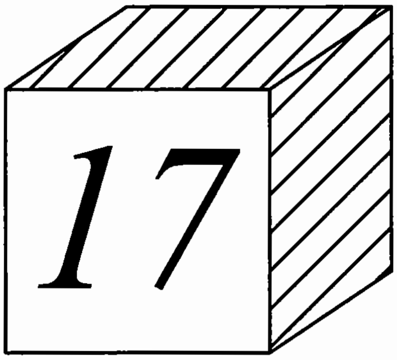
ج
٣,٥٠

مراجعه steel
رابعه إنشاءات
R /٣




# *Mid. Term Revision Summary 2012-2013*

# *Revision Content*

## *Summary For :-*

*1-Genral Lay out (Road+Rail)*

*2-Loads On Stringer (Road+Rail)*

*3-Design of Stringer as Hot Rolled (Road+Rail)*

*4-Loads On Cross girder (Road+Rail)*

*5-Loads On Main girder (Road+Rail)*

*6-Design of Built-Up Section (Road+Rail)*

*7-Lateral torsional buckling of comp. flange*

*8-Curtailment of Flange plate for Main girder*

*9-Check web buckling*

*10-Design of Web Stiffener*

*11-Design of Splices*

*12-General layout of truss bridge*

*13-Maximum forces in truss members*

# Mid term Revision
# 1-General Lay Out

تكون المعلومات المعطاه فى الامتحان لرسم اى Lay Out هى

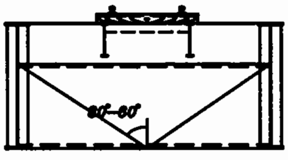
1-Bridge Span "L" طول الكوبرى

2-Bridge Width "B"

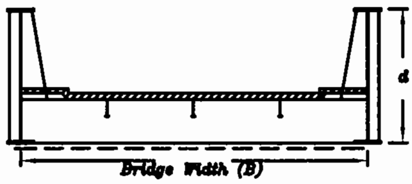
3-Side Walk Length in case of road way bridge

وتكون هذه المعلومات اساسيه ويجب ان تكون معطاه ولرسم اى Lay Out يتم اعطاء معلومه اخرى وتكون واحده من الاتى

## A-Cross Section



Cross section of Rail way bridge




Cross section of Road way bridge

حيث فى هذه الحاله يعطى فى المساله شكل قطاع الكوبرى ومن ثم يتم معرفة نوع الكوبرى اما Deck Or Pony ويتم معرفة هل هناك Cross Girder Cantliver ام لا

ويتم معرفة نوع ال Bracing المستخدم فى ال Cross Section هل سوف يتم استعمال Bracket و Frame "X" or "V"

## B-available height of Construction Ha

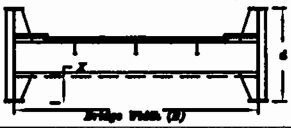
**Road Way**

if
+2 Cm safety
+L/600 deflection
+6 Cm flanges
$\frac{L}{8 \rightarrow 12}$ +30 Cm
< Ha

∴ Use Deck Bridge

if Hc > Ha

∴ Use semi deck bridge




if X > Ha

∴ Use pony bridge

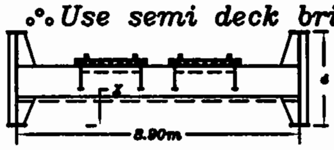
**Rail Way**

if
+2 Cm safety
+L/800 deflection
+6 Cm flanges
$\frac{L}{8 \rightarrow 12}$ +45 Cm
< Ha

∴ Use Deck Bridge

if Hc > Ha

∴ Use semi deck bridge

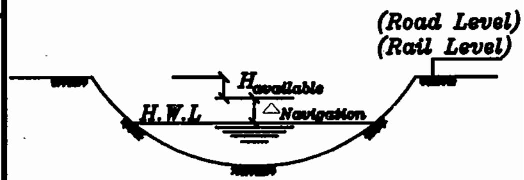



if X > Ha

∴ Use pony bridge

## C-levels to get Ha

فى هذه الحالة لايعطى ال Ha مباشرة ولكن يتم حسابها من خلال القطاع




(Road Level) (Rail Level) ⟶ Given

H.W.L ⟶ Given

△Navigation ⟶ Given

$H_{available}$ ⟶ Required

$H_{available}$ = Road Level − H.W.L − △Navigation

ثم يتم معرفة نوع الكوبرى مثل الحالة الحالة السابقة

## Steps Of Drawing (Lay Out)خطوات رسم ال

يتم بداية رسم ال (Lay Out)برسم القطاع

١-اولا يتم تحديد نوع الكوبرى كما سبق ذكر ذلك

٢-يتم حساب ارتفاعات ال M.G وال X.G وال Stringer

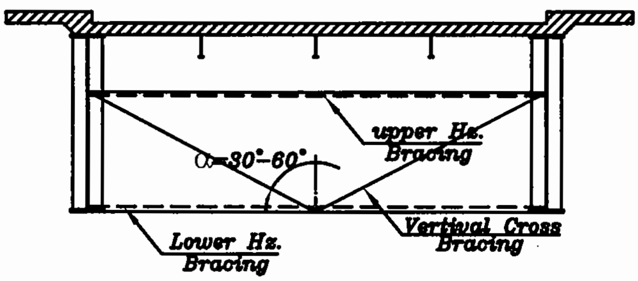
$$d_{X.G}=\frac{B}{7\longrightarrow 9} \qquad d_{Stringer}=\frac{S}{10} \qquad d_{M.G}=\frac{L}{8\longrightarrow 12}$$

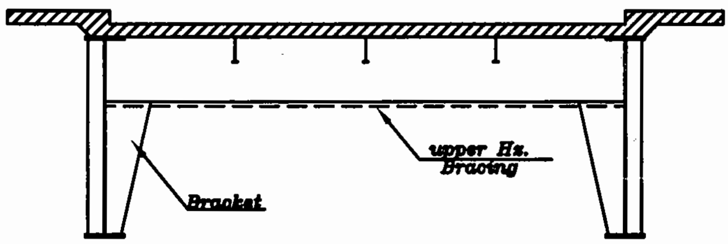
٣-يتم تحديد نوع ال Wind Bracing على الكوبرى

يتم استخدام V-Bracing اولا واذا لم تكن الزاويه ما بين 30°-60°

يتم استخدام Bracket

غالبا ما يتم عمل Bracket ما لم يذكر خلاف ذلك فى المساله




$$\alpha=\frac{h_{M.G}-h_{X.G}}{B/2}= \text{From } 30^\circ \text{ to } 60^\circ$$

لاحظ انه فى حالة الPony Bridge لا يتم استعمال الا Bracket

٤-يتم رسم الPlan بعد ذلك وحساب المسافات بين ال Cross Girder

بحيث تؤدى الى عدد مسافات زوجى

$$n=\frac{L}{4\longrightarrow 6}=\text{no. of spacing between X.G}$$

٥-يتم حساب المسافات بين ال Stringers ولايهم ان تكون عدد المسافات زوجى اوفردى

$$n=\frac{B}{1.75\longrightarrow 2.25}=\text{no. of spacing between stringers}$$

خلى بالك

فى حالة رسم ال *Cross Section* لا تنسى الخط ال *Dashed*
الذى يتم رسمه تحت ال *X.G* والذى يعبر عن ال *Wind Bracing*

فى حالة ال *Road Way* لو كان طول ال *Side Walk* اكبر من واحد متر
يتم عمل *Cross Girder Cantliver* لكى يحمل ال *Side Walk*

عند رسم ال *Plans* فى حالة الكوبرى ال *Deck*

*For Deck Bridge* → *Using X–Frame 2Plans*
*For Deck Bridge* → *Using Bracket 1Plan*

*For Pony Bridge* → *Using Bracket and always use 1plan*

٦-يتم رسم ال *Elevation For M.G* وهو عباره عن مستطيل طوله هو
طول الكوبرى وارتفاعه هو ارتفاع ال *M.G* ثم يتم رسم ال *End Bracket*
بعد ال *Supports 2* من ٣٠ الى ٥٠ سم
ثم يتم بعدها رسم ال *Stiffners*

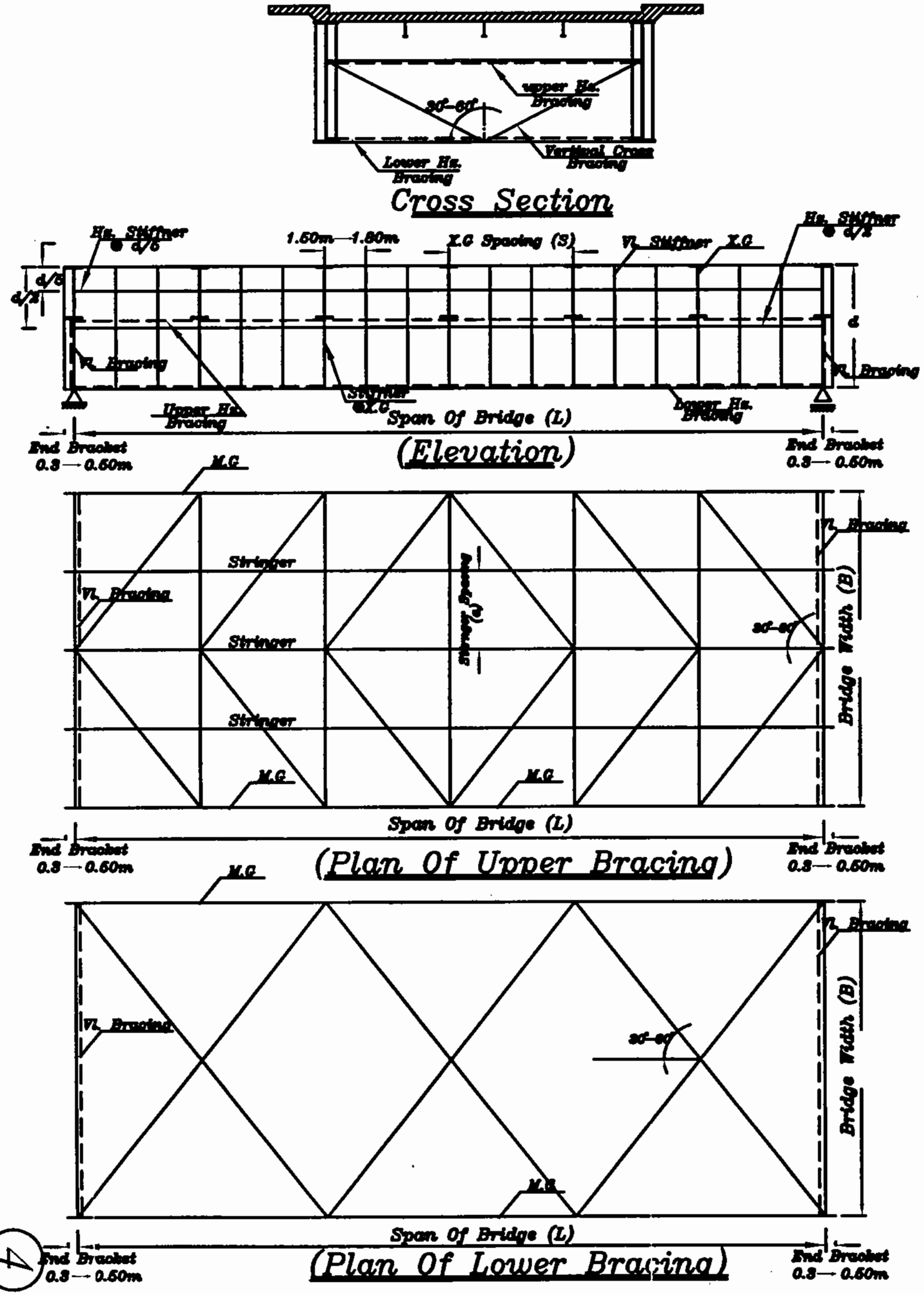
$h_{M.G} \not> 1$ → *no Stiff.*

$h_{M.G}$ *From(1m to 2m) Use Vl Stiff. Only each from 1.5m to 1.8m*

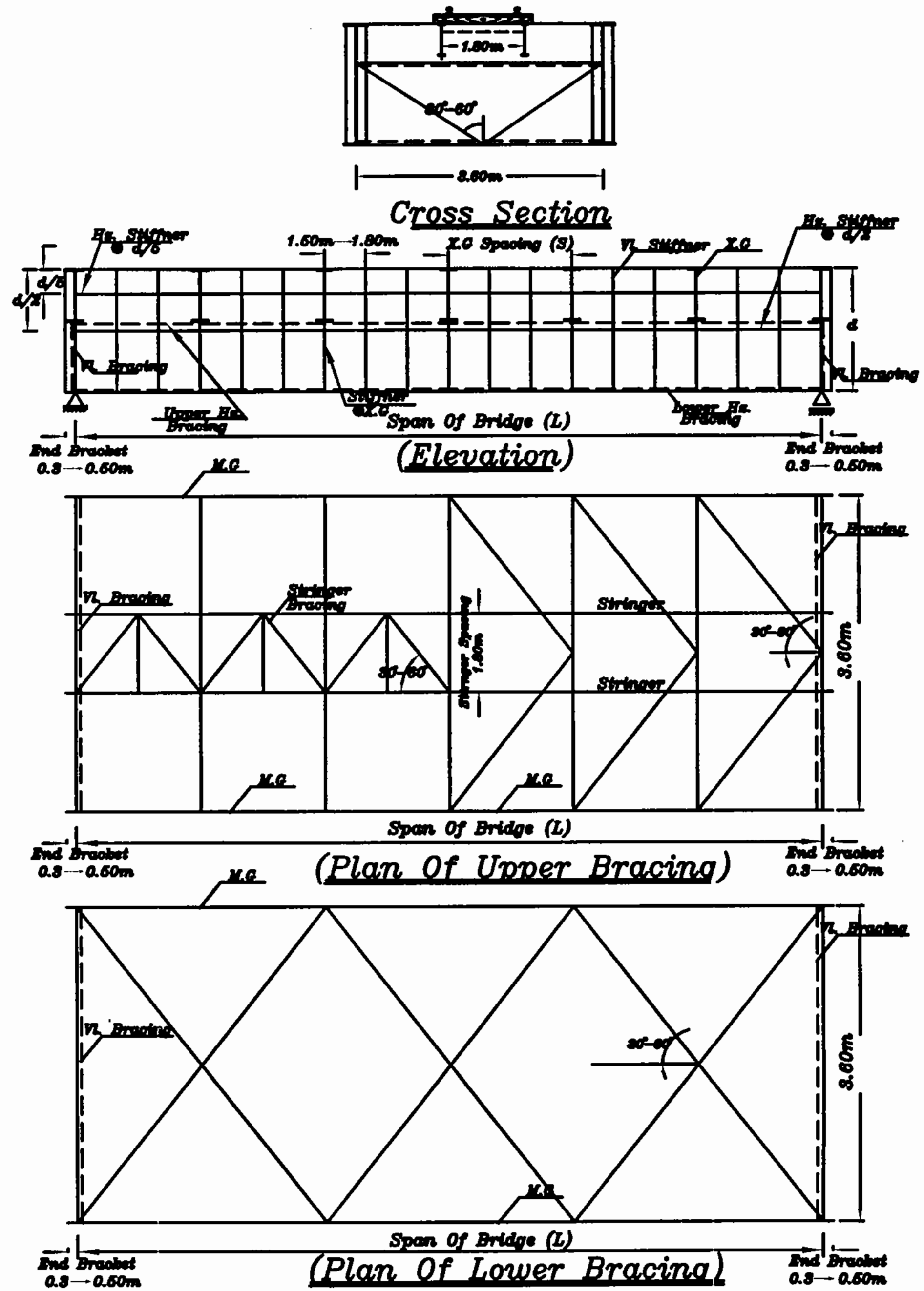
$h_{M.G}$ *From(2m to 2.8m) Use Vl Stiff. & One Hz. Stiff @ H/5 From Comp. Flange*

$h_{M.G} > 2.8m$ *Use Vl. Stiff. and two Hz. Stiff. One @ H/5 From Comp. Flange and the other @ H/2*

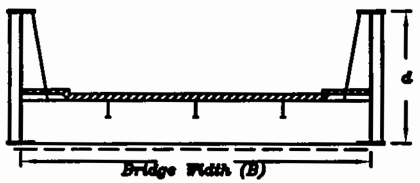
## Plate Girder Deck Bridge Road Way With Vertical Bracing



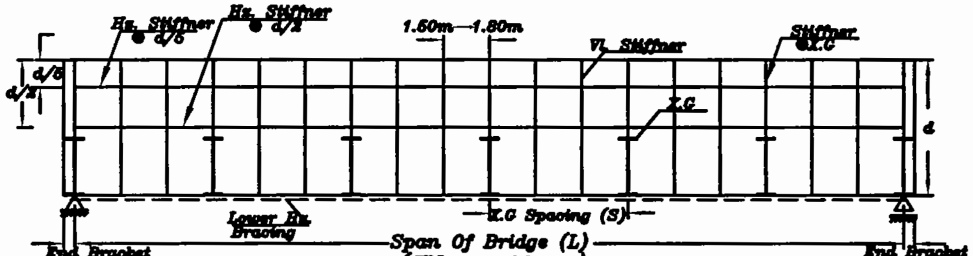

## Plate Girder Deck Bridge Rail Way With Vertical Bracing (Single Track)



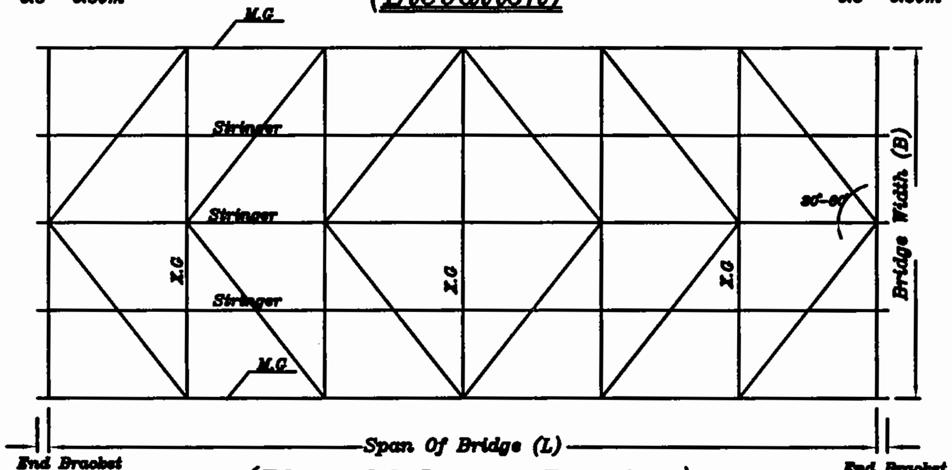
## Plate Girder Road Way Pony Bridge




Cross Section

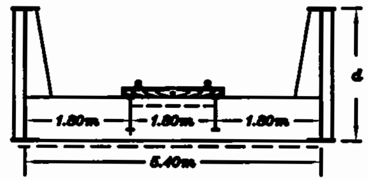



(Elevation)

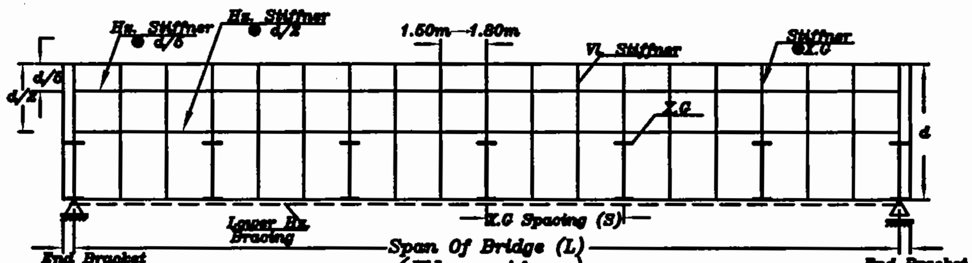



(Plan Of Lower Bracing)

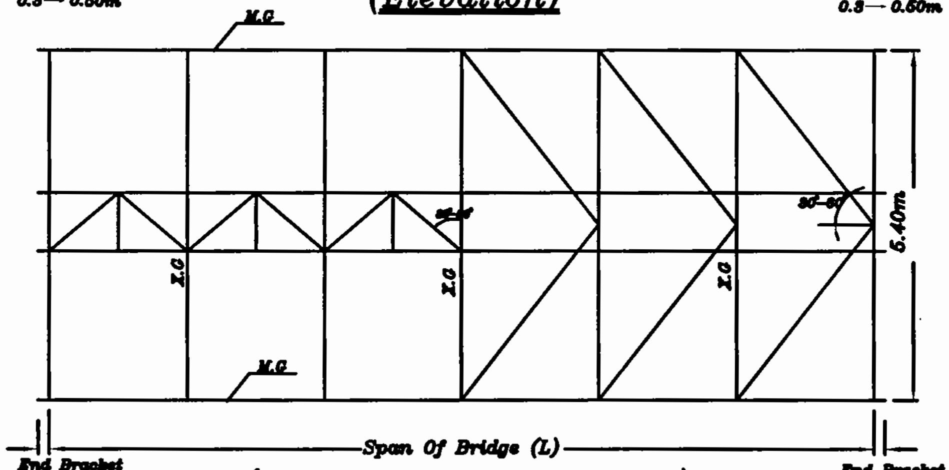
## Plate Girder Rail Way Pony Bridge Single track




