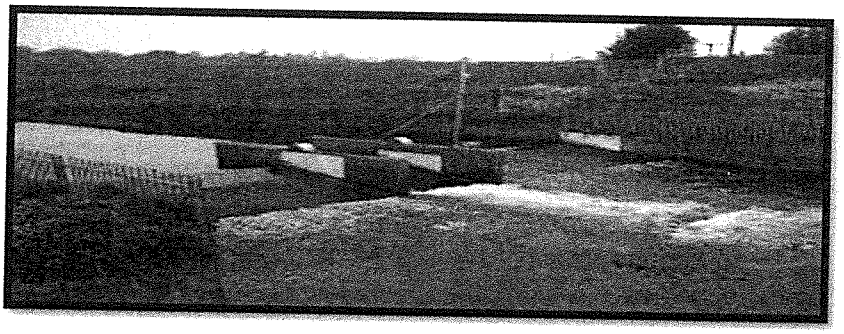
DESIGN OF IRRIGATION STRUCTURE (2)

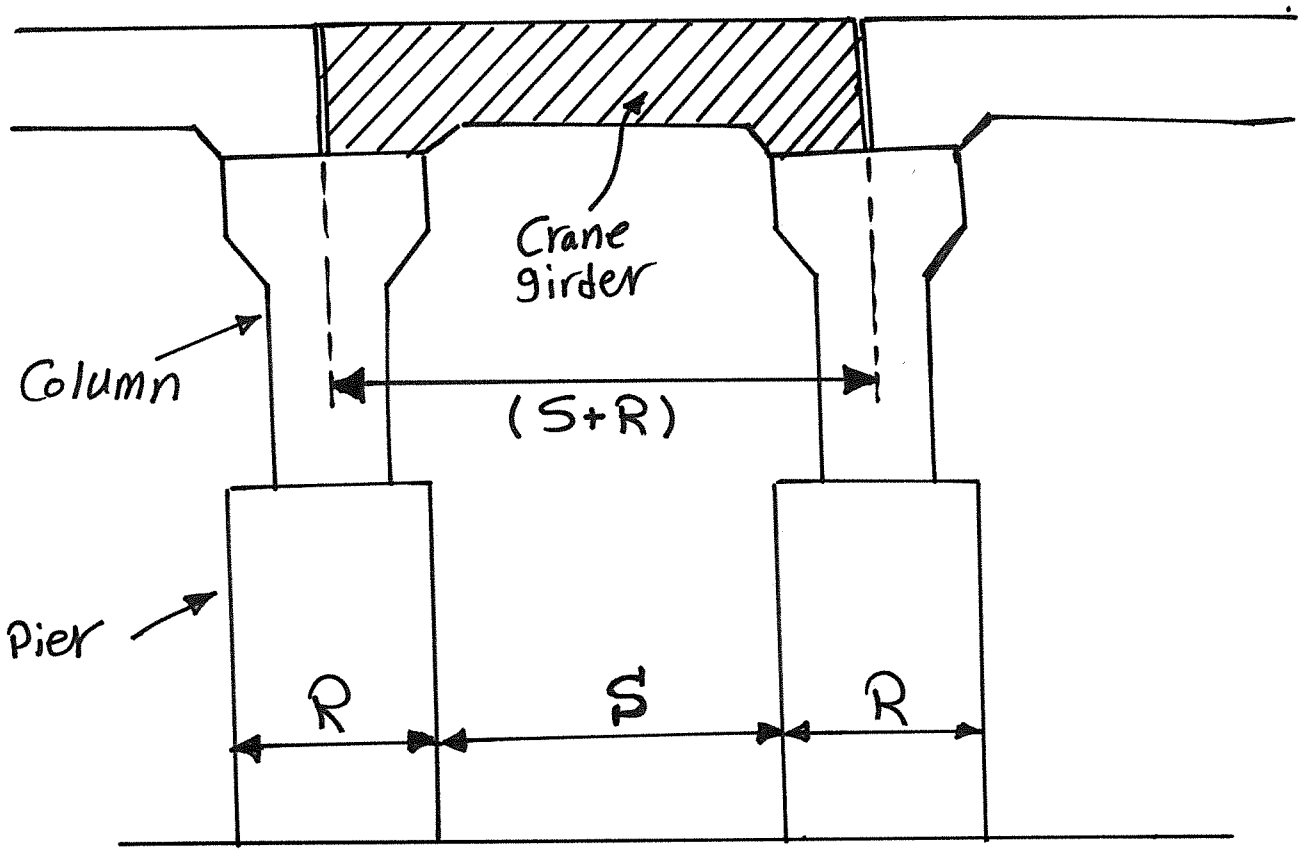
رابعة مدني



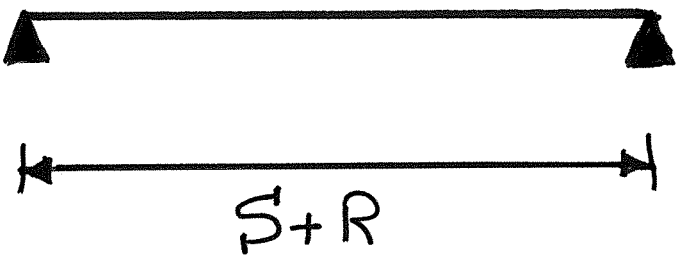
Regulator
(Gate lifting structure)
b- Part (2)

7

6- Design of Crane girder :-



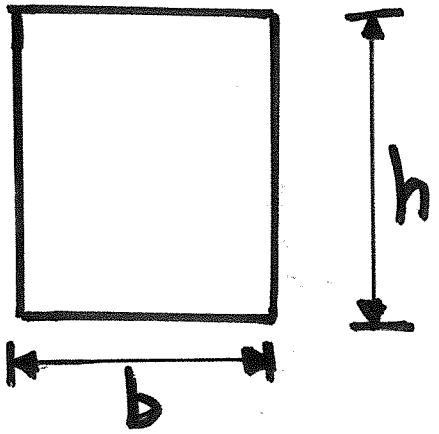
* Structure system :-



Dimensions

$$b = 0.45\ m$$

$$h = \frac{Span}{10} = \frac{S+R}{10}$$



Loading

1- Dead Loads :-

الأحمال Dead المؤثرة على البوابة.

① g_1 ← وزن الكمرة نفسها

$$g_1 = \gamma_{R.C} \ (b * h) = \text{?? } t/m'$$

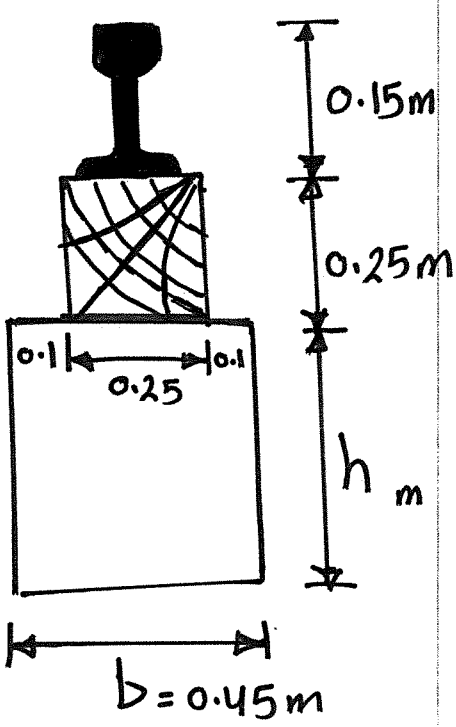
$\gamma_{R.C} \rightarrow 2.5\ t/m^3$

② g_2 ← وزن الـ Rail + sleeper

$$g_2 = 0.05 + (0.25 * 0.25 * 0.9)$$

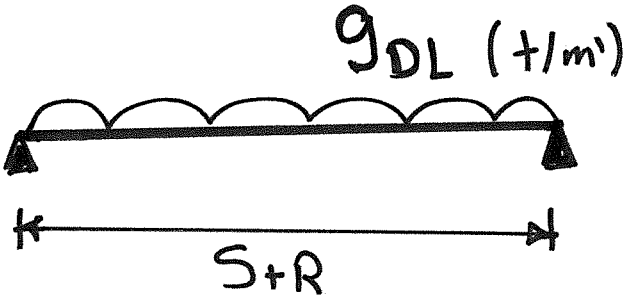
③ g_3 ← وزن الـ 2 [Channel

$$g_3 = \frac{0.2\ (b + 0.2)}{2}$$



$$\therefore g_{D.L} = g_1 + g_2 + g_3$$

..



$$M_{D.L} = \frac{g_{D.L} * (S+R)^2}{8} = \dots \text{ t.m}$$

$$Q_{D.L} = \frac{g_{D.L} * (S+R)}{2} = \dots \text{ ton}$$

Live Load :-

الاحمال الحية هى (البوابات والونش)

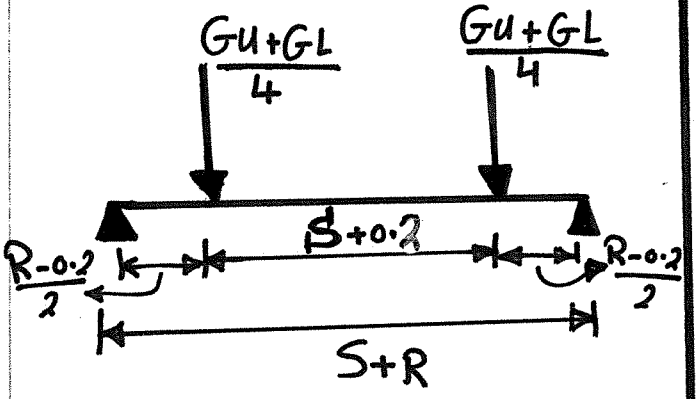
* هناك ثلاث حالات للتحميل

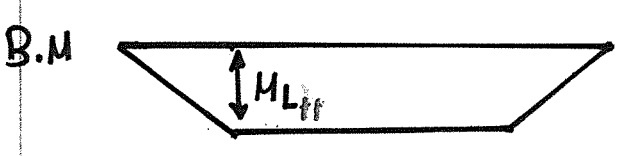
Case 1

→ The Two gates are suspended and the Crane just moving .

