ijrtsm
IJRTSM
INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT

"Design And Stress Analysis of Various Cross Section of Hook Using FEM Method By ANSYS"

Ankit Sahu[1], Dr. S.S.Chauhan[2], Asst. Prof. Ranjeet Kumar[3]

[1]*M.Tech. Scholar, Department of Mechanical Engineering, Vaishanavi Institute of Technology & Science, Bhopal, M.P., India*

[2] *Guide & Head, Department of Mechanical Engineering, Vaishanavi Institute of Technology & Science, Bhopal, M.P., India*

[3] *Co- Guide & Asst. Prof., Department of Mechanical Engineering, Vaishanavi Institute of Technology & Science, Bhopal, M.P., India*

ABSTRACT

The present thesis deals with the designing and analysis of a crane hook synthesized from High strength low alloy structural steel. Hook of crane is a curved bar to be used as a weight lifting mechanism the loads in cranes. Present document is prepared by analyzing four cross sections of crane hooks; rectangular, circular, trapezoidal and triangular. Designing of the hook is done through analytical method with different area of cross section and are analyzed for stress and flow of material (deformation) through FEA (ANSYS) software. The results lead us to the stress concentration area determination and thus the estimation of working life of hook.

KEYWORDS: *Stress, Deformation, FEA, FEM, Crane hook, ANSYS*.

I. INTRODUCTION

Crane elements

The structure strength is the important characteristic to respond the load bearing capability of the elevating equipment. Hook of a crane is a curved type of bar used for lifting the heavy loads in the cranes. In order to reduce the structure failure of a crane hook, induced stresses are analyzed. Fatigue damage is the initiation of crack due to fluctuating loads. It is caused due to stress levels which are insufficient to cause damage in a single application. It is a highly responsible and important component used for industrial applications.

Crane hooks are generally prone to failure due to concentration of stress. It is an element to elevate the loads in constructional sites and industries.

A crane is a kind of machine, loaded with a hoist, wire and ropes or chains and sheaves used to lift and move heavy materials. Some of the types of cranes are: overhead crane, mobile crane, telescopic crane, gantry crane, jib crane, deck crane, loader crane.

Hook is used to grab and lift the loads. It is a hoisting fixture designed to engage a ring or link of a lifting chain or the pin of a shackle or cable socket. These are designed for maximum performance without failure.

ISSN : 2455-9679
Impact Factor : 2.015

Hoisting is the process of lifting something or some load or person from lower position to higher position with the help of some device or mechanisms known as hoisting devices or mechanisms. The hoisting devices are used to lift or lower the load by assistance of drum or lift-wheel. The cranes may be manually, pneumatically of electrically operated and may use chain, fiber or wire ropes as its medium.
Hoisting part of a crane includes:

- Hoist motor
- Gear box
- Drum
- Pulleys
- Wire rope
- Hook

Fig 1.1 Crane model

Development of a hook is a long process which requires number of tests to validate the design and manufacturing variables. We have used CAE to shorten this development thereby reducing the tests. A systematic procedure is obtained where CAE and tests are used together. In fact, their use has enabled the automakers to reduce product development cost and time while improving the safety, comfort, and durability of the crane hook they produce. In this paper work is carried out on hook of any heavy crane. The objective of this work is to carry out computer aided design and analysis of hook. The material of the hook is Steel. The CAD modeling and finite element analysis is done in ANSYS ver 14.0.

II. MATERIAL ASSIGNMENT

Many industries manufacture Hook by steel material . These materials are widely used for production of hook and beams of different cross sections. Other than the load carrying capacity of hook, it must also be able to absorb the vertical load and deflection (induced due to variable loads). Ability to store and absorb more amount of strain energy ensures the safety of crane. The mechanical properties of steel has been shown in Table2.1below

ISSN : 2455-9679
Impact Factor : 2.015

Table 2.1 Mechanical Properties of Steel Hook

PARAMETER	Material selected	Young's Modulus (E)	Poisson's Ratio	Tensile Strength Yield	Density	Thermal Expansion	Cross section area	Applied Load
VALUE	Steel	2x10^11 N/m^2	0.266	2.5e+008 N/m^2	7860 kg/m^3	1.17x10^{-5} / °C	0.008m^2	4 Tonne (39240 N)

