Important Stress and Strain Formulas PDF

Formulas
Examples
with Units

List of 61
Important Stress and Strain Formulas

1) Bar of Uniform Strength Formulas

1.1) Area at Section 1 of Bars of Uniform Strength Formula

Evaluate Formula

Formula

$$A_1 = A_2 \cdot e^{\gamma \cdot \frac{L_{Rod}}{\sigma_{Uniform}}}$$

Example with Units

$$0.0013\,\mathrm{m^2} = 0.001250\,\mathrm{m^2} \cdot e^{70\,\mathrm{kN/m^3} \cdot \frac{1.83\,\mathrm{m}}{27\,\mathrm{MPa}}}$$

1.2) Area at Section 2 of Bars of Uniform Strength Formula

Evaluate Formula

Formula

$$A_2 = \frac{A_1}{e^{\gamma \cdot \frac{L_{Rod}}{\sigma_{Uniform}}}}$$

Example with Units

$$0.0013\,\mathrm{m^2} = \frac{0.001256\,\mathrm{m^2}}{e^{70\,\mathrm{kN/m^3} \cdot \frac{1.83\,\mathrm{m}}{27\,\mathrm{MPa}}}}$$

1.3) Weight Density of Bar using Area at Section 1 of Bars of uniform Strength Formula

Evaluate Formula

Formula

$$\gamma = \left(2.303 \cdot \log10\left(\frac{A_1}{A_2}\right)\right) \cdot \frac{\sigma_{Uniform}}{L_{Rod}}$$

Example with Units

$$70.663\,\mathrm{kN/m^3} = \left(2.303 \cdot \log10\left(\frac{0.001256\,\mathrm{m^2}}{0.001250\,\mathrm{m^2}}\right)\right) \cdot \frac{27\,\mathrm{MPa}}{1.83\,\mathrm{m}}$$

2) Circular Tapering Rod Formulas

2.1) Diameter at One End of Circular Tapering Rod Formula

Evaluate Formula

Formula

$$d_2 = 4 \cdot W_{Applied\ load} \cdot \frac{L}{\pi \cdot E \cdot \delta l \cdot d_1}$$

Example with Units

$$0.0318\,\mathrm{m} = 4 \cdot 150\,\mathrm{kN} \cdot \frac{3\,\mathrm{m}}{3.1416 \cdot 20000\,\mathrm{MPa} \cdot 0.020\,\mathrm{m} \cdot 0.045\,\mathrm{m}}$$

2.2) Diameter at Other End of Circular Tapering Rod Formula

Evaluate Formula

Formula

$$d_1 = 4 \cdot W_{\text{Applied load}} \cdot \frac{L}{\pi \cdot E \cdot \delta l \cdot d_2}$$

Example with Units

$$0.0409\,\text{m} = 4 \cdot 150\,\text{kN} \cdot \frac{3\,\text{m}}{3.1416 \cdot 20000\,\text{MPa} \cdot 0.020\,\text{m} \cdot 0.035\,\text{m}}$$

2.3) Diameter of Circular Tapered Rod with Uniform Cross Section Formula

Evaluate Formula

Formula

$$d = \sqrt{4 \cdot W_{\text{Applied load}} \cdot \frac{L}{\pi \cdot E \cdot \delta l}}$$

Example with Units

$$0.0378\,\text{m} = \sqrt{4 \cdot 150\,\text{kN} \cdot \frac{3\,\text{m}}{3.1416 \cdot 20000\,\text{MPa} \cdot 0.020\,\text{m}}}$$

2.4) Elongation of Circular Tapering Rod Formula

Evaluate Formula

Formula

$$\delta l = 4 \cdot W_{\text{Applied load}} \cdot \frac{L}{\pi \cdot E \cdot d_1 \cdot d_2}$$

Example with Units

$$0.0182\,\text{m} = 4 \cdot 150\,\text{kN} \cdot \frac{3\,\text{m}}{3.1416 \cdot 20000\,\text{MPa} \cdot 0.045\,\text{m} \cdot 0.035\,\text{m}}$$

2.5) Elongation of Prismatic Rod Formula

Evaluate Formula

Formula

$$\delta l = 4 \cdot W_{\text{Applied load}} \cdot \frac{L}{\pi \cdot E \cdot \left(d^2\right)}$$

