TU Delft

Offshore & Dredging Engineering

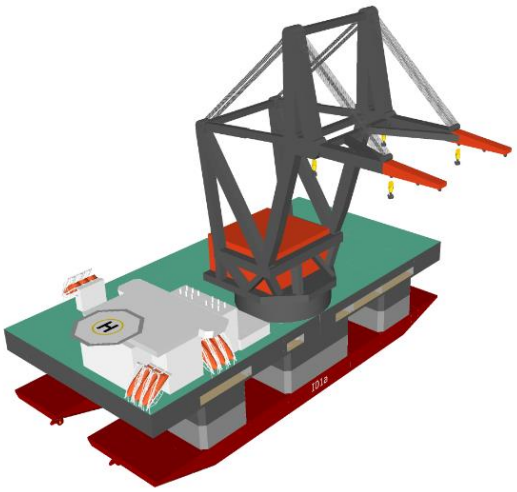
Technische Universiteit Delft

Feasibility study of a tub crane with an unconventional quadruple hook arrangement

In the offshore industry, structures are constantly increasing in weight and size. The installation of these structures demands more lifting capacity and increasing workability. Heerema Marine Contractors (HMC) is exploring the possibilities of meeting these demands with a new crane vessel. A promising concept is an asymmetric semi-submersible with a single crane placed amidships on port side. A new type of crane is introduced with an unconventional rectangular quadruple hook arrangement with the ability to lift and slew 24,000t.

The unconventional crane design raises several questions on the feasibility of the concept and the potential workability. This study addresses three topics: the configuration optimization, the static structural integrity and the dynamics of the crane's daily operations. Additionally a comparison is made between an unconventional and a conventional semi-submersible crane vessel (SSCV). The aim of this thesis is to determine the structural show stoppers of the crane and to potentially increase the vessel's workability.

Based on the initial design of the crane, an optimization of the configuration has been performed. Based on typical transit-, survival- and operational conditions, a set of load cases has been created. The optimization showed an overall reduction of the crane height, a change in the tub connection legs and a lower center of gravity.



The obtained configuration has been subjected to a static analysis using the finite element software Abaqus. Nine typical heavy lift cases including dynamic amplification have been defined and applied on the model to analyze the structural integrity of the crane. The results of the analyses show sufficient structural strength for all loading conditions.

A time domain analysis has been performed in Abaqus to include the dynamic effect on the structural integrity of the crane. After determining the favorable position for the crane during a storm, the crane was submitted to typical survival conditions. Although several brace members exceeded the allowable stress, the survival conditions are not identified as show stoppers. The operational dynamic analysis for a mild sea state introduced unexpected exceedance of the allowable stress levels, indicating large excitations of the lifted object. Further research showed resonance behavior of the lift object. A combination of the short pendulum length of the unconventional hook arrangement and the vessel motion resulted in wave heading and period dependable behavior.

A comparison with a conventional SSCV confirms the reduced workability for certain wave headings and peak periods. A combination of the roll response of the vessel and the low Eigen periods of the system causes these dependencies.

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