

The Experimental Study on the Hollow Wave Dissipation Structure of a Semi-Submersible Embedded Ball Box in the Specification Spectrum Wave

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Abstract. In order to break wave to protect coast without coastal landscape destruction, for better coastal protection and development. Based on the physical experiment mode, a kind of semi-submersible embedded spherical block wave structure is proposed. In this paper, we discussed the effect of this wave dissipation structure. The experimental results show that the wave structure has a good wave dissipation effect. At the same time, the specially designed ball box net box can be used as the incubator to bring economic benefits.

1. Introduction

Before the 1960s, the main protection of the coast was the construction of seawalls, this is a passive form of coastal protection, although the coast is reinforced but the development and utilization of the coastal zone is inconvenient.[1]-[3] With the maturity of marine engineering technology, the way to protect the coastline begins from the traditional single way and develops in the form of multi mode combination. In addition, people begin to pay more attention to the environment when they exploit and utilize the resources. The green, environment-friendly and sustainable development projects are becoming more and more popular. The floating breakwater has the advantages of improving the water quality and economy in the harbor area compared with the fixed breakwater.[4]-[6] At present, there are many related researches on the wave performance of floating box structure.[7]-[11] Therefore, a physical model of the hollow block type wave dissipation structure is proposed, which can reduce the erosion of the coastal area and protect the coastal area without destroying the natural environment. Meanwhile, it also brings economic benefits.

The experiments were carried out at the wave flume (length 60m, width 1m, height 1.5m) at Jiangsu experimental base of Chinese Academy of fishery sciences. A wave maker is mounted at one end of the water tank and it can produce stable specification spectrum wave. The other end of water tank has wave screen to reduce the wave reflection.

2. Physical Model and Test Scheme

A physical model is a group wave eliminator consisting of several identical units connected together. The unit body is composed of 8 inner diameter 16mm, an outer diameter 20mm and three through right angle pipe 22, The joint is sealed and made into a six face type block with a side length of 100mm. There is a ball cage with a diameter of 80mm which can be used for breeding inside the permeable block. A small hanging ring is respectively fixed at the lower four corners of the permeable block body for the submergence and fixation of the model. The connection mode between the units is flexibly connected. The model consists of 15 rows and 6 columns, the transverse spacing between the units is fixed to 60mm, longitudinal row spacing has 50mm 100mm and 150mm, Each row of units in



the same dive depth of the regular arrangement and even row, singular row relative to diving 20mm 121 type of dislocation arrangement.

According to the gravity similarity criterion and the test equipment condition, the test scheme is shown in Table 1.

Table 1. Test scheme

Test water depths/m	Wave height/m	Wave cycle/s	Immersion depth/cm	Row spacing/cm	Arrangement mode
0.9	0.05	0.8	0	5	Regulation
	0.06	0.9		10	arrangement,
	0.07	1.0		15	121 arrangement
	0.08	1.1			

The model scale is 1:30.

3. Test Date Analysis

This paper focuses on wave attenuation performance of the hollow wave dissipation structure of a semi-submersible embedded ball box under the action of specification wave by comparing the experimental data with the regular wave and the J specthm(JONSWAP) wave.

Figure.1-Figure.3 are the experimental result analysis of the influence of wave height, period, longitudinal row spacing and arrangement mode of row on transmission coefficient.

