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MODELING AND ANALYSIS OF CRANE HOOKSSS BY ALLOY STEELS

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Abstract*— Crane hook is a component which will plays a major role in many engineering application Industries like Manufacturing. Aeronautical, marine, nuclear power plant, thermal power plant, atomic power plant, Transport and constructions industries. The manufacture designed Crank hook is to lifting and Transfer heavy loads while loading and unloading. At the time of application or lifting loads it will subjected to Stress concentration and undergoes deformation .Due the continuous loading and unloading the crank hook nomenclature will gets changes and causes failure. At the time of designing crank hook mainly focused on the material, dimension and cross section. From the above mentioned three factors this paper (thesis) focused on the selection of cross section and material. Generally the crank hook was designed by different cross sections like Trapezoidal, Rectangular, Square, Circular and Triangular. Hook was manufactured by using Forged steel, and structural steel. In this review introducing some more alloy steel materials, for finding better one. Initially the bed diameter of hook is taken from the Winkler-bach's formulae of curved beam theory. Then remaining Specifications (Parameters)hook considered approximate values for safe design of hook for the load of 225KN and 250 KN.

Keywords*— Crane hook , Cross section ,Trapezoidal, Mangalloy(metal steel), Wrougt iron alloy, Unigraphics and NX Nastran(ANSYS)

Introduction

Crane hook is extremely very important part used for lifting serious load with the assistance of chain or links. Crane hook area unit wide victimisation in industries like aeronautic, Marine, Agriculture, Chemical, nuclear energy plant, Thermal powerhouse, nuclear energy plant and Constructional works etc for holding and shifting Brobdingnagian hundreds from one place to a different place. Hook is essentially a hoisting fixture designed to have interaction a link or ring of a lifting chain or the pin of a cable socket or shackle and should follow the health & safety guide lines. Failure of a crane hook primarily depends on 3 major factors these area unit Dimension, Material , Overload . This project is bothered towards dynamical the fabric of the hook at the constant safe load and constant cross sectional dimensions of the 4 completely different sections .The selected sections area unit triangular, rectangular , Trapezoidal and quadrangle. The hook space whereas dynamical the cross section of the 4 completely different sections.The main topic of this study is most stress concentration and deformation estimation of The best cross section of constellation hook. Our estimation is to acknowledge the tendency at the different load condition. at first we have a tendency to examine the utmost stress and deformation of crane hook {for completely different for various} cross section of hook and choosing the most effective cross section for safe style of hook and so examination these results with different material by simulation analysis. at first the model is ready in NX-CAD completely different cross sections by getting ready the flight with the parameters taken from the planning information book. During this project results of analytical calculations is compared with the advanced simulation of NATRAN with constant space of cross section of hook of material. These area unit extremely liable Accessories and area unit perpetually subjected to failure because of the number of stresses elicited in it which might ultimately cause hook failure. so as minimize the failure of crane hook; the strain concentration within the hook should be studied.

1.2 History

movement cranes of the hand operated sort were offered in use since 1880's. regarding this point sophisticated styles of power-driven motion operated were offered by English and yank Engineers and builders, that involve a driving shaft on the runway and multiple clutches for transferring the facility from the driving shaft to the hoist, trolley car or bridge motions. subsequently in every and each business there serious masses lifting conditions the appliance crane hooks square measure takes place

1.3 Varieties of Crane hooks

Laminated hook
Gantry crane hook
Tower crane hook
Forging hook

Overhead cranes hook
Mobile crane hook
Single and double crank hook
Electric rotary hook

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2. Literature review

Mr.M.Shaban [1] have done Stress distribution in Crane Hook by mistreatment Caustic methodology .The complete study is associate degree initiative to determine a FEA procedure. Model was ready in ABAQUS code. consistent with his methodology for reducing the failures of hooks the estimation of stresses, their magnitudes and attainable locations area unit important. From this stress analysis we've discovered the cross section of Georgia home boy stress space. If the world on the inner facet of the hook at the portion of Georgia home boy stress is augmented then the stresses can get reduced. He projected caustic methodology is extremely powerful methodology to notice the strain distribution for classy mechanical parts like hooks. Mr.Joseph Leo .A et. al[2] his examination on Structural analysis of crank hook compared 3 totally {different|completely different} cross sections hooks the strain distribution on y direction of all the 3 different cross sectional hooks, it's obtained that there's increase within the safe load altogether the 3 sections whereas dynamic the cross sectional dimensions. the strain analysis is completed mistreatment ANSYS fourteen.5 work bench. the traditional stress on y direction, deformation on y direction and strain is taken into account and he proved the quadrilateral cross section will with stand most load among the 3 cross sections. Anshuman Purohit et. al(2013)[3] centered on "structural analysis of a crane hook mistreatment finite component method". He purchased a crane hook from the market and done finite component analysis thereon .High strength low steel (HSLA) is taken into account for his paper. at first he performed tension check on the hook in UTM machine in tension to find the world having most stress and to find the yield purpose. at the moment hook is shapely in CAE code having dimension and material just like constellation hook that he was purchased . Finally he compared the results with theoretical analysis. Takuma Nishimura et. al[4] chiefly think about "Damage issue estimation of crane-hooks". He tested the relation between the load condition and its deformation by numerical analysis (FEM) relation is recorded into the info. The feature points area unit detected from the crane-hook pictures wherever these points area unit outlined so as to correspond to the numerical analysis leads to the info. The detected points area unit compared to the relation that the info that have. He defines information is that the force that minimizes the distinction between the feature points of the image and also the malformed nodal position of the info. He used "Bayesian theory" that estimates the distribution of the load condition just in case of that the crane-hooks area unit broken. He offers information wasting the fabric and balance economy. the strain concentration factors ar wide utilized in strength and sturdiness analysis of machine parts. Model of crane hook is developed with the assistance of ABAQUS code of hook done by solid works 3Ddesign tool.regarding the crane-hooks from the estimation result. The load condition lies between the foremost downward purpose and also the tip-end purpose and also the direction is toward the gravity direction.

