DESIGN OF IRRIGATION STRUCTURE (2)

رابعة مدني

Regulator
(Gate lifting structure)
a- Part (1)

6

Gate Lifting structure

قبل تصميم اى حاجة لابد من تحديد نوع البوابة :-

$$\therefore Ag = Bg * Hg$$

$$Ag \leqslant 16\ m^2 \rightarrow \text{single gate}$$

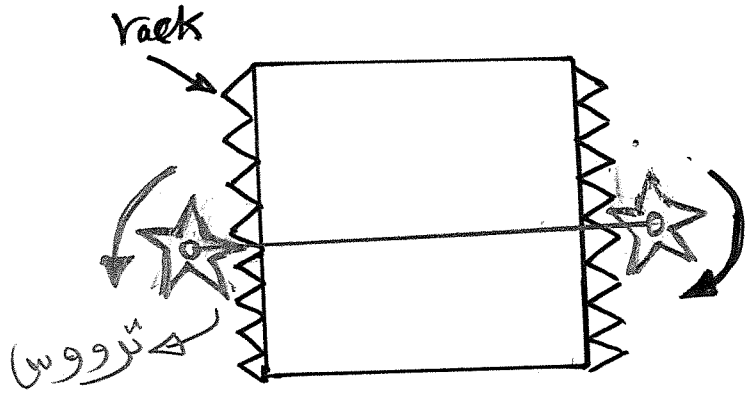
$$Ag > 16\ m^2 \rightarrow \text{Double gate}$$

* بعد تصميم الـ gate سنبدأ فى تصميم منشأ رفع البوابات (gate lifting structure) ولكن لاحظ الاتى :-

* For single gate :-

فى حالة البوابة واحدة يتم رفع البوابة بالنظام الاتى :-

(Fahmy Henein type)



(Fahmy Henein gate)

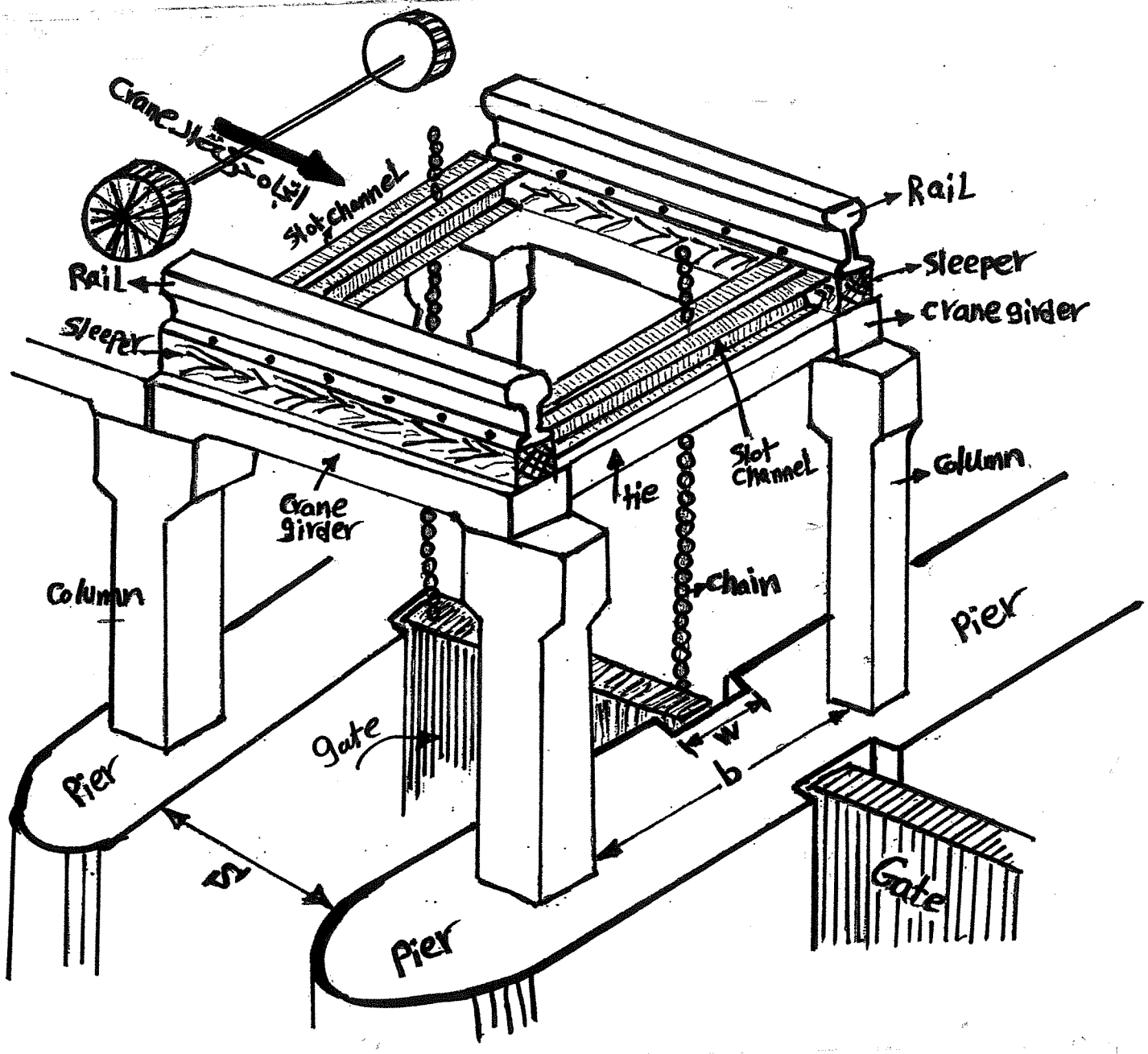
ولاتحتاج لمنشأ رفع البوابات (gate lifting structure) وانما يتم استخدامة فى الـ (Double gate) فقط

For Double Gates

- يتم استخدام ونش (Crane) لرفع البوابة وبدلاً من عمل ونش لكل فتحة من فتحات القناطر يتم عمل نظام لتحريك الونش بين الفتحات .
- يتم وضع عمودين (2 Columns) على كل Pier ويرتكز عليهم كمرة رئيسية خرسانية (Crane girders) ويتم وضع القضبان (Rails) التي سيتحرك عليها الونش .
- طقاومة الاهتزازات الناتجة من حركة الونش يتم وضع كمرة خرسانية (Tie) بين كل عمودين في الاتجاه العرضي .

