Important Stress and Strain Formulas PDF

Formulas
Examples
with Units

List of 20
Important Stress and Strain Formulas

1) Axial Elongation of Prismatic Bar due to External Load Formula

Evaluate Formula

Formula

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

Example with Units

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

2) Bulk Modulus given Bulk Stress and Strain Formula

Evaluate Formula

Formula

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

Example with Units

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

3) Bulk Modulus given Volume Stress and Strain Formula

Evaluate Formula

Formula

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

Example with Units

$$0.3667\,\text{Pa} = \frac{11\,\text{Pa}}{30}$$

4) Deflection of Fixed Beam with Load at Center Formula

Evaluate Formula

Formula

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

Example with Units

$$0.1843\,\text{mm} = \frac{18\,\text{mm} \cdot 4800\,\text{mm}^3}{192 \cdot 50.0\,\text{Pa} \cdot 1.125\,\text{kg·m}^2}$$

5) Deflection of Fixed Beam with Uniformly Distributed Load Formula

Evaluate Formula

Formula

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

Example with Units

$$0.4424\,\text{mm} = \frac{18\,\text{mm} \cdot 4800\,\text{mm}^4}{384 \cdot 50.0\,\text{Pa} \cdot 1.125\,\text{kg·m}^2}$$

6) Elastic Modulus Formula

Evaluate Formula

Formula

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

Example with Units

$$1600\,\text{Pa} = \frac{1200\,\text{Pa}}{0.75}$$

7) Elongation Circular Tapered Bar Formula

Evaluate Formula

Formula

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

Example with Units

$$7051.7882\,\text{mm} = \frac{4 \cdot 3.6\,\text{kN} \cdot 2000\,\text{mm}}{3.1416 \cdot 5200\,\text{mm} \cdot 5000\,\text{mm} \cdot 50.0\,\text{Pa}}$$

8) Elongation of Prismatic Bar due to its Own Weight Formula

Evaluate Formula

Formula

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

Example with Units

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

9) Equivalent Bending Moment Formula

Evaluate Formula

Formula

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

Example with Units

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

10) Equivalent Torsional Moment Formula

Evaluate Formula

Formula

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

Example with Units

$$72.8629 = \sqrt{53\,\text{N*m}^2 + 50\,\text{N*m}^2}$$

11) Hooke's Law Formula

Evaluate Formula

Formula

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

Example with Units

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

12) Moment of Inertia about Polar Axis Formula

Evaluate Formula

Formula

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

Example with Units

$$0.2036\,\text{m}^4 = \frac{3.1416 \cdot 1200.0\,\text{mm}^4}{32}$$

13) Moment of Inertia for Hollow Circular Shaft Formula

Evaluate Formula

Formula

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

Example with Units

$$8.6\text{E-}8\,\text{m}^4 = \frac{3.1416}{32} \cdot \left(40\,\text{mm}^4 - 36\,\text{mm}^4 \right)$$

14) Normal Stress 1 Formula

Evaluate Formula

Formula

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

Example with Units

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

15) Normal Stress 2 Formula

Evaluate Formula

Formula

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

Example with Units

$$-0.5188\,\text{Pa} = \frac{100\,\text{Pa} + 0.2\,\text{Pa}}{2} - \sqrt{\left(\frac{100\,\text{Pa} - 0.2\,\text{Pa}}{2}\right)^2 + 8.5\,\text{Pa}^2}$$

16) Rankine's Formula for Columns Formula

Evaluate Formula

Formula

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

Example with Units

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

17) Shear Modulus Formula

Evaluate Formula

Formula

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

Example with Units

$$34.8571\,\text{Pa} = \frac{61\,\text{Pa}}{1.75}$$

18) Slenderness Ratio Formula

Evaluate Formula

Formula

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

Example with Units

$$0.5657 = \frac{1.98\,\text{m}}{3.5\,\text{m}}$$

19) Torque on Shaft Formula

Evaluate Formula

Formula

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

Example with Units

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

20) Total Angle of Twist Formula

Evaluate Formula

Formula

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

Example with Units

$$2.1199° = \frac{0.625\,\text{N*m} \cdot 0.42\,\text{m}}{34.85\,\text{Pa} \cdot 0.203575\,\text{m}^4}$$

Variables used in list of Stress and Strain Formulas above

- 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)*
- 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)*

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

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- 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 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*

- 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)*
- 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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