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Hydrodynamic Study of Enayam Coast

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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. Hydraulic design of harbour facility is governed by complex coastal environmental parameters such as waves, currents, winds and sediment movement. Hydraulic model studies are essential for the design of coastal harbours. The paper includes the hydrodynamic study of Enayam in Tamil Nadu and designing of the fishing harbour. Hydrodynamic study deals with the bathymetric survey, study on tide, wind, wave, etc. The bathymetric survey was carried out using MIKE21 software, wave and wind direction were found from the wind rose diagram and wave rose diagram respectively. The wave height was determined using wave atlas and matrix analysis.**

***Keywords*— Fishing Harbour; Hydrodynamics; Bathymetry,**

I. INTRODUCTION

The coast, also known as the coastline or seashore, is defined as the area where land meets the sea or ocean, or as a line that forms the boundary between the land and the ocean. In planning a small fishing port along sandy beach, the most important points to be taken into consideration are how to prevent shoaling of the port entrance by drift sand and how to eliminate adverse effects of the structures on coastal topography such as downstream erosion and excessive accretion at the updrift beach. Movement of sea bottom materials is very active in the littoral zone, and even a small sized fishing port must be designed to avoid littoral sand deposits at the port entrance.

Hydrodynamic study deals with wave direction, wave height, wave frequency which has been obtained from wave atlas. Wave direction was identified and the percentage frequency of occurrence of wave for each month is studied. Wind wave model of the study area was generated. It will give the maximum wind specification which is used for the harbour construction. Wind and wave data during monsoon and non-monsoon period were collected from wave Atlas and global wave Atlas and also the soil profile details were collected. Based on these data, wind rose diagram and wave rose diagram are plotted. The dead load, live load and seismic load are considered during the construction of harbour. Understanding marine hydrodynamics can help us to design better ocean vessels and to understand physical ocean processes. Studying marine hydrodynamics provides a greater understanding of a wide range of phenomena of considerable complexity involving fluids. Hydraulic design of harbour facility is governed by complex coastal environmental parameters such as waves, currents, winds and sediment movement. Hydraulic model studies are essential for the design of coastal harbours. Hydraulic design of layout and the major components of the harbour is important step in development of fishing harbour. Harbour layout, length and alignment of protective breakwaters, location of various wharfs, jetties, hauling facilities, safe parking area for the fishing crafts in the harbour and dredging requirements for maintaining depths are decided through hydraulic model studies. Studies are generally carried out using physical or mathematical modelling techniques. The objective of the paper is to study the hydrodynamic characteristics of Enayam coast using MIKE 21 software. MIKE 21 is a computer program that simulates flows, waves, sediments and ecology in rivers, lakes, estuaries, bays, coastal areas and seas in two dimensions. MIKE 21 can be used for design data assessment for coastal and offshore structures, optimization of port layout and coastal protection measures, cooling water, desalination and recirculation analysis, environmental impact assessment of marine infrastructures, water forecast for safe marine operations and navigation, coastal flooding and storm surge warnings, inland flooding and overland flow modelling.

II. STUDY AREA

The area chosen is Enayam, Tamilnadu. Enayam is located 32 kilometres west of district capital Nagercoil and 741.5 kilometres from the state capital, Chennai. Villages near Enayam include Thengapattanam, Midalam, Painkulam, Killiyur, Thoothoor, and Paloor, Karungal, Kollankodu and Unnamalaikadai are other nearby cities. It is located on the coast of the Arabian sea a satellite map is shown as figure 1. Fishing harbour is situated at 8°12’52.89”N latitude and 77°11’38.95”E longitude. Wave direction from month of January to December were identified and the values were noted. People in Enayam also support the upcoming fishing harbour as it can boost up the employment in that area. Maximum wave height is observed at the month of November. Hydrodynamic study and bathymetric survey was conducted in the proposed area. These datas were transformed by MIKE21 software.

Considering the soil profile, shore-foreshore and offshore profile have been identified and studied. It showed that for a thickness of 1 m, loose to medium dense silty sands was observed, up to a thickness of 3 m dense to very dense sand and for a thickness of 4m very weak sandstone and finally up to six meter weak sandstone was found. When considering soil profile for deep waters it shows that the area has medium to dense silty sand up to a depth of 4 m, dense sand clay up to 8m and very dense and sandy clay below. Enayam is located on the basement of the Kanniyakumari District coastal belt. It consists of Charnockite, Granite, Gneiss, Leptinite Gneiss, Peninsular Gneiss, laterite and Warkalai, Sandstone. There are several indications of numerous episodes of deformation, which caused repeated folds, faults, joints and fracture

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systems. A preliminary study of material sources has been performed in order to analyse available materials for the construction, distance to the quarry areas, quality and nature of the materials. Visual recognition shows granite and gneiss quarries with good quality and extensive availability in neighbouring districts of Kanniyakumari.

