

Critical Speed of a Shaft

Sample document with complete example values. It shows the report the purchased export produces for YOUR input - it is not itself a report for any part.

Project: Sample project

Part/Position: no real part

Prepared by: Sample, not released

Bending critical speed of the stepped shaft on two bearings

Operating range: subcritical - Assessment: OK

Inputs

Span l	800 mm
Young's modulus	210,000 N/mm ²
Density	7,850 kg/m ³
Self-weight included	yes
Operating speed n _B	3,000 min ⁻¹

Shaft segments (from bearing A to bearing B)

No.	Length in mm	Diameter in mm
1	200	40
2	400	60
3	200	45

Discrete masses

No.	Position x in mm	Mass in kg	Deflection w in µm	Slope tan β	n _{crit} individual in rpm
1	300	20	44	0.000037	6,500
2	550	15	39	-0.000079	8,346

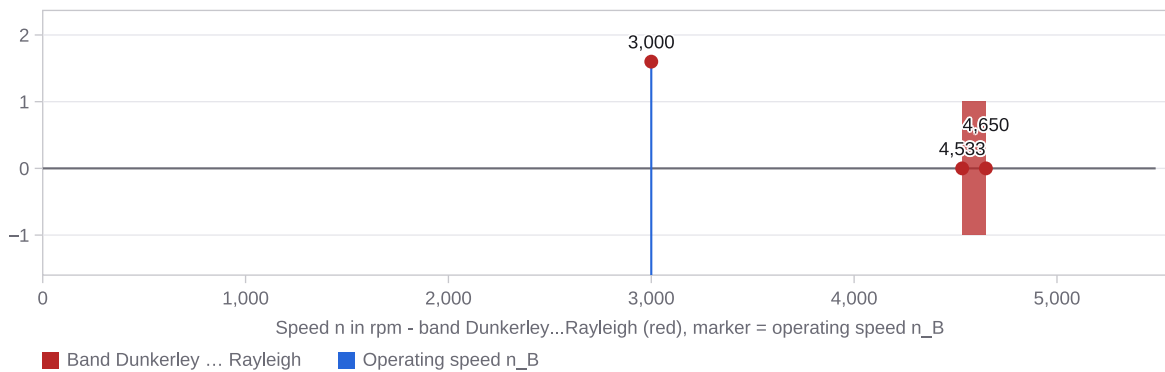
Results

n _{crit} per Rayleigh (upper bound)	4,650 min ⁻¹
n _{crit} per Dunkerley (lower bound)	4,533 min ⁻¹
n _{k1} exact (discrete masses, massless shaft)	5,298 min ⁻¹
n _{k2} exact	20,430 min ⁻¹
n _{crit} shaft alone (self-weight)	9,690 min ⁻¹
Max. deflection f _{max}	46 µm
Location of max. deflection	377 mm
Bearing slope A / B (tan)	0.000249 / -0.000209

