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PLANNING AND DESIGN OF CONTAINER TERMINAL

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Abstract - *A container port must be planned to satisfy prompt accommodation of ships with minimum waiting time in port, and with maximum use of berth facilities. Somewhere between these opposing objectives each container port must reach a compromise, the number of berths which will achieve the most economical transfer of cargo between ships and shore. And also to construct a harbor components of (Breakwater, Jetties and Wharf). The Breakwater is prepared with cross section by using AutoCAD. The Breakwater is generally designed to consist of three layers thar are core, secondary layer and an armour layer. Jetties are lifeline structures as they provide a cost effective method for transporting large quantities of goods and raw materials. Jetty structures are generally located in deep sea. Generally structures are subjected to dead load, live load, wind load, earthquake load and temperature load while Jetties are subjected to additional marine loads like current load, wave load, berthing load and mooring load.*

This paper is focused towards the calculation of various forces acting on jetty structure and its application to the model for analysis. In the present dissertation a berthing structure of Wharf was analyzed and designed using different load conditions and the best possible way to construct a new berthing structure was described. The main objective of the analysis is to compare the results thus obtained from both the manual analysis and Staad analysis methods. Generally structures are subjected to dead load, live load, wind load, earthquake load, while Berths are subjected to additional marine loads like current load, wave load, berthing load and mooring load.

Keywords: **ContainerTerminal,Wharf,Breakwater,Jetties Seismic and wind loads.**

1.INTRODUCTION

A harbour can be defined as a sheltered area of the sea in which vessels could be launched, built or taken for repair; or could seek refuge in time of storm; or provide for loading and unloading of cargo and passengers. Harbours are broadly classified as:

- Natural harbours
- Semi-natural harbours
- Artificial harbours.

2. OBJECTIVE

- To satisfy prompt accommodation of ships with minimum waiting time in port, and with maximum use of berth facilities.
- To plan and control activities in container terminals.
- To provide a complete design of a harbor(jetties, breakwater and wharf structure) by calculating the loads acting on the structure.

3.STUDY AREA

- The Port is considered for planning in between Enayam and Colachel at Kanyakumari District .
- The draft at the harbour is proposed at 16m capable of handling 18000 TEU capacity Container vessels and cape size Coal vessels.
- The prime advantage of Colachel (Enayam) site is the availability of deep waters closer to shoreline (20m depth at a distance of about 1.5 to 2km from the shoreline).

