A STUDY ON THE DESIGN OF A FISHERY HARBOUR

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Abstract - *The role of the fishing port may be considered as the interface between the netting of the fish and its consumption. It is every country's wish to import the health hazard free quality of landed catch in order to increase export of seafood products. It helps to develop and standardize the fisheries. It will help to improve handling, transporting and marketing fishers in the area. This project describes the design features of a fishery harbour. Thesis includes a detailed survey steps for a fishery harbour. Rubble mound breakwater is designed.*

1. INTRODUCTION

A fishing harbour is a port for landing and distributing fish. These are designed to provide better landing and berthing facilities to fishing craft and provide basic facilities for deep sea fishing. The role of the fishing port may be considered as the interface between the netting of fish and its consumption.

India is endowed with along coastline of approximately 8100KM. Hence to explore the rich marine resources, the country has fishing fleet of 2,80,546 boats and out of which 53684 are mechanized and rest of them traditional vessels.

1.1 Location and regional settings of project site

Parappanangadi is one of the important fishing centres of Malappuram District with extensive fishing activity involving motorized and mechanized crafts. The project site (Chappapadi) is situated in Parappanagadi municipality of Tirur Taluk. The site is easily accessible from Parappanangadi town is situated 1.3 Km from the beach. This is an open beach where a fishing gap is provided in the seawall protected coastline. The site is located about 40 km from Ponnani fishery harbour (commissioned in 201 l) and about 23 km from Beypore fishing harbour. The present proposal consists of construction of two rubble-mound breakwaters. Apart from the breakwaters, a landing quay and auction hall, approach roads and parking area, gear shed, shops and canteen, toilet facilities and other ancillary facilities required for the establishment of a fishery harbour are proposed here.

Two roads run approximately parallel to the coastline in the north south direction at the site. These are the Tirur - Kadalundi road and the Seethikoya thangal road. Seethikoya thangal Road is the closest to the coastline and runs through the entire length of the study area. Tirur - Kadalundi road runs at about l .5 km east of the coastline. The railway line runs parallel to the coastline and is about 2.5 kms east of the coastline (Mangalapuram-shornur line) Parappanagadi railway station is nearest to the study area.

2. LITERATURE REVIEW

Supriya shinde et al: Design of breakwaters for the development of fishery harbour- a case study (2017)

In this work they explained procedure of rubble mound break water by using empirical formulas. Constructed the geometrical similar 2D hydraulic model and carried out the experiments in a wave flume for different wave heights and periods. They found that the stability of rubble mound structures is dependent mainly upon the stability of rubble mound armour units on its seaward slope. A wide toe-berm reduces the cost of construction of breakwater by dissipating the energy of waves before striking the armour layer. Studies indicated that a wide toe-berm at the low water level of breakwater reduces the required weight of armour units by about 10-20%. In the optimal design of breakwater, the total quantity of materials required for the breakwater can be saved more than 20%.

Supriya Shinde et al: A review on rubble mound breakwater design by empirical formulae and hydraulic model tests (2017)

In this present work, they found the applications and limitations of empirical formulae especially Hudson's formula for designing of rubble mound breakwater. They observed that the cross section of breakwater is optimized with the help of wave flume testing and most of the work was done by experimenting on models in wave flumes. Finally, they concluded that normal 2-D models are used for model test but 3-D models give accurate result. They strongly suggested that it is mandatory to conduct wave flume studies.

Hasan Gokhan Gluer et al: A comparative study on the stability formulas of rubble mound breakwaters (2014)

Major stability equations were used to design these types of breakwaters are Hudson (CERC, 1977 CERC, 1984), Van der meer (1998) and Van Gent et al. (2004) formulations. In this study, discrepancies in applications of Van der Meer (1998) and Van Gent et al. (2004) formulations were clarified by conducting an example study. Example study and comparative study showed that there can be up to

70% relative difference in armour stone weight between Van der Meer and Van Gent et al approaches.

Jergen juhl et al: Roundhead stability of berm breakwaters (1996)

3-D model tests were carried out for studying the stability of a berm breakwater roundhead and the adjacent trunk section. Observed that the maximum recession occurs at the area directly exposed to the waves and the recession/erosion pattern follows the wave direction.

Nikolay Lissev et al: Influence of the core configuration on the stability of berm breakwater (1996)

The model test was done for different core configuration of breakwater. Concluded that the core can be extended into the berm of a berm breakwater based on the result obtained in the study. Since the core material is generally cheaper than the armour stones, the concept of extending the core material into the berm will give a cheaper berm breakwater structure.

3. STUDY ON SURVEY AND SOIL INVESTIGATION

3.1 Geotechnical Investigation

Geotechnical investigation are conducted to obtain information on the physical properties of soil earthwork and foundations for proposed structures and for repair of distress to earthworks and structures caused by surface conditions. This type of investigations called site investigation. There are different methods of soil investigations to determine the properties of soil. A geotechnical investigation of the sea bed is required to determine the type of founding material and its extent. The results of this investigation will have a direct bearing on the type of cross section of the breakwater.

