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Design and Stress Analysis of various cross section of Hook

Govind Narayan Sahu[1], Narendra yadav[2]
Department Mechanical Engineering
B.E. Scholar, Maha Maya College of Technology, Raipur Chhattisgarh India[1]
Asst. Prof., Rungta College of Engineering and Technology, Raipur Chhattisgarh India[2]

Abstract: *Hooks are employed in heavy industries to carry tonnes of loads safely. These hooks have a big role to play as far as the safety of the crane loaded is concerned. With more and more industrialization the rate at which these hooks are forged are increasing. This work has been carried out on one of the major crane hook carrying a larger load comparatively. The cad model of the crane hook is initially prepared with the help of existing drawings. It is then followed by implementation of modified cross section of hook in the static structural analysis workbench of catia v5. These results lead us to the determination of stress and deflections in the existing model. In order to reach the most optimum dimensions several models in the form of different dimensions of hook were tested and the most optimum dimension was selected. The selection was based on the satisfaction of several factors in the form of load carrying capacity, stress induced and deflection.*

Keywords: *Computer Aided Design (CAD), Computer Aided Engineering (CAE), Cross Section Area (CSA), Von Misses Stress (VMS).*

I. INTRODUCTION

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 CATIA V5R20.

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	$1.17x10^{-5}$ / ^oC	$0.008m^2$	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.

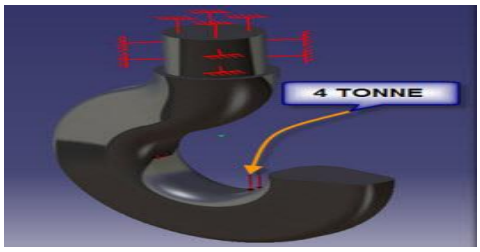

Fig. 4.1 Boundary conditions and application of load

FEA on circular CSA hook

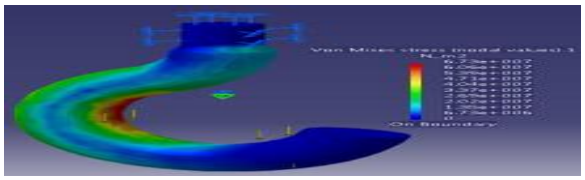

Fig.4.2 Stress Plot for circular CSA hook

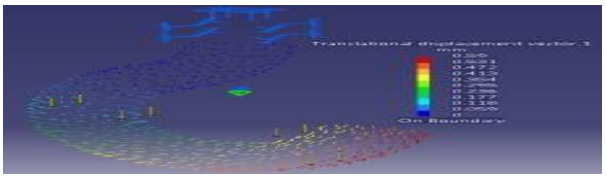

Fig. 4.3 Deflection Plot for circular CSA hook

FEA on rectangular CSA hook

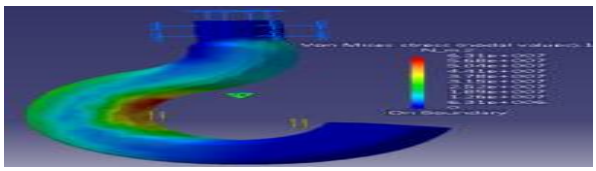

Fig. 4.4 Stress Plot for rectangular CSA hook

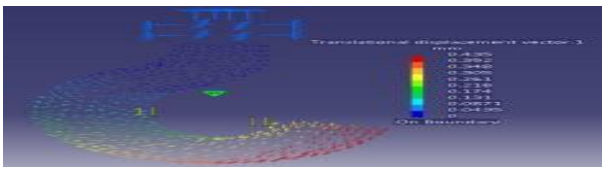

Fig. 4.5 Deflection Plot for rectangular CSA hook

FEA on curved CSA hook

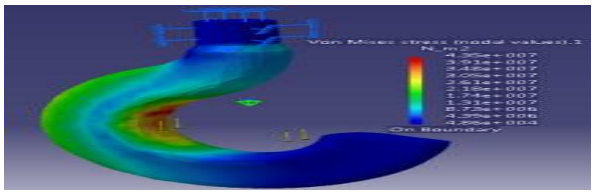

Fig. 4.6 Stress Plot for curved CSA hook

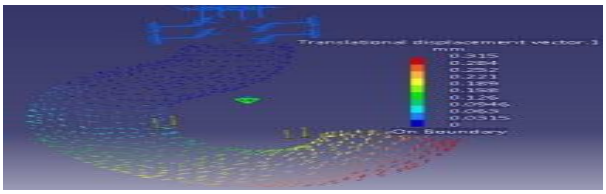

Fig. 4.7 Deflection Plot for curved CSA hook

FEA on modified curved CSA hook

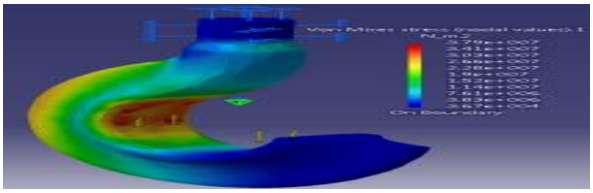

Fig.4.6 Stress Plot for modified curved CSA hook

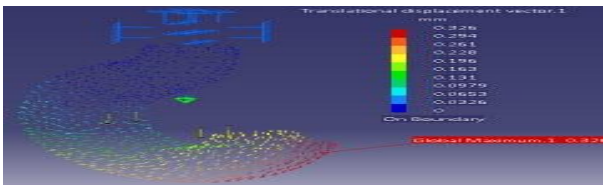

Fig.4.7 Deflection Plot for modified curved CSA hook

V. RESULTS & CONCLUSIONS

Stress induced and displacement in "Modified Curved Hook" is least because of curved shape and fillet edges as well as stress concentration are distributed uniformly. It have less mass due to this we are able to save the material and balance economy.

Table 5.1 Comparative Analysis for all hooks

Cross section	Mass (Kg)	V.M.S. (MPa)	Displacement (mm)
Square	45.108	63.1	0.435
Circular	50.203	67.3	0.590
Curved	51.798	43.5	0.316
Modified curved	45.725	37.9	0.326

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