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Evaluation of Cumulative Fiber-Breaksin a CFRP by Markov Process Model

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Abstract

A stochastic model was proposed to estimate the number of cumulative fiber-break points of a unidirectional carbon fiber-reinforced plastic composite based on a Markov process. This model assumesthat each state is assigned in the order of the number of fiber-break points in the composite. In this model also the stress recovery lengths around the fiber-break points are taken into account, but the effect of stress concentration occurring after the fiber-break is not contained. In addition, this model defines the transition to two states from one state. When a state including fiber-break point(s) transits to the next statecausinga composite fracture, the next state must be anabsorption state. On the other hand, if the composite is not fractured, itmust be a surviving state while being damaged.Thus, each stage accompanied with fiber-break point(s) has two states, and is modelled to generate the fiber breaking process successively and stochastically. To verify the present model, mini composites with two, three and four filaments were produced using carbon fibers and epoxy resin, and tensile tested. Results showed that failure probability curves obtained from the present model approached tothe experimental data with increase in fiber-break point, and were finally fitted well with them. The number of fiber-break points up to fracture was estimated probabilistically, and resulted in accumulated more than the number of filaments. This demonstrates that a cumulative fiber breaking process is one of the factors to increase the composite strength.Finally, this paper discussed applicability of the present model to a composite inducing stress concentration around fiber-break point(s), using the shear-lag theory.

Key-words

Stochastic process, Carbon fiber, Fiber-reinforced composites, Tensile strength, Weibull distribution