Straight Bevel Gear Tooth Forces

Tangential, radial and axial forces on a straight bevel gear from torque, mean pitch diameter, pressure angle and pitch cone angle, for shaft and bearing design.

Method: Shigley's Mechanical Engineering Design (Budynas and Nisbett); ch. 13 (bevel gear force analysis)

Input parameters

Unit system: SI

Parameter	Value	Unit
Torque on the gear	100.00	N·m
Mean (mid-face) pitch diameter	90.000	mm
Pressure angle	20.000	°
Pitch cone angle of this gear	18.430	°

Calculated results

Parameter	Value	Unit
Tangential force	2.2222	kN
Radial force W_t tan φ cos γ	0.76734	kN
Axial force W_t tan φ sin γ	0.25571	kN

Notes for this case

- The radial force on one gear is the axial force on its mate (shafts at 90°).

Formula and method

$$W_t = \frac{2T}{d_{av}}, \quad W_r = W_t \tan\phi \cos\gamma, \quad W_a = W_t \tan\phi \sin\gamma$$

Variables

T	Torque on the gear	N·m
d_{av}	Mean (mid-face) pitch diameter	m
ϕ	Pressure angle	rad
γ	Pitch cone angle of this gear	rad
W_t	Tangential force	N
W_r	Radial force W_t tan φ cos γ	N
W_a	Axial force W_t tan φ sin γ	N

Method and standards

Force resolution on the pitch cone.

Assumptions and limits

- Straight teeth, friction neglected.

References

- Shigley's Mechanical Engineering Design (Budynas and Nisbett)
- ch. 13 (bevel gear force analysis)

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/bevel-gear-forces

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.