Structural Stability Of Crane Boom Using Hypermesh

Ehteshamhusain Bilgi[1], S.S.Chappar[2]

[1]*M.Tech student, Dept.of Mechanical Engineering, B.L.D.E.ACET BIJAPUR, Karnataka, India*
[2]*Asistant Professor, Dept.of Mechanical Engineering, B.L.D.E.ACET BIJAPUR, Karnataka, India*

---***---

Abstract - *As there is rapid transformation of technology in 21st era ,it is very essential to be more efficient in product development aspects , and we all know the demands is being more because of increase in population and if the materials are not being used in a proper manner they could depleted soon. So , Great minds decided to reduced the utilization of material up to certain limit by reducing FOS and improving material properties and made more stable equipment from it for mankind .This equipment is vastly utilized in Transportation sector, Construction sector & Manufacturing sector and many more , so it should have properties like toughness , flexible, weighs less with good load carrying capacity & structurally stable. So our analysis focuses on structural strength stability of crane boom.*

***KeyWords*: Factorof safety (F.O.S), Construction Sector, Manufacturing Sector, Toughness, Structurally Stable**

1. INTRODUCTION

A machine which is equipped with wire or chain ropes, hoist rope and sheaves is called crane. Crane is basically used to lower or lift the heavy materials and also can be used to move the heavy material back and forth in horizontal direction. Normally it is difficult to lift the heavy materials by human, where as crane make use of simple machine links to create the mechanical assembly and thus it is possible to lift the heavy material beyond the normal capacity of the humans.

The Transport industry makes use of crane to load or unload the commercial goods in shipping.

The Construction industry makes use of crane for lifting or lowering of the heavy material like cement, concrete and steel rods etc during the construction of small or multistoried buildings.

The Manufacturing industry makes use of crane for lifting or lowering and to move the manufactured parts from one place to another place. It is of great advantage during the assembly of the heavy components especially machines like laths and milling machines.

Ancient Greeks were the first to invent the cranes, and made use of men or animals such as donkeys to power the cranes to lift or lower the material. As the commercial business improved across the different empires and the main transportation was waterways, So Greeks introduced harbor cranes to load and unloads the goods on to ships. Initially the cranes were built using wood and as the industrial revolution took place the cranes were built using cast iron and steel.

Till 18th century the cranes were powered either by men or animals. Later during the mid of 18th century with invention of steam engines, the physical exerted power to crane was replaced by steam engine power and hence the steam cranes were first introduced. Currently the modern cranes are more powered and have more lifting capacity. This is been possible by making use of sophisticated electric motor, IC engines and hydraulic systems.

2.FEM HISTORY

To solve the engineering problems and physics problems by the use of mathematical governing equa tions.The problems involving complex geometries, non-linear material properties and complex loadings cannot be solved by analytical methods, thus the FEM has evolved and attained the great importance in engineering sectors. The FEM developed out of the aerospace industries during World War II. The demand for light weight airplane structures, level of accuracy in the stress results, the need for missiles, space flights and jets during the World War II give an extra encouragement for the growth of FEM.

3. FINITE ELEMENT SIMULATION

Finite element simulation involves the following three steps.

3.2a) Meshing

Pre-processing is the first step and it refers to the converting the real world model/system into simplified physical model. The necessary material properties, loads and boundary conditions are applied in the pre-processing process.

3.2b) Solving of the governing equations

Once the physical model is discritized. The elements make use of the material properties to elemental stiffness matrix. These stiffness matrixes are assembled to form the algebraic governing equations. The algebraic equations are solved by numerical methods to find the unknowns. Thus the unknown results are interpolated to find the corresponding stress and strains.

3.3c) Post Processing

The results of the stresses and strains obtained and are interpreted to make necessary design decisions.

4.METHODOLOGY

Telescopic boom structure parts are explained as below:

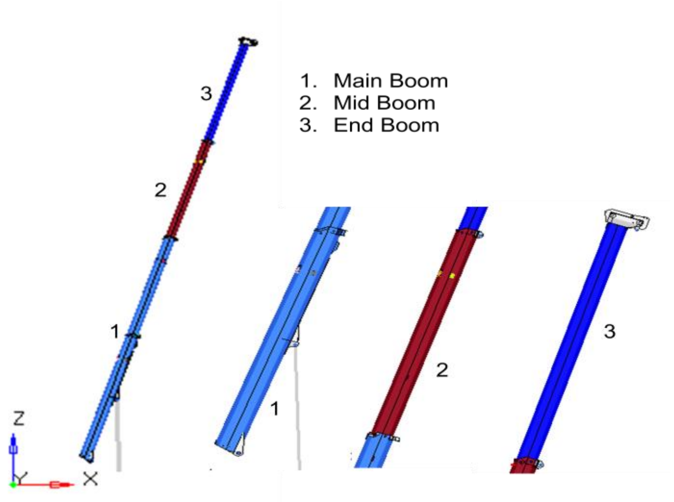


Fig -1: Parts of crane boom

The Main-Boom section is mounted and hinged to the crane mast structure at one end. It is also connected to the hydraulic cylinder rod at 1/4th the length of the boom.

