

DESIGN AND ANALYSIS OF CRANE HOOK BY USING COMPOSITE MATERIAL

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Abstract - The study focuses on design and analysis of crane hook using composite material. Cranes are industrial machines that are mainly used for material movements in construction, production halls, and similar places. Commercial crane hooks are manufactured using forged steel material. The forged steel have sufficient strength to withstand high loads with minimum stresses and deformation. As per the numerical calculation the design is safe. In this project we have selected Compacted Graphite Iron for design of crane hook. Design of crane hook is prepared by using CATIA V5R20. We have comparatively studied stresses and deformations induced in forged steel and CGI by using ansys 14.2 software. Thus we conclude that CGI crane hook minimize stresses and weight in crane hook as compared to forged steel crane hook. Hence CGI used alternative material for crane hook

Key Words: Catia V5 R20, Ansys 14.2, Composite Materials.

1. INTRODUCTION

In this chapter, the introduction of Crane Hook, objective of project is discussed.

1.1 Crane hook

A Crane hooks are the components which are always subjected to failure due to accumulation of large amount of stresses which can eventually lead to its failure. Crane hooks are generally used to lift heavy load in industries and constructional sites.

1.2 Types of Crane Hooks

Crane hooks are classified depending on their manufacturing materials as well as the intended usage and, (amongst other factors) according to this, some aspects are more important than others. Different types of crane hooks can be classified according to their shapes, method of manufacture, mode of operation or other unique characteristics. They are made in a variety of styles to meet specific needs and they are rated for loads of specific type and size. To understand this deeply, we'll focus on the main types of crane hooks available in the market and see which applications they are most suitable for. Before we start though, is important to remember that crane hooks or lifting hooks are necessary in order to move different and many types of loads and that there are a lot of uses depending on the application the intended use is for.

Single Crane Hooks vs. Double Crane Hooks

This being said, when you're looking to define crane hooks depending on their shape, you will usually be able to choose between single crane and double crane hooks. As the name suggests, the main difference between these two options is the number of hooks included, and there are different sub-types possible such as the C-hooks (which is essentially a single hook variant with a slightly different shape).

Single Crane Hooks are the right choice if your machinery deals with loads of up to 75 tons; this lifting hook is very simple and easy to use no matter which variant you choose.

Single Crane Hooks vs. Double Crane Hooks



Figure :1.2.1 Single crane hook

- **Double Crane Hooks** are similar in conception, but their design provides superior bearing which is suitable for heavier loads of over 75 tons.



Figure:1.2.2 double crane hook

Forging Crane Hooks vs. Laminated Crane Hooks

When it comes to the manufacturing methods used to create crane hooks, there are two main styles available: forging crane hooks and laminated crane hooks. Each option offers particular benefits and drawbacks that must be kept in mind while deciding which is better suited for our specific requirements.

Forging Crane Hook are forged from a single piece of high quality steel with low carbon which is cooled slowly to ensure optimum stress resistance (usually ranging from 16Mn to 36MnSi). These hooks typically feature very simple manufacturing and are also very simple to use, since they're made of a single piece, with installation being very straight forward.



Figure:1.2.3 Forging crane hook

Laminated Crane Hooks are a little more complex, and are comprised of several steel plates riveted together to ensure higher stress resistance and increased safety. These hooks are conceived in a way that allows the hook to keep working even if some of the individual parts are damaged. Laminated hooks are available as single hooks or double laminated hooks, and there are several models available to match different applications.



Figure1.2.4 Laminated crane hooks

Closed Hooks vs. Semi-Closed Crane Hooks

If you're concerned about having the right hook attachments, then you have to choose between closed and semi-closed crane hooks. These types of hook feature an attachment for added security for carrying heavy loads; as the name suggests, the attachment can be closed or semi-closed.

- **Closed Crane Hooks** attachments are somewhat harder to use and more time-consuming, but they offer the highest possible safety measures and load bearing potential



Fig 1.2.5 Closed crane hook

Semi-Closed Crane Hooks aim to bridge the gap, as they offer increased security levels compared to standard lifting hooks, while being reasonably simpler to attach and dismount than closed hooks.



