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Torsional Rigidity and Polar Modulus Formulas

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List of 16 Torsional Rigidity and Polar Modulus Formulas

Torsional Rigidity and Polar Modulus

Polar Modulus

1) Diameter of Solid Shaft with known Polar Modulus

$$\text{fx } d = \left(\frac{16 \cdot Z_p}{\pi} \right)^{\frac{1}{3}}$$

[Open Calculator !\[\]\(de95854c7ee024cfadc48187bbb781b2_img.jpg\)](#)

$$\text{ex } 0.28405\text{m} = \left(\frac{16 \cdot 4.5\text{e-}3\text{m}^3}{\pi} \right)^{\frac{1}{3}}$$

2) Inner diameter of Hollow Shaft using Polar Modulus

$$\text{fx } d_i = \left((d_o^4) - \left(\frac{Z_p \cdot 16 \cdot d_o}{\pi} \right) \right)^{\frac{1}{4}}$$

[Open Calculator !\[\]\(6a9b39b98eb945faa14c645ec99e4eaa_img.jpg\)](#)

$$\text{ex } 0.688002\text{m} = \left(\left((700\text{mm})^4 \right) - \left(\frac{4.5\text{e-}3\text{m}^3 \cdot 16 \cdot 700\text{mm}}{\pi} \right) \right)^{\frac{1}{4}}$$



3) Polar Modulus

$$\text{fx } Z_p = \frac{J}{R}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$\text{ex } 0.037273\text{m}^3 = \frac{4.1\text{e-}3\text{m}^4}{110\text{mm}}$$

4) Polar Modulus of Hollow Shaft

$$\text{fx } Z_p = \frac{\pi \cdot ((d_o^4) - (d_i^4))}{16 \cdot d_o}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$\text{ex } 0.004501\text{m}^3 = \frac{\pi \cdot (((700\text{mm})^4) - ((0.688\text{m})^4))}{16 \cdot 700\text{mm}}$$

5) Polar Modulus of Solid Shaft

$$\text{fx } Z_p = \frac{\pi \cdot d^3}{16}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$\text{ex } 0.004498\text{m}^3 = \frac{\pi \cdot (0.284\text{m})^3}{16}$$

6) Polar Modulus using Maximum Twisting Moment

$$\text{fx } Z_p = \left(\frac{T}{\tau_{\max}} \right)$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

$$\text{ex } 0.000667\text{m}^3 = \left(\frac{28\text{kN}\cdot\text{m}}{42\text{MPa}} \right)$$



7) Polar Moment of Inertia given Torsional Section Modulus

$$\text{fx } J = Z_p \cdot R$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

$$\text{ex } 0.000495\text{m}^4 = 4.5\text{e-}3\text{m}^3 \cdot 110\text{mm}$$

8) Polar Moment of Inertia of Solid Shaft

$$\text{fx } J = \frac{\pi \cdot d^4}{32}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$\text{ex } 0.000639\text{m}^4 = \frac{\pi \cdot (0.284\text{m})^4}{32}$$

9) Polar Moment of Inertia using Polar Modulus

$$\text{fx } J = R \cdot Z_p$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$\text{ex } 0.000495\text{m}^4 = 110\text{mm} \cdot 4.5\text{e-}3\text{m}^3$$

Torsional Rigidity

10) Angle of Twist for Shaft using Torsional Rigidity

$$\text{fx } \theta = \frac{T \cdot L_{\text{shaft}}}{TJ}$$

[Open Calculator !\[\]\(c1168d6a8b365d11e842ece304635fa7_img.jpg\)](#)

$$\text{ex } 1.420155\text{rad} = \frac{28\text{kN} \cdot \text{m} \cdot 4.58\text{m}}{90.3\text{kN} \cdot \text{m}^2}$$



11) Length of Shaft using Torsional Rigidity

$$\text{fx } L_{\text{shaft}} = \frac{TJ \cdot \theta}{T}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$\text{ex } 4.5795\text{m} = \frac{90.3\text{kN} \cdot \text{m}^2 \cdot 1.42\text{rad}}{28\text{kN} \cdot \text{m}}$$

12) Modulus of Rigidity with Known Torsional Rigidity

$$\text{fx } G = \frac{TJ}{J}$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$\text{ex } 0.022024\text{GPa} = \frac{90.3\text{kN} \cdot \text{m}^2}{4.1\text{e-}3\text{m}^4}$$

13) Polar Moment of Inertia with Known Torsional Rigidity

$$\text{fx } J = \frac{TJ}{G}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$\text{ex } 0.004105\text{m}^4 = \frac{90.3\text{kN} \cdot \text{m}^2}{0.022\text{GPa}}$$

14) Torque on Shaft using Torsional Rigidity

$$\text{fx } T = \frac{TJ \cdot \theta}{L_{\text{shaft}}}$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80_img.jpg\)](#)

$$\text{ex } 27.99694\text{kN} \cdot \text{m} = \frac{90.3\text{kN} \cdot \text{m}^2 \cdot 1.42\text{rad}}{4.58\text{m}}$$



15) Torsional Rigidity

$$f_x \quad T J = G \cdot J$$

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)

$$ex \quad 90.2 \text{ kN} \cdot \text{m}^2 = 0.022 \text{ GPa} \cdot 4.1 \text{e-}3 \text{ m}^4$$

16) Torsional Rigidity using Torque and Length of Shaft

$$f_x \quad T J = \frac{T \cdot L_{\text{shaft}}}{\theta}$$

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5_img.jpg\)](#)

$$ex \quad 90.30986 \text{ kN} \cdot \text{m}^2 = \frac{28 \text{ kN} \cdot \text{m} \cdot 4.58 \text{ m}}{1.42 \text{ rad}}$$



Variables Used

- **d** Dia of Shaft (Meter)
- **d_i** Inner Dia of Shaft (Meter)
- **d_o** Outer Diameter of Shaft (Millimeter)
- **G** Modulus of Rigidity SOM (Gigapascal)
- **J** Polar Moment of Inertia (Meter⁴)
- **L_{shaft}** Length of Shaft (Meter)
- **R** Radius of Shaft (Millimeter)
- **T** Torque (Kilonewton Meter)
- **TJ** Torsional Rigidity (Kilonewton Square Meter)
- **Z_p** Polar Modulus (Cubic Meter)
- **θ** Angle of Twist (Radian)
- **T_{max}** Maximum Shear Stress (Megapascal)



Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288
Archimedes' constant
- **Measurement:** **Length** in Meter (m), Millimeter (mm)
Length Unit Conversion 
- **Measurement:** **Volume** in Cubic Meter (m³)
Volume Unit Conversion 
- **Measurement:** **Pressure** in Gigapascal (GPa)
Pressure Unit Conversion 
- **Measurement:** **Angle** in Radian (rad)
Angle Unit Conversion 
- **Measurement:** **Torque** in Kilonewton Meter (kN*m)
Torque Unit Conversion 
- **Measurement:** **Second Moment of Area** in Meter⁴ (m⁴)
Second Moment of Area Unit Conversion 
- **Measurement:** **Torsional Rigidity** in Kilonewton Square Meter (kN*m²)
Torsional Rigidity Unit Conversion 
- **Measurement:** **Stress** in Megapascal (MPa)
Stress Unit Conversion 



Check other formula lists

- **Torsional Rigidity and Polar Modulus Formulas** 

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