Analysis and Design of Wind Turbine Blades using Simplified Global Models

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ABSTRACT

At Siemens Gamesa Renewable Energy (SGRE) the wind turbine blades are designed as an Aero-elastic Tailored Blade (ATB). The ATB effects can be designed to reduce the loads on the structure by controlling the bend-twist and shear-twist effects, such that the blade will deflect out of the wind when it is subjected to high aerodynamic loads.

The response of the ATB is accurately captured by a numerical demanding global shell model. In order to estimate the loads and energy production on turbine level by dynamic finite element simulations, a more computationally efficient model is desired. In this project, a simplified global model consisting of beam elements with piecewise constant cross-sectional properties will be investigated. The task is to capture the complex response of the shell model while preserving the efficiency of the beam model. In order to determine the properties of the different cross sections, the program BECAS [1] will be used on the given model of the ATB. In this context, the influence of various changes to the geometry of the cross sections can be considered. Among these could be, placement of the shear web and changes to the fiber layup, which could be changed to achieve the desired bend-twist and shear-twist coupling effects.

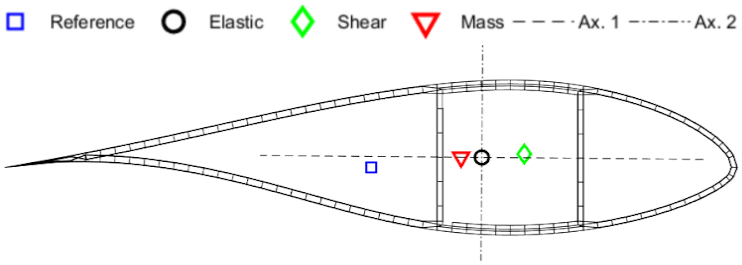

Figure 1: Cross-section of the Wind turbine blade using BECAS [1].

In Figure 1, a cross section of a wind turbine blade is shown with its FE mesh and its centre of mass, and shear and elastic centre. These properties are found using BECAS and will be used to construct the simplified global model which is utilized for analysis and design optimization of the ATB.

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REFERENCES

[1] J.P. Blasques, R. Bitsche, B. Lazarov, M. Stolpe, V. Fedorov and D. Verelst, *User's Manual for BECAS*, A cross section analysis tool for anisotropic and inhomogeneous beam sections of arbitrary geometry, Department of Wind Energy - Technical University of Denmark, 2015.