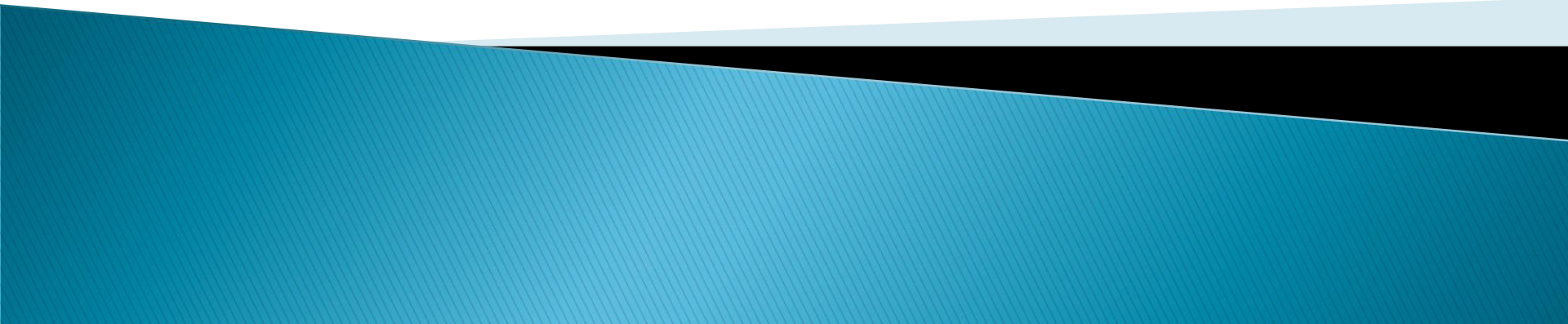
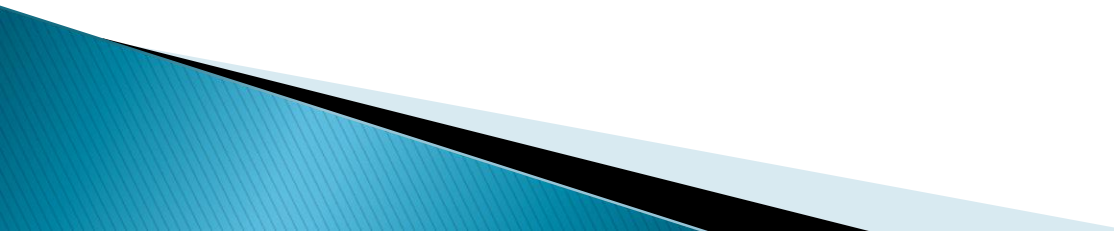


Spring Design



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.**

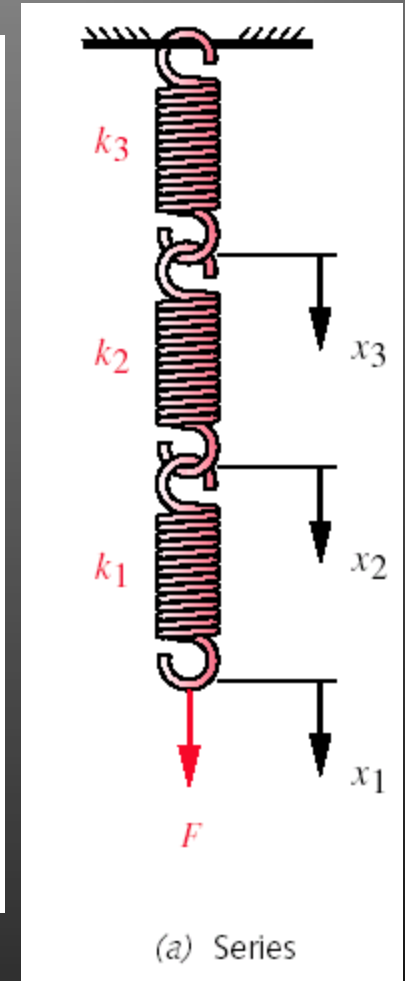
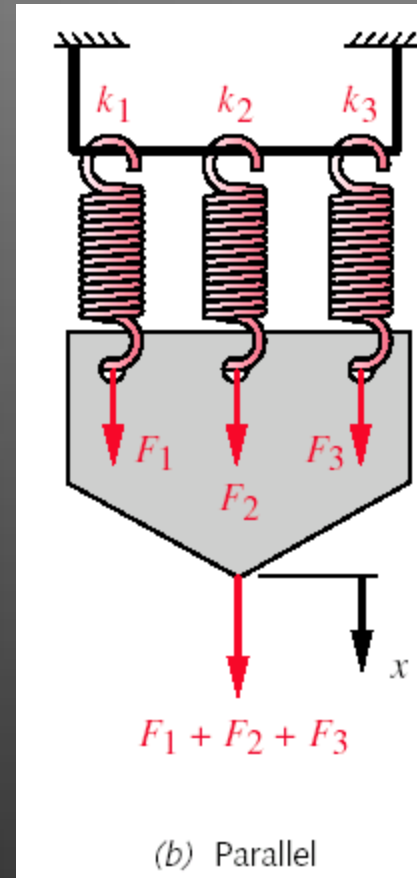
Basic Spring Behavior

