TECHSPRING
Stratford 21/10/2009

Mark Hayes, Project Manager

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Partners

Trade Associations

ANCCEM, Italy

DSA, The Nethelands

SMEs

Wire supplier, Joh. Pengg, Austria

Springmakers, Mevis, Turton, and Metalpol,

High speed camera expert, Lake, UK and Eire

Residual stress expert, Peen Services, Italy

Research Providers

IST and Innotec, Germany

Stress Analysis of Springs

Improvements to CAD
Other methods – when should springmakers use them?
Finite Element Analysis
MKS
Residual stress analysis
Strain gauges
High speed camera
Non-axial force testing
Higher strength spring wires

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Results See www.spring-tech.eu

a) Techspring reports 1 – 26 on website at end of project.

b) Techspring CAD software – see v.8

c) Training supplied, Italy (2), Netherlands (2), Poland, Germany, France, UK

d) Conference papers, Nagoya, Leoben, Stratford & Istanbul

Project ends November 30th 2009

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Reports

1 Loop size vs. fatigue
2 Effect of initial tension on fatigue
3 Peening of stainless steel ext spring hooks
4 Effect of Prestressing on fatigue of compression springs
5A Stress Profile in larger wires
6 Speed of loading vs. fatigue life
7 Stress relief LTHT vs. fatigue life
8 Torsion spring fatigue
9 Push-pull springs

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Reports

10 Speed of Production

11 Effect of hooks in extension springs

12 Effect of prestressing on dimensions and fatigue

13A Effect of leg type on torsion springs

14 Effect of non-axial forces, grinding, plating

15 End coil failures

16 Push-pull springs

17A Effect of high tensile wire

18A Shot peening appearance

19 Speed of testing

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Reports

20A Use of strain gauges for dynamic stress measure.

20B Non-axial resonances in compression springs

20C Use of strain gauges for torsion spring stresses

21 Stress relief heat treat of carbon steel comp. springs

22 FEA of a suspension spring

23 FEA of a spring clip

24 Effect of stress relief on stainless steel comp springs

25 Extension spring hook deflections – elastic / plastic

26 Hot coiled vs. cold coiled processes for large compression springs

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Reports

2 Effect of initial tension on fatigue

3 Peening of stainless steel ext spring hooks

11 Effect of hooks in extension springs

CAD programs can include hook fatigue data as a result of Techspring, but these data need to be tested by a wider community of springmakers.

A new project in which static and dynamic stress limits are investigated for compression, extension and torsion springs is appropriate.

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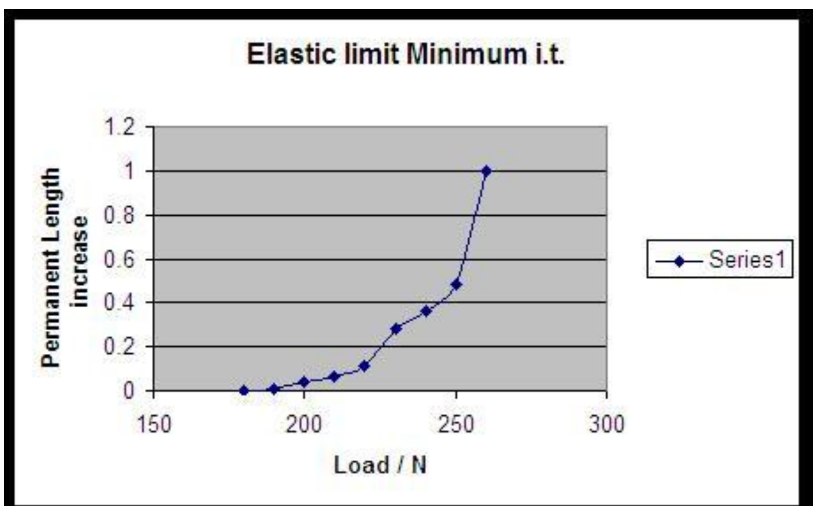
THE EFFECT OF INITIAL TENSION STRESS ON EXTENSION SPRING ELASTIC LIMIT AND FATIGUE PERFORMANCE

Report 2 showed

Open Coiled – no initial tension	elastic limit 180N
Min. Initial Tension – 5N	elastic limit 190N
Max. Initial Tension – 30N	elastic limit 230N



