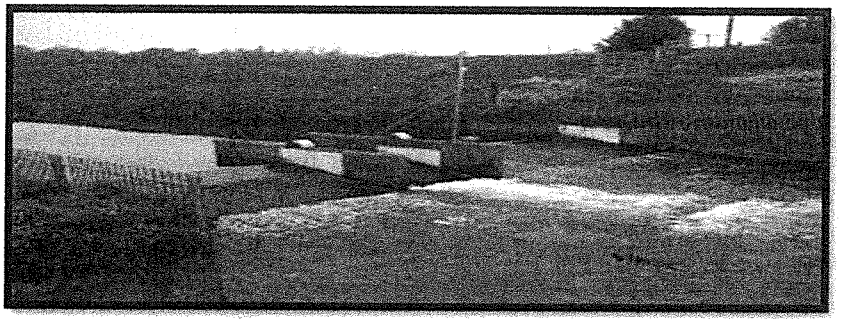
DESIGN OF IRRIGATION STRUCTURE (2)

رابعة مدني



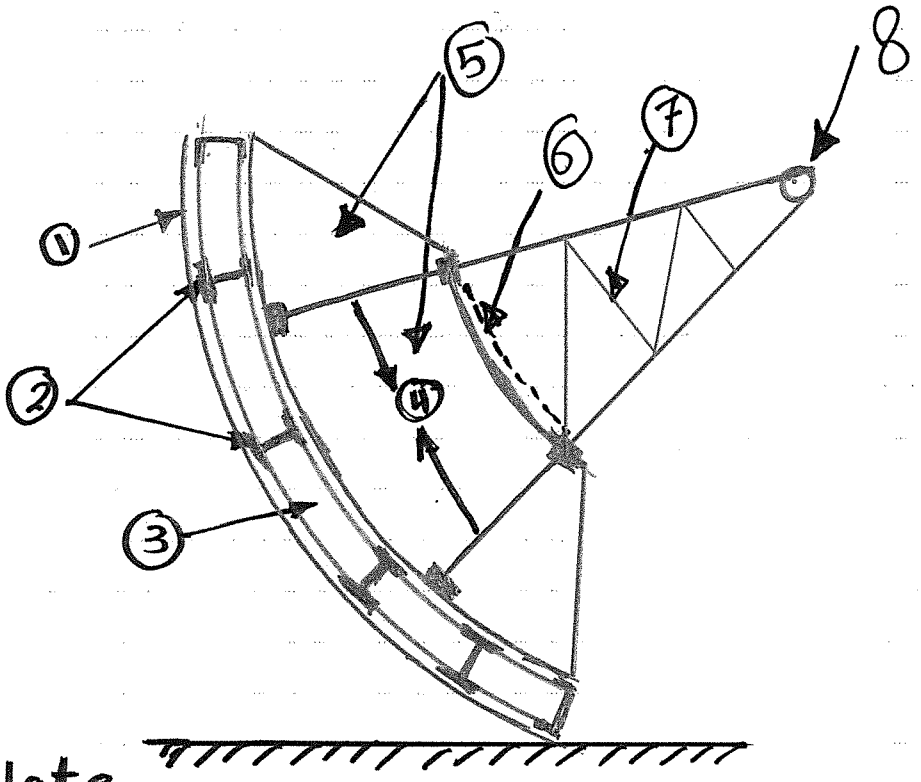
Regulator
(Design of Gates)
b- Radial Steel Gate

5

Radial Gate

* Component of Radial gate :-

مكونات البوابة.



