REGULATORS

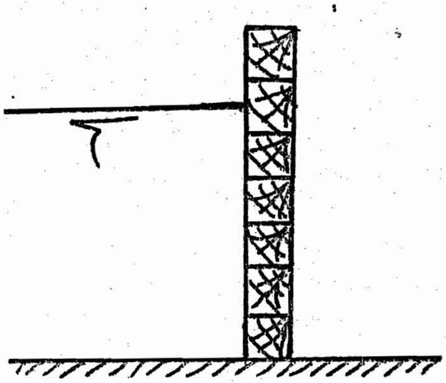
DESIGN OF SLIDING GATE

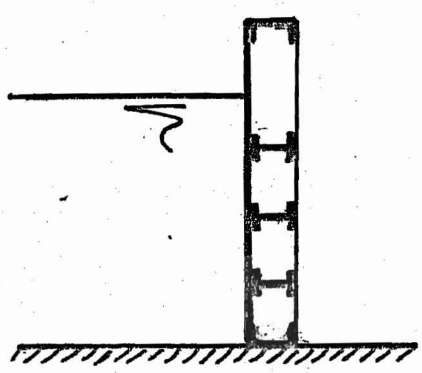
Structure Design

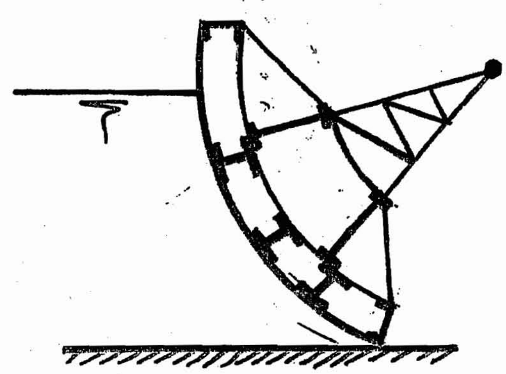
1- Design of Gate.
2- Design of Gate lifting structure.
3- Design of Pier.
4- Design of Floor.
5- Design of abutment and wing wall.
6- Design of bridge.

1-Gates

- Timber Gate
- Vertical Steel Sliding Gate
- Radial Gate





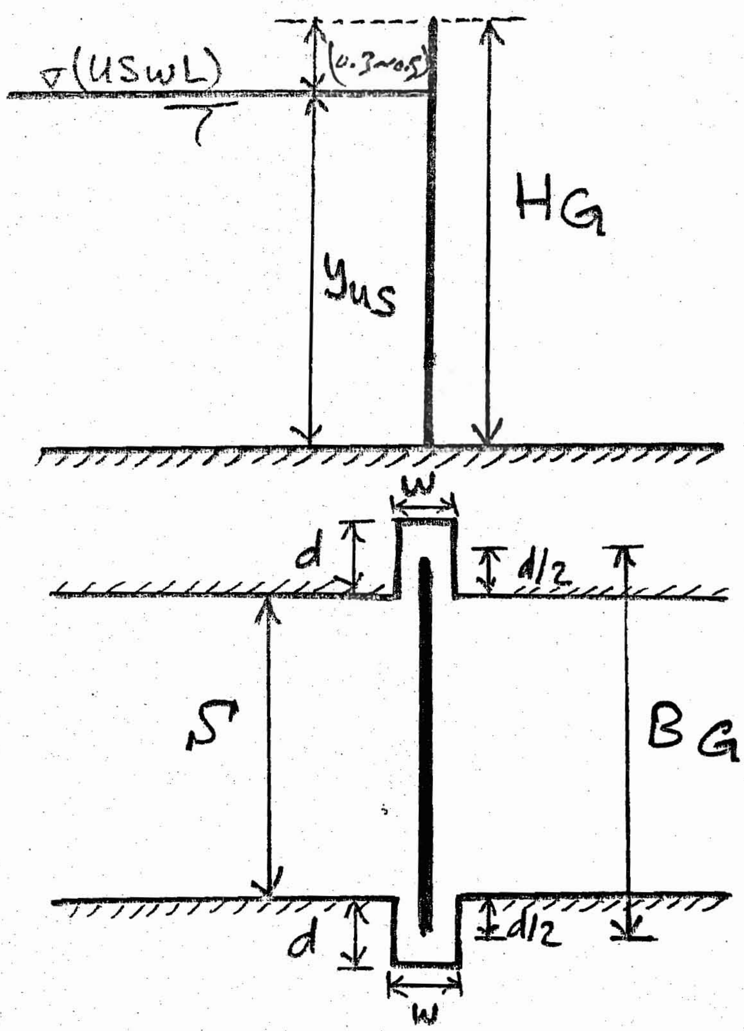


Sliding Gate

أول خطوه يجب أن نحدد هل بوابه single gate ولا double gate

- If $S * y_{ds} < 16\ m^2 \rightarrow \therefore$ use single gate
- If $S * y_{ds} \geq 16\ m^2 \rightarrow \therefore$ use double gate

