Flow field measurements in broken waves and bores

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Abstract

The wave dynamics after breaking is widely investigated also because it controls several phenomena in the surf zone and in the swash zone. Several numerical models based essentially on non linear shallow water equations (NLSWE) have been developed, but all them need a model for turbulence in the bore. Many authors have measured fluid velocity in bores using Laser Doppler Velocimetry (LDV), Hot Wire and Hot Film anemometry, Particle Image Velocimetry (PIV) with good results and with several limitations essentially due to air bubbles.

In order to overcome such limitation, a set of experiments were carried out in a flume using Doppler Ultrasonic Technique for fluid velocity measurements. The instrument, DOP1000, essentially works as a radar, with ultrasound in the range 1 MHz-8 MHz as carrier, and is able to measure fluid velocity in several points along the US beam with negligible time delay. The maximum data rate obtained is ≈30 profiles per second per each probe, with three probes and maximum 255 points per profile. The generated waves have period T=2.0; 2.5 and 3.0 s, break as spilling on a 1:20 bottom. UDVP velocity profiles have been collected in three sections, one at the breaking point and two in the bore region after breaking. The data have been phase averaged to obtain the fluid velocity (Fig.1a) and also time averaged in order to obtain the mean fluid velocity (Fig.1b). The classical undertow is evident.

UDVP technique has several advantages respect to other fluid velocity measurements. It can be used in opaque fluids. The error in measurements is strictly related to the accuracy of set-up, and can be reduced to less than 5%. The present limits are essentially due to the low data rate, which allows at most macro-turbulence measurements. The low data rate is intrinsic in the carrier celerity, around 1000 m/s.

Fig.1 a) Phase average velocity. b) mean phase and mean phasic velocity (undertow). T=3.0 s
The main advantage of UDVP is that it can give information on spatio-temporal velocity, with data rate virtually independent on seeding concentration.

The aim of the present work is to use the UDVP data for fluid velocity, macro turbulence estimation and bottom stress in a breaking wave and in a bore. This last measurements are rarely available, because of the difficulty in measuring fluid velocity in a strongly aerated flow field.

The results will improve flow field modelling under breaking waves and bores.

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References


