Straining Actions

القوى الداخلية

نسألكم الدعاء

Table of Contents

STRAINING ACTIONS

لدراسة أى قطاع يجب معرفة القوى التى تؤثر على هذا القطاع و هى

١- *Normal force (N)* ← مجموع القوى الموازية لمحور **Z** او العمودية على القطاع

٢- *Shear force (Qx)* ← مجموع القوى الموازية لمحور **X**

٣- *Shear force (Qy)* ← مجموع القوى الموازية لمحور **Y**

٤- *Moment (Mx)* ← مجموع عزوم القوى حول محور **X**

٥- *Moment (My)* ← مجموع عزوم القوى حول محور **Y**

٦- *Moment (Mz)* ← مجموع عزوم القوى حول محور **Z**

و هذه القوى تنقسم الى جزئين

الجزء الاول يسبب اجهادات عمودية على القطاع *Normal Stresses*

و هى *N , Mx , My*

و الجزء الاخر يسبب اجهادات موازية للقطاع *Shear Stresses*

و هى *Qx , Qy , Mz*

و لحساب هذه القوى يتم اتباع الاتى

١- يتم رسم مسقط موازى للقطاع

٢- يتم تحديد المحاور على هذا المسقط بحيث يكون محور *Y , X* فى مستوى القطاع و محور *Z* عمودى على القطاع

٣- يتم تجميع القوى الموازية لمحور *Z* فتكون هى الـ *Normal force (N)*

٤- يتم تجميع القوى الموازية لمحور *X* فتكون هى الـ *Shear force (Qx)*

٥- يتم تجميع القوى الموازية لمحور *Y* فتكون هى الـ *Shear force (Qy)*

٦- يتم اهمال القوى التى توازى محور X و التى تقطع محور X و يتم أخذ العزوم لباقى القوى حول محور X فيكون هو $Moment\ (Mx)$

٧- يتم اهمال القوى التى توازى محور Y و التى تقطع محور Y و يتم أخذ العزوم لباقى القوى حول محور فيكون هو $Moment\ (My)$

٨- يتم اهمال القوى التى توازى محور Z و التى تقطع محور Z و يتم أخذ العزوم لباقى القوى حول محور فيكون هو $Moment\ (Mz\ or\ Mt)$

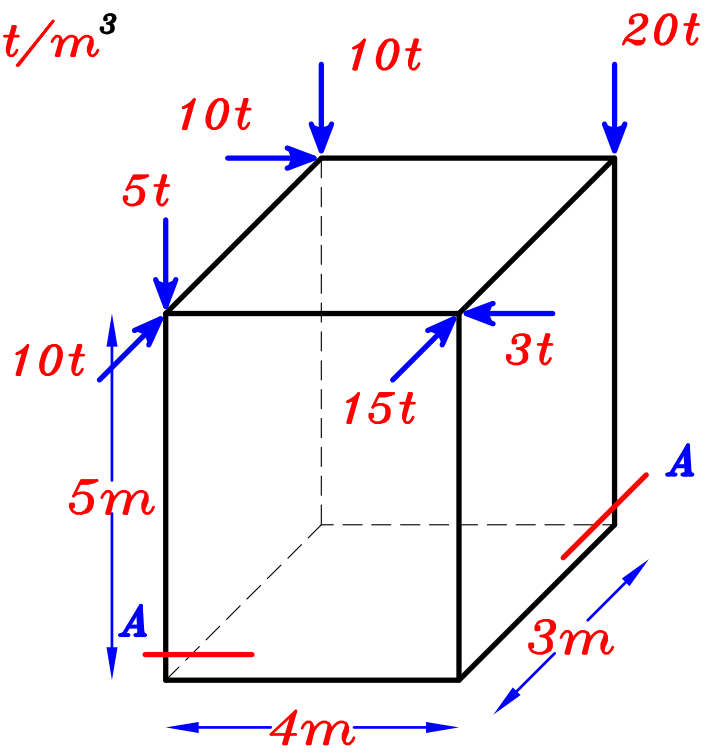
ملحوظة هامة جدا

اذا كانت القوى التى تقطع المحور ظاهرة فى المسقط عبارة عن نقطة فانها تقطعه و اذا كانت ظاهرة فى المسقط عبارة عن سهم فيجب التأكد من المسقط الاخر اذا كانت تقطع المحور أم لا

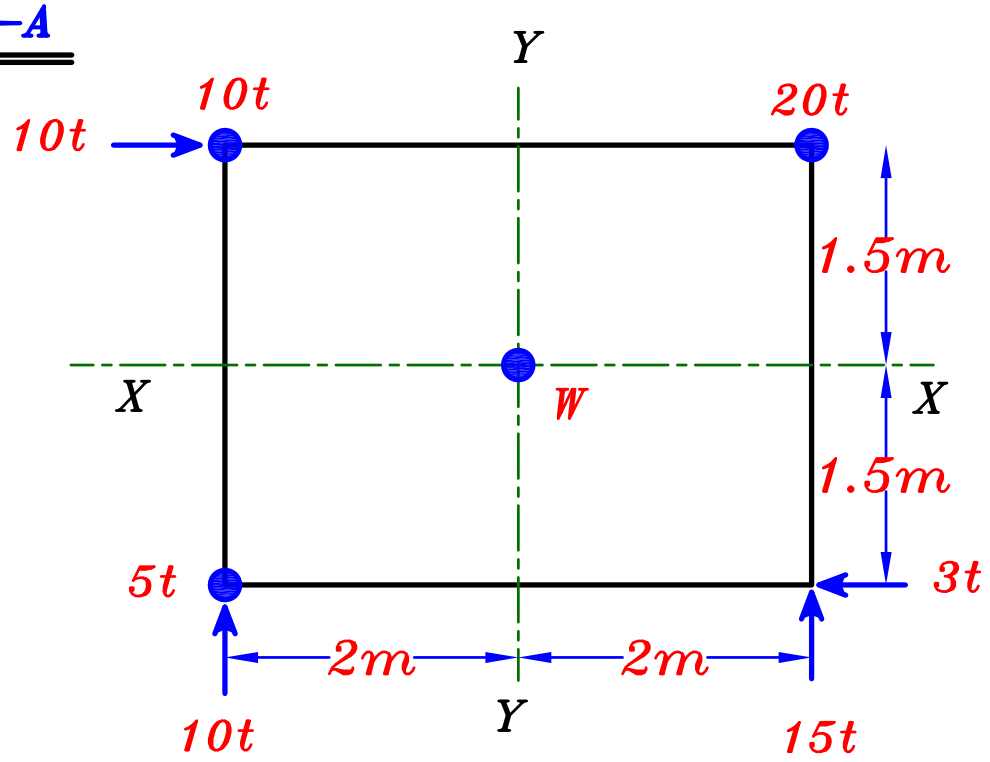
Example

For the shown concrete block determine the straining actions at section (A – A).

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



Sec A–A



$Weight = 3 \times 4 \times 5 \times 2.5 = 150\ t\ (Comp.)$

$1 - N = W + 20 + 10 + 5 = 185\ t$

$2 - Qx = 10 - 3 = 7t \rightarrow$

$3 - Qy = 10 + 15 = 25t \uparrow$

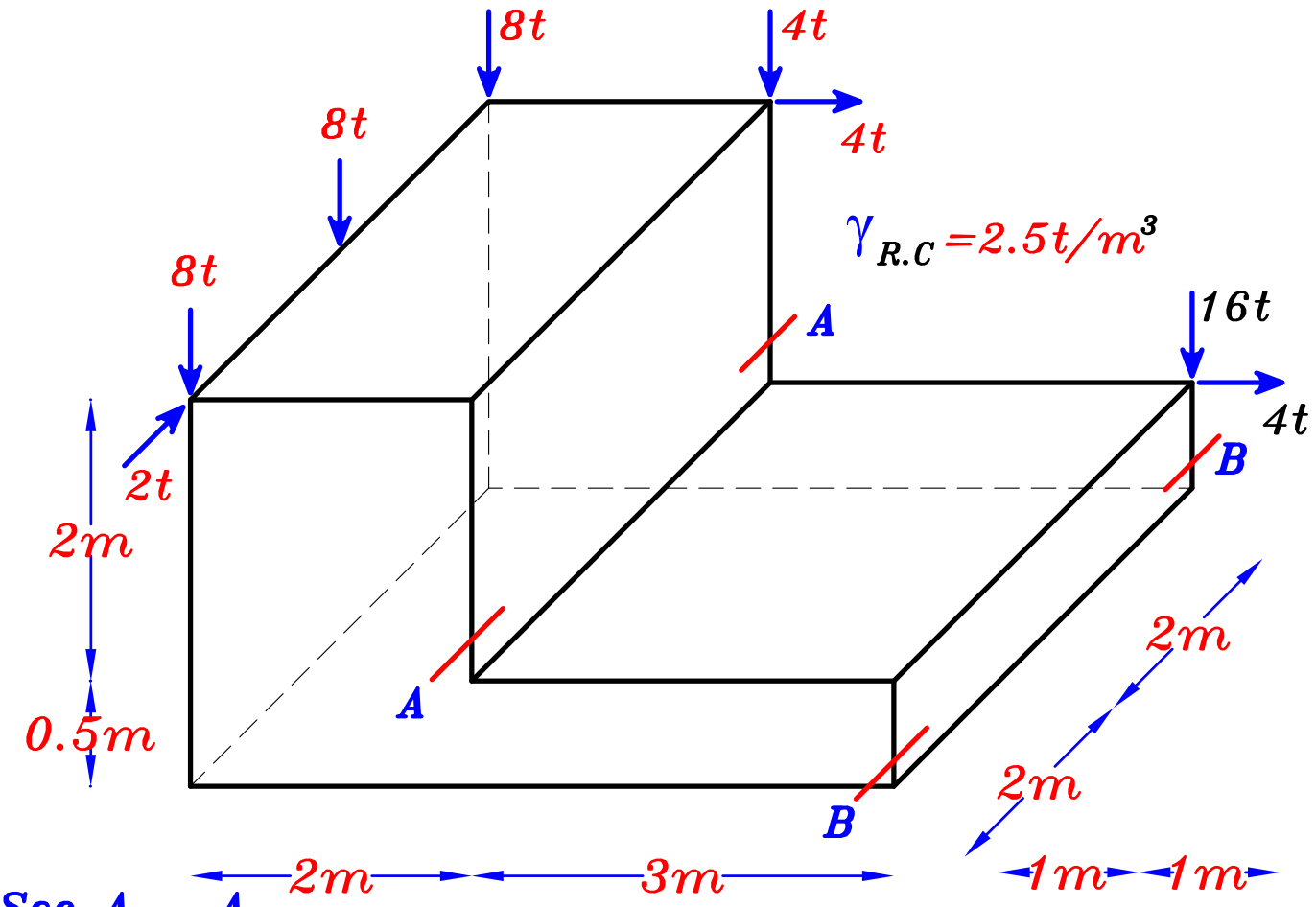
$4 - Mx = (10 + 15)(5) + (10 + 20)(1.5) - (5)(1.5) = 162.5\ m.t \uparrow$

$5 - My = (10 - 3)(5) + (20)(2) - (10 + 5)(2) = 45\ m.t \rightarrow$

$6 - Mt = (10)(1.5) + (3)(1.5) - (15)(2) + (10)(2) = 9.5\ m.t$ ↷

Example

For the shown block it is required to find the straining actions at section (A – A) .



