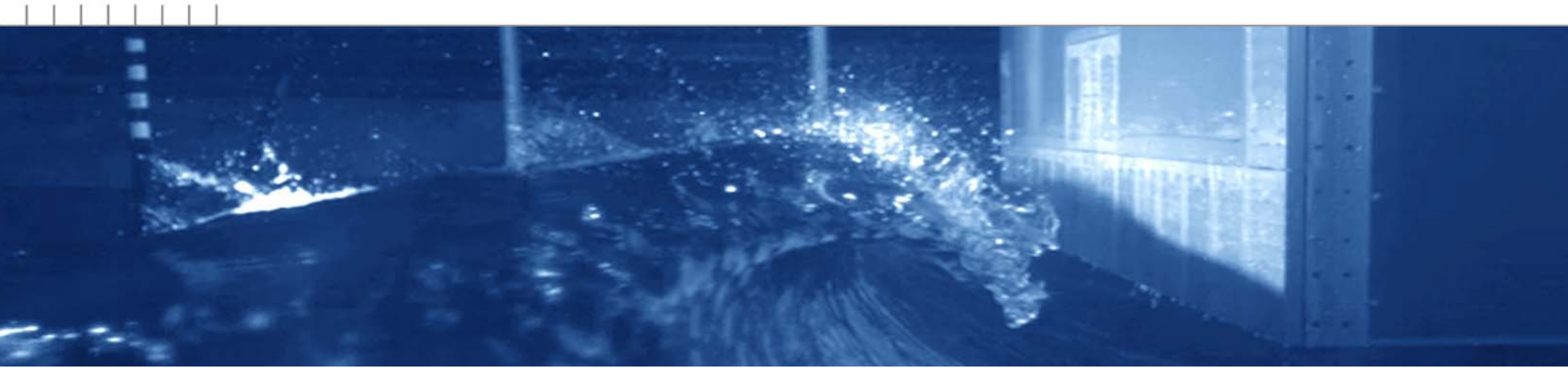
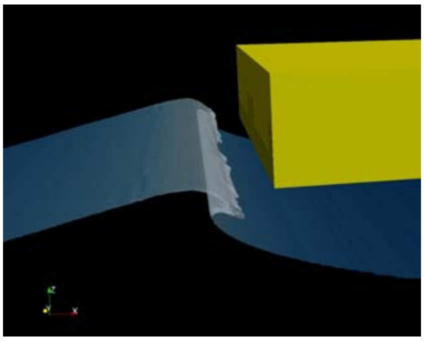


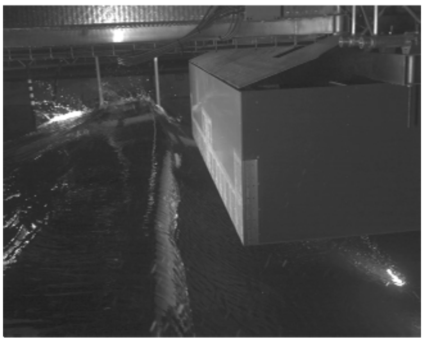
BreaKin CFD JIP

Simulation of BreaKin JIP model tests with CFD (Joint Industry Project)

BreaKin CFD is a new joint research initiative aiming at confirmation, further analysis and understanding of underlying physical processes of the BreaKin JIP model test data through CFD simulations.

Objective
To confirm and complement findings of the BreaKin JIP by comparing CFD simulations with existing model test data.



