International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

DESIGN AND ANALYSIS OF CRANE HOOK USING DIFFERENT PROFILE AND MATERIAL

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A B S T R A C T

The hook is designed using an analytical method in this work, and it is designed for various materials such as forged steel, wrought iron, and high tensile steel. The crane hook is an important component that is used to hoist a cargo using chain or wire ropes. Crane hooks are extremely brittle components that are frequently subjected to bending stresses, which can lead to crane hook failure. In order to avoid failure, the strain created in the crane hook must be studied. A crane is necessary to load and unload continuously. As a result, the crane hook's structural integrity may be jeopardised. Following the analytical process, the hook is designed and modelled in modelling software. The modelling is done with the help of design calculations, and the analysis of the hook is done with FEA software. As a result of this finding, we were able to determine the stress in the existing model. The hook working life increases and reduces failure stress by forecasting the stress concentration location.

Keywords: AISI 1010 STEEL, Gray Cast Iron, Structural Steel.

1. Introduction:

Crane hooks are extremely prone to failure as a result of the accumulation of substantial amounts of stresses, which can finally lead to collapse. Crane hooks are modules that are commonly used in industries and building locations to hoist big loads. A crane is a machine that has a hoist attached to it. A crane hook is a device that is used to grip and high loads using a crane. It's essentially a lifting fixture that engages a lifting chain's circle or linkage, or the pin of a fetter or chain outlet. Circular, rectangular cross section crane hooks are often employed. As a result, it must be planned and produced in such a technique that it can give maximum performance without weakening. Crane hooks are used primarily in the transportation, construction, and manufacturing industries. Some of the most widely utilised cranes include overhead cranes, mobile cranes, tower cranes, telescopic cranes, gantry cranes, deck cranes, jib cranes, and loader cranes

Figure 1: Single crane hook

2. Literature Review

Yu Huali et. al (2009), The load-bearing capabilities of the elevating equipment is measured using the structure-strength index. The static feature of the hook that performs at a limited weight must be researched and analysed in order to design a bigger tonnage hook correctly. The hook of the drill well DG450 was investigated in this study. To begin, a 3-D entity model of the hook was created in Pro/E utilising characteristic modelling technology. Second, FEM software ANSYS was used to do a static study on three harmful work circumstances at the hook's ultimate load. This work elucidates the instructional significance and technical application value of the bigger tonnage drill well design and development.

Bernard Ross et. al (2007), The goal of this study is to debunk the Mitsubishi hypotheses of failure, which were supported by a jury verdict, by doing a complete engineering investigation of the crane disaster. Wind tunnel tests, structural assessments of the boom, metallurgy of broken pieces from a vital king-pin assembly, and soils engineering work linked to ground stresses and displacements during the lift were just a few of the issues highlighted. The significance of SAE J1093, the 2% design side load criterion, and Lampson's justification for an 85% crawler crane stability criterion were discussed.

Takuma Nishimura et. al (2010), crane-hook damage assessment was investigated. They calculated the load conditions that were thought to be important in causing crane-hook damage. A crane-hook FEM model was created, based on one of its actual designs. The FEM model was used to create a database, which consisted of a collection of various conceivable load circumstances and the related deformation values acquired from the FEM study. The information was utilised to detect the load circumstances that caused the crane-hooks to fail. On the crane-hook design, some feature points were chosen; the deformation of a damaged crane-hook may then be determined using the feature points recognised using image processing. By comparing the obtained real deformation with the simulated deformation values in the database, the critical load condition of the damaged crane-hook was computed. The critical load condition for the crane-hook was approximated as a statistical distribution based on these calculated load requirements using the Bayesian technique.

C. Oktay AZELOGLU et. al (2009), this study discusses the various stress calculation techniques for elating hooks based on various conventions. To obtain the stress area on the hook, they used curved beam theory, Finite Element Method, and optical elasticity experiments. As a result, alternative approaches for obtaining the hook's stress field are compared. For lifting hook calculations in field applications, certain recommendations were made [15].

3. Proposed Work

The crane hook is design to carry maximum load and stand with varying loading condition. In this project we studied two types of geometry first is circular and other one is triangular and also studied three different material AISI 1010 STEEL, Gray Cast Iron and structural Steel. With 980 N load and check the value of stress and load condition.

4. Methodology

The FEA process involves CAD modeling of piston in SOLIDWORKS design modeler. The model is developed as shown in figure 2 below. The model developed in SOLIDWORKS Simulation design modeler is imported for meshing.

