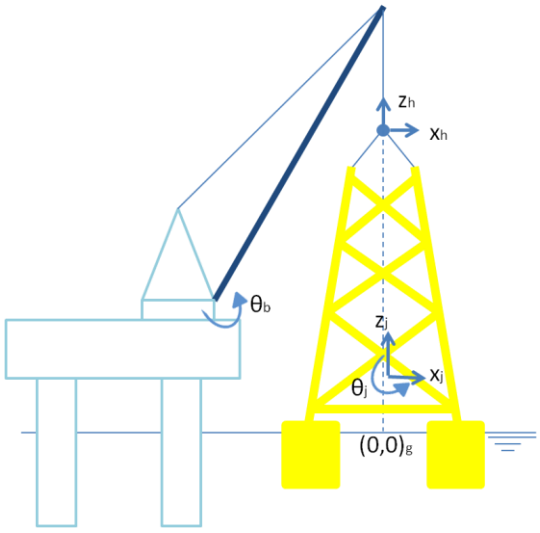
Offshore & Dredging Engineering

Technische Universiteit Delft

Environmental limitations in suction basked jacket foundation installation, using vertical lift off

In order to stay ahead on trends in the growing market of offshore wind, Siemens Wind Power has been working on its own four legged suction bucket based jacket foundation. The number of such foundations that are to be installed per wind park force installation works to take place over a long period of time, making it hard to plan around harsh weather conditions.

In order to find out whether installation works of this specific jacket design could take place in the same conditions as other offshore installation procedures, a 2D time domain MATLAB model has been created, containing the most important features of a heavy lifting jack-up crane vessel and its appropriate rigging elements. The model is used to calculate the forces in the crane cable, as a result of the jacket's behaviour through its interaction with the water.



The environmental forces that act upon the jacket during the installation are based on a 40 meter deep ocean with an irregular wave field, modelled with the JONSWAP spectrum. The most important forces and influences caused by these waves have been incorporated in the model. For this specific jacket design some particular phenomena occur when the large suction buckets are lowered through the splash zone: an air cushion is created within the buckets and a vertical slamming arises when the water collides with the inner top. The latter initiates a jump in the jacket's vertical velocity, resulting in oscillation in the crane.

With the resulting model, simulations are performed for a predefined set of wave combinations. The randomness of the irregular waves is taken into account by performing multiple simulations per wave combination, each using different initial conditions. A large number of such simulations (2000) was required to find out that the maximum dynamic amplification factor (DAF) values of the crane load cable has a Weibull distribution. In order to reduce computational time however, it is chosen to run only 50 simulations per wave condition of interest. Even though no statistically profound conclusions can be drawn from the results acquired, an insight is gained into which wave combinations should be handled with extra care. Those with a zero crossing period of 4 to 5 seconds showed resonant behaviour with the waves, causing un-acceptable slack and load cable DAF values to exceed the maximum allowable value of 1.3. For significant wave heights of 2 meters, wave periods longer than 8 seconds showed tolerable DAF values.

For the wave conditions that showed intolerable DAF values the jacket behaviour is studied more extensively, in order to find out what the individual force contributions are herein. Synchronization of the jacket's vertical oscillation with the waves showed to be an important initiator of high load cable forces. Since the initial oscillation is caused by slamming and its eigen-period is affected by the heave added mass, these two phenomena are very important. Profit in prevention of large cable forces can thus primarily be gained from reduction of both factors, e.g. by adjusting the rigging arrangement or the suction bucket design.

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