RESEARCHERID
THOMSON REUTERS
[Bhartendu et al., 6(12), Dec 2021]

ISSN : 2455-9679
Impact Factor : 4.256

IJRTSM
INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT

"REVIEW ON ANALYSIS OF STRUCTURAL OFFSHORE CONTAINER LIFTING FRAME"

***Bhartendu Vishwakarma* [1], *Prof. Ranjeet Kumar* [2], *Dr. R.S. Sikarwar* [3]**

[1] *M. Tech., Scholar, Department of Mechanical Engineering, Vaishnavi Institute of Technology and Science, Bhopal, M.P., India*

[2] *HOD., Department of Mechanical Engineering, Vaishnavi Institute of Technology and Science , Bhopal, M.P., India*

[3] *Director, Vaishnavi Institute of Technology and Science Bhopal, M.P, India*

ABSTRACT

Drop test is generally carried out to check the strength of the component against free fall. Offshore equipment Ex. Manifolds, Flowhead, etc. is mounted inside lifting frame, which is a cagestructure created for the transport and safety of equipment. When lifting frame is transported from one place to another in event of loading or unloading, crane release it just above the ground or ship deck. This can results into impact on the lifting frame and subsequently on equipment inside. This consequently results into high stresses and strain and eventually failure of the structure. Physical drop test involves huge cost of testing and enormous time, which can be replaced by Finite Element simulation of Drop test. In this thesis work, a new design for offshore container lifting frame is proposed and is tested using FEM as per DNV standards.

Key Words: *Drop test , Offshore Container, DNV 2.7-1, Lifting Frame, impact test..*

I. INTRODUCTION

As of January 2004, all SOLAS member States must also follow IMDG. The IMDG contains much more than guidelines for mariners. It applies to all companies and organizations connected to shipping. The IMDG code is updated every two years, but amendments that don't affect the principles of the code can be adopted by the MSC and issued as supplemental circulars. This allows the IMO to respond to transport developments in a shorter time frame. The IMDG code addresses the special nature of offshore containers and portable tanks handled in open seas. In Sections 12 and 13 of its introduction, the IMD G recognizes that these are different from conventional containers. However, inspections of all containers are governed by the other international treaty, the Convention for Safe Containers.

As is the case with many regulations, MSC/Circ. 860 does not contain detailed technical requirements. Instead, it is a guideline for how "approving competent authorities" should base their approval of offshore containers. The circular states that both design calculations and testing should be taken into account when approving an offshore container. It specifies six points to consider on the design of the containers, as well as three tests that should be done at a minimum. To help approving authorities, it references four standards:

- EN 12079
- DNV 2.7-1
- DNV 2.7-2
- BS 7072

ISSN : 2455-9679
Impact Factor : 4.256

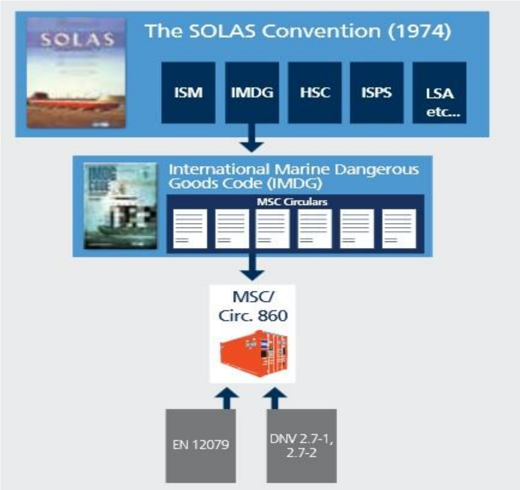

Figure 1.1 Offshore Regulatory Flowcharts

II. LITERATURE REVIEW

Below are some papers which have been studied and analyse as a pre-requisite reference for this thesis

[1]. Yucong Ma , Yihan Xing , Muk Chen Ong , Tor Henning Hemmingsen et al (2021) , The cargo carrying capacity of 16,362 m3. This to allow the SST to fulfil the annual storage demands of ongoing carbon capture and storage projects in Norway. It travels with a slow speed of 6 knots at 70 m constant water depth for maximum energy efficiency and offloads CO_2 via a connected coupling to the subsea well where CO_2 is directly injected. To be economically attractive, the SST has a high payload of 50% displacement which makes a low structural weight design extremely crucial.