Sec A – A

$W_1 = (4x2x2)\ (2.5) = 40\ t$

$N = (8 + 8 + 8 + 4 + W)$

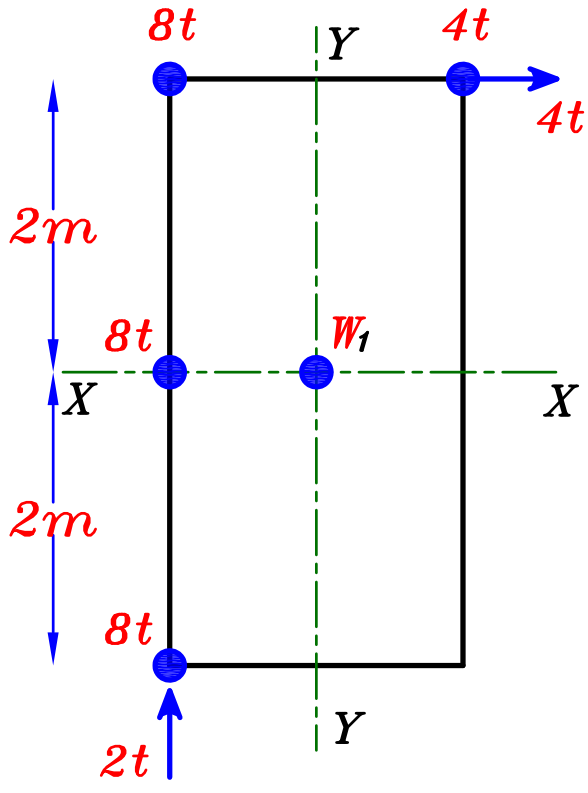
$= 68\ t\ (\ Comp.\ )$

$Mx = (8+4)(2) + (2)(2) - (8)(2)$

$= 12\ m.t.$ ↑

$My = (8+8+8)(1)-(4)(2)-(4)(1)$

$= 12\ m.t.$ ←

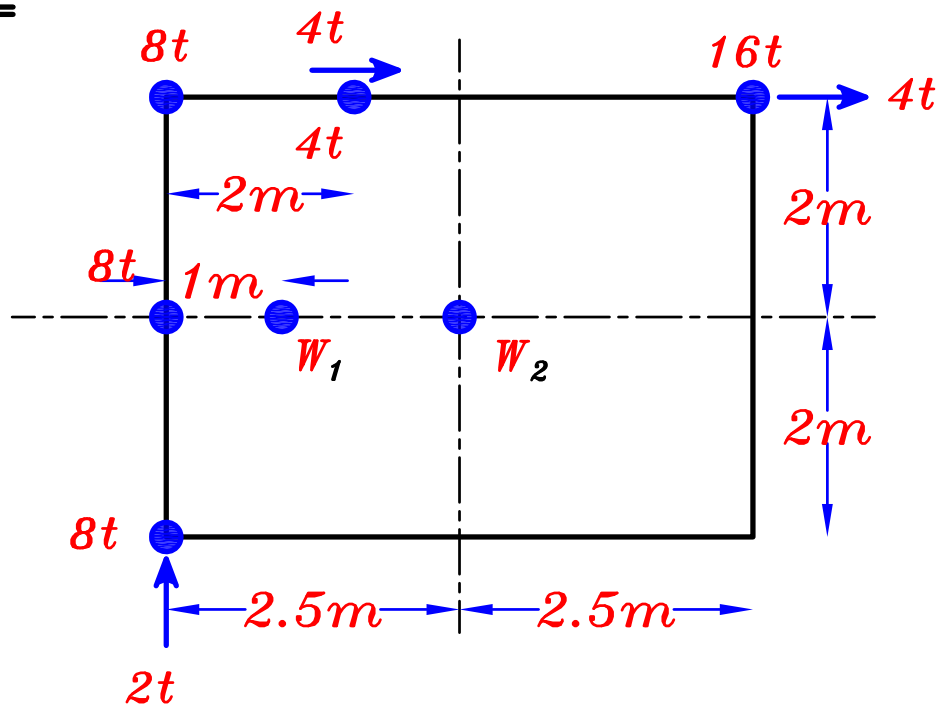


$Qx = 4t \longrightarrow$

$Qy = 2t \uparrow$

$Mt = (4)(2) + (2)(1) = 10\ m.t$ ↷

Sec B–B



$W_2 = 5 \times 5 \times 0.5 \times 2.5 = 25t$

$N = 8 + 8 + 8 + 4 + 16 + W_1 + W_2 = 109t\ (Comp.)$

$Qx = 4 + 4 = 8t \longrightarrow$

$Qy = 2t \uparrow$

$Mx = (8+4+16)(2) - (8)(2) + (2)(2.5) = 45m.t \uparrow$

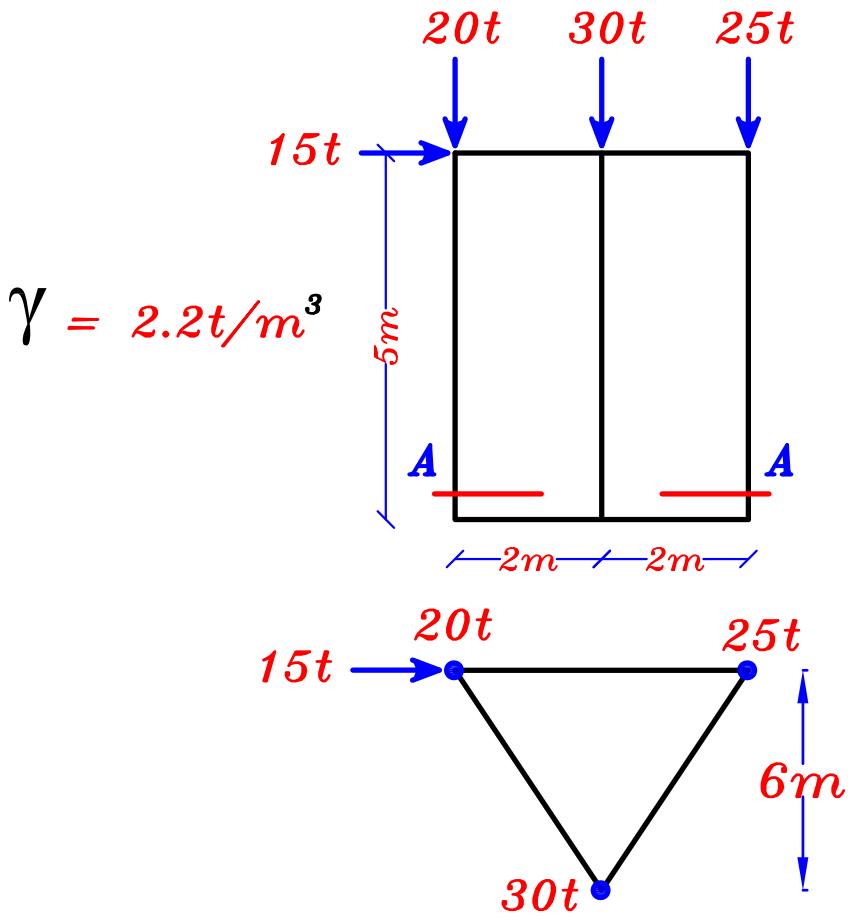
$My = (8+8+8)(2.5) + (W\ )(1.5) + (4)(0.5) - (16)(2)$

$- (4)(0.5) - (4)(2.5) = 78\ m.t \leftarrow$

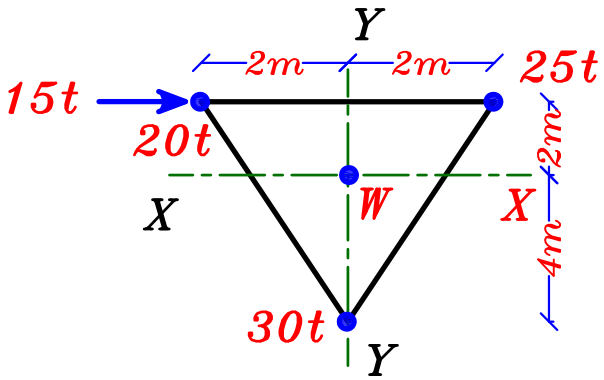
$Mt = (4+4)(2) + (2)(2.5) = 21\ m.t$ ↷

Example

For the shown concrete block determine the straining actions at section (A – A).



Sec A–A



$W = 0.5 \times 0.4 \times 6 \times 5 \times 2.2 = 132t$

$N = 20 + 25 + 30 + W = 207t$ (Comp.)

$Qx = 15t$ →

$Qy = 0$

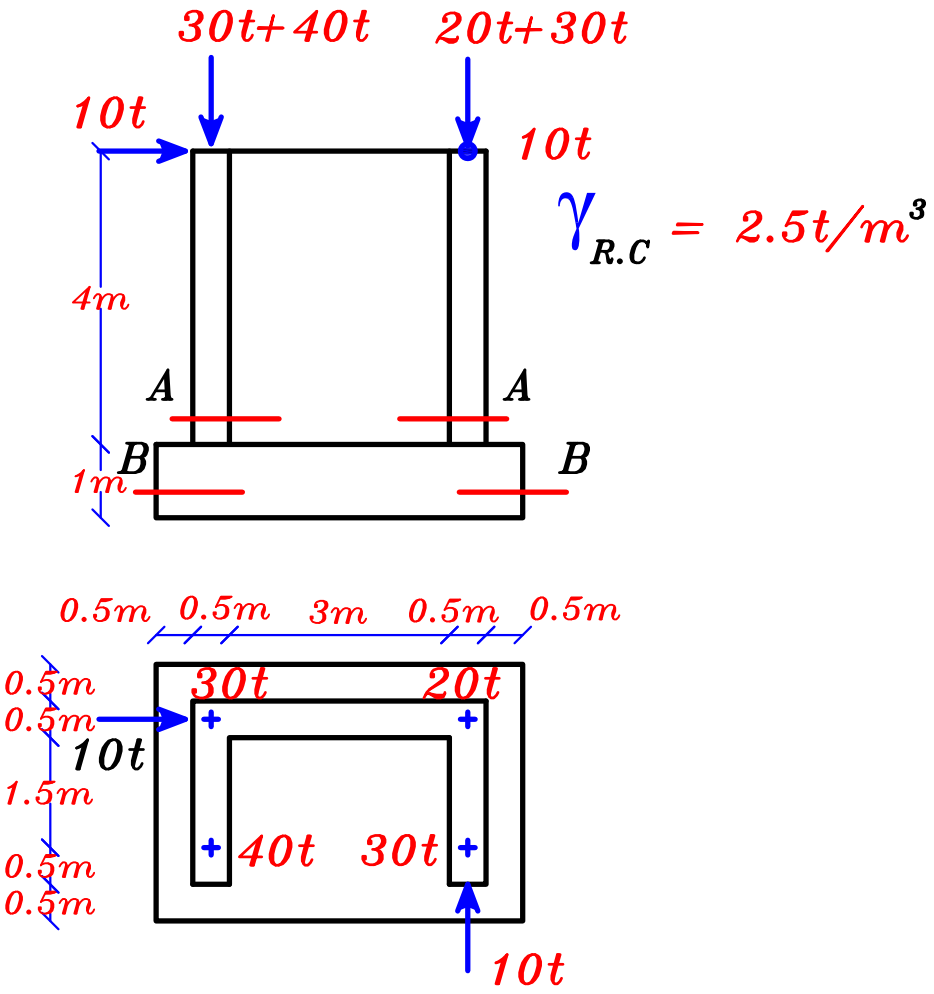
$Mx = (30)(4) - (20+25)(2) = 30m.t$ ↓

$My = (25)(2) + (15)(5) - (20)(2) = 85m.t$ →

$Mz = (15)(2) = 30m.t$ ↷

Example

For the shown concrete block determine the straining actions at section (A – A) & (B – B).

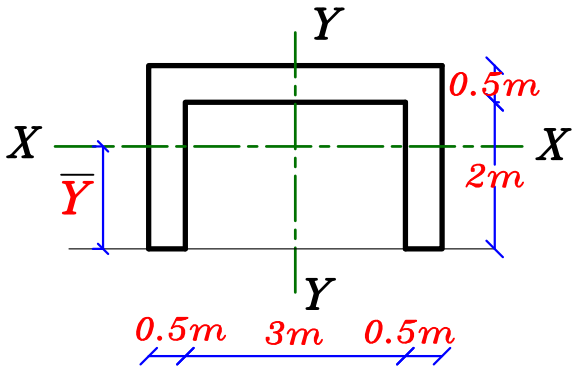


Sec A–A

$A = 4x2.5 - 3x2 = 4m^2$

$\overline{Y} = \dfrac{4x2.5x1.25 - 3x2x1}{4}$

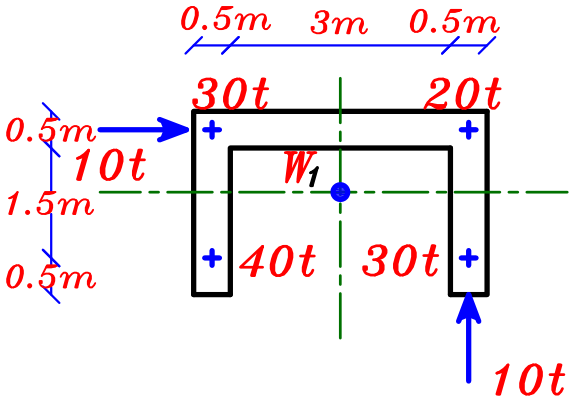
$= 1.625m$



$W_1 = 4 \times 4 \times 2.5 = 40t$

$N = 30+20+40+30+W_1$

$= 160t$ (Comp.)



