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Tidal turbine under non-collinear waves and currents.

1. Introduction

Tidal energy is at an early deployment stage and turbine costs need to be reduced in order to make this source of energy economically viable. Some of the high costs of tidal turbines are the result of load uncertainties which lead to the implementation of high factors of safety in the design to ensure survival. One of the most important causes of uncertainty is the extreme hydrodynamic loads.

2. Background

The turbine used in this study was developed for the X-MED project [1]. Original tests were carried out at the IFREMER flume in France with current and waves perpendicular to the rotor plane. This PhD project aims to extend the X-MED study to different waves and current incidence angles.

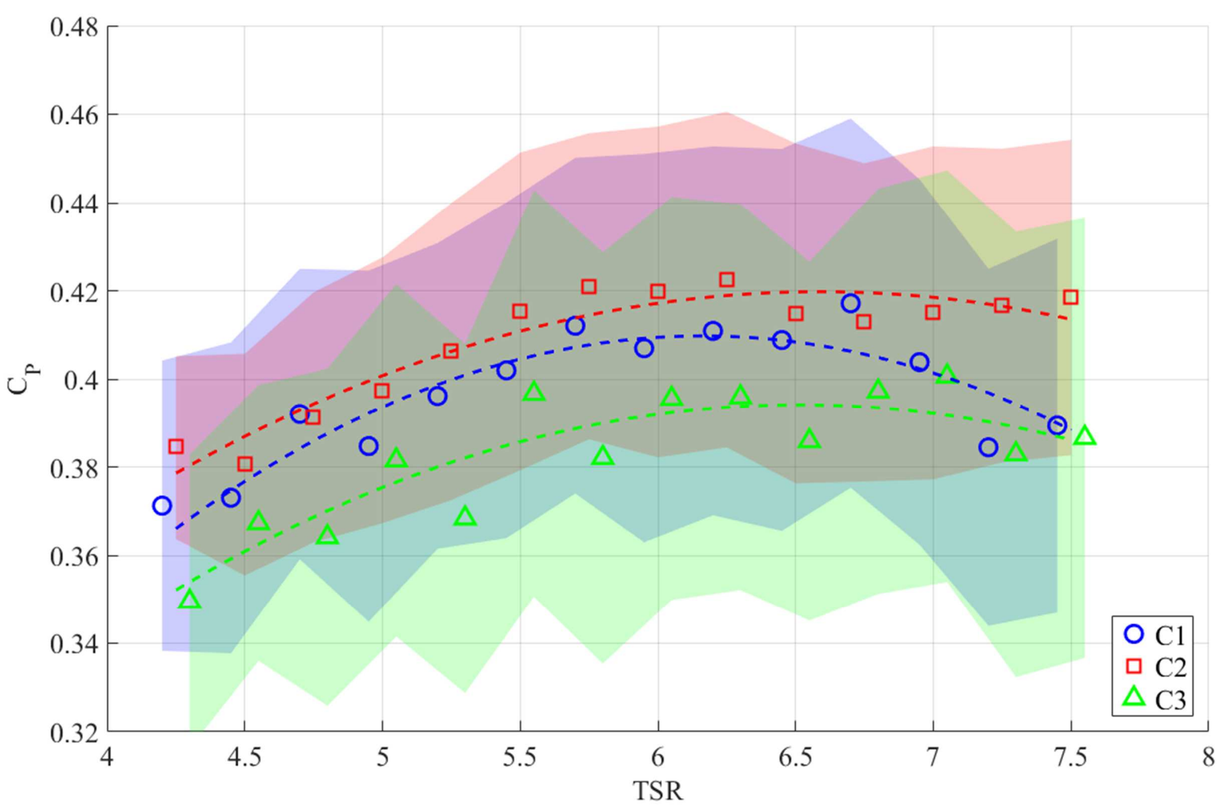

Figure 2 – Power coefficient (C_P) plotted against TSR

3. Tank Testing

For these tests [2], the flow was yawed by 0°, 10° and 20° with respect to the rotor axis. For each of these flow angles, three regular waves were generated at 0°, 45°, 135° and 315° to the rotor axis.

Tests were carried out with a 1.2m diameter 3 bladed turbine in the FloWave basin of Edinburgh University as seen in figure 1. The tank is circular with a 17m diameter and 2m depth. 15 physical quantities were measured including flow, waves and turbine loads.

