$\boxed{4}$

First Year Civil Engineering

Theory OF Structures (1)

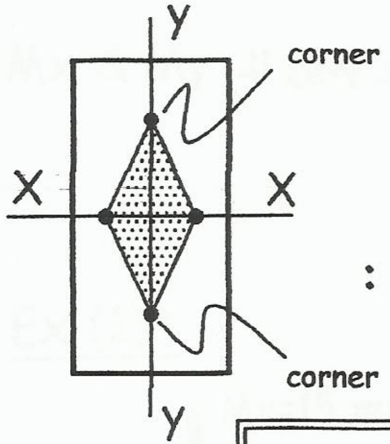
Chapter (8)

CORE METHOD

2009-2010

CORE METHOD

- هى طريقة تستخدم لعمل check على اجهادات ال Normal Stresses من الموضوع السابق



- ال Core هو مساحة وهمية داخل القطاع مكونة من من عدة corners
- سوف نستخدم مجموعة قوانين فى هذا الدرس و هى :

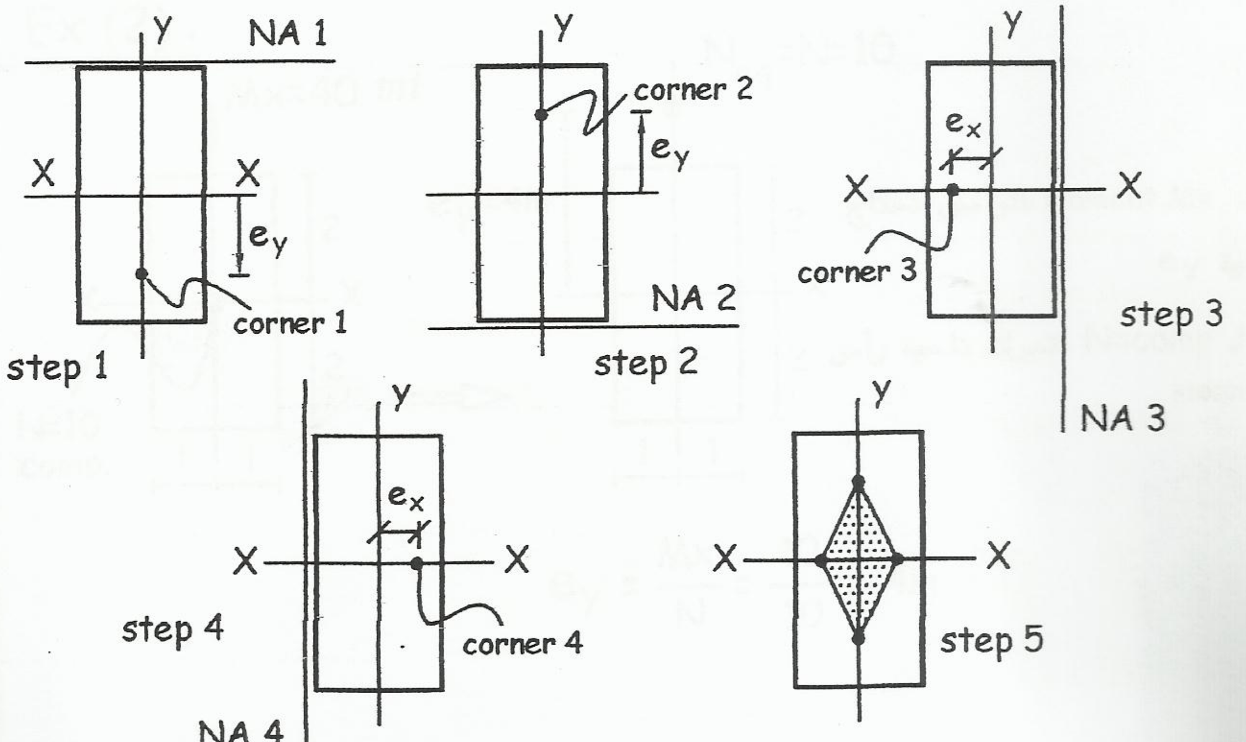
$$i_x^2 = \frac{I_x}{A} \qquad i_y^2 = \frac{I_y}{A} \qquad e_y = \frac{i_x^2}{y_{int}} \qquad e_x = \frac{i_y^2}{X_{int}}$$

- **خطوات الحل :**

1 - يتم حساب ال properties of area i_x^2 , i_y^2 , A , I_x , I_y

2 - يتم فرض مجموعة Neutral Axes (N.A) بحيث تمس القطاع

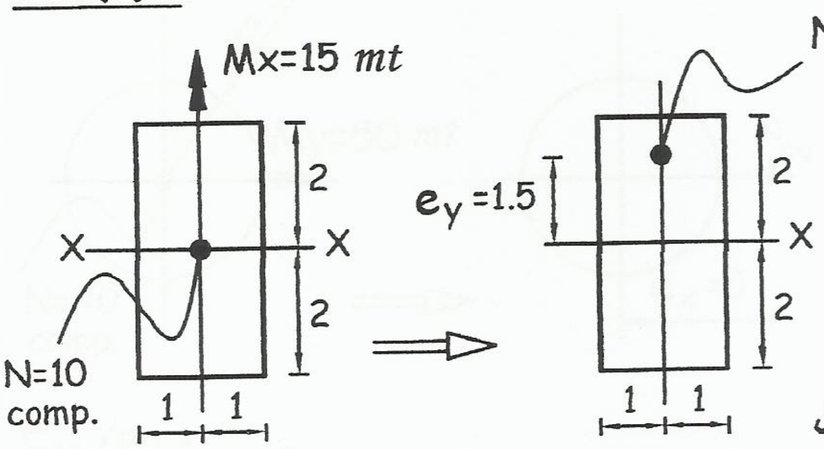
3 - عند فرض أى Neutral Axes (N.A) فانه يتواجد corner في الناحية المقابلة له على بعد فقى أو رأسى e_y , e_x بمعنى



• تابع خطوات الحل :

4 - بعد رسم الـ Core يتم تحديد مكان نقطة الـ N_{eq} equivlent normal و هى قوة لا تمر بالـ C.g و تساوى عدديا قيمة الـ N و تعتبر بديل للـ Mx & My مع ملاحظة توقيع الـ N_{eq} مع اتجاه الـ Mx & My

Ex (1) :



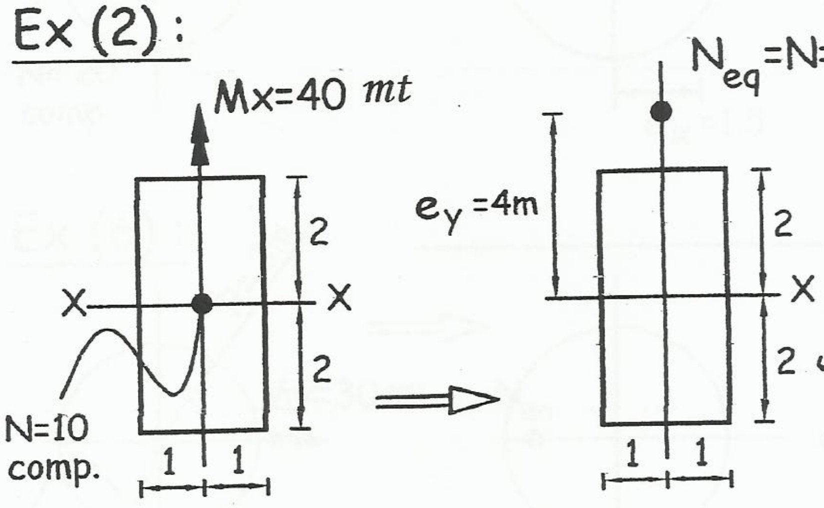
فى حالة الـ moment Mx الرأسى نحتاج مسافة رأسية e_y

اذا كان الـ N=comp نتحرك ناحية رأس الـ moment Mx

اذا كان الـ N=tension نتحرك ناحية ديل الـ moment Mx

$$e_y = \frac{Mx}{N} = \frac{15}{10} = 1.5m$$

Ex (2) :

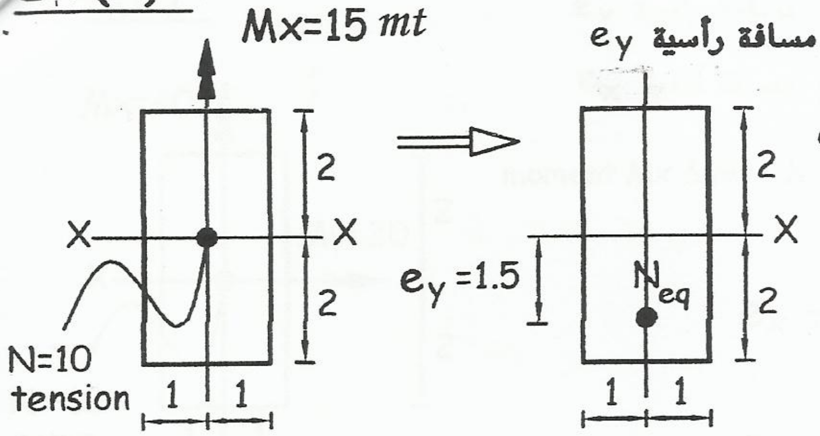


فى حالة الـ moment Mx الرأسى نحتاج مسافة رأسية e_y

نلاحظ أن الـ N=comp نتحرك ناحية رأس الـ moment Mx

$$e_y = \frac{Mx}{N} = \frac{40}{10} = 4m$$

Ex (3) :



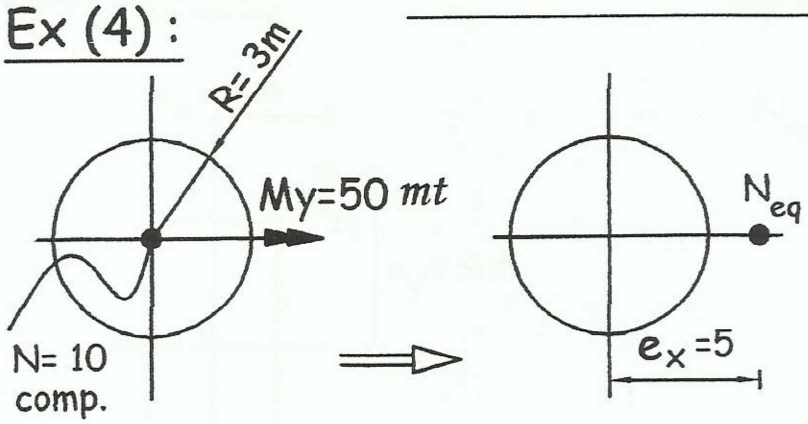
في حالة ال moment Mx الرأسى نحتاج مسافة رأسية e_y

اذا كان ال N=tension نتحرك ناحية ديل ال moment Mx

$$e_y = \frac{Mx}{N} = \frac{15}{10} = 1.5m$$

$$N_{eq} = N = 10 \ \text{tension}$$

Ex (4) :



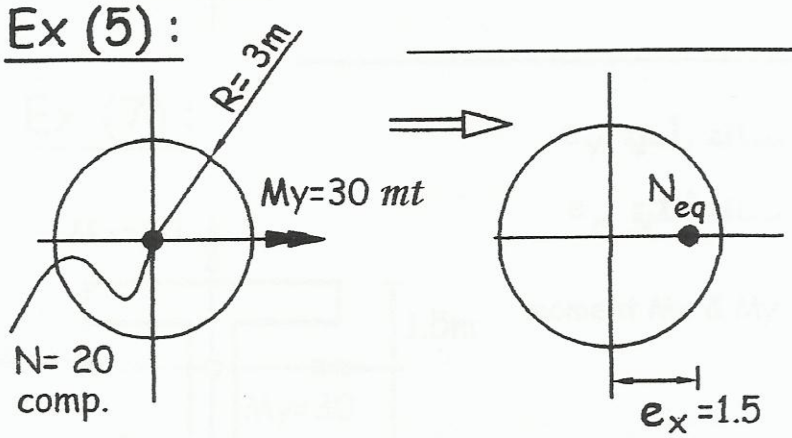
في حالة ال moment My الافقى نحتاج مسافة أفقية e_x

اذا كان ال N=comp نتحرك ناحية رأس ال moment My

$$e_x = \frac{My}{N} = \frac{50}{10} = 5 \ m$$

$$N_{eq} = N = 10 \ \text{comp.}$$

Ex (5) :



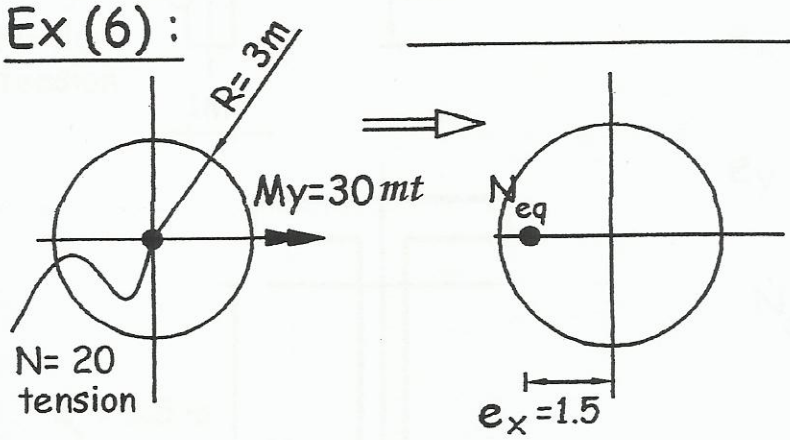
في حالة ال moment My الافقى نحتاج مسافة أفقية e_x

اذا كان ال N=comp نتحرك ناحية رأس ال moment My

$$e_x = \frac{My}{N} = \frac{30}{20} = 1.5 \ m$$

$$N_{eq} = N = 20 \ \text{comp.}$$

Ex (6) :



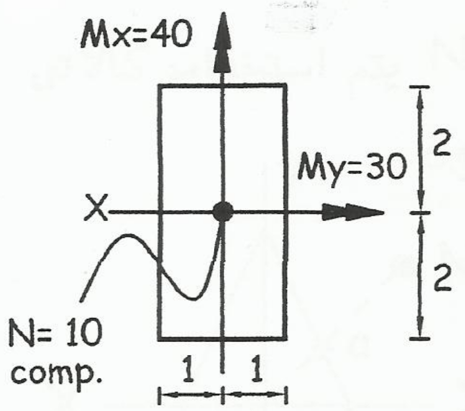
في حالة ال moment My الافقى نحتاج مسافة أفقية e_x

اذا كان ال N=tension نتحرك ناحية ديل ال moment Mx

$$e_x = \frac{My}{N} = \frac{30}{20} = 1.5 \ m$$

$$N_{eq} = N = 20 \ \text{tension}$$

Ex (6) :



