A Review on Design Analysis and Optimization of Parallel Motion Fender

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Abstract— Transportation is an important part of any nation's economy. Marine transport are critically important to the transportation of people and goods throughout the world. But there is also some problem regarding collision between ships and jetty or another ships during berthing operation. The study shows the effect of fender system during collision between vessel or boat that berth against jetty or another vessel.

Key words: Berthing, Collision, FEM, Jetty, Parallel Motion Fender, Vessel

I. INTRODUCTION

Now a days marine transport has an important factor of many nation's economy, because it is a most inexpensive way of transporting heavy goods to the very long distances.

Today, navigation technology has vastly improved and has moved towards using bigger ships with deeper drafts. These ships include container cargo ships and LNG Tankers, whose displacements are in the order of thousands of dead weight tonnage (DWT).

Hence, ports and terminals need to be adequately designed for the berthing of these massive vessels without damage to the ship or the dock structure and often the ship channels must be dredged to accommodate these ships.

There are many types of fendering system is used for berthing the vessels against jetty or another vessels. The type of fender that is most suitable for an application depends on many variables, including dimensions and displacement of the vessel, maximum allowable stand-off, berthing structure, tidal variations and other berth-specific conditions. The size of the fender unit is based on the berthing energy of the vessel which is related to the square of the berthing velocity.

Fenders are typically manufactured out of rubber, foam elastomer or plastic. Rubber fenders are either extruded or made in a mould.

The pollution level of the diesel engine can be controlled and the performance of the engine can be enhanced by following methods:-

A. Parallel motion fender:

The Parallel Motion Fender, also called torsion fender is an individual design complete fender system. Turning level arm (Torsion arm) mounted between the back structure (concrete or steel) and the front steel panel restrains the panel movement during the entire fender compression, allowing it to move only parallel to its mounting irrespective of impact level and angle.

Parallel Motion Technology can reduce reaction forces up to 60% compare with other traditional design.

There are mainly defects occurred in four components of Parallel Motion Fender,

- Torsion arm
- Bearings
- Panel facing
- Fender cones

Fig. 1: Parallel motion fender[9]

This type of defects can be controlled or overcome by varying its geometric properties or changing with suitable material like changing the arm material of welding, changing bearing type from bearing calculation or polyamide bearing.

II. LITERATURE SURVEY

Time rolls on and shadow falls but the work carried out by the eminent personalities will always be the stepping-stone for the future revelations. Following are the research works have been investigated in the field of berthing of ships or vessels against jetty. A review of collision analysis by various researcher has been described in following orders

Wuttrich R. et al. [1] The paper present result of the research project aimed at evaluating the crashworthiness of the system. The research efforts concentrated on computational analysis of a Jumbo Hopper barge impacting commonly constructed fender. LS-DYNA, a nonlinear explicit dynamic finite-element code, was used for analysis. Various initial velocities and impact angles were used to represent possible collision conditions. Computational analyses were adopted to assess the crashworthiness performance of the constructed fender system and to identify its weakest components for possible retrofit. It appears that such retrofits could further improve the energy absorbing capabilities of existing bridge fenders.

of alloys of copper of tungsten, or copper and chromium for continuous working.

Ueda S. et al. [2] done static Design of fender for berthing Ship. Currently, fender is designed by calculating berthing energy for the maximum size ship or standard size ship considering ship mass, virtual mass factor, design approach velocity and eccentricity Factor. Recently, ship size increases so fast. For instance, size of modem container ships became more than 100,000 DWT. in this paper, analysis was made for conventional cargo ships by use of statistical data of arriving ships in some major port in Japan. In this study they took ship size DWT for analysis and analyze the relation between DWT and Approach Velocity, virtual Mass factor, Eccentricity factor. By calculating got ratio of energy absorption of fender against catalogue value and obtain energy absorption of design fender and ship's berthing energy then compared both energy values. Then they calculated the probability of exceedance of the ship's berthing energy over the energy absorption of design fender. Calcu1ate the energy absorption of fender and the safety factor which satisfies the required probability.

Gye-Hee Lee et al. [3] were done the collision analysis for the fender system that designed for protection of collision between vessel and bridge. The bow of objective vessel that was standardized by codes was modelled as shell elements, and bridge substructure was modelled as fixed support. Since, the impact analysis have the dynamic nonlinear features, such as, material nonlinear, large deformation and contact, explicit structural analysis program was used. The reaction force as fender systems are evaluated and analyzed. The collision force obtained from explicit analysis showed the large differences in behaviors as fender system, and the design collision loads described in codes have a large conservatism. Therefore, the consideration of fender system in calculation of collision load for bridge design is necessary for economical design of bridges.

Neser G. et al. [4] analyzed one passenger ship During berthing on a port with mathematical modelling by taking various forces of berthing Ship towards buckling type V-fender with respect to time and concluded that motion of ship during impact with fender is found to be virtually unaffected than without fender . However, marine fender system is safe for berthing and mooring of ship with various force parameters.