① Skin Plate

② Horizontal Beams (MG)

③ Curvilinear members

④ Two Cross bars

⑤ Cross Diaphrames

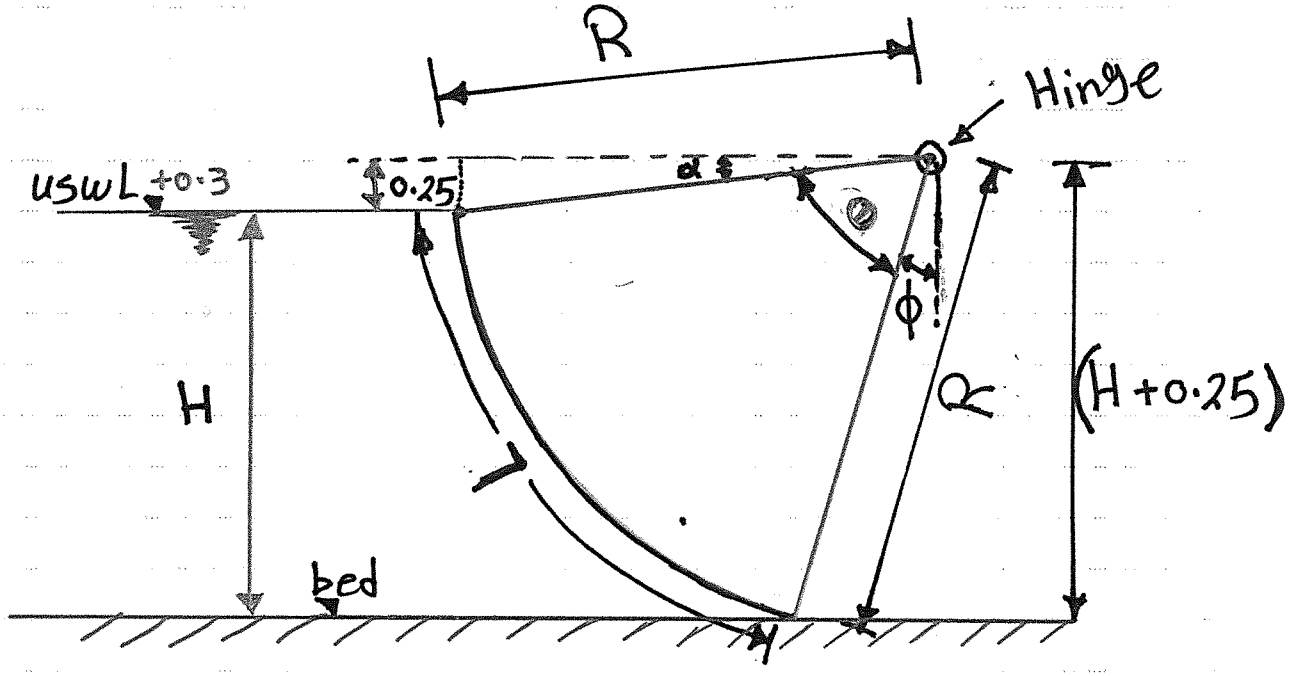
⑥ Bracing

⑦ Two arms. ذراع

⑧ Fixed support Hinges

* Dimension of Radial gate

ابعاد البوابة.



$\therefore H = y_{us} + 0.3$

$\therefore R = (1.2 \text{ to } 1.5)\, H$ (gate radius)

نصف قطر البوابة.

