EXERCISE (1) STRESSES IN MACHINE PARTS

(1.1) A rectangular tie bar, 10 mm thick carries a load of 50 kN. It is attached to a bracket by means of 2 bolts, as shown in Fig. P(1.1). Calculate the height of the tie bar if the maximum tensile stress in the tie bar is 150 MPa, and the maximum shear stress in the bolts is not to exceed 75 MPa. [Ans. 77.3 mm]

(1.2) The rod ABC , shown in Fig. P(1.2) is made of an aluminum for which E = 70 GPa. Knowing that P = 6 kN and Q = 42 kN , determine ; (a) stress at section a-a , (b) stress at section b-b , (c) the deflection at point A , (d) the deflection at point B.
Now if the load P changed to be 4 kN, determine the value of Q so that the deflection at A is zero , what the corresponding deflection of B in this case?
[Ans. -12.74 , 19.11 , 0.0182 , -0.091 , 32.8 , -0.073]

(1.3) Determine the deformation of the steel rod, shown in Fig. P(1.3) under the given load . Also find the stress at sections a-a and b-b. Take E = 200 GPa.
[Ans. 4.8mm , 159 MPa , 1910 MPa]

(1.4) In the steel structure shown in Fig. P(1.4) , a 6-mm diameter pin is used at C, and 10 mm diameter pins are used at B and D. The ultimate shearing stress is 150 MPa at all connections , and the ultimate normal stress is 400 MPa in link BD. Knowing that a factor of safety 3 is desired , determine the largest load P which may be applied at A.
[Ans. 1685 N]

(1.5) A reinforced concrete column is 3 m high , and of uniform cross-section 375 mm x 375 mm . It is reinforced by four bars 25 mm diameter steel rods , as shown in Fig. P(1.5) , if the column carries an axial load of 600 kN, determine the stresses in the steel reinforcement , and in the concrete . How much energy is stored in the column. Take E for steel = 207 GPa , and for concrete = 13.8GPa.
[Ans. 53.6 MPa , 3.56MPa , 231J]

(1.6) A pull of 80 kN is transmitted from a bar X to the bar Y through a pin as shown in Fig. P(1.6). If the maximum permissible tensile stress in the bar is 100 MPa and the permissible shear stress in the pin is 80 MPa , find the diameter of bars and of the pin.
[Ans. 32 mm , 25.2 mm]

(1.7) The eye-bolt shown in Fig. P(1.7) has to withstand a tensile load of 80 kN. Find the diameter , d, of the bolt if the tensile stress is not to exceed 90 MPa. Find also the diameter of pin assuming that the pin is (a) in shear , and that the shear stress is not to exceed 60 MPa , (b) supported at A and B , loading is uniformly distributed between these points, and that the bending stress in tension and compression is not to exceed 90 MPa. If the pin diameter is calculated from (b) , what will be the bearing pressure at the bearing surface?
[Ans. 33.64 mm , 29.13 mm , 40.8 mm , 49 MPa]

(1.8) A length of solid , circular section , bar is to be bent into the arc of a circle 2.7 m in diameter , but must capable of recovering its straight form. Determine the maximum diameter of the cross-section of the bar if the elastic limit stress is 230 MPa, and E = 200 GPa. What will be the maximum bending moment exerted by the bar in the bent form?

[Ans. 0.673 kN-m , 3.1 mm]

(1.9) An axle 1 m long supported in bearings at its ends carries a flywheel weight 30 kN at the center. If the stress is not to exceed 60 MPa , find the diameter of the axle.

[Ans. 108.4 mm]

(1.10) A steel bar has a rectangular section, 200 mm by 50 mm . If the bar is used as a beam , compare the relative strengths in resisting bending moment when it is (a) laid flat , (b) laid on its smaller edge. If when laid flat , the bar rests on supports 1.8 m apart , find the intensity of uniformly distributed load to give a maximum stress due to bending of 75 MPa.

[Ans. 4 , 15.4 kN/m]

(1.11) A hollow shaft is required to transmit 600 kW at 110 rev/min., the maximum torque being 20% greater than the mean. The shear stress is not to exceed 63 MPa and twist in a length of 3 m not to exceed 1.4°.Find the external diameter of the shaft if the internal diameter to the external diameter is 3/8 . Take modulus of rigidity as 84 GPa.

[Ans. 172.8 mm]

(1.12) Determine the maximum allowable power which can be transmitted by a 150 mm diameter shaft running at 240 rev/min , when the permissible shear stress is 55 MPa. The shaft has a coupling on it , having 6 bolts on a 260 mm diameter pitch circle . Determine the diameter of the bolts if the maximum shear stress in the bolts must not exceed 100 MPa .

[Ans. 917 kW , 24.4 mm]

(1.13) During the conversion of a ship's propelling machinery , it is decided to replace an existing 250 mm diameter solid propeller shaft , transmitting 950 kW at 80 rev/min. , by a hollow steel shaft , the internal diameter of which is to be one-half of its external diameter . The hollow shaft is to be capable of transmitting 1500 kW at 80 rev/min. , with the same maximum shear stress as for solid shaft . Calculate this maximum shear stress , and use the value obtained to determine the dimensions of the hollow shaft .

[Ans. 37 MPa , 297.4 mm]

(1.14) For the stressed element shown in Fig. P(1.14) , find the principal stresses and the maximum shear stress . Show the position of the principal planes on a suitable diagram

[Ans. 87 MPa , 23 MPa , 32 MPa]

(1.15) Find the normal and shear stresses on the plane AB in the stressed element shown in Fig .P (1.15) .

[Ans. 8.5 MPa (comp.) , 39.7 MPa]

(1.16) An overhang crank , as shown in Fig. P(1.16) , carries a tangential load of 10 kN at the center of the crankpin . Find the maximum principal stress and the maximum shear stress at the center of crankshaft bearing .

[29.45 MPa , 18.58MPa]

(1.17) C-clamp as shown in Fig. P(1.17) carries a load P=25 kN . the cross-section of the clamp at x-x is rectangular having b=2t . Assuming that the clamp is made of steel casting with an allowable stress of 100 MPa , find its dimensions . Also determine the stress at section y-y.

[Ans. 77 mm , 50.55 MPa, -42.2 MPa , 25.45 MPa]

(1.18) A hollow shaft of 40 mm outer diameter and 25 mm inner diameter , as shown in Fig P(1.18) , is subjected to a twisting moment of 120 N-m , simultaneously , it is subjected to an axial thrust of 10 kN and a bending moment of 80 N-m . calculate the maximum compressive and shear stress

[Ans. 32 MPa , 18 MPa]

(1.19) A machine component is subjected to a flexural stress which fluctuates between 300 MPa and 150 MPa . Determine the value of the ultimate strength according to Soderberg relation. Take yield strength as 55% of ultimate strength and endurance strength as 50% of ultimate strength .Use factor of safety = 2.0 .

[Ans . 1173 MPa]

(1.20) A steel connecting rod is to be subjected to a completely reversed axial load of 180 kN. Determine the required diameter of the rod , using a factor of safety =2.0 . Assume no column action.Take the ultimate tensile strength = 1.07 GPa , and the yield strength = 910 MPa .

[Ans 39.7 mm]

(1.21) A cantilever beam , made of carbon steel of circular cross section as shown in Fig. P(1.21) , is subjected to a load which varies from –F to 3f . Determine the maximum load that this member can withstand for an indefinite life using a factor of safety = 2 . Analyze at the change of cross section only. Take : stress concentration factor at the change of cross section , with fillet of radius 3 mm , $K_f = 1.38$, correction factor of size , $K_{sz} = 0.85$, correction factor for surface finish , $K_{sur}=0.89$, ultimate tensile strength = 550 MPa ,and yield strength = 470 MPa .

[Ans . 56 N]

.22) A steel rod is to be subjected to a torsional load that will vary from -110 N-m to 440 N-m .Determine the required diameter of the rod using a factor of safety = 1.75 .Take : the ultimate tensile strength = 460 MPa , yield strength = 310 MPa . Assume no stress concentration .Use correction factor for shear loading , $K_s = 0.55$, correction factor for size (for d > 8mm) , $K_{sz} = 0.85$, and correction factor for surface finish , $K_{sur} = 0.68$.

