HELICAL SPRING

Unit 3

WHAT IS SPRING?

- Springs are elastic bodies (generally metal) that can be twisted, pulled, or stretched by some force. They can return to their original shape when the force is released.
- In other words it is also termed as a resilient member.

CLASSIFICATION OF SPRINGS

1) Helical springs:
    a) Tension helical spring
    b) Compression helical spring
    c) Torsion spring
    d) Spiral spring

2) Leaf springs

HELICAL SPRING CLASSIFICATION

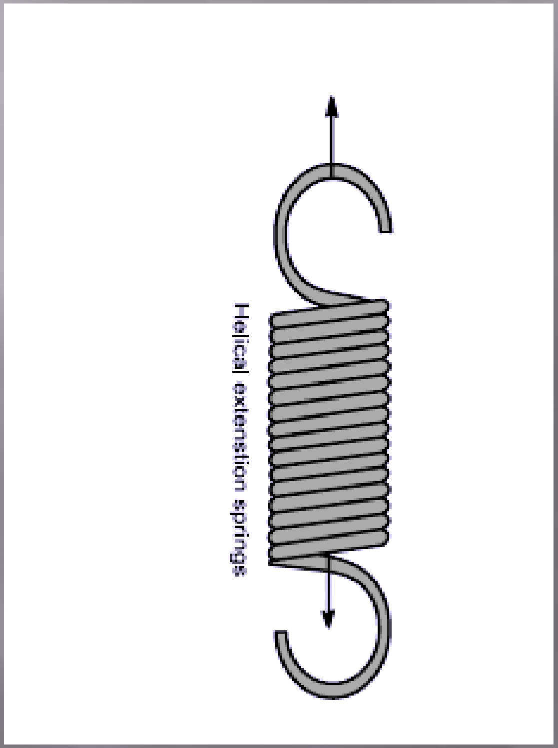
1) Open coil helical spring
2) Closed coil helical spring
3) Torsion spring
4) Spiral spring

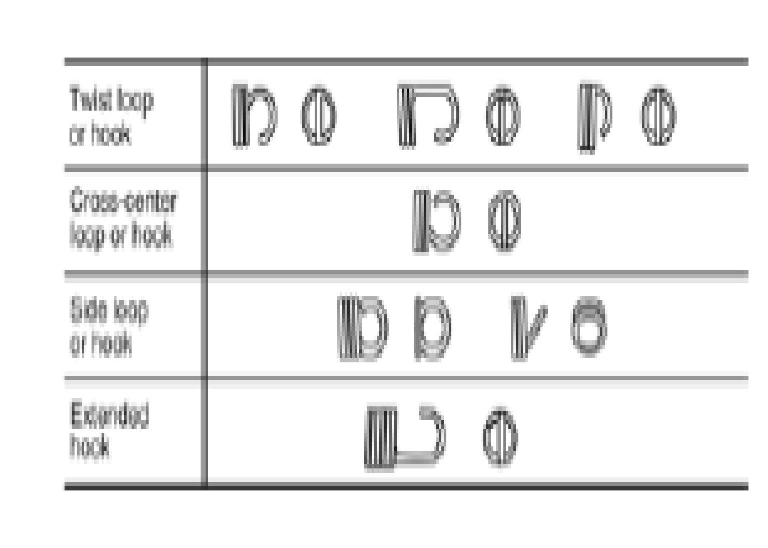
TENSION HELICAL SPRING (OR) EXTENSION SPRING

1. It has some means of transferring the load from the support to the body by means of some arrangement.
2. It stretches apart to create load.
3. The gap between the successive coils is small.
4. The wire is coiled in a sequence that the turn is at right angles to the axis of the spring.
5. The spring is loaded along the axis.
6. By applying load the spring elongates in action