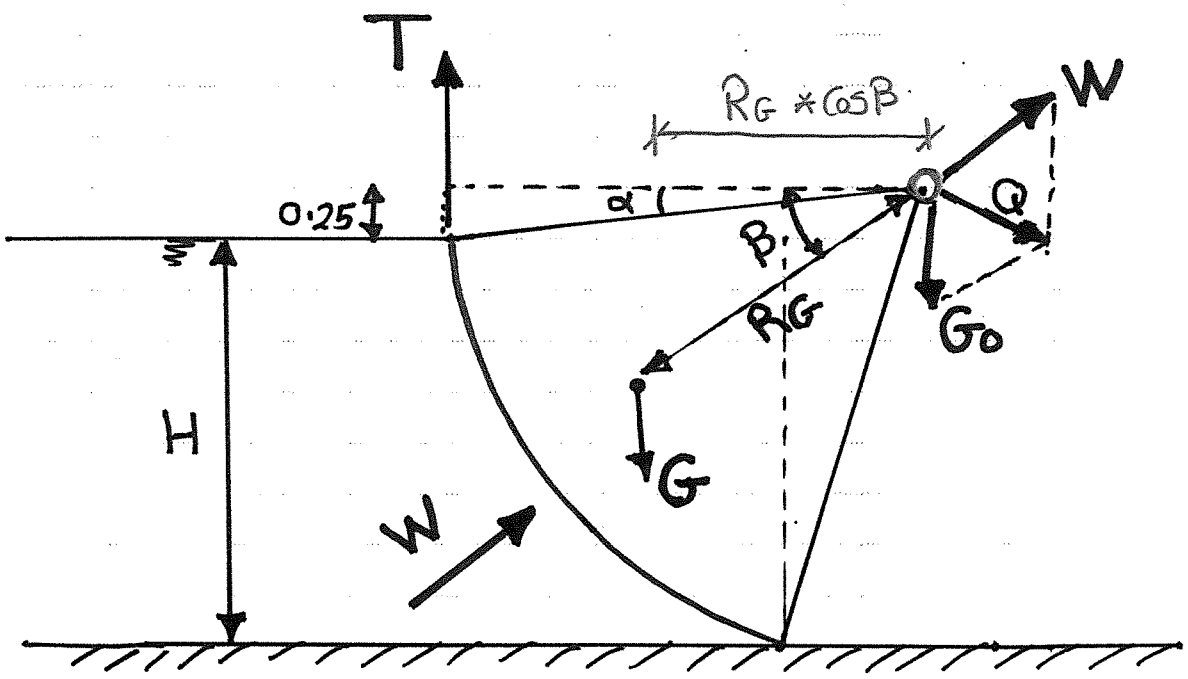
$\therefore \sin\alpha = \frac{0.25}{R} \rightarrow \alpha = \text{??}$

