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ANALYSIS OF A WHARF STRUCTURE FOR ALAPPUZHA

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ABSTRACT:A structure on the shore of a harboror on the bank of a river or canal where ships may dock to load and unload cargo or passengers is known as Wharf.A multipurpose wharf with single berth is proposed here since the port is minor. This paper deals with the modelling and analysis of the structure.The structure is modelled in ANSYS.16. The analysis carried out are standard analysis and mooring analysis. The basic loads carried out for the analysis in this paper are berthing load, mooring load and other live loads. Analysis is done in ANSYS.16.
Keywords: Wharf, Analysis, Loads, ANSYS.16
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1. INTRODUCTION

A structure on the shore of a harboror on the bank of a river or canal where ships may dock to load and unload cargo or passengers is known as Wharf. A Wharf consists of a soil or rock embankment, a concrete deck structure, and piles that carry the deck and resists the lateral loads. A single wharf with a singleberth constructed along the land adjacent to the water is commonly adopted. A pier, raised over the wateris commonly used for cases wherethe weight or volume of cargos will be low. The proposed port in Alappuzha is a minor port and it will be used mainly for the loading and unloading of cargoes.

2 STUDY AREA

Kerala State has a long history of maritime trade and a number of vital industries such as mineral factories, coir factories, seafood processing units, etc., is situated in the coastal region. This has led to development of port activities at several places along the coast. There are one major port and 13 intermediate and minor ports situated along the coast.
The proposed project site is situated in Alappuzha Municipal area in Alappuzha district (Latitude of 9^{o} 30" N and Longitude of 76^{o} 19" E) about 50 km south of Kochi. The beach is 1500 m in lengthand 100 meters in width. Apart from thebeach, some parts of land adjacent to thebeach road also come under the purviewof the Port.Alappuzha, one of the two intermediate
Ports on the west coast of Kerala.

The proposed Alappuzha port is an artificial harbor protected from the sea conditions with breakwaters. The sea bed in the area predominantly comprises of sand and silt content is not significant. The present depth in the harbor basin is around 10m Below Chart Datum (BCD). The port has proposal for further deepening the harbor basin in stages according to the requirement.

3. GENERAL CONSIDERATIONS

3.1Design Vessel

With a dredged depth of 15.0m BCD in the berth basin, the permissible vessel draft for normal operation is 10.50m after allowing for the under keel clearance and clearance for accommodating siltation during the period between two maintenance dredging. The design vessel is a container vessel with following parameters.

Table 1 Parameters of feeder container vessel

DRAFT (m)	CAPACITY (T)	DEAD WEIGHT TONNAGE	LENGTH(m)	BEAM (m)
7.00	800	10000	135	22
8.00	950	12500	140	23
9.00	1200	16000	156	25
10.00	1800	22000	175	27
10.50	2200	26000	185	28

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Table 2 Parameters of container vessel (source: KITCO Ltd., Eranalkualm)

Capacity	2300 T
Dead weight	26000 T
Displacement tonnage	35000 T
Length (L)	180m
Breadth (B)	30m
Draft (D)	10.50m

3.2 Locationof Berth

The location selected is in front of the storage area developed for cargo handling. This is the prime location for berth construction and all developments are to be adjusted with reference to this prime location.

3.3 Wave Data

Offshore wave data for Alappuzha region as obtained from CESS Trivandrum.

Table 3 Wave data (source: Harbour engineering Dept, Alappuzha)

Month	Wave direction wrt north (degrees)	Max. wave height (m)	Significant wave height(m)	Wave period(s)
Jan	50	4.5 4.5	1.5 1.5	5 5
Feb	40	5.1	1.9	6.2
Mar	180	2.3	1	6
Apr	180	2.4	1.4	4.8
May	270	3.6	2	5.4
June	270	4.5	2	6
July	270	3.2	1.6	5.9
Aug	270	2.7	1.4	5.6
Sep	270	3.9	1	4
Oct	270	2.4	1.5	6
Nov	180	4.5	1.7	6.2
Dec	180	3.1	1.4	5.7

3.4 Sounding Data

The bathymetry detail of the region is obtained from the hydrographic survey map from the chief hydrographic survey wing, Trivandrum. The chart datum is 2.503m below the bench mark marked on the triangulated survey station. [4] proposed a system, this fully automatic vehicle is equipped by micro controller, motor driving mechanism and battery. The power stored in the battery is used to drive the DC motor that causes the movement to AGV. The speed of rotation of DC motor i.e., velocity of AGV is controlled by the microprocessor controller.This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains an essential part of the system although with changing demands on physical input as the degree of mechanization is increased.

