High-speed Particle Image Velocimetry in oscillatory boundary layer flow.

Report on Short Research Visit by Dominic van der A to University of Dundee.

The SRV involved Dominic van der A visiting Dr Yong Sung Park at the School of Civil Engineering at the University of Dundee between 12-16 March 2018. The aim of the visit was to perform a collaborative experiment involving high-speed Particle Image Velocimetry (PIV) measurements of oscillatory boundary layer flow over rough and mobile beds. One of the objectives of the visit was to see if high-speed PIV was possible by combining components from both institutes: a high-speed camera (PCO HS1200) from Dundee and a continuous laser source (ILT 5500A 300mW Argon Laser) and PIV-processing software (Dantec DynamicStudio) from Aberdeen.

The experiments were conducted in Dundee's small-scale oscillatory flow tunnel which can be seen in Figure 1, in which the insert show the camera and laser sheet arrangement. We spent the first couple of days on setting up the PIV equipment, preparing the facility and installing a layer of glass marble beads at the bottom to represent the bed roughness. Two subsequent days were spent on testing various PIV configurations and performing measurements for oscillatory flow conditions with different amplitudes and periods of the piston.

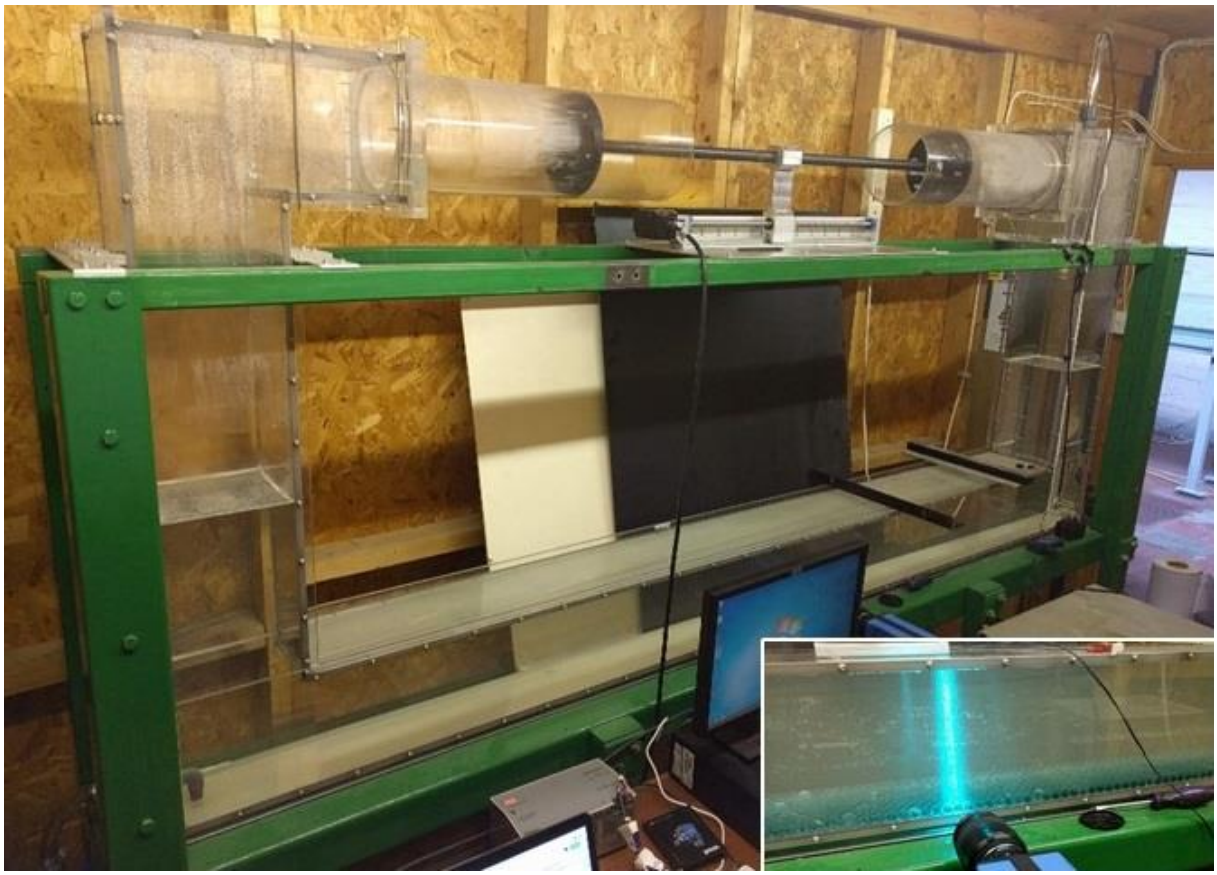

Figure 1: Dundee's Oscillatory Flow Tunnel facility, the insert shows the high-speed camera and laser sheet over a glass marble-covered bed.

Successful measurements were obtained, of which example PIV vector maps are shown in Figure 2 below. These images were sampled at 500 Hz which we found was the highest possible with the current illumination source – with a more powerful laser we expect PIV to be possible at the highest sampling rate of the camera of 1200 Hz.

Processing of the PIV data is still ongoing and we intend to use the results to support a joint proposal between Aberdeen and Dundee focusing on the exchange flow between the oscillatory boundary layer flow and the porous media flow within the rough bed. Furthermore, following this successful SRV the high-speed PIV system will be used this summer to measure flow structure downstream of movable weir as part of a collaborative project between Univ. of Dundee and Inje University in South Korea.

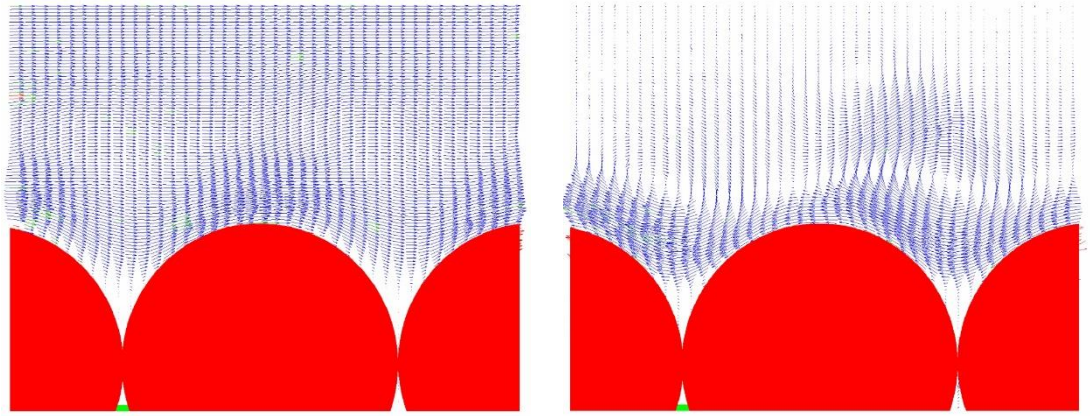

Figure 2: Example velocity vector maps. Left: velocity field at maximum free-stream velocity; right shows the velocity field at free-stream flow reversal. The free-stream velocity has a period of 1.65s and amplitude of 0.06 m. The masked glass marbles have a diameter of 10mm. PIV sampling rate 500 Hz.