

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:

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

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.

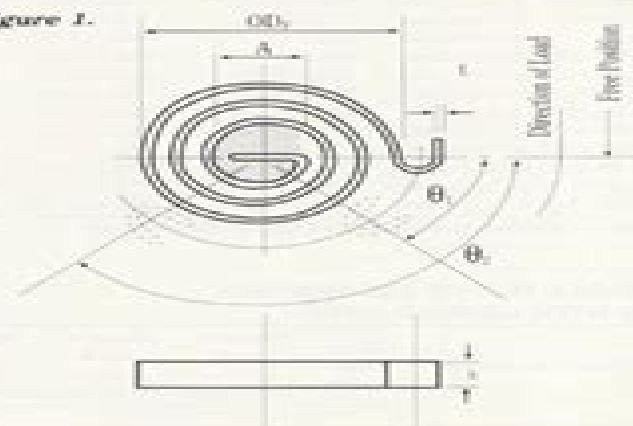
The arbor diameter (A) and outside diameter in the free condition (OD_f) do not appear in the formulas for torque or stress, but the space occupied by the spring must be considered in design. A spring which is too small may wind up tight on the arbor before the desired deflection is reached. If the outside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

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

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

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

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

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

$$S = \frac{6(4.5)}{0.25(0.032)^2} = 105,000 \text{ psi (724 MPa)}$$

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

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

Flat Spring Design Guide

Anees Ahmad

A red circular graphic with a gradient, appearing as a semi-circle or a partial circle, located to the right of the author's name.

Flat Spring Design Guide:

Design Handbook, 1981 *Handbook of Optomechanical Engineering* Anees Ahmad, 1996-12-20 Good optical design is not in itself adequate for optimum performance of optical systems The mechanical design of the optics and associated support structures is every bit as important as the optics themselves Optomechanical engineering plays an increasingly important role in the success of new laser systems space telescopes and instruments biomedical and optical communication equipment imaging entertainment systems and more This is the first handbook on the subject of optomechanical engineering a subject that has become very important in the area of optics during the last decade Covering all major aspects of optomechanical engineering from conceptual design to fabrication and integration of complex optical systems this handbook is comprehensive The practical information within is ideal for optical and optomechanical engineers and scientists involved in the design development and integration of modern optical systems for commercial space and military applications Charts tables figures and photos augment this already impressive handbook The text consists of ten chapters each authored by a world renowned expert This unique collaboration makes the Handbook a comprehensive source of cutting edge information and research in the important field of optomechanical engineering Some of the current research trends that are covered include

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Recovery System Design Guide E. G. Ewing, H. W. Bixby, T. W. Knacke, Irvin Industries Inc. California Division, 1979 This document serves as the third revision of the USAF Parachute Handbook which was first published in 1951 The data and information represent the current state of the art relative to recovery system design and development The initial chapters describe representative recovery applications components subsystems material manufacture and testing The final chapters provide empirical data and analytical methods useful for predicting performance and presenting a definitive design of selected components into a reliable recovery system

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