



Design of Shafts Formulas

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List of 62 Design of Shafts Formulas

Design of Shafts 🕑

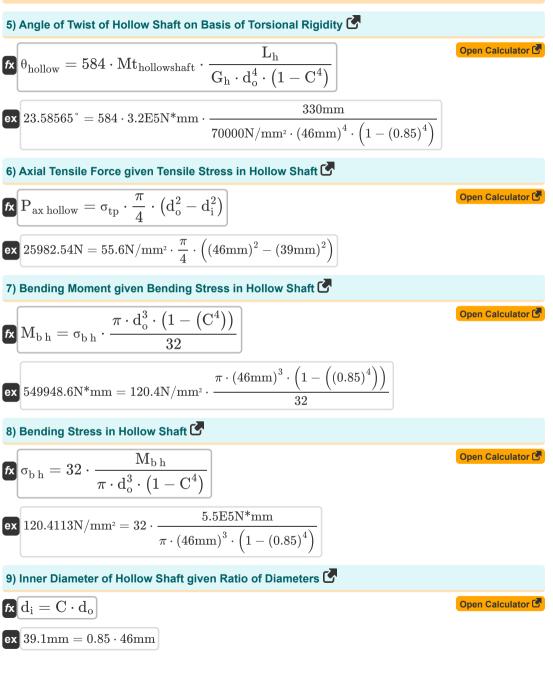
ASME Code for Shaft Desgin 🕑

1) Diameter of Shaft given Principle Shear Stress 🕑

$$d_{ASME} = \left(\frac{16}{\pi \cdot \tau_{max ASME}} \cdot \sqrt{\left(Mt_{shaft} \cdot k_{t}\right)^{2} + \left(k_{b} \cdot M_{b}\right)^{2}}\right)^{\frac{1}{3}}$$
Open Calculator (§)
$$d_{ASME} = \left(\frac{16}{\pi \cdot \tau_{max ASME}} \cdot \sqrt{\left(Mt_{shaft} \cdot k_{t}\right)^{2} + \left(k_{b} \cdot M_{b}\right)^{2}}\right)^{\frac{1}{3}}$$
2) Equivalent Bending Moment when Shaft is Subjected to Fluctuating Loads (F)
$$Mb_{feq} = k_{b} \cdot M_{b} + \sqrt{\left(Mt_{shaft} \cdot k_{t}\right)^{2} + \left(k_{b} \cdot M_{b}\right)^{2}}$$
Open Calculator (§)
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Open Calculator (§)
$$Mt_{feq} = \sqrt{\left(Mt_{shaft} \cdot k_{t}\right)^{2} + \left(k_{b} \cdot M_{b}\right)^{2}}$$
Open Calculator (§)
$$T_{max ASME} = \frac{16}{\pi \cdot d_{ASME}^{3}} \cdot \sqrt{\left(Mt_{shaft} \cdot k_{t}\right)^{2} + \left(k_{b} \cdot M_{b}\right)^{2}}}$$
Open Calculator (§)
$$T_{max ASME} = \frac{16}{\pi \cdot (48mm)^{3}} \cdot \sqrt{\left(3.3E5N^{*}mm \cdot 1.3\right)^{2} + \left(1.8 \cdot 1.8E6N^{*}mm\right)^{2}}$$

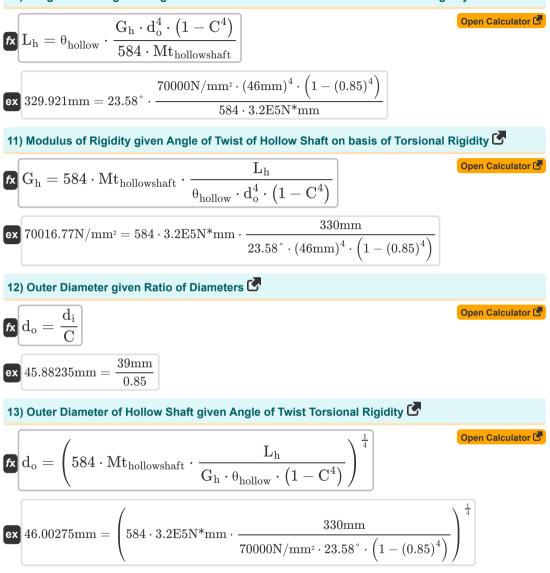


Design of Hollow Shaft 🚰











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14) Outer Diameter of Hollow Shaft given Bending Stress of Hollow Shaft 🕑