تعالوا نشوف شكل
(gate lifting
structure)

مكونات (Gate lifting structure)



المكونات

1- Crane الونش

2- Rail

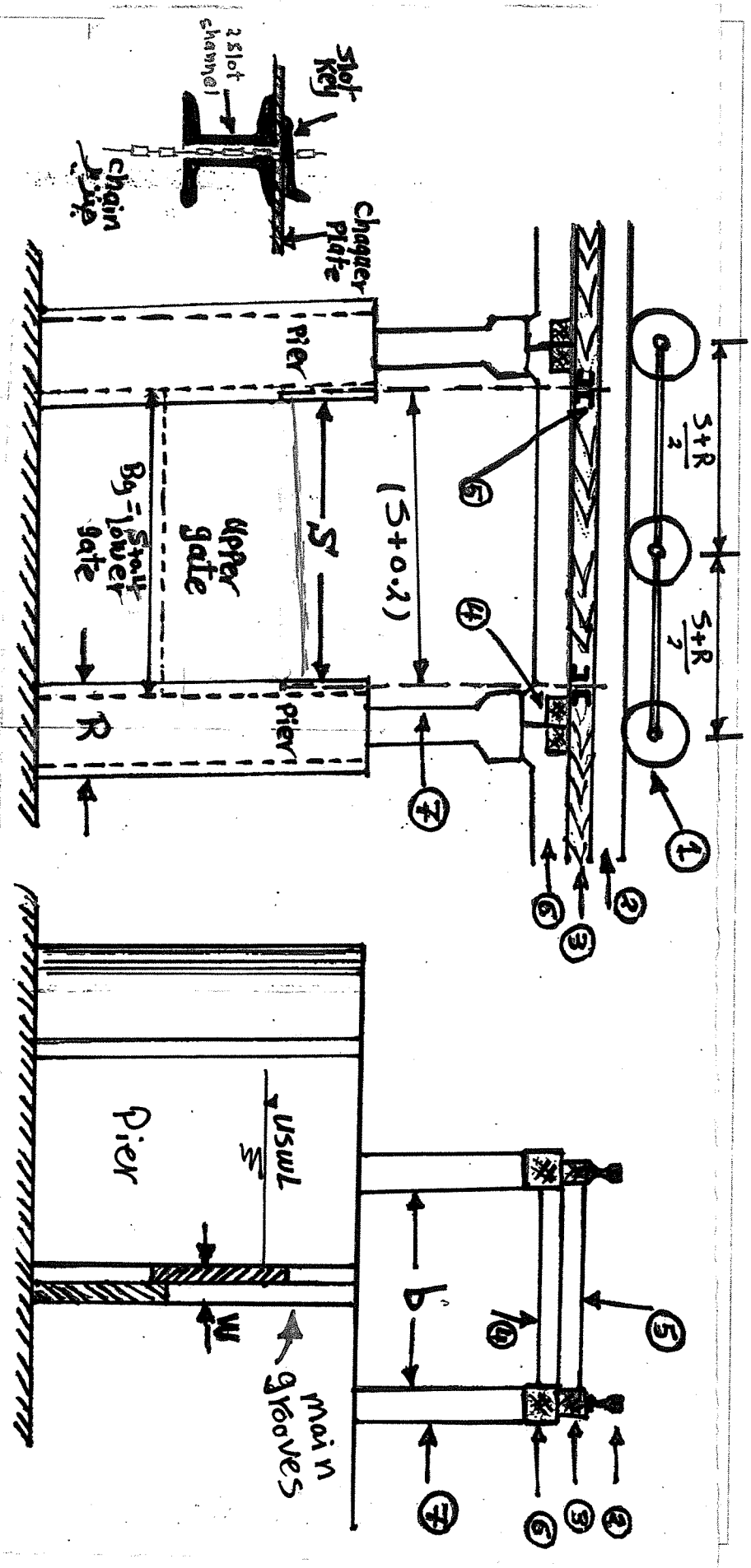
3- sleeper الفلنكات

4- Tie

5- 2 Slot channel

6- Crane girder

7- Column



(See S.V)

See ELEV

S(m)	b(m)	W(m)
3	1.0	0.6
4	1.0	0.75
5	1.25	0.9
6	1.5	1.0
8	1.8	1.2

Design of gate lifting structure

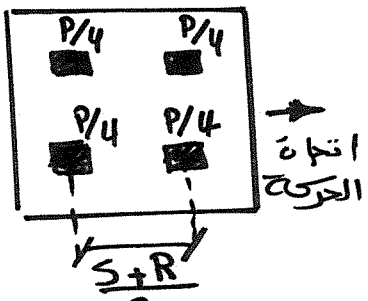
1- Crane :-

يوجد نوعين من الونش :-

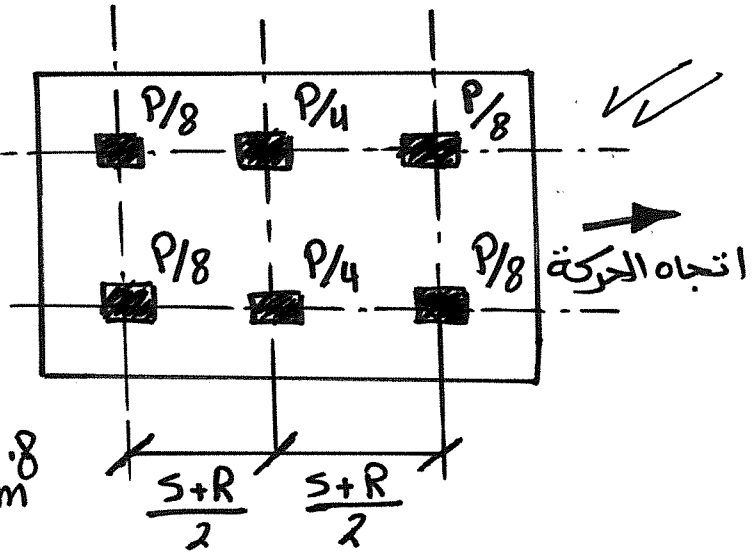
1- 4 wheel 4 عجلات

2- 6 wheel 6 عجلات

if $S \leq 4m$
4 (wheel)



if $S > 4m$
6 (wheel)



$\therefore R = \frac{S}{5-8}$ عرض Pier RC

$\leftarrow 0.8\ m$

* يرتكز الونش على 6 عجلات .

