International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 4, Issue 10, October-2018

DESIGN OF NODULAR CAST IRON CULTIVATOR AND ANALYSIS IN NASTRON

M Jayaram[1], B Anjaneyulu[2],

[1]M. Tech student, Dept. of Mechanical Engineering, Gates Institute of Technology, Gooty, A.P.-515401, India [2]Assistant Professor, Dept. of Mechanical Engineering, Gates Institute of Technology, Gooty, A.P.-515401, India

Abstract— Abstract - The application of CAD/CAM in design optimization of agricultural cultivator on the basis of finite element method and simulation method is done by using UG-software for the structural analysis. The weight and strength of agricultural cultivator a compromising is required in the productivity of soils. There are mainly three different soils red soils, loam soils and black soils are present in our areas. The soil conditions were taken to model a better cultivator tool section in tractor-implement systems.

Modifications are required in the existing cultivator for making flexibilities in width of the tools between them. And select hollow section for reducing the total weight of cultivator to improve fuel economy. In my modal 4 number of ductile cast iron hollow rectangular sections for tool, having length 350 mm and thickness 6 mm. The tools were fixed one is to back frame and other is to front frame with two plates by nut and bolt joints. The widths in between the tools were varied and total length of the cultivator is 790 mm, fixed frame is cast iron material for optimization the cost parameter (Ductile cast iron: Rs30/kg, steel: Rs45/kg, alloy steel (40nimocr10-4): Rs80/kg). Ductile cast iron was chosen for better in failure predictions, though it's strength is not enough compared to steels but, this materials are better in the black and loam sands that are not enough stiff in top layers. The seed and fertilizer tubes were also fixed in such a way that the modified section implements such facilities to farmers.

Key Words: Agriculture, cultivator, cultivating tools, Design, Analysis, UG-NX, Ductile cast iron, Hollow Rectangle.

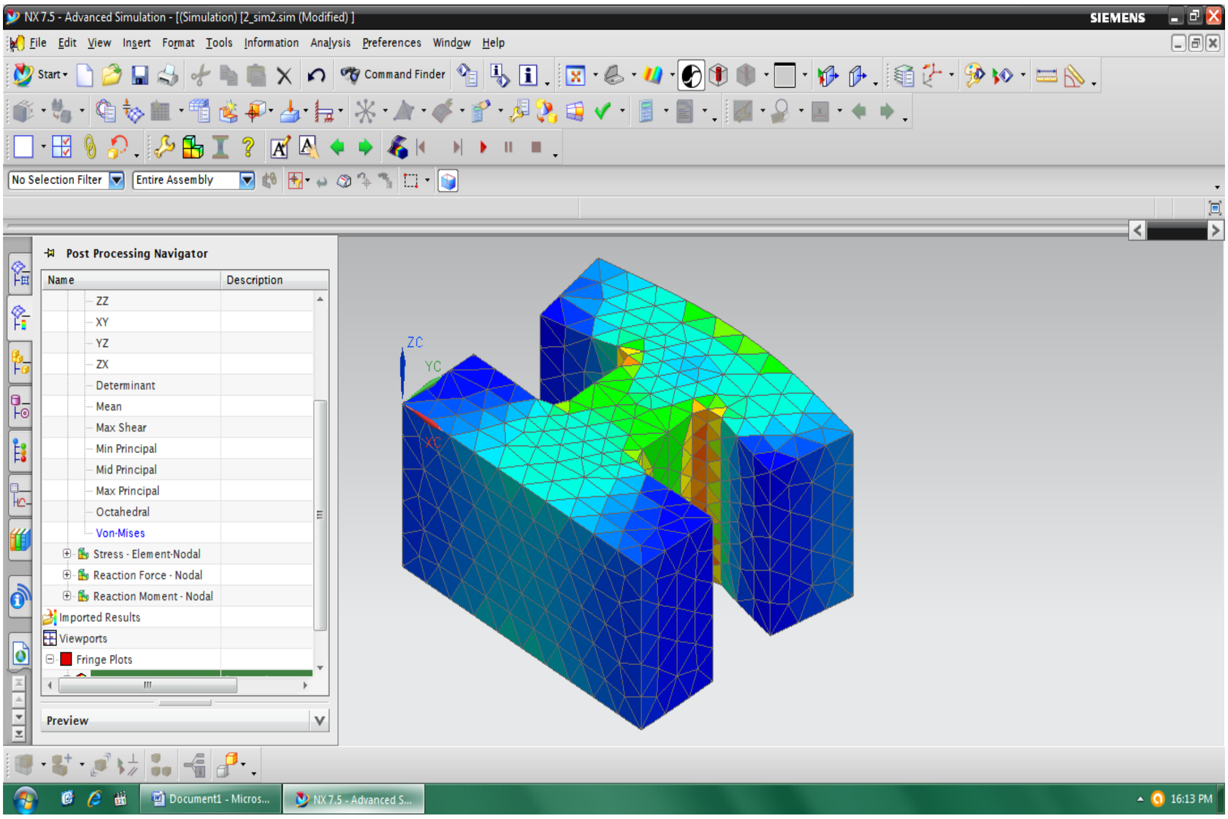
I. INTRODUCTION

1.1 About Cultivator

NX is high-end modelling and designing software systems that are costlier but more powerful. These software systems also have computer aided manufacturing and engineering analysis capabilities. NASTRAN is mainly used for analysis of structures. Different software is used for different proposes. The weight and strength of agricultural cultivator a compromising is required in the productivity of soils. There are mainly three different soils red soils, loam soils and black soils are present in our areas. The soil conditions were taken to model a better cultivator tool section in tractor-implement systems. Existing cultivators was done by providing 5 or 6 number of M.S. plate, length 800 mm and thickness 3 mm. The width of plate in central 600 mm length was 30 mm. These 5 plates were fixed in the cultivator in such a manner that they cover the entire width of 1.8 m and formed 15 cm high ridge. These fixed plates are not preferable if any modifications in the fields or crop lands. Because, while seeding the width of plantation is not fixed, so this cause higher cost of cultivation during prebearing periods. Hence, Modifications are required in the existing cultivator for making flexibilities in width of the tools between them. And select hollow section for reducing the total weight of cultivator to improve fuel economy.

1.2 Design of Solid-I, Hollows Rectangular and Circular Sections

By using NX DESIGN, the three different sections of 3-D models are designed having dimensions 100:100:50mm and analysis was done by NASTRON. The following Results were obtained over a load of 7000N.



Solid-I section

Figure 1

It deforms a Magnitude of 0.00391mm and the Max principle Stress induced in the section is 5121 (MN/mm^2(kpa)).

