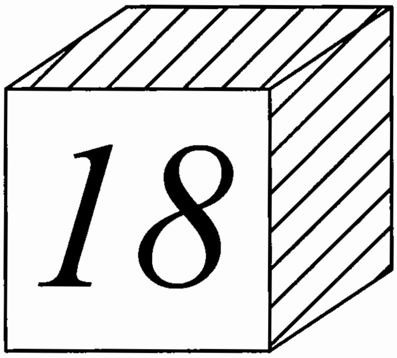
ح
١١,٠

مراجعه Steel
رابعه إنشاءات
R /١٢

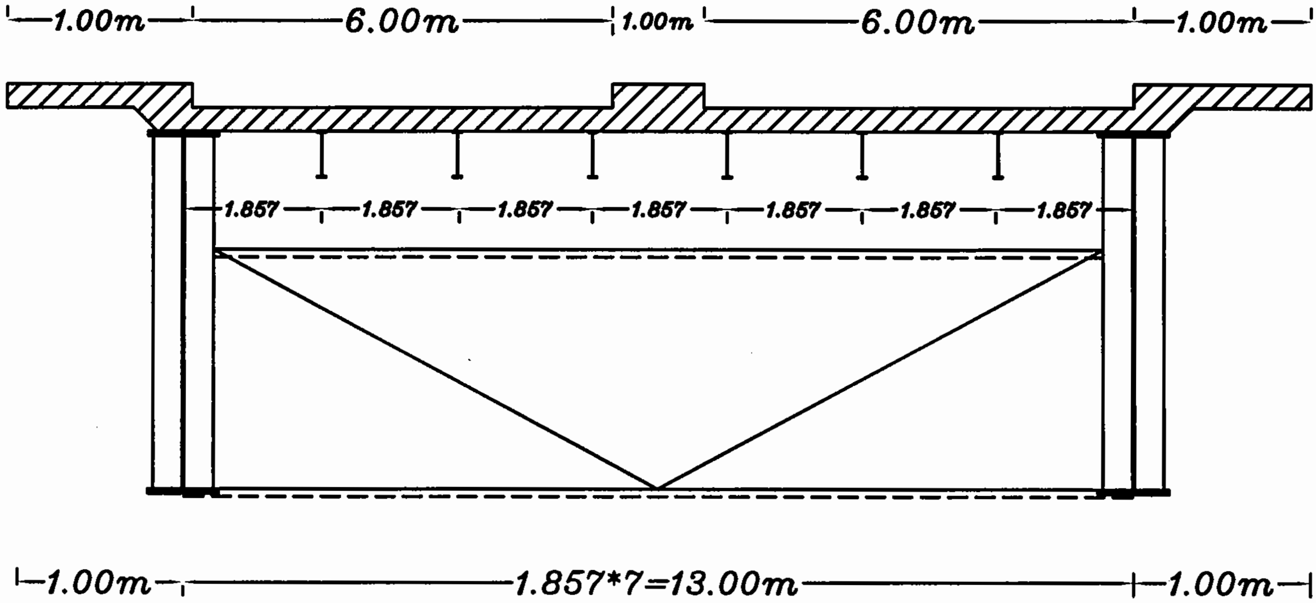


Mid. Term Revision Examples 2012-2013

steel used is st.44

Example 1

Mid. term Revision



the shown figure shows a cross section for a road Way Bridge with a 5.50m spacing between cross-girders.

spacing between main girders is 13.00m the bridge contains two sides walk of 1.00m (bridge span is 33.00m)

a 1.00m wide median is installed to road way as shown in the Figure, it is required to

1)Complete general lay out for the shown bridge

2)Calculate max. b.m and max. s.f for critcal stringer

3)design asuitable stringer as simple and continuous beam

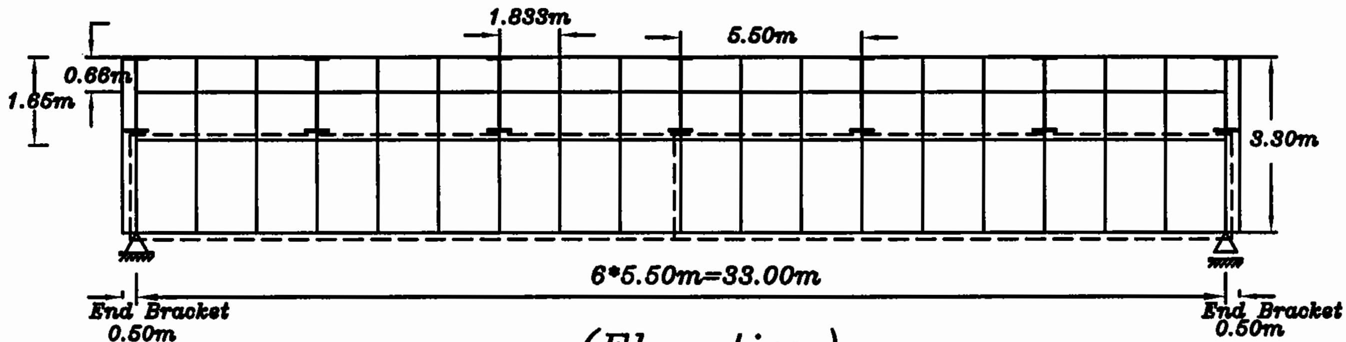
4)Calculate the max. b.m and max. s.f for an intermediate x.g due to live load + impact only.

5)Calculate the max. b.m and Max. s.f acting on the m.g

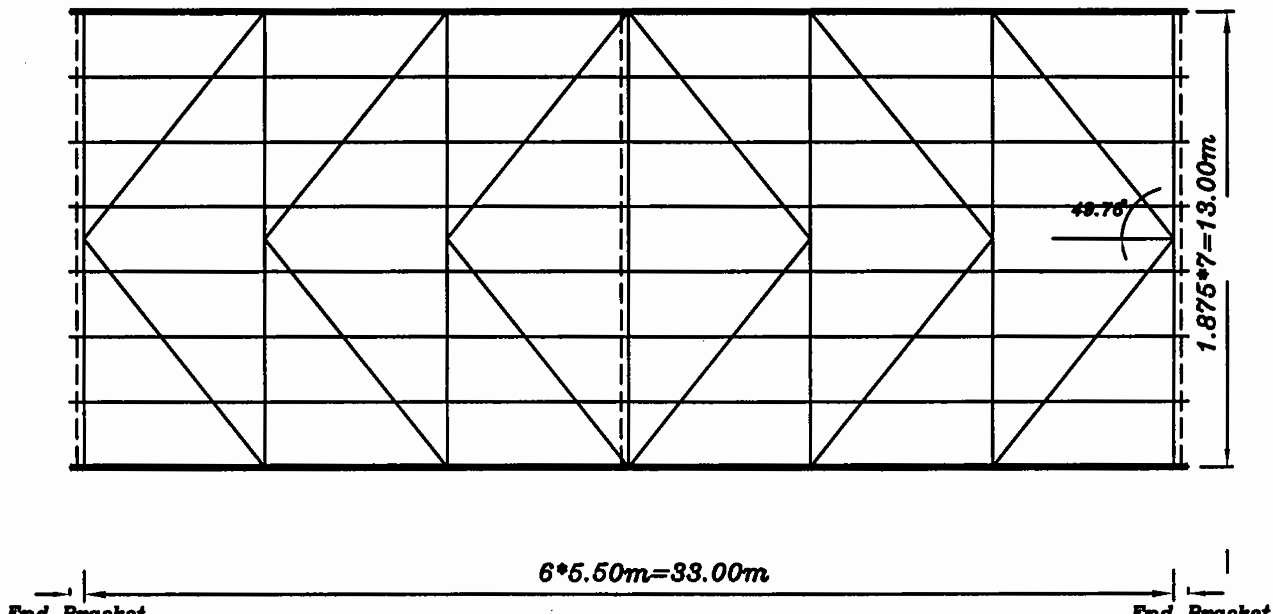
6)Explian how can the wind load transmite to the bearing level

7)the types and function of stiffeners used for plate girder

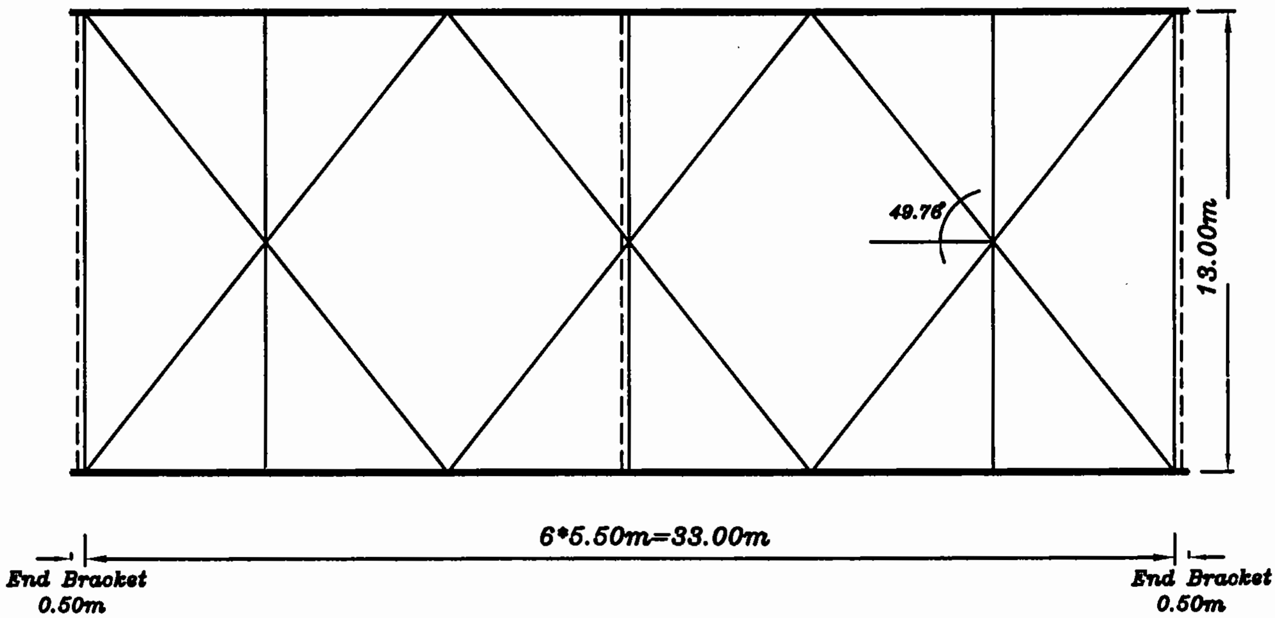
Question One



(Elevation)

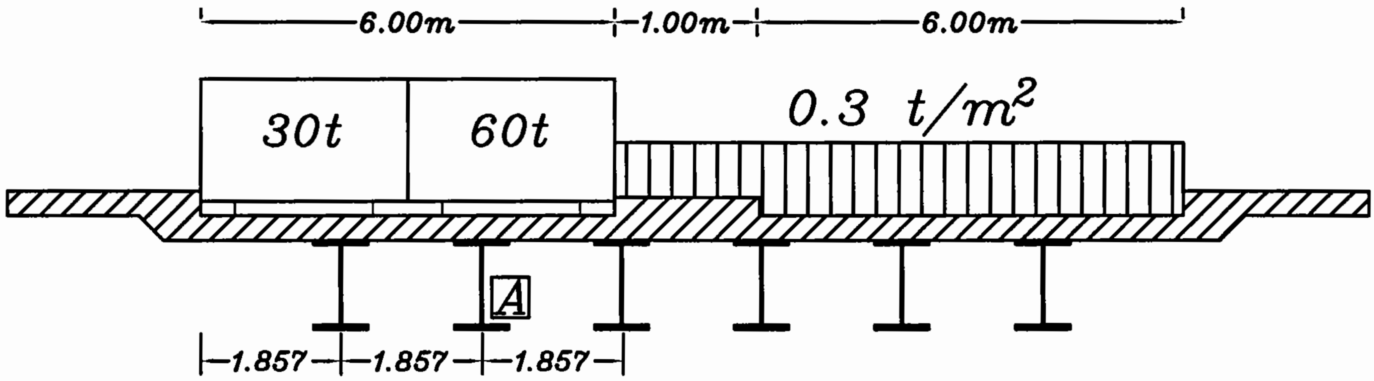


(Plan Of Upper Bracing)



(Plan Of Lower Bracing)

Question Two

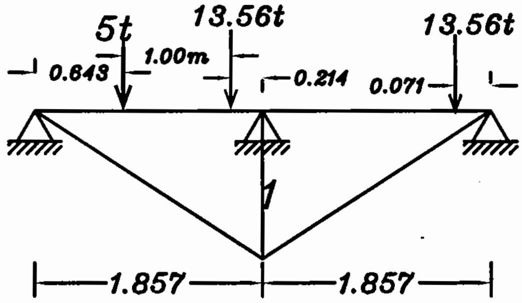


For Stringer A

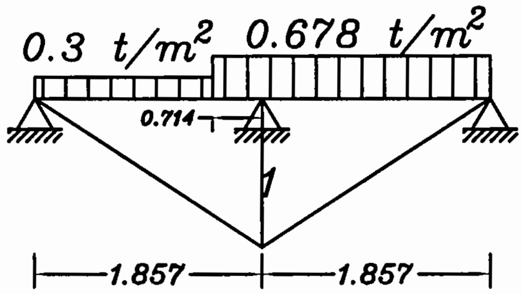
$I = 0.4 - 0.008 * L$

$I = 0.4 - 0.008 * 5.50m = 0.356$

$1.857*2-(0.5+2+1)=0.214$



Strip 1



Strip 2

Strip 1

$R_1 = 13.56 * 0.88 + 13.56 * 0.038 + 5 * 0.346$

$\therefore R_1 = \boxed{14.18t}$

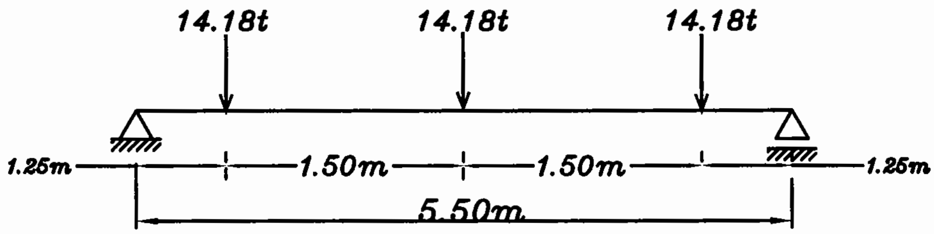
Strip 2

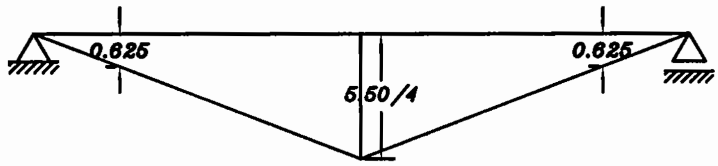
$W_2 = 0.678 * 1.857 * 0.50 + 0.678 * 0.714 * 0.80 +$
$0.3 * 1.143 * 0.307$

$\boxed{W_2 = 1.12t \backslash m'}$

to get maximum moment + impact

Max. B.M.D

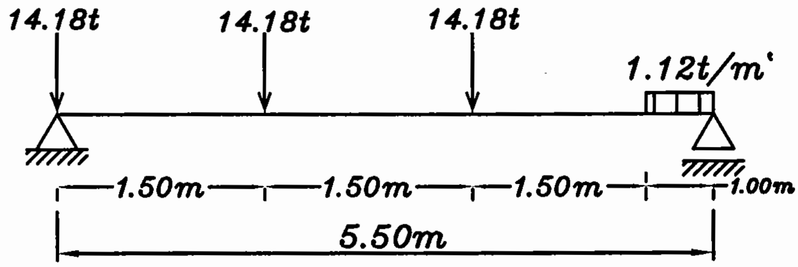


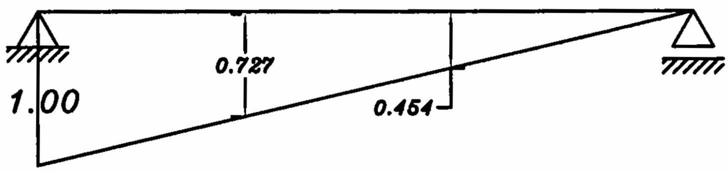


$M_{LL+I}=2(14.18*0.625) + 14.18 * 1.375$

$$\boxed{M_{LL+I}=37.22 m.t}$$

to get maximum shear + impact





$Q_{LL+I} = 14.18+14.18*0.727+14.18*0.454+1.12*1*0.09$

$$\boxed{Q_{LL+I} = 31.027t}$$

Dead Loads

$$W_d = (\underset{t_{R.C}}{0.21}*\underset{\gamma_c}{2.5}+\underset{F.C}{0.175})*\overset{Spacing}{1.857} + \underset{O.W}{0.15}$$

$$\therefore W_d = 1.45 t\backslash m'$$

$$M_d = \frac{1.45*5.50^2}{8} = 5.48 m.t$$

$$Q_d = \frac{1.45*5.50}{2} = 3.98 t$$

Design Value

$$M_{Max.} = M_{d.l} + M_{l.l}$$

$$M_{Max.} = 5.48 + 37.22 = \boxed{42.70\ m.t}$$

$$M_{Min.} = M_{d.l} = \boxed{5.48\ m.t}$$

$$Q_{Max.} = 3.98 + 31.027 = \boxed{35.007t}$$

Question Three

a) as a simple beam

From Page 39

$N = 2,000,000$

From Page 41 Detail A For Rolled Sec.

$$\therefore F_{Sr} = 1.68 t/Cm^2$$

$$F_{Max.} = \frac{F_{Sr}}{\left(1 - \frac{M_d}{M_d + 0.6 M_{LL+I}}\right)} = \frac{1.68}{\left(1 - \frac{5.48}{5.48+0.6*37.22}\right)} =$$

$$F_{Max.} = 2.10 t/Cm^2 > 0.64 F_y = 1.792 t/Cm^2$$

$$\therefore Use\ 0.64 F_y = 1.792 t/Cm^2$$

$$1.792 t/Cm^2 = \frac{M_{d+l+I}}{S_x} = \frac{42.7*100}{S_x}$$

$$\therefore S_x = 2383 Cm^3$$

∴ Use (I.P.E) from tables No. 550

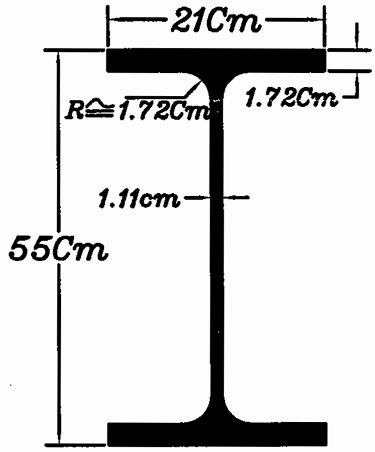
Checks

1) Check Compactness Of The Section

section is compact if

$$\frac{C}{t_f} < \frac{16.9}{\sqrt{F_y}} \quad , \quad \frac{8.225}{1.72} = 4.78 < \frac{16.9}{\sqrt{2.8}} = 10$$

$$\frac{h_w}{t_w} < \frac{127}{\sqrt{F_y}} \quad , \quad \frac{48.12}{1.11} = 43.3 < \frac{127}{\sqrt{2.8}} = 76$$



$$C = b/2 - t_w/2 - r$$

$$C = 21/2 - 1.11/2 - 1.72 = 8.225$$

$$h_w = 55 - 4*1.72 = 48.12$$

∴ section is compact ∴ $F_t = 0.64*2.8 = 1.792 t/Cm^2$

2) Check Maximum Stresses

$$\frac{M_{d+l+I}}{S_x} = \frac{42.7*100}{2440} = 1.75 t/Cm^2 < 0.64 F_y = 1.79 t/Cm^2$$

3) Check Stress Range

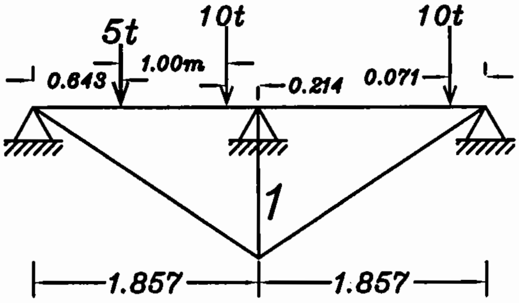
$$\frac{0.6 M_{LL+I}}{S_x} = \frac{0.6*37.2*100}{2440} = 0.91 t/Cm^2 < F_{Sr} = 1.68 t/Cm^2$$

4) Check Shear Stress

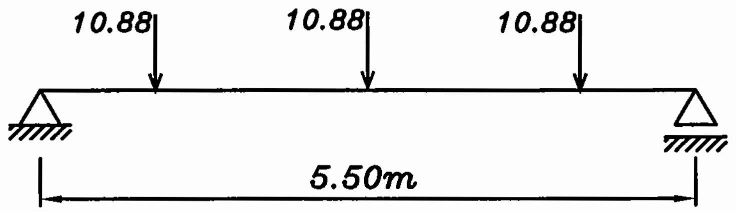
$$\frac{Q_{d+l+I}}{d_w * t_w} = \frac{35}{55*1.11} = 0.57 t/Cm^2 < 0.35 F_y = 0.98 t/Cm^2$$

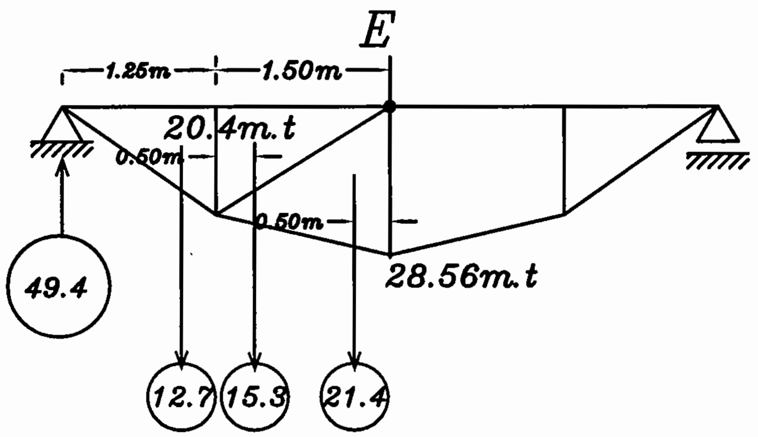
5) Check Deflection

يجب وضع الاحمال الحيه على الكمره من غير احمال الصدم



∴ $R = 10*(0.88+.038)+5*0.34$
$= 10.88t$





$M_E = \{49.4*5.50/2-[21.4*0.5 + 15.3*1 + 12.7(1.5+(5.5/2-1.5)/3)]\}$

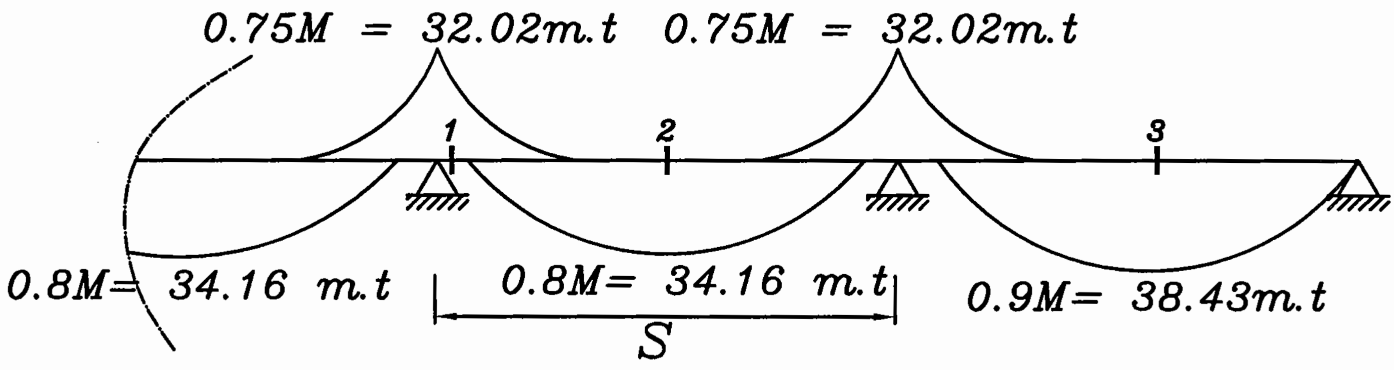
$M_E = 85.508m^3.t$

$$\triangle Simple = \frac{M_E * 10^6}{E * I_x} \ngtr \frac{Span}{600}$$

$$\triangle Simple = \frac{85.508 * 10^6}{2100*67120} = 0.606Cm \ngtr \frac{550}{600} = 0.91Cm$$

∴ safe

b) as a continuous beam



sec(1−1)

From Code Page 39

N = 2,000,000

From Code Page 41 Detail B For Sec. (1−1)

$\therefore F_{Sr} = 1.26 t/Cm^2$

$$F_{Max1} = \frac{F_{Sr}}{\left(1 - \frac{M_d}{M_d + 0.6 M_{LL+I}}\right)} = \frac{1.26}{\left(1 - \frac{5.48}{5.48 + 0.6 * 37.22}\right)} =$$

$F_{Max1} = 1.56 t/Cm^2 < 0.64 F_y = 1.792 t/Cm^2$

$\therefore$ Use $1.56 t/Cm^2$

$$1.56 \ t/Cm^2 = \frac{M_{d+l+I}}{S_{x1}} = \frac{3202}{S_{x1}}$$

$\therefore S_{x1} = 2052 Cm^3$

sec(2−2)

From Code Page 39

N = 2,000,000

From Code Page 41 Detail A For Sec. (2−2)

$\therefore F_{Sr} = 1.68 t/Cm^2$

$$F_{Max2} = \frac{F_{Sr}}{\left(1 - \frac{M_d}{M_d + 0.6 M_{LL+I}}\right)} = \frac{1.68}{\left(1 - \frac{5.48}{5.48 + 0.6 * 37.22}\right)} =$$

$F_{Max2} = 2.10 t/Cm^2 > 0.64 F_y = 1.792 t/Cm^2$

$\therefore Use\ 0.64F_y = 1.792 t/Cm^2$

$$1.792 t/Cm^2 = \frac{M_{d+l+I}}{S_{x2}} = \frac{3416}{S_{x2}}$$

$\therefore S_{x2} = 1906.25 Cm^3$

$\therefore Use\ S_x = 2052 Cm^3$

$\therefore$ From tables Choose I.P.E No. 550

$S_x = 2440 Cm^3$

Checks

1) Check Compactness Of The Section

Section Is Compact If

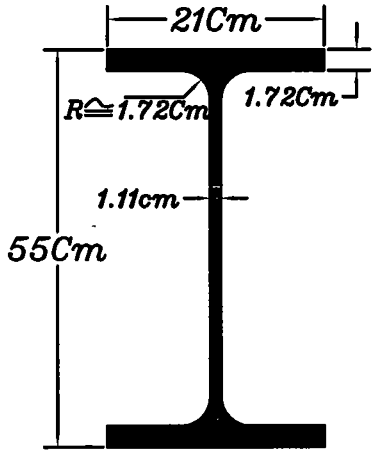
$$\frac{C}{t_f} < \frac{16.9}{\sqrt{F_y}} \ , \quad \frac{8.225}{1.72} = 4.78 < \frac{16.9}{\sqrt{2.8}} = 10$$

$$\frac{h_w}{t_w} < \frac{127}{\sqrt{F_y}} \ , \quad \frac{48.12}{1.11} = 43.3 < \frac{127}{\sqrt{2.8}} = 76$$

$C = b/2 - t_w/2 - r$

$C = 21/2 - 1.11/2 - 1.72 = 8.225$

$h_w = 55 - 4*1.72 = 48.12$



$\therefore$ section is compact $\quad \therefore F_t = 0.64*2.8 = 1.792 t/Cm^2$

2) Check Maximum Stresses For Sec. (3−3)

$$\frac{38.43*100}{2440} = 1.57 t/Cm^2 < 0.64F_y = 1.79 t/Cm^2$$

$\therefore$ Safe

3) Check Stress Range

Sec.(3−3)

$$\frac{0.6*(0.9*37.22*100)}{2440} = 0.82 t/Cm^2 < F_{Sr} = 1.68 t/Cm^2$$

$\therefore$ Safe

Sec.(1−1)

$$\frac{0.6*(0.75*37.22*100)}{2440} = 0.68 t/Cm^2 < F_{Sr} = 1.26 t/Cm^2$$

$\therefore$ Safe

4) Check Shear Stress

$$\frac{1.1 * Q_{d+l+I}}{d_w * t_w} = \frac{1.1*35}{55*1.11} = 0.63\, t/Cm^2 < 0.35F_y = 0.98 t/Cm^2$$

5) Check Deflection

$$\triangle_{Continous} = 0.8 \triangle_{Simple} \not> \frac{Span}{600}$$

يتم حساب ال$Deflection$ نتيجه كمره$Simple$ ثم يتم ضرب هذه القيمه فى 0.8

وقد تم حساب ال $\triangle_{Simple}$

$$\therefore \triangle_{Continous} = 0.8 \triangle_{Simple} = 0.8 * 0.606Cm = 0.48Cm$$

$$\not> \frac{550}{600} \quad \therefore Safe$$

Question Four

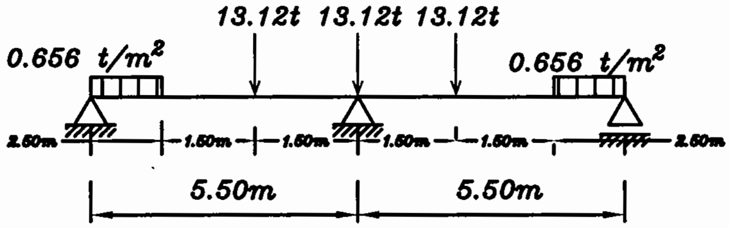
Live Loads + Impact

$$I = 0.4 - 0.008L$$

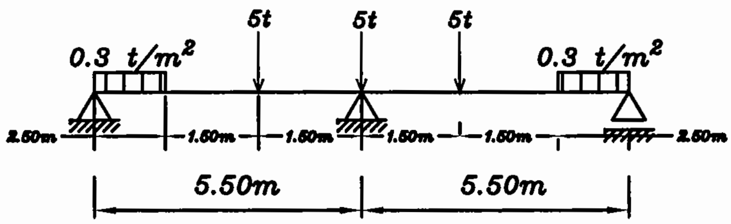
$$I = 0.4 - 0.008(2*5.50=11.00m) = 0.312$$

$$10(1+0.312) = 13.12t \ , \ 0.5(1+0.312) = 0.656t/m^2$$

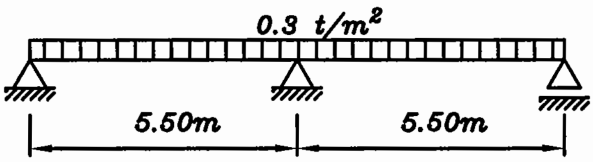
Strip1
Get R_1 , W_1

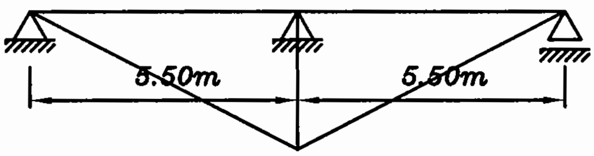


Strip2
Get R_2 , W_2



Strip3
Get W_3





$$R_1 = 13.12(1+2*0.727) = 32.2t$$

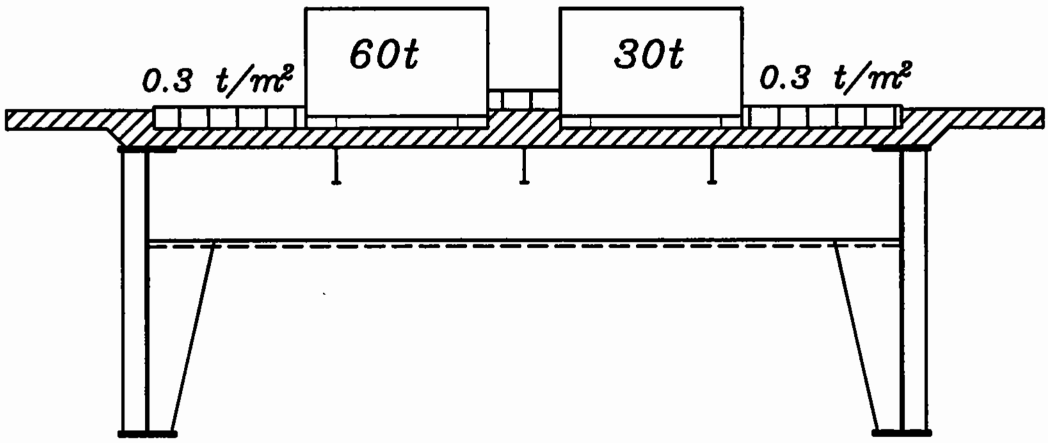
$$R_2 = 5(1+2*0.727) = 12.27t$$

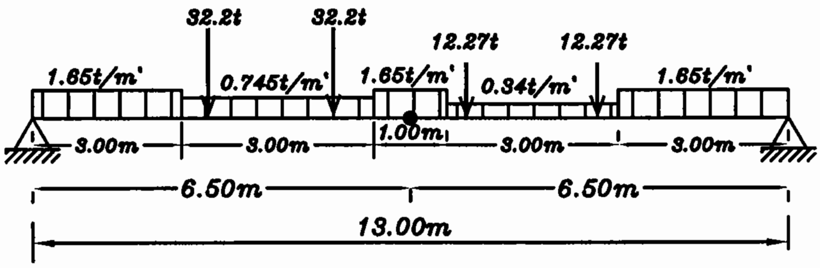
$$W_1 = 0.656*2.50*0.227*2 = 0.745t/m'$$

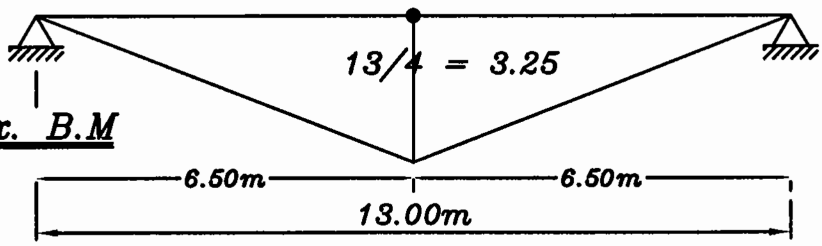
$$W_2 = 0.30*2.50*0.227*2 = 0.34t/m'$$

$$W_3 = 0.30*5.5*0.5*2 = 1.65t/m'$$

Case Of Max. Bending Moment





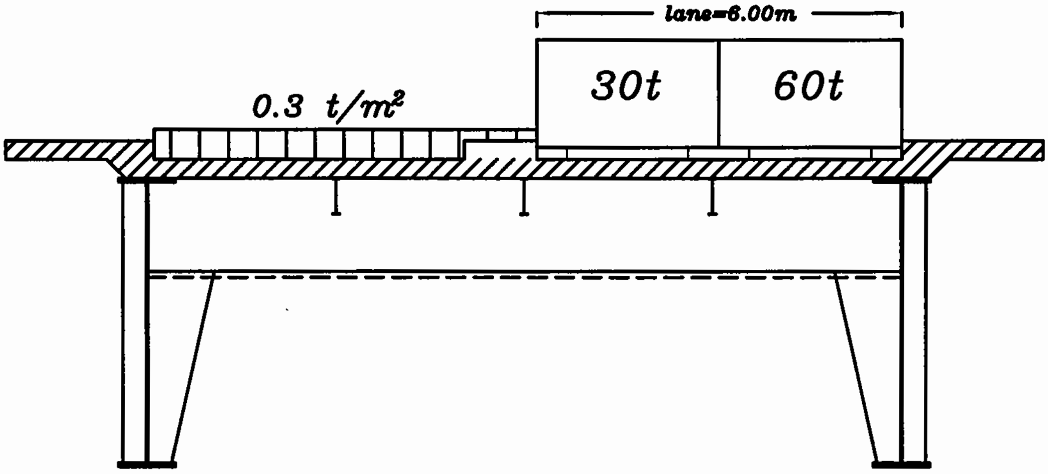


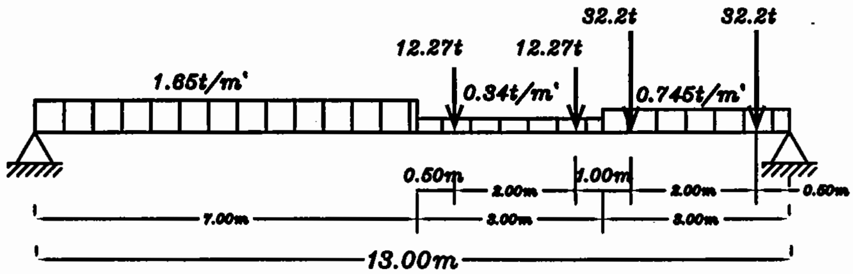
I.L For Max. B.M

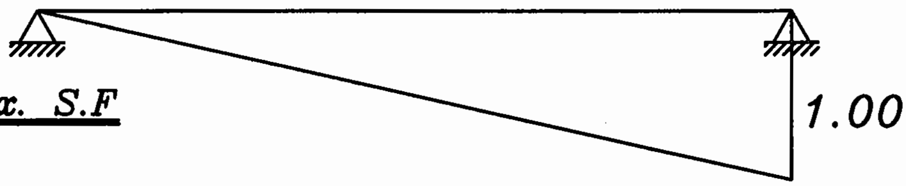
$$M_{LL+I}=32.2*(2.75+1.75)+12.27*(2.75+1.75)+0.745*3*2.25+0.34*3*2.25+1.65*(3*2*0.75+0.5*3.125*2)$$

$$= \boxed{220.02\ m.t}$$

Case Of Max. Shear Force



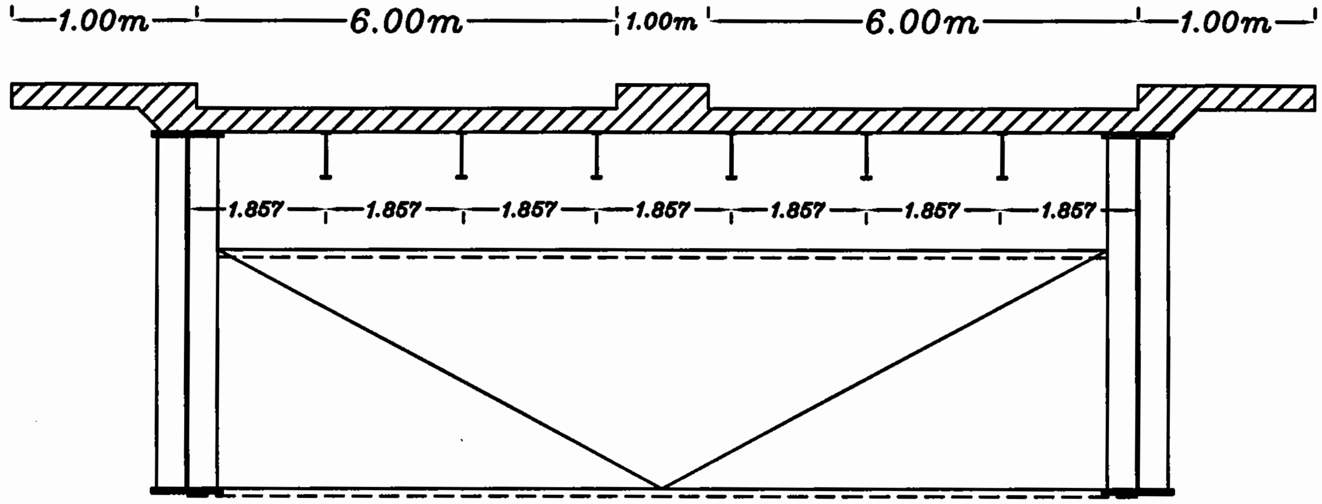




I.L For Max. S.F

$$Q_{LL+I}=(32.2*2+0.745*3)*0.884+(2*12.27+0.34*3)*0.65$$
$$+1.65*7*0.27 = \boxed{78.637t}$$

Question Five



Solution

1) Dead Loads

$W_{S.S.inside} = 150+4L+0.03L^2= \ldots\ldots Kg/m^2$

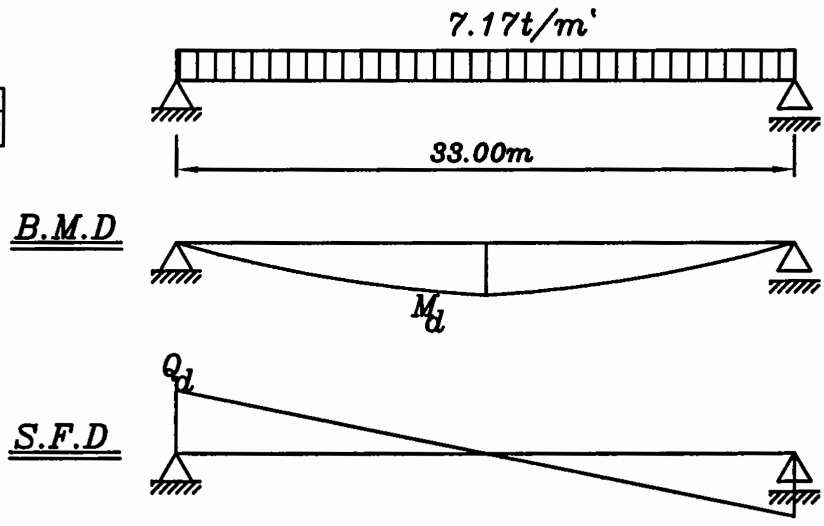
$W_{S.S.inside} = 150+4*33+0.03*33^2=315 Kg/m^2$

$W_{dead}= (t_s * \gamma_c +f.c) *Lc + (t_s * \gamma_c +f.c+W_{S.S.in}) *B'/2$

$W_{dead}=(0.16*2.5+0.175)*1.0+(0.21*2.5+0.175+0.315)*6.50=7.17t/m'$

$$M_d = \frac{7.17 * 33^2}{8} = \boxed{976m.t}$$

$$Q_d = \frac{7.17 * 33}{2} = \boxed{118t}$$

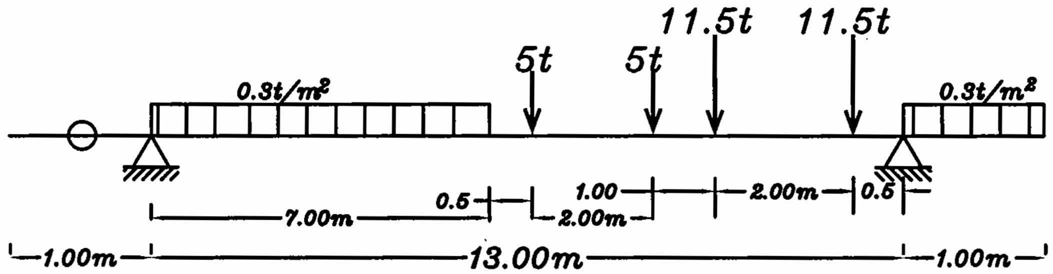


2) Live Loads For M.G

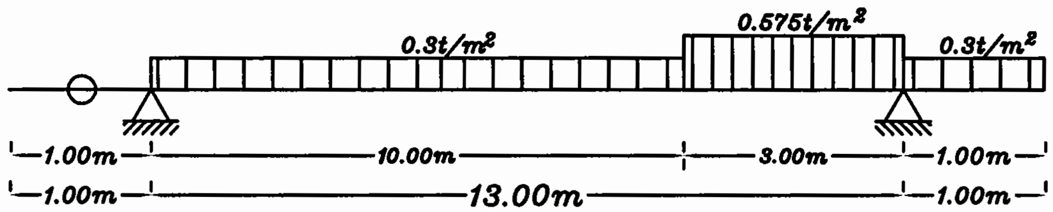
Impact factor $I = 0.4 - 0.008 * 33 = 0.136 < 0.15$

$\therefore I = 0.15$

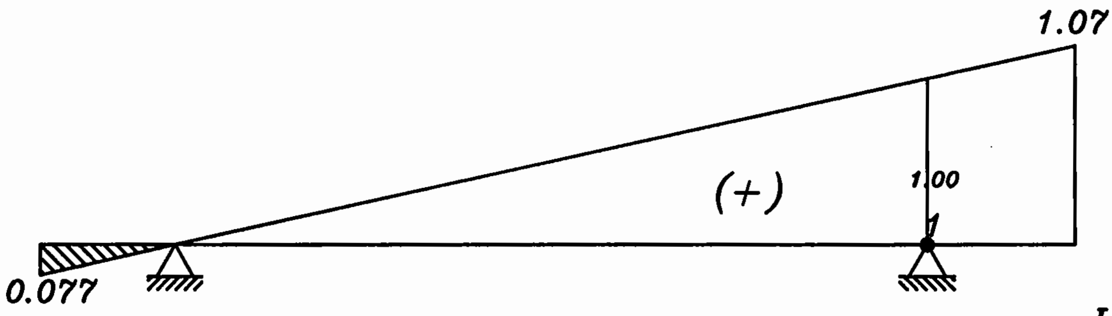
$10(1+I) = 11.5t$, $0.5(1+I) = 0.575 t/m^2$