3.1.1 Basic geotechnical investigation

Normally suffice for small or artisanal projects, especially when the project site is remote and access poor. A basic geotechnical investigation should be carried out or supervised by an experienced engineer or geologist familiar with the local soil condition.

3.1.2 Advanced geotechnical investigation

Normally requires the retrieval of undisturbed core sample, taken from the level of the seabed down to a depth ranging from 10 to 30m, depending on the type of structure envisaged and the ground conditions obtaining at the site. Advanced geotechnical investigations normally carried out by specialist contractors or soil laboratories and require a model drilling rig. The drilling rig can travel to most destinations but installed on a stable platform before it can be used to drill for cores over water.

3.2 Topographical survey

This survey shows the height, depth, size and location of any manmade or natural features on a given parcel of land, as well as the changes or contours in elevation throughout the parcel. While boundaries focus on horizontal measurements, topographic surveys are about elevation.

3.3 Hydrographical survey

It is also known as bathymetric survey is therefore essential if the correct design decisions are to be made right from the project inception stage to ensure that landing is easy to use and free of major maintenance problems under all conditions. It is mainly carried out by the means of sensors, sounding electronic sensor system for shallow water.

4. BREAKWATER

The protective barrier constructed to enclose harbour and to keep the harbour waters undisturbed by the effect of heavy and strong seas are called breakwater. There are many different types of breakwaters: natural rock and concrete, or a combination of two, are the materials which form 95% or more of all the break waters constructed. It is a large pile of rock built parallel to the shore it is designed to block the waves and the surf. Some breakwaters are below the water's surface. A breakwater can be offshore, under water or connected to land. As with growing the jetties, when the long shore current is interrupted, a breakwater will dramatically change the profile of the beach. Overtimes, sand will accumulate towards a breakwater, down drift sand will erode.

Different types of breakwaters are:

Permanent break water (rubble mound, vertical and vertical composite type)

Temporary breakwater (pneumatic, hydraulic and floating breakwaters)

5. DESIGN OF RUBBLE MOUND BREAKWATER

5.1 General

Rubble mound breakwaters are structures constructed on coasts as a part of coastal management or to protect an anchorage from the effect of both weather and long shore drift. It reduces the intensity of wave action in inshore waters and thereby reduces coastal erosion or provides safe harborage. The design of breakwater carried out using procedure recommended by US Army Corps of engineers. The design procedure is discussed in the Shore Protection Manual (1984). The harbour engineer department, govt.of Kerala has constructed a number of breakwaters in various fishing harbour in Kerala. The breakwaters have withstood the wave condition. The present cross sections of the designed breakwaters are executed by the harbour engineer department earlier for other fishery harbors located nearby. The breakwater cross section is trapezoidal with number of layers, typically the side slopes will be 1 is to 1.5 up to 1 is to 2.5 that is for the trunk portion.

5.2 Design of breakwater section

From the bathymetry of proposed site the breakwater section should be designed for the water depths of 1m, 2.4m, 3m, 3.5m and 4m with maximum wave height of 3m and time period of waves equal to 8 seconds.

5.2.1 Breakwater Design -2.4m Depth

Water depth= 2.4 m

Time period, T = 8 sec

Specify design condition

Maximum wave height, H= 3m

Then, design wave height,

H/d= 0.78 (standard value)

Then H= 0.78 x d= 0.78 x 2.4= 2m

Design wave height is the lowest of above value = 2 m

$L_0 = 1.56\,T^2$ or $(gT^2)/2\pi$

$= 1.56 \times 8^2$ or $(9.81 \times 8^2)/2\pi$

=99.84 m

d/L_0 =0.024038

H/H_0' =1.168, (SPM Wave table: SPM Vol2 – Table C -1, Appendix C, Page c-6)

Then H_0' =2/1.168 = 1.72 = 1.8 m

For determine the wave run up height,

$H_0'/gT^2 = 1.8/9.81 \times 8^2 = 0.003$

R_u/H_0' = 1 for side slope of 1 in 2 (SPM wave table Vol 2, Fig 7-20, Page 7-31)

$R_u = H_0' \times 1 = 1.8$ m

Crest elevation

D = 2.4m

R_u = 1.8m

Minimum = (2.4+1.8) = 4.2m

Assume free board = 1m

Core level = MHWL = 1.30m

R_u = 1.8m

Crest level = MHWL + R_u= (1.3+1.8) = 3.1m

Total height of breakwater (crest level+d) = 3.1+2.4 = 5.5m

Armour unit design

Armour unit – rough quarry stone

Assume armour and under layer material is quarry stone, γ_a = 2.65 t/m³

Structure slope 1:2

(A) Design of primary layer

The weight of armour stones to be used for the construction of breakwater is calculated using Hudson's formula,

$W = (W_r H_d^3) / (K_d(S_s-1)^3 \cot\alpha)$ (SPM Vol 2- Equation 7-116)

