**** A circular cast iron specimen of 6cm diameter and 180 mm height is subjected to axial compression load equal 14 ton until the failure. If the friction angle is 12º.**

-Determine the respective stresses in the specimen.

Solve

$\phi = 12^{o}$ $\qquad \theta = 45 + \phi/2 = 45 + 12/2 = 51^{o}$

$$A = \frac{\pi \times D^2}{4} = \frac{\pi \times 6^2}{4} = 28.27 \text{ cm}$$

$$B = \frac{A}{\cos \theta} = \frac{28.247}{\cos 51} = 44.928 \text{ cm}^2$$

$$N = P.\ \text{Cos}\ \theta = 14000 \times \cos 51 = 8810.485 \text{ kg}$$

$$Q = P.\ \text{Sin}\ \theta = 14000 \times \sin 51 = 10880.043 \text{ kg}$$

$$F = N.\ \tan = 8810.485 \times \tan 12 = 1872.726 \text{ kg}$$

**** لحساب الاجهادات المتولده :**

$$* \sigma_p = \frac{P}{A} = \frac{14000}{28.27} = 495.22 \text{ kg/cm}^2$$

$$* \sigma_N = \frac{N}{B} = \frac{8810.485}{44.928} = 196.13 \text{ kg/cm}^2$$

$$* \sigma_Q = \frac{Q}{B} = \frac{10880.043}{44.928} = 242.2 \text{ kg/cm}^2$$

$$* \sigma_F = \frac{F}{B} = \frac{1872.726}{44.928} = 41.7 \text{ kg/cm}^2$$

$$* \sigma_{Failure} = \sigma_r = \sigma_Q - \sigma_F \qquad 242.2 - 41.7 = 200.5 \text{ kg/cm}^2$$

**** A reinforced concrete column 50 cm x 50 cm in section is reinforced with 8 steel bars of 19 mm diameter. The column is carrying a load of 200 tones. Find the stresses in the concrete and steel bars.**

Take E for steel = 2 x 10^6 kg/cm^2 and E for concrete = 180 x 10^3 kg/cm^2

Solve

$A_{total} = 50 \times 50 = 2500\ cm^2$ مساحة مقطع العمود

A_{steel} = عدد الأسياخ × مساحة السيخ الواحد $= \frac{\pi \times D^2}{4} \times n = \frac{\pi \times 1.9^2}{4} \times 8 = 22.68\ cm^2$

$A_{total} = A_{concrete} + A_{steel}$

$A_{concrete} = A_{total} - A_{steel} = 2500 - 22.68 = 2477.32\ cm^2$

بما ان العمود محمل بحمل ضغط منتظم فان انفعال الخرسانه مساوى انفعال الحديد

$\varepsilon_{Steel} = \varepsilon_{concrete}$

وطول العمود ثابت خرسانة وحديد $L_{concrete} = L_{Steel}$

$\Delta_{Concrete} = \Delta_{Steel}$ ..... Equ 1

$$\frac{P_c \times L_c}{E_c \times A_c} = \frac{P_S \times L_S}{E_S \times A_S}$$

$$\frac{P_c}{180 \times 10^3 \times 2477.32} = \frac{P_S}{2 \times 10^6 \times 22.68}$$

$$P_c = 9.831\ P_s$$

$P_{total} = P_{concrete} + P_{steel}$ ..... Equ 2

$$200 \times 10^3 = P_{concrete} + P_{steel}$$

From 1, 2

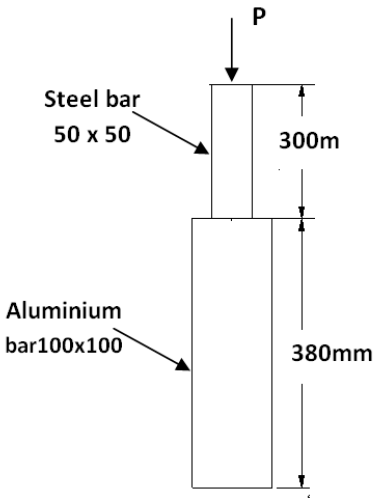
$P_{steel} = 18466.14\ kg = 18.47\ ton$

$P_{concrete} = 181533.8\ kg = 181.53\ ton$

$$\sigma_C = \frac{P_c}{A_c} = \frac{181533.8}{2477.32} = 73.28\ kg/cm^2$$

$$\sigma_s = \frac{P_s}{A_s} = \frac{18466.14}{22.68} = 814.2\ \ kg/cm^2$$

**** A member formed by connecting a steel bar to an aluminum bar is shown in figure. Assuming that the bars are prevented from buckling sidewise, calculate the magnitude of force P, which will cause the total length of member to decrease 0.25mm. The values of elastic modulus for steel and aluminum are 210 kN/mm^2 and 70 kN/mm^2 respectively.**