Strip1
Get R_1 , W_1



Strip2
Get W_2



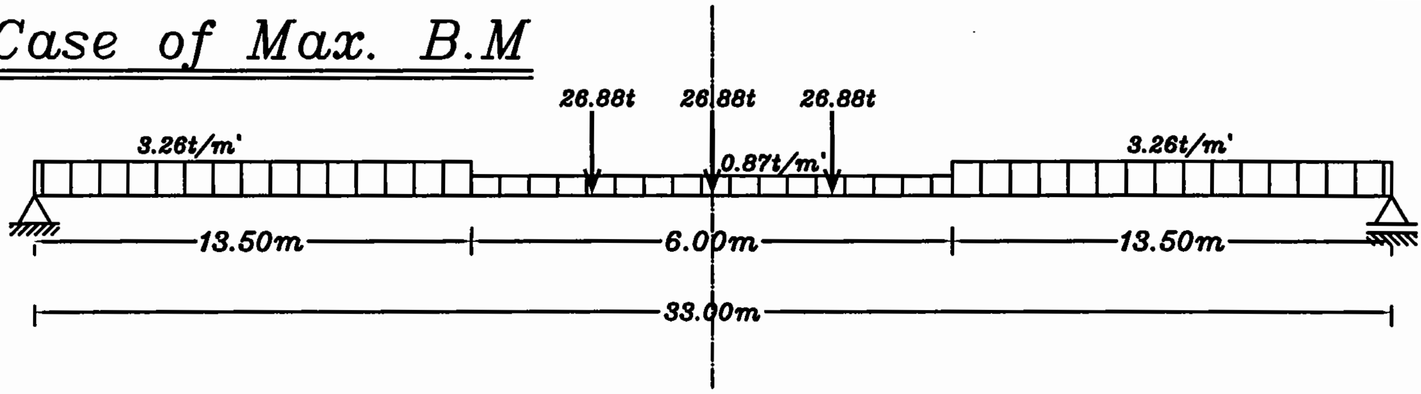
I.L For Reaction @ 1

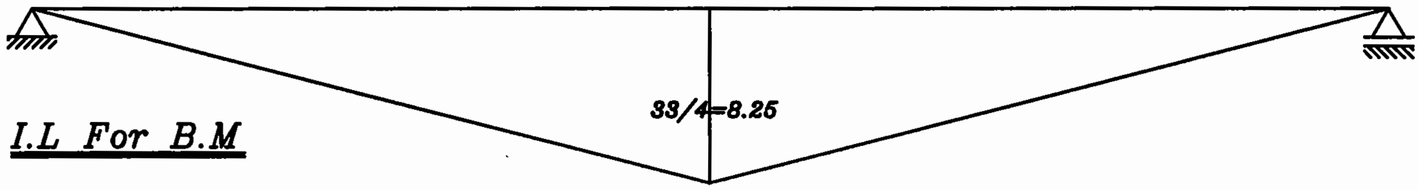
$$R_1 = 5*\left(\frac{9.5+7.5}{13.0}\right) + 11.5*\left(\frac{10.5+12.5}{13.0}\right) = \boxed{26.88t}$$

$$W_1 = 0.3*1*1.035 + 0.3*7*3.5/13.0 = \boxed{0.87t/m'}$$

$$W_2 = 0.3*1*1.035 + 0.57*3*0.88 + 0.3*10*0.484 = \boxed{3.26t/m'}$$

Case of Max. B.M



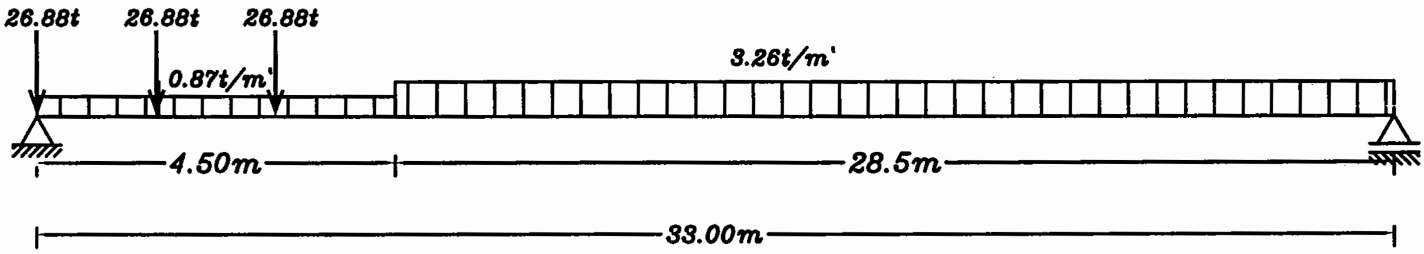


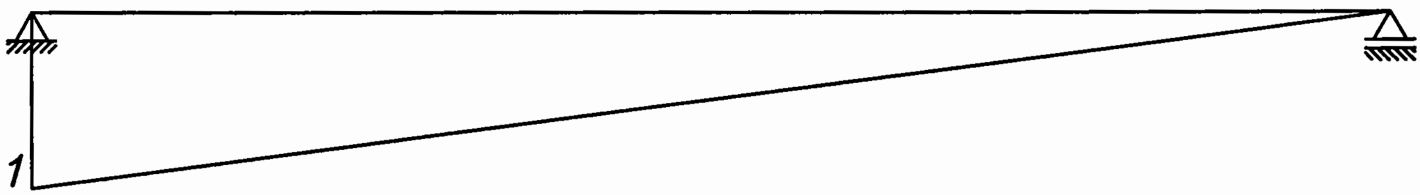
I.L For B.M

$$M_{LL+I}=26.88(8.25+2*7.50)\ +0.87*3*7.50*2\ +3.26*13.5*3.375*2$$

$$M_{LL+I}=\boxed{961 m.t}$$

Case of Max. S.F



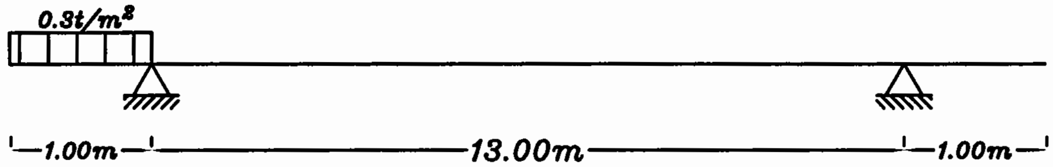


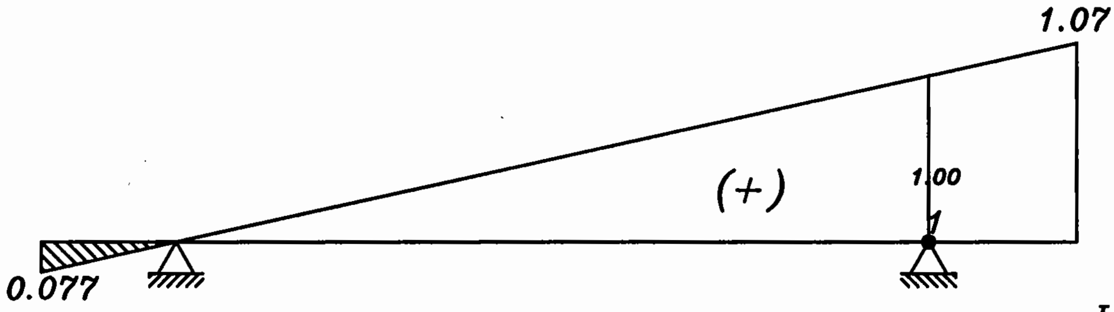
I.L For S.F

$$Q_{LL+I}=3.26*28.5^2/2*1/33+26.88\left(\frac{30+31.5+33}{33}\right)+0.87*4.5*\frac{30.75}{33}$$

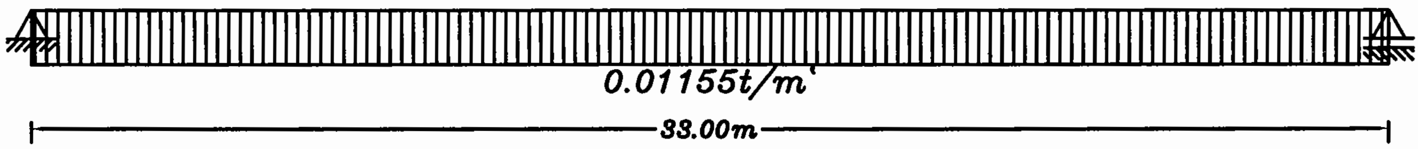
$$Q_{LL+I}=\boxed{121 t}$$

Case of min. B.M due to live load





W_{min} =0.3*1*0.0385 = 0.01155t/m'



$M_{ll.\ min} = \dfrac{0.0115*33^2}{8} = \boxed{1.57m.t}$

$M_{max.} = M_{D+LL+I} = 976+961 = \boxed{1937m.t}$

$M_{min.} = M_D - M_{ll.\ min} = \boxed{974.43m.t}$

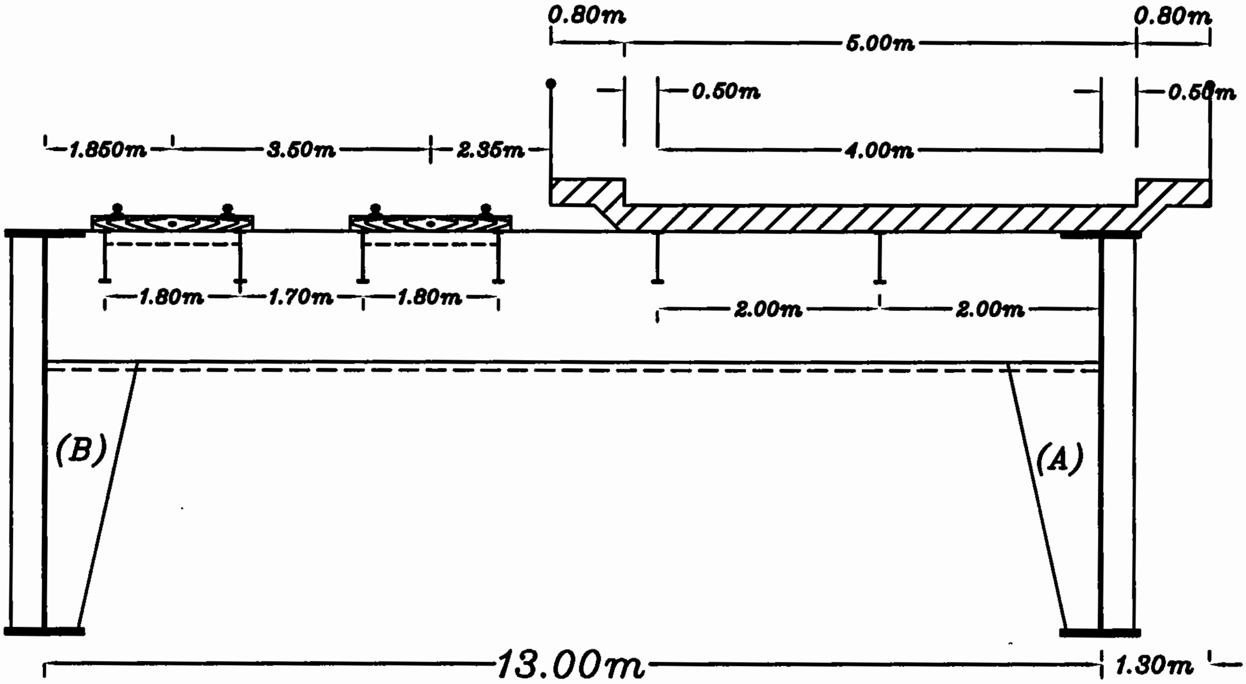
$Q_{max.} = Q_{D+LL+I} = 118+121 = \boxed{239t}$

Design Values

من الممكن اهمال هذه الخطوه فى الامتحان نظرا لان قيمة $M_{ll.\ min.}$ تكون صغيره جدا

Example 2

Mid. term Revision



A rail–roadway Plate girder deck bridge of the shown cross section has a span of 40.00ms and is divided into 8 equal pannel 5.00ms each. The main girders are spaced 13.00ms apart.

it is Required to

1–Complete general layout for the shown cross section

2–Find the maximum bending moment and the maximum Shearing force for an intermediate cross girder due to live loads Plus impact only

3–Find the maximum bending moment and max.max. shearing Force @ mide Span For the two M.G (A,B)

4–Explian how can the wind load transmite to the bearing level

5)Explian how can the wind load transmite to the bearing level

6)the types and function of stiffeners used for plate girder

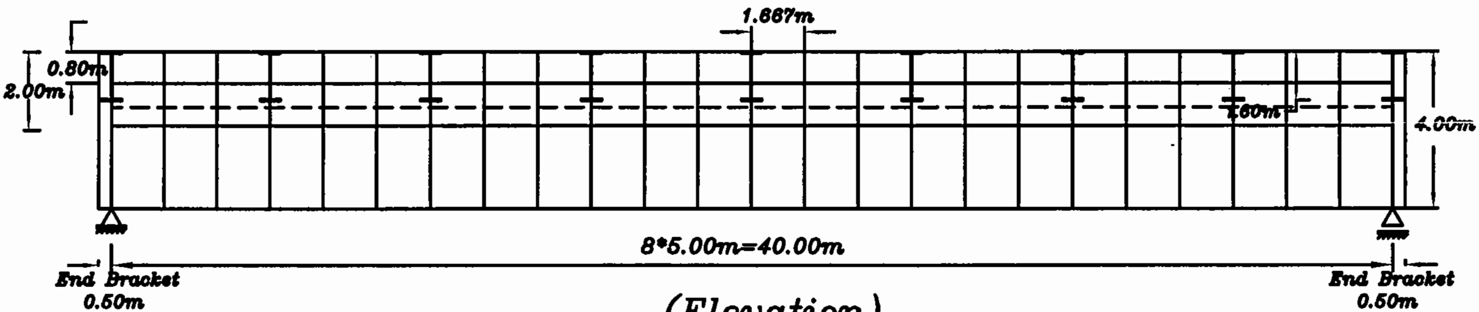
7-Explain using neat sketches whenever possible How can the the bracking force transmitte to the bearing level

8- state the effect of removal of stringer bracing using neat sketches whenever possible

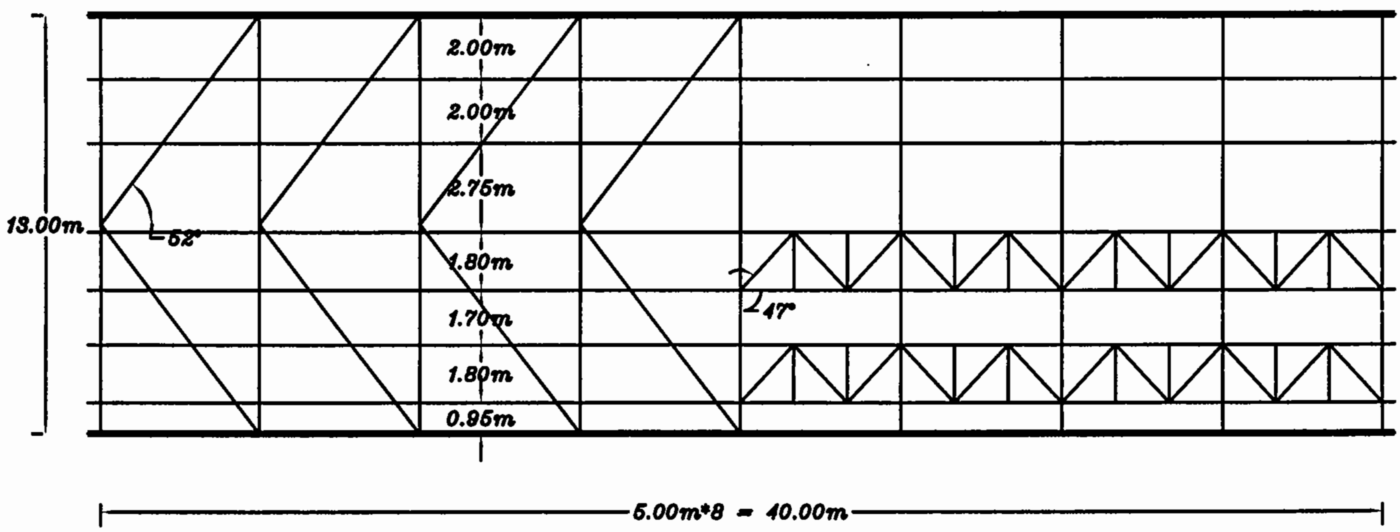
9-state types of fatigue affecting members

10-state the effect of removal bracking force bracing system

Question One



(Elevation)

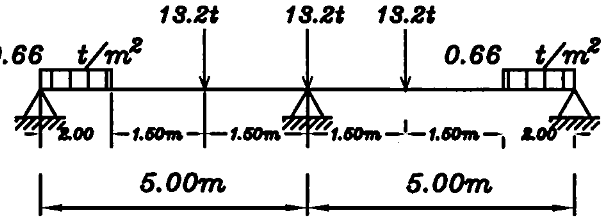


(Plan Of Upper Bracing)

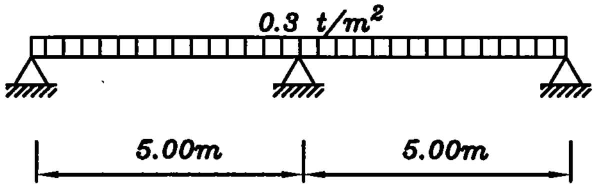
Question Tow

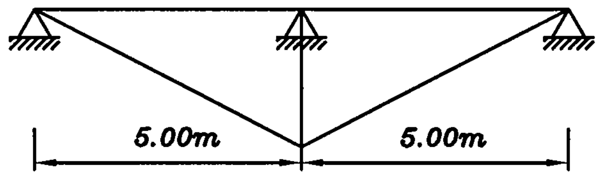
For Road Way Part

Strip1
Get R_1 , W_1



Strip3
Get W_3





$$I = 0.4 - 0.008L$$

$$I = 0.4 - 0.008(2*5.00=10.00m) = 0.320$$

$$10(1+0.320) = 13.20t \ , \ 0.5(1+0.320) = 0.66t/m'$$

$$R_1 = 13.20(1+2*0.70) = \boxed{31.68t}$$

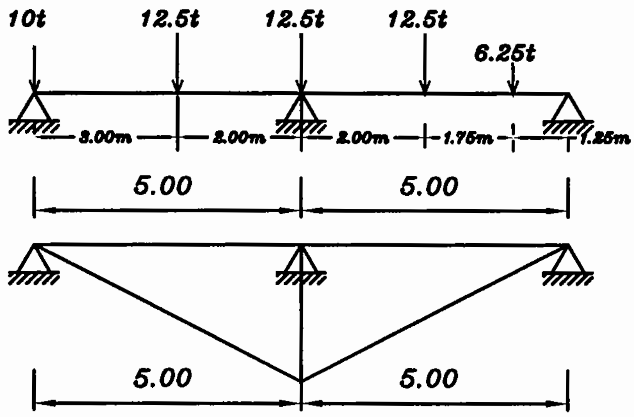
$$W_1 = 0.66*2.00*0.2*2 = \boxed{0.53t/m'}$$

$$W_3 = 0.30*5.00*0.5*2 = \boxed{1.5t/m'}$$

خلى بالك

لم تظهر الشريحه الثانيه للعربه ال ٣٠طن نظرا لان عرض الطريق اقل من ٦م

For Rail Way Part



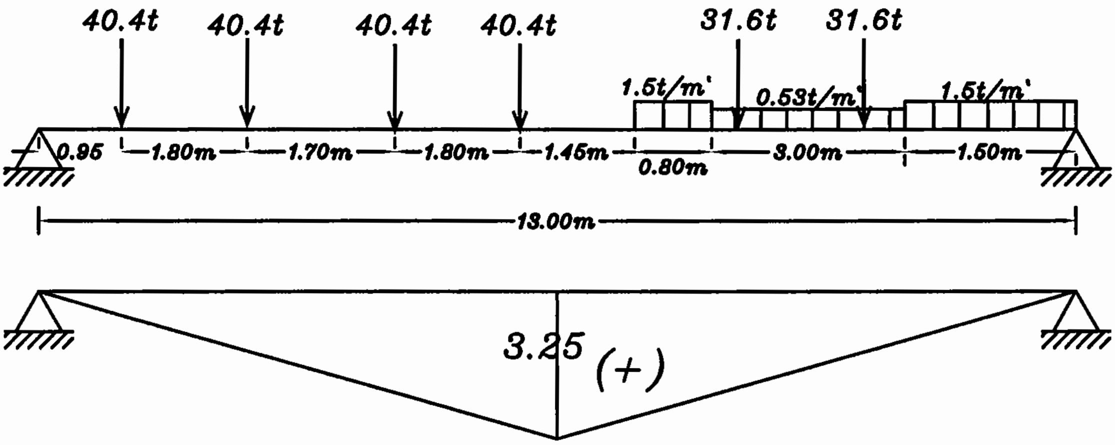
$$Impact\ Factor = I = \frac{24}{24+4*5.00} = 0.545$$

$$R_{ll} = 12.5(1+2*0.60)+6.25*0.25 = 29.06t$$

$$R_{ll+i} = 29.06t *1.54 = 44.75t$$

$$R_{(D.T)ll+i} = 44.75t *0.9 = \boxed{40.4t}$$

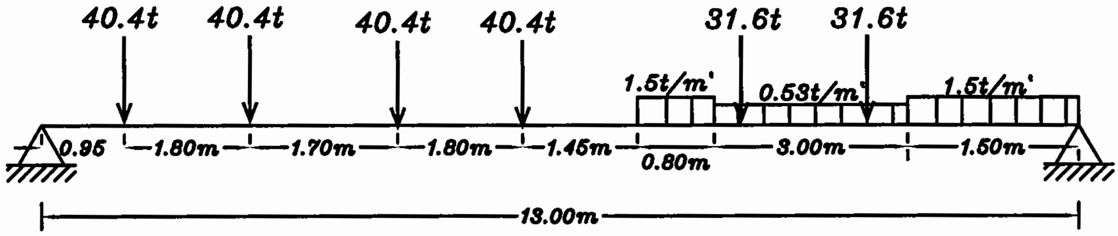
Case Of Max. Bending Moment

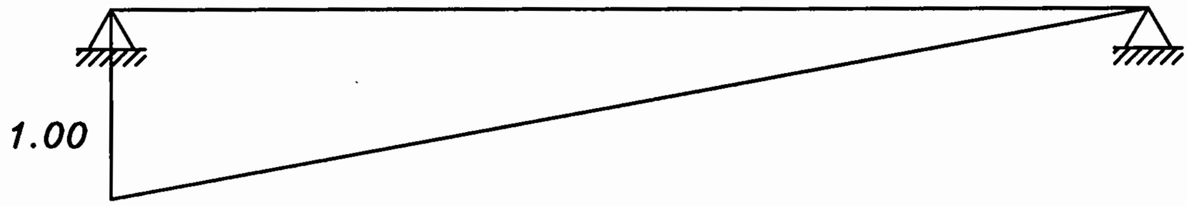


$$M_{LL+I} = 2*31.6*1.50+1.5*(1.5*0.375+0.8*2.45)$$
$$+0.53*3*1.5+40.4*4*1.80$$

$$\boxed{391.84m.t}$$

Case Of Max. Shear Force





خلى بالك

نفس حالة تحميل ال *B.M* هى نفسها حالة تحميل ال*Shear*
لاننا سوف نحسب من عند ال *Support*اللى ناحية ال *Rail Way*
وذلك للتسهيل فقط لكن من المفروض حساب ال *shear force*
من الجهتين *Rail & Road* واخذ القيمه الاكبر

$$Q_{LL+I} = 40.4*4*0.723 + 1.5*(0.8*0.376+1.5*0.057)$$
$$0.53*3*0.23 + 31.6(0.307+0.154)$$

132.35t

For M.G A

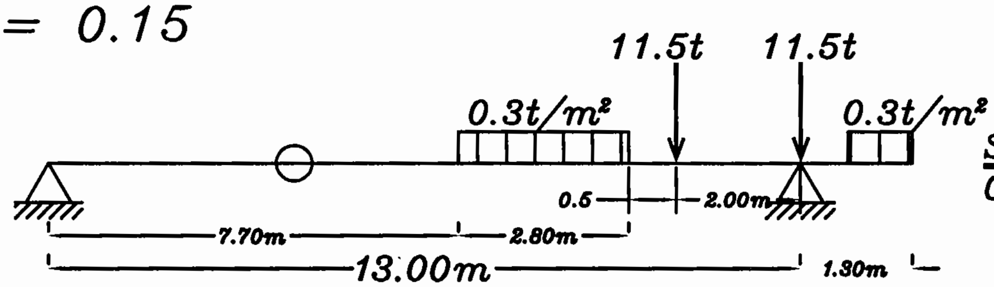
Question 2

Road Way Part

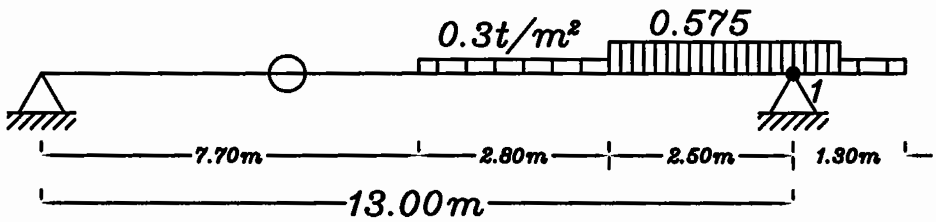
$I = 0.4 - 0.008L$

$I = 0.4 - 0.008*40=0.08<0.15$

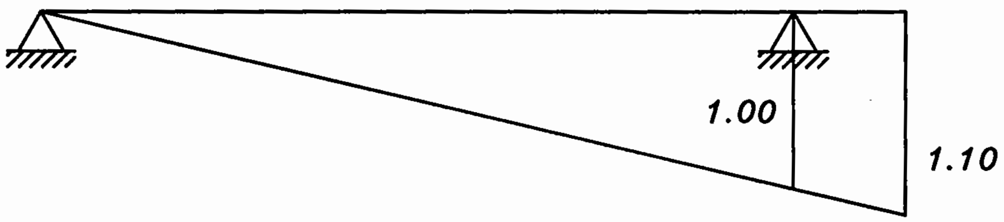
$\therefore I = 0.15$



Strip1
Get R_1, W_1



Strip2
Get W_2



$R_1 =11.5*(1+0.846)=$ **21.23t**

$W_1 =0.3*2.8*0.7+0.3*0.8*1.07=$ **0.8448t/m**

$W_2 =0.575*2.5*0.9+0.3*2.80*0.7+0.3*0.8*1.07=$ **2.13t/m**

For max. Shear @ mide Span

$I = 0.4 - 0.008L$

$I = 0.4 - 0.008*20=0.24>0.15$

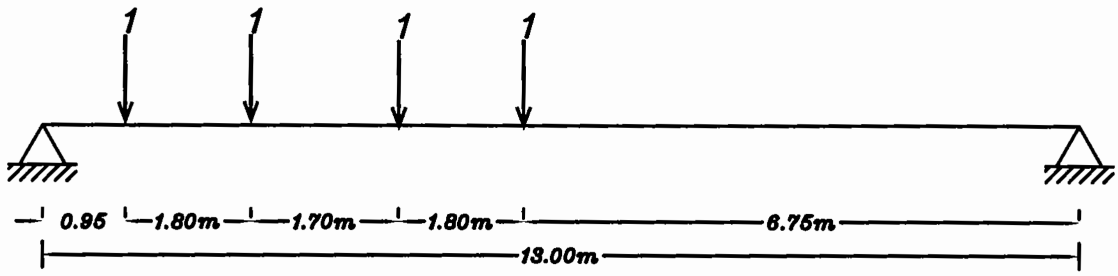
$R_1 =21.23*\frac{1.24}{1.15} =$ **22.89t**

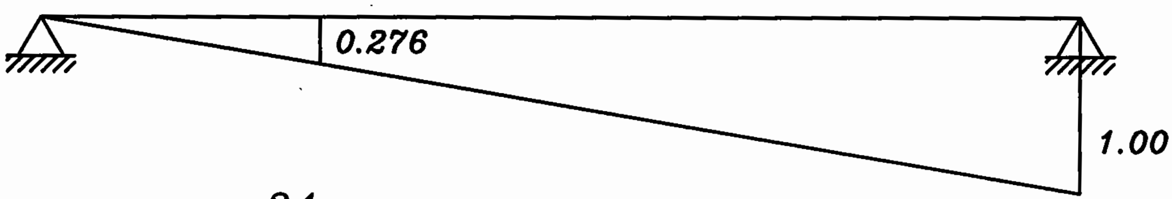
$W_2 =0.8448+1.29*\frac{1.24}{1.15} =$ **2.23t/m**

لاحظ انه طلب max. max. shear @ mid span

ولم يطلب max. shear affecting main girder

Rail Way





Impact factor $I=\frac{24}{24+2*40}=0.23 < 0.25$

$R=4*0.276=\boxed{1.104}$

Reduction For Double track = 0.9

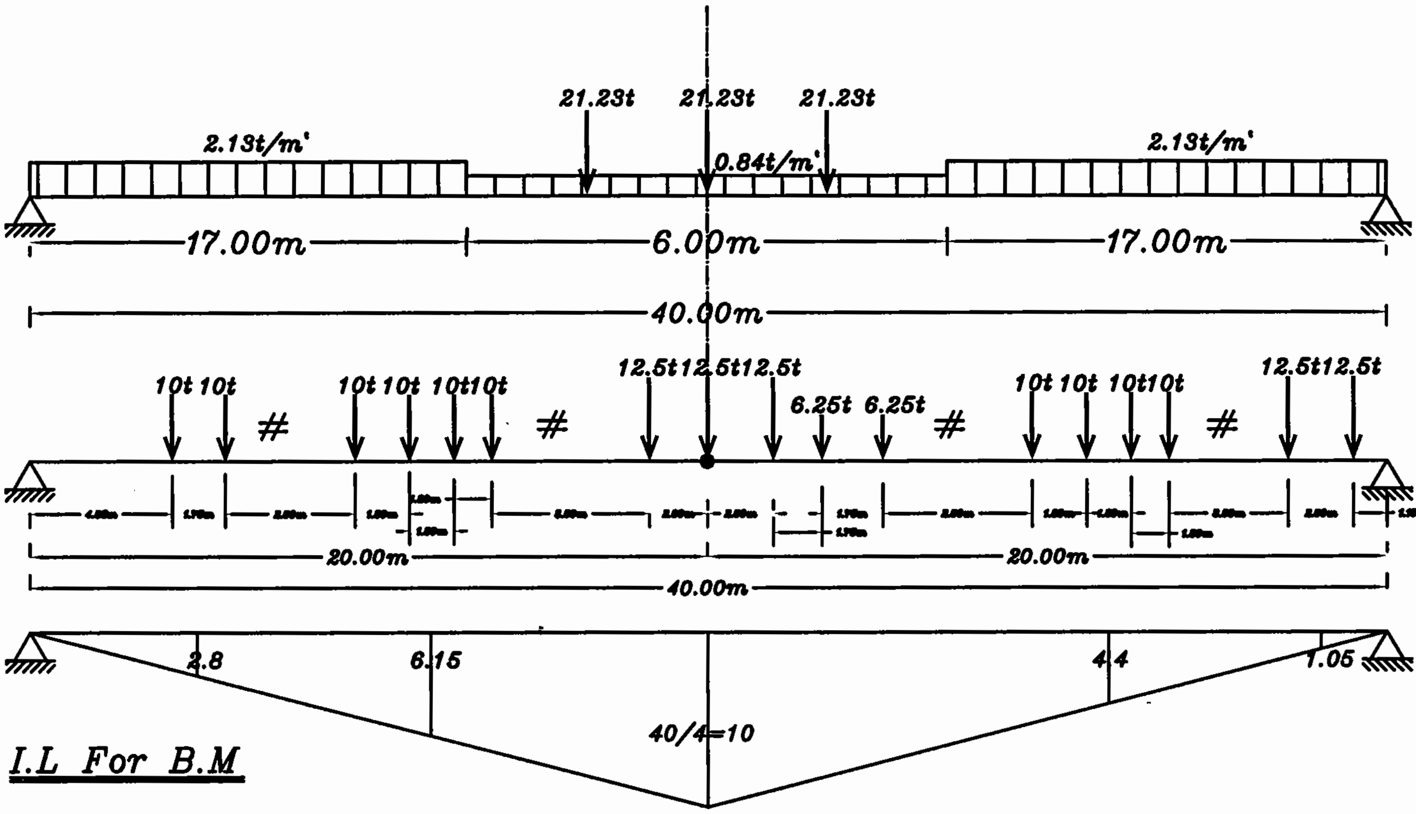
خلى بالك

لاحظ انه فى حالة ما كان الكوبرى ال Rail Way متماثل كان كل M.G يحمل نصف الكوبرى اما فى هذه الحاله فالكوبرى غير متماثل وعلى هذا يتم فرض Factor مقداره [1] مكان كل Rail ومعرفة قيمة قيمة ال Reaction عند ال M.G المطلوبه وبهذا يتم معرفة قيمة نسبة الحمل على كل M.G من ال Rail Way

وللحصول على ال Max. B.M سوف يتم حل ال M.G على اساس مبدا ال Super Position

اى سوف يتم حساب العزوم على الكمره نتيجة ال Rail Way ثم يتم جمع العزوم عليها نتيجة ال Road Way

Case Of Max. Bending Moment



I.L For B.M

Road Way

$M_{LL+I} = 21.23(10+2*9.25) + 0.84*3*9.25*2 + 2.13*17*4.25*2$

$M_{LL+I} = \boxed{959.4mt}$

Rail Way

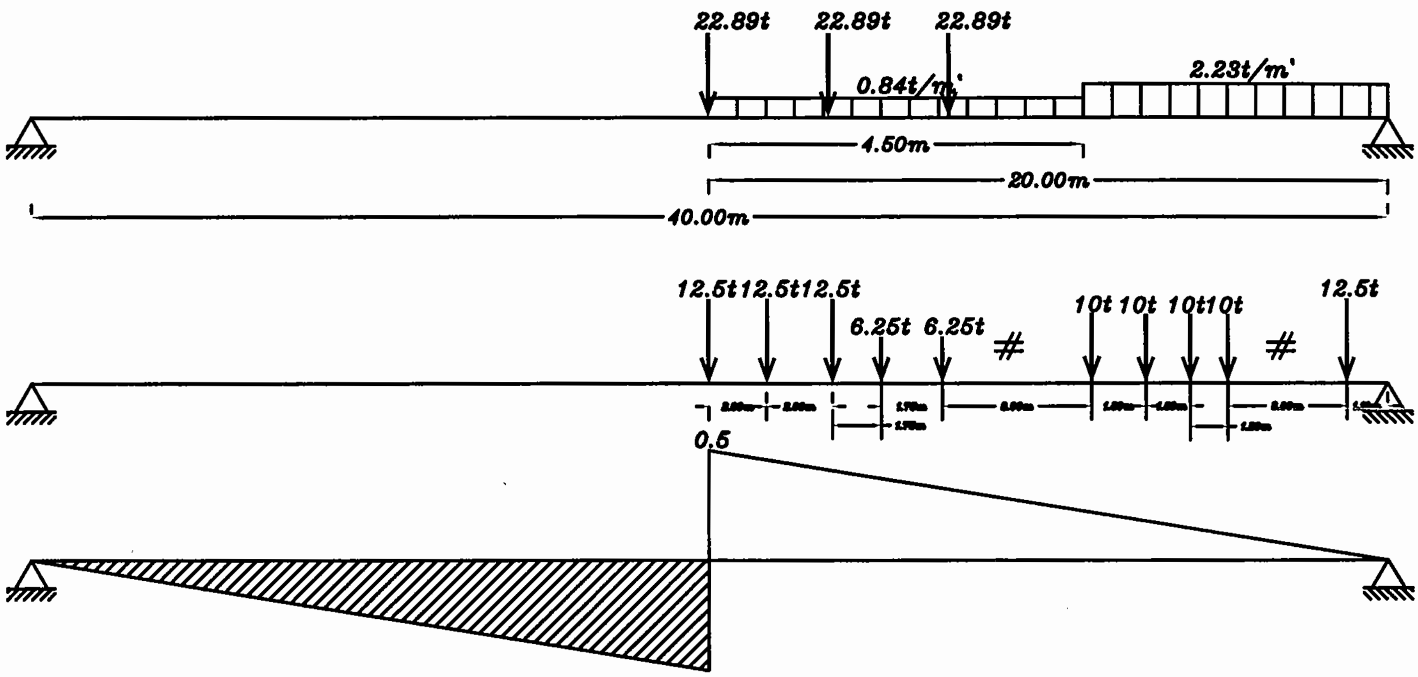
$M_{LL} = 12.5(10+2*9) + 2*6.25*7.68 + 4*10*(4.4+6.15) + 2*10*2.8$

$+2*12.5*1.05 = 950.25$

$M_{LL+I} = 950.25*1.25*0.9*1.104 = \boxed{1180.21m.t}$

$M_{LL+I(Road+Rail)} = 959.4 + 1180.21 = \boxed{2139m.t}$

Case Of Max. Shearing Force @ mide Span



Road Way

$$Q_{LL+I} = 3*22.89*0.46+0.84*4.5*0.443+2.23*15.5*0.193 = \boxed{39.933t}$$

Rail Way

$$\text{Impact factor} \quad I = \frac{24}{24+2*20} = 0.375 > 0.25$$

$$Q_{LL} = 3*12.5*0.45+2*6.25*0.36+4*10*0.17+12.5*0.0275 = 28.52t$$

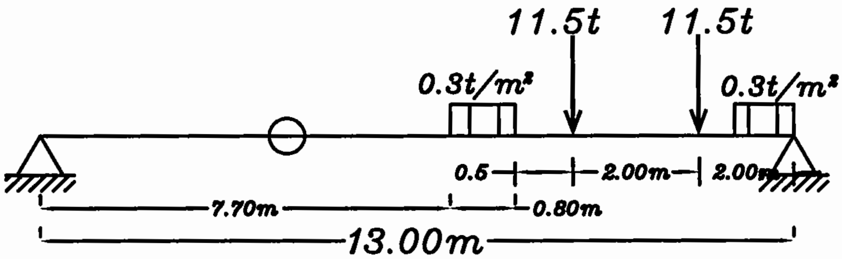
$$Q_{LL+I} = 28.52*1.375*0.9*1.104 = \boxed{38.96t}$$

$$Q_{LL+I(Rail+Road)} = 39.933+38.96 = \boxed{78.893t}$$

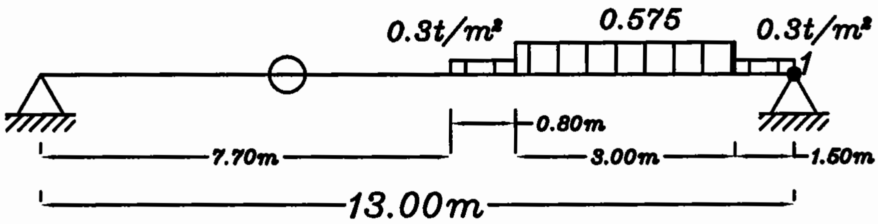
For M.G B

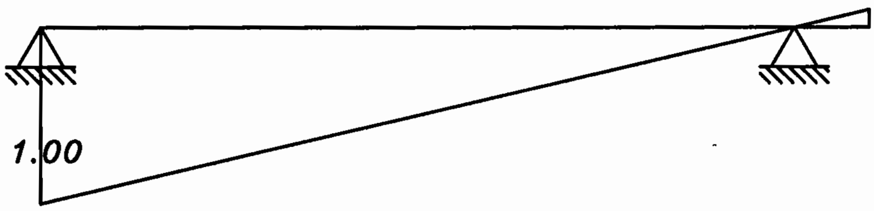
Road Way Part

Strip1
Get R_1 , W_1



Strip2
Get W_2





$R_1 = 11.5*(0.154+0.3) = \boxed{5.22t}$

$W_1 = 0.3*0.8*0.37+0.3*1.5*0.05 = \boxed{0.112t/m'}$

$W_2 = 0.112+0.575*3*0.23 = \boxed{0.51t/m'}$

shear

$I = 0.4 - 0.008L$

$I = 0.4 - 0.008*20 = 0.24 > 0.15$

$R_1 = 5.22*\frac{1.24}{1.15} = \boxed{5.628t}$

$W_1 = \boxed{0.112t/m'}$

$W_2 = 0.396*\frac{1.24}{1.15}+0.112 = \boxed{0.54t/m'}$

Rail Way

$R = 4 - 1.104 = \boxed{2.896}$

From the Previous I.L For B.M For Road and Rail Way

Road Way

$5.22*10+2*5.22*9.25+2*0.112*3*9.25+2*0.51*17*4.25$

$M_{LL+I}=\boxed{228.68m.t}$

Rail Way

$950.25*1.25*0.9*2.896=\boxed{3095.91m.t}$

$$\boxed{M_{LL+I(Road+Rail)}=228.68+3095.91 = \boxed{3324.59m.t}}$$

Shear

Road Way

$Q_{LL+I(Road)}=3*5.628*0.46+0.112*4.5*0.443+0.54*15.5*0.193=9.60t$

$Q_{LL+I(Road)}=\boxed{9.60t}$

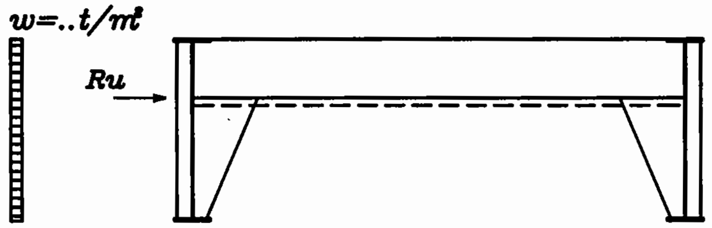
Rail Way

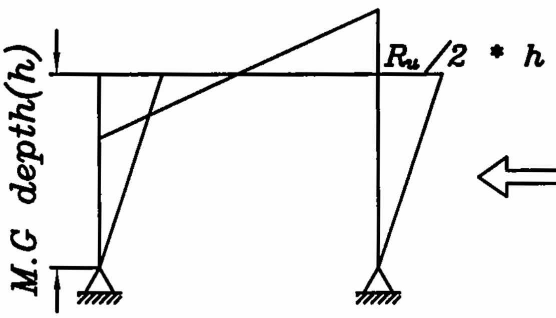
$Q_{LL+I(Rail)}=28.52*1.375*0.9*2.896 = \boxed{102.21t}$

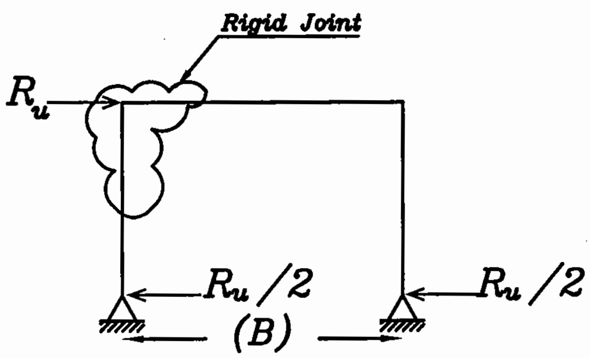
$$\boxed{Q_{LL+I(Road+Rail)}= 102.21+9.60t = \boxed{111.80t}}$$

Question 4

Wind transmite directly to the upper wind bracing and by inverted u frame action at each X.G the wind load be transmitted to the bearing



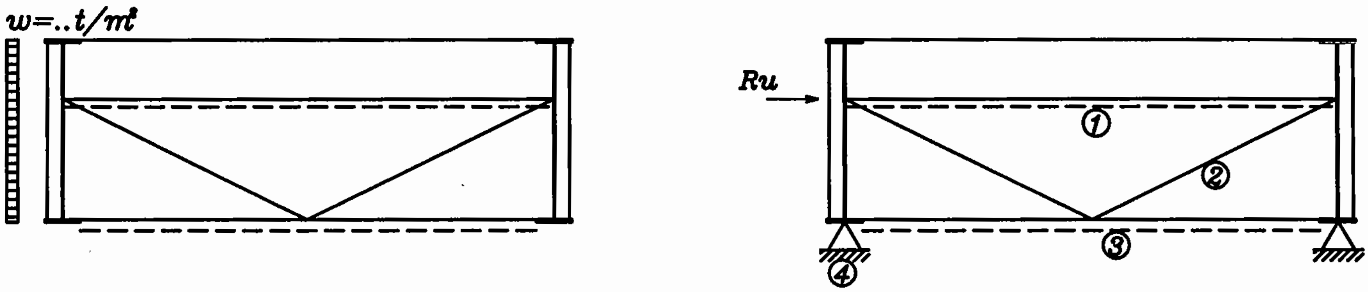




Question 5

Deck Bridge with vertical bracing

Wind transmite to the upper wind bracing and then to the vertical bracing and then to the lower bracing and then to the bearing



Question 6

the types and function of stiffeners used for plate girder

1-Use transverse (Vertical) end bearing Stiffner at the bearing of the M.G to resist the high reaction of the M.G

2-Use transverse (Vertical) intermediate bearing Stiffners at Points Of Concentrated Load (X.G)

3-Use transverse (Vertical) intermediate Stiffners every distance 1.50m ⟶ 1.80m between X.G to Support the web plate against buckling

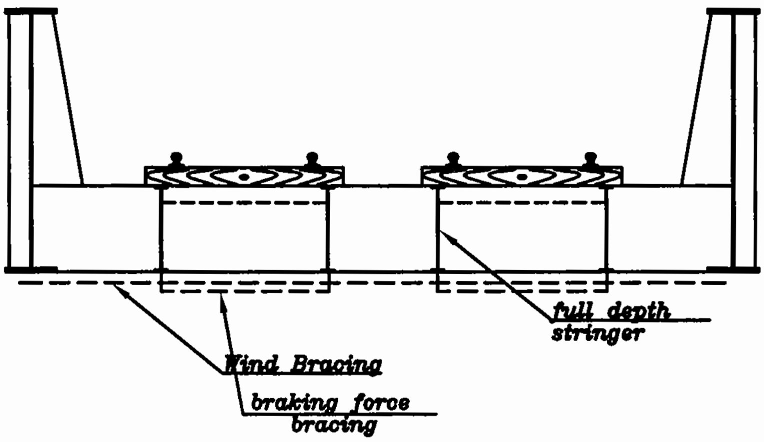
4-Use Longitudinal (Horizontal) Stiffners For Plate girders with big Web Depth

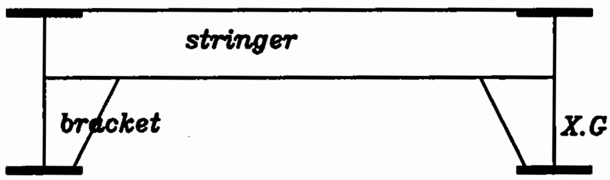
Question 7

to trasmitte the braking force , by using braking force bracing is at the lower level of the flange of cross girder

and to transmitte this force we use either full depth stringer at the first and last pannels

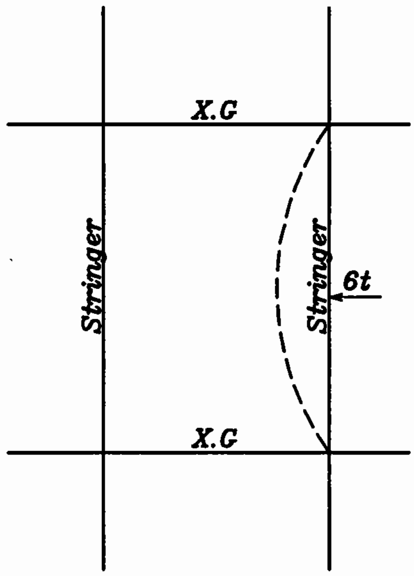
or using inverted u-frames at the place of braking force bracing to transmite the bracking force to the bracing level and then to the bearing level





