

16.18 (a) This portion of the problem calls for computation of values of the fiber efficiency parameter. From Equation 16.20

$$E_{cd} = KE_f V_f + E_m V_m$$

Solving this expression for K yields

$$K = \frac{E_{cd} - E_m V_m}{E_f V_f} = \frac{E_{cd} - E_m(1 - V_f)}{E_f V_f}$$

For glass fibers, $E_f = 72.5$ GPa (Table 16.4); using the data in Table 16.2, and taking an average of the extreme E_m values given, $E_m = 2.29$ GPa (0.333×10^6 psi). And, for $V_f = 0.20$

$$K = \frac{5.93 \text{ GPa} - (2.29 \text{ GPa})(1 - 0.2)}{(72.5 \text{ GPa})(0.2)} = 0.283$$

For $V_f = 0.3$

$$K = \frac{8.62 \text{ GPa} - (2.29 \text{ GPa})(1 - 0.3)}{(72.5 \text{ GPa})(0.3)} = 0.323$$

And, for $V_f = 0.4$

$$K = \frac{11.6 \text{ GPa} - (2.29 \text{ GPa})(1 - 0.4)}{(72.5 \text{ GPa})(0.4)} = 0.353$$

(b) For 50 vol% fibers ($V_f = 0.50$), we must assume a value for K . Since it is increasing with V_f , let us estimate it to increase by the same amount as going from 0.3 to 0.4—that is, by a value of 0.03. Therefore, let us assume a value for K of 0.383. Now, from Equation 16.20

$$\begin{aligned} E_{cd} &= KE_f V_f + E_m V_m \\ &= (0.383)(72.5 \text{ GPa})(0.5) + (2.29 \text{ GPa})(0.5) \\ &= 15.0 \text{ GPa} \quad (2.18 \times 10^6 \text{ psi}) \end{aligned}$$