TU Delft

Offshore & Dredging Engineering

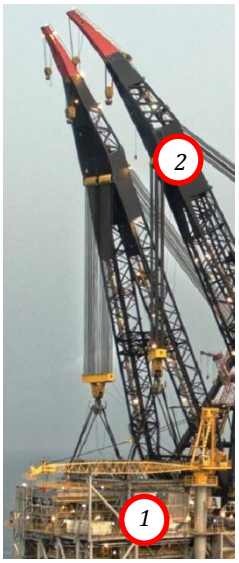
Technische Universiteit Delft

Hook load fluctuations during offshore heavy lifting

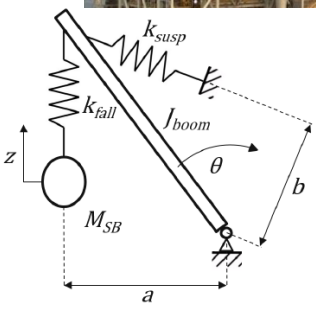
Heerema Marine Contractors (HMC) owns and operates several semi-submersible crane vessels (SSCVs), used for offshore heavy lift operations. In preparation of these operations, hydrodynamics analyses in the frequency domain are conducted using software developed in-house at HMC. These analyses result in Response Amplitude Operators (RAOs), which are used for estimating dynamic response to a certain sea state. Crane hook load fluctuations response modelled in this manner is generally larger than measured, however. Since hook load is often a limiting criterion, an overestimation of hook load fluctuations in the models could undesirably affect perceived operability. Three possible root causes for this discrepancy have been identified:

a. Modelled hydrodynamics are inaccurate
b. Dynamic tension measuring equipment is inaccurate
c. Measured dynamic tension does not represent dynamic hook load

In order to assess root cause (a.), a comparison study has been conducted. Hydrodynamic models have been created for four stages of heavy lift operation: the free-floating, lift-off, free-hanging and set-down stages. Measurements have been obtained for a project which concerned lifting a topsides module from a barge onto a jacket support structure. Measuring equipment included 6DoF motion sensors on the SSCV, module (*1.* in figure) and in one of the SSCV's crane boom tips (*2.* in figure). Generally, modelled motion responses are found to be quite accurate. However, measured hook load fluctuations prove to be smaller than modelled for all stages considered. Hook load fluctuations are governed by relative vertical motions of the module and the SSCV's crane boom tip. Magnitude and phasing of these signals imply over- and underestimations of wire rope elasticity and damping properties respectively. Furthermore, the ratio between measured hook load fluctuations and hook load fluctuations corresponding to measured relative motions is quite different per stage. A stage dependent contribution of root causes (b.) and/or (c.) is therefore expected to add to the overall discrepancy.



In an attempt to obtain accurate crane wire rope elasticity properties from a simplified 2DoF dynamic crane model, natural frequencies during the free-hanging stage are searched for, to serve as input for this model. Unfortunately, response peaks found within a frequency range corresponding to probable stiffnesses of the wire rope sections in the system are not very explicit. They therefore cannot undeniably be attributed to the modes searched for. modelled, Subsequently, lift object vertical motions time traces are input. using imposed (measured) motions of the SSCV's crane tip as trace that Damping values are varied in order to obtain a modelled time best fits measured vertical motions of the lift object.



Although applying lower stiffness and higher damping properties thus obtained in the models results in better correspondence to measured motions and hook load fluctuations, reliable values for these properties cannot be derived from the measured signals used. An assessment of root causes (b.) and (c.), and repetitions of this research for other lifts using more accurate measuring equipment are therefore recommended.

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