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Blade System Design Study Part II: Final Project Report (GEC)

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Abstract

As part of the U.S. Department of Energy's Low Wind Speed Turbine program, Global Energy Concepts LLC (GEC)[1] has studied alternative composite materials for wind turbine blades in the multi-megawatt size range. This work in one of the Blade System Design Studies (BSDS) funded through Sandia National Laboratories.

The BSDS program was conducted in two phases. In the Part I BSDS, GEC assessed candidate innovations in composite materials, manufacturing processes, and structural configurations. GEC also made recommendations for testing composite coupons, details, assemblies, and blade sub-structures to be carried out in the Part II study (BSDS-II). The BSDS-II contract period began in May 2003, and testing was initiated in June 2004.

The current report summarizes the results from the BSDS-II test program. Composite materials evaluated include carbon fiber in both pre-impregnated and vacuum-assisted resin transfer molding (VARTM) forms. Initial thin-coupon static testing included a wide range of parameters, including variation in manufacturer, fiber tow size, fabric architecture, and resin type. A smaller set of these materials and process types was also evaluated in thin-coupon fatigue testing, and in ply-drop and ply-transition panels. The majority of materials used epoxy resin, with vinyl ester (VE) resin also used for selected cases. Late in the project, testing of unidirectional fiberglass was added to provide an updated baseline against which to evaluate the carbon material performance.

Numerous unidirectional carbon fabrics were considered for evaluation with VARTM infusion. All but one fabric style considered suffered either from poor infusibility or waviness of fibers combined with poor compaction. The exception was a triaxial carbon-fiberglass fabric produced by SAERTEX. This fabric became the primary choice for infused articles throughout the test program. The generally positive results obtained in this program for the SAERTEX material have led to its being used in innovative prototype blades of 9-m and 30-m length, as well as other non-wind related structures.

[1] GEC was acquired by the Norwegian foundation, Det Norske Veritas (DNV) in May 2008, forming a new entity known as DNV Global Energy Concepts Inc. For purposes of this report, the previous company name, GEC, is used.