Structural Analysis Of Eye Headed Crane Hook Of Different Cross Sections With Different Materials

K.Venu Vardhan [1], Eagala Raghavendra Yadav [2]
[1]dept Of Mechanical Engineering
[2]professor, Dept Of Mechanical Engineering
[1, 2] Aditya College Of Engineering And Technology ,Surampalem, Andhra Pradesh, India

Abstract- *The crane hook is a particularly responsible element and is always subject accumulation of large amounts of pressure that can eventually lead to your failure. In this article, the hook design is done with an analytical method and design for various materials such as wrought steel and high strength steel. After the analytical method and the modeling of the hook in the modeling software (pro-E). Modeling is done using the drawing Calculation of the hook analysis modeling is done in the FEA software (ANSYS). This result leads us to determine the pressure on the existing model. From predicting the stress concentration area, increases the lives of the winners and repeats the stress of failure. To study the draft of the crane hook in its loading state, a model of a sturdy crane hook is prepared with the help of the PRO-E software present study, to study the different design parameters and the standard stress of the crane hook in a charging state for different cross sections, the design and processing of the crane the hook will be prepared using ANSYS.*

With finite element analysis, anxiety which are to be formed in many cross-sections are compared with the drawing Calculation. Stress concentration factors are used in strength and durability evaluation of the structure and element of the engine. In this work, we also noticed parameter that affects weight reduction. To minimize the failure of the crane hook, the stress that is caused in this should be studied. A crane is subject to continuous loading and unloading. This can cause it the crane hook, but the load cycle frequency is too low. If a crack is created crane hook, especially in areas of concentration stress, can cause to connect and lead to serious accidents. In a ductile fracture, the crack spreads continuously and more readily detected and therefore preferred against brittleness fracture. In the fragile fracture, there is a sudden spread of the slit and the hook failure suddenly. Crane hooks are the components generally used for lifting weight and construction sites. Recently, crane excavators are widely used at the construction site.

Keywords- Crane hook , Forged Steel , Stainless Steel, Stress , Simulation.

I. INTRODUCTION

In industries, transport and constructional work crane hooks are the generally used components to lift the heavy loads. In constructional works site crane hooks are the widely used for excavators. The main reason is that excavator is much convenient operations for digging tasks and conveniently used for suspension works. Another reason is that there are jobs where the crane Trucks for suspension jobs are not available due to the tightness of the space. Generally, a bulldozer has superior versatility than a crane truck. Very little People have already worked on crane hook optimization. General hardware type and cross-section and radius are design parameters that affect the weight of the crane hook. Cast iron, structural steel is generally used as a construction Hardware for crane hook. The behavior of the mechanical properties of different types of steel in the high temperatures must be known to understand the behavior of steel and the structures that make up the fire. Very simplified material models are used to estimate, e.g. Structural strength of steel structures. In more methods, for example in finite element or finite element analysis it is important to use accurate hardware to get reliable results.

PRINCIPLE OF HOOKS

The crane hook is a very important component used for lifting the load with the help of steel chains or cables. The crane hooks are extremely responsible components and always subject to bending stresses leading to damage of the crane hook. To minimize the failure of the crane hook, the induced tension on the crane to study. A crane is subject to continuous loading and unloading. That can causes structural failure of the crane hook. This effort has been attempted which is done by looking at four different types of crane sections and is projected theoretically using the concept of the beam curve. CATIA software is used for the model of the crane hook and the ANSYS software used to detect trends. As a consequently, the results obtained from ANSYS and the theoretical calculations are comparison

FAILURE OF CRANE HOOKS

To minimize the failure of the crane hook, the induced tension on the crane must be studied. The crane is subject to continuous loading and unloading. This can cause fatigue crane hook failure, but the load cycle frequency is too low. If there is a crack which develops in the crane hook, especially in areas of concentration stress, can cause fracture and cause serious accidents. In ductile fracture, crack is constantly spread and is more easily detectable and therefore preferable fracture. In the fragile fracture, there is a sudden the hook suddenly fails. This type of crash is very dangerous because it is difficult detection. To aggravate aging of fragments due to continuous loading and unloading changes the microstructure. Bending stresses in combination with tensile stresses, weakening of the hook due to wear, plastic distortion due to overloading and Excessive thermal stress is some of the other reasons for failure. Consequently the continued use of crane hooks can increase the magnitude of these trends hook failure. All the above failures can be preventing if stress.

1.1 MARKING

- The manufacturer's identity must be forged, moulded or sealed in one low pressure area and not wearing the hook.
- Lifting hooks provided by the original lifting equipment manufacturer as an integral part of the lift assembly or the original lift manufacturer such as replacement hooks are not required by manufacturers.

1.2 ATTACHMENTS

The lifting hooks must be provided with a latch for the opening of the neck to prevent the accidental release of belts or accessories. Hooks can be used without a lock - special applications where the latch would obstruct its proper use provided that the use of the hook is limited to the application for which the hook is used Approved, and in disputed cases, competition is acquired by organization. If a handle or latch support is required welded to the hook, welding must be done before the final heat treatment.