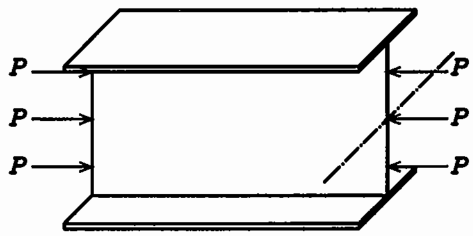
Question 8

Removal Of Stringer Bracing System in rail way bridge lateral Chock of the train (6t) will affect the stringer by My

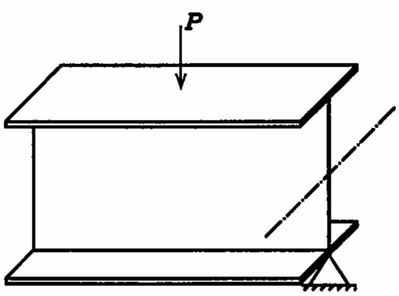


Question 9

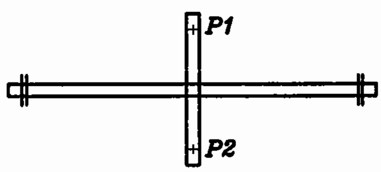
1-axial fatigue



2-Bending Fatigue



3-Torssion fatigue

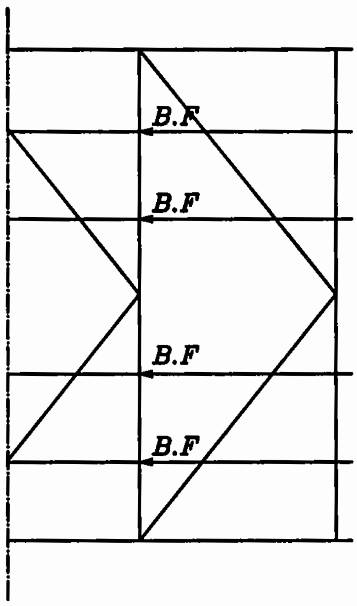


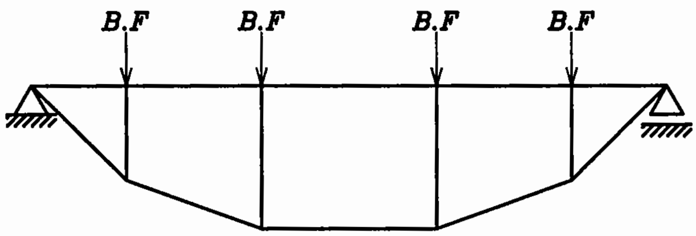
Question 10

if there is no braking force bracing the braking force would not transmitte to the bearing

and it will effect cross girder as shown below

Braking Force(B.F)

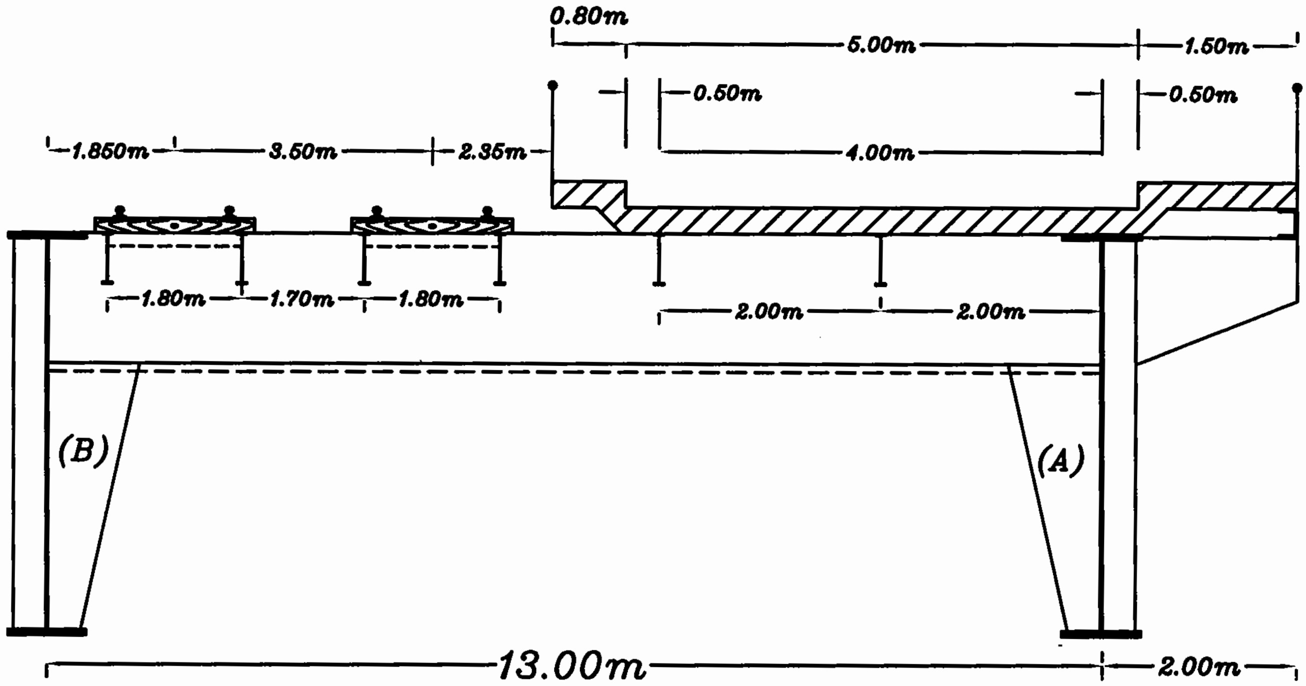




the braking force cause M_Y on cross girder (out palne moment)

Example 3

Mid. term Revision



A rail–roadway Plate girder deck bridge of the shown cross section has a span of 40.00ms and is divided into 8 equal pannel 5.00ms each. The main girders are spaced 13.00ms apart.

it is Required to

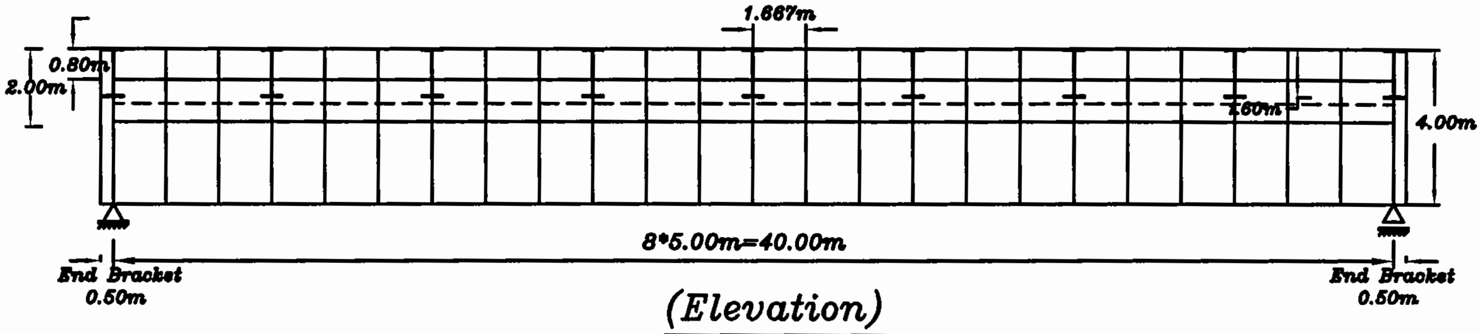
1–Complete general layout for the shown cross section

2–Find the maximum bending moment and the maximum Shearing force for an intermediate cross girder due to live loads Plus impact only

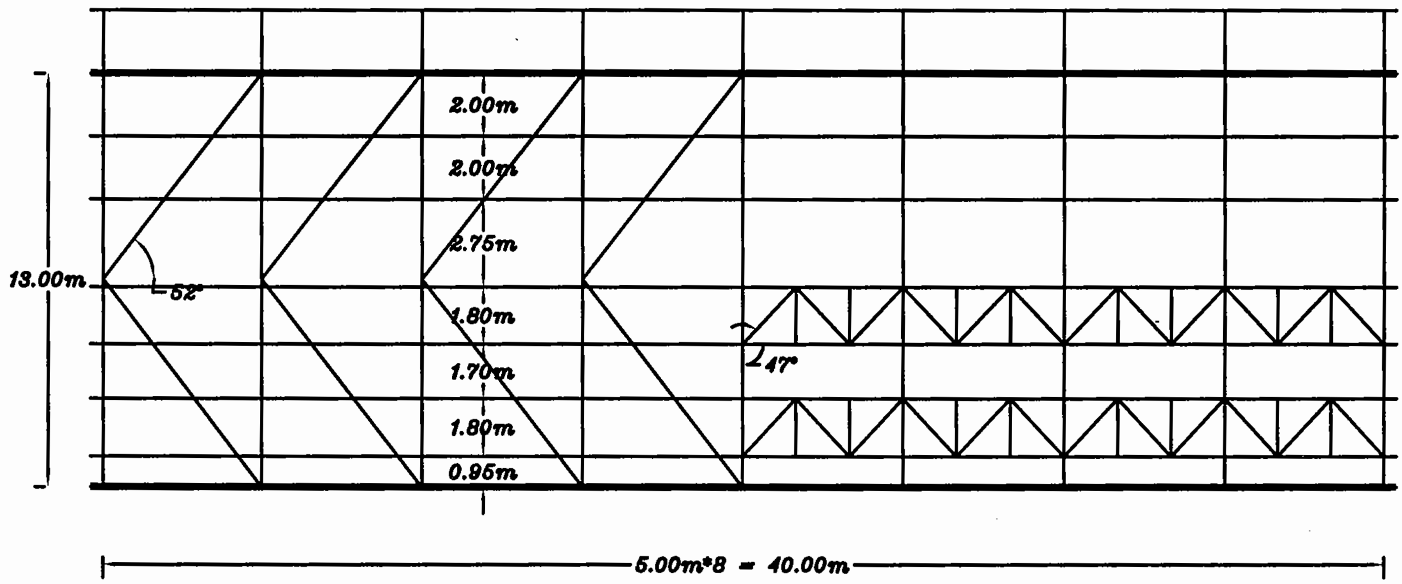
3–Find the maximum bending moment and max.max. shearing Force @ mide Span For the two M.G (A,B)

4–Explian how can the wind load transmite to the bearing level

Question One



(Elevation)



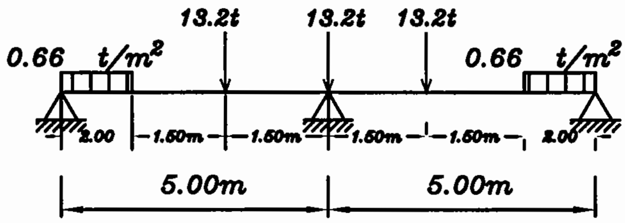
(Plan Of Upper Bracing)

Question Tow

For Road Way Part

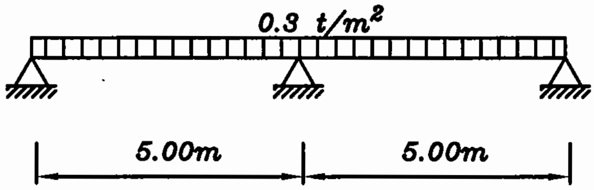
Strip1

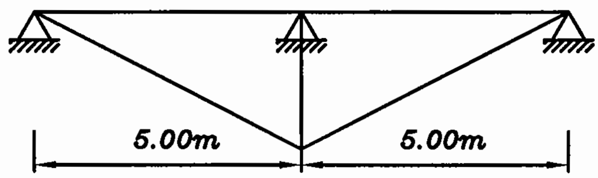
Get R_1 , W_1



Strip3

Get W_3





$$I = 0.4 - 0.008L$$

$$I = 0.4 - 0.008(2*5.00=10.00m) = 0.320$$

$$10(1+0.320) = 13.20t \ , \ 0.5(1+0.320) = 0.66t/m'$$

$$R_1 = 13.20(1+2*0.70) = \boxed{31.68t}$$

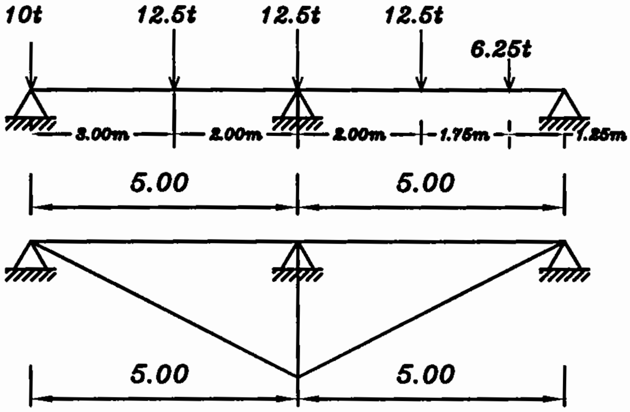
$$W_1 = 0.66*2.00*0.2*2 = \boxed{0.53t/m'}$$

$$W_3 = 0.30*5.00*0.5*2 = \boxed{1.5t/m'}$$

خلى بالك

لم تظهر الشريحه الثانيه للعربه ال ٣٠طن نظرا لان عرض الطريق اقل من ٦م

For Rail Way Part



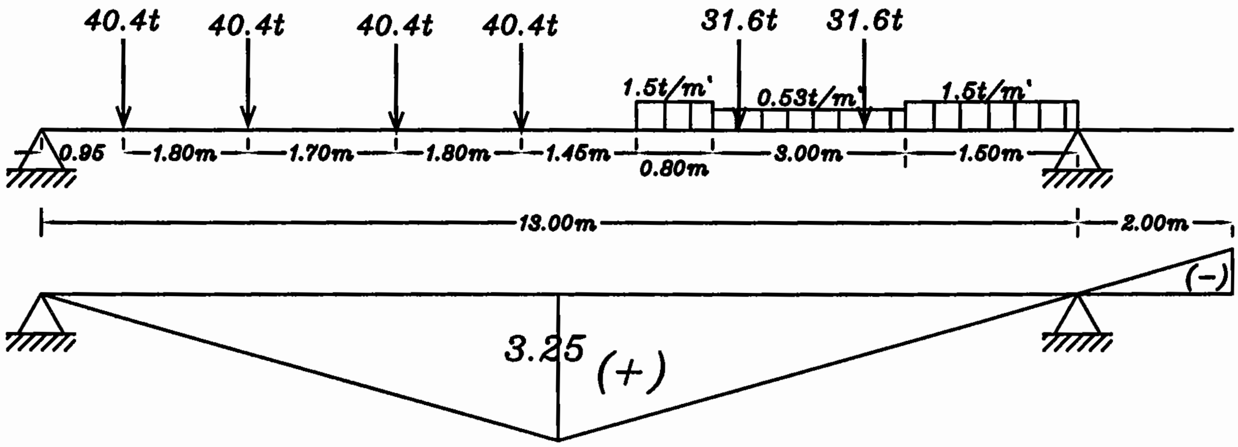
$$Impact\ Factor = I = \frac{24}{24+4*5.00} = 0.545$$

$$R_{ll} = 12.5(1+2*0.60)+6.25*0.25 = 29.06t$$

$$R_{ll+i} = 29.06t *1.54 = 44.75t$$

$$R_{(D.T)ll+i} = 44.75t *0.9 = \boxed{40.4t}$$

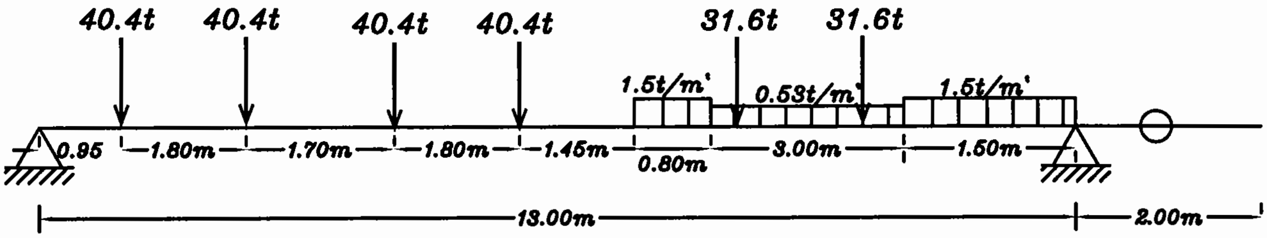
Case Of Max. Bending Moment

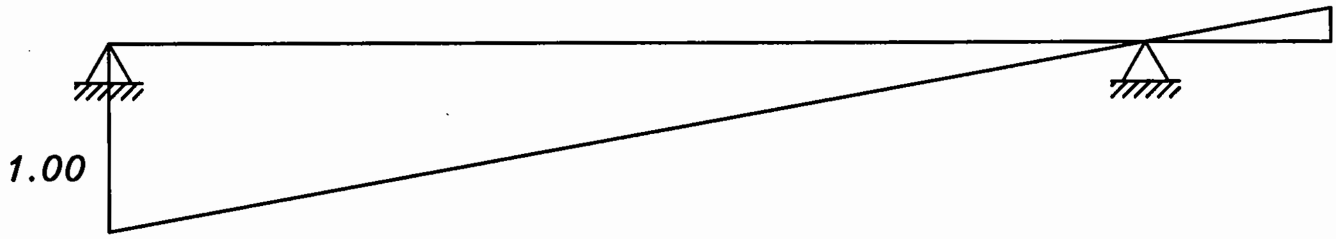


$$M_{LL+I} = 2*31.6*1.50+1.5*(1.5*0.375+0.8*2.45)$$
$$+0.53*3*1.5+40.4*4*1.80$$

$$\boxed{391.84m.t}$$

Case Of Max. Shear Force





خلى بالك

نفس حالة تحميل ال B.M هى نفسها حالة تحميل ال Shear
لاننا سوف نحسب من عند ال Support اللى ناحية ال Rail Way
وذلك للتسهيل فقط لكن من المفروض حساب ال shear force
من الجهتين Road & Rail واخذ القيمه الاكبر

$$Q_{LL+I} = 40.4*4*0.723 + 1.5*(0.8*0.376+1.5*0.057)$$
$$0.53*3*0.23 + 31.6(0.307+0.154)$$

$\boxed{132.35t}$

For M.G A

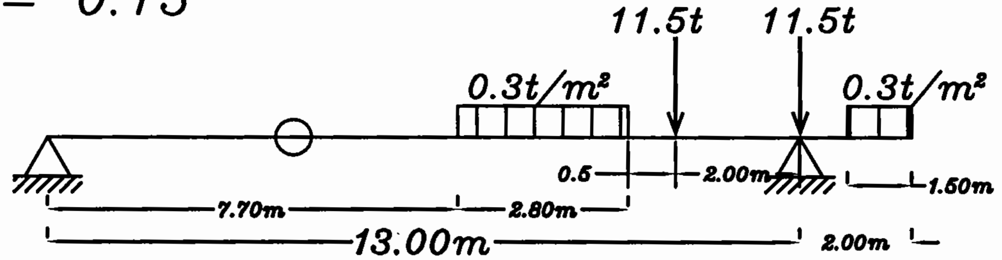
Question 2

Road Way Part

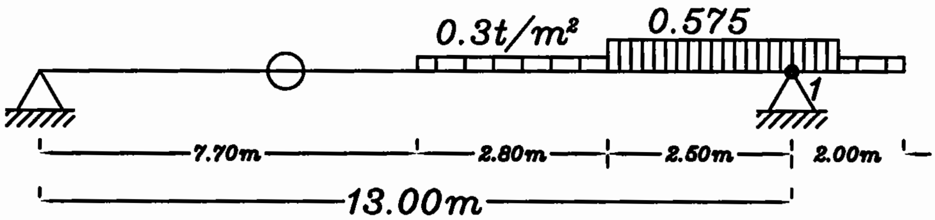
$$I = 0.4 - 0.008L$$

$$I = 0.4 - 0.008*40 = 0.08 < 0.15$$

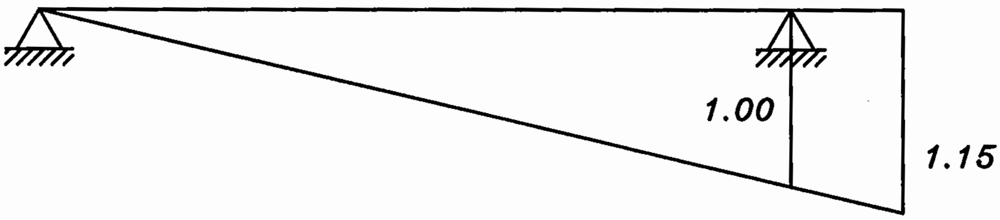
$$\therefore I = 0.15$$



Strip1
Get R_1, W_1



Strip2
Get W_2



$$R_1 = 11.5*(1+0.846) = \boxed{21.23t}$$

$$W_1 = 0.3*2.8*0.7 + 0.3*1.5*1.09 = \boxed{1.0785t/m}$$

$$W_2 = 0.575*3.0*0.8 + 0.3*2.80*0.7 + 0.3*1.5*1.09 = \boxed{2.45t/m}$$

For max. Shear @ mide Span

$$I = 0.4 - 0.008L$$

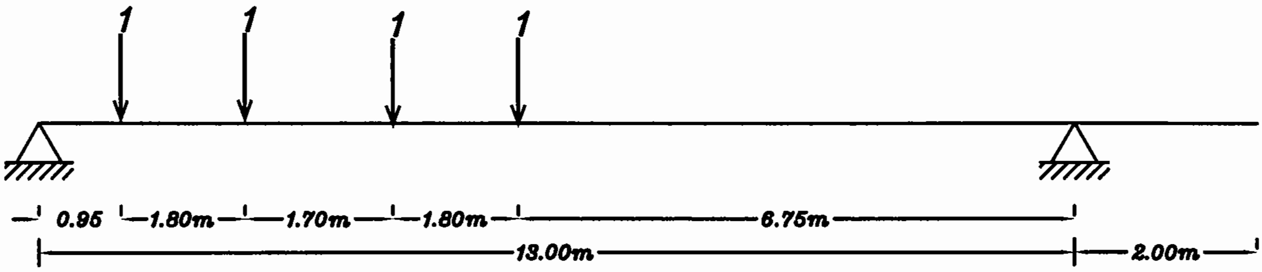
$$I = 0.4 - 0.008*20 = 0.24 > 0.15$$

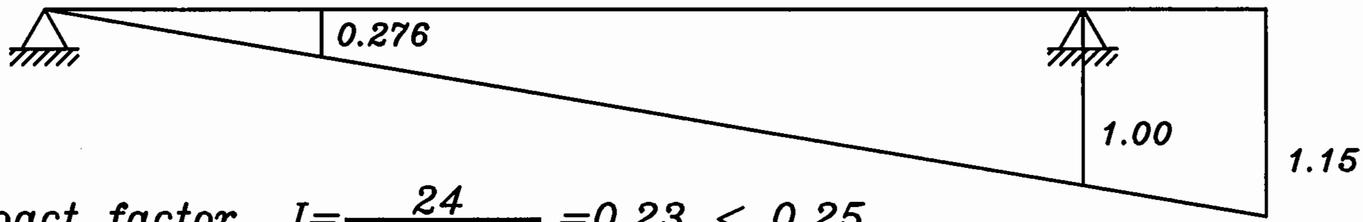
$$R_1 = 21.23*\frac{1.24}{1.15} = \boxed{22.89t}$$

$$W_2 = 1.0785 + 1.38*\frac{1.24}{1.15} = \boxed{2.56t/m}$$

لاحظ انه طلب max. max. shear @ mid span
ولم يطلب max. shear affecting main girder

Rail Way





Impact factor $I=\frac{24}{24+2*40}=0.23 < 0.25$

$R = 4*0.276 = \boxed{1.104}$

Reduction For Double track = 0.9

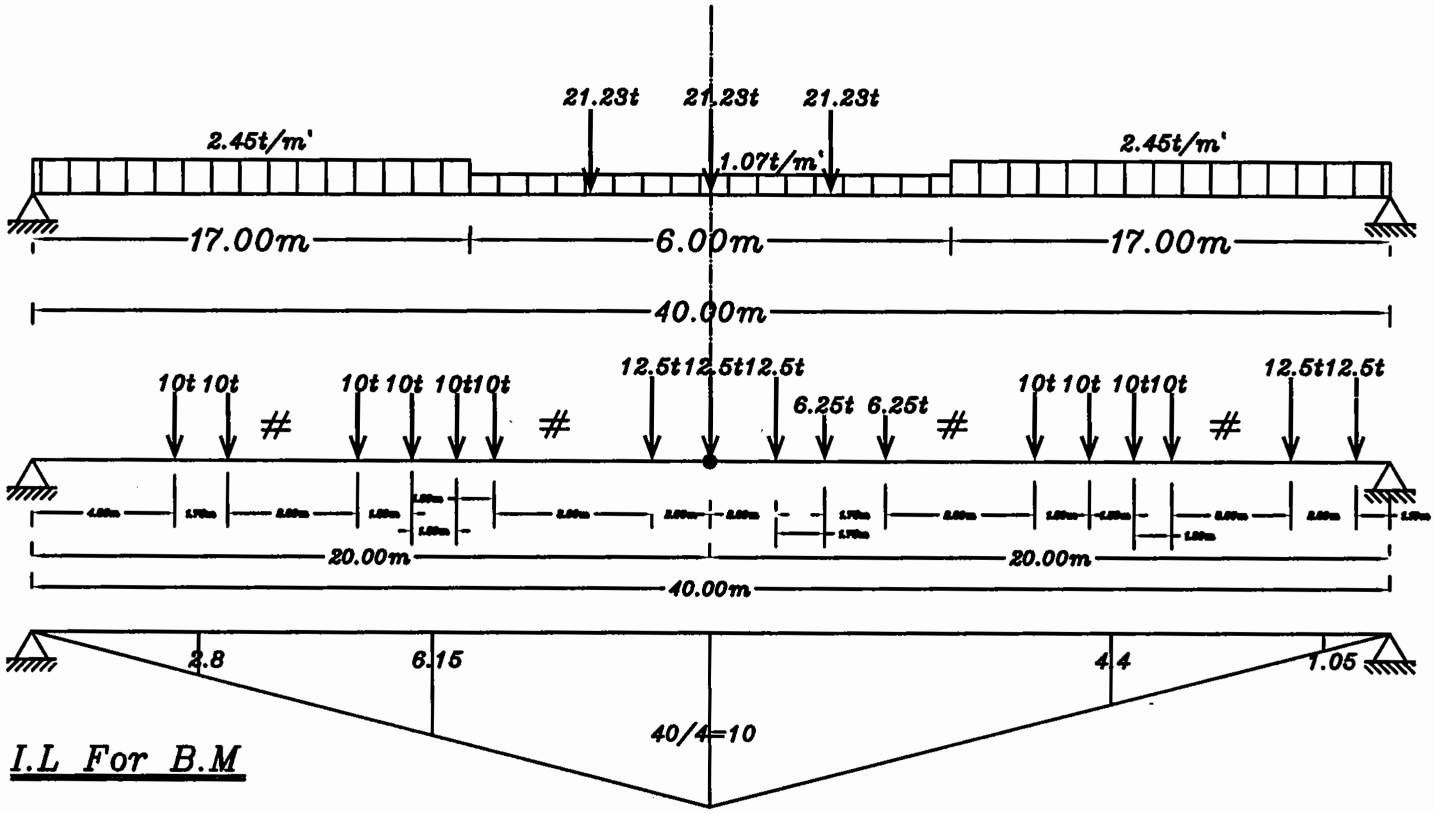
خلى بالك

لاحظ انه فى حالة ما كان الكوبرى ال Rail Way متماثل كان كل M.G يحمل نصف الكوبرى اما فى هذه الحاله فاالكوبرى غير متماثل وعلى هذا يتم فرض Factor مقداره 1 مكان كل Rail ومعرفة قيمة قيمة ال Reaction عند ال M.G المطلوبه وبهذا يتم معرفة قيمة نسبة الحمل على كل M.G من ال Rail Way

وللحصول على ال Max. B.M سوف يتم حل ال M.G على اساس مبدا ال Super Position

اى سوف يتم حساب العزوم على الكمره نتيجة ال Rail Way ثم يتم جمع العزوم عليها نتيجة ال Road Way

Case Of Max. Bending Moment



I.L For B.M

Road Way

$M_{LL+I}=21.23(10+2*9.25)\ +1.07*3*9.25*2\ +2.45*17*4.25*2$

$M_{LL+I}=$ **1018.46mt**

Rail Way

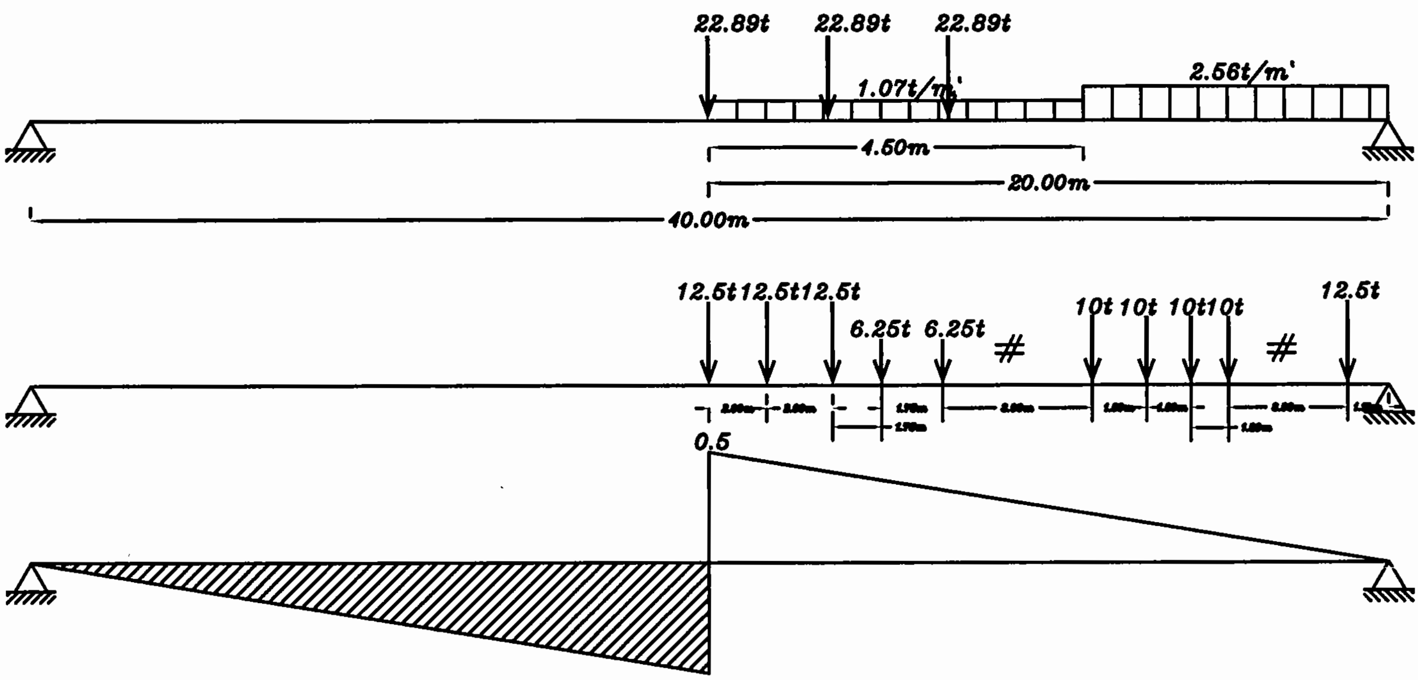
$M_{LL}=12.5(10+2*9)+2*6.25*7.68+4*10*(4.4+6.15)+2*10*2.8$

$+2*12.5*1.05\ =\ 950.25$

$M_{LL+I}=950.25*1.25*0.9*1.104=$ **1180.21m.t**

$M_{LL+I(Road+Rail)}=1018.46+1180.21=$ **2198.6m.t**

Case Of Max. Shearing Force @ mide Span



Road Way

Q_{LL+I}=3*22.89*0.46+1.07*4.5*0.443+2.56*15.5*0.193 = **41.379t**

Rail Way

Impact factor $I=\frac{24}{24+2*20}$ =0.375 > 0.25

Q_{LL} =3*12.5*0.45+2*6.25*0.36+4*10*0.17+12.5*0.0275= 28.52t

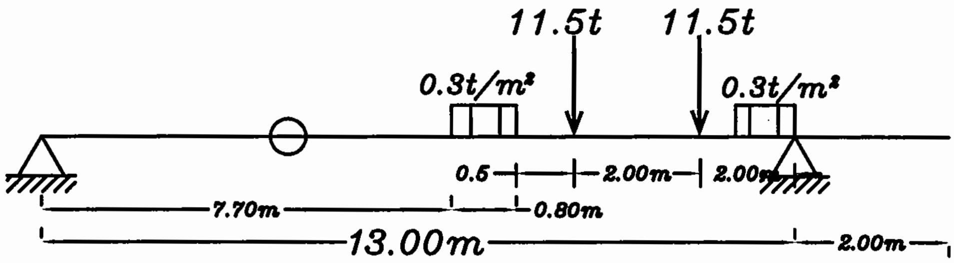
Q_{LL+I}=28.52*1.375*0.9*1.104= **38.96t**

$Q_{LL+I(Rail+Road)}$=41.379+38.96= **80.339t**

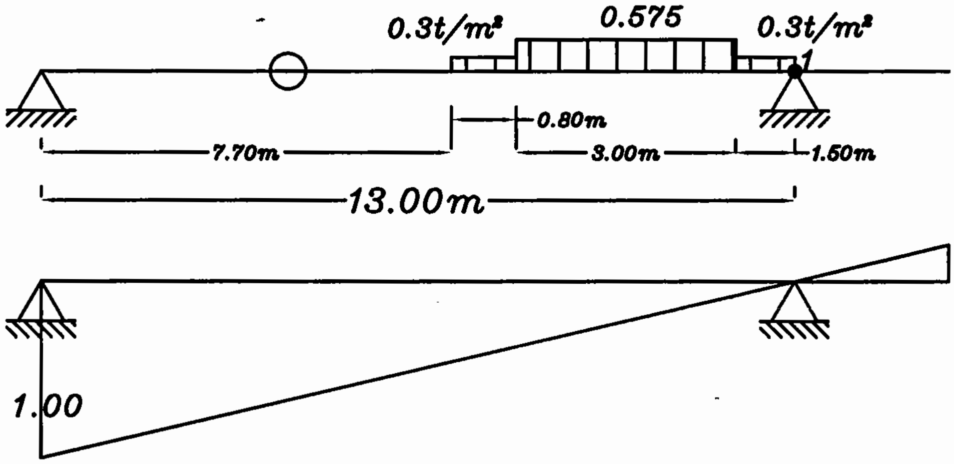
For M.G B

Road Way Part

Strip1
Get R_1 , W_1



Strip2
Get W_2



$R_1 = 11.5*(0.154+0.3) =$ **5.22t**

$W_1 = 0.3*0.8*0.37+0.3*1.5*0.05 =$ **0.112t/m'**

$W_2 = 0.112+0.575*3*0.23 =$ **0.51t/m'**

shear

$I = 0.4 - 0.008L$

$I = 0.4 - 0.008*20 = 0.24 > 0.15$

$R_1 = 5.22*\frac{1.24}{1.15} =$ **5.628t**

$W_1 =$ **0.112t/m'**

$W_2 = 0.396*\frac{1.24}{1.15} + 0.112 =$ **0.54t/m'**

Rail Way

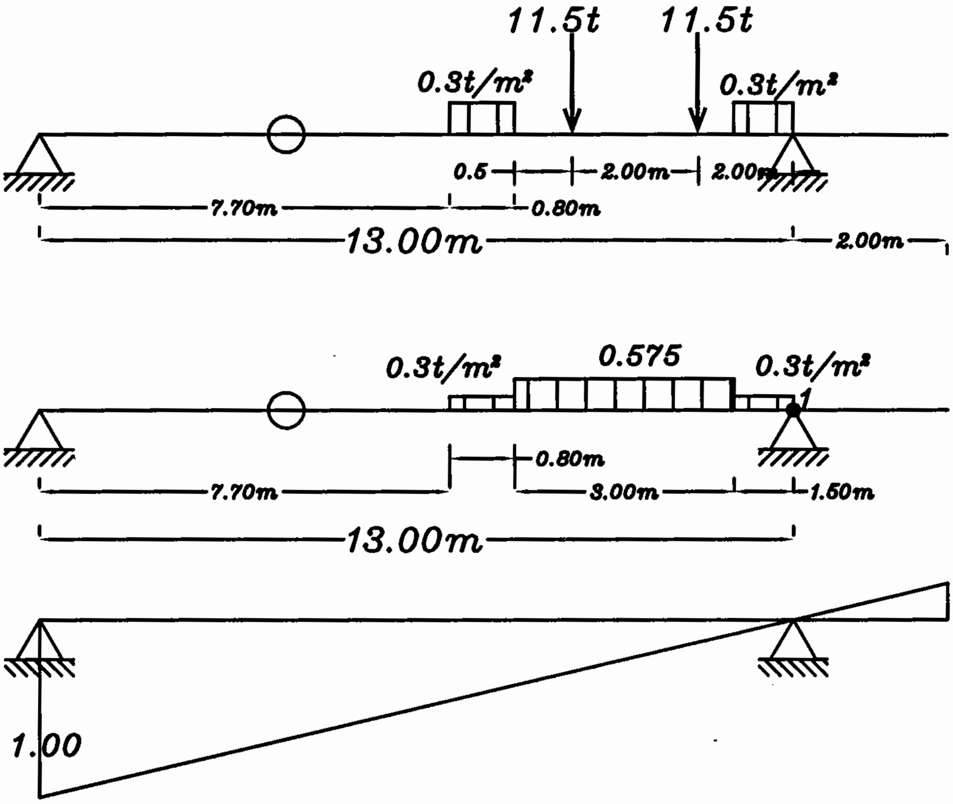
$R = 4 - 1.104 =$ **2.896**

For M.G B

Road Way Part

Strip1
Get R_1 , W_1

Strip2
Get W_2



$R_1 = 11.5*(0.154+0.3) =$ **5.22t**

$W_1 = 0.3*0.8*0.37+0.3*1.5*0.05 =$ **0.112t/m'**

$W_2 = 0.112+0.575*3*0.23 =$ **0.51t/m'**

shear

$I = 0.4 - 0.008L$

$I = 0.4 - 0.008*20 = 0.24 > 0.15$

$R_1 = 5.22*\frac{1.24}{1.15} =$ **5.628t**

$W_1 =$ **0.112t/m'**

$W_2 = 0.396*\frac{1.24}{1.15}+0.112 =$ **0.54t/m'**

Rail Way

$R = 4 - 1.104 =$ **2.896**

From the Previous I.L For B.M For Road and Rail Way

Road Way

5.22*10+2*5.22*9.25+2*0.112*3*9.25+2*0.51*17*4.25

M_{LL+I} = 228.68m.t

Rail Way

950.25*1.25*0.9*2.896= 3095.91m.t

$M_{LL+I(Road+Rail)}$ =228.68+3095.91 = 3324.59m.t

Shear

Road Way

$Q_{LL+I(Road)}$ =3*5.628*0.46+0.112*4.5*0.443+0.54*15.5*0.193=9.60t

$Q_{LL+I(Road)}$ = 9.60t

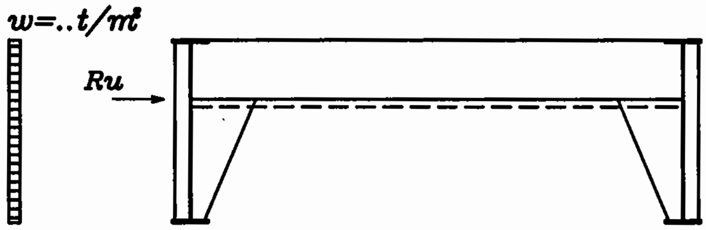
Rail Way

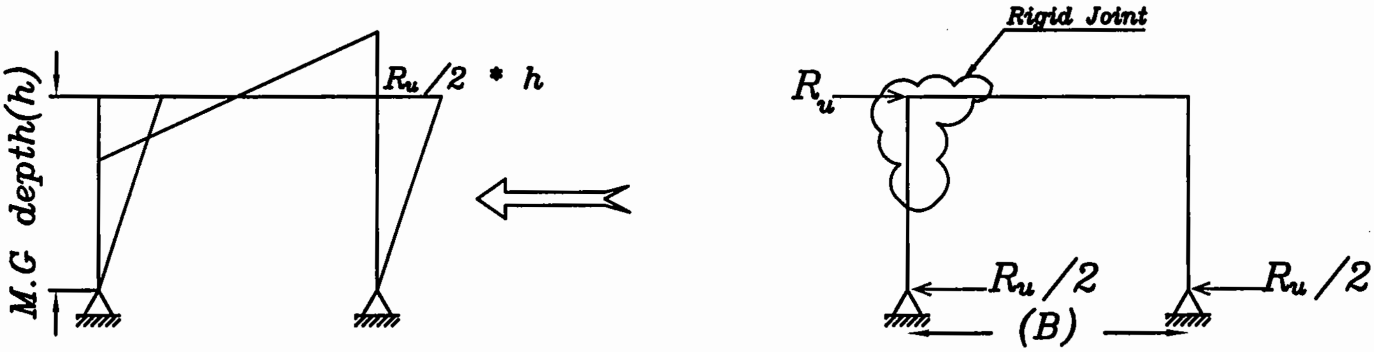
$Q_{LL+I(Rail)}$ =28.52*1.375*0.9*2.896 = 102.21t

$Q_{LL+I(Road+Rail)}$ = 102.21+9.60t = 111.80t

Question 4

Wind transmite directly to the upper wind bracing and by inverted u frame action at each X.G the wind load be transmitted to the bearing



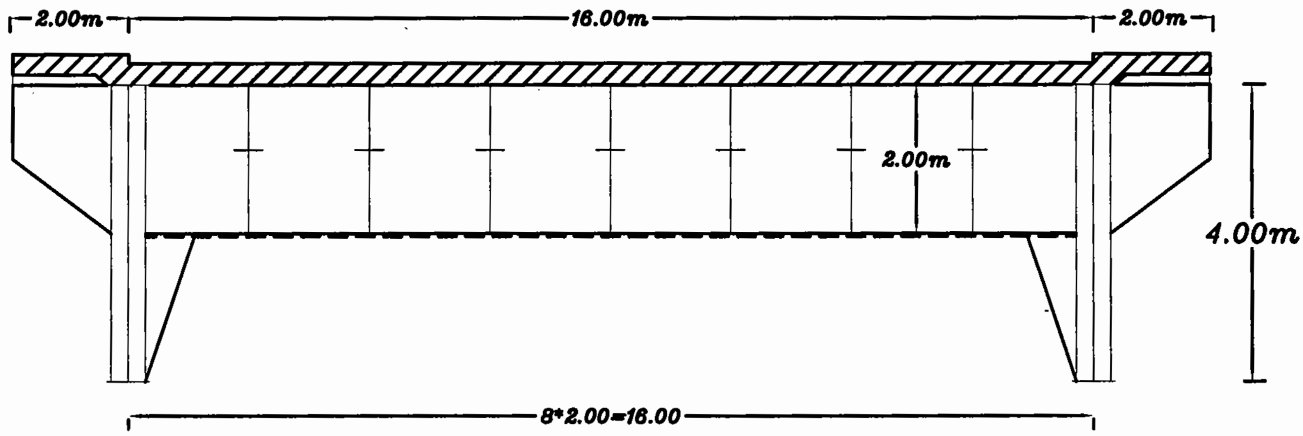


using st. 44

Example 4

Mid. term Revision

For the shown cross section of road way deck bridge having a span of 40.00m and bridge width of 16.00m and stringer spacing is 2.00m



it is required to

1-Complete General Layout

2-Check validity of use I.P.E no. 500 for continous stringer & state recomendations if it unsafe.

3-Design a built up section for an intermediate X.G.

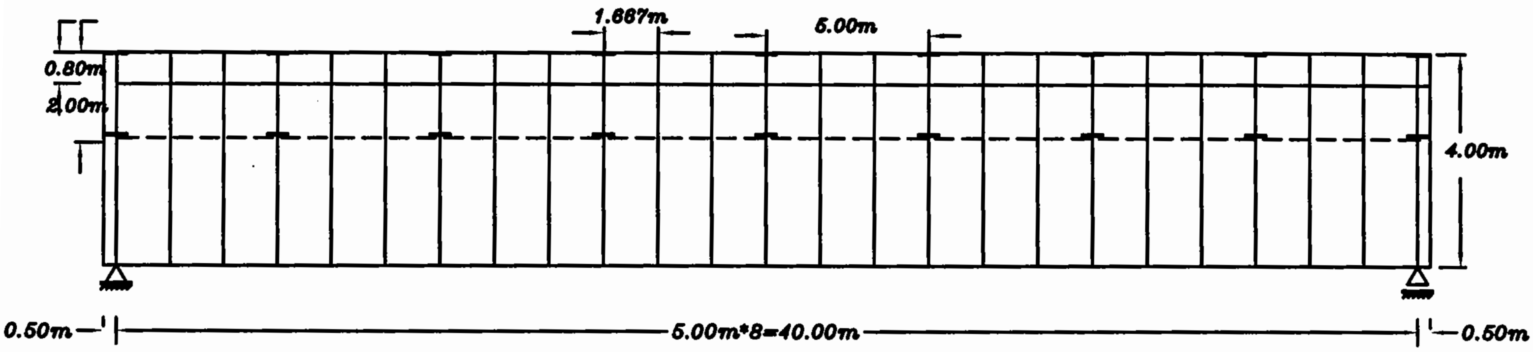
4-Design a built up section for main girder.

