

16.17 In this problem, for an aligned glass fiber-epoxy matrix composite, we are asked to compute the longitudinal tensile strength given the following: the average fiber diameter (0.015 mm), the average fiber length (2.0 mm), the volume fraction of fibers (0.25), the fiber fracture strength (3500 MPa), the fiber-matrix bond strength (100 MPa), and the matrix stress at composite failure (5.5 MPa). 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 σ_{cl}^* using Equation 16.17, otherwise, use of either Equations 16.18 or 16.19 is necessary. Thus,

$$l_c = \frac{\sigma_f^* d}{2\tau_c} = \frac{(3500 \text{ MPa})(0.015 \text{ mm})}{2(100 \text{ MPa})} = 0.263 \text{ mm} \quad (0.010 \text{ in.})$$

Inasmuch as $l > l_c$ (2.0 mm > 0.263 mm), but since l is not much greater than l_c , then use of Equation 16.18 is necessary. Therefore,

$$\begin{aligned} \sigma_{cd}^* &= \sigma_f^* V_f \left(1 - \frac{l_c}{2l}\right) + \sigma_m' (1 - V_f) \\ &= (3500 \text{ MPa})(0.25) \left[1 - \frac{0.263 \text{ mm}}{(2)(2.0 \text{ mm})}\right] + (5.5 \text{ MPa})(1 - 0.25) \\ &= 822 \text{ MPa} \quad (117,800 \text{ psi}) \end{aligned}$$