مراجعه Steel
رابعه انشاءات
م/ رمزي (1)

ج ٣,٢٥

Final Term Revision

Part (1-A)

Summary

2013-2014

Revision Content

Summary For :-

1-Genral Lay out (Road+Rail)

2-Loads On Stringer (Road+Rail)

3-Design of Stringer as Hot Rolled

4-Loads On Cross girder (Road+Rail)

5-Loads On Main girder (Road+Rail)

6-Design of Built-Up Section

7-Lateral torsional buckling of comp. flange

8-Curtailment of Flange plate for Main girder

9-Check web buckling

10-Design of Web Stiffeners

11-Design of Field Splice

Mid term Revision

1-General Lay Out

تكون المعلومات المعطاه فى الامتحان لرسم اى *Lay Out* هى

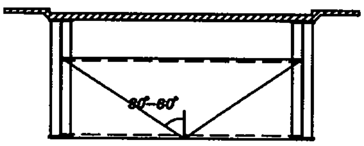
1-Bridge Span "L" طول الكوبرى

2-Bridge Width "B"

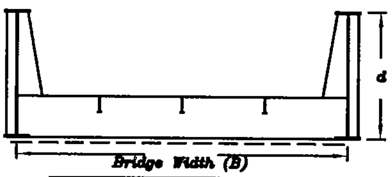
3-Side Walk Length in case of road way bridge

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 deck bridge



Cross section of Pony 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 "X" or "V" Frame

B-available height of Construction Ha

Road Way

if

+2 Cm safety
+L/600 deflection
+6 Cm flanges
$\frac{L}{10}$ +30 Cm

$< Ha$

∴ Use Deck Bridge

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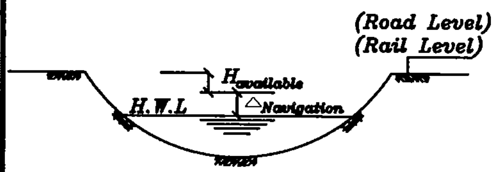
if $Hc > Ha$

∴ 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

$\triangle_{Navigation}$ ⟶ Given

$H_{available}$ ⟶ Required

$$H_{available} = \text{Road Level} - \text{H.W.L} - \triangle_{Navigation}$$

ثم يتم معرفة نوع الكوبرى مثل الحاله 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*

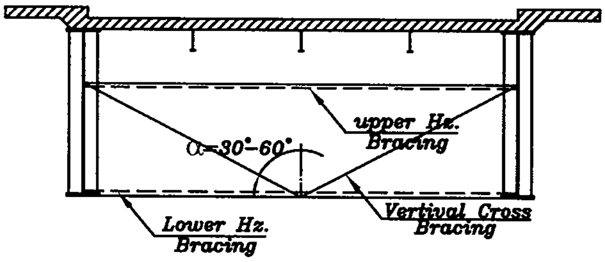
$$d_{X.G}=\frac{B}{7\longrightarrow 9} \qquad d_{Stringer}=\frac{S}{10} \qquad d_{M.G}=\frac{L}{10}$$

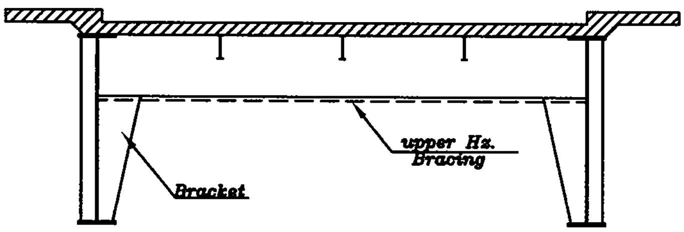
٣-يتم تحديد نوع ال *Wind Bracing* على الكوبرى

يتم استخدام *V-Bracing* اولا واذا لم تكن الزاويه ما بين $30^\circ-60^\circ$

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 ال *Pony Bridge* لا يتم استعمال الا *Bracket*

٤-يتم رسم ال *Plan* 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*

$h_{M.G} \ngtr 1$ → *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

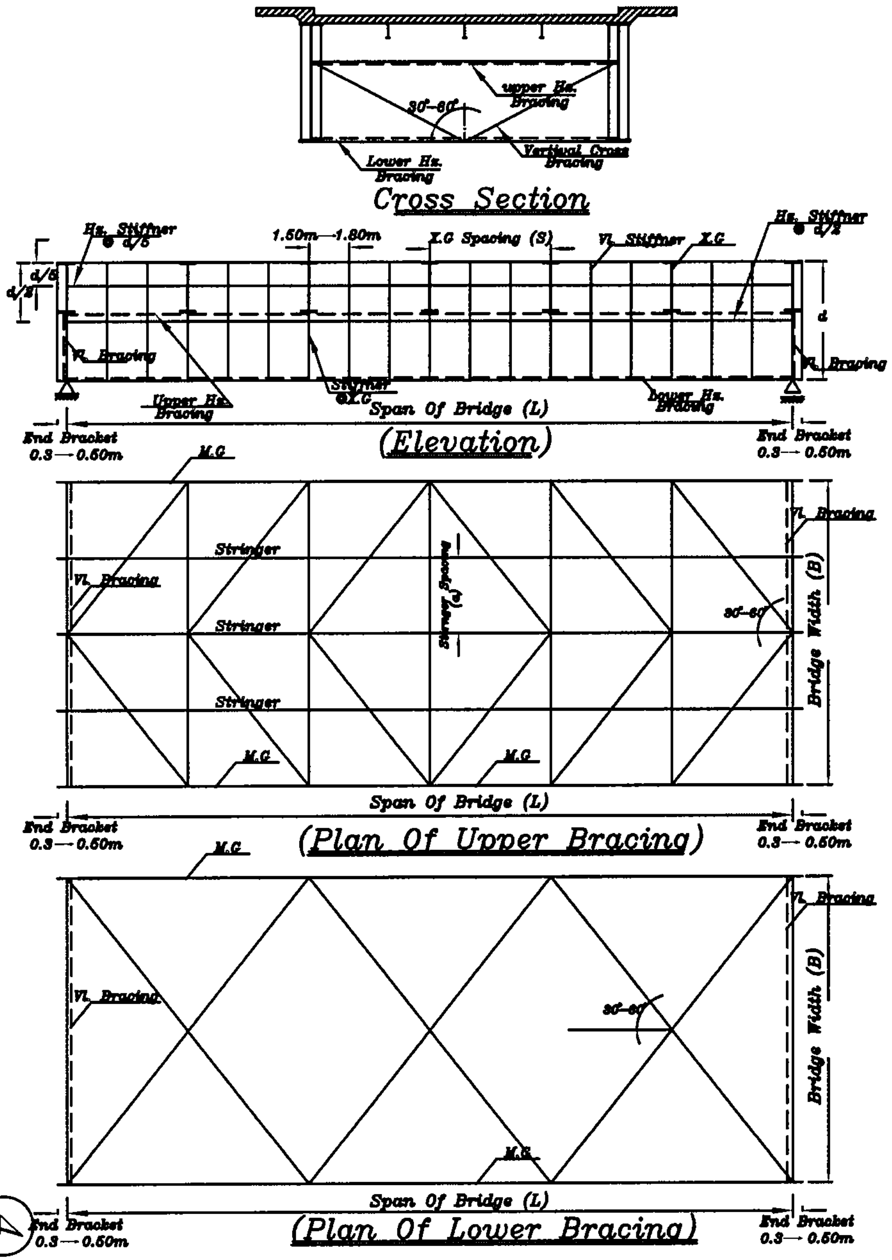


Plate Girder Deck Bridge Rail Way With Vertical Bracing (Single Track)

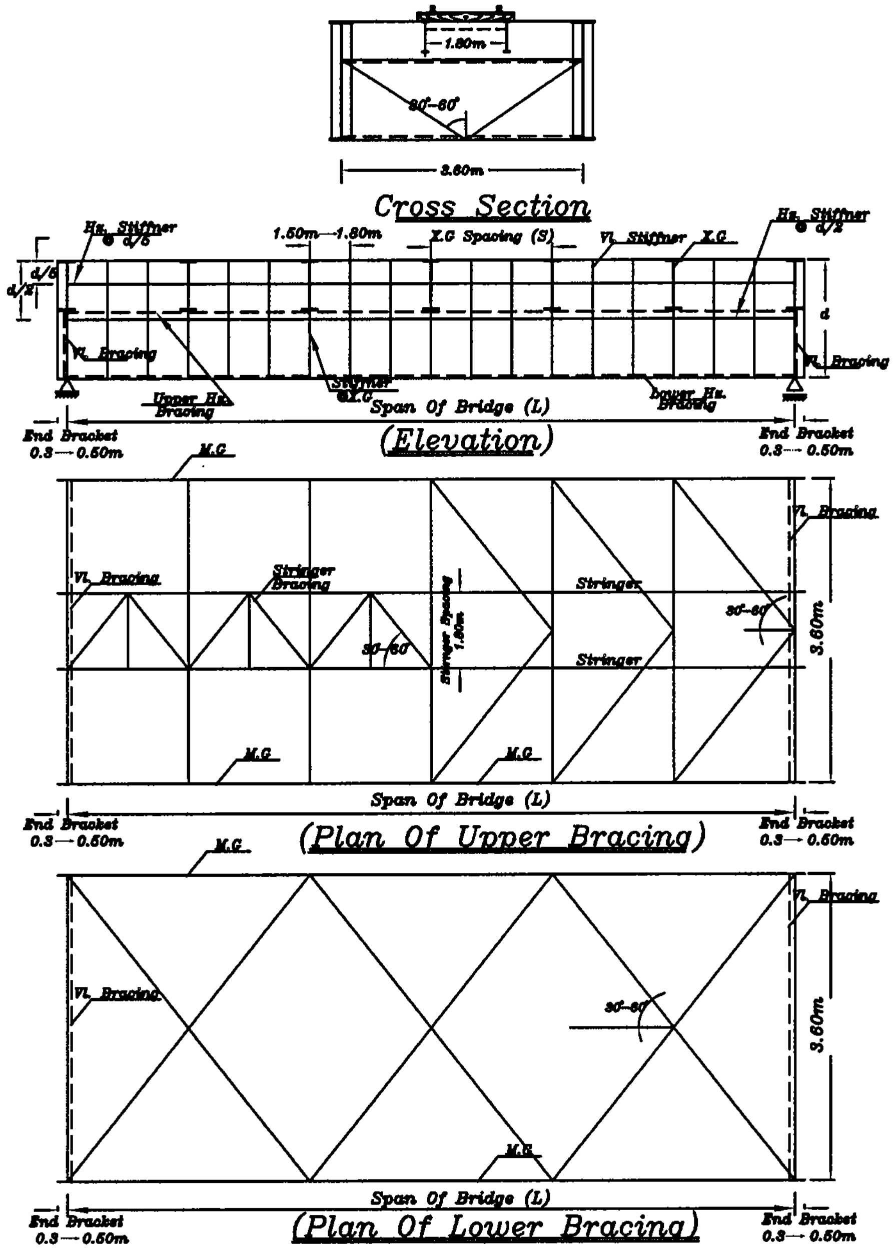


Plate Girder Road Way Pony Bridge

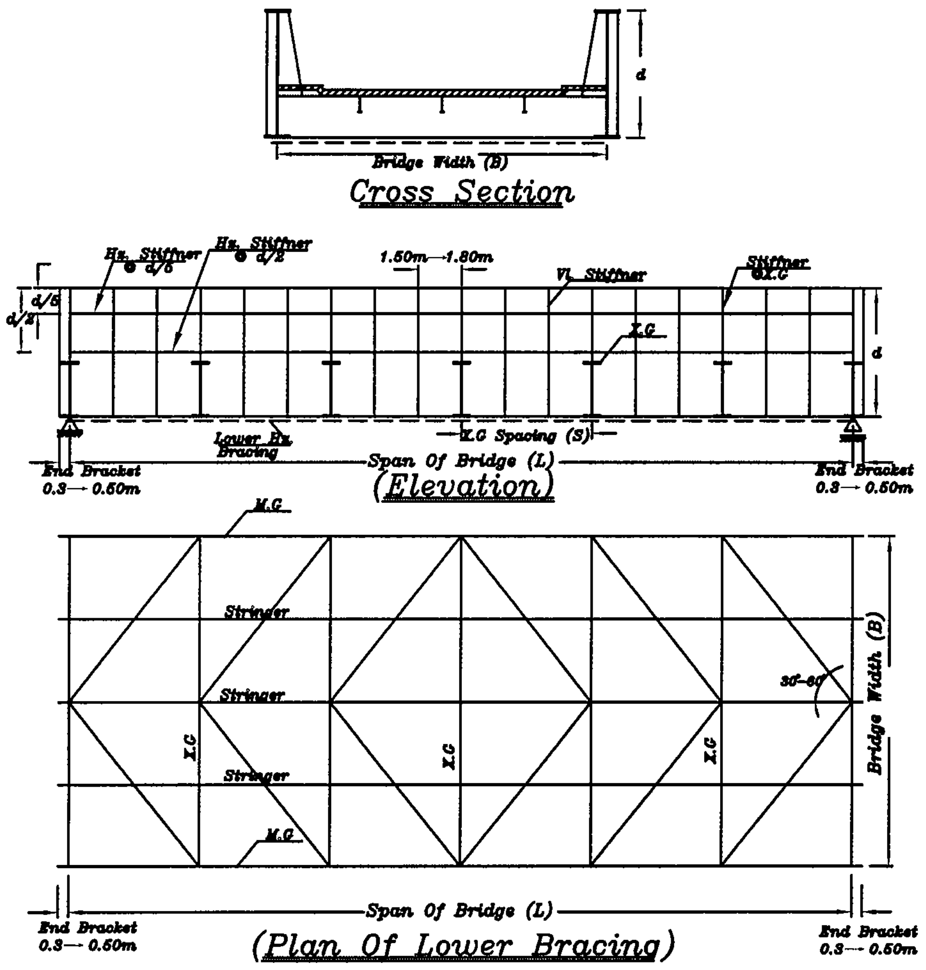


Plate Girder Rail Way Pony Bridge Single track

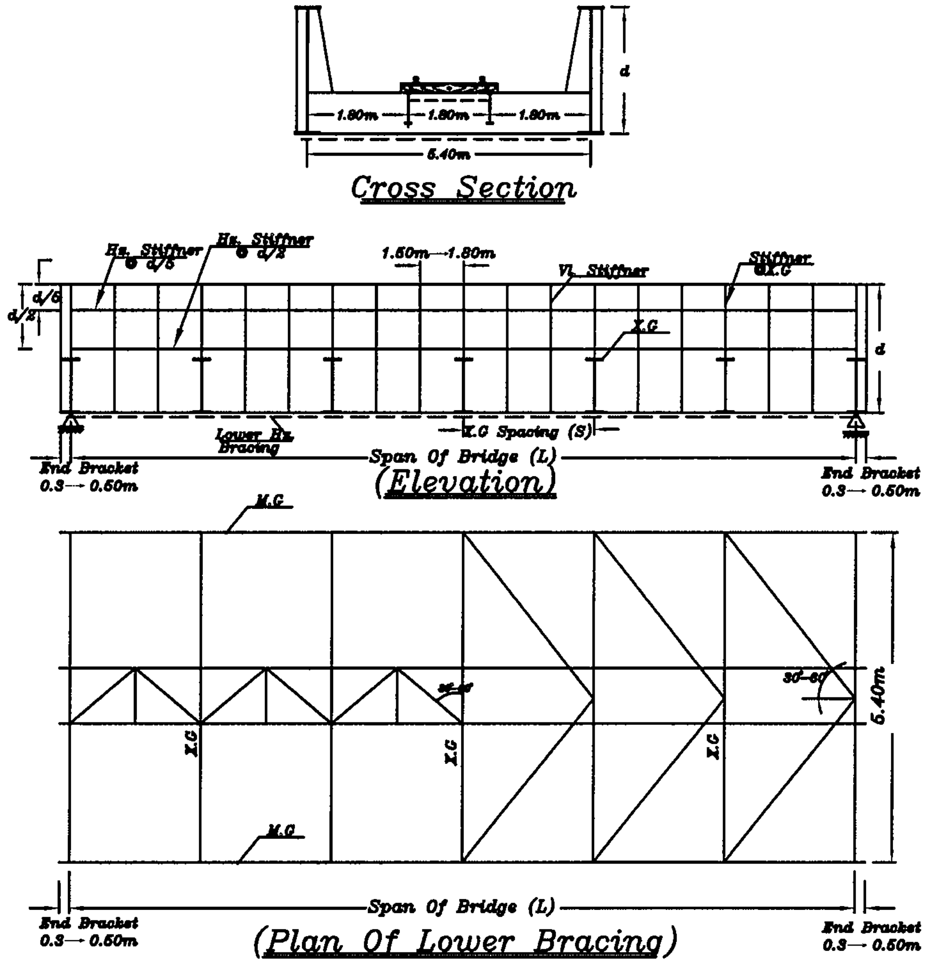


Plate Girder Rail Way Semi-Deck Bridge With U-Frame (Double track)

