Tech-Spring Report 3
EFFECT OF SHOT PEENING ON STAINLESS STEEL EXTENSION SPRINGS

Introduction

A batch of stainless steel extension springs were supplied that were understood to fail prematurely in service – in which both ends of the spring moved simultaneously, but with operating lengths of 48.0 and 56.5 mm (26 - 40N). In the first instance it was of interest to know by how much shot peening would improve the fatigue life of these springs, which had crossover or English loops. The spring design is shown in figure 1. Load testing revealed that the springs had a rate of 1.66 N/mm and initial tension load of 11.2 N. At an applied load of 52N less than 2 N of initial tension had been pulled out.

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Spring Type Round Wire Extension

Designed To:	BS 1726-2: 1988	
Tolerance Standard:	BS 1726-2: 2002	

Material

EN 10270 Pt3 Aust. Stainless

Youngs Mod (E):	185000	N/mm^2
Rigidity Mod (G):	73000	N/mm^2
Density:	.00000790	Kg/mm^3
Unprestress:	0-40	%
End Type:	Crossover Loop	
Loop Selection	Equal to Body Dia.	
Loop Outside Diameter:	10.02	mm

Calculated Data

Estimated Free Length:	39.11	mm
Initial Tension Stress:	161.02	N/mm^2
Body Length:	23.99	mm
Body Length (Max):	24.28	mm
Stress Factor:	1.20	
Spring Index:	7.15	
Inside Diameter:	7.56	mm
Mean Coil Dia.	8.79	mm
Loop Inside Diameter:	7.56	mm
Wire Length:	566.57	mm
Weight / 100:	0.532	Kg
Natural Freq:	17663	RPM

Design Parameters

Wire Diameter:	1.23	mm	
Outside Diameter:	10.02	mm	
Total Coils:	18.50		
Spring Rate:	1.66	N/mm	(Calculated)
Initial Tension:	11.20	N	
Free Length:	39.07	mm	

Stress Data

			Operating Positions	
	Lower		% Tensile	
	Tensile	I. T.	1	2
NS	1850	9 U	11 U	41 O
HS	2000	8 U	10 U	38 U
Specified				

Operating Data

	Operating Positions	
	1	2
Length (mm)	40.68	63.73
Load (N)	13.88	52.19
Deflection (mm)	1.61	24.66
Body Stress (N/mm^2)	200	750
Loop Stress (N/mm^2)	384.34	1445.6
Load Tol. Grade 1 (N)		
Load Tol. Grade 2 (N)		

Figure 1

The fatigue test results were

Body stress range /MPa	Life without shot peening	Life with peening
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 @ 1m
200 – 550 (14 – 38N)	2 @ 1m	

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

Conclusion

The should not have failed in service, but shot peening will add significantly to the safety of this application. Peening of this small wire was successful, both in terms of increasing the life at higher stresses and increasing the stress range available without risk of failure.

The premise that these springs fail because both ends move simultaneously would merit further investigation.

The shot peening was significantly less effective at the sharp bend because part of the bend was shielded by the coil below. This is the reason the failure position often changed to the bend position in the shot peened springs. The bending stress at the sharp bend should be less than in the hook, but it would be very interesting to know by how much, bearing in mind the net stress will be the applied minus the residual.

IST software (figure 2) predicts failure in the body at 100k cycles when the body stress range is 200 – 750N. This advice is only useful if you are going to design the hooks to a stress low enough to prevent failure in the hook. The "toolkit" developed in Tech-Spring should enable much more helpful and accurate prediction of extension spring hook fatigue failures.

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Goodman Diagram

Material:	EN 10270 Pt3 Aust. Stainless
Grade:	NS
Shot Peened:	No

Operating Positions

	1	2
Length (mm):	40.68	63.73
Load (N):	13.88	52.19
Stress (N/mm^2):	200	750

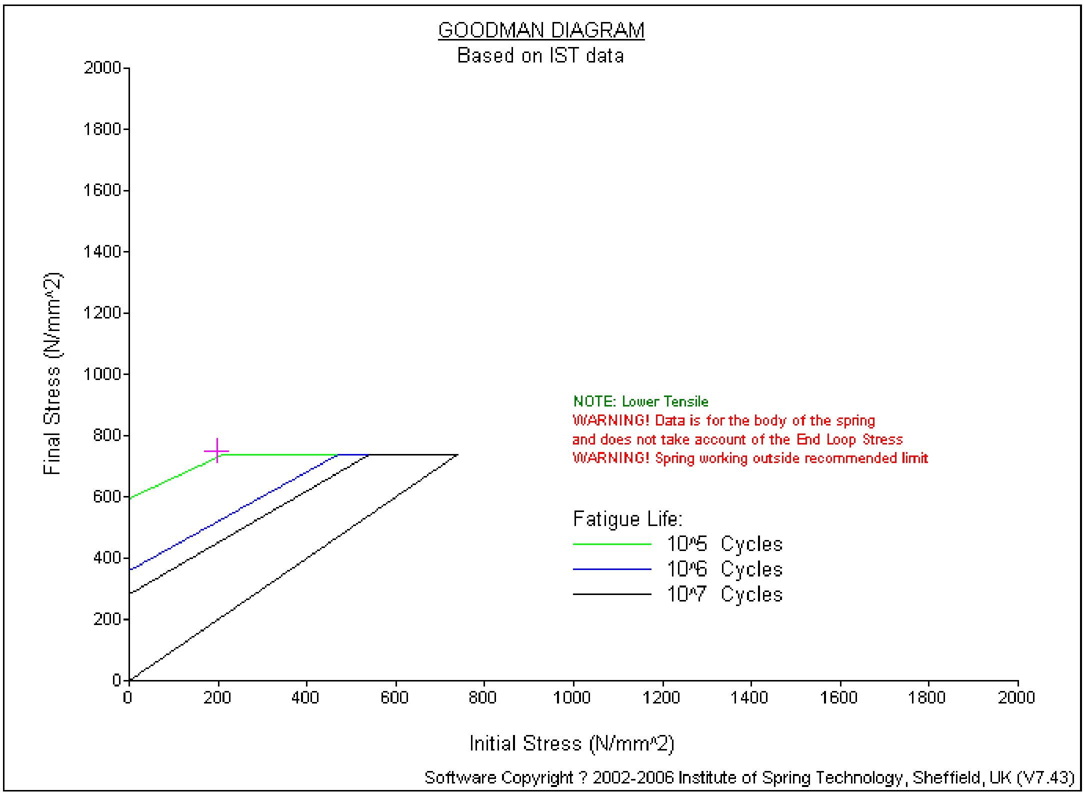

Figure 2