III. CAD MODELLING

CAD Modeling is the base of any project. Finite Element software will consider shapes, whatever is made in CAD model. The model of the four cross section of hook is prepared by using CATIA V5 R20 software. The 3D model of the Hooks shown in fig. 3.1 respectively

Fig. 3.1 Circular, Square, Curved and Modified Curved cross section Hook

IV FINITE ELEMENT ANALYSIS

The Finite Element Method (FEM) has developed into a key, indispensable technology in the modeling and simulation of advanced engineering systems in various fields like housing, transportation, manufacturing, and communications and so on. In building such advanced engineering systems, engineers and designers go through a sophisticated process of modeling, simulation, visualization, analysis, designing, prototyping, testing, and lastly fabrication. Note, that much work is involved before the fabrication of the final product or system. The Crane hook taken into consideration is having a load carrying capacity of 4 Tonnes with factor of safety 4.

ISSN : 2455-9679
Impact Factor : 2.015

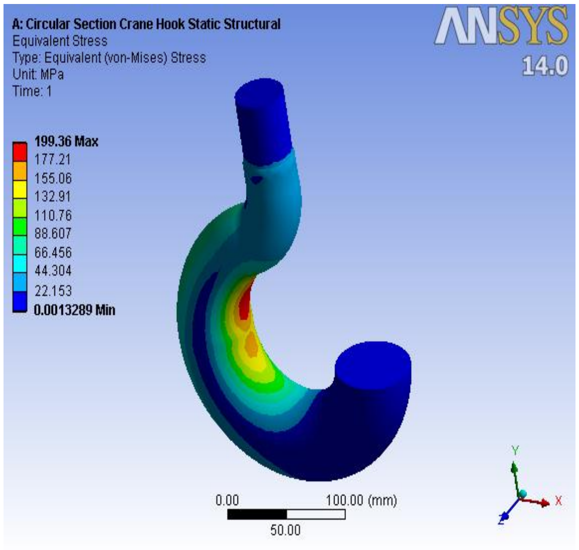


Fig. 4.1 Stress analysis on circular section

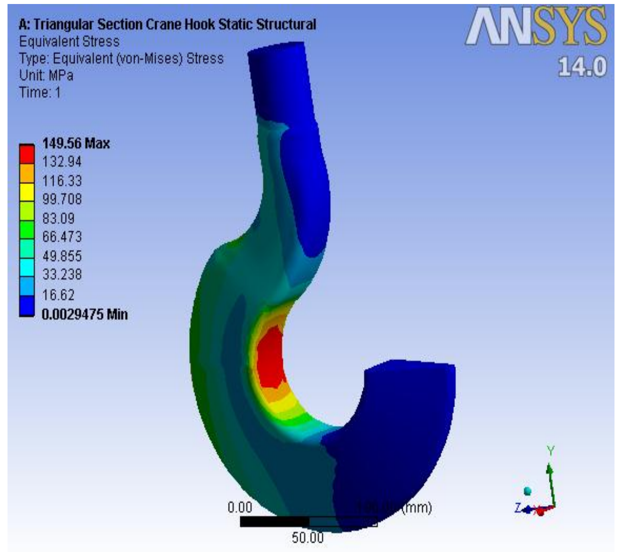


Fig. 4.2 Stress analysis on triangular section

