Design And Fe Analysis of Crane For 5 Tonne Capacity

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Abstract- *In today's world of growing competition, all industries are trying their best to give the components of high quality with minimum expenditure. So this project deals with the design and analysis of 5tonne capacity crane by using CAD and Analysis software. To determine the stress and displacement we will perform static analysis.*

In proposed work the crawler crane for 5 tonne capacity will be designed. Complete kinematic synthesis analysis of the mechanism will be performed. The static analysis will be done to determine the critical area of load application. This data will be used to design various components of the crane. Modern CAD tools will be used to 2D and 3D model along with the simulation of the crane. All the critical components like pins at various joints will be analyzed using the analysis software like Hypermesh. A standard design procedure will be prepared for selection material, size of the components. The boom (rigger) calculations were also performed to calculate stress and mass .Hence we are getting safe bending stress (σ_b) 159 Mpa which is less than permissible or allowable stress .

I. INTRODUCTION

Cranes are having very wide application in material lifting and material handling requirements. Cranes are widely used in the heavy industries as well as heavy construction sites and for rad side assistance. Many types of cranes are available, different mechanism have been used for building a crane. Most commonly used mechanism is a simple four bar mechanism.

This project will be very much useful for designing a crane using four bar mechanism as per the customer requirement.

Types of cranes :

Mounted Crane : A crane mounted on a truck carrier provides the mobility for this type of crane .Generally, these cranes are able to travel on highways, eliminating the need for special equipment to transport the crane. When working on the jobsite, outriggers are extended horizontally from the chassis then vertically to level and stabilize the crane while stationary and hoisting.

Rough Terrain Crane ; A crane mounted on an undercarriage with four rubber tires that is designed for pick-and-carry operations and for off-road and "rough terrain" applications. Outriggers are used to level and stabilize the crane for hoisting. These telescopic cranes are single-engine machines, with the same engine powering the undercarriage and the crane, similar to a crawler crane. In a rough terrain crane, the engine is usually mounted in the undercarriage rather than in the upper, as with crawler crane.

Side lift Crane: A side lifter crane is a road-going truck or semi-trailer, able to hoist and transport ISO standard containers. Container lift is done with parallel crane-like hoists, which can lift a container from the ground or from a railway vehicle.

All Terrain Crane : A mobile crane with the necessary equipment to travel at speed on public roads, and on rough terrain at the job site using all-wheel and crab steering. AT's combine the road ability of Truck-mounted Cranes and the maneuverability of Rough Terrain Cranes. AT's have 2-9 axles and are designed for lifting loads up to 1200 metric tons.

Crawler Crane: Crawler is a crane mounted on an undercarriage with a set of tracks (also called crawlers) that provide stability and mobility. Crawler cranes range in lifting capacity from about 40 US tons to 3500 US tons. Their main advantage is that they can move around on site and perform each lift with little setup, since the crane is stable on its tracks with no outriggers.

Railroad Crane : A railroad crane has flanged wheels for use on rail roads. The simplest form is a crane mounted on a rail road car.

Tower Crane: The tower crane is a modern form of balance crane. Fixed to the ground (and sometimes attached to the sides of structures as well), tower cranes often give the best

combination of height and lifting capacity and are used in the construction of tall buildings.

Telescopic Crane : A telescopic crane has a boom that consists of a number of tubes fitted one inside the other. A hydraulic or other powered mechanism extends or retracts the tubes to increase or decrease the total length of the boom. These types of booms are often used for short term construction projects, rescue jobs, lifting boats in and out of the water, etc. The relative compactness of telescopic booms make them adaptable for many mobile applications.

Deck Crane : Located on the ships and boats, these are used for cargo operations or boat unloading and retrieval where no shore unloading facilities are available. Most are diesel-hydraulic or electric-hydraulic.

