DESIGN OF IRRIGATION STRUCTURE (2)

رابعة مدني

Regulator
(Design of Gates)
a- Vertical Steel Sliding Gate
Continue.....

4

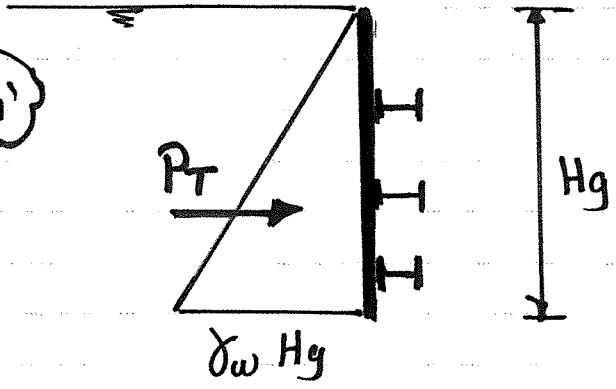
3- Design of main girder :. MG

- نحسب كمرات الـ MG ضغط الماء الكلى (P) وتتم توزيعة بالتساوى على عدد MG الموجودة.

* For Single gate

$$P = \frac{1}{2}\gamma_w H_g^2 = \text{--} \ t/m'$$

الحمل الكلى الواقع على البوابة لعرض ١ متر



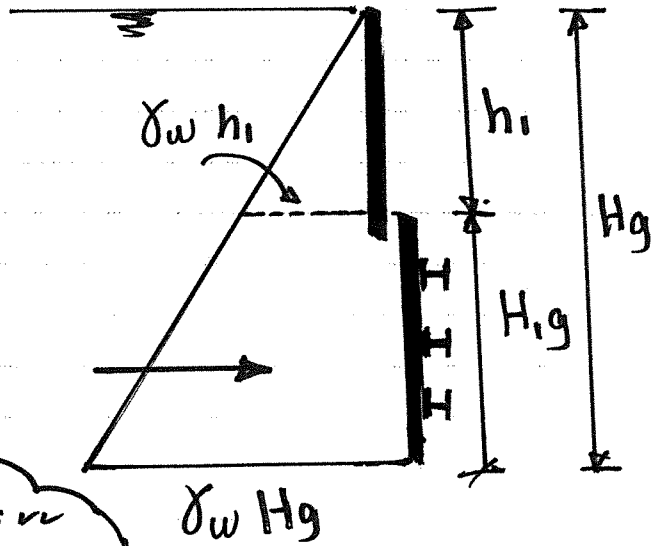
For Double gate

$$H_g = y_{us} + (0.3 \rightarrow 0.5) \text{ --}$$

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

$$h_1 = H_g - H_{1g} = \text{--}$$

$$P = \frac{\gamma_w h_1 + \gamma_w H_g}{2} * H_{1g} = \text{--} \ t/m'$$



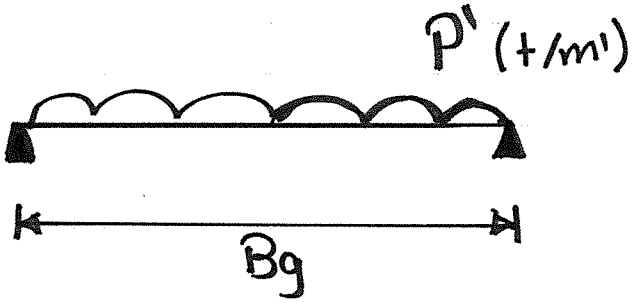
* Find P'

حساب الحمل الواقع على كل كمرة MG

$$P' = \frac{P}{n} = \text{..} \quad t/m'$$

$n \rightarrow$ No. of Main Girder عدد كمرات MG

Design



$$M_{Max} = \frac{P' * Bg^2}{8} = \text{..} \quad t.m$$

$$Q = \frac{P' * Bg}{2}$$

$$\therefore Z_{req} = \frac{M * 10^5}{f = 1000\ kg/cm^2} = \text{..} \quad cm^3$$

بقيمة Z ندخل بجداول الـ steel ونختار القطاع

Choose SIB No = ..

Check of shear

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

4- Design of upper and lower and side Beam:-

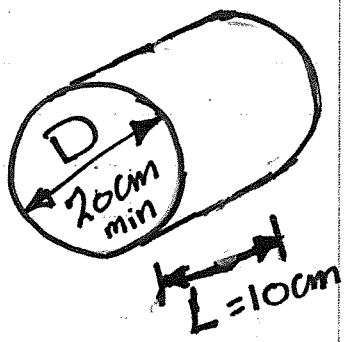
لا يتم تصميمهم ولكن يتم اختيار قطاعهم نفس
ارتفاع الـ (MG)

5- Design of rollers :-

n_r يتم تحديد عدد العجلات لان العجلة يتم شرائها جاهزة.

