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A Case Study On Design And Analysis Of Hydraulic Forklift

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ABSTRACT: This paper presents the significance of hydraulic forklift. In modern life, there are many types of forklifts, from a large heavy loading truck to one operating between narrow corridors. Forklifts have become one of the basic transportation tools we use in our lives. With all the existing forklifts, we find that there are improvements that can be made to bring the forklift to better performance. The design of the existing forklift is limited in rotation and the structure has a potential safety hazard. Our new design has 180 rotating forks attached to the body of the truck at both ends. Also, it has a screed height under the user's cabinet that enhances stability. By measuring and analyzing the machine's vibration, it is possible to determine both the nature and severity of the defect, and hence predict the machine's failure. The vibration signal of a gearbox carries the signature of the fault in the gears, and early fault detection of the gearbox is possible by analyzing the vibration signal using different signal processing techniques. This paper presents analysis of vibration in gears using modal analysis and FFT analysis. It also presents analysis of gears with crack and gear with missing teeth. It also presents the analysis of Natural frequency in steady as well as running condition.

Index Terms* – *Hydraulic forklift, design and analysis

1.INTRODUCTION

This project deals with a Study on the A forklift truck is a powered industrial truck used to lift and move materials short distances. The forklift was developed in the early 20th century by various companies including the transmission manufacturing company Clark and the hoist company Yale & Towne Manufacturing. Following World War II the use and development of the forklift truck has greatly expanded worldwide. Forklifts have become an indispensable piece of equipment in manufacturing and warehousing operations. Forklifts are primarily used for lifting and transferring heavy loads to stations or locations in warehouses, shops or construction sites. Usually there are two forks in the front of a forklift (some type of forklifts have the forks on the side) that are used to lift loads that may weigh up to thousands of pounds. These forks can be moved forward and backward, and also up and down for lifting and moving cargo. Forks are classified into 4 different groups depending on the spacing between the fork hooks, i.e. Class I (Rated for loads up to 2000 lbs. with the spacing at 13 inches), Class II (Rated for loads up to 5,550 lbs. with the spacing at 16 inches), Class III (Rated for loads up to 10,000 lbs. with the carriage bar spacing at 20 inches), and Class IV (Rated for loads up to 15,500 lbs. with the spacing at 25 inches). Forks are responsible for picking up the load and carry it during the transportation. In this process, there are two kinds of failure: sudden fracture due to the heavy load and fatigue fracture due to the vibration caused by uneven ground during the transportation. These can be effectively analyzed using FEA. In this project we deals with the analysis of forklift forks and cylinders etc., where the load will be effective by using the ansys software. To make a note of analysis we created a model by solidworks software.

2. LITERATURE REVIEW

1)Ravi G. Kaithwas stated that, Forklifts are designed to handle and transport both raw materials and goods carefully and efficiently. From time to time these machines must be transported from one work site to another. A normalsit-down forklift with the ability to lift 5,000 pounds will itself weigh as much as 9,000 pounds. The average automobile weighs approximately 4,000 pounds. Weighing in at more than two times the weight of the average family automobile. This paper presents research related to the choice of the criteria that can be used to fill the gap between the forklift's minimum capacity and works maximum capacity to lift the objects from a place to another place in warehouse operation. The analysis had been done with the aimof exploring the requirements of warehouses and construction sites. With some changes to forklift we designed a two-wheeler forklift, this research paper gives an exact idea about how should be a two-wheel forklift is useful, safer and efficient in narrow passages working sites and how to design and contrast the two-wheel aisle forklift for such working places.

2) Anil A. Sequeira stated that Forklift is defined as an industrial truck which is capable of lifting hundreds of kilograms. Forklift is commonly used in warehousing and manufacturing and it consists of two metal forks at the front of the vehicle in order to lift and transfer the load. The way the load is lifted in case of forklift is in such a way that the operator is going to move forward the vehicle until the two forks push under the cargo and then it is lifted by operating the forks.