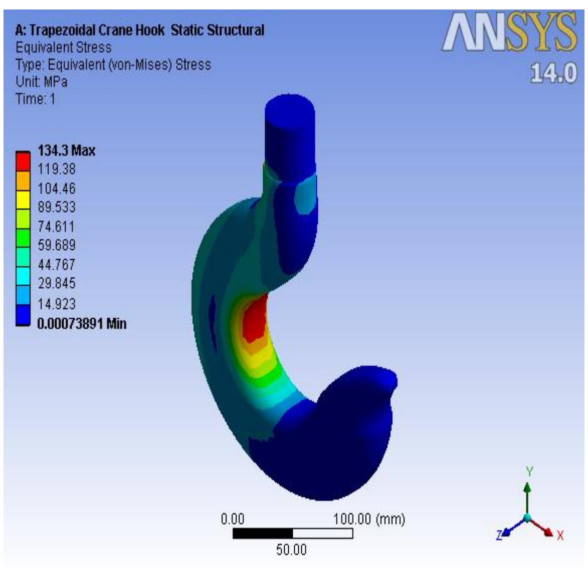


Fig. 4.3 Stress analysis on trapezoidal section

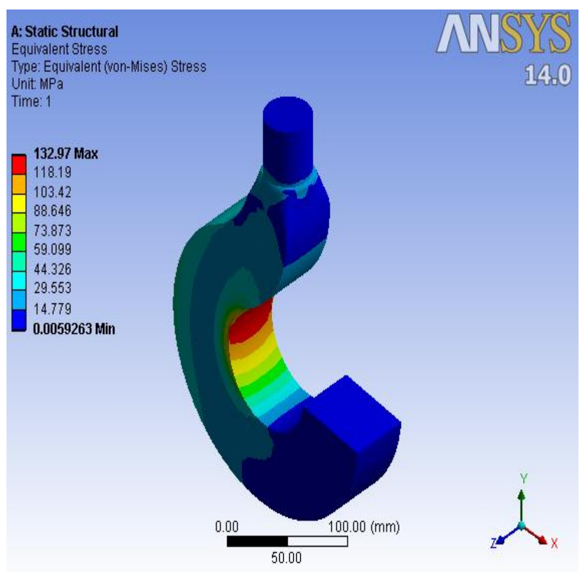


Fig. 4.4 Stress analysis on rectangular section

ISSN : 2455-9679
Impact Factor : 2.015

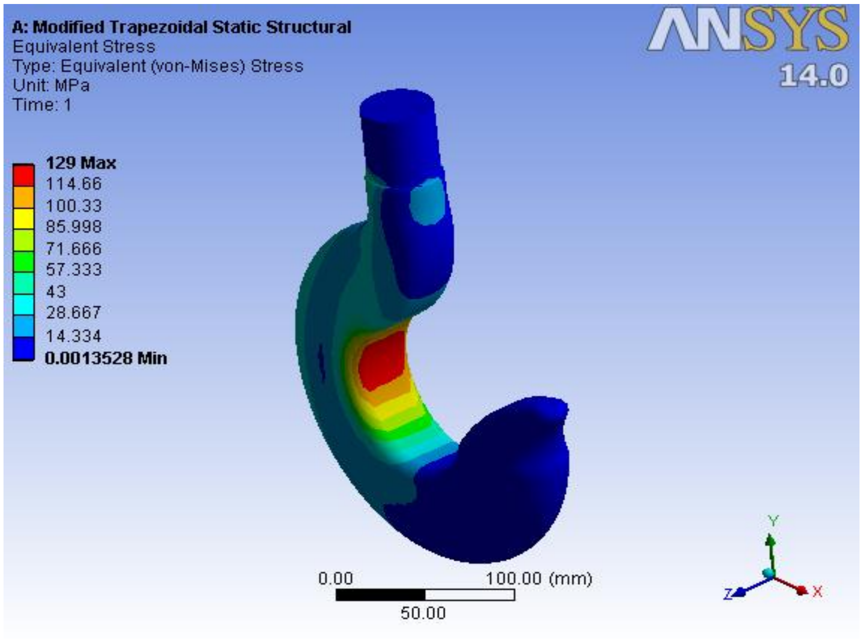


Fig. 4.5 Stress analysis on modified trapezoidal section

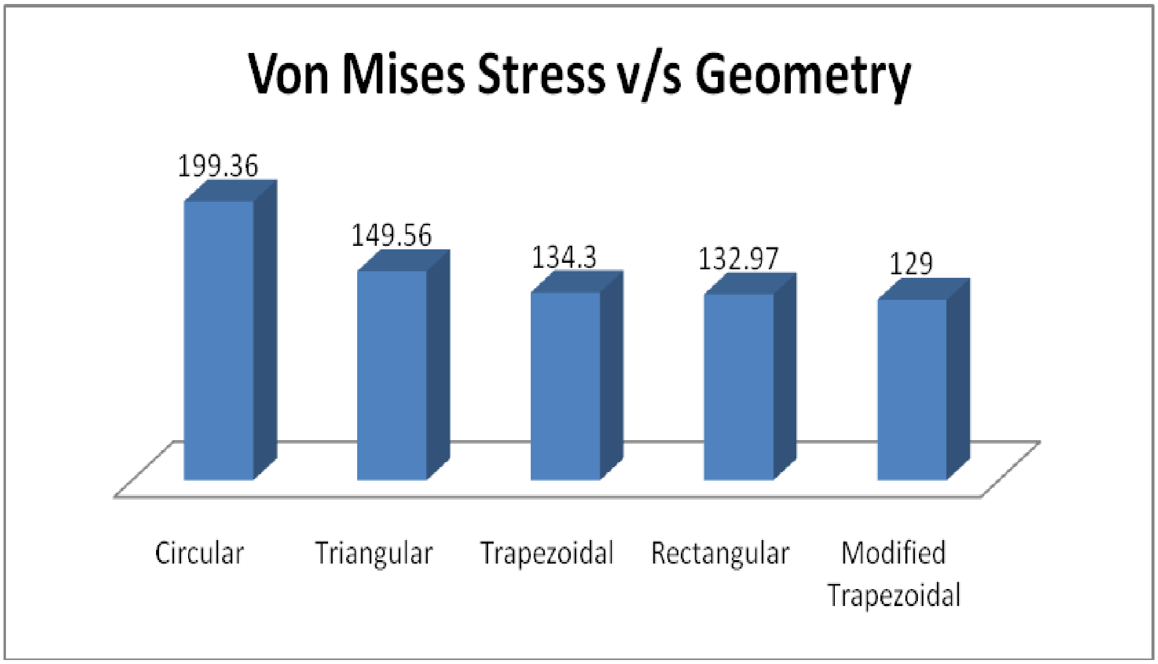
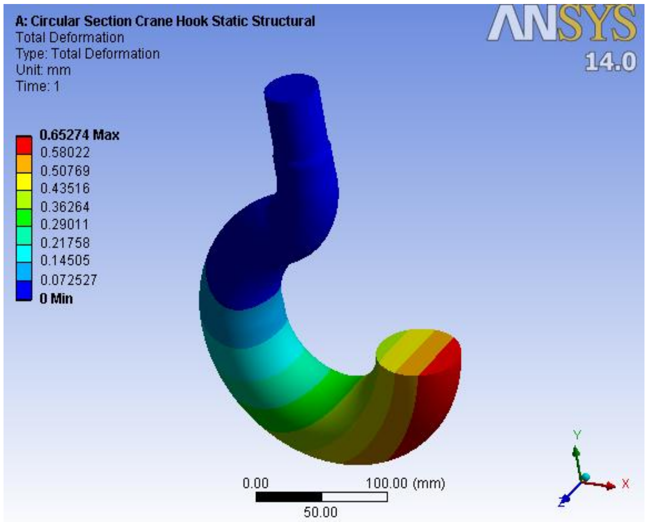


Fig. 4.6 Graphical comparison of Von Mises stresses of various geometries

ISSN : 2455-9679
Impact Factor : 2.015



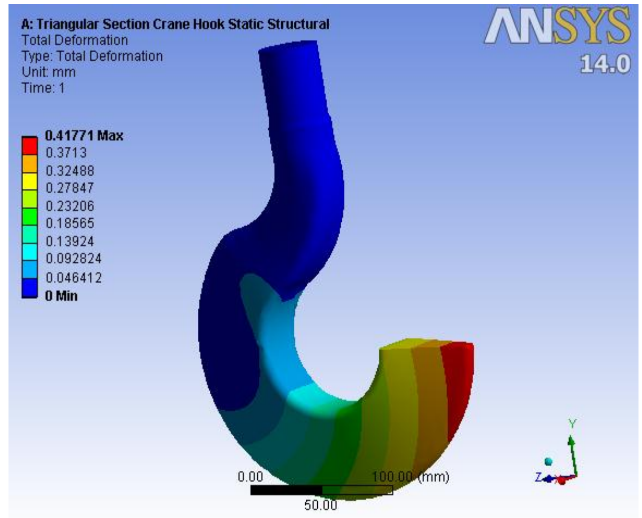
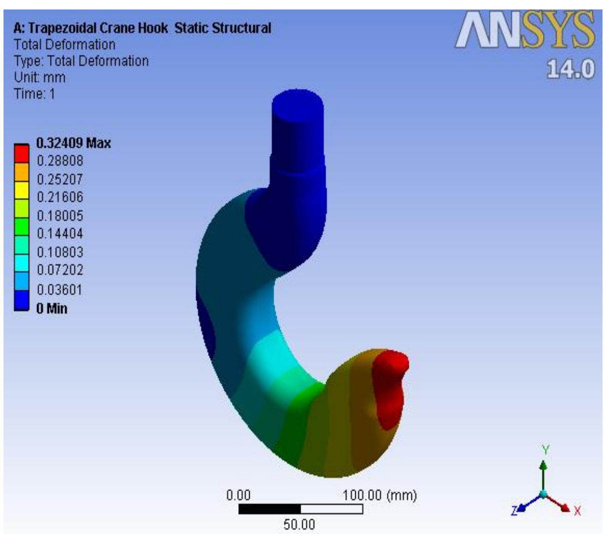


