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Aeroelasticity analysis of wind turbine blades based on CFD-CSD coupling

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Summary

Understanding the aeroelastic behavior of the blade is crucial to the design of large wind turbines, which has been attracting more and more research efforts. Essentially, the aeroelasticity problem of wind turbine blades is a fluid-solid interaction problem with obvious interface. At the present time, in the aeroelasticity analysis of wind turbine, CFD software based on the incompressible Reynolds-averaged Navier-Stokes (RANS) equations are not yet routinely used , in part because of the lack of experience with regard to the application of these software to various wind turbine rotors for a wide range of conditions and the complexity of the rotor flow problem.

A CFD and CSD coupling procedure for the aeroelasticity analysis of large wind turbine blades is presented in this paper. Firstly aerodynamics analysis is performed using CFD methods to predict aerodynamic loads on the blade. Then with the help of a code developed here, the load information obtained from the previous aerodynamic analysis is fed into the solid domain to perform CSD analysis of the blade. To validate the procedure, the NREL Phase VI rotor with S809 airfoil is selected as an example, and the coupling analysis has been performed at free stream velocities from 7m/s to 25m/s. It is found that the numerical results obtained in this paper are in reasonable agreement with wind tunnel measurements.

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