# DAMPING OF TSUNAMI AND STORM WAVES BY COASTAL FORESTS – PARAMETERIZATION AND HYDRAULIC MODEL TESTS

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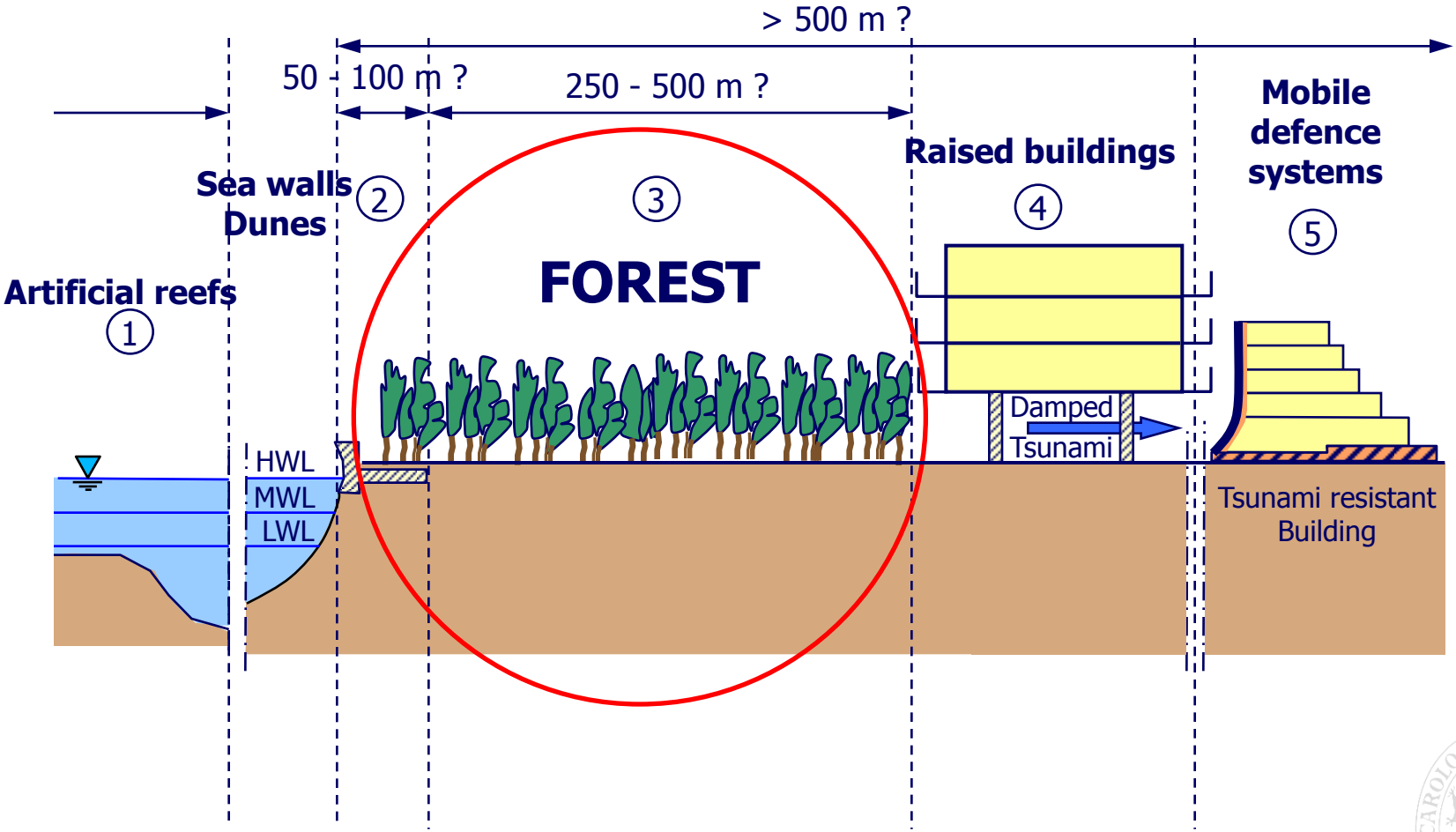
1. **Motivation and objectives**
2. Parameterization of mangroves
3. Laboratory experiments on hydrodynamic performance of mangrove forest
4. Outlook

# MULTI DEFENCE LINE STRATEGY (Oumeraci, 2006)




- Damping performance of forest
- Structural integrity of single tree

- Generate knowledge base for better insight into **physical processes** involved in interaction of tsunami/storm waves with **coastal forests**, incl. subsequent **energy attenuation**

- Develop generic methodology for **coastal forest parameterization** based on easily measurable/observable parameters

- Develop and validate/verify **prediction models** (analytical/ numerical, semi-empirical) for **hydraulic performance of coastal forests** as a protection against tsunami/storm waves.