Example with Units

$$0.002\,\text{m} = 4 \cdot 150\,\text{kN} \cdot \frac{3\,\text{m}}{3.1416 \cdot 20000\,\text{MPa} \cdot \left(0.12\,\text{m}^2\right)}$$

2.6) Length of Circular Tapered Rod with Uniform Cross Section Formula

Evaluate Formula

Formula

$$L = \frac{\delta l}{4 \cdot \frac{W_{Applied\ load}}{\pi \cdot E \cdot \left(d^2\right)}}$$

Example with Units

$$30.1593\,\text{m} = \frac{0.020\,\text{m}}{4 \cdot \frac{150\,\text{kN}}{3.1416 \cdot 20000\,\text{MPa} \cdot \left(0.12\,\text{m}^2\right)}}$$

2.7) Length of Circular Tapering rod Formula

Evaluate Formula

Formula

$$L = \frac{\delta l}{4 \cdot \frac{W_{Applied\ load}}{\pi \cdot E \cdot d_1 \cdot d_2}}$$

Example with Units

$$3.2987\,\text{m} = \frac{0.020\,\text{m}}{4 \cdot \frac{150\,\text{kN}}{3.1416 \cdot 20000\,\text{MPa} \cdot 0.045\,\text{m} \cdot 0.035\,\text{m}}}$$

2.8) Load at End with known Extension of Circular Tapering Rod Formula

Evaluate Formula

Formula

$$W_{Applied\ load} = \frac{\delta l}{4 \cdot \frac{L}{\pi \cdot E \cdot d_1 \cdot d_2}}$$

Example with Units

$$164.9336\,\text{kN} = \frac{0.020\,\text{m}}{4 \cdot \frac{3\,\text{m}}{3.1416 \cdot 20000\,\text{MPa} \cdot 0.045\,\text{m} \cdot 0.035\,\text{m}}}$$

2.9) Modulus of Elasticity of Circular Tapering Rod with Uniform Cross Section Section Formula

Evaluate Formula

Formula

$$E = 4 \cdot W_{Applied\ load} \cdot \frac{L}{\pi \cdot \delta l \cdot \left(d^2\right)}$$

Example with Units

$$1989.4368\,\text{MPa} = 4 \cdot 150\,\text{kN} \cdot \frac{3\,\text{m}}{3.1416 \cdot 0.020\,\text{m} \cdot \left(0.12\,\text{m}^2\right)}$$

2.10) Modulus of Elasticity using Elongation of Circular Tapering Rod Formula

Evaluate Formula

Formula

$$E = 4 \cdot W_{Applied\ load} \cdot \frac{L}{\pi \cdot \delta l \cdot d_1 \cdot d_2}$$

Example with Units

$$18189.1364\,\text{MPa} = 4 \cdot 150\,\text{kN} \cdot \frac{3\,\text{m}}{3.1416 \cdot 0.020\,\text{m} \cdot 0.045\,\text{m} \cdot 0.035\,\text{m}}$$

3) Elongation due to Self weight Formulas

3.1) Cross Sectional Area with known Elongation of Tapering Bar due to Self Weight Formula

Evaluate Formula

Formula

$$A = W_{Load} \cdot \frac{L}{6 \cdot \delta l \cdot E}$$

Example with Units

$$2187.5\,\text{mm}^2 = 1750\,\text{kN} \cdot \frac{3\,\text{m}}{6 \cdot 0.020\,\text{m} \cdot 20000\,\text{MPa}}$$

3.2) Elongation due to Self Weight in Prismatic Bar Formula

Evaluate Formula

Formula

$$\delta l = \gamma_{Rod} \cdot L \cdot \frac{L}{E \cdot 2}$$

Example with Units

$$0.0011\,\text{m} = 4930.96\,\text{kN/m}^3 \cdot 3\,\text{m} \cdot \frac{3\,\text{m}}{20000\,\text{MPa} \cdot 2}$$

