SPRING ENGINEERS

SPRING ENGINEERS OF HOUSTON, LTD • AN SEI METALTEK COMPANY

E-Book

How To Design A Spring

A Brief But Important Overview

Introduction

Springs are energy management devices. Spring design is challenging because of the conflicting priorities in a given application. Spring Engineers of Houston is highly experienced in the design of many types of springs, for many different industries. Our expertise allows us to assist customers in creating cost effective solutions.

There are many different resources and software packages available to help design springs. If the designer does not have the basic requirements identified, then the odds of success are much worse, and unexpected problems can arise later. We suggest the following work flow in designing springs. By addressing these six key questions, the great majority of spring designs can be quickly and successfully executed.

The 6 Questions To Answer

Determining Type & Force

Understanding different spring types will help select the best spring for any given application. Here we have broken down the essential types of springs and the force they produce.

Compression Springs

Arguably the most common type of spring. The spring is compressed from its free position, producing a linear force. The wire is actually stressed in torsion as the spring deflects. Normal working ranges are somewhere between a preload, and the spring's solid length.

Magnitude Of Force

Provides a linear force under deflection. The magnitude of desired force directly affects the spring's design. Under dynamic loading, forces can be quite complex.

Extension Springs

Extension springs are also common. The spring is stretched in service. Like a compression spring, the wire is stretched in torsion. The spring must be attached to a mechanism to allow its operation. Hooks (as shown left) are a common attachment. The attachment must be carefully considered as they can be a stress concentration. Swivel hooks and threaded plugs are sometimes specified.

Magnitude Of Force

Helical extension springs are normally wound with little or no space between coils, and the spring is stretched to create a linear force.

Torsion Springs

Torsion springs provide rotational force or torque to a given mechanism. Torsion bars also apply torque, but normally twist when they deflect.

Magnitude Of Force

Torsion springs apply a torque, also called a bending moment. If torque values are critical, the measuring method and mounting must be carefully considered.

Leaf/Bow Springs

Leaf and bow springs are compressed upon installation and their arch changes as the mechanism moves. When force is measured, the measurement is usually a load applied to the top of the arch. There are many different ways to mount leaf springs.

Magnitude Of Force

Leaf springs are normally compressed in use. The arch of the spring changes as loads are applied. When required, loads are measured the same as a compression spring, but special fixtures may be required. In the special case of a vehicle suspension, axle torque must be considered.

Common Question:

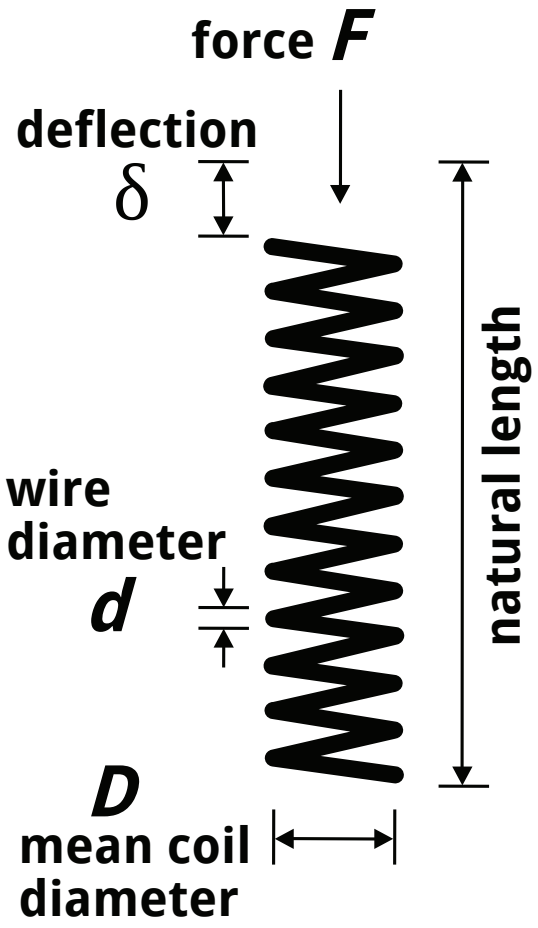
“What’s the Difference Between ‘Load’ & ‘Rate’?”

