SHATT AL-ARAB UNIVERSITY

COLLEGE ENG.

DEPARTMENT CIVIL ENG.

STRENGTH OF MATERIALS -I

SECOND YEAR

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The Syllabus

1. ***stress***
2. ***shear stress***
3. ***strain***
4. ***Torsi***on
5. ***thermal stress***
6. ***DRAW SFD BMD***
7. ***thin walled cylinder***

References

1. Hibbeler – Mechanics of Materials 8th Edition

2. Strength of Materials - Andrew Pytel , Ferdinand L. Singer - 3rd edition

3. Strength of Materials, Part 1, Elementary theory and problems

4. Lectures by Engineer Mustafa Jasim

Dimensions

$1 - Mpa \leftrightarrow \frac{N}{mm^2}$

$2 - pa \leftrightarrow \frac{N}{m^2}$

$3 - Kpa \leftrightarrow \frac{KN}{m^2}$

$4 - Ksi \leftrightarrow \frac{Kip}{in^2}$

$5 - Psi \leftrightarrow \frac{lb}{in^2}$

التحويل من m الى mm نضرب 10^3

التحويل من mm الى m نضرب 10^{-3}

التحويل من N الى KN نضرب 10^{-3} التحويل من KN الى N نضرب 10^{3}

التحويل من ft الى iN نضرب 12

التحويل من in الى ft نقسم 12

التحويل من Ksiالى Psi نضرب 10^{3}

التحويل من Psi اى Ksi نضرب 10^{-3}

التحويل من Kpa الى Mpa نضرب 10^{-3}

التحويل من Kpa الى pa نضرب 10^{3}

التحويل من Mpa الى pa نضرب 10^{6}

التحويل من Gpa الى Mpa نضرب 10^{3}

التحويل من Gpa الى pa نضرب 10^{9}

هذه التحويلات مهمه
جدا يجب ان تحفظ

1. Chapter one: Stress

1.1- Introduction

Mechanics of materials is a branch of mechanics that studies the internal effects of stress and strain in a solid body that is subjected to an external loading. Stress is associated with the strength of the material from which the body is made, while strain is a measure of the deformation of the body. In addition to this, mechanics of materials includes the study of the body's stability when a body such as a column is subjected to compressive Loading. A thorough understanding of the fundamentals of this subject is of vital importance because many of the formulas and rules of design cited in engineering codes are based upon the principles of this subject.

1.2- Equilibrium of a Deformable Body

Since statics has an important role in both the development and application of mechanics of materials, it is very important to have a good grasp of its fundamentals. For this reason, we will review some of the main principles of statics that will be used throughout the text.

External Loads. A body is subjected to only two types of external loads; namely, Surface forces and body forces, Fig. 1-1.

-Surface Forces. Surface forces are caused by the direct contact of one body with the surface of another.

-Body Forces. A both' force is developed when one body exerts a force on another body without direct physical contact between the bodies. Examples include the effects caused by the earth's gravitation or its electromagnetic field.

Internal Resultant Loadings. In mechanics of materials, statics is primarily used to determine the resultant loadings that act within a body. shown in Fig. 1-2

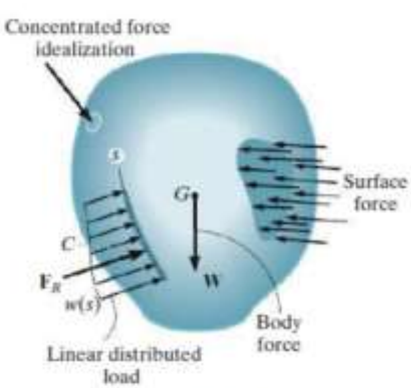


Fig. 1-1

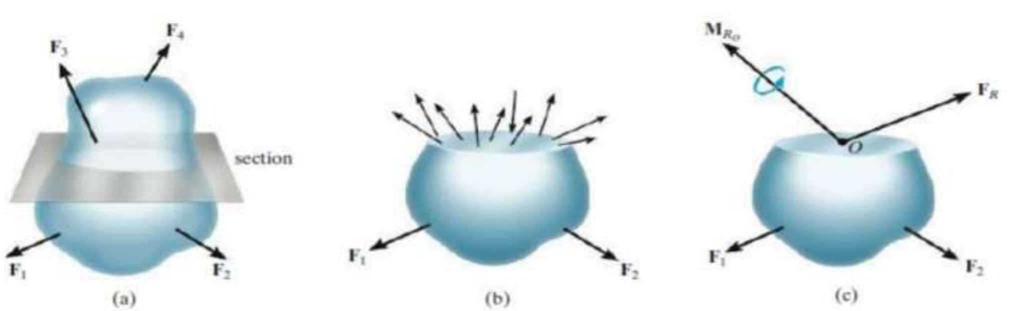


Fig. 1-2

stress

$$\sigma = \frac{P}{A}$$

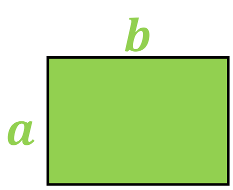
P → N

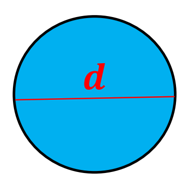
A → mm^2

وحدات Stress

$$N/mm^2 = Mpa$$

المساحه





$$A = a \times b$$

$$A = \frac{\pi}{4} \times d^2$$

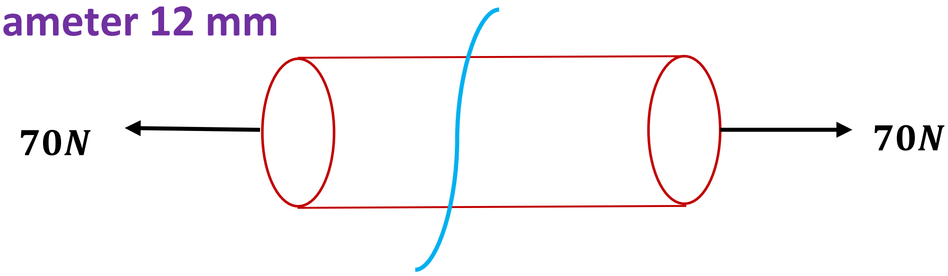
Compression

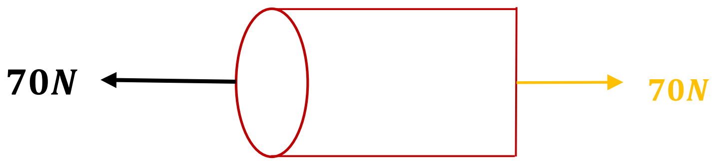
$$\sigma = -\frac{P}{A}$$

Tension

$$\sigma = +\frac{P}{A}$$

$Q1$/Find the σ if diameter 12 mm

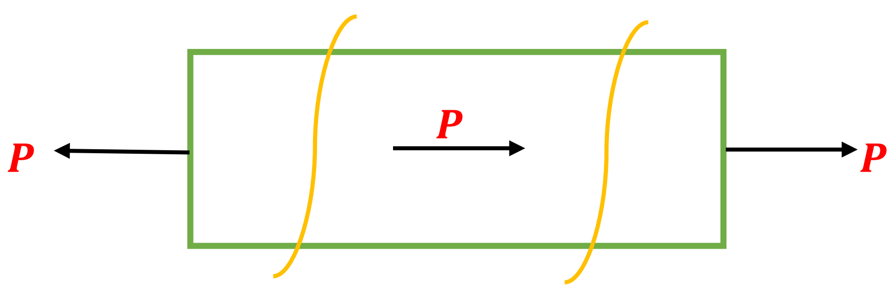




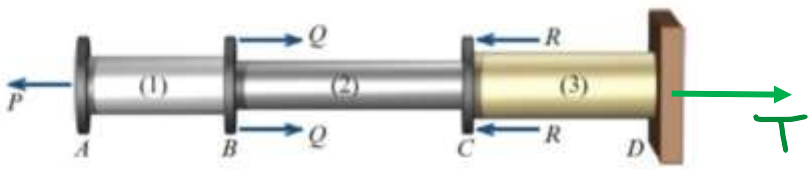
$$\sigma = \frac{P}{A}$$

$$\sigma = \frac{70}{\frac{\pi}{4} \times 12^{2}} \quad \Rightarrow \quad \boxed{\sigma = 0.62 Mpa}$$

عندما يحتوي المقطع على
اكثر من قوة يجيب ان
نعمل اكثر من قطع



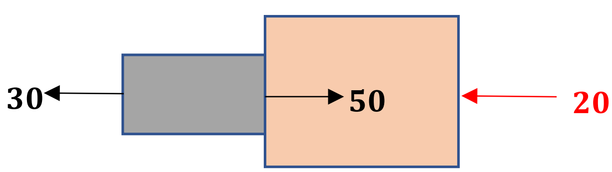
Q2/Axial loads are applied with rigid bearing plates to the solid cylindrical rods shown in. One load of P = 30 kips is applied to the assembly at A, two loads of Q = 25 kips are applied at B , and two loads of R = 35 kips are applied at C. The normal stress magnitude in aluminum rod (1) must be limited to 20 ksi . The normal stress magnitude in steel rod (2) must be limited to 35 ksi . The normal stress magnitude in brass rod (3) must be limited to 25 ksi . Determine the minimum diameter required for each of the three rods



$$\xrightarrow{+} \sum f_{x}=0$$

$$-30+50-70+T=0 \quad \Rightarrow \quad T=50\,Kip$$

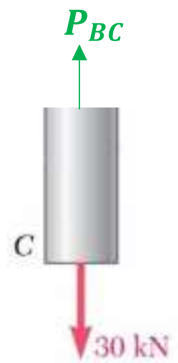
$$\sigma=\frac{P}{\frac{\pi}{4}\times d^2} \quad \Rightarrow \quad 20=\frac{30}{\frac{\pi}{4}\times d^2} \quad \Rightarrow \quad \boxed{d=1.3819\ in}$$

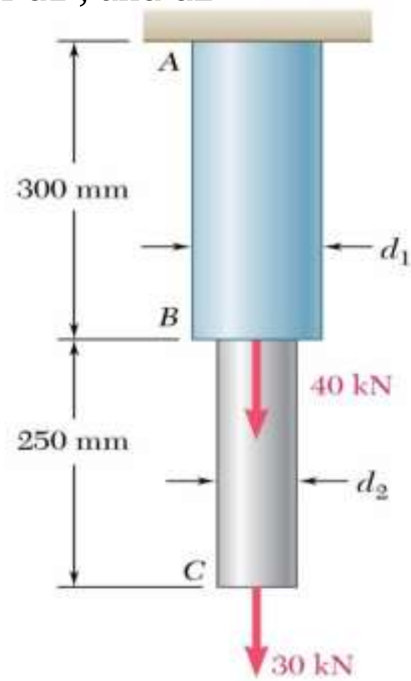


$$\sigma=\frac{P}{\frac{\pi}{4}\times d^2} \quad \Rightarrow \quad 35=\frac{-20}{\frac{\pi}{4}\times d^2} \quad \Rightarrow \quad \boxed{d=0.852\ in}$$

$$\sigma=\frac{P}{\frac{\pi}{4}\times d^2} \quad \Rightarrow \quad 25=\frac{50}{\frac{\pi}{4}\times d^2} \quad \Rightarrow \quad \boxed{d=1.595\ in}$$

Q3/Two solid cylindrical rods AB and BC are welded together at B loaded as shown . Known that the average normal stress must not exceed 140 MPa in each rod . Determine the smallest allowable value of d1 , and d2

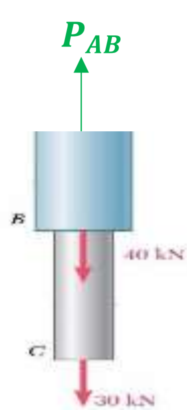




$\uparrow^{+} \sum f_{y=0}$

$P_{BC} - 30 = 0 \Rightarrow P_{BC} = 30KN$

$$\sigma = \frac{P}{\frac{\pi}{4} \times d^2} \Rightarrow 140 = \frac{30 \times 10^3}{\frac{\pi}{4} \times d^2} \Rightarrow \boxed{d_2 = 16.52\,mm}$$

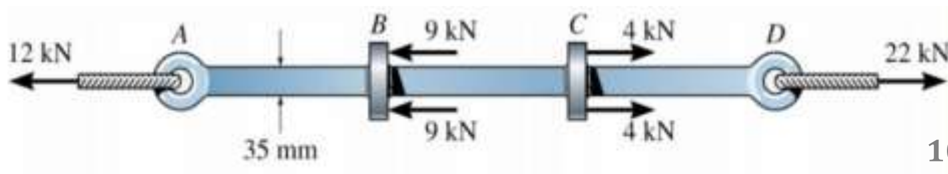


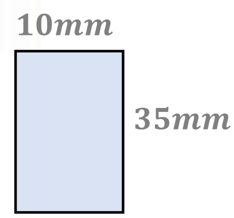
$\uparrow^{+} \sum f_{y=0}$

$P_{AB} - 30 - 40 = 0 \Rightarrow P_{AB} = 70KN$

$$\sigma = \frac{P}{\frac{\pi}{4} \times d^2} \Rightarrow 140 = \frac{70 \times 10^3}{\frac{\pi}{4} \times d^2} \Rightarrow \boxed{d_1 = 25.2mm}$$

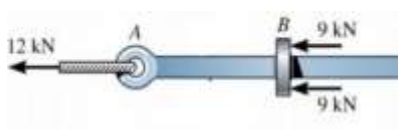
Q4/ has a constant width of 35 mm and a thickness of 10 mm . Determine the maximum average normal stress in the bar when it is subjected to the loading shown





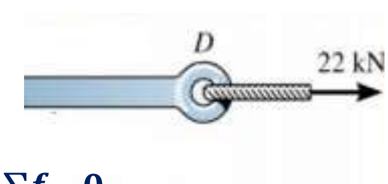
$\xrightarrow{+} \sum f_{x}=0$

$-12+P_{AB}=0 \Longrightarrow P_{AB}=12KN$



$\xrightarrow{+} \sum f_{x}=0$

$-12-18+P_{BC}=0 \Longrightarrow P_{BC}=30KN$

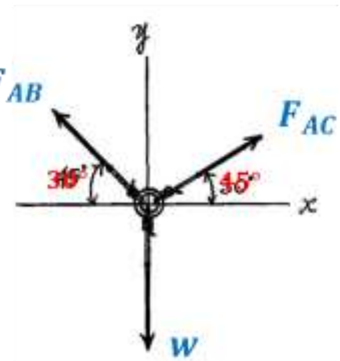


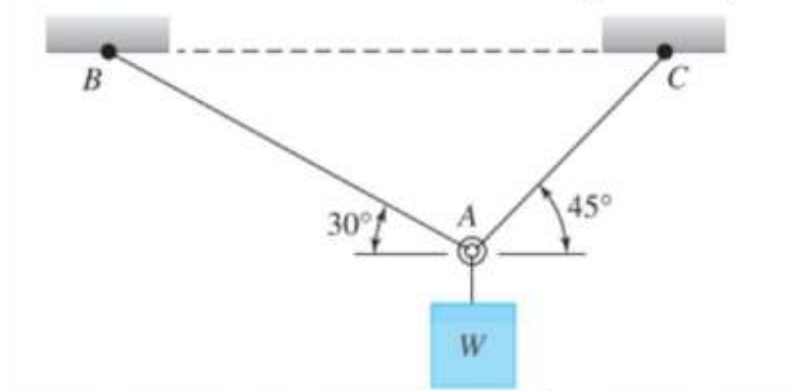
$\xrightarrow{+} \sum f_{x}=0$

$22-P_{CD}=0 \Longrightarrow P_{CD}=22KN$

$$\sigma_{max}=\frac{P}{A} \Longrightarrow \sigma_{max}=\frac{30\times10^{3}}{10\times35} \Longrightarrow \sigma_{max}=85.7Mpa$$

Q5 Determine the largest weight W that can be supported by the two wires AB and AC . The working stresses are 100 MPa for AB and 150 MPa for AC . The cross sectional areas of AB and AC are 400 mm² and 200 mm² , respectively





$\rightarrow^{+} \sum f_{x}=0$

$$F_{AC}\cos 45 - F_{AB}\cos 30 = 0$$

$$F_{AC}\,0.707 - F_{AB}\,0.866 = 0$$

$$F_{AC}\,0.707 = F_{AB}\,0.866$$

$$F_{AC} = \frac{F_{AB}\,0.866}{0.707}$$

$$\boxed{F_{AC} = 1.225\,F_{AB}} \quad eq\ 1$$

$\uparrow^{+} \sum f_{y}=0$

$$F_{AC}\sin 45 - F_{AB}\sin 30 - w = 0$$

$$\boxed{F_{AC}\,0.707 + F_{AB}0.5 = w} \quad eq\ 2$$

نعوض معادله 1 في معادله 2

$$1.225\,F_{AB} \times 0.707 + F_{AB}0.5 = w$$

$$0.8661\,F_{AB} + F_{AB}0.5 = w$$

$$1.3661 F_{AB} = w$$

$$F_{AB} = 0.732w$$

تعوض في معادله 1

$$F_{AC} = 1.225 \times 0.732w$$

$$F_{AC} = 0.8967W$$

$$\sigma_{AC} = \frac{P_{AC}}{A} \Rightarrow \sigma_{AC} = \frac{0.896w}{200}$$

W = 33482 N

$$\sigma_{AB} = \frac{P_{AB}}{A} \Rightarrow \sigma_{AC} = \frac{0.732w}{400}$$

W = 54644 N

2. Chapter Two: Shear Stress

shear stress

$$\tau = \frac{V}{A}$$

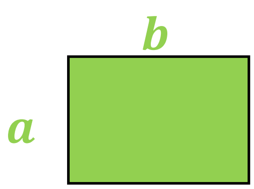
V → N

A → mm^2

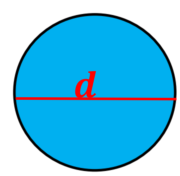
وحدات Shear Stress

$$N/mm^2 = Mpa$$

المساحه



$$A = a \times b$$



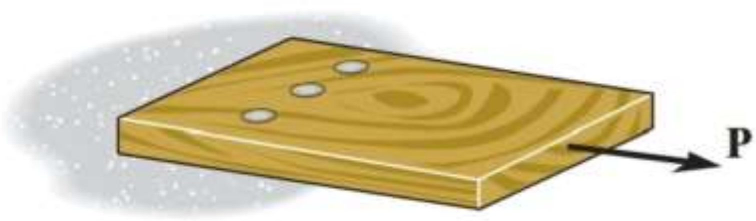
$$A = \frac{\pi}{4} \times d^2$$

معامل الامان

$$F.S = \frac{\tau_{ultimate}}{\tau_{allowable}}$$

يستخدم هذا القانون عندما يعطى في السؤال F.S

Q1/If each of the three nails has a diameter of 4 mm and can withstand an average shear stress of 60 MPa , determine the maximum allowable force P that can be applied to the board



