Q.1 Define Factor of Safety.

Ans: It is destined as the ratio of the maximum stress to the working stress mathematically

$$\text{Factor of safety} = \frac{\text{Maximum stress}}{\text{working or design stress}}$$

Q2. Define working stress

Ans: When designing machine parts, it is desirable to keep the stress linear than the maximum or ultimate stress at which failure of the material takes place. This stress is known as the working stress yield stress.

Q.3 Define strain energy and resilience -

Ans: Resilience → It is the property of a material used to store energy and to resist shock and impact loads.

Strain energy → It is the property of a material to resist fracture due to high impact loads like harmmer blows.

Q4. Name factors governing design of machine element

Ans: The factors which govern the design of machine element are cost, strength, stiffness, wear resistance light weight minimum dimensions realibility durability economy of performanance operation safty, ease of assembly, ease of similarity of service, easy in of materials appearance etc.

Q5. Define ultimate stress

Ans: It is defined as the largest stress obtained by dividing the largest value of the load reach in a test to the original cross-section area of the last piece, What do you mean by adaptive design: This type of design needs no skill. A designer of ordinary technical training can do this design. The designer makes slight modification in design of existing product.

Q6. What is yield point stress.

Ans: In case of ductile material thesttress corresponding to the yield point is called yield point stress. What is fatigue.

When a material is subjected to repeated stress it fails at stresses below yield point stress. Such type of failure of material is known as fatigue.

Q.8. Define hardness, briffeness toughness and creep

Ans: Hardness: It is that property of a material by virtue of which it can resist to wear scratch etc. It also means the ability of metal to cut another metal. Brittleness:- It is the property of a material opposite to ductility. It is the property of breaking of a material with little

III) **Creep:-** when a parft is subjected to a constant stress at high temperature for a long time, it will undergo a slow and permanent of deformation called creep

iv) **Machinability:-** It is the property of a material which resters to a relative case with which it can be cut.

v) **Malleabilituy:-** It is the property of a material which permits to be rolled or hammered into thin sheets or plates.

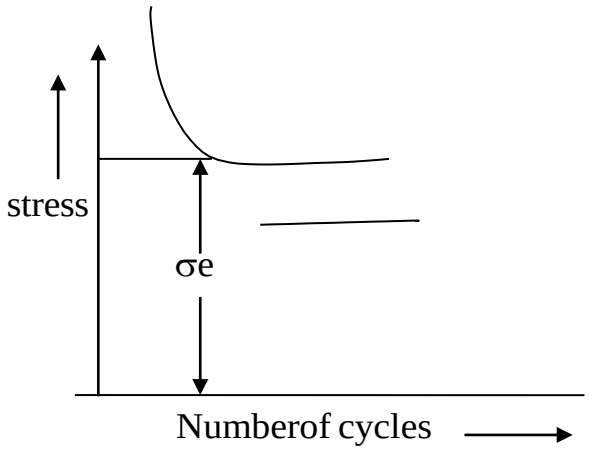
vi) **Stiffness:-** It is the ability of a material resist deformation under stress. The modulus at elasticity (E) is the measure of stiffness.

Q7. What is stress concentration.

Ans: Whenever a machine component changes the shape of its cross section, the simple stress distribution longer holds good and the neighbourhood of the discontinuity is different. This irregularity in the stress distribution caused by abrupt changes of form is called stress concentration.

08. Define endurance limit

Ans: It is defined as the maximum value of completely reversed bending stress which a polished standard specimen can with stand without failure for infinite number of cycles (10^7 cycles)



Q9. Describe design procedure

Ans:
i. Recognition of need or aim for which the machine is to be designed.
ii. Select the possible mechanism or group of mechanisms which will give the desired motion.
iii. Analysise the forces acting on each member of the machine and the energy transmitted by each member
iv. Select the material best suited for each member of the machine.
v. Design the machine elements i.e. size by considering the force or stress acting on them in such a way that each member should not deslect or destrom than the permissible limit.
vi. Modify the size of the member to facilitate ease of manufacturing cost optimization etc.

vii. Drow the detailed drowing of each element and the assembly of the machine with complete specification.

viii. As per drawing manufacture the product with the best suitable method.

