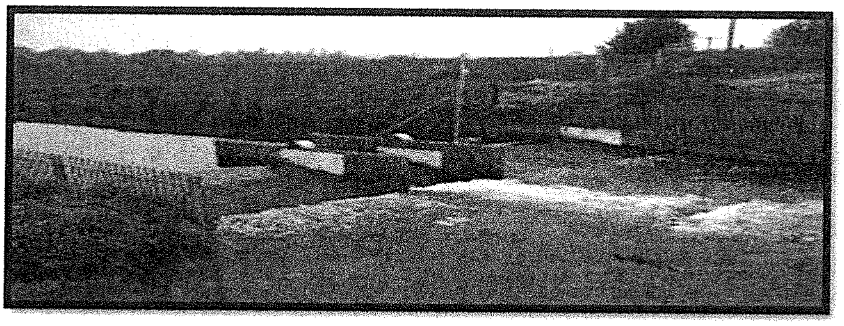
DESIGN OF IRRIGATION STRUCTURE (2)

engineer22.com رابعة مدني



Regulator
Design of Pier

8

Design of Pier

تصميم البغلة

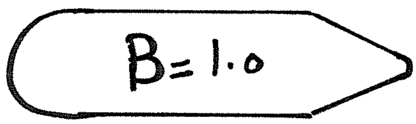
* استخدامات الـ Pier :-

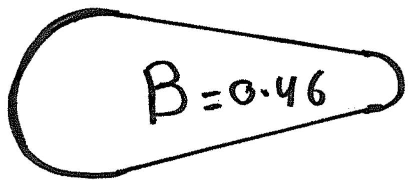
١- تقسيم القنطرة إلى فتحات .

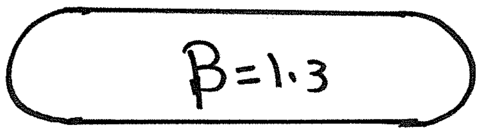
٢- يتم عمل grooves فيها لتحريك البوابات من خلالها .

٣- تعمل كركيزة للكوبري .

* أشكال الـ Pier







✓✓ محل دراستنا

ويوجد أشكال عديدة .

Dimension

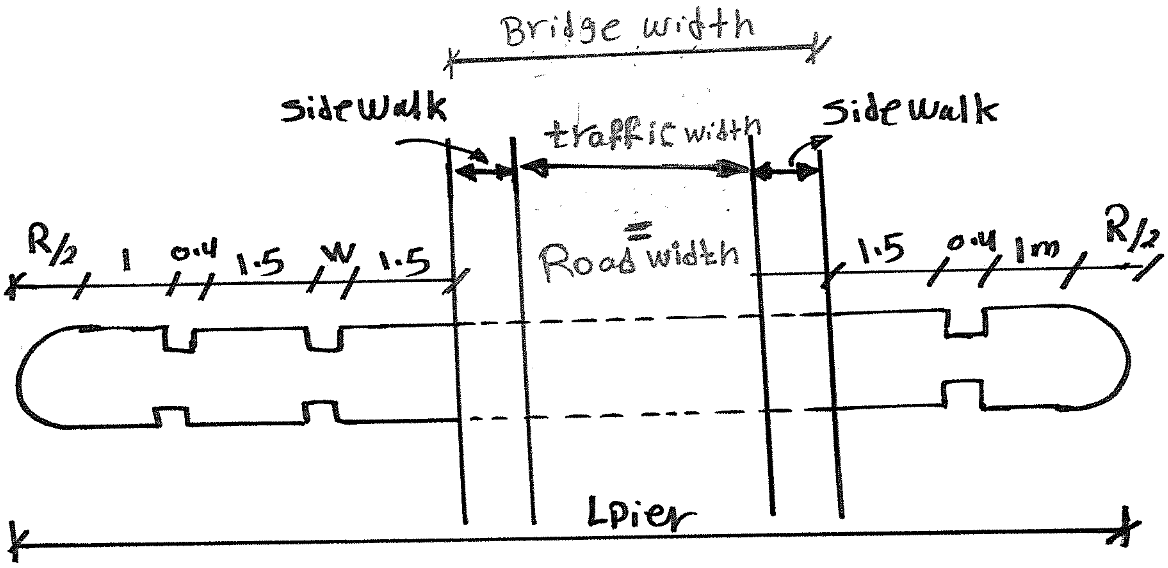
[1] Pier width R

$$R = \frac{S}{3 \to 4} \nless 1.0 \to P.C$$ الخرسانة العادية

$$R = \frac{S}{5 \to 8} \nless 0.8 \to RC$$ الخرسانة المسلحة

[2] Pier Length :- Lpier

* يتم فرض الابعاد كما بالرسم وذلك لحساب Lpier ولاحظ ان هذه الابعاد تعتمد على نوع البوابة

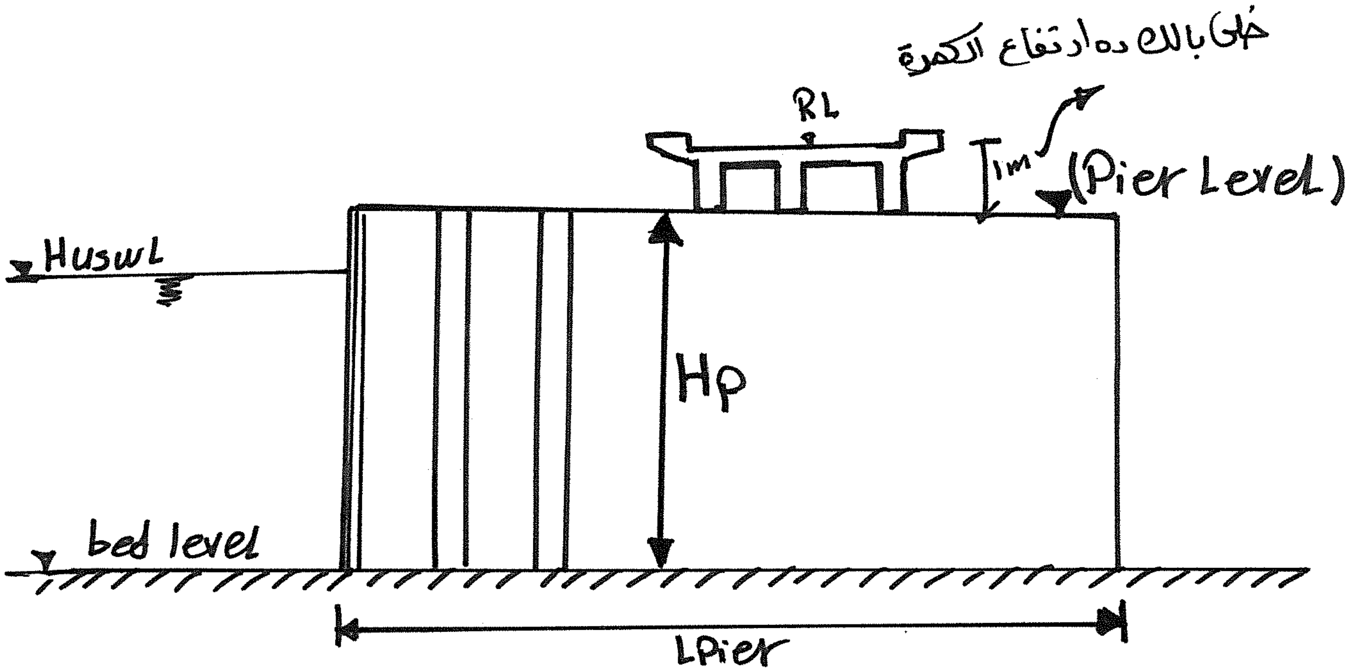


∴ W = 0.4 → Single gate

∴ W = S على حسب من الجدول → Double gate

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

3- Pier Hight Hp



$\therefore$ ▼ Pier level = ▼ (HUSWL + 0.5)
= ▼ (Road level − 1)
= ▼ (Berm Level)

