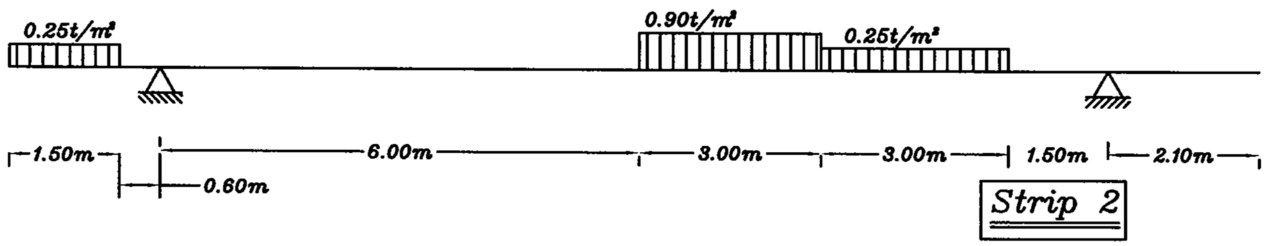
$$R = 2*1*0.8 = \boxed{1.60}$$

$$(1+I) = 0.73 + \frac{2.16}{\sqrt{62.0} - 0.2} = 1.01 \quad \boxed{< 1.1 \text{ use } 1.1}$$

Strip in Roadway







Strip in Roadway

Strip 1

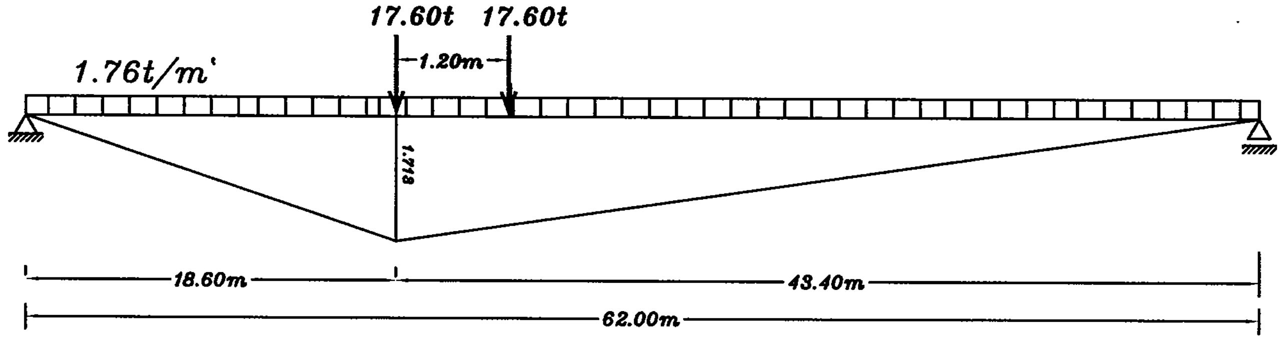
$R_1 = 2*10*0.22 + 2*15*0.44 = \boxed{17.60t}$

Strip 2

$W_2 = 0.25*3*0.22+0.90*3*0.44+0.25*1.5*1.1 = \boxed{1.76t/m'}$

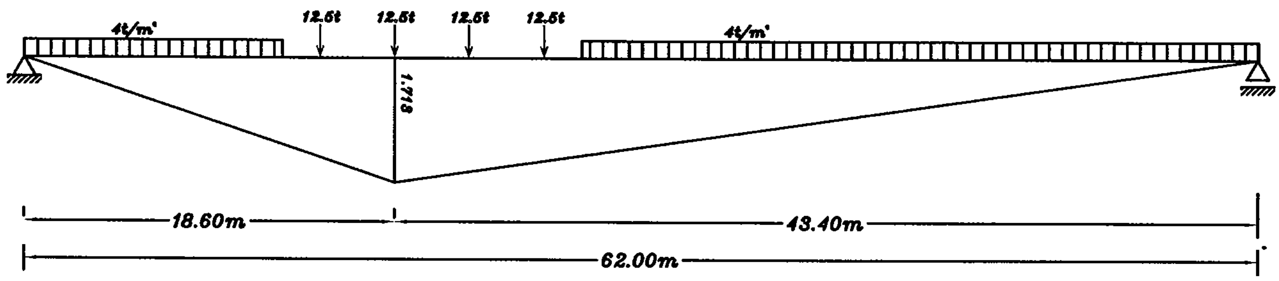
using superposition theory

force in chord member due to roadway only



$F_{LL+I} = 2*17.60*1.689+0.5*62*1.713*1.76 = 152.914t$

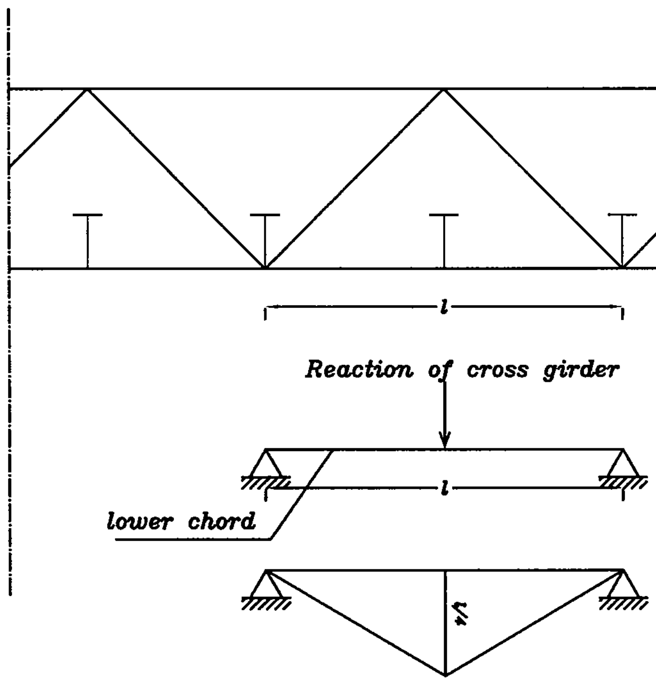
force in chord member due to railway only

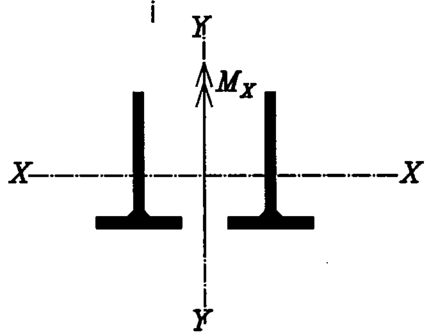


$F_{LL+I} = 3*12.5*1.645+12.5*1.565+4*(16.2*0.745+39.3*0.775)$
$* 1.10*1.60 = \boxed{442.386t}$

$F_{LL+I \; Road+Rail} = 152.91t + 442.386t = \boxed{595.2t}$

Question 4





if all vertical member are cancelled then the the X.g will be a concentrated Load on lower Chord Cause M_x On Lower chord