اى البوابتين معلقتين والونش على وشك الحركة.

* Gates are suspended

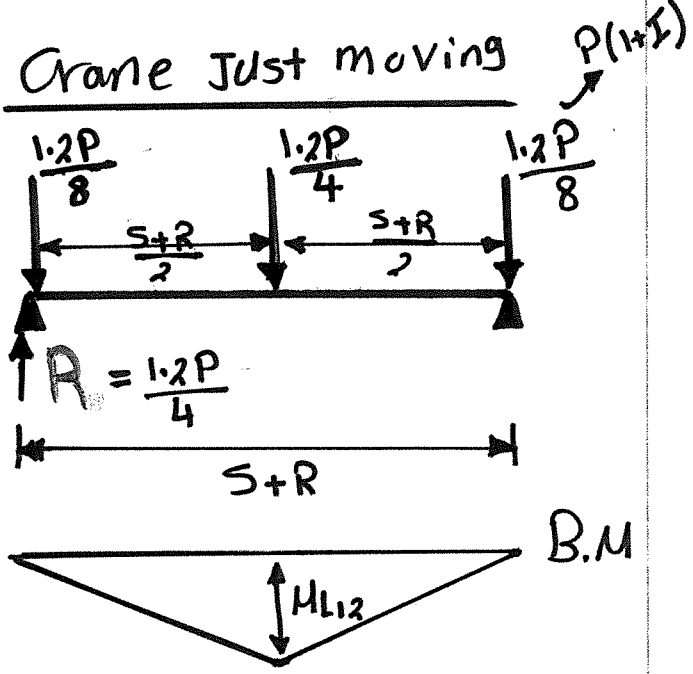




$$M_{L11} = \frac{GU+GL}{4} * \frac{R-0.2}{2}$$

$$Q_{L11} = \frac{GU+GL}{4}$$

* Crane just moving



$$Q_{L12} = \frac{1.2P}{8} \quad = \text{ton}$$

$$M_{L12} = Q_{L12} * \frac{S+R}{2} \quad = \text{t.m}$$

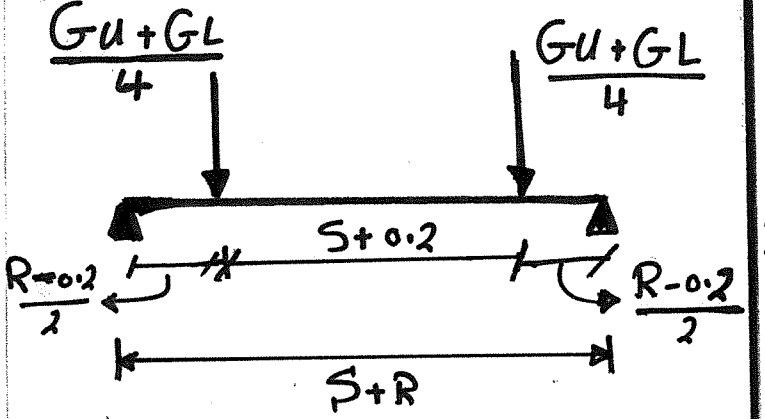
$$\therefore M_{L_1} = M_{L_{11}} + M_{L_{12}} = \quad t.m$$

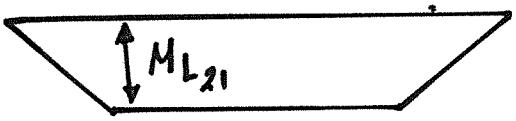
$$\therefore Q_{L_1} = Q_{L_{11}} + Q_{L_{12}} = \quad ton$$

Case 2

Two Gates are suspended and the Crane is Moving

* Two Gates Suspended



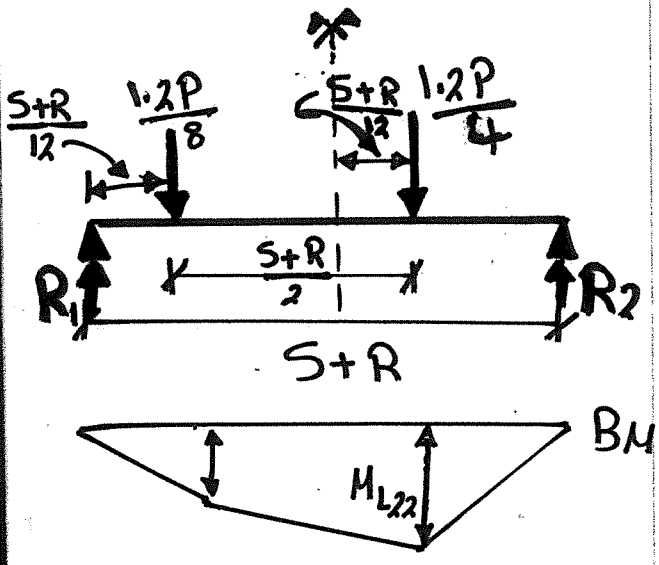


$$Q_{L_{21}} = \frac{GU+GL}{4}$$

$$M_{L_{21}} = \left(\frac{GU+GL}{4}\right)\left(\frac{R-0.2}{2}\right)$$

* Crane is Moving

- في حالة الحركة ينتبقى عجلتين فقط على الكمرة.
- نتيجة الحركة نضرب $P*(1+I)$



$$Q_{L_{22}} = R_1$$

$$M_{L_{22}} = R_2\left(\frac{S+R}{2} - \frac{S+R}{12}\right)$$

$$\therefore \quad M_{L2} = M_{L21} + M_{L22} \qquad = \text{vv t.m}$$

$$\therefore \quad Q_{L2} = Q_{L21} + Q_{L22} \qquad = \text{vv ton}$$

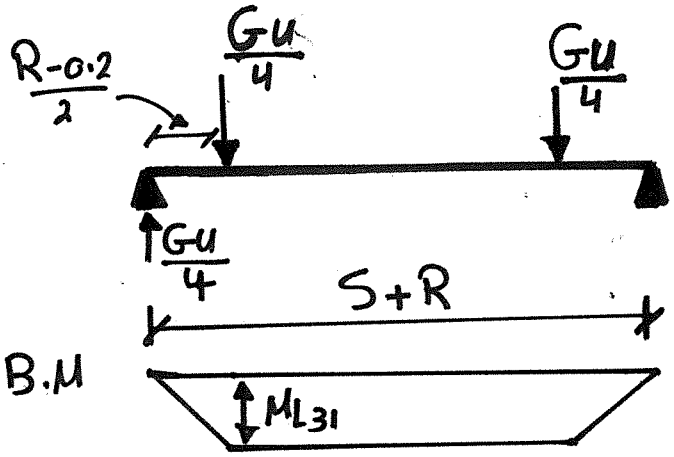
Case 3

The upper gate is suspended and the crane lifts the lower gate

البوابة العلوية معلقة والونش بيرفع البوابة السفلية

* هى الحالة التى تعطى اسوا حالة تحميل

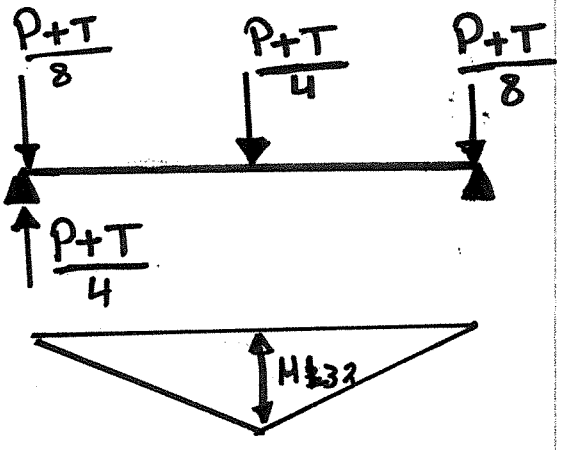
* Upper gate suspended



- $M_{L31} = \left(\frac{GU}{4}\right)\left(\frac{R-0.2}{2}\right)$
- $Q_{L31} = \frac{GU}{4}$

* Crane lifting lower gate

* الونش ثابت لا يوجد (I) impact
* وزن الونش يتم اضافة (T) القوة اللازمة لرفع البوابة موزعة على عجلات الونش بدون اضافة (I)



- $Q_{L32} = \frac{P+T}{8}$
- $M_{L32} = \left(\frac{P+T}{8}\right) * \left(\frac{S+R}{2}\right)$