* اقل عدد من العجلات (ثلاث) عجلات لكل جانب

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



P_T ← total Pressure force

$P_T = P' * B_g$

$P_T = \frac{1}{2} * \gamma_w * H_g^2 * B_g$ → Single gate

$P_T = \frac{\gamma_w h_1 + \gamma_w H_g}{2} * H_1 g * B_g$ → Double gate

$\therefore K = 117$ for rolled steel

معامل يتوقف على نوع مادة البوانت

$\therefore L_{(cm)}$ = Roller width عرض العجلة = 10 Cm

$\therefore D_{(cm)}$ = Roller Diameter $D_{min} = 20$ Cm

$N_r \rightarrow$ عدد العجلات $\rightarrow$ المطلوب حسابه

بحيث عدد العجلات لا يقل عن 3 عجلات لكل جانب

K = 117 kg/cm² For rolled steel
K = 750 kg/cm² For Cast steel

$$\frac{P_T * 10^3}{N_r} = \frac{K}{117} * \frac{L}{10\,cm} * \frac{D}{20\,cm}$$

ton ← $P_T * 10^3$ ← المطلوب

117 ← rolled steel

$N_r = ??$ $\rightarrow$ لا تقل عن 6

* خلي بالك ممكن يعطى في المسألة N_r ويطلب منك D

$D \geq 20\,cm$ يتم حسابها $D = ??$

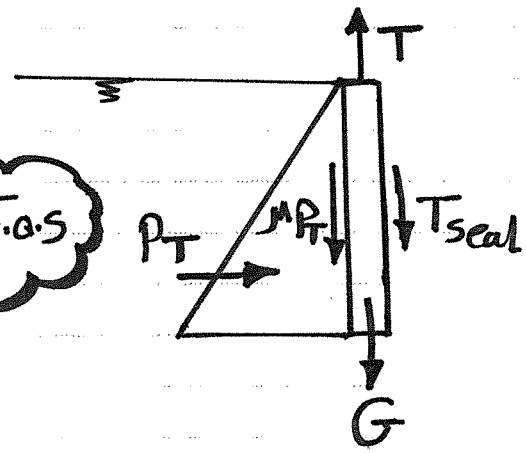
* او ممكن تحل بطريقة اخرى يتم فرض N_r وايجاد D

$$\frac{P_T * 10^3}{6\,N_r} = \frac{K}{117} * \frac{L}{10\,cm} * D$$

$D = ?? \geq 20\,cm$ ok لو اقل من 20 نأخذها 20 Cm

* Force Required to lift the gate :- (T)

الهدف هو حساب القوة اللازمة لرفع البوابة (T)



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

where

G → weight of gate وزن البوابة

$$G = g * A_g = \checkmark\checkmark \text{ ton}$$

→ $g = \frac{60}{1000} * (S_{Pan})$ وزن المتر المربع من البوابة (t/m^2)

→ $A_g = H_g * B_g = \checkmark\checkmark m^2$ → Single gate

$A_g = H_{1g} * B_g = \checkmark\checkmark m^2$ → Double gate

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$\mu = 0.34$ البوابة بدون Roller

$\checkmark\checkmark$ $\mu = 0.1$ البوابة لها Roller

$F.O.S = (1.25 \rightarrow 1.5)$ $\checkmark\checkmark$ معامل الامان

Factor of Safty

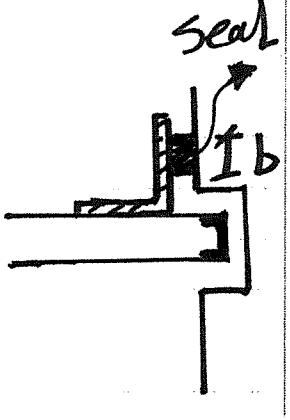
P_T → Total Pressure Force

$$P_T = \frac{1}{2} \gamma_w * Hg^2 * Bg \rightarrow \text{Single gate}$$

$$P_T = \frac{\gamma_w h_1 + \gamma_w Hg}{2} * H_1g * Bg \rightarrow \text{Double gate}$$

* T_{seal} → friction due to seal

$$T_{seal} = 2 * f * b * P_{av} * L$$



where

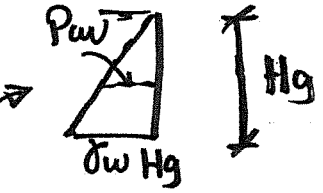
f → friction factor = 0.3

b → = 0.2 عرض الكاوتش (لو غير معطى)

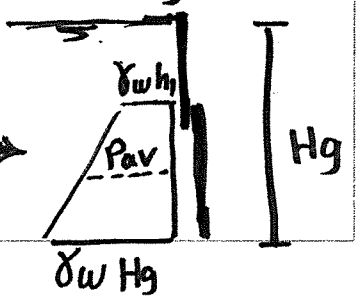
L = { Hg → single gate ; H_1g → Double gate }

P_{av} → الضغط المتوسط

$$P_{av} = \frac{\gamma_w * Hg}{2} \rightarrow \text{Single gate}$$



$$P_{av} = \frac{\gamma_w h_1 + \gamma_w Hg}{2} \rightarrow \text{Double gate}$$



ملاحظات

لاحظ اننا صممنا وعرفنا

١- نوع البوابة ← Single gate
← Double gate

٢- اماكن MG

٣- Design skin Plate

٤- Design of XG

٥- Design MG

٦- Design of Roller

٧- T

لازم نعرف اماكن MG ← ٣ و ٤

لازم نعرف نوع البوابة ← ٣ و ٤ و ٥ و ٦ و ٧

- مفيش ولا مطلوب من اللى فاتوا ينفع تحلهم من غير ما تعرف نوع البوابة ← SG / DG ← مطلوب ١

