DEMONSTRATION OF REAL-TIME HYBRID SIMULATION (RTHS) FOR OFFSHORE WIND TURBINES (OWTs)
ABAQUS FE Model
Experimental Substructure: Monopile Specimen Fixturing

- Electric Actuator
- Load cell
- Spherical Bearing
- Extension Tube
- Clevis
RTHS of OWTs - Demonstration

- Experimental Substructure: Monopile and Soil Instrumentation

- **Soil pressure sensors**
- **Strain gauges**

*SP* and PWP1-4 are found 6.5 ft below the soil surface.
*SP7-11 and PWP5-9 are found 20 ft below the soil surface.

Soil pressure sensors
Strain gauges
SAA
RTHS of OWTs - Demonstration

Experimental Substructure: Soil Raining

Video

Nuclear gauge measurements at different levels
RTHS of OWTs - Framework

a) OWT System
- Blade
- Monopile
- Tower
- Transition Piece

b) Analytical Substructure
- Aerodynamic Loads ($F_l^w$)
- Hydrodynamic Loads ($F_l^H$)
- Transition node
- Interface node
- MSL
- Transition Substructure
- Analytical Substructure
- Experimental Substructure node

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c) Experimental Substructure
- Tower-Blades Substructure
  (OpenFAST)
- Experimental Substructure
- Mudline
- Saturated Soil
- Monopile
Large-Scale RTHS Validation Test: Loading Conditions

- **Aerodynamic Loading:**
  1. Steady Wind
  2. Wind Speed = 11.4 m/s

- **Hydrodynamic Loading:**
  1. Regular Wave
  2. Significant Wave Height (Hs) = 3.66 m
  3. Wave Period = 7.12 sec.