

Design Analysis of Reshaped Rubble Mound Break Water (Berm Break Water) (Case Study: Escravos Sea)

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Abstract- The paper aims at analytical design of a berm break water for an Escravos Sea, where design conditions satisfies the functionality, technology and environment, at sea water dept of 4.0m, tidal correction of 0.8m, the design is carried out to satisfy the berm break water parameters such as design water dept, berm width, berm level, crest level, crest width, the size of stone in each layer for the berm break water according to engineering hand book which is often base on empirical expression developed by several experiment.

Indexed Terms- Escravos Sea, Berm Break Water, Reshape Mound

I. INTRODUCTION

Break water are generally used around the world which is primarily design to maintain tranquility condition inside the harbor, protect the shore against waves, guide current, reduce dredging at harbor navigation channel and also serves as quay facility for transfer of cargos within the port. In break water design, consideration of physical and topographical features, hydrographical and hydrological factors, meteorological factors, size and depth of the sea front, availability of construction materials should be evaluated to determine the consequential effect to best decision making.

1.1 Types of Break waters

There are many break waters which are classified in respect to their structural features such as sloping or mound, vertical and special types. They are further classified into two basic type of break water name rubble mound and composite break water as shown in table 1.1 below

Table 1.1 Types of Break Water

Vertical	Concrete Monolith Break Water
Horizontal	Cellular Block Break Water, Concrete Caisson Break Water, New Caisson Break Water
Composite	Block Masonry Break Water
Special (Non gravity)	Hydraulic Break Water, Floating Break Water, Pneumatic break Water, Horizontal Break Water, Curtain Wall Break Water, Steel Pile Break Water
Sloping (Mound)	Rubble Mound Break Water, Rubble Mound Break Water Multi-Layer, Rubble Mound Break Water Armor with Block, Reef Break Water (Break Water), Rubble Mound Break Water, Reshape Rubble Mound Break Water (Berm Break Water)

1.2 Factors Considered to Identify Consequential Effect to Best Decision Making

- Size and Depth: Adequate size of area and sea front, without excessive dredging should be considered.
- Physical and topographical Features: Sub soil conditions should be suitable for break water structure
 - Non eroding shore line's adjacent to land and slope away from the land should be preferred.
- Hydrographical and Hydrological Factors: Location with high tide and tidal bore should be avoided, also current velocity should not exceed 7.4km/m

- d. Metrological Factor: Location subject to pronounce server and frequent storm surge should be avoided.
- e. Construction material: Availability of construction material particularly rock for break water and construction work will be considered.

1.3 The paper considered reshaped rubble- mound break water (berm break water) due to the following reasons (at the designated site Escravos Sea)

- The availability of large quantity of rubble stone near the site which reduce material cost
- The use of smaller construction equipment is required
- Less environmental impact due to smaller reflected waves, dredging cost, current velocity, tidal level, erection of a natural reef.
- The shape of berm break water provides suitable place for sea life

II. SUMMARY REVIEW

2.1 Berm Break Water

The berm break water is a type of sloping mound break water which consists of heavy rock or shape design concrete block (Artificial Armor Block) in deep sea to resist the wave effect. The berm break water components comprise of foundation and super structure. Types of shape design concrete block (Artificial Armor Block) are shown in fig 2.1 below

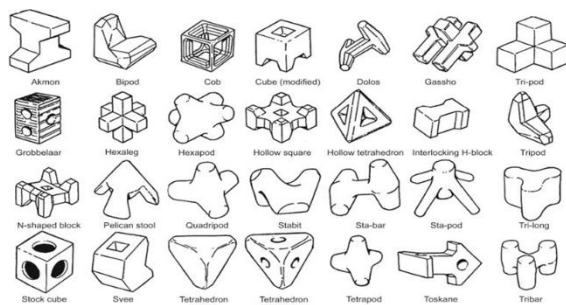


Fig 2.1 Types of shape design concrete block (Artificial Armor Block)

2.2 Foundation Components

- a. Toe Mound: Act as a protection to failure that would occur on the rolling down the stone, support armor and under layer, prevent penetration of wave and sediment.

- b. Bedding Layer: Act as a foundation to support the active super structure and prevent sediment of rubbles into sea bed and it is mostly base on the sea bed properties (sub soil bearing capacity)

2.3 Super Structure Component

- a. Core Layer: The core layer supports the protective armor cover and any under layer, also prevent sediment passing through the berm break water
- b. Under Armor layer: To support the amour unit and prevent sediment not to penetrate through the void of armor unit.
- c. Armor Layer: Is the primary layer which is a function of the wave height crest level to prevent wave forces, over topping and run up and it is made of rough quarry stone

2.4 Additional Design Components

- Crest elevation: To prevent storm, surge and run up
- Crest width: It should be constructed to prevent over topping
- Thickness of armor and underlayer: Depends on the size of the stone and number of layers
- Stability (slope of the break water) stability against scour and sliding which depends on design principle.

