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Combined Axial and Bending Loads Formulas

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List of 19 Combined Axial and Bending Loads Formulas

Combined Axial and Bending Loads

1) Axial Load given Maximum Stress for Short Beams

Open Calculator

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

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

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

Open Calculator

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

ex $$0.120001\text{m}^2 = \frac{2000\text{N}}{0.136979\text{MPa} - \left(\frac{7.7\text{kN*m} \cdot 25\text{mm}}{0.0016\text{m}^4} \right)}$$

3) Deflection for Axial Compression and Bending

Open Calculator

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

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

4) Deflection for Transverse Loading given Deflection for Axial Bending

Open Calculator

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

ex $$4.166667\text{mm} = 5\text{mm} \cdot \left(1 - \left(\frac{2000\text{N}}{12000\text{N}}\right)\right)$$

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

Open Calculator

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

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

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

Open Calculator

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

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

7) Maximum Bending Moment given Maximum Stress for Short Beams

Open Calculator

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

$$7.699989\text{kN*m} = \frac{\left(0.136979\text{MPa} - \left(\frac{2000\text{N}}{0.12\text{m}^2}\right)\right) \cdot 0.0016\text{m}^4}{25\text{mm}}$$

8) Maximum Stress for Short Beams

Open Calculator

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

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

9) Maximum Stress in Short Beams for Large Deflection

Open Calculator

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

$$0.137135\text{MPa} = \left(\frac{2000\text{N}}{0.12\text{m}^2}\right) + \left(\frac{(7.7\text{kN*m} + 2000\text{N} \cdot 5\text{mm}) \cdot 25\text{mm}}{0.0016\text{m}^4}\right)$$

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

Open Calculator

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

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

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

Open Calculator

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

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

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

Open Calculator

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

ex $$210526.3kN*m = \frac{0.0016m^4 \cdot 20000MPa}{152mm}$$

13) Moment of Resistance in Bending Equation

Open Calculator

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

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

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

Open Calculator

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

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

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

Open Calculator

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

$$24.99997\text{mm} = \frac{(0.136979\text{MPa} \cdot 0.12\text{m}^2 \cdot 0.0016\text{m}^4) - (2000\text{N} \cdot 0.0016\text{m}^4)}{7.7\text{kN*m} \cdot 0.12\text{m}^2}$$

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

Open Calculator

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

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

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

Open Calculator

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

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

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

Open Calculator

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

$$20000\text{MPa} = \left(\frac{152\text{mm} \cdot 3289.474\text{MPa}}{25\text{mm}} \right)$$

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

Open Calculator

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

ex $$0.43776\text{MPa} = \frac{4.608\text{kN*m} \cdot 152\text{mm}}{0.0016\text{m}^4}$$

Variables Used

- **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

- 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

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**

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