Proceedings of the 9th International Conference on Physical Modelling in Coastal Engineering (Coastlab24)
Delft, Netherlands, May 13-16, 2024

Extended Abstract, DOI: 10.59490/coastlab.2024.803

THE SURVIWEC PROJECT: AN OPEN-SOURCE EXPERIMENTAL DATABASE FOR EXTREME LOADS ON A MOORED CYLINDER UNDER REGULAR AND FOCUSED WAVES

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ABSTRACT

In this work, we introduce a novel open-source experimental database focused on the dynamic response of a moored floater under both regular and focused waves. The database provides detailed information about the motion (6 DOF) of a cylindrical floating body anchored using two distinct mooring configurations. The former configuration employs four tension legs evenly distributed around the perimeter of the float. The latter, utilizes catenary connections made of steel chains. This database holds significance in three key aspects. Firstly, by leveraging one of the largest wave facilities in Europe for wave generation, the wave-structure interaction is studied on a large scale (approx. 1:10 ratio). Due to this, scale effects are minimized. Secondly, the database captures critical hydrodynamic loads, including slamming and overtopping induced by extreme waves, as well as snap loads in the mooring lines. These represent unique features of the dataset. Lastly, the tests are conducted with meticulous consideration for subsequent analytical or numerical validations: preliminary tests with regular waves are followed by investigations under extreme sea states represented by focused waves.

KEYWORDS: Wave energy converters, Catenary lines, Tension legs, Extreme loads, Focused waves.

1 INTRODUCTION

Currently, globally recognized standardization organizations, such as DNV [1], provide a precise framework for establishing best practices in the design of moored offshore structures. Among various environmental factors and loads, waves emerge as the predominant forces influencing the design of mooring systems, especially during events associated with high return periods. Consequently, design methodologies still necessitate a deep understanding of critical information pertaining to structural response, including factors like maximum forces or dynamic components. Years of practical experience have solidified force estimation procedures for fixed offshore installations, which often rely on “constrained profiles”. [2] Yet these approaches lose their applicability for offshore floating structures due to the highly non-linear nature of wave-structure interaction, making accurate prediction challenging. Therefore, there is a pressing need for updated and specialized information concerning the interaction between moored offshore structures and waves [3].

The SURVIWEC (survivability of wave energy converters) project aims to provide a very specific database that concentrates on supporting the design phases of wave energy converters and floating offshore wind turbines thorough establishing numerical model procedure for code validation. Specifically, high-fidelity numerical tool, such as CFD-based models, can be precisely use for the estimation of extreme loads, but their accuracy should be proved prior to their use.

1.1 The wave flume and wave conditions

The experimental campaign was conducted in the CIEM wave flume (Canal d’Investigació i Experimentació Marítima) at the Universitat Politècnica de Catalunya - BarcelonaTech (Spain), which ranks among the largest wave flumes in Europe (100 meters in length, 3 meters in width, and reaches depths of up to 4 meters). The CIEM is considered a unique scientific infrastructure by the Spanish Ministry of Economy and Enterprise (MARHIS-ICTS). Its size allows for the generation and propagation of highly energetic wave conditions, with the model scaled down to 1/10. The floating device motion is tracked using a high-frequency Optitrack system. Figure 1 shows the two examined mooring configurations: i) four tension legs and ii) catenary connections made of steel chains. Line tension is measured using one load cell for each of the connections.

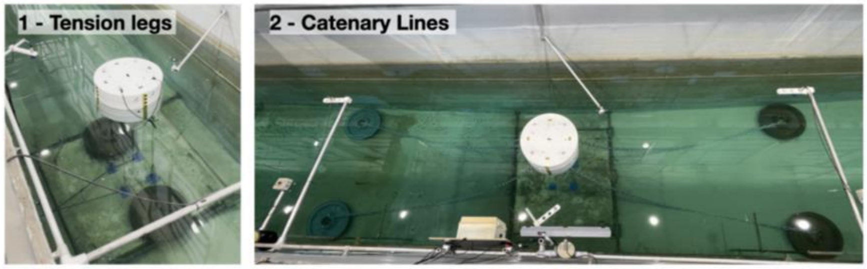

Figure 1. The two mooring configurations tested during SURVIWEC project: i) tension legs and ii) catenary lines.

The time series data illustrated in Figure 2 depicts the overall system response under regular waves (H=0.25 m, T=2.50 s, water depth=2.65 m). The first chart displays the free surface, while the second and third charts respectively show the surge and heave motion of the float for both the tension leg (TLP) and catenary line (Chain) configurations. The final chart depicts the tension time evolution.

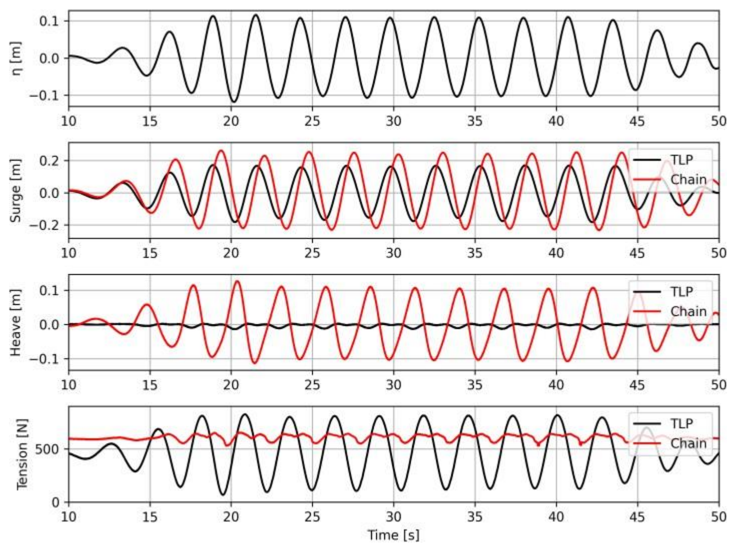

Figure 2. Response of the moored floater with two mooring layouts, under regular waves. Time evolution of the free-surface elevation (η); floater motion in surge and heave, and the mooring.

2 BEYOND THE STATE OF THE ART

This database will provide valuable data for experimentalists investigating scaling effects, as the experimental setup is designed to operate at around 1/10 of prototype scale. Moreover, it meticulously documents scenarios involving slamming, overtopping, and wave-induced snap loads in the mooring system. The presence of waves with similar characteristics in both regular and focused configurations [4] offers significant advantages for a step-by-step process of analytical and numerical model validation.

ACKNOWLEDGEMENT

This work was partially supported by the project SURVIWEC PID2020-113245RB-I00 financed by MCIN/AEI/10.13039/501100011033 and by the project ED431C 2021/44 "Programa de Consolidación e Estructuración de Unidades de Investigación Competitivas" financed by Xunta de Galicia, Consellería de Cultura, Educación e Universidade, Spain.

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