$\therefore M_{L3} = M_{L31} + M_{L32} = \text{vv}$ t.m

$Q_{L3} = Q_{L31} + Q_{L32} = \text{vv}$ ton

$\therefore M_t = M_{D.L} + M_{L.L\,Max}$ ← M_{L1} or M_{L2} or M_{L3}

$Q_t = Q_{D.L} + Q_{L.L\,Corr}$

$M_{L.L\,Max}$ المناظر

Design

$$d = k_1 \sqrt{\frac{M_t \times 10^5}{b}} = \text{vv cm}$$

b ← 45 cm $b = 0.45$ m

$h = d + d' = d + 5$ cm = vv ≯ h_{assume}

$\frac{S+R}{10}$

$d_{act} = h - 5 = \text{vv}$ cm

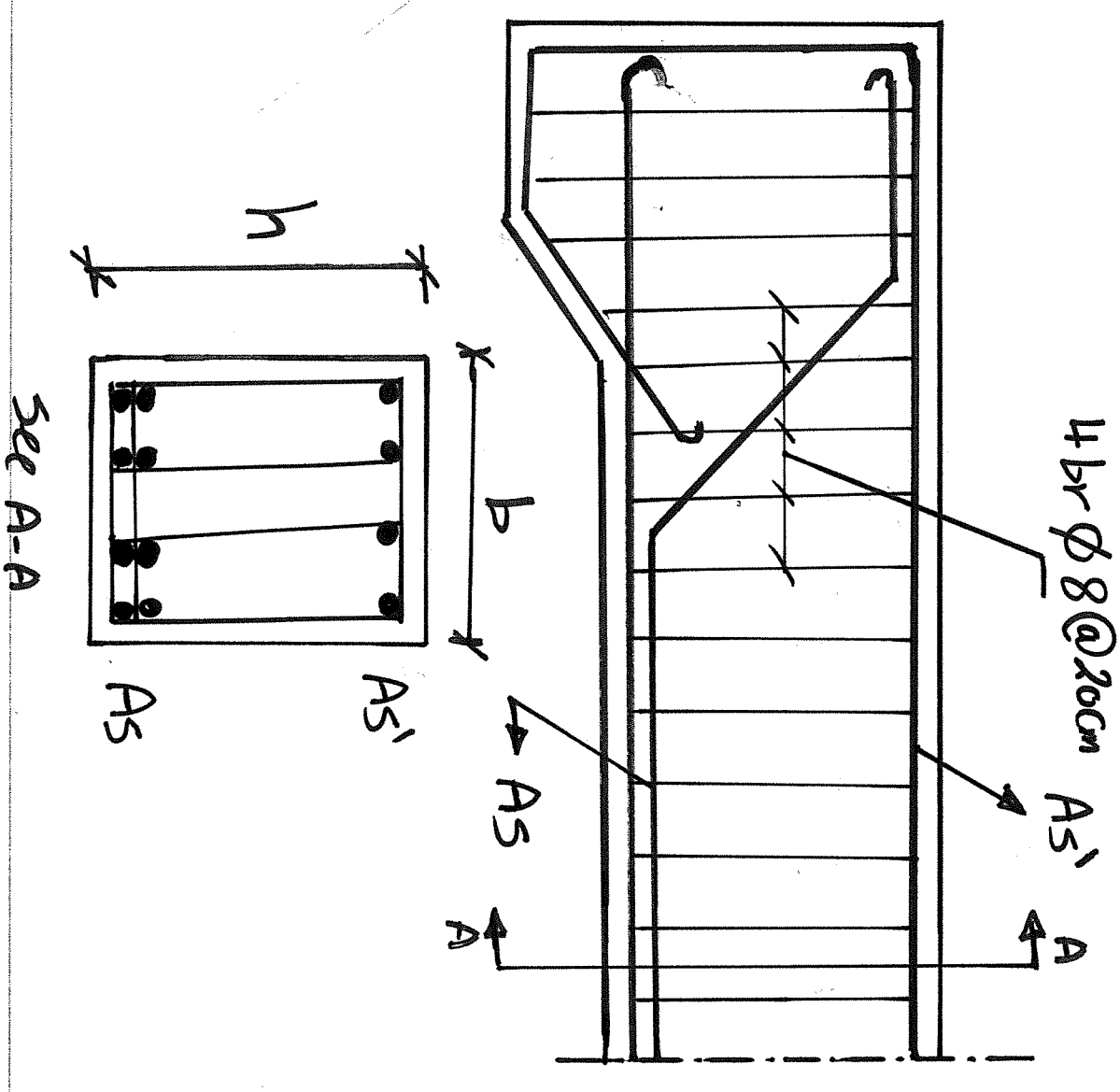
$$A_s = \frac{M_t * 10^5}{k_2\, d} = \text{vv cm}^2 \not< A_{s\,min}$$