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THE EFFECT OF INITIAL TENSION STRESS ON EXTENSION SPRING ELASTIC LIMIT AND FATIGUE PERFORMANCE

Report 2 -springs tested from 45N load and 75mm stroke

Maximum Initial Tension

111,489	143,108	10^6	10^6	10^6	10^6	78,297	-

Minimum Initial Tension

93,382	96,095	298,215	125,448	191,199*	116,418	10^6	139,479

Slightly Open Coiled

75,737	89,330	98,455	114,164	166,420*	392,811	636,395	10^6

The minimum life was independent of initial tension

THE EFFECT OF INITIAL TENSION STRESS ON EXTENSION SPRING ELASTIC LIMIT AND FATIGUE PERFORMANCE

Report 2 showed that

1. Elastic limit was greater when initial tension was large.
2. Stress range was the main influence on fatigue performance

EFFECT OF SHOT PEENING ON STAINLESS STEEL EXTENSION SPRINGS

Report 3 1.23mm diameter 302 stainless ext springs with crossover hooks, peened with glass beads

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

Peening was beneficial

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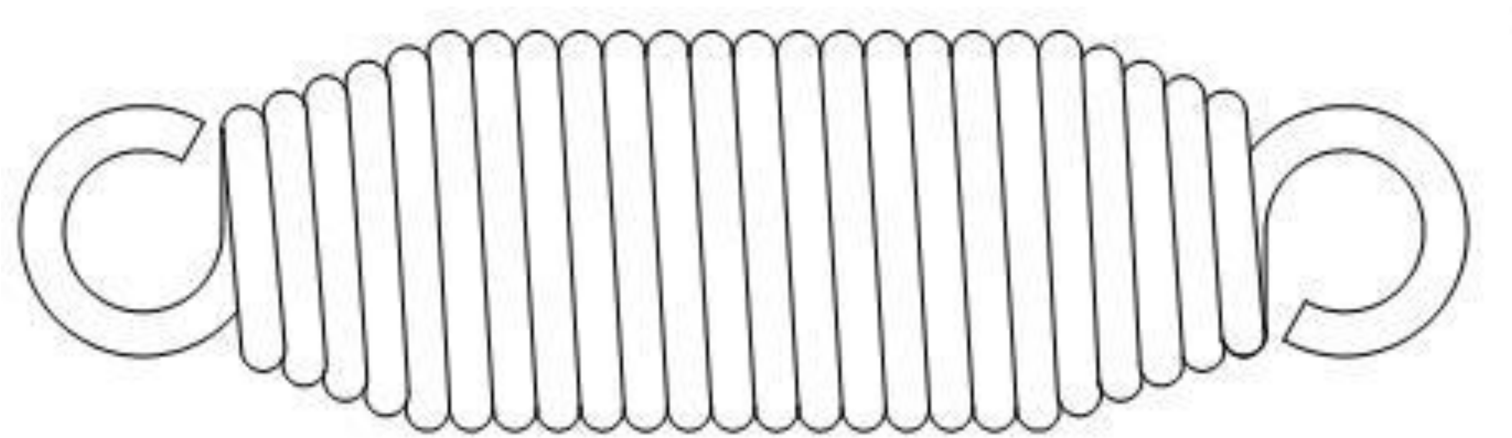
Extension Spring Hooks

Report 11 showed



How small hook needs to be so that the fatigue failure is in the body rather than the hook

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Extension Spring Hooks

Report 11 showed

2A

Lengths	**Body stress/ MPa**	**Loop stress/ MPa**	**Fatigue lives/k cycles**
173 – 327 173 – 348	177 – 715 177 – 789	282 – 1142 282 – 1259	91^{L} 94^{L} 119^{L} 10^{6} 48^{L} 50^{L} 53^{L} 73^{L}

2B

Lengths	**Body stress/ MPa**	**Loop stress/ MPa**	**Fatigue lives/k cycles**
165 – 313 165 – 334	177 – 715 177 – 792	251 – 1017 251 – 1126	141^{B} 143^{B} 193^{L} 10^{6} 63^{L} 86^{B} 96^{B} 107^{B}