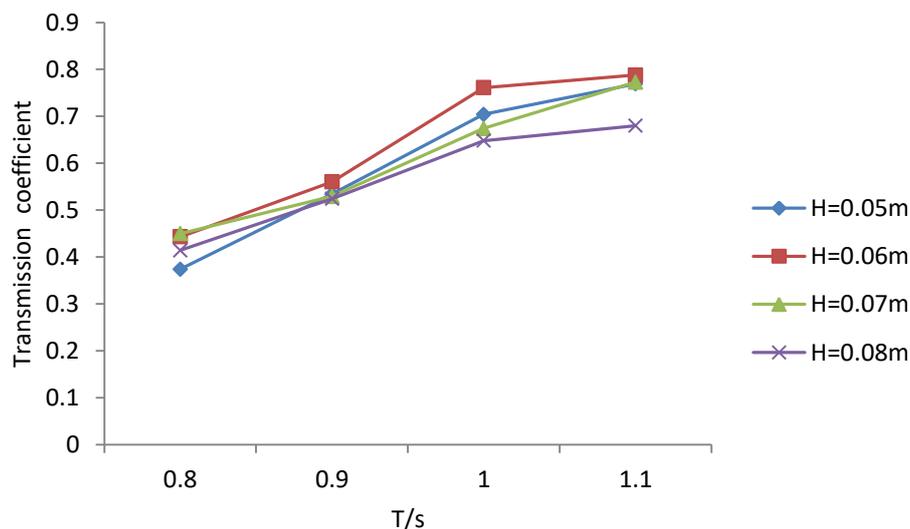


Figure 1. Effect of wave height on transmission coefficient

3.1. Effect of Wave Height on Transmission Coefficient

Figure 1 is the test result of the influence of the transmission coefficient of the semi-submersible embedded ball box with the anti-wave structure of the empty block in the space of 10cm, the descend depth 0cm, and the arrangement of the lines. It can be seen from the figure that, with the increase of wave height, the transmission coefficient is from the larger to the smaller. At wave height 0.06m is the largest transmission coefficient of 0.8. But the range of the numerical changes is not large. It means that wave height has little influence on transmission coefficient.

3.2. Effect of Row Spacing on Transmission Coefficient

Figure 2 is the experimental result of transmission coefficient of the semi-submersible embedded ball box with the anti-wave structure of the empty block under submerged 0cm, wave height 0.7m and row arrangement with regular arrangement under different row spacing. As can be seen from the diagram, the transmission coefficient decreases first and then increases with the increase of row spacing. In the condition of row spacing 10cm, the wave elimination effect is larger than the row spacing, and it is the

working condition of 5cm and 15cm. However, the range of numerical change is not large, that is, the longitudinal row spacing has little effect on the transmission coefficient.

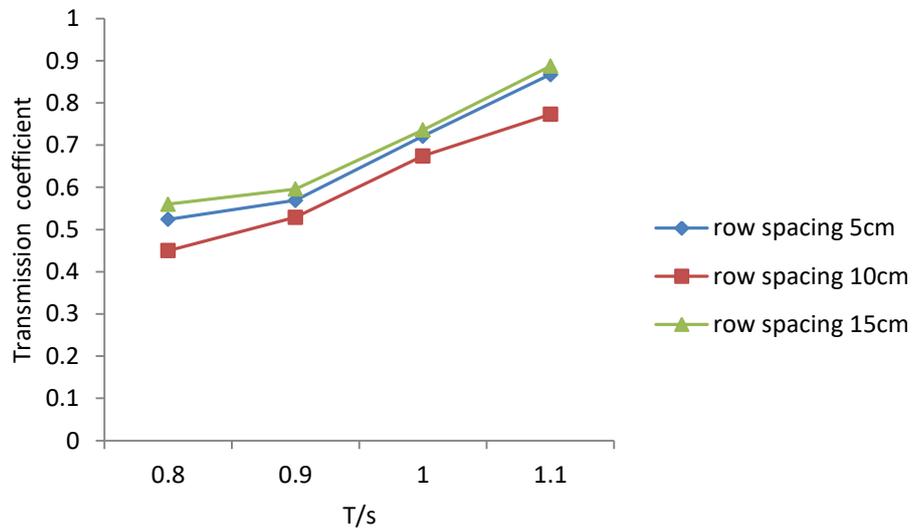


Figure 2. Effect of row spacing on transmission coefficient

3.3. Effect of the Way of Row Array on Transmission Coefficient

Figure 3 is the experimental comparing result between regular arrangement and 121 arrangement under the diving 0cm and row spacing of 10cm. It is shown from the graph that the transmission coefficients of 121 arrangement are smaller than those of regular arrangement. But it is larger in large cycles. It means that the wave dissipation performance of the 121 arrangement is better in small cycle, when the wave become larger the wave dissipation performance of the regular arrangement is better. Comparing the curves of the three wave heights, it can be seen that in the arrangement of the row spacing of wavelets, the range of numerical changes is very small, and the range of variation becomes larger with the increase of wave height. In the wave height 0.08m, the range of variation is about 0.15, that means the longitudinal arrangement has little effect on wave attenuation.