Mr. A. Gopichand et. al(2013)[5] worked on "Optimization of style parameters for crank hook mistreatment Thaghchi method".In this paper he all over that CI crank hook with Triangular cross section has having minimum von-misses stress comparison to alternative cross sections of crank hook for similar dimension. For the improvement of style parameters he used Taguchi methodology. at first the crank was shapely in PRO/E code. Mr.Santosh Sahu.et al. [6] created a model of crane hook of tetragon victimization CATIA V5R20.Then calculable the placement of stress when Appling the two ton load victimization FEM. They conjointly analyzed the impact of variation long of 2 parallel sides of tetragon seize on stress. Mr.Pradyumnakeshrimaharana.et. al [7] has calculable hook dimensions for varied cross section topology of crank by keeping the depth and cross section space of crank. He concludes from his work that the tetragon section was lest stressed.G.R.Dinesh(2015) [8] worked on the "Design and Determination of Stress Distribution in Crane Hook by Solid works" Stress concentration and displacement in weight reduced hook is least attributable to curve and fillet edges yet as stress concentration distributed uniformly. because of less mass there no chance to avoid

3.1 Causes of failure of crane hook

The most reason for failure in any element is stress concentration in this specific. once plying load on element it subjected to fret concentration and deformation .If the elicited stress of the element is among the elastic limit of the element material it doesn't undergoes any deformation. If the elicited stress within the element exceeds the elastic limit of the element material. The deformation of the fabric starts slowly and cracks are propagates within the material, that ends up in fracture the element. once continuous loading and unloading of element stresses are elicited in it. if the elicited stress exceeds the permissible worth that causes the fracture of the element (failure). The formation of fractures primarily 2 sorts supported cracks propagation within the material. These are

***1)Ductile fracture**: The ductile fracture is principally happens in ductile material. once continuous loading and unloading of ductile element stresses are elicited in it .if the elicited stress exceeds the permissible worth that causes cracks within the element. The cracks propagation is slowly fashioned and that leads fracture the element once reaching the yield strength of fabric.*

***2) Brittle fracture**: Brittle fracture is principally happens in brittle material. once continuous loading and unloading of brittle element stresses are elicited in it .if the elicited stress exceeds the permissible worth that causes cracks within the element. The cracks propagation is suddenly fashioned and that leads fracture the element once reaching the final word strength of fabric.*

3.2 Theories of failure

A mechanical part fails as a result of the applied stresses exceed the material's strength. beneath any load combination, there's invariably a mixture of traditional stresses induced in this part. because of the induced stress there's fracture in some parts yielding may also be thought-about as failure, if yielding distorts the part in such the simplest way that it not

functions properly. To finding the explanations for failure of crane hook vital and what styles of stresses area unit leads the failure of hook ought to be studied by some failure theories .There area unit 5 theories area unit projected by completely different authors to estimate the utmost limiting stress worth for the part according their theories.

Most principal stress theory *Most principal strain theory*
Most shear stress theory *Most strain energy theory*
Most shear strain energy theory

3.3 Material assignment

In engineering application the choice of materials plays a really impotent role. thanks to every and each tiny part works beneath completely different atmosphere, conditions and applications. because of this reason the choice of fabric for part is incredibly vital. Crane hooks area unit worked beneath significant load conditions in engineering application, in grips that abundant of load the Crane hooks area unit to be designed by terribly robust materials. therefore the materials ought to be isotropic in nature and since of it will elongate linearly per stress-strain relation.

AISI4140- solid steel At tempered condition. *AISI4150-formed steel At tempered condition.*
AISI4340-steel At tempered condition *ASTM A 148- steel At tempered condition.*
AISI1340- metal steel At tempered condition

4.10 Specification of crane hook

Winkler-Bach's formulae Bed distance across of hook is 'D' $\boxed{D = X\sqrt{P}}$
Where P = Application of load in KN and X = Constant running between 12 - 14

Unigraphics

Prologue to NX (Engineering) rapidly spreading fire 10.0 is ground-breaking programming used to make complex plans with extraordinary exactness. The structure goal of any three-dimensional (3D) model or get together is characterized by its detail and its utilization. You can utilize the intense apparatuses of NX-Engineer to catch the structure expectation of any mind boggling model by joining knowledge into the plan. When you comprehend the element based, acquainted, and parametric nature of NX-Engineer is intensity of a strong modeler. For selection of cross section Hook model design in Uni-graphics and Analysis of stress and deformation is done by using NASTRAN by applying load 225KN on Crane hook.