2C

Lengths	**Body stress/ MPa**	**Loop stress/ MPa**	**Fatigue lives/k cycles**
160 – 300 160 – 320	178 – 722 178 – 800	226 – 916 226 – 1014	149^{B} 189^{B} 2×10^{6} 130^{B} 131^{B} 139^{B} 152^{B}

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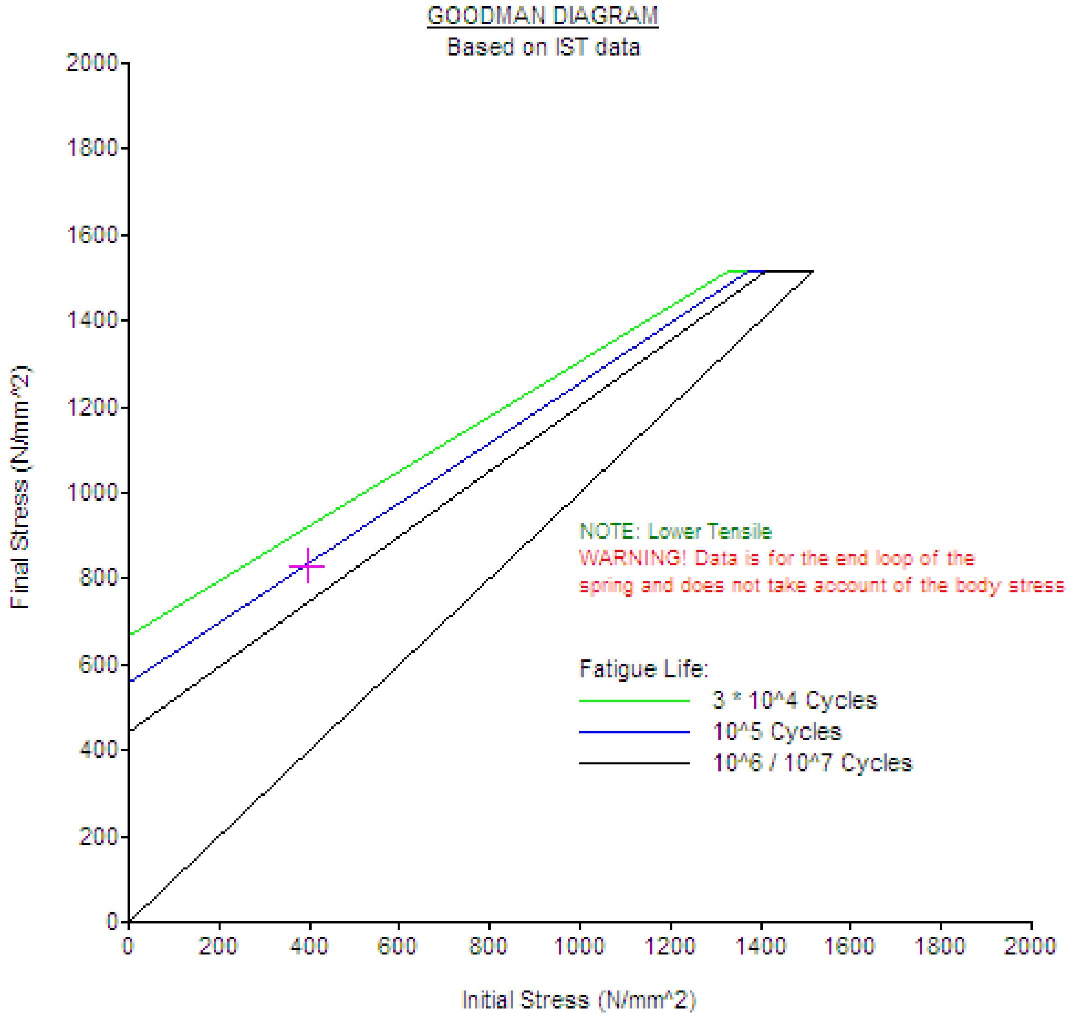
Extension Spring Hooks

Report 11 enabled Goodman diagrams for end hooks



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Conclusions

Techspring has answered many questions about extension springs, and other spring types too.

Use of FEA or MKS is seldom justified.

Use of residual stress analysis can provide confidence to springmakers that their processes are optimised.

Classical mechanics formulae for stress are adequate except for extension spring rate, torsion spring stress.

Use of strain gauges enables confirmation of applied stresses even under dynamic conditions.

CAD programs have been improved

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