Analysis And Design of Ship Repair Structure

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Abstract- *Structural design is one of the significant aspect of Civil Engineering focuses on the framework of structures on designing those structures to withstand the stresses, environment impacts, remain safe, stable and secure throughout their life.Ship repair structure which is used for the repairing and maintenance purposes. It is available in major ports and also for both commercial and military purposes. The design philosophy considered as limit state of service and limit state of collapse both have been considered for design. Analysis of structures have been performed in STAAD Connect Version Edition V22 and pile, pile cap, beams and slabs have been designed by using standard spread sheets. Those spread sheets followed according to the Bureau of Indian standards viz., IS 4651, IS 456, IS 2911, IS 875 and Crane and Hoist manufacturer data sheets. The structural drawings and reinforcement details have been prepared by using AutoCAD software.*

Keywords- DWT, Vessel, Mooring, Berthing forces, Platforms, Wave force, Crane Load

I. INTRODUCTION

A heavy-lift ship is a vessel designed to move very large loads that cannot be handled by normal ships. A Heavy Lift vessel (HLV) is a huge freight ship that has been designed to carry cargo that goes above and beyond the size and weight of the kind of items usually found on a container ship. The ship structure industry has ties to many other industries, such as marine engineering, offshore industries and defense.

Ship structure is concerned with the production of large, mainly ocean-going vessels for either merchant or military purposes. China, Japan and South Korea were the major ship structure nations in 2019, with China, for example, completing 22.3 million gross tonnes of ships that year. These nations remain the leading countries for today's global ship structure output.

The proposed site has been assuming as Chennai, Tamil Nadu State. Chennai Port, formerly known as Madras Port, is the second largest container port of India, behind Mumbai's Nhava Sheva. The port is the largest one in the Bay of Bengal.

Figure 1: Typical Ship Repair Platform Overview

II. LITERATURE REVIEW

Oh, Sin, Lee (2007)- The authors advised a plan for vitalization of Busan New port by activating ship repair industry for high value added jobs and specialized vessels like LNG carriers, where technology is not yet mastered in emergent markets and gain a lead in this field by fostering the link between the port and ship repair industry as an incentive to choose the port of Busan by ship-owners for such repair jobs.

Song, Seo, Yum (2010)- The authors of this study singled out the three factors of: (1) Cost of Repairs, (2) Repairs Technical Level and (3) Yard Location and analyzed their influence on the international competitiveness of ship repair industry compared to other global players in Europe, China, Japan, Vietnam & the Middle East.

Trochim & Donnelly (2007) indicated that the schema and breadth of the literature review must ensure that the researcher is exposed to an appropriate "range of ideas, concepts, and theories, which must identify related research to ensure the current dissertation research areas are within conceptual and theoretical contexts.

Fayek, Manjula & Oswaldo (2004) identified five major areas of rework with their associated root causes; Engineering, human resource capabilities, supply, leadership and planning. Their focus was to determine the major cost contributor of rework for 108 incidents in a construction project.

III. METHODOLOGY

In order to carry out a successful maintenance plan, the following steps are considered in order to form a strategic approach:

- Identifying the problem
- Establishing the clause
- Proposing solution
- Evaluating solution
- Implementing solution
- Evaluating effectiveness
- Solving

The main purpose of the Ship Repair Platform (SRP) is used to repair and maintenance the ships / vessels. This SRP can be handled with minimum 20,000 Dead Weight Tonnage (DWT) to 85,000 DWT. As per IS 4651 (1974), Code of Practice for Planning and Design of Ports and Harbors, Part III: Loading. Ship repair platform contain South and North Piers, transfer Platform, Access platform and maintenance or repair platform.

South pier and North piers which is used to mounting the hoist for pulling the ship/ Vessels from the Sea to platforms. Hoist can be installed above the South and North piers with fixed arrangement, also this hoist will support to lift the Vessel and safely transferred to the transfer platform.

Vessels can be transferred from platform to maintenance yard through rails. The vessel can be moved through rail mounted cranes in transverse as well as longitudinal directions. Meteorological data has been assumed for actual design and interpretation of design results, refer Cl.4 for more details.

Berth is the term used in ports and harbors for a designated location where a vessel may be moored, usually for the purposes of loading and unloading. Berths are designated by the management of a facility. Dead weight tonnage (DWT) is the weight of cargo, stores, fuel, passengers and crew carried the ship when loaded to her maximum summer load line.