$$\mathbf{f}_{\mathbf{k}} = \left(32 \cdot \frac{M_{b h}}{\pi \cdot \sigma_{b h} \cdot (1 - C^{4})} \right)^{\frac{1}{3}}$$
Open Catculator (*)
$$\mathbf{f}_{\mathbf{k}} = \left(32 \cdot \frac{M_{b h}}{\pi \cdot \sigma_{b h} \cdot (1 - C^{4})} \right)^{\frac{1}{3}}$$
15) Outer Diameter of Hollow Shaft given Principle Stress (*)
$$\mathbf{f}_{\mathbf{k}} = \left(16 \cdot \frac{M_{b h} + \sqrt{M_{b h}^{2} + Mt_{hollowshaft}^{2}}}{\pi \cdot \tau \cdot (1 - C^{4})} \right)^{\frac{1}{3}}$$
Open Catculator (*)
$$\mathbf{f}_{\mathbf{k}} = \left(16 \cdot \frac{M_{b h} + \sqrt{M_{b h}^{2} + Mt_{hollowshaft}^{2}}}{\pi \cdot \tau \cdot (1 - C^{4})} \right)^{\frac{1}{3}}$$
16) Outer Diameter of Shaft given Torsional Shear Stress (*)
$$\mathbf{f}_{\mathbf{k}} = \left(16 \cdot \frac{Mt_{hollowshaft}}{\pi \cdot \tau_{h} \cdot (1 - C^{4})} \right)^{\frac{1}{3}}$$
Open Catculator (*)
$$\mathbf{f}_{\mathbf{k}} = \left(16 \cdot \frac{Mt_{hollowshaft}}{\pi \cdot \tau_{h} \cdot (1 - C^{4})} \right)^{\frac{1}{3}}$$
Open Catculator (*)
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$$\mathbf{f}_{\mathbf{k}} = \left(16 \cdot \frac{Mt_{hollowshaft}}{\pi \cdot \tau_{h} \cdot (1 - C^{4})} \right)^{\frac{1}{3}}$$
Open Catculator (*)
$$\mathbf{f}_{\mathbf{k}} = \left(16 \cdot \frac{3.2E5N*mm}{\pi \cdot 35.1N/mm^{2} \cdot (1 - (0.85)^{4})} \right)^{\frac{1}{3}}$$





17) Principle Stress Maximum Principle Stress Theory 🕑

$$\tau = 16 \cdot \frac{M_{b h} + \sqrt{M_{b h}^{2} + Mt_{hollowshaft}^{2}}}{\pi \cdot d_{o}^{3} \cdot (1 - C^{4})}$$

$$(25)$$

$$129.86N/mm^{2} = 16 \cdot \frac{5.5E5N^{*}mm + \sqrt{(5.5E5N^{*}mm)^{2} + (3.2E5N^{*}mm)^{2}}}{\pi \cdot (46mm)^{3} \cdot (1 - (0.85)^{4})}$$

18) Ratio of Diameter given Torsional Shear Stress in Hollow Shaft 🕑

fx
$$\mathbf{C} = \left(1 - 16 \cdot rac{\mathrm{Mt}_{\mathrm{hollowshaft}}}{\pi \cdot \mathrm{d}_{\mathrm{o}}^3 \cdot au_{\mathrm{h}}}
ight)^{rac{1}{4}}$$

$$ex \ 0.850395 = \left(1 - 16 \cdot rac{3.2 ext{E5N*mm}}{\pi \cdot (46 ext{mm})^3 \cdot 35.1 ext{N/mm}^2}
ight)^rac{1}{4}$$

19) Ratio of Diameters given Angle of Twist of Hollow Shaft and Torsional Rigidity 🕑

$$\mathbf{fx} \left[\mathrm{C} = \left(1 - 584 \cdot \mathrm{Mt_{hollowshaft}} \cdot rac{\mathrm{L_h}}{\mathrm{G_h} \cdot \mathrm{d_o^4} \cdot \mathrm{\theta_{hollow}}}
ight)^{rac{1}{4}}
ight]$$

ex
$$0.849953 = \left(1 - 584 \cdot 3.2 \text{E5N*mm} \cdot \frac{330 \text{mm}}{70000 \text{N/mm}^2 \cdot (46 \text{mm})^4 \cdot 23.58^\circ}\right)^{\frac{1}{4}}$$