[Ans . 33.8 mm]

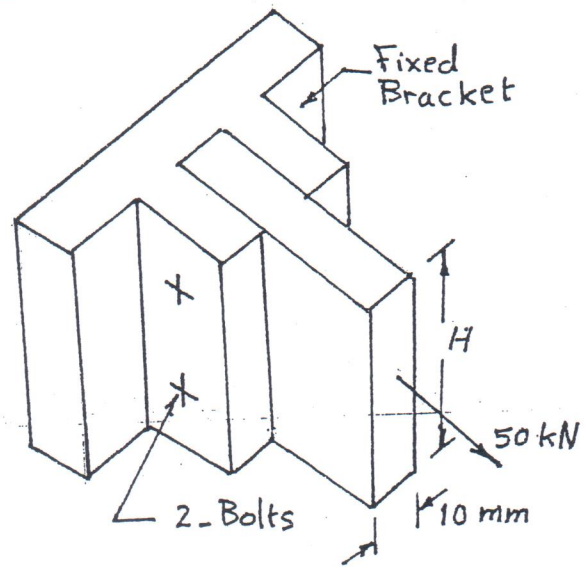


Fig. P(1.1)

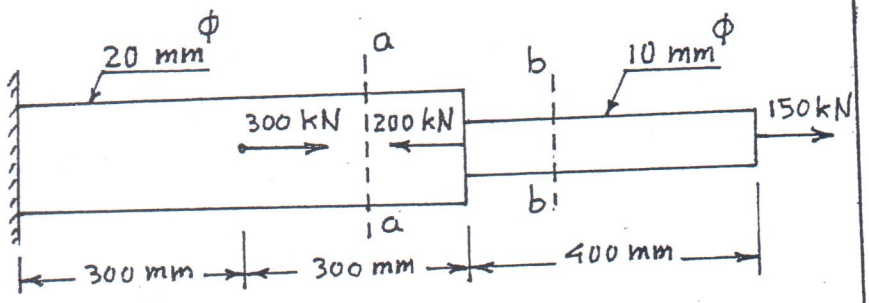


Fig. P(1.3)

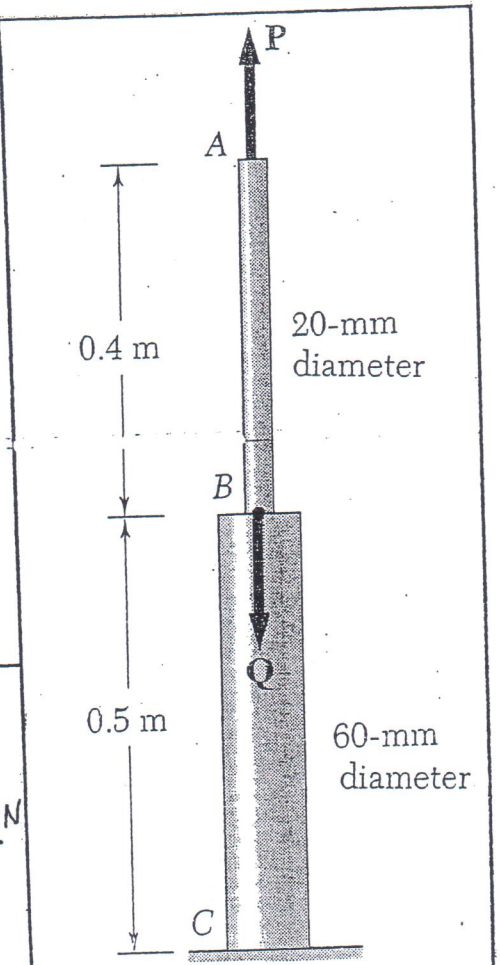


Fig. P(1.2)

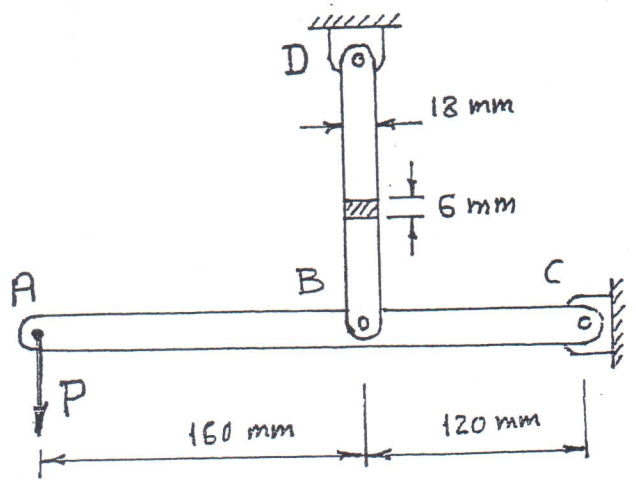


Fig. P(1.4)

$E_{steel} = 207 \times 10^3 \text{ N/mm}^2$

$E_{concrete} = 13{\cdot}8 \times 10^3 \text{ N/mm}^2$

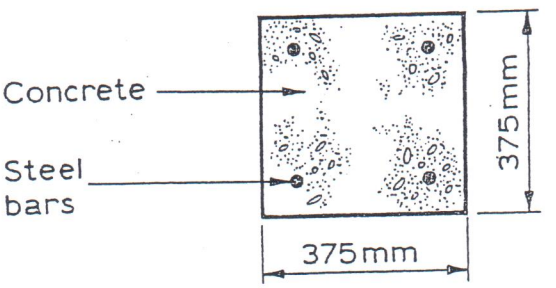


Fig. P(1.5)

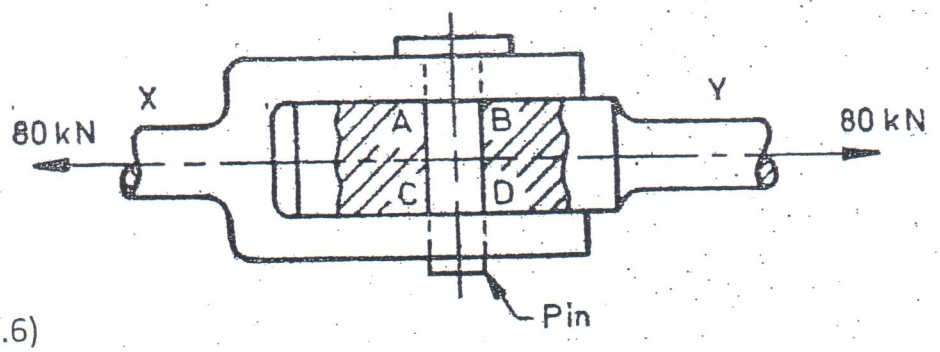


Fig. P(1.6)

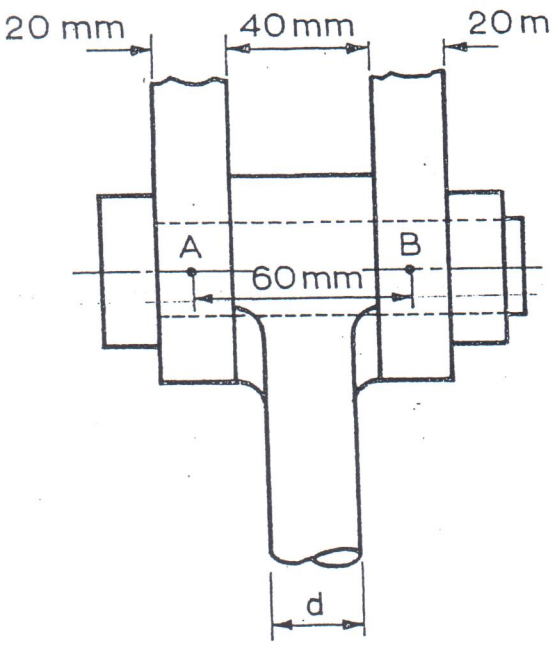


Fig. (1.7)

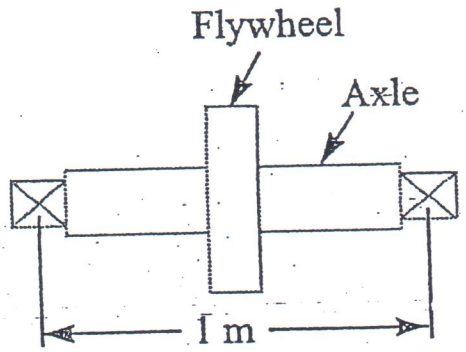
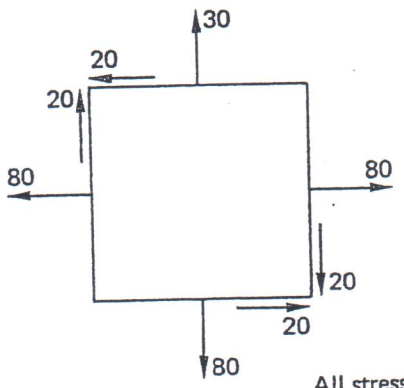