$Qx = 10t \rightarrow$

$Qy = 10t \uparrow$

$Mx = (40+30)(1.125) - (30+20)(0.625) - (10)(4)$

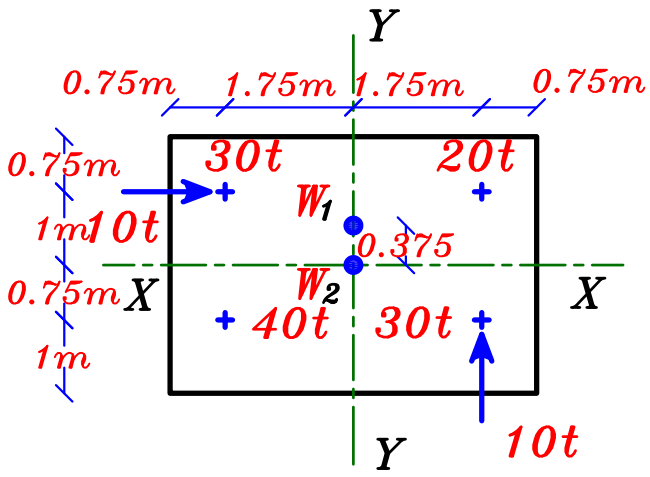
$= 7.5\ m.t \downarrow$

$My = (20+30)(1.75) + (10)(4) - (30+40)(1.75)$

$= 5m.t \rightarrow$

$Mt = (10)(1.75) - (10)(0.625) = 11.25\ m.t$ ↺

Sec B–B



$W_2 = 5 \times 3.5 \times 1 \times 2.5 = 43.75t$

$N = 20 + 30 + 40 + 30 + W_1 + W_2 = 203.75$ (Comp.)

$Qx = 10t \rightarrow$

$Qy = 10t \uparrow$

$Mx = (20+30)(1) + (W)(0.375) + (10)(5)$

$- (40+30)(0.75) = 62.5 m.t \uparrow$

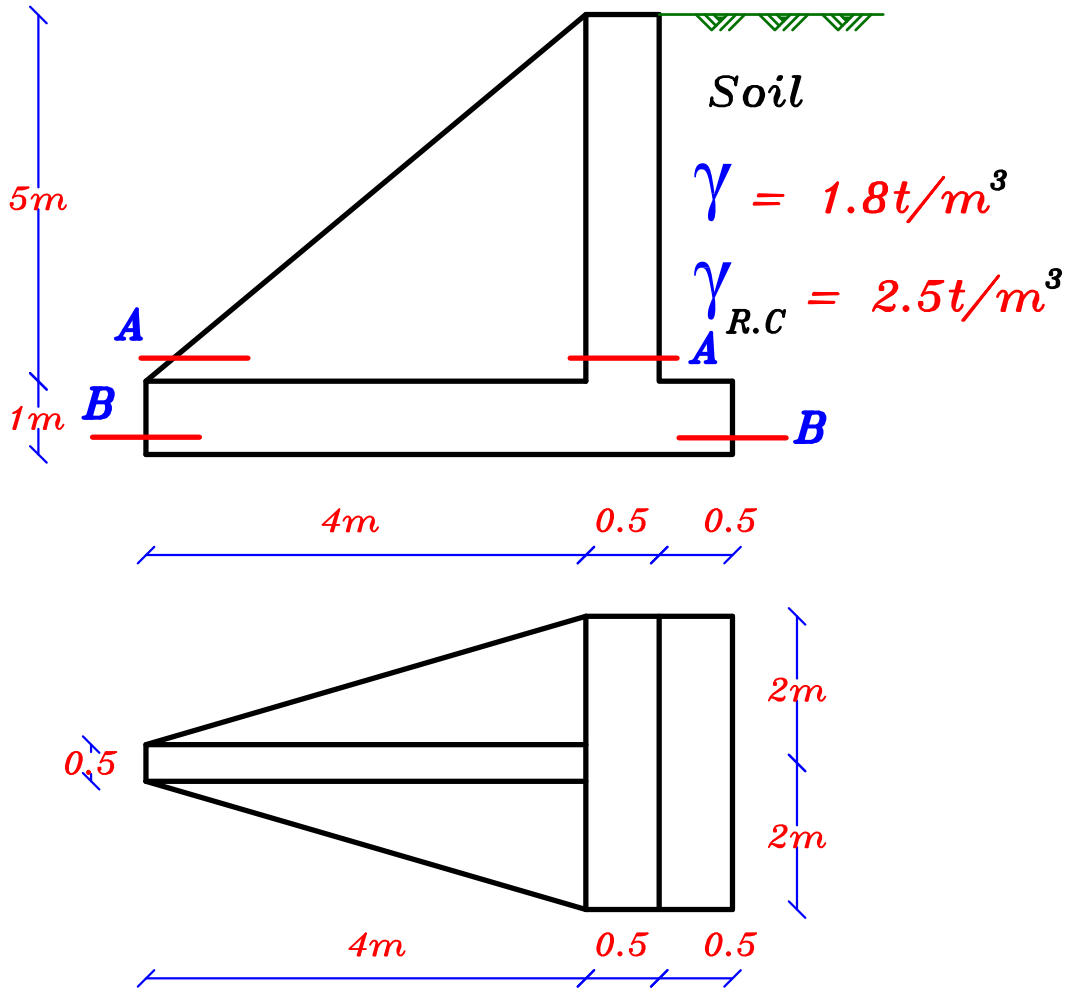
$My = (20+30)(1.75) + (10)(5) - (40+30)(1.75)$

$= 15 m.t \rightarrow$

$Mt = (10)(1.75) - (10)(1) = 7.5\ m.t$ ↺

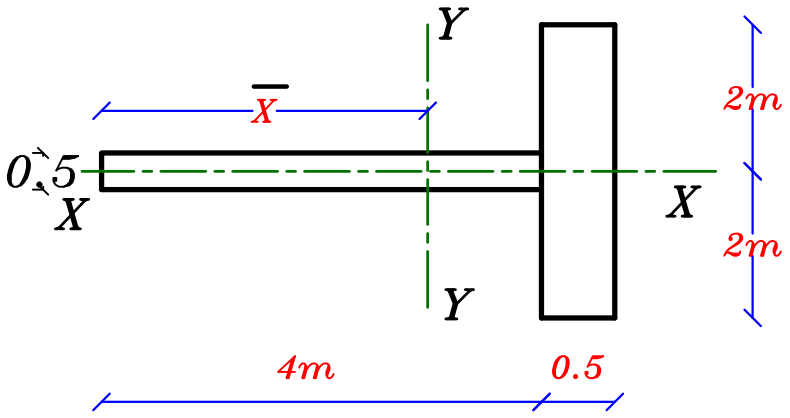
Example

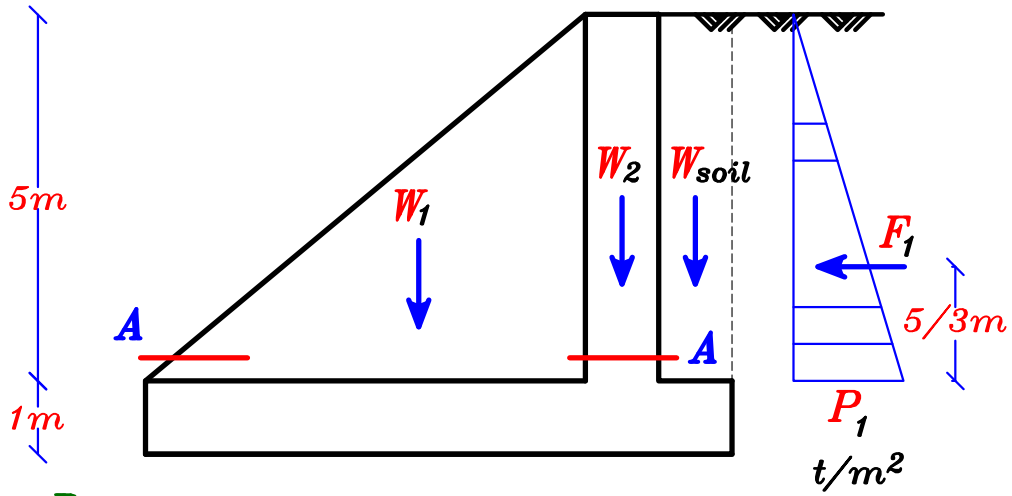
For the shown concrete block determine the straining actions at section (A – A) & (B – B).



Sec A–A

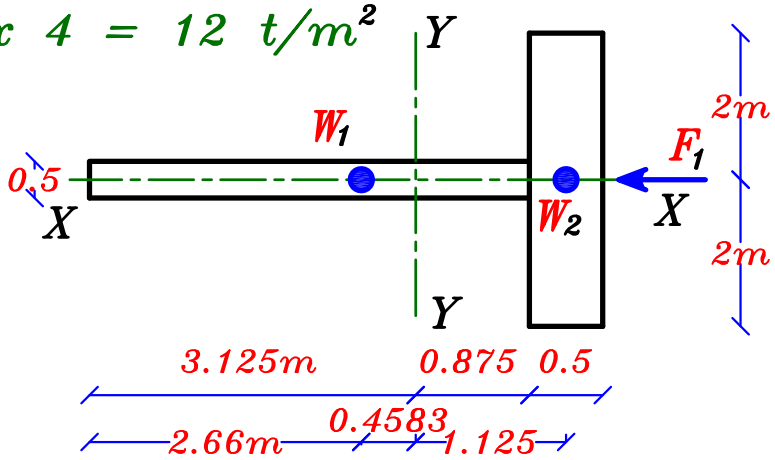
$$\bar{X} = \frac{(4)(0.5)(2) + (4)(0.5)(4.25)}{4} = 3.125m$$





