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Principal Stress Formulas

Calculators! Examples! Conversions!

List of 32 Principal Stress Formulas

Principal Stress

Combined Bending and Torsion Condition

1) Angle of Twist in Combined Bending and Torsion

Open Calculator

fx $$\theta = \frac{\arctan\left(\frac{T}{M}\right)}{2}$$

ex $$29.99995° = \frac{\arctan\left(\frac{0.116913\text{MPa}}{67.5\text{kN*m}}\right)}{2}$$

2) Angle of Twist in Combined Bending and Torsional Stress

Open Calculator

fx $$\theta = 0.5 \cdot \arctan\left(2 \cdot \frac{T}{\sigma_b}\right)$$

ex $$8.995819° = 0.5 \cdot \arctan\left(2 \cdot \frac{0.116913\text{MPa}}{0.72\text{MPa}}\right)$$

3) Bending Moment given Combined Bending and Torsion

Open Calculator

fx $$M = \frac{T}{\tan(2 \cdot \theta)}$$

ex $$67.49975\text{kN*m} = \frac{0.116913\text{MPa}}{\tan(2 \cdot 30°)}$$

4) Bending Stress given Combined Bending and Torsional Stress

Open Calculator

fx $$\sigma_b = \frac{T}{\frac{\tan(2 \cdot \theta)}{2}}$$

ex $$0.135\text{MPa} = \frac{0.116913\text{MPa}}{\frac{\tan(2 \cdot 30°)}{2}}$$

5) Torsional Moment when Member is subjected to both Bending and Torsion

Open Calculator

fx $$T = M \cdot (\tan(2 \cdot \theta))$$

ex $$0.116913\text{MPa} = 67.5\text{kN*m} \cdot (\tan(2 \cdot 30°))$$

6) Torsional Stress given Combined Bending and Torsional Stress

Open Calculator

fx $$T = \left(\frac{\tan(2 \cdot \theta)}{2}\right) \cdot \sigma_b$$

ex $$0.623538\text{MPa} = \left(\frac{\tan(2 \cdot 30^\circ)}{2}\right) \cdot 0.72\text{MPa}$$

Complementary Induced Stress

7) Angle of Oblique Plane using Normal Stress when Complementary Shear Stresses Induced

Open Calculator

fx $$\theta = \frac{a\sin\left(\frac{\sigma_\theta}{\tau}\right)}{2}$$

ex $$44.4537^\circ = \frac{a\sin\left(\frac{54.99\text{MPa}}{55\text{MPa}}\right)}{2}$$

8) Angle of Oblique Plane using Shear Stress when Complementary Shear Stresses Induced

Open Calculator

fx $$\theta = 0.5 \cdot \arccos\left(\frac{\tau_\theta}{\tau}\right)$$

ex $$29.61052^\circ = 0.5 \cdot \arccos\left(\frac{28.145\text{MPa}}{55\text{MPa}}\right)$$

9) Normal Stress when Complementary Shear Stresses Induced

Open Calculator

fx $$\sigma_\theta = \tau \cdot \sin(2 \cdot \theta)$$

ex $$47.6314\text{MPa} = 55\text{MPa} \cdot \sin(2 \cdot 30^\circ)$$

10) Shear Stress along Oblique Plane when Complementary Shear Stresses Induced

Open Calculator

fx $$\tau_\theta = \tau \cdot \cos(2 \cdot \theta)$$

ex $$27.5\text{MPa} = 55\text{MPa} \cdot \cos(2 \cdot 30^\circ)$$

11) Shear Stress due to Effect of Complementary Shear Stresses and Shear Stress in Oblique Plane

Open Calculator

fx $$\tau = \frac{\tau_\theta}{\cos(2 \cdot \theta)}$$

ex $$56.29\text{MPa} = \frac{28.145\text{MPa}}{\cos(2 \cdot 30^\circ)}$$

12) Shear Stress due to Induced Complementary Shear Stresses and Normal Stress on Oblique Plane

Open Calculator

fx $$\tau = \frac{\sigma_\theta}{\sin(2 \cdot \theta)}$$

ex $$63.49698\text{MPa} = \frac{54.99\text{MPa}}{\sin(2 \cdot 30^\circ)}$$

Equivalent Bending Moment & Torque

13) Bending Stress of Circular Shaft given Equivalent Bending Moment

Open Calculator

fx $$\sigma_b = \frac{32 \cdot M_e}{\pi \cdot (\Phi^3)}$$

ex $$0.724332\text{MPa} = \frac{32 \cdot 30\text{kN*m}}{\pi \cdot \left((750\text{mm})^3\right)}$$

14) Diameter of Circular Shaft for Equivalent Torque and Maximum Shear Stress

Open Calculator

fx $$\Phi = \left(\frac{16 \cdot T_e}{\pi \cdot (\tau_{max})}\right)^{\frac{1}{3}}$$

ex $$157.1413\text{mm} = \left(\frac{16 \cdot 32\text{kN*m}}{\pi \cdot (42\text{MPa})}\right)^{\frac{1}{3}}$$