Q10. State mechanical properties of material

Ans: **i. Strength** : It is the ability of a material to resist the externally applied forces without breaking or yielding.

ii. Elasticity: It is the ability of a material to regain its original shape after deformation when the external forces are removed. This property is desirable for materials used in tools and machines performance distortion cast iron is a brittle material.

Toughness: It is the property as a material to resist fracture due to high shock or impact loads like hammer blow. The toughness of the material decreases.

Creep: When a part is subjected to a constant stress at high temperature for a long time it will undergo a slow and permanent deformation called creep.

Q.11 What is Fatigue

Ans: When a material is subjected to repeated stresses, it fails at stresses below yield point stress, such type of failure of material is known as fatigue.

What do you mean by adaptive design.

This type of design needs no special knowledge or skill. A designer of ordinary technical training can do this design. In this type of design the designer makes slight modification in the design of existing product.

CHAPTER:2

QUESTIONS& ANSWER

Problem

A double riveted lap joint with chain riveting is to be made for allowable stresses are f_t = 60 MPa, f_s = 50Mpa and f_c = 80 Mpa. Find the rivet diameter pitch of rivet and distance between rows of rivet. 2015 (s), 4(c)

Given data :

t = 10 mm

f_t = 60 MPa =60 N/mm^2

f_s = 50 MPa = 50 N/mm^2

f_c = 80 MPa = 80 N/mm^2

Diameter of rivet: Since the thickness of plate is greater than 8 mm so diameter of rivet hole d = 6√t - 6√10 = 18.96 mm

The diameter of rivet hole , d = 19 mm corresponding to diameter of rivet of d = 18 mm

Problem:

A steam boiler is to be designed for a working pressure of 4N/mm^2 with a inside diameter of 160 cm. Give the design calculations for the circumferential joint for the following working stress for steel plates and rivets 2015(w),3(b)

In tension = 75 MPa

In shear = 60 MPa

In crushing = 125 MPa

Given data

P = 4N/mm^2

D = 160 cm = 1600 mm

$Б_t$ = 75 MPa = 75 N/mm^2

τ = 60 MPa = 60 N/mm^2

$Б_c$ = 125 MPa = 125 N/mm^2

Design of circumferential joint thickness of boiler shell (t)

Thickness of boiler shell t = $t = \frac{PD}{2\sigma_t} + 1mm$

$$= \frac{4 \times 1600}{2 \times 75} + 1mm = 53.6mm$$

Diameter of rivets

Since the curess of shell is greater than 8 mm so diameter of rivet d = $6\sqrt{t}=6\sqrt{53.6}=43.9$ mm

The diameter of rivet hole d = 44 mm

Corresponding to rivet dia of 43.9 mm

Number of rivets

Let n = Number of rivets

Shearing resistance of rivet = n × $\pi/4$ ××d^2

Total shearing load acting on the circumferential joint = $\pi/4 \times D^2 \times P$

Equating equation (i) and (ii) we get

$$n \times \frac{\pi}{4} \times d^2 \times \tau = \frac{\pi}{4} \times D^2 \times P$$

$$\Rightarrow n = \frac{D^2 P}{d^2 \times \tau} = \frac{(1600)^2 \times 4}{(44)^2 \times 60} = 88.15mm \text{ say } 89\,mm$$

Pitch of rivets

Assuming the joints to be double riveted lap joint with Zig-Zag riveting number of rivets per row 89/2 = 44.5 say 45

Pitch of rivets,

$$P_1 = \frac{\pi \times (D + t)}{\text{Number of rivets per row}}$$

$$= \frac{\pi(1600 + 53.6)}{45} = 115.4\,\text{mm say } 116\,\text{mm}$$

$$\frac{\text{Efficiency of Joint}}{\text{Efficiency of circumferential Joint}}$$

$$\eta_c = \frac{p_1 - d}{p_1} = \frac{116 - 44}{116} = 0.62 \text{ or } 62\%$$

$$\frac{\text{Distance between rows of rivets}}{\text{Distance between rows for zig} - \text{zag rivetting}}$$

$$= 0.33p_1 + 0.67 \times d = 0.33 \times 116 + 0.67 \times 44 = 67.76\,\text{mm say } 68\,\text{mm}$$

Margin

Margin, m = 1.5 d = 1.5 × 44 = 66 mm

Pitch of rivet (P)

Pitch of rivet is obtained by equating tearing resistance of plate to shearing resistance of rivet.