Cross Section

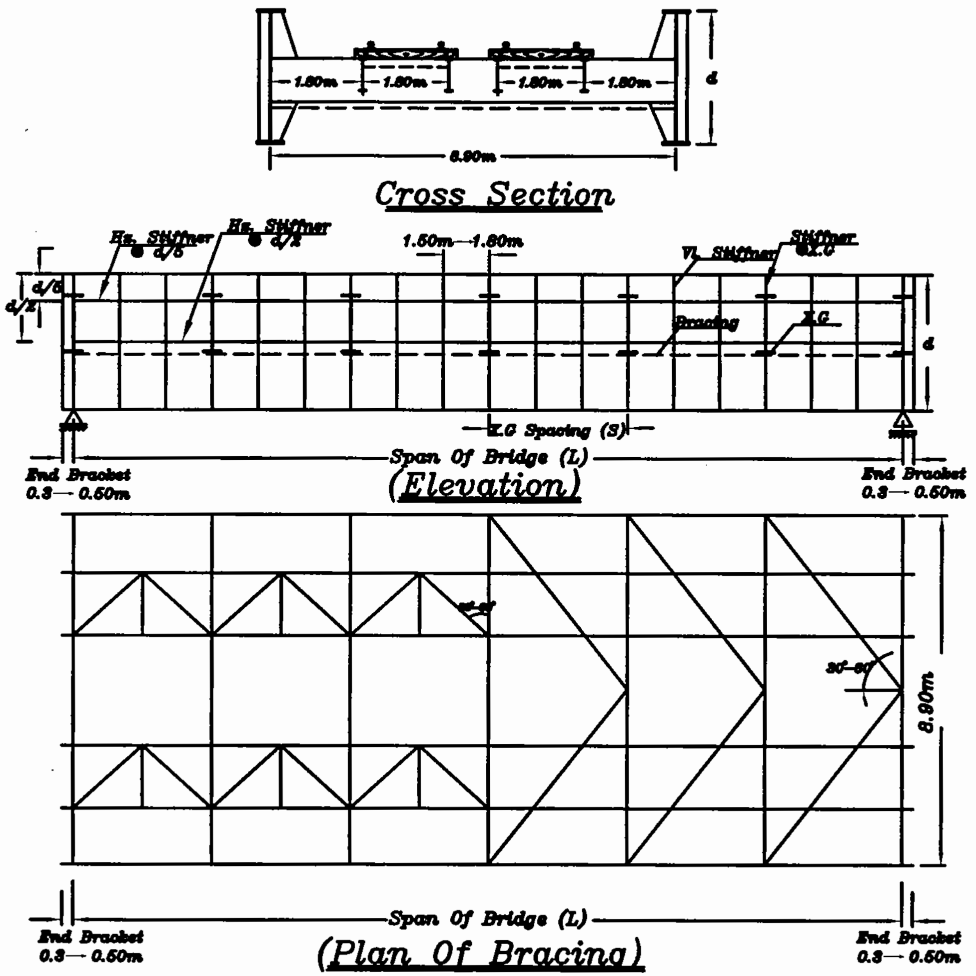



(Elevation)

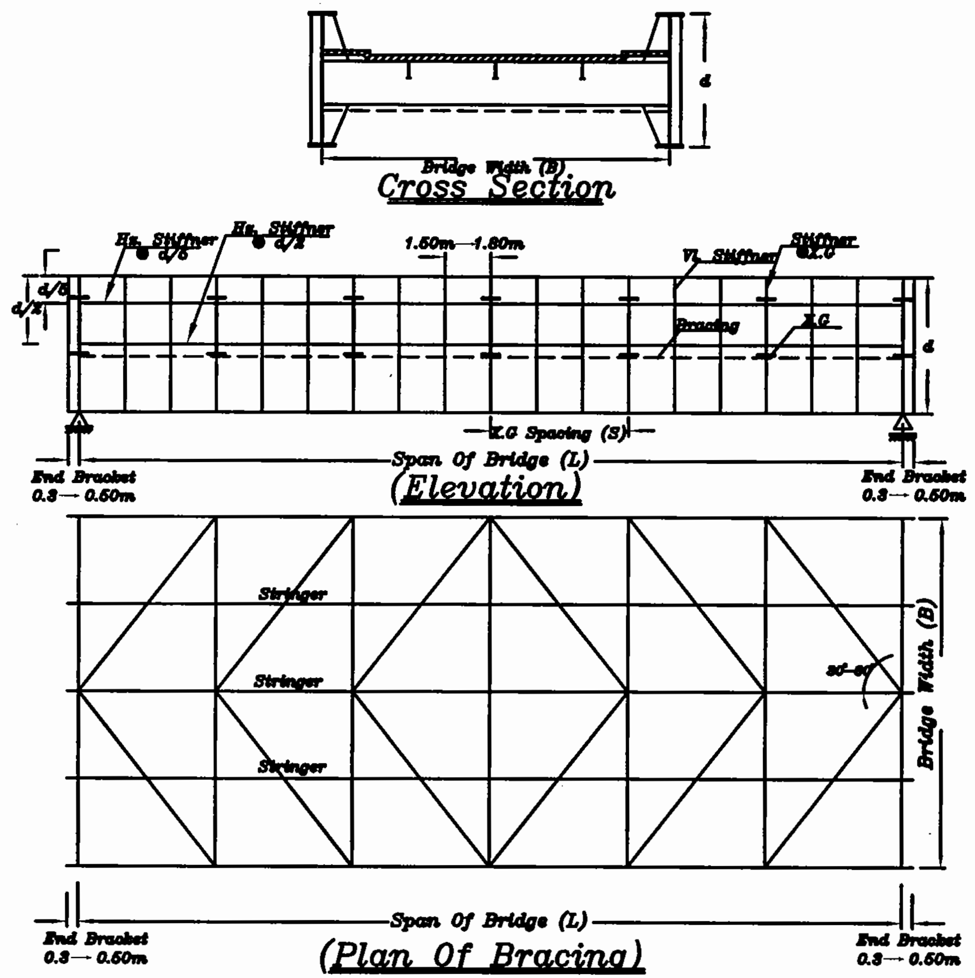



(Plan Of Lower Bracing)

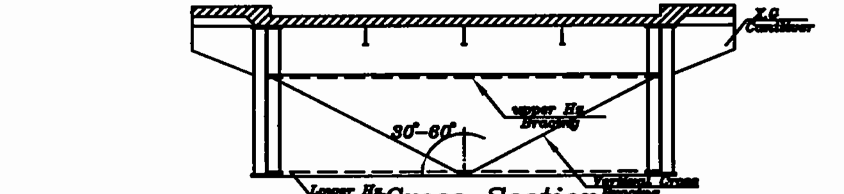
## Plate Girder Rail Way Semi-Deck Bridge With U-Frame (Double track)



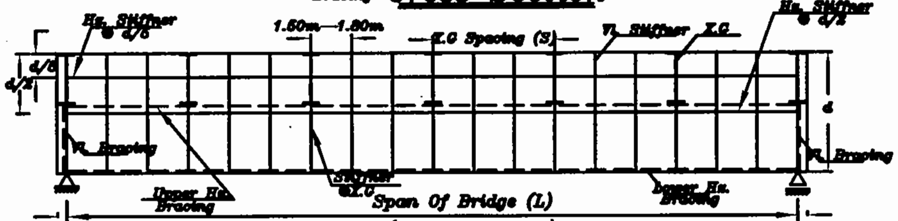

## Plate Girder Road Way Semi-Deck Bridge With U-Frame



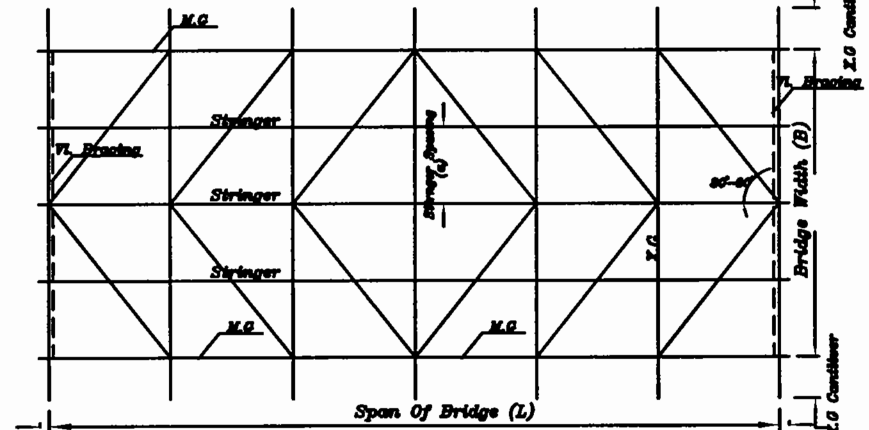
## Plate Girder Deck Bridge Road Way With Vertical Bracing and Double Cantliver X.G



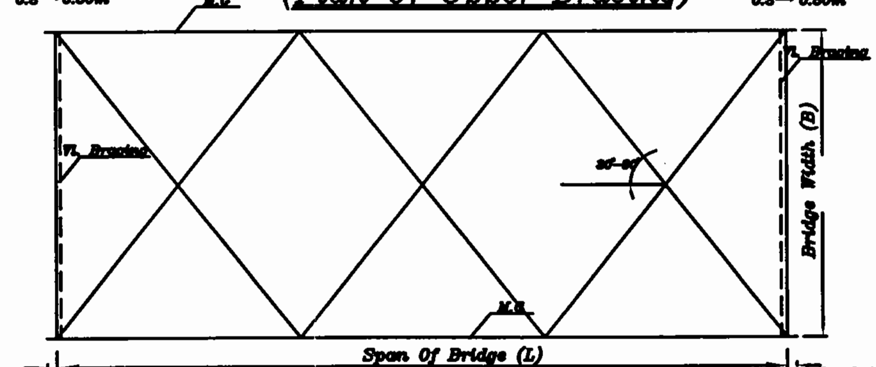

Cross Section




(Elevation)

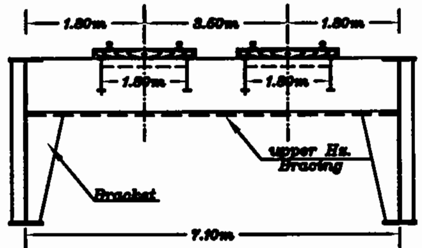



(Plan Of Upper Bracing)

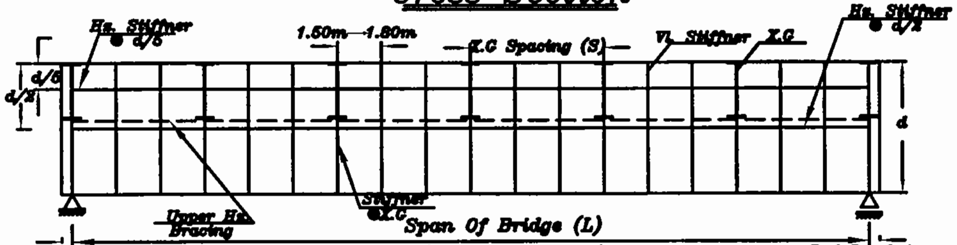



(Plan Of Lower Bracing)

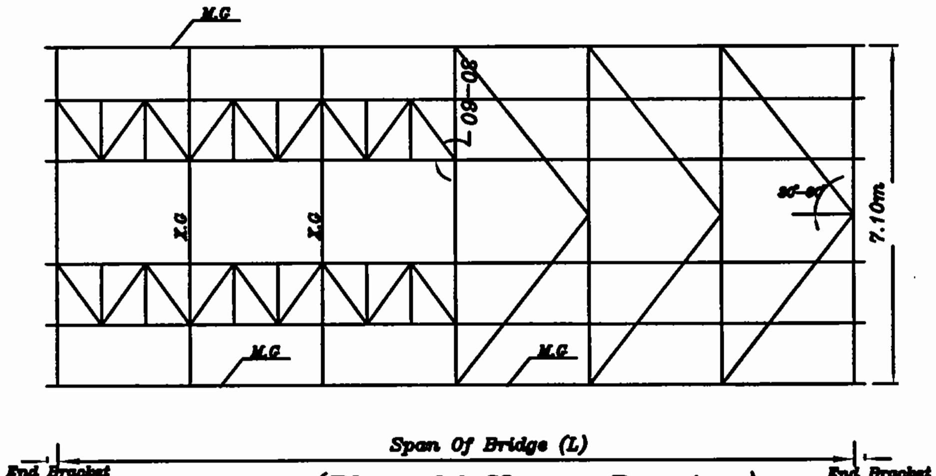
## Plate Girder Deck Bridge Rail Way With U-Frame (Double track)




Cross Section

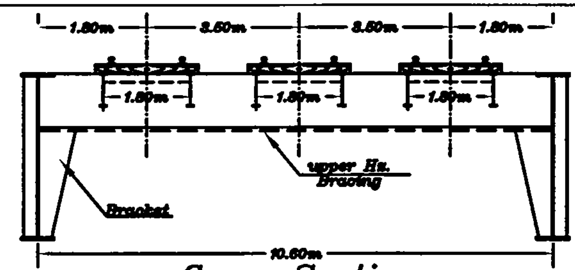



(Elevation)

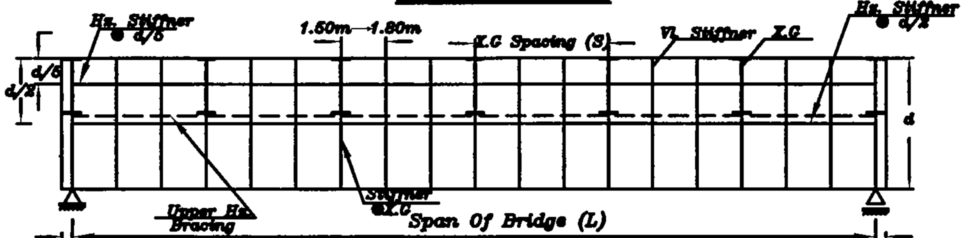



(Plan Of Upper Bracing)

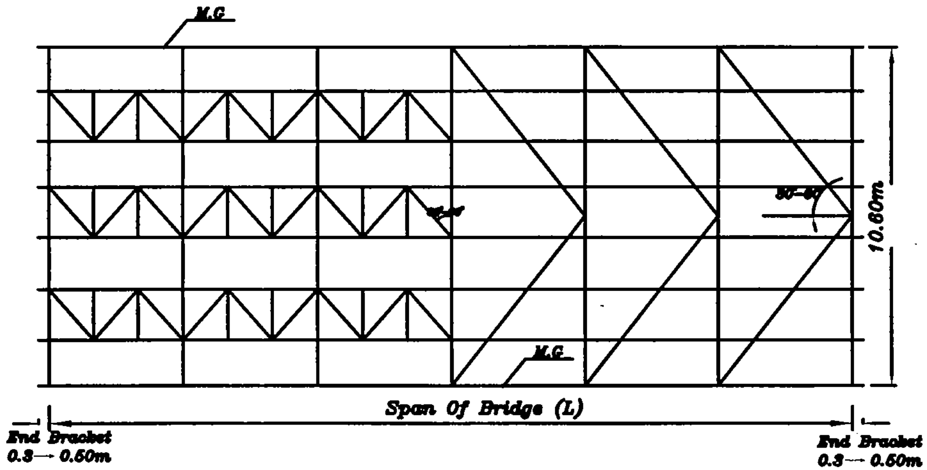
## Plate Girder Deck Bridge Rail Way With U-Frame. (triple track)




Cross Section

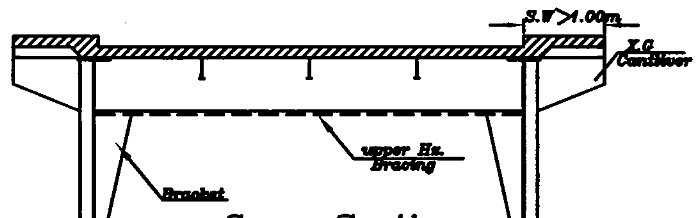



(Elevation)

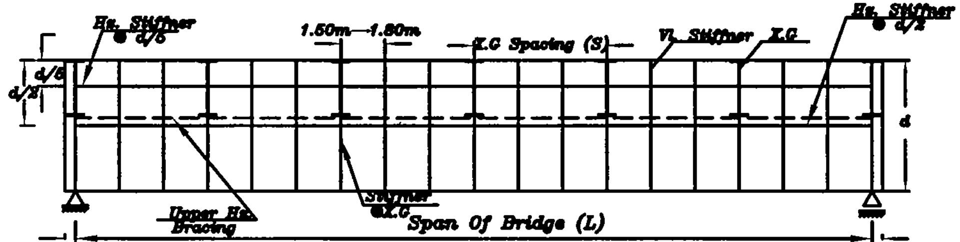



(Plan Of Upper Bracing)

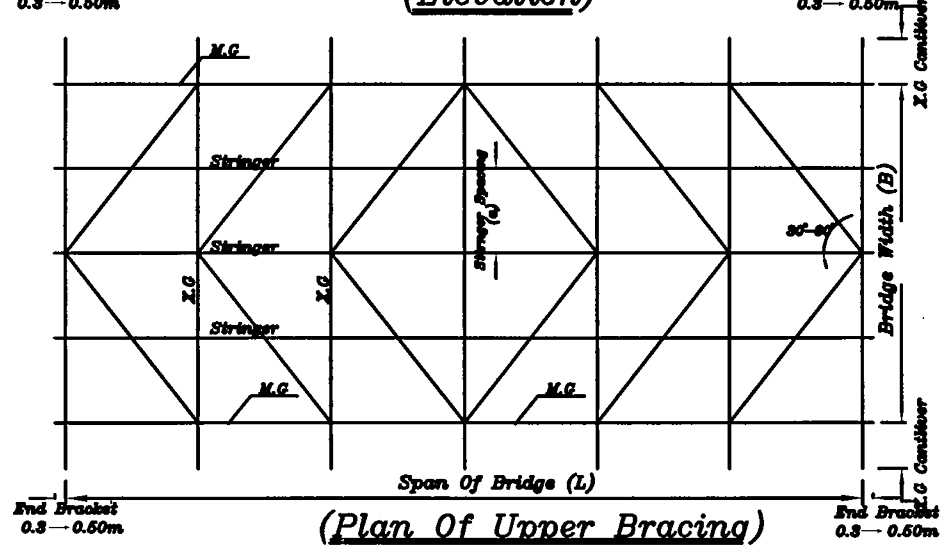
## Plate Girder Deck Bridge Road Way With U-Frame and Double Cantliver X.G




Cross Section




(Elevation)




(Plan Of Upper Bracing)

# 2-Loads On Stringer

# 2-a-Road Way Bridge

## 1) Dead Loads

$W_{Dead} = (t_S * \gamma_c + F.C) * \text{stringer Spacing} + O.W$

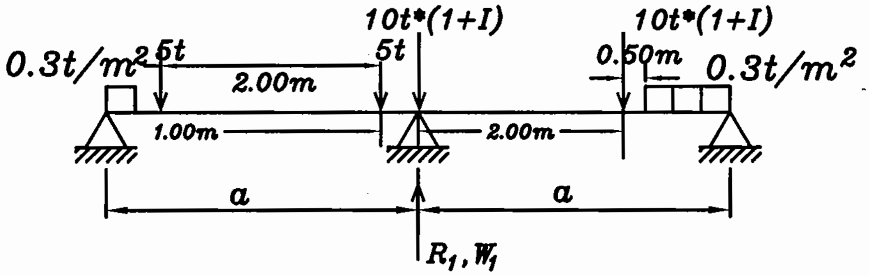
$W_{Dead} = (0.21m * 2.5t/m^3 + 0.175t/m^2) * a + 0.15t/m' = .......t/m'$

$M_d = \frac{W_d * S^2}{8} = ....\ m.t$ $\qquad Q_d = \frac{W_d * S}{2} = ....t$

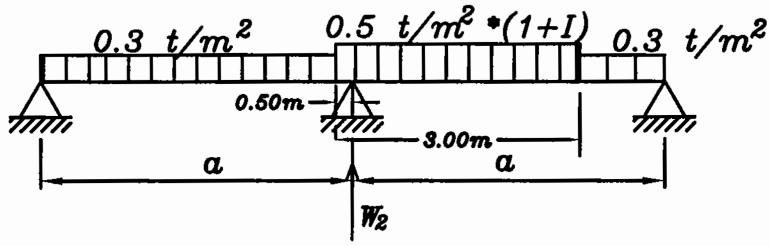
## 2) Live Loads + Impact

$I = 0.4 - 0.008L$ Where $L = S =$ Stringer Span

دائما يكون هناك شريحتان فقط الاولى داخل العربه ال ٦٠ وال ٣٠ طن والثانيه خارج العربه فى ال $0.3\ t/m^2$ , $0.5\ t/m^2$



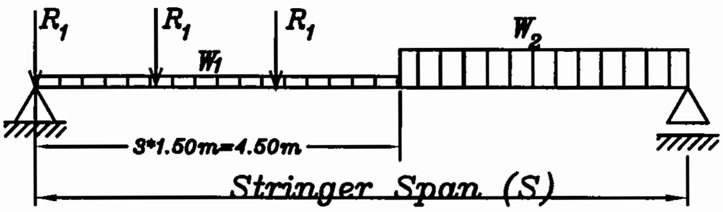

Strip 1



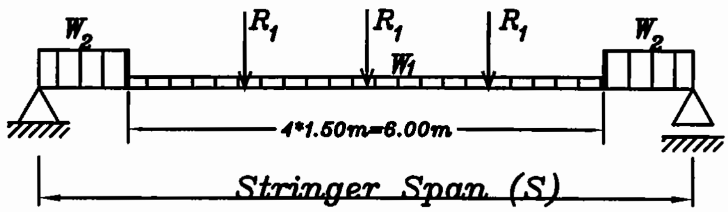

Strip 2

فى حالة ظهور $0.3\ t/m^2$ فى Strip1 يتم وضع W1 امام ال R بطول ٦م فى حالة الB.M.D وامام ال R بطول ٤٫٥م فى حالة ال Shear ولا يعتمد $W_1$ ابدا على طول ال Stringer بل يعتمد على a (If a > 2.5)