Hollow Rectangular section

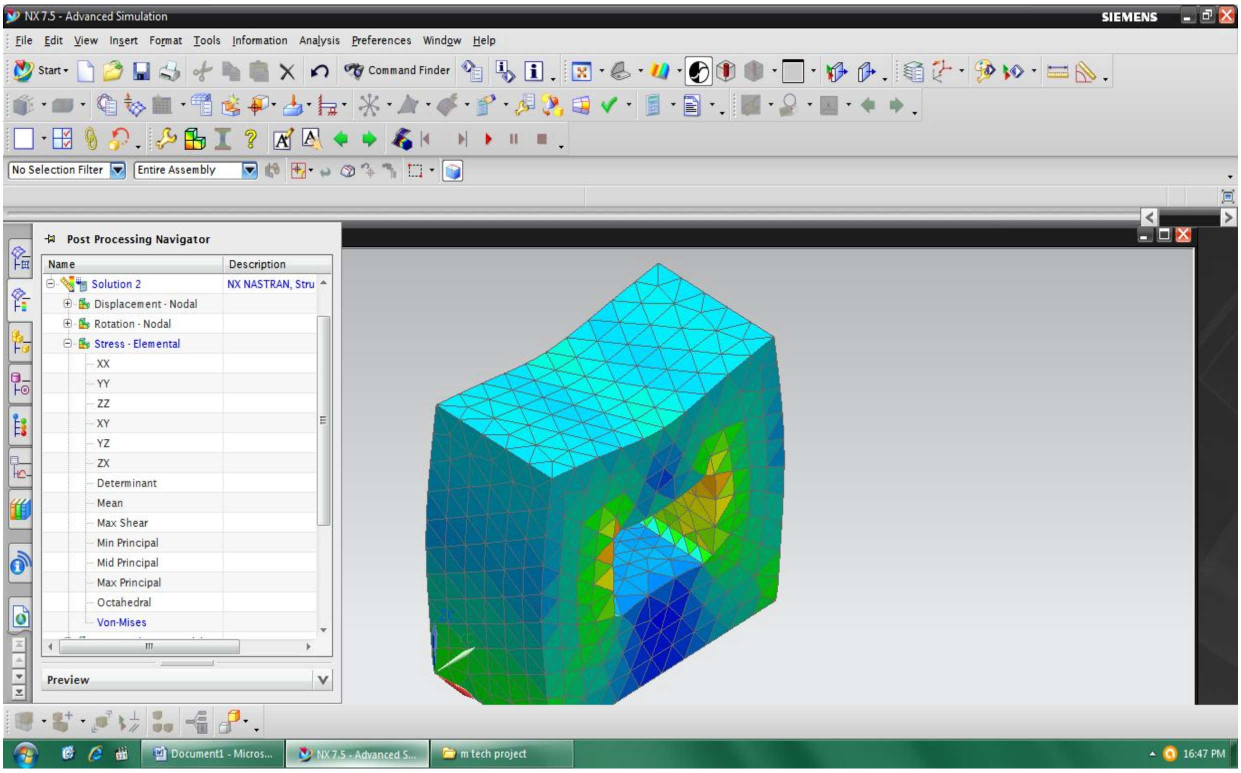
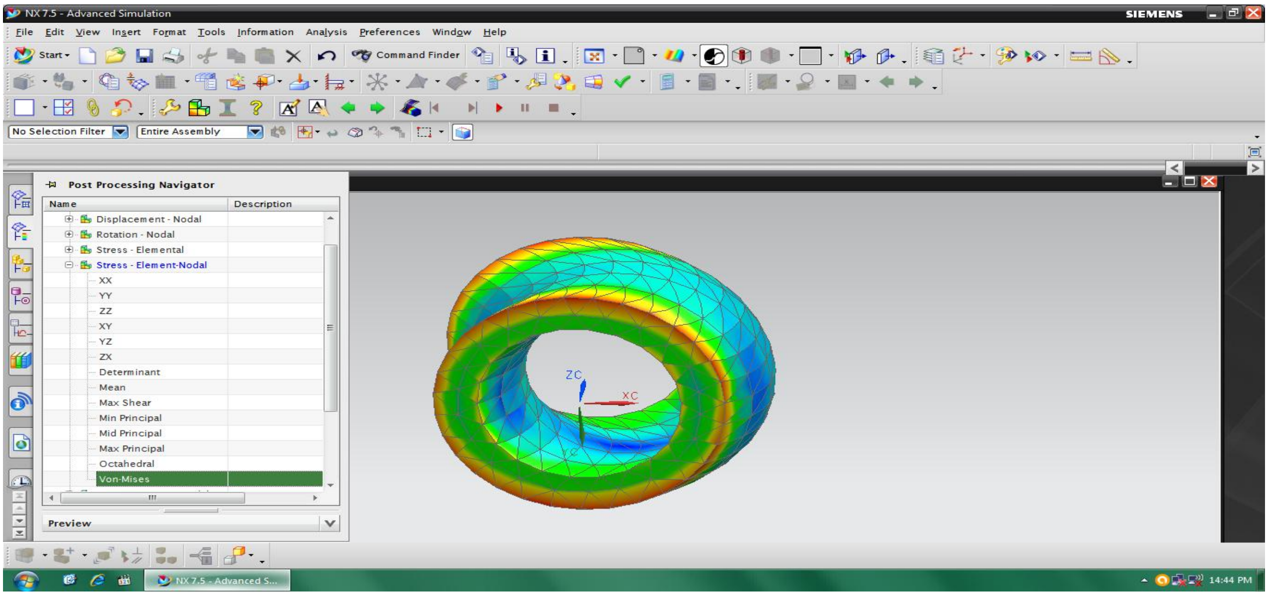


Figure 2

It deforms a Magnitude of 0.001787mm and the Max principle Stress induced in the section is 2668 (MN/mm^2(kpa))



Hollow Circular section

Figure 3

Finally, I can conclude that the "Hollow Rectangular section is also one of the best section for cultivator based on results obtained" in the below **Table 1** and considering cost factor also an account, having flexibilities for farmers by using this type of sections.

It deforms a Magnitude of 0.000251mm and the Max principle Stress induced in the section is 2803 (MN/mm^2(kpa)).

The von Mises yield criterion (also known as the maximum distortion energy criterion) suggests that yielding of a ductile material begins when the second deviatory stress invariant reaches a critical value. It is part of plasticity theory that applies best to ductile materials, such as some metals (Ductile cast iron). Prior to yield, material response can be assumed to be of a nonlinear elastic, viscose elastic, or linear elastic behaviour. In materials science and engineering the von Mises yield criterion can also be formulated in terms of the von Mises stress or equivalent tensile stress. The maximum principle stress is the tensile stress induced in the material, and it is zero when the shear stress maximum.

