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FAILURE ANALYSIS OF CRANE HOOK FOR DIFFERENT CROSS SECTION

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ABSTRACT

Crane hooks are stressed by repetitive loading and unloading, which finally leads to their failure. These are the reasons for crane hook fatigue failure. To avoid failure, the crane hook stress is examined and reduced to the maximum stress possible compared to the current (trapezoidal) crane hook. Crane hook stress can be reduced by changing the shape when compared to a standard crane hook. In this study, Using SOLIDWORK and SOLIDWORKS Simulation, these crane hooks are deigned and modelled and the consequences of each rebuilt crane hook are analysed. Hook test results are influenced by a number of variables, including the hooks' optimal stress, optimum deformation, endurance time, and overall weight.

Keywords: Crane hook, Stress, Optimization, Simulation, Solid works, Endurance time

Introduction

Crane hooks are classified based on the materials used in their construction as well as their intended purpose, and depending on these and other factors, such as the intended use, certain traits are more important than others. Crane hooks can be classified according to their various styles and sizes, as well as their production methods, modes of operation, and other differentiating characteristics. They come in a variety of designs to meet a variety of needs, and they're rated for various sorts and amounts of loads.Single crane hooks and double crane hooks are the two types of crane hooks, each with its own form factor. Nowadays, there are a lot of single crane hooks in use. The number of hooks on each of these options differs significantly; the C-hooks are an example of a different type of hook

1. Objectives

The major purpose of this research is to optimise and fatigue test crane hooks using the finite element method.

The study's particular goal is to:

- Reduce the amount of stress that is generated at the crane hook's high stress concentration point.
- This crane hook has a longer fatigue life compare to regular crane hook.

2. Compare the optimised and trapezoidal (standard) crane hooks in terms of deformation, stress, and minimum available life.

3. Analysis of crane hook

3.1 Circular Profile hook with AISI 1010 Steel Material

Model name: hook_circular
Current Configuration: Default

Solid Bodies			
Document Name and Reference	Treated As	Volumetric Properties	Document Path/Date Modified
Split Line1 	Solid Body	Mass:52.2869 kg Volume:0.00664423 m^3 Density:7,869.51 kg/m^3 Weight:512.411 N	C:\Users\Desktop\Hook static load analysis\hook_circular.SLDPRT Dec 30 02:52:31 2021

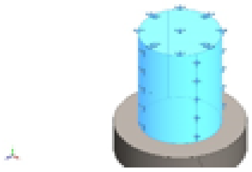
3.2 MaterialProperties (CircularProfile,AISI1010Steel)

Model Reference	Properties	Components
	Name: **AISI 1010 Steel, hot rolled bar** Model type: **Linear Elastic Isotropic** Default failure criterion: **Max von Mises Stress** Yield strength: **1.8e+08 N/m^2** Tensile strength: **3.25e+08 N/m^2** Elastic modulus: **2e+11 N/m^2** Poisson's ratio: **0.29** Mass density: **7,870 kg/m^3** Shear modulus: **8e+10 N/m^2** Thermal expansion coefficient: **1.22e-05 /Kelvin**	**SolidBody 1(Split Line1)(hook_circular)**
Curve Data:N/A		

MessDetails(Circular Profile,AISI1010Steel)

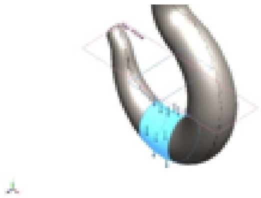
Total Nodes	38952
Total Elements	25734
Maximum Aspect Ratio	7.2057
% of elements with Aspect Ratio < 3	98.3
Percentage of elements with Aspect Ratio > 10	0
Percentage of distorted elements	0
Time to complete mesh(hh;mm;ss):	00:00:02
Computer name:	MSI

