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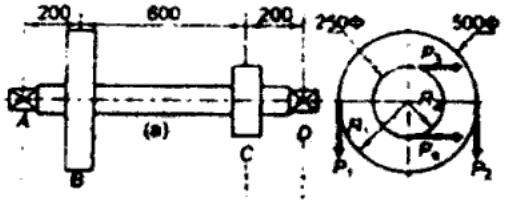
$6t$ + 41·28 mm, where t is the thickness of the plate and zigzag pattern of riveting to be done. The distance between the outer row and the next row is given by $0{\cdot}2p + 1{\cdot}15d$ and the distance between the middle and the inner rows is $0{\cdot}165p + 0{\cdot}67d$. The thickness of the two cover plates are $0{\cdot}75t$ and $0{\cdot}625t$ respectively. Draw a neat sketch of the joint.

11. The layout of a transmission shaft carrying two pulleys B and C and supported on bearing A and D as shown in figure below. Power supplied to the shaft by means of a vertical belt on the pulley B, which is then transmitted to pulley Carrying a horizontal belt. The maximum tension in the belt on the pulley B is 2·5 kN. The angle of wrap for both the pulleys is 180° and the coefficient of friction is 0·24. The shaft is made of plain carbon steel 30C8 (σ_{yt} = 400 N/mm^2) and the factor of safety is 3. Determine the diameter of the shaft.



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2013

DESIGN OF MACHINE ELEMENTS

Time Allotted : 3 Hours *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : 10 × 1 = 10

   i) In welded joint the throat of weld as compare to size of weld is

   a) about same size b) about 0·7 times

   c) about 0·5 times d) about 0·25 times

   e) about 1·25 times.

   ii) The property of a material, which enables it to resist fracture due to high impact load, is known as

   a) Elasticity b) Endurance

   c) Strength d) Resilience.

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iii) If a shaft made of ductile material is subjected to combined bending and twisting moments, which of the failure theory would give the conservative value ?

a) Maximum principal stress theory

b) Maximum shear stress theory

c) Maximum strain energy theory

d) Maximum distortion energy theory.

iv) When a helical compression spring is subjected to an axial compressive load, the stress induced in the wire is

a) tensile stress b) compressive stress

c) shear stress d) bending stress.

v) A bolt of M24 × 2 means that

a) the pitch of the thread is 24 mm and depth is 2 mm

b) cross-sectional area of the threads is 24 mm^2

c) the nominal diameter of bolt is 24 mm and pitch 2 mm

d) the effective diameter of the bolt is 24 mm and there are two threads per cm.

vi) Turn buckle has

a) right hand threads on both ends

b) left hand threads on both ends

c) left hand threads on one end and right hand threads on the other end

d) threads at the middle.

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vii) Endurance limit is determined by

a) the rotating beam method

b) static loading in universal testing machine

c) static loading in torsion testing machine

d) any one of these.

viii) Coupling and clutch connect two shaft

a) at rest

b) in motion

c) at rest and in motion respectively

d) all of these.

ix) When the possibility of misalignment between two shafts is nil or remote, the type of shaft coupling used is

a) flexible coupling b) gear coupling

c) rigid coupling d) universal coupling.

x) 'Nip' is a term related to design of

a) Helical spring b) Chain drive

c) Leaf-spring d) Belt drive.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

a) Explain the methods used to make the riveted joint leak proof.

b) Two plates of 10 mm thickness each are to be joined by means of a single riveted double strap butt joint. Determine the rivet diameter, rivet pitch, strap thickness and efficiency of the joint. Working stresses in tension and shearing as 80 MPa and 60 MPa respectively.

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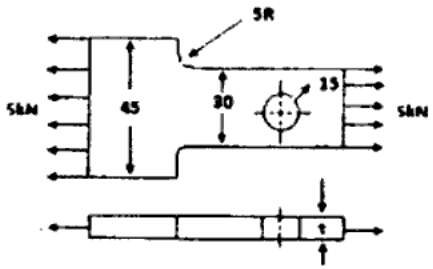
3. A steel shaft of yield strength 750 N/mm^2 is subjected to static load consisting of bending moment 10 kN-m and a torsional moment of 30 kN-m. Determine the diameter of the shaft using maximum shear stress theory. Assume a factor of safety is 2.

4. A flat plate subjected to a tensile force of 5 kN is shown in figure below. The plate material is grey cast iron FG200 and factor of safety is 2·5. Determine the thickness of the plate. Assume K_t = 1·8 corresponding to D/d = 1·5 and r/d = 0·167 and K_t = 2·16 corresponding to d/w = 0·5.



