CASE STUDY

HD-FOS for Defect Detection in Wind Turbine Blades

ABOUT US DOE & UMASS LOWELL

Industry: Energy

The United States Department of Energy is a cabinet-level department of the United States Government concerned with the United States' policies regarding energy and safety in handling nuclear material.

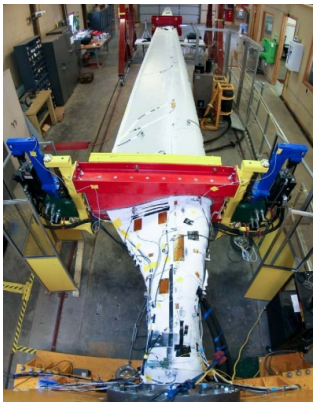
The University of Massachusetts Lowell is a public research university in Lowell, Massachusetts, with a satellite campus in Haverhill, Massachusetts. It is the northernmost member of the University of Massachusetts system and has been regionally accredited by the New England Commission of Higher Education since 1975.

The Challenge

Advanced composite materials are now used exclusively in the production of wind turbine blades and increasingly in aircraft production, but the design of large composite structures, subject to high loads, can be challenging, since material properties, fabrication methods and joining techniques are very different than those used for traditional metals. The manufacturing processes for composites are new and can add a substantial degree of variability to a wind turbine blade's (or aircraft wing's) structural performance. Manufacturers need to be able to predict when and where in the structure defects may occur that could potentially cause a catastrophic failure.

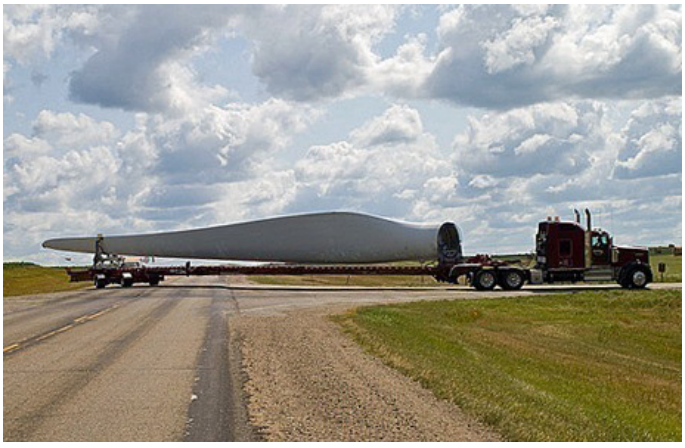
The Solution

Luna's High-Definition Fiber Optic Sensing (HD-FOS) solution provides thousands of strain sensing points distributed in and on the composite blade. In combination with Luna's readout electronics and software, engineers performing fatigue testing were able to pin-point areas of high residual strain and predict failure many times earlier than previously possible. The turbine blade was instrumented with HD-FOS sensors, and an eight channel optical switch was used to serially interrogate multiple sensors.



Cyclical Load Testing To failure

The turbine blade was mounted in a cantilevered load test stand. A universal excitation (UREX) system was used to apply an alternating bending moment at natural frequencies. A cyclical load was applied at +/-500lbs. At periodic cycle counts the turbine blade was statically loaded and data was taken from both the surface mounted HD-FOS sensors and point sensing strain gages.



INSTRUMENTS USED

Luna Optical Backscatter Reflectometer (OBR), high-definition fiber optic distributed sensors, (8) Channel Optical Switch

The Results

Luna's HD-FOS system, with its flexibility and low profile, was successfully embedded in large wind turbine blade during its fabrication without affecting the structural performance of the assembly. In testing, the HD-FOS sensor system was able to reveal the location and characterization of the defects that were intentionally induced during the fabrication process. The strain data taken with HD-FOS showed excellent correlation to the individual point sensing strain gages. The high-definition sensing also showed the full distribution of strain, as well as the shape of the strain profile in the vicinity of the defects. Lastly, the HD-FOS were able to identify crack initiation and chart the crack propagation ultimately leading to failure.

LUNA

+1 540.769.8400
solutions@lunainc.com
www.lunainc.com