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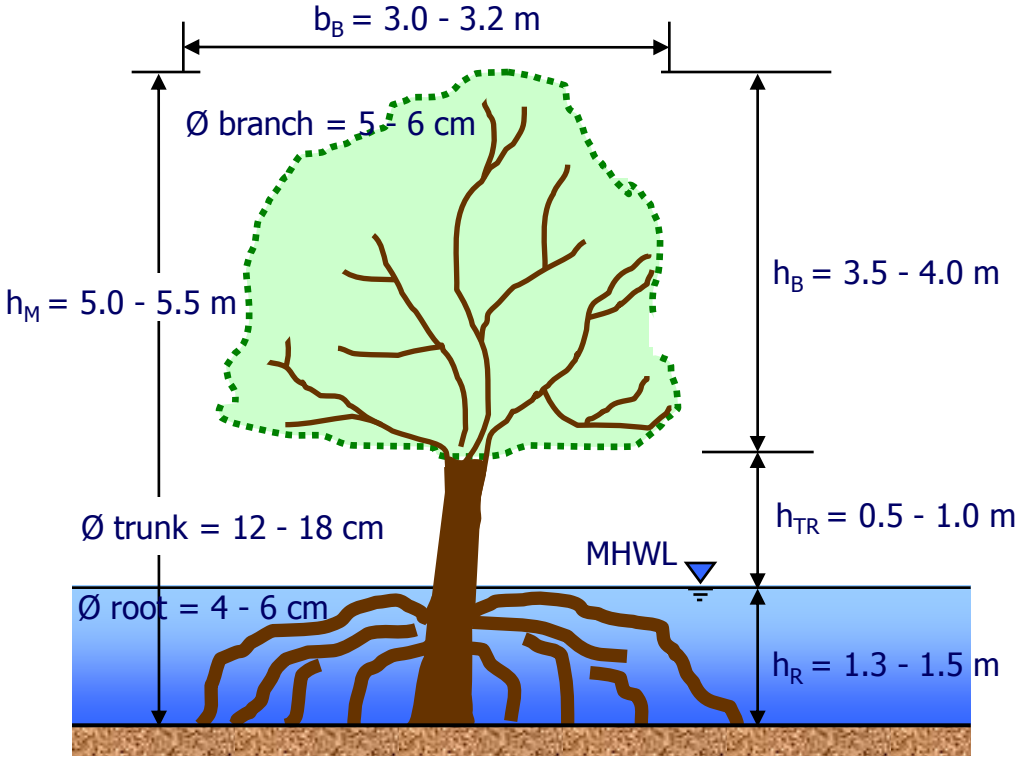
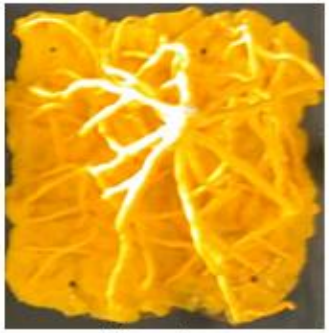
## Rhizophora sp.



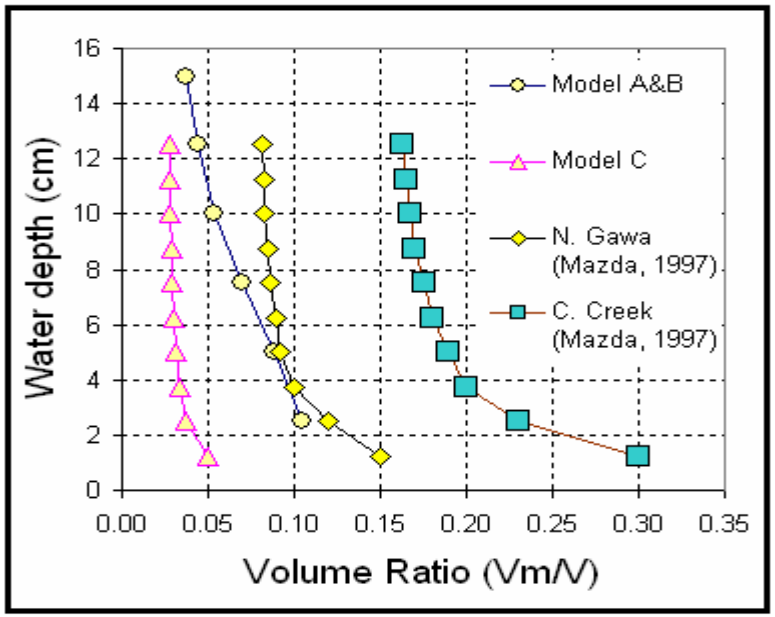

density of trunks = 0.8 - 1.0 trunks/m²
number of prop roots = 72 - 152 roots/trunk