ΔL_{total} = **0.25 mm**

E_s = **210 KN/mm^2**

E_{Al} = **70 KN/mm^2**

Solve

مقدار الانضغاط الكلى يساوى مجموع الانضغاط الحادث فى الحديد والالومنيوم

$$\Delta L_{total} = \Delta L_s + \Delta L_{Al} \quad \text{..... Equ 1}$$

القوه الموثره على الحديد هى نفسها القوه الموثره على الالومنيوم

$$P = P_s = P_{Al} \quad \text{..... Equ 2}$$

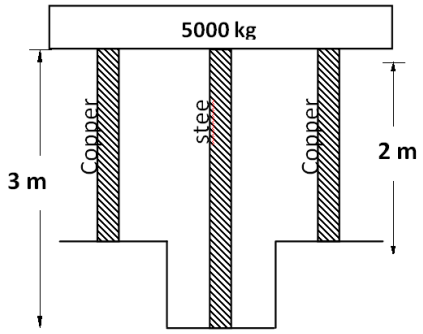
$$\Delta L_{total} = \frac{P_S \times L_S}{E_S \times A_S} + \frac{P_{Al} \times L_{Al}}{E_{Al} \times A_{Al}}$$

$$0.25 = \frac{P \times 300}{210 \times (50 \times 50)} + \frac{P \times 380}{70 \times (100 \times 100)}$$

P= 224.42 KN

*** A steel rod of cross-sectional area 16 cm^2 and two copper rods each of cross-sectional area of 10 cm^2 together support a load of 5000 kg as shown in figure. Find the stress in the rods.**

-Take: E for steel = 2.0 x 10^6 kg/cm^2 and E for copper = 1.0 x 10^6 kg/cm^2



Solve

$\mathbf{P_{total} = 2\,P_{copper} + P_{steel}}$ **……. Equ 1**

$5000 = 2\,P_{copper} + P_{steel}$

$\mathbf{\Delta_{copper} = \Delta_{steel}}$ **……. Equ 2** **لان الطول مختلف**

$$\frac{P_c \times L_c}{E_c \times A_c} = \frac{P_S \times L_S}{E_S \times A_S}$$

$$\frac{P_c \times 200}{1\times10^6 \times 10} = \frac{P_S \times 300}{2\times10^6 \times 16} \qquad P_c = 0.468\ Ps$$

$5000 = 2 \times 0.468\ P_s + P_s$

$P_s = 2582.6$ Kg

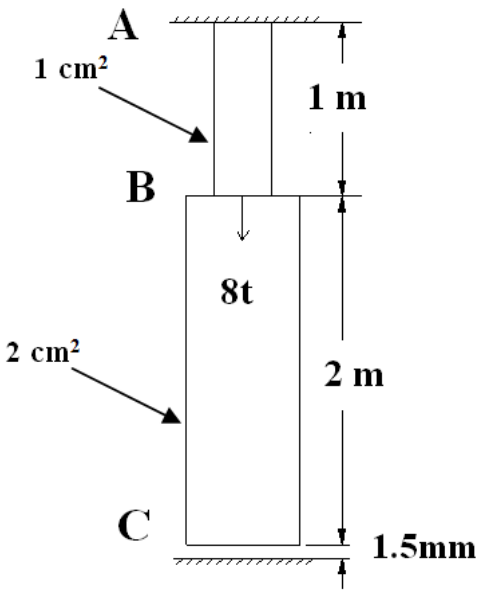
$P_c = 0.468 \times 2582.6 = 1208.67$ Kg

$$\sigma_c = \frac{P_c}{A_c} = \frac{1208.67}{10} = 120.867\ kg/cm^2$$

$$\sigma_s = \frac{P_s}{A_s} = \frac{2582.6}{16} = 161.4125\ kg/cm^2$$

*** A composite bar ABC, rigidly fixed at A and 1.5 mm above the lower support, it loaded as shown in figure, if the cross-sectional area of the section AB is 1cm^2, and that of the section BC is 2 cm^2.**

-Determine the reaction at the ends and the stresses in the two sections. - Take E = 2.0 x 10^6 kg/cm^2