لاننسى في المساحه
نضرب في عدد ابراغي

$$\tau = \frac{V}{A}$$

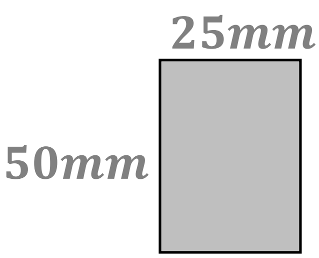
$$V = \tau \times A$$

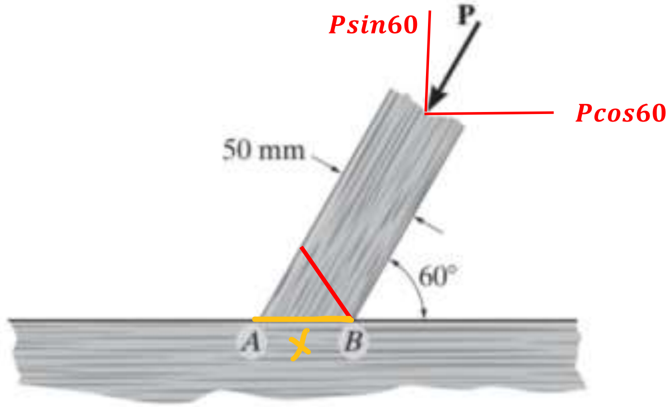
$$V = \tau \times \frac{\pi}{4} \times d^2 \times 3$$

$$V = 60 \times \frac{\pi}{4} \times 4^2 \times 3$$

$$V = 2260N$$

Q2/The strut is glued to the horizontal member at surface AB . If the strut has a thickness of 25 mm and the glue can withstand an average shear stress of 600 kPa, determine the maximum force P that can be applied to the strut





$$\tau = \frac{V}{A}$$

$$V = \tau \times A$$

$$\sin 60 = \frac{50}{X} \Rightarrow X = 57.7mm$$

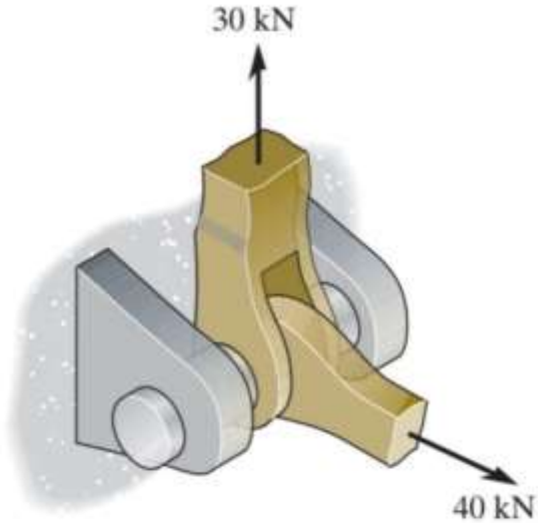
$$V = 600 \times 10^{-3} \times 57.7 \times 25$$

$$V\cos 60 = 600 \times 10^{-3} \times 57.7 \times 25$$

من حللنه اخذنا Cos 60
الان الاكس ع محور افقي

$$V = 1730N$$

Q3/Determine the maximum average shear stress developed in the 30 - mm - diameter pin



$$\tau = \frac{V}{A}$$

$$R = \sqrt{40^2 + 30^2}$$

$$R = 50KN$$

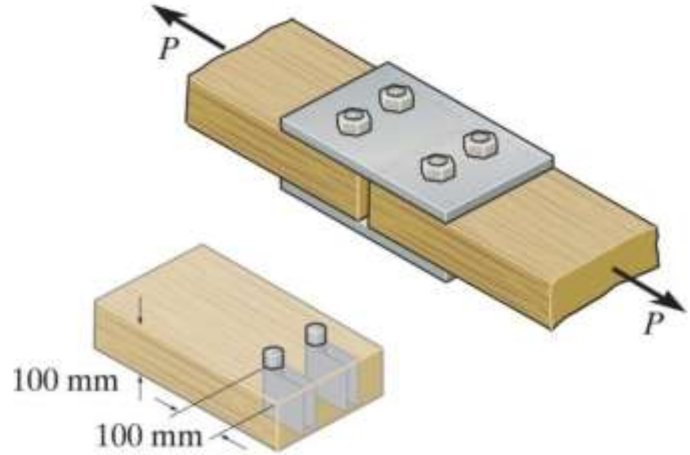
$$R = \frac{50}{2} = 25KN$$

لازم اقسم على 2 لانني ما
احتاج المحلصه اريد القوه

$$\tau = \frac{25 \times 10^3}{\frac{\pi}{4} \times 30^2}$$

$$\boxed{\tau = 35.3Mpa}$$

Q4/The average shear stress in each of the 6 mm diameter bolts and along each of the four shaded shear planes is not allowed to exceed 80 MPa and 500 kPa , respectively . Determine the maximum axial force P that can be applied to the joint



$$\tau_{bolt} = \frac{V}{A}$$

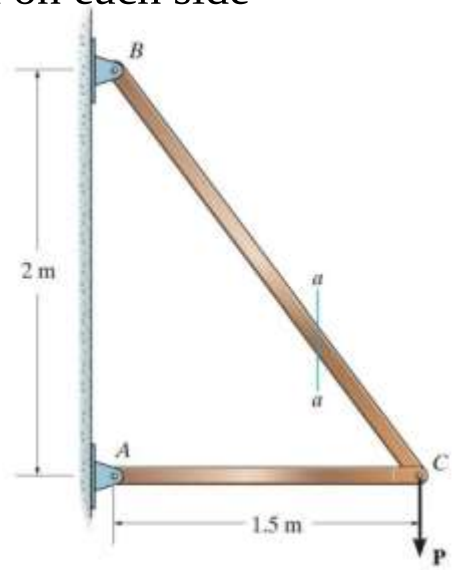
$$\tau_{bolt} = \frac{V}{\frac{\pi}{4} \times d^2 \times 4}$$

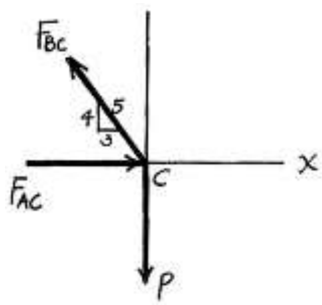
$$80 = \frac{V}{\frac{\pi}{4} \times 6^2 \times 4} \Rightarrow V_{bolt} = 9047N$$

$$500 \times 10^{-3} = \frac{V}{100 \times 100 \times 4} \Rightarrow V_{plan} = 20000N$$

Therefore, the maximum axial force V=9047 N

Q5/Determine the largest load P that can be a applied to the frame without causing either the average normal stress or the average shear stress at section a - a to exceed σ = 150 MPa and τ = 60 MPa , respectively . Member CB has a square cross section of 25 mm on each side

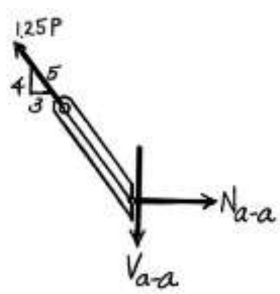




$\uparrow^{+} \sum f_{y=}0$

$F_{BC}\ \frac{4}{5}\ - P = 0 \Longrightarrow F_{BC}0.8 = P$

$F_{BC} = 1.25P$



$\rightarrow^{+} \sum f_{x=}0$

$-1.25P\ \frac{3}{5}\ + N = 0$

$N = 0.75P$

$\uparrow^{+} \sum f_{y=}0$

$1.25P\ \frac{4}{5}\ - V = 0$

$V = P$

$$\sigma = \frac{P}{A}$$

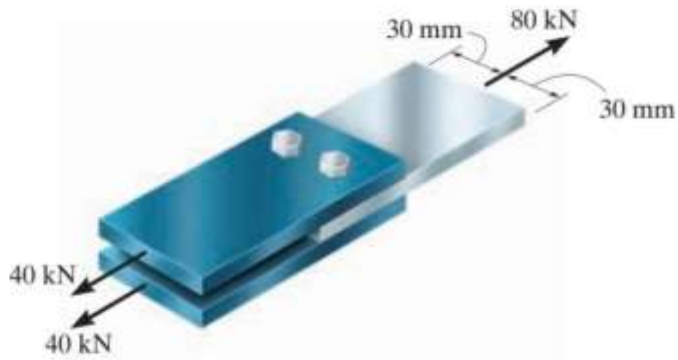
$$150 = \frac{0.75P}{\frac{25 \times 25}{\frac{3}{5}}} \Longrightarrow P = 208320N$$

$$\tau = \frac{V}{A}$$

$$60 = \frac{P}{\frac{25 \times 25}{\frac{3}{5}}} \Longrightarrow P = 62496N$$

The largest load P $= 62496N$

Q6/The joint is fastened together using two bolts .Determine the required diameter of the bolts if the failure shear stress for the bolts is fail = 350 MPa . Use a factor of safety for shear of F.S. = 2.5



$$F.S = \frac{\tau_{ultimate}}{\tau_{allowable}}$$

$$2.5 = \frac{350}{\tau_{allowable}} \Rightarrow \tau_{allowable} = 140\,Mpa$$

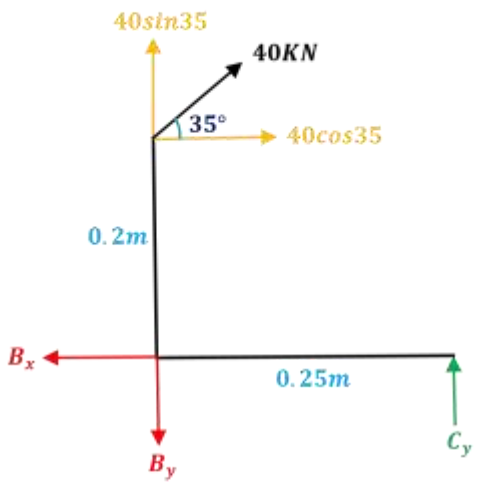
$$\tau = \frac{V}{A}$$

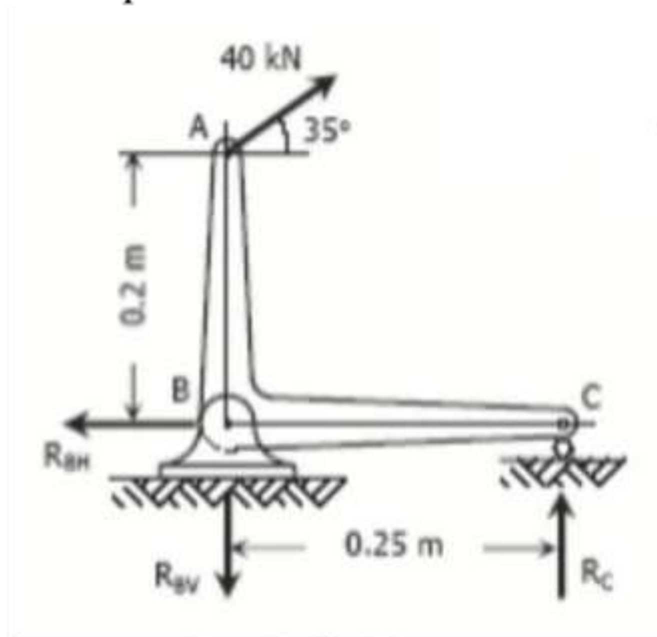
$$\tau = \frac{V}{\frac{\pi}{4} \times d^2 \times 2}$$

$$140 = \frac{40 \times 1000}{\frac{\pi}{4} \times d^2 \times 2}$$

$$\Rightarrow d = 13.5mm$$

Q7 /Determine the shear stress in fixed in point B if the Diameter d=20mm





$$+\curvearrowright \sum M_c = 0$$

$$-B_y \times 0.25 + 40cos35 \times 0.2 + 40sin35 \times 0.25 = 0$$

B_y=49.156KN

$$\rightarrow^+ \sum f_{x=}0$$

$$-B_x + 40cos35 = 0 \Rightarrow B_x = 32.766KN$$

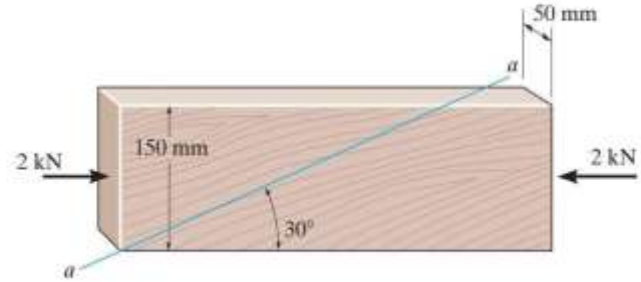
$$R = \sqrt{(32.766KN)^2 + (49.156)^2} \Rightarrow R = 59.076$$

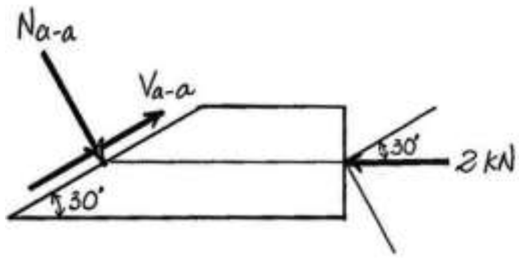
$$R = \frac{59.076}{2} = 29.538KN$$

لازم نقسم R على 2 الان
اني احتاج قوه مو محصله

$$\tau = \frac{V}{A} \Rightarrow \tau = \frac{29.538 \times 10^3}{\frac{\pi}{4} \times 20^2} \Rightarrow \tau = 94.02Mpa$$

Q8/ The block is subjected to a compressive force of 2 kN . Determine the average normal and average shear stress developed in the wood fibers that are oriented along section-a -a at 30 ° with the axis of the block





$\nearrow^{+} \sum f_{x}=0$

$-V_{a-a} - 2\cos 30 = 0 \Longrightarrow V_{a-a} = 1.732KN$

$\nwarrow^{+} \sum f_{y}=0$

$2\sin 30 - P_{a-a} = 0 \Longrightarrow P_{a-a} = 1KN$

$$A = \frac{\frac{150}{1000} \times \frac{50}{1000}}{\sin 30} = 0.015m^2$$

ماطول القطع مائل لازم اقسم المساحه على زاويه حتىتطلع مساحه

$\sigma = \frac{P}{A} \Longrightarrow \sigma = \frac{1}{0.015} \Longrightarrow \sigma = 66.6Kpa$

$\tau = \frac{V}{A} \Longrightarrow \tau = \frac{1.732}{0.015} \Longrightarrow \tau = 115.4Kpa$

3. Chapter Three: Strain

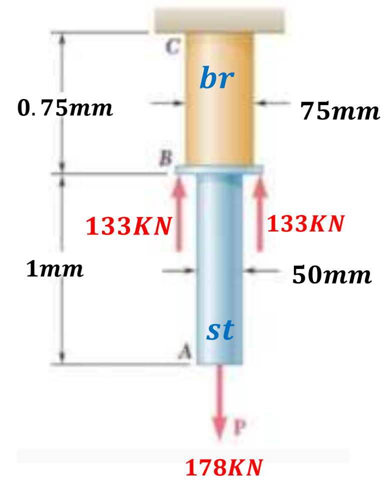
$E=\sigma/\varepsilon$, $\sigma= P/A$

$\varepsilon=\Delta L/L$, $\Delta L= \delta$

$$\delta = \frac{P\,L}{A\,E}$$

وحدات δ هى mm

Q1/Determine the deformation of the rod if E_{br} =105 Gpa and the E_{st} =200 Gpa



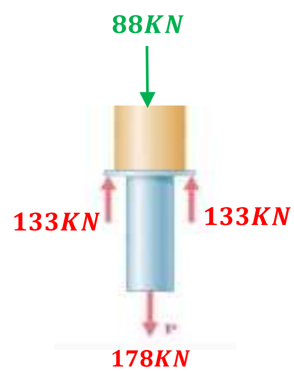
shaft AB

$$\delta_{AB} = \frac{P\,L}{A\,E}$$

$$\delta = \frac{178\times 10^3 \times 1}{200\times 10^3 \times \frac{\pi}{4}\times 50^2}$$

$$\delta_{AB} = 4.5\times 10^{-4} mm$$

shaft BC

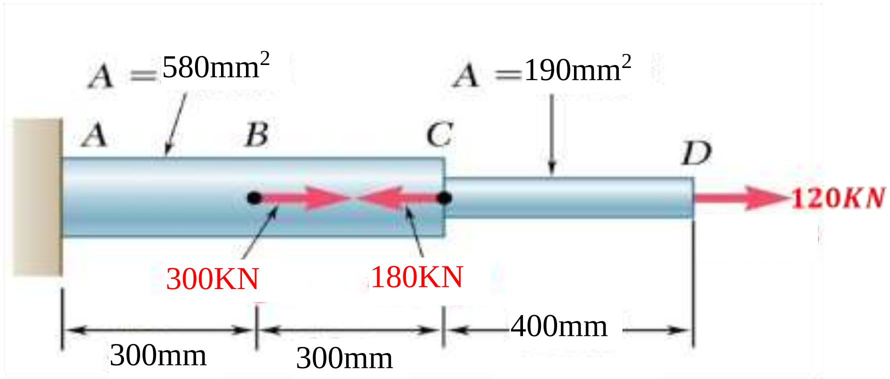


$$\delta_{BC} = \frac{P\,L}{A\,E}$$

$$\delta_{BC} = \frac{-88\times 10^3 \times 0.75}{105\times 10^3 \times \frac{\pi}{4}\times 75^2}$$

$$\delta_{BC} = -1.423\times 10^{-4} mm$$

Q2 /Determaine the deformation of the rod if E_{st}=200 Gpa



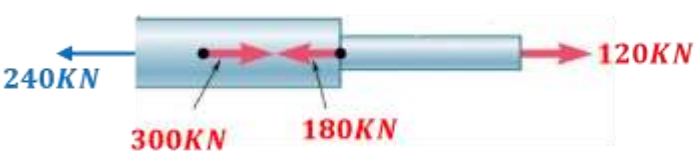
shaft CD

$$\delta_{CD} = \frac{P\,L}{A\,E} \Longrightarrow \delta_{CD} = \frac{120 \times 10^3 \times 400}{200 \times 10^3 \times 190} \Longrightarrow \boxed{\delta_{CD} = 1.26mm}$$

shaft BC

$$\delta_{BC} = \frac{P\,L}{A\,E} \Longrightarrow \delta_{BC} = \frac{-60 \times 10^3 \times 300}{200 \times 10^3 \times 580} \Longrightarrow \boxed{\delta_{BC} = -0.155mm}$$

shaft AB



$$\delta_{AB} = \frac{P\,L}{A\,E} \Longrightarrow \delta_{AB} = \frac{240 \times 10^3 \times 300}{200 \times 10^3 \times 580} \Longrightarrow \boxed{\delta_{AB} = 0.62mm}$$