20) Ratio of Diameters given Bending Stress of Hollow Shaft 🚰

$$\mathbf{fx} \mathbf{C} = \left(1 - 32 \cdot \frac{\mathbf{M}_{b\,h}}{\pi \cdot \mathbf{d}_o^3 \cdot \sigma_{b\,h}}\right)^{\frac{1}{4}}$$
$$\mathbf{ex} \mathbf{0.849982} = \left(1 - 32 \cdot \frac{5.5 \text{E5N*mm}}{\pi \cdot (46 \text{mm})^3 \cdot 120.4 \text{N/mm}^2}\right)^{\frac{1}{4}}$$

Open Calculator 🖸

Open Calculator

Open Calculator



21) Ratio of Diameters given Principle Stress

$$\mathbf{E} = \left(1 - 16 \cdot \frac{M_{b \, h} + \sqrt{M_{b \, h}^2 + Mt_{hollowshaft}^2}}{\pi \cdot d_o^3 \cdot \tau} \right)^{\frac{1}{4}}$$

$$\mathbf{E} = \left(1 - 16 \cdot \frac{5.5 \text{E5N*mm} + \sqrt{(5.5 \text{E5N*mm})^2 + (3.2 \text{E5N*mm})^2}}{\pi \cdot (46 \text{mm})^3 \cdot 129.8 \text{N/mm}^2} \right)^{\frac{1}{4}}$$

22) Ratio of Diameters given Tensile Stress in Hollow Shaft 🕑

fx
$$C = \sqrt{1 - \left(\frac{P_{ax \text{ hollow}}}{\frac{\pi}{4} \cdot \sigma_{tp} \cdot d_o^2}\right)}$$

ex
$$0.847842 = \sqrt{1 - \left(\frac{25980 \text{N}}{\frac{\pi}{4} \cdot 55.6 \text{N/mm}^2 \cdot (46 \text{mm})^2}\right)}$$

23) Ratio of Inner Diameter to Outer Diameter 🕑

fx
$$C = \frac{d_i}{d_o}$$

ex $0.847826 = \frac{39mm}{46mm}$

24) Tensile Stress in Hollow Shaft when Subjected to Axial Force 🚰

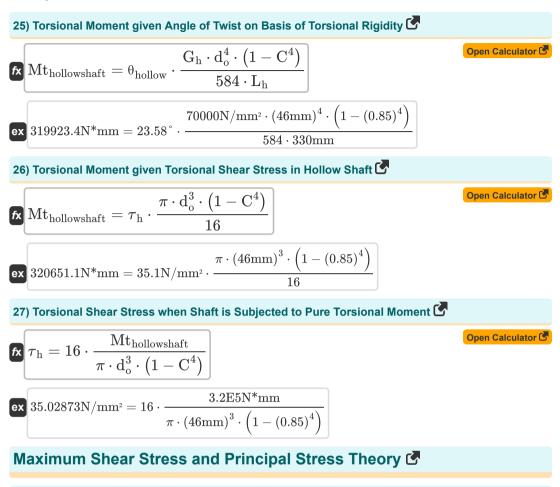




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Open Calculator 🕑

Open Calculator 🕑



28) Bending Moment given Maximum Shear Stress 🗗

 $\mathbf{k} \mathbf{M}_{b \text{ MSST}} = \sqrt{\left(\frac{\tau_{\text{max MSST}}}{\frac{16}{\pi \cdot d_{\text{MSST}}^3}}\right)^2 - M t_t^2}$ $\mathbf{ex} 980230 \text{N*mm} = \sqrt{\left(\frac{58.9 \text{N/mm}^2}{\frac{16}{\pi \cdot (45 \text{mm})^3}}\right)^2 - (3.87 \text{E5N*mm})^2}$

Open Calculator 🕑

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29) Diameter of Shaft given Permissible Value of Maximum Principle Stress 🖸

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39) Torsional Moment given Maximum Shear Stress 🕑



