Wind Energ. Sci. Discuss.,
https://doi.org/10.5194/wes-2019-64-SC2, 2019

Interactive comment on "Investigations of aerodynamic drag forces during structural blade testing using high fidelity fluid-structure interaction" *by* Christian Grinderslev et al.

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Received and published: 4 October 2019

Dear Leonardo Bergami, Thank you very much for your helpful comments! They will be considered in the revised manuscript.

Please see answers below.

Q1. Structural Damping Role.

"I could not find in the paper any mention to the role of structural damping modelling. I would guess that through the coupling with Hawc2 a Rayleigh structural damping model is included, and this would also contribute to a decay in the oscillation amplitude, similarly to aerodynamic damping effects. Structural damping values are typically rather uncertain input parameters in the model, and either from simulation and measurements, it might be difficult to split the damping contribution between structural and aerodynamic sources. What are your thoughts on this, how sensitive are the simulation results to the structural damping choices, and what and how is the structural damping level chosen?"

A1: The damping was tuned through Rayleigh damping in HAWC2 to 1% log dec for the first and second modes, as stated in section 2.4. This was a value conservatively based on the reference (Post, 2016). As mentioned in the comment, it is difficult to assess this value as it cannot be directly separated from the aerodynamic damping in experiments. To assess the sensitivity, HAWC2 simulations were conducted using structural damping of 0,1,2 and 3% log. dec. For the test, a CD of 5.3 was used. Along with this, a test without aerodynamic forces (CD=0) and 1% log. dec. was conducted to show the impact of aerodynamic forces compared to the structural damping.

The resulting tip displacement can be seen in the Figure 1. As seen, the structural damping has little effect on the overall decay of the tip displacement.

This study will be added to the appendix of the manuscript.

Q2. Effects of aerodynamics on eigen-frequency estimation.

"Did you quantify any eventual bias of the blade eigen-frequency response due to the aerodynamic forces interaction? The increased aerodynamic drag might cause an increased "aerodynamic) added mass" effect, which could potentially lower the frequency of the blade response (being now, not completely free, but subject to aerodynamic forces, higher than predicted by BEM). It could be interesting to show in the paper how much much (if any) the response frequency is shifted in the FSI response compared to the "structural-only" eigen frequency solution."

A2: No significant change in frequency due to the added mass was observed through the simulations. Likely, this possible effect will also change along the decaying vibration of the blade, as is seen with the effective drag. For oscillations with a constant amplitude, this effect might be more prominent.

Q3. (very minor terminology clarification)

"I would guess that since the blade is nonrotating, there is actually no induction modelling active in the FSI-BEM model (correctly). Some may argue that in this case, it wouldn't be a "Blade Element Momentum" model, as 1D momentum theory and induction modeling are not used. Anyway, just a matter of naming."

A3: This is a good point. The "BEM" notation will be changed to "BET" as Blade Element Theory, which should be more accurate.

Kind regards Christian Grinderslev

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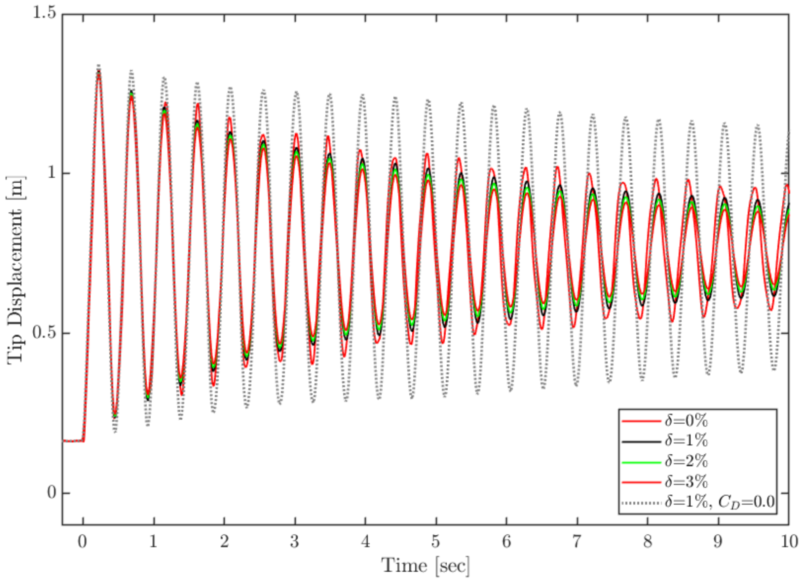
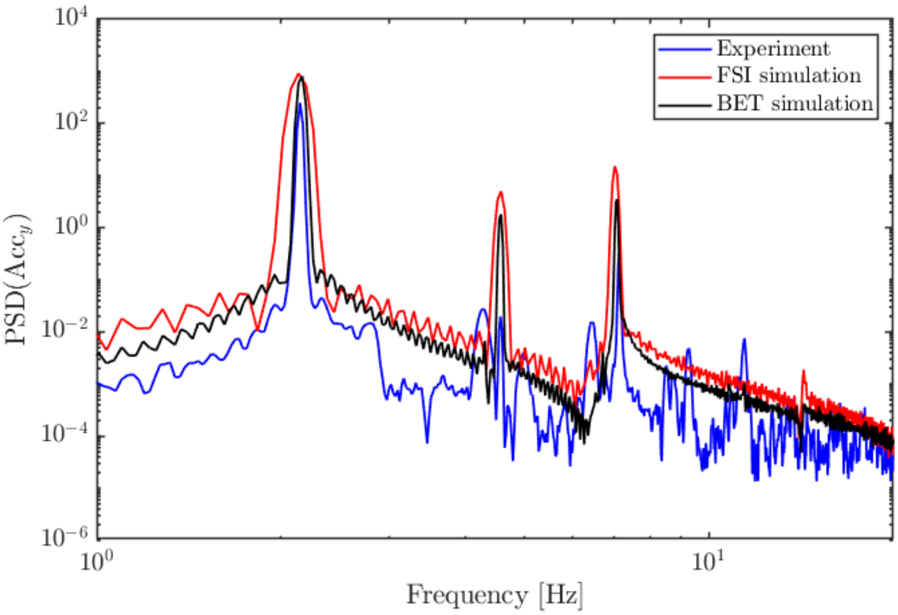


Tip Displacement [m]
Time [sec]
δ=0%
δ=1%
δ=2%
δ=3%
δ=1%, C_D=0.0

Fig. 1.



Experiment
FSI simulation
BET simulation
PSD(Acc$_y$)
Frequency [Hz]

Fig. 2.