$$F = ky$$

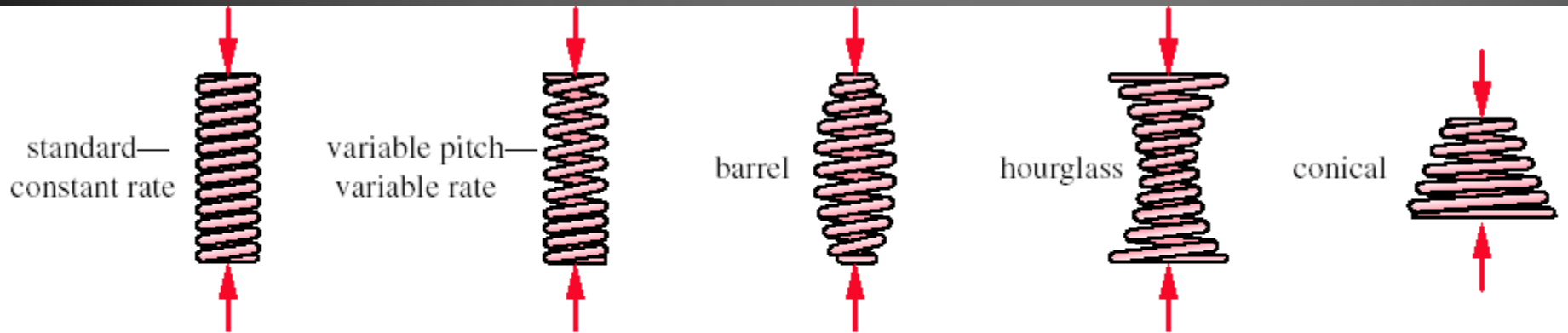
$$k = F / y$$

$$\frac{1}{k_{series}} = \frac{1}{k_1} + \frac{1}{k_2} + \frac{1}{k_3}$$

$$k_{parallel} = k_1 + k_2 + k_3$$



Some Types of Springs



(a) Helical compression springs. *Push*—wide load and deflection range—round or rectangular wire. Standard has constant coil diameter, pitch, and rate. Barrel, hourglass, and variable-pitch springs are used to minimize resonant surging and vibration. Conical springs can be made with minimum solid height and with constant or increasing rate.

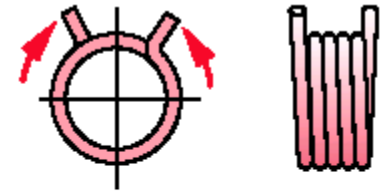
Some Types of Springs (2)



(b) Helical extension springs. *Pull*—wide load and deflection range—round or rectangular wire, constant rate.



(c) Drawbar springs. *Pull*—uses compression spring and drawbars to provide extension pull with fail-safe, positive stop.



(d) Torsion springs. *Twist*—round or rectangular wire—constant rate.