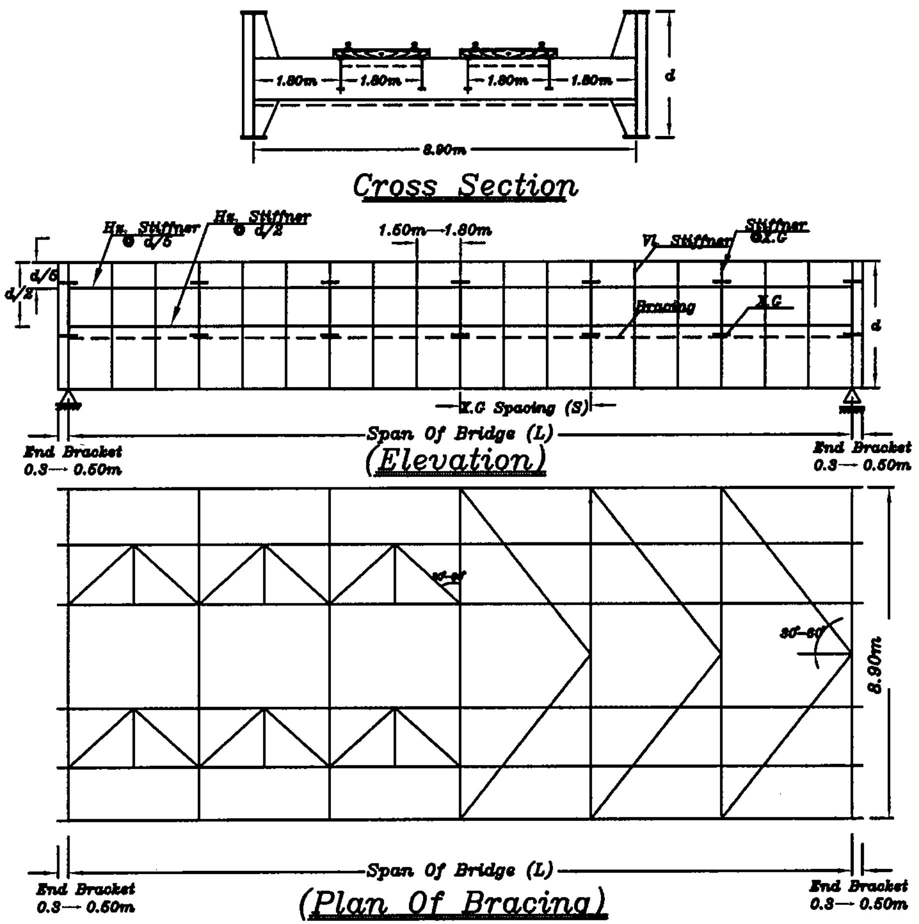


Plate Girder Road Way Semi-Deck Bridge With U-Frame

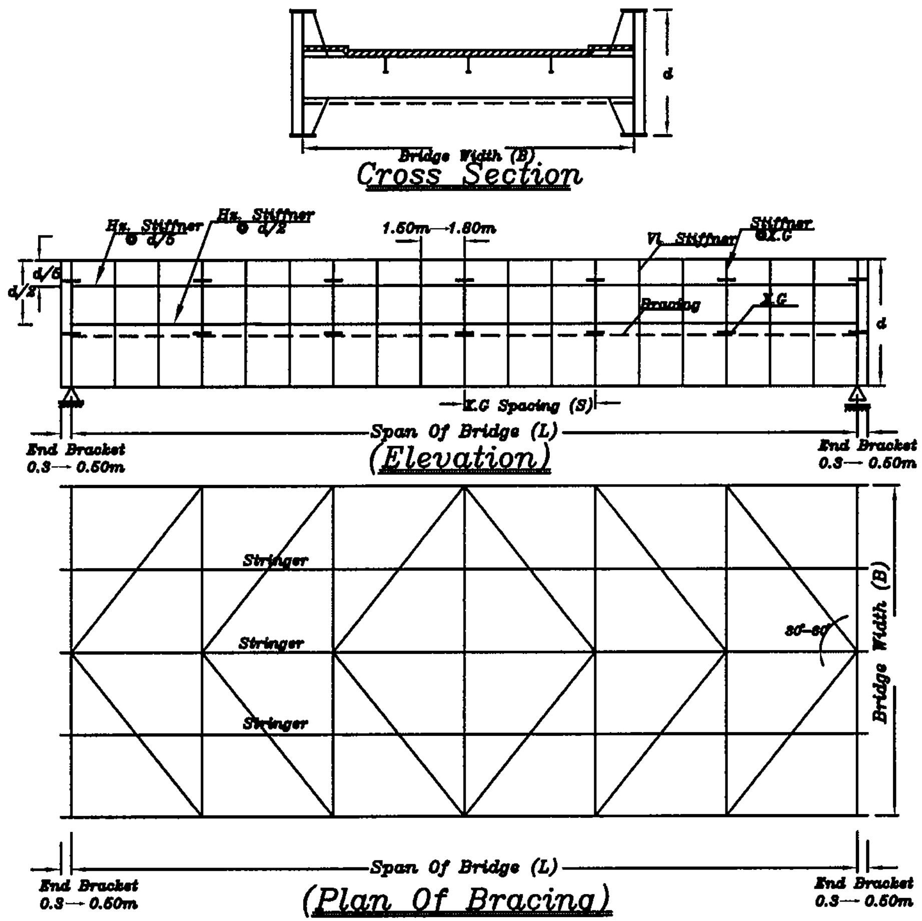
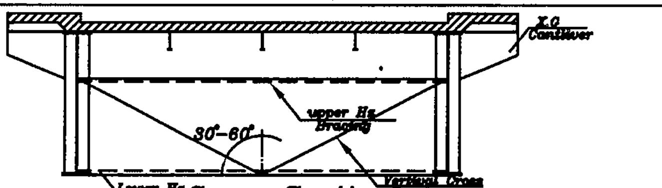
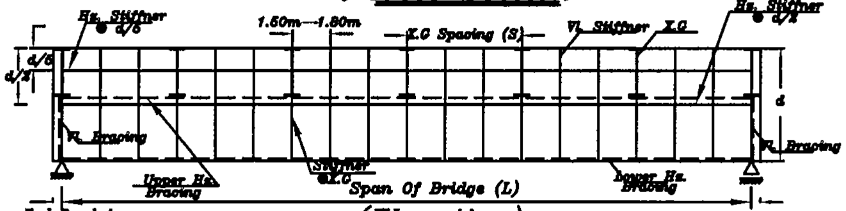


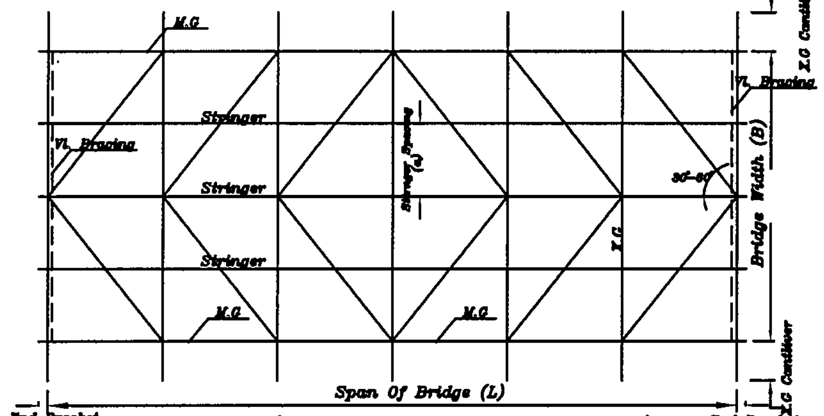
Plate Girder Deck Bridge Road Way With Vertical Bracing and Double Cantliver X.G



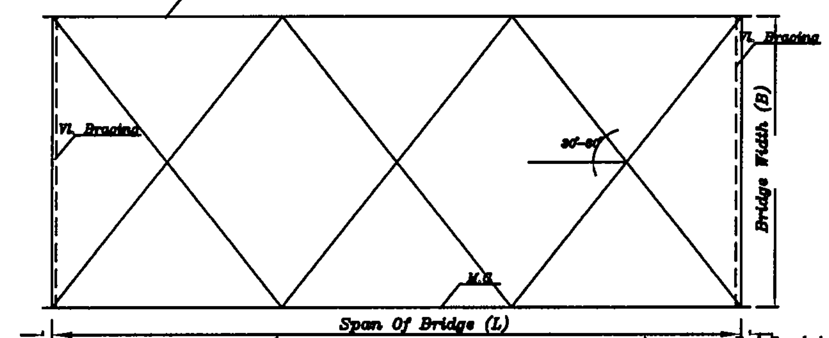
Cross Section



(Elevation)

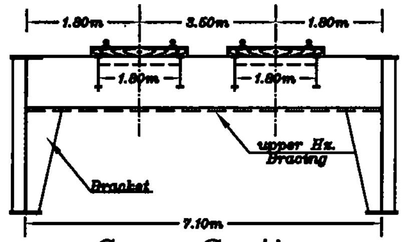


(Plan Of Upper Bracing)

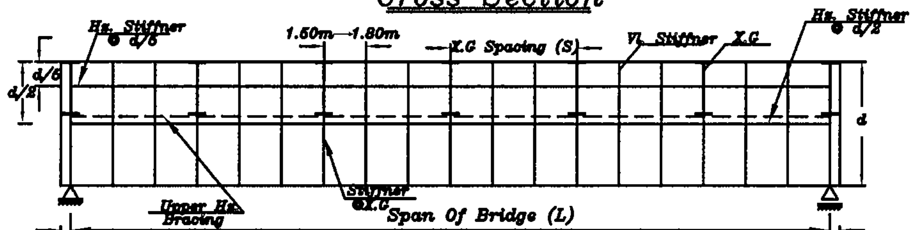


(Plan Of Lower Bracing)

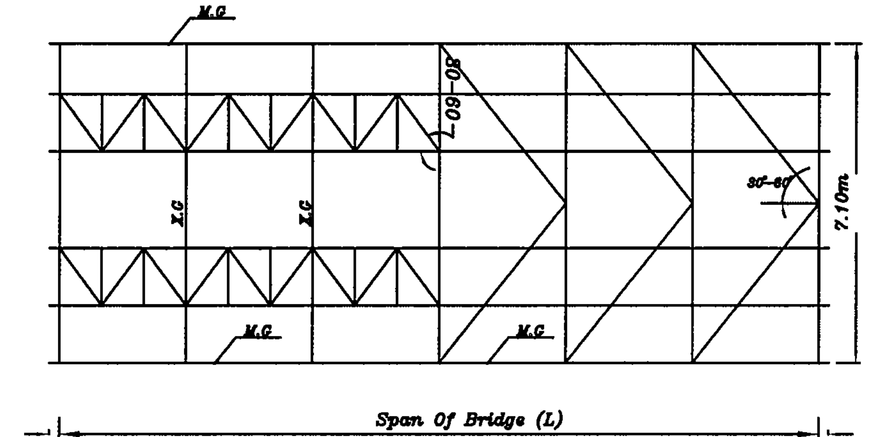
Plate Girder Deck Bridge Rail Way With U-Frame (Double track)



Cross Section

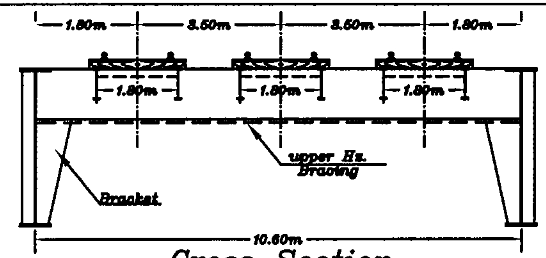


(Elevation)

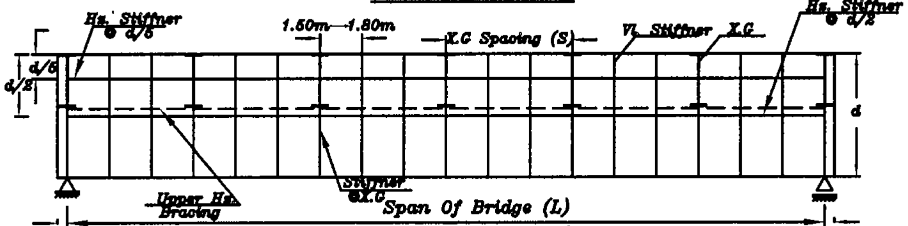


(Plan Of Upper Bracing)

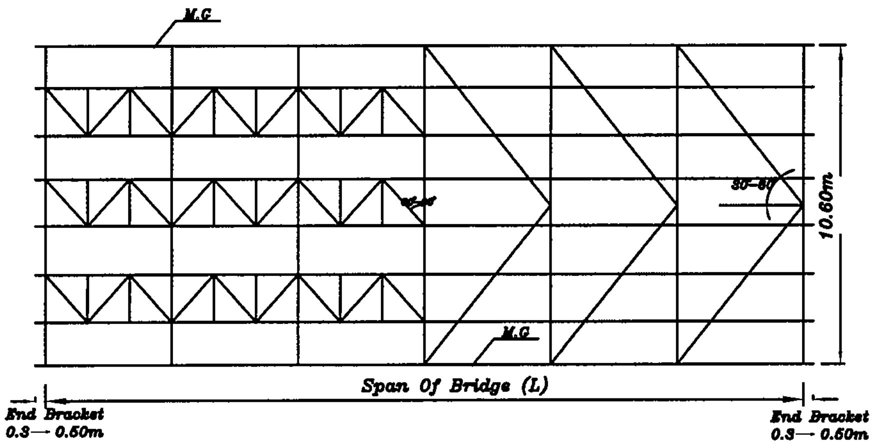
Plate Girder Deck Bridge Rail Way With U-Frame. (triple track)



Cross Section

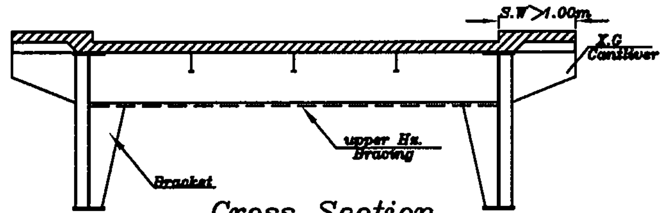


(Elevation)

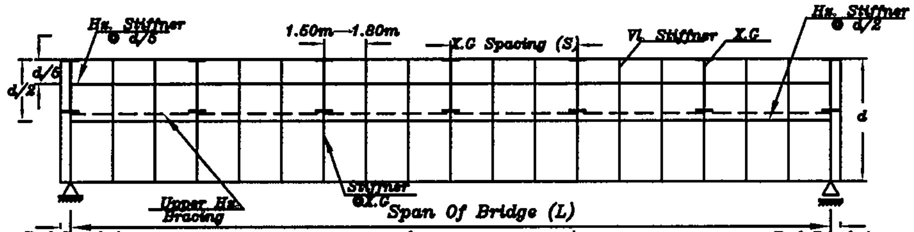


(Plan Of Upper Bracing)

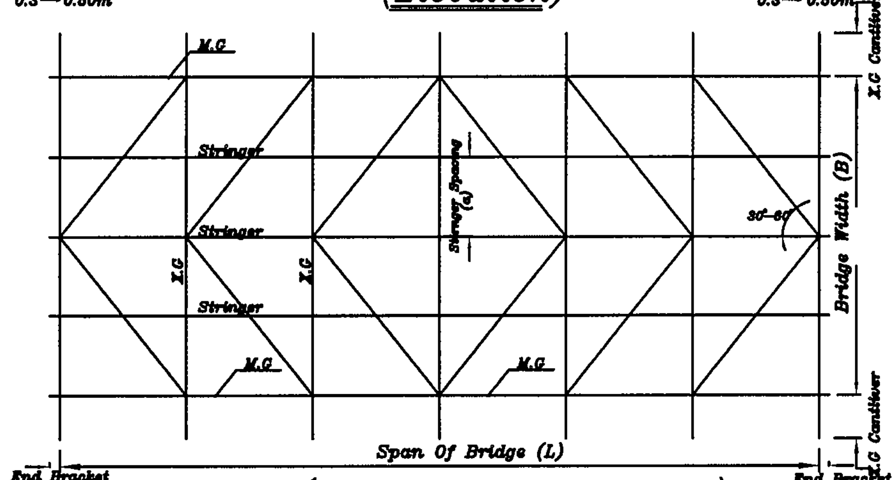
Plate Girder Deck Bridge Road Way With U-Frame and Double Cantliver X.G