- المطلوب ٣ Skin Plate و ٤ XG ∴

مينفعش تحلهم من غير ما تكون حاسب اماكن MG

مطلوب ٢

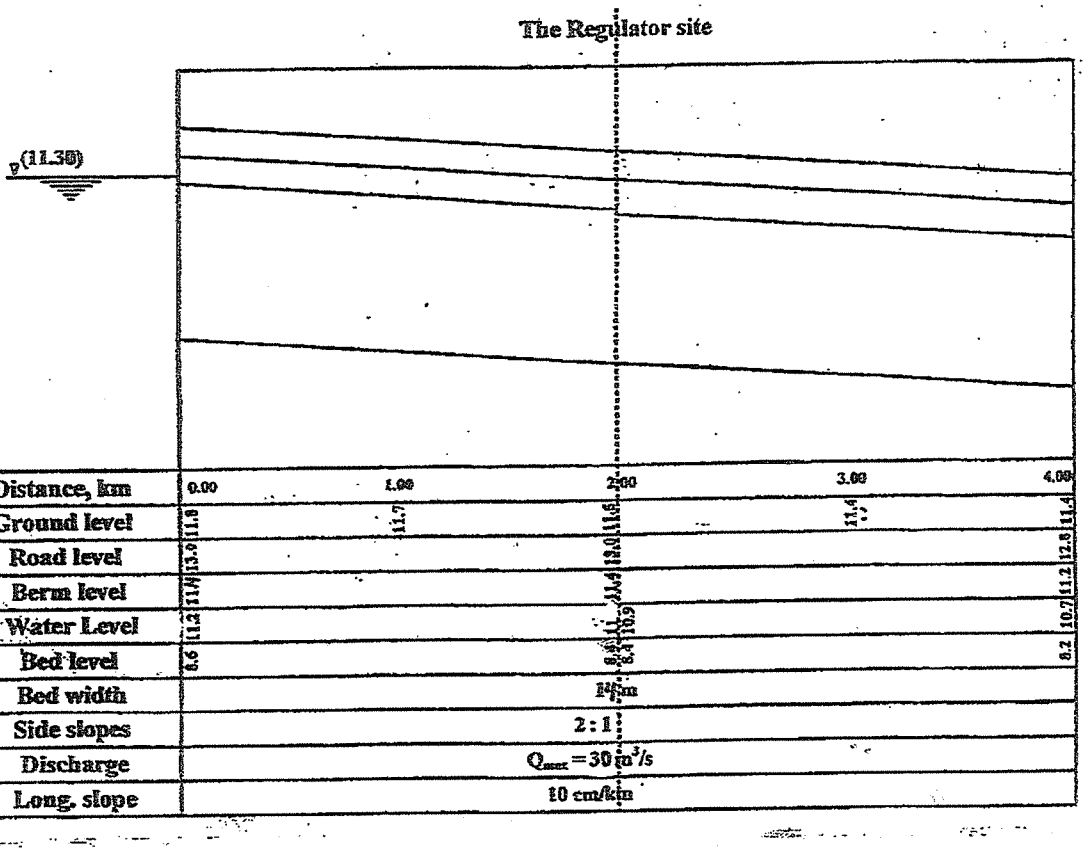
Regulators & Barrages

Sheet No. (2)

A reinforced concrete control regulator is to be constructed across a main canal at km 2.00. The longitudinal section of the canal is shown in the given figure. The bridge width over the regulator is 12.0 m and it has two sidewalks of 1.50 m width for each. The maximum allowable heading up through the regulator is 10 cm for case of fully opened gates. The width of each pier is 0.8 m and the span of each vent is 6.0 m. US broken & DS sloping wing walls are used.

It is required to:

1. Give the complete hydraulic design of the regulator,
2. Find the required floor dimensions according to scour and percolation (CB=12),
3. Give the complete design of the required steel sliding gate → (Use 3 MG. & 2 XG.)
4. Draw neat sketches showing the following:
   i. Plan (H.E.R)
   ii. Longitudinal section through the regulator



الحل

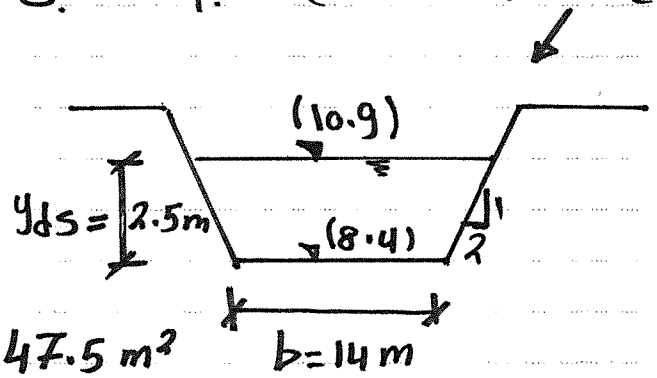
* at Regulator at site (km, 2)

* 1- Given the complete hydraulic Design :-

$Q_{Max} = 30\ m^3/sec$

$S = 6\ m$ (given)

تم استنتاج هذا القطاع من الجدول السابق.