Figure 2: CAD model of Crane Hook (Model-1)

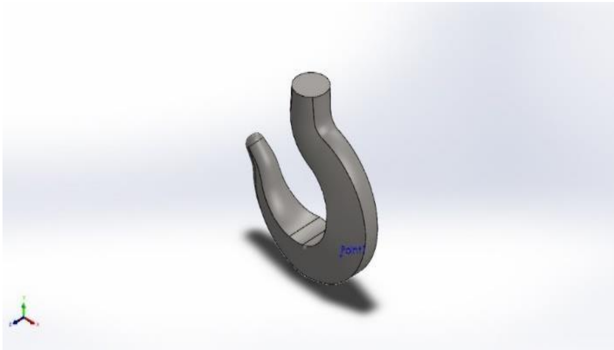

Figure 4: CAD model of crane Hook (Model-2)

Tetrahedral elements and precise sizing with curvature effects are used to mesh the CAD model. As indicated in the diagram above, model-1 generates 38952 elements and 25734 nodes, whereas model-2 generates 6710 elements and 10259 nodes. The figure depicts the shape of a tetrahedral element. It is made up of four nodes that are joined by a tetrahedral shape. After meshing, the CAD model of the suspension is applied with the required loads and boundary conditions. The lowest face of the suspension is held fixed, while the top region is applied down with a force of 980 N.

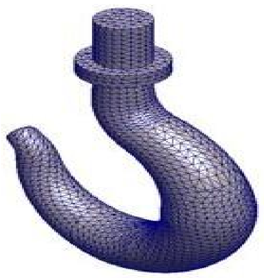

Figure 5: Model-1 Meshed

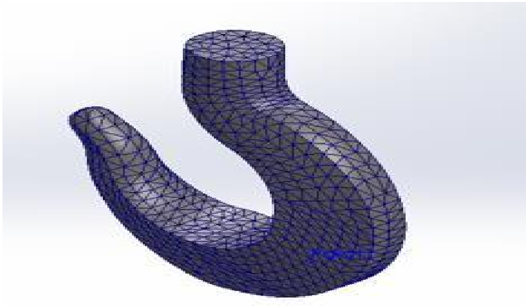

Figure 6: Model-2 Meshed

5. Results and Discussion

The results of FE simulation are generated. The radial stress and tangential stress generated on piston is generated as shown in figure 6 and figure 7 below