فى حالة ال moment Mx الرأسى نحتاج مسافة رأسية e_y

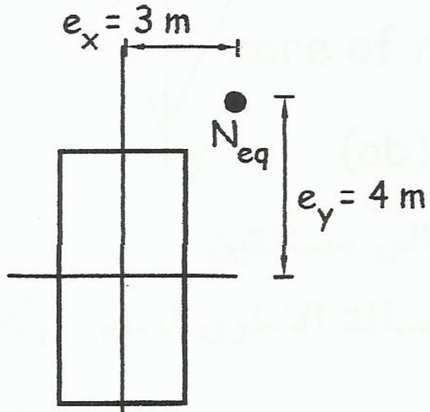
و فى حالة ال moment My الافقى نحتاج مسافة أفقية e_x

اذا كان ال N=comp تتحرك ناحية رأس ال moment Mx & My

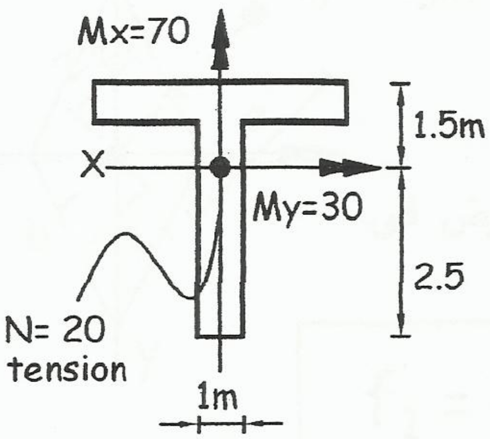
$$e_x = \frac{My}{N} = \frac{30}{10} = 3 \text{ m}$$

$$e_y = \frac{Mx}{N} = \frac{40}{10} = 4 \text{ m}$$

$$N_{eq} = N = 10 \text{ comp.}$$



Ex (7) :



فى حالة ال moment Mx الرأسى نحتاج مسافة رأسية e_y

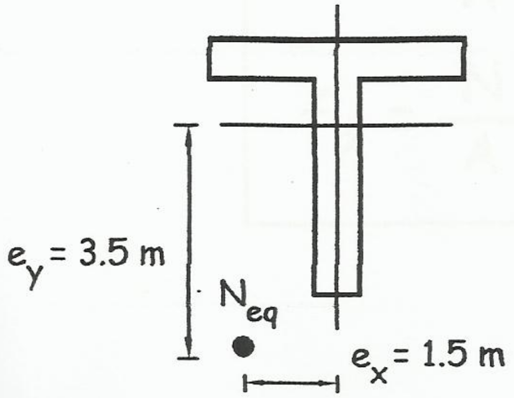
و فى حالة ال moment My الافقى نحتاج مسافة أفقية e_x

اذا كان ال N=tension تتحرك ناحية ديل ال moment Mx & My

$$e_x = \frac{My}{N} = \frac{30}{20} = 1.5 \text{ m}$$

$$e_y = \frac{Mx}{N} = \frac{70}{20} = 3.5 \text{ m}$$

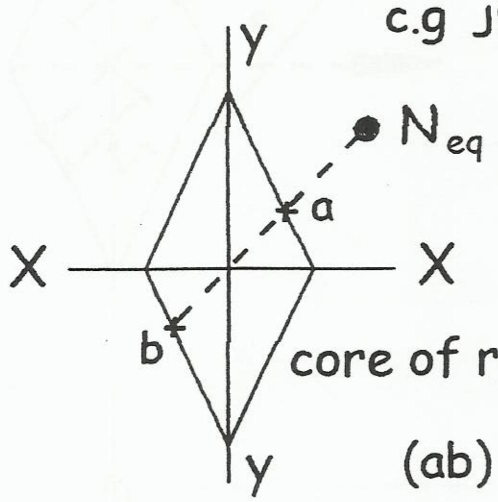
$$N_{eq} = N = 20 \text{ tension}$$



تابع خطوات الحل :

5 - بعد رسم الـ Core و تحديد مكان نقطة الـ N_{eq} يتم استخدامه كالاتى

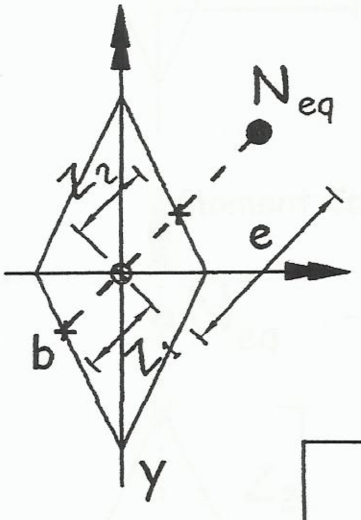
- نرسم خط من نقطة الـ N_{eq} حتى نقطة الـ c.g



- مسافة التقاطع مع الـ Core هى المسافة (ab)
- نقطة الـ c.g تقوم بتقسيم المسافة (ab) الى مسافتين

المسافة ناحية .Moment Comp تسمى Z_2 و المسافة الاخرى تسمى Z_1

- المسافة مباشرة من الـ N_{eq} حتى نقطة الـ c.g تسمى المسافة (e)



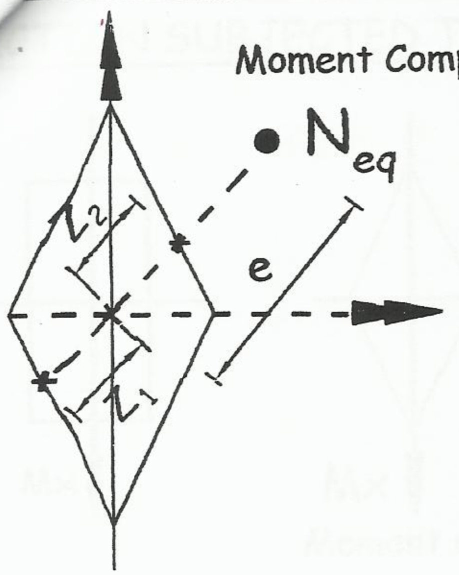
- يتم قياس المسافات (e) (Z_1) (Z_2) بالمسطرة

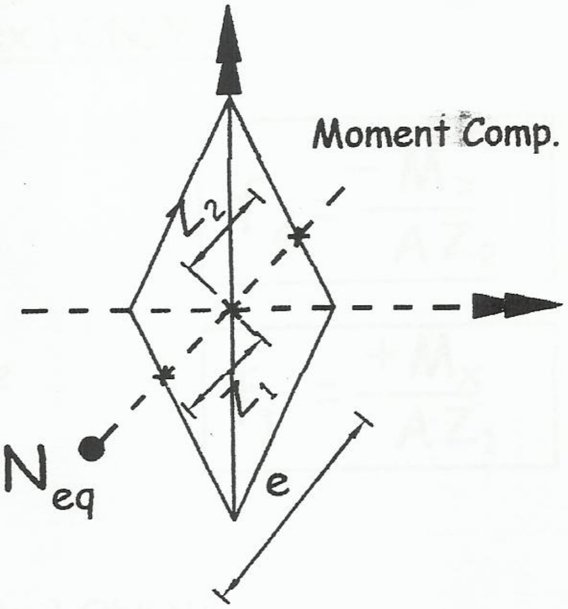
و عمل check stresses (f_1) (f_2) بالتعويض فى القوانين الاتية

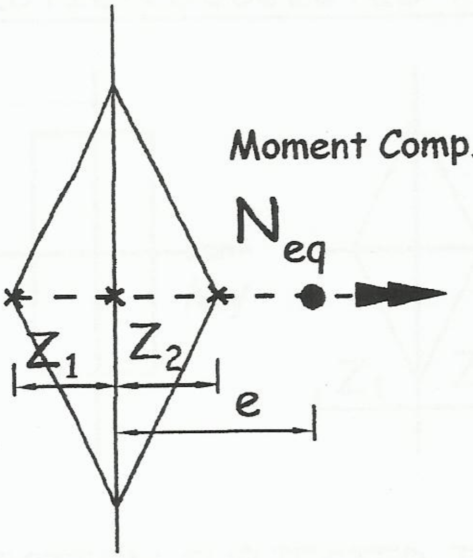
$$f_1 = \frac{N}{A}\left[\frac{Z_1 + e}{Z_1}\right]$$

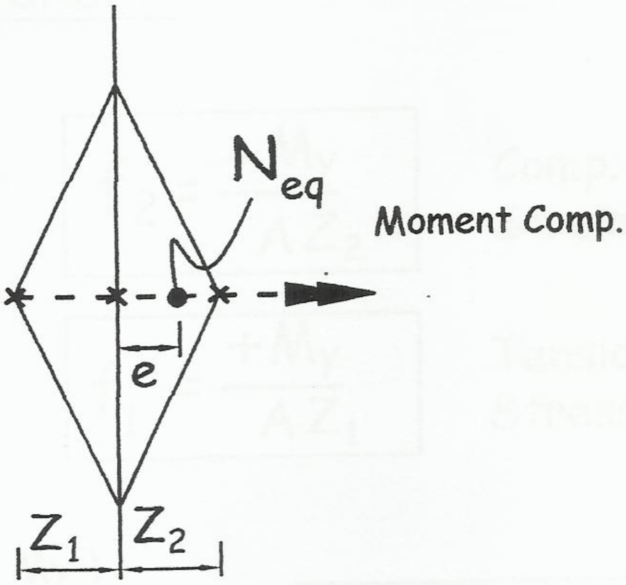
$$f_2 = \frac{N}{A}\left[\frac{Z_2 - e}{Z_2}\right]$$

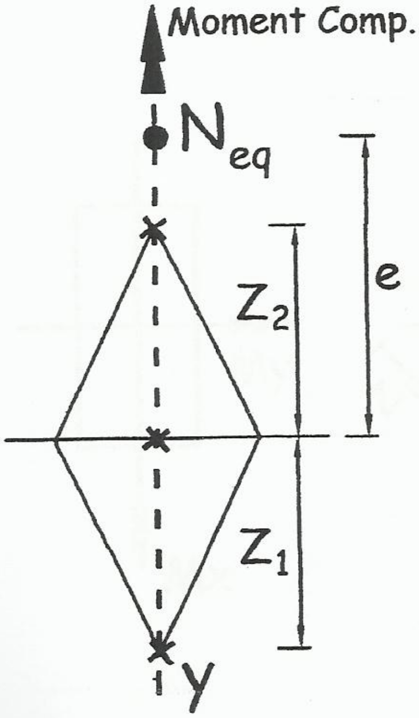
حفظ

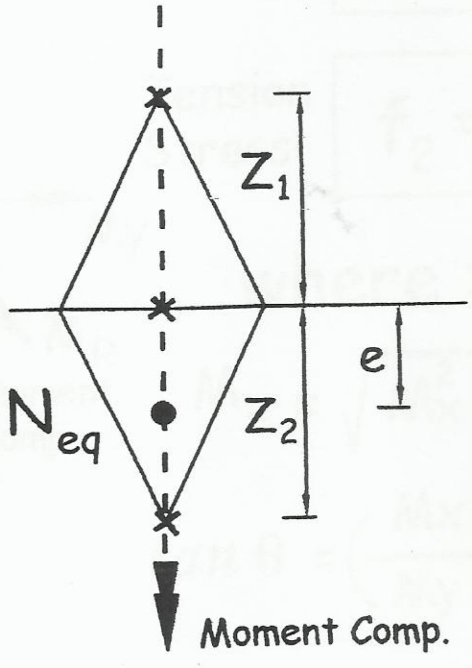

Moment Comp.
N_{eq}
Z_2
Z_1
e


Moment Comp.
Z_2
Z_1
N_{eq}
e

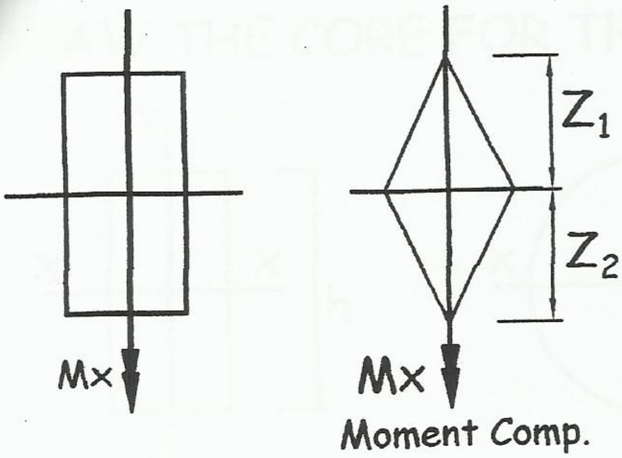

Moment Comp.
N_{eq}
Z_1
Z_2
e


N_{eq}
Moment Comp.
e
Z_1
Z_2


Moment Comp.
N_{eq}
e
Z_2
Z_1
y


Z_1
e
N_{eq}
Z_2
Moment Comp.