5 Advanced simulation (ansys) by NX-Nastran

NASTRAN is basically a solver for limited component examination. Yet, it doesn't have usefulness that takes into account graphically constructing a model or lattice. All info and yield to the program is as content documents. Be that as it may, numerous product sellers advertise pre-and present processors planned on improve building a limited component demonstrate and breaking down the outcomes. These product devices incorporate usefulness to import and streamline the CAD geometry, and work with limited components, and apply burdens and restrictions. NX apparatuses which enable the client to present an investigation to NASTRAN, and import the outcomes and show them graphically. Notwithstanding pre-and post-handling abilities, we have a few NASTRAN sellers have incorporated further developed nonlinear capacities into their NASTRAN items. NX-NASTRAN was planned at first to comprise of a few modules. other words play out a particular assignment preparing model geometry, collecting lattices, applying requirements, taking care of framework issues, ascertaining yield amounts, bantering with the database, and printing the arrangement, et cetera. These modules are controlled by an inner dialect called the Direct Matrix Abstraction Program (DMAP). Each sort of examination accessible is known as an answer arrangement.

Steps involved in FEA: *1.pre-processing 2.Solution 3 Post-processing*

1.pre-processing: *The examiner builds up a limited component work to separate the subject geometry into sub spaces for numerical investigation, and applies material properties and limit conditions.*

2.Solution: *Amid which the program infers the administering lattice conditions from the model and unravels for the essential amounts.*

3 Post-processing: *Investigation and assessment of the arrangement results is alluded to as post preparing. Postprocessor programming contains complex schedules utilized for arranging, printing, and plotting chosen results from a limited component arrangement*

Various Hook models for selection of cross section by NX-Unigraphics

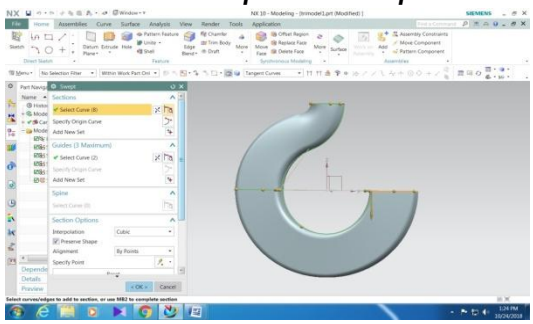

Figure20:Trapezoidal cross section

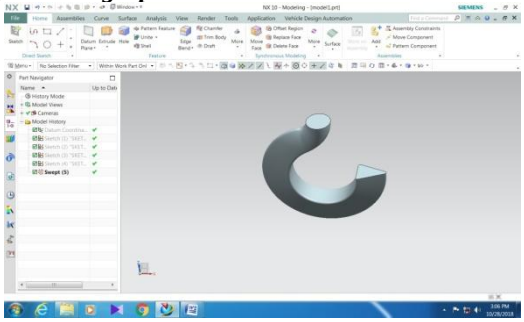

Figure21:Triangular cross section

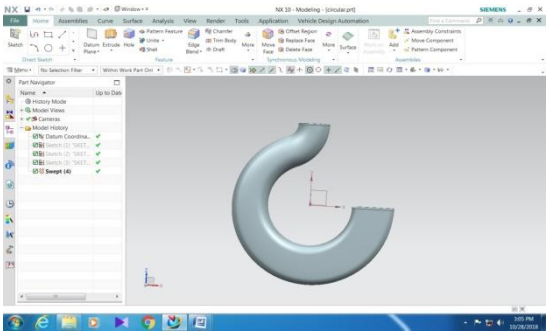

Figure22 : Square cross section

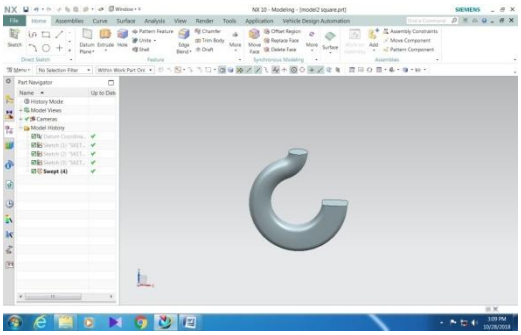

Figure23:Rectangular cross section

Various Hook models analysis for selection of cross section by Nastran on constant load 225 KN

