Tech-Spring Report 26
Hot Coiled vs. Cold Coiled Processes for Large Compression Springs

Introduction

The fatigue performance of a design of spring that was manufactured by two different process routes was assessed. The first method involved hardening and tempering the rod prior to coiling the springs (cold-coil method). The second method involved heating the rod and coiling the springs hot, annealing then hardening and tempering the springs (hot-coil method).

Results

Both the hot coiled and cold coiled springs were fatigue tested at three stress levels. In all cases the cycles to failure of the hot coiled springs was greater than for the cold coiled examples. The difference was more significant at lower stress levels.

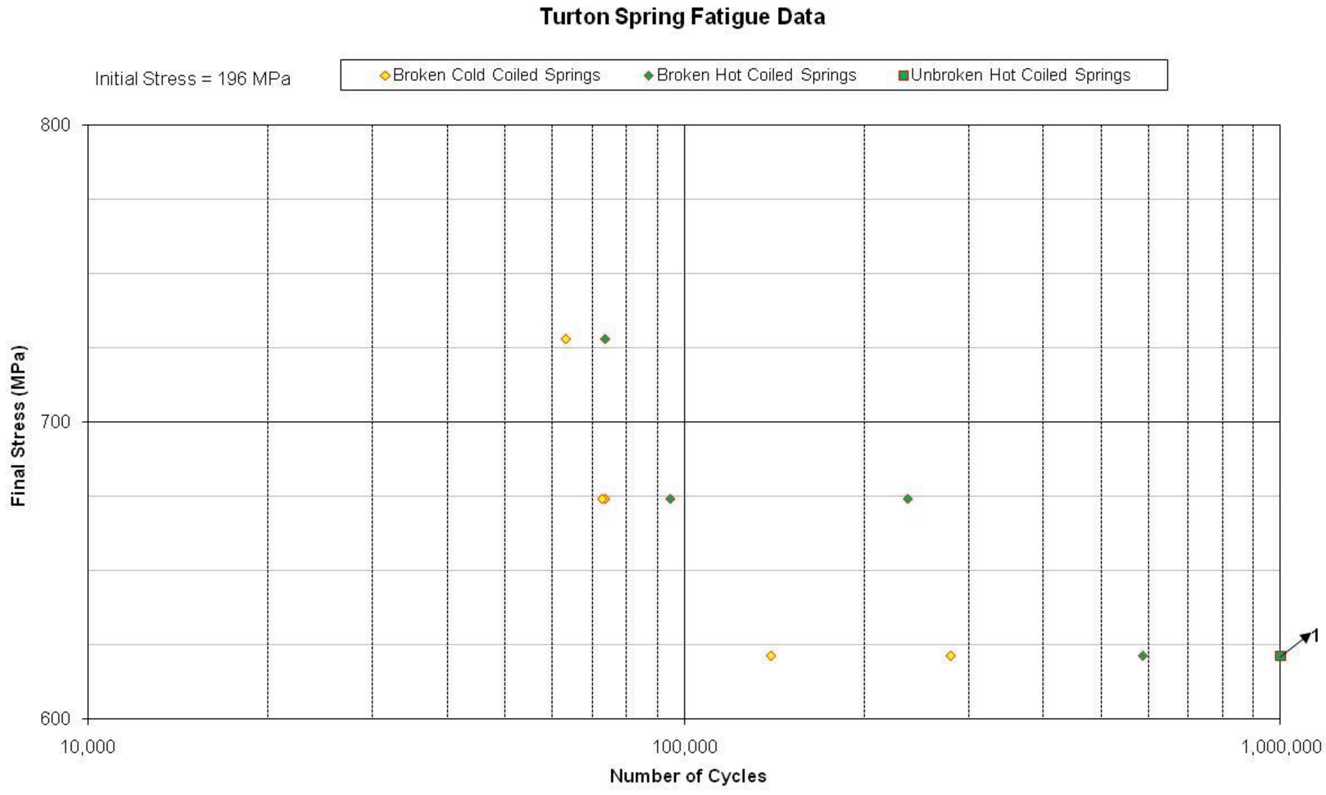

Figure 1. Fatigue data for hot and cold coiled springs.

Metallurgical Examination

Transverse sections were made from a hot coiled and a cold coiled spring for examination on a metallurgical microscope. Hardness tests were also performed on the two samples.

Both springs were painted, the average paint thickness being 60µm. The two samples also had partial decarburisation to a depth of 70µm. The cold coiled spring had been lightly shot peened, and is some areas an oxide layer was present beneath the paint layer (fig. 2). There were also surface defects to a depth of 50µm. The hot coiled sample had experienced a greater degree of peening, and there was no sign of any oxide under the paint layer. Defects were present to a depth of 20µm in this case.

