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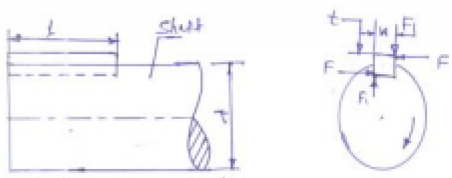
State applications of maximum shear stress theory and principal normal stress theory

(i) Applications of maximum shear stress theory : for ductile material , crank shaft, propeller shafts , c frames (ii) Applications of maximum principle normal stress theory : for brittle material , machine spindle, machine beds , c frames, overhang crank

Explain with the help of neat sketches, the design procedure of a square sunk key



T= Torque transmitted by the shaft , F= tangential force acting at the circumference of the shaft,

d = dia. Of shaft,

l = length of key,

w = width of key

t = thickness of key

τ and σ_c = shear and crushing stress for the material of key

Consider shearing of key, the tangential shearing force acting at the circumference of the shaft ,F = Area resisting shearing X shear stress = $l x w \times \tau$

Torque transmitted by the shaft , T = F X d/2 = $l \times w \times \tau \times d/2$

Consider crushing of key, the tangential crushing force acting at the circumference of the shaft ,F = Area resisting crushing x crushing stress = $l x t/2 \times \sigma_c$

Torque transmitted by the shaft , T = F X d/2 = $l x t/2 \times \sigma_c \times d/2$

The key is equally strong in shearing and crushing ,if

$l x w \times \tau \times d/2 = l x t/2 \times \sigma_c \times d/2$

$w/t = \sigma_c/2\tau$

as, w = t

therefore $\sigma_c = 2\tau$

Explain with the help of neat sketches three basic types of lever. State one application of each type.

In the first type of levers, the fulcrum is in between the load and effort. In this case, the effort arm is greater than load arm, therefore M.A. obtained is more than 1 Application: Bell crank levers used in railway signaling arrangement, rocker arm in I.C. Engines , handle of a hand pump, hand wheel of a punching press, beam of a balance, foot lever (any 1) In the second type of levers, the load is in between the fulcrum and effort. In this case, the effort arm is more than the load arm, therefore M.A. is more than 1.

A hollow shaft is required to transmit 50 kW power at 600 rpm. Calculate its inside and outside diameters if its ratio is 0.8. Consider yield strength of material as 380N/mm2 and factor of safety as 4.

Given : P= 50 KW = 50000W Speed = 600rpm k=Di/do = 0.8 σyt= 380 N/mm2 Factor of safety= 4 Design stress σt=σyt/fos =380/4 =95 Shear stress = τ =σt/2 = 95/2 =47.5N/mm2 Torque transmitted by hollow shaft T = P x 60/2πN T = 50000 x 60/2π x600 T = 795.67 N-m T= 795670 Nmm T= π/16 Xτ X do3 (1-k 4) 795670 =π/16 X 47.5 X do3 (1-0.84) Do3=144529.313 Do = 53 mm say 55 mm Di = 0.8X 55 = 44mm

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State and explain main considerations in machine design.

Main considerations in machine design Type of loads and stresses caused by the load: the load on a machine component, may act in several ways, due to which, the internal stresses are set up. Mechanism: the successful operation of any machine depends largely upon the simplest arrangement of the parts, which will give desired motion Selection of material: designer should know the deep knowledge of properties of materials and behavior under working conditions

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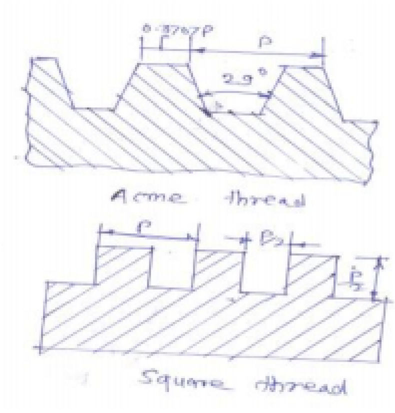
Draw neat labeled sketches of Acme and square thread profile and state its relative characteristics.



Characteristics of Acme thread : (i)thread angle is 290 (ii) permit the use of split nut (iii)easy to manufacture (iv) max. bursting pressure on the thread Characteristics of Square thread : (i) zero profile thread angle (ii) minimum bursting pressure on the nut

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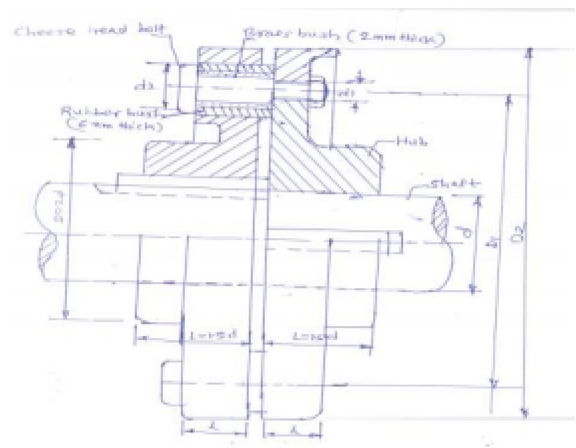
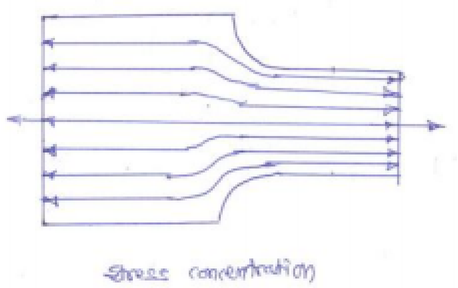
Draw a neat sketch of flexible flange coupling and label its main components.