3.3 LoadsandFixtures(circularProfile,AISI1010Steel)

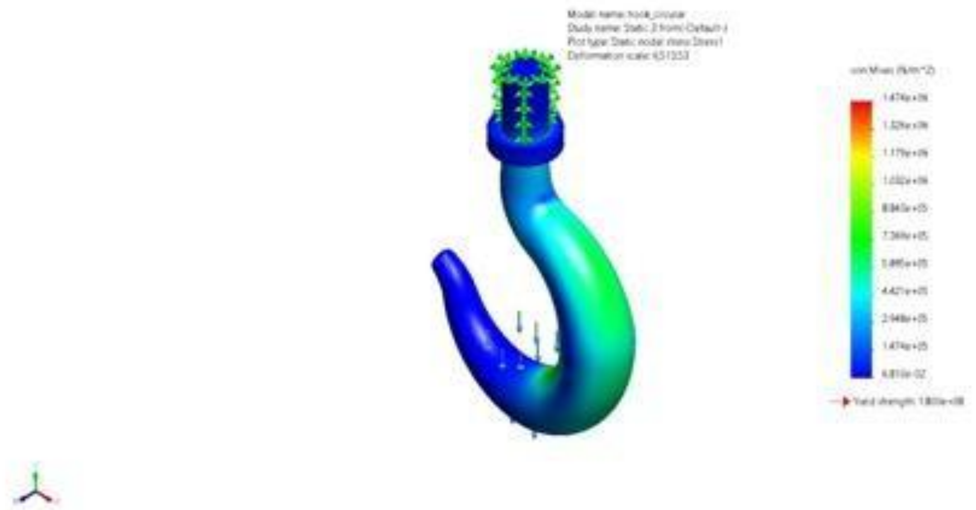
Fixture name	Fixture Image	Fixture Details
Fixed-1		**Entities:** 2 face(s) **Type:** Fixed Geometry

Resultant Forces

Components	X	Y	Z	Resultant
Reaction force(N)	0.00211249	980.004	0.00791819	980.004
Reaction Moment(N.m)	0	0	0	0

Load name	Load Image	Load Details
Force-1		**Entities:** 1 face(s), 1 plane(s) **Reference:** Top Plane **Type:** Apply force **Values:** 980 N

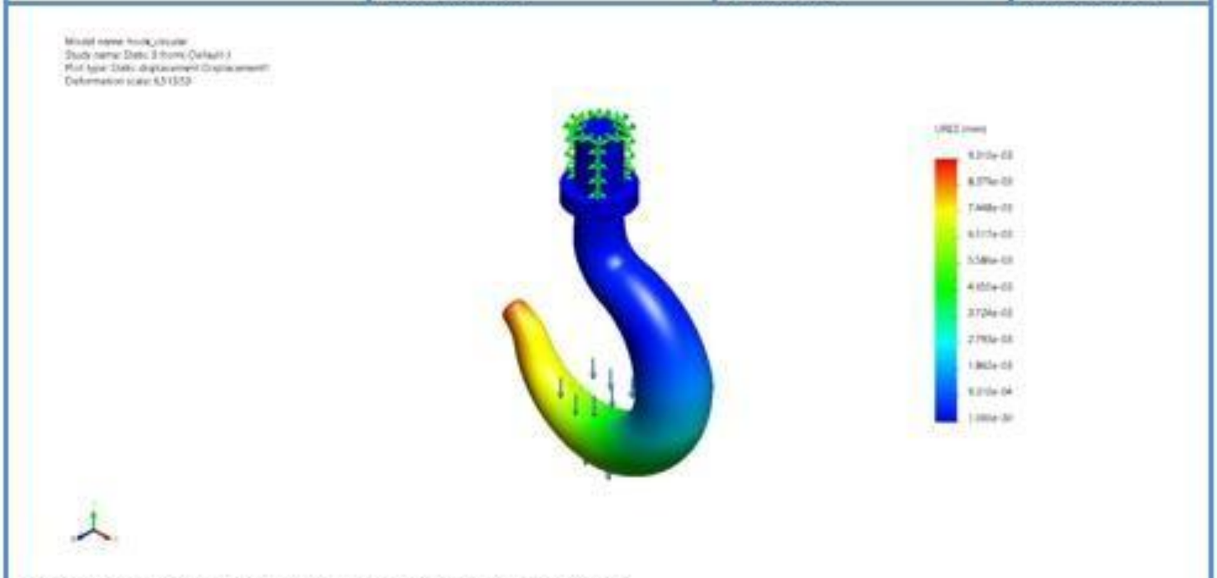
Name	Type	Min	Max
Stress1	VON: von Mises Stress	6.810e-02N/m^2 Node: 30096	1.474e+06N/m^2 Node: 1690



