Spur Gear Tooth Bending Stress (Lewis)

Tooth bending stress of a spur gear by the Lewis equation with the velocity factor, from transmitted power, speed, module, face width and the Lewis form factor.

Method: Budynas and Nisbett; Shigley's Mechanical Engineering Design; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Power transmitted	15.000	kW
Pinion speed	1,450.0	rpm
Pinion teeth	20.000	
Module	4.0000	mm
Face width	40.000	mm
Lewis form factor (from z and pressure angle)	0.32200	
Velocity factor form	Cut or milled teeth: 6.1/(6.1 + v)	

Calculated results

Parameter	Value	Unit
Pitch diameter	80.000	mm
Pitch-line velocity	6.0737	m/s
Tangential load	2.4696	kN
Velocity factor	0.50108	
Bending stress	95.665	MPa

Notes for this case

• Lewis equation with Barth-type velocity factors (Shigley). A first sizing check: final design uses AGMA or ISO 6336 factors for load distribution, geometry and life. Y for 20° full-depth teeth: 0.322 at 20 teeth, 0.359 at 30, 0.409 at 50.

Formula and method

$$\sigma = \frac{F_t}{K_v b m Y}, \quad F_t = \frac{P}{v}, \quad v = \pi d N, \quad K_v = \frac{6.1}{6.1 + v}\ \text{(cut)}, \quad \frac{3.56}{3.56 + \sqrt{v}}\ \text{(hobbed or shaped)}, \quad \frac{5.56}{5.56 + \sqrt{v}}\ \text{(ground)}$$

Variables

P	Power transmitted	W
N	Pinion speed	1/s
z	Pinion teeth	-
m	Module	m
b	Face width	m
Y	Lewis form factor (from z and pressure angle)	-
$\mathrm{velocity}$	Velocity factor form	-
d	Pitch diameter	m
v	Pitch-line velocity	m/s
F_t	Tangential load	N
K_v	Velocity factor	-
σ	Bending stress	Pa

Method and standards

Lewis equation.

Assumptions and limits

- One tooth carries the load at the tip.

References

- Budynas and Nisbett
- Shigley's Mechanical Engineering Design
- 10th ed. (McGraw-Hill, 2015)
- ch. 14 (Lewis bending equation and velocity factors)

Report details

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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/lewis-gear-bending

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Reopens the calculator with the inputs of this report.