Important Maximum Shear Stress and Principal Stress Theory Formulas PDF

Formulas
Examples
with Units

List of 17
Important Maximum Shear Stress and Principal Stress Theory Formulas

1) Bending Moment given Maximum Shear Stress Formula

Evaluate Formula

Formula

$$M_{b\,MSST} = \sqrt{\left(\frac{\tau_{max\,MSST}}{\frac{16}{\pi \cdot d_{MSST}^{3}}}\right)^{2} - Mt_{t}^{2}}$$

Example with Units

$$980000.0099\,\text{N*mm} = \sqrt{\left(\frac{58.9\,\text{N/mm}^2}{\frac{16}{3.1416 \cdot 45\,\text{mm}^{3}}}\right)^{2} - 387582.1\,\text{N*mm}^{2}}$$

2) Diameter of Shaft given Permissible Value of Maximum Principle Stress Formula

Evaluate Formula

Formula

$$d_{MPST} = \left(\frac{16}{\pi \cdot \sigma_{max}} \cdot \left(M_b + \sqrt{M_b^{2} + Mt_{shaft}^{2}}\right)\right)^{\frac{1}{3}}$$

Example with Units

$$51.5062\,\text{mm} = \left(\frac{16}{3.1416 \cdot 135.3\,\text{N/mm}^2} \cdot \left(1.8E6\,\text{N*mm} + \sqrt{1.8E6\,\text{N*mm}^{2} + 3.3E5\,\text{N*mm}^{2}}\right)\right)^{\frac{1}{3}}$$

3) Diameter of Shaft given Principle Shear Stress Maximum Shear Stress Theory Formula

Evaluate Formula

Formula

$$d_{MSST} = \left(\frac{16}{\pi \cdot \tau_{max\,MSST}} \cdot \sqrt{M_{b\,MSST}^{2} + Mt_{t}^{2}} \right)^{\frac{1}{3}}$$

Example with Units

$$45\,\text{mm} = \left(\frac{16}{3.1416 \cdot 58.9\,\text{N/mm}^2} \cdot \sqrt{980000\,\text{N*mm}^{2} + 387582.1\,\text{N*mm}^{2}} \right)^{\frac{1}{3}}$$

4) Equivalent Bending Moment given Torsional Moment Formula

Evaluate Formula

Formula

$$Mb_{eq} = M_{b\,MSST} + \sqrt{M_{b\,MSST}^{2} + Mt_{t}^{2}}$$

Example with Units

$$2E+6\,\text{N*mm} = 980000\,\text{N*mm} + \sqrt{980000\,\text{N*mm}^{2} + 387582.1\,\text{N*mm}^{2}}$$

5) Factor of Safety for Bi-Axial State of Stress Formula

Evaluate Formula

Formula

$$fos = \frac{\sigma_{yt}}{\sqrt{\sigma_1^{2} + \sigma_2^{2} - \sigma_1 \cdot \sigma_2}}$$

Example with Units

$$3 = \frac{154.2899\,\text{N/mm}^2}{\sqrt{87.5^{2} + 51.43\,\text{N/mm}^{2\,2} - 87.5 \cdot 51.43\,\text{N/mm}^2}}$$

6) Factor of Safety for Tri-axial State of Stress Formula

Evaluate Formula

Formula

$$fos = \frac{\sigma_{yt}}{\sqrt{\frac{1}{2} \cdot \left(\left(\sigma_1 - \sigma_2\right)^{2} + \left(\sigma_2 - \sigma_3\right)^{2} + \left(\sigma_3 - \sigma_1\right)^{2} \right)}}$$

Example with Units

$$3 = \frac{154.2899\,\text{N/mm}^2}{\sqrt{\frac{1}{2} \cdot \left(\left(87.5 - 51.43\,\text{N/mm}^2\right)^{2} + \left(51.43\,\text{N/mm}^2 - 51.430\,\text{N/mm}^2\right)^{2} + \left(51.430\,\text{N/mm}^2 - 87.5\right)^{2} \right)}}$$

7) Factor of Safety given Permissible Value of Maximum Principle Stress Formula

Evaluate Formula

Formula

$$fos_{shaft} = \frac{F_{ce}}{\sigma_{max}}$$

Example with Units

$$1.88 = \frac{254.364\,\text{N/mm}^2}{135.3\,\text{N/mm}^2}$$

8) Factor of Safety given Permissible Value of Maximum Shear Stress Formula

Evaluate Formula

Formula

$$fos_{shaft} = 0.5 \cdot \frac{\tau_{max}}{\tau_{max\ MSST}}$$

Example with Units

$$1.8803 = 0.5 \cdot \frac{221.5\,\mathrm{N/mm^2}}{58.9\,\mathrm{N/mm^2}}$$

9) Factor of Safety given Ultimate Stress and Working Stress Formula

Evaluate Formula

Formula

$$fos = \frac{f_s}{W_s}$$

Example with Units

$$3 = \frac{57\,\mathrm{N/mm^2}}{19\,\mathrm{N/mm^2}}$$

10) Maximum Shear Stress in Shafts Formula

Evaluate Formula

Formula

$$\tau_{max\ MSST} = \frac{16}{\pi \cdot d_{MSST}^{3}} \cdot \sqrt{M_{b\ MSST}^{2} + Mt_t^{2}}$$

