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EFFECT OF MEAN STRESS ON THE DAMAGE OF WIND TURBINE BLADES[*†]

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ABSTRACT

In many analyses of composite wind turbine blades, the effects of mean stress on the determination of damage are either ignored completely or they are characterized inadequately. An updated Goodman diagram for the fiberglass materials that are typically used in wind turbine blades has been released recently. This diagram, which is based on the MSU/DOE Fatigue Database, contains detailed information at thirteen R-values. This diagram is the most detailed to date, and it includes several loading conditions that have been poorly represented in earlier studies. This formulation allows the effects of mean stress on damage calculations to be evaluated. The evaluation presented here uses four formulations for the S-N behavior of the fiberglass. In the first analysis, the S-N curve for the composite is assumed to be independent of mean stress and to have a constant slope. The second is a linear Goodman diagram, the third is a bi-linear Goodman diagram and the fourth is the full Goodman diagram. Two sets of load spectra, obtained by the LIST (Long term Inflow and Structural Test) program, are used for this evaluation. The results of the analyses, equivalent fatigue loads and damage predictions, are compared to one another. These results illustrate a significant overestimation of the equivalent fatigue loads when the mean stress is not considered in the calculation. And, the results from the updated Goodman diagram illustrate that there are a significant differences in accumulated damage when the Goodman diagram includes information on the transition between compressive and tensile failure modes.

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