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Creep Rupture and Fiber Breaks Accumulation in Unidirectional Composite

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The use of composites for pre-stressed reinforcement elements leads to an interest for creep-rupture investigations. In present paper a stochastic kinetic fiber break clusters accumulation model was developed. The analysis, based on Markov-type stochastic kinetic equations, leads to the development of closed-form analytical solutions for probabilities of obtaining adjacent fiber breaks of a particular configuration in the loaded composite material. The chain-of-bundles material model was used. In this approach, all possible geometrical varieties of clusters were considered (up to eleven adjacent broken fibers, with analytical approximation for larger fiber clusters) and form-dependent cluster distributions were obtained. Stress concentration calculations were performed using the influence function's approach. To apply the theory to real material volumes, a lower-tail probabilities analysis was made. A parametric analysis was realized and discrepancies of damage accumulation in different types of polymer matrix composite systems were analyzed. Simultaneously, Monte Carlo simulations were numerically realized. Theoretical predictions for composite lifetimes were compared with experimental data.

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