**after Dinar et al. (2004)**

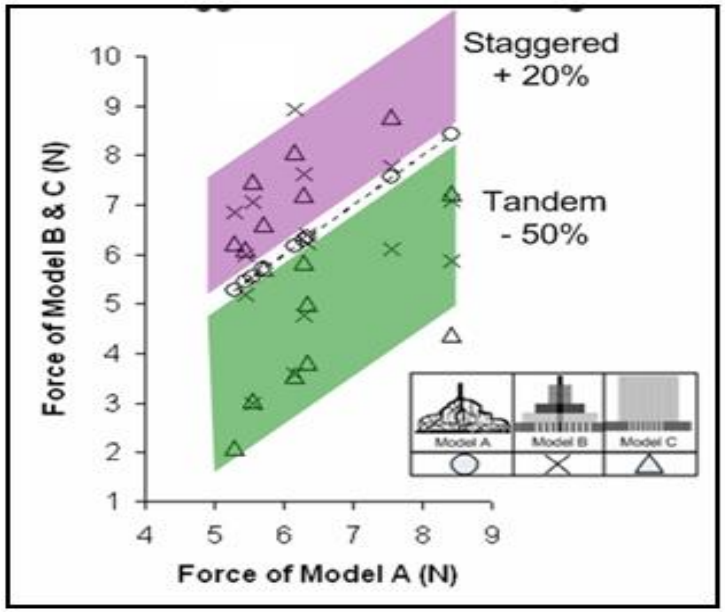
# PARAMETERIZATION OF MANGROVE TREE

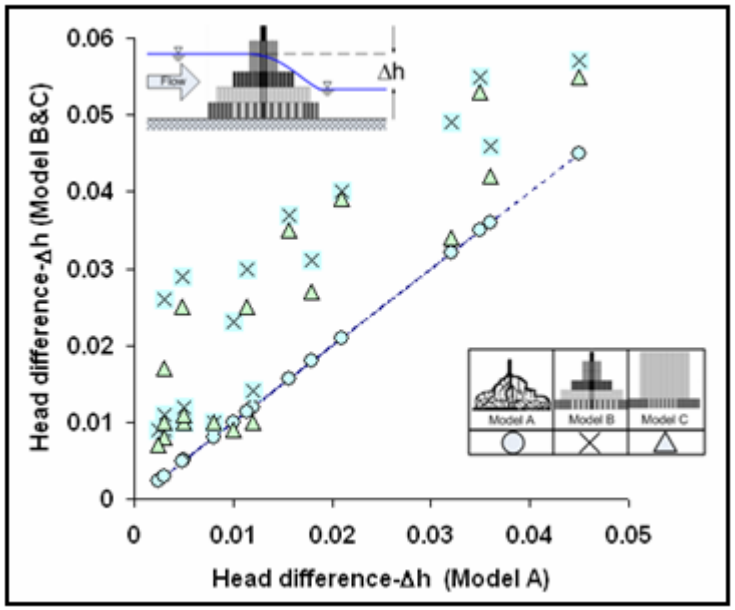
| Reference Model | Parameterised Models | |
|---|---|---|
| Model A | Model B (1st Parameterised Model) | Model C (2nd Parameterised Model) |
|  Cross section |  Cross section |  Cross section |
|  Top view |  Top view |  Top view |