EXTENSION SPRINGS

AND ITS END HOOKS

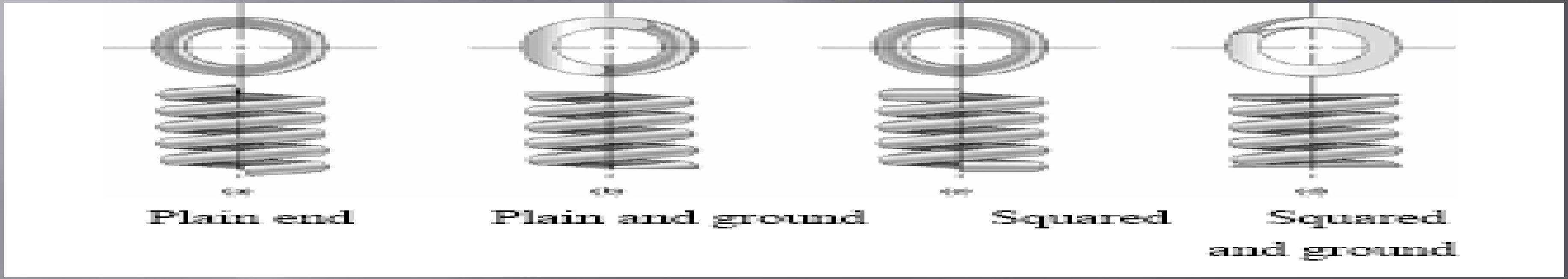


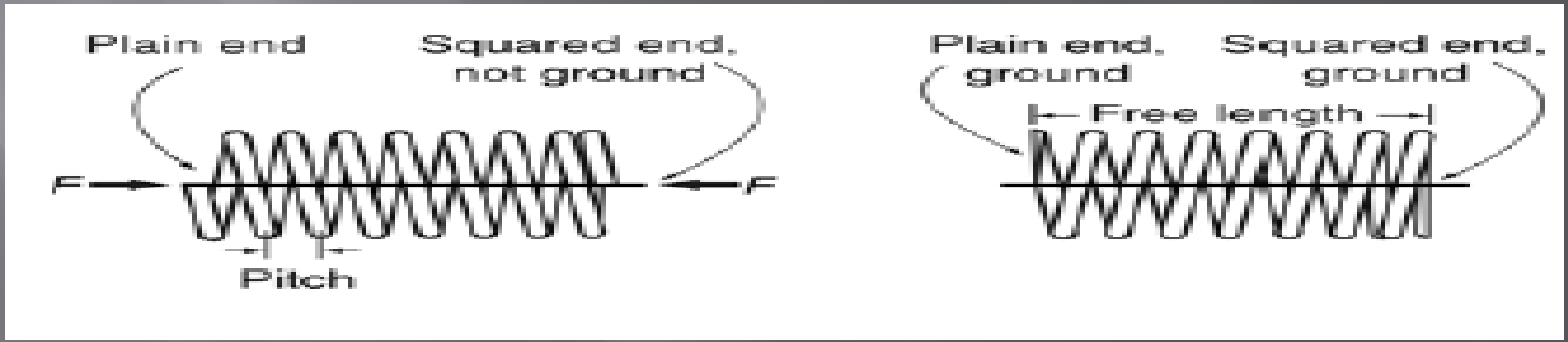


COMPRESSION HELICAL SPRING

Among the four types, the plain end type is less expensive to manufacture.

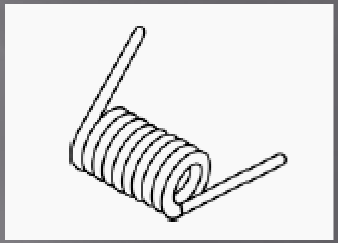
It tends to bow sideways when applying a compressive load.





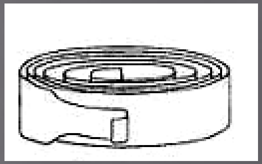
TORSION SPRING

1. It is also a form of helical spring, but it rotates about an axis to create load.
2. It releases the load in an arc around the axis.
3. Mainly used for torque transmission
4. The ends of the spring are attached to other application objects, so that if the object rotates around the center of the spring, it tends to push the spring to retrieve its normal position.