Type Of Section/Stress	**Magnitude (Mm)**	**Von-Mises Stress (MN/Mm^2)**	**Min Principal Stress (MN/Mm^2)**	**Max Principal Stress (MN/Mm^2)**	**Max Shear Stress (MN/Mm^2)**
Solid–I Section	0.00391	9980	160	5121	5075
Hollow Rectangular Section	0.001787	6674	315	2668	3370
Hollow Circular Section	0.000251	2586	428	2803	1492

Table 1

2. Agricultural cultivator Design and Analysis

In my modal four number of cast iron hollow rectangular sections for tool, having length 350 mm and thickness 6 mm. The tools were fixed one is to back frame and other is to front frame with two plates by nut and bolt joints, while the two middle locations were fixed with a couple of plates orienting on same directions with angle of inclinations to the frame base. The shank geometry was varied with respect to bend angle and bend length. Shank with 300 bend angle and 200 mm bend length gave minimum force at all depth of operation, as compared to other shanks. The widths in between the tools were varied and total length of the cultivator is 790 mm, fixed frame is cast iron material for optimization the cost parameter (Ductile cast iron: Rs30/kg, steel: Rs45/kg, alloy steel (40nimocr10-4): Rs80/kg). Ductile cast iron was chosen for better in failure predictions, though it's strength is not enough compared to steels but, this materials are better in the black and loam sands that are not enough stiff in top layers. The seed and fertilizer tubes were also fixed in such a way that the modified section implements such facilities to farmers. It is most useful in obtaining high weed removal efficiency.

Constructional Details

Hollow type ductile cast iron cultivator consists of following parts.

1. Frame
2. Tools
3. Bolts
4. Nuts
5. Supporting Plates
6. Load Bearing Pins

The constructional details are discussed below.

Frame

Frame of cultivator has to be rigid and strong as all parts are mounted on it. It was made by joining two hollow rectangular iron of size 50 x 80 x 10 mm (cross section). The frame was made by joining two rectangular box section members and four cross members of small sizes to get rectangular shaped frame of 790 x 200 mm size.

Tools

The tools were fabricated by 50 x 60 mm. Two holes of 12 mm diameter were drilled in the tools to fix these with frame with the help of supporting plates made up of steel material 8 mm in thick, bolts each 12 mm diameter made up of steel are used to fix the cultivator to frame.

3. Design Of Cultivator

Modelling for hollow rectangular frame

Procedure to draw the below sketch Insert > Sketch in task environment > Select plane > OK. Insert > Curve > Profile.

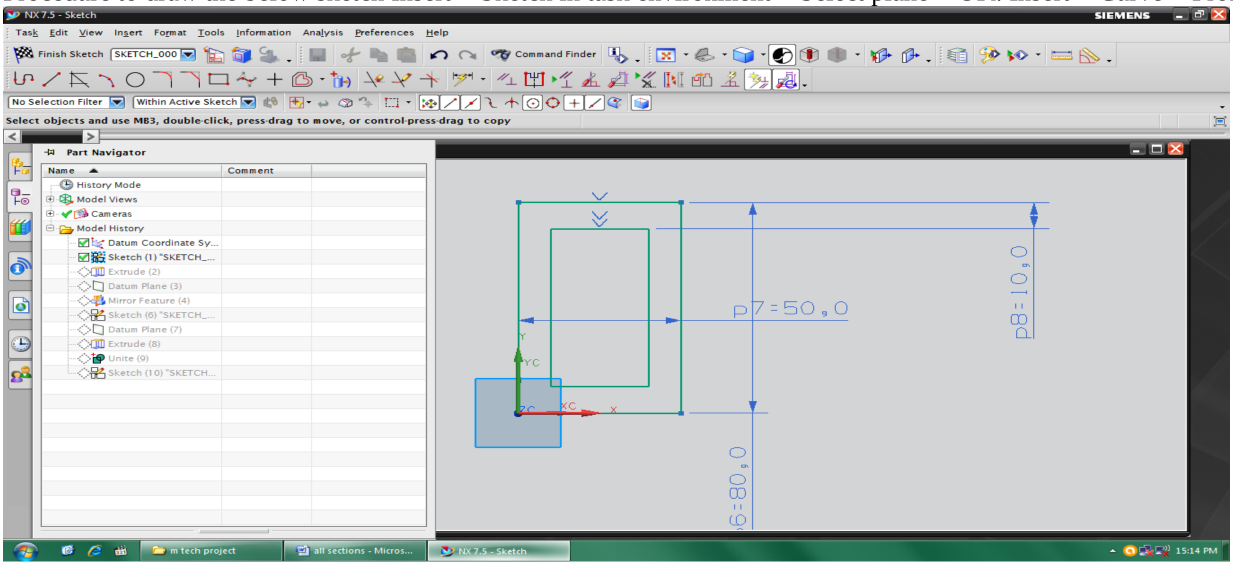


Figure 4

Extrude the sketch

Extrude command is used to create a body by Sweeping a 2D or 3D section of curves, Edges, sketches in a specified Direction. Insert > Design features > Extrude. Select curve > Limits > Start Value (0) & End Value (790) > Specify vector > Boolean operation (None) > OK.

