University of Liverpool - Division of Civil Engineering

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DESIGN OF MONOPILES FOR CYCLIC LOADING

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ABSTRACT

Offshore wind turbines are placed in loading environments with actions from wind and waves transferred through the monopile to the soil as cyclic loading. It is well established that cyclic loading of soil may lead to pore pressure accumulation and loss of effective stress and strength. The effect of cyclic loading therefore needs to be addressed when designing monopiles. This presentation will present a methodology to design monopiles for cyclic loading using a simplified approach. The methodology can be used together with simple spring models or more advanced finite element models. The methodology can for example be used used to calculate: the permanent rotation of the monopile at the end of the lifetime (Serviceability Limit State – SLS), the capacity under maximum loads (Ultimate Limit State – ULS), or the pile response during operation (Fatigue Limit State – FLS). The presented methodology is based on the work performed by Knut Andersen over the past years at NGI, and is here adapted for monopile design. The presentation will conclude on how to apply this general framework to monopile design for an entire wind farm. For this to be cost efficient, scalability and normalisation are key aspects that are essential when transferring results from a limited set of element tests to cover an entire wind farm area.

SPEAKER BIO

Rasmus Tofte Klinkvort received his PhD on centrifuge modelling of monopiles from the Technical University of Denmark in 2012. He joined NGI in Oslo just after in the section of offshore geotechnics. After 3 years in Oslo, he relocated to Paris and is now working as a consultant for NGI from there. His main focus is offshore foundation design and he has worked on projects with challenging soil conditions covering topics such as installation design, design for cyclic loading and also re-assessment of capacity based on aging of the soil. He has lead, reported and published several advanced centrifuge test studies on monopile and suction caisson foundation solutions for offshore wind turbines in both sand and clay.

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