Assignment 2 - Extended abstract
Comunication Skills I

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The rapid development of floating structures such as wave energy converters, floating wind turbines and aquaculture structures has increased the use of the marine space. The new uses involve more and complex marine operations, as part of industrialized operation and maintenance strategies, where apart from accessibility issues, device towing becomes a critical issue. Moreover, the installation of floating devices is usually done by a ship towing the device using a catenary line, as shown in Figure 1. However, submerged towing systems are also used in numerous ocean engineering applications such as sonars, seabed exploration, fishing or spotting sea mines.

Figure 1: Maneuver of installation of the Windfloat device towed by a PSV.

All these activities require well planned actions to lower the risk and to raise the impact over the OPEX costs. Therefore, numerical models become a crucial tool for optimized marine operations. The purpose of this paper is to provide a numerical tool to analyze the towing maneuver of floating and submerged bodies, to be integrated into future operational systems.

Submerged and floated towing maneuvers involve a cable that connects a ship with the towed device. There are different alternatives in the literature to study the mooring systems of floating bodies. These methods are based in the study of the cable dynamics using a finite element method (FEM) [1, 6] and lumped mass models (LM) [4, 3]. Zhu [7] proposed a new nodal position FEM (NP-FEM) to study the towing of submerged bodies. The possibility of improving the numerical results found in the literature for towing systems, and the model used for the tension term on the mooring or towing lines led to this paper, where an extension of these models is proposed, improving and adapting them for application in towing maneuvers.

The Environmental Hydraulics Institute already has an implementation of a numerical FEM model used to study mooring systems, based on [1, 2]. This code has been modified to study the towing

maneuvers, implying the modification of the boundary conditions used in the model. In the study of mooring lines, one boundary moves with the moored body, and the other boundary is fixed to the seabed. In this case, one boundary will move with enforced movements, simulating the motion of the towing ship, while the other boundary is free to move the body connected in it. The presented model is validated against experimental data published in the literature, [7, 5]. These experiments were chosen as good cases for checking correctness for computing snap tensions and cable positioning, respectively. Additionally, a sensitivity analysis for the number of elements used in the discretization of the line and the damping included in the model was performed.

The validated model has been used to study the towing of two bodies. The objective was to check that the code would yield reasonable results for real-scale problems. The first example studied was the simulation of the towing of a submerged body, such as a sonar, by a moving ship. Different line lengths and body weights were evaluated to study the final position at which the towed body navigated. In the second example, the towing body is floating, as shown in Figure 1. In this case, also, different line lengths were tested. The effect of including an intermediate body to add extra buoyancy, or weight, to the catenary, increasing or decreasing the vertical component of the force at the towed body was also tested. Finally, the influence of the vertical force was also evaluated, depending on the position of the intermediate body.

This paper contains a brief description of the numerical model used to study mooring lines and the new boundary condition applied to the study of the towing maneuver. Then, the validation of the proposed model using experimental works published in the literature is presented. Finally, the proposed methodology is applied to the towing of two bodies, one submerged and one floating. The work ends up with a discussion of the work done, presented.

References

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