Check of shear

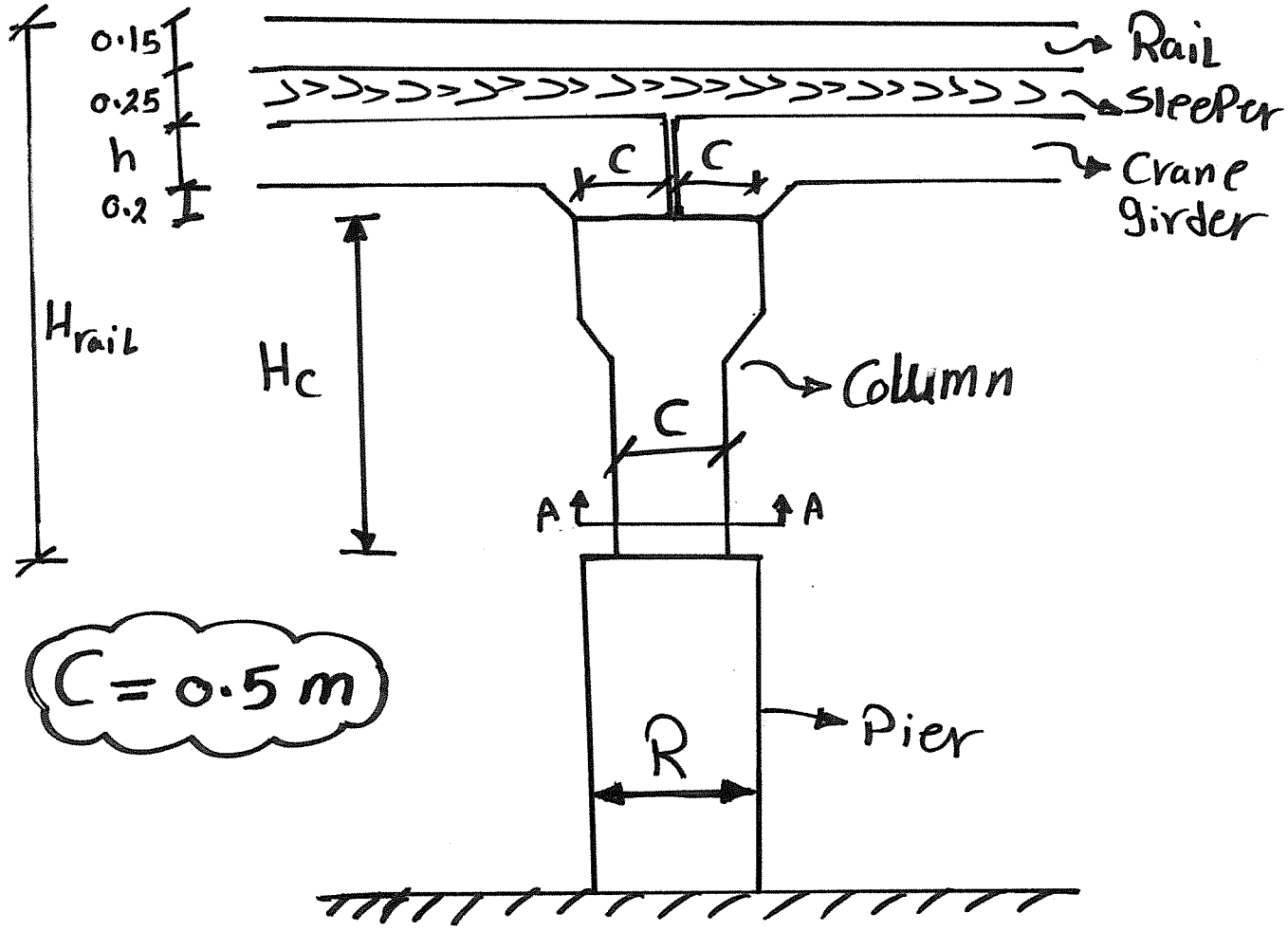
$A_s' = 0.2\, A_s = \text{vv cm}^2$

$$q_r = \frac{Q_t * 10^3}{b * d} = \text{vv} \not> q_{call}$$

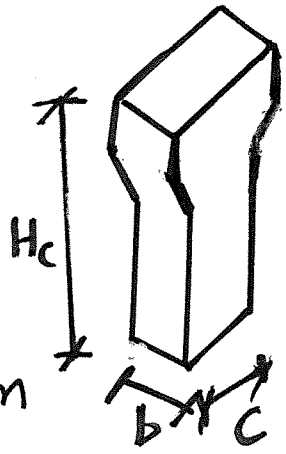
رسم حديد التسليح



7- Column



Dimension



$$H_c = H.g + 0.5$$

$$C = 0.5\ m$$

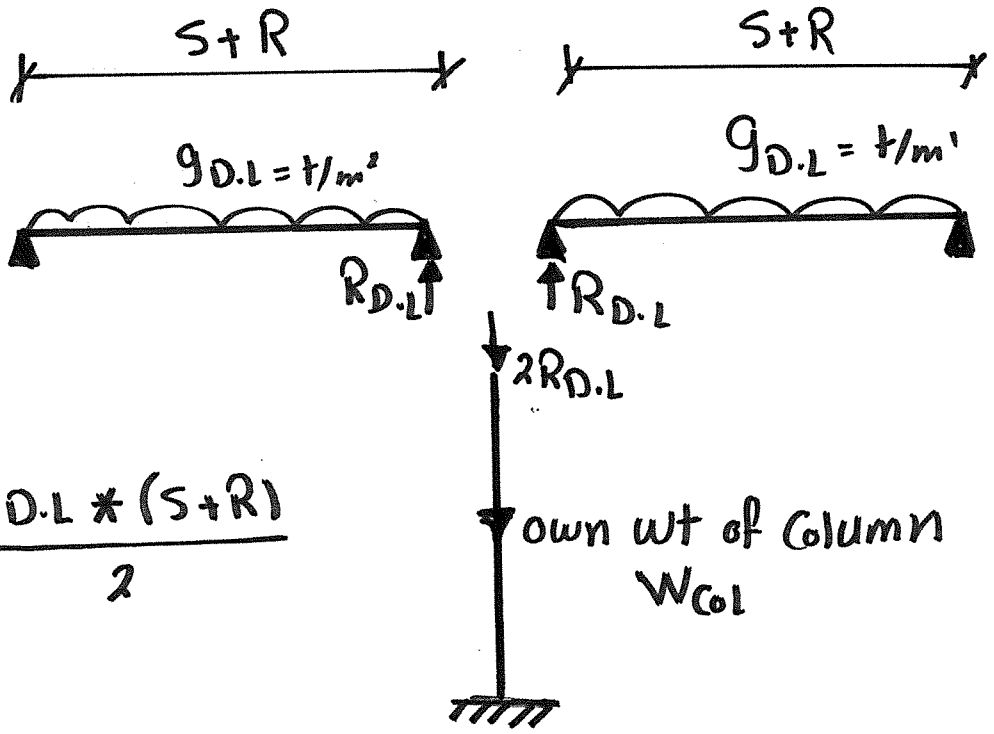
$$b_c = b_{crane\ girder} = 0.45\ m$$

$$H_{rail} = 0.15 + 0.25 + h + 0.2 + H_c$$

$$h = \frac{S+R}{10}$$

Loads

* Dead Loads



$$R_{D.L} = \frac{g_{D.L} * (S+R)}{2}$$

$$\therefore N_{DL} = W_{COL} + 2\,R_{D.L}$$

$$W_C = (b * C * H_C) * \gamma_{R.C} = \text{ton}$$

b: 0.45 m, C: 0.5 m, H_C: H_{lg} + 0.5, $\gamma_{R.C}$: 2.5 t/m³

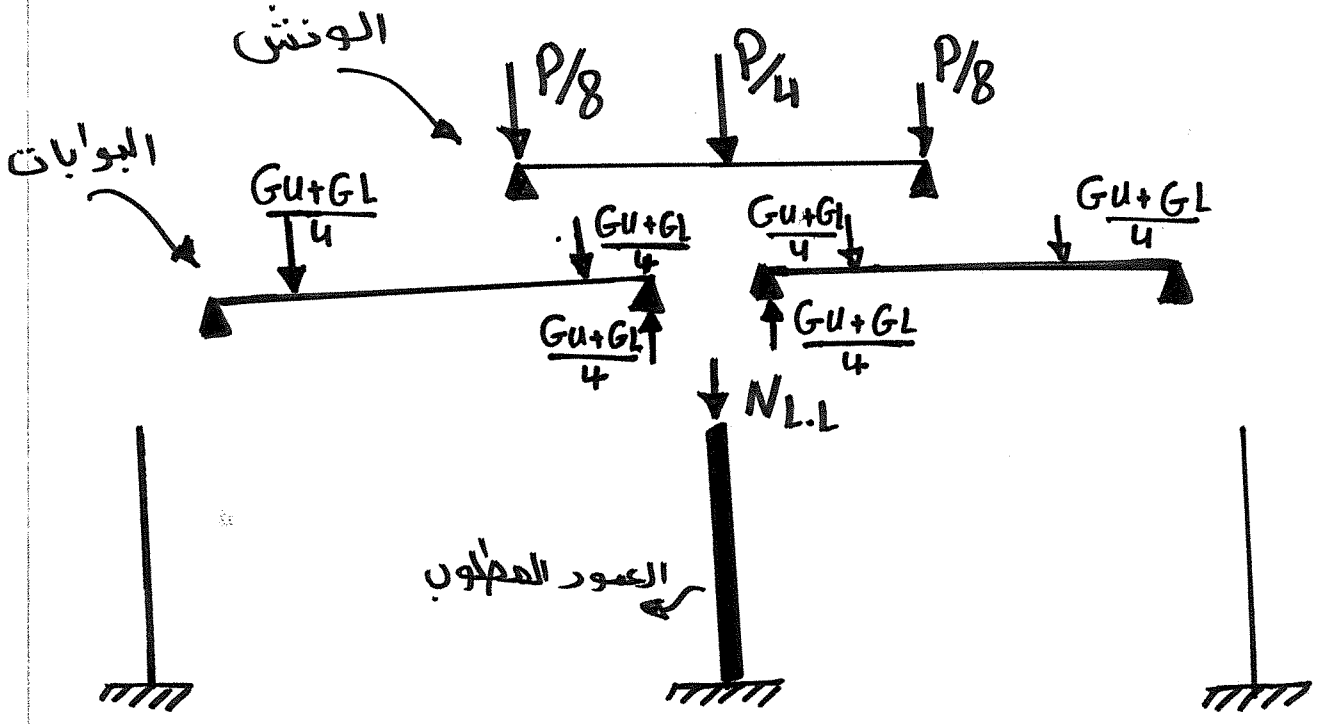
Live Load

يوجد حالتين تحميل لـ Live Load

Case1

Case of Max axial Force

اقصى قوى محورية على العمود تحصل عليها عندما تكون البوابتان معلقتان على الكمرتين المجاورتين للعمود والونش واقف فوق العمود (بحيث يكون عجلته الثقيلة $\frac{P}{4}$ فوق العمود مباشرة)



$$N_{L.L} = 2 * \frac{G_U + G_L}{4} + \frac{P}{4} + P/8$$

$$N_{Max} = N_{D.L} + N_{L.L} \quad ton$$

Design

قطاع معرض لـ (N) فقط (Short Column)

$$N_{Max} * 10^3 = A_c * f_{call} + 0.44 f_y A_{sc}$$
N_{Max} kg

- A_c: مساحة الخرسانة
- f_{call}: اجهاد الخرسانة المسموح بها
- f_y: اجهاد الخضوع للحديد
- A_{sc}: مساحة الحديد $0.01 A_c$

$$\therefore A_{sc} = 0.01 * A_c$$

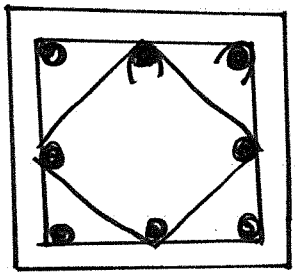
$$f_{call} = 50 \text{ kg/cm}^2$$

$$A_c = b * C$$

نتج ايجاد (A_c)