* البعد بين كل عجلتين فى اتجاه الحركة هو $(\frac{S+R}{2})$ بحيث يكون الونش فوق الفتحة تماماً فى حالة رفع البوابة .

* وزن الونش كله (P) وهو يساوى عرض الفتحة S

$\therefore P = S \text{ (ton)}$

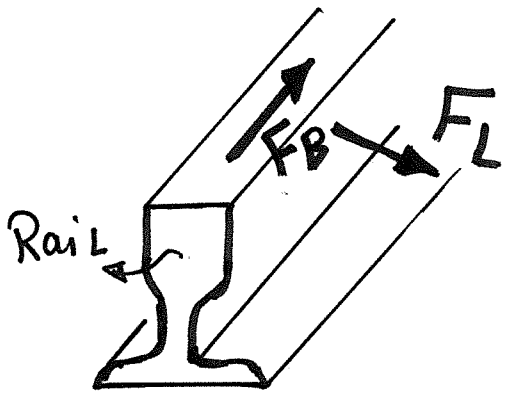
example if $S = 5m$ $\therefore P = 5$ ton

$S = 6m$ $\therefore P = 6$ ton

* ويوجد Impact نتيجة حركة الونش بمقدار (I) بحيث

$$I = 0.2$$

* ونحسب القوى الاتية :-



* F_B = Braking Force

القوة الناتجة من الفرامل

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

* F_L = Lateral Force

القوة الناتجة عن اهتزازات الونش

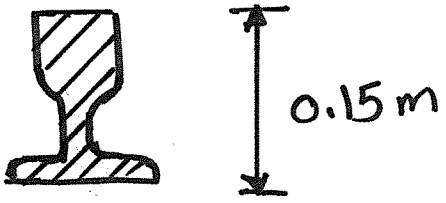
$$F_L = \frac{P}{4}$$

2- Rail :- القضبان

hight = 0.15 m

own wt = 0.05 t/m' (حفظ)

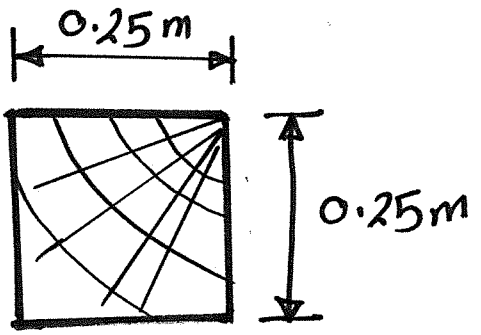
وزن Rail



3- Sleeper :- الفلنكات

تكون من الخشب وابعادها

(0.25 m * 0.25 m) حفظ



$\gamma_{wood} = 0.9\ t/m^3$

own wt = (0.25 * 0.25) * 0.9 = ٧٧ t/m'

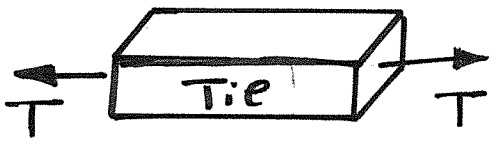
وزن الفلنكات

4- Tie :- الشداد

F_L هي كمرة خرسانية تتحمل القوى الجانبية

$$\therefore T = \frac{F_L}{2} = \frac{P/4}{2} = \frac{S}{8}$$

← بوجود شدادين في نفس الباكية



$\therefore$ To → Design Force

$$To = T * \frac{(F.O.S)}{4}$$

← معامل امان وياخد 4

من الاخر $\therefore$

$$To = \frac{S}{2} = \frac{P}{2}$$

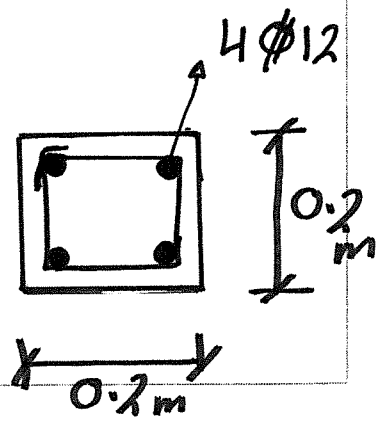
Design

$$A_S = \frac{To * 10^3}{f_s} = \text{?? } cm^2$$

← اللي بعده

$\therefore f_S = 1200\ kg/cm^2$

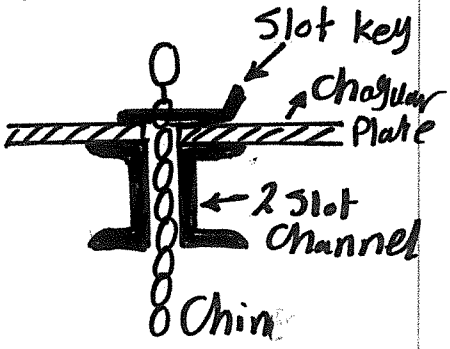
Using min steel $A_{S\,min}$ 4 ⌀ 12

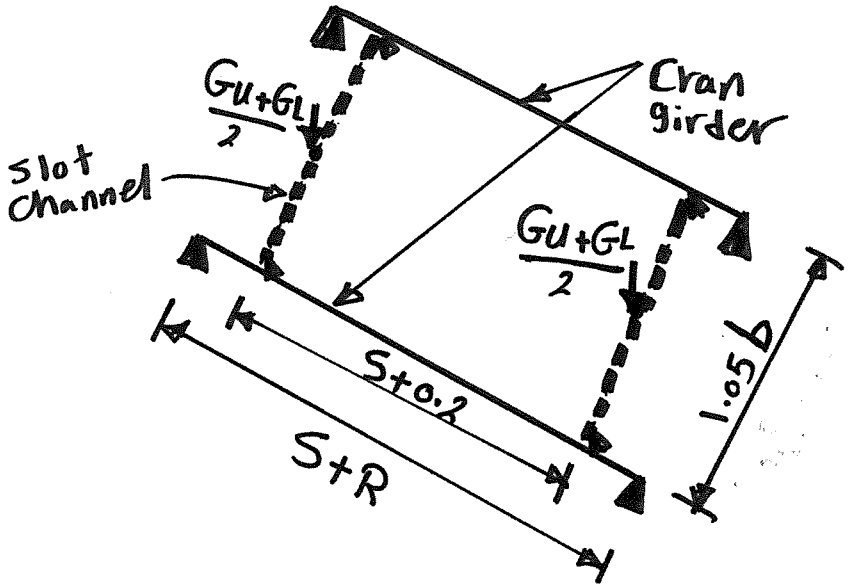


5- Slot Channel :-

هو عبارة عن كمرتين UPN (⊐⊏) مرتكزة على (Cran girder)

