#### Modelica Component Models for Oceanic Surface Waves and Depth Varying Current

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# Agenda

#### • Introduction

- Motivation
- History
- Current work
- Theory
  - General requirements
  - Regular waves
  - Irregular waves
  - Current
- Implementation
- Results
- Conclusions



# Introduction

- Motivation
  - Multiphysical simulation of systems with strong influence from hydrodynamics.

Ocean Engineering

- Black box nature of commercial software.
- High cost of commercial software.
- As a learning tool for students.







# Introduction

- History
  - OMAE2019 : Towards the development of an Ocean Engineering library for OpenModelica.
  - Compared hydrodynamic response of a catenary moored buoy modelled in OpenModelica and in Orcaflex.





## Introduction

- The current work
  - General requirements for developing ocean engineering component models
  - Component model for regular waves
  - Component model for irregular waves
  - Component model for current

• General requirements







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Regular waves ٠

 $\eta(x, t)$ 

**LPBC** 



FIXED COMPONENTS

VARIABLE COMPONENTS

$$\begin{split} \phi &= \frac{gH}{2\omega} \frac{\cosh k(z+h)}{\cosh(kh)} \sin(kx - \omega t), \\ \eta &= H/2\cos(kx - \omega t), \\ u &= \frac{\pi H}{T} \frac{\cosh k(z+h)}{\sinh(kh)}\cos(kx - \omega t), \\ w &= \frac{\pi H}{T} \frac{\sinh k(z+h)}{\sinh(kh)}\sin(kx - \omega t), \\ \dot{u} &= \frac{2\pi^2 H}{T^2} \frac{\cosh k(z+h)}{\sinh(kh)}\sin(kx - \omega t), \\ \dot{w} &= -\frac{2\pi^2 H}{T^2} \frac{\sinh k(z+h)}{\sinh(kh)}\cos(kx - \omega t), \\ \delta_x &= -\frac{H}{2} \frac{\cosh k(z+h)}{\sinh(kh)}\sin(kx - \omega t), \\ \delta_z &= \frac{H}{2} \frac{\sinh k(z+h)}{\sinh(kh)}\cos(kx - \omega t), \\ p &= \rho g \frac{H}{2} \frac{\cosh k(z+h)}{\cosh(kh)}\cos(kx - \omega t). \end{split}$$

• Irregular waves







• Current



Linear interpolation for current velocity at any depth  $Z_i$ 



# Implementation

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Start





# Implementation

• Current

Specified as vectors of depth and corresponding current velocities





#### **Results**

• Regular waves



#### **Results**

• Irregular waves



• Current



Figure 13. Current profile



Figure 12. Irregular waves.

# Conclusion

- Component models thus developed generate parameters that facilitate the computation of wave and current properties anywhere in the fluid domain.
- The output of the regular wave model is compared to theoretical values and corectness of results ascertained.
- The component models were packaged to form the preliminary ocean engineering library.

Scean Engineering