كيفية حل سؤال strain مثبت من الطرفين

اولا / نعمل $\sum f_{x=}$ اذا كان ال Rod افقي

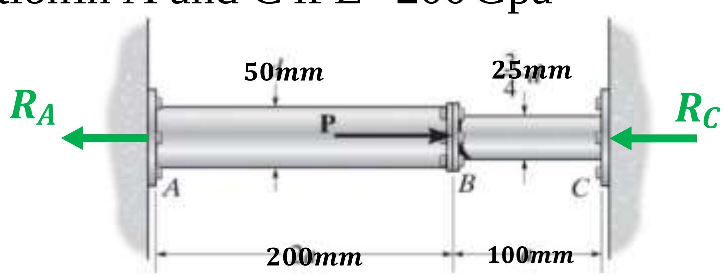
نعمل $\sum f_{y=}$ اذا كان ال Rod عامودي

ثانيا / نضع معادله $\delta_1 + \delta_2 = 0$

ثالثا / نعوض القيم ونستخرج مجاهيل بالكاسيو

Q3/Determine the support reaction in A and C if E=200 Gpa

If the P=200KN



$$\xrightarrow{+} \sum f_{x=}0$$

$$-R_A + 200 - R_C = 0$$

$$\delta_{AB} + \delta_{BC} = 0$$

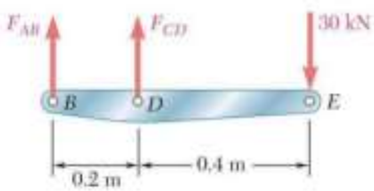
$$\left(\frac{PL}{AE}\right)_{AB} + \left(\frac{PL}{AE}\right)_{BC} = 0$$

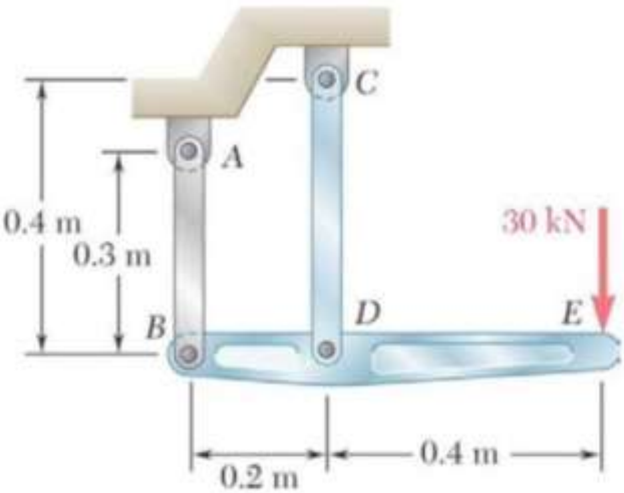
$$\overset{AB}{\left(\frac{R_A \times 200}{200\times 10^3 \times \frac{\pi}{4} \times 50^2}\right)} + \overset{BC}{\left(\frac{(R_A - 200) \times 100}{200\times 10^3 \times \frac{\pi}{4} \times 25^2}\right)} = 0 \Rightarrow \boxed{R_A = 133KN}$$

$$\boxed{R_C = 67KN}$$

$$-133 + 200 - R_C = 0$$

Q4/The rigid bar BDE is supported by two links AB and CD . Link AB is made of aluminum (E = 70 GPa) and has a cross - sectional area of 500 mm² ; link CD is made of steel (E = 200 GPa) and has a cross - sectional area of 600 mm² . For the 30 - kN force shown, determine the deflection (a) of B. (b) of D. (c) of E.





$+\curvearrowright \sum M_B = 0$

$-F_{CD}(0.2) + 30(0.6) = 0$

$$F_{CD} = 90KN$$

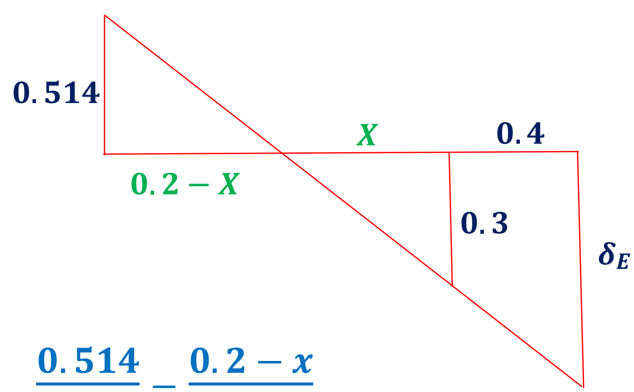
$\uparrow^{+} \sum f_{y}=0$

$F_{AB} + 90 - 30 = 0$

$$F_{AB} = -60KN$$

$$\delta_{AB} = \frac{-60 \times 10^3 \times 0.3}{70 \times 10^3 \times 500} = 0.514mm$$

$$\delta_{CD} = \frac{90 \times 10^3 \times 0.4}{200 \times 10^3 \times 600} = 0.3mm$$



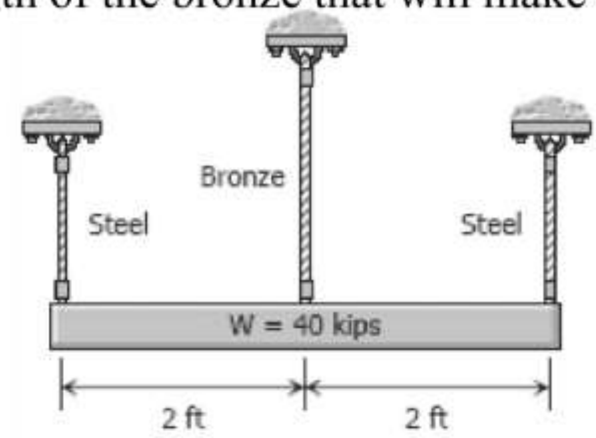
$$\frac{0.514}{0.3} = \frac{0.2 - x}{x}$$

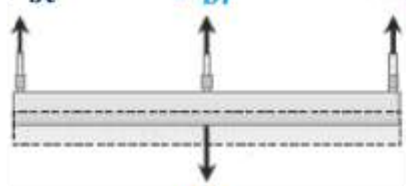
$x = 0.073m$

$$\frac{\delta_E}{0.3} = \frac{0.473}{0.073}$$

$\delta_E = 1.94mm$

Q5/ The lower ends of the three bars in are at the same level before the uniform rigid block weighing 40 kips is attached . Each steel bar has a length of 3 ft , and area of 1.0 in^2 . and E = 29 x 10^6 psl . For the bronze bar , the area is 1.5 in^2 . and E = 12 x 10^6 " psi . Determine (a) the length of the bronze bar so that the load on each steel bar is twice the load on the bronze bar , and (b) the length of the bronze that will make the steel stress twice the bronze stress





$$P_{st} = 2P_{br}$$

$$\uparrow^+ \sum f_{y=}0$$

$$2P_{st} + P_{br} = 40$$

$$2(2P_{br}) + P_{br} = 40$$

$$\boxed{P_{br} = 8Kip}$$

$$\boxed{P_{st} = 16Kip}$$

$$\delta_{br} = \delta_{st}$$

$$\frac{8 \times 10^3 \times l_{br}}{12 \times 10^6 \times 1.5} = \frac{16 \times 10^3 \times 3 \times 12}{29 \times 10^6 \times 1.5}$$

$$\boxed{l_{br} = 44.69\ in}$$

$$\sigma_{st} = 2\sigma_{br}$$

$$\uparrow^+ \sum f_{y=}0$$

$$2P_{st} + P_{br} = 40$$

$$2(\sigma_{st} \times A_{st}) + (\sigma_{br} \times A_{br}) = 40$$

$$2(2\sigma_{br} \times A_{st}) + (\sigma_{br} \times A_{br}) = 40$$

$$4\sigma_{br} \times 1 + \sigma_{br} \times 1.5 = 40$$

$$\boxed{\sigma_{br} = 7.27Ksi}$$

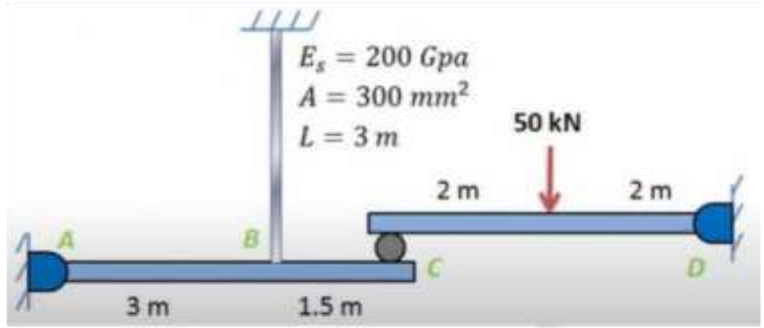
$$\boxed{\sigma_{st} = 14.54Ksi}$$

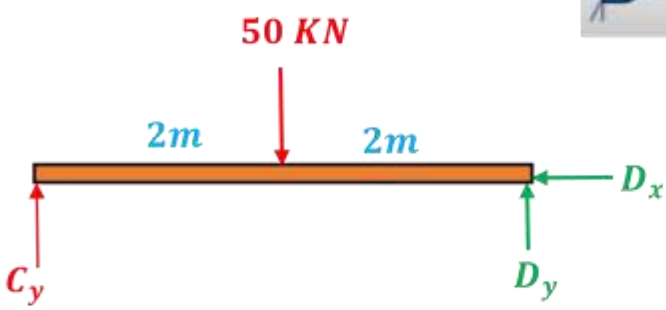
$$\delta_{br} = \delta_{st}$$

$$\frac{7.27 \times 10^3 \times l_{br}}{12 \times 10^6} = \frac{14.54 \times 10^3 \times 3 \times 12}{29 \times 10^6}$$

$$\boxed{l_{br} = 29.79\ in}$$

Q6 /Find the displacement the roller at C

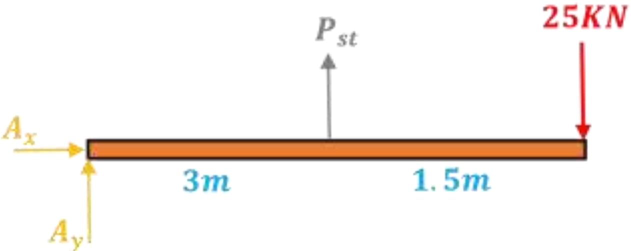




$$+\curvearrowright \sum M_D = 0$$

$$C_y(0.2) - 50(2) = 0$$

$$\boxed{C_y = 25KN}$$



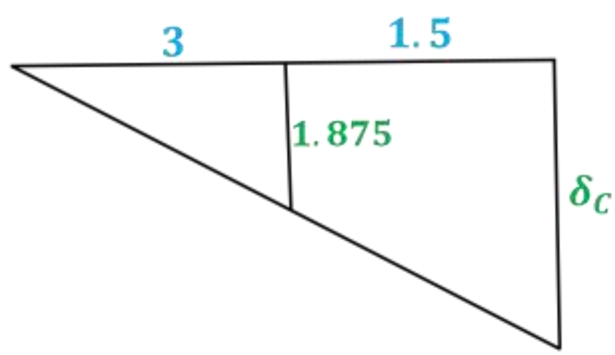
$$+\curvearrowright \sum M_A = 0$$

$$-P_{st}(3) + 25(4.5) = 0$$

$$\boxed{P_{st} = 37.5KN}$$

$$\delta_{st} = \frac{P\,L}{A\,E}$$

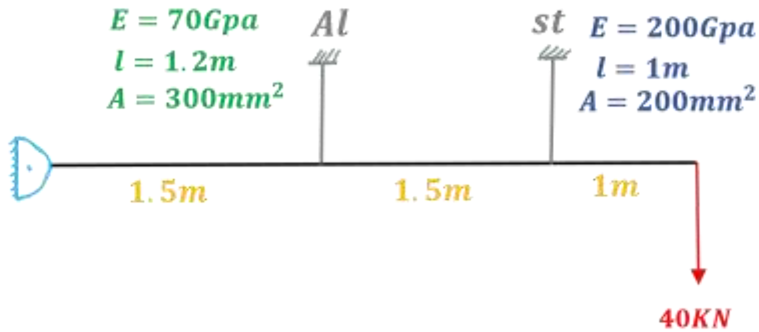
$$\delta_{st} = \frac{37.5 \times 3 \times 10^3}{300 \times 200} = 1.875mm$$

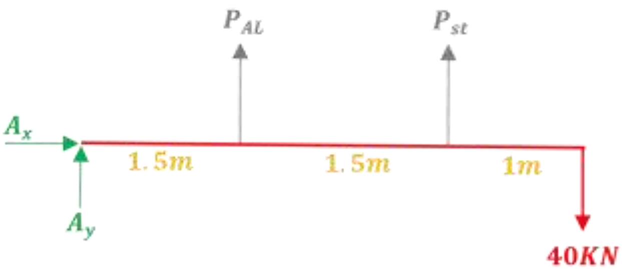


$$\frac{\delta_C}{3} = \frac{1.875}{1.5}$$

$$\boxed{\delta_C = 2.8125mm}$$

Q7/Find the stress in steel and Aluminum

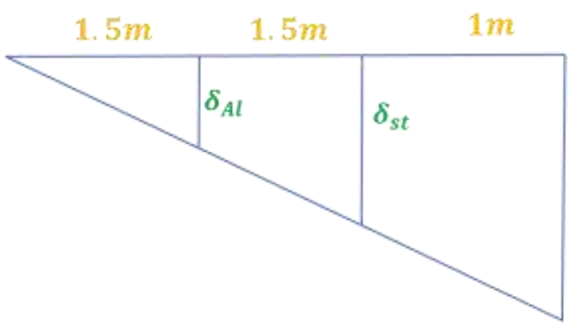




$$+\curvearrowright \sum M_A = 0$$

$$-P_{AL}(1.5) - P_{st}(3) + 40(4) = 0$$

$$\boxed{160 = 3P_{st} + 1.5P_{AL} = 0} \quad eq\ 1$$



$$\frac{\delta_{st}}{3} = \frac{\delta_{Al}}{1.5}$$

$$1.5\delta_{st} = 3\delta_{Al}$$

$$\boxed{\delta_{st} = 2\delta_{Al}}$$

$$\frac{P_{st} \times 1000}{200 \times 200} = 2\,\frac{P_{AL} \times 1200}{70 \times 300}$$

$$0.025P_{st} = 0.1143P_{Al}$$

$$\boxed{P_{st} = 4.572P_{Al}} \quad eq\ 2$$

$$160 = 3 \times 4.572P_{Al} + 1.5P_{AL} = 0$$

$$160 = 15.216P_{Al}$$

$$\boxed{P_{Al} = 10.515\ KN}$$

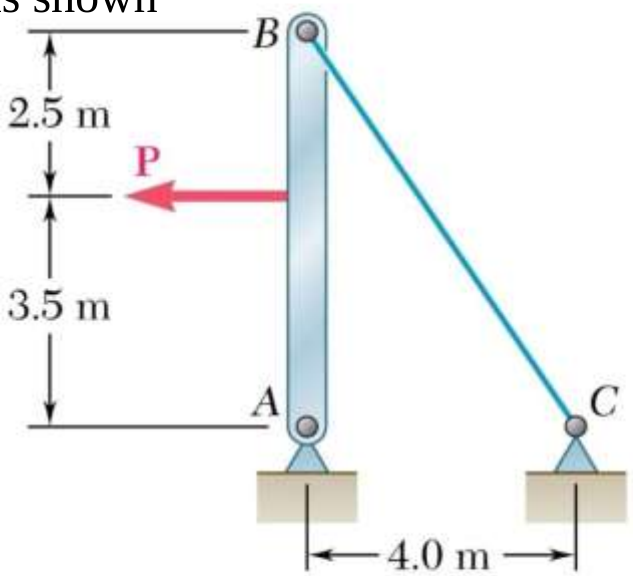
$$P_{st} = 4.572 \times 10.515$$

$$\boxed{P_{Al} = 48.1KN\ KN}$$

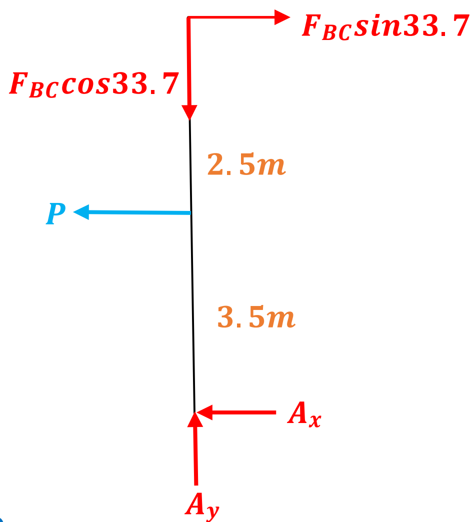
$$\sigma_{st} = \frac{P}{A} = \frac{48.1 \times 10^3}{200} = 240.5Mpa$$

$$\sigma_{AL} = \frac{P}{A} = \frac{10.515 \times 10^3}{300} = 35.05Mpa$$

Q8/ The 4 mm - diameter cable BC is made of a steel with E = 200 GPa Knowing that the maximum stress in the cable must not exceed 190 MPa and that the elongation of the cable must not exceed 6 mm, find the maximum load P that can be applied as shown



$$\theta = tan^{-1} = \frac{4}{6} \Rightarrow \theta = 33.7$$



$$+\curvearrowleft \sum M_A = 0$$

$$F_{BC}sin33.7(6) - P(3.5) = 0$$

$$\boxed{F_{BC} = 1.05P} \quad eq\ 1$$

stress

$$\sigma = \frac{P}{A}$$

$$190 = \frac{1.05\,P}{\frac{\pi}{4} \times 4^2}$$

$$\boxed{P = 2273.9N}$$

strian

$$l_{BC} = \sqrt{4^2 + 6^2} = 7.2m$$

$$\delta = \frac{P\,L}{A\,E}$$

$$6 = \frac{1.05P \times 7.2 \times 10^3}{200 \times 10^3 \times \frac{\pi}{4} \times 4^2}$$

$$\boxed{P = 1988N} \quad ANS$$

4. Chapter Four: Thearmal Stress

Thearmal stress

$$\delta_T = \alpha \times \Delta T \times l$$

$$\delta_T + \delta_P = 0$$

توجد نوعين من الاسئلة

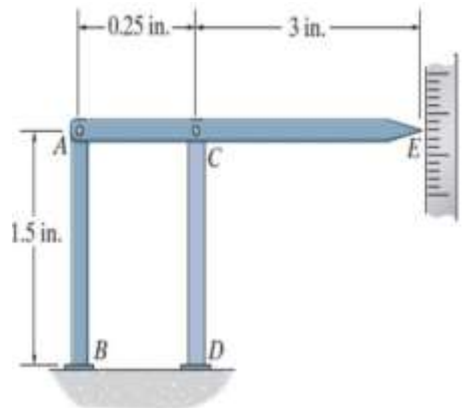
الأول / Rod يحتوي على اكثر من بار وطريقه حله:-

1- نطبق قانون رقم واحد 2- نستخدم تشابه المثلثات

الثاني /يكون الجسم مثبت من الطرفين وطريقه حله:-

1- نطبق قانون رقم واحد 2- نطبق قانون رقم اثنين

Q1/The device is used to measure a change in temperature. Bars AB and CD are made of steel and aluminum alloy, respectively. When the temperature is at 75 ° F , ACE is in the horizontal position . Determine the vertical displacement of the pointer at E when the temperature rises to 150 ° F .



