An Approach on Optimization of Berth Structure at Port Sectors for Handling Bulk Cargo and Containers

Mr. Deekshith Shetty
PG Student,
Department of Civil Engineering
Sahyadri College of Engineering & Management
Adyar, Mangaluru, India

Mr. Shashikanth P. Kodi
A. E. E,
Department of Civil Engineering
NMPT, Panambur
Mangaluru, India

Prof. Umesh S. S
Head of the Department
Department of Civil Engineering, SCEM
Adyar, Mangaluru, India

Abstract: **This paper presents basic ideas and terminology of structural optimization. The role of structural design optimization in the product design process is discussed. Nested and simultaneous formulations of structural optimization, as well as the basic geometric design parameterizations- size, shape, and quantity of materials are defined.**

The aim of the present investigation is to try the scope for optimization of the berth structure as per site conditions and assumptions made while analyzing and designing the berth structure. The study includes the comparison of forces for assumed model and different cases which may arrive as per site while construction. Also the design variations are tabulated for each case.

The present study is an attempt to observe the changes in design for different cases with respect to assumed model in which the pile founding level is same for all the piles. Three different cases has been modeled for which pile founding level has been varied which may arrive at site while construction and compared with the assumed model which has same founding level for all the piles. Case 1 model has only 25% of the pile founding in (-) 19.0m level and rest founding in (-) 24.0m level. Case 2 model has 50% of the pile founding in (-) 19.0m level and rest founding in (-) 24.0m level. Case 3 model has 75% of the pile founding in (-) 19.0m level and rest founding in (-) 24.0m level. For all the cases the forces and design has been compared with the basic assumed model in which all the piles are founded at (-)24.0m level.

***Analysis of frames has been done using SAP 2000Ver 14.1.0**

Keywords - Size; Shape ; Quantity; Berth Structure

INTRODUCTION

A port is a facility consisting one or more harbors where ships can dock and transfer people or cargo to or from land. Port always plays a strategic role in the development of domestic and international trade of a country whether it is a developing or developed country. Ports play an active role in sustaining the economic growth of a country.

A structure in mechanics is defined as "any assemblage of materials which is intended to sustain loads." Optimization means making things the best. Thus, structural optimization is the subject of making an assemblage of materials sustains loads in the best way. We want to find the structure that performs this task in the best possible way.

Many large reinforced concrete structures have been designed and constructed worldwide in the past decade. Before the development of computers, analysis and design steps were done by simplified approaches, mainly by trial and error. After the arrival of computers, some prominent software like ETABS and SAP etc., which help the engineers to analyse and design these structures. Using these software's optimization of the structure is done via trial and error method.

In this Work the analysis and design work is been carried out by using SAP 2000 (Ver.14.1.0) application is used for the analysis and design and further it is optimized and results are discussed. In this method Structural weight optimization is done by optimizing the steel quantity for the proposed structure. Models are developed with fixity condition for different site cases and results are tabulated. This application has been used to optimize the weight of several frames of varying length of pile, span and including its diameter.

This work presents an optimal design of three dimensional One-story reinforced concrete structures. The design is based on the IS: 456-2000 code and loadings are based on IS: 4651-1989 (part-2). Structural Analysis is carried out by using static analysis method. All the members are subjected to biaxial moments and axial loads. Pre-determined sections are assumed for beams and Piles.

OPTIMIZATION OF BERTH

First, a One-story frame with 6m span in X direction and in Y- direction outer two spans are of 7m and in between are of 6m is taken into consideration for actual Basic model. For different site cases with varied pile lengths, analysis is carried out to compare and to optimize the amount of steel.

For different site cases with varied pile lengths, analysis is carried out to compare and to reduce the amount of steel. Based on the results obtained steel quantity is calculated from the model for all the Zones depending upon the site condition.

The method demonstrated its capability for optimizing the weight of this size frame in a reasonable system. The procedure was able to reduce the structural weight of this frame compared to the original design weight. The final design obtained by the SAP application satisfied the desired Life Safety performance level. The optimized design frame was compared to the original design in terms of quantity of steel and concrete including cost during the analysis and design.

MODELLING AND ANALYSIS

Totally 16 models of different cases have been analyzed in which 4 are basic models for all the zones and remaining are for different cases as mentioned below. For basic model - there are totally 44Nos of piles having 1.2m diameter arranged as shown in fig no.1 in which it has 4 rows with 24m height for all the piles. The other configuration of models are as stated below which may occurs at any normal site while construction.

Case 1 model has only 25% of the pile founding in (-) 19.0m level and rest founding in (-) 24.0 level. Case 2 model has 50% of the pile founding in (-) 19.0m level and rest founding in (-) 24.0m level. Case 3 model has 75% of the pile founding in (-) 19.0m level and rest founding in (-) 24.0m level. For all the cases the forces and design has been compared with the basic assumed model in which all the piles are founded at (-)24.0m level.

