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"DESIGN AND STATIC STRESS ANALYSIS OF VARIOUS CROSS SECTION OF HOOK"

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ABSTRACT

In the industrial processes Crane Hook is used as lifting member. In the present paper crane hook of trapezoidal section is modeled in CATIA V5R20, then 4 ton load equivalent to 39240 N on it is applied. The location of maximum stress produced within the member is located and identified using Finite Element Method (FEM). 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

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.

Crane hook is the member used for lifting the mass using wire ropes and crane. In this paper we have used a CAD model of Trapezoidal section Crane Hook in CATIA V5R20 and assigned the material having mechanical properties of Steel hook used for manufacturing of crane hook. Finite Element Analysis is applied to find out the stress in the critical section where maximum stress is induced. The results obtained from Design of experiment is plotted to know the nature of the output parameters with respect to the varying parallel length of outer as well as inner surface. By this we established the relation

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between the cross section and the output parameters which are useful for selection of the cross section dimensions during manufacturing with respect to the desired output parameters

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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 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 17.0

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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

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

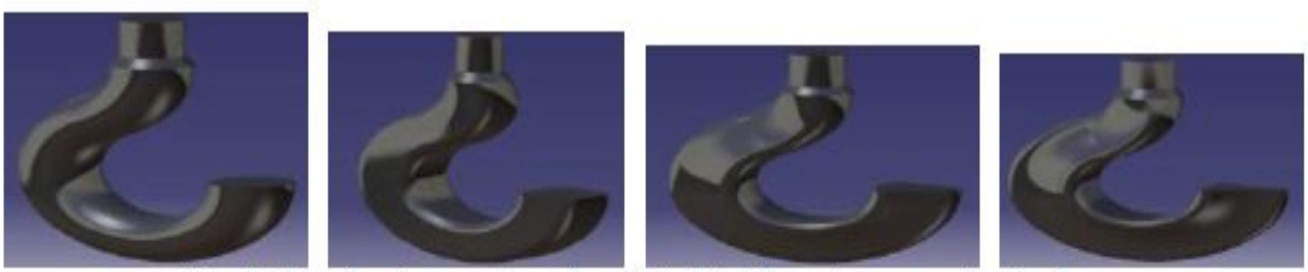

Fig. 3.1 Circular, Square, Curved and Modified Curved cross section Hook

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.

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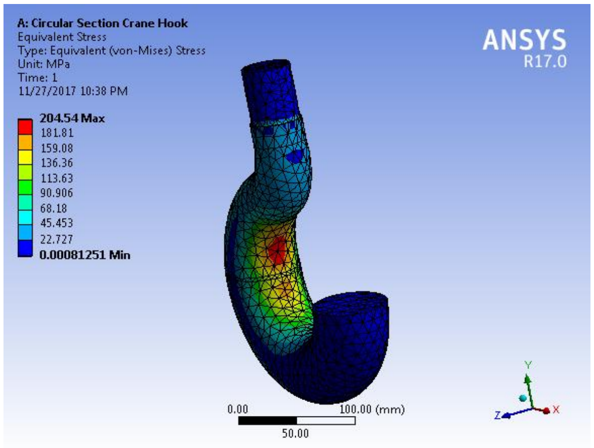