* Dimensions of single gate :-



- $H_G = y_{us} + (0.3 \rightarrow 0.5^m)$

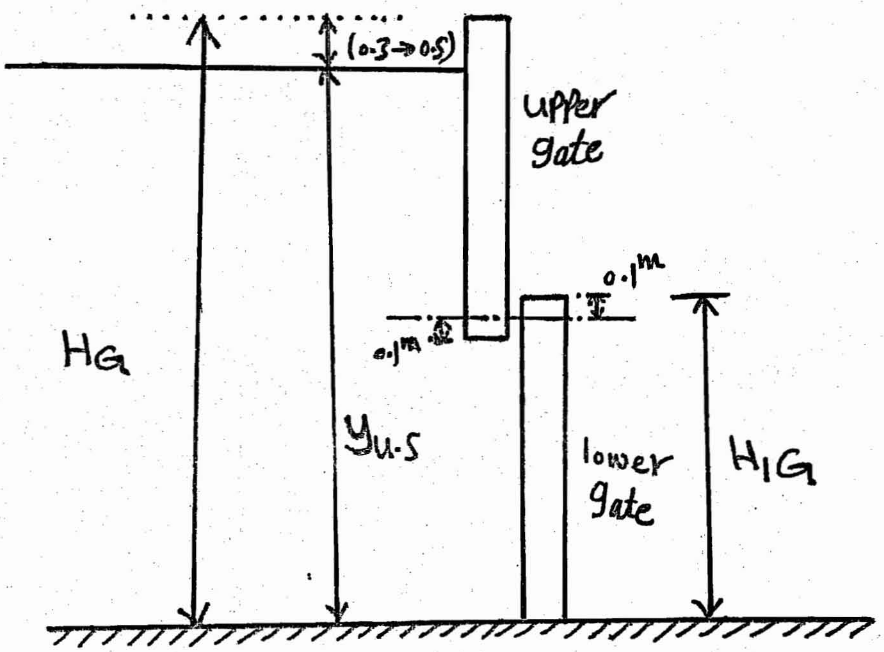
- $B_G = S + d$

$$d = \frac{w}{3}$$

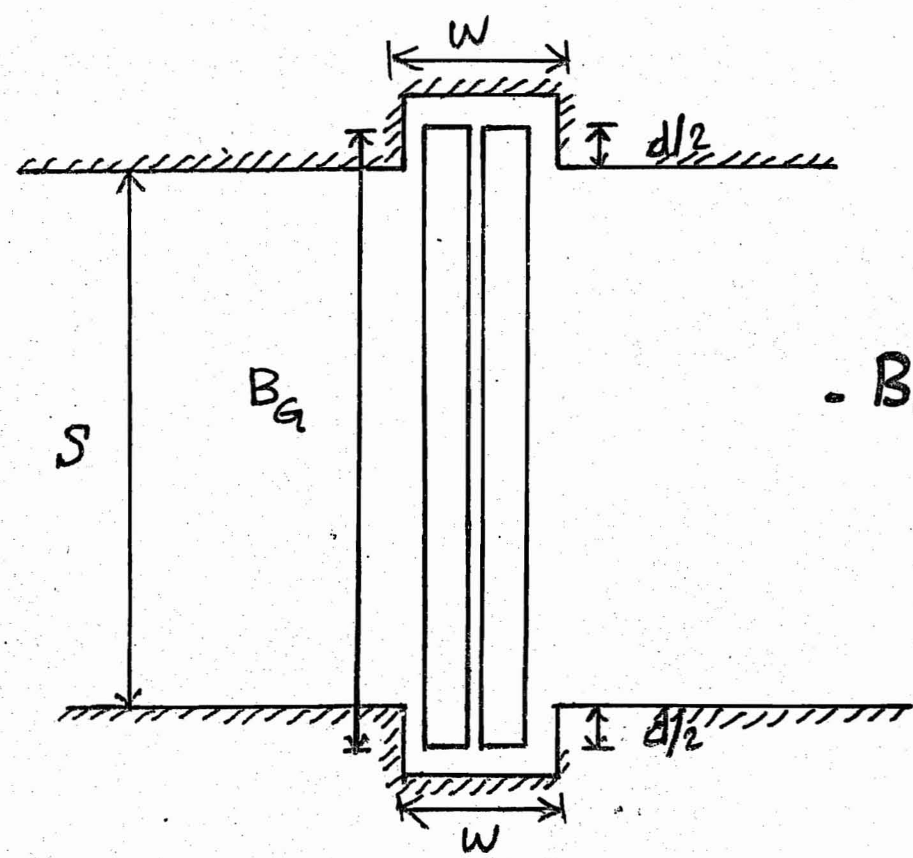
حفظ

S	3	4	5	6	8
w	0.6	0.75	0.9	1	1.2

Dimensions of double gate



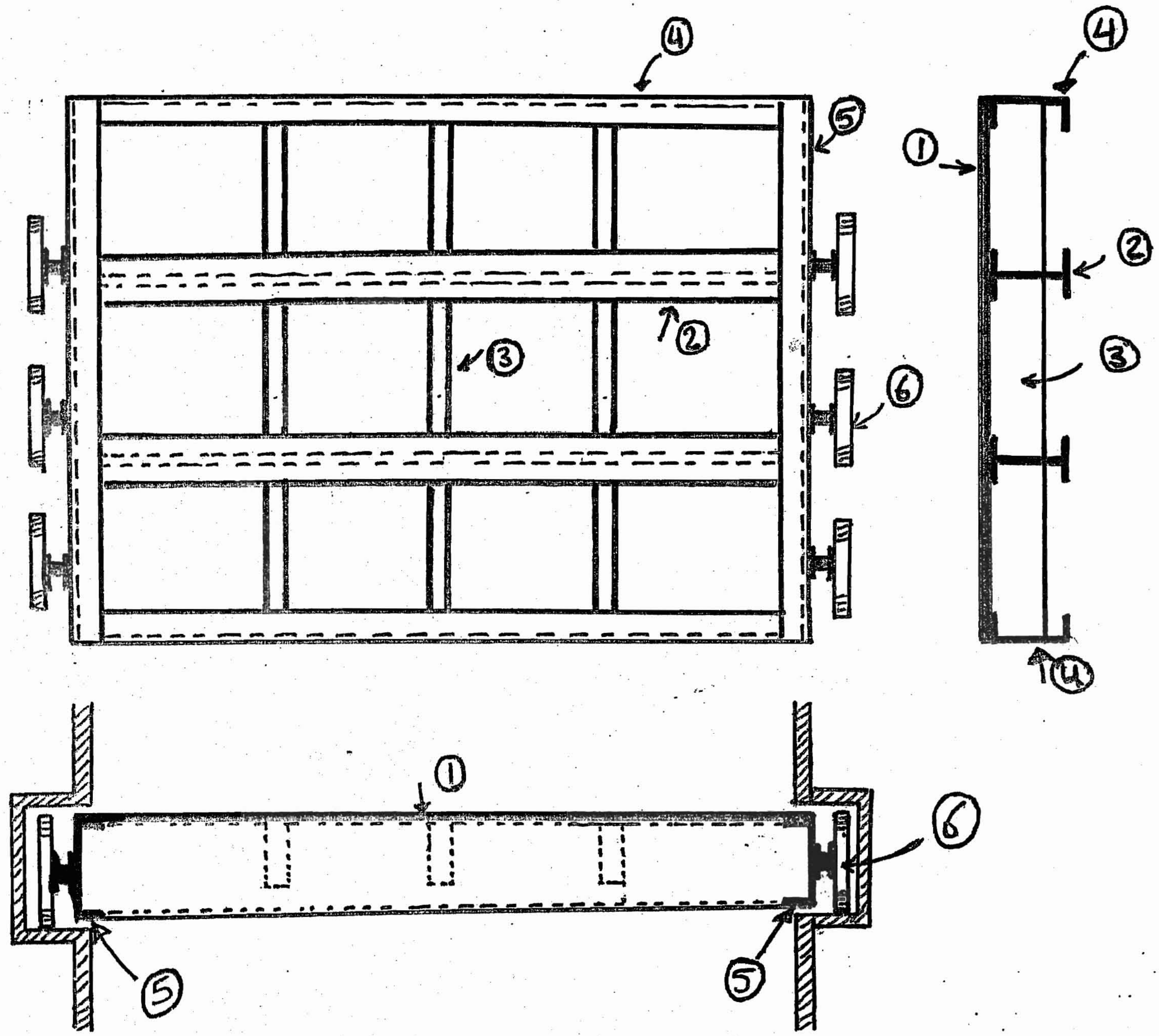
- $H_G = y_{u.s} + (0.3 \rightarrow 0.5)$
- $H_{1G} = \frac{H_G}{2} + 0.1$



- $B_G = S + d$

$d = \frac{w}{3}$

Gate Components :-



1- Skin Plate

2- Horizontal main girder

3- vertical cross girder

4- upper and lower beams (⊏)

5- Side beams (⊏)