* اسوا حالة لتصميم (2 slot channel) عندما تكون البوابتين معلقتين

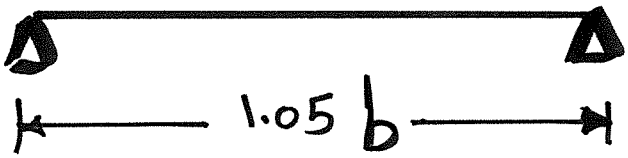




وظيفة (2 slot Channel) هو تعليق البوابات السفلية والعلوية.

* Structure system :-

b ← من جدول على حسب k



Loads

a- Dead Load

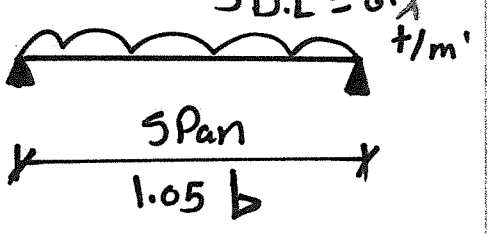
$$g_{D.L} = \text{own wt} + (\text{Chaquar Plate} + \text{L.L})$$

(Chaquar) تتباع لـ

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

$$\therefore M_{D.L} = \frac{g_{D.L} * \text{Span}^2}{8} = \text{--- t.m}$$

$$\therefore Q_{D.L} = \frac{g_{D.L} * \text{Span}}{2} = \text{--- ton}$$



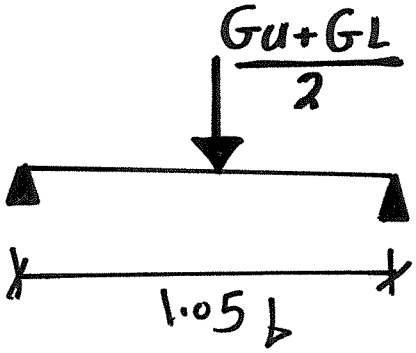
b- Live Load

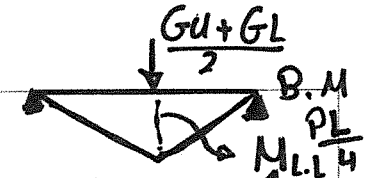
$\therefore$ Gu = GL (upper, lower) وزن البوابة

$$Gu = Ag * g$$

$$\therefore g = 0.06 * S$$

$$A_{1g} = B_g * H_{1g}$$





$$\therefore M_{L.L} = \frac{\left(\frac{Gu+Gl}{2}\right) * Span}{4} = \text{..} \ t.m$$

$$\therefore Q_{L.L} = \frac{\left(\frac{Gu+Gl}{2}\right)}{2} = \frac{Gu+Gl}{4}$$

$$\therefore \begin{cases} M_t = M_{D.L} + M_{L.L} = \text{..} \ t.m \\ Q_t = Q_{D.L} + Q_{L.L} = \text{..} \ ton \end{cases}$$

Design

$$Z_{2E} = \frac{M_t * 10^5}{\not{P_s}\,(1200)} = \text{..} \ cm^3$$

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

يتم اختيار القطاع من جدول (UPN)

Check of shear

$$q = \frac{Q_t * 10^3}{2\,t_w * h_w} = \text{..} \not< q_{all} \quad \text{ok}$$

2E

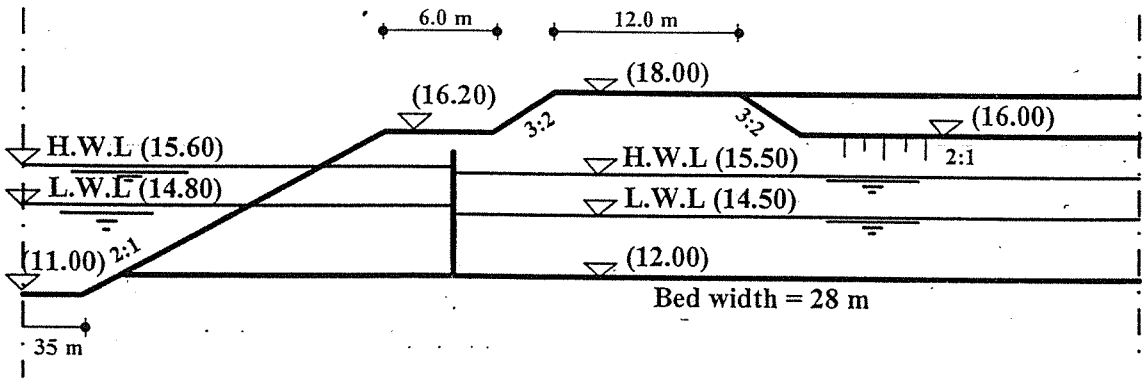
Regulators & Barrages

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: $\Phi = 30^o$, $\gamma_{bulk} = 1.65$ 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



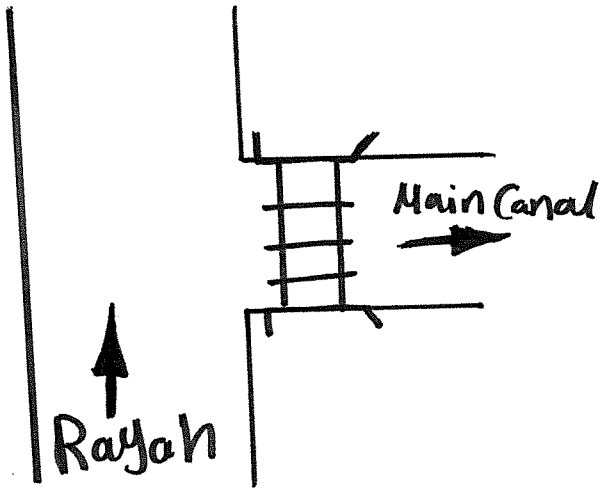
Given

* Head Regulator
* $N = 4$
* $S = 6\ m$
* $Q = 7.5 * 10^6\ m^3/day = \frac{7.5 * 10^6}{24 * 60 * 60} = 86.8\ m^3/sec$

* Check of hydraulic Design :

* خلى بالك معطى S ، N ولكن نعمل Check على α والـ V_r

* خلى بالك الـ (Head regulator) بيكون فى بداية الترعة الـ Main مغير درجة.