5-check stability of cross girder web due to pure shear and pur moment

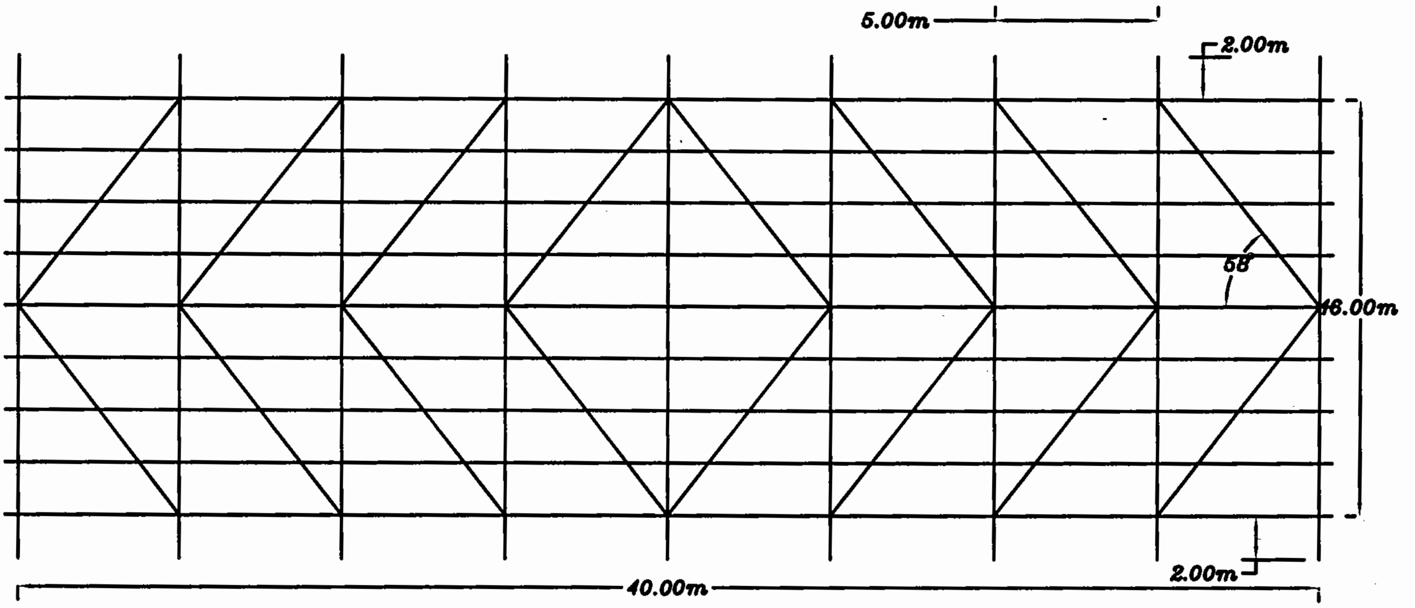
6-make a necessary curtailment for main girder flange

7-using neat sketches state the method of curtailment using cover plate over flange

Question One:



(Elevation)



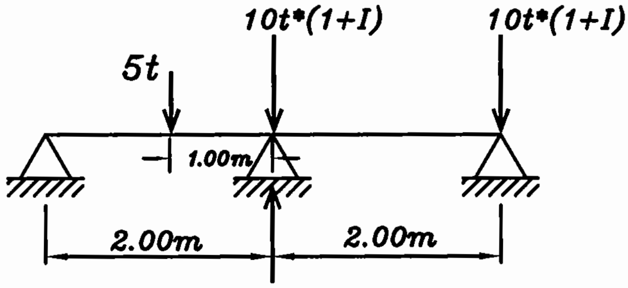
upper bracing

Question two:

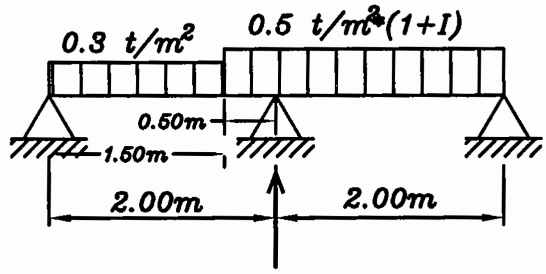
Stringer Span =5.00m

Spacing Of Stringers = 2.00m

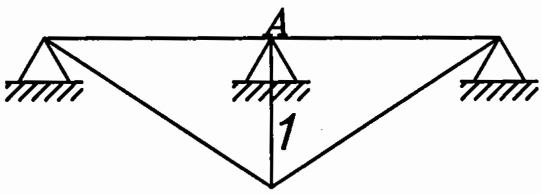
<u>Strip 1</u>   get R_1, W_1



<u>Strip 2</u>   get W_2



<u>I.L R_A</u>



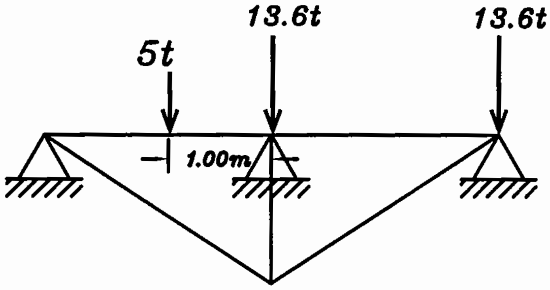
$$I = 0.4 - 0.008 * L$$

$$I = 0.4 - 0.008 * 5.00m = 0.36$$

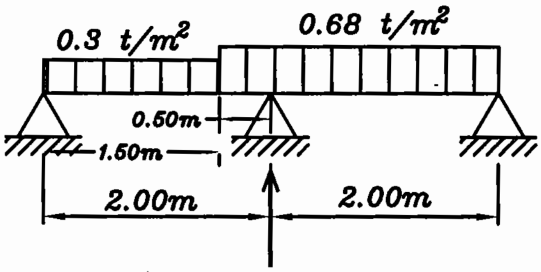
Reaction @ A For Strip 1

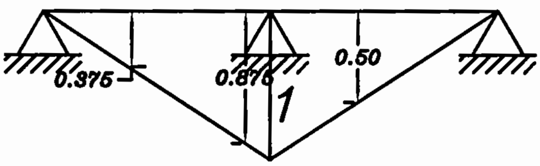
$R_1 = 13.60 * 1.00 + 5 * 0.50 = 16.10t$

$\therefore R_1 = \boxed{16.1t}$



Reaction @ A For Strip 2





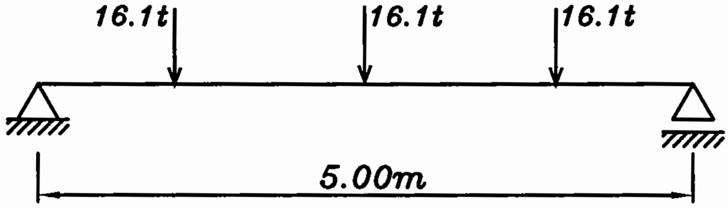
$W_2 = 0.68 * 2 * 0.5 + 0.68 * 0.5 * 0.875 + 0.3 * 1.5 * 0.375$

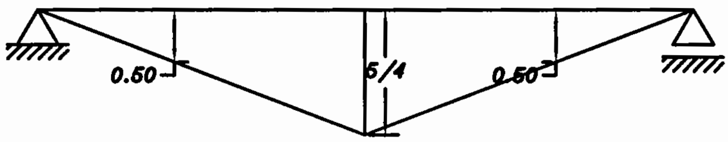
$1.15 \ t/m'$

$\boxed{W_2 = 1.15t \backslash m'}$

To Get Maximum Moment + Impact

Max. B.M.D

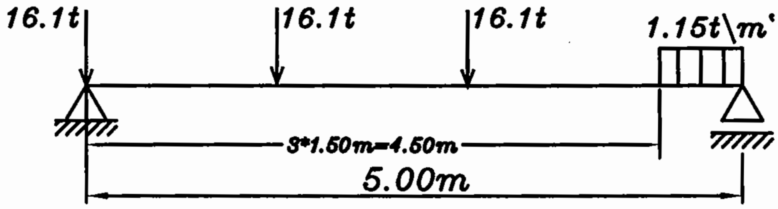


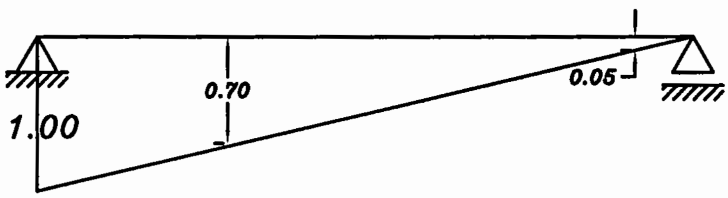


$$M_{LL+I} = 2(16.1 * 0.5) + 16.1 * 5/4 = 36.225 \ m.t$$

$$\boxed{M_{LL+I} = 36.225 m.t}$$

To Get Maximum Shear + Impact





$$Q_{LL+I} = 3 * 16.1 * 0.7 + 1.15 * 0.5 * 0.05 = 33.83t$$

$$\boxed{Q_{LL+I} = 33.8t}$$

Dead Loads

$$W_d = (\underset{t_{R.C}}{0.21} * \underset{\gamma_c}{2.5} + \underset{F.C}{0.175}) * \overset{Spacing}{2.00} + \underset{O.W}{0.15}$$

$$\therefore W_d = 1.55 t \backslash m'$$

$$M_d = \frac{1.55 * 5^2}{8} = 4.84 \ m.t$$

$$Q_d = \frac{1.55 * 5}{2} = 3.875 \ t$$

Design Value

$$M_{Max.} = M_{d.l} + M_{l.l}$$

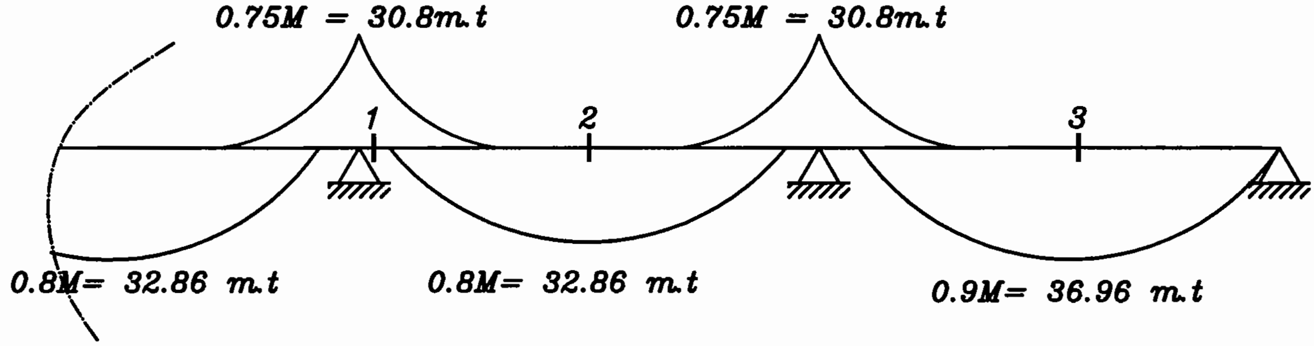
$$M_{Max.} = 4.84 + 36.225 = \boxed{41.065 \ m.t}$$

$$M_{Min.} = M_{d.l} = \boxed{4.84 \ m.t}$$

$$Q_{Max.} = 3.87 + 33.8 = \boxed{37.67 t}$$

---

1) As A Continous Beam

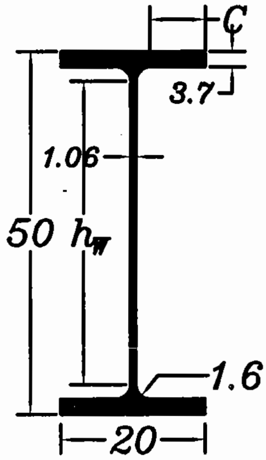


I.P.E NO. 500 S_x= 1930 Cm^3 From tables

Checks

1) Check Compactness Of The Section

Section Is Compact If



$$\frac{C}{t_f} < \frac{16.9}{\sqrt{F_y}}\ , \quad \frac{7.87}{3.70} = 2.12 < \frac{16.9}{\sqrt{2.8}} = 10$$

$$\frac{h_w}{t_w} < \frac{127}{\sqrt{F_y}}\ , \quad \frac{39.4}{1.06} = 37 < \frac{127}{\sqrt{2.8}} = 76$$

$C = b/2 - t_w/2 - r$

$C = 20.0/2 - 1.06/2 - 1.6 = 7.87$

$h_w = 50 - 2*1.6 - 2*3.7 = 39.4$

∴ Section Is Compact ∴ $F_t = 0.64*2.8 = 1.792 t/Cm^2$

2) Check Maximum Stresses For Sec. (3−3)

$$\frac{36.96*100}{1930} = 1.91 t/Cm^2 > 0.64F_y = 1.79 t/Cm^2$$

∴ unsafe

Sec (2−2)

$$\frac{32.86*100}{1930} = 1.71 t/Cm^2 < 0.64F_y = 1.79 t/Cm^2$$

∴ safe

3) Check Stress Range

Sec.(3-3)

$$\frac{0.6*0.9*36.225*100}{1930}=1.03\,t/Cm^2 < F_{Sr}= 1.68\,t/Cm^2$$

$\therefore$ Safe

Sec.(1-1)

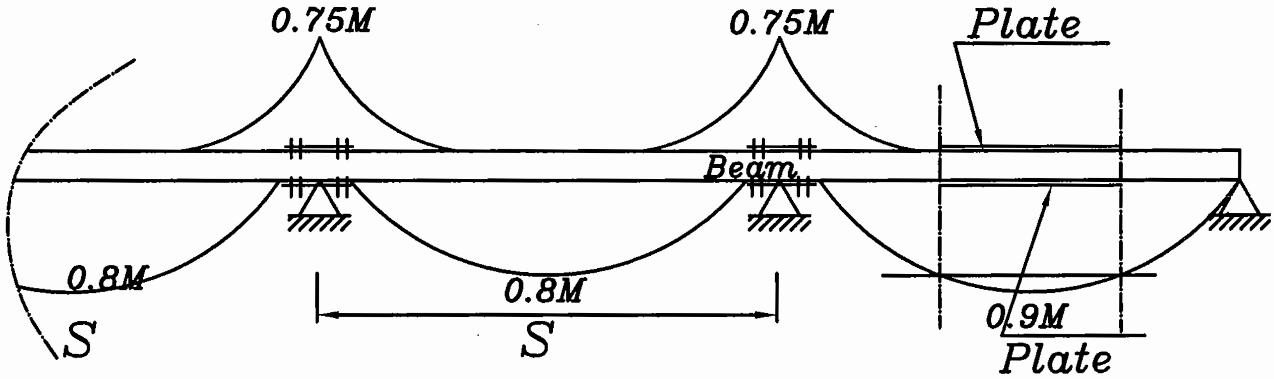
$$\frac{0.6*0.75*36.225*100}{1930}=0.84\,t/Cm^2 < F_{Sr}= 1.26\,t/Cm^2$$

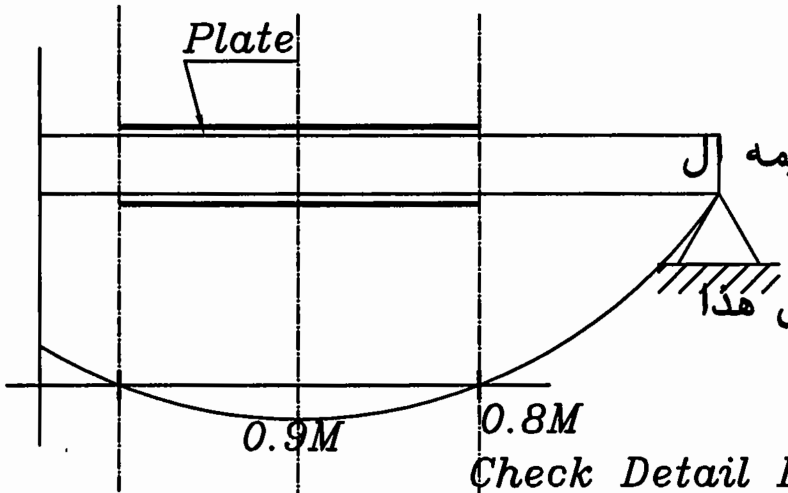
$\therefore$ Safe

4) Check Shear Stress

$$\frac{1.1\,Q_{d+l+I}}{d_w * t_w}=\frac{1.1*37.67}{50*1.06}=0.78\,t/Cm^2 < 0.35F_y = 0.98\,t/Cm^2$$

Recomendation For Sec. (3-3)





ويتم عمل هذا ال Plate حتى تصل قيمه ال Moment الى 0.8M حيث ان الكمره Safe على 0.8M كما تم عمل Check على هذا من قبل

Check Detail E'

$F_{Sr}= 0.41\,t/Cm^2$

Check Detail B'

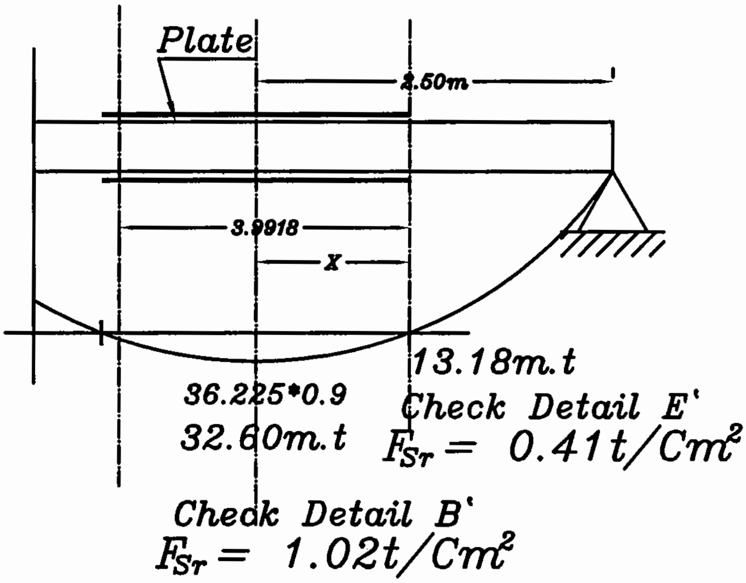
$F_{Sr}= 1.02\,t/Cm^2$

Plate Start

$$\frac{0.6*0.8*(M_{LL+I}*100)}{1930} = 0.41\, t/Cm^2$$

$0.8M_{LL+I} = 13.18 m.t$

∴ Plate start at bending moment $M_{LL+I} = 16.484 m.t$



$$M_{@any\ Section} = [1-(\frac{X}{0.5L})^2]*M_{max.}$$

$13.18 = [1-(X/0.5*5.0)^2]*32.60$ ∴ $X = 2.00m$

Plate length = 2*2.00m = 4.00m

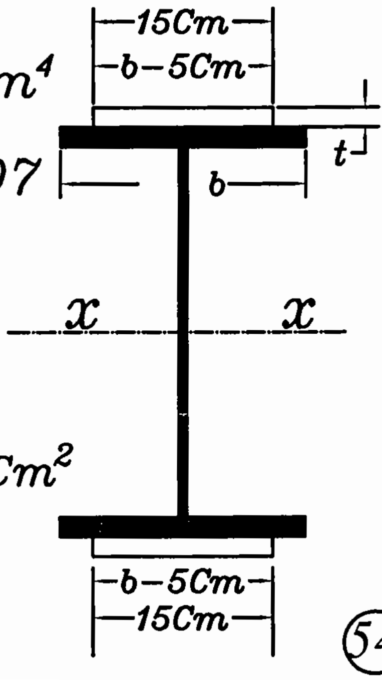
assume t = 1Cm

Check Maximum Stresses

$$I'_x = I_x + 2A_{Plate}*(h/2+t/2) = ...Cm^4$$

$$I'_x = 48200+2*1*15*(25+0.5)^2 = 67707$$

$\frac{36.96*100}{67707}*(25+1) = 1.42t/Cm^2 < 0.64F_y$



Check stress range

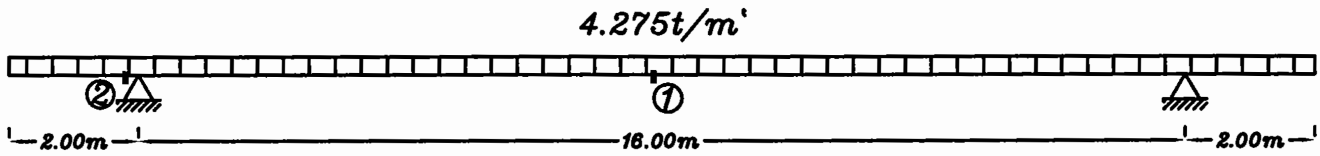
$\frac{0.6*0.9*36.225*100}{67707}*(25+1) = 0.75t/Cm^2 < 1.02\ t/Cm^2$

Question three:

1) Dead Loads

$$W_{D.L} = (t_S * \gamma_c + F.C + O.W_{stringer}/a) * X.g\ Spacing + O.W_{X.g}$$

$$W_{D.L} = (0.21*2.5+0.175+0.15/2) *5.00m + 0.40 = 4.275t/m'$$



$$M_{D.L1} = 4.275*16^2/8 - 4.275*2^2/2 = \boxed{128.25m.t}$$

$$M_{D.L2} = 4.275*2^2/2 = \boxed{8.55m.t}$$

$$Q_{D.L} = 42.75 - 4.275*2 = \boxed{34.2t}$$

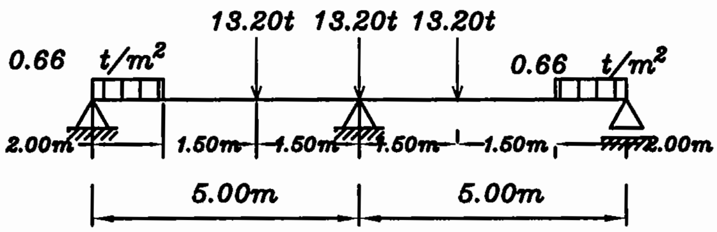
2) Live Loads + Impact

$$I = 0.4 - 0.008L$$

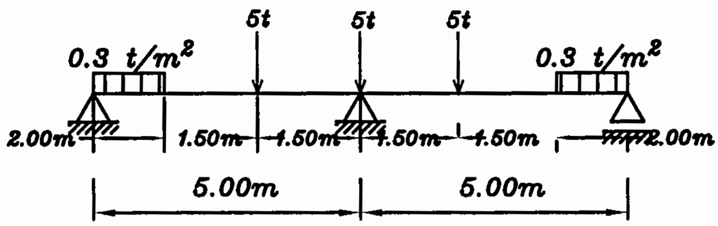
$$I = 0.4 - 0.008(2*5.00=10.00m) = 0.32$$

$$10(1+0.32) = 13.20t\ ,\ 0.5(1+0.32) = 0.66t/m^2$$

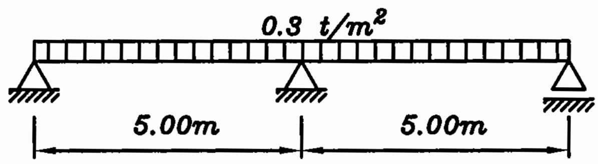
Strip1
Get R_1 , W_1



Strip2
Get R_2 , W_2



Strip3
Get W_3



$R_1 = 13.20(1+2*0.70) = 31.68t$

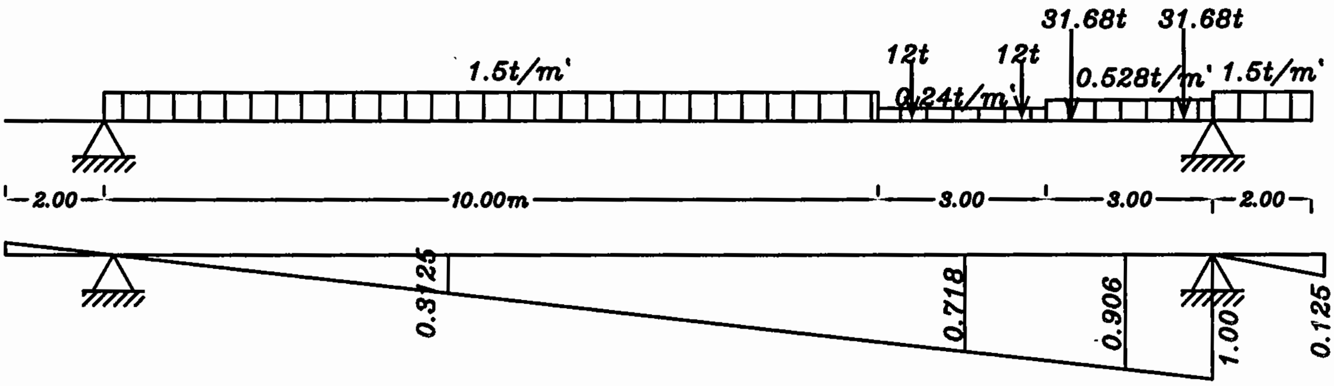
$R_2 = 5(1+2*0.70) = 12.00t$

$W_1 = 0.66*2.00*0.20*2 = 0.528t/m'$

$W_2 = 0.30*2.00*0.20*2 = 0.24t/m'$

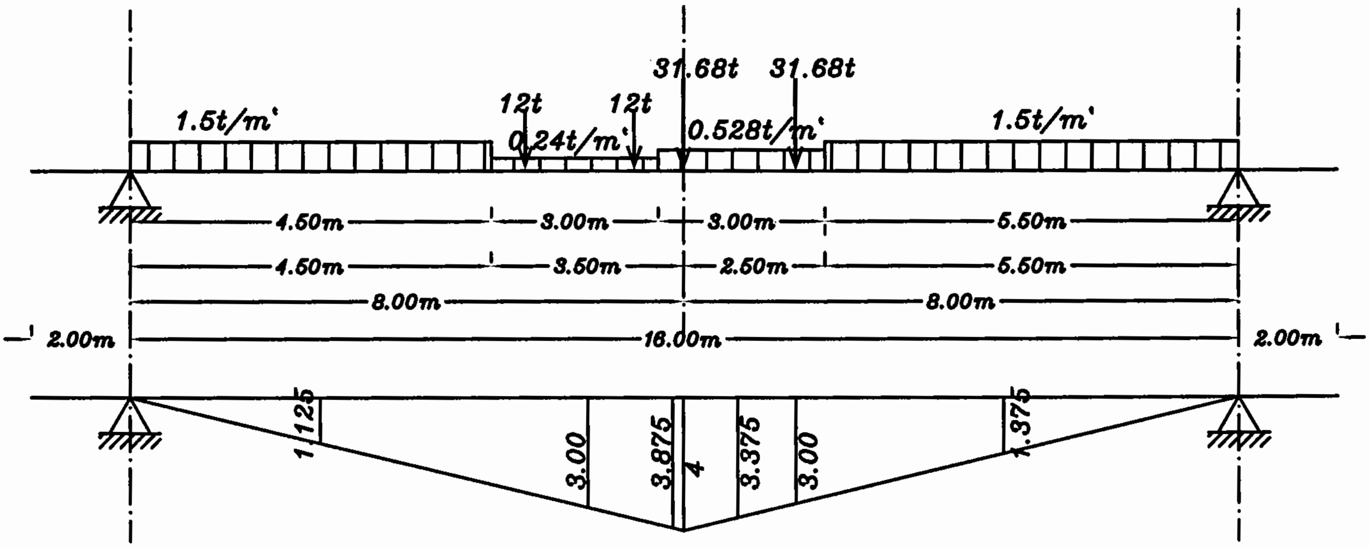
$W_3 = 0.30*5.00*0.5*2 = 1.50t/m'$

Case Of Max. Shear



$Q_{LL+I} = 1.5*2*0.06+2*31.68*0.906+0.528*3*0.906$
$+2*12*0.718+0.24*3*0.718+1.5*10*0.3 = \boxed{81t}$

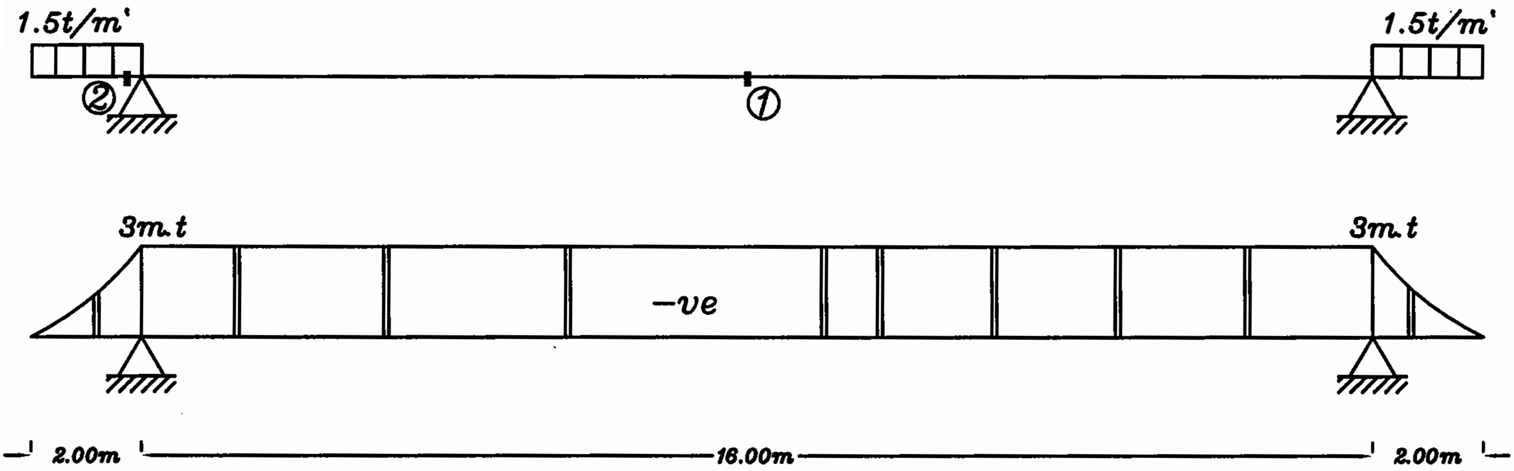
Case Of Max. Moment



$M_{LL+I} = 1.5*(4.5*1.125+5.5*1.375)+2*12*3+0.24*3*3$
$+0.528*0.5*3.875+31.68*(4+3)+0.528*2.5*3.375$
$= \boxed{320.33 \ m.t}$

Design Value

case of min. bending @ sec. 1



$$M_{Max.} = 128.25 + 320.33 = \boxed{448.58 m.t}$$

$$Q_{Max.} = 34.2 + 81 = \boxed{115.2 t}$$

$$M_{Min.} = 128.25 - 3 = \boxed{125.25 m.t}$$

Design Of Built-Up Section

Calculate Web depth = 200Cm (given)

Calculate Web thikness

→ $\frac{d_w}{t_{w1}} \leq \frac{830}{F_y}$ $\qquad \frac{200}{t_{w1}} \leq \frac{830}{F_y}$ $\qquad \therefore t_{w1} = 0.67Cm$

From Shear → $\frac{Q_{d+u+I}}{d_w * t_{w2}} = 0.35F_y$ $\qquad \frac{115.2}{200 * t_{w2}} = 0.35*2.8$ $\qquad \therefore t_{w2} = 0.58Cm$

$\therefore d_w = 200$ Cm
Vl. Stiff. Only → $\therefore \frac{d_w}{t_{w3}} = \frac{190}{\sqrt{F_y}}$ $\qquad \frac{200}{t_{w3}} = \frac{190}{\sqrt{F_y}}$ $\qquad \therefore t_{w3} = 1.76Cm$

The Web is Very Thick So Put a longitudinal stiff. @ h/5 to get an economic section

$\therefore \frac{d_w}{t_{w3}} = \frac{320}{\sqrt{F_y}}$ $\qquad \frac{200}{t_{w3}} = \frac{320}{\sqrt{F_y}}$ $\qquad \therefore t_{w3} = 1.04Cm$

From 1,2,3 $\therefore t_{w3} = 1.20Cm$

Get Flange Dimension

$$F_{Max.} = \frac{F_{sr}}{\left(1 - \frac{M_{min}}{M_{min} + 0.6M_{LL+I}}\right)} = \frac{1.12}{\left(1 - \frac{125.25}{125.25 + 0.6*320.3}\right)} = 1.84t/Cm^2$$

(Or)

$$0.58F_y = 1.624t/Cm^2$$

$\therefore$ allwable Stress=1.62t/Cm²

$F_{Max.}$ Or $0.58F_y = \frac{T \text{ or } C}{A}$ $\qquad \therefore$ get $A = \ldots\ldots Cm^2$

Calculate $T = C = \frac{M_{d+u+I}}{0.98d} = \frac{448.58*100}{0.98*200} = 228.86t$

$\therefore \frac{228.8}{A} = 1.62$ $\qquad \therefore A = 140.9Cm^2$

$A = b_f * t_f + 1/6 d_w * t_w$

$140.9 = b_f * t_f + 1/6*200*1.2 \qquad \therefore b_f * t_f = 100.9\ Cm^2$

$b_f \cong 20 t_f \qquad \therefore 20 t_f^2 = 100.9\ Cm^2$

$\boxed{t_f = 2.4 Cm}$ use $\boxed{b_f = 44\ Cm}$

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

$$I_X = \frac{1.2*200^3}{12} + 2*44*2.4(200/2+2.4/2)^2 = 2962992.13 Cm^4$$

$$\boxed{\therefore I_X = 2962992.13 Cm^4}$$

Checks

Check max. Stresses

$\frac{M_{d+u+I}}{I_X} * (d/2 + t_f) = \frac{448.6*100}{2962992.13}(200/2+2.4) = 1.55 t/Cm^2 \ngtr 1.6 t/Cm^2$ safe

Check Stress Range

$\frac{0.6 M_{u+I}}{I_X} * (d/2 + t_f) = \frac{0.6*320.3*100}{2962992.13} * (200/2+2.4) = 0.66 t/Cm^2 \ngtr F_{Sr} = 1.12 t/Cm^2$

Check Shear Stress

$\frac{Q_{d+u+I}}{d_w * t_w} = \frac{115.2}{200*1.2} = 0.48\ t/cm^2 \ngtr 0.35*2.8$

get Size of Weld

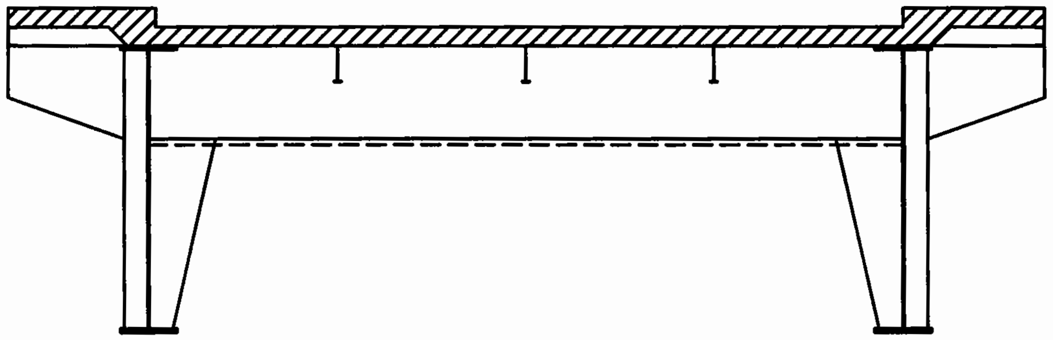
$$\frac{Q_{d+u+I} * [b_f * t_f * (d_w/2 + t_f/2)]}{I_X} = 2*S*0.2 F_U$$

$$\frac{115.2[(44*2.4)(2.4/2+200/2)]}{2962992.13} = 2*S*0.2*4.4$$

$S = 0.236 Cm \qquad$ Use $S = 0.6 Cm$

Question four:

1) Dead Loads



$W_{S.S.inside} = 150+4L+0.03L^2 = ...Kg/m^2$

$W_{S.S.inside} = 150+4*40+0.03*40^2 = 358Kg/m^2$ use $350Kg/m^2$

$W_{S.S.Outside} = 100+3L = ...Kg/m^2$

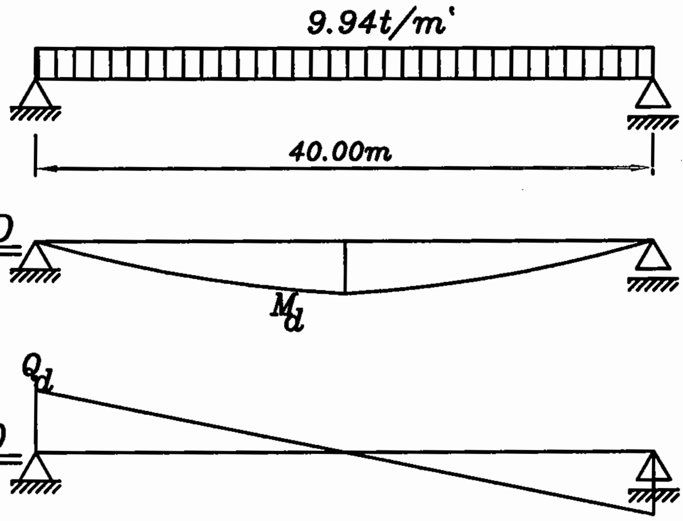
$W_{S.S.Outside} = 100+3*40 = 220Kg/m^2$

$W_{dead} = (t_s * \gamma_c + f.c + W_{S.S.out}) *Lc + (t_s * \gamma_c + f.c + W_{S.S.in}) *B/2$

$W_{dead} = (0.18*2.5+0.15+0.220)*2+(0.21*2.5+0.175+0.350)*8 = 9.94t/m'$

$M_d = \frac{9.94 * 40^2}{8} = \boxed{1988m.t}$

$Q_d = \frac{9.94 * 40}{2} = \boxed{199t}$

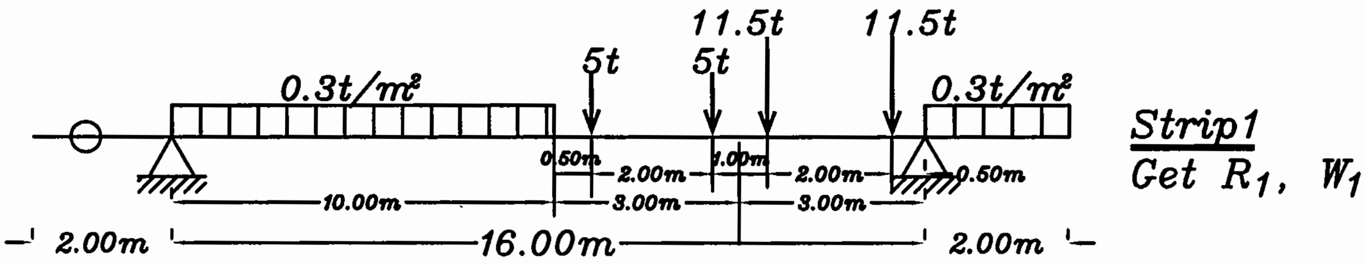


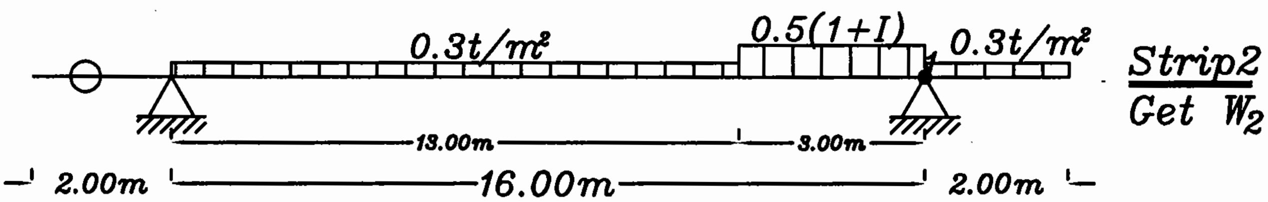
2) Live Loads

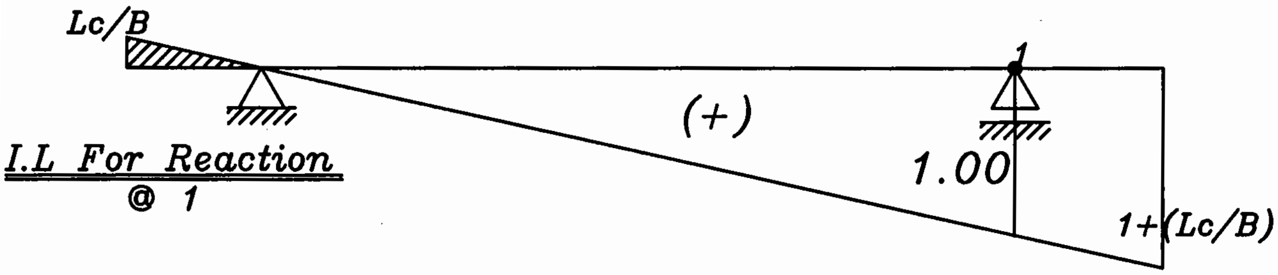
Impact factor $I=0.4-0.008*40 = 0.08 < 0.15$

$\therefore I = 0.15$

$10(1+I)=11.5t$, $0.5(1+I)=0.556t/m^2$





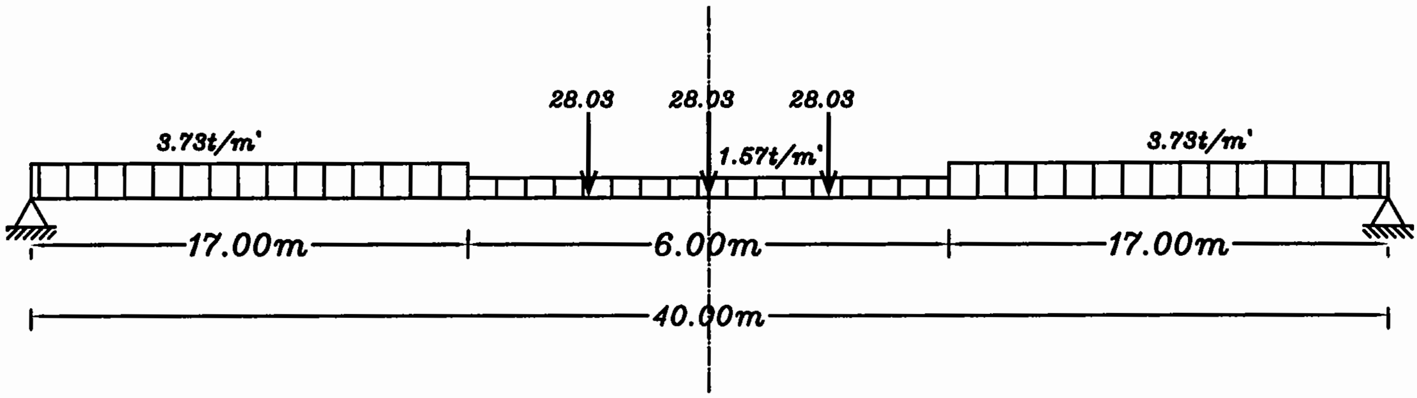


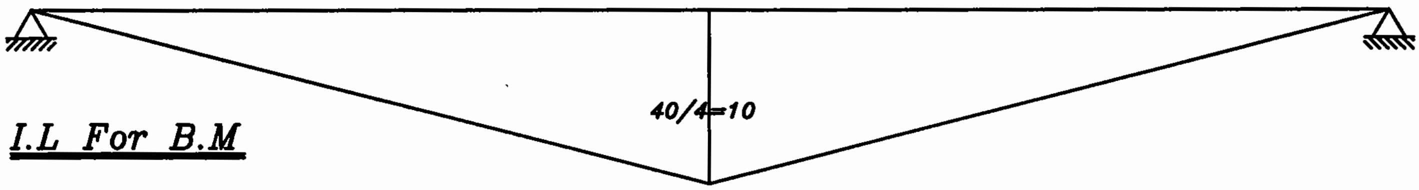
$R_1 = 5*\left(\frac{10.5+12.5}{16}\right) + 11.5*\left(\frac{13.5+15.5}{16}\right) = \boxed{28.03t}$

$W_1 = 0.3*10*5/16+0.3*2*17/16 = \boxed{1.575t/m'}$

$W_2 = 0.3*13*6.5/16+0.556*3*14.5/16+0.3*2*17/16 = \boxed{3.733t/m'}$

Case of Max. B.M



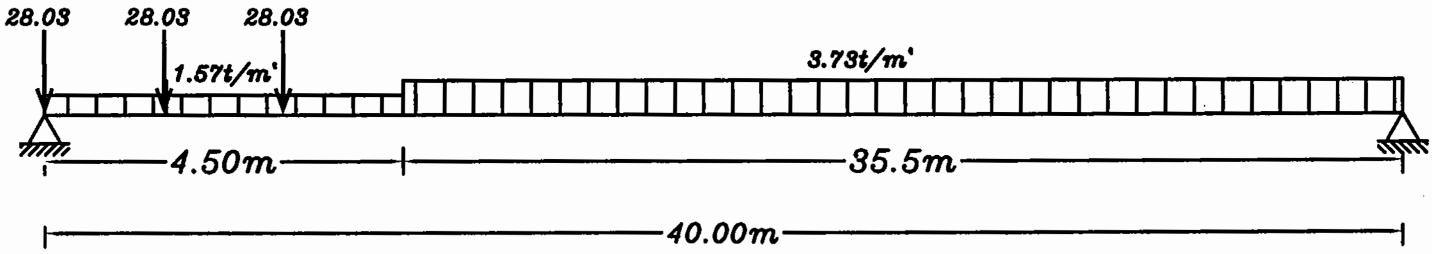


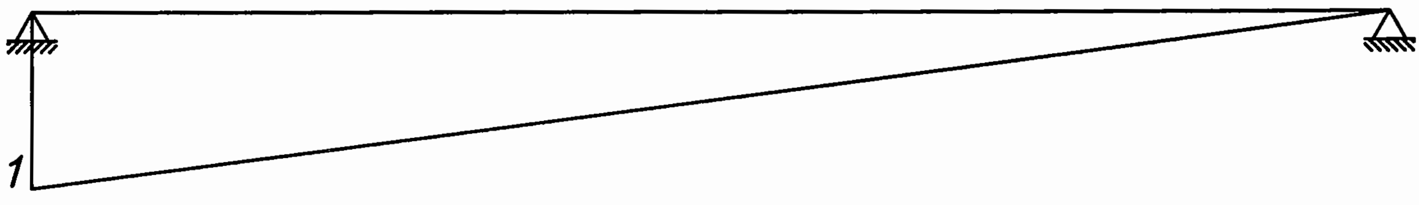
I.L For B.M

$$M_{LL+I} = 28.03(10+2*9.25) + 1.57*3*9.25*2 + 3.73*17*4.25*2$$

$$M_{LL+I} = \boxed{1417mt}$$

Case of Max. S.F





I.L For S.F

$$Q_{LL+I} = 3.73*35.5^2/2*1/40 + 27.72\left(\frac{37+38.5+40}{40}\right) + 1.5*4.5*\frac{37.75}{40}$$

$$Q_{LL+I} = \boxed{146t}$$

Design Of Built-Up Section

Calculate Web depth = 400Cm (given)

Calculate Web thikness

→ $\frac{d_w}{t_{w1}} \leq \frac{830}{F_y}$ $\quad \frac{400}{t_{w1}} \leq \frac{830}{F_y}$ $\quad \therefore t_{w1} = 1.35Cm$