3.3) Elongation due to Self Weight in Prismatic Bar using Applied Load Formula

Evaluate Formula

Formula

$$\delta l = W_{Load} \cdot \frac{L}{2 \cdot A \cdot E}$$

Example with Units

$$0.0234\,\text{m} = 1750\,\text{kN} \cdot \frac{3\,\text{m}}{2 \cdot 5600\,\text{mm}^2 \cdot 20000\,\text{MPa}}$$

3.4) Elongation of Truncated Conical Rod due to Self Weight Formula

Evaluate Formula

Formula

$$\delta l = \frac{\left(\gamma_{Rod} \cdot l^2\right) \cdot \left(d_1 + d_2\right)}{6 \cdot E \cdot \left(d_1 - d_2\right)}$$

Example with Units

$$0.02\,\text{m} = \frac{\left(4930.96\,\text{kN/m}^3 \cdot 7.8\,\text{m}^2\right) \cdot \left(0.045\,\text{m} + 0.035\,\text{m}\right)}{6 \cdot 20000\,\text{MPa} \cdot \left(0.045\,\text{m} - 0.035\,\text{m}\right)}$$

3.5) Length of Bar using Elongation due to Self Weight in Prismatic bar Formula

Evaluate Formula

Formula

$$L = \sqrt{\frac{\delta l}{\frac{\gamma_{Rod}}{E \cdot 2}}}$$

Example with Units

$$12.7374\,\text{m} = \sqrt{\frac{0.020\,\text{m}}{\frac{4930.96\,\text{kN/m}^3}{20000\,\text{MPa} \cdot 2}}}$$

3.6) Length of Bar using its Uniform Strength Formula

Evaluate Formula

Formula

$$L = \left(2.303 \cdot \log 10\left(\frac{A_1}{A_2}\right)\right) \cdot \left(\frac{\sigma_{Uniform}}{\gamma_{Rod}}\right)$$

Example with Units

$$0.0262\,\mathrm{m} = \left(2.303 \cdot \log 10\left(\frac{0.001256\,\mathrm{m^2}}{0.001250\,\mathrm{m^2}}\right)\right) \cdot \left(\frac{27\,\mathrm{MPa}}{4930.96\,\mathrm{kN/m^3}}\right)$$

3.7) Length of Rod of Truncated Conical Section Formula

Evaluate Formula

Formula

$$l = \sqrt{\frac{\delta l}{\frac{(\gamma_{Rod}) \cdot (d_1 + d_2)}{6 \cdot E \cdot (d_1 - d_2)}}}$$

Example with Units

$$7.8\,\mathrm{m} = \sqrt{\frac{0.020\,\mathrm{m}}{\frac{(4930.96\,\mathrm{kN/m^3}) \cdot (0.045\,\mathrm{m} + 0.035\,\mathrm{m})}{6 \cdot 20000\,\mathrm{MPa} \cdot (0.045\,\mathrm{m} - 0.035\,\mathrm{m})}}}$$

3.8) Modulus of Elasticity of Bar with known elongation of Truncated Conical Rod due to Self Weight Formula

Evaluate Formula

Formula

$$E = \frac{\left(\gamma_{Rod} \cdot l^2\right) \cdot (d_1 + d_2)}{6 \cdot \delta l \cdot (d_1 - d_2)}$$

Example with Units

$$19999.9738\,\mathrm{MPa} = \frac{\left(4930.96\,\mathrm{kN/m^3} \cdot 7.8\,\mathrm{m}^2\right) \cdot (0.045\,\mathrm{m} + 0.035\,\mathrm{m})}{6 \cdot 0.020\,\mathrm{m} \cdot (0.045\,\mathrm{m} - 0.035\,\mathrm{m})}$$

3.9) Modulus of Elasticity of Rod using Extension of Truncated Conical Rod due to Self Weight Formula

Evaluate Formula

Formula

$$E = \frac{\left(\gamma_{Rod} \cdot l^2\right) \cdot (d_1 + d_2)}{6 \cdot \delta l \cdot (d_1 - d_2)}$$

Example with Units

$$19999.9738\,\mathrm{MPa} = \frac{\left(4930.96\,\mathrm{kN/m^3} \cdot 7.8\,\mathrm{m}^2\right) \cdot (0.045\,\mathrm{m} + 0.035\,\mathrm{m})}{6 \cdot 0.020\,\mathrm{m} \cdot (0.045\,\mathrm{m} - 0.035\,\mathrm{m})}$$

