Design Optimization and Finite Element Analysis of Movable Jib Crane

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Abstract – The objective of this project is to design the industrial purpose jib crane & its components with the main emphasis on increasing the structural strength without compromising the stability with lighter design. It is aimed to accomplish this by comparing the national / international standard codes available on design of jib crane with the Finite Elements based designs. The achievable / reasonable transformations /amendments in some of the jib crane components shall be analyzed by statics analysis element Cranes are transport machines, which generally used in heavy machinery industry, shipyards, seaports, warehouses and construction sector. There are several factors that have to be taken into consideration when a crane being designed. Most important factors are; own weight of the crane, the weight of the bulk which has to be transported and the dynamic loads which occur during the movements.

Index Terms- Jib crane, finite element analysis, optimization.

I. INTRODUCTION

Cranes are industrial machines that are mainly used for materials movements in Construction sites, production halls, assembly lines, storage areas, power stations and similar places. Their design features vary widely according to their major operational specifications such as: type of motion of the crane structure, mass and type of the load, location of the crane, geometric features, operating regimes and environmental conditions. For high capacities, usually electric overhead cranes (EOT) are the preferred type.

II. ANALYSIS DETAILS

A. Design of Crane Mechanism

The design of crane mechanism shall be as per Section2 of IS:3177. However, duty classification for jib cranes shall be limited to M6. All components shall be selected or designed under loads & loading conditions specified in 7.3 of Section 2 of IS: 3177. Also IS:15419 shall be referred for mechanical requirements relating to the design, manufacture and erection of jib cranes of all types for shop floor and general purpose applications.

B. Structure

The crane shall be designed in accordance with IS:807 for the jib column & jib arm of the crane. The structural steel material for jib crane structure shall confirm to IS:2062 i.e. mild steel or IS:8500 i.e. structural steel only.

The boom of the jib crane shall be from section or fabricated type with rolled sections or tubular sections.
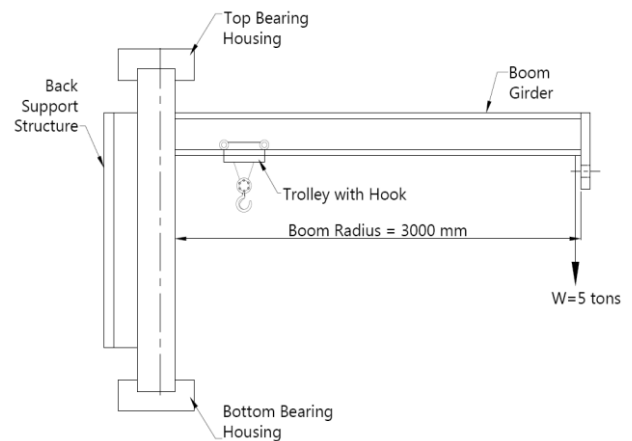

Figure 1. General Arrangement of Jib Crane.

The CAD system Autodesk Inventor is used to construct the 3-D model of wall mounted Jib crane. The crane has normal duty cycle, load capacity 5 tonnes. Typical wall mounted jib crane is shown in figure 1.