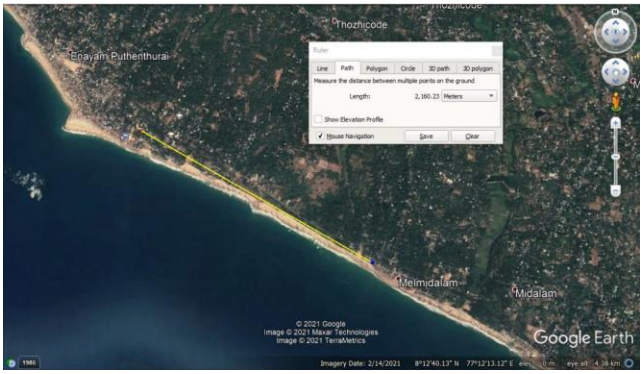

Fig 1 Satellite map Showing Enayam cost

III. DATA USED

A. *Wind*

A study of winds has been done during the monsoon period and non-monsoon period. The predominant wind direction during the monsoon period is west to north-west. On the other hand during the non-monsoon periods, the predominant wind direction is from north-east.

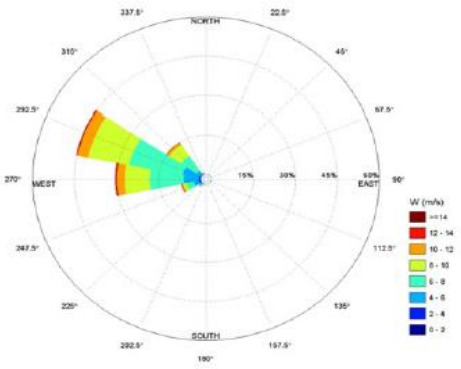

Fig 2 Winds in the monsoon period

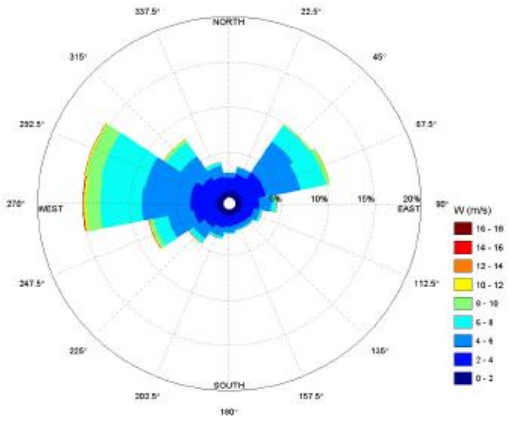

Fig 3 Winds in the non-monsoon period

B. *Wave*

The following wave roses represent the wave height, wave direction and the frequency of occurrence. The predominant wave direction is from south to south-southwest.

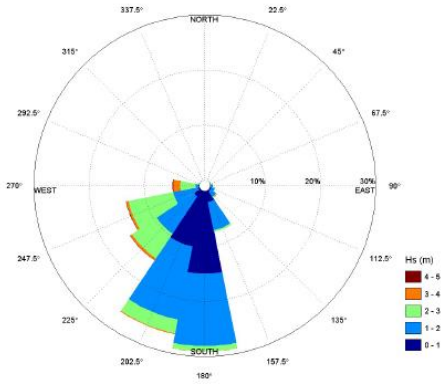

Fig 4 Wind rose Diagram

IV. METHODOLOGY

A. *General*

Hydrodynamic analysis is one of the key steps in safety assessment of a structure in waves. Here the software used for hydrodynamic study is MIKE 21. Using MIKE 21 bathymetric survey is carried out. After the bathymetric survey a near shore spectral wave formulation is carried out to produce a spectral wave module. This gives the accurate coastal region where the harbour can be constructed. A mathematical study of the wave is also carried out by matrix analysis and formation of wave rose diagrams. Maximum wave hight and period can also be identified by matrix analysis. Wind analysis is carried out with the help of global wind atlas.

B. *Bathymetric Study*

Bathymetry is the foundation of the science of hydrography, which measures the physical features of a water body. Hydrography includes not only bathymetry, but also the shape and features of the shoreline; the characteristics of tides, currents, and waves; and the physical and chemical properties of the water itself.

