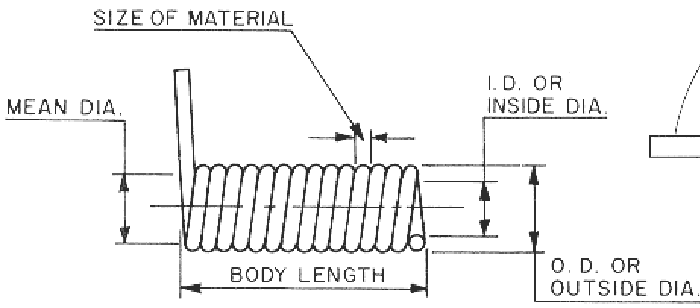
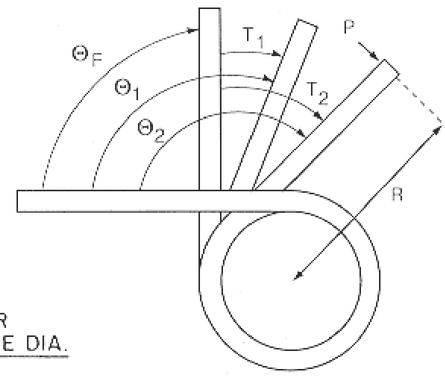
Torsion Springs Specification Form

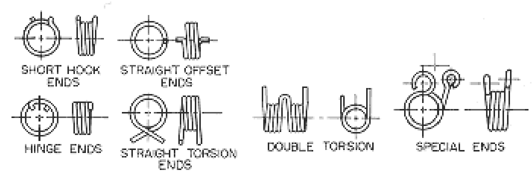




Mandatory Specifications

(fill in only those required)

1. To work over ____ in. dia. shaft.
2. OUTSIDE DIAMETER
   a. ____ in. max. or
   b. ____ in. ± ____ in.
3. INSIDE DIAMETER
   a. ____ in. min. or
   b. ____ in. ± ____ in.
4. Torque ____ in.-lb. ± ____ in-lb. at Θ_1= ____°.
   Torque ____ in.-lb. ± ____ in.-lb. at Θ_2= ____°.
5. Length of space available ____ in.
6. Maximum wound position ____ turns or
   ________° from free position.
7. Length of moment arm (R) ____ in.
8. Direction of helix (L, R, or optional). ____________
9. Type of ends ____________________



Advisory Data

1. Wire diameter ____ in.
2. Mean coil diameter ____ in.
3. No. of coils ____
4. Rate ____ in.-lbs. per turn (360°).
5. Θ_F = ____° free angle reference

Special Information

1. Type of material ____________________
2. Finish ____________________
3. Frequency of rotation, ____ cycles/sec, and working range, Θ= ____° to Θ= ____° deflection.
4. Operating temp. ______°F
5. End use or application ____________________
   ____
   ____
6. Other ____________________
   ____
   ____

Hot-Coiled Springs

General Data

Most springs with material diameters under three-eighths inch are cold coiled. Almost all springs using over five-eighths in. bar stock are hot coiled. There is an overlapping area from three-eighths in. to five-eighths in. material size in which the springs may be either cold coiled or hot coiled.

The transportation industry is the largest user of hot-coiled springs. Agricultural implement manufacturers and construction equipment builders make up the next largest segment.

Hot-coiled springs that are to be subjected to elevated temperatures or operate in a corrosive environment require the use of heat-treatable exotic alloys such as Inconel X 750, precipitation hardening stainless, and even tungsten bearing tool steels. However, most hot-coiled springs are made from bars of carbon or alloy steel. These bars are produced to fine grain practice and are ordered as special bar quality to insure minimum surface imperfections. Surface imperfections can be prevented completely by cold finishing or centerless grinding the bars. Since a large portion of the cost is in the material, however, this can significantly increase the cost of hot-coiled springs.

The finished hardness requirement for most hot-coiled springs is in the range of Rockwell C 44-49. In cases involving special materials and improved surfaces, final hardness as high as Rockwell C 53 may be necessary to withstand the design stresses. It should be noted that as hardness increases above Rockwell C 48 ductility and toughness of the steel falls off rapidly. Springs made to a hardness of Rockwell C 53, for example, have been known to shatter under a constant load. A spring manufacturer should be consulted for the best and most readily available alloy and optimum hardness for each application.

Hot-coiled springs are usually preset. They are wound to a length greater than the finished length, heat treated, then compressed solid one or more times to bring them to the specified length. Presetting introduces beneficial residual stresses which allow the springs to support greater loads than would otherwise be possible. This does not increase service life. Actually, since it allows higher stresses, presetting can materially decrease the service life.

Service life is increased by shot peening, which is particularly effective when both the hardness and working stress are high. Hot-rolled bars, even when ordered as special bar quality, can have seams and significant decarburization. Making the material acceptable requires 90 percent minimum surface coverage and high peening intensities, usually in the range of .006 -.010 C. Turned or centerless ground bars require less intensive peening, typically in the range .012 - .020 A, but still with 90 percent coverage.

Rust leads to pitting and pitting to early failure, so some form of protective finish is recommended. The kind of coating required will depend on the environment which the springs are expected to encounter in storage and service. Commonly used coatings include oil, grease, paint, various proprietary coatings, and, in some instances, cadmium or zinc plating.

Springs which must be extremely reliable usually require magnetic particle inspection and may have to meet a specification that "no true indications of defects shall be found." There should be a clear understanding between supplier and purchaser on this point, for there can often be "indications" which will not significantly affect performance in a specific high-duty application.

Design Formulas

The same design formulas and procedures that apply to cold-coiled springs also apply to hot-coiled springs with these two differences:

1. The effective modulus of rigidity for hot-coiled springs is reduced by 5 to 10 percent. Hot-rolled bars use a modulus of 10.5×10^6psi. If turned or centerless ground bars are used, the apparent modulus can be increased to 11×10^6psi.
2. The calculated height of hot-coiled compression springs is lower than for comparable cold-coiled springs because the taper forging operation produces a thinner end section. The solid height, which is one half a wire diameter smaller than for cold-coiled springs, is calculated as follows: $H = d(N - \frac{1}{2})$

When spring rate is specified, it should apply only in the deflection range from 20 to 60 percent of total deflection. The tolerance on spring rate should not be less than ± 10 percent.

The magnitude of allowable stress for hot-coiled springs is limited by the grade and condition of material used, the mechanical properties developed by heat treatment, and the kind of service the spring must provide. For static loading or variable but infrequent loading at relatively low stress ranges, the important considerations are the solid stress and the maximum working stress. Figure 1 shows recommended maximum uncorrected solid stress for these low duty applications. For highly variable, shock, and dynamic loading, consult a spring manufacturer instead of using this chart.

Figure 1.
SOLID DESIGN STRESS (UNCORRECTED) FOR HOT-COILED COMPRESSION SPRINGS