$\alpha_{st} = 6.6\times10^{-6}$ °C

$\alpha_{AL} = 128\times10^{-6}$ °C

$$(\delta_T)_{AB} = \alpha \times \Delta T \times l$$

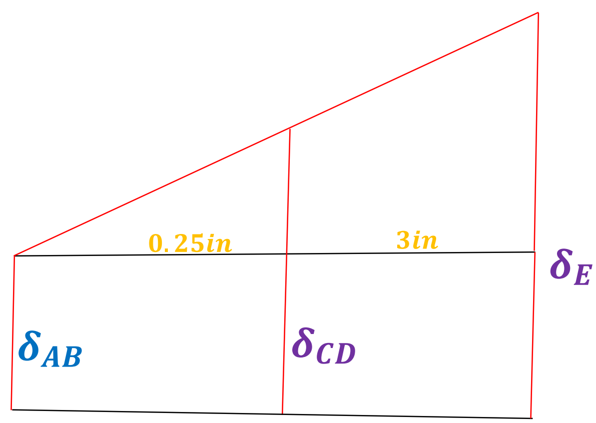
$$(\delta_T)_{AB} = 6.6\times10^{-6}\times(150-75)\times1.5$$

$$\boxed{(\delta_T)_{AB} = 7.425\times10^{-4}\,in}$$

$$(\delta_T)_{CD} = \alpha \times \Delta T \times l$$

$$(\delta_T)_{CD} = 12.8\times10^{-6}\times(150-75)\times1.5$$

$$\boxed{(\delta_T)_{CD} = 1.44\times10^{-3}\,in}$$

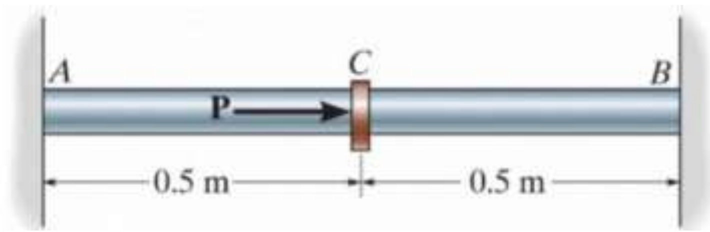


$$\frac{\delta_E-\delta_{AB}}{3.25} = \frac{\delta_{CD}-\delta_{AB}}{0.25}$$

$$\frac{\delta_E - 7.425\times10^{-4}}{3.25} = \frac{1.44\times10^{-3}-7.425\times10^{-4}}{0.25}$$

$$\boxed{\delta_E = 9.81\times10^{-3}\,in}$$

Q2/the steel rod diameter of 50mm if the Temperature 80℃ when $\alpha = 12 \times 10^{-6}$ F become Temperature 100 ℃ Find the Force P if E = 200 Pa



$$(\delta_T) = \alpha \times \Delta T \times l$$

$$(\delta_T) = 12 \times 10^{-6} \times (100 - 80) \times 1$$

$$(\delta_T) = 2.4 \times 10^{-4} m$$

$$\delta_P = \frac{P\,L}{A\,E}$$

$$\delta_P = \frac{P \times 0.5}{\frac{\pi}{4} \times \left(\frac{50}{1000}\right)^2 \times 200} \Longrightarrow \delta_P = 1.273P$$

$$-\delta_T + \delta_P = 0 \Longrightarrow \delta_T = \delta_P$$

$$2.4 \times 10^{-4} = 1.273P \Longrightarrow P = 1.885 \times 10^{-4}$$

5. Chapter Five: Torsion

Torsion

$$\tau_{max} = \frac{T \times r}{J}$$

القطر

Solid

$$J = \frac{\pi}{32} \times C^4$$

Hollow

$$J = \frac{\pi}{32} \times (C_o^4 - C_i^4)$$

نصف قطر

Solid

$$J = \frac{\pi}{32} \times r^4$$

Hollow

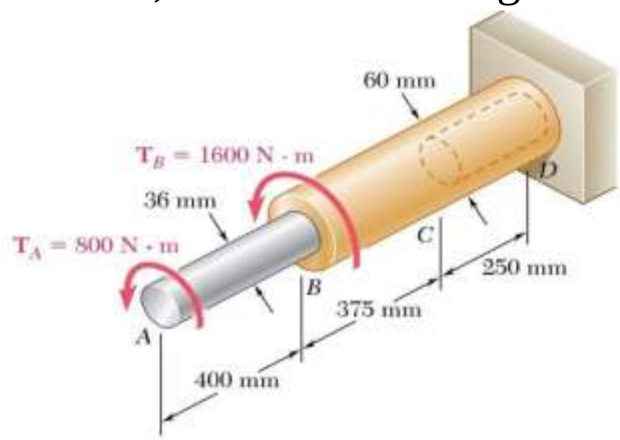
$$J = \frac{\pi}{2} \times (r_o^4 - r_i^4)$$

$$\theta = \frac{T \times L}{J \times G}$$

لتحويل الراد الى الدكري نضرب $\frac{180}{\pi}$

لتحويل الدكري الى الراد نضرب $\frac{\pi}{180}$

Q1/The aluminum rod AB (G = 27 GPa) is bonded to the brass rod BD (C = 39 GPa) . Knowing that portion CD of the brass rod is hollow and has an inner diameter of 40 mm , determine the angle of twist at A



$$\theta_A = \theta_{AB} + \theta_{BC} + \theta_{CD}$$

$$\theta_{AB} = \frac{T \times L}{J \times G} \Rightarrow \theta_{AB} = \frac{800 \times 10^3 \times 400}{\frac{\pi}{2} \times 18^4 \times 27 \times 10^3} \Rightarrow \boxed{\theta_{AB} = 0.0719\, rad}$$

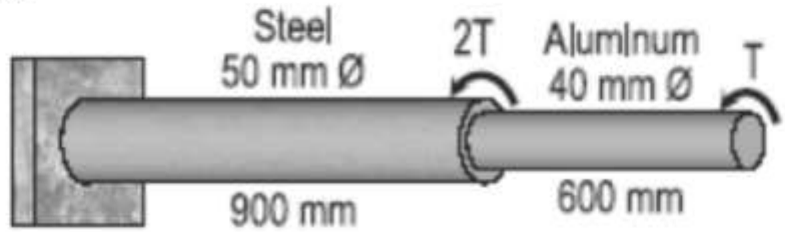
$$\theta_{BC} = \frac{T \times L}{J \times G} \Rightarrow \theta_{BC} = \frac{2400 \times 10^3 \times 375}{\frac{\pi}{2} \times 30^4 \times 39 \times 10^3} \Rightarrow \boxed{\theta_{BC} = 0.018\, rad}$$

$$\theta_{CD} = \frac{T \times L}{J \times G} \Rightarrow \theta_{BC} = \frac{2400 \times 10^3 \times 250}{\frac{\pi}{2} \times (30^4 - 20^4) \times 39 \times 10^3} \Rightarrow \boxed{\theta_{CD} = 0.015\, rad}$$

$$\theta_A = \theta_{AB} + \theta_{BC} + \theta_{CD}$$

$$\theta_A = 0.0719 + 0.018 + 0.015 \Rightarrow \boxed{\theta_A = 0.1049\, rad}$$

Q2/ compound shaft consisting of a steel segment and an aluminum segment is acted upon by two torques as shown in the figure . Determine the maximum permissible value of T subject to the following conditions : τ_{st} = 83 MPa , τ_{al} =55 MPa , and the angle of rotation of the free end is limited to 6 ° . For steel , G = 83 GPa and for aluminum , G = 28 GPa



Part1

$$\tau_{al} = \frac{T \times r}{J}$$

$$\tau_{al} = \frac{T \times 20}{\frac{\pi}{2} \times 20^4}$$

$$\tau_{al} = 691150.38\ N.mm$$

$$\boxed{\tau_{al} = 691.15\ N.m}$$

Part2

$$\tau_{st} = \frac{T \times r}{J}$$

$$\tau_{st} = \frac{3T \times 25}{\frac{\pi}{2} \times 25^4}$$

$$\tau_{st} = 679042.16\ N.mm$$

$$\boxed{\tau_{st} = 679.04\ N.m}$$

Part3

$$\theta = \theta_{al} + \theta_{st}$$

$$6 \times \frac{\pi}{180} = \frac{T \times 600}{\frac{\pi}{2} \times 20^4 \times 28 \times 10^3} + \frac{3T \times 900}{\frac{\pi}{2} \times 25^4 \times 83 \times 10^3}$$

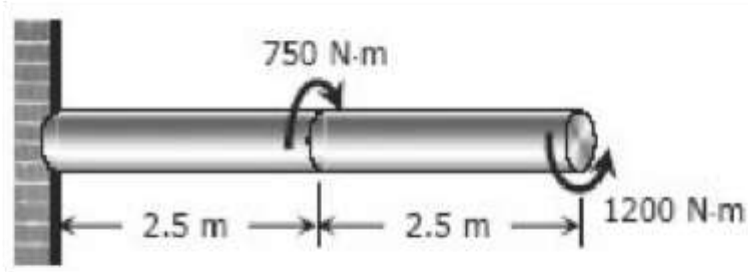
$$\theta = 757316.32\ N.mm$$

$$\boxed{\theta = 757.32\ N.m}$$

ANS

$$\boxed{\tau_{st} = 679.04\ N.m}$$

Q3/ A solid steel shaft is loaded as shown in Fig . P - 322 . Using G = 83 GPa , determine the required diameter of the shaft if the shearing stress is limited to 60 MPa and the angle of rotation at the free end is not to exceed 4 deg



Part1

$$T - 1200 = 0$$

$$T = 1200\ N.m$$

$$\tau = \frac{T \times r}{J}$$

$$60 = \frac{1200 \times 10^3 \times r}{\frac{\pi}{2} \times r^4}$$

$$r = 23.351mm \quad \times 2$$

$$\boxed{d = 46.7mm}$$

Part2

$$T - 1200 + 750 = 0 \quad \Rightarrow \quad T = 450\ N.m$$

$$\tau = \frac{T \times r}{J}$$

$$60 = \frac{450 \times 10^3 \times r}{\frac{\pi}{2} \times r^4}$$

$$r = 16.8389mm \quad \times 2$$

$$\boxed{d = 33.67mm}$$

Part3

$$\theta = \frac{T \times L}{J \times G}$$

$$4 \times \frac{\pi}{180} = \frac{1200 \times 10^3 \times 2.5 \times 10^3}{\frac{\pi}{2} \times r^4 \times 83 \times 10^3} + \frac{450 \times 10^3 \times 2.5 \times 10^3}{\frac{\pi}{2} \times r^4 \times 83 \times 10^3}$$

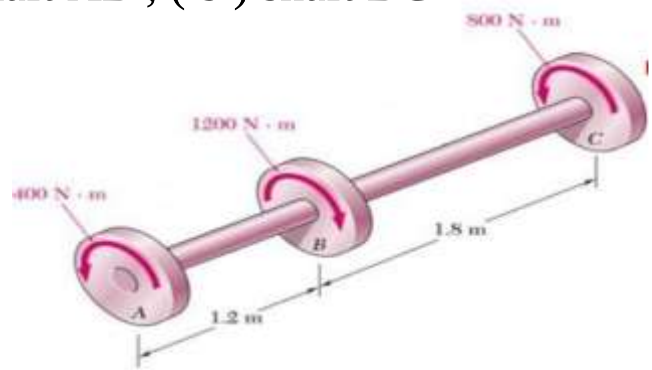
$$r = 25.294mm \quad \times 2$$

$$\boxed{d = 51.89mm}$$

ANS

$$\boxed{d = 51.89mm}$$

Q4/The shafts of the pulley assembly shown are to be redesigned Knowing that the allowable shearing stress in each shaft is 60 MPa , determine the smallest allowable diameter of (a) shaft AB , (b) shaft BC



Part1

$$T_{AB} = 400\ N.m$$

$$\tau = \frac{T \times r}{J}$$

$$60 = \frac{400 \times 10^3 \times r}{\frac{\pi}{2} \times r^4}$$

$$r = 19.19\ mm \quad \times 2$$

$$\boxed{d = 32.38\ mm}$$

Part2

$$T_{BC} = 800\ N.m$$

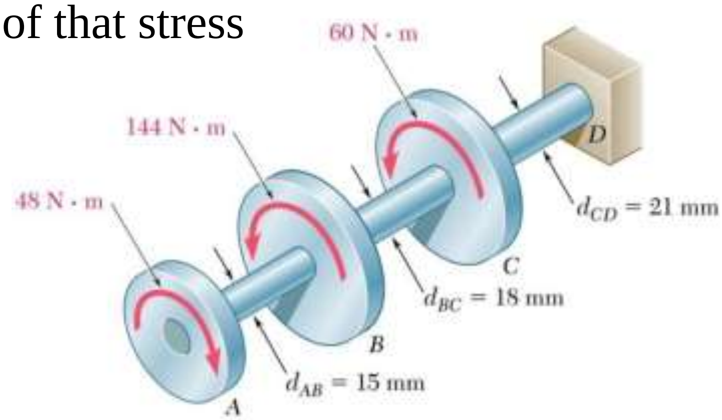
$$\tau = \frac{T \times r}{J}$$

$$60 = \frac{800 \times 10^3 \times r}{\frac{\pi}{2} \times r^4}$$

$$r = 20.39\ mm \quad \times 2$$

$$\boxed{d = 40.78\ mm}$$

Q5/Knowing that each of the shafts AB , BC , and CD consists of a solid circular rod , determine (a) the shaft in which the maximum shear ing stress occurs , (b) magnitude of that stress



Part1

$$T_{AB} = 48\ N.m$$

$$\tau_{AB} = \frac{T \times r}{J}$$

$$\tau_{AB} = \frac{48 \times 10^3 \times 7.5}{\frac{\pi}{2} \times 7.5^4}$$

$$\tau_{AB} = 72.4 Mpa$$

Part2

$$T_{BC} = 96 N.m$$

$$\tau_{BC} = \frac{T \times r}{J}$$

$$\tau_{BC} = \frac{96 \times 10^3 \times 9}{\frac{\pi}{2} \times 9^4}$$

$$\tau_{BC} = 83.8 Mpa$$

Part3

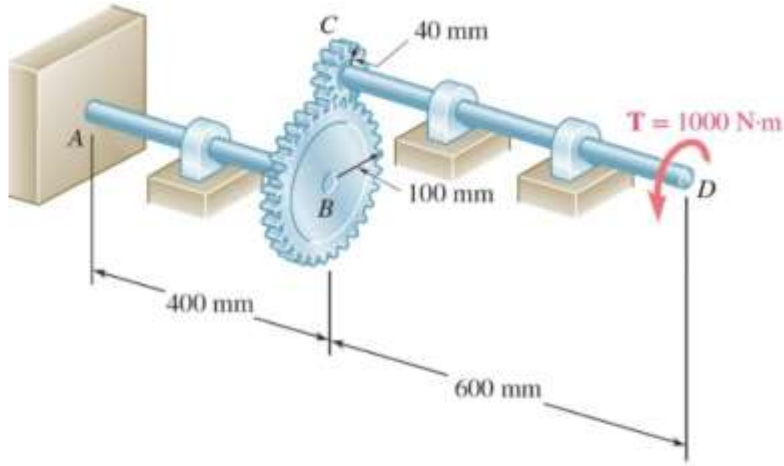
$$T_{CD} = 156\ N.m$$

$$\tau_{CD} = \frac{T \times r}{J}$$

$$\tau_{CD} = \frac{156 \times 10^3 \times 10.5}{\frac{\pi}{2} \times 10.5^4}$$

$$\tau_{CD} = 85.8 Mpa$$

Q6/A torque of magnitude T = 1000 Nm is applied at D as shown that the allowable shearing stress is 60 MPa in each shaft , determine the required diameter of (a) shaft AB , (b) shaft CD



shaft CD

$$\tau_{CD} = \frac{T \times r}{J}$$

$$60 = \frac{1000 \times 10^3 \times r}{\frac{\pi}{2} \times r^4}$$

$$r = 22mm \quad \times 2$$

$$\boxed{d = 44\ mm}$$

$$\frac{T_{CD}}{r_c} = \frac{T_{AB}}{r_B}$$

$$\frac{1000}{40 \times 10^{-3}} = \frac{T_{AB}}{100 \times 10^{-3}}$$

$$T_{AB} = 2500N.m$$

shaft AB

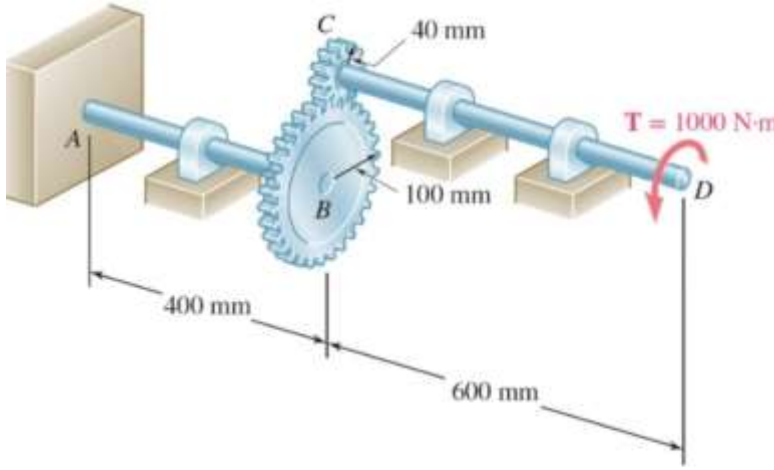
$$\tau_{AB} = \frac{T \times r}{J}$$

$$60 = \frac{2500 \times 10^3 \times r}{\frac{\pi}{2} \times r^4}$$

$$r = 29.8mm \quad \times 2$$

$$\boxed{d = 59.8\ mm}$$

Q7/A torque of magnitude T = 1000 N • m is applied at D as shown . Knowing that the diameter of shaft AB is 20 mm and that the diameter of shaft CD is 15 mm , determine the maximum shearing stress in (a) shaft AB , (b) shaft CD



shaft CD

$$\tau_{CD} = \frac{T \times r}{J}$$

$$\tau_{CD} = \frac{1000 \times 10^3 \times 7.5}{\frac{\pi}{2} \times 7.5^4}$$

$$\boxed{\tau_{CD} = 1509Mpa}$$

$$\frac{T_{CD}}{r_c} = \frac{T_{AB}}{r_B}$$

$$\frac{1000}{40 \times 10^{-3}} = \frac{T_{AB}}{100 \times 10^{-3}}$$

$$T_{AB} = 2500N.m$$

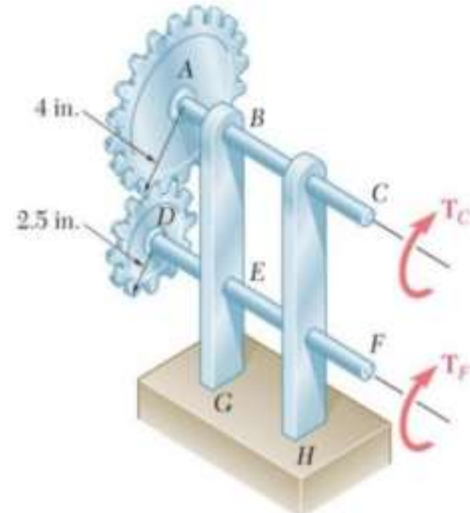
shaft AB

$$\tau_{AB} = \frac{T \times r}{J}$$

$$\tau_{AB} = \frac{2500 \times 10^3 \times 10}{\frac{\pi}{2} \times 10^4}$$

$$\boxed{\tau_{AB} = 1591Mpa}$$

Q8/The two solid shafts are connected by gears as shown and are made of a steel for which the allowable shearing stress is alle 7.0 ksi . This gear set is designed to lock - in the torque applied at C and F , respectively , so that the gear set is in static equilibrium . Knowing the diameters of the two shafts are , respectively , d_C=1.6 in . and d_F = 1.25 in . , determine the largest torque T_c that can be applied at C.



