Experimental and Numerical Investigation of the Effect of Mooring Stiffness on the Behaviour of Π-Type Floating Breakwaters

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ABSTRACT

Floating breakwaters (FBs) are suited to protect small marinas in mild sea conditions (wave periods up to 4 s and wave heights smaller than 1.5 m). Several companies in the world provide a very effective typology, a concrete rectangular caisson with two vertical plates protruding downwards from the sides. As these shapes resemble a Π, they are referred to as Π-type FBs.

In a previous paper, the Authors proposed a new formula for the transmission coefficient based on experiments on six different geometries of this type of FBs, with mass varying from 16 to 76 kg (representing prototypes at different scale, up to 130 tons), all anchored with chains. The formula identifies a key non-dimensional parameter as essential to describe the transmission phenomenon.

The aims of this paper are to investigate on the effect of the mooring stiffness, since the degree of restraining on the floating bodies is expected to alter significantly the FB’s efficiency.

For this purpose, new experiments were recently carried out in a wave flume on FB anchored with piles and tethered with elastic lines, and an exploratory analysis is performed by means of simplified numerical simulations.

Based on these investigation, a second non dimensional parameter (d/h, i.e. draft over water depth) is identified as essential to predict whether lower transmission is obtained with a larger or a lower mooring stiffness. Only qualitative predictions are anyway proposed.

KEY WORDS: Design formula; Floating Breakwaters; Mooring system; Physical model tests; Wave transmission.

INTRODUCTION

Floating structures are frequently used to protect coastal areas (lakes, open seas in mild wave conditions) or delicate ecosystems (lagoon marshes, tidal flats, etc), against wind or ship generated waves.

One of the advantages of floating structures is that their efficiency is almost independent from tide and, consequently, to sea level rise.

Furthermore, the environmental impact is low, the building and removal costs are small, the time required for installation is short and there is a possibility to rearrange the modules and/or to reshape the layout accommodating future modified uses.

A growing number of companies in Italy (Ingemar, AC Marine, Sistema Walcon, Martini Alfredo) and abroad (e.g. Archimedes Marinas, Greece; SF Marina, Sweden; Bellamer, Finland) provide concrete floating breakwaters (FBs) of patented shapes.

Each company provide more than one FB model. The larger ones are suited to protect the marinas from longer waves.

Examples of such models are (Cove, 2008):
- Ingemar (Italy), Type FCA 20x6, approx. 20x6 (160 tons)
- SF Marina (Sweden), Type SF 500, approx. 20x5 (60 tons)
- AC Marine (Italy), OSBW01, approx. 20x4 (40 tons)
- Bellamer (Finland), Type 180, approx. 20 x 3

The geometries of the FB models are similar and in fact they may be considered of the same typology. The common feature is the presence of two vertical plates protruding downwards from the sides. The plates may be observed for instance in Figs. 1 and 2. Several other patented FB models could be presented, all characterized by the presence of the vertical plates. As the shape of these FB resemble the Greek letter Π, they are referred to as Π-type FBs (e.g. Gesraha, 2006).

Fig. 1. breakwater Π type
SF 300-SF 400 – SF 500 (SF Marina)