Fig 1.2.6 Semi-closed crane hook

Electric Rotary Hooks

If you have a requirement for a state of the art crane hook that offers the best features as well as the highest convenience, you will likely have to choose between electric rotary hooks or other types of sophisticated crane hooks.



Fig 1.2.7 Electric rotary hooks

And **electric rotary hook** is a sophisticated piece of equipment that will improve the crane's manoeuvrability and effectiveness when hauling containers. These hooks feature the ability to rotate while keeping a strong hold on the cargo, which means they can be extremely convenient and productive in situations that involve moving many containers around limited spaces.

1.3 Objective of project

Objective of this project is to minimize stresses induced in crane hook and reduce the weight of crane hook using composite material.

2. Structural Analysis

Introduction

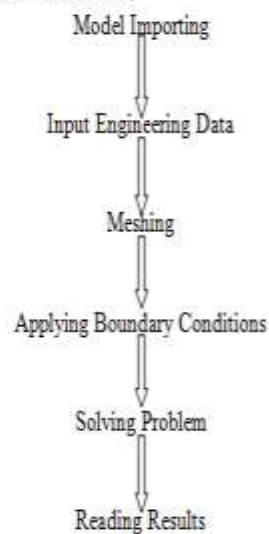
FEA is a computational technique used to obtain approximate results for boundary value problems in engineering. In mathematics, the finite element method (FEM) is a numerical technique for finding approximate solutions to boundary value problems for differential equations. It uses variational methods (the calculus of variations) to minimize an error function and produce a stable solution. Analogous to the idea that connecting many tiny straight lines can approximate a larger circle, FEM encompasses all the methods for connecting many simple element equations over many small sub domains, named finite elements, to approximate a more complex equation over a larger domain.

STRUCTURAL ANALYSIS OF CRANE HOOK

- Model Importing
- Input Engineering Data
- Meshing
- Applying Boundary conditions
- Reading Results

FEA Process

The process of FEA is expressed as follows,



A. Model Importing

After modeling the crane hook the file is saved in the readable format i.e. .igs format. This saved file is then imported into the ANSYS Workbench 14.5 software.

B. Input Engineering Data

As far as structural analysis is concerned, engineering data is most important factor. Engineering data consists of material properties which we are going to use.

In this analysis, the data given as input is,

- MATERIAL: COMPACTED GRAPHITE IRON
 - Density- 7.2g/cc
 - Young's Modulus- 155GPa
 - 0.2% Yield Strength- 365MPa
 - UTS- 525MPa
 - Thermal Conductivity- 38
 - Thermal Expansion Coefficient- 0.0125 /c
 - 0.2% Compressive Yield- 440MPa
 - Hardness- 241
 - Poisson's Ratio- 0.27
- MATERIAL : FORGED STEEL
 - Density- 7.81g/cc
 - Young's Modulus- 221GPa
 - Yield Strength- 625MPa
 - UTS- 827MPa
 - Poisson's Ratio- 0.28
 - Strenght Coefficient-1316MPa
 - Cyclic Strenght Coefficient-1159MPa
 - Cyclic Strain Hardening-0.128
 - Meshing

C. Meshing is heart of FEA. Meshing is nothing but the descritization of object i.e. dividing it in smaller elements. The element shapes are of any types i.e. tetrahedron, hexahedron, brick elements, etc. The element size taken is 5 mm.

D. Applying Boundary conditions

Boundary conditions are nothing but the loading conditions, placement conditions, etc. So depending upon the forces and fitment of different parts, we get the deflection, stresses and strains of crane hook.

