Project proposal for RVO 'Regeling Hernieuwbare Energie':

Gentle Driving of Piles

Public summary

Gentle Driving of Piles

This project “Gentle Driving of Piles” is part of the GROW programme on offshore wind energy. The GROW programme aims to reduce levelised costs of offshore wind electricity, to create added value for the Dutch economy and to strengthen the Dutch offshore wind industry. In the GROW programme 16 partners cooperate (June 2017). This project (Gentle Driving of Piles) will be executed in the Netherlands.

This project aims to reduce the costs of offshore wind energy production. The scope of this project will cover innovations in installation methods of monopile foundation. A novel technique for gentle driving of piles is proposed and jointly optimized in terms of the drivability, noise reduction and resulting soil bearing capacity.

1. Public summary

1.1. Introduction

Monopiles are the most commonly used foundations of the Offshore Wind Turbines (OWT). The size of the monopiles grows rapidly together with the size of the offshore wind turbines. A six-megawatt OWT, for example, needs a monopile of about 80 meters long and 8 meters in diameter which can weigh up to 1300 tonnes. These huge steel piles need to be driven into the ground for a significant part of their length. Organisation and execution of this process is challenging, time consuming and costly. Dutch contractors are world-leading in the installation of OWT foundations and it is in their best interest to make the pile installation process as efficient as possible.

1.2. Problem statement and objectives

This project aims to help the contractors achieve the goal of making the pile installation process as efficient as possible by means of testing a novel pile installation method based on simultaneous application of low-frequency and high-frequency vibrators exciting two different modes of motion of the monopiles. We call the proposed method “Gentle Driving of Piles” (GDP) for its envisaged capability to reduce the driving loads and the emitted installation noise which is harmful for the environment. These goals will be achieved without compromising the pile penetration speed and the soil bearing capacity, which is essential for a stable OWT operation. During this project, new models will be developed and validated with experimental data collected from a measurement campaign while novel pile installation methods will be tested.

1.3. Involved partners and their contributions

This research will be executed by the following partners in close cooperation:

- Research institutes: Delft university of technology, TNO, Deltares and ECN;
- Marine contractors: Van Oord offshore wind projects, Boskalis, IHC, Seaway Heavy lifting;
- Project developers Eneco and Shell;
- Monopile manufacturer: SIF;
- Wind turbine developer: DOT.

Each partner above will contribute with its own expertise to this project. TU Delft is in charge of the overall project management and together with the other knowledge institutes provide the scientific background to the project. The industry partners and contractors will provide practical experience and will share data collected by previously conducted measurement campaigns. They will be also actively involved in the design and execution of the experiments and provide input on the desired outcome of the project. In particular the contribution of each partner is given at the table below.

	Partners	**Role in the project**
0	GROW Office	• Project Secretary • Coordinating and supporting project reporting • Supporting GROW internal project cooperation and GROW internal and external communication • Coordination external project results dissemination • Project quality control

1	TU Delft	• Technical Coordinator of the project • Design and execute the experiments • Develop numerical models • Validate the models with data measurements
2	Boskalis	• Provide data of previous pile driving projects • Give feedback on results and their future implementation
3	Deltares	• Develop numerical methods for the installation process and lateral loading of a foundation pile using the Material Point Method (MPM) • Support the field validation tests (either offshore or onshore)
4	DOT	• Provide support staff for the execution of the experiments and the know-how on coupling turbine modelling and foundation design
5	Eneco	• Share experience and knowledge about certification, insurance and interfacing with other stakeholders • Support offshore testing locations (for a full-scale test)
6	Sif	• Manufacture and deliver the piles needed for the tests
7	TNO	• Work in collaboration with TUD on noise modelling and monitoring • Coupling source and propagation models to generate realistic examples of underwater noise around an offshore turbine • Share knowledge on soil material properties on the noise propagation
8	ECN	• Provide assistance in the execution of the experiments with technical staff • Share knowledge on sensors and data acquisition methods
9	Shell	• Provide their expertise on pile driving
10	IHC	• Provide input & data of piling equipment • Share knowledge of pile driving equipment • Involvement in the development of the torsional shaker • High involvement of the development of the numerical model on drivability
11	SHL	• Provide drivability data from previous projects • Share knowledge on installation requirements
12	Van Oord	• Share knowledge on installation of monopiles • Provide knowledge and data on soil conditions for the tests

1.4. Desired results

The main result of this project is the development of a novel pile installation technique based on simultaneous application of vibrators acting in vertical and torsional directions. The desired outcomes are envisaged as follows:

- Provide a solid “proof of concept” of the proposed installation method with the aim to show that the pile penetration speed and the soil bearing capacity stay uncompromised in order to issue a proposal for a full-scale verification of the installation method soon after the start of the project;
- Develop models to predict the effects of installation using GDP including noise emission.

1.5. Approach

The project will be executed in two parallel phases: one experimental and one theoretical. The experimental part will provide a first proof of concept that the proposed method of “Gentle Driving of Piles” is advantageous compared to other existing methods, while it does not compromise soil bearing capacity and pile penetration speed. The theoretical part aims to explain the physics governing the novel pile installation technique and optimise the procedure while at the same time it can show that noise generated with GDP is considerably reduced compared to conventional installation methods. In

order to enable a speedy, practical implementation of the results, the proposed method will first be validated experimentally such that in a relatively short period after the start of the project, a proposal can be issued for a full scale verification of the installation method. In parallel, numerical tools will be developed, which will allow an optimization of the installation procedure for new offshore wind farms.

1.6. Application of the results

Results of this project will be commercially applied by the GROW consortium at large and, especially, by the companies forming the team of this project, namely van Oord, Eneco, IHC, Shell, Boskalis and Seaway Heavy Lifting. These companies will either implement the developed technology or have direct interest in it. The developed technology may be applied to substantial part of the future monopile installations and will contribute to the reduction of cost and risks related to pile driving. This will strengthen the whole consortium for future projects.

1.7. Contribution to the GROW targets

The results of this project help to expand the role of the offshore wind in the energy system by reducing costs and removing barriers while strengthening the Dutch offshore wind sector by providing innovative technology to more competitively engage the construction of offshore wind farms.