Cross Section



(Elevation)



(Plan Of Upper Bracing)

2-Loads On Stringer

2-a-Road Way Bridge

1) Dead Loads

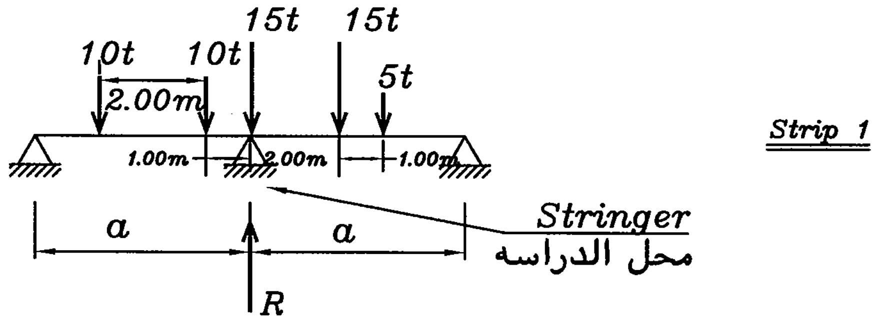
$W_{Dead} = (t_S * \gamma_c + F.C) * \text{stringer Spacing} + O.W$

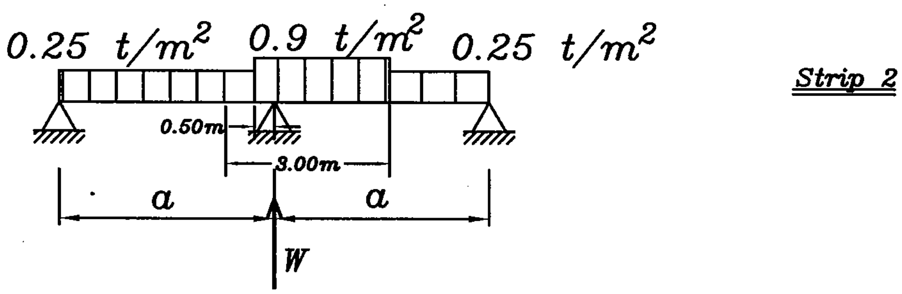
$W_{Dead} = (0.21m * 2.5t/m^3 + 0.175t/m^2) * a + 0.15t/m' = ...t/m'$

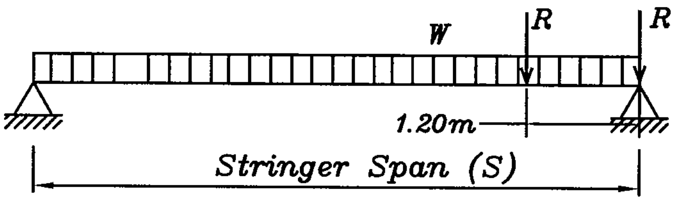
$M_d = \frac{W_d * S^2}{8} = ...\ m.t \qquad Q_d = \frac{W_d * S}{2} = ...t$

2) Live Loads + Impact

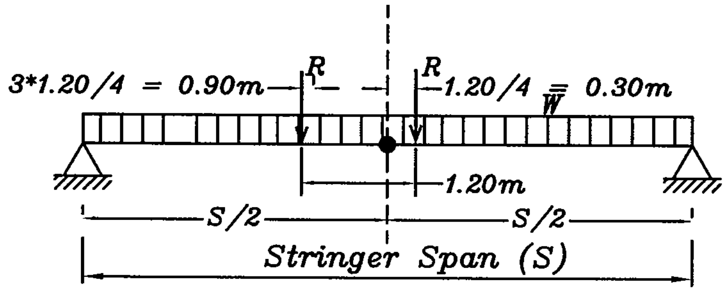
دائما يكون هناك شريحتان فقط الاولى داخل العربه ال ٦٠ وال ٤٠ طن والثانيه خارج العجل فى ال $0.9\ t/m^2$, $0.25\ t/m^2$







Max. S.F.D

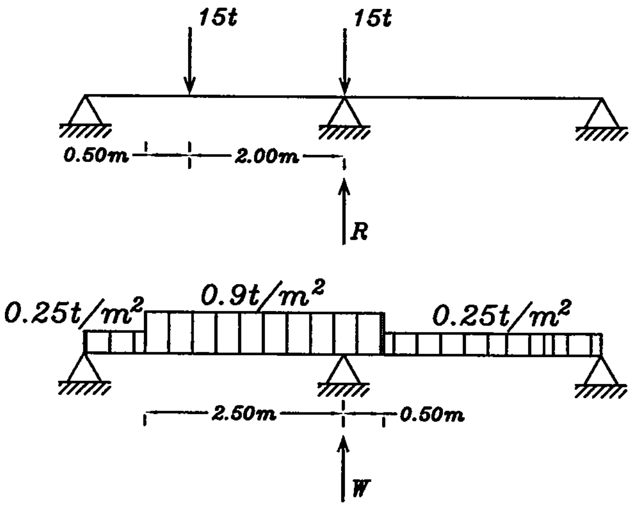


Max. B.M.D

in Case of Median

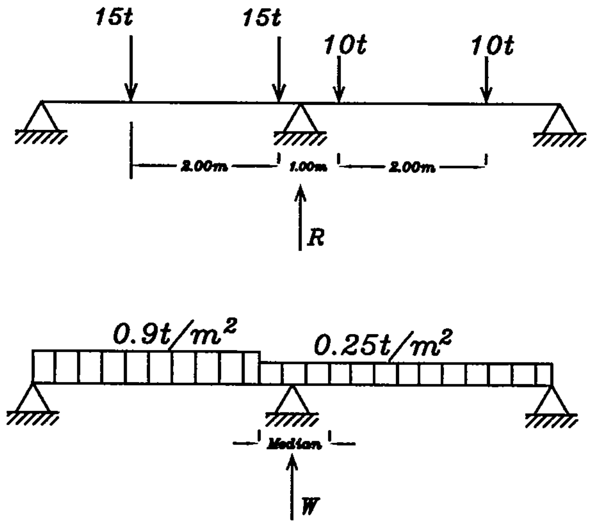
Lane ≯ 6.00m

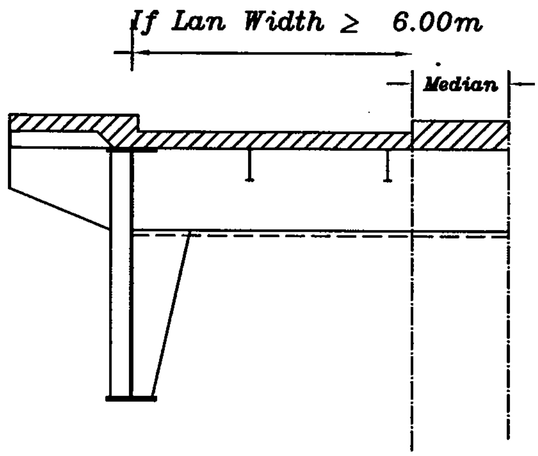
يتم وضع العربه ال ٦٠ طن فقط فى الحارة الواحده



Lane > 6.00m

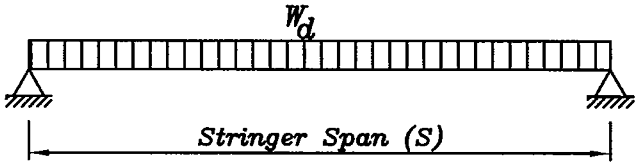
يتم وضع العربتان ال ٦٠ و ٤٠ طن فى حارة واحده



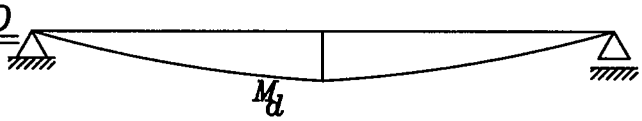


2-Loads On Stringer
2-b-Rail Way Bridge

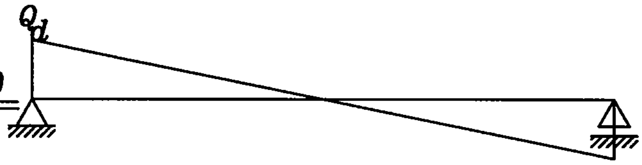
$W_{Dead} = 600/2 + 50/2 + O.W = ...Kg/m'$



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



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

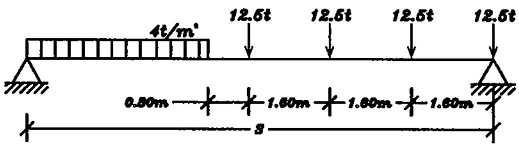


1) Live Loads

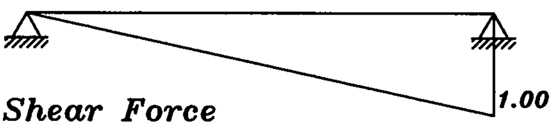
$$(1+I) = 0.73 + \frac{2.16}{\sqrt{L_1} - 0.2}$$

بحيث ان لايقل (1+I) عن 1.1 ولايزيد عن 2.0

Max. Shear



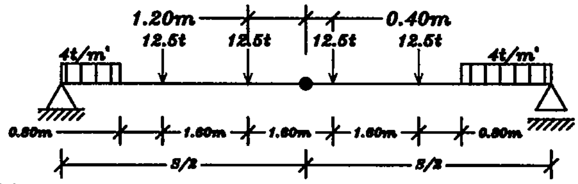
Max. Shear



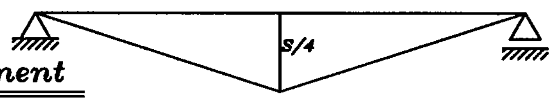
I.L Shear Force

Max. Moment

فى حالة ان بحر الكمرة اكبر من 4.80m يتم تحميل الحالة الاتية

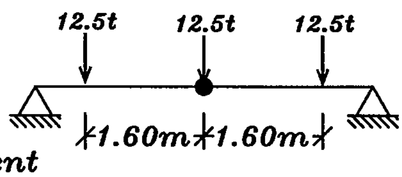


Max. Moment

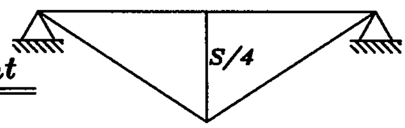


I.L Moment

فى حالة ان بحر الكمرة اصغر من 4.80m يتم تحميل الحالة الاتية



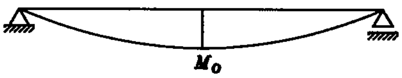
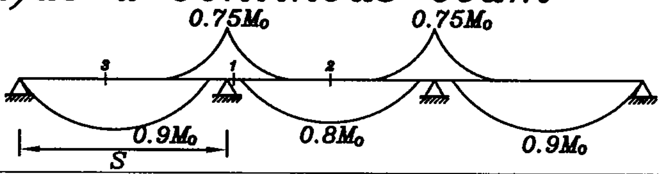
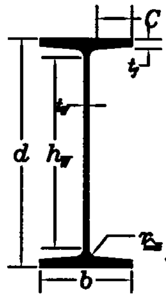
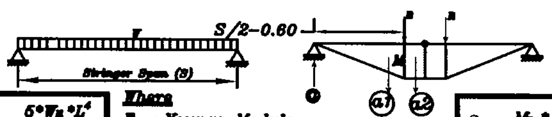
Max. Moment



I.L Moment

3-Design Of Stringer as Hot Rolled

3-a-Road way Bridge

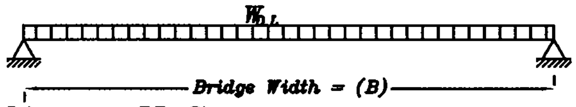
Steps	i)as a simple beam	i)as a Continous beam
		
A-Choice Of Section	assume Compact Sec. $\therefore F_t = 0.64F_y$ → $2.8 t/Cm^2$ St.44, → $3.6 t/Cm^2$ St.52 2) Calculate S_x $S_x = \frac{M_{d+LL+I}}{0.64F_y}$ → I.P.E, I.P.N, H.E.B	assume Compact Sec. $\therefore F_t = 0.64F_y$ → $2.8 t/Cm^2$ St.44, → $3.6 t/Cm^2$ St.52 2) Calculate S_x $S_x = \frac{0.9M_{d+LL+I}}{0.64F_y}$ → I.P.E, I.P.N, H.E.B للتسهيل يتم الاختيار على العزم الكبير
B-Compactness	Section is Compact if $\frac{C}{t_f} < \frac{16.9}{\sqrt{F_y}}$ $C = b/2 - t_w/2 - r$ $\frac{h_w}{t_w} < \frac{127}{\sqrt{F_y}}$ $h_w = d - 2t_f - 2r$	
C-bending	$F_b = \frac{M_{d+l+I} * 100}{S_x} = ... t/Cm^2 \le 0.64F_y$	Sec. 3 $F_b = \frac{0.9M_{d+l+I} * 100}{S_x} = ...$ $t/Cm^2 \le 0.64F_y$
d-stress range	$\frac{M_{Fatigue} * 100}{S_x} = ..t/Cm^2 \le F_{Sr} = 1.68 t/Cm^2$	Sec. 1 $\frac{0.75M_{Fatigue} * 100}{S_x} = ..t/Cm^2 \le F_{Sr} = 1.26 t/Cm^2$ Sec. 3 $\frac{0.90M_{Fatigue} * 100}{S_x} = ..t/Cm^2 \le F_{Sr} = 1.68 t/Cm^2$
e-Shear	$\frac{Q_{d+l+I}}{d_w * t_w} = ...$ $t/Cm^2 \le 0.35F_y$	$\frac{1.1Q_{d+l+I}}{d_w * t_w} = ...$ $t/Cm^2 \le 0.35F_y$
F-Deflection	 $\delta_1 = \frac{5 * W_s * L^4}{384 * E * I}$ Where E → Youngs Modulus I → Inertia of Stringer about X-X $\delta_2 = \frac{M_s * 10^6}{E * I_s}$ $\delta_F = \delta_1 + \delta_2 \ngtr \frac{Span}{600}$	$\triangle_{Continous} = 0.80 \triangle_{Simple} \ngtr \frac{Span}{600}$ If Check C Unsafe increase Sec. no.

4-Loads On cross Girder

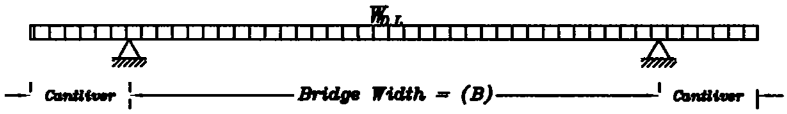
4-a-Road Way Bridge

1) Dead Loads

Pony & Deck Without Cantliver X.G



Deck With Cantliver X.G

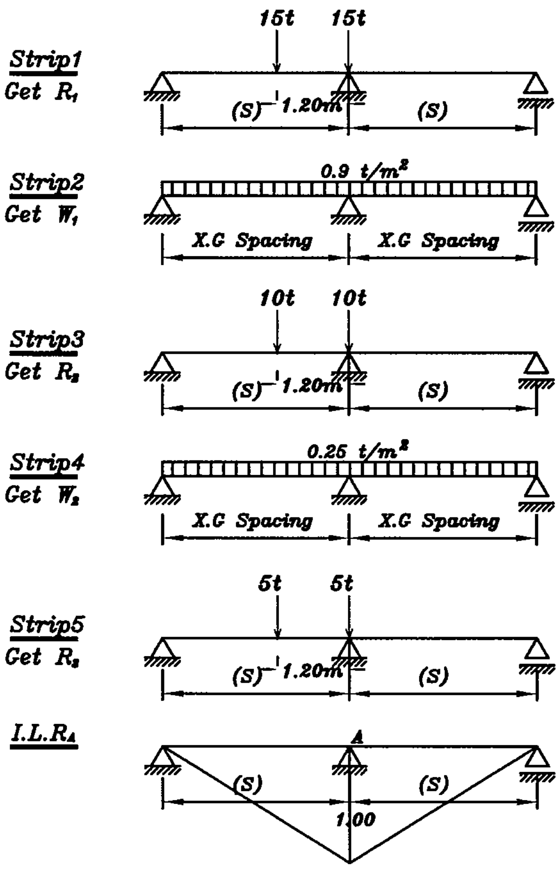


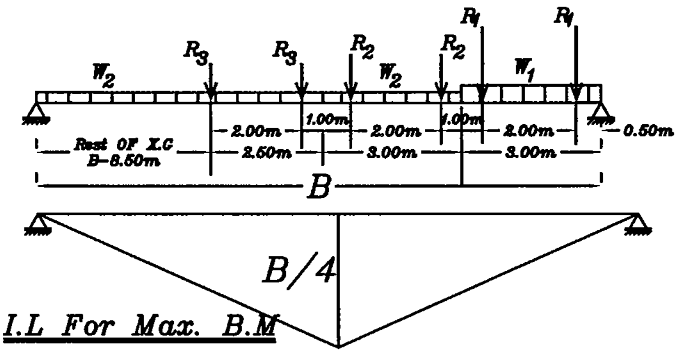
$W_{D.L}$ = (0.175+0.21*2.5+0.15/a)*S + 0.4t/m' = ...t/m'

where a = stringer spacing , S = cross girder spacing

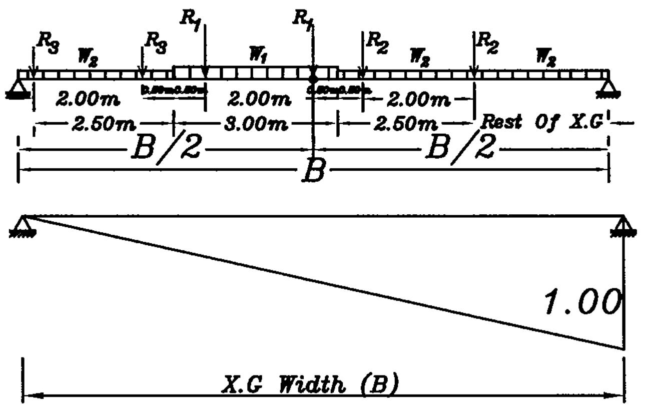
2) Live Loads + Impact

لاحظ ان هناك عدد من الشرائح الموجودة فى Cross Girder ويعتمد ظهورها على حسب بحر ال Cross Girder