ناخذ Max

$\therefore$ **Hp = ▼ Pier Level − ▼ Bed level**

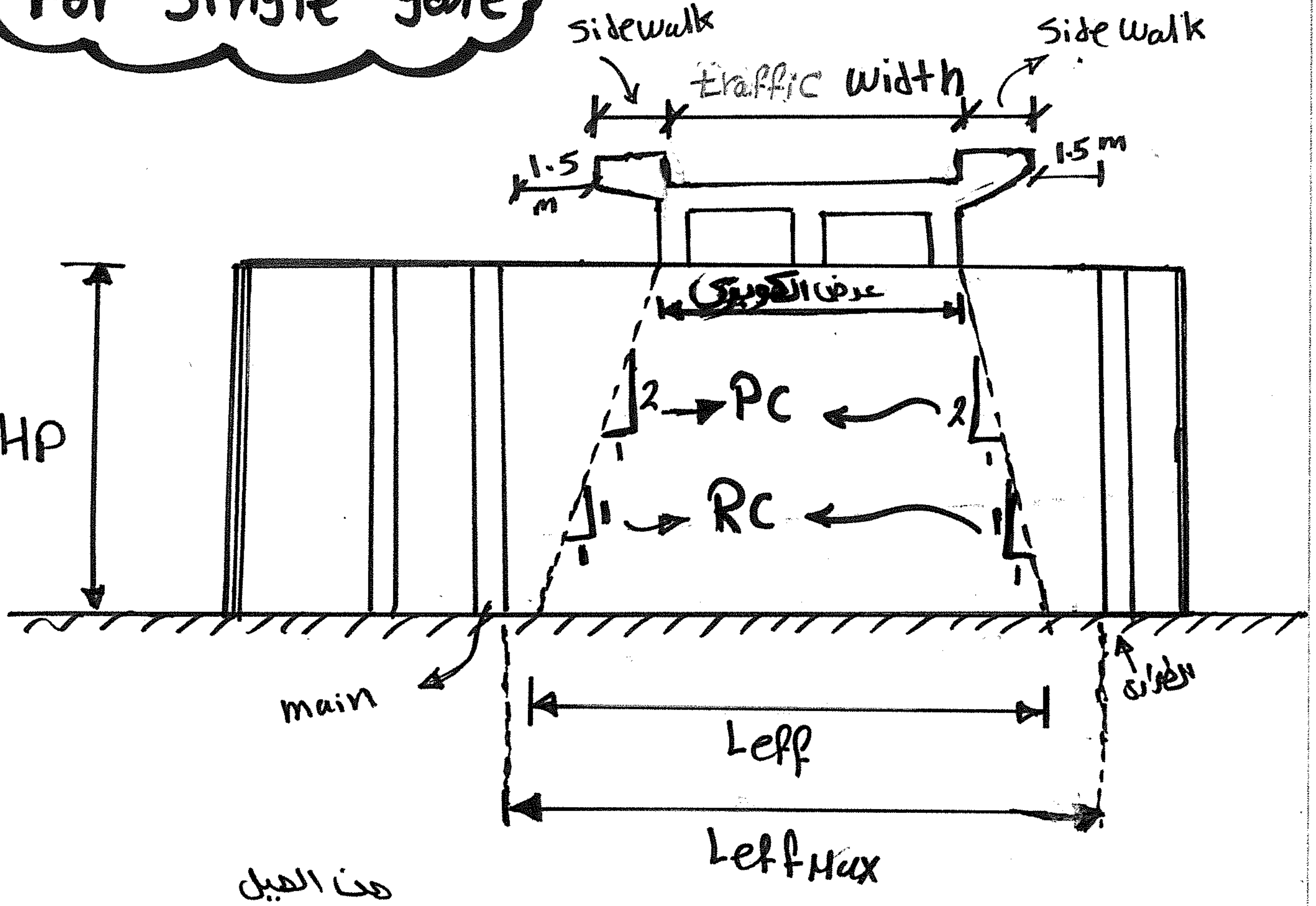
4- effective Lengthe: L_{eff}

لاحظ ان لا يدخل معنا L_{pier} بالكامل فى الحسابات ولكن نأخذ طول محدد منه فقط وهو يسمى L_{eff} يتم حسابة كما يلى :-

ويتوقف على نوع مادة الـ Pier (Pc او Rc) وشكل توزيع الاجهادات

L_{eff} → الطول الفعلى الذى يقاوم الاحمال

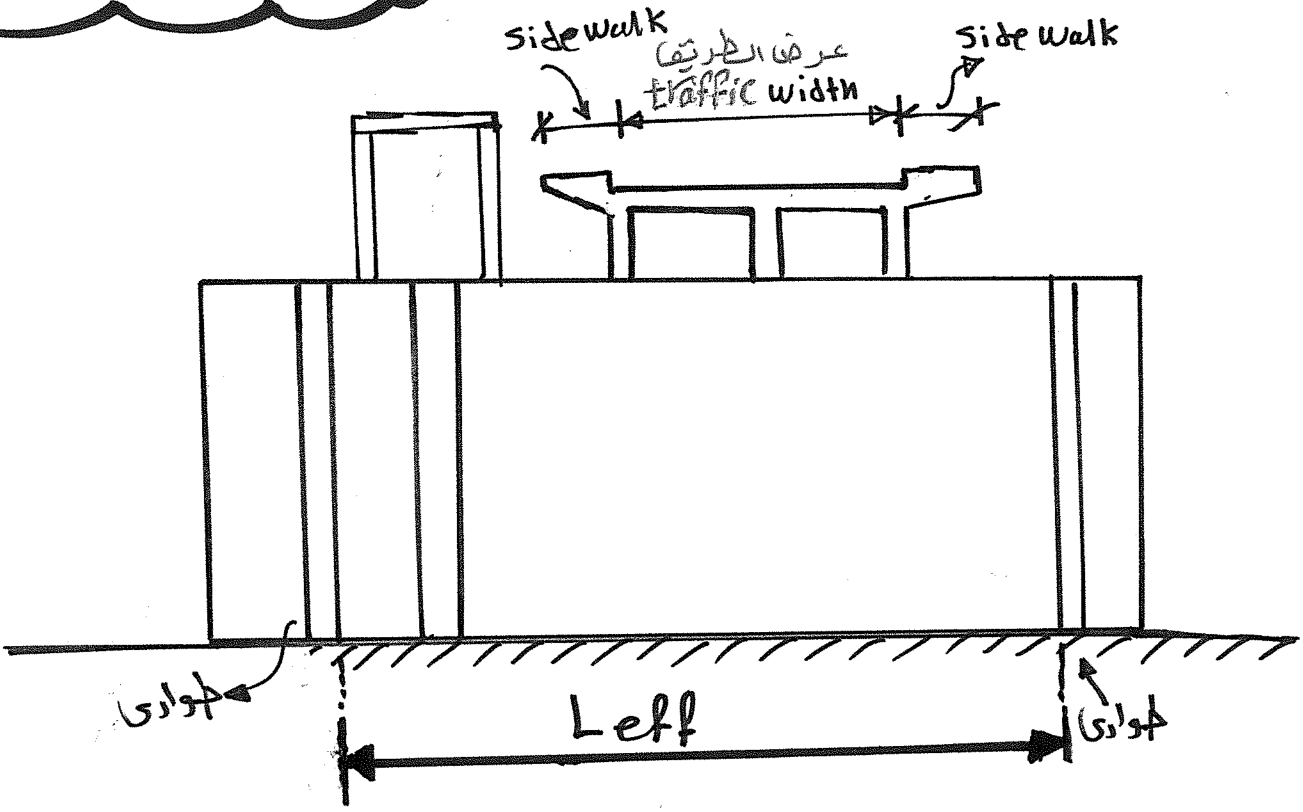
For single gate



* يتم حساب L_{eff} على حسب نوع المادة (R.C or P.c) من الهيكل ويتم مقارنتها بـ $L_{eff\,Max}$ ويتم اخذ Min من الاثنين .

