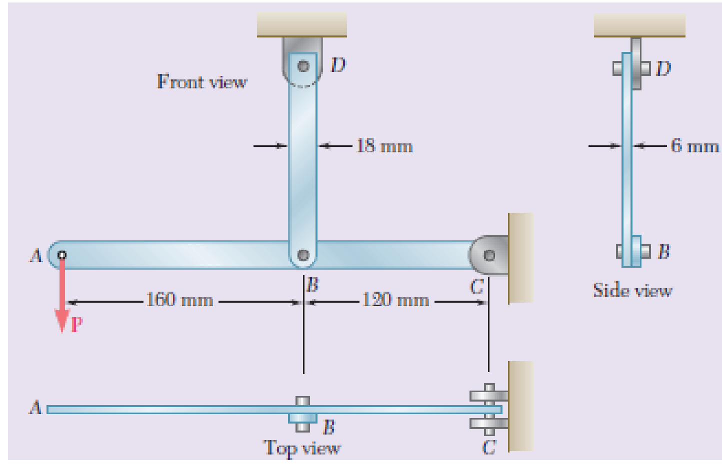
Mechanics of Material 80 Questions

Q.

In the structure shown, a *6 mm* diameter pin is used at *C* and *10mm* diameter at *B* and *D*.

If the load *P* is *15 kN*.

Determine *Normal stress* at link ***BD*** and *Shearing stress* at pins ***C*** and ***B***.

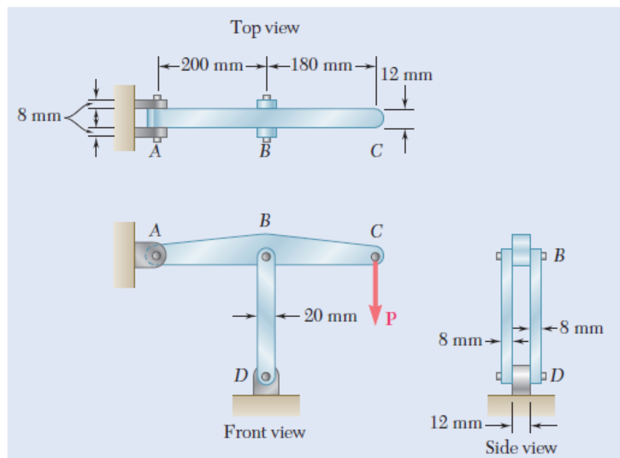


Q.

In the structure shown, an *8 mm* diameter pin at *A*, and *12 mm* diameter pins at *B* and *D*.

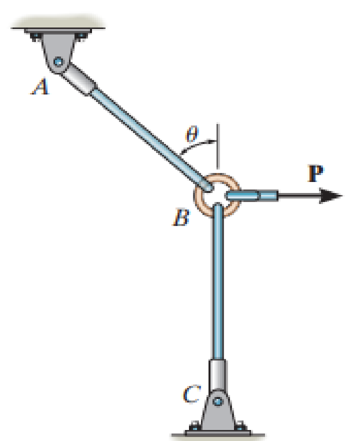
If the load *P* is *15 kN*.

Determine *Normal stress* at link ***BD*** and *Shearing stress* at pins ***A*** and ***B***.



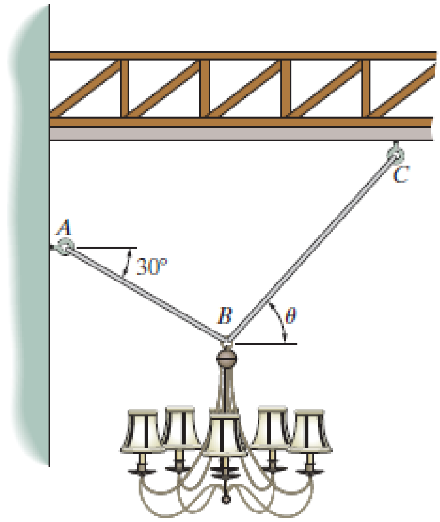
Q.

1. Rods *AB* and *BC* each have a diameter of *10 mm*. **Determine** the angle ***θ*** of rod ***BC*** so that the average *normal stress* in rod *AB* is *1.5 times* that in rod *BC*.
2. What is the **load *P*** that will cause this to happen if the average *normal stress* in each rod is not allowed to *exceed 130 MPa?*



Q.

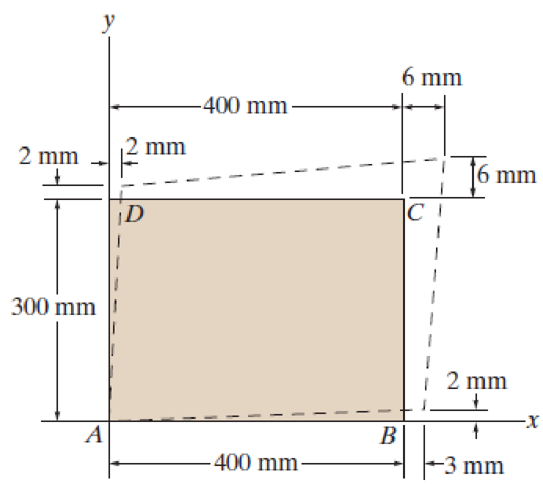
1. The *50 kg* chandelier is suspended from the wall and ceiling using rods *AB* and *BC*, which have diameters of *6mm* and *8mm* respectively. **Determine** the angle ***θ*** so that the average *normal stress* in both rods is the *same*.
2. What is the **Maximum *weight*** that will cause this to happen if the average *normal stress* in each rod is not allowed to *exceed 100 MPa?*



Q.

The rectangular plate is deformed into the shape shown by the dashed lines. Determine:

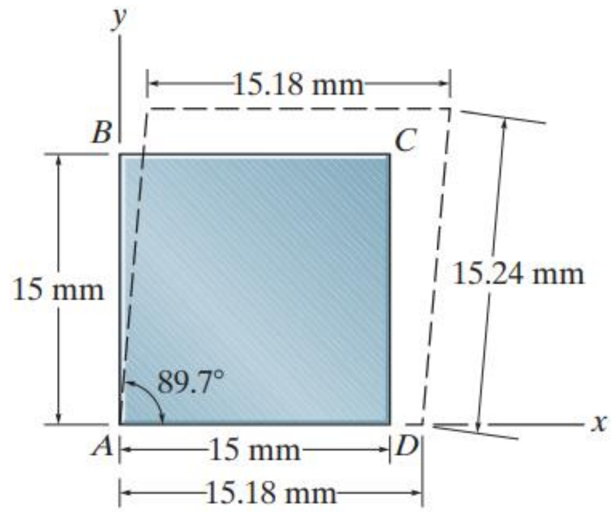
1. The average **normal strain** along diagonals ***AC*** and ***DB.***
2. The average **shear strain** at corners ***A*** and ***B***



Q.

A square piece of material is deformed into the dashed position. Determine:

1. The average **normal strain** along diagonals ***AC*** and ***DB.***
2. The average **shear strain** at corners ***A*** and ***C***



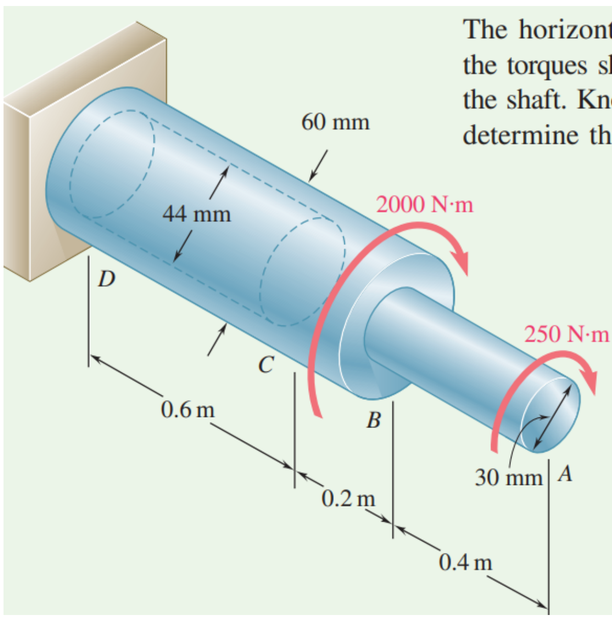
Q.

An aluminum rod has a length of *75 mm*, and a diameter of *15 mm*.

When the applied load is *40 kN*, the new diameter of the specimen is *14.983 mm*.

Compute the **shear modulus (G)** for the aluminum. Take $E_{al} = 70\ GPa.$

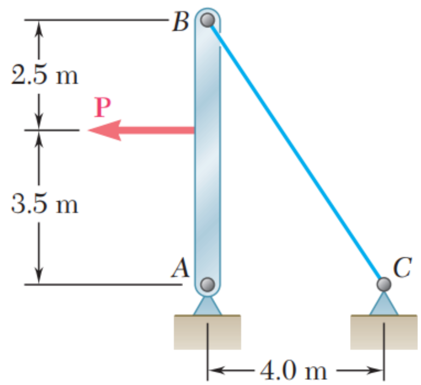
Q.



The horizontal shaft *AD* is attached to a fixed base at *D* and is subjected to the torques shown. A 44-mm-diameter hole has been drilled into portion *CD* of the shaft. Knowing that the entire shaft is made of steel for which *G* = 77 GPa, determine the angle of twist at end *A*.

