MEMT201
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CARDENAS

HW #13

Problem 1

A continuous and aligned fiber-reinforced composite is to be produced consisting of 30 vol% aramind fibers and 70 vol% of a polycarbonate matrix; mechanical characteristics of these two materials are as follows;

Material	Modulus of Elasticity, (GPa (psi))	Tensile Strength (MPa (psi))
Aramid Fiber	131 (19 x 10^6)	3600 (520,000)
Polycarbonate	2.4 (3.5 x 10^5)	65 (9425)

Also the stress on the polycarbonate matrix when the aramid fibers fail is 45 MPa (6500 psi)

For this composite, compute;

(a) the longitudinal tensile strength

From the PowerPoint on composites:

$$\sigma_{\text{cl}}^{*} = \sigma_{m}^{'}(1-\upsilon_{f}) + \sigma_{\text{f}}^{*}\upsilon_{f}$$

σ_{cl}^{*} = 45 MPa * (1 – 30%) + 3600 MPa * 30% = 45 MPa * 0.7 + 3600 MPa * 0.3 = <u>1111.5 MPa</u>

(b) the longitudinal modulus of elasticity

Likewise:

$$\text{E}_{L} = E_{f}\upsilon_{f} + E_{m}(1-V_{f})$$

E_L = 2.4 GPa * 70% + 131 GPa * 30% = 2.4 GPa * 0.7 + 131 GPa * 0.3 = <u>40.98 GPa</u>

Problem 2

For a continuous and oriented fiber-reinforced composite, the moduli of elasticity in the longitudinal and transverse directions are 19.7 and 3.66 GPa (2.8×10^6 and 5.3×10^5 psi), respectively. If the volume fraction of fibers is 0.25, determine the moduli of elasticity of fiber and matrix phases.

From the formula above:

19.7 GPa $= E_f * 0.25 + E_m(1- 0.25)$

$= 0.25E_f + 0.75E_m$

$E_m = 26.27 \text{ GPa} - 0.3333E_f$

Using the formula for transverse modulus:

$$E_T = \frac{E_f E_m}{E_f \upsilon_m + E_m \upsilon_f}$$

3.66 GPa = $E_f(26.27 \text{ GPa} - 0.3333Ef) / (E_f(1-0.25) + (26.27 \text{ Gpa} - 0.3333E_f))$

$E_f = 70.12$ GPa

$E_m = 26.27 \text{ GPa} - 0.3333(70.12 \text{ GPa}) = \underline{2.897 \text{ GPa}}$