3.10) Specific weight of Truncated Conical Rod using its elongation due to Self Weight Formula

Evaluate Formula

Formula

$$\gamma_{Rod} = \frac{\delta l}{\frac{(l^2)\cdot(d_1 + d_2)}{6 \cdot E \cdot (d_1 - d_2)}}$$

Example with Units

$$4930.9665\,\mathrm{kN/m^3} = \frac{0.020\,\mathrm{m}}{\frac{(7.8\,\mathrm{m}^2)\cdot(0.045\,\mathrm{m} + 0.035\,\mathrm{m})}{6 \cdot 20000\,\mathrm{MPa} \cdot (0.045\,\mathrm{m} - 0.035\,\mathrm{m})}}$$

3.11) Uniform Stress on Bar due to Self-Weight Formula

Evaluate Formula

Formula

$$\sigma_{Uniform} = \frac{L}{\frac{2.303 \cdot \log 10\left(\frac{A_1}{A_2}\right)}{\gamma_{Rod}}}$$

Example with Units

$$3088.684\,\mathrm{MPa} = \frac{3\,\mathrm{m}}{\frac{2.303 \cdot \log 10\left(\frac{0.001256\,\mathrm{m^2}}{0.001250\,\mathrm{m^2}}\right)}{4930.96\,\mathrm{kN/m^3}}}$$

4) Elongation of Tapering Bar due to Self Weight Formulas

4.1) Elongation of Conical bar due to Self Weight Formula

Evaluate Formula

Formula

$$\delta l = \frac{\gamma \cdot L_{Taperedbar}^{2}}{6 \cdot E}$$

Example with Units

$$0.02\,\mathrm{m} = \frac{70\,\mathrm{kN/m^3} \cdot 185\,\mathrm{m}^{2}}{6 \cdot 20000\,\mathrm{MPa}}$$

4.2) Elongation of Conical Bar due to Self Weight with known Cross-sectional area Formula

Evaluate Formula

Formula

$$\delta l = W_{Load} \cdot \frac{l}{6 \cdot A \cdot E}$$

Example with Units

$$0.0203\,\mathrm{m} = 1750\,\mathrm{kN} \cdot \frac{7.8\,\mathrm{m}}{6 \cdot 5600\,\mathrm{mm^2} \cdot 20000\,\mathrm{MPa}}$$

4.3) Length of Bar given Elongation of Conical Bar due to Self Weight Formula

Evaluate Formula

Formula

$$L_{Taperedbar} = \sqrt{\frac{\delta l}{\frac{\gamma}{6 \cdot E}}}$$

Example with Units

$$185.164\,\mathrm{m} = \sqrt{\frac{0.020\,\mathrm{m}}{\frac{70\,\mathrm{kN/m^3}}{6 \cdot 20000\,\mathrm{MPa}}}}$$

4.4) Length of Bar using Elongation of Conical Bar with Cross-sectional area Formula

Evaluate Formula

Formula

$$l = \frac{\delta l}{\frac{W_{Load}}{6 \cdot A \cdot E}}$$

Example with Units

$$7.68\,\mathrm{m} = \frac{0.020\,\mathrm{m}}{\frac{1750\,\mathrm{kN}}{6 \cdot 5600\,\mathrm{mm^2} \cdot 20000\,\mathrm{MPa}}}$$

4.5) Length of Circular Tapering Rod when deflection due to load Formula

Evaluate Formula

Formula

$$L = \frac{\delta l}{4 \cdot \frac{W_{Load}}{\pi \cdot E \cdot (d_1 \cdot d_2)}}$$

Example with Units

$$0.2827\,\text{m} = \frac{0.020\,\text{m}}{4 \cdot \frac{1750\,\text{kN}}{3.1416 \cdot 20000\,\text{MPa} \cdot (0.045\,\text{m} \cdot 0.035\,\text{m})}}$$

4.6) Length of Prismatic Rod given Elongation due to Self Weight in Uniform Bar Formula