What is stress concentration? State its significance in design

[of machine elements]

Whenever a machine component changes the shape of its cross section, the simple stress distribution no longer holds good. This irregularity in the stress distribution caused by abrupt changes of form is called as stress concentration



[Determine the power lost in a footstep bearing………..]

$W = 15$ KN , $N = 100$ rpm , $r = 7.5$ cm $= 0.075$ m

(i) Considering uniform pressure theory

Torque, $T = \frac{2}{3} \mu W R$ N-m

$= \frac{2}{3} \times 0.05 \times 15 \times 10^3 \times 0.075$

$= 37.5$ Nm ----- [2M]

Power lost,

$P = \frac{2 \pi N T}{60 \times 1000} = 0.393$ KW --- [2M]

(ii) Considering uniform wear theory

Torque, $T = \frac{1}{2} \mu W R$ N-m

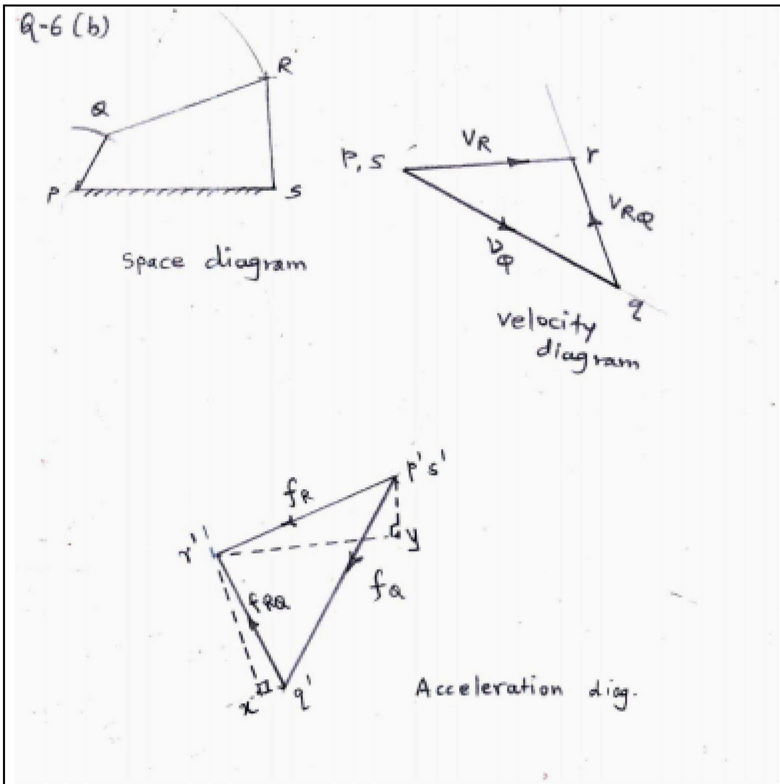
$= \frac{1}{2} \times 0.05 \times 15 \times 10^3 \times 0.075$

$= 28.1$ N-m ---- [2M]

Power lost,

$P = \frac{2 \pi N T}{60 \times 1000} = 0.294$ KW -- [2M]

PQRS is a four bar chain with link PS fixed……….



Calculations-

V_{QP} ■ ω_{QP} X PQ =10 X 0.0625 = 0.625 m/s

From Velocity diagram,

By measurement, V_{RQ} ■0.333 m/s,; ω_{QR} = V_{RQ} /RQ ■0.333/0.175 ■1.9 rad/s (Anti clockwise)...1M

By measurement, V_{RS} ■0.426 m/s,; ω_{RS} = V_{RS} /SR ■0.426/0.1125 ■3.78 rad/s (clockwise).....1M

Find out radial acceleration of each link by using formula -V^2/length of link

Fr_{QP} =6.25 m/s^2 ; fr_{RQ} = 0.634 m/s^2 ; fr_{RS} = 1.613 m/s^2

From acceleration diagram, measure all tangential components (ft)

Angular acceleration of link QR , α_{QR} = ft RQ /QR =4.1/0.175= 23.43 rad/s^2 (Anti clockwise)...1M

Angular acceleration of link RS , α_{RS}= ft RS /SR =5.3/0.1125= 47.1 rad/s^2 (Anti clockwise) ...1M

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