SNS COLLEGE OF TECHNOLOGY

16ME207- STRENGTH OF MATERIALS

UNIT II - TORSION AND SPRINGS

Strain energy in Torsion

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Strain energy in Torsion

When a body will be loaded then there will be deformation in the body and due to this deformation, energy will be stored in the body and that energy will be termed as strain.

Problems

A weight of 200 N is dropped on to a helical spring made of 15 mm wire closely coiled to a mean diameter of 120 mm with 20 coils. Determine the height of drop if the instantaneous compression is 80 mm. Assume: C = 84 GN/m2.

Solution :-

Given Data :-

Magnitude of falling weight, $W = 200N$

Diameter of wire, $d = 15mm$ (or) $0.015m$.

Mean diameter of Coils, $D = 120mm$ (or) $0.12m$.

Number of Coils, $n = 20$

Instantaneous Compression, $\delta = 80mm$ (or) $0.08m$.

$C = 84 GN/m^2$.

Height of drop, h :-

Using the relation, $\delta = \frac{64WR^3n}{Cd^4}$, we have.

$$0.08 = \frac{64W \times (0.06)^3 \times 20}{84 \times 10^9 \times (0.015)^4}$$

$$W = \frac{0.08 \times 84 \times 10^9 \times (0.015)^4}{64 \times (0.06)^3 \times 20} = 1230N$$

$$\boxed{W = 1230N}$$

(Where, W = gradually applied load).

Also, energy supplied by the impact load = Energy stored.

$$P(h + \delta) = \frac{1}{2} W\delta$$

$$200(h + 0.08) = \frac{1}{2} \times 1230 \times 0.08$$

$$h + 0.08 = 0.246.$$

$$h = 0.166m \text{ (or) } 166mm.$$

$$\boxed{h = 0.166m \text{ (or) } 166mm.}$$

Problems

For a close-coiled helical spring subjected to an axial load of 300 N having 12 coils of wire diameter of 16 mm, and made with coil diameter of 250 mm, find A)Axial deflection;B) Strain energy stored;C) Maximum torsional shear stress in the wire;D) Maximum shear stress using Wahl's correction factor. C = 80 GN/m2.

Solution :-

Given Data :-

Number of coils, $n = 12$ Coils.

Wire diameter, $d = 16\,mm = 0.016\,m$.

Coil diameter, $D = 250\,mm = 0.25\,m$.

Modulus of Rigidity, $C = 80\,GN/m^2$.

Axial load, $W = 300\,N$.

Axial deflection :- δ,

$$\delta = \frac{64WR^3n}{Cd^4} = \frac{64 \times 300 \times (0.25/2)^3 \times 12}{80 \times 10^9 \times (0.016)^4}$$

$$\boxed{\delta = 0.0858\,m \text{ (or) } 85.8\,mm}$$

Strain Energy Stored, U :-

$$U = \frac{1}{2} W\delta = \frac{1}{2} \times 300 \times 0.0858$$

$$\boxed{U = 12.87\,Nm}$$

Maximum Torsional Shear Stress, τ :-

$$\tau = \frac{16WR}{\pi d^3} = \frac{16 \times 300 \times (0.25/2)}{\pi \times (0.016)^3} \times 10^{-6}\,MN/m^2$$

$$\tau = 46.63\,MN/m^2.$$

$$\boxed{\tau = 46.63\,MN/m^2}$$

Problems

Maximum Shear Stress using Whal's factor:-

$$\tau = \frac{16WR}{\pi d^3} \times K$$

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

But S(Spring Index) $= \frac{D}{d} = \frac{250}{16} = 15.625$

$$K = \frac{4 \times 15.625 - 1}{4 \times 15.625 - 4} + \frac{0.615}{15.625}$$

$$= 1.0513 + 0.0394 = 1.0907$$

$$\tau = \frac{16 \times 300 \times (0.25/2)}{\pi \times (0.016)^3} \times 1.0907 \times 10^{-6} \, MN/m^2$$

$$\boxed{\tau = 50.85 \, MN/m^2}$$