

TECHNOLOGY

Current developments in offshore wind energy have focused the attention on jack-up crane vessels for installation and maintenance purposes. Vuyk Engineering Rotterdam has the required engineering technology available in-house and is currently working on a couple of new concepts. We also recently developed an integrated tool for a site assessment for the jack-up OCTOPUS of Herbosch-Kiere. Taking a certain water depth as a starting point, this tool allows Herbosch-Kiere to check whether the OCTOPUS can work safely in the environmental conditions present.

Air gap

The air gap -the space between the water surface and the bottom of the barge- is meant to accommodate the highest expected wave, still leaving some clearance between the top of the wave and the keel. The Octopus-tool automatically determines the minimum required air gap based on the wave height entered. In combination with the given leg length and water depth, the user is given a direct answer regarding the feasibility.

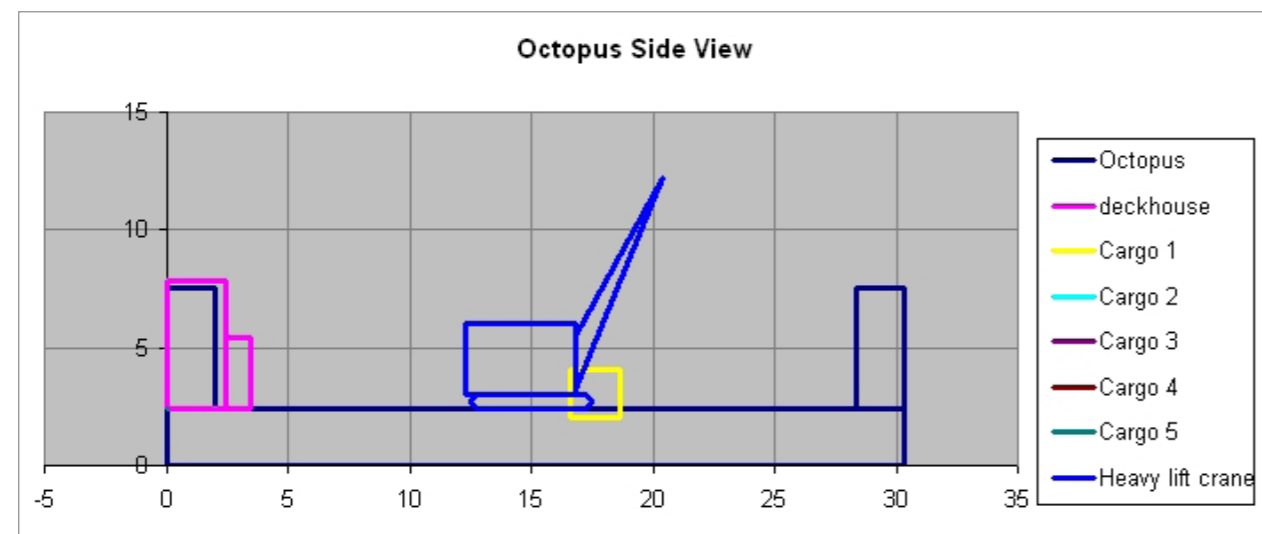
Overturning

During operations, the jack-up system is exposed to laterally acting wind, wave and current loads, as well as the self-weight loads. The self-weight loads may include a crane moment. The combined effect of these loads leads to an overturning moment, and thereby to an unequal distribution of the vertical leg reaction forces. The Octopus-tool lets the user model the wind area and the weight of items which are not included in the light ship weight. This input can be visually checked.

The current and wave loads depend on the water depth. The environmental factors (wind speed, wave height, wave period, wave spectrum, current speed and current profile) can be entered as well. The jack-up is then checked against the overturning moment for sufficient safety.

Leg structural response

The loads calculated for the OCTOPUS legs are automatically taken into account in an integrated buckling check. The user is warned if the pre-set stress limits will be exceeded. In this case, the environmental loads will have to be decreased in order to come to a feasible solution for the given water depth.



The purpose of this tool is to come to a fast method for a site assessment based on an existing design. The integrated tool discussed above is therefore based on simplified methods using an existing design, for which certain structural capacities are known.

Design approach

In the case of a new design, a more sophisticated approach is required to generate the input for the fast site assessment tool. We will then use a Finite Element Model (FEM) to validate the structural design of the complete jack-up vessel, hull, jacking system and legs. In this way, it will, for example, be possible to take into consideration the clearances between the leg and the jacking system, or the load redistribution between the legs. The latter is influenced by the stiffness of the hull and can be effectively modelled in a Finite Element Model.

Dynamic effects

Due to the flexibility of the jack-up system, the natural frequencies may very well be near the dominant wave frequency. If this is the case, a Dynamic Amplification Factor (DAF) has to be determined using frequency domain dynamic structural analyses. In case the structural response turns out to be critical, it may even be necessary to combine all geometrical non-linear and dynamic effects in a time domain analysis.

For the loads on the hull, the 3D-diffraction software AQWA is used, which generates input for the FEM model. In case of a feeder barge for turbine installation or, for example, a backhoe dredger with a barge alongside, one may need to consider the effects of barges moored alongside the jack-up. We will use the 3D-diffraction software AQWA to determine the loads caused by the combination of environmental factors and the moored barge. However, another whole article could be written on this subject. Watch for it in the following issues of the Vuyk Today, or on the Vuyk Engineering Rotterdam website.

