Important Combined Axial and Bending Loads Formulas PDF

Formulas Examples with Units

List of 19 Important Combined Axial and Bending Loads Formulas

1) Axial Load given Maximum Stress for Short Beams Formula

Evaluate Formula

Formula

$$P = A \cdot \left(\sigma_{max} - \left(\frac{M_{max} \cdot y}{I} \right) \right)$$

Example with Units

$$1999.98\,\text{N} = 0.12\,\text{m}^2 \cdot \left(0.136979\,\text{MPa} - \left(\frac{7.7\,\text{kN*m} \cdot 25\,\text{mm}}{0.0016\,\text{m}^4} \right) \right)$$

2) Cross-Sectional Area given Maximum Stress for Short Beams Formula

Evaluate Formula

Formula

$$A = \frac{P}{\sigma_{max} - \left(\frac{M_{max} \cdot y}{I} \right)}$$

Example with Units

$$0.12\,\text{m}^2 = \frac{2000\,\text{N}}{0.136979\,\text{MPa} - \left(\frac{7.7\,\text{kN*m} \cdot 25\,\text{mm}}{0.0016\,\text{m}^4} \right)}$$

3) Deflection for Axial Compression and Bending Formula

Evaluate Formula

Formula

$$\delta = \frac{d_0}{1 - \left(\frac{P}{P_c} \right)}$$

Example with Units

$$4.8\,\text{mm} = \frac{4\,\text{mm}}{1 - \left(\frac{2000\,\text{N}}{12000\,\text{N}} \right)}$$

4) Deflection for Transverse Loading given Deflection for Axial Bending Formula

Evaluate Formula

Formula

$$d_0 = \delta \cdot \left(1 - \left(\frac{P}{P_c} \right) \right)$$

Example with Units

$$4.1667\,\text{mm} = 5\,\text{mm} \cdot \left(1 - \left(\frac{2000\,\text{N}}{12000\,\text{N}} \right) \right)$$

5) Distance from Extreme Fiber given Moment of Resistance and Moment of Inertia along with Stress Formula

Evaluate Formula

Formula

$$y = \frac{I \cdot \sigma_b}{M_r}$$

Example with Units

$$25\,\text{mm} = \frac{0.0016\,\text{m}^4 \cdot 0.072\,\text{MPa}}{4.608\,\text{kN*m}}$$

6) Distance from Extreme Fiber given Young's Modulus along with Radius and Stress Induced Formula

Evaluate Formula

Formula

$$y = \frac{R_{curvature} \cdot \sigma_y}{E}$$

Example with Units

$$25\,\text{mm} = \frac{152\,\text{mm} \cdot 3289.474\,\text{MPa}}{20000\,\text{MPa}}$$

7) Maximum Bending Moment given Maximum Stress for Short Beams Formula

Evaluate Formula

Formula

$$M_{max} = \frac{\left(\sigma_{max} - \left(\frac{P}{A}\right)\right) \cdot I}{y}$$

Example with Units

$$7.7\,\text{kN*m} = \frac{\left(0.136979\,\text{MPa} - \left(\frac{2000\,\text{N}}{0.12\,\text{m}^2}\right)\right) \cdot 0.0016\,\text{m}^4}{25\,\text{mm}}$$

8) Maximum Stress for Short Beams Formula

Evaluate Formula

Formula

$$\sigma_{max} = \left(\frac{P}{A}\right) + \left(\frac{M_{max} \cdot y}{I}\right)$$

Example with Units

$$0.137\,\text{MPa} = \left(\frac{2000\,\text{N}}{0.12\,\text{m}^2}\right) + \left(\frac{7.7\,\text{kN*m} \cdot 25\,\text{mm}}{0.0016\,\text{m}^4}\right)$$

9) Maximum Stress in Short Beams for Large Deflection Formula

Evaluate Formula

Formula

$$\sigma_{max} = \left(\frac{P}{A}\right) + \left(\frac{\left(M_{max} + P \cdot \delta\right) \cdot y}{I}\right)$$

Example with Units

$$0.1371\,\text{MPa} = \left(\frac{2000\,\text{N}}{0.12\,\text{m}^2}\right) + \left(\frac{\left(7.7\,\text{kN*m} + 2000\,\text{N} \cdot 5\,\text{mm}\right) \cdot 25\,\text{mm}}{0.0016\,\text{m}^4}\right)$$

10) Moment of Inertia given Moment of Resistance, Stress induced and Distance from Extreme Fiber Formula

Evaluate Formula

Formula

$$I = \frac{y \cdot M_r}{\sigma_b}$$

Example with Units

$$0.0016\,\text{m}^4 = \frac{25\,\text{mm} \cdot 4.608\,\text{kN*m}}{0.072\,\text{MPa}}$$

11) Moment of Inertia given Young's Modulus, Moment of Resistance and Radius Formula

Evaluate Formula

Formula

$$I = \frac{M_r \cdot R_{curvature}}{E}$$

Example with Units

$$3.5E\text{-}8\,\mathrm{m^4} = \frac{4.608\,\mathrm{kN{*}m} \cdot 152\,\mathrm{mm}}{20000\,\mathrm{MPa}}$$

