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The Effect of Mean Stress on Damage Predictions for Spectral Loading of Fiberglass Composite Coupons[1]

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Abstract:

In many analyses of wind turbine blades, the effects of mean stress on the determination of damage in composite blades are either ignored completely or they are characterized inadequately. Mandell, et al [1] have recently presented an updated Goodman diagram for a fiberglass material that is typical of the materials used in wind turbine blades. Their formulation uses the MSU/DOE Fatigue Data Base [2] to develop a Goodman diagram with detailed information at thirteen R-values. Using these data, linear, bi-linear and full Goodman diagrams are constructed using mean and "95/95" fits to the data. The various Goodman diagrams are used to predict the failure stress for coupons tested using the WISPERX spectrum [3]. Three models are used in the analyses. The first is the linear Miner's rule commonly used by the wind industry to predict failure (service lifetimes). The second is a nonlinear variation of Miner's rule which computes a nonlinear Miner's Sum based upon an exponential degradation parameter. The third is a generalized nonlinear residual strength model that also relies on an exponential degradation parameter. The results illustrate that Miner's rule does not predict failure very well. When the mean Goodman diagram is used, the nonlinear models predict failures near the mean of the experimental data, and when the 95/95 Goodman diagram is used, they predict the lower bound of the measured data very well.

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