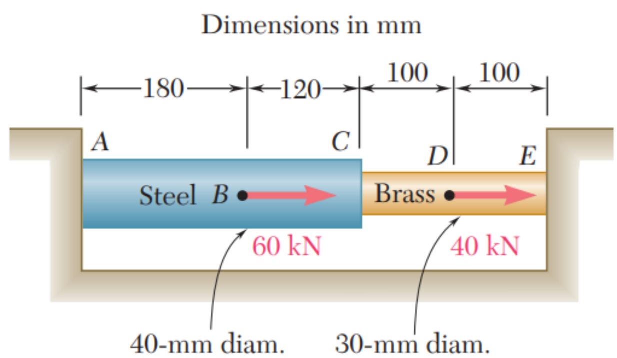
Q.

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.



Q.

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 *Es=200 GPa* and *Eb=105 GPa*, determine:

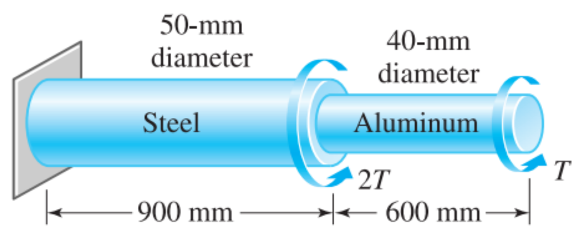


a. The **reactions** at **A** and ***E***,

b. The **displacement** of point ***C***.

Q.

The compound shaft, consisting of steel and aluminium segments, carries the two torques shown. **Determine** the maximum permissible value of ***T*** subject to the following design conditions:

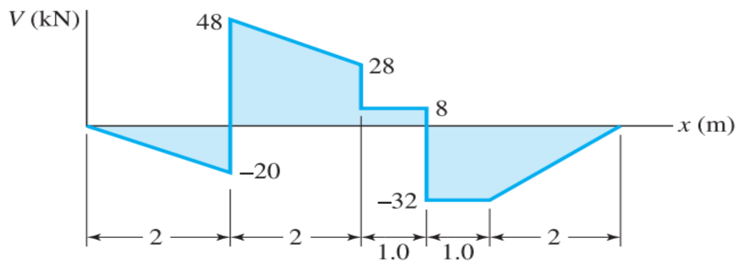


$\tau_{st} \leq 83\ MPa$, $\tau_{al} \leq 55\ MPa$, and $\Theta \leq 6^{o}$ (Θ is the angle of rotation of the free end).

Use G_{st} =*83 GPa*, and G_{al} = *28 GPa*

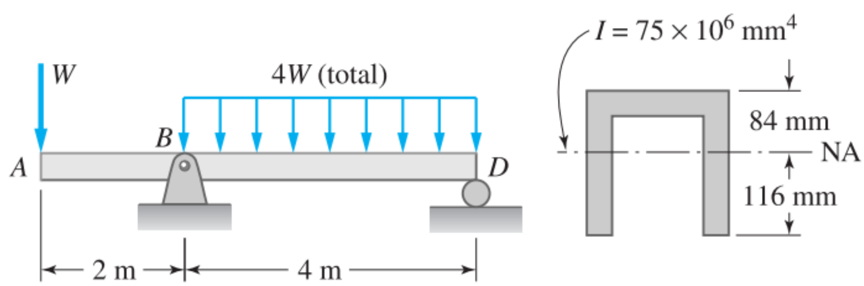
Q.

Draw the load and the bending moment diagrams that correspond to the given shear force diagram.



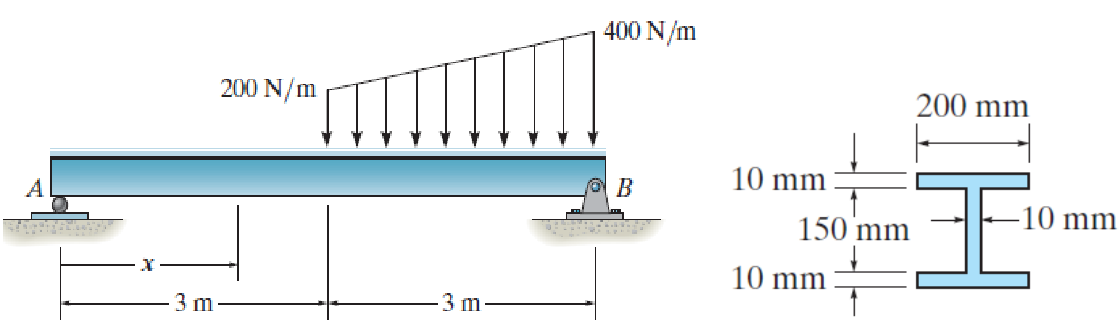
Q.

The beam carries a concentrated load *W* and a uniformly distributed load that totals *4W*. **Determine** the **largest** allowable value of **W,** if the maximum stresses are *60 MPa* in tension and *100 MPa* in compression.



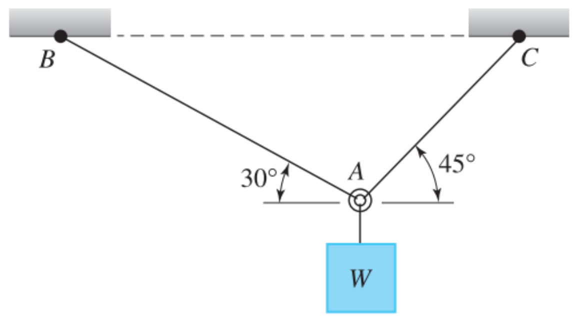
Q.

For the beam loaded as shown, compute **maximum shearing stress** at support *B.*



Q.

Determine the ***largest weight W*** that can be supported by the two wires *AB* and *AC*: The allowable stresses are *100 MPa* for *AB* and *150 MPa* for *AC*. The cross-sectional areas of *AB* and *AC* are *400* mm^2 and *200* mm^2, respectively.

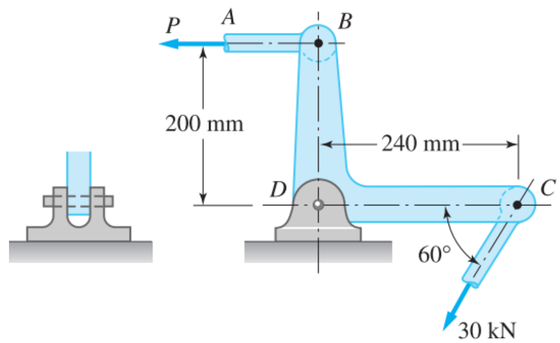


Q.

The bracket shown is supported by *a 20-mm*-diameter pin at *D* that is in double shear. Determine:

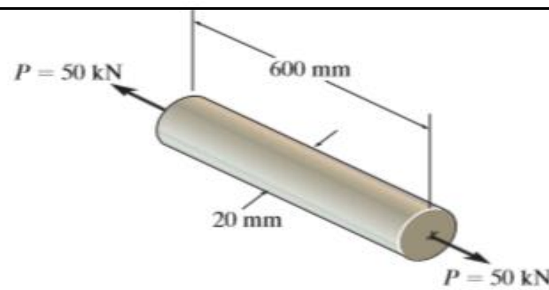
(a) the required **diameter** of the connecting rod *AB*, given that its allowable stress is *100 MPa*.

(b) the **shear stress** in the pin *D*



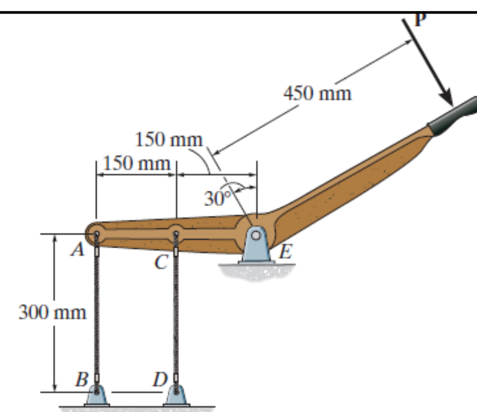
Q

For the shaft loaded as shown, if ***δ=1.4mm*** and ***d'=19.9837 mm***, determine the **modulus of rigidity G**



Q.

The lever arm is supported by two wires having the same diameter of ***4 mm. If P=3 kN,*** diameter is fixed with two red brass of ***50 mm*** diameter, determine ***the average normal stress*** in each wire and their elongations. Take ***E=200 GPa.***

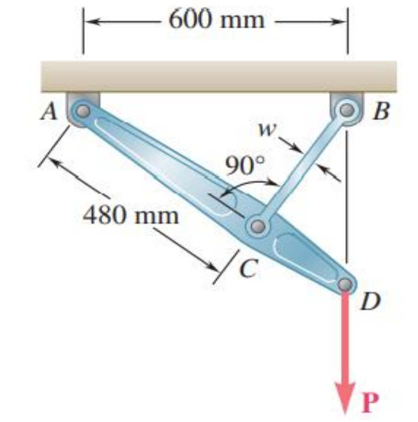


Q.

Link *BC is 6 mm* thick and is made of a steel with a maximum normal stress of *450 MPa* in tension.

1. What should be its **width w** if the structure shown is being designed to support a *20-kN* load *P* with a factor of safety of *3*?