Evaluate Formula

Formula

$$L = \frac{\delta l}{\frac{W_{Load}}{2 \cdot A \cdot E}}$$

Example with Units

$$2.56\,\text{m} = \frac{0.020\,\text{m}}{\frac{1750\,\text{kN}}{2 \cdot 5600\,\text{mm}^2 \cdot 20000\,\text{MPa}}}$$

4.7) Load on Conical Bar with known Elongation due to Self Weight Formula

Evaluate Formula

Formula

$$W_{Load} = \frac{\delta l}{\frac{l}{6 \cdot A \cdot E}}$$

Example with Units

$$1723.0769\,\text{kN} = \frac{0.020\,\text{m}}{\frac{7.8\,\text{m}}{6 \cdot 5600\,\text{mm}^2 \cdot 20000\,\text{MPa}}}$$

4.8) Load on Prismatic Bar with known Elongation due to Self Weight Formula

Evaluate Formula

Formula

$$W_{Load} = \frac{\delta l}{\frac{L}{2 \cdot A \cdot E}}$$

Example with Units

$$1493.3333\,\text{kN} = \frac{0.020\,\text{m}}{\frac{3\,\text{m}}{2 \cdot 5600\,\text{mm}^2 \cdot 20000\,\text{MPa}}}$$

4.9) Modulus of Elasticity of Bar given Elongation of Conical Bar due to Self Weight Formula

Evaluate Formula

Formula

$$E = \gamma \cdot \frac{L_{Taperedbar}^{2}}{6 \cdot \delta l}$$

Example with Units

$$19964.5833\,\text{MPa} = 70\,\text{kN/m}^3 \cdot \frac{(185\,\text{m})^{2}}{6 \cdot 0.020\,\text{m}}$$

4.10) Modulus of Elasticity of Conical Bar with known Elongation and Cross-sectional area Formula

Evaluate Formula

Formula

$$E = W_{Load} \cdot \frac{l}{6 \cdot A \cdot \delta l}$$

Example with Units

$$20312.5\,\text{MPa} = 1750\,\text{kN} \cdot \frac{7.8\,\text{m}}{6 \cdot 5600\,\text{mm}^2 \cdot 0.020\,\text{m}}$$

4.11) Modulus of Elasticity of Prismatic Bar with known Elongation due to Self Weight Formula

Evaluate Formula

Formula

$$E = \gamma \cdot L \cdot \frac{L}{\delta l \cdot 2}$$

Example with Units

$$15.75\,\text{MPa} = 70\,\text{kN/m}^3 \cdot 3\,\text{m} \cdot \frac{3\,\text{m}}{0.020\,\text{m} \cdot 2}$$

4.12) Self Weight of Conical section with known Elongation Formula

Evaluate Formula

Formula

$$\gamma = \frac{\delta l}{\frac{L_{Taperedbar}^2}{6 \cdot E}}$$

Example with Units

$$70.1242\,\text{kN/m}^3 = \frac{0.020\,\text{m}}{\frac{185\,\text{m}^2}{6 \cdot 20000\,\text{MPa}}}$$

4.13) Self Weight of Prismatic Bar with known Elongation Formula

Evaluate Formula

Formula

$$\gamma = \frac{\delta l}{L \cdot \frac{L}{E \cdot 2}}$$

Example with Units

$$88888.8889\,\text{kN/m}^3 = \frac{0.020\,\text{m}}{3\,\text{m} \cdot \frac{3\,\text{m}}{20000\,\text{MPa} \cdot 2}}$$

5) Hoop Stress due to Temperature Fall Formulas

5.1) Diameter of Tyre given Hoop Stress due to Temperature Fall Formula

Evaluate Formula

Formula

$$d_{tyre} = \frac{D_{wheel}}{\left(\frac{\sigma_h}{E}\right) + 1}$$

Example with Units

$$0.2303\,\text{m} = \frac{0.403\,\text{m}}{\left(\frac{15000\,\text{MPa}}{20000\,\text{MPa}}\right) + 1}$$

5.2) Diameter of Wheel given Hoop Stress due to Temperature Fall Formula

Evaluate Formula

Formula

$$D_{wheel} = \left(1 + \left(\frac{\sigma_h}{E}\right)\right) \cdot d_{tyre}$$

Example with Units

$$0.4025\,\text{m} = \left(1 + \left(\frac{15000\,\text{MPa}}{20000\,\text{MPa}}\right)\right) \cdot 0.230\,\text{m}$$

