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Strain Energy Formulas

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List of 44 Strain Energy Formulas

Strain Energy

1) Area to Maintain Stress as Wholly Compressive given Eccentricity

Open Calculator

fx $$A = \frac{Z}{e'}$$

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

2) Breadth for Rectangular Section to Maintain Stress as Wholly Compressive

Open Calculator

fx $$t = 6 \cdot e'$$

ex $$1200\text{mm} = 6 \cdot 200\text{mm}$$

3) Eccentricity for Rectangular Section to maintain Stress as Wholly Compressive

Open Calculator

fx $$e' = \frac{t}{6}$$

ex $$200\text{mm} = \frac{1200\text{mm}}{6}$$

4) Eccentricity for Solid Circular Sector to Maintain Stress as Wholly Compressive

Open Calculator

fx $$e' = \frac{\Phi}{8}$$

ex $$95\text{mm} = \frac{760\text{mm}}{8}$$

5) Eccentricity in Column for Hollow Circular Section when Stress at Extreme Fibre is Zero

Open Calculator

$$e' = \frac{D^2 + d_i^2}{8 \cdot D}$$

$$1281.25\text{mm} = \frac{(4000\text{mm})^2 + (5000\text{mm})^2}{8 \cdot 4000\text{mm}}$$

6) Eccentricity to Maintain Stress as Wholly Compressive

Open Calculator

$$e' = \frac{Z}{A}$$

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

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

Open Calculator

$$Z = e' \cdot A$$

$$1.1\text{E\^{}6mm}^3 = 200\text{mm} \cdot 5600\text{mm}^2$$

Strain Energy in Structural Members

8) Bending Moment using Strain Energy

Open Calculator

$$M = \sqrt{U \cdot \frac{2 \cdot E \cdot I}{L}}$$

$$53.87987\text{kN*m} = \sqrt{136.08\text{N*m} \cdot \frac{2 \cdot 20000\text{MPa} \cdot 0.0016\text{m}^4}{3000\text{mm}}}$$

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

Open Calculator

fx $$L = 2 \cdot U \cdot A \cdot \frac{G_{Torsion}}{V^2}$$

ex $$2981.263\text{mm} = 2 \cdot 136.08\text{N*m} \cdot 5600\text{mm}^2 \cdot \frac{40\text{GPa}}{(143\text{kN})^2}$$

10) Length over which Deformation takes place given Strain Energy in Torsion

Open Calculator

fx $$L = \frac{2 \cdot U \cdot J \cdot G_{Torsion}}{T^2}$$

ex $$3003.729\text{mm} = \frac{2 \cdot 136.08\text{N*m} \cdot 4.1\text{e-}3\text{m}^4 \cdot 40\text{GPa}}{(121.9\text{kN*m})^2}$$

11) Length over which Deformation takes place using Strain Energy

Open Calculator

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

ex $$3008.914\text{mm} = \left(136.08\text{N*m} \cdot \frac{2 \cdot 20000\text{MPa} \cdot 0.0016\text{m}^4}{(53.8\text{kN*m})^2}\right)$$

12) Modulus of Elasticity with given Strain Energy

Open Calculator

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

ex $$19940.75\text{MPa} = \left(3000\text{mm} \cdot \frac{(53.8\text{kN*m})^2}{2 \cdot 136.08\text{N*m} \cdot 0.0016\text{m}^4}\right)$$

13) Moment of Inertia using Strain Energy

Open Calculator

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

ex $$0.001595\text{m}^4 = 3000\text{mm} \cdot \left(\frac{(53.8\text{kN*m})^2}{2 \cdot 136.08\text{N*m} \cdot 20000\text{MPa}} \right)$$

14) Polar Moment of Inertia given Strain Energy in Torsion

Open Calculator

fx $$J = (T^2) \cdot \frac{L}{2 \cdot U \cdot G_{Torsion}}$$

ex $$0.004095\text{m}^4 = \left((121.9\text{kN*m})^2 \right) \cdot \frac{3000\text{mm}}{2 \cdot 136.08\text{N*m} \cdot 40\text{GPa}}$$

15) Shear Area given Strain Energy in Shear

Open Calculator

fx $$A = (V^2) \cdot \frac{L}{2 \cdot U \cdot G_{Torsion}}$$

ex $$5635.196\text{mm}^2 = \left((143\text{kN})^2 \right) \cdot \frac{3000\text{mm}}{2 \cdot 136.08\text{N*m} \cdot 40\text{GPa}}$$

16) Shear Force using Strain Energy

Open Calculator

fx $$V = \sqrt{2 \cdot U \cdot A \cdot \frac{G_{Torsion}}{L}}$$

ex $$142.5527\text{kN} = \sqrt{2 \cdot 136.08\text{N*m} \cdot 5600\text{mm}^2 \cdot \frac{40\text{GPa}}{3000\text{mm}}}$$