15) Diameter of Circular Shaft given Equivalent Bending Stress

Open Calculator

fx $$\Phi = \left(\frac{32 \cdot M_e}{\pi \cdot (\sigma_b)}\right)^{\frac{1}{3}}$$

ex $$751.5011\text{mm} = \left(\frac{32 \cdot 30\text{kN*m}}{\pi \cdot (0.72\text{MPa})}\right)^{\frac{1}{3}}$$

16) Equivalent Bending Moment of Circular Shaft

Open Calculator

fx $$M_e = \frac{\sigma_b}{\frac{32}{\pi \cdot (\Phi^3)}}$$

ex $$29.82059\text{kN*m} = \frac{0.72\text{MPa}}{\frac{32}{\pi \cdot \left((750\text{mm})^3\right)}}$$

17) Equivalent Torque given Maximum Shear Stress

Open Calculator

fx $$T_e = \frac{\tau_{max}}{\frac{16}{\pi \cdot (\Phi^3)}}$$

ex $$3479.068\text{kN*m} = \frac{42\text{MPa}}{\frac{16}{\pi \cdot ((750\text{mm})^3)}}$$

18) Location of Principal Planes

Open Calculator

fx $$\theta = \left(\left(\left(\frac{1}{2} \right) \cdot a\tan\left(\frac{2 \cdot \tau_{xy}}{\sigma_y - \sigma_x} \right) \right) \right)$$

ex $$6.245735^\circ = \left(\left(\left(\frac{1}{2} \right) \cdot a\tan\left(\frac{2 \cdot 7.2\text{MPa}}{110\text{MPa} - 45\text{MPa}} \right) \right) \right)$$

19) Maximum Shear Stress due to Equivalent Torque

Open Calculator

fx $$\tau_{max} = \frac{16 \cdot T_e}{\pi \cdot (\Phi^3)}$$

ex $$0.38631\text{MPa} = \frac{16 \cdot 32\text{kN*m}}{\pi \cdot ((750\text{mm})^3)}$$

Maximum Shear Stress on the Biaxial Loading

20) Maximum Shear Stress when Member is Subjected to like Principal Stresses

Open Calculator

fx $$\tau_{max} = \frac{1}{2} \cdot (\sigma_y - \sigma_x)$$

ex $$32.5\text{MPa} = \frac{1}{2} \cdot (110\text{MPa} - 45\text{MPa})$$

21) Stress along X-Axis when Member is Subjected to like Principal Stresses and Max Shear Stress

Open Calculator

fx $$\sigma_x = \sigma_y - (2 \cdot \tau_{max})$$

ex $$26\text{MPa} = 110\text{MPa} - (2 \cdot 42\text{MPa})$$

22) Stress along Y-Axis when Member is Subjected to like Principal Stresses and Max Shear Stress

Open Calculator

fx $$\sigma_y = 2 \cdot \tau_{max} + \sigma_x$$

ex $$129\text{MPa} = 2 \cdot 42\text{MPa} + 45\text{MPa}$$

Stresses in Bi-Axial Loading

23) Normal Stress Induced in Oblique Plane due to Biaxial Loading

Open Calculator

fx $$\sigma_\theta = \left(\frac{1}{2} \cdot (\sigma_x + \sigma_y)\right) + \left(\frac{1}{2} \cdot (\sigma_x - \sigma_y) \cdot (\cos(2 \cdot \theta))\right) + (\tau_{xy} \cdot \sin(2 \cdot \theta))$$

ex $$67.48538\text{MPa} = \left(\frac{1}{2} \cdot (45\text{MPa} + 110\text{MPa})\right) + \left(\frac{1}{2} \cdot (45\text{MPa} - 110\text{MPa}) \cdot (\cos(2 \cdot 30^\circ))\right) + (7.2\text{MPa} \cdot \sin($$

24) Shear Stress Induced in Oblique Plane due to Biaxial Loading

Open Calculator

fx $$\tau_\theta = -\left(\frac{1}{2} \cdot (\sigma_x - \sigma_y) \cdot \sin(2 \cdot \theta)\right) + (\tau_{xy} \cdot \cos(2 \cdot \theta))$$

ex $$31.74583\text{MPa} = -\left(\frac{1}{2} \cdot (45\text{MPa} - 110\text{MPa}) \cdot \sin(2 \cdot 30^\circ)\right) + (7.2\text{MPa} \cdot \cos(2 \cdot 30^\circ))$$

25) Stress along X- Direction with known Shear Stress in Bi-Axial Loading

Open Calculator

fx $$\sigma_x = \sigma_y - \left(\frac{\tau_\theta \cdot 2}{\sin(2 \cdot \theta)}\right)$$

ex $$45.00191\text{MPa} = 110\text{MPa} - \left(\frac{28.145\text{MPa} \cdot 2}{\sin(2 \cdot 30^\circ)}\right)$$