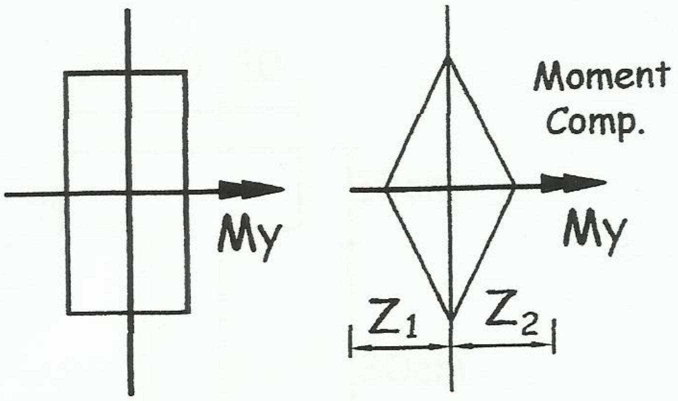
ECTION SUBJECTED TO (Mx) ONLY :



$$\boxed{f_2 = \frac{-M_x}{A Z_2}}$$ Comp. Stress

$$\boxed{f_1 = \frac{+M_x}{A Z_1}}$$ Tension Stress

SECTION SUBJECTED TO (My) ONLY :



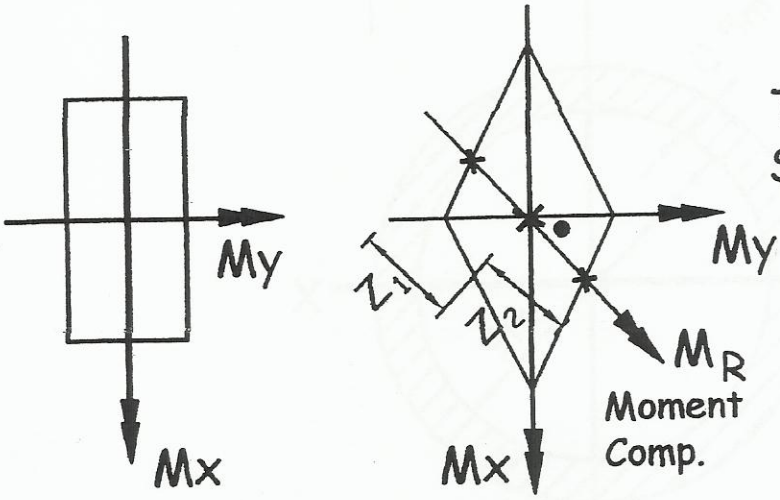
$$\boxed{f_2 = \frac{-M_y}{A Z_2}}$$ Comp. Stress

$$\boxed{f_1 = \frac{+M_y}{A Z_1}}$$ Tension Stress

SECTION SUBJECTED TO (Mx , My) :

Comp. Stress $$\boxed{f_1 = \frac{-M_R}{A Z_1}}$$

Tension Stress $$\boxed{f_2 = \frac{+M_R}{A Z_2}}$$



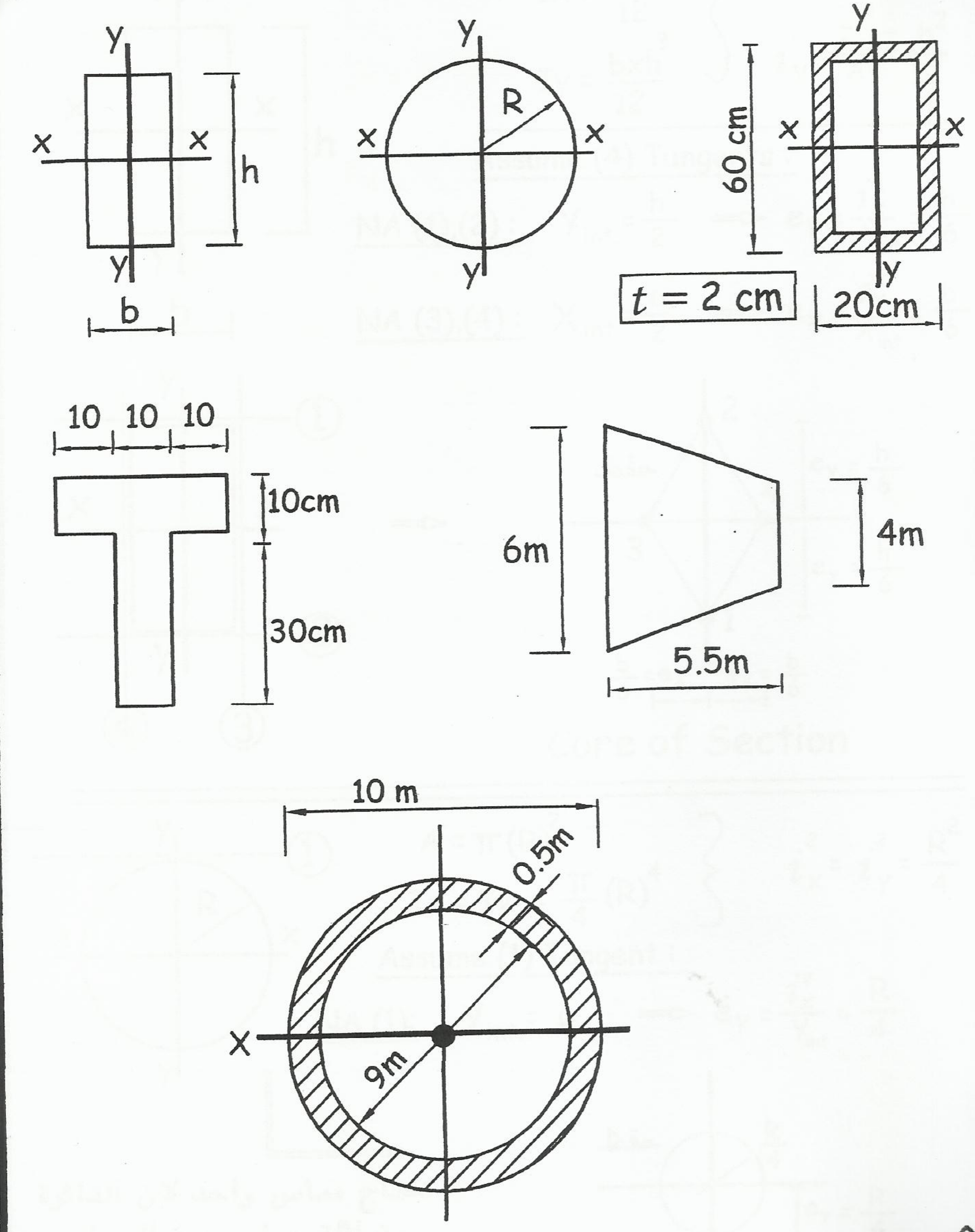
where :

$$M_R = \sqrt{M_x^2 + M_y^2}$$

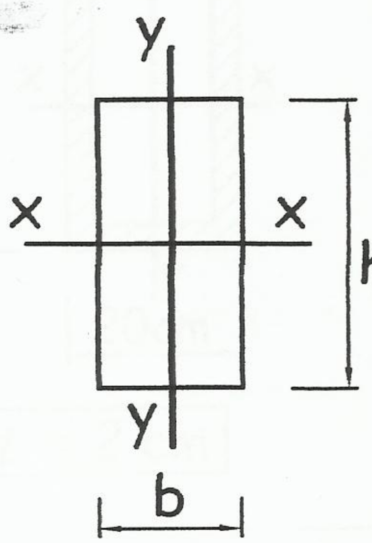
$$\tan\theta = \left(\frac{Mx}{My}\right)$$

PROBLEM(1):

DRAW THE CORE FOR THE SHOWN SECTIONS ?



SOLUTION :

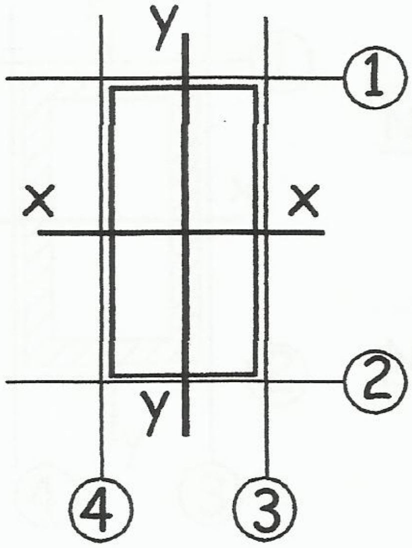


$$\left.\begin{aligned} A &= b \times h \\ I_x &= \frac{b \times h^3}{12} \\ I_y &= \frac{b \times h^3}{12} \end{aligned}\right\} \quad \begin{aligned} i_x^2 &= \frac{I_x}{A} = \frac{h^2}{12} \\ i_y^2 &= \frac{I}{A} = \frac{b^2}{12} \end{aligned}$$

Assume (4) Tangents :

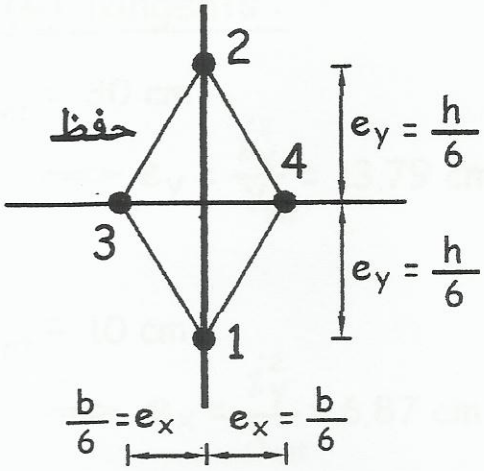
NA (1),(2) : $Y_{int.} = \frac{h}{2} \Longrightarrow e_y = \frac{i_x^2}{Y_{int}} = \frac{h}{6}$

NA (3),(4) : $X_{int.} = \frac{b}{2} \Longrightarrow e_x = \frac{i_y^2}{X_{int}} = \frac{b}{6}$

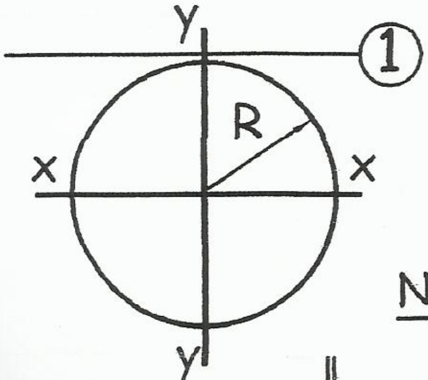


$\Longrightarrow$

حفظ



Core of Section



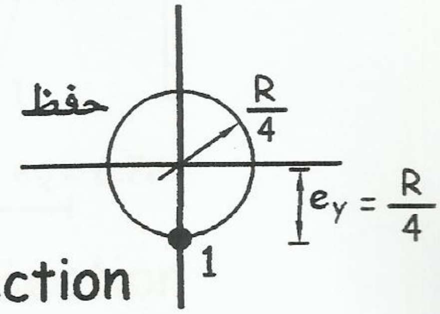
$$\left.\begin{aligned} A &= \pi (R)^2 \\ I_x = I_y &= \frac{\pi}{4} (R)^4 \end{aligned}\right\} \quad i_x^2 = i_y^2 = \frac{R^2}{4}$$

Assume (1) Tangent :

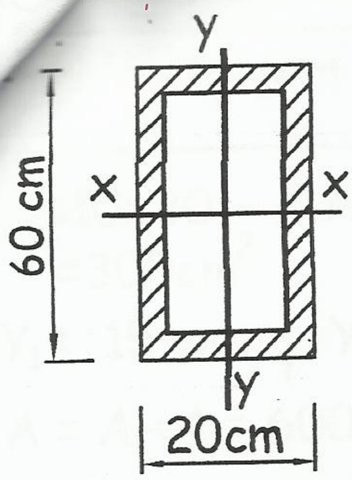
NA (1): $Y_{int.} = R \Longrightarrow e_y = \frac{i_x^2}{Y_{int}} = \frac{R}{4}$

نحتاج مماس واحد لان الدائرة
متماثلة حول جميع المحاور .

حفظ



Core of Section



$t = 2$ cm

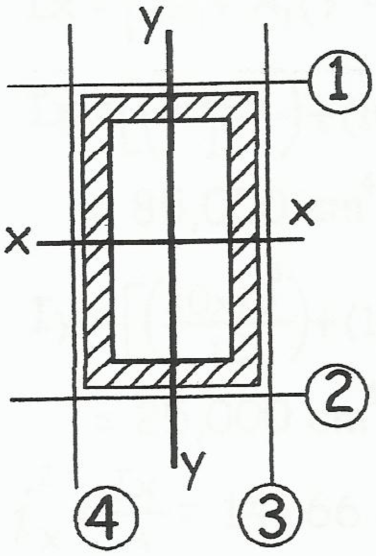
$$A = 20\times60 - 16\times56 = 304 \text{ cm}^2$$

$$Ix = \frac{20\times60^3}{12} - \frac{16\times56^3}{12} = 125\,845 \text{ cm}^4$$

$$Iy = \frac{60\times20^3}{12} - \frac{56\times16^3}{12} = 20\,885 \text{ cm}^4$$

$$i_x^2 = \frac{Ix}{A} = 413.96 \text{ cm}^2$$

$$i_y^2 = \frac{Iy}{A} = 68.7 \text{ cm}^2$$



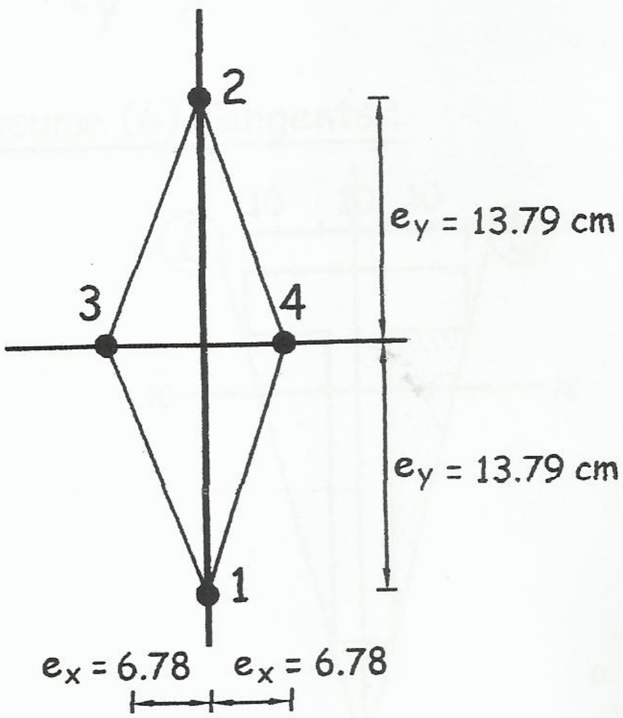
Assume (4) Tangents :

NA (1),(2) : $\quad Y_{int.} = 30$ cm

$$\Longrightarrow e_y = \frac{i_x^2}{Y_{int}} = 13.79 \text{ cm}$$

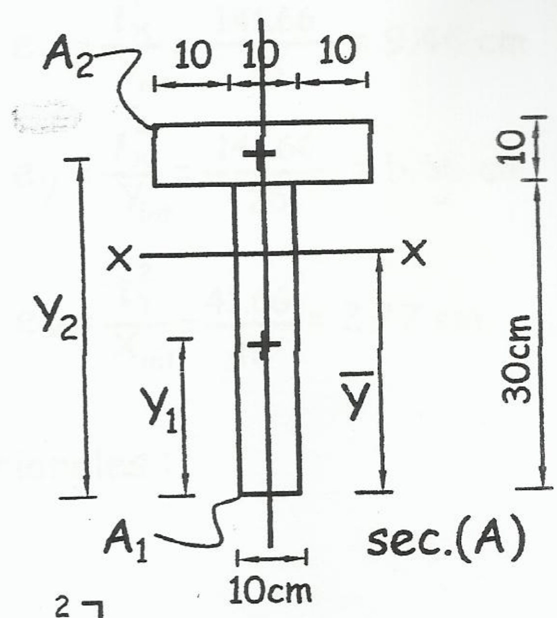
NA (3),(4) : $\quad X_{int.} = 10$ cm

$$\Longrightarrow e_x = \frac{i_y^2}{X_{int}} = 6.87 \text{ cm}$$



Core of Section

فى حالة عدم وجود محور(X) فاننا نحسـ
المسافة $\overline{Y}=?$



$A_1 = 10\times 30 = 300\,cm^2$	$A_2 = 10\times 30 = 300\,cm^2$
$Y_1 = 15\ cm$	$Y_2 = 35\ cm$

$$A = A_1 + A_2 = 600\ cm^2$$

$$\overline{Y} = \frac{\Sigma AY}{\Sigma A} = \frac{A_1 Y_1 + A_2 Y_2}{A_1 + A_2} = 25\ cm$$

$$Ix = \left[Ix_1 + A_1(\overline{Y} - Y_1)^2\right] + \left[Ix_2 + A_2(\overline{Y} - Y_2)^2\right]$$

$$Ix = \left[\left(\frac{10\times 30^3}{12}\right) + (10\times 30)(25-15)^2\right] + \left[\left(\frac{30\times 10^3}{12}\right) + (10\times 30)(25-35)^2\right]$$