5.3) Hoop Stress due to Temperature Fall Formula

Evaluate Formula

Formula

$$\sigma_h = \left(\frac{D_{wheel} - d_{tyre}}{d_{tyre}}\right) \cdot E$$

Example with Units

$$15043.4783\,\text{MPa} = \left(\frac{0.403\,\text{m} - 0.230\,\text{m}}{0.230\,\text{m}}\right) \cdot 20000\,\text{MPa}$$

5.4) Hoop Stress due to Temperature Fall given Strain Formula

Evaluate Formula

Formula

$$\sigma_h = \varepsilon \cdot E$$

Example with Units

$$15000\,\text{MPa} = 0.75 \cdot 20000\,\text{MPa}$$

5.5) Modulus of Elasticity given Hoop Stress due to Temperature Fall with Strain Formula

Evaluate Formula

Formula

$$E = \frac{\sigma_h}{\varepsilon}$$

Example with Units

$$20000\,\text{MPa} = \frac{15000\,\text{MPa}}{0.75}$$

5.6) Strain for Hoop Stress due to Temperature Fall Formula

Evaluate Formula

Formula

$$\varepsilon = \frac{\sigma_h}{E}$$

Example with Units

$$0.75 = \frac{15000\,\text{MPa}}{20000\,\text{MPa}}$$

6) Temperature Stresses and Strains Formulas

6.1) Change in Temperature using Temperature Stress for Tapering Rod Formula

Evaluate Formula

Formula

$$\Delta t = \frac{\sigma}{t \cdot E \cdot \alpha \cdot \frac{D_2 - h_1}{\ln\left(\frac{D_2}{h_1}\right)}}$$

Example with Units

$$13.5155\,{}^\circ\text{C} = \frac{20\,\text{MPa}}{0.006\,\text{m} \cdot 20000\,\text{MPa} \cdot 0.001\,{}^\circ\text{C}^{-1} \cdot \frac{15\,\text{m} - 10\,\text{m}}{\ln\left(\frac{15\,\text{m}}{10\,\text{m}}\right)}}$$

6.2) Coefficient of Thermal Expansion given Temperature Stress for Tapering Rod Section Formula

Evaluate Formula

Formula

$$\alpha = \frac{W}{t \cdot E \cdot \Delta t \cdot \frac{D_2 - h_1}{\ln\left(\frac{D_2}{h_1}\right)}}$$

Example with Units

$$0.001\,{}^\circ\text{C}^{-1} = \frac{18497\,\text{kN}}{0.006\,\text{m} \cdot 20000\,\text{MPa} \cdot 12.5\,{}^\circ\text{C} \cdot \frac{15\,\text{m} - 10\,\text{m}}{\ln\left(\frac{15\,\text{m}}{10\,\text{m}}\right)}}$$

6.3) Diameter of Tyre given Temperature Strain Formula

Evaluate Formula

Formula

$$d_{tyre} = \left(\frac{D_{wheel}}{\varepsilon + 1}\right)$$

Example with Units

$$0.2303\,\text{m} = \left(\frac{0.403\,\text{m}}{0.75 + 1}\right)$$

6.4) Diameter of Wheel given Temperature Strain Formula

Evaluate Formula

Formula

$$D_{wheel} = d_{tyre} \cdot (\varepsilon + 1)$$

Example with Units

$$0.4025\,\text{m} = 0.230\,\text{m} \cdot (0.75 + 1)$$

6.5) Modulus of Elasticity given Temperature Stress for Tapering Rod Section Formula

Evaluate Formula

Formula

$$E = \frac{\sigma}{t \cdot \alpha \cdot \Delta t \cdot \frac{D_2 - h_1}{\ln\left(\frac{D_2}{h_1}\right)}}$$

Example with Units

$$21624.8058\,\text{MPa} = \frac{20\,\text{MPa}}{0.006\,\text{m} \cdot 0.001\,{}^\circ\text{C}^{-1} \cdot 12.5\,{}^\circ\text{C} \cdot \frac{15\,\text{m} - 10\,\text{m}}{\ln\left(\frac{15\,\text{m}}{10\,\text{m}}\right)}}$$

