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Torsional Rigidity and Polar Modulus Formulas

Calculators!

Examples!

Conversions!

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

Open Calculator

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

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

Open Calculator

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

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

Open Calculator

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

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

4) Polar Modulus of Hollow Shaft

Open Calculator

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

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

5) Polar Modulus of Solid Shaft

Open Calculator

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

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

6) Polar Modulus using Maximum Twisting Moment

Open Calculator

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

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

7) Polar Moment of Inertia given Torsional Section Modulus

Open Calculator

fx $$J = Z_p \cdot R$$

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

Open Calculator

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

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

9) Polar Moment of Inertia using Polar Modulus

Open Calculator

fx $$J = R \cdot Z_p$$

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

Open Calculator

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

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

11) Length of Shaft using Torsional Rigidity

Open Calculator

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

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

12) Modulus of Rigidity with Known Torsional Rigidity

Open Calculator

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

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

13) Polar Moment of Inertia with Known Torsional Rigidity

Open Calculator

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

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

14) Torque on Shaft using Torsional Rigidity

Open Calculator

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

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

15) Torsional Rigidity

$$TJ = G \cdot J$$

Open Calculator

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

16) Torsional Rigidity using Torque and Length of Shaft

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

Open Calculator

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

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 *(Meter^4)*
- **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)*
- **τ_{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 (m^3)
  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 (m^4)
  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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