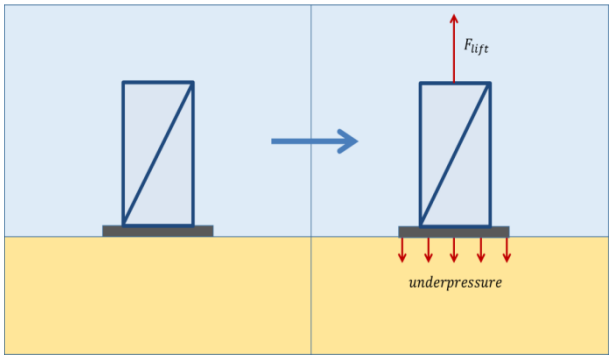
Offshore & Dredging Engineering

Technische Universiteit Delft

Passive Suction under Mud mats



Mud mats are used in the offshore industry to prevent structures from sinking in the soil after installation. If for some reason a structure has to be lifted, on the one side due to an installation error, on the other side due to removal the force needed to lift the structure sometimes exceeds the total submerged weight. This report contains a Literature survey conducted regarding the above subjects. This report also shows the design of a test setup and procedure for lifting a plate from a sand bed. In the end the report follows the modeling of an analytical model which is validated using the test data

The focus of the research lies with finding out what basic parameters dominate this force and what the influence of these parameters are during lifting is sand. Experiments will be conducted to test these parameters. In the end these parameters will be used to develop a simple analytical model to predict the order of the breakout force. The model will then be validated with the experiments. The main research question is:

How are the breakout force (F_{lift}) and breakout time influenced by the permeability of the sand and the lifting force? Can an analytical model, that uses these parameters, predicts the lifting force within a certain margin?

Literature states that no breakout forces are to be expected due to the large permeability of sand but from cutting theories it is known that under pressures exist around the blade tip, especially for the smaller grain sizes. A test setup was built to study the lifting process and measure the pressure under the plate and his displacement for a given load. The tests were performed in two different sands (Silverbond and Geba Weiss) for a range of different loads with two different plates: A 2-Dimensional setup and a 3-Dimensional setup. An analytical model was created to predict the lifting force for a given permeability and upward velocity of the plate. In the end the model was validated with the test data.

The test data showed that for the 2-Dimensional case the pressure profile was of a rectangular shape. A factor 10 in breakout time between the sands can be observed. The 2-Dimensional model gives a good estimation of the lifting load in Silverbond sand when using velocities from the beginning of the lifting process. For the Geba sand, after adjusting the length of the flow paths, the model also gives a good fit.

The experiments with the 3-Dimensional plate showed that the pressure profile under the plate is of a rectangular shape with steep slopes towards the edge of the plate. Nothing can be concluded about a relation between the breakout time and the permeability for the same load between the two different sands due to an inertia dominated process.
The 3-Dimensional model predict the lifting force accurately for the Silverbond sand using the velocities from the beginning of the lifting process. For the Geba sand the permeability had to be scaled to give a good fit. This is because of model assumptions and using flow paths. Adjusting the tune factor did not give satisfactory results.

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