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STRUCTURAL ANALYSIS OF CRANE HOOK

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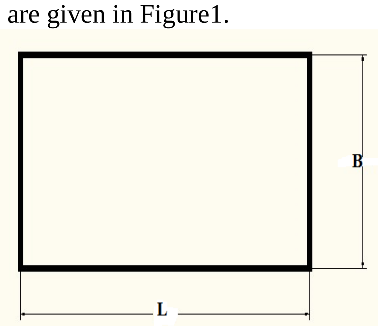
Abstract **-Crane hooks are highly liable components that are typically used for industrial purposes. Thus such components in an industry must be manufactured and designed in a way to deliver maximum performance without failure. Failure of a crane hook mainly depends on three major factors i.e. dimension , material , overload .The project is concerned towards increasing the safe load by varying the cross sectional dimensions of the three different sections .The selected sections are rectangular ,triangular, and trapezoidal . The area remains constant while changing the dimensions of the three different sections. The crane hook is modelled using PTC CREO software. The stress analysis is done using ANSYS 14.5 workbench. The normal stress along y direction, deformation along y direction and strain is considered. It is found that trapezoidal cross section yields maximum load of 700 kg for constant cross section area among three cross sections.**

Index terms – Crane hook , Structural analysis Trapezoidal , Safe load .

I. INTRODUCTION

A lifting hook is a device for grabbing and lifting loads by means of a device such as a hoist or crane. Such an important component in an industry must be manufactured and designed in a way so as to deliver maximum performance without failure. So, in order to minimize the stress distribution and deformation, the trapezoidal section is optimized to various dimensions. The area remains same while optimizing the dimensions. The inner width, height and the outer width of the crane hook are varied such that the cross section area remains constant. In this work, rectangular, triangular and trapezoidal sections are considered. The schematic representation of three sections are given in Figure1.



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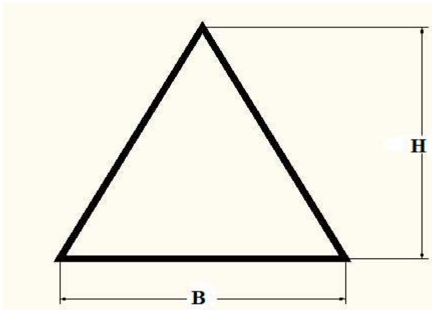

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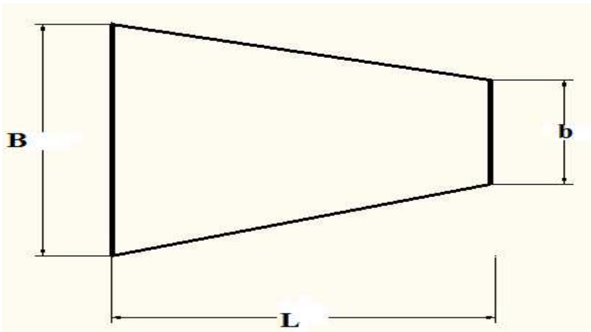

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Figure 1Schematic representationof(a) Rectangular(b) Triangular (c)Trapezoidal sections used in crane hook.

II. LITERATURE REVIEW

A.Gopichand and Lakshmi (2013)[1] have done optimization of design parameters for crane hook using TAGUCHI method .Here the optimization of design parameters is done using taguchi method, total mixed parameters are considered with mixed levels and L16 orthogonal array is generated .The analysis is done and the optimum combination of input parameters is determined for minimum von mises stress. Rashmi uddanwadiker[2] (2013) has made stress analysis of crane hook and the results are validated by using PHOTO ELASTICITY . The crane hook is modeled using modeling software and the analysis is done using ansys and the stress distribution and stress concentration factors in irregular geometries are determined using photo elasticity. Ajeet bergaley and Anshuman Purohit (2013)[3] made a structural analysis of a crane hook using finite element method. In this paper, a crane hook is purchased from the market for finite element analysis .The hook was tested in UTM machine in tension to locate the area having maximum stress and to locate the yield point. The hook is modeled in CAE software having dimension and material similar to the crane hook which was purchased from the market. The results obtained were compared with theoretical analysis.

