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Finite Element Analysis of JIB Crane

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***Abstract* - A jib crane is a type of crane with a cantilevered beam, a hoist, and a trolley that is attached to a building column or cantilevers vertically from an independent floor mounted column. This paper will primarily focus on floor-mounted jib cranes, in which the trolley hoist moves along the length of the boom and the boom spins, allowing the lifted load to be moved skillfully in a relatively circular area. Several factors must be considered when designing a jib crane, the most important of which are the crane's own weight and the weight of the goods. This project investigates the deformation patterns in the jib crane with different design and the work is carried out by designing reinforcement to overcome those stresses in the component. With existing dimensions, models are prepared in modeling software and the analysis is performed on the models by finite element solver with suitable conditions and results are compared.**

Keywords: FEM, I-section, Jib Crane.

I. INTRODUCTION

Three degrees of freedom are available with a jib crane. They are vertical, radial, and rotary in nature. They cannot, however, reach into corners. They are typically used in areas where activity is concentrated. The lifting capacity of such cranes can range from 0.5 to 200 tones, with a reach of a few meters to 50 meters. These cranes are used in a variety of settings, including ports, construction sites, and other outdoor activities. Lifting capacities for general cargo are typically 1.5 to 5 tones, with a maximum out reach of 30 meters.

Jib cranes cantilever vertically from an independent floor mounted column or are attached to a building column. Figure 1 depicts a jib crane that is mounted on a column. A jib crane is essentially a boom with a movable trolley hoist. The trolley hoist moves along the length of the boom, and the boom swivels, allowing the lifted load to move around in a relatively small semicircular area. Jib crane hoists and trolleys are typically slow moving and either manually or radio controlled. The arc swing is usually done by hand, but it can be mechanized if necessary. There are two types of column-mounted jib booms that are commonly encountered. The primary distinction between the two is in how the vertical column force is distributed.

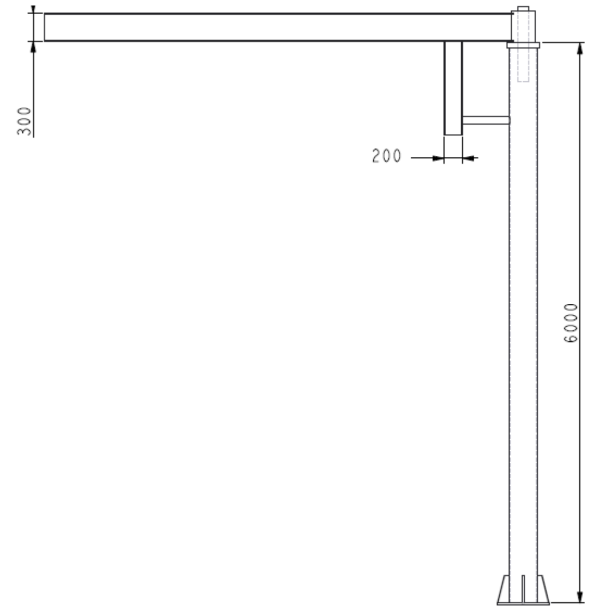

Figure 1: Jib Crane Model

1.1 Loads on Jib crane

- Trolley load: the weight of the trolley and equipment attached to the trolley.
- Dead load: the weight if all effective parts of the bridge structure, the machinery parts and the fixed equipment supported by the structure.
- Lifted load: The working load and the weight of the lifting devices.
- Vertical inertia Forces: Dead Load Factor + Hoist Load Factor.
  - According to CMAA, Dead load factor equals to 1.2 and Hoist load factor equals to 0.15.
- Inertia forces from drives: The inertia forces occur during acceleration or deceleration or crane motions and depend on the driving and braking torques.
  - Inertia forces from drives equals to 2.5% of the vertical load.
  - Test Loads will be 125 percent of related load.

II. FINITE ELEMENT ANALYSIS

Finite element analysis has been carried out for JIB crane.

2.1 Material properties

Material properties for given JIB crane are as shown table 1.