Trapezoidal cross section annsys

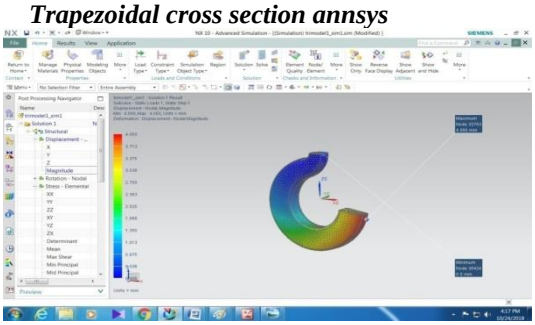

Figure 36: Displacement

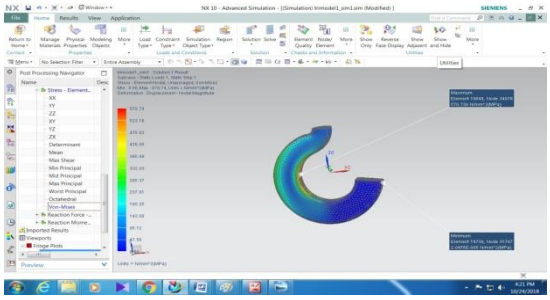

Figure37:Maximum stress

Triangular cross section

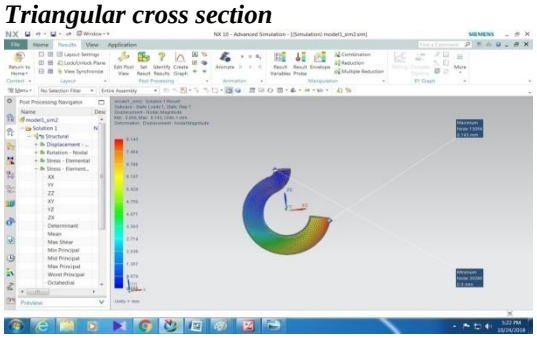

Figure 38: Displacement

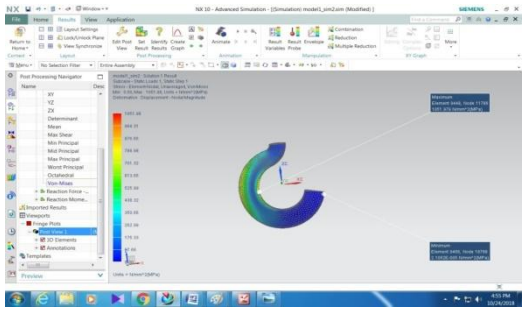

Figure 39 : Maximum stress

Square cross section

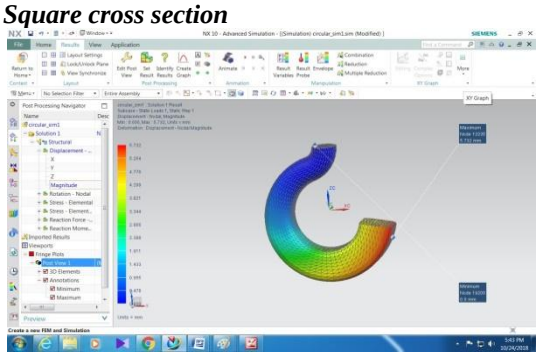

Figure 40: Displacement

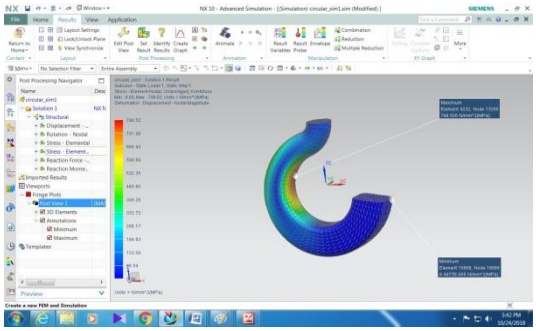

Figure 41 : Maximum stress

Rectangular cross section

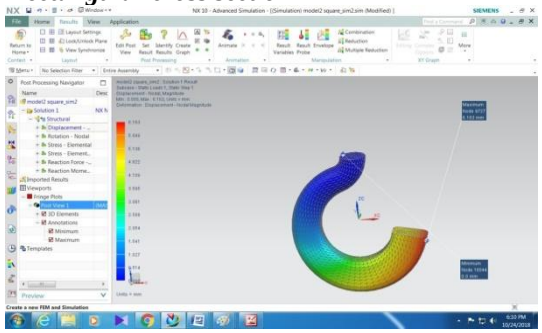

Figure 42: Displacement

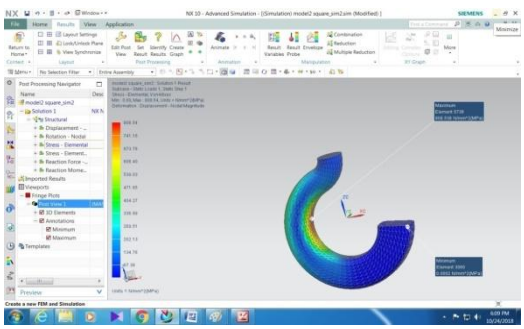

Figure43 : Maximum stress

5.11.5 Tabulated the Analysis Results

HookCross section	*Maximum Von-mises stress in N/mm^2(Mpa)*	*Deformation In mm*
Trapezoidal	*570.739*	*4.05*
Triangular	*1051.739*	*8.143*
Square	*798.52*	*5.732*
Rectangular	*808.538*	*6.163*

Table 1: Different cross section analysis results

Analysis of trapezoidal hook on various alloy steels by Nastran (Advanced simulation)