2. Determine **shearing stress at pin C** if the bolt is *15 mm* diameter and it is in single shear.



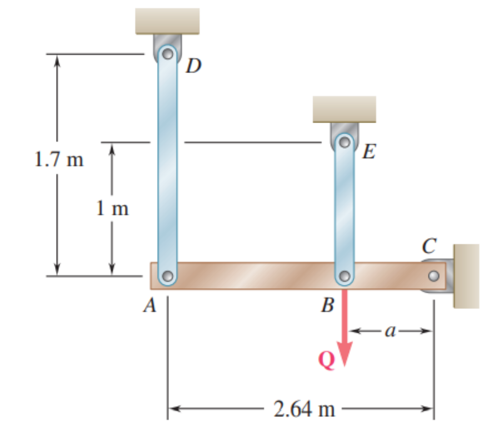
Q. The rigid bar *ABC* is supported by two links, *AD* and *BE*, of uniform *37.5 × 6-mm* rectangular cross section.

The magnitude of the force *Q* applied at *B* is *260 kN* and *a = 0.640 m*. determine:

(a) The **normal stress** in each link,

(b) The **maximum deflection** of point **B**.

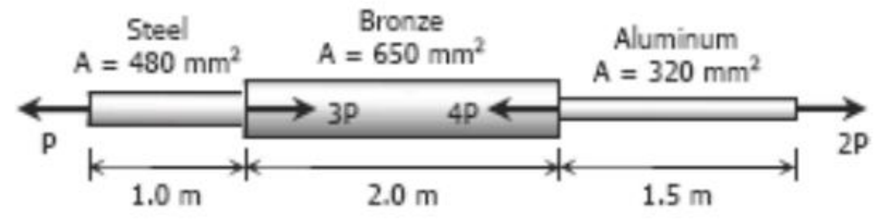
Take *E = 200 GPa.*



Q.

A bronze bar is fastened between a steel bar and an aluminum bar as shown. Axial loads are applied at the positions indicated.

Find the largest value of **P** that will not exceed an overall deformation of *3.0 mm*, or the following stresses: *140 MPa* in the steel, *120 MPa* in the bronze, and *80 MPa* in the aluminum. Use Est. = 200 GPa, Eal. = 70 GPa, and Ebr. = 83 GPa.



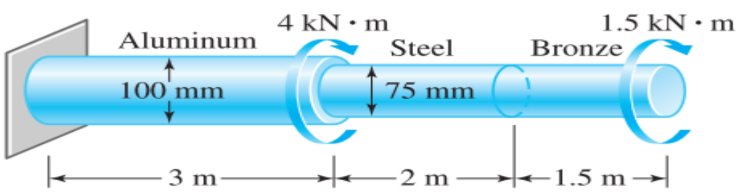
Q.

The solid compound shaft, made of three different materials, carries the two torques shown.

1. Calculate the **maximum shear stress** in each material.

2. Find the **angle of rotation** of the free end of the shaft.

Gal.= 28 GPa , Gst.= 83 GPa, Gbr.= 35 GPa.



Q

For the beam loaded as shown;

1. *Draw **shear** and **moment diagram**.*
2. *Determine **maximum flexural stress**.*
3. *Determine **maximum shearing stress**.*

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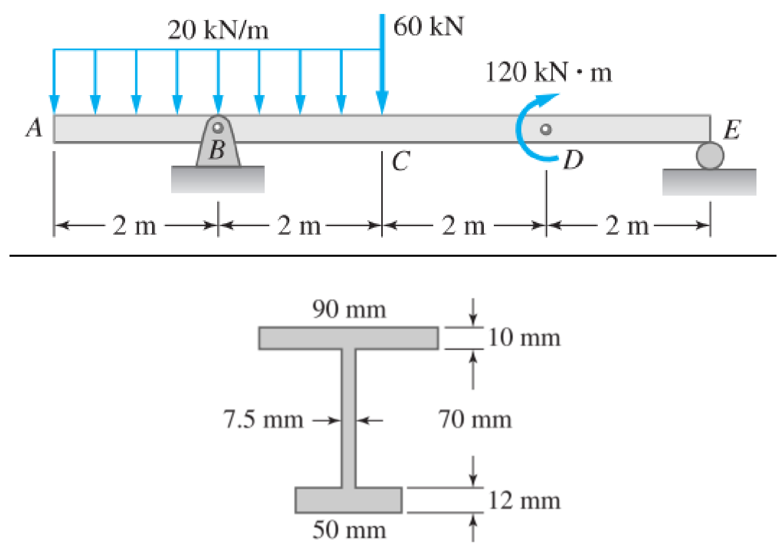
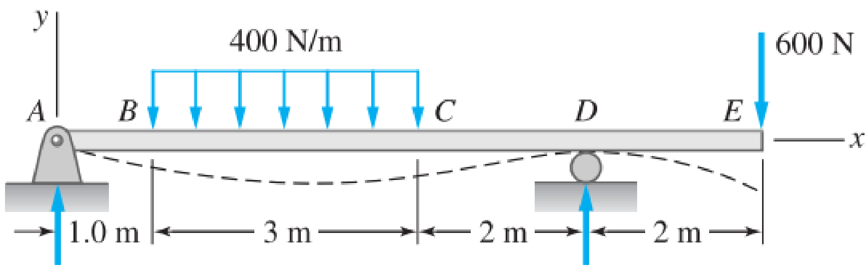


Q.

For the overhanging beam shown using double integration method, determine:

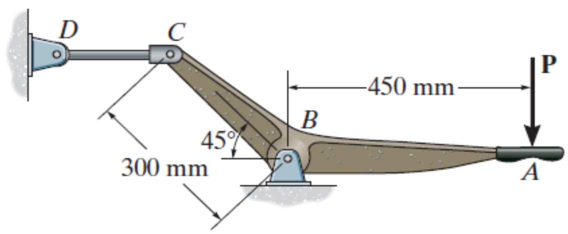
1. The ***equations*** for the elastic curve and rotation; and
2. The ***deflection*** at ***midway*** between the supports and at point ***E***.

Take $E = 70$ GPa, $I = 65 \times 10^6$ mm^4



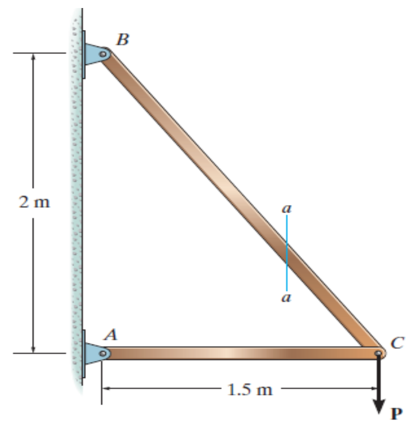
Q.

Determine the ***average normal stress*** *in the 10-mm diameter rod* ***CD*** *and the* ***average shear stress*** *in the 6-mm diameter pin* ***B*** *that is subjected to double shear. P=1.5 kN*



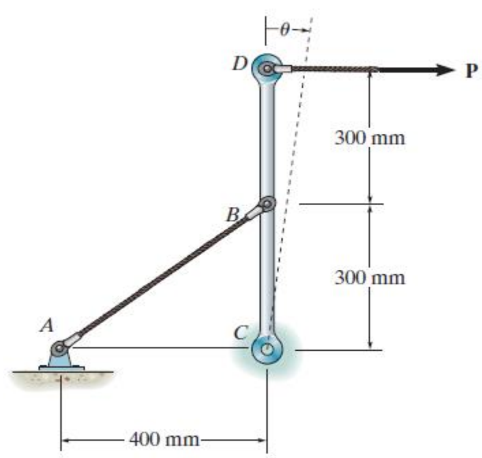
Q

Determine the largest load ***P*** that can be applied without causing either the average *normal stress* to exceed *150 MPa* or the average *shear stress* to exceed *60 MPa* at section *a-a*. Member *CB* has a *square* cross section of *25 mm* on each side.



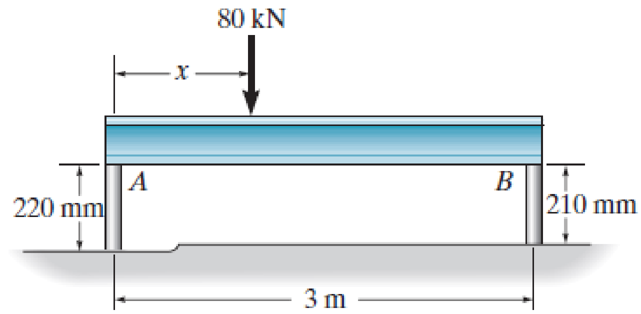
Q

The rigid member *CBD* and flexible cable *AB* is subjected to load at *D*, if the *normal strain* at cable *AB* is *0.0035*, determine the **displacement** of point ***D***.



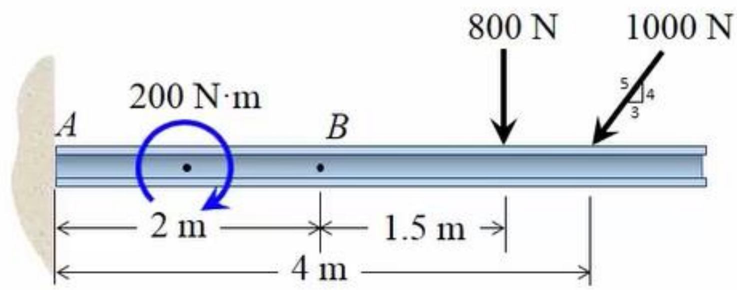
Q

The rigid horizontal Beam AB rests on two aluminum cylinders having a diameter of 30 mm. Determine the **displacement** x of the applied load ***80 kN*** so that the beam remain horizontal. What is the new diameter of cylinders ***A***, take υ ***= 0.4***, E=***70 GPa***



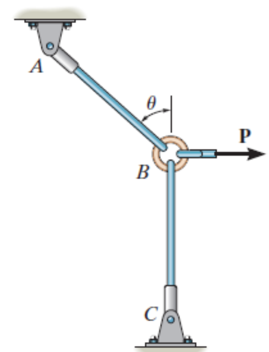
Q.