I.L For Max. B.M



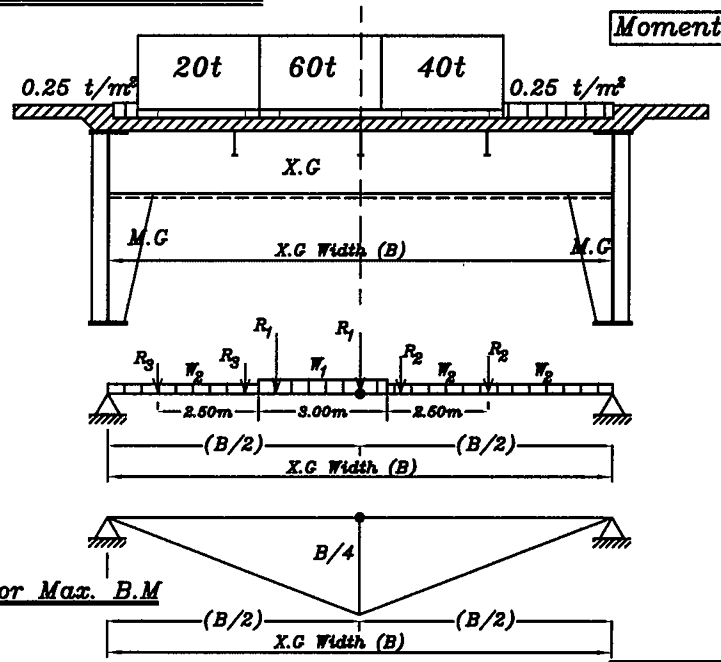
I.L For Max. S.F

Special Cases For Deck Bridge

1)Deck Bridge Without X.G Cantliver (B≥ 11.0m)

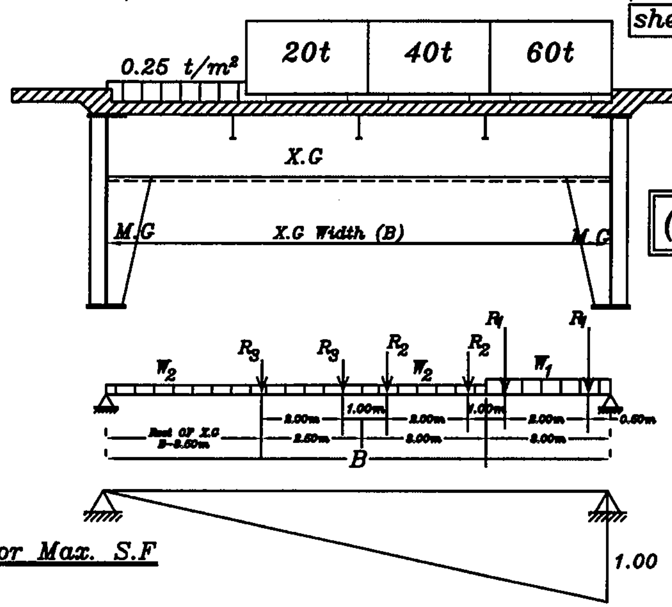
Side Walk≤ 1.00m

Moment Case



I.L For Max. B.M

shear Case



(B≥ 9.00m)

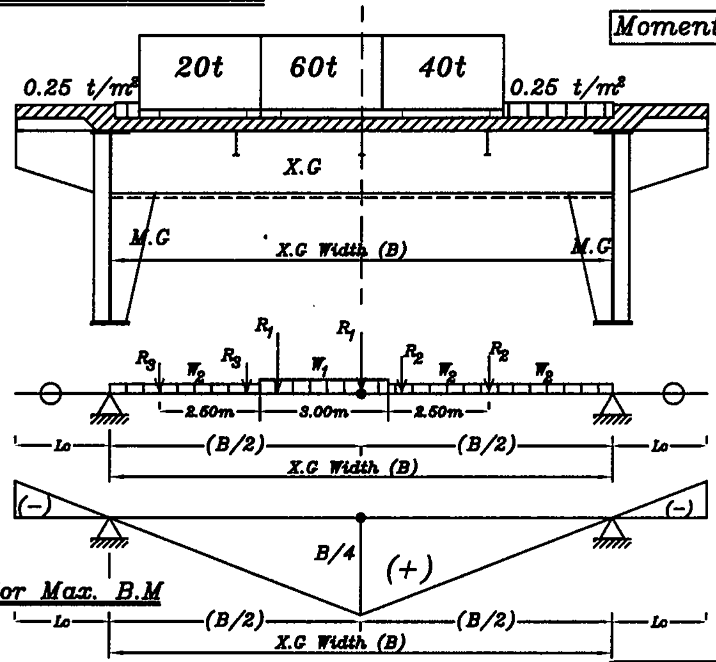
I.L For Max. S.F

Special Cases For Deck Bridge

2)Deck Bridge With X.G Cantliver (B≥ 11.0m)

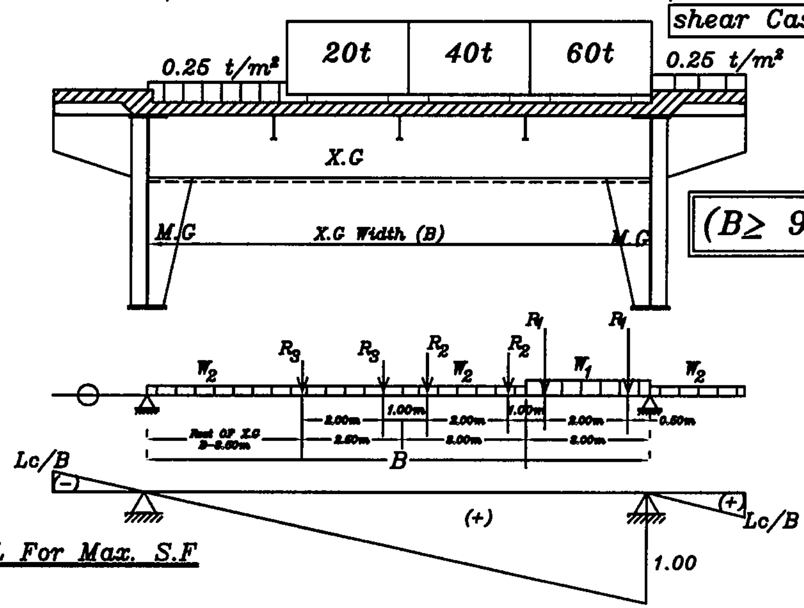
Side Walk>1.00m

Moment Case



I.L For Max. B.M

shear Case



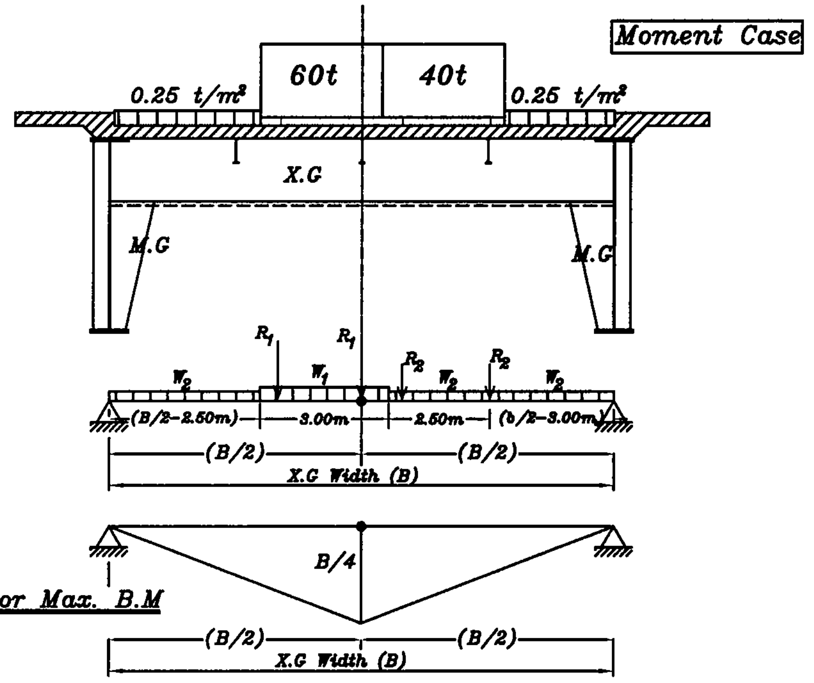
(B≥ 9.00m)

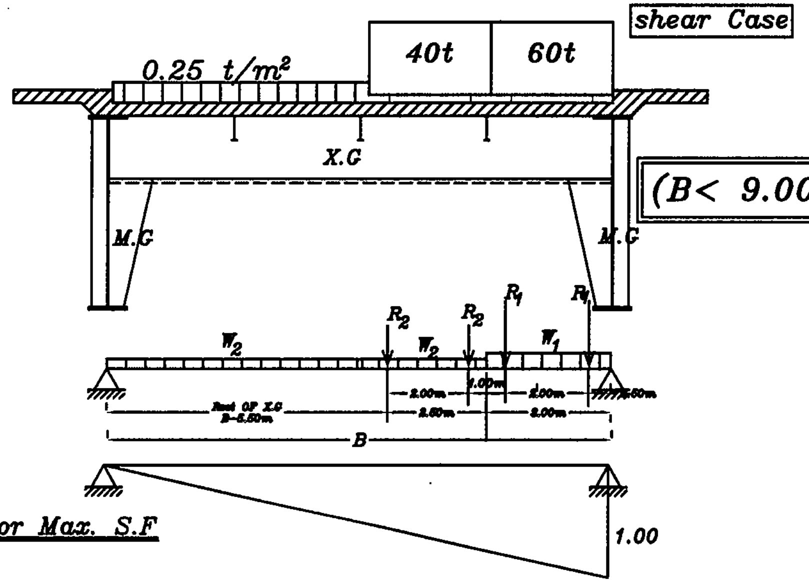
I.L For Max. S.F

Special Cases For Deck Bridge

3)Deck Bridge Without X.G Cantliver (B < 11.0m)

Side Walk≤ 1.00m



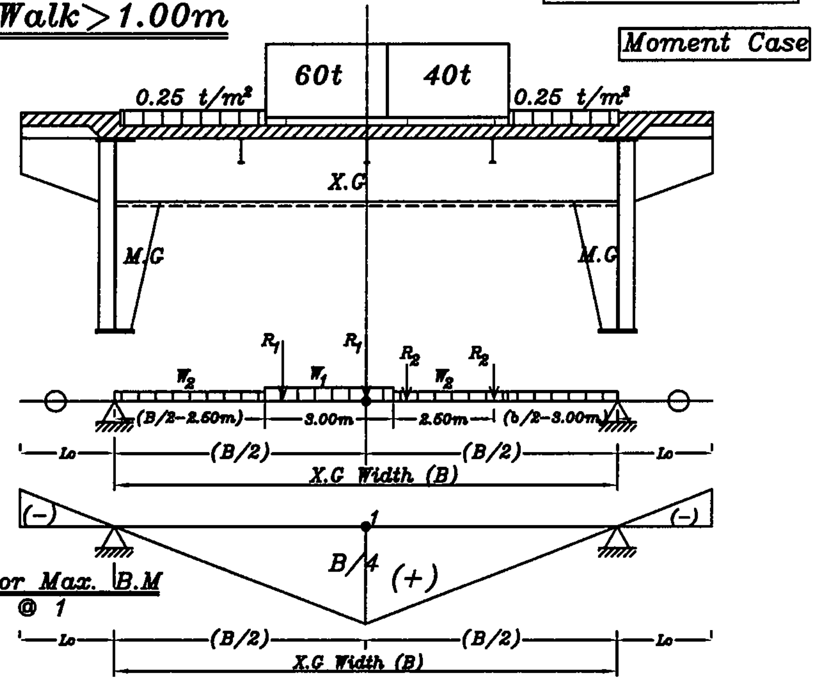


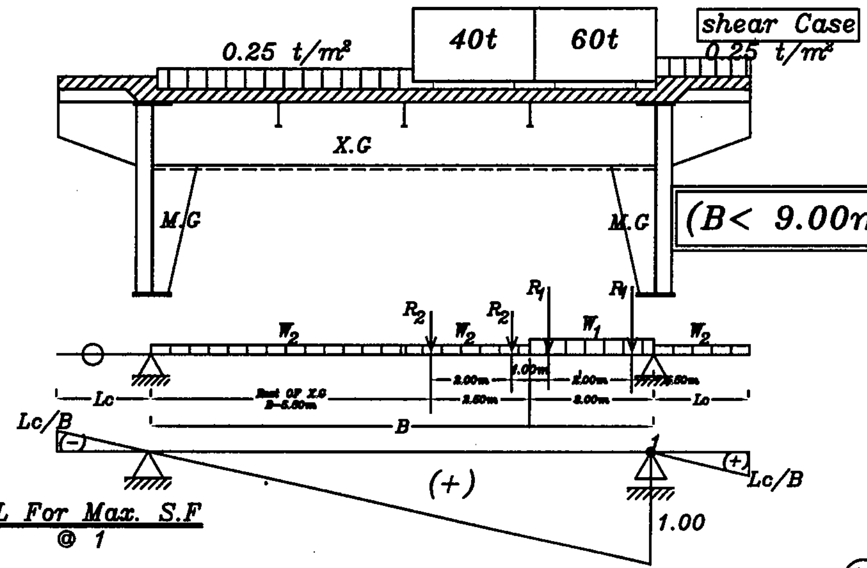
(B< 9.00m)

Special Cases For Deck Bridge

5)Deck Bridge With X.G Cantliver (B < 11.0m)

Side Walk>1.00m





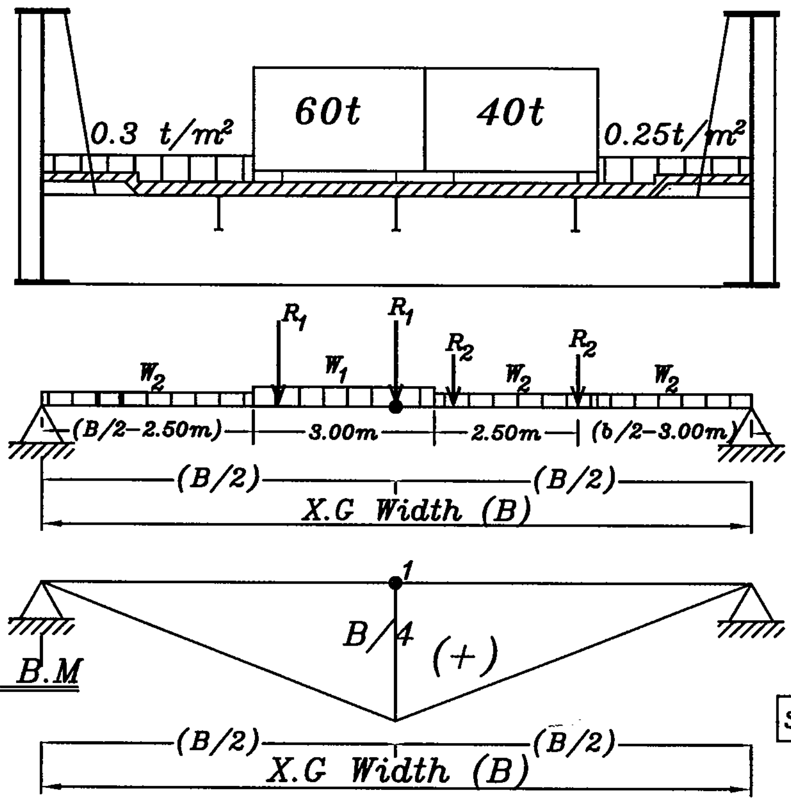
(B< 9.00m)

