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# Weight optimization of Crane hook having 8tons load capacity by Modifying cross section and comparison with various basic cross sections

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***Abstract— Crane hook is very basic and reliable component used in most industries. The design of crane hook contains such parameters like cross section of hook, material and radius of curvature. We have selected the cross section as a basic parameter to optimize the hook design which carries 8tons load. The design is generated in Creo2.0 and analyzed in ANSYS 15.0 workbench (FEM). By applying modified cross section in place of Standard Trapezoidal section of hook and considering Stress analysis, Weight optimization is carried out. The modified design is further compared with Trapezoidal, Triangular and Circular hook.***

***Keywords— Crane hook, Stress Analysis, Optimization of hook, FEM, Modified Cross section.***

## I. INTRODUCTION

A crane hook is designed to connect with chains and ropes attached to point loads like crates, construction beams, and machinery. The basic function of it is to lift the load, to carry it and to transfer it from one place to another. Sometimes an accident may occur due to stress concentration factor in it so stress analysis is necessary before make it applicable. Nowadays, the design and analysis both are carried out by softwares with the help of Advanced engineering. This article deals with the study of crane hook consists various cross sections as well as the modification of standard hook in which the weight optimization is done by changing cross section[1] and stress analysis is studied in ANSYS 15.0 [2]

## II. DESIGN OF HOOK APPLYING VARIOUS CROSS SECTIONS

The different cross sections are one of the important parameter while designing the crane hook.[3] The design for all cross sections is made in Creo 2.0 software using the advanced feature of Sweep Blend. All the dimensions are taken from standard design data book for 8tons load capacity.[4][5]

Fig 1 Design of Trapezoidal, Circular and Triangular cross sectioned hook

## III. ANALYSIS OF HOOK WITH RESPECT TO VARIOUS CROSS SECTIONS

The designed models are saved in .igs format and so can be imported in ANSYS workbench in which a Static structural analysis is carried out. The simulation process is then done which includes the generation of meshes by means of FEM(Finite Element Analysis) by taking Tetrahedron element.[6] A single point load (8 tons/ 78480N) is applied which is equally distributed throughout the selected surfaces and required results such as Equivalent stress, strain and total deformation is analysed. The material is selected by default as Structural steel having following characteristics[7]:

TABLE 1 - ENGINEERING MATERIAL PROPERTIES OF STRUCTURAL STEEL

| MECHANICAL PROPERTIES | VALUES | UNIT |
|---|---|---|
| YOUNG'S MODULUS | $2\times10^5$ | MPa |
| POISSON'S RATIO | 0.3 | - |
| SHEAR MODULUS | $7.6323\times10^4$ | MPa |
| DENSITY | 7850 | $Kg/m^3$ |
| TENSILE YIELD STRENGTH | 250 | MPa |
| TENSILE ULTIMATE STRENGTH | 460 | MPa |
| COMPRESSIVE YIELD STRENGTH | 250 | MPa |

 