1.3 MAINTENANCE

- One dead or lost hook should be repaired or replaced.
- A hook with a latch that does not bridle the neck opening must be removed until the lock is replaced or repaired and the hook is examined deformation with particular attention to the opening of the neck.
- A designated person will have to repair cracks, notches and jabs with sanding Longitudinally, following the contour of the hook, provided there is no dimension Reduced by more than 10% (or as recommended by the manufacturer) initial price.
- All other repairs must be carried out by the manufacturer or by qualified personnel. Spare parts, such as load handles for beam hooks, must be at least equal to specifications of the original manufacturer.

1.4 OPERATION

Hook users must do the following:

- Determine that the weight of the load to be lifted does not exceed the load classification of the hook.
- Avoid electrocution.
- Centre the load on the base (bowl or saddle) of the hook to avoid loading the hook.
- Do not use hooks to place a side load or back on hook.
- When using a device to tilt the opening of the hook neck, make sure it is not the part of the load is transferred from the bridge arrangement.
- Keep your hands and fingers between the hook and the load.
- • Place the double sided (sister) at corners equally on both sides, unless the hook designed specifically for one mission.
- Do not load the hole in the double sided (sister) hook beyond the nominal hook.

1.5 HOOK STANDARDS

- The design of the hook must meet the generally accepted hook design standards and be compatible with ASME B30.10 requirements.
- The hook material must have sufficient ductility to permanently deform before the room temperature at which the hook will be used.
- When a latch is provided, it should be designed to hold objects such as clamps in clearing conditions. The latch is not intended to carry the load.
- The cylindrical surfaces of the new hooks must be the bow of a circle. Calibre points or hook counters, to measure propagation after load testing.
- Hooks made in the field must meet the requirements of this section and must Approved by a qualified engineer.
- The hooks must not be loaded beyond nominal capacity, except for the duration of which they form part.

1.6. TYPES OF HOOKS

1.6.1 POINT HOOKS

It is a unique hook design that is made of high quality steel and is used especially with suspension of charges. It provides a wide range of hook points up to 10.5 tons of weight. Safety catches can be provided as an optional accessory and the length of the rod can be forged for its individual specifications.

Figure 1 Model of a crane for hook

Figure 2 Complete view of crane Hook

1.6.2 SHANK LIFTING HOOKS

The Crosby S319 Hoist Shank Hook 500 kg to 75 tonnes incorporate signals imported into the product addressed in two QUIC-CHECKS. Provided designed with deformation indices -Two strategically positioned signals, one just below the stem or the eye and the other within connection, which allows a QUIC-CHECK measurement to determine if the opening of the neck changed, indicating abuse or overload.

Figure 3 shank lifting hooks

1.6.3 RAMSHORN HOOKS

The double hook design makes it ideal for use with two belt straps; this design helps a lot with load distribution, avoids any damage to the lift cover and prevents choking on the hook. Ram-wreath the hooks are usually used with heavy cranes and are well-spaced containers and embarkation ports.

Figure 4 Ramshorn hooks

1.6.4 CLEVIS LIFTING HOOKS

A hook is a hook consisting of a keys, wedge and spike. The helmet is a U-shaped piece with holes in the end from the pins to accept the pin from the chassis. The pin of the stem is similar to a bolt, but it is only partially threaded or non-threaded cross-section for a spacer pin. The spike is a piece that fits into the space in the plate and is held in place by the frame pin. The combination of a simple trap that is provided with a pin is usually called a bracket, although a contract and a pin are just one of the many ways you can get a nail.

II. LITERATURE SURVEY

[1] Crane hook is a prominent component used for lifting the loads. They often undergo failure due to stress concentration. Hence a study on stresses induced in them helps us better understand how to prevent failure. The aim of the present work is to design a crane hook of different materials and calculate the von mises stress distribution and total deformation when load is applied at an ambient temperature of 25°C. This work gives us an insight on deformation and stress distribution in hooks of different materials, used for lifting in practical scenarios (under normal working conditions).

[2] 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.

[3] Crane hooks are one of the important components which are used to transfermaterials having heavy loads, mainly in industries. Crane hooks are liable components subjected to failure due to stress in accumulation of heavy loads. Failure of a crane hook mainly depends on three major factors i.e. dimension, material, overload. The design parameters for crane hook are area of cross section, material and radius of crane hook. In this project the design of EOT crane hook has been carried out. The dimensions of the hook have been determined for a load capacity between 9 to 12.5 Tones for Trapezoidal, Rectangular and Circular cross-sections. These dimensions are calculated on the basis of design criteria i.e. keeping area same for all cross-sections. After the analytical i.e. theoretical calculations, ANSYS 15 is used to calculate the deformation, stress and strain for all three cross-sections for different loads. The stresses obtained by theoretical method and by software are in good agreement. The model prepared is used for further studied with different loads and also for different materials. Index Terms: Lifted load, Eye diameter of hook, Direct stress, Bending stress, Equivalent stress, Deformation, Strain