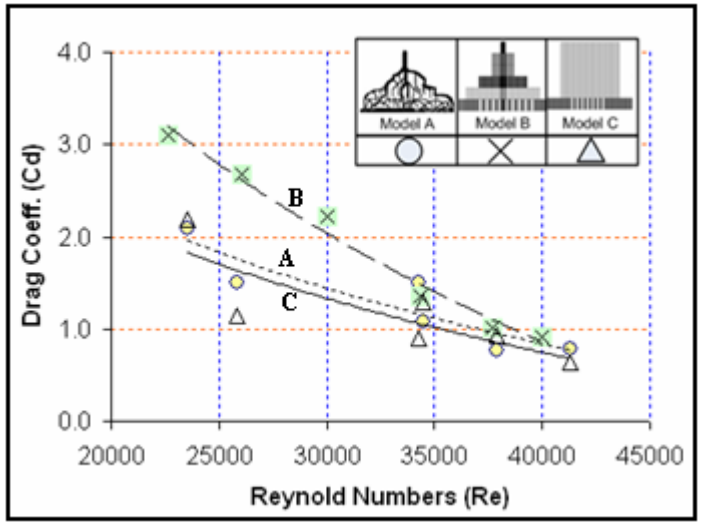
## Model Scale 1 : 20



# SELECTED RESULTS OF PARAMETERIZATION TESTS



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