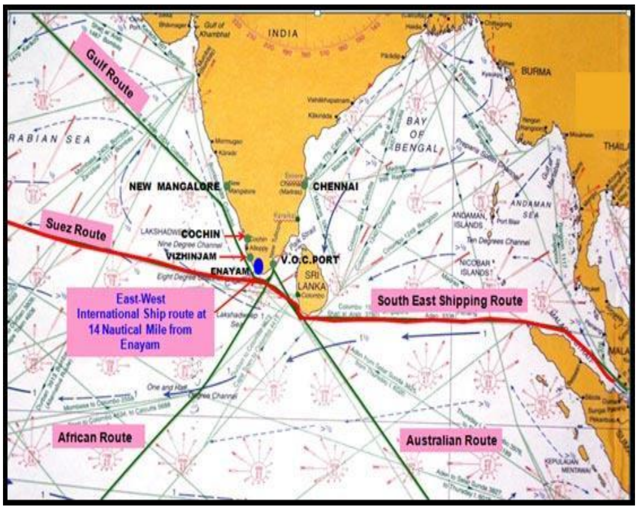


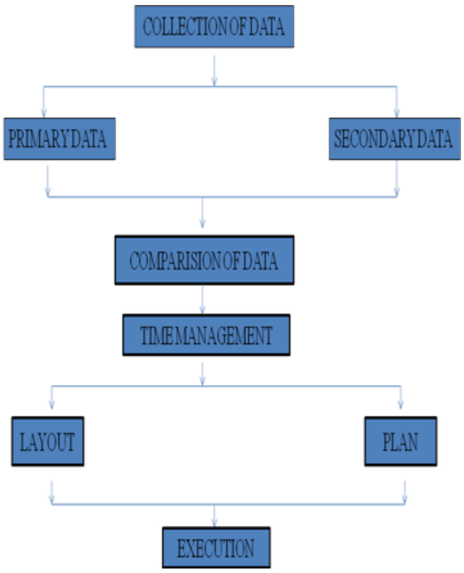
Fig -1: Enayam sea port location

4. METHODOLOGY

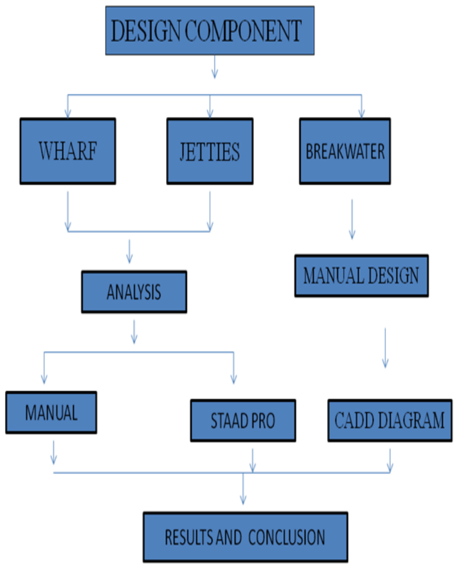
4.1 General

The Design components of harbor should be constructed depending upon the natural condition and the features of the entrance channel. The provision of components may either be made in initial stage of the layout of the harbor.

4.2 Flowchat 1



4.3 Flowchart 2



5. PLAN AND DEVOLOPEMENT

5.1 Phase of development

5.1.1 Phase 1

The phase 1 contain 2 numbers of berths which is 800m long. The minimum TEU of phase 1 is 1.60 and MTPA is 24. The overall capacity of phase 1 is 24 MTPA (Metric tons per unit).

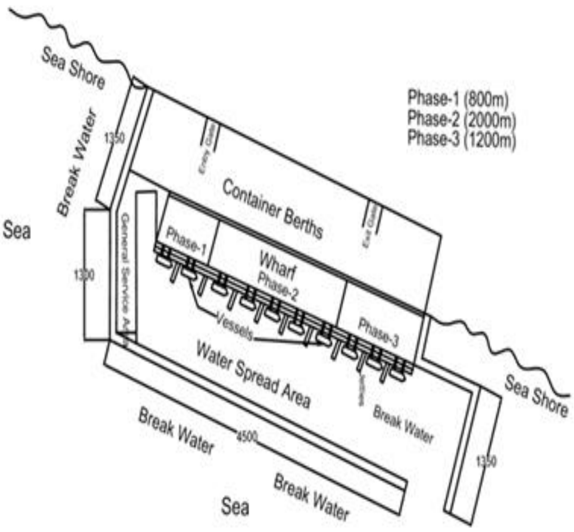


Fig -2: Plan

5.1.2 Phase 2

The phase 2 contain 5 numbers of berths which is 2000m long. The minimum TEU(Twenty foot equivalent unit) of phase 2 is 4.02 and MTPA is 60.30. It also contains a one berth (400m) for solid dry bulks which contains capacity of 3.30 MTPA. The overall capacity of phase 2 is 63.60 MTPA.

5.1.3 Phase 3

The phase 3 contain 3 numbers of berths which is 1200m long. The minimum TEU of phase 3 is 2.41 and MTPA is 36.15. It also contains a one berth (400m) for solid dry bulks which contains capacity of 3.30 MTPA. The overall capacity of phase 3 is 39.45 MTPA.