$$\tau = \frac{T_C \times r}{J}$$

$$7 = \frac{T_C \times 0.8}{\frac{\pi}{2} \times 0.8^4}$$

$$T_C = 5.63\ Kip\,.in$$

القيمة الأكبر هيه راح تكون مجهوله ونطبق عليها قانون مسننات

$$\tau = \frac{T_F \times r}{J}$$

$$7 = \frac{T_F \times 0.625}{\frac{\pi}{2} \times 0.625^4}$$

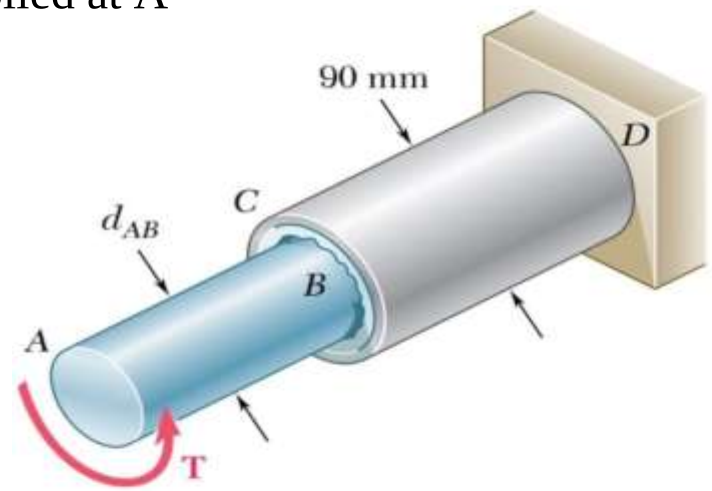
$$T_F = 2.68\ Kip\,.in$$

$$\frac{T_C}{4} = \frac{T_F}{2.5}$$

$$\frac{T_C}{4} = \frac{2.68}{2.5}$$

$$T_C = 4.288\ Kip\,.in$$

Q9/The solid rod AB has a diameter dB 60 mm and is made of a steel for which the allowable shearing stress is 85 MPa . The pipe CD , which has an outer diameter of 90 mm and a wall thickness of 6 mm , is made of an aluminum for which the allowable shearing stress is 54 MPa . Determine the largest torque T that can be applied at A



shaft AB

$$\tau = \frac{T \times r}{J}$$

$$85 = \frac{T \times 30}{\frac{\pi}{2} \times 30^4}$$

$$T = 3604977\ N.mm$$

$$d_i = d_o - 2 \times t$$

$$d_i = 90 - 2 \times 6 = 78mm$$

$$\tau = \frac{T \times r}{\frac{\pi}{2} \times (r_o^4 - r_i^4)}$$

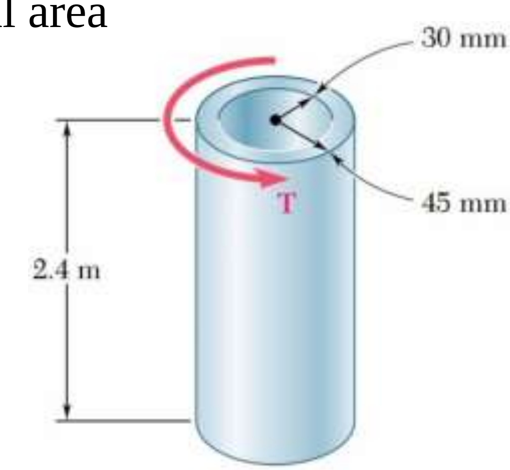
$$54 = \frac{T \times 45}{\frac{\pi}{2} \times (45^4 - 39^4)}$$

$$T = 3368762\ N.mm$$

ANS

$$T = 3368762\ N.mm$$

Q10/(a) Determine the torque T that causes a maximum shearing stress of 45 MPa in the hollow cylindrical steel shaft shown . (b) Deter mine the maximum shearing stress caused by the same torque T in a solid cylindrical shaft of the same cross - sectional area



(a)

$$\tau = \frac{T \times r}{\frac{\pi}{2} \times (r_o^4 - r_i^4)}$$

$$45 = \frac{T \times 45}{\frac{\pi}{2} \times (45^4 - 30^4)}$$

$$\boxed{T = 5169\ N.mm}$$

$$A_h = \frac{\pi}{4} \times (r_o^2 - r_i^2)$$

$$A_h = \frac{\pi}{4} \times (90^2 - 60^2)$$

$$A_h = 3534.3\ mm^2$$

(b)

$$A_h = A_s$$

$$3534.3 = \frac{\pi}{4} \times d^2$$

$$d_s = 67.08\ mm$$

$$\tau = \frac{T \times r}{J}$$

$$\tau = \frac{5169 \times 33.54}{\frac{\pi}{2} \times 33.54^4}$$

$$\boxed{\tau = 8.72\ Mpa}$$

6. Chapter Sex: Draw SFD and BMD

1. Introduction:

Members that are slender and support loadings that are applied perpendicular to their longitudinal axis are called beams. In general، beams are long, straight bars having a constant cross-sectional area. Often they are classified as to how they are supported. For example, a simply supported beam is pinned at one end and roller supported at the other، Fig. 6–1, a cantilevered beam is fixed at one end and free at the other, and an overhanging beam has one or both of its ends freely extended over the supports. Beams are considered among the most important of all structural elements. They are used to support the floor of a building, the deck of a bridge, or the wing of an aircraft. Also, the axle of an automobile, the boom of a crane, even many of the bones of the body act as beams.

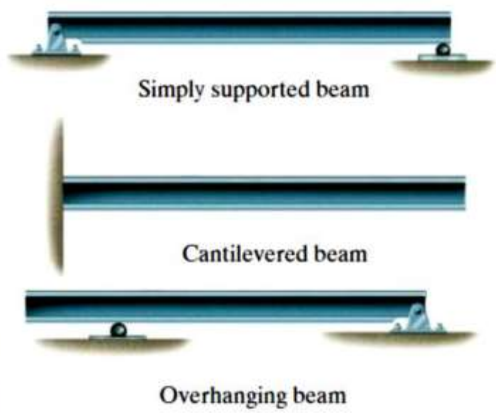


Fig. 6–1

Beam Sign Convention. Before presenting a method for determining the shear and moment as functions of x and later plotting these functions (shear and moment diagrams), it is first necessary to establish a sign convention so as to define "positive" and "negative" values for V and M . Although the choice of a sign convention is arbitrary, here we will use the one often used in engineering practice and shown in Fig. 6–3 . The positive directions are as follows: the distributed load acts upward on the beam; the internal shear force causes a clockwise rotation of the beam segment on which it acts; and the internal moment causes compression in the top

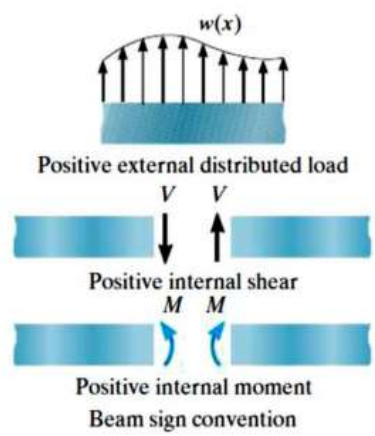


Fig. 6–3

2. Method of Drawing of Shear Force and Bending Moment

2.1 Section Method

Procedure for Analysis

The shear and moment diagrams for a beam can be constructed using the following procedure.

a) Support Reactions.

• Determine all the reactive forces and couple moments acting on the beam, and resolve all the forces into components acting perpendicular and parallel to the beam's axis.

b) Shear and Moment Functions.

• Specify separate coordinates x having an origin at the beam's left end and extending to regions of the beam between concentrated forces and/or couple moments, or where there is no discontinuity of distributed loading.

• Section the beam at each distance x, and draw the free-body diagram of one of the segments. Be sure V and M are shown acting in their positive sense, in accordance with the sign convention given in Fig. 6–3.

• The shear is obtained by summing forces perpendicular to the beam's axis.

• To eliminate V, the moment is obtained directly by summing moments about the sectioned end of the segment.

c) Shear and Moment Diagrams.

• Plot the shear diagram (V versus x) and the moment diagram (M versus x). If numerical values of the functions describing V and M are positive, the values are plotted above the x axis, whereas negative values are plotted below the axis.

• Generally it is convenient to show the shear and moment diagrams below the free-body diagram of the beam.

2.2 Graphical Method for Constructing Shear and moment diagrams

In cases where a beam is subjected to several different loadings, determining V and M as functions of x and then plotting these equations can become quite tedious. In this section a simpler method for constructing the shear and moment diagrams is discussed—a method based on two differential relations, one that exists between distributed load and shear, and the other between shear and moment.

$$\frac{dV}{dx} = w(x)$$

slope of shear diagram at each point = distributed load intensity at each point

$$\frac{dM}{dx} = V(x)$$

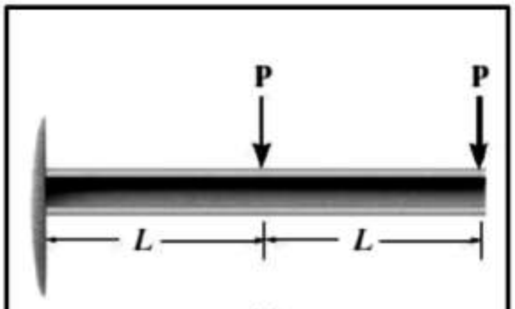
slope of moment diagram at each point = shear at each point

$$\Delta V = \int w(x)dx$$

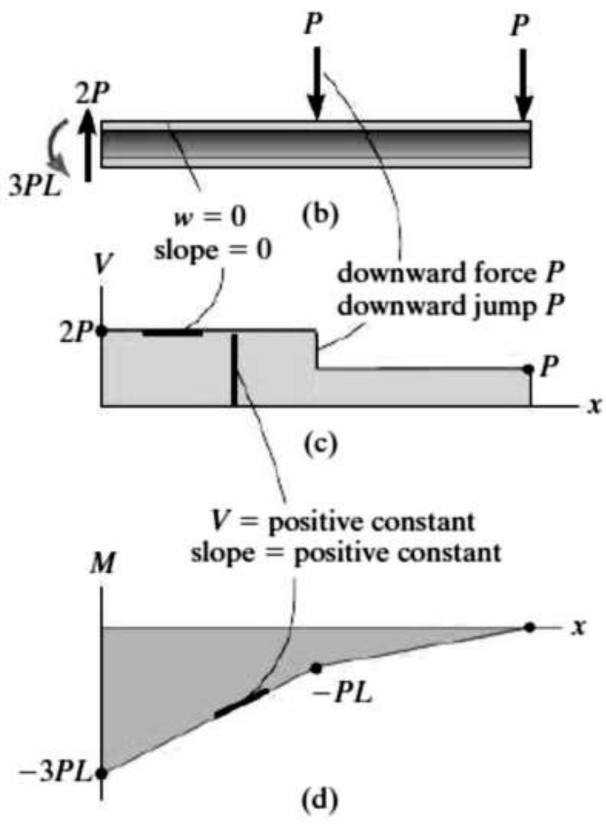
change in shear = area under distributed loading

$$\Delta M = \int V(x)dx$$

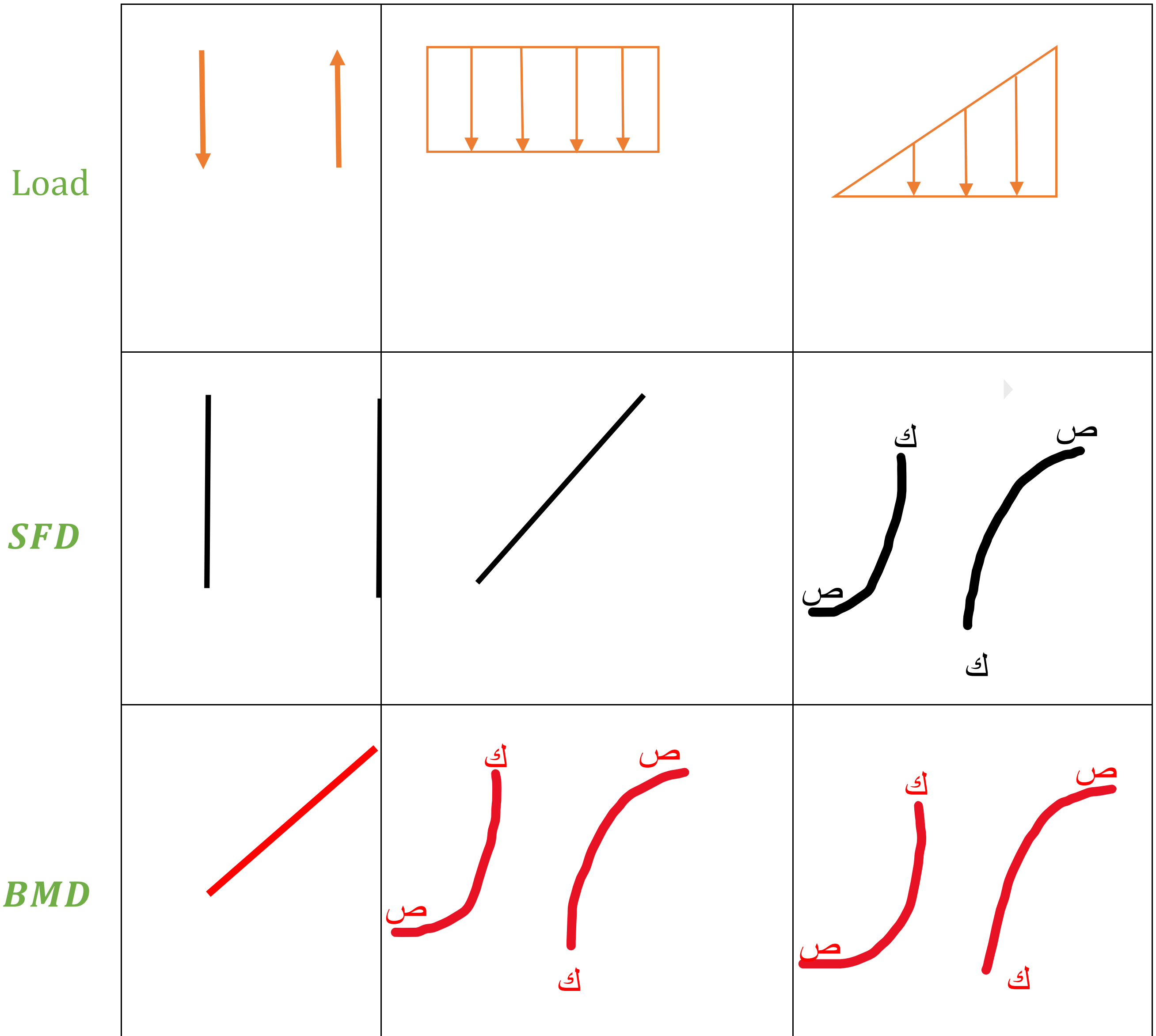
change in moment = area under shear diagram



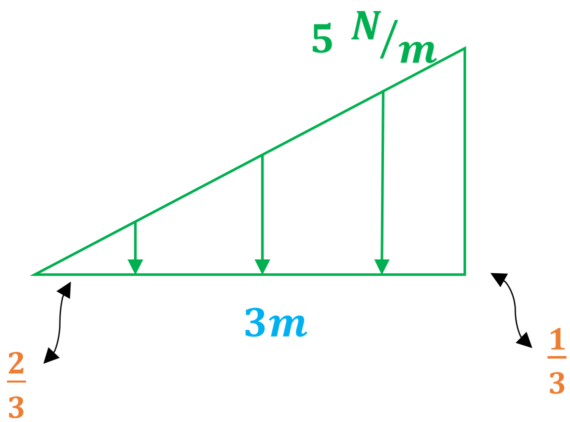
(a)

