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Experimental study of wake past combinations of wall-mounted cubic elements

Maria Ikhennicheu (1), Grégory Germain (1), Benoît Gaurier (1), and Philippe Druault (2)

(1) Marine Structure Laboratory, IFREMER, 150 Quai Gambetta, 62200 Boulogne sur Mer, France, (2) Sorbonne Universités, UPMC Univ Paris 06, CNRS, UMR 7190, Institut Jean Le Rond d'Alember, F-75005 Paris

There is a strong tidal energy potential in France, especially in the Alderney Race that presents currents up to $U_{is} = 5m/s$ (*is=in-situ*). Surveys give access to the bathymetry showing varied altitudes with a $H_{is} = 5m$ mean variation leading to high Reynolds number: $R_{e,is} = H_{is}U_{is}/\nu = 2.5 \times 10^7$. Such bathymetry variations are causing velocity fluctuations with a high turbulence rate in the water column: large coherent turbulent structures originate at the sea bottom and can be observed at the sea surface. Such events can have a major impact on the tidal turbines behaviour and structural fatigue.
To reproduce and analyse these turbulent events, tests are carried out in the wave and current circulating flume tank of IFREMER in Boulogne-sur-Mer. Before trying to reproduce a complex bathymetry, we chose to introduce the topic by studying elementary obstacles representative of real seabed elements (with an aspect ratio of the magnitude of the mean bathymetry variations). The wall-mounted obstacles considered are the following: a cube with dimension H, a wide square cylinder with dimensions : H length $\times$ $7H$ width $\times$ H height and finally an inclined floor with a $3m$ long $\times$ $3m$ wide plane and an inclination of $6.5°$. Experiments are carried out with Reynolds number as high as achievable in Froude similitude: $U = 1m/s$ and $H = 250mm$, in the tank: $R_e = 2.5 \times 10^5$ and $F_r = 0.23$.
First, the impact of the aspect ratio is studied by comparing the cube and cylinder cases, both followed by an inclined floor. Then, the addition of a wall-mounted cube upstream of the previous set-up is investigated. The distance between the cube and the cylinder is studied, considering the recirculation length of the flow in the cube wake. 2D-PIV (Particle Image Velocimetry) and LDV (Laser Doppler Velocimetry) measurements were performed and analyses are in process. Preliminary results show that the inclined floor gives a significant impulsion to the flow towards the water surface. It also shows that the higher the aspect ratio, the larger the obstacle wake and the more persistent the rising turbulent structures. These energetic turbulent structures originate in the shear layer and are shed into the flow. To detect and characterize these events, spatial and temporal analyses will be performed and quadrant method will be used.
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