12) Moment of Resistance given Young's Modulus, Moment of Inertia and Radius Formula

Evaluate Formula

Formula

$$M_r = \frac{I \cdot E}{R_{curvature}}$$

Example with Units

$$210526.3158\,\mathrm{kN{*}m} = \frac{0.0016\,\mathrm{m^4} \cdot 20000\,\mathrm{MPa}}{152\,\mathrm{mm}}$$

13) Moment of Resistance in Bending Equation Formula

Evaluate Formula

Formula

$$M_r = \frac{I \cdot \sigma_b}{y}$$

Example with Units

$$4.608\,\mathrm{kN{*}m} = \frac{0.0016\,\mathrm{m^4} \cdot 0.072\,\mathrm{MPa}}{25\,\mathrm{mm}}$$

14) Neutral Axis Moment of Inertia given Maximum Stress for Short Beams Formula

Evaluate Formula

Formula

$$I = \frac{M_{max} \cdot A \cdot y}{\left(\sigma_{max} \cdot A\right) - \left(P\right)}$$

Example with Units

$$0.0016\,\mathrm{m^4} = \frac{7.7\,\mathrm{kN{*}m} \cdot 0.12\,\mathrm{m^2} \cdot 25\,\mathrm{mm}}{\left(0.136979\,\mathrm{MPa} \cdot 0.12\,\mathrm{m^2}\right) - \left(2000\,\mathrm{N}\right)}$$

15) Neutral Axis to Outermost Fiber Distance given Maximum Stress for Short Beams Formula

Evaluate Formula

Formula

$$y = \frac{\left(\sigma_{max} \cdot A \cdot I\right) - \left(P \cdot I\right)}{M_{max} \cdot A}$$

Example with Units

$$25\,\mathrm{mm} = \frac{\left(0.136979\,\mathrm{MPa} \cdot 0.12\,\mathrm{m^2} \cdot 0.0016\,\mathrm{m^4}\right) - \left(2000\,\mathrm{N} \cdot 0.0016\,\mathrm{m^4}\right)}{7.7\,\mathrm{kN{*}m} \cdot 0.12\,\mathrm{m^2}}$$

16) Stress Induced using Moment of Resistance, Moment of Inertia and Distance from Extreme Fiber Formula

Evaluate Formula

Formula

$$\sigma_b = \frac{y \cdot M_r}{I}$$

Example with Units

$$0.072\,\mathrm{MPa} = \frac{25\,\mathrm{mm} \cdot 4.608\,\mathrm{kN{*}m}}{0.0016\,\mathrm{m^4}}$$

17) Stress Induced with known Distance from Extreme Fiber, Young's Modulus and Radius of curvature Formula

Evaluate Formula

Formula

$$\sigma_y = \frac{E \cdot y}{R_{curvature}}$$

Example with Units

$$3289.4737\,\text{MPa} = \frac{20000\,\text{MPa} \cdot 25\,\text{mm}}{152\,\text{mm}}$$

18) Young's Modulus given Distance from Extreme Fiber along with Radius and Stress Induced Formula

Evaluate Formula

Formula

$$E = \left(\frac{R_{curvature} \cdot \sigma_y}{y} \right)$$

Example with Units

$$20000.0019\,\text{MPa} = \left(\frac{152\,\text{mm} \cdot 3289.474\,\text{MPa}}{25\,\text{mm}} \right)$$

19) Young's Modulus using Moment of Resistance, Moment of Inertia and Radius Formula

Evaluate Formula

Formula

$$E = \frac{M_r \cdot R_{curvature}}{I}$$

Example with Units

$$0.4378\,\text{MPa} = \frac{4.608\,\text{kN*m} \cdot 152\,\text{mm}}{0.0016\,\text{m}^4}$$

Variables used in list of Combined Axial and Bending Loads Formulas above

- **A** Cross Sectional Area *(Square Meter)*
- **d_0** Deflection for Transverse Loading Alone *(Millimeter)*
- **E** Young's Modulus *(Megapascal)*
- **I** Area Moment of Inertia *(Meter⁴)*
- **M_{max}** Maximum Bending Moment *(Kilonewton Meter)*
- **M_r** Moment of Resistance *(Kilonewton Meter)*
- **P** Axial Load *(Newton)*
- **P_c** Critical Buckling Load *(Newton)*
- **$R_{curvature}$** Radius of Curvature *(Millimeter)*
- **y** Distance from Neutral Axis *(Millimeter)*
- **δ** Deflection of Beam *(Millimeter)*
- **σ_b** Bending Stress *(Megapascal)*
- **σ_{max}** Maximum Stress *(Megapascal)*
- **σ_y** Fibre Stress at Distance 'y' from NA *(Megapascal)*

Constants, Functions, Measurements used in list of Combined Axial and Bending Loads Formulas above

- Measurement: **Length** in Millimeter (mm)
  Length Unit Conversion
- Measurement: **Area** in Square Meter (m^2)
  Area Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Moment of Force** in Kilonewton Meter (kN*m)
  Moment of Force Unit Conversion
- Measurement: **Second Moment of Area** in Meter⁴ (m^4)
  Second Moment of Area Unit Conversion
- Measurement: **Stress** in Megapascal (MPa)
  Stress Unit Conversion

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