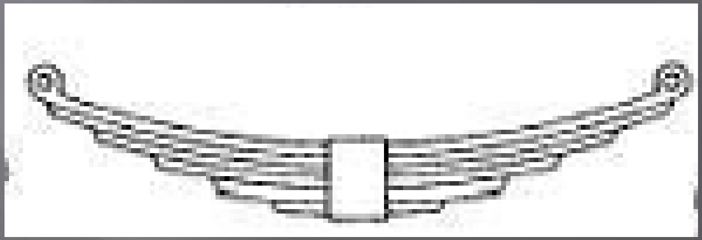
SPIRAL SPRING

1. It is made of a band of steel wrapped around itself a number of times to create a geometric shape.
2. Its inner end is attached to an arbor and outer end is attached to a retaining drum.
3. It has a few rotations and also contains a thicker band of steel.
4. It releases power when it unwinds.



LEAF SPRING

- Sometimes it is also called as a semi-elliptical spring, as it takes the form of a slender arc shaped length of spring steel of rectangular cross section.
- The center of the arc provides the location for the axle,while the tie holes are provided at either end for attaching to the vehicle body.
- Heavy vehicles,leaves are stacked one upon the other to ensure rigidity and strenth.
- It provides dampness and springing function.



•It can be attached directly to the frame at the both ends or attached directly to one end,usually at the front,with the other end attched through a shackle,a short swinging arm.

•The shackle takes up the tendency of the leaf spring to elongate when it gets compressed and by which the spring becomes softer.

•Thus depending upon the load bearing capacity of the vehicle the leaf spring is designed with graduated and Ungraduated leaves.

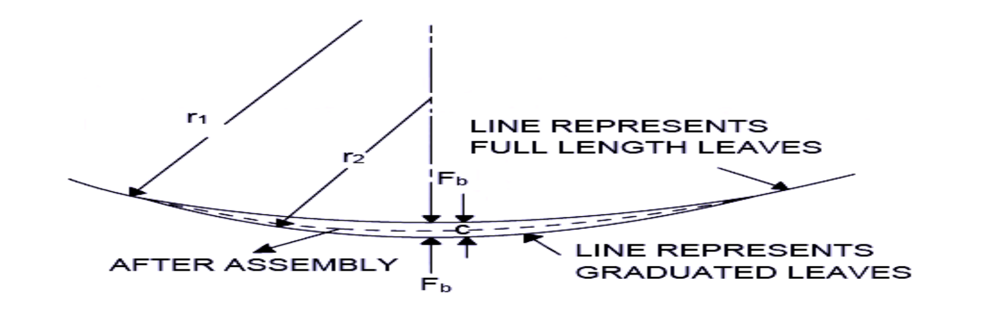
FABRICATION STAGES OF A LEAF SPRING

NIPPING IN LEAF SPRING?

•Because of the difference in the leaf length,different stress will be there at each leaf.To compensate the stress level,prestressing is to be done.Prestressing is achieved by bending the leaves to different radius of curvature before they are assembled with the center clip.

•The radius of curvature decreases with shorter leaves.

•The extra intail gap found between the extra full length leaf and graduated length leaf is called as nip.Such prestressing achieved by a difference in the radius of curvature is known as nipping.



SPRING MATERIALS

The mainly used material for manufacturing the springs are as follows:

1) Hard drawn high carbon steel.
2) Oil tempered high carbon steel.
3) Stainless steel
4) Copper or nickel based alloys.
5) Phosphor bronze.
6) Inconel.
7) Monel
8) Titanium.