Fig. 4.1 Stress analysis on circular section

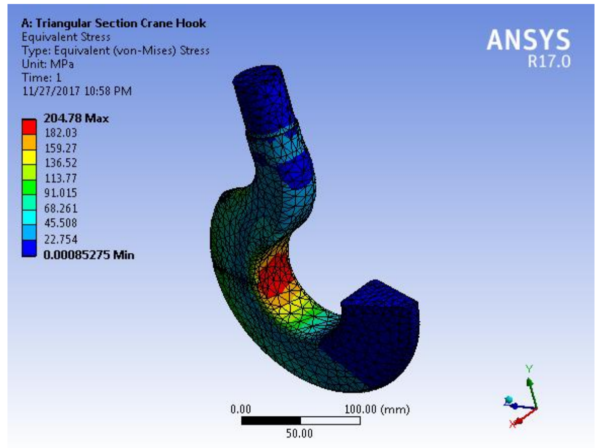

Fig. 4.2 Stress analysis on triangular section

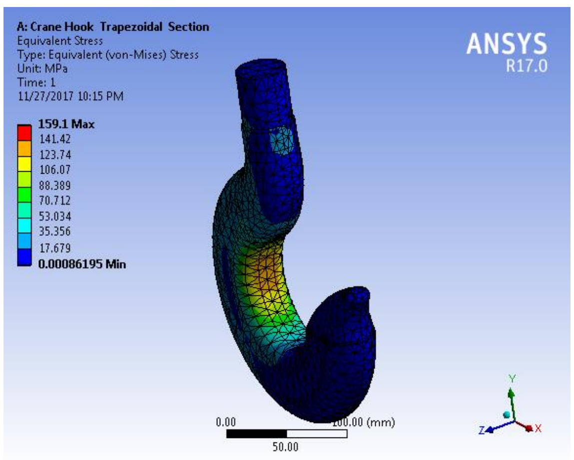

Fig. 4.3 Stress analysis on trapezoidal section

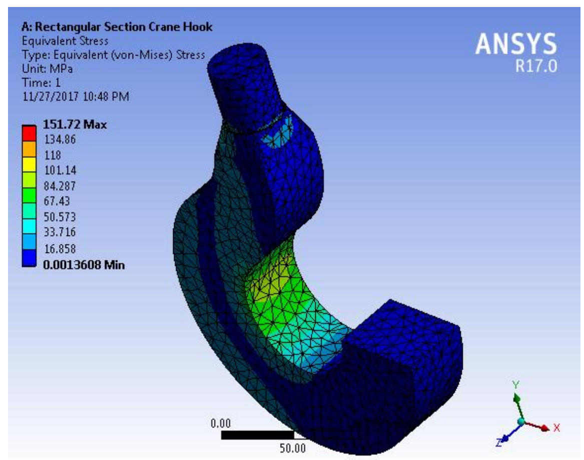

Fig. 4.4 Stress analysis on rectangular section

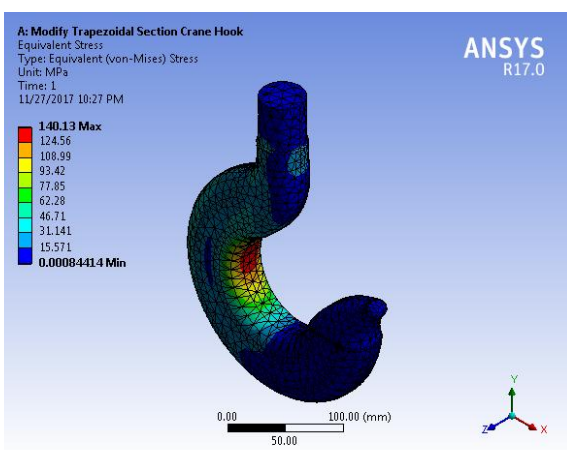

Fig. 4.5 Stress analysis on modified trapezoidal section