6)Pony Bridge (B < 11.0m)

فى حالة الPony Bridge يكون بحر الCross Girder مساويا لعرض الطريق(B) بالاضافة الى 2 Side Walk

Span Of Cross Girder = B + 2S

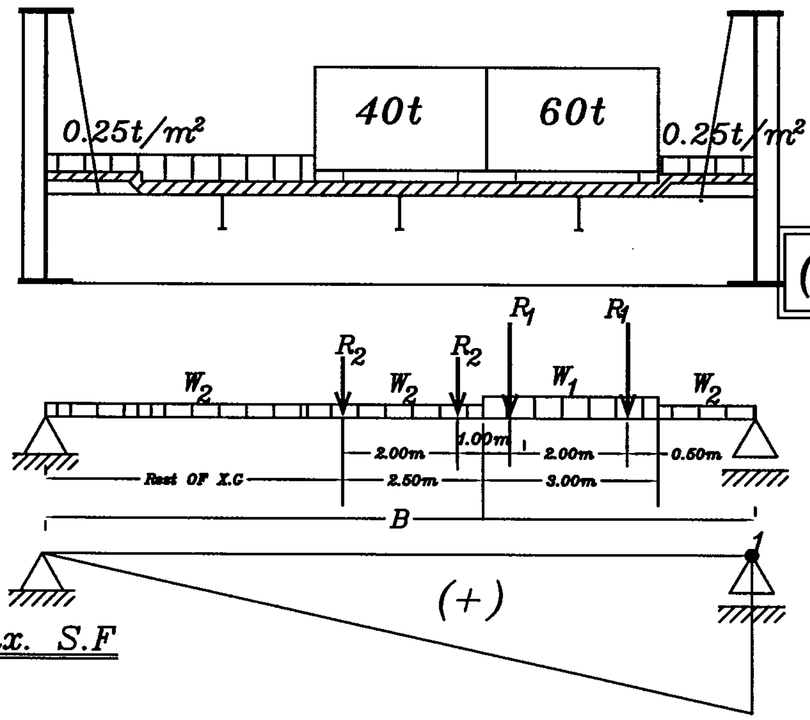
Moment Case



I.L For Max. B.M
@ 1

shear Case

(B< 9.00m)



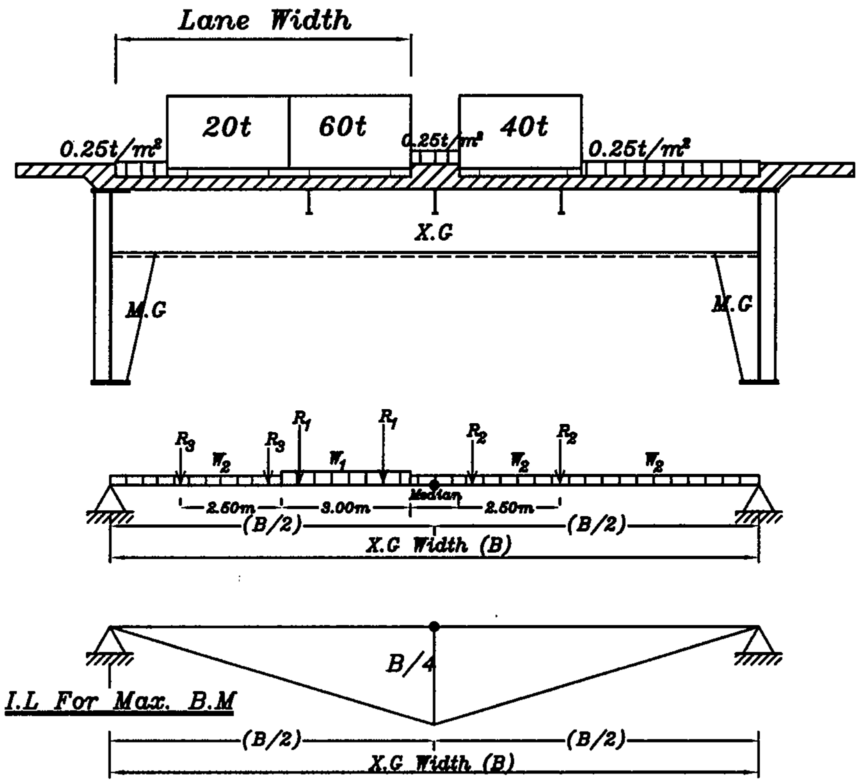
I.L For Max. S.F
@ 1

Special Cases Of Presence Of Median

بعض الحالات الخاصه فى حالة وجود جزيره

1-a-Case Of Max. Bending Moment [Lane width ≥ 6.00m]

للحصول على ال Max B.M يتم وضع العجله ال 15t فى منتصف ال X.G ونظرا لوجود جزيره فى منتصف ال X.G فلن نستطيع وضع ال 15t فى منتصف X.G فيتم وضع العربتان 60t,20t بجوار الجزيره ووضع العربه ال 40t بجوار الجزيره من الجهة الاخرى

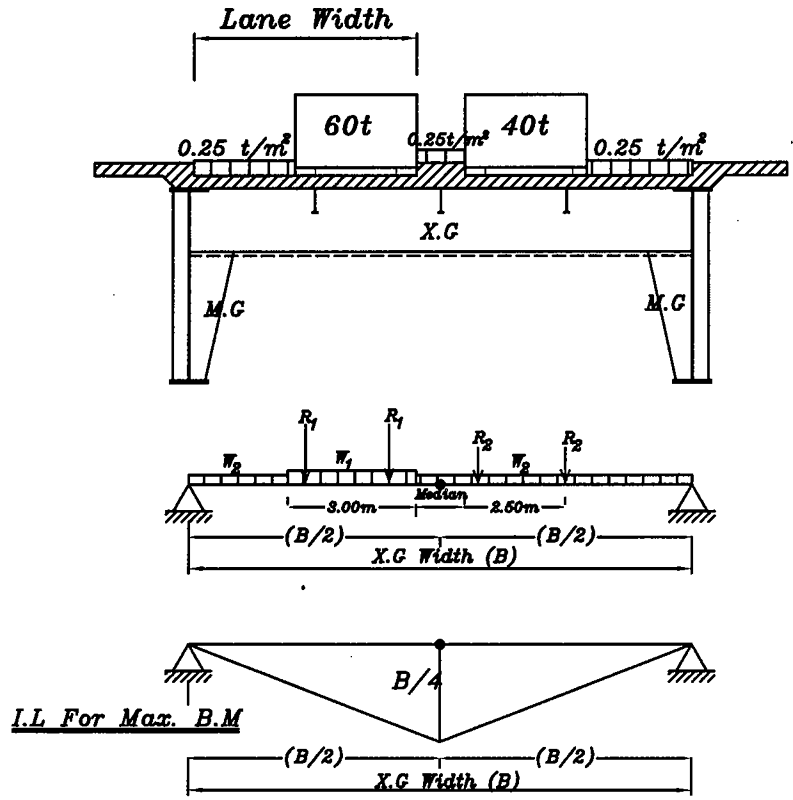


Special Cases Of Presence Of Median

بعض الحالات الخاصه فى حالة وجود جزيره

1-b-Case Of Max. Bending Moment [Lane width < 6.00m]

للحصول على ال Max B.M يتم وضع العجله ال 15t فى منتصف ال X.G ونظرا لوجود جزيره فى منتصف ال X.G فلن نستطيع وضع ال 15t فى منتصف X.G فيتم وضع العربه ال 60t بجوار الجزيره ووضع العربه ال 40t بجوار الجزيره من الجهة الاخرى

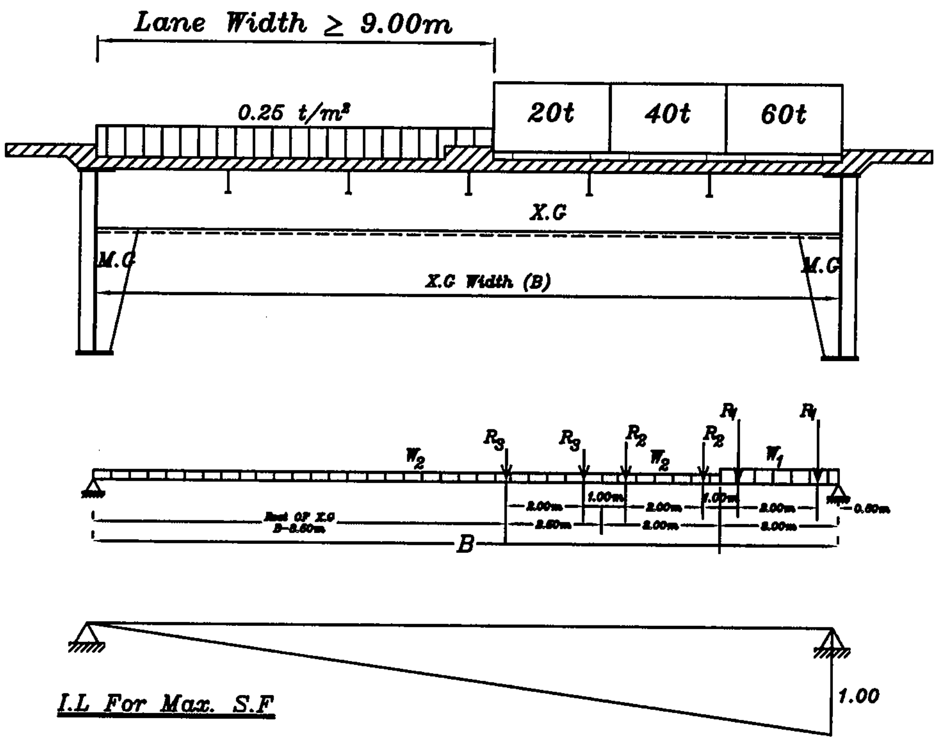


Special Cases Of Presence Of Median

بعض الحالات الخاصه فى حالة وجود جزيره

2-a-Case Of Max. Shear force [Lane width ≥ 9.00m]

فى حالة ان عرض الحارة اكبر من او يساوى ٩م يتم وضع الثلاث عربات فى حارة واحده ويتم تقريب العربة ال ٦٠ طن اقرب مايمكن للرصيف للحصول على اكبر قوى قص

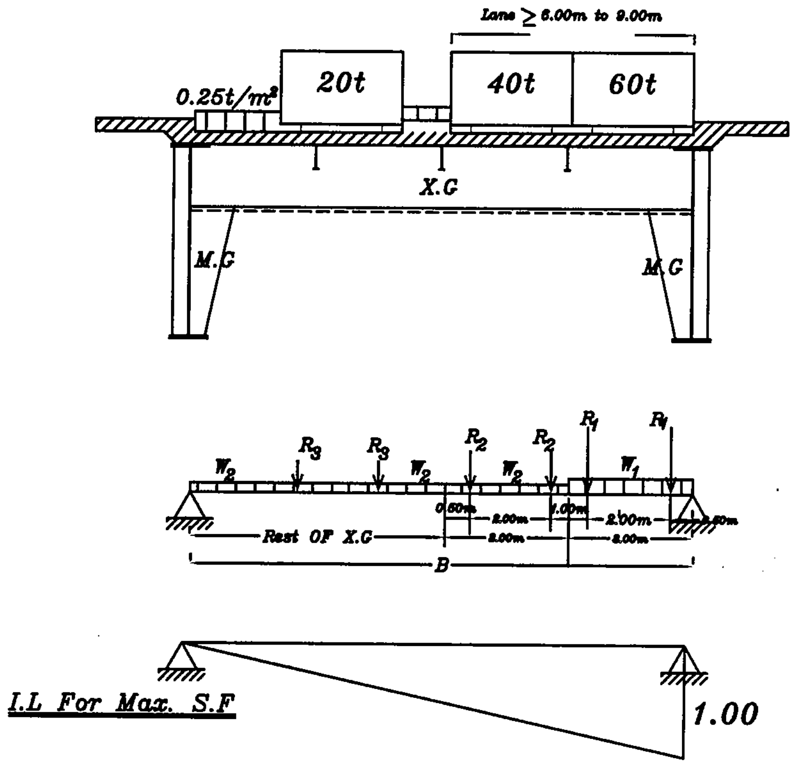


Special Cases Of Presence Of Median

بعض الحالات الخاصه فى حالة وجود جزيره

2-b-Case Of Max. Shear force [Lane width (9.00m-6.00m]

فى حالة ان عرض الحارة اكبر من ٦م يتم وضع العربه ال ٦٠ طن بجوار الرصيف ويتم وضع العربه ال ٤٠ طن بجوار العربه ال ٦٠ طن ووضع العربة ال ٢٠ طن بجوار الجزيرة فى الحارة الاخرى

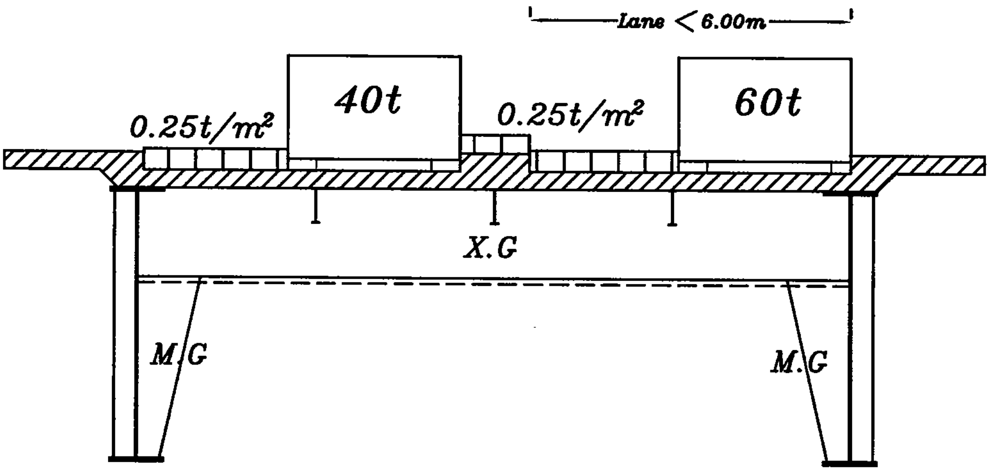


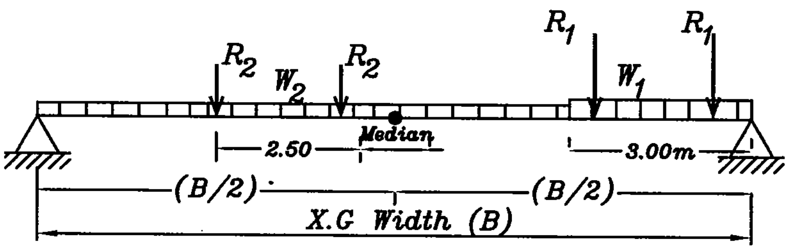
Special Cases Of Presence Of Median

بعض الحالات الخاصه في حالة وجود جزيره

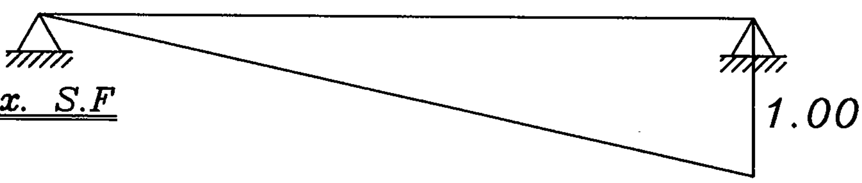
2-c-Case Of Max. Shear force [Lane width < 6.00m]

فى حالة ان عرض الحارة اقل من ٦م يتم وضع العربه ال ٦٠ طن بجوار الرصيف ويتم وضع العربه ال ٤٠ طن بجوار الجزيره نظرا لانه لم يتم وضع العربتان فى حاره واحده لان عرض العربتان يساوى ٦م وعرض الحاره اقل من ٦م