$\therefore \cos\phi = \frac{H+0.25}{R} \rightarrow \phi = \text{??}$

$\therefore \theta = 90^\circ - (\alpha^\circ + \phi^\circ)$

$\therefore L = 2\pi R * \frac{\theta}{360}$

Forces on the Radial Gate



∴ G → Gate weight وزن البوابة

∴ Go → Reaction at the hinge
رد الفعل الراسى عند المفصل

∴ Q → acting shearing Force at hinge
قوة الاحتكاك عند المفصل

∴ W → Total acting hydrostatic Force
قوة ضغط المياة على البوابة

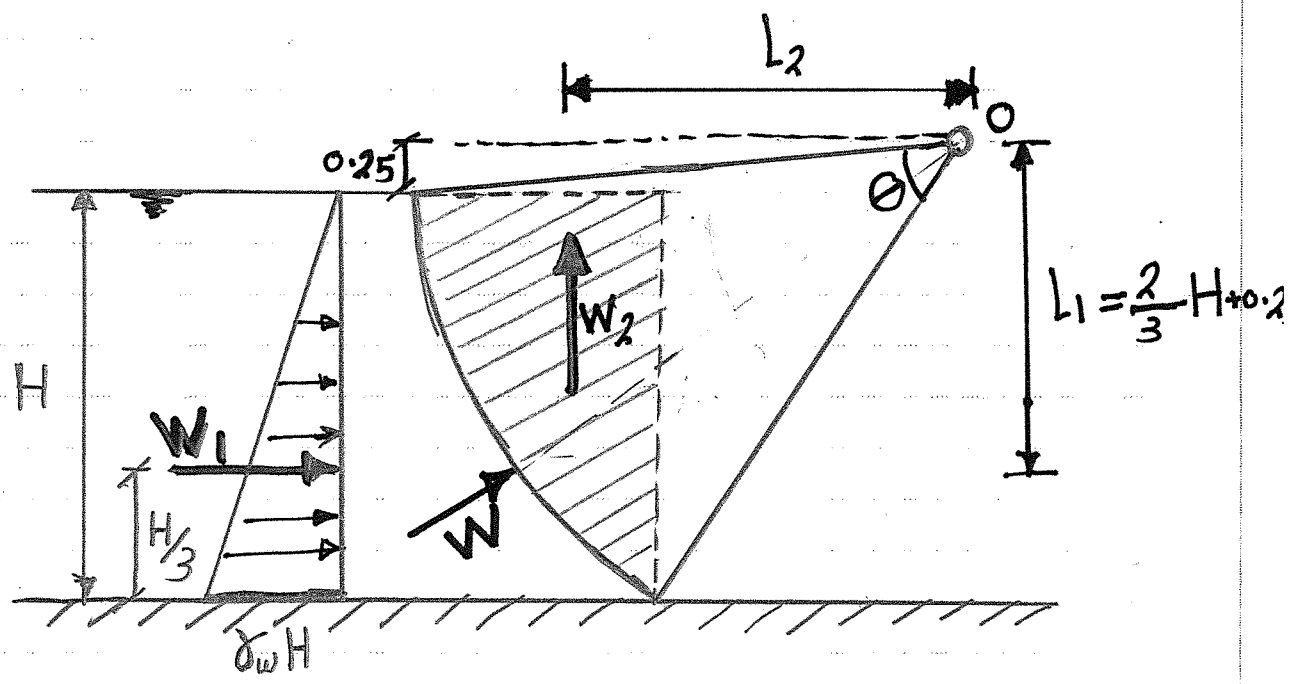
* حساب W

لحساب قوة ضغط الماء (W) على البوابة زى ما اتعلمنا فى سنة تانية حساب القوى على سطح غير مستوى يتم الحل بطريقة (Component) المركبات وفيها يتم تقسيم القوى إلى مركبتين .

$W_1 \rightarrow$ فى اتجاه محور $\overline{x}$

$W_2 \rightarrow$ فى اتجاه محور $\overline{y}$

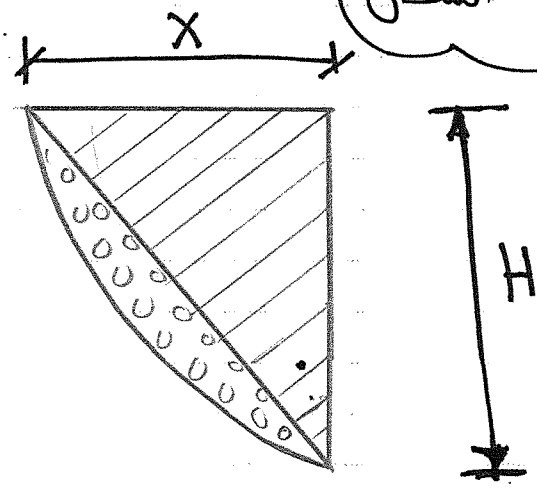
$$\therefore W = \sqrt{W_1^2 + W_2^2}$$



$$\therefore W_1 = \frac{1}{2}\gamma_w \; H * H * S$$

$$\therefore W_2 = \gamma_w * \text{مساحة الشكل} * S$$

لايجاد مساحة الشكل



$$\text{المساحة } A = \frac{R^2}{2}\left(\frac{\theta * \pi}{180} - \sin\theta\right) + \left(\frac{1}{2} * H * X\right)$$

لايجاد X يتم رسم المسألة بـ scale وايجاد (X)

لايجاد نقطة تأثير W_2 يتم اخذ عزوم حول O

$$\leftarrow M @ O = 0.0$$

$$W_1 * L_1 - W_2 * L_2 = 0.0$$

$$L_2 = \text{---} \; m$$

$$W = \sqrt{W_1^2 + W_2^2} = \text{---} \; ton$$

Stability of Radial gates

1- G → وزن البوابة

2- G_o → رد الفعل عند المفصل

3- T → القوى اللازمة لرفع البوابة

حساب وزن البوابة G

$$G = 0.15 \left(W * \frac{Span}{S} \right)^{0.7}$$

حساب رد الفعل عند المفصل G_o

$$G_o = G \left(1 - \frac{L_2}{R \cos\alpha} \right)$$

لحساب القوة T

القوة اللازمة لرفع البوابة.