$$\therefore A_{sc} = 0.01 * A_c = \text{VV } cm^2$$

$$A_{s_{min}} = 4 \varnothing 12$$



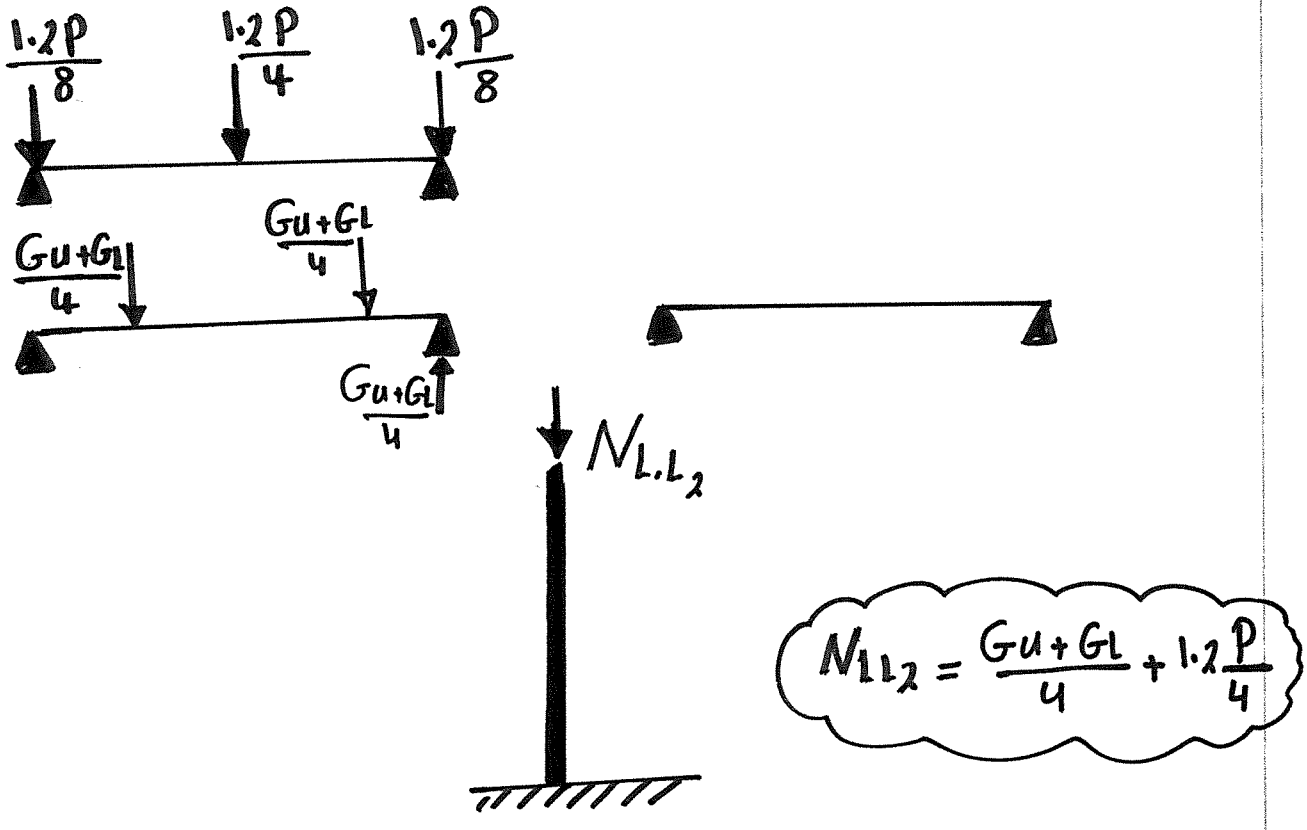
تشكل حديد التسليح

Case 2

Case of Max eccentricity

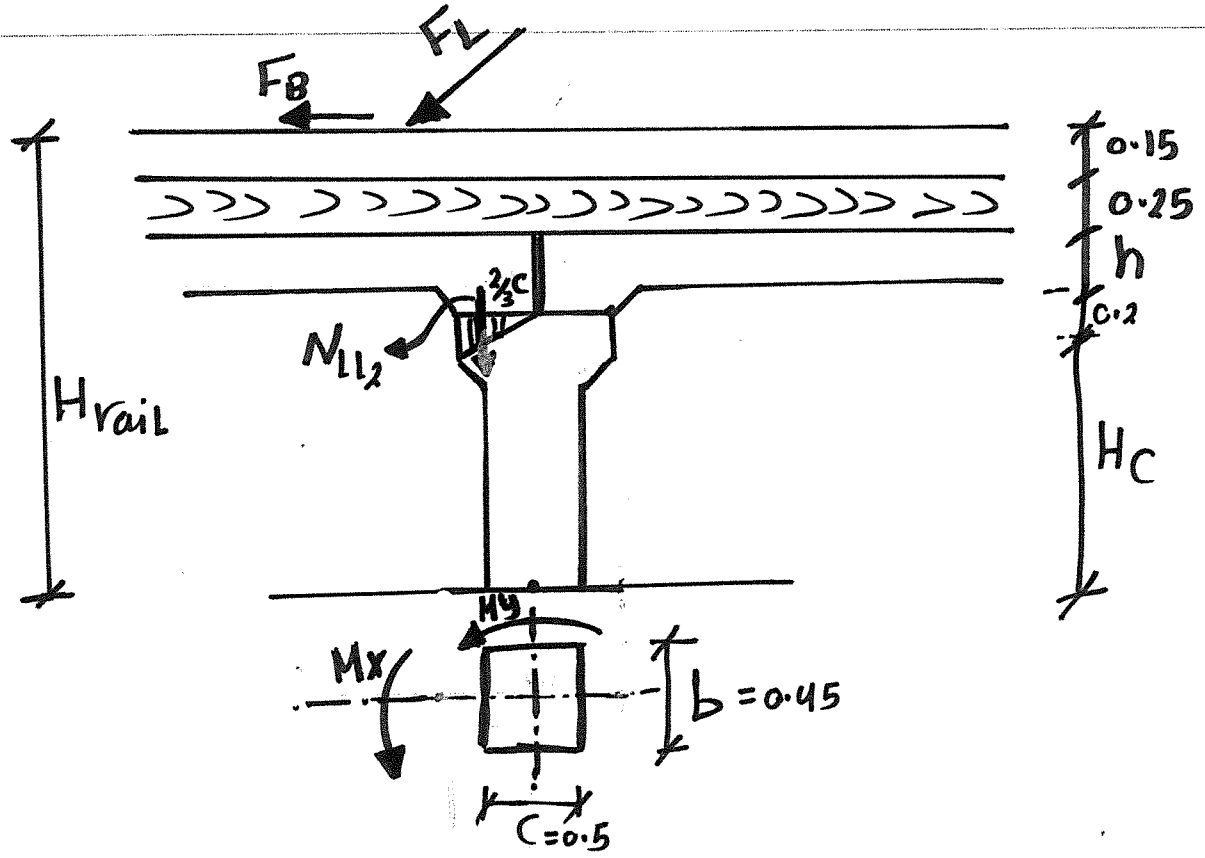
Max moment

الحصول على اقصى عزم على العمود (ندخل علية بتحميل الكمرة اليسرى بأقصى احمال والونش على وشك الوقوف على الكمرة اليسرى .



$$N_{LL_2} = \frac{Gu+Gl}{4} + 1.2\frac{P}{4}$$

$$N_{Max_2} = N_{D.L} + N_{LL_2}$$



$$\therefore F_B = \frac{P}{7}$$

$$\therefore F_L = \frac{P}{4}$$

$$\rightarrow M_y = (N_{LL2} * \frac{2}{3} C) + F_B * H_{rail}$$

$$\rightarrow M_x = F_L * H_{rail}$$

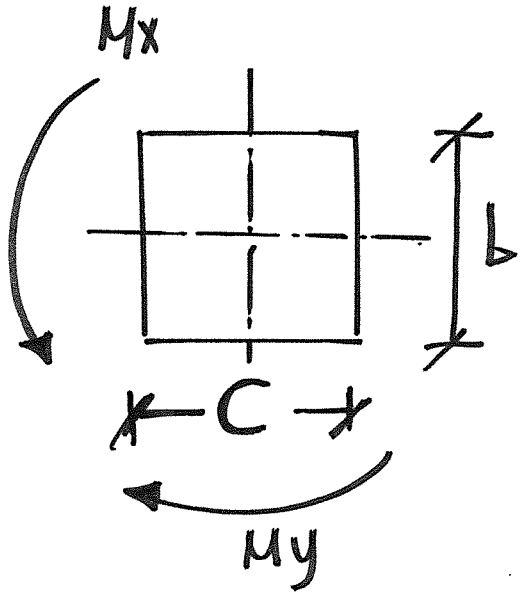
$$\rightarrow N_{Mux2} = N_{D.L} + N_{LL2}$$

Design

For **N, Mx**

$$d = k_1 \sqrt{\frac{M_x * 10^5}{C_{cm}}}$$

$$t = d + d'_{5cm} \quad * \quad b$$



$$A_s = \frac{M_x * 10^5}{k_2 \; d_{act} \rightarrow (b - 5cm)}$$

$$A_s' = A_s$$

For **N, My**

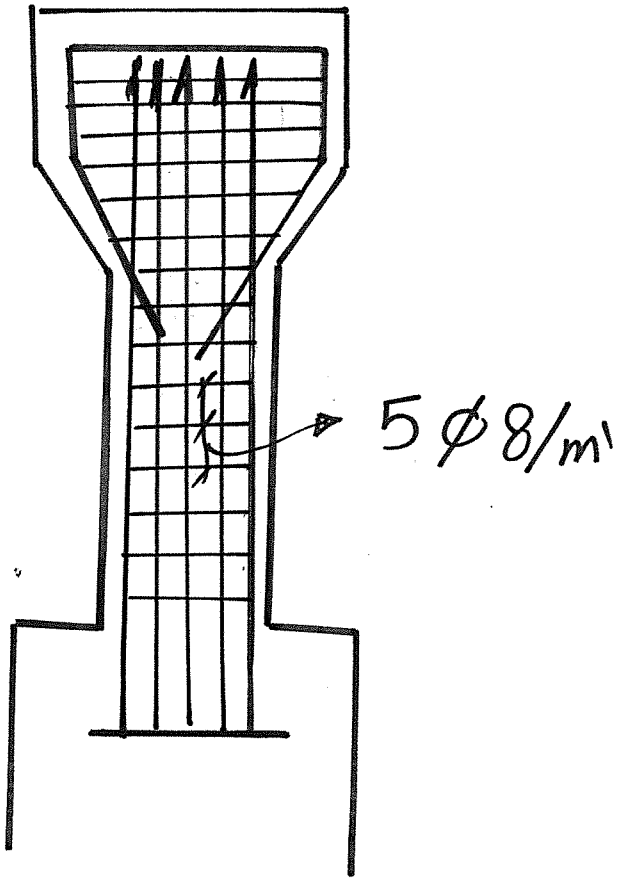
$$d = k_1 \sqrt{\frac{M_y * 10^5}{b_{cm}}}$$

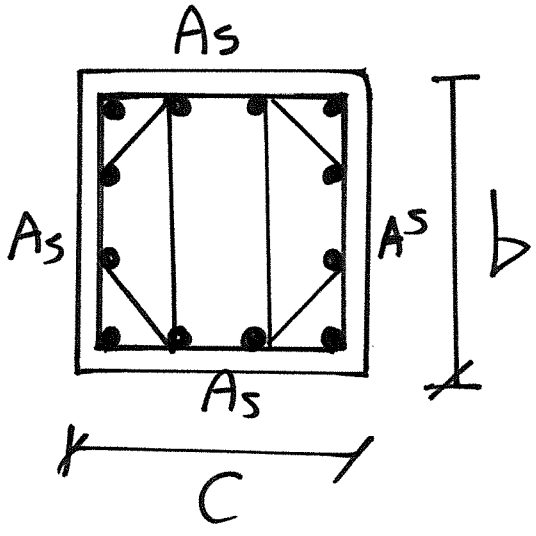
$$t = d + d'_{cm} \quad * \quad C$$

$$A_s = \frac{M_y * 10^5}{k_2 \; d_{act} \; (C - 5cm)}$$

$$A_s' = A_s$$

رسم حديد التسليح





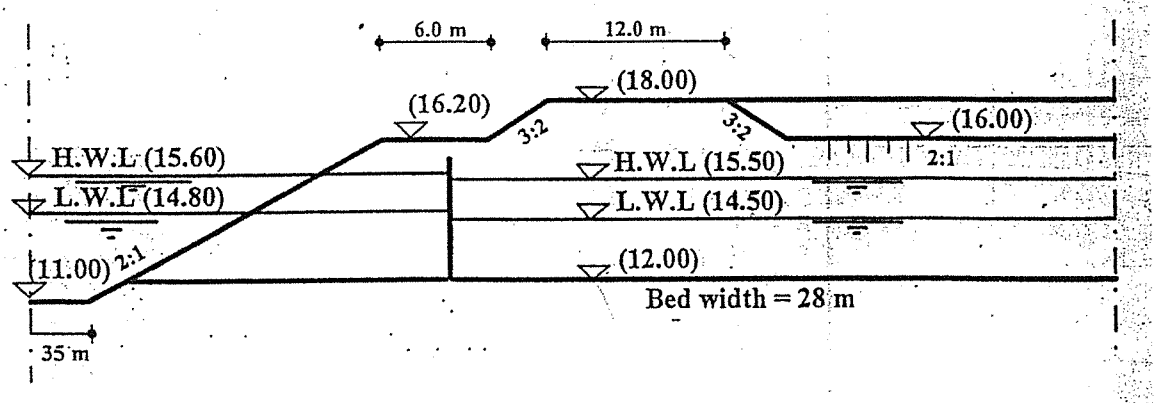
Regulators & Barrages

A reinforced concrete head regulator is to be constructed to feed a main canal from a Rayah. A longitudinal dimensioned section through the main canal at the regulator site is given in the figure. The available data for the regulator are:

- The regulator consists of *four* vents of 6.0 m span for each,
- The maximum allowable discharge through the main canal is 7.5 million m^3/d,
- The bridge width over the regulator is 12.0 m and it has two sidewalks of 1.50 m width for each,
- The equivalent D.L of the bridge, L.L on the traffic lanes, and L.L on the sidewalks are 2.0, 1.0, 0.4 t/m^2, respectively,
- The soil properties at the regulator site are: $\Phi = 30°$, $\gamma_{bulk} = 1.65$ t/m^3, and the allowable bearing capacity is 1.50 kg/cm^2, and
- Sliding vertical steel gates with horizontal main girders are used.