In modern industry, higher economic-technological demands are often requested from different kinds of transportations devices. Objects of interest in this project are some construction solutions of jib cranes. Some situations exist in which usually implemented construction solutions are not quite optimal through static-dynamic behavior analysis. For complex systems, like jib cranes are, analytical approach of calculations is not enough to determine global structure integrity. Total description of system static-dynamic behavior can be determined only with CAD technologies implementations or experimental evaluations.
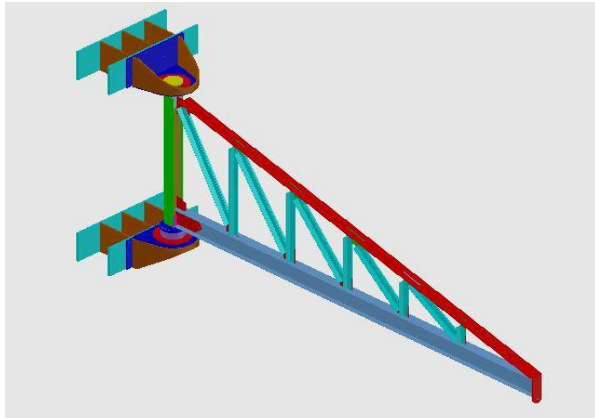
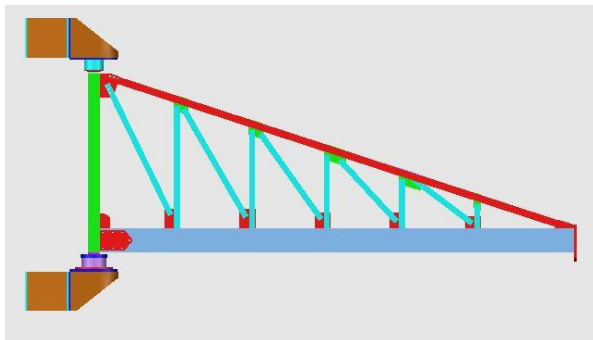Figure 2. Typical 3-d Model of Wall Mounted Jib crane

Figure 3. Elevation of Wall Mounted Jib crane

C. Simulation Research on the Metal Structure of Wall Mounted Jib Crane

The 3-D model created in the previous chapter is analyzed by the help of the finite element analysis (FEA).

After generating the corresponding 3-D geometry, it is transferred to the FEA (finite element analysis) application Autodesk Inventor 2012 for performing the structural analyses where all necessary conditions are set for performing the investigation. form the "3-D basic model" The basic3-D model, serves as a reference point for the further investigations.

D. Preparing the 3-D Basic Model Simulation

The 3-D basic model of the jib crane is analyzed with the help of the Autodesk Inventor 2012 stress analysis software (FEA) application. The Autodesk Inventor 2012 FEA provides a unified working environment for developing and managing a variety of CAE information and makes it easier for setting up and work with data at a high level. The crane geometry generated in Autodesk Inventor 2012 is imported here, where various boundary conditions, loadings and mesh controls provide powerful environment for the analyses.

The 3-D jib crane geometry is to be meshed with 3-D elements (solid elements) and such models are difficult to prepare, the most tedious to check for errors, and the most demanding of computer resources. However, when properly meshed and the proper boundary conditions, loadings and material properties are set, then the model could reveal in full details even the most complex stressed behavior of the structure.
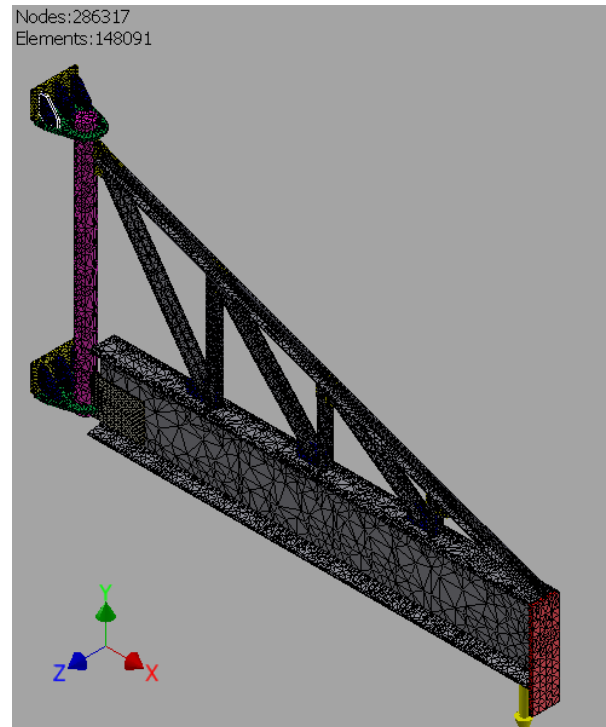

Figure 4. Solid Meshed Model of Jib Crane Arm Simulation Results of the 3-D Model**.**