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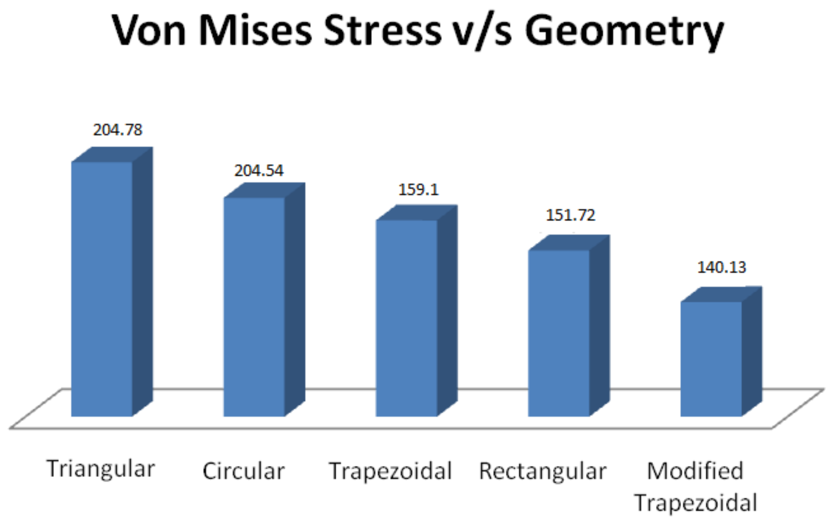
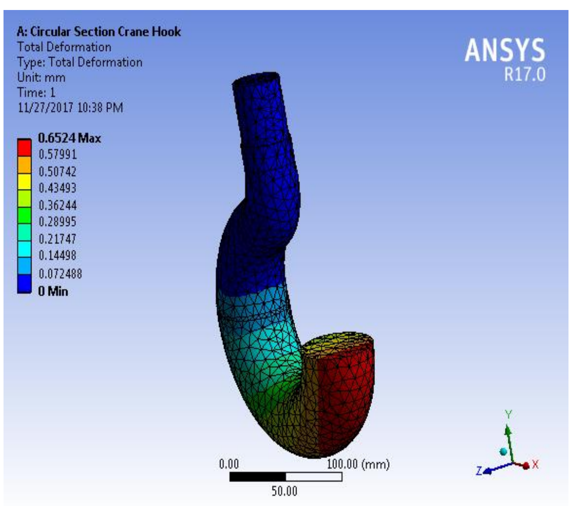


Fig. 4.6 Graphical comparison of Von mises stresses of various geometries



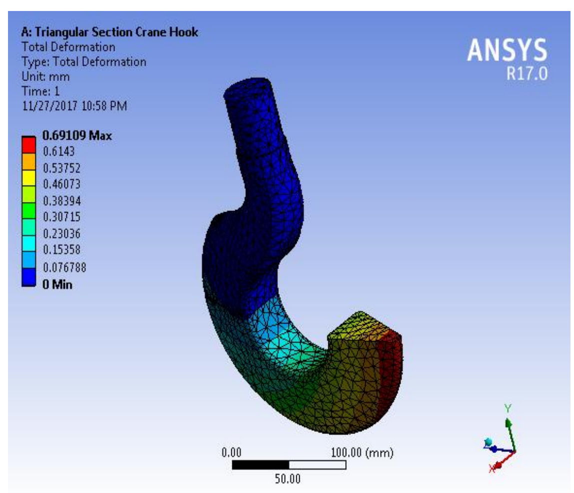


Fig. 4.7 Deformation analysis on circular section

Fig. 4.8 Deformation analysis on triangular section

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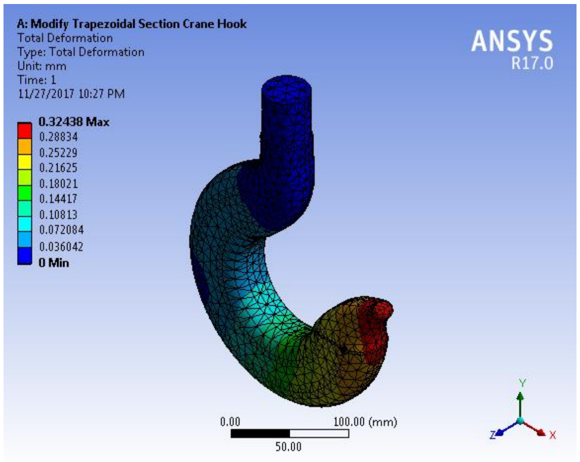