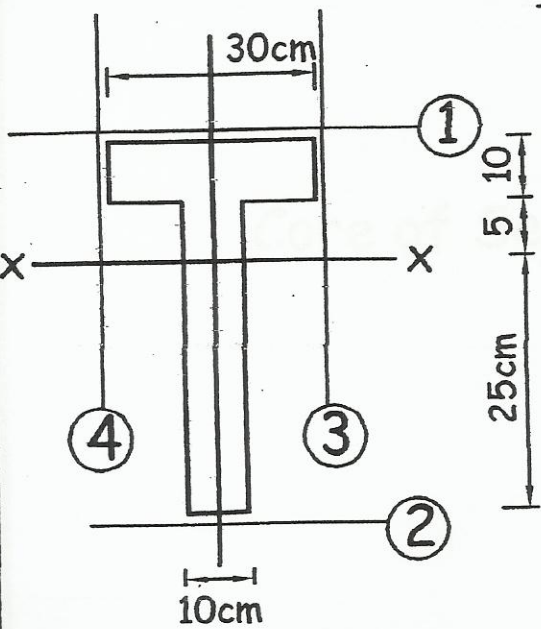
$$= 85{,}000\ cm^4$$

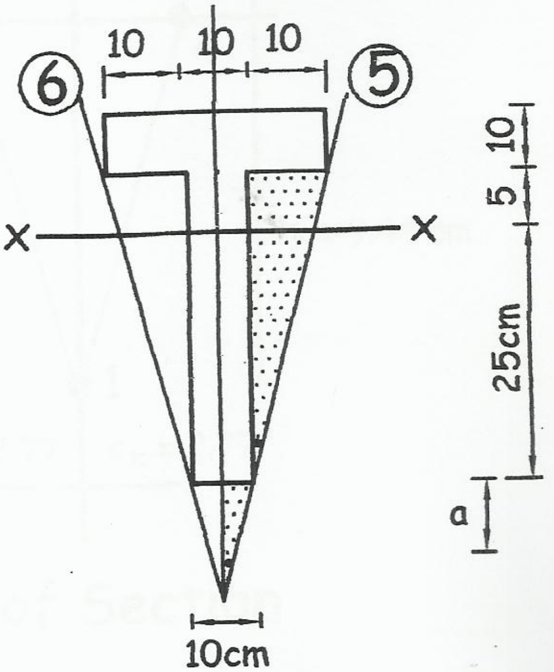
$$Iy = \left[\left(\frac{30\times 10^3}{12}\right) + (10\times 30)(0.0)^2\right] + \left[\left(\frac{10\times 30^3}{12}\right) + (10\times 30)(0.0)^2\right]$$

$$= 25{,}000\ cm^4$$

$$i_x^2 = \frac{Ix}{A} = 141.66\ cm^2 \qquad i_y^2 = \frac{Iy}{A} = 41.66\ cm^2$$

Assume (6) Tangents :





NA (1): $Y_{int.} = 15$ cm $\Longrightarrow$ $e_y = \dfrac{i_x^2}{Y_{int}} = \dfrac{141.66}{15} = 9.44$ cm

NA (2): $Y_{int.} = 25$ cm $\Longrightarrow$ $e_y = \dfrac{i_x^2}{Y_{int}} = \dfrac{141.66}{25} = 5.66$ cm

NA (3),(4) : $X_{int.} = 10$ cm $\Longrightarrow$ $e_x = \dfrac{i_y^2}{X_{int}} = \dfrac{41.66}{15} = 2.77$ cm

NA (5) : by simllarity of hatched triangles :

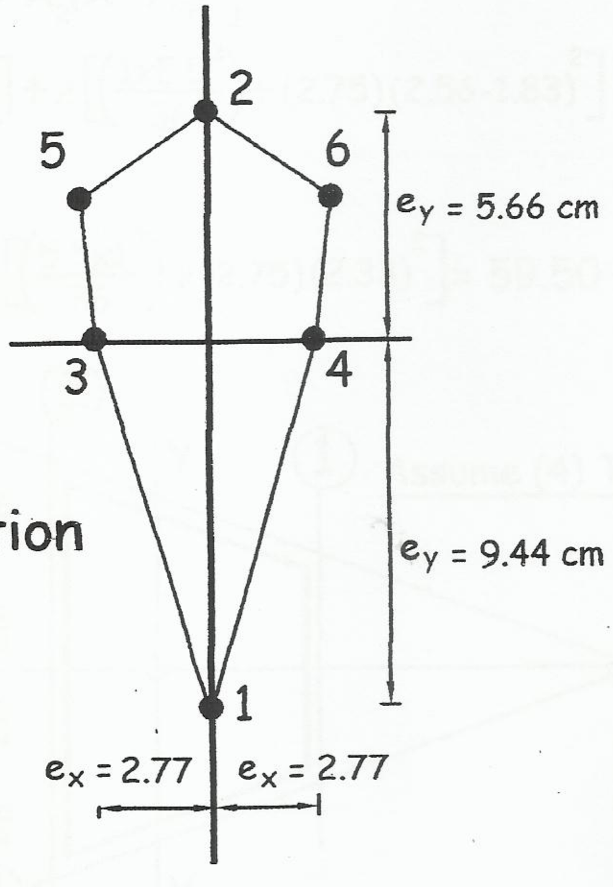
$$\frac{5}{a} = \frac{10}{30} = \frac{X_{int}}{Y_{int}} \Longrightarrow a = 15 \text{ cm}$$

$\Longrightarrow$ $Y_{int} = \overline{Y} + a = 25 + 15 = 40$ cm $\Longrightarrow$ $e_y = \dfrac{i_x^2}{Y_{int}} = \dfrac{141.66}{40} = 3.54$ cm

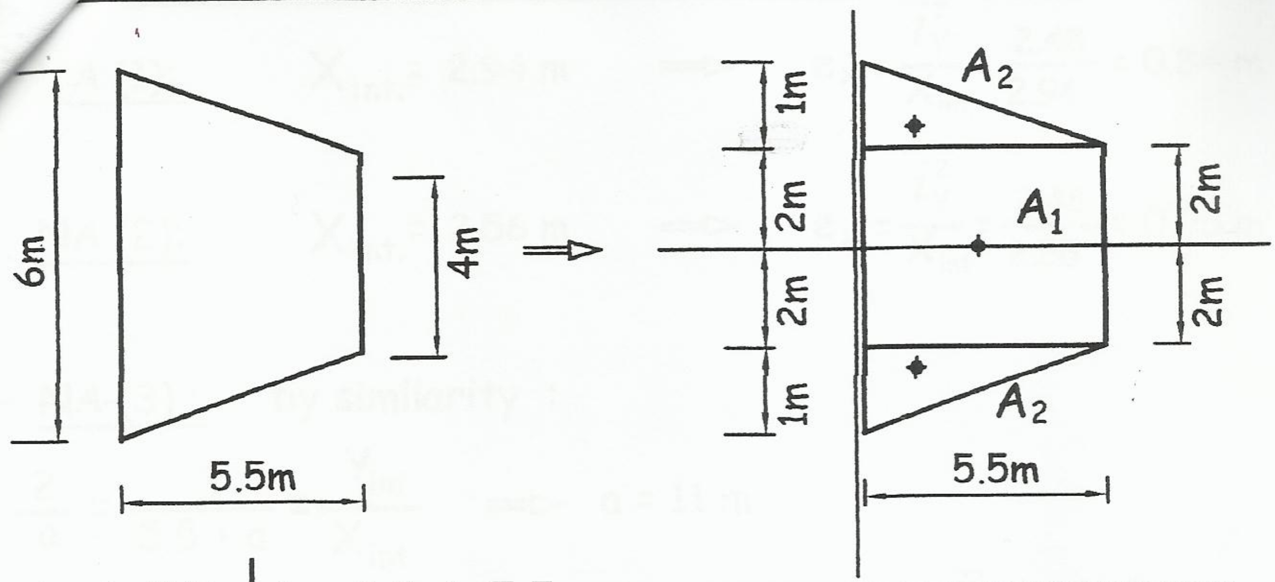
$\Longrightarrow$ $X_{int} = 13.33$ cm $\Longrightarrow$ $e_x = \dfrac{i_y^2}{X_{int}} = \dfrac{41.66}{13.33} = 3.12$ cm

NA (5) & NA (6) are the same

Core of Section



Core of Section



$A_1 = 4 \times 5.5 = 22\ m^2$, $X_1 = 2.75$

$A_2 = 0.5 \times 1 \times 5.5 = 2.75\ m^2$, $X_2 = 1.83$

فى حالة عدم وجود محور (Y) فاننا نحسب المسافة $\overline{X}$=?

$$A = A_1 + 2A_2 = 27.5\ m^2$$

$$\overline{X} = \frac{\Sigma AX}{\Sigma A} = \frac{A_1 x_1 + 2A_2 x_2}{A_1 + 2A_2} = 2.566\ m$$

$$Iy = \left[Iy_1 + A_1(\overline{X} - X_1)^2\right] + \left[Iy_2 + A_2(\overline{X} - X_2)^2\right]$$

$$Iy = \left[\left(\frac{4 \times 5.5^3}{12}\right) + (22)(2.56-2.75)^2\right] + 2\left[\left(\frac{1 \times 5.5^3}{36}\right) + (2.75)(2.56-1.83)^2\right]$$

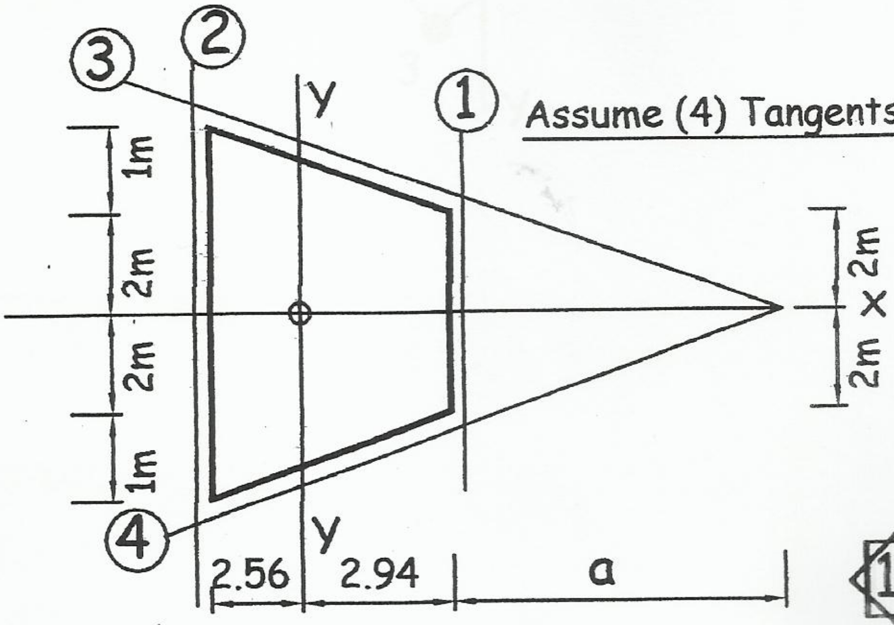
$$= 68.40\ m^4$$

$$Ix = \left[\left(\frac{5.5 \times 4^3}{12}\right) + (22)(0.0)^2\right] + 2\left[\left(\frac{5.5 \times 1^3}{36}\right) + (2.75)(2.33)^2\right] = 59.50\ m^4$$

$$i_x^2 = \frac{Ix}{A} = 2.16\ m^2$$

$$i_y^2 = \frac{Iy}{A} = 2.48\ m^2$$

Assume (4) Tangents :



NA (1): $X_{int.} = 2.94\ m \implies e_x = \frac{i_y^2}{X_{int}} = \frac{2.48}{2.94} = 0.84\ m$

NA (2): $X_{int.} = 2.56\ m \implies e_x = \frac{i_y^2}{X_{int}} = \frac{2.48}{2.56} = 0.96\ m$

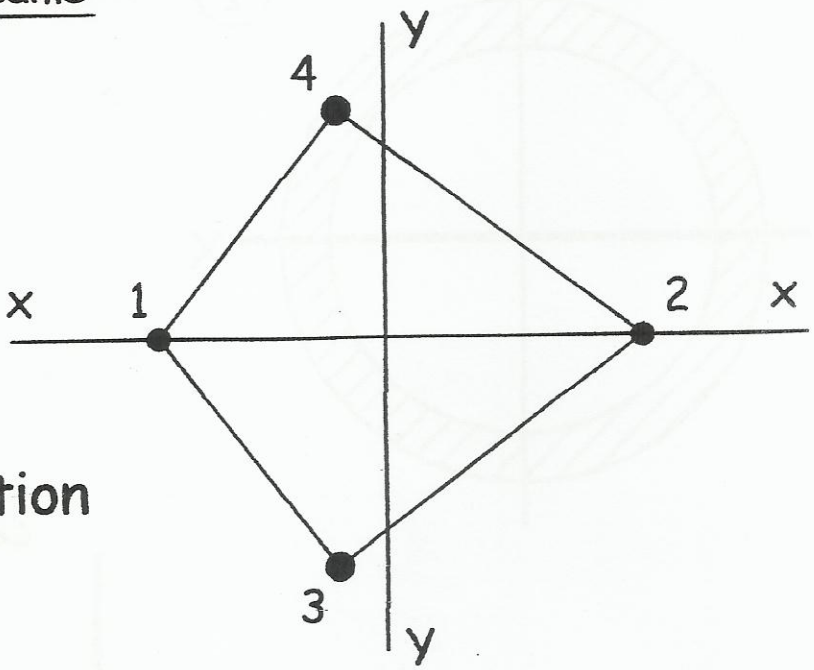
NA (3) : by simllarity :

$$\frac{2}{a} = \frac{3}{5.5 + a} = \frac{y_{int}}{X_{int}} \implies a = 11\ m$$

$$\implies X_{int} = 2.94 + a = 2.94 + 11 = 13.94\ m \implies e_y = \frac{i_x^2}{y_{int}} = \frac{2.16}{2.53} = 0.853\ m$$

$$\implies X_{int} = 2.53\ m \qquad \implies e_x = \frac{i_y^2}{X_{int}} = \frac{2.48}{13.94} = 0.178\ m$$