44) Bending Stress given Normal Stress 🕑

fx
$$\sigma_{
m b}=\sigma_{
m x}-\sigma_{
m t}$$

ex
$$177.8 \mathrm{N/mm^2} = 250.6 \mathrm{N/mm^2} - 72.8 \mathrm{N/mm^2}$$

45) Bending Stress in Shaft Pure Bending Moment 🕑

$$\sigma_{
m b}=rac{32\cdot{
m M}_{
m b}}{\pi\cdot{
m d}^3}$$
 Open Calculator (

ex
$$177.7273$$
N/mm² = $\frac{32 \cdot 1.8$ E6N*mm}{\pi \cdot (46.9mm)³

46) Diameter of Shaft given Bending Stress Pure Bending 🕑

$$f_{\mathbf{X}} \mathbf{d} = \left(\frac{32 \cdot M_{b}}{\pi \cdot \sigma_{b}}\right)^{\frac{1}{3}}$$

$$e_{\mathbf{X}} \mathbf{46.8936mm} = \left(\frac{32 \cdot 1.8E6N^{*}mm}{\pi \cdot 177.8N/mm^{2}}\right)^{\frac{1}{3}}$$

47) Diameter of Shaft given Tensile Stress in Shaft 🕑

fx
$$d = \sqrt{4 \cdot \frac{P_{ax}}{\pi \cdot \sigma_t}}$$

ex $46.94341 \text{mm} = \sqrt{4 \cdot \frac{1.26\text{E5N}}{\pi \cdot 72.8\text{N/mm}^2}}$

48) Diameter of Shaft given Torsional Shear Stress in Shaft Pure Torsion 🕑

$$\mathbf{fx} \mathbf{d} = \left(16 \cdot \frac{\mathrm{Mt_{shaft}}}{\pi \cdot \tau}\right)^{\frac{1}{3}}$$

$$\mathbf{ex} 46.9016\mathrm{mm} = \left(16 \cdot \frac{3.3\mathrm{E5N*mm}}{\pi \cdot 16.29\mathrm{N/mm^2}}\right)^{\frac{1}{3}}$$



Open Calculator 🕑

Open Calculator

Open Calculator 🕑

Open Calculator 🕑

49) Maximum Shear Stress in Shaft Bending and Torsion 🖸



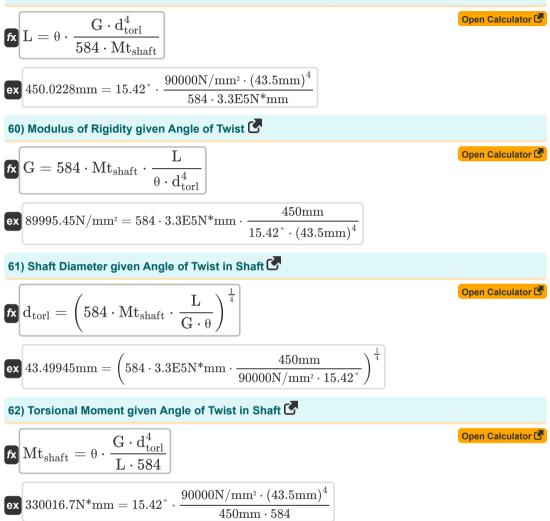
55) Torsional Moment given Torsional Shear Stress in Shaft Pure Torsion

$$\mathbf{f}_{\mathbf{x}} = \mathbf{M} \cdot \mathbf{m} \cdot \mathbf{m} \cdot \mathbf{h} \cdot$$





