



# **Strain Energy Formulas**

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Examples!

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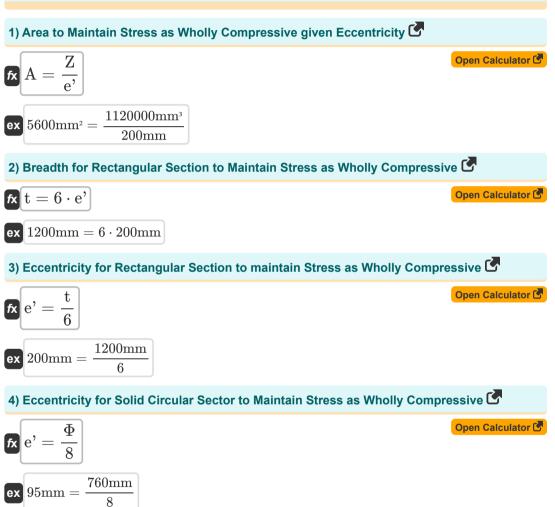
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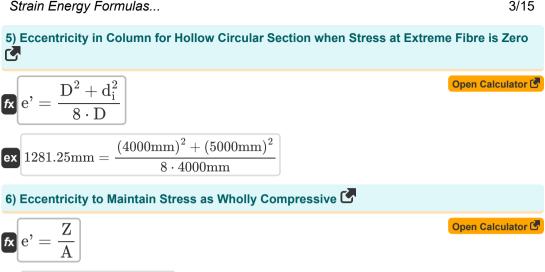


# List of 44 Strain Energy Formulas

# Strain Energy 🕑







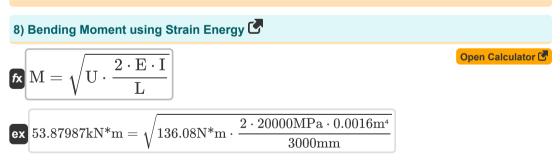
ex 
$$200 \text{mm} = \frac{1120000 \text{mm}^3}{5600 \text{mm}^2}$$

#### 7) Section Modulus to Maintain Stress as Wholly Compressive given Eccentricity

$$\mathbf{\hat{z}} = \mathbf{e}' \cdot \mathbf{A}$$
 Open Calculator  $\mathbf{\hat{z}}$ 

ex 
$$1.1\mathrm{E}^{6}\mathrm{mm^{3}}=200\mathrm{mm}\cdot5600\mathrm{mm^{2}}$$

### Strain Energy in Structural Members 🕑







9) Length over which Deformation takes place given Strain Energy in Shear 🖸

$$\begin{array}{l} \text{(2)} \label{eq:calculator} \\ \textbf{L} = 2 \cdot \textbf{U} \cdot \textbf{A} \cdot \frac{\textbf{G}_{Torsion}}{\textbf{V}^2} \\ \text{(2)} \\ \text$$



()

13) Moment of Inertia using Strain Energy 🕑

$$\mathbf{k} \quad \mathbf{I} = \mathbf{L} \cdot \left(\frac{\mathbf{M}^2}{2 \cdot \mathbf{U} \cdot \mathbf{E}}\right)$$

$$\mathbf{0} \text{ open Calculator } \mathbf{k}$$

$$\mathbf{I} = \mathbf{L} \cdot \left(\frac{\mathbf{M}^2}{2 \cdot \mathbf{U} \cdot \mathbf{E}}\right)$$

$$\mathbf{0} \text{ on } 001595\text{ m}^4 = 3000 \text{ mm} \cdot \left(\frac{(53.8 \text{ kN}^*\text{m})^2}{2 \cdot 136.08 \text{ N}^*\text{m} \cdot 20000 \text{ MPa}}\right)$$

$$\mathbf{14} \text{ Polar Moment of Inertia given Strain Energy in Torsion } \mathbf{C}$$

$$\mathbf{k} \quad \mathbf{J} = (\mathbf{T}^2) \cdot \frac{\mathbf{L}}{2 \cdot \mathbf{U} \cdot \mathbf{G}_{\text{Torsion}}}$$

