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RESEARCH ARTICLE

ON THE INVESTIGATION OF BASIC PARAMETERS OFDESIGNING PROTECTIVE LAYER OF THE OFFSHORE BREAKWATERS AT IRAN'S KHARG ISLAND

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ABSTRACT

Breakwaters are structures which are constructedin order to create peace in a pool of ports, to preventport erosion, and to protect the shipping channel. The sensitivity of these breakwaters to environmental conditions on the one hand and highexecutive costs and difficulty of maintenance on the other hand, as well as the importance of constructions on the top and behind these structures has made the design of the typical mound and Caisson compound breakwaters associated with a certain elegance. There are different rules for optimal design of the breakwaters. In designing Caisson compound breakwaters, at least five parameters can be changed. These variables include: (1) the height of the mound under Caisson, (2) the width of Caissons, (3) height of vertical cross-sectioncrest, (4) the width of the platform, (5) the depth of armor layer of mounding foundation to the water surface.The aim of this study was to evaluate the effect of each environmental feature of Kharg Island in designing this type of breakwater. To this end, the geometric sensitivity of these structures to the features of breakwater waves at different depths is evaluated. In this study, the specific circumstances of the region are first presented. Then, using authentic equations and the Breakwat and CRESS software, the features of the required stones have been calculated at different levels.

INTRODUCTION

Today, due to increasing development in the use of marine resources as well as the growth of the maritime transportation industry, so much effort has been made to develop safe and calm environment for mooring buoys. Breakwater is one of the most important structures which is structured to create a stilling basin at the port for the arrival of the ships in order to provide waterways and ports breakwater.

In addition to the stilling basin in harbors, breakwaters are used to reduce the energy of the waves and protect the coast as well. Breakwaters are of different types selected based on their expected performance, the water depth at the site, the bed condition, climatic conditions and availability of materials for the construction. In general, vertical crusher and crusher mound breakwaters constitute two major categories. One of the most worldwide used breakwaters are mounding breakwater which are divided into two groups: conventional mound breakwater and malleable mound breakwater.

The significance of research

Holding huge reserves of oil and gas, Iran is introduced as the world's fifth largest oil reservoir and the second largest gas reserve holder. Because of the ease of marine transport, Iranian oil exports are from the Persian Gulf (Kharg Island). Given that the exchange of goods between countries and especially through the ports, due to the growth in international trade, is increasing day by day, some studies have been conducted on the south coast foreshore areas over the recent years. Due to the high cost of constructing breakwaters, their being properly designed in terms of both economy and efficiency looks absolutely essential. This offshore breakwater has the advantage that wave overflowing is not a limitation on designing a breakwater. This allows the breakwater to be appropriate for reducing the load of the incident wave and optimization of construction cost. Moreover, because the length of the breakwater is relatively short, less material is needed to construct it.

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Review of the previous projects and research

Several research projects have been conductedon the design of breakwaters and dikes. Of the existing research, investigations of DavazdahImami (2004) and KaramiKhaniki (2004) can be cited. In these studies, CRESS model is widely used to design vertical dikes and breakwaters.

Designing and construction of Galakfishing port (2003-2007), designing and implementation of multipurpose small ports in the southern waters of Iran (1999-present), Kish commercial port development plan (2007-2008), Anzali port development plan (2006-2010) are among the projects in which the Breakwat software was used for the initial designing of breakwaters. KaramiKhaniki *et al*. (2005) examined the impact of the platform position (balance podium position) on the wave overflowing the dikes. For this purpose, they used the CRESS software. Tehran Berkeley Engineering Company has done the initial design and estimation of the operation for the mound breakwater at the Galak fishing port. The project was defined as the construction of fishing harbors by the Iranian GalakFisheries Company. The Break wat software was used in this project to calculate the weight of armor, the wave uptake, the Debbie rate of the wave overflowing flow.

Introducing the study area

Kharg Island is located at 14, 29 North and 19, 50 East. Kharg Island is resulted from the biological action of billions of corals over a million year. This coral mass removed water from its surface fourteen thousand years ago and appeared like stalactites. Its distance from Bushehris 46 km and it is 38 km away from Ganaveh.

The island is called with different names of "Arakia", "Ikara", "Ikaria" at various times. The island consists of fossils and coral organs, bivalves and other marine organisms mixed with sand particles and only a thin layer of the island with about twenty centimeters to five meters thickness and with a density of about 1.5is harder. The lower layers (which are seen in vertical slices) are composed of a soft and sediment tissue whichis weak against water flow. In many parts of Kharg, water and wind erosion has caused the loss of the inner layers and the collapse and disintegration of the upper resistive layers containing ancient patterns and works. The erosion process is already changing the coordinates of the island roughness.

The highest length of the island is an axial with approximately 7900 meters which connects the north of the island of Kharg to the midpoint of the south. The highest width in Kharg Island is located in the northern part with a distance of 5300 meters and with an area of 22 square kilometers.

