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State four important modes of gear failure.

Modes of Gear Failure: ANY 4 modes 1. Bending failure. Every gear tooth acts as a cantilever. If the total repetitive dynamic load acting on the gear tooth is greater than the beam strength of the gear tooth, then the gear tooth will fail in bending, 2. Pitting. It is the surface fatigue failure which occurs due to many repetition of Hertz contactstresses. 3. Scoring. The excessive heat is generated when there is an excessive surface pressure, high speed or supply of lubricant fails. 4. Abrasive wear.

Write the equation with Wahl’s factor, used for design of helical coil spring. State the SI unit of each term in the equation

Wahl’s Factor Equation:

$$K = \frac{4C - 1}{4C - 4} + \frac{0.615}{C}$$

S.I unit of Each Term:

C: Spring Index Unit: it is constant unit less term

State four examples of ergonomic considerations in the

design of a lathe machine.

Ergonomics consideration in the design of Lathe machine Any 4 1) The controls on lathe should be easily accessible and properly positioned. 2) the control operation should involve minimum motions. 3) Height of lathe should be match with worker for operation 4)Lathe machine should make less noise during operation. 5) force& power capacity required in turning the wheel as per operation or human being can apply normally. 6) should get required accuracy in operation.

Write the design procedure of knuckle joint.

Design of Knuckle joint Failure of rod in tension

Rod may fail in tension due to tensile load

Tensile strength of rod , P = $\frac{\pi}{4}xd^2x\sigma_t$

From this equation diameter of rod may obtained

Diameter of knuckle pin in shearing

Since the pin is in double shear, Shearing strength of pin P = $\frac{\pi}{4}$ $xd1^2$ $x\sigma_t$

Value of d_1 can be found here d_1=d

Fix the dimensions using empirical relations;

Dia. Of pin = d_1 =d

Outer dia. Of single or double eye = d_2 =2d

Dia. Of knuckle pin head and collar =d_3 = 1.5d

Thickness of single eye = t = 1.25d

Thickness of fork =t_1 = 0.75d

Thickness of collar pin =t_2 = 0.5d

Checking the failure of single eye in tension

σ_t = p/(d_2-d_1) x t

Checking the failure of single eye in crushing

σ_{ck} = p/d_1 x t

Checking the failure of single eye in shear

τ = p/(d_2-d_1) x t

Checking the failure of double eye in tension

σ_t= p/2(d_2-d_1) x t_1

Checking the failure of double eye in crushing

σ_c= p/2d_1 x t_1 Checking the failure of double eye in shear

τ = p/2(d_2-d_1) x t_1

Prove that for a square key sc = 2t where sc = crushing stress t = shear stress.

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 = lxw x 6s

Torque transmitted by the shaft , T = F X d/2 = lxw x 6s x d/2

Consider crushing of key, the tangential crushing force acting at the circumference of the shaft ,F = Area resisting crushing x crushing stress = lxt/2 x 6c

Torque transmitted by the shaft , T = F X d/2 = lxt/2 x 6c X d/2

The key is equally strong in shearing and crushing ,if

lxw x 6s x d/2= lxt/2 x σ_cX d/2

w/t =6c/2 τ

σ_c=2τ

Explain why bolts of uniform strength are preferred. Draw sketches of two different types of bolts of uniform strength

bolts of uniform strength: if a shank dia.is reduced to a core dia.as shown in fig. the stress become same through out the length of the bolt. Hence impact energy is distributed uniformly throughout the bolt length, thus relieving the threaded portion of high stress. The bolt in this way becomes stronger and lighter. This type of bolt is known as bolt of uniform strength.Another method of obtaining the bolt of uniform strength is shown in fig.in this method, instead of reducing the shank dia.an axial hole is drilled through the head down to

State the ‘Lewis equation’ for spur gear design. State SI unit of each term in the equation.

Lewis equation: WT = σw.b.π.m.y, WT= Tangential load acting at the tooth in N σw= bending stress in N/mm2 b= width of the gear face in mm m= module in mm y= lewis form factor.

Design single cotter joint to transmit 200 kN. Allowable stresses for the material are 75 MPa in tension and 50 MPa in shear.

Given : Load 200 KN= 200000N

σ_t =75 MPa, τ= 50 MPa

(i) **Dia of rod** $P = \pi/4 \times d^2 \times \sigma t$

$200000 = 0.7854 x\, d^2 \times 75$

d = 58.27mm say 60 mm

failure of spigot in tension across the slot

$p = \pi/4\,(d_2)^2 - d_2 x t$

200000 = 0.7854 xd2xd2 – d2x d2/4, $t = d_2/4 = 60/4 = 15$

$D_2^2 = 200000/(0.7854-0.25) x\ 75$

D_2 =70.58mm

Failure of spigot end in shear , P= 2Xaxd2x6s

200000 =2xax70.58x 50

a= 28.33mm

Failure of spigot collar in shear $P = \pi\, d_2 x\ t1\ x\ \tau$

200000 = 3.142x 70.58xt1x 50

t1= 18.03mm

failure of socket in tension across the slot, $P = \pi/4(d^2{}_1 - d^2{}_2) - (d_1 - d_2) x\ t\ x\ \sigma_t$

$d_1 x d_1$ -19.09d1-7028.85 =0

solving by quadratic eq. method

d_1= - (19.09)+- (-19,09x19.09- 4 x1x 7028.85)1/2/2

d_1 =84.925mm

failure of cotter in shearing P= 2xbxtxτ

200000= 2xbx15x50

b =133.33mm

State the composition of the materials 30 Ni 16 Cr5, 40C8,

FeE230 X15Cr25Ni 12

30 Ni 16 Cr5 : alloy steel carbon 0.3% of average, Nickel 16%, chromium 5% 40C8 : Plain carbon steel carbon 0.4% of average, manganese 0.8% FeE230 : Steel with yield strength of 230N/mm2

X15Cr25Ni12 : high alloy steel carbon 0.15% of average, chromium 25%, Nickel 12%,

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State two applications each of cotter joint and knuckle joint.

Applications of cotter joint: cotter foundation bolt, big end of the connecting rod of a steam engine, joining piston rod with cross head, joining two rods with a pipe Applications of knuckle joint: link of bicycle chain, tie bar of roof truss, link of suspension bridge, valve mechanism, fulcrum of lever, joint for rail shifting mechanism

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