Jet creation at the tip of a submerged plate forced by waves

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Wave energy is a very good candidate for a renewable energy source because it carries enormous amounts of energy. In the case of Europe, it could make a significant contribution to electricity supply, with an estimated capacity of 300-400 GW along the European Atlantic coasts alone (Babarit 2017) [1]. However, there are currently no wave energy converters (WECs) capable of harnessing wave energy on a large scale and at relatively low cost. A promising new WEC design consists of a flexible plate immersed near the free surface and exposed to the swell. For example, Shoele et al [2] investigated how a plate made of piezoelectric material could be used for energy harvesting. In our laboratory at PMMH, we are experimentally studying the behaviour of a flexible polycarbonate plate immersed in a wave field with a single held edge. Our system is not designed for energy recovery, but to better understand and quantify the interaction between the wave field and the plate.

Our study shows that the presence of the plate in the wave field strongly dissipates the incident wave energy. In particular, we have observed that for certain wave frequencies a significant fraction of the wave energy is dissipated by vortices shed at the edges of the plate, giving rise to a jet similar to that observed for a flapping fin, see figure 1. The wave field is measured using a Synthetic Schlieren technique [3]. In order to study and characterize in greater detail the jet created by waves forcing the flexible plate we use 2D Particle Image Velocimetry (PIV), which provides the instantaneous velocity field of particles in the fluid. Measurements are performed for plates of length $L = 19$ cm and $L = 28$ cm in different configurations of wave frequencies and amplitudes. Our experiments show that the size of the jet, its orientation and intensity depend on the membrane studied, the frequency and the amplitude of the waves. It is largest in the frequency range where wave energy dissipation is greatest. Finally, we have performed additional PIV experiments, this time in the plane orthogonal to the direction of wave propagation. Preliminary results show the existence of non-negligible transverse effects.

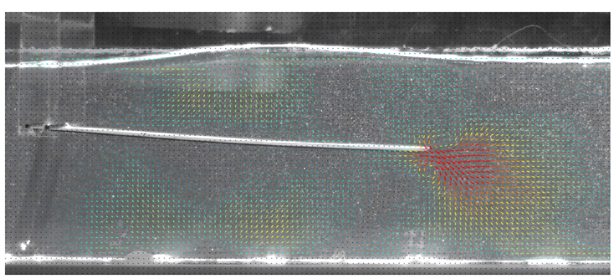

Figure 1. Example of a mean velocity field over 4 wave periods for waves of frequency $f = 2.4$ Hz for a plate of length $L = 19$ cm.

Références

1. A. Babarit, *Ocean wave energy conversion*, **ch. 1**, (2018).
2. K. Shoele, *Journal of Fluid Mechanics*, **968**, A31 (2023).
3. F. Moisy et al., *Experiments in Fluids*, **46.6**, 1021-1036 (2009).