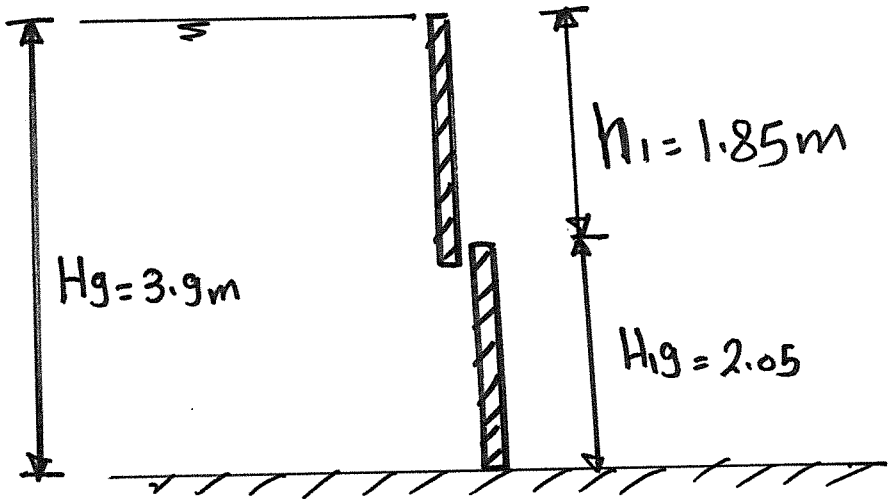
It is required to:

1. Check the hydraulic design of the regulator,
2. Give the complete structural design for each of the following elements:
   - The sliding gates and find the required lifting force,
   - The required R.C gate lifting structure,
   - The R.C piers, and
   - The R.C floor, considering the required lengths for percolation and scouring; $C_B = 12$.
3. Draw neat sketches showing the following:
   i. Plan (H.E.R)
   ii. Longitudinal section through the regulator



Design the gate lifting structure

البوابة Double gate ← تم تصميمها فى اول المثال.



$$Hg = y_{us} + 0.3$$

$$y_{us} = y_{Ds} + 0.1 = 3.5 + 0.1 = 3.6\ m$$

$$Hg = 3.6 + 0.3 = 3.9\ m$$

$$H_{1g} = \frac{Hg}{2} + 0.1 = \frac{3.9}{2} + 0.1 = 2.05\ m$$

$$Bg = S + 0.4 = 6.4\ m$$

نبدأ في تصميم مكونات الـ ..

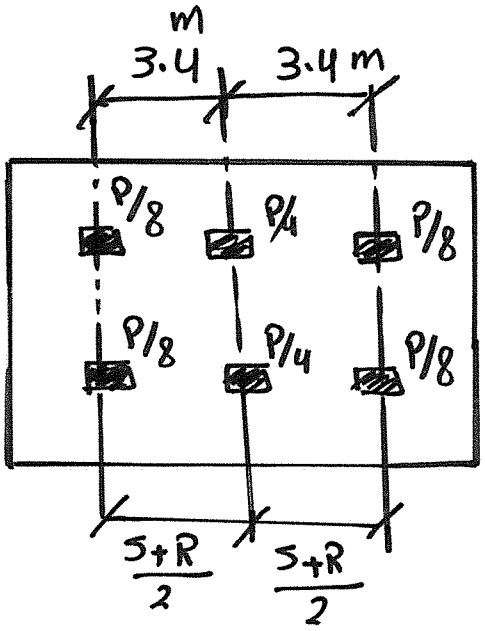
11 Crane :-

$\therefore S = 6m > 4m$ Use 6 wheel

$\therefore P = S$ ton

$\rightarrow P = 6$ ton

$\rightarrow I = 20\%$ Impact



$\rightarrow F_L = \frac{P}{4} = \frac{6}{4}$ ton $= 1.5$ ton القوة الجانبية

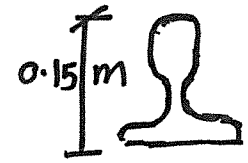
$\rightarrow F_B = \frac{P}{7} = \frac{6}{7}$ ton $= 0.857$ ton
قوة الفرامل

assume $R = \frac{S}{5 \rightarrow 8} = \frac{6}{5 \rightarrow 8} = (1.2 - 0.75)$

لعرض الـ Pier

For R.C Take $R = 0.8$ m

Rail

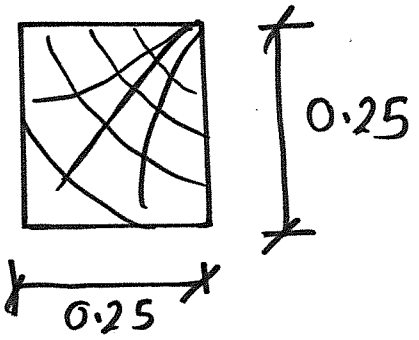


own wt = 0.05 t/m'

hight = 0.15 m = 15 Cm

Sleeper

γ = 0.9 t/m²



own wt = (0.25 * 0.25) * 0.9

own wt = 0.056 t/m'

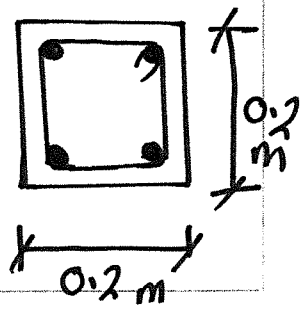
Tie

$$T = \frac{F_L}{2} = \frac{P/4}{2} = \frac{S}{8} = \frac{6}{8} = 0.75 \text{ ton}$$

$$To = T * (F.o.S) = 0.75 * 4 = 3 \text{ ton}$$

Design

$$As = \frac{To \times 10^3}{fs} = \frac{3 * 10^3}{1200} = 2.5 Cm^2$$



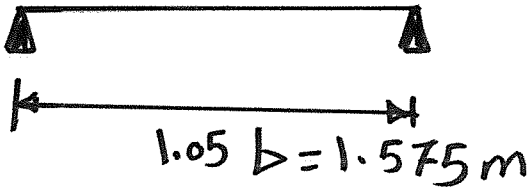
As = 0.45 ⌀12 → Used 4⌀12

Slot Channel

at $S = 6m$

$\therefore b = 1.5$ m Span

$\therefore w = 0.9$ m Load



Loading

a. Dead Load

$g_{D.L}$ = own wt + Chaquar Plate

$g_{D.L} = 0.05 + 0.15 = 0.2$ t/m'

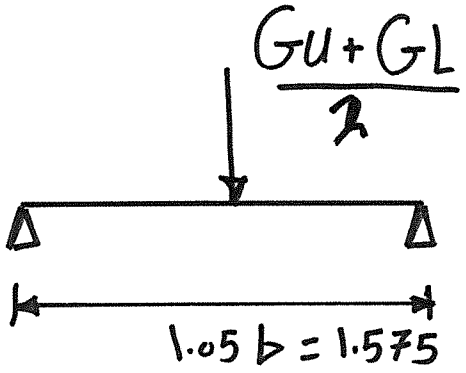
$$M_{D.L} = \frac{g_{D.L} * (1.05\,b)^2}{8} = \frac{0.2 * 1.575^2}{8}$$

$$M_{D.L} = 0.046 \text{ t.m}$$

$$Q_{D.L} = \frac{g_{D.L} * (1.05\,b)}{2} = \frac{0.2 * 1.575}{2}$$

$$Q_{D.L} = 0.118 \text{ ton}$$

b- Live Load :-



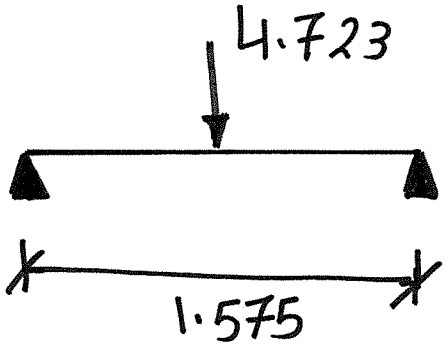
$Gu = GL$

$Gu = A_{1g} * g$

$g = 0.06 * S = 0.06 * 6 = 0.36 \rightarrow S > 5m$

$A_{1g} = H_{1g} * B_g = 2.05 * 6.4 = 13.12\ m^2$

$Gu = GL = 13.12 * 0.36 = 4.723\ ton$



$$M_{L.L} = \frac{4.723 * 1.575^2}{4} = 1.86\ t.m$$

$$Q_{L.L} = \frac{4.723}{2} = 2.36\ ton$$

$$M_t = M_{D.L} + M_{L.L}$$

$$M_t = 0.046 + 1.86 = 1.906 \text{ ton.m}$$

$$Q_t = Q_{D.L} + Q_{L.L}$$

$$Q_t = 0.118 + 2.36 = 2.478 \text{ ton}$$

Design

$$Z_{2E} = \frac{M_t * 10^5}{f_s\ 1200} = \frac{1.906 * 10^5}{1200} = 159 \text{ cm}^3$$

$$Z_{1E} = \frac{Z_{2E}}{2} = \frac{159}{2} = 79.5 \text{ cm}^3$$

(UPN) steel يتم اختيار القطاع من جدول الـ

Check of shear

$$q = \frac{Q_t * 10^3}{2\ t_w * h_w} = \nu * q_{all}$$

Design of Crane girder

$\therefore S = 6m$

$R = 0.8$

$S + R = 6.8\ m$

$\therefore b = 0.45\ m$

$$h = \frac{Span}{10} = \frac{6.8}{10} = 0.68 \simeq 0.7\ m$$

Loading

* Dead Load

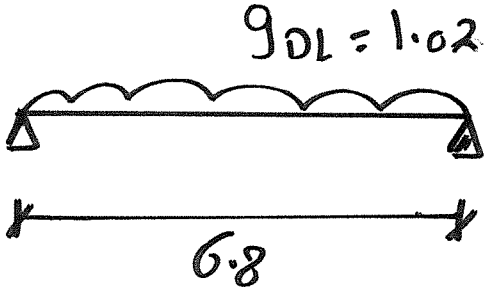
$$g_1 = \gamma_{RC}\,(b * h) = 2.5 * (0.45 * 0.7) = 0.787\ t/m'$$