4 LOADING

4.1 Mooring Loads

The mooring loads are lateral loads caused by mooring lines when they pull the vessel into or along the deck or hold it against the forces of the wind or current. Since the location of the berth is inside the area protected with breakwaters, there will be no current at berth location. The mooring load depends on the displacement tonnage of the ship. The displacement tonnage of the design vessel is 35000T. Based on the table 4 of IS:4651 (part III), bollard pull corresponding to 35000T displacement is 5 70T.

4.2 Berthing Load

When an approaching vessel strikes a berth through the fendering system a horizontal force is imported on the berth. The magnitude of this force depends on the kinetic energy of the vessel and load – energy absorption characteristics of the fender. The KE (E) imparted by the vessel is estimated as per the formula given in clause 5.2 of IS: 4651(Part III).

$E = W_D \text{ X } (V^2 /2g) \text{ X } C_m \text{ X } C_e \text{ X } C_s$ (Eq.(1))

W_D - Displacement tonnage of the vessel (350000T)

V - Approach velocity of vessel in m/s. For sheltered berth area and difficult berthing condition the value of V is taken as 0.15m/s as per table 2 in IS:4651(Part III)

g – Acceleration due to gravity (9.81 m/s^2)

C_m- Mass coefficient (1.7)

C_e - Eccentricity coefficient (0.51 as per IS:4651 (part III)

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C_s – Softness coefficient (0.95 as per clause 5.2.1.4 of IS:4651 (part III).

On substituting the above values the KE got as 34Tm.

4.3 Dead Load and Live Load

Self – weight of the structural members are considered as the dead load.

Live loads are considered as per IS 4651 – Part III – 1974. The various live loads considered are:

- Vertical live loads
    1. Uniform vertical load : 5T/m^2
    2. Truck load : 70R/Class A/ Class AA = 3.06T/m^2
    3. Crane load
    4. Reach stackers operational load
    5. Container placing load for single stack
- Berthing load
- Mooring load

4.4Calculation of wave slamming force

For Pile,

$$F_{SM} = 0.5 \text{ X } C_{SM} \text{ X } \rho_w \text{ X } D \text{ X } V_{SM} \text{ X } |V_{SM}|$$

F_{SM} – Wave slamming force

C_{SM} – Slamming coefficient

ρ_w – Density of water

D – Diameter of pile

V_{SM} – Velocity of the wave

By substituting the values of the above terms wave slamming force for pile foundation is obtained as **1.06 X 10^6 kN**

ForPile cover,

$$F_{SM} = 0.5 \text{ X } C_D \text{ X } A \text{ X } V^2$$

F_{SM} – Wave slamming force

C_D – Slamming coefficient

A – Area of the pile cover

V – Velocity of the wave

5 MODELLING

The structure is modelled in ANSYS.16 software. The dimensions of the structure are:

Diameter of pile: 1000mm

Width of each section: 7000mm

Length of each section: 6000mm

Fender size: 150mm X 150mm

5.2 Modelling in ANSYS.16

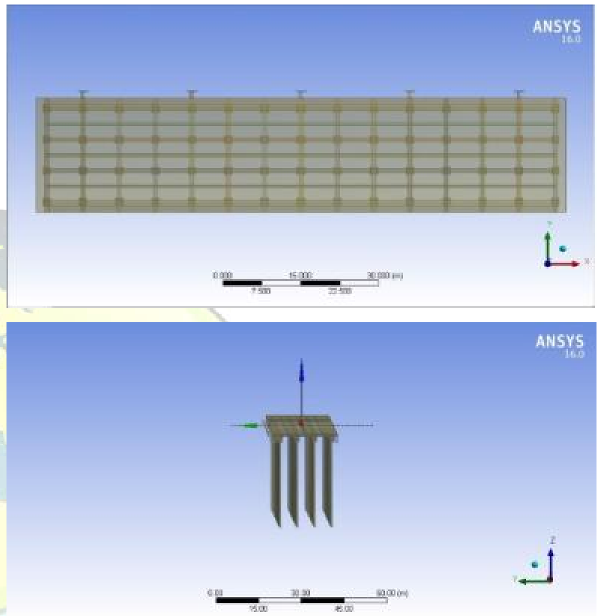

Fig 2 Model in ANSYS.16

6 MESHING

Meshing increases the accuracy of the result. Here the structure is meshed as both tectmesh and hexamesh. The berth of the wharf is hexamesh and the piles are tect mesh.

