ANALYSIS OF THE AERODYNAMIC LOADS ON A WIND TURBINE IN OFF-DESIGN CONDITIONS

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Key Words: *Wind energy, Aerodynamics, Turbulence, Overset.*

In this work, the aerodynamic loads acting on a large horizontal axis wind turbine are analysed in off-design conditions by means of computational fluid dynamics (CFD) simulations.

The turbulent wind flow is solved using an unsteady RANS approach and choosing the *k-epsilon* model. The inlet conditions first proposed by Richard and Hoxey [1] are imposed in order to include the atmospheric boundary layer (ABL) profiles for turbulence and velocity at the inlet of the computational domain. Modified wall functions [2] are employed on the ground wall in order to preserve the ABL profiles throughout the entire domain.

A structured background mesh is used. Several component meshes, reproducing the blades and the supporting structures (tower and nacelle), are overlapped and connected to the background mesh by means of an overset technique. The connectivity is then updated every time step to follow the rotation of the wind rotor.

Changing both the pitch angle of the blades and the tip-speed ratio (TSR) of the turbine, several operating points are investigated. The performance and the loads to be analysed are highly affected by the ABL, whose effect is highlighted. The performance of the wind turbine in each simulated operating point is compared to the best efficiency point (BEP). The aerodynamic loads are monitored, analysed and mutually compared throughout the motion of the rotor in order to identify and study the most critical conditions for the blade structures.

REFERENCES

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