AALBORG UNIVERSITY

Name: Mehdi Bayat

PhD Thesis: Evaluation of dynamics and damping effects in soil induced by the motion of an offshore foundation.
Aalborg : Department of Civil Engineering : Aalborg University, Unpublished.

Abstract: The offshore wind energy industry is turning out ever larger numbers of offshore wind turbines every year. Although significant progress has been made in making offshore wind energy more cost-effective, further cost reductions must be achieved to compete on equal terms with other sources of energy, such as gas and coal-powered energy and land-based wind energy. One way to achieve this is to have better design and understand the dynamic response of offshore structures. Hence, understanding dynamic behaviour of soil is becoming increasingly important, and soil should be modelled more precisely for that purpose. Generally, soil can be considered to be a porous medium consisting of solid phase (soil skeleton) and fluid phase (water and gas). When pore is fully occupied by water, soil is saturated. Determination of the dynamic response of fluid saturated porous media is an important problem in many practical engineering applications. Foundation piles have a significant influence on the response of fixed offshore structures. The pile–soil interaction is a complicated dynamic contact problem. Pile foundations of wind turbines are often exposed to dynamic loads such as waves, earthquakes and wind. In most cases, piles are liable to undergo some translation and rotation due to these applied loads, and the study of the pile subjected to transient load is important in the context of dynamic foundation design specially by presenting effective damping. To avert damage of offshore foundation and better design, it is necessary to identify and quantify the soil-structure interaction and damping effect. For the offshore wind turbine, the tower is longer, with wave loading at the lower end. Dynamic loading and fatigue are much greater problems than on land. Wave-induced oscillations give unwanted accelerations on the entire of the structure. For a deep water foundation installation, the major part of the structure is under water, and the water provides not only support to the structure, but also considerable damping for the wave-induced vibrations. It is important to understand how the soil interacts regarding damping. Fatigue problems are important issues for offshore wind turbines in comparison with inshore wind turbines, due to unsteady forces from earthquakes and different directions of water and wind waves. Besides the aerodynamic damping in wind turbine structure, the effective damping from saturate soil has a key role to present the dynamic responses. Saturated soil can be idealised as two-phase media comprising deformable soil skeleton and pore fluid. The dynamic response of the saturated soil is especially important to understand the deformations and the pore water pressures generated by earthquakes. The phenomenon of liquefaction is one of the most important subjects here. Soil nonlinearity and damping model have the prominent role in the analysis of strong ground motion due to earthquakes. The basic phenomenon of grout propagation is described as a continuous fluid-displacement in deformable saturated porous media. The solution of mathematical formulation results in a highly coupled and non-linear system requiring specific numerical techniques. Unfortunately, our understanding of groundwater behaviour is not sufficient to answer all of the questions related to soil-interaction phenomenon. So, the purpose of the current research is to present the appropriate model to describe damping effect by applying analytical and numerical methods to get suitable dynamic response to have better design in order to reduce the overall costs.

Supervisors: Associate Professor Lars Vabbersgaard Andersen
Professor Lars Bo Ibsen

Employed: 01-01-12 → 31-12-15