Experimental Study about the Wave Attenuation Performance of a Horizontal Interconnected Triple-Pipe Floating Breakwater

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ABSTRACT

Based on the idea of utilizing commercial pipes as float elements, a floating breakwater model has been developed by using three circular cylinders. This paper gives the details of the model, the test procedure and the transmission and reflection properties of the breakwater model. Though the results are promising, further research is needed to assess the mooring loads.

KEY WORDS: Floating breakwater; wave attenuation; pipe breakwater.

INTRODUCTION

Floating breakwaters are popular coastal structures for regions of relatively mild wave climate. Though they have common weaknesses such as requirement of maintenance and ineffectiveness against swell-type waves, their preference is primarily boosted based on their minimal environmental impacts and independency of applicability from foundation conditions.

Today, most of the studies and construction of floating breakwaters are mainly based on box- or pontoon-type breakwaters. Many other types of floating breakwaters also exist, most of which found very limited application or remained as paper-projects. For a detailed literature review about floating breakwaters, the user is referred to the work of Hales (1981), whereas some useful design criteria are given in McCartney (1985) and PIANC (1994).

Almost all floating breakwaters necessitate much specific methods of construction. Large units may even need to be manufactured in drydocks, whereas many smaller factory-produced types also exist today. This feature doubtlessly increases the quality of construction. On the other hand, if replacement breakwater units are needed in the case of damage, excessive corrosion or in case of rearrangement or extension of the breakwater, the owner has to call the production factory for the required replacements and/or additional modules. This is a cost-increasing factor, especially if the structure is large to be carried by conventional methods. In-situ constructable floating breakwater models also exist as floating tire breakwaters, however, their application is much limited to mild wave climates, whereas they are not considered as environmental friendly due to possibility of loss of individual tires into the marine environment.

This study is based on the ability of in-situ construction of a floating breakwater. For this purpose, a simple idea is to utilise commercial pipeline elements for wave attenuation. A float can easily be constructed by welding the two ends of a pipe segment shut, and the connection of the structure can be supplied with simple shackle elements or eyebolts welded onto the pipe body. Such a structure can easily be constructed at the construction site, while the connection shackles are the only specific elements to be produced, which, as stated, may be replaced by eyebolts.

Usage of circular cylinders as floating breakwaters is not a very recent case. Jackson (1964) conducted laboratory tests on a twin-log floating breakwater moored by vertical piles (Hales, 1981). Brebner and Ofuya (1968) tested a twin-cylinder floating breakwater, where emphasis has been kept on the effect of the ratio of submergence of the cylinders on wave transmission. They indicate that a twin-cylinder floating breakwater constructed from 1.8m diameter cylinders can be effective for deepwater waves having a length of up to 12 meters. Another variant has been developed as the A-frame floating breakwater, which deploys a vertical wall between the two cylinders, enhancing the structures reflection capacity (Ofuya, 1968). Yamamoto et al. (1980) developed a theoretical approach for the mooring forces, motion responses and wave attenuation properties of elastically moored floating breakwaters; they also made an experimental verification, which also includes the case of a single circular horizontal cylinder. Mays et al. (1999) investigated the motion responses, hydrodynamic forces and wave attenuation properties of submerged horizontal circular cylinders moored with taut mooring lines. Sundar et al. (2003) investigated the hydrodynamic performance of a floating pipe breakwater, which has been constructed as a raft made from a single row of cylinders with a distance equal to the cylinder diameter between each cylinder. Hedge et al. (2007) researched the performance of a pipe breakwater, which is also a raft composed of three layers of circular cylinders, forming a porous grid floating on the water surface. They also investigated the mooring forces on the same breakwater model (Hedge et al, 2008). Another application has been inspected by Ozeren et al. (2008), who inspected the applicability of commercial pipes as