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# Fatigue of Composite Materials and Substructures for Wind Turbine Blades

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## Abstract

This report presents the major findings of the Montana State University Composite Materials Fatigue Program from 1997 to 2001, and is intended to be used in conjunction with the DOE/MSU Composite Materials Fatigue Database. Additions of greatest interest to the database in this time period include environmental and time under load effects for various resin systems; large tow carbon fiber laminates and glass/carbon hybrids; new reinforcement architectures varying from large strands to prepreg with well-dispersed fibers; spectrum loading and cumulative damage laws; giga-cycle testing of strands; tough resins for improved structural integrity; static and fatigue data for interply delamination; and design knockdown factors due to flaws and structural details as well as time under load and environmental conditions. The origins of a transition to increased tensile fatigue sensitivity with increasing fiber content are explored in detail for typical stranded reinforcing fabrics. The second focus of the report is on structural details which are prone to delamination failure, including ply terminations, skin-stiffener intersections, and sandwich panel terminations. Finite element based methodologies for predicting delamination initiation and growth in structural details are developed and validated, and simplified design recommendations are presented.