hook_circular-Static 3 from-Stress-Stress1

Figure3-1:Von-missesstress(AISI1010Steel,circularProfile)

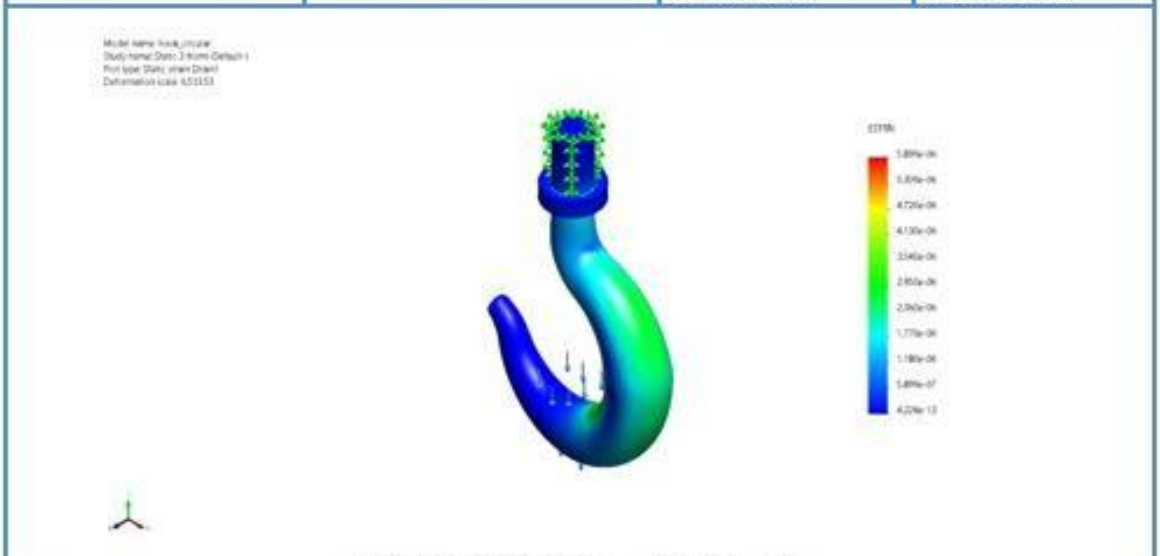
Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0.000e+00mm Node: 728	9.310e-03mm Node: 38886



hook_circular-Static 3 from-Displacement-Displacement1

Figure3-2:Deformation(AISI1010Steel,CircularProfile)

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	4.224e-13 Element: 4293	5.899e-06 Element: 3561



hook_circular-Static 3 from-Strain-Strain1

Figure3-3:Equivalentstrain(AISI1010Steel,CircularProfile)