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

$A_{ds} = (14 + 2.5*2)*2.5 = 47.5\ m^2$

* $V_{ds} = \frac{Q_{Max}}{A_{ds}} = \frac{30}{47.5} = 0.63\ m/sec$

* V_r

$$2V_{ds} \leq V_r \leq 3V_{ds}$$

$$2*0.63 \leq V_r \leq 3*0.63$$

$$1.26 \leq V_r \leq 1.89$$

$$1 \leq V_r \leq 2.0\ m/sec$$

Aww

$$A_{ww} = \frac{Q_{Max}}{V_r} = \frac{30}{1.26 - 1.89}$$

$$23.8 \geq A_{ww} \geq 15.87$$

B_{e_1}

$$B_{e_1} = \frac{A_{ww}}{y_{ds}}$$

$$\frac{23.8}{2.5} \geq B_{e_1} \geq \frac{15.87}{2.5}$$

$$9.52\ m \geq B_{e_1} \geq 6.35\ m$$

Contraction Condition

$$B_{e_2} \geq 0.5\ \frac{A_{ds}}{y_{ds}}$$

$$B_{e_2} \geq 0.5 * \frac{47.5}{2.5} = 9.5\ m$$

نتم اختيار B_e تحقق $B_{e_2} < B_{e_1}$

given

$\therefore S = 6$

$\therefore 9.52 = N * 6$

$\therefore N = 1.58 \simeq 2$

$\therefore S = 6m \ , N = 2$

Check of heading up

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

$$y_{us} = y_{DS} + h_{up} = 2.5 + 0.1 = 2.6\ m$$

$$A_{us} = (b + y_{us} Z)\, y_{us} = (14 + 2.6 * 2)2.6 = 49.92$$

$$V_{us} = \frac{Q_{max}}{V_{us}} = \frac{30}{49.92} = 0.6\ m/sec$$

$$A_{ww} = N * S * y_{ds} = 6 * 2 * 2.5 = 30\ m^2$$

at $S = 6\ m > 4 \rightarrow C = 0.92$

$$h_{up} = \frac{(0.6)^2}{2 * 9.81 * (0.92)^2}\left(\left(\frac{49.92}{30}\right)^2 - 1\right)$$

$$h_{up} = 0.038\ m = 3.8\ Cm < 10cm$$

ok

2- Find the required floor Dimension according to scour and Percolation (CB=12)?

حل انتا يا كبير.

3- Given the Complete Design of the required of the steel sliding gate?

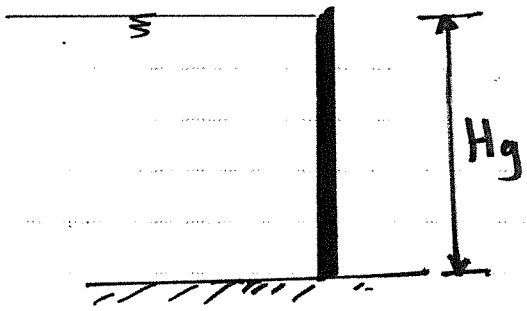
تصميم البوابة.

الحل

$\therefore S = 6m$ $\quad y_{us} = y_{ds} + h_{up_{all}}$ * (given)

$\therefore y_{us} = 2.5 + 0.1 = 2.6\ m$

* تحديد نوع البوابة



$Hg = y_{us} + 0.3 = 2.6 + 0.3 = 2.9m$

$Bg = S + 0.4 = 6 + 0.4 = 6.4m$

$\therefore Ag = Bg * Hg = 6.4 * 2.9 = 18.56\ m^2$

$\therefore Ag > 16\ m^2$ **Double Gate**

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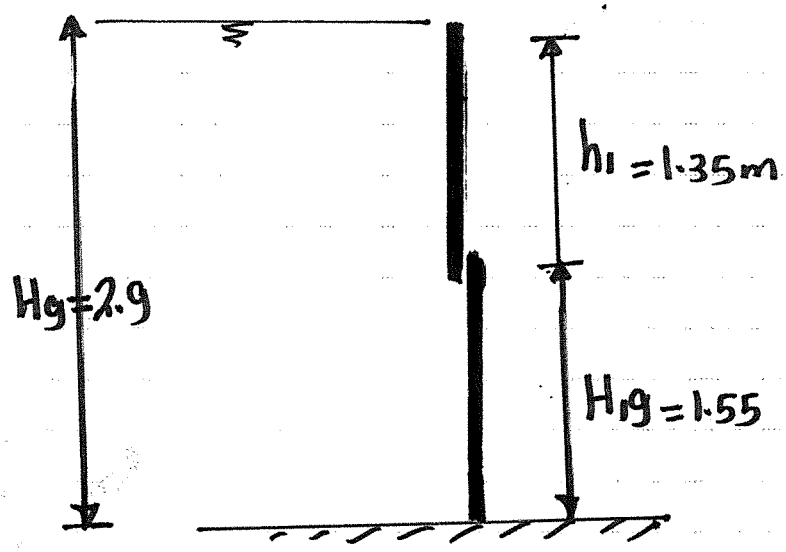
* تحديد ابعاد البوابة



$Bg = 5 + 0.4 = 6.4\ m$

$H_1g = \frac{Hg}{2} + 0.1 = \frac{2.9}{2} + 0.1$

$H_1g = 1.55\ m$

Use Double gate of Dimension (1.55 * 6.4)