$$\mathbf{0} \text{ open Calculator } \mathbf{C}$$

$$\mathbf{k} \quad \mathbf{J} = (\mathbf{T}^2) \cdot \frac{\mathbf{L}}{2 \cdot \mathbf{U} \cdot \mathbf{G}_{\text{Torsion}}}$$

$$\mathbf{0} \text{ open Calculator } \mathbf{C}$$

$$\mathbf{k} \quad \mathbf{A} = (\mathbf{V}^2) \cdot \frac{\mathbf{L}}{2 \cdot \mathbf{U} \cdot \mathbf{G}_{\text{Torsion}}}$$

$$\mathbf{0} \text{ open Calculator } \mathbf{C}$$

$$\mathbf{K} \quad \mathbf{A} = (\mathbf{V}^2) \cdot \frac{\mathbf{L}}{2 \cdot \mathbf{U} \cdot \mathbf{G}_{\text{Torsion}}}$$

$$\mathbf{0} \text{ open Calculator } \mathbf{C}$$

$$\mathbf{M} \quad \mathbf{V} = \sqrt{2 \cdot \mathbf{U} \cdot \mathbf{A} \cdot \frac{\mathbf{G}_{\text{Torsion}}}{\mathbf{L}}}$$

$$\mathbf{0} \text{ open Calculator } \mathbf{C}$$

$$\mathbf{M} \quad \mathbf{V} = \sqrt{2 \cdot \mathbf{U} \cdot \mathbf{A} \cdot \frac{\mathbf{G}_{\text{Torsion}}}{\mathbf{L}}}$$

$$\mathbf{0} \text{ open Calculator } \mathbf{C}$$

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$$\mathbf{0} \text{ open Calculator } \mathbf{C}$$

$$\mathbf{M} \quad \mathbf{U} = (\mathbf{V}^2) \cdot \frac{\mathbf{L}}{2 \cdot \mathbf{A} \cdot \mathbf{U}}$$

$$\mathbf{0} \text{ open Calculator } \mathbf{C}$$

$$\mathbf{M} \quad \mathbf{U} = (\mathbf{V}^2) \cdot \frac{\mathbf{L}}{2 \cdot \mathbf{A} \cdot \mathbf{U}}$$

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18) Shear Modulus of Elasticity given Strain Energy in Torsion 🖸

$$\mathbf{f}_{\mathbf{x}} = (\mathbf{T}^{2}) \cdot \frac{\mathbf{L}}{2 \cdot \mathbf{J} \cdot \mathbf{U}}$$

$$\mathbf{f}_{\mathbf{x}} = (\mathbf{T}^{2}) \cdot \frac{\mathbf{L}}{2 \cdot \mathbf{J} \cdot \mathbf{U}}$$

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$$\mathbf{f}_{\mathbf{x}} = (\mathbf{T}^{2}) \cdot \frac{\mathbf{L}}{2 \cdot \mathbf{U}}$$

$$\mathbf{f}_{\mathbf{x}} = (\mathbf{T}^{2}) \cdot \frac{\mathbf{U}}{2 \cdot \mathbf{U}}$$

$$\mathbf{f}_{\mathbf{x}} = (\mathbf{T}^{2}) \cdot \frac{\mathbf{U}}{2 \cdot \mathbf{U}}$$

$$\mathbf{f}_{\mathbf{x}} = (\mathbf{T}^{2}) \cdot \frac{(\mathbf{U} - (\frac{\pi}{180}))^{2}}{2 \cdot \mathbf{U}})$$

$$\mathbf{f}_{\mathbf{x}} = (\mathbf{U} - (\mathbf{U} - \frac{(\mathbf{U} - (\frac{\pi}{180}))^{2}}{2 \cdot \mathbf{U}})$$

$$\mathbf{f}_{\mathbf{x}} = (\mathbf{U} - (\mathbf{U}^{2}) \cdot \frac{\mathbf{U}}{2 \cdot \mathbf{U}})$$

$$\mathbf{f}_{\mathbf{x}} = (\mathbf{U} - (\mathbf{M}^{2}) \cdot \frac{\mathbf{L}}{2 \cdot \mathbf{E} \cdot \mathbf{I}})$$

