Helical Gear Geometry and Tooth Forces

Transverse module, pitch and tip diameters, centre distance, virtual teeth and axial pitch of a helical gear pair, with tangential, radial and axial forces.

Method: Involute helical gear geometry and force resolution

Input parameters

Unit system: SI

Parameter	Value	Unit
Normal module	3.0000	mm
Helix angle	20.000	°
Normal pressure angle	20.000	°
Pinion teeth	20.000	
Gear teeth	60.000	
Pinion torque	200.00	N·m

Calculated results

Parameter	Value	Unit
Transverse module	3.1925	mm
Pinion pitch diameter	63.851	mm
Gear pitch diameter	191.55	mm
Centre distance	127.70	mm
Pinion tip diameter	69.851	mm
Virtual teeth of the pinion	24.103	
Axial pitch	27.556	mm
Tangential force	6,264.6	N
Radial force	2,426.5	N
Axial (thrust) force	2,280.1	N

Notes for this case

• A helical gear cut with a standard normal module has a larger transverse module m_n/cos β, so its pitch diameter is z·m_n/cos β; centre distance can be tuned by the helix angle. Strength is assessed on the virtual spur gear of z/cos³β teeth. The tooth load splits into tangential (torque), radial (F_t tan α_n/cos β) and axial (F_t tan β) components; the axial thrust must be taken by the bearings or cancelled with double-helical gears. Tip diameter assumes standard addendum (one normal module) without profile shift.

Formula and method

$$m_t = \frac{m_n}{\cos\beta}, \quad d = z m_t, \quad z_v = \frac{z}{\cos^3\beta}, \quad F_t = \frac{2T}{d_1}, \quad F_r = \frac{F_t \tan\alpha_n}{\cos\beta}, \quad F_a = F_t \tan\beta$$

Variables

m_n	Normal module	m
β	Helix angle	rad
α_n	Normal pressure angle	rad
z_1	Pinion teeth	-
z_2	Gear teeth	-
T_1	Pinion torque	N·m
m_t	Transverse module	m

d_1	Pinion pitch diameter	m
d_2	Gear pitch diameter	m
a	Centre distance	m
d_{a1}	Pinion tip diameter	m
z_{v1}	Virtual teeth of the pinion	-
p_x	Axial pitch	m
F_t	Tangential force	N
F_r	Radial force	N
F_a	Axial (thrust) force	N

Method and standards

Helical gears.

Assumptions and limits

- Standard tooth proportions; no profile shift.

References

Involute helical gear geometry and force resolution

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

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