NA (3) & NA (4) are the same

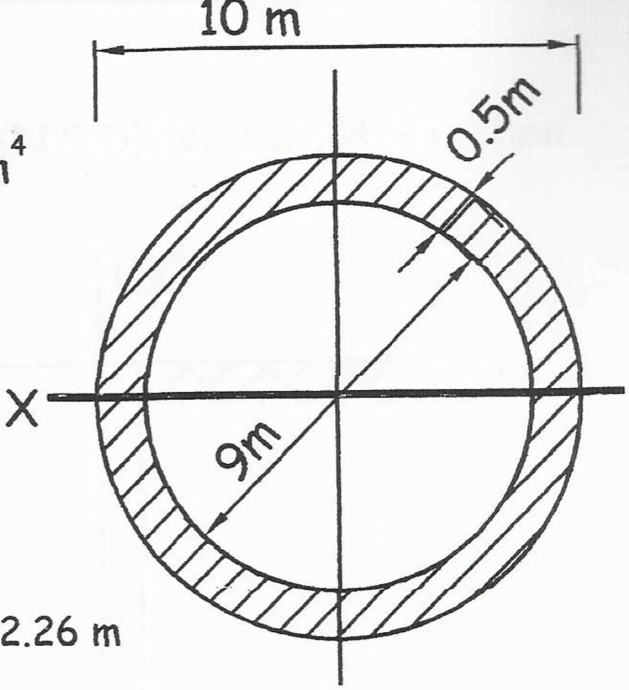


Core of Section

$$A = \frac{\pi}{4}\left[(10^2 - 9^2)\right] = 14.92\ m^2$$

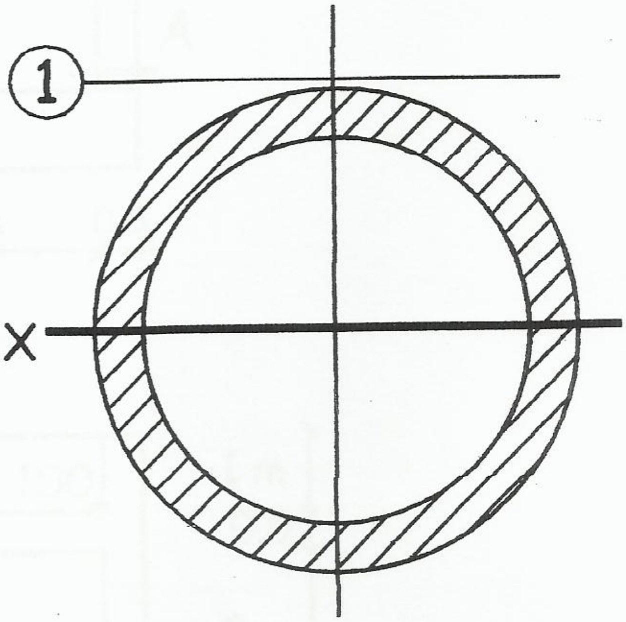
$$Iy = Ix = \frac{\pi}{64}\left[(10^4 - 9^4)\right] = 168.81\ m^4$$

$$i_x^2 = i_y^2 = \frac{Ix}{A} = 11.314\ m^2$$



NA (1):

$$Y_{int.} = 5\ m \Longrightarrow e_y = \frac{i_x^2}{Y_{int}} = \frac{11.314}{5} = 2.26\ m$$



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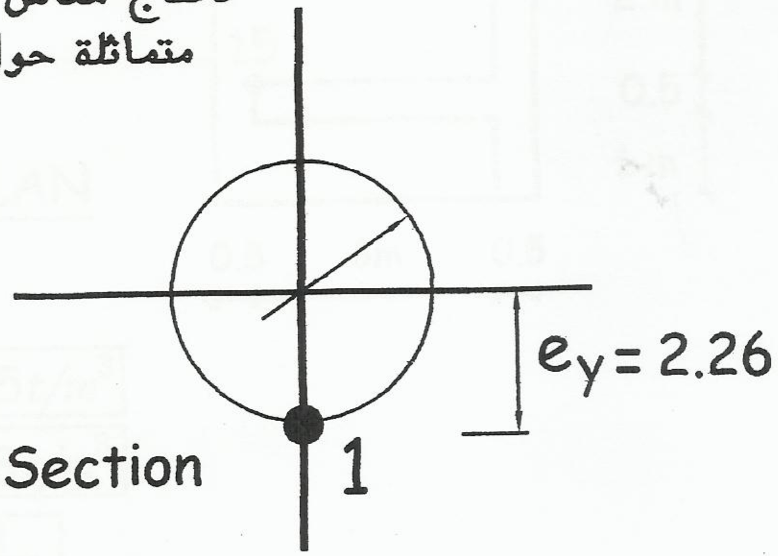
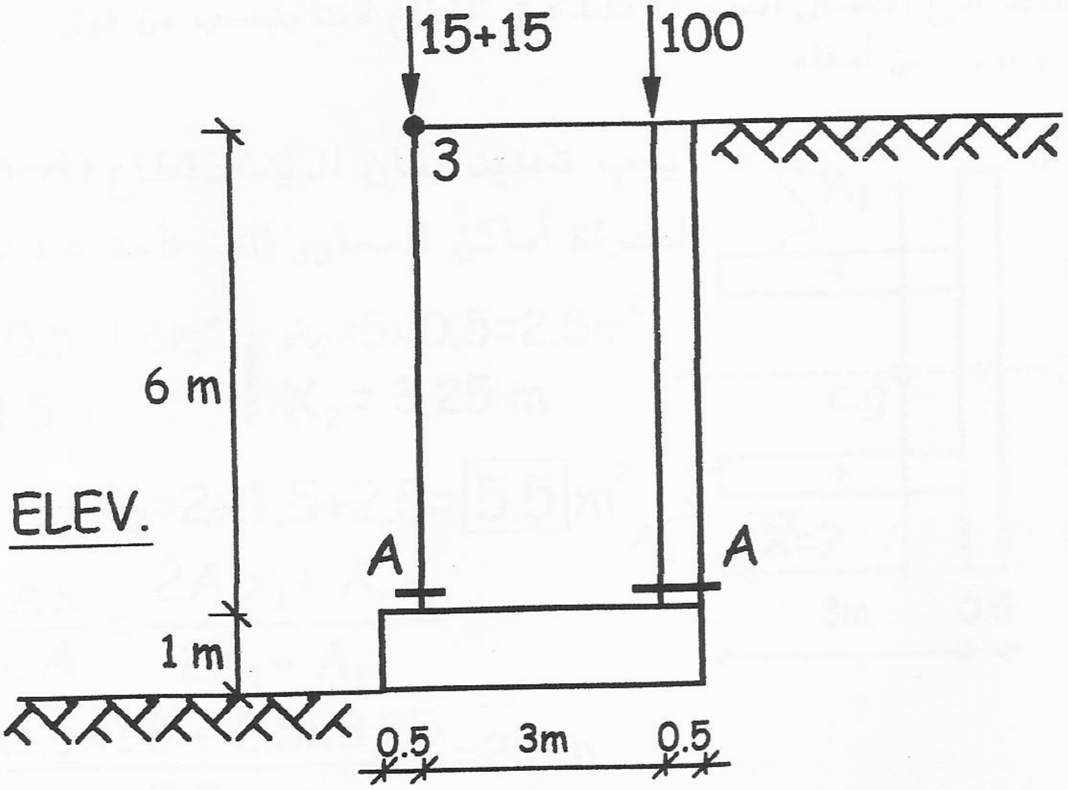
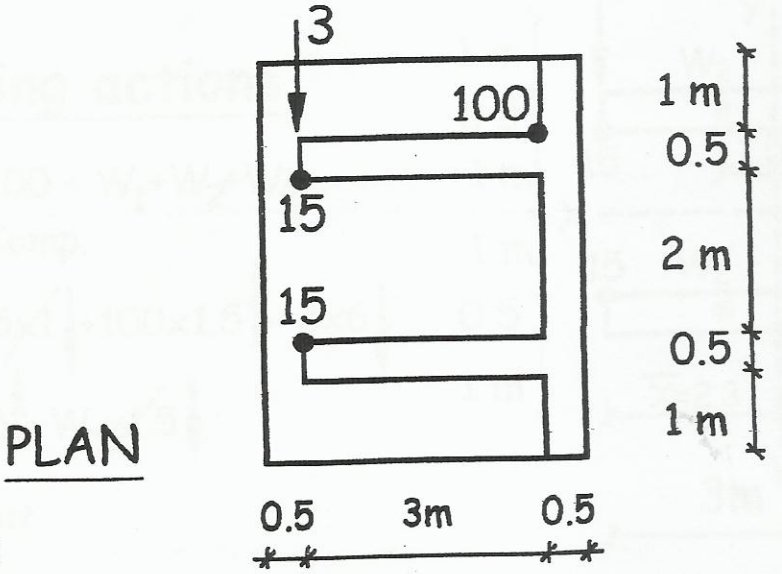


Core of Section

PROBLEM(2):

Draw Normal Stress Distribution (N.S.D) for sec .(A-A) , then check by core method ?





where:

$\boxed{\gamma_{R.C} = 2.5\,t/m^3}$

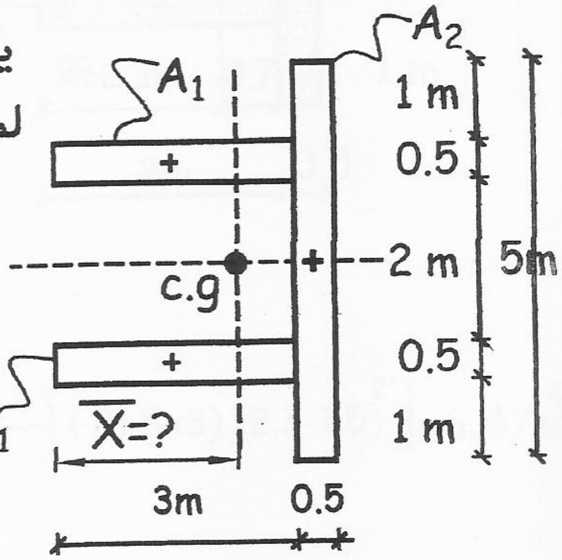
$\boxed{\gamma_{soil} = 1.8\,t/m^3}$

$\boxed{K_{soil} = \frac{1}{3}}$

For SEC. (A-A):

- يتم رسم شكل Sec(A) فى ورقة الاجابة و غالبا ما نحصل عليه من ال plan
- لا داعى لرسم ال Elevation فى ورقة الاجابة لتوفير الوقت
- يتم اسقاط جميع الاحمال الموجودة فقط فوق القطاع لاننا بنحسب من فوق القطاع و ليس من أسفله

يجب تحديد مكان ال c.g للقطاع (A-A) و ذلك لمعرفة أماكن المحاور التى نأخد عندها العزوم



$A_1=3\times0.5=1.5m^2$ | $A_2=5\times0.5=2.5m^2$

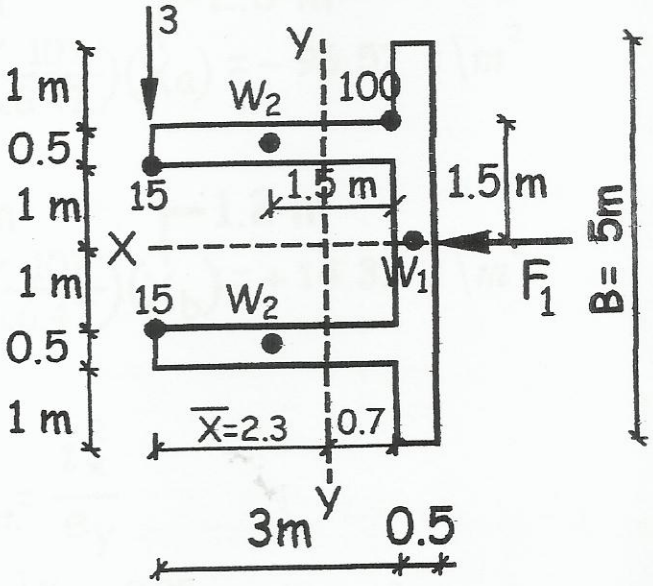
$X_1=1.5\ m$ | $X_2=3.25\ m$

$$A=2A_1+A_2=2\times1.5+2.5=\boxed{5.5}\,m^2$$

$$\overline{X}=\frac{\Sigma Ax}{\Sigma A}=\frac{2A_1X_1+A_2X_2}{2A_1+A_2}$$

$$\overline{X}=\frac{2\times1.5\times1.5+2.5\times3.25}{5.5}=2.3m$$

1-Straining actions



SEC(A-A)

$$N=15+15+100+W_1+W_2+W_2$$
$$=212.5\ \text{Comp.}$$

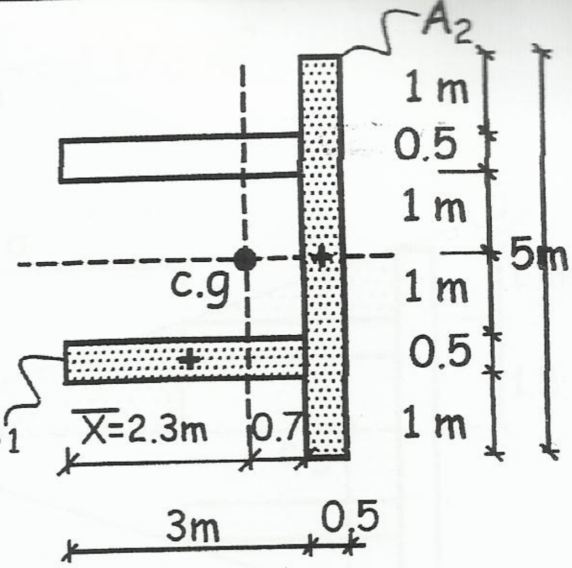
$$Mx=\cancel{15\times1}\uparrow-\cancel{15\times1}\downarrow+100\times1.5\uparrow-3\times6\downarrow$$
$$+W_2\cancel{\times1.5}\uparrow-W_2\cancel{\times1.5}\downarrow$$

$$Mx=132\uparrow\ mt$$

$$My=(15+15)\times2.3+2\times F_1-100\times0.7$$
$$+2W_2\cancel{\times}(1.5-0.7)-W_1\cancel{\times0.95}$$

$$My=107\ mt$$

-Properties of Area:



$$A = 2A_1 + A_2 = 2\times1.5 + 2.5 = \boxed{5.5}\ m^2$$

$$Ix = \sum\left[Ix + A\,(\Delta Y)^2\right]$$

$$Ix = \left[\left(\frac{0.5\times5^3}{12}\right) + (0.5\times5)\,(0.0)^2\right]$$

$$+\,2\left[\left(\frac{3\times0.5^3}{12}\right) + (0.5\times3)\,(1.25)^2\right]$$

$$Ix = 9.958\ m^4$$

$$Iy = \sum\left[Iy + A\,(\overline{X} - X)^2\right]$$

$$Iy = \left[\left(\frac{5\times0.5^3}{12}\right) + (0.5\times5)\,(2.3-3.25)^2\right] + 2\left[\left(\frac{0.5\times3^3}{12}\right) + (0.5\times3)\,(2.3-1.5)^2\right] = 6.47\,m^4$$