6- Rollers

Location of main girder

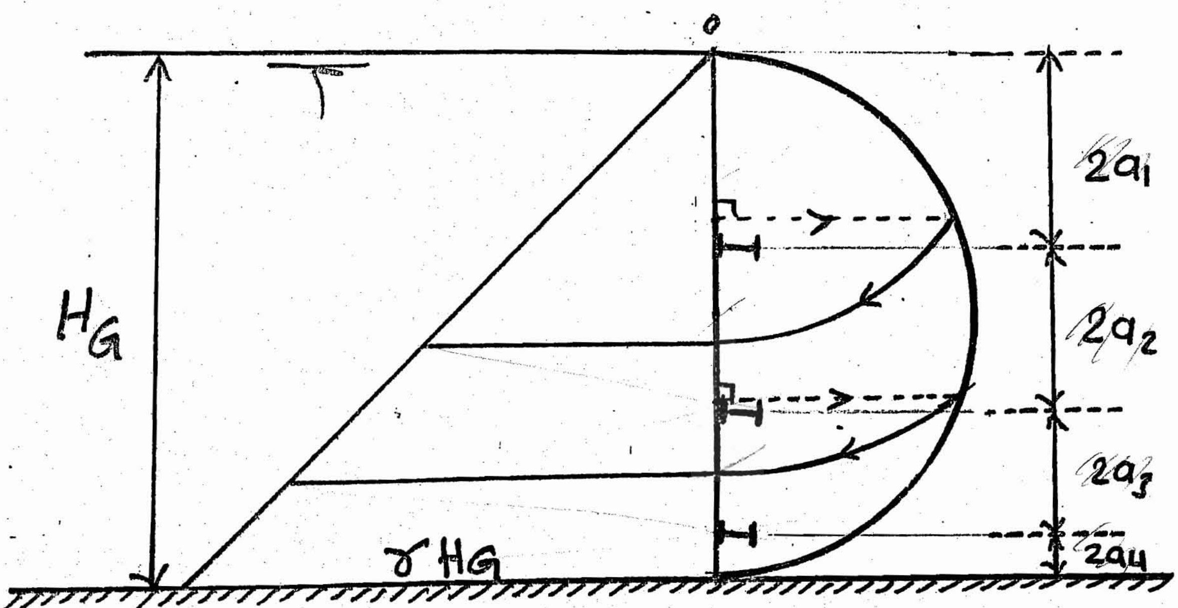
- يتم وضع (main girder) بحيث كلاً منها يشيل نفس الحمل
- يوجد طريقتين لتحديد أماكن (main girder)