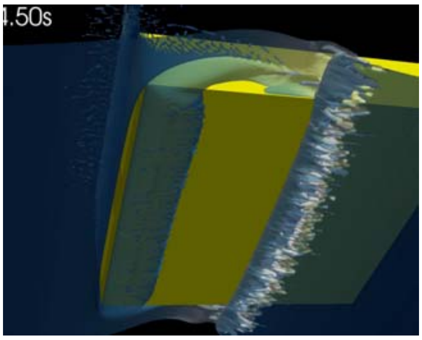


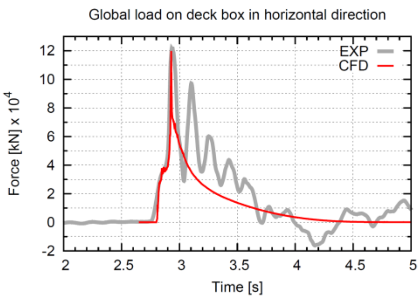
Motivation and background

To quantify loading due to breaking waves, model tests are currently the option of choice. However, during such tests it is suspected that scale effects can lead to an overestimation of the prototype loading. To gain more insight in how conservative impact load measurements at model scale are, the BreaKin Joint Industry Project was started. Wave-in-deck model tests were carried out in MARIN's Depressurised Wave Basin (DWB) at two scales (1:25 and 1:50) in atmospheric and depressurized condition, to quantify scale effects and investigate to which extend entrapped air in the wave and during the impact is of influence. The results of the model tests have shown that:

- The direct impact was the dominant loading process involved in the measured global impact loads for the specific type of tests.
- The shape of the wave just before impact is strongly affected by the ambient pressure (density ratio) and has a large influence on the resulting impact load.
- The negative vertical impact loads appear to be reduced in depressurized condition, and when testing at larger scale (scale 1:25 vs scale 1:50).
- Based on the comparisons between the measured loads at both scales, it appears that the measured loads at scale 1:50 are on the conservative side.
- Air entrapment and building jets on the front of the deck are observed, resulting mainly in variations in local loading.

To further understand the underlying physical processes responsible for the observations made within the BreaKin JIP, CFD simulations are proposed. In CFD, parameters can be systematically varied one-by-one to assess their individual influence, and detailed visualisations can provide in-depth understanding of the flow phenomena. As a starting point, one specific impact test of the BreaKin JIP was recalculated in CFD. A close match with the model tests results was obtained, indicating the potential value of the proposed scope of work (and also helping to quantify the dynamic response in the measurements).





Schedule and duration

Signature of contract:	End '19
Start:	Mid '19
Duration:	1-2 years

Budget and fees

Participation fee:	
BreaKin participants:	25kEuro
non-BreaKin participants:	35kEuro
Total budget:	150kEuro

Way forward

The project will start once a minimum of three participants have agreed to join the project.

Scope of work

To confirm the findings of the BreaKin JIP described above and to get more insights in scale effects involved in local loading and the negative vertical impact force, it is proposed to carry out CFD simulations. Initially the following set of simulations are proposed:

- 1-phase CFD simulations of steepest wave condition (one simulation already carried out during BreaKin JIP).
- 2-phase CFD simulations of steepest wave condition to confirm change of wave shape due to presence of air flow between wave and deck box, at different air-water density ratios and surface tension values (equivalent to scale 1:25, 1:50 and 1:1).
- Sensitivity study of impact due to small variations in incoming wave characteristics (similar variations will be used as found during repeat measurements in wave basin).

Tools: ComFLOW

The proposed scope of work will be carried out with ComFLOW. ComFLOW is a 1-phase / 2-phase CFD free-surface flow solver with sharp interface reconstruction (PLIC VoF). ComFLOW is specifically designed for the simulation of complex free-surface flows in offshore and maritime applications. In previous JIP projects relevant related topics have been studied, implemented and validated, such as:

- sloshing in LNG containment systems,
- air entrapment during wave impacts ("cushioning"),
- wave run-up, green water and deck impacts on ships and offshore structures,
- deterministic reconstruction of steep and breaking waves (by means of iterative wave matching).

Recent 2-phase developments include a new generation of ghost fluid algorithm using both state-of-the-art surface tension and interface-velocity decoupling models, to capture the energy exchange and instabilities at the free surface at a very high level of accuracy.

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