3-DRAW NORMAL STRESS:

$$\boxed{f = \pm\left(\frac{N}{A}\right) \pm \left(\frac{Mx}{Ix}\right)(Y) \pm \left(\frac{My}{Iy}\right)(X)}$$

$$\therefore f_a = \left(\frac{-212.5}{5.5}\right) - \left(\frac{132}{9.95}\right)(\underbrace{Y_a}_{1.5\text{ m}}) - \left(\frac{107}{6.47}\right)(\underbrace{X_a}_{2.3\text{ m}}) = -\,96.57\ t\backslash m^2$$

$$\therefore f_b = \left(\frac{-212.5}{5.5}\right) - \left(\frac{132}{9.95}\right)(\underbrace{Y_b}_{2.5\text{ m}}) - \left(\frac{107}{6.47}\right)(\underbrace{X_b}_{1.2\text{ m}}) = +\,14.37\ t\backslash m^2$$

$$X_{int.} = \frac{i_y^2}{e_x}$$

$$i_y^2 = \frac{Iy}{A} = \frac{6.47}{5.5} = 1.17\ m^2$$

$$e_x = \frac{My}{N} = \frac{107}{212.5} = 0.50\ m$$

$$X_{int.} = 2.32\ m$$

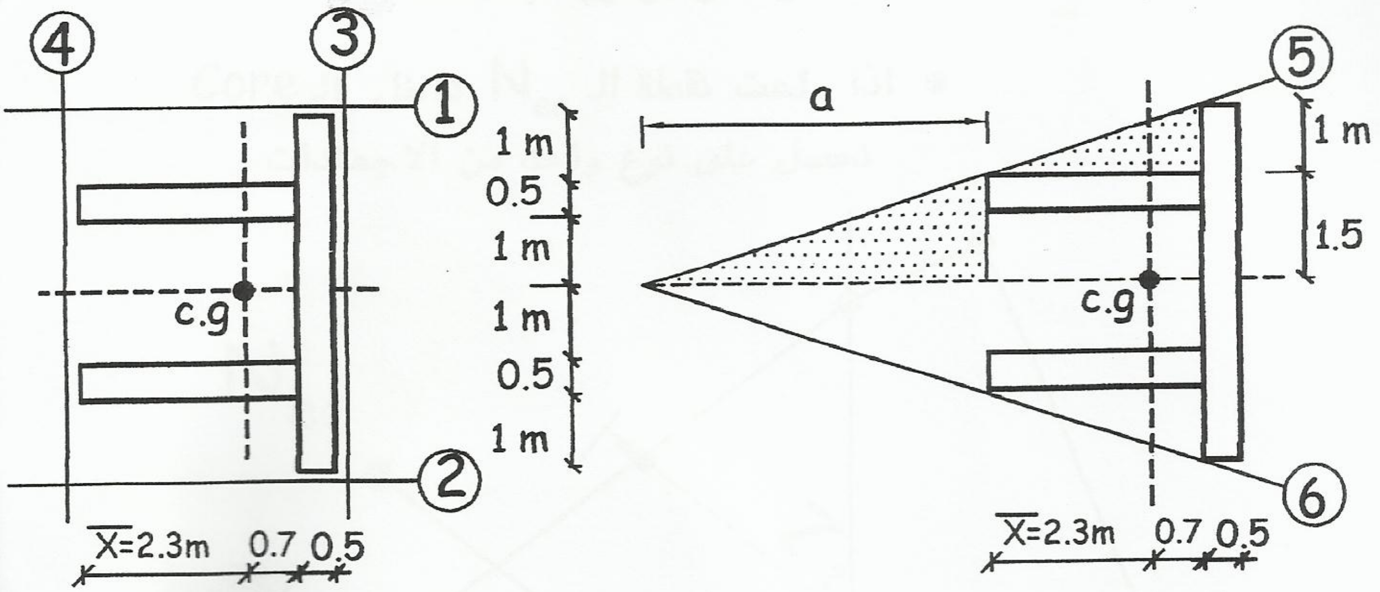
$$Y_{int.} = \frac{i_x^2}{e_y}$$

$$i_x^2 = \frac{Ix}{A} = \frac{9.95}{5.5} = 1.81\ m^2$$

$$e_y = \frac{Mx}{N} = \frac{132}{212.5} = 0.62\ m$$

$$Y_{int.} = 2.91\ m$$

$$i_x^2 = \frac{I_x}{A} = 1.81\ m^2 \qquad i_y^2 = \frac{I_y}{A} = 1.176\ m^2$$



NA (1)&(2): $Y_{int.} = 2.5\ m \Longrightarrow e_y = \frac{i_x^2}{Y_{int}} = \frac{1.81}{2.5} = 0.72\ m$

NA (3): $X_{int.} = 1.2\ m \Longrightarrow e_x = \frac{i_y^2}{X_{int}} = \frac{1.176}{1.2} = 0.98\ m$

NA (4): $X_{int.} = 2.3\ m \Longrightarrow e_x = \frac{i_y^2}{X_{int}} = \frac{1.176}{2.3} = 0.51\ m$

NA (5) : by simillarity :

$$\frac{1.5}{a} = \frac{1}{3} = \frac{Y_{int}}{X_{int}} \Longrightarrow a = 4.5\ m$$

$$\Longrightarrow X_{int} = \overline{X} + a = 2.3 + 4.5 = 6.8m \Longrightarrow e_x = \frac{i_y^2}{X_{int}} = \frac{1.176}{6.8} = 0.173\ m$$

$$\Longrightarrow Y_{int} = 2.26\ m \Longrightarrow e_y = \frac{i_x^2}{Y_{int}} = \frac{1.81}{2.26} = 0.798\ m$$

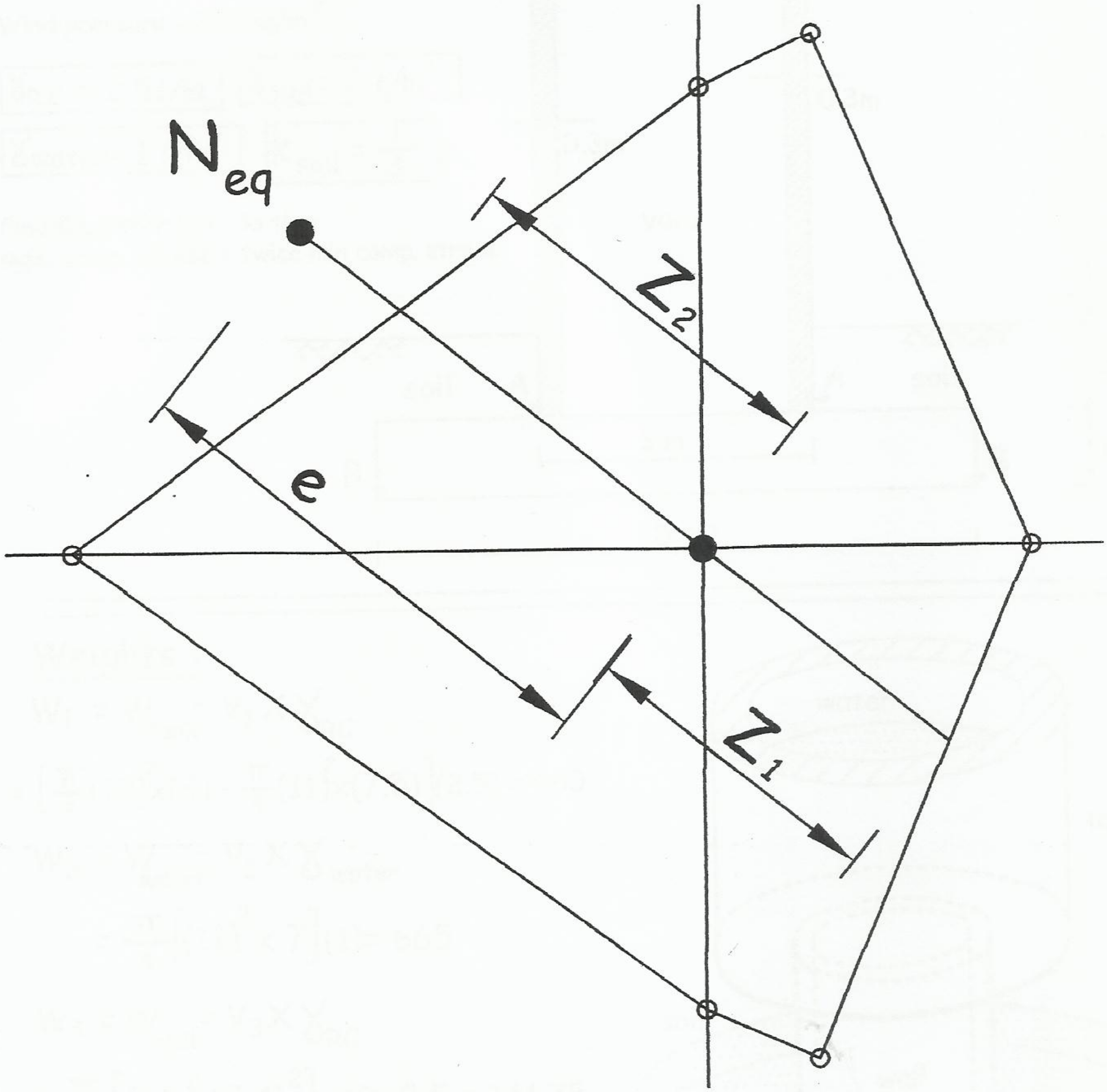
$$e_x = \frac{M_y}{N} = \frac{132}{212.5} = 0.62\ m$$

$$e_y = \frac{M_x}{N} = \frac{107}{212.5} = 0.5\ m$$

$N_{eq} = N = 212.5$ comp.

ملاحظة هامة جدا جدا

- اذا وقعت نقطة ال N_{eq} خارج ال Core
  نحصل على نوعين اجهادات
- اذا وقعت نقطة ال N_{eq} داخل ال Core
  نحصل على نوع واحد من الاجهادات



$$f_1 = \frac{N}{A}\left[\frac{Z_1 + e}{Z_1}\right] = \frac{-212.5}{5.5}\left[\frac{4.9 + 7.9}{4.9}\right] = -100\ t\backslash m^2$$

$$f_2 = \frac{N}{A}\left[\frac{Z_2 - e}{Z_2}\right] = \frac{-212.5}{5.5}\left[\frac{6 - 7.9}{6}\right] = +12.23\ t\backslash m^2$$

- يتم قياس المسافات e Z_1 Z_2 بالمسطرة

Example

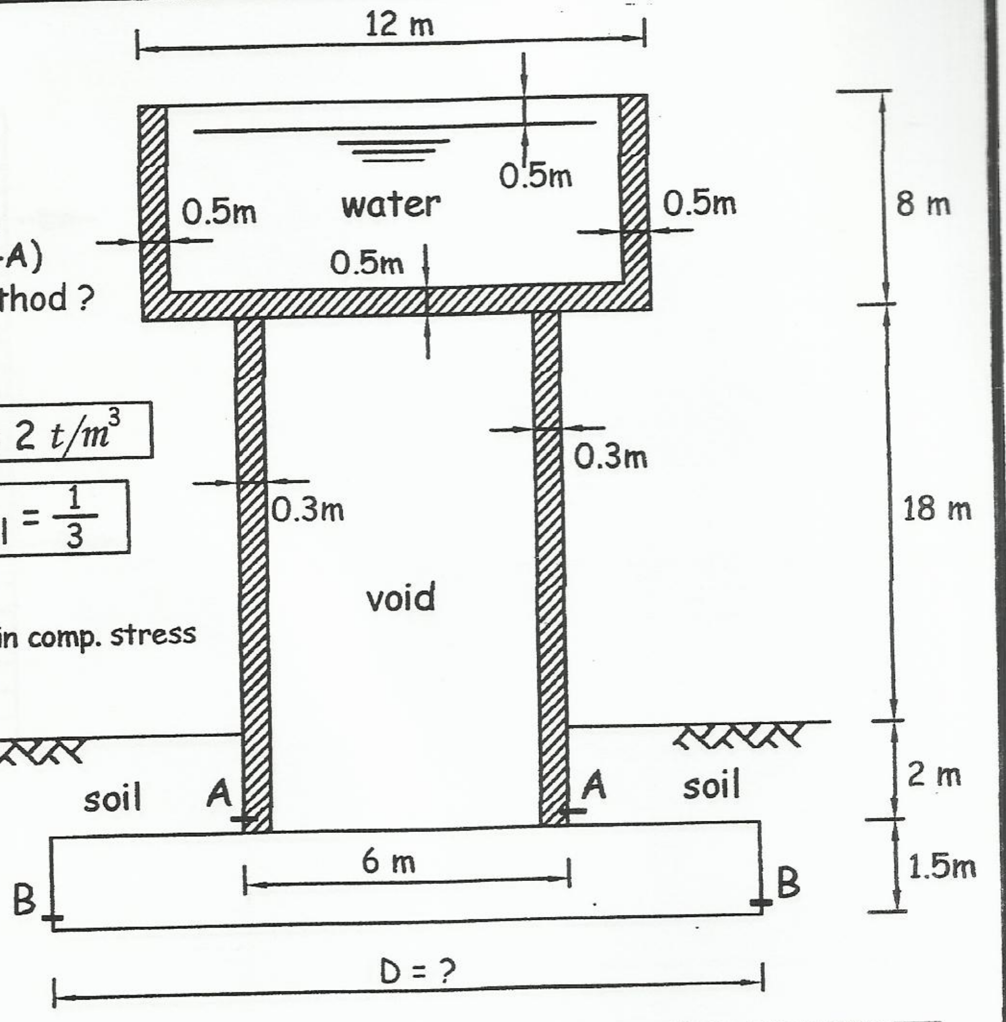
For the shown circular tank,
Draw (N.S.D) for sec .(A-A)
, then check by core method ?