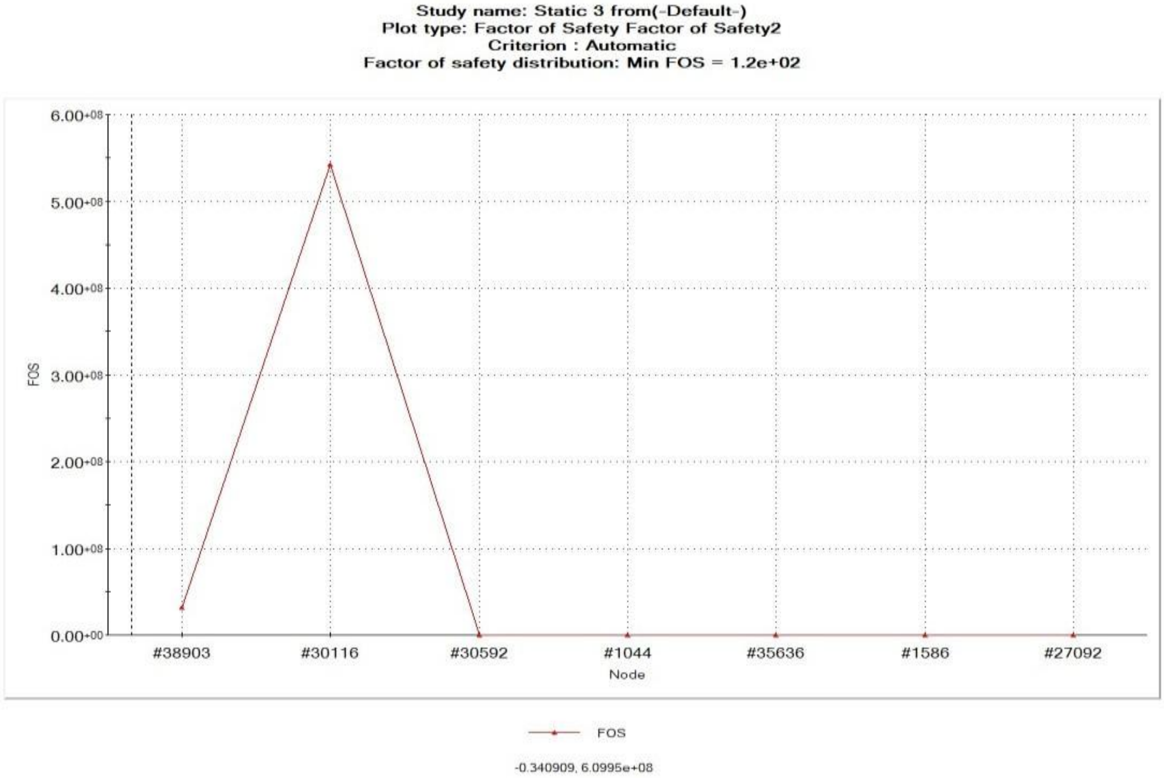


Figure3-4:S-NCurveforAISI1010 SteelwithCircular Profile

Circular Profile hook with Grey Cat Iron Material:

<table>
<tr><td colspan="4">
Model name: hook_circular
Current Configuration: Default</td></tr>
<tr><td colspan="4">Solid Bodies</td></tr>
<tr><td>Document Name and Reference</td><td>Treated As</td><td>Volumetric Properties</td><td>Document Path/Date Modified</td></tr>
<tr><td>Split Line1
</td><td>Solid Body</td><td>Mass:47.8355 kg
Volume:0.00664423 m^3
Density:7,199.55 kg/m^3
Weight:468.788 N</td><td>C:\Users\jiten\Desktop\Hook static load analysis\hook_circular.SLDPRT
Dec 30 02:37:02 2021</td></tr>
</table>

