Aeroelastic study of a wind turbine tower undergoing Vortex Induced Vibrations (VIV)

Vortex Induced Vibrations (VIV) are a complex Fluid-Structure Interaction (FSI) instability phenomena. These can occur on wind turbine blades in standstill position, during installation and commissioning. A wind turbine tower can be also subjected to VIV when it faces a lock-in phenomenon. This is the interaction of the structural edgewise motion and the wake motion, which in this case takes the name of vortex shedding.

The goal of this thesis is to investigate the 3D vortex shedding and its dynamics for a rigid tapered tower and in a second phase consider a time accurate structural coupling to examine the VIV mechanism. Starting from the CFD model of the tower of the WINSENT turbine, and adapting it to only tower simulations, calculations based on different DES algorithms will be performed to recognize the vortex shedding frequency. This is important because, in VIV, significant vibration amplitudes quickly build up leading to a limit cycle oscillation synchronizing with flow shedding frequency.

Afterwards, FSI simulations will be carried comparing the usage of both a 1D FEM and a 3D FEM model of the tower. In this way it will be possible to prove if edgewise deformations are occurring and if they are correlated to the vortex shedding.

The CFD solver that will be used for the FSI simulation is FLOWer. In order to perform the simulations, a maximum timestep analysis needs to be carried out and maybe some changes in the meshes will be necessary, using the commercial software Pointwise. It may be necessary to consider different inflow velocities to catch the lock-in phenomena.

The structural solver that will be used is KRATOS, that is coupled to FLOWer in an explicit way. Stability of the simulation will show if an implicit coupling is necessary to obtain physical results.

At the end, all results of the work will be documented.

Tasks:
- Only tower CFD simulations with investigation of the produced wake.
- Performance of FSI simulations with two different structural fidelity models.
- Investigation of the VIV phenomena in the flexible case.
- Documentation of the work.

Starting: As soon as possible
Ending: 6 months after

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