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Modeling and analysis of hoist in workshop in CAE tool A Review

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Abstract - Heavy duty tasks in any industry or workshop are managed by several mechanical equipment's like cranes, hoists, lifts etc; it involves loading/unloading of goods, shipping of heavy materials, lifting and dropping heavy equipment's. Heavy duty tasks such as engine removal from vehicle for repairing/rebuilding and restoring, likewise complex operations that involves the movement of heavy engine parts in the workshop from one place to another. The task usually requires time depending on the hoisting device employed. Chain hoist requires more time as it is operated manually by human efforts and has certain limitations, like it is fixed with some constructed beam or tripod on other hand, hydraulic hoist has more capacity to lift heavier engine than chain hoist and electrical hoist. However, Electrical hoist has lifting capacity up to weight of about 200-250Kg but has adequate speed than other lifting devices like chain hoist and hydraulic hoist. In this servey, several design concepts are considered for hoisting/lifting heavy engine assembly more than 250kg and we planned to test the portable lifting hoist by modeling the assembly in Creo Parametric and analyze it in Ansys Workbench with prescribed engineering data and different loading conditions to optimize various failure stages, equivalents stresses and other optimistic findings.

Keywords - Engine Hoist, Crain, Hydraulic Lifting Device, Chain Hoist, Electric Hoist, Hoisting Device.

I. INTRODUCTION

The hoisting process has become a very essential system for the transportation of heavy equipment as well as personnel. According to design the hoist consists of several components in which there are winders, ropes hydraulic actuators, chain, grabbing hook, electric motors, structural frame etc. The safety and reliability of the hoist depends on its design, therefore proper and accurate design of a hoist is very important. The engine hoist consists of a solid support system that typically consists of welded or aluminum steel. It includes an expanding beam from the frame that is fitted with chain connections built to link the tool to the engine anchor. It can be used manually, electrically, and pneumatically when raising a certain load from one stage to the other, using the wires, fibers, or wire ropes. The load is connected with a hook to the hoisting unit. The operator can easily lift the heavy load and can drop it wherever needed.

Fig -1: Portable Engine Hoist

It incorporates a cantilever beam that extends from the frame that has chain attachments designed to connect the tool to the anchored point of the engine. Its operation may be achieved manually, electrically or pneumatically and may use chain, fiber or wire

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rope while lifting a given load from one point to another. The load is anchored to the hoisting device by means of a hook. Some hoist enables the operator to lift engines out of their compartments and maneuvers them into work areas.

In this survey, we found the design of each element assembled with hoist was performed thoroughly. Different types and configurations of hoisting systems were considered and compared regarding their suitability to small scale workshops. The three basic types of hoisting devices commonl used for load lifting applications include:

- Hydraulic Engine Hoist
- Electric Hoist
- Chain Hoist

All three types of hoisting devices have certain merits and demerits with similar task to perform as taking out the vehicle engine for repairs/replace. Engine hoist is important in the sense that the average engine weighs about 400-600lb (182- 272Kg), and may be highly cumbersome to achieve if human effort is employed in the removal process. Also, the least safe act in an engine removal process is when it is being lifted outwards from the engine seat having loosed the bolts and nuts, and the engine suddenly experience free fall from a certain height. Studies have shown that manual handling of heavy loads such as the automotive engine or its parts can result in severe health problems such as Musculoskeletal disorders, tremors of the hand, misalignment of slip disc in pelvic region, Lumbar scoliosis etc

II. LITERATURE SURVEY

N. Rudenko[1] In this book “Material Handling Equipment” divided into three parts. In first part explains general information of material handling equipment and also mansions its application in industry, role in production. Enumerates the main types of material handling equipment.

In second part, description of parts of hoisting machinery such as chains, ropes, pulleys, drums, braking gears, drives, hoisting, slewing jib and lifting mechanisms of cranes. Various types of crane are also the subjects for practical designing wok. Design model and theory are given in their application to general- purpose machines. Special types of crane are not mansion in this book. In third part, gives a brief description of elevators (lifts).

Yuantal Crane [2]:
M/S Yuantal crane had introduced working principal of Electric overhead travelling crane. The motor is linked to the drum through gearbox. The wire rope winds in the drum and it connected through the pulley block and lifting appliance. Motor provides motion of positive and negative direction to drum according to that rolls or releases wire rope so that the sling and hoisting realizes lifting movement.

Indian Standard (807-2006) [3]:
This standard describe design of structural portion for cranes, hoists, specifics permissible stresses and other details of design. In order to ensure economy in design in reliability in operation. To deal with the subject conventionally, cranes have been broadly classified into eight categories based on their nature of duty and number of hours in service per year. It is producers or manufactures responsibility to ensure the correct classification.

Indian Standard (3177-1999) [4]: Indian standards are broader in concept and give a standard principle in a generalized form because of uniformity of a product or services.
This standard covers the mechanical and electrical drives of the cranes. The components of crane are made with dimensions or design in accordance with the help of Indian standard.

IS 3177-1999 covers all selection criteria of components in EOT crane such as lifting hooks, shafts, wire rope, rope drum, flanges, sheaves, bearings, gear boxes, couplings, fasteners, motor, etc.

