Important Strain Formulas PDF

Formulas
Examples
with Units

List of 15
Important Strain Formulas

1) Mechanical Strain Formulas

1.1) Bulk Strain Formula

Evaluate Formula

Formula

$$B.S = \frac{\Delta V}{V_T}$$

Example with Units

$$88.8889 = \frac{56\,\text{m}^3}{0.63\,\text{m}^3}$$

1.2) Lateral Strain Formula

Evaluate Formula

Formula

$$Sd = \frac{\Delta d}{d}$$

Example with Units

$$0.0253 = \frac{50.5\,\text{mm}}{2000\,\text{mm}}$$

1.3) Poisson's Ratio Formula

Evaluate Formula

Formula

$$\nu = -\left(\frac{\varepsilon_L}{\varepsilon_{longitudinal}}\right)$$

Example

$$0.3 = -\left(\frac{-0.06}{0.2}\right)$$

1.4) Shear Strain Formula

Evaluate Formula

Formula

$$\eta = \tan(\phi) + \cot(\phi - \alpha)$$

Example with Units

$$2.3384 = \tan(46.3°) + \cot(46.3° - 8.56°)$$

1.5) Shear Strain given Tangential Displacement and Original Length Formula

Evaluate Formula

Formula

$$\eta = \frac{t}{l_0}$$

Example with Units

$$1.1356 = \frac{5678\,\text{mm}}{5000\,\text{mm}}$$

1.6) Tensile Strain Formula

Evaluate Formula

Formula

$$e_{tension} = \frac{\Delta L}{L}$$

Example with Units

$$0.3346 = \frac{1100\,\text{mm}}{3287.3\,\text{mm}}$$

1.7) Volumetric Strain Formula

Evaluate Formula

Formula

$$\varepsilon_v = \frac{\Delta V}{V_T}$$

Example with Units

$$88.8889 = \frac{56\,\text{m}^3}{0.63\,\text{m}^3}$$

2) Strain Energy Formulas

2.1) Strain Energy Density Formula

Evaluate Formula

Formula

$$S_d = 0.5 \cdot \sigma \cdot \varepsilon$$

Example with Units

$$1176 = 0.5 \cdot 49\,\text{Pa} \cdot 48$$

2.2) Strain Energy due to Pure Shear Formula

Evaluate Formula

Formula

$$U = \tau \cdot \tau \cdot \frac{V_T}{2 \cdot G_{pa}}$$

Example with Units

$$0.315\,\text{KJ} = 100\,\text{Pa} \cdot 100\,\text{Pa} \cdot \frac{0.63\,\text{m}^3}{2 \cdot 10.00015\,\text{Pa}}$$

2.3) Strain Energy due to Torsion in Hollow Shaft Formula

Evaluate Formula

Formula

$$U = \tau^2 \cdot \left(d_{outer}^{\,2} + d_{inner}^{\,2} \right) \cdot \frac{V}{4 \cdot G_{pa} \cdot d_{outer}^{\,2}}$$

Example with Units

$$3.3203\,\text{KJ} = 100\,\text{Pa}^2 \cdot \left(4000\,\text{mm}^2 + 1000\,\text{mm}^2 \right) \cdot \frac{12.5\,\text{m}^3}{4 \cdot 10.00015\,\text{Pa} \cdot 4000\,\text{mm}^2}$$

2.4) Strain Energy given Applied Tension Load Formula

Evaluate Formula

Formula

$$U = W^2 \cdot \frac{L}{2 \cdot A_{Base} \cdot E}$$

Example with Units

$$2.2387\,\text{KJ} = 452\,\text{N}^2 \cdot \frac{3287.3\,\text{mm}}{2 \cdot 10\,\text{m}^2 \cdot 15\,\text{N/m}}$$

2.5) Strain Energy given Moment Value Formula

Evaluate Formula

Formula

$$U = \frac{M_b \cdot M_b \cdot L}{2 \cdot e \cdot I}$$

Example with Units

$$5.0811\,\text{KJ} = \frac{417\,\text{N*m} \cdot 417\,\text{N*m} \cdot 3287.3\,\text{mm}}{2 \cdot 50\,\text{Pa} \cdot 1.125\,\text{kg·m}^2}$$