6.1 Analysis of Trapezoidal crane hook by AISI 4140

6.1.1 Analysis results of AISI4140 at 225 KN

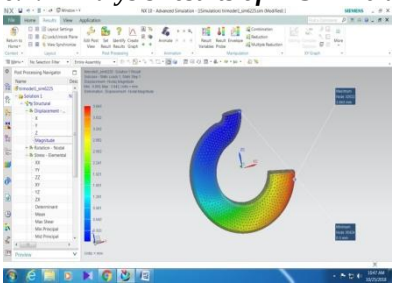
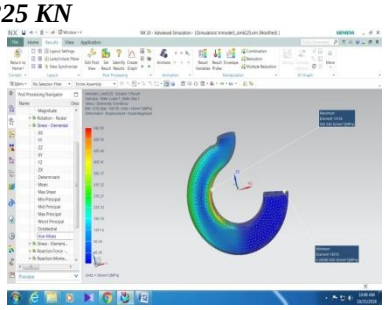
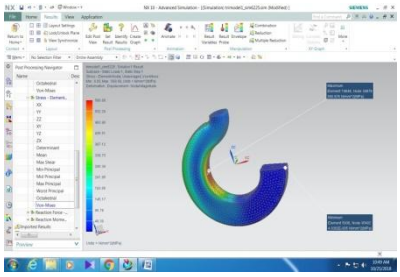

Figure 44 : Displacement Figure 45 : Yield stress Figure 46 : Tensile stress

6.1.2 Analysis results of AISI4140 at 250 KN

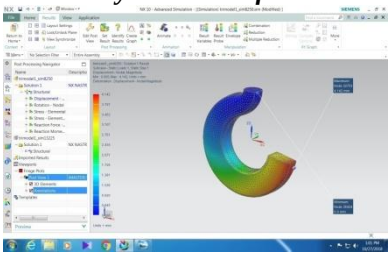
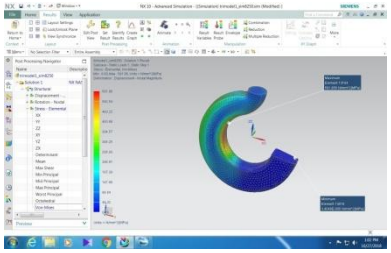
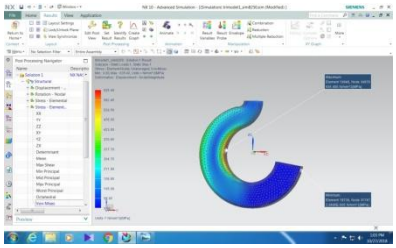

Figure 47 : Displacement Figure 48 : Yield stress Figure 49 : Tensile stress

6.1.3 Tabulated analysis results of AISI4140

Load	*Values*	*Von-mises Yield Stress in N/mm^2(Mpa)*	*Von-mises Tensile Stress in N/mm^2(Mpa)*	*Deformation in mm*
225KN	***Maximum at Node***	*540.548 At 13104*	*580.676 At 34878*	*3.843 At 32753*
	Minimum at Node	*4.0909E-005 At 14616*	*4.0302E-005 At 35402*	*0.00 At 35424*
250KN	***Maximum at Node***	*591.858 At 13104*	*635.400 At 34878*	*4.142 At 32522*
	Minimum at Node	*3.8048E-005 At 14616*	*2.8495E-005 At 31747*	*0.00 At 35424*

Table 2

6.2 Analysis of Trapezoidal crane hook by AISI 4150

6.2.1 Analysis results of AISI4150 at 225 KN

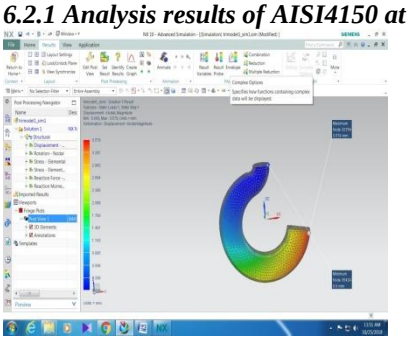
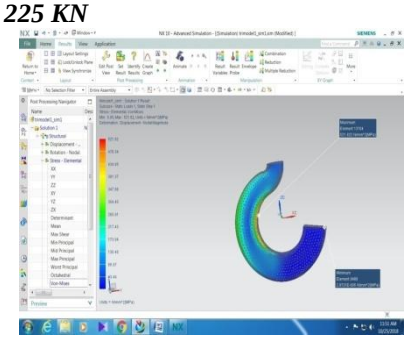
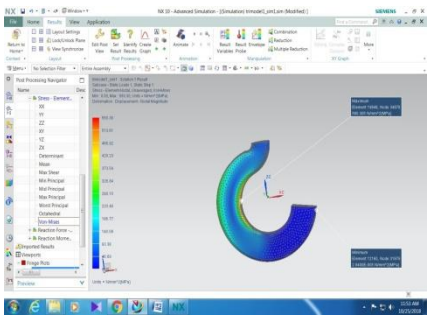