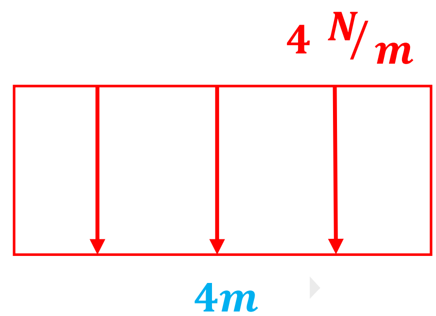


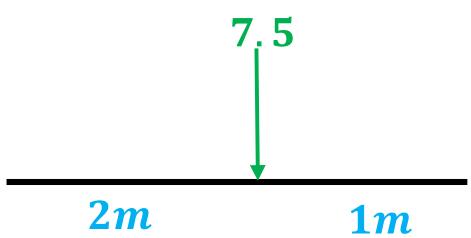
Draw – SFD – BMD

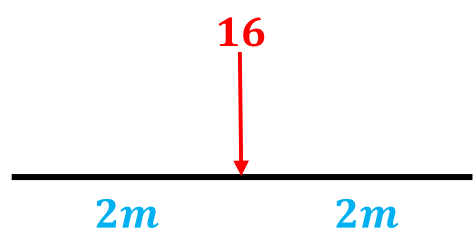


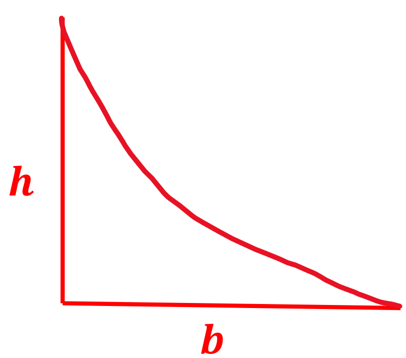
تحويل الحمل المنتشر الى قوه



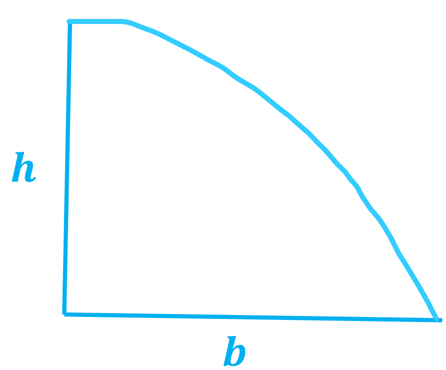






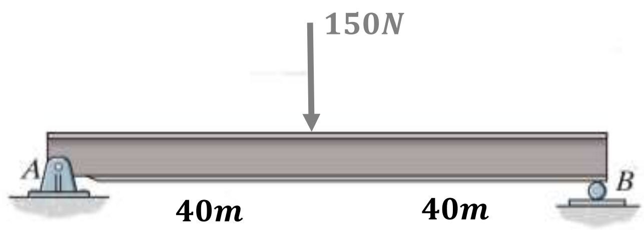


$$A = \frac{1}{3} \times b \times h$$



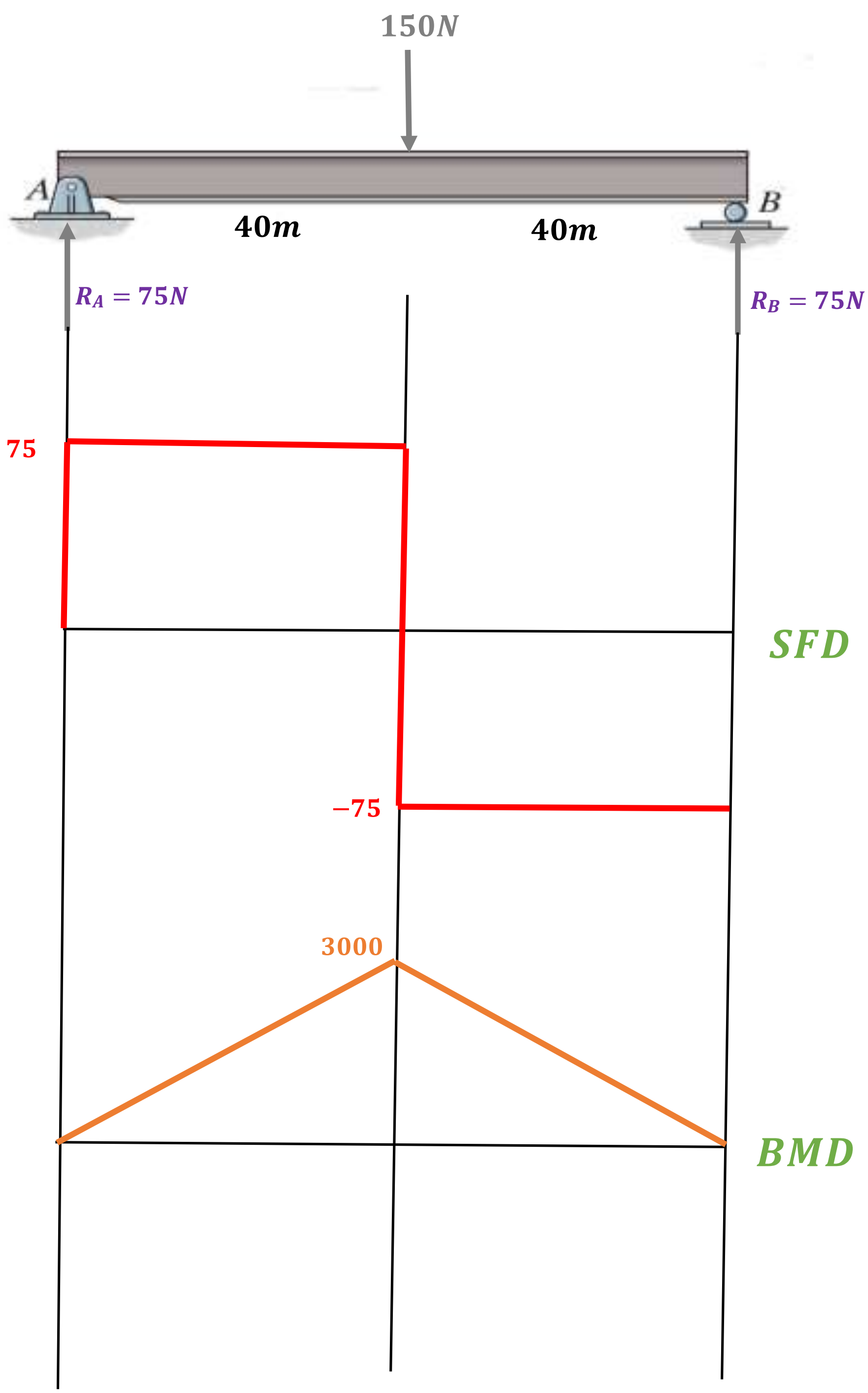
$$A = \frac{2}{3} \times b \times h$$

Q1/ Draw SFD and BMD

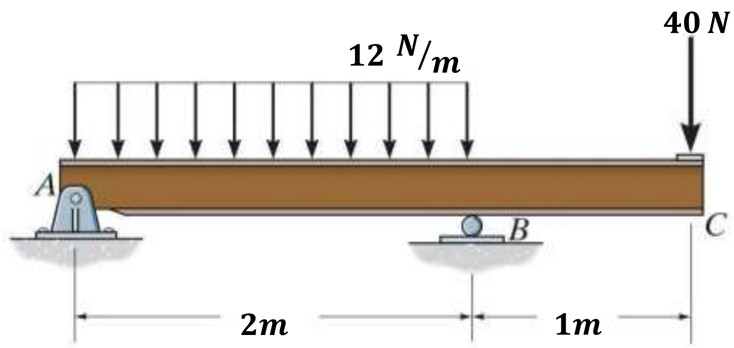


$R_A = 75\ N$

$R_B = 75\ N$

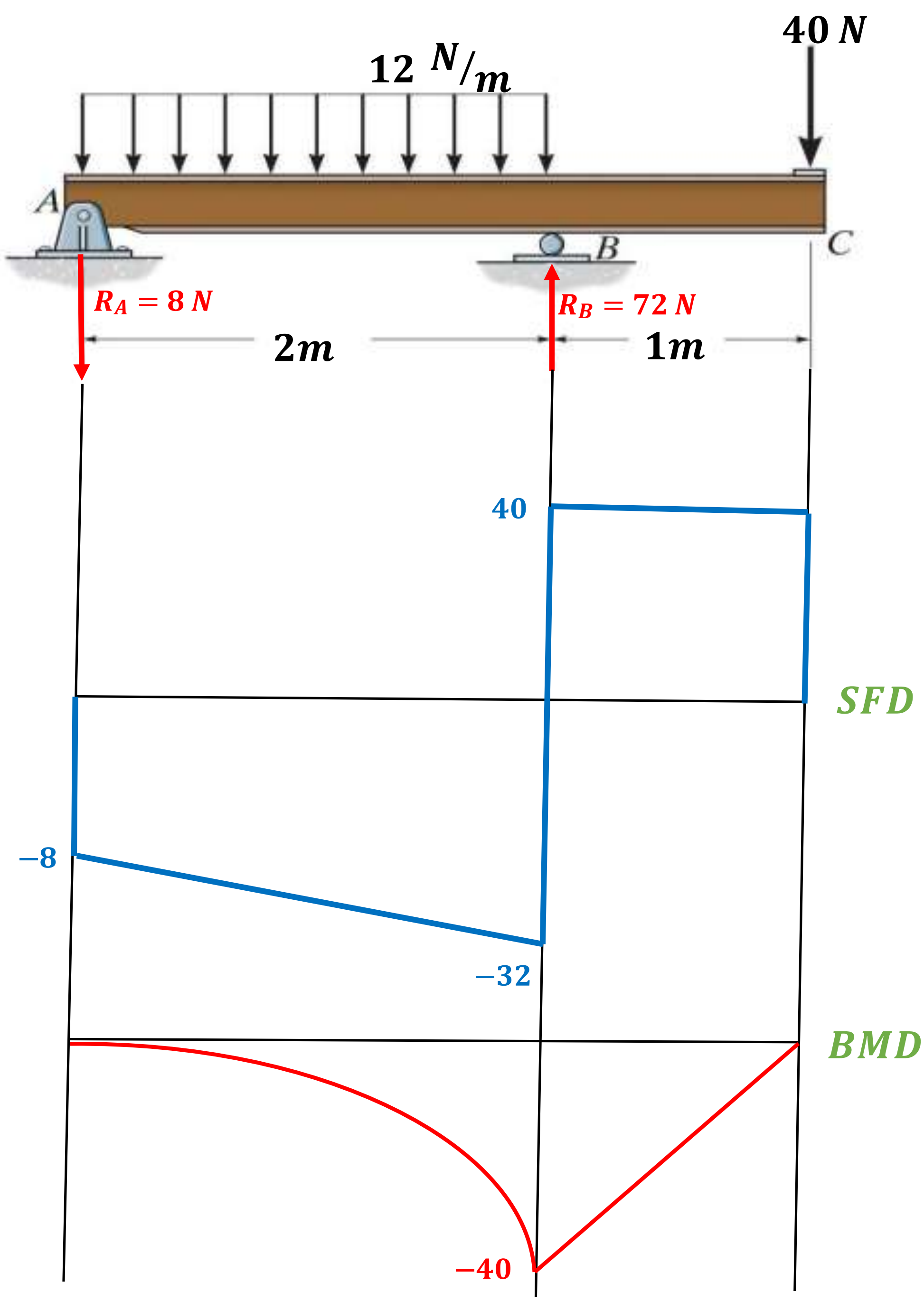


Q2/ Draw SFD and BMD

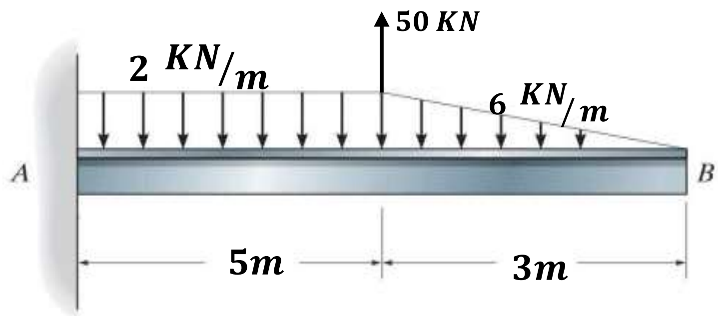


$R_A = -8\ N$

$R_B = 72\ N$

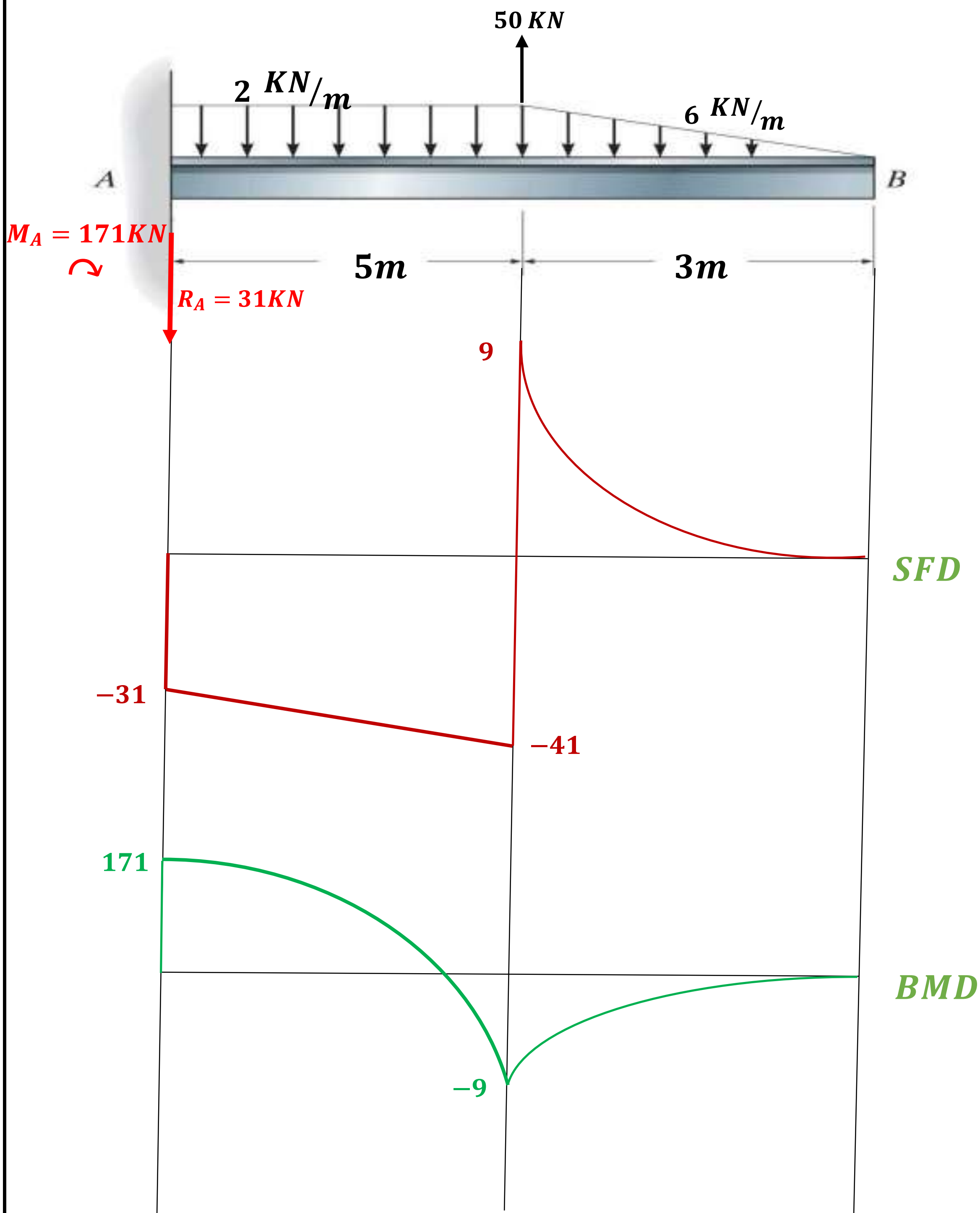


Q3/ Draw SFD and BMD

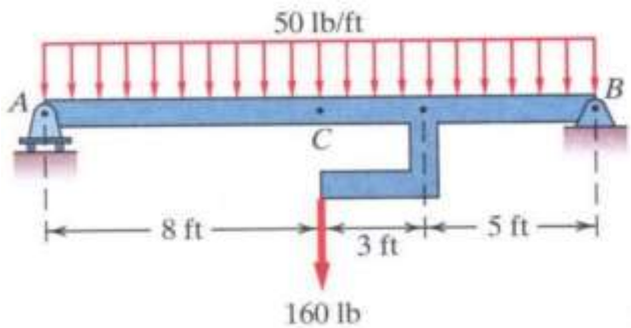


$R_A = -31KN$

$M_A = 171KN$

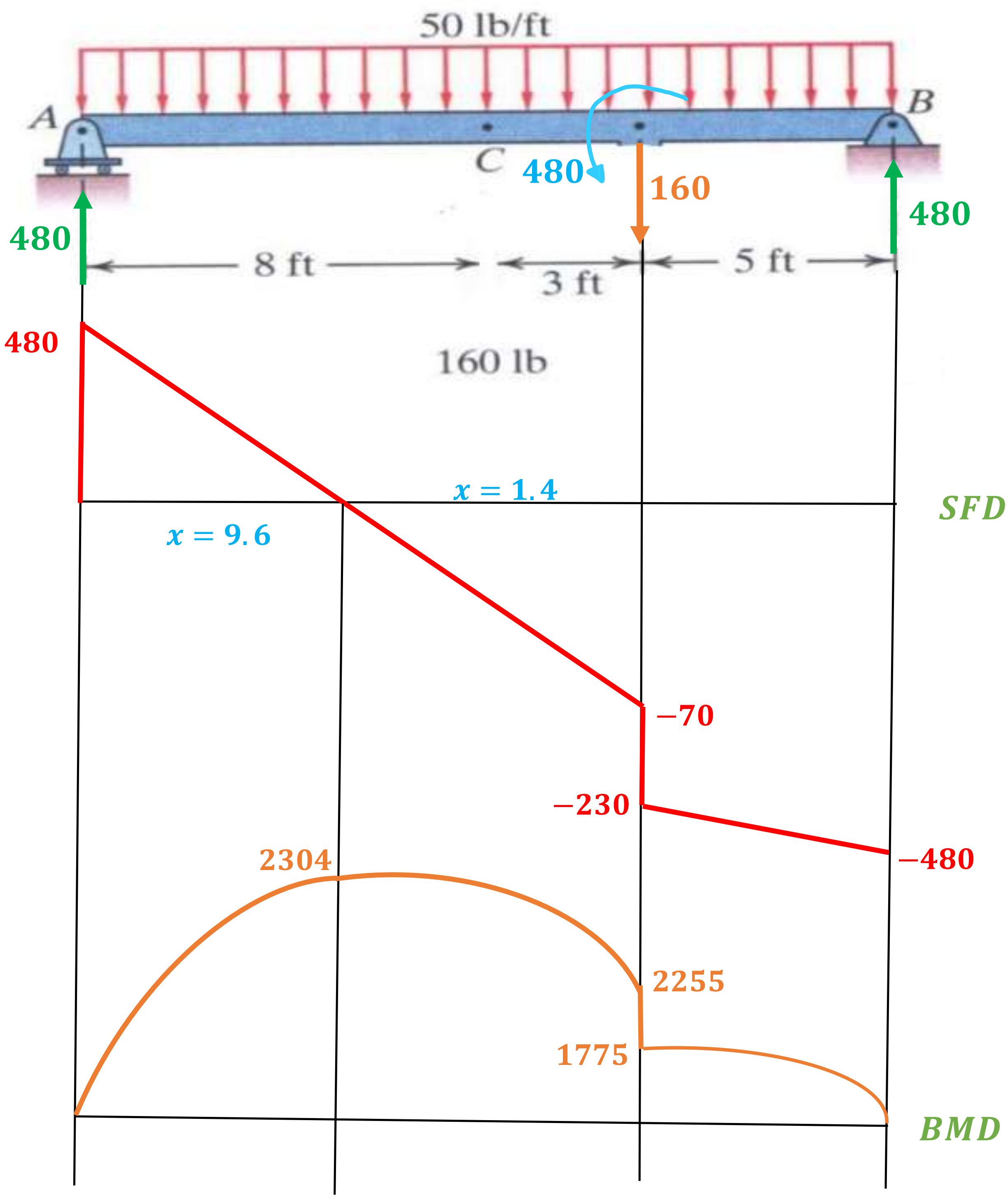


Q4/ Draw SFD and BMD

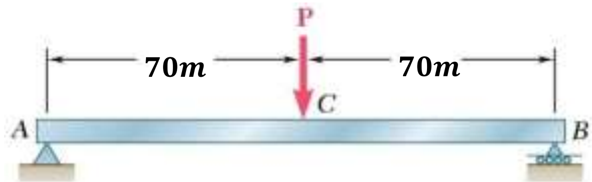


$R_A = 480\ lb$

$R_B = 480\ lb$

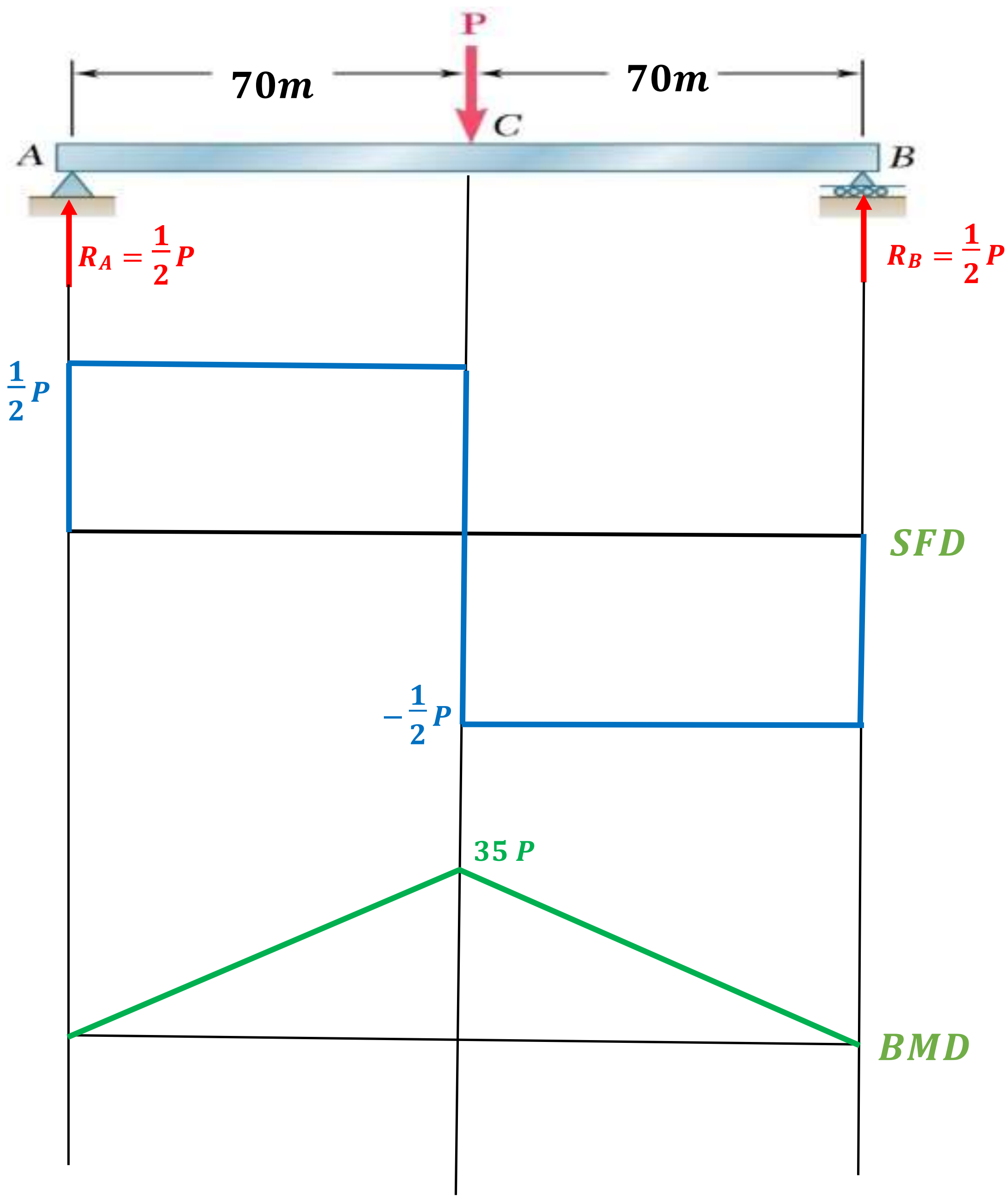


Q5/ Draw SFD and BMD

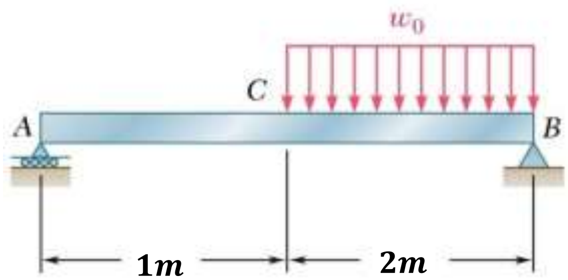


$R_A = \frac{1}{2}P$

$R_B = \frac{1}{2}P$

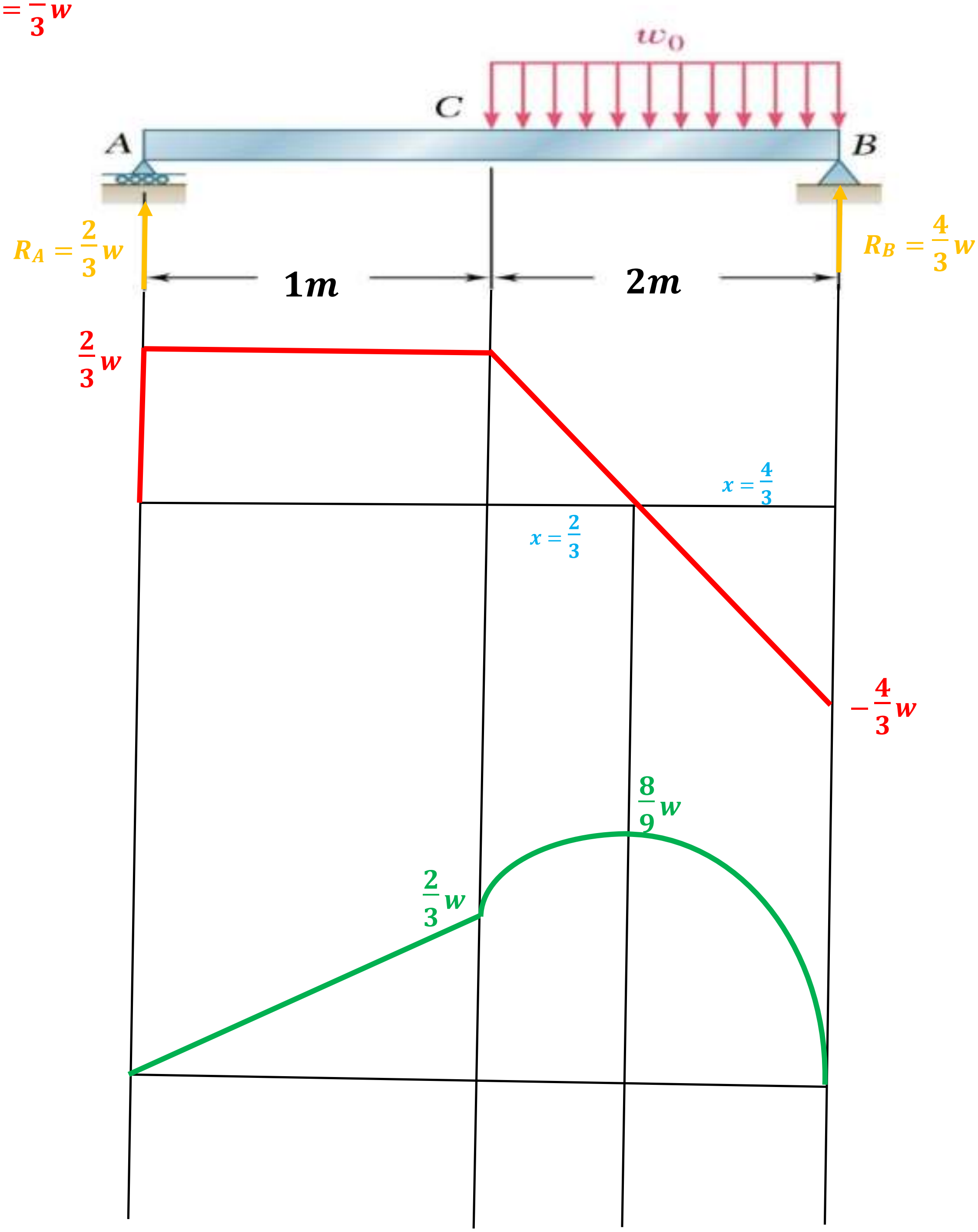


Q6/ Draw SFD and BMD



$R_A = \frac{2}{3}w$

$R_B = \frac{4}{3}w$



7. Chapter Seven: Thin Walled Cylinder

Thin – walled Cylinder

1− *Hoop stress* (σ_h)

tangetial — *Circumferential*

$$\sigma_h = \frac{P \times D}{2 \times t}$$

internal prussere عندما يعطي او يطلب

نستخدم

$$\sigma_h = \frac{P \times D}{2 \times t}$$

2− *longitud stress* (σ_l)

$$\sigma_l = \frac{P \times D}{4 \times t}$$

Q1/ A cylindrical pressure vessel is fabricated from steel plating that has a thickness of 20 mm. The diameter of the pressure vessel is 450 mm and its length is 2.0 m. Determine the maximum internal pressure that can be applied if the longitudinal stress is limited to 140 MPa, and the circumferential stress is limited to 60 MPa

Circumferential

$$\sigma_h = \frac{P \times D}{2 \times t}$$

$$60 = \frac{P \times 450}{2 \times 20}$$

$$P = 5.33\ Mpa$$

Longitudinal

$$\sigma_l = \frac{P \times D}{4 \times t}$$

$$140 = \frac{P \times 450}{4 \times 20}$$

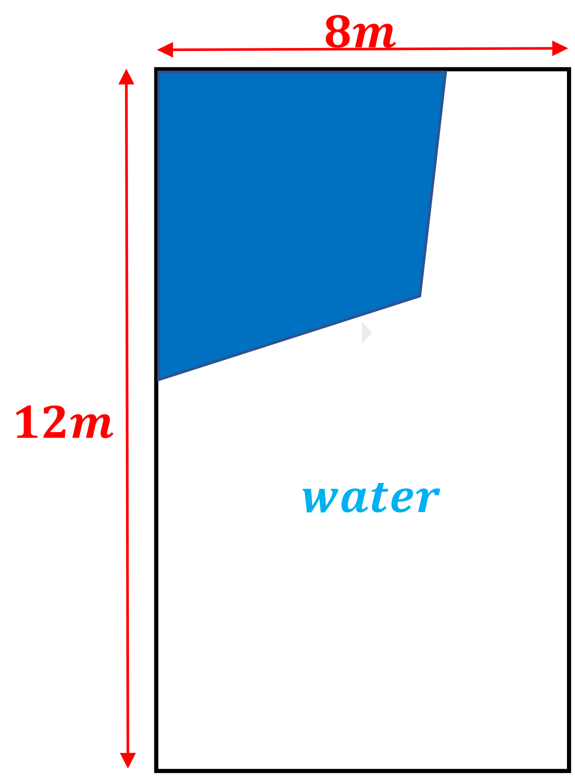