Example with Units

$$58.9\,\mathrm{N/mm^2} = \frac{16}{3.1416 \cdot 45\,\mathrm{mm}^{3}} \cdot \sqrt{980000\,\mathrm{N{*}mm}^{2} + 387582.1\,\mathrm{N{*}mm}^{2}}$$

11) Permissible Value of Maximum Principle Stress Formula

Evaluate Formula

Formula

$$\sigma_{max} = \frac{16}{\pi \cdot d_{MPST}^{3}} \cdot \left(M_b + \sqrt{M_b^{2} + Mt_{shaft}^{2}} \right)$$

Example with Units

$$135.349\,\mathrm{N/mm^2} = \frac{16}{3.1416 \cdot 51.5\,\mathrm{mm}^{3}} \cdot \left(1.8E6\,\mathrm{N{*}mm} + \sqrt{1.8E6\,\mathrm{N{*}mm}^{2} + 3.3E5\,\mathrm{N{*}mm}^{2}} \right)$$

12) Permissible Value of Maximum Principle Stress using Factor of Safety Formula

Evaluate Formula

Formula

$$\sigma_{max} = \frac{F_{ce}}{fos_{shaft}}$$

Example with Units

$$135.3\,\mathrm{N/mm^2} = \frac{254.364\,\mathrm{N/mm^2}}{1.88}$$

13) Permissible Value of Maximum Shear Stress Formula

Evaluate Formula

Formula

$$\tau_{max\ MSST} = 0.5 \cdot \frac{\tau_{max}}{fos_{shaft}}$$

Example with Units

$$58.9096\,\mathrm{N/mm^2} = 0.5 \cdot \frac{221.5\,\mathrm{N/mm^2}}{1.88}$$

14) Torsional Moment given Equivalent Bending Moment Formula

Evaluate Formula

Formula

$$Mt_t = \sqrt{\left(Mb_{eq} - M_{b\ MSST} \right)^2 - M_{b\ MSST}^{\ 2}}$$

Example with Units

$$387582.0775\,\text{N*mm} = \sqrt{\left(2033859.51\,\text{N*mm} - 980000\,\text{N*mm} \right)^2 - 980000\,\text{N*mm}^{\ 2}}$$

15) Torsional Moment given Maximum Shear Stress Formula

Evaluate Formula

Formula

$$Mt_t = \sqrt{\left(\pi \cdot d_{MSST}^{\ 3} \cdot \frac{\tau_{max\ MSST}}{16} \right)^2 - M_{b\ MSST}^{\ 2}}$$

Example with Units

$$387582.1251\,\text{N*mm} = \sqrt{\left(3.1416 \cdot 45\,\text{mm}^{\ 3} \cdot \frac{58.9\,\text{N/mm}^2}{16} \right)^2 - 980000\,\text{N*mm}^{\ 2}}$$

16) Yield Strength in Shear Maximum Shear Stress Theory Formula

Evaluate Formula

Formula

$$S_{sy} = 0.5 \cdot fos_{shaft} \cdot \sigma_{max}$$

Example with Units

$$127.182\,\text{N/mm}^2 = 0.5 \cdot 1.88 \cdot 135.3\,\text{N/mm}^2$$

17) Yield Stress in Shear given Permissible Value of Maximum Principle Stress Formula

Evaluate Formula

Formula

$$F_{ce} = \sigma_{max} \cdot fos_{shaft}$$

Example with Units

$$254.364\,\text{N/mm}^2 = 135.3\,\text{N/mm}^2 \cdot 1.88$$

Variables used in list of Maximum Shear Stress and Principal Stress Theory Formulas above

- d_{MPST} Diameter of Shaft from MPST *(Millimeter)*
- d_{MSST} Diameter of Shaft from MSST *(Millimeter)*
- F_{ce} Yield Strength in Shaft from MPST *(Newton per Square Millimeter)*
- f_s Fracture Stress *(Newton per Square Millimeter)*
- **fos** Factor of Safety
- fos_{shaft} Factor of Safety of Shaft
- $M_{b\ MSST}$ Bending Moment in Shaft for MSST *(Newton Millimeter)*
- M_b Bending Moment in Shaft *(Newton Millimeter)*
- Mb_{eq} Equivalent Bending Moment from MSST *(Newton Millimeter)*
- Mt_{shaft} Torsional Moment in Shaft *(Newton Millimeter)*
- Mt_t Torsional Moment in Shaft for MSST *(Newton Millimeter)*
- S_{sy} Shear Yield Strength in Shaft from MSST *(Newton per Square Millimeter)*
- W_s Working Stress *(Newton per Square Millimeter)*
- σ_1 Normal Stress 1
- σ_2 Normal Stress 2 *(Newton per Square Millimeter)*
- σ_3 Normal Stress 3 *(Newton per Square Millimeter)*
- σ_{max} Maximum Principle Stress in Shaft *(Newton per Square Millimeter)*
- σ_{yt} Tensile Yield Strength *(Newton per Square Millimeter)*
- τ_{max} Yield Strength in Shaft from MSST *(Newton per Square Millimeter)*
- $\tau_{max\ MSST}$ Maximum Shear Stress in Shaft from MSST *(Newton per Square Millimeter)*

Constants, Functions, Measurements used in list of Maximum Shear Stress and Principal Stress Theory 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: **Pressure** in Newton per Square Millimeter (N/mm²) *Pressure 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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