Fig. 4.7 Deformation analysis on circular section Fig. 4.8 Deformation analysis on triangular section



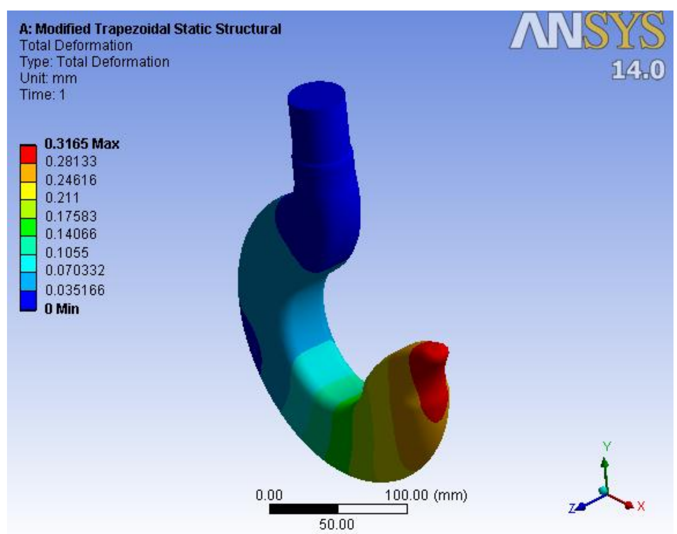


Fig. 4.9 Deformation analysis on circular section Fig. 4.10 Deformation analysis on circular section

