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Dynamic Soil-Pile Interaction For Emerging Large-Diameter Monopiles Supporting Offshore Wind Turbines – A Finite Element Updating Approach

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Introduction to DSSI

A dynamic soil-structure interaction (**DSSI**) analysis evaluates the **dynamic response** of the **structure**, the **foundation** and the **soil** lying underneath the foundation. Conventionally, the soil-foundation system is considered as a **fixed, undeformed** base. However, the **soil** is highly **nonlinear** and **deformable**. Two main methods are used to model the soil-foundation system, the direct method of **continuum** modelling and the **substructure** approach.

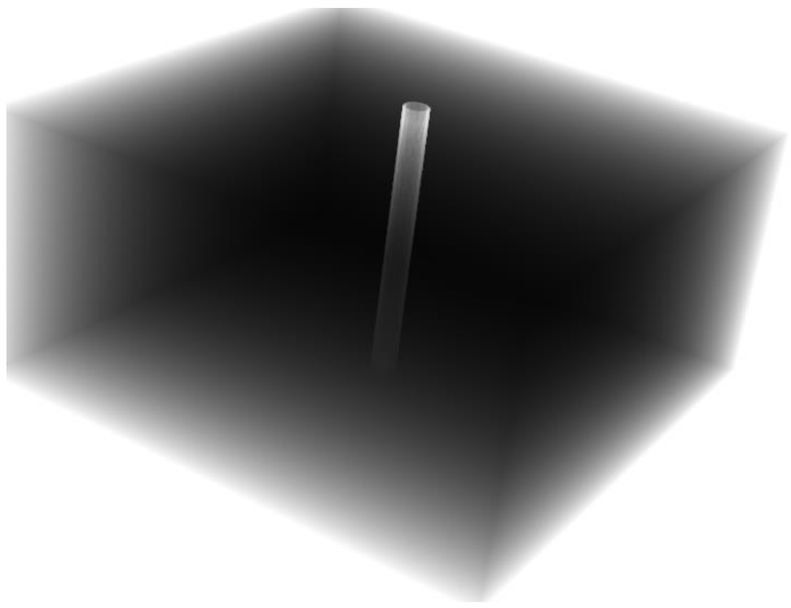

Figure 1: FEM Continuum Model

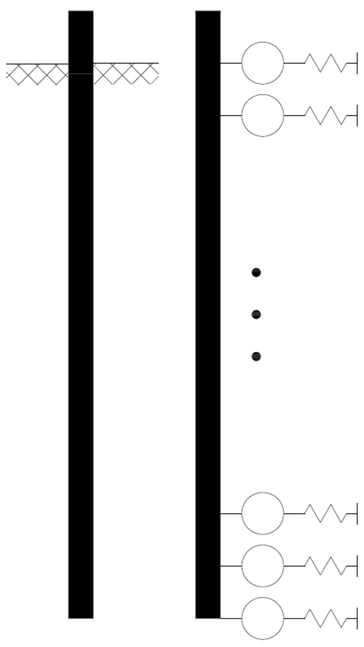

Figure 2: Winkler Model

Methodology

Governing Equation:

Integration schemes used to calculate the **acceleration**, **velocity** and **displacement** profiles are the:

- **Forward Euler**
- **Wilson–Theta**
- **Newmark–Beta**
- **RK-4**

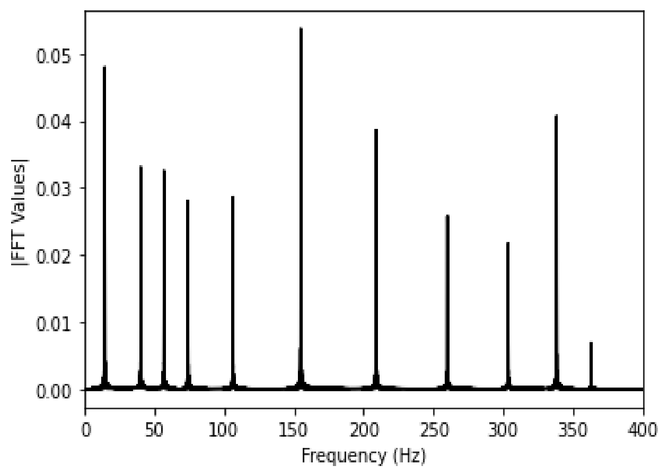

Figure 3: FFT Transformation

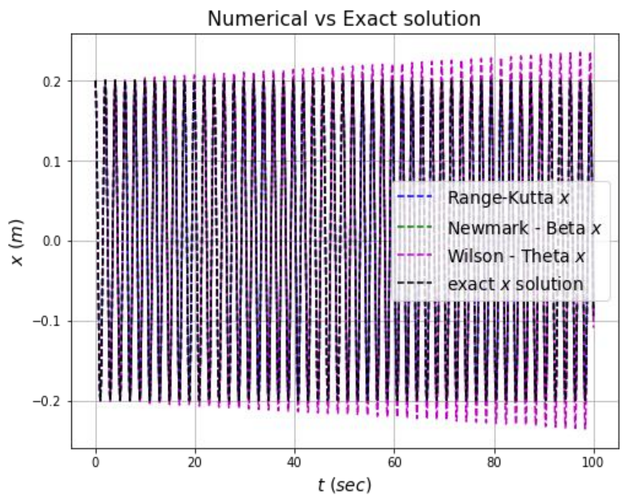

Figure 4: Integration schemes against the exact analytical solution of the displacement profile for a SDOF model