Figure 50: Displacement Figure 51 : Yield stress *Figure 52 : Tensile stress*

6.2.2 Analysis results of AISI4150 at 250 KN

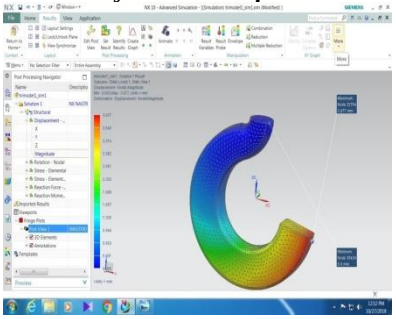
Figure 53: Displacement

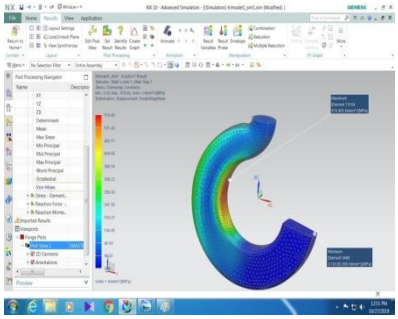
Figure 54 : Yield stress

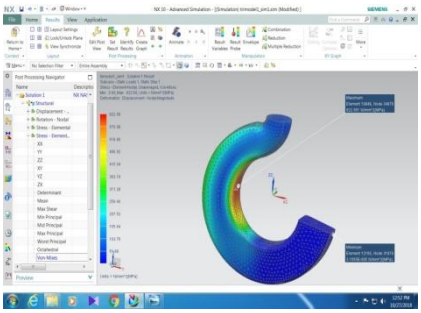
Figure 55 : Tensile stress

6.2.3 Tabulated analysis results of AISI4150

Load	*Values*	*Von-mises Yield Stress in N/mm²(Mpa)*	*Von-mises Tensile Stress in N/mm²(Mpa)*	*Deformation in mm*
225KN	***Maximum at Node***	*521.822 At 13104*	*560.305 At 34878*	*3.579 At 32754*
	Minimum at Node	*2.8721E-005 At 9488*	*2.84001E-005 At 31879*	*0.00 At 35424*
250KN	***Maximum at Node***	*579.803 At 13104*	*622.561 At 34878*	*3.977 At 32754*
	Minimum at Node	*3.1912E-005 At 9488*	*3.1555E-005 At 31879*	*0.00 At 35424*

Table 3

6.3 Analysis of Trapezoidal crane hook by AISI 4340

6.3.1 Analysis results of AISI4340 at 225

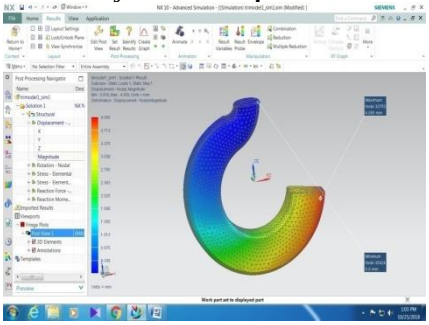
Figure 56: Displacement

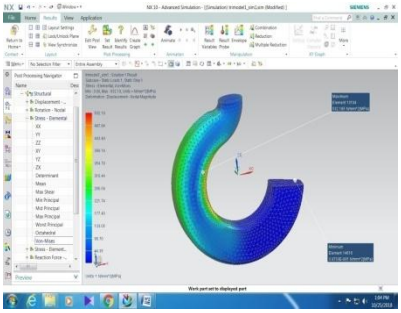
Figure 57 : Yield stress

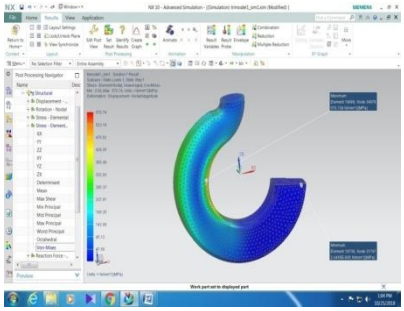
Figure 58 : Tensile stress

6.3.2 Analysis results of AISI4340 at 250

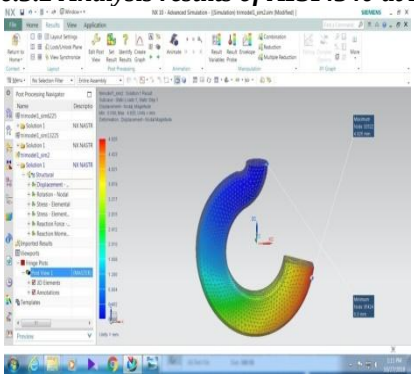
Figure 59: Displacement

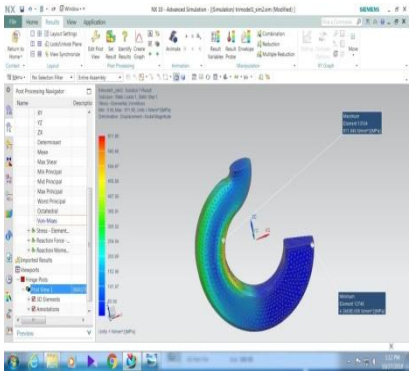
Figure 60 : Yield stress

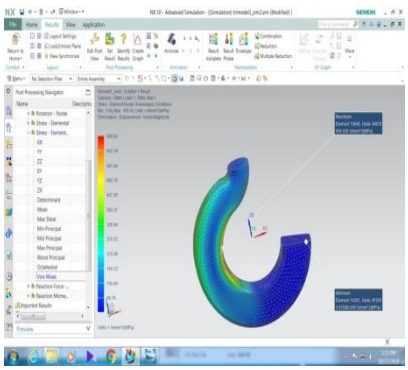
Figure 61 : Tensile stress

6.3.3 Tabulated analysis results AISI 4340

Load	*Values*	*Von-mises Yield Stress in N/mm^2(Mpa)*	*Von-mises Tensile Stress in N/mm^2(Mpa)*	*Deformation in mm*
255 KN	*Maximum at Node*	*532.185 At 13104*	*570.739 At 34878*	*4.050 At 32753*
	Minimum at Node	*3.9733E-005 At 14616*	*2.0455E-005 At 31747*	*0.00 At 35424*
250 KN	*Maximum at Node*	*611.849 At 13104*	*656.928 At 34878*	*4.825 At 32522*
	Minimum at Node	*4.3963E-005 At 12748*	*3.5169E-005 At 35358*	*0.00 At 35424*

