

16.15 In this problem, for an aligned carbon fiber-epoxy matrix composite, we are given the volume fraction of fibers (0.20), the average fiber diameter (6×10^{-3} mm), the average fiber length (8.0 mm), the fiber fracture strength (4.5 GPa), the fiber-matrix bond strength (75 MPa), the matrix stress at composite failure (6.0 MPa), and the matrix tensile strength (60 MPa); and we are asked to compute the longitudinal strength. It is first necessary to compute the value of the critical fiber length using Equation 16.3. If the fiber length is much greater than l_c , then we may determine the longitudinal strength using Equation 16.17, otherwise, use of either Equation 16.18 or Equation 16.19 is necessary. Thus, from Equation 16.3

$$l_c = \frac{\sigma_f^* d}{2\tau_c} = \frac{(4.5 \times 10^3 \text{ MPa})(6 \times 10^{-3} \text{ mm})}{2(75 \text{ MPa})} = 0.18 \text{ mm}$$

Inasmuch as $l \gg l_c$ (8.0 mm \gg 0.18 mm), then use of Equation 16.17 is appropriate. Therefore,

$$\begin{aligned}\sigma_{cl}^* &= \sigma_m'(1 - V_f) + \sigma_f^* V_f \\ &= (6 \text{ MPa})(1 - 0.20) + (4.5 \times 10^3 \text{ MPa})(0.20) \\ &= 905 \text{ MPa (130,700 psi)}\end{aligned}$$