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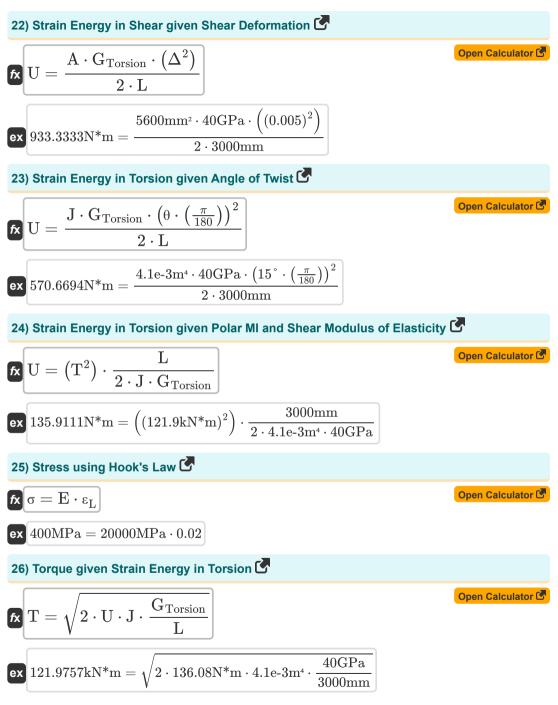
$$\mathbf{f}_{\mathbf{x}} = (\mathbf{U} - (\mathbf{U}^{2}) \cdot \frac{\mathbf{L}}{2 \cdot \mathbf{E} \cdot \mathbf{I}})$$

$$\mathbf{f}_{\mathbf{x}} = (\mathbf{U} - (\mathbf{U}^{2}) \cdot \frac{\mathbf{L}}{2 \cdot \mathbf{E} \cdot \mathbf{I}})$$

$$\mathbf{f}_{\mathbf{x}} = (\mathbf{U} - (\mathbf{U}^{2}) \cdot$$



6/15





# Strain Energy Formulas... 8/15 Strain Energy stored by the Member 27) Area of Member given Strain Energy Stored by Member 🕑 fx $A = rac{2 \cdot E \cdot U_{member}}{L \cdot \sigma^2}$ Open Calculator $\begin{array}{l} \textbf{ex} \ 5599.999 \text{mm}^2 = \frac{2 \cdot 20000 \text{MPa} \cdot 301.2107 \text{N*m}}{3000 \text{mm} \cdot (26.78 \text{MPa})^2} \end{array}$ 28) Length of Member given Strain Energy Stored by Member 🕑 fx $L = rac{2 \cdot E \cdot U_{member}}{A \cdot \sigma^2}$ Open Calculator ex $3000 \text{mm} = \frac{2 \cdot 20000 \text{MPa} \cdot 301.2107 \text{N*m}}{5600 \text{mm}^2 \cdot (26.78 \text{MPa})^2}$ 29) Modulus of Elasticity of Member given Strain Energy Stored by Member 🕑 Open Calculator $\mathbf{fx} = \frac{\left(\sigma^2\right) \cdot \mathbf{A} \cdot \mathbf{L}}{2 \cdot \mathbf{U}}$ ex 20000MPa = $\frac{((26.78 \text{MPa})^2) \cdot 5600 \text{mm}^2 \cdot 3000 \text{mm}}{2 \cdot 301.2107 \text{N*m}}$ 30) Strain Energy Stored by Member 🕑 Open Calculator $\mathbf{fx} \left[ \mathrm{U}_{\mathrm{member}} = \left( \frac{\sigma^2}{2 \cdot \mathrm{E}} \right) \cdot \mathrm{A} \cdot \mathrm{L} ight]$ ex 301.2107N\*m = $\left(\frac{(26.78 MPa)^2}{2 \cdot 20000 MPa}\right) \cdot 5600$ mm<sup>2</sup> · 3000mm





