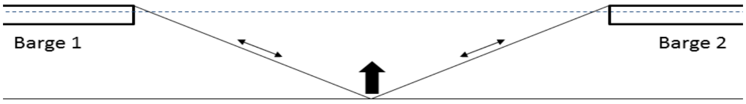
Technische Universiteit Delft

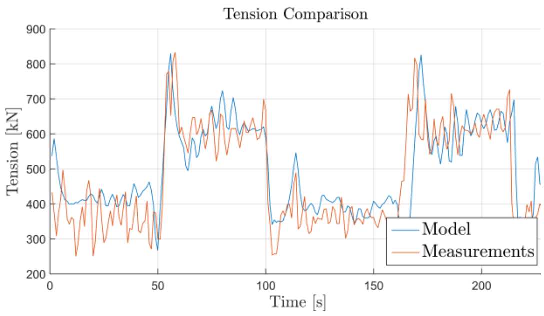
Offshore & Dredging Engineering

Design Assessment Of The Sawing Wire System Used In Salvage Operations

The Smit sawing wire system was used in the salvage operation of the Baltic Ace. The sawing wire was drilled underneath the wreck and connected to two barges on opposite side. Winches were placed on the barges to make a controlled cut through the wreck by pulling the sawing wire back and forth. The cut was made in an upward direction as is shown in the figure. While the sawing wire was pulled in by one winch, the winch on the other side kept a holding tension on the sawing wire to create a normal force in the wreck. This normal force was necessary to make the cut through abrasive wear. To get a better insight into the forces experienced in the sawing wire system, measurements were conducted during the cutting operations. The objective of this research project is to contribute to the assessment of the sawing wire system, by providing a simulation model based on theory and compare this with measurements of the salvage operation of the Baltic Ace. The measurements show a peak tension at the beginning of the sawing cycle that is unexpected. In friction theory, this is called the breakaway force that is needed to get the sawing wire moving. The breakaway force is caused by the difference in static and kinetic friction coefficients between the sawing wire and the wreck.



The simulation model is made in Orcaflex and includes the friction at the contact points, barge movement, and the heave compensators. The friction is included by a Coulomb friction model for the kinetic friction, a tension for the breakaway force and a stick-slip damper for the intermittent motion of the wire. The heave compensator stroke is controlled by a code in python that measures the sawing wire angle and the heave motion of the barges at the fairlead position. The barge motions were included by force-RAO's, calculated in AQWA. The wave environmental forces are simulated using a JONSWAP spectrum with the wave height and period similar to those during the sawing operation. After completion of the model, the results were compared with the measurements. The tension graph of the model has similar peak forces at the beginning of the cycle (50s.) and similar lower force fluctuations in the constant part (60-100 s.). These results together with the comparison in the frequency domain are used to verify the model, hereafter the model is considered correct and ready for use in future sawing calculations.



The design of the sawing wire system is assessed for implementation in future operations. The assessment includes the effect of the heave compensators, the influence of the friction force concerning a larger or smaller diameter wreck and the elimination of the peak tension. Simulations show that the heave compensator has no effect on the peak tension located at the beginning of the sawing cycle. Though some recommendations are given for the case when lower fluctuation of the tension is required. Simulations show an increase of the compensation effect when the declination angle is changed from 20 to 30 degrees, thus placing the barges closer together. Both the bending of the steel cable inside of the surrounding bushes and the required lateral forces limit the increase of the declination angle. Secondly, it is advised to extend the controller of the motion compensation by including the horizontal motions of the barges, resulting in lower tension fluctuations in the sawing wire. Furthermore, calculations of the friction force for a different diameter wreck result in lower forces for a smaller diameter wreck. With lower forces in the system, the required power is also smaller. Alternatively, for a bigger wreck the fiction forces and required power will be higher. Furthermore, theory shows that the peak tension can be eliminated if lower maximum forces in the system are desired. This is done by lowering the holding force at the start of the sawing cycle and raising the tension in the kinematic stage with a PID controller.

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