Find the support reactions and the internal forces at point B

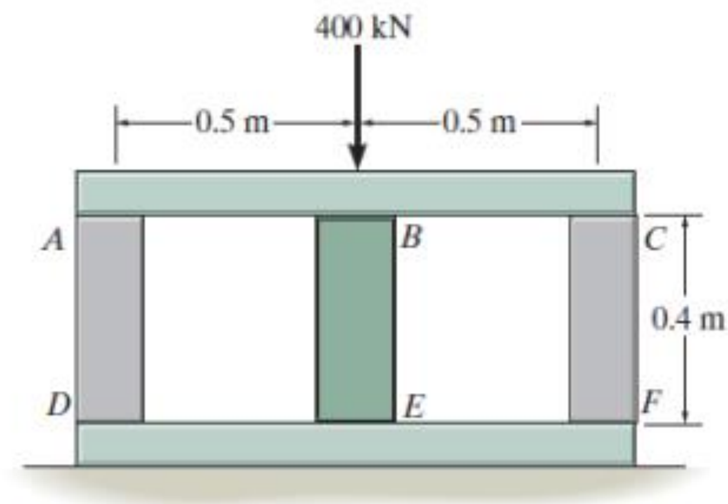


Q

Rods *AB* and *BC* have a diameter of *5mm*. If *P=2 kN* and *ϴ=60°*, determine the average **normal stress** in each rod.



*4–60. The assembly consists of two posts AD and CF made of A-36 steel and having a cross-sectional area of 1000 mm^2, and a 2014-T6 aluminum post BE having a cross-sectional area of 1500 mm^2. If a central load of 400 kN is applied to the rigid cap, determine the normal stress in each post. There is a small gap of 0.1 mm between the post BE and the rigid member ABC.



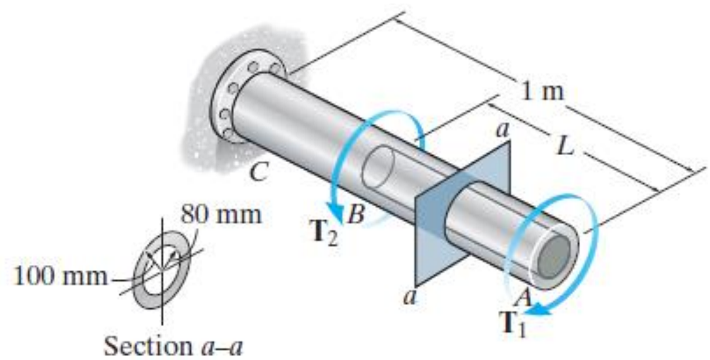
Q

The shaft is made of copper with an allowable shear stress of

$\tau_{all.}$ = $20\ MPa$, Determine;

The ***maximum torques*** $T1$ and $T2$ that can be applied.

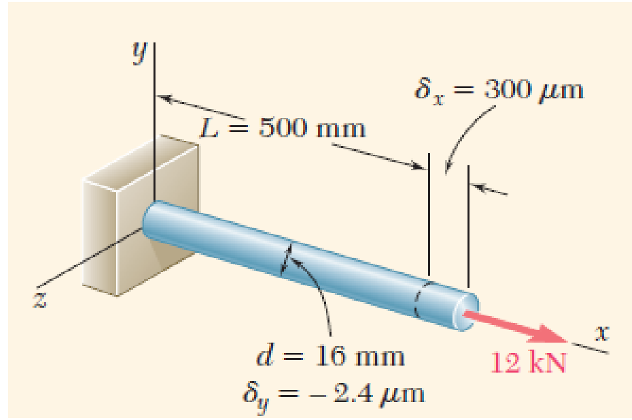
And ***angle of twist*** of end A if L=$0.75m$.Take G= $37\ GPa$.



Q.

A *500 mm* long, *16mm* diameter rod is observed to increase in length by *300 μm*, and to decrease in diameter by *2.4 μm* when subjected to an axial 12 kN load.

Determine the **modulus of elasticity** and **Poisson's ratio**.

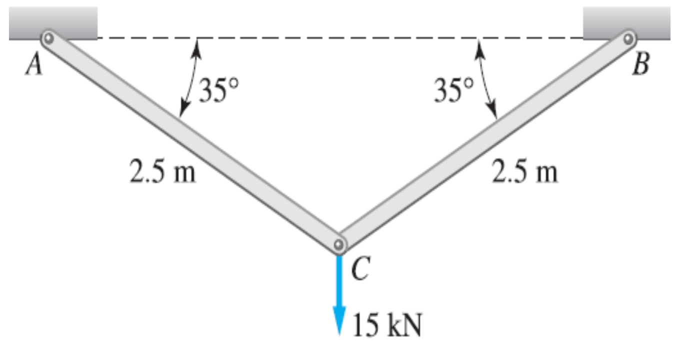


Q.

The steel bars *AC* and *BC*, each of cross-sectional area *120 mm2*, are joined at *C*.

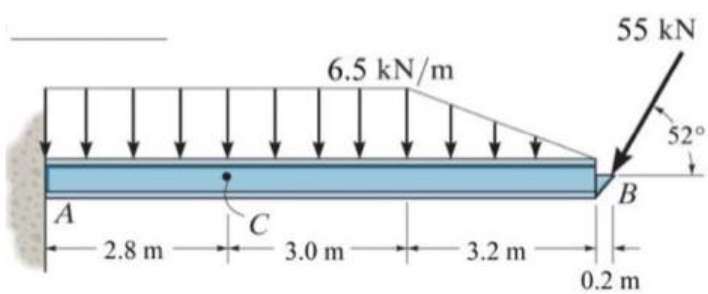
Determine the ***displacement of point C*** by the *15 kN* load.

Use *E= 200GPa* for steel.

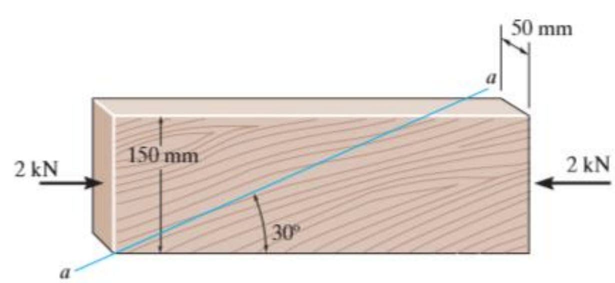


Q

Find the internal forces at point C

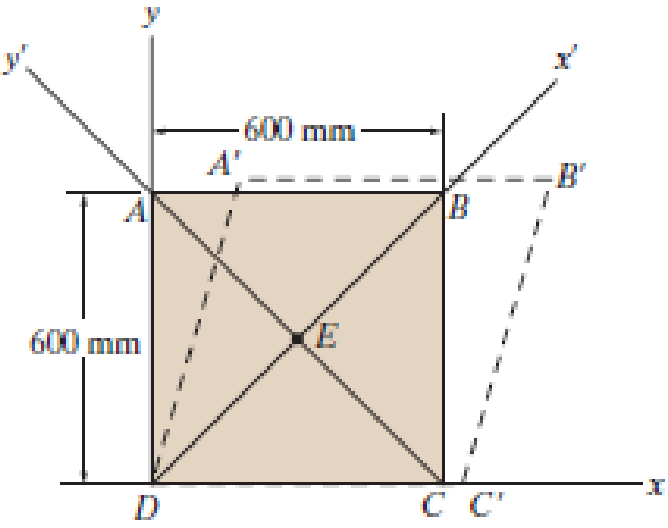


Q Determine average **normal** and average **shear stress** along the section a-a.



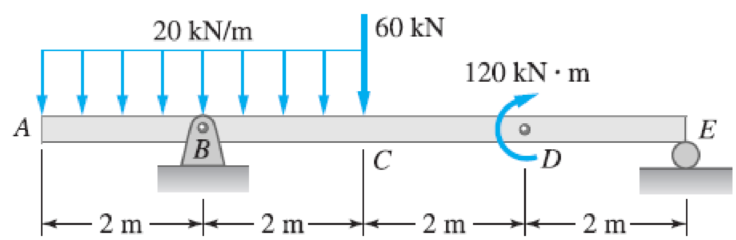
The square plate is deformed into the shape shown by the dashed lines.

If *DC* has a normal strain $\epsilon_x = 0.004$, *DA* has a normal strain $\epsilon_y = 0.005$ *and* at *D*, $\gamma_{xy} = 0.02$ rad., determine the average **normal strain** along diagonal CA and the average **shear strain** at point ***E*** with respect to the *x'* and *y'* axes.