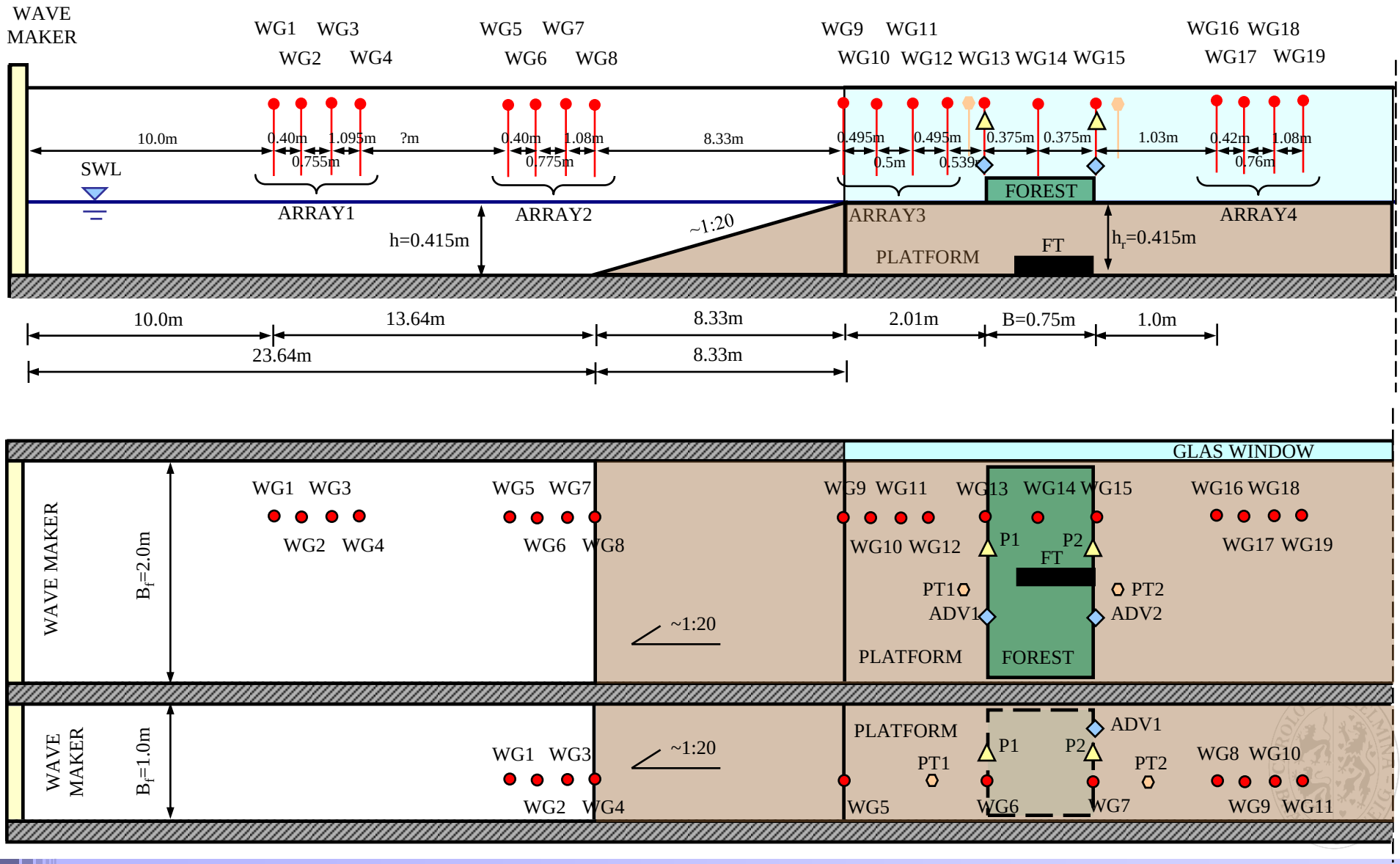
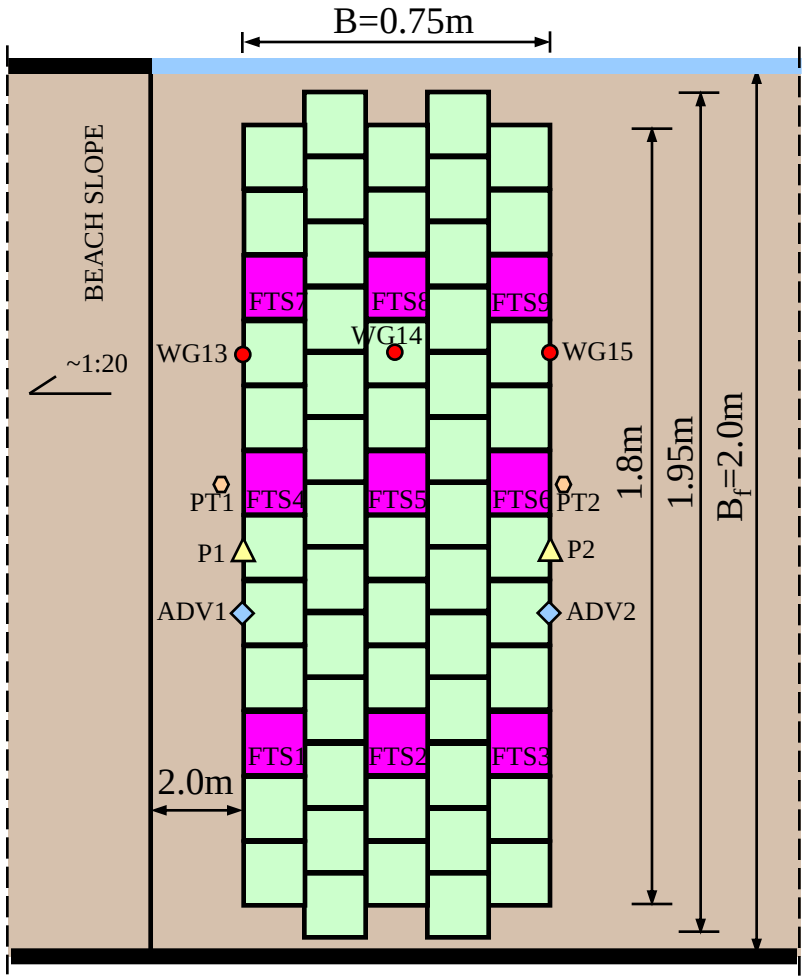
# EXEMPLARY MODEL SET-UP FOR FOREST WIDTH B=0.75m (1)