2.6) Strain Energy given Torsion Moment Value Formula

Evaluate Formula

Formula

$$U = \frac{T \cdot L}{2 \cdot G_{pa} \cdot J}$$

Example with Units

$$2.2828\,\text{KJ} = \frac{75000\,\text{N} \cdot 3287.3\,\text{mm}}{2 \cdot 10.00015\,\text{Pa} \cdot 5.4\,\text{m}^4}$$

2.7) Strain Energy in Torsion for Solid Shaft Formula

Evaluate Formula

Formula

$$U = \tau^2 \cdot \frac{V}{4 \cdot G_{pa}}$$

Example with Units

$$3.125\,\text{KJ} = 100\,\text{Pa}^2 \cdot \frac{12.5\,\text{m}^3}{4 \cdot 10.00015\,\text{Pa}}$$

2.8) Strain Energy in Torsion using Total Angle of Twist Formula

Evaluate Formula

Formula

$$U = 0.5 \cdot \tau \cdot \boldsymbol{\theta} \cdot \left(\frac{180}{\pi}\right)$$

Example with Units

$$1.032\,\text{KJ} = 0.5 \cdot 34.4\,\text{N*m} \cdot 60° \cdot \left(\frac{180}{3.1416}\right)$$

Variables used in list of Strain Formulas above

- Δd Change in Diameter *(Millimeter)*
- ΔV Change in Volume *(Cubic Meter)*
- A_{Base} Area of Base *(Square Meter)*
- **B.S** Bulk Strain
- **d** Original Diameter *(Millimeter)*
- d_{inner} Inner Diameter of Shaft *(Millimeter)*
- d_{outer} Outer Diameter of Shaft *(Millimeter)*
- **e** Elastic Modulus *(Pascal)*
- **E** Young's Modulus *(Newton per Meter)*
- $e_{tension}$ Tension Strain
- G_{pa} Shear Modulus *(Pascal)*
- **I** Moment of Inertia *(Kilogram Square Meter)*
- **J** Polar Moment of Inertia *(Meter⁴)*
- **L** Length *(Millimeter)*
- l_0 Initial Length *(Millimeter)*
- M_b Bending Moment *(Newton Meter)*
- S_d Strain Energy Density
- **Sd** Lateral Strain
- **t** Tangential Displacement *(Millimeter)*
- **T** Torsion Load *(Newton)*
- **U** Strain Energy *(Kilojoule)*
- **V** Volume of Shaft *(Cubic Meter)*
- V_T Volume *(Cubic Meter)*
- **W** Load *(Newton)*
- **α** Rake Angle *(Degree)*
- **ΔL** Change in Length *(Millimeter)*
- **ε** Principle Strain
- ε_L Lateral Strain
- $\varepsilon_{longitudinal}$ Longitudinal Strain
- ε_v Volumetric Strain
- **σ** Principle Stress *(Pascal)*
- **τ** Torque *(Newton Meter)*
- **ϕ** Shear Angle Metal *(Degree)*
- **ν** Poisson's Ratio

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

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- Functions: **cot**, cot(Angle) *Cotangent is a trigonometric function that is defined as the ratio of the adjacent side to the opposite side in a right triangle.*
- Functions: **tan**, tan(Angle) *The tangent of an angle is a trigonometric ratio of the length of the side opposite an angle to the length of the side adjacent to an angle in a right triangle.*
- Measurement: **Length** in Millimeter (mm) *Length Unit Conversion*
- Measurement: **Volume** in Cubic Meter (m³) *Volume Unit Conversion*
- Measurement: **Area** in Square Meter (m²) *Area Unit Conversion*
- Measurement: **Pressure** in Pascal (Pa) *Pressure Unit Conversion*
- Measurement: **Energy** in Kilojoule (KJ) *Energy Unit Conversion*
- Measurement: **Force** in 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: **Stiffness Constant** in Newton per Meter (N/m) *Stiffness Constant Unit Conversion*

- η Shear Strain
- τ Shear Stress *(Pascal)*
- θ Total Angle of Twist *(Degree)*

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

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