17) Shear Modulus of Elasticity given Strain Energy in Shear

Open Calculator

fx $$G_{Torsion} = (V^2) \cdot \frac{L}{2 \cdot A \cdot U}$$

ex $$40.2514\text{GPa} = \left((143\text{kN})^2 \right) \cdot \frac{3000\text{mm}}{2 \cdot 5600\text{mm}^2 \cdot 136.08\text{N*m}}$$

18) Shear Modulus of Elasticity given Strain Energy in Torsion

Open Calculator

fx $$G_{Torsion} = \left(T^2\right) \cdot \frac{L}{2 \cdot J \cdot U}$$

ex $$39.95034\text{GPa} = \left(\left(121.9\text{kN*m}\right)^2\right) \cdot \frac{3000\text{mm}}{2 \cdot 4.1\text{e-}3\text{m}^4 \cdot 136.08\text{N*m}}$$

19) Strain Energy for Pure Bending when Beam rotates in One End

Open Calculator

fx $$U = \left(E \cdot I \cdot \frac{\left(\theta \cdot \left(\frac{\pi}{180}\right)\right)^2}{2 \cdot L}\right)$$

ex $$111.3501\text{N*m} = \left(20000\text{MPa} \cdot 0.0016\text{m}^4 \cdot \frac{\left(15^\circ \cdot \left(\frac{\pi}{180}\right)\right)^2}{2 \cdot 3000\text{mm}}\right)$$

20) Strain Energy in Bending

Open Calculator

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

ex $$135.6769\text{N*m} = \left(\left(\left(53.8\text{kN*m}\right)^2\right) \cdot \frac{3000\text{mm}}{2 \cdot 20000\text{MPa} \cdot 0.0016\text{m}^4}\right)$$

21) Strain Energy in Shear

Open Calculator

fx $$U = \left(V^2\right) \cdot \frac{L}{2 \cdot A \cdot G_{Torsion}}$$

ex $$136.9353\text{N*m} = \left(\left(143\text{kN}\right)^2\right) \cdot \frac{3000\text{mm}}{2 \cdot 5600\text{mm}^2 \cdot 40\text{GPa}}$$

22) Strain Energy in Shear given Shear Deformation

Open Calculator

fx $$U = \frac{A \cdot G_{Torsion} \cdot \left(\Delta^2\right)}{2 \cdot L}$$

ex $$933.3333\text{N*m} = \frac{5600\text{mm}^2 \cdot 40\text{GPa} \cdot \left((0.005)^2\right)}{2 \cdot 3000\text{mm}}$$

23) Strain Energy in Torsion given Angle of Twist

Open Calculator

fx $$U = \frac{J \cdot G_{Torsion} \cdot \left(\theta \cdot \left(\frac{\pi}{180}\right)\right)^2}{2 \cdot L}$$

ex $$570.6694\text{N*m} = \frac{4.1\text{e-}3\text{m}^4 \cdot 40\text{GPa} \cdot \left(15^\circ \cdot \left(\frac{\pi}{180}\right)\right)^2}{2 \cdot 3000\text{mm}}$$

24) Strain Energy in Torsion given Polar MI and Shear Modulus of Elasticity

Open Calculator

fx $$U = \left(T^2\right) \cdot \frac{L}{2 \cdot J \cdot G_{Torsion}}$$

ex $$135.9111\text{N*m} = \left((121.9\text{kN*m})^2\right) \cdot \frac{3000\text{mm}}{2 \cdot 4.1\text{e-}3\text{m}^4 \cdot 40\text{GPa}}$$

25) Stress using Hook's Law

Open Calculator

fx $$\sigma = E \cdot \varepsilon_L$$

ex $$400\text{MPa} = 20000\text{MPa} \cdot 0.02$$

26) Torque given Strain Energy in Torsion

Open Calculator

fx $$T = \sqrt{2 \cdot U \cdot J \cdot \frac{G_{Torsion}}{L}}$$

ex $$121.9757\text{kN*m} = \sqrt{2 \cdot 136.08\text{N*m} \cdot 4.1\text{e-}3\text{m}^4 \cdot \frac{40\text{GPa}}{3000\text{mm}}}$$

Strain Energy stored by the Member

27) Area of Member given Strain Energy Stored by Member

Open Calculator

fx $$A = \frac{2 \cdot E \cdot U_{member}}{L \cdot \sigma^2}$$

ex $$5599.999\text{mm}^2 = \frac{2 \cdot 20000\text{MPa} \cdot 301.2107\text{N*m}}{3000\text{mm} \cdot (26.78\text{MPa})^2}$$

