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Mooring Force Study of Flexible Bladder Bag Type Breakwaters

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Abstract

Flexible breakwaters have been a hot topic of research in recent years, reducing the risk of breakwater damage and solving the problem of interconnecting traditional breakwaters. High-strength fabric reinforced structure applied to the breakwater has a very good effect. In this paper, combined with the capsule manufacturing capability of large high-strength composite fabric structure in China, a flexible floating breakwater with a large flexible capsule as the embankment body is proposed, and the mooring force of its anchor chain system is experimentally studied in the regular wave-making pool. The results show that the width of the breakwater body relative to the wave (W/L) has a significant effect on the mooring force of the mooring chain system, and that the force on the waveward side of the breakwater is always greater than that on the backward side.

Keywords

Flexible Breakwaters; Fabric-reinforced Structures; Mooring Forces.

1. Introduction

Breakwaters are good for protecting the coastline and marine development projects, but traditional breakwaters are too expensive and have greater interference with the water circulation in the protected sea area, therefore, new flexible floating breakwaters have entered the research horizon of scholars at home and abroad[1]. Based on the research of domestic and foreign scholars, this paper proposes a new type of flexible floating breakwater and conducts an experimental study on the mooring force of the mooring chain system of the flexible breakwater in a regular wave-making pool.

Because the high-strength fabric reinforced structure has good stiffness characteristics and China now has the manufacturing capability of large-scale high-strength fabric. This paper designs a new type of flexible floating breakwater with a flexible bladder bag as the main body, which, combined with the high strength of the fabric-reinforced structure, has a good hair protection capability in the face of waves and is a good protection for coastal facilities and marine development facilities.

2. Physical Model Design

The physical model of a flexible floating breakwater is usually used to investigate the wave dissipation and protection capabilities of a flexible floating breakwater. The Froude gravity similarity criterion is widely used in wave-making pool experiments[2]. Its expression is as follows:

$$F_r = \frac{\mu_p}{\sqrt{g_p L_p}} = \frac{\mu_m}{\sqrt{g_m L_m}} \tag{1}$$

$$Fr_p = Fr_m \tag{2}$$

μ is the wave propagation velocity; L is the characteristic length; m,p represents the model and prototype of the flexible breakwater.

The main body of the flexible bladder bag floating breakwater consists of a cylindrical flexible bladder bag, with a warp and weft "shell" of high strength polyester yarn on the outside to strengthen

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the pressure resistance of the flexible floating breakwater, with an anchor chain system on both sides to provide security and enhance the wave dissipation capability of the flexible breakwater. The flexible bladders that make up the flexible bladder bags are shown in the following figures.

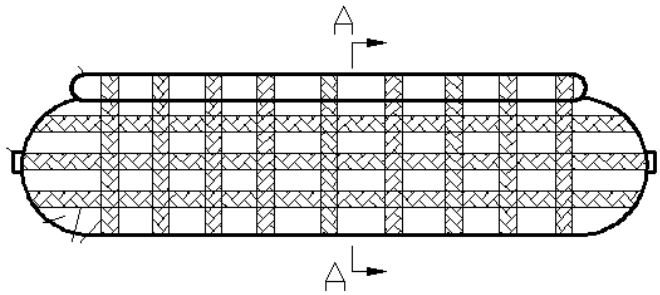

Fig. 1 Capsule shape structure

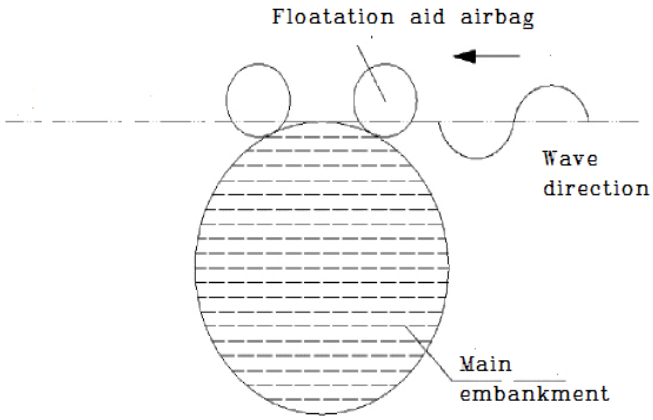

Fig. 2 Schematic diagram of the breakwater section

After the physical model of the flexible bladder bag floating breakwater was prepared according to the model similarity criterion, the mooring chain system was further designed and finally the mooring force of the breakwater mooring chain system was experimentally investigated in a regular wave-making pool to explore the mooring force of the flexible bladder bag floating breakwater.

3. Mooring Force Experiments

The study of wave dissipation performance and kinematic response of floating structures at sea is generally carried out in a standard wave-making pool.A regular wave generator, a wave height meter for measuring wave height, experimental control equipment and a wave energy dissipation network are required as standard.

The physical model experiments for the flexible floating wave break mooring setup studied in this paper were carried out in a standard regular wave-making pool. A schematic layout of this physical model is shown in Figure 3 below.