For each Gate

Location of MG

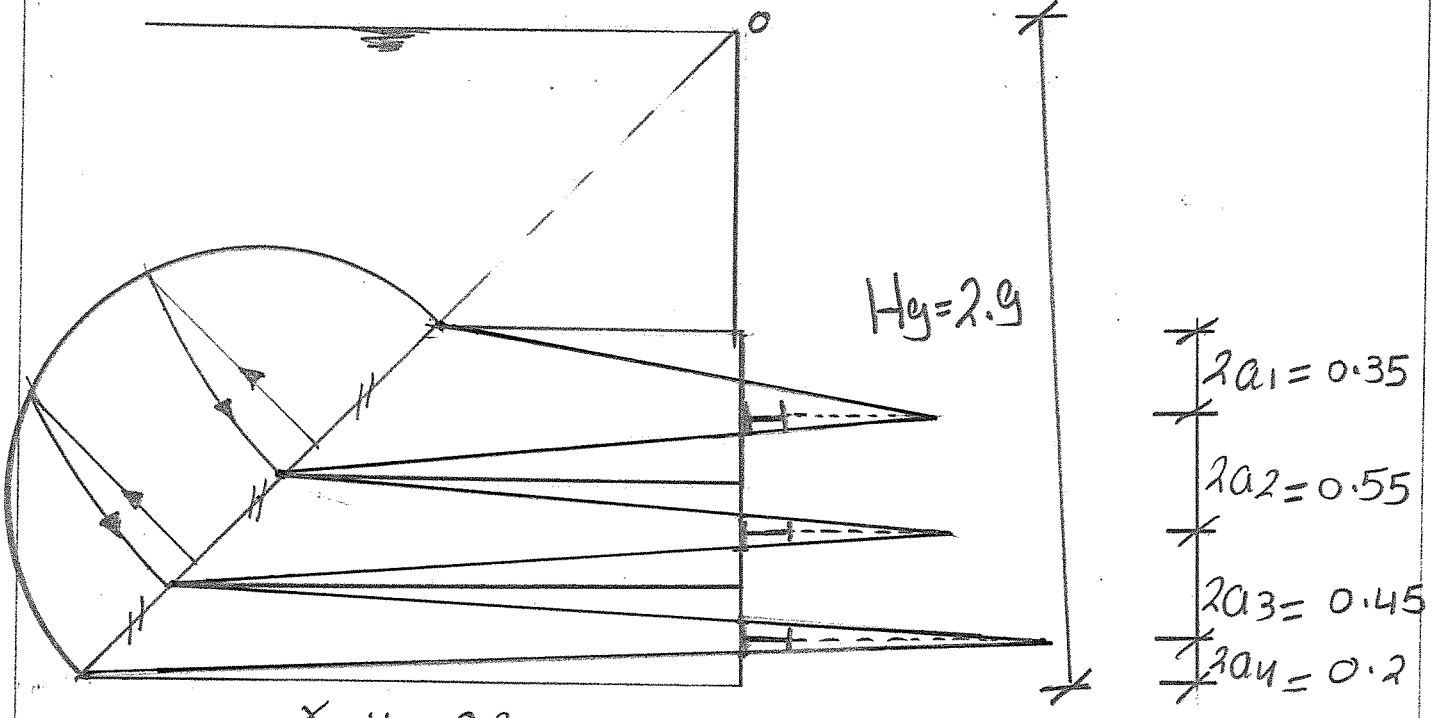
تحديد اماكن MG

عدد الكمرات MG $N_{MG} = 3$ given

scale

1 m = 3 cm

الرسم الطبيعة

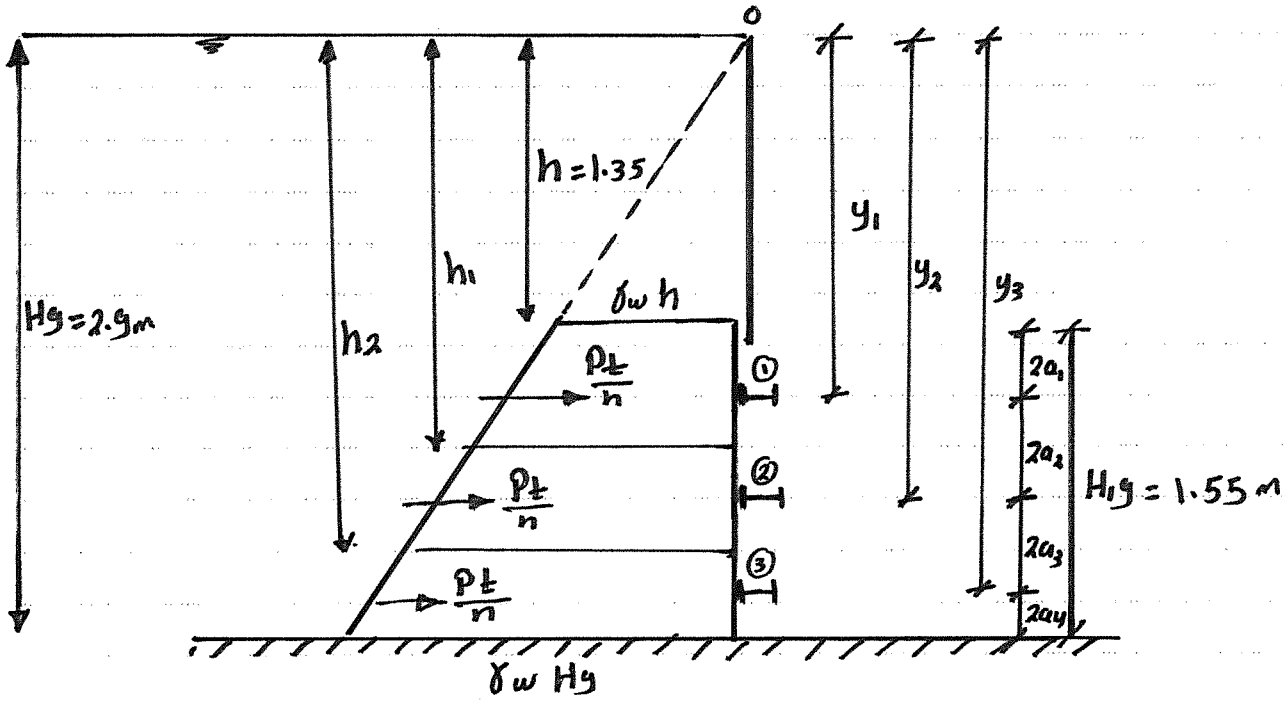


$\gamma_w H_g = 2.9 * 1 = 2.9$

وتاكدات

$$2a_1 + 2a_2 + 2a_3 + 2a_4 = H_1 g = 1.55\ m$$

حل بالطريقة الحسابية :- (حل آخر)



$$\therefore P_t = \frac{\gamma_w h + \gamma_w H_g}{2} * H_{1g}$$

$$P_t = \frac{1*1.35 + 1*2.9}{2} * 1.55 = 3.29 \text{ ton}$$

$$\frac{P_t}{n} = \frac{3.29}{3} = 1.096 \text{ ton}$$

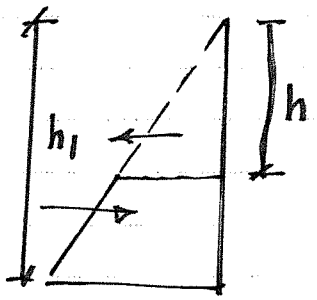
n عدد ← MG

EMG

$$\frac{P_t}{n} = \frac{1}{2}\gamma_w h_1^2 - \frac{1}{2}\gamma_w h^2$$

$$1.096 = \frac{1}{2} * 1 * h_1^2 - \frac{1}{2} * 1 * 1.35^2$$

$h_1 = 2.003$ m



$\Sigma M @ o$

$$\frac{P_t}{n} y_1 = \frac{1}{2}\gamma_w h_1^2 * \frac{2}{3} h_1 - \frac{1}{2}\gamma_w h^2 * \frac{2}{3} h_1$$