3) Jian-Yi Wang stated that Forklift truck is one of the most important tool sin logistics. However, the general mast system of a forklift truck not only restrains the driver's vision, but also increases the whole weight of a truck and decreases the fuel economy. Therefore, this paper focuses on the innovative design of a new lifting mechanism for forklift truck. Firstly, a spatial multi-link lift-guidance mechanism is proposed. And then, under the constraints of this mechanism, the mobility of the fork and fork frame is investigated in theory. Lastly, a new lifting mechanism based on it is presented and computer simulation is used to demonstrate the feasibility of motion. This multi-link lifting mechanism takes advantage of flexible cable drive and rigid body guidance, which not only provides the operator with a wider field of vision but also reduces the equilibrate weight of a vehicle and therefore improves the fuel economy. Forklift trucks are usually used at railway stations, warehouses, ports and factories for loading, unloading and conveying. A general weight-balanced forklift truck consists of a chassis and a work device which can be tilted and lifted vertically. However, the general forklifts have the following major disadvantages. First, the mast system composed of several large components will badly affect the driver's field of vision because it locates in front of the driver. Many accidents involving collisions between pedestrians and trucks are due to inherently bad visibilities of the forklift trucks.

3)METHODOLOGY

3.1 Experimental Procedure:

Step 1: - We started the work of this project with literature survey. We gathered many research papers which are relevant to this topic. After going through these papers, we learnt about car towing machine.
Step2: - After that the components which are required for my project are decided.
Step 3: - After deciding the components, the 3 D Model and drafting will be done with the help of CATIA software.
Step 4: - The components will be manufactured and then assembled together.
The testing will be carried out and then the result and conclusion will be drawn.
In this two-wheel drive fork lifting machine, we have used Arduino circuit to control the fork translation and drive train. This Arduino circuit is used to control servo motor which controls the motion of lead screw attached to guide the fork for upward and downward motion. Another servo motor is used to drive the unit to its required position. Basically, the main components of this project are Fork, Lead screw which guides the fork for lifting and lowering motion, Arduino circuit to control the drive of respective servo motors, and the base unit for the mounting of servo motors and Arduino circuit.

3.1 Drive train: The drive train is one of the most important system in the forklift as it allows the vehicle to move from one place to other. The driver is going to steer the front wheel in the desired direction whereas the power to the forklift is given to the rear wheel which is powered by the battery. The drive train of this forklift consists of many components in order to drive the driving wheels and also it converts electrical energy into mechanical energy. The energy from the drive train is consisting of a reduction drive in order to convert speed into torque. The output of the reduction drive is supplied to the wheels of the forklift for movement.

3.2 Power supply: This forklift machine consists of rechargeable battery and the charging unit as shown in Figure 3. Also, it is known that power supply available is 230 V AC. These batteries act as power source for driving the forklift. A battery capacity of 12 V, 38 AH which is capable to run for 20hrs have been used and the designed forklift consists of 2 batteries. This machine is equipped with electric circuit in order to convert AC into DC and to charge the batteries. The provision for charging the battery have been provided in such a way that it can be plugged into AC supply during recharging.

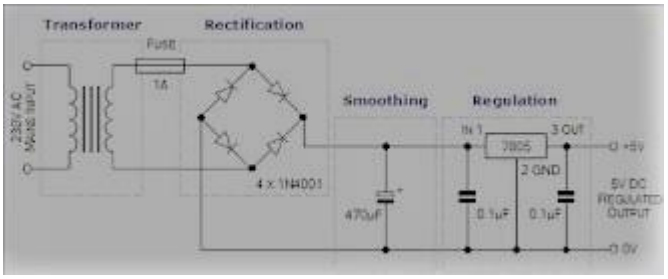


Figure (1): Power supply circuit system

3.3 Control system: the control system is used in order to move the vehicle front or back as well as to right and left. This helps to navigate the vehicle in different directions. It also facilitates the switching the machine on or off. The power to the drive wheel is provided by the motor which in turn is connected to the rear wheel using gearing arrangement. This machine is also equipped with an emergency switch in which it is possible to cutoff the power. This emergency switch is also located in the control system designed for this forklift machine.