Where, W_r = unit weight of armour unit = 2.65 t/m³

H_d= design wave height= 2m

S_r= Specific gravity of armour unit, relative to water at the structure

$= W_r/W_w$

W_w= unit weight of water = 1.03 t/m³

$W_r/W_w = 2.65/1.03 = 2.57$

K_d = 2, for structure trunk with rough angular quarry stone

(from SPM Vol 2- table 7-8 Page 7-206)

$W= (W_r H_d^3)/K_d(S_s-1)^3 \cot\alpha$

$=2.65 \times 2^3/(2 \times (2.57-1)^3 \times 2) = 1.37$ tons

=1.5 tons

Armour thickness(t) – primary layer

N= 2 (the thickness of armour layer (for random placed armour units and minor overtopping)

K_Δ= layer thickness coefficient = 1.02 (for quarry stone)

(From SPM Vol 2- Table 7 -13- Page 7-234)

P= Porosity percentage = 38% (for rough quarry stone)

Thickness, $t= nK_\Delta(W/\gamma_a)^{1/3}$ (SPM Vol 2 – Equation 7-121)

$= 2 \times 1.02 \times (1.5/2.65)^{1/3} = 1.7\text{m} \risingdotseq 2\text{m}$

Thickness of armour, t = 2m

Crest width

$B= nK_\Delta(W/\gamma_a)^{1/3}$ (SPM Vol 2-Equation7-120)

N= 3, minimum width shoulder be equalto that of 3 quarry stone

$= 3 \times 1.02 \times (1.5/2.65)^{1/3}= 2.6$ m

Provide a minimum width = 3m

Base width = crest width = slope width on either sides for each water depth

Base width = (1.5x5.5) +3+ (2x5.5) = 22.3m

Number armour unit per surface area

$N_a/A = nK_\Delta(1-(P/100)(\gamma_a/W)^{2/3})$ (SPM Vol 2 –Equation 7-122)

$= 2x\ 1.02x\ (1-0.38)x(2.65/1.5)^{2/3}$

$= 1.85$ unit/m^2

Gradation of primary layer= 0.75 W to 1.25W (SPM Vol 2- Page 7-205)

= 1.2 ton to 2 ton

(B) Design of secondary layer

Secondary stone size = W/10 to W/15 (SPM Vol 2- Page 7-227)

= 0.1 ton to 0.15 ton

Thickness (t)- secondary layer :

Minimum two stone thick (n=2)

Thickness, $t= nK_\Delta(W/\gamma_a)^{1/3} = 2x1.02x(0.2/2.65)^{1/3} = 0.8$ m

(C) Design of core

Minimum two stone thick (n=2)

Under layer unit weight = W/200 to W/6000 of armour (SPM Vol 2-Page 7-227)

= 0.25kg to 7.5kg

(D) Toe design

Size of stone

W/5 to W/10 = 1.5 /5 to 1.5/ 10 = 0.15ton to 0.3ton

Toe layer thickness (t) = $nK_\Delta(W/\gamma_a)^{1/3} = 2x1.02x(0.3/2.65)^{1/3}$

= 1m

Toe layer width (B) = $nK_\Delta(W/\gamma_a)^{1/3} = 3x1.02x(0.3/2.65)^{1/3}$

= 1.48m

(E) Lee armour

Slope 1:1.5

Size – W to W/3 = 0.5 ton to 1.5ton

(F) Bedding layer

Thickness of bedding layer = 0.6m (SPM Vol 2 – Page 240)

Offset minimum 3m from toe

7. CONCLUSIONS

The project Study on the design of fishery harbour has been completed. The project site is located at India, Kerala, and Parappanangadi. The different surveys and investigation required for the design and construction of a fishery harbour is discussed. Geotechnical, topographical and hydrographical surveys are the different types of investigation, and also these are categorised to many. Rubble mound breakwaters are structures constructed on coasts as a part of coastal management or to protect an anchorage from the effect of both weather and long shore drift. A rubble mound breakwater reduce the intensity of wave action in inshore waters and thereby reduces coastal erosion or provide safe harbourage. And thus the rubble mound breakwater is proposed to the site, designed according to Shore Protection Manual (1984).

REFERENCES

1. Prof. Supriya Shinde et al: “Design of breakwater for the development of fishery harbour- a case study”, Volume 4,pp.2043-2047,April 2017
2. Prof. Supriya Shinde et al: “ A review on rubble mound breakwater design by empirical formulae and hydraulic model tests”, Volume 4,pp.2039-2042, April 2017
3. Hasan Gokhan Guler et al: “A comparative study on the stability formulas of rubble mound breakwaters”,pp.1-11,2014
4. Jergen juhl et al: “Roundhead stability of berm breakwaters”,pp.1673-1706,1996
5. Nikolay Lissev et al: “Influence of the core configuration on the stability of berm breakwaters”, pp. 1735-1747,1993
6. Sreenivasan.R: “Harbour dock and tunnel engineering”, 1st edn, Charortar, karnadaka, 1958
7. Dr Ponmia.B.C, “ Reinforced concrete structures”, 2nd edn, Laxmi publications, Newdelhi,2003