$$P_1 = k \times \gamma \times h_1 \times B$$

$$= \tfrac{1}{3} \times 1.8 \times 5 \times 4 = 12\ t/m^2$$



$$W_1 = 0.5x4x5x0.5x2.5 = 12.5t$$

$$W_2 = 4x0.5x5x2.5 = 25t$$

$F_1 = 0.5 x P_1 \; x \; h_1 = 0.5 \; x \; 12 \; x \; 5 = 30 \; t$

$N = W_1 + W_2 = 37.5 \; (\; Comp. \;)$

$Qx = F_1 = 30t \leftarrow$

$Qy = 0$

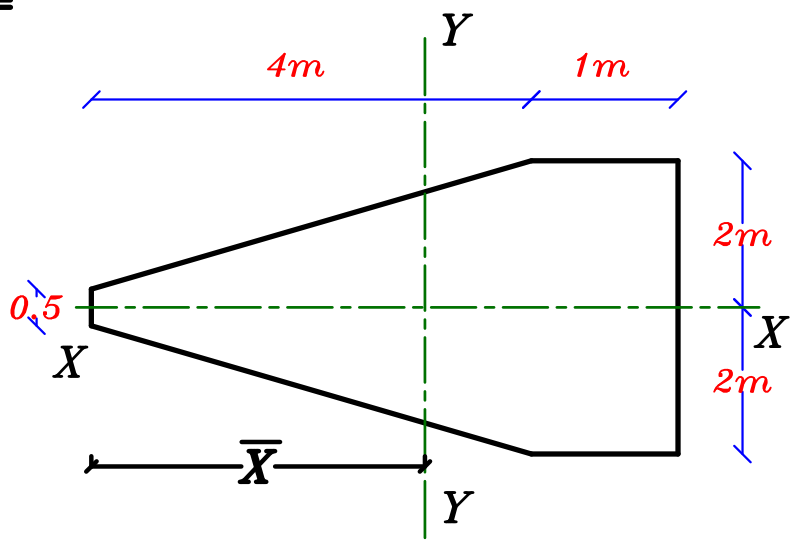
$Mx = 0$

$My = (W_1)(0.4583) + (F_1)(5/3) - (W_2)(1.125)$

$= (12.5)(0.4583) + (30)(5/3) - (25)(1.125) = 27.6 m.t \leftarrow\leftarrow$

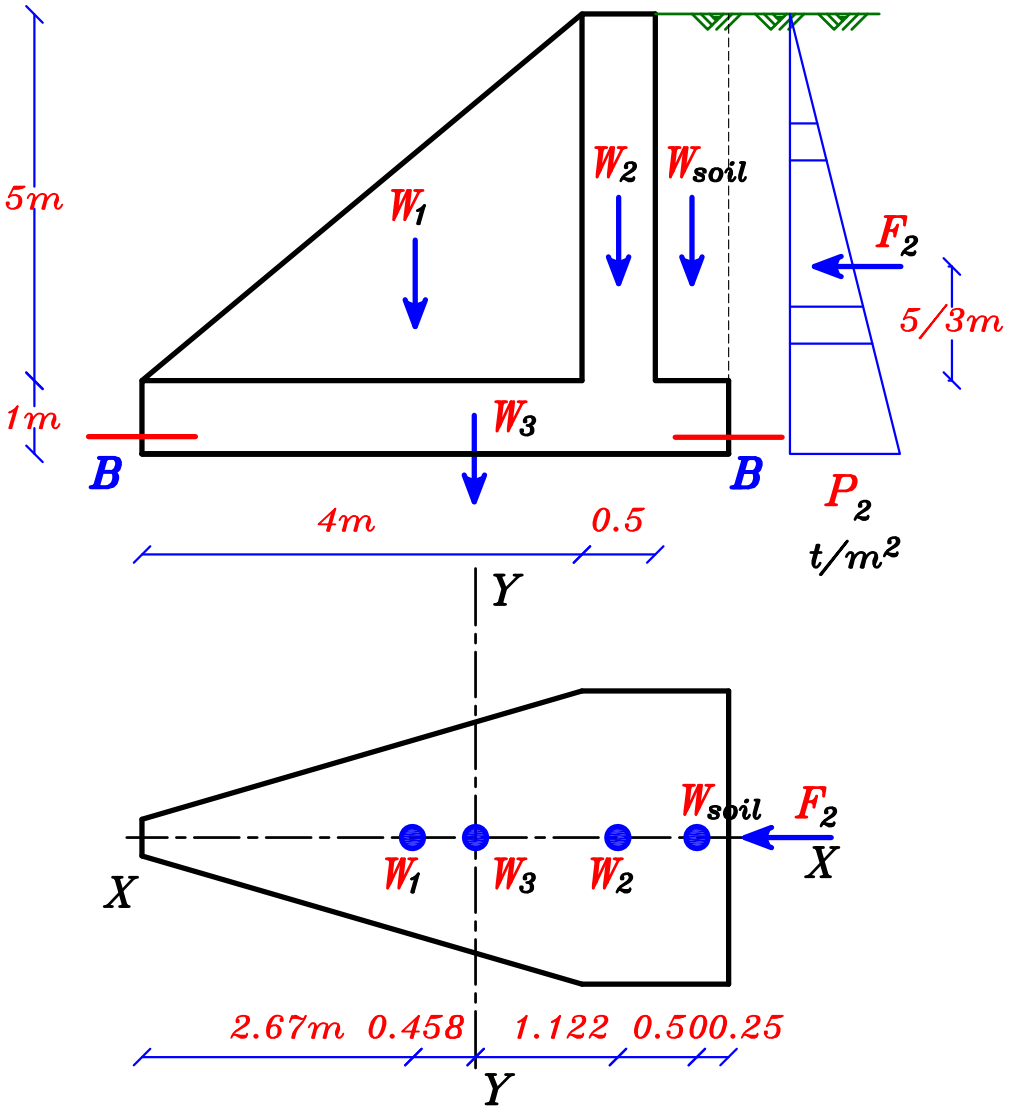
$Mt = 0$

Sec B–B



$A = 4x5 - 0.5x4x1.75x2 = 13 m^2$

$$\overline{X} = \frac{(4)(5)(2.5) - (4)(0.5)(1.75)(4/3)(2)}{13} = 3.128 m$$



$W_3 = 13x1x2.5 = 32.5t$

$W_{soil} = 4x0.5x5x1.8 = 18t$

$P_2 = k \; x \; ? \; x \; h_2 x \; B = ⅓ \; x \; 1.8 \; x \; 6 \; x \; 4 = 14.4 \; t/m^2$

$F_2 = 0.50 \; x \; P \; x \; h_2 = 0.50 \; x \; 14.4 \; x \; 6 = 43.2 \; t$

$N = W_1 + W_2 + W_3 + W_{soil} = 88 \; (\; Comp. \;)$

$Qx = F_2 = 43.2 \; t \; \leftarrow$

$Qy = 0$

$$Mx = 0$$

$$My = (W_1)(0.458) + (F_2)(2) - (W_2)(1.122)$$

$$- (W_{soil})(1.622)$$

$$= (12.5)(0.458) + (43.2)(2) - (25)(1.122)$$

$$- (18)(1.622) = 34.88 \ m.t \leftarrow\leftarrow$$

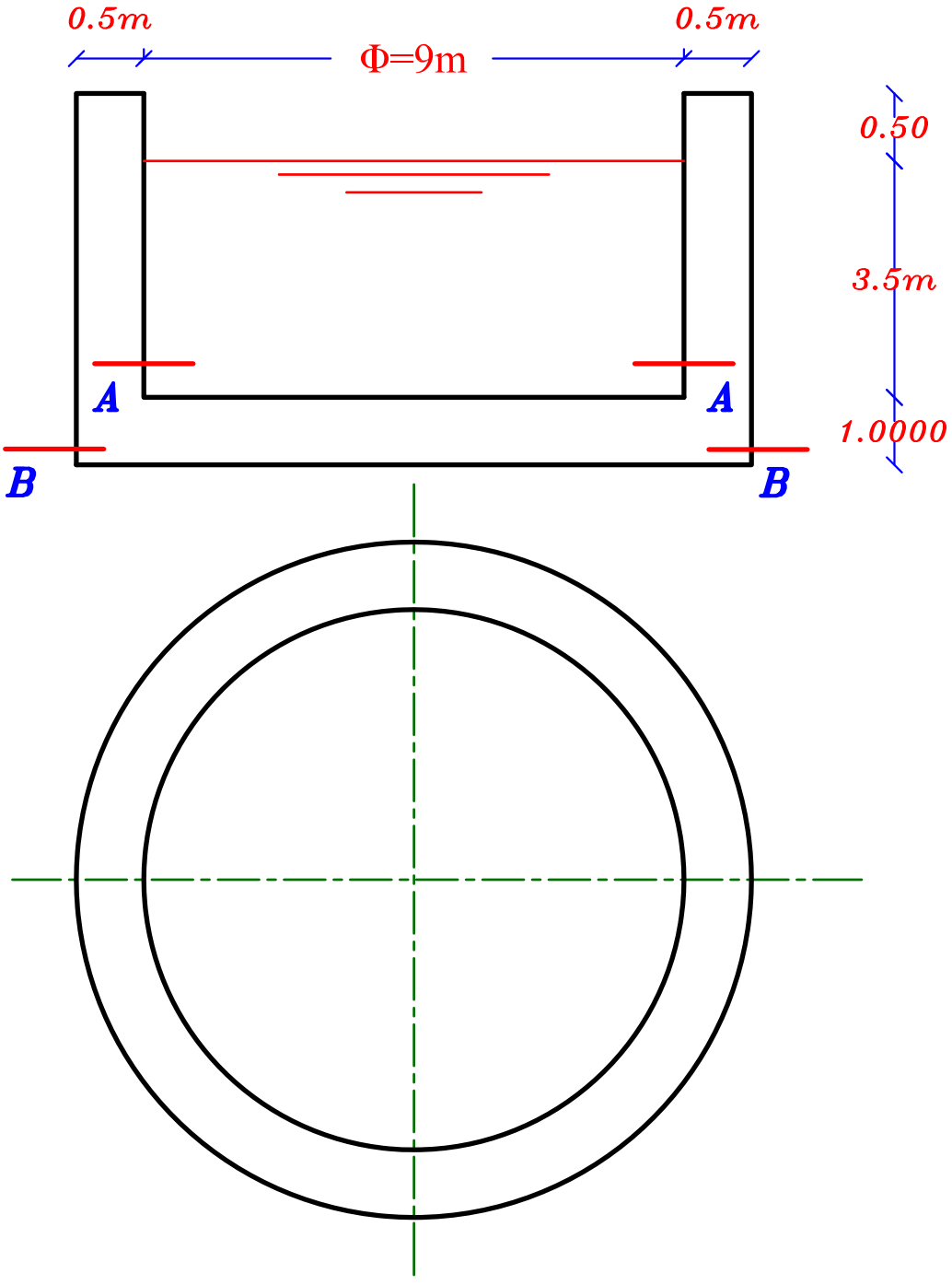
$$Mt = 0$$

ملحوظة هامة

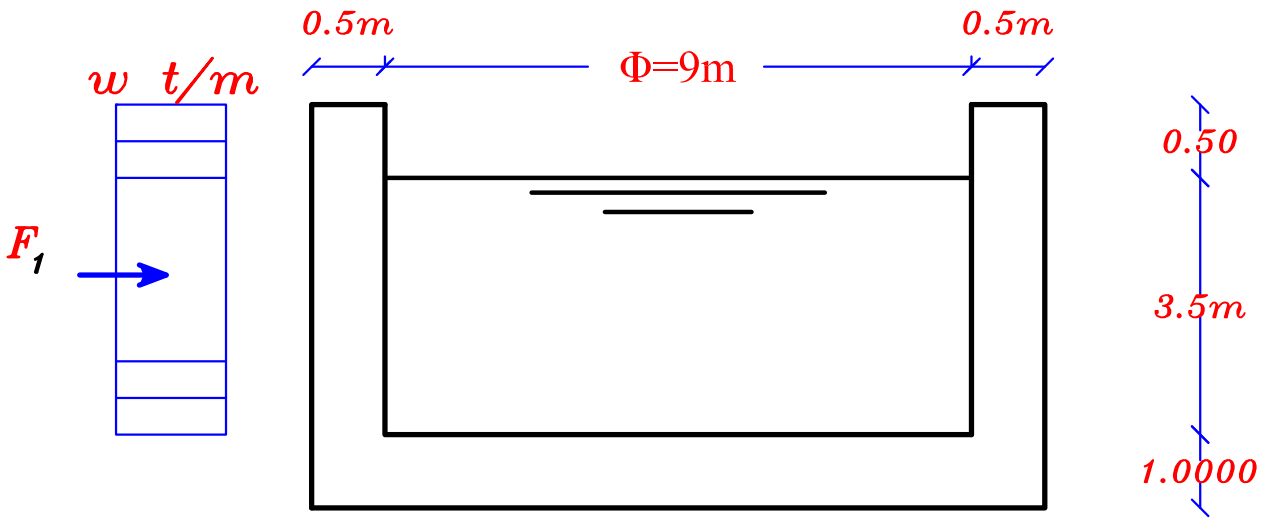
فى حالة وجود رياح يتم تحويل شدة الرياح الى *uniform load* و ذلك عن طريق ضرب قيمة شدة الرياح فى عرض المنشأ الذى تصطدم به الرياح فيكون الناتج هو قيمة الـ *uniform load*

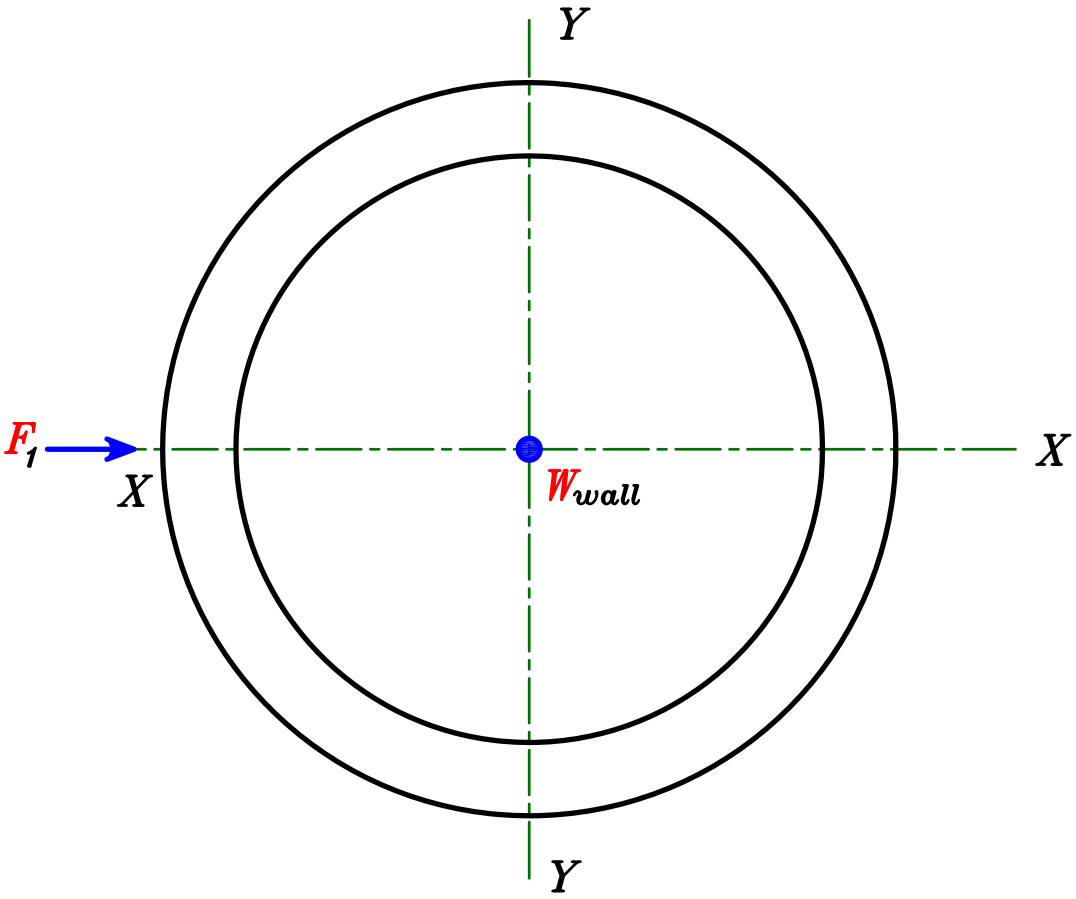
Example

For the shown water tank subjected to a wind pressure with intensity of 0.2 t/m^2 , determine the straining actions at section (A – A) & (B – B).