Table 4

6.4 Analysis of Trapezoidal crane hook by *ASTM A 148*

6.4.1 Analysis results of ASTM A 148 at 225

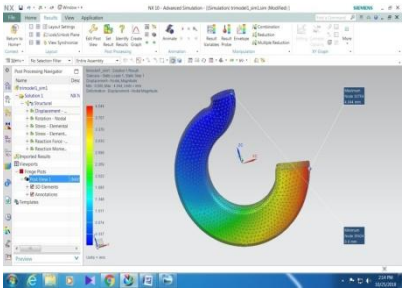

Figure 62: Displacement

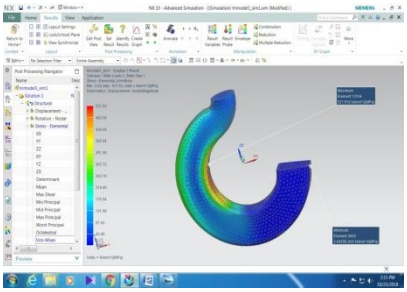

Figure 63 : Yield stress

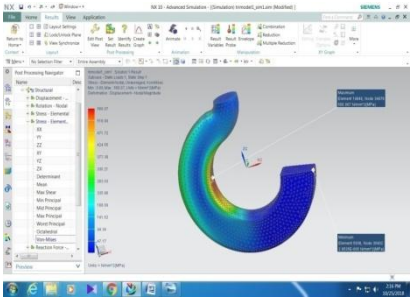

Figure 64 : Tensile stress

6.4.2 Analysis results of ASTM A 148 at 250

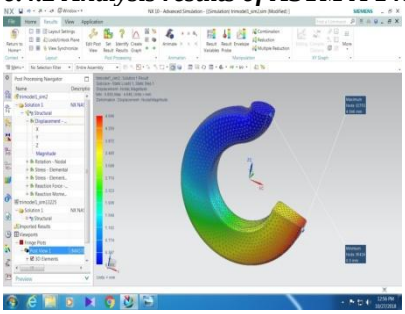

Figure 65: Displacement

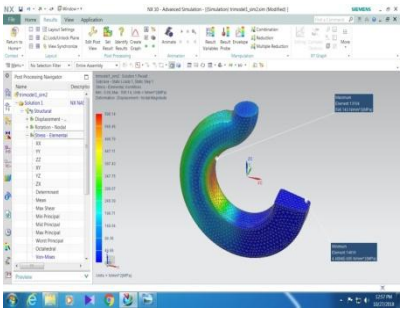

Figure 66 : Yield stress

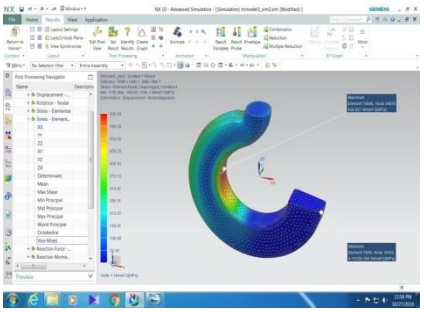

Figure 67 : Tensile stress

6.4.3 Tabulated analysis results of ASTM A 148

Load	**Values**	**Von-mises Yield Stress in N/mm^2(Mpa)**	**Von-mises Tensile Stress in N/mm^2(Mpa)**	**Deformation in mm**
225 KN	**Maximum at Node**	527.519 At 13104	566.067 At 34878	4.044 At 32754
	Minimum at Node	3.8455E-005 At 9802	2.8535E-005 At 35402	0.00 At 35424
250KN	**Maximum at Node**	596.143 At 13104	639.627 At 34878	4.646 At 32753
	Minimum at Node	4.4084E-005 At 14616	4.1522E-005 At 35402	0.00 At 35424