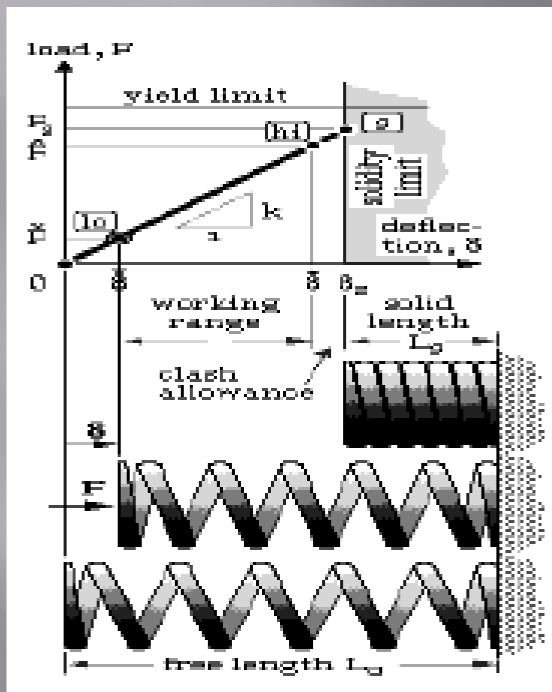
9)Chrome vanadium.

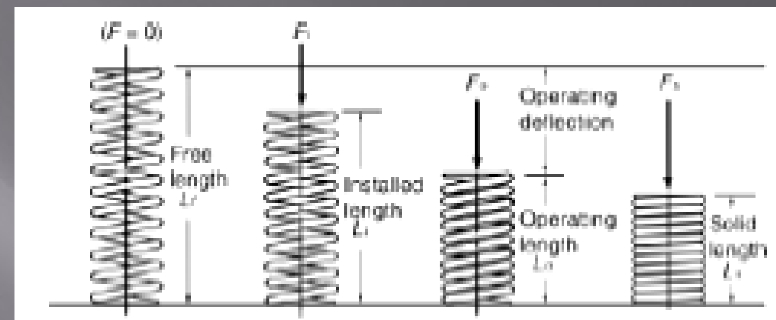
10) Chrome silicon.

MATERIAL SELECTION CHART FOR SPRINGS

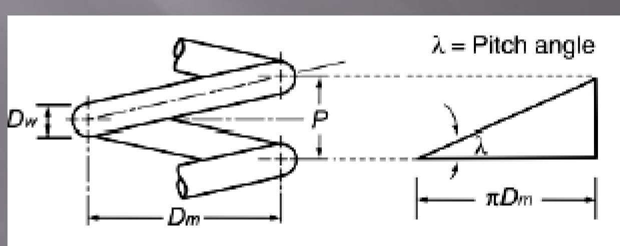
NAME OF MATERIAL	SIMILAR SPECIFICATION	DESCRIPTION
Music wire,	UNS G10850 AISI 1085 ASTM A228-51	This is the best, toughest, and most widely used of all spring materials for small springs. It has the highest tensile strength and can withstand higher stresses under repeated loading than any other spring material. Available in diameters 0.12 to 3mm(0.005 to 0.125 in). Do not use above 120 C (250 F) or at subzero temperature
Oil-tempered wire, 0.60-0.70C	UNS G10650 AISI 1065 ASTM 229-41	This general-purpose spring steel is used for many types of coil springs where the cost of music wire is prohibitive and in sizes larger thena available in music wire. Not for shock or impact loading. Available in diameters 3 to 12 mm (0.125 to 0.5000 in),but larger and smaller sizes may be obtained. Not for use above 180 C (350 F) or at sub-zero temperatures
Hard-drawn wire, 0.60-0.70	UNS G10660 AISI 1066 ASTM 227-47	This is the cheapest general purpose spring steel and should be used only where life, accuracy, and deflection are not too important. Available in diametes 0.8 to 12 mm (0.031 to 0.500 in). Not for use above 120 C (250 F) or at subzero temperatures
Chrome Vanadium	UNS G61500 AISI 6150 ASTM 231-41	This is the most popular allowy spring steel for conditions involving higher stresses than cn be used with the high- carbon steels and for use wherefatigue resistanceand long endureance are needed. Aslo good for shock and impact loads. Widely used iforaircraft engine valve springs and for temperaturesto 220 C (425 F) Available in annealed or pretemperedsizes 0.r to 12mm(0.031 to 0.500 in) in diameter
Chrome silicon	UNS G92540 AISI 9254	This alloy is an excellent material for highly stressed springs that requrire long lfe and are subjected to shock loading. Rockwell hardnesses of C50 to C53 are quite common, and the material may be used up to 250 C(475 F). Available form 0.8 to 12 mim (0.031 to 0.500 in) in diameter

