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Dynamic stresses

Two recent enquiries from users of the “Spring Calculator Professional” (SCP) software concerned the implications of utilising compression and extension springs at speeds fast enough to generate dynamic stresses. This article sets out to confirm the information available, and by inference data that cannot be accurately predicted.

Conventional wisdom has it that if a spring is operated at a speed in excess of one thirteenth of its natural frequency, then dynamic stresses will arise above and beyond the stresses calculated as a result of that calculated from the deflection due to the statically applied load. SCP calculates natural frequency using units of rpm for both compression and extension springs. If the Techspring design method is utilised, it further displays the maximum speed at which dynamic stresses may be assumed to be zero, and this time in units of rpm and Hz. This calculation is simply one thirteenth of the natural frequency. Research carried aout some years ago at IST showed that at this frequency the additional dynamic stresses were much less than 2%, a small amount, but not quite zero.

Many springs are used at speeds at which dynamic stresses are present, and usually they operate quite reliably too. SCP estimates these dynamic stresses and will plot them on a Goodman Diagram, as figure 1 shows.

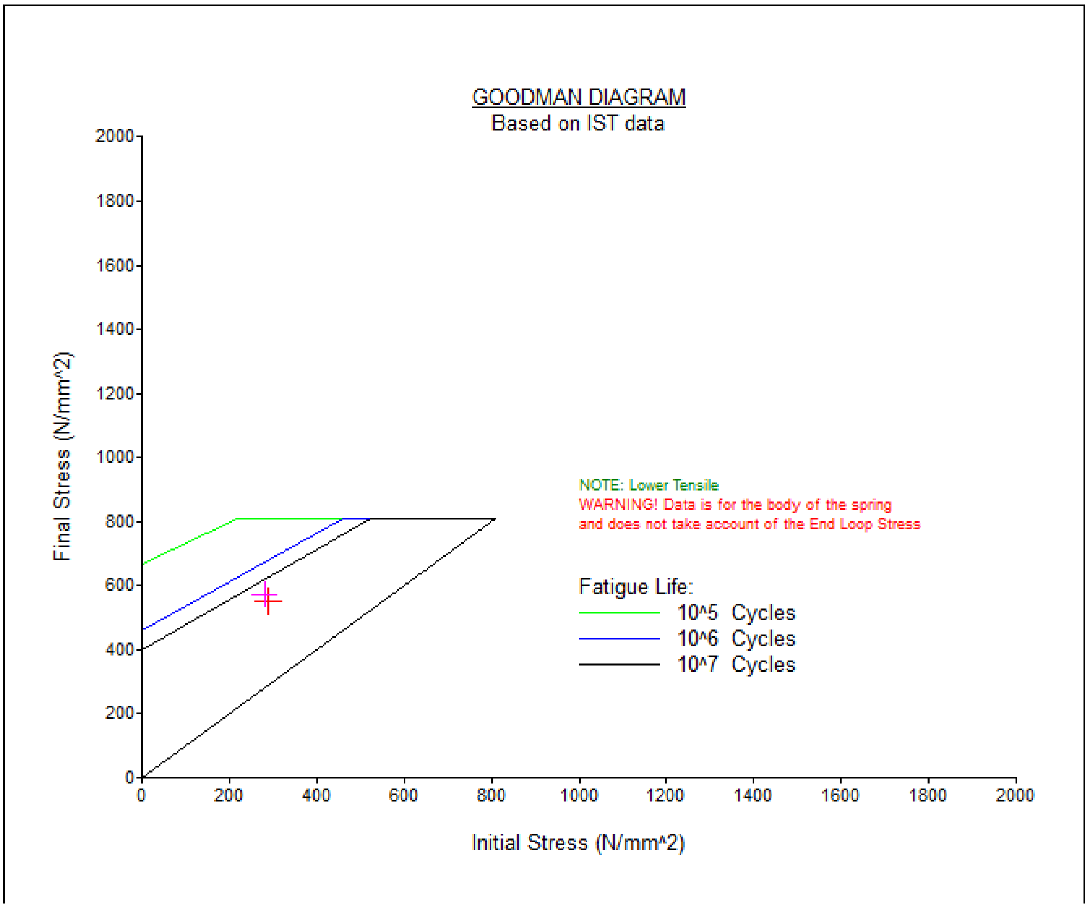

Figure 1 Goodman diagram for the body of an extension spring operating at 6 Hz and 12 Hz

The two crosses on this diagram are close to each other, but the one NW of the other applies at 12 Hz, and is still within the 10 million cycle line so the body of this spring is predicted to be safe at this speed. As it happens the loop stresses are also within the Goodman Diagram, but that is something that will be discussed in a future column.

The maximum speed at which a spring will operate is its natural frequency, but at this speed it is certain to resonate, and so it makes no sense to try and operate a spring so fast however small the amplitude of deflection. However, at one half or one quarter of the natural frequency the resonant amplitude may not be so great that failure will occur. If readers want to be assured that resonance is not always fatal, the spring shown on the front page of www.spring-tech.eu still exists despite doing more than a million cycles at 2,400 rpm, its second harmonic.

This spring was loaded axially, but if you look carefully at the moving image, you will see that the spring is also resonating rotationally and laterally. The lateral resonance and dynamic stresses are particularly important in springs when they are deflected axially and laterally simultaneously.

The one parameter that cannot be predicted accurately in SCP is the amplitude of resonant deflections, but there is much more data available than some users of this software were aware.

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