Important Composite Materials Formulas PDF

Formulas
Examples
with Units

List of 18
Important Composite Materials Formulas

1) Elastic Modulus Formulas

1.1) Elastic Modulus of Composite in Longitudinal Direction Formula

Evaluate Formula

Formula

$$E_{cl} = E_m \cdot V_m + E_f \cdot V_f$$

Example with Units

$$200.01\,\text{MPa} = 200.025\,\text{MPa} \cdot 0.4 + 200\,\text{MPa} \cdot 0.6$$

1.2) Elastic Modulus of Composite in Transverse Direction Formula

Evaluate Formula

Formula

$$E_{ct} = \frac{E_m \cdot E_f}{V_m \cdot E_f + V_f \cdot E_m}$$

Example with Units

$$200.01\,\text{MPa} = \frac{200.025\,\text{MPa} \cdot 200\,\text{MPa}}{0.4 \cdot 200\,\text{MPa} + 0.6 \cdot 200.025\,\text{MPa}}$$

1.3) Elastic Modulus of Fiber using Composite (Transverse Direction) Formula

Evaluate Formula

Formula

$$E_f = \frac{E_{ct} \cdot E_m \cdot V_f}{E_m - E_{ct} \cdot V_m}$$

Example with Units

$$200\,\text{MPa} = \frac{200.01\,\text{MPa} \cdot 200.025\,\text{MPa} \cdot 0.6}{200.025\,\text{MPa} - 200.01\,\text{MPa} \cdot 0.4}$$

1.4) Elastic Modulus of Fiber using Composite's Longitudinal Direction Formula

Evaluate Formula

Formula

$$E_f = \frac{E_{cl} - E_m \cdot V_m}{V_f}$$

Example with Units

$$199.9833\,\text{MPa} = \frac{200.0\,\text{MPa} - 200.025\,\text{MPa} \cdot 0.4}{0.6}$$

1.5) Elastic Modulus of Matrix using Composite (Transverse Direction) Formula

Evaluate Formula

Formula

$$E_m = \frac{E_{ct} \cdot E_f \cdot V_m}{E_f - E_{ct} \cdot V_f}$$

Example with Units

$$200.025\,\text{MPa} = \frac{200.01\,\text{MPa} \cdot 200\,\text{MPa} \cdot 0.4}{200\,\text{MPa} - 200.01\,\text{MPa} \cdot 0.6}$$

1.6) Elastic Modulus of Matrix using Composite's Longitudinal Direction Formula

Evaluate Formula

Formula

$$E_m = \frac{E_{cl} - E_f \cdot V_f}{V_m}$$

Example with Units

$$200\,\text{MPa} = \frac{200.0\,\text{MPa} - 200\,\text{MPa} \cdot 0.6}{0.4}$$

2) Polymer Matrix Composites Formulas

2.1) Critical Fiber Length Formula

Evaluate Formula

Formula

$$l_c = \sigma_f \cdot \frac{d}{2 \cdot \tau_c}$$

Example with Units

$$10.5897\,\text{mm} = 6.375\,\text{MPa} \cdot \frac{10\,\text{mm}}{2 \cdot 3.01\,\text{MPa}}$$

2.2) Fiber Diameter given Critical Fiber Length Formula

Evaluate Formula

Formula

$$d = \frac{l_c \cdot 2 \cdot \tau}{\sigma_f}$$

Example with Units

$$10\,\text{mm} = \frac{10.625\,\text{mm} \cdot 2 \cdot 3\,\text{MPa}}{6.375\,\text{MPa}}$$

2.3) Fiber-Matrix Bonding Strength given Critical Length of Fiber Formula

Evaluate Formula

Formula

$$\tau = \frac{\sigma_f \cdot d}{2 \cdot l_c}$$

Example with Units

$$3\,\text{MPa} = \frac{6.375\,\text{MPa} \cdot 10\,\text{mm}}{2 \cdot 10.625\,\text{mm}}$$

2.4) Longitudinal Strength of Composite Formula

Evaluate Formula

Formula

$$\sigma_{cl} = \tau_m \cdot \left(1 - V_f\right) + \sigma_f \cdot V_f$$

Example with Units

$$31.865\,\text{MPa} = 70.1\,\text{MPa} \cdot \left(1 - 0.6\right) + 6.375\,\text{MPa} \cdot 0.6$$

2.5) Tensile Strength of Fiber from Longitudinal Tensile Strength of Composite Formula