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Table 1: Material Properties

Sr. No.	Mechanical Properties	Value
1	Density	7850 kg/m3
2	Young's Modulus	200 GPa
3	Tensile Yield strength	250 MPa
4	Poison's ratio	0.3

2.2 Meshing and boundary conditions for JIB crane with conventional and modified design

Jib crane as mentioned above is meshed using hexahedral element because of its simple geometry. For crane, with conventional design and with modification by applying support, tetrahedral elements have been selected to accommodate minor details of the geometry. Total number of nodes and elements are16058and 13760 respectively. Mesh model of Jib cranes shown in the figure 2 and figure 3. Jib crane is fixed at bottom of column and subjected to 27000 N concentrated loads at the end of boom as shown in figure 4.

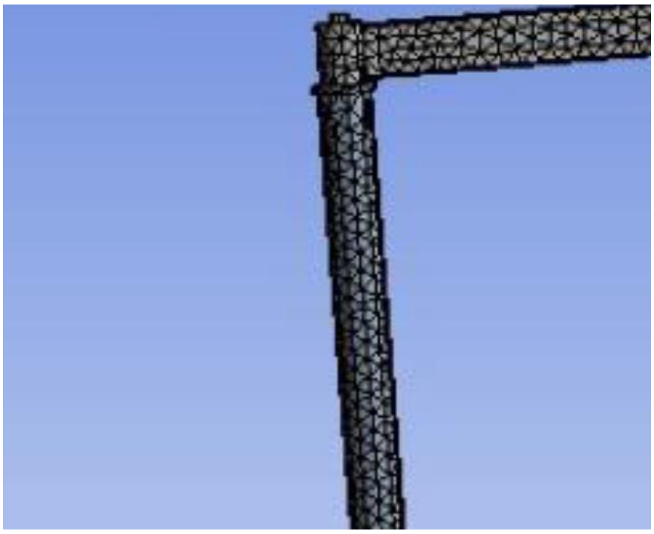

Figure 2: Mesh model of JIB crane without support

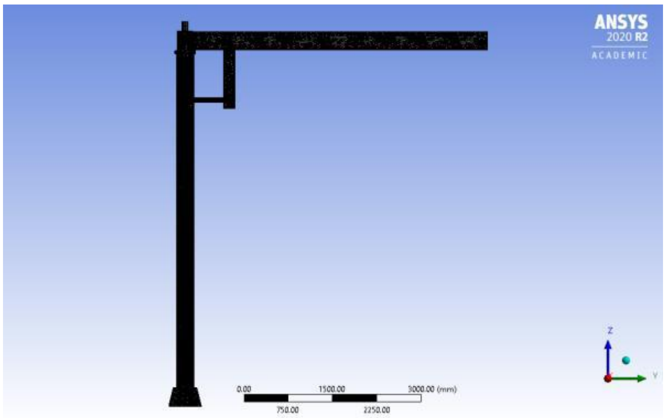

Figure 3: Mesh model of JIB crane with support

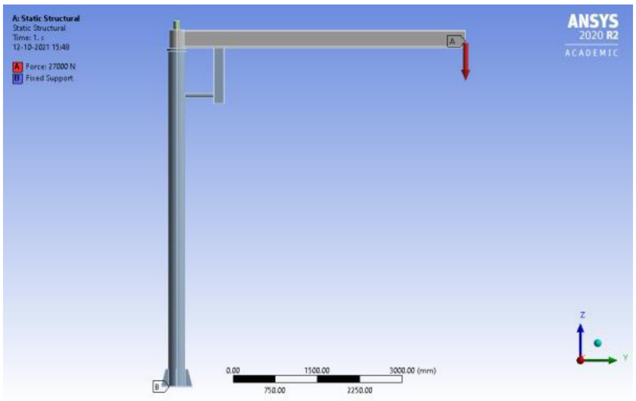

Figure 4: Boundary Condition

III. RESULTS

Stress and deformation contour of above-mentioned design show good conformation between analytical and numerical approach. Figure 4 and figure 5 show stress distribution and deformation contour respectively without support. Figure 6 and figure 7 show stress distribution and deformation contour respectively with support.