Similarly modelling for cross bars

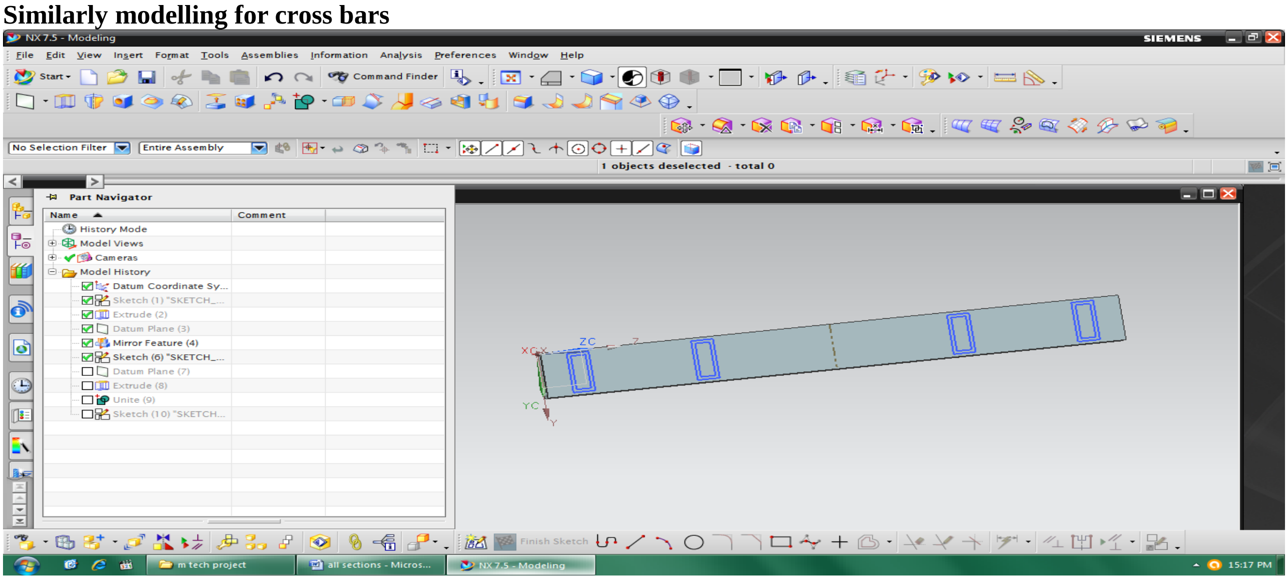


Figure 5

Modelling for tool

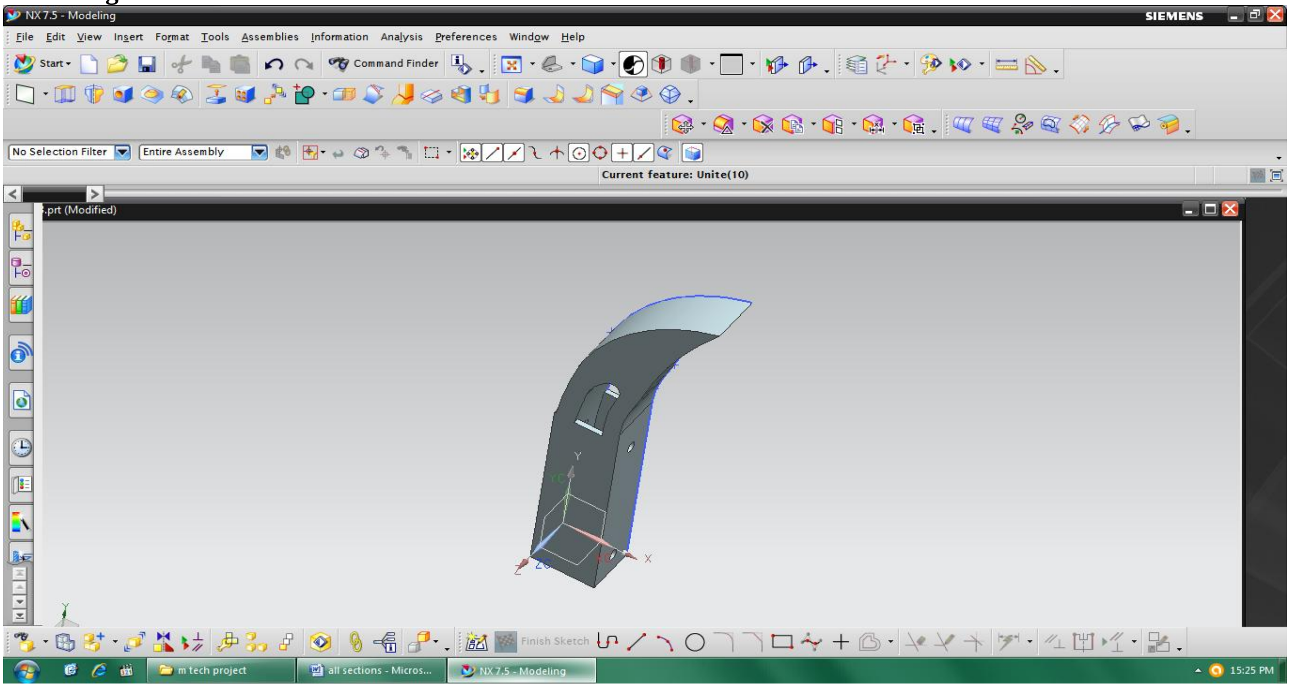


Figure 6

Modelling for bolt

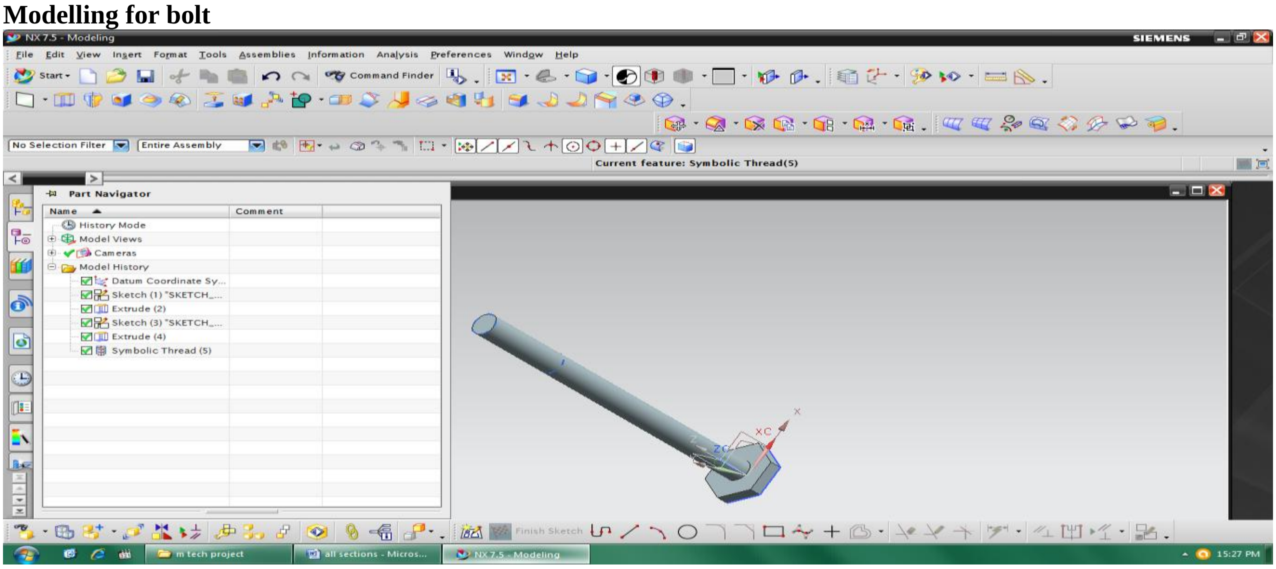


Figure 7

Modelling for nut

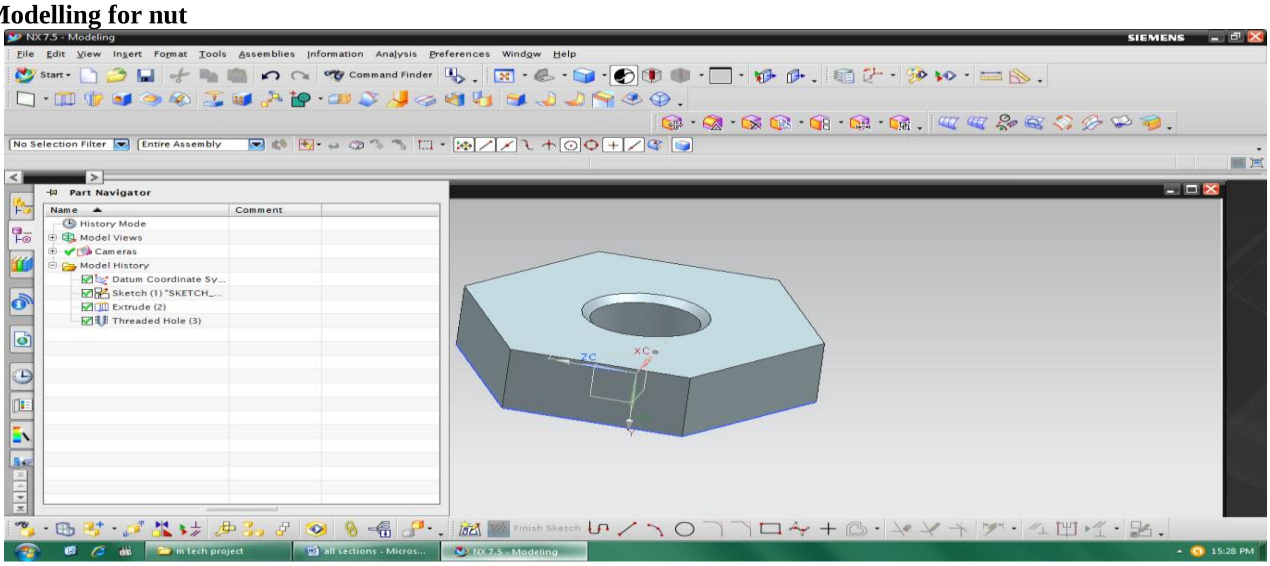


Figure 8

Modelling for supporting plate

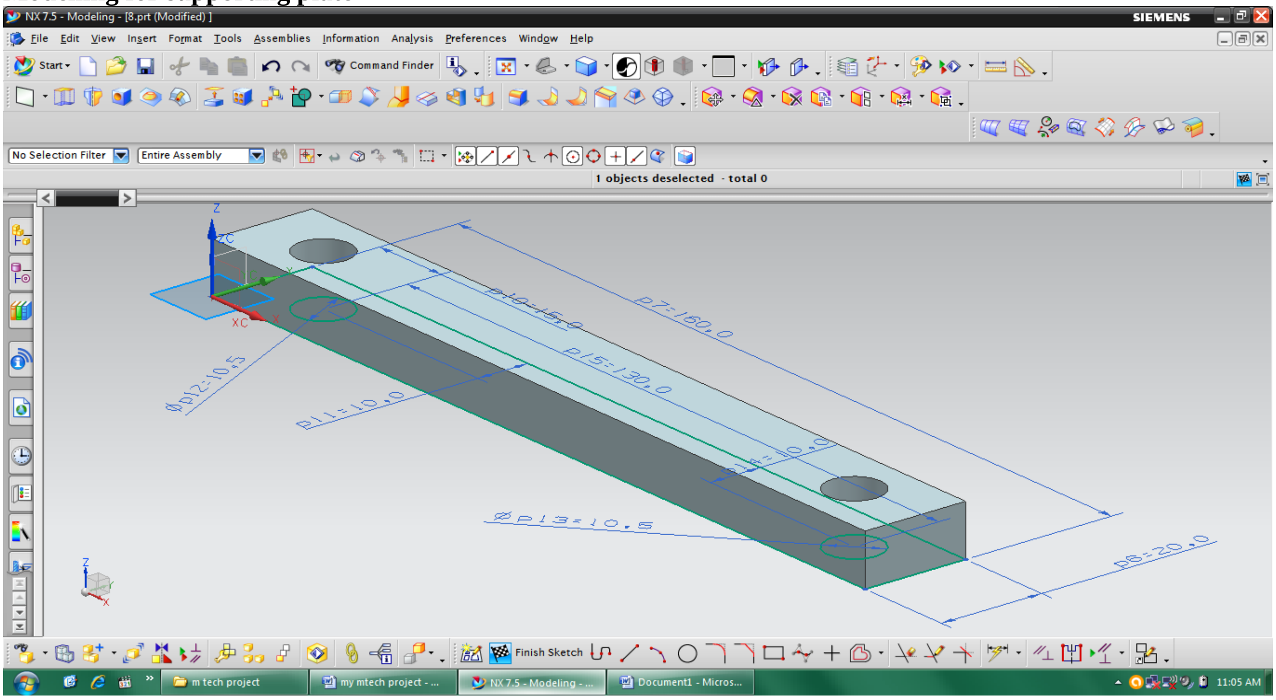


Figure 9

Modelling for load bearing pin

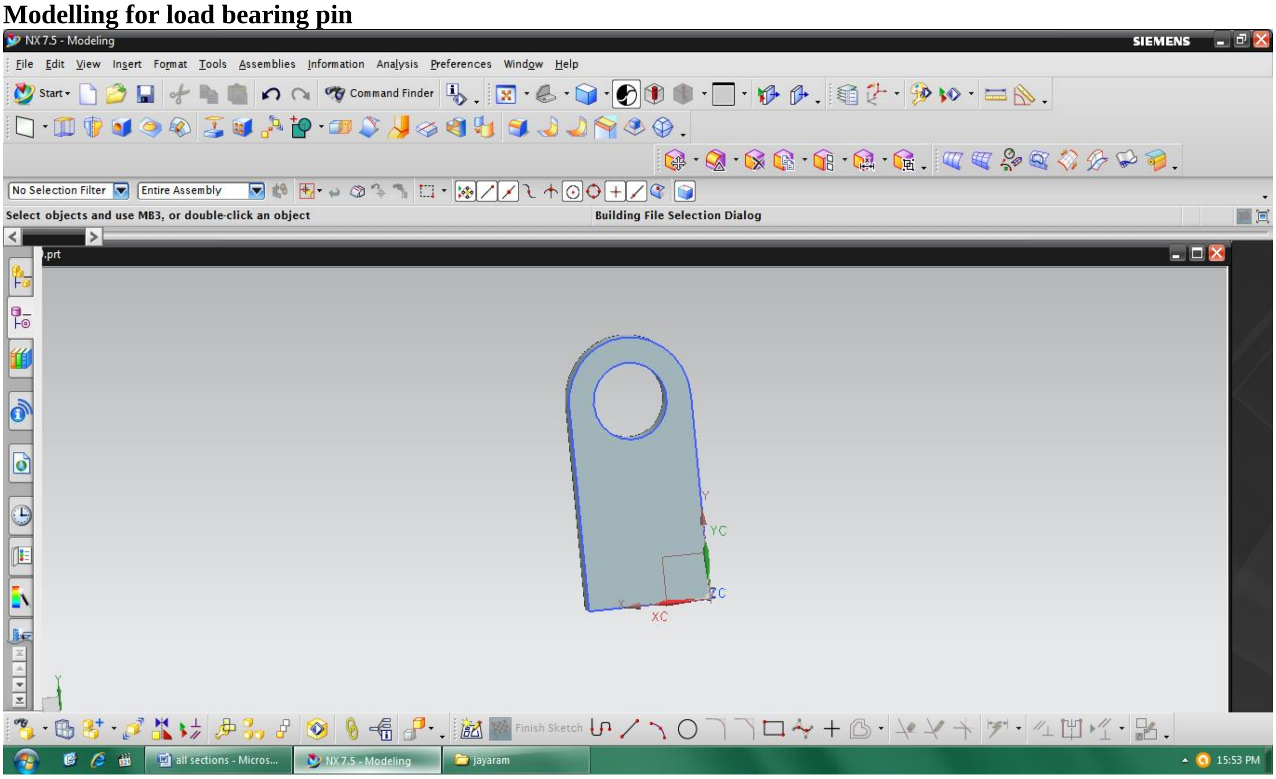


Figure 10

4. Assembly of model

NX7 Assembly could be a half file that contains the individual components. They're additional to the half go in such how that the components are virtual within the assembly and connected to the first half. This eliminates the requirement for making separate memory house for the individual components within the laptop.
All the components are selectable and may be utilized in the planning method for info and practice to insure an ideal work as supposed by the designers. The subsequent figure could be a schematic, which shows however parts are additional to create an assembly.

