Damping from Free Vibration: Logarithmic Decrement

Logarithmic decrement, damping ratio, damped natural frequency and quality factor from two peak amplitudes a number of cycles apart in a free-vibration decay.

Method: Rao; Mechanical Vibrations; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
First peak amplitude	10.000	mm
Peak amplitude n cycles later	4.0000	mm
Cycles between the peaks	5.0000	
Measured damped frequency	12.000	Hz

Calculated results

Parameter	Value	Unit
Logarithmic decrement	0.18326	
Damping ratio	2.9154	%
Undamped natural frequency	12.005	Hz
Quality factor 1/(2ζ)	17.150	

Notes for this case

• Viscous damping assumed; friction damping gives a linear, not exponential, decay. A bump test of a structure gives this decay directly.

Formula and method

$$\delta = \frac{1}{n}\ln\frac{x_1}{x_{n+1}}, \quad \zeta = \frac{\delta}{\sqrt{4\pi^2+\delta^2}}, \quad f_n = \frac{f_d}{\sqrt{1-\zeta^2}}$$

Variables

x_1	First peak amplitude	m
x_{n+1}	Peak amplitude n cycles later	m
n	Cycles between the peaks	-
f_d	Measured damped frequency	1/s
δ	Logarithmic decrement	-
ζ	Damping ratio	-
f_n	Undamped natural frequency	1/s
Q	Quality factor 1/(2ζ)	-

Method and standards

Viscous damping decay.

Assumptions and limits

- Viscous damping; single mode.

References

• Rao
• Mechanical Vibrations
• 6th ed. (Pearson, 2017)
• ch. 2 (logarithmic decrement)

Report details

Report reference	FCC-X48P-7HF3 (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/damping-log-decrement

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.