High-Fidelity aeroelastic analysis of Wind-Turbines in complex terrain - Structural Model and FSI-Coupling

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Abstract

The simulation of wind turbines operated in complex terrain poses additional challenges to the simulation process. The distributed inflow conditions with flow inclination and increased turbulence created by the complex terrain may result in stronger fluctuations of the aerodynamic loads on the turbine. Those fluctuations make it challenging for the coupled problem to converge. The operation of wind turbines in complex terrain is investigated within the WindForS research project WINSENT. High fidelity simulations are conducted using the CFD fluid solver FLOWer and the FEM structural solver Kratos.

Two versions of the high fidelity structural FEM model are being considered: based on beam elements and based on shell elements. The differences between the two models is being investigated to determine whether it is sufficient to use beam elements or if a better representation of the structure is necessary through the use of shell elements to accurately capture the response of the structure. One of the main questions is whether the changes in cross section make a difference, which can only be represented by a shell model.

The coupling of the solvers is done with the coupling tool EMPIRE. It is done in an explicit manner, the data is exchanged only once between the solvers per timestep. Predictors like proposed in [1] are used for increasing the stability of the coupling.

The coupled FSI simulations are conducted using only one blade to start investigating the behavior of the coupling without having the computationally expensive simulation of the entire turbine. Results for uniform inflow together with explicit coupling will be presented and compared. An outlook on the further simulations will be given along with an explanation of the coupling of the participating solvers.

References

[1] Dettmer, W. G. and Peri, D., A new staggered scheme for fluid structure interaction, *Int. J. Numer. Meth. Engng*, 93: 1-22. doi:10.1002/nme.4370, 2013.