$$1.096 * y_1 = \frac{1}{2} * 1 * \frac{2}{3} * 2.003^3 - \frac{1}{2} * 1 * 1.35^3 * \frac{2}{3}$$

$$y_1 = 1.7\ m$$

MG2

$$\frac{P_t}{n} = \frac{1}{2}\gamma_w h_2^2 - \frac{1}{2}\gamma_w h_1^2$$

$$1.096 = \frac{1}{2} * 1 * h_2^2 - \frac{1}{2} * 1 * 2.003^2$$

$$h_2 = 2.49\ m$$

$\Sigma M @ o$

$$\frac{P_t}{n} * y_2 = \frac{1}{2} * \gamma_w h_2^2 (\frac{2}{3} h_2) - \frac{1}{2}\gamma_w h_1^2 (\frac{2}{3} h_1)$$

$$1.096\ y_2 = \frac{1}{2} * 1 * 2.49^2 (\frac{2}{3} 2.49) - \frac{1}{2} * 1 * 2.003^2 (\frac{2}{3} * 2.003)$$

$$y_2 = 2.25\ m$$

MG3

$\Sigma M @ o$

$$\frac{P_t}{n} * y_3 = \frac{1}{2} * \gamma_w H_9^2 (\frac{2}{3} H_9) - \frac{1}{2}\gamma_w h_2^2 (\frac{2}{3} h_2)$$

$$1.096\ y_3 = \frac{1}{2} * 1 * 2.9^2 (\frac{2}{3} 2.9) - \frac{1}{2} * 1 * 2.49^2 (\frac{2}{3} 2.49)$$

