TRANSIENT MODELLING OF THE ROTOR-TOWER INTERACTION OF WIND TURBINES USING FLUID-STRUCTURE INTERACTION SIMULATIONS

G. Santo [1]*, M. Peeters [2], W. Van Paepegem [2], J. Degroote [1]

[1] Department of Flow, Heat and Combustion Mechanics, Ghent University
Sint-Pietersnieuwstraat 41 – 9000 Ghent, Belgium
{gilberto.santo; joris.degroote}@ugent.be

[2] Department of Material Science and Engineering, Ghent University
Technologiepark-Zwijnaarde 903 – 9052 Zwijnaarde, Belgium
{mathijs.peeters; wim.vanpaepegem}@ugent.be

ABSTRACT

In this work, we focus on the effect of supporting structures on the loads acting on a large horizontal axis wind turbine. The transient fluid-structure interaction (FSI) is simulated by an in-house code which couples two solvers, one for the computational fluid dynamics (CFD) and one for the computational structure mechanics (CSM). Strong coupling is applied as the force and displacement equilibriums are always enforced on the fluid-structure interface.

The three blades of the considered machine are simulated as flexible. The accurate CSM model reproduces in details the composite layups, foam, adhesive and internal stiffeners of these structures. On the other hand, the supporting structures (tower and nacelle) are considered to be rigid.

On the fluid side, a fully hexahedral mesh is generated by a multi-block strategy. The same mesh is continuously deformed and adapted according to the displacement of the fluid-structure interface. The atmospheric boundary layer (ABL) under neutral conditions is included and consistently preserved along the computational domain.

Using the outlined model, the blade deflections with and without supporting structure are compared. The effects of this transient interaction are highlighted throughout the rotation of the rotor, in terms of both wind energy conversion performance of the machine and structural response of each component. The maximal stress in the blade material as a function of time is compared with and without the presence of the tower in the wake of the rotor. Only a few similar works are reported to appear in literature ([1], [2]).

REFERENCES

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