Sheet (3)

Key and coupling

1)

Design the rectangular key for a shaft of 50 mm diameter . The shearing and crushing stresses for the key material are 42Mpa and 70 Mpa

Solution

Given :D=50mm , τ = 42MPa , σ_c=70 Mpa , w =16mm, t = 10mm

For calculating torque transmitted:-

T=l*w*τ*$\frac{d}{2}$ = l *16*42*$\frac{50}{2}$=16800 N-mm (1)

Torsional shearing strength :-

T=$\frac{\pi}{16}$*τ*d^3*= $\frac{\pi}{16}$*42*(50)^3=1.03*10^6 N-mm (2)

∴from equation (1),(2)

L=1.013*10^6 /16800=61.31 mm

T=l*$\frac{t}{2}$*σ_c*$\frac{d}{2}$= l *$\frac{10}{2}$*70*$\frac{50}{2}$=8750 /N-mm (3)

From equations (2) and (3):-

L=1.03*10^6/8750 =117.7 mm ≈120 mm

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2) A 45mm diameter shaft is made of steel with a yield strength of 400 Mpa . A parallel key of size 14mm wide and 9mm thick made of steel with a yield strength of 340 Mpa is to be used . Find the required length of the key . if the shaft is loaded to transmit the maximum permissible torque . use maximum shear stress theory and assume a factor of safety of 2.

Solution

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3) A 15KW , 960 R.P.M motor has a mild steel shaft of 40mm diameter and the extension being 75mm. The permissible shear and crushing stresses for the mild steel key are 56 Mpa and 112 Mpa. Design the keyway in the motor shaft extension . Check the shear strength of the key against the normal strength of the shaft .

Solution

Given:P=15KW=15*10^{3}w , N=960 R.P.M , d=40mm , l=75mm , τ=56Mpa , σ_c=112Mpa

The torque transmitted by the motor :-

T=$\frac{P*60}{2\pi N}$=$\frac{15*10^3*60}{2*\pi*960}$=149*10^3 N-mm

W=width of the key

Considering the torque in shearing , we know that the torque transmitted (T) :-

149*10^3=l*w*τ*$\frac{d}{2}$= 75*w*56*$\frac{40}{2}$=84*10^3 w

W=149*10^3/84*10^3=1.8mm

The width of keyway is too small , the width of keyway should be at least d/4

$\frac{d}{4}$=$\frac{40}{4}$=10mm

Since σ_c=2τ therefore the a square key of w =10mm and t =10mm is adopted according to H.F.Moore

the shaft strength factor ,

e=1-0.2($\frac{w}{d}$)-1.1($\frac{h}{d}$)= 1-0.2($\frac{10}{20}$) − ($\frac{10}{2*40}$)=0.8125

strength of the shaft with keyway,

=$\frac{\pi}{16}$*τ*d^3*e=$\frac{\pi}{16}$ ∗ 56(40)^{3}0.8125=571844 N

And shear strength of the key ,

L*w*τ*$\frac{d}{2}$ =75*10*56*20=840000 N

$$\frac{\text{Shear strength of the key}}{\text{Shear strength of the shaft}} = \frac{840000}{571844} = 1.47$$