$$y_3 = 2.7\ m$$

$\therefore 2a_1 = y_1 - h = 1.7 - 1.35 = 0.35\,m$

$2a_2 = y_2 - y_1 = 2.25 - 1.7 = 0.55\,m$

$2a_3 = y_3 - y_2 = 2.7 - 2.25 = 0.45\,m$

$2a_4 = Hg - y_3 = 2.9 - 2.7 = 0.2\,m$

للتأكد

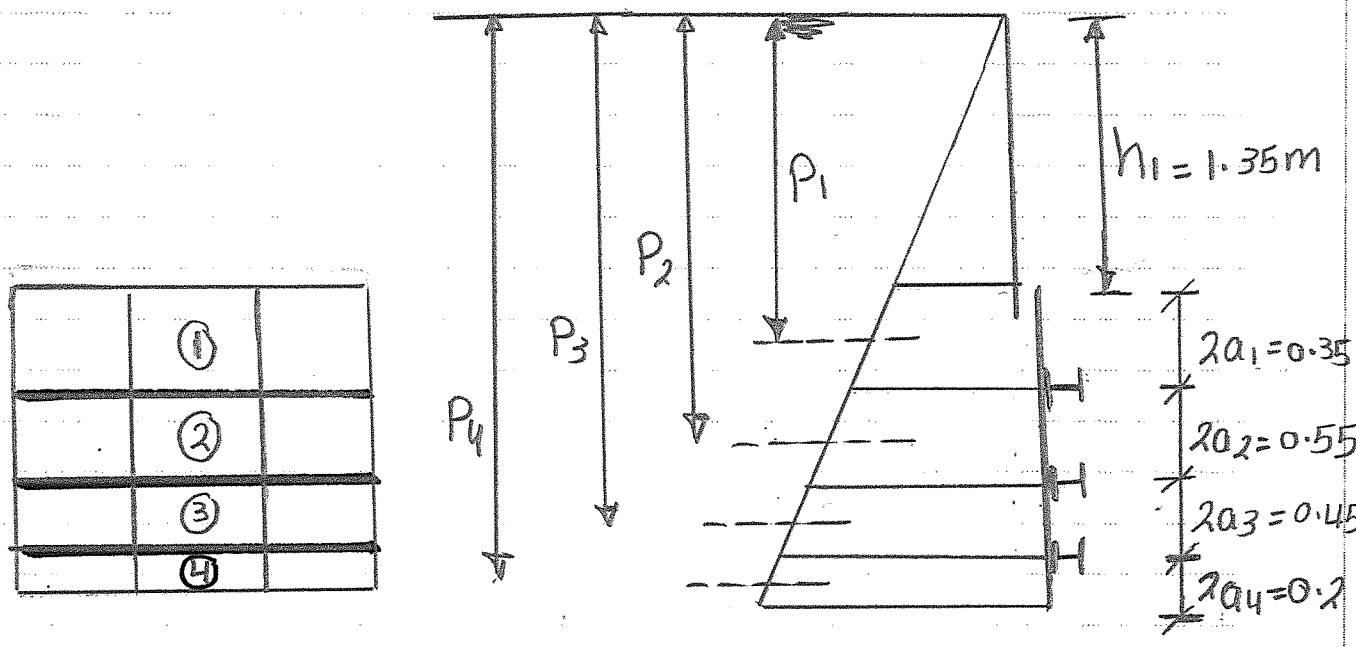
$2a_1 + 2a_2 + 2a_3 + 2a_4 = H.g$

$0.35 + 0.55 + 0.45 + 0.2 = 1.55\,m$ ✓✓

* Design of Skin Plate

No of X.G = 2 given

$$\therefore 2b = \frac{BG}{(N_{XG}+1)} = \frac{6.4}{3} = 2.13\,m$$



$$\therefore t(cm) = \overset{m}{a} * \overset{m}{b} * \sqrt{\frac{2MP}{f(a^2+b^2)}}$$

where

$f = 1\ t/cm^2$

$M = 0.94$

$P =$ الضغط من سطح الماء وهي منتصف اللباكية

No	a(m)	b(m)	P (t/m²)	t(m)
1	0.175	1.065	1*(1.35 + 0.175) = 1.525	0.29
2	0.275	1.065	1*(1.35 + 0.35 + 0.275) = 1.97	0.512
3	0.225	1.065	1*(1.35 + 0.35 + 0.55 + 0.225) = 2.475	0.47
4	0.1	1.065	1*(1.35 + 0.35 + 0.55 + 0.225 + 0.1) = 2.8	0.23

$t_{Max} = 0.512 < 1\ cm$

$\therefore t_{Max} = 1.0\ cm$

Design of XG

نفس ارقام Skin Plat

$2/3\ P*2a$, $1/2\ P*2a$, $\frac{P_M * SPan^2}{8}$, $\frac{P_S * SPan}{2}$

No	SPan	(P) t/m²	P_M (t/m')	P_S (t/m')	M (t.m)	Q (t)
1	$2a_1 = 0.35$	1.525	0.35	0.27	0.005	0.047
2	$2a_2 = 0.55$	1.97	0.72	0.54	0.027	0.149
3	$2a_3 = 0.45$	2.475	0.74	0.56	0.018	0.126
4	$2a_4 = 0.2$	2.8	0.37	0.28	0.002	0.028

