PIV measurements of breaking waves

Vested, Malene Hovgaard

Publication date:
2017

Document Version
Publisher's PDF, also known as Version of record

PIV measurements of breaking waves

Malene Hovgaard Vested[1],
Supervisors: Stefan Carstensen[1] and Erik Damgaard Christensen[1]

[1]Section for Fluid Mechanics, Coastal and Maritime Engineering, Department of Mechanical Engineering, DTU. Contact: mlhv@mek.dtu.dk

October 4, 2017

Understanding the physics of breaking waves is an ongoing research topic, not only due to our fundamental curiosity, but also due to the influence breaking waves have on offshore structures. When estimating the wave forces, it is crucial to know the kinematics taking place under the water surface. In their nature, breaking waves are rather hard to assess experimentally and impossible to describe though simple analytical models. Therefore it is the hope that future numerical models will be able to describe the complicated physics of breaking waves more accurately, thus enabling more precise estimates of the associated wave forces. In order to validate these models, however, dedicated experiments are crucial. Fortunately, the recent years have seen a development in experimental methods that has facilitated a new insight into the physics of breaking waves.

In this study we have investigated the wave kinematics under steep and breaking waves on a laboratory beach with a slope of 1/25. The velocity field is measured by use of Particle Image Velocimetry (PIV) at a sample rate of 96Hz. The high sample rate allows for the accelerations to be determined directly from the sampled velocity fields. Through these experiments we have found that both velocities and accelerations differ from the ones predicted from common wave theories such as linear theory and streamfunction theory. This is especially evident at the top part of the wave close to the surface. This is not surprising, since the breaking event is highly non-linear. We expect that the experimental results presented here may be of assistance assistance for validating numerical models by shedding light on the physical mechanisms behind breaking waves.

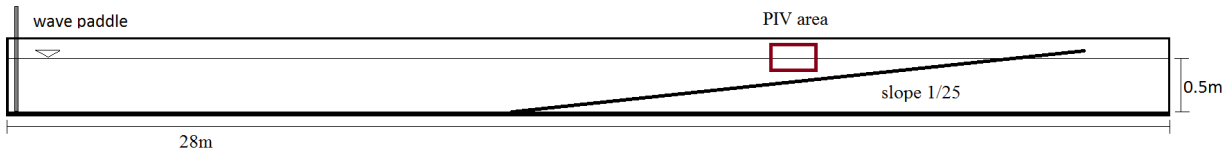
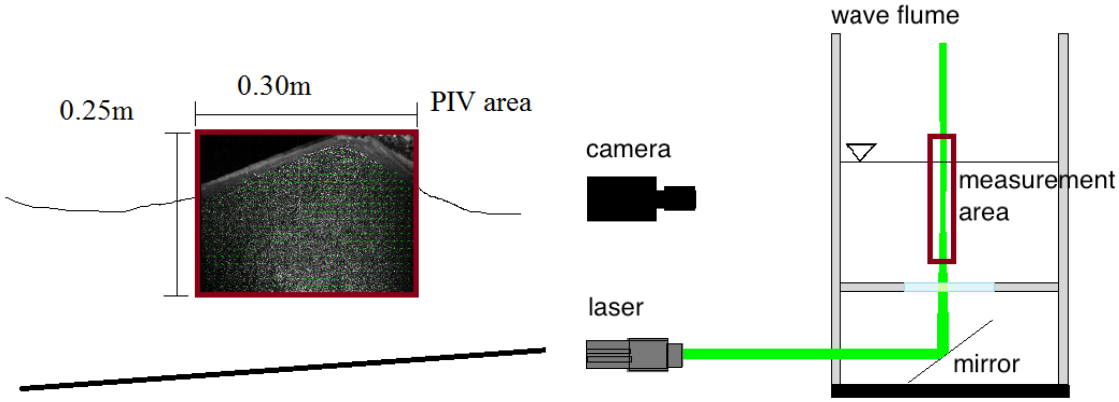


Figure 1: Schematic of the wave flume with the PIV measurement area indicated by a red square. The waves are generated by the wave paddle to the left and propagate onto the sloping bed.