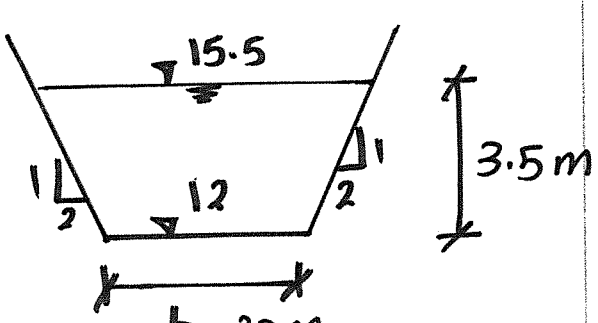


$A_{ds} = (b + y_{ds} Z)\, y_{ds}$

$A_{ds} = (28 + 3.5 * 2) * 3.5 = 122.5\ m^2$

$\therefore A_{ww} = N * S * y_{ds}$

$A_{ww} = 4 * 6 * 3.5 = 84\ m^2$



(Main Canal x-section)

* $V_r = \dfrac{Q}{A_{ww}} = \dfrac{86.8}{84} = 1.03\ m/sec$

$1.0 < V_r < 2.0$ ok

ممكن السرعة تقل عن ١ عادى

* $B_{eact} = N * S = 6 * 4 = 24\ m$

$B_{e2} \geq 0.5\ \dfrac{A_{ds}}{y_{ds}}$

$B_{e2} \geq 0.5\ \dfrac{122.5}{3.5} = 17.5\ m$

$\therefore B_{eact} > 17.5\ m$ ok

24 m

شرط محقق

Check of heading up

$$h_{up} = \frac{V_{us}^2}{2g\,C^2}\left(\left(\frac{A_{us}}{A_{ww}}\right)^2 - 1\right) \neq h_{all}$$

$$A_{us} = (b + y_{us}\,Z)\,y_{us}$$

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

→ $A_{us} = (28 + 3.6 * 2)\,3.6) = 126.72\,m^2$

→ $V_{us} = \frac{Q}{A_{us}} = \frac{86.8}{126.72} = 0.684\ m/sec$

→ $\therefore\ S > 4 \quad \therefore\ C = 0.92$

→ $A_{ww} = 84\,m^2$

$$h_{up} = \frac{(0.684)^2}{2 * 9.81 * (0.92)^2}\left(\left(\frac{126.72}{84}\right)^2 - 1\right) = 0.035\,m$$

$h_{up} = 3.5\ cm < 10\ cm$ ok

2- Given the Complete structural Design for each:

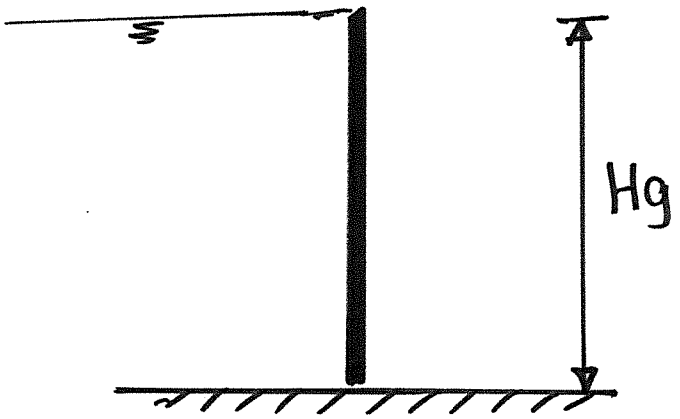
- **The steel Sliding gates and Find the required Lifting Force?**

الحل

$S = 6\ m$

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

* تحديد نوع البوابة



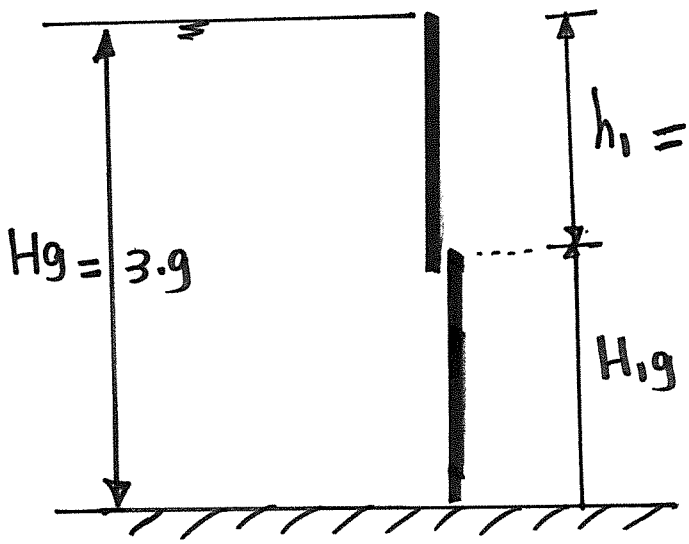
$H_g = y_{us} + 0.3 = 3.6 + 0.3 = 3.9\ m$