Tearing resistance of plate $P_t = (p - d) \times t \times f_t$

$= (p - 19) \times 10 \times 60$ N $= (p - 19) \times 600$ N.

Shearing resistance of rivet, $P_s = n \times \pi/4 \times d^2 \times f_s$

$= 2 \times \pi/4\ (19)^2 \times 50$ N = 28338.5 N

$$\text{or } p = \frac{28338.5}{600} 47.23 \text{mm}$$

Or p = 47.23 + 19 = 66.23 mm

According to I.B.R

Maximum pitch, P_{max} = c × t6 + 41.28 mm

=2.62 × 10 + 41.28 = 67.48 mm

Taking c = 2.62

Taking minimum value

Pitch, p = 66.23 mm

Distance between rows of rivet (p_b)

For chain riveting

P_d = 2d = 2 × 19 = 38 mm

Margin

M = 1.5 d = 1.5 × 19 = 28.5 mm

Failure of joint

Tearing resistance of plate, p_t = (p −d) × t × ft

= (66.23 − 19) × 10 × 60 N = 28338 N

Shearing resistance of rivet , $P_s = n \times \pi/4 \times d^2 \times f_s$

$= 2 \times \pi/4 \times (19)^2 \times 50$ N = 28338.5 N.

Crushing resistance of rivet $P_c = n \times d \times t \times f_c$

= 2 × 19 × 10 × 80 N = 30400 N

Strength of joint = least of p_t, p_s and p_c = 28338 N.

Strength of solid plate = $p \times t \times f_t$

$= 66.23 \times 10 \times 60$ N = 39738 N

Efficiency of joint, $\eta = \frac{\text{strength of joint}}{\text{strength of solid plate}} = \frac{28338}{29738} = 0.71 \text{ or } 71\%$

Q. Define pitch and diagonal pitch.

Ans: Pitch: It is the distance from centre of one rivet to the centre of next rivet measured parallel to seam. It is denote by 'p'

Diagonal pitch:- It is the distance between the centre of rivets in adjacent rows of zig-zag riveted joint, it is denoted by 'p_b'

Q. Write assumptions in design of pressure vessels.

i) The load on the joint is equally shared

ii) The tensile stress is equally distributed over the section of metal between rivets.

iii) The shearing stress of all rivets is uniform.

iv) the crushing stress is uniform.

v) There is no bending stress is rivets

vi) The friction between surface of plate is neglected.

Problem: A triple riveted lap joint with zig-zag riveting is to be designed to connect two plates of 6 mm thickness. Determine the diameter of rivet, pitch of rivet and distance between rows of rivet. Indicate how the joint will fail. Assume

$\sigma_t = 120$ MPa, $\tau = 100$ MPa and $\sigma_c = 150$ MPa 2014(w), 2(c)

Given data:

Thickness of plate, t = 6 mm

Permissible tensile stress, σ_t = 120 Mpa

Permissible shear stress, τ = 100 Mpa

Permissible crushing stress σ_c = 150 Mpa

Since thickness of plate is less than 8 mm so diameter of rivet hole is calculated by equating shearing resistance of rivet to crushing resistance of rivet. Since the joint is triple riveted lap joint and there are three rivets per pitch length so n = 3 is taken.

Shearing resistance of rivet

$$P_s = n \times \frac{\pi}{4} \times d^2 \times \tau = 3 \times \frac{\pi}{4} \times d^2 \times 100 N = 235.5 d^2 N.$$

Crushing resistance of rivet, $P_c = n \times d \times t \times \sigma_c$

$3 \times d \times 6 \times 150$ N = 2700 d N.

Taking $P_s = P_c$ we get

$235.5\ d^2 = 2700d$ or $d = 2700/235.5 = 11.5$ mm

The diameter of rivet hole d = 13 mm

Corresponding to diameter of rivet of Pitch of rivet.