Sakakibara S. et al [5] has proposed ship berthing and mooring system by using pneumatic-type fenders. Their system consists of present berth monitoring system including a mooring line load monitoring system. They calculated fender loads such as fender deflection and reaction force by measuring inner air pressure of the pneumatic fenders, which have unique characteristics in performance. They did parallel and angular compression test on pneumatic type fender and found different conditions under berthing load. Their monitoring system can not only measure loads of the fenders and the mooring lines simultaneously, but also estimated the moored ship motions by the measured loads. The obtained data can be watched on a computer display and recorded easily. Their system is controlled by a proper control program, which can also indicate alarm for several critical conditions.

Beckett T. [6] introduced types of failure in parallel motion fender by doing number of experiments on test ring. A number of tests in test ring were carried out first and after 10 full compressions it was found that the reaction curve was essentially unaffected by the compression rate. They found failure type and failure location. Parallel motion fenders are a relatively recent development in fender technology. PM fenders have two significant advantages over convention, fender units in that they remain close to vertical when compressed by an off centre berthing impact and they produce a reduced reaction force on their supporting structure, PM fenders are however significantly more complicated in their structural form than conversional fender systems and the loading within a PM mechanism Can be difficult to determine. Perhaps as a result of this complexity PM-fenders have experienced a number of structural failures in service. This article considers the reasons for some of these failures. The use of' cellular rubber fender units below water level is one possible cause offender failure and results from tests on model fender cones immersed in water are reported. These test results have significance for the design of any fender system where cell units are installed below high tide level.

Graczykowski C. et al. [7] Collisions with small service ships are serious dangers for offshore wind turbines. Installing of the adaptive torus-shaped pneumatic fender that surrounds wind turbine tower at water level constitutes one method of effective protection against such events. The paper presents numerical simulations of ship collision against wind turbine tower protected by adaptive fender conducted by means of FEM-based software. Here they introduced innovative pneumatic fender to protect ship and structure from collision by modelling in software and analyzed it. They concluded adaptive pneumatic fender surrounding the tower at the water level can effectively protect the offshore wind turbine and the ship in case of collision.

Lee T. T. [8] this paper summarizes the world-wide effectiveness of marine-fender systems a design criteria is recommended as a result of an extensive research and development program. Marine fender system is a protective installation designed to prevent direct contact between ship and dock so that mechanical damage caused by impact and abrasion can be reduced to a minimum. In this paper by doing experimental Investigation the effects of berthing impact on the design of berthing structures, definition, function, and types of fender systems, advantages and disadvantages of various fender systems, cost-effectiveness and design procedures for different marine environment and exposure conditions they concluded factors for Selection of fender.

(1) Resistance to tangential forces
(2) Reliability in operation.
(3) Cost of maintenance.
(4) Evaluation of systems that have given satisfactory service at or near the proposed installation.
(5) Resistance to longitudinal component of berthing force
(6) Ease and economy of replacement

III. SUMMARY OF LITERATURE SURVEY

A marine fender system for berthing the ships has been the centre of attraction for many past decades. From the above literature survey, it could be concluded that fender is very critical component of marine system and it is often sustain cyclic load due to ship berthing and waves from ocean. Due to continuous cyclic load, fender often fails by certain cycle and at certain location so aim of researcher is to increase life of fender by changing its design parameter.

IV. ABBRIVIATION

LNG	Liquefied Natural Gas
DWT	Dead Weight Tonnage
FEA	Finite Element Analysis
PM	Parallel Motion

V. REFERENCES

[1] R. Wuttrich, J. Wekezer, N. Yazdani and C. Wilson, "Performance Evaluation of Existing Bridge Fenders," Journal of Performance of Constructed Facilities, 2001.
[2] T. H. S. Y. Shigeru Ueda, "Statistical Design of Fender for Berthing Ship," International Offshore and Polar Engineering Conference, pp. 545-551, 2002.
[3] H.-W. L. a. S.-W. Y. Gye-Hee Lee, "An Analysis of Steel Fender System for Vessel Collision," European Congress on Computational Methods in Applied Sciences and Engineering ECCOMAS 2004, pp. 24-28, July 2004
[4] D. U. Gokdeniz Nesser, "Dynamics of Ships and Fenders during Berthing in a Time Domain," Ocean Engineering, pp. 1919-1934, 2005.
[5] M. K. Shigeki Sakakibara, "Ship Berthing and Mooring Monitoring System by Pneumatic-Type Fenders," Ocean Engineering, p. 1174–1181, 26 July 2006.
[6] T. Beckett, "Parallel Motion Fenders, Some Design Considerations, Including the Immersion of Fender Cones," pp. 1-15, 2010.
[7] J.H.-S.Cezarygraczykowski, "Adaptive Pneumatic Fenders for Extreme Off-shore Docking Operations," EACS 2012 – 5th European Conference on Structural Control, pp. 1-8, 2012.
[8] T. T. Lee, "Design Criteria Recommended for Marine Fender System", Coastal Engineering, pp. 1159-1184.
[9] Safe Berthing and Mooring – Trelleborg Catelogue