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Interactive comment on "Reliability analysis of offshore wind turbine foundations under lateral cyclic loading" *by* Gianluca Zorzi et al.

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GENERAL COMMENTS

This paper concerns an important issue in the design of support structures for offshore wind turbines, namely the estimation of the permanent tilt suffered by monopile foundations under long-lasting cyclic loading. Specifically, the Authors propose a probabilistic framework to obtain a reliability index (or probability of failure) associated to a specific monopile design - when driven by SLS requirements. This work appears sufficiently relevant and cross-disciplinary, the combination of reliability analysis and (simplified) geotechnical analysis of monopile cyclic tilt takes a step forward with respect to the current (and mostly deterministic) state of practice. I would, however, recommend revision

at several levels. The paper seems to be mainly written for a geotechnical readership, something probably not in the spirit of the WES journal. Given the many sources of existing knowledge contributing to the proposed analysis framework, it would be useful (and certainly fair) to acknowledge more extensively previous research.

SPECIFIC COMMENTS

- very geotechnical terminology is widely used throughout the text – concepts like "undrained conditions", "CPT", "relative density" are not necessarily in the background of many WES readers. Two possible solutions: (1) rephrasing and explaining "geo-jargon" (terms like porosity, constant-volume conditions, etc. will make more "common-sense" than those currently adopted); (2) creating an appendix in which important geotechnical concepts are briefly explained;

- in the introduction, the design of offshore foundations is described as dominated by ULS and/or SLS requirements. The important role played by fatigue limit states (FLS) should be clearly acknowledged and integrated in the global picture;

- the final reference list is very limited. While the main contribution of the Authors lies in the proposed probabilistic framework, existing geotechnical knowledge is instrumentally used. More references to existing literature should be introduced in relation to (i) lateral response of offshore monopiles under cyclic loading, (ii) probabilistic analysis in foundation engineering, (iii) representation of cyclic soil behaviour through the notion of "cyclic contour diagrams", (iv) theory underlying the derivation of the "response surface".

- the "soil cluster degradation" (SCD) method adopted by the Authors to predict cyclic monopile tilt sounds related to the work of Achmus and co-workers in Hannover. Please acknowledge any connections to such thread of research, if any;

- it is appreciated that the paper focuses on the development and use of the probabilistic framework. There seems to be, however, little concern about the validation of

its single “building stones”. In particular, the abovementioned SCD method relies on a number of simplifying assumptions, some of which would be found quite “crude” after closer inspection. It would be good to remark the generality of the proposed framework, and suggest the inclusion of more accurate geotechnical analysis as new/better methods become available in the near future;

- in section 3.1 monopile design is “based on the Winkler-type approach”, with p-y curves used exclusively. However, the PISA project has clearly put in evidence that more components of soil reactions are needed to properly analyse the performance of stubby monopiles (i.e., with low L/D ratio). Limitations in this respect should also be openly mentioned;

- preliminary 3D FE simulations seem to have been performed by using PLAXIS’ Hardening Soil model. Later in the text reference to the simpler Mohr-Coulomb model is made. Please explain this seeming mismatch;

- it could be helpful to complement Fig. 6 with an explicit representation of the Young’s modulus probability distribution at one or more selected depths.

TECHNICAL CORRECTIONS

I am not suggesting specific text amendments, but I feel that letting a native English speaker review the final manuscript would be beneficial.

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