Helical Compression Spring Rate, Stress and Deflection

Spring rate, spring index, Wahl factor, corrected shear stress and deflection of a helical compression or extension spring of round wire under a load.

Method: A.M. Wahl; Mechanical Springs (1963); ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Wire diameter	6.0000	mm
Mean coil diameter	45.000	mm
Number of active coils	8.0000	
Shear modulus of the wire Spring steel about 79 GPa; stainless about 69 GPa; phosphor bronze about 41 GPa.	79.300	GPa
Load	500.00	N

Calculated results

Parameter	Value	Unit
Spring rate	17.622	N/mm
Spring index D/d	7.5000	
Wahl stress factor	1.1974	
Shear stress with the Wahl factor	317.62	MPa
Deflection under the load	28.373	mm

Formula and method

$$k = \frac{G d^4}{8 D^3 n_a}, \quad C = \frac{D}{d}$$

$$K_W = \frac{4C - 1}{4C - 4} + \frac{0.615}{C}, \quad \tau = K_W \frac{8FD}{\pi d^3}, \quad \delta = \frac{F}{k}$$

Variables

d	Wire diameter	m
D	Mean coil diameter	m
n_a	Number of active coils	-
G	Shear modulus of the wire	Pa
F	Load	N
k	Spring rate	N/m
C	Spring index D/d	-
K_W	Wahl stress factor	-
τ	Shear stress with the Wahl factor	Pa
δ	Deflection under the load	m

Method and standards

The rate of a close-coiled helical spring follows from the torsion of the wire; Wahl's factor corrects the nominal torsional stress for curvature and direct shear.

Assumptions and limits

- Round wire, close-coiled; static load.

- Fatigue and buckling not checked; the stress is not compared with an allowable, and the solid height (coil clash, which limits the deflection) is not checked.

References

- A.M. Wahl
- Mechanical Springs (1963)
- Shigley's Mechanical Engineering Design
- ch. 10

Report details

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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

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Reopens the calculator with the inputs of this report.