Cautionary Tale: Wire Quality

The last cautionary tale concerned the skills gap in spring manufacturing, and how it might be closed by training. This prompted questions about springmakers' raw material supply industry and training, in particular for wire drawers. It is the opinion of some spring manufacturers that the quality levels achievable are limited by the quality of spring wire despite being told in an IST training course, and in this column, that the quality of spring wire has been improving everywhere in the world over the last thirty years.

IST stand by their contention that the quality of spring wire is improving, but spring wire is far from perfect, and there have been two quality complaints that the author of this column has had to address recently. The first concerns the presence of surface defects in stainless steel spring wire, and the second relates to the quality of music wire when the rod raw material has not been lead patented. In both instances the wire supplier commented that the springmaker's improved inspection facilities were revealing the faults that have always been present. Companies that are ISO 9001 accredited are obliged to show evidence of pursuing continuous improvement – this applies to wire drawers and springmakers alike, and improved inspection equipment is one way of driving quality standards up.

Stainless Steel Spring Wire Quality

A spring manufacturer was having problems with failures on life test at his customer's test of the final assembled product. The problem was attributed to wire defects, which metallographic examination revealed to be of a depth of 1.4%d. The springmaker wanted to know whether there was a simpler way to measure such defects accurately, but was disappointed to be advised that IST did not believe there was a better way than metallography. They then asked whether such a defect would be considered "harmful to use". That answer was easy because the springs were failing life test and IST's software said they should not. Then the question arose "why is the maximum defect level permitted for dynamic springs not clearly written into the supply standards?" The maximum defect permitted in dynamic quality (not valve quality) music wire and SiCr is stated to be 1.0%d in most international standards, but not for stainless steel. IST are of the opinion that the maximum defect level should be the same for all wire qualities intended for a dynamic application. They recommend that spring manufacturers add a clause to their stainless steel wire purchases requiring a maximum defect level of 1.0%d when they know the wire will be used for springs with a dynamic application. Indeed, at larger sizes, greater than 5.0mm there is also merit in specifying a maximum defect level of 50 microns – a size that may be reliably found by the only applicable non-destructive test for spring wire, eddy current testing. After all, if making dynamic springs in 10mm wire, a defect approaching 100 microns or 0.1mm deep would be damaging. Shot peening of springs of this size would give rise to a residual compressive stress of about 150 microns deep, not much deeper than the defect, which itself would have a significant stress raising effect.

Music Wire Quality

Music wire is generally drawn from wire that has been lead patented during wire manufacture. At sizes smaller than about 2mm, the lead patent process route is the only one possible, albeit that some manufacturers use a fluidised bed instead of liquid lead, for fear that one day the use of liquid lead may be banned on health and safety grounds. IST believe that the use of liquid lead in the wire industry is safe, but are not confident that health and safety legislators will listen to their compelling arguments. However, that is another story.

Larger sizes of music wire are sometimes drawn directly from Stelmor cooled (air patented rod). The interlamellar spacing of the pearlite will be larger when air patenting compared to

lead patenting, and it is this parameter that determines the ductility of the wire during drawing. As-patented the wire is ductile, but at every wire drawing die the wire becomes stronger and less ductile. Eventually the wire ductility will be reduced to such a low level that there is a risk of internal cracks forming along the centre line of the wire. Such defects are not acceptable in spring wire as the wire will be prone to fracture during spring coiling, or during service. It is IST's opinion that the production route adopted by the wire drawer should be left to their discretion, but if patented wire is drawn too far it will form cracks like the ones shown here as figure 1.

Figure 1 Over-drawn music wire with chevron shaped cracks along the centre line.

The moral of this cautionary tale is that wire quality may limit a spring manufacturer's quality, but these problems are rare, and with continuous improvement, should become rarer. It is hoped that by publishing details of these quality problems, IST are playing their part in driving quality standards up.

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Readers are encouraged to contact him with comments about this cautionary tale, and with subjects that they would like to be addressed in future tales - e-mail ist@ist.org.uk