A Review on Design and Analysis of Hoisting Machinery in EOT Crane

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Abstract— In today's modern era, crane is very important material handling equipment in industry because of safety reliability, fast speed, economy etc. There are several components used for hoisting mechanism in EOT crane. In this review paper, discussed about various parts of hoisting mechanism. Carried out design calculation of various parts and analysed it for structural or functional aspect.

Key words: EOT, ElectroMech FZE

I. INTRODUCTION

Need of the present day, equipment to handle heavy loads with fast speed, reliability, safety, economy etc. So the crane is used. Crane is one of the most important equipment used in the industries. It works as a material handling equipment or device.

Applications of material handling device is a prime consideration in the construction industry for the movement of material, in the manufacturing industry for the assembling of heavy equipment, in the transport industry for the loading and unloading and in shipping etc. This device increase output, improve quality, speed up the deliveries and therefore, decrease the cost of production. The utility of this device has further been increased due to increase in labour costs and problems related to labour management.

Crane is a combination of separate hoisting mechanism with a frame for lifting or a combination of lifting and moving load. There is very much useful to pick up a load at one point and be able to transport the object from one place to another place to increase human comfort.

There are three major considerations in the design of cranes. First, the crane must be able to lift the weight of the load. Second, the crane must not topple. Third, the crane must not rupture.

There are so many types of crane are available such as Tower crane, Truck mounted crane, EOT crane, Telescopic crane, Gantry crane, Aerial crane, stocker crane, etc. Here, discus about Electric Overhead Travelling (EOT) crane. EOT crane is also known as bridge crane. Electric Overhead cranes typically consist of either a single girder or a double girder construction.

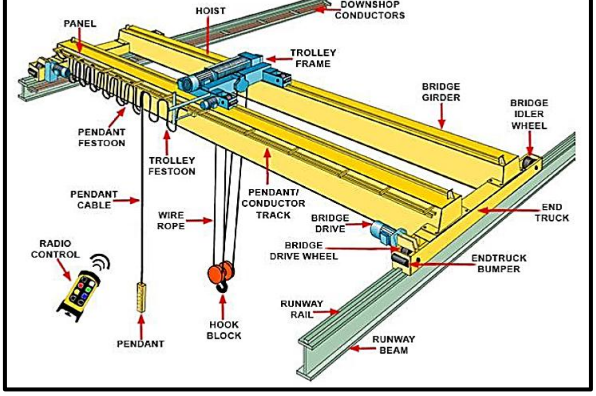

Fig. 1: Double Girder EOT Crane [12]

An overhead crane consists three types of motion:

- The bridge providing long travel motion of the hoist, trolley and the load.
- The trolley providing cross travel motion of the hoist and the load.
- The hoist providing up-down motion of the load

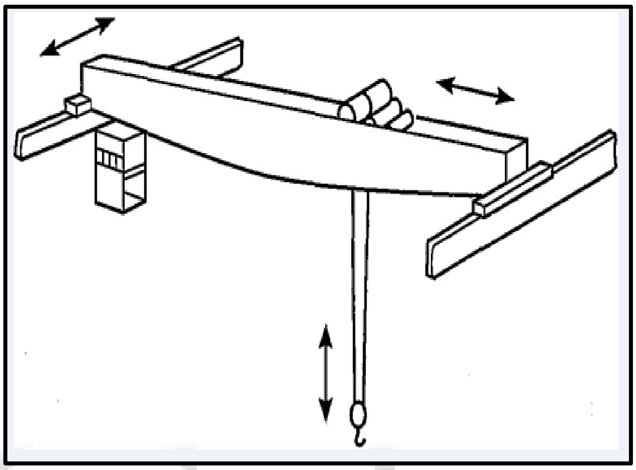

Fig. 2: Motion of Crane [13]