ElectroMech FZE [5]:
M/S ElectroMech had introduced a new design as “Double decked arrangement of trolley mechanism” in single failure proof EOT crane. They developed a single failure proof EOT crane by using two independent rope drums. Both the rope drum are driven by separate gearboxes and motors. These

double decked arrangement are shown in figure 3. Both the wire ropes reeving are taken on alternate pulleys to maintain equilibrium of load in case of failure of one rope system or single mechanism. The hooks used are of duel design with dual attaching points thereby if one attachment falls, the other load path continues to support the load without excessive drop or swing.

Nuclear Regulatory Commission [6]:
In this guideline, discus about rope relieving system as well as different hoisting machinery of single failure proof EOT crane.

Rope reeving system defines special consideration during the design and analysis of the system. The load carrying rope will suffer accelerated wear if it rubs excessively on the sides of the grooves in the drum and sheaves because of the improper alignment or large fleet angle between the grooves. The load reeving rope will furthermore suffer excessive loading if it is partly held by friction on the groove hall and then suddenly released to enter the bottom of the groove.

The rope can be protected by the selection of conservation fleet angle Rope may also suffer damage due to excessive strain development if the strain construction and the pitch diameter of the sheaves are not properly selected. Fatigue stress in ropes can be minimized when the pitch diameter of the sheave selected large enough to produce only nominal stress levels. The pitch diameter of the sheaves should be large for rope moving at the drum and can be smaller for sheaves used as equalizers where the rope is stationary. Protection against excessive wire rope wear and fatigue damage can be ensured through scheduled inspection and maintenance.

The design of the rope reeving system is in diagonally and also it should be duel with each system providing separately the load balance on the head and load blocks through configuration of the ropes and rope equalizer. So load is equally distributed on rope falls.

Remain hoisting machinery such as rope drum, hoist braking system, lifting devices includes pulley block should arrange the duel.

Ranjendra Parmanik [7]: Rajendra parmanik in a post "Design of hoist arrangement of EOT crane(2008), he has discussed about the history of crane, various types of crane, application, the design of the hoist of EOT crane is done by algebraic calculations and a model design of the various parts of EOT crane.

Dr. Frank Jauch [8]:
Dr. Frank jauch in a post "Care, use and maintenance of wire ropes on cranes", he has discussed about drum. There are two types of drum: single layer drum and multi-layer drum. Both are used based on lifting capacity of an object. He has also discussed about crane ropes.

Pradyumnakesharimaharana[9]:
Pradyumnakesharimaharana, in the thesis "Computer aided analysis and design of hoisting mechanism of an EOT crane" states that wire rope is liable component in crane and failure due to large amount of stresses. So increase the number of rope falls decrease the tension on rope falls and also used factor of safety.

Ultimately reduce the risk of wire rope failure. Increase number of rope falls so increase length of wire rope which is expensive. The arrangement of wire rope is also important and arrange in between upper pulley block and bottom pulley block. He has been found various cross section of shape for crane hook and calculated stress and deflection at critical points using ANSYS. So conclude that trapezoidal section show less stress. Also calculated rating of motor, brakes used in hoist mechanism. Motor power required depends on lifting speed and load applied.

Z Donazet, F. Luksa, M. Bugarin [10]:
In this paper "Failure of two overhead crane shafts" states that failure analysis of shafts such as overhead drive shaft and gearbox shaft fractured as a result of rotational bending fatigue. Fracture occurred due to high stress concentration. The fracture of the overhead crane drive shaft due to small radius fillet

between two different diameters of the shaft. The fracture of the overhead crane gearbox shaft was initiated on the intersection of two stress raisers, on the sharp corner in the keyway and on the radius of the fillet at the change in the shaft diameter. The failure analysis revealed that the design load should not have led to shaft fracture and that there also existed additional load, unforeseen by the design.

The post- failure verification in both cases revealed parallel misalignment between two shaft axes. Corrective actions were considered in two ways: to improve service life by a small change in the design and to remove the unforeseen additional load due to misalignment between two shaft axes. In the case of the overhead crane drive shaft, increasing the size of the fillet radius from 1.5 mm to 5 mm decreased maximum local stress below the endurance limit, resulting in significant increasing of the fatigue life. In the case of the overhead crane gearbox shaft, increasing the radius size at the change in the shaft diameter from 2.5 mm to 4 mm and the increasing of the radius size in the keyway corner from 0.2 to 0.6 mm extends the fatigue life more than twice.

The gear coupling, compared to the roller chain coupling and especially to split muff coupling, allows more angular and parallel misalignment, prolonging significantly shaft service life. Based on this analysis, the actual service life of shaft can be improved from finite to infinite lifetime

Naresh Chauhan, P. M. Bhatt [11]:
In the paper, "Improving the durability of the EOT crane structure by finite element analysis and optimize the hook material for improving its solidity" states that crane is one of the most important material handling equipment and wide application in different fields of engineering. Many cranes are used beyond their lifting capacity so analysis of crane structure is essential. So the analyse has been calculated. The stresses and strains state of the power structure of overhead crane bridge for increasing its toughness is made using the NX NASTRAN. The results are shown that resulting stresses are well under the permissible stresses limits. And also study about the dimension optimization of the power structure in order to design hook.

III. CONCLUSIONS

Considering the design criteria and constraints for the design of an engine hoisting device, the requirements were met from the preliminary stage and planning through the embodiment design and then the concept design. Proper assessment of the final design of the system was carried out and a good design efficiency was obtained. However, to swap engines heavier than 2KN, operators will require standby electric source and electric motor of higher capacity which is more expensive but faster than hydraulic and chain hoist.

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