Review of paper wes-2020-22:

Aero-elastic analysis of wind turbines under turbulent inflow conditions

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Brief summary

The author's present a high fidelity FSI model based on the CFD code FLOWer and the structural multibody code SIMPACK in an explicit coupling. Different complexities of the FSI model are presented from a blade alone model over rotor model to full modelling of the rotor, nacelle and tower. Uniform inflow as well as turbulent inflow cases are simulated. The simulations are carried on the so-called DANAERO rotor, a 2MW NM80 turbine with an 80 m rotor.
Comparing the different simulated cases, the impact on Damage Equivalent Loading (DEL) of turbine flexibility and turbulence is discussed. For the relative low wind speed case simulated with turbulence it is concluded that turbulence has, by far the highest impact on the DEL compared with impact of flexibility.

Overall comments

The overall subject of presenting a high fidelity FSI model is of considerable relevance for the research community as the turbines are continuously upscaled leading to more flexible designs where the aeroelastic effects become more and more important and require such FSI models to be truly analysed. The authors also mention this motivation in the introduction.

However, a limitation of the paper content is that the simulations are carried out on a turbine design that is more than 20 years old and with a structural design that is much stiffer than designs that are more recent. Also the size of 2MW and a diameter of 80m for the chosen turbine is quite different from both recent reference turbine designs (e.g. the INNWIND and AVATAR reference rotors defined several years ago) in the research community as well as industrial designs that now have exceeded 10MW and 200m in diameter.

The actual choice of the DANAERO turbine might be because detailed aerodynamic measurements are available for this turbine but the experimental data are only used in one case in the paper.

So due to fact that the simulations are carried out on a relative stiff turbine design, some of the results and discussions of e.g. impact of flexibility on elastic torsion which are in the range of tenths of a degree, become somewhat theoretical without any real impact.

Specific comments

Title

The present title indicates that the paper has a considerable focus and part on simulating turbulent inflow conditions. However, it is a limited part of the paper so it could be considered to change the title, e.g. to:

A High Fidelity Simulation Tool for Aeroelastic Simulations of Wind Turbine

Abstract

Introducing the turbine used for the simulations as ".. the DANAERO turbine …" is not precise as many in the research community do not know that specific turbine.

So it should be changed to a real description of the turbine, e.g. "a 2MW NM80 turbine with an 80m diameter rotor".

Also the text: " .. specific case of the DANAERO experiment.." could be more informative, e.g. like:

" .. of the inflow turbulence is analysed for a specific case in comparison with experimental data from the DANAERO experiment."

1. Introduction

Satisfactory introduction and description of previous work within the field and the intro to the contents of the present paper at the end.

Minor typos

Line 22:

- .. where the only blades ..

Line 29:

- .. and the compared to BEM ..

2. Methodology

Section 2.2

Line 96-97

- The description of the turbulence generation by body forces is very brief – please expand, e.g. over what axial distance are the body forces applied and how much does the turbulence decay down to the turbine ?

Line 128

- What is the actual FMT time simulation length and what did determine the length ?

3 Results

3.1 Aeroelastic effects

Line 165-167

- The discussion of this case is very short – please expand
- Why isn´t this case simulated with turbulence as the experimental data are shown, probably from several revolutions in turbulent inflow

Line 173-174

- The percentage values are shown with two decimals. They are probably based on the time trace values so maybe better just to show one decimal or how accurate are these values ?

Line 187

- that Mx in 6 – please correct

Line 215

- An increase in power for coupled case of 3.5% is quite much – is it a time varying flow due to separation in the region of 40-50% radius or what can be the causes?

Line 248

- " .. in FMT a peak appears close to the first flap bending eigenfrequency of the blade (f1 = 0.938Hz) that could lead to instabilities .. ". Please show the position of that frequence by a vertical line in the spectrum.
- As concerns instability – how can this lead to instability ?

Line 282-285

- Could numerical stabilities in the coupling generate the considerable number of small oscillations?

Final conclusion of review

The reviewer can recommend publication of the paper considering to include the above comments/questions.