$B_g = S + 0.4 = 6 + 0.4 = 6.4\ m$

$\therefore A_g = H_g * B_g = 3.9 * 6.4 = 24.96 > 16\ m^2$

Double gate

* تحديد ابعاد البوابة



$B_g = S + 0.4 = 6.4m$

$H_{1g} = \frac{H_g}{2} + 0.1$

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

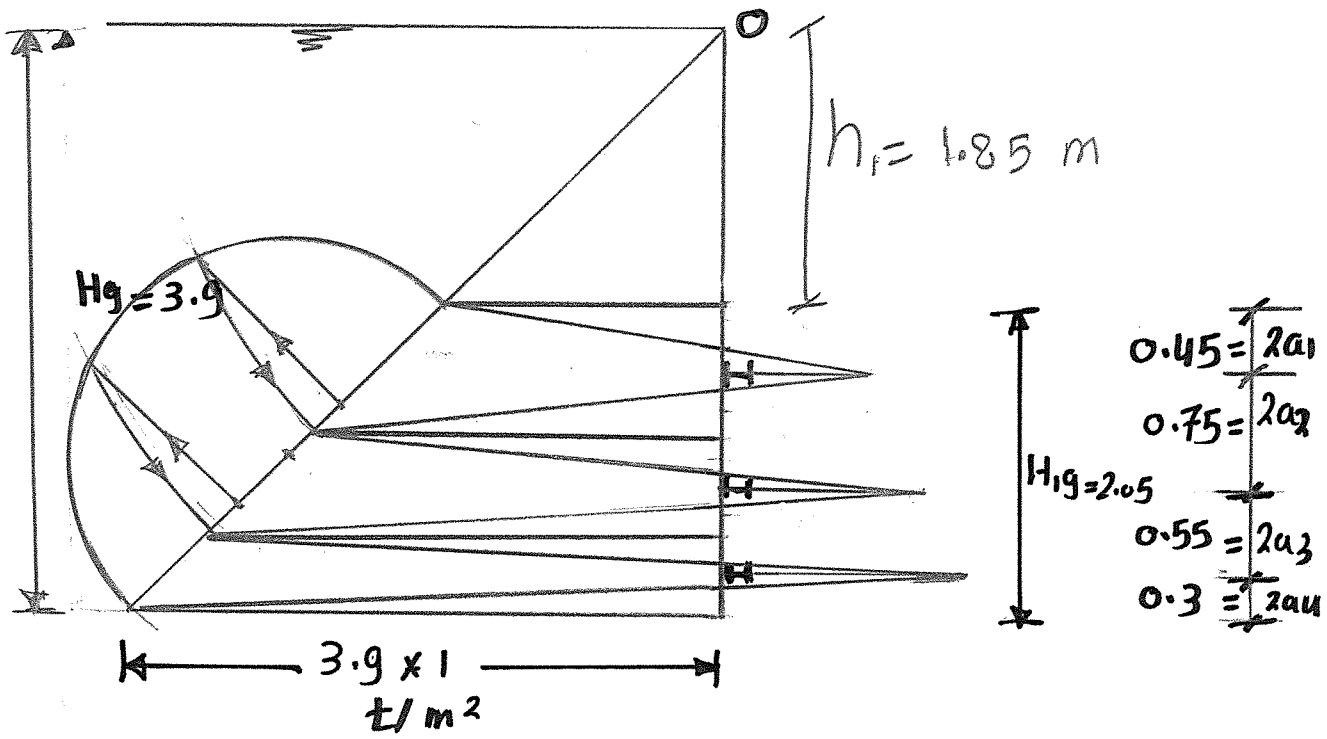
Used Double Gate of Dimension

(6.4 * 2.05) For each gate

Location of MG

لو يعطى عدد MG يتم فرضها 3 MG او 4 MG

assume $N_{MG} = 3\ MG$



ولازم نتاكد ان

$$2a_1 + 2a_2 + 2a_3 + 2a_4 = H_{1g} = 2.05\ m$$

Design of Skin Plate

فرض

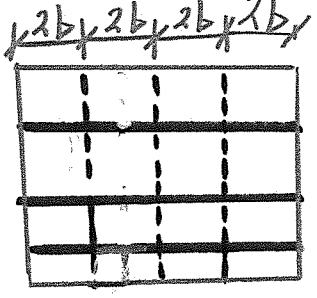
No of XG assume = 3 XG

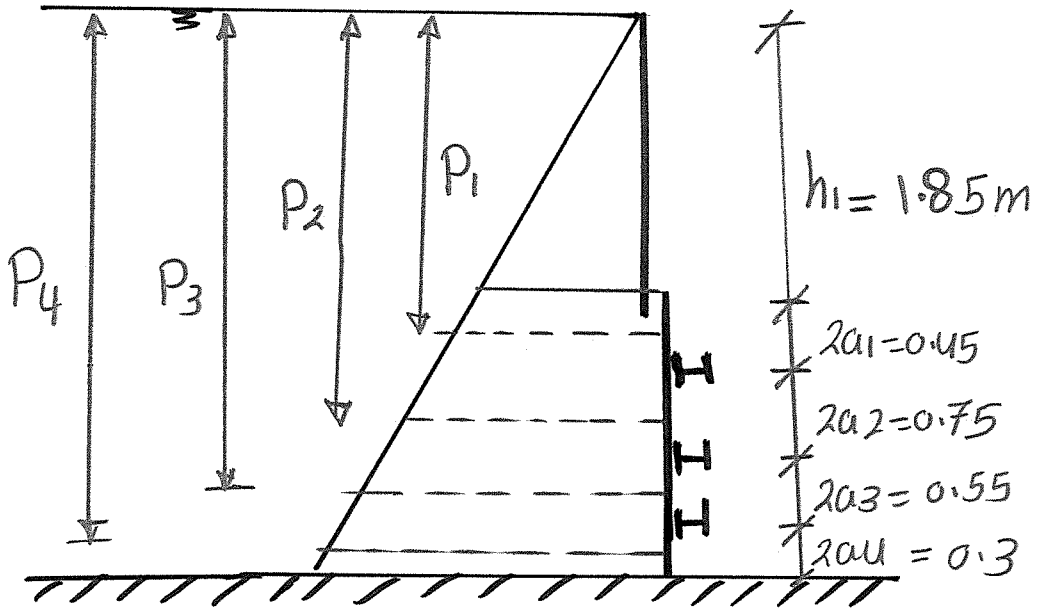
$$2b = \frac{BG}{(N_{XG}+1)} = \frac{6.4}{4} = 1.6\ m$$

$$\therefore t_{(cm)} = a * b * \sqrt{\frac{2*\mu*P}{f(a^2+b^2)}}$$

$f = 1\ t/cm^2$

$\mu = 0.94$





No	$a_{(m)}$	$b_{(m)}$	P (t/m^2)	t (cm)
1	0.225	0.8	$1*(1.85+0.225) = 2.075$	0.43
2	0.375	0.8	$1*(1.85+0.45+0.375) = 2.675$	0.761
3	0.275	0.8	$1*(1.85+0.45+0.75+0.275) = 3.325$	0.65
4	0.15	0.8	$1*(1.85+0.45+0.75+0.55+0.15) = 3.75$	0.39