[4]. Stress analysis plays an important role in the design of structures like crane hook under loading conditions. Crane hook is a reliable lifting component being used in industries. Structure failure of crane hook occurs because of the stress induced due to repetitive loading and unloading conditions. In this study, solid modeling of crane hook having trapezoidal cross-section referring to one of its existing design is done using SOLIDWORKS. Further, analyses are carried out in ANSYS Workbench and nCode DesignLife. The lengths of two parallel sides of the cross-section of crane hook are varied and different candidates are obtained for loading capacity of 30 ton on the basis of Mass, total Displacement and Von-Mises stress.This is done to reduce weight and balance economy. Further, out of these candidates, best candidates are considered and fatigue analysis is performed on these candidates.

[5] 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.

[6] In this paper the crane hook is designed by analytical method and design is done for the different materials like ASTM grade 60(grey cast iron), high strength low alloy steel, structural steel, SAE 1040 and wrought iron. After the analytical method, by using modeling software (CATIA) the design and modeling of crane hook is done. Then analysis of hook is done in FEA software (ANSYS) with different materials. Stress in existing model is determined by the result obtained from ANSYS. By predicting the stress concentration area, the hook working life increase and reduce the failure stress.

[7] 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 NX-UG and analyzed in Hypermesh (FEM). In this project we have compared the circular cross section with trapezoidal cross section.

[8] In this paper the design of the hook is done by analytical method and design is done for the different materials like forged steel and high tensile steel. After the analytical meth-od design and modeling of hook is done in modeling soft-ware (solid edge) .The modeling is done using the design calculation from the modeling the analysis of hook is done in FEA software (ANSYS).This result lead us to the deter-mination of stress in existing model. By predicting the stress concentration area, the hook working life increase and re-duce the failure stress

[9] Crane hooks are highly liable components that are typically used for industrial purposes. Failure of a crane hook mainly depends on three major factors i.e. dimension, material. In this paper load carrying capacity is studied by

varying the cross sections. The selected sections are I-section and T-section. The area remains constant while changing the dimensions for the two different sections. The crane hook is modelled using SOLIDWORKS software. The stress analysis is done using ANSYS 14.0 workbench Educational version. It is found that T cross section yields minimum stresses at the given load of 6 ton for constant cross section area among two cross sections. The stress distribution pattern is verified for its correctness on model of crane hook using Winkler-Bach theory for curved beams.

III. PREPARATION OF CAD MODEL HOOK:

To create the CAD model of the crane hook, quite geometric and the dimensions are selected. Some features are approximate for simplification. Pro-E Wildfire 5.0 software is used to create a solid hook model. Scanning curve the advanced Pro-E function is used. The complete solid CAD model is prepared and stored in .igs format. Similarly for All the required CAD profile model is created. PTC Creo, formerly known as pro / ENGINEER is a parametric and integrated 3D CAD / CAM / CAE solution created by Parametric Technology Corporation (PTC). He was the first in the market parametric software, modeling of solid models. The application runs on the Microsoft Windows platform and provides stable modeling, assembly modeling and processing, finite element analysis, direct and parametric modeling, surface subdivision and nurbs, and NC and tool functionality for mechanical engineers. It has a set of 10 applications that work within program.

The name Pro / ENGINEER changed to Creo Elements / Pro, also known as Wildfire 5.0 on October 28, 2010, coinciding with Creo's PTC announcement, new software application package design. Creo Elements / Pro will stop after version 2 in favour of the Creo design suite. Creo Elements / Pro and now Creo Parametric compete on the market with PRO-E and Siemens NX. Creo Elements / Pro (formerly Pro / ENGINEER), PTC's 3D parametric CAD / CAM / CAE solution is used by discrete ones Manufacturers of mechanical engineering, design and manufacture. Pro / ENGINEER was the first restriction based on industry rule (sometimes called "parametric" or "variant" 3D modeling system). The parametric modeling The approach uses parameters, dimensions, resources and relationships to record behavior of the intended product and generate revenue that allows design automation and optimizing product design and development processes.

This plan this approach is used by companies whose family or family-based product strategy where an editorial design strategy is critical to success, the design process, incorporating mechanical constraints and relationships project or where the resulting geometry can be complex or based on the equations. Creo Elements / Pro provide a complete set of designs, analysis and production on an integrated and scalable platform. That's all required features include Solid Modeling, Surface, Rendering, Data Interoperability, Route Planning, Simulation, Tolerance Analysis and NC and tool design.

Creo Elements / Pro can be used to create a complete 3D digital model processed goods. The models consist of data from solid 2D and 3D models that can is also used downstream in finite element analysis, rapid prototypes, design and manufacture of CNC.