II. LITERATURE REVIEW

A. 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).

B. 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.

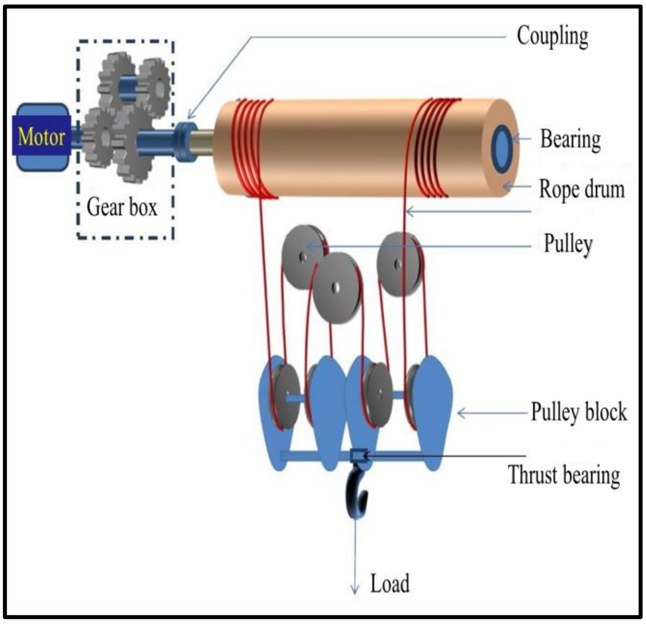

Fig. 3: Hoisting Mechanism of Crane [9]

C. 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.

D. 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.

E. 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.

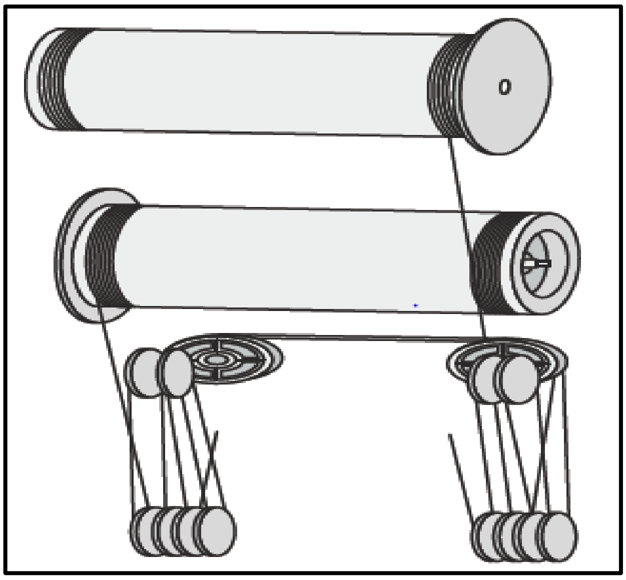

Fig. 4: Double Decked Arrangement of Trolley Mechanism [5]

F. 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.

G. 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.

H. 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.

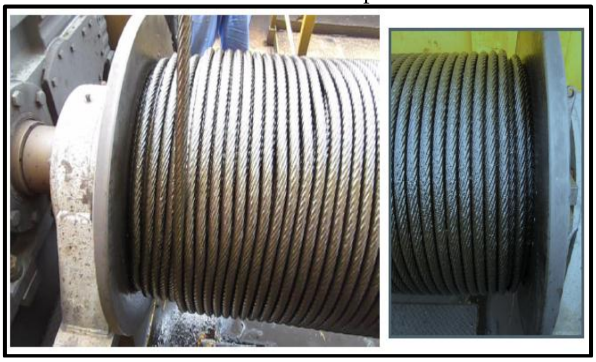

Fig. 5: Rope Drum [8]

I. 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.

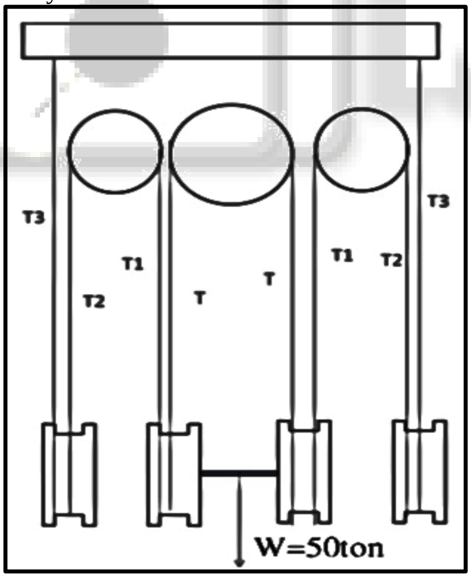

Fig. 6: Distribution of Load on Rope Falls [9]

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.