Sec A–A





Sec A–A

Uniform load = wind intensity x width

= 0.20 x 10 = 2 t/m

$F_1 = (w) (4) = 8 \ t$

$Wwall = \pi [(5)^2 - (4.5)^2] (4) (2.5) = 149.22 \ t$

$N = Wwall = 149.22t$ (Comp.)

$Qx = 8t \longrightarrow$

$Qy = 0$

$Mx = 0$

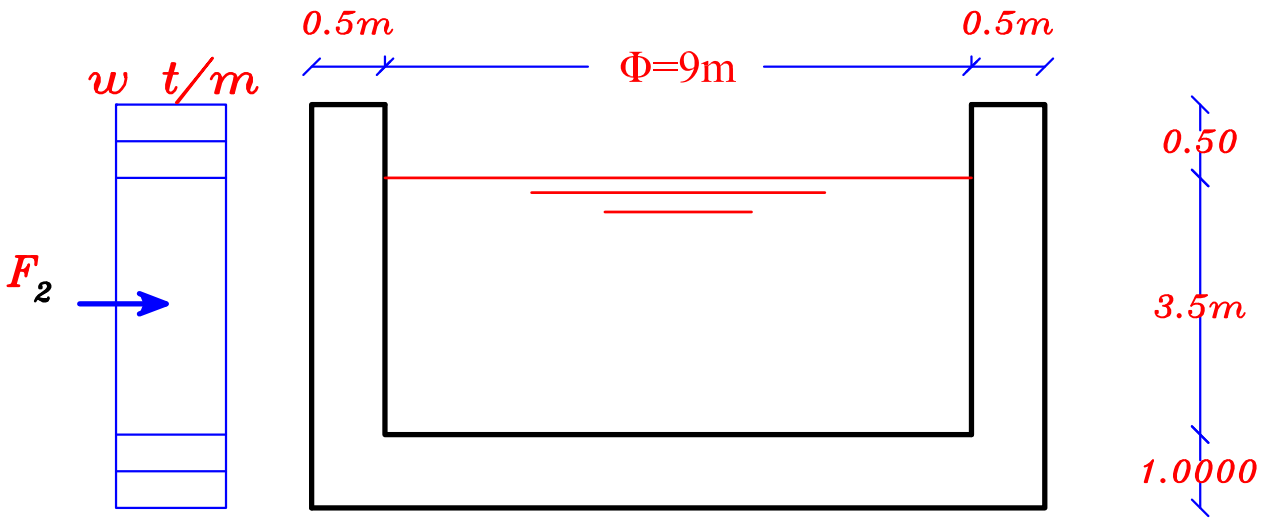
$My = (F_1) (2) = 16 \ m.t \twoheadrightarrow$

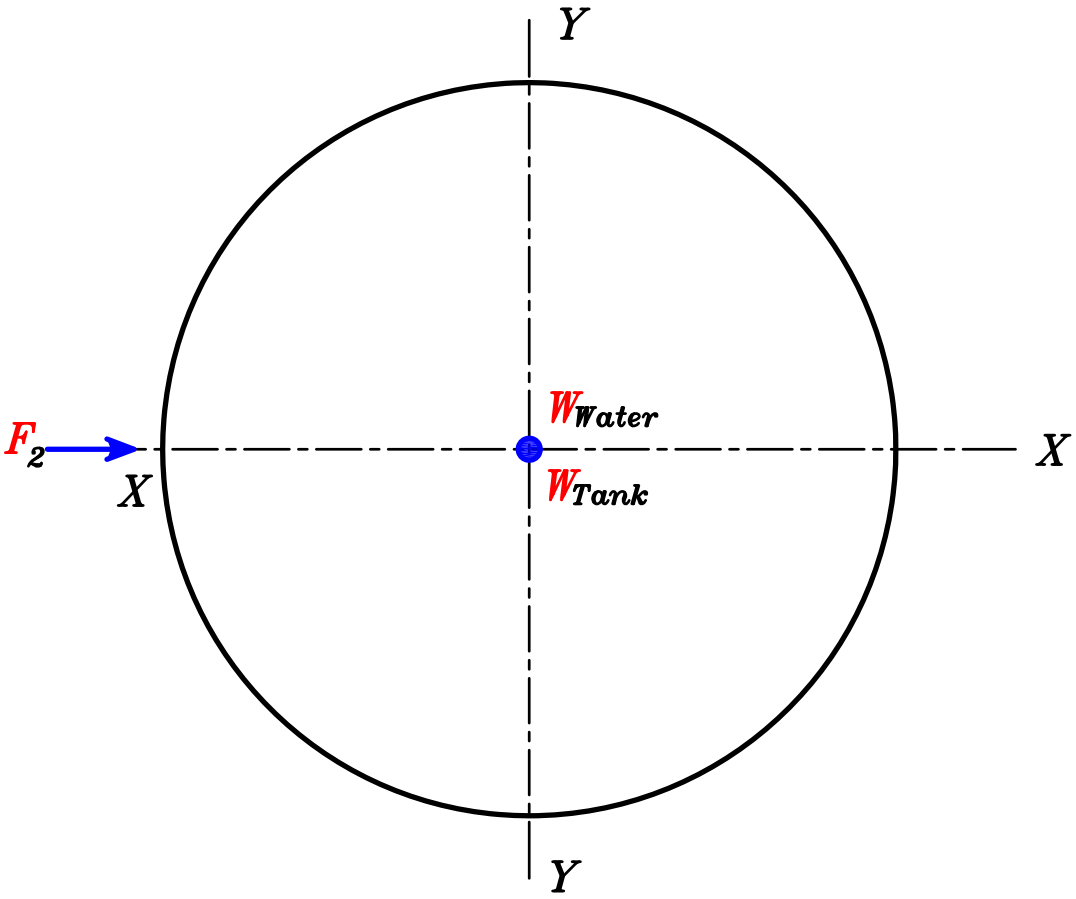
$Mt = 0$

ملحوظة هامة

فى حالة Sec A–A لا يتم أخذ وزن المياه معنا فى الحسابات و ذلك لان المياه محملة على قاعدة الخزان بينما Sec A–A يوجد فى حوائط الخزان

Sec B–B





Sec B–B

Uniform load = wind intensity x width

$= 0.20 \times 10 = 2 \ t/m$

$F_2 = (w) (5) = 10 \ t$

$Wwall = [\pi (5)^2 (5) - \pi (4.5)^2 (4)](2.5) = 345.5 \ t$

$Wwater = [\pi (4.5)^2 (3.5)] (1.0) = 222.66t$

$N = Wwall + Wwater = 568.16t$ (Comp.)