Wind pressure = 200 kg/m^2

$\boxed{\gamma_{R.C} = 2.5 t/m^3}$ $\boxed{\gamma_{soil} = 2\ t/m^3}$

$\boxed{\gamma_{water} = 1\ t/m^3}$ $\boxed{K_{soil} = \frac{1}{3}}$

Find Diameter (D), So that
max. comp. stress = twice min comp. stress



Weights :

$W_1 = W_{tank} = V_1 \times \gamma_{RC}$

$= \left[\frac{\pi}{4}(12)^2 \times (8) - \frac{\pi}{4}(11)^2 \times (7.5)\right](2.5) = 480$

$W_2 = W_{water} = V_2 \times \gamma_{water}$

$= \frac{\pi}{4}\left[(11)^2 \times 7\right](1) = 665$

$W_3 = W_{wall} = V_3 \times \gamma_{RC}$

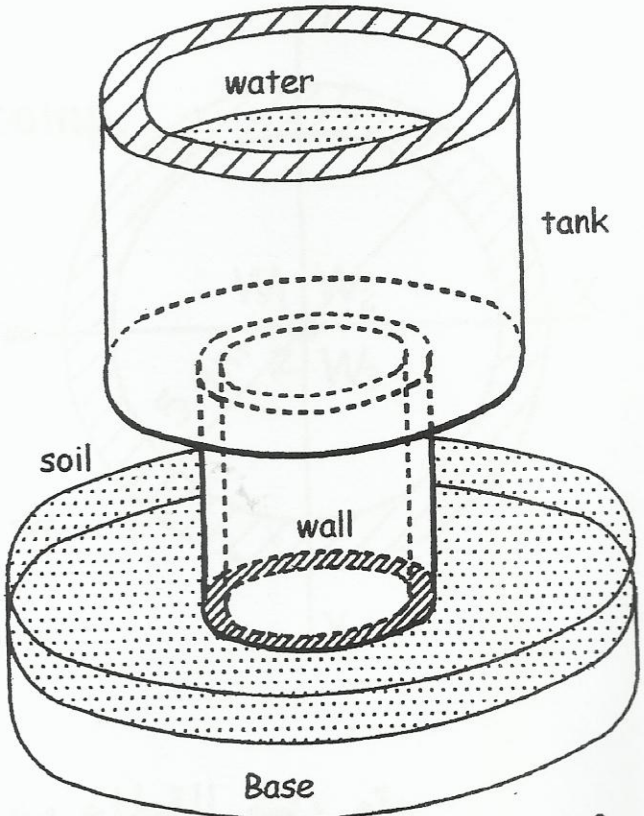
$= \frac{\pi}{4}\left[(6)^2 - (5.4)^2\right] \times 18 \times 2.5 = 241.75$

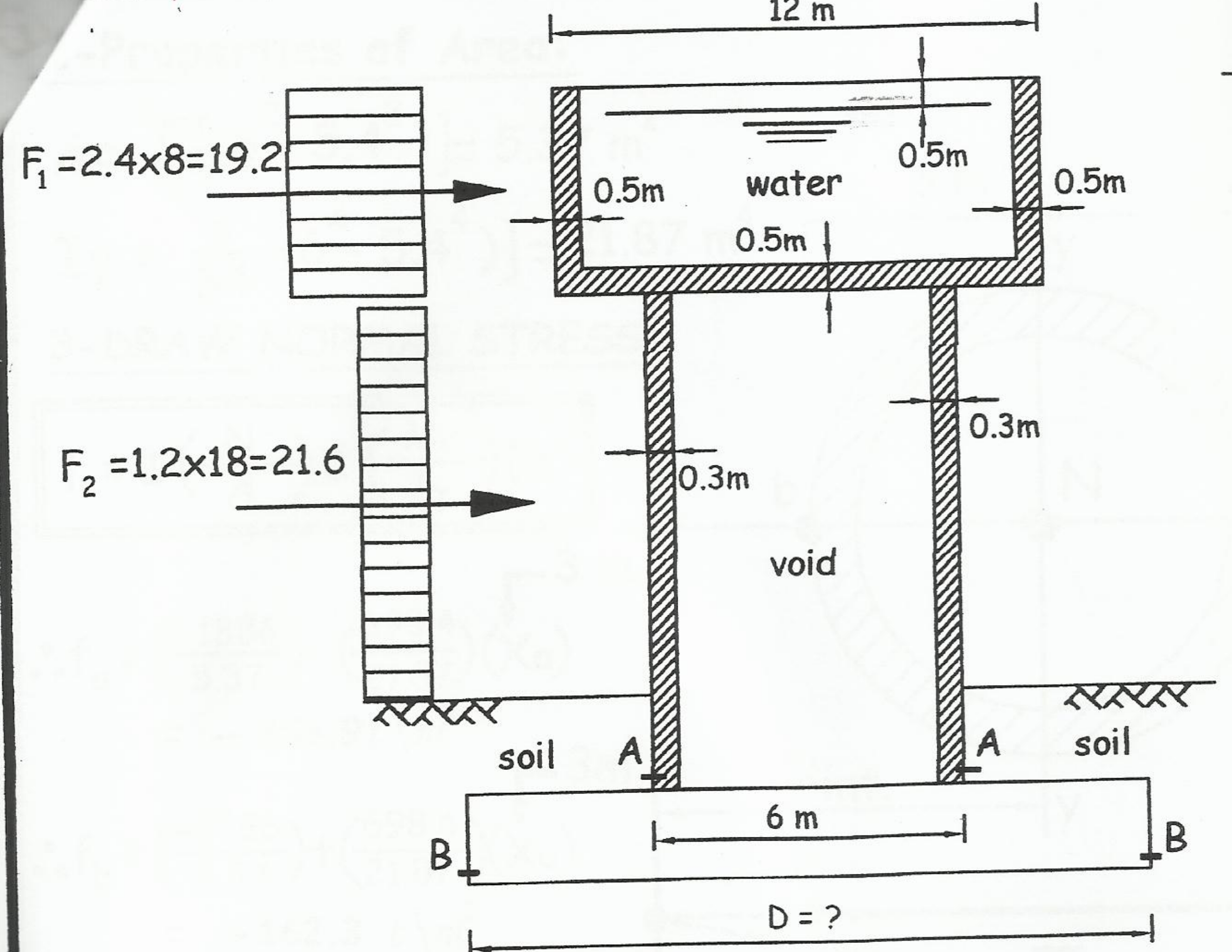
$W_4 = W_{soil} = V_4 \times \gamma_{soil}$

$= \frac{\pi}{4}\left[(D)^2 - (6)^2\right] \times 2 \times 2 = 3.14\ D^2 - 113$

$W_5 = W_{base} = V_5 \times \gamma$

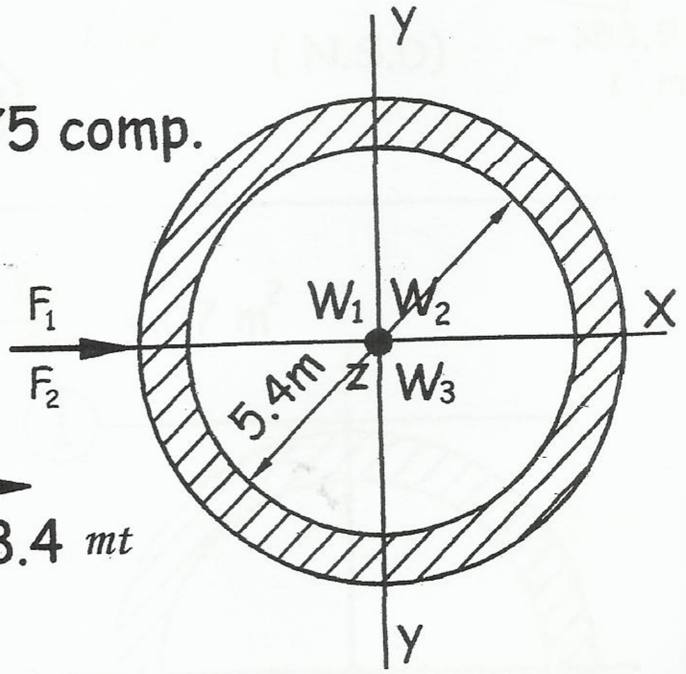
$= \frac{\pi}{4}\left[(D)^2 \times 1.5\right](2.5) = 2.945\ D^2$





For section (A):

$$N = W_1 + W_2 + W_3 = 1386.75 \text{ comp.}$$



$$Mx = 0.0$$

$$My = \overrightarrow{11xF_2} + \overrightarrow{24xF_1} = \overrightarrow{698.4}\ mt$$

يتم رسم القطاع مع المحاور الخاصة به و اسقاط
كل الاحمال الموجودة فوق منسوب القطاع

2-Properties of Area:

$$A = \frac{\pi}{4}\left[(6^2 - 5.4^2)\right] = 5.37\ m^2$$

$$I_y = \frac{\pi}{64}\left[(6^4 - 5.4^4)\right] = 21.87\ m^4$$

3-DRAW NORMAL STRESS:

$$\boxed{f = \pm\left(\frac{N}{A}\right) \pm \left(\frac{M_y}{I_y}\right)(X)}$$

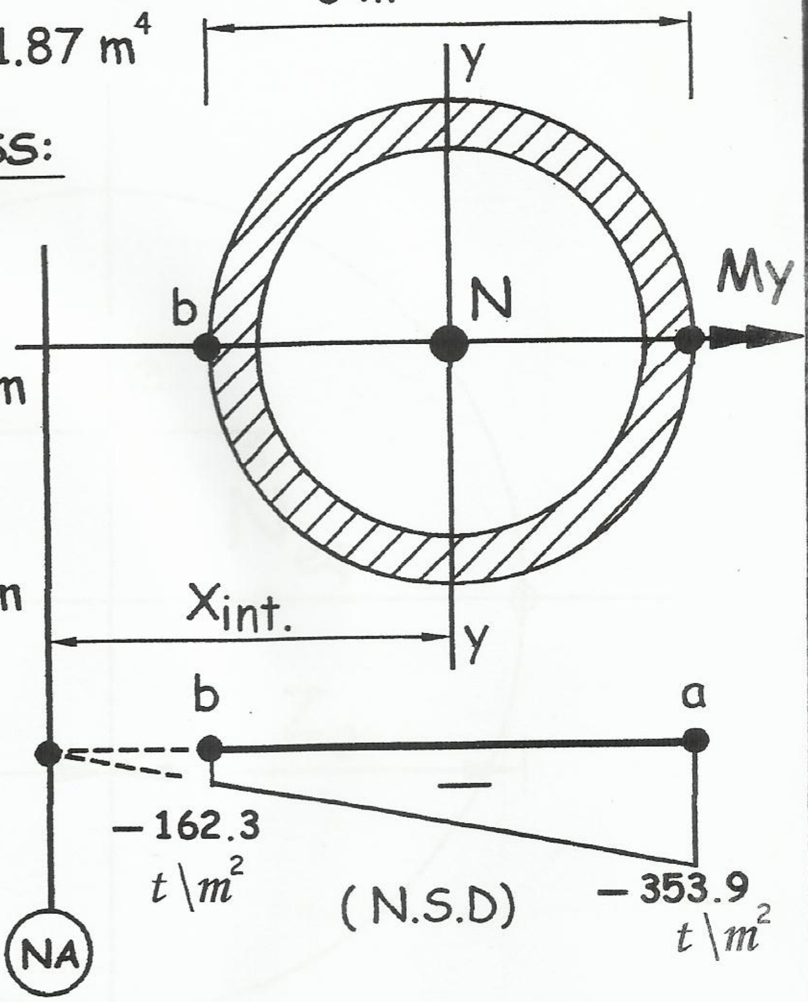
$$\therefore f_a = \left(\frac{-1386}{5.37}\right) - \left(\frac{698.4}{21.87}\right)(\overset{3\ m}{X_a})$$

$$= -353.9\ t\backslash m^2$$

$$\therefore f_b = \left(\frac{-1386}{5.37}\right) + \left(\frac{698.4}{21.87}\right)(\overset{3m}{X_a})$$

$$= -162.3\ t\backslash m^2$$

$$X_{int.} = \left|\frac{\left(\frac{1386}{5.37}\right)}{\left(\frac{698.4}{21.87}\right)}\right| = 8.08\ m$$



Check by Core : $i_x^2 = i_y^2 = \frac{I_x}{A} = 4.07\ m^2$

NA (1):

$Y_{int.} = 3\ m \Rightarrow$

$$e_y = \frac{i_x^2}{Y_{int}} = \frac{4.07}{3} = 1.35\ m$$

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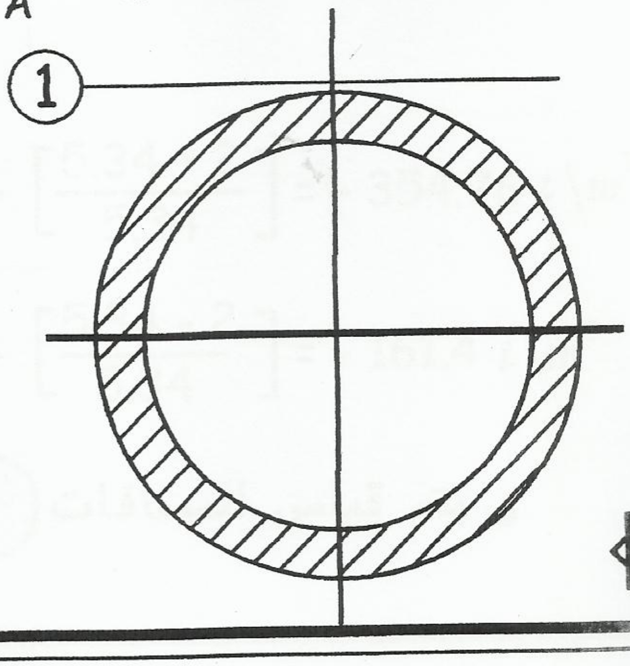
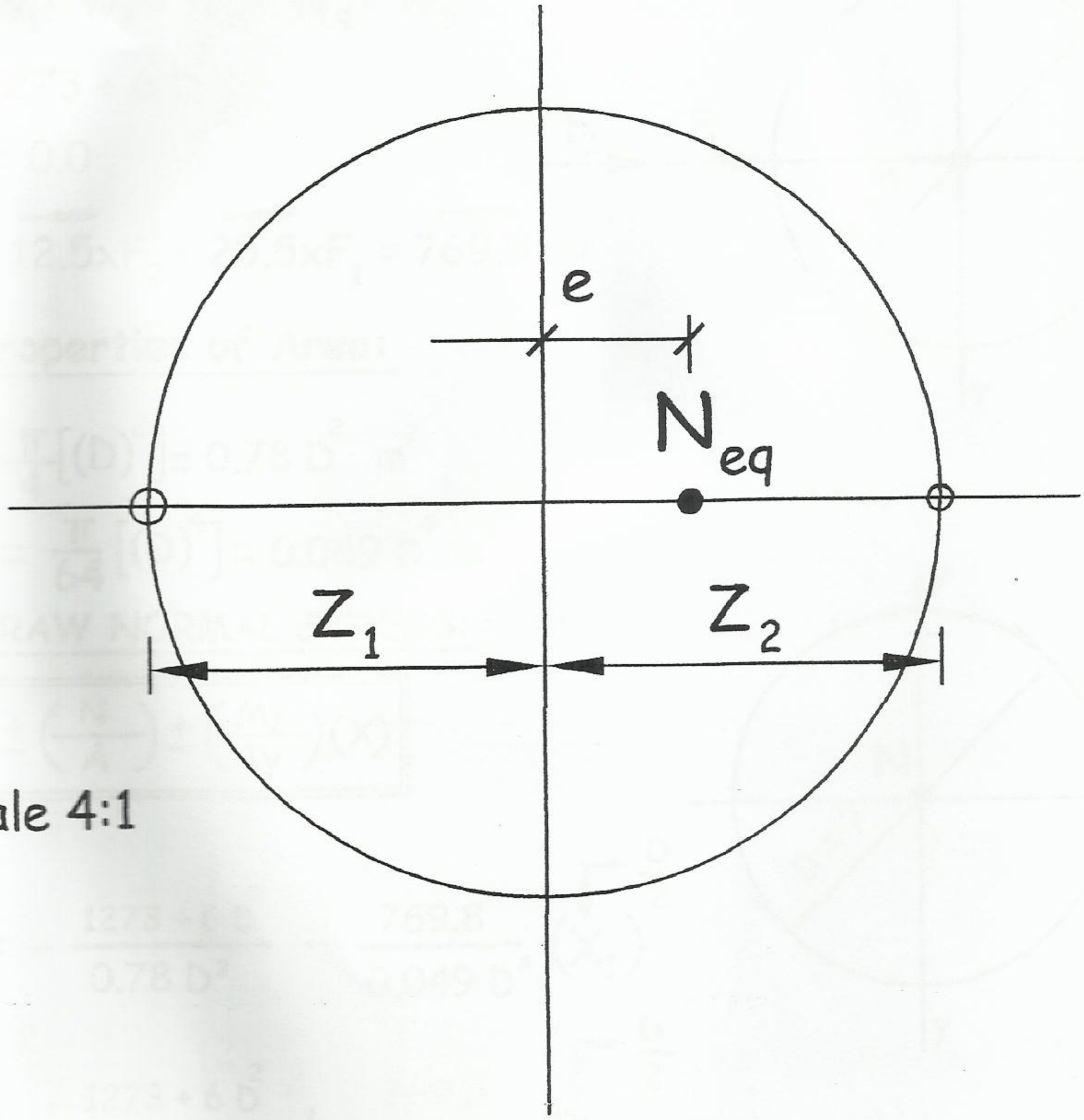
متماثلة حول جميع المحاور