The two samples were of identical hardness, which was 500 HV30.

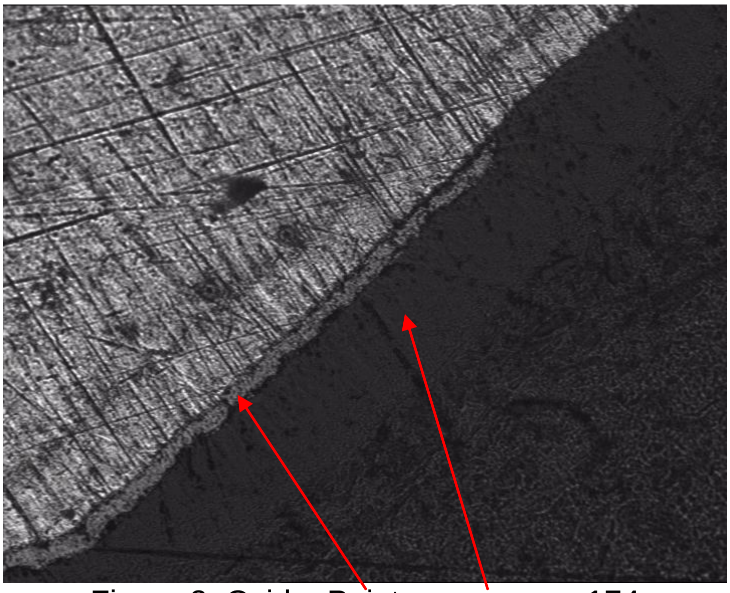

Figure 2. Oxide. Paint. x174

Conclusion

The results show that it is possible to cold coil this type of spring and to achieve a similar fatigue performance as per the hot coiled method. The slightly lower fatigue performance of the cold coiled samples is due to the peening being less thorough than it was for the hot coiled samples.

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Identifier: turtons

Spring Type Round Wire Compression

Designed To:	EN 13906-1: 2002
Tolerance Standard:	DIN 2095 / 2096

Material

DIN 17223 Pt2. Silicon -Cr

Youngs Mod (E):	206000	N/mm^2
Rigidity Mod (G):	79500	N/mm^2
Density:	.00000785	Kg/mm^3
Unprestress:	0-45	%
Prestress:	45-56	%
End Type:	Closed and Ground	
Dead Coils:	2.00	
Tip Thickness:	50.00	%
End Fixation:	Fixation not known	

Design Parameters

Wire Diameter:	15.90	mm	
Outside Diameter:	139.00	mm	
Total Coils:	7.00		
Spring Rate:	68.10	N/mm	(Calculated)
Free Length:	300.00	mm	

Calculated Data

Solid Length:	111.30	mm
Min. Length (static):	126.40	mm
Min. Length (dynamic):	133.95	mm
Solid Load:	12850	N
Solid Stress:	1002.1	N/mm^2
Stress Factor:	1.18	
Active Coils:	5.00	
Spring Index:	7.74	
Helix Angle:	7.90	Deg
Buckling Possible:	Not Applicable	
Buckling Definite:	Not Applicable	
Spring Pitch:	53.64	mm
Inside Diameter:	107.20	mm
Mean Coil Dia.:	123.10	mm
Wire Length:	2726.3	mm
Weight / 100:	424.94	Kg
Natural Freq:	4509.4	RPM

Stress Data

			Operating Positions				
	Lower		% Tensile				
	Tensile	Solid	1	2	3	4	5
KLASSE VD	NO DATA						
KLASSE FD	1550	65 O	9 U	43 U	13 U	47 P	44 U
Specified							

Operating Data

	Operating Positions				
	1	2	3	4	5
Length (mm)	275.00	175.00	263.00	163.00	173.00
Load (N)	1702.4	8512.0	2519.6	9329.1	8648.2
Deflection (mm)	25.00	125.00	37.00	137.00	127.00
Stress (N/mm^2)	133	664	196	728	674
Stress % Solid	13	66	20	73	67
Load Tol. Grade 1 (N)	185.52	249.87	193.25	257.60	251.16
Load Tol. Grade 2 (N)	294.48	396.62	306.74	408.88	398.67
Load Tol. Grade 3 (N)	471.17	634.60	490.78	654.21	637.87
O.D. Expansion (mm)	0.231	1.15	0.342	1.26	1.17