NOMENCLATURE OF A COMPRESSION HELICAL SPRING





$$\lambda = \tan^{-1}\frac{P}{\pi D_m}$$



TERMINOLOGIES IN A COMPRESSION HELICAL SPRING

1)Free length

2)Pitch

3)Endurance limit

4)Slenderness ratio

5)Pitch

6)Active coils

7)Solid length

8)Pitch angle

9)Hysterisis

10)Initial tension

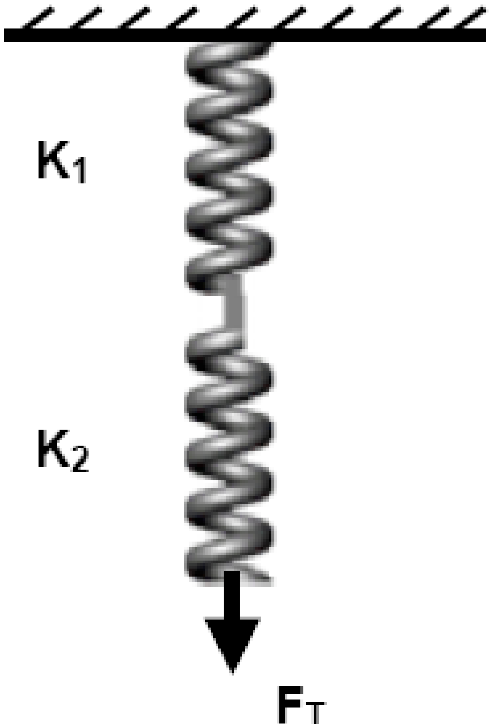
11)Permanent set

12)Set

13)Spring rate

14)Spring index

Kequivalent-when springs are in series



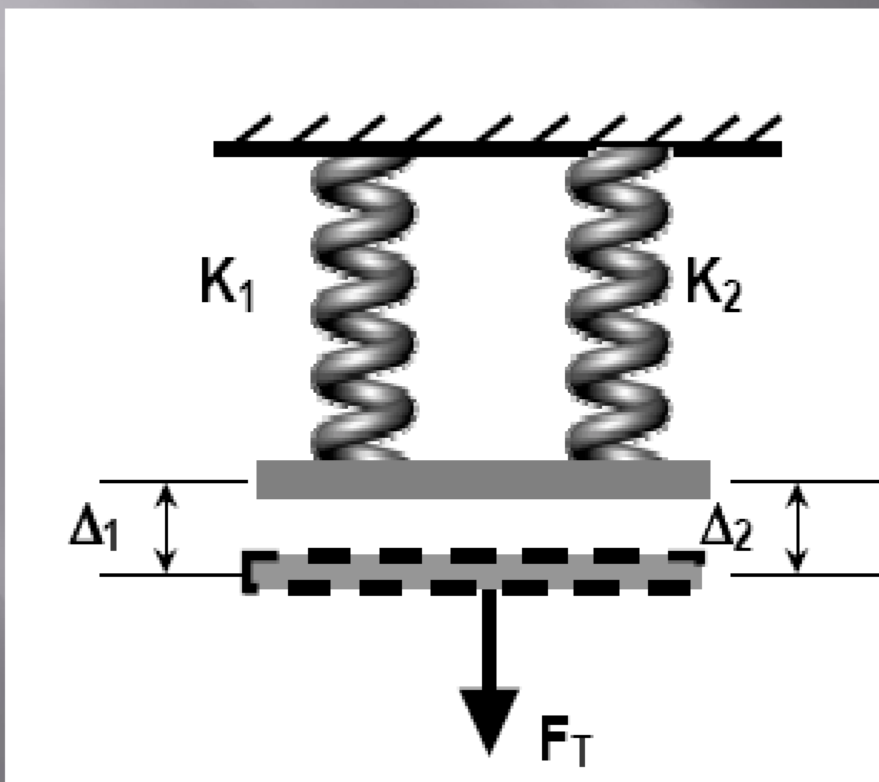
$$F_T = F_1 = F_2$$

$$\Delta_T = \Delta_1 + \Delta_2 = \frac{F_1}{K_1} + \frac{F_2}{K_2} = \frac{F_T}{K_1} + \frac{F_T}{K_2}$$