$L_{eff\,Max}$ → من الطوارى الى main

For Double gate

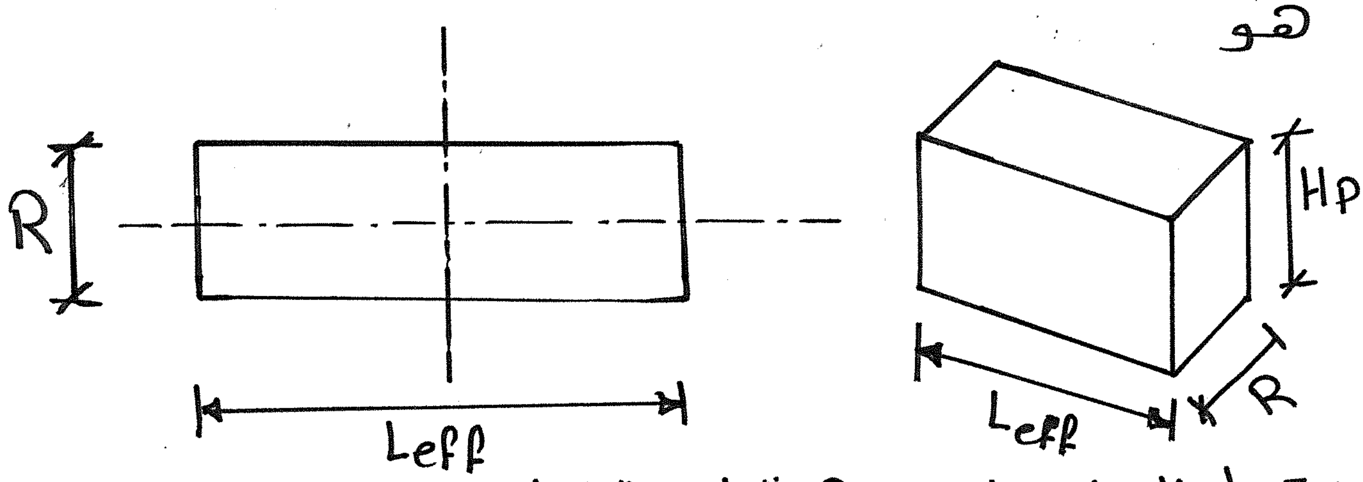


Leff → من الطوارى إلى الطوارى
في Double gate

الآن بعد تحديد Leff اصبح معانا كل الابعاد لل Pier

وبالتالى يكونا قطاع الـ Pier الذى سندرسة ونحسب الاحمال علية

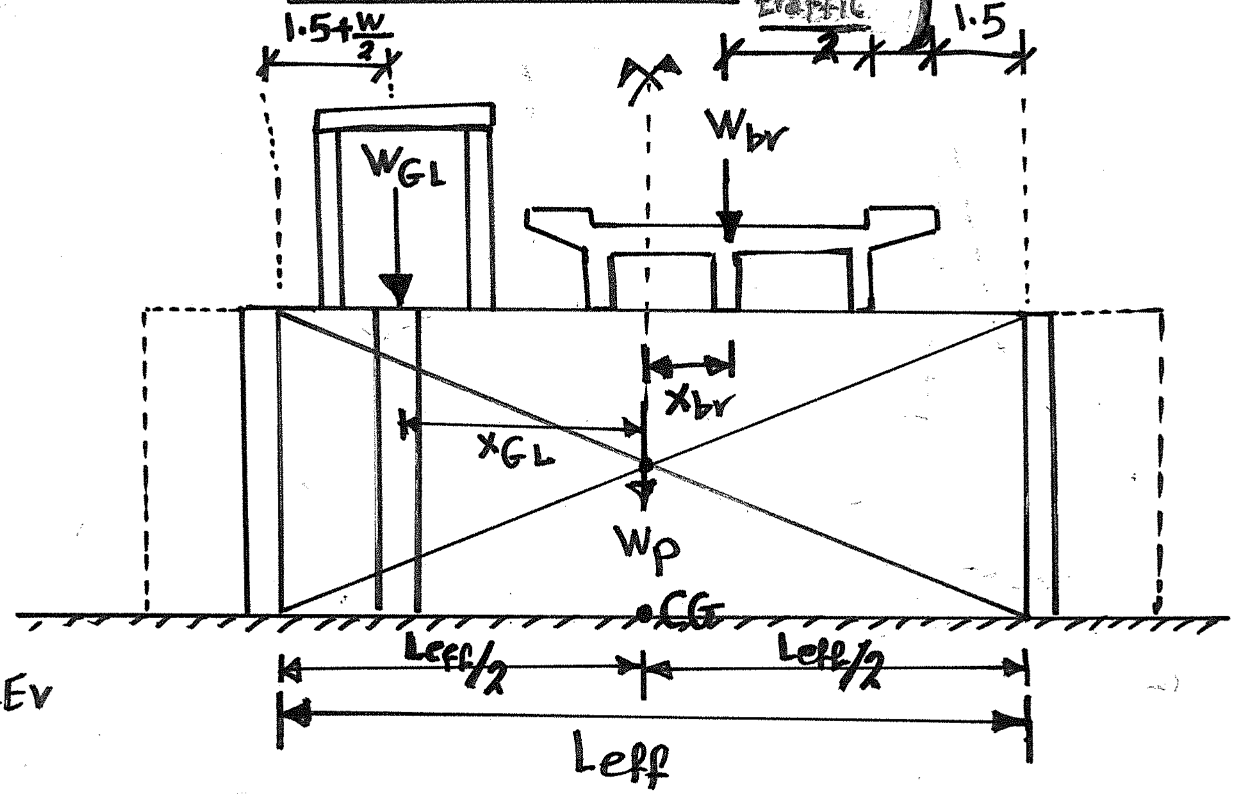
هو



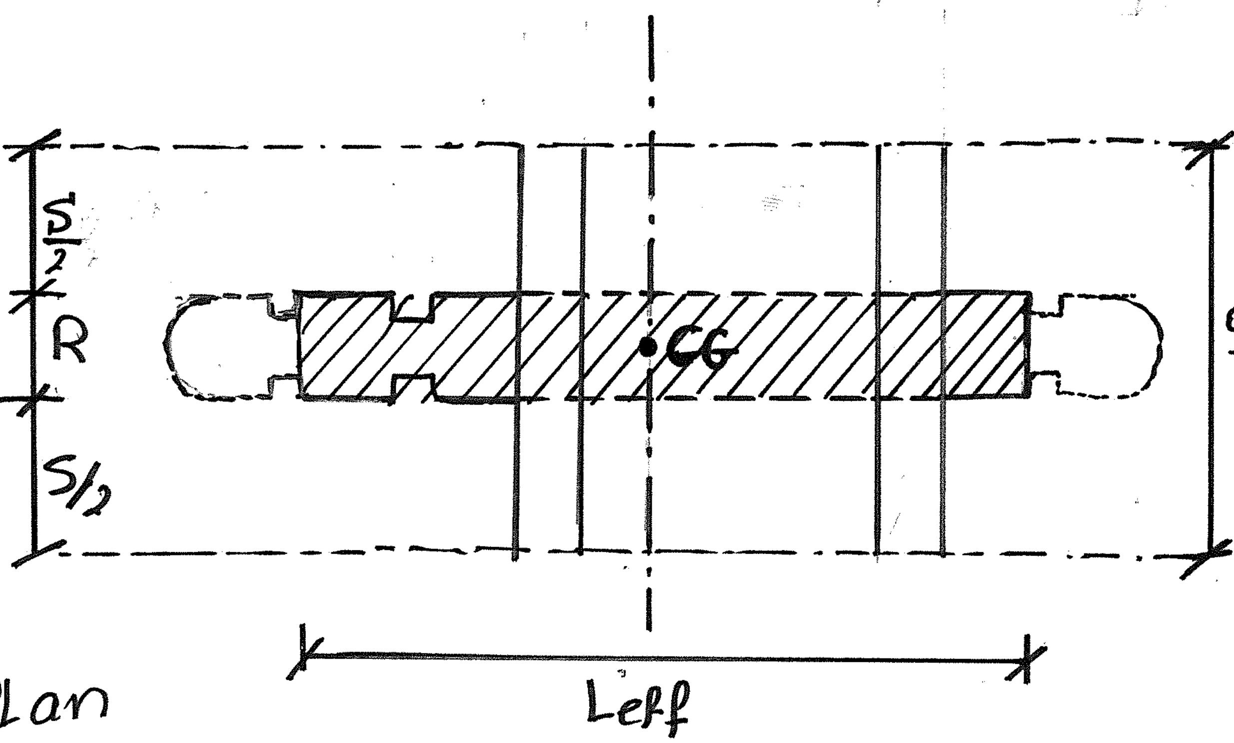
* بعد ايجاد الـ Dimension نتم ايجاد الاحمال.

Loads

* Dead Loads :-



ELEv



Plan

وتتكون الـ D.L من 3 احمال رئيسية :-

1- W_p → وزن الـ Pier

2- W_{br} → وزن الكوبري

3- W_{GL} → رد الفعل من عمودين الـ Gate lifting structure

ملحوظة

W_{GL} ← تكون في حالة الـ (Double gate) فقط

1- W_p :-

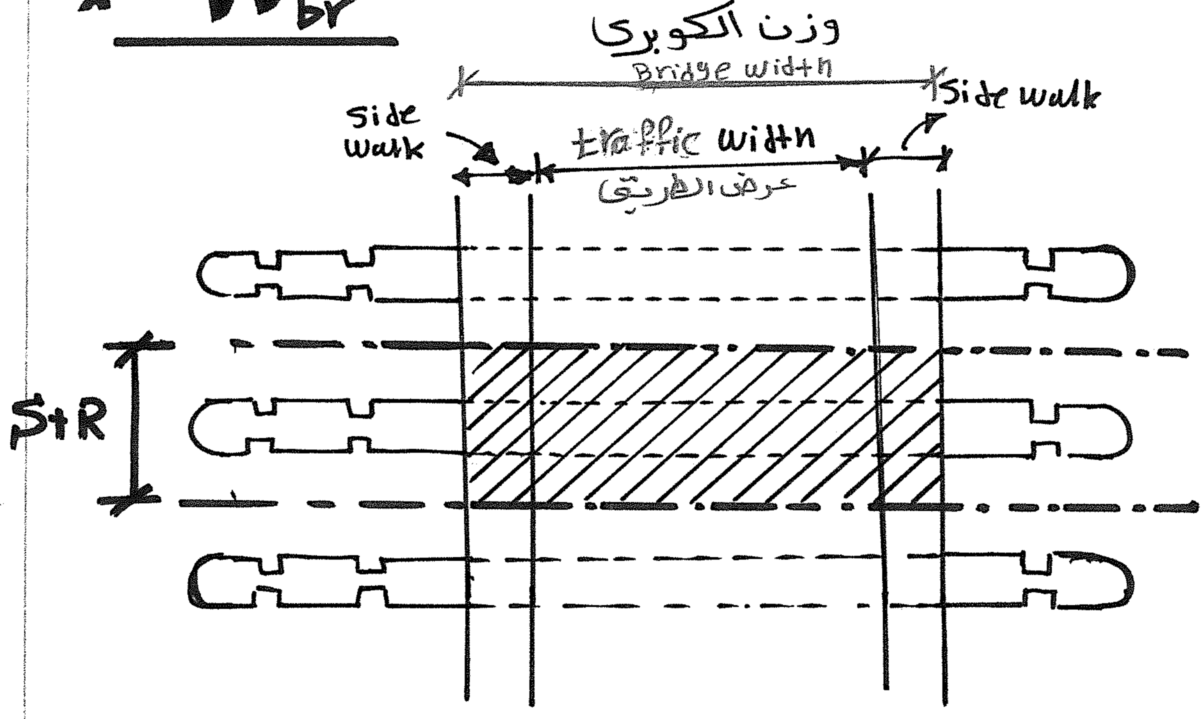
$$W_p = R * L_{eff} * H_p * \gamma_c$$

γ_c → For Rc → $\gamma_{RC} = 2.5\ t/m^3$

For Pc → $\gamma_{P.C} = 2.2\ t/m^3$

وتؤثر W_p في الـ CG للـ Pier اى منتصف L_{eff}

2- W_{br}



$$W_{br} = g_{DL} * (\text{traffic width} + 2\ \text{side walk}) * (S+R)$$

(Bridge width = traffic width + 2 side walk)

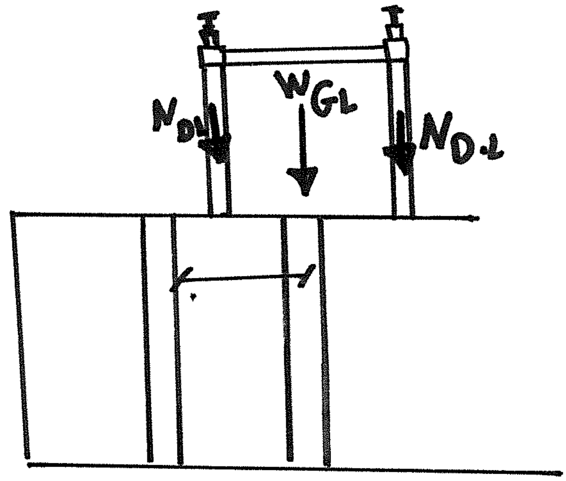
$\therefore$ g_{DL} = … t/m^2 given

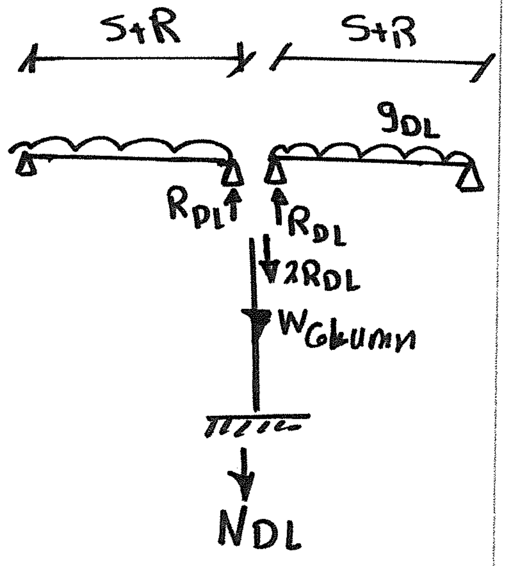
if not given take $g_{D.L} = 1.2\ t/m^2$ (1.1 → 1.3)

* وتؤثر W_{br} على مسافة X_{br} من CG

$$X_{br} = \frac{L_{eff}}{2} - 1.5 - \text{side walk} - \frac{\text{traffic width}}{2}$$

3- W_{GL} :-





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

$\therefore W_{col} = b * c * H_c * \gamma_{RC}$

$\therefore N_{D.L} = W_{col} + 2R_{DL}$ → من تصميم الـ Column

$\therefore W_{GL} = 2 * N_{DL}$

وتؤثر على مسافة X_{GL} من CG

$$X_{GL} = \frac{L_{eff}}{2} - \left(1.5 + \frac{W}{2}\right) = \text{..} \, m$$

* Live Loads

* تتكون أحمال L.L من 3 أحمال رئيسية.