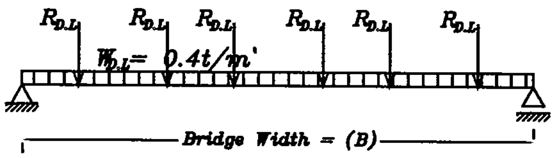
I.L For Max. S.F



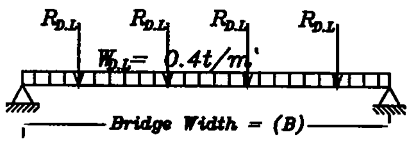
4-Loads On cross Girder

4-b-Rail Way Bridge

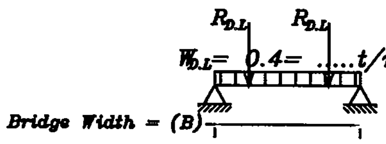
1) Dead Loads



Dead Loads On X.G For Triple Track



Dead Loads On X.G For Double Track



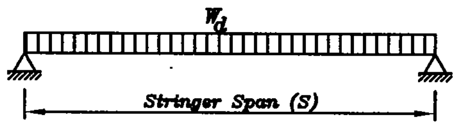
Dead Loads On X.G For Single Track

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

R_d = 2*Q_d Of Stringer

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

$R_d = W_d * S$



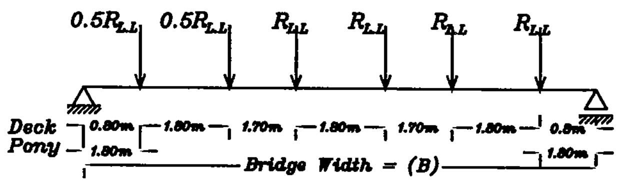
2) Live Loads

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

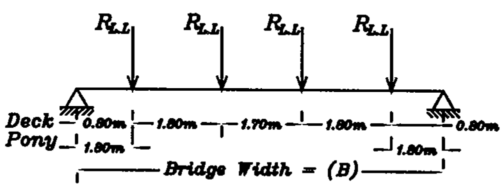
$$L_1 = 2 * B$$

Where : B = Cross girder span

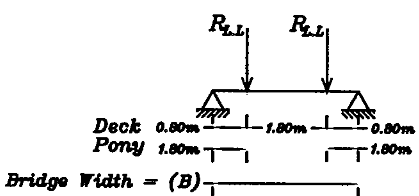
بحيث ان لايقل (1+I) عن 1.1 ولايزيد عن 2.0



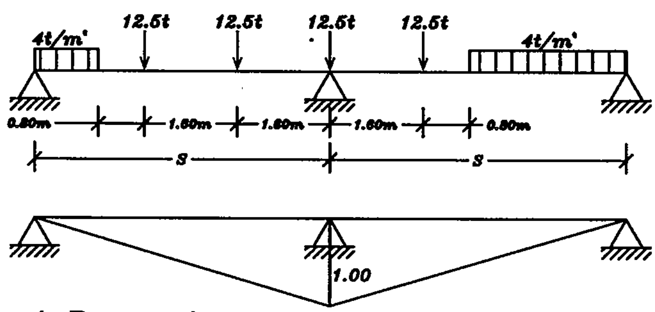
Live Loads On X.G For Triple Track



Live Loads On X.G For Double Track



Live Loads On X.G For Single Track



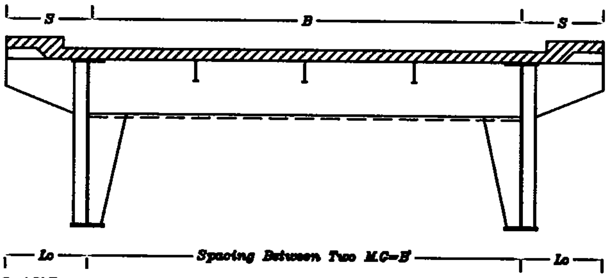
get R_u= ...t

5-Loads on Main Girder

5-a-Road Way Bridge

1) Dead Loads

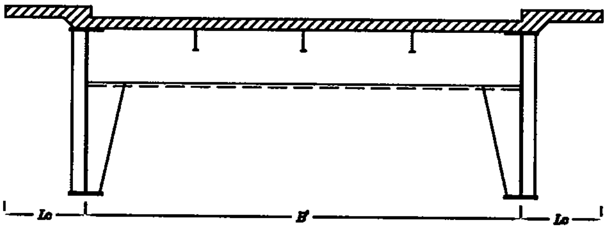
Deck Bridge With Cantliver X.G



0.21 0.175 0.18 0.15

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

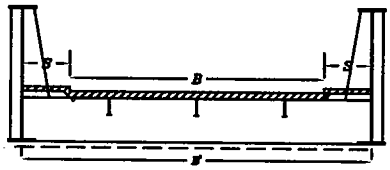
Deck Bridge Without Cantliver X.G



0.21 0.175 0.18 0.15

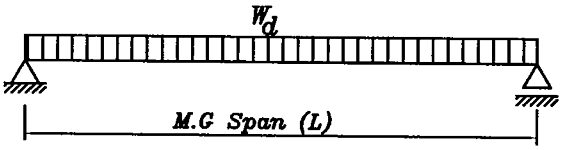
$$W_{dead} = (t_s * \gamma_c + f.c + W_{S.S.in}) * B'/2 + (t_s * \gamma_c + f.c) * Lc$$

Pony Bridge



0.21 0.175

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



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

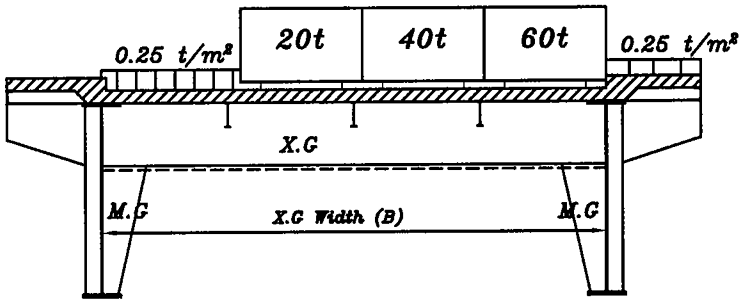
$$Q_d = \frac{W_d * L}{2} = \ldots t \quad \underline{S.F.D}$$

$$W_{ss\ in} = 150 + 4L + 0.03L^2$$
$$W_{ss\ out} = 100 + 3L$$

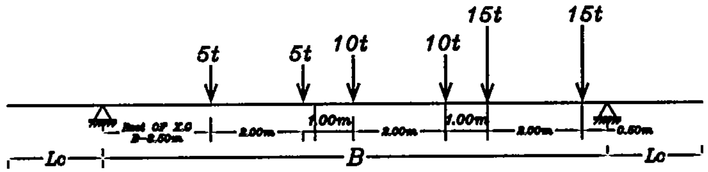
Special Cases For Deck Bridge

2)Deck Bridge With X.G Cantliver (B≥ 9.00m)

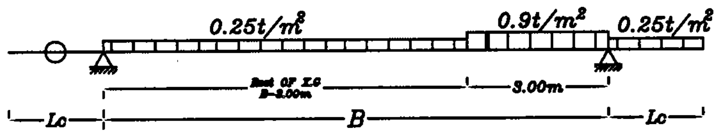
Side Walk>1.00m

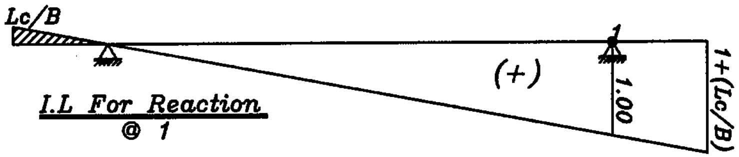


Strip1
Get R_1



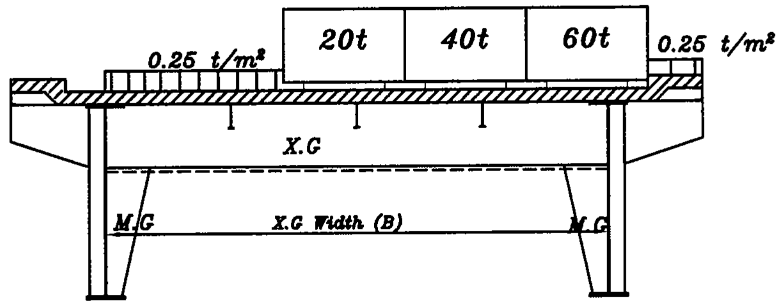
Strip2
Get W_1



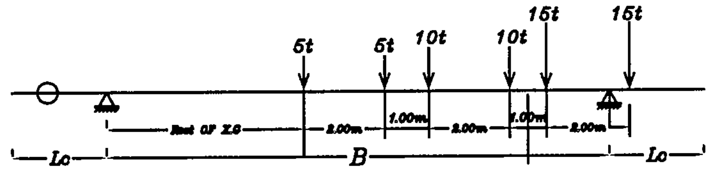


I.L For Reaction
@ 1

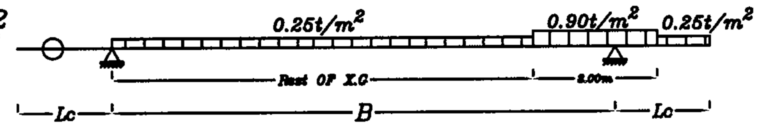
2-A)If The Side Walk< Cantliver Length

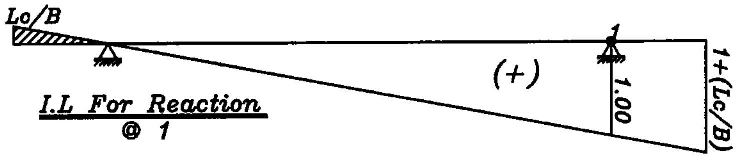


Strip1
Get R_1



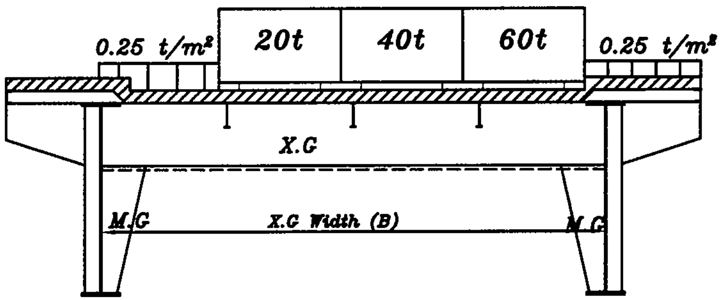
Strip2
Get W_1



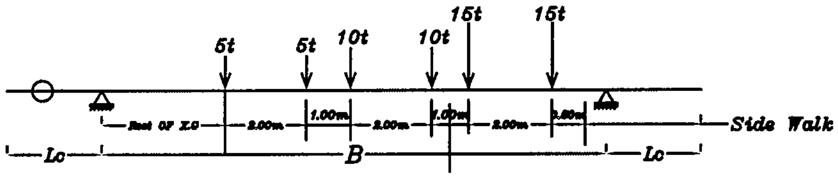


I.L For Reaction
@ 1

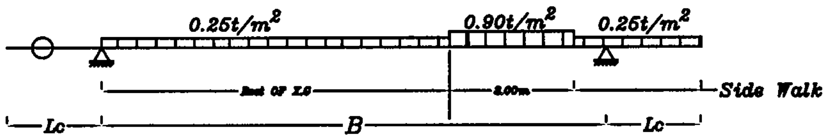
2-B)If The Side Walk > Cantliver Length

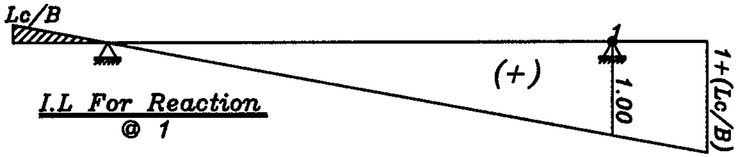


Strip1
Get R_1



Strip2
Get W_1



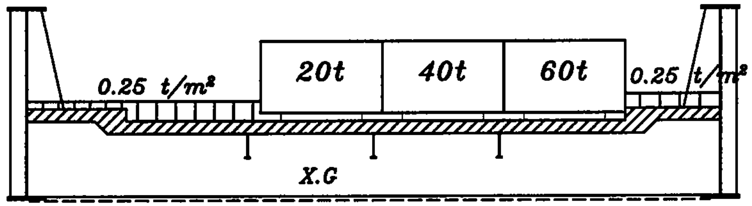


I.L For Reaction
@ 1

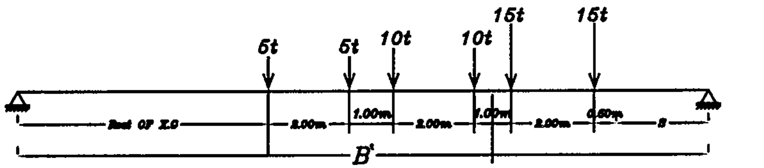
3)Pony Bridge B≥ 9.00m

فى حالة ال Pony Bridge يكون بحر الشريحة مساويا لعرض الطريق(B) بالاضافة الى 2 Side Walk

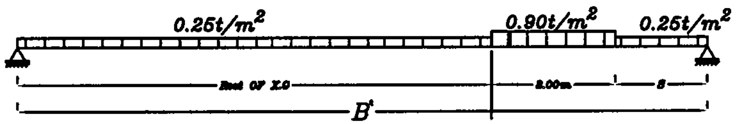
Span of the strip = B + 2S

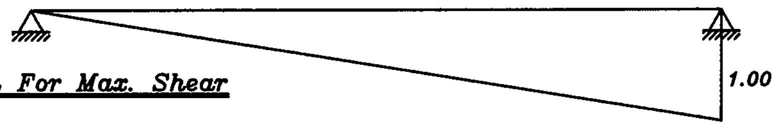


Strip1
Get R_1



Strip2
Get W_1



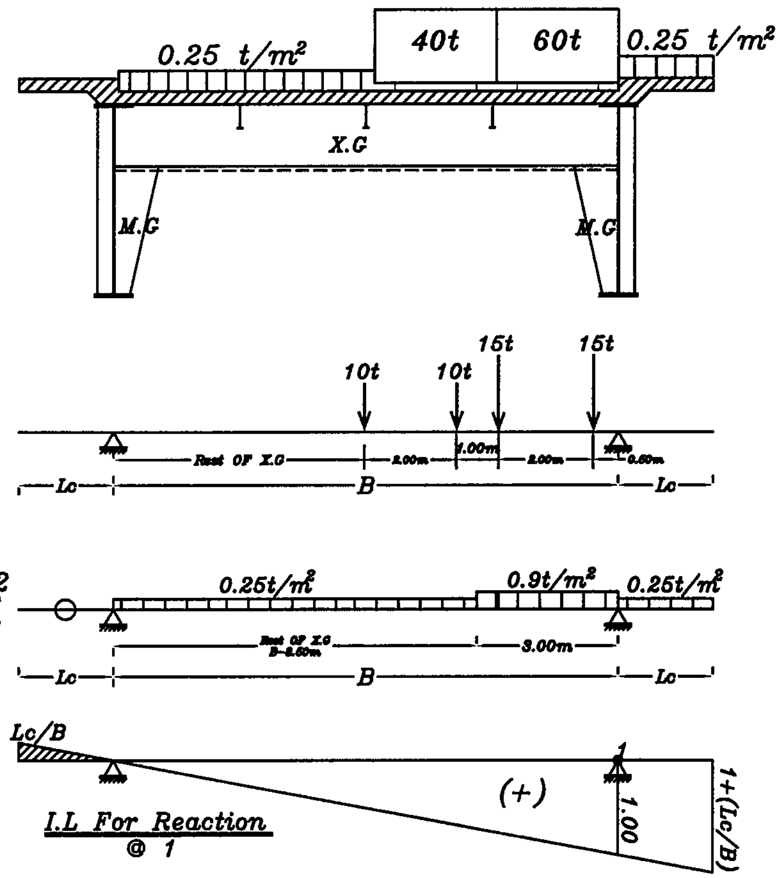


I.L For Max. Shear

Special Cases For Deck Bridge

4)Deck Bridge Without X.G Cantliver (B (6m–9m))