Let P = Pitch of rivet

Tearing resistance of plate

$P_t = (p - d) \times t \times \sigma_t = (p - 13) \times 6 \times 120$ N $= (p - 13) \times 720$ N.

Shearing resistance of rivet

$P_s = n \times \pi/4 \times d^2 \times \tau = 3 \times \pi/4 \times (13)^2 \times 100$ N = 39799.5 N

Pitch of rivet is obtained by equating $p_t = p_s$

$\therefore (p - 13) \times 720 = 39799.5$

Or $p - 13 = \frac{39799.5}{720} = 55.28$

Or $p = 55.28 + 13 = 68.28$ mm

According to IBR, maximum pitch $P_{max} = c \times t + 41.28$ mm

For lap joint and 3 rivets per pitch length C = 3.47 is taken

$\therefore P_{max} = C \times t + 41.28$ mm $= 3.47 \times 6 + 41.28$ mm $= 20.82 + 41.28 = 62.1$ mm say 63 mm

Since P_{max} is less than p so pitch, $P = P_{max} = 63$ mm.

Distance between rows of rivet

Distance between rows of rivets for zig-zag riveting

$P_b = 0.33p + 0.67\ d$

$= 0.33 \times 63 + 0.67 \times 13 = 20.79 + 8.71 = 29.5$ mm

Q.7 How does a riveted Joint fail ? 2003 (3-a)

Ans: A riveted joint will fail due to following reasons.

i) Due to tearing of plate at an edge.

ii) Due to shearing of rivet.

iii) Due to crushing of rivet.

Q.8 State Types of welded joint 2010 (1-g), 2019-s-6-a,

Ans: Following two types of welded joint are important from the subject point of view

a) Lap joint or filled joint

b) bult joint

The bult joint may be

i) square bult joint

ii) single v – bult joint

iii) single U – bult joint

iv) Double V – bult joint

v) Double U bult joint

Problem:

A plate of 75mm width and 12.5 mm thick is joined with another plate by means of a single transverse and double parallel fillet weld. The maximum tensile and shear stress 70and 56 MPa respectively. Find the length of each parallel fillet weld joint as the joint is subjected to both static and fatigue load.

2018-W-2-c

Ans:

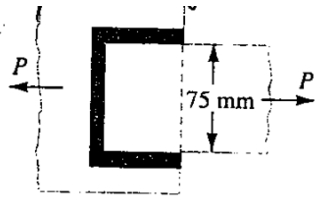


Fig. 10.15

Solution. Given : Width = 75 mm ; Thickness = 12.5 mm ; $\sigma_t = 70$ MPa = 70 N/mm^2 ; $\tau = 56$ MPa = 56 N/mm^2.

The effective length of weld (l_1) for the transverse weld may be obtained by subtracting 12.5 mm from the width of the plate.

$$\therefore \quad l_1 = 75 - 12.5 = 62.5 \text{ mm}$$

Length of each parallel fillet for static loading

Let l_2 = Length of each parallel fillet.

We know that the maximum load which the plate can carry is

$$P = \text{Area} \times \text{Stress} = 75 \times 12.5 \times 70 = 65\,625 \text{ N}$$

Load carried by single transverse weld,

$$P_1 = 0.707\, s \times l_1 \times \sigma_t = 0.707 \times 12.5 \times 62.5 \times 70 = 38\,664 \text{ N}$$

and the load carried by double parallel fillet weld,

$$P_2 = 1.414\, s \times l_2 \times \tau = 1.414 \times 12.5 \times l_2 \times 56 = 990\, l_2 \text{ N}$$

$\therefore$ Load carried by the joint (P),

$$65\,625 = P_1 + P_2 = 38\,664 + 990\, l_2 \quad \text{or} \quad l_2 = 27.2 \text{ mm}$$

Adding 12.5 mm for starting and stopping of weld run, we have

$$l_2 = 27.2 + 12.5 = 39.7 \text{ say } 40 \text{ mm Ans.}$$

Length of each parallel fillet for fatigue loading

From Data book, we find that the stress concentration factor for transverse welds is 1.5 and for parallel fillet welds is 2.7.