Fig. (1.9)



All stresses in N/mm^2

Fig. P(1.14)

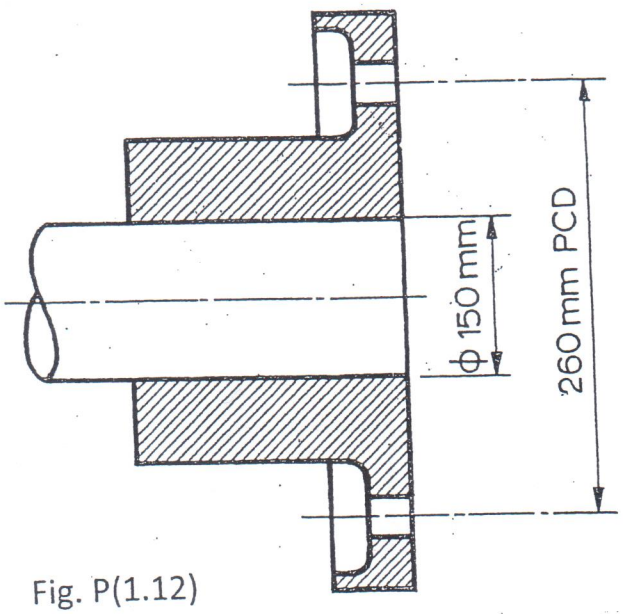


Fig. P(1.12)

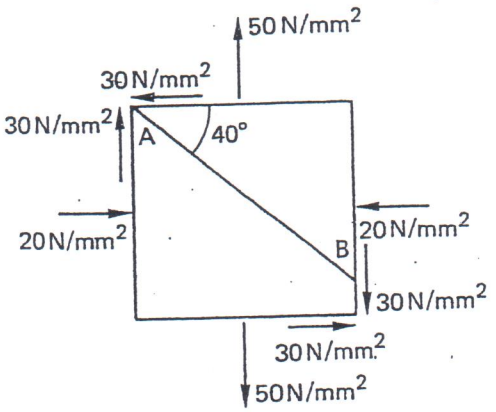


Fig. P(1.15)

(2.8) The lead screw of a lathe has Acme threads of 60 mm outside diameter and 8 mm pitch . It supplies drive to a tool carriage which need an axial force of 2000 N. A collar bearing with inner and outer radius as 30 mm and 60 mm respectively is provided. The coefficient of friction for the screw threads is 0.12 and for the collar is 0.10. Find the torque required to drive the screw and the efficiency of the screw.

[Ans. 14.04 N.m , 18 %]

(2.9) A bevel-gear drive is used for lifting a sluice gate , Fig. P(2.9) . The gate which has a weight of 30 kN , is subjected to pressure of 0.275 MPa over a surface 2.4 m in diameter. The vertical screw spindle has a square thread of mean diameter 75 mm , and 25 mm pitch . The screw passes through a bush fixed to the spindle . The coefficient of friction between the sluice and the vertical facing on which it presses , and also between the screw and bush , is 0.1 . The bevel wheel keyed to the spindle has 40 teeth , and the driving pinion on the motor shaft has 15 teeth . Determine the torque on the motor shaft required to raise the gate , neglecting all losses other than frictional at the threads and sluice facing .

[Ans. 252 N.m]

(2.10) A sluice valve , used in water pipe lines , consists of a gate raised by a spindle, which is rotated by the hand wheel . The spindle has single start square thread . The nominal diameter of the spindle is 36 mm and the pitch is 6 mm . The friction collar has inner and outer diameters of 32 mm and 50 mm respectively . The coefficient of friction at the threads and the collar are 0.12 and 0.18 respectively . The weight of the gate is 7.5 kN and the frictional resistance to open the valve due to water pressure is 2.75 kN . Determine : (a) Torque required to raise the gate , (b) overall efficiency.

[Ans. 58 N-m , 16.9 %]

(2.11) The press shown in Fig. P (2.11) , has a rated load of 22.25 kN . The twin screws have Acme threads , a diameter of 75 mm and a pitch of 12 mm . Coefficients of friction are 0.05 for the threads and 0.06 for the collar bearings . Collar diameter is 125 mm . The gears have an efficiency of 95 percent and speed ratio of 75 : 1 . A slip clutch , on the motor shaft, prevents overloading. The load motor speed is 1720 rev / min .

(a) When the motor is turned on , how fast will the press head move ?

(b) What should be the power rating of the motor ?

[Ans.4.587 mm/ s , 418.6 W]

(2.12) The following data apply to the C-clamp , shown in fig. P(2.12) .

Single Acme thread having outside diameter 12 mm .

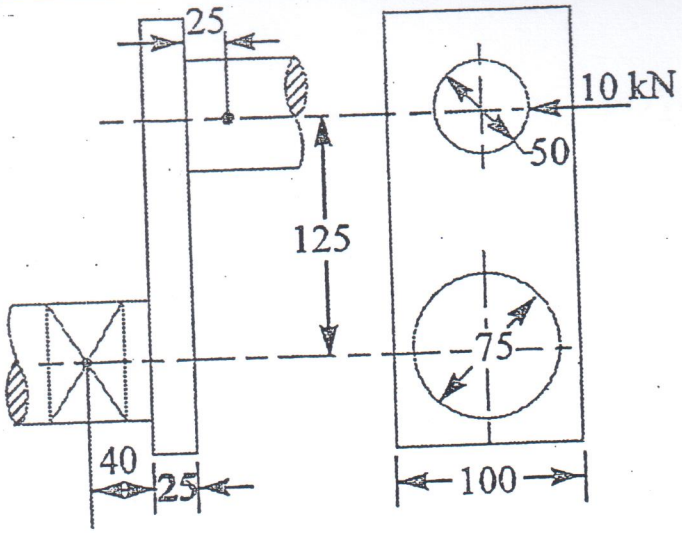
Pitch = 1.75 mm

Root diameter = 9.853 mm

Coefficient of threads friction = 0.12

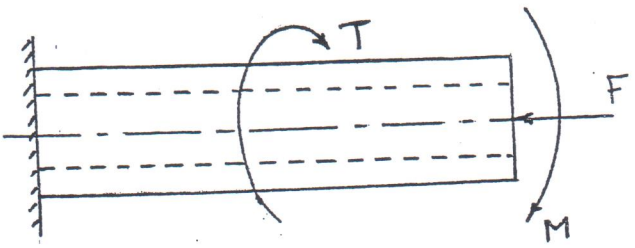
Coefficient of collar friction = 0.25

Mean collar diameter = 12 mm



All dimensions in mm.

Fig. P(1.16)



O/D = 40 mm

I/D = 25 mm

Fig. P(1.18)

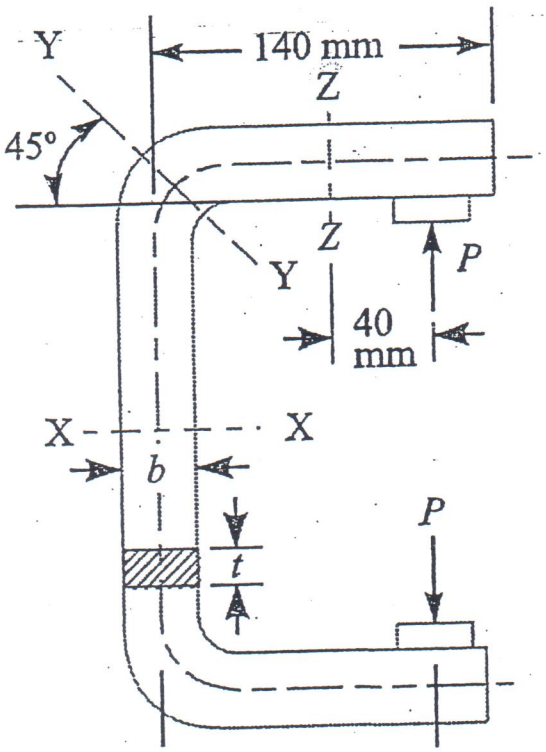


Fig. P(1.17)

