Helical Spring Surge (Natural) Frequency

Natural (surge) frequency of a helical compression spring from wire and coil diameters, active coils and material, with its margin over the forcing frequency.

Method: Surge frequency of a helical spring treated as a distributed mass

Input parameters

Unit system: SI

Parameter	Value	Unit
Wire diameter	4.0000	mm
Mean coil diameter	32.000	mm
Active coils	8.0000	
Shear modulus	79.300	GPa
Material density	7,850.0	kg/m³
End condition	Both ends against flat plates	
Forcing (operating) frequency	25.000	Hz

Calculated results

Parameter	Value	Unit
Spring rate	9.6802	N/mm
Mass of the active coils	79.336	g
Surge frequency	174.65	Hz
Margin over the forcing frequency	6.9861	

Notes for this case

- Surge frequency of the spring as a distributed mass (fixed–fixed: ½√(k/m); fixed–free: ¼√(k/m)). Keep it at least 15–20 times the forcing frequency, including harmonics of cam-driven motion.
- The surge frequency is less than 15 times the forcing frequency: risk of spring surge.

Formula and method

$$k = \frac{G d^4}{8 D^3 N_a}, \quad m_a = \frac{\pi^2 d^2 D N_a \rho}{4}$$

$$f_n = \frac{1}{2}\sqrt{\frac{k}{m_a}} \ \text{(both ends fixed)}, \quad f_n = \frac{1}{4}\sqrt{\frac{k}{m_a}} \ \text{(one end free)}$$

Variables

d	Wire diameter	m
D	Mean coil diameter	m
N_a	Active coils	-
G	Shear modulus	Pa
ρ	Material density	kg/m³
ends	End condition	-
$f_{forcing}$	Forcing (operating) frequency	1/s
k	Spring rate	N/m

m_a	Mass of the active coils	kg
f_n	Surge frequency	1/s
$f_n / f_{forcing}$	Margin over the forcing frequency	-

Method and standards

Wave (surge) frequency of a helical spring.

Assumptions and limits

- Uniform helical compression spring; small damping.

References

Surge frequency of a helical spring treated as a distributed mass

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

https://calc.firecad.com/mechanical/machine-design/helical-spring-surge-frequency

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.