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# Maximum Shear Stress and Principal Stress Theory Formulas

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

## Maximum Shear Stress and Principal Stress Theory

### 1) Bending Moment given Maximum Shear Stress

Open Calculator

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

ex $$980000\text{N*mm} = \sqrt{\left(\frac{58.9\text{N/mm}^2}{\frac{16}{\pi \cdot (45\text{mm})^3}}\right)^2 - (387582.1\text{N*mm})^2}$$

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

Open Calculator

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

ex $$51.50622\text{mm} = \left(\frac{16}{\pi \cdot 135.3\text{N/mm}^2} \cdot \left(1.8\text{E6N*mm} + \sqrt{(1.8\text{E6N*mm})^2 + (3.3\text{E5N*mm})^2}\right)\right)^{\frac{1}{3}}$$

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

Open Calculator

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

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

### 4) Equivalent Bending Moment given Torsional Moment

Open Calculator

fx $$Mb_{eq} = M_{b\,MSST} + \sqrt{M_{b\,MSST}^2 + Mt_t^2}$$

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

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

Open Calculator

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

ex $$3.000001 = \frac{154.2899\mathrm{N/mm^2}}{\sqrt{(87.5)^2 + (51.43\mathrm{N/mm^2})^2 - 87.5 \cdot 51.43\mathrm{N/mm^2}}}$$

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

Open Calculator

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

ex $$3.000003 = \frac{154.2899\mathrm{N/mm^2}}{\sqrt{\frac{1}{2} \cdot \left((87.5 - 51.43\mathrm{N/mm^2})^2 + (51.43\mathrm{N/mm^2} - 51.430\mathrm{N/mm^2})^2 + (51.430\mathrm{N/mm^2} - 87.5)^2\right)}}$$

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

Open Calculator

fx $$\mathrm{fos}_{shaft} = \frac{F_{ce}}{\sigma_{max}}$$

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

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

Open Calculator

fx $$\mathrm{fos}_{shaft} = 0.5 \cdot \frac{\tau_{max}}{\tau_{max\ MSST}}$$

ex $$1.880306 = 0.5 \cdot \frac{221.5\mathrm{N/mm^2}}{58.9\mathrm{N/mm^2}}$$

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

Open Calculator

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

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

## 10) Maximum Shear Stress in Shafts

Open Calculator

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

ex $$58.9\text{N/mm}^2 = \frac{16}{\pi \cdot (45\text{mm})^3} \cdot \sqrt{(980000\text{N*mm})^2 + (387582.1\text{N*mm})^2}$$

## 11) Permissible Value of Maximum Principle Stress

Open Calculator

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

ex $$135.349\text{N/mm}^2 = \frac{16}{\pi \cdot (51.5\text{mm})^3} \cdot \left(1.8\text{E6N*mm} + \sqrt{(1.8\text{E6N*mm})^2 + (3.3\text{E5N*mm})^2}\right)$$

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

Open Calculator

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

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

## 13) Permissible Value of Maximum Shear Stress

Open Calculator

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

ex $$58.90957\text{N/mm}^2 = 0.5 \cdot \frac{221.5\text{N/mm}^2}{1.88}$$

## 14) Torsional Moment given Equivalent Bending Moment

Open Calculator

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

ex $$387582.1\text{N*mm} = \sqrt{(2033859.51\text{N*mm} - 980000\text{N*mm})^2 - (980000\text{N*mm})^2}$$

## 15) Torsional Moment given Maximum Shear Stress

Open Calculator

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

ex $$387582.1\text{N*mm} = \sqrt{\left(\pi \cdot (45\text{mm})^3 \cdot \frac{58.9\text{N/mm}^2}{16}\right)^2 - (980000\text{N*mm})^2}$$

## 16) Yield Strength in Shear Maximum Shear Stress Theory

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

ex $127.182 \text{N/mm²} = 0.5 \cdot 1.88 \cdot 135.3 \text{N/mm²}$

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

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

ex $254.364 \text{N/mm²} = 135.3 \text{N/mm²} \cdot 1.88$

## Variables Used

- $d_{MPST}$ 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)*
- $\sigma_1$ Normal Stress 1
- $\sigma_2$ Normal Stress 2 *(Newton per Square Millimeter)*
- $\sigma_3$ Normal Stress 3 *(Newton per Square Millimeter)*
- $\sigma_{max}$ Maximum Principle Stress in Shaft *(Newton per Square Millimeter)*
- $\sigma_{yt}$ Tensile Yield Strength *(Newton per Square Millimeter)*
- $\tau_{max}$ 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

- Constant: **pi**, 3.14159265358979323846264338327950288
  *Archimedes' constant*
- Function: **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*

## Check other formula lists

- **Maximum Shear Stress and Principal Stress Theory Formulas**

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