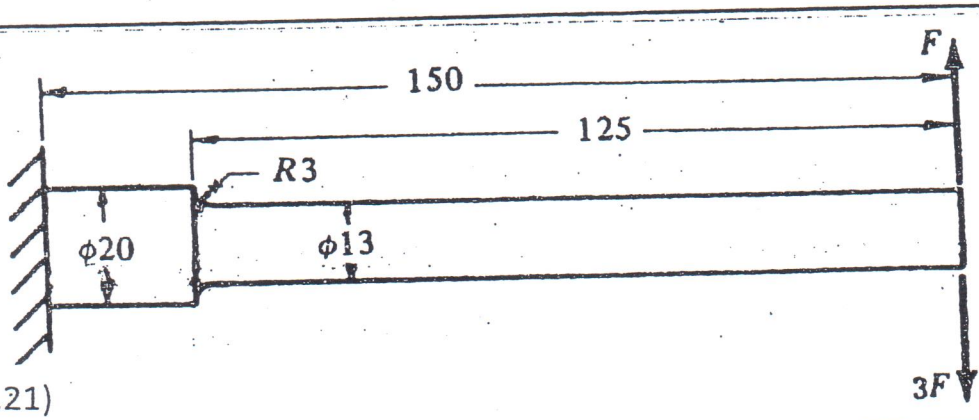


Fig. P(1.21)

EXERCISE (2) POWER SCREW

(2.1) A power screw is 25 mm in diameter and has a thread pitch of 5 mm .
(a) Find the thread depth , the thread width , the mean and root diameters , and the lead , provided square threads are used .
(b) Repeat part (a) for Acme threads .
[Ans. 2.5 mm , 2.5 mm , 22.5 mm , 20 mm , 5 mm]

(2.2) Using the following relations to show that the tensile-stress area is: $A_t = \pi/4\ (d_o - 0.93\ p)^2$.
The relations are : $d_r = d_o - 1.226\ 869\ p$
$D_m = d_o - 0.649519\ p$

(2.3) Show that for zero collar friction the efficiency of a square thread screw is given by the equation ; $e = \tan \frac{1 - \mu \tan}{\tan \lambda + \mu}$
Plot a curve of the efficiency for lead angles , λ , up to 45 ° . Use $\mu = 0.8$.

(2.4) Find the power required to drive a 40-mm power screw having double square threads with a pitch of 6 mm . The nut is to move at velocity of 48 mm/s and move a load of 10 kN . The frictional coefficients are 0.10 for the threads and 0.15 for the collar .The frictional diameter of the collar is 20 mm .
[Ans. 2.1 kW]

(2.5) A single square-thread power screw has an input power of 3 kW at a speed of 1 rev/s . The screw has a diameter of 36 mm and a pitch of 6 mm . The frictional coefficients are 0.14 for the threads and 0.09 for the collar , with a collar friction radius of 45 mm . Find the axial resisting load F and the combined efficiency of the screw and collar .
[Ans. 65.05 KN , 13 %]

(2.6) The lead screw of a lathe has Acme threads of 50 mm outside diameter and 10 mm pitch . It drives the tool carriage and exerts an axial force 2.5 kN . A collar bearing with outside diameter 100 mm and inside diameter 50 mm is provided to take the axial load . If the lead screw rotates at 30 rev/min . Find the efficiency and power required to drive the screw . Take coefficient of friction for screw threads as 0.15 and for collar as 0.12 .
[Ans. 16.7 % , 74.87 W]

(2.7) A single-threaded power screw , 25 mm diameter and with a pitch of 5 mm . A vertical load on the screw reaches a maximum of 6 kN . The coefficients of friction are 0.05 for collar and 0.08 for the threads . The frictional diameter of the collar is 40 mm . Find the overall efficiency and the torque to "raise" and "lower" the load .
[Ans. 29.4% , 6.62 N-m]

Axial load = 4000 N

Operator can comfortably exert a force of 80 N at the end of the handle .

(a) What length of handle , L , is needed ?

(b) what is the bearing stress on the threads ?

[Ans. 0.124 m , 7.45 MPa]

(2.13) A steel screw driving a bronze nut is to develop an axial load of 300 kN in an extrusion press .The screw has an outside diameter of 100 mm and a single square thread with a lead of 16 mm . The length of nut is to be chosen so that the bearing pressure between screw and nut threads will not exceed 16 MPa and the shearing stress on the nut threads will not exceed 28 MPa . Determine a suitable nut length .

[Ans. 130 mm]

(2.14) The screw , as shown in fig .P(2.14) is operated by a torque applied to the lower end . The nut is loaded and prevented from turning by guides' . Assume friction in the ball bearing to be negligible . The screw is a triple start Acme thread . The outside diameter of the screw is 48 mm and pitch is 8 mm. The coefficient of friction of the thread is 0.15 .

Find :

(a) Load which can be raised by a torque of 40 N-m .

(b) Whether the screw is overhauling .

(c) Average bearing pressure between the screw and nut thread surface .

[Ans. 5.385 kN , 1.56 MPa]

(2.15) A vertical square threads screw of a 70 mm mean diameter and 10 mm pitch supports a vertical load of 50 kN. It passes through the boss of spur gear wheel of 70 teeth which acts as a nut. In order to raise the load , the spur gear wheel is turned by means of a pinion having 20 teeth. The mechanical efficiency of pinion and gear wheel drive is 90 percent. The axial thrust on the screw is taken up by a collar bearing having a mean radius of 100 mm . The coefficient of friction for the screw and nut is 0.15 and that for collar bearing is 0.12 . Find :

(a) Torque to be applied to the pinion shaft .

(b) Maximum principal and shear stresses in the screw .

(c) Height of nut , if the bearing pressure is limited to 12 MPa.

[Ans. 299.8 N-m , 16.5 MPa , 40 mm]

(2.16) The screw of a shaft straightener exerts a load of 30 kN , as shown in fig. P(2.16) . The screw is square threaded of outside diameter 75 mm and 6 mm pitch . Determine :

(a) Force required at the rim of 300 mm diameters hand wheel , assuming the coefficient of friction for the threads as 0.12 .

(b) Maximum compressive stress in the screw , bearing pressure on the threads and the shearing stress in the nut threads due to axial loading .

(c) Efficiency of the straightener .

[Ans. 1.059 kN , 8 MPa , 1.77 MPa , 1.85 MPa , 18 %]

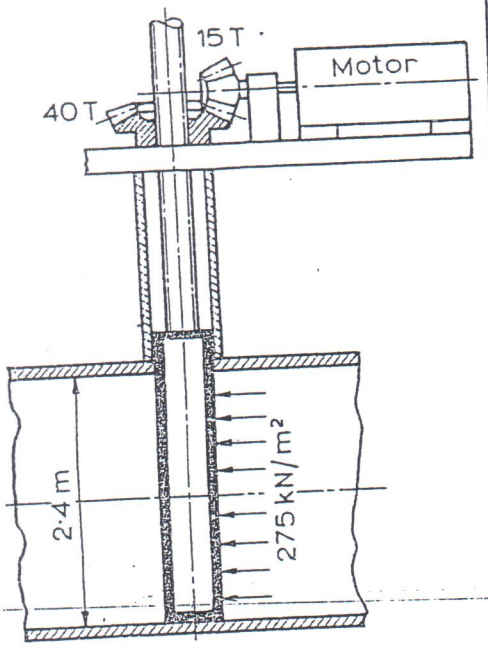


Fig. P(2.9)