① - طريقة بيانية

② - طريقة حسابية

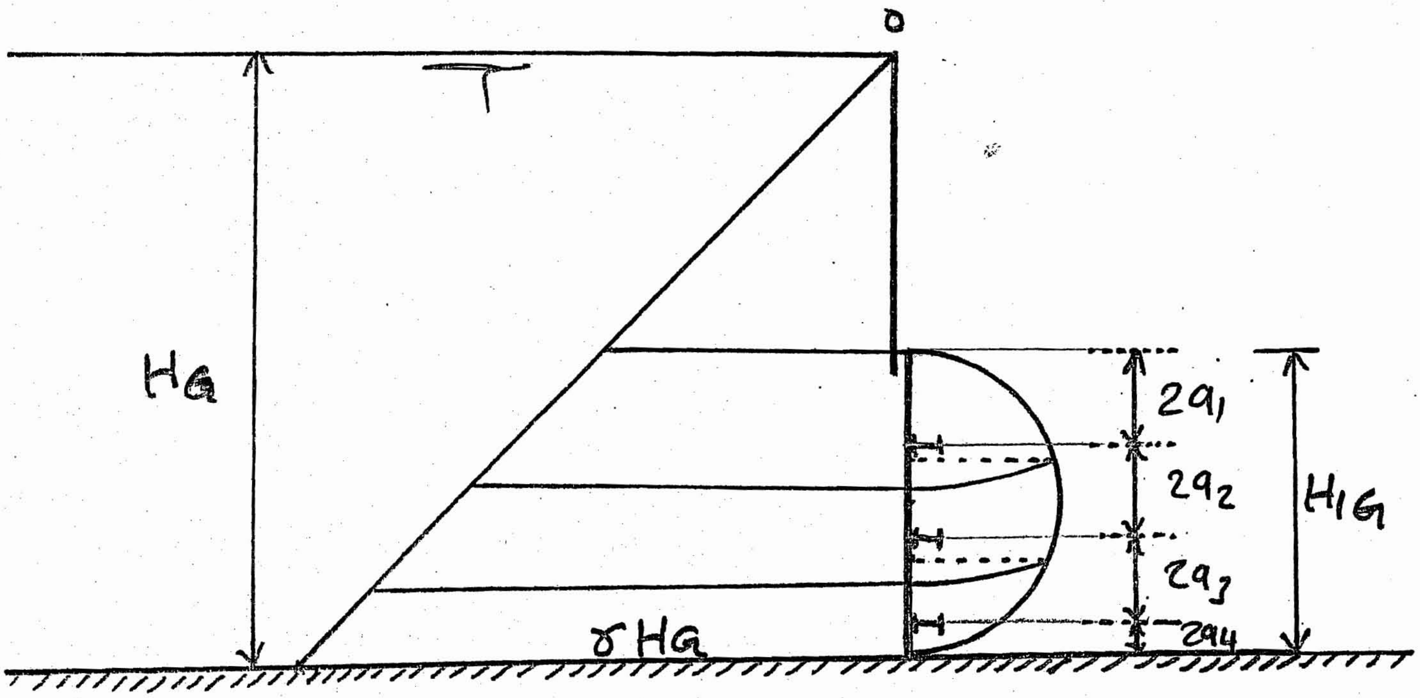
1- Graphical Solution

I- For single gate

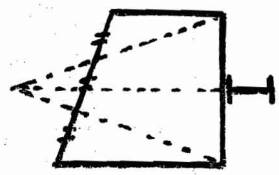


II- for Double gate :-

يتم تصميم البوابه السفليه وتعميم التصميم على البوابه العلويه

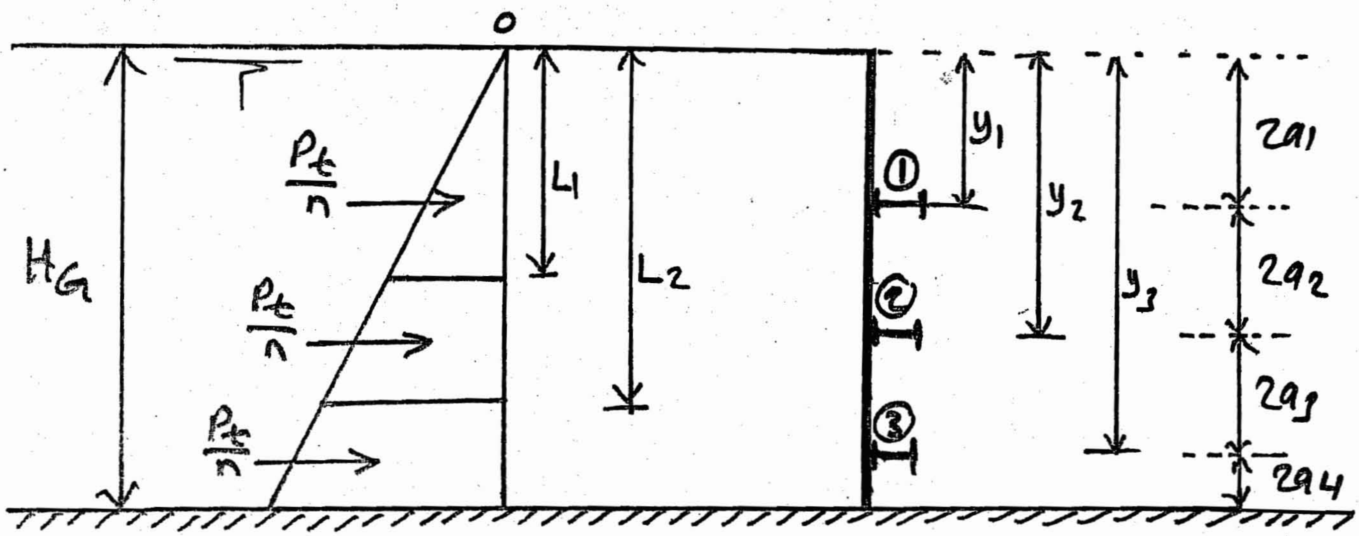


- إذا لم يحدد عدد (X-G) أو عدد (M-G) يتم فرضهم ثلاثه
- يتم وضع (M-G) فى مركز المساحه



2- Analytical Solution

I- for Single Gate :-



• $P_t = \frac{1}{2} \gamma_w H_G^2 B_G = \checkmark$

for G_1

$$\frac{P_t}{n} = \frac{1}{2} \gamma_w L_1^2 B_G$$

$$\therefore L_1 = \checkmark$$

$$\therefore y_1 = \frac{2 L_1}{3}$$

for G_2

$$\frac{P_t}{n} = \frac{1}{2}\gamma_w L_2^2 B G - \frac{1}{2}\gamma_w L_1^2 B G$$

$$\therefore L_2 = \checkmark$$

ΣM@o

$$\frac{P_t}{n} * y_2 = \frac{1}{2}\gamma_w L_2^2 B G * (\tfrac{2}{3} L_2) - \frac{1}{2}\gamma_w L_1^2 B G (\tfrac{2}{3} L_1)$$

$$\therefore y_2 = \checkmark$$

For G_3

ΣM@o

$$\frac{P_t}{n} * y_3 = \frac{1}{2}\gamma_w H_G^2 B G * (2/3\, H_G) - \frac{1}{2}\gamma_w L_2^2 B G (\tfrac{2}{3} L_2)$$

$$\therefore y_3 = \checkmark$$

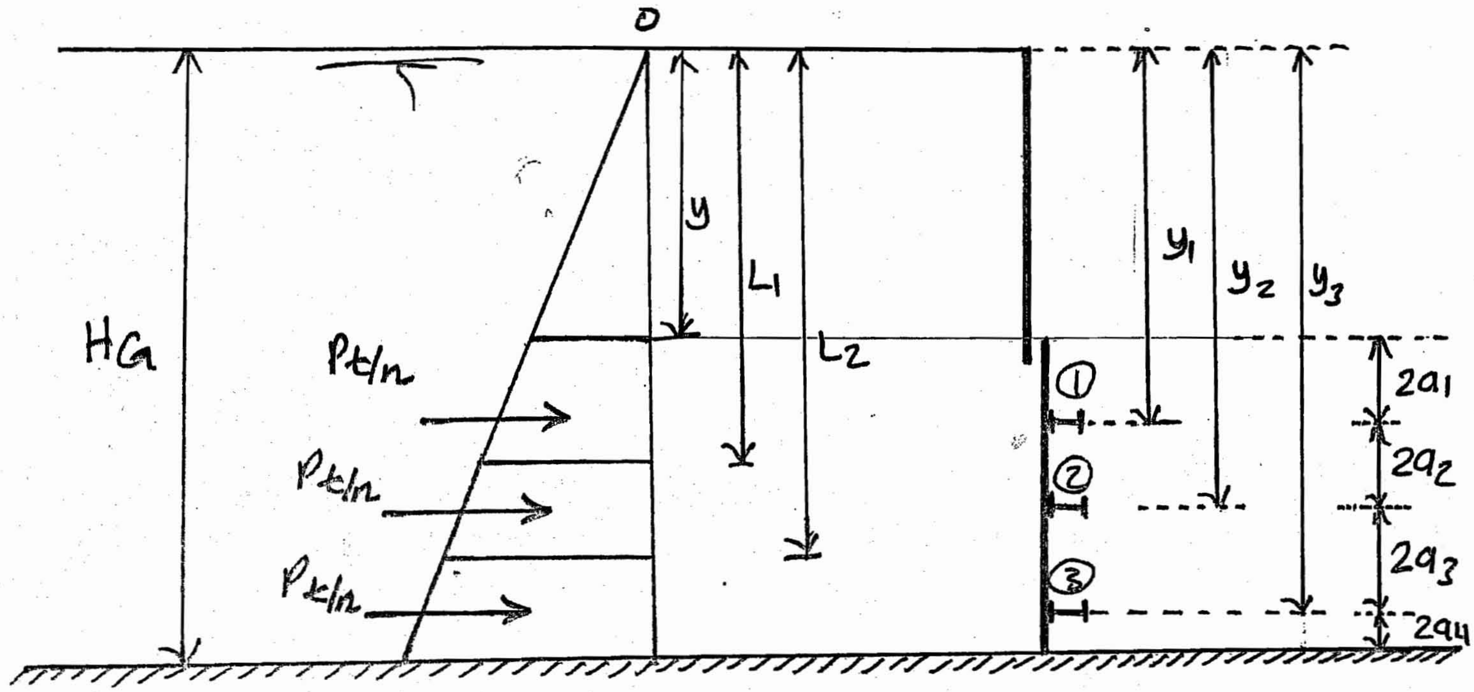
$$\therefore 2a_1 = y_1$$

$$\therefore 2a_2 = y_2 - y_1$$

$$\therefore 2a_3 = y_3 - y_2$$

$$\therefore 2a_4 = H_G - y_3$$

II – for double gate :-



$$\bullet\ P_t = \left(\frac{\gamma_w y + \gamma_w H_G}{2}\right) * H_{1G} * B_G$$

for G1

$$\frac{P_t}{n} = \frac{1}{2}\gamma_w L_1^2 B_G - \frac{1}{2}\gamma_w y^2 B_G$$

$$\therefore L_1 = \text{—}$$

ΣM @ o

$$\frac{P_t}{n} * y_1 = \frac{1}{2}\gamma_w L_1^2 B_G * \left(\frac{2}{3}L_1\right) - \frac{1}{2}\gamma_w y^2 B_G\left(\frac{2}{3}y\right)$$

$$\therefore y_1 = \text{—}$$

for G_2

$$\frac{P_t}{n} = \frac{1}{2}\gamma_w L_2^2 \, B_G - \frac{1}{2}\gamma_w L_1^2 \, B_G$$

