



**Tech-Spring Report 4A  
EFFECT OF PRESTRESSING ON FATIGUE LIFE**

**Introduction**

A batch of compression springs made from DIN 17224 302 stainless steel quality was obtained. The springs had not been shot peened, but were of a design that would shorten appreciably when cold prestressed, as shown in Figure 1.

The springs were fatigue tested at corrected stress levels suitable to cause the springs to fail by fatigue initially, and were then re-tested at stress levels at which they would survive.

Prior to fatigue testing the springs were

	<u>Free Length</u>
a) Not prestressed	64.3mm
b) Prestressed to 38mm	63.8mm
c) Prestress to 30mm	62.7mm
d) Prestressed to solid (i.e. 20.5mm approximately and 600N)	60.4mm
e) Hot prestressed to 21.1mm at 200°C.	58.6mm
f) Hot set to 22mm at 200°C.	55.6mm

The fatigue test results were as shown in Table 1.

**Batch - Not Prestressed**

Corr. Stress Range / MPa	U/B at 10 million	Life to Failure
100-700	-	2 @ 100 & 106k
100-650	-	2 @ 94 & 112k
100-550	-	2 @ 221 & 258k
100-500	1	3 @ 396k, 463k & 900k
100-475	3	1 @ 1.69m
100-450	4	

**Batch - Prestressed to 38mm**

Corr. Stress Range / MPa	U/B at 10 million	Life to Failure
100-700	-	2 @ 117k
100-650	-	2 @ 311k
100-550	-	3 @ 854k
100-500	1	3 @ 2.17k, 6.19k & 9.10m
100-475	4	

**Batch - Prestressed to 30mm**

Corr. Stress Range / MPa	U/B at 10 million	Life to Failure
100-700	-	2 @ 141k
100-600	-	2 @ 471k & 1.61m
100-550	-	2 @ 230k & 307k
100-525	2	2 @ 5.5m & 8.9m
100-500	4	-

**Batch - Prestressed to Solid**

Corr. Stress Range / MPa	U/B at 10 million	Life to Failure
100-700	-	2 @ 141k & 194k
100-600	-	2 @ 685k & 1.14m
100-550	1	1 @ 2.06m
100-525	3	1 @ 1.22m
100-500	6	-

**Batch - Hot Prestressed**

Corr. Stress Range / MPa	U/B at 10 million	Life to Failure
100-550	1	3 @ 0.43m, 1.10m & 3.11m
100-500	3	1 @ 6.71m
100-475	3	1 @ 2.17m

These springs appeared to have transverse, longitudinal and 45° cracks, as shown in figure 2



**Figure 2**

**Batch - Hot Set**

Corr. Stress Range / MPa	U/B at 10 million	Life to Failure
100-550	2	-
100-600	2	.

**Table 1 Fatigue Test Results**

## Conclusion

Prestressing improved the fatigue stress limit of these springs from 100-450MPa to 100-500MPa. No further benefit was accrued by prestressing beyond a length of 30mm. The hot prestressed batch was worse than the cold prestressed due to cracks, as shown in Figure 2. The cause of the cracking is not yet understood. Hot setting might bring further fatigue benefits.

### INSTITUTE OF SPRING TECHNOLOGY

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Part No.: INOX  
Details: 810

#### Spring Type Round Wire Compression

Designed To: BS 1726-1: 1987  
Tolerance Standard: BS 1726-1: 2002

#### Calculated Data

Solid Length: 21.11 mm  
Solid Load: 655.53 N  
Solid Stress: 1269.8 N/mm<sup>2</sup>  
Stress Factor: 1.18  
Active Coils: 4.10  
Spring Index: 7.73  
Helix Angle: 8.83 Deg  
Buckling Possible: STABLE  
Buckling Definite: STABLE  
Spring Pitch: 13.04 mm  
Inside Diameter: 23.28 mm  
Mean Coil Dia.: 26.74 mm  
Wire Length: 516.71 mm  
Weight / 100: 3.84 Kg  
Natural Freq: 24226 RPM

#### Material

EN 10270 Pt3 Aust. Stainless  
Youngs Mod (E): 185000 N/mm<sup>2</sup>  
Rigidity Mod (G): 73000 N/mm<sup>2</sup>  
Density: .00000790 Kg/mm<sup>3</sup>  
Unprestress: 0-40 %  
Prestress: 40-59 %  
End Type: Closed and Ground  
Dead Coils: 2.00  
Tip Thickness: 50.00 %  
End Fixation: Both Ends Fixed and Guided

#### Design Parameters

Wire Diameter: 3.46 mm  
Outside Diameter: 30.20 mm  
Total Coils: 6.10  
Spring Rate: 16.68 N/mm (Calculated)  
Free Length: 60.40 mm

#### Stress Data

	Operating Positions			
	Lower Tensile	Solid	% Tensile	
			1	2
NS	1550	82 O	6 U	32 U
HS	1650	77 O	6 U	30 U
Specified				

#### Operating Data

	Operating Positions	
	1	2
Length	57.30	44.92
Load	51.72	258.25
Deflection	3.10	15.48
Stress	100	500
Stress % Solid	8	39
Load Tol. Grade 1	20.25	24.38
Load Tol. Grade 2	30.38	36.58
O.D. Expansion	0.0388	0.194

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**Figure 1 Spring Design**