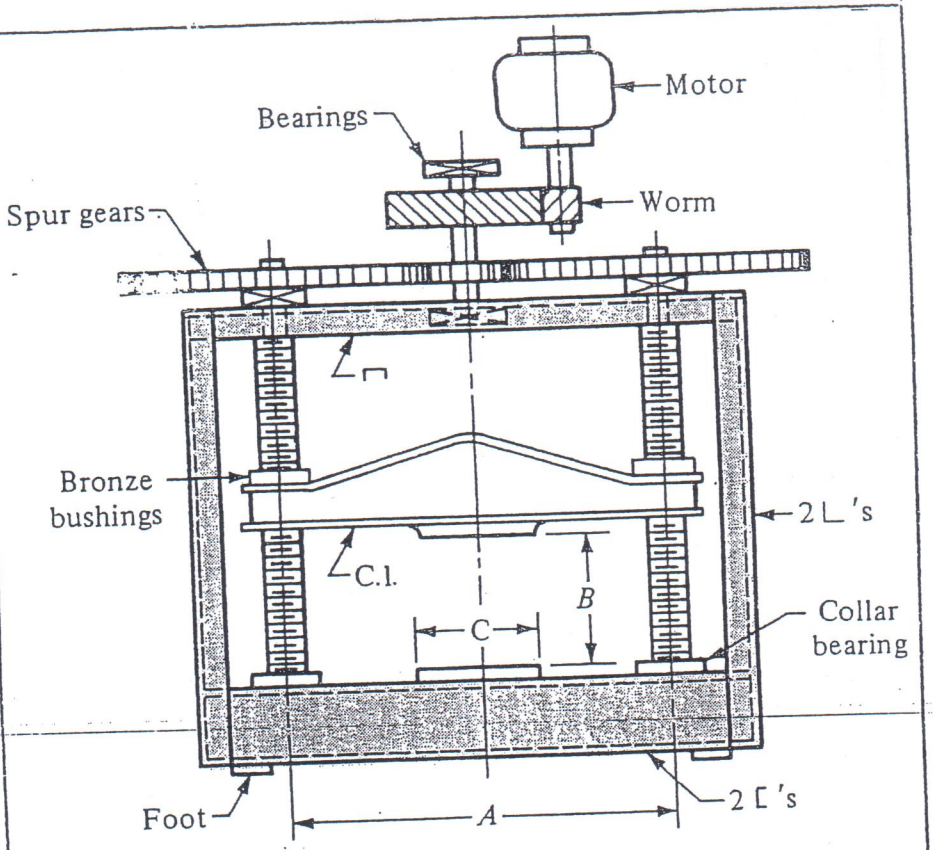


Fig. P(2.11)

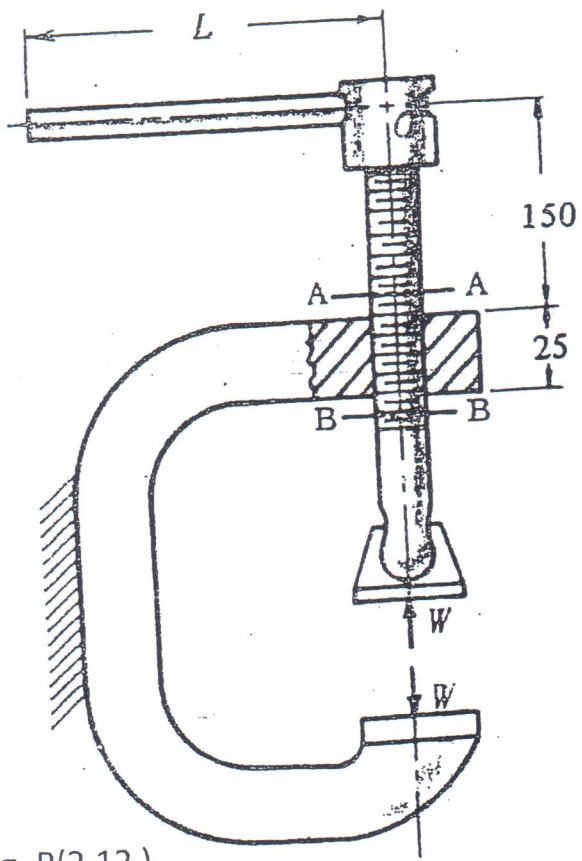


Fig. P(2.12)

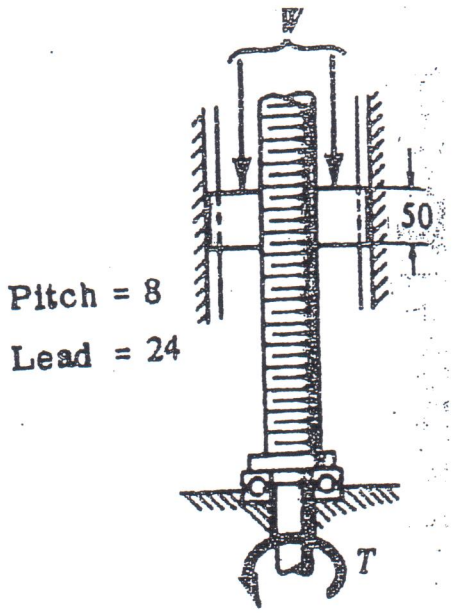


Fig. P(2.14)

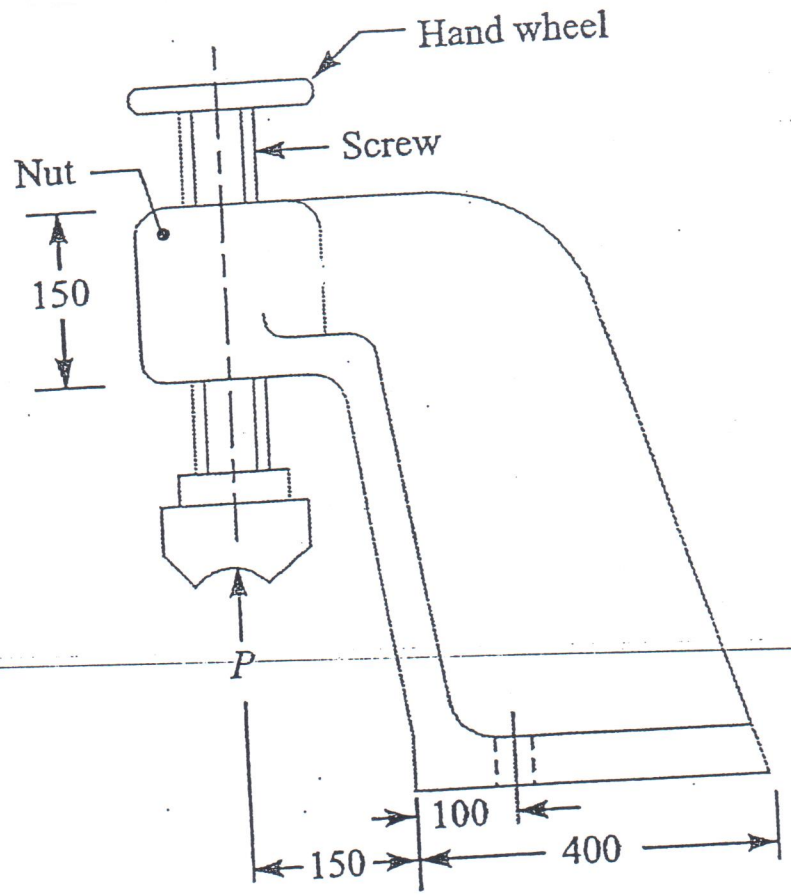


Fig. P(2.16)

EXERCISE (3) PRESSURE VESSELS

(3.1) Prove that the hoop stress in a thin cylinder subjected to internal pressure is twice the corresponding longitudinal stress.A copper cylinder is 450 mm in internal diameter, and 7.5 mm thick. Calculate the safe operating pressure if the tensile strength of the material is 140 MPa, and there is to be a factor of safety of 4.

[Ans. 1.17 MPa]

(3.2) A cylindrical shell, 2.1 m mean diameter, is constructed of mild-steel plate having an ultimate tensile strength of 450 MPa. It is subjected to an internal pressure of 1.75 MPa gauge, and the efficiency of the longitudinal joint is 74%. Using a factor of safety of 5, determine the thickness of plate which can be used.
What will be the value of the axial stress in the plate?

[Ans. 27.57 mm , 45 MPa]

(3.3) A spherical pressure vessel of 900 mm outer diameter is to be fabricated from a steel having an ultimate stress of 400 MPa . Knowing that a factor of safety of 4 is desired and that the gauge pressure can reach 3.5 MPa , determine the smallest wall thickness that should be used .

[Ans. 7.74 mm]

(3.4) A cylindrical shell, 2.7 m mean diameter, is constructed of mild-steel plate having a tensile strength of 430 MPa . It is subjected to an internal pressure of 1.4 MPa gauge . Calculate the thickness of the shell plate , assuming a factor of safety of 5 , and the efficiency of the longitudinal joint to be 78%.

