ENGR145 HW7

15.9) Longitudinal Modulus of Elasticity = 35GPa = 5×10^6 psi
Transverse Modulus of Elasticity = 5.17 GPa = 7.5×10^5 psi
Elastic Modulus of the epoxy = 3.4 GPa = 4.93×10^5 psi
Investigating Aramid fiber-epoxy matrix composite
- Modulus of Elasticity = 131 GPa = 1.9×10^7 psi

Longitudinal: $E_{cl} = E_m V_m + E_f V_f$ Transverse: $E_{cl} = \frac{E_m E_f}{V_m E_f + V_f E_m}$

$V_f + V_m = 1 \Rightarrow V_m = 1 - V_f$, solve for V_f in each

Longitudinal

$E_{cl} = E_m(1-V_f) + E_f V_f$

$E_{cl} = E_m - E_m V_f + E_f V_f$

$E_{cl} = E_m - V_f(E_m - E_f)$

$V_f = -\frac{E_{cl} - E_m}{E_m - E_f}$

Compute and compare V_f for each with $E_m = 3.4$ GPa and $E_f = 131$ GPa

Longitudinal: $E_{cl} = 35$ GPa

$V_f = -\frac{35 - 3.4}{3.4 - 131} = 0.248$

Transverse

$E_{cl} = \frac{E_m E_f}{(1-V_f)E_f + V_f E_m}$

$E_{cl} = \frac{E_m E_f}{E_f - E_f V_f + V_f E_m}$

$E_{cl} = \frac{E_m E_f}{E_f - V_f(E_f - E_m)}$

$E_{cl}(E_f - V_f(E_f - E_m)) = E_m E_f$

$E_{cl}E_f - E_{cl}V_f(E_f - E_m) = E_m E_f$

$E_{cl}V_f(E_f - E_m) = E_{cl}E_f - E_m E_f$

$V_f = \frac{E_{cl}E_f - E_m E_f}{E_{cl}(E_f - E_m)}$

Transverse: $E_{cl} = 5.17$ GPa

$V_f = \frac{5.17(131) - 3.4(131)}{5.17(131 - 3.4)} = 0.351$

Because the volume fractions for longitudinal and transverse are different (.248 ≠ .351), it is not possible to produce and continuous fiber-epoxy matrix composite.

15.19) **(a)** The Matrix phase binds the fibers together and distributes applied stress to the fibers. It also protects the fibers from damage from the environment or harmful chemicals. Finally, it separates fibers to prevent development of brittle cracks that could lead to failure.
(b) The Matrix phase should be ductile while the fiber should have a much higher modulus of elasticity. Fibers should be stiff while the matrix phase should be relatively soft and plastic. The bonding between the two phases must be very high.
(c) The bonding between the two phases must be strong to maximize the amount of stress that is transmitted from the matrix phase to the fiber phase. A strong bond also prevents fibers from slipping apart and keeps cracks from easily forming and spreading.