# ARRANGEMENT OF TREE MODELS AND INSTRUMENTATION




**FOREST WIDTH: B=0.75m**

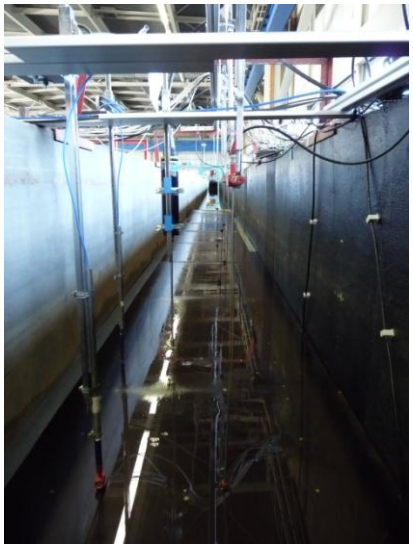
**TREE NUMBER: N=62**

**SIZE OF SINGLE TREE MODEL: 15x15cm**

**Measuring devices:**

| | |
|---|---|
| WG | Wave gauge |
| P | Propeller |
| ADV | Acoustic Doppler Velocimeter (ADV) |
| PT | Pressure Transducer |
| FTS | Force Transducer for single tree |

# EXEMPLARY MODEL SET-UP FOR FOREST WIDTH B=0.75m (2)

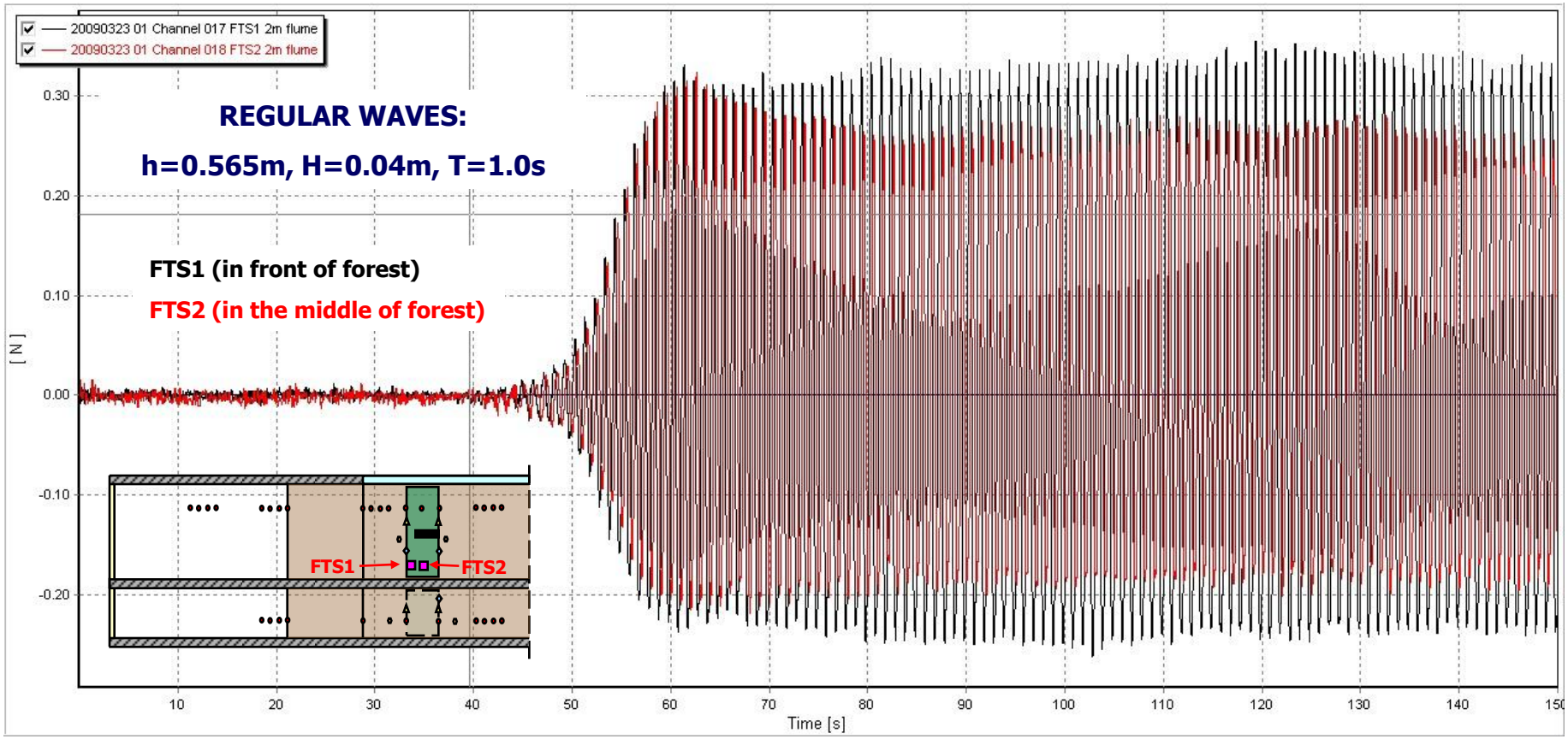


## **1. STAGE:** Mangrove Forest

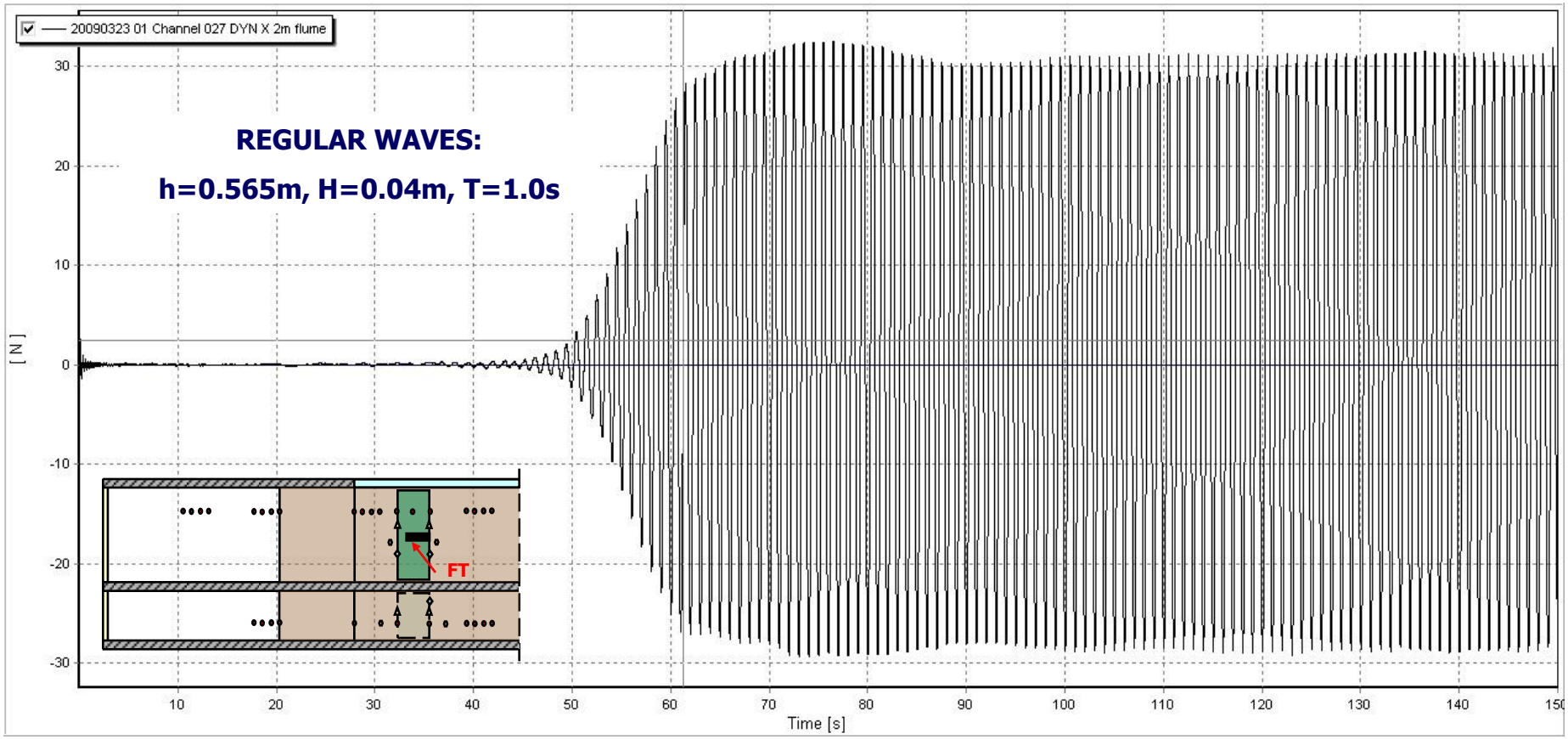
## **2. STAGE:** Pine Forest

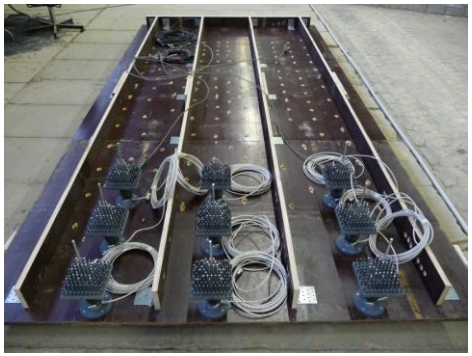
- **MODEL SCALE**: 1:25
- **MODEL STIFFNESS**: MANGROVE FOREST - stiff tree models
  (submergence depth up to canopy)
  MANGROVE & PINE FOREST - stiff/flexible tree models
  (submergence depth up to canopy)
- **FOREST WIDTH**: B=0.0, 0.75, 1.5, 2.25, 3.0 … m
- **WATER DEPTH**: h=0.415, 0.465, 0.515, 0.565, 0.615m
- **WAVE TYPES**: storm waves (regular and irregular waves), tsunami (solitary waves and bore)
- **WAVE PARAMETERS**: wave height H=0.04-0.20m; wave period T=1.0-6.0s