5.1.4 Key facts:

- Major port at Enayam will act as a major gateway container port for Indian cargo that is presently trans-shipped outside the country.
- It will help to reduce the logistics cost for exporters/importers in South India who currently depend on trans-shipment other foreign ports, incurring additional port handling charges.
- It has 10 million TEUs (twenty foot equivalent units) capacity and later can be expanded to 18 million TEUs.

Table -1 Phases of Development

Description	Unit	Phase-I	Phase-II	Phase-III
Container Berth	M	800(2 No's)	2000(5 No's)	1200 (3No's)
Capacity	Min TEU	1.60	4.02	2.41
	MTPA	24	60.30	36.15
Solid dry bulk	M	-	400 (1 No's)	400 (1 No's)
Capacity	MTPA	-	3.30	3.30
Overall Capacity	MTPA	24	63.60	39.45

6. DESIGN APPROACH

Table – 2 Loads And Study Details

Load considered	Study Details
Dead load Live load Mooring force Berthing force Seismic force Wind load	Seismic weight = 55318.5kN Importance factor = 1.5 Response reduction factor = 5 Time period = 0.31 sec Wind speed (V_z) =48.78m/sec wind pressure, p = 1.427 kN/m^2

Table -3 Vessel parameters for jetties

Vessel parameters	Vessel specification
Vessel size	90 m
Draft level	5.9 m
Displacement tonnage	2800
Width	14 m
Berthing Velocity (m/sec)	0.15 m/sec

Table -4 Vessel parameters for wharf

Vessel parameters	Vessel specification
Vessel size	350 m
Draft level	16 m
Displacement tonnage	20000
Width	23 m
Berthing Velocity (m/sec)	0.75 m/sec

7. DESIGN OF JETTIES

The slab for jetties is divided into three parts in which the two slabs are designed in one way slab method and one slab is designed in two way slab method. The beam are designed into three beams of main, lateral and secondary beam. The pile is designed as square and cylindrical pile. The dead loads of structure is taken by calculating the self weight of the slab, beam and pile. The live load is calculated according to code book of IS4651 part III.

7.1 Dead loads

Wearing coat (Apron) = 0.20 X 25 = 5 kN/m^2
(density of the concrete is taken 25 kN/m^3)
Slab weight = 0.40 X 25 = 10 kN/m^2
Beam = 600mm×400mmx25=60kN/m^2
Pile = $(\pi/4)$X1.50X1.50X20X25=920.12 kN/m^2

7.2 Live loads

A live load of 10kN/m^2 (from IS 4651 part-iii) is considered for jetty .

Table -5 Design components and details

COMPONENT	TYPE	NOS	DETAILS
Slab	(i) One way slab	2	10mm ϕ @ 300mm
	(ii) Two way slab	1	8mm ϕ @ 400mm
Beam	(i) Main beam	1	25mm ϕ @ 130mm
	(ii) Lateral beam	1	25mm ϕ @ 130mm
	(iii) Secondary beam	1	20mm ϕ @ 250mm
Pile Head	Square	1	16mm ϕ @ top 20mm ϕ @ bottom
Pile	Cylindrical	1	50 nos of 30mm ϕ

8.DESIGN OF WHARF

The wharf are designed to the length of 4500m, in which the is divided into 450m. The slab for wharf is designed in one way slab and for beam the is designed in square beam . The pile is designed in cyclindrical shape .

8.1 Dead loads

Wearing coat (Apron) = 0.20 X 25 =5kN/m^2
Slab weight = 0.30 X 25 = 7.55 kN/m^2
Pile= $(\pi/4)$x1.70X21.65X25=920.12 kN/m
Transverse beams = 1.10 X 0.60 X25 = 16.5kN/m
Longitudinal beam = 1.10 X 0.60 X 25 =16.5 kN/m

8.2 Live loads

A live load of 10kN/m^2 (from IS 4651 part-iii) is considered for jetty .

