Problem of Practices
on
Mechanical Engineering Design
Chapter-16 Clutches & Brakes

Prepared By

Brij Bhooshan
Asst. Professor
B. S. A. College of Engg. And Technology
Mathura, Uttar Pradesh, (India)

Supported By:
Purvi Bhooshan

Please welcome for any correction or misprint in the entire manuscript and your valuable suggestions kindly mail us *brijrbedu@gmail.com* or *brijbhooshanin@gmail.com*.

1. A single-plate clutch has an inner diameter d and outer diameter D. The pressure distribution between the contact surfaces is given by

$$P = A + \frac{B}{r}$$

where r is the distance from the centre of the disc and A and B are constants. Determine the torque that can be transmitted by a single-plate clutch and the axial thrust. Suggest how A and B may be determined.

2. A car has a three cylinder engine which produces maximum torque of 200 N-m at 2000 rpm. The power is transmitted by a single plate friction clutch of 230 mm outside diameter. Design dimensions of friction surfaces. Further when the car is engaged at a speed of 60 km/hr, calculate the clutch slip period (time) during engagement. Additional data as under:

(i) Engine speed at beginning of clutch engagement: 2000 rpm
(ii) Engine torque at engagement: 100 N-m
(iii) Mass of car (loaded): 1500 kg
(iv) Wheel diameter: 710 mm
(v) Coefficient of friction: 0.3

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(vi) Permissible pressure for friction material: 0.25 N/mm^2
(vii) Mass moment of inertia of engine rotating parts, flywheel and driving side of clutch 1.5 kg-m^2
(viii) Gear reduction at differential: 4.12
(ix) Torque available at the rear wheels: 105 N-m

Uniform wear theory may be used for the clutch plate design.

3. A centrifugal clutch with four shoes is used to transmit 15 kW to 720 r.p.m. The speed at which engagement begins is 80% of full speed. The inside diameter of the drum is 325 mm and outside diameter of the drum is 350 mm. The radial distance of C.G. of each shoe from the axis of shaft is 120 mm. The radial clearance between the shoe and the rim is 10 mm. The pressure exerted on the shoe during engagement is 0.1 MPa. The coefficient of friction between shoe lining and the drum is taken as 0.25. Determine:

(i) Mass of each shoe.
(ii) Size of the shoe if the angle subtended by shoe at centre is 60°.

Also design the helical spring used in the shoes taking the safe shear stress of spring material as 600 MPa and modulus of rigidity of the material as 80 kN/mm^2. Use the spring index of 6.

4. A single plate clutch is designed to transmit 10 kW power at 2000 rpm. The equivalent mass and radius of gyration of the input shaft are 20 kg and 75 mm respectively. The equivalent mass and radius of gyration of the output shaft are 35 kg and 125 mm respectively. Calculate:

(i) the time required to bring the output shaft to the rated speed from rest; and
(ii) the heat generated during the clutching operation.

5. Differentiate between uniform pressure and uniform wear theory. What would you conclude, about the effect over friction radius, under following two conditions of operation of a clutch, considering uniform pressure theory and uniform wear theory in both the conditions.

(i) Outer Radius – 100 mm
Inner Radius – 90 mm
(ii) Outer Radius – 100 mm
Inner Radius – 25 mm

6. A single-plate clutch is used to rotate a machine from a shaft rotating at a uniform speed of 300 rpm. Both sides of the clutch are effective, friction lining is of 140 mm inner diameter and 220 mm outer diameter, respectively. The coefficient of friction between friction lining and flywheel surface is 0.28. Assuming uniform wear theory for clutch and maximum intensity of pressure 0.1 MPa, determine the time required to attain full speed by the machine if moment of inertia of the rotating parts is 7.2 kg-m^2. How much energy has been lost during slipping of the clutch?

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