1- Live Load on bridge.

2- Live Load From Water Pressure.

3- Live Load From gate lifting structure. نهمل

← يتم اهمال هذا الحمل لأنه يقلل العزم الناتج

* Cases of Loading

يوجد حالتين

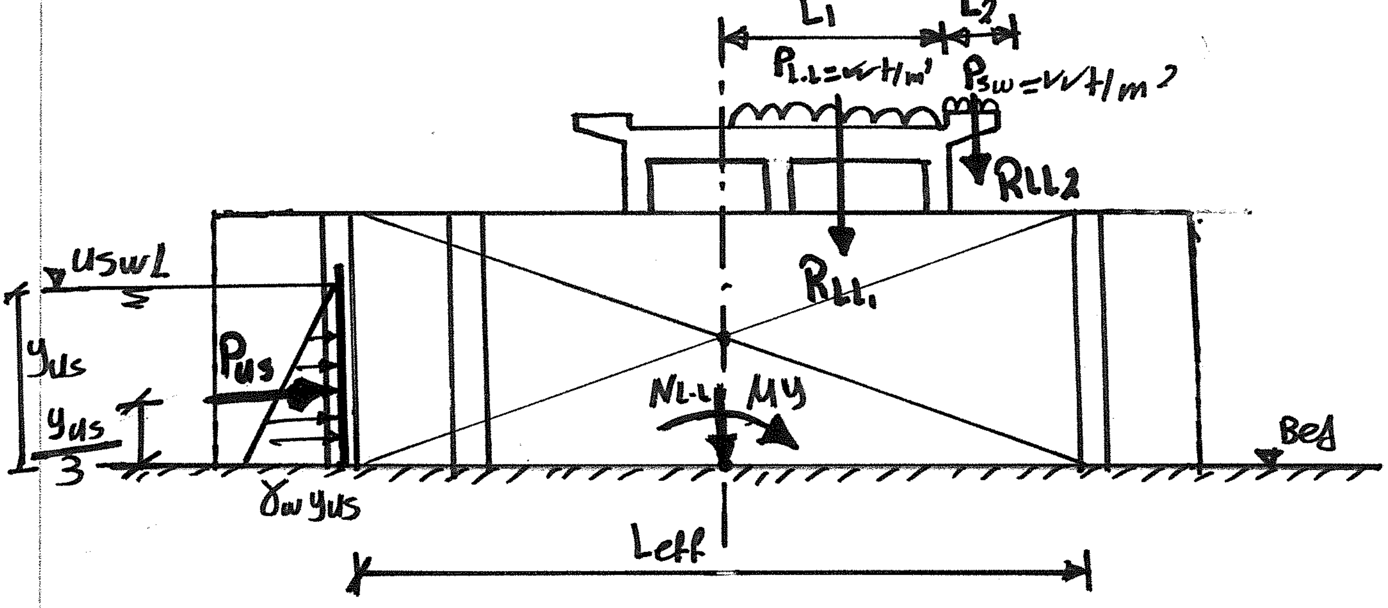
1- Case of Single moment (Dry Ds)

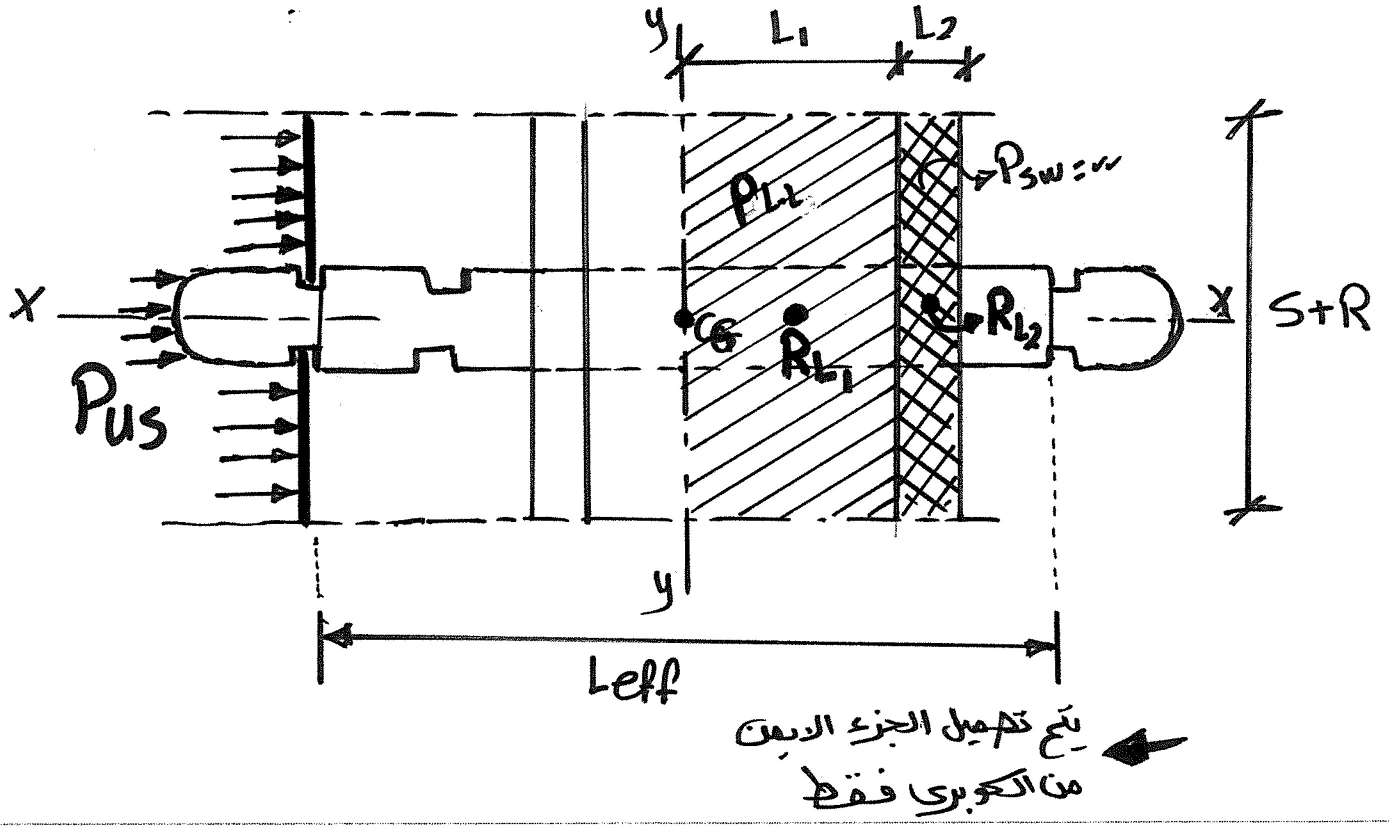
تعطى (N, My)

2- Case of Double moment (N, Mx, My) تعطى

* Case of single moment OR Dry Ds

• لايجاد اقصى My من L.L يتم تحميل جزء من الكوبري وليس الكوبري كله واعتبار الماء في Us فقط و (dry Ds) كما في الرسم