# MEASUREMENTS OF FORCE TRANSDUCERS FOR A SINGLE TREE (FTS)

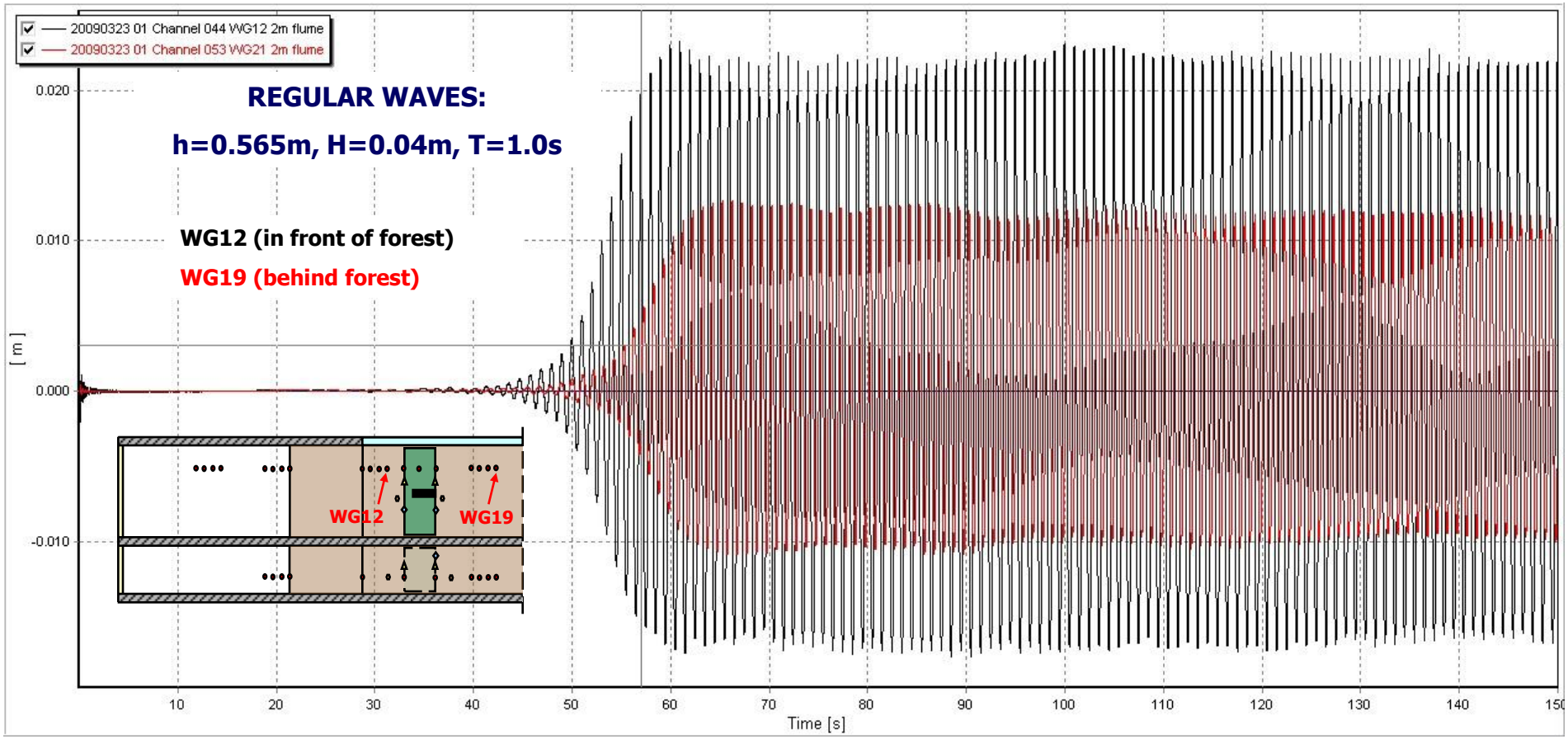



# MEASUREMENTS OF FORCE TRANSDUCER FOR ENTIRE FOREST (FT)



# MEASUREMENTS OF WAVE GAUGES (WG)



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- Preparation of equipments required for performance of the experiments (e.g. coastal pine models, gate for a bore generation in twin wave flumes)
- performance of laboratory experiments on mangrove effectiveness on wave energy reduction for varying water depths and wave conditions
- performance of laboratory experiments on Casuarina effectiveness on wave energy reduction for varying water depths and wave conditions
- determination of hydraulic performance of both types of forest (wave transmission, reflection and energy dissipation)
- Use of experimental results for the development of numerical model

# THANK YOU FOR YOUR ATTENTION !