Steps to be carried out:-

1) Bathymetry setup:-

Setup of Bathymetry by importing geographical data with soundings based on a survey or digitized from nautical chart

2) Creating the Bathymetry:-

Nautical chart of the enayam coast is identified from ‘The Nautical Chart of India Book’. Based on the sea chart we define our working area in the Bathymetry Editor.

Defining the Working Area with projection system of (UTM Zone 43) in MIKE21 software. Add the geographical coordinates, longitude 77.11416666666678 and latitude 8.150212669171138. Easting and Northing will appear automatically as per latitude and longitude specification. Easting is 732944.457033082 m and Northing is 901513.646537505 m. Grid orientation will appear too by latitude and longitude. Import digitised shoreline data (land.xyz) and digitised water data (water.xyz) from gebco ‘General Bathymetric Chart of the Oceans’ in ASCII files.

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Convert the ASCII files into .xyz format by extracting it into notepad. Import these data from backround management in work area. While importing remember to convert the projection system to LONG/LAT.

For defining the bathymetry select new from grid bathymetry management in work area and import the base file and drag mouse over points of interest, selected points are now changing colour, finally click on 'Import from Background' once more. Interpolate xyz data to grid points. Save the bathymetry specification file and load the generated dfs2 file into the Grid Editor. Bathymetry of the proposed area is obtained

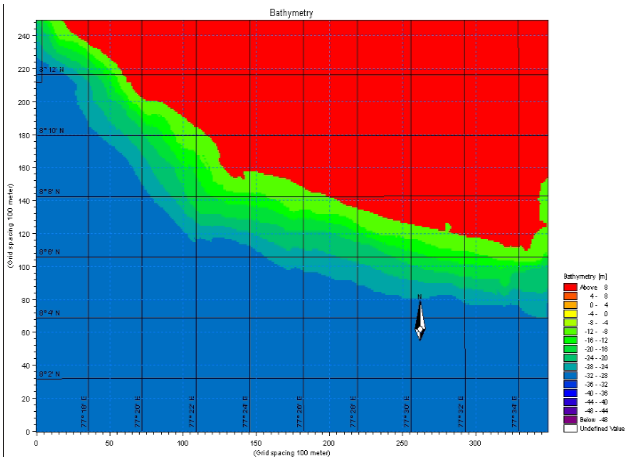

Fig 5 Bathymetry

The digitized bathymetry is saved as setup file in mike zero. Now create new project by selecting near shore spectral wave. A dialogue box will appear for giving the specifications, except the boundary condition of offshore, Mike automatically generates the parameters from the bathymetric data.

Input data for offshore:-
Type of boundary condition – version 1
Boundary data type- constant values
Significant wave height, Hm0 – 2
Mean wave period, Tm – 7 sec
Mean wave deflection, MwD- 240 deg
Directional spreading index,n -5
Max.deviation from MwD,MDwD – 30 deg

C. Matrix Analysis

Wave direction, wave height and its frequency is studied from the wave atlas. In wave atlas the directions are represented at 10* intervals. The inclination at enayam is given from 120* bearing to 300* bearing. Either from map or from the lattitude and longitude value of enayam coast, corresponding grid is identified i.e; grid 6.

Fig 6 Map showing grid

Matrix is obtained from the graph plotted and the the total percentage frequency of each month is obtained. The percentage of occurace per day is also calculated for each month by the equation:-

Percentage frequency at specific wave height* no. of days in month*24 ÷ 100

The total percentage of occurance per day for each wave height is obtained for every month. This value is plotted to obtain a graph against wave height and % frequency. Probability of occurance of wave for each wave height is identidied and a graph is plotted using this probability, the cumulative probability for each wave height is obtained. The standard deviation for above wave data is identified by finding the mean and varience.

Wave Directions

The bearing value of enayam falls in between 120deg to 300 deg. So the maximum value of wave direction for each month is identified from the wave atlas. Corresponding to this wave direction a graph is plotted against wave height and percentage frequency for each month.