Model-1

Von-misses stress

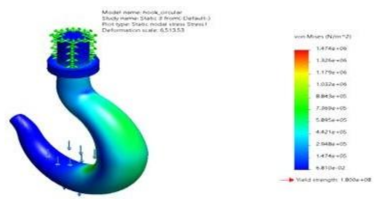

Figure: AISI 1010 STEEL

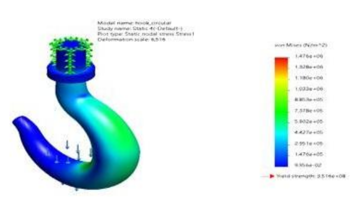

Figure: Structural Steel

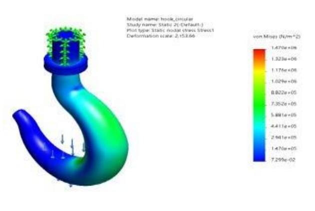

Figure: Gray Cast Iron

Resultant Displacement

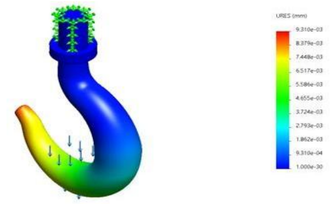

Figure: ASIS 1010 STEEL

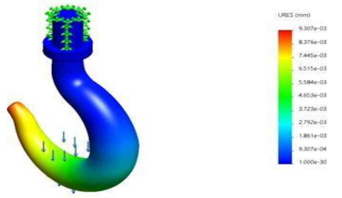

Figure: Structural Steel

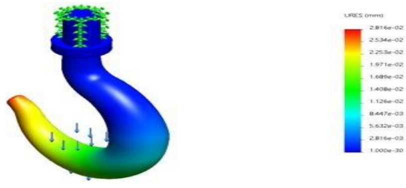

Figure: Gray Cast Iron

Equivalent Strain

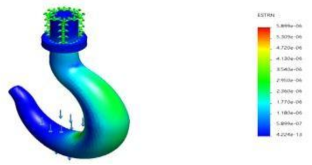

Figure: ASIS 1010 STEEL

Figure: Structural Steel

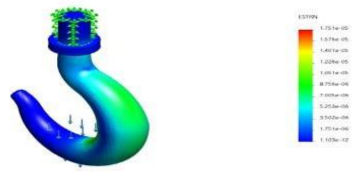

Figure: Gray Cast Iron

Model – 2

Von- misses stress

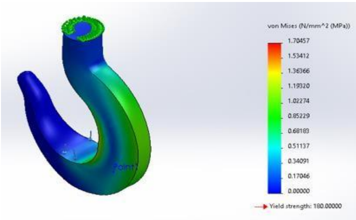

Figure: ASIS 1010 STEEL

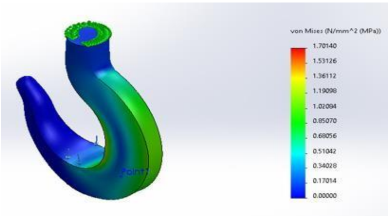

Figure: Structural Steel

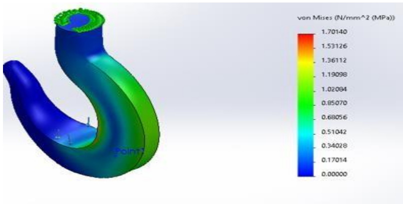

Figure: Gray Cast Iron

Resultant Displacement

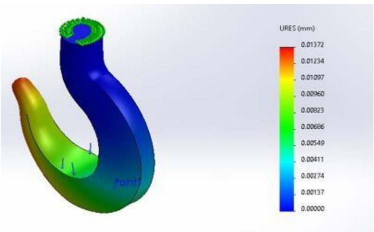

Figure: ASIS 1010 STEEL

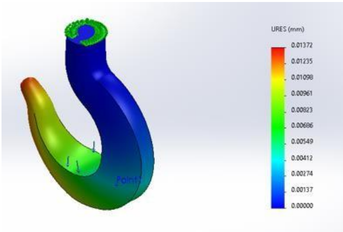

Figure: Structural Steel

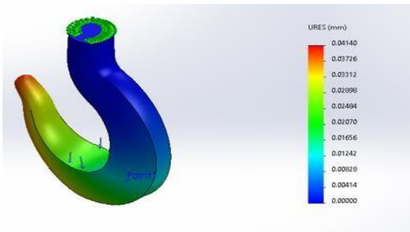

Figure: Gray Cast Iron

Factor Of safety

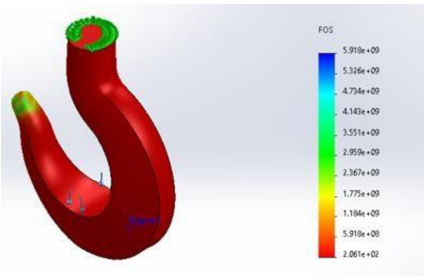

Figure: ASIS 1010 STEEL

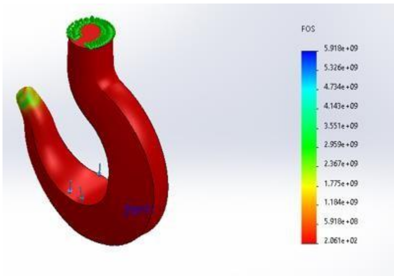

Figure: Structural Steel

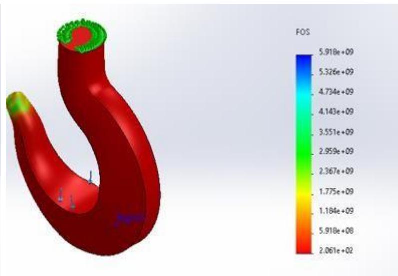

Figure: Gray Cast Iron

Table 1: Model-1 Analysis Result

Material	Von-misses stress (N/mm^2)	Resultant Displacement (mm)	Equivalent Strain
AISI 1010STEEL	6.810e-02	9.310e-03	5.899e-06
STRUCTURAL STEEL	9.956e-02	9.307e-03	5.952e-06
GRAY CAST IRON	7.299e-02	2.816e-02	1.751e-05

Table 2: Model-2 Analysis Result

Material	Von-misses stress (N/mm^2)	Resultant Displacement (mm)	Equivalent Strain
AISI 1010STEEL	1.70621	1.70140	1.70457
STRUCTURAL STEEL	0.01372	0.04140	0.01372
GRAY CAST IRON	6.549e-06	1.928e-05	6.492e-06

6. Conclusion

The stress study findings for various materials such as ASTM grade 60 (grey cast iron), high strength low alloy steel, structural steel, and AISI 1010 STEEL are determined using FEA analysis. By maintaining the tone the same with varied material topologies, we will obtain distinct results for all different materials. It has been discovered that the high strength low alloy steel material produces the least amount of stress, as shown in the table above.

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