(a) The 2D PIV measurement area

(b) Side-view of the wave flume

Figure 2: Details of the PIV measurement set-up. The PIV system consists of a camera capturing flow images of the measurement area covered by a thin vertical light sheet.

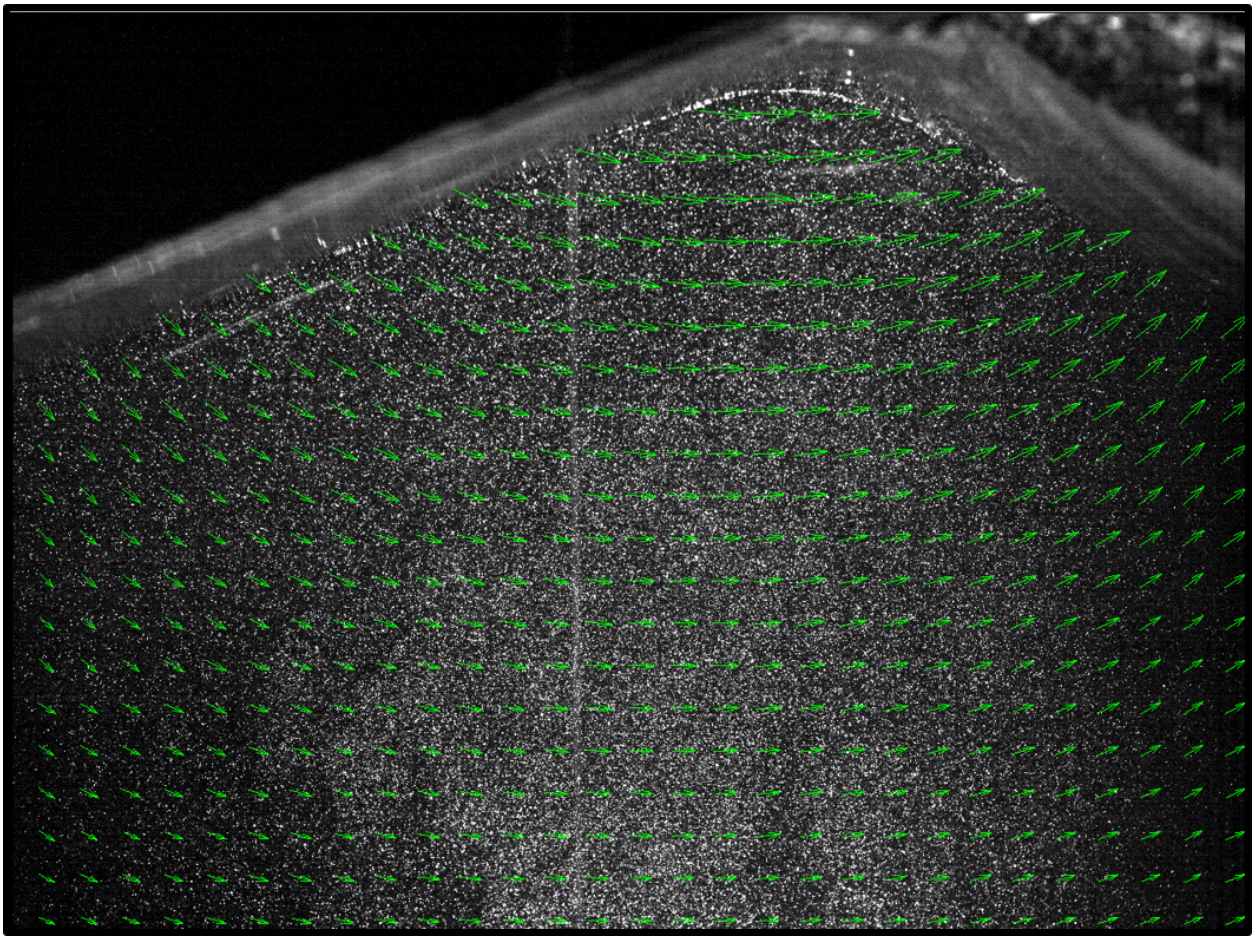


Figure 3: Example of obtained velocity field from PIV measurement. The wave is mildly breaking, as seen from the air bubbles in the roller on the top of the wave (top right in the image). Note that the measurement area only covers the top part of the water column.