26) Stress along Y- Direction using Shear Stress in Bi-Axial Loading

Open Calculator

fx $$\sigma_y = \sigma_x + \left(\frac{\tau_\theta \cdot 2}{\sin(2 \cdot \theta)}\right)$$

ex $$109.9981\text{MPa} = 45\text{MPa} + \left(\frac{28.145\text{MPa} \cdot 2}{\sin(2 \cdot 30^\circ)}\right)$$

Stresses of Members Subjected to Axial Loading

27) Angle of Oblique Plane using Shear Stress and Axial Load

Open Calculator

fx $$\theta = \frac{ar\sin\left(\left(\frac{2 \cdot \tau_\theta}{\sigma_y}\right)\right)}{2}$$

ex $$15.38948^\circ = \frac{ar\sin\left(\left(\frac{2 \cdot 28.145\text{MPa}}{110\text{MPa}}\right)\right)}{2}$$

28) Angle of Oblique plane when Member Subjected to Axial Loading

Open Calculator

fx $$\theta = \frac{a\cos\left(\frac{\sigma_\theta}{\sigma_y}\right)}{2}$$

ex $$30.00301^\circ = \frac{a\cos\left(\frac{54.99\text{MPa}}{110\text{MPa}}\right)}{2}$$

29) Normal Stress when Member Subjected to Axial Load

Open Calculator

fx $$\sigma_\theta = \sigma_y \cdot \cos(2 \cdot \theta)$$

ex $$55\text{MPa} = 110\text{MPa} \cdot \cos(2 \cdot 30^\circ)$$

30) Shear Stress when Member Subjected to Axial Load

Open Calculator

fx $$\tau_\theta = 0.5 \cdot \sigma_y \cdot \sin(2 \cdot \theta)$$

ex $$47.6314\text{MPa} = 0.5 \cdot 110\text{MPa} \cdot \sin(2 \cdot 30^\circ)$$

31) Stress along Y-direction given Shear Stress in Member subjected to Axial Load

Open Calculator

fx $$\sigma_y = \frac{\tau_\theta}{0.5 \cdot \sin(2 \cdot \theta)}$$

ex $$64.99809\text{MPa} = \frac{28.145\text{MPa}}{0.5 \cdot \sin(2 \cdot 30^\circ)}$$

32) Stress along Y-direction when Member Subjected to Axial Load

Open Calculator

fx $$\sigma_y = \frac{\sigma_\theta}{\cos(2 \cdot \theta)}$$

ex $$109.98\text{MPa} = \frac{54.99\text{MPa}}{\cos(2 \cdot 30^\circ)}$$

Variables Used

- **M** Bending Moment *(Kilonewton Meter)*
- **M_e** Equivalent Bending Moment *(Kilonewton Meter)*
- **T** Torsion *(Megapascal)*
- **T_e** Equivalent Torque *(Kilonewton Meter)*
- **θ** Theta *(Degree)*
- **σ_b** Bending Stress *(Megapascal)*
- **σ_x** Stress along x Direction *(Megapascal)*
- **σ_y** Stress along y Direction *(Megapascal)*
- **σ_θ** Normal Stress on Oblique Plane *(Megapascal)*
- **τ** Shear Stress *(Megapascal)*
- **τ_{max}** Maximum Shear Stress *(Megapascal)*
- **τ_{xy}** Shear Stress xy *(Megapascal)*
- **τ_θ** Shear Stress on Oblique Plane *(Megapascal)*
- **Φ** Diameter of Circular Shaft *(Millimeter)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **acos**, acos(Number)
  Inverse trigonometric cosine function
- Function: **arccos**, arccos(Number)
  Inverse trigonometric cosine function
- Function: **arctan**, arctan(Number)
  Inverse trigonometric tangent function
- Function: **arsin**, arsin(Number)
  Inverse trigonometric sine function
- Function: **asin**, asin(Number)
  Inverse trigonometric sine function
- Function: **atan**, atan(Number)
  Inverse trigonometric tangent function
- Function: **cos**, cos(Angle)
  Trigonometric cosine function
- Function: **ctan**, ctan(Angle)
  Trigonometric cotangent function
- Function: **sin**, sin(Angle)
  Trigonometric sine function
- Function: **tan**, tan(Angle)
  Trigonometric tangent function
- Measurement: **Length** in Millimeter (mm)
  Length Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Torque** in Kilonewton Meter (kN*m)
  Torque Unit Conversion
- Measurement: **Moment of Force** in Kilonewton Meter (kN*m)
  Moment of Force Unit Conversion
- Measurement: **Stress** in Megapascal (MPa)
  Stress Unit Conversion

Check other formula lists

- **Mohr's Circle of Stresses Formulas**
- **Beam Moments Formulas**
- **Bending Stress Formulas**
- **Combined Axial and Bending Loads Formulas**
- **Elastic Stability of Columns Formulas**
- **Principal Stress Formulas**
- **Slope and Deflection Formulas**
- **Strain Energy Formulas**