$$P = 24.88\ Mpa$$

ANS

$$P = 5.33\ Mpa$$

من يطلب maximum نختار الاقل

Q2/ A water tank is 8m in diameter and 12m high . If the tank is to be completely filled , determine the minimum thickness of the tank plating if the stress is limited to 40Mpa ? The density of water is 1000Kg / m³



$$P = \rho \times g \times h$$

$$P = 1000 \times 10 \times 12$$

$$P = 120000\ Pa$$

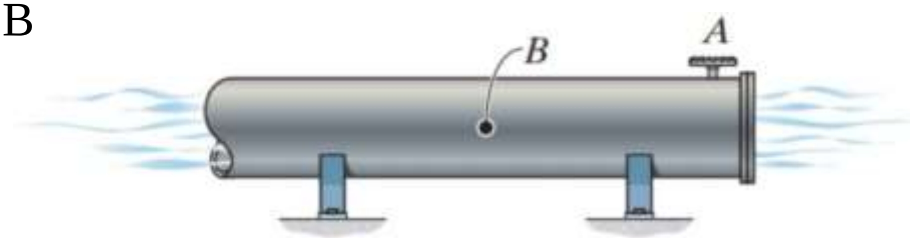
$$\sigma_h = \frac{P \times D}{2 \times t}$$

$$40 = \frac{120000 \times 10^{-6} \times 8 \times 10^{3}}{2 \times t}$$

$$\boxed{t = 12\ mm}$$

الماء يضغط على الجدار من الداخل
يعني يكون internal pressure
فنستخدم Hoop stress

Q3/ The steel water pipe has an inner diameter of 12 inch . and a wall thickness of 0.25 inch . If the valve A is opened in case and closed in another case and the flowing water has a pressure of 250 psi as it passes point B , determine the longitudinal and hoop stress developed in the wall of the pipe at point B



OPEN CAUS

مباشرا صفر عندما تكون مفتوحه

$$\sigma_l = 0$$

$$\sigma_h = \frac{P \times D}{2 \times t}$$

$$\sigma_h = \frac{250 \times 12}{2 \times 0.25}$$

$$\sigma_h = 6000\ Psi$$

CLOSED CAUS

$$\sigma_l = \frac{P \times D}{4 \times t}$$

$$\sigma_l = \frac{250 \times 12}{4 \times 0.25}$$

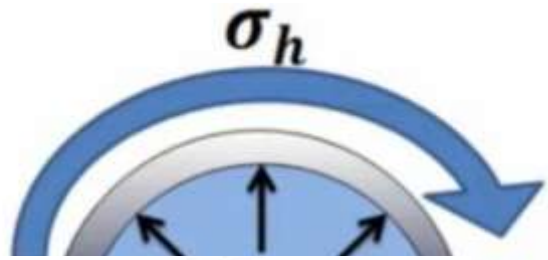
$$\sigma_l = 3000\ Psi$$

$$\sigma_h = \frac{P \times D}{2 \times t}$$

$$\sigma_h = \frac{250 \times 12}{2 \times 0.25}$$

$$\sigma_h = 6000\ Psi$$

Q4 / A cylindrical pressure vessel is fabricated from steel plates which have a thickness of 20mm. The diameter of the pressure vessel is 500mm and it's length is 3m. Determine the maximum internal pressure Which can be applied if the stress in the steel is limited to 140 Mpa. If the internal pressure were increased until The vessel burst, sketch the type of fracture which would occur



Hoop stress

لان عندي
اجهاد واحد فقط هوه 140 وطلب
يعني استخدم internal pressure

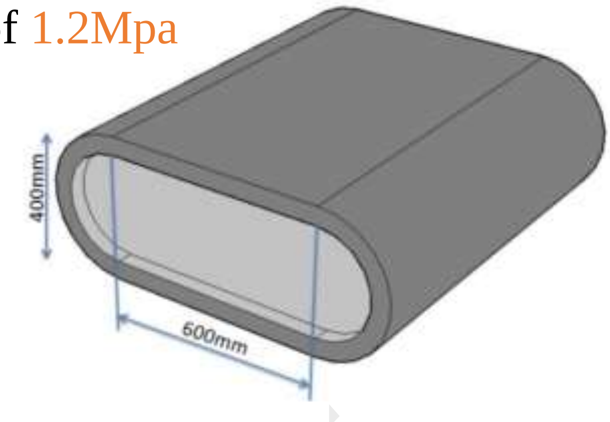
Hoop stress

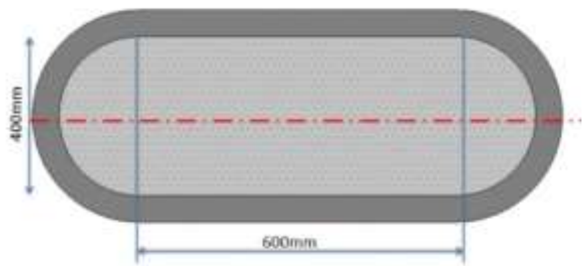
$$\sigma_h = \frac{P \times D}{2 \times t}$$

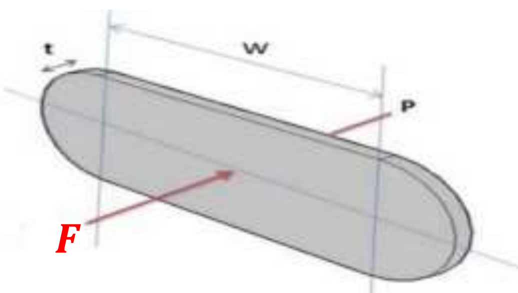
$$140 = \frac{P \times 500}{2 \times 20}$$