The Mid-Boom section is smaller in the dimension and will slide in the main boom. The load transfer takes place through the wear pads which are placed at the interface of mid boom and main boom.

The End-Boom section is smaller in the dimension and will slide in the mid boom. The load transfer takes place through the wear pads which are placed at the interface of mid boom and main boom.

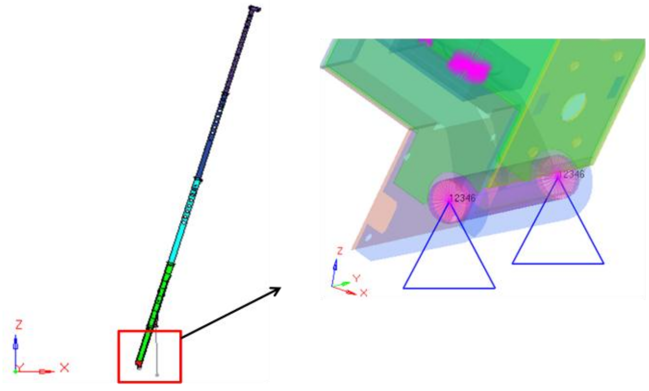
The Hydraulic cylinder serves as thrust giving member to raise and lower the main boom. It is connected to the swelling mast structure at one end and other end is connected to the main boom structure.

4.1 Boundary conditions

The following boundary conditions are applied on the boom structure as follows
Bottom boom pin is fixed in all translation dof and x and z rotation.

Hydraulic cylinder pin is fixed in all translation dof and x and z rotation.

The static structural analysis is carried out on the structure with following loads.



Bottom boom pin is fixed in all translation dof and x and z rotation.
Hydraulic cylinder pin is fixed in all translation dof and x and z rotation.

Fig -2: Boundary conditions

Loads applied on the boom			
Sl.No	Forces(N)		
	X (Axial load)	Y (Side Load)	Z (Vertical)
1	-8439	-1748	-86180
2	-10127	-2098	-103416

4.3 Load Details

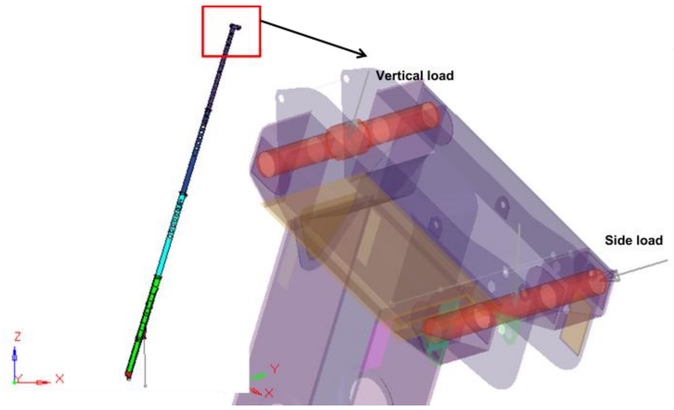


Fig -3: Load conditions(CAD model)

The structure is analyzed for two different loading conditions. Initially, in condition-1 the loads are actual service loads and In condition-2 the loads are increased by 20% of the actual service loads.

5.RESULTS

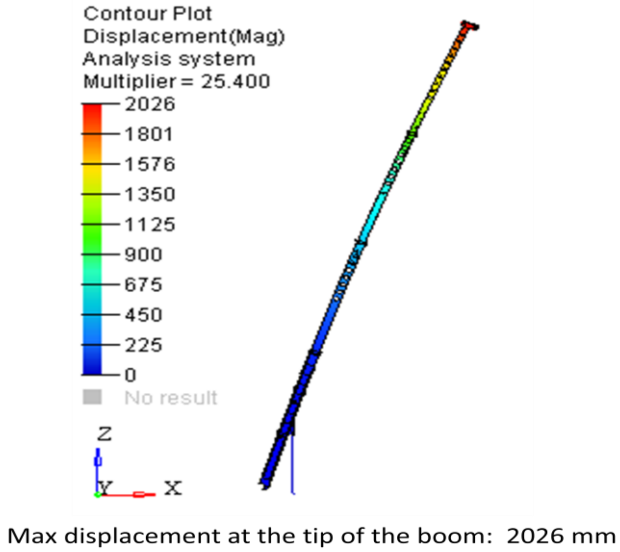


Fig -4: Load conditions (X-AXIS)

