Cautionary Tale: Marketing of Extension Springs

The best way to market extension springs is to claim that your company's springs outperform your competitors'. If this marketing is based upon research results, it should be sound. However, very little research has been done to quantify the performance of extension springs until now. A systematic study of extension spring loops has been conducted within Techspring, a European research project of which I was the project manager.

In this cautionary tale, readers will be exposed to Techspring research results in order to answer some of the marketing claims made to me by springmakers, like:

- "I changed from English (crossover) loops to German, and the customer reported that life was now satisfactory."
- "I changed from German loops to English, and this sorted the breakage problem."
- "By increasing the hook diameter slightly, the life of the extension springs was improved."
- "By reducing the hook diameter, it stopped the hook failing in service."
- "Shot peening the end loops delayed the service failures by over a year."

One or two of the above reports may be exaggerations, delusions or marketing hype of the worst kind.

As the croupier* to the spring industry might say "Messieurs, faites vos jeux." Translated: "Gentlemen, place your bets." Is your money on English or German hooks, enlarged or reduced loops compared to the body coils? Or do you put all your faith in shot peening?

One thing is certain from the Techspring project— the reliability of the extension spring was never transformed to complete satisfaction. The life improvement from each of these measures was always disappointingly small.

The project first looked at English vs. German loops. It was observed that springs which rolled smoothly on a bench performed better than those that did not. In other words, when the end hooks protruded outside the space envelope made by the body coils, the hooks failed prematurely on test. When the loops protruded, the springs "rocked and rolled" on the bench. While rock 'n' roll has its place, it is not best for extension spring life. The research results were very similar for English or German loops for extension springs of index 8 and larger, when these hooks were accurately made. So claims A and B cannot be justified. Many think that the sharp bend required to form the English loop is a stress raiser, and indeed it is (especially when the index is small), but this is not the position of maximum stress. The loops all failed at the position shown in figure 1, whether they were German or English loops.

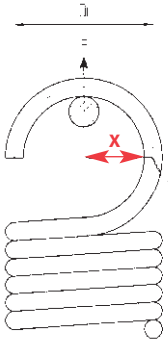

Figure 1 Fatigue fracture always occurs in this region

The bending stress at the failure position should be calculated. The Techspring project studied the formula used by IST, which is as follows:

$$q_b = \frac{16\,FD_L K_L}{\pi d^3} + \frac{4F}{\pi d^2}$$

$$k_L = \frac{4w_L - 1}{4w_L - 4} \quad where \quad w_L = \frac{D_L}{d}$$

qb = bending stress in the loop or hook
F = spring load
DL = Mean diameter of loop
d = wire diameter

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This formula proved to be accurate and is recommended. It is one that is absent from spring design standards such as EN13906-2.

Looking at this formula it is clear that the stress in the end loop will be minimized if the loop diameter is reduced. I guess the claimants (and there have been a few), who said enlarged loops improved the life were deluding themselves. How much should the loop diameter be reduced so that the springs no longer fail in the loops? For the answer to this question, you will have to wait for the next installment of this thrilling tale of extension spring loop research in the next issue of *Springs*.

The claim made for shot peening of end loops should be examined first, because this might be the simplest way to stop the end loop being the weakest point in an extension spring. 302 stainless steel extension springs with accurately made English loops were supplied to the Techspring project. They were tested without glass bead peening and all the springs failed at the position shown in Figure 1. After glass bead peening, some springs failed in the loop, but others failed at the sharp bend at a position shadowed from the streamed shot. The fatigue lives were as shown below.

The moral of this cautionary tale is "Base your marketing on research and not on guesses." That will improve the standing of your company and the industry in general. Claims A to E may all have had an element of truth, but to solve end loop problems you will have to wait for the next installment of this tale. ●

**A croupier or dealer is a casino employee who takes and pays out bets or otherwise assists at a gambling table. (Source: Wikipedia)*

Body stress range/MPa Load Positions/N	Life without shot peening / cycles	Life with peening / cycles
200 - 750 (14 - 52N)	21.8k H, 23.3k H	53.4k H, 64.1k B
200 - 700 (14 - 48.5N)	27.6k H, 29.9k H	81.4k H, 114.6k B
200 - 650 (14 - 45N)	26.7k H, 46.0k H	189k B, 196k B
200 - 600 (14 - 41.5N)	44.1k H, 44.2k H	4 @ 1000k
200 - 550 (14 - 38N)	2 @ 1000k	

H = Failure in the hook B = Failure at the sharp bend at the base of the hook

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