

Development of NWT using Ansys Fluent for the Future Development of Floating Offshore Wind Turbine Platform Analysis

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Area of Study

- Ireland's large maritime - 490,000 square kilometers. [1]
- Winds speed offshore is steadier and stronger than onshore
- Majority off offshore wind in Ireland located in locations with 60m depth [2]





Objective

To develop an Ansys Fluent Numerical Wave Tank, which may provide a basis for future Development of Models which can be used for floating offshore Wind Turbine platform testing using Ansys Fluent





Methodology

01

Creation Of
NWT



02

Replicate OC5
MARINTEK
Experiment



03

Implement varied
Conditions and
Structure



Early Development



Ansys Fluent Model

Wave Propagation

- Open Boundary Waves
- Wave Height = 0.28m
- Wave Length = 3.67m
- Free Surface Level = 4m
- 2nd Order Wave Theory

Boundary Conditions

Boundary	Boundary Condition Type
Inlet	Velocity Inlet
Outlet	Pressure Outlet
Side Walls	Symmetry
Top	Pressure Outlet
Bed	Wall
Cylinder	Wall

Methods

- **Volume of Fluids**
 - VOF Method used for Multiphase Interface Capture
- **PISO**
 - Pressure-Velocity Coupling
- **Least Cells Squares Based.**
 - Spatial Discretisation Gradient
- **PRESTO!**
 - Spatial Discretisation Pressure
- **Modified HRIC**
 - Volume Fraction
- **2nd Order**
 - Momentum and Transient Formulation

Solution Methods ?

Pressure-Velocity Coupling

Scheme: PISO

Skewness Correction: 1

Neighbor Correction: 1

Skewness-Neighbor Coupling

Spatial Discretization

Gradient: Least Squares Cell Based

Pressure: PRESTO!

Momentum: Second Order Upwind

Volume Fraction: Modified HRIC

Pseudo Time Method: Off

Transient Formulation: Second Order Implicit

Non-Iterative Time Advancement Options...

Frozen Flux Formulation

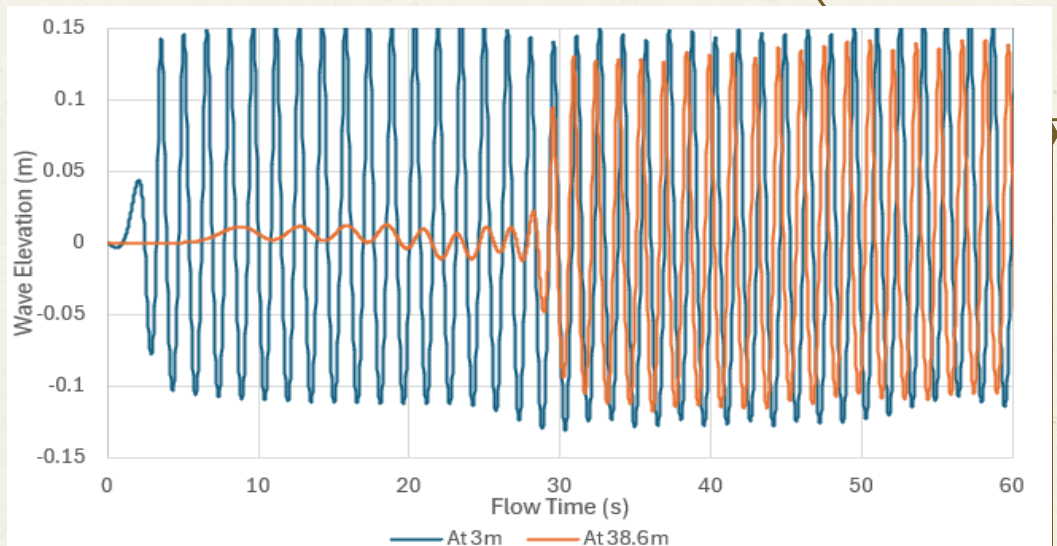
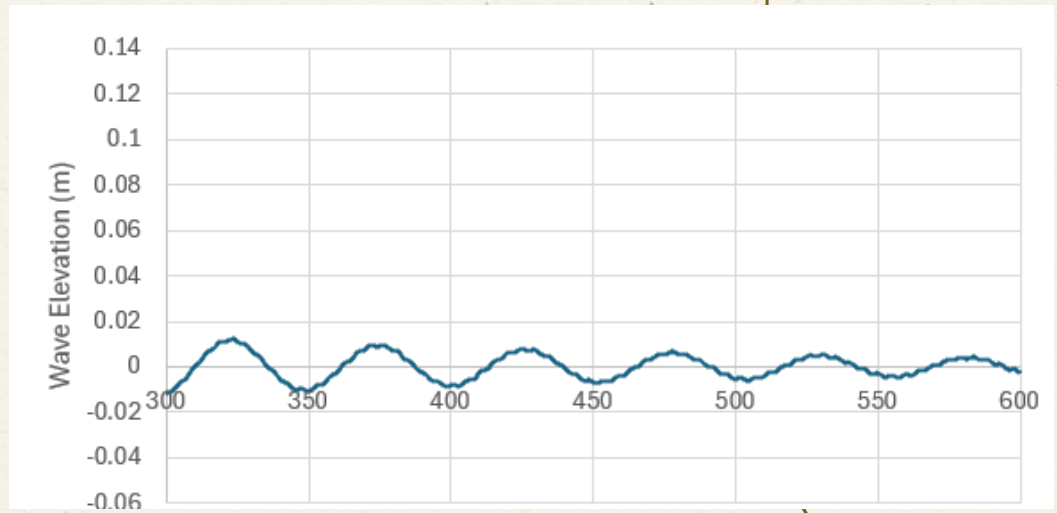
Warped-Face Gradient Correction