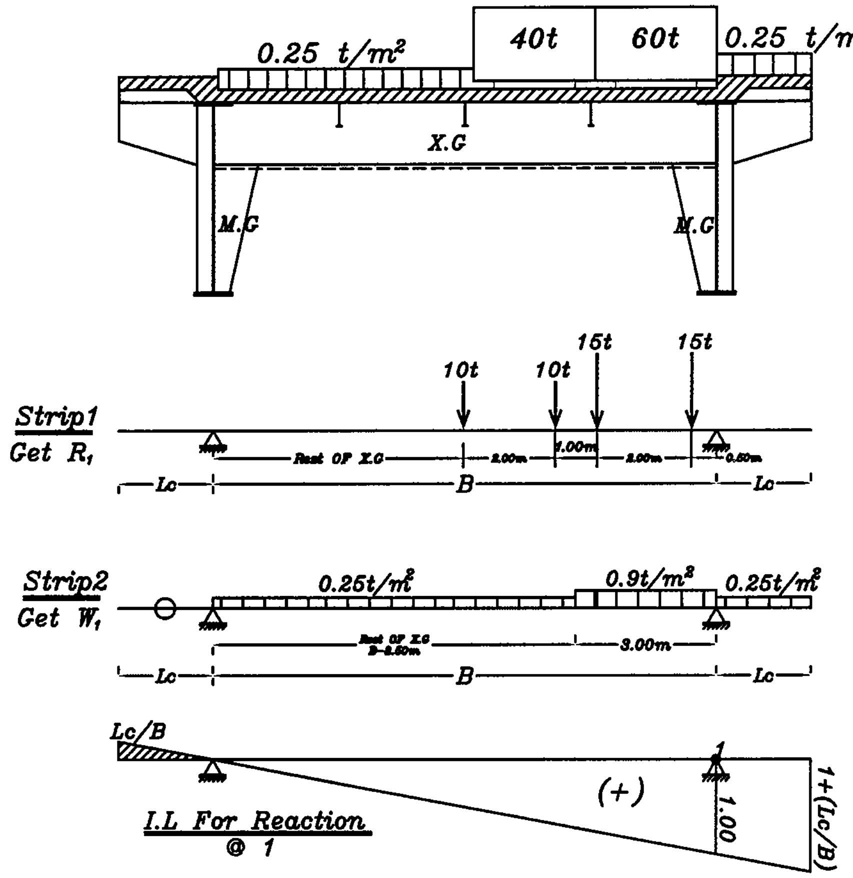
Side Walk≤ 1.00m



Special Cases For Deck Bridge

5)Deck Bridge With X.G Cantliver (B (6m–9m))

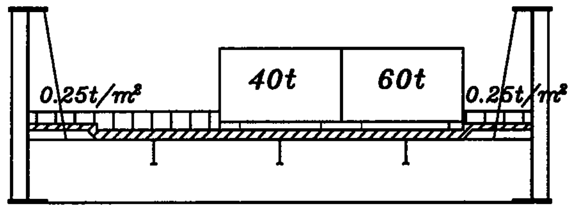
Side Walk>1.00m



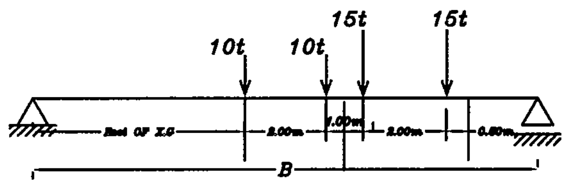
6)Pony Bridge (B (6m–9m))

فى حالة ال Pony Bridge يكون بحر الشريحة مساويا لعرض الطريق(B) بالاضافة الى 2 Side Walk

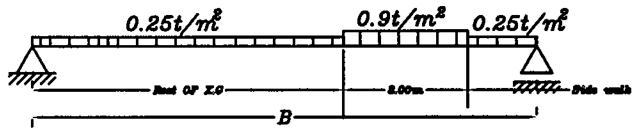
Span of the strip = B + 2S

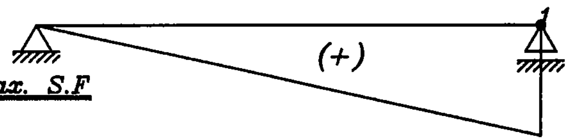


Strip1
Get R_1



Strip2
Get W_1



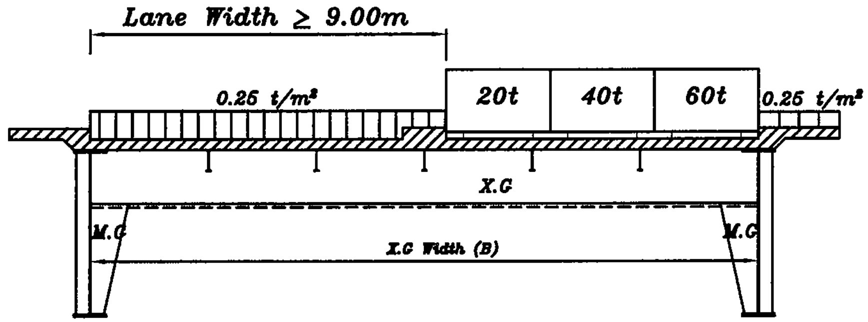


I.L For Max. S.F
@ 1

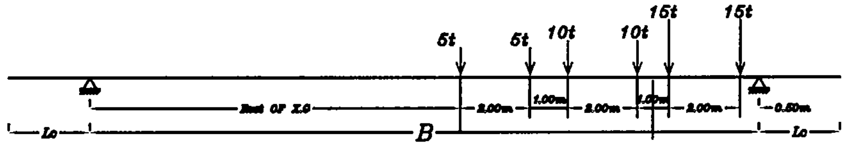
Special Cases Of Presence Of Median

بعض الحالات الخاصه فى حالة وجود جزيره lane width ≥ 9m

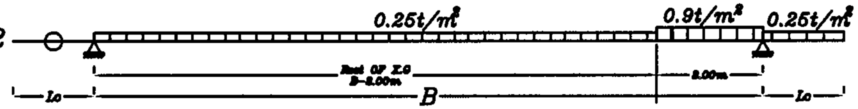
فى حالة ان عرض الحارة اكبر من او يساوى ٩م يتم وضع الثلاث عربات فى حارة واحده ويتم تقريب العربة ال ٦٠ طن اقرب مايمكن للرصيف للحصول على اكبر رد فعل

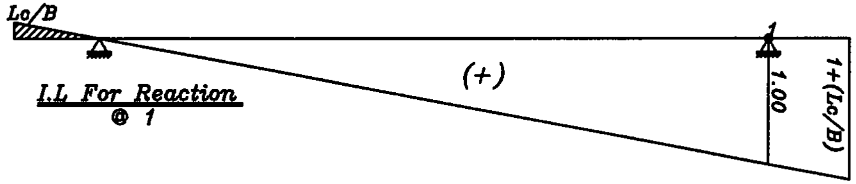


Strip1
Get R_1



Strip2
Get W_1



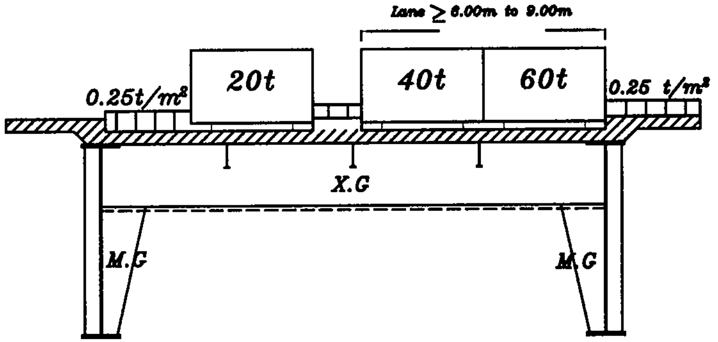


I.L For Reaction
@ 1

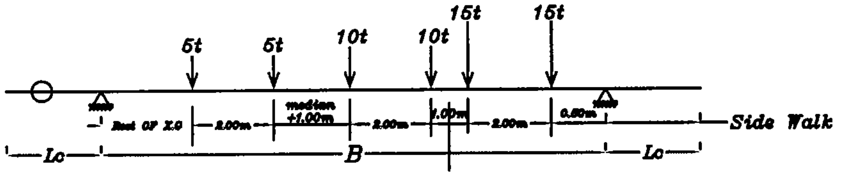
Special Cases Of Presence Of Median

lane width(9m–6m) بعض الحالات الخاصه فى حالة وجود جزيره

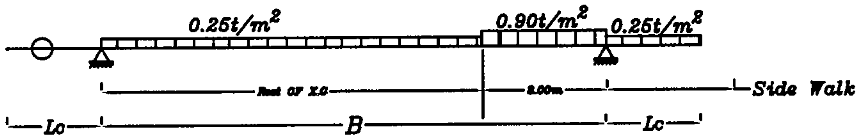
فى حالة ان عرض الحارة اكبر من ٦م يتم وضع العربه ال ٦٠ طن بجوار الرصيف ويتم وضع العربه ال ٤٠ طن بجوار العربه ال ٦٠ طن ووضع العربة ال ٢٠ طن بجوار الجزيرة فى الحارة الاخرى

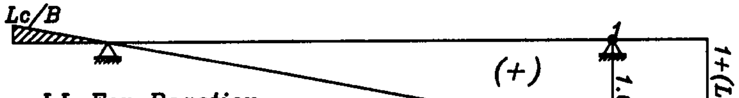


Strip1
Get R_1



Strip2
Get W_1



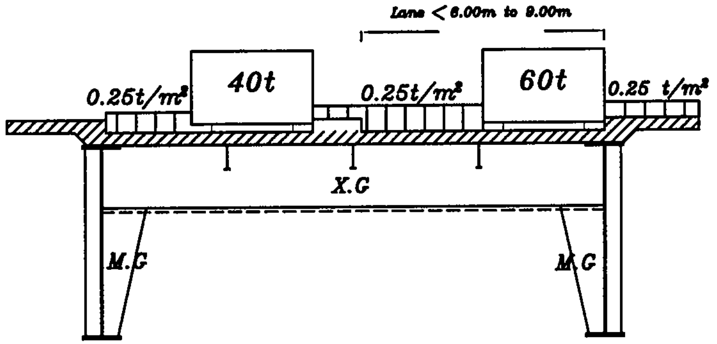


I.L For Reaction
@ 1

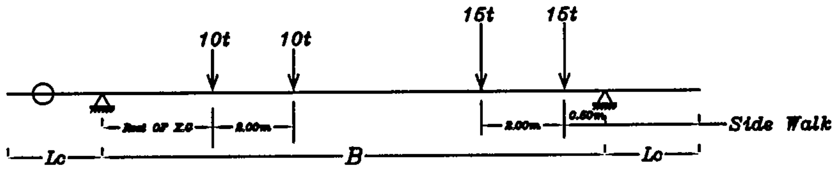
Special Cases Of Presence Of Median

lane width< 6m بعض الحالات الخاصه فى حالة وجود جزيره

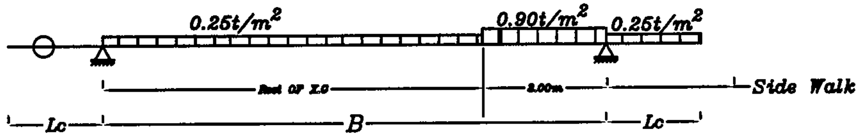
فى حالة ان عرض الحارة اقل من ٦م يتم وضع العربه ال ٦٠ طن بجوار الرصيف ويتم وضع العربه ال ٤٠ طن بجوار الجزيره نظرا لانه لم يتم وضع العربتان فى حاره واحده لان عرض العربتان يساوى ٦م وعرض الحاره اقل من ٦م

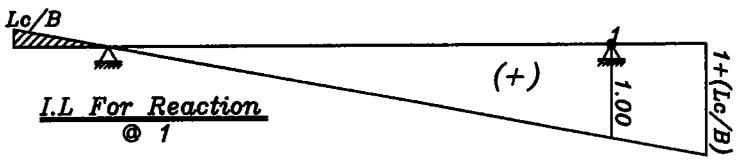


Strip1
Get R_1



Strip2
Get W_1

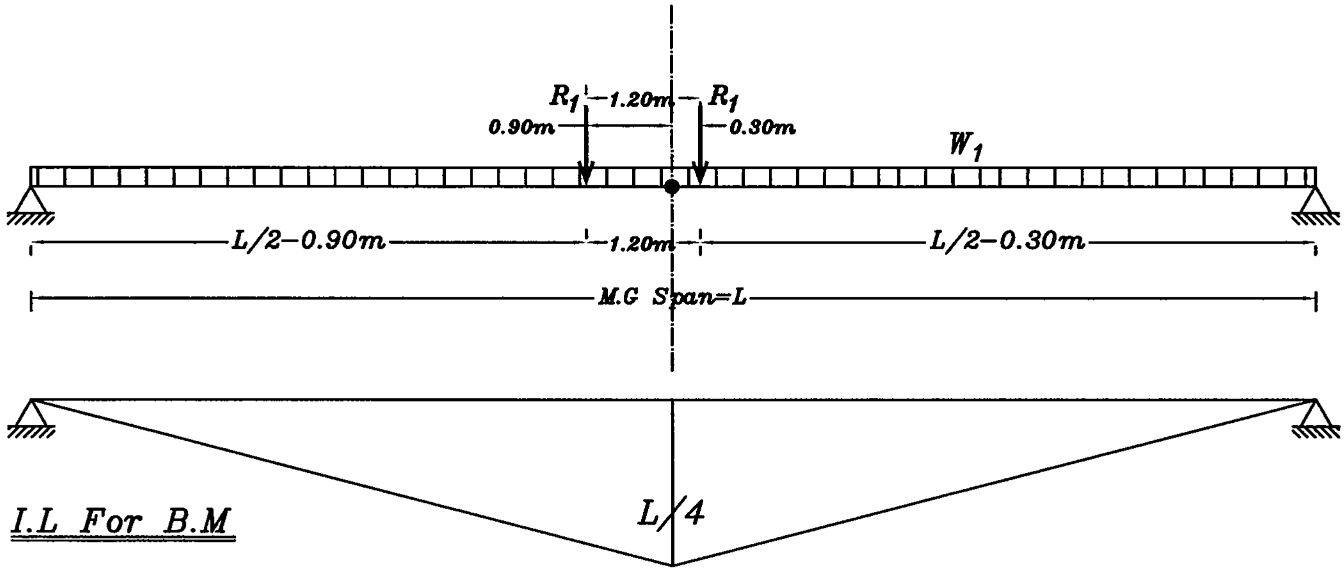




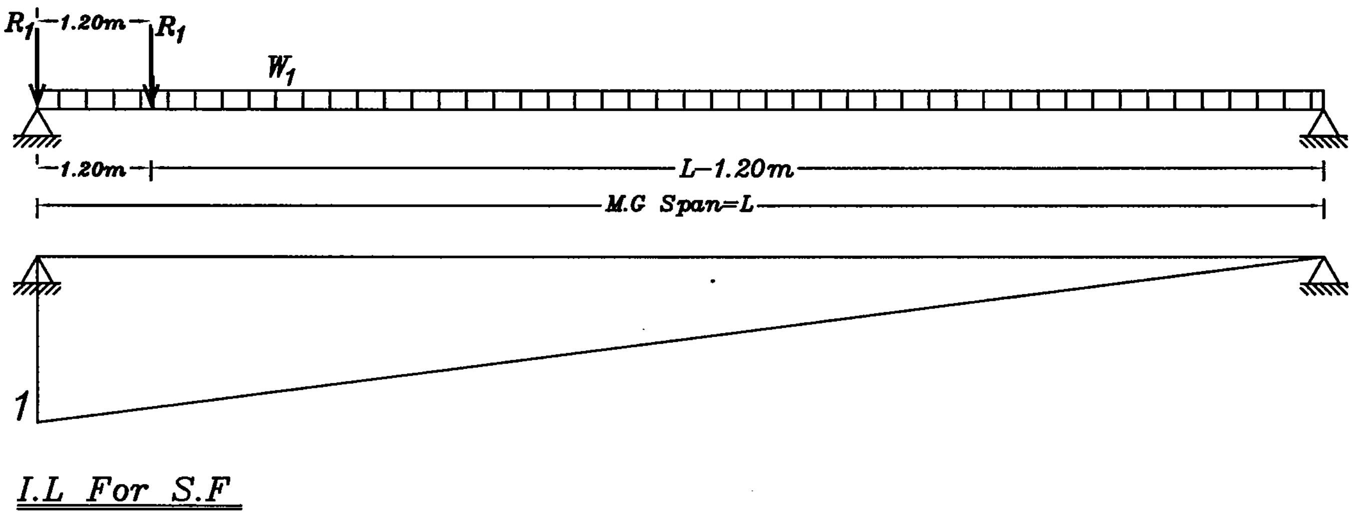
I.L For Reaction
@ 1

بعد ان تم حساب ردود الافعال من الشرائح على حسب شكل قطاع كل كوبرى سوف يتم حساب *Max. B.M* وال *Max. S.F*

<u>*Case of Max. B.M*</u> *[For all bridges type]*



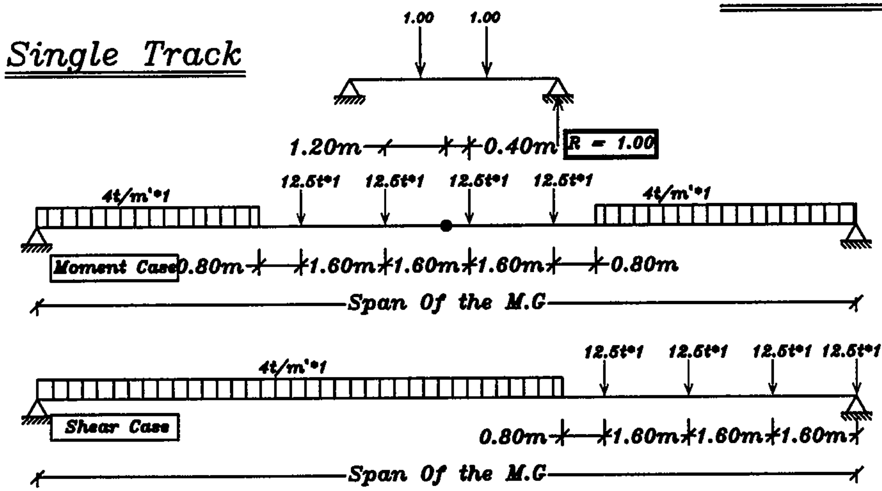
<u>*Case of Max. S.F*</u> *[For all bridges type]*