Some Types of Springs (3)



Belleville



wave



slotted



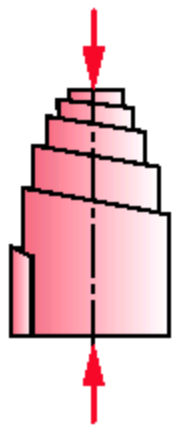
finger



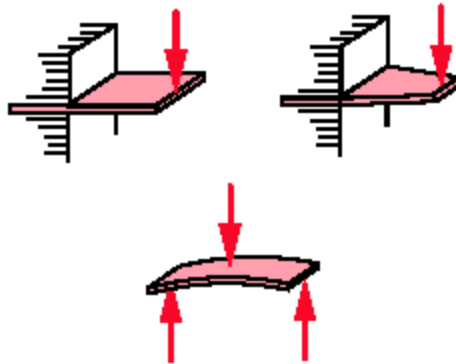
curved

- (e) Spring washers. *Push*—Belleville has high loads and low deflections—choice of rates (constant, increasing, or decreasing). Wave has light loads, low deflection, uses limited radial space. Slotted has higher deflections than Belleville. Finger is used for axial loading of bearings. Curved is used to absorb axial end play.

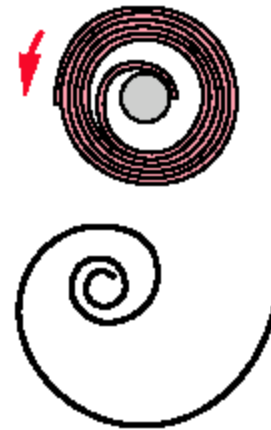
Some Types of Springs (4)



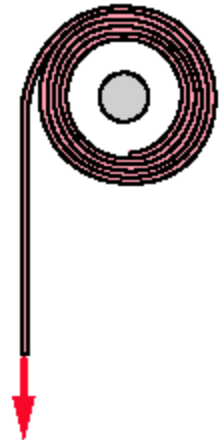
(f) Volute spring. *Push*—may have an inherently high friction damping.



(g) Beam springs. *Push or Pull*—wide load but low deflection range—rectangular or shaped cantilever, or simply supported.



(h) Power or motor springs. *Twist*—exerts torque over many turns. Shown in, and removed from, retainer.



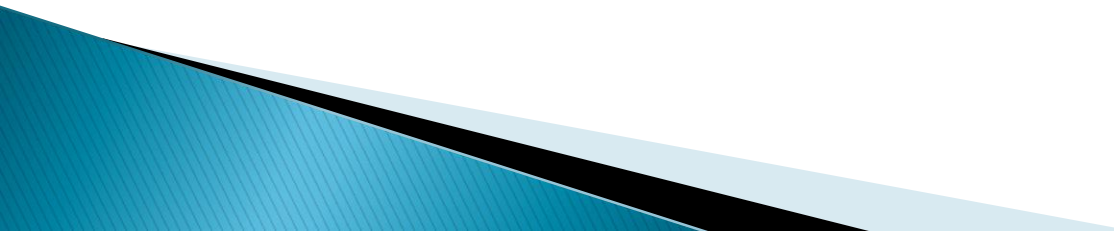
(i) Constant Force. *Pull*—long deflection at low or zero rate.

FIGURE 13-2

Spring Configurations (Adapted from: *Design Handbook: Engineering Guide to Spring Design*, 1987, Associated Spring, Barnes Group Inc., 10 Main St., Bristol, Conn., with permission)

Spring Materials: Wires

Properties of interest

- ▶ High strength
 - ▶ High yield
 - ▶ Modulus may be low for energy storage
 - ▶ Cost
 - ▶ Temperature resistance (e.g. valve springs)
 - ▶ Corrosion resistance
- 

Common Materials (partial list for wires)

Table 13-1 Common Spring Wire Materials

Source: Reference 2

ASTM #	Material	SAE #	Description
A227	Cold-drawn wire ("hard-drawn")	1066	Least expensive general-purpose spring wire. Suitable for static loading but not good for fatigue or impact. Temperature range 0°C to 120°C (250°F).
A228	Music wire	1085	Toughest, most widely used material for small coil springs. Highest tensile and fatigue strength of all spring wire. Temperature range 0°C to 120°C (250°F).
A229	Oil-tempered wire	1065	General-purpose spring steel. Less expensive and available in larger sizes than music wire. Suitable for static loading but not good for fatigue or impact. Temperature range 0°C to 180°C (350°F).
A230	Oil-tempered wire	1070	Valve-spring quality—suitable for fatigue loading.
A232	Chrome vanadium	6150	Most popular alloy spring steel. Valve-spring quality—suitable for fatigue loading. Also good for shock and impact loads. For temperatures to 220°C (425°F). Available annealed or pretempered.
A313 (302)	Stainless steel	30302	Suitable for fatigue applications.

