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Principal Stresses Formulas

Calculators! Examples! Conversions!

List of 22 Principal Stresses Formulas

Principal Stresses

1) Angle of Obliquity

Open Calculator

fx $$\phi = a\tan\left(\frac{\tau}{\sigma_n}\right)$$

ex $$84.05314° = a\tan\left(\frac{2.4\text{MPa}}{0.250\text{MPa}}\right)$$

2) Major Principal Stress if Member is Subjected to Two Perpendicular Direct Stress and Shear Stress

Open Calculator

fx $$\sigma_{major} = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau^2}$$

ex $$3.054683\text{MPa} = \frac{0.5\text{MPa} + 0.8\text{MPa}}{2} + \sqrt{\left(\frac{0.5\text{MPa} - 0.8\text{MPa}}{2}\right)^2 + (2.4\text{MPa})^2}$$

3) Maximum Axial Force

Open Calculator

fx $$P_{axial} = \sigma \cdot A$$

ex $$0.0768\text{kN} = 0.012\text{MPa} \cdot 6400\text{mm}^2$$

4) Minor Principal Stress if Member is Subjected to Two Perpendicular Direct Stress and Shear Stress

Open Calculator

fx $$\sigma_{minor} = \frac{\sigma_x + \sigma_y}{2} - \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau^2}$$

ex $$-1.754683\text{MPa} = \frac{0.5\text{MPa} + 0.8\text{MPa}}{2} - \sqrt{\left(\frac{0.5\text{MPa} - 0.8\text{MPa}}{2}\right)^2 + (2.4\text{MPa})^2}$$

5) Resultant Stress on Oblique Section given Stress in Perpendicular Directions

Open Calculator

fx $\sigma_R = \sqrt{\sigma_n^2 + \tau^2}$

ex $2.412986\text{MPa} = \sqrt{(0.250\text{MPa})^2 + (2.4\text{MPa})^2}$

6) Safe Stress given Safe Value of Axial Pull

Open Calculator

fx $\sigma = \frac{P_{safe}}{A}$

ex $0.195312\text{MPa} = \frac{1.25\text{kN}}{6400\text{mm}^2}$

7) Safe Value of Axial Pull

Open Calculator

fx $P_{safe} = \sigma_w \cdot A$

ex $38.4\text{kN} = 6\text{MPa} \cdot 6400\text{mm}^2$

8) Stress along Maximum Axial Force

Open Calculator

fx $\sigma = \frac{P_{axial}}{A}$

ex $0.171875\text{MPa} = \frac{1.1\text{kN}}{6400\text{mm}^2}$

Normal Stress

9) Equivalent Stress by Distortion Energy Theory

Open Calculator

fx $\sigma_e = \frac{1}{\sqrt{2}} \cdot \sqrt{(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2}$

ex

$41.05127\text{N/m}^2 = \frac{1}{\sqrt{2}} \cdot \sqrt{(87.5 - 51.43\text{N/m}^2)^2 + (51.43\text{N/m}^2 - 96.1\text{N/m}^2)^2 + (96.1\text{N/m}^2 - 87.5)^2}$

10) Normal Stress across Oblique Section

Open Calculator

fx $\sigma_n = \sigma \cdot \left(\cos\left(\theta_{oblique}\right)\right)^2$

ex $0.011196\text{MPa} = 0.012\text{MPa} \cdot (\cos(15°))^2$

11) Normal Stress for Principal Planes at Angle of 0 Degrees given Major and Minor Tensile Stress

Open Calculator

fx $\sigma_n = \frac{\sigma_1 + \sigma_2}{2} + \frac{\sigma_1 - \sigma_2}{2}$

ex $124\text{MPa} = \frac{124\text{MPa} + 48\text{MPa}}{2} + \frac{124\text{MPa} - 48\text{MPa}}{2}$

12) Normal Stress for Principal Planes at Angle of 90 degrees

Open Calculator

fx $\sigma_n = \frac{\sigma_1 + \sigma_2}{2} - \frac{\sigma_1 - \sigma_2}{2}$

ex $48\text{MPa} = \frac{124\text{MPa} + 48\text{MPa}}{2} - \frac{124\text{MPa} - 48\text{MPa}}{2}$

13) Normal Stress for Principal Planes when Planes are at Angle of 0 Degree

Open Calculator

fx $\sigma_n = \frac{\sigma_1 + \sigma_2}{2} + \frac{\sigma_1 - \sigma_2}{2}$

ex $124\text{MPa} = \frac{124\text{MPa} + 48\text{MPa}}{2} + \frac{124\text{MPa} - 48\text{MPa}}{2}$

14) Normal Stress on Oblique Section given Stress in Perpendicular Directions

Open Calculator

fx $\sigma_n = \frac{\sigma_1 + \sigma_2}{2} + \frac{\sigma_1 - \sigma_2}{2} \cdot \cos\left(2 \cdot \theta_{oblique}\right)$

ex $118.909\text{MPa} = \frac{124\text{MPa} + 48\text{MPa}}{2} + \frac{124\text{MPa} - 48\text{MPa}}{2} \cdot \cos(2 \cdot 15°)$