The applied loads, constraints and contacts of type bonded convert the problem to linear static structural solution and a direct solver is used. The solution took about 30-40mins and after a successful solution.
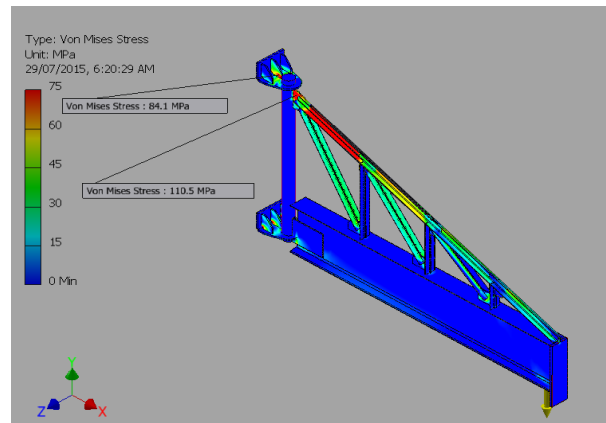

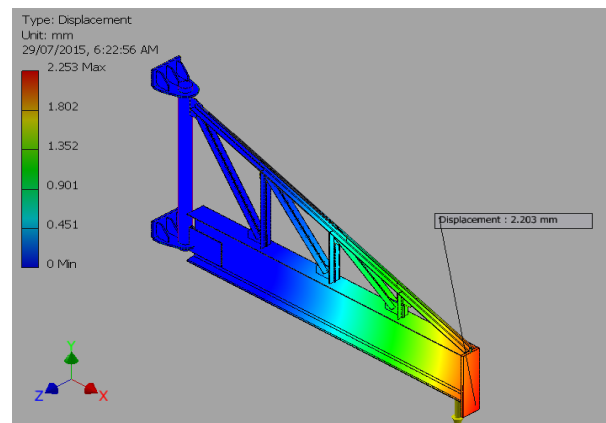Figure 5. Maximum and Minimum values of Von Mises Stress

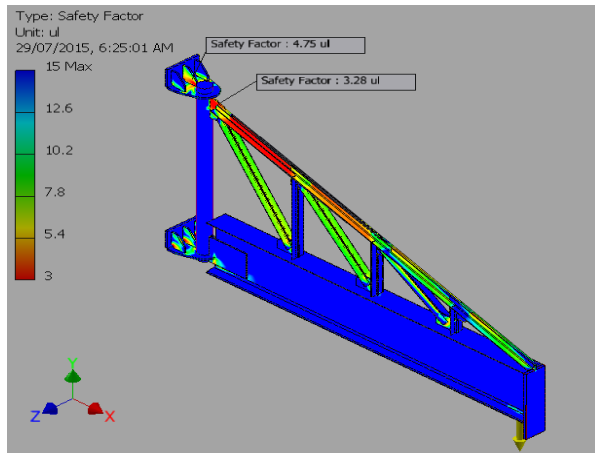Figure 6. Maximum and Minimum values of Displacement Along Y-axi**s.**

Figure 7. Maximum and Minimum values

III. RESULTS

Redesigned 3D-model& FEA model of Jib Crane is shown in Fig. .The applied loads, constraints and contacts of type bonded converts the problem to linear static structural solution and a direct solver is used. The solution took about 30-40mins and after a successful solution, there could be retrieved a multitude of results for the jib crane static structural response as shown in figure. From the above FEA results of re-designed wall mounted Jib crane, it is clearly seen that the maximum stress & displacement which is obtained from the Finite Element Analysis lies within the allowable parameters of Indian Standard Codes. Thus, 3D- model is perfectly designed, constrained and properly meshed.

IV. CONCLUSIONS

The chapter gives out the conclusion of work. The carrying metal construction is the most metal-intensive part of jib crane and is often subject to optimization and reduction.

This project objective, aimed also at reducing the structural mass of a real-world wall mounted Jib crane, is fulfilled through the use of modern computer modeling and simulation methods and applications.

In this connection, two models of a Jib crane carrying structure have been designed in the project and thoroughly statically investigated. One of the models includes the 3-D structure of a wall mounted jib crane, referred to as Conventional model. Models of new, lighter design than the basic model have been developed and studied, named as Re-designed model.

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