All data is cooperative and interchangeable between CAD, CAE and CAM modules without conversion. One product and one A complete BOM can be accurately formed with a fully correlated relationship technical drawings and revision control information. The cooperative the functionality of Creo Elements / Pro allows users to make design changes at any time during the product development process and automatic update downstream products. This feature allows for simultaneous design, engineering analysis and construction that work in parallel - and simplifies product development processes.

TRAPEZOIDAL CROSS-SECTION CRANE HOOK CREATED BY PRO-E

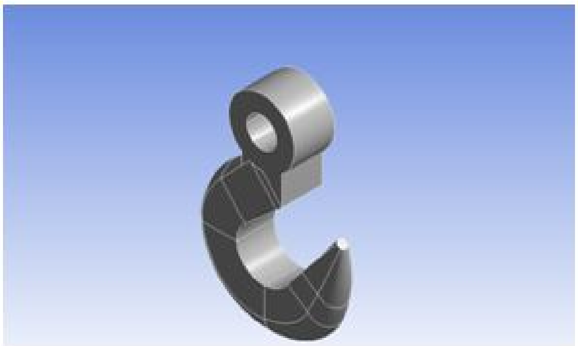

Figure 5 TRAPEZOIDAL CROSS-SECTION CRANE HOOK CREATED BY PRO-E

5.3. CIRCULAR CROSS-SECTION CRANE HOOK CREATED BY PRO-E

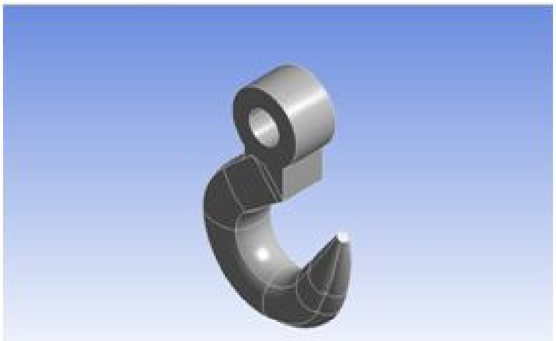

Figure 6 CIRCULAR CROSS-SECTION CRANE HOOK CREATED BY PRO-E

RECTANGULAR CROSS-SECTION CRANE HOOK CREATED BY PRO-E

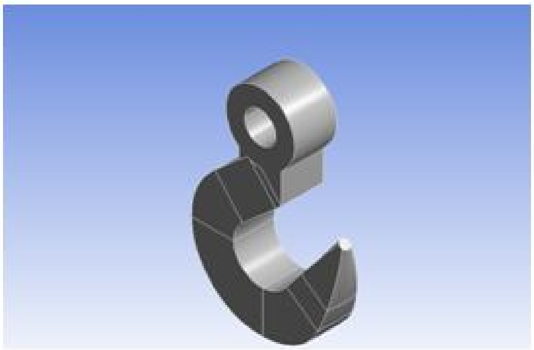

Figure 7 RECTANGULAR CROSS-SECTION CRANE HOOK CREATED BY PRO-E

IV. ANALYSIS OF CRANE HOOK

The finite element method is used to solve partial differential equations numerically. Almost all natural phenomena are formed using differential equations and in most cases equations are very complex to solve methods. The finite element method approach is to divide the area of interest in smaller elements, finite elements. Instead of looking for one area-wide approach, an approach that applies to a small one part of the area is used. Smaller parts are bound to their limits, which makes it possible to build a system of global equations that describes it behavior of the whole area. It is a characteristic behavior of the finite element that as the number of finite elements used to describe a problem is the approach error is reduced. The finite element method can which will be used to solve differential equations describing the flow of underground, electrical flow, laminar flow in pipes and many other physical engineering problems.

This module expresses the FE analysis process, Structural diagram of a typical finite element computer program. Before you sign in program pre-processor, the user must have designed the template and necessary data. In the pre-processor block, you set the model through commands available in the pre-processor. The definition includes importing and creates all the points on the node. ANSYS is a finite element tool that provides powerful design and analysis software package. ANSYS mechanical software is a complete FEA (finite element) tool for structural analysis, including linear, non-linear and dynamic studies. The engineering simulation product provides a complete set of elements behavioral modeling, material models, and solution solutions for equations across a wide range of mechanisms problems. In addition, ANSYS Mechanical offers thermal protection conjugated physics capabilities including acoustic, piezoelectric, thermal-structural and thermoelectric analysis. It is considered by many researchers and engineers as modern, expensive, durable and visually sensitive tool to provide solutions many mechanical and scientific problems.

