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The effects of long-time strong wave condition on breakwater construction

S. Chen[a], G. Liang[b], H. Chen[a]*, R. Zhou[a]

[a]*Tianjin Research Institute of Water Transport Engineering, Jianjin, 30045, China*
[b] *Second Engineering Company of China Fourth Harbour Engineering Co., Ltd., Guangzhou, 510300, China*

Abstract

In this paper, long-time strong wave condition is defined according to the comparison between the China's Ocean and the Indian Ocean, as well the characteristic of long-time strong wave condition is described. Combined with practical works, the effects of long-time strong wave condition on breakwater construction are analyzed. Some specific construction measures, including placement of rock material, wave prediction and breakwater head protection during construction period, are introduced. Some valuable references are provided for similar projects in the future.

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Keywords: long-time strong wave; Indian ocean; breakwater; breakwater head protection

1. Introduction

As the development of Chinese port construction technology, more and more countries employ Chinese company to build wharfs and breakwaters. Most of the projects are located around the Indian Ocean, such as Indonesia, Malaysia and Sri Lanka etc. The wave dynamic condition in such project sites is main long period swell, which is significantly different from the wind wave in the China's Ocean. Therefore the traditional breakwater construction technology and test method which were successfully used for China's Ocean is no longer applicable in the Indian Ocean. Some specific construction measures should be developed in order to conform with the long-time strong wave condition.

* Corresponding author. Tel.: +86-22-5980-5205; fax: +86-22-5980-5205.
E-mail address: chenhanbao@163.com

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This paper is organized as followed. In the second section, the definition of long-time strong wave condition is given by comparing the China's Ocean wave with the Indian Ocean wave. The effects of long-time strong wave condition on breakwater construction are analyzed in the next section, and some specific measures are proposed. Finally some conclusions are given.

2. Wave comparisons between China's Ocean and Indian Ocean

2.1. The wave characteristics in China

In China, the coastline is 18000 kilometers long from south to north, crossing the tropic, subtropics and temperate zone. But generally speaking, the wave is mainly induced by wind in China's sea. The main dynamic of the wind wave are monsoon, gale and typhoon. The key influence factors in different areas are different. For example, in the Bohai Sea and the Yellow Sea, gale (monsoon) is considered commonly, and in the South China Sea typhoon is the key factor, while typhoon and gale (monsoon) are both focused in the East China Sea.

The average wave heights in Chinese nearshore are listed in Table 1. It can be seen that the average wave heights in Chinese nearshore are all fairly small, and most of them are below 1.0 meter. The wave in Bohai Sea is smallest, while the ones in East Sea and South Sea are much larger. The reason why the wave heights are such small is that the wave in Chinese sea is controlled by monsoon. In winter the prevailing northerly wind is offshore but with a short fetch. Although in summer the prevailing southerly onshore wind has a long fetch, the frequency of the strong wind which is faster than 13.8m/s is very low (less than 5% in Bohai Area and the north of Yellow Sea, 5%~10% in the south of Yellow Sea and East China Sea, 5%~20% in South China Sea). The largest wave is often generated by tropical cyclone (typhoon) and cold wave. However the occurrencefrequency of the extreme weather is very low per year. Therefore the strong wave weather would not last for a long time(Chen and Zhang, 2005).

Table 1. The average wave height (Ha) of China's coast in different sites(m)

Station	H_a	Station	H_a	Station	H_a	Station	H_a
Da lu island	0.56	Qing ji island	0.83	Zha pu	0.23	Nao zhou island	0.96
Xiao chang shan	0.5	Cheng shan jiao	0.66	Nan ji	0.96	Bai sha men	0.54
Lao hu tan	0.54	Shi island	0.59	Tai shan	1.26	Yu bao	0.61
Chang xing island	0.8	Qian li yan	0.97	Ping tan	0.91	Dong fang	0.75
Ba yu quan	0.44	Xiao mai island	0.7	Chong wu	1.18	Ying ge hai	0.72
Hu lu island	0.58	Shi jiu suo	0.59	Yun ao	1.03	Yu lin	0.49
Zhi mao wan	0.67	Lian yun gang	0.66	Biao jiao	1.07	Lang wang ya	0.51
Qin huangisland	0.57	Gao qiao	0.31	Zhe lang	1.18	Tong peng ling	0.9
Tang gu	0.72	Yin shui chuan	1.02	Da ya wan	0.75	Wei zhou island	0.64
Bei huang cheng	1.06	Da ji shan	1.04	He bao island	1.13	Bei hai	0.32
Qi mu island	0.95	Sheng shan	1.07	Chuan island	0.7	Bai long wei	0.61
Zhi fu island	1.44	Tan hu	0.59	Shui dong	0.78		

2.2. The wave characteristics in south coast of Java Island, Indonesia

Indonesia facing the northern Indian Ocean has lots of wave related issues. Java Island is the most important regions in Indonesia, not only concentrates 60% of the population, but also the location of the capital Jakarta ,