اما Strip2 يتم الحصول منها على $W_2$ ويعتمد $W_2$ على طول ال Stringer ويظهر $W_2$ فى حالة ان طول الStringer اكبر من ٦م فى حالة ال B.M.D ويظهر $W_2$ فى حالة ال Shear فى حالة ان طول الStringer اكبر من ٤٫٥م




## Max. S.F.D



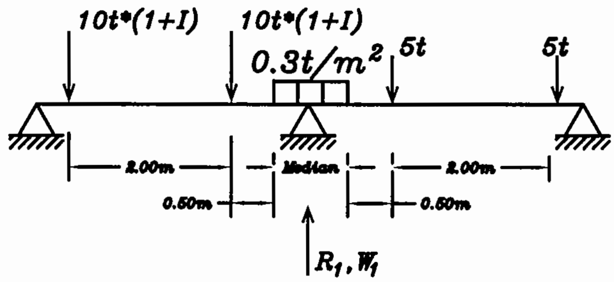

## Max. B.M.D

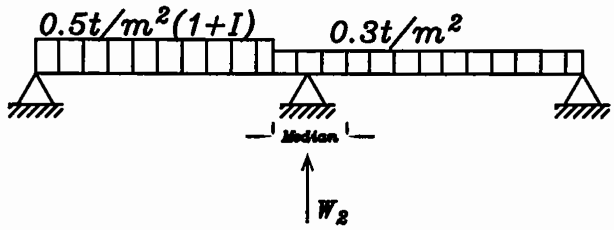
اذا كان بحر ال Stringer اقل من ٤٫٥ م لاتظهر الشريحه الثانيه

## in Case of Median

### Lane ≯ 6.00m

يتم وضع العربتان ال ٦٠ و ٣٠ طن يمين وشمال الجزيرة

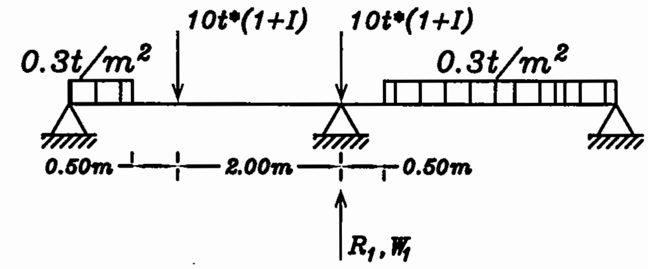


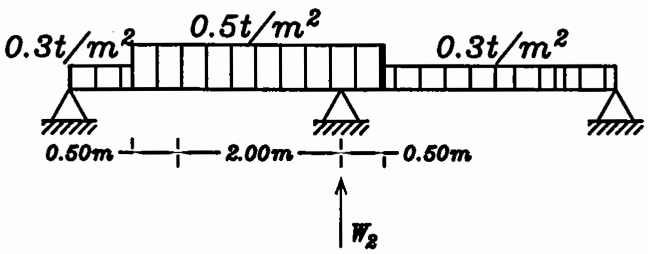




**OR**

**this is the critical case**

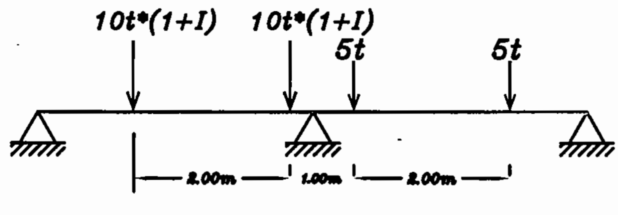
يتم وضع العربه ال ٦٠طن فقط فى الحارة الواحده

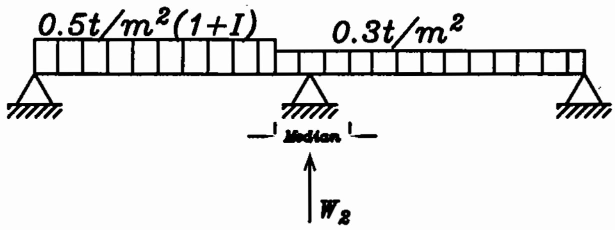


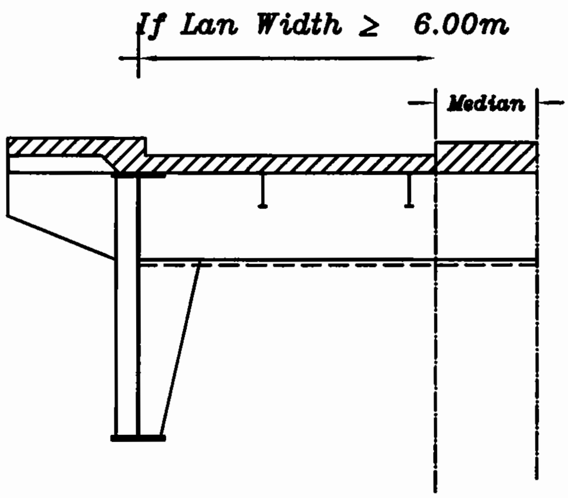




### Lane > 6.00m

يتم وضع العربتان ال ٦٠ و ٣٠ طن فى حارة واحده



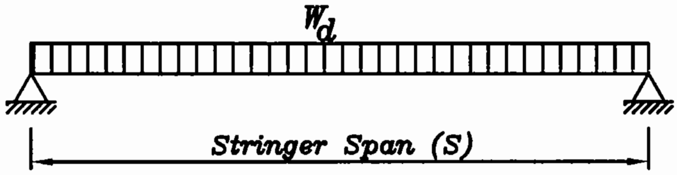



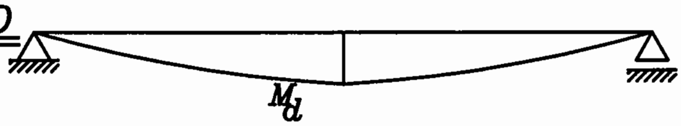
# 2-Loads On Stringer

## 2-b-Rail Way Bridge

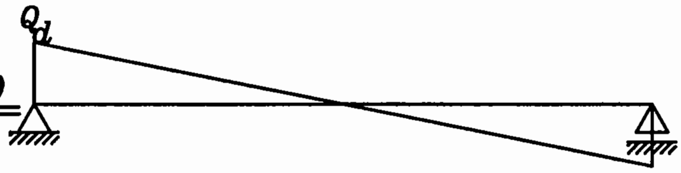
$W_{Dead} = 600/2 + 50/2 + O.W = .........Kg/m'$




$$M_d = \frac{W_d * S^2}{8} = .... \ m.t$$



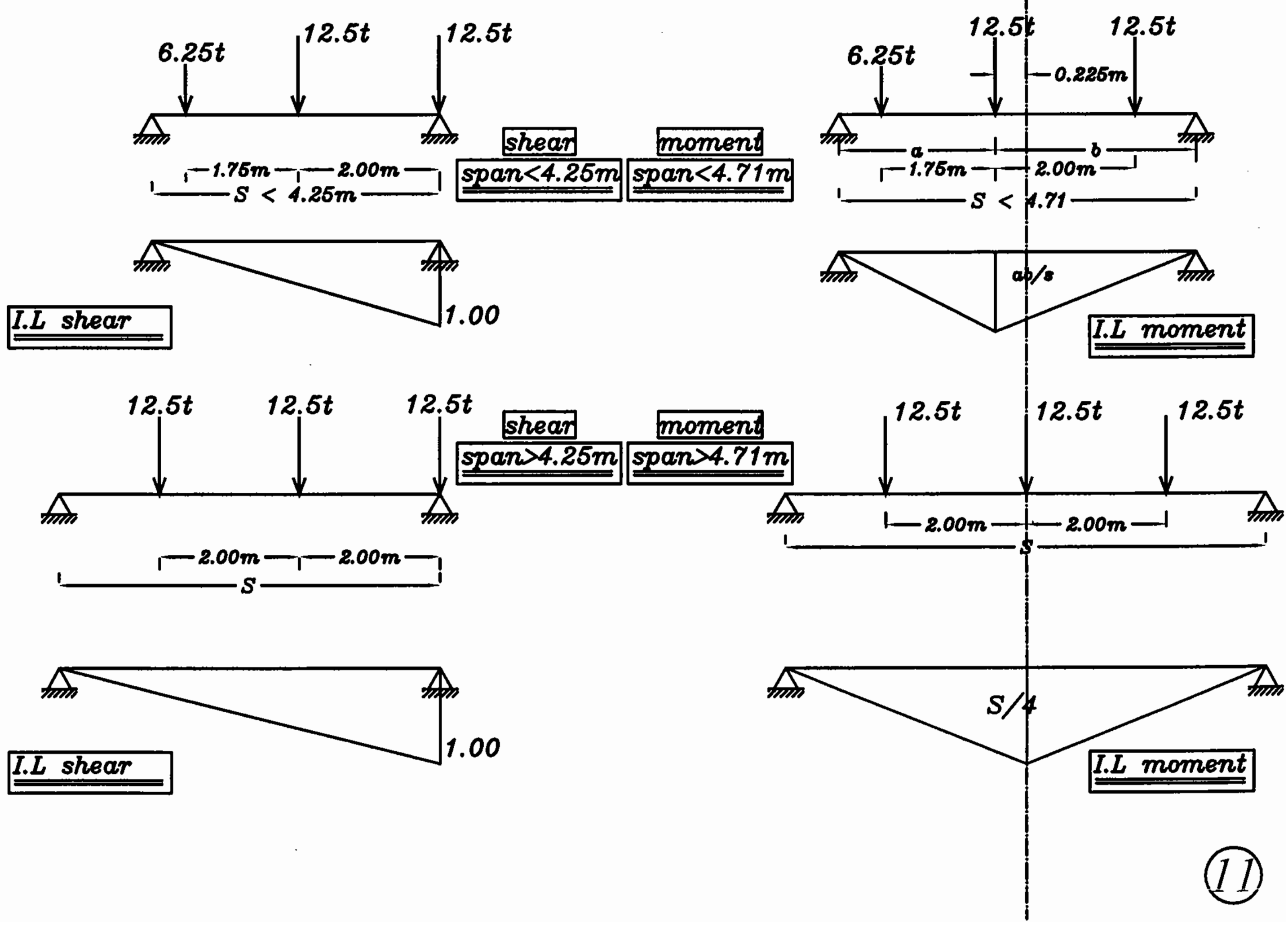

$$Q_d = \frac{W_d * S}{2} = \ ....t$$




## 1) Live Loads

$$Impact\ Factor = I = \frac{24}{24+L} = ............... < 0.75 \ , > 0.25$$

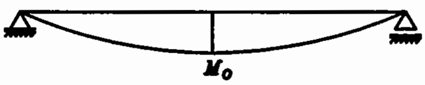
**Max. Shear** — **Max. Moment**



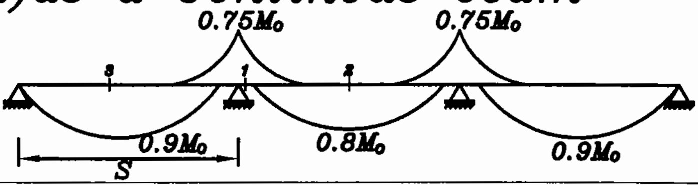
# 3-Design Of Stringer as Hot Rolled
## 3-a-Road way Bridge

### Steps

**i) as a simple beam**




**i) as a Continous beam**




### A-Choice Of Section

**Simple beam:**

assume Compact Sec.

$\therefore F_t = 0.64F_y$ → $2.8 t/Cm^2$ St.44 ; → $3.6 t/Cm^2$ St.52

2) Calculate $F_{Max.}$

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

$S_x = \frac{M_{d+LL+I}}{F_{Max.}}$ → I.P.E, I.P.N, H.E.B

**Continuous beam:**

$$\text{Sec1: } F_{Max.} = \frac{F_{Sr} = 1.26 t/Cm^2}{\left(1 - \frac{M_d}{M_d + 0.6 M_{LL+I}}\right)}$$

$$S_{x1} = \frac{0.75 M_{d+LL+I} * 100}{F_{Max.}} = Cm^3$$

$$\text{Sec2: } F_{Max.} = \frac{F_{Sr} = 1.68 t/Cm^2}{\left(1 - \frac{M_d}{M_d + 0.6 M_{LL+I}}\right)}$$

$$S_{x2} = \frac{0.80 M_{d+LL+I} * 100}{F_{Max.}} = Cm^3$$

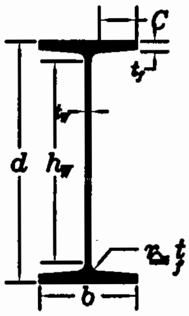
take the bigger Sec.

### B-Compactness

Section is Compact if

$\frac{C}{t_f} < \frac{16.9}{\sqrt{F_y}}$ $\quad C = b/2 - t_w/2 - r$

$\frac{h_w}{t_w} < \frac{127}{\sqrt{F_y}}$ $\quad h_w = d - 2t_f - 2r$




### C-bending

**Simple beam:**

$F_b = \frac{M_{d+l+I} * 100}{S_x} = ..... t/Cm^2 \leq 0.64 F_y$

**Continuous beam:**

Sec. 3

$F_b = \frac{0.9 M_{d+l+I} * 100}{S_x} = .....\ t/Cm^2 \leq 0.64 F_y$

### d-stress range

**Simple beam:**

$\frac{0.6 M_{LL+I} * 100}{S_x} = ..t/Cm^2 \leq F_{Sr} = 1.68 t/Cm^2$

**Continuous beam:**

Sec. 1

$\frac{0.6 * 0.75 M_{LL+I} * 100}{S_x} = ..t/Cm^2 \leq F_{Sr} = 1.26 t/Cm^2$

Sec. 3

$\frac{0.6 * 0.90 M_{LL+I} * 100}{S_x} = ..t/Cm^2 \leq F_{Sr} = 1.68 t/Cm^2$

### e-Shear

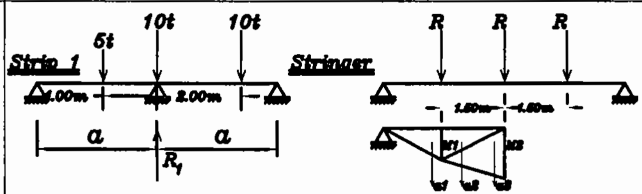
**Simple beam:**

$\frac{Q_{d+l+I}}{d_w * t_w} = .....\ t/Cm^2 \leq 0.35 F_y$

**Continuous beam:**

$\frac{1.1 Q_{d+l+I}}{d_w * t_w} = .....\ t/Cm^2 \leq 0.35 F_y$

### F-Deflection




$M_s = \{a * S/2 - [a_3 * 0.5 + a_2 * 1 + a_1 * (1.5 + (S/2 - 1.5)/3)]\}$

$\frac{M_s * 10^6}{E * I_x} \not> \frac{Span}{600}$

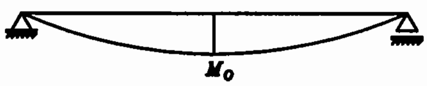
$\triangle_{Continous} = 0.80 \triangle_{Simple} \not> \frac{Span}{600}$

If Check C Unsafe increase Sec. no.

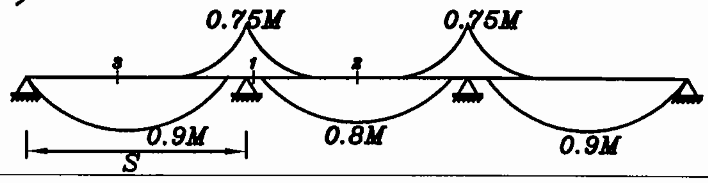
# 3-Design Of Stringer as Hot Rolled
## 3-b-Rail way Bridge

### Steps

**i) as a simple beam**




**i) as a Continous beam**




### A-Choice Of Section

**i) as a simple beam**

assume Compact Sec.

$F_t = 0.64F_y$ → $2.8\,t/Cm^2$ St.44 ; $3.6\,t/Cm^2$ St.52

2) Calculate $F_{Max.}$

$$F_{Max.} = \frac{F_{Sr} = 1.68\,t/Cm^2}{\left(1 - \frac{M_d}{M_d + M_{LL+I}}\right)}$$

$$S_x = \frac{M_{d+LL+I}}{F_{Max.}} \longrightarrow \text{I.P.E, I.P.N, H.E.B}$$

**i) as a Continous beam**

Sec1: $$F_{Max.} = \frac{F_{Sr} = 1.12\,t/Cm^2}{\left(1 - \frac{M_d}{M_d + M_{LL+I}}\right)}$$

$$S_{x1} = \frac{0.75 M_{d+LL+I} * 100}{F_{Max.}} = Cm^3$$

Sec2: $$F_{Max.} = \frac{F_{Sr} = 1.68\,t/Cm^2}{\left(1 - \frac{M_d}{M_d + M_{LL+I}}\right)}$$

$$S_{x2} = \frac{0.80 M_{d+LL+I} * 100}{F_{Max.}} = Cm^3$$

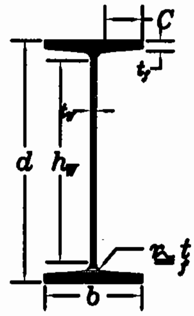
take the bigger Sec.

### B-Compactness

Section Is Compact If

$$\frac{C}{t_f} < \frac{16.9}{\sqrt{F_y}} \qquad C = b/2 - t_w/2 - r$$

$$\frac{h_w}{t_w} < \frac{127}{\sqrt{F_y}} \qquad h_w = d - 2t_f - 2r$$




### C-bending

**i) as a simple beam**

$$F_b = \frac{M_{d+l+I} * 100}{S_x} = .....\,t/Cm^2 \le 0.64F_y$$

**i) as a Continous beam**

Sec. 3

$$F_b = \frac{0.9 M_{d+l+I} * 100}{S_x} = .....\,t/Cm^2 \le 0.64F_y$$

### d-stress range

**i) as a simple beam**

$$\frac{M_{LL+I} * 100}{S_x} = ..\,t/Cm^2 \le F_{Sr} = 1.68\,t/Cm^2$$

**i) as a Continous beam**

Sec. 1

$$\frac{0.75 M_{LL+I} * 100}{S_x} = ..\,t/Cm^2 \le F_{Sr} = 1.12\,t/Cm^2$$

Sec. 3

$$\frac{0.90 M_{LL+I} * 100}{S_x} = ..\,t/Cm^2 \le F_{Sr} = 1.68\,t/Cm^2$$

### e-Shear

**i) as a simple beam**

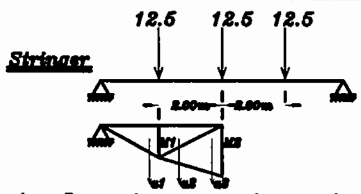
$$\frac{Q_{d+l+I}}{d_w * t_w} = .....\,t/Cm^2 \le 0.35F_y$$

**i) as a Continous beam**

$$\frac{1.1 Q_{d+l+I}}{d_w * t_w} = .....\,t/Cm^2 \le 0.35F_y$$

### F-Deflection

**i) as a simple beam**




$$M_x = \{a * S/2 - [a_3 * 2/3 + a_2 * 4/3 + a_1 * (2 + (S/2 - 2)/3)]\}$$

$$\frac{M_x * 10^6}{E * I_x} \ngtr \frac{Span}{800}$$

**i) as a Continous beam**

$$\triangle_{Continous} = 0.8 \triangle_{Simple} \ngtr \frac{Span}{600}$$

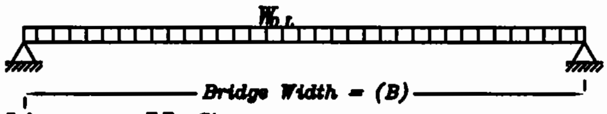
If Check C Unsafe increase Sec. no.

