SPRINGS & THINGS INCORPORATED

Spiral Torsion Springs

General Data

Spiral torsion springs, which are usually made of rectangular section material, are wound flat, generally with an increasing space between the coils. The torque delivered per revolution is linear for the first 360°. At greater angular rotations, the coils begin to close on the arbor, and the torque per turn increases rapidly. For this reason, springs of this type are usually used in applications requiring less than 360° of rotation.

Design Formulas

The formula for torque delivered by a spiral torsion spring is:

$$(1)\quad M = \frac{\pi E b t^3 \theta}{6L} \text{ lb.•in } (N•mm)$$

where

E = Modulus of elasticity, psi (MPa)

θ = Angular deflection in revolutions

L = Length of active material, in. (mm)

M = Moment or torque, lb.•in (N•mm)

b = Material width, in. (mm)

t = Material thickness, in. (mm)

The stresses imposed on a spiral torsion spring are in bending, and the deflecting beam formula for stress may be used:

$$(2)\quad S = \frac{6M}{bt^2} \text{ psi } (MPa)$$

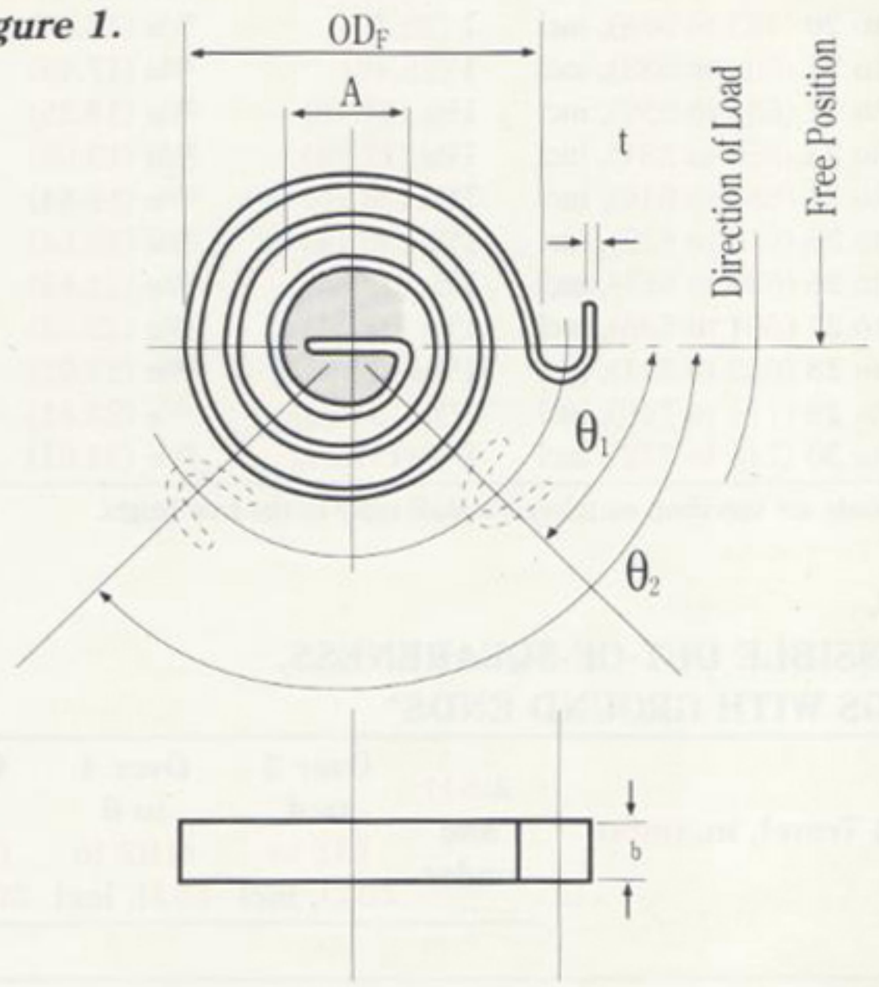
Spiral torsion springs for general use can be stressed from 175,000 to 200,000 psi (1210–1380 MPa), depending on material hardness. In applications where higher stresses and material fatigue are involved, it is suggested that a spring manufacturer be consulted.

The arbor diameter (A) and outside diameter in the free condition (OD_F) do not appear in the formulas for torque or stress, but the space occupied by the spring must be considered in design. A spring which is too small may wind up tight on the arbor before the desired deflection is reached. If the outside diameter is too large, the spring will not fit the space available.

The following formula, based on concentric circles with a uniform space between the coils, gives a close approximation of the minimum OD_F:

$$OD_F = \frac{2L}{\pi\left(\frac{\sqrt{A^2 + 1.27Lt} - A}{2t} - \theta\right)} - A \text{ in. } (mm)$$

Figure 1.



Design Example

Assume that a spiral torsion spring is made of 0.032 in. (0.81 mm) thick by 0.250 in. (6.35 mm) wide 1070 carbon steel and must deliver a moment of 4.5 lb.•in. (508 N•mm) at 135° deflection. The spring is to work over a 0.250 in. (6.35 mm) diameter arbor. What is the active length of material required, the stress imposed on the spring, and the spring O.D.?

Transposing the formula for torque, active length of material (L) is given by:

$$L = \frac{\pi E b t^3 \theta}{6M} \text{ in. (mm)}$$

where

$$\theta = \frac{135°}{360°} = 0.375 \text{ Revolutions}$$

$$L = \frac{\pi(30 \times 10^6)(0.25)(0.032)^3(0.375)}{6(4.5)} = 10.72 \text{ in. } (272.3 \text{ mm})$$

(L does not include the material needed for the end configurations)

$$S = \frac{6(4.5)}{0.25(.032)^2} = 105.000 \text{ psi } (724 \text{ MPa})$$

$$OD_F = \frac{2(10.72)}{3.14\left(\frac{\sqrt{0.25^2 + 1.27(10.72)(0.032)} - 0.25}{2(0.032)} - 0.375\right)} - 0.25$$

$$OD_F = 0.762 \text{ in. } (19.35 \text{ mm})$$