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Experimental study of resonant shallow flows past a lateral cavity: a benchmark test for high-resolution numerical models

Sergio Martínez Aranda[1], Adrián Navas-Montilla[1], Antonio Lozano[2], and Pilar García-Navarro[1]
[1]Fluids Mechanics, University of Zaragoza, Spain
[2]LIFTEC-CSIC, Zaragoza, Spain

The study of resonant shallow flows past a lateral cavity is of great relevance due to their interest in civil and environmental engineering [1]. Such flows exhibit the presence of a standing gravity wave, called seiche, which is coupled with the shedding of vortices at the opening of the cavity. A complete understanding of such phenomenon is necessary as it may determine the mass exchange between the main channel and the cavity [2]. A better insight into this phenomenon helps to improve the design and implementation of innovative river bank restoration techniques. An experimental study of the resonant flow in a laboratory flume with a single lateral cavity is herein presented. Five different flow configurations at a fixed Froude number (Fr=0.8) are considered. The main novelty of the present work is the use of a pioneering non-intrusive experimental technique [3] to measure the water surface at the channel-cavity region. This optical technique offers high resolution 2D data in time and space of the water surface evolution, allowing to determine the relevant features of the seiche oscillation, i.e. spatial distribution of oscillation nodes and anti-nodes, oscillation modes and amplitude of the oscillation. Such data are supplemented with Particle Image Velocimetry measurements to perform a more detailed study of the resonance phenomenon. High-resolution two-dimensional amplitude oscillation maps of the seiche phenomenon are presented for the experimental water depth. Experimental velocity fields inside the cavity are presented and confirm the inherent coupling between the unstable shear layer at the opening of the cavity and the gravity standing wave. The high quality of the experimental data reported in this work makes this data set a suitable benchmark for numerical simulation models in order to evaluate their performance in the resolution of turbulent resonant shallow flows.

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