$Qx = 10t \longrightarrow$

$Qy = 0$

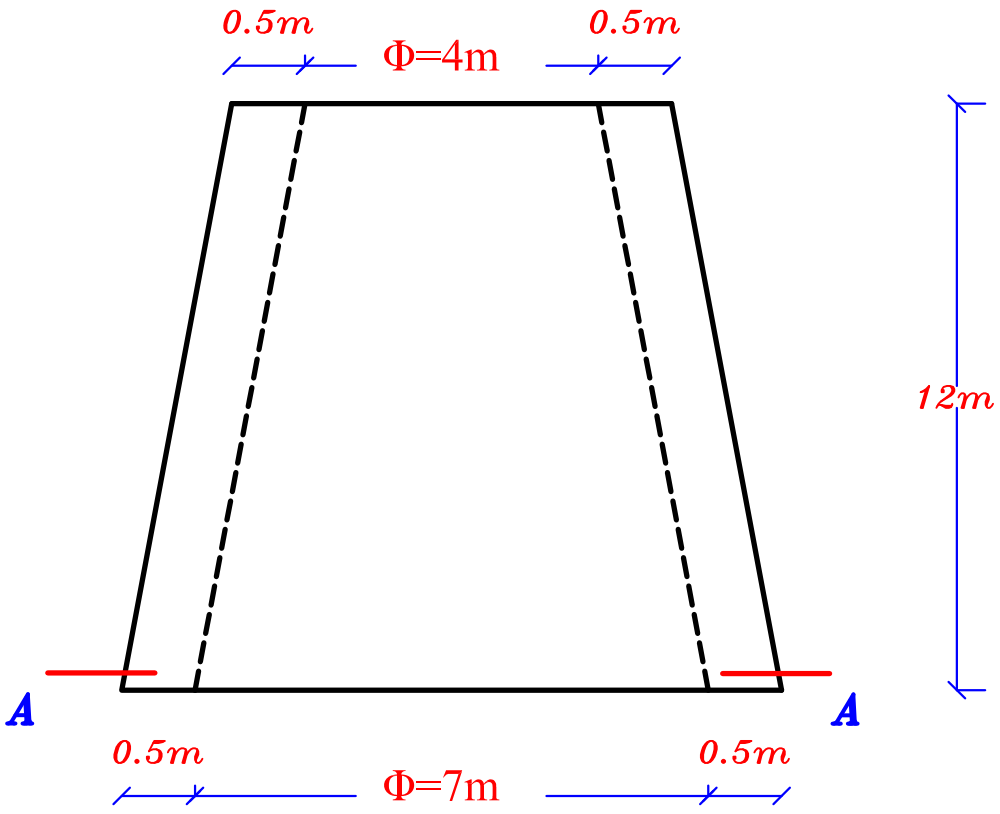
$Mx = 0$

$My = (F_2) (2.5) = 25 \ m.t \twoheadrightarrow$

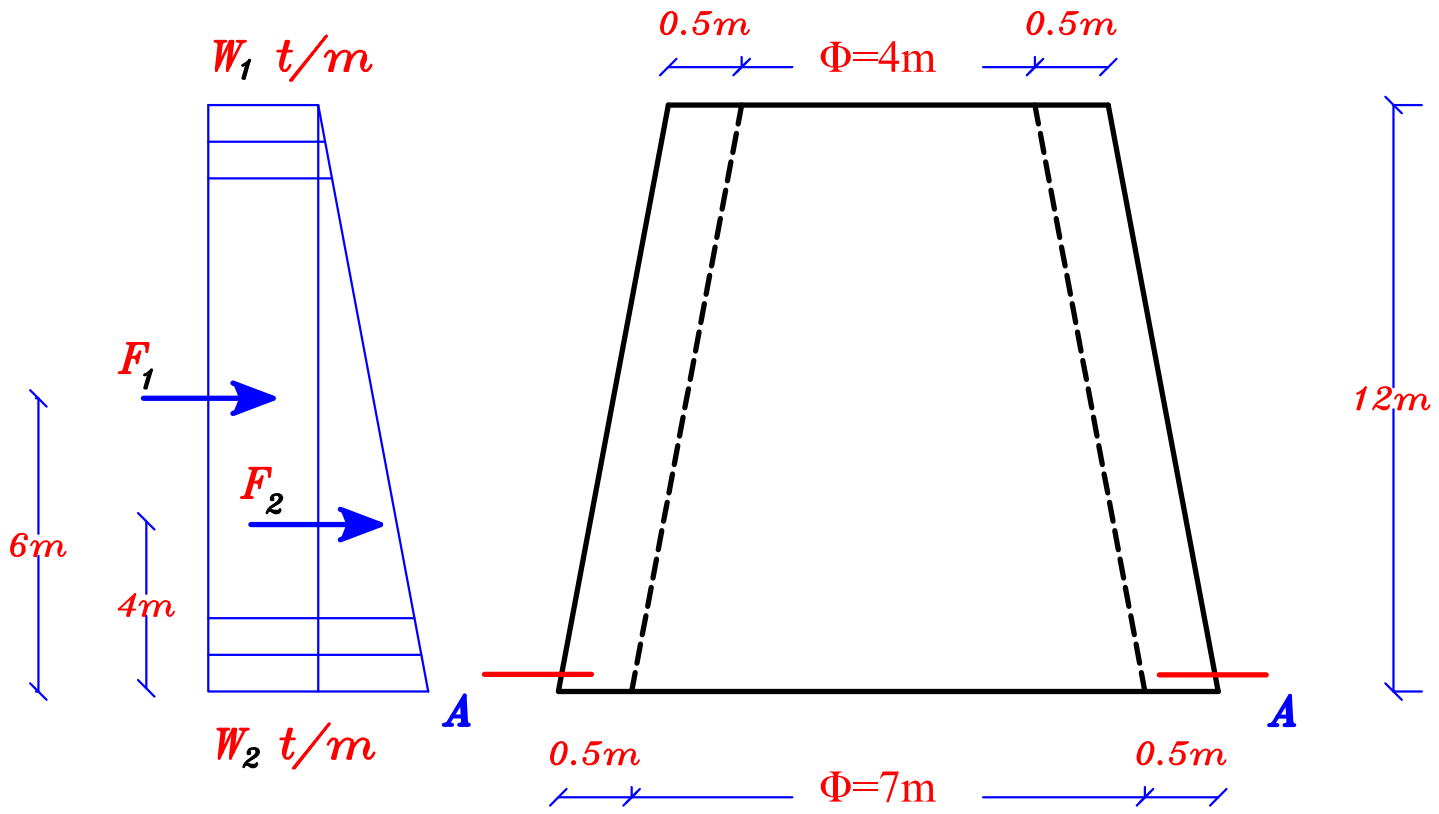
$Mt = 0$

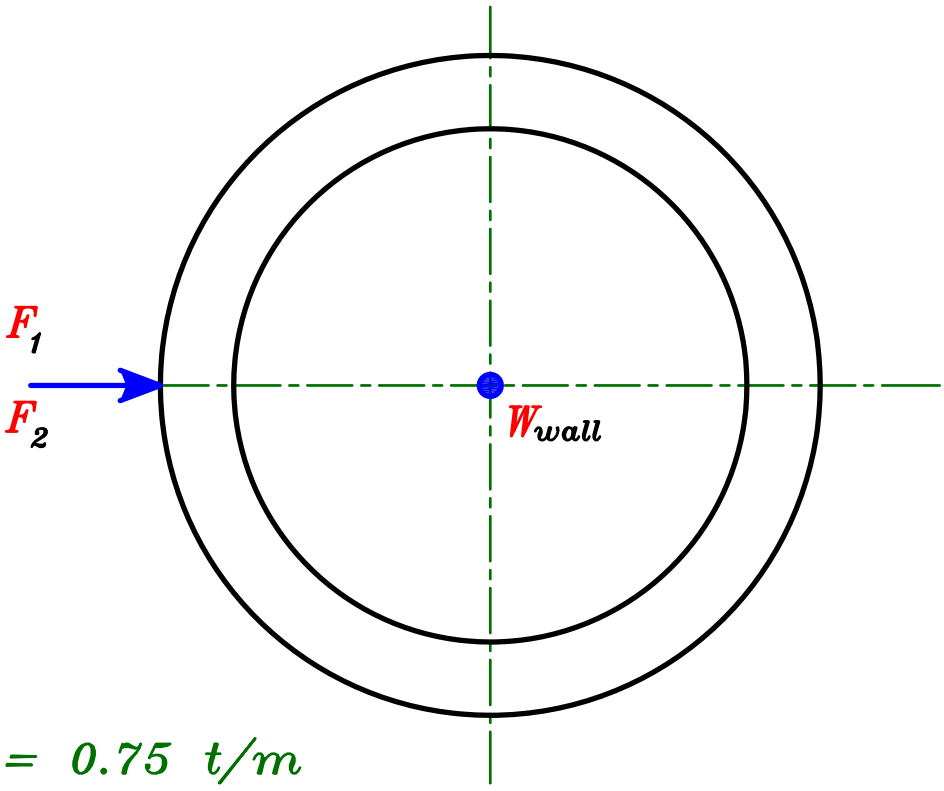
Example

For the shown concrete chimeny subjected to a wind pressure with intensity of 0.15 t/m^2 , determine the straining actions at section (A – A) .



Sec A–A





$W_1 = 0.15 \times 5 = 0.75 \ t/m$

$W_2 = 0.15 \times 8 = 1.2 \ t/m$

$F_1 = W_1 \; x \; 12 = 9t$

$F_2 = 0.5 \; (\; W_2 - W_1 \;) \; x \; 12 = 2.7t$

$Wwall = A_{mean} \; x \; h \; x \; \gamma$

$A_{mean} = \pi \; [\; (3.25)^2 - (2.75)^2 \;] = 9.424 \; m^2$

$Wwall = 9.424 \; x \; 12 \; x \; 2.5 = 282.75 \; t$

$N = Wwall = 282.75 \; (\; Comp. \;)$

$Qx = F_1 + F_2 = 11.7t \longrightarrow$

$Qy = 0$

$Mx = 0$

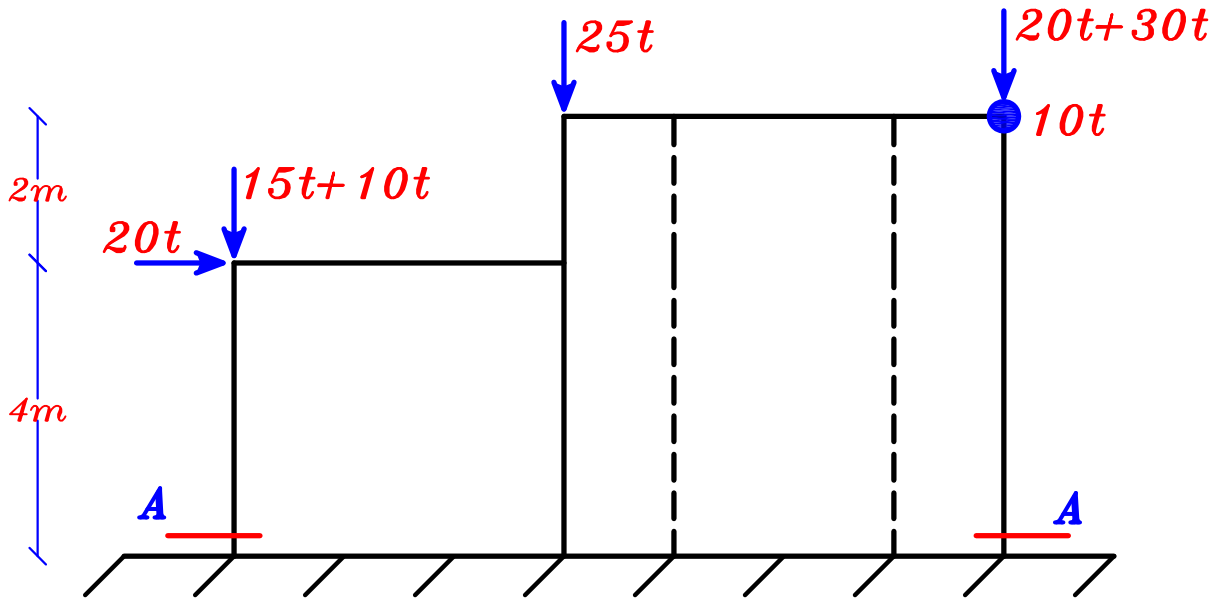
$My = (\; F_1 \;) \; (\; 6 \;) + (\; F_2 \;) \; (\; 4 \;)$

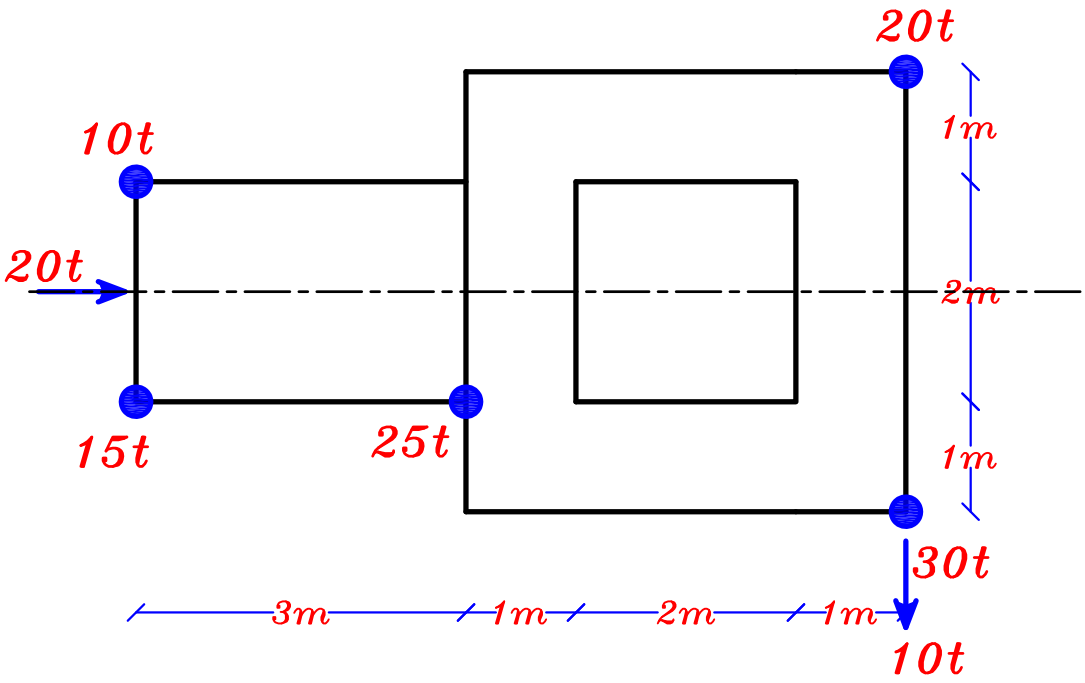
$= 64.8 \; m.t \longrightarrow$

$Mt = 0$

Example

For the shown block it is required to find the straining actions causing normal stresses only at section (A – A) .