The structure has modeled using SAP 2000 software with version 14.1.0 having X and Y as horizontal direction and Z as vertical direction. The berth structure is basically modeled as three dimensional structures. The frame element has been selected for the members of berth structures which have 6 degrees of freedom at both ends of the member.

For analysis and validation purpose support conditions is taken as fixity. Live loads are considered 55kN/M^2 as per IS: 4651:1989(part-2). Berthing Load on structure calculated and considered 1391.40 KN at fender locations. Mooring Load on structure calculated and considered 1099.80 KN at bollard locations. Concrete grade considered as M40 and steel grade as Fe500D CRS/HCR bars.

The basic model is validated with the pile load both by manual calculation and Staad Pro analysis.

Further the forces are tabulated for different cases and study is made to know the variations in the forces for all the different cases with respect to basic model. The berth and its structural components have been designed as per limit state method. The partial safety factors for loads in limit state design method has been used. Accordingly, load combinations have been considered as per IS: 4651-2007

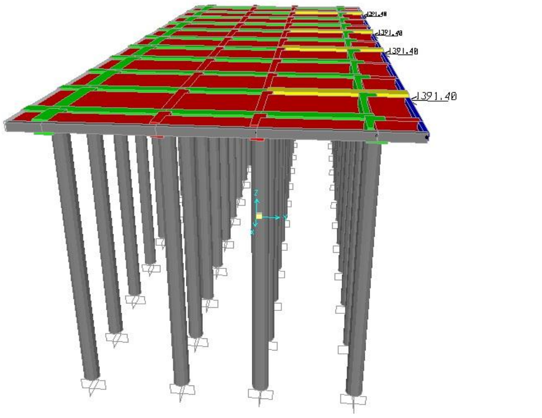

Fig. 1: Typical model of panel showing Berth Loading

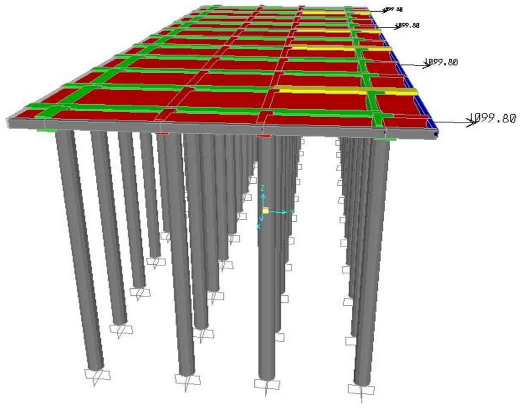

Fig. 2: Typical model of panel showing Mooring Loading

STRUCTURAL MODEL

Following figure shows the model for various cases.