59) Length of Shaft Subjected to Torsional Moment given Angle of Twist G



Variables Used

- C Ratio of Inner to Outer Diameter of Hollow Shaft
- d Diameter of Shaft on Strength Basis (Millimeter)
- d_{ASME} Diameter of Shaft from ASME (Millimeter)
- d_i Inner Diameter of Hollow Shaft (Millimeter)
- **d_{MPST}** Diameter of Shaft from MPST (Millimeter)
- d_{MSST} Diameter of Shaft from MSST (Millimeter)
- do Outer Diameter of Hollow Shaft (Millimeter)
- dtorl Diameter of Shaft from Torsional Rigidity (Millimeter)
- Fce Yield Strength in Shaft from MPST (Newton per Square Millimeter)
- **f**_S Factor of Safety of Shaft
- G Modulus of Rigidity of Shaft (Newton per Square Millimeter)
- Gh Modulus of Rigidity of Hollow Shaft (Newton per Square Millimeter)
- kb Combined Shock Fatigue Factor of Bending Moment
- kt Combined Shock Fatigue Factor of Torsion Moment
- L Length of Shaft from Torsional Rigidity (Millimeter)
- L_h Length of Hollow Shaft (Millimeter)
- M_{b h} Bending Moment in Hollow Shaft (Newton Millimeter)
- Mb MSST Bending Moment in Shaft for MSST (Newton Millimeter)
- Mb Bending Moment in Shaft (Newton Millimeter)
- M_t Torque transmitted by Shaft (Newton Millimeter)
- Mbeg Equivalent Bending Moment from MSST (Newton Millimeter)
- Mb_{feq} Equivalent Bending Moment for Fluctuating Load (Newton Millimeter)
- Mtfeg Equivalent Torsion Moment for Fluctuating Load (Newton Millimeter)
- Mt_{hollowshaft} Torsional Moment in Hollow Shaft (Newton Millimeter)
- Mt_{shaft} Torsional Moment in Shaft (Newton Millimeter)
- Mtt Torsional Moment in Shaft for MSST (Newton Millimeter)
- N Speed of Shaft (Revolution per Minute)
- P Power Transmitted by Shaft (Kilowatt)
- Pax hollow Axial Force on Hollow Shaft (Newton)



- Pax Axial Force on Shaft (Newton)
- Ssv Shear Yield Strength in Shaft from MSST (Newton per Square Millimeter)
- **θ** Angle of Twist in Shaft (Degree)
- θ_{hollow} Angle of Twist of Hollow Shaft (Degree)
- σ₁ Maximum Principle Stress in Shaft (Newton per Square Millimeter)
- σ_{b h} Bending Stress in Hollow Shaft (Newton per Square Millimeter)
- σ_b Bending Stress in Shaft (Newton per Square Millimeter)
- σ_t Tensile Stress in Shaft (Newton per Square Millimeter)
- σ_{tp} Tensile Stress in Hollow Shaft (Newton per Square Millimeter)
- **σ_x** Normal Stress in Shaft (Newton per Square Millimeter)
- σ_{vt} Yield Strength in Shaft from MSST (Newton per Square Millimeter)
- T Maximum Principle Stress in Hollow Shaft (Newton per Square Millimeter)
- Tmax Principal Shear Stress in Shaft (Newton per Square Millimeter)
- Tsmax Maximum Shear Stress in Shaft (Newton per Square Millimeter)
- *τ* Torsional Shear Stress in Shaft (Newton per Square Millimeter)
- au_h Torsional Shear Stress in Hollow Shaft (Newton per Square Millimeter)
- $\tau_{\max \text{ ASME}}$ Maximum Shear Stress in Shaft from ASME (Newton per Square Millimeter)
- τ_{max MSST} Maximum Shear Stress in Shaft from MSST (Newton per Square Millimeter)



Constants, Functions, Measurements used

- Constant: pi, 3.14159265358979323846264338327950288 Archimedes' constant
- Function: sqrt, sqrt(Number) Square root function
- Measurement: Length in Millimeter (mm) Length Unit Conversion
- Measurement: Power in Kilowatt (kW) Power Unit Conversion
- Measurement: Force in Newton (N) Force Unit Conversion
- Measurement: Angle in Degree (°) Angle Unit Conversion
- Measurement: Frequency in Revolution per Minute (rev/min) Frequency Unit Conversion
- Measurement: Torque in Newton Millimeter (N*mm) Torque Unit Conversion
- Measurement: Stress in Newton per Square Millimeter (N/mm²) Stress Unit Conversion



- Design against Fluctuating Load Formulas C. Design of Keys Formulas C
- Design of Bevel Gear Formulas G
- Design of Chain Drives Formulas
- Design of Cotter Joint Formulas G
- Design of Coupling Formulas C
- Design of Flywheel Formulas C
- Design of Friction Clutches Formulas
- Design of Helical Gears Formulas

Design of Knuckle Joint Formulas

- Design of Lever Formulas C
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