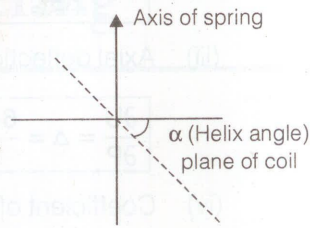
10. SPRINGS

Spring are used to absorb energy and restore it slowly or rapidly.

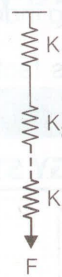
TYPE OF SPRING ON THE BASIS OF HELIX ANGLE

- If helix angle is ***less than*** or ***equal*** to 10° then it is called closed coil spring.
- If helix angle is ***greater than*** 10° then it is called open coil spring.
- The best form of spring absorbs ***greatest amount*** of energy for a given stress.
- Spring stores energy in the form of ***resilience***.

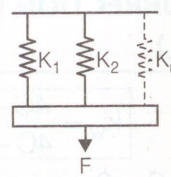


SERIES AND PARALLEL ARRANGEMENT OF SPRINGS/ EQUIVALENT SPRING CONSTANT (k_{eq})

- In Series: $\frac{1}{k_{eq}} = \frac{1}{k_1} + \frac{1}{k_2} + \cdots \frac{1}{k_n}$



- In parallel: $k_{eq} = k_1 + k_2 + \cdots k_n$



- Stiffness of spring is inversely proportional to number of coils in the spring. Therefore when a spring is cut into two parts its stiffness become ***double*** for every ***individual*** part.
- Springs are added just like as capacitors in electronics. Both does the same work i.e., absorbs energy.

CLOSED COIL HELICAL SPRING UNDER AXIAL PULL

(i) $$\tau_{max} = \frac{16PR}{\pi d^3}$$

(ii) Strain energy stored in spring

$$U = \frac{T^2L}{2GI_P} = \frac{32P^2R^3n}{Gd^4}$$

(iii) Axial deflection under load P

$$\frac{\partial U}{\partial P} = \Delta = \frac{64PR^3n}{Gd^4}$$

(iv) Coefficient of stiffness of spring (k)

$$k = \frac{P}{\Delta} = \frac{Gd^4}{64R^3n} \qquad k \propto \frac{1}{n}$$

Spring index (C) = $\frac{D}{d}$

Wahl's factor is considered to consider the effect of direct shear stress and curvature effect.

STRAIN ENERGY STORED IN SPRING (U)

$$U = \frac{1}{2} T \cdot \theta$$

T = torque applied

θ = angular deflection

WAHL'S CORRECTION FACTOR (k_w)/STRESS CONCENTRATION FACTOR (k_c)

$$k_w = \frac{4C-1}{4C-4} + \frac{0.615}{C} \qquad k_c = \frac{4C-1}{4C-4}$$

Here, C = Spring index

The ***average*** value of modulus of rigidity for ***steel*** used for spring equal to ***79300 MPa.***

Shot peening, result in raising the ***fatigue*** life of spring because it leave the surface in compression.

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