3.4 MESH: ANSYS Meshing is a general-purpose, intelligent, automated high-performance product. It produces the most appropriate mesh for accurate, efficient multi physics solutions. A mesh well suited for a specific analysis can be generated with a single mouse click for all parts in a model. Full controls over the options used to generate the mesh are available for the expert user who wants to fine-tune it. The power of parallel processing is automatically used to reduce the time you have to wait for mesh generation.

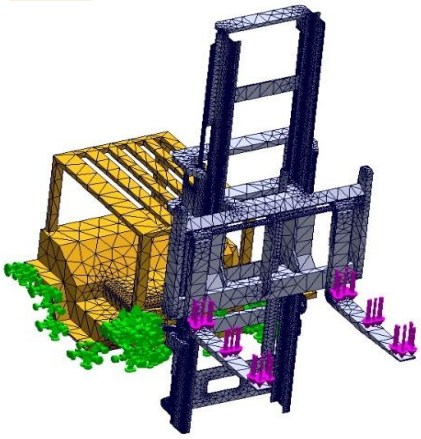


Figure (2): MESH

4. RESULTS AND DISCUSSIONS

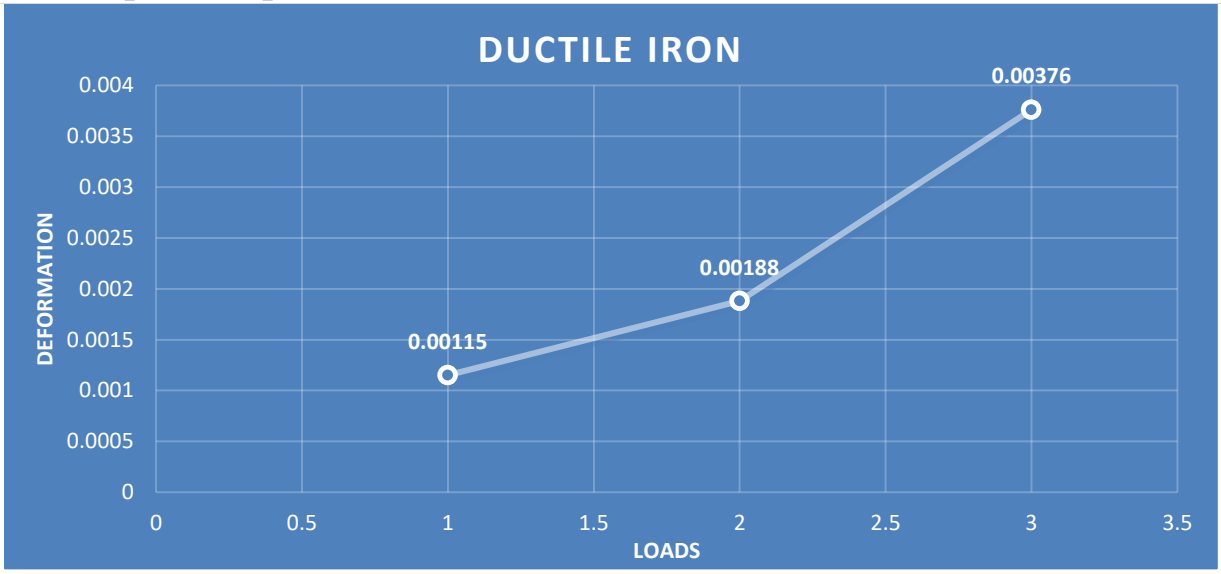
The case study on the design and analysis of a hydraulic forklift provides valuable insights into the engineering process and considerations involved in developing a reliable and efficient hydraulic forklift. By examining the specific case, it is evident that the design of a hydraulic forklift requires a comprehensive understanding of various factors, including load capacity, stability, ergonomics, maneuverability, and safety.

Throughout the case study, the engineers focused on optimizing the forklift's design to meet the specific requirements of lifting and transporting heavy loads in a variety of industrial settings. They took into account the selection of appropriate hydraulic components, such as cylinders, valves, and pumps, to ensure the necessary power and control for efficient operation.