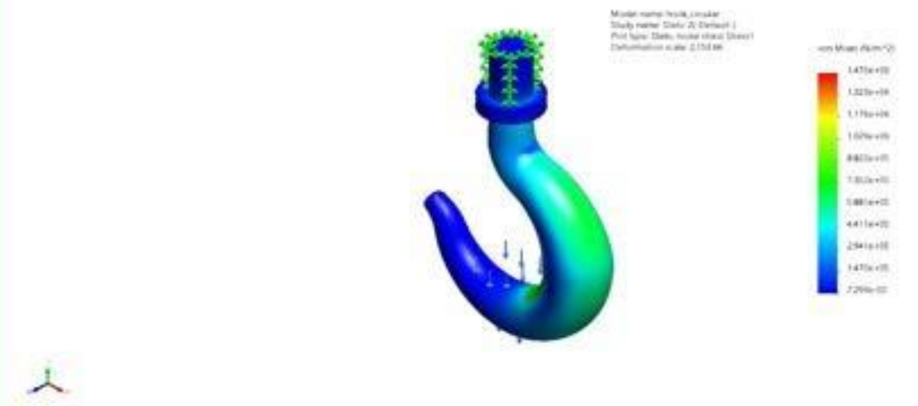
Material Properties

Model Reference	Properties	Components
	Name: **Gray Cast Iron** Model type: **Linear Elastic Isotropic** Default failure criterion: **Mohr-Coulomb Stress** Tensile strength: **1.51658e+08 N/m^2** Compressive strength: **5.72165e+08 N/m^2** Elastic modulus: **6.61781e+10 N/m^2** Poisson's ratio: **0.27** Mass density: **7,200 kg/m^3** Shear modulus: **5e+10 N/m^2** Thermal expansion coefficient: **1.2e-05 /Kelvin**	**SolidBody 1(Split Line1)(hook_circular)**
Curve Data:N/A		

MessInformation

Total Nodes	38952
Total Elements	25734
Maximum Aspect Ratio	7.2057
% of elements with Aspect Ratio < 3	98.3
Percentage of elements with Aspect Ratio > 10	0
Percentage of distorted elements	0
Time to complete mesh(hh;mm;ss):	00:00:02
Computer name:	MSI
	

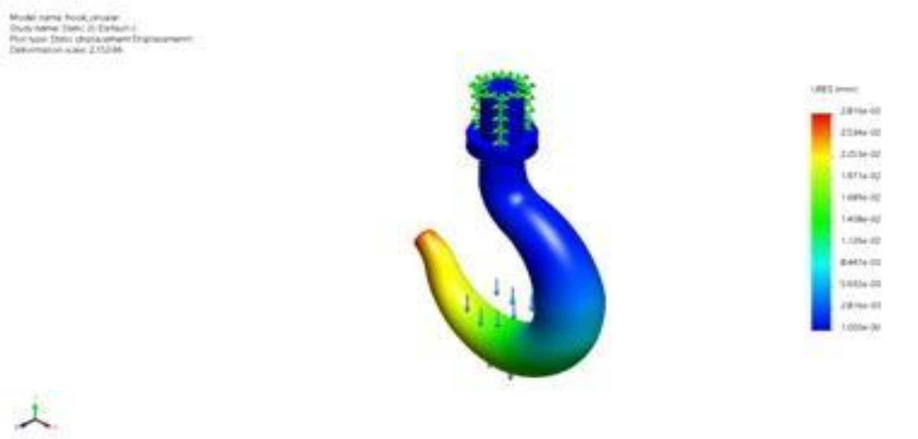
Name	Type	Min	Max
Stress1	VON: von Mises Stress	7.299e-02N/m^2 Node: 30096	1.470e+06N/m^2 Node: 1690



hook_circular-Static 2-Stress-Stress1

Figure 3-5: Von-misses stresses (Grey Cast Iron, Circular Profile)

Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0.000e+00mm Node: 728	2.816e-02mm Node: 38886



hook_circular-Static 2-Displacement-Displacement1

Figure3-6:Deformation(Grey CastIron, Circular Profile)

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	1.103e-12 Element: 4293	1.751e-05 Element: 3561

