Shaft Diameter for Torque and Bending

Diameter of a solid or hollow shaft for transmitted power and a bending moment, by the maximum shear stress theory with shock and fatigue factors.

Method: Maximum shear stress (Tresca) theory with shock and fatigue factors

Input parameters

Unit system: SI

Parameter	Value	Unit
Power transmitted	30.000	kW
Shaft speed	1,450.0	rpm
Bending moment at the section	150.00	N·m
Allowable shear stress From the shaft material and your design practice (keyways lower it).	40.000	MPa
Shock and fatigue factor for bending	1.5000	
Shock and fatigue factor for torsion	1.0000	
Bore ratio of a hollow shaft d_i/d_o (0 = solid)	0	%

Calculated results

Parameter	Value	Unit
Torque transmitted	197.57	N·m
Equivalent torque	299.43	N·m
Shaft diameter (outside)	33.657	mm
Bore diameter (hollow shaft)	0	mm

Notes for this case

- Static strength only: check deflection, critical speed, keyway stress concentration and fatigue for the final size, then round up to a standard diameter.

Formula and method

$$T = \frac{P}{2\pi n}$$

$$T_e = \sqrt{(K_m M)^2 + (K_t T)^2}$$

$$d_o = \left[\frac{16 T_e}{\pi \tau_a (1 - k^4)}\right]^{1/3}, \quad d_i = k\, d_o$$

Variables

P	power	W
n	speed	rev/s
M	bending moment	N·m
τ_a	allowable shear stress	Pa
K_m	bending shock and fatigue factor	-
K_t	torsion shock and fatigue factor	-
k	bore ratio d_i/d_o	-
T	torque	N·m
T_e	equivalent torque	N·m

d_o	outside diameter	m
d_i	bore diameter	m

Method and standards

Maximum shear stress theory for a shaft under bending and torsion: the equivalent torque with shock and fatigue factors gives the diameter at the allowable shear stress.

Assumptions and limits

- Static strength; deflection, critical speed and detailed fatigue to be checked separately.
- The factor of safety is inside the allowable shear stress you enter. K_m and K_t are your inputs: machine design texts tabulate the ASME code values for transmission shafting (for a rotating shaft with gradually applied load, K_m = 1.5 and K_t = 1.0; higher for shock loads).

References

- Maximum shear stress (Tresca) theory with shock and fatigue factors

Report details

Report reference	FCC-YKZ0-4599 (the same inputs always give the same reference)
Generated	17 November 2026, 19:44 UTC
Calculator	Shaft Diameter for Torque and Bending
Method last reviewed	12 November 2026
Software release	FireCAD Calc, release of 17 November 2026
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/shaft-diameter

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Reopens the calculator with the inputs of this report.