#### 31) Stress of Member given Strain Energy Stored by Member 🕑

fx 
$$\sigma = \sqrt{rac{2 \cdot U_{member} \cdot E}{A \cdot L}}$$

ex 26.78MPa = 
$$\sqrt{\frac{2 \cdot 301.2107 \text{N*m} \cdot 20000 \text{MPa}}{5600 \text{mm}^2 \cdot 3000 \text{mm}}}$$

#### Strain Energy stored per unit Volume 🕑

#### 32) Modulus of Elasticity of Member with known Strain Energy Stored per Unit Volume 🕑

$$\mathbf{\widehat{K}} \mathbf{E} = \frac{\sigma^2}{2 \cdot U_{density}}$$
 Open Calculator **C**  

$$\mathbf{\widehat{K}} \mathbf{E} = \frac{\sigma^2}{2 \cdot U_{density}}$$

$$\mathbf{\widehat{K}} 20000 \text{MPa} = \frac{(26.78 \text{MPa})^2}{2 \cdot 17929.21 \text{J/m}^3}$$

$$\mathbf{\widehat{K}} \mathbf{U}_{density} = \frac{\sigma^2}{2 \cdot \mathbf{E}}$$

$$\mathbf{\widehat{K}} \mathbf{U}_{density} = \frac{\sigma^2}{2 \cdot \mathbf{E}}$$

$$\mathbf{\widehat{K}} 17929.21 \text{J/m}^3 = \frac{(26.78 \text{MPa})^2}{2 \cdot 20000 \text{MPa}}$$

$$\mathbf{\widehat{K}} \mathbf{\sigma} = \sqrt{U_{density} \cdot 2 \cdot \mathbf{E}}$$

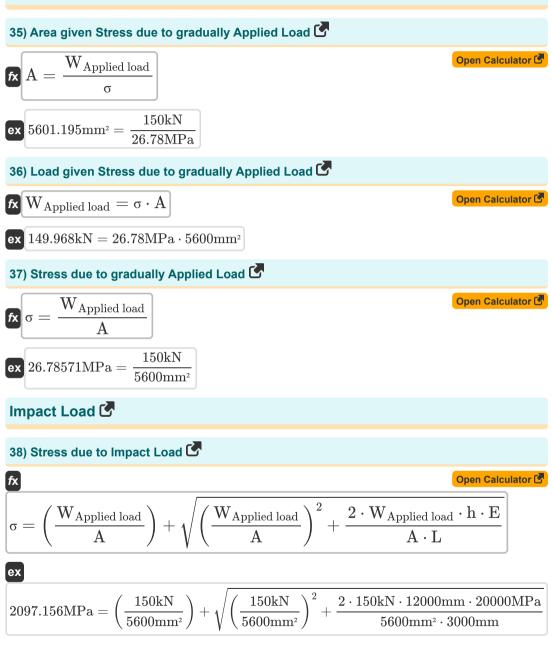
$$\mathbf{\widehat{K}} \mathbf{\sigma} = \sqrt{U_{density} \cdot 2 \cdot \mathbf{E}}$$

$$\mathbf{\widehat{K}} 26.78 \text{MPa} = \sqrt{17929.21 \text{J/m}^3 \cdot 2 \cdot 20000 \text{MPa}}$$

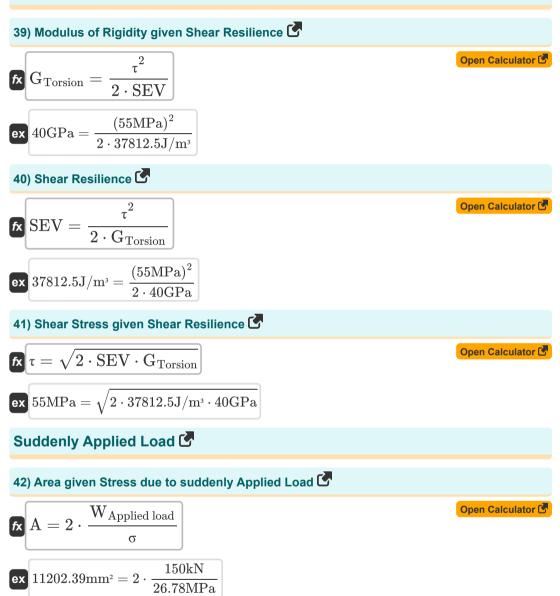
$$\mathbf{Stress \ due \ to \ \mathbf{\widehat{K}} }$$