# 4-Loads On cross Girder

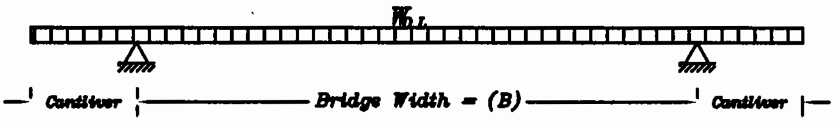
## 4-a-Road Way Bridge

### 1) Dead Loads

### Pony & Deck Without Cantliver X.G




### Deck With Cantliver X.G



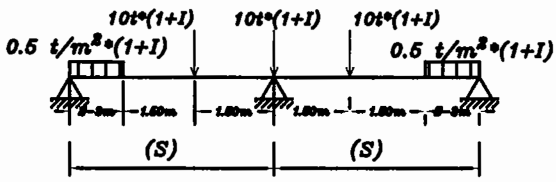

$W_{D.L}$ = (0.175+0.21*2.5+0.15/a)*S + 0.4t/m' = ....t/m'

| where a = stringer spacing , S = cross girder spacing |
| --- |

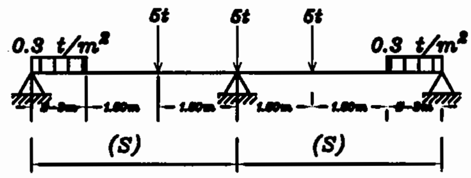
### 2) Live Loads + Impact

دائما يظهر الثلاث شرائح فى حالة ال Cross Girder

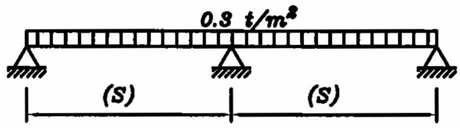
**Strip1**
Get $R_1$ , $W_1$



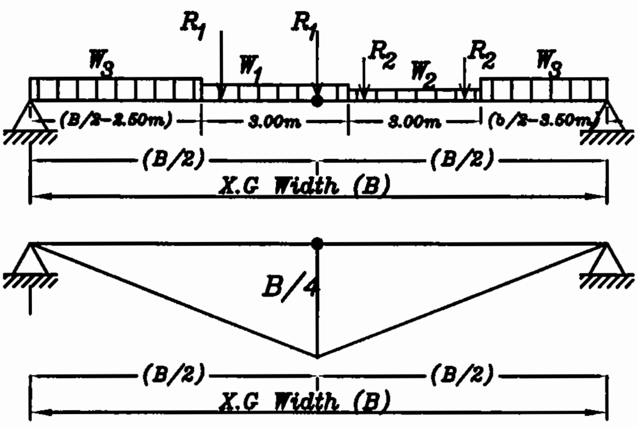

**Strip2**
Get $R_2$ , $W_2$



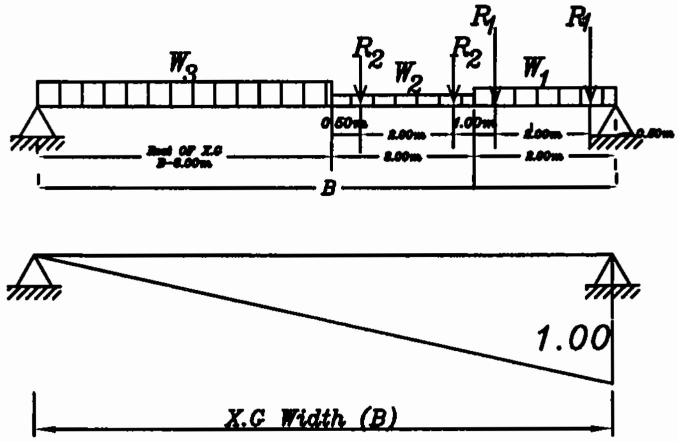

**Strip3**
Get $W_3$




يتم وضع الخمس نواتج على ال Cross Girder بحيث يتم الحصول على




I.L For Max. B.M

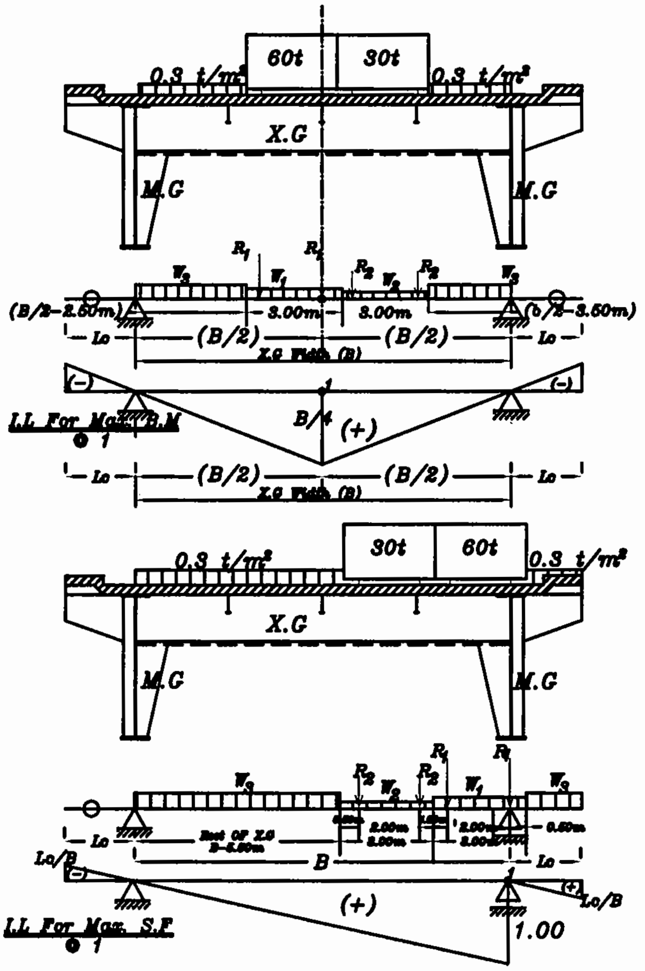



I.L For Max. S.F

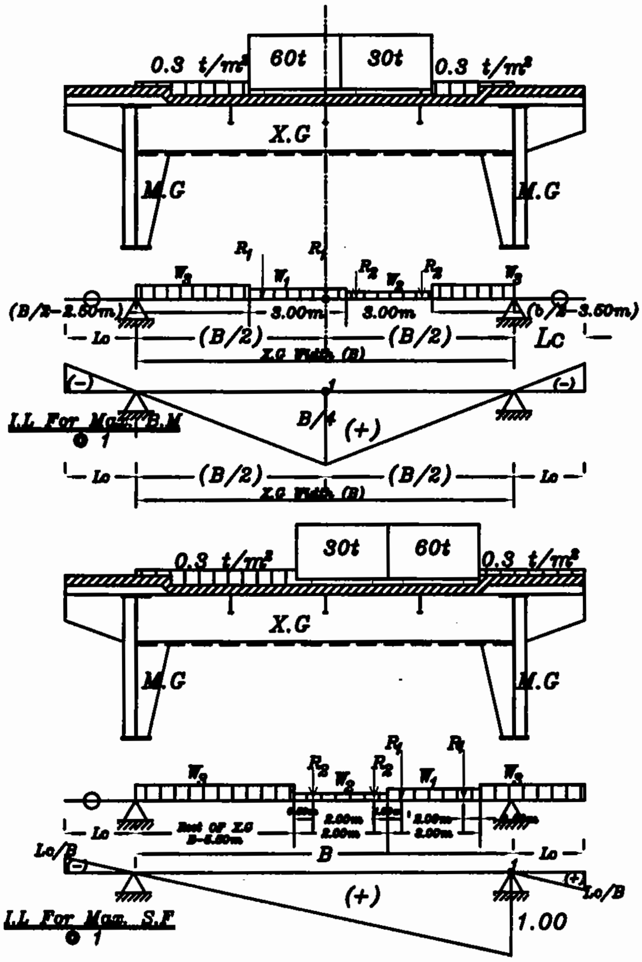
I=0.4-0.008L     Where L = 2 * X.G Spacing

# Special Cases For Loads On Cross Girder

## a) If The Side Walk < Cantliver Lenghth

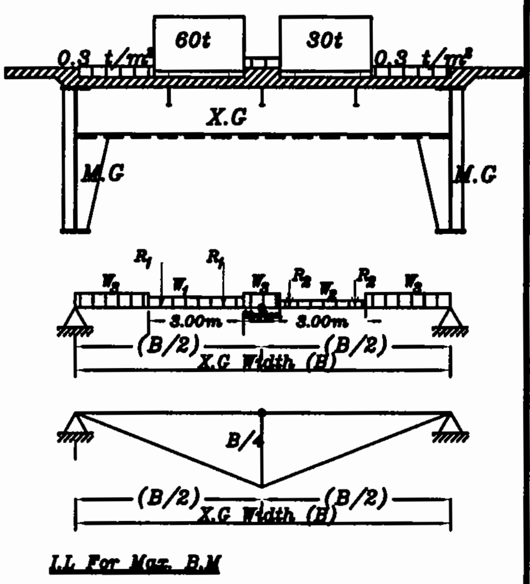



## b) If The Side Walk > Cantliver Lenghth



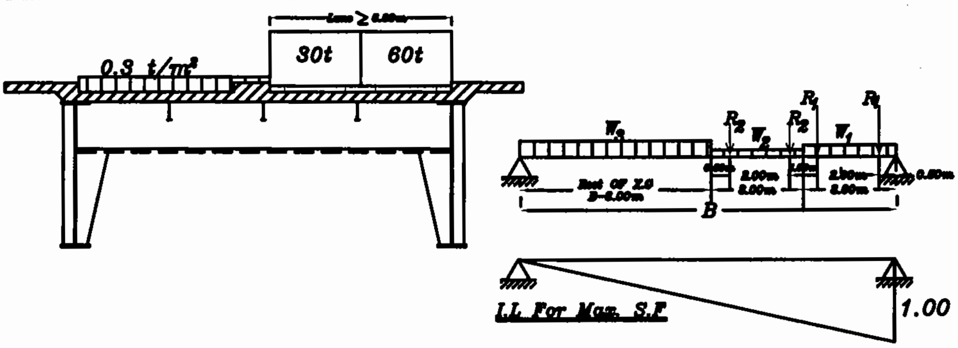

## Median

### I) Case Of Max. Moment

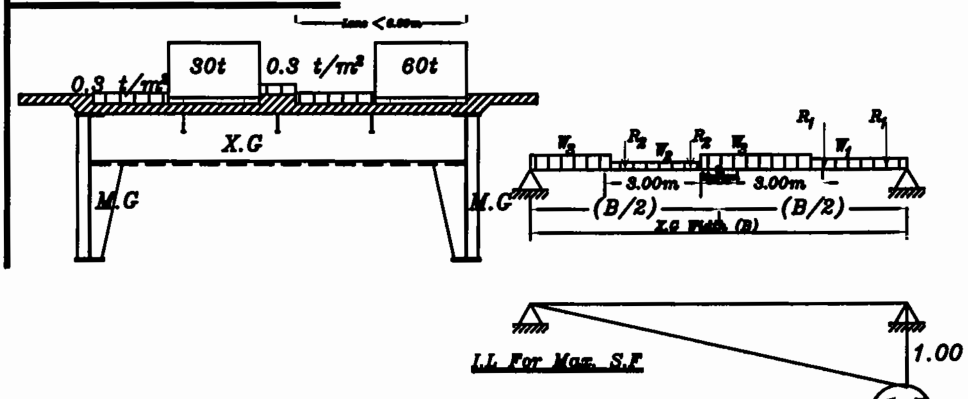



### II) Case Of Max. Shear

#### Lane Width ≥ 6.00m



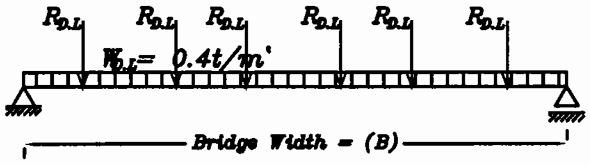

#### Lane Width < 6.00m



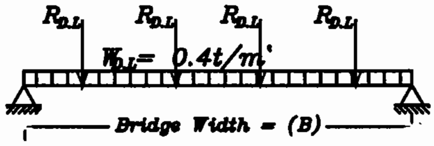
# 4-Loads On cross Girder

# 4-a-Road Way Bridge

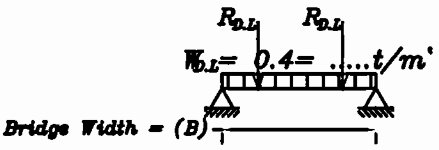
## 1) Dead Loads




Dead Loads On X.G For Triple Track




Dead Loads On X.G For Double Track



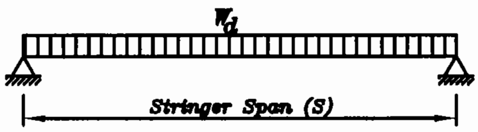

Dead Loads On X.G For Single Track

$$Q_d = \frac{Wd * S}{2} = ....t$$

$R_d = 2 * Q_d$ Of Stringer

$W_{Dead} = 600/2 + 50/2 + 0.W = .........Kg/m'$

$R_d = W_d * S$



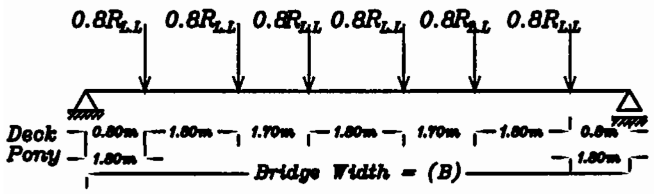

## 2) Live Loads

$$\text{Impact Factor} = I = \frac{24}{24+nL} = ............... \qquad 0.75 \;, \qquad 0.25$$

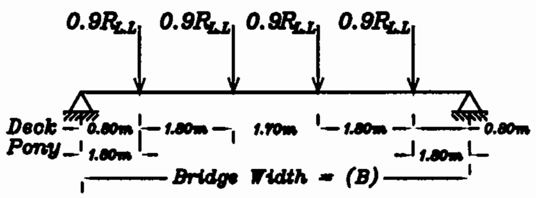
$nL = 2S$ For Single Track

$nL = 4S$ For Double Track

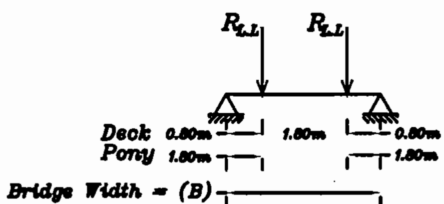
$nL = 6S$ For Triple Track



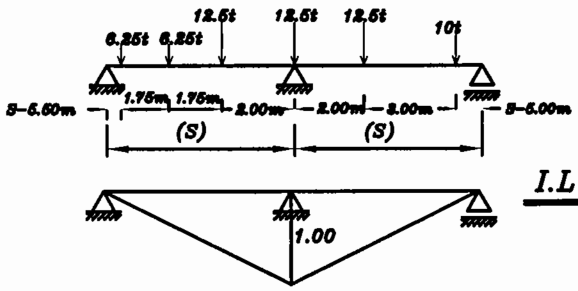

Live Loads On X.G For Triple Track




Live Loads On X.G For Double Track




Live Loads On X.G For Single Track




I.L Reaction

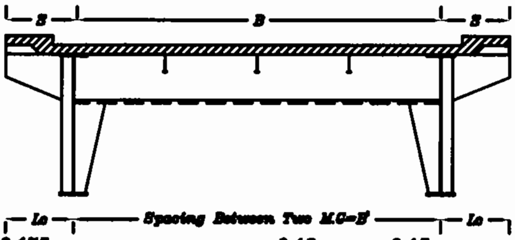
get $R_u = ...t$

# 5-Loads on Main Girder

## 5-a-Road Way Bridge

### 1) Dead Loads

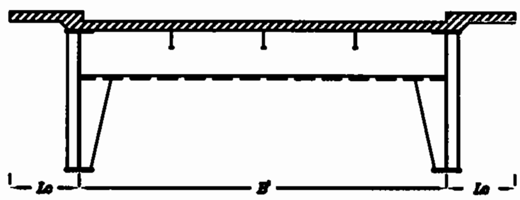
**Deck Bridge With Cantliver X.G**




0.21 0.175 0.18 0.15

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

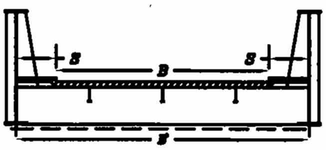
**Deck Bridge Without Cantliver X.G**




0.21 0.175 0.18 0.15

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

**Pony Bridge**

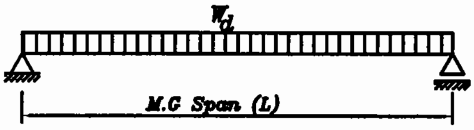



0.21 0.175

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

$W_{ss\ in} = 150 + 4L + 0.03L^2$

$W_{ss\ out} = 100 + 3L$



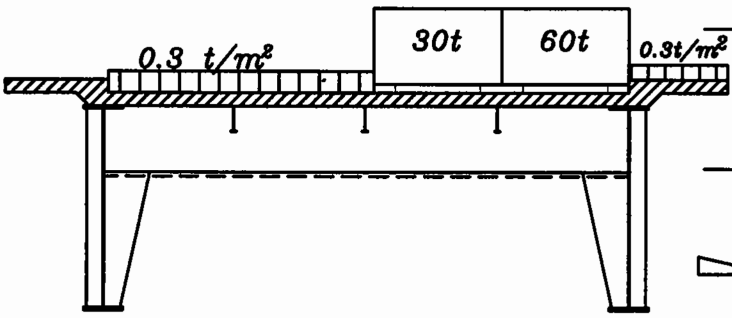

$M_d = \frac{W_d * L^2}{8} = ....\ m.t$ B.M.D

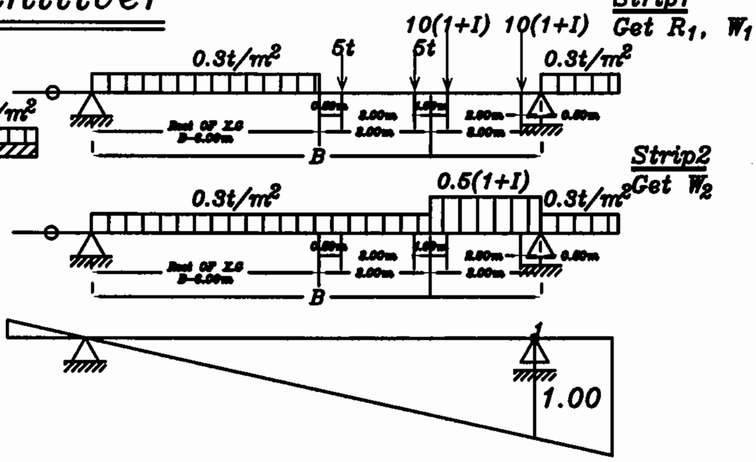
$Q_d = \frac{W_d * L}{2} = ....t$ S.F.D

### 2) Live Loads

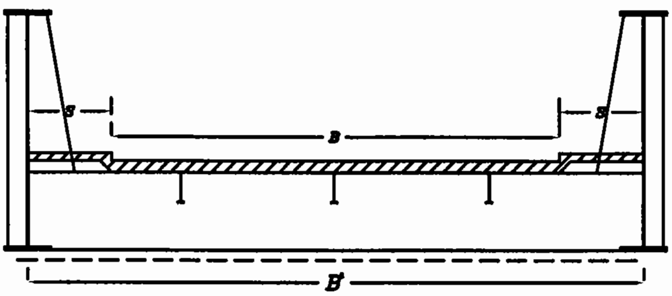
$I = 0.4 - 0.008L$ Where L = Main Girder Length

