1/19/2021 - 3013C

Proposed Layup Orientation

I would like to use carbon fiber rather than fiberglass because carbon fiber is more lightweight. I am interested in the application of turbine blades for wind energy. The primary matl used today is fiberglass because it is cheaper. I would like to investigate carbon fiber to see if there is a fiber direction that minimizes cost and maximizes performance. I believe this will be random orientation mat because it will have isotropic strength. However DoIT PoMS says that radom orientation has a low packing efficiency so it cannot meet the high fibre volume fraction necessary for large loads. The solution DoIT PoMS suggests is stacking together plies with different fiber orientation.

Using a 65% fiber (as recommend by video 2 on fibers), I calculated the elastic constants for 4 plies w/ stacking sequences of 0, 0/90, and 0/45/90/45 in DoIT PoMs.

For 0, the laminate was stiffest along the fiber direction, and most ductile ⊥ to the fibers. For 0/90/0/90, the fiber was the most stiff @ loading angles of 0° & 90°, and least stiff @ 45°. For 0/45/90/45 the fiber was strongest @ 45°, and got slightly weaker in both directions. This has the most isotropic stacking sequence. The stiffness of fiberglass for this sequence was 36 GPa while the stiffness for carbon fiber was 141.

1/19/2021 - 3017C

Proposed Layup Orientation

The large difference in stiffness of carbon fiber (41) to fiberglass (3b) justifies the use of carbon fiber for wind turbine blades. As blades get longer they need to be more stiff, which carbon fiber can help with. For the 0/90 part of my stack, I can either use two sheets of unidirectional or 1 sheet of woven mat. Twill is diagnol, which makes it great for the 45° part of my stack. I am going to use a combination of unidirectional and twill because I am reading a lot online that says unidirectional is stronger and stiffer than woven.