III. MATERIAL PROPERTIES

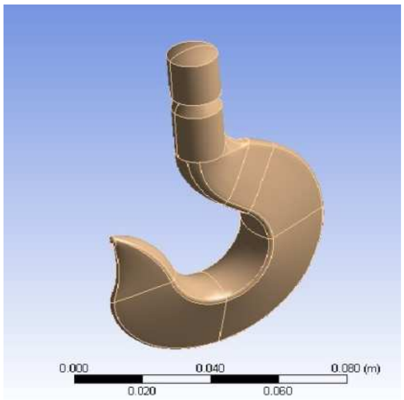
In this work, High strength low alloy steel (HSLA) is considered . HSLA steels contain relatively low levels of carbon of about 0.05%. It also contains other elements such as chromium, nickel, molybdenum, vanadium, titanium, and niobium. HSLA steels are resistant to atmospheric corrosion and are better suited to welding than carbon steel.

Table. IMechanical Properties of High Strength Low Alloy Steel

Properties	*Value*
Density	*7850 kg/m^3*
Tensile yield strength	*250MPa*
Poisson's ratio	*0.3*
Tensile ultimate strength	*460MPa*

IV. MODELING OF CRANE HOOK

The crane hook is modeled using PTC CREO using the dimensions given in the design data book (12) . The created solid model is imported in ANSYS for stress analysis. The three dimensional model of the crane hook for three cross sections is shown in the Figure 2.



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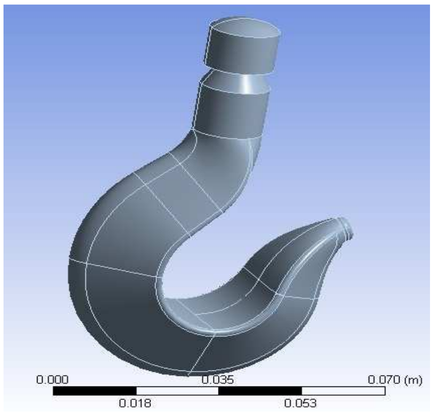

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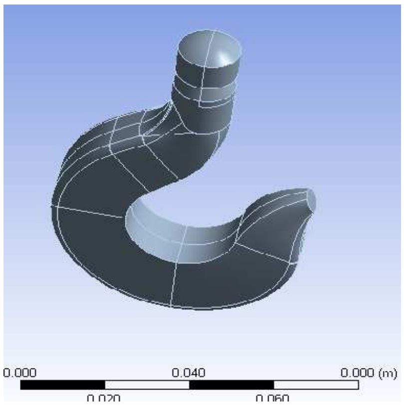

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Figure 2-Three dimensional model of the crane hook in (a)trapezoidal, (b)triangular and (c)rectangular cross section

V.STRUCTURAL ANALYSIS OF CRANE HOOK

The solid model of the crane hook is imported in ANSYS workbench. The material properties of the hook have been given. The model is meshed by taking an element size of 0.001. The boundary conditions and loading conditions are applied. The hook is fixed at the shank end and the load is applied as pressure over the curved surface of the hook. The

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analysis is performed and the normal stress along y direction, deformation along y direction and strain is considered for analysis. The tensile stress (σ_t) and compressive stress (σ_c) for three cross sections are given in Table 1 to 3 respectively. The stress values are considered for constant cross section area. The trapezoidal cross sections are considered as TP1, TP2, TP3, TP4 and TP5. The triangular cross sections are considered as TG1, TG2, TG3 and TG4.The rectangular cross sections are considered as RC1, RC 2, RC 3 and RC 4.

