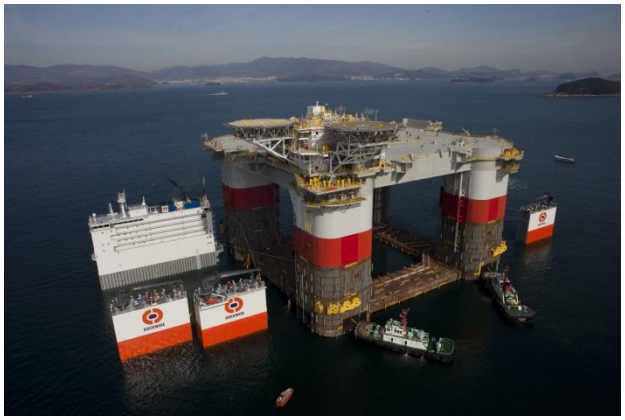
TU Delft

Offshore & Dredging Engineering

Technische Universiteit Delft

Development of relative horizontal motion reduction systems

In the recent years, the demand for energy resources kept rising worldwide and it is expected that it keeps rising. This caused a shift from the traditional exploration areas to more remote areas. The large offshore structures (FPSOs, Semi-subs) used at these locations need to be transported from the fabrication yard to the exploration area. The transportation of these structures (cargo) is done by self-propelled semi-submersible heavy transport vessels (HTVs).



At this moment the locations of the loading and discharge operations are limited to areas with benign environmental conditions i.e. sheltered locations. This provides a severe limitation for projects which are located far away from a shore. Therefore Dockwise is investigating the possibility to perform the loading and discharge operations offshore in harsh environments, close to the intended production site of the cargo. However there are challenges which need to be solved before this is possible. One of the main challenges involves the amplitude of the relative motions which occur when the HTV and the cargo are floating on top of each other, with only a small gap of water in between them. The amplitude of these motions should be reduced in order to ensure a safe and reliable operation.

The aim of this thesis is to develop a system which is capable of reducing the relative horizontal motions of the cargo with respect to the HTV. A multibody hydrodynamic model is used to gain insight in the behaviour of the HTV-cargo system when the standard cargo handling system is used. The standard cargo handling system is the system which is presently used to control the motions of the cargo. The performed simulations showed that this system is not capable of controlling the amplitude of the motions sufficiently, during an offshore loading and discharge operation. Therefore a relative horizontal motion reduction system needs to be developed. For this purpose a range of concepts is generated. Two concepts are selected of which a preliminary design is obtained; a *Clamping system* and a *Line tension actuator*. The principle of the *Clamping system* is to increase the stiffness of the connection between the HTV and the cargo over time. Due to the increase in stiffness, the amplitude of the relative horizontal motions is reduced. The principle of the *Line tension actuator* is to control the tensions in the lines connecting the HTV and the cargo.

Different MATLAB-Simulink simulations are conducted to investigate the effect of design parameters on the performance of the systems. The simulations show that both systems are able to sufficiently reduce the relative horizontal motions. The presented preliminary design forms a good basis for detailed design, during which also operational aspects need to be covered.

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