$$\therefore L_2 = \_$$

$\Sigma M @ O$

$$\frac{P_t}{n} * y_2 = \frac{1}{2}\gamma_w L_2^2 B_G\left(\frac{2}{3}L_2\right) - \frac{1}{2}\gamma_w L_1^2 B_G\left(\frac{2}{3}L_1\right)$$

$$\therefore y_2 = \_$$

for G_3

$\Sigma M @ O$

$$\frac{P_t}{n} * y_3 = \frac{1}{2}\gamma_w H_G^2 B_G\left(\frac{2}{3}H_G\right) - \frac{1}{2}\gamma_w L_2^2 B_G\left(\frac{2}{3}L_2\right)$$

$$\therefore y_3 = \_$$

$\therefore 2a_1 = y_1 - y$

$\therefore 2a_2 = y_2 - y_1$

$\therefore 2a_3 = y_3 - y_2$

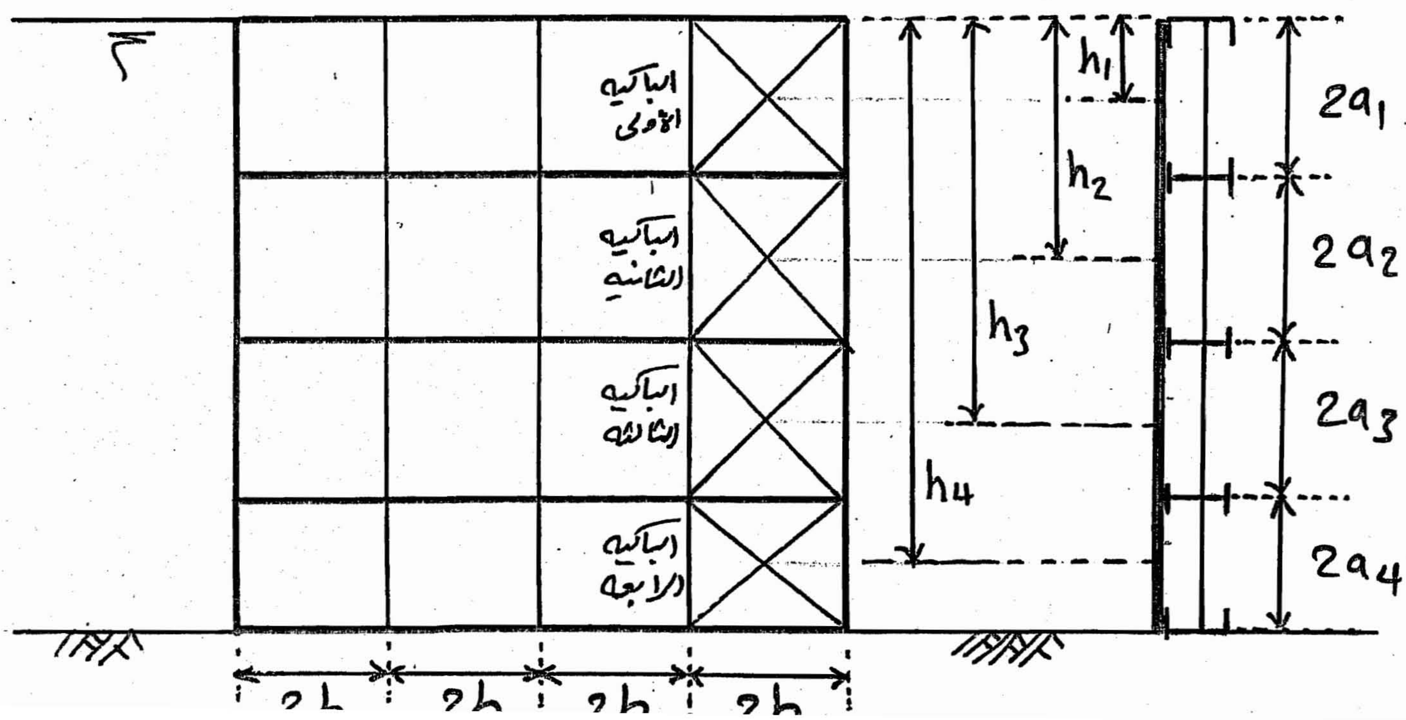
$\therefore 2a_4 = H_G - y_3$

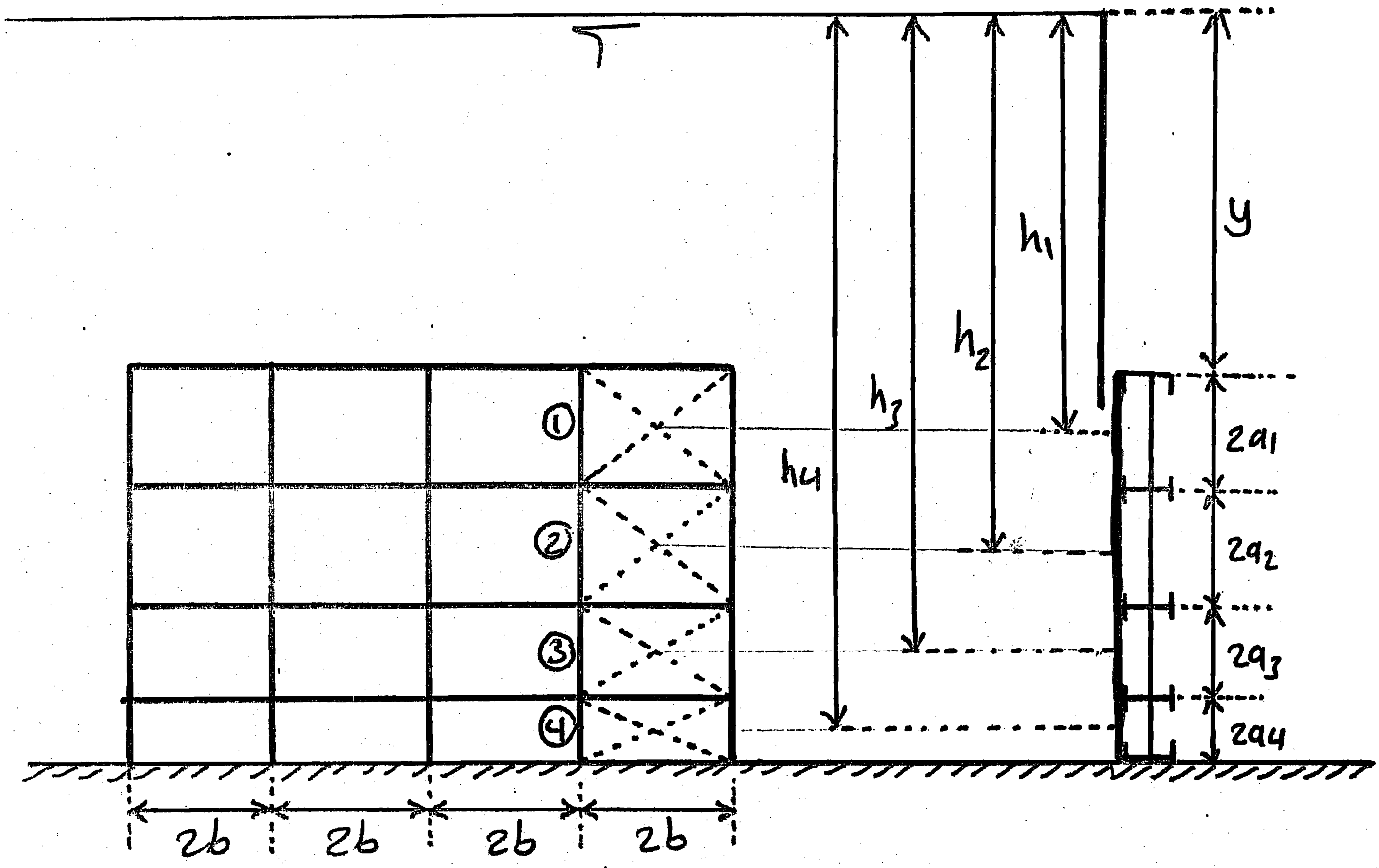
Design of Gate Components

1- Design of Skin Plate :-

$$t = a.b\sqrt{\frac{2\mu P}{f(a^2+b^2)}}$$

- t: Plate thickness (cm)
- μ: Degree of fixation = 0.94
- f: Working steel stress = $1\ t/cm^2$
- P: ضغط الماء في منتصف الباكيه = $\gamma h\ (t/m^2)$
- a: نصف عمق الباكيه = $\frac{2a}{2}$ (m)
- b: نصف عرض الباكيه = $\frac{2b}{2}$ (m)





- $h_1 = y + \frac{2a_1}{2}$

- $h_2 = y + 2a_1 + \frac{2a_2}{2}$

- $h_3 = y + 2a_1 + 2a_2 + \frac{2a_3}{2}$

- $h_4 = y + 2a_1 + 2a_2 + 2a_3 + \frac{2a_4}{2}$

No.	$a_{(m)}$	$b_{(m)}$	h_m	$P_{(t/m^2)}$	$t_{(cm)}$
1	a_1	b	h_1	γh_1	✓
2	a_2	b	h_2	γh_2	✓
3	a_3	b	h_3	γh_3	✓
4	a_4	b	h_4	γh_4	✓

