Important Thermal Stress Formulas PDF

Formulas
Examples
with Units

List of 11
Important Thermal Stress Formulas

1) Actual Expansion when Support Yields Formula

Evaluate Formula

Formula

$$AE = \alpha_L \cdot L_{bar} \cdot \Delta T - \delta$$

Example with Units

$$6\,\text{mm} = 0.0005\,\text{K}^{-1} \cdot 2000\,\text{mm} \cdot 10\,\text{K} - 4\,\text{mm}$$

2) Actual Strain given Support Yields for Value of Actual Expansion Formula

Evaluate Formula

Formula

$$\varepsilon_A = \frac{AE}{L_{bar}}$$

Example with Units

$$0.003 = \frac{6\,\text{mm}}{2000\,\text{mm}}$$

3) Actual Strain when Support Yields Formula

Evaluate Formula

Formula

$$\varepsilon_A = \frac{\alpha_L \cdot \Delta T \cdot L_{bar} - \delta}{L_{bar}}$$

Example with Units

$$0.003 = \frac{0.0005\,\text{K}^{-1} \cdot 10\,\text{K} \cdot 2000\,\text{mm} - 4\,\text{mm}}{2000\,\text{mm}}$$

4) Actual Stress given Support Yields for Value of Actual Strain Formula

Evaluate Formula

Formula

$$\sigma_{a'} = \varepsilon_A \cdot E_{bar}$$

Example with Units

$$0.693\,\text{MPa} = 0.0033 \cdot 210\,\text{MPa}$$

5) Actual Stress when Support Yields Formula

Evaluate Formula

Formula

$$\sigma_{a'} = \frac{\left(\alpha_L \cdot \Delta T \cdot L_{bar} - \delta\right) \cdot E_{bar}}{L_{bar}}$$

Example with Units

$$0.63\,\text{MPa} = \frac{\left(0.0005\,\text{K}^{-1} \cdot 10\,\text{K} \cdot 2000\,\text{mm} - 4\,\text{mm}\right) \cdot 210\,\text{MPa}}{2000\,\text{mm}}$$

6) Extension of Rod if Rod is Free to Extend Formula

Evaluate Formula

Formula

$$\Delta L_{Bar} = l_0 \cdot \alpha_T \cdot \Delta T_{rise}$$

Example with Units

$$7.225\,\text{mm} = 5000\,\text{mm} \cdot 17\text{E-}6\,^{\circ}\text{C}^{-1} \cdot 85\,\text{K}$$

7) Thermal Strain Formula

Evaluate Formula

Formula

$$\varepsilon = \frac{\Delta L}{l_0}$$

Example with Units

$$0.2 = \frac{1000\,\text{mm}}{5000\,\text{mm}}$$

8) Thermal Strain given Coefficient of Linear Expansion Formula

Evaluate Formula

Formula

$$\varepsilon_c = \alpha_L \cdot \Delta T_{rise}$$

Example with Units

$$0.0425 = 0.0005\,\text{K}^{-1} \cdot 85\,\text{K}$$

9) Thermal Strain given Thermal Stress Formula

Evaluate Formula

Formula

$$\varepsilon_s = \frac{\sigma_{th}}{E}$$

Example with Units

$$0.4348 = \frac{0.01\,\text{MPa}}{0.023\,\text{MPa}}$$

10) Thermal Stress given Coefficient of Linear Expansion Formula

Evaluate Formula

Formula

$$\sigma_c = \alpha_L \cdot \Delta T_{rise} \cdot E$$

Example with Units

$$0.001\,\text{MPa} = 0.0005\,\text{K}^{-1} \cdot 85\,\text{K} \cdot 0.023\,\text{MPa}$$

11) Thermal Stress given Thermal Strain Formula

Evaluate Formula

Formula

$$\sigma_s = \varepsilon \cdot E$$

Example with Units

$$0.0046\,\text{MPa} = 0.2 \cdot 0.023\,\text{MPa}$$

Variables used in list of Thermal Stress Formulas above

- **AE** Actual Expansion *(Millimeter)*
- **E** Young's Modulus Bar *(Megapascal)*
- E_{bar} Modulus of Elasticity of Bar *(Megapascal)*
- l_0 Initial Length *(Millimeter)*
- L_{bar} Length of Bar *(Millimeter)*
- α_L Coefficient of Linear Expansion *(Per Kelvin)*
- α_T Coefficient of Thermal Expansion *(Per Degree Celsius)*
- δ Yield Amount (Length) *(Millimeter)*
- ΔL Prevented Extension *(Millimeter)*
- ΔL_{Bar} Increase in Bar Length *(Millimeter)*
- ΔT Change in Temperature *(Kelvin)*
- ΔT_{rise} Temperature Rise *(Kelvin)*
- ε Thermal Strain
- ε_A Actual Strain
- ε_c Thermal Strain given Coef. of Linear Expansion
- ε_s Thermal Strain given Thermal Stress
- $\sigma_{a'}$ Actual Stress with Support Yield *(Megapascal)*
- σ_c Thermal Stress given Coef. of Linear Expansion *(Megapascal)*
- σ_s Thermal Stress given Thermal Strain *(Megapascal)*
- σ_{th} Thermal Stress *(Megapascal)*

Constants, Functions, Measurements used in list of Thermal Stress Formulas above

- Measurement: **Length** in Millimeter (mm)
  Length Unit Conversion
- Measurement: **Pressure** in Megapascal (MPa)
  Pressure Unit Conversion
- Measurement: **Temperature Difference** in Kelvin (K)
  Temperature Difference Unit Conversion
- Measurement: **Temperature Coefficient of Resistance** in Per Degree Celsius ($°C^{-1}$)
  Temperature Coefficient of Resistance Unit Conversion
- Measurement: **Coefficient of Linear Expansion** in Per Kelvin (K^{-1})
  Coefficient of Linear Expansion Unit Conversion

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