Important Shaft Design on Strength Basis Formulas PDF

Formulas
Examples
with Units

List of 16
Important Shaft Design on Strength Basis Formulas

1) Axial Force given Tensile Stress in Shaft Formula

Evaluate Formula

Formula

$$P_{ax} = \sigma_t \cdot \pi \cdot \frac{d^2}{4}$$

Example with Units

$$125767.0708\,\text{N} = 72.8\,\text{N/mm}^2 \cdot 3.1416 \cdot \frac{46.9\,\text{mm}^2}{4}$$

2) Bending Moment given Bending Stress Pure Bending Formula

Evaluate Formula

Formula

$$M_b = \frac{\sigma_b \cdot \pi \cdot d^3}{32}$$

Example with Units

$$1.8E{+}6\,\text{N*mm} = \frac{177.8\,\text{N/mm}^2 \cdot 3.1416 \cdot 46.9\,\text{mm}^3}{32}$$

3) Bending Stress given Normal Stress Formula

Evaluate Formula

Formula

$$\sigma_b = \sigma_x - \sigma_t$$

Example with Units

$$177.8\,\text{N/mm}^2 = 250.6\,\text{N/mm}^2 - 72.8\,\text{N/mm}^2$$

4) Bending Stress in Shaft Pure Bending Moment Formula

Evaluate Formula

Formula

$$\sigma_b = \frac{32 \cdot M_b}{\pi \cdot d^3}$$

Example with Units

$$177.8\,\text{N/mm}^2 = \frac{32 \cdot 1800736.547\,\text{N*mm}}{3.1416 \cdot 46.9\,\text{mm}^3}$$

5) Diameter of Shaft given Bending Stress Pure Bending Formula

Evaluate Formula

Formula

$$d = \left(\frac{32 \cdot M_b}{\pi \cdot \sigma_b}\right)^{\frac{1}{3}}$$

Example with Units

$$46.9\,\text{mm} = \left(\frac{32 \cdot 1800736.547\,\text{N*mm}}{3.1416 \cdot 177.8\,\text{N/mm}^2}\right)^{\frac{1}{3}}$$

6) Diameter of Shaft given Tensile Stress in Shaft Formula

Evaluate Formula

Formula

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

Example with Units

$$46.9\,\text{mm} = \sqrt{4 \cdot \frac{125767.1\,\text{N}}{3.1416 \cdot 72.8\,\text{N/mm}^2}}$$

7) Diameter of Shaft given Torsional Shear Stress in Shaft Pure Torsion Formula

Evaluate Formula

Formula

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

Example with Units

$$46.9\,\text{mm} = \left(16 \cdot \frac{329966.2\,\text{N*mm}}{3.1416 \cdot 16.29\,\text{N/mm}^2}\right)^{\frac{1}{3}}$$

8) Maximum Shear Stress in Shaft Bending and Torsion Formula

Evaluate Formula

Formula

$$\tau_{smax} = \sqrt{\left(\frac{\sigma_x}{2}\right)^2 + \tau^2}$$

Example with Units

$$126.3545\,\text{N/mm}^2 = \sqrt{\left(\frac{250.6\,\text{N/mm}^2}{2}\right)^2 + 16.29\,\text{N/mm}^2{}^2}$$

9) Normal Stress given Both Bending and Torsional act on Shaft Formula

Evaluate Formula

Formula

$$\sigma_x = \sigma_b + \sigma_t$$

Example with Units

$$250.6\,\text{N/mm}^2 = 177.8\,\text{N/mm}^2 + 72.8\,\text{N/mm}^2$$

10) Normal Stress given Principal Shear Stress in Shaft Bending and Torsion Formula

Evaluate Formula

Formula

$$\sigma_x = 2 \cdot \sqrt{\tau_{max}^2 - \tau^2}$$

Example with Units

$$250.6011\,\text{N/mm}^2 = 2 \cdot \sqrt{126.355\,\text{N/mm}^2{}^2 - 16.29\,\text{N/mm}^2{}^2}$$

11) Power transmitted by Shaft Formula

Evaluate Formula

Formula

$$P = 2 \cdot \pi \cdot N \cdot M_t$$

Example with Units

$$8.8342\,\text{kW} = 2 \cdot 3.1416 \cdot 1850\,\text{rev/min} \cdot 45600\,\text{N*mm}$$

12) Tensile Stress given Normal Stress Formula

Evaluate Formula

Formula

$$\sigma_t = \sigma_x - \sigma_b$$

Example with Units

$$72.8\,\text{N/mm}^2 = 250.6\,\text{N/mm}^2 - 177.8\,\text{N/mm}^2$$

13) Tensile Stress in Shaft when it is Subjected to Axial Tensile Force Formula

Evaluate Formula

Formula

$$\sigma_t = 4 \cdot \frac{P_{ax}}{\pi \cdot d^2}$$

Example with Units

$$72.8\,\text{N/mm}^2 = 4 \cdot \frac{125767.1\,\text{N}}{3.1416 \cdot 46.9\,\text{mm}^2}$$

14) Torsional Moment given Torsional Shear Stress in Shaft Pure Torsion Formula

Evaluate Formula

Formula

$$Mt_{shaft} = \tau \cdot \pi \cdot \frac{d^3}{16}$$

Example with Units

$$329966.2358\,\text{N*mm} = 16.29\,\text{N/mm}^2 \cdot 3.1416 \cdot \frac{46.9\,\text{mm}^3}{16}$$

15) Torsional Shear Stress given Principal Shear Stress in Shaft Formula

Evaluate Formula

Formula

$$\tau = \sqrt{\tau_{max}^2 - \left(\frac{\sigma_x}{2}\right)^2}$$

Example with Units

$$16.294\,\text{N/mm}^2 = \sqrt{126.355\,\text{N/mm}^2{}^2 - \left(\frac{250.6\,\text{N/mm}^2}{2}\right)^2}$$

16) Torsional Shear Stress in Shaft Pure Torsion Formula

Evaluate Formula

Formula

$$\tau = 16 \cdot \frac{Mt_{shaft}}{\pi \cdot d^3}$$

Example with Units

$$16.29\,\text{N/mm}^2 = 16 \cdot \frac{329966.2\,\text{N*mm}}{3.1416 \cdot 46.9\,\text{mm}^3}$$

Variables used in list of Shaft Design on Strength Basis Formulas above

- **d** Diameter of Shaft on Strength Basis *(Millimeter)*
- M_b Bending Moment in Shaft *(Newton Millimeter)*
- M_t Torque Transmitted by Shaft *(Newton Millimeter)*
- Mt_{shaft} Torsional Moment in Shaft *(Newton Millimeter)*
- **N** Speed of Shaft *(Revolution per Minute)*
- **P** Power Transmitted by Shaft *(Kilowatt)*
- P_{ax} Axial Force on Shaft *(Newton)*
- σ_b Bending Stress in Shaft *(Newton per Square Millimeter)*
- σ_t Tensile Stress in Shaft *(Newton per Square Millimeter)*
- σ_x Normal Stress in Shaft *(Newton per Square Millimeter)*
- τ_{max} Principal Shear Stress in Shaft *(Newton per Square Millimeter)*
- τ_{smax} Maximum Shear Stress in Shaft *(Newton per Square Millimeter)*
- τ Torsional Shear Stress in Shaft *(Newton per Square Millimeter)*

Constants, Functions, Measurements used in list of Shaft Design on Strength Basis Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- Functions: **sqrt**, sqrt(Number) *A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.*
- 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: **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*

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