28) Length of Member given Strain Energy Stored by Member

Open Calculator

fx $$L = \frac{2 \cdot E \cdot U_{member}}{A \cdot \sigma^2}$$

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

fx $$E = \frac{\left(\sigma^2\right) \cdot A \cdot L}{2 \cdot U_{member}}$$

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

30) Strain Energy Stored by Member

Open Calculator

fx $$U_{member} = \left(\frac{\sigma^2}{2 \cdot E}\right) \cdot A \cdot L$$

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

31) Stress of Member given Strain Energy Stored by Member

Open Calculator

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

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

Strain Energy stored per unit Volume

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

Open Calculator

fx $$E = \frac{\sigma^2}{2 \cdot U_{density}}$$

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

33) Strain Energy Stored per Unit Volume

Open Calculator

fx $$U_{density} = \frac{\sigma^2}{2 \cdot E}$$

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

34) Stress generated due to Strain Energy Stored per Unit Volume

Open Calculator

fx $$\sigma = \sqrt{U_{density} \cdot 2 \cdot E}$$

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

Stress due to

Gradually Applied Load

35) Area given Stress due to gradually Applied Load

Open Calculator

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

ex $$5601.195\text{mm}^2 = \frac{150\text{kN}}{26.78\text{MPa}}$$

36) Load given Stress due to gradually Applied Load

Open Calculator

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

ex $$149.968\text{kN} = 26.78\text{MPa} \cdot 5600\text{mm}^2$$

37) Stress due to gradually Applied Load

Open Calculator

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

ex $$26.78571\text{MPa} = \frac{150\text{kN}}{5600\text{mm}^2}$$

Impact Load

38) Stress due to Impact Load

Open Calculator

fx $$\sigma = \left(\frac{W_{\text{Applied load}}}{A}\right) + \sqrt{\left(\frac{W_{\text{Applied load}}}{A}\right)^2 + \frac{2 \cdot W_{\text{Applied load}} \cdot h \cdot E}{A \cdot L}}$$

ex $$2097.156\text{MPa} = \left(\frac{150\text{kN}}{5600\text{mm}^2}\right) + \sqrt{\left(\frac{150\text{kN}}{5600\text{mm}^2}\right)^2 + \frac{2 \cdot 150\text{kN} \cdot 12000\text{mm} \cdot 20000\text{MPa}}{5600\text{mm}^2 \cdot 3000\text{mm}}}$$

Shear Resilience

39) Modulus of Rigidity given Shear Resilience

Open Calculator

fx $$G_{Torsion} = \frac{\tau^2}{2 \cdot SEV}$$

ex $$40GPa = \frac{(55MPa)^2}{2 \cdot 37812.5J/m^3}$$

40) Shear Resilience

Open Calculator

fx $$SEV = \frac{\tau^2}{2 \cdot G_{Torsion}}$$

ex $$37812.5J/m^3 = \frac{(55MPa)^2}{2 \cdot 40GPa}$$

41) Shear Stress given Shear Resilience

Open Calculator

fx $$\tau = \sqrt{2 \cdot SEV \cdot G_{Torsion}}$$

ex $$55MPa = \sqrt{2 \cdot 37812.5J/m^3 \cdot 40GPa}$$

Suddenly Applied Load

42) Area given Stress due to suddenly Applied Load

Open Calculator

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

ex $$11202.39mm^2 = 2 \cdot \frac{150kN}{26.78MPa}$$

43) Load given Stress due to suddenly Applied Load

Open Calculator

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

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

44) Stress due to suddenly Applied Load

Open Calculator

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

ex $$53.57143\text{MPa} = 2 \cdot \frac{150\text{kN}}{5600\text{mm}^2}$$

Variables Used

- **A** Area of Cross-Section *(Square Millimeter)*
- **D** Outer Depth *(Millimeter)*
- d_i Inner Depth *(Millimeter)*
- **e'** Eccentricity of Load *(Millimeter)*
- **E** Young's Modulus *(Megapascal)*
- $G_{Torsion}$ Modulus of Rigidity *(Gigapascal)*
- **h** Height of Crack *(Millimeter)*
- **I** Area Moment of Inertia *(Meter⁴)*
- **J** Polar Moment of Inertia *(Meter⁴)*
- **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)*
- $U_{density}$ Strain Energy Density *(Joule per Cubic Meter)*
- U_{member} Strain Energy stored by Member *(Newton Meter)*
- **V** Shear Force *(Kilonewton)*
- $W_{Applied\ load}$ Applied Load *(Kilonewton)*
- **Z** Section Modulus for Eccentric Load on Beam *(Cubic Millimeter)*
- **Δ** Shear Deformation
- ε_L Lateral Strain
- **θ** Angle of Twist *(Degree)*
- **σ** Direct Stress *(Megapascal)*
- **τ** 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^3)
  Volume Unit Conversion
- Measurement: **Area** in Square Millimeter (mm^2)
  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^3)
  Energy Density Unit Conversion
- Measurement: **Second Moment of Area** in $Meter^4$ (m^4)
  Second Moment of Area Unit Conversion
- Measurement: **Stress** in Megapascal (MPa)
  Stress Unit Conversion

Check other formula lists

- Mohr's Circle of Stresses Formulas
- Beam Moments Formulas
- Bending Stress Formulas
- Combined Axial and Bending Loads Formulas
- Elastic Constants Formulas
- Elastic Stability of Columns Formulas
- Principal Stress Formulas
- Shear Stress Formulas
- Slope and Deflection Formulas
- Strain Energy Formulas
- Stress and Strain Formulas
- Torsion Formulas

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