Types of boom cross section :

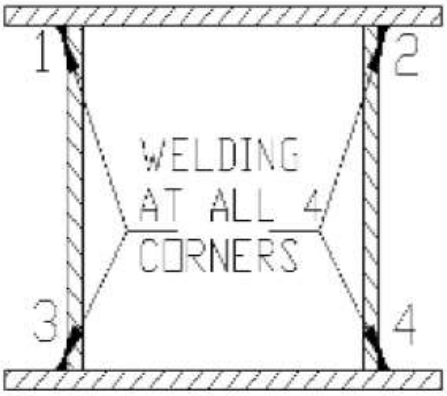

Fig ; Four plate Boom section

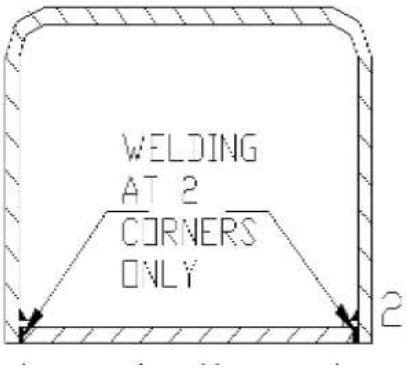

Fig ; U shaped Boom section

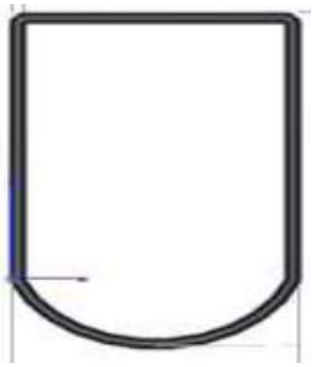

Fig : Extruded section

Material Handling involves short-distance movement within the confines of a building and a transportation vehicle. It utilizes a wide range of manual , semi-automated, and automated equipment and includes consideration of the protection, storage, and control of material throughout their manufacturing, warehousing, distribution, and disposal. There are two types of material handling

Manual Handling- Manual handling refers to the use of a workers hands to move individual items by lifting, lowering, filling, emptying, or carrying them.
Automated Handling- Whenever technically and economically feasible, equipment can be used to reduce and sometimes replace the need to manually handle material.

Crane and hoisting machine are used for lifting heavy loads and transferring them from one place to another. A crane is a lifting machine, generally equipped with a winder (also called a wire rope drum), wire ropes or chains and sheaves that can be used both to lift and lower materials and to move them horizontally. It uses one or more simple machines to create mechanical advantage and thus move loads beyond the normal capability of a human. Cranes are commonly employed in the transport industry for the loading and unloading of freight, in the construction industry for the movement of materials and in the manufacturing industry for the assembling of heavy equipment.

Different varieties of crane exist. Broughton grouped all cranes into four main categories which remain applicable today, namely:

Overhead travelling - fixed rails lying on one or two elevated girders with a trolley or crane bridge (with hoisting apparatus) that can transverse the length of the rails.

Jib - usually consists of an inclined member that can rotate about a central point and suspends the load from the outer end of the inclined member.

Gantry - A girder, or girders, connected to vertical members which are either fixed or move along tracks at the base of the vertical member. The hoisting equipment can usually transverse the bridge girder, or girders.

Cantilever or tower - A vertical mast with a horizontal cantilever that rotates horizontally around the vertical member .The trolley and hoisting equipment move along the horizontal cantilever.

Basic Components of Cranes:

Crawler: To move the crane (creep) in the work area by means of a motor rotating tram tracks on his sprocket.

Superstructure: The crane PaddleWheel, control room operat or, or where other equipment.

Counterweight: The weights used to balance the load and a heavy crane to provide stability during lifting.

Additional Counterweight: Weightof additional (optional) to balance the load and a heavy crane.

Jib: additional extension boom attached to the point of giving additional boom length for lifting specified.

Mast: Theplace toproper rope or wire balancer cranes, hoists, and pulley.

Pulley: To play the part of the hook so that it can be raised or lowered.

II. LITERATURE REVIEW

Yongfeng Zheng et al , YouminHu et al, Bo Wu et al ,Pengxing Yi et al, Jie Liu [1] In their work on the four-link combination boom portal crane which typed MQ2533 of Wei hua Group for study, According to the structural characteristics of boom system in the premise of reasonable and simplified model, it utilize the ANSYS software to build a four-bar linkage FEM model and does modal analysis, which evaluate the dynamic characteristics and provides a theoretical reference for the lightweight design of four-link mechanism.

Apeksha K. Patel et al, Prof. V.K. Jani,[2] In their work on the main Component of Overhead Crane is Girder Beam which transfers load to structural member. In Present Practice, industries overdesign girder beam which turns costly solution. The weight reduction of girder which has direct effect on cost of girder and also performance Optimization is done for fatigue (life) point of view. The FE analysis of girder beam is carried out for the specific load condition i.e. turning operation. Here, a mathematical design calculation crane component, and thrust forces are used in FE analysis. ANSYS WORK BENCH V12.1.Software used for the FE analysis of the girder beam. Through this analysis the results were carried out in terms of stresses and deformation and this result are within the allowable limits.