Open Calculator 🕑







### 43) Load given Stress due to suddenly Applied Load 🕑

$$fx W_{Applied load} = \sigma \cdot \frac{A}{2}$$

$$ex 74.984kN = 26.78MPa \cdot \frac{5600mm^2}{2}$$

$$44) Stress due to suddenly Applied Load C
$$fx \sigma = 2 \cdot \frac{W_{Applied load}}{A}$$

$$Open Calculator C
$$fx \sigma = 2 \cdot \frac{W_{Applied load}}{A}$$$$$$

ex 
$$53.57143$$
MPa  $= 2 \cdot \frac{150$ kN}{5600mm<sup>2</sup>

# Variables Used

- A Area of Cross-Section (Square Millimeter)
- D Outer Depth (Millimeter)
- d<sub>i</sub> Inner Depth (Millimeter)
- e' Eccentricity of Load (Millimeter)
- E Young's Modulus (Megapascal)
- Grosion Modulus of Rigidity (Gigapascal)
- **h** Height of Crack (Millimeter)
- Area Moment of Inertia (Meter<sup>4</sup>)
- J Polar Moment of Inertia (Meter<sup>4</sup>)
- L Length of Member (Millimeter)
- M Bending Moment (Kilonewton Meter)
- SEV Shear Resilience (Joule per Cubic Meter)
- t Dam Thickness (Millimeter)
- **T** Torque SOM (Kilonewton Meter)
- U Strain Energy (Newton Meter)
- Udensity Strain Energy Density (Joule per Cubic Meter)
- Umember Strain Energy stored by Member (Newton Meter)
- V Shear Force (Kilonewton)
- WApplied load Applied Load (Kilonewton)
- Z Section Modulus for Eccentric Load on Beam (Cubic Millimeter)
- A Shear Deformation
- ε<sub>L</sub> Lateral Strain
- **θ** Angle of Twist (Degree)
- σ Direct Stress (Megapascal)
- T Shear Stress (Megapascal)
- **Φ** Diameter of Circular Shaft (Millimeter)

# **Constants, Functions, Measurements used**

- Constant: pi, 3.14159265358979323846264338327950288 Archimedes' constant
- Function: **sqrt**, sqrt(Number) Square root function
- Measurement: Length in Millimeter (mm) Length Unit Conversion
- Measurement: Volume in Cubic Millimeter (mm<sup>3</sup>) Volume Unit Conversion
- Measurement: Area in Square Millimeter (mm<sup>2</sup>) Area Unit Conversion
- Measurement: Pressure in Gigapascal (GPa) Pressure Unit Conversion
- Measurement: Energy in Newton Meter (N\*m) Energy Unit Conversion
- Measurement: Force in Kilonewton (kN) Force Unit Conversion
- Measurement: Angle in Degree (°) Angle Unit Conversion
- Measurement: Torque in Kilonewton Meter (kN\*m) Torque Unit Conversion
- Measurement: Moment of Force in Kilonewton Meter (kN\*m) Moment of Force Unit Conversion
- Measurement: Energy Density in Joule per Cubic Meter (J/m<sup>3</sup>) Energy Density Unit Conversion
- Measurement: Second Moment of Area in Meter⁴ (m⁴) Second Moment of Area Unit Conversion ☑
- Measurement: Stress in Megapascal (MPa) Stress Unit Conversion





## **Check other formula lists**

- Mohr's Circle of Stresses Formulas C
- Beam Moments Formulas C
- Bending Stress Formulas
- Combined Axial and Bending Loads
   Formulas
- Elastic Constants Formulas G
- Elastic Stability of Columns Formulas

- Principal Stress Formulas G
- Shear Stress Formulas C
- Slope and Deflection Formulas
- Strain Energy Formulas C
- Stress and Strain Formulas G
- Torsion Formulas

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