High Order Term Relaxation

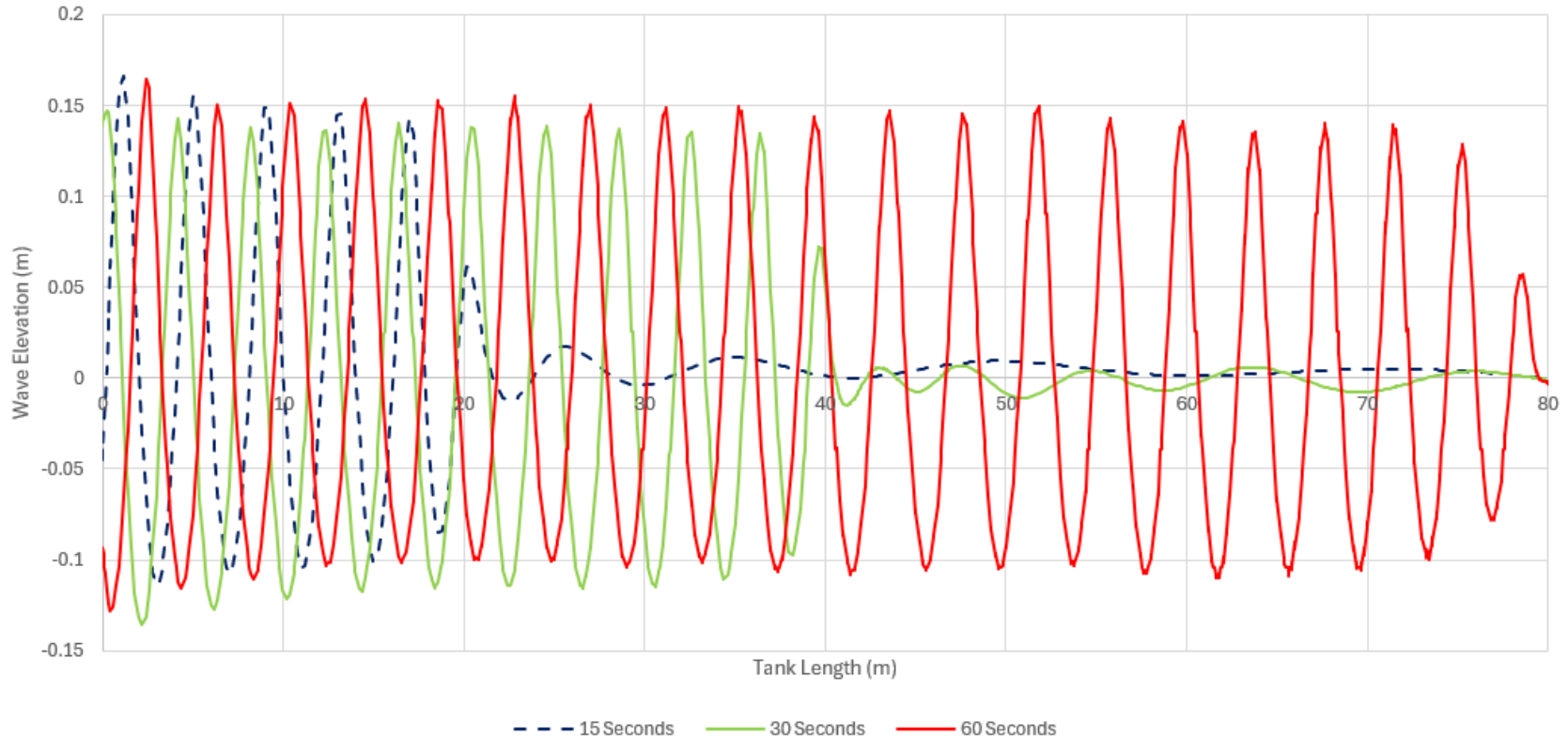
Default

With 0.2m E

5 Elements/Height
15 Elements per
Length



Wave Tank Over Time