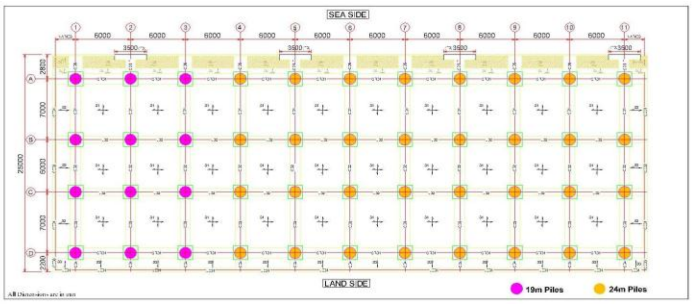

Fig. 3: Typical panel layout showing case-1

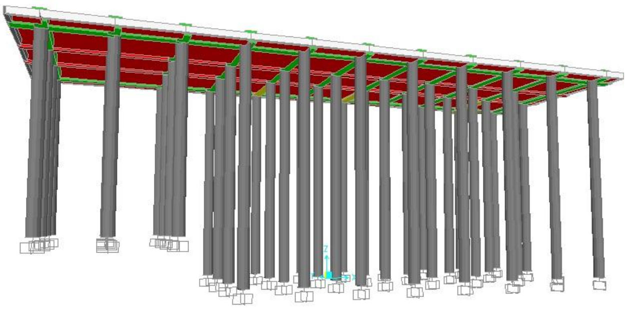

Fig. 4: Typical model of panel showing case-1

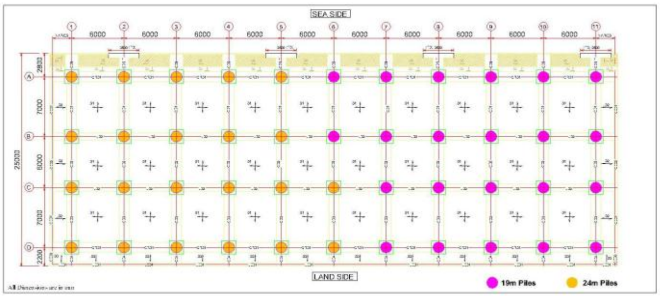

Fig. 5: Typical panel layout showing case-2

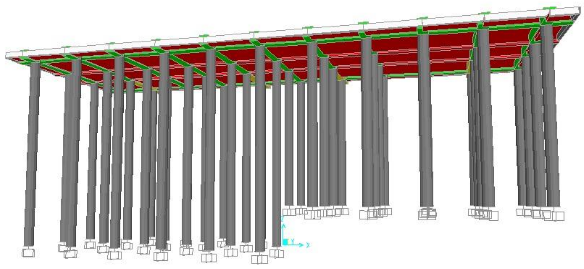

Fig. 6: Typical model of panel showing case-2

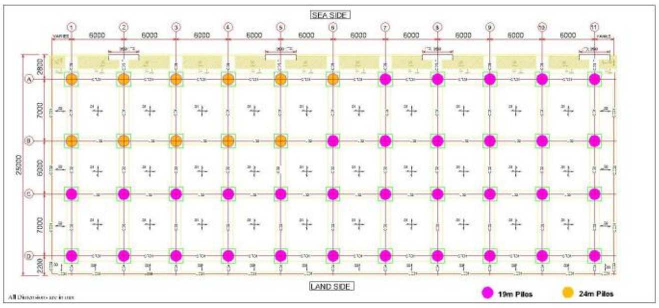

Fig. 7: Typical panel layout showing case-3

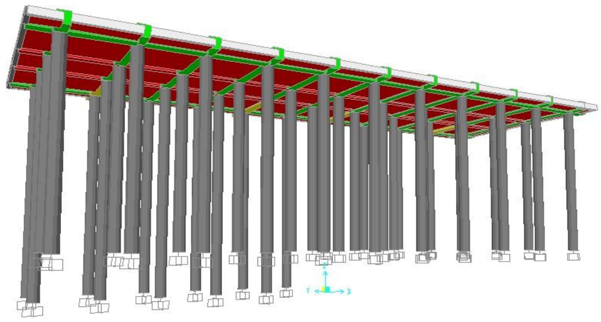

Fig. 8: Typical model of panel showing case-3

RESULTS AND DISCUSSIONS

Table 1: Percentage variation in Quantity of steel for various cases with respect to Basic Model

6m span							
Seismic Zones	Total weight of steel in piles (MT)				% Variation		
	Basic Model	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
Zone-II	129	110	93	79	15	28	39
Zone-III	122	103	93	79	16	24	36
Zone-IV	142	127	114	86	11	20	40
Zone-V	182	162	140	115	11	23	37

Based on the results and design for case 1 structure, due to the force variations minimum 11% to 16% reduction in steel is observed when compared with basic model in all the zones. For case 2 structure minimum 20% to maximum 28% reduction in steel is observed when compared with basic model in all the zones and for case 3 structure minimum 36% to maximum 40% reduction in steel is observed when compared with basic model in all the zones. Over all there is drastic reduction in steel which may be cost effective if designed for site cases with accurate assumptions.

CONCLUSION

This paper presents an approach for optimal sizing and reinforcing multi bay single storey RC structure incorporating optimal stiffness to the structural members. The paper presents the use of trial and error based optimization techniques in the design of reinforced concrete piles considering parametric uncertainities in pile founding level with varied spans.

An attempt has been made in the present study to obtain optimum design for a reinforced concrete piles and study result shows that significant reduction in cost can be achieved, overall there is drastic reduction in steel which may be cost effective if designed for site cases with accurate assumptions.

.

ISSN: 2278-0181
Vol. 4 Issue 07, July-2015

REFERENCES

[1] P. K. Basudhar, 2007 "Cost Optimization of Reinforced Earth Walls"

[2] G. L. Sivakumar Babu and B. Munwar Basha, 2008 "Optimum Design of Cantilever Retaining Walls Using Target Reliability Approach"

[3] S. Andres Guerra and Panos D. Kiousis, "Design optimization of reinforced concrete structures" Computers and Concrete, Vol. 3, No. 5 (2006) 313-334

[4] IS:4651:1989(Part-IV), "Code of practice for planning and Design of Ports and Harbours", 2nd revision, Bureau of Indian Standards, New Delhi, India.

[5] IS:2911:2010, section-2 "Code of practice for Design and construction of Pile Foundations", 2nd revision, Bureau of Indian Standards, New Delhi, India.

[6] IS:1893:2002 (part-1), "Criteria for Earthquake Resistant Design of structures", 5th revision, Bureau of Indian Standards, New Delhi, India.

[7] IS:456:2000, "Code of practice for plain and reinforced concrete", Bureau of Indian Standards, New Delhi, India.