Evaluate Formula

Formula

$$\sigma_f = \frac{\sigma_{cl} - \sigma_m \cdot \left(1 - V_f\right)}{V_f}$$

Example with Units

$$6.375\,\text{MPa} = \frac{31.825\,\text{MPa} - 70\,\text{MPa} \cdot \left(1 - 0.6\right)}{0.6}$$

2.6) Tensile Strength of Fiber given Critical Fiber Length Formula

Evaluate Formula

Formula

$$\sigma_f = \frac{2 \cdot l_c \cdot \tau}{d}$$

Example with Units

$$6.375\,\text{MPa} = \frac{2 \cdot 10.625\,\text{mm} \cdot 3\,\text{MPa}}{10\,\text{mm}}$$

2.7) Tensile Strength of Matrix given Longitudinal Tensile Strength of Composite Formula

Evaluate Formula

Formula

$$\sigma_m = \frac{\sigma_{cl} - \sigma_f \cdot V_f}{1 - V_f}$$

Example with Units

$$70\,\text{MPa} = \frac{31.825\,\text{MPa} - 6.375\,\text{MPa} \cdot 0.6}{1 - 0.6}$$

2.8) Volume Fraction of Fiber from EM of Composite (Longitudinal Direction) Formula

Evaluate Formula

Formula

$$V_f = \frac{E_{cl} - E_m \cdot V_m}{E_f}$$

Example with Units

$$0.6 = \frac{200.0\,\text{MPa} - 200.025\,\text{MPa} \cdot 0.4}{200\,\text{MPa}}$$

2.9) Volume Fraction of Fiber from EM of Composite (Transverse Direction) Formula

Evaluate Formula

Formula

$$V_f = \frac{E_f}{E_{ct}} - \frac{V_m \cdot E_f}{E_m}$$

Example with Units

$$0.6 = \frac{200\,\text{MPa}}{200.01\,\text{MPa}} - \frac{0.4 \cdot 200\,\text{MPa}}{200.025\,\text{MPa}}$$

2.10) Volume Fraction of Fiber from Longitudinal Tensile Strength of Composite Formula

Evaluate Formula

Formula

$$V_f = \frac{\sigma_m - \sigma_{cl}}{\sigma_m - \sigma_f}$$

Example with Units

$$0.6 = \frac{70\,\text{MPa} - 31.825\,\text{MPa}}{70\,\text{MPa} - 6.375\,\text{MPa}}$$

2.11) Volume Fraction of Matrix from EM of Composite (Longitudinal Direction) Formula

Evaluate Formula

Formula

$$V_m = \frac{E_{cl} - E_f \cdot V_f}{E_m}$$

Example with Units

$$0.4 = \frac{200.0\,\text{MPa} - 200\,\text{MPa} \cdot 0.6}{200.025\,\text{MPa}}$$

2.12) Volume Fraction of Matrix from EM of Composite (Transverse direction) Formula

Evaluate Formula

Formula

$$V_m = \frac{E_m}{E_{ct}} - \frac{E_m \cdot V_f}{E_f}$$

Example with Units

$$0.4 = \frac{200.025\,\text{MPa}}{200.01\,\text{MPa}} - \frac{200.025\,\text{MPa} \cdot 0.6}{200\,\text{MPa}}$$

Variables used in list of Composite Materials Formulas above

- **d** Fiber Diameter *(Millimeter)*
- E_{cl} Elastic Modulus Composite (Longitudinal Direction) *(Megapascal)*
- E_{ct} Elastic Modulus Composite (Transverse Direction) *(Megapascal)*
- E_f Elastic Modulus of Fiber *(Megapascal)*
- E_m Elastic Modulus of Matrix *(Megapascal)*
- l_c Critical Fiber Length *(Millimeter)*
- V_f Volume Fraction of Fiber
- V_m Volume Fraction of Matrix
- σ_{cl} Longitudinal Strength of Composite *(Megapascal)*
- σ_f Tensile Strength of Fiber *(Megapascal)*
- σ_m Tensile Strength of Matrix *(Megapascal)*
- τ Fiber Matrix Bonding Strength *(Megapascal)*
- τ_c Critical Shear Stress *(Megapascal)*
- τ_m Stress in Matrix *(Megapascal)*

Constants, Functions, Measurements used in list of Composite Materials Formulas above

- Measurement: **Length** in Millimeter (mm)
  Length Unit Conversion
- Measurement: **Pressure** in Megapascal (MPa)
  Pressure Unit Conversion

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