**SPRINGS**

**Spring:** Device for storing energy (strain energy) and releases back whenever it’s required.

Springs are design to have **high resilience**. Eg. Shock Absorbers, Spring Matters, Spring Balance.

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| **Helical Springs** | |
| **Open Coil Helical Springs** | **Closed Coil Helical Springs** |
| Compression Springs | Expansion Spring |
| Eg. Ball Point Pen, Shock Absorber | Eg. Bike Stands |
| Helix Angle (α) More | Helix Angle (α) Less |
| Effect is present due to bending and torsion effect | Effect is present due to torsion effect |

**Closed Coil Helical Springs:**

**Assumptions:** 1) Stress developed in the spring is pure shear

2) Axial force in wire is ignored.

3) Bending Couple is ignored.

τmax = [(8WD)/πd3] \* [1+1/(2C)]

If D >>> d, τmax = (8WD) / πd3

For Safety Condition, τmax ≤ τallowable

δ = θ \* D/2

θ = TL/GJ = 16 WnD2 / (Gd4)

Kspring = W/ δ = Gd4 / (8nD3)

Where, d = Wire Diameter,

D = Coil Diameter,

N = number of active turns in coil,

C = D/d = Spring Index,

θ = Angle of twist in wire cross section,

Kspring = Spring Stiffness,

δ = Deflection in spring.

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| **Springs In Series** | **Springs In Parallel** |
| δeq = δ1 + δ2 | δeq = δ1 = δ2 |
| Peq = P1 = P2 | Peq = P1 + P2 |
| Keq = K1K2 / (K1+K2) | Keq = K1+K2 |

**Laminated / Leaf Springs: (Rarely Asked Question)**

**Leaf/Laminated Spring:** It Consist of no. of parallel strips of a metal having **different length** and **same width & thickness** place one above the other and act as beam. It works on concept of beam of uniform strength.

Applied Bending moment = Total Resisting bending moment be “n” Springs.

(W/2) (L/2) = σmaxnbt2/6 ===> σmax = (3/2) WL / (nbt2) ≤ σallowable (For Safety condition)

Where, L = Span of Spring,

b = Width of plate

t = thickness of plate

σmax = Maximum Stress developed in each plate

n = number of plates

Central deflection, δ= L2 / 8R = L2 σmax / (Ey) = (3/8) WL3 / (nbt3 E) (From Flexure Formula)