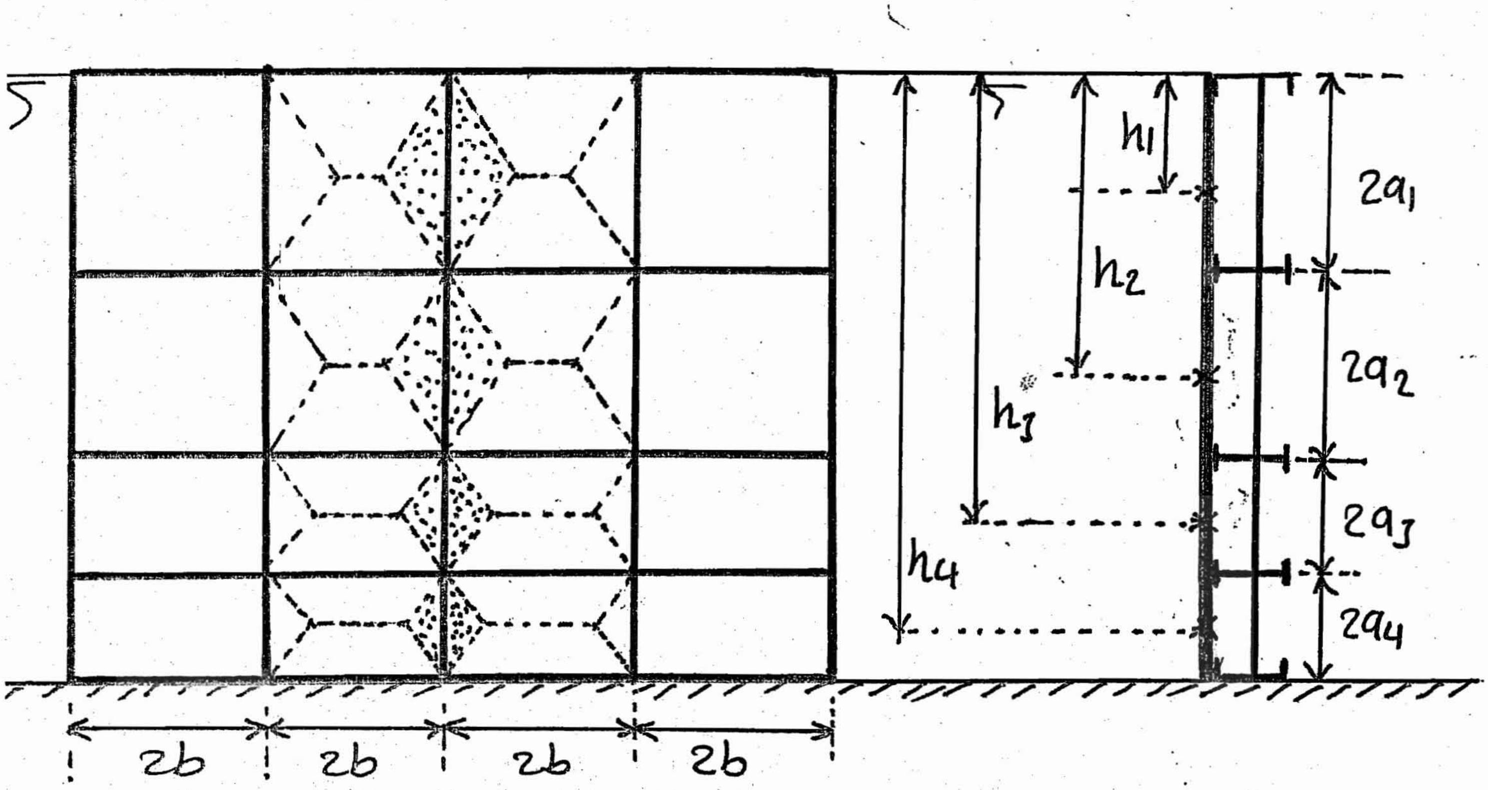
يتم إختيار أكبر (t) من الجدول

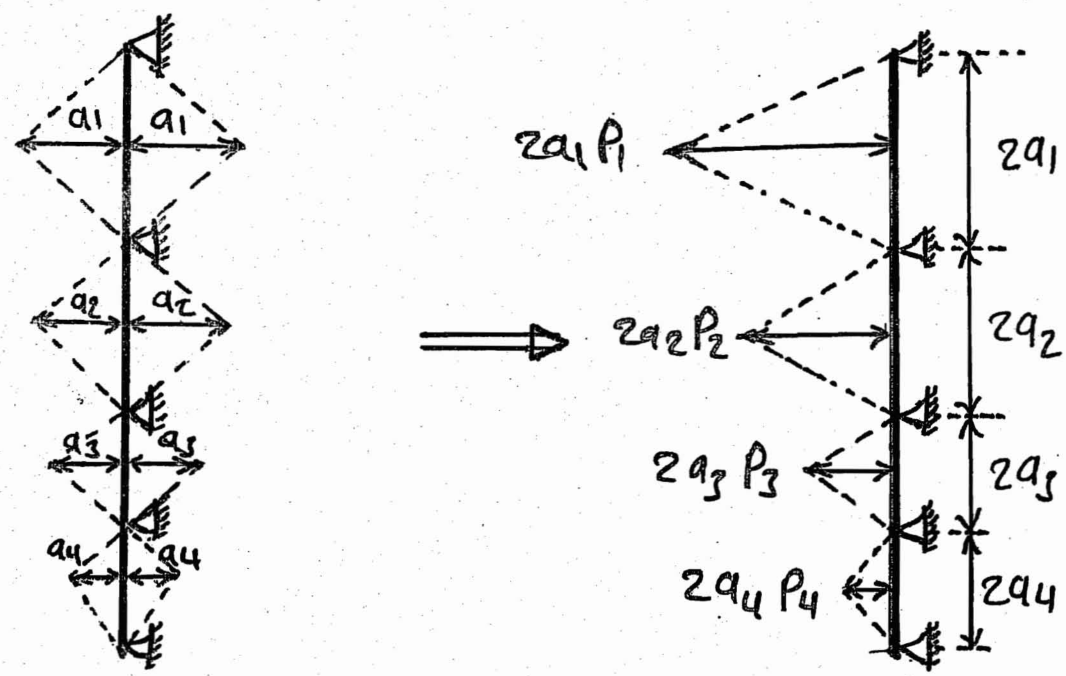
$$t_{max} = ✓\ cm \nless 1\ cm$$

نقرب الـ (t) لأقرب 2 mm أو 5 mm

(1, 1.2, 1.4, 1.5, 1.6, 1.8, 2, 2.2, 2.4, 2.5)

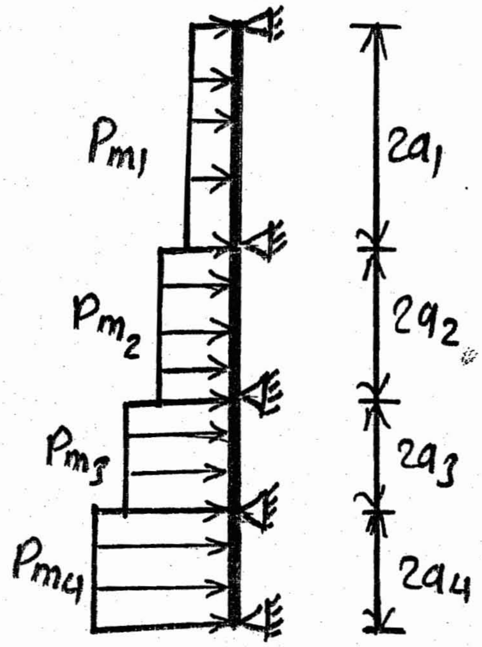
2- Design of Cross girder :-





للتحويل من حمل مثلث إلى حمل uniform نضرب * $\frac{2}{3}$

$$\therefore P_m = \frac{2}{3}(2aP)$$



- $P_{m_1} = \frac{2}{3}(2a_1 P_1)$

- $P_{m_2} = \frac{2}{3}(2a_2 P_2)$

- $P_{m_3} = \frac{2}{3}(2a_3 P_3)$

- $P_{m_4} = \frac{2}{3}(2a_4 P_4)$

No.	Span (m)	$P=\gamma h$ (t/m^2)	P_m (t/m)	M (t.m)
1	$2a_1$	$P_1=\gamma h_1$	P_{m1}	$\frac{P_{m1}(2a_1)^2}{8}$
2	$2a_2$	$P_2=\gamma h_2$	P_{m2}	$\frac{P_{m2}(2a_2)^2}{8}$
3	$2a_3$	$P_3=\gamma h_3$	P_{m3}	—
4	$2a_4$	$P_4=\gamma h_4$	P_{m4}	—

من الجدول نختار Mmax

$$\therefore Z = \frac{M_{max}^{\,t.m}}{f_{=1000\,kg/cm^2}} = \frac{M_{max} * 10^5}{1000} = \text{—}\ cm^3$$

Choose from table SIB No ----

Sheet (3)

Regulators

1- Figure (1) shows the D.S cross section of a main canal in which a reinforced concrete regulator is to be constructed. The regulator consists of 4 vents each 3.0 m width. The maximum discharge through the regulator is $Q = 50\ m^3/sec$ and the maximum heading up is 10 