4.1. MESH GENERATING OF TRAPEZOIDAL CROSS SECTION BY ANSYS

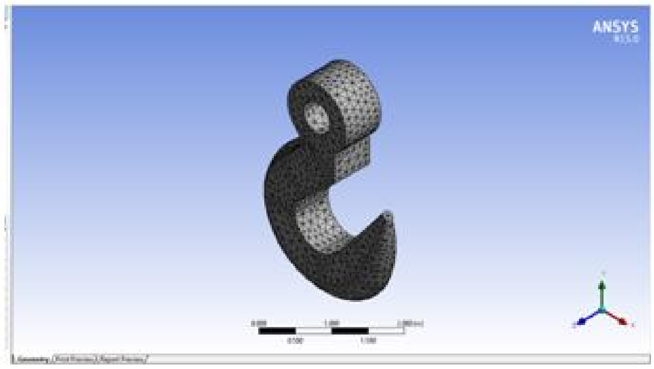

Figure 8 MESH GENERATING OF TRAPEZOIDAL CROSS SECTION BY ANSYS

4.2 WHAT IS VON MISES STRESS

Von Mises stress is widely used by designers to determine if their design will be can withstand a specific load condition

$\sigma 2$ =min stress

σy = yield stress

FS= Factor of safety

Von Mises stress is considered a safe haven for design engineers. Using this information that an engineer can say that your project will fail if the maximum value of Von Mises's stress caused by the material is more than the strength of the material. Projects well in most cases, especially when the material is pliable in nature. One of the easiest ways to check when a material fails is a simple endurance test. Here the material is pumped from both ends.

When the material reaches yield (For ductile material) the material can be considered as failed. A real problem with a complicated loading state. We can also say here the material fails when the maximum value of the caused normal tension in the material is more than the value of the yield limit. If you use this hypothesis, it would be using a bankruptcy theory called "normal stress theory". Many years of engineering Experience has shown that the theory of normal stress does not work in most cases. The most preferred error theory used in industry is stress-based "Von Mises". We will explore what Von Mises's stress is in the next section.

4.3 INDUSTRIAL APPLICATION OF VON MISES STRESS

The theory of energy deformation is the most preferable error theory used in industry. This is highlight from the above discussions that whenever an engineer resorts to the energy of distortion the theory can use Von Mises's stress as a failure criterion.

DISTORTION ENERGY THEORY:

The notion of stress of Von mises arises from the theory of failure of energy failure.

The theory of distortion energy failure is the comparison between two types of actions,

- Energy distortion in the present case
- Distortion energy in case of a single voltage at the failure time.

According to this theory, the error occurs when it is deformed the energy in the present case is greater than the deformation energy in a simple voltage case at the failure time. It can be noted that Von Mises' stress is at its peak to its constant end beam. This is lower than the performance value of soft steel. So the design is safe. Inside a small task for an engineer is to maintain the maximum pressure value caused by Von Mises in the material less than its power

