How carbon fiber–reinforced epoxy composite laminates fail when wet

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Scientists from two Asian universities, Universiti Teknologi Malaysia (UTM) and Newcastle University in Singapore, have completed a study to understand how the mechanical behavior of carbon fiber–reinforced

epoxy composite laminates could be compromised by moisture seepage.

A team of researchers, led by KJ Wong (UTM, Malaysia), has developed a model for reliable prediction of the delamination behavior as moisture progressively seeps into the fiber reinforced composites that are used in aircraft fuselage, such as Boeing B787 and Airbus A350. This model is known as the Bilinear-Exponential Traction-Separation (BETS) law. The model can account for how fibers bridge cracks, e.g., mode I delamination, of carbon fiber reinforced epoxy composite laminates in wet states.

The BETS of the moisture-delamination problem was implemented with the help of a computer simulation approach known as Finite Element Analysis. By evaluating the effects of moisture content on the composite force-displacement behavior under loading, the researchers found that the BETS law agreed very well with results from experiments derived from the double cantilever beam testing.

Importantly, the proposed BETS law has the advantage of not requiring crack growth monitoring during experiment, and only one fitting parameter was needed to describe the bridging law at different moisture content levels. Consequently, the BETS law is an important step towards the development of structural fail-safe approaches, i.e., an early warning system to alert the engineers working in maintenance, repair and operations to fix the delamination problem early, before the problem becomes critical.

The work has been published in *Polymer Composites*.

More information: King Jye Wong et al, Fiber bridging mechanism in moisture-induced mode I delamination in carbon/epoxy composites: Finite element analysis and experimental investigation, *Polymer Composites* (2022). DOI: 10.1002/pc.27179

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