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Numerical modelling of wave energy absorption by a floating point absorber system

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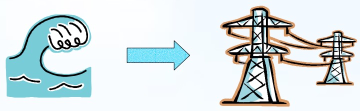
Wave Energy

Ocean waves contain huge amounts of -unexploited renewable energy, offering gigantic opportunities. This energy can be absorbed by wave energy converters (WECs). Ocean energy is a renewable energy type that is becoming more and more important.

Point absorber systems are wave energy converters consisting of oscillating bodies with small dimensions compared to the wave length.



Purpose

Numerical simulation of the behaviour of a **heaving point absorber** in relative motion to a floating platform in order to:

-find an optimal **buoy geometry.**

-define the **absorbed power** for a certain wave climate.

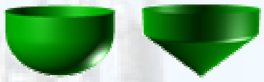
-assess the effect of **restrictions** imposed on buoy motion.

Buoy Geometry

Two buoy shapes are investigated:

-A cone (top angle 90 °) + cylinder

-A hemisphere + cylinder



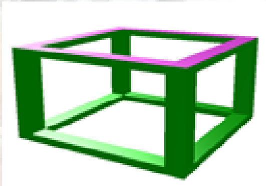
Size and draft of the buoy are varied:

-Diameters: 3 – 3.5 – 4 – 4.5 – 5 m

-Draft: 3 different drafts between 2 and 4.5 m

Platform Size

The considered platform measures are: 40 m x 40 m x 20 m

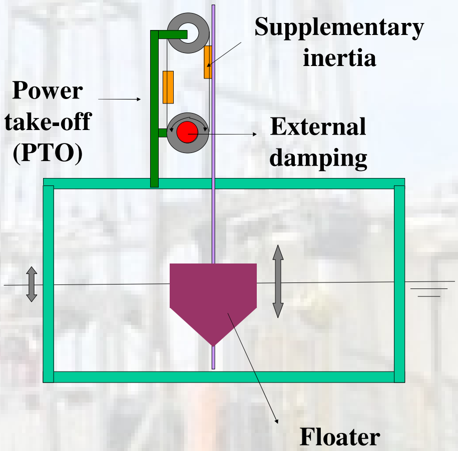


Linear Model

-The **hydrodynamic coefficients** for heave in the equation of motion are determined with the boundary element method software Wamit.

-Energy extraction is modelled by an **external damping force**, proportional to the velocity.

-Motion control is realized by adding **supplementary inertia** m_{sup} which allows for adapting the natural period of the floater.



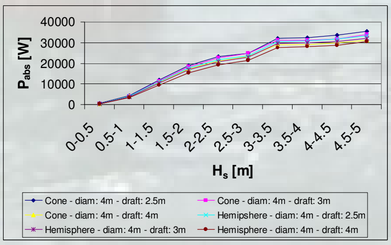
Restrictions & Absorbed Power

-A restriction on the displacement of the floater is applied to decrease the probability of **slamming,** a phenomenon that may occur when the buoy looses contact with the water surface.

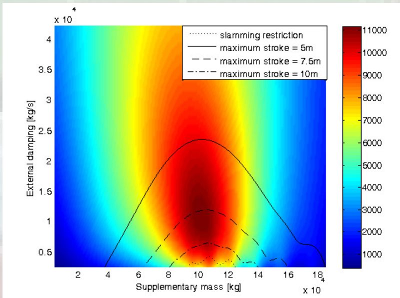
-A second restriction is imposed by the **limited stroke** of the mechanical system connecting the point absorber to the platform.

These restrictions reduce the power that can be absorbed, as can be clearly seen in the figures on the right.

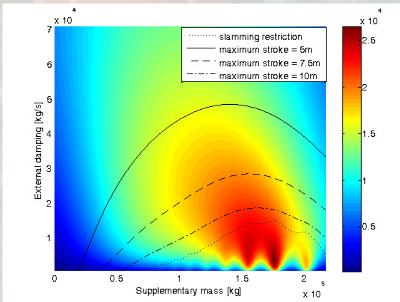
For a given stroke and slamming criterion, optimal values of external damping and supplementary mass can be selected in order to maximize the power that can be absorbed, which is shown in the figure below.



Power that can be absorbed if optimum control is achieved as a function of the significant wave height (H_s) class. All buoy shapes have a diameter of 4 m. The maximum allowed stroke was 10 m.



Absorbed power [W] as a function of external damping and supplementary mass with implementation of slamming and stroke limitations for H_s values between 1 and 1.5 m. The buoy is a cone-cylinder with diameter of 4m and draft of 3 m. The area enclosed by the contour lines has to be avoided in order to satisfy the restrictions.



Absorbed power [W] for the same buoy geometry but for a more energetic wave class: Hs between 2 and 2.5 m.

Discussion & Future Work

-The cone-cylinder shape has a slightly better performance than the hemisphere, but the difference is only 3 to 5 %.

The graphs show that the slamming criterion is less restrictive than the stroke criterion, at least when the draft is not too low.

-When the restrictions get more rigorous, power absorption drops faster in higher energy classes.

-In a next step these numerical simulations will be validated by scale model tests. Future work comprises also the investigation of the mutual interaction between the point absorbers in order to find an optimal configuration of the point absorbers in the platform.

IWT

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