The Design and Validation of the Equations of Motion of a Point Wave Energy Converter Buoy

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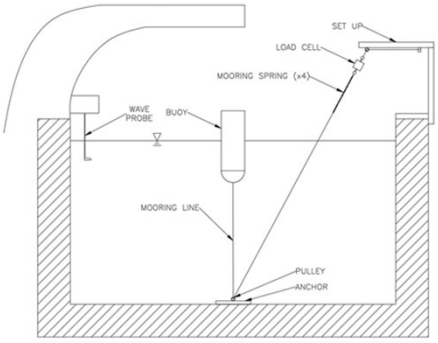
Abstract

The energy demand has been steadily increasing as global trade and economies grow. Global interest in alternative methods of generating energy has been exponential in the 21st century. The next form of alternative energy generation to gain traction, as apparent by the prototypes currently being launched in the United States, are wave energy converters (WEC). According to the US Energy Information Administration, the approximate upper limit of energy potential in wave energy in our waters is 2.64 trillion kW-hr. This thesis involves the building and testing of a WEC for the Robinson Model Basin. The result of the testing are compared against the validated CFD program Wadam, and a MathCad program made by Danilczyk and Petersen. After initial analysis, modifying the weight of the model for a given wave frequency by changing the mass of the model can return higher response amplitudes.

Objective

To establish a foundation for wave energy buoy testing in the Robinson Model Basin through the building and testing of a scaled-point wave energy converter (PWEC) buoy. These tests will then be compared against a full-scale buoy evaluated with the CFD program Wadam.

Experimental Set Up and Model



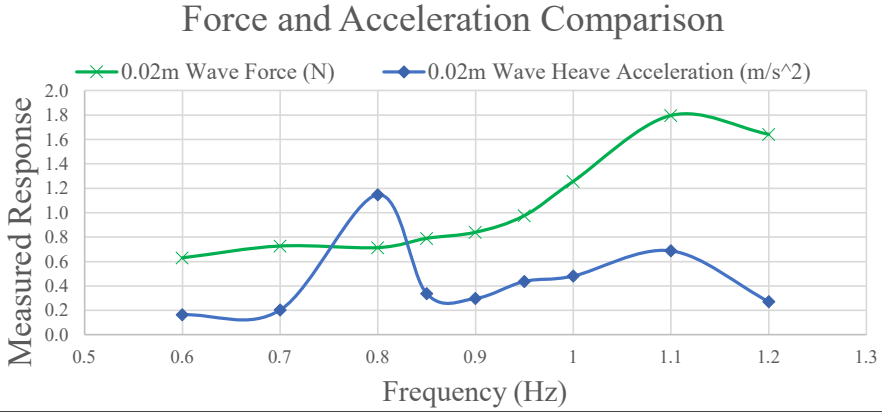
Previous Work

- William Danilczyk and Brian Petersen (Webb 2007)
  - Created Mathcad model of PWEC
- James Lusas (Webb 1983)
  - Tested PWEC buoy in RMB

Model	Scale	Diameter (in)	Depth (in)	Draft (in)
Danilczyk & Petersen (D&P)	1:1	168.1	429.1	214.6
Flanagan & Johansson (From D&P)	1:20	8.4	21.5	10.7
Lusas (tank model)	1:30	13.6	6.4	

Results

- The resonance of the buoy can occur prior to the system resonance. This resonance results in violent pitching of the model in response to encountered waves. The blue plot shows this as the first peak of heave acceleration. Which occurs in a region where the force on the mooring line is mostly constant.
- The approximate system resonance can be seen later when force is at its maximum and heave acceleration is at a local maximum.



Conclusions

- Build and tested scaled-point wave energy converter (PWEC) buoy for the RMB
- Higher frequencies should be tested at lower amplitudes to evaluate results around the frequencies determined in the Fourier transforms
- The complex problem of oscillatory motion in waves depends largely on the frequency of the waves

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