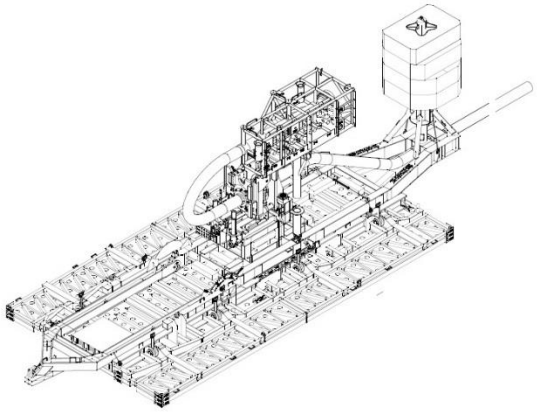
TU Delft

Offshore & Dredging Engineering

Technische Universiteit Delft

Hydrodynamic behavior of in-line structures

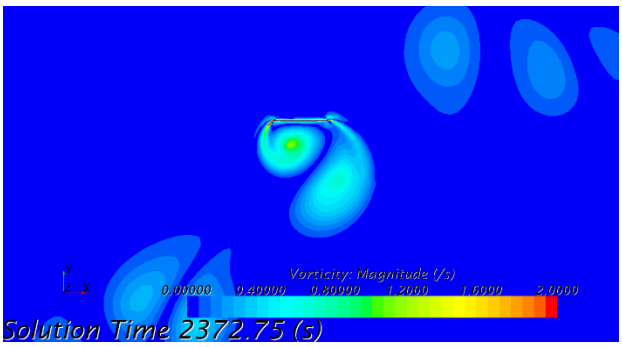
Heerema Marine Contractors (HMC) is, amongst other activities, involved in the installation of subsea pipelines and subsea structures. In order to increase efficiency during production and installation these subsea structures are welded into the pipeline instead of installed separately.



The presence of subsea structures in the pipeline increases the stresses in pipelines during installation.
The stresses in pipelines during installation are analyzed beforehand. These analyses show that with subsea structures becoming bigger, the workability of in-line subsea structure installation becomes unacceptably low.

In order to model the hydrodynamic forces acting on subsea structures simplified models are used. The suspicion is that these simplified models are conservative because of the lack of knowledge on the hydrodynamics around complex shaped structures. A first research on the behavior of in-line structure installation and the effects of alternative hydrodynamic loading models has been performed at HMC. On the basis of this research, questions remain. The most important ones are:

- Is Morison's equation applicable for sharp edged and asymmetric structures?
- Can forced motion experiments be used to model the dynamic behavior of subsea structures?
- Is the motion of sharp edged and asymmetric structures decoupled?



This thesis is performed to investigate the hydrodynamics around subsea structures and answer these questions.. With the use of Dynamic Fluid Body Interaction (DFBI) simulations the dynamic behavior of sharp edged and asymmetric structures and the description of this behavior have been investigated.

Subsea structures are simplified as thin flat plates and simulations in one and two degrees of freedom have been performed. Over a range of frequencies the behavior in regular oscillating flow has been investigated.

From the research it can be concluded that over the range of Keulegan-Carpenter (KC) numbers associated with in-line subsea structure installation Morison's equation can be used to describe forces accurately and these forces are decoupled. Further research should be performed on the hydrodynamic coefficients for subsea structures as the DNV GL prescribed coefficients cause large differences with the simulated behavior where KC dependent coefficients perform better. Hydrodynamic moments are observed which are not taken into account during installation analysis. The impact of these moments on the dynamic behavior of subsea structures should be further investigated.

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