T = 5s



T = 10s



T = 15s



T = 30s

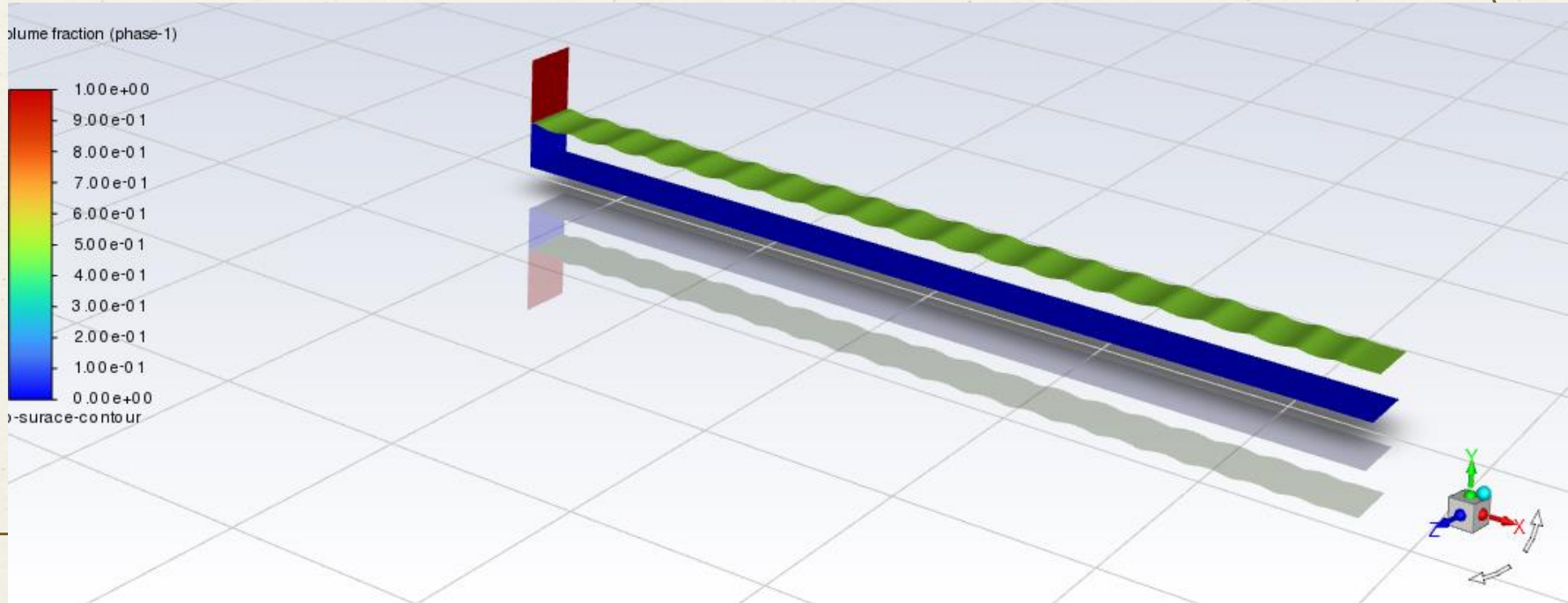


T = 60s





Wave Propagation within Empty Tank

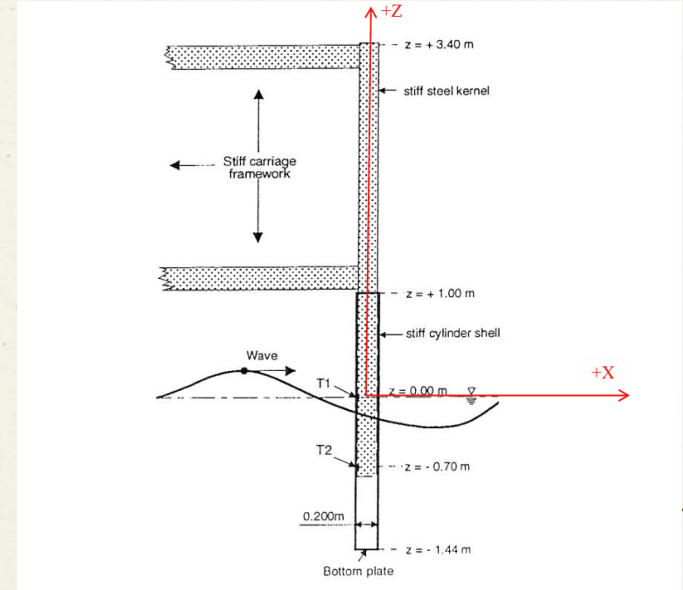