Adding the frame

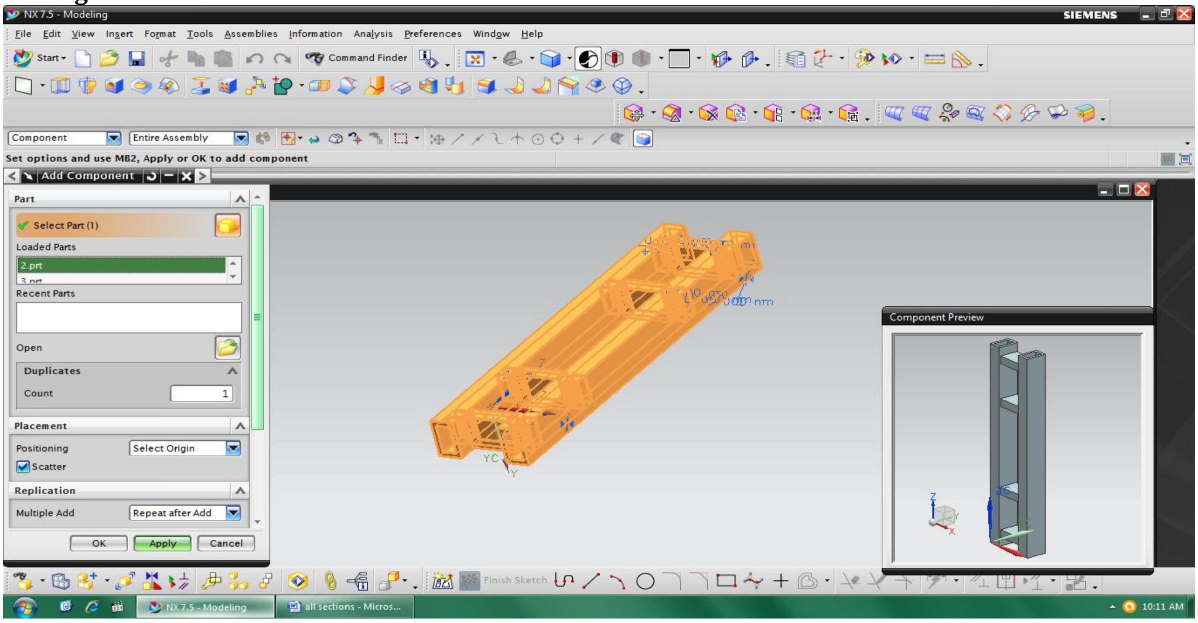


Figure 11

Adding the all components and final assembly

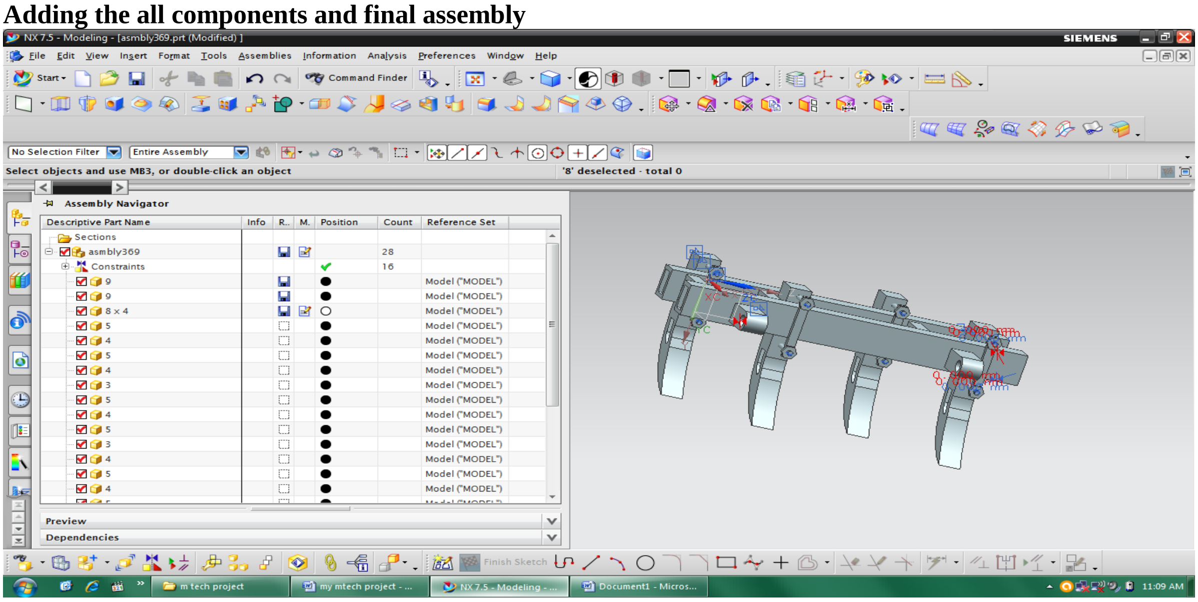


Figure 12

Selecting the material

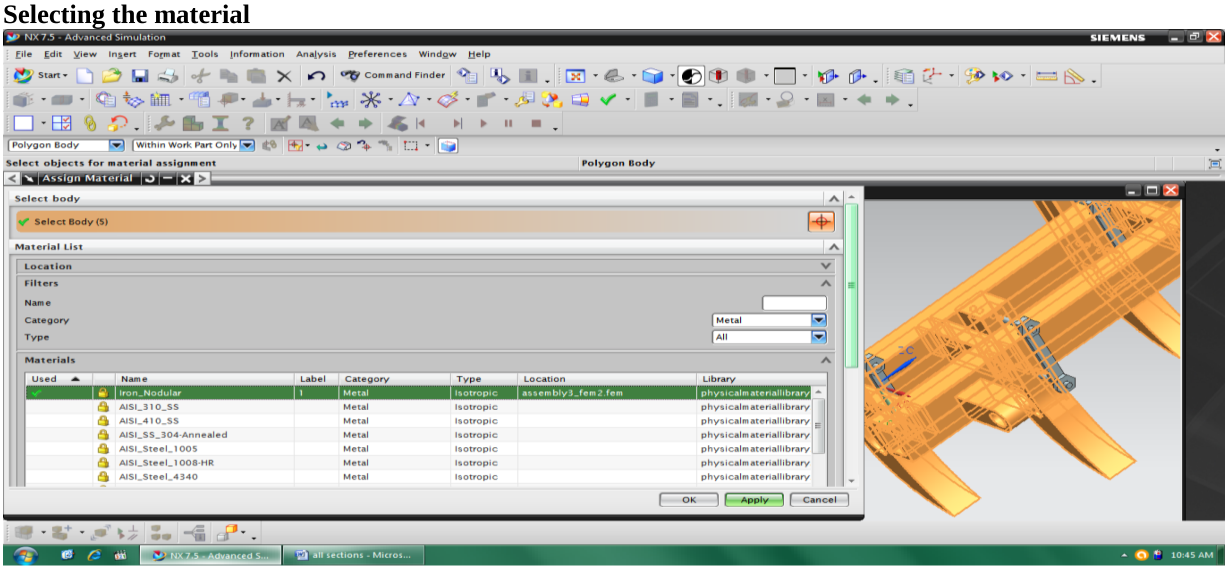


Figure 13

Applying 3-D tetrahedral mesh

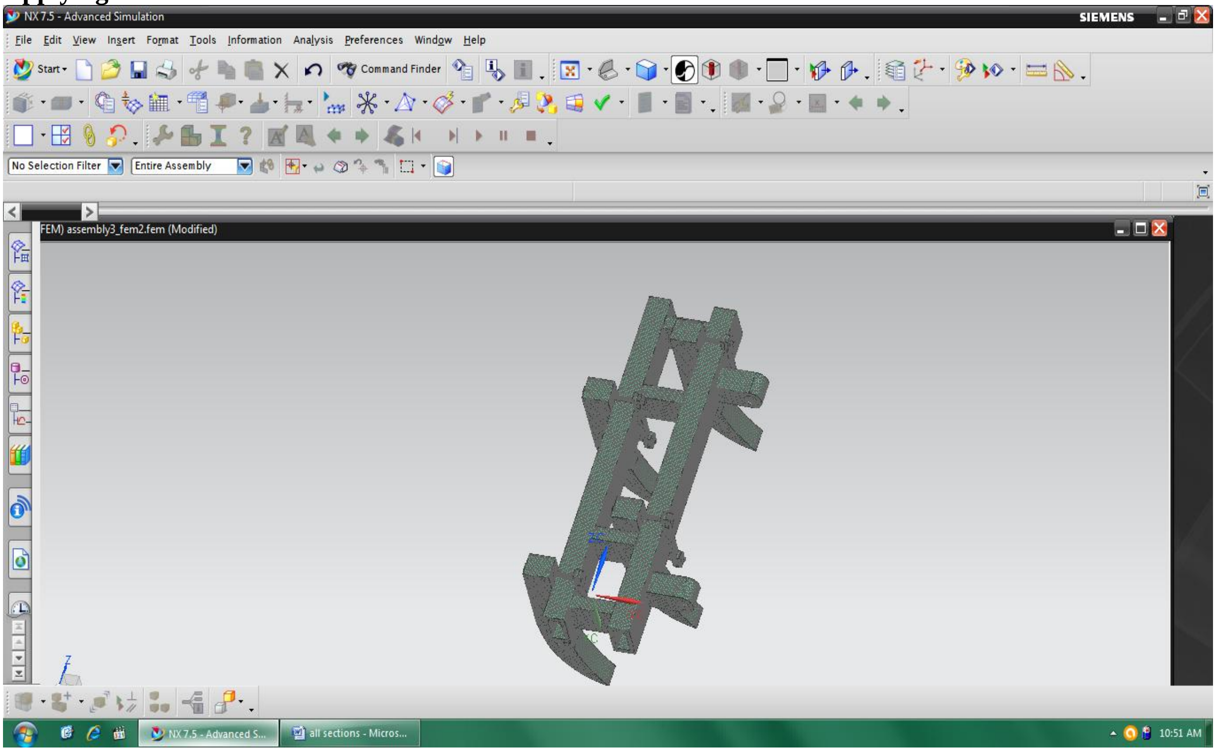


Figure 14

Application of load

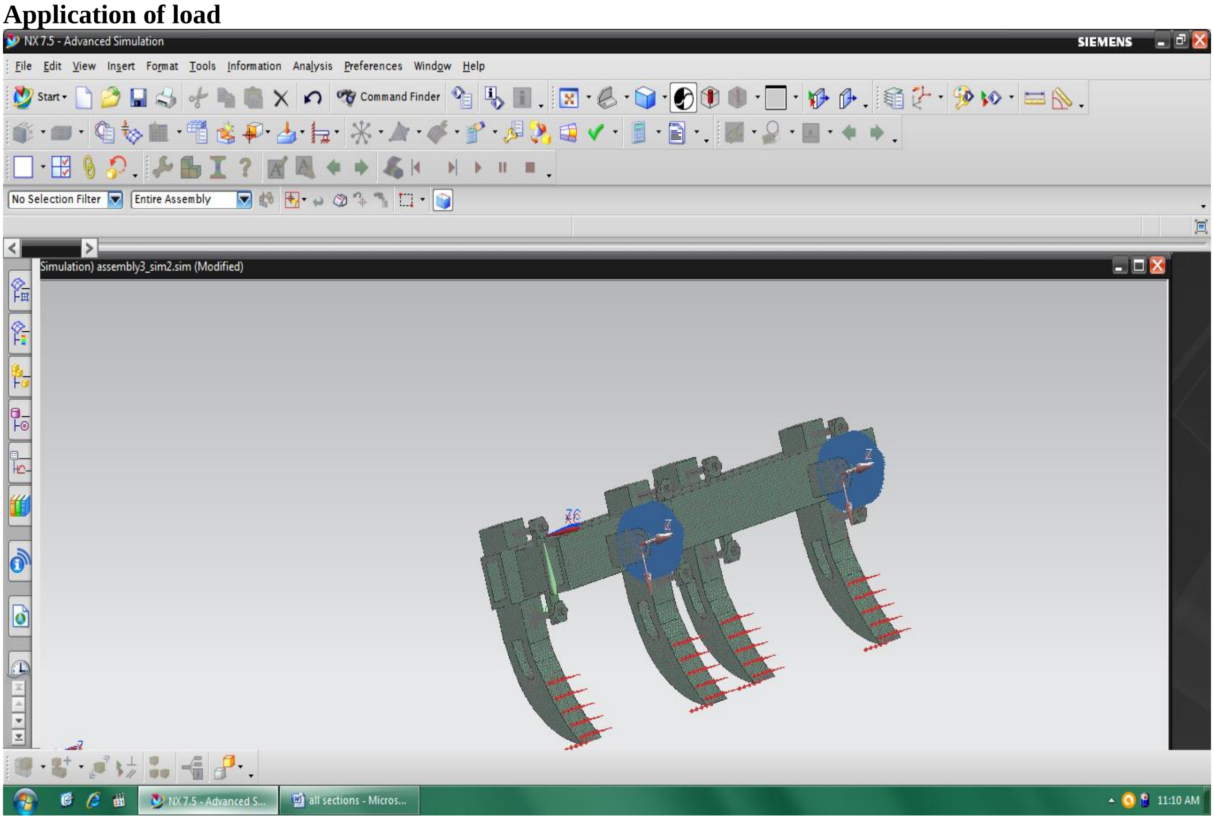


Figure 15

First of all arrest all degrees of freedom to load bearing pin then apply 5000N force to the front faces of four tools at bottom of the tool in the negative Z-axis or opposite to the fixed support.

Solution

Solving the loading model and results obtained as below

