Evaluation of 1/100th Scale Mooring Systems for Wave Energy Converters Dataset Description

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Introduction

This study evaluates the feasibility, accuracy, and limitations of using 1/100th scale physical mooring systems to represent full-scale mooring behavior for wave energy converters (WECs) during small-scale tank testing. The work focuses on an RM3-style point absorber deployed in conditions representative of the PacWave South test site and examines whether small-scale physical testing can reliably inform numerical modeling, design decisions, and future prototype development.

Test Cases

Four mooring configurations were designed at full scale: "**Catenary with Float", "Taut Nylon", "Semitaut Nylon", and "Semitaut Polyester".** These designs were then scaled using Froude scaling laws for implementation in the National Laboratory of the Rockies (NLR) Sea Wave Environment Lab (SWEL) wave tank. Due to geometric constraints, the mooring layouts were approximated with a two-line planar (fore–aft) system, providing equivalent longitudinal stiffness for unidirectional wave conditions. See the **"Configuration Properties"** sheet of the **"Metadata.xlsx"** workbook for the specifications of each line as deployed during testing.

For each mooring line configuration, two load cell configurations were tested. The **"Free Hanging (FH)"** configuration describes the configuration where the fairlead load cells are present and left to hang freely. The **"No Load Cell (NLC)"** configuration describes the configuration where fairlead load cells are *not* connected. For the catenary with float case there is an additional load cell configuration called **"Secured (SEC)".** For this case the fairlead load cells are secured to the tower by their cable rather than left to hang.

For each combination of mooring and load cell configurations, three repetitions of **forced displacement tests** were conducted by manually disturbing the device in a positive and negative direction. All three repetitions in both directions were recorded in the same file for each configuration. Additionally, three repetitions of **free decay tests** were conducted in all six degrees of freedom (DOF) by disturbing the device in each degree of freedom then letting it return to its neutral position. For each DOF, the three repetitions were recorded in the same file. Finally, the device was subject to three **wave cases** with approximately three repetitions each recorded in separate files. See the **"Tank Testing Matrix"** sheet of the **"Metadata.xlsx"** workbook for a full record of tests conducted in the tank.

Additional tests besides device testing include wave **tank characterization**. Waves were run in the tank without the WEC being deployed. This was done both with and without the sea bed riser

in place. Also, the mooring line **spring constants** were measured with load cells according to the **"Spring Constant Test Matrix"** sheet of the **"Metadata.xlsx"** workbook.

Data Repository Directory Structure

* Each data folder contains raw data files (.tdms or .tsv) as well as filtered and trimmed files (.parquet).

**For each wave run case the file name contains the wave height and period as well as the repetition number

- **Calibration Waves Folder** – Tank calibration data files
  - **Characterization_No Table** – Tank calibration without table deployed
  - **Characterization_Table** – Tank calibration with table deployed
  - **Tuning_No Table** – Pre test tank tuning
- **SpringConstants –** Spring constant measurements
  - **Catenary**
  - **SemiTautNylon**
  - **SemiTautPolyester**
  - **TautNylon**
- **CatenaryWithFloat2_FH –** All data for the catenary with float mooring configuration with the free hanging load cell configuration**
  - **Force Disp**
    - **EDASS –** Load cell and wave height data
    - **Qualisys –** 6DOF motion data for the heave plate and float bodies
  - **FreeDecay**
    - **EDASS –** Load cell and wave height data
    - **Qualisys –** 6DOF motion data for the heave plate and float bodies
  - **WaveRuns**
    - **EDASS –** Load cell and wave height data
    - **Qualisys –** 6DOF motion data for the heave plate and float bodies

- … Repeat above for each mooring configuration and load cell configuration combination

Data File Structure

See the **"Channel List"** sheet of the **"Metadata.xlsx"** workbook for a complete list of channels in each file type.

Coordinate System: +x is the positive surge direction, +y is the positive sway direction, and +z is the positive heave direction. During testing, the waves traveled in the positive surge direction.

Sample Rate: Load cell and wave height data – 1000 Hz, 6DOF data – 240 Hz

Raw 6DOF Motion Data

The raw 6DOF motion data is saved in the .tsv file format. The file is prepended with a 13 line header containing metadata including the file start time.

Processed 6DOF Motion Data

The processed 6DOF motion data is saved in the .parquet file format. Each column of interest has been filtered by removing outliers, filling gaps, and smoothing high frequency noise. Additionally, some files may have been trimmed to remove excess data recorded before or after the test.

Raw Load Cell and Wave Gauge Data

The raw load cell and wave gauge data is saved in the .tdms file format. The locations of each load cell are depicted in the **"Load Cell Layout"** sheet of the **"Metadata.xlsx"** workbook. The wave gauges are in a straight line down the middle of the tank starting with gauge 1 in the farthest aft direction. The wave gauges update at 20Hz but are sampled at 1000HZ, so the signal will resemble a stairstep pattern before it is filtered.

Processed Load Cell and Wave Gauge Data

The processed load cell and wave gauge data is saved in .parquet file format. Each column of interest has been filtered by removing outliers, filling gaps, and smoothing high frequency noise. Additionally, a low pass filter was used to smooth the stairstep pattern of the wave height signal.