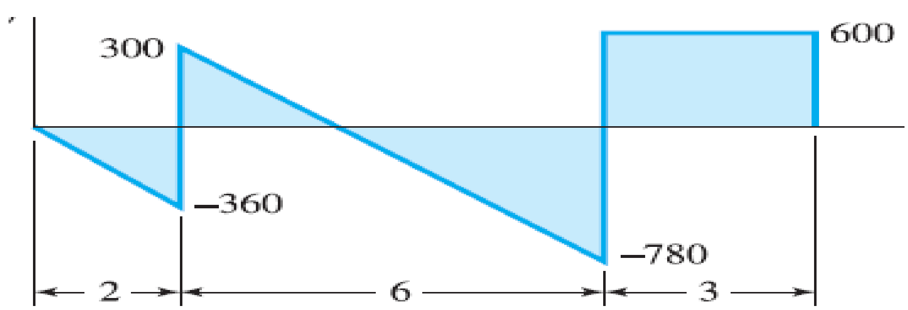
Q

1. Write shear and moment equations for part DE, then draw shear and moment diagrams for the beam loaded as shown.



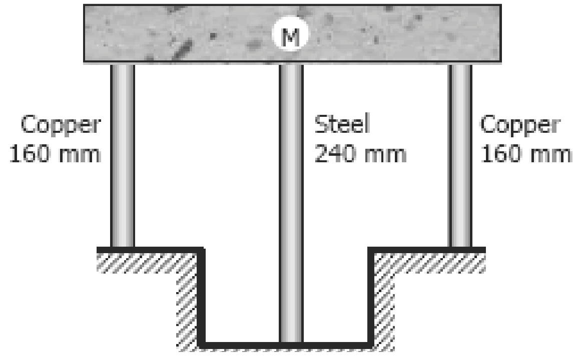
Q

1. Draw Load and moment diagrams from the shear diagram shown.



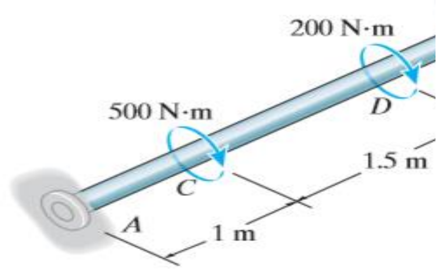
Q.

A rigid block of mass ***M*** is supported by three symmetrically spaced rods as shown. Each copper rod has an area of *900 mm²*; *E=120 GPa*; and the allowable stress is *70 MPa*. The steel rod has an area of *1200 mm²; E=200 GPa*; and the allowable stress is *140 MPa*. Determine the ***largest mass M*** that can be supported.



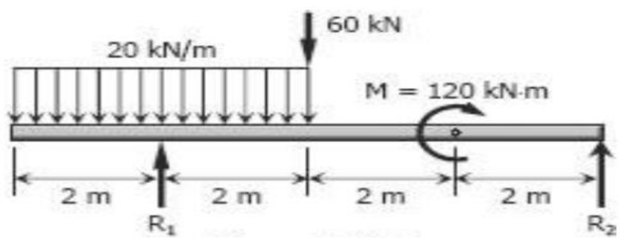
Q.

The steel shaft of ***60 mm*** diameter is fixed at both ends ***A*** and ***B***, determine ***maximum shearing stress*** in the shaft. take ***G=80 GPa***

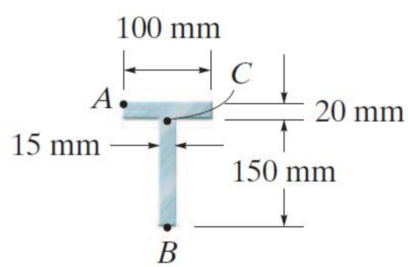


Q.

Draw **shear** and **moment diagrams** for the beam shown, then:



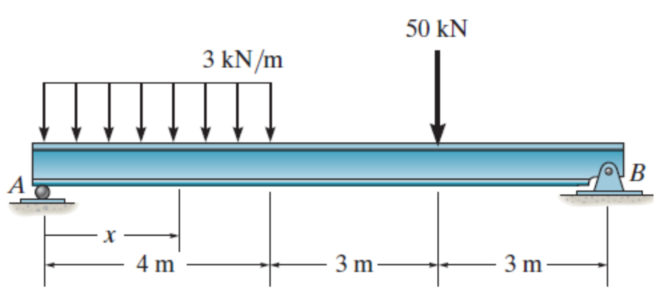
1. Find **maximum flexure stress**.
2. Find **maximum shearing stress**.
3. Find **flexure** and **shearing** stress at points *A, B*, and *C*, at $x = 4.0m$.



Q.

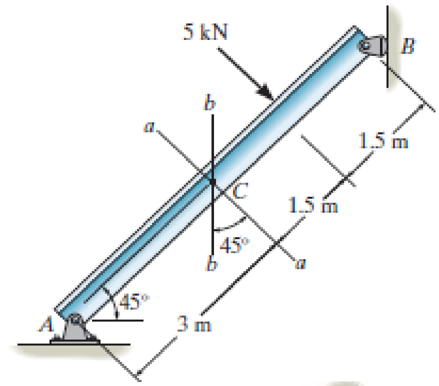
For the beam loaded as shown. Determine the **deflection** at location of point load and **slope** at point A.

Take $E = 200$ GPa, $I = 65 \times 10^6$ mm^4.

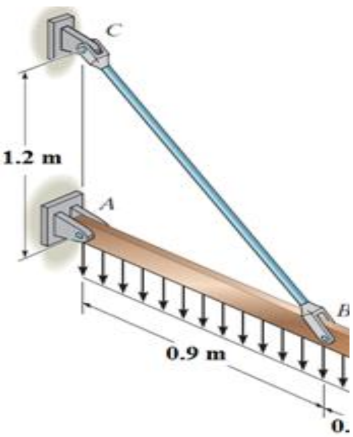


Q.

Determine ***normal*** and ***shear stresses*** acting on sections ***a-a*** and ***b-b***, the cross-section of member ***AB*** is square (*50mm x 50mm*)



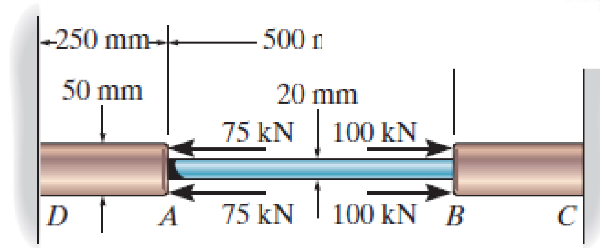
Q.



If the allowable shear stress for each of the *10-mm*-diameter steel pins at *A*, *B*, and *C* is τ_{allow} = *90 MPa*, and the allowable normal stress for the *13-mm*-diameter rod *BC* is σ_{allow} = *150 MPa*, determine the **largest uniform distributed load *w*** that can be suspended from the beam.

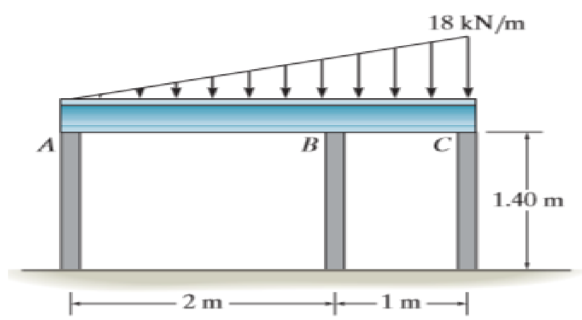
Q.

The steel shaft of ***20 mm*** diameter is fixed with two red brass of ***50 mm*** diameter, determine ***the average normal stress*** in each shaft due to applied load and the **displacement** of point ***A*** with respect to point ***B***. Take ***E_{st}=200 GPa, E_b=101 GPa.***



Q.

Determine the **displacement** of point ***B*** if the diameter of each support rods ***A,B***, and ***C*** is ***120mm*** and ***E=120 GPa***



Q.

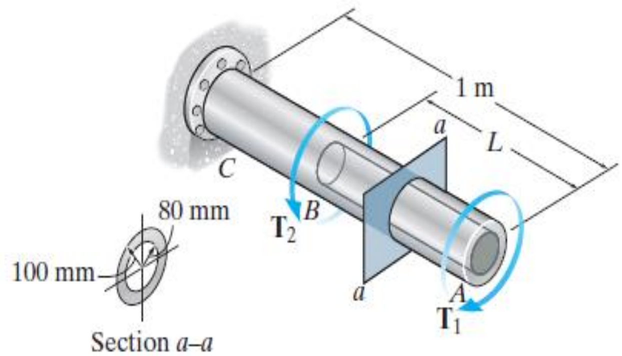
The shaft is made of copper with an allowable shear stress of

$\tau_{all.} = 20$ MPa, Determine;

a. The ***maximum torques T1*** and ***T2*** that can be applied.

b. Angle of twist of end A

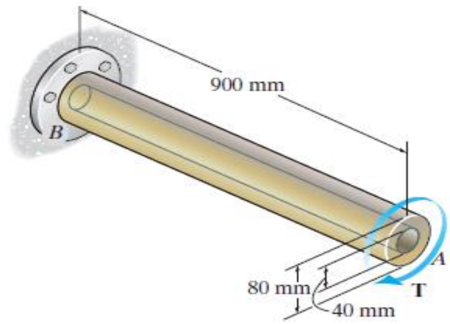
if $L = 0.75m$, $G = 37$ GPa.



Q.

The steel rod of **40 mm** diameter is bonded to magnesium tube as shown. If a torque of ***T = 5 kN****.m* is applied to end A, determine the **maximum shear stress** in each material.

Take G_{st}=75 GPa, G_{mg}=18 GPa



Q.