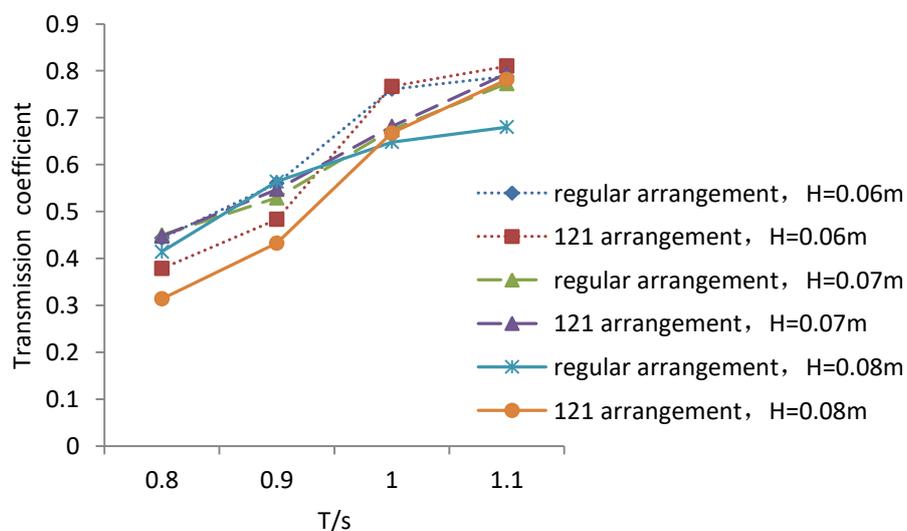


Figure 3. Effect of the way of row array on transmission coefficient

3.4. Effect of Cycle on Transmission Coefficient

According to the results of Figure 1 —Figure 3, the results show that the transmission coefficient increases with the increase of the period under the specification spectral wave. In small cycles, the slope of the change curve of the transmission coefficient is small, and the slope of the curve becomes larger with the increase of the cycle. The wave structure has obvious effect on small cycle. When the cycle reaches 1.1s, the transmission coefficient is 0.8, and there is still a certain wave elimination effect.

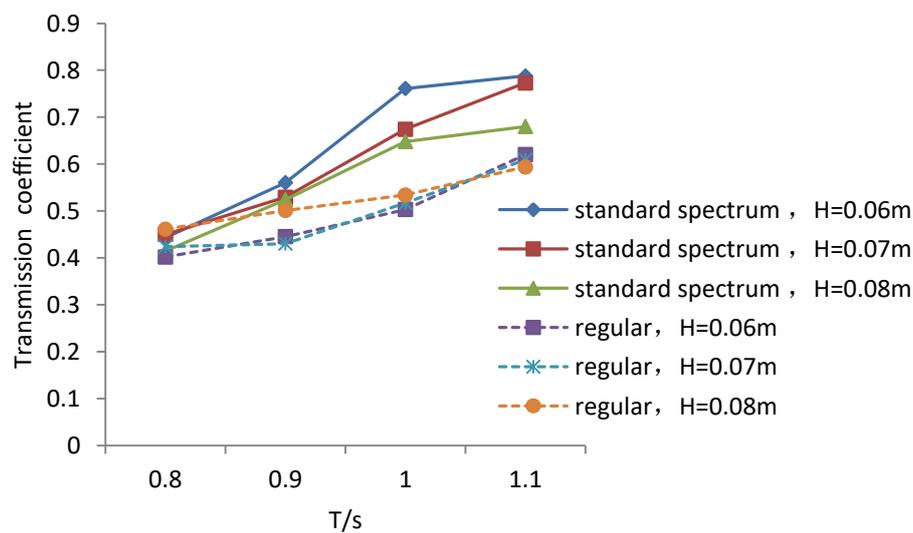


Figure 4. Effect of the cycle between code spectrum wave and regular wave on transmission coefficient