$$e_x = \frac{My}{N_{eq}} = \frac{698.4}{1386} = 0.5\ m$$



Scale 4:1

$$f_1 = \frac{N}{A}\left[\frac{Z_1 + e}{Z_1}\right] = \frac{-1386}{5.37}\left[\frac{5.34 + 2}{5.34}\right] = -354.76\ t\backslash m^2$$

$$f_2 = \frac{N}{A}\left[\frac{Z_2 - e}{Z_2}\right] = \frac{-1386}{5.37}\left[\frac{5.34 - 2}{5.34}\right] = -161.4\ t\backslash m^2$$

- يتم قياس المسافات e Z_1 Z_2 بالمسطرة

• يتم رسم القطاع مع المحاور الخاصة به و اسقاط الموجودة فوق منسوب القطاع

For section (B):

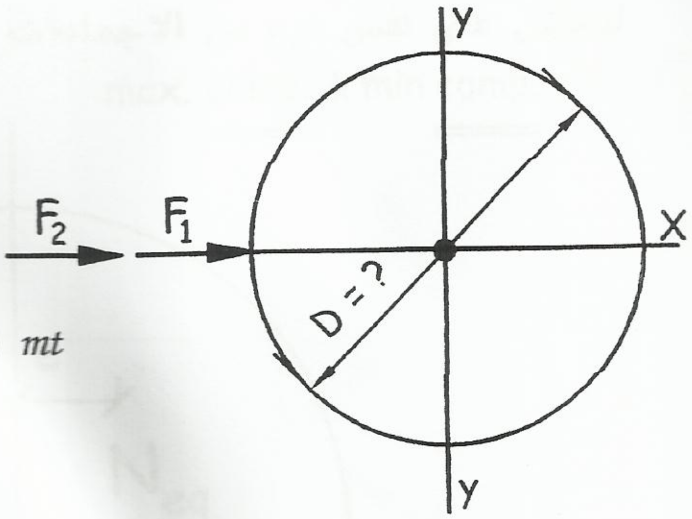
1-Straining actions

$N = W_1 + W_2 + W_3 + W_4 + W_5$

$N = 1273 + 6\,D^2$

$Mx = 0.0$

$My = \overrightarrow{12.5 \times F_2} + \overrightarrow{25.5 \times F_1} = \overrightarrow{769.8}$ *mt*



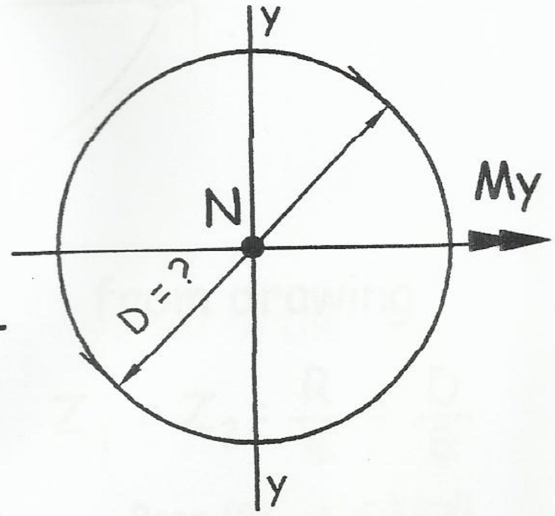
2-Properties of Area:

$$A = \frac{\pi}{4}\left[(D)^2\right] = 0.78\,D^2 \;\; m^2$$

$$Iy = \frac{\pi}{64}\left[(D)^4\right] = 0.049\,D^4 \;\; m^4$$

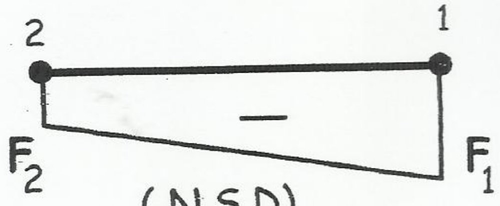
3-DRAW NORMAL STRESS:

$$\boxed{f = \pm\left(\frac{N}{A}\right) \pm \left(\frac{My}{Iy}\right)(X)}$$



$$\therefore f_1 = -\frac{1273 + 6\,D^2}{0.78\,D^2} - \frac{769.8}{0.049\,D^4}\,(\overset{\frac{D}{2}}{X_1})$$

$$\therefore f_2 = -\frac{1273 + 6\,D^2}{0.78\,D^2} + \frac{769.8}{0.049\,D^4}\,(\overset{\frac{D}{2}}{X_2})$$



(N.S.D)

But , $\boxed{f_1 = 2 f_2}$ Given

$$-\frac{1273 + 6\,D^2}{0.78\,D^2} - \frac{769.8}{0.049\,D^4}\left(\frac{D}{2}\right) = 2\left[-\frac{1273 + 6\,D^2}{0.78\,D^2} + \frac{769.8}{0.049\,D^4}\left(\frac{D}{2}\right)\right]$$

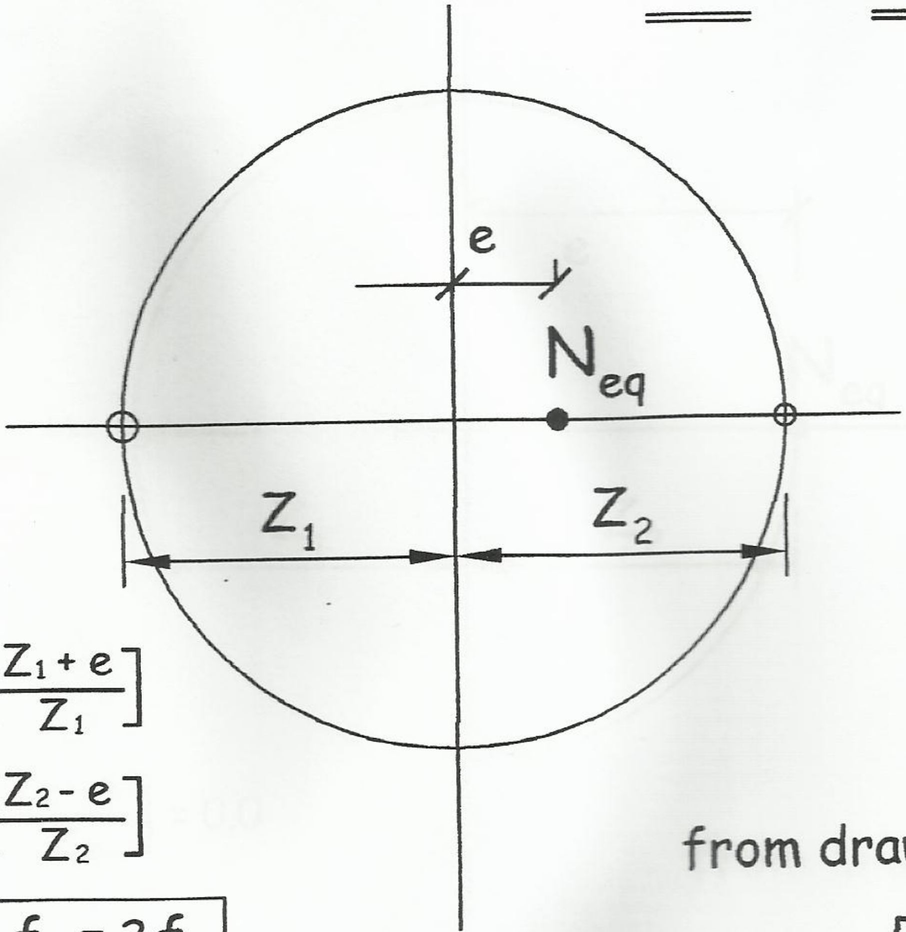
Get $\boxed{D = 9.88 \text{ m}}$

Get (D) by Core method :

ملاحظة هامة جدا جدا

- يجب أن تقع الـ N_{eq} داخل الـ Core لنحصل على نفس نوع من الاجهادات max. comp. & min comp.

$$\Longrightarrow e_x = \frac{My}{N_{eq}} = \frac{769.8}{1273 + 6D^2}$$



$$f_1 = \frac{N}{A}\left[\frac{Z_1 + e}{Z_1}\right]$$

$$f_2 = \frac{N}{A}\left[\frac{Z_2 - e}{Z_2}\right]$$

from drawing

$$Z_1 = Z_2 = \frac{R}{4} = \frac{D}{8}$$

الاثبات فى Page (9)

But , $\boxed{f_1 = 2f_2}$

$$\frac{N}{A}\left[\frac{Z_1 + e}{Z_1}\right] = (2)\frac{N}{A}\left[\frac{Z_2 - e}{Z_2}\right]$$

$$\cancel{\frac{N}{A}}\left[\frac{Z_1 + e}{\cancel{Z_1}}\right] = (2)\cancel{\frac{N}{A}}\left[\frac{Z_2 - e}{\cancel{Z_2}}\right]$$

$$Z_1 + e = (2)\left[Z_1 - e\right]$$

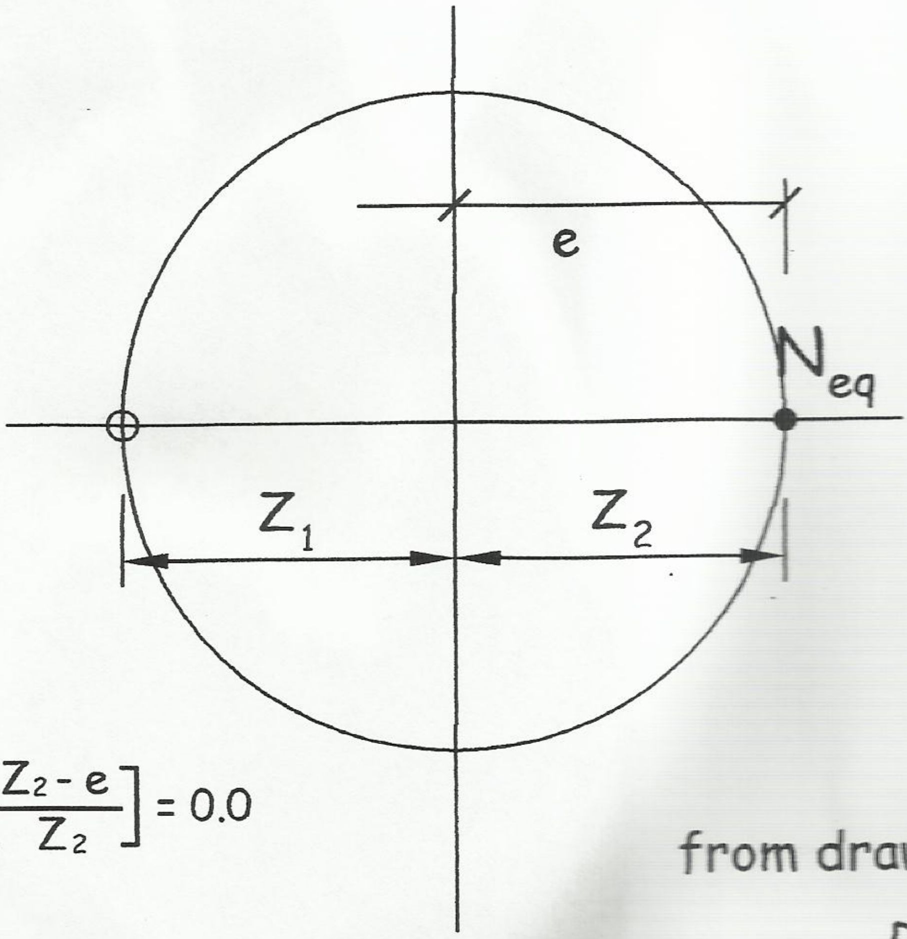
$$\Longrightarrow 3e = Z \Longrightarrow 3\left[\frac{769.8}{1273 + 6D^2}\right] = \frac{D}{8}$$

$$\Longrightarrow \boxed{D = 9.88 \text{ m}}$$

ملاحظة هامة جدا جدا

- لو طلب ال D بحيث No tension stress
  و ال N_{eq} موجودة على مسار ال Core

$$f_2 = \frac{N}{A}\left[\frac{Z_2 - e}{Z_2}\right] = 0.0$$



$$f_2 = \frac{N}{A}\left[\frac{Z_2 - e}{Z_2}\right] = 0.0$$

from drawing

$$Z_1 = Z_2 = \frac{R}{4} = \frac{D}{8}$$

الاثبات فى Page (9)

$$Z_2 - e = 0.0$$

$$Z_2 = e$$

$$\frac{D}{8} = \left[\frac{769.8}{1273 + 6\,D^2}\right]$$

$$\Longrightarrow \boxed{D = 4.43 \text{ m}}$$