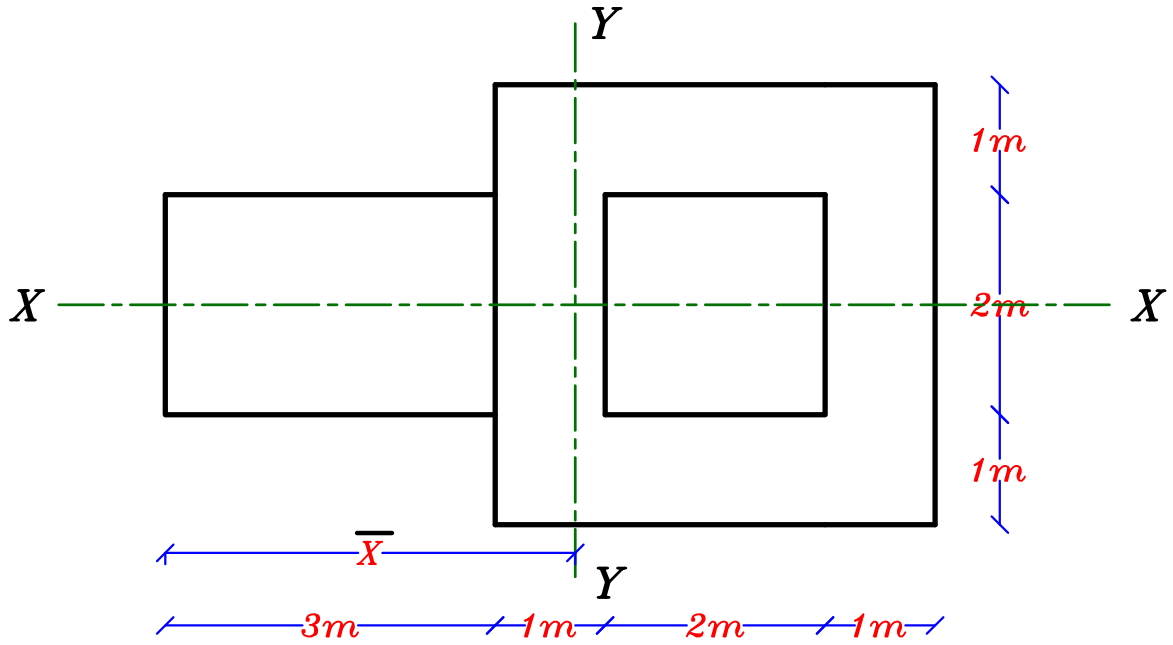




$$\gamma_{R.C} = 2.5 t/m^3$$

For sec A – A

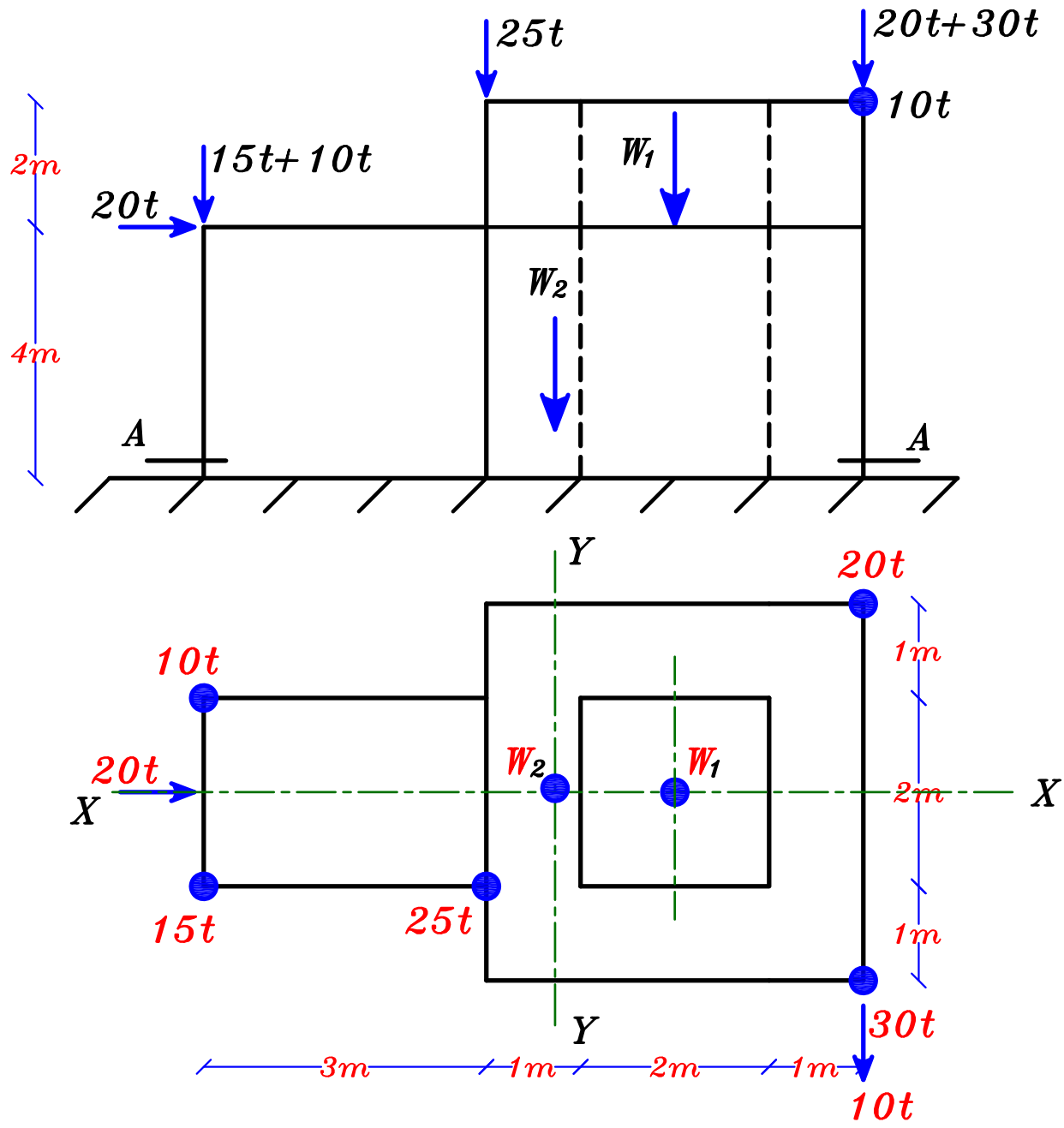
1– Properties of area



$$A = (3x2) + (4x4 - 2x2) = 18\ m^2$$

$$\overline{X} = \frac{(3x2)(1.5) + (4x4)(5) - (2x2)(5)}{18} = 3.833\ m$$

2- Straining actions



$W_1 = (4x4 - 2x2)\ (2)\ (2.5) = 60\ t$

$W_2 = (18)\ (4)\ (2.5) = 180\ t$

$N = 10 + 15 + 25 + 30 + 20 + W_1 + W_2$

$= 340\ t\ (\ Comp.\ )$

$$Mx = (15x1) + (25x1) + (30x2) + (10x6) - (10x1)$$

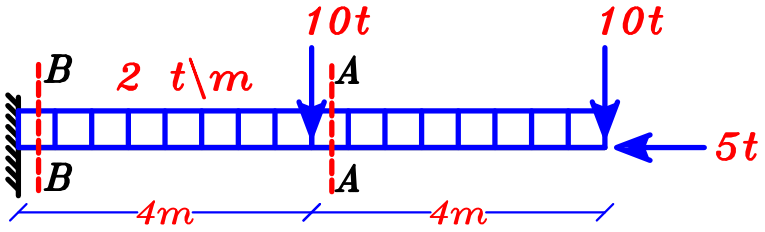
$$- (20x2) = 110 \ m.t \downarrow$$

$$My = (20+30)(3.167) + (W_1)(1.167) + (20x4)$$

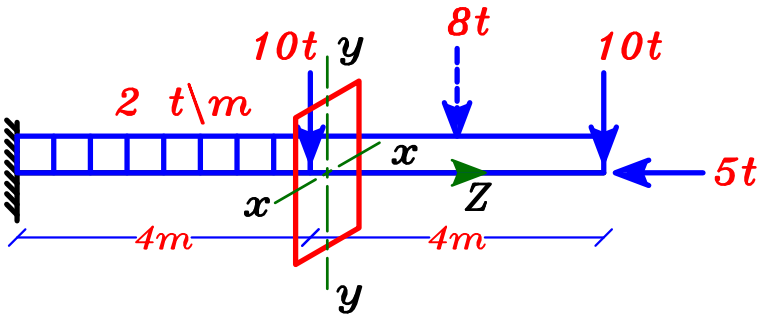
$$- (25x0.833) - (10+15)(3.833) = 191.66 \ m.t \rightarrow$$

Example

For the shown beam subjected to the in plane loads shown it is required to find the straining actions at section (A – A) & (B – B) .



Sec. A–A



$5\ t$ (Comp.)

$= 0$

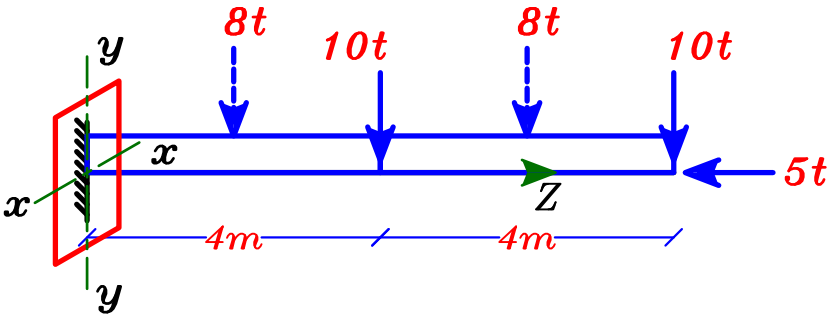
$Q_Y = 18\ t \downarrow$

$M_X = 10 * 4 + 8 * 2 = 56\ m.t \downarrow\downarrow$

$M_Y = 0$

$M_Z = 0$

Sec. B–B



$N = 5\ t$ (Comp.)

$Q_X = 0$

$Q_Y = 36\ t \downarrow$

$M_X = 10 * 8 + 8 * 6 + 10 * 4 + 8 * 2 = 184\ m.t \downarrow\downarrow$

$M_Y = 0$

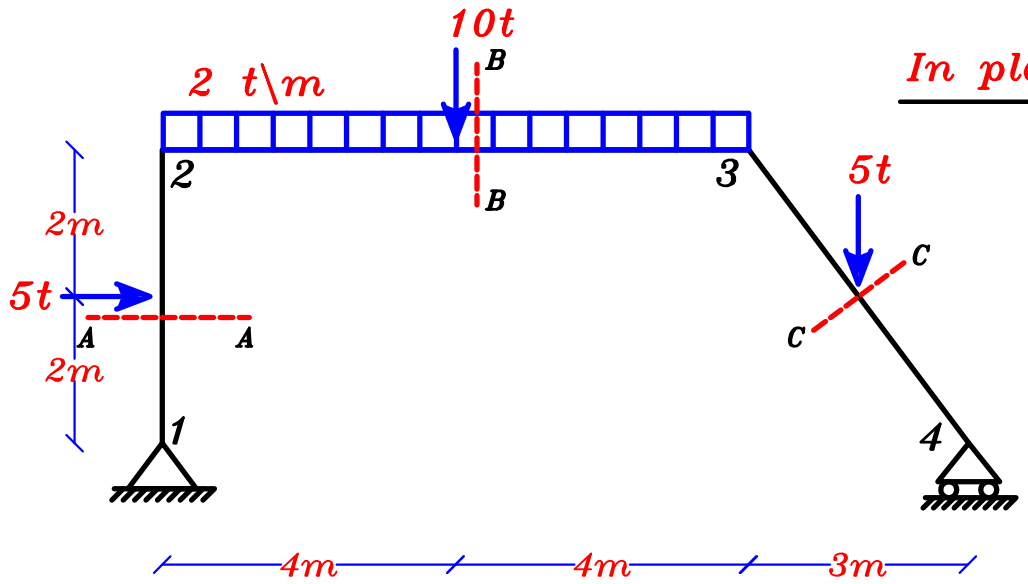
$M_Z = 0$

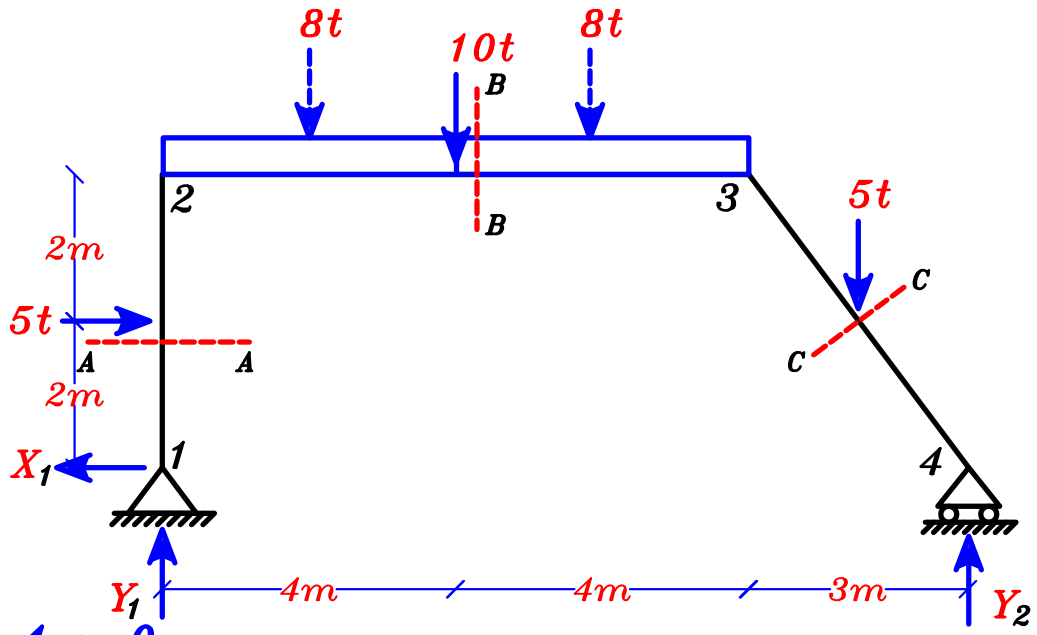
و من الممكن حساب الـ *Shear & moment* مباشرة فى الكمرات و يكون الـ *Shear* هو Q_Y و الـ *moment* هو M_X .

Example

For the shown frame it is required to find the straining actions at section (A – A) & (B – B) & (C – C) .

