Spring–Mass Natural Frequency and Static Deflection

Undamped natural frequency of a spring–mass system from stiffness and mass, its static deflection, and the frequency found from a measured deflection.

Method: Rao; Mechanical Vibrations; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Spring stiffness	200.00	kN/m
Mass	500.00	kg
Measured static deflection (for the check)	5.0000	mm

Calculated results

Parameter	Value	Unit
Natural circular frequency (rad/s)	20.000	
Natural frequency	3.1831	Hz
Static deflection mg/k	24.517	mm
Frequency from the measured deflection	7.0485	Hz

Notes for this case

- f_n = (1/2π)√(g/δ) is handy on site: a 5 mm static sag means about 7 Hz.

Formula and method

$$\omega_n = \sqrt{\frac{k}{m}}, \quad f_n = \frac{\omega_n}{2\pi}, \quad \delta_{st} = \frac{mg}{k}, \quad f_n = \frac{1}{2\pi}\sqrt{\frac{g}{\delta_{st}}}$$

Variables

k	Spring stiffness	N/m
m	Mass	kg
δ_{st}	Measured static deflection (for the check)	m
ω_n	Natural circular frequency (rad/s)	-
f_n	Natural frequency	1/s
δ	Static deflection mg/k	m
$f_{n,\delta}$	Frequency from the measured deflection	1/s
g	Standard gravity, 9.806 65	m/s²

Method and standards

Single degree of freedom.

Assumptions and limits

- Linear spring; undamped.

References

- Rao
- Mechanical Vibrations
- 6th ed. (Pearson, 2017)
- ch. 2

Report details

Report reference	FCC-BK4R-CH74 (the same inputs always give the same reference)
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Release checks	2 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/statics-dynamics/spring-mass-natural-frequency

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.