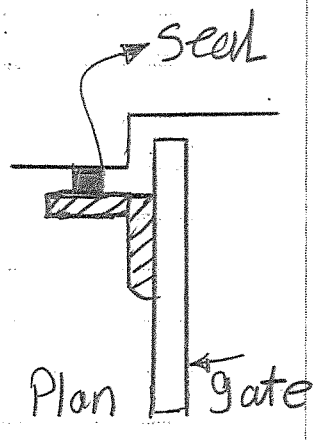
$$\sum M@O = 0.0$$

$$T * R\cos\alpha - G * R_G \cos\beta - T_{seal} * R_{seal} - f * Q * r = 0.0$$

T = ?? ton

where

$$R_{seal} = R + 0.1$$



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

$f \rightarrow$ friction factor $= 0.3$

$b \rightarrow$ seal width $= 0.2\ m$

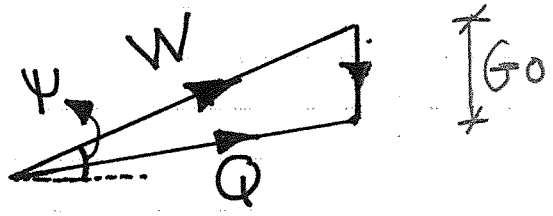
L = Length of gate $= 2\pi R * \frac{\theta}{360}$

$$P_{av} = \gamma_w * \frac{H}{2}$$

$Q \rightarrow$ acting shearing force at hinge

يتم ايجاد Q برسم متجهات القوى بـ scale

$\Psi = \tan^{-1} \frac{W_2}{W_1}$



$r \rightarrow$ inner radius of the hinge $= 0.05\ m$

$\therefore R_G \cos\beta = L_2 \Rightarrow$ assume G and W_2 at the same Line

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حنشتغل بهذه الطريقة // طريقة اخرى لحساب T

L_2

$$T = \frac{(G * R_G \cos\beta) * k_1 + (T_{seal} * R_{seal} + f * Q * r) * k_2}{R \cos\alpha}$$

where

k_1 and $k_2 \rightarrow$ factor of Safty

$k_1 = 1.1$

$k_2 = 1.2$

example

it's required to find the suitable Dimension for the regulator gates as a radial Type. The Maximum DS water depth is 3.6 m and the span of each vent is 4 m. check the stability of the gate and find the required lifting force.