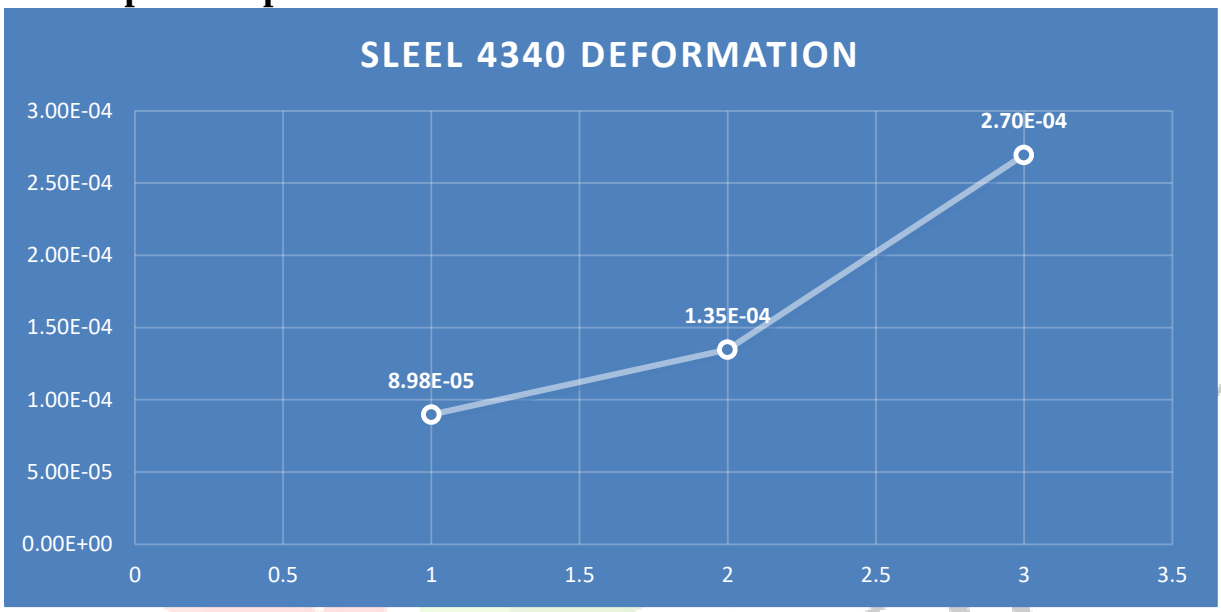
The analysis phase of the case study played a crucial role in evaluating the structural integrity and stability of the forklift. This involved assessing stress distribution, load-bearing capabilities, and safety factors to ensure that the design could handle the intended loads and maintain stability during operation.

By combining engineering principles, (SOLID WORKS) software, and simulation techniques, the case study demonstrated how modern technology can assist in the design and analysis process. The use of SOLID WORKS allowed for precise modeling and visualization of the forklift's components, while simulation tools enabled engineers to evaluate the performance and behavior of the design under different operating conditions.

4.1 Graphical representation of ductile iron material



4.2 Graphical representation of deformation ductile iron material



5. CONCLUSION

This project deals with the static structural analysis of a pair of forks in lifting a crate weighing 10N,20N,30N . The parameters that define the fork arms were analyzed to design the fork effectively, while considering the cost and FOS based on yielding. A good dimension for the fork, considering all the causes, effects and restrictions was found. The material suggested for the fork was STEEL 4340 . The visual results obtained were as expected and the simulations gave a good idea of where to expect failure. Due to the license agreement, a mesh size smaller than 0.8 inches could not be used. In the future, smaller mesh sizes could be used to verify the results and get a more accurate solution. Furthermore, as was observed in results and discussions, there was minimal stress concentration along the length of the fork, towards the tip, and also, between the hooks. So, the edges were filleted out to try and reduce the weight. Another option to reduce the weight would be to counter-sink a hole on the fork arm. This would drastically reduce the weight and thus the cost of the fork. This report covered the basic initial setup for the design of fork arms and can be used as a base parameter setup for further complicated iterations

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