[Ans. 28.18 mm]

(3.5) An AISI 1020 cold-drawn steel tube has an ID of 45 mm and an OD of 60 mm . what maximum internal pressure can this tube take if the largest principal normal stress is not to exceed 80% of the minimum yield strength of the material ?
(take minimum yield strength = 490 MPa)

[Ans. 109.7 MPa]

(3.6) An AISI 1020 cold-drawn steel tube has an ID of 30 mm and an OD of 44 mm. What maximum external pressure can this tube take if the largest principal normal stress is not to exceed 80% of the minimum yield strength of the material ?
(take yield strength = 490 Mpa)

[Ans. -104.9 MPa]

(3.7) An aluminum alloy pressure vessel is made of tubing having an outside diameter of 200 mm and a wall thickness of 6 mm .
(a) What pressure can the cylinder carry if the permissible tangential stress is 82 MPa and the theory of thin-walled vessels is assumed to apply ?
(b) On the basis of the pressure found in part (a), compute all of the stress components using the theory for thick-walled cylinders.

[Ans. 5.23 MPa , 84.6 MPa , 5.23 MPa , 38.5 MPa]

(3.8) The maximum force exercted by a small hydraulic press is 500 kN. The working pressure of the fluid is 20 MPa. Determine the diameter of the plunger, operating the table. Also suggest the

thickness for the cast steel cylinder in which the plunger operates, if the permissible stress for cast steel is 100 MPa . [Ans. 180 mm , 20 mm]

(3.9) An hydraulic control for a straight line motion as shown in Fig. P(3.9), utilizes a spherical pressure tank "A"connected to a working cylinder "B". The pump maintains a pressure of 3 MPa in the tank.

(a) If the diameter of pressure tank is 800 mm, determine its thickness for 100% efficiency of the joint. Assume the allowable tensile stress as 50 MPa.

(b) Determine the diameter of cast iron cylinder and its thickness to produce an operating fore, F=25 kN. Assume:

(i) An allowance of 10% of operating force F for friction in the cylinder and packing, and

(ii) A pressure drop of 0.2 MPa between the tank and cylinder. Take safe stress for cast iron as 30 MPa.

(c) Determine the power output of the cylinder, if the stroke of the piston is 450 mm and the time required for the working stroke is 5 seconds.

(d) Find the power of the motor, if the working cycle repeats after every 30 seconds and the efficiency of the hydraulic control is 80% and that of pump 60%

[Ans. 24 mm , 112 mm , 52 mm, 2.475 kW, 0.86 kW]

(3.10) A torque of magnitude T=12 kN-m is applied to the end of a tank containing compressed air and a pressure of 8 MPa. Knowing that the tank has a 180 mm inner diameter and a 12 mm wall thickness, determine the maximum normal stress and the maximum shearing stress on the tank wall.

[Ans. 68.6 MPa , 23.65 MPa]

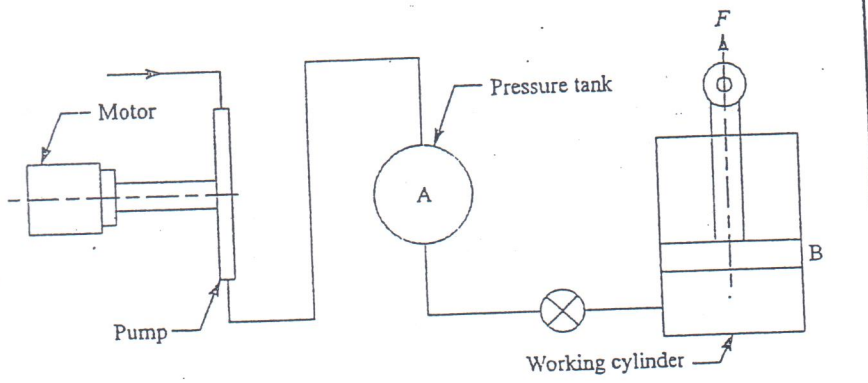


Fig. P(3.9)

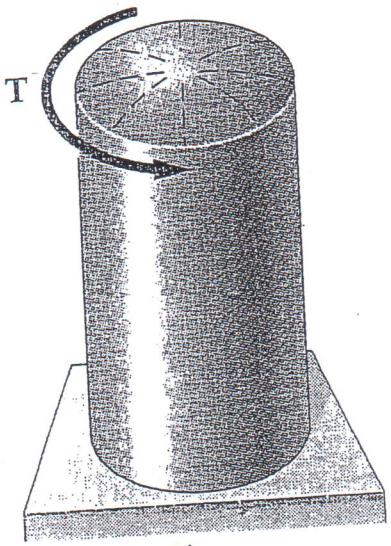


Fig. P(3.10)

Exercise (4) Bolted Joints

(4.1) A cast iron bracket to carry a shaft and belt pulley is shown in Fig. P (4.1). The bracket is fixed to the main body by means of four standard bolts. The tension in the slack and tight sides of the belts are 2.2 kN and 4.25 kN respectively. Find the size of the bolts , if the safe tensile stress for bolts is 50 MPa .

(4.2) A pulley bracket, as shown in Fig. P (4.2) is supported by 4 bolts, two at A-A and two at B-B. Determine the size of bolts using an allowable shear stress of 35 MPa for the material of the bolts.

(4.3) A bracket, as shown in Fig. P (4.3), is fixed to a vertical steel column by means of five standard bolts. Determine: (a) The diameter of the fixing bolts, (b) The thickness of the arm of the bracket. Assume safe working stress of 70 MPa in tension and 50 MPa in shear.

(4.4) The member shown in Fig. P (4.4) is bolted to a wall by means of two M10 through bolts made of steel having a yield strength of 620 MPa. The member is subjected to a load of 6 kN and a torque of 500 N.m. Determine (a) the least factor of safety for bolts , (b) the value and position of the maximum normal stress in the circular cross-section of the member . Note : For coarse pitch series of bolts p=1.5 mm ($d_c = d_o - 1.227\ p$)

(4.5) The member shown in Fig. P (4.5) is bolted to a stanchion by means of four M8 through bolts made of nickel steel having a yield strength of 620 MPa. Determine the least factor of safety for bolts. Note : $d_c = d_o - 1.227\ p$.

(4.6) Find the total shear load on each of the three bolts for the connection shown in Fig. P (4.6) and compute the significant bolt shear stress and bearing stress. Compute the moment of inertia of the 8 mm plate on a section through the three bolts holes and find the maximum bending stress in the plate.

(4.7) A cold-drawn BS 640 M40 steel bar is to be fastened using three M12 x 1.75 grade 9.8 bolts to the 150 mm channel shown in Fig. P(4.7) . What maximum force F can be applied to this cantilever if the factor of safety is to be at least 2.8 ?. Do not consider the channel. Use shear strength of bolts as 410 MPa, and yield strength for member as 600 MPa.

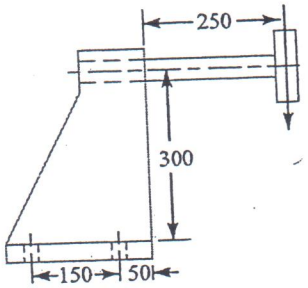
(4.8) The bracket shown in Fig. P(4.8) is secured to a" T" column by means of three M14 through bolts having a yield strength of 620 MPa. The bracket is subjected to a vertical load of 30 kN. Determine the factor of safety for the bolts.

(4.9) Four M10 bolts are used to secure the bracket shown in Fig. P(4.9) in position to a wall. The bolts are made of steel having a yield strength of 620 MPa. Determine the least factor of safety for the bolts.

(4.10) A bracket, as shown in Fig. P (4.10) supports a load of 30 kN. Determine the size of bolts, if the maximum allowable tensile stress in the bolts material is 60 MPa. The distances are: L_1=80 mm , L_2= 250 mm , and L = 500 mm.

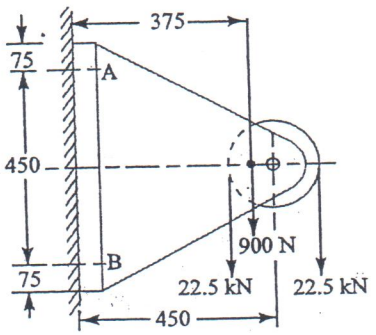
(4.11) A mounting plate for a drive unit is fixed to the support by means of four M12 bolts as shown in Fig. P (4.11). The core diameter of the bolts can be considered as 9.858 mm. Determine the maximum value of " W" if the allowable tensile stress in bolt material is 60 MPa.

(4.12) For supporting the travelling crane in a workshop,the brackets are fixed on steel columns as shown in Fig. P (4.12). The maximum load that comes on the bracket is 12 kN acting vertically at a distance of 400 mm from the face of the column. The vertical face of the bracket is secured to a column by four bolts, in two rows (two in each row) at a distance of 50 mm from the lower edge of the bracket. Determine the size of the bolts if the permissible value of the tensile stress for the bolt material is 84 MPa.



