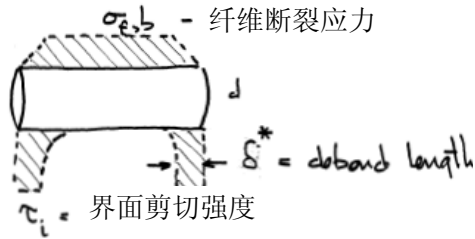


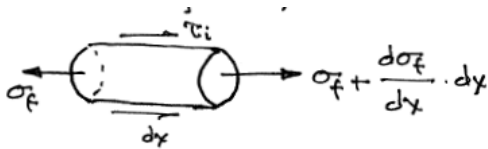
短纤复合材料

- 易于构建复曲率 *easier fabrication, especially complex curvatures*
- 临界纤维长度



$$l_c = 2\delta^* = \frac{\sigma_{f,b}}{2\tau_i}$$

剪滞理论



$$\left(\frac{d\sigma_f}{dx} \cdot dx\right) \frac{\pi d^2}{4} = -\tau_i (\pi d) dx \rightarrow \frac{d\sigma_f}{dx} = -\frac{4}{d} \tau_i$$

单位长度的剪切值

$$2\pi\gamma \cdot \tau = \pi d \tau_i \rightarrow \tau = \frac{d}{2\gamma} \cdot \tau_i$$

基体中的剪切应变

$$\gamma = \frac{du}{d\gamma} = \frac{\tau}{G} = \frac{d}{2\gamma} \cdot \frac{\tau_i}{G}$$

$$u = \int \frac{du}{d\gamma} \cdot d\gamma \rightarrow u_1 - u_f = \frac{d}{2G} \tau_i \ln \frac{2R}{d}$$

$$\rightarrow \left(\frac{d}{2n}\right) \frac{d^2 \sigma_f}{dx^2} - \sigma_f = -E_f \varepsilon_1, n = \sqrt{\frac{2G_m}{E_f \ln \frac{2R}{d}}}$$

$$\sigma_f = E_f \varepsilon_1 + C \sinh \frac{2nx}{d} + D \cosh \frac{2nx}{d}$$

$$b.c: \sigma_f = 0 @ x = \pm \frac{l}{2}$$

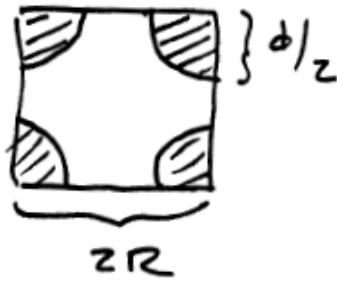
$$\sigma_f = E_f \varepsilon_1 \left[1 - \frac{\cosh\left(na \frac{2x}{l}\right)}{\cosh(na)} \right] \quad a = \frac{l}{d}$$

剪滞理论

$$E_1 = \eta \nu_f E_f + \nu_m E_m \left\{ \begin{array}{l} n = \sqrt{\frac{2G_m}{E_f \ln \frac{2R}{d}}} \\ a = \frac{l}{d} \\ \eta = 1 - \frac{\tanh(na)}{na} \end{array} \right.$$

N66 中含 30%E-glass

$$\tau_i = 20MPa, d = R\mu, l = 1mm$$



$$\nu_f = \frac{\frac{\pi}{4}d^2}{(2R)^2} \rightarrow \frac{2R}{d} = \sqrt{\frac{\pi}{4\nu_f}} = 1.618$$

$$a = \frac{l}{d} = \frac{10^{-3}}{12 \times 10^{-6}} = 83.3$$

$$n = \sqrt{\frac{2(1.015 \times 10^9)}{76e^9 \ln(1.618)}} = 0.2356$$

$$\eta = 1 - \frac{\tanh[(0.2356)(83.3)]}{(0.2356)(83.3)} = 0.949$$

$$E_1 = (0.949)(0.3)(76e^9) + (0.7)(2.7e^9) = 23.5GPa$$