$*0.75$ للتسهيل

$\therefore M_{Max} = 0.027$ t.m

$Q_{Max} = 0.149$ t

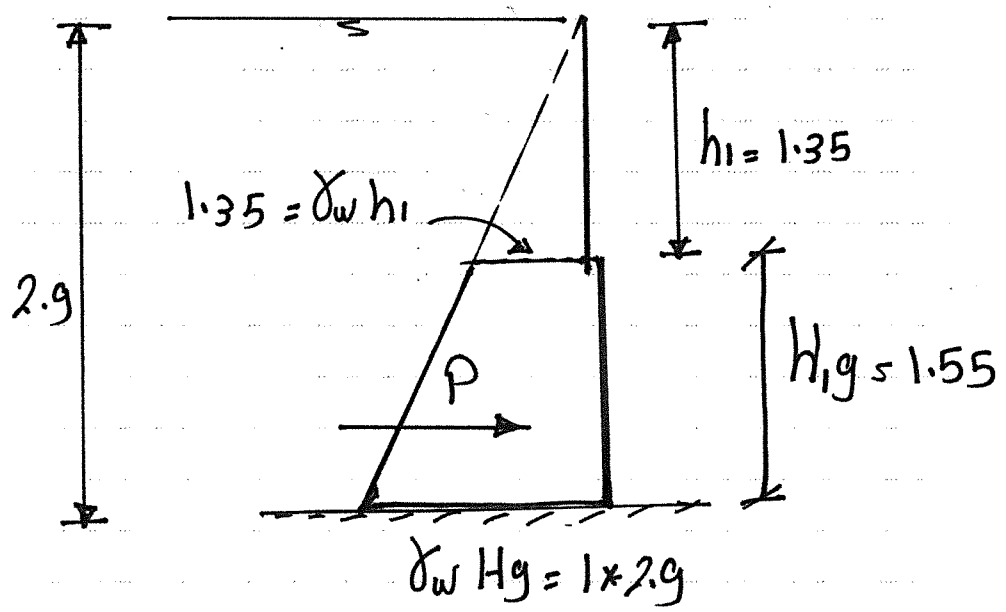
$$\therefore Z_{Req} = \frac{M * 10^5}{f = 1000} = \frac{0.027 * 10^5}{1000} = 2.7\ Cm^3$$

Use SIB No = ١٧ steel Joist

Check of shear

$$q = \frac{Q * 10^3}{t_w * h_w} = ١٧ * q_{all}$$

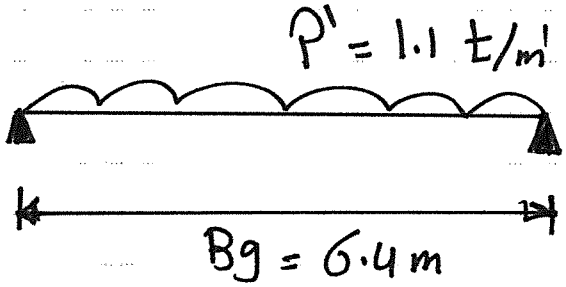
Design of MG



$$\therefore P = \frac{\gamma_w h_1 + \gamma_w H_g}{2} * H_1 g$$

$$= \frac{(1 * 1.35) + 1 * 2.9}{2} * 1.55 = 3.29 \text{ t/m'}$$

$$P' = \frac{P}{No \cdot MG} = \frac{3.29}{3} = 1.09 \simeq 1.1 \text{ t/m'}$$



$$\therefore M = \frac{P' * Bg^2}{8} = \frac{1.1 * 6.4^2}{8} = 5.632 \text{ t.m}$$

$$Q = \frac{P' * Bg}{2} = \frac{1.1 * 6.4}{2} = 3.52 \text{ t}$$

$$Z_{req} = \frac{M * 10^5}{f} = \frac{5.632 * 10^5}{1000} = 563 \text{ cm}^3$$

Use SIB No = 22 steel الحديد

Check of shear

$$q = \frac{Q * 10^3}{t_w * h_w} \neq q_{all}$$

Design of Roller

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

assume $D = 20\ cm$

$L = 10\ cm$

$k = 117\ Kg/cm^2$ حفظ

$$P_T = P * Bg = 3.29 * 6.4 = 21.056 \text{ ton}$$

بالتعويض

$$\frac{21.056 * 10^3}{N_r} = 117 * 20 * 10$$

$N_r = 0.89 \rightarrow 1$

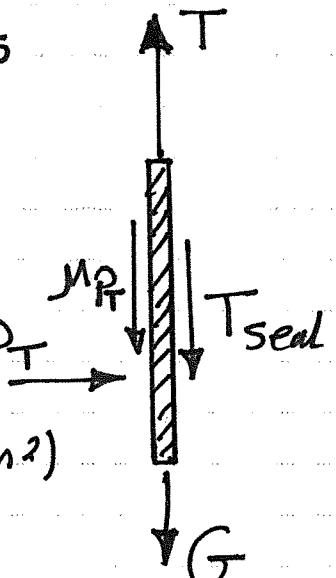
كدا انت محتاج عجلة واحدة

3 = Side ولابدان يكون اقل عدد من العجلات لكل

$\therefore$ No of Roller $= 2 * 3 = 6$ Roller

* Force Required to lift the gate

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



$$\therefore \; G = g * Ag$$

$$g = \frac{60}{1000} * S_{span} \rightarrow (t/m^2)$$

$$= \frac{60}{1000} * 6 = 0.36 \quad (t/m^2)$$

$$Ag = Bg * H_1g = 6.4 * 1.55 = 9.92 m^2$$

$$\therefore G = 0.36 * 9.92 = 3.57 \text{ ton}$$

$$\therefore P_T = 21.056 \text{ ton}$$

$$\therefore \mu = 0.1 \quad (\text{with roller})$$

$$T_{seal} = 2 * f * P_{av} * H_1g * b$$

$$= 2 * 0.3 * \left(\frac{(1*1.35)+(1*2.9)}{2}\right) * 1.55^{m} * 0.2^{m} = 0.4 \text{ ton}$$

$$T = (3.57 + 0.1 * 21.056 + 0.4) * 1.25^{F.o.S} = 7.59 \text{ ton}$$