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UNCERTAINTY QUANTIFICATION IN THE COMPUTATIONAL DESIGN AND ANALYSIS OF OFFSHORE WIND FARMS

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ABSTRACT

Offshore wind-energy farms play an important role in the transition to renewable energy. They benefit from stronger and more reliable wind than on land. However, costs of offshore wind farms and risks perceived by investors are still relatively high. Uncertainty in loading conditions, e.g., uncertainty in wind and wave conditions during the turbine life, is the reason for these high costs and perceived risks. In today's design practice, safety factors are used to compensate for these uncertainties. The cumulative impact of these safety factors leads to high construction costs though. Moreover, uncertainties in external conditions and turbine loads may also severely affect costs of maintenance and operations.

The research to be presented in this mini-symposium concerns computational models and methods for predicting uncertainty in: *(i)* wind, wave and soil loads, and *(ii)* failure mechanisms and dynamic soil-structure interaction.

The specific challenges of the research to be presented in this mini-symposium are:

- *with respect to fluid dynamics: (i)* to develop uncertainty-propagation models for loads generated by wind and waves, including their correlation, *(ii)* to extend two-week weather ensembles to four-week ensembles, *(iii)* to develop realistic probability models for wind and wave conditions from existing climatological data, on spatial scales relevant for offshore wind farms,
- *with respect to structural mechanics: (i)* to develop models for computing stress distributions in offshore wind-turbine structures, from the external loads on these structures, *(ii)* to develop advanced computational methods for crack initiation and propagation, including the effects of fatigue, and welding and installation loads,

- *with respect to fluid-structure interaction: (i)* to develop computational methods for scour and seabed variations to enable the prediction of foundation stability, and ultimately *(ii)* to bring all computational approaches applied in offshore wind-farm engineering to the same high level as computational fluid dynamics for wind-farm aerodynamics [1].

The mini-symposium will bring experts working in a large ongoing research program on uncertainty reduction for offshore wind systems together with other experts.

REFERENCES

[1] B. Sanderse, S.P. van der Pijl and B. Koren, "Review of computational fluid dynamics for wind turbine wake aerodynamics", *Wind Energy*, Vol. **14**, pp. 799–819 (2011).