MARIN

Challenging wind and waves

Linking hydrodynamic research to the maritime industry

Wave impact loading on offshore structures due to BREAKing waves and their KINematics (Joint Industry Project)

BREAKIN JIP

"BreaKin" is a new joint research initiative addressing the kinematics of extreme waves and the resulting wave impact loading to be considered in the design of offshore structures.

Motivation and background

Previous projects, such as the ShorTCresT JIP, answered questions on extreme wave statistics, directional waves and the related wave impacts on offshore structures.

During that work and cooperation with various participating companies from the offshore industry, among others the following new questions and research demands were identified:

- How should breaking waves be considered in the design of offshore structures?
- What are the kinematics of breaking waves and how can they be determined?
- How do the different types of breaking affect the local and global (horizontal) loading?
- To quantify the loading due to breaking waves, model tests are currently the option of choice. However, what are the scale effects involved and how realistic are the results?
- What are the extreme design loads to be considered?
- Can extreme breaking wave events "explain" observed structural damages?

These questions will be addressed in the present research initiative.

Objectives

The objective of the BreaKin JIP is to get more insights on scale effects involved in wave-in-deck model tests and to take first steps towards linking wave kinematics with measured impact loads.

Scope of work

Wave-in-deck model tests

To quantify the loading due to breaking waves, model tests are currently the option of choice. However, it is suspected that scale effects lead to an overestimation of the prototype loading. As such, a typical question is how conservative load measurements are. To understand how realistic model testing is in this respect, it is necessary to quantify scale effects in the measured loading.

In horizontal and vertical wave-in-deck events different elementary loading processes play a role (ELPs). For different loading processes different scale effects may apply. Therefore, an assessment of different loading processes is required, for vertical and horizontal impacts separately. A parameter variation, to further study the scale effects of individual loading processes, will be based on the outcomes of this first assessment.

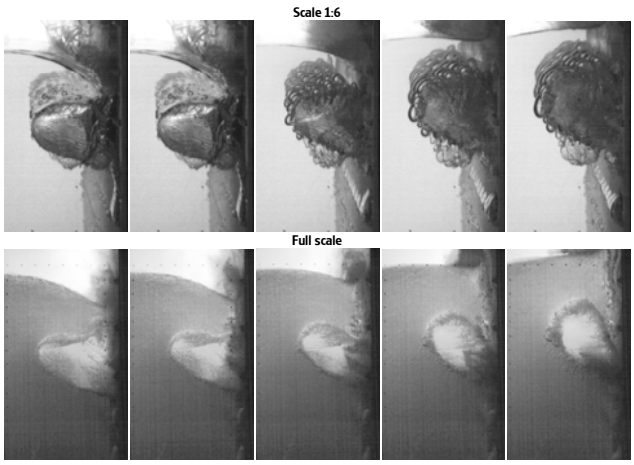
The following steps are proposed to identify scale effects of horizontal and vertical impact load measurements:

1. Identification of elementary loading processes (ELP) at large scale 1:25 = Which ELPs play a role?
    a. Vertical impacts: Confirm hypotheses based on ShorTCresT results
    b. Horizontal impacts: Assessment ELP considering e.g. Sloshel results

MARIN
P.O. Box 28
6700 AA Wageningen
The Netherlands
T +31 317 49 39 11
F +31 317 49 32 45
E info@marin.nl
I www.marin.nl

V. 2013/05/27_department

2. Model test study on parameter variations: If air entrapment
    a. plays a role, then vary ambient pressure
    b. plays no role, then carry out parameter variations (scale, design variations)
3. Identification of scale effects based on ELPs and parameter variations

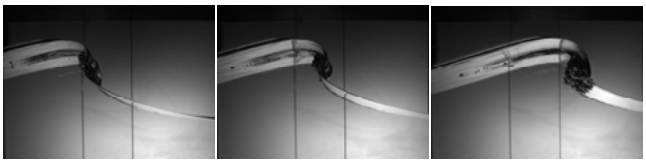


Wave impacts against instrumented wall measured during Sloshel JIP at two scales

Wave impact measurements on structures varying model scale and ambient pressure conditions will be carried out in MARIN's Depressurized Wave Basin. Guidance will be provided as how to quantify the measured loading due to different types of breaking wave impacts.

Validation of wave kinematics

In addition to the crest elevation the associated water particle velocities play a very important role in determining wave-in-deck loading. Especially in breaking waves the horizontal particle velocities can become extremely high and difficult to predict by commonly used methods for estimating wave kinematics.



Particle Image Velocimetry (PIV) measurements have been carried out to investigate measurement techniques for capturing the kinematics of different types of near breaking to breaking waves. These measurements have been carried out at small scale as internal research project at MARIN in 2015.

The available PIV wave kinematics data will be used as validation of the kinematics resulting from existing wave models, such as e.g. OceanWave3D, and CFD (ComFlow and Refresco).

Comparison of measured impact loads with available simplified loading models

To investigate the link between wave kinematics and wave-in-deck impact loads, simplified loading models for estimating horizontal and vertical deck impact loads will be applied and compared to the measured impact loads.

CompFLOW simulations with breaking waves for comparison with model test data (to be confirmed)

In cooperation with the ComMotion JIP wave-in-deck simulations with ComFLOW will be carried out with near breaking to breaking wave conditions as used for the model tests and compared to the model test data. This part of the project is still to be confirmed, as it is depending on available budget of the ComMotion JIP.

Schedule and duration

Signature of contract: October 2016
Start: April 2016
Duration: 1.5 – 2 years

Budget and fees

Participation fee: 25 kEuros
Total budget: 620 kEuro

Way forward and contact

The project has started this year based on MARIN research budget. Participants are welcome to join until October 2016 through a small participation fee of 25 kEuro.

For more information please contact Jule Scharnke:
T +31 317 49 34 77
E j.scharnke@marin.nl