III. MATERIAL AND METHODS

3.1 Data Collection or Design condition for the water (Escravos sea)

The design condition for the berm break water is shown in table 3.1 below

Table 3.1 Data Collection or Design condition for the water

Mean water depth	4.0m
Tidal correction	0.8m
Stability co-efficient (N_2)	2 and 1.7
Unit weight of armor (w_r)	2.65t/m ³
Unit weight of sea water (W_w)	1.025t/m ³
Berm slope (sea side)	1:1.5
Slope (harbor side)	1.2
Free board	0.5m
No over topping	
No of layer (crest and toe)	3
No of layer (Amour thickness)	2
Layer co- efficient (k_d)	1.15

The design condition must fulfill

- Functionality
- Technology
- Environment
- Lost and benefit
- Paper work (drawing board)
- Matter (actuals construction)

3.2 Methods

The method uses in analyzing the parameters of the berm break water is given in table 3.2 below

Table 3.2 Methods for berm break water parameters

Design water depth (d)	Mean water depth + tidal correction
Maximum wave height (H_{max})	$0.78 \times \text{water depth (d)}$
Significant wave height (H_s)	$h_{max}/1.6 \text{ to } 1.8 \text{ (m)}$
Berm width	$3.5 \times H_s \text{ (m)}$
Berm level	$d + (0.65 \times H_s) \text{ (m)}$
Crest level	
Deep water wave length (L_o)	$d/0.5 \text{ (m)}$
Deep water condition	$d/\xi = 0.5$
Surf similarity parameter	$\xi = \tan \theta / \sqrt{\frac{H_s}{L_o}}$
Run-up (R)	$\xi \times H_s$
Crest level	$d + \text{run-up} + \text{freeboard (m)}$

Crest width	
Relative mass density of stone	$\Delta^{w_r}/w_w - 1$
Diameter of individual armor unit	$D_{50} = H_s/\Delta \times N$
Crest width	$N \times K_d \times D_{50} \text{ (m)}$
Armor layer	
Armor individual unit weight (quarry stone) (W_{50})	$(D_{50})^3 \times W_r \text{ (MT)}$
Armor thickness (T)	$N \times K_d \times D_{50} \text{ (m)}$
Under armor layer	
Armor individual unit weight	$W = W_{50}/10 \text{ to } W_{50}/15$
Armor individual unit diameter	W/W_r
Core layer	
Armor individual unit weight	$W = W_{50}/100 \text{ to } W_{50}/1000$
Armor individual unit diameter	W/W_r
Bedding layer	
Thickness of stone	0.05m
Diameter and weight of stone	Weight and diameter is the same with that of core layer
Toe mound	
Diameter of stone	Is the same with that of armor layer
Width	$N \times K_d \times D_{50} \text{ (m)}$
Height	$2 \times K_d \times D_{50} \text{ (m)}$

IV. DISCUSSION AND RESULT

4.1 Result: The result obtained from table 3.2 above are given in table 4.1 below

Table 4.1 the Result of berm break water design parameters

S/No	Design Parameters		Stability	
		No		
		2	1.7	
1	Design water depth (d) (m)	4.8	4.8	
2	Maximum wave height (H_{\max}) (m)	3.74	3.74	
3	Significant wave height (H_s) (m)	2.34	2.34	
4	Berm width (m)	8.19	8.19	
5	Berm level (m)	6.32	6.32	
6	Crest level (m)	8.48	8.48	
7	Crest width (m)	2.55	3.00	
8	Armor layer	D_{50} (m)	0.74	0.87
		W_{50} (MT)	1.07	1.74
		Thickness (m)	1.70	2.00
9	Under Armor layer	D_{50} (m)	0.04	0.07
		W (MT)	0.11	0.17
10	Core layer	D_{50} (m)	0.004	0.007
		W (MT)	0.01	0.02
11	Bedding layer	D (m)	0.004	0.007
		W (MT)	0.01	0.02
		Thickness (m)	0.05	0.05
12	Toe mound	D (m)	0.74	0.87
		Width (m)	2.55	3.00
		Height (m)	1.70	2.00

4.2 Discussion

The result indicates that when the stability number decreases (1.7), it increases the size, dimension and weight of the berm break water parameters such as the crest width, armor layer, under armor layer and toe layer, but the berm width, berm level, design sea water level, crest level remain the same. Indicating that if lower stability number is used the structure will have greater frictional resistance effect to wave forces, buoyancy forces and current forces

CONCLUSION

The above method use in the analyses of berm break water parameters was gotten from coaster engineering hand book base on several empirical experiment and was systematically and accurately followed, this had

created a more robust and efficient way of designing berm break water and also improve reliability, durability and economy efficiency

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