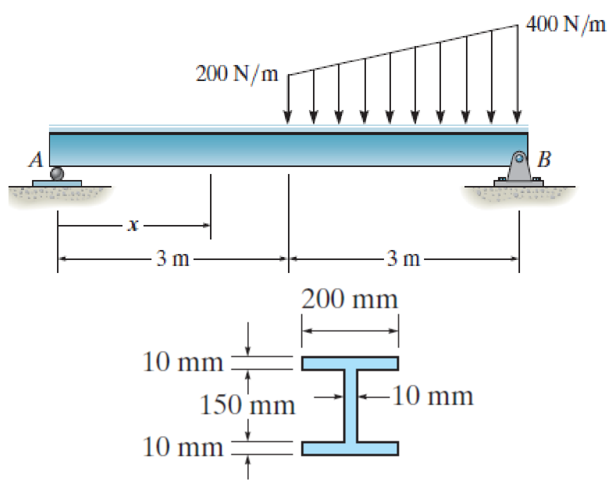
For the beam loaded as shown;

a. Write ***shear*** *and* ***moment*** *equations.*

b. Draw ***shear*** *and* ***moment*** *diagram.*

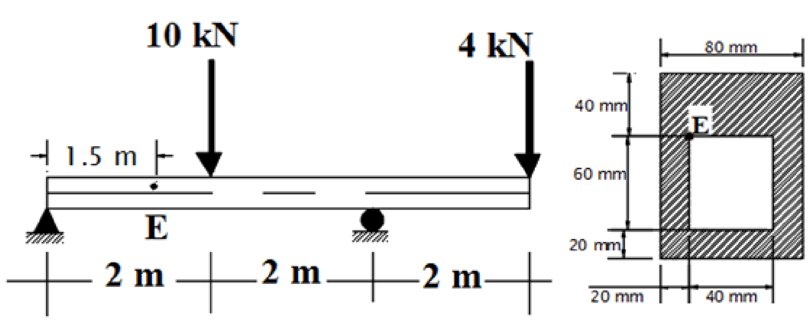
c. Compute maximum flexural stress.

d. Compute maximum shearing stress.

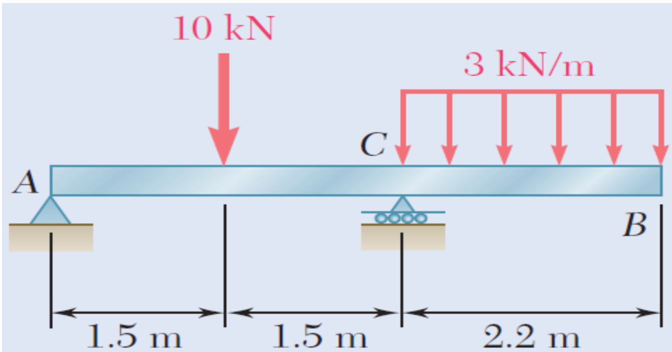


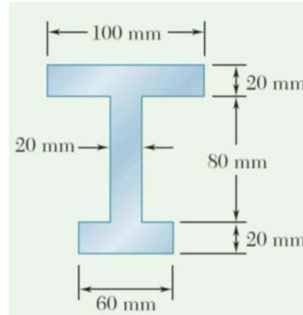
Q

a. Find the flexure stress at point E. b. Find maximum shear stress.

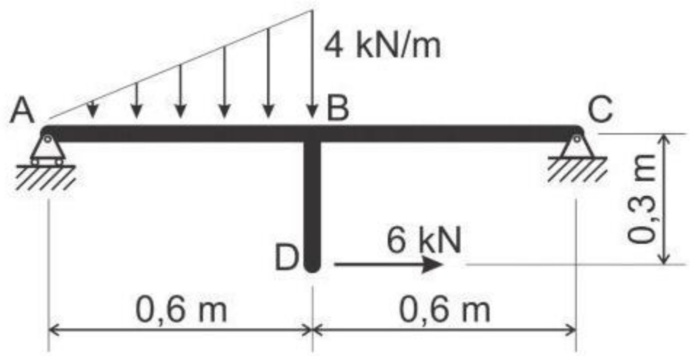


Q Find maximum shear stress.

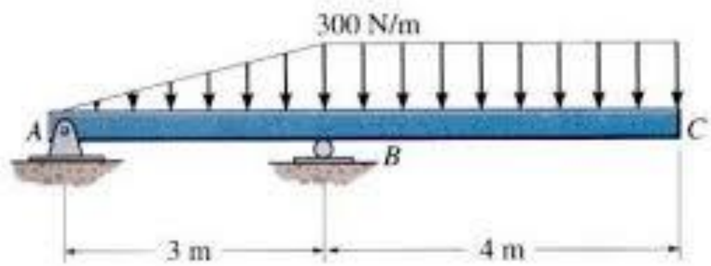




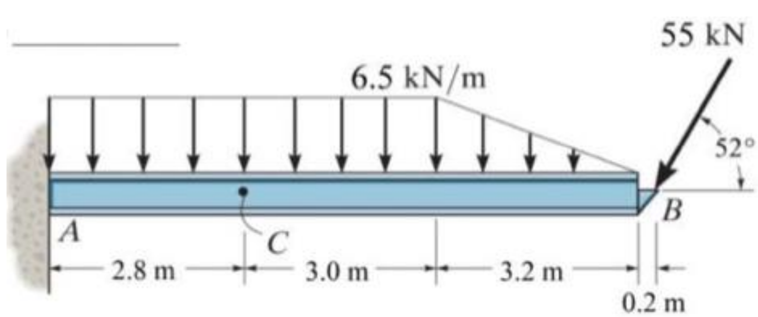
Q Find the internal forces at points E & F



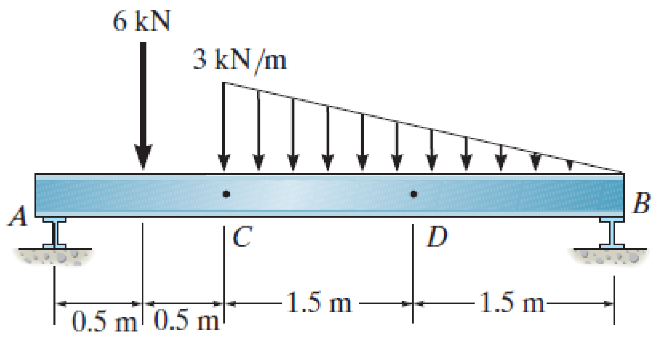
Q Find the internal forces at points D & E



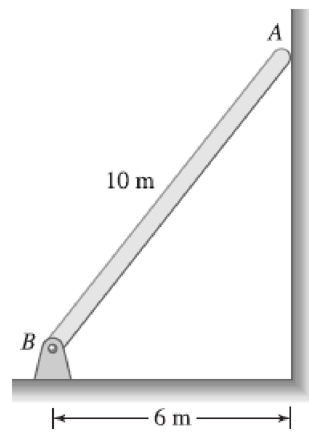
Q Find the support reactions and the internal forces at point C



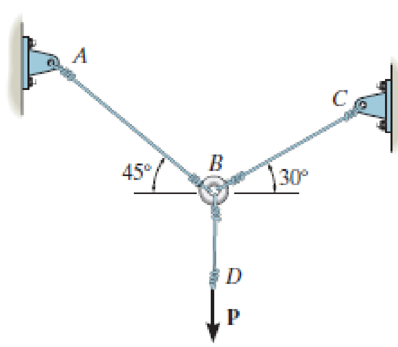
Q Find the internal forces at points C & D



Q The uniform 2 Mg bar is supported by a smooth wall at A and by a pin at P that is in double shear, determine the shear stress at pin B if the bolt diameter is 30 mm.



Q If wires *AB* and *BC* have allowable stress of *165 MPa*, determine the required **diameter** of each wire if *P= 6 kN.*



Q

Three rods, each of area 250 mm2, jointly support a 7.5 kN load, as shown in Fig. P-256. Assuming that there was no slack or stress in the rods before the load was applied, find the stress in each rod. Use E_{st} = 200 GPa and E_{br} = 83 GPa.

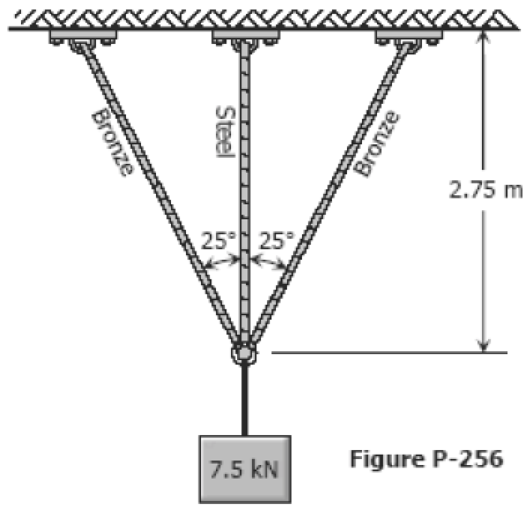
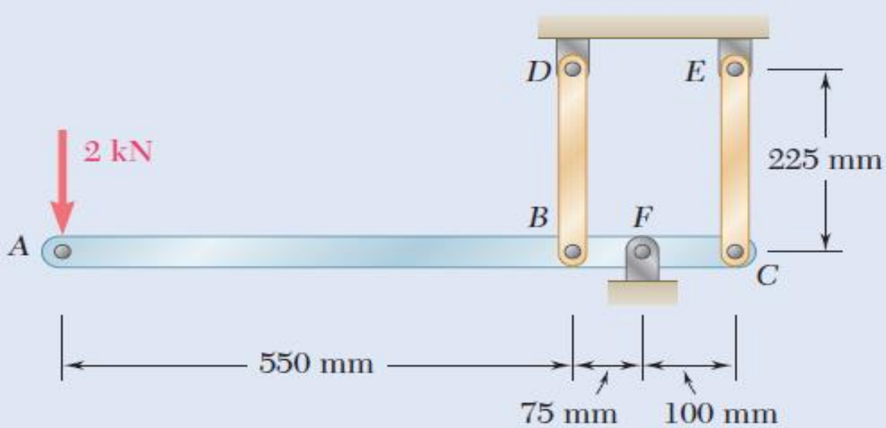


