Offshore & Dredging Engineering

Technische Universiteit Delft

Vibrations in an active controlled hexapod

Safe offshore access for people and cargo is a major challenge in the offshore industry. The Ampelmann system is an active motion compensated system for six degrees of freedom. Creating a platform isolated from the motions of the vessel makes offshore access as easy as crossing the street. All the Ampelmann system can be used for is personnel transfer, while some of the systems can also be used as a cargo crane. The basic system can be divided in two main systems: the hexapod and the transfer deck and gangway. Usually the system is installed on a ship deck. However, in various cases the height of the Ampelmann system is not sufficient to reach the landing point. An often-used solution is to place the system on a pedestal which can be over 15 meters high. The Ampelmann system occasionally starts vibrating unexpectedly, especially while the system is placed on a pedestal. These vibrations are believed to be caused by the eigenfrequencies of the system and/or amplification caused by the motion control algorithm. In this research an investigation in this phenomenon was done.

This investigation was done via an analysis of the eigenfrequencies of the active-controlled hexapod. A finite element method model was created to determine the eigenfrequencies of the system. This model was made using MATLAB and the toolbox StaBIL 2.0, created by the university of Leuven. All the elements of the system are modeled as beams except the hydraulic actuators. The properties of the elements which represent the hydraulic actuators are calculated separately using a modelling study on stiffness characteristics of hydraulic cylinder under multi-factors.

Possible causes for the unexpected vibrations have been investigated via measurements performed on Ampelmann systems. Data which was readily available is analyzed. Based on this data three possible causes have been determined. These are: the influence of the pedestal, residual motions due to limitations of the Ampelmann system and vibrations in the bottom frame due to compensating for gangway motions.

To investigate the influence of the pedestal and the vibrations in the bottom frame two experiments have been performed. The residual motions have been investigated via calculations based on data already available. The amplitude of the response in the results from the experiment performed to investigate the vibrations in the bottom frame due to gangway motions is negligible over the entire test period. The data from the calculations done to investigate the effect of the residual motions show no amplification. The results of the experiment and the calculations lead to the conclusion that these do not cause unwanted behavior.

The experiment to determine the influence of the pedestal shows four peaks in the frequency domain of both the signals. The first is directly caused by vessel motions. The other three have a cause which is not directly related to vessel motions. The data from the sensor on the Ampelmann system, at the top of the pedestal, does not contain a peak which is not also present at the ship deck. From this it can be concluded that the eigenfrequencies of the pedestal do not have a relevant influence. For one of these peaks the amplitude of the graph related to the top of the pedestal is higher than the one corresponding to the ship deck. A possible explanation for this phenomenon could be the eigenfrequencies and corresponding eigenmodes of the ship deck. The pedestal functions as a lever arm amplifying the rotations related to eigenmodes of the ship deck (Figure 1). This may cause the unexpected vibrations.

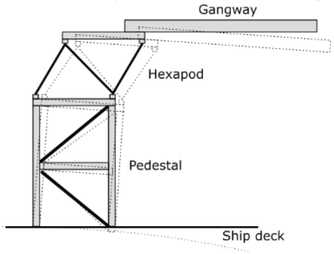

Figure 1: Schematic overview ship deck vibrations

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