**Geometric parameters for a 2D-Numerical Wave**

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**Aim**
This poster aims to be a storyboard on the realisation of a 2D-Numerical Wave Tank (2D-NWT), simulating numerically a wave-tank and its experiments.

**Context**
In the atmosphere of after the COP21 and its 2°C agreement, ORE shows even more its potential. But, engineering design and survivability of devices are still critical, and consist of a key point to secure the sector development.

**Setup**
Like a Physical Wave Tank (PWT), the 2D-NWT is composed of three parts:
- **INLET/wavemaker**
  - non-physically-realistic area where waves/2D tank allows different wave types to be generated (regular, irregular, combined) through a relaxation zone.
- **BEACH**
  - non-physically-realistic area where waves/2D tank absorbs the incoming wave and prevents from reflection.

**Process**
The depth is fixed to 2.8m according to Plymouth University Ocean Basin, and the three parameters left to define are:
- **NWT length**
- **Beach length**
- **Cell-size**

First, the cell-size, as it has minor influence on both other parameters.

**Application**
- Plymouth University Ocean Basin data:
  - Time-series of surface-elevation of different position
  - Extreme events (NewWave)
  - Time-series of loads
  - Time-series of model movement
  - Several models or without
- 4 cases with increasing steepness and non-linearity were simulated using a wave-gauge (WG) time-series.

**Physics and equations**
- **Physics:** two incompressible viscous fluids
- **Mathematical model:** Navier-Stokes for incompressible fluids

- Continuity equation: \( \nabla \cdot \mathbf{U} = 0 \)
- Mass conservation: \( \frac{\partial \rho}{\partial t} + \nabla \cdot (\rho \mathbf{U}) = -\nabla \cdot (\rho \mathbf{F}) \)
- **Numerical method:** Finite Volume Method for space and time discretisation
- **Interface air/water:** Volume of Fluid (VoF) Method - a fraction \( \alpha \) at each cell (0 is pure air, 1 is pure water)
- **Unknowns:** \( \mathbf{U} \) (velocity), \( \rho \) (density), \( \alpha \) (air/water)

- **OpenFOAM architecture**
- **Case directory**
- **OpenFOAM is set up with lots of different classes C++ special names - use to define different parameters**

**Reflection issue**
Even in NWT and whatever the length of the beach, some reflections will happen!

- A simulation in a 60m long non-optimised NWT shows four distinct behaviours:
  - Initial transient
  - Steady-state no-reflection
  - Transient reflection
  - Steady-state with reflection

**Conclusion**
- **Simulation in a non-optimised 60m NWT**
  - In this NWT, simulations with different beach length show that the reflection phenomenon always takes place at the same time (2.1s). So the reflection occurs at all the end of the NWT.
  - But it goes faster - \((25\% -6\%)/21=5.4m/s\) - for a 4.3m/s input waves.

**References**

**Acronyms**
- **RMSE:** Root Mean Square Difference between results and theory
- **correlation coefficient:** MATLAB script
- **NWT:** Numerical Wave Tank
- **PWT:** Physical Wave Tank

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**Tools**
- OpenFOAM, an open-source software made of a set of C++ libraries written on text files, allowing customization
- Waves2D, a library allowing generation and absorption of waves.

**Boundaries**
- **2D-WNT + 3D-NWT with one-cell thickness in the third direction, plus two boundaries type empty for both left and right sides.**

**Surface elevation with increasing steepness time-series**

**Future development**
This NWT is indeed a solid basis for future development:
- **Go 3D**
- **Fixed structure**
- **Single faulted moored buoy**
- **Multi-body**
- And as part of WaveDyn development:
  - Comparison with WaveDyn
  - Coupling with OpenFOAM
  - OpenFOAM community and its development will be very helpful: a moored buoy, a multi-body floating device, a water-turbine...

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