AUTOMATED MODEL GENERATION OF LARGE WIND TURBINE BLADES: ADVANTAGE OF SOLID OVER SHELL ELEMENTS

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Due to market demand the size of wind turbines has been rapidly increasing due to the expected reduction in cost of energy for larger turbines. This leads to blades of extreme complexity, both in terms of geometry and materials. The increased structural complexity of larger turbines requires a better understanding of their behaviour, thus demanding the usage of higher fidelity numerical models. The behaviour of these structures is usually investigated using Outer Mold Layer (OML) shell models, however different studies have identified significant drawbacks of this approach. One of the drawbacks is related with the mechanical response of the blade under torsional loads, which shows a lower stiffness when simulated using OML based shell elements when compared to solid elements [1]. The second issue with the shell approach is related to the correct representation of the adhesive joints in the blade, since the inner surfaces that make contact with the adhesive are not directly modelled. This is usually resolved by changing the geometry of the modelled adhesive and scaling its stiffness, ensuring the correct stiffness of the blade's section, or by using multi-point constraints to connect the adhesive with the OML shell. Finally, the usage of solid elements allows a better representation of the stress state within the composite materials, which increases its fidelity and is essential when predicting damage progression and failure.

In this work, a novel approach to create FE blade models, which allows both shell, solid and hybrid modelling strategies to be employed is presented [2]. The developed modelling approach is implemented as a software tool that handles all the different steps of the model creation process in a matter of seconds without manual intervention. The novel approach considers the blade to consist of a collection of parametric pre-defined blocks, allowing models consisting of shell elements, solid elements or combinations to be created. By including the tools to accurately partition the OML, create the required offset surfaces and calculate accurate element-wise material orientations, a high level of detail and fidelity can be achieved. The developed software is used to create a high fidelity model of a 43m long glass-fibre epoxy wind turbine blade that is analysed under different static loading conditions [3].

References

[1] K. Branner, P. Berring, C. Berggreen, and H. Knudsen, "Torsional performance of wind turbine blades - Part 2: Numerical validation," 16th ICCM, 2007.

[2] M. Peeters, G. Santo, J. Degroote, and W. Van Paepegem, "High-fidelity finite element models of composite wind turbine blades with shell and solid elements," Compos. Struct., vol. 200, pp. 521–531, Sep. 2018.

[3] M. Peeters, G. Santo, J. Degroote, and W. Van Paepegem, "Comparison of Shell and Solid Finite Element Models for the Static Certification Tests of a 43 m Wind Turbine Blade," Energies, vol. 11, no. 6, p. 1346, May 2018.