The mooring force experiments of the flexible bladder bag floating breakwater mooring chain system were carried out in a standard regular wave generating pool. The pool is 1320 long, 10m wide and has a maximum working depth of 2m. It is equipped with a three-dimensional pusher-type 24-unit wavemaker, which can create regular waves, two-dimensional constant-peak non-regular waves and three-dimensional directional waves. The wave generator is capable of generating wave periods of 0.5s-4s and wave heights of 0.01m-0.4m; at the other end of the pool, a multi-layer flexible structure of energy dissipation nets is installed to minimise wave reflection from the pool walls. The wave data was collected using a YWS100-AXX capacitive wave height meter. The systems and instruments were calibrated before the experiment to ensure the accuracy of the results.

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According to previous research, the best mooring performance is achieved when the breakwater is placed in a "V" shape[3], so the mooring forces under this arrangement are studied.

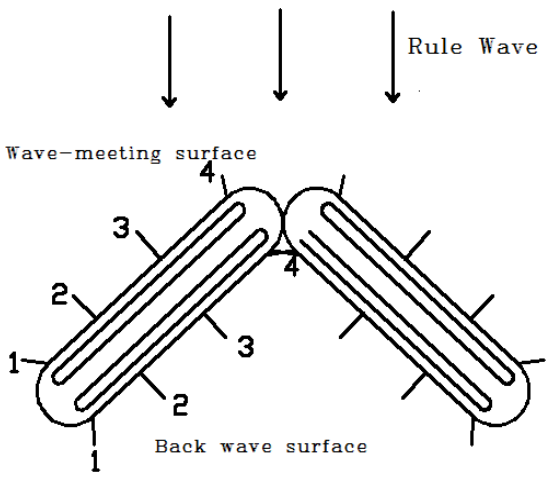

Fig. 3 Mooring force experimental arrangement

4. Experimental Results

The results of the flexible bladder bag floating breakwater physical model mooring force experiments are shown in Figure 4 below.

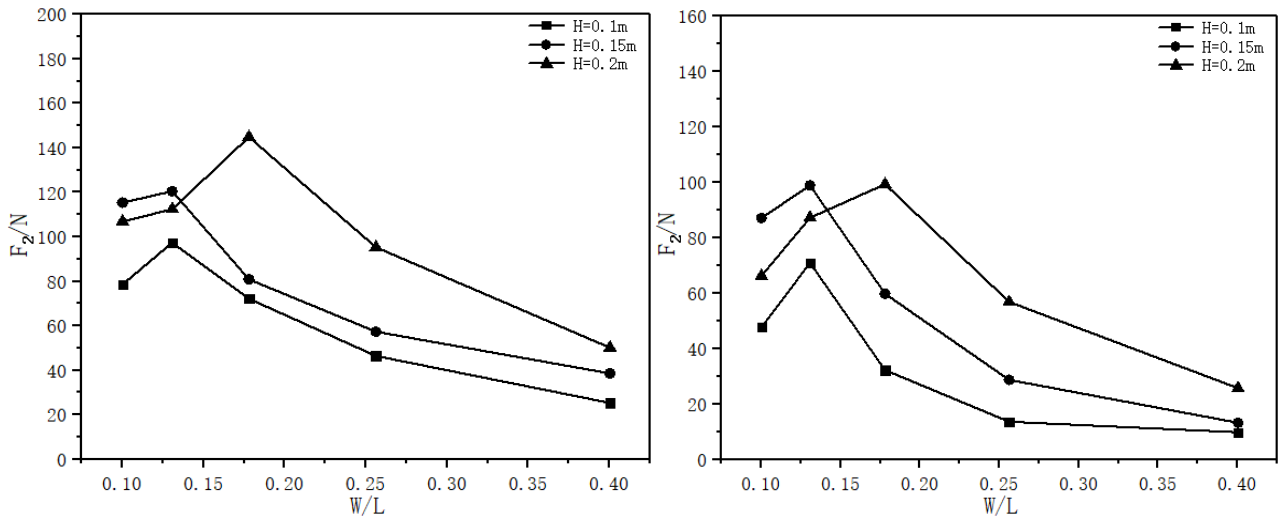

Fig. 4 Mooring forces on the wave front and wave back

The experimental results show that the mooring forces of the mooring chain system of the flexible breakwater are significantly different between the wave front and the wave back, with the mooring forces on the wave front always being greater than those on the wave back[4]. The effect of wave height and the width of the flexible breakwater body on mooring forces is significant, and the longer the wave period, the greater the effect.

5. Conclusions

This experimental study was carried out to investigate the mooring force of the mooring chain system of the designed flexible bladder bag floating breakwater under the set experimental conditions in a standard rule wave wave-making pool, and more accurate results were obtained. The results of the

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previous theoretical studies on the new flexible bladder bag floating breakwater are verified and provide accurate theoretical and experimental data support for the subsequent breakwater studies.

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