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Strain Formulas

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List of 14 Strain Formulas

Strain

1) Bulk Strain

Open Calculator

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

ex $$88.88889 = \frac{56m^3}{0.63m^3}$$

2) Lateral Strain

Open Calculator

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

ex $$0.02525 = \frac{50.5mm}{2000mm}$$

3) Shear Strain

Open Calculator

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

ex $$2.338424 = \tan(46.3°) + \cot(46.3° - 8.56°)$$

4) Shear Strain given Tangential Displacement and Original Length

Open Calculator

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

ex $$1.1356 = \frac{5678mm}{5000mm}$$

5) Strain Energy Density

Open Calculator

fx $S.E.D = 0.5 \cdot \sigma \cdot \varepsilon$

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

6) Tensile Strain

Open Calculator

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

ex $0.334621 = \frac{1100\text{mm}}{3287.3\text{mm}}$

7) Volumetric Strain

Open Calculator

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

ex $88.88889 = \frac{56\text{m}^3}{0.63\text{m}^3}$

Strain Energy

8) Strain Energy due to Pure Shear

Open Calculator

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

ex $0.314995\text{KJ} = 100\text{Pa} \cdot 100\text{Pa} \cdot \frac{0.63\text{m}^3}{2 \cdot 10.00015\text{Pa}}$

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9) Strain Energy due to Torsion in Hollow Shaft

Open Calculator

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

ex

$$3.320263\text{KJ} = (100\text{Pa})^2 \cdot \left((4000\text{mm})^2 + (1000\text{mm})^2\right) \cdot \frac{12.5\text{m}^3}{4 \cdot 10.00015\text{Pa} \cdot (4000\text{mm})^2}$$

10) Strain Energy given Applied Tension Load

Open Calculator

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

ex

$$2.238695\text{KJ} = (452\text{N})^2 \cdot \frac{3287.3\text{mm}}{2 \cdot 10\text{m}^2 \cdot 15\text{N/m}}$$

11) Strain Energy given Moment Value

Open Calculator

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

ex

$$5.081114\text{KJ} = \frac{417\text{N*m} \cdot 417\text{N*m} \cdot 3287.3\text{mm}}{2 \cdot 50\text{Pa} \cdot 1.125\text{kg·m}^2}$$

12) Strain Energy given Torsion Moment Value

Open Calculator

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

ex

$$2.282813\text{KJ} = \frac{75000\text{N} \cdot 3287.3\text{mm}}{2 \cdot 10.00015\text{Pa} \cdot 5.4\text{m}^4}$$

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13) Strain Energy in Torsion for Solid Shaft

Open Calculator

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

ex $$3.124953\text{KJ} = (100\text{Pa})^2 \cdot \frac{12.5\text{m}^3}{4 \cdot 10.00015\text{Pa}}$$

14) Strain Energy in Torsion using Total Angle of Twist

Open Calculator

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

ex $$1.032\text{KJ} = 0.5 \cdot 34.4\text{N*m} \cdot 60^\circ \cdot \left(\frac{180}{\pi}\right)$$

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Variables Used

- 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 *(Meter^4)*
- **L** Length *(Millimeter)*
- l_0 Initial Length *(Millimeter)*
- M_b Bending Moment *(Newton Meter)*
- **S.E.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_v Volumetric Strain
- **τ** Torque *(Newton Meter)*

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- ϕ Shear Angle Metal *(Degree)*
- ε Principle Strain
- η Shear Strain
- σ Principle Stress *(Pascal)*
- 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: **cot**, cot(Angle)
  Trigonometric cotangent function
- Function: **tan**, tan(Angle)
  Trigonometric tangent function
- 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

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

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Check other formula lists

- **Basics of Strength of Materials Formulas**
- **Strain Formulas**
- **Stress Formulas**
- **Stress and Strain Formulas**

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