$\therefore$ Permissible tensile stress,

$$\sigma_t = 70 / 1.5 = 46.7 \text{ N/mm}^2$$

and permissible shear stress,

$$\tau = 56 / 2.7 = 20.74 \text{ N/mm}^2$$

Load carried by single transverse weld,

$$P_1 = 0.707\, s \times l_1 \times \sigma_t = 0.707 \times 12.5 \times 62.5 \times 46.7 = 25\,795 \text{ N}$$

and load carried by double parallel fillet weld,

$$P_2 = 1.414\, s \times l_2 \times \tau = 1.414 \times 12.5\, l_2 \times 20.74 = 366\, l_2 \text{ N}$$

$\therefore$ Load carried by the joint (P),

$$65\,625 = P_1 + P_2 = 25\,795 + 366\, l_2 \quad \text{or} \quad l_2 = 108.8 \text{ mm}$$

Adding 12.5 mm for starting and stopping of weld run, we have

$$l_2 = 108.8 + 12.5 = 121.3 \text{ mm Ans.}$$

Problem:

Two plates of 10 mm thickness each are to be joined by means of single riveted double strap bult joint. Determine the rivet diameter, rivet pitch, strap thickness and efficiency of Joint. Take the working stresses in tension and shearing as 80 MPa and 60 Mpa respectively. 2012(W). 3(c)

Given data:

Thickness of plate, t = 10 mm

Tensile, stress σ_t = 80 MPa = 80 N/mm^2

Shear stress, τ = 60 MPa = 60 N/mm^2

Diameter of rivet (d)

Since thickness of plate, is greater than 8 mm Diameter of rivet hole,

$d = 6\sqrt{t} = 6\sqrt{10} = 18.97$ mm

From design data Book

The standard diameter of rivet hole (d) is 19 mm corresponding to diameter of rivet 18 mm

Pitch of rivet (p)

Tearing resistance of plate, $P_t = (p - d) \times t \times \sigma_\tau$

$= (P - 19) \times 10 \times 80 = 800 (P - 19)$ N---------- (1)

Shearing resistance of rivet

$P_S = n \times 1.875 \times \pi/4 \times d^2 \times t$

$= 1 \times 1.875 \times \pi/4 \times (19)^2 \times 60 = 31,90$ N---------- (2)

Equating equation (1) and (2)

$800 (P - 19) = 31, 900 \Rightarrow P - 19 = 39.87 \Rightarrow P = 39.87 + 19 = 58.87$ say 60 mm

According to 1.3.2

The maximum pitch of rivet for double strap Joint the value C = 1.7.5

$P_{max} = 1.75 \times 10 + 41.28$ mm = 58.75 mm say 60 mm

$\therefore P = P_{max} = 60$ mm

THICKNESS OF COVER PLATE.

$T_1 = 0.625\ t = 0.625 \times 10 = 6.25$ mm

EFFICIENCY OF JOINT. TEARING RESISTANCE OF PLATE

$P_t = (p - d) \times t \times \sigma_t = (60 - 19) \times 10 \times 80 = 32, 800$ N

SHEARING RESISTANCE OF RIVET.

$P_S = n \times 1.875 \times \pi/4 \times d^2 \times \tau$

$= 1 \times 1.875 \times \pi/4 \times (19)^2 \times 60 = 31{,}900$ N

Strength of Joint = least of p_t and $p_S = 31{,}900$ N.

Strength of un riveted plate per pitch length , $P = P \times t \times \sigma_t = 60 \times 10 \times 800 = 48{,}000$ N

Efficiency of Joint, η = least of p_t of P_s/Strength of un riveted palte

= 31,900/48,000 = 0.665 or 66.5 %.