g_2 = Wt of Rail + wt of sleeper

$$g_2 = 0.05 + (0.25 * 0.25 * 0.9) = 0.106\ t/m'$$

$$g_3 = \frac{0.15 * (b + 0.2)}{2} = \frac{0.2\,(1.5 + 0.2)}{2} = 0.17\ t/m'$$

$$g_{D.L} = \underset{g_1}{0.787} + \underset{g_2}{0.106} + \underset{g_3}{0.17} = 1.02\ t/m'$$



$$M_{D.L} = \frac{1.02 * 6.8^2}{8} = 5.89 \text{ t.m}$$

$$Q_{D.L} = \frac{1.02 * 6.8}{2} = 3.468 \text{ ton}$$

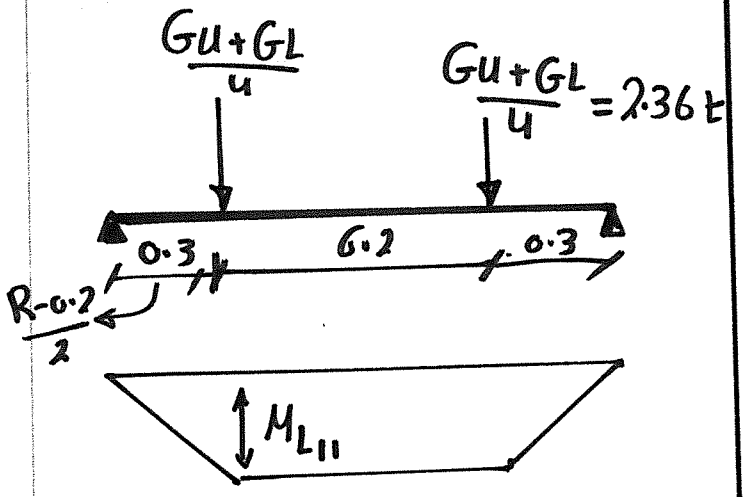
Live Load

Case I

$\therefore GU = GL = 4.723$ ton

$P = 5$ ton $= 6$ ton

Gates are suspended

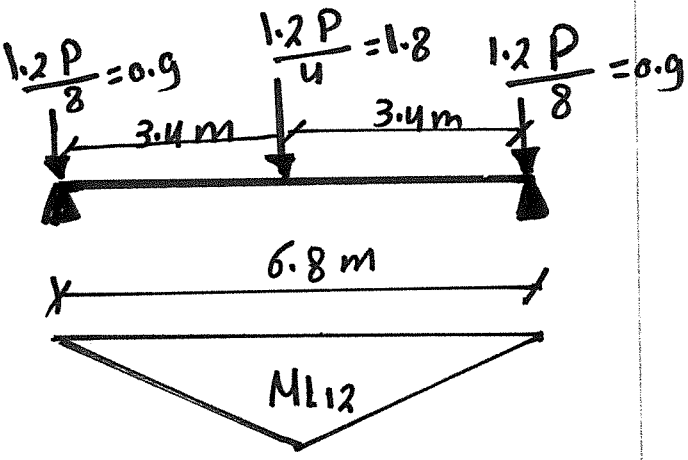


$$M_{L11} = \frac{GU+GL}{4} * \left(\frac{R-0.2}{2}\right)$$

$M_{L11} = 2.36 * 0.3 = 0.7$ t.m

$$Q_{L11} = \frac{GU+GL}{4} = 2.36 \text{ ton}$$

Grane Just moving



$$Q_{L12} = \frac{1.2\,P}{8} = 0.9 \text{ ton}$$

$$M_{L12} = 1.2\frac{P}{8}\left(\frac{S+R}{2}\right)$$

$$= 1.2 * \frac{6}{8}(3.4) = 3.06$$

$M_{L1} = 0.7 + 3.06 = 3.76$ t.m

$Q_{L1} = 2.36 + 0.9 = 3.26$ ton

Case 2

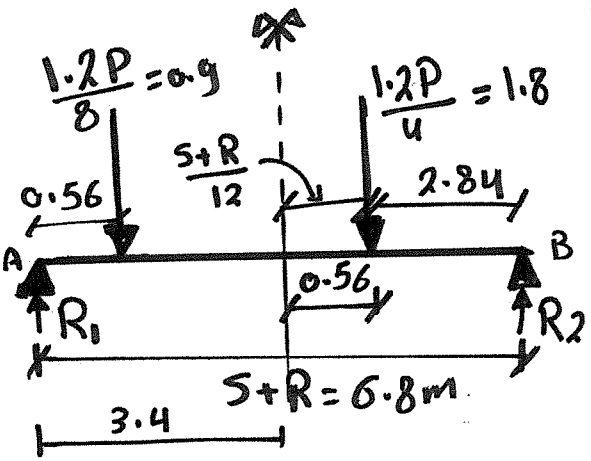
Gates are suspended

Case 1 مثل الحالة السابقة

$M_{L21} = 0.7$ t.m

$Q_{L21} = 2.36$ ton

Crane is Moving



$(0.9 * 0.56) + (1.8 * (3.4 + .56)) - R_2 * 6.8 = 0.0$

$R_2 = 1.12$ ton

$R_1 = (1.8 + 0.9) - 1.12 = 1.58$ ton

$\therefore Q_{L21} = R_1 = 1.58$ ton

$M_{L21} = R_2 \left(\frac{S+R}{2} - \frac{S+R}{12}\right)$

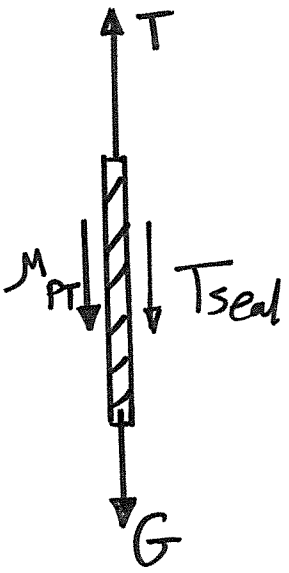
$= 1.12\ (2.84) = 3.1$ t.m

$M_{L2} = 0.7 + 3.1 = 3.8$ t.m

$Q_{L2} = 2.36 + 1.58 = 3.94$ t

* Force to required Lifting gate :

$$T = (G + \mu P_T + T_{seal}) * F.O.S$$



$G = g * Ag$

$g = 0.06 * S = 0.06 * 6 = 0.36$

$Ag = Bg * H.g = 6.4 * 2.05 = 13.12\ m^2$

$\therefore G = 13.12 * 0.36 = 4.72$ ton

$P_T = 37.696$ ton

$\mu = 0.1$ (with roller)

$T_{seal} = 2 * f * b * H.g * Pav$

$= 2 * 0.3 * 0.2 * 2.05 * \left(\frac{(1 * 1.85) + (1 * 3.9)}{2}\right)$

$T_{seal} = 0.707$ ton

$$T = (4.72 + 0.1 * 37.696 + 0.707) * 1.25$$

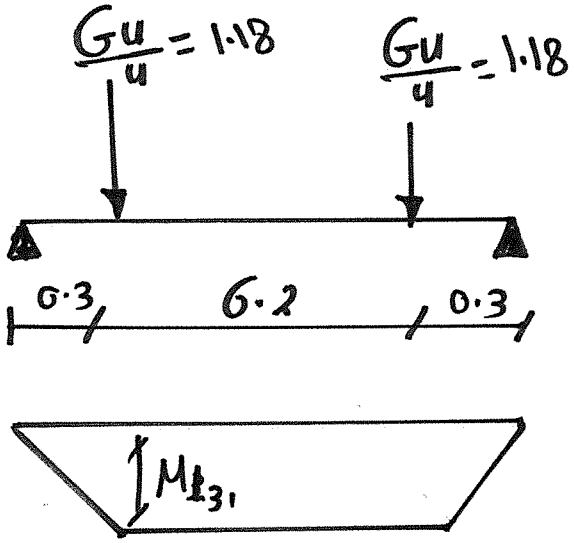
$$T = 9.19 \text{ ton} * 1.25$$

Case 3

$\therefore T = 9.19$ ton تم إيجادها

$GU = 4.723$ ton

Upper gate suspended

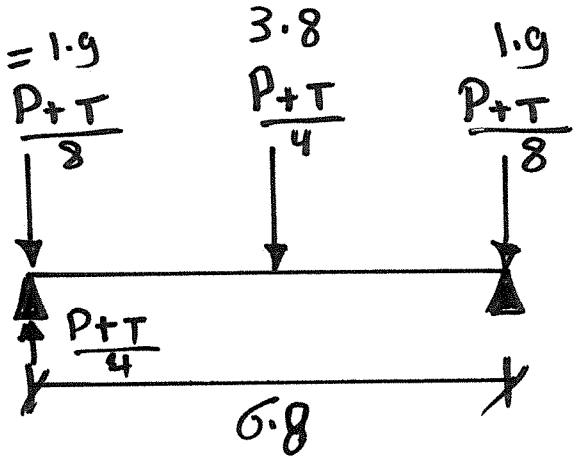


$$M_{L31} = \frac{GU}{4}\left(\frac{R-0.2}{2}\right)$$

$$= 1.18\ (0.3) = 0.35\ t.m$$

$$Q_{L31} = \frac{GU}{4} = 1.18\ ton$$

Crane lifting lower gate



$$Q_{L32} = \frac{P+T}{8} = 1.9\ ton$$

$$M_{L32} = \frac{P+T}{8} * \frac{6.8}{2}$$

$$= 1.9 * 3.4 = 6.46\ t.m$$

$$M_{L3} = 0.35 + 6.46 = 6.81\ t.m$$

$$Q_{L3} = 1.18 + 1.9 = 3.08\ t$$

$$M_T = M_{DL} + M_{L.L_{Max}}$$

$$= 5.89 + 6.81 = 12.7 \text{ t.m}$$

$$Q_T = 3.468 + 3.08 = 6.54 \text{ ton}$$

Design

$$d = k_1 \sqrt{\frac{M_t * 10^5}{b}}$$

assume $k_1 = 0.3$ $k_2 = 1218$

$$d = 0.3 \sqrt{\frac{12.7 * 10^5}{45}} = 50 \text{ cm}$$

$\therefore d' = d + 5 \text{ cm} = 55 \text{ cm}$

take $t = 70 = h \Rightarrow$ duct $= 65$ cm

$$A_S = \frac{M_t * 10^5}{k_2 d} = \frac{12.7 * 10^5}{1218 * 65} = 16.04 \text{ cm}^2$$

