EXPERIMENTS ON STRATIFIED EXCHANGE FLOWS PAST A SUBMERGED SILL

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Density stratified flows are ubiquitous in nature and have important consequences in many environmental engineering problems. Natural water bodies with different salt or sediment concentrations or different temperatures present the typical properties of a density stratified flow. Results from an experimental study using Particle-Image-Velocimetry (PIV) measurements are presented.

Hydraulic theory of two-layer flows was first studied by Schijf & Schonfeld (1953) who extended classical one-layer hydraulics to two-layer estuaries. Armi and Farmer (1986) applied the two-layer hydraulics to exchange flows and studied flow regimes as a function of flow conditions, channel geometry and topography.

At the interface of such exchange flows, flow instabilities, like Kelvin-Helmholtz-billows or Holmboe waves (Holmboe 1962) develop, which lead to mixing between upper and lower layers. Earlier studies have shown that the rate of the exchanges are controlled and/or influenced by the generation of these hydrodynamic instabilities at the interface of the two layers (Zhu and Lawrence 2000). Significant flow entrainment is also reported when the heavier fluid in the lower layer leaves the connecting channel and flows down a slope into the neighboring water body (Morin et al 2004). Morin et al (2004) reported that the generation and break-up of large scale Kevin-Helmholtz instabilities at the interface of the two layers are mainly responsible for the entrainment of the ambient lighter fluid into the heavier lower layer. This flow entrainment thus modifies the density of the inflow and its eventual mixing and fate.

The objectives of the study are to analyze the generation mechanisms of Kelvin-Helmholtz and of Holmboe instabilities as well as the influence of the bottom friction and the geometry on their generation and development by linear stability analysis. Furthermore, the influence of the instabilities, of the bottom friction and of the geometry on the mixing processes, are investigated experimentally.

Laboratory experiments will be conducted using advanced synoptic measurements techniques (coupled PIV/PLIF).

First results of laboratory experiments using a PIV measurement system are presented showing velocity pattern in a measurement window of 80 cm x 80 cm. From these data, information about the mean flow conditions and turbulence characteristics can be obtained.

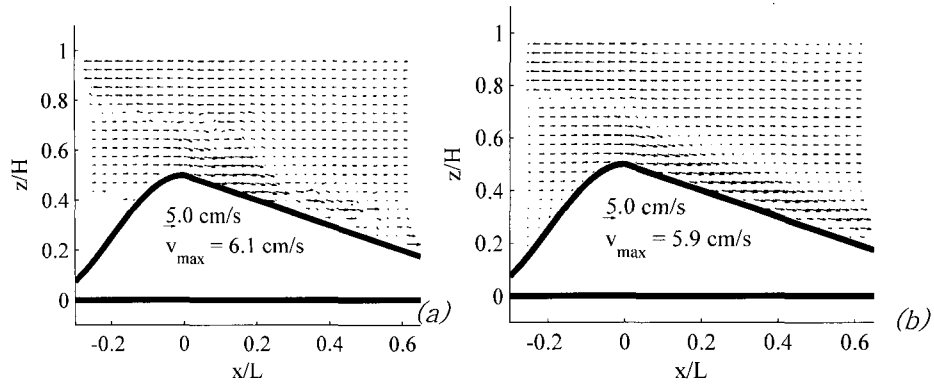

Fig. 5 PIV results of density stratified exchange flow over a sill; a) instantaneous velocity field at t=452s ; b) the mean velocity field are given by the vectors.

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