Solve

عند اول التحميل فان 8 طن توثر على الجزء AB فقط ويوجد حالتان :

If $\Delta_{AB} \leq 1.5$ mm $\therefore R_A = 8$ ton, $R_C = 0.0$ ton

If $\Delta_{AB} \geq 1.5$ mm $\therefore R_A =$ قيمه, $R_C =$ قيمه

$\Delta_{AB} = \frac{P \times L}{E \times A} = \frac{8000 \times 100}{2 \times 10^6 \times 1} = 0.4$ cm $= 4$ mm ≥ 1.5 mm ∴ يوجد رد فعل عند C

$R_A + R_c = 8000$ kg , $R_A = P_1 + R_{A2}$

<u>أولا</u> يتم ايجاد الحمل الذى يحدث استطاله مقدارها 1.5 mm فى الجزء AB (P_1)

Take $\Delta_{AB} = 1.5$ mm

$\Delta_{AB} = \frac{P \times L}{E \times A} = \frac{P_1 \times 100}{2 \times 10^6 \times 1} = 0.15$ cm $\therefore P_1 = 3000$ Kg القوه المسببه لجعل الشكل Fixed-Fixed

$R_{A2} + R_c = 8000\text{-}3000 = 5000$ Kg الحمل المتبقى من 8000kg

ثانيا :عند وصول الجزء BC عند النقطه C فان مقدار الاستطاله للجزء AB هيساوى مقدار الانضغاط للجزء BC

$\therefore \boldsymbol{\Delta_{AB} = \Delta_{BC}}$

$$\frac{R_{A2} \times \mathbf{L_{AB}}}{\mathbf{E} \times \mathbf{A_{AB}}} = \frac{R_c \times \mathbf{L_{BC}}}{\mathbf{E} \times \mathbf{A_{BC}}}$$

$$\frac{R_{A2} \times \mathbf{100}}{\mathbf{1}} = \frac{R_c \times \mathbf{200}}{\mathbf{2}}$$

$\therefore R_{A2} = R_c$

$R_{A2} = R_c = 2500$ Kg

$R_A = P_1 + R_{A2}$

$\therefore R_A = 3000 + 2500 = 5500$ Kg

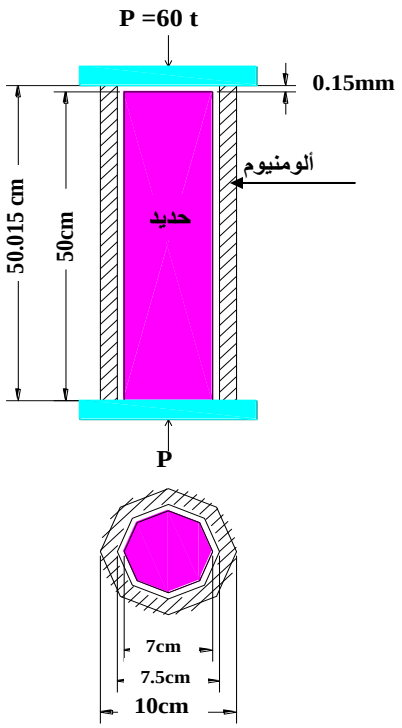
$$\boldsymbol{\sigma_{AB}} = \frac{\mathbf{R_{AB}}}{\mathbf{A_{AB}}} = \frac{\mathbf{5500}}{\mathbf{1}} = 5500 \text{ Kg/cm}^2$$

$$\boldsymbol{\sigma_{BC}} = \frac{\mathbf{R_C}}{\mathbf{A_{BC}}} = \frac{\mathbf{2500}}{\mathbf{2}} = 1250 \text{ Kg/cm}^2$$

*** A solid steel bar, 50 cm long and 7 cm diameter, is placed inside an aluminum tube having 7.5 cm inside diameter and 10 cm outside. The aluminum cylinder is 0.015 cm longer than the steel bar. An axial load of 60000 kg is applied to the bar and cylinder through rigid cover plates as shown in figure.**

-Find the stresses developed in the steel bar and aluminum tube.

