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Study of Various Stresses on a Crane Hook using FEA and Mathematical Data Analysis

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Abstract: ***Stress analusis is a must criterion for any stuructural component. Loading elements such as Crane Hook frequently comes under various Stress impacts and Bending Moment impacts. A numerical study with various stress analysis has been done on a Crane Hook to provide further modifications in the design of a crane hook.***
Keywords: ***Crane Hook, Stress, Principal Stress, Stress Intensity, Meshed structure, ANSYS R19.0.***

I. INTRODUCTION

Crane hook is a mechanical component used in various engineering purposes for lifting loads and material handling by means of an hoist or crane. While performing the loading and unloading of load a Crane hook comes under various types of stresses. The analysis is made by designing the crane hook on Ansys Workbench with referral dimensions and creating a Mesh on the same software.

Stresses: Applying a load on any object generate stress in the object to resist the external effect of load. When applied axially it becomes an axial load which may be of Compressive or Tensile in nature whereas in the direction along the area generates Shear Stress.

An study of various stresses on a Crane Hook is as follows:

Structre, load, geometry & fixed end other material details:

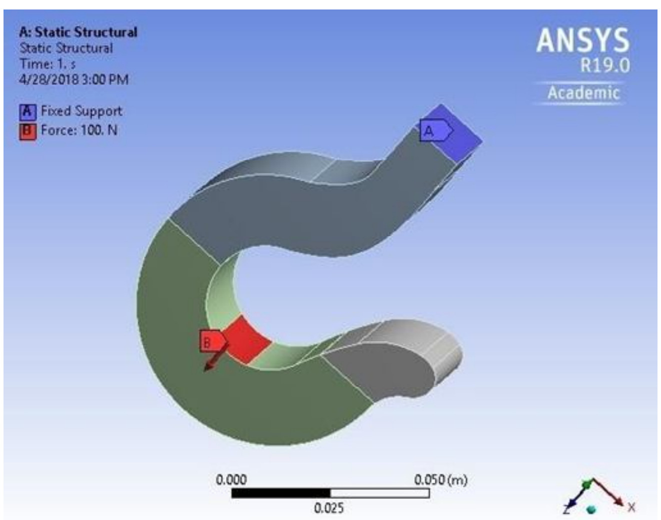


TABLE- I
Material Properties:
Density = 7850kg-m^3
Coefficient of thermal expansion = 1.2e-005/C°
Yield Strength(Pa) = 2.5e008
Tensile Yield Strength = 2.5e008
Tensile Ultimate Strength = 4.6e+008
Strength Coefficient(Pa) = 9.2e008
Strength Exponent = -0.106
Ductility Exponent = -0.47
Cyclic Strength Coefficient(Pa) =1e009
Young's Modulus (Pa)= 2e011
Poisson's Ratio =0.3
Shear Modulus(Pa) = 7.6923e010

TABLE- II
Mass = 0.72726 kg
Volume = 9.2644e-005m^3

TABLE- III
Directional Vectors
X-axis data [1.0.0]
Y-axis data [0.1.0]
Z-axis data [0.0.1]

TABLE-IV
Co-ordinate System:
X component = 0N
Y component = 0N
Z component = 100N

II. MESHING

Meshingof the Hook refines the structure to to reduce errors in a finite element calculation. It is used to approximate a complex design into a geometric domain to simply the tests carried out on it for a precise result. A meshed structure of the crane hook design is shown in the diagram below.

MESHED DIAGRAM:

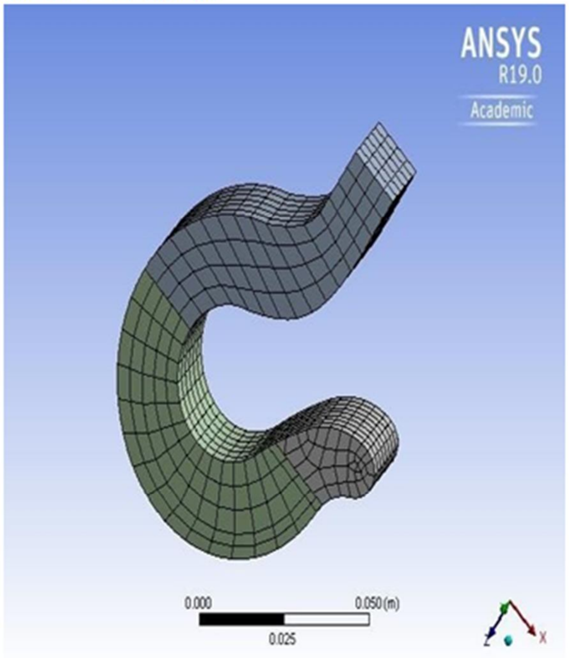


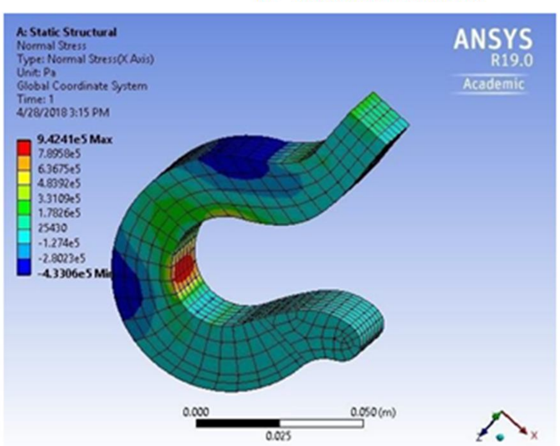
TABLE-V
Bounding Box Conditions:
Length X = 7.8788e-002m
Length Y =3e-002m
Length Z = 9.627e-002m

TABLE- VI
INFLATION:
TRANSITION RATIO=0.272
MAXIMUM LAYERS=5
GROWTH RA|TE= 1.2

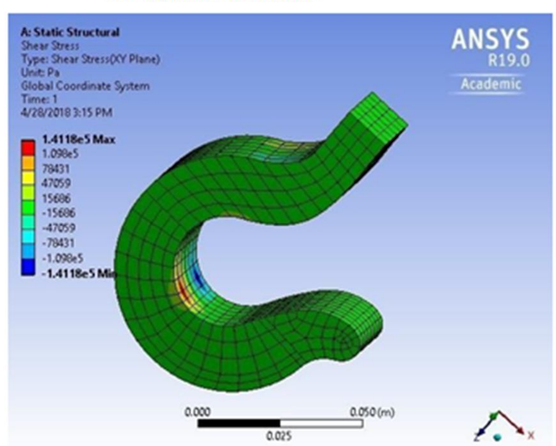
Here we have 3 active body parts in the given crane hook which have:
Total no. of Nodes = 6073
Total no. of Elements = 1112

TABLE- VII
The Bounding Box which carries the Meshed Design has following specification:
Bounding Box Diagonal =0.128240m
Average Srface Area = 6.7815e-004m^2
Minimum Edge Length = 2.2285e-003m

III. NORMAL STRESS:



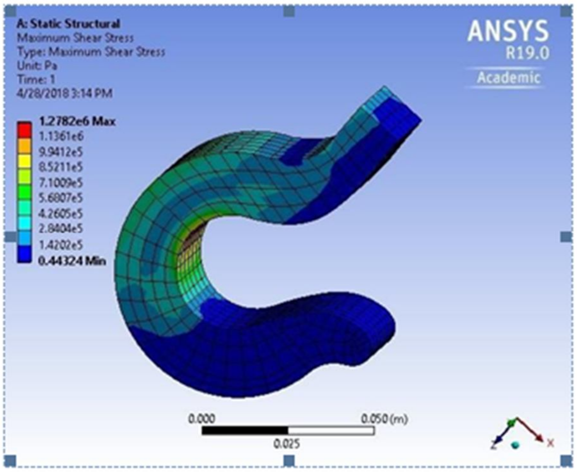
IV. SHEAR STRESS:



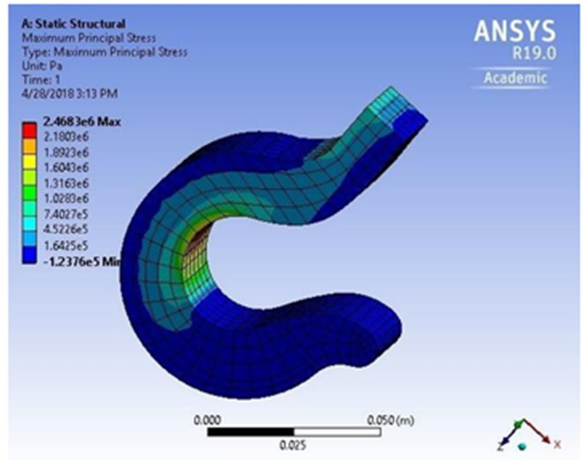
A. Normal Stress & Shear Stress

The force has been applied normally in Z-direction influencing it for 1 second. As we can see in diagram normal stress has a greater impact than the shear force in tension. Shear stress more tends to compress from a value of 15686 Pa to 1.4118e5 Pa, while the effect of normal stress pushes the hook to a higher tension value of 9.4241e5 Pa.

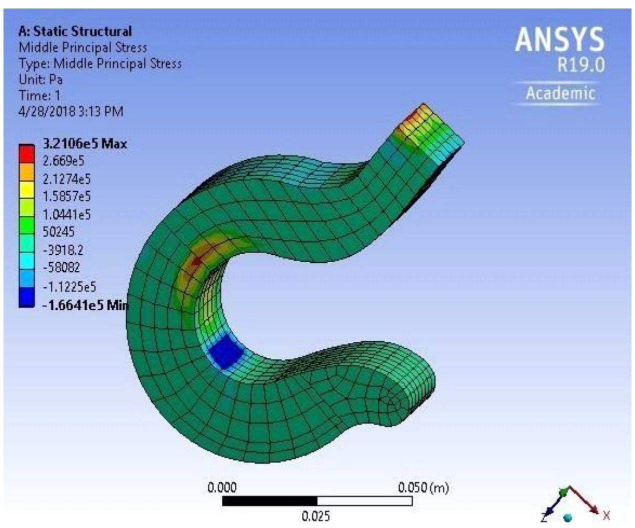
V. MAXIMUM SHEAR STRESS:



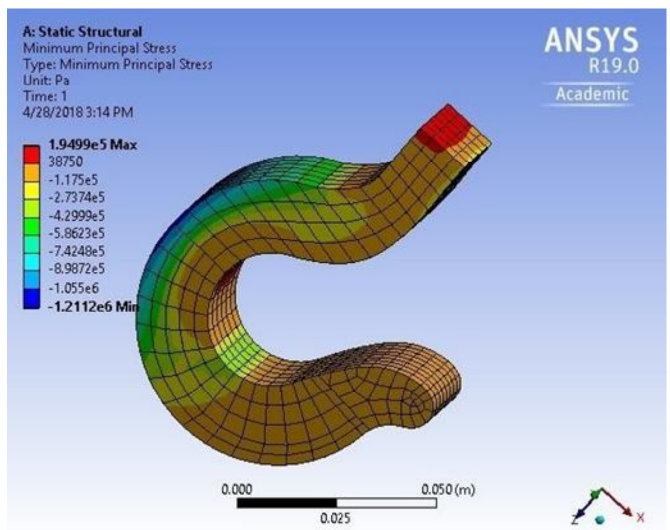
VI. MAXIMUM PRINCIPAL STRESS:



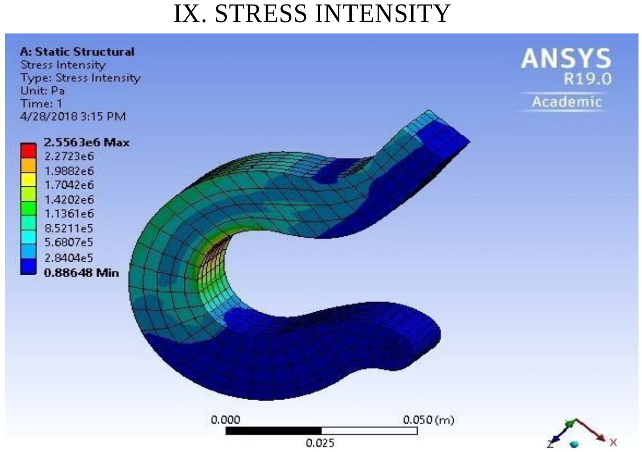
VII. MIDDLE PRINCIPAL STRESS:



VIII. MINIMUM PRINCIPAL STRESS:



IX. STRESS INTENSITY



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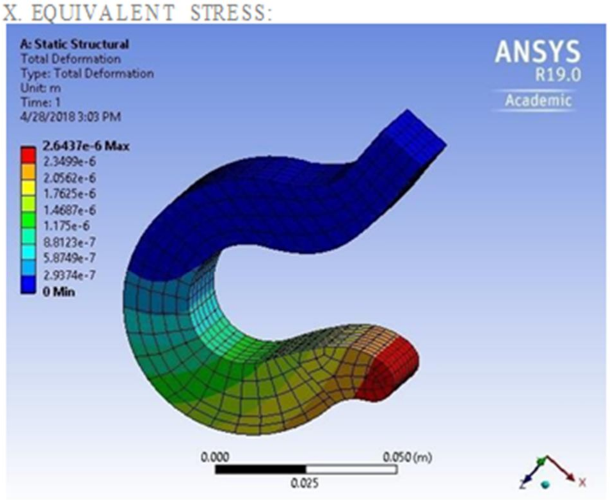
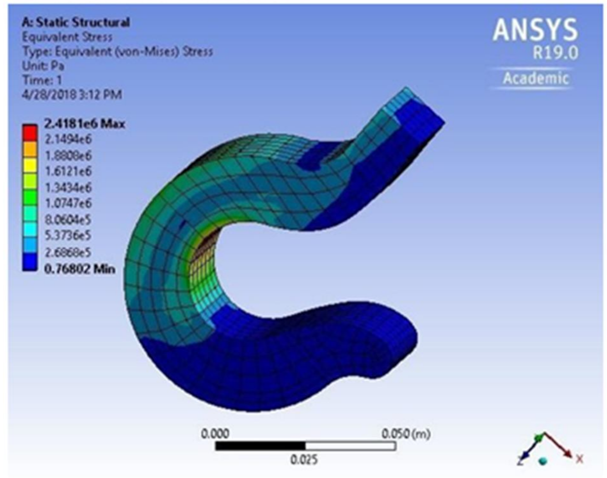
X. EQUIVALENT STRESS:



XI. TOTAL DEFORMATION:

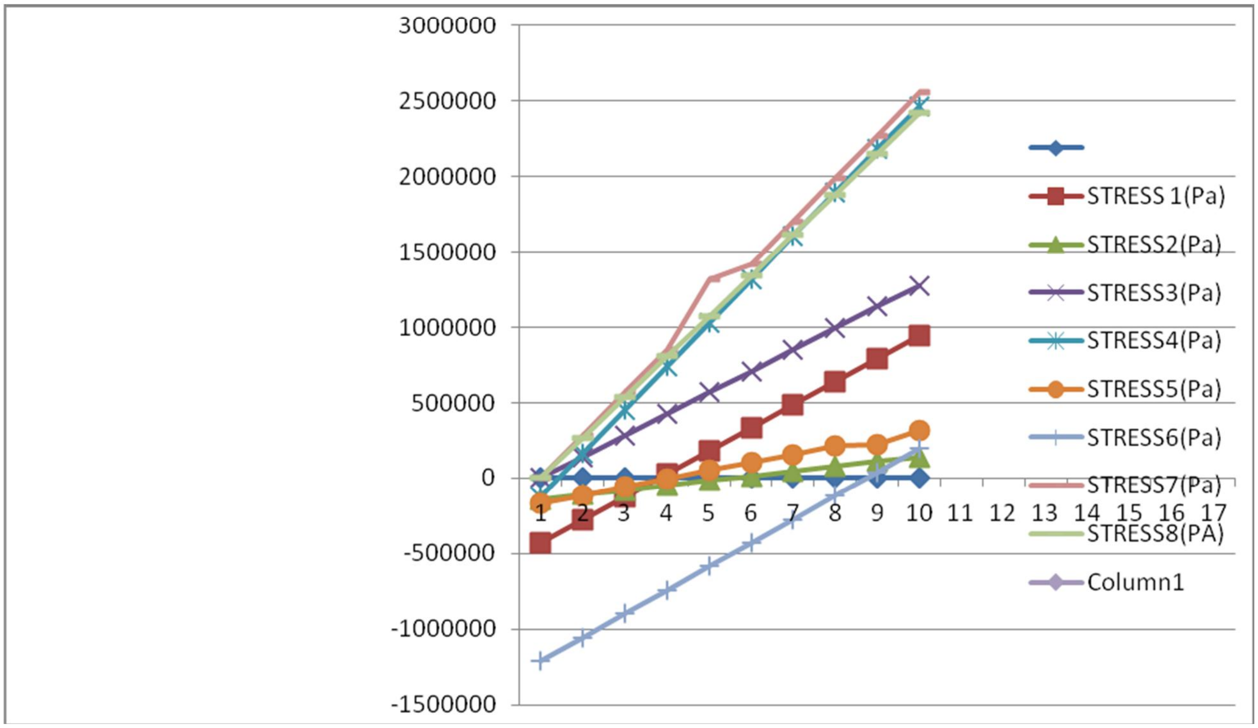


III. RESULTS & CONCLUSION

A. TOLERANCE VALUE=3.059e-004m
B. TRIM TOLERANCE= 3.205e-004m
C. DEFORMATION TIME =1SEC FOR APPLICATION OF LOAD
D. MINIMUM = 0
E. MAXIMUM= 2.6437e-006m iii) AVERAGE 1.0822e-006m
F. A LIST OF ALLT HE VALUES(from minimum to maximum) OF DIFFERENT STRESSES CALCULATED HAS BEEN TABULATED BELOW & IS DEPICTED IN THE GRAPH

TABLE VIII

SERIAL NO.	NORMAL STRESS(X-axis)	SHEAR STRESS (XY-plane)	MAXIMUM SHEAR STRESS	MAXMUM PRINCIPAL STRESS	MIDDLE PRINCIPAL STRESS	MINIMUM PRINCIPAL STRESS
1.	-4.3306e5	-1.4118e5	+0.44324	-1.2376e5	-1.6641e5	-1.2112e6
2.	-2.8023e5	-1.098e5	+1.4202e5	+1.6425e5	-1.1225e5	-1.055e6
3.	-1.274e5	-78431	+2.8404e5	+4.5226e5	-58082	-8.9872e5
4.	+25430	-47059	+4.2605e5	+7.4027e5	-3918.2	-7.4248e5
5.	+1.7826e5	-15686	+5.6807e5	+1.0283e6	+50245	-5.8623e5
6.	+3.3109e5	+15686	+7.1009e5	+1.3163e6	+1.0441e5	-4.2999e5
7.	+4.8392e5	+47059	+8.5211e5	+1.6043e6	+1.5857e5	-2.7374e5
8.	+6.3675e5	+78431	+9.9412e5	+1.8923e6	2.1274e5	-1.175e5
9.	+7.8958e5	+1.098e5	+1.1361e6	+2.1803e6	2.2669e5	38750
10.	+9.4241e5	+1.4118e5	+1.2782e6	+2.4683e6	3.2106e5	1.9499e5
	All the values are in Pascal.					



GRAPH-I

A comparative chart of all the stresses has been shown in figure below:

Here

Stress1= Normal Stress (X-axis)

Stress2= Shear Stress (XY-Plane)

Stress3= Maximum Shear Stress

Stress4= Maximum Principal Stress

Stress5= Middle Principal Stress

Stress6= Minimum Principal Stress

Stress7=Stress Intensity

Stress8= Equivalent Stress

IV. ACKNOWLEDGMENT

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