From Shear → $\frac{Q_{d+u+I}}{d_w * t_{w2}} = 0.35F_y$ $\quad \frac{345}{400 * t_{w2}} = 0.35*2.8$ $\quad \therefore t_{w2} = 0.88Cm$

$\therefore d_w = 400$ Cm → $\therefore \frac{d_w}{t_{w3}} = \frac{365}{\sqrt{F_y}}$ $\quad \frac{400}{t_{w3}} = \frac{365}{\sqrt{F_y}}$ $\quad \therefore t_{w3} = 1.83Cm$

The Web is Very Thick So that try to reduce main girder depth

Web depth = 4000/12 = 333.3333Cm use **340** Cm

$\therefore \frac{d_w}{t_{w3}} = \frac{365}{\sqrt{F_y}}$ $\quad \frac{340}{t_{w3}} = \frac{365}{\sqrt{F_y}}$ $\quad \therefore t_{w3} = 1.60Cm$

From 1,2,3 $\therefore t_{w3} = 1.60Cm$

Get Flange Dimension

$$F_{Max.} = \frac{F_{Sr}}{\left(1 - \frac{M_{min}}{M_{min} + 0.6M_{LL+I}}\right)} = \frac{1.68}{\left(1 - \frac{1988}{1988 + 0.6*1417}\right)} = 5.6 \ t/Cm^2$$

(Or)

$$0.58F_y = 1.624t/Cm^2$$

$\therefore$ allwable Stress=1.62t/Cm²

$$F_{Max.} \text{ Or } 0.58F_y = \frac{T \text{ or } C}{A} \quad \therefore \text{ get } A = ...Cm^2$$

$$\text{Calculate } T=C= \frac{M_{d+u+I}}{0.98d} = \frac{3405*100}{0.98*340} = 1021.908t$$

$$\therefore \frac{1022}{A} = 1.62 \quad \therefore A = 630Cm^2$$

$A=b_f * t_f+1/6 d_w * t_w$

$630 = b_f * t_f+1/6*340*1.6 \quad \therefore b_f * t_f = 539.3 \ Cm^2$

$b_f \triangleq 20 t_f \quad \therefore 20 t_f^2 = 539.3 \ Cm^2$

$\boxed{t_f = 5.2 Cm}$ use $\boxed{b_f = 104 Cm}$

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

$$I_X = \frac{1.6*340^3}{12} + 2*104*5.2(340/2+5.2/2)^2 = 37462219.35 Cm^4$$

$$\boxed{\therefore I_X = 37462219.35 Cm^4}$$

Checks

Check max. Stresses

$$\frac{M_{d+u+I}}{I_X} *(d/2+t_f) = \frac{3405*100}{37462219.35}(340/2+5.2) = 1.56 t/Cm^2 \ngtr 1.6 t/Cm^2 \qquad \text{safe}$$

Check Stress Range

$$\frac{0.6 M_{u+I}}{I_X} *(d/2+t_f) = \frac{0.6*1417*100}{37462219.35} *(340/2+5.2) = 0.39 t/Cm^2 \ngtr F_{Sr} = 1.68 t/Cm^2$$

Check Shear Stress

$$\frac{Q_{d+u+I}}{d_w * t_w} = \frac{345}{340*1.6} = 0.63 \ t/cm^2 \ngtr 0.35*2.8$$

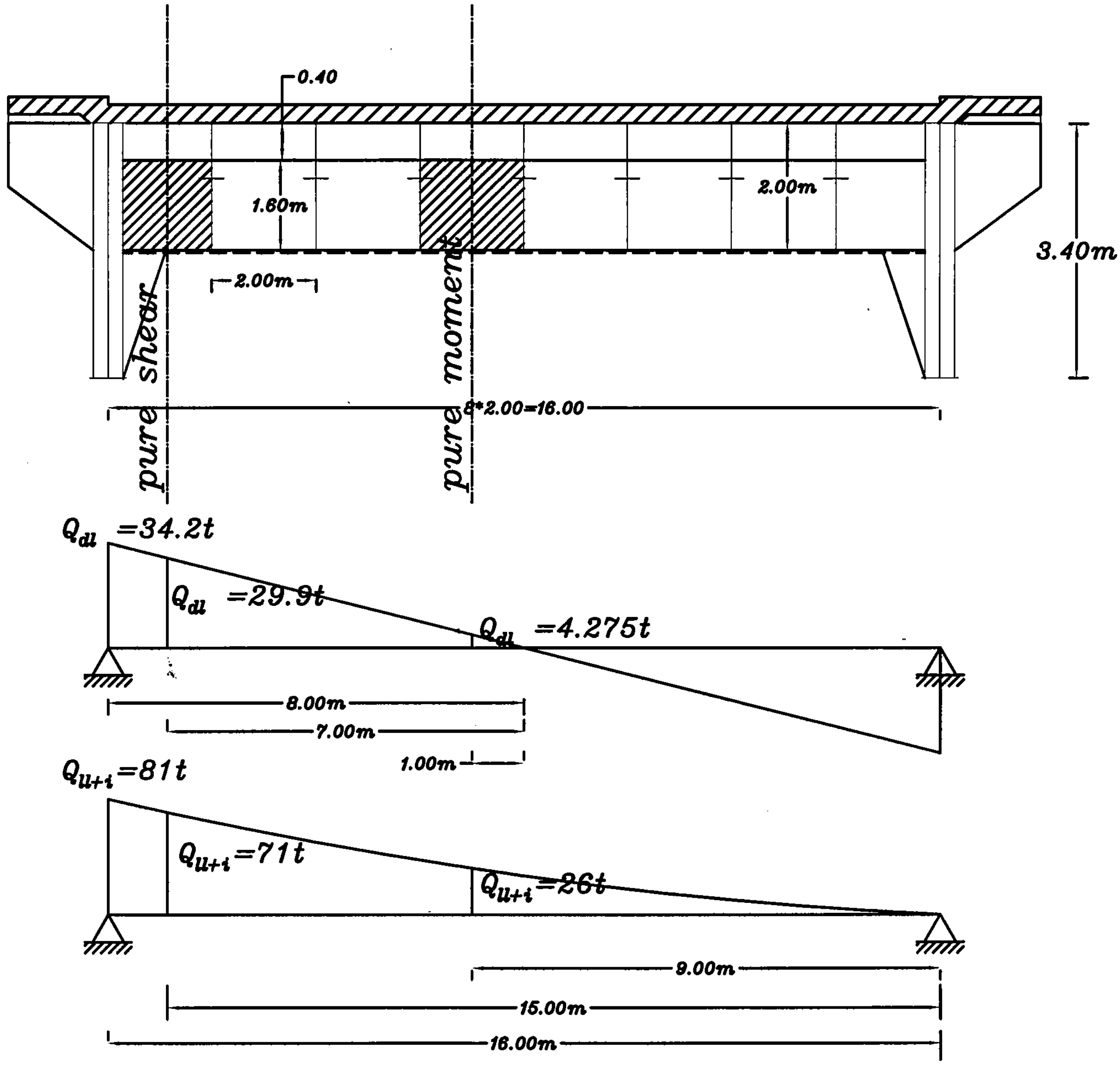
get Size of Weld

$$\frac{Q_{d+u+I} *[b_f * t_f *(d_w/2+t_f/2)]}{I_X} = 2*S*0.2 F_U$$

$$\frac{146[(104*5.2)(5.2/2+340/2)]}{37462219.35} = 2*S*0.2*4.4$$

$S=0.322 Cm \qquad$ Use $S=0.6 Cm$

Question five:



1−Buckling @ Support (Pure Shear)

1−Calculate $\alpha = \frac{d_1}{d} = \frac{2.00}{1.60} = 1.25$

2−Calculate $K_q = 5.34 + \frac{4.00}{\alpha^2}$ if $\alpha > 1$

$$K_q = 5.34 + \frac{4.00}{1.25^2} = 7.90$$

3−Calculate $\lambda_q = \frac{dw/tw}{57}\sqrt{\frac{F_y}{K_q}} = \frac{160/1.2}{57}\sqrt{\frac{2.8}{7.90}} = 1.39 > 1.2$

4-Calculate

$$q_b = (\frac{0.9}{\lambda_q}) * 0.35 F_y \quad \text{Where } \lambda_q \geq 1.2$$

$$q_b = (\frac{0.9}{1.39}) * 0.35 * 2.8 = \boxed{0.634 \ t/Cm^2}$$

$$Q_{@mid\ Pannel} = 29.9t + 71t = \boxed{100.9t}$$

5-Check Shear Stresses $\frac{Q_{d+u+I}}{d_w * t_w} = \frac{100.9t}{200*1.2} = 0.42 \ t/Cm^2 \not> 0.643 t/Cm^2$

3-Buckling @ mid Span

$$Q_{@mid\ Pannel} = 4.275t + 26t = \boxed{30.27t}$$

5-Check Shear Stresses $\frac{Q_{d+u+I}}{d_w * t_w} = \frac{30.27}{200*1.2} = 0.12 \ t/Cm^2 \not> 0.643 t/Cm^2$

$$F_b = (0.8 - 0.36 \frac{0.12}{0.643}) * 2.8 = 2.05 t/Cm^2 > 1.6 t/Cm^2$$

$\therefore F_b = 1.6 t/Cm^2$

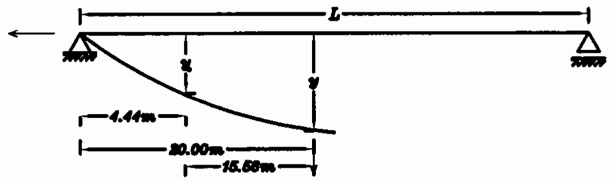
Check max. Stresses

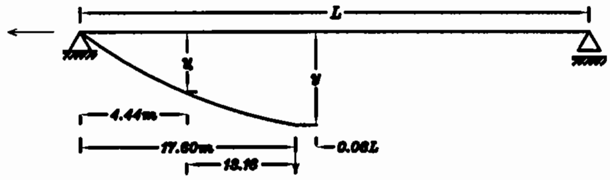
$$\frac{M_{d+u+I}}{I_x} * (d/2 + t_f) = \frac{448.6*100}{2962992.13} (200/2+2.4) = 1.55 t/Cm^2 \not> \boxed{1.6 t/Cm^2} \qquad \text{safe}$$

Question six:

∴ $L > 30.00m$ ∴ two Curtailment @L/4 @ L/9 From Support

∴ $L/4=30.00/4=10.00m$





$$M_{@1/4L}= \{1-[\frac{(0.50-1/4)L}{0.50L}]^2\}*1988 +\{1-[\frac{(0.44-1/4)L}{0.44L}]^2\}*1417$$

$$M_{@1/4L}= 2643.7 \ m.t$$

try to reduce both width and thikness

$$0.58F_y = \frac{M_X/0.98d_W}{b_{new}*t_f+1/6*d_W*t_W} = \frac{(2643.7/0.98*340)*100}{b_{new}*t_{f_{new}}+1/6*340*1.6} = 1.6$$

$$b_{new}*t_{f_{new}} = 405.22 \ Cm^2$$

$b_f \triangleq 20t_f$ ∴ $20t_f^2 = 405.22 \ Cm^2$

$t_f = 4.6Cm$ use $b_f = 90Cm$

$$b_{f.min.} = 2*(\frac{h_W}{30}+5)+t_W = 2*(340/30+5)+1.6 = 35Cm$$

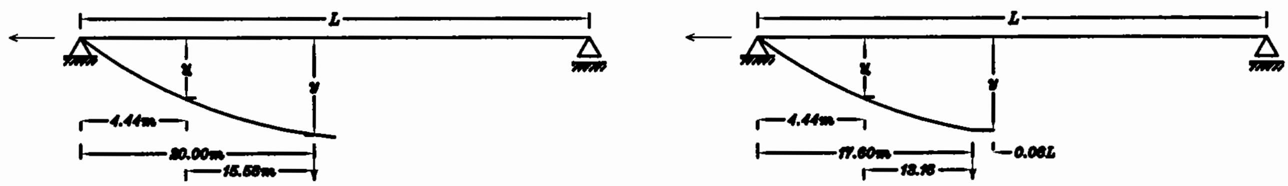
$$I_X = \frac{1.6*340^3}{12}+2*90*4.6(340/2+4.6/2)^2 = 29821609.45 \ Cm^4$$

∴ $I_X = 29821609.45Cm^4$

Checks

Check max. Stresses

$$\frac{M_{d+u+I}}{I_X}*(d/2+t_f) = \frac{2643*100}{29821609.45}(340/2+4.6) = 1.54t/Cm^2 \ngtr 1.6t/Cm^2$$ safe



$$M_{@1/9L} = \{1-[\frac{(0.50-1/9)L}{0.50L}]^2\}*1988 + \{1-[\frac{(0.44-1/9)L}{0.44L}]^2\}*1417$$

$$M_{@1/9L} = 1410.6 \ m.t$$

try to reduce both width and thikness

$$0.58F_y = \frac{M_X/0.98d_W}{b_{new}*t_f + 1/6*d_W*t_W} = \frac{(1410.6/0.98*340)*100}{b_{new}*t_{f_{new}} + 1/6*340*1.6} = 1.6$$

$$b_{new}*t_{f_{new}} = 173.92 \ Cm^2$$

$b_f \cong 20t_f$ $\quad \therefore 20t_f^2 = 173.92 \ Cm^2$

$t_f = 3.0Cm$ use $b_f = 58Cm$

$$b_{f.min.} = 2*(\frac{h_W}{30} + 5) + t_W = 2*(340/30+5)+1.6 = 35Cm$$

$$I_X = \frac{1.6*340^3}{12} + 2*58*3.0(340/2+3.0/2)^2 = 15475996.33 \ Cm^4$$

$$\therefore I_X = 15475996.33Cm^4$$

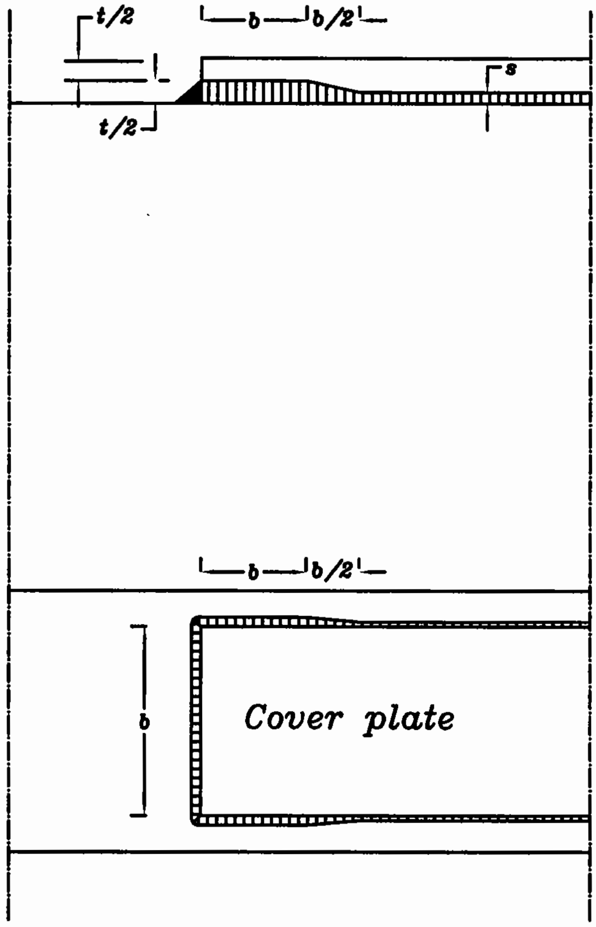
Checks

Check max. Stresses

$$\frac{M_{d+L+I}}{I_X}*(d/2+t_f) = \frac{1410*100}{15475996.33}(340/2+3.0) = 1.57t/Cm^2 \ngtr 1.6t/Cm^2 \quad \text{safe}$$

Question seven:

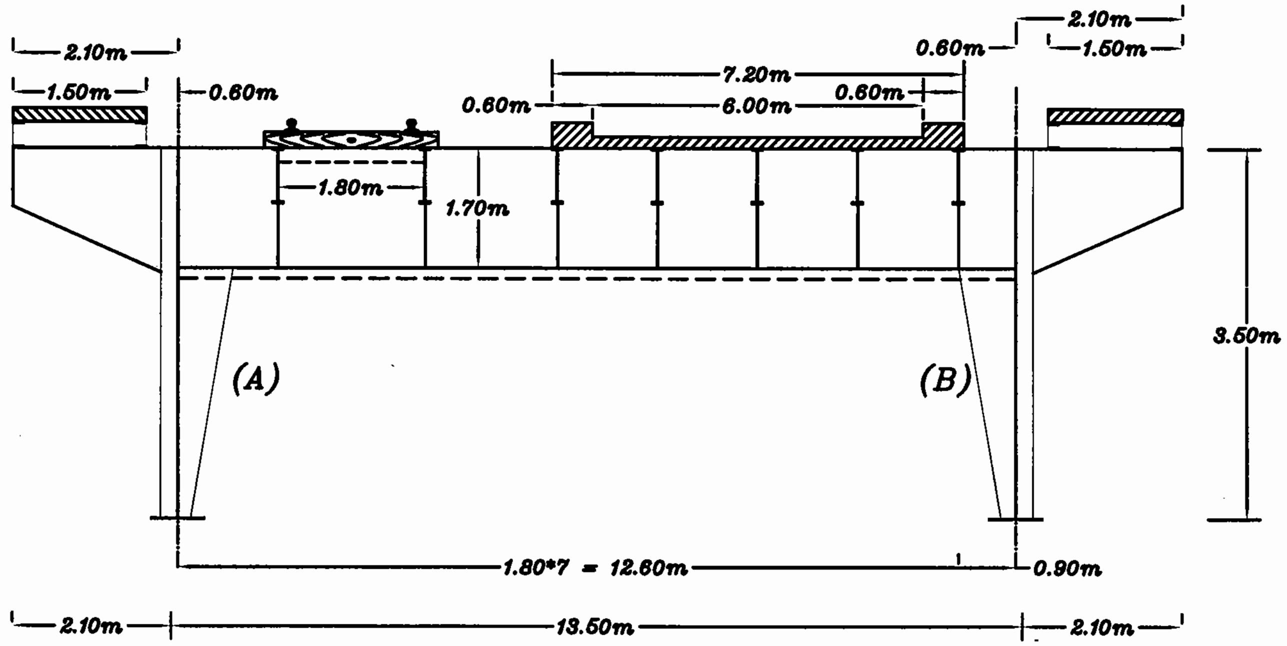
neat sketches for cover plate



using st. 52

Example 5

Mid. term Revision



a rail–road welded plate girder deck bridge of shown cross section has a span of 37.20ms divided into six panels 6.20ms each and depth of 3.50ms it is required to

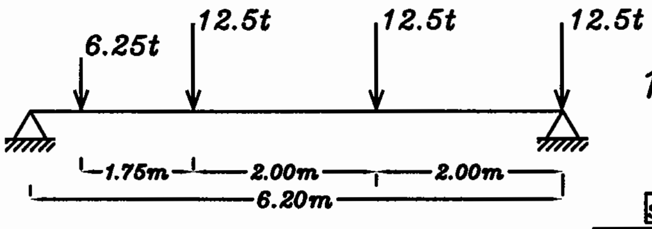
1–design an intermediate stringer under the railway part

2–for main girdr "A" it is required to calculate max. bending bending moment due to live load + impact only @ l/6 from support (due to combined effect of road + rail)

Question one

1) Live Loads

Max. Shear

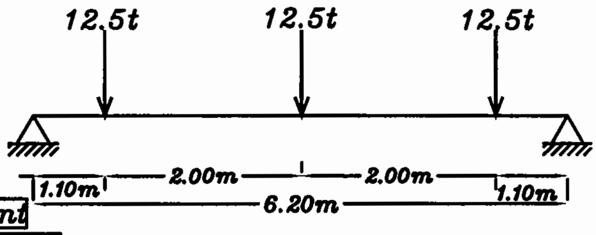


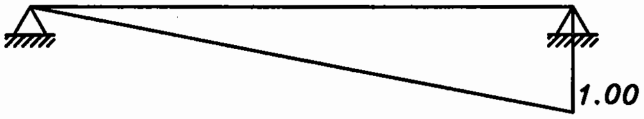
1St. Trial

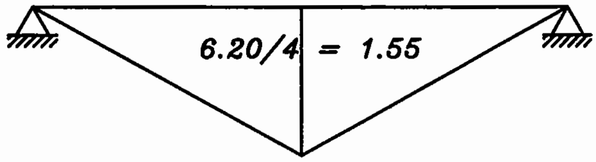
shear
span>4.25m

moment
span>4.71m

Max. Moment







$M1 = 12.5*1.55 + 2*12.5*0.35 = 28.12 m.t$

$Q1 = 12.5 + 2*12.5*0.516 + 6.25*0.072 = 25.85 t$

$Impact\ Factor = I = \frac{24}{24+6.20} = 0.79 \quad < 0.75 \ , > 0.25$

$Impact\ Factor = I = 0.75$

$M_{LL+I} = 28.12*1.75 = \boxed{49.21 m.t}$

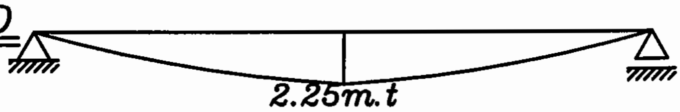
$Q_{LL+I} = 25.85*1.75 = \boxed{45.23 t}$

2) Dead Loads

$W_{Dead} = 0.6/2 + 0.05/2 + 0.15 = 0.47 t/m'$

$M_d = \frac{0.47*6.20^2}{8} = \boxed{2.2 m.t}$

B.M.D



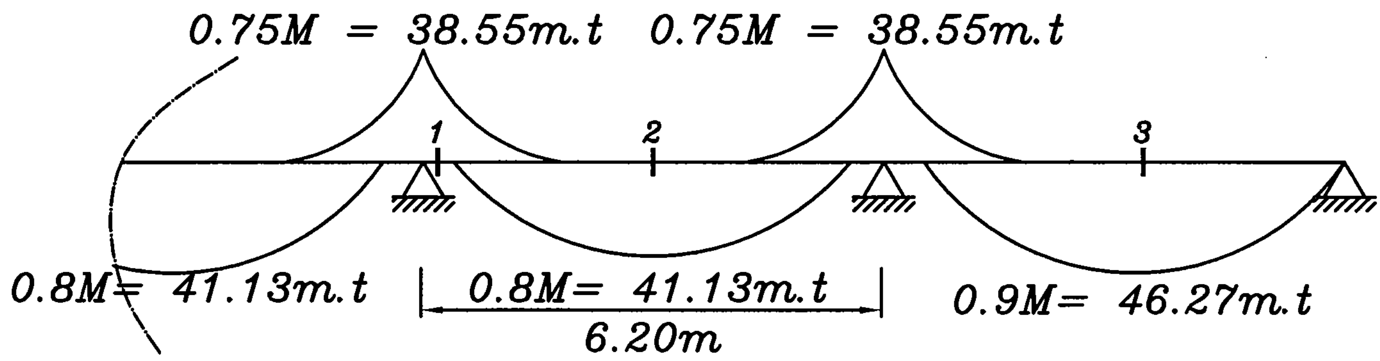
$Q_d = \frac{0.47*6.20}{2} = \boxed{1.45 t}$

S.F.D

$M_{d+LL+I} = 51.41 m.t$

$Q_{d+LL+I} = 46.68 t$

1) As A Continous Beam



sec(1−1)

From Code Page 40

N = Over 2,000,000

From Code Page 41 Detail B For Sec. (1−1)

$\therefore F_{Sr} = 1.12 t/Cm^2$

$$F_{Max1} = \frac{F_{Sr}}{\left(1 - \frac{M_d}{M_d + M_{LL+I}}\right)} = \frac{1.12}{\left(1 - \frac{2.25}{2.25+49.21}\right)} =$$

$F_{Max1} = 1.17 t/Cm^2 < 0.64 F_y = 2.304 t/Cm^2$

$\therefore$ Use $1.17 t/Cm^2$

$$1.17 \; t/Cm^2 = \frac{M_{d+l+I}}{S_{x1}} = \frac{38.55*100}{S_{x1}}$$

$\therefore S_{x1} = 3294 Cm^3$

sec(2−2)

From Code Page 40

N = Over 2,000,000

From Code Page 41 Detail A For Sec. (2−2)

$\therefore F_{Sr} = 1.68 t/Cm^2$

$$F_{Max2} = \frac{F_{Sr}}{\left(1 - \frac{M_d}{M_d + M_{LL+I}}\right)} = \frac{1.68}{\left(1 - \frac{2.25}{2.25+49.21}\right)} =$$

$F_{Max2} = 1.76 t/Cm^2 < 0.64 F_y = 2.304 t/Cm^2$

∴ Use $1.76 t/Cm^2$

$$1.76\ t/Cm^2 = \frac{M_{d+l+I}}{S_{x2}} = \frac{41.13*100}{S_{x2}}$$

∴ $S_{x2} = 2336 Cm^3$

∴ Use $S_x = 3294 Cm^3$

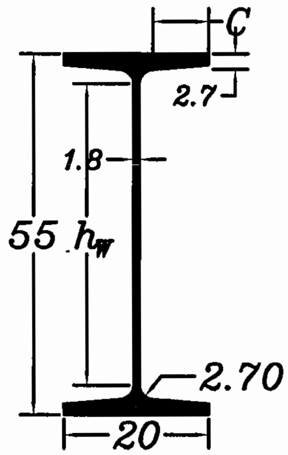
∴ From Tables Choose I.P.N No.550

$S_x = 3610 Cm^3$

Checks

1) Check Compactness Of The Section

Section Is Compact If



$$\frac{C}{t_f} < \frac{16.9}{\sqrt{F_y}}\ ,\quad \frac{6.40}{2.70} = 2.3 < \frac{16.9}{\sqrt{3.6}} = 8.9$$

$$\frac{h_w}{t_w} < \frac{127}{\sqrt{F_y}}\ ,\quad \frac{44.20}{1.80} = 24 < \frac{127}{\sqrt{3.6}} = 67$$

$C = b/2 - t_w/2 - r$

$C = 20/2 - 1.80/2 - 2.70 = 6.40$

$h_w = 55 - 4*2.70 = 44.20$

∴ Section Is Compact ∴ $F_t = 0.64*3.6 = 2.304 t/Cm^2$

2) Check Maximum Stresses For Sec. (3−3)

$$\frac{46.27*100}{3610} = 1.28 t/Cm^2 < 0.64F_y = 2.30 t/Cm^2$$

∴ Safe

3) Check Stress Range

Sec.(3−3)

$$\frac{(0.9*49.21*100)}{3610} = 1.22 t/Cm^2 < F_{Sr} = 1.68 t/Cm^2$$

∴ Safe

Sec.(1−1)

$$\frac{(0.75*49.21*100)}{3610} = 1.02 t/Cm^2 < F_{Sr} = 1.12 t/Cm^2$$

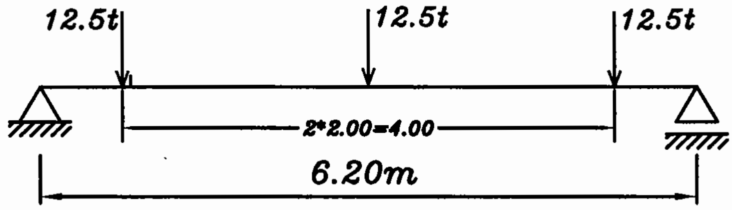
∴ Safe

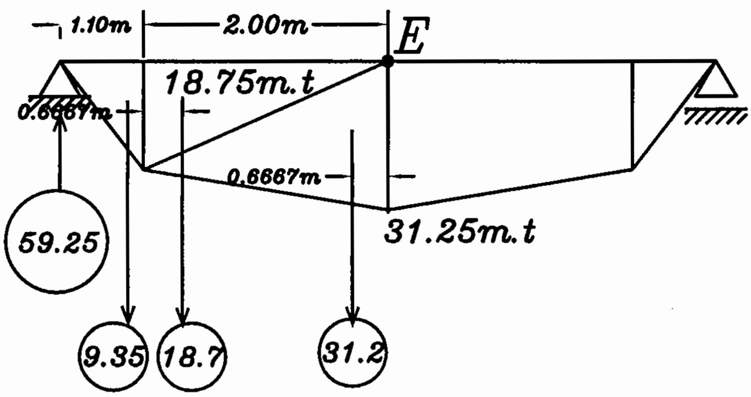
4) Check Shear Stress

$$\frac{1.1Q_{d+l+I}}{d_W * t_W} = \frac{1.1*46.68}{55*1.80} = 0.51\ t/Cm^2 < 0.35F_y = 1.26t/Cm^2$$

5) Check Deflection

يجب وضع الاحمال الحيه على الكمره من غير احمال الصدم





M_E ={59.25*3.10−[9.35*2.36 + 18.7*1.33 + 31.25*0.66]}

$M_E = 218.46m^3 .t$

$$\triangle_{Simple} = \frac{M_E * 10^6}{E * I_x} \not> \frac{Span}{800}$$

$$\triangle_{Simple} = \frac{218.46 * 10^6}{2100*99180} = 1.04Cm$$

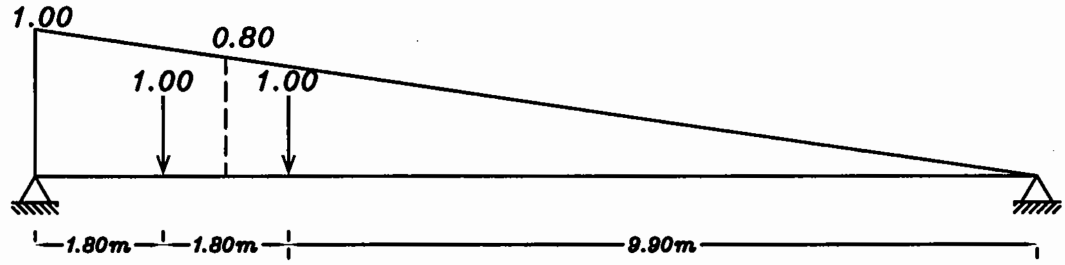
∴ $\triangle_{Continous} = 0.8\ \triangle_{Simple} = 0.8 * 1.04Cm = 0.84Cm$

$> \frac{620}{800}$ ∴unSafe

∴From Tables Choose I.P.N No.600

Question two

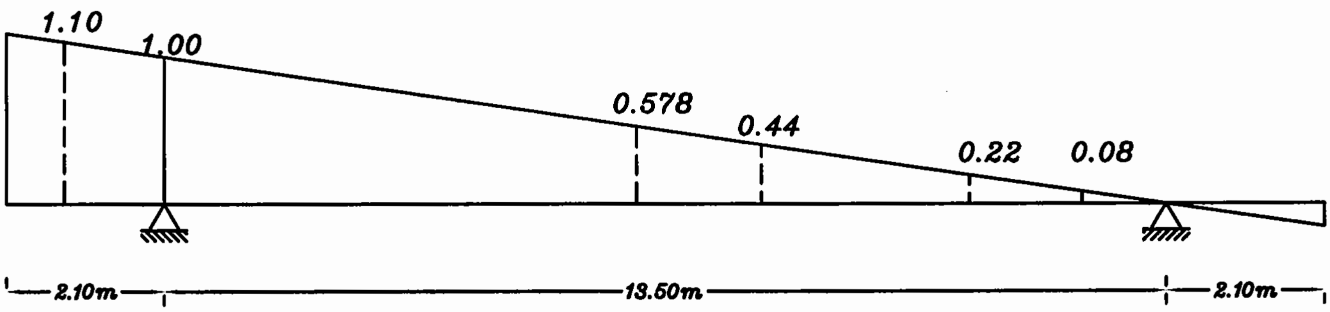
Strip in Railway

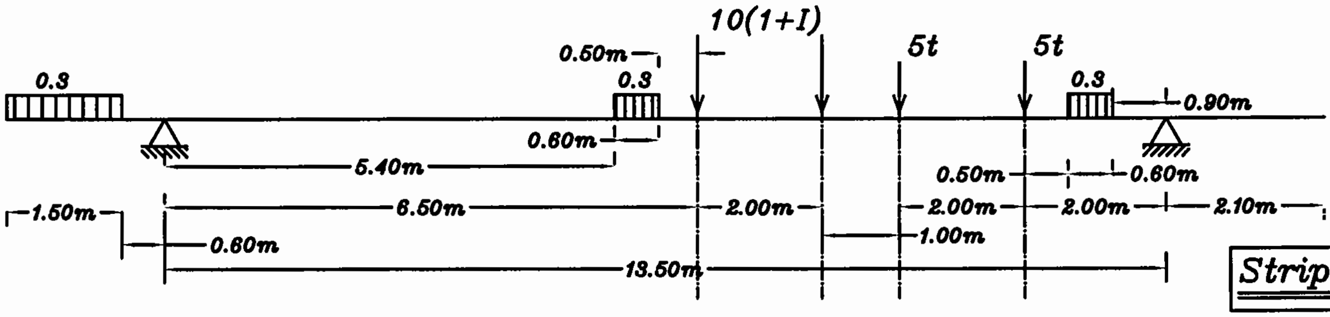


$$n = 2*1*0.8 = \boxed{1.60}$$

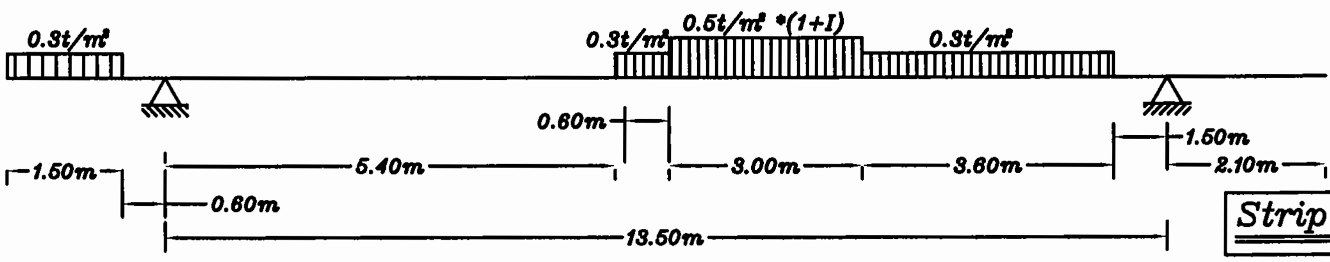
$$\text{Impact Factor} = I = \frac{24}{24+37.2} = 0.39 \quad < 0.75 \ , > 0.25$$

Strip in Roadway





Strip 1



Strip 2

$$\text{Impact Factor} = I = 0.40 - 0.008*37.2 = 0.1024 \text{ use } \boxed{I = 0.15}$$

Strip in Roadway

Strip 1

$R_1 = 2*5*0.22 + 2*11.5*0.44 = \boxed{12.32t}$

$W_1 = 0.3*1.5*1.10 + 0.3*0.6*(0.578+0.08) = \boxed{0.613t/m'}$

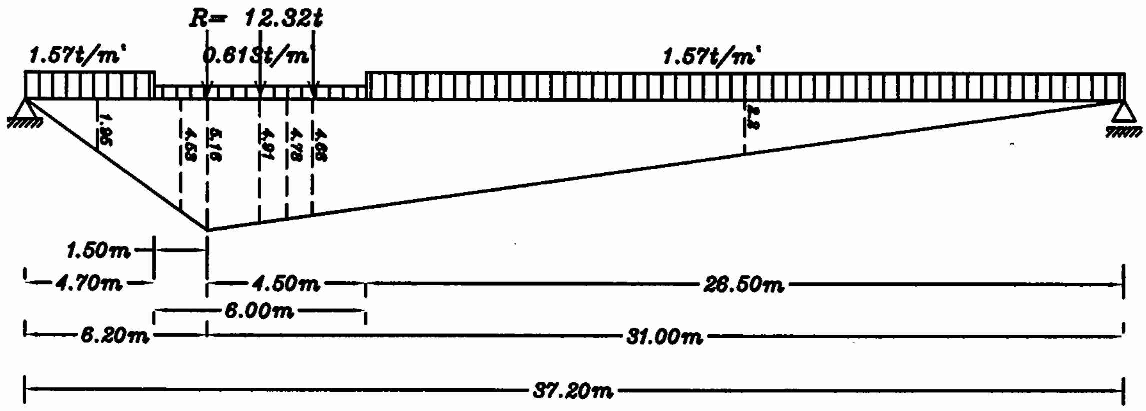
Strip 2

$W_2 = 0.3*3*0.22+0.575*3*0.44+0.3*1.5*1.1+0.3*0.6*(0.578+0.08)$

$W_2 = \boxed{1.57\ t/m'}$

using superposition theory

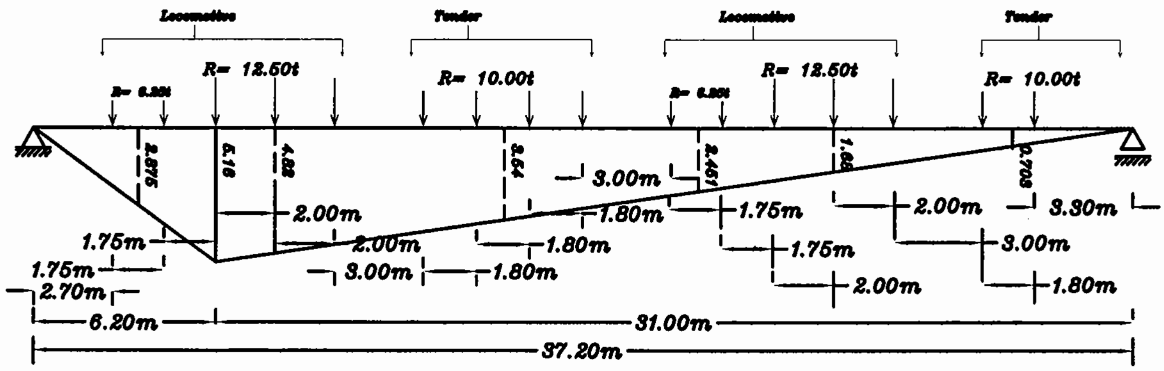
Maximum moment due to (road way part)



$M_{LL+I} = [3*12.32*4.91]+[0.613*4.5*4.78+0.613*1.5*4.53]$

$+[1.57*26.50*2.2+1.57*4.70*1.95] = \boxed{304.74m.t}$

Maximum moment due to (rail way part)



$M_{LL+I} = 2*6.25*2.875+3*12.50*4.82+4*10*3.54+2*6.25*2.451$

$+3*12.5*1.68+2*10*0.703 * 1.39 * 1.60 = \boxed{1036m.t}$

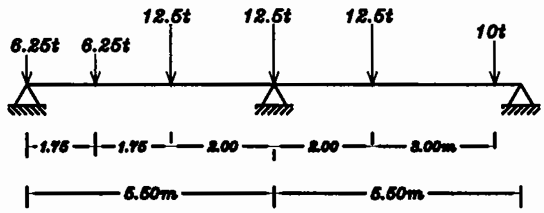
$$\boxed{\underset{Road+Rail}{M_{LL+I}} = 304.74m.t + 1036m.t = \boxed{1340m.t}}$$

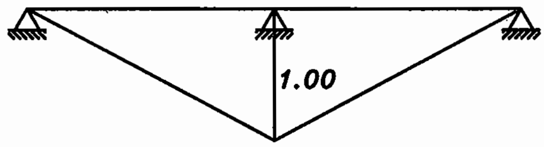
May. 2003 (Str.)

Question (1-2)

1)Live Loads

For Rail Way Part





I.L Reaction

$R_{LL} = 12.5[1+2*0.636]+10*0.1+6.25*0.32 = 31.3t$

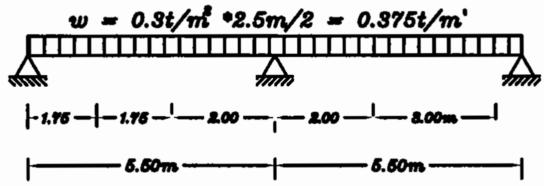
Reduction 0.8 For Triple Track

$\therefore R_{LL} = 31.3t*0.8 = 25.04t$

$$\text{Impact Factor} = I = \frac{24}{24+L} = \frac{24}{24+3*2*5.5} = 0.42$$

$\therefore R_{LL+I} = 25.04t * (1.42) = \boxed{35.6t}$

For Side Walk



$\therefore R_{LL} = 0.375*5.50m = \boxed{2.1t}$

2)Dead Loads

For Rail Way Part

$W_{Dead} = 600/2 + 50/2 + O.W = ...Kg/m'$

$W_{Dead} = 0.6/2 + 0.05/2 + 0.15 = 0.47t/m'$

$R_d = W_d * S = 0.47 * 5.50 = \boxed{2.60t}$

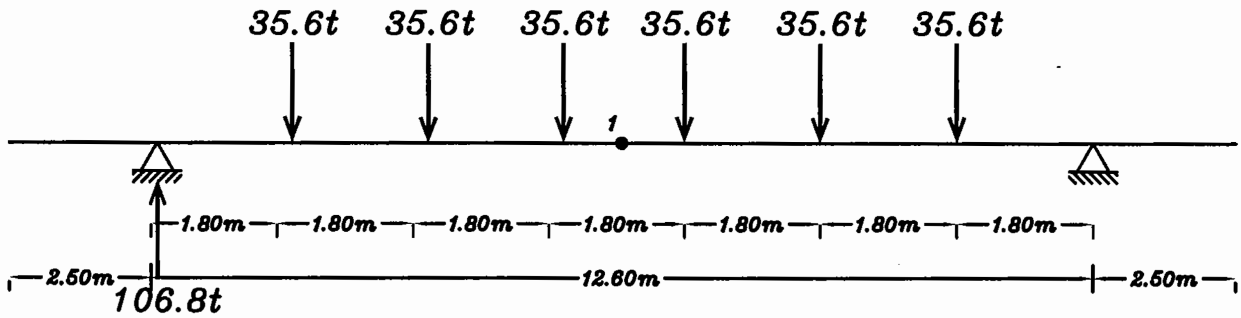
$O.W = 0.3t/m'$

For Side Walk

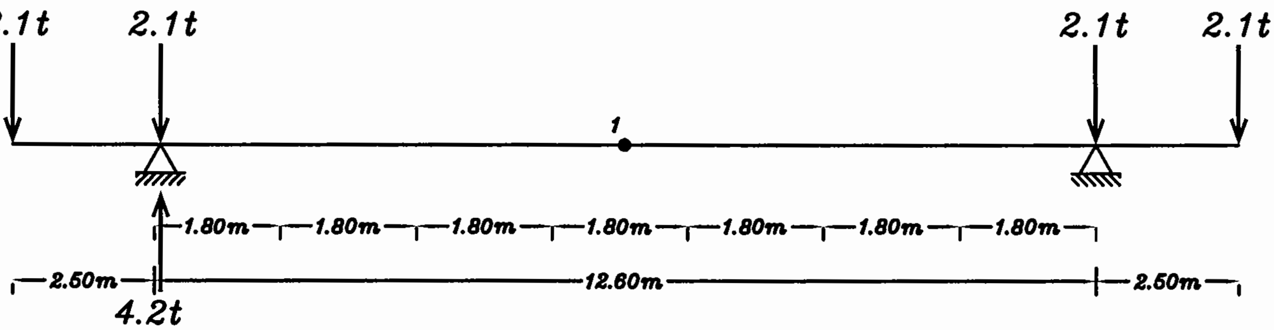
$W_{Dead} = (t_s * \gamma_c + F.C.) * a/2 + o.w = (0.16*2.5+0.15)*2.5/2 = \boxed{0.84t/m'}$

$R_d = W_d * S = 0.84 * 5.50 = \boxed{4.60t}$

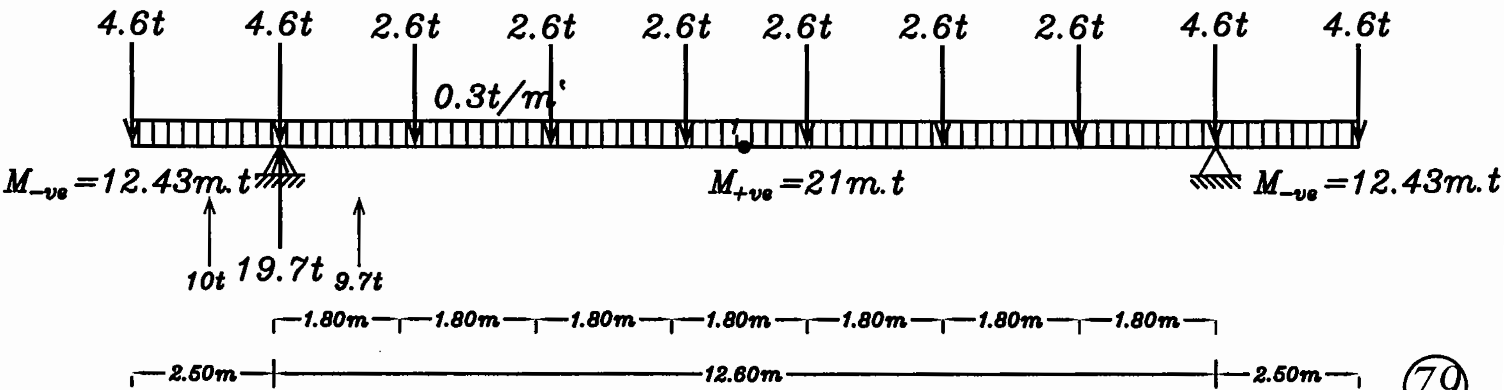
Max. +ve moment @ Sec. 1 due to LiveLoad+Impact



Max. –ve moment @ Sec. 1 due to LiveLoad+Impact



Total dead Loads



$Q_{LL+I} = 106.8t$ $\quad$ $Q_d = 9.7t$ (right)

$Q_{LL+I} = 4.2t$ $\quad$ $Q_d = 10t$ (Left)

$M_{LL+I} = 384$ m.t (@ mid. Span) $\quad$ $M_{ll+I} = 5$ m.t (@ Support)

$M_d = 21$ m.t (@ mid. Span) $\quad$ $M_d = 12$ m.t (@ Support)

$M_{max.} = M_{d+ll+I} = 405$ m.t (@ mid. Span)

$M_{min.} = 21-5 = 16$ m.t (@ mid. Span)

$M_{max.} = 17$ m.t (@ Support)

$M_{min.} = 12$ m.t (@ Support)

Design Of Built-Up Section

Calculate Web depth = 150Cm

Calculate Web thikness

→ $\frac{d_w}{t_{w1}} \leq \frac{830}{F_y}$ $\quad \frac{150}{t_{w1}} \leq \frac{830}{F_y}$ $\quad \therefore t_{w1} = 0.65Cm$