cm. The following data are also considered in the design: (i) The bridge width = 10.0 m and it has 2 sidewalks of 1.0 m each, (ii) The pier width =1.0 m,(iii) Box and sloping wing walls are used for upstream and downstream sides, respectively, and (iv)Vertical sliding steel gates with *four* Main girders are used

It is required to:

a) Check the value of heading up for fully open gates.

b) Give a complete structure design of the gate, and find the required lifting force.

c) Draw neat sketch showing each of the following views:

i. Plan (H.E.R.)

ii. Longitudinal section through a vent centerline.

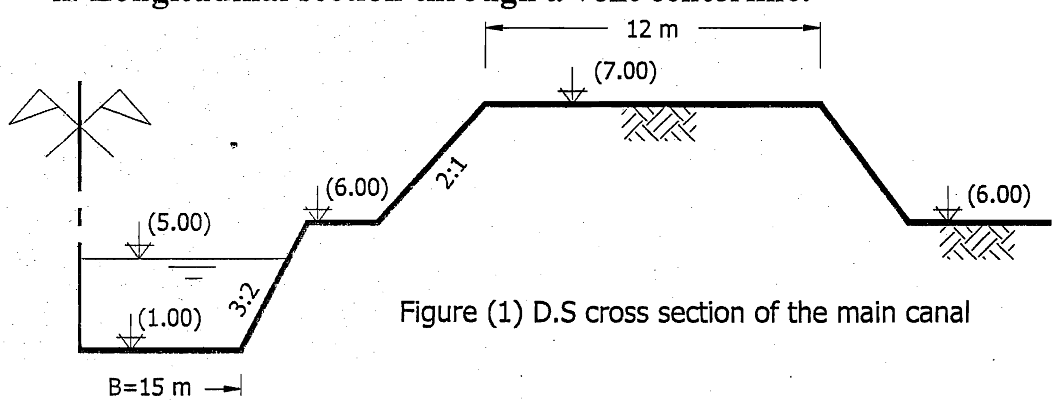


Figure (1) D.S cross section of the main canal

2- A reinforced concrete head regulator with 200.0 m approach channel is to be constructed to feed a main canal from a Rayah. The cross sections data for the canal and Rayah at the crossing site are given in the following table. The available data for the regulator are:

- Maximum allowable discharge through the canal is $6.8*10^6\ m^3/day$
- The span of vents is 5.0 m,
- The bridge width over the regulator is 10.0 m and it has two sidewalks of 1.0 m width for each,
- U.S and D.S box wing walls are used,
- The width of the intermediate piers is 1.0 m.