 ISSN : 2455-9679
Impact Factor : 2.015

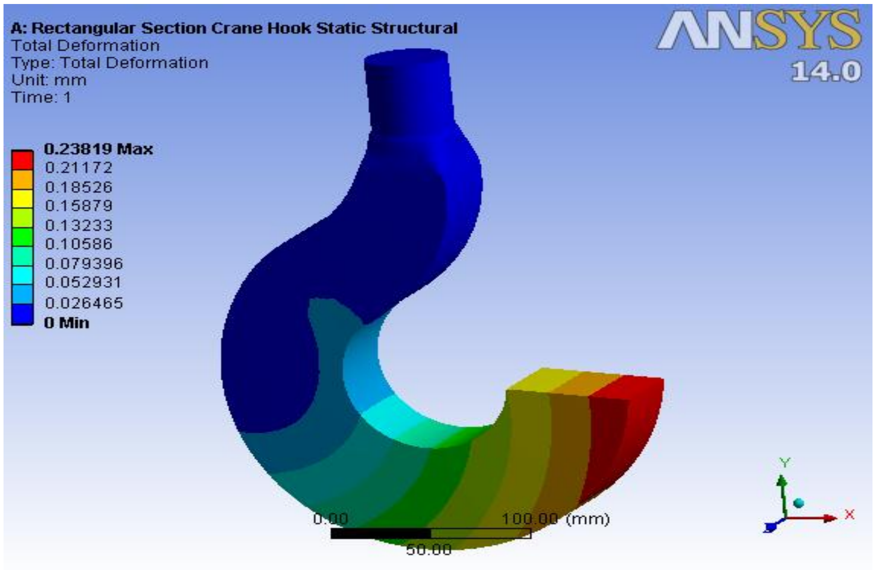


Fig. 4.11 Deformation analysis on circular section

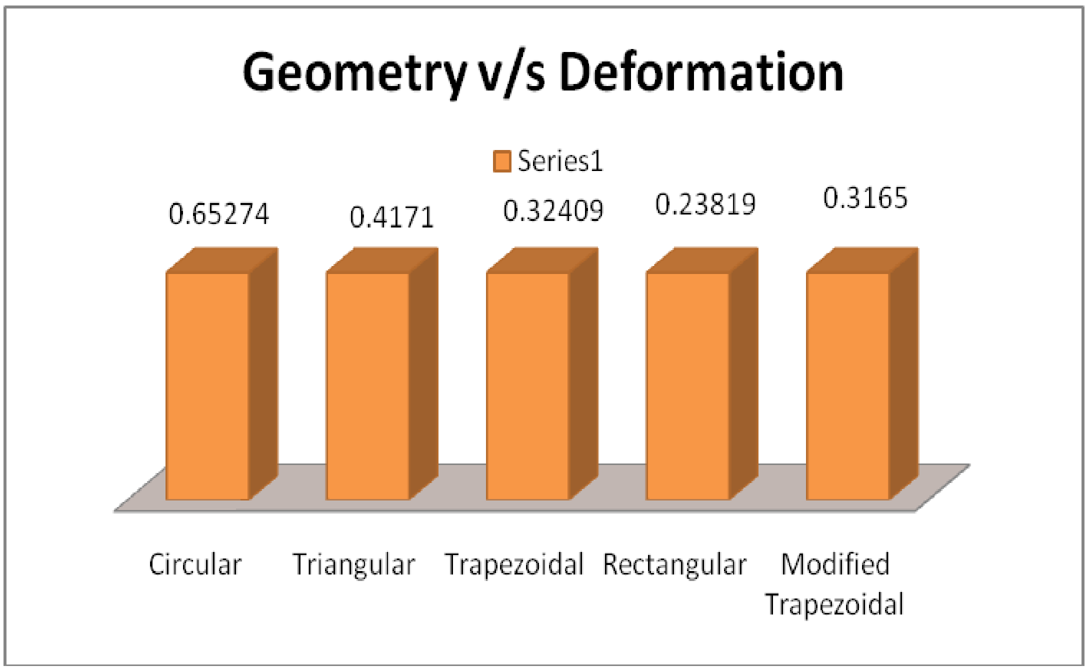


Fig 4.12 Graphical comparison of the deformation in various geometries

ISSN : 2455-9679
Impact Factor : 2.015

V. RESULTS & CONCLUSIONS

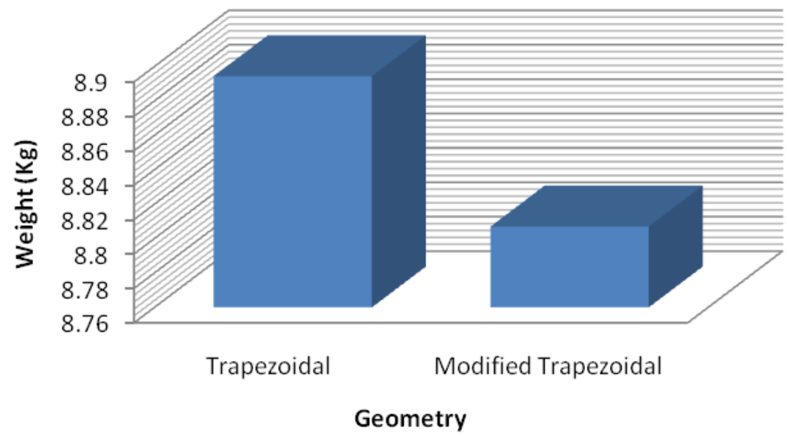


Fig 5.1 Graphical comparison of weights of trapezoidal and modified trapezoidal cross section