15) Normal Stress using Obliquity

Open Calculator

fx $\sigma_n = \frac{\tau}{\tan(\phi)}$

ex $2.4\text{MPa} = \frac{2.4\text{MPa}}{\tan(45°)}$

16) Stress Amplitude

Open Calculator

fx $$\sigma_a = \frac{\sigma_{max} - \sigma_{min}}{2}$$

ex $$-21.935\text{N/m}^2 = \frac{62.43\text{N/m}^2 - 106.3\text{N/m}^2}{2}$$

Shear Stress

17) Condition for Maximum or Minimum Shear Stress given Member under Direct and Shear Stress

Open Calculator

fx $$\theta_{plane} = \frac{1}{2} \cdot a\tan\left(\frac{\sigma_x - \sigma_y}{2 \cdot \tau}\right)$$

ex $$-1.788167^\circ = \frac{1}{2} \cdot a\tan\left(\frac{0.5\text{MPa} - 0.8\text{MPa}}{2 \cdot 2.4\text{MPa}}\right)$$

18) Maximum Shear Stress given Major and Minor Tensile Stress

Open Calculator

fx $$\tau_{max} = \frac{\sigma_1 - \sigma_2}{2}$$

ex $$38\text{MPa} = \frac{124\text{MPa} - 48\text{MPa}}{2}$$

19) Maximum Shear Stress given Member is under Direct and Shear Stress

Open Calculator

fx $$\tau_{max} = \frac{\sqrt{\left(\sigma_x - \sigma_y\right)^2 + 4 \cdot \tau^2}}{2}$$

ex $$2.404683\text{MPa} = \frac{\sqrt{(0.5\text{MPa} - 0.8\text{MPa})^2 + 4 \cdot (2.4\text{MPa})^2}}{2}$$

20) Shear Stress using Obliquity

Open Calculator

fx $$\tau = \tan(\phi) \cdot \sigma_n$$

ex $$0.25\text{MPa} = \tan(45^\circ) \cdot 0.250\text{MPa}$$

Tangential Stress

21) Tangential Stress across Oblique Section

Open Calculator

fx $$\sigma_t = \frac{\sigma}{2} \cdot \sin\left(2 \cdot \theta_{oblique}\right)$$

ex $$0.003\text{MPa} = \frac{0.012\text{MPa}}{2} \cdot \sin(2 \cdot 15^\circ)$$

22) Tangential Stress on Oblique Section given Stress in Perpendicular Directions

Open Calculator

fx $$\sigma_t = \sin\left(2 \cdot \theta_{oblique}\right) \cdot \frac{\sigma_1 - \sigma_2}{2}$$

ex $$19\text{MPa} = \sin(2 \cdot 15^\circ) \cdot \frac{124\text{MPa} - 48\text{MPa}}{2}$$

Variables Used

- A Area of Cross-Section *(Square Millimeter)*
- P_{axial} Maximum Axial Force *(Kilonewton)*
- P_{safe} Safe Value of Axial Pull *(Kilonewton)*
- $\theta_{oblique}$ Angle made by Oblique Section with Normal *(Degree)*
- θ_{plane} Plane Angle *(Degree)*
- σ Stress in Bar *(Megapascal)*
- σ_1 Normal Stress 1
- σ_1 Major Tensile Stress *(Megapascal)*
- σ_2 Normal Stress 2 *(Newton per Square Meter)*
- σ_2 Minor Tensile Stress *(Megapascal)*
- σ_3 Normal Stress 3 *(Newton per Square Meter)*
- σ_a Stress Amplitude *(Newton per Square Meter)*
- σ_e Equivalent Stress *(Newton per Square Meter)*
- σ_{major} Major Principal Stress *(Megapascal)*
- σ_{max} Maximum Stress at Crack Tip *(Newton per Square Meter)*
- σ_{min} Minimum Stress *(Newton per Square Meter)*
- σ_{minor} Minor Principal Stress *(Megapascal)*
- σ_n Normal Stress *(Megapascal)*
- σ_R Resultant Stress *(Megapascal)*
- σ_t Tangential Stress *(Megapascal)*
- σ_w Safe Stress *(Megapascal)*
- σ_x Stress acting along x-direction *(Megapascal)*
- σ_y Stress acting along y-direction *(Megapascal)*
- ϕ Angle of Obliquity *(Degree)*
- τ Shear Stress *(Megapascal)*
- τ_{max} Maximum Shear Stress *(Megapascal)*

Constants, Functions, Measurements used

- Function: **atan**, atan(Number)
  Inverse tan is used to calculate the angle by applying the tangent ratio of the angle, which is the opposite side divided by the adjacent side of the right triangle.
- Function: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Function: **sin**, sin(Angle)
  Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.
- 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.
- Function: **tan**, tan(Angle)
  The tangent of an angle is a trigonometric ratio of the length of the side opposite an angle to the length of the side adjacent to an angle in a right triangle.
- Measurement: **Area** in Square Millimeter (mm^2)
  Area Unit Conversion
- Measurement: **Pressure** in Megapascal (MPa), Newton per Square Meter (N/m^2)
  Pressure Unit Conversion
- Measurement: **Force** in Kilonewton (kN)
  Force Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Stress** in Megapascal (MPa)
  Stress Unit Conversion

Check other formula lists

- **Principal Stresses Formulas**

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