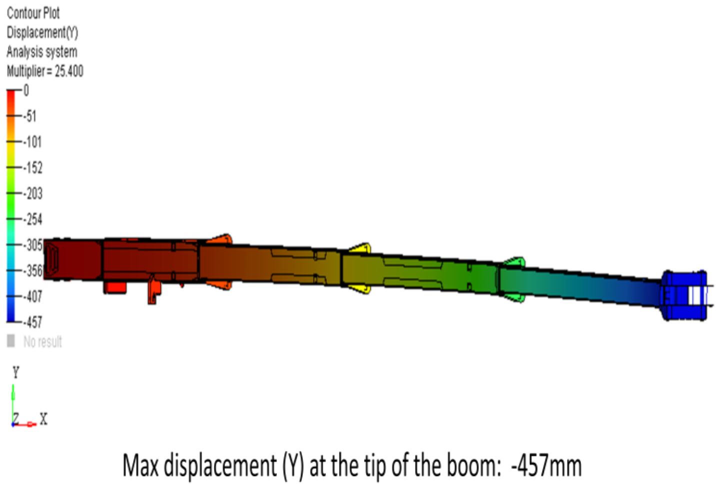


Fig -6: Load conditions (Y-AXIS)

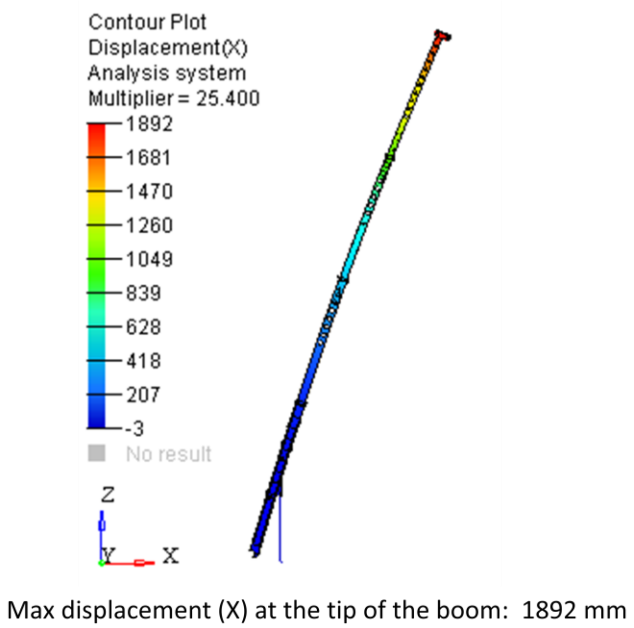


Fig -5: Load conditions (X-AXIS)

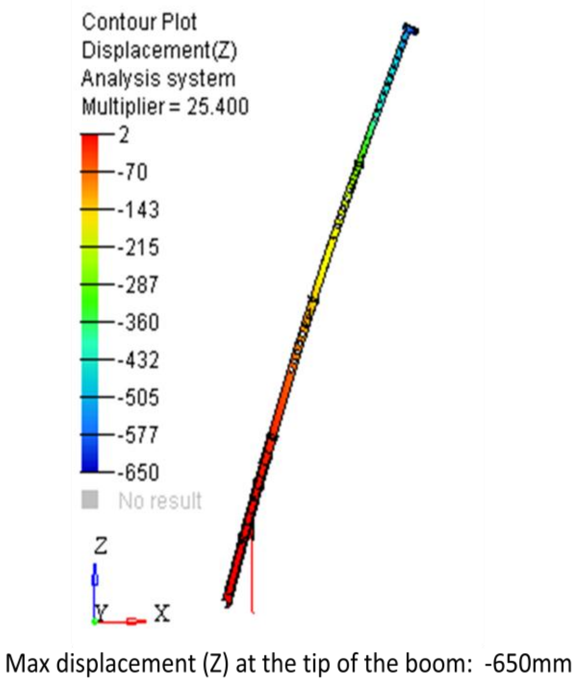


Fig -6: Load conditions (X-AXIS)