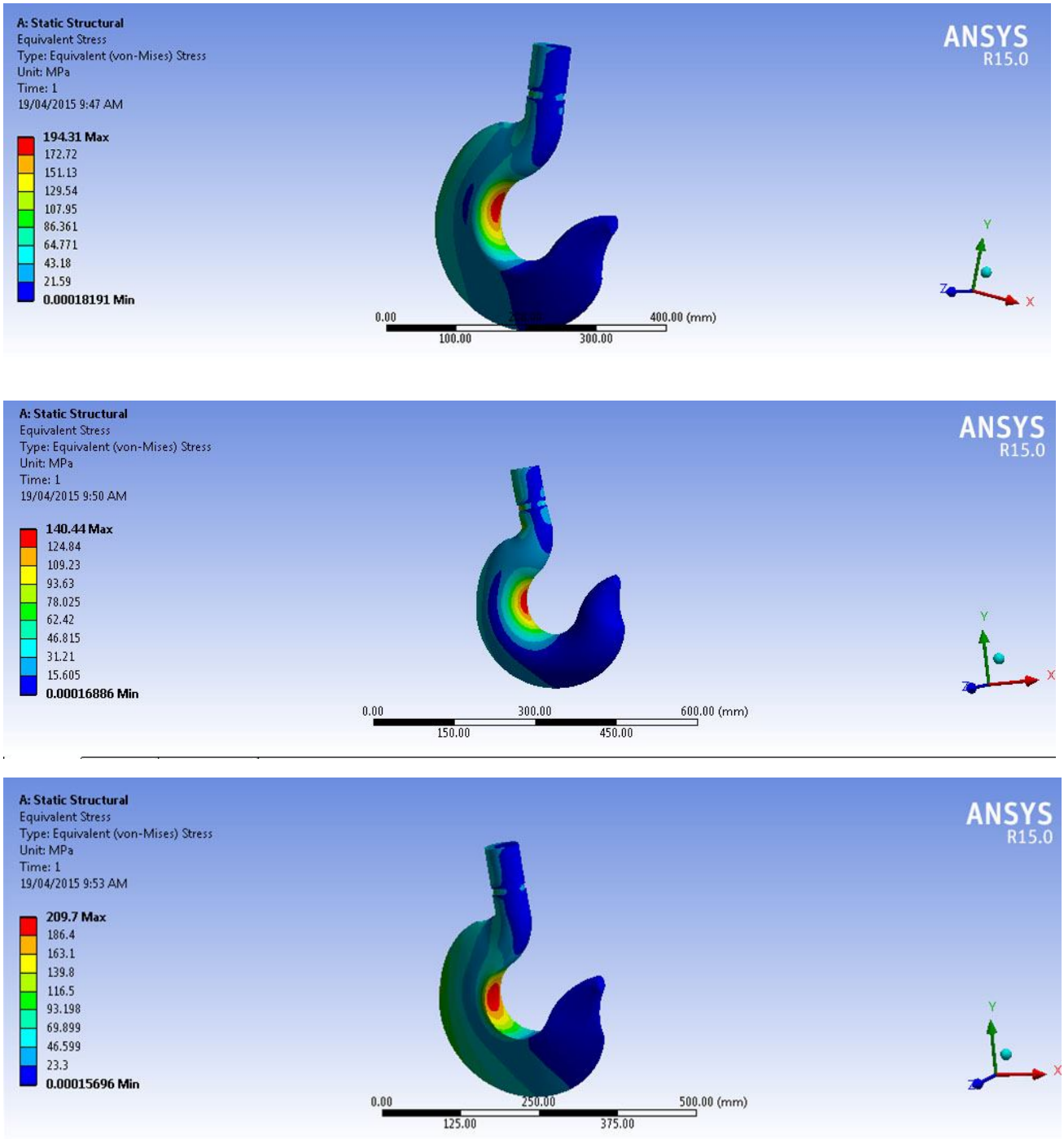


Fig 2 Analysis of Trapezoidal, Circular and Triangular cross sectioned hook

## IV. DESIGN AND ANALYSIS OF MODIFIED CROSS SECTIONED HOOK

The optimization is done by reducing the material with either having stress same or in its extreme limits. The mass and volume are reduced by reducing the material but an application remains same. The analysis of modified hook shows that stress is slightly increased compared to the standard hook by means of reducing the contact area but within limits i.e less than 250Mpa which means the design is safe and practically applicable. Fig 3 shows the comparison of cross sections between standard trapezoidal and modified hook.

 