(assume) $P_{LL} = (1 \rightarrow 1.5)\ t/m^2$

$P_{LL_{SW}} = (0.4 \rightarrow 0.5)\ t/m^2$

if not given

لو غير معطى

$\therefore L_2 =$ Side walk width

$\therefore L_1 = \frac{L_{eff}}{2} - L_2 - 1.5$

$\therefore P_{US} = \frac{1}{2} \gamma_w y_{US}^2 * (S+R)$

$\therefore R_{LL_1} = P_{LL} * (L_1) * (S+R)$

$\therefore R_{LL_2} = P_{LL_{SW}} * L_2 * (S+R)$

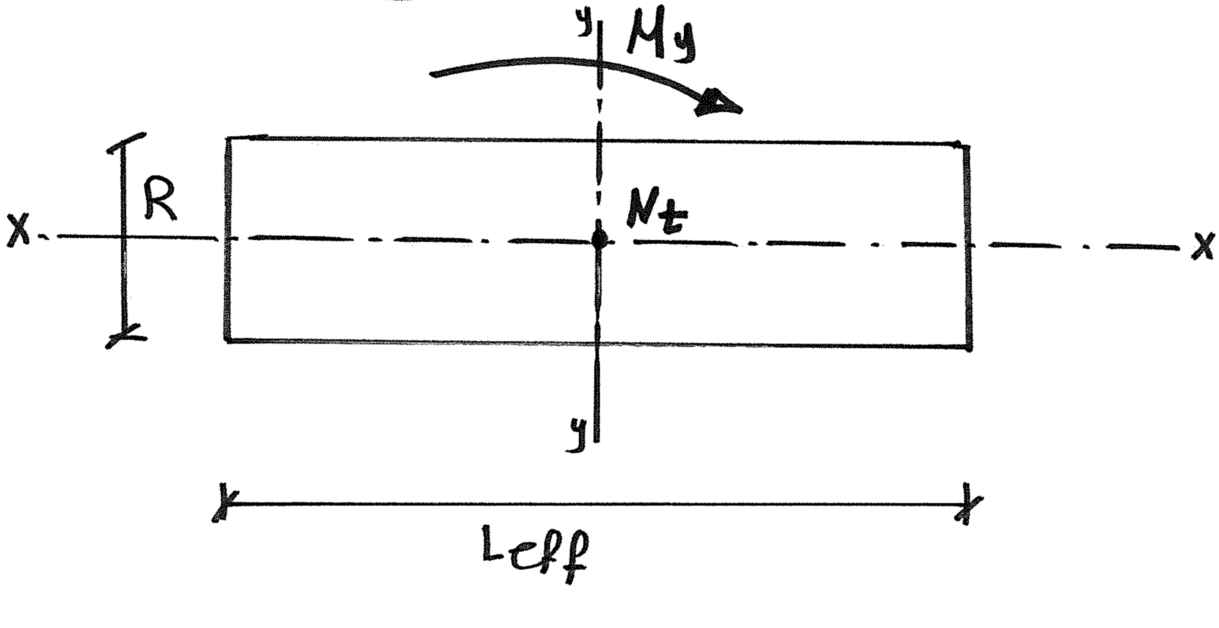
* Straining action From Live Load

$$N_{L.L} = R_{LL_1} + R_{LL_2}$$

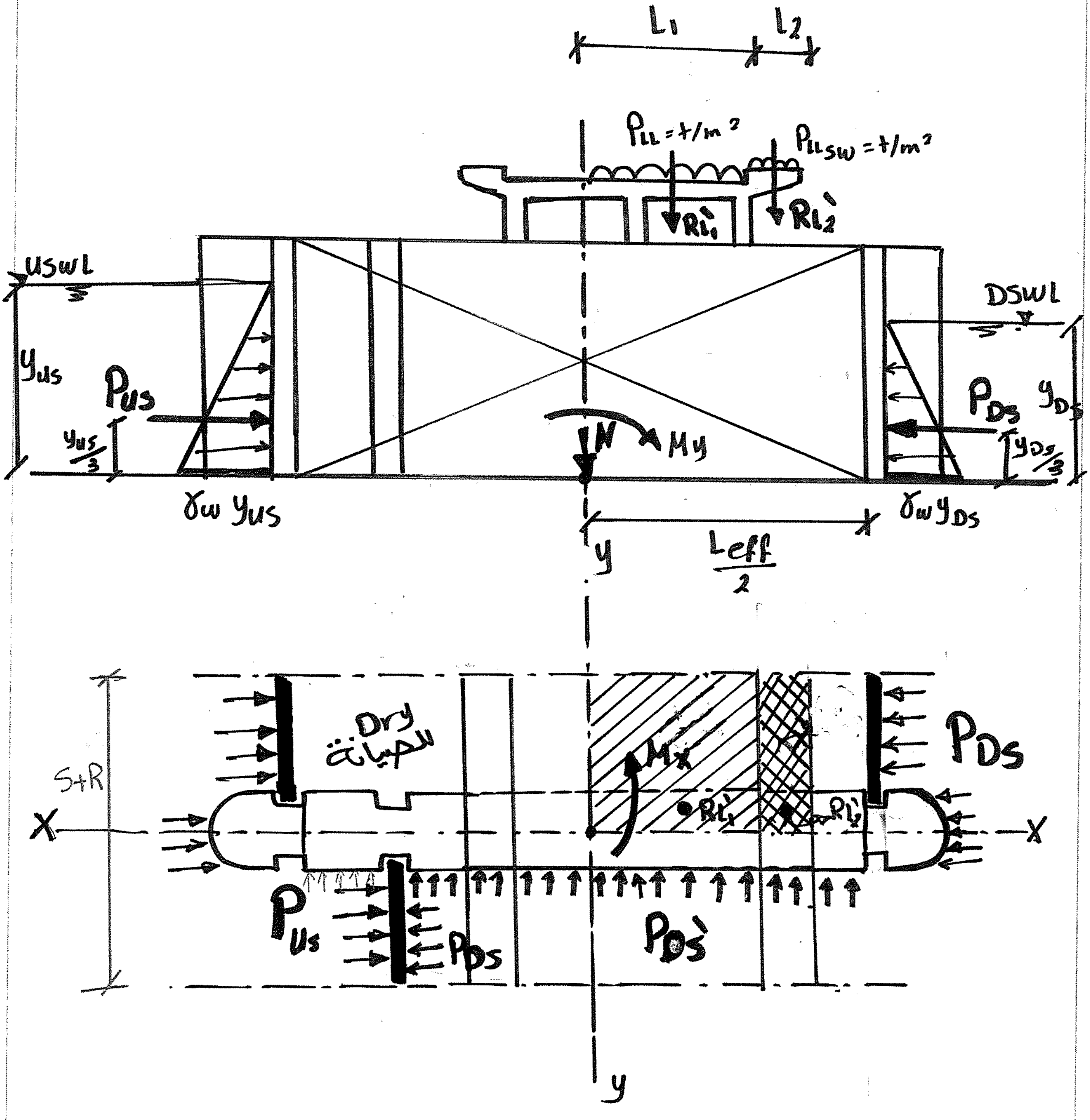
$$My_{LL} = R_{LL_1} * \frac{L_1}{2} + R_{LL_2}\left(L_1 + \frac{L_2}{2}\right) + P_{us} * \frac{y_{us}}{3}$$

$$\therefore N_t = N_{D.L} + N_{L.L}$$

$$\therefore M_y = M^y_{DL} + M^y_{L.L}$$



* Case of Double moment (N, Mx, My)



$\rightarrow L_2$ = side walk width

$\rightarrow L_1 = \frac{L_{eff}}{2} - L_2 - 1.5$

$\rightarrow P_{US} = \frac{1}{2} * \gamma_w * y_{US}^2 * (S+R)$

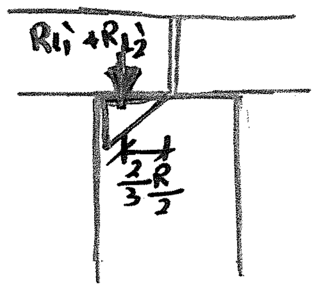
$\rightarrow P_{DS} = \frac{1}{2} * \gamma_w * y_{DS}^2 * (S+R)$

$\rightarrow P_{DS}' = \frac{1}{2} * \gamma_w * y_{DS}^2 * (L_{eff})$

$\rightarrow R_{L_1}' = P_{LL} * L_1 * \left(\frac{S+R}{2}\right)$

$\rightarrow R_{L_2}' = P_{LLsw} * L_2 * \left(\frac{S+R}{2}\right)$

Straining action From live Load



$$N_{LL} = R_{L_1}' + R_{L_2}'$$

$$M_{x_{LL}} = (R_{L_1}' + R_{L_2}') * \left(\frac{2}{3}\frac{R}{2}\right) + P_{DS}' * \left(\frac{y_{DS}}{3}\right)$$

$$M_{y_{LL}} = \left(R_{L_1}' * \frac{L_1}{2}\right) + \left(R_{L_2}' * \left(L_1 + \frac{L_2}{2}\right)\right) + P_{US}\left(\frac{y_{US}}{3}\right) - P_{DS}\left(\frac{y_{DS}}{3}\right)$$

$$\therefore N_t = N_{DL} + N_{LL}$$

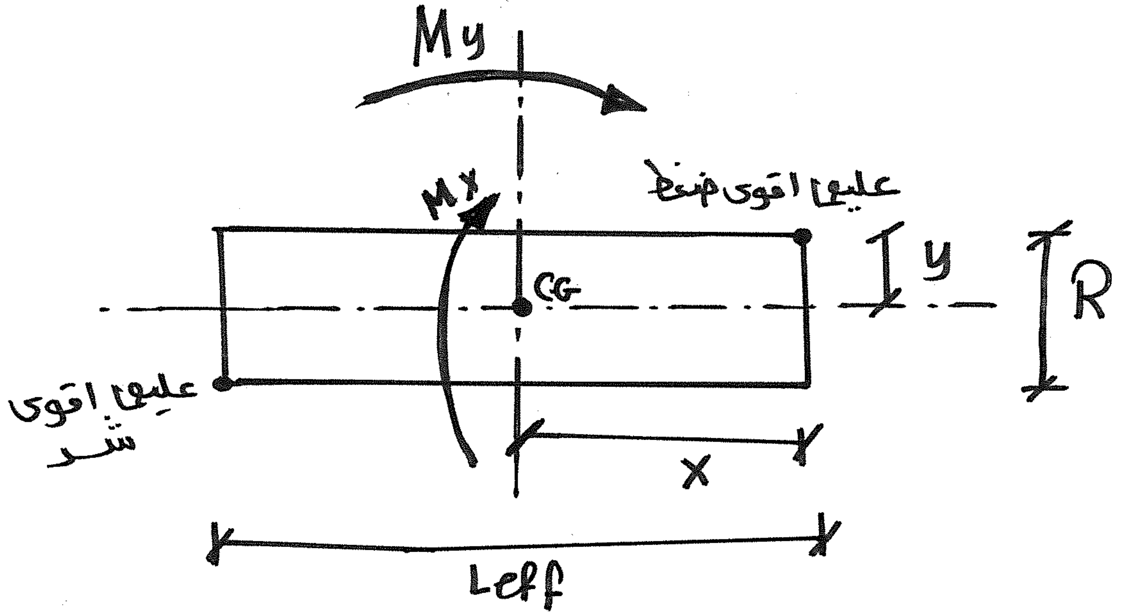
$$M_{x_t} = M_{xLL}$$

$$M_{y_t} = M_{yDL} + M_{yLL}$$

Design of PC

لو بجمعم الـ Pier من الخرسانة العادية P.C

يتم عمل cheek على الاجهادات



$$F_{\frac{1}{2}} = \frac{-N}{A} \pm \frac{M_x}{I_x} * y \pm \frac{M_y}{I_y} * x$$