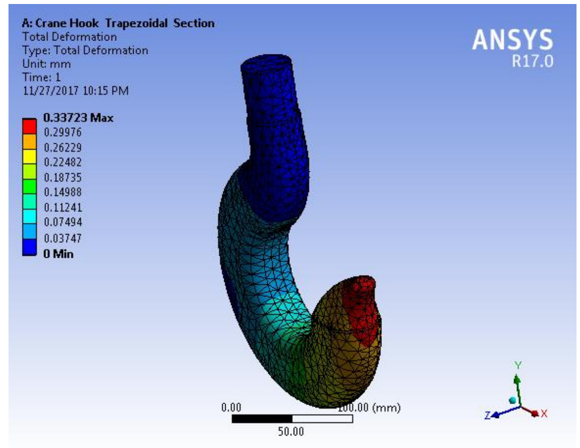

Fig. 4.9 Deformation analysis on trapezoidal section

Fig. 4.10 Deformation analysis on modify trapezoidal section

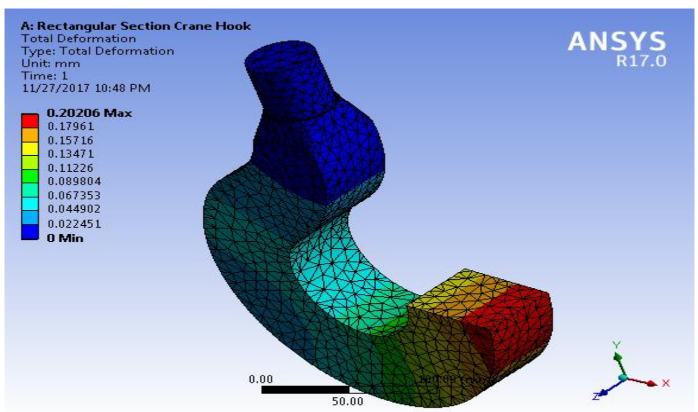

Fig. 4.11 Deformation analysis on rectangular section

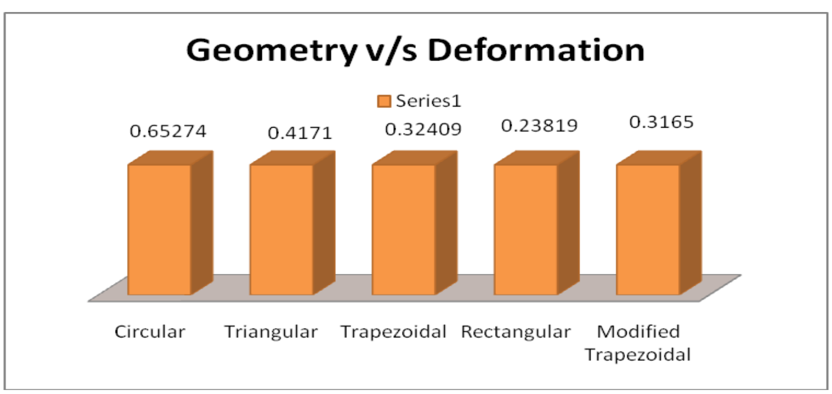

Fig 4.12 Graphical comparison of the deformation in various geometries

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V. RESULTS & CONCLUSIONS

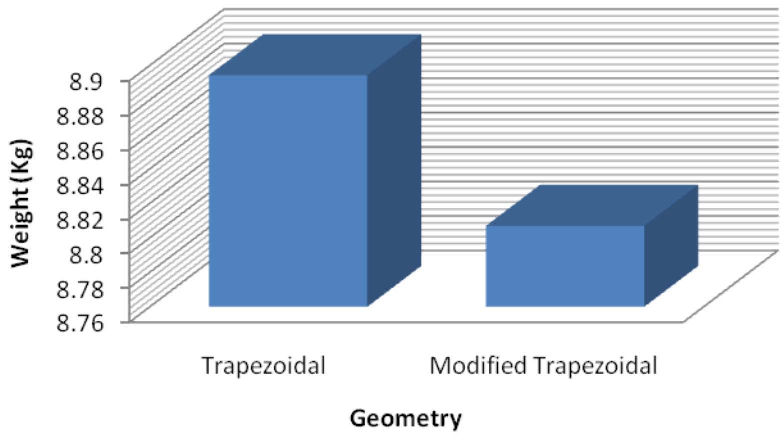

Fig 5.1 Graphical comparison of weights of trapezoidal and modified trapezoidal cross section

The analysis of the crane hook has been carried over FEA software. Drafting of the hook model is carried over ANSYS and analyzed 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 behavior 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 140.13 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 5mm to 12mm and it is observed that the magnitude of stress decreased considerably to 140.13 MPa and a decreased value of deformation in hook is also observed.

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