V. RESULTS

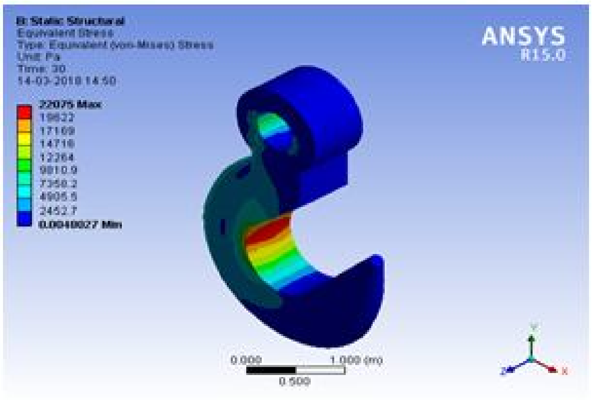

Figure 9 Stress analysis on eye-headed forged steel hook

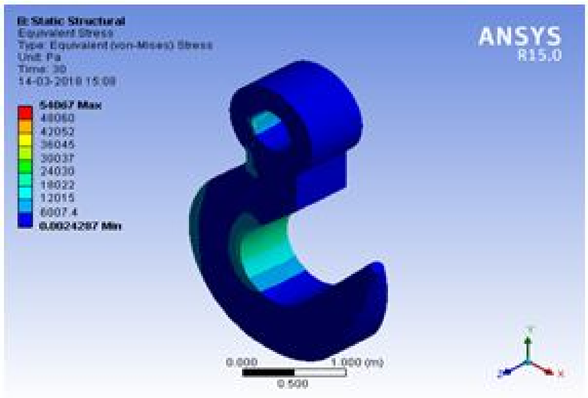

Figure 10 Stress analysis on eye-headed forged steel hook

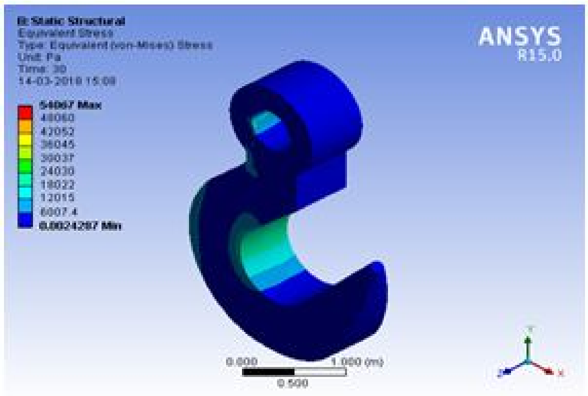

Figure 11 Stress analysis on eye-headed forged steel hook

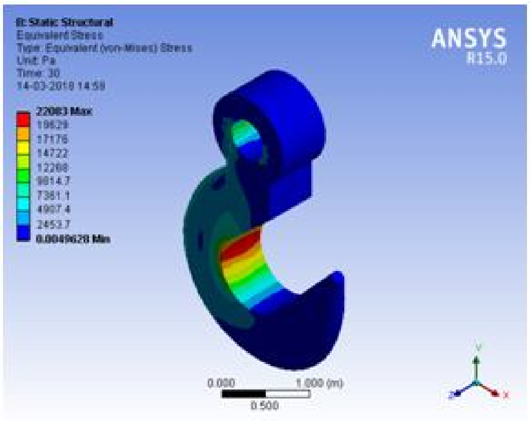

Figure 12 Stress analysis on eye-headed stainless steel hook

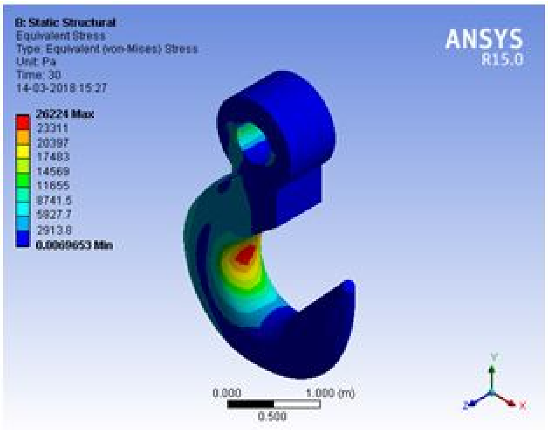

Figure 14 Stress analysis on eye-headed stainless steel hook

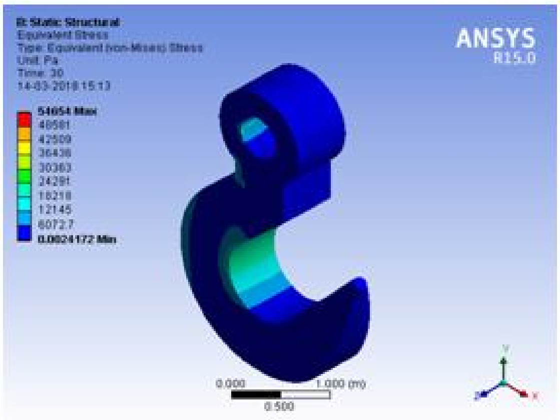

Figure 15 Stress analysis on eye-headed stainless steel hook

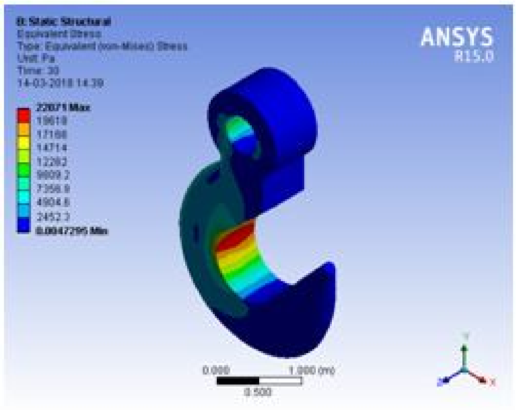

Figure 16 Stress analysis on eye-headed structural steel hook

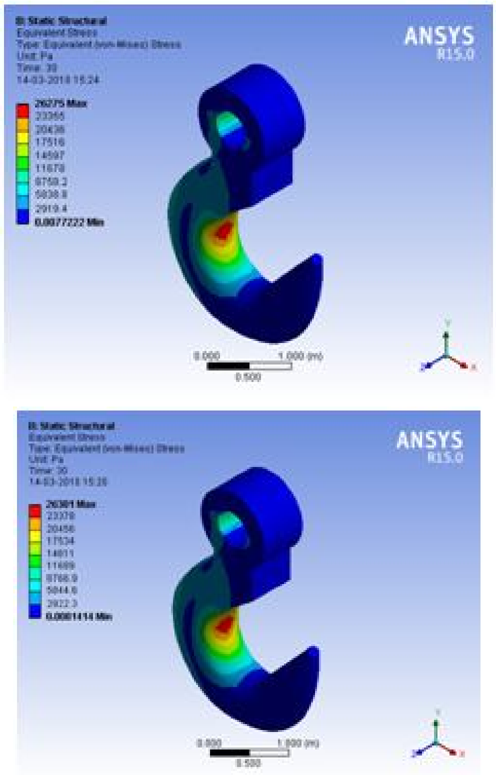

Figure 17 Stress analysis on eye-headed structural steel hook

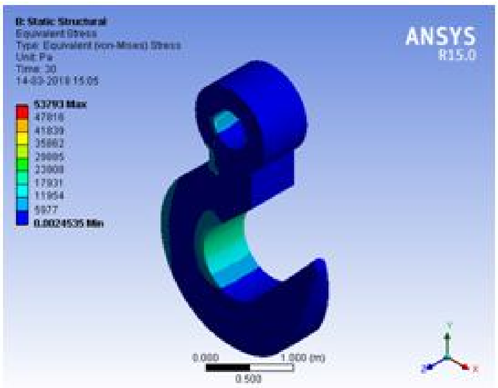

Figure 18 Stress analysis on eye-headed structural steel hook

5.1 TOTAL DEFORMATION COMPARISON BETWEEN TRAPEZOIDAL HOOK, CIRCULAR HOOK AND RECTANGULAR HOOK

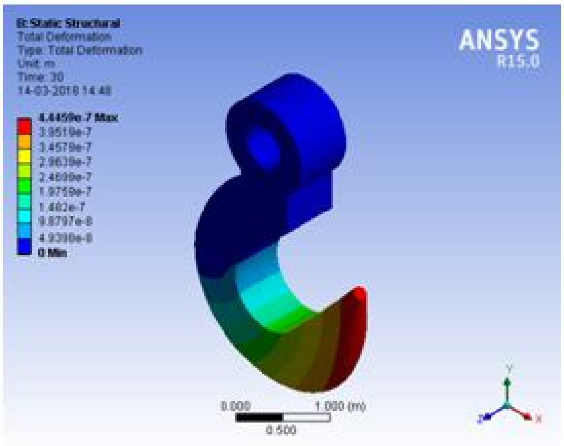

Figure 19 total deformation on eye-headed forged steel hook

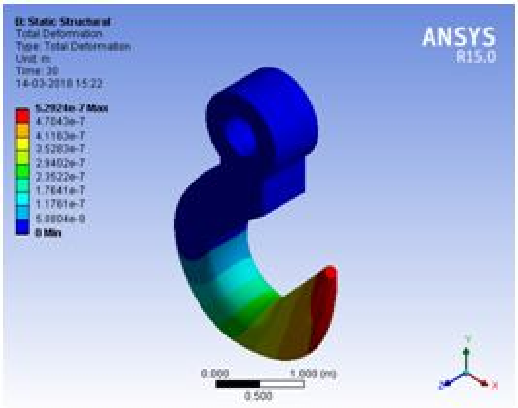

Figure 20 total deformation on eye-headed forged steel hook

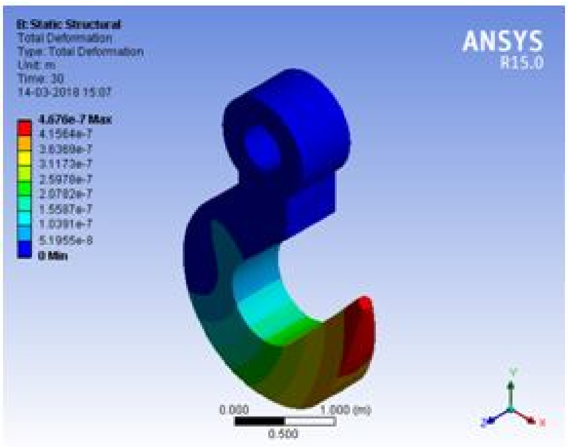