The island is somewhat triangular and some have likened it to sail. There are mountains and heights. Its bank in the northern and eastern shores is sandy with a gentle slope, but on the other two directions, the bank is high and steep slopes. Water depth varies around the coast and large ocean-going vessels are docked along the waterfront. Kharg Island is one of the few islands at the Persian Gulf that has plenty of freshwater. Khark Island fresh water has been provided through digging tens of wells, a series of Qanats, and artificial directing of surface water obtained from rainfall to small dams and natural pits.Today, the Kharg Island is one of the major terminal to load crude oil in Iran.

Table 1 Average hourly wind speed in different directions in 75km West of Kharg Island with return Periods of 1 to 100 years

	Hourly mean wind speed					
Direction	Return Period					
	Month		1	5 10	50100	
all	14	16.6	19.1	20.7	24.6	26
N	9.4	12.8	14.5	15.2	19.1	20.6
NE	5.9	8.6	10	11.2	16.5	18.6
E	9.3	13.5	15.8	16.7	18.7	19.9
SE	12	16.6	19.1	20.1	23.4	25.2
S	6.4	9.8	11.5	14	20	22.3
SW	6.3	8.9	10.3	10.8	15.2	17
W	10.7	13,4	14.9	15.4	18.3	19.8
NW	14	16.5	18.7	20.7	24.6	26

Table 2 Water level fluctuations due to non-astronomical factors atKharg Island

	Min (North Wind)	Max (south wind)
seasonal fluctuations	-0.1m	+0.1m
Wind (with a return period of 100 years)	-1.5m	+1.5m
atmospheric pressure (with a return period of 100 years)	-0.2m	+0.35m
rise in mean sea level (the design life of 50 years)	0.0	+0.3m
Total	-1.8m	+2.25m

RESULTS

In this study, to calculate the required mass of the armor stones on the sloping surface of mounding breakwater, the Van der Meer method (1988b) is used. The parameters include *N* the number of waves, *P* porosity of the structure, *Sd* damage level parameter, *CS* correction factor resulting from wave breaking and HDesign = HS designed wave height.

It should be noted that the maximum number of waves that should be used in a stability equation is 7500. Having this number of waves, the structure almost reaches equilibrium. In the present study, N = 3000 (it is assumed that a wave can be seen on average at 7.6 seconds during 22800 seconds). According to the waves plan set forth in Table 3-9, armor weight values for the slopes of 1: 1.5 and 1: 2, 1: 2.5 and 1: 3 are calculated and the results are presented in Figure 1 (as graph) and Table 3.

Table 3 The stone diameter obtained from the CRESS Software for different slopes

N				
	1.5	2	2.5	3
3000	2	1.73	1.55	1.42
	7600	9900	13721	21200

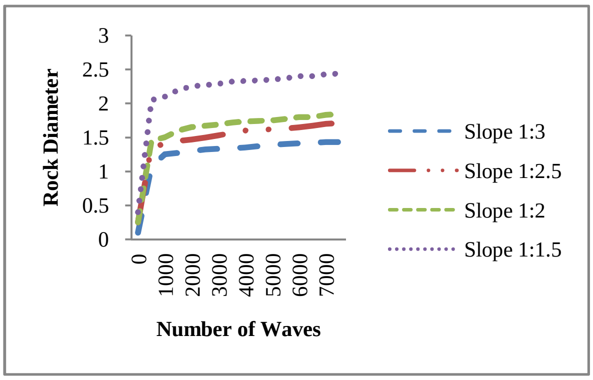

Figure 1 –Stone diameter for waves (the storm duration), the effect of the structure tilt angle

As it is observed in Figure 1, increasing the slope increases the stone diameter for use in the protective layer. As a general principle, mass needed for the stones or blocks of armor layer (M50u) should be approximately as much as 1.20 or more ofthe mass of armor parts.This value should preferably be about 1.20- 1.15 forsteep breakwater. Minimum thickness of the protective layer should be (ta and tu) 2.1 Dn 50, that Dn50 is the nominal diameter of rock layers. Crest width of a mound breakwater is a function of the amount of wave overflowingfrom the structure and other structural conditions. If there is no overflow of the breakwater, then the waves are not involved in determining the crest width. On the other hand, if there is overflow and crest is capped by basic parts, then the possibility of putting three pieces of armor should be available in the crest width (B). In this study, to calculate the weight of the secondary components of armor layer (substrate), rock armor layer thickness, the width of the crest (if using stone armor) and the thickness of the substrate, recommendations from the Design Principles of Coastal Structures (Chegini, 2011) is used

Table 4 Results of calculations for different slopes

SLOPE	[illegible](Kg)	[illegible](m)	B(m)	[illegible](m)
1:15	2120	4.6	6.9	2.13
1:2	1372.1	4	6	1.85
1:25	990	3.6	5.4	1.66
1:3	760	3.3	4.9	1.52

Because the extraction of rocky parts with high weight (more than 10 to 15 tons) in hard rock mines is difficult and transportation (depending on the distance between the mine site and the breakwater) and placing them in the breakwater are also of concern, these are regarded as limitations and difficulties of this study. On the other hand, production of stone pieces in desired shapes is practically impossible, hence it will not be too far-fetched that concrete armorsbeused as an appropriate option and a replacement for metal components.

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