
Interaction between water waves and a submerged membrane

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Abstract

Forced motion of membranes in a fluid offers various fascinating problems. A scarcely documented forcing consists in placing a submerged membrane in a water wave field, thus imposing the excitation frequency along the whole membrane. This type of interaction has first been studied for potential applications as a wave barrier. It also has been shown that a submerged membrane attached to the seafloor could be an efficient and robust wave energy harvester. So far, the interaction between waves and a submerged membrane has been studied mostly analytically and numerically, with a strong focus on applications, while only few experimental works have been performed to characterize it.

In this study, we address the problem of the interaction between water waves and a submerged membrane, by means of physical experiments, with a view to highlighting and quantifying the various physical phenomena which contribute to the interaction.

A thin flexible membrane, clumped at one end, is placed horizontally in a wave field. The simultaneous measurement of the waves (using full reconstructions of the wave field based on top view visualizations of the experimental flume) and of the deformation of the elastic plate (using side view video recording) provides many key parameters for an in-depth understanding of the interaction, such as the energy reflected and transmitted by the structure, or the membrane deflection modes. It is found that the membrane reflects little energy but tends to withdraw energy from the waves, for wavelengths close to the membrane length. The mechanism for wave energy attenuation is further investigated using Particle Image Velocimetry. Observations suggest that a significant part of membrane momentum is transferred to the fluid, in the form of a local horizontal stream near the membrane free edge, instead of radiated waves.

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