TABLE I WAVE DIRECTIONS IN DEGREES

WAVE HEIGHT	***% FREQUENCY OF OCCURANCE***
0.5	*87*
1	*167*
1.5	*203*
2	*174*
2.5	*94*
3	*108*
3.5	*14*
4	*38*
4.5	*55*
TOTAL	*940*

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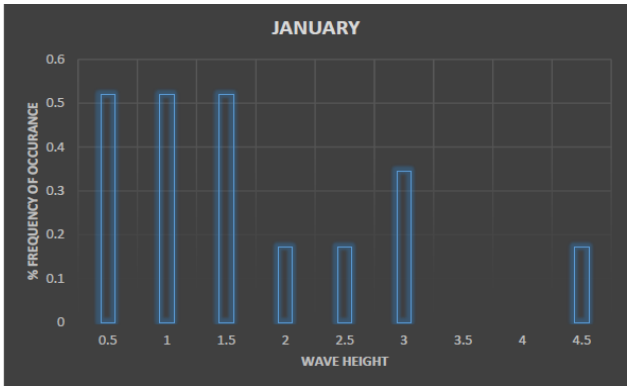

Fig 7 An example % Frequency of month January

V. RESULT AND DISCUSSION

From the studies we have obtained the results;

The bathymatry of the Enayam coast is shown in the figure 7, it shows the mean wave deflection

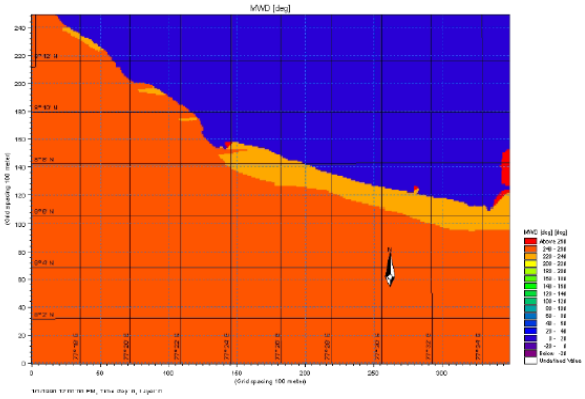

Fig 8 Mean wave deflection of 240°

And from the matrix analysis we have calculated the percntage frequency of wave occurance for one day as shown in the table below for different wave heights.

TABLE 2 SHOWING % FREQUENCY OF OCCURANCE OF WAVE

MONTH	***WAVE DIRECTIONS (in degree)***
JANUARY	*120*
FEBRUARY	*300*
MARCH	*180*
APRIL	*180*
MAY	*270*
JUNE	*270*
JULY	*270*
AUGUST	*270*
SEPTEMBER	*270*
OCTOBER	*270*
NOVEMBER	*180*
DECEMBER	*180*

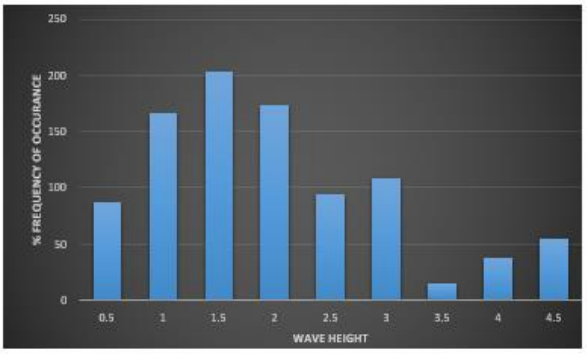

Fig 9 Graph showing % frequency

Cumulative frequency for each wave height is found and plotted a graph.

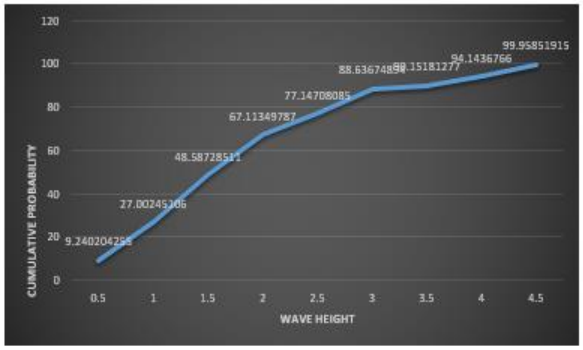

Fig 10 Graph showing Cumulative probability

V. CONCLUSION

The coast of Enayam located at a region of longitude 77.11416666666678 and latitude 8.150212669171138 is studied for the hydrodynamic characteristics. Hydrodynamic study is carried out by MIKE 21 software. Bathymetry of the proposed area is found using MIKE 21 and the depth of ocean were identified. A Near-Shore Spectral Wind Wave model was also generated to find the maximum wind wave conditions of the coast. Matrix analysis was done for the region by the help of wave atlas which helped in identifying the frequency of occurrence of wave in each month, its probability of occurrence with respect to wave height, etc. From the bathymetric study it was observed that the critical range of wave lies between 240 to 280. And the total percentage frequency of the wave was found out to be 940.

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