From Shear → $\frac{Q_{d+u+I}}{d_w * t_{w2}} = 0.35F_y$ $\quad \frac{116.5t}{150 * t_{w2}} = 0.35*3.6$ $\quad \therefore t_{w2} = 0.61Cm$

$\therefore d_w = 220$ Cm
Vl. Stiff. Only → $\therefore \frac{d_w}{t_{w3}} = \frac{190}{\sqrt{F_y}}$ $\quad \frac{150}{t_{w3}} = \frac{190}{\sqrt{F_y}}$ $\quad \therefore t_{w3} = 1.49Cm$

From 1,2,3 $\therefore t_{w3} = 1.60Cm$

Get Flange Dimension

$$F_{Max.} = \frac{F_{sr}}{\left(1 - \frac{M_d}{M_d + M_{LL+I}}\right)} = \frac{1.45}{\left(1 - \frac{16}{405}\right)} = 1.50t/Cm^2$$

(Or)

$$0.58F_y = 2.1t/Cm^2$$

$\therefore$ allwable Stress$=1.50t/Cm^2$

$F_{Max.}$ Or $0.58F_y = \frac{T \text{ or } C}{A}$ $\quad \therefore$ get $A = ...Cm^2$

Calculate $T=C= \frac{M_{d+u+I}}{0.98d} = \frac{405*100}{0.98*150} = 275.51t$

$\therefore \frac{275.51}{A} = 1.50$ $\quad \therefore A = 183.67Cm^2$

$A = b_f * t_f + 1/6 d_w * t_w$

$183.6 = b_f * t_f + 1/6 * 150 * 1.6 \qquad \therefore b_f * t_f = 143.6 \ Cm^2$

$b_f \cong 20 t_f \qquad \therefore 20 t_f^2 = 143.6 \ Cm^2$

$\boxed{t_f = 2.8 Cm}$ use $\boxed{b_f = 52 \ Cm}$

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

$$I_X = \frac{1.6 * 150^3}{12} + 2 * 52 * 2.8 (150/2 + 2.8/2)^2 = 2149722.7 Cm^4$$

$$\boxed{\therefore I_X = 2149722.7 \ Cm^4}$$

Checks

Check max. Stresses

$$\frac{M_{d+u+I}}{I_X} * (d/2 + t_f) = \frac{405 * 100}{2149722.7} (150/2 + 2.8) = 1.46 t/Cm^2 \not> 2.1 t/Cm^2 \qquad \text{safe}$$

Check Stress Range

$$\frac{M_{u+I}}{I_X} * (d/2 + t_f) = \frac{384 * 100}{2149722.7} * (150/2 + 2.8) = 1.38 t/Cm^2 \not> F_{Sr} = 1.45 t/Cm^2$$

Check Shear Stress

$$\frac{Q_{d+u+I}}{d_w * t_w} = \frac{116.8 t}{150 * 1.6} = 0.48 \ t/cm^2 \not> 0.35 * 3.6$$

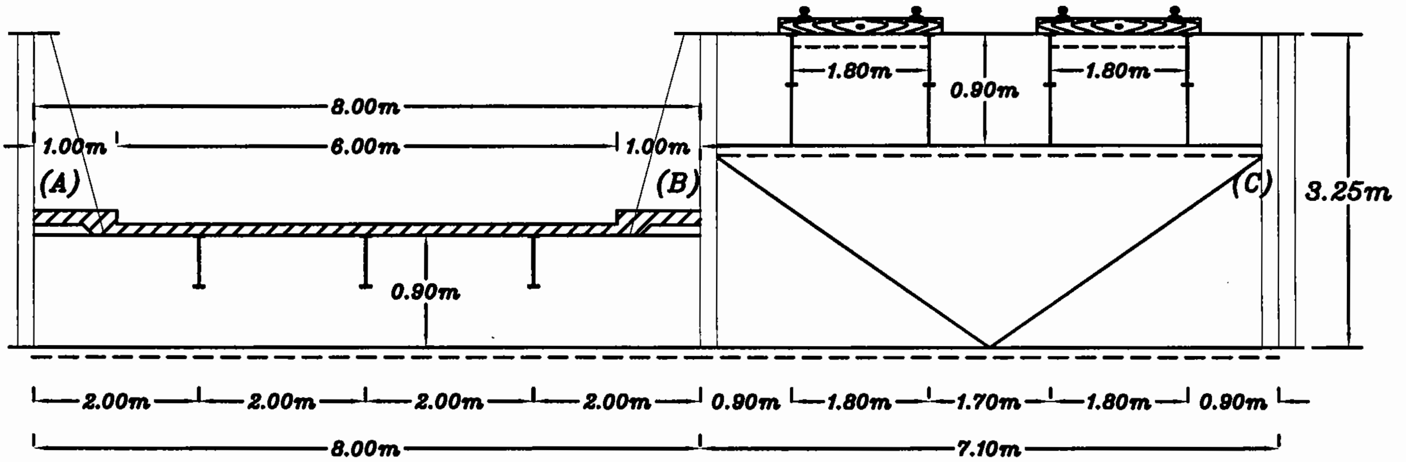
get Size of Weld

$$\frac{Q_{d+u+I} * [b_f * t_f * (d_w/2 + t_f/2)]}{I_X} = 2 * S * 0.2 F_U$$

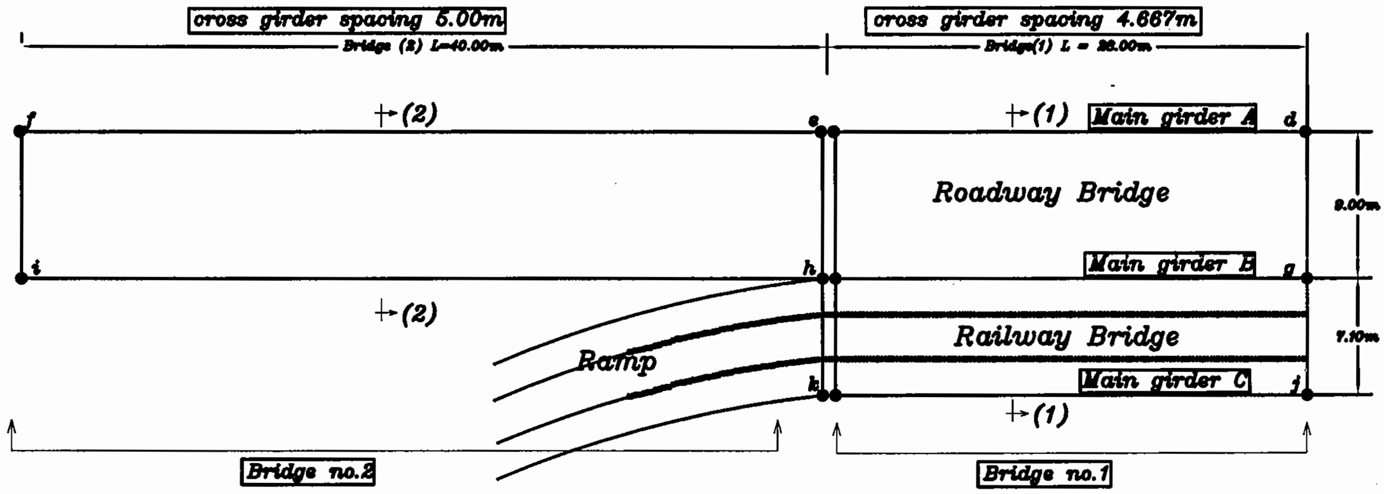
$$\frac{116.8 [(52 * 2.8)(2.8/2 + 150/2)]}{2149722.7} = 2 * S * 0.2 * 5.2$$

$S = 0.26 Cm \qquad$ Use $S = 0.6 Cm$

Example 7
Mid. term Revision

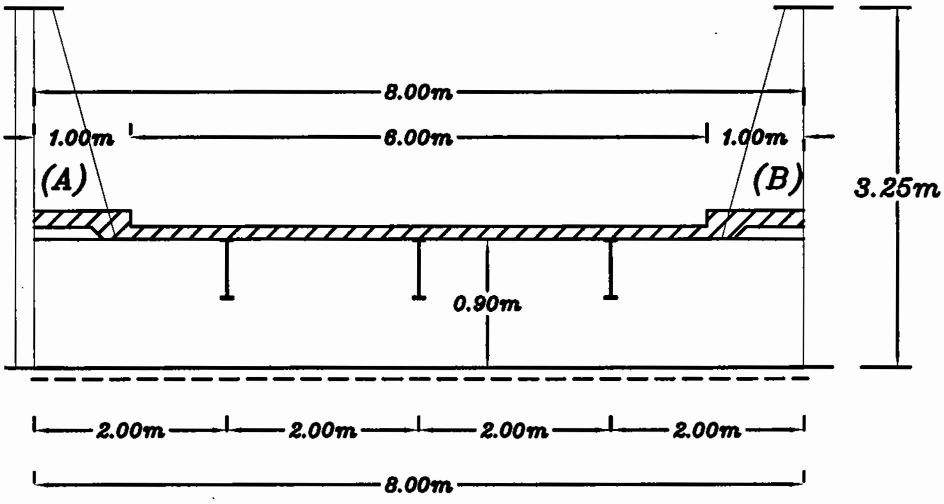


Sec (1-1)



A combined road–railway pony, deck bridge is adjoined at Bridge (1) ,as shown in the figure, Railway is double–track line and the road way is 8.00m wide with two sidewalks 1.00m each as shown in section (1–1). Only the road way line is continual over bridge 2 with the pony bridge 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



Sec (2-2)

2-calculate the maximum bending bending moment and the maximum shearing force for an intermediate cross girder due to live load + impact only, for both road & rail way

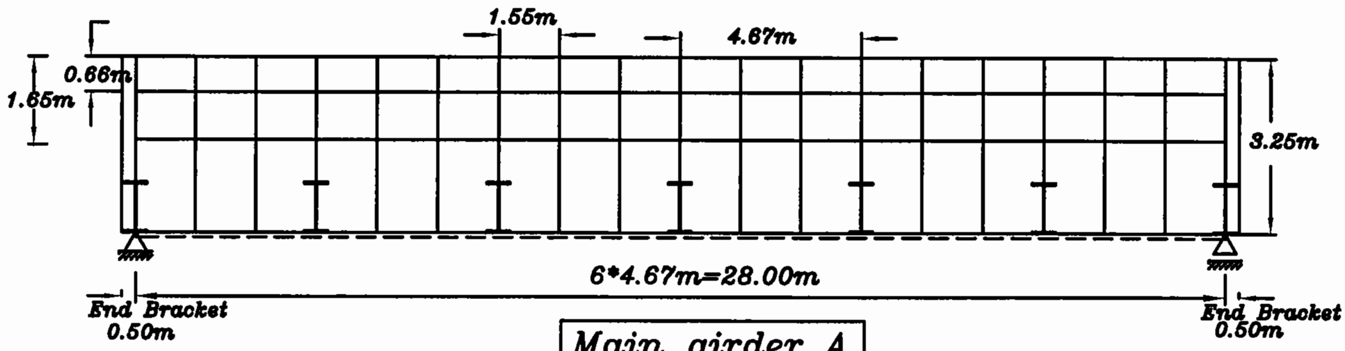
3-calculate the maximum bending moment and the max. shearing force affecting main girder (g-h in plane) due to live load + impact (take the effect of the two bridge on the main girder.

4-for the previous main girders it is required to design main girder a,b,c given that : (Cosider L.T.B)

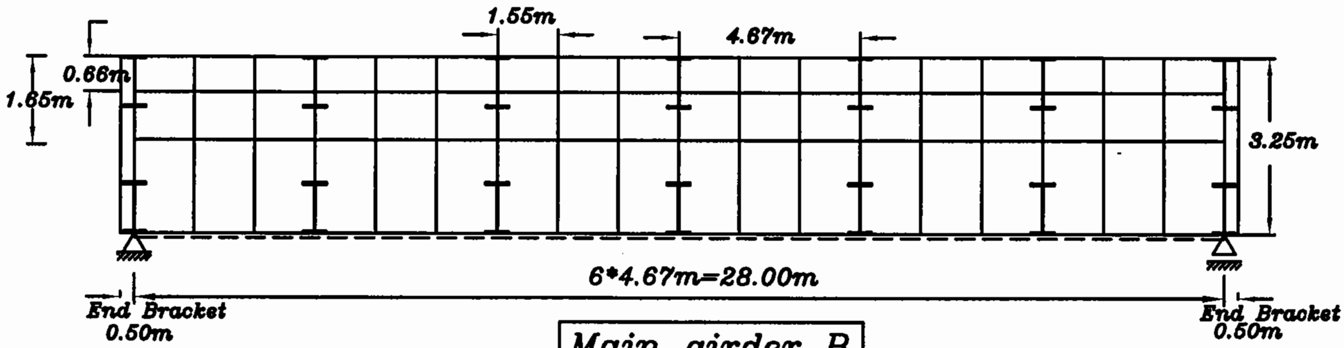
M.G	M_d	M_{ll+i}	Q_{d+ll+i}	δ flexiblity
A	563	493	146.6t	0.05
B	1874	1124	486t	0.05
C	1284	631	339.5t	-----

Question one

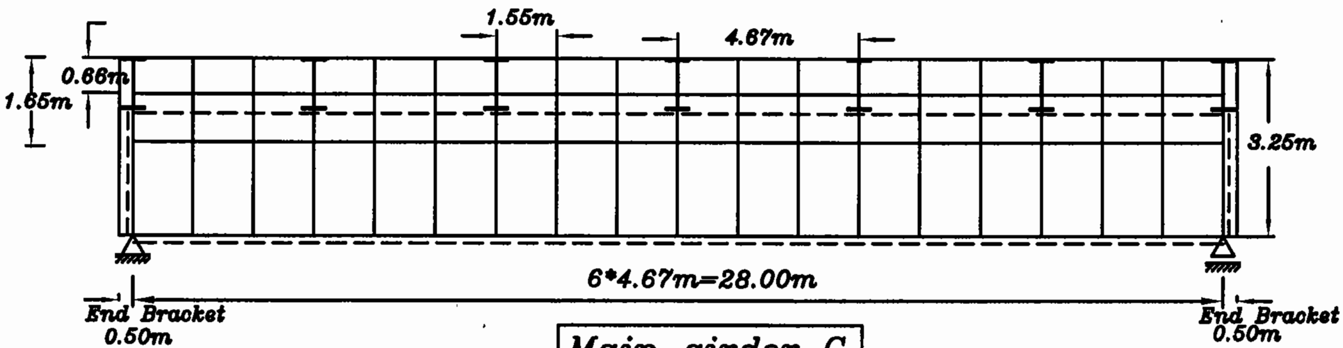
bridge no. 1



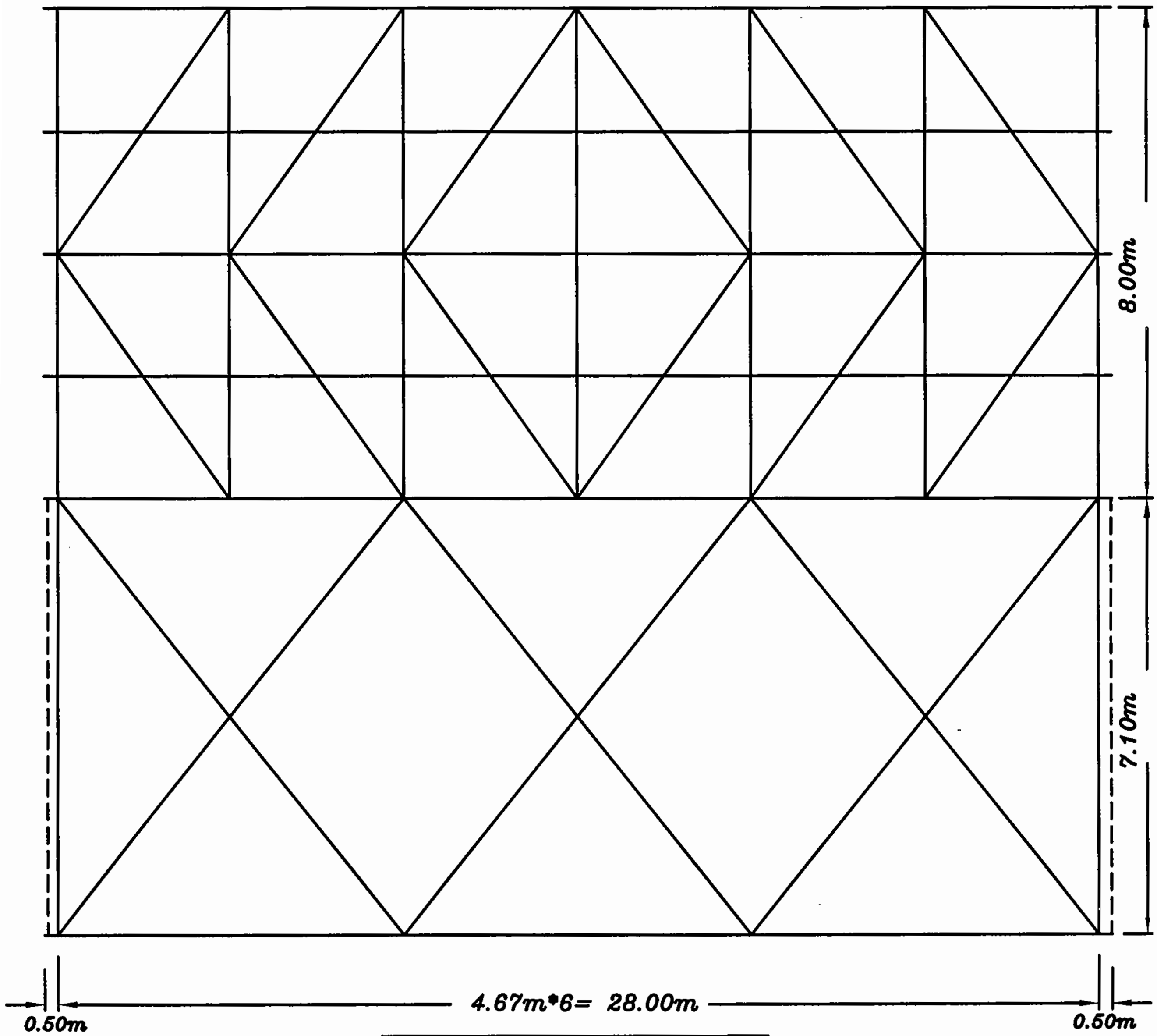
Main girder A



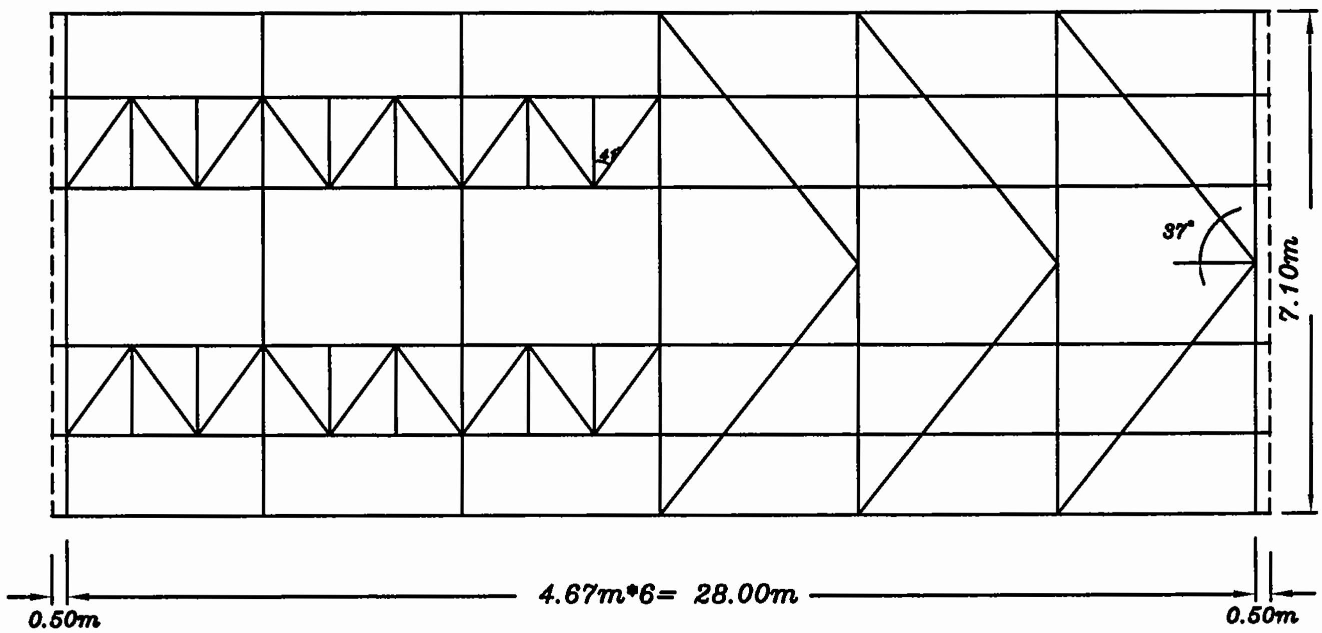
Main girder B



Main girder C

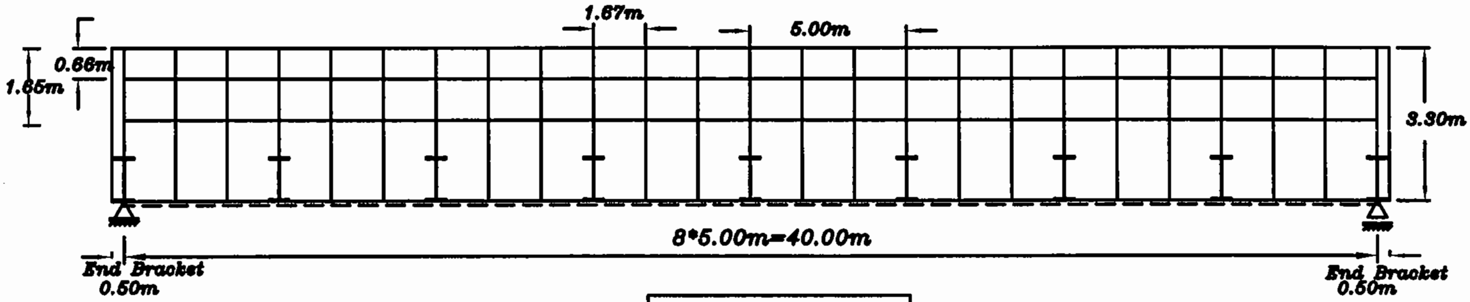


Plan of lower bracing

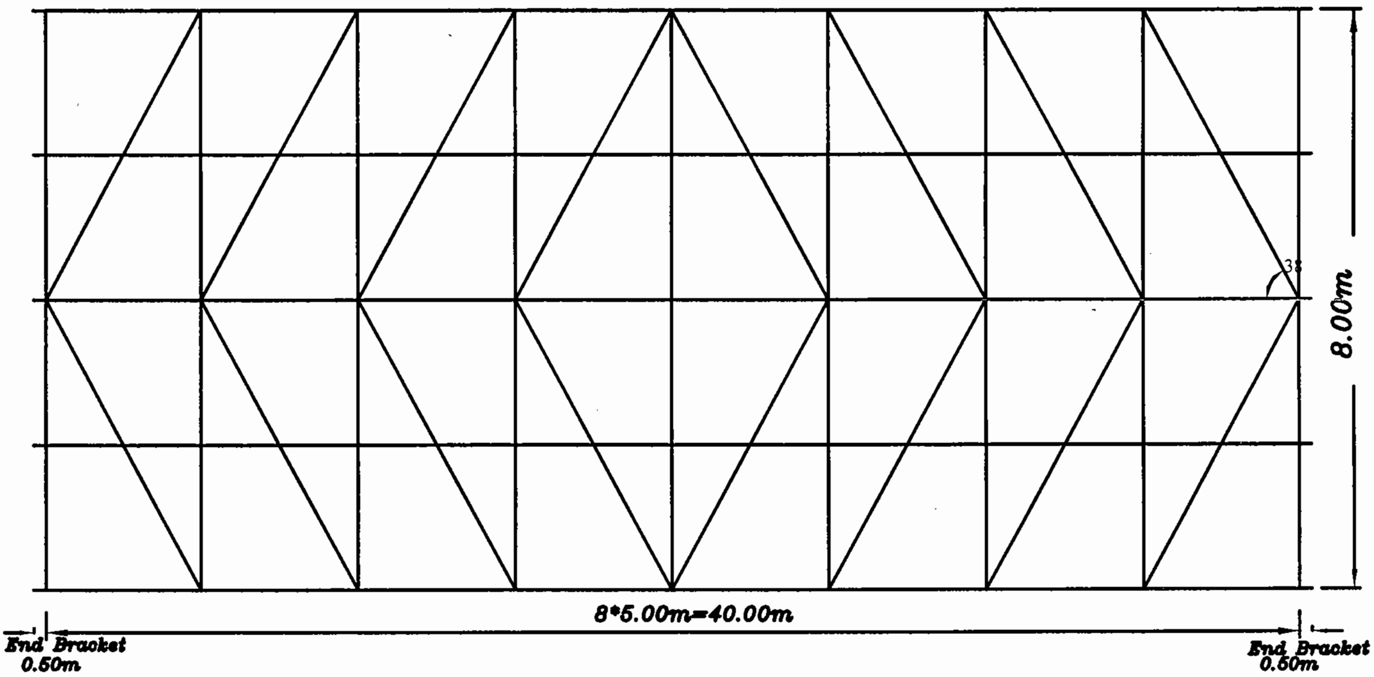


Plan of upper bracing

bridge no. 2



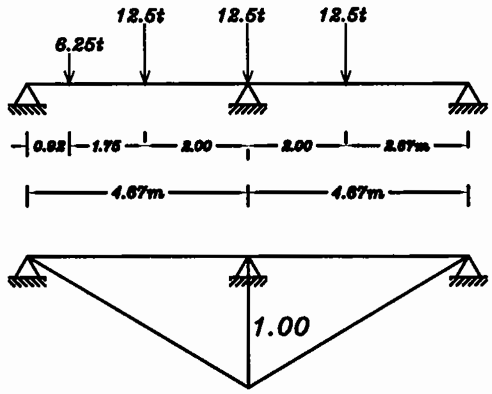
Main girder A



Plan of upper bracing

Question two

rail way part



I.L Reaction

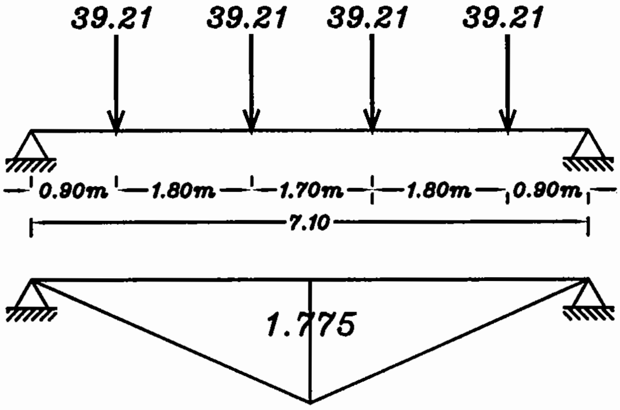
$R_{LL} = 12.5[1+2*0.57]+6.25*0.19 = 27.93t$

Reduction 0.9 For Double Track

∴ $R_{LL} = 27.93t*0.9 = \boxed{25.137t}$

Impact Factor $= I = \dfrac{24}{24+L} = \dfrac{24}{24+2*2*4.67} = 0.56$

∴ $R_{LL+I} = 25.137t * (1.56) = \boxed{39.213t}$



$M_{LL+I} = 39.21*[0.45*2+1.35*2] = \boxed{141 m.t}$

$Q_{LL+I} = \dfrac{39.21*4}{2} = \boxed{78.42t}$

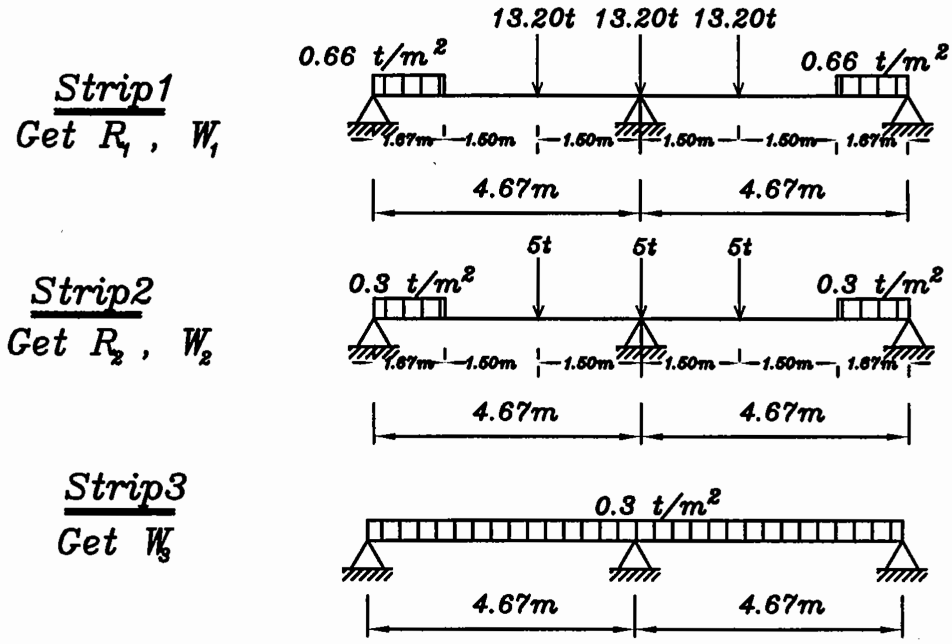
road way part

Live Loads + Impact

$$I = 0.4 - 0.008L$$

$$I = 0.4 - 0.008(2*4.67=9.34m) = 0.32$$

$$10(1+0.32) = 13.20t \ , \ 0.5(1+0.32) = 0.66t/m^2$$



$$R_1 = 13.20(1+2*0.678) = 31.09t$$

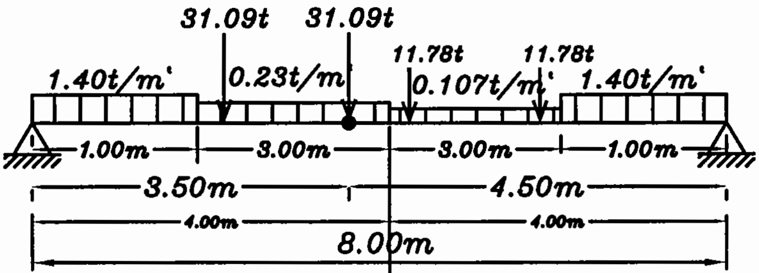
$$R_2 = 5(1+2*0.678) = 11.78t$$

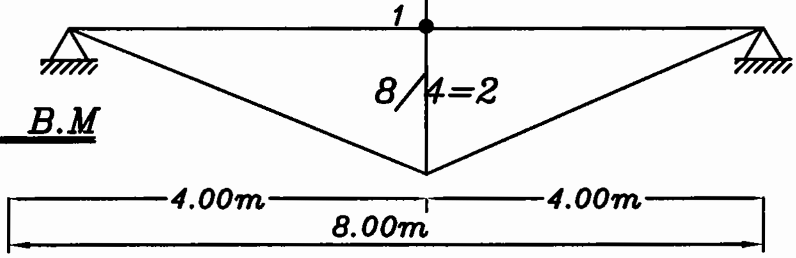
$$W_1 = 0.66*2*0.178 = 0.234t/m'$$

$$W_2 = 0.30*2*0.178 = 0.107t/m'$$

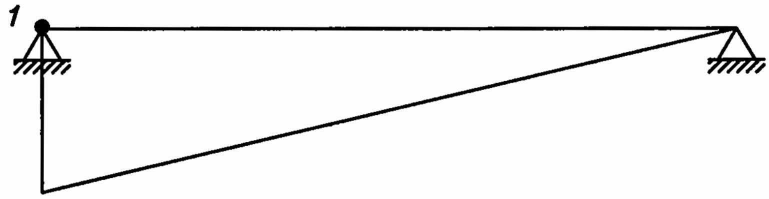
$$W_3 = 0.30*4.67*0.5*2 = 1.401t/m'$$

Case Of Max. Bending Moment





I.L For Max. B.M
@ 1



I.L For Max. S.F
@ 1

M_{LL+I}=31.09*(0.75+1.75)+11.7*(1.75+0.75)+1.4*1.00
*0.25*2+0.23*3.0*1.25+0.107*3*1.25 =108.93 m.t

M_{LL+I}= **108.93m.t**

Q_{LL+I}=1.40*1*0.9375+0.23*3*0.6875+31.09*2*0.6875
+2*11.78*0.3125+0.107*3*0.3125+1.4*1*0.0625

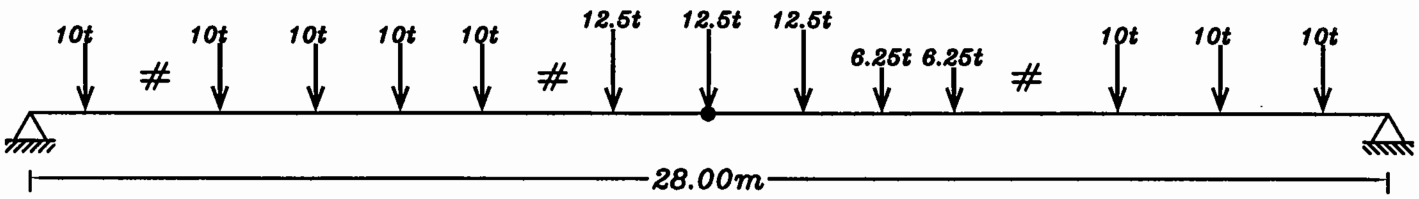
Q_{LL+I}= **52.086m.t**

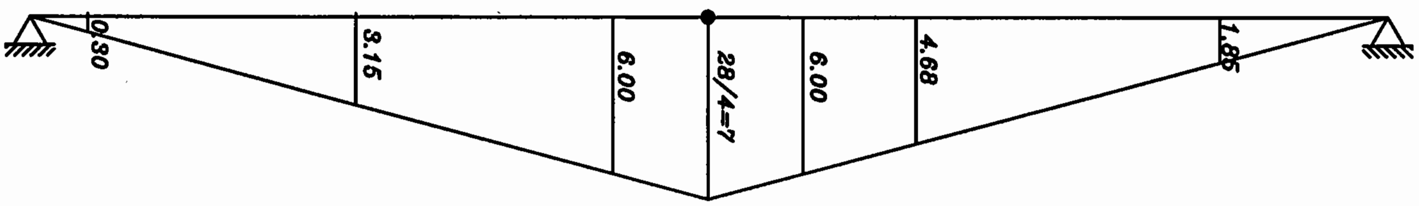
Question three

سوف يتم حل هذه الكمره عن طريق مبدا ال super position

1-rail way part

max. moment



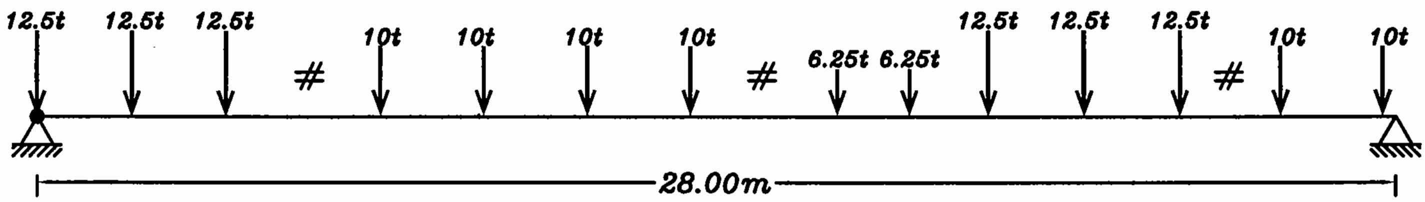


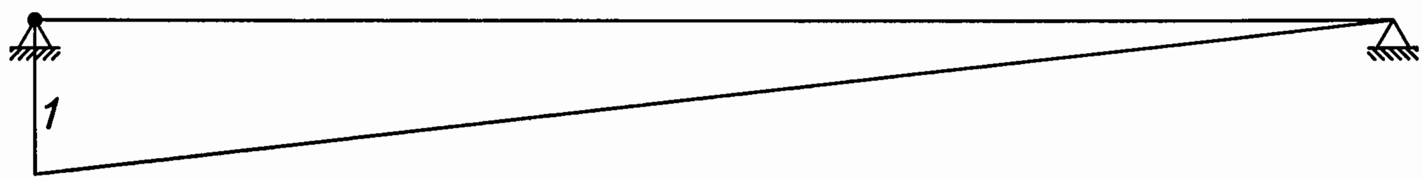
$M_{LL}=3*10*1.85+2*6.25*4.68+2*12.5*6+12.5*7+$
$4*10*3.15+10*0.3 \;=\; \boxed{480.5m.t}$

Impact factor $I=\dfrac{24}{24+2*28}=0.30$

$M_{LL+I}=480.5*1.3*2*0.9 \;=\; \boxed{1124.37m.t}$

max. shear force





$Q_{LL}=3*12.5*0.93+4*10*0.65+2*6.25*0.42+3*12.5*0.25$
$+2*10*0.043 \;=\; 76.36t$

$Q_{LL+I}=76.36*1.3*2*0.9 \;=\; \boxed{178.68t}$

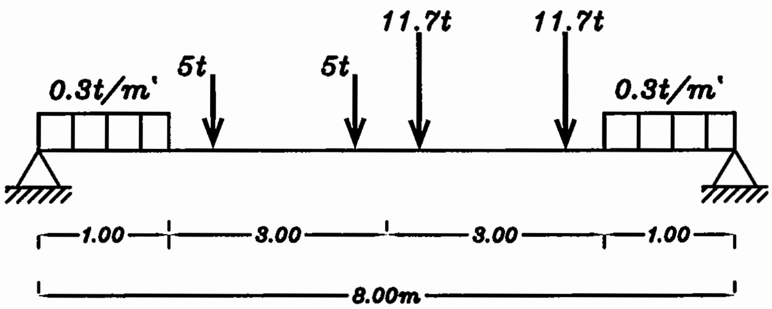
2–road way part

Impact factor $I=0.4-0.008*28 = 0.176 > 0.15$

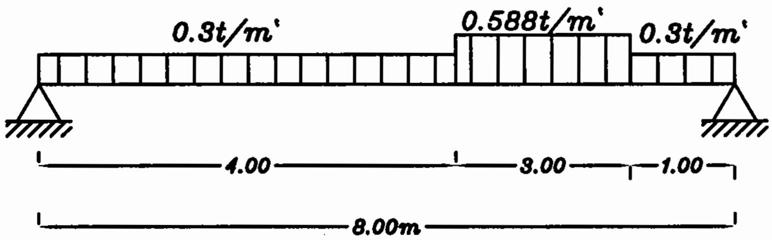
$\therefore I = 0.176$

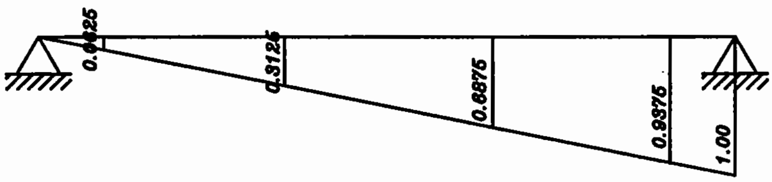
$10(1+I)=11.7t$, $0.5(1+I)=0.588t/m^2$

Strip1



Strip2



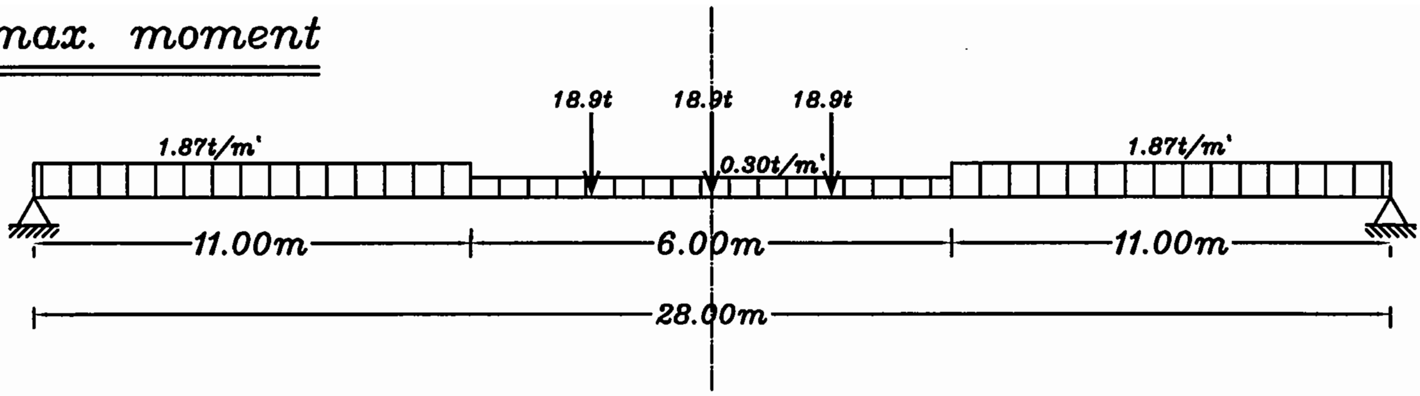


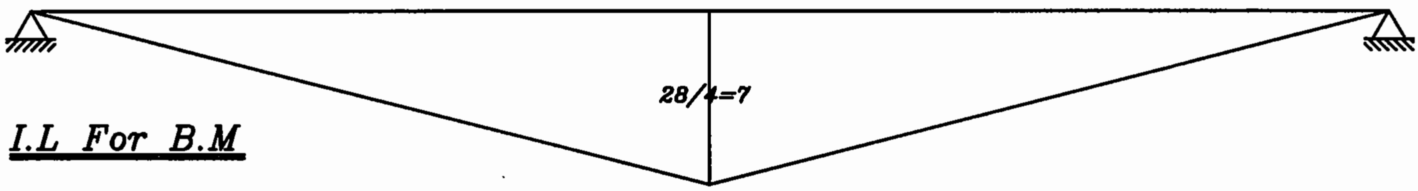
$R_1 = 2*11.7*0.6875+2*5*0.3125=$ $\boxed{18.9t}$

$W_1 = 0.3*1*0.9375+0.3*1*0.0625 =$ $\boxed{0.30t/m'}$

$W_1 = 0.3*1*0.9375+0.3*4*0.3125+0.588*3*0.6875 =$ $\boxed{1.87t/m'}$

max. moment



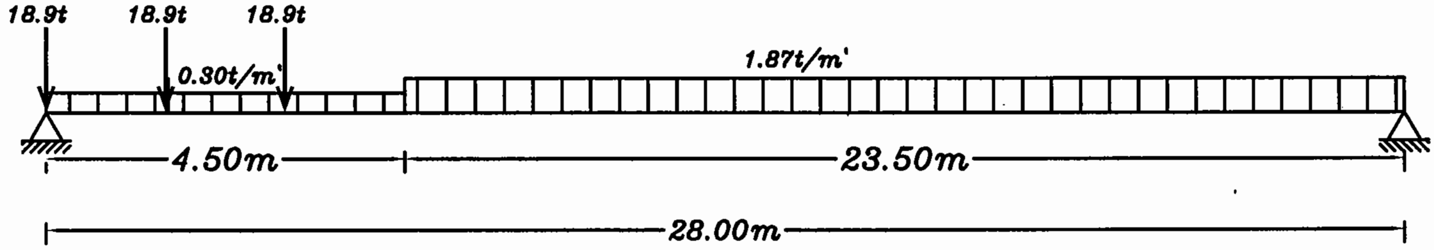


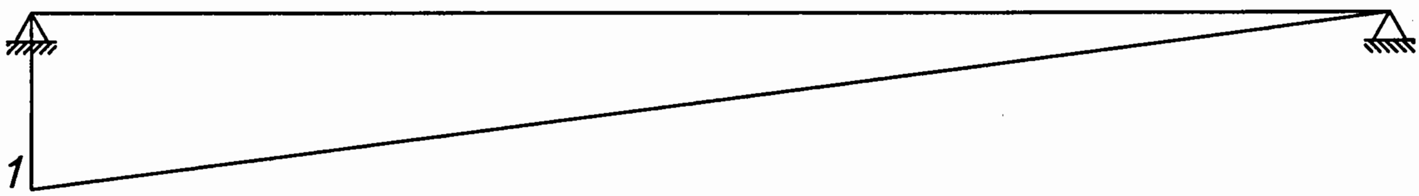
I.L For B.M

$$M_{LL+I} = 18.9(7+2*6.25) + 0.30*3*6.25*2 + 1.87*11*2.75*2$$

$$M_{LL+I} = \boxed{492.9mt}$$

max. shear force





I.L For S.F

$$Q_{LL+I} = 1.87*23.5^2/2*1/28 + 18.90\left(\frac{25+26.5+28}{28}\right) + 0.30*4.5*\frac{25.75}{28}$$

$$Q_{LL+I} = \boxed{73.34t}$$

$$\underset{Road+Rail}{M_{LL+I}} = 492.9+1124.37 = \boxed{1617.27m.t}$$

$$\underset{Road+Rail}{Q_{LL+I}} = 73.34+178.68 = \boxed{252.02m.t}$$

Question four

main girder a

Calculate Web depth = 325Cm (given)

Calculate Web thikness

→ $\frac{d_w}{t_{w1}} \leq \frac{830}{F_y}$ $\quad \frac{325}{t_{w1}} \leq \frac{830}{F_y}$ $\quad \therefore t_{w1} = 1.10Cm$

From Shear → $\frac{Q_{d+u+I}}{d_w * t_{w2}} = 0.35F_y$ $\quad \frac{146.6}{325 * t_{w2}} = 0.35*2.8$ $\quad \therefore t_{w2} = 0.46Cm$

$\therefore d_w = 280$ Cm → $\therefore \frac{d_w}{t_{w3}} = \frac{365}{\sqrt{F_y}}$ $\quad \frac{325}{t_{w3}} = \frac{365}{\sqrt{F_y}}$ $\quad \therefore t_{w3} = 1.49Cm$

From the previous Values $\boxed{\therefore t_w = 1.60Cm}$

get F_{sr} (road way)

$\therefore F_{sr} = 1.26 t/Cm^2$ N=2,000,000 Detail B

Get Flange Dimension

$$F_{Max.} = \frac{F_{sr}}{\left(1 - \frac{M_d}{M_d + 0.6M_{LL+I}}\right)} = \frac{1.26}{\left(1 - \frac{563}{493+0.6*563}\right)} = 3.91 t/Cm^2$$