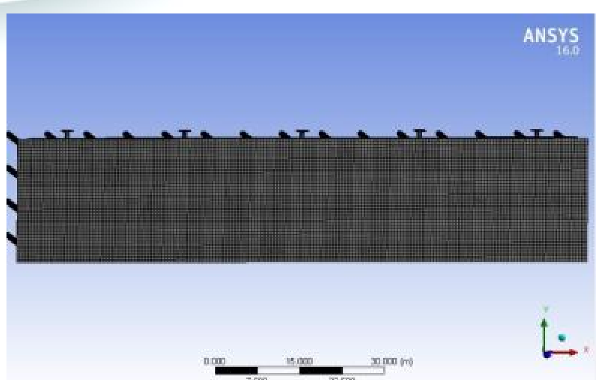

Fig 3 Meshing on the berth of wharf

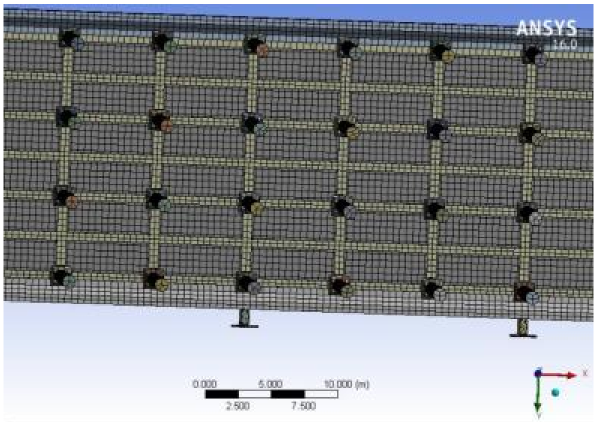

Fig 4 Meshing on the pile of the wharf

7 ANALYSIS AND DESIGN METHODOLOGY

The dead loads are calculated and assigned as self – weight in the analysis software. For vertical live loads the wheel load of the trucks and cranes are considered as moving load. The structural design should be done as per the Limit State Design for concrete structures.

8 ANALYSIS RESULT

The model was analyzed in ANSYS.16. The base of the pile and the side which is on the shore is given as fixed. The water level is up to 12m from the bottom of the structure. The maximum deformation of the structure is on the pile and the value is 9.0 cm. Fig 5 shows the total deformation of the structure. Fig 6 shows the equivalent stress distribution of the structure. The maximum stress is 2.52 X 10^4 MPa.

- The deflection of the structure is more on the shorter faces than the longer faces.
- Shear force is maximum at the faces of the wharf.

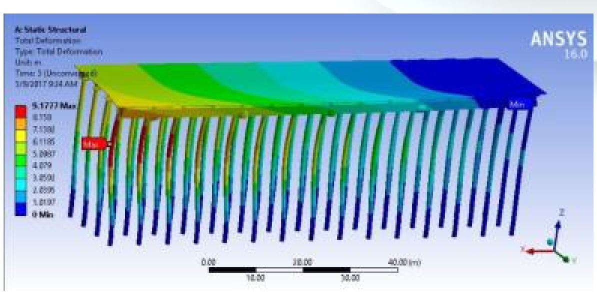

Fig 5 Total deformation Diagram

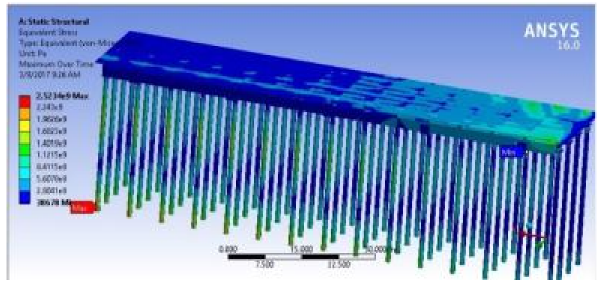

Fig 6 Equivalent stress

CONCLUSION

Working in severe ocean circumstance, the security of wharfs is important. The maximum displacement obtained from the analysis is 5.5cm. This value is not acceptable since the structure is placed in offshore. So the thickness of the berth is increased from 2m to 3m. Nearly all national codes lack specific address to portstructures, and seismic assessment and considerations, and general analysis and design haveto follow practices specific for other particular structures such as bridges and buildings. Thesecan be inappropriate since the criteria requirements can differ. For instance, the design of apile supported wharf considers the pile deck element as a frame.

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