$t_{Max} = 0.761\ cm < 1\ cm$

take $\therefore$ (t = 1 cm)

Design of XG

نفس الارقام من Skin Plate

No	Span 2a	P (t/m²)	P_M (t/m') $= \frac{2}{3} P*2a$	P_S (t/m') $= \frac{1}{2} * P*2a$	M (t.m) $= \frac{P_M * Span^2}{8}$	Q (t) $= \frac{P_S * Span}{2}$
1	0.45	2.075	0.62	0.467	0.015	0.105
2	0.75	2.675	1.337	1003	0.094	0.375
3	0.55	3.325	1.22	0.914	0.046	0.251
4	0.3	3.75	0.75	0.56	0.008	0.084

$M_{Max} = 0.094$ t.m ($Q_{Max} = 0.375$ ton

$$Z_{req} = \frac{M * 10^5}{1000} = \frac{0.094 * 10^5}{1000} = 9.4\ cm^3$$

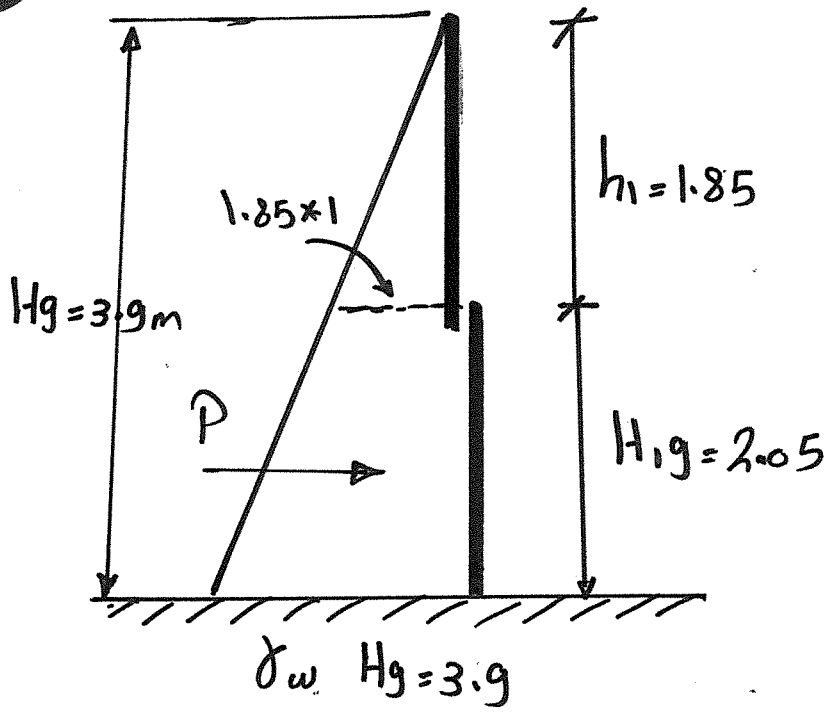
Use SIB $N_o = \nu\nu$

Check of Shear

$$q = \frac{Q * 10^3}{t_w\ h_w} = \nu\nu \not< q_{all}$$

$0.94\ t/cm^2$

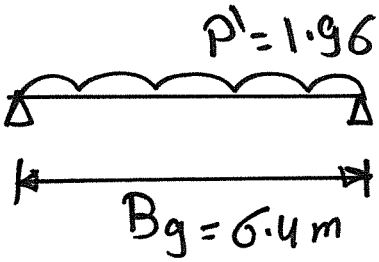
Design of MG



$$P = \frac{\gamma_w h_1 + \gamma_w H_g}{2} * H_{1g} = \frac{(1*1.85)+(1*3.9)}{2} * 2.05$$

$$P = 5.89 \ t/m'$$

$$P' = \frac{P}{N_o\ MG} = \frac{5.89}{3} = 1.96 \ t/m'$$



$$M = \frac{P' * Bg^2}{8} = \frac{1.96 * 6.4^2}{8} = 10.03 \ t.m$$

$$Q = \frac{P' * Bg}{2} = \frac{1.96*6.4}{2} = 6.272 \ ton$$

$$\therefore Z_{req} = \frac{M * 10^5}{1000} = \frac{10.03 * 10^5}{1000} = 1003 \text{ Cm}^3$$

Use SIB No = W

Check of shear

$$q = \frac{Q * 10^3}{t_w * h_w} \not< q_{all}$$

$q_{all} = 0.94 \text{ t/cm}^2$

Design of roller

$$\frac{P_T * 10^3}{N_r} = K * D * L$$

assume D = 20 cm , L = 10cm K = 117

$$P_T = P * B_g = 5.89 * 6.4 = 37.696 \text{ ton}$$

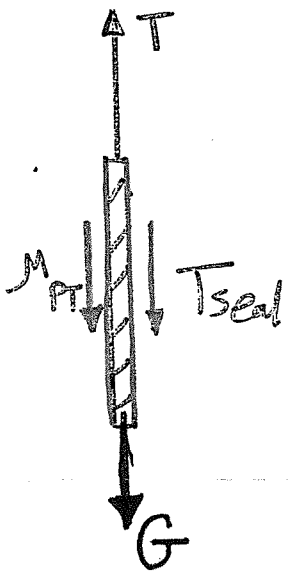
$$\frac{37.696 * 10^3}{N_r} = 117 * \underset{20 \text{ cm}}{D} * \underset{10 \text{ cm}}{L}$$

$$\therefore N_r = 1.6 \text{ roller}$$

$\therefore$ **Used 6 roller**

* Force to required Lifting gate :

$$T = (G + \mu P_T + T_{seal}) * F.O.S \quad (1.25)$$



$G = g * Ag$

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

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

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

$P_T = 37.696$ ton

$\mu = 0.1$ (with roller)

