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Stress and Strain Formulas

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List of 20 Stress and Strain Formulas

Stress and Strain

1) Axial Elongation of Prismatic Bar due to External Load

Open Calculator

fx $$\Delta = \frac{W_{load} \cdot L_{bar}}{A \cdot e}$$

ex $$2250\text{mm} = \frac{3.6\text{kN} \cdot 2000\text{mm}}{64\text{m}^2 \cdot 50.0\text{Pa}}$$

2) Bulk Modulus given Bulk Stress and Strain

Open Calculator

fx $$K = \frac{B_{stress}}{B.S}$$

ex $$249.1509\text{Pa} = \frac{10564\text{Pa}}{42.4}$$

3) Bulk Modulus given Volume Stress and Strain

Open Calculator

fx $$k_v = \frac{VS}{\varepsilon_v}$$

ex $$0.366667\text{Pa} = \frac{11\text{Pa}}{30}$$

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4) Deflection of Fixed Beam with Load at Center

Open Calculator

fx $$\delta = \frac{W_{beam} \cdot L_{beam}^3}{192 \cdot e \cdot I}$$

ex $$0.18432mm = \frac{18mm \cdot (4800mm)^3}{192 \cdot 50.0Pa \cdot 1.125kg{\cdot}m^2}$$

5) Deflection of Fixed Beam with Uniformly Distributed Load

Open Calculator

fx $$d = \frac{W_{beam} \cdot L_{beam}^4}{384 \cdot e \cdot I}$$

ex $$0.442368mm = \frac{18mm \cdot (4800mm)^4}{384 \cdot 50.0Pa \cdot 1.125kg{\cdot}m^2}$$

6) Elastic Modulus

Open Calculator

fx $$E = \frac{\sigma}{\varepsilon}$$

ex $$1600Pa = \frac{1200Pa}{0.75}$$

7) Elongation Circular Tapered Bar

Open Calculator

fx $$\Delta_c = \frac{4 \cdot W_{load} \cdot L_{bar}}{\pi \cdot D_1 \cdot D_2 \cdot e}$$

ex $$7051.788mm = \frac{4 \cdot 3.6kN \cdot 2000mm}{\pi \cdot 5200mm \cdot 5000mm \cdot 50.0Pa}$$

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8) Elongation of Prismatic Bar due to its Own Weight

Open Calculator

fx $$\Delta_p = \frac{W_{load} \cdot L_{bar}}{2 \cdot A \cdot e}$$

ex $$1125\text{mm} = \frac{3.6\text{kN} \cdot 2000\text{mm}}{2 \cdot 64\text{m}^2 \cdot 50.0\text{Pa}}$$

9) Equivalent Bending Moment

Open Calculator

fx $$M_{eq} = M_b + \sqrt{M_b^2 + T_s^2}$$

ex $$125.8629\text{N*m} = 53\text{N*m} + \sqrt{(53\text{N*m})^2 + (50\text{N*m})^2}$$

10) Equivalent Torsional Moment

Open Calculator

fx $$T_{eq} = \sqrt{M_b^2 + T_s^2}$$

ex $$72.86288 = \sqrt{(53\text{N*m})^2 + (50\text{N*m})^2}$$

11) Hooke's Law

Open Calculator

fx $$E_h = \frac{W_{load} \cdot \Delta}{A_{Base} \cdot l_0}$$

ex $$115.7143\text{Pa} = \frac{3.6\text{kN} \cdot 2250\text{mm}}{10\text{m}^2 \cdot 7\text{m}}$$

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12) Moment of Inertia about Polar Axis

Open Calculator

fx $$J = \frac{\pi \cdot d_s^4}{32}$$

ex $$0.203575\text{m}^4 = \frac{\pi \cdot (1200.0\text{mm})^4}{32}$$

13) Moment of Inertia for Hollow Circular Shaft

Open Calculator

fx $$J_h = \frac{\pi}{32} \cdot \left(d_{ho}^4 - d_{hi}^4\right)$$

ex $$8.6\text{E}\hat{}\text{-8m}^4 = \frac{\pi}{32} \cdot \left((40\text{mm})^4 - (36\text{mm})^4\right)$$

14) Normal Stress 1

Open Calculator

fx $$\sigma_1 = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \varsigma_u^2}$$

ex $$100.7188\text{Pa} = \frac{100\text{Pa} + 0.2\text{Pa}}{2} + \sqrt{\left(\frac{100\text{Pa} - 0.2\text{Pa}}{2}\right)^2 + (8.5\text{Pa})^2}$$

15) Normal Stress 2

Open Calculator

fx $$\sigma_2 = \frac{\sigma_x + \sigma_y}{2} - \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \varsigma_u^2}$$

ex $$-0.518771\text{Pa} = \frac{100\text{Pa} + 0.2\text{Pa}}{2} - \sqrt{\left(\frac{100\text{Pa} - 0.2\text{Pa}}{2}\right)^2 + (8.5\text{Pa})^2}$$

16) Rankine's Formula for Columns

Open Calculator

fx $$P_r = \frac{1}{\frac{1}{P_E} + \frac{1}{P_{cs}}}$$

ex $$385.5667\text{kN} = \frac{1}{\frac{1}{1491.407\text{kN}} + \frac{1}{520\text{kN}}}$$

