CFD Modelling and experimental validation of induced swell in a wave flume

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Keywords: CFD modelling, Offshore renewables, Wave energy, Wave flume testing.

ABSTRACT

Nowadays, the scientific community is focused in growing research activities in the field of wave energy because of its enormous potential considered as one of the most promising renewable energy sources [1, 2]. This work deals with the characterization of the swell generated inside a wave flume and the corresponding validation of a CFD model.

The wave flume (295.5 cm long, 40.0 cm wide and 50.0 cm high) is equipped with: i) a linear induction motor wave maker, attached to a paddle closely fitted to the flume sidewalls, ii) two wave gauges, based on ultrasonic level transmitters and iii) a passive wave absorption zone, consisting on a porous stone bed. A self-developed software was implemented, aiming to specify the desired amplitude (A_p [m]), averaged velocity (U [m/s]) and acceleration-deceleration (a [m/s^2]) of the paddle linearly oscillating motion, as well as to obtain experimental results regarding the paddle: position (x [m]), pulse velocity (u [m/s]) and hydrodynamic force (F [N]) as a function of time (t [s]), together with experimental results regarding the generated waves: free surface displacement (y [m]) as a function of time (t [s]), velocity of the wave propagation (c [m/s]), wavelength (λ [m]), period (T_w [s]) and amplitude (A_w [m]).

The 2D model (in STAR-CCM+ v11.02) was built with a computational mesh accounting 220,000 cells of 2 mm base size in those sections of special interest around the free surface estimated area. It was based on a two-phase Eulerian "Volume of Fluid" (VoF) unsteady model, taking into account the effect of gravity and surface tension, and the k-ε model for the characterization of the turbulence. The user function, defined by period of the paddle T_p, describes the cyclic motion of the linear induction motor. Both the period T_p and amplitude A_p of the paddle motion can be varied together with the initial location of the water free surface to generate a broad range of waves showing different frequencies, amplitudes and velocities of propagation. These results are in good agreement with the outcomes obtained through the experimental test campaign corresponding to a shallow water, for the several cases studied.

REFERENCES

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