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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](#)

$$M_b \text{ MSST} = \sqrt{\left(\frac{\tau_{\max} \text{ MSST}}{\frac{16}{\pi \cdot d_{\text{MSST}}^3}}\right)^2 - M_t^2}$$

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

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

[Open Calculator](#)

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

$$\text{ex } 51.50622 \text{ mm} = \left(\frac{16}{\pi \cdot 135.3 \text{ N/mm}^2} \cdot \left(1.8 \text{ E}6 \text{ N*mm} + \sqrt{(1.8 \text{ E}6 \text{ N*mm})^2 + (3.3 \text{ E}5 \text{ N*mm})^2}\right)\right)^{\frac{1}{3}}$$

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

[Open Calculator](#)

$$d_{\text{MSST}} = \left(\frac{16}{\pi \cdot \tau_{\max} \text{ MSST}} \cdot \sqrt{M_b^2 \text{ MSST} + M_t^2}\right)^{\frac{1}{3}}$$

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


4) Equivalent Bending Moment given Torsional Moment

[Open Calculator](#)

$$M_{b_{\text{eq}}} = M_b \text{ MSST} + \sqrt{M_b^2 \text{ MSST} + M_t^2}$$


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



5) Factor of Safety for Bi-Axial State of Stress [Open Calculator !\[\]\(4729e517bc6a7cd81c8025b9646574fb_img.jpg\)](#)

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

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

6) Factor of Safety for Tri-axial State of Stress [Open Calculator !\[\]\(e474458956c9a37fbf9586ddb60a7fa1_img.jpg\)](#)

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

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

7) Factor of Safety given Permissible Value of Maximum Principle Stress [Open Calculator !\[\]\(4fe57c3593bf1b21d272ae7ac8dfaf77_img.jpg\)](#)

$$f_x \text{ fos}_{\text{shaft}} = \frac{F_{ce}}{\sigma_{\max}}$$

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

8) Factor of Safety given Permissible Value of Maximum Shear Stress [Open Calculator !\[\]\(2bae76de5ebbd5c4d7d47162f1673734_img.jpg\)](#)

$$f_x \text{ fos}_{\text{shaft}} = 0.5 \cdot \frac{\tau_{\max}}{\tau_{\max \text{ MSST}}}$$


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

9) Factor of Safety given Ultimate Stress and Working Stress [Open Calculator !\[\]\(5d954b3e270654ad8ab0d5913161c03c_img.jpg\)](#)

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

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



10) Maximum Shear Stress in Shafts 

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

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

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

11) Permissible Value of Maximum Principle Stress 

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

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

$$\text{ex } 135.349\text{N/mm}^2 = \frac{16}{\pi \cdot (51.5\text{mm})^3} \cdot \left(1.8\text{E}6\text{N*mm} + \sqrt{(1.8\text{E}6\text{N*mm})^2 + (3.3\text{E}5\text{N*mm})^2} \right)$$

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

$$\text{fx } \sigma_{\max} = \frac{F_{\text{ce}}}{f_{\text{OS}_{\text{shaft}}}}$$

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


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

13) Permissible Value of Maximum Shear Stress 

$$\text{fx } \tau_{\max \text{ MSST}} = 0.5 \cdot \frac{\tau_{\max}}{f_{\text{OS}_{\text{shaft}}}}$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

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

14) Torsional Moment given Equivalent Bending Moment 

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

[Open Calculator !\[\]\(40770d9ed6ed4f1222ebf89a1396e8b2_img.jpg\)](#)

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


15) Torsional Moment given Maximum Shear Stress 

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

[Open Calculator !\[\]\(8b0a097b4b9c9c3eeaea0f4289ea77e5_img.jpg\)](#)

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




16) Yield Strength in Shear Maximum Shear Stress Theory 

$$f_x \quad S_{sy} = 0.5 \cdot f_{OS_{shaft}} \cdot \sigma_{max}$$

[Open Calculator](#) 

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

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

$$f_x \quad F_{ce} = \sigma_{max} \cdot f_{OS_{shaft}}$$

[Open Calculator](#) 

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







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)
- M_{beq} Equivalent Bending Moment from MSST (Newton Millimeter)
- $M_{t_{shaft}}$ Torsional Moment in Shaft (Newton Millimeter)
- M_{t_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)
- T_{max} Yield Strength in Shaft from MSST (Newton per Square Millimeter)
- τ_{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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