Prob(1)

b-

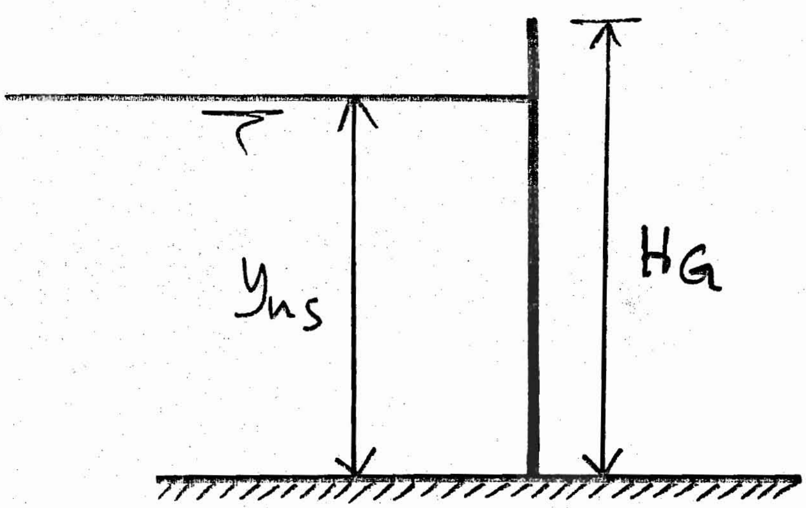
• $S = 3.0^{m}$, • $y_{ds} = 4.0^{m}$

$$S * y_{ds} = 3*4 = 12\ m^2 < 16\ m^2$$

∴ use Single gate

• $y_{us} = y_{ds} + h_{up} = 4 + 0.057 = 4.057^{m}$

• ∵ $S' = 3^{m} \xrightarrow{\therefore} w = 0.6^{m} \xrightarrow{\therefore} d = \frac{w}{3} = 0.2^{m}$



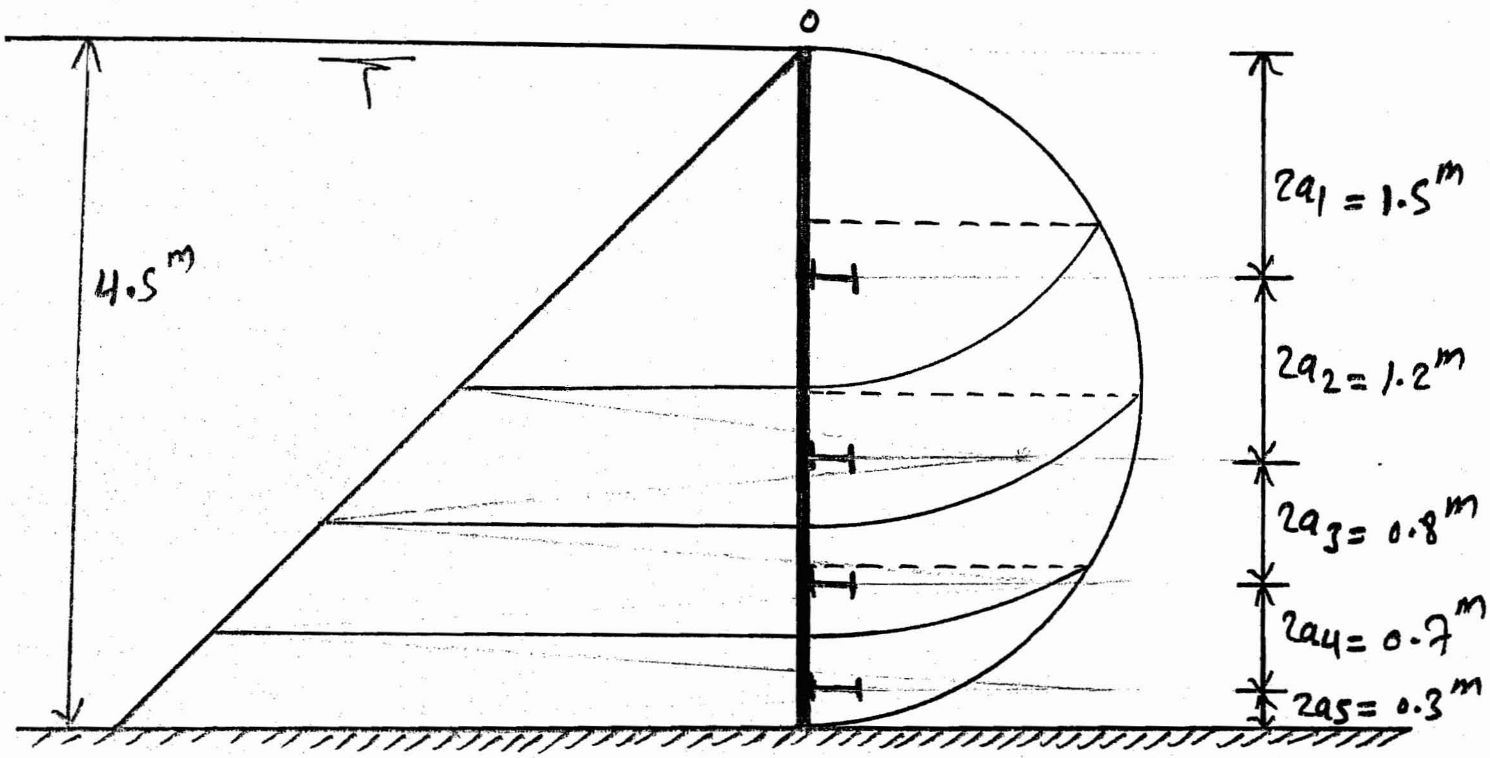
• $HG = y_{us} + (0.3 \rightarrow 0.5^{m}) = 4.357 \rightarrow 4.557$

take $HG = 4.5^{m}$

• $BG = S' + d = 3 + 0.2 = 3.2^{m}$

* Location of main girders

Scale 1:50



* Design of Skin Plate

take No. at X.G = 3.0 ⟶ ∴ $2b = \frac{B G}{4} = 0.8^m$

No	$a_{(m)}$	$b_{(m)}$	$h_{(m)}$	$P_{(t/m^2)}$	$t_{(cm)}$
1	0.75	0.4	0.75	0.75	0.42
2	0.6	0.4	2.1	2.1	0.66
3	0.4	0.4	3.4	3.4	0.72
4	0.35	0.4	3.85	3.85	0.71
5	0.15	0.4	4.35	4.35	0.4

∴ $t_{max} = 0.72^{cm} \not< 1.$

∴ take

$t = 1.0^{cm}$

* Design of cross girder

No.	Span (m)	$P=\gamma h$ t/m^2	P_m (t/m')	M $(t.m)$
1	1.5	0.75	0.75	0.21
2	1.2	2.1	1.68	0.3
3	0.8	3.4	1.81	0.14
4	0.7	3.85	1.8	0.11
5	0.3	4.35	0.87	0.0098

$\therefore M_{max} = 0.3 \ t.m$

$$\therefore Z = \frac{0.3 * 10^5}{1000} = 30 \ cm^3$$

Choose from table SIB No ....