“Load” is a force applied to a spring, like weight or linear force. “Rate” describes how the load changes, as the spring deflects. Most springs are fairly constant in rate, but can vary in some conditions. Variable rate springs are sometimes used to allow a greater use variety of loading conditions.

Deflection at Forces

In order to establish the basic spring design, the desired deflection and the desired forces should be known. Unsure of how to calculate this? That's what Spring Engineers of Houston is here for!

If operating deflections are variable, for example auto suspension, then you at least need to set a minimum and maximum deflection of the application. The desired deflection will drive the target spring rates, as well as the rest of the design.



These desired deflections drive the target spring rates, and the rest of the design.

Dimensional Constraints

Determining the working envelope (assuring the spring fits the rest of the assembly). Here are some common issues with various spring types:

Compression Issues

- The variety of desired working lengths
- How much solid length it can allow
- Whether or not it can fit over a shaft
- Whether or not it fits inside a bore or cylinder

Extension Issues

- The variety of desired working lengths
- Whether or not it fits a bore
- Whether the end attachments can fit in other parts of the application

Compression springs grow in outside diameter when compressed, so if the part fits in a bore, it must be checked for potential binding.

Other Considerations

- Spring washers also change dimensions as they compress.
- Torsion springs grow in length, and shrink in i.d. as they deflect.
- Dimensional changes must be considered or the spring could bind and perform poorly in service.

Working Conditions

Temperature & Corrosion

Working temperatures and corrosion issues must be considered, to prevent unexpected failures. Here are a few tips:

Temperature Extremes

- High temperatures usually cause plastic deformation or loss of load. Also called “set”.
- The modulus of material naturally decreases at elevated temp., even without set.
- Regardless of material, high stress increases set at elevated temps.
- Rough order of high temperature resistance, in common materials, least to highest; carbon steel, alloy steel, stainless steel, nickel alloys, superalloys.
- Very low (cryogenic temperature) can induce brittleness of the material.

Corrosion Concerns

- “Corrosion is a big problem when it’s a surprise.” i.e. rapid failure, like the photo at left.
- High strength stainless can be subject to rapid failure in surprisingly benign conditions - example 17-7 near, but not in sea water can fail rapidly.
- Coatings may sometimes be cost effective, but are not always reliable.
- For known corrosive applications, many different alloys are available. Stainless is NOT automatically a valid choice.

Special Performance Requirements

Fatigue Life (resistance to breakage)

- Classic example automotive engine valve springs - must last millions of cycles.
- For some accessories a few thousand cycles may be acceptable, such as a hood spring.
- Might be continuous cycling between fixed points, or might be subject to variable loading, like a suspension spring.

Dynamic Loading

- When loading is at a very high speed, or impact related, stress calculations are complex.

Load Loss, or Set

- Customer expects spring to retain loads over time.

Other Requirements

Many other special performance requirements are possible - important to spell out the acceptance criteria, in the design process.

Commercial Issues

The best commercial approach for a spring design can vary, depending on the organization's structure and goals. A designer may not have commercial responsibility for his design, but a good designer will always work to compliment the commercial needs of his organization.

What quantity of parts is required and what is the desired delivery?

A process feasible for small volumes of production may not be satisfactory for large volumes. Lead times can vary, depending on materials and the degree of automation used for production.

What is the stage of production?

Is the part currently in production, or brand new? What is the motivation for potential design changes?

What are the manufacturability expectations?

Determine required critical dimensions, if any. Avoid double dimensioning - if all physical dimensions of the spring are fixed, then the forces may not be readily adjustable. Special process requirements can influence cost & leadtime. The design validation methods, and responsible parties should also be determined.

Get Started Now!

By following the provided steps, the design calculations can be performed quickly and accurately, and expectations can be met. Spring Engineers is happy to provide complimentary design assistance for our customers. Tell us about your project today!

Contact Information:

Call Us: **713-690-9488**

Or fill out a form on our site:

http://www.springhouston.com