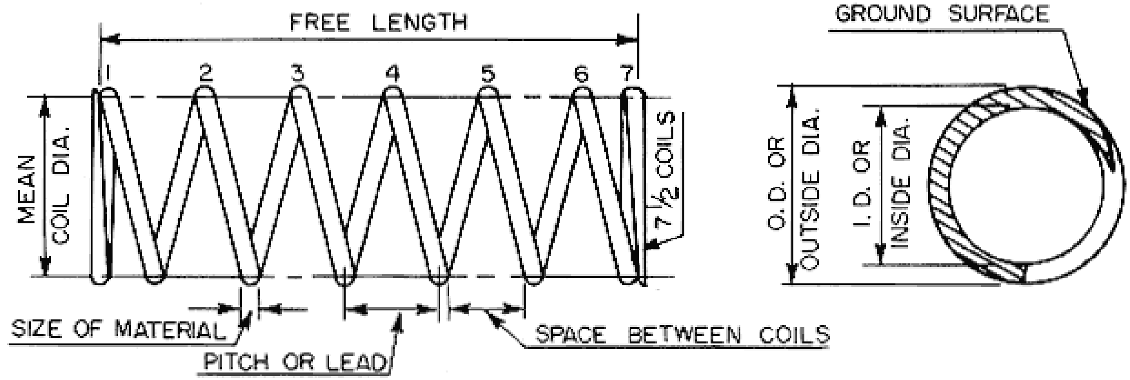
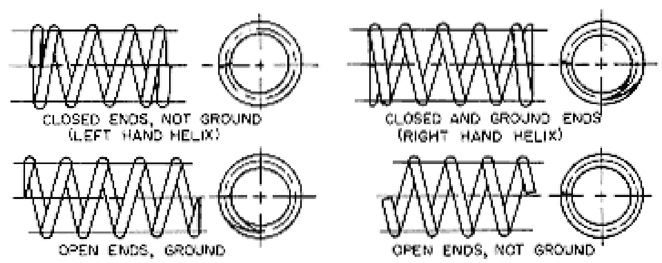
Compression Springs Specification Form



Mandatory Specifications
(fill in only those required)

1. FREE LENGTH
   a. ____in. max., ____in. min. or
   b. ____in. ± ____in.
2. OUTSIDE DIAMETER
   a. ____in. max. or
   b. ____in. ± ____in.
3. INSIDE DIAMETER
   a. ____in. min. or
   b. ____in. ± ____in.
4. Load ____lb. ± ____lb. @ ____in.
   Load ____lb. ± ____lb. @ ____in.
   Rate ____lb. per in. ± ____lb. per in.
   between lengths of ____in. and ____in.
5. Maximum solid height ____in.
6. Direction of helix (L, R or optional) ____
7. Type of ends____________



Advisory Data

1. Wire diameter ____in.
2. Mean coil diameter ____in.
3. No. of active coils ____
4. Total no. of coils ____

Special Information

1. Type of material ____________
2. Finish ____________
3. Squareness (free): within ____°
4. Frequency of compression, ____cycles/sec.
   and working range, ____in. to ____in. of length.
5. Operating temp. ____°F
6. End use or application____________
   ____
   ____
7. Other____________
   ____
   ____

Design Examples

EXAMPLE 1

Design a compression spring to meet the following requirements: O.D. = .925 in., free length L = 1.713 in., load P_1 = 50 lb. ± 5 lb. at L_1 = 1.278 in., ends closed and ground, maximum solid height H = 1.060 in. The material is oil-tempered wire.

Rate

The required spring rate (R) is determined in

R = P/F = 50/(1.713 − 1.278) = 115. lb. per in. and the approximate load at solid height (P_s) is

P_s = R (L − H) = (115) (1.713 − 1.060) = 75.1 lb.