Figure 21 total deformation on eye-headed forged steel hook

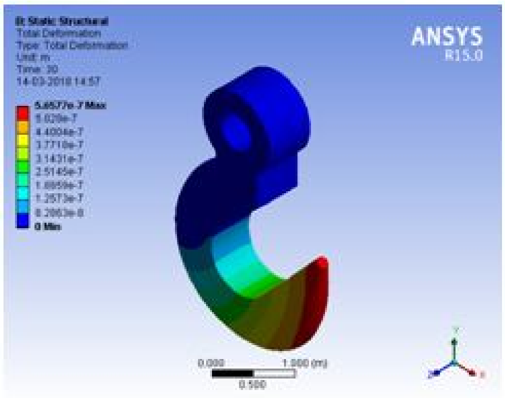

Figure 22 total deformation on eye-headed stainless steel hook

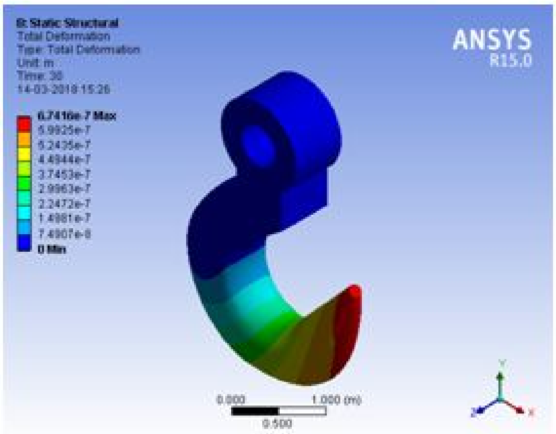

Figure 23 total deformation on eye-headed stainless steel hook

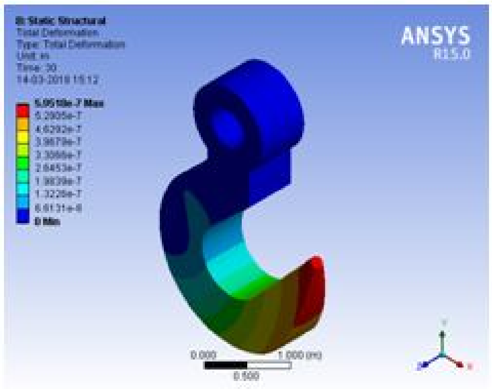

Figure 24 total deformation on eye-headed stainless steel hook

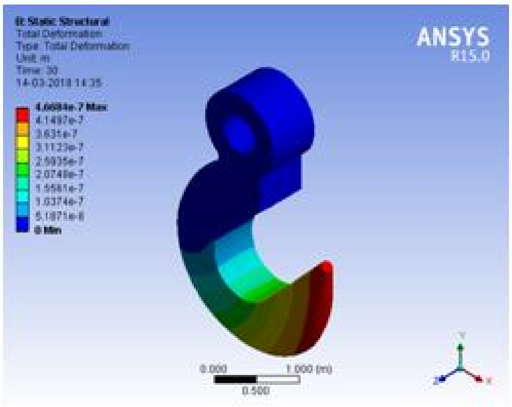

Figure 25 total deformation on eye-headed structural steel hook

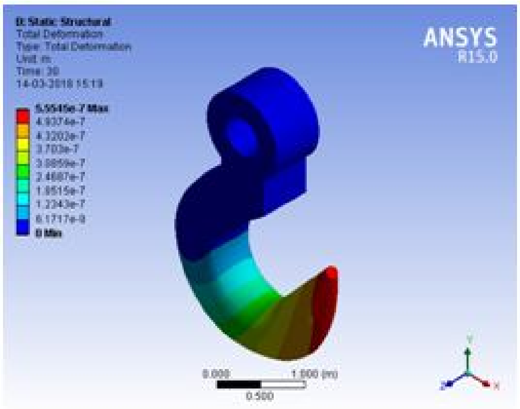

Figure 26 total deformation on eye-headed structural steel hook

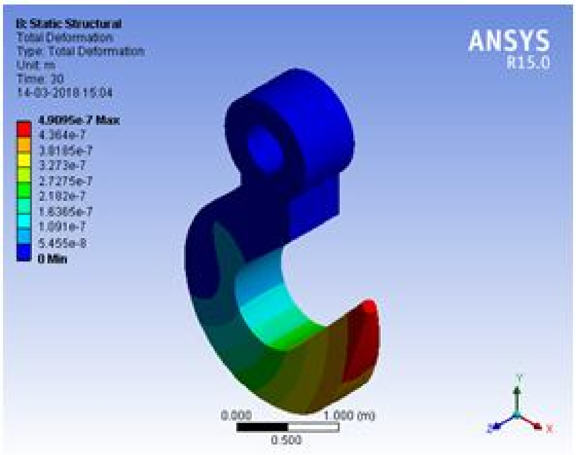

Figure 27 total deformation on eye-headed structural steel hook

VI. CONCLUSION

This project work has provided me an excellent opportunity and experience, to use my limited knowledge. I gained a lot of practical knowledge regarding, planning, designing and computer aided analysis while doing this project work.

I am proud that I have completed the work with the limited time successfully. The “STRUCTURAL ANALYSIS OF EYE HEADED CRANE HOOK OF DIFFERENT CROSS SECTIONS WITH DIFFERENT MATERIALS” is done successfully. I have done to my ability and skill making maximum use of available facilities. In conclusion remarks of my project work, let me add a few more lines about my impressive project work.

Thus I have designed and performed stress analysis on Crane Hooks of Different Cross Sections with Different Materials basing on the journal paper published by Mr. Abhijit Devaraj in international journal for research in applied science & engineering technology (IJRASET). I had modified the design by changing the dimensional values of crane hook designed by him by reducing to a scale of 1:2 and performed analysis by applying a load of 1KN. finally I got succeed to get very minute increase in stress values compared to Mr. Abhijit Devaraj reports by just 0.45% approximately as we can see in my results.

VII. LIMITATION OF USE

- Working load limit (WLL) should never be exceeded.
- Hook-blocks should be used in vertical lift only.
- Rigging blocks should be used only as in design specifications. Blocks should not be used for towing unless specifically designed and marked for that purpose.
- Swivels should be used in either vertical or horizontal plain only.
- Horizontal and vertical lead sheaves used only as indicated in description.
- Shock or side loading should not be applied unless equipment is designed for that purpose.
- Load should always be in seat of hook or eye. Never at point!

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