Technically Speaking X

Prestressing of Springs Stressed in Bending

Prestressing of compression springs is very well known and was the subject of the fifth article that IST prepared in this series. Compression springs are stressed in torsion, but prestressing is equally applicable to spring materials stressed in bending. This subject was studied in **Techspring**, a research project part funded by the **European Commission**, and undertaken by a consortium of European companies of which IST was one.

Prestressing is a process in which the spring is deflected beyond its elastic limit so that the surface of the spring is plastically deformed. Hence the shape of the spring is permanently changed. Few other industries use the process. Springmakers know that the process improves the available elastic deflection of springs and improves their relaxation and fatigue resistance. Springmaker's customers often question whether the high cost of this process is justified, and are reluctant to carry it out themselves. The purpose of this article is to confirm the benefits of this process, and also to show that the design limits previously published are very conservative and could increased safely bringing benefits to all.

Prestressing of leaf springs is a process that involves bending the spring to an arc that causes the bow to be permanently changed. This process is often carried out simultaneously with shot peening so that the residual compressive stress depth is significantly increased compared to peening the spring in its free state. The stress recommended to be applied for this strain peening is 130% of the tensile strength of the material from which the spring is made. That is to say, the applied bending stress right at the spring's tensile surface is the nominal tensile strength multiplied by 1.3. This high stress gives rise to no risk of fracture in a correctly heat treated spring. So leaf springs, like compression springs, are regularly and beneficially prestressed in manufacture.

Why then, do spring manufacturers seldom if ever prestress torsion springs, which are stressed in bending like leaf springs? The answer is that it is a difficult and expensive process for them to carry out. In addition, the published prestress stress limit is usually 100% of the wire tensile strength, and at this stress the change in leg angle, and the benefits obtained, are small. A few torsion springs are prestressed by the installer. Now the costs associated with the process at the time of installation can be quite small. For instance roller shutter door springs can easily be "overwound" a little when installed to compensate for the loss of torque due to relaxation in the first few weeks of use. It is quite common for installers of such springs to be called back because the spring soon loses the ability to fully wind the door, and so the installer puts a few more degrees of wind on (prestresses, although they don't usually know this is what they are doing) and the door works OK thereafter. In the Techspring project torsion springs were frequently prestressed to 130% of the wire tensile strength. They never broke. They always performed better after this process. So IST advise increasing the prestress design limit for torsion springs from 100% to 130%, and this change has been built into the Techspring version of IST's CAD programs.

When I was in India, a young lady engineer asked me whether this same principle could and should be applied to spiral springs. She had observed that the springs her company made functioned well, but were stressed at 110 – 120% of the strip tensile strength, and she was concerned about some imminent disaster. Most assuredly the same principles apply, and 130% may be used as the prestress design limit for spiral springs. The maximum stress limit in IST's CAD program for spiral springs will be upgraded at the next revision.

A typical torque test machine on which the principles espoused here may be tried out for yourself is shown in figure 1.

Figure 1 Spring Torque Test Machine

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Readers are encouraged to contact him with comments about this technically speaking column, and with subjects that they would like to be addressed in future.
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