[2]. M. Saeed Khalid , Salman Nisar , Sohaib Zia Khan , Muhammad Ali Khan , Armin W. Troeschet et al This study focuses on the development of a blended technique in moving frame which encompasses nonlinearities and real time simulation of the vital early design parameters using combined exact nonlinear and quasi-nonlinear forcing terms. The difference between the forward speed correction used for time simulation in the blended method and the strip-theory in the frequency domain has been explained. The use of radial basis functions for the estimation of quasi-nonlinear combined radiation and diffraction pressures in moving frame and their conversion between two and three dimensions has been demonstrated and validated experimentally.

[3]. Amrit Shankar Verma , Zhiyu Jiang , Zhen Gao , Nils Petter Vedvik *et al* (2020) , The investigate the effects of a passive tuned mass damper on the impact velocities manifested between the blade root and hub during the mating phase and its effect on the response-based limiting sea states. Time-domain multi-body simulations of an installation system characterising the mating operation. It is found that the tuned mass damper can reduce the relative impact velocities by more than 40% and can substantially expand the allowable sea states and operability for the mating operation.

[4]. Jae-Hyun Kim, Yeong-Hoon Jeong, Dong Soo Kim *et al* (2020) , As offshore structures grow larger with increasing depth and distance from shore, their foundations must increase in strength owing to the larger supporting capacity needed. Requires new approaches to ensure economic and reliable infrastructure. Suction bucket foundations are viable options in offshore settings owing to their easy installation and affordability. The results demonstrated the feasibility and superior performance.

[5]. Kyriazis Pitilakis , Sotiris Argyroudis , Stavroula Fotopoulou , Stella Karafagka , Kalliopi Kakderi , Jacopo Selva *et al* (2019), Generic or site-specific fragility models are used for all exposed elements and considered hazards. Risk metrics and objectives are defined related to the functionality of the system and the structural losses. In the first level of

ISSN : 2455-9679
Impact Factor : 4.256

the assessment phase, the performance of each component is evaluated using a risk-based approach. Then, a system level probabilistic risk analysis is conducted separately for earthquake and tsunami hazards.

[6]. Xuefei Wang, Xiangwu Zeng, Xu Yang, Jiale Li *et al* (2019), Centrifuge test results reveal that the hybrid monopile foundation is effective in reducing the lateral displacement during the shaking. In the saturated condition, soil keeps its strength and stiffness beneath and adjacent to the foundation. The hybrid foundation system tends to settle more due to the larger shear stress caused by the soil structure interactions. Influences of the wheel specifications are illustrated. The foundations with larger thicknesses lead to smaller lateral displacements and lower tendencies of liquefaction, but the settlements are intensified.

[7]. P.P. Li, Q.L. Yu (2019), A reliable low-velocity impact method employing pendulum impact test set-up is designed and applied. The results show that the residual strength of UHPFRC beams after impact follows while the residual rigidity, toughness and impact resistance tend to linearly decrease. The rigidity and toughness are more appropriate indicators than ultimate bearing capacity based on the analysis ondamage index. An analytical model is proposed to predict the residual impact resistance of UHPFRC beams with the static property of flexural toughness and validated against the experimental data.

[8]. Abhijit Ekhande, Prof S..B. Naik et al (2017), Transportation skid plays very important role in various industries. Offshore skids play a vital role in transportation of heavy pumps, engines and blender units used during manufacturing treatments at the well site. For universal acceptance and usage of these skids worldwide, the offshore design should meet various applicable codes and regulations, such as Bureau Veritas, Lloyds, ABS, or Det Norske Veritas design standards.

[9]. Raouf A. Ibrahim , (2014), Highlight the main differences of the two disciplines. It begins with a brief account of the theory of vibro-impact dynamics based on modeling and mapping of systems experiencing discontinuous changes in their state of motion due to collision.

[10]. Pankaj S. Anjikar *et al* (2013), Performed FEA Simulation and Validation on Prototype of Compressor Crash Frame for Drop Test as per Industry Standard DNV 2.7-1. A simulation is carried out on weak frame to identify the critical regions which are prone to more damage then simulation is carried out on actual frame where critical regions are examined. Experimental set up is created as per the requirement of DNV standard. Finite Element Analysis result and Test results are correlated. Conclusion is made based on result correlation.LS-DYNA version 971, commercial used software is used for drop test simulation, Hypermesh v11.0 is used for meshing and set up, Hyper graph v11.0 and Hyper view v11.0 isused for post processing.