الحل

* radial gate
* $S = 4\,m$
* $y_{ds} = 3.6\ m$

|

* Dimension

$$\therefore y_{us} = y_{DS} + h_{up} = 3.6 + 0.1 = 3.7\,m$$

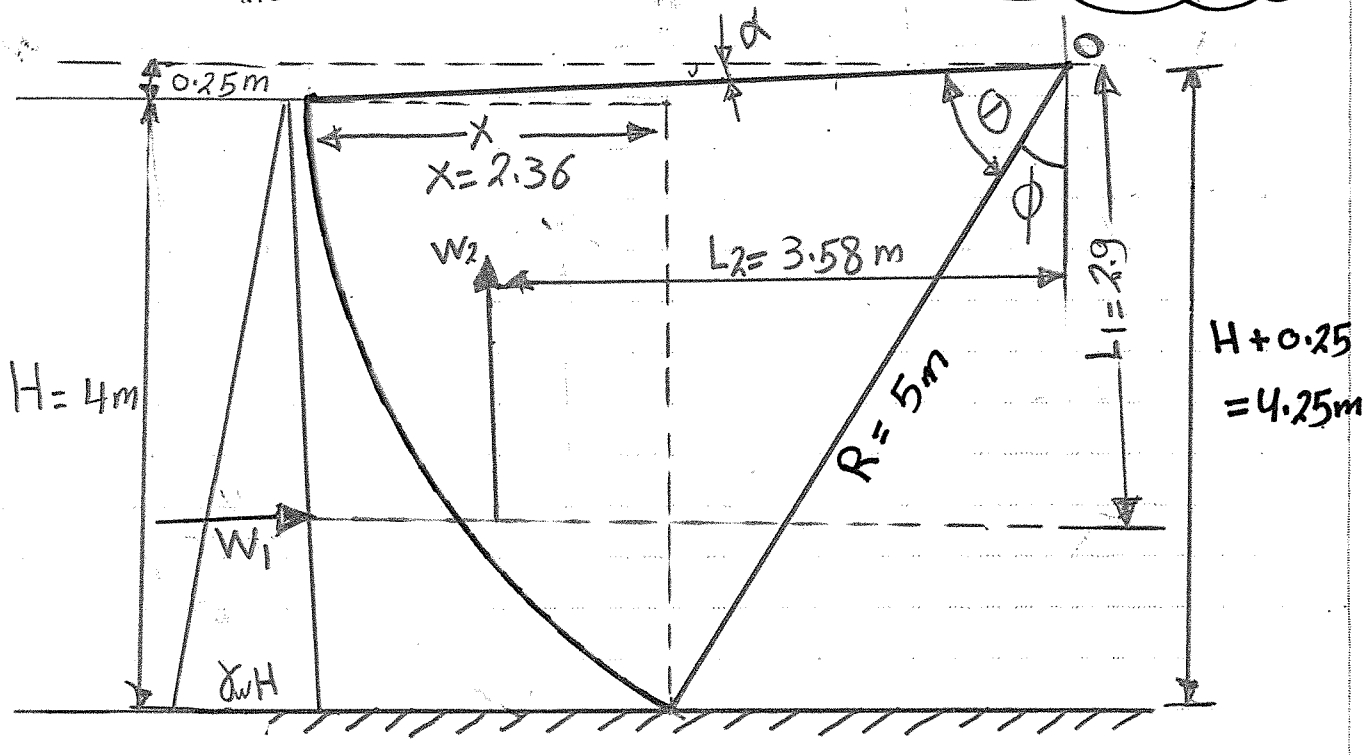
$$H = y_{us} + 0.3 = 3.7 + 0.3 = 4\,m$$

$$R = (1.2 \text{ to } 1.5)\,H = (1.2 \to 1.5)\,4 = 4.8 \text{ to } 6$$

$$\therefore \text{Used } R = 5\,m$$

Scale الرسم الطبيعة 1 : 2

* تتم الرسم بـ Scale



$$\therefore \sin\alpha = \frac{0.25}{R} = \frac{0.25}{5} = 0.05 \to \alpha = 2.86^\circ$$

$$\therefore \cos\phi = \frac{4.25}{R} = \frac{4.25}{5} = 0.85 \to \phi = 31.79^\circ$$

$$\therefore \theta = 90 - (\alpha + \phi) = 90^\circ - (2.86^\circ + 31.79^\circ)$$

$$\theta = 55.35^\circ$$

$$\therefore L = 2\pi R\left(\frac{\theta}{360}\right) = 2*\pi*5*\left(\frac{55.35}{360}\right) = 4.8m$$

Forces

* hydrostatic Force :-

$$\therefore W_1 = \tfrac{1}{2} * \gamma_w * H * H * S$$

$$= \tfrac{1}{2} * 1 * 4^2 * 4 = 32 \text{ ton}$$

$W_2 = \gamma_w *$ مساحة القطاع $H * S$

$$W_2 = 1 * \left[\left(\frac{R^2}{2}\left(\frac{\theta * \pi}{180} - \sin\theta\right)\right) + \tfrac{1}{2} H * X\right] * S$$

