Important Castigliano's Theorem for Deflection in Complex Structures Formulas PDF

Formulas
Examples
with Units

List of 14
Important Castigliano's Theorem for Deflection in Complex Structures Formulas

1) Cross-sectional Area of Rod given Strain Energy stored in Rod Formula

Evaluate Formula

Formula

$$A = P^2 \cdot \frac{L}{2 \cdot U \cdot E}$$

Example with Units

$$552.6987\,\text{mm}^2 = 55000\,\text{N}^2 \cdot \frac{1432.449\,\text{mm}}{2 \cdot 37.13919\,\text{J} \cdot 105548.9\,\text{N/mm}^2}$$

2) Force Applied on Rod given Strain Energy Stored in Tension Rod Formula

Evaluate Formula

Formula

$$P = \sqrt{U \cdot 2 \cdot A \cdot \frac{E}{L}}$$

Example with Units

$$55000.0019\,\text{N} = \sqrt{37.13919\,\text{J} \cdot 2 \cdot 552.6987\,\text{mm}^2 \cdot \frac{105548.9\,\text{N/mm}^2}{1432.449\,\text{mm}}}$$

3) Length of Rod given Strain Energy Stored Formula

Evaluate Formula

Formula

$$L = U \cdot 2 \cdot A \cdot \frac{E}{P^2}$$

Example with Units

$$1432.4491\,\text{mm} = 37.13919\,\text{J} \cdot 2 \cdot 552.6987\,\text{mm}^2 \cdot \frac{105548.9\,\text{N/mm}^2}{55000\,\text{N}^2}$$

4) Length of Shaft given Strain Energy Stored in Shaft Subjected to Bending Moment Formula

Evaluate Formula

Formula

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

Example with Units

$$1431.8821\,\text{mm} = 2 \cdot 37.13919\,\text{J} \cdot 105548.9\,\text{N/mm}^2 \cdot \frac{552.5\,\text{mm}^4}{55001\,\text{N*mm}^2}$$

5) Length of Shaft when Strain Energy in Shaft Subjected to External Torque Formula

Evaluate Formula

Formula

$$L = \frac{2 \cdot U \cdot J \cdot G}{\tau^2}$$

Example with Units

$$1433.541\,\text{mm} = \frac{2 \cdot 37.13919\,\text{J} \cdot 553\,\text{mm}^4 \cdot 105591\,\text{N/mm}^2}{55005\,\text{N*mm}^2}$$

6) Modulus of Elasticity given Strain Energy Stored in Shaft Subjected to Bending Moment Formula

Evaluate Formula

Formula

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

Example with Units

$$105590.6916\,\text{N/mm}^2 = 55001\,\text{N*mm}^2 \cdot \frac{1432.449\,\text{mm}}{2 \cdot 37.13919\,\text{J} \cdot 552.5\,\text{mm}^4}$$

7) Modulus of Elasticity of Rod given Strain Energy Stored Formula

Evaluate Formula

Formula

$$E = P^2 \cdot \frac{L}{2 \cdot A \cdot U}$$

Example with Units

$$105548.8926\,\text{N/mm}^2 = 55000\,\text{N}^2 \cdot \frac{1432.449\,\text{mm}}{2 \cdot 552.6987\,\text{mm}^2 \cdot 37.13919\,\text{J}}$$

8) Modulus of Rigidity of Rod given Strain Energy in Rod Formula

Evaluate Formula

Formula

$$G = \tau^2 \cdot \frac{L}{2 \cdot J \cdot U}$$

Example with Units

$$105510.5658\,\text{N/mm}^2 = 55005\,\text{N*mm}^2 \cdot \frac{1432.449\,\text{mm}}{2 \cdot 553\,\text{mm}^4 \cdot 37.13919\,\text{J}}$$

9) Moment of Inertia of Shaft when Strain Energy Stored in Shaft Subjected to Bending Moment Formula

Evaluate Formula

Formula

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

Example with Units

$$552.7188\,\text{mm}^4 = 55001\,\text{N*mm}^2 \cdot \frac{1432.449\,\text{mm}}{2 \cdot 105548.9\,\text{N/mm}^2 \cdot 37.13919\,\text{J}}$$

10) Polar Moment of Inertia of Rod given Strain Energy in Rod Formula

Evaluate Formula

Formula

$$J = \tau^2 \cdot \frac{L}{2 \cdot U \cdot G}$$

Example with Units

$$552.5788\,\text{mm}^4 = 55005\,\text{N*mm}^2 \cdot \frac{1432.449\,\text{mm}}{2 \cdot 37.13919\,\text{J} \cdot 105591\,\text{N/mm}^2}$$

11) Strain Energy in Rod when it is Subjected to External Torque Formula

Evaluate Formula

Formula

$$U = \tau^2 \cdot \frac{L}{2 \cdot J \cdot G}$$

Example with Units

$$37.1109\,\text{J} = 55005\,\text{N*mm}^2 \cdot \frac{1432.449\,\text{mm}}{2 \cdot 553\,\text{mm}^4 \cdot 105591\,\text{N/mm}^2}$$

12) Strain Energy Stored in Rod Subjected to Bending Moment Formula

Evaluate Formula

Formula

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

Example with Units

$$37.1539\,\text{J} = 55001\,\text{N*mm}^2 \cdot \frac{1432.449\,\text{mm}}{2 \cdot 105548.9\,\text{N/mm}^2 \cdot 552.5\,\text{mm}^4}$$

13) Strain Energy Stored in Tension Rod Formula

Evaluate Formula

Formula

$$U = \frac{P^2 \cdot L}{2 \cdot A \cdot E}$$

Example with Units

$$37.1392\,\text{J} = \frac{55000\,\text{N}^2 \cdot 1432.449\,\text{mm}}{2 \cdot 552.6987\,\text{mm}^2 \cdot 105548.9\,\text{N/mm}^2}$$

14) Torque given Strain Energy in Rod Subjected to External Torque Formula

Evaluate Formula

Formula

$$\tau = \sqrt{2 \cdot U \cdot J \cdot \frac{G}{L}}$$

Example with Units

$$55025.9621\,\text{N*mm} = \sqrt{2 \cdot 37.13919\,\text{J} \cdot 553\,\text{mm}^4 \cdot \frac{105591\,\text{N/mm}^2}{1432.449\,\text{mm}}}$$

Variables used in list of Castigliano's Theorem for Deflection in Complex Structures Formulas above

- **A** Cross Sectional Area of Rod *(Square Millimeter)*
- **E** Modulus of Elasticity *(Newton per Square Millimeter)*
- **G** Modulus of Rigidity *(Newton per Square Millimeter)*
- **I** Area Moment of Inertia *(Millimeter⁴)*
- **J** Polar Moment of Inertia *(Millimeter⁴)*
- **L** Length of Rod or Shaft *(Millimeter)*
- **M_b** Bending Moment *(Newton Millimeter)*
- **P** Axial Force on Beam *(Newton)*
- **U** Strain Energy *(Joule)*
- **τ** Torque *(Newton Millimeter)*

Constants, Functions, Measurements used in list of Castigliano's Theorem for Deflection in Complex Structures Formulas above

- 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)
  Length Unit Conversion
- Measurement: **Area** in Square Millimeter (mm²)
  Area Unit Conversion
- Measurement: **Energy** in Joule (J)
  Energy Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Torque** in Newton Millimeter (N*mm)
  Torque Unit Conversion
- Measurement: **Second Moment of Area** in Millimeter⁴ (mm⁴)
  Second Moment of Area Unit Conversion
- Measurement: **Stress** in Newton per Square Millimeter (N/mm²)
  Stress Unit Conversion

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