[11]. M. Muni Prabaharan *et al* (2013)., Performed Drop Test Simulation on Pen Drive by using Ansys. In this paper the Drop test analysis on a pen-drive with different materials is carried out using ANSYS, to evaluate the structural safety of component, when pen-drive is falling on ground with random velocity. Developing CAD model, meshing and results are analysed by using ANSYS. Dimensions of pen-drive are considered with respect to industrial standards. Material properties are selected as per the ASTM standard (A36). Initially carbon steel is used for the drop test analysis. Later carbon steel is replaced by kinematic inelastic material (Plastic material) to find the safety of component under drop test boundary conditions. Finally results are compared with both materials value.

[12] Y.Y. Wang *et al* .(2005) performed a Simulation of drop/impact reliability for electronic devices. In this paper, the finite element method (FEM) is used to simulate drop test numerically, while the attentionis paid to the methodology for analysing the reliability of electronic devices under drop impact. Modelling and simulation method for such kind of complex structure is discussed. Some important issues, such as control of the simulation and material model, are addressed. Numerical examples are presented to illustrate the application of FEM on virtual product development. Effective modelling and simulation method are concluded from the numerical example and authors’ experience accumulated from serial industry projects on drop impact simulations.

ISSN : 2455-9679
Impact Factor : 4.256

[13]. C.Y. Zhou *et al* (2008) worked on Drop/impact tests and analysis of typical portable electronic devices. This paper presents investigation on the dynamic behaviour of typical portable electronic devices under drop impact loading. First, an idealized system which contained an outer case and a Printed Circuit Board (PCB) with an attached packaged chip was adopted as specimen. The actual impact force pulses were measured by employing a Hopkinson bar in a dynamic test rig. Dynamic strains at sever allocations of the PCB were simultaneously recorded to explore the correlation between the dynamic strains and the impact force pulse. Particular attention was paid to the dependence of the dynamic response of the PCB on the impact velocity, the force pulse, as well as the impact orientation. A simplified analytical model isproposed to interpret the experimental results. Technical measures are suggested to guide the design ofthe relevant devices with better drop/impact protection.

[14]. T. Noguchi (1999), Strength evaluation of cast iron grinding balls by repeated drop tests. In this paper, repeated drop tests were performed on Ni-hard and high-Cr cast iron grinding balls with material toughness varied by heat treatment. Instrumented impact tests and bending fatigue tests were also performed on bar specimens with the same heat treatment, and correlation between drop strength and other strength characteristics were discussed. In the drop tests from various heights, balls fractured by breakage or spalling, with longer life (Nf) at lower drop heights (H) giving H–Nf curves similar to theS–N curves in fatigue tests. Experiments show that drop strength correlated better with fatigue strength and hardness than with impact toughness (KId) in both irons. The stress causing spalling by repeated drops was inferred to be repeated contact stress, and internal tensile stress caused by surface plastic deformation assists the fracture. Breakage from the ball center is caused by cyclic tensile radial stress byimpact body force, and is assisted by residual casting stress.

[15]. K. E. Jackson & E. L. Fasanella *et al* (2005) has done Crash Simulation of a Vertical Drop Test of a Commuter-Class Aircraft. In this paper a finite element model of an ATR42-300 commuter-class aircraft was developed and a crash simulation was executed. Analytical predictions were correlated with data obtained from a 30-ft/s (9.14-m/s) vertical drop test of the aircraft. The purpose of the test was to evaluate the structural response of the aircraft when subjected to a severe, but survivable, impact. The aircraft was configured with seats, dummies, luggage, and other ballast. The wings were filled with 8,700 lb. (3,946 kg) of water to represent the fuel. The finite element model, which consisted of 57,643nodes and 62,979 elements, was developed from direct measurements of the airframe geometry. The seats dummies, luggage, simulated engines and fuel, and other ballast were represented using concentrated masses. The model was executed in LS-DYNA, a commercial finite element code for performing explicit transient dynamic simulations. Analytical predictions of structural deformation and selected time-history responses were correlated with experimental data from the drop test to validate thesimulation.