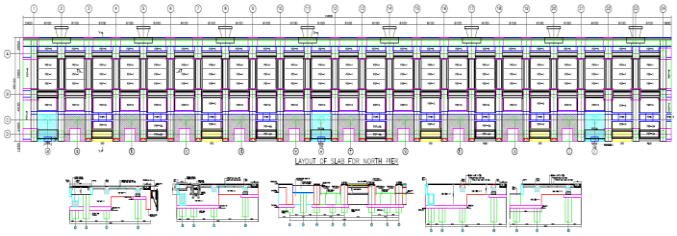

Figure2: General arrangement of SRP

IV. LOADS

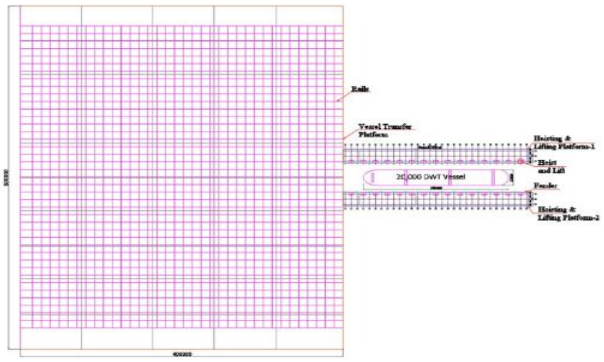

Figure 3: GA drawing- Ship repair structure

The SRP can be resist with the following loads:

- Dead load- all dead loads like load due to
  - Pile cap,
  - Hoist pad pile cap,
  - Fender (Absorb the impact of berthing vessel and also the chatter of the moored vessel in order to avoid damages to the vessel and to the structure),
  - Slab,
  - Wearing coat,
  - Hoist load,
  - Capstan, etc.,

which are not modelled applied in the created model with respect to the weight of vessels as per IS 4651 (Part-3) having consideration of bulk carrier of 20,000DWT

- Maximum live load- as per IS 4651 (Part-3), uniform vertical live load of 50kN/m^2 to be adopted having consideration of heavy cargo berth
- Wind load is calculated having assumption that location is Chennai. Basic wind speed is obtained as 50m/s and load are applied on all the directions as wind pressure according to IS 875 (Part-3)
- Seismic (or) Earthquake load is calculated having medium soil is present at the proposed location and remaining factors are calculated as per IS 1893 (Part-1)
- Berthing load- Load is calculated with respect to the size of vessel as per Appendix A of IS 4651 (Part-3), accordingly energy and loads are calculated. It is due to the weight of vessel acting on the berth. Maximum berthing force having consideration of 0.4m/s berthing velocity normal to berth as per IS 4651 (Part-3) and it shall be less than 40T/m^2

DWT (assumption) =20000 t
As per IS 4651 (Part-3):1974,
Length of the vessel, L =180m
Width of the vessel, B =22.8m
Height of the vessel, H =13m
Draught of the vessel, D =9.7m
Berthing angle, θ =10deg
Site condition = Moderate wind and swells
Berthing condition = Moderate
DT/DWT =1.32
[As per IS 4651 (Part-3):1974,Cl 3.1.2]
As per IS 4651 (Part-3):1974, Cl 5.2.1.,
Displacement tonnage,DT or WD =26400t
Velocity of the vessel, v =0.323m/s
Acceleration due to gravity, g = 9.81m/s^2
Mass coefficient, Cm =1.85
Radius of gyration of rational radius,r =45m
Approach angle θ =10deg
Distance between C.G of the vessel to point of contact, l = 44.32m
Eccentricity coefficient,Ce =0.52
Softness coefficient, Cs =0.90
Berthing Energy of the vessel, E = 121.29 Tm
Factor of Safety = 1.40
Ultimate Berthing Energy= 169.806Tm=1698.06 kN-m
Fender suggest for above energy=SCN1150 TRELLEBORG
Reaction of fender = 1779kN
Berthing force along longitudinal direction applied =1779kN
30% of Berthing force in Transverse direction= 533.7kN

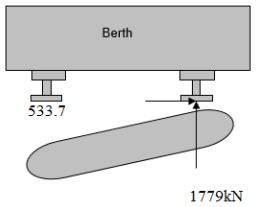

Figure 4: Berthing load

- Mooring load- Lateral loads caused by the mooring lines when they pull the ship into or along the dock or hold it against the forces of wind or current.

