Dottorato di ricerca in “Ingegneria per l’innovazione e lo sviluppo sostenibile”

Avviso di Seminario

Title: **Development of Turbisoft: A Finite Element Tool for Dynamic and Seismic Analysis of OWTs with Monopile Foundations**

Speaker: BAKHTI Rachid MCA, DMS Department ENSTP, Algeria

When: Wednesday, October 29th 15:00 – 15:30 Where: Aula Mucciarelli (ex aula Seminari), 3rd floor

Abstract:

The dynamic analysis of offshore wind turbines (OWTs) with monopile foundations is a critical step in evaluating their performance under seismic and environmental dynamic loads. Accurate prediction of the structural response requires a realistic representation of the turbine–soil–foundation interaction, which cannot be captured using the simplified analytical formulas commonly employed for natural frequency estimation. Therefore, numerical approaches such as the finite element method (FEM) are needed to properly assess the full dynamic behaviour of OWT systems. However, using 3D finite elements to model the entire OWT–monopile–soil system leads to a high computational cost, which limits their practicality for routine design or parametric studies.

To address this challenge, a computer code called Turbisoft was developed, based on the finite element method (FEM) and Fourier series expansion. The software models the complete turbine–soil–foundation system using 4-node, 8-node ring elements, and joint elements, allowing the study of the influence of soil profile, pile–soil interaction, and foundation flexibility on the dynamic behaviour of OWTs. Two main versions of Turbisoft have been developed: Turbisoft v2 and Turbisoft v3.

The second version, Turbisoft 2, focuses on computing the natural frequencies of OWTs. It was validated through nine case studies from the literature, showing that quadratic (8-node) elements provide the most accurate results and that the soil–pile interaction has a major influence on the frequency.

The latest version, Turbisoft 3, extends the software to include seismic loading analysis, enabling the evaluation of the dynamic response of OWTs under earthquake conditions. It also features an improved graphical user interface (GUI), making it more intuitive, user-friendly, and efficient. The results are highly satisfactory, showing good agreement with published data and offering useful insights into the seismic performance of monopile-supported OWTs.

This presentation focuses on the program structure, used technologies, mathematical background, and the main results obtained from the recent versions of Turbisoft.

Presentation of the research activities carried out in the LTPiTE Laboratory of the 'Ecole Nationale Supérieure Des Travaux Publics' (ENSTP), Algeria.

When: Wednesday, October 29th 15:30 – 16:00 Where: Aula Mucciarelli (ex aula Seminari), 3rd floor

Speaker: Dr. HEMAIDI ZOURGUI Nadjib

Abstract:The research areas of LTPiTE Laboratory at ENSTP cover diverse themes ranging from numerical modelling in soil mechanics, valorisation of local materials, structural optimization, environmental management, and the application of new technologies such as artificial intelligence and geospatial modelling.

1. Soil and Structure Dynamics
    a. Nonlinear behaviour of soil mechanical properties
    b. Soil and foundation dynamics: numerical modelling, vibrations of soil masses and buried foundations.
    c. Reduction of soil liquefaction risk
    d. Amplification and settlement of soils, wave propagation, improvement of numerical methods
2. Development of Innovative Materials
    a. Utilization of industrial by-products to formulate new materials
    b. Use of polymers to enhance construction materials
    c. Durability of civil engineering structures, valorisation of local materials
3. Structural Optimization
    a. Optimization of steel and concrete quantities to reduce costs of reinforced and prestressed concrete projects
    b. Modelling for optimal structural design
4. Water, Energy, and Environmental Engineering
    a. Resilience of structures to hydro-climatic hazards, energy efficiency of structures with a life cycle assessment approach.
5. Dynamics of Structures and Public Works
    a. Seismic vulnerability and damage, sustainable management of infrastructure, structural dynamics, BIM and seismic digital twins, structural performance and health monitoring
6. Geospatial Techniques and Modelling for Resilient Transport Infrastructure
    a. Development of innovative approaches for transport infrastructure resilience throughout their life cycle