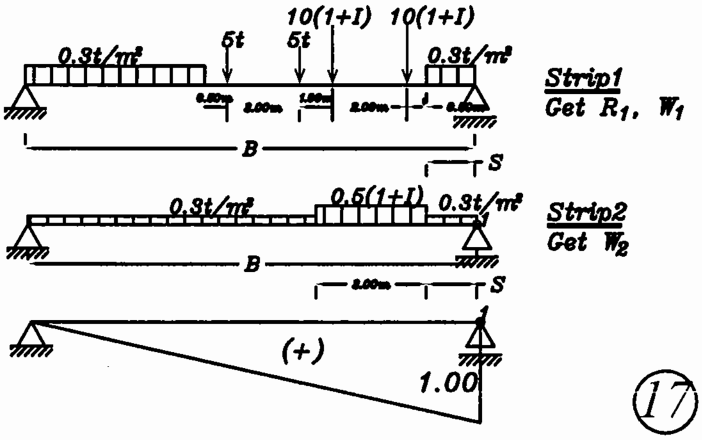
**Deck Bridge Without X.G Cantliver**



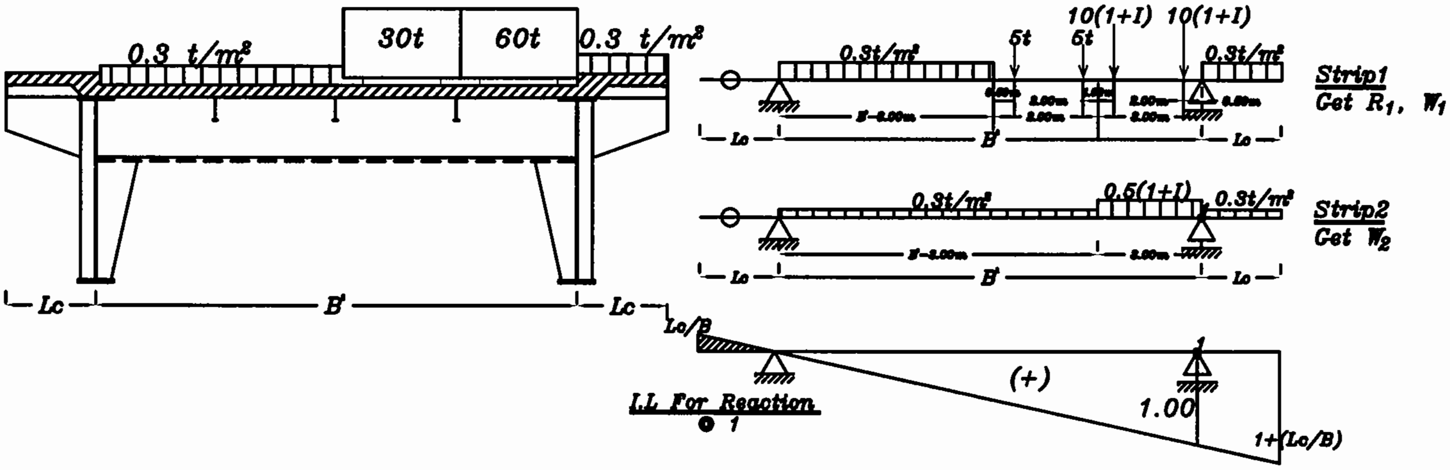




**Pony Brigde**

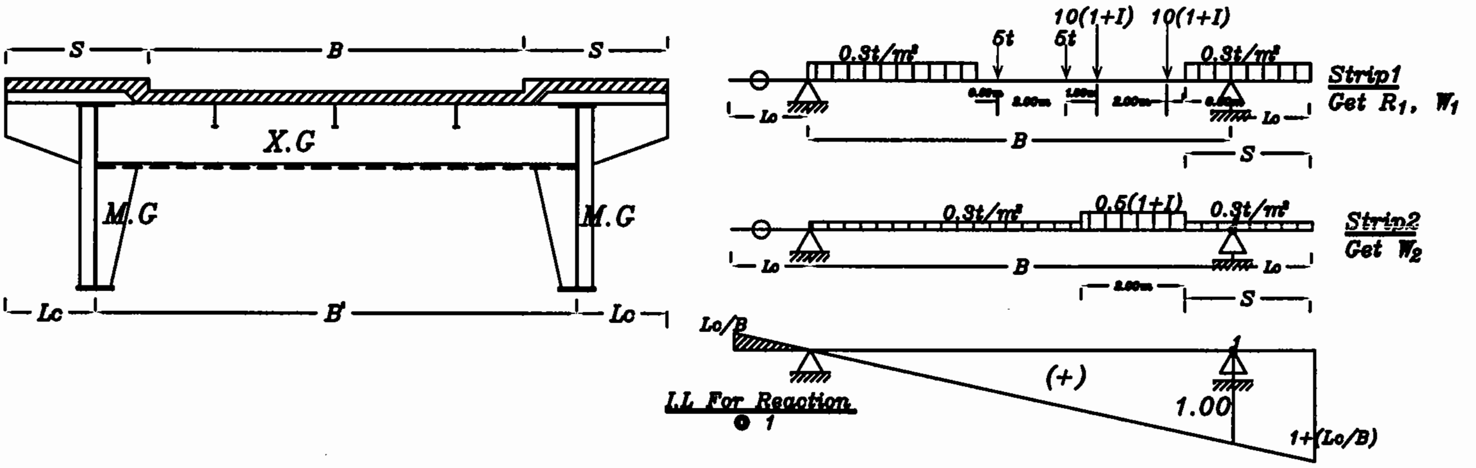


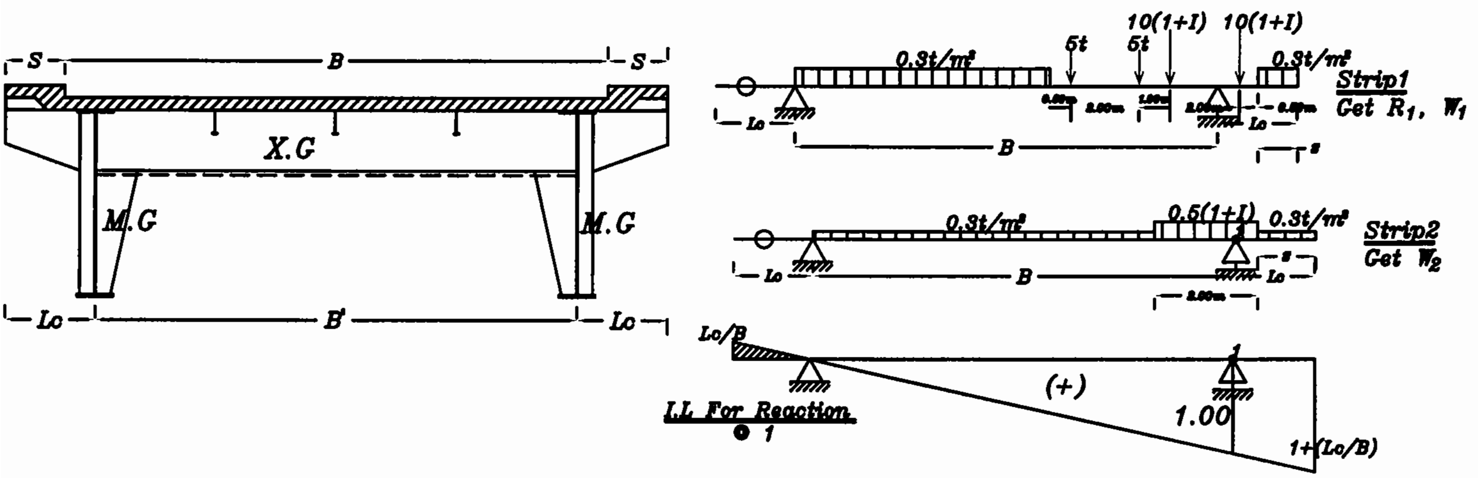
# Deck Bridge With X.G Cantliver



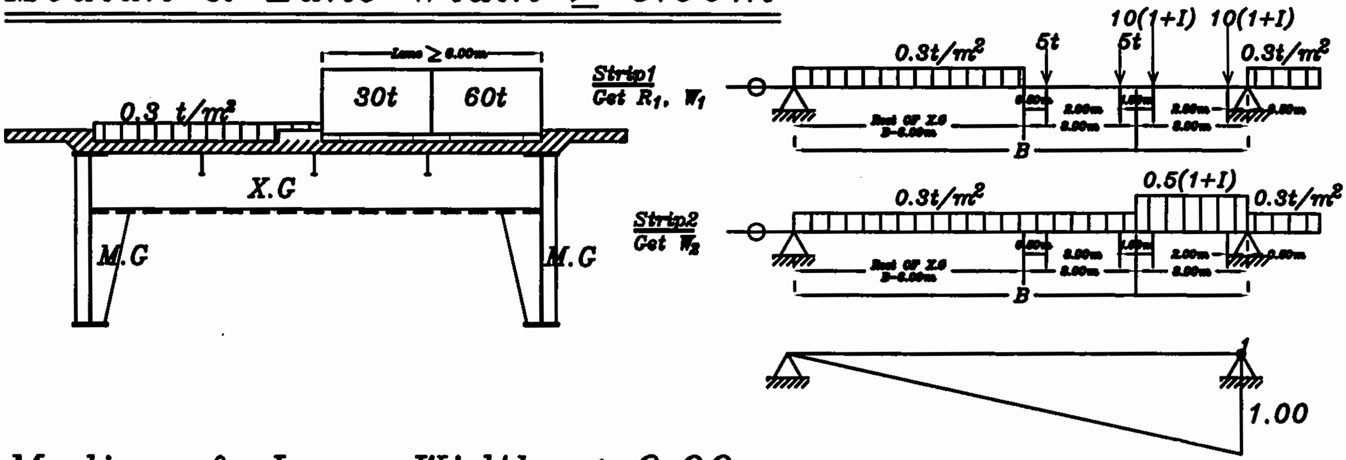

# Deck Bridge With X.G Cantliver(side walk > X.G Cantliver)



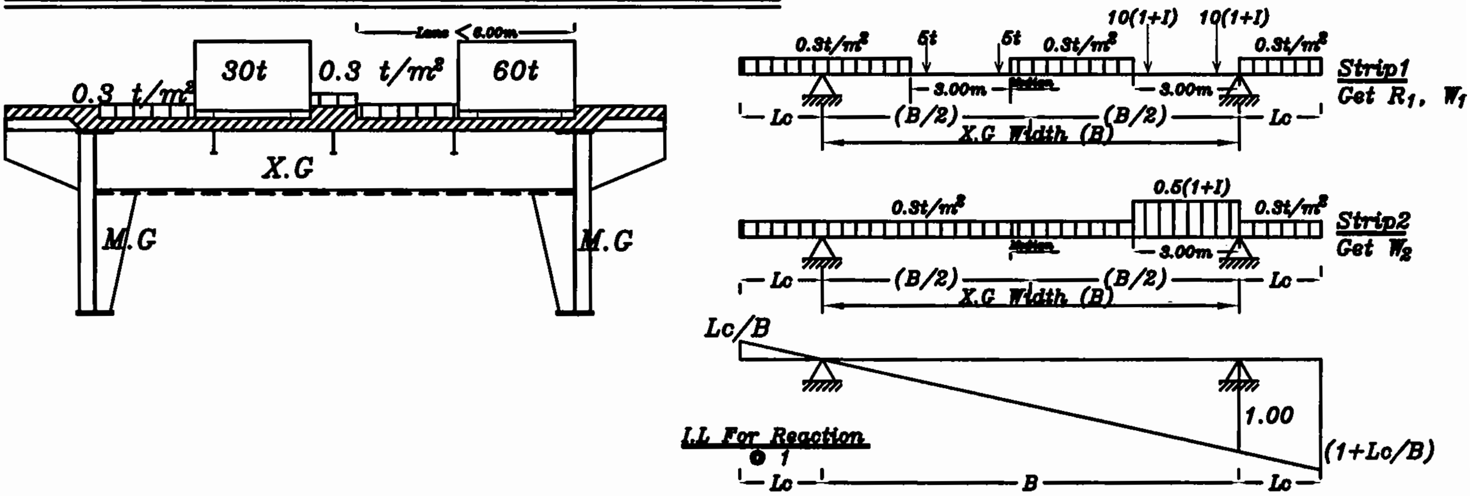

# Deck Bridge With X.G Cantliver(side walk < X.G Cantliver)



# Median & Lane Width ≥ 6.00m

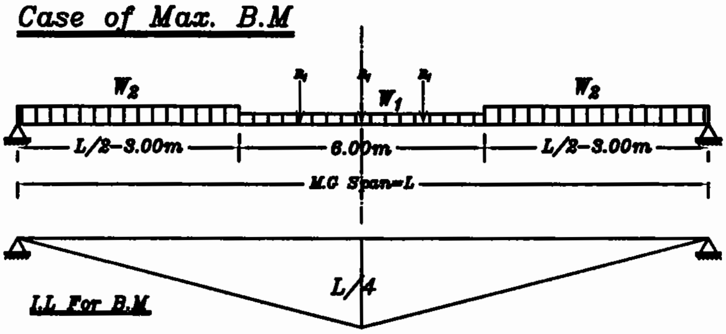



# Median & Lane Width < 6.00m

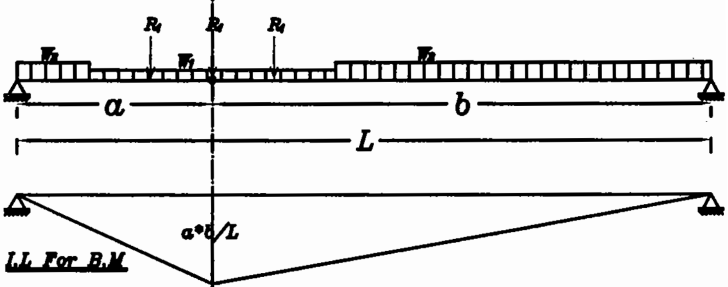



# Straining Actions On M.G

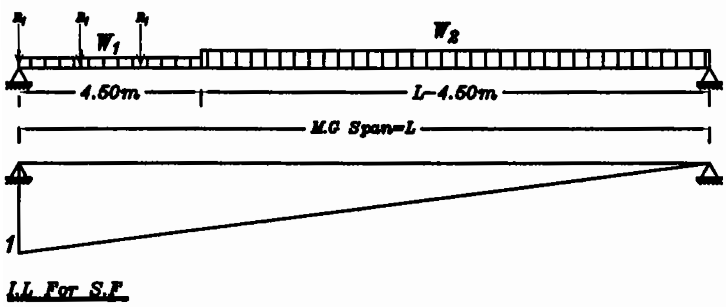
## Case of Max. B.M



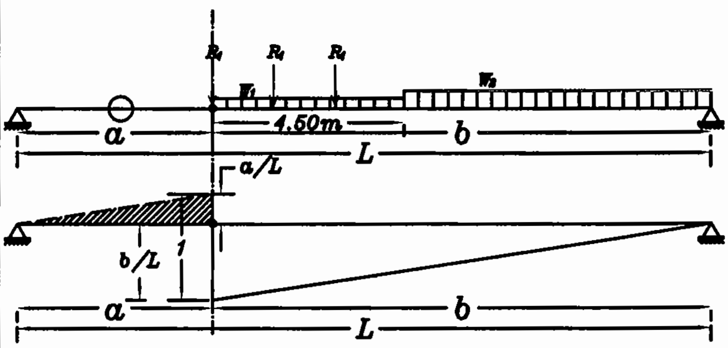

## Case of Max. Max. B.M at sec.




## Case of Max. S.F




## Case of Max. Max. S.F at Sec.



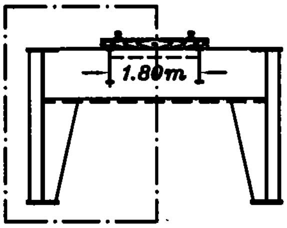
# 5-Loads on Main Girder

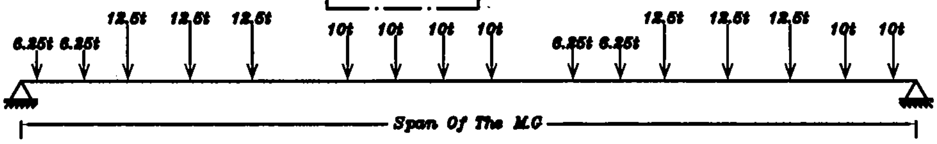
## 5-b-Rail Way Bridge

### Live Loads

تعتبر كل M.G تحمل نصف الكوبرى وهذا يعنى ان فى حالة كون الكوبرى Single Track تعتبر ال M.G تحمل الاحمال التى تؤثر على ال Rail الواحد فقط

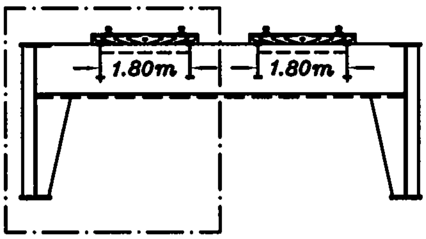
### Single Track

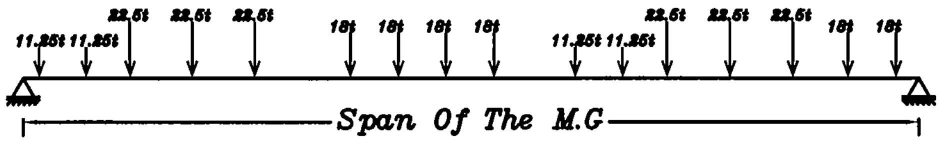



### Double Track

تتضاعف الاحمال على ال M.G الواحد وذلك نظرا لان ال M.G تعتبر حامله ل 2Rails

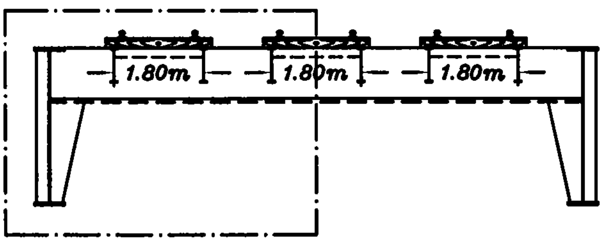


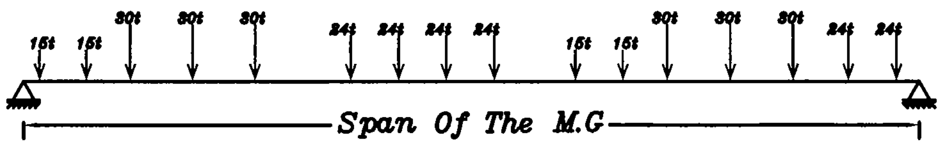




| |
|---|
| 6.25t*2*0.9=11.25t |
| 10t*2*0.9=18t |
| 12.5t*2*0.9=22.5t |

فى حالة الكوبرى ال Double Track يتم ضرب الاحمال فى Factor قيمته 0.9 فتصبح الاحمال كالتالى

### Triple Track



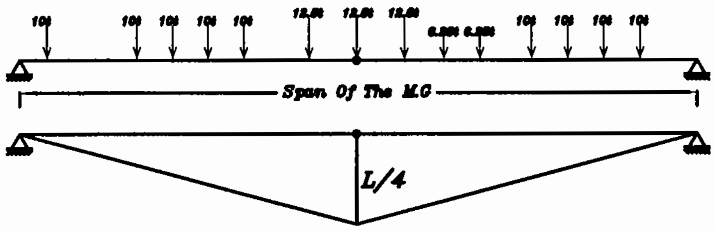




| |
|---|
| 6.25t*3*0.8=15t |
| 10t*3*0.8=24t |
| 12.5t*3*0.8=30t |

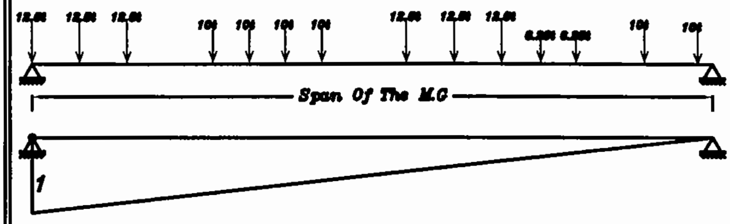
فى حالة الكوبرى ال Triple Track يتم ضرب الاحمال فى Factor قيمته 0.8 فتصبح الاحمال كالتالى

# Straining Actions On M.G

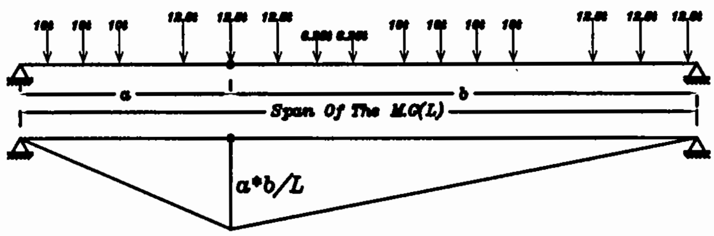
### Case of Max. B.M



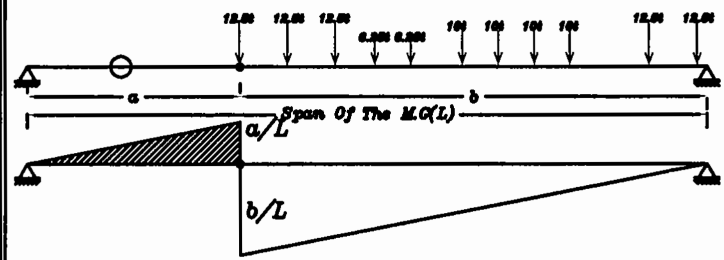

### Case of Max. S.F




### Case of Max. Max. B.M at sec.




### Case of Max. Max. S.F at Sec.




فى حالة طلب ال Max. Moment يتم وضع العجله الوسطى 12.5t فى منتصف الكمرة

بعد ضرب الاحمال فى احداثيات ال I.L For B.M نحصل على قيمة العزوم ثم يتم ضرب قيمة العزوم فى

$$M_{LL+I(Single\ Track)} = M*(1+I)$$

$$M_{LL+I(Double\ Track)} = M*(1+I) * 2* 0.9$$

$$M_{LL+I(Triple\ Track)} = M*(1+I) * 3* 0.8$$

فى حالة طلب ال Max. Shear يتم وضع العجله الاولى 12.5t عند ال Support

بعد ضرب الاحمال فى احداثيات ال I.L For S.F نحصل على قيمة Shear ثم يتم ضرب قيمة Shear فى

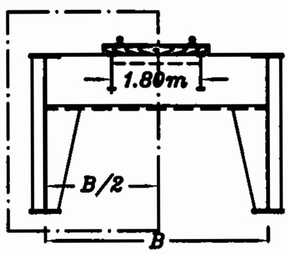
$$Q_{LL+I(Single\ Track)} = Q*(1+I)$$

$$Q_{LL+I(Double\ Track)} = Q*(1+I) * 2* 0.9$$

$$Q_{LL+I(Triple\ Track)} = Q*(1+I) * 3* 0.8$$

# Dead Loads

$$W_{Dead} = \frac{n*0.6}{2} + \frac{0.05*n}{2} + [(150+4L+0.03L^2)/1000] * B/2 \quad = ...t/m'$$



# 6-Built-Up Section

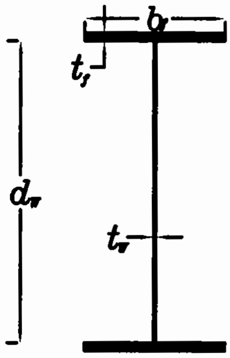
**Steps Of Design Built up Section**

**1-Calculate Web depth[$d_w$]**

$d_w = \frac{L}{8 \boxed{10} 12}$ (For Main Girder)

$d_w = \frac{S}{10}$ (For Stringer)

$d_w = \frac{B}{7 \boxed{8} 9}$ (For Cross Girder)




**2-Calculate Web thikness**

**(2-i) min. thikness**

$\frac{d_w}{t_{w1}} \leq \frac{830}{F_y}$ ⟶ get $t_{w1}$=....Cm

**(2-ii) From Shear**

$\frac{Q_{d+LL+I}}{d_w * t_{w2}} = 0.35F_y$ ⟶ get $t_{w2}$=....Cm

**(2-iii) From Buckling**

**(2-iii-a) If no Stiff. d<1.00m**

$\frac{Q_{d+LL+I}}{d_w * t_{w3}} = \frac{119}{(d_w/t_{w3}) * \sqrt{F_y}} * 0.35F_y$ ⟶ get $t_{w3}$=....Cm

**(2-iii-b) Vl. Stiff. Only (d=1-2.00m)**

$\frac{d_w}{t_{w3}} = \frac{190}{\sqrt{F_y}}$ ⟶ get $t_{w3}$=....Cm

**(2-iii-c) Vl. Stiff.+Hz.@1/5d (d=2-2.80m)**

$\frac{d_w}{t_{w3}} = \frac{320}{\sqrt{F_y}}$ ⟶ get $t_{w3}$=....Cm

**(2-iii-d) Vl. Stiff.+2Hz.@1/5d,1/2d (d>2.80m)**

$\frac{d_w}{t_{w3}} = \frac{365}{\sqrt{F_y}}$ ⟶ get $t_{w3}$=....Cm

---

$t_w$ =1.00 Cm if L < 21.00m

$t_w$ =1.20 Cm if 21.00 < L < 28.00m

$t_w$ =1.40 Cm if L > 28.00m

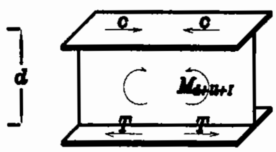
$\boxed{t_{w(min.)} = 0.8Cm}$ $\boxed{t_{w(max.)} = 1.6Cm}$

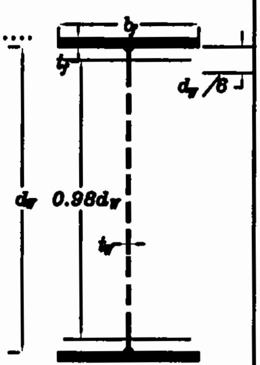
**3-Get Flange Dimension**

Calculate $F_{Max.}$

$F_{Max.} = \frac{F_{sr}}{\left(1 - \frac{M_d}{M_d + 0.6M_{LL+I}\ \text{(Road way)} \ / \ M_{LL+I}\ \text{(Rail way)}}\right)}$ =..........