6.6) Modulus of Elasticity using Hoop Stress due to Temperature Fall Formula

Evaluate Formula

Formula

$$E = \frac{\sigma_h \cdot d_{tyre}}{D_{wheel} - d_{tyre}}$$

Example with Units

$$19942.1965\,\text{MPa} = \frac{15000\,\text{MPa} \cdot 0.230\,\text{m}}{0.403\,\text{m} - 0.230\,\text{m}}$$

6.7) Temperature Strain Formula

Evaluate Formula

Formula

$$\varepsilon = \left(\frac{D_{wheel} - d_{tyre}}{d_{tyre}} \right)$$

Example with Units

$$0.7522 = \left(\frac{0.403\,\text{m} - 0.230\,\text{m}}{0.230\,\text{m}} \right)$$

6.8) Temperature Stress for Tapering Rod Section Formula

Evaluate Formula

Formula

$$W = t \cdot E \cdot \alpha \cdot \Delta t \cdot \frac{D_2 - h_1}{\ln\left(\frac{D_2}{h_1}\right)}$$

Example with Units

$$18497.276\,\text{kN} = 0.006\,\text{m} \cdot 20000\,\text{MPa} \cdot 0.001\,{}^{\circ}\text{C}^{-1} \cdot 12.5\,{}^{\circ}\text{C} \cdot \frac{15\,\text{m} - 10\,\text{m}}{\ln\left(\frac{15\,\text{m}}{10\,\text{m}}\right)}$$

6.9) Thickness of Tapered Bar using Temperature Stress Formula

Evaluate Formula

Formula

$$t = \frac{\sigma}{E \cdot \alpha \cdot \Delta t \cdot \frac{D_2 - h_1}{\ln\left(\frac{D_2}{h_1}\right)}}$$

Example with Units

$$0.0065\,\text{m} = \frac{20\,\text{MPa}}{20000\,\text{MPa} \cdot 0.001\,{}^{\circ}\text{C}^{-1} \cdot 12.5\,{}^{\circ}\text{C} \cdot \frac{15\,\text{m} - 10\,\text{m}}{\ln\left(\frac{15\,\text{m}}{10\,\text{m}}\right)}}$$

