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Abstract: Regarding offshore wind energy converter (OWEC) structures, it is well known that in many cases, wind turbines for electricity production have been increasing drastically these past years both in production capability and in size. With the goal to further develop the share of renewable energies of Denmark’s electricity supply, offshore wind turbines are now being produced with an electricity production of 3 to 5 MW. In Denmark, there are political strategies to enlarge the Danish offshore wind energy sector by up to 3,000 MW within the following years. An enlargement of this size will cost approximately 1,000,000,000 EUR relating only to the wind turbine support structures.

Offshore wind turbines structures are traditionally founded on gravity concrete foundations or on mono-piles. The expenses related to foundations constitute about 1/3 of the total budget for an offshore wind farm and a great part of this relatively high cost is due to the current design practice. When wind turbines are to be installed offshore, geotechnical field measurements are carried out at the location of each turbine, usually as cone penetration tests (CPT) and/or borehole tests. Based on the measured soil properties, the characteristic strength and deformation parameters are determined, typically as 5th percentile values. The application of partial safety factors then provides the design values, and a deterministic design of each foundation is performed, modelling the soil as a locally homogeneous material within each detected soil layer. Large statistical uncertainties are related to this methodology and the overall reliability of the foundations is unknown. Firstly, the design of each individual foundation is based on scarce data – even if several tests are carried out for a wind park. Secondly, soil is a heterogeneous material, even within a single layer. Hence, the utilisation of a locally homogeneous model of the soil in each layer leads to an erroneous prediction of the bearing capacity and the settlements, qualitatively as well as quantitatively. In order to reduce the statistical and model uncertainties related to the design of wind turbine foundations, stochastic fields must be utilised to model the spatial distribution of the soil parameters. So, the purpose of the current research is using the computational model to plan further tests, and the results from new field investigations, to improve the model to reduce the overall costs as well as the uncertainty.

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