INSTITUTE of SPRING TECHNOLOGY

Tech-Spring Report 6
EFFECT OF SPEED OF LOADING ON FATIGUE LIFE

A batch of Compression Springs made from EN 10270-1 DH wire was supplied with the design shown in Figure 1. It is generally assumed that if springs are dynamically tested at a speed less than 1/13 of their natural frequency, then the speed of testing will not affect the life to failure. At higher speeds than 1/13 of natural frequency there will be additional stresses due to the dynamic loading and the fatigue performance will be reduced. The natural frequency of these springs was 48,436. The test speeds selected were 1/16 and 1/96 of this frequency i.e. 3000rpm and 500rpm. The springs were prestressed to 8.9mm prior to dynamic testing.

The fatigue test results were:

Speed	Stress range / MPa	Unbroken	Life
3000rpm	352-1010	4	-
500rpm	352-1010	2	-
3000rpm	352-1062	-	220k, 450k, 1.1m, 3.6m
500rpm	352-1062	-	<580k, 2.3m, <2.6m, <2.6m

The 500rpm test speed led to IST’s failure detection method to fail repeatedly, and so failure was only observed some time after actual failure.

All springs failed from the inside surface of their active coils.

Conclusion

Test speed has had no significant effect upon life to failure, but more testing is required to put statistical confidence on this result. Is further testing justified?
Is this design appropriate for this investigation?

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Identifier:	Speed of loading spriings
Details:	810

Spring Type Round Wire Compression

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

Material

EN 10270 Pt1 Patented Carbon

Youngs Mod (E):	206000	N/mm^2
Rigidity Mod (G):	81500	N/mm^2
Density:	.00000785	Kg/mm^3
Unprestress:	0-49	%
Prestress:	49-70	%
End Type:	Closed and Ground	
Dead Coils:	1.60	
Tip Thickness:	35.00	%
End Fixation:	Both Ends Fixed and Guided	

Calculated Data

Solid Length:	6.58	mm
Solid Load:	87.26	N
Solid Stress:	1253.0	N/mm^2
Stress Factor:	1.14	
Active Coils:	3.40	
Spring Index:	9.71	
Helix Angle:	9.32	Deg
Buckling Possible:	STABLE	
Buckling Definite:	STABLE	
Spring Pitch:	7.01	mm
Inside Diameter:	12.20	mm
Mean Coil Dia.:	13.60	mm
Wire Length:	215.61	mm
Weight / 100:	0.261	Kg
Natural Freq:	48436	RPM

Design Parameters

Wire Diameter:	1.40	mm	
Outside Diameter:	15.00	mm	
Total Coils:	5.00		
Spring Rate:	4.58	N/mm	(Calculated)
Free Length:	25.65	mm	

Stress Data

	Lower Tensile	Solid	Operating Positions % Tensile 1	2	3	4
SL	1620	77 O	35 U	63 P	22 U	66 P
SM	1870	67 P	30 U	55 P	19 U	57 P
DM	1870	67 P	30 U	55 P	19 U	57 P
SH	2110	59 P	27 U	49 U	17 U	50 P
DH	2110	59 P	27 U	49 U	17 U	50 P
Specified						

Operating Data

	Operating Positions 1	2	3	4
Length (mm)	17.00	10.00	20.30	9.49
Load (N)	39.58	71.61	24.48	73.95
Deflection (mm)	8.65	15.65	5.35	16.16
Stress (N/mm^2)	568	1028	352	1062
Stress % Solid	45	82	28	85
Load Tol. Grade 1 (N)	3.62	4.26	3.32	4.31
Load Tol. Grade 2 (N)	5.43	6.40	4.98	6.47
O.D. Expansion (N)	0.136	0.247	0.0843	0.255

Figure 1