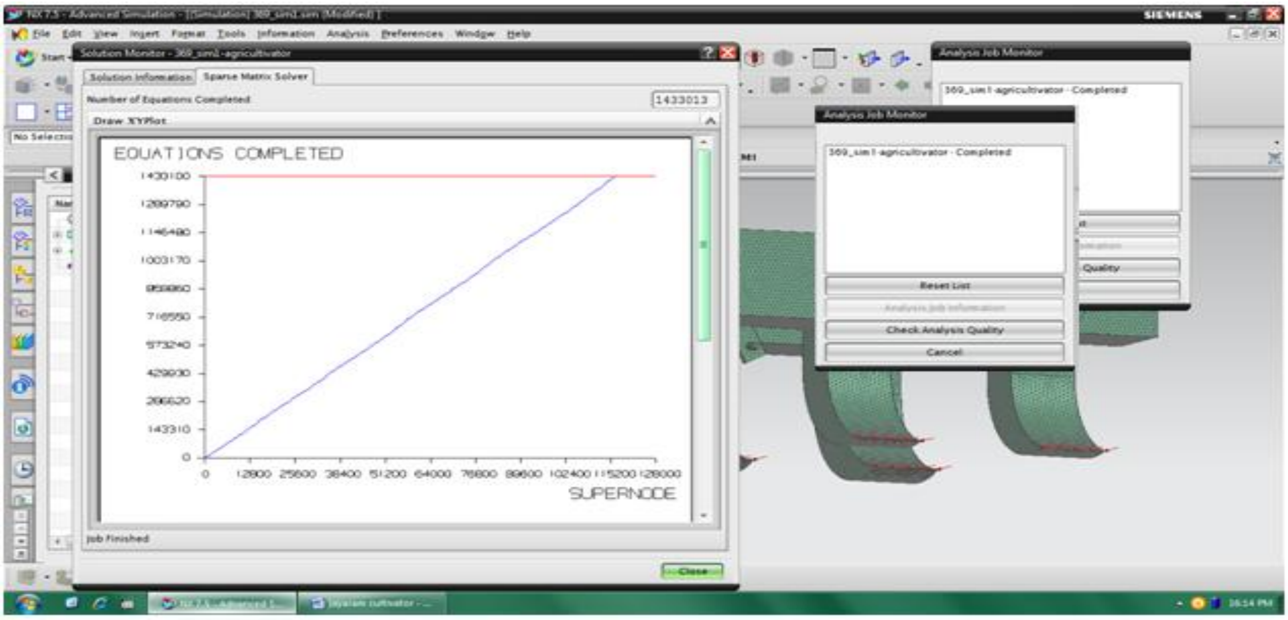


Figure 16

Structural Results

Load Case 1 : Number of Iterations = 1							
	Displacement (mm)				Stress (N/mm^2/(MPa))		
	X	Y	Z	Magnitude	Von-Mises	Min Principal	Max Principal
Max	0.836	0.147	3.958	4.24	464	72.3	506
Min	-2.584	-0.022	-0.282	0	0	-298	-36.8

Table 2

The nodal deformation in Z-axis over a load of 5000N is the maximum 4.242 mm, the elemental stress induced as maximum principle stress 505.66 MPa, maximum shear stress 245.24 MPa and Von-Mises stress is 464.35 MPa. The deformation approximately 0.84mm over a load of 1KN and the maximum shear stress that it can bear 245N but we are applying only 50N so, its factor of safety is 4.9.

5. CONCLUSIONS

As per concerned of the objectives of the present study and results obtained,
Following conclusion can be drowns:

1. Suitable modifications in existing cultivator enable it to make better efficiency and Optimizing cost parameters.
2. Suitable planting mechanism attachment enables us to implement to Perform planting of seeds and fertilizers.
3. The existing implement is capable of withstands over and above a load of 5000N in the agriculture fields.
4. The material used for design of cultivator is sufficient for the loam and black soils but, red soils it may require better strength materials (alloy steels).

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