

Technically Speaking XVI

Spring Design Stresses

The last article in this series introduced “Spring Calculator Professional”. The newly added features to this software will be described in the next few editions of this column. The subject this time is spring design stresses – probably the least well defined parameter of spring design in all the international standards for spring design around the world.

To start, the perceived faults with current standards will be described, as this will reveal the rationale behind IST’s addition to SCP of a new design protocol called “Techspring”. This new spring design protocol arose out of this research project, which was described in earlier columns in this series.

The EN 13906 series of spring design standards and their counterparts in Japan like JIS B2704 utilise uncorrected stresses to define whether a spring needs prestressing, or whether it is overstressed. The calculated stress is compared with the material tensile stress to make this decision – this approach continues to be used in Techspring. The EN value for prestressed springs is the same for all spring materials, which seems to IST to be unlikely to be appropriate, although the value given for carbon and oil tempered wire is considered to be accurate. However, the percentage for springs without prestressing is definitely too high. The Japanese standards acknowledge that there should be differences in the design limits for different materials – stainless steel and copper alloys having lower values than carbon steel for instance, but often the values in the Japanese standards are too low – a very conservative and safe approach, but this will lead to spring designs that are too safe to be competitive on the world market today.

The American standards and the obsolete standards of UK and Italy utilise corrected stresses to define the need for prestressing and “overstressing”. They describe different limits for different materials, which IST believe to be correct. However, these standards take no account of coiling ratio (index) in defining the percentage. This leads to spring designs that cannot be made at large index and very conservative maximum design stresses at small index.

The Techspring design protocol attempts to combine the good features of using uncorrected and corrected stresses, and to this IST have added an additional calculation, that was observed in the Techspring research project, that the elastic limit of springs with a large index is a little lower than that of springs with a small index. Corrected stresses are used.

An example of a printout of a compression spring design using the Techspring design protocol is shown in figure 1.

Identifier: WFTI Example
 Part Number: 1
 Details: Techspring

Spring Type Round Wire Compression

Designed To: Techspring: 2008
 Tolerance Standard: EN 15800: 2010

Calculated Data

Solid Length: 13.00 mm
 Solid Load: 335.46 N
 Solid Stress: 1388.1 N/mm²
 Stress Factor: 1.30
 Active Coils: 5.20
 Spring Index: 5.00
 Helix Angle: 7.46 Deg
 Buckling Possible: STABLE
 Buckling Definite: STABLE
 Spring Pitch: 4.12 mm
 Inside Diameter: 8.00 mm
 Mean Coil Dia.: 10.00 mm
 Wire Length: 221.42 mm
 Weight / 100: 0.547 Kg
 Natural Freq: 82480 RPM
 As-Coiled Length (l): 24.62 mm
 Max Recommended Cycle Speed: 6815 RPM

Material

ASTM A228 Music Wire
 Youngs Mod (E): 206844 N/mm²
 Rigidity Mod (G): 79290 N/mm²
 Density: .00000786 Kg/mm³
 Unprestress: 0-49.4 %
 Prestress: 49.4-76.4 %

End Type: Closed and Ground
 Dead Coils: 1.80
 Tip Thickness: 25.00 %
 End Fixation: Both Ends Fixed and Guided

Design Parameters

Wire Diameter: 2.00 mm
 Outside Diameter: 12.00 mm
 Total Coils: 7.00
 Spring Rate: 30.50 N/mm (Calculated)
 Free Length: 24.00 mm

Stress Data

	Lower Tensile	Solid	Operating Positions	
			1	2
Specified	1944	71 P	19 U	45 U

Operating Data

	Operating Positions	
	1	2
Length (mm)	21.00	17.00
Load (N)	91.49	213.47
Deflection (mm)	3.00	7.00
Stress (N/mm ²)	379	883
Stress % Solid	27	64
Load Tol. Grade 1 (N)	12.28	13.43
Load Tol. Grade 2 (N)	19.49	21.32
Load Tol. Grade 3 (N)	31.19	34.11
O.D. Expansion (mm)	0.0261	0.0608

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Figure 1

This is an index 5 compression spring in music wire. The Techspring design protocol says this spring needs to be prestressed, but is not overstressed at its block or solid length. It advises that an as-coiled length of 24.62 mm would lead to a length of 24mm after prestressing. Assuming that the wire was supplied at the bottom limit of its tensile strength range, the EN standard gives the same results as above, but without the “guesstimate” of the as-coiled length. The US, UK and JIS standards say that this spring would be overstressed and so would not attain 24mm free length if prestressed to its solid length.

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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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