In plane loads





$\Sigma M_{@\ 4} = 0$

$10 * 7 + 8 * 5 + 8 * 9 + 5 * 1.5 - 5 * 2 - Y_1 * 11 = 0$

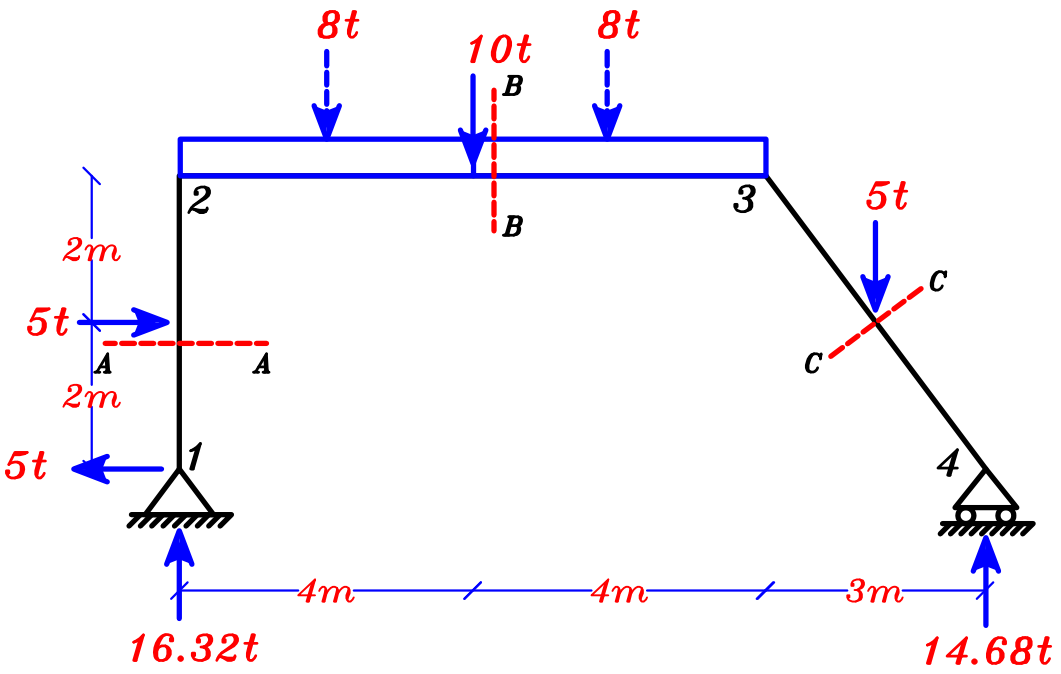
$\boxed{Y_1 = 16.32\ t}$

$\Sigma Y = 0$

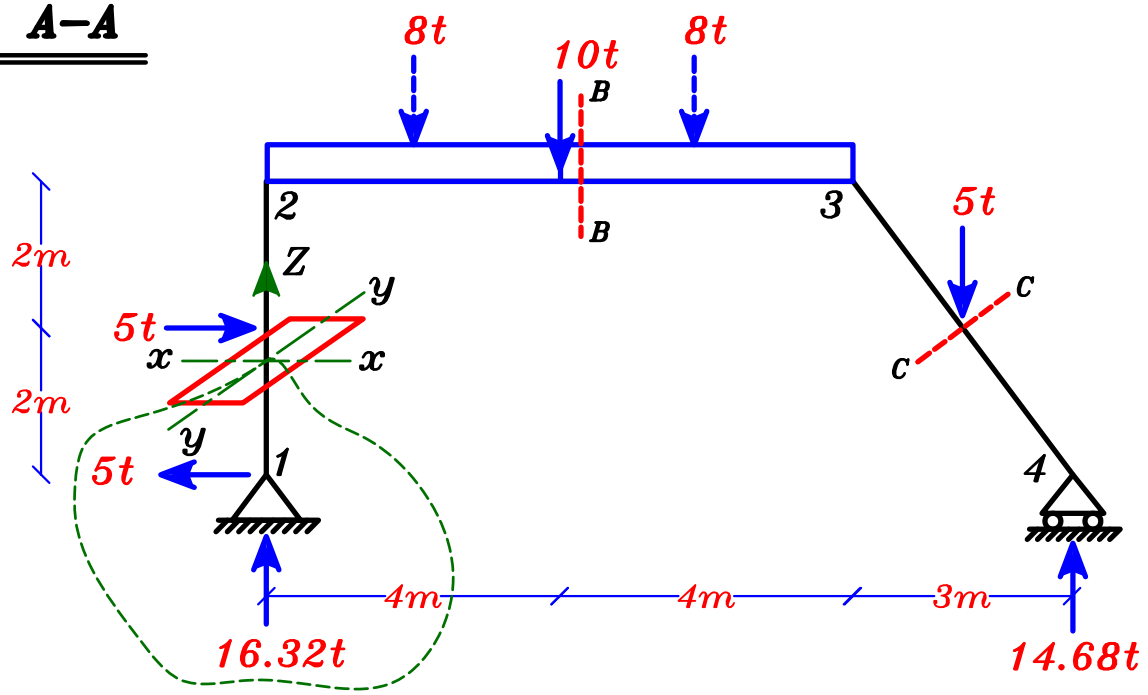
$8 + 8 + 10 + 5 - 16.32 + Y_4 = 0$ $\quad \boxed{Y_2 = 14.68\ t}$

$\Sigma X = 0$

$5 - X_1 = 0$ $\quad \boxed{X_1 = 5\ t}$



Sec. A–A



$N = 16.32$ t (Comp.)

$Q_X = 5$ t ←

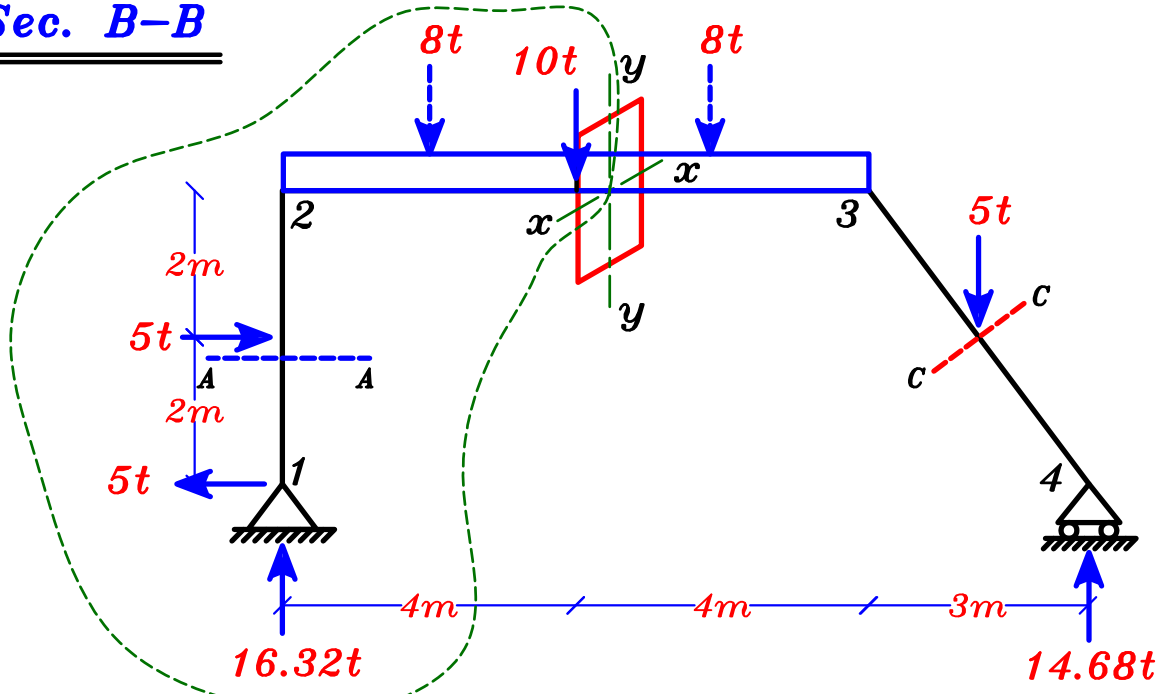
$Q_Y = 0$

$M_X = 0$

$M_Y = 5 * 2 = 10$ m.t ←←

$M_Z = 0$

Sec. B–B



$N = 5 - 5 = 0$

$Q_X = 0$

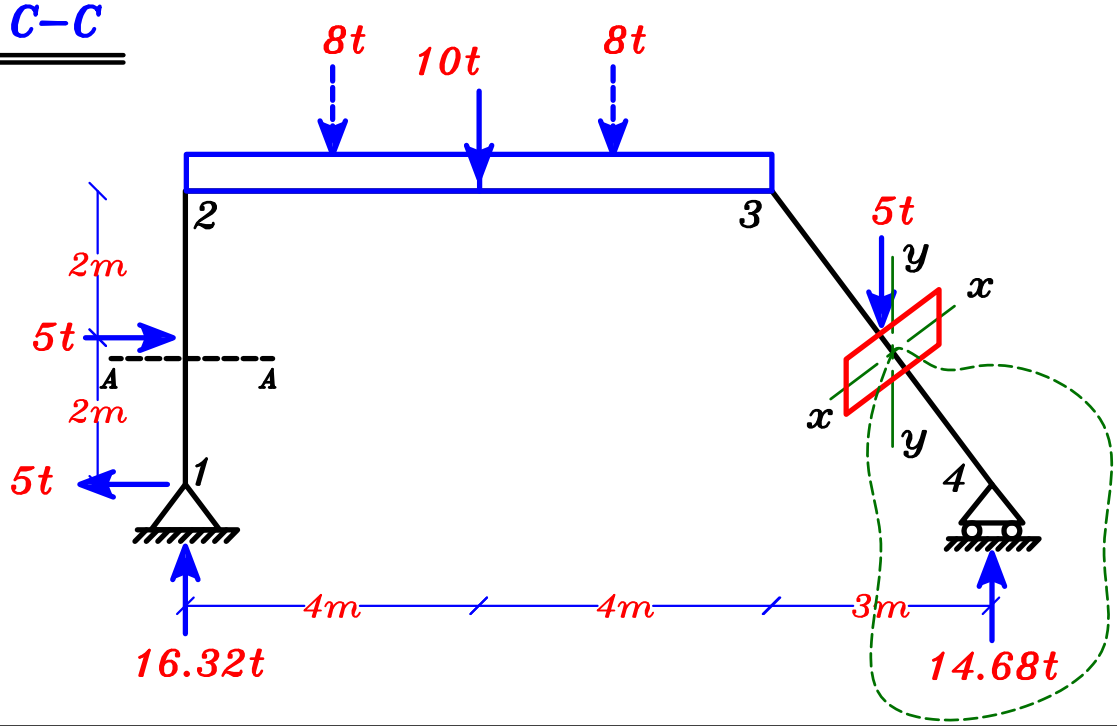
$Q_Y = 8 + 10 - 16.32 = 1.68 \ t$ ↓

$M_X = 16.32 * 4 - 8 * 2 + 5 * 4 - 5 * 2 = 59.28 \ m.t$ ↑

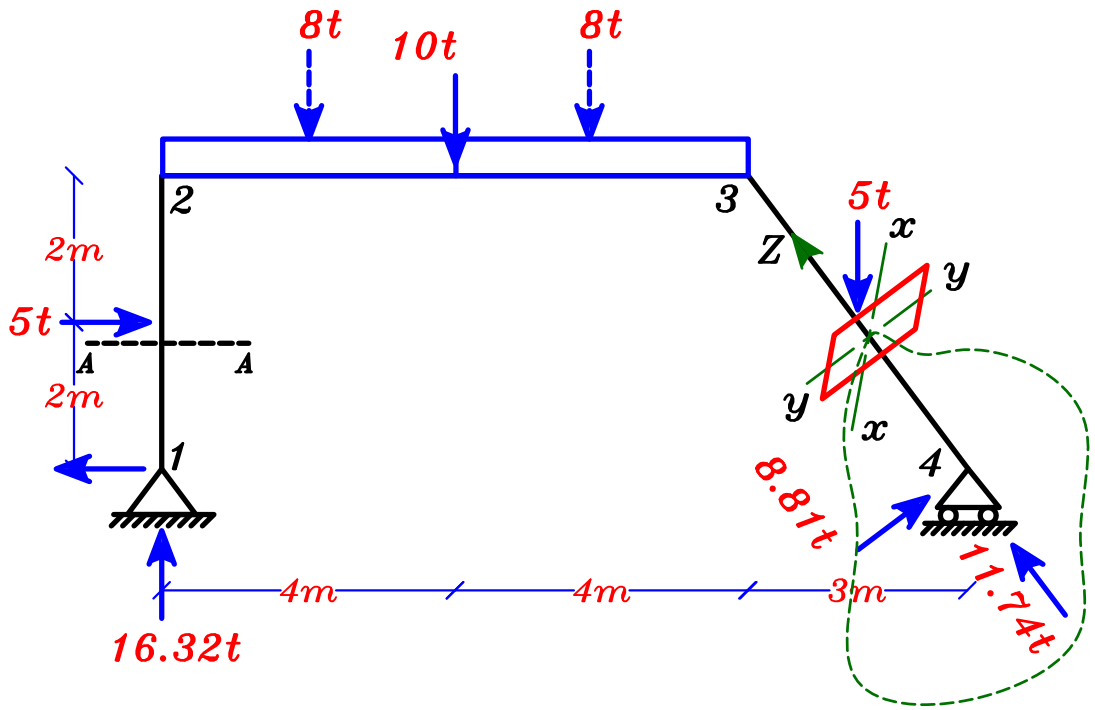
$M_Y = 0$

$M_Z = 0$

Sec. C–C



الـ member المائل يعامل معاملة الافقى أى يكون $Q_X = M_Y = M_Z = 0$.



$N = 11.74\ t\ (Comp.)$

$Q_X = 0$

$Q_Y = 8.81\ t$ ↗

$M_X = 14.68 * 1.5 = 22\ m.t$ ↑

$M_Y = 0$

$M_Z = 0$

و من الممكن حساب الـ Shear & moment مباشرة فى الـ member الافقى
و يكون الـ Shear هو Q_Y و الـ moment هو M_X .
و من الممكن حساب الـ Shear & moment مباشرة فى الـ member الرأسى
و يكون الـ Shear هو Q_X و الـ moment هو M_Y .
و من الممكن حساب الـ Shear & moment مباشرة فى الـ member المائل
و يكون الـ Shear هو Q_Y و الـ moment هو M_X .