DETERMINE STRENGTH AND EFFICIENCY OF RIVETTED JOINT (2019-s-6-b)

TEARING OF PLATE

p = pitch of rivet

d = diameter of rivet hole

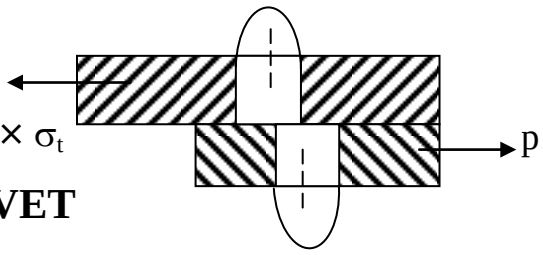
t = the cuver of plate

σ_t = permissible tensile strem for plate material

Tearing area per pitch length

$At = (p - d) \times t$

Tearing resistance, $p_t = At$, $\sigma_t = (p - d) \times t \times \sigma_t$



Shearing of rivet in lag joint

SHEARING RESISTANCE OF RIVET

Shearing area $A_s = \pi/4 \times d^2$

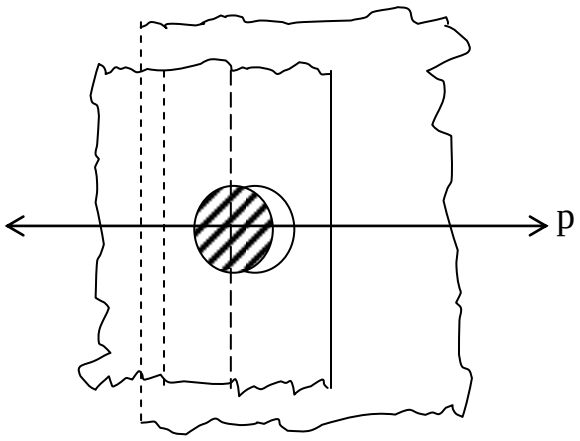
Shearing resistance $P_s = n \times \pi/4 \times d^2 \times \tau$

CRUSHING RESISTANCE OF RIVET

Crushing area per rivet

$A_C = d \cdot t$

Total crushing area = n.d.t.



Crushing resistance P_C = n.d.t. σ_C

Strength of joint is the maximum force which the joint can transmit with out failure

Strength o+f Joint = least of p_t, p_s or p_C

Efficiency of Joint it is the ratio of strength of joint to the strength of solid plate

$$\text{Efficiency of joint, } \eta = \frac{\text{Strength of joint}}{\text{Strength of solid plate}}$$

Q. Define pitch and diagonal pitch

Ans: Pitch: It is the distance from centre of one rivet to the centre of next rivet measured parallel to seam. It is denoted by 'P'

Diagonal pitch: It is the distance between the centres of rivets in adjacent rows of zig-zag riveted joint. It is denoted by 'Pb'

Q. Write assumption in design of pressure vessel

i. The load on the joint is equally shared by all rivets

ii. The tensile stress is equally distributed over the section of metal between rivets.

iii. The shearing stress of all rivets is uniform

iv. The crushing stress is uniform.

v. there is no bending stress in rivets.

vi. The friction between surface of plate is neglected.

CH-3

Design of Shafts & Keys

Short Questions & Answers

Q.1. What is the function of shafts ?

Ans. A shaft is a rotating machine element, which is used to transmit power from one place to another.

The power is delivered to the shaft by some tangential force and the resultant torque or twisting moment set up within the shaft permits the power to be transferred to various machines linked up to the shaft. In order to transfer the power from one shaft to another, the various members such as pulleys, geers etc are mounted on it.

Q.2. What is the difference between Shaft and Axle ?

Ans. Shaft :
- ✸ A shaft is a rotating machine element.
- ✸ A shaft is used for the transmission of twisting moment and Bending Moment.

Axle :
- ✸ An axle is a stationary machine element.
- ✸ An axle is used for the transmission of bending moment only.

Q.3. Write the designing shafts on the basis of strength ?

Ans. The designing shafts on the basis of strength are :
- ✸ Shaft subjected to shear stress or twisting moment or torque only.
- ✸ Shaft subjected to bending moment only.
- ✸ Shaft subjected to combined bending moment and twisting moment.

Q.4. Write the two theories for designing of shaft subjected to combined twisting moment and bending moment ?

Ans. The followng two theories are :
- ✸ Maximum shear stress theory or Guest's Theory. It is used for ductile matrial such as Mild Steel (M.S.)
- ✸ Maximum normal stress theory or Rankine's Theory. It is used for brittle material, such as Cast Iron (C.I.).

Q.5. Write the expression for equivlent twisting moment to evaluate the diameter of shaft ?

