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The Dynamics and Vibroacoustics of the Support Structures for Offshore Wind Turbines

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This presentation is focused on the monopole that is the most widely used support structure for offshore wind turbines. The monopole is “just” a cylindrical shell and it may seem surprising to devote a plenary lecture to such a simple structural element. However, nowadays, the monopoles are about 80 meters long and 8 meters in diameter. Nearly two thirds of the length of the monopole should be driven into the soil by huge hammers and after the installation the monopoles should withstand tremendous bending stresses for many years. There are quite a few challenging aspects of the dynamics and vibroacoustics of the monopole that are associated with its installation and operation and this presentation will focus on those. Another justification for the choice of the topic is that the Netherlands aims, by 2050, to cover 50% of the electricity needs of the country by means of offshore wind turbines.

Four particular topics will be addressed in the presentation. I will begin with a consideration of the underwater noise generated during installation of monopoles by means of impact hammers. The role of the monopole-water-soil interaction in the noise generation and propagation will be focused upon.

The second subject matter will be related to the dynamic interaction of the monopole with the soil upon installation. A recent full-scale experimental investigation will be discussed and the effective dynamic stiffness of the soil in interaction with the monopole will be deduced.

The third focal point will be a so-called slip-joint connection, which is currently being prepared for a full-scale test offshore. The slip-joint connection can be used to connect the top part of the wind turbine with a monopole. It is a very simple bolt-free connection, which makes it very attractive for engineering. It is the vibro-installation of this connection and assessment of its quality that will be focused upon in this presentation.

Finally, the ice-induced vibrations of wind turbines that can occur due to interaction of level ice with a monopole will be discussed. This is a very interesting synchronization phenomenon, which is potentially important for offshore wind turbines to be installed in the Baltic Sea.

It has to be noted that this presentation is based on the studies performed by my former PhD students Dr. Apostolos Tsouvalas, Dr. Pim Versteijlen, Dr. Maxim Segeren and Dr. Hayo Hendrikse.