VORTEX INDUCED VIBRATIONS ON AN ”ARTIFICIAL SEABED” FOR SUPPORT OF A FLOATING BRIDGE

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Objective

The main objectives in this Master thesis are:

- Conduct model experiments in the Marine Cybernetics Laboratory to get hydrodynamic data for a pipe bundle consisting of 3 pipes.
- Calculate VIV on an artificial seabed when both attached to and detached from a floating bridge using the hydrodynamic coefficients found from the experiments.

Introduction

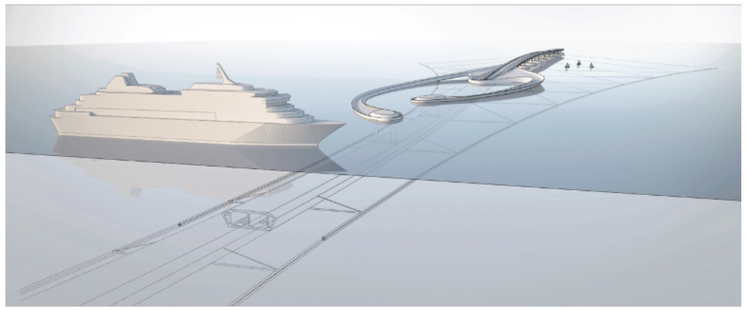

Figure 1: The floating bridge and tunnel connected to the artificial seabed.

The subsea services company Deepocean is on behalf of Reinertsen working on a consept of a floating bridge going across the Sognefjord. The concept is illustrated in the picture above. Since the Sognefjord is very deep (1300m) anchoring the floating bridge will be a problem. Reinertsen has therefore come up with the idea of an ”artificial seabed” to mount the floating bridge to. The picture below shows the design of the artificial seabed.

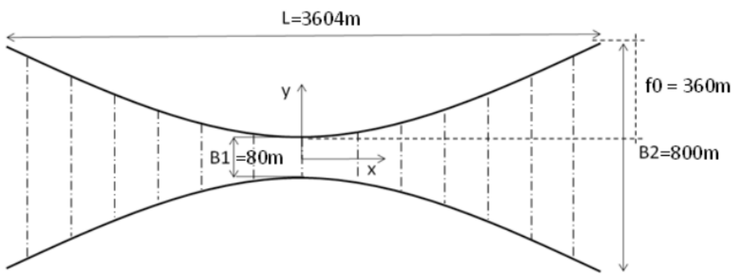

Figure 2: The artificial seabed as seen from above.

The bold black lines in the picture above indicates the two bundles going across the fjord. The bundles are pulled together by 13 cross pipes illustrated as dashed lines in the figure. The bundles each consist of three pipes as shown in the next figure.

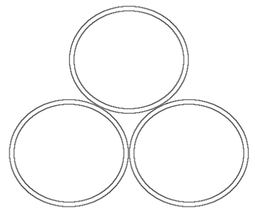

Figure 3: Cross section of one pipe bundle

Methods

- To get the hydrodynamic coefficients for a bundle with three pipes model experiments were done in the Marine cybernetics laboraty (MC-lab). The results from these experiments are excitation, added mass, drag and lift coefficients as well as the Strouhals number.
- To calculate vortex induced vibrations (VIV) on the artifical seabed, the software VIVANA was used together with a model of the artificial seabed build in RIFLEX. The hydrodynamic coefficients from the experiments were inserted into VIVANA. The main result from the VIVANA analysis is the fatigue (damage) of the construction due to VIV.

Experiments

A small model of one bundle in the artificial seabed was made. This model was attached to a carriage system as shown in the figure below.

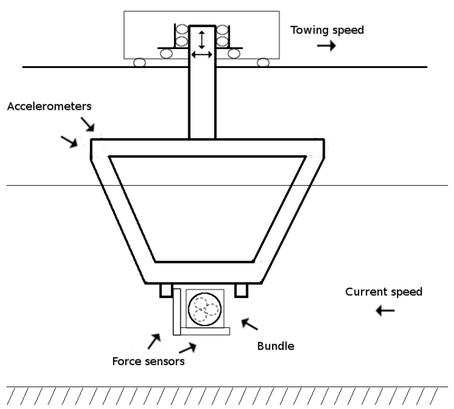

Figure 4: The apparatus and bundle model used for force vibration experiments.

The experiments in the MC-lab were done using forced vibrations with given nondimensional amplitudes and frequencies. The experiments were done using three different orientations of the bundle relative to the current direction. During each forced vibration run, the force and displacement is measured by sensors. From these data the excitation, added mass, drag and lift coefficients can be calculated. The calculations were done in MATLAB. The hydrodynamic coefficients are finally added to contour plots showing all the coefficients as functions of nondimensional amplitudes and frequencies.

Results

The main results from the experiments in the MC-lab are the hydrodynamic coefficients. These are presented as contour plots, with the nondimensional amplitudes and frequencies along the axes. An example of one contour plot from the results is shown in the figure below.

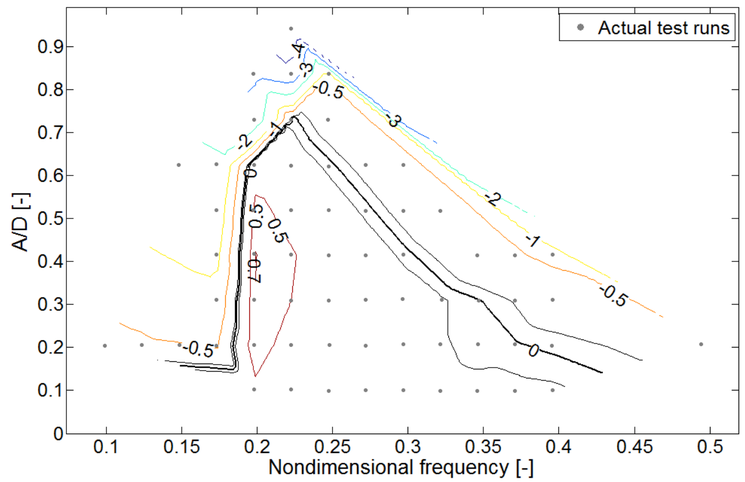

Figure 5: Contour plot of the excitation coefficients found for one specific orientation.

The area with positive excitation coefficients in the figure above is called the excitation zone. That is the combination of nondimensional amplitudes and frequencies that will lead to excitation of the pipe bundle.

The VIV analyses of the artificial seabed in VIVANA is still going on. However early indiciations show that the artificial seabed may experience VIV, but is safe regarding the fatigue (damage) from these effects.

Conclusions

- The methods used in this Master thesis indicate that the artificical seabed may be experiencing vortex induced vibrations (VIV).
- The artificial seabed will probably not be broken due to fatigue (damage) from VIV within its lifetime.

References