OC5 MARINTEK Experiment

MARINTEK Wave Basin, Trondheim, Norway

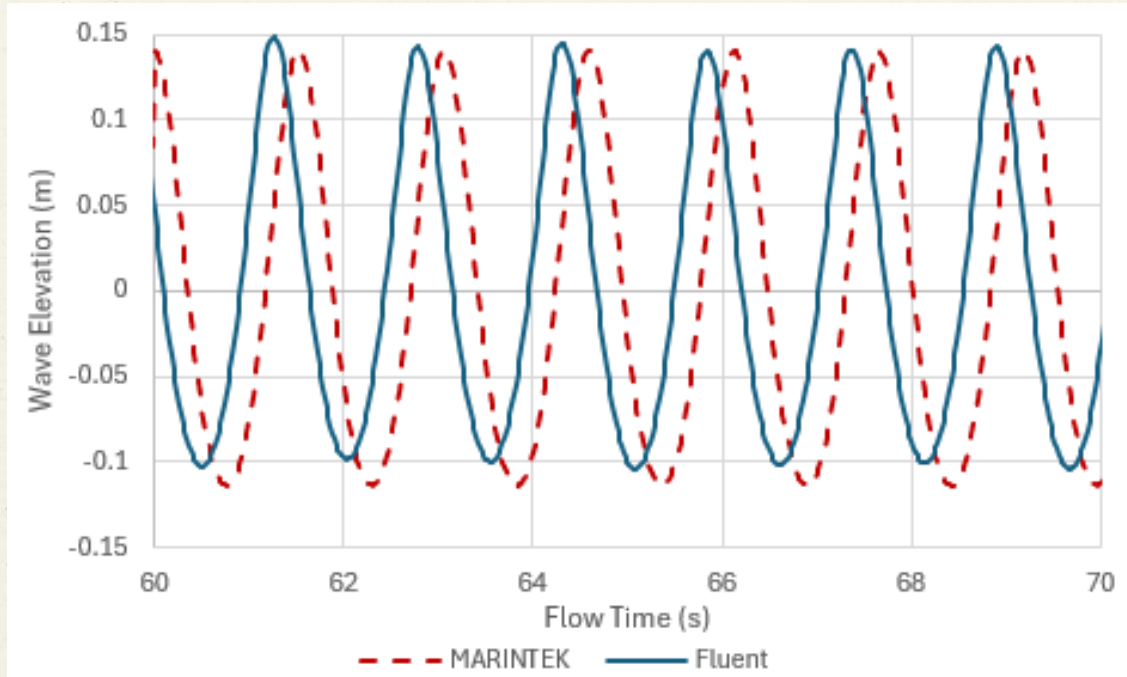
OC5 Phase 1a – Cylinder Position [3]