5. A helical spring is made from a wire of 6 mm diameter and has outside diameter of 75 mm. If the permissible shear stress is 350 MPa and modulus of rigidity 84 kN/mm^2, find the axial load which the spring can carry.

6. a) What is slip of the belt ? How is it related with the speed of the pulleys ?

   b) A flat belt is required to transmit 30 k W from a pulley of 1·5 m effective diameter running at 300 r.p.m. The angle of contact is spread over 11/24 of the

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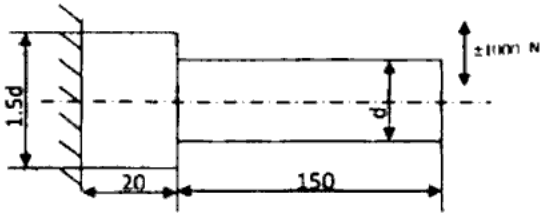
circumference. The coefficient of friction between the belt and pulley surface is 0·3. Determine, taking centrifugal tension into account, width of the belt required. It is given that the belt thickness is 9·5 mm, density of its material is 1100 kg/m^3 and related permissible working stress is 2·5 MPa. 2 + 3

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) A cantilever beam of circular cross-section as shown in the figure below is made of cold drawn steel having a surface finish factor of 0·78 and ultimate tensile strength of 540 MPa. The beam is subjected to completely reversed bending load of ± 1000 N. The fatigue stress concentration factor and the reliability factor are given as 1·2975 and 0·897 respectively. Determine the diameters of the beam for a life of 10,000 cycles.



   b) Briefly explain what are the meant by alignment and misalignment of the shaft. 12 + 3

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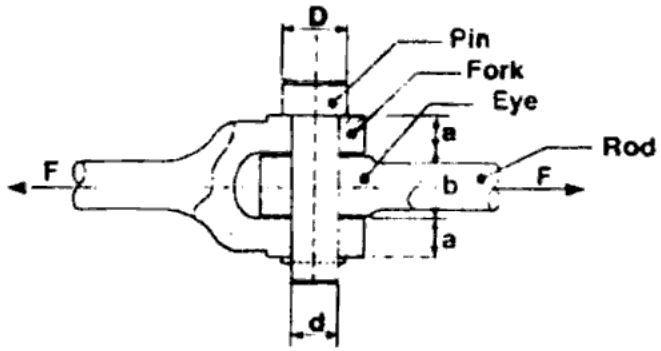
8. Design a screw jack for lifting a safe load of 150 kN through a maximum lift of 350 mm. The elastic strength of the material of the screw may be taken as 240 N/mm^2, in tension and compression and 160 N/mm^2 in shear. The nut is to be made of phosphor bronze for which the elastic strengths in tension, compression and shear are 130, 115 and 100 N/mm^2 respectively. Safe crushing stress for the material of the body is 100 N/mm^2. The coefficient of friction for the screw as well as collar may be taken as 0·15. The factor of safety for both screw and nut may be taken as 2. The design should include the design of (i) screw, (ii) nut and (iii) cup and handle. Also find out the efficiency of the screw jack.

You can take the help of the following standard chart for basic dimensions of the square threads in 'mm'.

Nominal diameter of bolt (mm)	40	42	44	46	48	50	52	55	58	60
Core diameter of bolt (mm)	33	35	37	38	40	42	44	46	49	51
Pitch of the bolt (mm)	7	7	7	8	8	8	8	9	9	9

9. a) It is required to design a Knuckle Joint as shown in figure below. The axial force acting on the rod is 15 kN. The fork, eye and the pin are made of plain carbon steel 30C8 with tensile yield strength of 400 N/mm^2. The

compressive yield strength is the same as that in tension. Shearing yield stress is 0·577 S_{yt}. Use a factor of safety 5 for all type of load.



b) Explain the methods used to make the riveted joint leak proof.

c) What do you mean by SURGING of spring and how can it be eliminated ? 9 + 3 + 3

10. Design the longitudinal joint for a boiler whose internal diameter is 2·4 m and is subjected to an internal pressure of 1 N/mm^2. The longitudinal joint is triple riveted butt joint with an efficiency of about 85%. The pitch in the outer rows of the rivets is to be double than that of the inner rows and with width of the cover plates to be unequal. The resistances of the rivets in double shear are taken as 1·875 times that of the single shear according to I.B.R. The allowable stresses are 77 N/mm^2 in tension, 56 N/mm^2 in shear. For longitudinal joint the pitch will be within $2d$ and

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