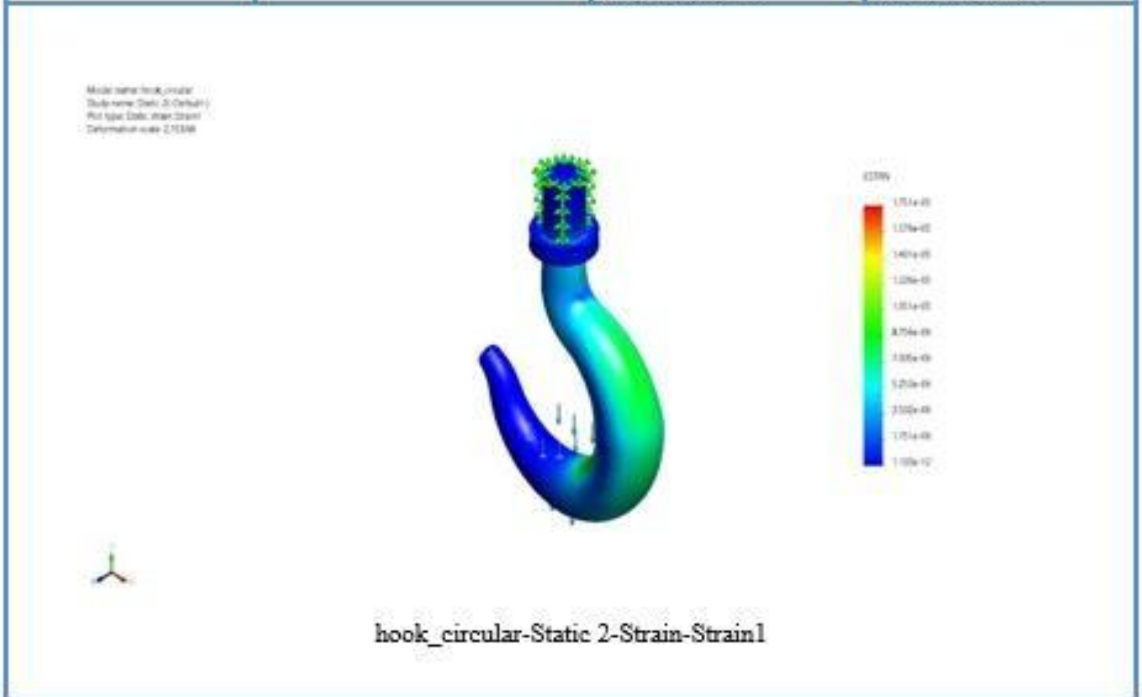


Figure 3-7: Equivalent Strain (Grey Cast Iron, Circular Profile)

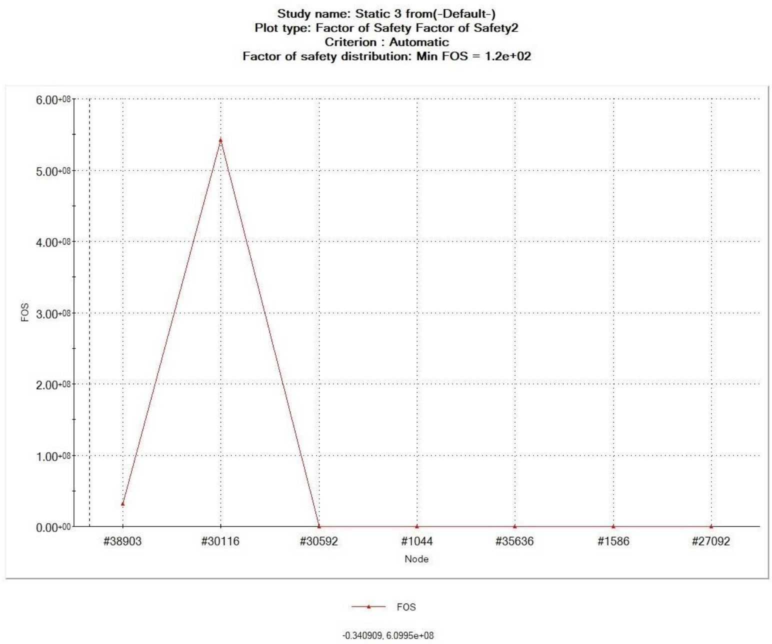


Figure3-8:S-N CurveforGrey CastIronwithCircular Profile

4. Conclusion

To decide that the maximum Von-Misses stress and total deformation of models -1 and -2 are raised, the results of each updated modelling crane hook must be compared to the results of a standard crane hook. The normal crane hook, which is included in both the model-1 and model-2 variants of the crane hook, is less fatigue resistant. The maximal Von-Misses stress is decreasing, whereas overall deformation is increasing. The crane hook with fatigue resistance has a much longer life span than standard crane hooks.

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