Ans. The expression is

$$Te : \sqrt{M^2 + T^2} = \frac{\pi}{16} T_{Max}.d^3$$

from the expression, the diameter of shaft may be evaluated. Where,

Te = Equivalent Twisting Moment. M = Bending Moment

T = Twisting Moment

d = diameter of shaft

Q.6. Write the expression for equivalent bending moment to evaluate the diameter of shaft ?

Ans. The expression is

$$Me = \frac{1}{2}\left[M + \sqrt{M^2 + T^2}\right] = \frac{\pi}{32}\ \sigma_b\ d^3$$

from this expression, the diameter of shaft may be evaluated.

Where, Me = equivalent bending moment.
M = Bending Moment
T = Twisting Moment
d = diameter of shaft.

Q.7. Write the expression for equivalent pending moment and twisting moment to calculate the diameter of Hollow Sfaft ?

Ans. In case of follow shaft,

$$Te = \sqrt{M^2 + T^2} = \frac{\pi}{16}\ \tau_{max}.do^3\ \ [I\text{-}K^4]$$

$$Me = \frac{1}{2}[M+\sqrt{M^2+T^2}] = \frac{\pi}{32}\ \sigma_b\ do^3\ [I\ -K^4]$$

Where, do = Outer diameter of Hollow Shaft
di = Inner diameter of Hollow Shaft.
$K = \frac{di}{do}$, σ_b = Bending Stress
τ max = Maximum shear stress.

It is suggested that, the diameter of shaft may be obtained by using both the theories and the larger of two values is adopted.

Q.8. What is the function of keys ?

Ans. A keys is a piece of MS inserted between the shaft and hub or boss of the pulley to connect together in order to prevent relative motion between them

Keys are used to temporary fastening and are subjected to crushing and shearing stresses.

Q.9. Write the types of keys ?

Ans. The following types of keys are :

- Sunk Keys
- Saddle Keys
- Tangest Keys
- Round Keys
- Splines.

Q.10. What is the efect of key ways ?

Ans. The effect of key ways are :

- To reduce a load carrying capacity of the shaft.
- To reduce the cross sectional area of the shaft i.e. torsioal strength of the shaft is reduced.

The following relation for the weakning effect of key ways is :

$$\boxed{e = 1 - 02\left(\frac{w}{d}\right) - 1.1\left(\frac{h}{d}\right)}$$

Where, e = Shaft strength factor

$$= \frac{\text{Strength of shaft with keyway}}{\text{Strength of shaft without keyway}}$$

W = Width of keyway

h = depth of keyway = $\frac{t}{2}$

t = thickness of keyway

d = diameter of shaft.

Long Questions :

Q.1. Derive the expression for shaft subjected to combined twisting moment and Bending Moment of (a) Solid Shaft (b) Hollow Shaft.

Q.2. Derive the expression for strength of sunk key ?

Q.3. A solid circular shaft is subjected to a bending moment of 3000 N-M and a torque of 10,000 N-M. The shaft is made of 45C8 steel having ultimate tensile stress of 400MPa and ultimate shear stress of 500MPa. Determine the diameter of the shaft. ?
Assume fos = 6.

Q.4. Compare the weight, strength and stiffness of Hollow Shaft of same external diameter as that of solid shaft. The inside diameter of Hollow shaft being half the external diameter. Both the shafts have the same material and length ?

Q.5. Design the rectangular key for a shaft of 50mm diameter. The shearing and crushing stress for the key material are 42MPa and 70MPa. ?

CH-4

Design of Coupling

Short Questions & Answers

Q.1. What do you mean by Coupling ?

Ans. A coupling is termed as a device used to make permanent or semi-permanent connection, where as a clutch permit rapid connection or disconnection at will of the operator.

Q.2. What is Shaft Coupling ?

Ans.
- To provide for the connection of shafts that are manufactured separately such as motor and generator.
- To provide for misalignment of the shaft or to introduce mechanical flexibility.
- To reduce the transmission of shock loads from one shaft to another.
- To introduce the protection against overloads.
- It should have no projecting parts.

Q.3. What are the requirements of a Good Shaft Coupling ?