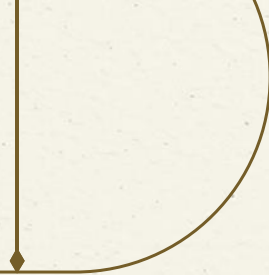


Wave Validation

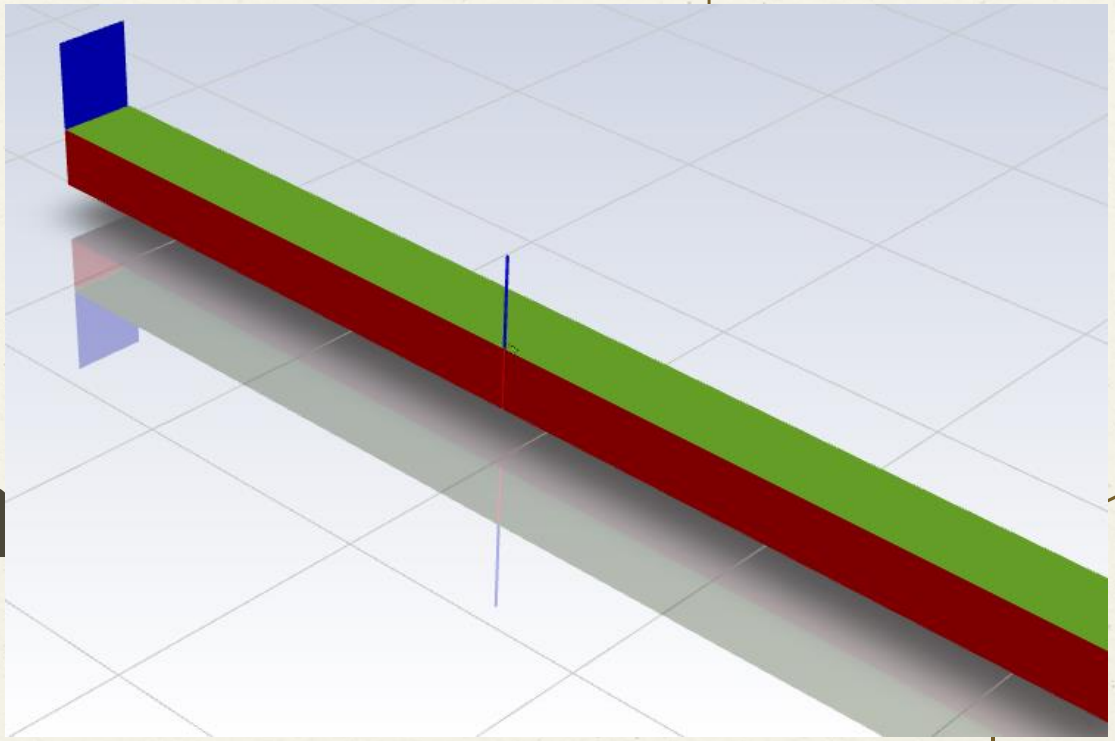
Fluent Model Vs Experimental



Slight underestimation in the wave Trough, due to slight numerical damping.



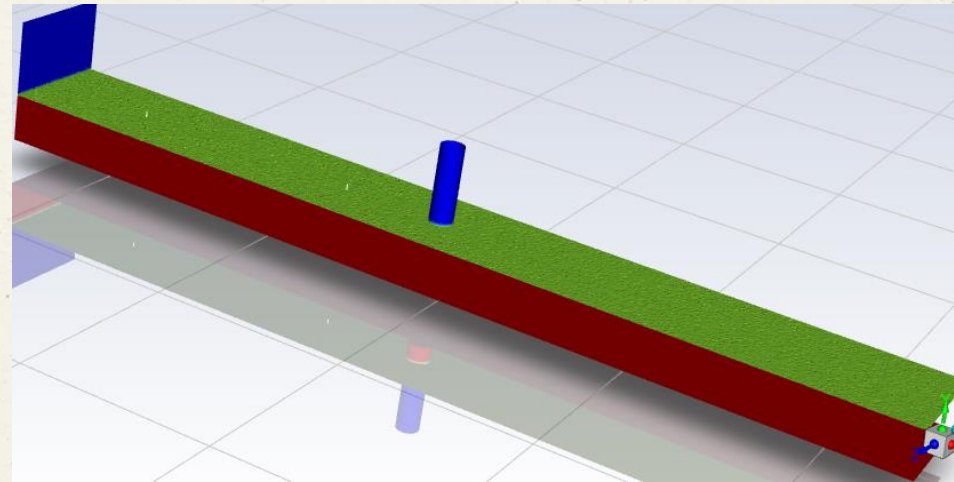
Cylinder Dra Validation





Findings

- Adding a structure to NWT reduces the accuracy of wave propagation.
- More structured elements, combined with an inflation layer, provide initial accuracy but may lead to divergence
- Adding further density to the area around the cylinder may provide both accuracy and model stability



References

1. DMAP.Gov, n.d. gov - Designated Maritime Area Plan (DMAP) Proposal for Offshore Renewable Energy [WWW Document]. URL <https://www.gov.ie/en/publication/36d9a-designated-maritime-area-plan-dmap-proposal-for-offshore-renewable-energy/> (accessed 9.20.24).
2. A. Meseguer and R. Guanche, “Wind turbine aerodynamics scale-modeling for floating offshore wind platform testing,” *Journal of Wind Engineering and Industrial Aerodynamics*, vol. 186, pp. 49–57, Mar. 2019, doi: 10.1016/j.jweia.2018.12.021.
3. Robertson, A., & Jonkman, J. (n.d.). OC5 Phase I: Definition of MARINTEK Cylinder Dataset
4. “Climate Action Plan Ireland 2024”.
5. <https://www.eirgrid.ie/>