$$Keq = \frac{F_T}{\Delta_T} = \frac{F_T}{\Delta_1 + \Delta_2} = \frac{F_T}{\frac{F_T}{K_1} + \frac{F_T}{K_2}} = \frac{1}{\frac{1}{K_1} + \frac{1}{K_2}}$$

<u>Kequivalent-when springs are in parallel</u> PARALLEL(SYMMETRIC DISPLACEMENTCASE)

($\Delta 1 = \Delta 2$)

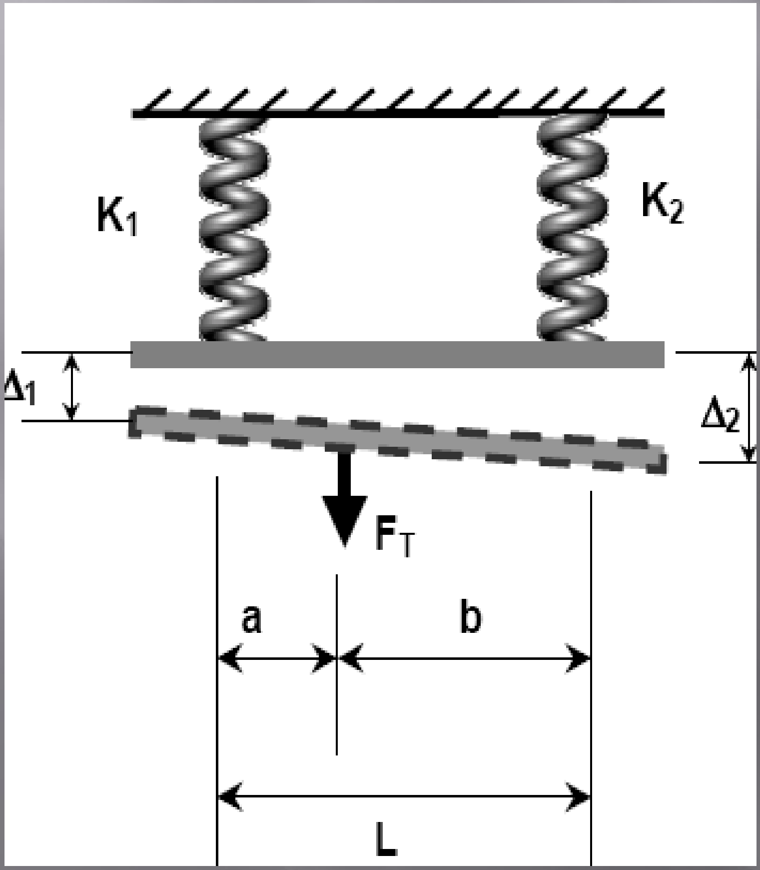


$$\Delta_T = \Delta_1 + \Delta_2$$

$$F_T = F_1 + F_2 = K_1\Delta_1 + K_2\Delta_2 = K_1\Delta_T + K_2\Delta_T$$

$$Keq = \frac{F_T}{\Delta_T} = \frac{K_1\Delta_T + K_2\Delta_T}{\Delta_T} = K_1 + K_2$$