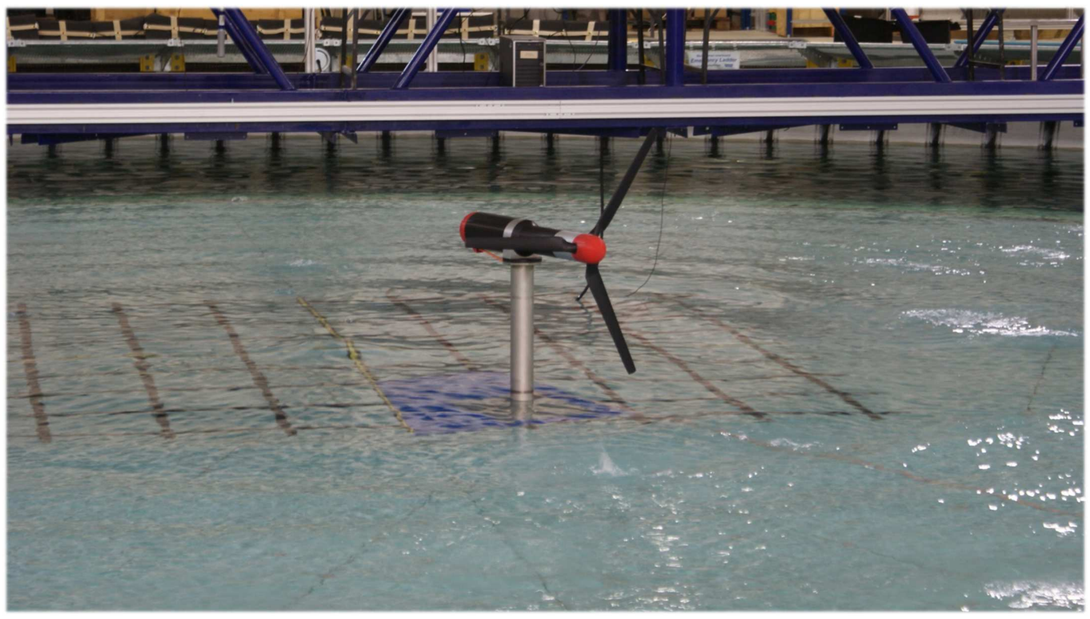

Figure 1 – Turbine mounted on tank floor

4. Results

The C_P curve at the three different current yaw angles and no wave are shown in Figure 2. The table below shows mean and standard deviation values of torque and thrust for the same flow conditions from Figure 2.

Figure 3 shows the frequency analysis of thrust with waves and in the dry. The flow spectra without waves is included for comparison. The thrust curve shows the peaks associated to the wave frequency and the one associated to the three blades passage in front of the turbine plus its harmonics.

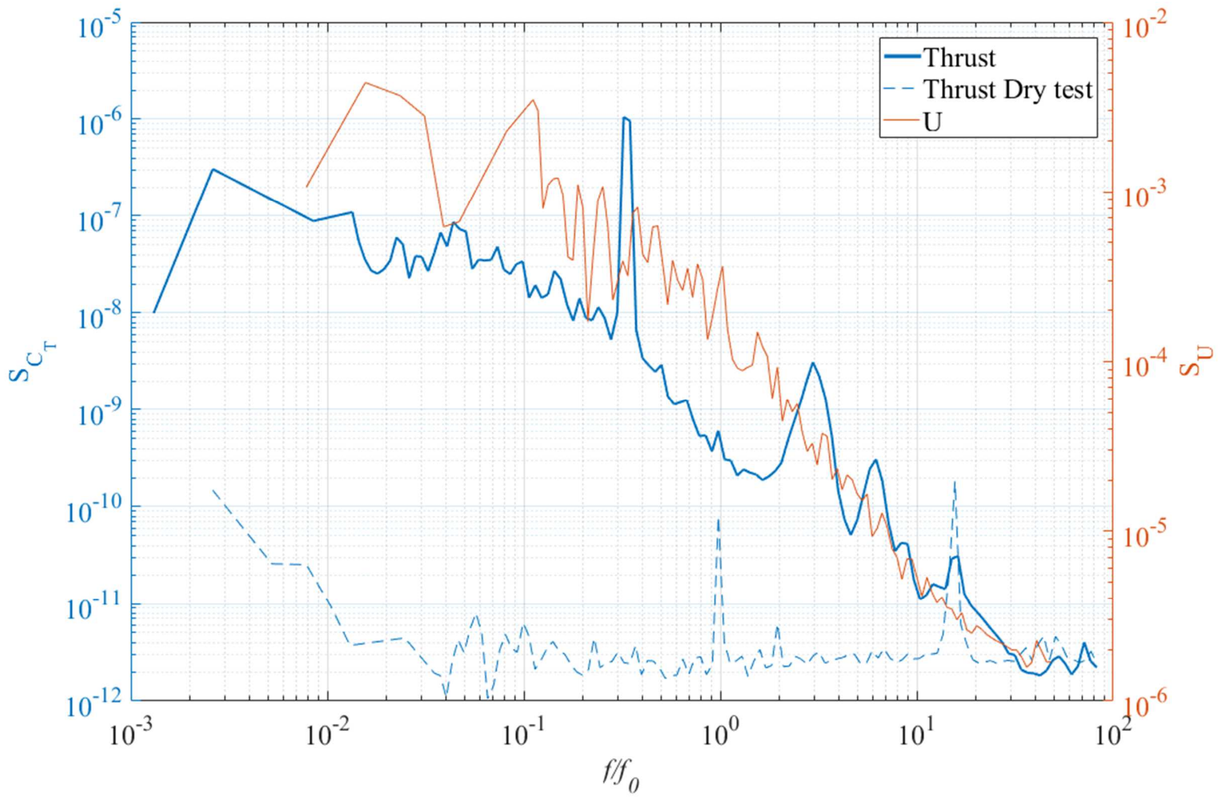

Figure 3 – Normalise velocity spectral density for all components

Flow at -20°	Torque N·m	Torque SD	Thrust N	Thrust SD
No waves	13.2	1.3	277	16
T=2.0s; H=102mm	13.3	2.3	278	27
T=2.5; H=91mm	13.2	3.5	277	40
T=3.0s; H=86mm	13.1	2.3	277	27

References

[1] Payne, G.S., Stallard, T., Martinez, R., Bruce, T., 2018. Variation of loads on a three-bladed horizontal axis tidal turbine with frequency and blade position. J. Fluids Struct. 83, 156–170. https://doi.org/10.1016/j.jfluidstructs.2018.08.010

[2] Martinez, R., Payne, G.S., Bruce, T., 2017. The effects of oblique waves and current on the loadings and performance of tidal turbines. Ocean Eng.

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CONACYT

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