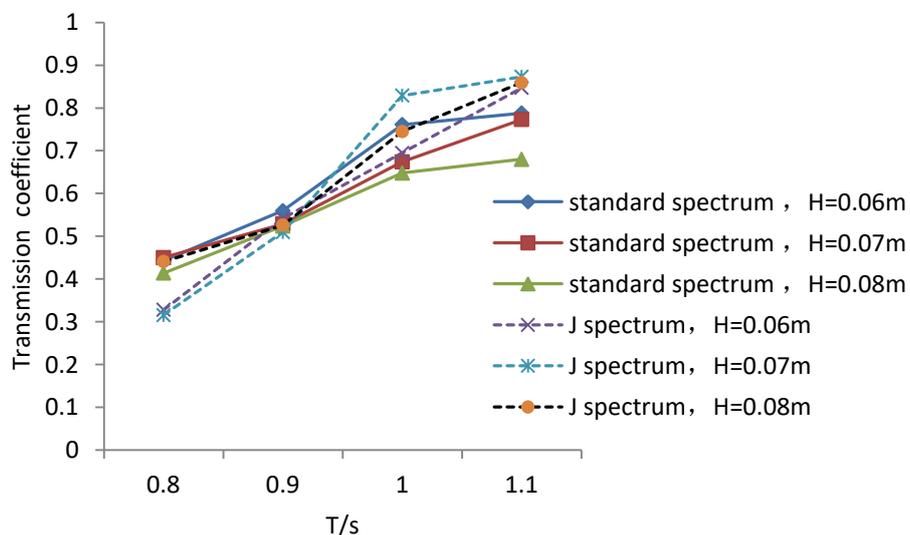


Figure 5. Effect of the cycle between code spectrum wave and J spectrum wave on transmission coefficient

3.5. The Influence of Cycles on Transmission Coefficients under Different Bop

Figure 4 and figure 5 are the contrast of the experimental data of the influence of the period of the gauge spectrum and the regular wave and the J spectral wave on the transmission coefficient, It can be seen from the figure 4 that the transmission coefficient of J spectrum under small cycle is smaller than that of normal spectral wave. But with the change of the period, the slope of the

transmission coefficient change curve of the J spectrum is larger than the slope of the normal spectral wave, At periodic 1.0s, the transmission coefficients of J spectrum waves are larger than those of standard spectral waves.

It can be seen from the figure 5 that the transmission coefficients of the canonical spectrum and regular wave are basically the same at periodic 0.8s, As the cycle increases, the curve of the gauge spectrum increases more than the regular wave. During the cycle 1.0s, the two sets of curves were clearly differentiated.

4. Summary

In this paper, the physical model test of a semi submerged sphere block wave elimination structure under the action of standard spectral wave is studied, analyzed the influence of wave height, period, longitudinal row spacing and arrangement of row arrangement on transmission coefficient. And compare it with the experimental data of periodic influence factors under regular wave and J spectrum wave. The influence of wave height, longitudinal arrangement spacing and arrangement mode on transmission coefficient has a certain regularity, but it has little influence on transmission coefficient. The period is the main factor affecting the transmission coefficient, and there is a similar change rule under the action of specification wave, J wave and regular wave, but there are differences.

5. Reference

- [1] Luan Chengjiang, Xie Qingliang 2000 *China J. Coastal erosion and its control countermeasures in China. Journal of soil and water conservation.* 14 pp 44-47
- [2] Zuo Shuhua, Li Jiujiang, Chen Shenliang 2006 *China J. Coastal erosion and its causes and protection engineering. Yellow River* 28 pp 23-25
- [3] Omer Yuksek, Hizir Onsoy, Alin R B 1995 *J. Coastal erosion in eastern black sea region Turkey. Coastal Engineering*
- [4] S.A Sannasiraj, V.Sundar, R.Sundarravadivelu 1998 *J. Mooring forces and motion Responses of pontoon-type floating breakwaters. Ocean Engineering*
- [5] Wang Yongxue, Wang Guoyu 2002 *China J. Research progress and application of floating breakwaters, Shipbuilding of China* 43 pp 69-75
- [6] Jiang Muhuai, Zhou Xiaoguo Liu Mingwei 2013 *China J. Research and application progress of wave dissipation effect of permeable breakwater. Chinese water transportation* 13 pp 360-361
- [7] K.Murali, J.S.Mani 1997 *J. Performance of cage floating breakwater. Journal of Waterway, Port, Coastal and Ocean Engineering*
- [8] Jiang Changbo, Yuan Shengliang, Liu Jing 2012 *China J. Experimental study on wave dissipation characteristics of permeable breakwater with permeable box. Traffic science and Engineering* 28 pp 56-61
- [9] Wang Yongxue, Wang Guoyu 2002 *China J. Research progress and application of floating breakwaters, Shipbuilding of China* 43 pp 69-75
- [10] Huang Lu 2013 *D. Ananalysis of wave dissipation performance of T type perforated breakwater. Dalian University of Technology*
- [11] He Chaoyong, Wang Dengting, Feng Weibing 2014 Study on wave dissipation performance of rectangular square box floating breakwater *J. Water transport engineering* chapter 1 pp 14-18