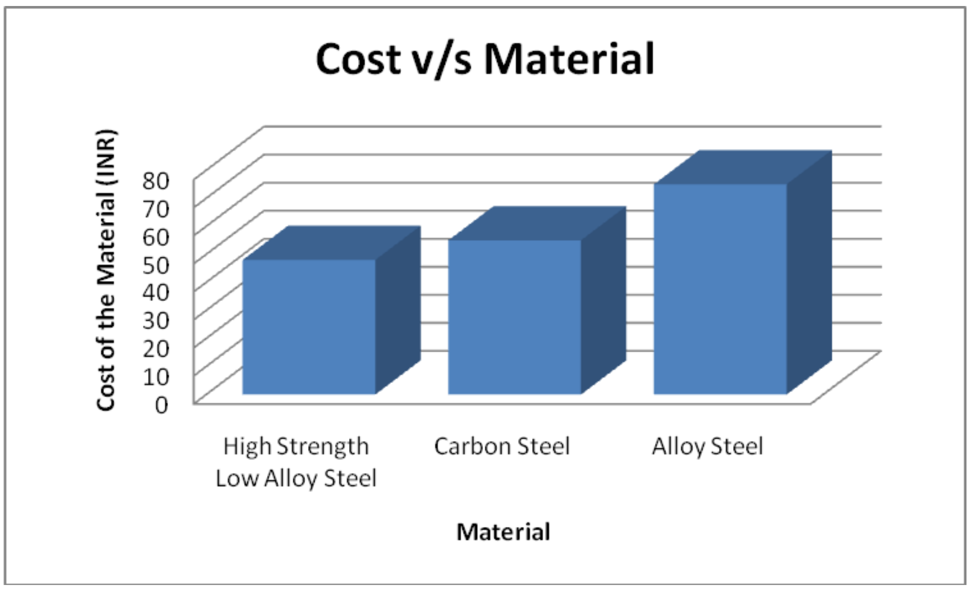


Fig 5.2 Cost comparison of various materials to design a crane hook

The analysis of the crane hook has been carried over FEA software. Drafting of the hook model is carried over ANSYS and analysed for maximum principal stresses and deformation in the hook. A load of about 4 ton is applied on the hook. Cross sections like circular, triangular, trapezoidal and rectangular are used to apply the load. A study was done on these models to see the effect of stresses and flow behaviour of the material due to change in cross sections and following result is obtained:

- Trapezoidal cross sections obtained with the minimum value of the principal stress of 129 MPa.
- It is also seen that the material flow in the case of trapezoidal cross section is also comparatively lower.

- Trapezoidal cross section is also studied along with some design modifications in it. Fillet radius is changed from 6mm to 14mm and it is observed that the magnitude of stress decreased considerably to 129 MPa and a decreased value of deformation in hook is also observed.

REFERENCES

[1] Spasoje Trifkovic' et al, "Stress analysis of crane hook using FEM", *Infoteh-Jahorina Vol. 10, Ref. C-2, p. 244- 248, March 2011.*

[2] Nishant Soni,"crane-hook shapes optimization and thermal analysis using finite element too" in *International journal of advanced and innovation research", ISSN: 2278-7844.*

[3] Pradyumnakesharimaharana, "Computer Aided Analysis and Design of Hoisting Mechanism of an EOT Crane", *.Thesis, National Institute of Technology Rourkela May- 2012.*

[4] Mr. A. Gopichand, Ms. R. V. S. Lakshmi, Mr. B. Maheshkrishna "Optimization of design parameter for crane hook using taguchi method" in *international journals of innovative research in science ,engineering and technology, vol. 2, Dec 2013, ISSN: 2319- 8753.*

[5] E.Narvydas, N.Puodziuniene, "Circumferential Stress Concentration Factor at the Asymmetric shallow Notches Of The lifting hook of trapezoidal cross-section" in *Mechanika, vol. 18(2), 2012, ISSN 1392-1207*

[6] Chetan N. Benkar, Dr. N. A. Wankhade "Finite Element stress Analysis of Cran Hook with Different Cross Sections" in *International Journal For Technological Research in Engineering, volume 1, Issue 9,May-2014, ISSN 2347- 4718.*

[7] M. Shaban, M. I. Mohamed, A. E. Abuelezz and T. Khalifa, "Determination of Stress Distribution in Crane Hook by Caustic" in *International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2 Issue 5, May2013, ISSN: 2319-8753*

[8] Apeksha. K. Patel, Prof. V. K. Jani, "Design and Dynamic Analysis of 70T Double Girder Electrical Overhead Crane" in *Journal of Information, Knowledge and Research in Mechanical Engineering Vol.2, Oct-2013, ISSN-975-668X.*

[9] Rashmi Uddanwadiker (August 26,2011):- *Stress analysis of crane hook and validation by photo elasticity.*

[10] C. Oktay Azeloglu, Onur Alpay"Investigation of a Lifting Hook with Different Method, Verification of the Distribution with Photo elasticity Experiments", in *Electronic journal of Machine Technology, vol-6, 2009, ISSN 1304-4141.*

[11] Takuma Nishimura, Takao Muromaki, Kazuyuki Hanahara, "Damage factor Estimation of Crane Hook (A database approach with Image, Knowledge and simulation)" in *Research publishing services, 2010, ISBN: 978-981-08-5118-7.*

[12] Chetan N. benkar, Dr.N.A. Wankhade (may 2014):-*Finite element stress analysis of crane hook with different cross-section.*