7) Volumetric Strain of a Rectangular Bar Formulas

7.1) Strain along Breadth given Volumetric Strain of Rectangular Bar Formula

Evaluate Formula

Formula

$$\varepsilon_b = \varepsilon_v - \left(\varepsilon_l + \varepsilon_d \right)$$

Example

$$-0.0052 = 0.0001 - \left(0.002 + 0.0033 \right)$$

7.2) Strain along Depth given Volumetric Strain of Rectangular Bar Formula

Evaluate Formula

Formula

$$\varepsilon_d = \varepsilon_v - \left(\varepsilon_l + \varepsilon_b \right)$$

Example

$$-0.0266 = 0.0001 - \left(0.002 + 0.0247 \right)$$

7.3) Strain along Length given Volumetric Strain of Rectangular Bar Formula

Evaluate Formula

Formula

$$\varepsilon_l = \varepsilon_v - (\varepsilon_b + \varepsilon_d)$$

Example

$$-0.0279 = 0.0001 - (0.0247 + 0.0033)$$

7.4) Volumetric Strain of Rectangular Bar Formula

Evaluate Formula

Formula

$$\varepsilon_v = \varepsilon_l + \varepsilon_b + \varepsilon_d$$

Example

$$0.03 = 0.002 + 0.0247 + 0.0033$$

8) Volumetric Strain of Sphere Formulas

8.1) Change in Diameter given Volumetric Strain of Sphere Formula

Evaluate Formula

Formula

$$\delta_{dia} = \varepsilon_v \cdot \frac{\Phi}{3}$$

Example with Units

$$0.0002\,\mathrm{m} = 0.0001 \cdot \frac{5.05\,\mathrm{m}}{3}$$

8.2) Diameter of Sphere using Volumetric Strain of sphere Formula

Evaluate Formula

Formula

$$\Phi = 3 \cdot \frac{\delta_{dia}}{\varepsilon_v}$$

Example with Units

$$1515\,\mathrm{m} = 3 \cdot \frac{0.0505\,\mathrm{m}}{0.0001}$$

8.3) Strain given Volumetric Strain of Sphere Formula

Evaluate Formula

Formula

$$\varepsilon_L = \frac{\varepsilon_v}{3}$$

Example

$$3.3E\text{-}5 = \frac{0.0001}{3}$$

8.4) Volumetric Strain of sphere Formula

Evaluate Formula

Formula

$$\varepsilon_v = 3 \cdot \frac{\delta_{dia}}{\Phi}$$

Example with Units

$$0.03 = 3 \cdot \frac{0.0505\,\mathrm{m}}{5.05\,\mathrm{m}}$$

8.5) Volumetric Strain of Sphere given Lateral Strain Formula

Evaluate Formula

Formula

$$\varepsilon_v = 3 \cdot \varepsilon_L$$

Example

$$0.06 = 3 \cdot 0.02$$

Variables used in list of Stress and Strain Formulas above

- **A** Area of Cross-Section *(Square Millimeter)*
- **A_1** Area 1 *(Square Meter)*
- **A_2** Area 2 *(Square Meter)*
- **d** Diameter of Shaft *(Meter)*
- **d_1** Diameter1 *(Meter)*
- **d_2** Diameter2 *(Meter)*
- **D_2** Depth of Point 2 *(Meter)*
- **d_{tyre}** Diameter of Tyre *(Meter)*
- **D_{wheel}** Wheel Diameter *(Meter)*
- **E** Young's Modulus *(Megapascal)*
- **h_1** Depth of Point 1 *(Meter)*
- **l** Length of Tapered Bar *(Meter)*
- **L** Length *(Meter)*
- **L_{Rod}** Length of Rod *(Meter)*
- **$L_{Taperedbar}$** Tapered Bar Length *(Meter)*
- **t** Section Thickness *(Meter)*
- **W** Load Applied KN *(Kilonewton)*
- **$W_{Applied\ load}$** Applied Load *(Kilonewton)*
- **W_{Load}** Applied Load SOM *(Kilonewton)*
- **α** Coefficient of Linear Thermal Expansion *(Per Degree Celsius)*
- **γ** Specific Weight *(Kilonewton per Cubic Meter)*
- **γ_{Rod}** Specific Weight of Rod *(Kilonewton per Cubic Meter)*
- **δ_{dia}** Change in Diameter *(Meter)*
- **δl** Elongation *(Meter)*
- **Δt** Change in Temperature *(Degree Celsius)*
- **ε** Strain
- **ε_b** Strain along Breadth
- **ε_d** Strain along Depth
- **ε_l** Strain along Length
- **ε_L** Lateral Strain
- **ε_v** Volumetric Strain

Constants, Functions, Measurements used in list of Stress and Strain Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- constant(s): **e**, 2.71828182845904523536028747135266249 *Napier's constant*
- Functions: **ln**, ln(Number) *The natural logarithm, also known as the logarithm to the base e, is the inverse function of the natural exponential function.*
- Functions: **log10**, log10(Number) *The common logarithm, also known as the base-10 logarithm or the decimal logarithm, is a mathematical function that is the inverse of the exponential function.*
- 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.*
- Measurement: **Length** in Meter (m) *Length Unit Conversion*
- Measurement: **Area** in Square Meter (m²), Square Millimeter (mm²) *Area Unit Conversion*
- Measurement: **Force** in Kilonewton (kN) *Force Unit Conversion*
- Measurement: **Temperature Difference** in Degree Celsius (°C) *Temperature Difference Unit Conversion*
- Measurement: **Temperature Coefficient of Resistance** in Per Degree Celsius (°C⁻¹) *Temperature Coefficient of Resistance Unit Conversion*
- Measurement: **Specific Weight** in Kilonewton per Cubic Meter (kN/m³) *Specific Weight Unit Conversion*
- Measurement: **Stress** in Megapascal (MPa) *Stress Unit Conversion*

- σ Thermal Stress *(Megapascal)*
- σ_h Hoop Stress SOM *(Megapascal)*
- $\sigma_{Uniform}$ Uniform Stress *(Megapascal)*
- Φ Diameter of Sphere *(Meter)*

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