Important Mohr's Circle Formulas PDF

Formulas
Examples
with Units

List of 14
Important Mohr's Circle Formulas

1) Mohr's Circle when a Body is Subjected to Two Mutual Perpendicular and a Simple Shear Stress Formulas

1.1) Condition for Maximum Value of Normal Stress Formula

Evaluate Formula

Formula

$$\theta_{plane} = \frac{atan\left(\frac{2 \cdot \tau}{\sigma_x - \sigma_y}\right)}{2}$$

Example with Units

$$24.3339° = \frac{atan\left(\frac{2 \cdot 41.5\,\text{MPa}}{95\,\text{MPa} - 22\,\text{MPa}}\right)}{2}$$

1.2) Condition for Minimum Normal Stress Formula

Evaluate Formula

Formula

$$\theta_{plane} = \frac{atan\left(\frac{2 \cdot \tau}{\sigma_x - \sigma_y}\right)}{2}$$

Example with Units

$$24.3339° = \frac{atan\left(\frac{2 \cdot 41.5\,\text{MPa}}{95\,\text{MPa} - 22\,\text{MPa}}\right)}{2}$$

1.3) Maximum Value of Normal Stress Formula

Evaluate Formula

Formula

$$\sigma_{n,max} = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau^2}$$

Example with Units

$$113.7675\,\text{MPa} = \frac{95\,\text{MPa} + 22\,\text{MPa}}{2} + \sqrt{\left(\frac{95\,\text{MPa} - 22\,\text{MPa}}{2}\right)^2 + 41.5\,\text{MPa}^2}$$

1.4) Maximum Value of Shear Stress Formula

Evaluate Formula

Formula

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

Example with Units

$$55.2675\,\text{MPa} = \sqrt{\left(\frac{95\,\text{MPa} - 22\,\text{MPa}}{2}\right)^2 + 41.5\,\text{MPa}^2}$$

1.5) Minimum Value of Normal Stress Formula

Evaluate Formula

Formula

$$\sigma_{n,min} = \frac{\sigma_x + \sigma_y}{2} - \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau^2}$$

Example with Units

$$3.2325\,\text{MPa} = \frac{95\,\text{MPa} + 22\,\text{MPa}}{2} - \sqrt{\left(\frac{95\,\text{MPa} - 22\,\text{MPa}}{2}\right)^2 + 41.5\,\text{MPa}^2}$$

1.6) Normal Stress on Oblique Plane with Two Mutually Perpendicular Unequal Stresses Formula

Evaluate Formula

Formula

$$\sigma_\theta = \frac{\sigma_{major} + \sigma_{minor}}{2} + \frac{\sigma_{major} - \sigma_{minor}}{2} \cdot \cos(2 \cdot \theta_{plane})$$

Example with Units

$$62.25\,\text{MPa} = \frac{75\,\text{MPa} + 24\,\text{MPa}}{2} + \frac{75\,\text{MPa} - 24\,\text{MPa}}{2} \cdot \cos(2 \cdot 30^\circ)$$

1.7) Shear Stress on Oblique Plane given Two Mutually Perpendicular and Unequal Stress Formula

Evaluate Formula

Formula

$$\sigma_t = \frac{\sigma_{major} - \sigma_{minor}}{2} \cdot \sin(2 \cdot \theta_{plane})$$

Example with Units

$$22.0836\,\text{MPa} = \frac{75\,\text{MPa} - 24\,\text{MPa}}{2} \cdot \sin(2 \cdot 30^\circ)$$

2) Mohr's Circle when a Body is Subjected to Two Mutual Perpendicular Stress which are Unequal and Unlike Formulas

2.1) Normal Stress on Oblique Plane for Two Perpendicular Unequal and Unlike Stress Formula

Evaluate Formula

Formula

$$\sigma_\theta = \frac{\sigma_{major} - \sigma_{minor}}{2} + \frac{\sigma_{major} + \sigma_{minor}}{2} \cdot \cos(2 \cdot \theta_{plane})$$