Wire Diameter

In this case, assume a trial mean diameter .100 in. less than the nominal O.D. and a trial design stress of 0.45 (200,000) = 90,000 psi, where S_t = 200,000 psi is in the high-diameter range for oil-tempered wire. Transpose the stress formula 2 and solve for a trial wire diameter.

$$d = \sqrt[3]{\frac{8PD}{\pi S}} = \sqrt[3]{\frac{8(75.1)(.825)}{\pi(90,000)}} = .121 \text{ in.}$$

(suggest using .125)

S_t = 220,000 psi for d = .125 in.; since this is only 10 percent over the assumed S_t = 200,000 there is no need to recalculate d in formula 2. Using the .125 in. temporarily as the acceptable d, solve for D = O.D. − d = .925 − .125 = .800 in.

Number of Active Coils

Solve for n by transposing the spring rate formula 1.

$$n = \frac{Gd^4}{8RD^3} = \frac{(11.5 \times 10^6)(.125)^4}{8(115)(.800)^3} = 5.96 \text{ (use 6) coils}$$

Solid Height

With closed and ground ends, solid height (H) is determined in

H = d (n + 2) = .125 (6 + 2) = 1.00 in.

Because this solid height is smaller than the 1.060 in. specified, d = .125 in. can be accepted with regard to this space limitation.

Stress

Calculate the uncorrected stress for solid compression in

$$S_s = \frac{8PD}{\pi d^3} = \frac{8(75.1)(.800)}{\pi(.125)^3} = 78,300 \text{ psi (uncorrected)}$$

and the corrected stress is determined for C = D/d = .800/.125 = 6.4 (using Wahl correction chart, page 7). K = 1.24 S_k = 1.24 (78,300) = 97,092 psi (corrected).

The maximum allowable design stress is .45 (220,000) = 99,000 psi, so that stress will be safe for the application.

EXAMPLE 2

Design a compression spring with closed ends to support a plunger which slides in a .203 in. hole. Type 302 stainless steel is needed because of the marine environment in the end use. The minimum length between the end of the plunger and the bottom of the hole is .340 in. The length of the spring at its normal position is .385 in., and it is never compressed further in either application or assembly. A trial spring of .035 in. music wire which operated satisfactorily exerted 7.2 lb. at its normal position and was .475 in. long when free.

Rate

The spring rate is

R = P/F = 7.2/(.475 − .385) = 80 lb. per in.

Mean Diameter

Allowing .015 in. for coil diameter tolerance (Table 2 in Tolerances section) and coil expansion due to deflection, the O.D. is then .188 in., and D = O.D. — d = .188 — .035 = .153 in.

Number of Active Coils

Assuming the same wire diameter of .035 in. as in the trial spring, using G = 10 x 10^6 for Type 302 stainless steel, solve for the number of active coils (n) in

$$n = \frac{Gd^4}{8RD^3} = \frac{(10 \times 10^6)(.035)^4}{8(80)(.153)^3} = 6.5 \text{ coils}$$

Solid Height

N = 8.5 total coils for a closed end spring and solid height (H) is

H = d(N + 1) = .035(8.5 + 1) = .333 in.

This allows clearance since .340 is maximum space available.

Stress

Calculate the uncorrected stress at the normal assembly position in

$$S_t = \frac{8PD}{\pi d^3} = \frac{8(7.2)(.153)}{\pi(.035)^3} = 66,000 \text{ psi (uncorrected)}$$

and the corrected stress is determined for C = D/d = .153/.035 = 4.4 using the Wahl correction formula, page 7.

$$K = \frac{4(4.4) - 1}{4(4.4) - 4} + \frac{0.615}{4.4} = 1.36$$

S_{tk} = 1.36(66,000) = 90,000 psi (corrected)

Maximum allowable design stress is .35(274,000) = 95,900 psi. The stress at normal position is then acceptable. But if the spring were to be compressed much below normal position, it may be expected that it would lose load since it appears that S_{sk} would exceed maximum allowable.