

23.5 Terms used in Compression Springs

The following terms used in connection with compression springs are important from the subject point of view.

1. Solid length. When the compression spring is compressed until the coils come in contact with each other, then the spring is said to be *solid*. The solid length of a spring is the product of total number of coils and the diameter of the wire. Mathematically,

Solid length of the spring,

$$L_S = n'.d$$

where

n' = Total number of coils, and

d = Diameter of the wire.

2. Free length. The free length of a compression spring, as shown in Fig. 23.6, is the length of the spring in the free or unloaded condition. It is equal to the solid length plus the maximum deflection or compression of the spring and the clearance between the adjacent coils (when fully compressed). Mathematically,

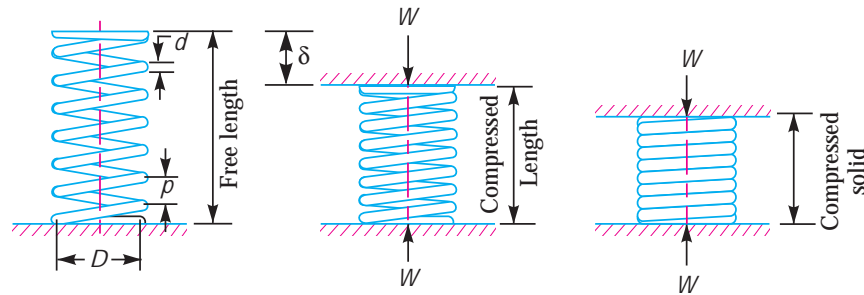


Fig. 23.6. Compression spring nomenclature.

Free length of the spring,

$$L_F = \text{Solid length} + \text{Maximum compression} + \text{*Clearance between adjacent coils (or clash allowance)}$$

$$= n'.d + \delta_{max} + 0.15 \delta_{max}$$

The following relation may also be used to find the free length of the spring, *i.e.*

$$L_F = n'.d + \delta_{max} + (n' - 1) \times 1 \text{ mm}$$

In this expression, the clearance between the two adjacent coils is taken as 1 mm.

3. Spring index. The spring index is defined as the ratio of the mean diameter of the coil to the diameter of the wire. Mathematically,

$$\text{Spring index, } C = D / d$$

where

D = Mean diameter of the coil, and

d = Diameter of the wire.

4. Spring rate. The spring rate (or stiffness or spring constant) is defined as the load required per unit deflection of the spring. Mathematically,

$$\text{Spring rate, } k = W / \delta$$

where

W = Load, and

δ = Deflection of the spring.

* In actual practice, the compression springs are seldom designed to close up under the maximum working load and for this purpose a clearance (or clash allowance) is provided between the adjacent coils to prevent closing of the coils during service. It may be taken as 15 per cent of the maximum deflection.

5. Pitch. The pitch of the coil is defined as the axial distance between adjacent coils in uncompressed state. Mathematically,

$$\text{Pitch of the coil, } p = \frac{\text{Free length}}{n' - 1}$$

The pitch of the coil may also be obtained by using the following relation, *i.e.*

$$\text{Pitch of the coil, } p = \frac{L_F - L_S}{n'} + d$$

where

L_F = Free length of the spring,

L_S = Solid length of the spring,

n' = Total number of coils, and

d = Diameter of the wire.

In choosing the pitch of the coils, the following points should be noted :

(a) The pitch of the coils should be such that if the spring is accidentally or carelessly compressed, the stress does not increase the yield point stress in torsion.

(b) The spring should not close up before the maximum service load is reached.

Note : In designing a tension spring (See Example 23.8), the minimum gap between two coils when the spring is in the free state is taken as 1 mm. Thus the free length of the spring,

$$L_F = n.d + (n - 1)$$

and pitch of the coil,
$$p = \frac{L_F}{n - 1}$$

23.6 End Connections for Compression Helical Springs

The end connections for compression helical springs are suitably formed in order to apply the load. Various forms of end connections are shown in Fig. 23.7.