Calculate $T = C = \frac{M_{d+LL+I}}{0.98d}$




If $F_{Max.} > 0.58F_y$ Then Take $F_{Max.} = 0.58F_y$

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

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

∴ $b_f * t_f$ =.......$Cm^2$ $b_f \doteq 20t_f$ ∴ $b_f * t_f = 20t_f * t_f$

get $t_f$ =...Cm (even no. in mm.) , get b=......Cm

Calculate $I_x$

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

**4-Checks**

**(4-i)Check max. Stresses**

$\frac{M_{d+LL+I}}{I_x} * (d/2 + t_f)$=.......$t/Cm^2$ ≯ $0.58F_y$

**(4-ii)Check stress range**

$\frac{0.6M_{LL+I(Road)} \ / \ M_{LL+I(Rail)}}{I_x} * (d/2 + t_f)$=.......$t/Cm^2$ ≯ $F_{sr}$

Road way only
- Stringer(1.26t/$Cm^2$)
- X.G(1.12t/$Cm^2$)
- M.G(1.26t/$Cm^2$)

**(4-iii)Check Shear Stress**

$\frac{Q_{d+LL+I}}{d_w * t_w}$ =........ $t/Cm^2$ ≯ $0.35F_y$

**5-Get Size of Weld**

$\boxed{\text{Shear Follow} = \frac{Q_{d+LL+I} * [b_f * t_f * (d_w/2 + t_f/2)]}{I_x} = ........ \ t/Cm'}$

(Area Flange ; بعد ال Flange عن C.g القطاع)

$\boxed{\frac{Q_{d+LL+I} * [b_f * t_f * (d_w/2 + t_f/2)]}{I_x} = 2 * S * 0.2F_y}$

get Size of Wels (S)=......Cm ≮ 0.6Cm

Where $0.2F_y$ is allwable Stress in Weld

## 7-Lateral Torsional buckling of compression flange

### 1-Get $L_{u\ act}$

$L_u$=spacing between X.G. (deck) , Zero if R.C. Connect to M.G.

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

بعد حساب الطول الغير ممسوك $L_U$ يتم تعيين $F_{LTB}$ وهناك طريقتان لحساب $F_{LTB}$

طريقه تقريبيه (approximate method)

طريقه دقيقه (Exact method)

### approximate method

فى هذه الطريقه يتم اعتبار ال Comp. Flange كانها Comp. member

وبالتالى يتم اعتبار $L_{U\ act.} = L_{U\ buckling}$

**خطوات الحساب**

1- $\lambda = \dfrac{L_{U\ buckling}}{r_t}$

$r_t = \sqrt{\dfrac{I_y}{A}}$

$I_y \cong \dfrac{t * b^3}{12}$ , $A = b_f * t_f + (d_w/6) * t_w$

$r_t \cong 0.25 b_f$

2-Calculate

$F_C = 1.6 - 8.5*10^{-5} * \lambda^2$ For St.44

$F_C = 2.1 - 13.5*10^{-5} * \lambda^2$ For St.52

IF $F_C > 0.58 F_y$

$\therefore$ Use $F_C = 0.58 F_y$

### Exact method

يتم حساب $F_{LTB}$ بالطريقه العاديه من الكود وهى تعتبر ان ال Flange المضغوطه وجزء من ال Web معرض للانبعاج الجانبى

**خطوات الحساب**

1-Calculate $L_{U\ act.}$

2-Calculate $L_{U\ Max.}$ بالطرق السابق ذكرها

$L_U = \dfrac{20 b_f}{\sqrt{F_y}}$

$L_U = \dfrac{1380 A_f * C_b}{d F_y}$

ايهما اصغر

$L_{U\ act.} < L_{U\ Max.}$

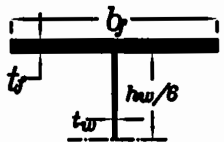
$\therefore$ No need to Check L.T.B

$F_{L.T.B} = 0.58 F_y$

$L_{U\ act.} > L_{U\ Max.}$ $\therefore$ Calculate $F_{L.T.B}$

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

4-Calculate $r_t$




$r_t = \sqrt{\dfrac{I_y}{A}}$

$I_y \cong \dfrac{t * b^3}{12}$ , $A = b_f * t_f + (d_w/6) * t_w$

$r_t \cong 0.25 b_f$

٥-يتم حساب $L_U / r_t$ ومقارنتها بالارقام الموجوده بالكود صفحة ١٨ ومنها يتم حساب $F_{L.T.B2}$

$\therefore F_{L.T.B} = \sqrt{F_{L.T.B1}^2 + F_{L.T.B2}^2} < 0.58 F_y$

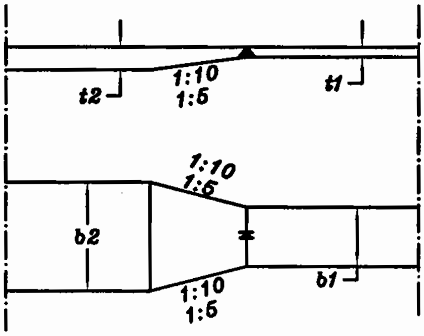
# 8-Curtailment Of Flange Plate

## When do We need Curtailment?

1-L ≤ 15m (No Curtailment)
2-15 < L ≤ 30m (One Curtailmet at Span/6)
3-L > 30m (Two Curtailment at Span/4 & Span/9)

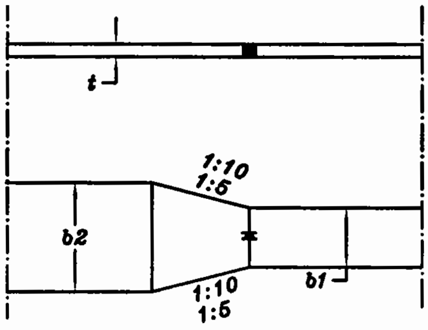
**وهناك ثلاث طرق لتغيير ال Flange**

### Case1



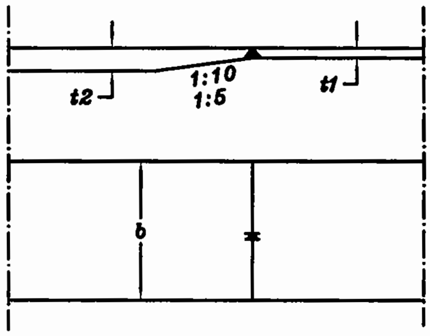

تم تقليل عرض وتخانة ال Flange

### Case2




تم تقليل عرض ال Flange فقط

### Case3

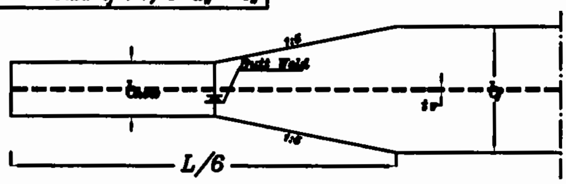



تم تقليل تخانة ال Flange فقط

## Steps Of Curtailment

### L ≤ 30m

$$0.58F_y = \frac{M_x/0.98d_w}{b_{new}*t_f + 1/6*d_w*t_w}$$ get $b_{new}$=.....Cm

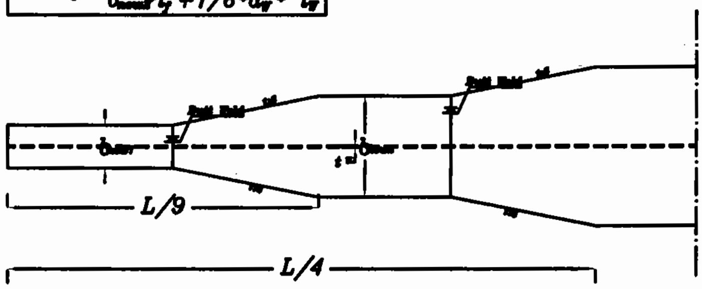



$$b_{min} = 2b_{Stiffenr} + t_w$$

### L > 30m

$$0.58F_y = \frac{M_x/0.98d_w}{b_{new1}*t_f + 1/6*d_w*t_w}$$ → Get $b_{new1}$ =............Cm

$$0.58F_y = \frac{M_x/0.98d_w}{b_{new2}*t_f + 1/6*d_w*t_w}$$ → Get $b_{new2}$ =............Cm




Plan Of M.G Flange

## 1)Max. Stresses

$$\frac{M_{D+LL+I \text{ at Curtailment}}}{S_{x\ new}} \leq F_b = ....t/Cm^2$$

$$S_{x\ new} = \frac{I_x}{y}$$

## 2)Stress Range

$$\frac{0.6M_{LL+I}}{S_{x\ new}} \leq F_{sr} = ....t/Cm^2$$ (Detail C) Or Given

# 9-Check Web Buckling

خطوات حساب ال Web Plate Buckling

## 1-Buckling @ Support (Pure Shear)

1-Calculate $\alpha = \frac{d_1}{d}$ where $d_1$ Spacing between VL. Stiffner

2-Calculate $K_q = 5.34 + \frac{4}{\alpha^2}$ if $\alpha \geq 1$

$K_q = 4.00 + \frac{5.34}{\alpha^2}$ if $\alpha < 1$

3-Calculate $\lambda_q = \frac{dw/tw}{57}\sqrt{\frac{F_y}{K_q}}$

4-Calculate

$q_b = 0.35F_y$ When $\lambda_q \leq 0.8$

$q_b = (1.5 - 0.625\,\lambda_q)0.35F_y$ When $0.8 < \lambda_q < 1.2$

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

5-Check Shear Stresses $\frac{Q_{d+u+I}}{d_w * t_w} = ........$ $t/Cm^2 \ngtr q_b$

Where $Q_{d+u+I}$ is the shear force in the middle of the first pannel

## 2-Buckling @ Position Of Curtailment

1-Calculate $\alpha$ (as Before)

2-Calculate $K_q$ (as Before)

3-Calculate $\lambda_q$ (as Before)

4-Calculate $q_b$ (as Before)

5-Check Shear Stresses $q_{act} = \frac{Q_{d+u+I}}{d_w * t_w} = ........$ $t/Cm^2 \ngtr q_b$

6-Check Bending Stresses

$F_b = (0.8 - 0.36\,\frac{q_{act}}{q_b})F_y$ , Check $\frac{M_{d+u+I}}{I_x} * (d/2 + t_f) = .......t/Cm^2 \ngtr$ Wich Smaller $\begin{cases} 0.58F_y \\ Or \\ F_b \end{cases}$

$M_{d+u+I}$ , $I_x$ after curtailment

## 3-Buckling @ mid Span

1-Calculate $\alpha$ (as Before)

2-Calculate $K_q$ (as Before)

3-Calculate $\lambda_q$ (as Before)

4-Calculate $q_b$ (as Before)

5-Check Shear Stresses $q_{act} = \frac{Q_{d+u+I}}{d_w * t_w} = ........$ $t/Cm^2 \ngtr q_b$

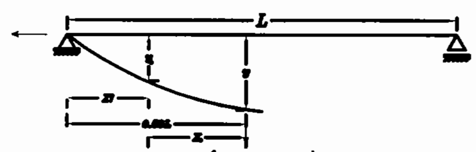
6-Check Bending Stresses

$F_b = (0.8 - 0.36\,\frac{q_{act}}{q_b})F_y$ , Check $\frac{M_{d+u+I}}{I_x} * (d/2 + t_f) = .......t/Cm^2 \ngtr$ Wich Smaller $\begin{cases} 0.58F_y \\ Or \\ F_b \end{cases}$

## كيف يتم حساب العزوم وقوى القص فى منتصف كل باكيه

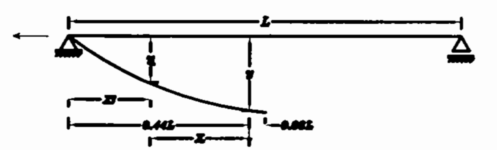
بمعرفة المسافه بين ال VL. Stiffner يتم تنصيفها ويتم حساب القوى عندها

**For B.M**



$M_{x1} = \{1 - [\frac{(0.50 - X1)L}{0.50L}]^2\} * M_{dl}$

Dead Load

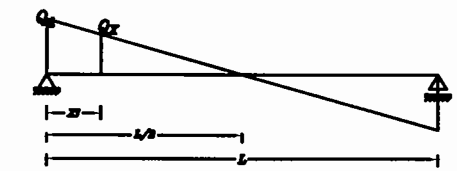


$M_{x1} = \{1 - [\frac{(0.44 - X1)L}{0.44L}]^2\} * M_{LL+I}$

Live Load

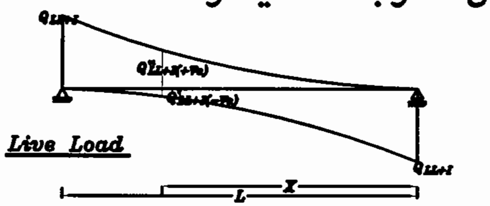
**For S.F**

يتم حساب قوى القص عند القطاع نتيجة الاحمال الميته على حده ونتيجة الاحمال الحيه على حده وذلك نظرا لان معادلة الاحمال الحيه معادله من الدرجه الثانيه ومعادلة الاحمال الميته معادله من الدرجه الاولى



Dead Load

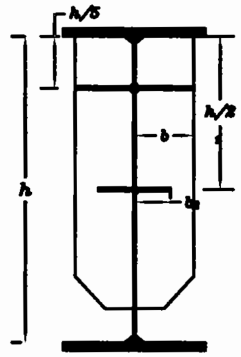
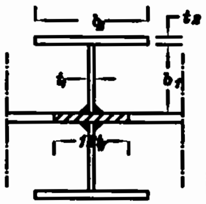
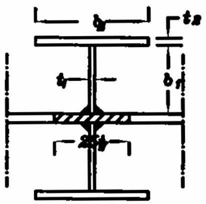
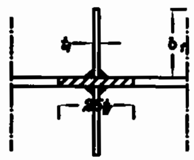
$\frac{Q_x}{Q_d} = \frac{L/2 - X1}{L/2}$



Live Load

$\frac{Q_{LL+X(+ve)}}{Q_{LL+X(+ve)}} = (\frac{X}{L})^2$ $\frac{Q_{LL+X(-ve)}}{Q_{LL+X(-ve)}} = (\frac{L-X}{L})^2$

# 10-Web Stiffners

| Steps | End Bearing Transv. Stiff. | Int. Bearing Transv. Stiff. | Int. Transverse Stiff. | Longitudinal Hz. Stiff. |
|---|---|---|---|---|
| a-Design Force | $Q_{D+LL+I}$ (Reaction For M.G.) | $Q_{d+LL+I}$ Of The X.G (govern) (OR) $C_s = 0.65*(\frac{0.35F_y}{q_b} - 1)*Q_{act}$ | $C_s = 0.65*(\frac{0.35F_y}{q_b} - 1)*Q_{act}$ <br> $Q_{act}$ = reaction of M.G. |  |
| b-Shape | $Area = \frac{Force}{1.4t/Cm^2 \ (st.44) \ 1.7t/Cm^2 \ (st.52)}$ <br> $b_{2min} = 6\phi + t_w$  | $Area = \frac{Force}{1.4t/Cm^2 \ (st.44) \ 1.7t/Cm^2 \ (st.52)}$ <br> $b_{2min} = 6\phi + t_w$  | $Area = \frac{Force}{1.4t/Cm^2 \ (st.44) \ 1.7t/Cm^2 \ (st.52)}$  | |
| C-Dimension | $Area = 12t_w^2 + 2b_1 t_1 + 2b_2 t_2$ <br> $b_1 = h_w/30 + 5Cm$, take $t_1 = t_w$ <br> then get $b_2 * t_2 = ...Cm$ <br> $b_2 = 20t_2$ $b_2 = ..Cm$ , $t_2 = ..Cm$ | $Area = 25t_w^2 + 2b_1 t_1 + 2b_2 t_2$ <br> $b_1 = h_w/30 + 5Cm$, take $t_1 = t_w$ <br> then get $b_2 * t_2 = ...Cm$ <br> $b_2 = 20t_2$ $b_2 = ..Cm$ , $t_2 = ..Cm$ | $Area = 25t_w^2 + 2b_1 t_1$ <br> $b_1 = h_w/30 + 5Cm$ <br> Get $t_1 = ..Cm$ | Cross Section |
| d-Check Non Compact | $\frac{b_1}{t_1} \le \frac{64}{\sqrt{F_y}}$ , $\frac{b_2/2}{t_2} \le \frac{21}{\sqrt{F_y}}$ | $\frac{b_1}{t_1} \le \frac{64}{\sqrt{F_y}}$ , $\frac{b_2/2}{t_2} \le \frac{21}{\sqrt{F_y}}$ | $\frac{b_1}{t_1} \le \frac{30}{\sqrt{F_y}}$ | assume Stiffener @ h/5 to be <br> $b_1 = \frac{h_w}{30} + 5Cm$ $t_1 = t_w$ <br> assume Stiffener @ h/2 to be <br> $b_2 = 10Cm$ $t_2 = t_w$ |
| e-Prop. Of Area | $Area = 12t_w^2 + 2b_1 t_1 + 2b_2 t_2$ <br> Calculate $I_x = 2\frac{t_1 * b_1^3}{12} + 2t_1 b_1 (\frac{b_1}{2} + \frac{t_w}{2})^2 + 2t_2 b_2 (\frac{t_2}{2} + b_1 + \frac{t_w}{2})^2 = ...Cm^4$ <br> Calculate $r_x = \sqrt{\frac{I_x}{A}} = ..........Cm$ | $Area = 25t_w^2 + 2b_1 t_1 + 2b_2 t_2$ <br> (Calculate $I_x$ and $r_x$ as for End Bearing Transv. Stiff.) | $Area = 25t_w^2 + 2b_1 t_1$ <br> $I_x = 2\frac{t_1 * b_1^3}{12} + 2t_1 b_1 (\frac{b_1}{2} + \frac{t_w}{2})^2 = .Cm^4$ <br> Calculate $r_x = \sqrt{\frac{I_x}{A}} = ..........Cm$ | for (d/5) <br> $I_y = 2[\frac{b_1^3 * t_1}{12} + b_1 * t_1 * (\frac{b_1}{2} + \frac{t_w}{2})^2] > 4 * h_w * t_w^3$ |
| f-Check buckling | $\lambda = \frac{L_b}{r_x} = \frac{0.8h_w}{r_x} < 110$ (Road Way) , 90 (Rail Way) <br> $F_c = 1.6 - 8.5*10^{-5} * \lambda^2$ For St.44 <br> $F_c = 2.1 - 13.5*10^{-5} * \lambda^2$ For St.52 | | | for (d/2) <br> $I_y = 2[\frac{b_2^3 * t_2}{12} + b_2 * t_2 * (\frac{b_2}{2} + \frac{t_w}{2})^2] > h_w * t_w^3$ |
| g-Check Stresses | $f = \frac{force}{area} \le F_c$ | | | |
| h-Size Of Weld | $S = \frac{Q_{D+LL+I} (R.R)}{(0.2f_u) * 4h_w} = .... \ge 0.6Cm$ | $S = \frac{Q_{D+LL+I} (R.R) \text{ or } C_s}{(0.2f_u) * 4h_w/3} = .... \ge 0.6Cm$ | $S = \frac{C_s}{(0.2f_u) * 4h_w/3} = .... \ge 0.6Cm$ | |

# 11-Field Splice

## A-Design of Splice Plates

### A-1-Design of Plate no.1

$b_1 * t_1 = 0.5 * \text{Flange area}$

$\therefore b_1 * t_1 = 0.5 * b_f * t_f$ , $\because b_1 = b_f$ , $\therefore t_1 = t_f / 2 =$ ......(even no. in mm.)

