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Thermal Stress Formulas

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List of 18 Thermal Stress Formulas

Thermal Stress

Actual Stress and Strain

1) Actual Expansion when Support Yields

Open Calculator

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

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

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

Open Calculator

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

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

3) Actual Strain when Support Yields

Open Calculator

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

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

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

Open Calculator

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

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

5) Actual Stress when Support Yields

Open Calculator

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

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

Thermal Stress and Strain

6) Extension of Rod if Rod is Free to Extend

Open Calculator

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

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

7) Thermal Strain

Open Calculator

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

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

8) Thermal Strain given Coefficient of Linear Expansion

Open Calculator

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

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

9) Thermal Strain given Thermal Stress

Open Calculator

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

ex $0.434783 = \frac{0.01 MPa}{0.023 MPa}$

10) Thermal Stress given Coefficient of Linear Expansion

Open Calculator

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

ex $0.000978 MPa = 0.0005 K^{-1} \cdot 85 K \cdot 0.023 MPa$

11) Thermal Stress given Thermal Strain

Open Calculator

fx $\sigma_s = \varepsilon \cdot E$

ex $0.0046 MPa = 0.2 \cdot 0.023 MPa$

Thermal Stress in Composite Bars

12) Actual Expansion of Copper

Open Calculator

fx $$AE_c = \alpha_T \cdot \Delta T_{rise} \cdot L_{bar} - \frac{\sigma_{c'}}{E} \cdot L_{bar}$$

ex $$-434779.718696\text{mm} = 17\text{E}\hat{}\text{-}6\,^\circ\text{C}^{-1} \cdot 85\text{K} \cdot 2000\text{mm} - \frac{5\text{MPa}}{0.023\text{MPa}} \cdot 2000\text{mm}$$

13) Actual Expansion of Steel

Open Calculator

fx $$L = \alpha_T \cdot \Delta T_{rise} \cdot L_{bar} + \frac{\sigma_t}{E} \cdot L_{bar}$$

ex $$15046.37\text{mm} = 17\text{E}\hat{}\text{-}6\,^\circ\text{C}^{-1} \cdot 85\text{K} \cdot 2000\text{mm} + \frac{0.173000\text{MPa}}{0.023\text{MPa}} \cdot 2000\text{mm}$$

14) Contraction due to Compressive Stress Induced in Brass

Open Calculator

fx $$L_c = \frac{\sigma_{c'}}{E} \cdot L_{bar}$$

ex $$434782.6\text{mm} = \frac{5\text{MPa}}{0.023\text{MPa}} \cdot 2000\text{mm}$$

15) Expansion due to tensile stress in steel

Open Calculator

fx $$\alpha_s = \frac{\sigma}{E} \cdot L_{bar}$$

ex $$1043.478\text{mm} = \frac{0.012\text{MPa}}{0.023\text{MPa}} \cdot 2000\text{mm}$$

16) Free Expansion of Copper

Open Calculator

fx $\Delta L_{cu} = \alpha_T \cdot \Delta T_{rise} \cdot L_{bar}$

ex $2.89\text{mm} = 17\text{E}\hat{}\text{-}6\,^\circ\text{C}^{-1} \cdot 85\text{K} \cdot 2000\text{mm}$

17) Free Expansion of Steel

Open Calculator

fx $\Delta L_s = \alpha_T \cdot \Delta T_{rise} \cdot L_{bar}$

ex $2.89\text{mm} = 17\text{E}\hat{}\text{-}6\,^\circ\text{C}^{-1} \cdot 85\text{K} \cdot 2000\text{mm}$

18) Load on Brass or Steel

Open Calculator

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

ex $0.768\text{kN} = 0.012\text{MPa} \cdot 64000\text{mm}^2$

Variables Used

- **A** Cross Sectional Area of Bar *(Square Millimeter)*
- **AE** Actual Expansion *(Millimeter)*
- **AE_c** Actual Expansion of Copper *(Millimeter)*
- **E** Young's Modulus Bar *(Megapascal)*
- **E_{bar}** Modulus of Elasticity of Bar *(Megapascal)*
- **L** Actual Expansion of Steel *(Millimeter)*
- **l_0** Initial Length *(Millimeter)*
- **L_{bar}** Length of Bar *(Millimeter)*
- **L_c** Contraction Due to Compressive Stress in Brass *(Millimeter)*
- **W_{load}** Load *(Kilonewton)*
- **α_L** Coefficient of Linear Expansion *(Per Kelvin)*
- **α_s** Expansion of Steel under Tensile Stress *(Millimeter)*
- **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)*
- **ΔL_{cu}** Free Expansion of Copper *(Millimeter)*
- **ΔL_s** Free Expansion of Steel *(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
- σ Stress in Bar *(Megapascal)*
- $\sigma_{a'}$ Actual Stress With Support Yield *(Megapascal)*
- σ_c Thermal Stress given Coef. of Linear Expansion *(Megapascal)*
- $\sigma_{c'}$ Compressive Stress on Bar *(Megapascal)*
- σ_s Thermal Stress Given Thermal Strain *(Megapascal)*
- σ_t Tensile Stress *(Megapascal)*
- σ_{th} Thermal Stress *(Megapascal)*

Constants, Functions, Measurements used

- Measurement: **Length** in Millimeter (mm)
  Length Unit Conversion
- Measurement: **Area** in Square Millimeter (mm²)
  Area Unit Conversion
- Measurement: **Pressure** in Megapascal (MPa)
  Pressure Unit Conversion
- Measurement: **Force** in Kilonewton (kN)
  Force 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
- Measurement: **Stress** in Megapascal (MPa)
  Stress Unit Conversion

Check other formula lists

- Analysis of Bar Formulas
- Direct Strains of Diagonal Formulas
- Elastic Constants Formulas
- Mohr's Circle Formulas
- Principal Stresses and Strains Formulas
- Relationship between Stress and Strain Formulas
- Strain Energy Formulas
- Thermal Stress Formulas
- Types of Stresses Formulas

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