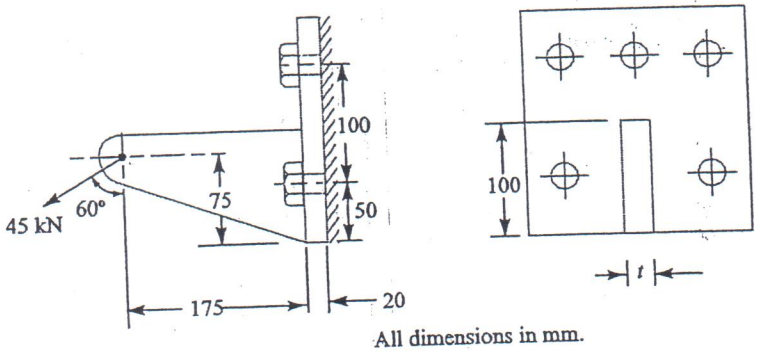
All dimensions in mm.

Fig. P (4.1)



All dimensions in mm.

Fig. P (4.2)



All dimensions in mm.

Fig. P (4.3)

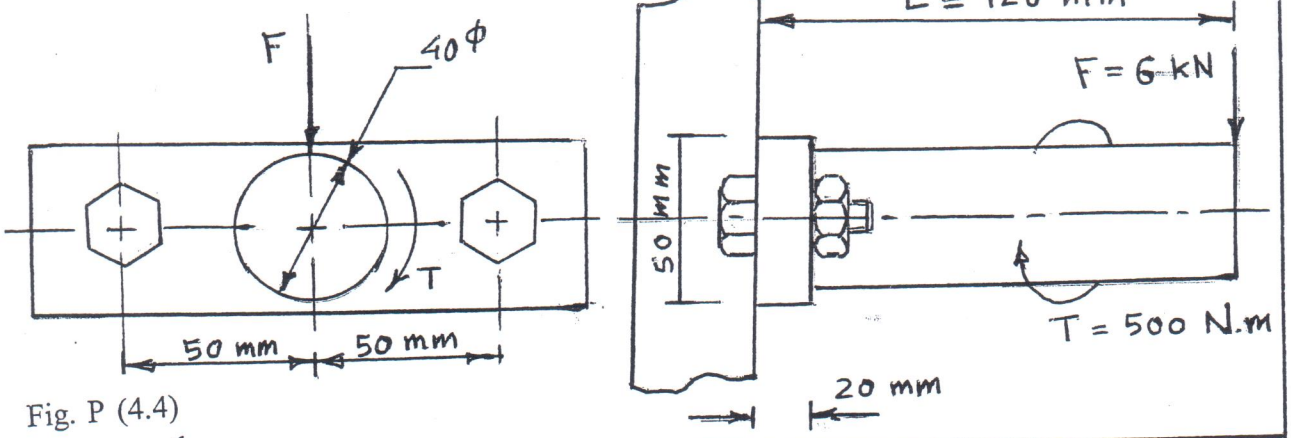


Fig. P (4.4)

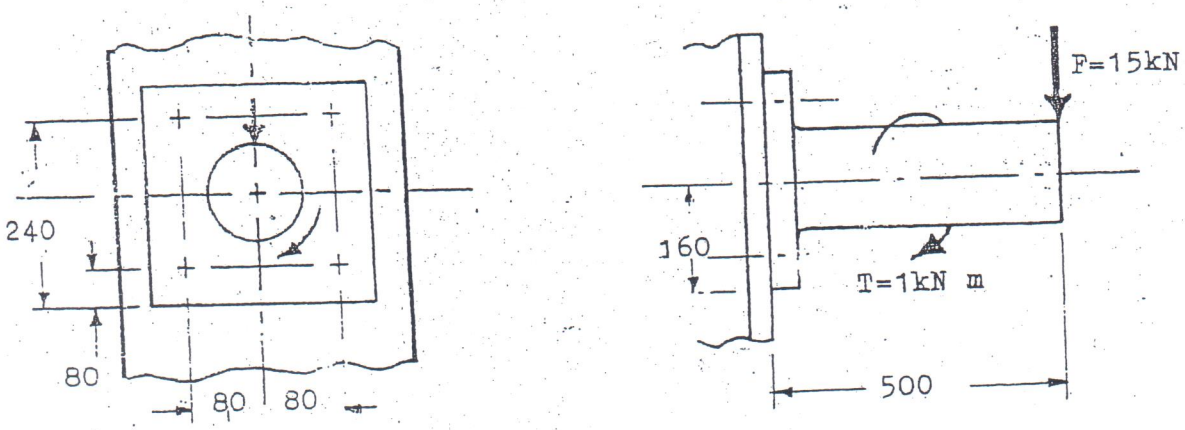


Fig. P (4.5)

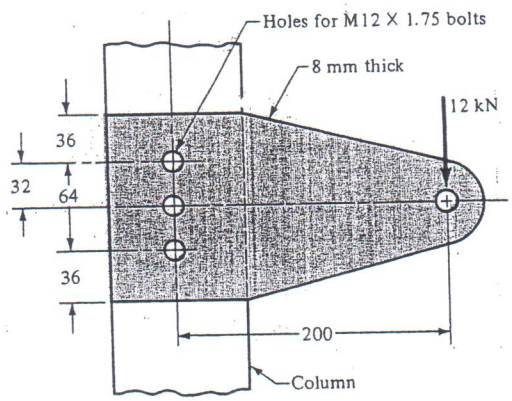


Fig. P (4.6)

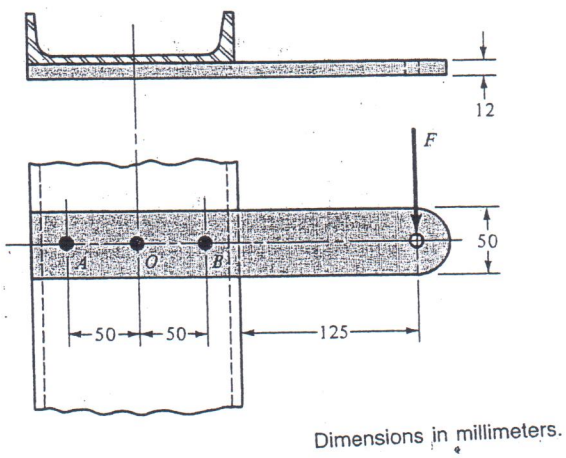


Fig. P(4.7)

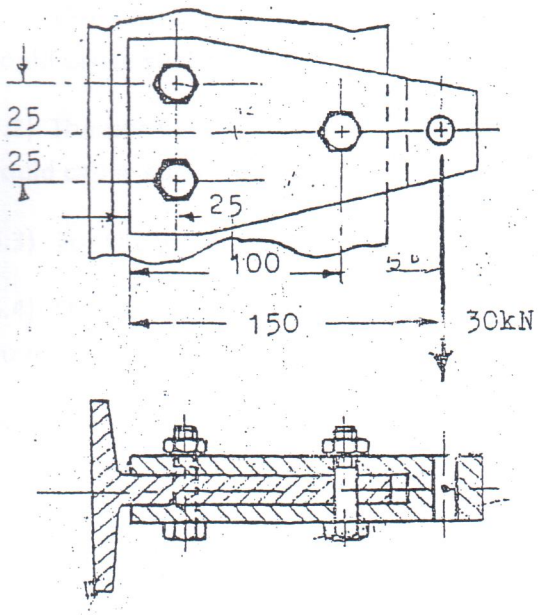


Fig. P(4.8)

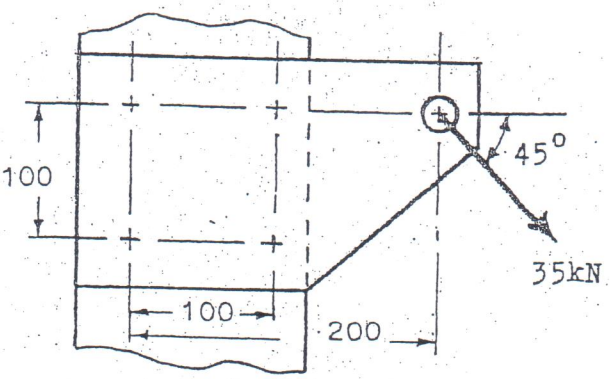


Fig. P(4.9)