(Or)

$$0.58F_y = 1.6 \ t/Cm^2$$

$\therefore$ allwable Stress=1.60t/Cm²

$F_{Max.}$ Or $0.58F_y = \frac{T \text{ or } C}{A}$ $\quad \therefore$ get A = ...Cm²

Calculate $T = C = \frac{M_{d+u+I}}{0.98d} = \frac{1056*100}{0.98*325} = 331.55t$

$\therefore \frac{331.55}{A} = 1.624 \quad \therefore \quad A = 204.15Cm^2$

$A = b_f * t_f + 1/6 d_w * t_w$

$204.1 = b_f * t_f + 1/6 * 325 * 1.6 \qquad \therefore b_f * t_f = 117.43\ Cm^2$

$b_f \cong 20 t_f \qquad \therefore 20 t_f^2 = 117.43\ Cm^2 \qquad t_f = 2.42 Cm$

$\boxed{t_f = 2.6 Cm}$ use $\boxed{b_f = 50\ Cm}$

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

$$I_X = \frac{1.6 * 325^3}{12} + 2*50*2.6(325/2 + 2.6/2)^2 = 11552997.73 Cm^4$$

$$\boxed{\therefore I_X = 11552998\ Cm^4}$$

<u>Checks</u>

<u>Check max. Stresses</u>

For Pony Bridge Unsupported length equal

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

$L_U = 2.5 \sqrt[4]{2100 * (2.6 * 50^3/12) * 467 * 0.05}$

$L_U = 477.34 Cm > 467 Cm$

$\therefore L_U = 477.34 Cm$

<u>Using Exact method</u>

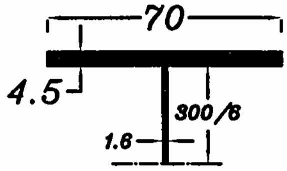
$$L_{U\ Max.} = \begin{cases} = \dfrac{20 b_f}{\sqrt{F_y}} = \dfrac{20*50}{\sqrt{2.8}} = 597.61 Cm \\ = \dfrac{1380 A_f}{d F_y} * C_b = \dfrac{1380*(50*2.6)}{325*2.8} * 1.13 = \boxed{222 Cm} \quad \text{govern} \end{cases}$$

$L_U > L_{U\ Max.}$

Where $F_{L.T.B1} = \dfrac{800}{\dfrac{L_U * d}{A_f}} * C_b \le 0.58 F_y$

$$F_{L.T.B1} = \frac{800}{\dfrac{477.3*325}{50*2.6}} * 1.13 = 0.75 t/Cm^2$$

$$r_t = \sqrt{\frac{I_y}{A}} = \sqrt{\frac{(2.6*50^3/12)}{(50*2.6+1/6*325*1.6)}}$$



$$r_t = 11.18 \ Cm$$

$$L_U / r_t = 477.34/11.18 = 42.69$$

$$84\sqrt{\frac{C_b}{F_y}} = 84\sqrt{\frac{1.13}{2.8}} = 53.36$$

$$L_U / r_t < 84\sqrt{\frac{C_b}{F_y}} \qquad \therefore F_{L.T.B2} = 0.58Fy \ t/Cm^2$$

$$\therefore F_{L.T.B} = \sqrt{F_{L.T.B1}^2 + F_{L.T.B2}^2} < 0.58F_y = \sqrt{0.75^2 + 1.624^2} = 1.79 t/Cm^2$$

$$\therefore Use \ f_{L.T.B} = 0.58 \ F_y = 1.624 t/Cm^2$$

$$\frac{M_{d+u+I}}{I_x} *(d/2+t_f) = \frac{1056*100}{11552998}(325/2+2.6) = 1.51 t/Cm^2 \ngtr 1.6 t/Cm^2 \qquad safe$$

Check Stress Range

$$\frac{0.6M_{u+I}}{I_x} *(d/2+t_f) = \frac{0.6*493*100}{11552998} *(325/2+2.6) = 0.42 t/Cm^2 \ngtr F_{Sr} = 1.26 t/Cm^2$$

Check Shear Stress

$$\frac{Q_{d+u+I}}{d_w * t_w} = \frac{146.6}{325*1.6} = 0.282 t/cm^2 \ngtr 0.35*2.8$$

get Size of Weld

$$\frac{Q_{d+u+I} *[b_f *t_f *(d_w/2+t_f/2)]}{I_x} = Shear \ Follow$$

$$Shear \ Follow = \frac{146.6[(50*2.6)(2.6/2+325/2)]}{11552998} = 0.270 t/Cm'$$

$$0.27 = 0.2F_U *2*S = 0.2*4.4*2*S$$

$$\therefore S = 0.15Cm \qquad Use \quad S = 0.6Cm$$

Question four

main girder b

Calculate Web depth = 325Cm (given)

Calculate Web thikness

$\rightarrow \frac{d_W}{t_{W1}} \leq \frac{830}{F_y}$ $\quad \frac{325}{t_{W1}} \leq \frac{830}{F_y}$ $\quad \therefore t_{W1} = 1.10Cm$

From Shear $\rightarrow \frac{Q_{d+u+I}}{d_W * t_{W2}} = 0.35F_y$ $\quad \frac{486}{325 * t_{W2}} = 0.35*2.8$ $\quad \therefore t_{W2} = 1.525Cm$

$\therefore d_W = 325$ Cm $\rightarrow \therefore \frac{d_W}{t_{W3}} = \frac{365}{\sqrt{F_y}}$ $\quad \frac{325}{t_{W3}} = \frac{365}{\sqrt{F_y}}$ $\quad \therefore t_{W3} = 1.49Cm$

From the previous Values $\boxed{\therefore t_W = 1.60Cm}$

get F_{Sr} (road way is critical in stress range)

$\therefore F_{Sr} = 2.00t/Cm^2$ N=500,000 Detail B (rail way)

$\therefore F_{Sr} = 1.26t/Cm^2$ N=2,000,000 Detail B (road way)

Get Flange Dimension

$$F_{Max.} = \frac{F_{Sr}}{\left(1 - \frac{M_d}{M_d + M_{LL+I}}\right)} = \frac{1.26}{\left(1 - \frac{1874}{1874+1124}\right)} = 3.36t/Cm^2$$

(Or)

$0.58F_y = 1.6\ t/Cm^2$

$\therefore$ allwable Stress=1.60t/Cm²

$F_{Max.}$ Or $0.58F_y = \frac{T \text{ or } C}{A}$ $\quad \therefore$ get A = ...Cm²

Calculate $T=C= \frac{M_{d+u+I}}{0.98d} = \frac{2998*100}{0.98*325} = 941t$

$\therefore \frac{941}{A} = 1.624$ $\quad \therefore \quad A = 579.61Cm^2$

$A = b_f * t_f + 1/6 d_w * t_w$

$579.6 = b_f * t_f + 1/6 * 325 * 1.6 \qquad \therefore b_f * t_f = 492.93\ Cm^2$

$b_f \cong 20 t_f \qquad \therefore 20 t_f^2 = 492.93\ Cm^2 \qquad t_f = 4.96 Cm$

$\boxed{t_f = 5.0 Cm}$ use $\boxed{b_f = 100 Cm}$

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

$$I_X = \frac{1.6 * 325^3}{12} + 2 * 100 * 5.0 (325/2 + 5.0/2)^2 = 31802083.33 Cm^4$$

$$\boxed{\therefore I_X = 31802083 \quad Cm^4}$$

Checks

Check max. Stresses

$L_U = 467$, distance between cross girder

Using Exact method

$$L_{U\ Max.} = \begin{cases} = \dfrac{20 b_f}{\sqrt{F_y}} = \dfrac{20*100}{\sqrt{2.8}} = 1195.22 Cm \\ = \dfrac{1380 A_f}{d F_y} * C_b = \dfrac{1380*(100*5)}{325*2.8} * 1.13 = \boxed{856 Cm} \quad \text{govern} \end{cases}$$

$L_U < L_{U\ Max.}$ no need to check L.T.B

$$\frac{M_{d+u+I}}{I_x} *(d/2+t_f)= \frac{2998*100}{31802083} (325/2+5.0)=1.57t/Cm^2 \not> 1.6t/Cm^2 \quad \text{safe}$$

Check Stress Range

$$\frac{M_{u+I}}{I_x} *(d/2+t_f)= \frac{1124*100}{31802083} *(325/2+5.0)=0.59t/Cm^2 \not> F_{Sr} =2.00t/Cm^2$$

Check Shear Stress

$$\frac{Q_{d+u+I}}{d_w * t_w} = \frac{486}{325*1.6} =0.93t/cm^2 \not> 0.35*2.8$$

get Size of Weld

$$\frac{Q_{d+u+I} *[b_f *t_f *(d_w/2+t_f/2)]}{I_x} = \text{Shear Follow}$$

$$\text{Shear Follow} = \frac{486[(100*5.0)(5.0/2+325/2)]}{31802083} = 0.63t/Cm'$$

$$0.63 = 0.2F_U *2*S = 0.2*4.4*2*S$$

$\therefore S=0.36Cm$ Use $S=0.6Cm$

Question four

main girder c

Calculate Web depth = 325Cm (given)

Calculate Web thikness

→ $\frac{d_w}{t_{w1}} \le \frac{830}{F_y}$ $\qquad \frac{325}{t_{w1}} \le \frac{830}{F_y}$ $\qquad \therefore t_{w1} = 1.10Cm$

From Shear → $\frac{Q_{d+u+I}}{d_w * t_{w2}} = 0.35F_y$ $\qquad \frac{339.5}{325 * t_{w2}} = 0.35*2.8$ $\qquad \therefore t_{w2} = 1.06Cm$

$\therefore d_w = 280$ Cm → $\therefore \frac{d_w}{t_{w3}} = \frac{365}{\sqrt{F_y}}$ $\qquad \frac{325}{t_{w3}} = \frac{365}{\sqrt{F_y}}$ $\qquad \therefore t_{w3} = 1.49Cm$

From the previous Values $\boxed{\therefore t_w = 1.60Cm}$

get F_{Sr} (rail way)

$\therefore F_{Sr} = 2.00 t/Cm^2$ N=500,000 Detail B

Get Flange Dimension

$$F_{Max.} = \frac{F_{Sr}}{\left(1 - \frac{M_d}{M_d + M_{LL+I}}\right)} = \frac{2.00}{\left(1 - \frac{1284}{1284+631}\right)} = 6.07 t/Cm^2$$

(Or)

$0.58F_y = 1.6\ t/Cm^2$

$\therefore$ allwable Stress=1.60t/Cm²

$F_{Max.}$ Or $0.58F_y = \frac{T \text{ or } C}{A}$ $\qquad \therefore$ get A = ...Cm²

Calculate $T = C = \frac{M_{d+u+I}}{0.98d} = \frac{1915*100}{0.98*325} = 601t$

$\therefore \frac{601}{A} = 1.624 \quad \therefore \quad A = 370.23Cm^2$

$A = b_f * t_f + 1/6 d_w * t_w$

$370.2 = b_f * t_f + 1/6*325*1.6 \qquad \therefore b_f * t_f = 283.53 \ Cm^2$

$b_f \cong 20 t_f \qquad \therefore 20 t_f^2 = 283.53 \ Cm^2 \qquad t_f = 3.76 Cm$

$\boxed{t_f = 3.8 Cm}$ use $\boxed{b_f = 76 Cm}$

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

$$I_X = \frac{1.6*325^3}{12} + 2*76*3.8(325/2+3.8/2)^2 = 20188086.47 Cm^4$$

$$\boxed{\therefore I_X = 20188086 \quad Cm^4}$$

Checks

Check max. Stresses

$$\frac{M_{d+u+I}}{I_X} *(d/2+t_f) = \frac{1915*100}{20188086}(325/2+3.8) = 1.57 t/Cm^2 \not> 1.6 t/Cm^2 \qquad \text{safe}$$

Check Stress Range

$$\frac{M_{u+I}}{I_X} *(d/2+t_f) = \frac{631*100}{20188086} *(325/2+3.8) = 0.52 t/Cm^2 \not> F_{Sr} = 2.00 t/Cm^2$$

Check Shear Stress

$$\frac{Q_{d+u+I}}{d_w * t_w} = \frac{339.5}{325*1.6} = 0.65 t/cm^2 \not> 0.35*2.8$$

get Size of Weld

$$\frac{Q_{d+u+I} *[b_f * t_f *(d_w/2 + t_f/2)]}{I_X} = \text{Shear Follow}$$

$$\text{Shear Follow} = \frac{339.5[(76*3.8)(3.8/2+325/2)]}{20188086} = 0.79 t/Cm'$$

$0.79 = 0.2 F_U *2*S = 0.2*4.4*2*S$

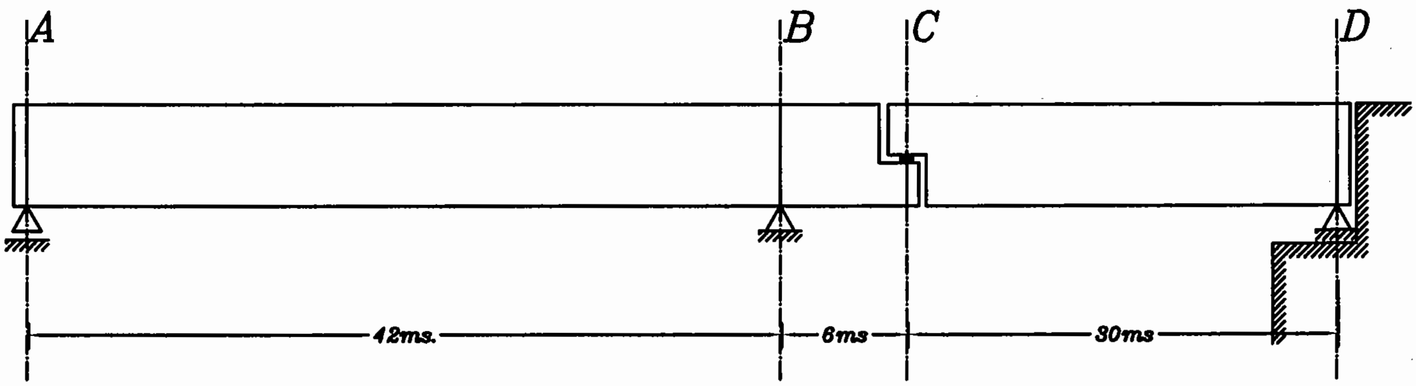
$\therefore S = 0.44 Cm \quad$ Use $\quad S = 0.6 Cm$

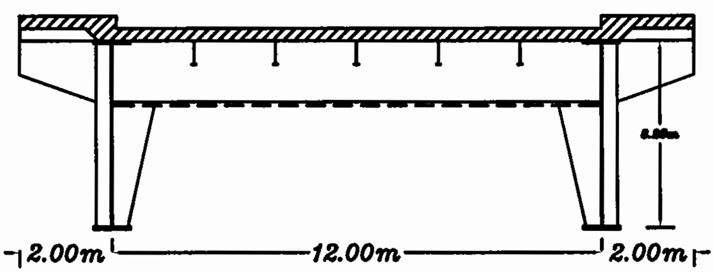
using st. 44

Example 8
Mid. term Revision

A roadway Plate girder bridge of the given cross section has total width 12ms the road width is 12ms and the sidewalks are 2.0 ms each. the bridge has two Spans AB,CD of Lengths 42ms and 30ms respectively. Outer Span CD is Provided With intermediate hinge C Located 6ms away from the support B the Plate Girder bridge has a depth of 3.25ms. each span of bridge is divided into equal panels 6ms. each ,where cross girder are located.

Vertical stiffeners are spaced every 1.50m ms. while horizontal stiffeners are located at half and one fifth of the depth from the compression side both stringers and cross girders are built-up section of depth 70Cm 150Cm respectively it is required to





1-Calculate the maximum bending moment due to live load + impact at sec. (B-B)

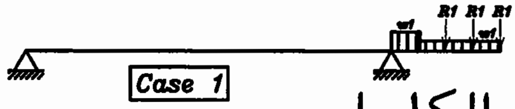
2-Complete general lay out. for span A,B,C only

Question one

Live Loads Case1

لحساب اقصى عزم عند هذا القطاع سوف يتم استخدام طريقتين

١ - تحميل الكابولى فقط بالاحمال الحيه



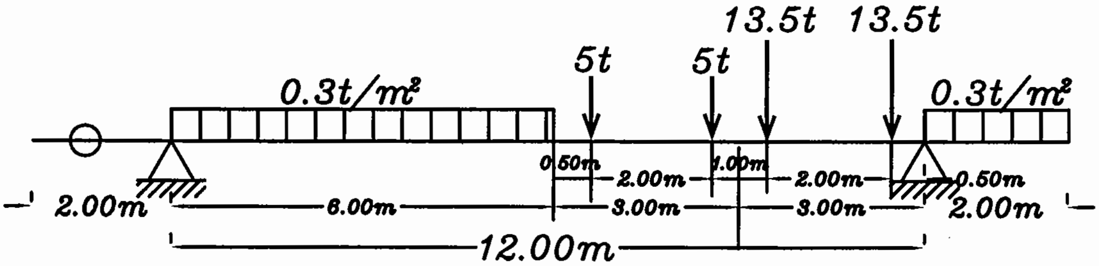
٢ - تحميل البحر C-D ونقل ال reaction على الكابولى

ثم يتم اخذ العزم الاكبر من case 1 or case 2

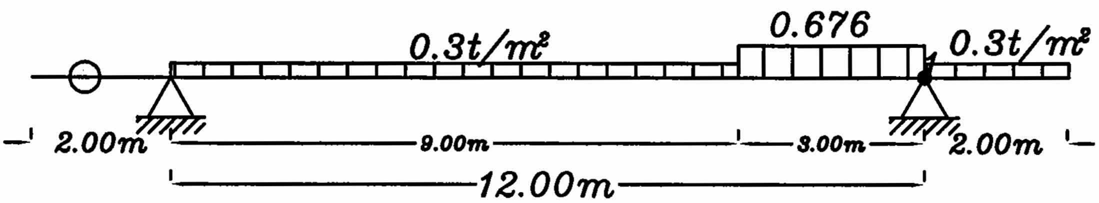
Impact factor $I=0.4-0.008*6 = 0.352 > 0.15$

$\therefore I = 0.352$

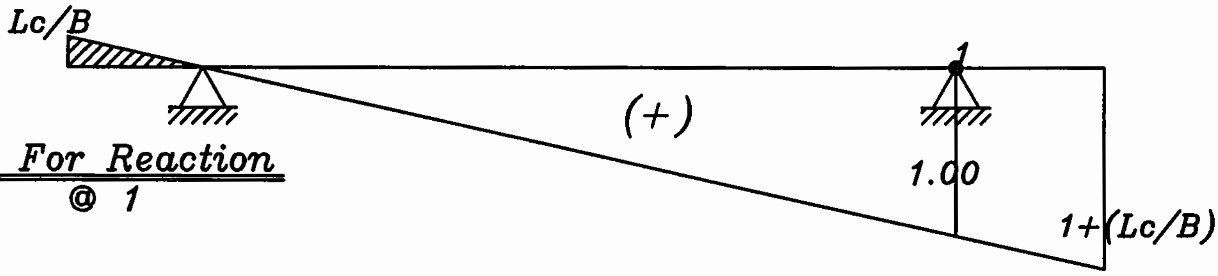
$10(1+I)=13.5t \quad , \quad 0.5(1+I)=0.676 t/m^2$



Strip1
Get R_1, W_1



Strip2
Get W_2



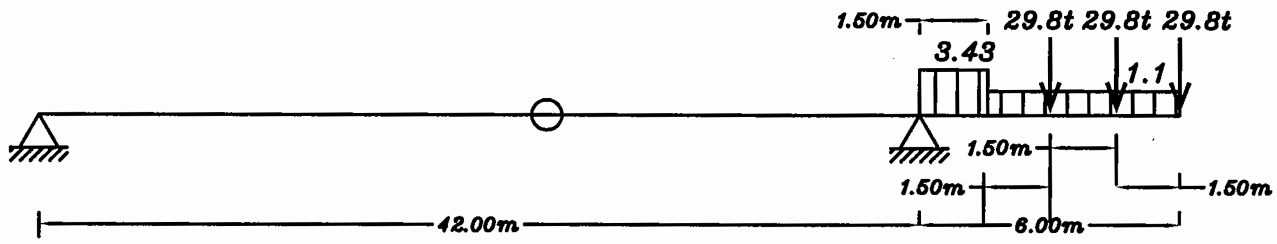
I.L For Reaction
@ 1

$R_1 = 5*(\frac{6.5+8.5}{12}) + 13.5*(\frac{9.5+11.5}{12}) = \boxed{29.87t}$

$W_1 = 0.3*6*3/12 + 0.3*2*13/12 = \boxed{1.1 t/m'}$

$W_2 = 0.3*9*4.5/12 + 0.676*3*10.5/12 + 0.3*2*13/12 = \boxed{3.43 t/m'}$

Case of Max. B.M Sec.(B−B) Case1



$M_{LL+I} = 29.8*(6+4.5+3)+1.1*4.5*3.75+1.5*3.43*0.75 = 418.76$

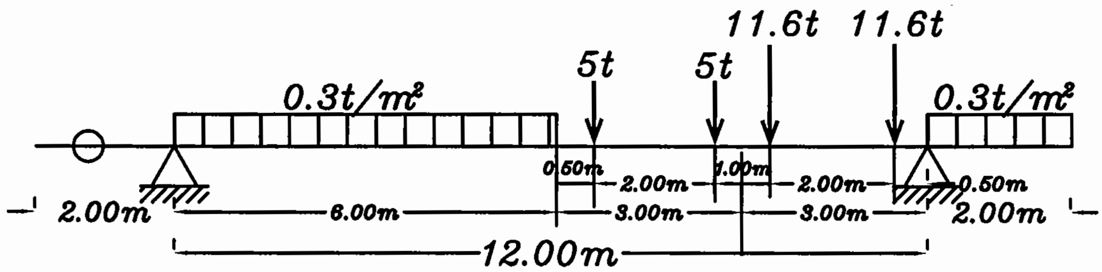
$M_{LL+I} =$ **418.76mt**

Live Loads Case2

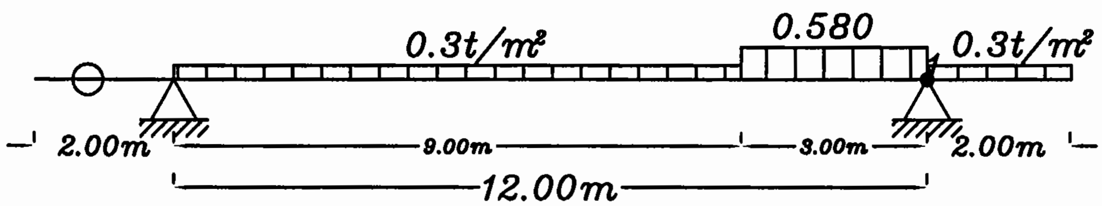
Impact factor $I = 0.4 - 0.008*30 = 0.16 > 0.15$

$\therefore I = 0.16$

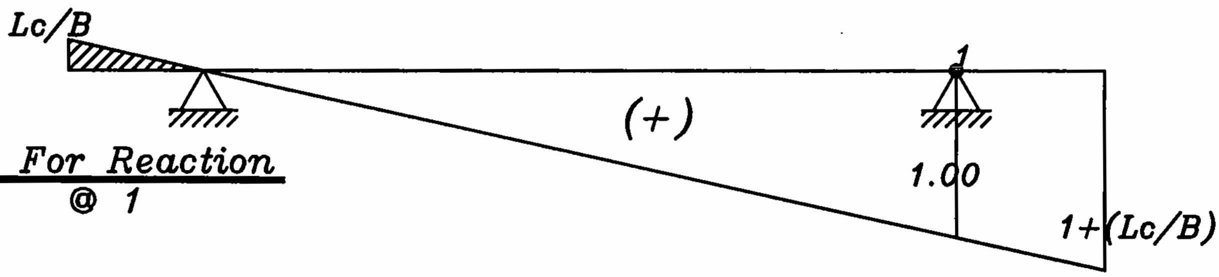
$10(1+I) = 11.6t$, $0.5(1+I) = 0.580 t/m^2$



Strip1
Get R_1, W_1



Strip2
Get W_2



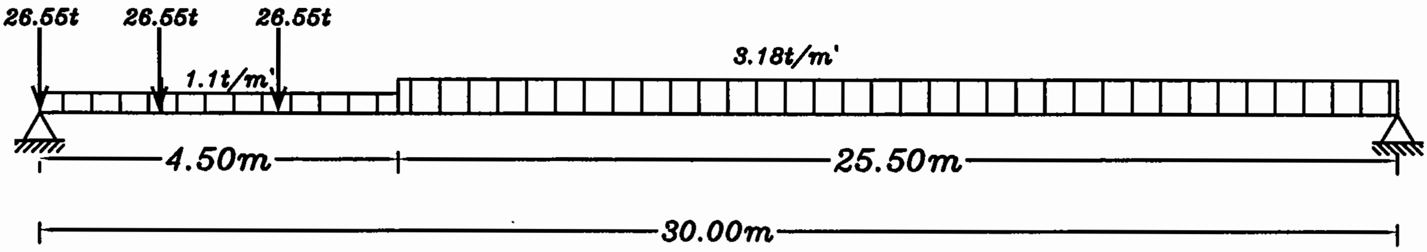
I.L For Reaction
@ 1

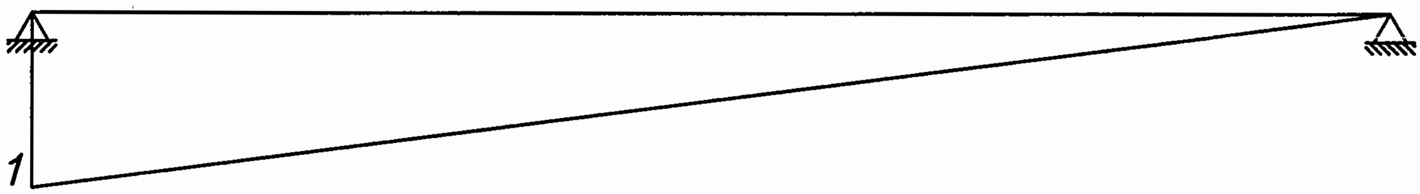
$$R_1 = 5*\left(\frac{6.5+8.5}{12}\right) + 11.6*\left(\frac{9.5+11.5}{12}\right) = \boxed{26.55t}$$

$$W_1 = 0.3*6*3/12 + 0.3*2*13/12 = \boxed{1.1t/m'}$$

$$W_2 = 0.3*9*4.5/12 + 0.580*3*10.5/12 + 0.3*2*13/12 = \boxed{3.18t/m'}$$

reaction from beam (C–D)





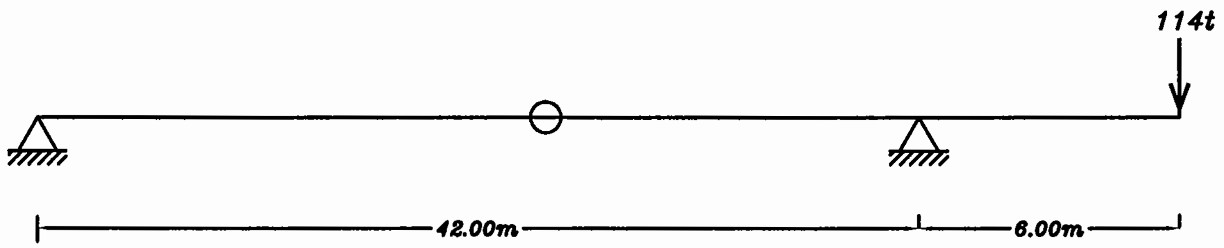
I.L For S.F

$$Q_{LL+I} = 3.18*25.5^2/2*1/30 + 26.55\left(\frac{30+28.5+27}{30}\right) + 1.1*4.5*\frac{27.75}{30}$$

$$Q_{LL+I} = \boxed{114t}$$

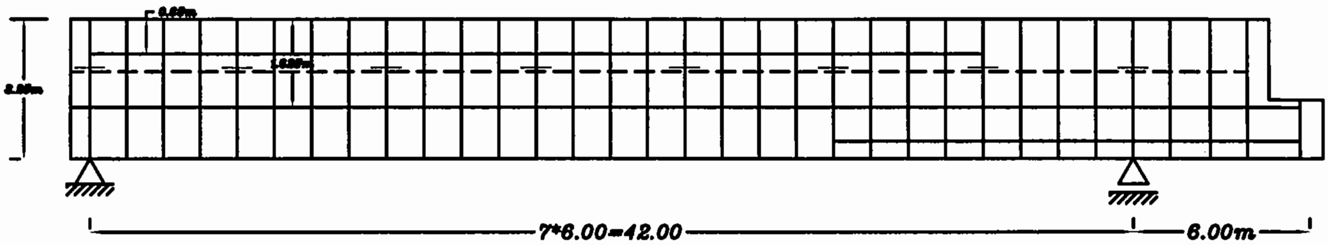
Case of Max. B.M Sec.(B–B) Case1

$$M_{LL+I} = 114*6 = \boxed{684m.t}$$

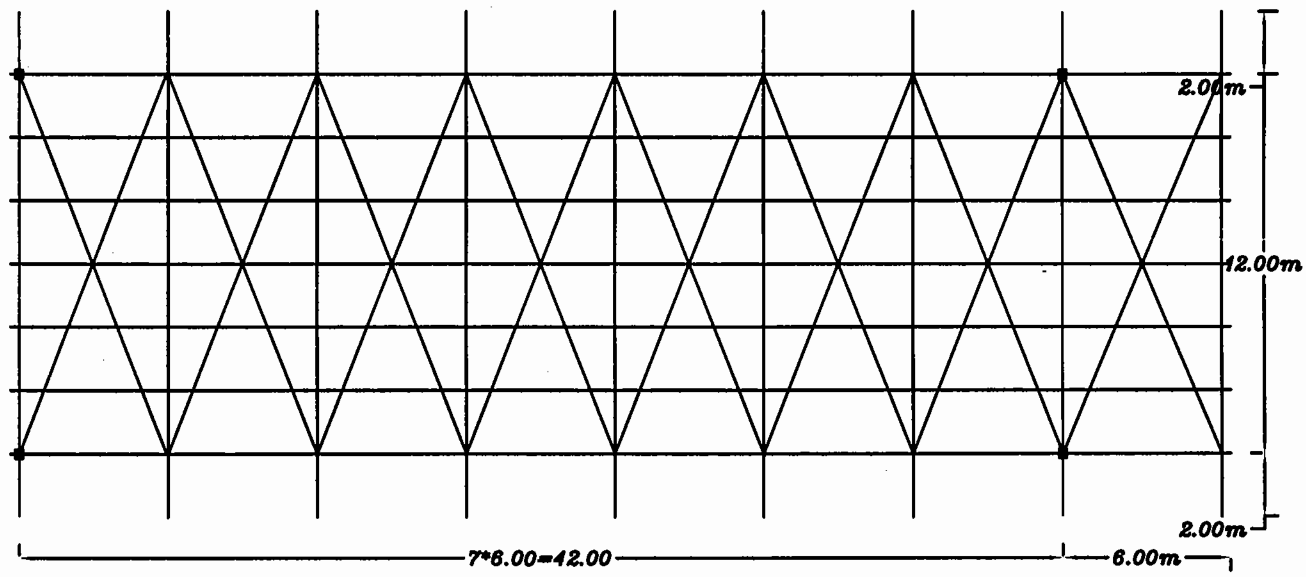


$$\boxed{use\ M_{LL+I} = 684m.t}$$

Question two



Elevation



Plan

Example 9

Mid. term Revision

it is required to construct an open-timber floor double track rail way plate girder bridge with theoretical span of 36.00m and available height of construction of 1.65m . Depth of the cross girder is taken as 1.30ms. Braking forces will be resisted by the cross girders.

-Using a reasonable scale , draw a general layout (plan , elevation & Cross Section) of the bridge showing the main structural elements , stiffeners and all bracing systems

---

Solution

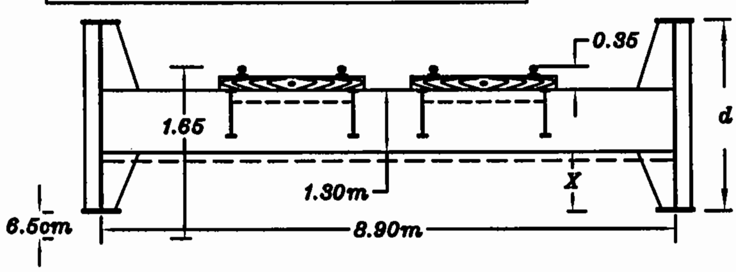
Height Of construction =

web of M.G. = L/10	=	360cm
+ two flanges of M.G. = 2*3	=	6cm
+ sleepers height	=	20cm
+ rail height	=	15cm
+ deflection of M.G.=L/800	=	4.5cm
+ safety	=	2cm
		407.5cm

Height Of construction = 4.075m

4.075m > 1.65m

∴ deck bridge is not allowed try semi deck bridge



$X = 1.65m - 0.35m - 1.30m - 0.065 = -0.065m < 0.50m$

∴ Semi-Deck bridge is not allowed

∴ try to use Pony bridge

Height Of construction for pony bridge =

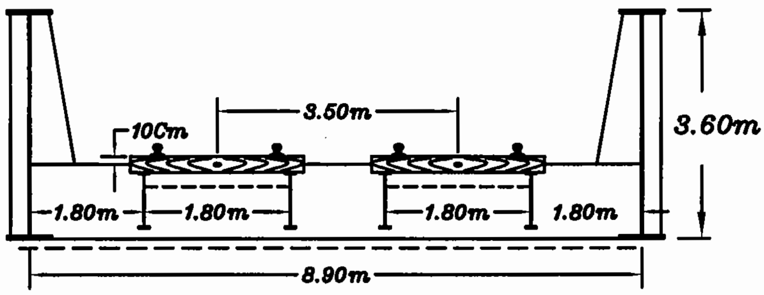
web of X.G. = L/7 to 9	=	130Cm
+ two flanges of X.G. =	2*2=	
+ sleepers height	=	20cm
+ rail height	=	15cm
+ deflection of M.G.=L/800	=	4.5cm
+ safety	=	2cm
		171.5cm

Height of construction = 1.715m

$1.715m > 1.65m$

diff. between H.c and H.a = 1.715−1.65 = 0.065m = 6.5cm

decrease height of construction for pony bridge by 10 cm



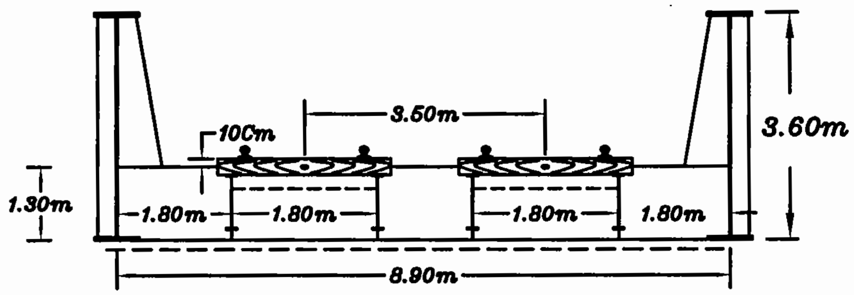
<u>Cross Section</u>

Height Of construction for pony bridge =

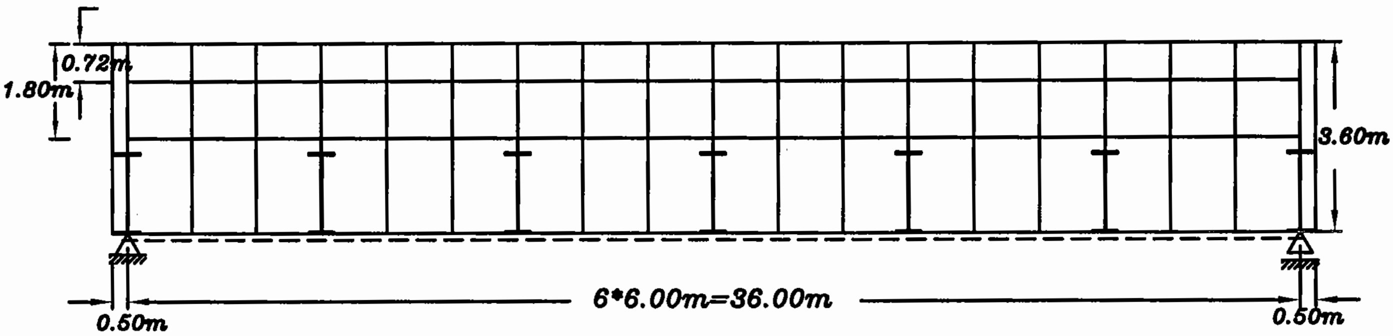
web of X.G. = L/7 to 9	=	130Cm
+ two flanges of X.G. =	2*2=	
+ sleepers height	=	10cm
+ rail height	=	15cm
+ deflection of M.G.=L/800	=	4.5cm
+ safety	=	2cm
		161.5cm

$1.615m < 1.65m$

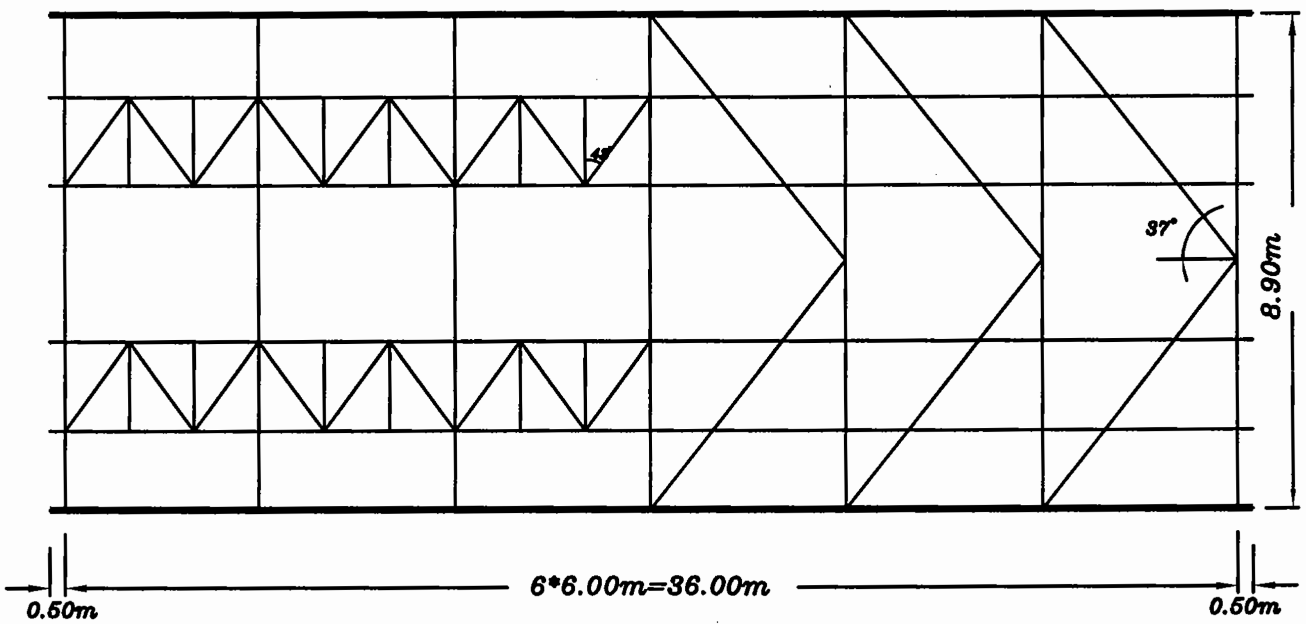
∴ use Pony bridge



Cross Section

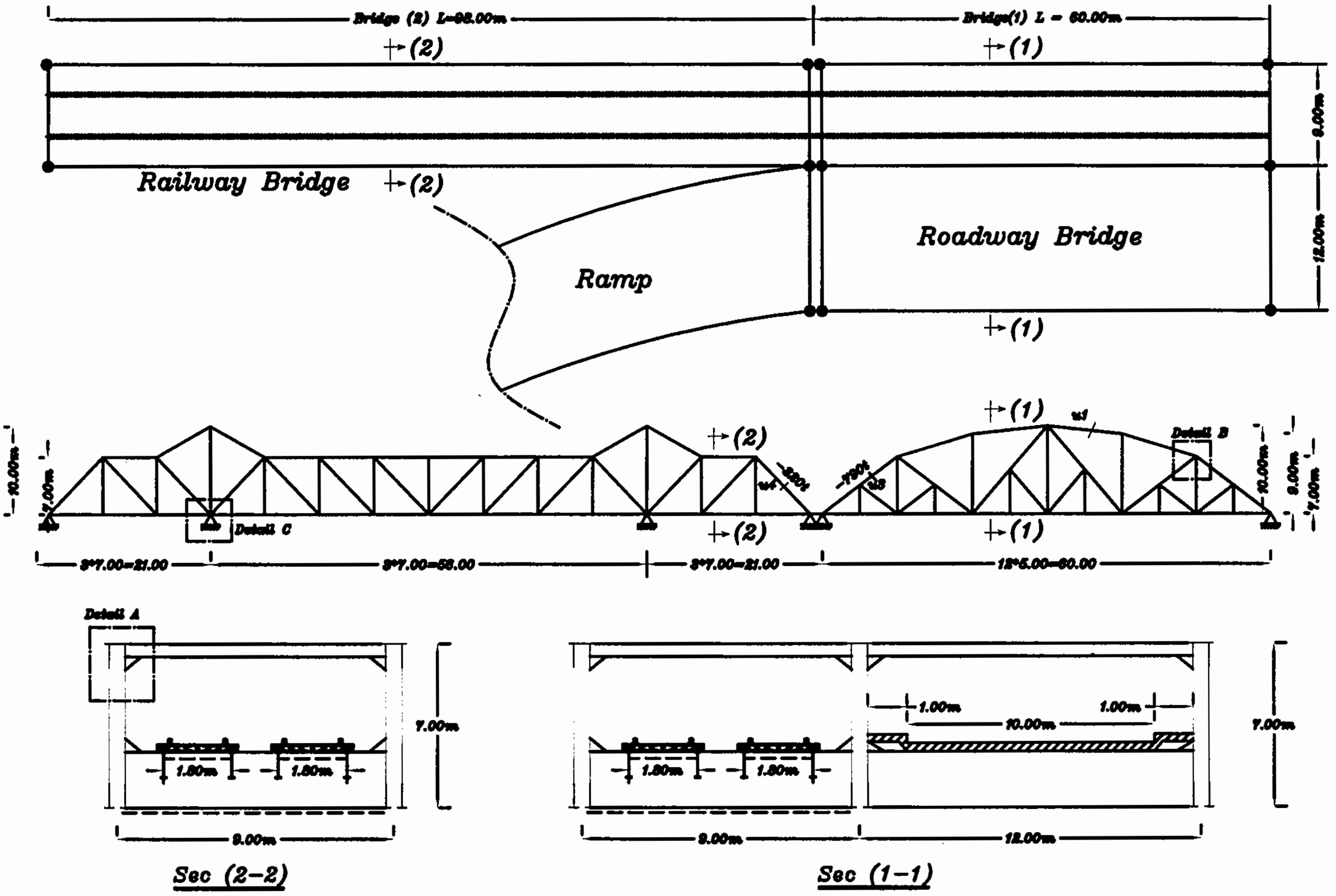


(Elevation)



(Plan Of Bracing)

Example 10
Mid. term Revision

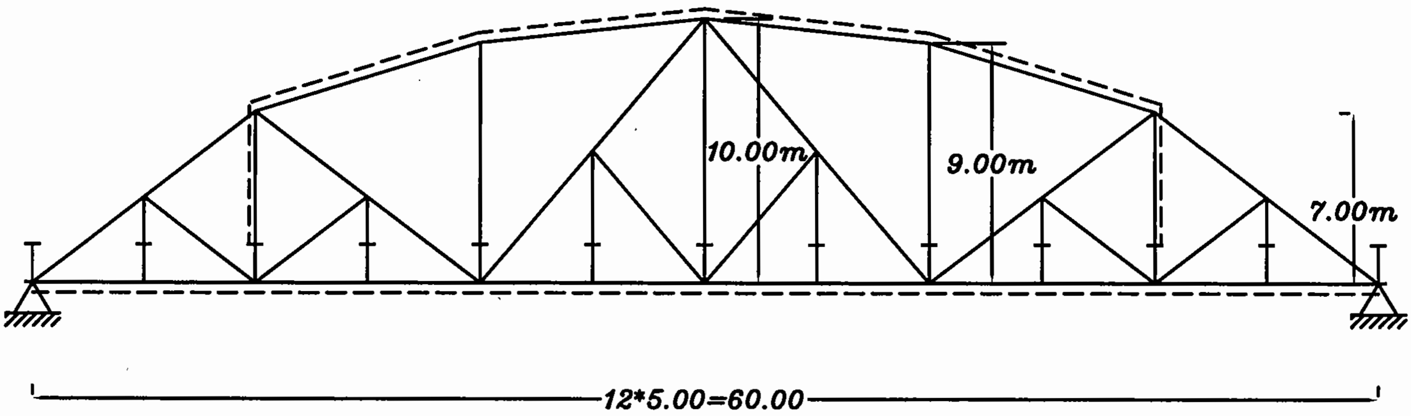


A combined road–railway through bridge is adjoined at Bridge (1) , with three main camel–back truss system , as shown is the figure, Railway is double–track line and the roadway is 10.00m wide with two sidewalks 1.00m each as shown in section (1–1). Only the rail way line is continual over Bridge 2 with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