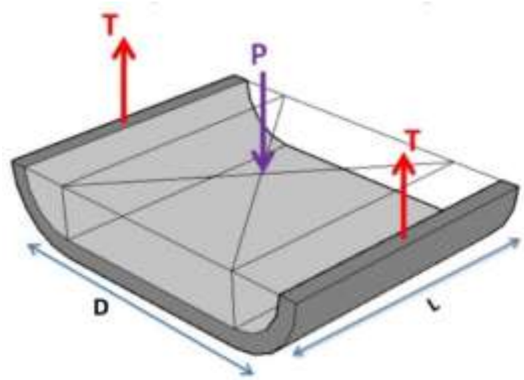
$$P = 11.2\ Mpa$$

Q5/ The tank shown in figure, is fabricated from 10mm steel plate. Determine the maximum longitudinal and circumferential (hoop) stresses caused by an internal pressure of 1.2Mpa









$$F = PA$$

$$F = 1.2 \times (600 \times 400 + \frac{\pi}{4} \times 400^2$$

$$\boxed{F = 438796N}$$

$$\sigma_l = \frac{P}{A} = \frac{P}{2wt + \pi dt}$$

$$\sigma_l = \frac{438796}{2 \times 600 \times 10 + \pi \times 400 \times 10}$$

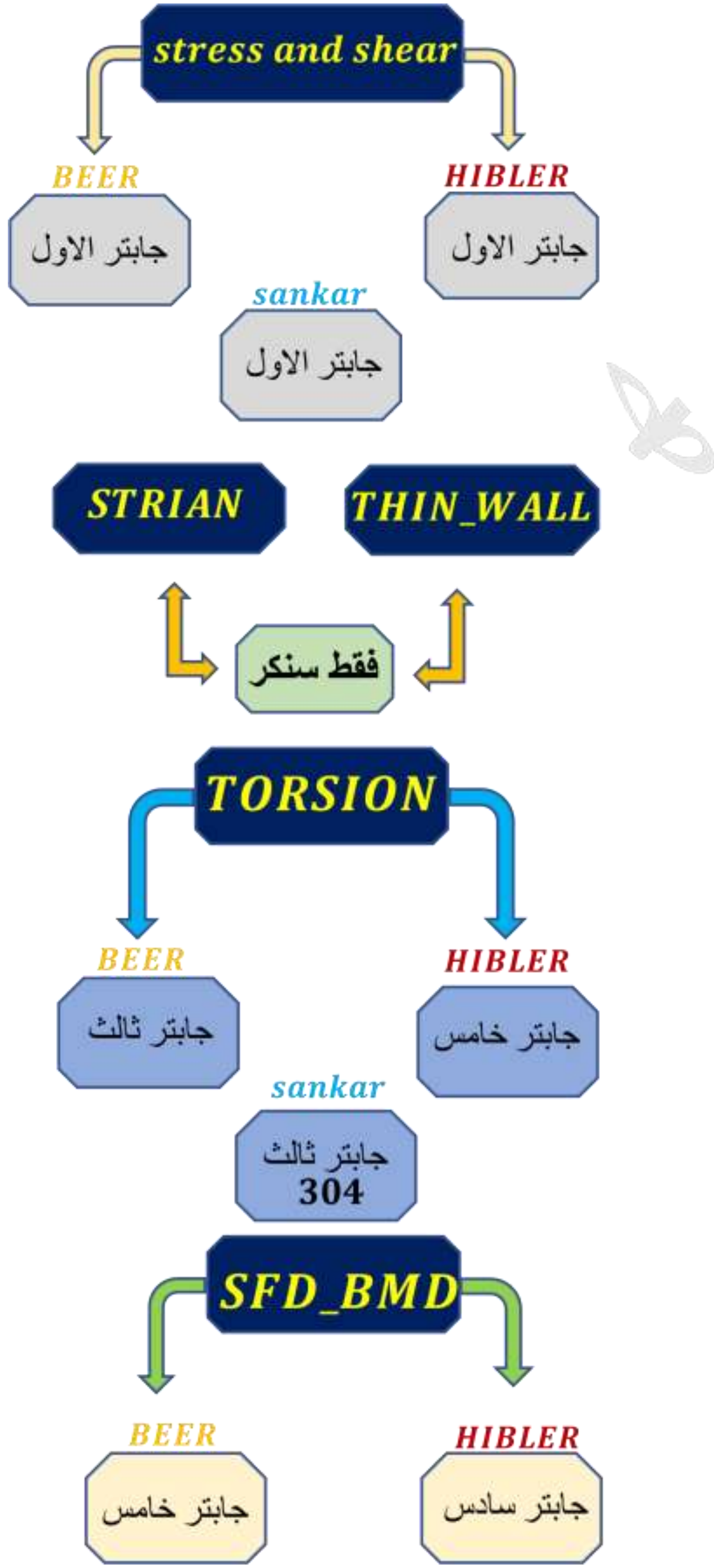
$$\boxed{\sigma_l = 17.86Mpa}$$

$$\sigma_h = \frac{P}{A} = \frac{PA}{2tl} = \frac{PDl}{2tl}$$

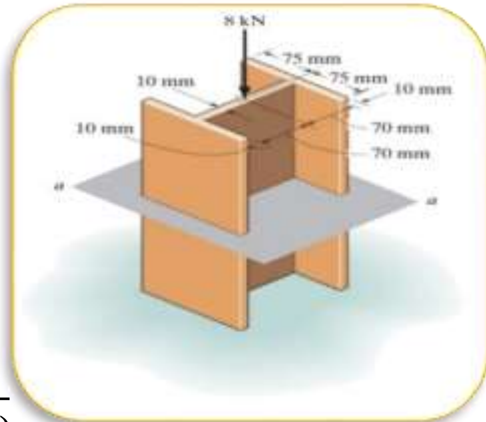
$$\sigma_h = \frac{PD}{2t}$$

$$\sigma_h = \frac{1.2 \times (600 + 400)}{2 \times 10}$$

$$\boxed{\sigma_h = 60Mpa}$$


stress and shear
BEER
جابتر الاول
HIBLER
جابتر الاول
sankar
جابتر الاول
STRIAN
THIN_WALL
فقط سنكر
TORSION
BEER
جابتر ثالث
HIBLER
جابتر خامس
sankar
جابتر ثالث
304
SFD_BMD
BEER
جابتر خامس
HIBLER
جابتر سادس

1) The column is subjected to an axial force of 8 kN , which is applied through the centroid of the cross- sectional area . Determine the average normal stress acting at section a - a . Show this distribution of stress acting over the area's cross section



مصدر هبلر

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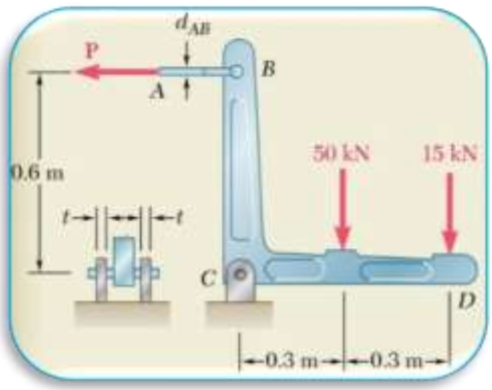
2) Two forces are applied to the bracket BCD as shown . (a) Knowing that the control rod AB is to be made of a steel having an ultimate normal stress of 600 MPa , determine the diameter of the rod for which the factor of safety with respect to failure will be 3.3 . (b) The pin at C is to be made of a steel having an ultimate shearing stress of 350 MPa . Determine the diameter of the pin C for which the factor of safety with respect to shear will also be 3.3 . (C) Determine the required thickness of the bracket supports at C knowing that the allowable bearing stress of the steel used is 300 MPa



مصدر بير

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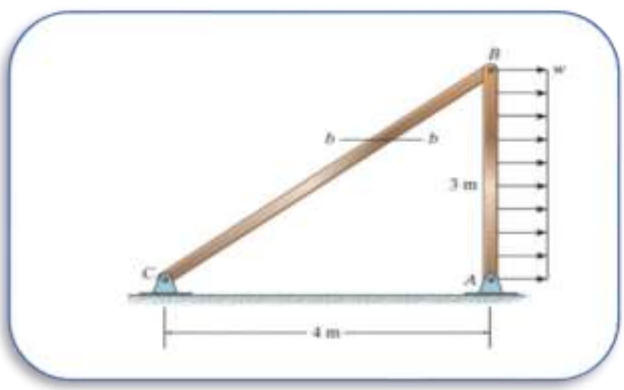
3) Determine the largest intensity w of the uniform loading that can be applied to the frame without causing either the average normal stress or the average shear stress at section b- b to σ = 15 MPa and τ = 16 MPa , respectively . Member CB has a square cross section of 30 mm on each side



Ans

$w = 20000N$

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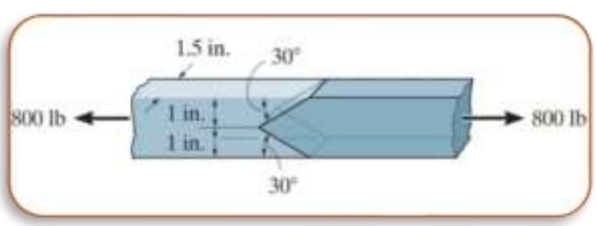
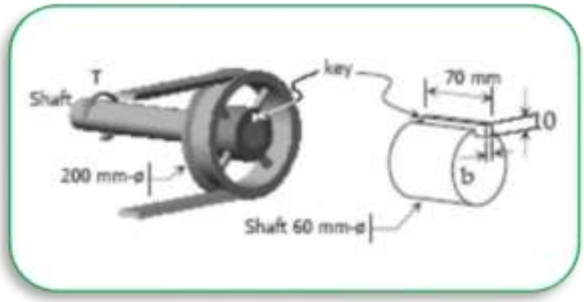
4) The two members used in the construction of an aircraft fuselage are joined together using a 30 ° fish - mouth weld . Determine the average normal and average shear stress on the plane of each weld . Assume each inclined . plane supports a horizontal force of 400 lb



مصدر هبلر

5) A 200- mm - diameter pulley is prevented from rotating relative to 60 - mm - diameter shaft by a 70 - mm - long key , as shown If a torque T = 2.2 kN - m is applied to the shaft , determine the width b if the allowable shearing stress in the key is 60 MPa



مصدر سنكر

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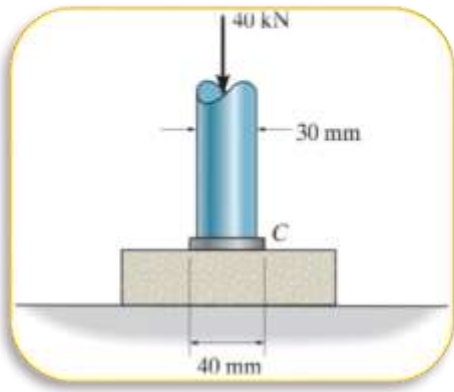
6) The shaft is subjected to the axial force of 40 kN . Determine the average bearing stress acting on the collar C and the normal stress in the shaft



مصدر هبلر

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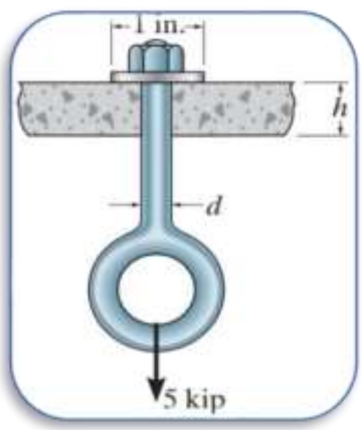
7) The eye bolt is used to support the load of 5 kip . Determine its diameter d to the nearest $\frac{1}{8}\,in$. and the required thickness h to the nearest $\frac{1}{8}\,in$. of the support so that the washer will not penetrate or shear through it . The allowable normal stress for the bolt is σ_{allow} = 21 ksi and the allowable shear stress for the supporting material is σ_{allow} = 5 ksi



مصدر هبلر

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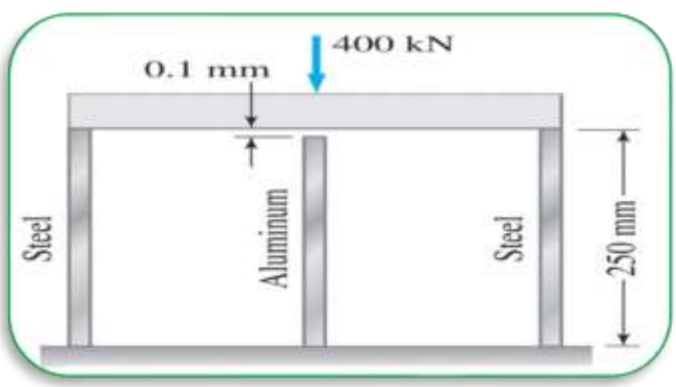
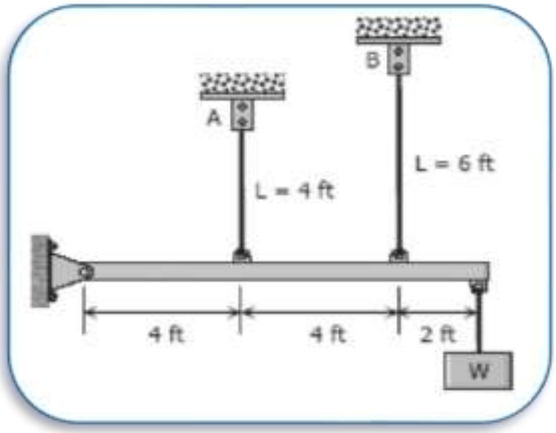
8) Before theP= 400 kN load is applied , the rigid platform rests on two steel bars , each of cross - sectional area 1200 mm² , as shown in the figure . The cross - sectional area of the aluminum bar is 2400 mm² . Compute the stress in the aluminum bar after the 400 kN load is applied . Use E = 200 GPa for steel and E = 70 GPa for aluminum . Neglect the weight of the platform



مصدر سنكر

9) The two vertical rods attached to the light rigid bar are identical except for length . Before the load W was attached , the bar was horizontal and the rods were stress - free . Determine the load in each rod if W = 6600 lb



مصدر سنكر

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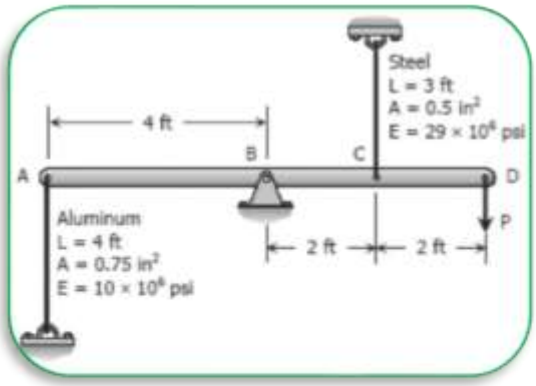
10) The light rigid bar ABCD shown is pinned at B and connected to two vertical rods . Assuming that the bar was initially horizontal and the rods stress - free , determine the stress in each rod after the load after the load P = 20 kips is applied



مصدر سنكر

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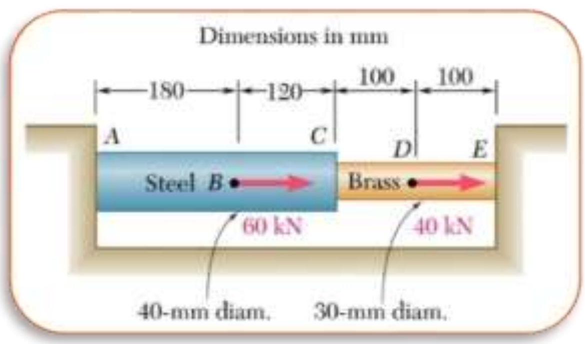
11) Two cylindrical rods one of steel and the other of brass , are joined at C and restrained by rigid supports at A and E. For the loading shown and knowing that E , 200 GPa and E = 105 GPa , deter mine (a) the reactions at A and E , (b) the deflection of point C



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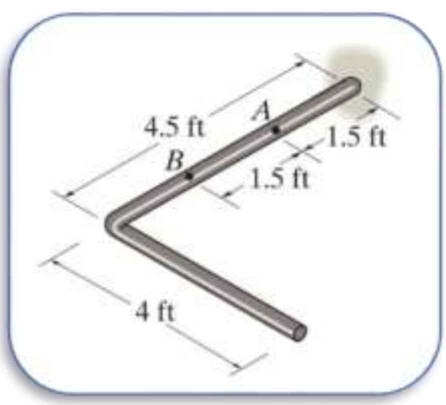
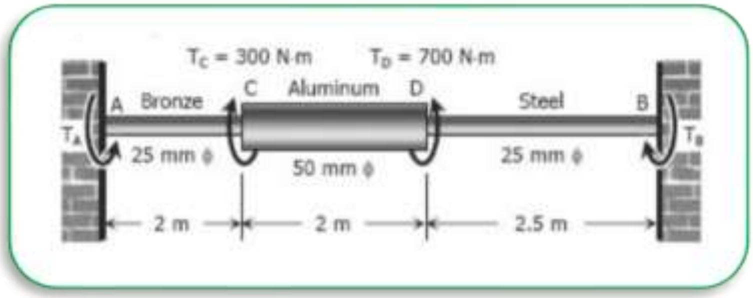
12) The rod has a diameter of 1 in . and a weight of 15 lb / ft . Determine the maximum torsional stress in the rod at a section located at B due to the rod's weight



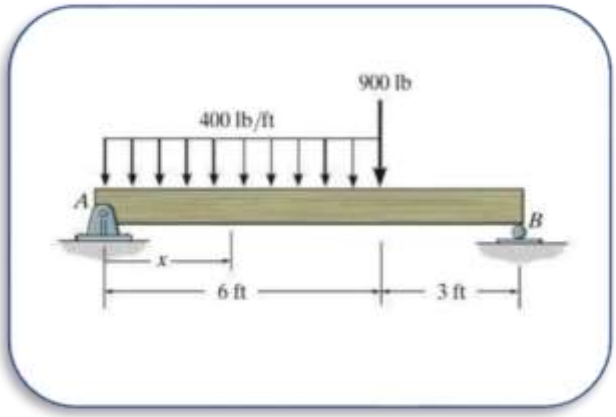
مصدرهبلر

A shaft composed of segments AC , CD and DB is fastened to rigid supports and loaded as shown For bronze , G = 35 GPa ; aluminum , G = 28 GPa , and for steelG = 83 GPa . Determine the maximum shearing stress developed in each segment



مصدرهبلر

DRAW SFD AND BMD



خارجي /

DRAW SFD AND BMD

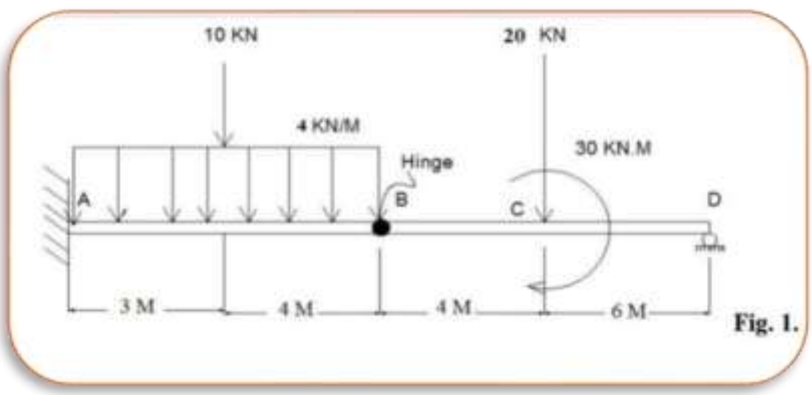
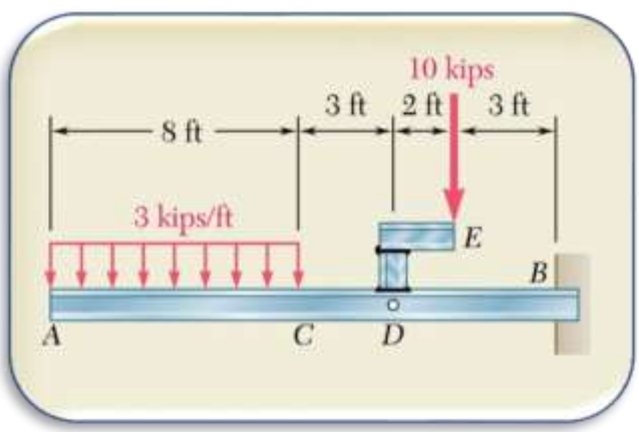


Fig. 1.

خارجي /

DRAW SFD AND BMD



مصدربير