Example with Units

$$50.25\,\text{MPa} = \frac{75\,\text{MPa} - 24\,\text{MPa}}{2} + \frac{75\,\text{MPa} + 24\,\text{MPa}}{2} \cdot \cos(2 \cdot 30^\circ)$$

2.2) Radius of Mohr's Circle for Unequal and Unlike Mutually Perpendicular Stresses Formula

Evaluate Formula

Formula

$$R = \frac{\sigma_{major} + \sigma_{minor}}{2}$$

Example with Units

$$49.5\,\text{MPa} = \frac{75\,\text{MPa} + 24\,\text{MPa}}{2}$$

2.3) Shear Stress on Oblique Plane for Two Perpendicular Unequal and Unlike Stress Formula

Evaluate Formula

Formula

$$\sigma_t = \frac{\sigma_{major} + \sigma_{minor}}{2} \cdot \sin\left(2 \cdot \theta_{plane}\right)$$

Example with Units

$$42.8683\,\text{MPa} = \frac{75\,\text{MPa} + 24\,\text{MPa}}{2} \cdot \sin\left(2 \cdot 30^\circ\right)$$

3) Mohr's Circle when a Body is Subjected to Two Mutual Perpendicular Tensile Stress of Unequal Intensity Formulas

3.1) Maximum Shear Stress Formula

Evaluate Formula

Formula

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

Example with Units

$$55.2675\,\text{MPa} = \frac{\sqrt{\left(95\,\text{MPa} - 22\,\text{MPa}\right)^2 + 4 \cdot 41.5\,\text{MPa}^2}}{2}$$

3.2) Normal Stress on Oblique Plane with Two Mutually Perpendicular Forces Formula

Evaluate Formula

Formula

$$\sigma_\theta = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2} \cdot \cos\left(2 \cdot \theta_{plane}\right) + \tau \cdot \sin\left(2 \cdot \theta_{plane}\right)$$

Example with Units

$$112.6901\,\text{MPa} = \frac{95\,\text{MPa} + 22\,\text{MPa}}{2} + \frac{95\,\text{MPa} - 22\,\text{MPa}}{2} \cdot \cos\left(2 \cdot 30^\circ\right) + 41.5\,\text{MPa} \cdot \sin\left(2 \cdot 30^\circ\right)$$

3.3) Radius of Mohr's Circle for Two Mutually Perpendicular Stresses of Unequal Intensities Formula

Evaluate Formula

Formula

$$R = \frac{\sigma_{major} - \sigma_{minor}}{2}$$

Example with Units

$$25.5\,\text{MPa} = \frac{75\,\text{MPa} - 24\,\text{MPa}}{2}$$

3.4) Tangential Stress on Oblique Plane with Two Mutually Perpendicular Forces Formula

Evaluate Formula

Formula

$$\sigma_t = \frac{\sigma_x - \sigma_y}{2} \cdot \sin\left(2 \cdot \theta_{plane}\right) - \tau \cdot \cos\left(2 \cdot \theta_{plane}\right)$$

Example with Units

$$10.8599\,\text{MPa} = \frac{95\,\text{MPa} - 22\,\text{MPa}}{2} \cdot \sin\left(2 \cdot 30°\right) - 41.5\,\text{MPa} \cdot \cos\left(2 \cdot 30°\right)$$

Variables used in list of Mohr's Circle Formulas above

- **R** Radius of Mohr's circle *(Megapascal)*
- **θ_{plane}** Plane Angle *(Degree)*
- **σ_{major}** Major Principal Stress *(Megapascal)*
- **σ_{minor}** Minor Principal Stress *(Megapascal)*
- **$\sigma_{n,max}$** Maximum Normal Stress *(Megapascal)*
- **$\sigma_{n,min}$** Minimum Normal Stress *(Megapascal)*
- **σ_t** Tangential Stress on Oblique Plane *(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 in Mpa *(Megapascal)*
- **τ_{max}** Maximum Shear Stress *(Megapascal)*

Constants, Functions, Measurements used in list of Mohr's Circle Formulas above

- Functions: **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.
- Functions: **cos**, cos(Angle)
  Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- Functions: **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.
- 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.
- Functions: **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: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Stress** in Megapascal (MPa)
  Stress Unit Conversion

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