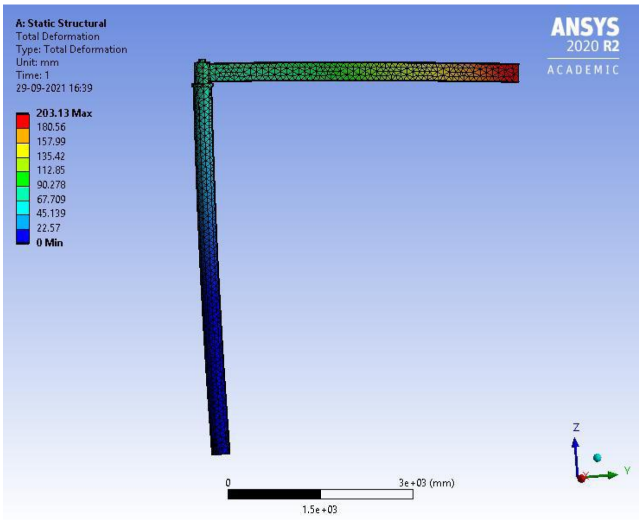

Figure 5: Deformation Pattern

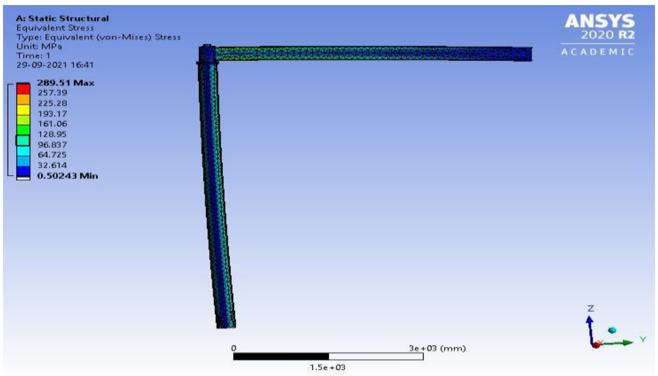

Figure 6: von-Mises Stresses

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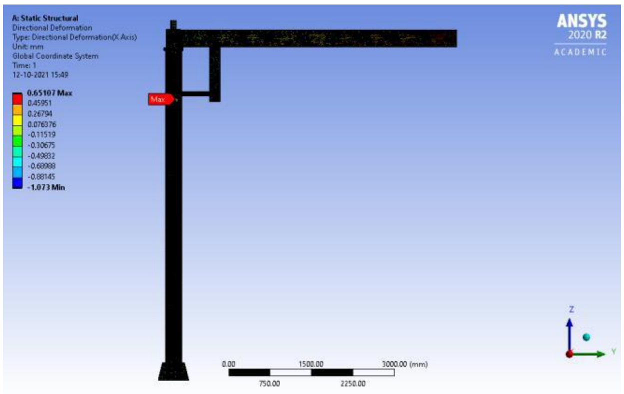

Figure 7: Deformation

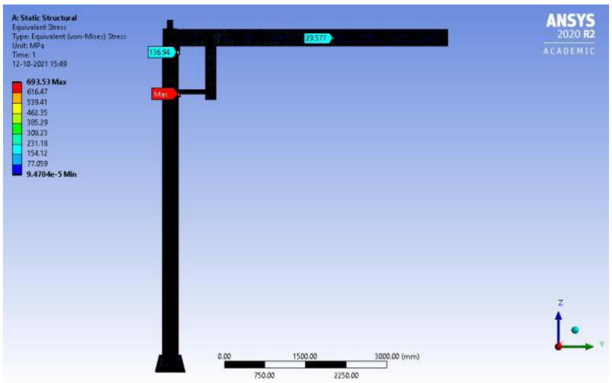

Figure 8: von-Mises Stresses

IV. CONCLUSION

Finite element analysis is very useful tool in order to carry our optimization. From the above results it can be concluded that boom with support has very less deformation as compare to boom without support. Stress pattern shows, maximum stress occurs on vertical column where short column in contact with it. This stress can be minimized by some design modification at contact surface.

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