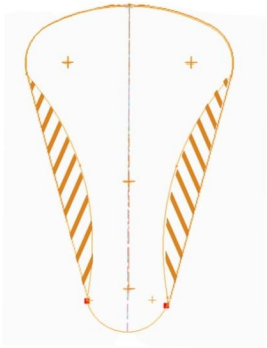

Fig 3 Modified cross section compared with standard section

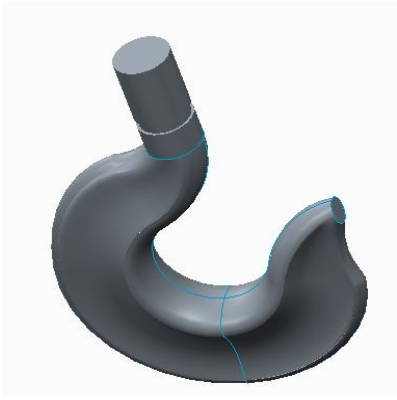

Fig 4 Design of Modified Cross sectioned hook

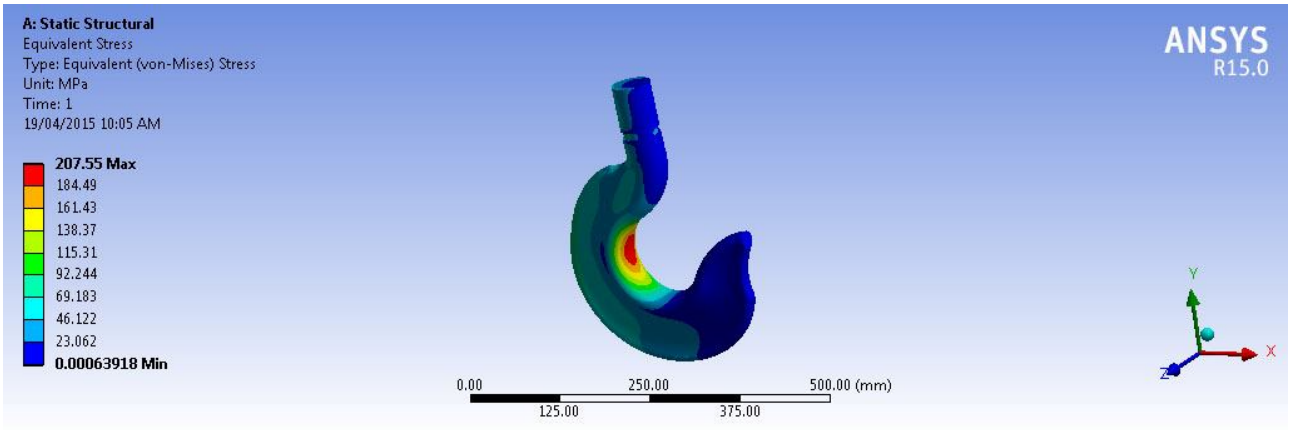


Fig 5 Contour plot of Modified Cross sectioned hook

## V. REPORT AND COMPARISON OF MODIFIED HOOK

The weight of modified hook is reduced by 2.483kg compared to the standard hook which shows the weight optimization of it. Fig 4 shows the report generated in Creo 2.0 software whereas Table 2 shows the comparison of different parameters for different cross sectioned hook[8].Fig 6 shows the comparison between properties of both, standard hook and optimized hook.

| Standard Hook | |
|---|---|
| Properties | |
| Volume | 2.2206e+006 mm³ |
| Mass | 17.432 kg |
| Scale Factor Value | 1. |

| Optimized Hook | |
|---|---|
| Properties | |
| Volume | 1.9043e+006 mm³ |
| Mass | 14.949 kg |
| Scale Factor Value | 1. |

Fig 6 Comparison of Standard Hook & Optimized Hook

TABLE 2
COMPARISON OF DIFFERENT PARAMETERS OF VARIOUS CROSS SECTIONAL HOOK

| Different cross sections | Max equivalent stress (MPa) | Max strain | Total deformation (mm) | Mass of hook (kg) |
|---|---|---|---|---|
| **Circular** | 140.44 | 0.007 | 0.3489 | 29.21 |
| **Triangular** | 209.7 | 0.001 | 0.7074 | 13.28 |
| **Trapezoidal** | 194.31 | 0.0009 | 0.5504 | 17.43 |
| **Modified Trapezoidal** | 207.5 | 0.001 | 0.6166 | 14.94 |

 

## VI. CONCLUSIONS

We have optimized the standard design applying various cross sections and the optimized cross section has been selected in which the stress is increased by 6.79% which is acceptable and the weight is reduced by 18% nearly which can be considered as optimize results.

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