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Energy

Absorbing wavemaker design and control

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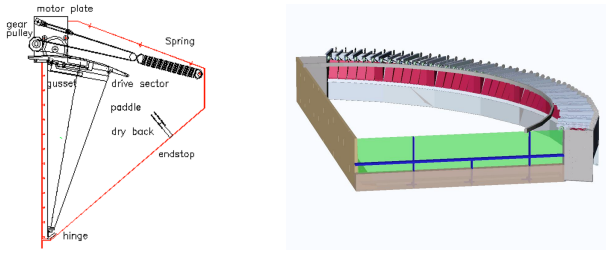
Introduction

This project is concerned with modeling active wave makers using CFD code. The control of these numerical paddles is based on the active absorption methods implemented by the wave paddles in Edinburgh's curved wave tank. These paddles use a hydrodynamic force feedback mechanism, pioneered by Stephen Salter [1] to dynamically control the paddle velocity to absorb incident waves.



Edinburgh Designs wave paddle and Curved Wave tank at University of Edinburgh

The Problem

Experimental wave tanks are used to test scale models before building expensive prototypes for the real sea. Numerical wave tanks are used for the very same reason, but give the designer more detailed feedback information and are proving to be an invaluable design tool. The problem is that both of these tools are adversely affected by wave reflections that send spurious waves into that test region.

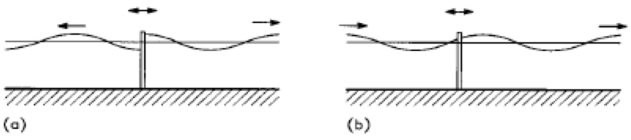


FIG. 1. (a) Wave Generation and (b) Active Wave Absorption

The Solution

Optimal absorption is achieved if the paddle is moved in such a way that the boundary appears transparent to impinging waves. This can be achieved if a radiated wave of equal amplitude and opposite phase cause destructive interference with in reflected wave. Resulting in perfect absorption at a given distance from the paddle.

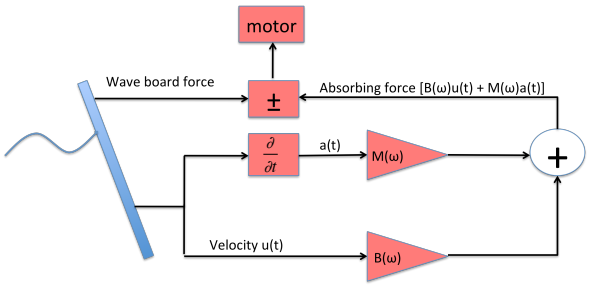


Fig 2: Control schematic for spring-damper control

Methodology

"*To destroy a wave means to create a wave*"
The method used is analogous to that of impedance matching used in signal processing. Falnes [2] states two conditions required for maximal absorption:

1) Oscillation velocity must be in phase with excitation force.

2) Absorption is at it's maximum when destructive interference between incident and radiated wave is largest

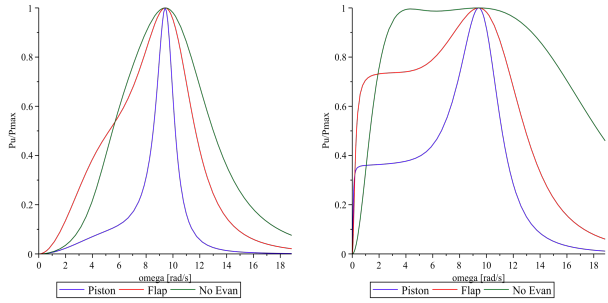


Fig 3: Absorption characteristics using two different control strategies, mass-damper (left) and spring damper (right)

Results

It has been shown that there are large increases in absorption efficiency can be obtained, depending on what control strategy is implemented and the shape of the wavemaker. An absorbing hyperbolic sine wavemaker using three control coefficients exhibited the best absorption characteristics.

References

1.Salter, S.H., (1982), Absorbing wave-makers and wide tanks, in 'Directional wave Spectra Applications', Berkley

2.Falnes, J., (2005) 'Oscillating waves and oscillating systems.', Cambridge University Press

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