Caner KARA [3] : In their work on the investigate the feasibility of glass fiber reinforced polymer (GFRP) I-beams as the main girder of double girder overhead crane. Two different geometries of GFRP I-beams with simply supported beam configurations and with fix span length are experimentally, numerically and analytically tested under crane motion loads to evaluate their dynamic flexural response

J. J. Rubio-Ávila et al , R. Alcántara-Ramírez et al , J. Jaimes-Ponce et al , I. I. Siller-Alcalá.[4] In their work on the new concept of a tower crane, which greatly reduces the ballast and eliminates the anchoring, as will be "self-balancing" which implies removing the anchoring replaced by a sliding counterweight trolley. Also, the design of the mechanics as well as the final assembled self-balancing tower crane are presented. Its dynamical model has been obtained and controlled by means of classical and anti-sway controllers. Simulations are conducted in order to show the effectiveness of the proposed tower crane.

Sasi BhushanBeera et al , Srikanth Avala [5] In their work on the four bar mechanism is modeled in Pro-E and kinematic and dynamic analysis is performed to determine the joint rates, accelerations, reaction forces and torques at the joints. And compared the Pro-E analysis results with the analytical calculations and they agreed with a good degree of precision. The Dutch crane is successfully rendered in Pro E using idealized models for the components. The dimensions for the components are approximated to the original values. The final rendered assembly and is animated using Pro E mechanism package. The maximum motion of the crane is given by its driven angle Q which varies from 49 degrees at maximum reach to 132 degrees at minimum reach.

III. IDENTIFIED GAPS IN THE LITERATURE

Most of the researchers till now have presented a modifications in crane lifting mechanism , weight reduction in components of cranes , and its geometries . There is still a need to modify, optimize and customize the arms of the crane and its components to lift maximum load with optimized crane structures . and very less amount of work has been observed onit . This work is focused on design design and fe analysis of crane for 5 tonne capacity .

IV. PROBLEM FORMULATION

This project is based on the design and FE analysis of Crane for 5 tonne capacity. At present the failures in crane is due to :

Failures in pin joint , Failures in various links .To overcome the above mentioned problem we are performing design and FE analysis of crane . This will able to complete the lifting task quickly, efficiently and economically without any failure .

V. RESEARCH METHODOLOGY

In present study, we will be accumulating all the essential and necessary data of crane for 5 tonne capacity to create the existing CAD model. Considering the problems identified we will then create modifications in the existing design . Then calculations and FE analysis of the design model will be performed. After that results will be discussed and design will be finalized.

VI. CONCLUSIONS

With the successful completion of this project, the company will be directly benefited as improvement in lifting capacity of crane will lead to lift the load upto 5 tonne which was less than 5 tonne previously ..The modification and changes made in design of crane will make it compact and at the same time also reduce the failures occurring in crane components due to loads and stresses .

REFERENCES

[1] Yongfeng Zheng1, YouminHu1, Bo Wu1*, Pengxing Yi1, Jie Liu1 Finite Element ModalAnalysis of Four-link Combination Portal Crane, 3rd International Conference on Mechatronics,Robotics and Automation (ICMRA 2015)

[2] Apeksha.K.Patel, Prof. V.K.Jani, Design And Dynamic Analysis Of 70t Double Girder Electrical Overhead Crane, Journal of Information, Knowledge and Research in Mechanical Engineering Issn 0975 – 668x Nov 12 To Oct 13 | Volume – 02, Issue - 02 Page 496

[3] Caner KARA, Analysis of the Different Main Frame of the Bridge Cranes, January, 2008 İZMİR

[4] J. J. Rubio-Ávila, R. Alcántara-Ramírez, J. Jaimes-Ponce, I. I. Siller-Alcalá, Simulation Design, construction, and control of a novel tower crane, International Journal of Mathematics and Computers

[5] Sam Hutcheson by Sam T. Hutcheson, Design and Construction of a Portable Gantry Hoist, BioResource and Agricultural Engineering, December 5, 2013.

[6] Crane K Suresh Bollimpelli1, V Ravi Kumar2, Design and Analysis of Column Mounted JIB International Journal of Research in Aeronautical and Mechanical Engineering Issn (Online): 2321-3051 .