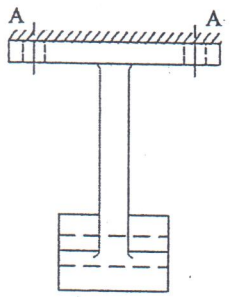
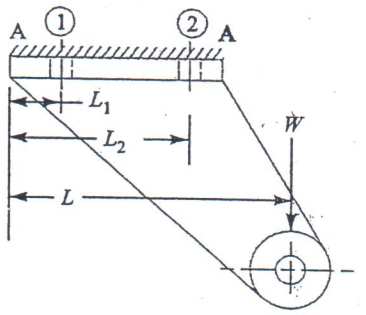


Fig. P (4.10)



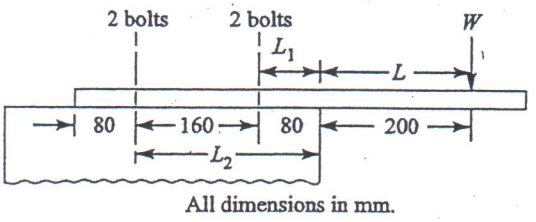


Fig. P (4.11)

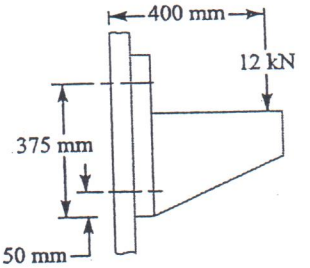


Fig. P (4.12)

EXERCISE (5) WELDED JOINTS

(5.1) The permissible shear stress for the welds shown in Fig.P(5.1), is 140 MPa. Find the load F that would cause such a stress. [Ans. 101 kN]

(5.2) The permissible shear stress for the welds shown in Fig. P(5.2), is 140 MPa. Find the load F that would cause such a stress. [Ans. 35.6 kN]

(5.3) For the welds shown in Fig. P(5.3), find the maximum shear stress. [Ans. 137.7 MPa]

(5.4) The permissible shear stress for the welds shown in Fig. P(5.4) is 140 MPa. Find the load F that would cause such a stress. [Ans. 12.67 kN]

(5.5) The permissible shear stress for the welds shown in Fig. P(5.5) is 140 MPa. Find the load F that would cause such a stress. [Ans. 9.09 kN]

(5.6) A force F=7.5 kN acts on the bracket shown in Fig.P(5.6). Find the maximum combined stress in the weld metal. [Ans. 17.6 MPa , 34 MPa]

(5.7) Find the load F that will produce a maximum shear stress of 140 MPa in the weld shown in Fig. P(5.7). [Ans. 49.8 kN]

(5.8) A 50 mm diameter solid shaft is welded to a flat plate as shown in Fig. P(5.8), if the size of the weld is 15 mm, find the maximum normal and shear stress in the weld. [Ans. 96.4 MPa , 48.4 MPa]

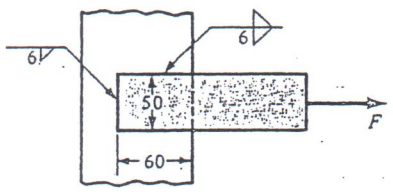


Fig.P(5.1)

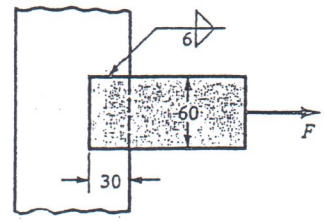


Fig. P(5.2)

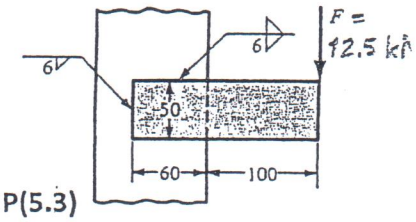


Fig. P(5.3)

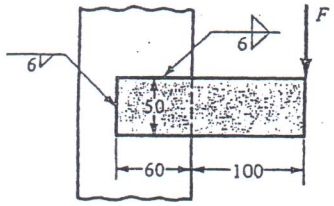


Fig. P(5.4)

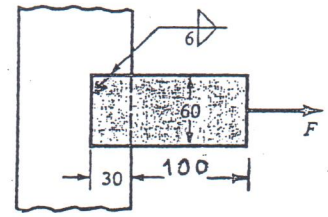


Fig. P(5.5)

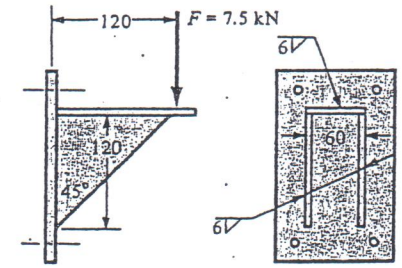


Fig.P(5.6)

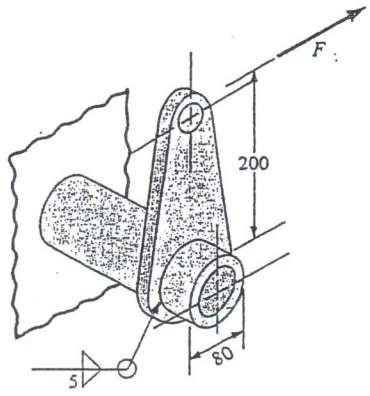


Fig. P(5.7)

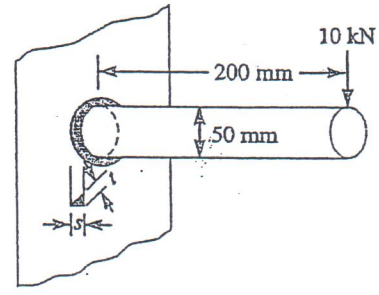


Fig. P(5.8)

EXERCICE (6) SPRINGS

(6.1) A helical compression spring having 12.5 active turns, 120 mm free length, 3.4 mm wire diameter, and 50 mm mean coil diameter. Compute; (a) The spring rate, (b) What force is required to close the spring to its solid height ?, (c) After the spring has been closed to its solid height once, and the compressive force removed, will it spring back to its original free length ?. Take torsional yield strength = 640 MPa , and modulus of rigidity = 79.3 GPa.

(6.2) Design a compression helical spring to carry a load of 500 N with a deflection of 25 mm. The spring index may be taken as 8. Assume the permissible shear stress = 350 MPa, and modulus of rigidity = 84 kPa.

(6.3) A compression spring has 18 active coils, an outside diameter of 7.14 mm , and plain ends, it is made of 0.90 mm BS 5216 grade 4 cold-drawn wire. (a) What should be the free length of the spring such that no permanent deformation will occur when it is compressed solid? , (b) What force is necessary to compress the spring to its solid length?

(6.4) Tow steel compression coil springs are to be nested. The outer spring has an inside diameter of 38.1 mm, a wire diameter of 3.0 mm, and 10 active coils. The inner spring has an outside diameter of 31.8 mm, a wire diameter of 2.24 mm, and 13 active coils. (a) Compute the spring rate of each spring, (b) What force is required to deflect the nested spring assembly a distance of 25 mm? (Both have the same free length), (c) Which spring will be stressed the most? , Calculate this stress using the result of (b). Take G = 79.3 GPa.

(6.5) A helical compression spring made of oil tempered carbon steel, is subjected to a load which varies from 600 N to 1600 N. The spring index is 6 and the design factor of safety is 1.43. If the yield shear stress is 700 MPa and the endurance stress in shear is 350 MPa, find the size of the spring wire and mean diameter of the spring coil.

(6.6) A compression coil spring is made of 2 mm music wire and has an outside diameter of 12.5 mm. The maximum and minimum values of the fatigue load to which the spring is subjected are 90 N and 45 N, respectively, find the factor of safety.

(6.7) A compression coil spring of 3.4 mm music wire, having an outside diameter of 22 mm, has 8 active coils. Determine the stress and deflection caused by a static load of 270 N. Take G = 79.3 GPa.

(6.8) A helical compression spring, made of music wire, has a wire size of 2.3 mm, an outside diameter of 14.3 mm, a free length of 105 mm, 21 active coils, and both ends squared and ground. The spring is to be assembled with a preload of 22 N and will operate to a maximum load of 153 N during use. (a) Find the factor of safety guarding against a fatigue failure; (b) Find the critical operating frequency. Take the yield shear stress as 850 MPa, and the endurance stress in shear = 350 MPa. Take G = 79.3 GPa.