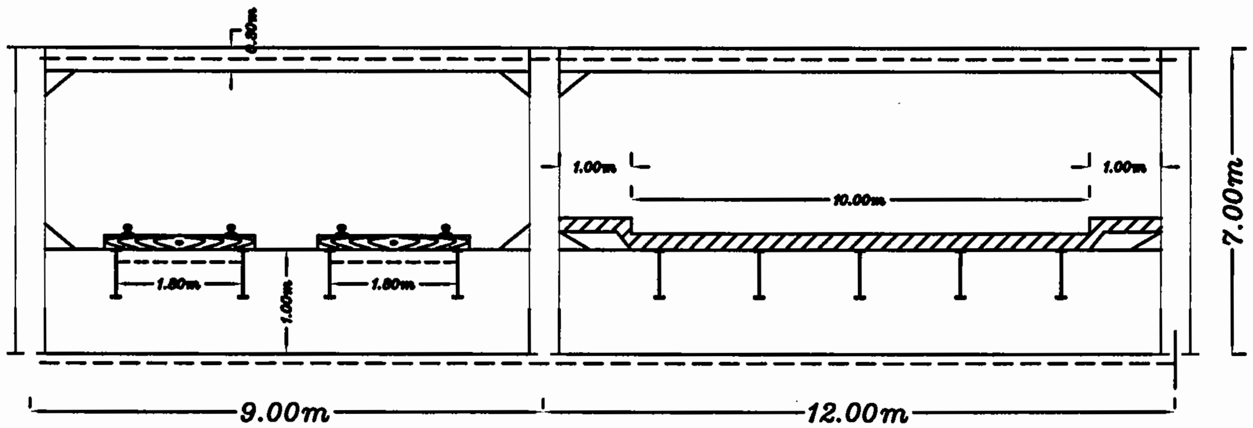
1–Draw a complete general layout for both bridges (1)&(2) to reasonalble sclae (plans,elevations & cross sections) showing the required bracings of both bridges

2–For the marked member calculate the max. forces due to Live load+Impact

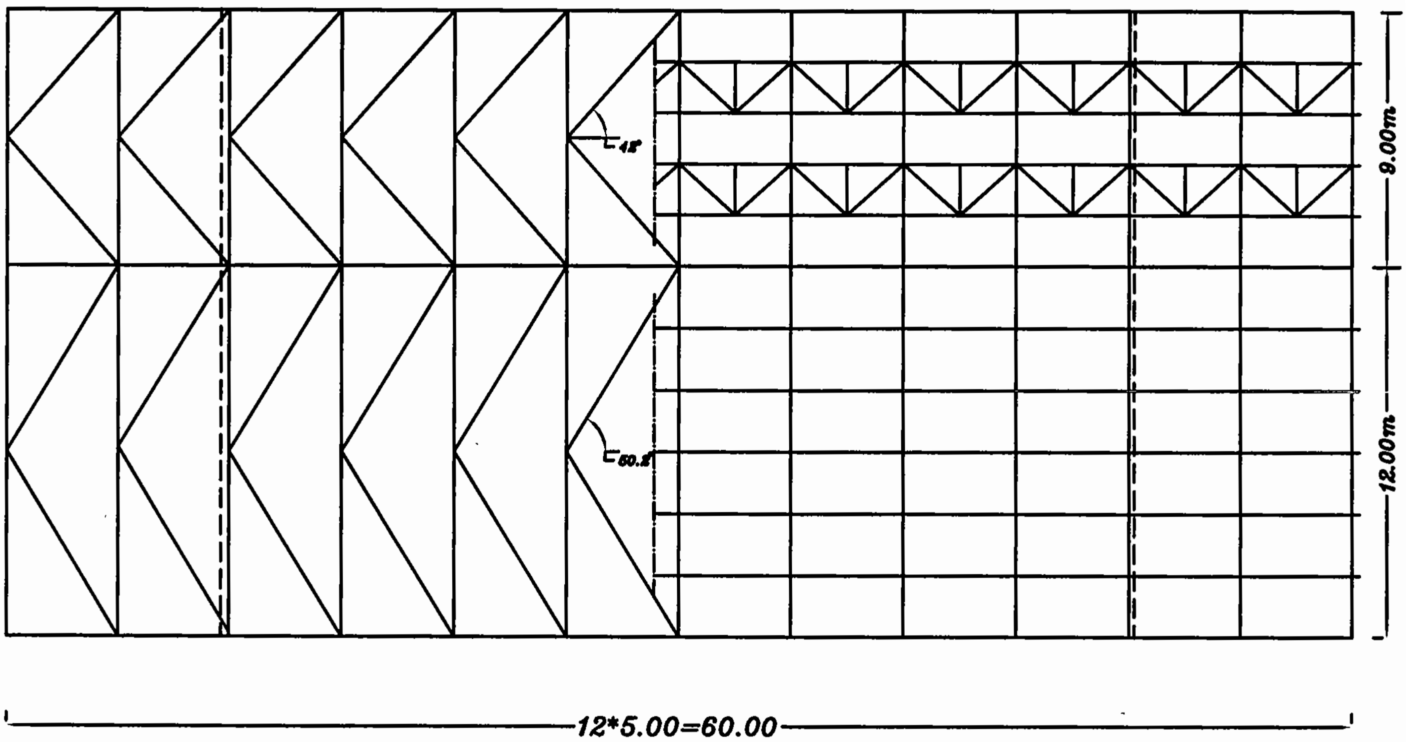
Bridge one



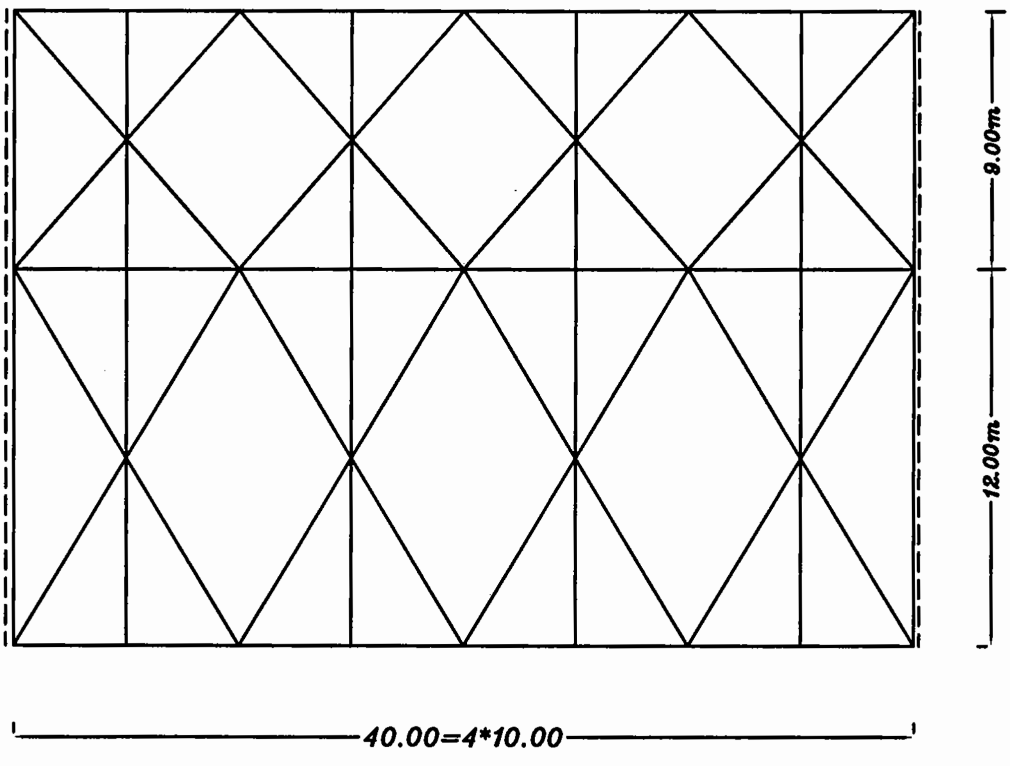
Elevation



Sec (1-1)

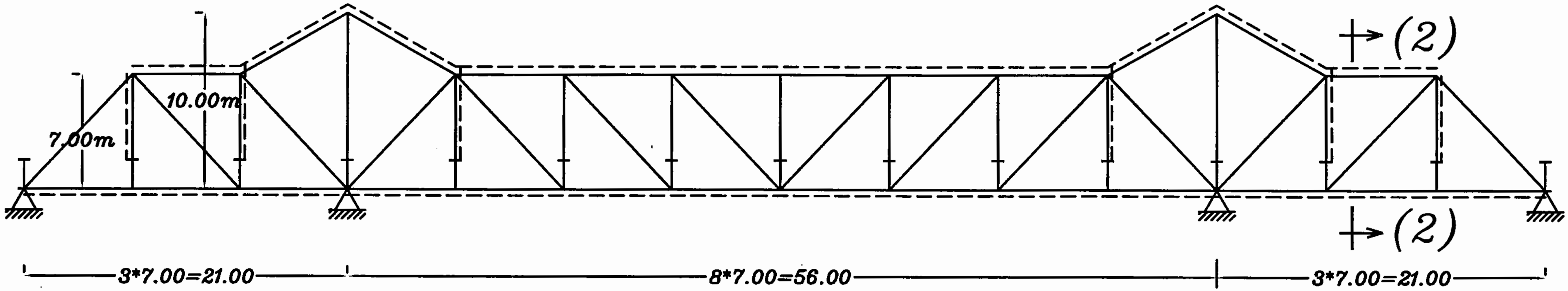


Plan of lower bracing

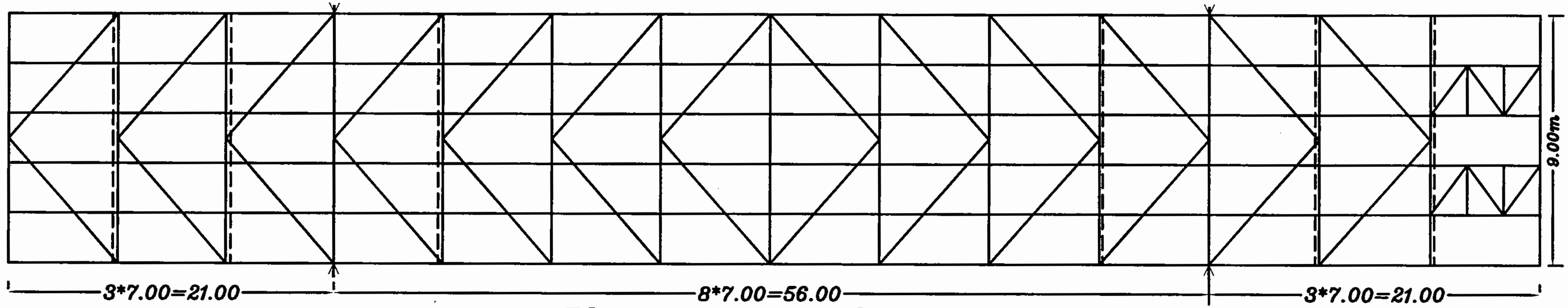


Plan of upper bracing

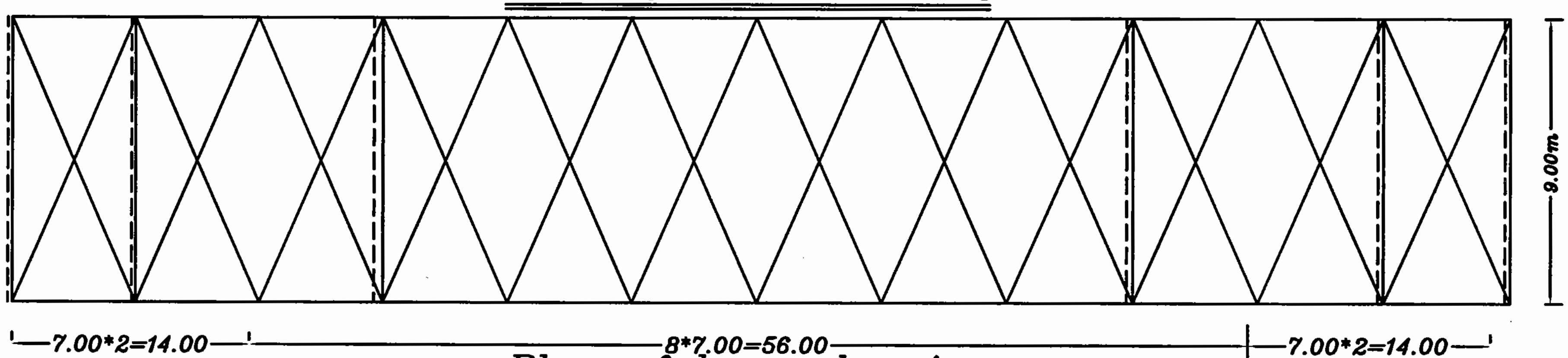
Bridge two



Elevation



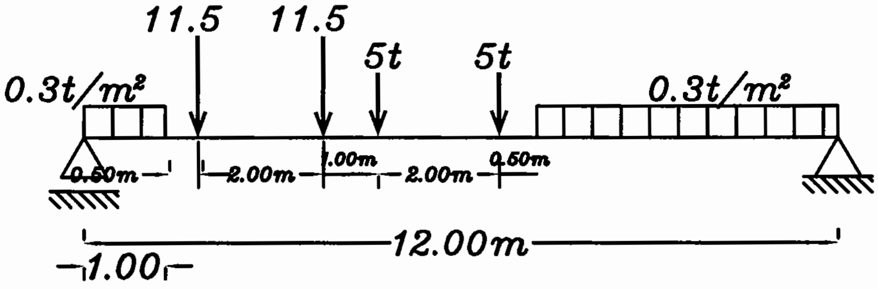
Plan of upper bracing



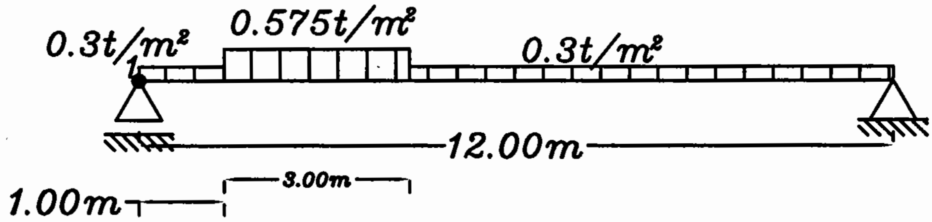
Plan of lower bracing

Question 3

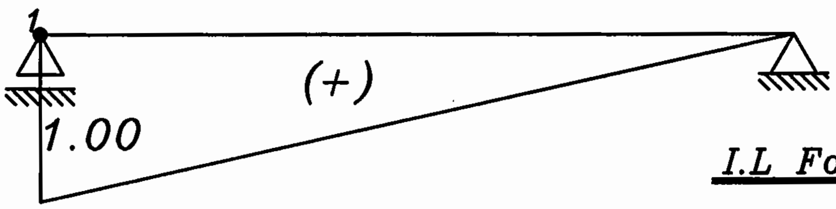
For road way part



Strip1
Get R_1, W_1



Strip2
Get W_2



I.L For Reaction
@ 1

Impact factor $I = 0.4 - 0.008 * 60 = 0.08 < 0.15$

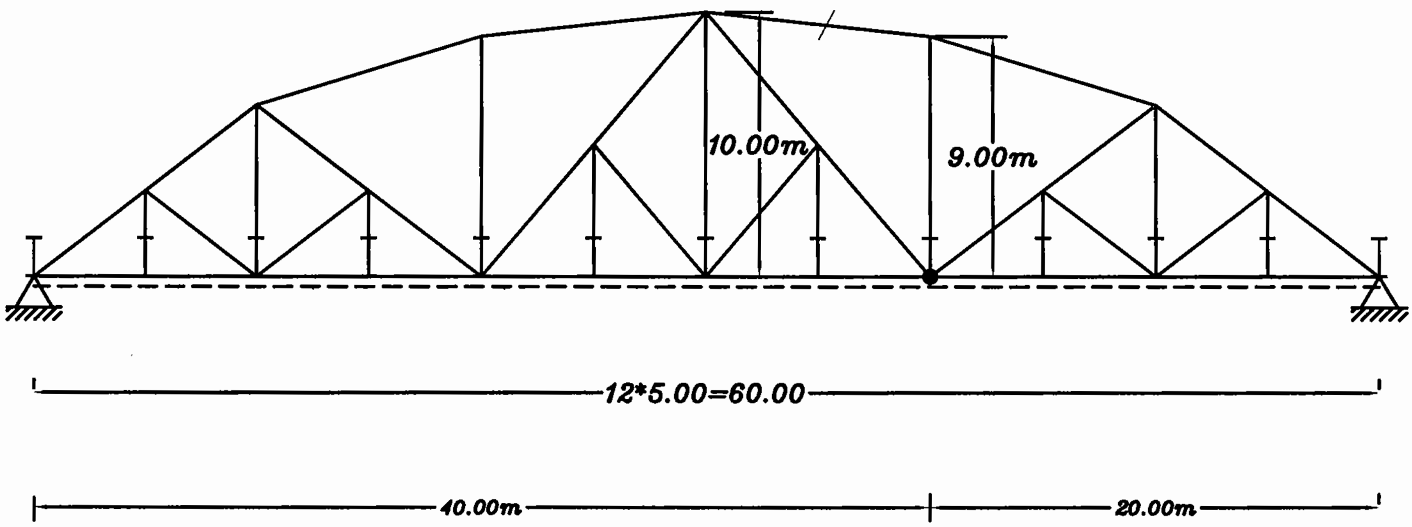
$I = 0.15$

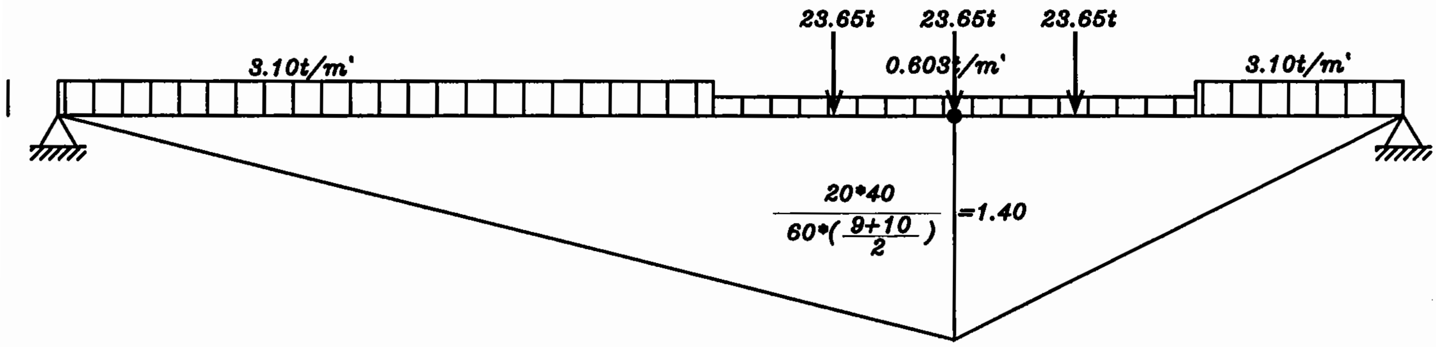
$10(1+I) = 11.5t$, $0.5(1+I) = 0.575t/m^2$

$R_1 = \boxed{23.65t}$

$W_1 = \boxed{.603t/m}$

$W_2 = \boxed{3.10t/m}$

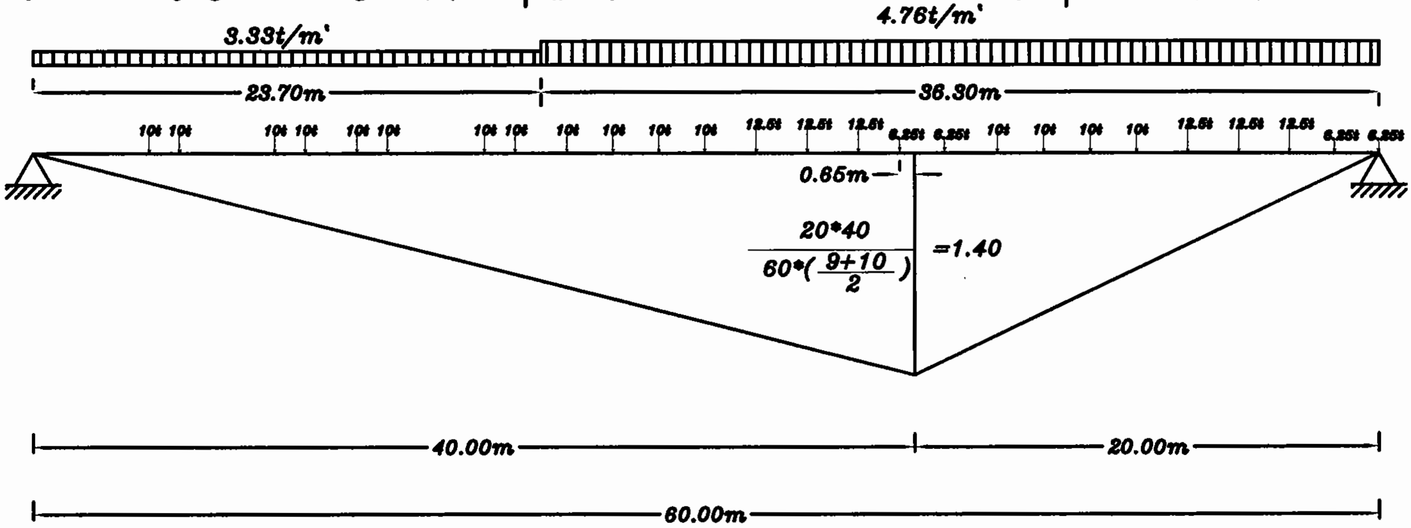




$$F_{\underset{Road}{LL+I}}=23.65*(1.4+1.295+1.347)+0.603*(1.295+1.347)+3.1*17*0.595$$
$$+3.1*37*0.64 \; = \boxed{206t}$$

For rail way part

طريقه تقريبيه باستخدام ال *distributed load* ولا يتم كتابتها فى الامتحان وذلك للسرعه



$$F_{LL_{Rail}} = 2*6.25*0.06+3*12.5*0.385+4*10*0.924+6.25*1.32+6.25*1.37$$
$$+3*12.5*1.246+4*10*0.976+4*10*0.619+4*10*0.199 = \boxed{187.44t}$$

طريقه تقريبيه باستخدام ال *distributed load* ولا يتم كتابتها فى الامتحان وذلك للسرعه

$$F_{LL_{Rail}} = 4.76*20*0.70+4.76*16.30*1.11+3.33*23.70*0.414 = \boxed{185.43t}$$

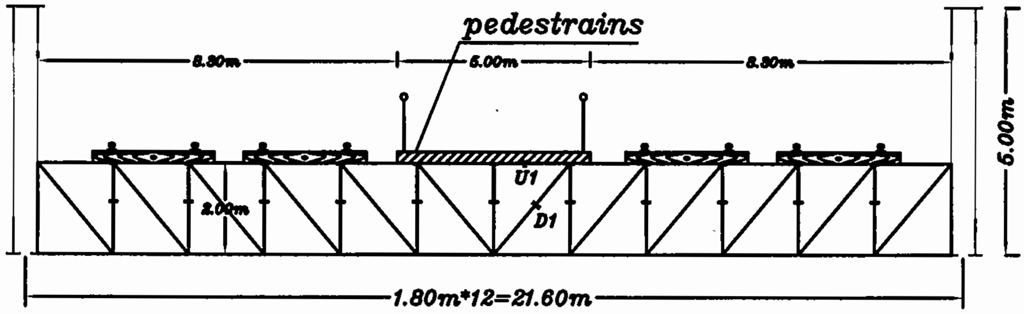
$$F_{LL+I_{Rail}} = 187.44*2*0.9*1.25 = \boxed{421.74t}$$

$$F_{LL+I_{Rail+Road}} = 421.74t+206t = \boxed{-627.74t\ Comp.}$$

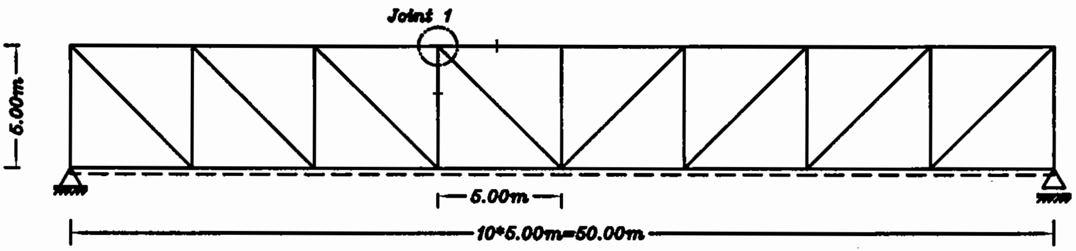
Example 11

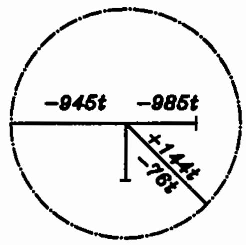
Mid. term Revision

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 it is required to:



Cross Section





Joint 1

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

Main Truss

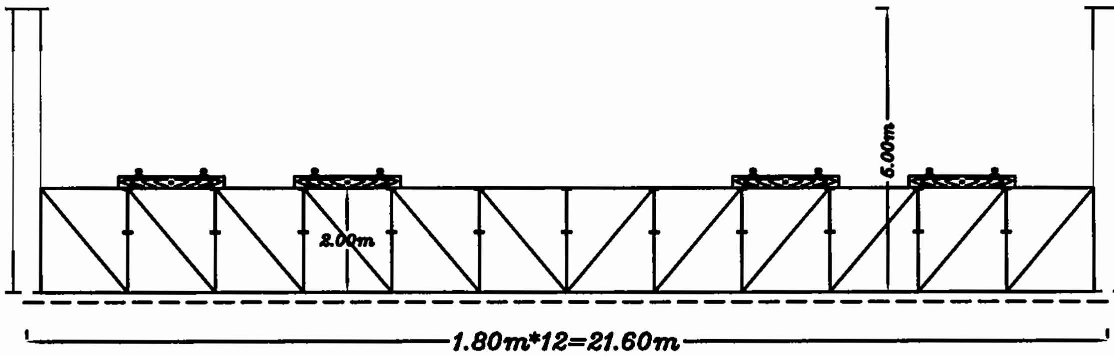
1–for the above mentioned bridge draw to scale 1:100 Complete General lay out.

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

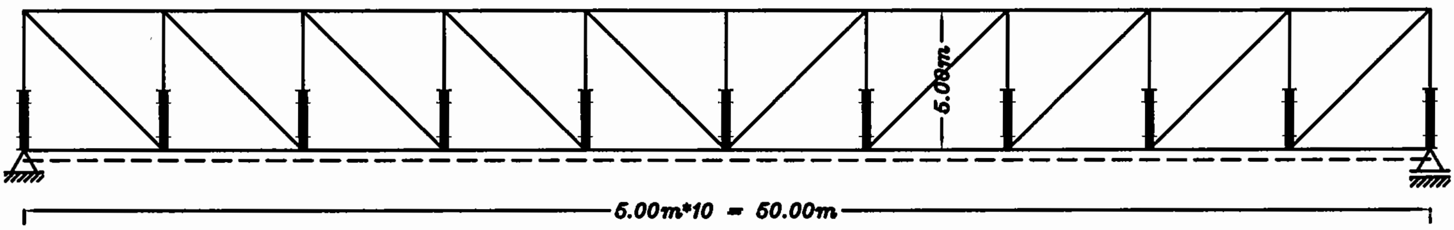
3–Calculate max. and min. force due to LL+I Only for D1 (x.g).

the live load on roadway part from pedestrains and it equal $300Kg/m^2$

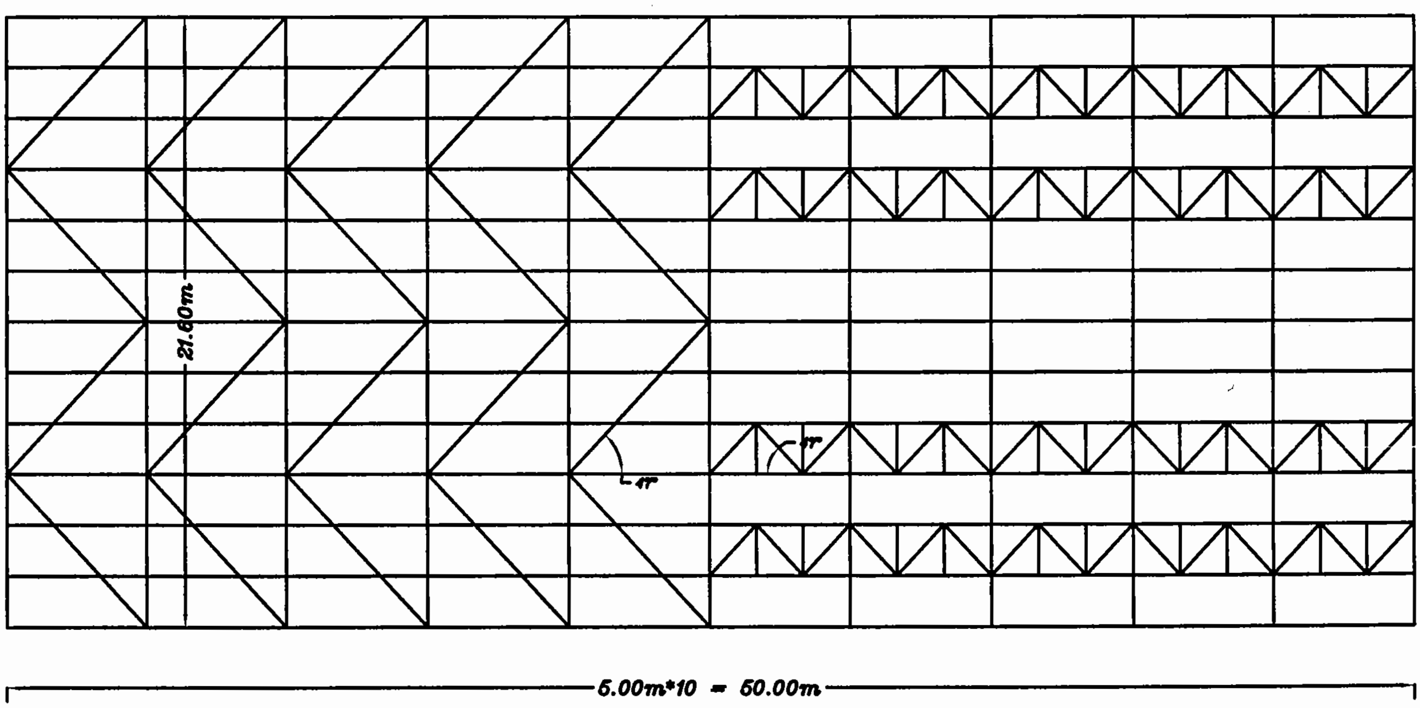
Question 1



Cross Section



Elevation



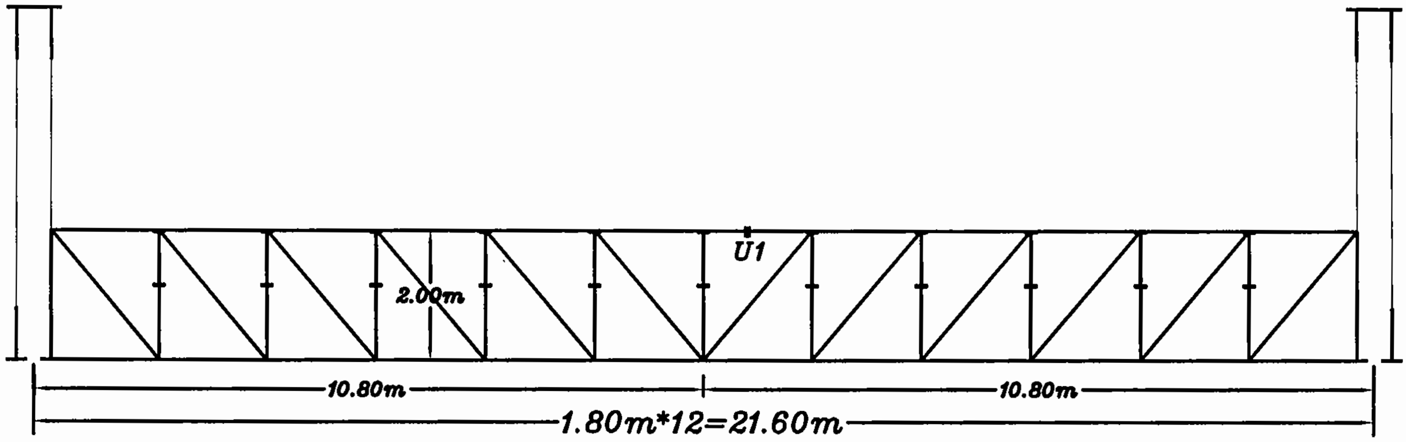
Plan of Lower Bracing

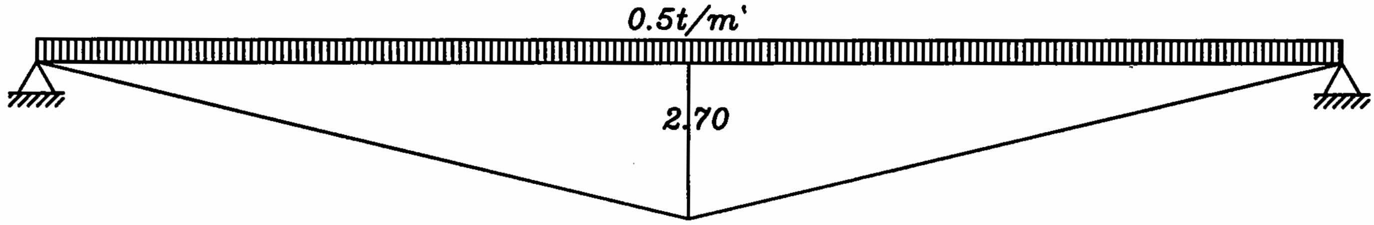
Question 2

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

$W_{Dead} = 600/2 + 40/2 + 0.W = ...Kg/m'$

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

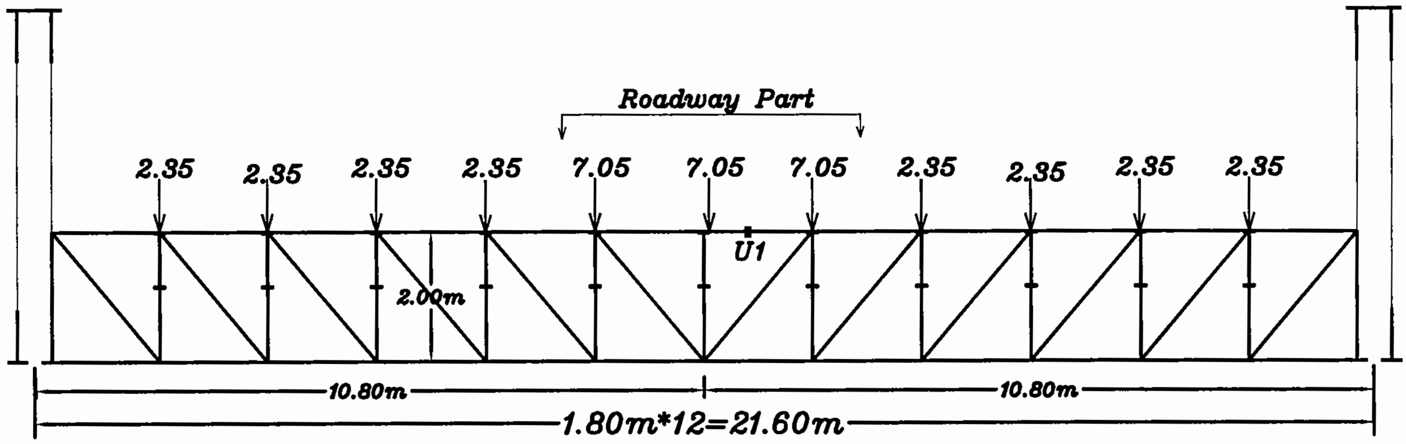
$R_d = W_d *S = 0.47 * 5.00 = \boxed{2.35t}$

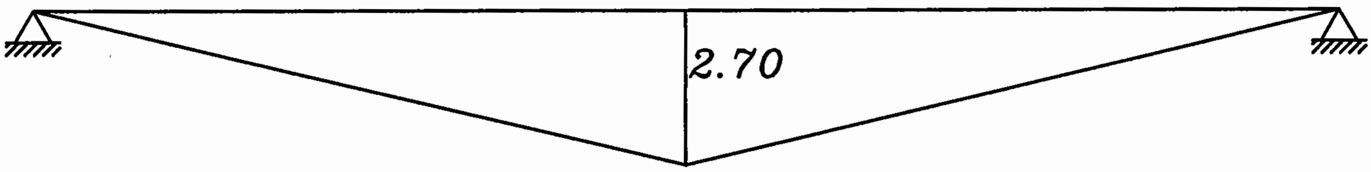
2-ii road way part

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

$W_d = 1.41t\backslash m'$

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





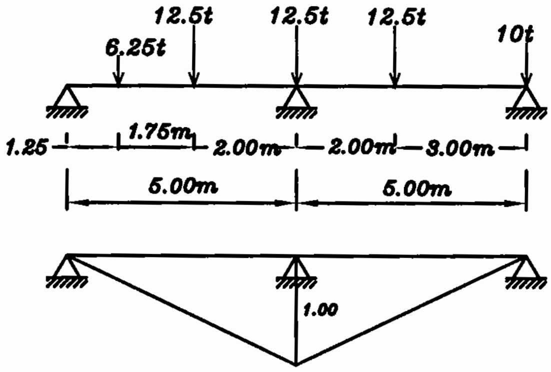
$$F_{D.L} = 4*2.35*2*1.125+2*7.05*2.25+7.05*2.70 = 71.91t$$

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

<u>*upper chord u1*</u>

<u>*Live Load + impact*</u>

<u>*Railway Part*</u>



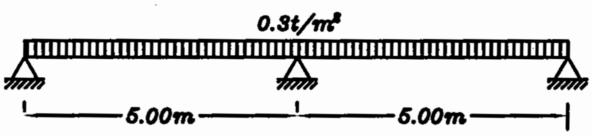
$$\text{Impact Factor} = I = \frac{24}{24+nL} = \frac{24}{24+4*2*5.00} = 0.375$$

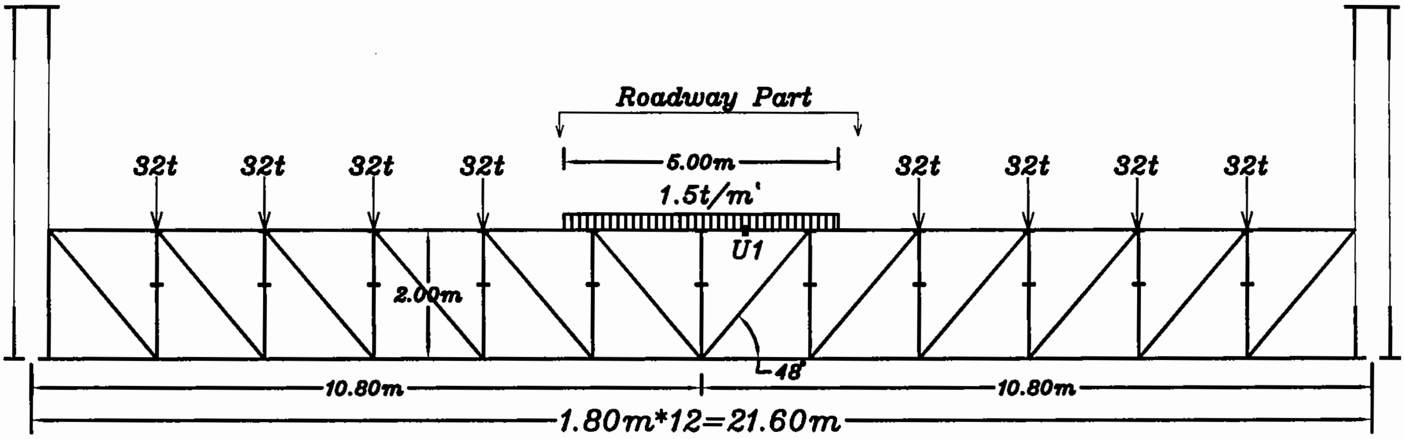
$$R_{LL} = 12.5+2*12.5*0.60+6.25*0.25 = 29.06t$$

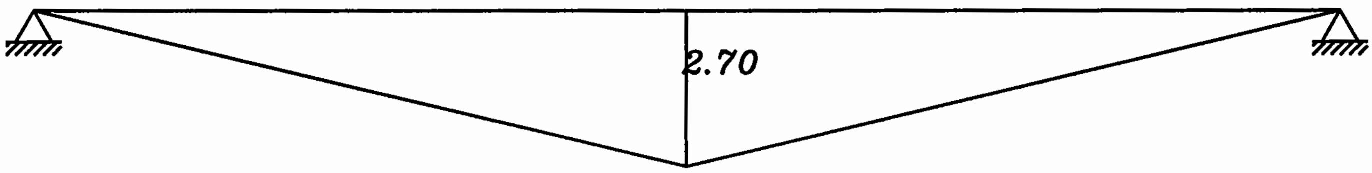
$$R_{LL+I} = 29.06*1.375*0.8 = 32t$$

<u>*Roadway Part*</u>

$$W_{LL} = 0.30*5 = 1.50t/m'$$







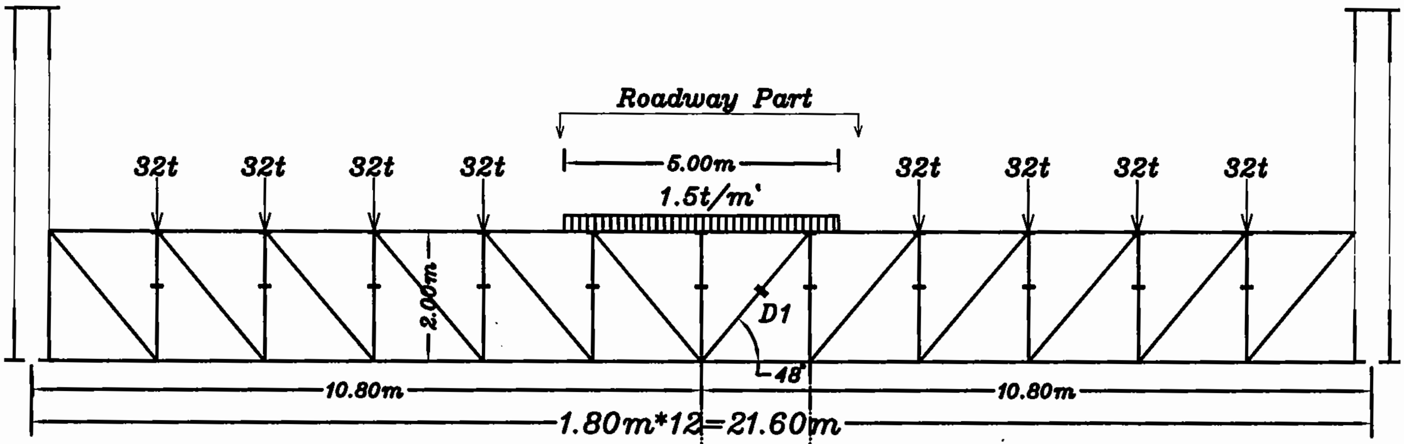
$F_{L.L+I} = 4*32*2*1.125+2*1.5*2.5*2.38 = 305.85t$

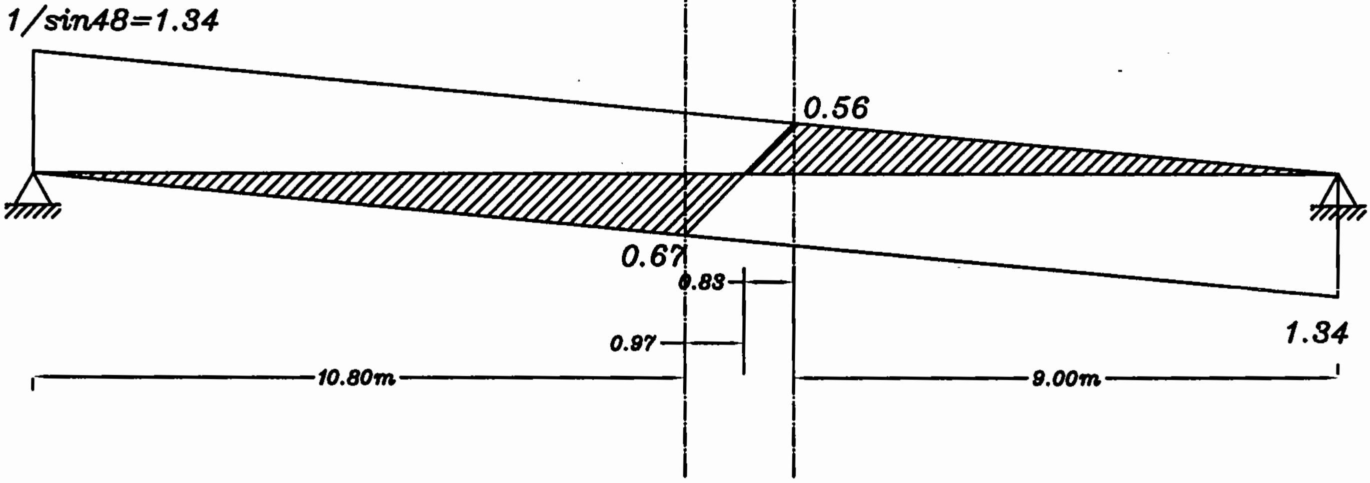
Design Values

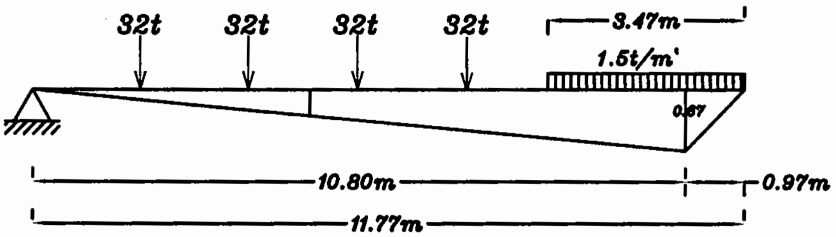
$F_{max.} = 305.85t+86.49 =$ **−392.34t (comp.)**

$F_{min.} =$ **−86.49 (comp.)**

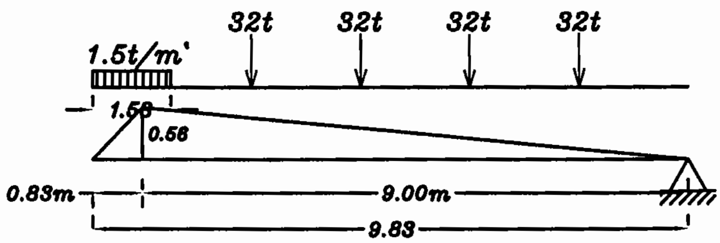
Question 3
Diagonal D2
Live Load + impact







$$F_{L.L+I(tens.)} = 1.5*0.97*0.335+1.5*2.5*0.59+4*32*0.28 = +38.54$$



$$F_{L.L+I(comp.)} = 1.5*0.83*0.28+1.5*0.7*0.54+4*32*0.28 = -36.75$$