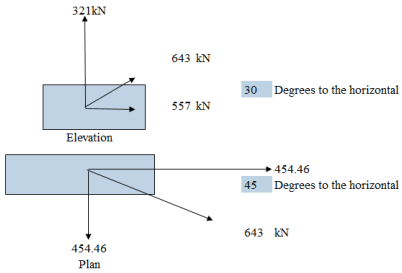

Figure 5: Mooring load

Line pull as per IS 4651 (Part-3):1974,Table 4=64.3t

- Lifting load- Mobile harbour crane load of 241T is considered as prescribed in the vendor data sheet.

As per Model Liebherr LHM 280,
Total weight =241T
Standard supporting base =11m x11m
Standard pad dimension =5.5m x1.3m
Standard supporting area of pads
=5.5 x 1.3=7.15m^2
Max. area pressure =241/7.15
=33.71T/m^2

- Temperature load- Load are calculated having assumption that maximum and minimum temperature as 45°C and 20°C respectively
- Wave and current forces are calculated assuming the wave length, period, height, etc., and water depth as 15m
- Load combinations shall be as per IS 456 &4651 (Part-4)

V. DESIGN AND ANALYSIS

The SRP complete design shall be followed primary as per IS 456 &4651 part 1 to 4, the size of the platform, provision of expansion joints. The platform contains piled foundation with maximum dead and live load as per manufacturer recommendation and as per IS 4651_Part 1 to 4. Components of element can be classified as

- Cast-in-situ pile,
- Pre-cast Pile cap,
- Pre cast beams,
- Precast slab,
- Cast-in-situ slab,
- Crane mounting beams,
- Fender beams,
- Wearing coat, etc.

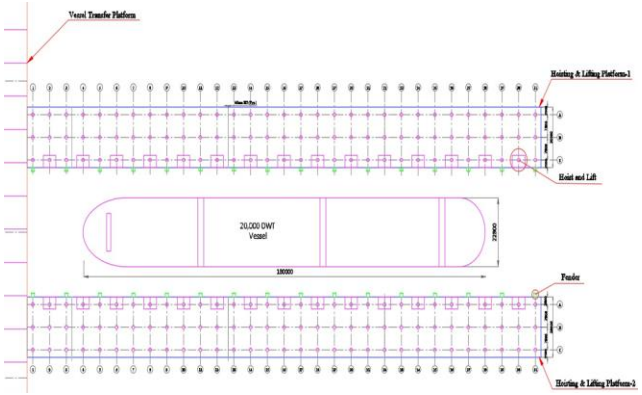

Figure 6: General arrangement of berth

Diameter of the pile and spacing between the piles are assumed as 1.2m and 7.5m. Layout of this SRP and model are created by the means of AUTOCAD software and STAAD. CONNECT latest version Edition V22 software.

Considering this as onshore structures, hence, precast members are used for construction and which shall be designed for design life of 100years under consideration of maximum loads as per vendor data sheet and IS 4651 standards.

Loads and load combinations are applied as prescribed in clause 4. Assumed properties are assigned to the members, if the result is safe, then proceed with the assumed properties or else revise the properties in order to qualify them. After that, pile, beam and slab reinforcement are designed as per IS 2911, IS 456.

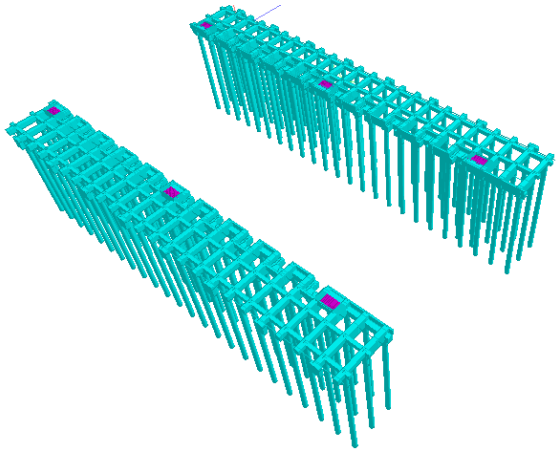

Figure 7: Ship lift structure

VI. CONCLUSION

This paper provides the brief understanding of SRP design as per IS 4651_ Code of Practice for Planning and Design of Ports and Harbours. The proposed design is suitable for the vessel of having 20,000 DWT with respect to the assumption of meteorological data, soil type and some parameters.

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