Table -6 Design components and details

Components	Type	Nos	Details
Slab	Two way	1	32mmϕ300mmc/c
Beam	Traverse beam	1	9mmϕ32mmc/c
	Longitudinal beam	1	9mmϕ32mmc/c
Pile	cyclindrical	1	16mmϕ300mmc/c

9. DESIGN OF BREAKWATER

9.1 Design conditions

Significant wave height, H_s = 1.5 = 1.5m
Depth of water, d = 2.5m
Time period of approaching waves = 8 s
Stability coefficient, K_D = 2 (for rough quarry stone)
Table for K_D value(source: EM 1110-2-1614)
Unit weight of armour, ρ_a = 2.65 T/m^3
Density of sea water, ρ_w = 1.025 T/m^3
Slope, ɵ = 1 in 1.5

9.2 Wave Height :(Source: ISSN 0974-5904 Vol 08)

By analyzing cumulative data from 2006 to 2016 wave height is 4m .

Tide level is 12 sec (from 2006 to 2016).

9.3 Armour Design

$W_a = (\rho_a H_s^3)/(K_D \Delta^3 \cot\theta)$
$= 3.46$T

9.4 Crest Width

$B = nK_\Delta (W_a/\rho_a)^{(1/3)}$
N = Number of stones
= 3
K_Δ = 1
B = 3 x 1(3.46/2.65)$^{(1/3)}$ = 3.27 m

9.5 Thickness of armour

$t = nK_\Delta (W_a/\rho_a)^{(1/3)}$
n = 2
t = 2.18 m

9.6 Underlayer Design

$W_a/10$ to $W_a/15$
= 0.346T to 0.231T

Thickness of under layer = depth of armour = 2.18m
Depth of Core layer = depth of toe berm
= 1 m
Structure height = Thickness of armour layer + thickness of Underlayer +depth of toe berm + belty layer
= 6.36 m
Weight of strut = Weight of armour unit + weight of under layer + weight of core + toe berm
= 4.19 T
Overall bottom width of breakwater = length of breakwater/100
= 4500/100 = 45m