### A-2-Design of Plate no.2

$b_2 * t_2 = 0.25 * \text{Flange area}$ $\therefore b_2 * t_2 = 0.25 * b_f * t_f$

$b_2 = 0.5[b_f - t_w - 2*2Cm] =$ .......... Cm

then get $t_2 =$ .............(even no. in mm)

### A-3-Design of Plate no.3

$b_3 * t_3 = 0.5 * \text{Area web}$

$b_3 * t_3 = 0.5 * h_w * t_w$

$b_3 = h_w - 2t_2 - 2*2Cm =$ ..........Cm

get $t_3 =$ .....$\geq 1Cm$

## B-number of Bolts

### B-1-Bolts between plate 1 and plate two

$$n_1 = \frac{\text{Force in Flange}}{2P_s} = \frac{(0.58F_y \text{ Or } F_{L.T.B}) * b_f * t_f}{2P_s} = \text{................(even no.)}$$

### B-2-Bolts between Splice plate and web

$$n_2 = \frac{\text{height of plate} = b_3}{\text{Pitch} = 4\phi} = \text{........}$$

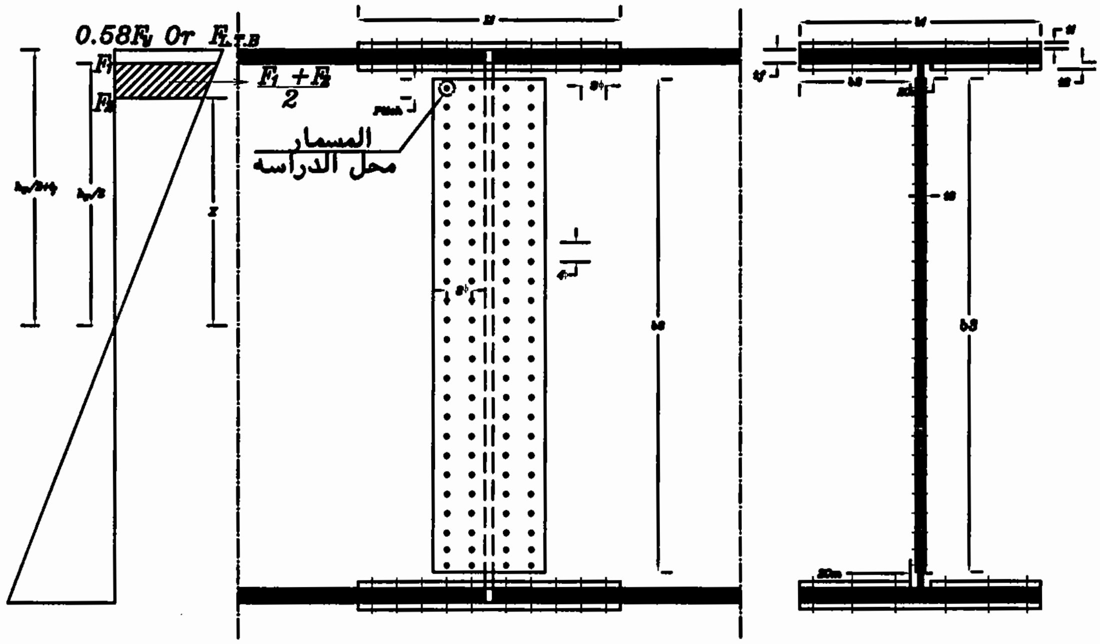
$$H = 1/2[(\frac{F_1 + F_2}{2}) * (\text{Pitch} + t_2 + 2Cm)] * t_{web}$$

$$F_1 = \frac{h_w/2}{h_w/2 + t_f} * (0.58F_y \text{ Or } F_{L.T.B})$$

$$F_2 = \frac{X}{h_w/2 + t_f} * (0.58F_y \text{ Or } F_{L.T.B}) = \frac{h_w/2 - t_2 - 2Cm - \text{Pitch}(4\phi)}{h_w/2 + t_f} * (0.58F_y \text{ Or } F_{L.T.B})$$

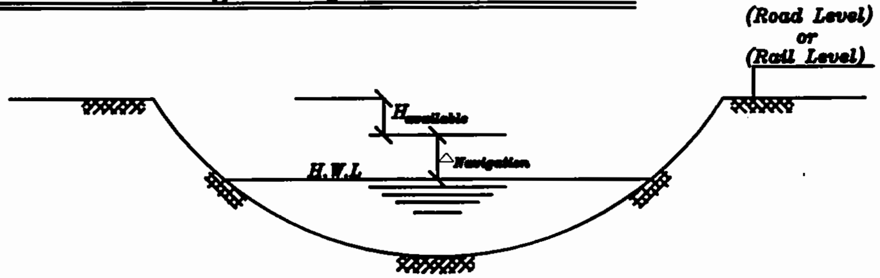
$$V = \frac{Q_{D+LL+I} \text{ @splice}}{2n_2}$$

$$\boxed{R = \sqrt{H^2 + V^2} = \text{.........} \not> 2P_s}$$



## 12-General Lay out

### Available Height Of Construction




$H_{available}$ = Road Level (Rail Level) − H.W.L − $\triangle$Navigation

$\triangle$Navigation(Given) , Road Level(Given) , H.W.L(Given)

$H_{available}$ ??

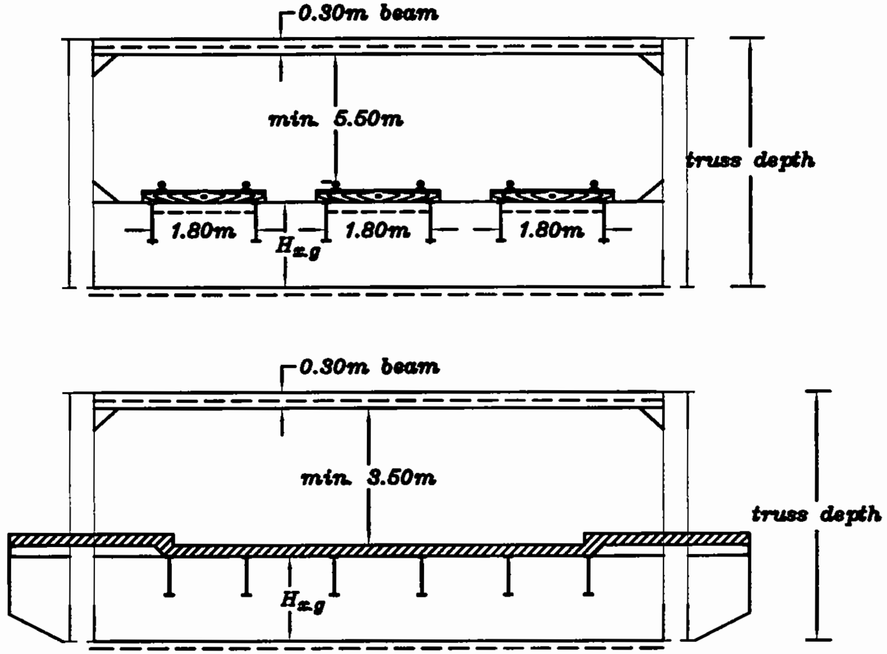
وعلى هذا يجب ان يكون $H_{Construction}$ اقل من او يساوى $H_{available}$

If $H_{deck} = \frac{Span\ (L)}{(8 \rightarrow 12)} + X.00m \leq H_{available}$ , Use Deck Bridge
X.00m (Road way)

If $H_{deck} = \frac{Span\ (L)}{(8 \rightarrow 12)} + X.00m > H_{available}$ , Use Pony Or through
X.00m (Road way)

من القوانين السابقه نستنتج انه اذا كان ارتفاع الكمره + X سم
اقل من الارتفاع المسموح (معطى فى المساله) يتم استعمال Deck Bridge
اما اذا كان اكبر يتم استعمال through Or Pony
ولكى يتم معرفه ما اذا كان الكوبرى through Or Pony

## How to Determine Wither the bridge is through or pony



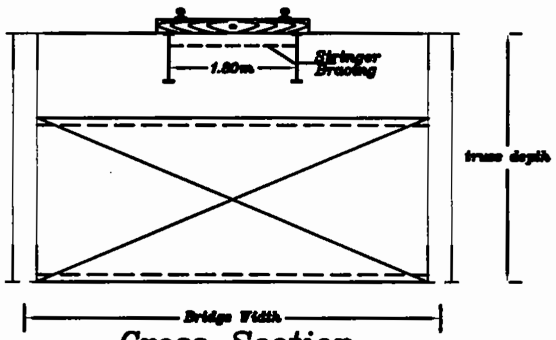

If $H_{truss} - 0.35(Rail)$ Or $0.3(Road) - 0.3(beam) - H_{s.g} \geq$

3.50m (RoadWay) then use through bridge

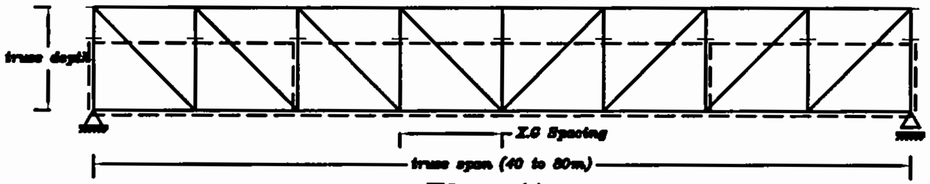
5.50m (RailWay) then use through bridge

**If not use pony bridge**

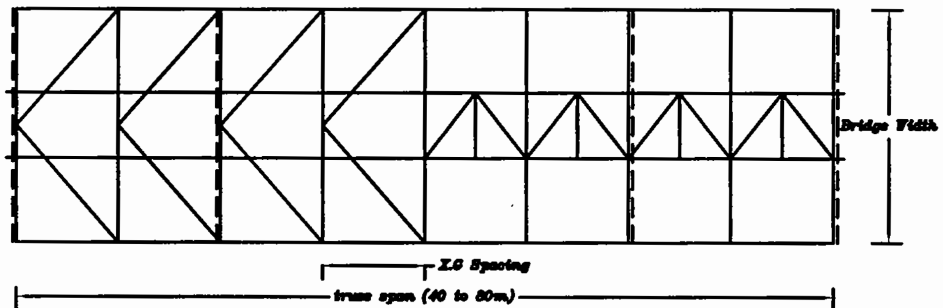
## truss deck bridge railway single track with Vertical Bracing



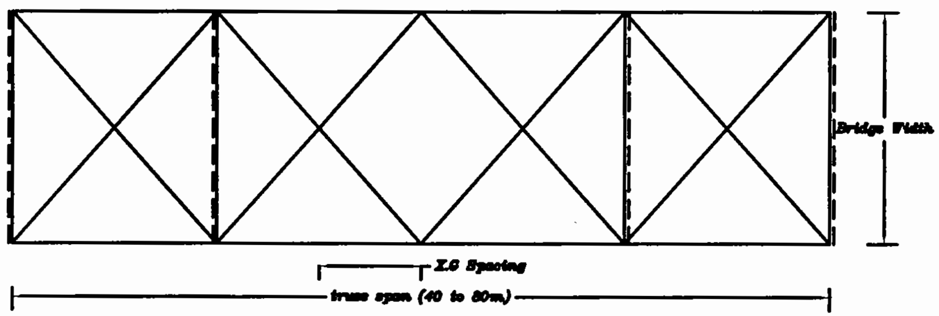

Cross Section




Elevation

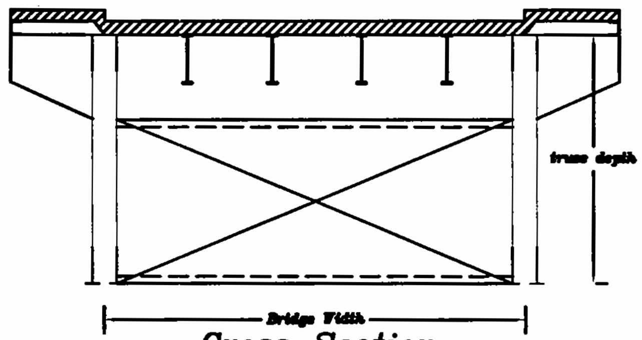



plan of upper bracing

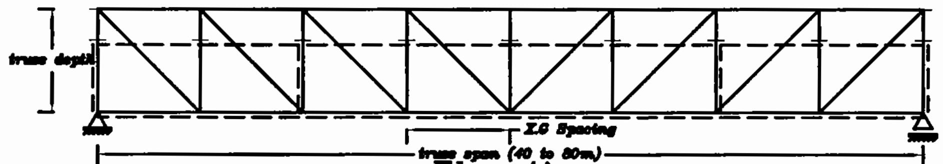



plan of lower bracing

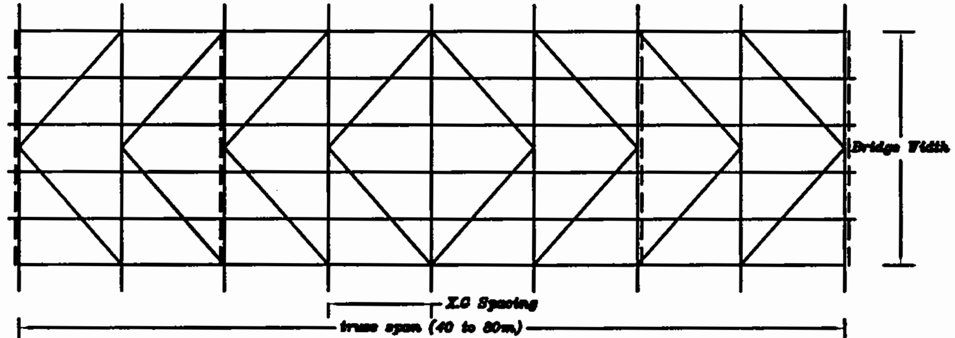
## truss deck bridge roadway with Vertical Bracing



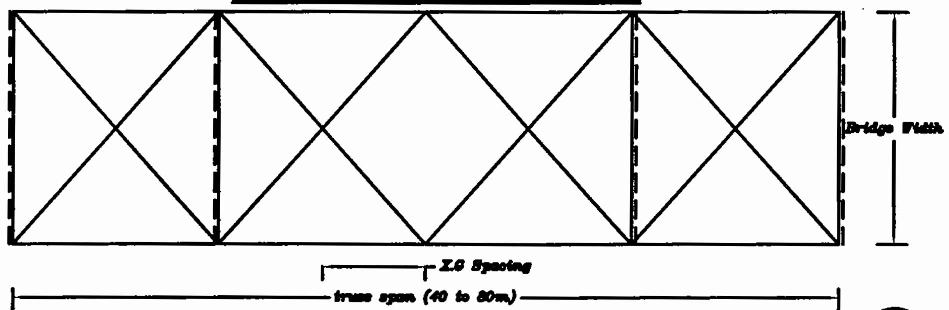

Cross Section




Elevation

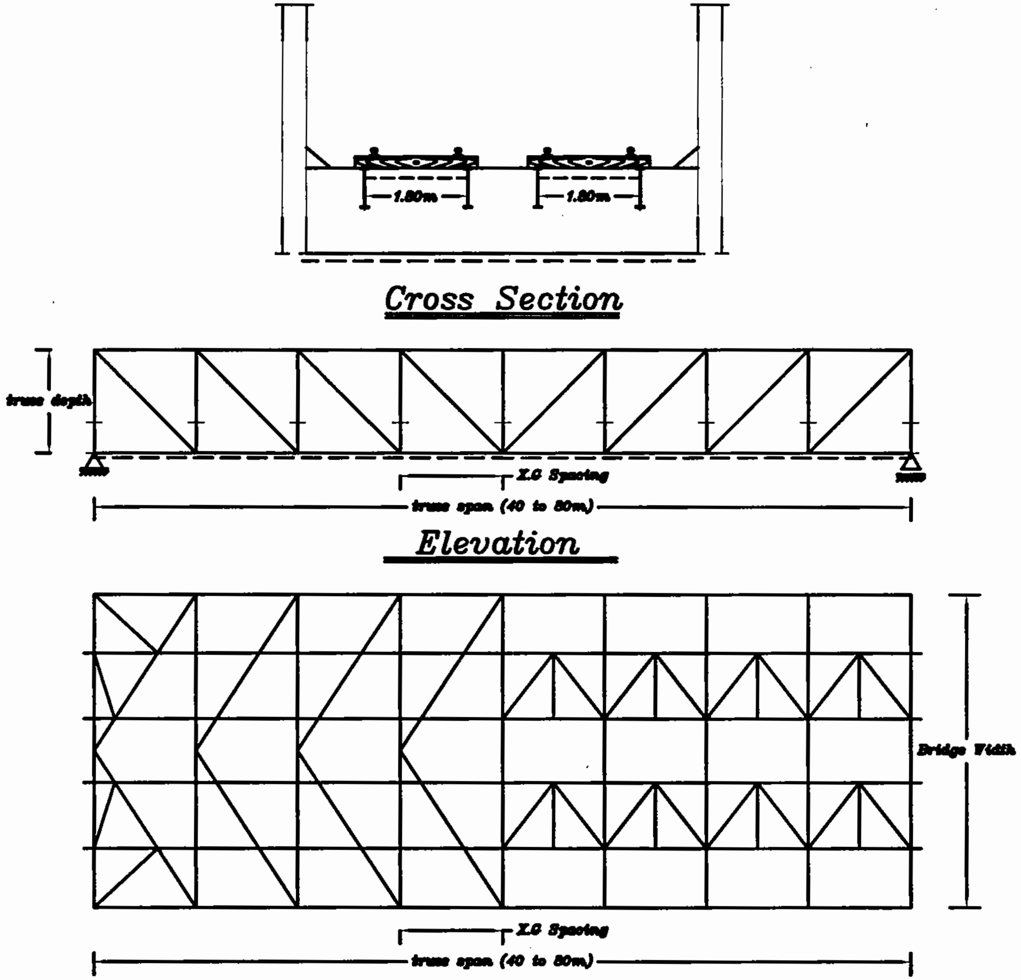



plan of upper bracing




plan of lower bracing

## truss Pony bridge railway Double track

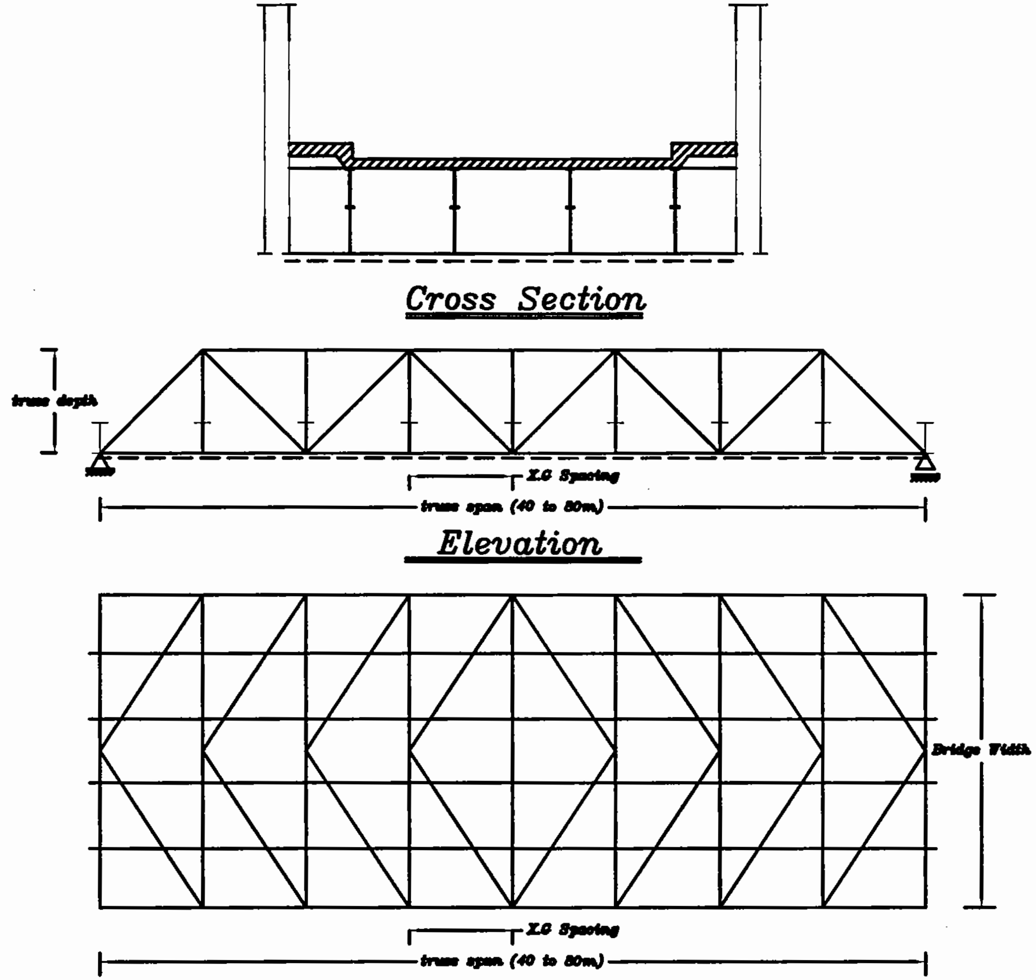



**Cross Section**

**Elevation**

**plan of lower bracing**

## truss Pony bridge road way



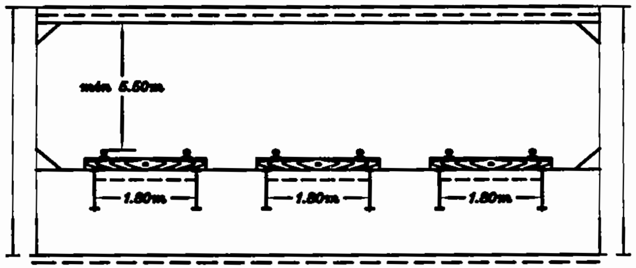

**Cross Section**

**Elevation**

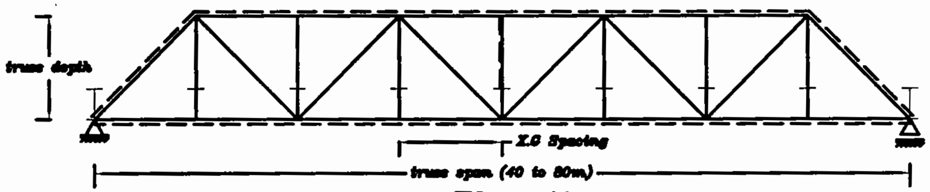
**plan of lower bracing**

هذا الشكل مفضل تماما لل Pony Bridge

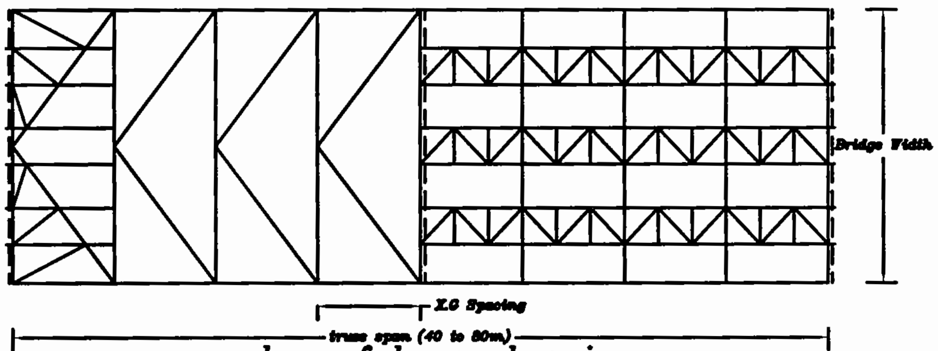
## truss through bridge rail way triple track (1)



