International Journal of Interdisciplinary Innovative Research &Development (IJIIRD)
ISSN: 2456-236X
Vol. **05** Special Issue **01** | **2020**

Literature review on design of overhead guard against falling objects

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ABSTRACT

The importance of forklift is very high in material handling procedures. Fork lifts are very commonly used in warehouse, farms, shipping yards, construction sites for lifting various objects, assemblies and even liquids filled tanks. The safety of the operator is the most important factor to be considered while designing of the forklift. The operator has to be safe inside the guard cage. Different criteria can be defined for testing of the forklift guard cage.

The majority of the accidents occur because of overhead falling on the operator. Hence a protective structure is must for any material handling machinery. Overhead guard is a critical component in the Fork Lift Truck, has to meet the strict requirements of deformations as per the ISO standards for driving safety. In this paper the review of various white papers and codes is done to find the procedure for designing the safe and optimized protective structure also called as overhead guard.

Keyword: - forklift, overhead guard, finite element analysis, falling objects protective structure, safety standards

1. Introduction:

The operator cabin can be subjected to crash fall from top. So, it is necessary that structure should be robust enough. Intent of this paper is to review different methodologies and procedures for design a save and robust design. To protect the operator for following down object from height and to obtain his safety by performing different physical test for Forklift Overhead Guard such as lumber and Cube drop ISO test. Overhead guard is a critical component in the Fork Lift Truck, has to meet the strict requirements of deformations as per the ISO standards for driving safety. The overhead guard shall extend over the operator when in the normal operating position as defined.

The paper thus describes the overview of the different design aspects along with codes used for design of the overhead guard used in forklift and material handling equipments.

2. Literature review:

The overview of the literature gives an eyesight for the research of domain. The industrial codes are available for defining the criteria for design of the different components for material handling equipments. Different researchers have studied the phenomena of falling object with respect to codes. Currently protective structures for construction and mining machines are required to provide safety in case of a rollover during engineering work (ROPS – Rollover Protective Structure – ISO 3471, EN 13510:2004) and protect construction machines against falling objects (FOPS – Falling Object Protective Structures – ISO 3449, EN13627:2002). Following papers were reviewed;

Ömer Yavuz Bozkurt et al., (2017) [1] in his paper discussed about validation of the crucial parts of diesel forklifts. The author used finite element analysis to validate the structural parts from forklift. FEA was done for the chassis of

the forklift for various load conditions. The head guard analysis was performed against the falling object for roll-over protective structure test. The simulation was carried out in accordance to EN ISO 3471 standard. The conclusion said that results according to EN ISO 3471 were safe.

Shuuichi Kaneda et al., (2003) [2] described the simulation for falling object on protective structure. The paper introduces the use computer simulation for crash analysis to test the simulating the performance of FOPS (falling object protective structure) to determine whether or not FOPS meet the prescribed standards. Safety standards for FOPS are prescribed in ISO 3449-1992 and SAE J231. The author simulated three different structures against the crash fall. From calculation one of the structures was selected depending on the minimum deflection on impact.

Prakash Gore et al., (2014) [3] in his paper discussed the procedure for design of the protective structure of operator cabin against the falling objects. In his paper author simulated the test and design with standard ISO 3449:2005(E). Along with simulation on computer experimental testing was also carried out to validate the results. Basis FE Analysis / Simulation & experimental test carried out with ref to ISO 3449 (level I or II). Minimum performance requirements of ISO 3449 (level I or II) were met in this FE simulation & experimental test. The operator Cab Structure with the mounting system passes / meets the requirement.

Georgi Todorov et al., (2009) [4] discussed about the safety and reliability of the forklift cabin. The author used ISO 6055: 2004 (E) standard which contributes to forklift safety requirements. The author examined four different variants of designs. The finite element analysis was performed to obtain the deflection and strain for sample load. The results were compared and the best variant is to be elected for subsequent detailed design and analyses at ISO 6055: 2004 (E) requirements. The choice of the best variant was selected on the robustness and the visibility for operator.

Janka Cafolla et.al, (2017)[5] describes about the validation of the physical test and computer simulation test for overhead guard of a Forklift . Two overhead guards were selected. The physical testing was done for different load magnitudes and load locations. The CAD model of same was created and using CAE software package adynamic analysis was performed for same load conditions as that of physical testing. It was noted in conclusion that only 10% of deviation in the results of physical test and CAE test were observed. Author thus suggested to use the CAE results for study of variants for overhead guards.

Akshay R omnal et al., (2016) [6] presented a paper on use of FEA simulation for design of a falling object protective structure for extractor cabin. Author performed FEA simulation for the conditions as mentioned in EN ISO 3449. Total three variants having different pillar thicknesses were selected for analysis. The CAD model and finite element model were created for analysis. Three different drop height were also considered for analysis. Deflection of the cabin were noted down for three different heights. The variant having low deflection for maximum drop height was considered suitable for use.

P Dumitrache et al.,(2017) [7] discussed about the behavior of protective structure of machinery cabins against standard shock. The author in this paper proposes the use of FEA platform. In this paper the two different acceptance levels of falling were considered. So the FEA was performed for two different heights and weight. Numerical correlation was also considered for validating the FEA result case study.

Vidya Pardeshi (2015) [8] in her paper discussed the procedure for design of ROPS (Roll Over Protective Structure) For Operator Cabin. As per ISO 3449:2005 (E) , two levels of performance criteria are specified for impact testing based on machine end use. Author use FEA platform to find the load carrying capacity for the specified load. The deflection of each condition was noted and checked against the safe distance available.

3. CONCLUSION:

From the above literature review one can find that different standards are available for design of the operator overhead guard. Finite element analysis can be used for find the results of drop test mentioned in standards. Researches have suggested to perform FEA for selecting the different variants but have also suggested to perform the physical testing. The design of the overhead guard thus should sustain the impact load and should have provide the visibility to operator. Thus, one can conclude that use of FEA platform to test the overhead guard for the specified standards will be helpful.

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