Technically Speaking 21

Compression springs

Users of the “Spring Calculator Professional” (SCP) - software for designing springs - have raised questions about the types of compression springs that can be calculated using this software and how accurate the results would be. In particular, does Finite Element Analysis (FEA) provide results that are more accurate? To answer these questions, it is appropriate to describe IST’s method for reconciling load test results of a compression spring with the output of SCP, as this illustrates how confidence has been acquired in the accuracy of SCP.

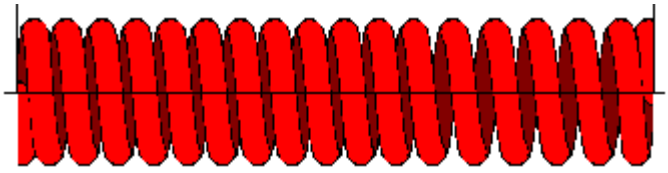
For a parallel sided compression spring of constant pitch in the active coils, the load-deflection characteristic will be a straight line, and so measuring the load at two working lengths is sufficient to establish the design. There is almost always a discrepancy between the rate results and the values of SCP when the accurately measured dimensions are input. This discrepancy arises almost entirely because of uncertainty about the number of inactive coils. Hence adjustment of the number of inactive coils so that the actual and theoretical rate are identical is sufficient. Now the load values are usually lower than those given by SCP, and this is because the spring ends are not perfectly parallel, and so it is the free length corresponding to the length at which all active coils are fully engaged that needs to be used. Hence the input free length is adjusted to a slightly lower value than the maximum measured. Many research projects have shown that the classical mechanics formulae for calculating the torsional stress in the active coils of a compression spring are accurate to within one or two percent. By this method, the measured design of a spring with closed and ground ends, which is assumed to have two inactive coils, is adjusted as shown in table 1.

Parameter	Measured values	SCP before adjustment	SCP adjusted
Wire Diameter, d	3.2	3.2	3.2
Outside diameter, D_o	27.0	27.2	27.2
Total coils, n_t	6.25	6.25	6.25
Active coils, n	4.25	4.25	4.60
Load at 36 mm, N	84	97	84
Load at 26 mm, N	252	279	252
Rate, N/mm	16.80	18.18	16.80
Free length, L_0	41.35	41.35	41.00

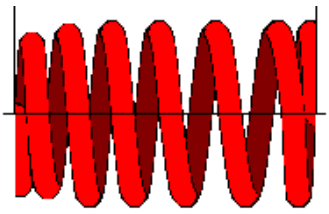
Table 1 Example of adjustments made to measured values to achieve SCP design – in this example the number of inactive coils has been adjusted from 2 to 1.65, and L_0 from 41.35 to 41.00 mm.

The correspondence between load and stress for the adjusted SCP design has been shown to be accurate, and can safely be used by spring manufacturers to calculate whether this spring. needs prestressing and for estimating the relaxation and fatigue performance that can be expected in service. In this case, this spring made from music wire, would not need prestressing, would relax by 1.5% in one year of use at 30°C and would survive ten million cycles without risk of fatigue.

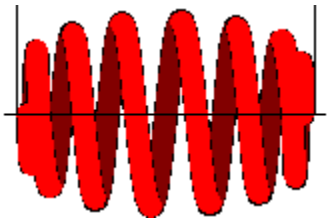
These same principles may be applied to compression springs of the shapes shown in figure 1 using the “non-standard compression” module of SCP.



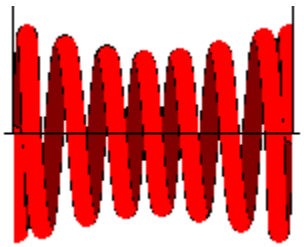
Dual rate suspension spring



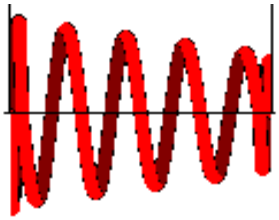
Beehive valve spring with variable pitch



Barrel shaped spring made from machined wire



Diabolo shaped spring



Conical spring

Figure 1 Examples of springs calculated accurately using SCP

Use of the non-standard module enables the correspondence between load and stress to be established. FEA could be used to undertake this same function, but the results would be no more accurate, and FEA would not enable relaxation and fatigue performance to be estimated.

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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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