17) Shear Modulus

Open Calculator

fx $$G_{pa} = \frac{\tau}{\eta}$$

ex $$34.85714\text{Pa} = \frac{61\text{Pa}}{1.75}$$

18) Slenderness Ratio

Open Calculator

fx $$\lambda = \frac{L_{eff}}{r}$$

ex $$0.565714 = \frac{1.98\text{m}}{3.5\text{m}}$$

19) Torque on Shaft

Open Calculator

fx $$T_{shaft} = F \cdot \frac{D_{shaft}}{2}$$

ex $$0.625\text{N*m} = 2.5\text{N} \cdot \frac{0.50\text{m}}{2}$$

20) Total Angle of Twist

Open Calculator

fx $$\theta = \frac{T_{shaft} \cdot L_{shaft}}{G_{pa} \cdot J}$$

ex $$2.119946^\circ = \frac{0.625\text{N*m} \cdot 0.42\text{m}}{34.85\text{Pa} \cdot 0.203575\text{m}^4}$$

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Variables Used

- Δ Elongation *(Millimeter)*
- **A** Area of Prismatic Bar *(Square Meter)*
- A_{Base} Area of Base *(Square Meter)*
- B_{stress} Bulk Stress *(Pascal)*
- **B.S** Bulk Strain
- **d** Deflection of Fixed Beam with UDL *(Millimeter)*
- D_1 Diameter of Bigger End *(Millimeter)*
- D_2 Diameter of Smaller End *(Millimeter)*
- d_{hi} Inner Diameter of Hollow Circular Section *(Millimeter)*
- d_{ho} Outer Diameter of Hollow Circular Section *(Millimeter)*
- d_s Diameter of Shaft *(Millimeter)*
- D_{shaft} Shaft Diameter *(Meter)*
- **e** Elastic Modulus *(Pascal)*
- **E** Young's Modulus *(Pascal)*
- E_h Young's Modulus from Hook's Law *(Pascal)*
- **F** Force *(Newton)*
- G_{pa} Shear Modulus *(Pascal)*
- **I** Moment of Inertia *(Kilogram Square Meter)*
- **J** Polar Moment of Inertia *(Meter⁴)*
- J_h Moment of Inertia for Hollow Circular Shaft *(Meter⁴)*
- **K** Bulk Modulus *(Pascal)*
- k_v Bulk Modulus given Volume Stress and Strain *(Pascal)*

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- l_0 Initial Length *(Meter)*
- L_{bar} Length of Bar *(Millimeter)*
- L_{beam} Beam Length *(Millimeter)*
- L_{eff} Effective Length *(Meter)*
- L_{shaft} Shaft Length *(Meter)*
- M_b Bending Moment *(Newton Meter)*
- M_{eq} Equivalent Bending Moment *(Newton Meter)*
- P_{cs} Ultimate Crushing Load for Columns *(Kilonewton)*
- P_E Euler's Buckling Load *(Kilonewton)*
- P_r Rankine's Critical Load *(Kilonewton)*
- r Least Radius of Gyration *(Meter)*
- T_{eq} Equivalent Torsion Moment
- T_s Torque Exerted on Shaft *(Newton Meter)*
- T_{shaft} Torque *(Newton Meter)*
- VS Volume Stress *(Pascal)*
- W_{beam} Width of Beam *(Millimeter)*
- W_{load} Load *(Kilonewton)*
- δ Deflection of Beam *(Millimeter)*
- Δ_c Elongation in Circular Tapered Bar *(Millimeter)*
- Δ_p Elongation of Prismatic Bar *(Millimeter)*
- ε Strain
- ε_v Volumetric Strain
- λ Slenderness Ratio
- σ Stress *(Pascal)*

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- σ_1 Normal Stress 1 *(Pascal)*
- σ_2 Normal Stress 2 *(Pascal)*
- ς_u Shear Stress on Upper Surface *(Pascal)*
- σ_x Principal Stress along x *(Pascal)*
- σ_y Principal Stress along y *(Pascal)*
- η Shear Strain
- τ Shear Stress *(Pascal)*
- θ Total Angle of Twist *(Degree)*

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Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- 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.
- Measurement: **Length** in Millimeter (mm), Meter (m)
  Length Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Pressure** in Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Force** in Kilonewton (kN), Newton (N)
  Force Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Torque** in Newton Meter (N*m)
  Torque Unit Conversion
- Measurement: **Moment of Inertia** in Kilogram Square Meter (kg·m²)
  Moment of Inertia Unit Conversion
- Measurement: **Moment of Force** in Newton Meter (N*m)
  Moment of Force Unit Conversion
- Measurement: **Second Moment of Area** in Meter⁴ (m⁴)
  Second Moment of Area Unit Conversion
- Measurement: **Bending Moment** in Newton Meter (N*m)
  Bending Moment Unit Conversion

- Measurement: **Stress** in Pascal (Pa)
  Stress Unit Conversion

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Check other formula lists

- **Strain Formulas**
- **Stress Formulas**
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