Table 5

6.5 Analysis of Trapezoidal crane hook by AISI 1340

6.5.1 Analysis results of AISI1340 at 225

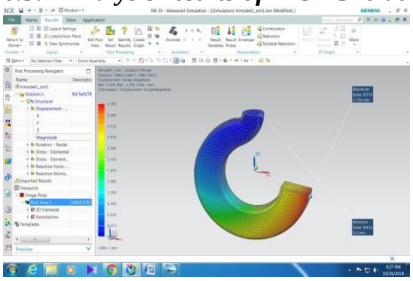

Figure 68: Displacement

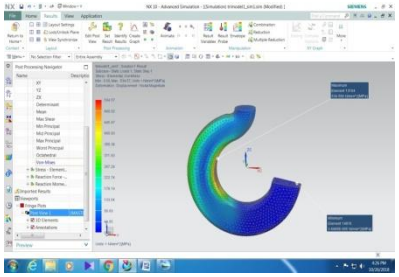

Figure 69 : Yield stress

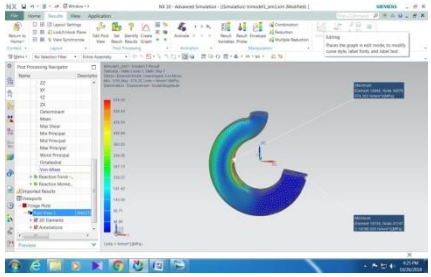

Figure 70 : Tensile stress

6.5.2 Analysis results of AISI1340 at 250

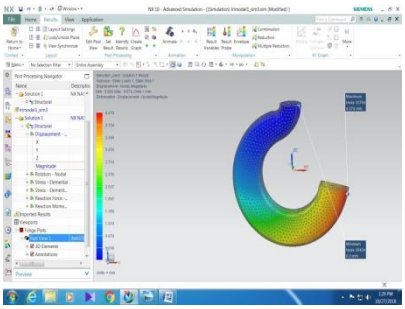

Figure 71: Displacement

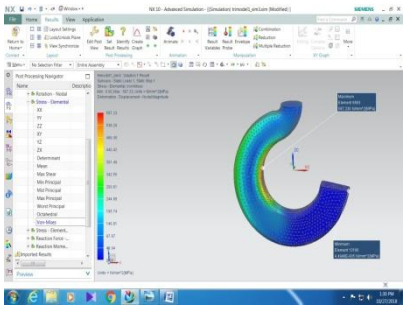

Figure72 : Yield stress

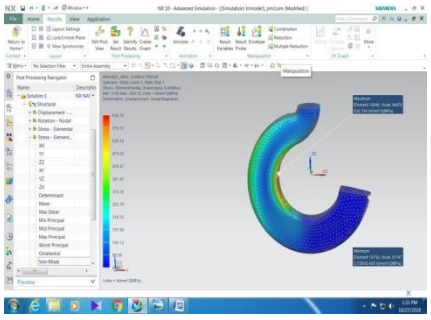

Figure 73 : Tensile stress

6.4.3 Tabulated analysis results of AISI1340

Load	*Values*	*Von-mises Yield Stress in N/mm²(Mpa)*	*Von-mises Tensile Stress in N/mm²(Mpa)*	*Deformation in mm*
225 KN	*Maximum at Node*	*534.568 At 13104*	*574.252 At 34878*	*3.759 At 32753*
	Minimum at Node	*3.6995E-005 At 14616*	*2.1418E-005 At 31747*	*0.00 At 35424*
250KN	*Maximum at Node*	*587.230 At 13104*	*630.704 At 34878*	*4.074 At 32754*
	Minimum at Node	*4.4946E-005 At 12160*	*2.7351E-005 At 31747*	*0.00 At 35424*

Table 6

RESULTS COMPARISION OF DIFFERENT ALLOY MATERIAL

NAME OF THE MATERIAL	*MAXIMUM VON-MISES STRESS in N/mm²(Mpa)*				*MAXIMUM DEFORMATION in mm*	
	Load : 225 KN		*Load : 250 KN*		*Load : 225 KN*	*Load : 250 KN*
	Tensile	*Yield*	*Tensile*	*Yield*		
AISI4140 Forged steel	*580.676*	*540.548*	*635.400*	*591.858*	*3.843*	*4.142*
AISI4150 Wrought iron alloy	*560.305*	*521.822*	*622.561 s*	*579.803*	*3.579*	*3.977*
AISI4340 Structural steel alloy	*570.739*	*532.185*	*656.928*	*611.849*	*4.050*	*4.825*
ASTM A 148 Cast steel alloy	*566.067*	*527.519*	*639.627*	*596.143*	*4.044*	*4.646*
AISI1430 Manganees steel alloy	*574.252*	*534.568*	*630.704*	*587.230*	*3.759*	*4.074*

CONCLUTION

A structure demonstrate was built to robotize the plan of a Lever-activated Crane hook (snare) for lifting heap of 225 KN and 250KN. An utilitarian methodology was received to reason about the capacity of a Crane snare(hook) and afterward to disintegrate its plan into its capacity, conduct and structure. The number, introduction, situation and measurements of the segments that make up the carne snare and which fulfill the capacities and practices' are registered. The structure of the plan show is rehashed for steady load application on various compound steel materials and consistent geometry of the model, yet holding a similar capacity and conduct, the structure display was executed in the Uni-designs 10.0 framework. The limited component examination (FEA done by utilizing NX NASTRAN 10.0 framework

From the investigation of the leaver impelled crane snare we presumed that AISI 4150 Wrought iron compound was subjected to least von-mises ductile worry of 560.305 N/mm2(Mpa) and least distortion of 3.579 mm under the heap of 225 KN and von-mises malleable worry of 622.561 N/mm2(Mpa) and least miss happening of 3.977 mm under the heap of 250KN among the other amalgam steel which are utilized in this paper. From the analysis results we concluded that when applying the load 250 KN the hook subjected to more stress which are very nearer to theoretical stress values this causes damage of hook. But applying 250 KN load the induced stresses in the hook are under the so far the theoretical stress values . So we proposed the modeling hook used in this paper is suitable for loads up to 225 KN.

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