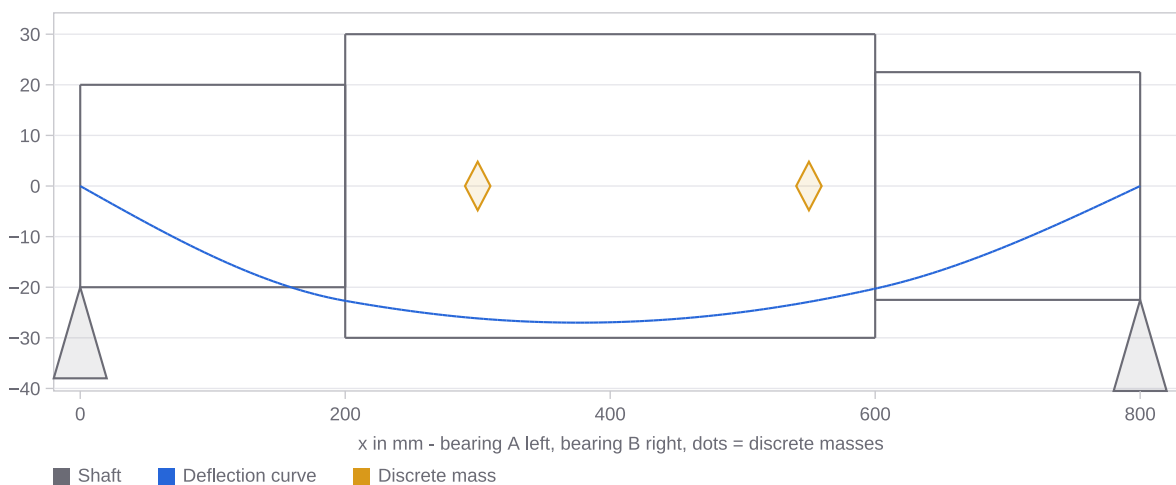
Evaluation criteria

Criterion	Value	Limit	Status
Margin to the critical speed n _B in rpm	3,000	<= 3,626 / >= 5,812	● OK
Max. deflection f _{max}	46 µm	264 µm	● OK
Bearing slope tan(β)	0.000249	0.001	● OK

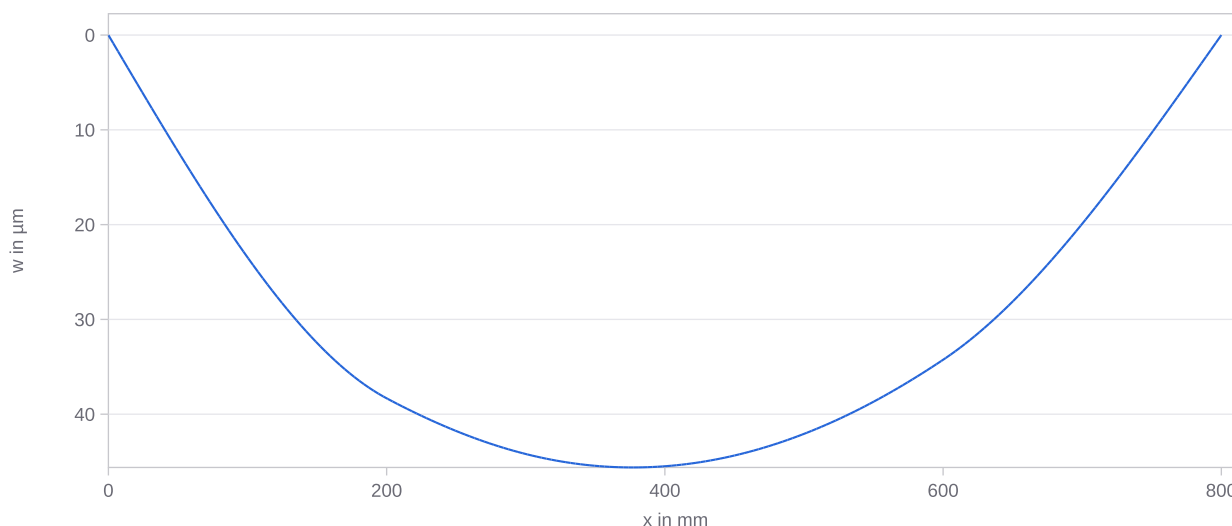
Critical speed (1st order)



Shaft geometry and deflection curve (exaggerated)



Deflection curve under weight loads



Calculation basis

Model: stepped solid shaft on two rigid simple supports at the shaft ends, carrying discrete masses, with self-weight optionally included as a distributed mass. The first bending critical speed is determined per Rayleigh (energy quotient with the gravity deflection curve as trial function, upper bound) and per Dunkerley (summation of the individual flexibilities, lower bound); in addition the exact eigenvalue problem of the discrete masses is solved via the influence coefficient matrix. The traffic light rates the margin of the operating speed to the Dunkerley-Rayleigh band (subcritical green up to 80 % of $n_{\text{Dunkerley}}$, supercritical from 125 % of n_{Rayleigh}). Guideline values: allowable deflection 0.33 mm per m of span, bearing slope $\tan(\beta) \leq 0.001$.

About this sample

All values on these pages come from a freely chosen example calculation and belong to no real part. The purchased export contains the same sections with your input, your header data (project, part, prepared by) and as searchable text. Pricing and scope: maschinenbaurechner.de/en/pricing

Note: The results are design and orientation aids. They do not replace independent verification, calculation and approval by a qualified person. The terms of use at maschinenbaurechner.de apply.