Figure P-256

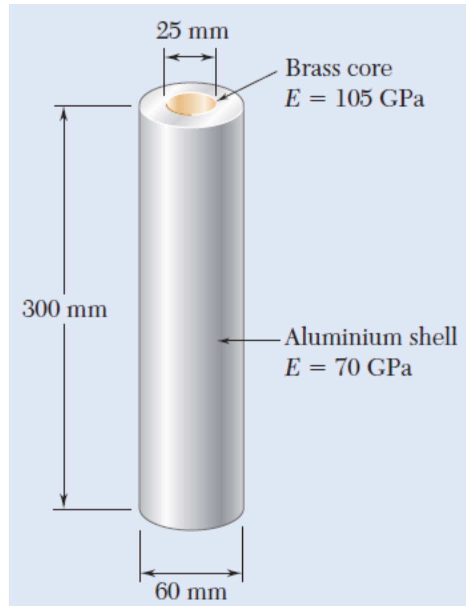
Q

Each of the rods *BD* and *CE* is made of brass (E = 105 GPa) and has a cross-sectional area of 200 mm^2. Determine the deflection of end *A* of the rigid member *ABC* caused by the 2-kN load.

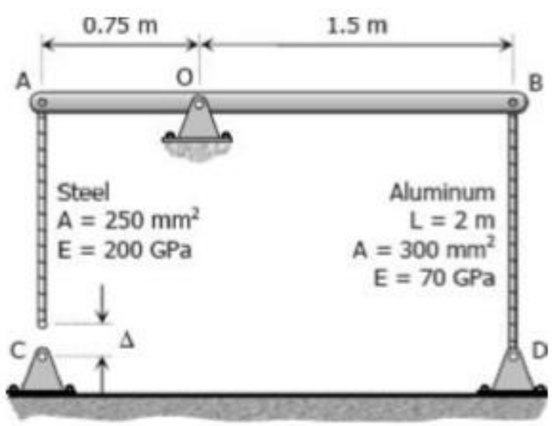


Q

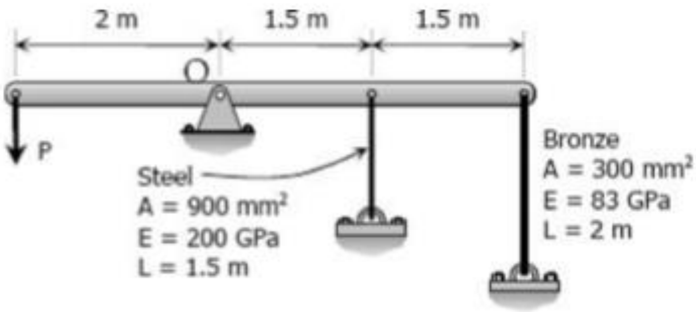
The length of the assembly shown decreases by 0.40 mm when an axial force is applied by means of rigid end plates. Determine (*a*) the magnitude of the applied force, (*b*) the corresponding stress in the brass core.



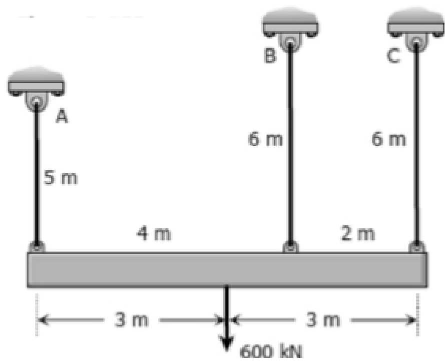
Q The rigid bar AB is pinned at O. Compute the stress in the aluminum rod when the lower end of the steel rod is attached to its support, Δ=5mm



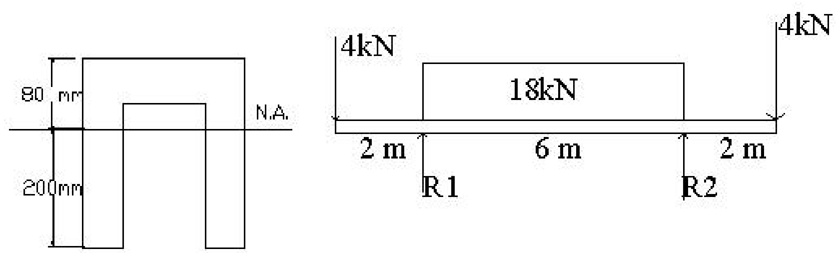
Q Find maximum load P that can be applied without exceeding stresses of 150 MPa in the steel rod and 70 MPa in the bronze rod.



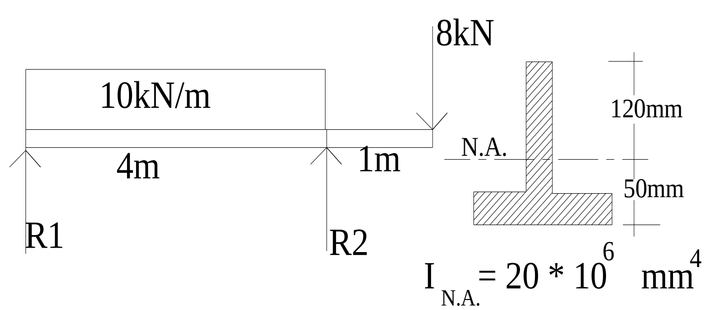
Q Compute the load in each rod. The three rods are of the same area and material.



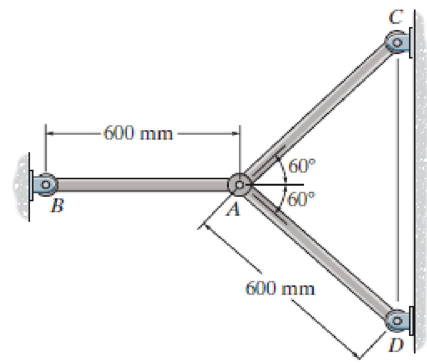
Q A cast-iron beam carries the loads as shown. Determine the maximum shear stress ***$I_{N.A.}$= 40 * 10^6 mm^4.***



Q For the beam loaded as shown. Determine the maximum shear stress



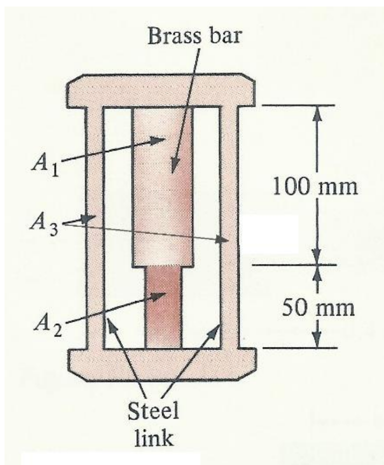
Q Steel rods (AB, AC and AD) have the same 25 mm diameter and 600mm length. Determine the forces developed in each rod when the temperature increases 50º C.



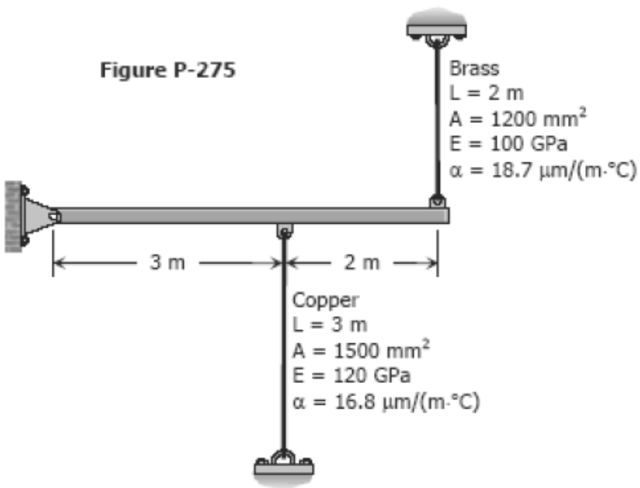
Take α_{st}*=12x10*$^{-6}$ */ º C.*

E_{st} *= 200 GPa.*

Q A stepped brass bar 150 mm length is inserted into a steel link with rigid ends, as shown. Initially, no axial forces exist in the bar. If the temperature increases 40ºC, determine the **maximum normal stress** produced in the bar. Use E_b =105 GPa, α_b =20 x 10^{-6} /ºC, E_s =200 GPa, α_s =12 x 10^{-6} /ºC, and the cross-sectional areas A_1 =500 mm^2, A_2 =400 mm^2, A_3 = 900 mm^2.

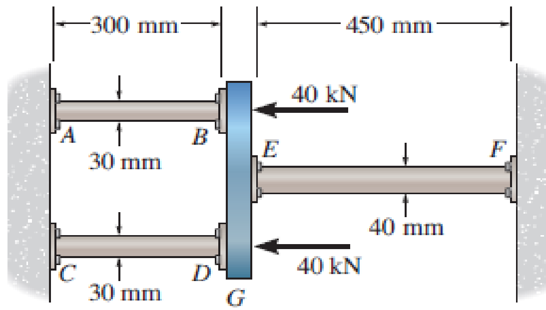


Q A rigid horizontal bar of negligible mass is connected to two rods as shown. If the system is initially stress-free. Calculate the temperature change that will cause a tensile stress of 90 MPa in the brass rod.