Table .II- Normal stress distribution of trapezoidal cross sectional crane hook

Section	*B (mm)*	*b (mm)*	*H (mm)*	*A (mm^2)*	*σ_t (MPa)*	*σ_c (MPa)*
TP1	*14.2*	*9.48*	*25.11*	*278.01*	*93.32*	*-36.4*
TP2	*15.2*	*7.46*	*25.11*	*276.85*	*96.1*	*-249.6*
TP3	*16.2*	*6.48*	*25.11*	*276.74*	*261.8*	*-717.3*
TP4	*17.2*	*5.20*	*25.11*	*277.45*	*305.8*	*-132.9*
TP5	*18.2*	*3.48*	*25.11*	*276.18*	*434.5*	*-343.6*

Table .III- Normal stress distribution of triangular cross sectional crane hook

Section	*B (mm)*	*L (mm)*	*A (mm^2)*	*σ_t (MPa)*	*σ_c (MPa)*
TG1	*27.04*	*21*	*276.99*	*266.75*	*-166.56*
TG2	*28.40*	*20*	*276.08*	*125.13*	*-101.91*
TG3	*29.89*	*19*	*276.38*	*248.2*	*-186.63*
TG4	*31.50*	*18*	*276.08*	*309.61*	*-215.67*

Table .IV- Normal stress distribution of rectangular cross sectional crane hook

Section	*B (mm)*	*H (mm)*	*A (mm^2)*	*σ_t (MPa)*	*σ_c (MPa)*
REC1	*19.9*	*14*	*276.44*	*311.25*	*-174.69*
REC2	*18.3*	*15.2*	*276.88*	*126.88*	*-64.596*
REC3	*16.4*	*17*	*277.08*	*241.94*	*-104.16*
REC4	*16*	*17.4*	*276.68*	*268.48*	*-139.25*

The stress distribution along y direction of rectangular cross section and trapezoidal cross section crane hook is given in Figure 3 and 4.

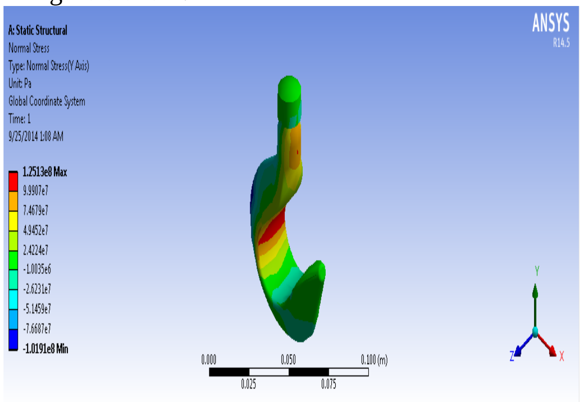

Figure 3-Stress distribution along y direction of triangular sectional crane hook

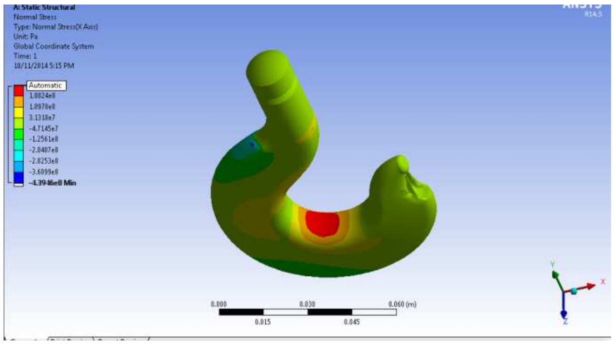

Figure 4 - Stress distribution along y direction of trapezoidal sectional crane hook

V. DISCUSSION

Comparing the stress distribution along y direction of all the three different cross sectional hooks, it is obtained that there is increase in the safe load in all the three sections while changing the cross sectional dimensions .The comparison of safe load values of the three sections are given in Table.V.

Table.V- Safe Load comparison of all the three different cross sections .

Section	*Obtained load*	*Section*	*Obtained load*	*Section*	*Obtained Load*
TP1	*700*	*TG1*	*495*	*RC1*	*450*
TP2	*600*	*TG2*	*640*	*RC2*	*550*

TP3	*500*	*TG3*	*500*	*RC3*	*500*
TP4	*435*	*TG4*	*480*	*RC4*	*495*
TP5	*410*				

From Table 4, it is observed that the safe load value of TP3 is 500 kg and the safe load values of TP1 and TP2 have 700 and 600 kg respectively. The safe load value of triangular section (TG3) is 500 kg and the TG2 section exhibits the safe load of 640 kg. For rectangular section, RC2 has a maximum safe load of 550 kg. Based on these results, it is found that trapezoidal cross section yields maximum load of 700 kg.

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