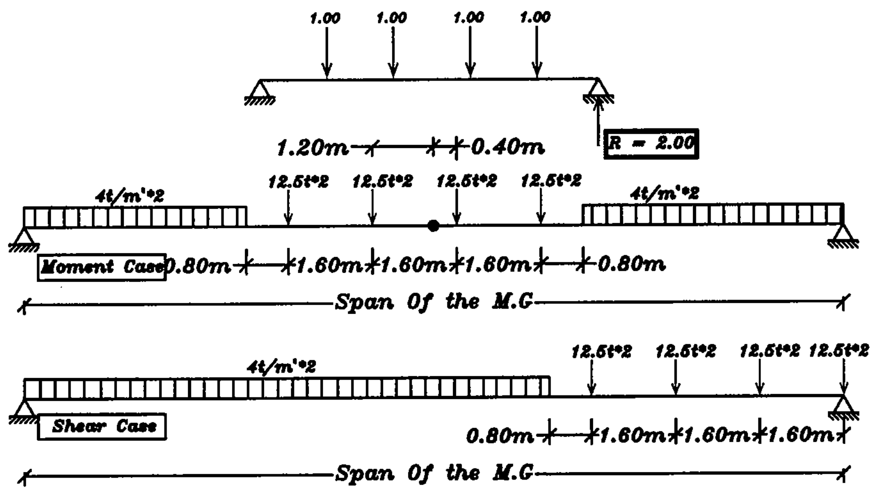
5-Loads on Main Girder

5-b-Rail Way Bridge

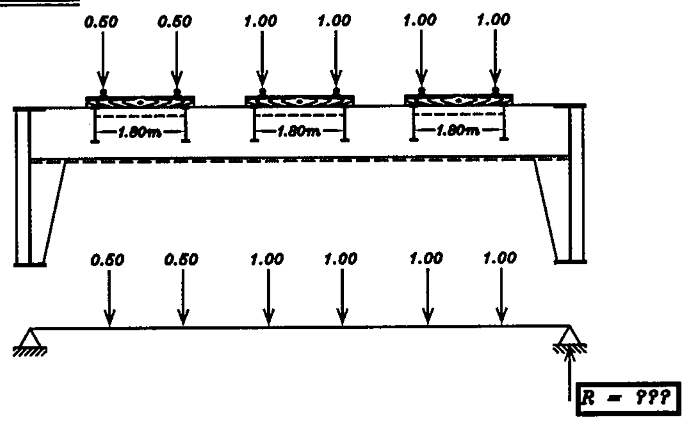
Single Track

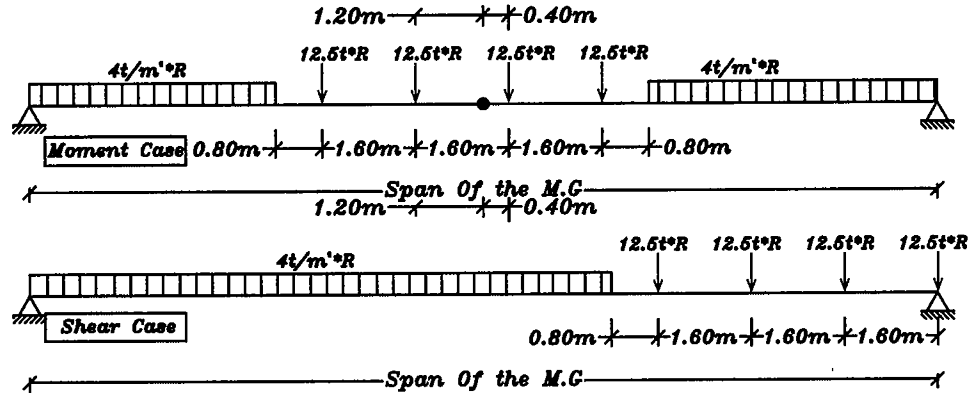


Double Track



Triple Track





Impact Factor

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

L_1 = Span of the Main girder

بحيث ان لايقل $(1+I)$ عن 1.1 ولايزيد عن 2.0

6-Built-Up Section

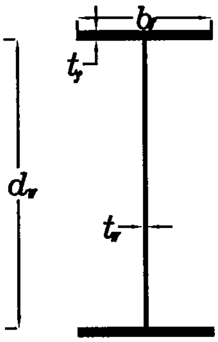
Steps Of Design Built up Section

1-Calculate Web depth[d_w]

$d_w = \frac{L}{10}$ (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

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

(2-ii) From Shear

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

(2-iii) From Buckling

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

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

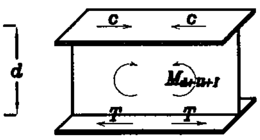
t_w =1.40 Cm if L > 28.00m

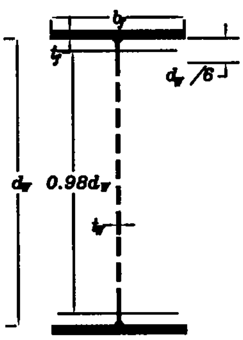
$\boxed{t_{w(min.)} = 0.8Cm}$ $\boxed{t_{w(max.)} = 1.6Cm}$

3-Get Flange Dimension

allowable stress= $0.58F_y$

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





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

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

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

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

Calculate I_x

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

4-Checks

(4-i)Check max. Stresses

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

(4-ii)Check stress range

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

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

5-Get Size of Weld

Area Flange

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

بعد ال Flange عن C.g القطاع

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

get Size of Wels (S)=......Cm ≮ 0.6Cm

Where $0.2F_y$ is allowable 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) | لايتم استخدامها الا لما يطلبها تحديدا |

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

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

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

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

$r_t \cong 0.25 b_f$

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 $F_C > 0.58F_y$

$\therefore$ Use $F_C = 0.58F_y$

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

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

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

ايهما اصغر

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

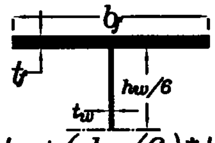
$\therefore$ No need to Check L.T.B

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

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

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

4-Calculate r_t



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

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

$r_t \cong 0.25 b_f$

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

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

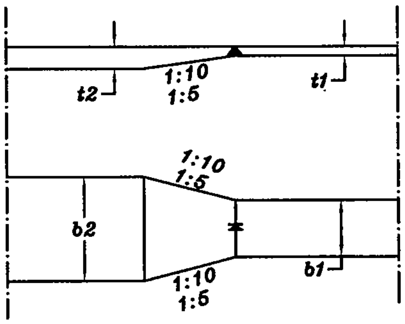
8–Curtailment Of Flange Plate

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)

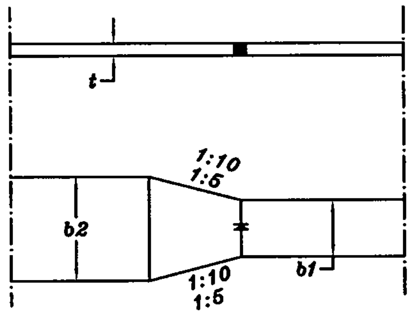
وهناك ثلاث طرق لتغيير الFlange

Case1



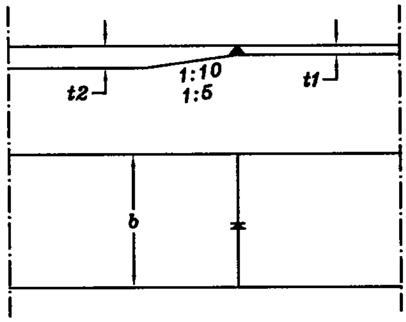
تم تقليل عرض وتخانة الFlange

Case2



تم تقليل عرض الFlangeفقط

Case3



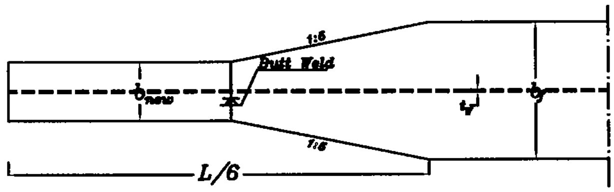
تم تقليل تخانة الFlangeفقط

Steps Of Curtailment

L ≤ 30m

$$0.58F_y = \frac{M_x * (h_w/2 + t_f)}{I_s}$$ get b_{new}=.....Cm

(y = $h_w/2 + t_f$)



$b_{min.}$= 20 Cm

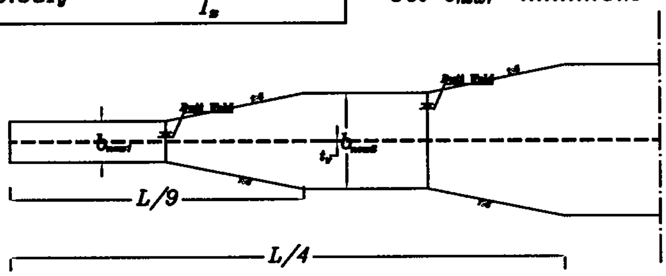
L > 30m

$$0.58F_y = \frac{M_{L/4} (h_w/2 + t_f)}{I_s}$$ → Get b_{new2} =.........Cm

$b_{min.}$= 20 Cm

$$0.58F_y = \frac{M_{L/9} (h_w/2 + t_f)}{I_s}$$ → Get b_{new1} =.........Cm

(y = $h_w/2 + t_f$)



Plan Of M.G Flange

9-Check Web Bucking

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 α (as Before)

2-Calculate K_q (as Before)

3-Calculate λ_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

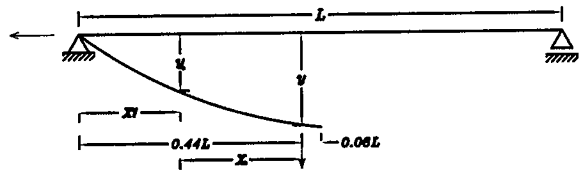
$F_b = (0.8 - 0.36\,\frac{q_{act}}{q_b})F_y$, Check $\frac{M_{d+u+I}}{I_x} * (d/2 + t_f)$ =.......$t/Cm^2 \ngtr$ 0.58F Or F_b (Wich Smaller)

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

كيف يتم حساب العزوم وقوى القص فى منتصف كل باكيه

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

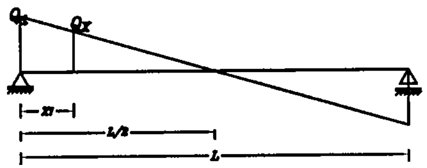
For B.M



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

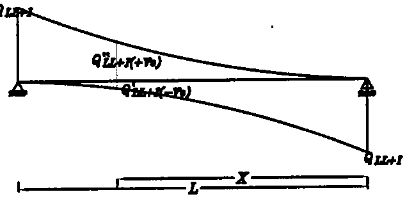
For S.F

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



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

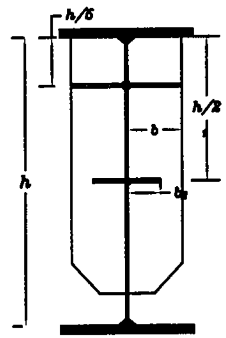
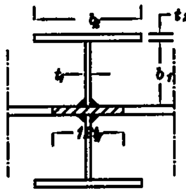
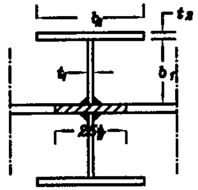
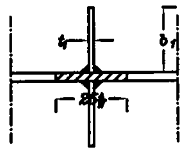
Dead Load



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

Live Load

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) $C_s = 0.65*(\frac{0.35F_y}{q_b} - 1)*Q_{act.}$	$C_s = 0.65*(\frac{0.35F_y}{q_b} - 1)*Q_{act.}$ $Q_{act.}$ = reaction of M.G.	 Cross Section
b-Shape	$Area = \frac{Force}{1.4t/Cm^2 \ (st.44),\ 1.7t/Cm^2 \ (st.52)}$ $b_{2\,min} = 6\phi + t_w$ 	$Area = \frac{Force}{1.4t/Cm^2 \ (st.44),\ 1.7t/Cm^2 \ (st.52)}$ $b_{2\,min} = 6\phi + t_w$ 	$Area = \frac{Force}{1.4t/Cm^2 \ (st.44),\ 1.7t/Cm^2 \ (st.52)}$ 	
C-Dimension	$Area = 12t_w^2 + 2b_1 t_1 + 2b_2 t_2$ $b_1 = h_w/30 + 5Cm$,take $t_1 = t_w$ then get $b_2 * t_2 = ...Cm$ $b_2 = 20t_2$ $b_2 = ..Cm$, $t_2 = ..Cm$	$Area = 25t_w^2 + 2b_1 t_1 + 2b_2 t_2$ $b_1 = h_w/30 + 5Cm$,take $t_1 = t_w$ then get $b_2 * t_2 = ...Cm$ $b_2 = 20t_2$ $b_2 = ..Cm$, $t_2 = ..Cm$	$Area = 25t_w^2 + 2b_1 t_1$ $b_1 = h_w/30 + 5Cm$ Get $t_1 = ..Cm$	assume Stiffener @ h/5 to be $b_1 = \frac{h_w}{30} + 5Cm$ $t_1 = t_w$ assume Stiffener @ h/2 to be $b_2 = 10Cm$ $t_2 = t_w$
d-Check Non Compact	$\frac{b_1}{t_1} \le \frac{64}{\sqrt{F_y}}$, $\frac{b_2/2}{t_2} \le \frac{21}{\sqrt{F_y}}$	$\frac{b_1}{t_1} \le \frac{64}{\sqrt{F_y}}$, $\frac{b_2/2}{t_2} \le \frac{21}{\sqrt{F_y}}$	$\frac{b_1}{t_1} \le \frac{30}{\sqrt{F_y}}$	

e-Prop. Of Area	$Area = 12t_w^2 + 2b_1 t_1 + 2b_2 t_2$
	 Calculate $I_x = 2\frac{t_1 * b_1^3}{12} + 2t_1 b_1 (\frac{b_1}{2} + \frac{t_w}{2})^2 + 2t_2 b_2 (\frac{t_2}{2} + b_1 + \frac{t_w}{2})^2 = ...Cm^4$
	 Calculate $r_x = \sqrt{\frac{I_x}{A}} = ...Cm$
		$Area = 25t_w^2 + 2b_1 t_1 + 2b_2 t_2$
		 (Calculate I_x and r_x as for End Bearing)
			$Area = 25t_w^2 + 2b_1 t_1$
			 $I_x = 2\frac{t_1 * b_1^3}{12} + 2t_1 b_1 (\frac{b_1}{2} + \frac{t_w}{2})^2 = .Cm^4$
			 Calculate $r_x = \sqrt{\frac{I_x}{A}} = ...Cm$
				for (d/5)
				 $I_{s1} = 2[\frac{b_1^3 * t_1}{12} + b_1 * t_1 * (\frac{b_1}{2} + \frac{t_w}{2})^2] > 4 * h_w * t_w^3$
				 for (d/2)
				 $I_{s2} = 2[\frac{b_2^3 * t_2}{12} + b_2 * t_2 * (\frac{b_2}{2} + \frac{t_w}{2})^2] > h_w * t_w^3$

f-Check buckling	$\lambda = \frac{L_b}{r_x} = \frac{0.8h_w}{r_x} < 110$(Road Way) , 90(Rail Way) $F_c = 1.6 - 8.5*10^{-5}*\lambda^2$ For St.44 $F_c = 2.1 - 13.5*10^{-5}*\lambda^2$ For St.52			
g-Check Stresses	$f = \frac{force}{area} \le F_c$			
h-Size Of Weld	$S = \frac{Q_{D+LL+I\ (R.G.)}}{(0.2f_u)*4h_w} = ... \ge 0.6Cm$	$S = \frac{Q_{D+LL+I\ (X.G.)} \text{ or } C_s}{(0.2f_u)*4h_w/3} = ... \ge 0.6Cm$	$S = \frac{C_s}{(0.2f_u)*4h_w/3} = ... \ge 0.6Cm$	

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 $t_3 = ... \geq 1 Cm$

B-number of Bolts

B-1-Bolts between plate 1 and plate two

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

B-2-Bolts between Splice plate and web

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

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

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

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

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

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