$\therefore A = L_{eff} * R$

$I_x = \frac{L_{eff} * R^3}{12}$ ، $I_y = \frac{R * L_{eff}^3}{12}$

$x = \frac{L_{eff}}{2}$ ، $y = \frac{R}{2}$

$\therefore f_1 \not> 50 \ kg/cm^2 =$

f_2 No tension

Design of RC

يتم ايجاد e

$$e_x = \frac{M_x}{N}$$

- → Small eccentricity $e < \frac{R}{2}$
- → Large eccentricity $e > \frac{R}{2}$

if Small → Use min A_s

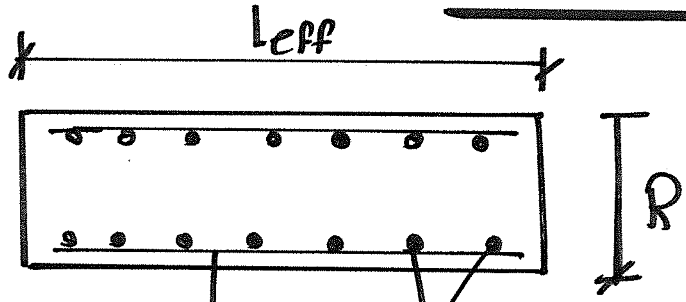
وردح صمم

Large → $A_s = \frac{M_x}{k_2 d}$

لا يقل عن $6\phi16$

مهمة

* تفاصيل التسليح



$A_s' = 0.3 A_s$

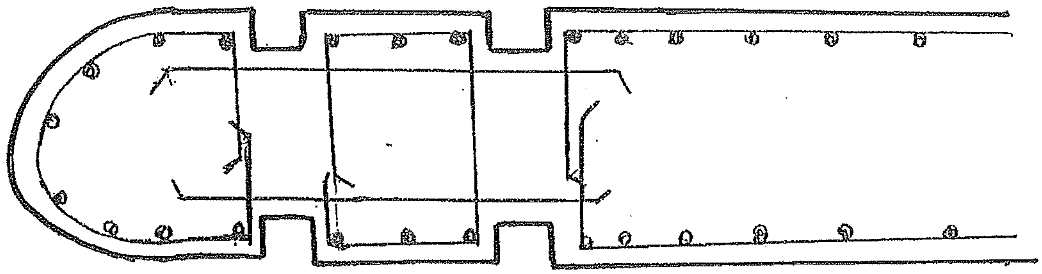
$A_s = $ Ku

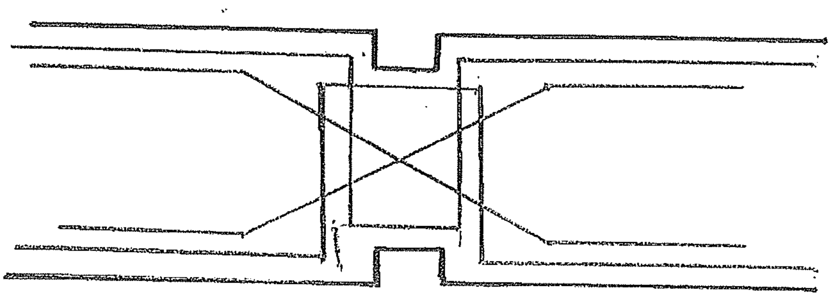
$A_s' \nless 5\phi12/m'$

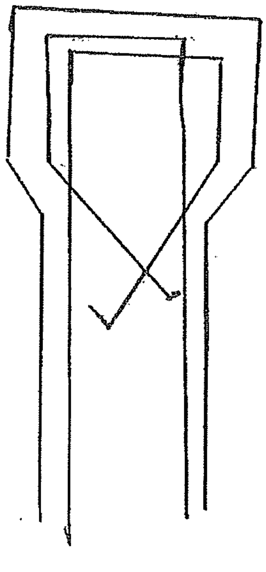
$A_s \nless 5\phi16/m'$

$$A_{s\,min} = \frac{0.25}{100}(L_{eff} * R)$$

(مهمة)







تفاصيل حديد
ال Column

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:

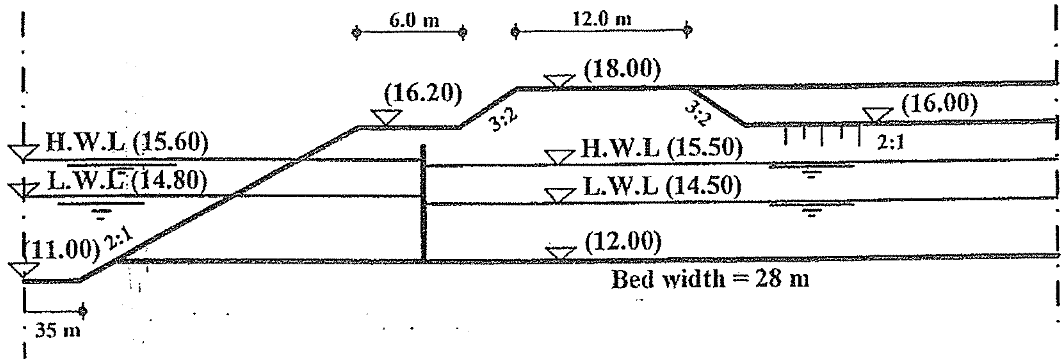
- The regulator consists of *four* vents of 6.0 m span for each,
- The maximum allowable discharge through the main canal is 4.5 million m^3/d,
- The bridge width over the regulator is 15.0 m and it has two sidewalks of 1.50 m width for each,
- The equivalent D.L of the bridge, L.L on the traffic lanes, 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



← تكملة مثال الملزمة السابقة

* البوابة (Double gate) تم تحديدها

$S = 6\ m$

$y_{DS} = 3.5\ m$

$y_{US} = 3.5 + 0.1 = 3.6\ m$

* Design of Rc Pier :-

(given) → Bridge width = 15 m

Side walk = 1.5 m

$g_{D.L} \rightarrow$ Bridge $= 2\ t/m^2$

$P_{LL} \rightarrow 1\ t/m^2$

$P_{LL_{sw}} \rightarrow 0.4\ t/m^2$

∴ traffic width = Bridge width − 2 side walk

traffic $= 15 - 2 * 1.5 = 12\ m$

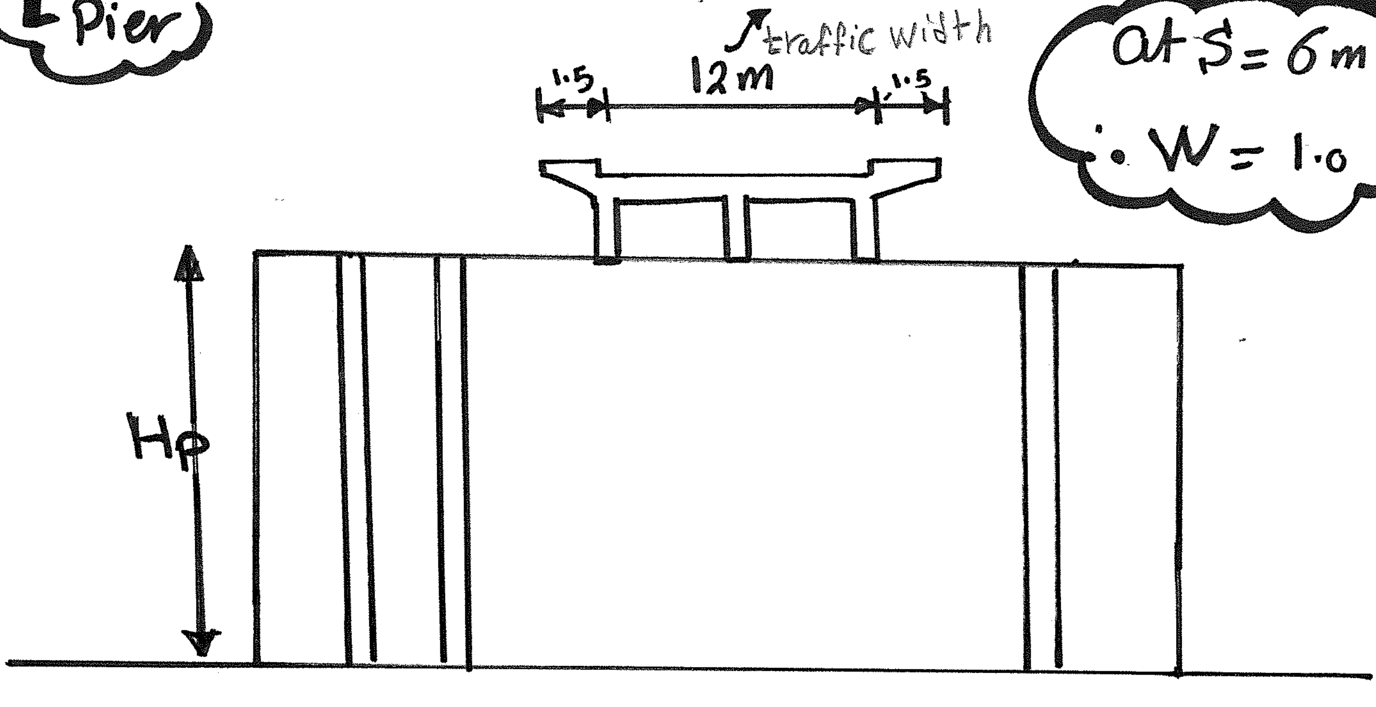
Dimension

(R)

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

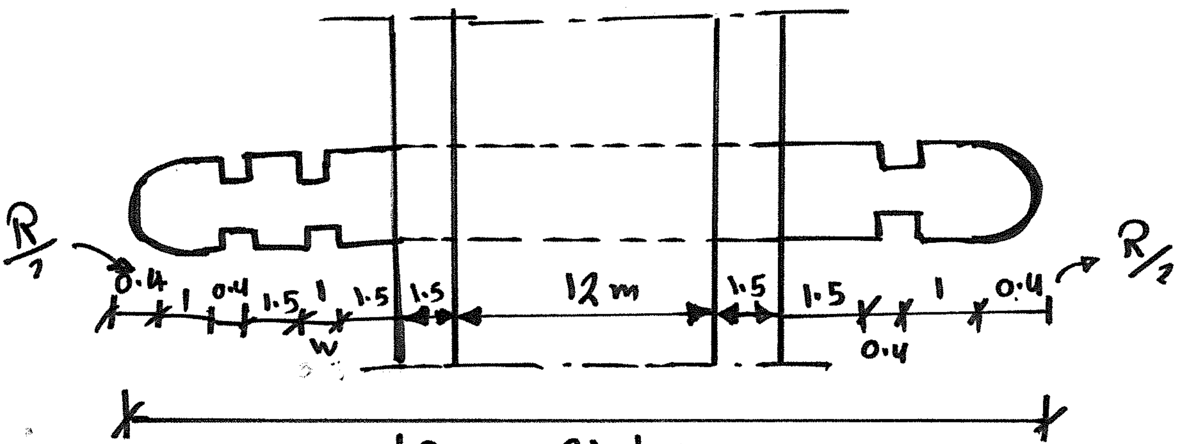
$$R = 0.8 \text{ m}$$

L_{pier}



at $S = 6$ m

$\therefore W = 1.0$



Hp

▼ Pier level = ▼ USWL + 0.5 = 15.6 + 0.5 = (16.1)