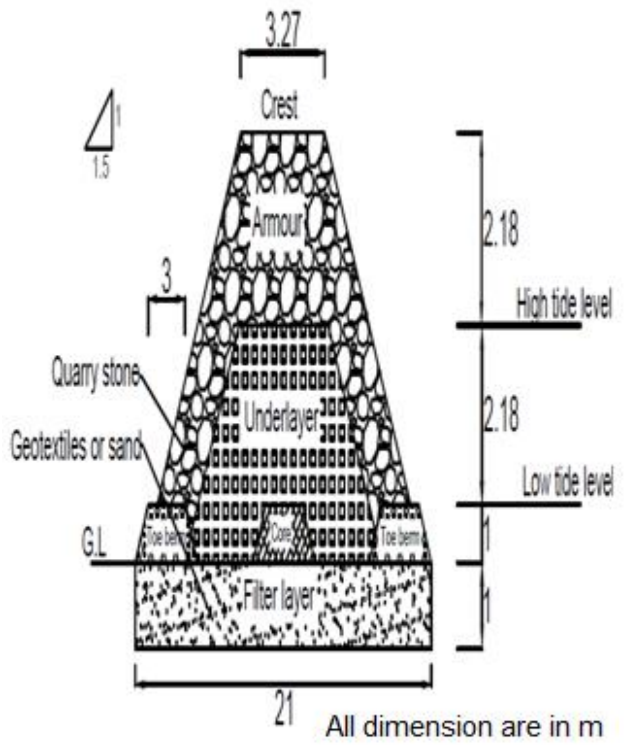


Fig -3: C/S view of breakwater

10. ANALYSIS OF JETTIES STRUCTURE

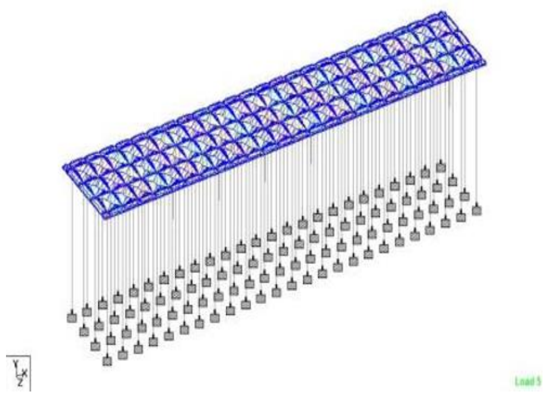


Fig.4 Application of Dead load

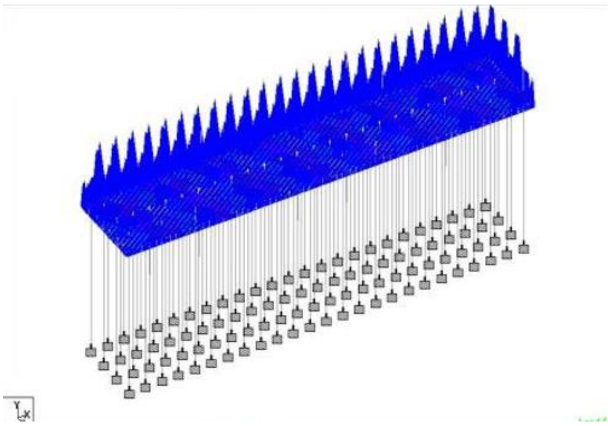


Fig.5 Application of Live load

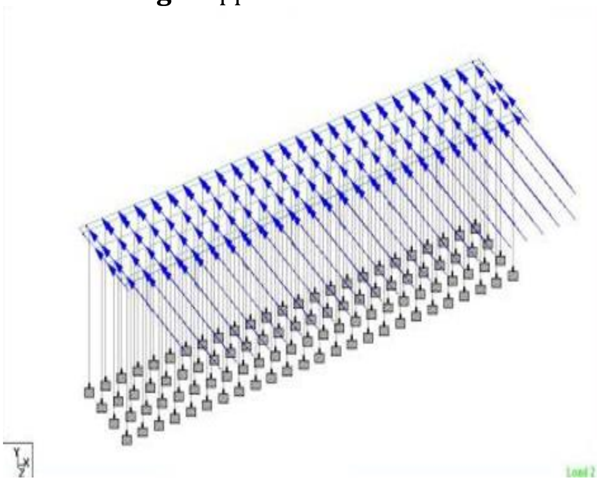


Fig.6 Application of Earthquake load in Z-direction

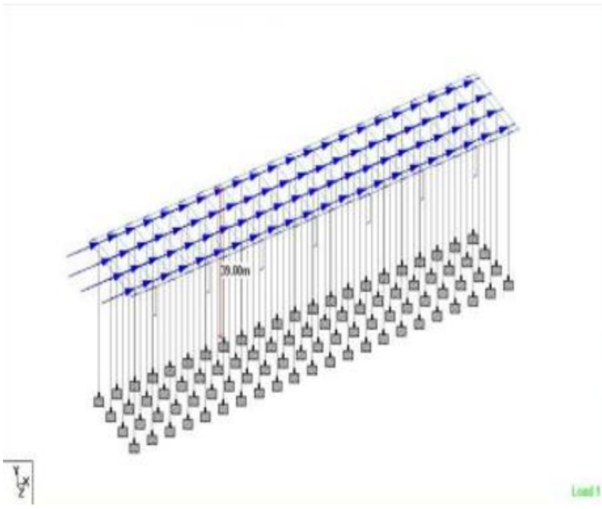


Fig.7 Application of Earthquake load in X-direction

11. ANALYSIS OF WHARF STRUCTURE

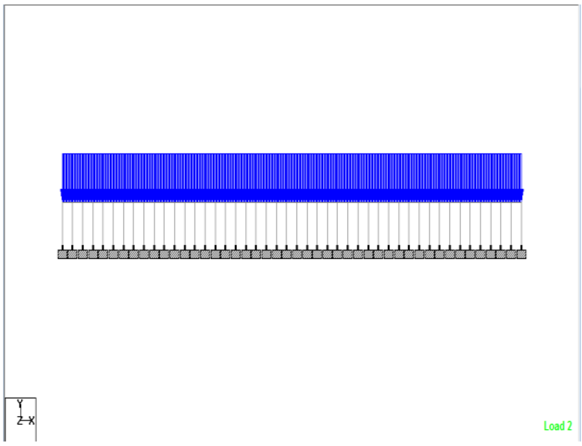


Fig.8 Application Of Live Load

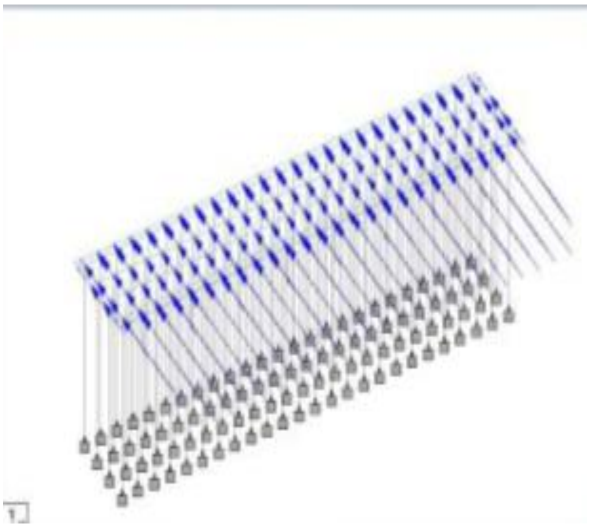


Fig.9 Application of Earthquake load in Z-direction

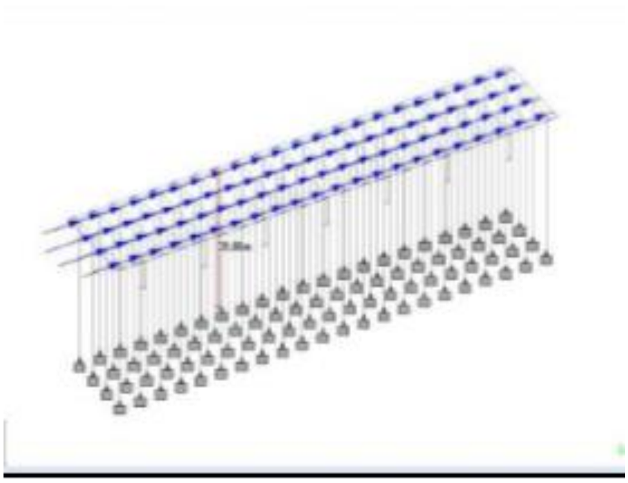


Fig.10 Application of Earthquake load in X-direction

12. CONCLUSION

The Planning and Design of Container Terminal has been Completed Successfully. The part of the works is completed by now, the final completion of the breakwaters and some of the construction of structure (jetty and Wharf) has completed .The Structural Components of Harbor (Breakwater, Jetties and Wharf) are designed manually. The whole Berthing structure (Jetties and Wharf) has been analyzed by using STAAD Pro Software. The Design of Slab, Beam has been done as per limit state design. The beam having the maximum positive and maximum negative bending moment is taken from the manual analysis report and it is designed using limit state method of design. The compression and tension reinforcement is calculated and the shear reinforcement is provided. Thus the structural elements in the berthing structure are designed and reinforcement details are calculated successfully.

12.1 FUTURE SCOPE

- Ability to service the cost effective hinterland for any proposed projects in future.
- Usage of composite sections and precast sections can make the construction cost effective and time effective.
- Auxillary port service (like pilotage ,tugging & mooring)
- Captive facilities for port based industries.
- Development in the economy by import and export.

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