Department of Mechanical Engineering

MD – II: Tutorial sheet for springs, Flat and V - Belt

1. In an automotive plate clutch, six helical compression springs arranged in parallel, provide the axial thrust of 1500 N. The springs are compressed by 10 mm to provide this thrust force. The springs are identical and the spring index is 6. The springs are made of cold drawn steel wires with ultimate tensile strength of 1200 MPa. The permissible shear stress for spring wires may be taken as 50% of the ultimate tensile strength (G = 81370 MPa). Springs have square and ground ends. There should be a gap of 1 mm between adjacent coils when the springs are subjected to maximum force. Design the springs and calculate: (i) wire diameter (ii) mean coil diameter (iii) number of active coils (iv) total number of coils (v) solid length (vi) free length (vii) required spring rate and (viii) actual spring rate (Ans: 3 mm; 18 mm; 6; 8; 24 mm; 41.62 mm; 25 N/mm; 23.54 N/mm)

2. A safety valve, 40 mm in diameter is to blow off at a pressure of 1.2 MPa. It is held on its seat by means of helical compression spring with initial compression of 20 mm. The maximum lift of the valve is 12 mm. The spring index is 6. The spring is made of cold drawn steel wire with ultimate tensile strength of 1400 MPa. The permissible shear strength can be taken as 50% of this strength. Modulus of rigidity is 81370 MPa. Calculate: (i) wire diameter (ii) mean coil diameter and (iii) number of active. (Ans: 8.12 or 9 mm; 54 mm; 6)

3. A composite spring has two closed coil helical springs. Outer spring is 15 mm larger than inner spring. Outer spring has 10 coils of mean diameter 40 mm and wire diameter 5 mm. Inner spring has 8 coils of mean diameter 30 mm and wire diameter 4 mm. When the spring is subjected to an axial load of 400 N, calculate: (i) compression of each spring (ii) load shared by each spring and (iii) shear stress induced in each spring. Assume G = 84 GPa. (Ans: 154 N; 135 N and 110 N; 192 MPa; 255 MPa)

4. A helical compression spring of a mechanism is subjected to an initial preload of 50 N and the maximum force during the load cycle is 300 N. The wire diameter is 5 mm while the spring index is 5. The spring is made of oil-hardened and tempered steel wire of Grade- SW (σ_u = 1440 MPa). Determine factor of safety against fluctuating stresses. (Ans: 1.82)

5. The layout of leather belt drive transmitting 15 kW power is shown in figure. The centre distance between pulleys is twice the diameter of bigger pulley. The belt should operate at a velocity of 20 m/sec approximately and stress in the belt should not exceed 2.25 MPa. Density of leather is 950 kg/m3 and coefficient of friction is 0.35. The thickness of belt is 5 mm. Calculate: (i) diameters of pulleys (ii) length and width of belt and (iii) belt tensions. (Ans: 270 mm and 810 mm; 4.9 m and 130 mm; 1429 N and 692 N)

6. A rope drive transmits 600 kW from a pulley of effective diameter 4 m that runs at a speed of 90 rpm. The angle of lap is 160° and angle of groove is 45°. Coefficient of friction is 0.28. The mass of rope is 1.5 kg/m and allowable tension in each rope is 2400 N. Find number of ropes required. (Ans: 20)

7. Power is transmitted by an open belt drive from a pulley 300 mm diameter running at 200 rpm to a pulley 500 mm in diameter. Angle of lap on smaller pulley is 160°. The belt is on the point of slipping when 3.5 hp is being transmitted. Coefficient of friction is 0.25. It is desired to increase the horse power to be transmitted. Which of the following two methods would be more effective: (i) initial tension in the belt is increased by 10% (ii) suitable dressing is given to the friction surface to increase its Coefficient of friction by 10%.

8. It is required to select a flat belt drive for a fan running at 720rpm which is driven by a 25 kW, 1440 rpm motor. Space is available for a centre distance of 3 m. The belt is open type. (Ans: 5 ply HI-speed belt, 152 mm wide; length = 7181 mm)

9. A V-belt drive is required for a 15 kW 1440 rpm electric motor that drives a centrifugal pump running at 360 rpm for a service of 24 hrs/day. From space considerations, the centre distance is approximately 1 m. Determine: (i) belt specifications (ii) number of belts (iii) correct centre distance and (iv) pulley diameters. (Ans: B3600 L_p; 3 belts; 968.12 mm; 200 and 800 mm)

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