▼ Pier level = ▼ Berm level = (16.2)

▼ Pier level = Road level − 1 = (18.0) − 1
= (17)

∴ Pier level = Max (16.1, 16.2, 17) = (17.00)

$$H_p = \underset{pier}{17} - \underset{bed}{12} = 5\,m$$

Leff

(Double gate) البوابة

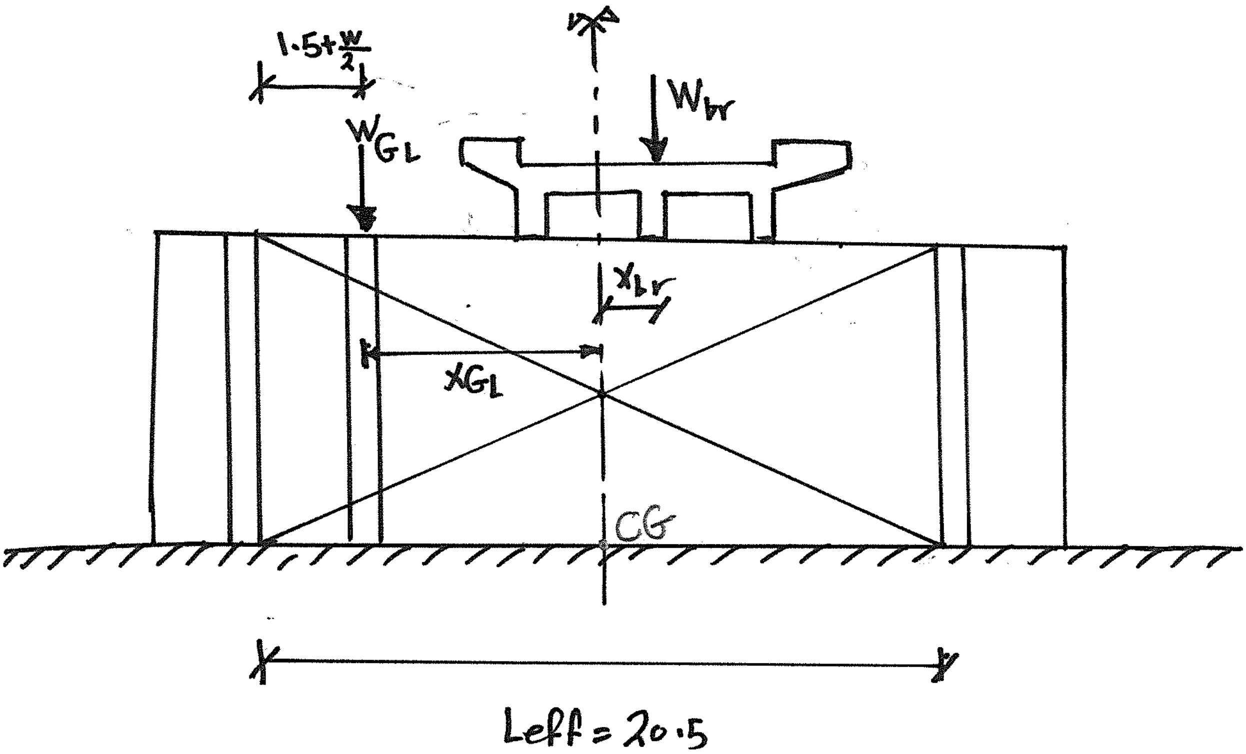
Leff → مقاس من بوابة الطوارئ إلى بوابة الطوارئ

$$L_{eff} = 12 + 2\ \text{side walk}\ (1.5) + 1.5 + 1 + 1.5 + 1.5$$

$$L_{eff} = 20.5\ m$$

Loads

* Dead Load:-



* $W_P = \gamma_{Rc} (R * H_P * L_{eff}) = (0.8 * 5 * 20.5) * 2.5 = 205$ ton

* $W_{br} = g_{D.L} * (\text{traffic width} + 2\,\text{sidewalk}) * (S + R)$

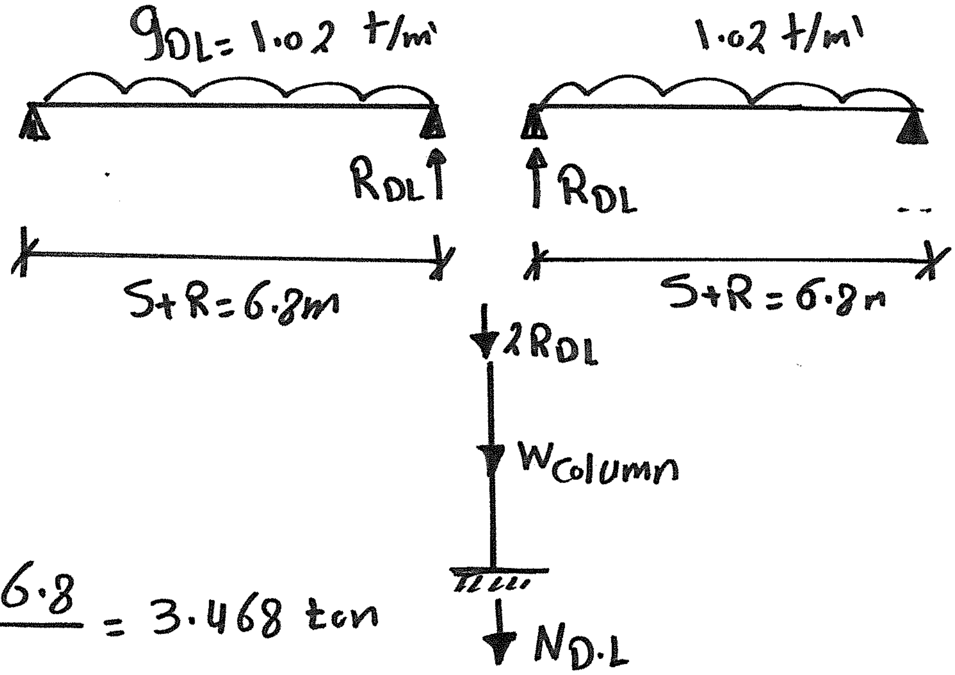
$= 2 * (12 + 2*1.5) * (6.8) = 204$ ton

given ↵

$X_{br} = \frac{L_{eff}}{2} - 1.5 - \frac{\text{traffic}}{2} - \text{sidewalk}$

$= \frac{20.5}{2} - 1.5 - \frac{12}{2} - 1.5 = 1.25$ m

W_{GL}



$$R_{DL} = \frac{1.02 * 6.8}{2} = 3.468 \text{ ton}$$

$$W_{column} = (b * t * H_c)\, \gamma_{RC} = (0.45 * 0.5 * 2.55)\, 2.5 = 1.434 \text{ ton}$$