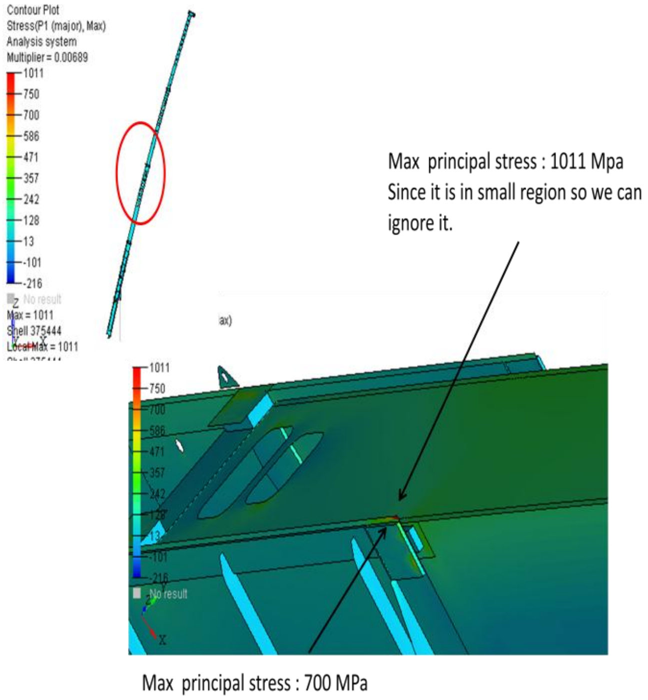


Fig -7 1011 Mpa is maximum principal stress is on the negligible area and hence it ignored. Hence the stress of 700MPa is considered for the section calculation.

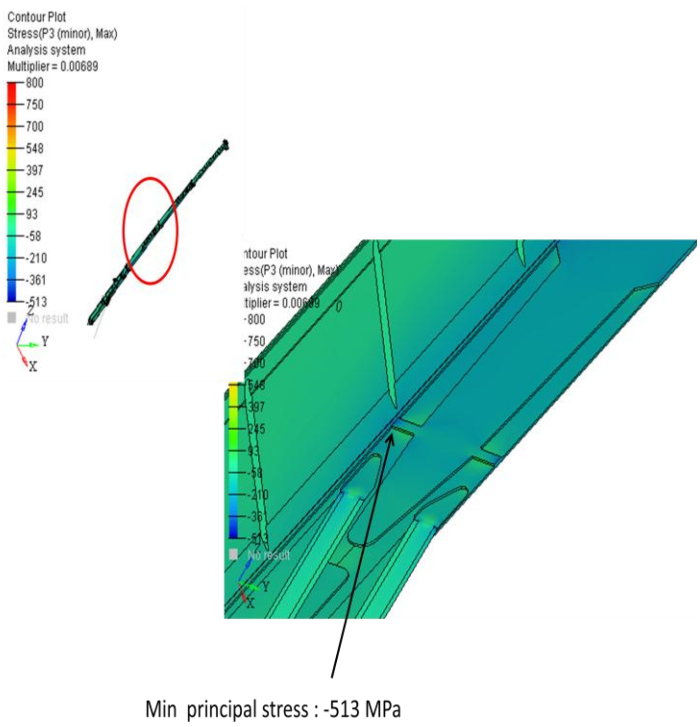


Fig -8 Minimum principal stress

Table-1

Result summary table					
Sl.No	YS (MPA)	Max Principal (Mpa)	Max Principal (Mpa)	Von-Moses (Mpa)	FOS
1	1150	700	-513	973	1.18

6. CONCLUSION

1. The stresses are well within the yield strength. Hence the structure is safe to manufacture.
2. The minimum factor of safety is around 1.18

7. FUTURE SCOPE OF PROJECT

The current section of the boom is hexagonal and requires bending operation to manufacture the hexagonal section. Instead of the hexagonal section, the boom section can be replaced by rectangular cross section. Use of rectangular section will avoid the bending operation which is cost effective from manufacturing point of view. Future scope can be performing analysis on rectangular section and compare the results with hexagonal section boom.

7. REFERENCES

[1]M.Shaban, M.I.Mohamed, A.E.Abuelezz and T.khalifa, “Determination of stress distribution in crane Hook by caustic” , International journal of Innovative Research in Science ,Engineering and Technology , Vol. 2 , Issue 5 ,May 2013

[2]E.Narvydas, N, puodziuniene “Circumfrential stress concentration factor at the asymmetric shallow notches of the lifting hooks of trapezoidal cross-section”, ISSN1392-1207. MECHANIKA .2012 Volume 18(2):152-157.

[3]Spasoje Trifkovic , NebojsaRadic et . Al, “Stress analysis of crane hook using FEM” , INOTEH-JAHORINA Vol.10, Ref .C-2 ,p. 244-248 , march 2011.

[4]Yu Huali , H.L and Huang Xieqing , “Structure strength of boom with ultimate load by finite element method” , Proceedings of the International Multi-conference of Engineers and Computer scientists , 2009 Vol II IMECS 2009 , March 18-20 ,2009 ,Hong Kong.