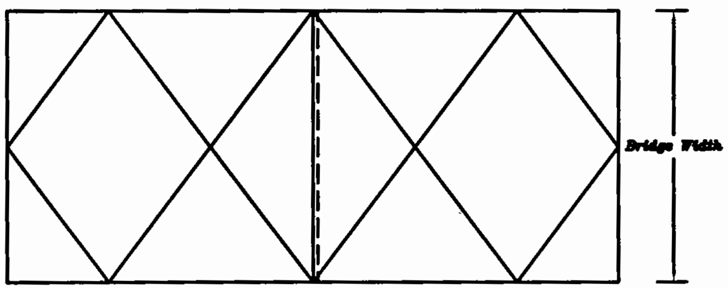

Cross Section




Elevation

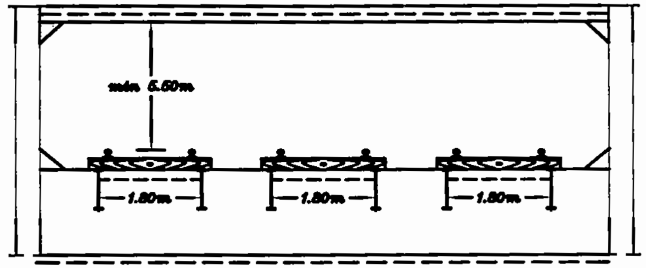



plan of lower bracing

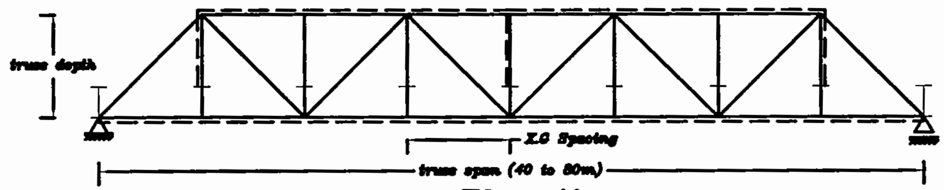



plan of upper bracing

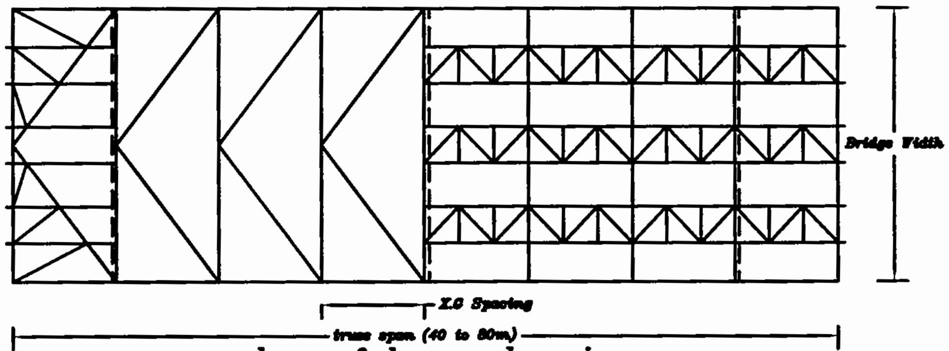
## truss through bridge rail way triple track (2)



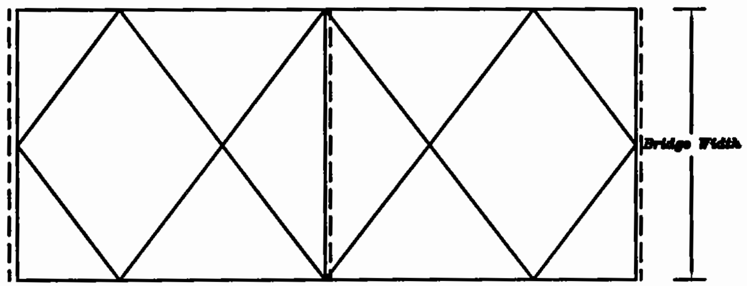

Cross Section




Elevation

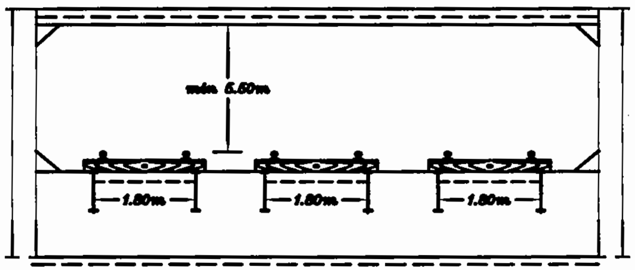



plan of lower bracing

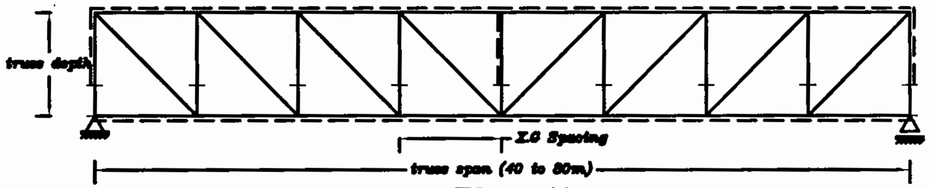



plan of upper bracing

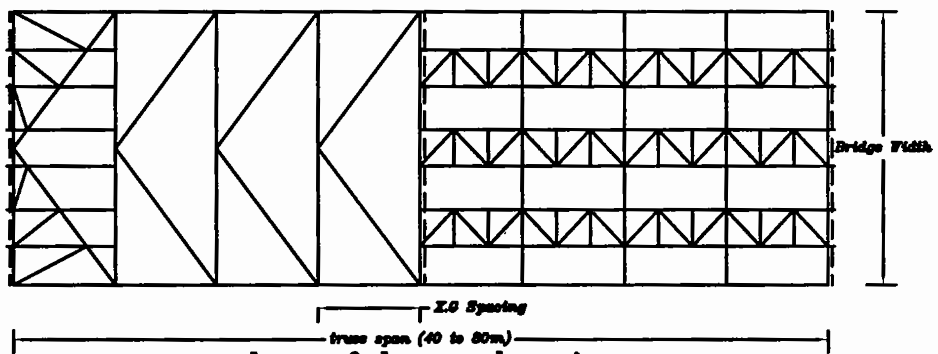
## truss through bridge rail way triple track (3)



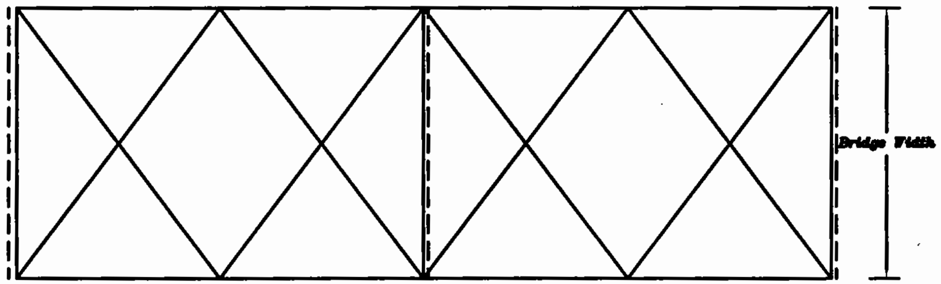

Cross Section




Elevation

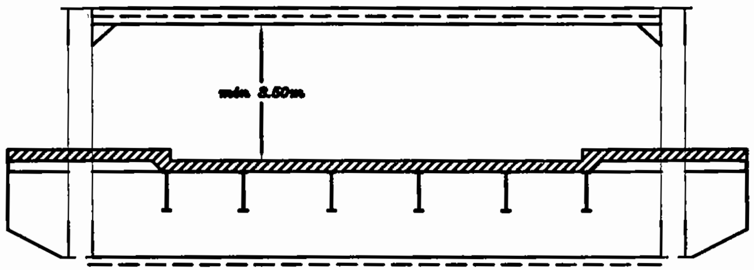



plan of lower bracing

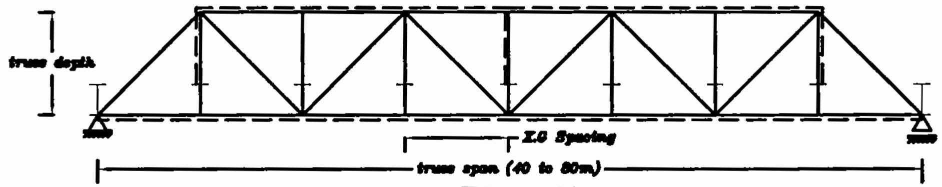



plan of upper bracing

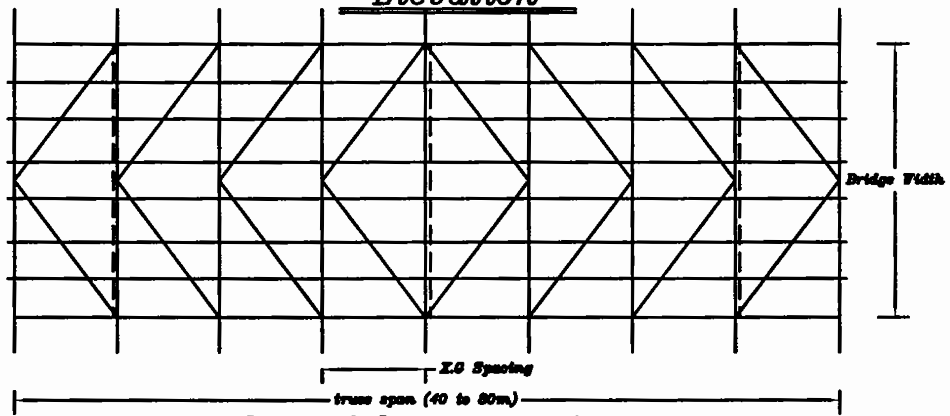
## truss through bridge roadway



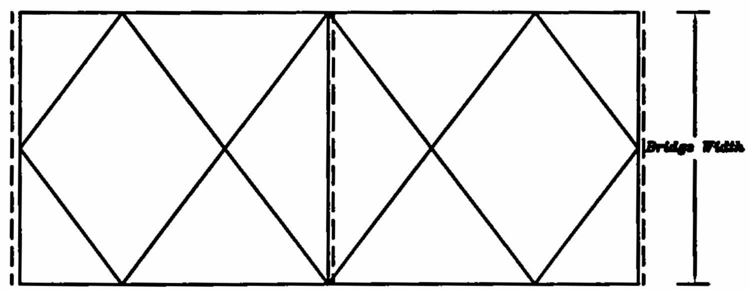
Cross Section




Elevation



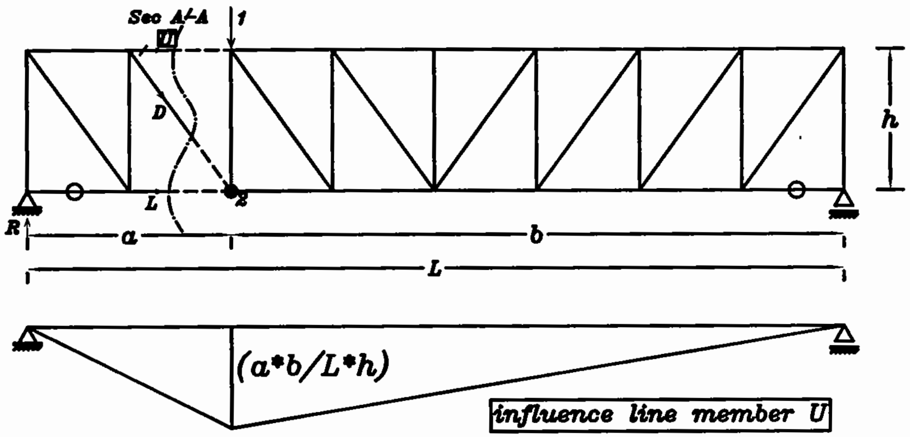

plan of lower bracing



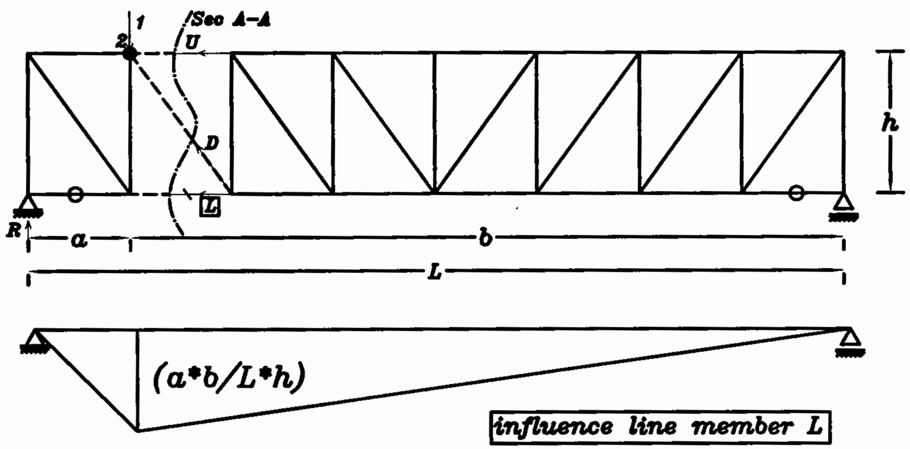

plan of upper bracing

## 13–Maximum Forces in truss members

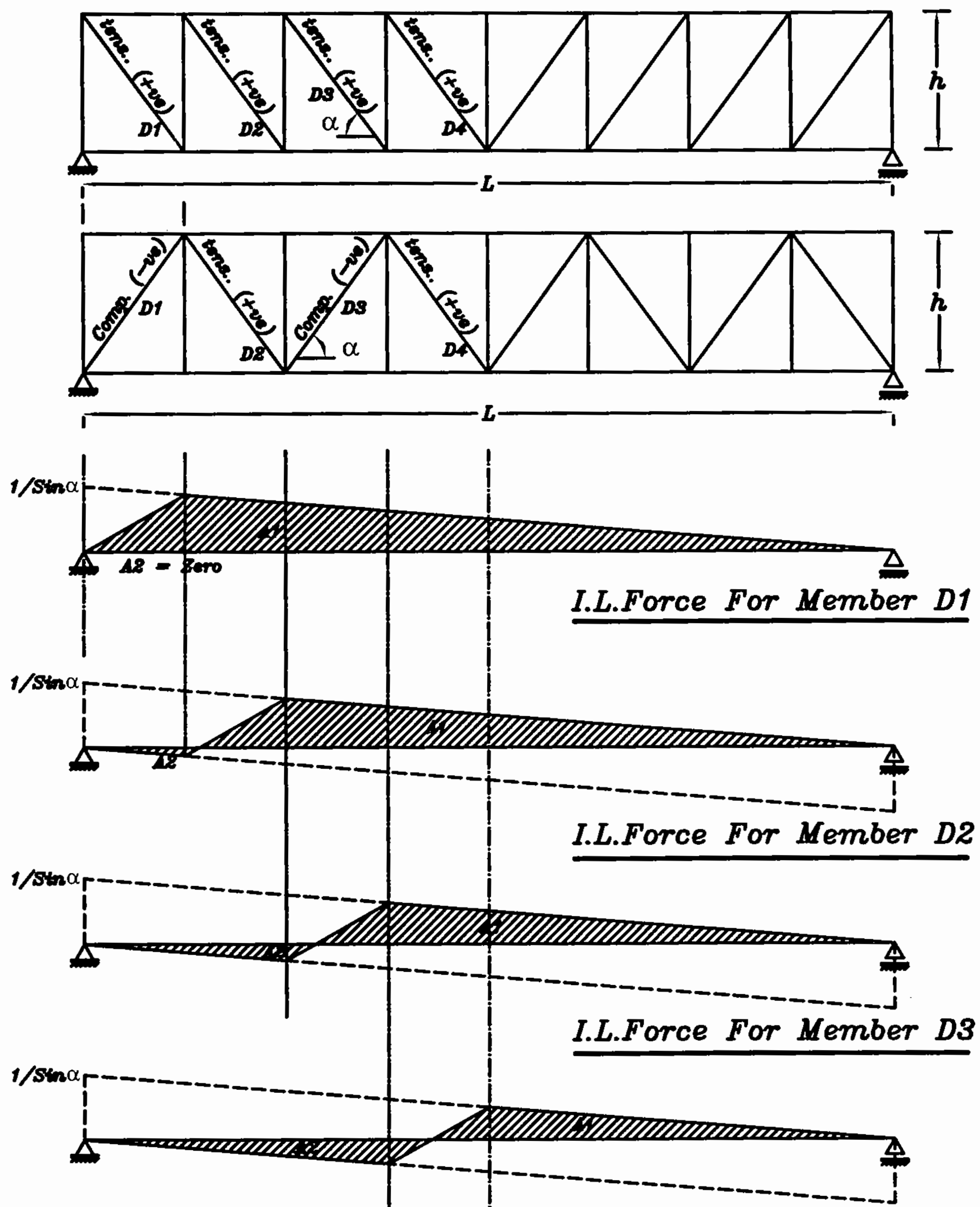
### a) Upper Chord (Comp.)




### b) Lower Chord (tension)



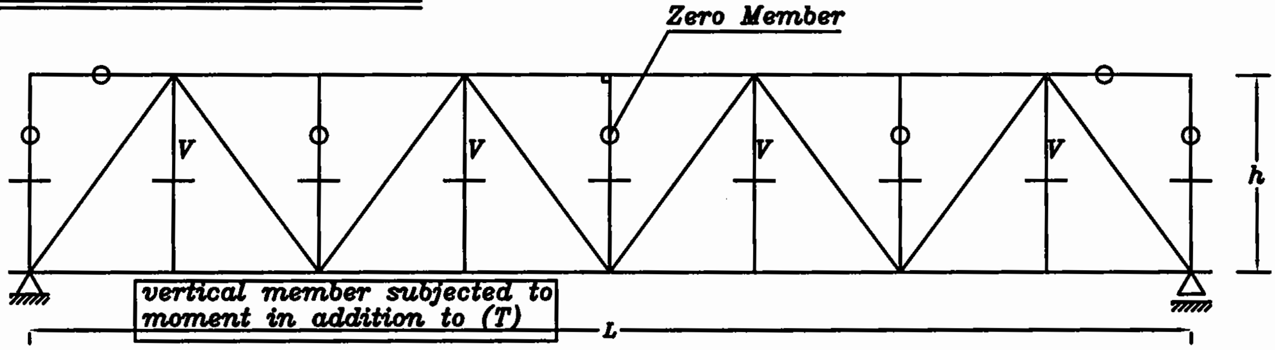

### c) I.L.Force For Diagonal Member



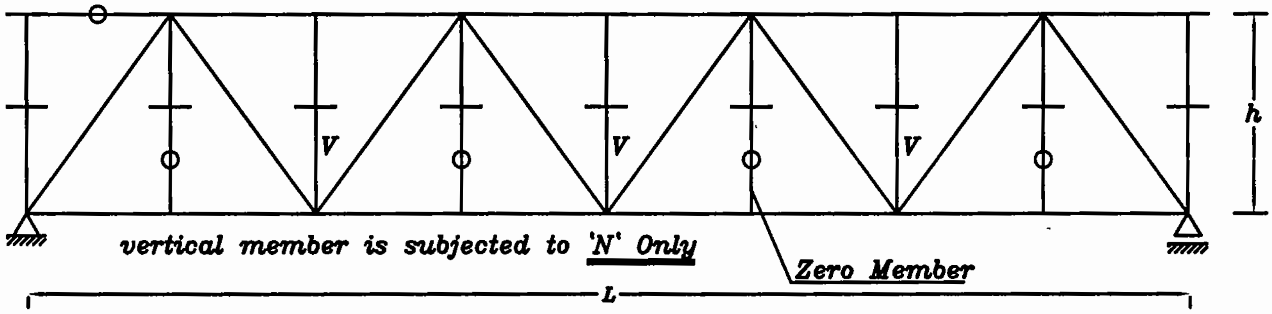

الاشارات الموضحة على الMembers تاتى نتيجة تحميل المساحة A1

# d–Calculating Force in Vertical Chord

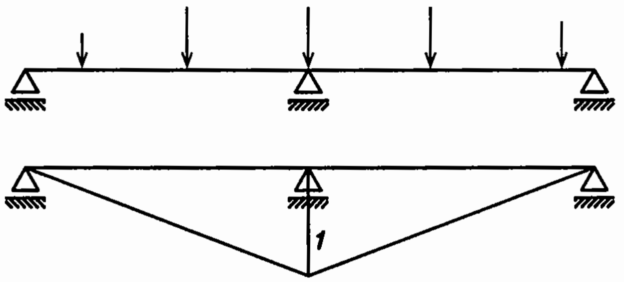
## d–i Warren truss




all Vertical member in pony bridge is **tension member**



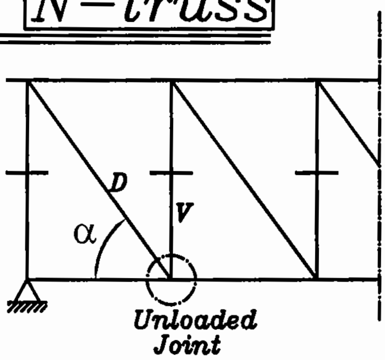

all Vertical member in Deck bridge is **Compression member**

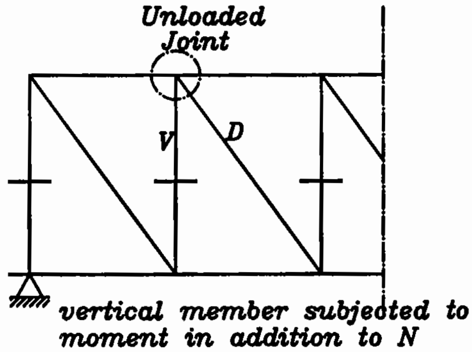



I.l.Force Vertical Member

**tension Or Compression**

## d–ii N–truss




$F_V = F_D * \sin\alpha$

if Diagonal member is tension then the vertical member is compression member

لاحظ انه يتم تحليل ال Joint التى ليس عندها X.G للحصول على ال Force داخل ال Vertical Member