$$N_{DL} = 2 R_{DL} + W_{column} = 2 * 3.468 + 1.434 = 8.37 \text{ ton}$$

$$W_{GL} = 2 N_{DL}$$

$$W_{GL} = 2 * 8.37 = 16.74 \text{ ton}$$

$$X_{GL} = \frac{L_{eff}}{2} - \left(1.5 + \frac{W}{2}\right)$$

$$X_{GL} = \frac{20.5}{2} - \left(1.5 + \frac{1}{2}\right) = 8.25 \text{ m}$$

Dead Load Straining action

$$N_{DL} = W_P + W_{br} + W_{GL}$$

$$= 205 + 204 + 16.74 = 425.74 \text{ ton}$$

$$My_{DL} = W_{br} * X_{br} - W_{GL} * X_{GL}$$

$$= 204 * 1.25 - (16.74) * 8.25$$

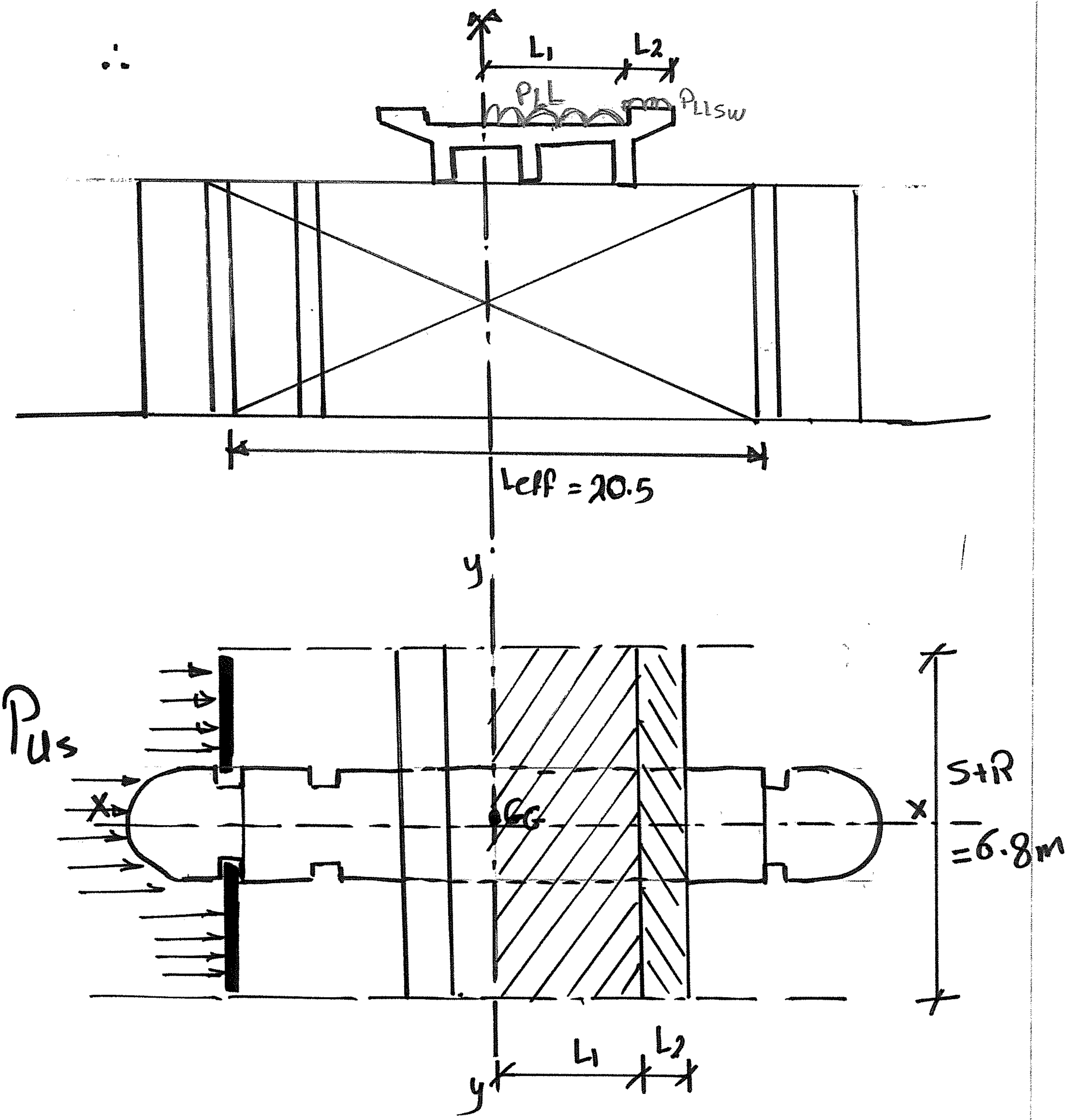
$$= 116.895 \text{ t.m}$$

$$N_{DL} = 425.74 \text{ ton}$$

$$My_{DL} = 116.895 \text{ t.m}$$

Live Load

* Case of single moment



$\therefore P_{LL} = 1 \ t/m^2$ given

$P_{LLSW} = 0.4 \ t/m^2$ given

L_2 = Side walk width = 1.5 m given

$L_1 = \frac{L_{eff}}{2} - 1.5 - L_2 = \frac{20.5}{2} - 1.5 - 1.5 = 7.25 \ m$

$\therefore R_{L_1} = P_{LL} * L_1 * (S+R) = 1 * 7.25 * 6.8 = 49.3 \ ton$

$\therefore R_{L_2} = P_{LLSW} * L_2 * (S+R) = 0.4 * 1.5 * 6.8 = 4.08 \ ton$

$\therefore P_{US} = \frac{1}{2} \gamma_w \, y_{US}^2 \, (S+R) = \frac{1}{2} * 1 * 3.6^2 * 6.8 = 44.06 \ ton$

Straining action From live Load

$N_{LL} = R_{L_1} + R_{L_2} = 49.3 + 4.08 = 53.38 \ ton$

$M_{y_{LL}} = R_{L_1} * \frac{L_1}{2} + R_{L_2} * (L_1 + \frac{L_2}{2}) + P_{US} * \frac{y_{US}}{3}$

$= (49.3 * \frac{7.25}{2}) + 4.08 (7.25 + \frac{1.5}{2}) + 44.06 * \frac{3.6}{3}$

$M_{y_{L.L}} = 264.2 \ ton.m$

$\therefore N_{LL} = 53.38 \ ton \qquad M_{y_{LL}} = 264.2 \ t.m$

$$\therefore M_{ty} = M_{DL_y} + M_{LL_y}$$

$$= 116.895 + 264.2 = 381.11 \text{ t.m}$$

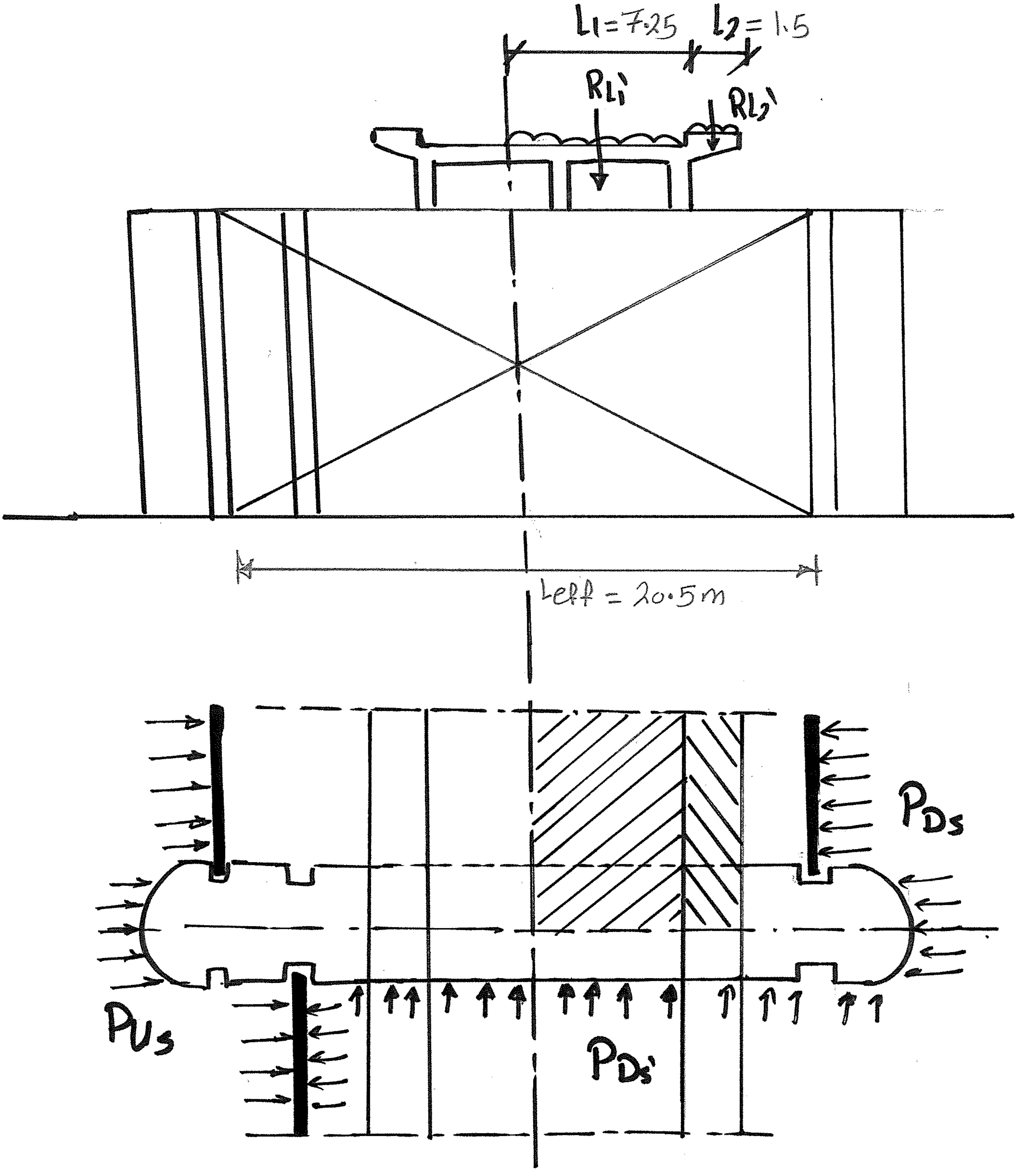
$$N_t = N_{D.L} + N_{L.L}$$

$$= 425.74 + 53.38 = 479.12 \text{ ton}$$

كدا معاك قطاع معرض لل M , N .

مهمة انت بقا

Case of Double moment



$\therefore L_2 = 1.5\ m$

$\therefore L_1 = 7.25\ m$

$\therefore P_{US} = \frac{1}{2} * y_{US}^2 (S+R)\,\gamma_w = \frac{1}{2} * 3.6^2 * 6.8 =$

$P_{US} = 44.064\ ton$

$\therefore P_{DS} = \frac{1}{2} * y_{DS}^2 (S+R) * \gamma_w = \frac{1}{2} * 3.5^2 * 6.8 =$

$P_{DS} = 41.65\ ton$

$\therefore P_{DS'} = \frac{1}{2} * \gamma_w\ y_{DS'}^2 (L_{eff}) = \frac{1}{2} * 3.5^2 * 20.5 =$

$P_{DS'} = 125.56\ ton$

$R_{L_1'} = P_{LL} * L_1 * \left(\frac{S+R}{2}\right) = 1 * 7.25 * \left(\frac{6.8}{2}\right)$

$R_{L_1'} = 24.65\ ton$

$R_{L_2'} = P_{LL_{SW}} * L_2 * \left(\frac{S+R}{2}\right) = 0.4 * 1.5 \left(\frac{6.8}{2}\right)$

$= 2.04\ ton$

$\therefore N_{LL} = R'_{L_1} + R'_{L_2} = 24.65 + 2.04 = 26.69$ ton

$$My_{LL} = R'_{L_1} * \frac{L_1}{2} + R'_{L_2} \left(L_1 + \frac{L_2}{2} \right) + P_{us} * \frac{y_{us}}{3} - P_{Ds} * \frac{y_{Ds}}{3}$$

$$My_{LL} = \left(24.65 * \frac{7.25}{2} \right) + 2.04 * \left(7.25 + \frac{1.5}{2} \right) + 44.06 * \frac{3.6}{3} - 41.65 * \frac{3.5}{3} = 109.95 \text{ t.m}$$

$$Mx_{LL} = \left(R'_{L_1} + R'_{L_2} \right) \left(\frac{2}{3} \frac{R}{2} \right) + P'_{Ds} \left(\frac{y_{Ds}}{3} \right)$$

$$= (24.65 + 2.04) \left(\frac{2}{3} * \frac{0.8}{2} \right) + 125.56 * \frac{3.5}{3}$$

$$Mx_{LL} = 153.6 \text{ t.m}$$

$N_t = N_{D.L} + N_{L.L} = 425.74 + 26.69 = 452.4$ ton

$Mx_t = M_{LLx} = 153.6$ t.m

$My_t = My_{D.L} + My_{LL} = 116.895 + 109.95 = 227$ t.m

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