III. CONCLUSION

To support research studies into large cargo vehicles, a baseline design of an SST is developed. The purpose of The simulation results adds confidence to the modeling approach and endorses the mesh size, material, Beam selection and contact definitions specific for problem statement describe in this thesis. This drop test simulation helps to improve the design of Lifting frame while it is in design life cycle, which reduces the cost of iterative physical testing and reduce the product life cycle time to great extent. Simulation is done considering free fall from 5 cm, which consumes approx. 15 hrs. of computational time. From the simulation results it can be concluded that lifting frame is meeting all criteria for drop test allowable limits per DNV 2.7-1 and so it's passing the Drop Test and Design will survive in event of accidental drop.

.

REFERENCES

[1] Yucong Ma , Yihan Xing , Muk Chen Ong , Tor Henning Hemmingsen *et al* (2021) , "Baseline design of a subsea shuttle tanker system for liquid carbon dioxide transportation" Ocean Engineering 240 (2021) 109891.

ISSN : 2455-9679
Impact Factor : 4.256

[2] M. Saeed Khalid , Salman Nisar , Sohaib Zia Khan , Muhammad Ali Khan , Armin W. Troeschet *et al* (2020) , "Simulation of blended nonlinear hydrodynamics forces using radial basis function in uniform moving frame" , Ocean Engineering 198 (2020) 106994.

[3] Amrit Shankar Verma , Zhiyu Jiang , Zhen Gao , Nils Petter Vedvik et al (2020) , "Effects of a passive tuned mass damper on blade root impacts during the offshore mating process" Marine Structures 72 (2020) 102778.

[4] Jae-Hyun Kim, Yeong-Hoon Jeong, Dong-Soo Kim et al (2020) , "Improved load capacity of a hybrid bucket foundation for offshore structures in sand" Applied Ocean Research 101 (2020) 102197.

[5] Kyriazis Pitilakis , Sotiris Argyroudis , Stavroula Fotopoulou , Stella Karafagka , Kalliopi Kakderi , Jacopo Selva *et al* (2019) "Application of stress test concepts for port infrastructures against natural hazards.The case of Thessaloniki port in Greece." Reliability Engineering and System Safety (2018), doi: 10.1016/j.ress.2018.07.005.

[6] Xuefei Wang, Xiangwu Zeng, Xu Yang, Jiale Li *et al* (2019), "Seismic response of offshore wind turbine with hybrid monopile foundation based on centrifuge modelling" Applied Energy 235 (2019) 1335–1350.

[7] P.P. Li, Q.L. Yu (2019), Responses and post-impact properties of ultra-high performance fibre reinforced concrete under pendulum impact , Composite Structures 208 (2019) 806–815.

[8] Abhijit Ekhande, Prof S..B. Naik *et al* (2017) , "Study & FEA Analysis of Transportation Skid", Volume 5, Issue 2 , International Journal of Engineering Development and Research , 2017.

[9] Raouf A. Ibrahim , (2014), "Recent advances in vibro-impact dynamics and collision of ocean vessels", Journal of Sound and Vibration , http://dx.doi.org/10.1016/j.jsv.2014.02.006 0022-460X & 2014.

[10] Pankaj S. Anjikar *et al* (2013) , "FEA Simulation and Validation on Prototype of Compressor Crash Frame for Drop Test as per Industry Standard DNV 2.7-1", International Journal of Engineering Research & Technology Vol. 2 Issue 12, December – 2013 2. 2013-1.

[11] M. Muni Prabaharan *et al* (2013) , "Static Analysis for Container Drop Test with a Case Study", International Journal of Modeling and Optimization, Vol. 2, No. 1, February 2012.

[12] Y.Y. Wang, C. Lu, J. Li, X.M. Tan,Y.C.*et al* (2005) , "Simulation of drop/impact reliability for electronic devices, Finite Elements in Analysis and Design", Vol. 41, Singapore, January 2005, pp. 667–680.

[13] C.Y. Zhou, T.X. Yu, Ricky S.W. Lee at al (2008), "Drop/impact tests and analysis of typical portable electronic device", International Journal of Mechanical Sciences, Vol. 50, Kowloon, Hong Kong, 2008, pp. 905- 917.

[14] T. Noguchi (1999), "Strength evaluation of cast iron grinding balls by repeated drop tests", Wear, Volume 231, Issue 2, July 1999.

[15] K. E. Jackson & E. L. Fasanella *et al* (2005), "Crash simulation of a vertical drop test of a commuter-class aircraft, International Journal of Crashworthiness", Vol.10, NASA Langley Research Centre, Hampton, VA, 2005, pp. 173-182. 2005-7.