HYDRAULIC MODEL TESTS ON WAVE ATTENUATION BY SEAWEED

SANAZ HADADPOUR [(1)] , ANDREAS KORTENHAUS [(2)] & HOCINE OUMERACI [(3)]

(1) & (3): Leichtweiss-Institute for Hydraulic Engineering and Water Resources (LWI), Department of Hydromechanics and Coastal Engineering, Technische Universität Braunschweig, Beethovenstr. 51a, D-38106 Braunschweig, Germany.

(2): Faculty of Engineering and Architecture, Department of Civil engineering, Ghent University, Technologiepark 904, 9052 Zwijnaarde/Ghent, Belgium

[(1)] s.hadadpour@tu-braunschweig.de

[(2)] Prof. Dr.-Ing., Andreas.Kortenhaus@UGent.be

[(3)] Prof. Dr.-Ing., h.oumeraci@tu-braunschweig.de

KEYWORDS:

Wave attenuation, Vegetation damping, Artificial seaweed, Laboratory tests, Aquaculture

1. Introduction

The increasing demand for aquatic food products by an ever growing population has led to the development of aquaculture in almost all regions of the world. Serious environmental impacts such as pollution and destructive fishing practices as well as the over-exploitation of coastal fisheries affect the decline of coastal fisheries despite the productive potential of the coastal environments. Therefore, the aquaculture which has been discriminated as a possible alternative to the fishery can capture the coastal productivity (Newkirk, 1996). In this sense, the utilization of existing or projected offshore constructions with a potential for multifunctional uses, represents an appropriate alternative for the development of marine aquaculture (Buck et al., 2004). Thus, the German section of the North Sea with planned offshore wind farms holds the potential for a commercially successful offshore aquaculture operation.
Among the aquaculture productions, there is a wide range of possible utilization of the aquatic plants dominated by seaweed. Farmed seaweeds, in addition to their use in the food industry, are also used for diverse applications, e.g. in the textile, pharmaceutical, cosmetic and biotechnological industry.
The effect of vegetation on wave attenuation, including extreme events such as tsunamis and hurricanes, which has been investigated in recent coastal studies, is still not fully understood. Hence, the importance of vegetation, especially seaweeds due to their applications in different industries and their role in wave attenuation and coastal protection shows the needs for more research on this topic. Therefore, this study aims to focus on some types of seaweeds and investigates their interactions with waves and their effects on wave attenuation.

2. Methodology

The literature review has shown that wave attenuation due to vegetation is highly dependent on both vegetation and wave characteristics. It was concluded that there are no ready-to-use hydraulic model test results available to predict the behaviour of sea state parameters propagating over seaweed in deeper water conditions. Therefore, hydraulic model tests have been carried out in the 1-m wide flume of Twin Wave Flume (TWF) at the Leichtweiss Institute (LWI), TU Braunschweig to study the effect of vegetation parameters (density and flexibility) and wave parameters (wave height and period) on wave attenuation. A series of experiments was performed for regular waves propagating over an artificial seaweed field, with a length of 4.2 m, in order to reproduce wave conditions of the North Sea. For this purpose, two different types of materials were used for preparing the artificial seaweeds. Moreover, two different densities of the seaweed field (i.e. 10 lines and 5 lines of artificial seaweeds) were considered.

3. Results

The wave analysis was performed on each time series measured in the wave flume using L-Davis (LWI Data Analysis and Visualization Software) tools. As a measure of the wave attenuation performance, the percentage of wave height reduction within the seaweed field was determined. The results for wave height attenuation are in good agreement with the results found in literature.

The wave height reduction showed the same trends for both materials (rigid and flexible), which were used for preparing the artificial seaweeds, and appeared to be more dependent on the period rather than on the height of the incident waves. From the analysis, it is demonstrated that the percentage of wave height reduction has an inverse relationship with wave period and a direct relationship with wave height. It means that, wave attenuation decreases for longer waves, while higher dissipation is induced by larger wave heights.

Furthermore, the results show how the vegetation density affects wave attenuation: with the higher vegetation density (10 lines of seaweeds) the wave height decreases only by 1- 4% more than the lower density with 5 lines of seaweeds. In addition, it was found that the vegetation stiffness also affects the amount of wave height damping: with rigid members, in most cases, the wave height is reduced by an extra 1- 3% compared to flexible members.

The experimental results show a total wave height reduction of nearly 7- 16% through the total length of the seaweed field. About 6- 13% reduction occurred in the first half of the seaweed field, while in the last half the decrease of the wave height was only around 1- 8%.

Acknowledgments

The authors would like to gratefully acknowledge the financial support of this study by the EU within the MERMAID project (FP7-OCEAN.2011-1 “Multi-use offshore platforms") as well as the nice collaboration within this project. We also gratefully acknowledge the continuous support and help of Jan-Joost Schouten from Deltares through this project. Dr. Maike Paul is much acknowledged for her helpful comments and useful discussion.

References

Buck, B.H.; Krause, G.; Rosenthal, H., 2004: Extensive open ocean aquaculture development within wind farms in Germany: the prospect of offshore co-management and legal constraints. *Ocean & Coastal Management, 47(3), 95-122.*

Newkirk, G., 1996: Sustainable coastal production systems: a model for integrating aquaculture and fisheries under community management. *Ocean & coastal management, 32(2), 69-83.*