X ← من الرسم مع مراعاة scale $X = 2.36m$

$$W_2 = 1 * \left[\left(\frac{5^2}{2}\left(55.35 * \frac{\pi}{180} - \sin 55.35\right)\right) + \tfrac{1}{2} * 4 * 2.36\right] * 4$$

$$W_2 = 26 \text{ ton}$$

$$W = \sqrt{W_1^2 + W_2^2} = \sqrt{32^2 + 26^2} = 41.23 \text{ ton}$$

$$\therefore L_1 = 0.25 + 2/3\ H = 0.25 + 2/3 * 4 = 2.91 \text{ m}$$

L_2 لديها

$$\leq M @ 0 = 0.0$$

$$W_1 * L_1 - W_2 L_2 = 0.0$$

$$32 * 2.91 - 26 * L_2 = 0.0$$

$$L_2 = 3.58 \text{ m}$$

$$\therefore \Psi = \tan^{-1} \frac{W_2}{W_1} = \tan^{-1} \frac{26}{32} = 39.09^\circ$$

Find

$G = ??$

$$G = 0.15 \left(W * \text{Span}_S\right)^{0.7}$$

$$G = 0.15(41.23 * 4)^{0.7} = 5.35 \text{ to}$$

Find $G_o = ??$

$$G_o = G\left(1 - \frac{L_2}{R\cos\alpha}\right)$$

$$G_o = 5.35\left(1 - \frac{3.58}{5 * \cos 2.86}\right)$$

$$G_o = 1.515 \text{ ton}$$

لدينا T

$$T = \frac{(G * \overbrace{R_G \cos B}^{L_2})\,k_1 + (T_{seal} R_{seal} + f * Q * r)\,k_2}{R\cos\alpha}$$

$\therefore k_1 = 1.1$

$\therefore k_2 = 1.2$

$\therefore R_G \cos B = L_2 = 3.58$ assume.

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

$f = 0.3$

$b = 0.2\,m$

$L = 4.8\,m$

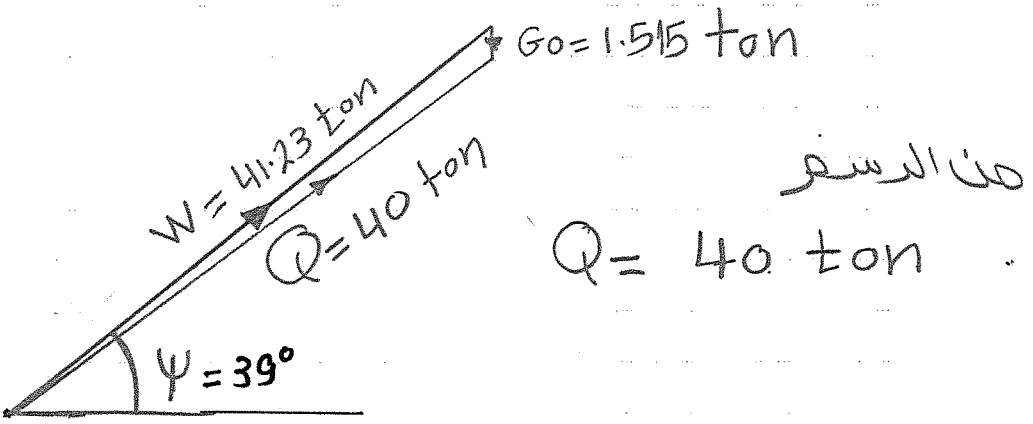
$P_{av} = \gamma_w \frac{H}{2} = 1 * \frac{4}{2} = 2\,t/m^2$

$$\therefore T_{seal} = 2 * 0.3 * 0.2 * 2 * 4.8 = 1.152 \text{ ton}$$
(f, b, P_w, L)

$$\therefore R_{seal} = R + 0.1 = 5 + 0.1 = 5.1 \text{ m}$$

$$\therefore r = 0.05 \text{ m}$$

Q ← يتم ايجادها من رسم شكل متجهات القوى بـ scale



من الرسم

$Q = 40$ ton

$$\therefore T = \frac{(5.35 * 3.58) * 1.1 + (1.152 * 5.1 + 0.3 * 40 * 0.05) * 1.2}{5 \cos(2.86)}$$

$$T = 5.774 \text{ ton}$$