MECA-H-406 Composite structures - Exercises 1

Material	E [GPa]	ν [/]	ρ [g/cm^3]	σ_u [MPa]
Epoxy matrix	3.5	0.34	1.2	52.5
Glass fiber	70	0.21	2.5	700
Carbon fiber	350	0.21	1.8	700
Kevlar fiber	147	0.23	1.5	1300
Boron fiber	390	0.22	2.63	2800

1. For the composite materials below, considering fibers with a circular cross-section and volume fractions of fibers V_f of respectively 20%, 45% and 60%, compute E_L and E_T.

(a) glass fibers - epoxy

(b) carbon fibers - epoxy

(c) Kevlar fibers - epoxy

2. Consider a composite material carbon fibers - epoxy subjected to a load in the longitudinal direction, P_c. Derive the expression of the ratio P_f/P_c (P_f is the longitudinal load in the fibers) as a function of the volume fraction of fibers, V_f. Plot the corresponding curve. Compare the result with that of a glass fibers - epoxy composite.

3. Compute V_{crit} and V_{min} for the three following composite materials :

(a) glass fibers - epoxy

(b) carbon fibers - epoxy

(c) boron fibers - epoxy

4. Consider a reference glass fibers - epoxy composite material with volume fractions such that V_m/V_f=3 .

What is the minimum volume fraction of carbon fibers that you have to add to the initial material in order to reinforce the composite, while maintaining a constant volume ratio epoxy/glass fibers ?

5. Consider a reference glass fibers - epoxy composite material with a volume fraction of epoxy of 35% .

(a) What is the volume fraction of carbon fibers that you have to add to the initial material to double the value of E_L, while maintaining the volume fraction of epoxy to 35% ?

(b) What is the reduction of the density achieved with the carbon fibers ?

(c) What is the ultimate strength of the two composites ?