-Assume: E for steel = 2.2 x 10^6 kg/cm^2 and, E for aluminum = 0.7 x 10^6 kg/cm^2



Solve

$A_s = \frac{\pi \times D^2}{4} = \frac{\pi \times 7^2}{4} = 38.49\ cm^2$

$A_{Al} = \frac{\pi \times D^2}{4} = \frac{\pi \times (10^2 - 7.5)}{4} = 34.36\ cm^2$

ماسورة الالومنيوم أطول من قضيب الحديد 0.015 سم وبالتالى لا يوجد قوه تأثر على الحديد حتى الان
اولا: تعيين الحمل الذى يحدث انضغاط قيمته 0.015 سم فى ماسورة الالومنيوم لينطبقوا على بعض (P_1)

Take Δ_{Al} = 0.015 cm

$\Delta_{Al} = \frac{P \times L}{E \times A}$

$0.015 = \frac{P_1 \times 50.015}{0.7 \times 10^6 \times 34.36}$ **∴ P_1 = 7210 Kg** **القوه المسببه لجعل الشكل Fixed-Fixed**

P_R= 60000-7210 = 52790 Kg **الحمل المتبقى من 60000 kg على ماسورة الالومنيوم و قضيب الحديد**

$P_R = P_s + P_{Al}$ = 52790 Kg

$$52790 = \sigma_s \times A_s + \sigma_{Al} \times A_{Al}$$

$$52790 = 38.49 \times \sigma_s + 34.36 \times \sigma_{Al} \quad \text{..... Equ 1}$$

ثانيا :عند وصول ماسورة الالومنيوم الى قضيب الحديد فان مقدار الانضغاط سيكون متساويا

$$\varepsilon_s = \varepsilon_{Al}$$

$$\frac{\sigma_s}{E_s} = \frac{\sigma_{Al}}{E_{Al}} \qquad \frac{\sigma_s}{2.2 \times 10^6} = \frac{\sigma_{Al}}{0.7 \times 10^6} \qquad \sigma_s = 3.143\, \sigma_{Al} \quad \text{..... Equ 2}$$

$$\sigma_s = 1068\ Kg/cm^2 \quad , \quad \sigma_{Al\,1} = 340\ Kg/cm^2$$

الاجهاد الموثر على ماسورة الالومنيوم عباره عن مجموع اجهادين الاول من تأثير الحمل الذى سبب انضغاط 0.015 سم والثانى من تأثير الحمل المتبقى على ماسورة الالومنيوم و قضيب الحديد معا

$$\sigma_{Al} = \sigma_{Al\,1} + \sigma_{Al\,2} = 340 + \frac{P_1}{A_{Al}} = 340 + \frac{7210}{34.36} = 550\ Kg/cm^2$$

$$\sigma_s = 1068\ Kg/cm^2$$

**** A load of 30t is applied on a short concrete column 25 x25 cm. The column is reinforced by steel bars of total area 56 cm^2. If the modulus of elasticity for steel is 15 times that of concrete, <u>find</u> the stresses in steel and concrete. If the stresses in concrete should not exceed 40 kg/cm^2, <u>find</u> the area of steel required so that the column may support a load of 60 t.**

<u>Solve</u>

$A_{total} = 25 \times 25 = 625\ cm^2$ **مساحة مقطع العمود**

$A_{total} = A_{concrete} + A_{steel}$

$A_{concrete} = A_{total} - A_{steel} = 625 - 56 = 569\ cm^2$

Case i

بما ان العمود محمل بحمل ضغط منتظم فان انفعال الخرسانه مساوى انفعال الحديد

$\varepsilon_{Steel} = \varepsilon_{concrete}$

$$\frac{\sigma_s}{E_s} = \frac{\sigma_c}{E_c}$$

$$\frac{\sigma_s}{15 * E_c} = \frac{\sigma_c}{E_c} \qquad \sigma_s = 15\ \sigma_c \quad \textbf{……. Equ 1}$$

$P_{total} = P_{concrete} + P_{steel}$

$30000 = \sigma_s * A_s + \sigma_c * A_c$

$30000 = \sigma_s * 56 + \sigma_c * 569$ **……. Equ 2**

$30000 = 15\ \sigma_c * 56 + \sigma_c * 569$

$\sigma_c = 21.29\ kg/cm^2$, $\sigma_s = 319.35\ kg/cm^2$

Case ii

$\sigma_c = 40\ kg/cm^2$

$\sigma_s = 15\ \sigma_c = 15*40 = 600\ kg/cm^2$

$A_{concrete} = A_{total} - A_{steel} = 625 - A_s$

$P_{total} = P_{concrete} + P_{steel}$

$60000 = \sigma_s * A_s + \sigma_c * A_c$

$60000 = 600 * A_s + 40 * (625 - A_s)$

$A_s = 62.5\ cm^2$