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

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

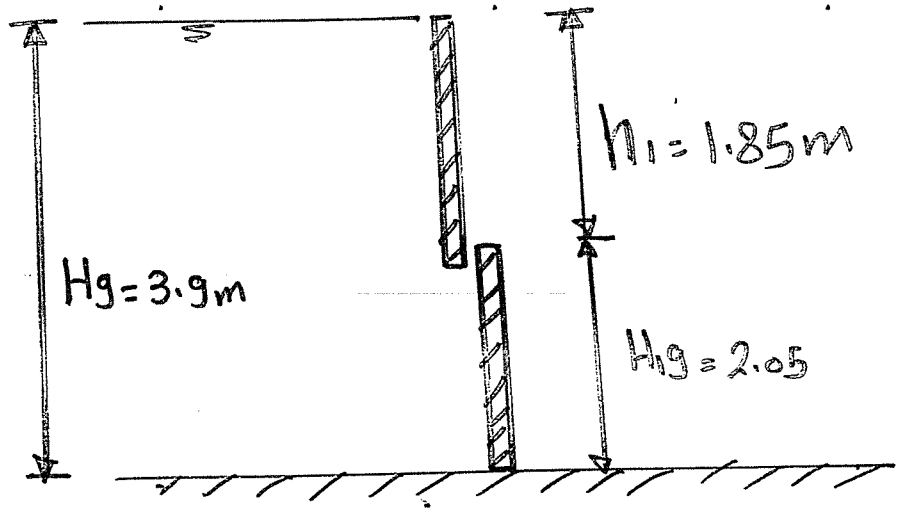
$T_{seal} = 0.707$ ton

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

$T = 9.19$ ton $* 1.25$ F.O.S

Design the gate lifting structure

البوابة Double gate ← تم تصميمها في اول المثال.



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

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

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

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

$$B_g = S + 0.4 = 6.4m$$

نبدأ في تصميم مكونات البوابة

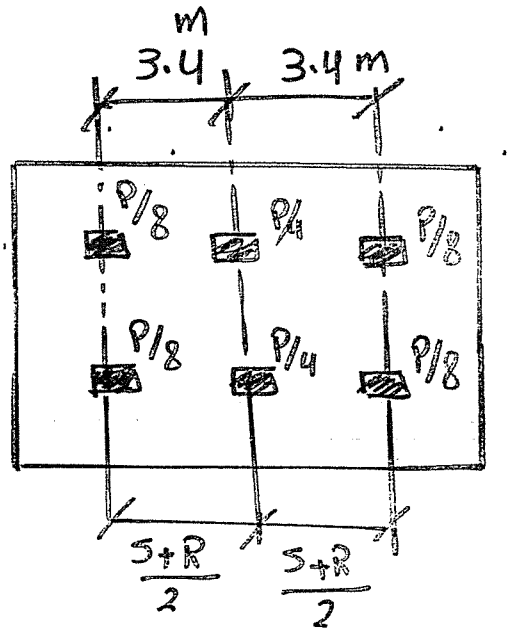
1 Crane :-

$\therefore S = 6m > 4m$ 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

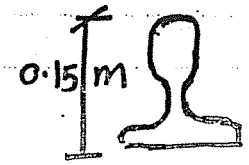
$\rightarrow F_B = \frac{P}{7} = \frac{6}{7}$ ton $= 0.857$ ton
قوة الفرامل

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

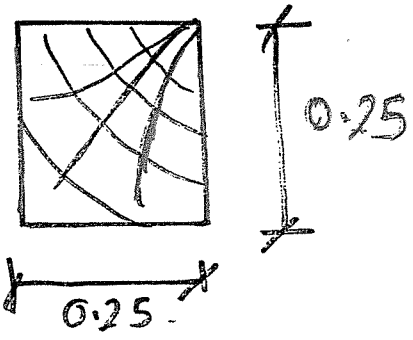


own wt = 0.05 t/m'

hight = 0.15 m = 15 Cm

Sleeper

γ = 0.9 t/m³



own wt = (0.25 * 0.25) * 0.9

own wt = 0.056 t/m'

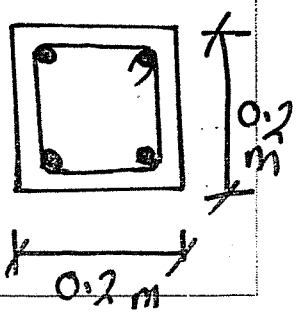
Tie

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

To = T * (F.o.S) = 0.75 * 4 = 3 ton

Design

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



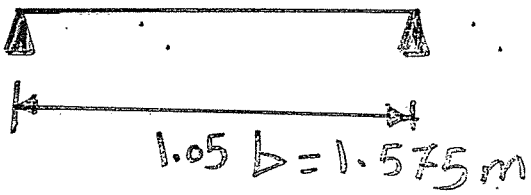
As = 0.45 ⌀ 12 → Used 4 ⌀ 12

Slot Channel

at $S = 6m$

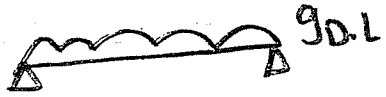
$\therefore b = 1.5\ m$ جدول

$\therefore W = 0.9\ m$ جدول



Loading

a- Dead Load



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

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

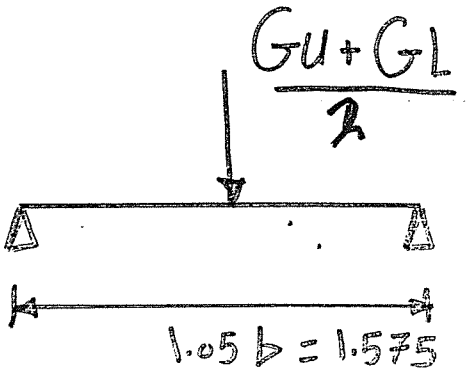
$$M_{D.L} = \frac{g_{D.L} * (1.05\,b)^2}{8} = \frac{0.2 * 1.575^2}{8}$$

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

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

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

b- Live Load :-



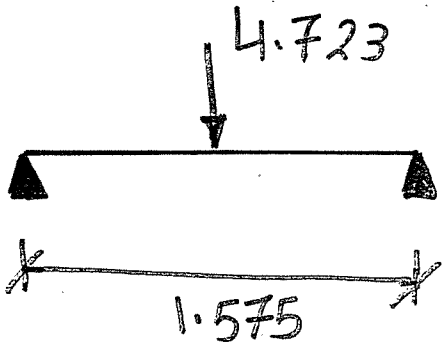
$Gu = GL$

$Gu = A_{lg} * g$

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

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

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



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

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

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

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

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

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

Design

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

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

ينتج اختيار القطاع من جدول الـ steel (UPN)

Check of shear

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