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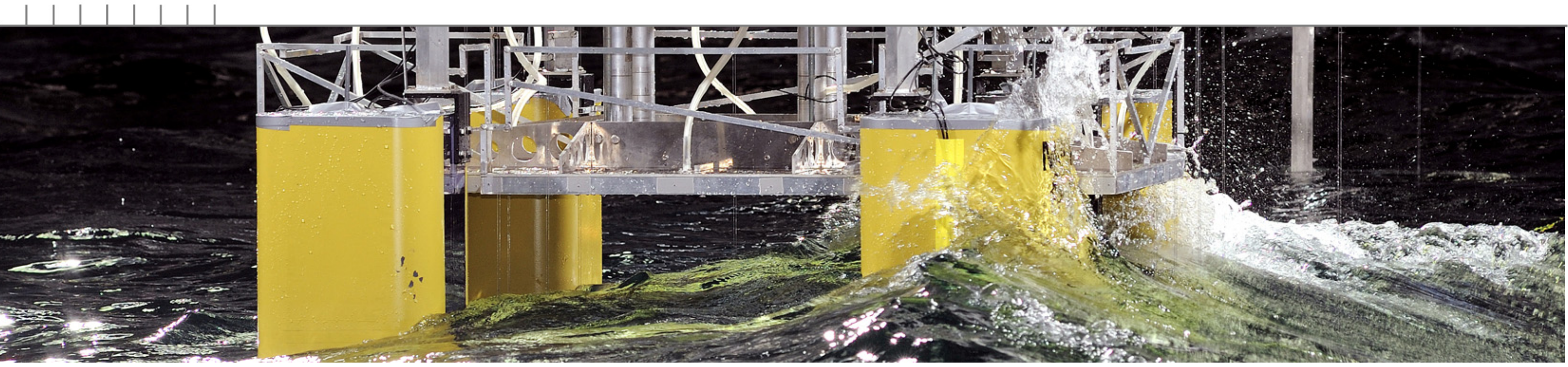


Air gap and impact load prediction

DNV's new guidelines, OTG13 and OTG 14, put forth new recommendations for the estimation of air gap and horizontal wave impact loads. This leaflet describes a combined simulation and model test procedure to address the new DNV guidelines and provide input to the air gap analysis and horizontal wave impact loads.

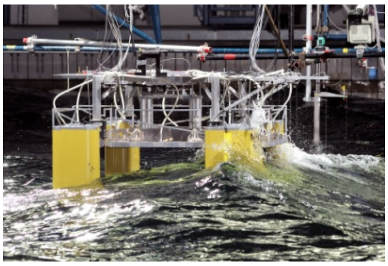
Services:

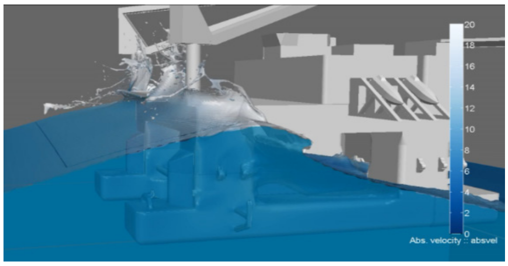
- **Linear diffraction analysis**
  A first assessment of a floaters air gap can be evaluated using linear diffraction analysis combined with DNV (OTG13) correction factors
- **Time domain simulations**
  If air gap exceedance is detected in Phase 1, time domain simulations can be used to combine the coupling between wave frequent and low frequent motions as well as the OTG13 correction factors.
- **Air gap model tests**
  If air gap exceedance is confirmed in Phase 2, model tests can be carried out to determine asymmetry factors and/or verify simulation results.
- **Model tests and/or CFD simulations to determine impact loads**
  If air gap exceedance is detected in Phase 2 and/or Phase 3, impact loads on the platform deck need to be determined according to DNV's OTG14.

Applicable tools

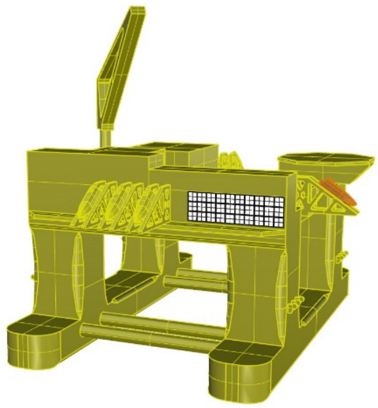
Depending on the project phase air gap analysis can be carried out using frequency domain diffraction tools such as Diffrac, time domain simulations with aNySIM XMF and/or model tests in one of MARIN's high-end facilities.

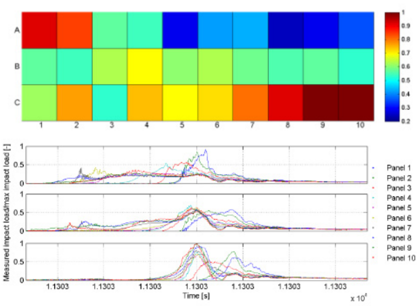
aNySIM XMF can simulate the wave frequent and low frequent motion behaviour of one or multiple (floating) bodies with hydrodynamic interactions. If large non-linear effects are expected air gap analysis can be carried out through model tests. Model test results can also be used to verify simulation results and provide input to simulations and determine applied correction factors (e.g. wave asymmetry factor, alpha).



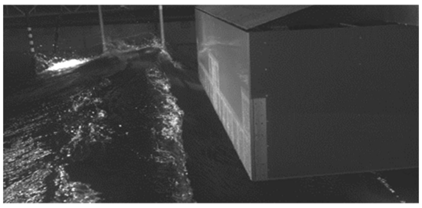


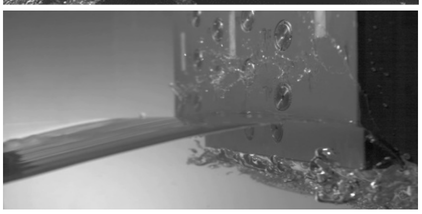
If air gap exceedance is detected additional model tests with a large number of force panels in the front of and underneath the platform deck can be carried out to determine impact loads on the deck box of the floater. The figure below (page 2 on the left) shows results of air gap model tests in the form of a 3X10 array of force panels on the front deck box of a semi-submersible.





Typical impact load measurement time traces of three rows of 10 force panels mounted in front of deck box of a semi-submersible





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In addition to model tests CFD simulations can also be carried out to determine impact loads. In this case, the number of simulations is typically restricted due to computational limits, however more detailed flow information is available, e.g. on the distribution of the impact load on the deck box.

Deliverables

Airgap analysis

Contour plots of the air gap around the structure for simulations results with and without DNV correction factors and identification of most critical sea states.

Impact load measurements

Measured impact loads, distribution of impact loads over deck area covered with force panels, 90% percentile load based on 2 parameter Weibull distribution. In addition to the impact load measurements high speed videos can be recorded of critical events and flow kinematics derived with CFD.

Track record

Commercial air gap model tests with fixed structures and floaters:

Extensive track record obtained over last 20 years.

BreaKin JIP 2016-2018

Increased the understanding of the scale effects involved in wave-in-deck model tests and provided a between link wave kinematics and impact loads.

ShorTCresT JIP 2011-2013

Accounted for short crestedness in the design of offshore structures against extreme waves based on a good description of their spectral characteristics, statistics, kinematics, breaking and loading and to deliver a concreted (empirical) design methodology.

CresT JIP 2008-2010

Developed models for realistic extreme waves and a design methodology for the loading and response of floating platforms.

ComMotion JIP 2015-2018

Developed fast and efficient CFD method for predicting wave loads on moving and deforming structures in extreme waves