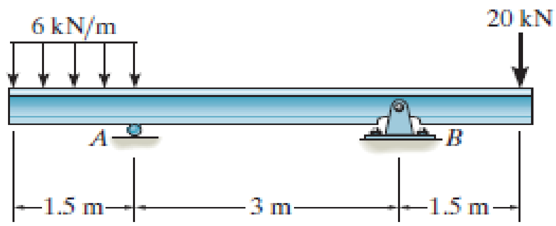


Q The assembly consists of two brass rods (AB & CD) of diameter 30mm and a steel rod EF of diameter 40mm and a rigid cap G, if the supports at A, C and F are rigid, determine the normal stress developed in each rod.

Take E_{brass} = 101 GPa, E_{steel}=193GPa

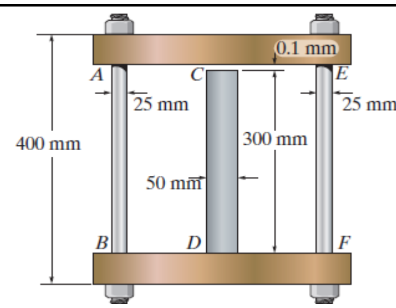


Q The beam subjected to the load shown. Determine the deflection at mid span between suppots. EI is constant.



Q.

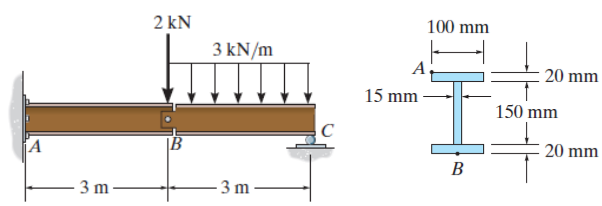
The assembly shown consists of two steel rods *AB* and *EF* and aluminum rod *CD*. At temperature *30ºC* the gap between the rod *CD* and rigid member *AE* is *0.1 mm*. Determine the ***normal stress in each material*** if the temperature rises to *130ºC*. Take $\alpha_{st}=12x10^{-6}$ / º C.
E_{st} = 200 GPa, $\alpha_{al}=24x10^{-6}$ / º C, E_{al} = 70 GPa.



Q.

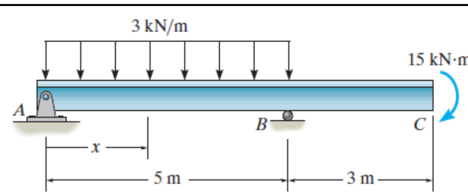
The compound beam is fixed at *A*, pin connected at B, and supported by a roller at C;

a. Draw shear and moment diagrams.
b. Compute maximum flexural stress.
c. Compute maximum shearing stress.



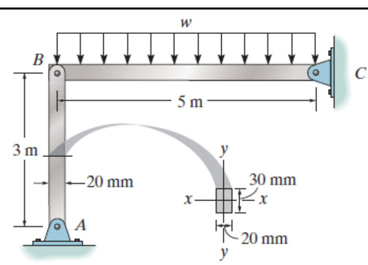
Q.

The beam sujected to the load shown. Determine the ***deflection*** at mid span between supports and at free end, Take *E* = *200 GPa*, *I* = $100x10^{6}$ mm^{4}



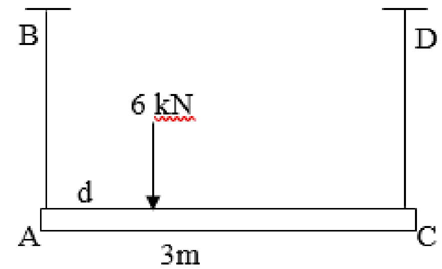
Q.

The steel bar *AB* has a rectangular cross section. If it is pin connected at its ends, determine the maximum allowable intensity of the distributed load ***w*** that can be applied to *BC* without causing bar *AB* to buckle. Use factor of safety of *1.5*.
Take *E* = *200 GPa*, σ_y = *360MPa*

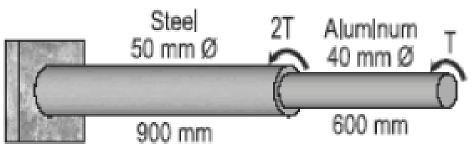


Problem

The uniform beam is supported by two rods *AB* and *CD* have cross-sectional area of *12* mm^2 and *8* mm^2 respectively. Determine the position ***d*** of the *6 kN* load that the normal stress in each rod is the same.



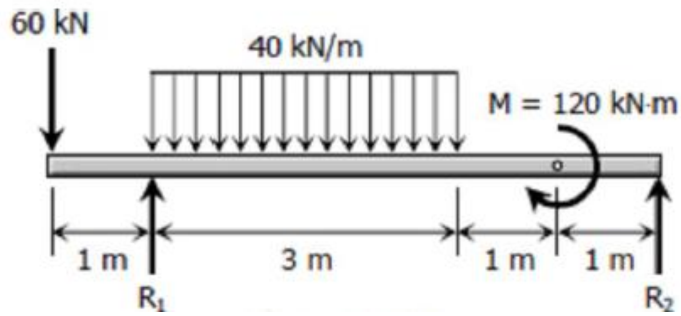
Determine the maximum torque ***T*** if the allowable shearing stresses are τ_{st} = ***83 GPa,*** τ_{al} = ***55 GPa***, and the angle of rotation of the free end is limited to *6º*. G_{st}=83GPa, G_{al}=28GPa.

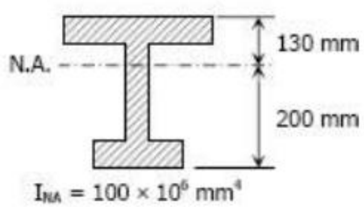


Problem

For the beam loaded as shown, Determine:

a. The maximum flexural stresses.
b. The maximum shearing stress.

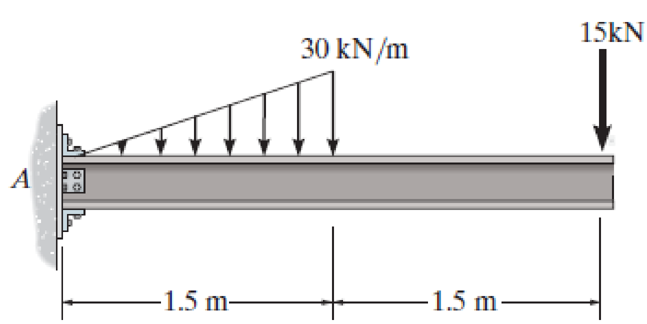




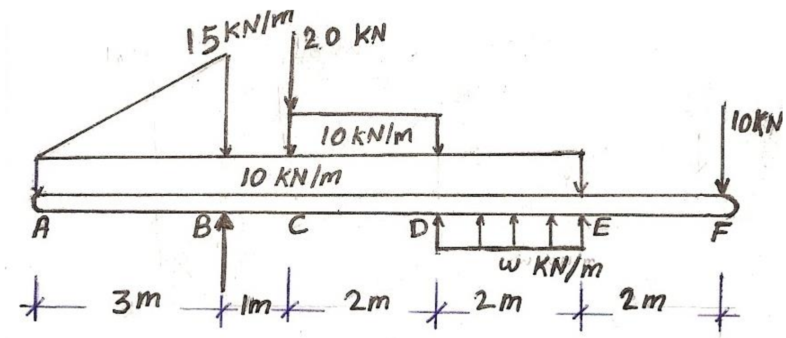
Problem

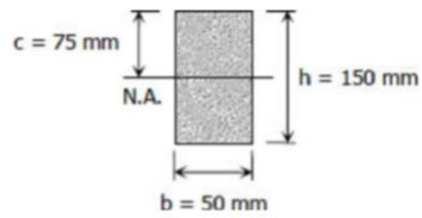
Determine the **maximum deflection** for the cantilevered beam;

E=200GPa and I = 65 (10^6) mm^4



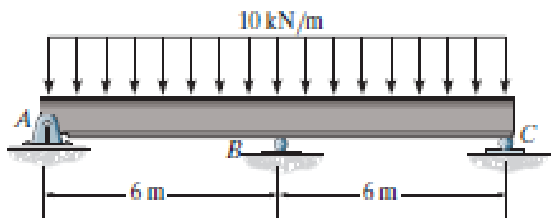
Q Write **shear** and **moment equations** for part ***CD*** and find ***maximum flexural stress***?



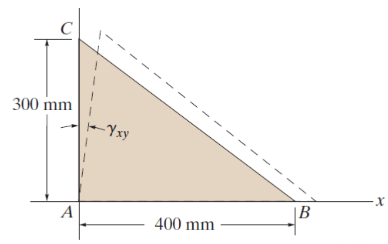


Problem

Determine the **reaction** at the roller support ***B***; take $E = 200\ GPa$, and $I = 65 * 10^{-6}\ mm^4$



The triangular plate *ABC* is deformed into the shape shown by the dashed lines. If at *A* $\varepsilon_{AB} = 0.0075$, $\varepsilon_{AC}=0.01$ and $\gamma_{xy} = 0.005\ rad$. determine the average ***normal strain*** along edge ***BC***.



Draw ***Shear*** and ***moment diagram*** using shear and moment equations, then find maximum shear and moment in the beam.