ICCM2014
28-30th July, Cambridge, England

Uncertainty in modelling for wave energy device design

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Renewable energy has been developed as a means to generate energy, in part to mitigate the human influence on climate change from fossil fuel energy production. Wave energy devices seek to extract energy from ocean free surface waves. The intention of the design engineer is to be able to predict the energy captured from the device for energy supply and revenue prediction, together with a prediction of load for structural and system design.

The response analysis of a wave energy device requires the prediction of the hydrodynamic plus energy extraction (or Power Take Off) induced forcing. Hydrodynamic analysis has predominantly based on linear hydrodynamic potential flow models with empirical corrections for viscosity. This neglects nonlinear hydrodynamics and the true effects of viscosity which can be significant, dependent on the design of the device. The use of linear hydrodynamic potential flow models is via time domain modelling and a convolution integral to additionally allow the representation of the typically nonlinear PTO. CFD methods have been implemented to provide higher fidelity, however the large range of parameters to be evaluated for design is problematic to simulate due to the computational expense in modelling the range of length scales of interest and the free surface.

Future design increasingly will be based on probabilistic methods due to the need to design for extreme events. Such methods require an estimation of the uncertainty in modelling methods together with that of the environmental and material inputs. Methods are therefore sought to estimate the uncertainty in system simulation to assist in engineering design.

Keywords: wave energy, time domain, design, hydrodynamics