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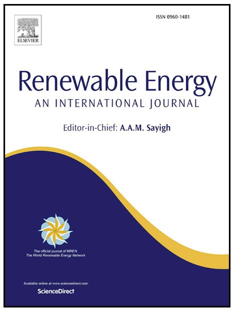

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Effects of aeroelastic tailoring on performance characteristics of wind turbine systems

Samuel Scott[a], Marco Capuzzi[a], David Langston[a], Ervin Bossanyi[b], Graeme McCann[b], Paul M. Weaver[a], Alberto Pirrera[a,*]

[a] *Advanced Composites Centre for Innovation and Science (ACCIS), Department of Aerospace Engineering, University of Bristol, Queen's Building, University Walk, Bristol, BS8 1TR, UK.*
[b] *DNV GL, One Linear Park, Avon Street, Bristol, BS2 0PS, UK.*

Abstract

Some interesting challenges arise from the drive to build larger, more durable wind turbine rotors. The rationale is that, with current designs, the power generated is theoretically proportional to the square of the blade length, however, theoretical mass increases cubically. Aeroelastic tailoring aims to improve the ratio between increased power capture and mass by offering enhanced combined energy capture and system durability. As such, the design and full system analysis of two adaptive, aeroelastically tailored wind turbine blades is considered herein. One makes use of material bend-twist coupling, whilst the other combines both material and geometric bend-twist coupling. Each structural design meets a predefined coupling distribution, that approximately matches the stiffness of a baseline blade.

The performance characteristics of the wind turbine systems are assessed and compared in terms of power production, load alleviation and pitch system considerations. The blade with both couplings displays scope for potential increases in energy yield. Additionally, beneficial flapwise load alleviation is demonstrated by the adaptive blades from both International Electrotechnical Commission prescribed fatigue, and extreme operational gust analysis. Finally, the adaptive blades display power smoothing capabilities and reductions in pitch rate, however, increases in blade root torsional moment possibly contrast these pitch system benefits.

Keywords: Aeroelastic tailoring, Variable stiffness, Wind turbine blade, Load alleviation, Composites, Bend-twist coupling

*Corresponding author
Email address: alberto.pirrera@bristol.ac.uk (Alberto Pirrera)