Helical Compression Springs

- Lengths
 - Free
 - Assembled
 - Solid or shut height
 - Working deflection

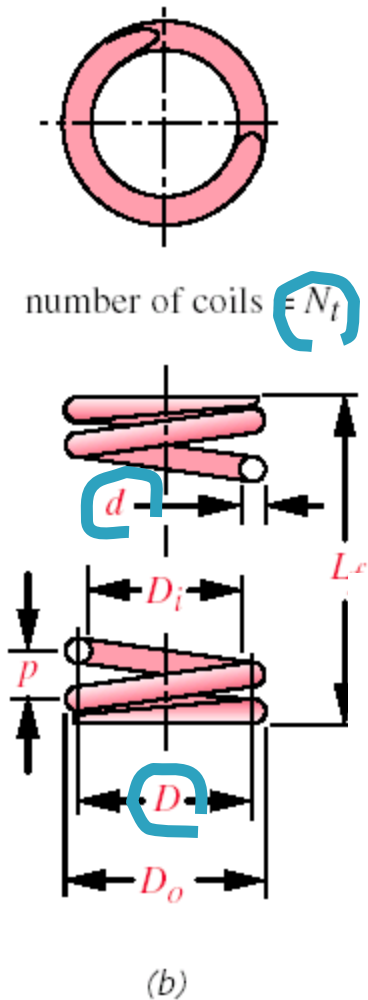


FIGURE 13-7

(a) Sample Springs and
(b) Dimensional

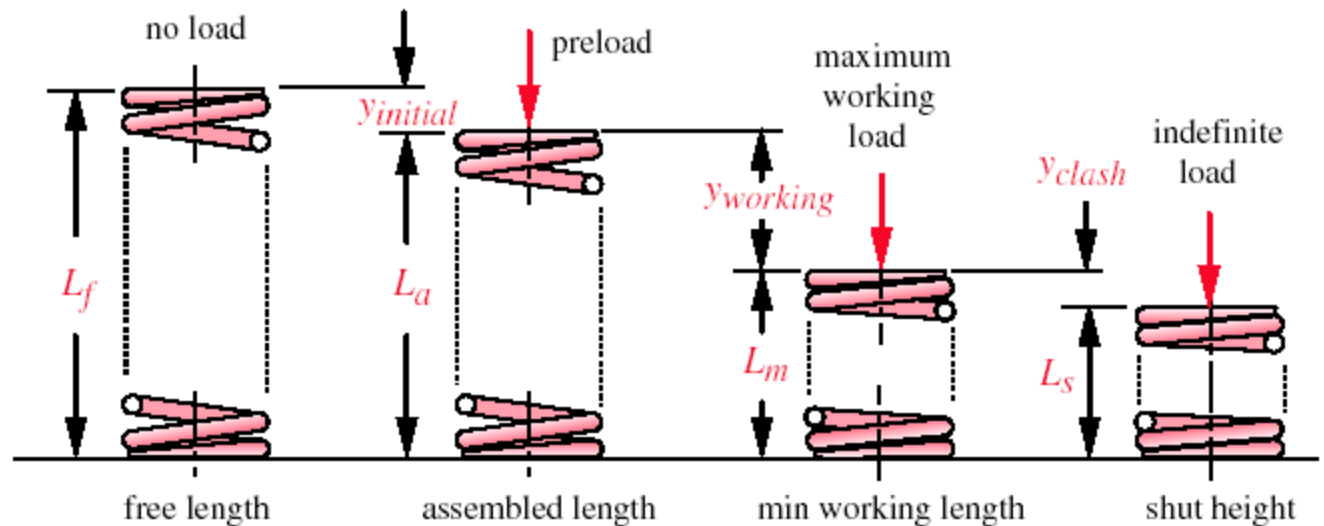


FIGURE 13-8

Various Lengths of a Helical Compression Spring in Use