Ans. The following requirements are :
- It should be easy to connect or disconnect.
- It should transmit the full power from one shaft to the other shaft without losses.
- It whould hold the shaft in perfect alignment.
- It should reduce the transmission of shock load from one shaft to another.
- It should have no projecting parts.

Q.4. Define Rigid Coupling ?

Ans. It is used to connect two shafts which are perfectly aligned.

The following types of Rigid Coupling are :
- Sleeve or Mulf Coupling.
- Clamp or Split-Muff or Compression Coupling.
- Flange Coupling.

Q.5. Define Flexible Coupling ?

Ans. It is used to connect two shafts having both lateral and angular misalignment.

The following types of Flexible Coupling are :
- Bushed Pin Type Coupling
- Universal Coupling
- Oldham Coupling

Long Questions :

Q.1. Write the design procedure of Sluve or Muff Coupling with neat sketch.

Q.2. With neat sketch, write the design procedure of Clamp or Compression Coupling.

Q.3. Design a Muff Coupling to connect two shafts transmitting 40KW at 120 r.p.m. The permissible shear stress and crushing stress for the shaft and Key Material((M.S) are 30MPa and 80MPa respectively. The matrial of Muff is cast iron with permissible shear stress of 15MPa. Assume that the maximum torque transmitted is 25% greater than mean torque.

Q.4. Design a compression coupling for a shaft to trensmit 1300N-M. The allowable shear stress for the shaft and key is 40MPa and the number of botts connecting the two halves are 4. The permissible tensile stress for the bott material is 70MPa. The co-efficient of froction between the Muff and the Shaft surface may be taken as 0.3.

CH-5

Design a Closed Coil Helical Spring

Short Questions & Answers

Q.1. Define Spring ?

Ans. A spring is defened as an elastic body, whose function is to distort when loaded and to recover its original shape, when the load is removed.

Q.2. Define Helical Spring ?

Ans. The helical spring are made up of a wire coiled in the form of a helix and primarily intended for compressive or tensile loads. The cross sectin of the wire for which the spring made may be circular, square or reatangular.

Q.3. Define Solid Length of Spring ?

Ans. When the compression spring is compressed. Until the coils come in contact with each other, then spring is called to be solid. The solid length of a spring is the product of total number of coils and the diameter of the wire.

$\boxed{Ls = n^1 \times d}$ where, n^1 = total number of coils
d = diameter of wire
Ls = Solid Length of Spring.

Q.4. Define Spring Index and Spring Rate ?

Ans. **Spring Index :** It is defined as the ratio of mean diameter of coil to the diameter of wire.

Mathematically, $\boxed{C = \frac{D}{d}}$ Where, C = Spring Index
D = Mean diameter of Coil
d = diameter of wire.

Spring Rate : The Spring Rate or Stiffiness or Spring Constant is defined as the load required per unit deflection of the spring.

Mathematically, $\boxed{K = \frac{W}{\delta}}$ Where, W = Load
δ = deflection of the spring

Q.5. What are the methods to eliminate Surge in Spring ?

Ans. The following methods are :

- By using friction dampers on the centre coil, so that wave propagation dies out.
- By using spring of high natural frequency.
- By using spring having pitch of the coils near the ends different than at the to have different natural frequencies.

Long Questions :

Q.1. Briefly explain Surge in Springs ?

Q.2 Derive Stresses in Helical Springs of Circular Wire ?

Q.3. A Helical spring is made from a wire of 6mm diameter and has outside diameter of 75mm. If the permissible sheer stress is 350MPa and modulus of regidity is 84KM/mm^2. Find the axial oad which the spring can carry and the deflection per active turn ?

Q.4. Design a spring for a balance to measure 0 to 1000N over the length of 80mm. The spring is to be enclosed in a casing of 25mm diameter. The approximate number of turns is 30. The modules of regidity is 85KN/m^2. Also calculate the maximum shear stress induced ?

Q.5. Design a closed helical compression for a service load rasging from 2250N to 2750N. The axial deflection of the spring for the load range is 6mm. Assume a spring Index of 5. The permissible shear stress is 420MPa and modulus of rigidity is 84KN/mm^2. Neglect the effect of stress concentration ?