UNSYMMETRICAL DISPLACEMENT(Δ1, Δ2, ΔTOTAL) WHEN THE SPRINGS ARE IN PARALLEL (Δ1≠ Δ2)



$$F_T = F_1 + F_2$$

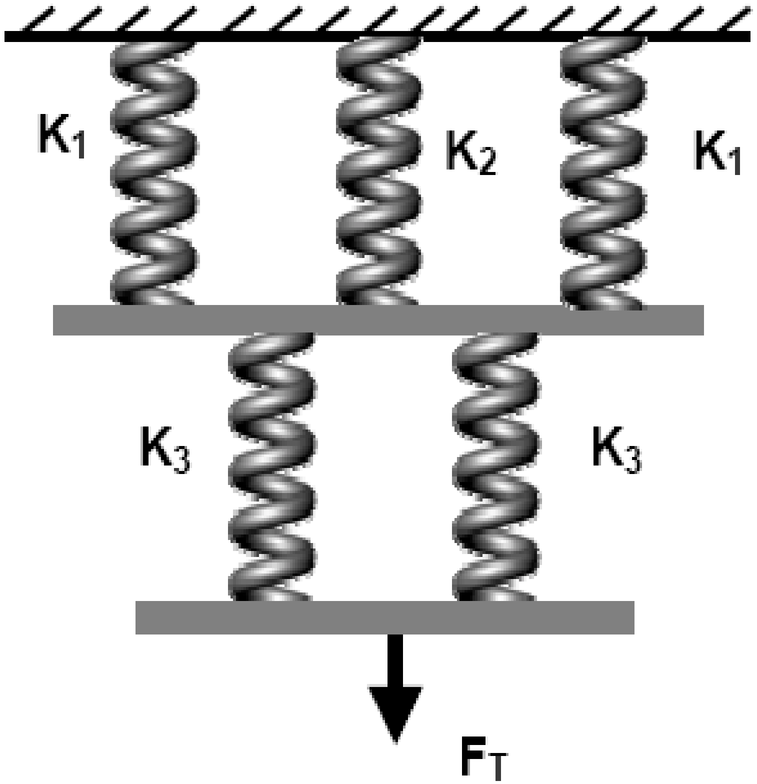
$$F_1 = \frac{b}{L} F_T; \qquad F_2 = \frac{a}{L} F_T$$

$$\Delta_T = \frac{b}{L}\Delta 1 + \frac{a}{L}\Delta 2 = \frac{b}{L}\frac{F_1}{K_1} + \frac{a}{L}\frac{F_2}{K_2}$$

$$= \frac{b^2}{L^2}\frac{F_T}{K_1} + \frac{a^2}{L^2}\frac{F_T}{K_2}$$

$$Keq = \frac{F_T}{\Delta_T} = \frac{F_T}{\frac{b^2}{L^2}\frac{F_T}{K_1} + \frac{a^2}{L^2}\frac{F_T}{K_2}} = \frac{L^2}{\frac{b^2}{K_1} + \frac{a^2}{K_2}}$$

COMBINED SYSTEM(BOTH SERIES AND PARALLEL)



$$Keq = \frac{1}{\dfrac{1}{K_1 + K_2 + K_1} + \dfrac{1}{K_3 + K_3}}$$

TERMINOLOGIES IN A COMPRESSION HELICAL SPRING

1)Free length

2)Pitch

3)Endurance limit

4)Slenderness ratio

5)Pitch

6)Active coils

7)Solid length

8)Pitch angle

9)Hysterisis

10)Intial tension

11)Permanent set

12)Set

13)Spring rate

14)Spring index

APPLICATIONS OF SPRINGS

1) To apply forces and controlling motion, as in brakes and clutches.
2) Measuring forces, as in the case of a spring balance.
3) Storing energy, as in the case of springs used in watches and toys.
4) Reducing the effect of shocks and vibrations in vehicles and machine foundations.