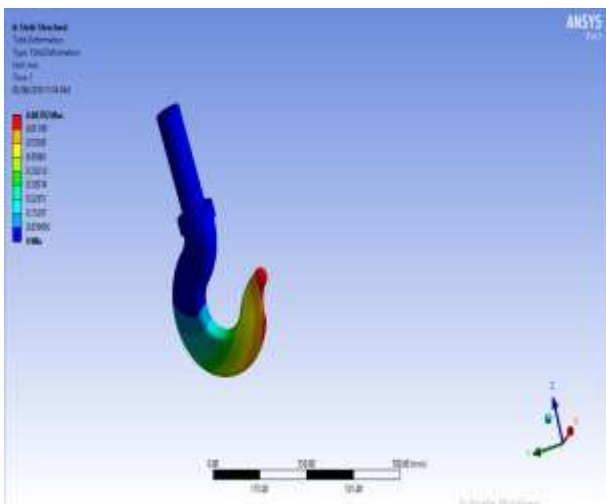
E. Reading Results

When the solution is done, the results are taken from results module. In that whichever results we want to observe are selected from result menu. i.e. stresses, strains, deflection, directional stresses, etc.

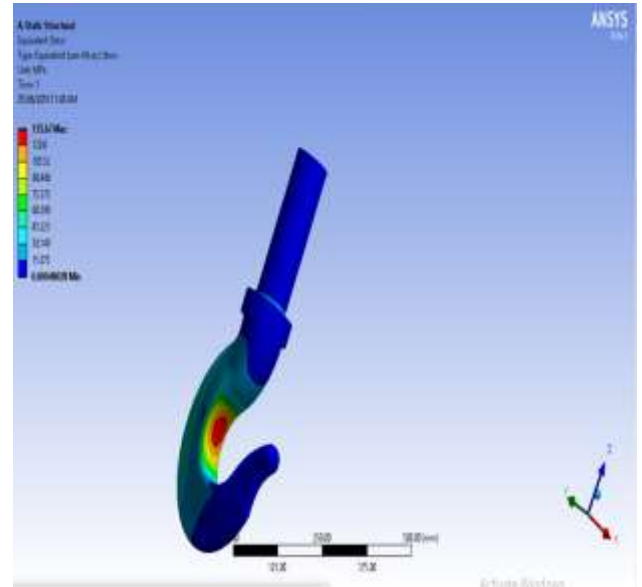
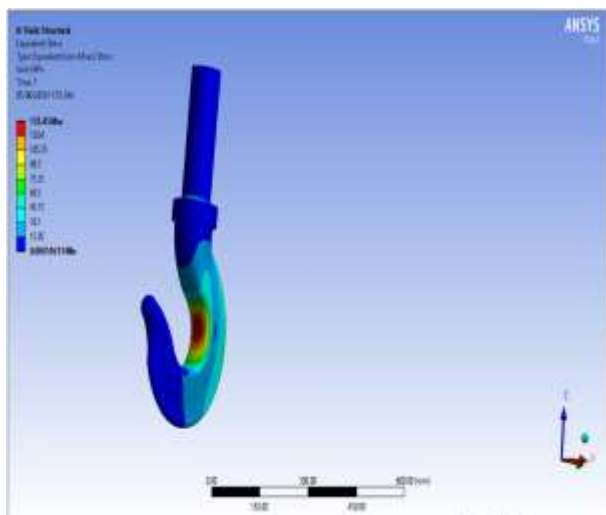
The main two results are as shown bellow.

1) COMPACTED CAST IRON

CGI total deformation



CGI equivalent stress



3. Scope Of Project

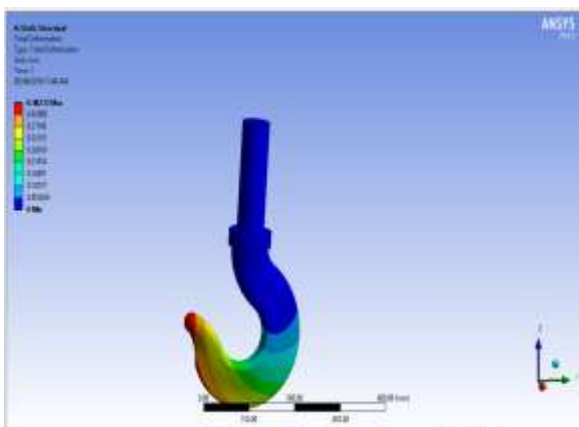
Compacted Graphite Iron is better alternative to the Forged Steel. Hence this material can be used in future.

4. References:-

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2) FORGED STEEL

Forged steel total deformation



Forged steel equivalent stress