16.13 The problem stipulates that the cross-sectional area of a composite, A_c, is 480 mm^2 (0.75 in.^{2}), and the longitudinal load, F_c, is 53,400 N (12,000 lb$_f$) for the composite described in Problem 16.8.

(a) First, we are asked to calculate the F_f/F_m ratio. According to Equation 16.11

$$\frac{F_f}{F_m} = \frac{E_f V_f}{E_m V_m} = \frac{(131\ \text{GPa})(0.45)}{(2.4\ \text{GPa})(0.55)} = 44.7$$

Or, $F_f = 44.7F_m$

(b) Now, the actual loads carried by both phases are called for. From Equation 16.4

$$F_f + F_m = F_c = 53,400\ \text{N}$$

$$44.7F_m + F_m = 53,400\ \text{N}$$

which leads to

$$F_m = 1168\ \text{N}\ \ (263\ \text{lb}_\text{f})$$

$$F_f = F_c - F_m = 53,400\ \text{N} - 1168\ \text{N} = 52,232\ \text{N}\ \ (11,737\ \text{lb}_\text{f})$$

(c) To compute the stress on each of the phases, it is first necessary to know the cross-sectional areas of both fiber and matrix. These are determined as

$$A_f = V_f A_c = (0.45)(480\ \text{mm}^2) = 216\ \text{mm}^2\ \ (0.34\ \text{in.}^2)$$

$$A_m = V_m A_c = (0.55)(480\ \text{mm}^2) = 264\ \text{mm}^2\ \ (0.41\ \text{in.}^2)$$

Now, the stresses are determined using Equation 6.1 as

$$\sigma_f = \frac{F_f}{A_f} = \frac{52,232\ \text{N}}{(216\ \text{mm}^2)(1\ \text{m}/1000\ \text{mm})^2} = 242 \times 10^6\ \text{N/m}^2 = 242\ \text{MPa}\ \ (34,520\ \text{psi})$$

$$\sigma_m = \frac{F_m}{A_m} = \frac{1168\ \text{N}}{(264\ \text{mm}^2)(1\ \text{m}/1000\ \text{mm})^2} = 4.4 \times 10^6\ \text{N/m}^2 = 4.4\ \text{MPa}\ \ (641\ \text{psi})$$