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Composite Materials Formulas

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List of 18 Composite Materials Formulas

Composite Materials

Elastic Modulus

1) Elastic Modulus of Composite in Longitudinal Direction

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

Open Calculator 

$$ex \quad 200.01MPa = 200.025MPa \cdot 0.4 + 200MPa \cdot 0.6$$

2) Elastic Modulus of Composite in Transverse Direction

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

Open Calculator 

$$ex \quad 200.01MPa = \frac{200.025MPa \cdot 200MPa}{0.4 \cdot 200MPa + 0.6 \cdot 200.025MPa}$$

3) Elastic Modulus of Fiber using Composite (Transverse Direction)

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

Open Calculator 

$$ex \quad 200MPa = \frac{200.01MPa \cdot 200.025MPa \cdot 0.6}{200.025MPa - 200.01MPa \cdot 0.4}$$



4) Elastic Modulus of Fiber using Composite's Longitudinal Direction

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

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$ex \quad 199.9833MPa = \frac{200.0MPa - 200.025MPa \cdot 0.4}{0.6}$$

5) Elastic Modulus of Matrix using Composite (Transverse Direction)

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

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$ex \quad 200.025MPa = \frac{200.01MPa \cdot 200MPa \cdot 0.4}{200MPa - 200.01MPa \cdot 0.6}$$

6) Elastic Modulus of Matrix using Composite's Longitudinal Direction

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

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$ex \quad 200MPa = \frac{200.0MPa - 200MPa \cdot 0.6}{0.4}$$



Polymer Matrix Composites

7) Critical Fiber Length

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

[Open Calculator !\[\]\(23d9fc146e83b5c3013cfa32c784f8d5_img.jpg\)](#)

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

8) Fiber Diameter given Critical Fiber Length

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

[Open Calculator !\[\]\(aa53ad6fea213b8b2226d3077e30533a_img.jpg\)](#)

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

9) Fiber-Matrix Bonding Strength given Critical Length of Fiber

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

[Open Calculator !\[\]\(626ce8ac21792b9405bfddfea8e0c96a_img.jpg\)](#)

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

10) Longitudinal Strength of Composite

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

[Open Calculator !\[\]\(c1168d6a8b365d11e842ece304635fa7_img.jpg\)](#)

$$ex \quad 31.865\text{MPa} = 70.1\text{MPa} \cdot (1 - 0.6) + 6.375\text{MPa} \cdot 0.6$$



11) Tensile Strength of Fiber from Longitudinal Tensile Strength of Composite

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

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

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

12) Tensile Strength of Fiber given Critical Fiber Length

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

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

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

13) Tensile Strength of Matrix given Longitudinal Tensile Strength of Composite

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

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

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



14) Volume Fraction of Fiber from EM of Composite (Longitudinal Direction)

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

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)

$$ex \quad 0.59995 = \frac{200.0MPa - 200.025MPa \cdot 0.4}{200MPa}$$

15) Volume Fraction of Fiber from EM of Composite (Transverse Direction)

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

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5_img.jpg\)](#)

$$ex \quad 0.6 = \frac{200MPa}{200.01MPa} - \frac{0.4 \cdot 200MPa}{200.025MPa}$$

16) Volume Fraction of Fiber from Longitudinal Tensile Strength of Composite

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

[Open Calculator !\[\]\(ab4e2b3fc7e7887b7a72f548aa6f5e60_img.jpg\)](#)

$$ex \quad 0.6 = \frac{70MPa - 31.825MPa}{70MPa - 6.375MPa}$$



17) Volume Fraction of Matrix from EM of Composite (Longitudinal Direction)

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

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5_img.jpg\)](#)

$$\text{ex } 0.39995 = \frac{200.0\text{MPa} - 200\text{MPa} \cdot 0.6}{200.025\text{MPa}}$$

18) Volume Fraction of Matrix from EM of Composite (Transverse direction)

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

[Open Calculator !\[\]\(2b376d1a92330ab09dad2665d2f89bf5_img.jpg\)](#)

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



Variables Used

- 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)
- T Fiber Matrix Bonding Strength (Megapascal)
- T_c Critical Shear Stress (Megapascal)
- T_m Stress in Matrix (Megapascal)



Constants, Functions, Measurements used

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



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