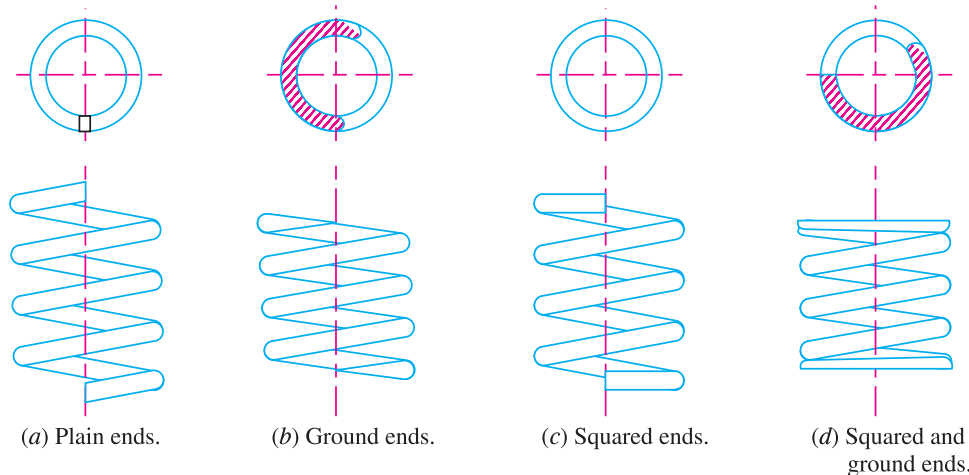


Fig 23.7. End connections for compression helical spring.

In all springs, the end coils produce an eccentric application of the load, increasing the stress on one side of the spring. Under certain conditions, especially where the number of coils is small, this effect must be taken into account. The nearest approach to an axial load is secured by squared and ground ends, where the end turns are squared and then ground perpendicular to the helix axis. It may be noted that part of the coil which is in contact with the seat does not contribute to spring action and hence are termed as *inactive coils*. The turns which impart spring action are known as *active turns*. As the load increases, the number of inactive coils also increases due to seating of the end coils and the amount of increase varies from 0.5 to 1 turn at the usual working loads. The following table shows the total number of turns, solid length and free length for different types of end connections.

Table 23.3. Total number of turns, solid length and free length for different types of end connections.

Type of end	Total number of turns (n')	Solid length	Free length
1. Plain ends	n	$(n + 1) d$	$p \times n + d$
2. Ground ends	n	$n \times d$	$p \times n$
3. Squared ends	$n + 2$	$(n + 3) d$	$p \times n + 3d$
4. Squared and ground ends	$n + 2$	$(n + 2) d$	$p \times n + 2d$

where n = Number of active turns,
 p = Pitch of the coils, and
 d = Diameter of the spring wire.

23.7 End Connections for Tension Helical Springs

The tensile springs are provided with hooks or loops as shown in Fig. 23.8. These loops may be made by turning whole coil or half of the coil. In a tension spring, large stress concentration is produced at the loop or other attaching device of tension spring.

The main disadvantage of tension spring is the failure of the spring when the wire breaks. A compression spring used for carrying a tensile load is shown in Fig. 23.9.



Tension helical spring

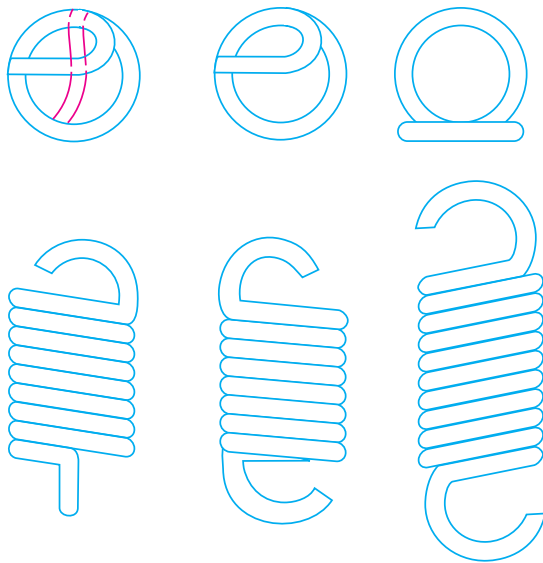


Fig. 23.8. End connection for tension helical springs.

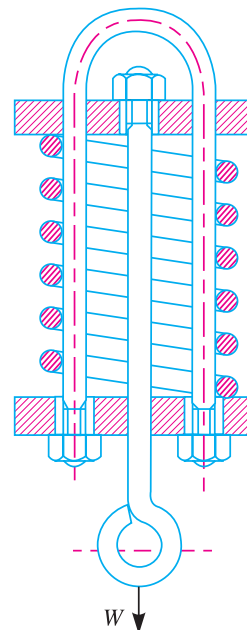


Fig. 23.9. Compression spring for carrying tensile load.