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EXPERIMENTAL STUDY ON WAVE DAMPING POTENTIAL OF SEAWEED AQUACULTURE SYSTEMS ON THE PORTUGUESE COAST

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1 INTRODUCTION

The sea-level rise and intensification of extreme weather events pose a significant threat to coastal regions and their communities worldwide. With significant wave heights reaching over 5 m, and wave periods over 10 s (Mendes & Oliveira, 2021), the Portuguese coastline is exposed to major coastal erosion, due to the marine harsh conditions of the North Atlantic. In the last decades the preferred strategy to protect the coastline from coastal hazards has been the construction of hard-engineering structures such as seawalls and breakwater, which tend to be expensive and unsustainable, often becoming obsolete and were not designed to account for the increasing sea level. As such, there has been a growing trend over the adoption of soft, adaptative, and nature-based coastal protection measures (Pranzini et al., 2015).

Longline seaweed aquaculture systems have long been identified as a nature-based, soft structure with wave damping potential by several studies performed by Mork (1996), Liu et al. (2015) among others. The AquaBreak Project aims at exploring the synergetic applications of seaweed aquaculture systems on food production, coastal protection, and sea decarbonization on the Portuguese coast with the creation of the AOS - the AquaBreak Offshore System (Miranda et al., 2023; Proença et al., 2023). However, in order to create a strategic and effective implementation plan for the AOS, it is important to assess the wave damping potential of such structure exposed to the common maritime conditions of the Portuguese Coast.

2 EXPERIMENTAL WORK

The current study was performed at the wave flume of the Hydraulics Laboratory of the Faculty of Engineering of the University of Porto (FEUP). The 29 m long, 1 m wide flume is equipped with a wavemaker capable of generating regular and irregular wave trains. The wave characteristics were measured using resistive wave probes placed upstream and downstream of a seaweed longline aquaculture physical model. The physical model was built on a 1:40 model scale of the Froude similitude and consists of multiple nylon lines with 80 individual polyurethane sheet stripes (0.075 m x 0.01 m). The nylon lines with polyurethane stripes were placed inside the flume perpendicular to the wave propagation direction and 0.05 m below the water surface (see Figure 1.a). The test plan consisted of testing seven maritime conditions characteristic of the Portuguese coast for three different aquacultures system lengths:1.25 m, 2.5 m, and 5 m, and two different water depths: 0.28 m, and 0.34m.

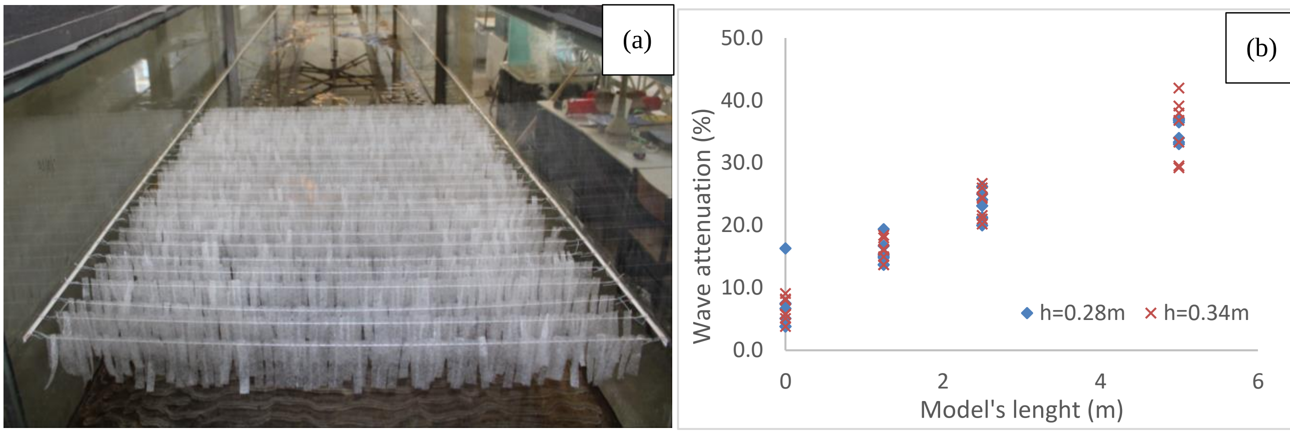

Figure 1. (a) Longline seaweed aquaculture system physical model. (b) Average wave attenuation (1-Tr) for different model lengths.

3 RESULTS

The current study showed that the wave height downstream of the seaweed aquaculture physical model were dampened (Wave attenuation = 1 - Transmission coefficient, Tr) by around 15%, ranging from 13.7% - 19.4%, for a physical model length of 1.25 m (50 m in prototype scale), around 25%, ranging from 20% - 26-7%, for a physical model length of 2.5 m (100 m in prototype scale), and around 35%, ranging from 29.2% - 42% for a physical model length of 5 m (200 m in prototype scale, also see Figure 1.b). There was no significant influence in the results for different water depths (further testing should be performed to clarify this aspect). Furthermore, tests without the presence of the model (0 m) revealed a small attenuation, around 7%, due to the flume imperfections and occasional wave breaking. At this preliminary stage, the model’s length was defined considering that the AOS may allow for several models to be coupled to each other. However, the model did not account for technical criteria related to the aquaculture installation.

4 CONCLUSIONS

The results of the current study showed that the presence of suspended seaweed aquaculture systems can decrease the incident significant wave height tested. These results are in line with the similar setups tested in the literature, *e.g.* by Mork (1996) and Liu *et al.* (2015). This study also highlights the potential benefits of the implementation of aquaculture systems not only for seafood production, but also for coastal erosion prevention and eventually to improve the performance of already designed seawalls and breakwaters near which the AOS can be installed.

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