Stochastic Models for Strength of Wind Turbine Blades using Tests

Toft, Henrik Stensgaard; Sørensen, John Dalsgaard

Published in:
EWEC 2008 Conference Proceedings

Publication date:
2008

Document Version
Publisher's PDF, also known as Version of record

Stochastic models for strength of wind turbine blades using tests

Henrik Stensgaard Toft, Aalborg University
John Dalsgaard Sørensen, Aalborg University and Risø/DTU

Relevant Topics:
T12: Structural design and materials

Summery: (88 words)
Structural cost of wind turbine blades is dependent on the values of the partial safety factors which reflect the uncertainties in the design values, including statistical uncertainty from a limited number of tests. This paper presents a probabilistic model for ultimate and fatigue strength of wind turbine blades especially considering the influence of prior knowledge and tests results and how partial safety factors can be updated when additional full scale tests are performed. This updating is performed by adopting a probabilistic design basis based on Bayesian statistical methods.

Full Description: (330 words)
Cost reduction is a substantial requirement in order that wind turbines can become competitive compared to other energy supply methods. In traditional deterministic, code-based design, the structural costs are among other things dependent on the value of the partial safety factors, which reflects the uncertainty related to the design parameters.

To verify the ultimate and fatigue strength of wind turbine blades tests must be performed. For new designs normally several tests on small parts of the blades and only one full scale test are carried out resulting in considerable statistical uncertainty which must be used in the assessment of partial safety factors for the blades. This also implies that more tests and thereby a reduction of the statistical uncertainty will lead to a decrease in the partial safety factor.

The statistical uncertainty can mainly be reduced by performing additional full scale tests and partly by taking expert knowledge and information from previous blade testing into account. However, these sources of information can only be taking into account by adopting a probabilistic design approach. This paper describes how the results of full scale tests can be combined with the prior information by use of Bayesian statistics.

Based on representative limit state equations for wind turbine blade failure modes, information from tests and associated uncertainties, it is possible to determine updated partial safety factors. The updated partial safety factor will decrease when the number of tests is increased because the uncertainty associated to the design values for blades is reduced. A illustrative numerical example is presented. The decrease in the partial safety factors will lead to a lighter design of the wind turbine blades. Even though full scale tests of wind turbine blades is time-consuming and expensive the benefits from a lighter design is excessive, since also loads on other parts of the wind turbine are reduced. Besides, the series production of blades implies the possibility that costs of more tests can be paid due to the decrease in use of materials.