J. 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.

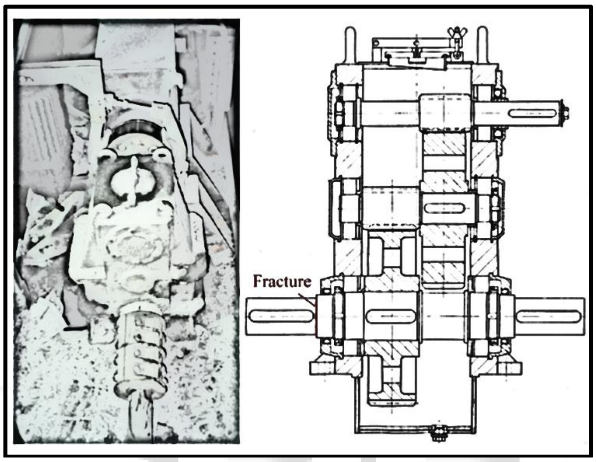

Fig. 7: Overhead Crane Trolley Gearbox [10]

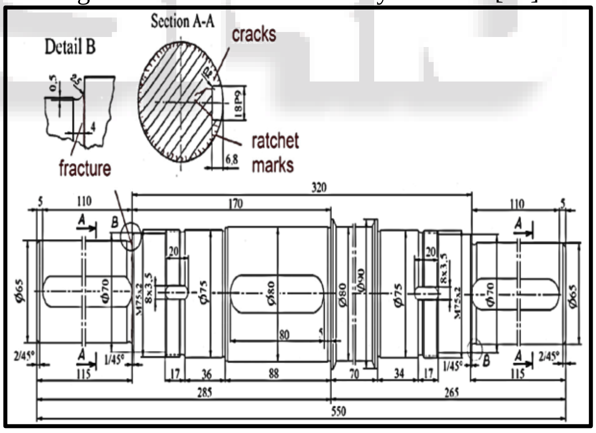

Fig. 8: Steeped Drive Shaft [10]

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.

K. 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.

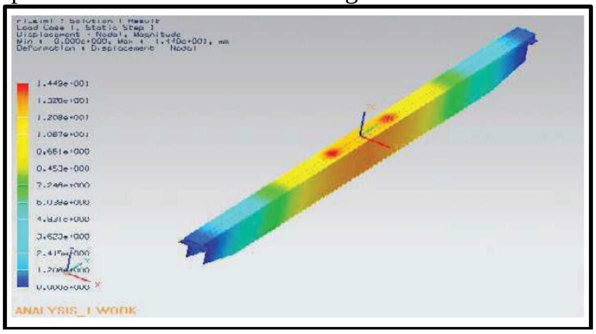

Fig. 9: Displacement Result of Main Longitudinal Girder [11]

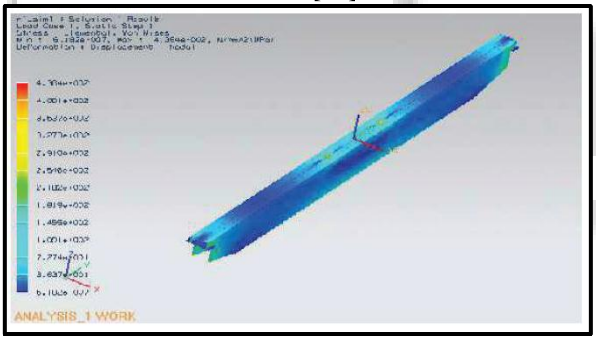

Fig. 10: Stress Result of Main Longitudinal Girder [11]

III. Conclusion

In EOT crane, there are different components used to perform function. Generally, there is one rope drum, gearbox and motor used in hoisting mechanism. It means that only single drive mechanism is used for lifting purpose & displacement of an objects.

EOT crane involved failure of components & mechanism so it cannot perform function and it may damage an object.

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