University of Victoria | Graduate Studies

Notice of the Final Oral Examination for the Degree of Master of Applied Science

of

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BSc (University of Costa Rica, 2006)

"The Influence of Mooring Dynamics on the Performance of Self Reacting Point Absorbers"

Department of Mechanical Engineering

Tuesday, May 24, 2016
9:00 A.M.
Engineering Office Wing
Room 430

Supervisory Committee:
Dr. Brad Buckham, Department of Mechanical Engineering, University of Victoria (Co-Supervisor)
Dr. Curran Crawford, Department of Mechanical Engineering, UVic (Co-Supervisor)

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Dr. Anne Marshall, Department of Education, psychology and Leadership Studies, UVic

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Abstract

The design of a mooring system for a floating structure is a significant challenge the choice of line structure and layout determine highly nonlinear hydrodynamic behaviors that, in turn, influence the dynamics of the whole system. The difficulty is particularly acute for Self-Reacting Point Absorber Wave Energy Converters (SRPA WEC) as these machines rely on their movements to extract useful power from wave motions the mooring must constrain the SRPA WEC motion without detracting from power production. In this thesis this topic has be addressed in an innovative way and new ideas on how these devices should be moored were generated.

As part of the study, an optimization routine was implemented to investigate the optimal mooring design and its characteristics. In this process, different challenges were faced. To evaluate the different mooring configurations, a high fidelity representation of the system hydrodynamics is necessary which captures the non-linearities of the system. Unfortunately, high-fidelity modeling tends to be very computationally expensive, and for this reason previous studies based mooring design largely relies on simplified representations that only reflect part of the mooring design space since some physical and hydrodynamic properties are dropped. In this work, we present how a full hydrodynamic time domain simulation can be utilized within a Metamodel-Based Optimization to better evaluate a wider range of mooring configurations spanning the breadth of the full design space. The method uses a Metamodel, defined in terms of the mooring physical parameters, to cover the majority of the optimization process a high fidelity model is used to establish the Metamodel in a pre-processing stage. The method was applied to a case study of a two-body heaving SRPA WEC. Survivability constrains where introduce into the model using a new statistical approach which reduces its execution time, and allowed to included it into the optimization routine.

The analysis results lead to the conclusion that for SRPA WEC the mooring loads have a significant impact on how the body reacts with the waves affecting both, the energy that enter the system as well as the energy that leaves the system as power, This

implies that, in some cases, the moorings lines need to be considered in early stages of the design opposed to an afterthought, as is presently done. Results indicate that an optimal mooring design can result in a 26% increase in total annual power production.In addition, the mooring lines impact on mitigating parasitic pitch and roll were analyzed. It was established that in regular waves, the mooring lines can reduce the parametric excitations and improve the power extraction up to 56% for a particular sea state. By applying a computationally efficient iterative design approach to a device's mooring, parasitic motions and suboptimal device operation can be reduced ultimately making WECs a more competitive source of energy.