$$A_S = 8 \phi 16$$

$$A_S' = 0.2 * A_S$$

← ارسم حديد التسليح

Column

$H_{.g} = 2.05\ m$

Dimension

$H_c = H_{.g} + 0.5 = 2.05 + 0.5 = 2.55\ m$

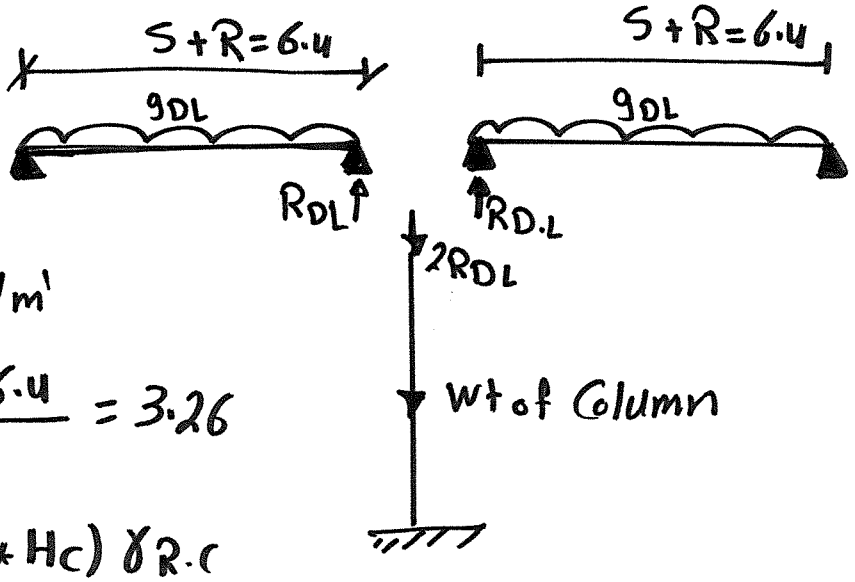
$C = 0.5\ m$

$b = 0.45\ m$

$H_{rail} = 0.15 + 0.25 + \overset{h}{0.7} + 0.2 + 2.55 = 3.85\ m$

Loading

Dead Load



$g_{DL} = 1.02\ t/m'$

$R_{D.L} = \frac{1.02 * 6.4}{2} = 3.26$

$W_C = (b * C * H_C)\,\gamma_{R.C}$

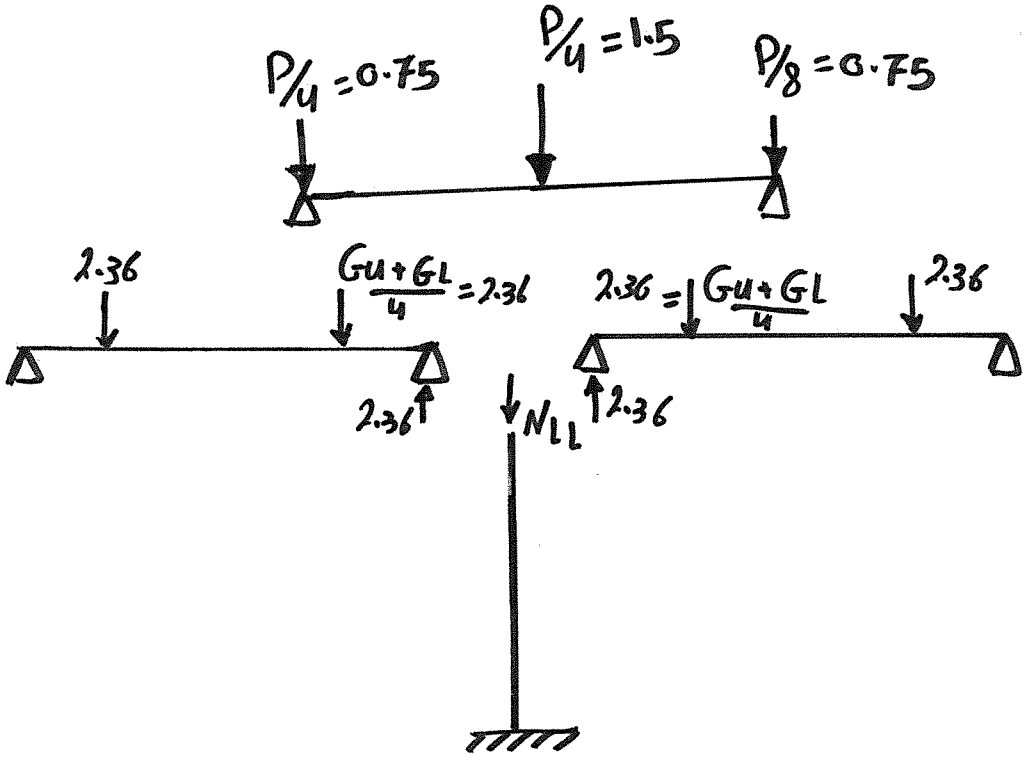
$= (0.45 * 0.5 * 2.55) * 2.5 = 1.434\ ton$

$$N_{D.L} = 2 * 3.26 + 1.434 = 7.95\ ton$$

Live Load

Case 1

Case of Max axial Force



$$N_{L.L} = 2 * 2.36 + 1.5 + 0.75 = 6.97 \text{ ton}$$

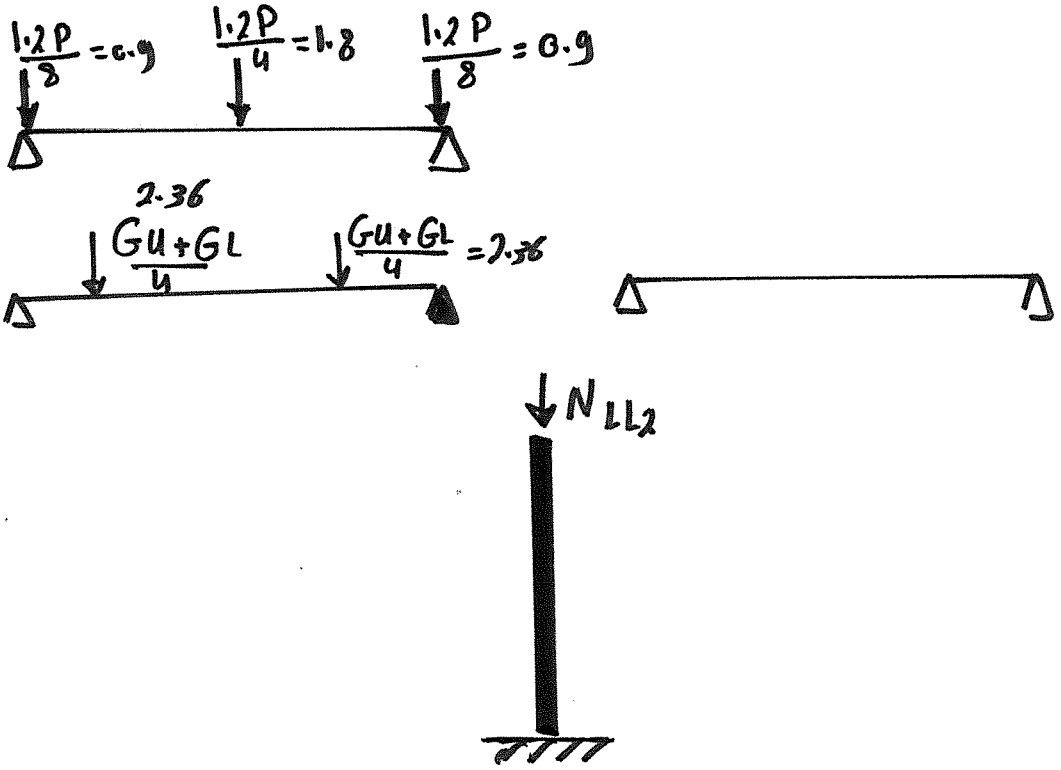
$$N_{Max} = N_{D.L} + N_{L.L}$$

$$N_{Max} = 7.95 + 6.97 = 14.92 \text{ ton}$$

كمل انت ترجمة
N قطاع معروف

Case 2

Case of Mux eccentricity



$$N_{LL2} = \frac{GU+GL}{4} + 0.9 + \frac{1.8}{2}$$

$$N_{LL2} = 2.36 + 1.8 = 4.16 \text{ ton}$$

$$N_{MUX2} = N_{D.L} + N_{L.L} = 7.95 + 4.16$$

$$N_{MUX2} = 12.11 \text{ ton}$$

$$\therefore F_B = \frac{P}{7} = \frac{6}{7} = 0.857 \text{ ton}$$

$$\therefore F_L = \frac{P}{4} = \frac{6}{4} = 1.5 \text{ ton}$$

$$M_y = (N_{L.L_2} * \frac{2}{3} C) + F_B * H_{rail}$$

$$M_y = (4.16 * \frac{2}{3} * 0.5) + 0.857 * 3.85$$

✓ $M_y = 4.686$ t.m

✓ $M_x = F_L * H_{rail} = 1.5 * 3.85 = 5.77$ t.m

✓ $N_{max} = 12.11$ ton

وهعمر انتا بقى
وارسم هديه التسليح
زى ما اتعلمنا