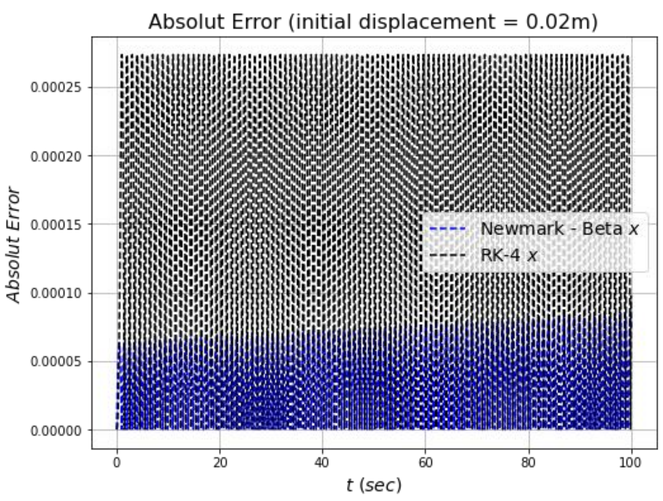

Figure 5: Absolut error of the Newmark- Beta and RK-4 methods

Finite Element Model Updating

Model updating, is about correcting **invalid** assumptions by processing **vibration test results**.

The Frequency-Response Function (**FRF**) is obtained and a set of **weights** for the **stiffness** and **mass** of the **numerical** model is calculated to match the **experimental** FRF.

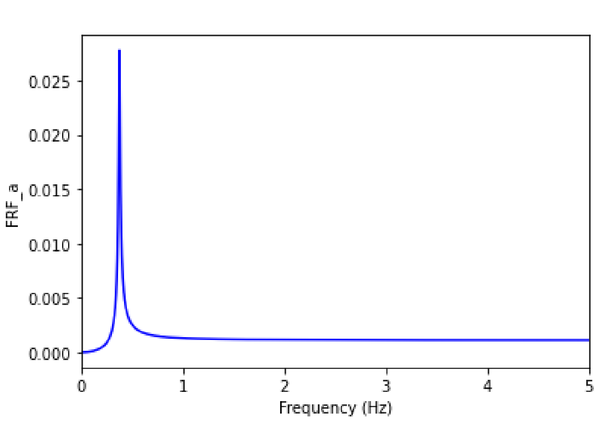

Figure 6: FRF for a SDOF model

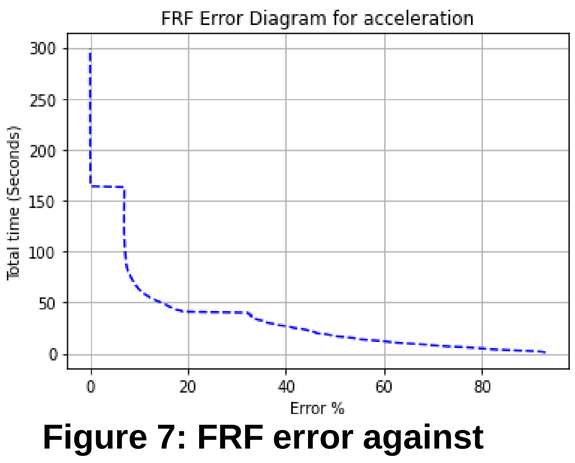

Figure 7: FRF error against the total time of running the experiment

Results & Future Work

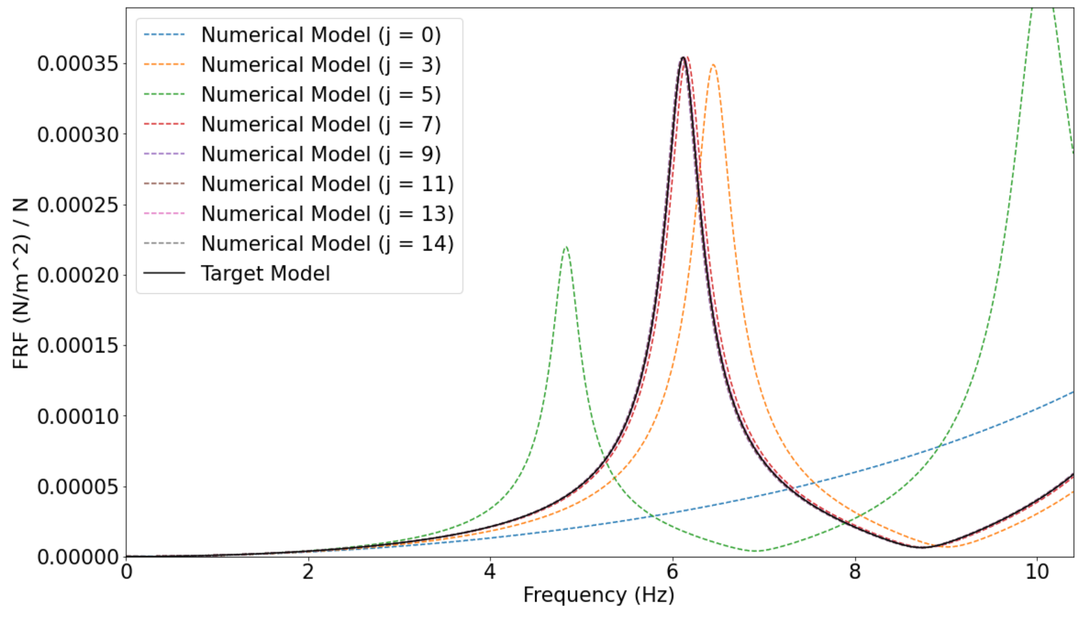

Figure 8: FEM updating results

- Develop a **FEM** code using **FENiCS** to perform the **DSSI**
- Incorporate **non-linearity** in soil response
- Benchmark Results using **experimental data**

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